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OPERATION OF THE MUSKEGON RIVER FISH WEIR, 1939

by

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In view of the interest expressed by the Fish and Game Divisions in the role that Houghton Lake may play in contributing to the fish supply of the Muskegon River and the Muskegon River Flooding Project, a two-way fish weir was installed during the spring of 1939 on the river approximately one mile below Houghton Lake and one-eighth of a mile below the Roscommon County Dam.

The site chosen for the weir was decided upon after cruising all of the river that was accessible by road. This site was approximately the same as the one used in the past by the CCC. The important reasons for selecting this site are as follows: (1) accessibility; (2) favorable bottom for driving stakes; (3) the maximum depth did not exceed three feet. Although the river was wide at this point (120 feet) and the north bank was low, other locations, where the river was narrow and the banks were high, had unfavorable depth and bottom for successful operation of a weir.

The design for the weir is a combination of the ideas of Dr. D. S. Shetter of the Institute for Fisheries Research, Mr. H. L. Peterson, Superintendent of the Grayling Hatchery, and the writer. Changes were made from time to time when certain faults in construction were noted.

The writer and Mr. Harold Bowditch were mainly responsible for these changes.

The Muskegon River weir was installed by the Houghton Lake CCC. We are indebted to Mr. Sam Cline, Superintendent of the camp, for his cooperation, assistance, and for the loan of certain materials, and to Mr. Peterson for the transportation of materials and for the loan of equipment. I wish to thank Dr. A. S. Hazzard for suggestions offered during the operation of the weir. I am grateful for the assistance rendered by Mr. Harold Bowditch, Mr. Tom White, Mr. Houghton King and Mr. Phil Woodworth.

The weir consisted of a main arm 151 feet long, blocking the stream in an almost north and south direction, and at an angle of about 25 degrees with the current. The traps were connected to the ends of the main arm. The trap taking the fish going downstream was located on the upstream side of the main arm (see diagram), and the trap that caught the fish moving upstream was located on the downstream side of the main arm. The main arm was constructed by driving a row of pine posts, eight feet long, and with four to six inch tops, at intervals of six feet apart, across the stream. Each post was driven from 2 to  $3\frac{1}{2}$  feet into the bottom. Downstream two feet from each of these posts another row of posts was placed across the river, six feet apart, making a double row of posts across the river (see diagram). A double row of 2" x 4" 's approximately  $2\frac{1}{2}$  feet long connected the two rows of posts and acted as braces. Planks were placed on these double braces to form a catwalk across the river. To the upstream side of the first line of posts, 2" x 4" x 12' 's were spiked,  $1\frac{1}{2}$  feet above and parallel to the river bottom. Another line of 2" x 4" 's were nailed on the same posts,  $2\frac{1}{2}$  feet above the lower row (see diagram). These two lines of 2" x 4" 's

served to brace the posts and held the 1" x 2" slats in place. A space of  $1\frac{1}{2}$  inches was left between each slat. The slats were not nailed directly to the 2" x 4" 's, but were held in place by driving a ten penny nail on each side of the slat in both the upper and lower 2" x 4" (see diagram). When all of the slats were in place between the nails, a second 2" x 4" was spiked to each of the 2" x 4" 's holding the slats in position (see diagram). This piece of lumber added extra strength to the weir and kept the pickets from buckling when driven into the bottom. Stakes could therefore be driven into the bottom or replaced at any time and yet the spacing between them would remain constant. Additional posts were placed at intervals on both the down and upstream sides of the weir and were connected to the weir by braces to add extra strength.

The traps were boxes five feet square, constructed of 1" x 6" boards driven into the bottom. A space of one inch was left between each board. The main arm of the weir was used as one side of each trap (see diagram). When first constructed the traps were partially buried in the river bank, but on April 18, to increase the effectiveness of the weir, the upstream trap was moved out in the stream, 43 feet from the North bank, and the downstream trap was moved into the stream 28 feet from the South bank and increased in size to 5 x 8 feet. Each trap was fitted with hinged doors and was kept padlocked. The entrance to the traps underwent many changes until we were completely satisfied with their effectiveness. The funnel (or entrance) finally used was constructed of half inch heavy wire screen, and was three feet long and five inches in diameter at the small end of the funnel and thirty inches in diameter at the large end. The small end of the funnel projected 8 inches in from the side of the trap and was  $1\frac{1}{2}$  feet above the bottom of the river. Several large pieces of wire screen were

wired to the large end of the funnel, one on the bottom to serve as an apron, and one on either side to bring the funnel flush with the sides of the trap.

A boom, consisting of posts driven into the bottom of the river at intervals of ten feet and connected with floating logs, was placed approximately fifty feet above the weir. This boom was of great assistance in stopping logs and grass, especially during periods of high water.

The total cost of materials for the weir was \$84.84, exclusive of labor and truck expense. The materials, labor, etc. used in building the weir are itemized below.

Rough lumber (Norway)

|                              |      |            |                        |         |
|------------------------------|------|------------|------------------------|---------|
| 455' - 1x6x12                | at   | \$28.00    | per 1,000 B.F.         | \$14.14 |
| 98' - 1x4x12                 | at   | 28.00      | " " " "                | 2.74    |
| 740' - 1x2x8                 | at   | 35.00      | " " " "                | 25.90   |
| 328' - 2x4x12                | at   | 35.00      | " " " "                | 11.48   |
| 4' - 2x4x6                   | at   | 35.00      | " " " "                | .14     |
| 250' - 1x6x12                | at   | 18.00      | " " " " (Rough poplar) | 4.50    |
| 8 lb.- 6d nails              | at   | .06        | per lb.                | .48     |
| 22 lb.- 8d "                 | at   | .06        | " "                    | 1.32    |
| 36 lb.-10d "                 | at   | .05        | " "                    | 1.80    |
| 5 lb.-12d "                  | at   | .05        | " "                    | .25     |
| 15 lb.-20d "                 | at   | .05        | " "                    | .75     |
| 25 lb.-30d "                 | at   | .05        | " "                    | 1.25    |
| 2 padlocks                   | - at | .50        | each                   | 1.00    |
| 10 lbs. No. 12 wire          |      |            |                        | .80     |
| 4 pair, 6 "T" hinges         |      |            |                        | 1.00    |
| 2 1/2 inch wing hasps        |      |            |                        | .30     |
| 6 2/3 doz. 1 3/4 inch screws |      |            |                        | .45     |
| I. F. R. truck #1526         | -    | \$5.00     |                        |         |
| Carbine                      | -    | 5 1/2 days |                        |         |
|                              |      |            |                        | \$68.30 |

Materials, labor, etc. furnished by Houghton Lake CCC camp.

|                                      |                  |     |       |                                    |
|--------------------------------------|------------------|-----|-------|------------------------------------|
| Mandays - CCC                        | -                | 42  |       |                                    |
| CCC foreman                          | -                | 5   |       |                                    |
| Truck                                |                  |     | 30.00 |                                    |
| 80 posts, 4"-5" top, 8' long         | at               | .10 |       | \$ 8.00                            |
| 2 1/4 B.F. - 2x8x12                  | -                |     |       | 8.54                               |
| 15 green poplar logs                 | (no charge made) |     |       |                                    |
| Scrap (100 ft. 2x4 assorted lengths) | (no charge made) |     |       |                                    |
| Scrap (100 ft. 1x6 " " " ")          | (no charge made) |     |       |                                    |
|                                      |                  |     |       | Total for materials only - \$16.54 |

Materials furnished by H. L. Peterson, Sup't. of the  
Grayling Hatchery.

