Original: Fish Division
cc: Education-Game
Inst. for Fish. Res.
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INSTITUTE FOR FISHERIES RESEARCH
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MICHIGAN DEPARTMENT OF CONSERVATION
COOPERATING WITH THE
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September 16, 1953

Report No. 1385

OBSERVATIONS ON PIKE SPAWNING AT THE NORTH END OF OTSEGO LAKE, OTSEGO COUNTY, DURING THE SPRING OF 1953

by

John E. Williams and Floyd E. Simonis

Abstract

The marsh at the north end of Otsego Lake, Otsego County, has been the subject of a long circuit court case in which the Department of Conservation has sought to modify resort construction so that the spawning of pike will not be adversely affected. This marsh is the last major spawning area available to pike from the lake and its continued use by pike is necessary if Otsego Lake is to remain a prominent pike-fishing lake. Observations conducted during the pike spawning periods of 1951 and 1952 have been reported previously. During the July, 1953 term of circuit court at Gaylord, the Conservation Department was awarded a consent decree and will be allowed to stipulate management terms for that part of the marsh (below 1,274.5 feet m.s.l.) which has been ruled lake bottom.

The marsh is divided by two roads into three sections, connected by culverts. The westernmost section, A, is connected to the lake by a lagoon. The center section, B, and the eastern section, C, are connected to the lake only by the culverts installed under the roads.

Pike spawned in all three sections this spring (1953), the period extending from March 30 to April 9. By the use of a gill net at the culvert between Sections A and B it was estimated that 50 to 55 pike spawned in Sections B and C. At least as many spawned in Section A also.

Of the 28 pike which were sexed at the gill net, 23 were males and 5 were females. Seventy percent of the fish handled were over 24 inches in length, indicating a population with an unusually small number of younger fish under 24 inches in length. This is substantiated by creel-census information from the lake during the past year, which indicated that small fish were non-existent in the catch.

Water levels in Otsego Lake (and the marsh) this spring were the highest ever recorded in the 27 years of gage operation (1,274.53 feet m.s.l.). Since the water level remained high for at least 3 months after spawning, water level conditions **should** have been optimum for pike spawning.

A fry trap was operated in the culvert between Sections B and C from shortly after spawning to August, in order to check the number of young pike migrating to the lake. No pike were taken, although 2,650 other fish were captured. Extensive attempts at collecting fry and fingerlings with scap nets and D. C. shocker resulted in the capture of only 1 pike fingerling. Most of the other fish captured by the fry-trap and the shocker were mudminnows, perch and bullheads. Stomach analysis of 533 of these fish proved that perch were feeding heavily on pike eggs shortly after the pike had spawned. It was suspected that the predators were also eating the fry that resulted from eggs which escaped predation.

Adult pike were still present in the marsh 6 weeks after finishing

spawning, and some pike may remain overwinter in deeper parts of the marsh.

The Otsego Lake Chamber of Commerce has asked for and been granted permission to buy approximately 1,500 adult pike from Lake Huron commercial fishermen this fall. The Conservation Department will furnish transportation for these fish and tag them. The Chamber of Commerce has also asked the Conservation Department to close Otsego Lake to fishing this winter in order to allow these pike to spawn next spring.

It is recommended that the Fish Division attempt experimentally to improve the survival of young pike in Sections B and C. This will be done by poisoning these sections this fall to rid them of the population of predator species, screening the culvert access to these sections and allowing only pike to enter next spring. Without the predators present the survival to fingerling size should be much greater. Section A will remain as it was this year, as a control.

It is further recommended that short, shallow, narrow channels could be dredged into Section A from the lagoon, which would give pike additional marshy fringe to spawn on during years of low-water level. This would be an excellent, inexpensive project for the local club.

Connecting the marsh, behind the barrier at the south end of the lake, to the lake as an additional spawning area is not considered practical from an engineering standpoint.

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Observations during previous springs at the north end of Otsego Lake have already been reported for 1951 in Institute for Fisheries Research Report No. 1286 (Williams, 1951) and for 1952 in Institute for Fisheries Research Report No. 1347 (Williams and Simonis, 1952). The legal history of the court action to keep this marsh from being destroyed for a real-estate development has already been summarized in the earlier reports and will not be repeated here. During the July, 1953 term of circuit court at Gaylord the Conservation Department was awarded a consent decree and will be allowed to stipulate management terms for that part of the marsh below 1,274.5 feet m.s.l.

Observations this past spring at Otsego Lake have been made daily by the junior author, who is the creel census clerk at the lake. The senior author has supplemented these observations at special times.

