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A FISH POPULATION STUDY OF THIRD SISTER LAKE 1/

1/ Contribution from the Michigan Institute for Fisheries Research

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Abstract

The fish population of Third Sister Lake was removed by angling, netting and poison (rotenone). Fish were recovered after poisoning by intensive hand picking. An unknown number of fish, particularly those of the smaller sizes, did not come to the surface when killed by the poison and were therefore not recovered or included in the population analysis. A total of 15,454 fish weighing 866.6 pounds was recovered from all operations or 86.6 pounds per acre. Bluegills of legal length accounted for about 50 pounds per acre. Legal game fish made up approximately 70 per cent of the total weight of all fish.

In 80 man-hours of hook and line fishing during the 22 days prior to poisoning, 431 fish weighing 153 pounds were captured. Approximately one fourth of the total number of legal largemouth bass and bluegills in the lake were removed by this angling effort which equaled 4.6 fish per hour. Coarse fish made up 16.3 per cent and forage fish 3.4 per cent of the weight of all fish.

* * * *

The complete removal of fish from Third Sister Lake was not carried out for the primary purpose of making a fish population analysis but rather as part of a general investigation on the existing relationship between the fish and fish-food organisms in this lake. The study has now been in progress for three full years and may be continued through the next two or three years.

The destruction of the fish population was accomplished by means of rotenone (Derris root). This was supplemented by netting and angling during the three weeks previous to poisoning. The actual poisoning process and its effect on the fish and other organisms found in the lake is described in a separate report (Brown and Ball, manuscript).

The first poisoning operation was carried out on May 6, 1941, before the spawning season and before the aquatic vegetation was extensive enough to hamper the recovery of fish. Test nets were set in the lake during the middle part of May in order to determine if live fish were still present in the lake. On May 14 and during the ensuing three days 4 large bluegills and one pumpkinseed were captured. Large schools of bluegill and pumpkinseed fry began to appear about the middle of July. Because the first poisoning did not kill all the fish, a second application was made on August 18 and 19 when water temperatures were more favorable. Only a very few adult fish were recovered along with many thousand bluegill and pumpkinseed fry. These were not included in the population figure. After that time, however, no fish were seen in the lake until June, 1942, when a few long-eared sunfish entered the lake, presumably via the outlet during high water. We believe that the poisoning was 100 per cent effective in the removal of fish in August.

The fish killed by poison were recovered by intensive hand picking which was persistently applied until no fish could be found. We have no information on the efficiency of this method but feel confident that a very high percentage of fish which came to the surface or could be seen from the surface were recovered. On the other hand we found evidence that not all dead fish float. This is particularly true of small specimens, and large numbers may never come within reach of the picker. This has also been noted in earlier poisoning work by other Institute staff members. We firmly believe that careful research will show a considerable number are never recovered, even under the most favorable conditions. In presenting these data we do so knowing full well that the recovered fish population is probably considerably less than the actual population and that the recovery of the different species and sizes within species may not be proportional to their actual abundance. Minnows, darters and the young of game fishes are, because of their size, missed more often than larger specimens. However, we believe the figures on total poundage are not seriously affected by this loss.

All of the fish were measured and weighed at the time of their recovery. Scale samples were saved from the various sizes of bass, bluegills and pumpkinseeds, and age was determined by examining the scales for annuli in the usual manner. Since collections were made approximately at the spawning season, an annulus was counted on the edge of all scales.

We lack confidence in many of our age determinations. Annuli interpretations, particularly in older fish, varied considerably with the interpreter. The oldest group given for each species includes all fish which we considered that age or older.

Game fish not actually aged were arbitrarily assigned to age groups representative of their size.

Third Sister Lake has a surface area of about 10 acres and a maximum depth of 55 feet. Approximately 35 per cent of the lake bottom is shallow enough to produce higher aquatic plants. This zone sustains predominantly yellow water lilies and pondweeds. Fish find abundant shelter and food in these plant beds and the lake compares favorably with the more productive small lakes of southern Michigan. The following species of fish were present before poisoning: Largemouth bass (Huro salmoides), bluegills (Lepomis macrochirus), pumpkinseeds (Lepomis gibbosus), green sunfish (Lepomis cyanellus), hybrid sunfish (Lepomis cyanellus X Lepomis gibbosus), bullheads (Ameiurus natalis), common suckers (Catostomus commersonnii), chub-suckers (Erimyzon sucetta), mud pickerel (Esox vermiculatus), black-chinned shiner (Notropis heterodon), black-nosed shiner (Notropis heterolepis), common shiner (Notropis cornutus), golden shiner (Notemigonus crysoleucas), mud-minnow (Umbra limi), and Iowa darter (Poecilichthys exilis).