Use of tubs, dip nets, and truck  
5 square yards of  $\frac{1}{2}$ " mesh wire screen

The following species of fish were taken in the weir: common sucker (Catostomus c. commersonii), northern redhorse (Moxostoma aureolum), dogfish (Amia calva), great northern pike (Esox lucius), walleyed pike (Stizostedion vitreum), black bullhead (Ameiurus m. melas), rock bass (Ambloplites rupestris), bluegill (Lepomis macrochirus), spotted sucker (Minytrema melanops), northern channel catfish (Ictalurus l. lacustris), common sunfish (Lepomis gibbosus), and the smallmouth bass (Micropterus dolomieu).

The size range of the fish taken in the Muskegon River weir is presented in the following table.

| <u>Species</u> | <u>Total length in inches</u> |                |
|----------------|-------------------------------|----------------|
|                | <u>Minimum</u>                | <u>Maximum</u> |
| Redhorse       | 9.8                           | 22             |
| Common sucker  | 11.0                          | 25             |
| Dogfish        | 21.5                          | 30.5           |
| Northern pike  | 21.25                         | 40.25          |
| Walleye        | 14.5                          | 23.25          |

The results obtained from the operation of the weir are summarized in Table 1.

The major portion of the run was composed largely of suckers, with dogfish and redhorse next in abundance. Suckers are seldom caught by hook and line by fishermen in Houghton Lake, but are occasionally taken with the aid of a spear during ice fishing. Redhorse and suckers are much sought after during the spring migration when they are taken with spears and dip nets. Young suckers and redhorse are probably important items in the diet of the larger game species found in the river and in Houghton Lake. It is interesting to note that large numbers of dogfish migrated from the lake into the river for spawning. Numerous dogfish were observed in the

river and above the county dam for several weeks during their spawning season. All of the dogfish taken in the weir were killed and their stomachs were preserved for food analysis. (Stomachs were examined by Dr. K. F. Lagler, Report 569). Only a small percentage of the total run was composed of game fish.

The suckers and redhorse are primarily stream spawners and were expected to run in large numbers. Walleyes are known to spawn in lakes, in the mouths of large rivers, and occasionally in the slower stretches of rivers. Northern pike usually run upstream to spawn but will run downstream. Many sections of the river from Houghton Lake to Mead's Landing (about 2 miles below Houghton Lake) offer ideal spawning grounds for northern pike. The majority of the suckers and redhorse spawned in the river from about a quarter of a mile below the weir to the county dam and immediately above the dam.

Some of the fish caught going upstream had already passed through the downstream trap. We cannot be certain just how many of the fish that were caught in the downstream trap returned upstream because none of the fish were fin clipped or tagged. Some of the fish moving up may have been normal residents of the river, and a few may have gone downstream before the weir was installed.

Of the 1,701 fish taken in the two traps, 1,211 were taken in the downstream trap and 490 were taken in the upstream trap. The number of fish taken in each trap is as follows.

| <u>Downstream trap</u> |        | <u>Upstream trap</u> |       |
|------------------------|--------|----------------------|-------|
| Common sucker          | - 902  | Common sucker        | - 435 |
| Redhorse               | - 117  | Redhorse             | - 28  |
| Dogfish                | - 150  |                      |       |
| Walleye                | - 16   |                      |       |
| Northern pike          | - 13   | Northern pike        | - 16  |
| Bullhead               | - 8    | Dogfish              | - 10  |
| Rock bass              | - 3    | Catfish              | - 1   |
| Bluegill               | - 1    |                      |       |
| Spotted sucker         | - 1    |                      |       |
| Total                  | -1,211 | Total                | - 490 |

A large percentage of the suckers and redhorse died after spawning. Many of these fish that did run upstream probably died before reaching the lake. The number of fish that died above the weir and were picked up against the weir is as follows:

|                 |   |            |
|-----------------|---|------------|
| Redhorse        | - | 289        |
| Common sucker   | - | 7          |
| Walleyes        | - | 5          |
| Bullhead        | - | 19         |
| Rock bass       | - | 2          |
| Common sunfish  | - | 2          |
| Smallmouth bass | - | 2          |
|                 |   | <u>326</u> |

The largest movement of fish occurred between 6 and 10 P.M. Just an occasional fish entered the weir during the day and between midnight and morning.

There was no apparent correlation between the movement of the fish and the water temperatures taken.

The actions of the various fish in the vicinity of the weir and in the traps are as follows:

1. Common suckers were always on the move while in the trap. They were never quiet a second but would nose around covering every inch of the trap. If one sucker happened to find and go through a crack large enough to permit passage, or the opening of the funnel, the remaining suckers would "follow the leader" and escape. This happened several times during the course of our observations. Suckers would usually follow the (angle of the) weir toward the trap, but were easily frightened by any movement, or by a light (at night).

2. Redhorse, moving downstream, would follow the weir for short distances but usually would turn and go upstream before traveling more than 20 or 30 feet. This probably accounts for the small number of redhorse taken in the traps, because on several occasions large numbers of redhorse could be seen

immediately above the weir. Many redhorse spawned just upstream from the weir, whereas the suckers seemingly went farther downstream to spawn. Redhorse were much more elusive than suckers. They were also much harder to dip up and to seine. Redhorse were more easily frightened by lights and by the movements of observers than were suckers.

3. Because so few northern pike and walleyes were taken in the weir, observations on their actions are meager. Northern pike were successfully dipped up on several occasions before they had a chance to enter the traps. They were not as readily frightened by light or movements of the observer at night. Pike would remain quiet in the traps for long periods, occasionally jumping out of the water in trying to clear the top of the trap or weir. Many times northern pike were observed to turn on their sides and try to force their "bills" through the opening between the slats. This probably accounted for the sore and injured snouts of most of the pike taken. One night when we arrived at the weir to remove the fish from the traps, a loud noise could be heard from the river bank which sounded like something was ramming the main arm of the weir. On investigation we found that a large northern pike would retreat a short distance, then would run right into the weir. After watching this process repeated several times, we dipped up the fish and found that its nose was badly battered.

