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OPERATION OF THE MUSKEGON RIVER FISH WEIR, 1940

by

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In the spring of 1939, a two-way fish weir was installed on the Muskegon River, approximately one mile below Houghton Lake, to determine the extent of the spawning migration of fish to and from Houghton Lake (see report 580). In 1940 another weir was placed in the river at about the same location as the 1939 weir.

The 1939 weir consisted of a single wing, blocking the stream at an angle of about 25 degrees with the current. We were not too well satisfied with the operation of the 1939 weir, because of the small percentage of the total run of fish that was trapped, and because additional wings had to be constructed to act as leads. The 1939 weir, when final adjustments were made, was almost a double "V" structure. In 1940, Mr. H. L. Peterson, Supervisor of Fisheries Operations, District No. 5, Mr. Philip Woodworth, who assisted in the construction of the weir, and the writer, designed a much improved, double "V" weir.

The weir was installed by the Houghton Lake CCC. We are indebted to Mr. Sam Cline, Superintendent of the CCC Camp, for his cooperation and for the loan of various materials and tools. Mr. Peterson, Supervisor of Fisheries

Operations, District No. 5, graciously assisted in all phases of the work and was responsible for transporting materials and for the loan of equipment. Thanks are due Mr. Tom White, Mr. Houghton King, Mr. Philip Woodworth, Mr. Joseph Farrar and Mr. Harold Bowditch for assistance rendered during the operation of the weir.

In general, the same type of construction used in the 1939 weir was followed in building the 1940 weir. The only difference between the two weirs was in the placement of the traps and in the slope of the wings. For the details of construction, the reader is referred to I.F.R. Report No. 580, and the pictures and diagram at the end of this report.

The weir consisted of a trap 12' by 5', located approximately in the center of the river, with the long axis parallel to the river banks. Four wings, each approximately 85 feet long, connected each corner of the trap to the nearest shore, at an angle of about 25 degrees with the current. (See picture.) This resulted in a double "V" weir. A partition of 1' by 2" slats divided the trap into equal parts (each 5' by 6'). These slats were driven deep into the river bottom, and each one was then sawed off a few inches above the bottom. Each slat could then be removed, by sliding upward, thus serving as a gateway for the passage of debris when cleaning the weir. Each trap was provided with a removable, slide funnel (see pictures and diagram at end of report), constructed in such a manner that it could be lifted out of the trap to facilitate cleaning of the weir. The bottom edge of each funnel rested on a base of 1' by 2" slats sawed off just above the river bottom. These slats acted as sheet piling to prevent the current from cutting a hole beneath the funnel.

Leaves, grass, sticks and other debris carried by the water would continually lodge against the weir. At periods of high water the funnel

of the downstream trap would often become plugged with debris. Therefore it was necessary to clean the weir at daily intervals while the weir was in operation. Because of the "V" construction of the weir, all debris could be swept toward the traps. While cleaning the weir, the downstream funnel was removed until the upstream wings had been cleaned. The downstream funnel was then replaced and the partition slats and upstream funnel were then removed and the debris was swept downstream by the current. In this manner we were able to keep fish from moving through the traps while the weir was being cleaned.

The total cost of the 1940 weir was $81.06, exclusive of labor, truck expense and the material salvaged from the 1939 weir. The materials used in the construction of the weir are itemized below.

1000' - 1" x 2" x 8' rough norway at $35.00 per 1000 B.F.	$35.00
270' - 1" x 2" x 8' rough poplar at 20.00 " " "	5.40
850' - 2" x 4" x 12' rough norway at 35.00 " " "	29.95
84' - 2" x 4" x 12' rough poplar at 20.00 " " "	1.68
100' - 1" x 6" x 12' rough norway at 28.00 " " "	2.80
31' - 1" x 6" x 12' rough poplar at 20.00 " " "	.62
20 lb, No. 12 gal. wire	1.60
2 pr., 6" strap hinges	.46
32, 1 3/4" screws	.22
1 padlock	.25
2 hinge hasps	.30
25 lbs. 8d nails at $.05 per lb.	1.25
60 lbs. 10d " " " " "	3.00
25 lbs. 20d " " " " "	1.25
25 lbs. 30d " " " " "	1.25
5 lbs. 40d " " " " "	.25
4 lbs. 1 3/4" stables at $07 per lb.	.28
	$85.56
Less material used on small N. pike weir at Peterson's	4.50
	81.06

Other materials used in construction of weir:

400 - 1" x 2" x 8' slats left from 1939 weir
80 posts 4" - 5" top, 8' long, left from 1939 weir
40 " " " " " " donated by Tom White
40 " " " " " " " " Philip Woodworth
400 B.F. 2" x 10" x 12' plank for catwalk donated by Philip Woodworth
5 sq. yds. ½" mesh, heavy wire screen furnished by Grayling Hatchery.

Construction of the weir was begun on March 21, 1940, and completed on March 31. The river was partially covered with ice during this period and was completely frozen over several times. The weir was removed on July 11 after 104 days of continuous operation. (The 1939 weir was in operation over a period of 73 days, April 7 - June 18.)

The following species of fish were taken in the weir: common sucker (Catostomus c. commersonnii), northern redhorse (Moxostoma aureolum), northern pike (Esox lucius), walleyed pike or yellow pike perch (Stizostedion vitreum), dogfish (Amia calva), channel catfish (Ictalurus lacustris), rock bass (Ambloplites rupestris), bullheads, (Ameiurus sp.), garpike (Lepisosteus osseus oxyurus), black crappie (Pomoxis nigro-maculatus), largemouth bass (Huro salmoides), bluegill (Lepomis macrochirus), and the yellow perch (Perca flavescens). Two species of turtles, the snapping turtle (Chelydra serpentina), and the painted turtle (Chrysemys bellii marginata), were also taken in the traps of the weir.

The size range of the most important species of fish taken in the weir is presented in the following table:

Species	Number measured	Total length in mm. and (inches). Minimum	Average	Maximum
Common sucker	262	329 (12.9)	469.2(18.5)	564 (22.2)
Redhorse	165	370 (14.6)	471.2(18.6)	565 (22.25)
Northern pike	137	435 (17.25)	629.3(24.8)	956 (37.6)
Walleyed pike	25	278 (10.9)	448.4(17.6)	552 (21.7)
Channel catfish	6	956 (37.6)	977.0(38.5)	1009 (39.7)

All of the fish that were taken in the traps were fin-clipped (left pectoral), except the northern pike, walleyed pike and the channel catfish, which were jaw tagged. After marking, each fish was released in the direction in which it had been moving when taken in the trap.

The results obtained from the operation of the weir are summarized in tables: 1, the daily catch by species, 2, the total daily catch and 3, the weekly catch by species.

Table 1. **Daily Record of the Number and Species of Fish Taken in the Muskegon River Weir - 1940**

Repeats in ( )

Date	Downstream									Upstream				
	Common sucker	N.pike	Red-horse	Walleyed pike	Dog-fish	Rock bass	Bull-head	Misc.	Daily total	Common sucker	N.pike	Red-horse	Walleyed pike	Daily total
April 2	18	3	1	..	..	..	..		22					
3	1	..	..	..	..	..	..		1					
4	..	..	..	..	..	..	..		..					
5	2	2	..	..	..	..	..		4					
6	19	5	..	..	..	..	..		24					
7	46	14	..	3	..	..	..		63					
8	16	4	..	..	..	..	..		20					
9	57	3	..	..	..	..	..		60					
10	[4]87	12	..	2	..	..	..		101					
11	69	3	..	..	..	..	..		72					
12	84	5	..	..	..	..	..		89					
13	[2]57	11	..	1	..	..	..		69					
14	118	11	..	2	..	..	..		131					
15	[3]136	3	..	2	..	..	..		141					
16	153	7	..	..	..	..	..		160					
17	17	2	..	..	..	..	..		19	..	1	..	..	1
18	..	3	..	..	..	..	..		3	1	1	..	..	2
19	[4]64	1	..	2	..	..	..		67	..	..	..	..	..
20	42	6	1	2	..	..	..		51	..	..	..	..	..
21	43	8	..	..	..	..	..		51	..	..	..	1	1
22	74	1	..	1	..	..	..		76	..	..	..	..	..
23	237	3	1	..	3	..	..		244	26	..	..	..	26
24	48	2	..	..	1	..	..		51	..	1	..	..	1
25	51	3	2	..	2	..	..		58	..	2	..	..	2
26	276	..	1	1	4	1	..		283	10	1	..	..	11
27	92	..	5	1	4	..	..		102	3	2	..	..	5
28	494 (2)	1	3	..	8	..	..		508	21	3	..	..	24
29	357	1	10	..	8	1	1		378	37	2	..	..	39
30	343 (2)	3	5	..	11	..	1	2 painted turtles	365	32	5	1	..	38
	3,001 (4)	117	29	17	41	2	2	2 "	3,213	130	18	1	1	150

[4]72 suckers seined from north "V" section of weir. Weir undercut on north wing next to trap, allowing many suckers to get caught in "V".

[2]10 suckers and 5 northern pike seined from north "V".

[3]31 suckers and one northern pike seined from north "V".

[4]23 suckers and two walleyed pike seined from north "V". All of the fish seined up above were part of those entering "V" on April 10 through hole.

Daily Record of the Number and Species of Fish taken in the Muskegon River Weir - 1940

Table 1. (Continued)

Repeats in ( )

Date	DOWNSTREAM Common sucker	N.pike	Red-horse	Walleyed pike	Dog-fish	Rock bass	Misc.	Daily total	UPSTREAM Common sucker	N.pike	Red-horse	Walleyed pike	Dog-fish	Misc.	Daily total
May 1	229 (2)	..	3 (1)	1	4	..	..	240	30	1	..	..	..	1 bullhead	32
2	120 (4)	3	..	..	..	..	..	127	11	1	..	..	..	..	12
3	20 .	..	..	..	..	..	..	20	3	..	..	..	..	..	3
4	46 .	1	2	..	3	..	1 garpike	53	3	1	..	..	2	..	6
5	69 (11)	1	4	..	5	..	..	90	25 (3)	..	2	..	1	..	31
6	152 (53)	8	15	..	7	..	..	235	101(26)	..	2	..	14	..	143
7	61 (24)	1	1	..	1	..	..	88	28 (6)	..	..	..	..	..	34
8	43 (8)	..	1	..	5	..	..	57	31 (8)	2	..	..	..	..	41
9	8 (5)	..	6	..	2	..	1 bl.crappie	22	6 (7)	2	1	..	..	..	16
10	5 (4)	..	..	..	..	..	..	9	6 (3)	..	..	..	..	..	9
11	↓173(64)	1	13	1	2	..	1 bullhead	255	12 (6)	..	..	..	..	..	18
12	11 (3)	1	26	..	2	..	..	43	20(11)	7	10	..	..	..	48
13	1 (1)	1	26	..	..	..	..	29	14(35)	..	13	..	..	..	62
14	19 (7)	1	73	1	8	..	..	109	53(58)	3	32	..	1	..	147
15	14 (5)	1	34	..	8	..	1 bullhead	63	21(10)	1	13	1	2	..	48
16	11 (2)	..	12	..	2	..	..	27	7 (4)	2	14	..	..	..	27
17	.. .	..	2	..	1	..	..	3	1 (1)	..	..	..	..	..	2
18	.. (1)	..	38	..	3	..	..	42	.. .	..	13	..	..	..	13
19	3 (3)	4	97	..	4	..	..	111	6 (8)	4	17 (1)	..	..	..	36
20	.. (2)	..	57 (4)	..	..	..	..	63	1 .	..	14	..	..	..	15
21	.. .	..	38	..	3	..	..	41	9 (4)	..	22	..	..	..	35
22	1 (1)	..	14	..	..	..	..	16	3 (4)	..	9 (1)	..	..	..	17
23	1 (1)	..	20	..	2	..	..	24	3 (3)	1	10	..	..	..	17
24	1 (1)	..	14 (1)	..	..	..	..	17	.. (1)	..	4	..	..	..	5
25	.. .	..	11 (1)	..	..	1	..	13	1 .	..	6	..	..	1 rock bass	8
26	5 .	..	14	1	..	..	..	20	1 (1)	..	4 (1)	..	..	..	7
27	.. .	..	14	..	..	..	..	14	1 (1)	..	..	..	..	..	2
28	.. .	..	20 (1)	..	1	..	..	22	4 (7)	..	13	..	..	..	24
29	1 .	..	20 (2)	..	..	1	1 L.M.bass	25	2 (5)	..	4	..	1	..	12
30	1 (3)	..	3(19)	..	..	..	..	26	10 (2)	..	7	..	(2)	1 bullhead	22
31	.. (1)	..	30 (1)	..	1	..	..	33	.. (1)	1	8	..	1	..	11
Total	995(206)	23	608(30)	4	64	2	1 garpike 1 bl.crappie 1 L.M.bass 2 bullheads	1,937	413(215)	26	218 (3)	1	22(2)	1 rock bass 2 bullheads	903

↓226 suckers [164 + (62)], 10 redhorse, 1 walleye, 1 northern pike were seined from south "V". A hole was present in the downstream trap on May 10, allowing these fish to enter the south "V". The fish were trapped in here, unable to go either upstream or downstream.

