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FURTHER NOTES ON THE NATURAL REPRODUCTION OF WALLEYED PIKE IN LAKE GOGEBIC

BY

Paul Eschmeyer

Introduction

An intensive study of the natural reproduction of walleyed pike in Lake Gogebic in 1941 has been reported upon in an earlier paper.* The species is of such outstanding importance in Lake Gogebic that the improvement of fishing in this water resolves to a large extent around the improvement of the walleye fishery. Less is known about the life history of the walleye than about most of our other common food and game fishes. For these reasons, and because it was thought highly desirable to re-check certain of the observations made in 1941, further studies were carried on in 1942. These are discussed in the following pages of this report.

Weather conditions during the 1942 spawning season were considerably less favorable for the observation of the spawning of walleyed pike than they were in 1941. Consequently the observations were somewhat restricted.

Nature of Observations

Work during 1942 was divided into several categories. A method of censusing the number of walleyes spawning during a given night was developed. The actual spawning act was further observed. An attempt was made to determine the extent of egg production and fry survival. Further observations were made on the habits of extremely young fry. Development of a technique for photographing spawning fish was attempted.

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*Paul Eschmeyer, "Notes on the Natural Reproduction of the Walleyed Pike in Lake Gogebic", Institute for Fisheries Research Report No. 695, 1941 (manuscript).

Census of Spawning Walleyes

To census the number of walleyes spawning during a given night in Lake Gogebic, ten sections of shoreline, each 500 feet in length, were selected at random within the known spawning grounds. Spawning fish were counted within these representative areas, and the results were applied to the entire 46,600 feet (8.83 miles) of shoreline which the observations in 1941 had shown to be used by walleyes. Except for a few straggling fish along the shore in sections 26 and 35 (T. 47 N., R. 42 W.), the walleye spawning area begins near the south line of section 23 (T. 47 N., R. 42W.) and extends northwest, along the east shore of the lake, to a point about 1/4 mile N. E. of the north line of section 17 (T. 48 N., R. 42 W.). A few isolated walleyes occur beyond this point. Compensation is made for these few fish above and below the principal spawning areas by a section of shoreline, about 1/4 mile in length, in Six-mile Bay, well within the main spawning grounds, which is not used by the walleyes for spawning.

The counting plots for the census of spawning fish were set up in the following manner: at the south end of the spawning grounds, at a point about 250 feet south of the south line of section 23, along the east shore of Lake Gogebic, a muslin flag, 18 x 18 inches, was suspended from a tree hanging over the water. On it appeared the letters 0a, to designate the beginning, or south end, of a counting station. A distance of 500 feet was measured along the shoreline, in a northerly direction, from this point. A second muslin flag, lettered 0b, was conspicuously placed at the end of this distance. From the point 0b, a boat equipped with an outboard motor was run at top speed for a period of 8 minutes, in a northerly direction, near the east shoreline. At the end of this distance, a marker, lettered 1a was placed, and a 500 foot counting station was measured northward along the shore. A flag lettered 1b was placed at its north end. This procedure was repeated along the entire east shore until a total of 10 stations had been established. The tenth station (9a-9b) was located about 1/4 mile north of the south line of section 17, which is an 8 minute interval by motor from the northern end of the known spawning grounds. Both extremities of station 4a-4b, a typical counting station, are shown in Figure 1. For the 46,600 feet of shoreline used by the walleyes, the 5,000 feet of measured shoreline constituted a total of 10.73 percent.

Since walleye spawning is almost entirely nocturnal, a strong spotlight, the current for which was supplied by an automobile battery, was used. The beginning flags for each station were easily found, and a small boat was rowed along the section, about 15 feet from shore. The fish could be very easily counted due to the conspicuous orange-red glow of their eyes, reflected by the light, as shown in Figs. 11, 12, and 13.* (In counting walleyes under such conditions, it is necessary that the observer have his eyes relatively close to the source of light. A person a few feet away from the source of light (e. g., the spotlight) cannot detect the reflection of the eyes).

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*These figures cannot be reproduced at the time. The kodachrome slides from which the figures will be made are on file in the Institute photograph file at Ann Arbor.

Table 1
Derivation of the Estimate of the Number of Walleyes Spawning in Lake Gogebic, in 1942.

Date---	4/23	4/29	5/1	5/5	5/7	5/9	5/12	5/22
Station								
0	1	53		91		38	16	1
1	2	195		87		86	38	2
2		189		187		106	19	5
3				66		72	11	2
4			95	353		164	70	3
5			3	251	211		26	1
6			143	221	142		23	6
7			273	330	273		43	3
8			206	177	179		47	5
9			198	249	128		54	5
Totals	3	437	918	2012	933	466	347	33
Percent of total spawning area in sample		9.87		10.73		10.73	10.73	10.73
Calculated number of walleyes spawning		13728		18751		13038	3234	308

Table 1 shows the number of walleyes counted in each of the sample plots on the various days on which the weather permitted a census. On several occasions, stormy weather interrupted work when the count was only partly completed. On such occasions, the walleyes at the remainder of the stations were counted on the next night of quiet weather, results were combined for the two days, and the census was considered as having occurred on the date between the dates of the two partial censuses.