Table 2 gives the data on the northern pike and walleyes taken in the weir and the tagging results.

From the small number of northern pike and walleyes that were taken in the weir, we might assume that very few of them leave the lake to spawn in the river, or else the majority of them spawned above the weir. There is also a possibility that the run started before the weir was completed. People living at Houghton Lake insist that the pike run in the river before they run



in the ditches and marshes. Further proof that the run may have been earlier is that the majority of the pike running upstream had not passed through the downstream trap. Only four of the thirteen pike that passed through the downstream trap returned through the upstream trap while the weir was in operation. Pike No. 4104 (tag number), which was caught by a fisherman in Houghton Lake on May 23 while the weir was still in operation, was not reported going through our upstream trap. This pike, as well as others that did not return through our upstream trap, may have passed through the weir on May 11 or 12 when the weir was badly undermined due to the high water that resulted when the boards were removed from the county dam. The other six pike reported by fishermen were tagged while passing through the upstream trap.

None of the 16 walleyes recorded going downstream passed through the upstream trap. The question is did these pike return to the lake later in the summer or at the time when the weir was undermined or did they remain in the river? One of the walleyes tagged at the weir was caught out in the lake on July 3, fifteen days after the weir was removed. This may indicate that some of the walleyes returned to the lake.

No doubt there were many fish which would normally have run downstream or upstream that were not taken in the weir. This may have been caused by the fact that the weir frightened the fish, or that the angle of the weir was not great enough to lead them properly.

There has been some question as to whether or not the young of these species return to Houghton Lake. Fred Crooks, caretaker of the county dam, claims that many young pike go up over the dam in the fall. Minnow dealers around Houghton Lake report that many young suckers and redhorse are obtained in the vicinity of the county dam in the late summer and early fall. Our observations further corroborate this.

The majority of the suckers running upstream after spawning had lampreys attached (Table 3).

We have estimated that between 80 and 90 percent of the suckers were infested with lampreys. Accurate computations are not available because very few records concerning the lampreys were kept at the beginning of the season.

Lampreys had become attached to the suckers after they were released from the trap, or while they were spawning or on their return upstream. The scars on most of the fish examined were not prominent, indicating that the lampreys had been attached only a short time. The lampreys were collected by dipping the fish directly into large wash tubs. This was done to decrease the loss of lampreys because many of them drop off the fish as soon as they are lifted out of the water.

A total of 485 lampreys were removed from the 435 suckers that ran upstream (Table 3). This does not include the number of lampreys that dropped off the fish while dipping them out of the trap. It also includes the number of fish on which lamprey records are not available. Five lampreys were removed from fish other than suckers. One lamprey was taken from a northern pike and 2 lampreys were taken from both a redhorse and a dogfish. Because only an occasional lamprey was taken from fish other than suckers it leads us to conclude that the lampreys were more or less localized in the area where the suckers spawned.

The lampreys that were taken from the fish that were running downstream are listed as follows:

April 24 - 1 lamprey taken from 1 common sucker  
April 25 - 2 adult lampreys dipped out of trap  
May 1 - 1 lamprey taken from 1 sucker  
May 7 - 3 lampreys taken from 3 common suckers  
          3 lampreys taken from 1 dead redhorse  
May 9 - 15 lampreys taken from 3 common suckers

The lampreys that were taken on the first three days listed above were large adults, probably on their way downstream to spawn. The other lampreys were all small subadults.

The weir was removed by the Houghton Lake CCC June 19 and 20 because the small number of fish being taken did not justify the expense of keeping the weir operating. All materials used in the weir were salvaged and stored at the Grayling State Fish Hatchery.

#### Recommendations for 1940 weir.

1. The weir should be constructed in the same location. The same type of construction and same materials should be used. Some additional materials will be needed to replace those broken during removal. The weir should be built with a greater slope than the 1939 weir (at least at a 45° angle with bank).

2. The weir should be installed earlier than last year to determine whether pike and walleyes run before the suckers and redhorse.

3. The Roscommon County commissioners should agree to maintain the lake at a certain level. In 1939 the boards in the county dam were removed and replaced at will. The boards were removed four times while the weir was in operation. The County commissioners should be made to realize that sudden fluctuations in level leave many adult fish, eggs and spawn stranded in the marshes. The swift current following the removal of slash boards washes or covers with sand untold millions of eggs and fry downstream, probably killing many of them. On the lake itself the fluctuation in level during the early spring probably results in the death of many adult pike, eggs and fry.

4. A more complete investigation should be made of the lamprey problem to determine abundance and spawning grounds, to locate the ammocoetes and to determine the percentage of infestation.

5. The river should be closed to fishing and minnow seining between April 1 and July 1 for that portion of the river located between the county dam to 1/4 mile above Mead's Bridge.

6. An attendant should be located at the weir to eliminate the interference caused by poachers and sightseers.

7. Stomachs should be taken from all dogfish collected for examination.

INSTITUTE FOR FISHERIES RESEARCH

Report typed by A. Crowe

Table 1. Daily record of the number of fish taken in the Muskegon River Weir - 1939.

