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INCREASED GROWTH RATE OF ROCK BASS (AMBLOPLITES RUPESTRIS) FOLLOWING REDUCTION IN THE DENSITY OF THE POPULATION [1]

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[1] Contribution from the Michigan Institute for Fisheries Research.

William C. Beckman

Michigan Department of Conservation, Ann Arbor, Michigan

Abstract

Lakes with dense population of stunted fish have long presented a difficult problem to fisheries biologists. In 1937 the Michigan Institute for Fisheries Research began a series of planned experiments in the reduction of the populations of over-crowded lakes. In one of these experiments the south basin of Standard Lake was poisoned with derris root. Samples of the rock bass population were taken at the time of the poisoning. During 1939 and 1940 further collections were made in order to determine the effect of the population reduction. An increased growth rate, too great to be accounted for by any normal growth fluctuation, had occurred in fish of all ages. The reduction of the density of the populations is therefore suggested as one solution to the problem of lakes with large populations of stunted fish.

Introduction

The problem of lakes in which populations of stunted fish occur has troubled fisheries managers for some time (Hubbs and Eschmeyer, 1938). Numerous small lakes in northern Michigan were found by Eschmeyer (1937, 1938) to contain populations of stunted perch. The majority of lakes on which he worked were otherwise suited for trout. He therefore completely removed the perch (by poisoning), and the lakes were restocked successfully with trout.

Many of the lakes that contain an over-abundance of undersized fish and few "keepers" are not suited, however, for trout or other cold-water species. Standard Lake, located at the junction of the boundaries of Cheboygan, Charlevoix, and Otsego County, Michigan, was such a lake. Standard Lake has an area of 32.5 acres, and a maximum depth of 31 feet, and is divided nearly equally into a north basin of 16.5 acres and a south basin of 16 acres. The two parts of the lake are connected by a channel which is shallow but of sufficient depth (about 1 foot) and width (about 200 feet) to permit the free passage of fish.

In order to test the effect of reducing the total population of fish, 110 pounds of derris root (retenone content 5 per cent) was put into the south basin on September 6, 1937. The channel was blocked off with sand bags to prevent the movement of fish to or from the south basin during the treatment with derris root, and to restrict the action of the poison to that part of the lake. Dr. R. W. Eschmeyer, formerly of the Institute for Fisheries Research, was then in charge of this experiment. Following his resignation, the writer took over the investigation.

All the fish killed by the poison that could be found were picked up, to be weighed and counted by species (Table 1). A total of

TABLE 1. NUMBER AND WEIGHT OF FISH IN THE SOUTH BASIN OF STANDARD LAKE ON SEPTEMBER 6, 1937

Species	Number	Average weight in ounces	Total weight in pounds
Perch	4,827	0.47	146.4
Rock bass	1,233	0.70	53.9
Forage fish	14,054	0.07	62.9
Suckers	78	17.50	85.5
Total	20,192	...	348.7

20,192 fish (1,262 per acre) was collected. These fish weighed 348.7 pounds (21.8 pounds per acre). The species of fish found in the basin were: perch (Perca flavescens), rock bass (Ambloplites rupestris), red-bellied dace (Chrosomus erythrogaster), fine-scaled dace (Pfrille neogaea), Iowa darter (Poecilichthys exilis), mud minnow (Umbra limi), golden shiner (Notemigonus crysoleucas auratus), black-nosed shiner (Notropis h. heterolepis), blunt-nosed minnow (Hyborhynchus notatus), and the common sucker (Catostomus c. commersonnii).

On the basis of the random sample which was taken to the laboratory, the lake contained only 2.7 legal-sized game fish per acre (2.4 perch, and 0.3 rock bass). The entire 16-acre basin contained 42 legal-sized game fish, or less than two limit catches. That a scarcity of legal-sized fish was characteristic of the lake was verified by interviews with local inhabitants.

After a sufficient time had been allowed for the derris root to lose its potency, the sand bags were removed. The unharmed fish of the north basin were thus allowed to move freely throughout the entire lake.

Further collections of rock bass were made in Standard Lake in May, June, and October 1939, and July 1940, to obtain comparative material for the determination of any changes in growth rate that might have followed the reduction in the numbers of this species. Most of the 1939 and 1940 samples of 228 rock bass were taken in experimental gill nets (5 by 125 feet, with five sections of different mesh sizes, varying from 1 1/2 to 4 inches, stretched measure); a few fish were caught by hook and line. At the time of the poisoning a random sample of 182 rock bass was saved.

Method of Calculating Lengths

Scale samples were taken from all the fish collected, and "key" scales (scales from an exactly specified location on the body) were taken from most of them. The age of each fish was determined by counting the number of annuli on the scale.[2] At a magnification of

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[2] The validity of the annulus on rock bass scales as a true year mark was proved by Hile (1940).

