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HOUGHTON LAKE NORTHERN PIKE INVESTIGATIONS, 1939

PROGRESS REPORT

by

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The great northern pike is one of our largest fresh water fishes. Although there are many references to this fish in scientific literature, very little has actually been published about the life history and habits of the pike. The fisheries biologist has been unable to explain satisfactorily the apparent increase or decrease of pike in Houghton and other lakes because of this lack of knowledge. The rate of growth of the pike has not been carefully studied as the scales are among the most difficult to read (for age determination). Because of this meager knowledge concerning the life history of the northern pike, it was decided that an investigation should be conducted in connection with the operation of the Muskegon River weir (see I. F. R. Report No. 580). Previous surveys and examinations had revealed that Houghton Lake offered better possibilities for life history studies on the pike than any body of water with which we were acquainted.

This investigation covered a period of approximately four months (April to July) and included observations on the pike run, spawning, and the return of the young pike to the lake. All spawning fish were tagged

on their return journey through a weir installed on a small ditch entering North Bay. The small number taken in the weir on the Muskegon River was also jaw tagged. The fishermen's returns of these tagged fish have given us data concerning the growth, migration and the number of days each fish was out between the time of tagging and recovery.

The writer wishes to express his thanks to Mr. Harold Bowditch, Mr. Tom White and Mr. Philip Woodworth for their valuable assistance; to Dr. A. S. Hazzard and various members of the staff of the Institute for Fisheries Research for their guidance and assistance; and to Mr. H. L. Peterson, District Supervisor of Fisheries Operations, and Mr. John Peterson for the use of facilities and equipment during the course of this investigation.

Houghton Lake is the headwaters of the Muskegon River. "Old timers" tell us that years ago literally thousands of pike descended the river during the spawning season. There are seven streams flowing into Houghton Lake, and at least three of these (as far as is known) have pike runs of moderate proportion each spring. There are at least five drainage ditches flowing into Houghton Lake, two of which are known to have pike runs. Besides the river, the streams and ditches, there are a number of small canals (to increase lake shore property by giving landowners access to the lake) which may serve as pike spawning grounds. There is also a great deal of low swamp land around the shores of Houghton Lake that might possibly afford some spawning. One such area known as "Burnt Point," between North and Muddy bay, has accommodated many spawning pike in the past (local people agree on this).

For our experiments the ditches flowing into North Bay at John Peterson's were used (see map). These ditches were dredged to facilitate

the draining of the marshes on both sides of the roads running east and west, and north and south. The ditches which were under observation and where collections were made are listed and described as follows: (shown on map as I, II, III, etc.)

1. Ditch I runs east and west on the north side of the road running directly into North Bay at Peterson's, and is approximately one-quarter of a mile long. This is the main ditch and leads directly into the lake. At the west end it is connected directly to Ditch V by a culvert. This culvert was plugged on April 2 to keep the pike from going into Ditch V.

2. Ditch II forms one arm of a triangle with Ditches I and III, and is about 250 yards in length.

3. Ditch III extends in an almost north-south direction for  $1 \frac{1}{4}$  miles from the point where it enters Ditch I. Adult and young pike were found in the lower mile of this ditch.

4. Ditch IV is parallel to and on the opposite side of the road from Ditch III, but is only one mile long.

The above mentioned ditches are the most important as all of the spawning occurred here. Ditches V, VI and VII enter the picture later but will be described below.

5. Ditch V runs east and west, and is connected with Houghton Lake through ditch No. I. This ditch flows directly into the Muskegon River, even during periods of high water. This ditch is approximately three miles long and enters the river at a point about a half mile south of the old Michelson lumber mill. Ditches VI and VII run in an almost north-south direction, on opposite sides of a new road (still under construction). These ditches are blind at their southern ends and flow directly into

Ditch No. V.

The ditches under observation have a length of approximately 2 1/4 miles and vary in width from 6 to 15 feet, and/a <sup>have</sup> maximum depth of 2 1/2 feet. Most of the ditches have sand bottoms with only occasional patches of muck. Marsh grass is the dominant vegetation and is especially dense along the edges where the water is from one foot deep to the bank (see pictures). Filamentous algae, duckweed and moss are the only other important plants present in the ditches. The banks are all low, not being over a foot above the high water level. During periods of high water, numerous areas varying in size are flooded to a depth varying from one to 12 inches. The water in the ditches ranges from light to dark brown in color.

The usual practice at Houghton Lake in the fall is to lower the water level of the lake about two feet. This is accomplished by removing slash boards in the county dam on the Muskegon River. Most of the shore damage that would be caused from the ice push is thus prevented. As soon as the ice breaks up in the spring the boards are placed in the dam. This brings the lake level up to its highest point at the time of the spring thaw. At high water level the water flows from the lake into Peterson's ditch (No. I). This in turn floods the marshy area surrounding the ditches. That is probably one reason that Ditch V was dredged out clear to the river. Another reason is that the landowners objected to the standing water in the marshes and the subsequent hordes of mosquitoes. During July (or thereabout, depending upon the dryness of the season) in a normal year, the water level falls in Houghton Lake and the ditches dry up and become filled with grass and weeds. If by any chance heavy autumn

rains occur, the ditches may partially fill with water. Seldom do they fill sufficiently, however, for water to flow into the lake. Usually it remains stagnant. When winter comes, this water, if any is present (as it was the fall of 1939), and the snow freeze to the bottom in these ditches.

When this investigation was begun in late March, 1939, the ditches were completely frozen over. Ice reached to the bottom in most of the ditches, except for occasional pools in which the water was over two feet in depth. It may have been possible for fish to survive throughout the winter in these ditches, providing that water was flowing into the lake during the fall, but it is highly improbable that any fish were present.

On April 1 the ditches were still completely frozen over, and just a small amount of water was flowing into the lake (Table 3) through a small opening at the mouth of Ditch I. The ice in the lake at the mouth of the ditch reached to the bottom, obstructing all passage of fish from the lake at that time. On April 2 the weather was rather warm and the ditch opened up in places next to Peterson's house. A fair stream of water was then flowing into the lake. This water did not cause a very large hole in the ice on the lake (which was 17 inches in thickness), but did make an opening between the lake bottom and the ice. The bottom of the ditch was still frozen, even in the open spot. The night of April 2 was cold, and the temperature was well below freezing. April 3 was rather warm again, but not as warm as April 2. At 10:00 a.m. John Peterson came over to the river (where we were installing the big weir) and told us that some pike ran the night before (April 2). He estimated that approximately 50 pike ran up the ditch, most of them were small.

On the afternoon of April 3, I went over to Peterson's. The ditch

was open from the road (junction of Ditches I and IV) to the lake, a stretch of about 200 feet. The rest of the ditch had a heavy coating of ice and snow, making it impossible to see anything. The bottom of the ditch was frozen, except in the center, but we decided to put in the weir at that time. An onshore wind blew most of the day and this helped to open up a hole about 10 feet in diameter in the lake ice at the mouth of the ditch.