| Date     | Downstream    |          |         |               |                               | Upstream         |          |               |                    |  |
|----------|---------------|----------|---------|---------------|-------------------------------|------------------|----------|---------------|--------------------|--|
|          | Common Sucker | Redhorse | Dogfish | Northern Pike | Miscel-<br>Walleye<br>laneous | Common Sucker    | Redhorse | Northern Pike | Miscel-<br>laneous |  |
| April 19 | 57            |          |         | 2             | 1                             |                  |          |               |                    |  |
| 20       | 77            |          |         | 2             | 4                             |                  |          |               |                    |  |
| 21       | 97            |          | 1       | 1             |                               |                  |          |               |                    |  |
| 22       | 85            |          |         | 3             | 2                             |                  |          |               |                    |  |
| 23       | 41            |          | 4       |               | 3                             |                  |          |               |                    |  |
| 24       | 45            |          | 3       | 1             |                               |                  |          |               | 1 Bluegill         |  |
| 25       | 16            |          | 12      |               | 1                             |                  |          |               |                    |  |
| 26       | 33            | 1        | 4       |               |                               |                  |          |               |                    |  |
| 27       | 28            | 3        | 4       |               |                               |                  |          |               |                    |  |
| 28       | 40            | 3        | 7       |               |                               |                  |          | 2             |                    |  |
| 29       | 9             | 2        | 21      | 1 dead        |                               | 21               |          |               | 6                  |  |
| 30       | 23            | 3-       | 19      |               | 1                             | 8                |          |               | 4                  |  |
| May 1    | 38            | 1        | 6       | 1             |                               | 1                |          |               |                    |  |
| 2        | 22            |          | 5       | 1             |                               | 31               |          |               |                    |  |
| 3        | 44            |          | 1       |               |                               | 15               |          |               |                    |  |
| 4        | 44            | 2        | 1       |               |                               | 37               |          |               |                    |  |
| 5        | 35            | 7        | 5       |               | 1                             | 1 Rockbass       |          |               | 56                 |  |
| 6        | 33            | 6        |         |               |                               | 1 "              |          |               | 36                 |  |
| 7        | 31            | 6        | 2       | 1             |                               |                  |          |               | 38                 |  |
| 8        | 17            | 3        | 8       |               |                               |                  |          |               | 32                 |  |
| 9        | 26            | 2        | 18      |               |                               |                  |          | 1             | 1                  |  |
| 10       | 14            | 4        | 5       |               |                               | 1 Spotted sucker |          |               | 21                 |  |
| 11       | 8             | 9        |         |               |                               |                  |          |               |                    |  |
| 12       | 8             | 15       | 1       |               | 3                             | 1 Bullhead       |          |               | 2                  |  |
| 13       |               | 1        |         |               |                               |                  |          |               |                    |  |
| 14       | 1             |          | 1       |               |                               |                  |          |               | 1                  |  |
| 15       | 14            | 5        | 8       |               |                               |                  |          |               | 2                  |  |
| 16       | 3             | 4        | 2       |               |                               |                  |          |               | 1                  |  |
| 17       | 1             | 1        | 1       |               |                               | 1 Bullhead       |          |               |                    |  |
| 20       | 1             | 6        | 1       |               |                               | 1 "              |          |               |                    |  |
| 21       |               |          |         |               |                               |                  |          | 1             |                    |  |
| 22       | 2             |          | 1       |               |                               | 8                |          |               |                    |  |
| 23       |               | 1        |         |               |                               | 10               |          |               | 1                  |  |
| 24       | 2             | 1        |         |               |                               | 49               | 1        |               | 1 Dogfish          |  |
| 25       | 1             | 5        | 1       |               |                               | 12               | 5        |               | 1 Dogfish          |  |
| 26       | 1             | 3        | 3       |               |                               | 10               | 3        |               | 1 Dogfish          |  |
| 27       | 1             | 6        |         |               |                               | 3                | 2        |               | 1 Dogfish          |  |
| 28       | 1             | 5        |         |               |                               |                  | 7        |               | 1 Dogfish          |  |
| 29       | 1             | 6        | 1       |               |                               |                  | 3        |               |                    |  |
| 30       |               | 4        |         |               |                               |                  |          |               |                    |  |
| June 1   |               | 1        | 1       |               |                               |                  |          |               | 1 Dogf.            |  |
| 3        |               |          |         |               |                               | 2                | 2        |               | 1 Dogf.            |  |
| 4        |               |          |         |               |                               | 1                |          |               | 1 Catf.            |  |
| 5        |               |          |         |               |                               |                  | 3        |               |                    |  |
| 6        |               | 1        | 1       |               |                               | 2 Bullh.         | 1        |               | 2 Dogf.            |  |
| 7        |               |          | 2       |               |                               |                  |          |               |                    |  |
| 8        | 2             |          |         |               |                               | 1 Bullh.         | 1        |               | 2 Dogf.            |  |
|          |               |          |         |               |                               | 1 Rockbass       |          |               |                    |  |
|          |               |          |         |               |                               | 1 Bullh.         |          |               |                    |  |
| 10       |               |          |         |               |                               |                  |          |               |                    |  |
| 11       |               |          |         |               |                               |                  | 1        |               |                    |  |
| 12       |               |          |         |               |                               |                  | 2        |               |                    |  |
| 14       |               |          |         |               |                               |                  |          |               | 1 Dogf.            |  |
| 15       |               |          |         |               |                               | 1 Bullh.         |          |               |                    |  |
| 16       |               |          |         |               |                               |                  | 1        |               |                    |  |
| Total    | 902           | 117      | 150     | 13            | 16                            | 435              | 28       | 16            |                    |  |
|          |               |          |         |               |                               | 8 Bullheads      |          |               | 10 Dogfish         |  |
|          |               |          |         |               |                               | 3 Rock Bass      |          |               | 1 Catfish          |  |
|          |               |          |         |               |                               | 1 Bluegill       |          |               |                    |  |
|          |               |          |         |               |                               | 1 Spotted Sucker |          |               |                    |  |

Total of all species downstream - 1,211

Total of all species upstream - 490

Table 2. Summary of the northern pike and walleyed pike that were tagged at the Muskegon River weir.

