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# FURTHER STUDIES ON THE INCREASED GROWTH RATE OF THE ROCK BASS AMBLOPLITES RUPESTRIS (RAFINESQUE), FOLLOWING THE REDUCTION IN DENSITY OF THE POPULATION 1/

1/ Contribution from the Michigan Institute for Fisheries Research

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## Abstract

An increased growth rate, too great to be accounted for by any normal growth fluctuation, was shown to have occurred in all age groups of rock bass, following the reduction in the population by poisoning the fish of the south basin of Booth (formerly called Standard) Lake, Michigan. Additional information was obtained in 1941 and 1942 which made it possible to analyze the change in growth in weight as well as length. Not only did the length and weight increase, but the mean coefficient of condition, K, also increased. Thus it appears that reduction in numbers is one solution to the problem of lakes with large populations of stunted fish.

## Introduction

The effect of reducing the density of the population of rock bass in Booth Lake (formerly called Standard Lake), Charlevoix and Otsego Counties,

Michigan, was reported by Beckman (1940). An increased growth rate, too great to be accounted for by any normal growth fluctuation, was shown to have occurred in all age groups of the rock bass following the reduction in the population by poisoning the fish of the south basin of Booth Lake. Additional information has been obtained on the growth of the rock bass in this lake from collections of 25 rock bass made on July 20, 1941, and of 37 fish taken on May 24-25, 1942. The 1941 collection was made by fly fishing while in 1942 four experimental gill nets (5 by 125 feet, with five sections of different mesh sizes, that varied from 1 1/2 to 4 inches stretched measure) were used in addition to the fly rod.

## Continued increased growth rate

The age of each fish was determined by counting the number of annuli on the scale. Measurements and growth calculations were made by the methods described in the earlier report.

At the time of the poisoning there were five legal-sized (6 inches) rock bass in the 1,233 rock bass recovered. Since the poisoning, 289 rock bass have been taken of which 20 were legal-size. Reports from fishermen indicate that the lake is regaining some of its former popularity as a fishing lake.

The average calculated annual increments of length for each of several year classes of males and females according to year of life, and average calculated increments for all year classes combined before and after the poisoning, are presented in Tables 1 and 2. It will be seen that a decided increase in growth occurred after the reduction in numbers, and that the increased growth rate has been maintained rather well for the 4 years following the poisoning. The males have a slight advantage over the females

Table 1.--Average growth increments (based on standard length in millimeters) for male rock bass from Booth Lake, according to calendar year and year of life, before and after reduction in numbers by poison.

(number of specimens in parentheses)

| Computed for year of life | Calculated growth in millimeters | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Before poisoning | | | | | | After poisoning | | | | |
| | 1933 | 1934 | 1935 | 1936 | 1937 | Average | 1938 | 1939 | 1940 | 1941 | Average |
| 1 | 33(27) | 32(30) | 30(32) | 34(17) | 32(20) | 32(125) | 34(17) | 36(25) | ... | ... | 35(42) |
| 2 | ... | 20(27) | 18(30) | 20(32) | 20(17) | 19(106) | 35(20) | 35(17) | 32(25) | ... | 34(62) |
| 3 | ... | ... | 18(27) | 15(30) | 14(20) | 16( 77) | 41(17) | ... | 35( 3) | 35(20) | 38(40) |
| 4 | ... | ... | ... | 10(27) | 12(17) | 11( 44) | 30(20) | 29( 1) | ... | 19( 3) | 29(24) |
| 5 | ... | ... | ... | ... | 9( 5) | 9( 5) | 28(17) | 18( 1) | ... | ... | 27(18) |
| 6 | ... | ... | ... | ... | ... | ... | ... | 22( 5) | 11( 1) | ... | 20( 6) |

Table 2.—Average growth increments (based on standard length in millimeters) for female rock bass from Booth Lake, according to calendar year and year of life, before and after reduction in numbers by poison.