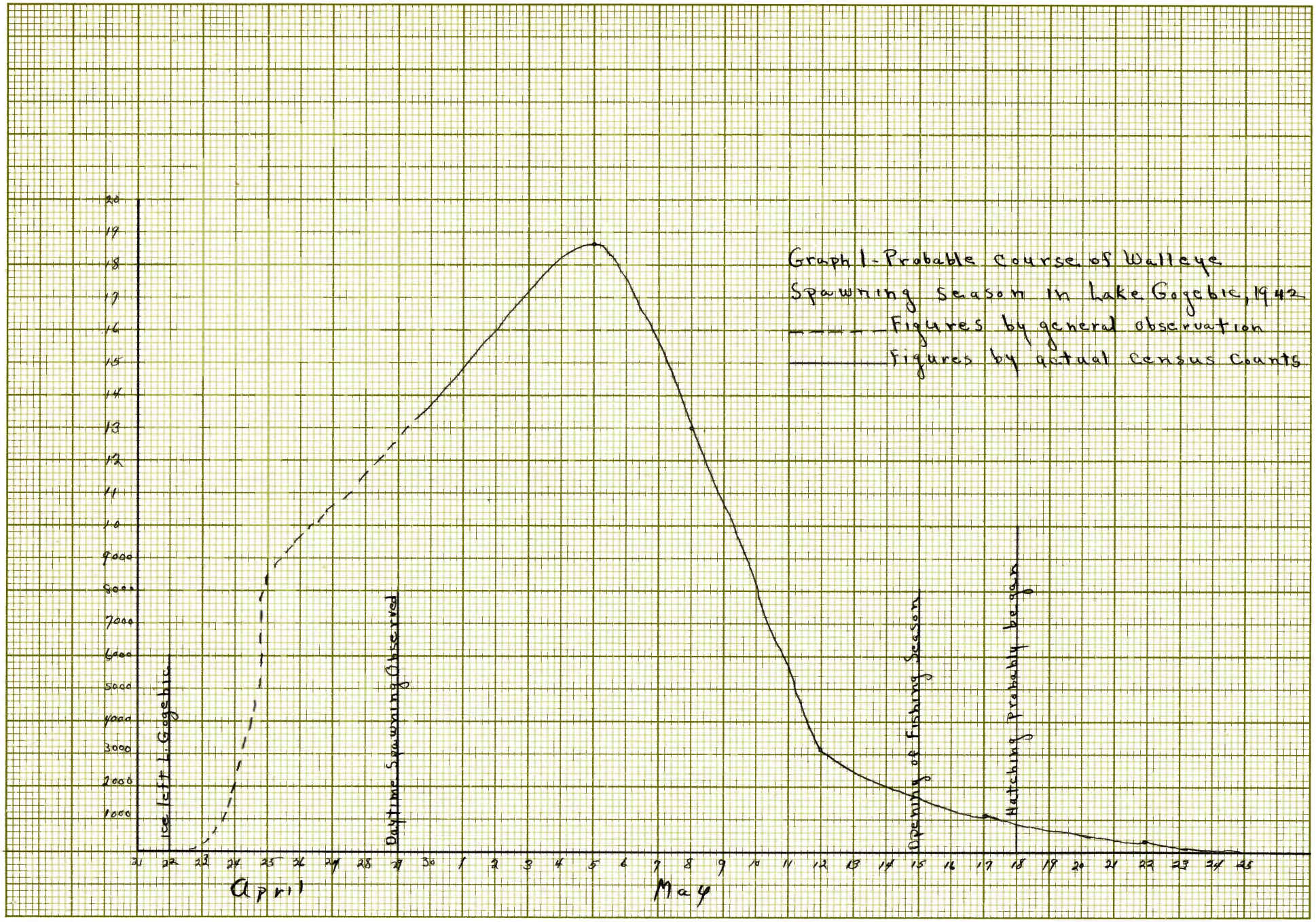
The table shows that walleyes began congregating on the spawning beds in small numbers within a day after the ice left the lake (which was on April 22). Temperature on the shoal areas was already up to 40° F, however. (The census on April 23 is an estimate based on a count of walleyes along 1½ miles of shoreline, which included stations 0 and 1; all other censuses are based on counts within the 500 foot sections described above). Inclement weather prevented the measurement of the 500 foot sections and the completion of a census until several days after spawning had begun. However, by April 25 (shoal water temperature 45° F. at 9 p. m.) walleyes were observed to be spawning quite heavily along much of the east shore. On April 30, in estimated 13,728 walleyes were on the spawning beds. By May 5, this figure had climbed to 18,751. Insofar as can be determined from the available data, this represented the peak of the spawning season. Shoal water