| Northern Pike (Downstream) |         |       |      |         |                |                |                     |           |
|----------------------------|---------|-------|------|---------|----------------|----------------|---------------------|-----------|
| Date Tagged                | Tag No. | S.L.  | T.L. | Sex     | Date Recovered | Total Days Out | Distance Traveled*  | Growth    |
| April 19                   | 4101    | 568   | 651  | ♂ Green |                |                |                     |           |
| 19                         | 4102    | 440   | 632  | ♂ "     |                |                |                     |           |
| 20                         | **4104  | 511   | 600  | ♂ Ripe  | May 23         | 34             | 8 $\frac{1}{2}$ mi. | +15.8mm.  |
| 20                         | 4105    | 460   | 538  | ♂ "     |                |                |                     |           |
| 21                         | 4106    | 609   | 705  | ♂ Green |                |                |                     |           |
| 22                         | 4107    | 635   | 734  | ♂ "     |                |                |                     |           |
| 22                         | 4108    | 645   | 749  | ♂ "     |                |                |                     |           |
| 24                         | 4109    | 580   | 675  | ♂ "     |                |                |                     |           |
| May 1                      | 4121    | 550   | 638  |         |                |                |                     |           |
| 2                          | 4122    | 612   | 705  |         |                |                |                     |           |
| 7                          | 4123    | 634   | 726  |         |                |                |                     |           |
| Northern Pike (Upstream)   |         |       |      |         |                |                |                     |           |
| April 28                   | **50152 | 879.5 | 1022 | ♀ Spent | June 27        | 61             | 7 mi.               | -19       |
| 28                         | **4110  | 505   | 582  | ♂ Ripe  | May 20         | 22             | 8 mi.               | -23.2mm.  |
| 28                         | 4112    | 724   | 810  | ♀ Spent |                |                |                     |           |
| 28                         | 4113    | 672   | 763  | ♀ "     |                |                |                     |           |
| 28                         | **4114  | 525   | 603  | ♂ Ripe  | June 4         | 38             | 5 $\frac{1}{2}$ mi. | +6.6mm.   |
| 28                         | 4115    | 471   | 548  | ♂ "     |                |                |                     |           |
| 29                         | *4101   | 566   | 657  | ♂ "     |                |                |                     |           |
| 29                         | *4106   | 612   | 704  | ♂ "     |                |                |                     |           |
| 29                         | **4116  | 515   | 601  |         | June 14        | 47             | 4 $\frac{1}{2}$ mi. |           |
| 29                         | *4107   | 632   | 730  | ♂       |                |                |                     |           |
| 30                         | 4117    | 555   | 638  |         |                |                |                     |           |
| 30                         | **4118  | 483   | 558  |         | July 4         | 66             | 2 $\frac{3}{4}$ mi. |           |
| 30                         | 4119    | 652   | 750  |         |                |                |                     |           |
| 30                         | **4120  | 643   | 736  |         | June 16        | 48             | 5 $\frac{1}{2}$ mi. | -12.1     |
| May 8                      | 4124    | 636   | 735  |         |                |                |                     |           |
| 23                         | *4109   | 581   | 674  | ♂ Ripe  |                |                |                     |           |
| Walleye (Downstream)       |         |       |      |         |                |                |                     |           |
| April 19                   | 4103    | 360   | 432  | ♂ Ripe  |                |                |                     |           |
| 20                         | 4201    | 360   | 445  | ♀ Green |                |                |                     |           |
| 20                         | 4202    | 370   | 443  | ♂ Ripe  |                |                |                     |           |
| 20                         | 4203    | 425   | 510  | ♀ Ripe  |                |                |                     |           |
| 20                         | 4204    | 350   | 422  | ♂ Ripe  |                |                |                     |           |
| 22                         | 4205    | 426   | 510  | ♀ Green |                |                |                     |           |
| 22                         | 4206    | 390   | 479  | ♀ "     |                |                |                     |           |
| 23                         | 4207    | 490   | 590  | ♀ Ripe  |                |                |                     |           |
| 23                         | 4208    | 307   | 377  | ♂ Ripe  |                |                |                     |           |
| 23                         | 4209    | 417   | 497  | ♀ "     |                |                |                     |           |
| 25                         | 4210    | 321   | 390  |         |                |                |                     |           |
| 30                         | 4211    | 356   | 422  | ♂ Ripe  |                |                |                     |           |
| May 5                      | **4212  | 405   | 495  |         | July 3         | 60             | 7 $\frac{1}{4}$ mi. | +13.0 mm. |
| 12                         | 4215    | 342   | 411  |         |                |                |                     |           |
| 12                         | 4216    | 305   | 369  | ♀ Green |                |                |                     |           |
| 12                         | 4217    | 381   | 456  | ♀ "     |                |                |                     |           |

\*\*Recovered in lake

\*Tagged going downstream - recovered in upstream trap

Table 3. Number of lampreys, Ichthyomyzon castaneus, taken from the fish taken in the upstream trap of the Muskegon River weir.

| Date               | Number of Suckers | Number of lampreys removed from suckers |
|--------------------|-------------------|---|
| Upstream migration |                   |   |
| April 28           | 2                 | 5                                       |
| 29                 | 21                | 19                                      |
| 30                 | 8                 | * 5                                     |
| May 1              | 1                 | 0                                       |
| 2                  | 31                | 25                                      |
| 3                  | 15                | ** 0                                    |
| 4                  | 37                | 29                                      |
| 5                  | 56                | 65                                      |
| 6                  | 36                | ***10                                   |
| 7                  | 38                | 59                                      |
| 8                  | 32                | 72                                      |
| 9                  | 30                | 26                                      |
| 10                 | 21                | 39                                      |
| 12                 | 2                 | 0                                       |
| 14                 | 1                 | 1                                       |
| 15                 | 2                 | 1                                       |
| 16                 | 1                 | 0                                       |
| 22                 | 8                 | 14                                      |
| 23                 | 10                | 13                                      |
| 24                 | 49)               | 66                                      |
| 25                 | 12)               |   |
| 26                 | 10                | 8                                       |
| 27                 | 3                 | 10                                      |
| June 3             | 2                 | 2                                       |
| 4                  | 1                 | 1                                       |
| 6                  | 1                 | 3                                       |
| 8                  | 1                 | 3                                       |
| 11                 | 1                 | 2                                       |
| 12                 | 2                 | 5                                       |
| 16                 | 1                 | 2                                       |
| Total              | <u>435</u>        | <u>485</u>                              |

\*The lampreys were not counted. These 5 were on 1 sucker.

\*\*The lampreys were not counted.

\*\*\*The lampreys were not counted on 33 suckers. The 10 lampreys listed here were on 3 suckers.

Temperatures at Muskegon River Weir - 1939.