Mr. Simonis kept the marsh under surveillance during March and when the senior author arrived on March 27 some parts of the marsh were free of ice. The channels were still frozen over and no current was present at either culvert. Water levels of the lake and marsh and

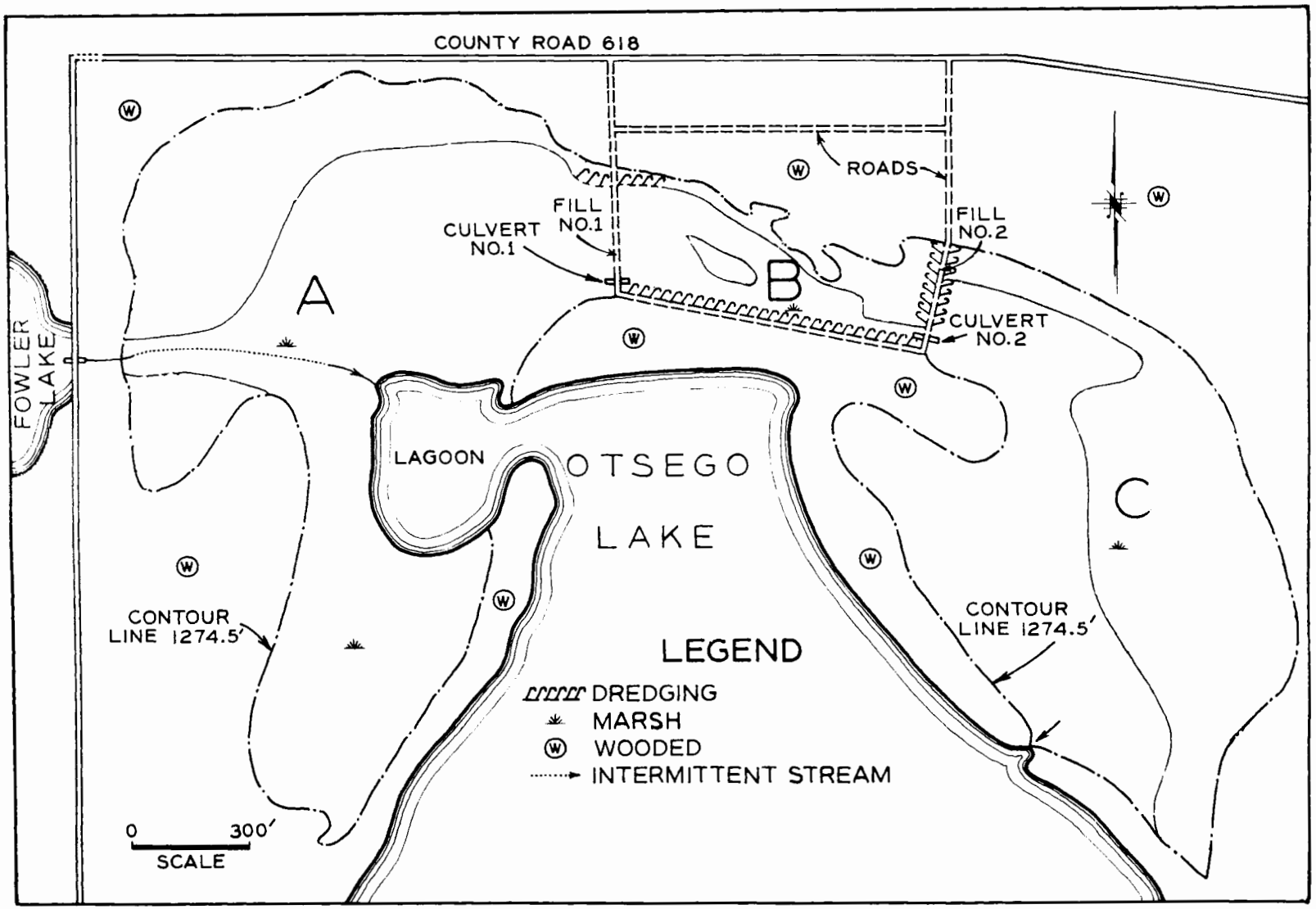
water and air temperatures are given in Appendix I (on file with the Institute copy of the report). No pike were present in the marsh when on March 28 Mr. Simonis staked a gill net in a semicircle around the eastern end of culvert No. 1 (see Figure 1), forming a small pen. It was thought that pike moving through the culvert could thus be caught and tagged. The net was supported about 3 feet above the water by stakes which also drove the lead line of the net into the bottom.

On March 28 the lake level was 2.36 feet (1,274.39 feet m.s.l.) on the U. S. G. S. gage. This was only .11 foot under the high water record of 1922 (1,274.5 feet m.s.l.) used as a dividing contour line between lake bottom and uplands in the consent decree. Water temperature in the marsh rose to 38° F. on March 28 and to 42° F. on March 29.

On March 30 skim ice covered the entire marsh in the morning, but a definite westward current had begun in the culverts. No fish had been observed in the marsh to this date. During the afternoon of the 30th water temperature rose to 54°, and at 2:00 p.m. the first fish movement was seen in the marsh in Section A, when a large fish rolled. At 6:30 p.m. the first pike, a 24.5-inch male, was captured in the gill net after coming through the culvert and was tagged and released in Section B. Between this time and 7:45 p.m. six more disturbances, presumably caused by pike, occurred in Section A.

At 8:15 a.m. on March 31, 3 more male pike were found caught in the gill net and were tagged and released in Section B. Marsh water temperatures ranged from 42° to 58° during the day and pike were seen in pairs and trios in Section A. Considerable water disturbance was seen during the day but the pike were wild and did not stay paired long. The action ceased entirely at 3:00 p.m., and no further action was noted until shortly before dark when action again was fairly vigorous.

Figure 1. Sketch of marsh at north end of Otsego Lake.