(number of specimens in parentheses)

| Computed for year of life | Calculated growth in millimeters | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Before poisoning | | | | | | | After poisoning | | | | |
| | 1932 | 1933 | 1934 | 1935 | 1936 | 1937 | Average | 1938 | 1939 | 1940 | 1941 | Average |
| 1 | 31(2) | 32(19) | 31(41) | 30(42) | 33(27) | 30(11) | 31(141) | 32(28) | 34( 8) | ... | ... | 32(36) |
| 2 | ... | 25( 2) | 21(19) | 17(41) | 19(42) | 19(19) | 19(123) | 37(12) | 30(28) | 27( 8) | ... | 31(48) |
| 3 | ... | ... | 15( 2) | 18(19) | 16(41) | 16(32) | 16( 94) | 29(19) | 19( 1) | 37(22) | 27( 7) | 32(49) |
| 4 | ... | ... | ... | 6( 2) | 8(19) | 12(24) | 10( 45) | 27(32) | ... | 30( 1) | 17(10) | 25(43) |
| 5 | ... | ... | ... | ... | 6( 2) | ... | 6( 2) | 24(24) | 19( 1) | ... | 13( 1) | 23(26) |
| 6 | ... | ... | ... | ... | ... | ... | ... | ... | 24( 1) | ... | ... | 24( 1) |

in growth, and this advantage has been somewhat more evident following the poisoning. The grand average calculated lengths, based upon the successive addition of the weighted average growth increments, are shown in Figure 1 and Table 3. There was very little difference between the lengths at the end of the first year of life before and after the reduction in the density of the population. This may be due to the nature of the feeding habits of the young of the year and older age groups. The young of the year are mainly plankton feeders, and the plankton in the lake probably was sufficiently abundant to provide a normal food supply to all these fish. However, the food supply for the older fish probably was not sufficient with the result that stunting was prevalent before the poisoning. Following the poisoning the food available was adequate to supply the remaining fish enough food to permit improved growth. In fact, the growth after 1937 was found to be better than average when compared with the tentative state average (unpublished data).

## Growth in weight

No attempt was made to analyze the growth in weight in the earlier report. The length-weight relationship has been determined for the materials collected after the reduction in numbers. Equations were calculated originally for the sexes separately, but the differences between them were so small that a combination of the data was considered justifiable. The equation for the combined data is:

$$W = 3.597 \times 10^{-5} L^{3.025},$$

where W = weight in grams,

and L = standard length in millimeters.

Figure 1.--Growth of rock bass in Booth Lake, before (broken lines) and after (solid lines) reduction in the density of the population. Growth curves (upper curves) based upon successive addition of the grand average calculated increments in length (lower curves).

Table 3.--Grand average calculated lengths based on the successive addition of average calculated increments before and after poisoning

| Year of life | Before poisoning | | After poisoning | |
|---|---|---|---|---|
| | Male | Female | Male | Female |
| 1 | 32 | 31 | 35 | 32 |
| 2 | 51 | 50 | 69 | 63 |
| 3 | 67 | 66 | 107 | 95 |
| 4 | 78 | 76 | 136 | 120 |
| 5 | 87 | 82 | 163 | 143 |
| 6 | ... | ... | 183 | 167 |

In logarithmic form the equation may be stated:

$$\log W = -4.4440438 + 3.025 \log L.$$

From this equation the weights corresponding to the lengths at the end of each year of life for growth after the reduction in population density were calculated and are given in Table 4 and Figure 2.

No individual weights were taken at the time of the poisoning. A collection of 13 fish (range of standard length--79 to 99 millimeters) was made in August, 1937, just a month prior to the poisoning. The average coefficient of condition, K, for these fish, which were weighed individually, was determined as 3.07--a value much lower than that of 4.10 for rock bass after the poisoning. The difference in condition in the two periods is evident when a comparison is made of the estimated weights for the rock bass of the same length before and after poisoning. A 50-millimeter fish, before the poisoning, would have weighed 4 grams, while after the poisoning fish of the same length would have weighed 5 grams, and the corresponding weights for a fish 75 millimeters long are 13 grams and 17 grams respectively. Because of the evidence for a pronounced improvement in the condition following the reduction in density of the population, it was considered advisable to base estimates of the growth in weight before poisoning on the coefficient of condition of fish taken at that time (though based on relatively few individuals) rather than on the length-weight equation determined from fish taken after the poisoning.

