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NUMERICAL ABUNDANCE AND EXTENT OF EXPLOITATION BY DIP NETS OF THE WALLEYE RUN IN THE MUSKEGON RIVER, 1954

By

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Introduction

For many years fishermen have known that an annual run of walleyes occurs in the Muskegon River in the early spring. A power dam, at the town of Newaygo, 39 miles above the mouth of the river, prevents continued upstream progress by migrating fish, most of which are walleyes. Since 1923, varying numbers of walleyes, usually several thousands, have been captured by dip nets in the river below Newaygo Dam and transported to the various impoundments above Newaygo. This operation, which has become known as the "Newaygo Transfer," has been conducted and supervised by the Fish Division of the Conservation Department since 1928.

Almost from its inception the transfer has been favored by those fishermen whose interests lie with the river above Newaygo Dam, and strongly opposed by those whose interests lie with the fishing in the river below Newaygo Dam, particularly Muskegon Lake.

In 1936, in an effort to minimize the contention between the two factions, arbitrary limits were placed on the operation. It was decided that a maximum of 10,000 walleyes would be transferred, or that dipping would be continued

for a maximum of 15 consecutive nights, and that the transfer would be terminated for the year when either of these conditions was met.

These provisions were apparently satisfactory for a time, but recently the controversy has again become active, and it was obviously needful to determine the numerical magnitude of the run, and the extent of its exploitation by dip nets in order to learn whether the established policies for the operation of the transfer were proper or otherwise.

The 1953 investigation

In 1953 a report (I. F. R. Report 1376) was prepared in which reasons for, and objectives of this investigation were stated. Pertinent background information was also presented in the earlier report. For the sake of continuity the more important results of the 1953 investigation are summarized below:

(1) In 1953, between the dates of March 13 and March 31, a total of 676 walleyes were caught, tagged, and released in Muskegon Lake. Of these, 491 (72.6 percent) were captured in a seine, and 185 (27.4 percent) were captured in trap nets.

(2) During the Newaygo Transfer, which took place during the period April 4-18, 7,661 walleyes were captured in dip nets located a short distance below Newaygo Dam. Forty-two (6.2 percent) of the walleyes tagged and released in Muskegon Lake were recaptured in dip nets while the transfer was in progress.

(3) The 1953 run was estimated to contain 113,882 walleyes. That year, the Newaygo Transfer amounted to 6.7 percent of the walleyes theoretically available.

(4) In 1953, tagged walleyes released in Muskegon Lake required an average of 20.9 days (range 11-35 days) to reach Newaygo and be captured in a dip net.

(5) In 1953, the sex ratio of walleyes captured in the dip nets was one male to one female. Males had an average total length of 17.3 ± 0.05 inches, and females were 20.4 ± 0.06 inches long.

Muskegon River investigation, 1954

In 1954, the investigation of the spawning migration of walleyes in the Muskegon River was repeated. There has been, and is, such great interest in the Newaygo Transfer that an evaluation of the 1953 results was needed in order to justify continuation of present Fish Division policies regarding the transfer.

The tagging operation in Muskegon Lake was repeated and 687 walleyes were tagged and released in Muskegon Lake between the dates of March 11 and April 6. A detailed record of the operation is presented in Table 1, and Figure 1 more graphically illustrates the distribution of the tagged fish in Muskegon Lake. As can be seen from the map, most of the tagged fish were captured with a seine and released at the east end of the lake, near the mouth of the south channel of the Muskegon River. In 1954 trap net fishing was less successful than in 1953, and of the 687 walleyes tagged only 67 (9.8 percent) were caught in trap nets. The seine-caught walleyes were released in three groups; 35 off the mouth of the north channel of the river on March 18, another group of 426[1] off the mouth of the south channel on March 24, and 158 off the south channel on April 6.

So that later estimates of numerical abundance would be more or less unbiased, it was necessary that the sample of tagged walleyes should be representative of the whole population (or at least that part of it which ascended the Muskegon River to spawn). All of the tagged fish were measured (total length) and the sex of each individual was determined. In Table 2, tagged walleyes are compared with samples of "transferred" walleyes according to length and sex ratio.

An examination of Table 2 reveals certain similarities and differences between the tagged fish and the large sample of transferred walleyes.