The weir was constructed of four-foot plaster lath and consisted of two wings set in the bank and running to the center of the ditch in the form of a "V."



The lath were driven into the bottom, an inch apart, and braced in the middle and at the top by a 1 x 3 inch board. The small end of the "V" was 3 1/2 inches. The wings of the "V" formed an angle of approximately 45 degrees with the banks. A single wing was installed perpendicular to

each bank and 15 feet from the apex of the "V." This single wing was also constructed of lath driven into the bottom to depths ranging from 6 inches to 2 feet, depending upon the composition of the bottom. Boards 1 x 3 inches were placed in the middle and at the top of the laths to act as braces and spacers. In places where the bottom was still frozen, holes were made by driving a crowbar into the bottom with an axe. The weir was completed by 7:30 p.m. on April 3. Later a trap of similar construction was installed on the ditch to take the fish moving downstream.

#### The Upstream Run

Table 1 summarizes the pike run by days. Northern pike spawners ran up the ditches at Peterson's over a period of 24 days. The largest number of fish that ran on any one day was 53. On only five days during the entire run did the number exceed 25 per day. Most of the fish came up during the first four days of the run and again during the last 10 days. The majority entered the trap between the hours of 6 p.m. and 3 a.m., with most of the fish appearing between 9 p.m. and midnight. Approximately as many fish ran between 6 p.m. and 9 p.m. as between midnight and 3 a.m. On five nights' observations were made until 3 a.m. (one night until day break). On these particular nights very few fish entered the weir after 3 a.m. Just a few scattered individuals ran between 9 a.m. and 6 p.m.

Males comprised 65 per cent of the total run, or 1.88 males per female. But of the 131 females that entered the ditches, 23 were taken for samples (Table 4). Therefore 108 females were allowed to spawn in the ditch. Consequently there were 2.287 males to each female that

spawned in the ditch.

There was very little difference in the size of males or females at the beginning and at the end of the run (Table 2). The females averaged larger than the males for each day of the run and for the total number of fish that ran. The average total length of all of the females was 23.5 inches, while that of the males was 21.2 inches. ✓

The run of spawners in Peterson's ditch was composed of average-sized fish as shown by the creel census records of previous years. The average length of all of the pike taken during the winter of 1936-37 was 21.2 inches (I. F. R. Report No. 417). During all of the census years the average remained about the same.

Very little correlation could be found between the temperature of the water and the number of fish ascending the ditches each day (Table 3). The large run of pike on April 16 (Table 1) may have been due in part to the six degree rise in temperature on April 15, but from the data that we have collected so far, it appears that the fish were attracted to the ditches by the current (and possibly by the warmer water of the ditches spreading out over that of the lake water at the mouths). This is further borne out by the fact that the first pike that ran up the ditch at Peterson's were ripe (both males and females) to the extent that milt and eggs would drop from almost every fish picked up. There were 13 green females (9.9%) out of the 131 that ran up to spawn, while every male was ripe. This would indicate that the fish were mostly ripe before the ice on the lake opened sufficiently to allow the fish to ascend the ditches. Apparently the ice in the lake opened sufficiently to permit the passage of fish late in the evening of April 2. Rain, snow and cloudiness had



little or no effect on the number of fish that ran, because most of the fish ran at night.

The majority of the fish that ran at night were not afraid of lights or the sudden movements of the observers. Many fish, apparently dazed by the light, could be picked up by hand. At night most of the fish were rather quiescent, moving slowly about the trap. When disturbed by the observers while dipping them out, the pike would usually try to get downstream. Very few of the spawning pike would try to jump over the weir at night. Sometimes at daybreak and later on in the day some of the pike would become restless and attempt to jump over or "crawl" (they would actually jump out of the water and attempt to "flop" around the wings of the weir) around the weir.

#### Observations of Spawning Activities

The first activities interpreted as spawning were observed for the first time on April 11, nine days after the first pike entered the ditches (Table 3). April 11 was the first day that any great portion of the ditch was open, and any spawning that might have taken place previous to this date must have been under the ice and could not have been observed. From April 2 to 8 the only portion of the ditch system that was open was the stretch beside Peterson's house (approximately 250 feet). On the afternoon of April 9 a few spots here and there opened in the east-west ditch (No. I). These spots froze over completely on the night of April 9-10. Approximately the same number of holes opened in Ditch I on April 10. The night of April 10-11 was cold enough to put a thin film of ice on these open areas, but the entire ditch (No. I) was open on April 11.

On the night of April 11-12, and all during the day of April 12, the ditch was completely frozen over and the snow that fell that day covered the ice. Ditch No. I was open again on the afternoon of April 13, and spawning was again noted. Ice formed again on this ditch the night of April 13-14, and during the day of April 14 the ditch was fully opened, but spawning was not observed. Ice formed again that night but melted off by 2 p.m. on April 15 and spawning actions were noted again. The ice disappeared entirely from the entire ditch system on April 15. All of the ditches remained open from this date on except for a thin film of ice that formed the night of April 19-20, which melted early on the morning of the 20th. (The ice did not leave Houghton Lake until April 23.)

At this time we cannot say definitely whether water temperatures (Table 3) control spawning activities or not. Except for the first two days that spawning took place, when the average water temperatures were about the same, the rest of the spawning occurred when the average water temperatures were higher and increasing from day to day. Most of the spawning took place in the afternoon. The earliest hour that spawning was recorded was 11:30 a.m., and the latest just at dusk. This might indicate that the pike do not start to spawn until the water warms up. From other observations we know that all fish were ripe at the time they entered the ditches. Therefore, discounting other contributing factors, the fish were ready (that is because the eggs and milt were ripe) to spawn as soon as they entered the ditches.

Some interesting data are presented in Table 4. From the data available on the number of hours per day of clear and cloudy skies, we find that on cloudy days spawning did not occur. (This was first observed in the

field.) On clear and partly cloudy days (partly cloudy with relatively few and scattered clouds to almost completely overcast sky) spawning was observed. Of the 17 days between April 11 and April 27 (the period during which spawning was actually observed), spawning was noted on only 10 days. There were periods during each of these ten days when the sky was either clear or partly cloudy (Table 3). On six of the remaining seven days the skies were completely cloudy. On the seventh day the skies were cloudy all but seven hours, when it was partly cloudy.

The data presented in Table 3 on wind velocity and direction are not complete enough for definite correlations with spawning activities. From information available, spawning occurred on more calm days than on days when strong winds were blowing. This may have been partially due to the fact that it was easier to make observations on clear, calm days.

Actual spawning observations were limited to some extent by the following:

1. Ice, cloudiness and wind have been discussed above.
2. Other duties made it impossible to obtain continuous observations.
3. The water in the ditches was mostly from swamp land, giving it a light brown color. It was impossible to see the bottom clearly in water over 1 1/2 feet in depth except when the sun was shining. Plankton, filamentous algae and duckweed also made it difficult to see the bottom clearly. Also present was a dense growth of marsh grass and other plants, especially in shallow water. Pike, both adult and fingerlings were able to hide successfully in this grass. The bottom of the ditches was covered in many places by a thin coat of black muck, making it difficult to distinguish dark objects.
4. The surface reflection was eliminated most of the time through the use of polaroid sun glasses.

