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MATURITY AND FECUNDITY OF LARGEMOUTH BASS AS A FUNCTION OF AGE AND SIZE[1]

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

Abstract

The fecundity and rate of maturity of typical Michigan largemouth bass reared in ponds at the Saline Fisheries Research Station were determined in 1980-84. The smallest mature bass we observed was 7.8 inches long and the largest immature bass noted was 8.7 inches long. For both sexes, all bass over 9.0 inches long which were 2 or more years old were mature. Female bass produced about 30,000 eggs per pound. Age had no effect, independent of female length or weight, on fecundity. Low fecundity in one year (1983) may have been due to poor growth or cool spring weather. The current 12-inch minimum size limit on largemouth bass fisheries protects an "average" Michigan bass through two spawning seasons. This degree of protection seems to be more than adequate for maintaining wild populations.

Introduction

Although the largemouth bass (Micropterus salmoides) is a common and important sport fish in Michigan, there is little precise information on its maturity and fecundity (Latta 1974). Such basic information is needed to properly manage the species and to understand how bass populations respond to perturbations such as fishing. Traditionally, minimum size limits have been set close to the size at which a species matures to insure adequate broodstock and ample reproduction. Selection of the proper size limit has become more critical in recent years because bass fishing has been increasing (Schneider and Lockwood 1979; Goudy 1981).

In 1976, Michigan raised the minimum size limit on largemouth bass from 10 to 12 inches. At that time little information was available on the relationship of age and size to sexual maturity and fecundity. In the only Michigan study, Clady (1970) had reported that females matured at age IV, 10 inches in length, and produced about 10,000 eggs. However, those bass were from a slow-growing Upper Peninsula population and probably were not typical for Michigan as a whole.

Other reports of largemouth bass maturity and fecundity in the scientific literature are variable. In Lake George, Minnesota, Kramer and Smith (1962) reported that males matured at 11.5 inches and females at 12.2 inches. In Canada, Scott and Crossman (1973) reported males matured at 3 to 4 years of age and females at 4 to 5 years. Heidinger (1976) concluded that sexual maturity was more related to size than to age and that maturity is reached at a rather small size--about 25 cm (9.8 inches) for females about 22 cm (8.6 inches) for males. Carlander (1977) noted that largemouth bass maturity was correlated to latitude and climate, with fast growers in Florida and Cuba maturing as early as 9 months of age. The only thorough study of

largemouth bass fecundity in the literature was done by Kelley (1962) for a population in Maine.

This report presents data on the fecundity and the rate of maturity of largemouth bass and considers how they respond to changes in growth. The bass were reared in experimental ponds in southern Michigan. As used in this report, fecundity means the number of mature eggs in the ovaries prior to spawning, and rate of maturity refers to the probability of being sexually mature at a given size or age.

Methods

The experiment was conducted at the Saline Fisheries Research Station from 1980 to 1984. Largemouth bass were bred and reared in 0.5-acre ponds with mean depths of 3.2 to 4.2 feet (Laarman and Merna 1980). Bass growth was varied by manipulating bass density. The original stock of bass was obtained from a native population in Swan Creek Pond, Allegan County. These fish are believed to be typical Michigan largemouth bass.

Samples of largemouth bass were collected in mid-May, just prior to spawning. For the maturity phase of the study, 271 bass, 7.0 to 14.8 inches long, ages I to VII, were sacrificed and examined. For the fecundity phase of the study, 91 female bass, 8.2 to 14.8 inches long, ages II to VII, were examined. Ovaries were removed and preserved in 10% formalin. Later, each ovary was blotted dry and weighed. Three subsamples were weighed and the number of mature eggs were counted. Mature eggs were defined as those larger than 0.75 mm in diameter (Kelley 1962). Then the number of eggs per gram of ovary and the total number of eggs per ovary were calculated. The size-frequency of eggs in 13 ovaries was determined.

Results

Maturity

The attainment of sexual maturity was a function of sex, size, and age (Table 1). Surprisingly, females matured at a slightly smaller size and younger age than males. Within each sex, older and larger individuals had a higher probability of being mature than younger or smaller bass.

For males, the smallest mature specimen was 8.1 inches and the largest immature fish was 8.7 inches. For females, the smallest mature bass was 7.8 inches and the largest immature one was 8.7 inches. For both sexes, all bass over 9.0 inches long which were 2 or more years old were mature.