| Date    | Time       | Air | Water | Weather, sky, etc.                        | Color of Water | Water level |
|---------|------------|-----|-------|---|----------------|-------------|
| April 5 | 11:30 AM   | 31° | 33°   | Cloudy, cold                              | Clear          | Normal      |
| 6       | 8:30 AM    | 27° | 33°   | Cloudy, snow flurries                     | "              | "           |
| 7       | 9:00 AM    | 21° | 33°   | Cloudy, calm                              | "              | "           |
| 7       | 6:00 PM    | 29° | 34°   | Snow, strong W. wind, snowed 4" overnight | Muddy          | ** 8" high  |
| 8       | 9:30 AM    | 28° | 34°   | Snow flurries, cloudy                     | "              | 8" high     |
| 9       | 9:00 AM    | 33° | 35°   | Partly cloudy                             | Clear          | Normal      |
| 10      | 10:30 AM   | 38° | 37°   | Partly cloudy                             | "              | "           |
| 11      | 11:45 AM   | 51° | 38°   | Clear                                     | "              | "           |
|         | 7:00 PM    | 25° | 41°   | Clear                                     | "              | "           |
| 12      | 1:45 PM    | 28° | 37°   | Snow, hard W. Wind                        | "              | "           |
| 13      | 8:30 AM    | 31° | 39°   | Partly cloudy                             | "              | "           |
|         | 5:30 PM    | 40° | 42°   | Clear                                     | "              | "           |
| 14      | 1:00 PM    | 35° | 38°   | Cloudy, calm                              | "              | "           |
|         | 7:00 PM    | 33° | 38°   | Cloudy, snowing, calm                     | "              | "           |
| 15      | 9:30 AM    | 39° | 38°   | Clear, calm                               | Cloudy         | 1 1/2" high |
|         | 10:00 PM   | 31° | 43°   | Cloudy                                    | "              | 1 1/2" high |
| 16      | 11:00 AM   | 36° | 38°   | Clear                                     | "              | 1 1/2" high |
|         | 6:00 PM    | 39° | 41°   | Clear, light SE wind                      | "              | 1 1/2" high |
|         | 10:00 PM   | 31° | 38°   | Clear, light SE wind                      | "              | 1 1/2" high |
| 17      | 2:00 PM    | 36° | 37°   | Clear                                     | "              | 2" high     |
|         | 9:45 PM    | 45° | 38°   | Clear                                     | "              | 2" "        |
| 18      | 10:00 AM   | 40° | 38°   | Cloudy, rain                              | "              | 2" "        |
|         | 4:00 PM    | 43° | 40°   | Cloudy, rain, snow                        | "              | 2" "        |
| 19      | 1:00 PM    | 34° | 38°   | Cloudy, snow                              | "              | 2" "        |
|         | 10:00 PM   | 34° | 38°   | Cloudy                                    | "              | 2" "        |
|         | 11:00 PM   | 34° | 38°   | Cloudy                                    | "              | 2" "        |
| 20      | 12:00 noon | 53° | 40°   | Clear                                     | "              | 2 1/2" high |
|         | 7:30 PM    | 42° | 43°   | Clear                                     | "              | 2 1/2" "    |
|         | 10:30 PM   | 39° | 42°   | Clear                                     | "              | 2 1/2" "    |
| 21      | 11:00 AM   | 40° | 40°   | Cloudy, rain, calm                        | "              | 3" high     |
|         | 10:15 PM   | 39° | 39°   | Cloudy                                    | "              | 3" "        |
| 22      | 10:40 AM   | 44° | 40°   | Clear to partly cloudy                    | "              | 3" "        |
|         | 11:45 PM   | 44° | 43°   | Partly cloudy                             | "              | 3" "        |
| 23      | 1:00 PM    | 57° | 44°   | Clear                                     | "              | 2" high     |
|         | 10:30 PM   | 46° | 41°   | Clear                                     | "              | 2" high     |
| 24      | 10:30 AM   | 60° | 43°   | Clear                                     | Clear          | 2" "        |
|         | 11:45 PM   | 49° | 46°   | Clear                                     | "              | 2" "        |
| 25      | 11:00 AM   | 79° | 50°   | Clear, hot, calm                          | "              | 2" "        |
|         | 10:45 PM   | 52° | 54°   | Clear                                     | "              | 2" "        |
| 26      | 10:00 AM   | 70° | 53°   | Partly cloudy, light SW wind              | "              | Normal      |
|         | 11:30 PM   | 44° | 53°   | Partly cloudy                             | "              | "           |



| Date       | Time        | Air        | Water    | Weather, sky, etc. | Color of            |                           |                           |
|------------|-------------|------------|----------|--------------------|---------------------|---------------------------|---------------------------|
|            |             |            |          |                    | Water               | Water level               |                           |
| April      | 27 10:00 AM | 48         | 47       | Cloudy, calm       | Clear               | Normal                    |                           |
|            | 11:00 PM    | 45         | 52       | Partly cloudy      | "                   | "                         |                           |
|            | 28          | 10:45 AM   | 49       | 51                 | Clear               | "                         | "                         |
|            |             | 4:00 PM    | 62       | 45                 | Clear               | "                         | "                         |
|            |             | 12:30 AM   | 32       | 44                 | Clear               | "                         | "                         |
|            | 29          | 8:15 AM    | 50       | 49                 | Clear               | "                         | "                         |
|            |             | 2:30 PM    | 59       | 55                 | Clear               | "                         | "                         |
|            |             | 11:00 PM   | 55       | 53                 | Partly cloudy       | "                         | "                         |
|            | 30          | 12:00 noon | 54       | 54                 | Partly cloudy, rain | "                         | "                         |
|            |             | 9:00 PM    | 35       | 55                 | Clear, calm         | "                         | "                         |
| 12:00 mid. |             | 30         | 51       | Clear, calm        | "                   | "                         |                           |
| May        | 1           | 7:30 AM    | 38       | 49                 | Partly cloudy       | Clear                     | Normal                    |
|            |             | 4:00 PM    | 47       | 53                 | Cloudy              | "                         | "                         |
|            | 11:00 PM    | 34         | 50       | Cloudy             | "                   | "                         |                           |
|            |             | 3          | 11:00 AM | 48                 | 50                  | Clear                     | "                         |
|            | 3           | 11:00 PM   | 33       | 53                 | Clear               | "                         | "                         |
|            |             | 11:30 AM   | 56       | 53                 | Clear               | Cloudy                    | ** 1 1/2" high            |
|            |             | 5:45 PM    | 64       | 57                 | Clear               | "                         | 1 1/2" "                  |
|            | 4           | 10:40 PM   | 40       | 53                 | Clear               | "                         | 1 1/2" "                  |
|            |             | 11:00 AM   | 69       | 54                 | Clear               | "                         | 2" "                      |
|            |             | 4:30 PM    | 65       | 58                 | Cloudy, light wind  | "                         | 2" "                      |
|            | 5           | 10:00 PM   | 57       | 56                 | Partly cloudy       | "                         | 2" "                      |
|            |             | 10:45 AM   | 74       | 57                 | Clear               | Clear                     | Normal                    |
|            |             | 3:30 PM    | 80       | 62                 | Clear               | Clear                     | "                         |
|            | 6           | 11:30 PM   | 57       | 61                 | Partly cloudy       | Clear                     | "                         |
|            |             | 11:15 AM   | 81       | 62                 | Clear               | Clear                     | "                         |
|            |             | 2:00 PM    | 81       | 64                 | Clear               | Clear                     | "                         |
|            | 7           | 10:00 PM   | 61       | 64                 | Clear               | Clear                     | "                         |
|            |             | 7:30 AM    | 71       | 60                 | Clear               | Clear                     | Normal                    |
|            |             | 11:00 PM   | 68       | 65                 | Cloudy, rain )      | Clear                     | 1.56" <del>11" high</del> |
|            | 8           | 6:45 AM    | 60       | 63                 | Cloudy )            | rainfall                  | Cloudy 1" high            |
|            |             | 10:30 PM   | 60       | 65                 | Cloudy, rain )      | Cloudy                    | 1" high                   |
|            | 9           | 10:15 AM   | 63       | 64                 | Clear               | Cloudy                    | 2" high                   |
|            |             | 10:00 PM   | 59       | 65                 | Clear               | Cloudy                    | 2" "                      |
|            | 10          | 10:30 AM   | 59       | 60                 | Cloudy              | Cloudy                    | 2" "                      |
|            |             | 10:30 PM   | 49       | 60                 | Clear               | "                         | 2" "                      |
|            | 11          | 8:00 AM    | 39       | 55                 | Cloudy              | Extra cloudy              | ** 12" high               |
|            |             | 9:30 PM    | 31       | 55                 | Clear               | " "                       | 12" "                     |
|            | 12          | 10:00 AM   | 46       | 53                 | Clear               | Cloudy, but clearer       | 13" "                     |
|            |             | 4:00 PM    | 58       | 58                 | Clear               | "                         | 13" "                     |
|            |             | 9:30 PM    | 40       | 56                 | Clear               | "                         | 13" "                     |
|            | 13          | 8:00 AM    | 40       | 53                 | Clear               | Clearer                   | 3" high                   |
|            |             | 10:45 PM   | 44       | 55                 | Cloudy              | (Beards replaced) Clearer | 3" high                   |
|            | 14          | 11:30 AM   | 61       | 55                 | Cloudy              | Extra roily               | * 6" high                 |
|            |             | 10:00 PM   | 50       | 55                 | Cloudy, rain        | "                         | 6" "                      |
|            | 15          | 10:45 AM   | 42       | 53                 | Cloudy              | Cloudy                    | 4" high                   |
|            |             | 11:00 PM   | 38       | 55                 | Clear               | "                         | 2" high                   |
| 16         | 7:30 AM     | 41         | 52       | Clear              | "                   | 2" high                   |                           |
|            | 10:00 PM    | 51         | 59       | Clear              | "                   | 2" high                   |                           |