X 44.3 measurements were made of the scale image from the focus outward along the middle of the most nearly anterior inter-radial space.

The body-scale relationship was determined from measurements of the "key" scales to be described by a straight line with an intercept on the abscissa at 15 millimeters. The following formula therefore was used for the calculation of growth:

$$L_n = 15 + S_n \frac{L_T - 15}{S_T} ,$$

where L_n = the length of the fish in millimeters at the n^{th} year of life,

S_n = the scale radius within the n^{th} annulus,

L_T = the standard length of the fish in millimeters at the time of capture,

S_T = the total scale measurement.

Change in Growth Rate Following Poisoning

By means of the formula given in the preceding section, the lengths of the males and females were claculated for each year of their lives (Table 2). The average standard lengths of the age groups at capture are given in Table 3. Since the only difference in the growth of the sexes lies in the more rapid growth of the males in the later years of life, the following remarks apply to both sexes.

The rock bass of the 1939 and 1940 collections were notably larger at the time of capture than were fish of the corresponding age and sex in the 1937 sample (Table 3). The difference seems to be attributable to an accelerated growth following the reduction in the numbers of this fish. The data are doubly impressive when it is considered that about two-thirds of the 1939 specimens were taken in May and June, when at this latitude, according to recent investigations (Beckman, MS), the growth of the fish has just begun, whereas the entire 1937 sample was collected on September 6, when the seasonal growth was almost completed. The difference in size appears to be relatively the greatest for age-group I, but the data for this group are not believed to be reliable for the present comparison, since the gill nets employed for the collection of 1939 specimens may have taken only the larger individuals of the age group. This belief was supported by the comparison of the lengths of the I-group fish with the length distribution of rock bass from 1 1/2-inch mesh gill nets given by Hile (1940).

TABLE 2. AVERAGE CALCULATED LENGTH OF ROCK BASS IN STANDARD LAKE AT END OF EACH YEAR OF LIFE. THESE GRAND AVERAGES ARE BASED ON THE SUCCESSIVE ADDITION OF THE WEIGHTED AVERAGE GROWTH INCREMENTS. NUMBER OF SPECIMENS IN PARENTHESES.

Sex and year of capture	Calculated lengths in millimeters at end of each year of life					
	1	2	3	4	5	6
MALES						
1937	32 (57)	52 (47)	70 (35)	79 (22)	...	...
1939	32 (75)	54 (75)	76 (55)	98 (39)	124 (19)	146 (2)
FEMALES						
1937	32 (56)	52 (48)	69 (38)	72 (21)	83 (2)	...
1939	30 (84)	52 (84)	71 (73)	92 (54)	116 (23)	...

TABLE 3. SIZE OF ROCK BASS IN STANDARD LAKE AT TIME OF CAPTURE

	Average standard length in millimeters at time of capture (Number of specimens in parentheses)					
	Males			Females		
Age group	[1] 1937	[2] 1939	[2] 1940	1937	1939	1940
[3] I	57 (10)	88 (16)	... ...	57 (8)	84 (22)	... ...
II	73 (12)	89 (20)	91 (11)	70 (10)	85 (11)	85 (6)
III	84 (13)	105 (16)	... ...	80 (17)	89 (19)	... ...
IV	88 (22)	108 (20)	140 (1)	83 (19)	102 (31)	... ...
V	... ...	114 (17)	... ...	90 (2)	115 (23)	126 (1)
VI	... ...	118 (5)	... ...	... ...	... ...	135 (1)

[1] All fish of the 1937 collection were taken on September 6.

[2] In 1939 the specimens were taken in May, June, and October--about two-thirds in May and June; in 1940 the specimens were taken in July.

[3] The 1939 data for age-group I are considered unreliable due to gear selectivity.

That the increased growth followed the reduction in the density of the population is demonstrated more clearly by an analysis of the growth increments for each year of life by calendar years (Tables 4 and 5). A comparison of growth in the same year of life, regardless of age-group, shows a close agreement in their calculated increments up to the time of poisoning in 1937, whereas the increments for 1938 and 1939 are considerably larger. The possible explanation that the increased increment was due to chance is negated by the consistency of the findings, for the calculated increments for the five years prior to the poisoning agreed very closely. Another possible explanation might be offered, that the original sample taken at the time of poisoning was not representative, having come from only one basin, where there may have been a distinct population with slower growth than in the basin which was not poisoned. This explanation also is negated by the fact that the growths calculated from the 1939 and 1940 collections agreed very well with those made from the 1937 collections, and the increased growth was made only after the poisoning. That the greater growth in the calendar years 1938 and 1939 was due to normal fluctuation in growth rates such as those found by Hile (1940) for the rock bass and Hubbs and Hubbs (1933) for bluegills (_Lepomis macrochirus_), pumpkinseeds (_Lepomis gibbosus_) and the hybrids (_Lepomis macrochirus_ x _Lepomis gibbosus_) is rendered very improbable by the consistency of occurrence of the small increments over a period of 5 years prior to the poisoning. It appears valid to conclude, therefore, that the reduction in the density of the population was the factor responsible for the improved growth.