Of the 7,840 walleyes transferred to the various impoundments, 2,232 (28 percent) were measured and "sexed." So that the measured sample would be

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[1] A single specimen, included with this group on the map, was released on March 22.

Table 1.--Tagging record, Muskegon Lake, March 11 to April 6, 1954 showing method of capture and point of release of 687 walleyes

Date	Number tagged	Method of capture	Point of release
March 11	2	Trap net	Off north shore, east of state park.
	2	" "	West shore, just north of ship canal.
12	21	" "	Off north shore, east of state park.
14	4	" "	West shore, just north of ship canal.
	2	" "	Off north shore, east of state park.
15	1	" "	West shore, just north of ship canal.
16	1	" "	Off north shore, east of state park.
17	2	" "	Near buoy, center of lake, south of Bear Lake channel.
	3	" "	Off north shore, east of state park.
	1	" "	West shore, just north of ship canal.
18	2	" "	Near buoy, center of lake, south of Bear Lake channel.
	35	Seine	East shore, near mouth of north channel of Muskegon River.
19	5	Trap net	Southwest of Bear Lake channel.
	2	" "	West shore, just north of ship canal.
20	2	" "	Southwest of Bear Lake channel.
	5	" "	West shore, just north of ship canal.
21	1	" "	Near buoy, center of lake, south of Bear Lake channel.
	2	" "	Southwest of Bear Lake channel.
	2	" "	West shore, just north of ship canal.
22	1	Seine	East shore, near mouth of south channel of Muskegon River.
23	5	Trap net	Southwest of Bear Lake channel.
	2	" "	West shore, just north of ship canal.
24	426	Seine	East shore, near mouth of south channel of Muskegon River.
April 6	158	"	East shore, near mouth of south channel of Muskegon River.

Figure 1.--Diagrammatic map of Muskegon Lake, showing method of capture and points of release for 687 walleyes tagged between March 11 and April 6, 1954. Numbers within symbols are numbers of walleyes tagged.

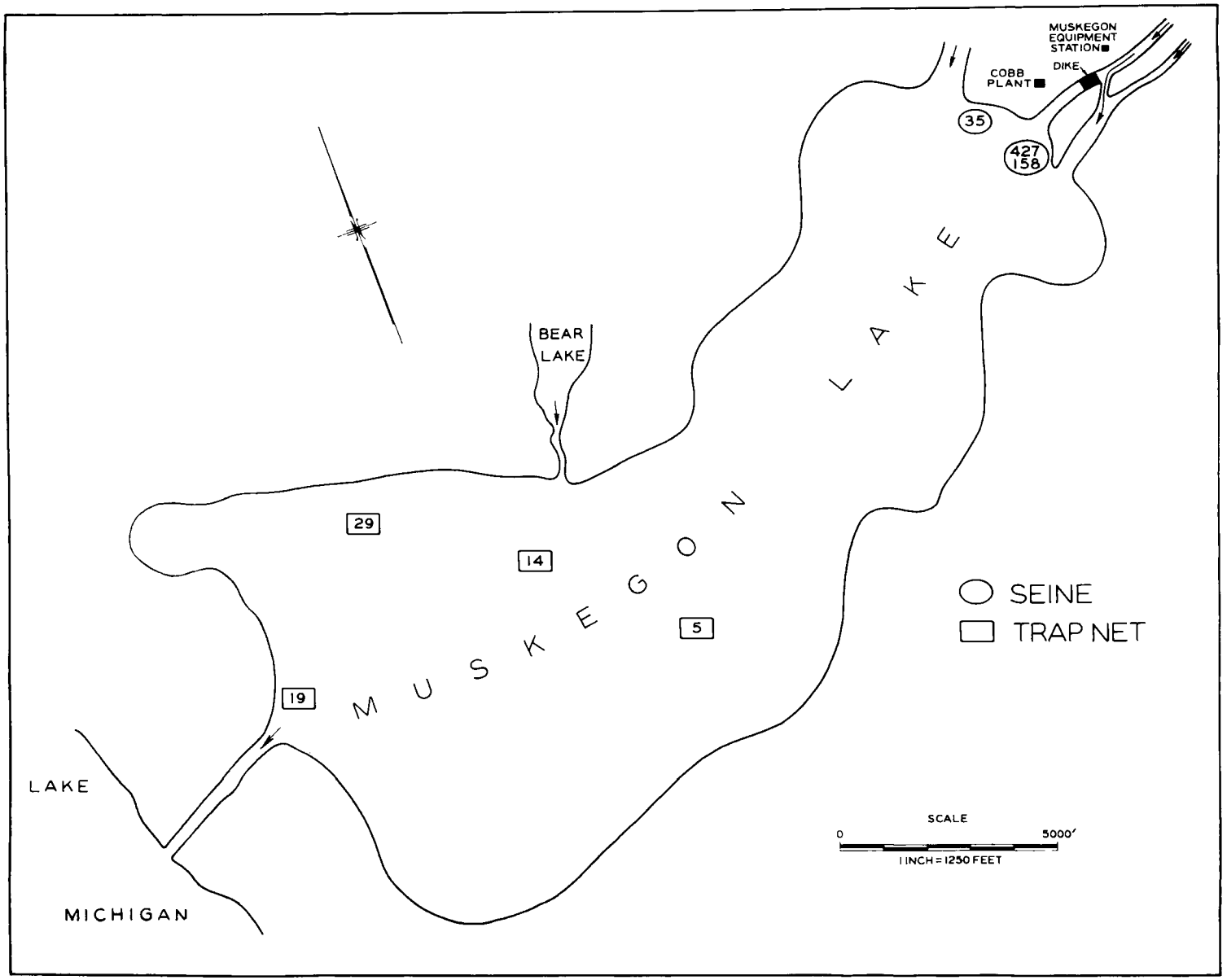
MUSKEGON EQUIPMENT STATION
DIKE
COBB PLANT
35
427
158
BEAR LAKE
MUSKEGON LAKE
29
14
5
19
SEINE
TRAP NET
LAKE
MICHIGAN
SCALE
0
5000'
1 INCH = 1250 FEET