COUNTY ROAD 618
ROADS
FILL NO.1
CULVERT NO.1
FILL NO.2
CULVERT NO.2
A
B
C
FOWLER LAKE
LAGOON
OTSEGO LAKE
CONTOUR LINE 1274.5'
CONTOUR LINE 1274.5'
LEGEND
DREDGING
MARSH
WOODED
INTERMITTENT STREAM
0 300'
SCALE

During the night of March 31-April 1 splashing was heard at midnight by Conservation Officer Marlatt and he released into Section B 2 pike caught in the net.

At 8:00 a.m., on April 1, 5 pike were in the net and 4 were tagged and put in Section B. During the remainder of the day and the next night 4 more pike were released in Section B and 3 were released in Section A. Marsh water temperature ranged from 42° to 61° on April 1 and spawning pairs were commonly seen in Section A and occasionally in Sections B and C.

Three ripe males were put upstream in the a.m. on April 2, but no other fish moved through the culvert for the remainder of the day. Water temperature ranged from 43° to 62° and activity was heavy all day, mostly in Sections A and B. At most times from 1 to 3 pairs of spawning pike were active at the same time. Action was quite heavy from 6:30 - 7:15 p.m., but by 7:20 p.m. there was only occasional slight movement of single fish. By 8:00 p.m. there was no movement seen for 20 minutes. Single splashes were heard occasionally from 9:00 p.m. to midnight. No splash was ever repeated in the same place and when investigation was made in the immediate area either muskrats were seen or nothing was present. No splashes were traced to pike and it is not believed that the pike were spawning at night. Undoubtedly they do move at night (since they were often caught in the net) but splashes are believed due to sudden movements of single fish (or 2 fish if they should meet) or to muskrats. Comments by personnel of the Field Administration Division to the effect that "pike were splashing all night in the marsh" are believed based on the above noises.

Spawning on April 3 began at 6:05 a.m., shortly after daybreak. At that time water temperature ranged from 41° - 43° and ice covered the

surface wherever it was protected by plant growth. Spawning was sporadic all morning, but sometimes 2 or 3 pairs were spawning at the same time. Water temperature reached 52° by 1:30 p.m. but action was slowing and no action was noted for the remainder of the day, which was overcast with snow flurries.

April 4 was cold and overcast with a drizzle turning to snow about 11:00 a.m. No spawning action was noted all day and water temperature ranged from 40° to 45°. At 6:00 p.m. 3 pike were seen singly near the net indicating that, perhaps due to the colder weather, pike were attempting to go back downstream. This was substantiated when 3 ripe males were found heading downstream in the net at 8:30 p.m.

One male pike was found in the net at 12:30 a.m. on April 5 and examination of its gonads proved it to be about 50 percent spent. Water temperature rose during the day from 37° at 7:30 a.m. to 43° by afternoon but no spawning was apparent.

Water temperature rose on April 6 to 47° and some spawning was noted in Section A just before dark. No fish moved into the net during the day.

On April 7 at 8:00 a.m. 2 pike were in the net, one escaping into Section B. The other, a 9-pound ripe female, was moving upstream and was tagged (F806) and released in Section B. Water temperature rose from 40° to 63° during the day. No spawning was noted during the day until 6:00 p.m., when 1 pair was spawning in Section A, and 7:30 p.m. when a pair was also seen spawning in Section A. A partly ripe male moved downstream at 11:00 p.m.

On April 8 at 6:00 a.m. 2 ripe males were released into Section B. Four fish moved downstream during the day and next night, including

the first completely spent fish (probably a female). April 8 was warm with water temperature ranging from 44° to 58°. No spawning action was noted during the day until 4:30 p.m., when 2 separate actions were observed in Section A. No further action occurred until 7:00 p.m., when 2 pairs spawned in Section A and 1 pair in Section B. Spawning actions were not as vigorous or lengthy as during the beginning of the month.

Four pike were passed up and 1 was passed down on April 9 at 7:00 a.m. Water temperature ranged from 46° to 48°. The day was cloudy and cool and only one spawning action was seen all day. This was at 4:00 p.m. along the edge of the east-west dredging in Section B. The female involved was the 9-pound F806 put up on April 7. The 25-inch male spawning with her had been passed down on April 8 and had evidently returned through the net.

On April 10 the weather turned cold again and water temperature dropped from 45° at 8:00 a.m. to 38° at 9:30 p.m. The net was removed on April 11 for the convenience of the Field Administration Division as it had accomplished its purpose and spawning was apparently over. This was true as no further action was seen.

Two pike were preserved for specimens during the spawning but no other pike were observed lost to predators. There was no known attempt at poaching.

The small marsh adjacent to boat canals on the west side of the lake, 1/4 mile north of Otsego County Park, was checked several times during the spawning period, but no pike were seen here this year (2 pike were seen here on 2 separate occasions last year). A careful check of the lake was also made to find additional spawning areas but none were found, nor have any been reported. It is felt that the north-end marsh is the most satisfactory spawning area present.

Estimate of Numbers of Pike Spawning

Some attempt was made this spring to estimate the total number of pike using the marsh at the north end of Otsego Lake for spawning. This was mostly concentrated on an estimate for Sections B and C by the use of the 1-1/4" bar-mesh gill net installed above Culvert No. 1. Since it was assumed that some pike would go through the net (muskrats ceaselessly chewed holes in the net), many of the pike were streamer tagged to enable an estimate of the proportion of tagged to untagged pike seen in the marsh and returning downstream.