| Date       | Time          | Air         | Water    | Weather, sky, etc. | Color of Water | Water level |      |      |
|------------|---------------|-------------|----------|--------------------|----------------|-------------|------|------|
| May        | 17 8:15 AM    | 47          | 58       | Clear              | Cloudy         | 2" high     |      |      |
|            | 18 10:00 PM   | 54          | 58       | Partly cloudy      | "              | 2" "        |      |      |
|            | 19 5:30 AM    | 49          | 56       | Cloudy             | "              | 2" "        |      |      |
|            |               | 6:45 PM     | 73       | 65                 | Clear          | "           | 2" " |      |
|            | 20 12:00 noon | 68          | 61       | Cloudy             | "              | 2" "        |      |      |
|            |               | 10:00 PM    | 58       | 61                 | Cloudy         | "           | 2" " |      |
|            | 21 7:00 AM    | 52          | 60       | Partly Cloudy      | "              | 2" "        |      |      |
|            |               | 9:30 PM     | 51       | 61                 | Cloudy, rain   | "           | 2" " |      |
|            | 22 9:15 AM    | 60          | 59       | Clear              | "              | 4" "        |      |      |
|            |               | 10:00 PM    | 57       | 64                 | Clear          | "           | 4" " |      |
|            | 23 11:00 AM   | 47          | 62       | Clear              | "              | 4" "        |      |      |
|            | 24 6:00 AM    | 44          | 59       | Clear              | "              | 5" "        |      |      |
|            |               | 10:30 PM    | 57       | 61                 | Clear          | "           | 5" " |      |
|            | 25 9:45 AM    | 59          | 63       | Cloudy             | "              | 4" "        |      |      |
|            |               | 10:15 PM    | 54       | 61                 | Clear          | "           | 4" " |      |
|            | 26 11:00 AM   | 73          | 63       | Partly cloudy      | "              | 4" "        |      |      |
|            |               | 10:00 PM    | 67       | 62                 | Clear          | "           | 4" " |      |
|            | 27 10:30 AM   | 78          | 66       | Cloudy             | "              | 5" "        |      |      |
|            |               | 10:00 PM    | 67       | 69                 | Clear          | "           | 5" " |      |
|            | 28 11:00 AM   | 65          | 67       | Cloudy, rain       | "              | 5" "        |      |      |
|            |               | 10:15 PM    | 52       | 66                 | Cloudy         | "           | 5" " |      |
|            | 29 11:00 AM   | 54          | 65       | Clear              | "              | 5" "        |      |      |
|            |               | 12 midnight | 54       | 66                 | Clear          | "           | 5" " |      |
|            | 30 11:15 AM   | 79          | 68       | Clear              | "              | 5" "        |      |      |
|            |               | 8:00 PM     | 76       | 72                 | Clear          | "           | 5" " |      |
|            | 31 11:00 AM   | 84          | 72       | Clear              | "              | 5" "        |      |      |
|            |               | 9:00 PM     | 59       | 72                 | Clear          | "           | 5" " |      |
|            | June          | 1 6:00 AM   | 54       | 69                 | Partly cloudy  | "           | 5" " |      |
|            |               |             | 7:45 PM  | 71                 | 76             | Clear       | "    | 5" " |
|            |               |             | 10:30 PM | 63                 | 74             | Clear       | "    | 5" " |
|            |               | 2 10:00 AM  | 74       | 71                 | Clear          | "           | 6" " |      |
|            |               | 8:30 PM     | 70       | 74                 | Cloudy         | "           | 6" " |      |
| 3 9:30 AM  |               | 72          | 72       | Cloudy             | "              | 4" "        |      |      |
|            |               | 3:00 PM     | 67       | 74                 | Clear          | "           | 4" " |      |
|            |               | 8:45 PM     | 59       | 73                 | Clear          | "           | 4" " |      |
| 4 11:00 AM |               | 76          | 68       | Clear              | "              | 4" "        |      |      |
|            |               | 8:30 PM     | 60       | 71                 | Clear          | "           | 4" " |      |
| 5 11:00 AM |               | 76          | 70       | Clear              | Clear          | 2" "        |      |      |
|            |               | 8:00 PM     | 70       | 72                 | Clear          | "           | 2" " |      |
| 6 10:45 AM |               | 77          | 72       | Clear              | "              | 2" "        |      |      |
|            |               | 8:30 PM     | 70       | 76                 | Partly cloudy  | "           | 2" " |      |
| 7 10:30 AM |               | 80          | 74       | Cloudy             | Cloudy         | 3" "        |      |      |
|            | 8:45 PM       | 64          | 73       | Cloudy, rain       | "              | 3" "        |      |      |
| 8 10:14 AM | 66            | 70          | Cloudy   | "                  | 4" "           |             |      |      |
|            | 9:30 PM       | 57          | 73       | Cloudy             | "              | 4" "        |      |      |
| 9 6:30 AM  | 60            | 69          | Clear    | "                  | 4" "           |             |      |      |
|            | 9:00 PM       | 68          | 75       | Cloudy, rain       | Cloudy         | 4" "        |      |      |
| 10 9:45 AM | 68            | 72          | Cloudy   | "                  | 5" "           |             |      |      |
|            | 7:00 PM       | 64          | 70       | Cloudy             | "              | 5" "        |      |      |
| 11 6:45 AM | 59            | 66          | Cloudy   | "                  | 6" "           |             |      |      |
|            | 6:15 PM       | 49          | 64       | Cloudy, rain       | "              | 6" "        |      |      |

| Date    | Time     | Air | Water | Weather, sky, etc. | Color of Water | Water level |
|---------|----------|-----|-------|--------------------|----------------|-------------|
| June 12 | 11:00 AM | 46  | 58    | Cloudy             | Cloudy         | 6" high     |
|         | 9:30 PM  | 45  | 58    | Clear              | "              | 6" "        |
| 13      | 10:45 AM | 60  | 58    | Partly cloudy      | "              | 4" "        |
| 14      | 10:45 AM | 66  | 62    | Clear              | "              | 4" "        |
| 15      | 12:30 PM | 69  | 62    | Cloudy             | "              | 3" "        |
| 16      | 9:45 AM  | 51  | 60    | Cloudy, rain       | "              | 2" "        |
| 17      | 9:15 AM  | 53  | 59    | Cloudy             | "              | 2" "        |
| 18      | 10:15 AM | 64  | 59    | Cloudy             | "              | 3" "        |

\* Boards pulled out of dam.