Table 2.--Comparison of tagged walleyes with "transferred" walleyes by size distribution, mean length in inches ($\bar{x}$), standard error of mean length ($S_{\bar{x}}$), and sex ratio

Length, inches	Tagged walleyes				Transferred walleyes			
	♂	♀	?	All	♂	♀	?	All
11-11.9			1	1	1		1	2
12-12.9			1	1	6			6
13-13.9			1	1	30			30
14-14.9	2		0	2	91			91
15-15.9	15		4	19	189		1	190
16-16.9	45	3	6	54	199			199
17-17.9	49	7	11	67	137	15		152
18-18-9	66	13	9	88	106	51	1	158
19-19.9	61	43	9	113	93	211	1	305
20-20.9	34	81	3	118	20	364		384
21-21.9	10	91	6	107	10	396	1	407
22-22.9	4	64	2	70	6	210		216
23-23.9	3	19	1	23	2	48	1	51
24-24.9	5	4	0	9	3	13		16
25-25.9		0	0	0	1	4		5
26-26.9		3	0	3		7		7
27-27.9		1	1	2		4		4
28-28.9		6		6		5		5
29-29.9		3		3		3		3
30-30.9						1		1
Number	294	338	55	687	894	1,332	6	2,232
$\bar{x}$	18.6	21.3	18.5	19.9	16.8	21.1	18.3	19.4
$S_{\bar{x}}$	0.095	0.012	0.13	0.008	0.042	0.018	3.1	0.003
Percent	42.8	49.2	8.0	100	40.0	59.7	0.3	100

representative of the fish transferred (fish in the spawning run), a part of each day's catch was measured and some fish were measured at all dip-net sites. Certainly, the measured sample was representative of the fish in the transfer, and we have no reason to suspect that the transferred fish differed greatly from the fish in the run, except that possibly females may be slightly more vulnerable to the dip nets than males.

Our second concern was to determine whether the tagged walleyes differed from the transferred ones. The data in Table 2 suggest that the tagged walleyes may have differed in certain respects from those transferred. Statistical comparison (t test) of the two lots of fish (tagged and transferred) by size reveals that the larger size of the tagged males was significant at the 95 percent level. The size difference is also shown by the fact that only two (0.7 percent) of the tagged males were less than 15 inches long, while 128 (14.3 percent) of the males in the transfer were under 15 inches in length. The size difference in the males of the two groups is readily explicable on the basis of gear selectivity. The mesh in the seine used to catch walleyes for tagging was sufficiently large to permit the smaller walleyes, most of which were doubtless males, to escape. Since mature female walleyes are considerably larger than males, females were uniformly vulnerable to the seine. Note (Table 2) that no mature females less than 16 inches long were recorded in either lot. Mesh in the dip nets used at Newaygo was small enough to capture even the smaller males. Statistical comparison of the females in the two groups reveals no significant difference in mean length. When the two groups of fish are compared without regard to sex, the difference in mean length is again significant at the 95 percent level; the difference being directly traceable to the larger size of the tagged males.