Pike handled (both tagged and untagged) showing length, weight, sex, date, time and direction of movement are given in Appendix II (on file with the Institute copy of the report). A total of 24 pike were tagged with white plastic streamer tags just below the origin of the dorsal fin. The tag rested along or in front of the dorsal fin and was quite easily seen in the water.

Of the 24 pike tagged, 17 were moving upstream (east) and 7 were going downstream (west). Since the net was stretched tightly the fish could not roll in it and consequently were usually just held by the maxillaries or the gills, or were just pushing against it with their snouts and their direction of movement was easily determined. An additional 8 pike were passed upstream without tagging but since an unknown number escaped through holes in the net unnoticed, the total population migrating into Sections B and C was unknown. The number present, however, can be estimated because a known number of tagged fish were passed up. Notes were kept of the proportion of tagged to untagged fish seen in cruising, and observing spawning in these two sections. If the total number of tagged fish seen in the marsh is compared to the total number of untagged pike seen

over the entire period, a proportion based on the number of tagged fish present can be derived.

On 4 days during spawning 7 tagged and 8 untagged fish were definitely identified in the marsh. The tagged fish were present in the ratio of 17 to 19 with the untagged, i.e.,

$$7 : 8 = 17 : X$$

$$X = 19$$

The total number of fish present is thus estimated as 17 (tagged) plus 19 (untagged) or 36.

It is definitely felt that this estimate is too low for the untagged fish. Observations were only counted when a fish was definitely seen to be either tagged or untagged. Tagged fish were usually easy to recognize. Untagged fish, however, if not seen clearly or if seen moving, oftentimes could not be recorded as either tagged or untagged simply because of the feeling that a tag may have been there but may have been unobserved. Most of the fish then listed as doubtful were probably untagged, while tagged fish under the same circumstances were usually counted. The senior author believes that as many of the untagged fish seen were listed doubtful as were counted. If this is true the estimate would be 17 + 38 = 55.

Another method used to estimate the pike population in Sections B and C was again a simple proportion. The ratio of tagged to untagged fish moving downstream should be equal to the ratio of tagged to untagged fish that went up, i.e.,

Number tagged going down : Number tagged going up = Number untagged going down : Number untagged going up

Since 17 fish were tagged going up and 5 tagged and 10 untagged were taken moving down the proportion becomes

$$5 : 17 = 10 : X$$

$$X = 34$$

The estimated 34 untagged going up plus the 17 tagged ones known to go up gives a total estimate of 51 fish going up into Sections B and C.

It is felt that estimates of untagged fish are justified by comparison of tagged to untagged fish since no untagged fish were handled which had lost tags.

A further slight clue to the proportion of tagged to untagged fish is furnished by the capture of 2 tagged and 2 untagged pike in a gill net put in Section B dredging on May 22.

An estimate of 50 to 55 pike using Sections B and C for spawning is thought to be close, with possible extreme limits put at 35 to 60 fish.

It is believed that as many pike spawned in Section A as in Sections B and C combined. More may have spawned here due to the deeper water near the lake and the nearness of the lake. However, spawning action was seen as often above Culvert No. 1 as below, and cruises on foot through all three sections revealed no heavier concentration of pike in Section A.

Composition of the Spawning Run

The fish examined moving upstream at the net revealed a ratio of 17 males to 2 females. Adding to this the new fish handled moving downstream (6 males and 3 females) gives a total ratio of 23 males to 5 females. The fact that there was a greater percentage of females in the downstream movement than in the upstream suggests that either

females went up before the net was installed or they were more able to get through the net. Both of these suggestions are doubtful. If any fish were going to be able to get through the net, the small males would be the ones, unless the large size of the females (29.7 inches average) enabled them to break through. However, there was no indication during spawning in Sections B and C that males were overly abundant. At other locations the senior author has seen 2 or more males with each female as often as he has seen 1 male with each female. At Otsego Lake the pattern was usually 1 male with each female.

Evidence given in Appendix II would lead to the suspicion that, since the first 8 fish sexed moving up were males, males were moving first. However, 5 fish of unknown sex also moved up before the first known female and a female moved down during the early period.

Of most interest in the composition of the spawning run was the size and age of the fish. The population was made up of a highly indicative size relationship which could almost be called skewed. In a normal pike run there will be a fair number of fish between 13 and 16 inches, equally as great or greater numbers from 16 to 19 inches and 19 to 21 inches, and less numbers progressively from 21 to 24 inches, 24 to 27 inches, etc. However, as is shown in Table 1, numbers here were radically different. Of the 30 fish measured, 17 were between 24 and 27 inches in length while only 9 fish (30 percent) were between 14 and 24 inches. Ordinarily, over 75 percent of the fish would be expected to be less than 24 inches in length.