Table 1. (Continued)

Daily Record of the Number and Species of Fish Taken in the Muskegon River Weir - 1940

Repeats in ( )

Date	DOWNSTREAM Common sucker	N. pike	Red-horse	Wall-eyed pike	Dog-fish	Rock bass	Bull-head	Channel catfish	Misc.	Daily total	UPSTREAM Common sucker	N. pike	Red-horse	Dog-fish	Misc.	Daily total
June 1	1 .	..	25(3)	..	..	..	..	..	..	29	4 (5)	..	2 (2)	.. .	..	13
2	. (1)	..	54(1)	..	..	..	..	..	..	56	4 (8)	..	12 (4)	.. .	..	28
3	. .	..	28(2)	..	..	..	..	..	..	30	1 (1)	..	1 (1)	..(2)	..	6
4	↓90(72)	..	87(3)	..	5	..	..	..	..	257	.. .	..	5 (2)	.. .	..	7
5	. .	..	4 .	..	..	..	..	..	.. ..	4	1 (1)	..	2 (5)	..(2)	1 walleyed pike	12
6	. .	..	7(3)	..	..	..	..	..	..	10	6 (4)	..	8(14)	..(1)	..	33
7	. (4)	..	3(3)	..	..	..	..	1	..	11	2 (2)	1	2(16)	..(1)	..	24
8	. (1)	..	5 .	..	..	..	..	..	..	6	. ..	..	3 (4)	..(1)	..	8
9	. .	..	1 .	..	..	..	..	..	..	1	.. .	..	2 (6)	..(6)	..	14
10	. .	..	..(2)	..	..	..	..	..	..	2	.. .	..	.. .	..(1)	..	1
11	. (1)	..	1 .	..	..	..	..	..	1 snap. turtle	2	2 (1)	..	1 (1)	..(4)	..	9
12	. .	..	.. .	..	..	..	4	2	..	6	2 (1)	..	2 (2)	..(1)	..	8
13	. .	..	1(1)	..	..	..	..	1	1 snap. turtle	3	..(3)	..	1 (6)	..(6)	..	16
14	. (1)	..	1(1)	..	..	..	..	..	..	3	.. .	..	..(1)	..(2)	..	3
15	. .	..	.. .	..	..	..	..	2	1 snap. turtle	2	.. .	..	1 (4)	.. .	..	5
16	1 .	..	1 .	..	1	..	..	..	1 snap. turtle	3	1 .	..	1 (1)	.. .	1 walleyed pike	4
17	1 .	..	..(1)	..	..	..	..	2	1 bluegill	5	.. .	..	..(2)	.. .	1 rock bass	3
18	. .	..	..(1)	..	..	..	..	..	1 snap. turtle	1	..(7)	..	1 (5)	1(1)	..	15
19	. (1)	..	.. .	..	..	..	..	1	..	2	7(13)	..	..(6)	..(3)	..	29
20	. (1)	..	.. .	..	..	..	..	..	2 snap. turtles	1	..(2)	..	1 (2)	.. .	1 yellow perch	6
21	. .	..	.. .	..	..	..	..	1	..	1	.. .	3	1 (1)	.. .	..	5
22	. .	..	.. .	..	..	..	..	..	..	..	3 (2)	..	..(1)	..(1)	..	7
23	1 .	..	.. .	1	..	..	..	..	..	2	..(1)	..	..(5)	.. .	1 rock bass	7
24	. .	..	.. .	..	..(1)	..	..	..	..	1	1(10)	..	.. .	.. .	..	11
25	2 (2)	..	.. .	1	..	..	..	..	..	5	..(1)	..	.. .	.. .	..	1
26	. (3)	..	.. .	..	..	..	..	..	1 snap. turtle	3	..(1)	..	1 .	.. .	..	2
27	. .	..	.. .	..	..	..	..	..	..	..	.. .	..	..(2)	.. .	..	2
28	. .	..	.. .	..	..	1	..	..	2 snap. turtles	1	1 .	..	..(4)	.. .	..	5
29	. (2)	..	.. .	..	..	..	..	..	1 snap. turtle	2	.. .	..	..(2)	..(1)	..	3
30	. .	..	.. .	..	..	..	..	..	..	..	.. .	..	..(1)	.. .	..	1
Totals	96(89)	0	218(21)	2	6(1)	1	4	10	11 snapping turtles 1 bluegill	449	35(63)	4	47(100)	1(33)	2 walleyed pike 2 rock bass 1 yellow perch	288

↓162 suckers [90 + (72)], 63 redhorse, and 5 dogfish were removed from the south "V" by seining. These fish entered "V" from undercut upstream wing and downstream trap.

Table 1. Daily Record of the Number and Species of Fish Taken in the Muskegon River Weir - 1940
(Continued)

Repeats in ( )

Date	DOWNSTREAM					UPSTREAM				
	Common sucker	Redhorse	Dogfish	Miscellaneous	Daily total	Common sucker	Redhorse	Dogfish	Walleyed pike	Daily total
July 1	..	..	...	1 painted turtle	..	..	..(1)	..(2)	..	3
2, 8:20 a.m.	..(1)	..	...	..		..	..	..	1	..
2, 8:00 p.m.	..	..	..(1)	..	2	..	..(1)	..(1)	..	3
3, a.m.	1	..	...	..	1	..	..	..	..	..
4	..	..	...	2 snappers	..	..	..	..	..	..
5, a.m.	..	..	...	..	..	..	..(1)	..(1)	1	..
5, p.m.	..	..	...	..	..	..	..(1)	..	..	4
6	..	..	...	..	..	..	..	..(4)	..	4
Total	1(1)	..	..(1)	2 snapping turtles 1 painted turtle	3	..	..(4)	..(8)	2	14

Table 2. Total daily catch of fish taken in the Muskegon River Weir, 1940.

DOWNSTREAM				UPSTREAM			
Date	Number	Date	Number	Date	Number	Date	Number
April 2	22	May 23	24	April 17	1	June 9	14
3	1	24	17	18	2	10	1
5	4	25	13	21	1	11	9
6	24	26	20	23	26	12	8
7	63	27	14	24	1	13	16
8	20	28	22	25	2	14	3
9	60	29	25	26	11	15	5
10	101	30	26	27	5	16	4
11	72	31	33	28	24	17	3
12	89	June 1	29	29	39	18	15
13	69	2	56	30	38	19	29
14	131	3	30	May 1	32	20	6
15	141	4	257	2	12	21	5
16	160	5	4	3	3	22	7
17	19	6	10	4	6	23	7
18	3	7	11	5	31	24	11
19	67	8	6	6	143	25	1
20	51	9	1	7	34	26	2
21	51	10	2	8	41	27	2
22	76	11	2	9	16	28	5
23	244	12	6	10	9	29	3
24	51	13	3	11	18	30	1
25	58	14	3	12	48	July 1	3
26	283	15	2	13	62	2	3
27	102	16	3	14	147	5	4
28	508	17	5	15	48	6	4
29	378	18	1	16	27		
30	365	19	2	17	2	Total	1,355
May 1	240	20	1	18	13		
2	127	21	1	19	36		
3	20	23	2	20	15		
4	53	24	1	21	35		
5	90	25	5	22	17		
6	235	26	3	23	17		
7	88	28	1	24	5		
8	57	29	2	25	8		
9	22	July 2	2	26	7		
10	9	3	1	27	2		
11	255			28	24		
12	43	Total	5,602	29	12		
13	29			30	22		
14	109			31	11		
15	63			June 1	13		
16	27			2	28		
17	3			3	6		
18	42			4	7		
19	111			5	12		
20	63			6	33		
21	41			7	24		
22	16			8	8		

Table 3. The weekly catch of fish in the Muskegon River weir from April 1 to July 6, 1940.

Date	Downstream Trap					Upstream Trap				
	Common sucker	Northern pike	Redhorse	Walleyed pike	Dogfish	Common sucker	Northern pike	Redhorse	Walleyed pike	Dogfish
April 1-6	40	10	1	-	-	-	-	-	-	-
April 7-13	416	52	-	6	-	-	-	-	-	-
April 14-20	530	33	1	8	-	1	2	-	-	-
April 21-27	821	17	9	3	14	39	6	-	1	-
April 28-May 4	1619	9	24	1	34	137	13	1	-	2
May 5-11	680	11	40	1	22	268	4	5	-	15
May 12-18	75	4	211	1	24	235	13	95	1	3
May 19-25	14	4	257	-	9	43	5	84	-	-
May 26-June 1	12	-	152	1	2	44	1	41	-	4
June 2-8	168	-	200	-	5	30	1	79	1	7
June 9-15	2	-	8	-	-	9	-	27	-	20
June 16-22	4	-	3	-	1	35	3	22	1	6
June 23-29	10	-	-	2	1	15	-	14	-	1
June 30-July 6	2	-	-	-	1	-	-	5	2	8
Total	4,393	140	906	23	113	856	48	373	6	66

The first fish were taken in the traps on April 2, the fourth day that the weir had been in operation. The bulk of the downstream moving fish were taken during the month of April. The run gradually diminished through May and June until the weir was removed on July 11. During the last 5 days of April and the first 2 days in May, 2,003 fish were taken in the downstream trap. A total of 3,213 fish was taken in the downstream trap during April, 1,937 in May, and 449 in June. The greatest number of fish taken in the downstream trap in one 24 hour period was 508 on April 28.

The first fish were taken in the upstream trap on April 17. Until May 5, when the first marked fish was taken, the upstream run was composed of inhabitants of the river (all were small and none of them were marked fish returning upstream). The largest movement of fish upstream occurred during May. The catch of fish in the upstream trap was more sporadic than the catch in the downstream trap. A total of 150 fish was taken in the upstream trap during April, 903 in May, and 288 in June. The largest number of fish taken in the upstream trap in any 24 hour period was 147 on May 14.

Common suckers made up the bulk of the run, with redhorse, northern pike, dogfish and walleyed pike next in abundance. Very few fish of other species were taken in the weir. This was partially due to the fact that the spaces between the slats of the weir were far enough apart to allow the smaller species such as perch, bluegills, etc., to pass through. Another probability is that these smaller species do not move, especially during the period that the weir was in operation.

The Downstream Run, by Species

Common suckers moved downstream during the entire period that the weir was functioning. The major run occurred between April 7 and May 11, with the peak of the run coming the week of April 28-May 4. The majority of the

northern pike moved downstream during April, and gradually diminished during May (Tables 1 and 3). Northern pike were not taken in the downstream trap during June. The first redhorse was caught in the downstream trap on April 25, but the major run did not start until May 12, and continued to and including June 4, with stragglers entering the weir until June 18. Most of the walleyed pike ran during April, with but a few individuals moving in May and June. The dogfish run started on April 23, and continued through the last week of May. Just an occasional dogfish entered the weir during June. Ten channel catfish were taken in the weir between June 7 and 21.