Another difference in the two lots of walleyes (tagged and transferred) lies in the proportions of the different sexes. During the tagging operation

at Muskegon Lake the sex of a portion (8.0 percent) of the walleyes could not be determined--either because they were too "green" or because there were a few immature fish among them. At Newaygo, some time later, only 0.3 percent of the walleyes could not be "sexed." At Muskegon Lake 49 percent of the tagged walleyes were females, while at Newaygo 60 percent of the transferred walleyes were females. No explanation of this phenomenon can be offered except to suggest, as was indicated earlier, that females may be somewhat more vulnerable to the dip nets than males. The same idea was suggested by Eschmeyer (1950).

The question of the sex ratio among the Muskegon River walleyes is of some interest, in that it differs radically from that which has been reported by other workers for spawning runs of walleyes in other waters. Other investigators have always reported a preponderance of males in spawning runs. This is in contrast to the situation at Newaygo where the sex ratio appears to favor the females, either because of highly selective gear, or because the sex ratio actually differs from that reported for other waters. The walleyes in the Muskegon have been the subject of a more or less intensive investigation since 1947 and during the period many data on the sex ratio have been secured. These data are summarized in Table 3. While some bias may have resulted from the type of collecting gear used, it is nevertheless apparent that females form a substantial portion of the walleyes which ascend the Muskegon River to spawn.

Table 4 presents numbers of walleyes captured by dip nets and numbers of tagged fish recaptured. During the period of the 1954 transfer, 7,840 walleyes were captured, of which 38 had been tagged and released in Muskegon Lake in 1954, and 28 had been tagged and released in Muskegon Lake in 1953. From the ratio of tagged to untagged walleyes in the total catch by the dip nets it is possible to estimate the number of walleyes in the spawning run.

Table 3.--Percentages of male or female walleyes collected at Muskegon Lake, or in Muskegon River at Newaygo

Year	Muskegon River			Muskegon Lake		
	♂	♀	?	♂	♀	?
1947	42	58	...	...	...	...
1948	28	72	...	73	27	...
1950	36	64	...	...	...	...
1953	50.2	49.5	0.3	27.2	49.8	23.0
1954	40.0	59.7	0.3	42.8	49.2	8.0

Table 4.--Daily summary of walleye catch, and tag recoveries during the "Newaygo Transfer," April 6 to April 20, 1954

Date	Dip net catch	Tagged recoveries	
		1954*	1953+
April 6	362	1	1
7	383	1	1
8	572	0	2
9	649	0	3
10	665	2	2
11	819	1	4
12	982	10	6
13	668	3	4
14	648	2	1
15	546	6	1
16	664	5	1
17	344	2	0
18	274	3	2
19	155	2	0
20	109	0	0
Total	7,840	38	28

*Recoveries of walleyes tagged in Muskegon Lake, 1954.
+Recoveries of walleyes tagged in Muskegon Lake, 1953.

Before turning to the estimates of the walleye run in the Muskegon River in 1954, a few observations on the distribution and recovery of tagged walleyes are in order. Certain questions naturally arise:

(1) Do the walleyes congregating in Muskegon Lake and moving up the river ascend as far as Newaygo Dam and thus become available to the dip nets?

(2) Did the tagged fish (and the untagged ones) make the trip to Newaygo Dam quickly enough to become available to the dip nets during the period when the transfer was in progress?

(3) Were tagged fish mixed with the untagged fish both in time and space?

(4) Were tagged fish from the entire tagging operation equally represented throughout the period of recovery?

