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THE FISH POPULATION AND HARVEST IN SUGARLOAF LAKE, WASHTENAW COUNTY, in 1962 COMPARED TO 1948-55 [1]

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ABSTRACT

Population data collected at Sugarloaf Lake from 1948 to 1962 are summarized and compared. The data set includes mark-and-recapture estimates of larger fish, by species, in 7 years; survival estimates based on age-frequency collections in 4 years; and estimates of angler catch in all years. Because of trap net size selectivity, it is believed that the estimates of population size are somewhat low and the estimates of survival somewhat high. The data indicate that the total population was quite stable and exploitation was moderate. Raising the size limit on largemouth bass reduced the harvest and rates of fishing mortality considerably and probably improved bass survival slightly. Raising the size limit on northern pike reduced the rate of harvest slightly but had no noticeable effect on the pike population.

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[1] Contribution from Dingell-Johnson Project F-35-R, Michigan.

Introduction

Estimates of the fish population in Sugarloaf Lake, Washtenaw County, were made in the fall of 1948 and during the springs of 1949, 1950, and 1951 (Cooper 1953). Population estimates were also made in the fall of 1952 (Cooper and Latta 1954), 1954, and 1955 (Cooper, Latta, and Schafer 1957). Seven years later, in the fall of 1962, an estimate of the fish population was again made. This report compares the 1962 estimates of population size and mortality with the data from earlier years.

Sugarloaf Lake is located within the Waterloo Recreation Area in the northwest corner of Washtenaw County. The lake has a surface area of 180 acres and a maximum depth of 20 feet although most of the lake is less than 5 feet deep. Additional information on the physical features of the lake, and on the fish fauna and angling is contained in Christensen (1953), and Schneider (1973), as well as the above publications.

Special fishing regulations were in effect from 1946 through 1963. From 1946 through 1953, a 10-inch minimum size limit was in effect on largemouth bass, Micropterus salmoides, and a 14-inch minimum size limit on northern pike, Esox lucius. For 1954 through 1958, the minimum size limits were increased to 16 inches on bass and 24 inches on northern pike, and for 1959 through 1963, they were reduced to 14 inches on bass and 20 inches on pike.

Methods

In 1962, as in the earlier studies, trap nets were used to collect fish for mark-and-recapture population estimates. Netting began on 15 September and was terminated on 1 November. A lake map was overlaid with a 0.5-inch grid and each square was numbered. Sites for nets to be set were selected by picking random numbers. The six nets used were moved daily. Scale samples were taken randomly.

Estimates of the fish population in this study were limited to largemouth bass 10 inches and larger, northern pike and bowfin, Amia calva, 14 inches and larger, and all other species 6 inches and larger. Fish of the above

mentioned lengths are defined as desirable size fish in this report. In reality, northern pike less than 20 inches were not collected in 1962.

The estimates of yellow perch are known to be inadequate. Perch were probably as abundant as bluegills, judging from catches by anglers.

Because of the methods used in field work and computation, it is now believed that all the population estimates compiled for Sugarloaf Lake are conservative. Latta (1959) observed that trap nets are size selective even among the larger, desirable size fish, and that population estimates have a systematic bias unless they are computed for relatively small size groups (e.g., inch groups) and then summed. Such a stratification by size was not made in the studies at Sugarloaf Lake and the bias probably exists. Judging from the examples given by Latta, the Sugarloaf Lake estimates of population size may be low by 12 to 50% and the estimates of survival rates may be high by 22 to 38%. Nevertheless, these estimates make a valuable addition to our understanding of fish population dynamics.

Population estimates

The Schumacher and Eschmeyer formula was used to calculate the population estimates for 1962, as in the previous years (Ricker 1975). Population estimates of desirable size fish for 1948-62 are given in Table 1. In addition to the species already mentioned, estimates for the following species are included: bluegill, Lepomis macrochirus; black crappie, Pomoxis nigromaculatus; rock bass, Ambloplites rupestris; pumpkinseed, Lepomis gibbosus; warmouth, Lepomis gulosus; yellow perch, Perca flavescens; yellow bullhead, Ictalurus natalis; and brown bullhead, Ictalurus nebulosus. Estimates for the yellow and brown bullhead were combined and as pointed out above, the estimate of yellow perch is much too low.