Fecundity

The number of eggs produced by largemouth bass was an exponential function of length. A $\log_{10}$ transformation, followed by least squares fit, produced linear regressions for each year's data. Regressions for 1980, 1981, 1982, and 1984 had overlapping confidence limits so could be pooled (Fig. 1). The regression for 1983 was significantly lower, indicating that bass were less fecund that year. The pooled regression, considered to be typical for Michigan largemouth bass, is as follows:

$$\log_{10} \text{eggs} = 0.9047 + 3.2857 \log_{10} (\text{length in inches})$$

The metric equivalent is:

$$\log_{10} \text{eggs} = -0.4254 + 3.2857 \log_{10} (\text{length in cm})$$

On the average, a 9-inch largemouth bass produced about 11,000 eggs and a 15-inch bass almost 59,000 eggs (Fig. 1). However, there was much scatter in the pooled data so only 71% of the variation in fecundity could be attributed to the effect of female length.

Female weight was a slightly better predictor of fecundity than length. The pooled regression of log eggs on

log weight had an R^2 of 73%. About 30,000 eggs were produced per pound of female bass.

Age had no significant effect, independent of length or weight, on fecundity. In a multiple regression which included all of the data, partial correlation coefficients were 0.49 for log weight, 0.31 for log length, and only 0.07 for age.

As noted earlier, bass collected in 1983 were significantly less fecund than bass of the same size collected in other years (Fig. 1). The reason for the difference is not clear. Bass sampled in 1983 had experienced very poor growth the previous year. Their ovaries were a smaller proportion of the total female weight than in other years--4.7% compared to 6.6-10.9%. Also, spawning occurred later than usual because April-May temperatures were 6.9 F below normal in 1983. However, eggs collected at the usual time, mid-May, appeared normal.

As expected (Kelley 1962), two size groups were present and eggs larger than about 0.8 mm in diameter appeared to be mature (Table 2).

Discussion

Heidinger (1976) concluded that largemouth bass females mature at about 9.8 inches and mature males at about 8.6 inches based on his review of the literature. In our study females matured at a smaller size (between 7.8 and 8.7 inches) and males at about the same size (between 8.1 and 8.7 inches). None of our study bass reached maturity until age II; however, northern largemouth bass can mature at age I if growth is exceptionally good. Yearling largemouth bass, averaging about 10 inches long, successfully produced a year class in a southern Michigan lake (J. W. Merna, personal communication). This lake had been chemically treated to kill all fish (no bass were present then) and restocked with young-of-the-year bass just a year before the reproduction occurred.

Reports on largemouth bass fecundity have been extremely variable, mostly due to uncertainties in judging egg maturity (Heidinger 1976). Our estimates fell well within the reported range. Kelley (1962) suggested that a decline in egg production occurs in large (about 18-inch) and old (about age-VII) largemouth bass. A further complication in evaluating fecundity is that sometimes not all mature eggs are laid (Clady 1970).

The current minimum size limit of 12 inches for largemouth bass fishing in Michigan provides extensive protection to bass broodstocks. On the average, wild bass in Michigan waters grow to 7.1 inches by May of age II, to 9.4 inches by May of age III, and to 11.6 inches by May of age IV (Merna et al. 1981). Based on our study, none of the "average" bass would be mature at age II and all would be mature at age III. Thus, the 12-inch size limit allows most females to spawn twice and to produce about 30,000 eggs before entering the fishery.

Clady (1970) found largemouth bass in an Upper Peninsula population reached maturity at a larger size (10 inches) and older age (V). Also, his bass had about 35% fewer eggs. However, because of their slower growth, the 12-inch size limit also protects these bass for two spawning seasons.

On the other hand, field tests indicate that wild largemouth bass rarely need this protection to maintain their populations. Studies of native populations in lakes have found no relationship between number of adult spawners, or their reproductive potential, and the size of the year class they produce (see review by Latta 1974). In pond studies, a few adult bass produced as many (or more) fall fingerlings as many adult bass (Laarman and Merna 1980).