Of course, the use of an average coefficient of condition for the computation of unknown weights from known lengths is valid only if the length-weight relationship conforms rather closely to the "cube law," that is, if the exponent in the length-weight equation deviates only

Table 4.—Calculated weight for calculated lengths at end of each year of life

| Males | | | | | Females | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Before poisoning | | After poisoning | | | Before poisoning | | After poisoning | |
| Year of life | Calculated length (millimeters) | Calculated weight (grams) | Calculated length (millimeters) | Calculated weight (grams) | Year of life | Calculated length (millimeters) | Calculated weight (grams) | Calculated length (millimeters) | Calculated weight (grams) |
| 1 | 32 | 1 | 35 | 2 | 1 | 31 | 1 | 32 | 1 |
| 2 | 51 | 4 | 69 | 13 | 2 | 50 | 4 | 63 | 10 |
| 3 | 67 | 9 | 107 | 50 | 3 | 66 | 9 | 95 | 35 |
| 4 | 78 | 15 | 136 | 103 | 4 | 76 | 14 | 120 | 70 |
| 5 | 87 | 20 | 163 | 177 | 5 | 82 | 17 | 143 | 119 |
| 6 | ... | ... | 183 | 251 | 6 | ... | ... | 167 | 191 |

Figure 2.--Calculated weight of rock bass from Booth Lake at end of each year of life before (broken lines) and after (solid lines) reduction in numbers

slightly from the value 3. There is considerable evidence that in general the weight of the rock bass tends to increase approximately as the cube of the length. The value of the exponent for Booth Lake fish (after poisoning) was given above as 3.025. In the length-weight equation derived by Hile (1941) for the Nebish Lake (Wisconsin) rock bass, the exponent was 3.003. Finally, the value in the equation for combined samples of rock bass from different localities throughout the state of Michigan (Beckman, MS) was 2.969. These values are all sufficiently close to 3 to suggest that no great systematic error was involved in the use of the mean $\bar{X}$ for the estimation of the growth in weight before the population density was reduced.

Thus the reduction in the density of the rock bass population was followed by increases in the rate of growth in length and weight, and in the coefficient of condition.

One additional factor has now entered into the problem. In 1937, after the poisoning, a planting of 25 adult smallmouth black bass (Micropterus d. dolomieu) was made, and in 1938 fingerlings were planted as follows: 200 largemouth black bass (Huro salmoides); 5,000 bluegills (Lepomis m. macrochirus); and 1,500 perch (Perca flavescens). None of the bluegills have been recovered to date. As perch[2] were already present in the lake,

[2] An insufficient number of perch has been taken since the poisoning to determine whether or not any change in growth rate has occurred in this species.

it is not known whether or not the planting was successful. The plantings of black bass were successful. These fish have reproduced in the lake.

The black bass may now have become sufficiently numerous to be an important predator of the rock bass as well as a competitor for food. It is possible that the black bass will keep the numbers of rock bass reduced, and that the rock bass, through predation on young black bass, will in turn control the numbers of those fish. If this situation obtains both species should maintain normal growth. Observations will be made on the lake in the future to ascertain what changes may occur.

## Summary

1. The fish population of the south basin of Booth Lake (formerly Standard Lake), Michigan, was destroyed by poison in 1937 to determine the effect of reduction in density of the population on the growth rate.

2. In 1940, a report was presented on the increased length of the rock bass. Additional collections have been made and further analysis of the data are presented.

3. The increased rate of growth in length has been maintained rather well.

4. Growth in weight also increased sharply following the reduction in population density. Furthermore, the mean coefficient of condition, K, was much greater (4.10) after than before the poisoning (3.07).

5. The reduction in the density of the population therefore appears to be one solution to the problem of improving fishing in the lakes overrun with stunted fish.

## Literature cited

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(References have been checked against original sources)

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