A portion of each night was spent in making observations on the habits of the pike after dark. At no time were we able to detect fish in the

act of spawning at night. Most of the pike observed at night were not paired, but occurred singly.

Spawning pike were seen throughout the length of Ditches I and II, along one mile of Ditch III and in No. IV to a point opposite Phil Woodworth's house (approximately  $1/4$  of a mile from Ditch I). Most of the spawning took place in the shallow water, near the banks, where the marsh grass was most abundant. A number of flooded areas were noted adjacent to these ditches. Three of these flooded areas were used for spawning and were as follows: 1. An area approximately 100 feet long and 10 feet wide, north of Ditch I. 2. A large area 100 yards long and fifty feet wide north of Ditch II. 3. A small area 10 feet square, west of Ditch III. These marsh areas were flooded for the first time on April 17, when the melting snow and a  $1\frac{1}{4}$ -hour rain caused the ditches to overflow their banks. Water in these flooded areas varied in depth from one to 12 inches.

Pike do not construct a nest, but spawn over a large area of marsh or ditch, broadcasting their adhesive eggs on vegetation, sticks, etc. Most of the pike that we were able to see spawning were in very shallow water from  $1/4$  to 12 inches in depth. In this shallow water the grass and weeds were usually rather dense. In many cases the dorsal and/or caudal fins of the spawning fish were out of water. During the actual spawning, breeders could be located by the loud, resounding splashes caused by powerful blows of their tails. Until April 17, all spawning was found to occur in the shallow areas of the ditches, but after this date many spawning fish were occupying flooded marshy areas.

In the majority of cases two males accompanied each female during the spawning act, one male on either side, even with or slightly above or below the female. On one occasion one male and one female were spawning,

and in another instance three males were found paired with one female. In the normal spawning position, the males would press close to the body of the female. On one occasion we found the male (on the left side of the female) with his head and front half of his body below and slightly under the female, and the posterior portion of his body was arched above the female and projected above the surface of the water. Most groups of spawners would remain quiet during the rest periods between the spawning act. When actually depositing eggs and milt, the paired fish would move forward, lashing the water with their tails. The color of the water, reflections on the surface of the water and the forward motion plus the violent actions of the spawners made it most difficult to observe the position and action of individual fish during the spawning act. It was also difficult to approach spawning fish without frightening them. At night most fish could be readily approached, but during the day any movement startled and sent them scurrying for cover. When (and if) fortunate to approach a group of spawners, they would sometimes make another spawning dash. It was therefore rather difficult to observe the actions of the same group of spawners for any protracted length of time. After acquiring experience, we were able to approach within a foot of a group of spawners. Spawning fish would not remain in any one area for any length of time, but would go up or down stream, or in a circle (about 6-8 feet in diameter). Many times individual groups of spawners were observed to cover fifty to sixty linear feet of ditch during one "spurt." Rest periods were frequent. At times rest periods lasted but a few seconds between successive spurts; again rest periods lasted as long as a half an hour. Sometimes many successive dashes were made. Many times males were observed chasing other males that

were trying to approach the spot where a female was located. The chase would last for fifty feet or so, then the male doing the chasing would return to a spot near the female, but not always at her side. Loud splashes were sometimes heard during the pursuit. Once, while a large male and female were being watched, two smaller males approached and proceeded to move in position beside the female. The large male immediately gave chase. This process was repeated several times. The large male would often remain away for as long as five minutes at a time, and on returning would not always take up a position beside the female, but would remain at a distance of from two to five feet away. The female remained motionless the entire time. We were unable to observe actual spawning procedure in the flooded, marshy areas because of the shallow water and dense, high grass. On one afternoon approximately 40 pike were occupying the flooded marsh north of Ditch II.

Only single fish were observed at night. We never saw fish paired up at night. We were also unable to determine the length of time required by one female to deposit her entire supply of eggs.

#### The Downstream Run of Spawners

Two males were the first adult fish to be taken in the downstream trap (night of April 16). Both of these fish were still running milt, and were placed above the weir to see which way they would go. The two fish ran upstream and did not return. Again on the night of April 20, two fish ran downstream, but when the observer approached they became frightened and ran upstream. Two males ran downstream on April 21 and were placed in the lake. Several fish ran down to the weir on April 23 and 24. When they discovered that they could not get through (to the lake), they faced upstream. On the morning (7:30 a.m.) of April 25, six spent fish were in the grass beside the weir. They had probably attempted to get around

the weir by way of land. Three of these fish were dead and another died later. The remaining two were tagged and placed in the lake. (One of these died several days later and was washed up on shore.) On this same morning there were other fish in the weir trying to get into the lake. These fish jumped out of the water, swam up the ditch banks (attempting to swim around) and jumped several feet up on the ditch bank. Many of these fish were able to "flop" into the water again. Our biggest downstream run of fish occurred on April 26.

The total number of fish that ran downstream and were jaw tagged and released in Houghton Lake are given below.

<u>Date</u>	<u>No. of Fish</u>	<u>Date</u>	<u>No. of Fish</u>
April 25	1	May 7	11
26	77	8	4
27	53	9	4
29	26	10	4
30	23	11	2
May 1	26	20	3
2	32	21	5
3	12	23	1
4	15	30	2
5	25		
6	32	Total	<u>358</u>

A period of 35 days elapsed between the time the first pike came down until the last pike left the ditch. The majority of the spawners ran downstream to the lake during the first 12 days of the return run. A few stragglers remained in the ditches until May 30. From the evidence presented above, we find that adult pike do not return to the lake immediately after spawning. Whether this was due to the slight current in the ditches after May 10, we do not know. But it would seem logical to suppose that they might follow the current when leaving the ditches.

The majority of the spent pike were rather quiescent in the weir at

night. For the most part they faced upstream and when frightened would run up instead of downstream. On occasion they would fight the weir at night, in trying to get through. At daybreak and during the day the pike were restless and were always trying to get out of the weir.

Most of the fish were fin-clipped when they ran up to spawn. (When only two or three fish ran each night, fin-clipping was not attempted.) A different fin or combination of fins was clipped each night. This was performed to assist in determining the length of time each fish spent in the ditch and whether or not all of the fish that ran up to spawn on the same day would return at the same time. No correlation was found between the time the fish were fin-clipped and the time of return. From the first night's run on, a mixture of fin-clipped fish returned to the lake. Toward the end of the run some of the fish marked first returned.

The fish taken in the downstream trap were in relatively poor condition. Many were thin; others were scarred, injured and fungused, due both to fighting, spawning, fin-clipping, and injuries sustained in trying to go through the weir. Many pike were seen turning on their sides and trying to force their "bills" through the narrow openings between the slats of the weir. Several fish appeared to have been captured and partially swallowed by other pike.