The population of desirable size fish remained quite stable at about 17,000 through the years. Bluegills, the predominant species, averaged 64.1 per acre (range, 35 to 80) and comprised between 56 and 78% of the estimated total population. Largemouth bass averaged 4.4 per acre (2 to 11% of the total). Because of high year-to-year variation it cannot be established that they increased as a result of the increases in the size

limit. Northern pike averaged 2.4 per acre (less than 1 to 5% of the total) and, again, there was no clear evidence of increase under higher size limits.

Survival and mortality

Survival was computed by an indirect method described by Ricker (1958). The method is based on the assumption that the samples taken are representative of the numbers of fish in the various age groups in the population, but as pointed out in the Methods section, smaller and younger fish may have been under sampled. Survival of an age group is expressed by the number of fish in a particular age group divided by the number of fish in the next younger age group. An average survival rate for the life span of a species is obtained by the formula:

$$s = \frac{II + III + IV + \ldots}{I + II + III + \ldots}$$

Numbers of fish to be substituted for each age group in the formula were obtained from the scale samples and then applied to the number of fish collected. For example, we determined from the scale samples that 89% of the 5.0- to 5.9-inch bluegills were age III and 11% were age IV. From percentages obtained in this manner the age-frequency distribution was determined for the collected fish.

The age-frequency distribution and the mean annual survival rates for seven species of fish are shown in Table 2 for collections in 4 years. Analyses were limited to those age groups that are readily caught in trap nets, to reduce the bias caused by gear selectivity. Generally (excluding bass and pike) the youngest age group that is adequately sampled is also the age group which would reach desirable size to the angler in another year. Largemouth bass would not reach desirable size to the angler until age VI due to the 14-inch minimum size limit in 1962. The geometric means in Table 2 are the best estimates of average survival rates obtainable from these data. The wide variation in estimates of survival among the years is due to uneven recruitment and sampling problems. Such high variation

makes the slight increase in largemouth bass survival in years of higher size limits of doubtful significance.

Reconstructed dynamics

Population estimates, survival estimates, and angler harvest estimates (from a creel census) were used to reconstruct the changes in the species populations and their sources of mortality during the year. This was done for the 1962 data (Table 3), as it had been done by Cooper et al. (1957) for the averages of all the earlier data (Table 4). The reconstructions required five steps:

1. Total annual mortality in percent was computed as equal to 1-survival rate in percent.
2. Total annual mortality in numbers of fish was calculated from the formula:

$$\frac{\text{Population estimate (numbers)}}{\text{Total annual mortality (numbers)}} = \frac{\text{Annual survival (percent)}}{\text{Total annual mortality (percent)}}$$

3. The population calculated to be present at the start of the year equaled the population estimate at the end of the year plus the total annual mortality in numbers of fish (spring and fall estimates).
4. The creel census provided an estimate of the numbers of fish which died because of fishing. This estimate was divided by the calculated population at the start of the year and multiplied by 100 to obtain the corresponding fishing mortality as a percentage.
5. The difference (in both numbers of fish and percent) between total mortality and fishing mortality was ascribed to natural mortality.

The results of some of the calculations appear to be reasonable and consistent. Fishing mortality estimates in 1962 and 1948-55 were similar for bluegill and rock bass but dissimilar for black crappie and pumpkinseed (Table 5). These dissimilarities can be attributed to an unusually low number of age II black crappies available to anglers in 1962 (Table 2), and to the wide confidence limits on the 1962 creel census estimate for pumpkinseed (Table 5).

(The latter also accounts for the discrepancy in Table 3, in which more pumpkinseeds were estimated to have been caught than were present.) The most reliable estimates and calculations are for the bluegill. In a typical year, the bluegill population started at about 35,000, of which 9,000 (25%) were harvested by anglers, 15,000 (40%) died from other causes, and 11,000 (30%) were left (Tables 3 and 4).

Size limits

The experimental design called for an analysis of the effects of the low, medium, and high size limits on largemouth bass and northern pike by means of creel census and population data. However, the conclusions which can be drawn are limited because of the imprecision of the data, irregular recruitment, and the subtleness of the effects. The bass analysis (Table 6) is based on a complete set of creel census estimates but only three survival estimates. Only five population estimates were made under the low size limit, two under the high limit, and one under the medium limit.

For bass, average annual harvest declined (as expected) from 808 with a 10-inch limit, to 281 with a 14-inch limit, to 87 with a 16-inch limit. Corresponding estimates of fishing mortality rate probably declined also, from a relatively high level (a figure has not been calculated because the estimate of the population available to anglers was too low), to about 16%, then to about 6%, under the respective size limits. Unexpectedly, bass survival and bass abundance increased only slightly, if at all.