Fishing has been banned on this lake for the past 9 years. A number of fish were removed for stomach analyses during the two years (April 1, 1939-April 14, 1941) previous to poisoning. These included the following: 30 largemouth bass (19.4 pounds), 628 bluegills (148 pounds), 15 pumpkinseeds (2.6 pounds), 4 green sunfish (0.6 pound), 18 common shiner (3.0 pounds), 2 mud pike (0.1 pound), 2 bluegill-pumpkinseed hybrids (0.3 pound). This represents a total of 699 fish weighing 174.3 pounds. In addition to these, there was very probably a small number removed by poachers. All fish taken during the ice-free period of 1941, regardless of the method or purpose for which they were used, are included in the population figures. It is assumed

that those taken earlier were probably compensated for in weight if not in numbers by the time of complete removal. It is believed that the fish population represents approximately the maximum carrying capacity for the lake.

Analysis of fish population

Largemouth bass.--Largemouth bass were the second most important game fish present in the lake on the basis of total weight. A total of 470 specimens weighing 126.9 pounds made up 3.04 per cent of the total number and 14.64 per cent of the total weight of all fish recovered. A summary of the bass by age groups is given in Table 1.

Table 1.—The age, size, number and weight of largemouth bass recovered from Third Sister Lake

Age group	Number of specimens aged	Size range total length (inches)	Average total length (inches)	Number	Per cent of total number	Average weight (ounces)	Total weight (pounds)	Per cent of total weight
I	124	2.1-4.1	2.9	231	49.1	0.14	2.01	1.6
II	20	5.9-7.0	6.5	20	4.3	1.82	2.28	1.8
III	85	7.0-11.0*	8.7	100	21.3	4.25	26.58	20.9
IV	68	7.6-14.4**	11.2	85	18.1	9.45	50.25	39.6
V	17	11.8-15.2	13.1	19	4.0	15.85	18.83	14.8
VI	11	14.0-17.1	14.9	11	2.3	24.57	16.87	13.3
VII and older	4	15.9-18.1	16.7	4	0.9	40.50	10.13	8.0
Grand Total	...	...	...	470	...	...	126.90	...

* Six specimens were legal length.

** Five specimens were sub-legal length.

As might be expected, the largest number (49.1 per cent) of bass were in the one-year age group. The two-year class was much smaller than expected with only 4.3 per cent of the total number. The three-year group was strong, with almost half as many fish as the one-year group, or 21.3 per cent of the total. Likewise, the four-year group was well represented with 18.1 per cent of the total number. Thompson and Bennett (1939) found the third and fourth year groups to be weaker in Lincoln Lakes, Illinois, than the fifth and sixth, while Eschmeyer (1938) reports that the first and fourth summer largemouth were more numerous in Howe Lake, Michigan, than bass of other ages. Exactly 100 legal bass were collected from Third Sister Lake constituting 21.28 per cent of the total number of bass found. These weighed 96.08 pounds, or 75.71 per cent of all bass taken. The three-, four-, five- and six-year age groups made up 88.6 per cent of the total weight of all bass. Of these, the four-year class made up 39.6 per cent. Third Sister Lake bass reached legal length (10 inches) late in their third or early in their fourth year.

Bluegills.---The bluegill was by far the most abundant game fish in the lake. A total of 4,057 specimens weighing 537.3 pounds made up 26.25 per cent of the total number and 61.99 per cent of the total weight of all fish recovered. A summary of the bluegills by age groups is given in Table 2.

Table 2.—The age, size, number and weight of bluegills recovered from Third Sister Lake

Age group	Number of specimens aged	Size range total length (inches)	Average total length (inches)	Number	Per cent of total number	Average weight (ounces)	Total weight (pounds)	Per cent of total weight
I	28	1.1-1.8	1.4	1,345	33.2	0.03	2.45	0.5
II	107	2.5-4.4	3.4	915	22.6	0.32	18.16	3.4
III	59	4.4-6.9	5.2	237	5.8	1.14	16.94	3.2
IV	72	4.7-7.3	6.5	280	6.9	2.87	50.23	9.3
V	63	6.1-8.4	7.4	296	7.3	4.20	77.79	14.5
VI	68	6.8-8.7	8.0	360	8.9	5.38	120.97	22.5
VII	63	7.6-9.0	8.3	270	6.7	5.99	101.00	18.8
VIII	19	6.6-9.1	8.6	166	4.1	6.46	66.99	12.5
IX	17	8.2-9.3	8.7	108	2.7	6.79	45.85	8.5
X and over	4	8.1-9.6	9.0	80	2.0	7.39	36.93	6.9
Grand Total	...	...	...	4,057	...	...	537.30	...