A total of 358 pike were tagged. Besides those tagged, an aggregate of 60 pike were taken for samples, died in the ditch or were otherwise accounted for (Table 4). Therefore a total of 418 fish used this ditch system. Only 378 fish were actually counted going upstream to spawn. Mr. Peterson estimated that approximately 50 fish ran up the ditch the night of April 2 (the first night of the run). If we add these 50 to the 378 that were actually counted, we would have a total of 428 fish, or 10 less than were actually accounted for coming down. These 10 fish (more or less) may have been eaten by other pike, birds, turtles, or



may have died in the ditch unobserved.

Observations On Eggs and Young

The eggs of the northern pike are semi-adhesive and are broadcast over the vegetation, roots, debris and bottom. A few collections of eggs were made to determine the percentage of fertilization in nature. (Have not been examined yet.) It was rather difficult to locate the eggs. Certain areas where spawning was actually observed were marked with stakes, and egg collections were made later. Ovary counts from green females entering the weir are being made and will also be reported later.

The first fry were seen on the afternoon of May 5. At this time less than a half dozen were observed in the entire ditch system. On the morning of May 6, more fry were found. Late that same afternoon still more were showing up. Most of the fry remained close to shore in shallow water, and when frightened, would dart into the weeds or down to the bottom to hide. Even the smallest fry were exceedingly active. Many of these young still carried remnants of yolk. True yolk fry were not found. Late on the afternoon of May 6, small fry were found in all stretches of the ditches, and in sections of flooded marsh. The water in the ditches started to go down on April 30, and on May 6, only occasional isolated holes in the once flooded marsh contained water and between four and ten fry were seen in these holes. We were unable to determine the number of young pike that perished in the flooded areas of the marshes. Most of the fry are believed to flow the receding water.

Several days after hatching, fry were observed eating small plankters (zooplankton) in the water. Pike started feeding on one another at a length of 21 mm. ( 13/16 inch) -- See picture. A number of pike fry and fingerlings have been preserved and stomach examinations will be made at a later date.

On May 9, several pike fry were observed going through the culvert above Peterson's house in Ditch I. On May 10, six fry were seen in the adult pike weir opposite Peterson's house (100 feet from the lake), and were apparently moving toward the lake. The first fry were observed actually entering the lake on May 12; therefore on this day a fry trap was designed and installed by Mr. Harold Bowditch (see map for location of fry weirs). The trap was constructed by building two frames, each 2 1/2 feet wide and 6 feet long, covered with fine wire screen (see picture). These screens were placed in the ditch, each wing buried securely in one bank, and angling downstream to form a V. The small end of the V was left open. This gap was filled by nailing a large square, tin funnel on each side of each of the two wings. A glass minnow trap was slipped over the small end of the funnel that projected downstream. Later in the season wire minnow traps were substituted for the glass traps. On June 2 the plug was removed from the culvert leading between Ditches I and V. This was done to allow the water to drain from the ditches. At this time the water ceased to flow from the ditches into Houghton Lake because of the barrier of sand and debris that was piled at the mouth of the ditch by the wave action. Fry trap No. 1 was moved to a point approximately 2 miles from Peterson's house (location 2 on map, and now called fry trap No. 2). Fry trap No. 3 was installed on June 12 in Ditch I, next to the culvert joining Ditches I and V.

Table No. 5 summarizes the daily run of pike fry that were taken in the traps and released in Houghton Lake.

The majority of the pike fry returned to the lake during the month of May. More pike fry moved down the ditches on clear, bright days than

on cloudy days. It was observed that the young pike more or less drifted along with the current (head or tail first or sideways), just beneath the surface of the water. Altogether 7,239 young pike returned to the lake. This represents the total production resulting from the spawning of 108 females and 247 males. The dorsal fins of 1,651 of these young pike were clipped before they were released into the lake.

The average daily lengths of the young pike are presented in Table 6. In this table we have combined both preserved and fresh measurements because shrinkage factors on pike are not available. But regardless of the shrinkage (which should not be over 3 per cent), we are able to get a picture of the growth.

The maximum size attained by any pike when the ditches dried up on July 23 was 9 inches, and this fish was collected on July 10. During May, the growth increased steadily from day to day, averaging just under 2 mm. per day. By the first of June, over 6,000 pike had returned to the lake. During June and July some of the fish maintained an average growth of about two mm. per day, whereas some of the smaller pike because of a lack of the proper sized food grew very little. This may have been due to the fact that fewer pike were to be found in the ditch, as these smaller individuals probably made up the bulk of the food consumed by the larger pike fingerlings. Young fry, probably representing successive hatches of eggs, appeared in our daily collections up to and including May 13. Other broods may have appeared in the ditches even later than this, but were not taken because of our method of sampling. (Previous to May 12, when the traps were installed, dipping and seining were the methods employed in collecting the fish.)

On May 11, 185 pike fry, averaging 20 mm. in length, were dipped from the ditches, placed in milk cans and taken to the Drayton Plains hatchery, where they were released in experimental pond No. 9. This

pond was well supplied with minnows of all sizes during the entire summer. When drained on October 19, 1939 (over 5 months after being stocked), 10 pike were removed. These fish averaged 12.54 inches in length (total) with a minimum length of 11.25 inches and a maximum length of 14.25 inches.

The water in the ditch system ceased to flow on July 22. A few low spots and occasional potholes still contained water for several weeks after this. These holes were thoroughly seined and the majority, if not all, of the pike, were removed. The ditches remained dry until the middle of August, when heavy rains placed several inches of water in the entire ditch system.

Would it be possible for pike to remain in the ditches over winter? We are of the opinion that they could not. In the first place, the ditches are dry during the latter part of the summer, and during the winter are frozen to the bottom, except for a few deep holes. If pike were expected to live in the ditches over winter, they would have to enter during late fall or early winter; and if pike could enter the ditches at this time, so could minnows and game fish. None of these other species were found in the ditches during early spring.

#### Recovery of Tagged Adults in the Lake

The number of pike that were tagged in the ditches and released in Houghton Lake, together with the total recovery of tagged fish, is presented in Table 7.

Of the 358 pike that were tagged, 72, or 20.11 per cent, have been reported caught. This is a high percentage of recovery considering that no creel census was in operation at Houghton Lake. The records were

turned in by the boat livery men, conservation officers and the fishermen themselves. Posters describing the tagging and the type of data required for each tagged fish captured were placed at many conspicuous points about the lake. We have heard of several tagged pike that were caught but were not reported. The first month of the pike fishing season is the best time of the year to catch pike in Houghton Lake. This is a well known fact among the people living at Houghton Lake. Over 80 per cent of the tagged pike recovered were taken during May. In June only 11 per cent were taken. During the remainder of 1939 only 7 per cent were caught. Only one fish has been reported taken through the ice up to the middle of February, 1940.

By comparing the number of pike that were tagged each day with the returns during the season from this same day's tagging, we find that on April 26, 77 pike were tagged and 26 (33.8 per cent) were recovered during the entire season. On April 27, 53 pike were tagged and 13 (24.5 per cent) were recovered during the season. In other words, more than half (54.2 per cent) of the pike recovered were tagged and released the first two days of tagging. Of the total of 36 pike that were tagged after May 6, only 4 have been recovered, and 3 of these were from the 4 fish that were tagged on May 10.