The data in Tables 5, 6, and 7 are presented to answer some of these questions. The data in Table 5 indicate that tagged fish from throughout the tagging period were recovered at Newaygo. While all of the recoveries in dip nets were of seine-caught walleyes, anglers recaptured two walleyes which had been caught in trap nets: one tagged on March 12 and recovered a short distance below Newaygo on April 25, and the other tagged on March 17 and recovered a short distance below Newaygo on April 22. While these two angler-caught fish were not considered in making the estimates, they serve to show that the relatively few trap-net caught fish got up the river along with the seine-caught fish. Also note (Table 4) that tagged walleyes were recovered on most days of the transfer. It is obvious from an examination of Table 4 that nearly all (90 percent) of the walleyes were tagged in three groups: 37 on March 18, a second group of 426 on March 24, and a third group of 158 on April 6, so it is logical to expect most recoveries to be from these groups. That fish from other tagging-days also reached Newaygo is shown by the angler-caught walleyes already mentioned. The second question (concerning length of time elapsed between tagging in Muskegon Lake and recovery by dip nets at Newaygo) is

Table 5.--Summary of recoveries of tagged walleyes showing number of recoveries from each tagging day

Date of tagging	Number tagged	Number recovered[1]	Percent recovered
March 11	4		
12	21		
14	6		
15	1		
16	1		
17	6		
18	37	2	5.4
19	7		
20	7		
21	5		
22	1		
23	7		
24	426	28	6.6
April 6	158	8	5.1
Total	687	38	5.5

[1] All recoveries made by dip nets at Newaygo, April 6 to April 20. All tagging done at Muskegon Lake.

Table 6.--Summary of recoveries of tagged walleyes, separated by type of gear used to capture them for tagging

Date of tagging	Method of capture, Muskegon Lake		Recoveries at Newaygo*	
	Seine	Trap net	Seine	Trap net
March 11		4		
12		21		
14		6		
15		1		
16		1		
17		6		
18	35	2	2	
19		7		
20		7		
21		5		
22	1			
23		7		
24	426		28	
April 6	158		8	
Total	620	67	38	

*All recoveries at Newaygo by means of dip nets, April 6 to 20.

Table 7.--Summary of recoveries of walleyes showing time lapse in days between tagging at Muskegon, and capture by dip nets at Newaygo

Time lapse, days	Number
6	1
7	1
8	1
9	1
10	1
11	1
12	3
13	...
14	...
15	...
16	2
17	1
18	9
19	3
20	1
21	4
22	4
23	1
24	1
25	2
26	...
27	...
28	...
29	...
30	1

partially answered by the data presented in Table 7. It appears that fish may make the 39-mile trip from Muskegon Lake to Newaygo Dam relatively quickly, possibly in as short a time as 6 days. The average number of days required for a walleye to make the trip upriver and be captured by dip net at Newaygo was computed to be 18.5 days (standard deviation 5.75 days, standard error of the mean 0.87 days). In 1954, walleyes made the trip more quickly than in 1953 (18.5 days compared to 20.9 ± 0.79; the difference is statistically significant at the 95 percent level). It is suggested that the difference resulted from the fact that in 1954 most of the tagging took place later in the run than in 1953. From the records secured during the two years it may be inferred that the later arrivals in Muskegon Lake move up the river more rapidly than the early ones. In 1954 the bulk of the tagging was done late in the run, and time lapse was short, while in 1953 with the tagging spread more uniformly over a longer period the average time lapse was longer. However, in both years fish which made a quick trip were tagged late.

That tagged fish were mixed with untagged fish, more or less evenly, is apparent from Table 4. Tagged fish were captured along with untagged on most days.

In addition to the information obtained from the tagging and recapture results there are other observations which tend to substantiate the belief that most walleyes from Muskegon Lake ascend the river as far as Newaygo Dam, and that they make the trip quickly enough to become available to the dip nets. For years, the upstream movement has been common knowledge among fishermen, and they habitually follow the progress of the run upriver. In late March and early April most fishermen's efforts are concentrated in the river immediately above Muskegon Lake. As the season progresses fishermen move up the river along with the walleyes, so that while the transfer is in progress the bulk of the fishing is being done in the vicinity of Newaygo. Before the current

experiments verified the length of time required for walleyes to move from Muskegon Lake to Newaygo, numerous fishermen had reported to me that it was their belief that walleyes made the trip in about 3 weeks.