Acknowledgments

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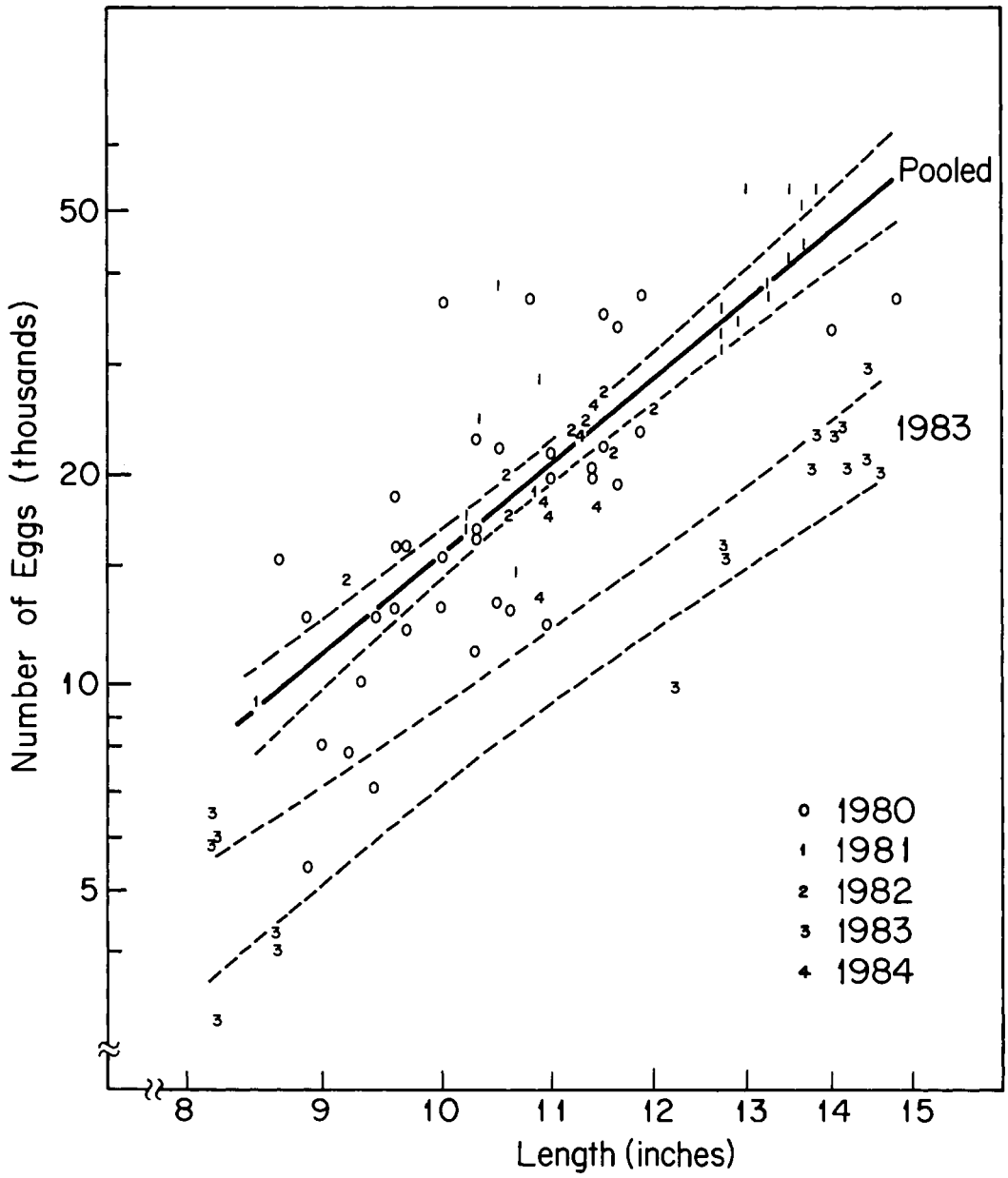

Figure 1. Regressions (log scale) of fecundity on total length of largemouth bass, with 95% confidence belts (broken lines) for the 1983 sample and for the pooled 1980, 1981, 1982, and 1984 sample.

Table 1. Percent of largemouth bass sexually mature in relation to length and age. (Number of bass examined in parentheses.)

Sex and length group (inches)	Age[1]		
	2	3	4-7
Male			
7.0-7.9	0 (9)	--- ---	--- ---
8.0-8.9	0 (8)	100 (22)	--- ---
9.0-9.9	100 (1)	100 (4)	--- ---
10.0-14.9	100 (14)	100 (27)	100 (34)
Female			
7.0-7.9	0 (9)	67 (3)	--- ---
8.0-8.9	38 (8)	100 (28)	100 (1)
9.0-9.9	100 (6)	100 (4)	100 (6)
10.0-14.9	100 (10)	100 (32)	100 (45)

[1] Eight age-I bass, 3.7 to 6.5 inches long, of undetermined sex, were immature.

Table 2. Frequencies (percent) of egg diameters for 13 largemouth bass collected in 1980.

Fish length (inches)	Egg diameter (mm)							
	<0.48	0.55	0.69	0.83	0.97	1.10	1.24	>1.31
8.2	36	14	4	8	8	21	9	tr[1]
8.2	31	15	4	7	10	21	11	tr
8.2	29	21	2	6	15	18	8	tr
8.7	37	16	4	14	9	12	6	2
9.0	34	8	4	11	14	12	10	6
12.3	16	12	5	13	22	19	10	3
12.8	31	17	5	8	11	13	12	3
13.8	41	15	5	7	15	10	6	tr
13.8	20	7	4	16	13	18	14	8
14.1	18	11	4	12	11	22	18	4
14.1	33	9	4	10	15	14	12	2
14.4	23	8	6	11	14	15	17	6
14.6	21	15	5	11	16	16	12	4
Mean	28	13	4	10	13	16	11	3

[1]Tr = less than 1%.

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