The six-year group was strong, contributing 8.9 per cent of the total number and 22.5 per cent of the total weight of the entire bluegill population. There were 1,560 legal bluegills, constituting 38 per cent of all bluegills recovered. These weighed 499.76 pounds, or 93.01 per cent of the total weight.

Like the bass, most of the Third Sister Lake bluegills reached legal length late in their third or early in their fourth growing season.

Pumpkinseed.--Only 610 pumpkinseeds were recovered from the lake. These weighed 29.18 pounds, or 3.37 per cent of the total weight of all fish. A summary of pumpkinseed population by age groups is given in Table 3.

Table 3.—The age, size, number and weight of pumpkinseeds recovered from Third Sister Lake

Age group	Number of specimens aged	Size range total length (inches)	Average total length (inches)	Number	Per cent of total number	Average weight (ounces)	Total weight (pounds)	Per cent of total weight
I	19	1.7-2.3	2.0	406	66.55	0.05	1.38	4.73
II	39	3.0-4.4	3.9	145	23.77	0.82	7.41	25.40
III and over	34	4.1-8.4	6.4	59	9.67	5.53	20.39	69.87
Grand total	...	...	...	610	...	...	29.18	...

All of the fish with three or more annuli were lumped into one group because we could not separate these older fish into age classes with any degree of certainty. There were 32 fish of legal length recovered which weighed 11.68 pounds, or 10.03 per cent of the entire pumpkinseed population. Most of the pumpkinseeds probably reach legal length (6 inches) in their third or fourth year.

Green sunfish.--A total of 96 green sunfish was recovered from the lake. These weighed 5.4 pounds and made up 0.62 per cent of the total weight of all fish in the lake. Only 5 of these fish had attained a length of 6 inches or longer.

Hybrid sunfish.--Thirteen hybrid sunfish were found. Five of these were pumpkinseed x bluegills and 8 were pumpkinseed x green sunfish. They had a total weight of 2.2 pounds and made up 0.25 per cent of the total weight of the entire fish population.

Bullheads.--The yellow bullhead was the second most abundant coarse fish found in Third Sister Lake. A total of 670 specimens were recovered, constituting 4.34 per cent of the total number of all fish. These had a weight of 88.1 pounds, or 10.16 per cent of the total weight of the entire fish population.

It was possible on the basis of size distribution to divide the bullhead population into 3 groups (Table 4). The first group, with an average total length of 2.1 undoubtedly represents the one-year class. This group includes 61.3 per cent of the total number of all bullheads recovered. Likewise, we believe the second group, with an average total length of 4.9 inches, represents the second year class and this includes about 9 per cent of the total bullhead population. Those in the third group include fish three years and over and make up 29.7 per cent of the number and 91.4 per cent of the weight of all bullheads.

Table 4.--The size, number, and weight of yellow bullheads recovered from Third Sister Lake

Size range (inches)	Average total length (inches)*	Number	Per cent of total number	Average weight (ounces)	Weight (pounds)	Per cent of total weight (pounds)
1.2-2.6	2.1	411	61.34	0.06	1.60	1.82
3.5-5.9	4.9	60	8.96	0.89	3.32	3.77
6.0-and over	9.3	199	29.70	6.69	83.16	91.44
Grand total	...	670	...	...	88.08	...

* Figures only approximate.

Common sucker.--Only 10 common suckers having a combined weight of 22.8 pounds were recovered. It is evident that this species was not reproducing in the lake and that its presence was due either to migration or introduction. All of the specimens were either three or four years old. It is entirely possible that these fish found their way up through the intermittent outlet during some previous high water period. Conditions in Third Sister Lake are apparently not suited for the natural reproduction of this species and the common shiner described below.

Chub-sucker.--The chub-sucker was the most common coarse fish in the lake. We recovered 947 specimens constituting 6.13 per cent of the total number of all fish in the lake. These weighed 16.6 pounds, or 1.92 per cent of the total weight of all fish recovered.

