Effects of Stocking Density on Third-Year Growth of Largemouth Bass, *Micropterus salmoides*, Fed Prepared Diets in Ponds

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ABSTRACT. Largemouth bass, *Micropterus salmoides*, with an average weight of 383 g were stocked into six 0.04-ha ponds at stocking densities of either 3,750 or 7,500 fish/ha. Fish were fed a custom-formulated floating diet, containing 44% protein, for 334 days, once daily to satiation at water temperatures >5°C and twice weekly at <5°C. At final harvest, there was no significant difference ($P > 0.05$) in average individual weight, percentage weight gain, feed conversion ratio, or survival of bass stocked at the two densities. Total yield and total production of fish were significantly greater ($P < 0.05$) for bass stocked at the higher density (3,909 kg/ha and 1,040 kg/ha, respectively) than for bass stocked at the lower density (1,758 kg/ha and 341 kg/ha, respectively). Averaged over the study period, there were no significant differences ($P > 0.05$) in total ammonia-nitrogen (TAN), nitrite-nitrogen, or un-ionized ammonia concentrations in ponds in which bass were stocked at the two densities. These data indicate that largemouth bass, of the size used in this study, are amenable to pond culture at densities of at least 7,500 fish/ha and that higher stocking densities may be possible or even advantageous. *[Article copies available for a fee from The Haworth Document Delivery Service: 1-800-342-9678. E-mail address: getinfo@haworthpressinc.com]*

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INTRODUCTION

Interest in the culture of largemouth bass, *Micropterus salmoides,* to sizes greater than those normally utilized in sportfish stocking has increased in recent years (Brandt 1991). Uses for fish >100 g include corrective stocking, fee-fishing (JSA 1983), managed trophy fisheries (Dupree and Huner 1984), and as live-food products in ethnic Asian markets (Tidwell et al. 1996). Although interest in and demand for largemouth bass of advanced sizes is quite strong there are very little reliable data on culture methods. Lovell (1989) observed that feed consumption, growth rate, and feed conversion efficiencies generally decrease as fish size increases. Busch (1985) demonstrated in channel catfish that growth slowed and feed conversion ratios increased during third-year growth. Tidwell et al. (1994) reported that decreasing stocking density increased weight gain in hybrid sunfish but did not affect feed conversion. Tidwell et al. (1998) reported that during second-year growth largemouth stocked at higher density had significantly lower feed conversion ratios than those stocked at low density. The objective of this study was to evaluate the effects of stocking density on growth and feed conversion of largemouth bass during third-year growth.

MATERIALS AND METHODS

Largemouth bass averaging 383 ± 16 g (mean ± SE) used in a previous nutrition study (Tidwell et al. 1996) and a second-year growth/density study (Tidwell et al. 1998) were held in tanks, then stocked in a systematic rotation (Cochran and Cox 1957) into six 0.04-ha ponds on May 3, 1995. Treatments (stocking densities) were randomly assigned to experimental units (ponds) using a random number generator. Three ponds were stocked at 3,750/ha and three at 7,500/ha. Ponds used in the study were approximately 1.5 m deep and were supplied with water from a reservoir filled by rain runoff. Water levels in the ponds were maintained at constant depth by periodic additions of reservoir water. Fish were fed a floating 44% crude protein diet as described in Tidwell et al. (1996). At temperatures greater than 5°C, fish were fed once daily, seven days a week, all they could consume in a 30-minute period, based on feed response. At temperatures below 5°C, fish were offered diet twice weekly, except during periods of ice-over (Brandt and Flickinger 1987). The weight of diet fed to fish in each pond was recorded daily.

Water temperature and dissolved oxygen were monitored in each pond twice daily (09.00 and 16.00 hours) at a depth of 0.5 m using a YSI Model 57 oxygen meter (YSI, Yellow Springs, Ohio[1]). Mechanical aeration supplied supplemental oxygen if the dissolved oxygen was predicted (Schwedler 1983) to fall below 5 mg/L during the night. Ammonia, nitrite, and pH were determined weekly (1600 hours) by means of a HACH DREL/2000 spectrophotometer (HACH, Loveland, Colorado).

After stocking, a sample of ≥50 fish per pond were captured monthly, bulk weighed, counted, and returned to the pond to determine average weights. At temperatures <10°C, fish were not sampled to prevent stress. At harvest on April 2, 1996 total number and weight of fish in each pond were determined after a 334-day culture period. Feed conversion ratio (FCR) was calculated from FCR = weight of feed fed (kg)/live weight gain (kg). Data were analyzed using Student's t-test (Statistix Analytical Software 1994) to determine the effects of stocking density on growth, feed conversion, survival, and water quality variables. All percentage and ratio data were transformed to arc sin values prior to analysis (Zar 1984).