Of the 72 pike that were recovered, the average time that elapsed between the time of tagging and the time of capture was 28.4 days, and the time varied from 31.5 hours to 279 days (Table 8). More than half of the fish were recovered within 16 days after tagging.

The average number of miles from the point of capture to the place at which the 72 pike that were caught were tagged was approximately

2.55 miles and varied between 1/8 of a mile to 8.25 miles. Several fish were captured a few hours after tagging, and in these few hours had traveled more than 2 miles from the point of release (Table 8).

Approximately half of the fish recovered were caught in Muddy Bay. North Bay was next in number of fish taken. Only 15 fish were recovered at other parts of the lake.

A total of 425 fish have been tagged in Houghton Lake. Besides the fish mentioned in this report, the following species have been tagged and released: 23 northern pike tagged in the Muskegon River, and 16 walleyed pike tagged in the Muskegon River. These fish have already been discussed in another report on the Muskegon River weir. Mr. Harold Bowditch tagged and released 28 different fish that he caught while fishing in Houghton Lake. These consisted of 1 northern pike, 21 walleyes, 3 small-mouthed bass, 2 large-mouthed bass and 1 rainbow trout. One of the walleyed pike tagged by Bowditch was taken 24 days after tagging. This fish was caught 5 miles from the point where it was released.

Recommendations For the Improvement of Pike Fishing in  
Houghton Lake

Pike fishing has been fairly good in Houghton Lake in the past. For the past few years many complaints have been received relative to the apparent scarcity of this fish in Houghton Lake. Institute for Fisheries Report No. 363, summarizing Tom White's (Conservation Officer at Houghton Lake) creel census, also verifies these statements. John Peterson and others have noticed the decrease during the past few years in the number of pike ascending the ditches in the spring. There are several points that should be discussed at this time relative to spawning.

(1) The ditch system discussed in this report is rather extensive and according to residents of Houghton Lake, many thousands of fish spawned

here years ago. During the past year slightly more than 400 pike ran up this ditch. The amazing thing is that only 7,200 young pike, the progeny of 400 adults, returned to the lake. If we could be certain that each of these young pike would live to reach legal length, the results of this spawning would perhaps provide full creels for many fishermen. But at this time we are uncertain as to the number of pike that will survive, but we will hazard a guess that not many will survive. We must recall that 6,000 of these young returned to the lake before reaching a length of over 2 1/2 inches. These small fish would be easy prey for larger game fish. We do not know the number of eggs deposited by each female (many ovaries were collected and will be examined soon), but are certain that it would average at least 10,000 for each female. On the basis of this, we could assume that at least 1,000,000 eggs were deposited during the spawning.

(2) The Peterson ditch system connects Houghton Lake with the Muskegon River. In late spring, when the water is high in Houghton Lake, a barrier is formed at the mouth of the ditch by wave action. Therefore, the water in the ditches drains directly into the Muskegon River at a point at least 6 miles below Houghton Lake. This means that many young pike go directly into the river. It is doubtful whether these fish would ever return to Houghton Lake.

(3) Another factor that must be considered are the minnows and young yellow perch that run up Peterson's ditch at about the time the pike eggs are hatching. Whether these fish ascend the ditches to feed on the pike fry, to spawn, or are just attracted by the warmer water in the ditches, has not been determined. In 1939 we allowed these fish to enter the ditch for one day only, and then placed a screen across the ditch to keep them out. Samples of these minnows and perch were taken at intervals during the time the young pike were in the ditches. Stomach examinations

will be made at a later date.

(4) In the early spring the marshes are flooded. At this time the pike are spawning and many spawners prefer this shallow, flooded marsh area for spawning. It is a known fact among fisheries biologists and fishermen that many pike perish when left stranded by declining water levels and drying marshes. This can be remedied to a certain degree at Peterson's by plugging the culvert between Ditches I and V, and if necessary, by plugging the mouth of the ditch.

(5) For the past ten years land owners have been filling in marshy land along the lake shore. This practice, while increasing the number and price of good lake lots, has also decreased tremendously the amount of available spawning territory. At the present rate of increase, it will be just a matter of a few years until all lake shore property will be occupied by cottages.

(6) In the past it has been the habit of land owners to plug the ditches to keep spawning fish from entering from the lake in the spring. They contend that many adult pike may be speared, or stranded, or run into the Muskegon River and therefore be lost to fishermen. They are also afraid that many of the young are stranded when the water recedes or dries up in the marshes. As stated in the beginning of this report, there are a number of permanent creeks entering Houghton Lake, but the extent that these are used by spawning pike has not been determined. Furthermore, we are not certain whether or not pike will spawn in the shallow, weedy portions of the lake. The facts pointed out above may make it necessary some time in the future for the state or county to set aside or buy certain ditches for pike to spawn in. Specific areas--namely Blood Creek, at the north end of the lake, and Burnt Point at the southwestern end of North Bay--are known to be of value for northern pike spawning and may be suggested at this time.



The investigation at Houghton Lake is to be continued this year. More definite answers to the questions raised in this study and more specific recommendations should be possible at the conclusion of the research in 1940.

INSTITUTE FOR FISHERIES RESEARCH

TABLE 1. DAILY AND HOURLY SPAWNING RUN OF NORTHERN PIKE

Date	Total Daily Run	Number of Males	Number of Females	Time of Run (Periods)					
				12 p.m. to 9 a.m.	9 a.m. to 12 noon	12 noon to 3 p.m.	3 p.m. to 6 p.m.	6 p.m. to 9 p.m.	9 p.m. to 12 p.m.
April 2	↓ 50 ±	...	...	...	...	...	...	...	...
3	15	11	4	...	...	...	1	2	12
4	53	32	21	...	...	1	1	15	36
5	4	2	2	2 ↓ 10	...	...	1	3	...
6	26	10	16	3 ↓ 19	...	...	...	2	5
7	7	6	1	5	...	...	...	...	2
8	8	4	4	7	...	...	...	1	...
9	6	3	3	3	...	...	...	1	2
10	9	1	8	3	...	...	...	2	4
11	11	3	8	2 ↓ 4	...	...	2	2	7
12	5	2	3	3	...	...	...	...	2
13	16	12	4	3	...	1	...	2	10
14	12	6	6	4 ↓ 7	...	...	...	4	1
15	9	6	3	...	...	...	1	5	3
16	31	22	9	5 ↓ 14	...	2	1	8	6
17	9	6	3	...	...	...	...	2	7
18	16	7	9	4	...	...	...	3	9
19	11	11	0	5 ↓ 4	...	...	...	5	2
20	27	20	7	...	...	1	1	14	11
21	29	17	12	10	...	...	1	5	13
22	26	20	6	15	...	...	...	3	8
23	24	22	2	6 ↓ 8	...	1	...	6	17
24	11	11	0	8	1	2	...	...	...
25	13	13	0	13	...	...	...	...	...
Total	↓ 378	247	131	118	1	8	9	85	157

↓ Reported by John Peterson -- estimated -- ran from 9 p.m. on.

