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RELATIONSHIP BETWEEN POPULATION DENSITY OF ADULT NORTHERN LARGEMOUTH BASS, *MICROPTERUS SALMOIDES SALMOIDES*, AND POND PRODUCTION OF YOUNG-OF-THE-YEAR

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ABSTRACT

Adult largemouth bass were stocked into three 0.08-hectare experimental ponds at three different densities (50, 150 or 300 individuals per hectare). The number of offspring censused in the low, moderate and high density ponds were 79,288, 58,863 and 17,413 per hectare, respectively. The data indicate a negative relationship between the density of adults stocked and the number of juvenile largemouth bass produced.

INTRODUCTION

Many factors are involved in determining the success of largemouth bass, *Micropterus salmoides*, reproduction and recruitment. It has been postulated that under certain types and degrees of competition, the disappearance of some populations of game fishes may be associated with the inability to successfully spawn (Bennett, 1954). Variations in chemical and physical characterisitics of a pond have been shown to affect the success of largemouth bass spawning. High pH, fluctuating water levels, temperature changes, and composition and abundance of other fish species may be important in limiting reproduction (Bennett, 1954; Buck and Thoits, 1970; Barwick and Holcomb, 1976; Smith, 1976).

A negative relationship was found between the number of largemouth bass spawners and the number of fry produced in Ridge Lake, Illinois during 1941-51 (Bennett, 1954; Bennett et al., 1969). Buck and Thoits (1970) studied one-species populations of smallmouth, *Micropterus dolomieui*, and largemouth bass in 0.4-hectare ponds in Illinois. They found that the number of young-of-the-year largemouth bass produced was inversely correlated with the number of adult largemouth bass stocked. However, this was not found to be true for smallmouth bass populations. It should be noted that fingerlings and subadults were also present in these ponds. Rickett (1976) found that when adult largemouth bass and black bullheads, *Ictalurus melas*, were cultured together, ponds with larger number of largemouth bass resulted in a depletion of the young of both species. Other studies of largemouth bass, however, indicated that the degree of reproductive success is not affected by the density of brood stock (Stroud and Jenkins, 1962; Johnson and McCrimmon, 1967).

This study investigates the relationship between the number of largemouth bass spawners and the resulting abundance of young-of-the-year in small ponds in central Illinois which contained fathead minnows, *Pimephales promelas*, as forage.

METHODS

This study was conducted at the Aquatic Research Field Laboratory of the Illinois Natural History Survey, located on the Urbana-Champaign campus of the University of Illinois. Northern largemouth bass, *M. s. salmoides*, collected from a 5.7-hectare central Illinois lake, were stocked into three adjacent 0.08-hectare experimental ponds in October 1978. Pond A (low density) was stocked with two male and two female largemouth bass (50 bass per hectare); Pond B (moderate density) was stocked with six male and six female (150 bass per hectare); and Pond C (high density) was stocked with 14 male and 10 female (300 bass per hectare). All largemouth bass were weighed, measured, and tagged prior to introduction, and the mean total lengths and weights were similar among ponds (Table 1). Each of the three ponds was stocked with approximately 1.70 kg of fathead minnows, *Pimephales promelas*, as forage. No other fish were present in the experimental ponds.

Fishing was conducted for one week in the fall of 1978 and seven weeks in the spring of 1979 as a component of a study not reported here. All largemouth bass caught were returned to the ponds. Substantial spawning had occurred in all ponds prior to initiation of fishing on 22 May, and later, large schools of largemouth bass fry were observed in all three ponds. The ponds were drained between 26 July and 6 August 1979, at which time the adult largemouth bass originally stocked were recovered. A complete population census of the juveniles was conducted for each pond. Samples of 100 offspring from each pond were individually measured for total length to obtain length-frequency distributions and then group weighed to calculate mean weights. Abnormally large fingerlings (over 50 mm) were present in Pond A (low density) only; mean total length and weight were calculated separately for these larger fingerlings.

RESULTS AND DISCUSSION

Considerable differences occurred in the number, mean lengths and mean weights of offspring between the three ponds (Table 2). At the time of draining, Pond A (low density broodstock) contained 6,263 young-of-the-year largemouth bass averaging 34 mm and 0.6 g. Offspring from Pond B (moderate density broodstock) total 4,549; mean length was 47 mm and mean weight was 1.4 g. The fewest offspring(1,393) were recovered from Pond C (high density broodstock), although these were larger in mean length (51 mm) and mean weight (1.9 g).

When the three ponds were drained, fathead minnows remained only in Pond A (approximatly 3.50 kg) (43.75 kg/ha). There was little correlation ($r = 0.406$) between the number of spawners and the total weight of juveniles produced, but a highly negative correlation ($r = -0.999$) existed between the number of spawners and the number of juveniles produced (Fig. 1).