The Upstream Run by Species

The upstream run of suckers started on April 23, (Table 1) and continued through the last week of June. The majority of the suckers were taken during the first half of May. Northern pike started to move upstream on April 24 and continued through to the 18th of May with just an occasional straggler entering until the weir was removed. The upstream run of northern pike may be characterized as spotty. The redhorse run started during the first week of May and remained more or less constant throughout the period that the weir was in operation. Dogfish started to move upstream on May 4. Most of the dogfish taken during May, 22 out of 24, were unmarked fish, while 41 of the 42 taken during June and July had been clipped on their way downstream. All of the marked dogfish caught in the traps were killed and their stomachs were preserved for food analysis.

A total of 13 large snapping turtles, each weighing between 10 and 20 pounds, were taken in the downstream trap during June and July. These turtles were much larger than the small opening of the funnel of the

trap, and entered by forcing the wire funnel.

Of the 6,957 fish that were caught in the weir, 5,602 (80.52%) were taken in the downstream trap, and 1,355 (19.48%) in the upstream trap. The number of each species of fish taken in each trap is as follows:

Muskegon River Weir - 1940

Summary of the number of fish taken in the Muskegon River Weir, 1940.

Downstream trap			Upstream trap		
Species	*Number	Number of repeats	Species	Number	Number of repeats
Common sucker	4,393	300	Common sucker	856	278
Northern pike	140	-2	Northern pike	48	33
Redhorse	906	51	Redhorse	373	107
Walleyed pike	23	-	Walleyed pike	6	-4
Dogfish	113	2	Dogfish	66	43
Channel catfish	10	-	Bullhead	2	-
Rock bass	5	-	Rock bass	3	-
Bullhead	8	-	Yellow perch	1	-
Garpike	1	-			
Black crappie	1	-	Total	1,355	465
Largemouth bass	1	-		19.48%	
Bluegill	1	-			
Snapping turtles	13	-			
Painted turtles	3	-			
Total	5,602	355			
80.52%					

Grand total: 6,957

* This includes the repeats.

Just a small percentage of the fish that were marked returned through the weir again. The number and percentage of returns is given in the following table.

Species	Total number of marked fish -downstream	Return of marked fish -upstream	% returns	Total number of marked fish -upstream	Returns of marked fish downstream	% returns
Common sucker	4,393	278	6.33	856	300	35.0
Northern pike	140	32	22.9	48	2	4.2
Redhorse	906	107	11.8	373	81	13.7
Walleyed pike	23	2	8.7	6	0	-
Dogfish	113	43	38.1	66	2	3.0

The returns listed in the above table are not complete because many fish undoubtedly made their way through holes under the weir that were caused from undercutting. Several northern pike that had been tagged going downstream were caught in Houghton Lake without being recorded as passing through the upstream trap, proving that the weir was not entirely fish proof. Because the weir was removed early in July, it is possible that many fish that had not returned at that time, returned later. It is known that many suckers and redhorse die after spawning, which may explain the low percentage of returns of these species. It is a little more difficult to explain the fact that 35% of the suckers that were tagged going upstream, returned later through the downstream trap. Perhaps these fish were largely river inhabitants that spawned above the weir, later returning downstream without going into Houghton Lake. A little over 38% of the dogfish that were marked and released downstream, returned through the upstream trap. Undoubtedly, more of these dogfish would have been taken in the upstream trap had the weir been in operation for a longer period.

Many fish died above the weir, the majority probably caused from injuries or deficiencies induced by spawning or by the spawning migration. Some fish may have been injured in the weir, traps or in handling. Others undoubtedly died of old age. The number of fish that died above the weir and were picked up next to the weir is as follows:

Muskegon River Weir - 1940
Number of fish found dead above weir, or against weir
Marked fish in ()

Species	Number
Common sucker	39 (26)
Redhorse	60 (17)
Northern pike	3
Bullhead	11
Common sunfish	9
Bluegill	6
Walleyed pike	2
Rainbow trout	1
Dogfish	2
Smallmouth bass	4
Rock bass	2
Black crappie	1
Total	183

The movement of suckers up and down the river would usually start at 3:00 P.M. and continue until about 9:00 P.M. The run would gradually diminish between 9:00 and 11:00 P.M. The majority of the suckers caught in the traps, entered between dusk and about 9:00 P.M. On only one night (May 1), did the suckers continue to run after 11:00 P.M. On this night the traps were emptied at 11:00 P.M. and inspected, as usual, the next morning, when 73 suckers were taken from the downstream trap.

The redhorse would usually move between dusk and 11:00 P.M. Northern pike and walleyed pike were found to run between 3:00 P.M. and about 6:00 A.M. Dogfish would usually enter the traps in greater numbers at night, but frequently were taken during the day.

The majority of the suckers and redhorse that were caught in the traps during the operation of the weir were females. (Personal observation rather than actual count.) Actual count of 261 suckers of three separate collections yielded 43 or 16.5% males and 218 or 83.5% females. Of 165 redhorse taken at random at six different periods, 56 or 34.0% were males and 109 or 66% were females. It does not seem possible that this sex-ratio would hold on the spawning beds because all evidence available on the spawning habits of the suckers points to an excess of males over females. It is entirely possible that many small male suckers were able to get through the spaces between the slats of the weir and therefore were not observed or recorded. It is also possible that male suckers will spawn with more than one female sucker. Of the several hundred suckers that were observed at one commercial dip netter's at Denton Creek, on several different occasions, most of the males were small (10-14"). Many suckers of this size could undoubtedly get through the weir.

The writer observed redhorse (Moxostoma aureolum) spawning above the County Dam on the afternoons of May 25 and 26, 1939. The fish were spawning on washed gravel varying in size from $\frac{1}{2}$ to 4 inches in diameter, in water that ranged in depth from shore to more than six feet. Actual spawning occurred in water between 4 inches and 2 feet in depth. The current at this point was rather swift due to the fact that the old river channel was narrow at the junction of the dam and a considerable amount of water was going over the dam. Approximately fifty fish were present on this spawning bed.

All of the redhorse, after spawning, would drop downstream to deep water to a point immediately above the dam. Here they would remain, apparently resting, with their heads pointed upstream (see diagram). At intervals a female (or several females), would slowly move upstream. Suddenly, a male would approach, and press close to one side of a female. Immediately, but not always, from one to four other males would dart in and come in contact with this female. Usually, two males would spawn with one female, but instances were observed when only one male, or as many as five males were present. When two males were present, they took up positions on opposite sides of the female. When more than two males were part of a spawning group, the extra males took up positions above the original trio (but, mostly above the female) or to either or both sides of the first males. The caudal portion of the spawners were so close together that their bodies appeared fused, and their movement synchronous. As soon as the males were in contact with the female, the spawning group would either slowly move upstream for several feet, or remain in one spot. Then the group as a whole would tremble, or quiver. This was assumed to be when the eggs and milt

were actually deposited, although actual deposition was not observed. (Reighard, in his paper on the spawning habits of suckers, claims that eggs and milt are deposited at this time). Some spawners were in such shallow water that their dorsal fins protruded. The water was definitely agitated when the fish quivered, and attempts to take pictures of this action always resulted in a print showing ripples on the surface of the water. The spawning act lasted for just a second or two. After this brief spawning act, the group would break up, the fish generally, but not always, going into deeper water or following the current to the lower end of the spawning grounds, next to the dam. After a period of rest, these fish would become parts of other groups of spawners. There were usually two or three groups spawning at the same time. I am not certain whether the same males spawn with the same female all of the time, but seriously doubt it.

Spawning has been observed on bright, clear days as well as dull, cloudy days. There is some indication that redhorse spawn at night, but evidence was not obtained because as soon as lights were flashed on, all fish would scatter. Common suckers were found to use this same area for spawning.

Green female suckers were taken in the traps of the weir up to and including May 30, 1940. This indicates that the spawning season in 1940 lasted from about April 15 to about the end of the first week in June. (The first suckers to enter the traps on April 2, and for about ten days thereafter, were not ripe or tubercled.)

Suckers were observed, on several occasions, to enter the downstream trap, through the funnel, tail first. At times two or three sucker tails projected through the small funnel opening into the trap, at the same time. Dogfish, northern pike and walleyed pike were observed to enter the trap

headfirst.

In 1939, it was found that during a heavy run of fish in the river, a large concentration of fish was usually present in front of the trap, and above the entire main wing of the weir. In 1940, no such concentration of fish was observed above the weir. It is assumed that this was due to the more efficient "V" shaped construction of the weir in 1940.

In 1939, only 13 northern pike were taken in the downstream trap and 16 in the upstream trap of the weir. In 1940, the downstream run of pike totaled 140 (Table 4) and the upstream run, 48 (table 5). There are several possible explanations for this difference in the 1939 and 1940 pike run. In the first place, it is possible that the 1939 run started before the weir was completed. We are certain that the 1940 weir was finished before the run started. The second big factor was in the design, construction and placement of the traps in the two years. There is hardly any doubt but that the 1940 weir was more efficient in taking fish and did not block the upstream or downstream migration. The third factor that should be mentioned here is that the low water level of Houghton Lake in 1940 may have eliminated certain spawning areas around the lake and may account in part for the increase in the number of pike that ran in the river. (Less than half the fish entered Peterson's ditch in 1940 than ran in 1939.) It is also possible that a larger population of pike was present in Houghton Lake in 1940. Despite the fact that many fish did run down the Muskegon to spawn in 1940, this number is only a small percentage of the pike that are present in the lake.

Northern pike are extremely difficult to tag. Pike produce large quantities of mucous which makes them difficult to hold, and their large size

and sharp teeth also present difficulties. Because of this difficulty that we experienced in tagging pike, a number of fish escaped either during or immediately after tagging, (Table 4).

Only 48 pike were recorded passing through the upstream trap. That this number is not the total number of tagged pike (pike tagged going downstream, later returning upstream) that actually passed upstream has been determined from several sources. On May 6, 1940 (Table 4), and for some time thereafter, a number of tagged pike were recorded going downstream without having passed through the upstream trap. Eight fish were recorded going downstream twice, and three fish recorded three times. The only explanation that can be offered is that these fish made their way upstream through holes in the weir that were formed by undercutting. It is reasonable to assume that many untagged fish also made their way upstream through these holes. Many tagged fish made their way upstream through holes in the weir and did not return downstream again, but went into Houghton Lake as we discovered when checking the tagged fish that were caught in Houghton Lake before the weir was removed. (This will be discussed further in section on tag returns.) Only two fish were recorded going upstream twice without having passed through the downstream trap in between (Table 5).

In 1939, only 25% (4 out of 16) of the northern pike taken in the upstream trap had been tagged going downstream. In 1940, 70% (34 out of 48) of the pike caught in the upstream trap had been tagged going downstream. This certainly indicates that most of the northern pike running upstream are part of those that left Houghton Lake to run downstream to spawn.

From the small number of walleyed pike that were taken in the weir in 1939 (16) and 1940 (29), we might assume that few walleyes leave Houghton

Table 4.

Muskegon River Weir - 1940

Summary of northern pike that were tagged at the Muskegon River weir, 1940.

Northern Pike - Downstream Trap

Date	Tag No.	Standard Length	Total Length	Sex	
April 2	50232	625	723	♀	
	12001	Escaped while tagging			
	12003	378	440	♀	
April 5	12004	513	598	♀	
	12005	430	498	♀	
April 6	12006	537	626	♂	
	12007	548	634	♂	
	50233	715	820	♀	
	12008	475	544	♀	
	12009	468	541	♂	
April 7	50234	865	956	♀	
	12010	497	573	♀	
	12011	596	681	♀	escaped upstream after tagging
	12012	580	661	♂	
	50235	705	803	♀	
	12013	488	563	♂	
	12014	514	591	♂	
	12015	494	571	♂	
	12016	528	608	♀	
	12017	490	562	♂	
	12018	421	491	♂	
	12019	403	465	♂	
	12020	374	435	♂	
	* 4112	783	880	♀	
April 8	12021	580	664	♂	
	12022	595	678	♀	
	12023	465	536	♀	
	12024	535	618	♂	escaped upstream after tagging
April 9	12025	588	690	♂	
	12103	383	438	♂	
	12026	478	557	♂	
April 10	12027	528	621	♂	
	12028	529	614	♂	
	12029	528	611	♀	
	12030	487	568	♀	
	12031	455	522	♂	
	12032	487	560	♂	
	12033	545	621	♂	
	12034	510	589	♀	
	12035	482	559	♂	
	12036	505	582	♂	
	12037	513	599	♀	
	50236	697	806	♀	
April 11	12038	574	664	♂	
	12039	578	668	♂	
	12041	557	642	♀	
April 12	12040	472	552	♂	
	12042	625	720	♀	
	12043	516	595	♀	
	12044	516	599	♂	
	50237	655	756	♂	

*Tagged at Muskegon River Weir in 1939.