temperatures ranged from 46° to 48° F. By May 8, the number of spawners was estimated at 13,038. Four days later, spawning had decreased considerably, with only 3,234 fish on the shoals. Temperature of water on the shoals had raised from 52° to 55° F. On May 22, spawning was almost completely terminated, with a total of only 308 fish remaining on the spawning grounds, and almost all of these occurring singly. The water temperature at 12:30 a. m. was 50° F.

The figures given in Table I are conservative. The best available map of Lake Gogebic, from which measurements of the length of the east shoreline of the lake were taken, has a scale of 2411 feet to the inch. Many of the indentations of the shore are not shown, and the total actual shoreline would be greater than that shown on the map. As a result, the 5,000 feet of measured shoreline would be less than 10.73 percent of the true total, and the estimate of the number of spawning walleyes should be increased.

It is of interest to note that in the case of station 5, only 3 fish were seen on May 1, while on other dates on which a census was taken, this section compared well with other sections which were censused. This was due primarily, if not entirely to two factors,- the heavy wave action on that night, and the eroding, soft red clay banks which bound much of this section (see figure 2). High waves, in throwing water up against the shore, eroded the bank and caused the water to become greatly roiled from shore outward to a distance of 50 feet or more. Similar conditions prevailed along a short stretch of section 6. Walleyes avoided the entire area thus affected. It is not known whether they sought more suitable areas upon which to spawn, or whether spawning was temporarily postponed. The observation suggests that walleyes show some local (or temporary) selectivity in choosing their spawning areas, just as they show general selectivity in choosing, in most cases, the leeward shore on which to spawn. In Lake Gogebic, walleyes are not known to spawn in areas other than those earlier described, even though equally suitable bottom types occur along much of the west shore of the lake. In Indian Lake, Schoolcraft County, walleyes spawn along a section of shoreline facing the west (Fig. 3) but do not spawn on an immediately adjacent area facing south (Fig. 4). The two shorelines have very similar bottom types (Figs. 5 (west exposure) and 6 (south exposure). In this water, however, this species also spawned along a portion of the west shore, which, though exposed to considerable wave action, does not directly face the apparently prevailing wind (NW).

If the spawning of walleyes, which begins soon after the ice leaves, reaches a peak, and then slowly recedes in intensity, the partly theoretical material shown in graph 1 shows the probable course of spawning activity in Lake Gogebic during the 1942 season. It has not been definitely established, however, that there are not significant temporary fluctuations during the course of the season. Theoretical portions of the curve are based on general field observations at times when no actual census was taken. It is unfortunate that maximum and minimum temperatures are not available for the period concerned. In the absence of a permanent type of installation, no means was found by which a thermometer could be held in place along the wave-swept east shore, without breaking the instrument or jarring loose the maximum and minimum indicators.



Except on May 5, when the census was begun at 9:15 p. m. C.W.T., walleye counts were made between the hours of 10:00 p. m. and 2:00 a. m. To determine whether there was a definite nightly peak in the number of walleyes on a given shoal, which might have some bearing on the accuracy of a census requiring several hours to complete, some intensive observations were made on May 7. Hourly counts were made of the walleyes present on section 7a-7b, from 8:00 p. m. to 4:00 a. m. This section was chosen because it had shown uniformly large concentrations of fish during previous censuses, and would be expected to show the desired information more clearly than a less used section. The results are shown in Table II. (Shoal water temperatures were 48° F. at 9 p. m.)

Table II.

A Census of Spawning Walleyes at Station 7, on May 7, 1942.

Hour (C.W.T.)	No. Walleyes Counted	Hour	No. Walleyes Counted
8 p. m.	0	1 a. m.	234
9 p. m.	110	2 a. m.	273
10 p. m.	247	3 a. m.	247
11 p. m.	232	4 a.m.	222
12 midnight	219		

Table II shows that there was some fluctuation throughout the night in numbers of walleyes present on the spawning beds, but that this fluctuation was relatively light between the hours of 10 p. m. and 4 a. m. It is shown that there is some movement of walleyes to and from a given shoal area, and one may infer that a given group of walleyes may not occupy a given shoal area throughout the night. (However, the fact that the walleyes were driven from the beds each hour may have had some bearing on the fluctuations in number which did occur). If the observation were substantiated by other similar observations, it would show that a census conducted between the hours of 10:00 p. m. and 4 a. m. would be relatively accurate. By 5:00 a. m., it was almost dawn. A sudden squall prevented a census at that time. Observations made near dawn on other dates suggest that the number of fish spawning at that time is greatly diminished.