For northern pike, the annual harvest declined from 183 with a 14-inch size limit, to 145 with a 20-inch limit, to 108 with a 24-inch limit. The pike population data are so variable (Table 1) that no conclusions can be drawn.

Growth

Growth rates of fish in 1952 and 1962 were compared (Table 7). Bluegills, rock bass, pumpkinseed, warmouth, and yellow perch were generally slower growing in 1962 than in 1952. Black crappies and largemouth bass were growing at similar rates in the two years. The growth

rate of northern pike was generally faster in 1962 than in 1952. Thus the increase in minimum size limit on the predator species, largemouth bass and northern pike, did not lead to an increase of growth rates in the panfish nor did it cause a slowdown in the growth of predators.

Table 1.--Estimated numbers of fish minimum size and larger, by species, in Sugarloaf Lake, 1948-62.

Species, and minimum size (inches)	Season and year							
	fall 1948	spring 1949	spring 1950	spring 1951	fall 1952	fall 1953	fall 1955	fall 1962
Bluegill (6)	12,494	12,949	14,012	14,450	11,450	6,345	10,659	9,930
Pumpkinseed (6)	775	883	825	540	-	346	323	784
Yellow perch (6)	-	-	1,615	-	232	-	-	1,543
Black crappie (6)	511	302	126	530	381	593	463	708
Rock bass (6)	972	277	997	600	253	768	1,201	1,227
Warmouth (6)	-	1,570	2,389	1,160	1,497	1,386	1,786	551
Bullhead[a] (6)	543	374	992	580	1,146	707	764	300
Largemouth bass (10)	1,718	367	518	470	712	1,279	256	1,023
Northern pike (14)	80	119	271	-	922	-	833	431
Bowfin (14)	555	183	433	280	484	-	831	1,022
Total	17,648	17,154	22,178	18,610	17,077	11,424	17,116	17,519

[a] Includes both brown and yellow bullheads.

Table 2.--Age-frequency distributions and annual survival rates (s) for six species of fish in 1952, 1954, and 1955 (Cooper et al. 1957), and in 1962.

Species, and year of collection	Age group								s	Geometric mean s
	I	II	III	IV	V	VI	VII	VIII		
Bluegill										
1952	-	18	187*	64	12	14	1	3	0.34	
1954	-	98	126*	41	45	10	-	-	0.45	
1955	-	77	276*	59	16	8	-	-	0.24	
1962	-	169	2777*	213	813	132	24	1	0.30	0.32
Black crappie										
1952	36*	64	8	5	2	-	-	-	0.70	
1954	152*	9	4	4	-	-	-	-	0.10	
1955	60*	182	5	4	-	-	-	-	0.62	
1962	195*	4	67	5	1	-	-	-	0.28	0.33
Largemouth bass										
1952	6	27	69*	52	5	2	1	-	0.47	
1954	22	33	34*	22	9	4	-	1	0.51	
1955	3	18	9*	5	1	3	-	-	0.50	
1962	15	14	18	24*	16	10	1	2	0.57	0.51
Rock bass										
1952	1	393	53*	8	4	1	1	-	0.21	
1954	-	145	78*	88	10	-	-	-	0.59	
1955	-	72	315*	54	22	-	-	-	0.21	
1962	1	46	390*	83	8	3	-	-	0.20	0.27
Pumpkinseed										
1952	2	55	12*	1	-	-	-	-	0.08	
1954	-	109	71*	3	2	1	-	-	0.08	
1955	-	22	34*	5	1	-	-	-	0.15	
1962	-	31	250*	69	26	-	-	-	0.30	0.13
Warmouth										
1952	-	4	153*	28	15	15	-	-	0.30	
1954	-	184	110*	38	32	11	5	-	0.45	
1955	-	7	86*	17	7	-	-	-	0.23	
1962	-	21	32*	12	24	1	-	-	0.54	0.35
Northern pike										
1962	-	14*	9	4	1	1	-	-	0.54	

* The lowest age included in the calculation of survival rate.

Table 3.--Population and mortality estimates for six species of fish in 1962.