↘ Escaped -- ran back into lake.

↘ Observations not made between 10 p.m. (of night before) and 8 a.m. of April 6.

↓ Six fish entered weir between 3:30 and 7:30 a.m.

↘ Fourteen fish entered weir between 12:00 p.m. and 1:30 a.m.

↘ Eight fish were in weir at 3:00 a.m. -- escaped during night.

↓ Not counting the fifty fish that ran on April 2.

TABLE 2. AVERAGE DAILY LENGTH OF MALE AND FEMALE

SPAWNERS, 1939. (Averages in mm. and inches)

Date	Total Length of Males				Total Length of Females			
	Number in Sample	Minimum	Average	Maximum	Number in Sample	Minimum	Average	Maximum
April 3	7	465	547.3	663	4	566	634.7	770
4	26	497	567.4	675	9	518	606.3	735
10	1	559	559.0	559	8	571	707.9	952
11	3	479	486.7	495	8	527	578.1	667
12	2	489	519.0	549	3	543	560.0	578
13	12	475	519.1	632	4	502	577.7	641
14	6	468	515.0	582	6	483	523.7	578
15	6	462	541.8	641	3	565	578.7	599
16	21	456	536.8	665	9	505	556.4	635
17	6	499	533.8	610	3	534	587.7	659
18	7	475	566.0	682	9	530	571.7	665
19	11	468	530.4	625	0	...	...	...
20	20	459	531.3	624	7	541	601.8	675
21	17	417	534.8	621	12	484	608.4	889
22	20	452	548.8	626	6	528	609.5	721
23	22	501	556.0	651	2	599	631.0	663
24	11	487	552.2	650	0	...	...	...
25	13	313	532.3	639	0	...	...	...
Total	211		537.65 mm. (21.2 inches)		93		595.6 mm. (23.5 inches)	

TABLE 3. DAILY AIR AND WATER TEMPERATURES AND OTHER PHYSICAL DATA POSSIBLY CONNECTED WITH PIKE SPAWNING

Date	Average Air	Average Water	Sky--			Wind	Snow or Rain	Condition of Ditch	Clear sky During the Day	Partly Cloudy Sky During the Day	Spawning Noted
			Approx. No. of Hours								
			Clear	Partly Cloudy	Cloudy						
April 2	38	36 (1)	24	...	...	N. - strong	...	Ice	12	...	...
3	43.7	36.7 (4)	24	...	...	N. - strong	...	Ice	12	...	...
4	37.0	38.0 (4)	24	...	...	N. - strong	...	Ice	12	...	...
5	29.8	35.4 (5)	...	8	16	N. - NW.	Rain and snow	Ice	0	0	...
6	25.2	33.7 (4)	2	...	22	N. - strong	Snow	Ice	0	...	...
7	20.7	33.7 (3)	5	12	7	N.	Snow	Ice	0	12	...
8	23.0	35.0 (4)	8	2	14	Calm	...	Ice	3 $\frac{1}{2}$	2	...
9	34.4	37.5 (5)	12	12	...	N. wind to calm	...	Ice	5	6	...
10	30.2	36.2 (4)	8	6	10	Calm to N. wind	...	Ice	0	...	...
11	27.6	37.3 (7)	10	6	8	NW to calm to N wind	Snow	Ptly. open	.2	4	x
12	23.0	35.6 (6)	...	2	22	W. - brisk	Snow	Ice	0	0	...
13	31.0	38.5 (6)	16	...	8	NW.	...	Ptly. open	12	...	x
14	33.2	37.2 (5)	...	...	24	W.	Snow	Ice	0	...	...
15	38.6	42.8 (7)	16	4	4	Calm	...	Ptly. open	7	5	x
16	35.5	40.7 (4)	...	...	24	E. - brisk	...	Open	0	...	...
17	37.5	36.0 (4)	...	...	24	Calm	Rain	"	0	...	...
18	36.7	38.0 (4)	...	8	16	NE.	Rain	"	0	6	...
19	33.7	36.5 (4)	...	...	24	Calm	Snow	"	0	...	...
20	51.0	44.7 (4)	...	8	16	Calm	Rain	"	0	7	x
21	38.8	42.6 (5)	...	8	16	Calm	Rain	"	0	...	...
22	48.5	49.0 (4)	24	...	...	W.	...	"	12	...	x
23	45.8	50.0 (6)	3	18	3	Calm to strong E.	Rain	"	0	9	x
24	61.0	55.0 (5)	6	18	...	E. to W.	...	"	6	6	x
25	63.3	57.3 (3)	24	...	...	Calm	...	"	12	...	x
26	63.3	60.7 (3)	24	...	...	Calm	...	"	12	...	x
27	50.2	56.2 (4)	...	4	20	N.	...	"	0	...	x
28	43.0	50.5 (4)	...	...	24	W.	...	"	0	...	...
29	49.6	49.0 (3)	12	2	10	NW.	...	"	12	...	...
30	33.6	50.7 (3)	9	10	5	Calm	Rain	"	2	10	...

TABLE 4. HOUGHTON LAKE NORTHERN PIKE EXPERIMENT - 1939.

KNOWN LOSS OF SPAWNING PIKE IN DITCHES

Date	Number	Sex	Nature of Death
April 4	7	♀	Saved for sample
15	2	♀	" " "
16	2	♀	" " "
18	3	♀	" " "
20	1	♀	" " "
21	3	♀	" " "
22	2	♀	" " "
23	1	♀	" " "
Total	21		
April 20	1	♀	Stripped, eggs fertilized, ♀ not killed -- placed in lake.
25	1	♀	" " " " " " " " " "
Grand Total	23	♀	not allowed to spawn in ditch
April 21	2	♂	Placed in lake without being tagged
26	1	...	Escaped handlers -- went into lake -- not tagged
May 21	2	...	Placed in lake without being tagged
May 25	1	...	One escaped handlers without tagging
Total	6		fish escaped or placed in lake without tagging
April 25	5	...	Dead in ditch -- jumped out of weir (running downstream)
	1	...	One of above fish had partially digested pike in stomach
26	1	...	Large ♀ - 37.5" long died in ditch (Ran up to spawn on April 11)
	1		One partially digested 15" (T.L.) pike in stomach of above fish
	1		Found dead in weir
30	1		Died in ditch
	1		" " " -- jumped out
May 1	1		" " " " "
6	1	♀	Died in ditch -- had spawned
9	2		" " "
11	1		Preserved for sample
14	1		Found dead in ditch. Examined and buried
17	2		" " " " " " "
22	2		" " " " " " "
June 1	1		" " " " " " "
7	4		" " " " " " "
18	4		" " " " " " "
Total	31		died in ditch

Summary of Above

23 females not allowed to spawn  
 6 fish were not tagged  
 29 fish died in ditch  
 2 fish found in stomachs of above fish  
60 Dead or accounted for -- other than those fish that were tagged