These figures showing a high average size (23.6 inches) agree with figures from the summer creel census of 1952 in which the junior author reports seeing no fish under 20 inches, and with reports of

Table 1. Size frequency distribution of spawning pike at Otsego Lake, April, 1953

Total Length in inches	13.1-16.0	16.1-19.0	19.1-21.0	21.1-24.0	24.1-27.0	27.1-30.0	30.1-33.0
Number of pike	5	2	1	1	17	1	3

winter hook-and-line fishermen for 1952-53 who reported seeing or catching no small pike. Weights of 20 fish caught by 5 anglers last winter ranged from 4 pounds (26 inches) to 9-1/2 pounds (34 inches) and averaged 5-1/2 pounds (about 29 inches). It seems very definite that the mature pike in Otsego Lake during the past year were of an exceptionally large average size. It was surprising, therefore, to find the 5 small males in the spawning run (range 14.0 to 15.8 inches) which were young of 1952 and 3 slightly larger males (16.4 to 20.5 inches) which were young of 1951.

Lengths in inches of fish of various age groups are given below:

Age	I	II	III	IV	V	VI	VII
Year hatched	1952	1951	1950	1949	1948	1947	1946
(Length in	14.0	16.4	19.0	24.3	26.1	25.2	30.9
inches)	14.7	17.3		25.0		25.2	32.5
	14.8	20.5		26.4		27.0	26.5
	15.4			22.5		27.7	
	15.8						

Lake and Marsh Water Levels

The level of Otsego Lake at the beginning of the spawning period this year was 2.36 feet (1,274.39 feet m.s.l.) or .57 foot higher than at the same time last year. The elevation reached a high this year of about 2.50 feet (1,274.53) from April 27 to May 5 which was .03 foot above the record 27-year high of 1922 (1,274.5). Aerial photographs were taken of the north-end marsh on April 14, 1953 to show the area flooded by the high water. The water level remained high this year for some time, dropping only 2.2 inches to 1,274.35 feet by July 5,

3 months after spawning. According to water gauges in Sections A, B and C, water levels in the three sections dropped 2.4, 2.0 and 1.9 inches respectively. Actually the drop of water from the spawning period was even less (highest water was 2 weeks after spawning), the level of lake and marsh being only about one inch below the level at spawning. Since water levels were higher for a month after spawning than they were at spawning, no loss can be attributed to stranding of eggs or fry.

The extreme height of water this year was readily apparent as it crept up over the tops of the culverts. The culvert tops were established at the high water record of 1,274.5 feet m.s.l; thus it was apparent at once when the water was that high or higher.

As far as water level is concerned, conditions for spawning should have been the most ideal in the recorded history of the lake.

Direction of Current in Culverts

It was noticed during the spawning period that the current in the culverts did not always flow westward toward the lagoon. The current was sometimes definitely east in both culverts; on some days it would change direction several times, and at other times there would be no current at all. Below is given a summary of current observations and wind direction for 5 days during the spawning period.

Date	Time	Direction of current	Wind
4-7	12:00 noon	East	S.E. light
	8:30 p.m.	East	S.E. light
4-8	9:00 a.m.	East	S.W. light
	6:00 p.m.	East	S.E. light
	9:00 p.m.	West	S.E. moderate
	12:00 midnight	East	S.E. moderate
4-9	7:00 a.m.	West	E. moderate
	3:00 p.m.	East	E. moderate
4-10	8:00 a.m.	East	S.E. moderate
	4:30 p.m.	West	W. high
	9:30 p.m.	East	N.W. high
4-11	8:00 a.m.	West	W. moderate

An explanation of this phenomenon from the figures is impossible but there is an indication that on days when the wind blew from the southwest, south, or southeast the current had a tendency to be toward the east. This is, of course, reasonable for if the wind blew strongly for some time from the south, the water at the north end would rise and Section A, being connected, would also rise, putting its level higher than Section B and forcing the current to the east. When the wind is from the northeast, north, northwest or west the current should flow west. It was noted that when the direction of the current was checked on 26 days between May 5 and June 4 the current was west on 17 days, east on 8 and absent on 1. After June 5 the current was west every day up to July 9. Therefore, the current was certainly west often enough to enable pike fingerlings to migrate down if they were present. Adult pike were also not stopped from migrating up by a reversal of

current. ("up" in this report is taken to mean "up the culvert from Section A to Section B", although when the current reverses and flows east, "up" would actually be "downstream")

Operation of Fry Trap

Since it had been impossible to collect pike fry in either Section A, B or C last year after an apparently successful spawning, it was believed that an excessive mortality must have occurred to either the pike eggs or fry. Attempts at collecting young pike last year with a D. C. shocker resulted in the capture of large numbers of mudminnows and other fish in the marsh. It was suspected that these fish were responsible for the absence of pike fry and fingerlings (Williams and Simonis, 1952).

This year, therefore, a fry trap was installed in the upper end of Culvert No. 1 (connecting Sections B and A) on April 21, approximately 2 weeks after spawning. This trap consisted of a wire-mesh funnel cut to fit the inside of the culvert, the apex of the cone fitting into a glass minnow jar. It was thought that this trap, when tended daily, would indicate when and in what numbers young pike migrated out of Sections B and C and would also furnish us with daily samples of other fish present in the marsh for stomach analysis.