It was possible to separate the yearlings of this species from adults by their length frequencies. One-year-old specimens had a size range of 1.6-3.1 inches in total length (average 2.3 inches) while the adults ranged from 3.4-7.9 inches total length (average 5.1 inches). There was a total of 835 young as compared to 112 adult individuals. The combined weight of the one-year group was 4.28 pounds while that of the adults was 12.32 pounds.

Mud pickerel.--A total of 138 mud pickerel with a combined weight of 8.7 pounds was recovered from Third Sister Lake. These made up 0.89 per cent of the total number and 1.0 per cent of the total weight of the entire fish population.

It was not possible to age these fish or divide them into groups on the basis of size. They ranged from 4.6-11.0 inches in total length (average 6.1 inches).

Black-chinned shiner.--The black-chinned shiner and black-nosed shiner made up slightly more than 50 per cent of the total number of fish recovered in this study. There was a total of 3,215 of the black-chinned shiners constituting 20.8 per cent of the total number of all fish recovered. These weighed 6.6 pounds or 0.76 per cent of the total weight of the entire fish population.

They had a size range of 1.1-2.4 inches in total length (average 1.9 inches).

Black-nosed shiner.--The black-nosed shiner was the most abundant fish in Third Sister Lake, represented by 4,530 specimens constituting 29.31 per cent of all fish. This species had a weight of 8.3 pounds, or 0.96 per cent of the combined weight of all fish. Their size ranged from 1.5-2.5 inches in total length with an average of 1.7 inches.

Common shiner.--All of the 30 specimens of common shiner recovered were adults. As mentioned above, this species and the common sucker probably do not reproduce successfully in Third Sister Lake. The specimens recovered ranged in total length from 5.3-8.4 inches (average 7.6 inches).

Golden shiner.--Golden shiners, 174 in number, with a size range of 2.1-6.9 inches in total length (average 5.1 inches) were recovered. These made up 1.13 per cent of all the fish collected. The combined weight of this fish population was 5.9 pounds, or 0.68 per cent of the total weight of all fish collected. Both young and adult specimens were found but no attempt has been made to separate them.

Mudminnow.--The mudminnows recovered totaled 230 specimens or 1.49 per cent of the entire fish population. They weighed only 1.8 pounds, or 0.2 per cent of the total weight and ranged in size from 1.6-4.5 inches (average 2.8 inches).

Iowa darter.--A total of 264 darters weighing 0.3 pound were collected. This constitutes 1.71 per cent of the number and 0.04 per cent of the weight of all fish recovered. The darters ranged in size from 1.0-1.8 inches in total length (average 1.6 inches). The darters were the most inconspicuous and the least apt to float of any of the fish in the lake. We are sure that these figures are not representative of the actual population of this species.

Discussion

There was a total of 15,454 fish weighing 866.6 pounds recovered from Third Sister Lake (Table 5). These do not include the two largemouth bass, 17 bluegills, one pumpkinseed, one mudminnow, and one common shiner recovered either immediately before or after the second poisoning.

Third Sister Lake had a population of 86.7 pounds (1,545 fish) per acre. On the basis of existing fish population studies in North America, this production is intermediate between the northern natural lakes (Canada and Northern Michigan) and the southern artificial lakes (Illinois, Alabama, and Louisiana). It much more nearly approaches the northern averages, however. A comparison between the pounds per acre of the various waters studied does not have much significance unless the various factors contributing to lake productivity are considered. Natural lakes are more apt to be less productive than small artificial ponds because of their deeper basins and limited shallow water, regardless of whether they are situated in the north or the south. Three Nova Scotian lakes studied by Smith (1938) had an average of 24.3 pounds (977 fish) per acre while 6 Michigan lakes located in the upper part of the Lower Peninsula (Eschmeyer, 1938) had an average of 58.3 pounds (785 fish) per acre. Except for one lake (Standard) the

average pounds per acre on these Michigan lakes was very close to that of the Nova Scotian lakes. Two Illinois lakes (Thompson and Bennett, 1939 A and B; Bennett, Thompson and Parr, 1940) had an exceedingly high production (average 439 pounds; 2,888 fish per acre). These artificial lakes are small, shallow and in general of a highly productive nature.