Species	Population		Annual mortality					
			Fishing		Natural		Total	
	Estimated (end of year	Calculated (start of year)	Number	Percent	Number	Percent	Number	Percent
Bluegill	9,930	33,100	9,955	30	13,215	40	23,170	70
Black crappie	708	2,529	130	5	1,691	67	1,821	72
Rock bass	1,227	6,135	1,210	20	3,698	60	4,908	80
Pumpkinseed	784	2,613	2,815	108	-	-	1,829	70
Largemouth bass	1,023	1,795	186	10	586	33	772	43
Northern pike	431	798	185	23	182	23	367	46

Table 4.--Population and mortality estimates for five species of fish as reconstructed by Cooper et al. (1957) from the geometric mean survival rates for 3 years (1952, 1954, and 1955), and average harvest and population data for 7 years (1948-52, 1954, and 1955).

Species	Population		Annual mortality					
			Fishing		Natural		Total	
	Estimated (end of year)	Calculated (start of year)	Number	Percent	Number	Percent	Number	Percent
Bluegill	11,579	35,088	8,618	25	14,891	42	23,509	67
Black crappie	415	1,186	583	49	188	16	771	65
Rock bass	718	2,393	670	28	1,005	42	1,675	70
Pumpkinseed	615	6,150	859	14	4,676	76	5,535	90
Warmouth	1,608	5,187	383	7	3,196	61	3,579	69

Table 5.--Fishing mortality for 1962 (with 95% confidence limits) as compared to the mean fishing mortality for 1948 to 1955 for five species of fish.

Species	1962	1948-55
Bluegill	30 ± 9%	25
Black crappie	5 ± 4%	49
Rock bass	20 ± 11%	28
Pumpkinseed	108 ± 43%	14
Largemouth bass	10 ± 8%	-

Table 6.--Population and mortality estimates for largemouth bass in relation to size limits. Fishing mortality in numbers of bass is an average for all years of the size limit; other calculations are based on averages of lesser amounts of data than in Tables 1 and 2. See footnote.

Size limit and years	Population		Annual mortality					
			Fishing		Natural		Total	
	Estimated (end of year)	Calculated (start of year)	Number	Percent	Number	Percent	Number	Percent
10-inch [a]								
1946-53	757	-	808	-	-	-	-	53
14-inch [b]								
1959-63	1,023	1,795	281	16	491	27	772	43
16-inch [c]								
1954-58	768	1,506	87	6	651	43	738	49

[a] Population estimates for 1948-52; total mortality in percent for 1952.

[b] Estimates of population and total mortality for 1962.

[c] Population estimates for 1954 and 1955; total mortality in percent for 1954.

Table 7.--Mean length in inches at each year of life for eight species of fish from Sugarloaf Lake in 1952 and 1962. Number of fish in parentheses.

Species, and year	Age group I	II	III	IV	V	VI	VII	VIII
Bluegill								
1952		4.4 (20)	5.4 (186)	6.7 (63)	7.4 (10)	8.1 (14)	8.2 (2)	8.3 (2)
1962		3.7 (50)	4.9 (125)	6.2 (18)	7.0 (90)	7.9 (35)	8.4 (21)	8.8 (1)
Rock bass								
1952	4.0 (1)	5.2 (377)	7.8 (52)	8.7 (7)	9.5 (4)	9.7 (1)	10.7 (1)	
1962	3.6 (1)	4.7 (20)	6.0 (165)	8.0 (59)	8.8 (7)	9.3 (3)		
Black crappie								
1952	6.3 (34)	9.0 (62)	10.9 (7)	11.3 (5)	10.8 (3)			
1962	6.1 (125)	8.3 (3)	10.4 (57)	11.8 (4)	13.3 (1)			
Pumpkinseed								
1952	3.7 (2)	4.7 (54)	6.4 (10)	7.3 (1)				
1962		4.0 (20)	5.3 (126)	6.6 (42)	7.7 (21)			
Warmouth								
1952		5.5 (3)	6.6 (140)	7.6 (23)	7.7 (15)	7.9 (15)		
1962		4.7 (21)	5.8 (32)	6.8 (12)	7.2 (24)	7.7 (1)		
Largemouth bass								
1952	7.0 (6)	8.8 (25)	10.1 (67)	11.7 (48)	13.0 (4)	16.6 (1)	16.2 (1)	
1962	6.5 (9)	8.1 (11)	10.3 (18)	11.8 (24)	13.4 (15)	15.2 (10)	16.1 (1)	17.2 (2)
Northern pike								
1952	16.6 (6)	19.8 (42)	25.5 (1)	31.0 (1)		31.0 (2)		
1962		23.7 (14)	26.0 (9)	29.4 (4)	33.3 (1)	36.5 (1)		

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