In the absence of further information, it is probably not correct to use the number of walleyes counted on the spawning grounds to estimate the total population of adult fish in the lake. The average period of time required for a walleye to discharge its sexual products is not known. It seems certain, however, that a female walleye does not remain on the spawning beds throughout the spawning season. On May 3, 8 days after the probable real beginning of the spawning season, but 2 days before its apparent peak, 4 completely spent females were taken with hook and line near the mouth of Trout Brook, about 1/4 mile south of the southern extremity of the known spawning grounds. Four males taken were nearly spent, but still released some milt when pressure was exerted on their sides.

Notes on Spawning Behavior

Although walleyes are almost exclusively nocturnal spawners, several groups of them were observed spawning during the day of April 29. At 1:30 p. m. on that date the lake was very calm, the air temperature was 61° F. and the temperature of the water on the shoals was 56° F. A group of about 40 walleyes was seen spawning, about 100 feet north of station 7b, in water ranging from 2 to 8 inches in depth. The fish were seen swimming leisurely about over the spawning area, until one of them (presumably a female) made a sudden movement. Immediately from 4 to 9 fish (presumably males) rushed to the side of the first fish, and the group swam about in ovals (diameter from 2 to 15 feet) over the shoal. Much splashing occurred as they entered the shallow water, and their fins and backs protruded from the water. After several seconds of such milling about, they became quiet again and continued swimming slowly about over the area covered. The group of about 40 fish was subdivided into several smaller groups which alternately participated in the more vigorous manifestations of spawning behavior just described.

At about 4:30 p. m., a second group of spawning walleyes, just north of counting station 4, was more clearly observed. The group was approached by boat from the lake side. It consisted of 11 fish, presumably males, spaced rather evenly over an area of shoal about 15 feet long by 8 feet wide. They were swimming leisurely about, or were almost stationary when originally observed. Suddenly a larger, slightly darker walleye entered the shoal from the deeper water. Immediately 7 of the males gathered about the newcommer and began swimming about over the shoal. As they swam, they followed immediately behind her, in a manner such that their snouts were about even with her vent. Repeatedly one of the males spurted forward and attempted to get fully alongside the female. Vigorous action followed, with much milling and splashing of the whole group. However, other members of the group retained their approximate previous positions beneath, behind, and even above the female. Except for the individuals which attempted to get alongside the female, no bodily contact could be observed to occur between the female and others of the group. All seemed much excited during the proceedings, and it is believed that all fish in the group were discharging spawn. After a few moments the female left the spawning shoal for deeper water. The males swam leisurely over the area which the female had just covered. It appeared that they might still be spreading milt, as they seemed to be methodically swimming about, tilting their bodies now and then. After 3 minutes had elapsed, either the same or a different female entered the group, and the former process was again repeated. In this case there appeared a definite bend in the body of the female, at the vent, and she was most certainly extruding eggs. These could not be seen, however. After several further observations of the act were made, the area was examined, and hundreds of clear,

apparently freshly laid eggs, were observed.

Although, as reported in 1941, two walleyes apparently sometimes carry out the spawning act, the procedure as above described seems to be the typical method of spawning in Lake Gogebic. From 2 to 10 males and 1 female form a spawning group. Although when observed at night with a spotlight, any action in which the walleyes are engaged is almost immediately stopped when a light is thrown on them, their various positions on the shoals can be readily fitted into the above described procedure. It appears probable, however, that in many cases the spawning activity at night, particularly in water of over 1½ to 2 feet in depth, is less vigorous than that described above. The males follow the female in a more leisurely manner, and no fast swimming occurs. In such cases, the group seems more inclined to swim along the shoal in a more or less straight line, rather than in circles or ovals over a limited area of shoal.

It is thought that the sudden warming of the shoal waters, and the water of the lake in general, acted to increase the desire of some of the fish to spawn to the point where daylight spawning was undertaken.

During the afternoon of May 7, a considerable number of walleyes (about 100) was seen between stations 5 and 7. All were at least 20 inches long, and were seen lying near the bottom, in from 3½ to 5 feet of water, just off the spawning grounds. All had their heads pointed directly or at an angle toward the shoals. For the most part the fish lay absolutely motionless, but fled to deep water when disturbed. No spawning activity was observed, and the fish were not grouped, but appeared singly. Their uniformly large size and their widely distended sides suggested that they were possibly females, awaiting darkness and its attendant opportunity to spawn.