Not a single pike fry or fingerling migrated out of the marsh from April 21 until August 5. This was substantiated by the fact that scap net collection attempts on May 2 and 4 failed to collect any fry and extensive D. C. shocker use on May 25 collected only 1 pike fingerling (1-3/4 inches long from Section B). All attempts to collect young pike were carefully done at great length and covering especially all known spawning locations. Eggs had been observed at most of these locations during the spawning period.

In all, from April 21 to July 11, the fry trap took 2,650 fish, including 1,218 western mudminnows [Umbra limi (Kirtland)], 896 yellow perch [Perca flavescens (Mitchill)], 275 minnows (mostly bluntnose minnows [Pimephales notatus (Rafinesque)] and northern common shiners [Notropis cornutus frontalis (Agassiz)] but some northern creek chub [Semotilus a. atromaculatus (Mitchill)] and blackchin shiner [Notropis heterodon (Cope)]), 239 bullheads (mostly northern black bullhead [Ameiurus m. melas (Rafinesque)] and a few northern yellow bullhead [Ameiurus n. natalis (Le Sueur)], and lesser numbers of pumpkinseed [Lepomis gibbosus (Linnaeus)], northern logperch [Percina caprodes semifasciata (De Kay)] and Iowa darter [Etheostoma exile (Girard)].

The daily catch of the trap is given in Appendix III (on file with the Institute copy of the report). Apparently no fish attempted to migrate upstream during this period as they were never noticed in the corners of the trap when it was removed daily. Mudminnows ceased to migrate down about July 1 and perch about May 27.

Stomach analysis was made of a large percentage of the mudminnows, perch, bullheads and pumpkinseeds taken both with the D. C. shocker on April 9 and May 25 and from the fry trap. A larger percentage of the fish taken early in the season were stomach-analyzed than of those taken later. As the size of the pike being eaten would grow larger, small fish in the collection were discarded for stomach study.

The fish taken near the end of the spawning period on April 9 with the shocker were stomach-analyzed to see if they were feeding on pike eggs. The shocker was operated for about 1 hour in each of Sections A and B. In Section A the shocker was worked down the channel from the first culvert to the lagoon, along the edge of the lagoon (but in the marsh) westward to the Fowler Lake channel and thence back

across the marsh to the first road. Two trips were made east and west in Section B, working both marsh and dredgings.

In Section A a total of 133 fish were taken on April 9 and stomach-analyzed. The total included 74 perch (2.3" - 5.7"), 31 bluntnose minnow (1.6" - 3.5"), 15 mudminnows (1.5" - 2.9"), 6 pumpkinseeds (4.7" - 6.7"), 4 common shiners (2.2" - 4.1"), 2 bluegills (5.0" - 5.2") and 1 Iowa darter (2.9"). Of these, only the perch showed any evidence of predation on pike eggs.

Of the 74 perch taken, 45 had empty stomachs. Of the 29 that contained food, 21 contained pike eggs and the remaining 8 contained mainly insect remains and small clams. The 21 containing pike eggs had a total of 282 eggs, ranging from 1 to 43 each (average of 14 each). The perch that ate eggs ranged in size from 2.6 to 5.7 inches but over 75 percent of the egg-eating perch were over 3.5 inches in length and ate nearly 90 percent of the eggs eaten. (Actually perch over 3.5" in length made up only 45 percent of the captured perch.) In other words, most of the eating of pike eggs had been done by the less numerous larger perch instead of the more numerous small perch as might have been expected. There was little doubt that the eggs were all pike eggs due to their uniform and distinctive size. They were exactly the size of known pike eggs and the only other ripe fish in the marsh at the same time were mudminnows whose eggs were considerably smaller. Furthermore, female mudminnows captured in the fry trap remained ripe until about the last of April, indicating a later spawning time than for the pike.

In Section B a total of 55 fish were taken on April 9 and stomach-analyzed. The total contained 52 mudminnows (1.5" - 3.8"), 2 yellow bullheads (2.5" - 10.4") and 1 perch (4.5"). Of these fish, a single

mudminnow had eaten 1 pike egg. It is unfortunate that only 1 perch was taken (and that one empty), but perch can be assumed to have been fairly numerous in Sections B and C, since nearly a thousand of them migrated down through Culvert No. 1 later.

As mentioned above, from its installation on April 21 to the end of July 2,680 fish were taken in the fry trap. Of these, a total of 336 were stomach-analyzed, primarily from early collections which might show evidence of predation on pike fry, plus progressively larger fish through collections made in May which might show pike fingerlings. Fish analyzed included 193 mudminnows, 84 perch, 57 black bullheads and 2 yellow bullheads. Also a total of 34 of the larger (2.3" - 3.4") mudminnows, shocked on May 25 in the search for pike fingerlings, were also analyzed. None of these fish examined showed any evidence of having preyed on pike. Unfortunately, collections of perch and bullheads did not become numerous until after May 5. Perhaps by this time they had eaten most of the fry hatching but since they did not move downstream were not collected. Also since the fry trap was only emptied once daily stomach contents were often partly digested or the stomachs were empty. However, it is felt that if predation on pike fry was going on (in Section B especially) it would have been noticed in the stomach analysis.

Perch collected from the marsh had fed principally on insects, of which dragon-fly nymphs were most important. Mudminnows had fed mostly on insects (mayfly, damsel-fly, and dragon-fly nymphs, caddis fly larvae and beetle adults and larvae), snails and small clams. Bullheads had fed chiefly on insects plus a few mudminnows.