Most methods of estimating populations, based on a ratio between marked and unmarked individuals drawn from the population, make certain basic assumptions. The population must be a closed unit; that is, it is not being augmented or decimated during the period of the estimate. Marked individuals must be randomly distributed through the whole population, or the nets must take a random sample of the whole population. In this investigation the first assumption (of a closed population) is more or less satisfied. The spawning run of walleyes moving up the Muskegon River between Muskegon Lake and Newaygo Dam may be considered as a unit. The run consists entirely of mature fish seeking spawning grounds, and apparently they move up the river and return downstream more or less as a homogenous group of mature fish. There is at most only a sprinkling of immature fish. The second assumption (unbiased sampling) also seems to have been fairly well satisfied. As might have been expected the recoveries came from walleyes tagged after March 18, and no dip-net recoveries were secured from walleyes tagged prior to March 18. However, since only 39 walleyes were tagged before March 18, it could be expected that there might have been as few as zero recoveries from this group (chi-square); although the absence of recoveries from this group approaches statistical significance. Any existing bias was of such slight degree that its effect would be of small magnitude.

One method, and perhaps the simplest, of estimating the number of walleyes in the spawning run is to apply the recapture percentage to the total number of fish caught during the transfer. The recapture percentage was 38/687 = 5.5313; in other words 7,840 = 5.5+ percent of the total run, and the total run (computed) = 7,840/5.5313 x 100 = 141,739.

Similar computations might be made from the daily catch records from Table 4. For example, from Table 4 it can be seen that for April 6, 7, and 8 the total catch was 1,317 walleyes. During the same period there were 2 recoveries. Thus the estimate for April 6-8 may be computed as follows: $\frac{\text{total catch x number of marked fish}}{\text{number of recoveries}} = \frac{1317 \times 687}{2} = 452,390$. Such direct proportion estimates were made for each 3-day period. Estimates ranged from 73,921 to 488,457, with an average of 240,428. This estimate is considered to be erroneously high because the daily figures upon which it is based are so variable (note wide range in estimates for different 3-day periods).

Other methods, somewhat more refined, for computing population estimates for fishes have been described by Schnabel (1938) and by Schumacher and Eschmeyer (1943). By the Schnabel method an estimate of 139,327 was obtained. By the Schumacher and Eschmeyer method the estimate was computed as 140,344 ± 23,985.

All of the estimation techniques described above are designed for population estimates where marked fish are mixed at random in the population, or where sampling is random. There is the possibility that the requirements of random mixture and sampling were not completely satisfied in the present study. Therefore a method which allows for possible sampling bias has been employed in the following.

Schaefer (1951) has described an estimation technique which appears to be particularly applicable to the problem of determining the approximate numerical abundance of walleyes in the Muskegon River during the spawning run. In the abstract of his paper Schaefer says, "For some migratory fishes, which are marked at a point on their migration path and sampled at some other point, there exists, when the migration extends over a considerable space of time, a correlation between time of tagging and time of recovery at the point of subsequent sampling. In such cases the total number of fish marked or drawn in

subsequent samples cannot in general be regarded as random samples of the whole population. Where numbered tags are used to mark the individuals, so they may be identified individually, both when tagged and when recovered in the samples, a method of estimating N is suggested." Using Schaefer's method, an estimate of 138,776 was obtained. Note that the estimate by Schaefer's formula very closely approximates the estimates obtained by the other methods (except the daily estimate). The agreement between the several estimates indicates that no bias in sampling did exist, or if any bias was present it was inconsequential.

During the 1954 operation other information was secured which tended to substantiate the 1954 population estimate, and also to indicate that natural mortality among adult walleyes between 1953 and 1954 was not extensive. These contentions are based on recoveries of fish tagged in Muskegon Lake in 1953 and recovered by dip nets at Newaygo in 1954. In 1953, the tagging operation involved 676 walleyes. During the transfer operation in 1953, recaptures totaled 42. Of these 42 recaptures which were then transferred to upriver impoundments, none have been reported as having been captured downstream from Newaygo, so we may assume that all or most of them were unavailable to the dip nets in 1954. During 1953, anglers are known to have captured 52 of the walleyes tagged in 1953, and commercial fishermen captured 5 more from Lake Michigan in 1953. In 1954, between January 1 and April 6 (the transfer operation started on April 6), anglers captured 18 more of the fish tagged in 1953. Thus, between March 31, 1953 and April 6, 1954 there was a known loss of 117 or 17.3 percent of the walleyes tagged in 1953, leaving 559 of the walleyes tagged in 1953 still available at the beginning of the transfer in 1954. If we assume that there had been no unknown loss during the year, and that those walleyes tagged in 1953 were equally available to the dip nets in 1954 as were those tagged in 1954, the recovery in 1954 of 1953 tags should