TABLE 5. NORTHERN PIKE EXPERIMENT -- HOUGHTON LAKE -- J. PETERSON'S -- 1939

DAILY RECORD OF THE RETURN OF NORTHERN PIKE FRY TO LAKE

Trap No. 1			Trap No. 2			Trap No. 3					
Date	Number Taken	Number Fin-clipped	Date	Number Taken	Number Fin-clipped	Date	Number Taken	Number Fin-clipped			
May	12	80	...	June	2	27	27	June	12	1	1
	13	85	...		3	75	61		13	13	13
	14	20	...		4	24	19		14	8	8
	15	11	...		5	21	14		15	4	0
	16	56	...		6	17	17		16	7	7
	17	192	...		7	56	51		17	10	10
	18	249	...		8	59	57		18	8	5
	19	206	...		9	59	58		19	10	10
	20	626	...		10	8	0		20	7	5
	21	211	...		11	14	12		21	4	3
	22	1,314	...		12	5	5		22	6	6
	23	803	...		13	8	7		23	3	3
	24	580	...		14	2	2		24	5	3
	25	244	...		15	1	1		25	5	5
	26	278	...		16	2	2		26	4	4
	27	217	...		17	6	6		27	6	6
	28	208	...		18	28	25		28	5	5
	29	290	272		19	4	4		29	3	3
	30	188	184		20	2	2		30	2	2
	31	185	101		21	1	1	July	1	0	0
June	1	21	19		22	3	3		2	4	4
	2	0	0		23	3	3		3	6	6
		<u>6,094</u>	<u>576</u>		24	14	14		4	8	8
					25	11	9		5	7	6
					26	13	13		6	1	1
					27	6	6		7	9	9
					28	4	4		8	1	1
					29	6	5		9	1	1
					30	10	10		10	0	0
				July	1	5	5		11	3	3
					2	6	5		12	17	17
					3	21	20		13	4	4
					4	43	42		14	2	2
					5	16	16		15	4	4
					6	19	18		16	0	0
					7	68	68		17	1	1
					8	24	24		18	0	0
					9	19	19		19	0	0
					10	8	8			<u>179</u>	<u>166</u>
					11	19	18				
					12	27	26				
					13	34	34				
					14	25	25				
					15	8	8				
					16	10	10				
					17	0	0				
					18	0	0				

Table 5 - Continued

		Trap No. 2	
July	19	1	1
	20	0	0
	21	2	2
	22	1	1
	23	0	0
		<u>845</u>	<u>788</u>
		No.	No.
		taken	clipped

Pike fry<sup>1</sup> dipped from Peterson's minnow tank, and outlet of minnow tank

Date	No. Fish	No. Fin-clipped
May 15	18	18
19	61	61
20	6	6
21	16	16
22	4	4
23	6	6
	<u>2 10</u>	<u>10</u>
	121	121

<sup>1</sup> The overflow from Peterson's minnow tank emptied directly into the ditch. Several times during the summer the screen broke loose, allowing the pike to run into the tank.

<sup>2</sup> Sained from pools in the ditches.

TOTALS	No. Fish	No. Fin-clipped
Trap 1	6,094	576
Trap 2	845	788
Trap 3	179	166
Minnow tank	<u>121</u>	<u>121</u>
Grand total	7,239	1,651

TABLE 6. HOUGHTON LAKE (J. PETERSON'S DITCH) NORTHERN PIKE EXPERIMENT (1939)

## MEASUREMENTS OF YOUNG PIKE THAT HATCHED IN THE DITCHES

Date	Number in Sample	Total Length in mm.			Preserved measurements in laboratory -- or measurements of live fish later released in Houghton Lake	
		Min.	Average	Max.		
May	6	32	11	13.78	17	Preserved meas.
	7	22	12	16.41	21	" "
	8	44	12	17.48	23	" "
	9	32	14	19.16	30	" "
	10	22	12	19.91	27	" "
	11	15	13	20.80	30	" "
	12	23	13	22.26	29	" "
	13	15	14	22.93	28	" "
	14	25	17	28.80	39	" "
	15	15	17	25.33	33	" "
	17	12	20	29.25	38	" "
	18	9	20	27.27	36	" "
	19	8	21	29.50	38	" "
	20	10	23	32.10	42	" "
	22	15	21	34.67	52	" "
	24	10	29	39.30	56	" "
	25	27	35	48.70	66	" "
	27	16	27	48.62	77	" "
	29	12	38	53.50	79	" "
	31	104	36	56.09	114	" " 38 were meas. on live fish
June	1	16	48	69.87	96	" " 12 " " " " "
	3	9	53	59.22	81	" "
	5	7	59	86.14	113	" "
	7	5	37	82.20	125	" "
	8	20	60	106.2	127	All were meas. on live fish
	9	48	97	114.35	129	" " " " " "
	10	12	48	90.08	125	Preserved meas.
	15	4	89	106.75	129	" "
	18	30	54	120.70	160	" " 24 were meas. on live fish
	20	2	59	111.50	164	All were meas. on live fish
	21	1	124		124	Preserved meas.
	24	19	121	139.89	178	All were meas. on live fish
	25	11	122	147.45	194	" " " " " "
	27	3	144	181.67	215	" " " " " "
July	2	5	116	159.40	200	" " " " " "
	3	26	77	157.23	191	" " " " " "
	4	51	119	168.25	212	" " " " " "
	5	22	54	167.43	198	Preserved meas. 21 were meas. on live fish
	6	19	99	174.74	203	All were meas. on live fish
	7	77	108	161.81	213	" " " " " "
	8	25	139	178.28	200	" " " " " "
	9	20	122	177.00	210	" " " " " "
	10	8	111	174.37	229	" " " " " "
	11	37	94	170.64	211	Preserved meas. 36 were meas. on live fish
	12	30	114	167.07	211	All were meas. on live fish
	13	38	109	154.05	211	All were meas. on live fish
	14	27	107	143.56	206	" " " " " "
	15	30	101	164.37	216	" " " " " "
	16	10	110	132.50	155	" " " " " "
	19	62	116	173.11	219	" " " " " "
	20	6	152	176.83	212	" " " " " "
	21	18	98	163.94	205	" " " " " "
	22	5	126	171.40	207	" " " " " "
	23	16	107	160.44	191	" " " " " "
						1,187



TABLE 7. DATE OF TAGGING, NUMBER OF PIKE TAGGED AND NUMBER RECOVERED DURING TIME PERIODS IN 1939. ALSO PER CENT OF RECOVERY OF TOTAL NUMBER TAGGED, FOR EACH TIME PERIOD AND EACH DAY