From the above stomach analysis the authors are reasonably sure that the poor production of pike fingerlings from the marsh is due

largely to predation by other fish. This predation is probably heaviest on the eggs, but the fry that do hatch are probably eaten quickly by either mudminnows, perch or bullheads, all of which are known to feed on small fish if present. After this heavy predation on eggs and fry only a very small percent reach the size of the lone fingerling captured on May 25 and those that do may not migrate out of the marsh until later in the summer, if at all.

Adult Pike Remaining in Marsh

Because of the presence of some deeper water both in dredgings in Sections B and C and in potholes in Section C, it had been suspected that not all of the adult pike, spawning in the marsh, returned to the lake after spawning. To see whether all pike had left the marsh by April 21 (when the fry trap was installed in Culvert No. 1, cutting off escape into Section A and the lake) a gill net was stretched across the dredging at the east end of Section B on May 22. When the net was lifted on May 25, 4 pike were taken, 2 of which had been tagged during spawning early in April. Three of the fish were opened (2 spent males and 1 spent female) and all had been feeding on mudminnows.

It is possible that some pike may remain in the deeper parts of the marsh overwinter and this may account for some of the untagged fish migrating downstream during the spawning season this spring.

Management in Regard to Pike Spawning

Since the production of pike fingerlings by the marsh at the north end of Otsego Lake has been very low during the past two springs, steps should be suggested which might improve the production here. This is

especially true when the optimum water levels of these poor production years are considered. In order for Otsego Lake to become a good pike lake again the pike must be able to take advantage of high-water level years and produce large numbers of fingerlings.

Apparently the Otsego Lake Chamber of Commerce is planning to buy about 3 tons of 20-inch or larger pike from commercial fishermen this fall and stock them in Otsego Lake. The Fish Division will tag these fish and the lake may be closed to all fishing from December 1 to May 15. The idea of the Chamber of Commerce, of course, is to increase the number of adult pike in the lake, protect them overwinter so they may spawn, and then furnish better pike fishing next summer. It is the opinion of the senior author that, unless the population of pike in Otsego Lake is extremely low, this program may show slim results. In the first place, if pike spawning for the past 2 years has shown poor results, why should the addition of a few more pike make the production much better? Secondly, it is not thought that the addition of approximately 1 pike/acre (1,500 pike for 1,972 acres) is going to result in noticeably increased fishing success. Furthermore, if spawning success does not improve, the stocking will have to continue on a maintenance basis.

If pike are at an extremely low number (for instance 1/2 pike/acre), fishing may be improved temporarily. It might be mentioned that fishing in Otsego Lake the past year has produced a total of 380 pike (73 during spring 1952, 102 during summer 1952 and 205 during the winter 1952-53) as estimated by creel census conducted by the junior author. Admittedly fishing is poor based on catch/hour but it is doubtful if the pike are reduced to less than 1 pike/acre.

It is believed that to increase pike fishing success noticeably here the survival of eggs and fry must be increased. If natural mortality to the eggs and fry were reduced drastically, the spawning of 100 pike should produce enough fingerlings to amply stock the lake.

Strong evidence has been advanced that predation on eggs (and probably fry also) by fish present in the marsh is the limiting factor on fingerling production in the north-end marsh. If the other fish, principally perch, mudminnows and bullheads, can be eliminated from the marsh, fingerling production should be increased. It is, therefore, suggested that the control of other fish in Sections B and C be tried, keeping Section A as a control. Since the pike come into the marsh as soon as the ice is out in the spring (usually a week before ice-out in the lake) and fish undoubtedly winter over in 1 or both sections, control would have to be done in the fall. Poisoning of Sections B and C with rotenone, before the advent of cold weather should kill off the fish in the marsh. Then the first culvert would have to be equipped with a fine screen to prevent the reintroduction of fish this fall and winter. In the spring a fine-meshed trap would be installed at the upstream end of the culvert in order to release pike into Sections B and C and keep other fish out. In this manner pike could be allowed to spawn in the upper 2 sections in the absence of other fish, while those in Section A would spawn, as during the past 2 years, amongst an abundance of these fish. After hatching, checks could be made with a D. C. shocker for a known time or area in each section (at least at places where spawning occurred) to compare the relative production of fry and fingerlings. If a fry trap was also operated in Culvert No. 1, as was done this year,

comparative figures would be obtained between the two years as to numbers of young pike migrating to the lake.

Of course, if the water level next spring should be considerably less than this year, no spawning area might be available above the first culvert. Also for some reason pike might not migrate through the culvert next year. In that case an adequate number could be trapped in the lagoon and released in Section B. It is planned that the authors will do the poisoning this fall.

Another management possibility that has merit is constructing ditches into area A from the lagoon. It is well known that pike spawn along a fringe of marsh and deeper water. In 1951 (Williams 1951) the only pike seen in the marsh were spawning along the ecotone between the lagoon and marsh, since the rest of the marsh was dry. During other dry years branch ditches from the lagoon would be water-filled back into the marsh and would offer considerably more of this fringe area for spawning. Larger pike especially seem to prefer to spawn on marsh areas bordering on deeper water. Ditches, possibly 2 to 3 feet deep, at least 5 feet wide with sloping sides, and of any length practical would seem desirable.