have amounted to 31 (5.5 percent of 559). Actually 28 tags were recovered, which clearly indicates that the 1953 fish were present in about the expected numbers, and presumably there was little unknown loss. That the survivors from the 1953 run were well distributed in the 1954 run is clearly indicated by the fact that 1953 tags were secured on most days of the transfer along with 1954 tags, as shown in Table 4. Also, walleyes involved in the 1954 transfer were larger than walleyes in 1953 as indicated in Table 8, presumably because most of the 1954 fish were carryovers from the 1953 run and had added one year's growth. In other words the 1954 run was numerically larger because of the large carryover of 1953 fish augmented by new individuals which reached maturity during the preceding year.

Table 8.--Comparison of walleyes in Newaygo Transfer during the years 1953 and 1954. Number of specimens in parentheses, and lengths in inches

	1953	1954
Males	(1125) 17.3 ± 0.05	(894) 16.8 ± 0.042
Females	(1110) 20.4 ± 0.06	(1332) 21.1 ± 0.018
All	(2242) 18.8 ± 0.05	(2232) 19.4 ± 0.003

Summary

Results secured in 1954 were in close accord with those secured in 1953, and the following conclusions originally drawn from the 1953 study remain valid:

(1) The number of walleyes available to the dip nets at the dipping site below Newaygo in 1954 was approximately 140,000, and 5.6 percent of these fish were transferred to the various impoundments above Newaygo Dam. In 1953, with an estimated population of approximately 114,000 walleyes, 6.7 percent of the walleyes theoretically available were transferred to the various impoundments. If results from both years are considered in conjunction with known fishing

results at Hardy Reservoir and other upriver impoundments, it is apparent that a greater number (a larger percentage) of the run could reasonably be transferred. The rate of exploitation on the impoundments is greater than it is in the Lower Muskegon River, presumably because the walleyes in the impoundments are available throughout the season rather than for only a part of it. However, the catch by dip nets will not be greatly increased unless the operation is expanded through the use of more dip nets, or unless the operators are encouraged to fish more industriously through a higher price per fish. It is not my intention to make a definite recommendation for an expanded operation, but I do want to emphasize that the number of fish could justifiably be increased. This investigation and past experience have indicated that the catch of the dip nets is directly influenced by the number of fish available in the river near the dipping site and it is improbable that dip nets would catch more than 10 percent of the fish which congregate in the vicinity of Newaygo unless netting intensity were greatly increased.

(2) Most of the walleyes, congregated in Muskegon Lake prior to their spawning migration, ascend the river as far as Newaygo Dam. This was demonstrated in both 1953 and 1954 when representatives of most tagging days were secured on most days of the transfer. Also, as has already been mentioned fishermen customarily follow the run upstream, and doubtless fishermen have learned through experience over the years where the greatest concentrations of walleyes can be expected. During the transfer operation most of the angling is done in the vicinity of the dipping site.

(3) Walleyes tagged in 1953 were recovered during 1954 at the dipping site at approximately the same rate as those tagged in 1954, suggesting that unknown loss (mortality) was negligible during 1953.

(4) Small numbers of walleyes which congregate in Muskegon Lake may remain in the lake or return to Lake Michigan without ascending the river. This occurred in both 1953 and 1954.

(5) The time required for walleyes to make the 39-mile trip from Muskegon Lake to Newaygo, and be captured in a dip net is about 20 days. In 1953 the mean number of days was 20.9 (standard deviation 5.09, standard error of the mean 0.79) and in 1954 the mean number of days was 18.5 (standard deviation, 5.75, standard error of the mean 0.87). The quicker trip made by the 1954 fish can be explained by the fact that most of the 1954 fish were tagged late in the run, and in both years the later fish moved up the river more rapidly than the early ones.

(6) The sex ratio of the fish in the 1954 transfer differed from that of fish in the 1953 transfer. In 1953 the ratio was one male to one female, and in 1954 it was four males to six females. All information to the present indicates that the sex ratio of walleyes in the Muskegon run differs from that reported in other waters.

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