Table 4. (Continued) Muskegon River Weir - 1940

Summary of northern pike that were tagged at the Muskegon River weir, 1940.

Northern Pike - Downstream Trap

Date	Tag no.	Standard length	Total length	Sex	
April 13	12045	650	747	♀	
	12046	570	651	♂	
	12047	664	755	♀	
	12048	556	641	♀	
	12049	558	638	♂	
	12050	586	676	♀	
	12051	525	610	♀	
	12052	510	588	♀	
	12054	635	727	♀	
	12055	690	792	♀	
	12056	550	627	♂	
April 14	◈4119	704	795	♀	
	12057	645	736	♀	
	12058	595	682	♀	escaped upstream after tagging
	12059	567	664	♀	escaped upstream after tagging
	12061	538	618	♀	
	12062	496	575	♀	
	12063	521	602	♂	
	12064	470	542	♀	
	12065	447	628	♀	
	12066	472	545	♂	
	12068	595	695	♀	
April 15	12069	610	702	♂	
	12070	625	720	♀	
	12053	510	592	♂	lost tags recovered
April 16	12002	502	585	♂	
	12071	598	694	♀	
	50238	790	906	♀	
	12072	574	668	♂	
	12073	475	548	♀	
	12074	554	637	♀	
	12075	478	547	♂	
April 17	12076	503	579	♂	
	12078	555	642	♂	
April 18	*◈4495	539	620	♂	
	12080	520	609	♂	
	12081	529	617	♂	
April 19	12082	598	687	♀	
April 20	50239	648	742	♀	
	12083	435	502	♀	
	12084	534	608	♀	
	12085	543	621	♀	
	12086	515	603	♂	
	50240	626	715	♀	
April 21	12087	593	684	♀	
	12088	552	634	♂	
	12089	585	670	♀	
	12090	501	580	♀	
	12091	524	606	♀	
	12092	593	680	♀	

* Tagged in Muskegon River Weir in 1939.
*◈ Tagged at Peterson's - 1939.

Table 4 (Continued). Muskegon River Weir - 1940

Summary of northern pike that were tagged at the Muskegon River weir, 1940.

Northern Pike - Downstream Trap

Date	Tag no.	Standard length	Total length	Sex	
April 21	12093	585	670	♂	
	12094	450	522	♂	
April 22	12095	570	654	♀	escaped upstream after tagging
April 23	12096	510	588	♂	
	12097	562	647	♀	
	12098	480	558	♀	
April 24	12099	582	671	♂	
	12100	497	585	♂	
April 25	12151	504	582	♀	
	12058	Escaped while being tagged on April 14			
	12152	591	674	♀	
April 28	12059	Escaped while tagging on April 14			
April 29	12156	577	659	♂	
April 30	50241	507	585	♂	Had lost a tag; could use only large tag.
	12158	547	635	♂	
	12024	Escaped upstream after tagging on April 8			
May 2	12163	459	534	♂	
	12095	Escaped upstream after being tagged on April 22			
	12011	Escaped upstream after tagging on April 7			
May 4	12165	490	570	♂	
May 5	12166	497	578	♂	
May 6	12167	602	690	♀	
	12168	543	623	-	
	12169	552	631	♀	
	12093	Second time down - not recorded going up			
	12050	Second time down - not recorded going up			
	12091	Second time down - not recorded going up			
	50241	Second time down - not recorded going up			
	12012	Second time down - not recorded going up			
May 7	12151	Second time down - not recorded going up			
May 11	12012	Third time down - not recorded going up			
May 12	12172	562	645	-	
May 13	12160	Tagged going up			
May 14	12175	602	690	♀	
May 15	12089	Second time down - not recorded going up			
May 19	12091	Third time down - not recorded going up			
	12076	Second time down - not recorded going up			
	12050	Third time down - not recorded going up			
	12176	Tagged going upstream			

Table 5. Muskegon River Weir - 1940

Summary of northern pike that were tagged at the Muskegon River weir, 1940.

Northern Pike - Upstream Trap

Date	Tag no.	Standard length	Total length	Sex	
April 17	12077	576	664	♀	
April 18	12079	480	561	♀	
April 24	12068	-	-	-	
April 25	50236	-	-	-	
	12055	-	-	-	
April 26	4112	-	-	-	
April 27	12071	-	-	-	
	12153	623	715	♀	
April 28	12154	529	608	♂	
	4119	-	-	-	
	12047	-	-	-	
April 29	12087	-	-	-	
	12157	539	626	♂	
April 30	12039	-	-	-	
	12159	534	610	♂	
	12160	480	562	♂	
	12161	474	556	♂	
	12162	552	637	♂	
May 1	12072	-	-	-	
May 2	12164	417	481	-	
May 4	4495	-	-	-	
May 8	12170	494	571	♀	
	12171	477	559	♂	
May 9	50236	Up twice, recorded down only once			
	50239	-	-	-	
May 12	12023	-	-	-	
	12152	-	-	-	
	50240	-	-	-	
	12173	478	554	-	
	12174	494	571	-	
	12042	-	-	-	
	12006	-	-	-	
May 14	12081	-	-	-	
	12167	-	-	-	
	12086	-	-	-	
May 15	12038	This one escaped downstream during handling			
May 16	12074	-	-	-	
	12093	-	-	-	
May 19	12167	Second time up - down once			
	12176	537	616	-	Fin clipped, Peterson's, 1939
	12069	-	-	-	
	12021	-	-	-	
May 23	12080	-	-	-	
May 31	12050	-	-	-	
June 7	12065	-	-	-	
June 21	12076	-	-	-	
	12012	-	-	-	
	50238	795	909	-	

Lake to spawn in the river. In 1939 none of the 16 fish that were taken in the downstream trap, returned through the upstream trap of the weir. In 1940, 4 of the 23 walleyes that were tagged going downstream, returned through the upstream trap of the weir (Table 6). Only 2 other walleyes, besides the 4 mentioned above, passed through the upstream trap. Perhaps there are only a few resident walleyes in the river, or else walleyes do not migrate far during the spawning season in this area.

In 1939, only one channel catfish was taken in the weir, while ten were caught in 1940, (Table 7). Only 6 of these catfish were tagged because of the difficulty encountered by one man in attempting to tag such a large fish. All catfish were larger in circumference than the small opening of the funnel, consequently these fish entered by forcing their way in. The funnel had to be repaired after a catfish had entered. The size range between the largest and the smallest catfish was only 2 inches. During the summers of 1939 and 1940, several large channel catfish were caught in Houghton Lake and in the Muskegon River. One was recorded caught in Houghton Lake that weighed over forty pounds (Pontiac News, Aug. 1940). Not many people at Houghton Lake fish for channel catfish. Fred Crooks, caretaker of the County Dam, catches several each year.

There was no apparent correlation between the movement of fish and the temperature of the water. At times, an increase in the run of fish would follow the rise in water temperature, but, at other times, a decrease in the run would follow rising temperature. Of course, all movement of fish is slowed down when the temperature is low; in other words, after the water becomes so warm (about 38-40° F.), fish will start to run. There was still ice on Houghton Lake when the fish first started to run down the Muskegon

Table 6. Muskegon River Weir - 1940

Summary of walleyed pike that were tagged at the Muskegon River weir, 1940.

Walleyes - Upstream and Downstream

Date	Tag no.	Standard length	Total length	Sex
Downstream Trap				
April 7	12101	394	472	♀
	12102	395	471	♀
April 10	12104	314	377	♂
	12105	438	530	♀
April 13	12106	322	390	♂
April 14	12107	350	422	♂
	12108	290	352	♂
April 15	12109	395	478	♀
	12110	424	505	♀
April 19	12111	450	532	♀
	12112	404	485	♀
April 20	12113	450	534	♀
	12114	376	453	♀
April 22	12116	320	388	♀
April 26	12117	359	434	♂
April 27	12118	367	440	♀
May 1	12119	395	469	♀
May 11	12112	Taken in south wing V by seining		
May 14	12120	422	500	-
May 26	12122	417	497	-
June 23	12124	307	372	-
June 25	12125	303	367	-
Upstream Trap				
April 21	12115	229	278	-
May 15	12121	465	552	♀
June 5	12110	-	-	-
June 16	12102	-	-	-
July 2	12122	420	505	-
July 5	12116	340	408	-

Table 7. Muskegon River Weir - 1940

Summary of the largemouth bass and channel catfish tagged at the Muskegon River weir, 1940.

Downstream Trap

Date	Tag no.	Standard length	Total length
	Largemouth Bass		
May 29	12123	260	318
	Channel Catfish		
June 15	50286	835	976
	50287	820	956
June 17	50242	840	982
	50243	842	1009
June 19	50244	812	958
June 21	50245	-	981

River and we know that there can be a fluctuation of about 8 degrees F. under the ice, which is not much, but enough probably to induce fish to leave the lake. In 1940 the ice in Houghton Lake first started to break up on April 20, and did not leave the lake entirely for about six to eight days. I believe that the current, influenced by the amount of water flowing out of Houghton Lake had a great deal to do with the run of fish. Fish appeared to run just as well during cloudy weather as during clear weather.

All northern pike were tagged when they passed through the downstream trap. When these tagged fish returned through the upstream trap, we were able to tell how long each fish remained downstream, (Table 8).

Table 8. Number of days between tagging in downstream trap and return through upstream trap. (Left out those going down several times without being recorded going up in between.) (Data from Table 5.)

11
16
13
20
12
15
16
9
20
16
17
20
35
18
23
31
36
27
9
25
35
31
13
31
35
52
36
55
67
25.3 days

All fish having gone through either trap more than once, without an intervening trip through the trap in the opposite direction, are not included in this table. By the examination of the table, we find that the period of time varied from 9 to 67 days and averaged 25.3 days. This indicates that the fish remain downstream until through spawning and for varying periods thereafter. Naturally, this depends upon the distance each fish travels to reach a suitable spawning area. Some fish undoubtedly find conditions for food and shelter suitable some place along the line and remain there indefinitely or may be caught by anglers while down river. Some recoveries indicate that northern pike may remain in the river for almost a year. The recoveries plotted in Table 8 involve only a small percentage of the total downstream run. We know that a good many fish passed through the weir during periods when holes were present. So, the averages obtained from Table 8 are none too conclusive and are presented for what they may be worth for the sake of completeness.

Recoveries of tagged fish by Anglers

Data on the number of fish tagged and the number and percentage of recoveries during 1939 and 1940 are presented in Table 9.

Table 9. The number of fish that were tagged in the Muskegon River Weir in 1939 and 1940 and the number and percentage of recovery.

Location of tagging	When tagged	Species	Number tagged	Recovered 1939	% Recovery	Recovered 1940 [1]	% Recovery 1939,1940
Muskegon River Weir	1939	N.pike	23	7	30.4%	2	39.1%
	1940	N.pike	134	-	-	32	23.9%
	1939	Walleye	16	1	6.25%	3	25.0%
	1940	Walleye	23	-	-	-	-
	1940	Largemouth bass	1	-	-	-	-
	1940	Ch. cat.	6	-	-	-	-

[1] Does not include 1939 fish recovered in weirs in 1940.