\*\* Boards in dam broke loose.



Looking downstream on the Muskegon River weir from a point several hundred feet upstream. Note the flooded, grassy marsh in the foreground (north bank).



Looking downstream at the main arm of the Muskegon River weir showing the braces above the weir. This picture was taken by Dr. J. W. Leonard just after the weir was completed and before the traps had been moved out in river from their original position partially buried in either bank.



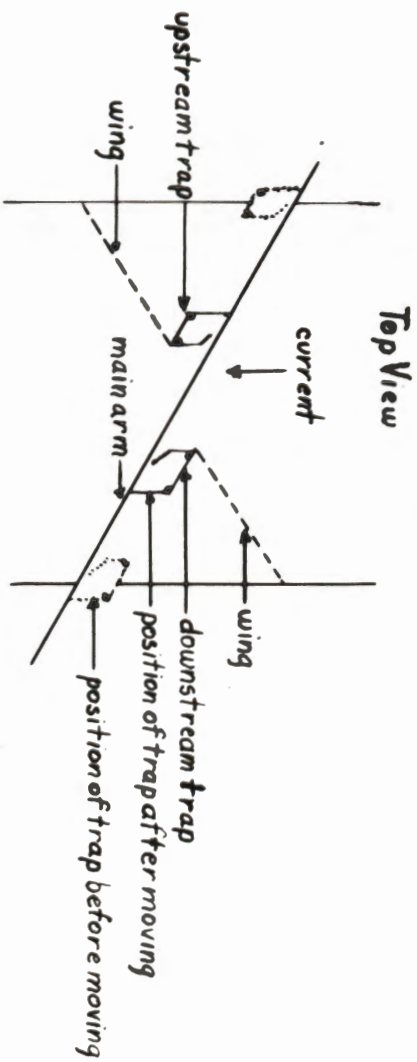
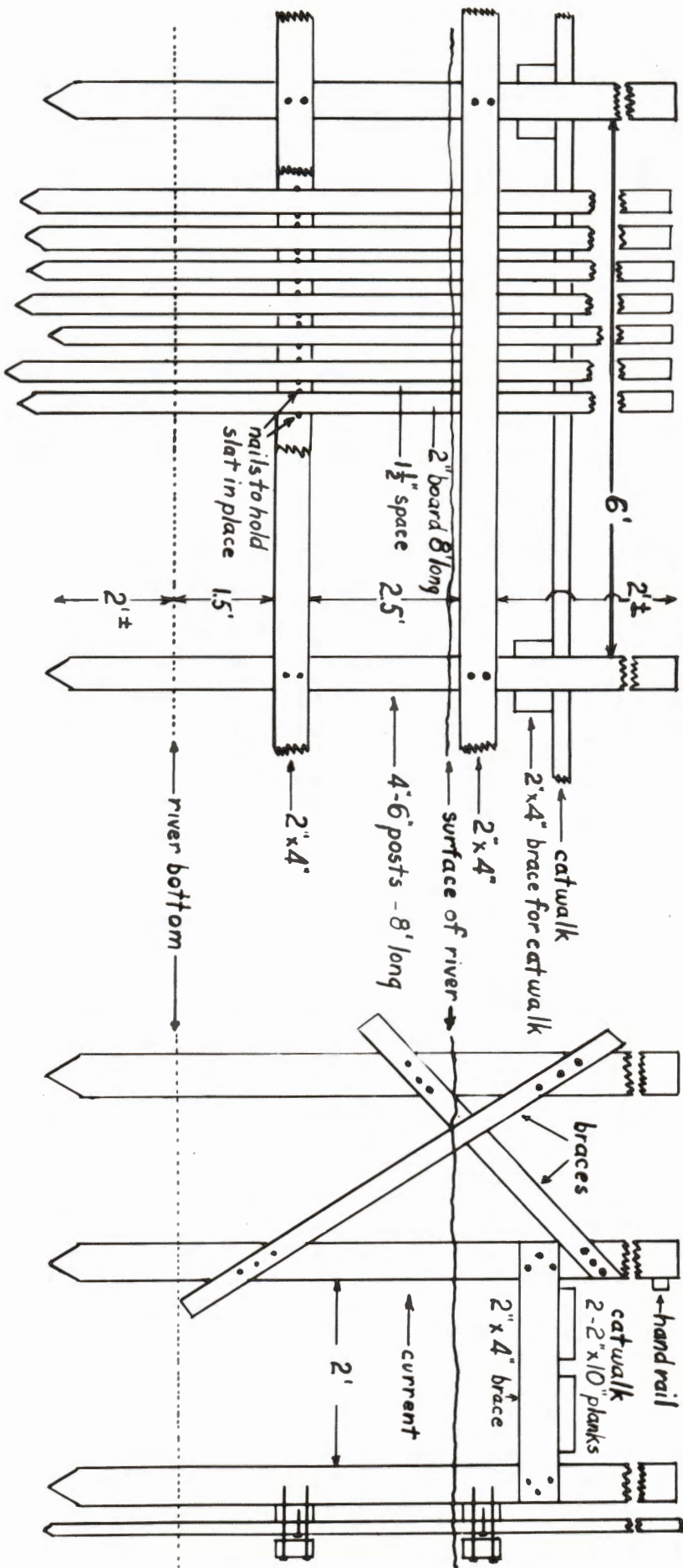
Front view (looking downstream) of the Muskegon River weir, showing the construction of the downstream trap, the main arm of the weir, and the small wing leading directly from the south bank to the trap.



Side view of the Muskegon River weir showing catwalk, the main arm of the weir with braces, and the short wings leading from the bank to each trap. Mr. Harold Bowditch, facing downstream, is stepping from the downstream trap to the catwalk.

# MUSKEGON RIVER FISH WEIR

diagrammatic plan



Type of Trap Used