TABLE 4. GROWTH INCREMENTS BY CALENDAR YEARS FOR MALE ROCK BASS OF STANDARD LAKE, DURING EACH YEAR OF LIFE, BEFORE AND AFTER REDUCTION IN NUMBERS BY POISON

Computed for year of life	Computed from age group	Calculated growth in millimeters for calendar year (For number of specimens see Table 3)						
		Before poisoning					After poisoning	
		1933	1934	1935	1936	1937	1938	1939
1	II	...	...	30	...	32	36	...
	III	...	32	...	34	...	...	...
	IV	33	...	30	[1](32)	...	...	...
	V	...	32	...	...	...	...	...
	VI	31	...	...	...	...	...	...
2	II	...	...	...	22	...	35	38
	III	...	...	18	...	20	...	...
	IV	...	20	...	18	(15)	...	...
	V	...	...	18	...	...	...	...
	VI	...	21	...	...	...	...	...
3	III	...	...	...	16	...	40	...
	IV	...	...	18	...	14	(53)	...
	V	...	...	...	14	...	...	...
	VI	...	...	18	...	...	...	...
4	IV	...	...	...	9	...	30	(29)
	V	...	...	...	...	12	...	...
	VI	...	...	...	10	...	...	...
5	V	...	...	...	...	...	28	...
	VI	...	...	...	...	9	...	...
6	VI	...	...	...	...	...	...	22

[1] Although conforming with the other data, the figures in parentheses are based on too few specimens to be of reliable significance, and are not considered in the discussion in the text.

TABLE 5. GROWTH INCREMENTS BY CALENDAR YEARS FOR FEMALE ROCK BASS OF STANDARD LAKE, DURING EACH YEAR OF LIFE, BEFORE AND AFTER REDUCTION IN NUMBERS BY POISON

Computed for year of life	Computed from age group	Calculated growth in millimeters for calendar year (For number of specimens see Table 3)							
		Before poisoning						After poisoning	
		1932	1933	1934	1935	1936	1937	1938	1939
1	I	...	...	...	...	34	...	35	...
	II	...	...	...	32	...	30	...	...
	III	...	...	32	...	32	...	...	...
	IV	...	32	...	30	...	...	...	...
	V	[1] (31)	...	30	(23)	...	...	...	...
	VI	...	...	(32)	...	...	...	...	...
2	II	...	...	...	...	20	...	39	35
	III	...	...	...	18	...	19	...	...
	IV	...	...	21	...	18	...	...	...
	V	...	(25)	...	17	(23)	...	...	...
	VI	...	...	...	(19)	...	...	...	...
3	III	...	...	...	...	16	...	29	...
	IV	...	...	...	18	...	16	...	...
	V	...	...	(16)	...	17	(14)	...	...
	VI	...	...	...	...	(13)	...	...	...
4	IV	...	...	...	...	8	...	27	...
	V	...	...	...	(6)	...	12	(41)	...
	VI	...	...	...	...	...	(13)	...	...
5	V	...	...	...	...	(6)	...	24	(19)
	VI	...	...	...	...	...	...	(30)	...
6	VI	...	...	...	...	...	...	...	(24)

[1] Although conforming with the other data, the figures in parentheses are based on too few specimens to be of reliable significance and are not considered in the discussion in the text.

The increase in growth rate that has been found to follow a reduction in the numbers of stunted fish is not only in agreement with expectation on biological grounds, but also suggests a method that may prove to be sound and effective procedure in fish management. Too often in the past the problem of stunted fish has been aggravated by the protection of the runts and even by further stocking.

Summary

1. Standard Lake, Michigan, has long had a reputation as a poor fishing lake. Undersized fish were over-abundant but fish of legal size were extremely scarce.

2. An Experiment to test the effect of reducing the density of the population was begun in 1937 by poisoning the fish in one basin of the lake.

3. From scale samples taken in 1939 and 1940, computations were made of the growth rates before and after the poisoning. The growth of rock bass of all ages improved following the poisoning.

4. The reduction of the density of population therefore may be a solution to the problem of improving fishing in lakes overrun with stunted fish.

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