To date, 39.1% (9 fish) of the 23 pike tagged in 1939 have been recovered. This is a high percentage of returns when we consider that no definite creel census was in operation and that we had to depend entirely upon fishermen and conservation officers to send in the returns. We know that some tagged fish were caught and were not reported. Posters describing the tagged fish were placed at numerous points about Houghton Lake and the Muskegon River. Twenty-five per cent of the 16 walleyes that were tagged in 1939 have been recovered. Of the 134 northern pike that were tagged in 1940, 32 or 23.9% have been caught and reported. None of the walleyed pike or other species of fish that were tagged in 1940 have been reported. A total of 203 fish were tagged in the Muskegon River weir during 1939 and 1940 and 45 or 22.16% have been recovered to date.

Of the 32 recoveries of northern pike tagged in 1940, the average number of days that elapsed between the time of tagging and the time of recovery was 50.7 days and varied from 7 to 117 days (Table 10). The average number of miles traveled by the northern pike from the point of tagging to the point

of recovery varied from 1.0 to 9.0 miles for an average of 4.84 miles (Table 10).

Table 11 presents a summary of the recoveries of the 32 northern pike that were tagged in the Muskegon River weir in 1940. All but 7 of the 32 fish were caught in Houghton Lake. Two fish were caught in the Dead Stream and 5 in the Muskegon River below the weir, before the weir was removed. The majority of these 7 fish would probably have returned to Houghton Lake if they had not been caught. Most of the tagged pike caught in Houghton Lake were taken in North Bay and Muddy Bay (See map). Those fish that are included in "other parts of the lake" were either fish reported caught just in Houghton Lake, or fish caught in scattered parts of the lake, and were lumped together under one heading to prevent a bulky table. Of the 25 northern pike that were reported captured in Houghton Lake, 15, had been tagged going downstream and had returned through the weir during periods when the weir was undercut.

Table 12 presents a summary of the 1940 recoveries of northern pike and walleyed pike that were tagged in the Muskegon River weir in 1939.

Muskegon River Weir
Northern Pike
1940

Table 10. Number of days out and distance traveled for each of the 32 recoveries of fish tagged in Muskegon River Weir.

Days	Distance traveled
7	7.5
10	7.5
20	1.5
26	7.5
26	7.0
29	5.0
30	2.0
36	5.0
38	7.5
41	5.0
42	7.0
43	1.0
45	7.0
46	8.5
47	3.0
47	9.0
48	5.0
49	2.0
49	3.5
50	2.0
50	2.0
51	6.5
55	8.0
55	9.0
61	3.0
64	1.0
68	3.5
70	1.5
87	5.0
102	3.0
113	-
117	4.0
Average 50.7 days	4.84 miles

Table 11. The weekly summary of the recoveries of northern pike tagged in the Muskegon River Weir in 1940.

Period of recovery	Number of tagged fish recovered	Av. number of days free	Av. number of miles traveled	Dead stream	Muskegon River below Weir	North Bay	Muddy Bay	Middle Grds.	Other parts lake
May 1-7	1	30	2	-	1	-	-	-	-
May 8-14	0	-	-	-	-	-	-	-	-
May 15-21	5	32	3.7	-	1	1	3	-	-
May 22-28	7	40	6.3	1	-	-	1	2	3
May 29-June 4	9	43.3	4.8	1	1	4	-	-	3
June 5-11	3	47.3	6.5	-	-	1	-	-	2
June 12-18	1	64	1	-	1	-	-	-	-
June 19-25	1	68	3.5	-	-	1	-	-	-
June 26-July 2	1	70	1.5	-	1	-	-	-	-
July 3-9	1	87	5	-	-	-	1	-	-
July 10-16	0	-	-	-	-	-	-	-	-
July 17-23	0	-	-	-	-	-	-	-	-
July 24-30	0	-	-	-	-	-	-	-	-
July 31-Aug.6	1	102	3	-	-	1	-	-	-
Aug. 7-13	1	117	4	-	-	1	-	-	-
Aug. 14-20	1	113	-	-	-	-	-	-	1
Totals	32			2	5	9	5	2	9

Table 12. Summary of the 1940 recoveries of walleyed pike, and northern pike tagged at the Muskegon River Weir in 1939.

Tag number	Date of tagging	Date of Recovery	Location of capture	Number of days free	Number of miles traveled	Growth in mm.
Walleyed pike						
4215	May 12, 1939	Sept.19, 1940	North Bay Houghton L.	497	3	-
4206	April 22, 1939	May 26, 1940	"	401	2	-
4209	April 23, 1939	April 15, 1940	Big Rapids Dam on Muskegon R.	359	130.5	+10
Northern pike						
4117	April 30, 1939	July 4, 1940	Houghton Beach	432	8.5	+22
4123	May 7, 1939	Feb.11, 1940	River	281	49	+87

The following fin-clipped fish have been reported from Houghton Lake and the Muskegon River.

1. On May 2, 1940, Conservation Officers arrested several men on Townline Creek, 3/4 of a mile upstream from the Muskegon River for illegal spearing and netting of suckers. Townline Creek is just 45 miles downstream from the weir. One of the eight suckers confiscated by the Officers was a green female that had been fin-clipped at the weir.

2. On May 11, 1940, two out of the eleven suckers caught at the Low Bridge on the Muskegon River, 15 miles downstream from the weir, were fin-clipped.

3. One dead fin-clipped sucker was found on the west shore of North Bay on June 10, 1940.

4. On June 19, 1940, one fin-clipped sucker was reported caught by CCC boys at the new dam (Reedsburg) on the Muskegon River, which is 11 miles downstream from the weir.

5. On May 10, 1941, Mr. John Peterson, of Houghton Lake, caught 5 suckers below the Reedsburg Dam on the Muskegon River; 3 of these had been fin-clipped.

6. During the first week in May, 1941, Conservation Officer, Tom White, arrested two men for dipping suckers below the Reedsburg Dam. Thirteen of the 82 suckers that were confiscated had been fin-clipped.

The above records of the recovery of fin-clipped suckers indicate that these fish move great distances down the Muskegon River. Perhaps suckers do not find enough suitable spawning areas in the Muskegon River and run up many tributary streams such as the Dead Stream, Townline Creek, West Branch of the Muskegon River, Wolf Creek, Bear Creek and many others which may provide suitable spawning grounds. Many of the above named tributaries are

trout streams with long stretches of gravel bottom.

Three northern pike that were tagged in the downstream trap of the Muskegon River weir were retaken in a small weir on a ditch (see map), about 2 miles east of the Muskegon River and 1 mile west of North Bay. This ditch drains the marshes north of Peterson's and connects Houghton Lake with the river. The small weir on this ditch is just 10 miles from the Muskegon River weir. The data on the three pike are as follows:

Tagged, Muskegon River Weir	Recovered in weir on ditch
12048 - 9:45 A.M. - April 13	9:00 P.M. on April 15 - 59 hrs.
12070 - 10 P.M. - April 15	8:15 A.M. on April 16 - 20 hrs.
12045 - 10 A.M. - April 13	6:30 A.M. on April 17 - 92.5 hrs.

Northern pike No. 12070 made the 10 mile journey from the Muskegon River weir to the weir on the ditch in 20 hours, for an average speed of .5 miles per hour. This fish probably traveled faster than that because it might have wandered through a good many ox-bows and other tributaries before finding the ditch. This might indicate that some pike travel long distances before finding suitable spawning grounds. From tag returns (discussed in preceding section), it was observed that three pike were caught in the Dead Stream.

Parasitic Lampreys

Many of the fish taken in the Muskegon River Weir had lampreys (Ichthyomyzon castaneus) attached. All of the common species of fish taken in the weir were susceptible to lamprey attack. In 1939 it was estimated that between 80 and 90% of the suckers taken in the upstream trap were infested with lampreys. In 1940, the percentage was not as high as this, but it did run over 50%. Accurate computations are not available because of the

large number of fish found in the traps and the ease with which lampreys drop off as the fish are dipped out of the traps. By dipping the fish directly into large washtubs, the loss of lampreys was minimized.

Because most of the lamprey scars on the suckers and redhorse taken in the upstream trap were small, this indicated that the lampreys had been attached for only a short period. Many scars on the suckers and northern pike, taken in the downstream trap, were large and bloody, probably due to the fact that lampreys had been attached to the fish for some time.

Table 13 presents a summary of the number of lampreys taken each day, and the number and species of fish taken in both traps of the weir each day. More lampreys were removed from fish traveling upstream than were taken from fish moving downstream. The large number of lampreys removed from fish in the downstream trap on the two days mentioned in the footnote at the bottom of Table 13, cannot be classed as representative of all fish running downstream. In most cases it was found that when fish were concentrated in the traps, a number of lampreys were able to escape, and could easily attach themselves to the large numbers of fish concentrated in the small area of the "V" section between the wings. It may also be true that lampreys were moving upstream at the time.

Many lampreys taken in the downstream trap during April and the first part of May were adults, probably on their way downstream to spawn. Several adult lampreys at this time were observed to be free-swimming, on their way downstream. On April 30, two adult lampreys were caught in a dipnet above the County dam by Fred Crooks, caretaker of the County dam. Mr. Crooks stated that he observed a large number of adult lampreys running downstream shortly after dawn on that day. When Mr. Crooks called this to my attention late

Table 13. Number of lampreys, Ichthyomyzon castaneus, removed from the fish taken in the Muskegon River Weir, 1940.

Downstream

Date	Number of lampreys	Common sucker	N.Pike	Redhorse	Dogfish	Walleyed pike	Bullhead	Ch. catfish
April 10	1	87	12	-	-	2	-	-
26	1	276	-	1	4	1	-	-
27	1	92	-	5	4	1	-	-
28	2	496	1	3	8	-	-	-
29	3	357	1	10	8	-	-	-
30	2	345	3	5	11	-	-	-
May 2	2	124	3	-	-	-	-	-
3	3	20	-	-	-	-	-	-
4	1	46	1	2	3	-	-	-
5	20	80	1	4	5	-	-	-
6	40	205	8	15	7	-	-	-
7	22	85	1	1	1	-	-	-
8	5	51	-	1	5	-	-	-
9	1	13	-	6	2	-	-	-
10	5	9	-	-	-	-	-	-
11	[1]192	237	1	13	2	1	-	-
12	6	14	1	26	2	-	-	-
14	11	26	1	73	8	1	-	-
15	7	19	1	34	8	-	-	-
16	3	13	-	12	2	-	-	-
19	8	6	4	97	4	-	-	-
20	1	2	-	61	-	-	-	-
21	1	-	-	38	3	-	-	-
22	1	2	-	14	-	-	-	-
23	1	2	-	20	2	-	-	-
24	3	2	-	15	-	-	-	-
29	3	1	-	22	-	-	-	-
30	5	4	-	22	-	-	-	-
June 2	1	1	-	55	-	-	-	-
4	[2]174	162	-	90	5	-	-	-
5	1	-	-	4	-	-	-	-
6	2	-	-	10	-	-	-	-
7	3	4	-	6	-	-	-	-
11	3	1	-	1	-	-	-	-
12	2	-	-	-	-	-	4	2
13	1	-	-	2	-	-	-	1
14	1	1	-	2	-	-	-	-
15	2	-	-	-	-	-	-	2
19	1	1	-	-	-	-	-	1
20	2	1	-	-	-	-	-	-
23	1	1	-	1	-	-	-	-
25	3	4	-	1	-	-	-	-
Total	548							

[1]187 of these lampreys removed from fish seined from south "V" (see text).
[2]172 of these removed from fish seined from south "V" (see text).