Although the larger number of females present in the moderate and high density ponds had the cumulative potential to produce more offspring than the females in the low density pond, total offspring survival after three months was highest in the low density pond. During this period, only the adult largemouth bass in the low density pond gained considerable weight (25.2%, Table 1). This weight gain apparently resulted from the relatively large amount of forage available. In addition, this abundance of forage also lowered the predation rate on the young-of-the-year largemouth bass. This high survivability resulted in the production of more juvenile bass per hectare, but smaller mean size (Table 2).

It has been reported that young-of-the-year largemouth bass feed mostly on invertebrates until they are 120-149 mm long (Applegate and Kruckenberg 1978). The offspring in our experiment did not have a large predatory impact on the forage fish because few grew large enough to consume the minnows. In addition, Johnson and McCrimmon (1967) reported that in a series of brood ponds with various combinations of largemouth bass and forage fish, the mean weight of fingerlings was not affected by the density of fingerlings produced in these ponds. This was not the case in the present study; both mean total lengths and weights of the offspring were negatively correlated to their density (r = −0.898 and −0.955, respectively).

The length-frequency distribution of the juvenile bass for all three experimental ponds is shown in Figure 2. Only Pond A contained some juvenile largemouth bass believed to be cannibals (not shown in Figure 2), which were much larger than the other fingerlings. Following the final census, several of these larger fish regurgitated small conspecifics. The presumed cannibals (N = 81) had a mean weight of 5.1 g and a mean total length of 72 mm. The cannibals recovered from the pond made up 1.3 percent of the number and 9.2 percent of the total weight of offspring. The length-frequency distribution in Pond B was closer to a normal distribution. Analysis of the length-frequency distribution of Pond C revealed a bimodal distribution. This bimodal distribution in Pond C might be due to cannibalism, however, the fairly small difference in size between the two classes does not strongly support this. In fact, temporal differences in spawning may be a more plausible explanation.

The lack of an adequate initial forage base in the moderate (Pond B) and high (Pond C) density brood ponds, confirmed by the loss of weight in the adults, could have resulted in increased predation on the young-of-the-year largemouth bass. The negative correlation between adult density and the density of fingerlings produced appears to result directly from the food resources available to the adults.

However, it is possible that factors other than food availability to adult broodstock have contributed to the resulting population densities of the young-of-the-year largemouth bass. Aggressive interactions due to territorially and competition between individual males for females may have prevented the successful spawning of some fish in the higher density ponds. Davis (1966) stated that behavioral competition with other members of the same species may disrupt complex courtship behavior patterns. Such competition would be more pronounced in denser populations. However, apparently there was adequate nesting space in each of the three ponds (Beaty and Childers, 1980), for all of the potentially nesting males present, although the actual number of successful nests in each pond is not known. Therefore, suppression of spawning through competition for nesting sites is not considered an important factor in this study. Differential physicochemical and biotic parameters among ponds may also have been responsible for fry/fingerling survival and food production (Buck et al., 1970). However, because the three experimental ponds were very similar in morphology and morphometry, as well as macrophyte cover, we believe that these parameters did not contribute extensively to the variation observed among ponds in the juvenile largemouth bass densities. In our experiment, the density of the broodstock appeared to have the greatest influence on the abundance of surviving young-of-the-year largemouth bass.

Current hatchery procedures are raising large numbers of largemouth bass fingerlings for stocking purposes using a substantial number of adult fish to serve as broodstock. If broodstock is to be selected continually from wild stocks (Smith and Chesser, 1981; Ryman, 1981; Philipp et., 1981, 1983), these collections may represent a substantial effort by production personnel. The procedures that maximize production efficiency should be sought and implemented. In this experiment, the lowest density of adults tested produced the highest number of surviving offspring. However, these fingerlings also had the smallest mean size. The moderate density pond (Pond B) produced a good compromise between number and size of young-of-the-year in this experiment (Fig. 1). An optimal production procedure may be obtained by locating the point at which the graphical lines of numbers and weights of fingerlings in Figure 1 intersect. This is approximately halfway between our low and moderate density ponds. It should be noted that these estimated predictions are based on results using a single size class of adult largemouth bass as spawners in small (0.08 hectare) ponds with a single concentration of fathead minnows as forage. Changes in the forage fish stocking rates would presumably alter the resulting density and size of largemouth bass fingerlings produced.

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Table 1. Lengths and weights of largemouth bass at the time of stocking and draining. The percent of change in length and weight between stocking and draining are shown. Standard deviations are indicated in parentheses.

	Stocking	N	Draining	N	Percent of Change
Pond A (low density)		4		4	
Mean Total Length (mm)	272(9)		307(13)		+12.9
Mean Total Weight (g)	329(57)		412(41)		+25.2
Pond B (moderate density)		12		12	
Mean Total Length (mm)	271(24)		285(15)		+ 5.2
Mean Total Weight (g)	316(88)		301(41)		− 4.8
Pond C (high density)		24		24	
Mean Total Length (mm)	271(14)		278(12)		+ 2.6
Mean Total Weight (g)	314(55)		275(37)		−12.4

Table 2. Numbers, weights, mean lengths, and mean weights of young-of-the-year largemouth bass recovered.