Two ponds situated in the deep south showed even greater production. Swingle and Smith (1940) report that a one-acre Alabama pond contained 657 pounds per acre while Viosca (1936) found 860 pounds of fish per acre in a small Burrow Pit in Louisiana. Tarswell (1941), on the other hand, found only 219 pounds of fish per acre in a two-acre pond in Alabama, and Juday (1938) gives an estimate of 365 pounds of fish per acre in a Wisconsin lake, showing that location alone does not determine the productivity.

Game fish.--The game fish represented by largemouth bass, bluegills, pumpkinseeds, and hybrid sunfish made up 33.3 per cent of the total number and 80.3 per cent of the total weight of all fish. About 11 per cent of the number and 70 per cent of the weight of all fish recovered were legal game fish. Bluegills were by far the most important species, a total of 1,560 legal bluegills being recovered. These weighed almost 500 pounds or about 50 pounds per acre.

Table 5.--Summary of numbers, weights, and pounds per acre of all fish recovered from Third Sister Lake

Species [1]	Number	Per cent of total number	Weight (pounds)	Per cent of total weight (pounds)	Pounds per acre
GAME					
Largemouth bass	470	3.04	126.9	14.64	12.69
Bluegill	4,057	26.25	537.3	61.99	53.73
Pumpkinseed	610	4.07	29.2	3.37	2.92
Hybrid sunfish	13	0.08	2.2	0.25	0.22
COARSE					
Green sunfish	96	0.62	5.4	0.62	0.54
Yellow bullhead	670	4.34	88.1	10.16	8.81
Common sucker	10	0.06	22.7	2.63	2.27
Chub-sucker	947	6.13	16.6	1.92	1.66
Mud pickerel	138	0.89	8.7	1.00	0.87
FORAGE					
Black-chinned shiner	3,215	20.80	6.6	0.76	0.66
Black-nosed shiner	4,530	29.31	8.3	0.96	0.83
Common shiner	30	0.19	6.6	0.76	0.66
Golden shiner	174	1.13	5.9	0.68	0.59
Mudminnow	230	1.49	1.8	0.20	0.18
Iowa darter	264	1.71	0.3	0.04	0.03
Grand total	15,454	...	866.6	...	86.66

[1] The categories of game, coarse, and forage are in accordance with the present legal classification in Michigan.

During the 22 days prior to poisoning (May 6, 1941), a record was kept of the number and kinds of fish removed by angling along with the number of hours of effort. All fishing was done with either fly rod or casting rod, using artificial lures. Fishermen were allowed to fish where they chose on the lake and operations were fairly well dispersed over the submerged plant beds in the lake. As might be expected, certain spots were favored. Several of the fishermen might well qualify as experts but about an equal number were either beginners or of only average skill and experience. We do believe, however, that in general the fishermen participating in this experiment would show a somewhat better average than the general run of fishermen over the state.

A total of 431 fish weighing 153 pounds were caught on fly rods in 80 man-hours of fishing. Of these, 9 were largemouth bass (weight 3.97 pounds), 396 were bluegills (weight 126.5 pounds), and 11 were pumpkinseeds (weight 2.8 pounds). One each of common shiner, bullhead and hybrid sunfish were also taken. A total of 22 largemouth bass weighing 19.04 pounds were caught with a casting rod in 5½ man-hours of fishing. The average catch per hour of all angling was 4.62 fish as compared to the one fish per hour average reported in the general creel census for Michigan. Bennett, Thompson and Parr (1939) report a catch of 4.37 fish per hour on Fork Lake, Illinois, but the fishing period was spread over a much longer time.

During the period covered by our experiment, 22 per cent by weight and 8.6 per cent by number of the entire fish population of Third Sister Lake was removed. The bluegills caught by hook and line constituted 24.4 per cent of the number and 25.1 per cent of the weight of all legal bluegills in the lake; the largemouth bass taken in this manner made up 31 per cent of the number and 23.9 per cent of the weight of all legal bass in the lake.

Coarse fish.--Green sunfish, yellow bullhead, common sucker, chub-sucker, and mud pickerel are considered in the category of coarse fish. They made up 12 per cent of the number and 16.3 per cent of the weight of all fish. There was a total of 14.1 pounds of coarse fish per acre.

Forage fish.--The six species of forage fish (Table 5) constituted 54.6 per cent of the number and 3.4 per cent of the weight of all fish recovered. There was a total of 2.95 pounds of forage fish per acre.

The numerical ratio between game, coarse and forage fish in Third Sister Lake was approximately 3:1:5 respectively and the weight ratio between these three categories was 27:5:1.

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