Table 13. (Continued) Number of lampreys, Ichthyomyzon castaneus, removed from the fish taken in the Muskegon River Weir, 1940. Upstream

Date	Number of lampreys	Common sucker	N.pike	Redhorse	Walleyed pike	Dogfish
April 27	2	3	2	-	-	-
28	1	21	3	-	-	-
30	1	32	5	1	-	-
May 1	2	30	1	-	-	-
3	1	3	-	-	-	-
5	4	28	-	2	-	1
6	14	127	-	2	-	14
7	6	34	-	-	-	-
8	14	39	2	-	-	-
9	11	13	2	1	-	-
10	4	9	-	-	-	-
11	19	18	-	-	-	-
12	34	31	7	10	-	-
13	5	49	-	13	-	-
14	184	111	3	32	-	1
15	27	31	1	13	1	2
16	7	11	2	14	-	-
17	1	2	-	-	-	-
19	27	14	4	18	-	-
21	13	13	-	22	-	-
22	13	7	-	10	-	-
23	19	6	1	10	-	-
24	3	1	-	4	-	-
25	4	1	-	6	-	-
26	4	2	-	5	-	-
27	1	2	-	-	-	-
28	25	11	-	13	-	-
29	5	7	-	4	-	-
30	10	12	-	7	-	2
31	2	1	1	8	-	1
June 1	11	9	-	4	-	-
2	20	12	-	16	-	-
3	3	2	-	2	-	2
4	2	-	-	7	-	-
5	4	2	-	7	1	2
6	27	10	-	22	-	1
7	8	4	1	18	-	1
8	2	-	-	7	-	1
9	13	-	-	8	-	6
10	3	-	-	-	-	1
11	4	3	-	2	-	4
12	4	3	-	4	-	1
13	9	3	-	7	-	6
14	1	-	-	1	-	2
15	1	-	-	5	-	-
16	6	1	-	2	1	-
17	2	-	-	2	-	-
18	8	7	-	6	-	2
19	13	13	-	6	-	3
20	3	2	-	3	-	-
21	2	-	3	2	-	-
22	2	5	-	1	-	1
24	6	11	-	-	-	-
25	1	1	-	-	-	-
27	1	-	-	2	-	-
30	3	-	-	1	-	-
July 1	2	-	-	1	-	2
2	1	-	-	1	1	1
5	1	-	-	2	1	1
6	2	-	-	-	-	4
Total	628	Grand total for up- and downstream - 1176 lampreys.				

that afternoon, I found several dead lampreys in the gravel, out of the water. These lampreys had probably been stranded by the lowering of the water that day, or while attempting to crawl over the gravel to get over the dam. It may be possible that the lampreys had been spawning on the gravel above the dam.

Whenever possible, the number of lampreys on each fish was recorded.

Table 14 Lampreys

The number of lampreys removed from individual fish caught in the Muskegon River Weir, 1940.

No. lampreys per fish / Hosts	1	2	3	4	5	6	7	8	No. lampreys	No. fish
C. suckers	23	4[2]	1	1	1	2	1	1	70	34
Redhorse	3	1[1]	1	-	-	-	-	-	8	5
N. Pike	8	3	1	1	-	-	-	-	21	13
Dogfish	3	1	-	-	-	-	-	-	5	4
Bullhead(dead)	1	-	-	-	-	-	-	-	1	1
Walleye	1	-	-	-	-	-	-	-	1	1
Ch. catfish	1	-	-	-	-	-	-	-	1	1
Total	40	18	9	8	5	12	7	8	107 lampreys	59 fish.
No. fish	40	9	3	2	1	2	1	1	59	

[1]Two lampreys were removed from a dead redhorse.

[2]Two lampreys taken from one dead sucker.

Although this table is incomplete, it at least gives us an idea as to the number of lampreys that can attach themselves to one fish.

Conclusions and recommendations

Despite the fact that more northern pike and walleye were taken in the Muskegon River in 1940 than in 1939, the numbers make up only a small percentage of the total population of both species in Houghton Lake. More northern pike ran up Peterson's ditch in 1940 than ran down the Muskegon River, and Peterson's is only one of perhaps a dozen spawning areas at Houghton Lake. From the records of tagged pike caught in Houghton Lake, we may assume that most of the pike tagged in the Muskegon River Weir, return to Houghton Lake.

Several problems are presented by the completion of the Reedsburg dam. One problem is the effect that the dam will have on the downstream spawning

migration of the various species of fish. Though few records are available, we do know that some pike, walleyes, suckers and redhorse do travel farther downstream than the new dam. Sufficient spawning areas for northern pike will probably be available in the backwaters of the dam; therefore, if pike are unable to negotiate the fish ladder in the dam, they may be able to spawn in the backwater of the dam. What effect the new dam will have on the migration of suckers is not known. (See report No. 677)

There are sufficient numbers of northern pike, rock bass, perch, large- and smallmouth bass, bluegills, crappies and minnows in the Muskegon River to form an adequate breeding stock for the lake formed by the Reedsburg dam. There is no doubt but that dogfish and garpike will also soon become abundant there.

The Roscommon County Board of Supervisors have never understood just what effect the County dam has on controlling the water level of Houghton Lake. It has been their habit to add or remove boards in the dam at any time, usually to satisfy the whims of some landowners. No one person is able to agree on the level to be maintained at Houghton Lake. The lake is always too high or too low to satisfy everyone. Mr. Otto H. Hall, Conservation Engineer for the CCC Planning Division, has supplied the following information on the Muskegon River and Houghton Lake in his letter dated March 14, 1941.

> "The total precipitation measured at the Houghton Lake Forest Headquarters for the year 1940 was 32.87 inches, being approximately 6 inches more than during 1939. There is only one evaporation station in Michigan, that being located at Germfask, Michigan, and showing an evaporation during the months of May, June, July, August, September and October of 1940, totaling 23.87 inches. No doubt, this evaporation is somewhat greater at Houghton Lake and I have been advised that at times on hot summer days the evaporation might be as much as 3/4 of an inch in one day. The capacity of the county-owned dam near the mouth of the Muskegon River with stoplogs

removed is only sufficient to lower Houghton Lake approximately one ineh in a period of time of between three and four weeks. In other words, a sheet of water one inch thick, covering the entire acreage of Houghton Lake, is of such volume that it could not go through the County dam in less than three or four weeks. For that reason the removal of one or two flashboards for the entire length of the dam would not have any appreciable effect on Houghton Lake and evaporation in summer would take the lake down faster than any adjustment of the flashboards. It is true, however, that the dam with flashboards in place, would retard the outflow from the lake and affect the water elevation in maintaining a higher level."

INSTITUTE FOR FISHERIES RESEARCH

By W. F. Carbine

Report approved by: A. S. Hazzard

Report typed by: B. MacLeod

Table 15.

Temperatures[1] and weather data taken at the Muskegon River weir, 1940.

Date	Time	Water temp. Max.	Water temp. Min.	Air temperatures[2] Max.	Air temperatures[2] Min.	Air temperatures[2] Ave.	Sky	Weather	Wind	Number hours sun	Water level in inches
April 2	8:30 a.m.	39	38	39	22	31.1	Cloudy	Cool	Lt. E.	...	8 3/4
	11:00 p.m.	39	38	..	..	..	Cloudy	Cool - lt. rain	Lt. E.	...	8 3/4
April 3	8:30 a.m.	39	37	35	30	33.0	Cloudy	Cool - rain, snow	St. E.	...	8 3/4
	10:00 p.m.	39	37	..	..	..	Cloudy	Cool - rain, snow	St. E.	...	8 3/4
April 4	10:00 a.m.	39	37	35	30	33.1	Cloudy	Cool - rain	Lt. N.W.	...	9 1/4
	10:00 p.m.	39	37	..	..	..	Clear	Cool	Lt. N.W.	6 hrs.	9 1/4
April 5	9:30 a.m.	39	37	38	26	31.6	Clear	Cool	St. N.	All day	9 1/2
	10:30 p.m.	41	37	..	..	..	Clear	Cool	Calm	All day	10
April 6	8:30 a.m.	39	38	50	26	36.9	Clear	Cool	Calm	All day	9 7/8
	10:30 p.m.	40	39	..	..	..	Clear	Cold	Calm	All day	10 1/2
April 7	10:00 a.m.	40	39	45	27	36.6	Cloudy	Cool	Lt. E.	...	10 1/4
	11:00 p.m.	40	39	..	..	..	Cloudy	Cool - rain	Lt. E.	...	10 3/4
April 8	9:00 a.m.	40	39	42	33	37.1	Cloudy	Cool - rain	Calm	...	10 3/4
	10:00 p.m.	39	38	..	..	..	Cloudy	Cool - rain, snow	Lt. N.W.	...	11
April 9	9:00 a.m.	39	37	36	29	33.0	Cloudy	Cold	St. N.W.	...	11
	10:30 p.m.	38	38	..	..	..	Clear	Cold - freezing	Calm	...	11 1/4
April 10	8:30 a.m.	40	37	43	21	33.0	Partly cloudy	Cool	Calm	...	11 1/8
	10:45 p.m.	41	40	..	..	..	Cloudy	Cool - rain	Calm	...	12
April 11	9:50 a.m.	40	39	42	19	30.1	Cloudy	Cold	St. N.	...	11 5/8
	10:00 p.m.	39	37	..	..	..	Partly cloudy	Cold	St. N.	...	11 5/8
April 12	9:45 a.m.	37	36	27	17	21.7	Partly cloudy	Cold	Lt. W.	...	11 5/8
	10:00 p.m.	39	37	..	..	..	Partly cloudy	Cold	Lt. W.	...	11 7/8
April 13	9:45 a.m.	39	37	35	15	24.2	Partly cloudy	Cold	St. N.E.	8 hrs.	11 5/8
	10:00 p.m.	37	36	..	..	..	Clear	Cold	Lt. N.W.	8 hrs.	12
April 14	8:30 a.m.	39	37	43	14	29.1	Clear	Cool	Lt. W.	8 hrs.	11 3/8
	10:10 p.m.	44	37	..	..	..	Partly cloudy	Cool	Calm	...	12 3/8
April 15	9:00 a.m.	40	37	49	32	38.7	Cloudy	Cool	Lt. N.E.	...	12 3/8
	10:15 p.m.	43	39	..	..	..	Clear	Cool	Lt. N.	...	12 3/4
April 16	8:30 a.m.	40	40	50	24	38.1	Clear	Cool	Lt. N.E.	8 hrs.	12 3/4
	10:30 p.m.	41	37	..	..	..	Clear	Cool	Lt. S.E.	...	13
April 17	9:30 a.m.	41	39	49	26	36.4	Cloudy	Cool	Lt. N.E.	...	13 1/8
	10:00 p.m.	39	39	..	..	..	Cloudy	Cool - snow	St. N.E.	...	13 1/8
April 18	10:00 a.m.	39	36	38	31	34.4	Cloudy	Cool - snow	Lt. N.	...	13 3/8
	10:00 p.m.	36	35	..	..	..	Clear	Cool	Calm	...[3]	6
April 19	8:30 a.m.	37	36	54	26	38.6	Clear	Cool	Calm	8 hrs.	5 1/4
	10:30 p.m.	45	36	..	..	..	Clear	Cool	Calm	...[4]	11 1/2
April 20	9:30 a.m.	41	40	49	27	38.2	Partly cloudy	Cold	St. N.E.	none	10 7/8
	10:45 p.m.	45	40	..	..	..	Clear	Cold	Calm	...	11 1/4
April 21	10:30 a.m.	43	39	57	27	42.7	Clear	Cold	Mod. N.	All day	11 1/4
	10:30 p.m.	45	42	..	..	..	Clear	Cold	Calm	...	11 1/2
April 22	9:30 a.m.	45	43	57	27	43.5	Clear	Cool	Calm	All day	11 1/2
	11:15 p.m.	48	44	..	..	..	Clear	Cold	Calm	...	11 7/8
April 23	9:30 a.m.	48	46	52	29	40.6	Partly cloudy	Cool	Lt. E.	...	11 3/4
	11:00 p.m.	47	46	..	..	..	Partly cloudy	Cool	Calm	...[5]	9
April 24	8:45 a.m.	46	45	47	33	38.2	Cloudy	Cool	Lt. W.	...	8 5/8
	10:45 p.m.	46	43	..	..	..	Cloudy	Cold	Calm	...	9
April 25	9:00 a.m.	42	41	51	29	38.4	Partly cloudy	Cool	Calm	3 hrs.	8 3/4
	11:45 p.m.	45	42	..	..	..	Partly cloudy	Cold	Calm	...	8 3/4
April 26	8:45 a.m.	43	43	52	27	41.9	Clear	Cool	Calm	All day	8 1/4
	10:00 p.m.	46	44	..	..	..	Partly cloudy	Cold	Calm	...	8 1/2
April 27	9:15 a.m.	45	42	59	26	43.2	Clear	Cool	Calm	All day	8
	10:00 p.m.	55	44	..	..	..	Clear	Cool	Calm	...	8 3/4
April 28	9:30 a.m.	53	46	68	34	50.1	Partly cloudy	Cool	Mod. S.	...	8 1/2
	10:30 p.m.	55	48	..	..	..	Partly cloudy	Cool	Lt. S.	...	8
April 29	9:00 a.m.	53	49	70	45	56.0	Partly cloudy	Cool	Lt. S.	5 hrs.	8 5/8
	10:30 p.m.	53	50	..	..	..	Cloudy	Cool - rain	St. S.	...	8 3/8
April 30	9:00 a.m.	54	52	72	50	58.7	Partly cloudy	Warm	St. S.	8 hrs.	8
	10:30 p.m.	59	53	..	..	..	Partly cloudy	Warm	Calm	...	6 3/4

[1] All temperatures given in °F.