The construction of the ditches when the marsh was dry or slightly frozen could be done by blasting or by dredging with a dragline. If done by blasting, 2 sticks of standard 50 percent blasting dynamite, placed every 2 feet, should give the approximate size ditch desired. Experimentation would soon show if more or less were needed. The main disadvantage with using dynamite would be that a spoil bank would be erected on both sides of the ditch, eliminating the marsh-ditch ecotone. With the use of the dragline the spoil bank could be confined to one side, set back from either side or

hauled away. A ditch with both edges suitable for spawning would, of course, be twice as good as a ditch with only one suitable edge. In addition, dredging would probably be cheaper. At any rate ditching the marsh would make a good club project. If not done as a club project it might be done by the Lake and Stream Improvement Section. However, preference should be given to the poisoning and screening recommendation as long as the water level is high at Otsego Lake.

These ditches would also be useful in high water years, serving as routes of travel into the marsh for adult pike and easing access to the lake for fingerlings. A ditch only 2-3 feet deep probably would not encourage muskrats as they would freeze out in the winter.

The possibility of connecting the marsh south of the "beaver-dam" barrier at the south end can also be considered. Since the lake is from 1-1/2 to 4 feet higher than the marsh (according to residents on the barrier) the marsh level would be raised by nearly that amount if connected to the lake. Residents at the south end would strongly object to this plan because of the possibility of flooding of yards, basements and roads built behind the barrier. The Engineering and Architectural Section examined this location on July 9, 1953, and stated that connecting this area to the lake was not practical from an engineering standpoint. They pointed out that the south end private and county roads would be flooded, a tremendous volume of water would be drawn from the lake proper and in most areas of the marsh water would be too deep for pike spawning. They also pointed out that flooding the south marsh would result in high transpiration and evaporation losses for a lake such as Otsego, which has no active inlet.

Conclusions

Conclusions reached concerning pike spawning and its results at the north end of Otsego Lake this spring as well as to management suggestions concerning improvement of spawning success are given below:

(1) Pike spawned at Otsego Lake this spring from March 30 to April 9.

(2) The water level in the lake and marsh this spring reached a record high and was optimum for spawning, hatching and migration purposes.

(3) An estimated 50 to 55 pike spawned in Sections B and C this spring with an equal or greater number spawning in Section A.

(4) The spawning population of pike was made up of small (14 to 17 inch) fish and large (24 to 32 inch) fish with large fish over 4 years of age predominating. Creel census figures bear out the conclusion that the general lake population is much the same. Usually 2- or 3-year-old pike from about 16 to 22 inches make up the majority of spawning runs and of pike caught by anglers. These fish are apparently few in Otsego Lake indicating poor spawning success in 1950 and 1951. Fish of the 1952 and 1953 year classes will probably be poorly represented in the future.

(5) A fry trap operated at Culvert No. 1 from April 21 to July took no migrating pike fry or fingerlings but did take 2,650 other fish, mostly mudminnows, perch and bullheads.

(6) Attempts to collect fry on May 2 and 4 were unsuccessful and extensive use of a D. C. shocker on May 25 produced only 1 pike fingerling. Survival of eggs to fingerlings was considered extremely low.

(7) Stomach analysis of 567 fish, mostly mudminnows, perch and bullheads, collected by the shocker and the fry trap, showed that perch were feeding heavily on pike eggs during the period near the end of pike spawning. Later collections showed no other predation. It was concluded that egg-predation by perch and probably fry-predation by perch, mudminnows and bullheads was responsible for the poor survival of pike to fingerling size.

(8) The proposed introduction by the Otsego Lake Chamber of Commerce of 1,500 adult pike in Otsego Lake this fall might result in increased fishing success next summer if the pike population is drastically low now. However, it is concluded that it will be of small help in increasing spawning success unless the survival rate of young pike is increased.

(9) A management suggestion for increasing the pike spawning success in the Otsego Lake marsh would be to poison the present fish populations in Sections B and C this fall and then place a screen in Culvert No. 1 overwinter. In the spring pike would be taken in a trap in Culvert No. 1, and placed in Section B, other fish being excluded. After spawning a fry trap would be operated to count fingerlings migrating downstream and to continue excluding other fish from the upper 2 sections. Comparison of production of fry and fingerlings in Section A with that in Sections B and C should determine whether exclusion of predator fish had increased the survival of pike to fingerling size.

(10) A suggestion for increasing the spawning area in Section A during low water level years would be to dredge shallow ditches from the lagoon into the marsh. This would give pike access to considerably more deep water-marsh border which might be beneficial in the critical low-water years.

Recommendations

It is recommended that the Fish Division check the effect on fingerling production of exclusion of other fish from the spawning area next spring as outlined in this report. Poisoning and screening off of Sections B and C will be done this fall by the authors.

It is further recommended that the Fish Division cooperate with the Otsego Lake Chamber of Commerce in their stocking of pike in Otsego Lake by furnishing transportation for these fish.

It is also recommended that these introduced fish be tagged so that their ratio in the spawning population and in anglers' catches may be determined next year and the original native population present estimated.

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