Date Tagged	Number Tagged	Number Recovered in Time Period During 1939										Caught Feb. 1, 1940	Total Number Recovered	% Recovered Each Day Tagged
		Apr. 25-30	May 1-15	May 16-31	June 1-15	June 16-30	July 1-15	July 16-31	Aug. 1-31	Sept. 1-30				
April 25	1	...	↓...	...	...	...	...	...	...	...	...	...	0	0
26	77	...	18	7	...	1	...	...	...	...	...	...	26	33.77%
27	53	...	5	2	2	1	...	1	...	1	...	1	13	24.5%
29	26	...	2	...	...	...	...	...	...	...	...	...	2	7.7%
30	23	...	2	1	2	...	...	...	...	...	...	...	5	21.7%
May 1	26	...	2	2 4	2	...	...	...	...	...	...	...	8	30.77%
2	32	...	3	...	...	...	1	...	...	...	...	...	4	12.5%
3	12	...	1	1	...	...	...	...	...	...	...	...	2	16.7%
4	15	...	...	...	...	...	...	...	...	...	...	...	0	0
5	25	...	1	...	...	...	...	...	...	1	...	...	2	8 %
6	32	...	4	2	...	...	...	...	...	...	...	...	6	18.75%
7	11	...	1	...	...	...	...	...	...	...	...	...	1	9.1%
8	4	...	...	...	...	...	...	...	...	...	...	...	0	0
9	4	...	...	...	...	...	...	...	...	...	...	...	0	0
10	4	...	...	2	...	...	...	...	1	...	...	...	3	75 %
11	2	...	...	...	...	...	...	...	...	...	...	...	0	0
20	3	...	...	...	...	...	...	...	...	...	...	...	0	0
21	5	...	...	...	...	...	...	...	...	...	...	...	0	0
23	1	...	...	...	...	...	...	...	...	...	...	...	0	0
30	2	...	...	...	...	...	...	...	...	...	...	...	0	0
Total 20 days	358	0	39	19	6	2	1	1	1	2	1	1	72	20.1117% recovered from total number tagged
% of the total No. recovered			54.17%	26.38%	8.33%	2.77%	1.38%	1.38%	1.38%	2.77%	1.38%			
														99.94% - Total

↓ The fishing season opened on May 1. It is probable that if the season had opened on April 25 more tagged pike would have been taken.

2 One of these caught and returned -- just undersize.

TABLE 8. HOUGHTON LAKE NORTHERN PIKE EXPERIMENT -- 1939

Tagged pike recovered -- giving the number of days that elapsed since tagging-- distance of the location of capture from place of tagging.

Number of Days Out	Distance in Miles (Average)	Number of Fish Taken
31½ hrs.	2.25	1
42 hrs.	2.75	1
55 hrs.	2.75	1
5 days	.125	2
6	2.75	1
7	2.25	3
8	3.625	2
9	2.3	5
10	3.31	4
11	2.59	4
12	2.625	5
13	1.56	4
15	2.75	1
16	2.75	4
17	2.5	2
18	2.5	1
19	2.75	1
20	.5	1
21	4.0	3
25	.5	1
26	5.625	2
29	.375	2
31	2.75	1
32	.937	2
33	1.25	2
34	1.25	3
36	3.75	1
39	3.0	1
41	3.625	2
46	4.25	1
62	2.75	1
63	5.5	1
65	2.75	1
84	3.5	1
88	3.5	1
123	3.5	1
144	2.75	1
279	4.333	1
<u>28.4 - ave. no.</u> of days out	<u>2.555</u> ave. miles	<u>72</u>

TABLE 9. HOUGHTON LAKE NORTHERN PIKE EXPERIMENT -- 1939

AVERAGE DAILY AIR AND WATER TEMPERATURES FOR MAY, JUNE, AND JULY, 1939

Date	Air	Water	Date	Air	Water	Date	Air	Water
May 1	31.0	48.0 (2)	June 1	64.3	71.0 (3)	July 1	68.6	68.3 (3)
2	38.0	52.0 (2)	2	71.3	71.6 (3)	2	70.6	72.3 (3)
3	39.0	51.0 (2)	3	66.2	69.5 (4)	3	74.3	73.3 (3)
4	55.0	56.0 (3)	4	68.5	68.7 (4)	4	73.3	73.0 (3)
5	65.0	61.3 (3)	5	74.6	70.2 (5)	5	75.3	76.0 (3)
6	71.3	67.3 (3)	6	71.8	72.2 (5)	6	86.0	85.6 (3)
7	71.0	68.0 (3)	7	70.3	71.6 (3)	7	78.0	83.6 (3)
8	62.6	66.6 (5)	8	68.0	69.0 (5)	8	72.6	79.0 (3)
9	62.7	66.5 (4)	9	63.5	65.5 (4)	9	72.0	76.7 (3)
10	51.6	58.3 (3)	10	66.6	65.0 (3)	10	63.6	73.3 (3)
11	36.0	52.2 (4)	11	53.0	60.5 (2)	11	66.5	72.5 (2)
12	45.5	55.2 (4)	12	45.8	53.2 (5)	12	75.0	75.0 (2)
13	47.2	54.0 (4)	13	59.7	60.5 (4)	13	81.6	80.0 (3)
14	51.5	53.5 (4)	14	63.7	64.0 (4)	14	59.0	68.0 (2)
15	45.7	56.0 (4)	15	59.3	61.0 (3)	15	62.6	70.0 (3)
16	49.5	58.0 (4)	16	54.5	56.5 (2)	16	49.5	67.5 (2)
17	42.7	55.2 (4)	17	55.5	59.0 (4)	17	65.3	70.0 (3)
18	50.6	55.6 (5)	18	64.6	64.3 (3)	18	71.0	73.3 (3)
19	57.0	61.7 (4)	19	69.0	68.2 (5)	19	71.3	71.6 (3)
20	56.0	62.0 (4)	20	71.5	70.0 (4)	20	57.0	59.0 (1)
21	53.7	60.3 (3)	21	66.7	69.6 (3)	21	72.5	72.0 (2)
22	64.2	64.1 (6)	22	69.0	70.0 (3)	22	59.0	59.0 (1)
23	51.1	64.0 (3)	23	65.3	70.2 (3)	23	69.5	72.0 (2)
24	52.0	59.6 (3)	24	74.6	73.6 (3)			
25	55.3	60.0 (3)	25	73.6	77.0 (3)			
26	68.7	66.2 (4)	26	78.0	78.3 (3)			
27	68.2	69.0 (4)	27	73.3	74.0 (3)			
28	58.3	67.6 (3)	28	72.3	78.3 (3)			
29	54.6	64.6 (3)	29	77.0	77.3 (3)			
30	71.5	70.2 (4)	30	66.0	72.0 (3)			
31	74.4	75.0 (5)						



Looking north along Ditch No. 3. Note flooded right bank with dense growth of marsh grass.



Northern pike fry removed from Peterson's ditch on May 21, 1939. Each pike has tail of another pike projecting from mouth. From the bottom upwards these pike are 21, 22 and 23 mm. in length.



Front view (looking upstream) of pike fry trap on Peterson's ditch. Note vegetation in ditch.



Back view (looking downstream) of pike fry trap on Peterson's ditch. Houghton Lake is in the background.



Looking west along Ditch No. 1. Note dense vegetation along ditch banks (leather leaf and marsh grass).