Attempted Studies of Egg Production and Percent of Hatching

An attempt was made during the course of the spawning season to obtain quantitative samples of the egg production in the spawning area. Early in the spawning season, square-yard plots (43.2 by 30 inches) of fine-count cheesecloth (surgical gauze) were placed on the shoals near each end of each of the 10 census stations. The dimensions of the plots were held by a framework of screen-door molding. The plots were carefully covered with boulders and gravel, as described in an earlier report (Institute for Fisheries Research Report #695).

Persistent inclement weather prevented the placement of some of the plots before the season was well under way. A severe storm beached and tore several of the plots, and buried others in sand and debris. Finally the entire attempt was abandoned, and no quantitative measurements of egg production or fertility were made. The nature of the approach to the problem is mentioned here only because it is believed that in a smaller lake, with less wind action or in Lake Gogebic during a year of more favorable weather, it would be workable means of obtaining the desired information. The sample plots should be more strongly made

than here described, however, for best results. Stronger material might be used for the framework, or coarse-mesh poultry netting used to back up the cheesecloth and hold the framework more firmly in place. Sufficient help should be available to put all the plots in place at the first opportunity after the ice leaves the lake. All plots should be lifted at 4 or 5 day intervals and the eggs counted and removed. Some plots will undoubtedly have to be replaced with new structures at the end of such an interval.

In attempting to study the percent of hatching under natural conditions, two cheesecloth "boxes", reenforced with muslin, were constructed, whose bottom dimensions (6feet by 3 feet) were maintained by screen-door lathe (see fig. 7). The sides were about 1½ feet high. When put in place, the sides were collapsed and the entire structures were covered with gravel and boulders. Both were placed in areas in which spawning had been heavy on previous nights. It was hoped that sufficient eggs would be laid on the plots during 1 or 2 nights to permit observations on time required for hatching and the production of fry from a known number of eggs. However, 6 days were required for a sufficient number of eggs to accumulate to warrant enclosing even one of the areas. At the end of this time, a heavy galvenized screen was placed around the exposed 3 sides of the plot (see Fig. 8 or 8a). This served the purposes of preventing further spawning on the plot, and of acting as a support for the cheesecloth sides of the plot, which were lifted and attached to the screen, a few days after the screen enclosure had been completed. The galvenized screen from which the enclosing structure was made was 4 feet wide. It was bent into an L-shape, after being cut to proper dimensions. One arm of the "L" was held upright, to form a side of the enclosure, while the other arm lay along the bottom of the lake, extending away from the plot. After the three sides of the enclosure had been put in place and wired together, boulders were heaped in the portion of the screens lying on the bottom. This procedure very effectively anchored the structure on the hard, rocky bottom, in spite of many severe winds. Heavy wind action soon tore the cheesecloth from the wire screen to which it had been fastened. Two drift logs were thrown against the structure by wave action. Waves were high enough during a portion of the hatching period to throw any fry which might have been hatching, out of the enclosure. The experiment was abandoned after it became apparent that very poor results, if any, would be obtained.

The described technique for studying fry survival evolved in large part from a conference held by the area biologists of the Wisconsin Conservation Department (Messrs. Lowell A. Woodbury, John O'Donnell and Lyman O. Williamson) and the writer on April 3, 1942. It has been described here in spite of the poor results obtained by its use because it is the opinion of the writer that it is a workable means of obtaining the desired information under certain conditions. In a smaller water, or under conditions of calm weather throughout the spawning season, it should work very well, particularly if one were fortunate in placing the plot at a spot where walleyes spawned heavily during the ensuing

night. The sides of the cheesecloth enclosure should extend above the water at least 2 feet and should preferably be of very fine mesh wire, rather than cloth. Very close and continued observation would be required during the time of hatching, and all fry collected as soon as possible, to prevent their destruction by wave action.

Effect of Wave Action on Walleye Eggs

A few observations were made on the possible effect of heavy wind action on walleye reproduction in a lake of the size of Lake Gogebic. On April 27, only 2 days after the walleye spawning got well underway, a severe storm arose while the writer was in the vicinity of station 7. During the storm a small scap (about 8 by 11 inches) covered with bobinette cloth was held just below the surface of the water, and a wave was allowed to wash through it. Inspection revealed that it contained 3 walleye eggs. This procedure was repeated 41 times. On 36 of these times, from 1 to 7 (ave. 2.4) walleye eggs were collected. The tremendous number of walleye eggs which were in suspension all along the east shore of Lake Gogebic, being buffeted by the waves, can only be imagined. It is difficult to believe that large numbers of them were not destroyed in this manner. Many viable eggs were found among those collected during the storm, although non-viable eggs were present in a greater proportion than they are in a normal run of eggs, as collected from undisturbed spawning grounds. By May 1, a very slight wave action (as shown in Fig. 9) was sufficient to bring large numbers of walleye eggs into suspension. However, most of these were dead. On May 22, unbelievable numbers of walleye eggs were found among bits of debris in Six mile Bay and other small bays along the east shore, where it is known that walleye spawning did not occur, to any appreciable extent. No viable eggs were found, however, suggesting that dead eggs, with their lighter density, are most affected by wind action. However, it appears probable that heavy wind action occurring during the spawning season may cause heavy egg mortality.