[2] Air temperatures courtesy of U. S. Weather Bureau, Houghton Lake, Michigan, Branch. Temperatures taken six times daily (maximum-minimum, four times daily).

[3] County Board of Supervisors placed all available boards in the dam on April 18.

[4] Some boards were removed from dam on April 19.

[5] Several boards placed in the dam April 23 to lower the water level in the river.

Table 15. (Continued)

Temperatures and weather data taken at the Muskegon River weir, 1940.

Date	Time	Water temp. Max. °F.	Water temp. Min. °F.	Air temperatures Max. °F.	Air temperatures Min. °F.	Air temperatures Ave. °F.	Sky	Weather	Wind	No. hours sun	Water level in inches
June 1	9:15 a.m.	64	61	78	57	71.6	Partly cloudy	Cool	Lt. N.W.	9 hrs.	8 1/2
	9:15 p.m.	69	62	..	..	..	Clear	Warm	Calm	...	8 3/4
June 2	10:15 a.m.	68	64	85	55	70.0	Clear	Warm	Lt. W.	11 hrs.	8 5/8
	9:00 p.m.	72	68	..	..	..	Cloudy	Warm	Lt. S.W.	...	8 5/8
June 3	9:30 a.m.	70	67	88	62	75.0	Clear	Warm	Lt. S.W.	9½ hrs.	8 3/8
	9:15 p.m.	75	68	..	..	..	Clear	Warm	Calm S.	...	8 1/2
June 4	10:00 a.m.	74	71	85	60	74.4	Clear	Warm	Lt. S.W.	9½ hrs.	8 3/8
	10:15 p.m.	75	71	..	..	..	Cloudy	Warm	Lt. S.W.	...	8 3/4
June 5	6:30 a.m.	73	70	77	65	70.7	Cloudy	Warm	Lt. S.W.	11 hrs.	8 1/2
	10:00 p.m.	76	70	..	..	..	Clear	Cool	Calm	...	8 1/4
June 6	9:30 a.m.	74	68	77	48	64.0	Cloudy	Cool	St. S.E.	6 hrs.	8 1/2
	9:00 p.m.	72	66	..	..	..	Clear	Warm	Lt. S.E.	...	8 5/8
June 7	10:30 a.m.	72	70	83	63	73.0	Clear	....	Lt. W.	6 hrs.	8 1/4
	8:30 p.m.	75	72	..	..	..	Cloudy	Warm - rain	Lt. N.E.	...	8 1/4
June 8	9:15 a.m.	74	70	80	61	68.2	Cloudy	Warm - rain	Lt. S.W.	4 hrs.	9 1/8
	9:30 p.m.	77	70	..	..	..	Cloudy	Cool	St. N.E.	...	◊5 7/8
June 9	9:30 a.m.	73	66	69	49	58.8	Cloudy	Cool	Lt. N.E.	...	◊◊7 3/8
	9:30 p.m.	70	67	..	..	..	Partly cloudy	Cool	Lt. S.	...	6 1/2
June 10	9:00 a.m.	71	67	85	59	68.1	Cloudy	Cool	Lt. S.W.	5 hrs.	6 5/8
	9:00 p.m.	77	69	..	..	..	Cloudy	Cool - lt. rain	Lt. N.E.	...	7
June 11	9:00 a.m.	77	71	78	59	68.1	Clear	Cool	Lt. N.E.	7 hrs.	7
	9:30 p.m.	78	71	..	..	..	Cloudy	Cool	Lt. S.E.	...	8
June 12	9:00 a.m.	75	71	72	58	60.5	Cloudy	Cool - lt. rain	Lt. E.	...	7 7/8
	9:30 p.m.	71	71	..	..	..	Cloudy	Cool - mist	Calm	...	7 3/4
June 13	9:00 a.m.	72	70	68	59	63.1	Cloudy	Cool	Lt. W.	6½ hrs.	6 1/2
	9:30 p.m.	74	64	..	..	..	Clear	Cool	Lt. N.	...	6 3/4
June 14	9:15 a.m.	71	65	79	41	61.7	Clear	Cool	Lt. S.W.	All day	8 1/4
	9:30 p.m.	73	67	..	..	..	Clear	Cool	Lt. S.W.	...	7 7/8
June 15	9:00 a.m.	71	64	73	61	68.3	Clear	Cool	Lt. N.W.	All day	6 1/8
	9:30 p.m.	75	63	..	..	..	Clear	Cool	Calm	...	7 1/8
June 16	9:00 a.m.	73	72	83	53	69.7	Clear	Cool	Lt. S.W.	All day	7 1/2
	9:30 p.m.	76	71	..	..	..	Clear	Warm	Calm	...	7 1/4
June 17	5:00 a.m.	73	71	90	60	76.2	Clear	Warm	Calm	All day	7 1/4
	9:00 p.m.	79	71	..	..	..	Clear	Warm	Lt. S.W.	...	7 1/4
June 18	9:00 a.m.	77	71	82	63	71.1	Cloudy	Cool - lt. rain	St. W.	8 hrs.	8 1/4
	9:30 p.m.	77	72	..	..	..	Cloudy	Warm	Calm	...	9
June 19	9:30 a.m.	76	70	75	51	58.2	Clear	Cool	St. N.W.	All day	8
	10:40 p.m.	75	67	..	..	..	Partly cloudy	Cool	...	...	8 1/2
June 20	9:15 a.m.	70	58	58	41	49.6	Partly cloudy	Cool - lt. rain	St. N.W.	12 hrs.	6 1/2
	8:45 p.m.	68	58	..	..	..	Clear	Cool	Lt. N.W.	...	8 1/2
June 21	9:15 a.m.	72	60	70	35	54.3	Clear	Cool	Calm	All day	8 3/8
	9:00 p.m.	71	63	..	..	..	Partly cloudy	Cool	Calm	...	8 5/8
June 22	9:00 a.m.	69	64	67	51	55.2	Cloudy	Cool	Mod. S.E.	...	9 5/8
	9:30 p.m.	65	62	..	..	..	Cloudy	Cool	Mod. S.E.	...	9 5/8
June 23	9:30 a.m.	62	60	62	54	57.6	Cloudy	Cool	Mod. S.E.	...	9 1/2
	9:00 p.m.	61	60	..	..	..	Cloudy	Cool	Mod. N.E.	...	9 1/2
June 24	8:45 a.m.	61	60	65	54	57.4	Cloudy	Cool	Lt. S.	...	10
	8:45 p.m.	60	60	..	..	..	Cloudy	Cool	Mod. W.	...	10 1/4
June 25	9:00 a.m.	58	57	66	49	56.4	Cloudy	Cool	Mod. W.	6 hrs.	10
	8:30 p.m.	65	55	..	..	..	Clear	Cool	Calm	...	10 1/8
June 26	8:30 a.m.	64	57	66	47	56.9	Partly cloudy	Cool	Lt. N.W.	8½ hrs.	10 1/4
	7:15 p.m.	65	60	..	..	..	Partly cloudy	Cool	Lt. W.	All day	10 1/8
June 27	9:00 a.m.	65	61	74	44	60.7	Clear	Cool	Lt. W.	...	10 1/2
	8:30 p.m.	69	61	..	..	..	Partly cloudy	Warm	Lt. W.	...	10 3/8
June 28	9:30 a.m.	67	63	74	56	63.0	Cloudy	Cool	Lt. S.	4 hrs.	10 1/2
	10:30 p.m.	68	65	..	..	..	Cloudy	Cool - lt. rain	Lt. W.	...	10 5/8
June 29	10:00 a.m.	67	62	68	50	59.7	Cloudy	Warm	Mod. W.	7 hrs.	9 1/2
	7:00 p.m.	69	62	..	..	..	Partly cloudy	Warm	Mod. N.W.	...	9 1/2
June 30	9:45 a.m.	68	62	67	51	59.9	Partly cloudy	Warm	Lt. N.W.	8½ hrs.	9 3/4
	9:00 p.m.	70	64	..	..	..	Clear	Warm	Calm	...	9 5/8

◊Boards placed in the dam by the County Board of Supervisors.
◊◊Several boards in dam removed by weir attendant.

Table 15. (Continued)

Temperatures and weather data taken at the Muskegon River weir, 1940.