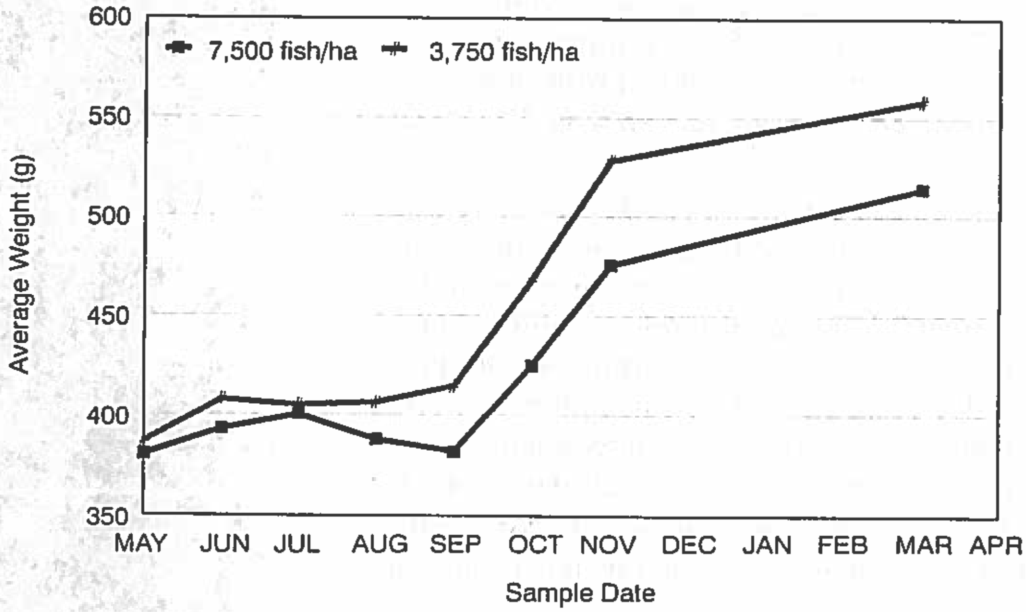
RESULTS AND DISCUSSION

There were no significant differences ($P > 0.05$) in overall mean dissolved oxygen concentration (11.7 mg/L), total ammonia-nitrogen (0.81 mg/L), un-ionized ammonia (0.13 mg/L), nitrite concentration (0.028 mg/L), or pH (8.6) for ponds assigned to two densities. One high density pond had unexplained low survival (59%). No sick or dead fish were seen in this pond. Considering the large size of fish involved (≥0.5 kg) unrecorded mortalities are unlikely. Poaching is a possibility. Even with this replication included in analyses, there was no significant difference ($P > 0.05$) in percentage survival (average = 82%). However, this replication was excluded from statistical analyses of other production and water quality variables.

The pattern of weight gain in this study (Figure 1) differs from that reported in Tidwell et al. (1998) for second-year largemouth bass. The primary difference is during the period of August to November in

1. Use of trade or manufacturer's name does not imply endorsement.

FIGURE 1. Mean sample weights of largemouth bass stocked at 3,750 and 7,500 fish/ha. There were no significant differences ($P > 0.05$) in average weights at any sampling date.



second-year fish those stocked at low density gained more weight, while in third-year fish those stocked at high density gained more weight. Production data are presented in Table 1. There was no significant difference ($P > 0.05$) in individual weight gain, with an overall average harvest weight of 536 g and average individual gain of 40%. This compares to 113% individual weight gain for channel catfish during third-year growth (Busch 1986). Since increased density did not reduce average fish size, treatment densities resulted in large differences in pond production data, with the high-density treatment producing significantly greater ($P < 0.05$) total yields and pond unit production rates than the low-density treatment (Table 1).

The differences in feed conversion ratios were large (9.6 and 3.8 in low and high-density ponds, respectively) but not statistically significant ($P > 0.05$) due to high within-treatment variation. Feed conversion ratios for third-year bass at high densities (3.8) were much higher than those reported for second-year bass at high density (2.3; Tidwell et al. 1998). These data agree with Lovell (1984) who stated that growth rate and feed conversion efficiencies generally decrease as fish size increases. Busch (1986) reported an FCR of 2.2 for third-year

TABLE 1. Initial individual weight (mean ± S.E.), final individual weight, final lengths, percent survival, average individual gain, total yield, and feed conversion ratio (FCR) for largemouth bass fed prepared diets for one year in ponds. Means within a row followed by the different letters are significantly different ($P < 0.05$).

	Stocking rate (fish/ha)	
	3,750/ha	7,500/ha
Individual stocking weight (g)	380 ± 24a	386 ± 5a
Individual harvest weight (g)	514 ± 38a	559 ± 7a
Individual weight gain (%)	35 ± 5a	47 ± 5a
Survival (%)	92.3 ± 4.0a	82.7 ± 16.1a
Production (kg/ha)	341 ± 123b	1,040 ± 66a
Total yield (kg/ha)	1,758 ± 230b	3,909 ± 19a
FCR	9.6 ± 4.0a	3.8 ± 0.4a

channel catfish. Average individual gains and FCRs averaged over both treatments (58% and 7.3, respectively), were similar to those reported for third-year walleye production in ponds (45% and 9.1, respectively) (Coyle and Tidwell 1997). High feed conversion ratios are usually indicative of overfeeding, inefficient utilization of consumed feed, or both. In this study feeding rates were based on fish response. This required that some feed be presented to fish in each pond to allow the opportunity to feed. On days when fish did not respond, this feed was wasted. This was especially true during the winter. During summer months fish normally consumed feed but apparently did not convert efficiently.

In summary, growth and feed conversion of third-year largemouth bass were not negatively impacted by the higher stocking density and were in fact slightly improved. Production per unit of pond area was over 200% greater in the high-density ponds, without sacrificing average fish size or negatively impacting water quality. Higher stocking densities of large fish should be evaluated as a means to possibly improve growth, feed conversion, and pond utilization in the production of largemouth bass.

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