During nights when there is considerable wave action, the waves sometimes wash spawning walleyes over boulders which, during quiet weather, have their surfaces exposed. In some instances, perhaps, waves capture eggs just as they are being laid and wash them up against such rocks. On the night of May 1, walleyes were spawning quite heavily near shore. Each wave washing upon the shoals moved them sidewise for from several inches to a foot or more but they gently coasted with it and continued swimming along, apparently spawning. On the following day it was found that, in some cases, freshly laid walleye eggs adhered to portions of boulders which extended entirely above the surface of the water, being washed by only occasional waves. Seventeen eggs were counted on the protruding area of 1 such rock, while 27 were found on another. Many eggs adhered to rocks and debris under water, but no such egg has yet been observed to be fertile. Eggs which are so fastened decay there, in all cases yet observed. One eyed egg thought to be adhering to a boulder was found to be held in place by moss growing on the rock, and was not attached by its own substance.

Hatching of Walleye Eggs and Behavior of Fry

Walleye eggs were first observed to be hatching on May 21. A number of empty shells were found, permitting the assumption that some hatching had occurred for perhaps several days before this time. A number of eyed eggs were collected on the shoals, by waving a small mesh bobinette scap through the swirl produced by a quick movement of the foot along the rubble bottom. When placed in a 2 qt. jar they soon began hatching. In hatching, in 7 out of 8 cases observed, the tail and part of the body breaks out of the egg as a direct result of vigorous movement of the walleye within the egg. The walleye spirals upward toward the surface, wearing the shell as a hood, and then settles to the bottom again for a short rest period. It swims with limited vigor for the first few minutes, but soon gains amazing strength. Within a minute of the time it first breaks loose from the egg, it is able to shake its hood from side to side rather violently, and to move its body forcefully, in its attempt to obtain release from the hood. In the observed cases, from 1 to 7 minutes were required to shake off the hood. Once entirely released from their shell, the fry swim vigorously (though with frequent rest periods at first), with their snouts up against the surface film. Temperature of the water in which hatching took place ranged from 53° F. (on the shoals in the lake) to 60° (after 15 hours).

One walleye fry, (not hatched in the jar) was seen to spiral up from the shoal bottom, almost reach the surface, and then drop down again. It had no hood. Extensive search was made in protected areas near shore to determine whether any young walleyes lurked there, but not a single fry was seen. One was observed, however, about 20 feet from shore, barely under the surface film, swimming vigorously out toward the center of the lake. No others could be found behaving similarly, so 4 fry which had just hatched in the 2 qt. jar mentioned above were released about 3 feet from shore, over about 8 inches of water. One struck out for deep water immediately. Two swam in circles and wandered about for a few minutes, but suddenly seemed to get their bearings and struck out for deep water. They were lost from view at wader depth. The fourth was lost while similarly circling about. All remained just under the surface film while moving about. It appears probable from these observations, and from the absence of concentrations of fry near shore, that the fish strike out for deep water almost immediately after hatching. The stimulus which causes them to react in this manner is not known. Walleye hatcheries utilize the apparent tendency of the fry of this species to follow a current, but there appeared to be no such surface current at the time the above observations were made. The gentle shoreward wash of the waves may have in some manner caused the observed reaction.

Photographing Spawning Fish

An attempt was made to photograph spawning walleyes. This was not successful insofar as the procurement of any clear pictures of fish engaged in the spawning act is concerned. However, a few notes on a

potentially successful procedure might be of value. To obtain figure 10, a 35 m m, camera, with kodachrome film, was mounted on a tripod and set up on a bank about 4 feet above the surface of the water. Before dark, it was focused on a point where the walleyes were known to have spawned heavily on previous evenings. Branches of trees and other obstructions were removed from the camera field. After dark, the shutter was opened momentarily, while a single No. 21 mazda photoflash bulb, in a small reflector, was flashed. The shutter opening used was 2 stops larger than that advised for indoor shots on the circular provided with the film. One stop compensates for outdoor conditions, while the second seems necessary to insure water penetration.

Photographs taken while any wave action is present or at too great an angle, as from a boat or while wading, generally lack detail, as shown in Figs. 11, 12 and 13. These figures show the characteristic glow of the eyes of this species which makes its census with a spotlight, as earlier described, possible.