	Number (per hectare)	Kilograms (per hectare)	Mean Length (mm)	Mean Weight (g)
Pond A (low density)	6,263 (78,288)	3.75 (46.88)	34	0.6
Pond B (moderate density)	4,549 (56,863)	6.23 (77.88)	47	1.3
Pond C (high density)	1,393 (17,413)	2.65 (33.13)	51	1.9

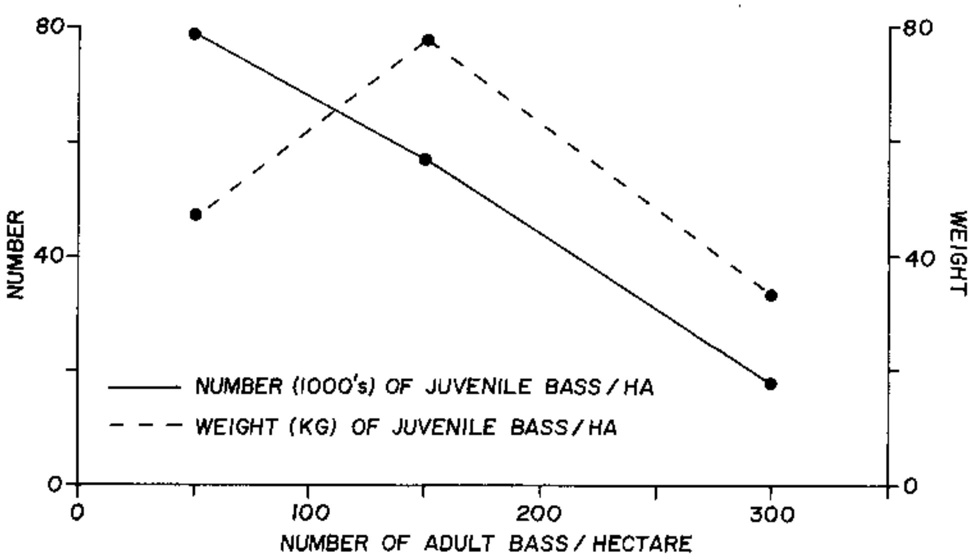

Figure 1. Number and weight per hectare of young-of-the-year largemouth bass relative to the number of adult bass stocked.

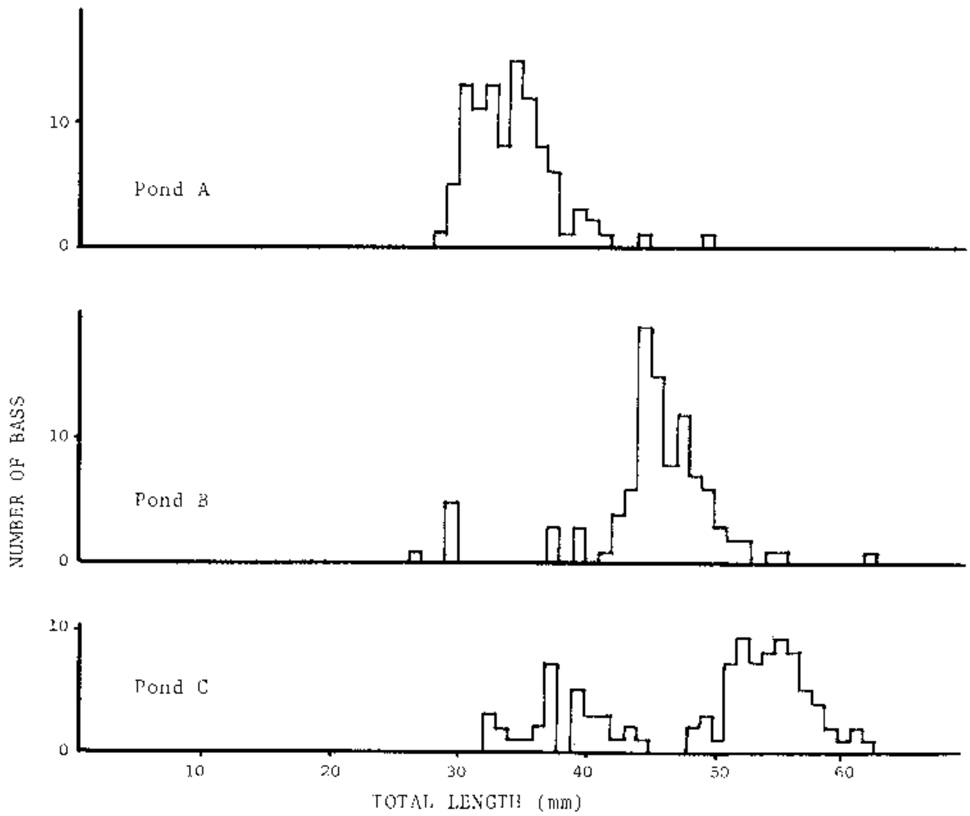

Figure 2. Length-frequency distribution of juvenile largemouth bass in low density, moderate density and high density ponds.