Date	Time	Water temp. Max. °F.	Water temp. Min. °F.	Air temperatures Max. °F.	Air temperatures Min. °F.	Air temperatures Ave. °F.	Sky	Weather	Wind	No. hours sun	Water level in inches
May 1	9:00 a.m.	55	48	53	39	43.8	Cloudy	Cool - rain	Mod. N.E.	none	6
	11:00 p.m.	48	49	..	..	..	Cloudy	Cold	Mod. N.E.	...	7 3/4
May 2	8:30 a.m.	49	44	40	32	36.1	Cloudy	Cool - lt. rain	Calm	...	7 1/4
	10:15 p.m.	48	44	..	..	..	Cloudy	Cool - rain, snow	Lt. N.	...	7
May 3	9:00 a.m.	43	41	40	33	36.9	Cloudy	Cold - rain	Lt. N.	...	6 1/2
	10:00 p.m.	44	40	..	..	..	Cloudy	Cold	Calm	...	6 3/8
May 4	9:45 a.m.	44	38	60	28	43.9	Clear	Cool	Lt. E.	8 hrs.	6 5/8
	10:00 p.m.	54	39	..	..	..	Partly cloudy	Cool	Lt. N.	...	7
May 5	10:00 a.m.	51	46	72	40	56.0	Clear	Cool	Lt. S.W.	All day	7 1/4
	9:30 p.m.	59	50	..	..	..	Cloudy	Warm - rain	Calm	...	7 1/4
May 6	8:30 a.m.	57	54	66	52	60.2	Partly cloudy	Warm	Mod. S.W.	8 hrs.	7 5/8
	11:45 p.m.	63	55	..	..	..	Partly cloudy	Cool	Calm	...	7
May 7	8:30 a.m.	58	50	60	36	46.3	Cloudy	Cool	Lt. N.	...	6 3/4
	10:00 p.m.	57	50	..	..	..	Partly cloudy	Cool	Calm	...	7 1/8
May 8	8:30 a.m.	57	53	60	43	50.4	Cloudy	Cool - rain	Lt. E.	...	7 1/4
	10:00 p.m.	56	53	..	..	..	Cloudy	Cool - lt. rain	Calm	...	7 1/2
May 9	8:30 a.m.	57	51	65	35	52.1	Clear	Cool	Lt. N.W.	All day	7
	10:00 p.m.	65	51	..	..	..	Clear	Cool	Lt. N.W.	...	7 1/4
May 10	8:45 a.m.	58	51	58	36	46.9	Cloudy	Cool	Lt. N.	...	6 3/4
	10:00 p.m.	58	49	..	..	..	Clear	Cool	Calm	...	6 1/4
May 11	9:00 a.m.	54	46	60	29	46.7	Clear	Cool	Lt. N.W.	All day	6 1/2
	10:00 p.m.	62	48	..	..	..	Clear	Cool	Calm	...	6 1/2
May 12	10:00 a.m.	57	52	73	44	58.1	Cloudy	Warm	Mod. S.W.	...	6 5/8
	11:30 p.m.	62	53	..	..	..	Partly cloudy	Warm	Calm	...	6 3/8
May 13	8:45 a.m.	57	52	77	48	63.4	Clear	Warm	Lt. N.E.	9 hrs.	6
	10:00 p.m.	69	56	..	..	..	Cloudy	Warm - lt. rain	Calm	...	6 3/8
May 14	9:00 a.m.	62	58	66	47	56.7	Cloudy	Cool - rain	Lt. E.	...	8
	11:00 p.m.	63	58	..	..	..	Partly cloudy	Warm	Calm	...	8 1/8
May 15	8:45 a.m.	62	59	62	44	53.8	Cloudy	Cool - rain	Lt. S.E.	...	8 1/8
	10:15 p.m.	60	57	..	..	..	Cloudy	Cool	Lt. S.	...	9
May 16	8:45 a.m.	58	54	48	41	43.7	Cloudy	Cool - rain	Lt. S.W.	...	8 1/2
	10:30 p.m.	55	55	..	..	..	Cloudy	Cool - rain	Calm	...	8 3/4
May 17	8:30 a.m.	55	51	45	36	40.9	Cloudy	Cold - mist	Lt. W.	...	8 1/2
	11:00 p.m.	51	51	..	..	..	Clear	Cold	Calm	...	8 1/2
May 18	9:30 a.m.	51	51	66	37	50.4	Clear	Cool	Calm	8 hrs.	8 5/8
	9:30 p.m.	59	51	..	..	..	Partly cloudy	Cool	Lt. E.	...	8 3/4
May 19	10:00 a.m.	58	53	60	45	53.2	Cloudy	Cool - rain	St. N.E.	...	11 3/4
	11:15 p.m.	57	53	..	..	..	Partly cloudy	Cool	Mod. S.W.	...	10 1/2
May 20	8:45 a.m.	53	52	62	42	52.1	Cloudy	Cold - rain	Mod. S.W.	...	10 7/8
	10:00 p.m.	54	51	..	..	..	Clear	Cool	Calm	...	9 3/8
May 21	8:30 a.m.	53	52	79	47	62.6	Partly cloudy	Warm	Lt. S.W.	All day	10
	9:45 p.m.	60	53	..	..	..	Partly cloudy	Warm	Calm	...	8 1/2
May 22	9:00 a.m.	59	56	68	47	58.0	Cloudy	Cool - rain	Lt. N.W.	...	8
	11:50 p.m.	62	56	..	..	..	Clear	Cool	Lt. N.W.	...	8 3/8
May 23	10:00 a.m.	59	58	65	45	56.3	Partly cloudy	Warm	Calm	...	8 1/2
	10:30 p.m.	62	59	..	..	..	Partly cloudy	Cool	Lt. N.E.	...	8 1/2
May 24	9:45 a.m.	60	57	65	42	54.6	Partly cloudy	Warm	Lt. N.E.	...	8 1/2
	11:50 p.m.	61	57	..	..	..	Cloudy	Cool - rain	Mod. N.W.	...	8 1/8
May 25	9:15 a.m.	58	55	64	45	53.1	Cloudy	Cool - lt. rain	Mod. N.W.	...	8
	9:50 p.m.	61	57	..	..	..	Partly cloudy	Cool	Lt. E.	...	8 1/2
May 26	9:25 a.m.	60	58	60	50	54.6	Cloudy	Cool	Mod. E.	...	8 7/8
	9:40 p.m.	58	57	..	..	..	Cloudy	Cool	Calm	...	8 3/4
May 27	9:00 a.m.	57	57	62	45	54.0	Cloudy	Cool	Lt. S.E.	...	9
	10:00 p.m.	61	57	..	..	..	Partly cloudy	Cool	Calm	...	9
May 28	9:30 a.m.	60	58	69	43	57.2	Partly cloudy	Warm	Calm	All day	9
	10:00 p.m.	65	59	..	..	..	Cloudy	Warm	Calm	...	9
May 29	9:20 a.m.	62	60	65	52	58.3	Cloudy	Warm	Lt. N.E.	...	9
	10:00 p.m.	63	62	..	..	..	Cloudy	Cool	Calm	...	9
May 30	8:30 a.m.	62	60	66	49	57.0	Cloudy	Cool	Lt. N.E.	...	8 7/8
	10:30 p.m.	64	60	..	..	..	Cloudy	Cool	...	...	9
May 31	9:30 a.m.	63	61	68	52	60.6	Cloudy	Cool	St. N.E.	...	8 1/2
	9:00 p.m.	67	61	..	..	..	Cloudy	Cool	...	...	8 3/4

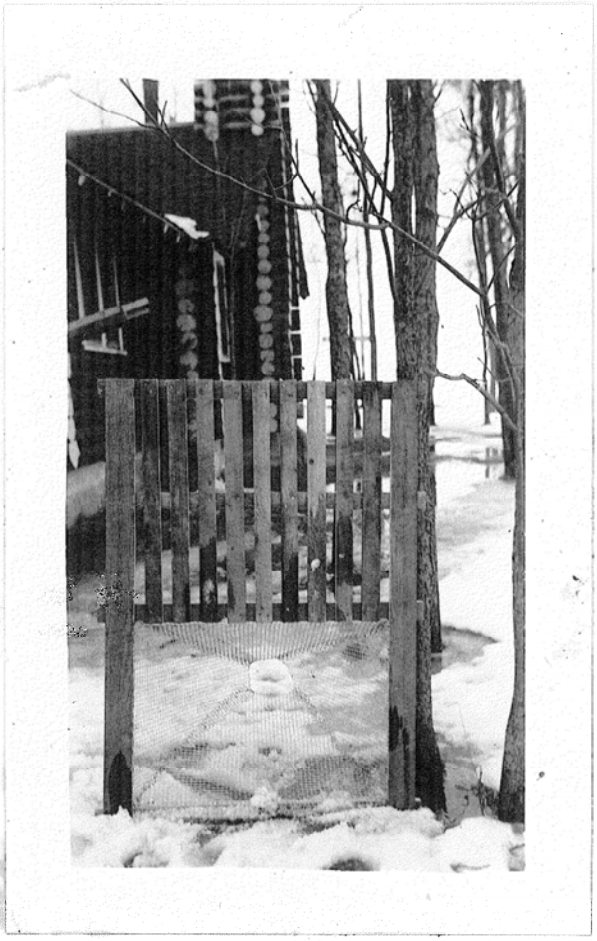
Table 15 (Continued). Muskegon River Weir - 1940

Temperatures and weather data taken at the Muskegon River weir, 1940.

Date	Time	Water temp. Max. °F.	Water temp. Min. °F.	Sky	Weather	Wind	No. hours sun	Water level in inches
July 1	8:30 a.m.	69	63	Cloudy	Warm	Lt. W.	1 hr.	9 7/8
	8:30 p.m.	69	62	Clear	Cool	Lt. N.W.	...	9 ~~7/8~~
July 2	8:20 a.m.	68	63	Clear	Cool	Lt. N.W.	All day	9 1/8
	8:00 p.m.	67	63	Clear	Cool	Lt. N.W.	...	9 ~~1/8~~
July 3	9:00 a.m.	67	63	Clear	Warm	Lt. W.	11 hrs.	9
	8:00 p.m.	69	63	Cloudy	Warm - rain	Calm	...	9 1/8
July 4	8:45 a.m.	68	64	Clear	Warm	Lt. N.W.	All day	9 1/8
	7:00 p.m.	72	64	Clear	Warm	Lt. W.	...	9
July 5	8:30 a.m.	72	66	Clear	Warm	Lt. S.E.	All day	9
	7:00 p.m.	..	..	Clear	Warm	Mod. S.E.	...	9 3/4
July 6	9:00 a.m.	76	69	Clear	Warm	Lt. S.	~~1/2~~ hrs.	8 3/4

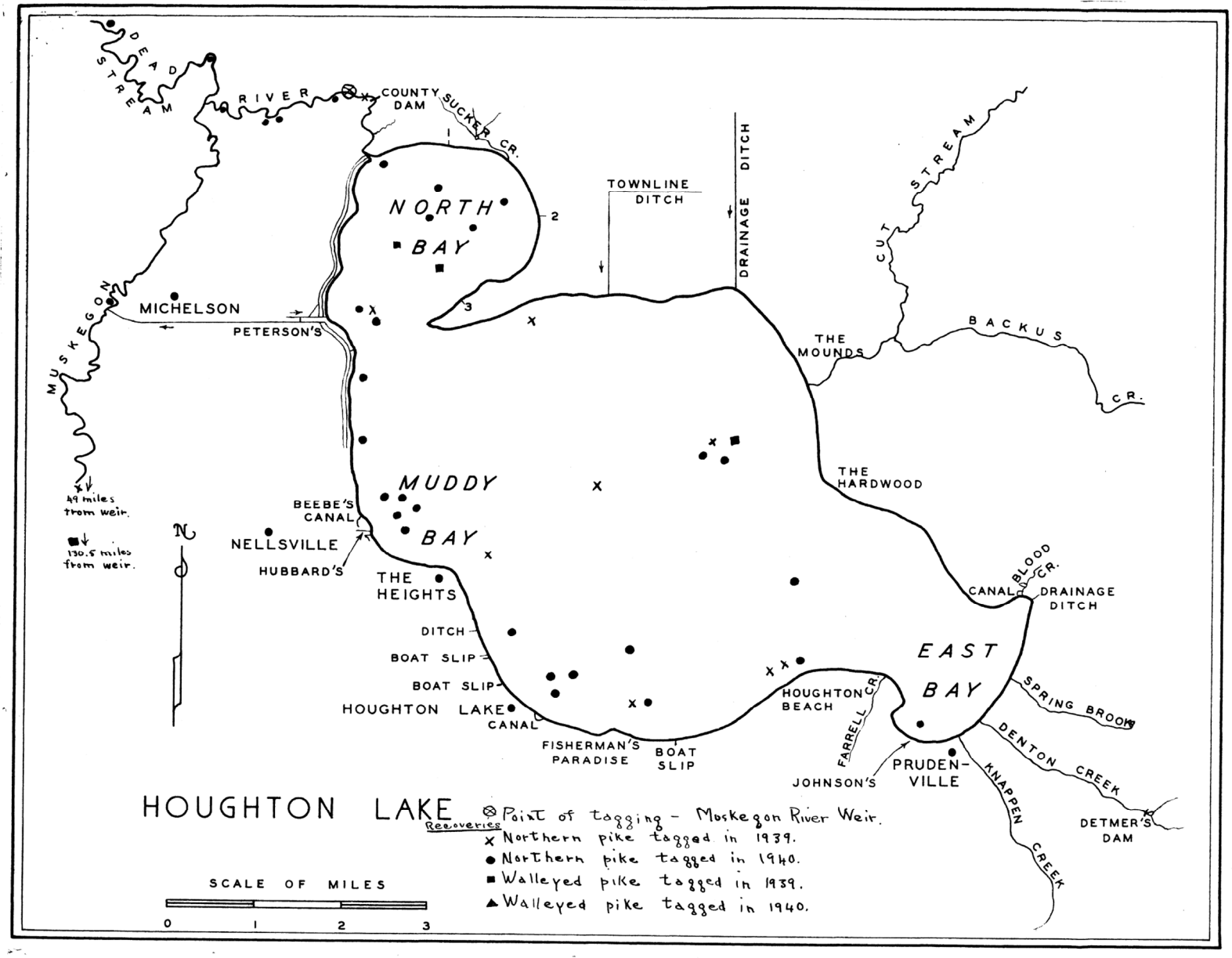
1. Downstream view of the Muskegon River Weir

2. A downstream view of one of the main arms of the weir, showing some details of construction.



3. Front view of funnel used in traps of the Muskegon River Weir.

4. Front and back views of funnels.



HOUGHTON LAKE

Recoveries

- ⊗ Point of tagging - Muskegon River Weir.
- × Northern pike tagged in 1939.
- ● Northern pike tagged in 1940.
- ■ Walleyed pike tagged in 1939.
- ▲ Walleyed pike tagged in 1940.