INSTITUTE FOR FISHERIES RESEARCH

by Paul Eschmeyer

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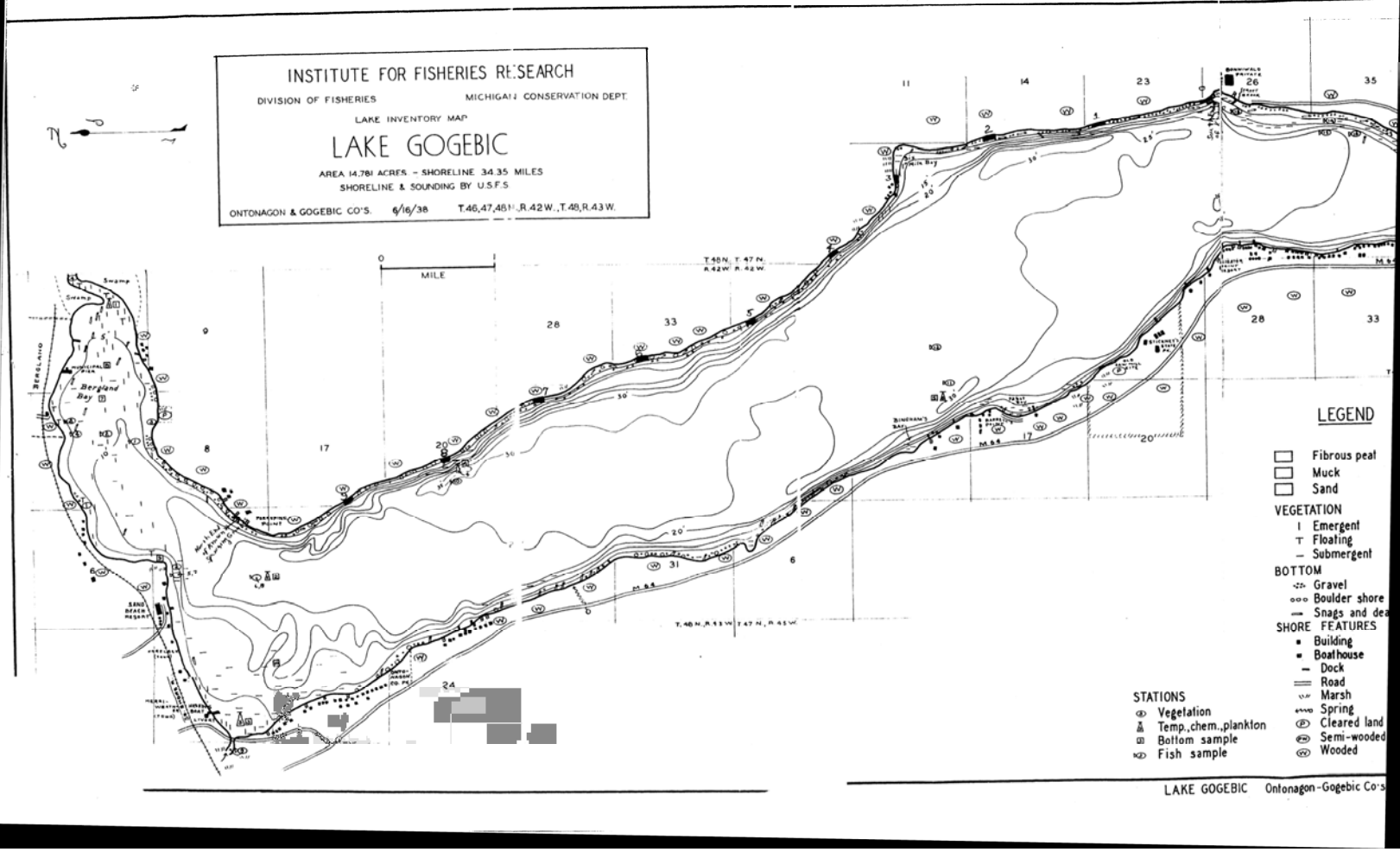
INSTITUTE FOR FISHERIES RESEARCH
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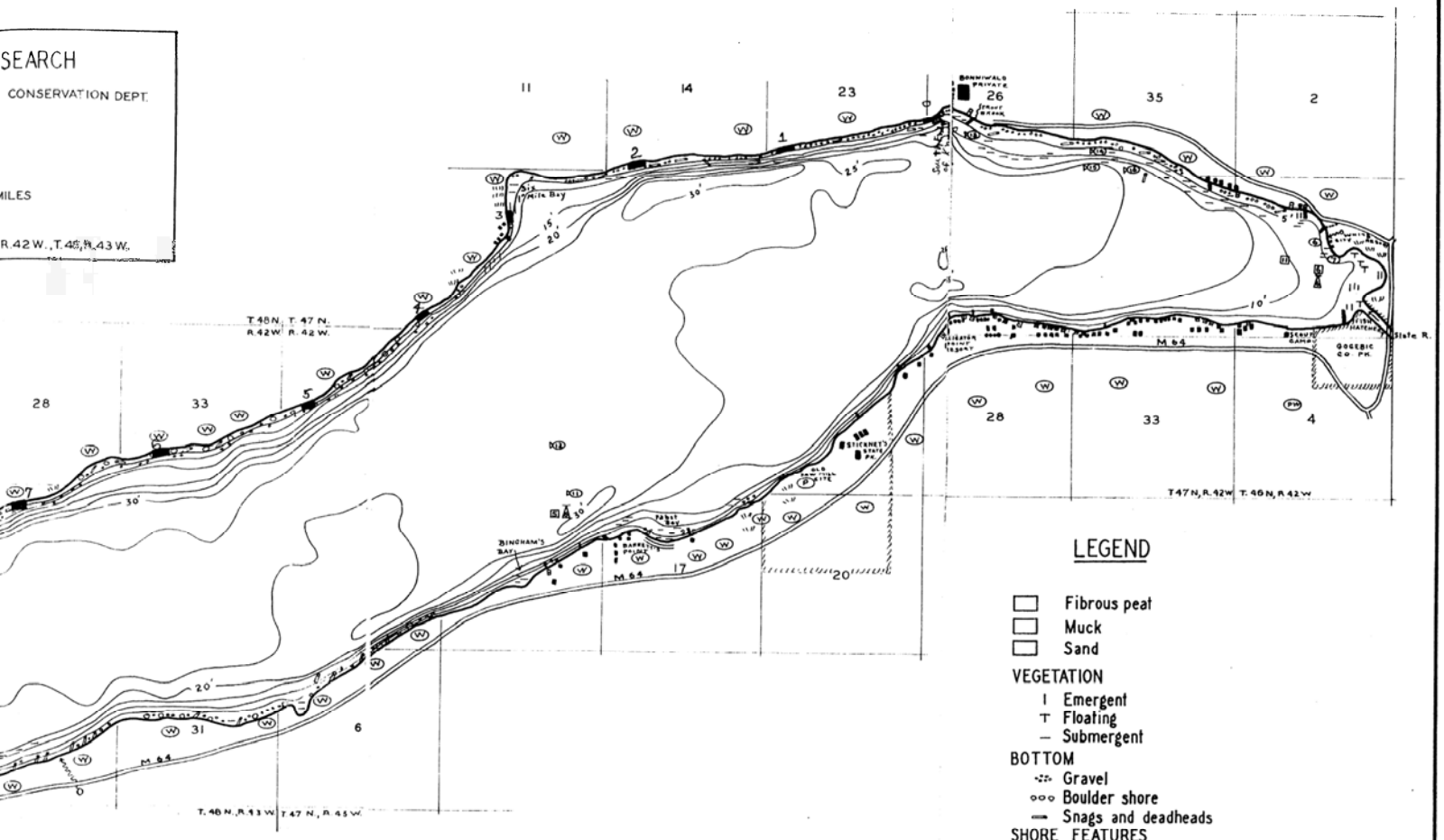
MICHIGAN CONSERVATION DEPT.
LAKE INVENTORY MAP
LAKE GOGEBIC
AREA 14,781 ACRES - SHORELINE 34.35 MILES
SHORELINE & SOUNDING BY U.S.F.S.
ONTONAGON & GOGEBIC CO'S. 6/16/38 T.46,47,48 N.,R.42 W.,T.48,R.43 W.
MILE
T.48 N., T.47 N., R.42 W., R.42 W.
T.48 N., R.43 W., T.47 N., R.43 W.
LEGEND
Fibrous peat
Muck
Sand
VEGETATION
Emergent
Floating
Submergent
BOTTOM
Gravel
Boulder shore
Snags and dea
SHORE FEATURES
Building
Boathouse
Dock
Road
Marsh
Spring
Cleared land
Semi-wooded
Wooded
STATIONS
Vegetation
Temp.,chem.,plankton
Bottom sample
Fish sample
LAKE GOGEBIC Ontonagon-Gogebic Co's

SEARCH

CONSERVATION DEPT.

MILES

R.42W., T.46, R.43W.



LEGEND

- Fibrous peat
- Muck
- Sand

VEGETATION

- I Emergent
- T Floating
- — Submergent

BOTTOM

- Gravel
- Boulder shore
- Snags and deadheads

SHORE FEATURES

- Building
- Boathouse
- Dock
- Road
- Marsh
- Spring
- (P) Cleared land
- (PW) Semi-wooded
- (W) Wooded

STATIONS

- Vegetation
- Temp., chem., plankton
- Bottom sample
- Fish sample

LAKE GOGEBIC Ontonagon-Gogebic Co's.