POLYCULTURE OF LARGEMOUTH BASS (*Micropterus salmoides*) WITH BLUE TILAPIA (*Oreochromis aurea*): USING TILAPIA PROGENY AS FORAGE

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Abstract

In this study, five, 0.04-ha ponds were stocked with advanced size largemouth bass fingerlings at densities of 124, 247, 494, 988, and 1136/ha. Tilapia broodfish were stocked at densities of 590/ha (male:female ratio was 1:3). Pond trials were conducted for a 6-month period, June to December 1985. Bass survival ranged from 40 to 89%. Bass stocked at densities ≤494/ha (low density) grew significantly larger than those at ≥988/ha (high density). Mean bass weights and percent weight gains at harvest in low versus high density ponds were 593 g and 3,318% and 120 g and 329%, respectively. High density bass ponds produced larger tilapia broodfish at harvest. The number of juvenile tilapia surviving in low density bass ponds was substantially greater (>20,000 juveniles/ha) than in high density bass ponds (99 and 420 juveniles/ha). The higher survival of tilapia juveniles in low density bass ponds was the apparent cause of significantly higher turbidity (determined from secchi disc measurements) in these ponds. The results of this study suggest that forage/predator ratios, based on densities of female tilapia broodfish to bass, of 0.7 and 1.4 are suitable for controlling spawn and producing large tilapia or for producing large bass, respectively.

1. Introduction

The proliferation of tilapia in public waters, their ability to reproduce rapidly and their acceptance as forage by piscivores have generated interest in the use of largemouth bass to manage tilapia reproduction and proliferation. Research by Schramm and Zale (1985) indicated that largemouth bass (*Micropterus salmoides*) show a preference for blue tilapia (*Oreochromis aurea*) over indigenous forage; this was dependent upon forage size and availability as well as vegetative cover. Swingle (1960, 1966) examined the ability of largemouth bass and peacock bass to utilize tilapia spawned in tilapia production ponds. The addition of piscivorous predators reduced the total number of tilapia (juveniles) while increasing the number of harvestable (large) tilapia.

The present study was designed to evaluate the use of largemouth bass to control tilapia reproduction as well as to provide base-line information concerning the number of bass that can be supported by the progeny of a fixed density of tilapia broodfish.

2. Materials and Methods

Five 0.04-ha ponds were stocked with largemouth bass fingerlings at the following densities: 124, 247, 494, 988, and 1136 fish/ha. The mean weight of individual fish stocked at densities of 124-988/ha was 17.3 g; 60.6 g bass were used at the 1136/ha density. Tilapia broodfish (150 g) were sexed and stocked at a density of 590/ha and a ratio of one male to three females; 340 g broodfish were stocked with the 60.6 g bass. Additionally, each pond was stocked with crawfish (*Procambarus* spp), 45 kg/ha, and top minnows (*Gambusia affinis*), 30 kg/ha, to provide forage until juvenile tilapia populations had become established.

A 32% protein, floating catfish feed was offered for the first three weeks of the experiment at a daily rate of 14.4 kg/ha to provide nutrients for tilapia broodfish and to stimulate natural pond productivity. After three weeks, feed was offered at a fixed daily allotment of 7.2 kg/ha until water temperature fell consistently below 15° C (the first week of November 1985). Fish were stocked 14 June 1985 and harvested from 17 to 21 December 1985.

Temperature and dissolved oxygen levels were measured in each pond three times weekly. No supplemental aeration was used. Well water was pumped into ponds continuously when freeze warnings were in effect to protect tilapia from low water temperatures. Since it was presumed that tilapia activity in the bottom sediments would affect turbidity, secchi disc measurements were initiated after tilapia populations were well established, approximately 3 months after stocking, and continued once weekly to assess water clarity. These data were intended as an indicator of visibility as encountered by the bass.

At harvest, individual weights, total biomass and survival of bass were determined. The gut contents of bass were examined to determine if they were consuming tilapia. Final biomass of the original tilapia broodfish and total biomass of unexploited juvenile tilapia were measured. Mean individual weights of tilapia broodfish were calculated by weighing the largest tilapia harvested from each treatment, equal in number to tilapia broodfish stocked. Broodfish survival was assumed to be 100% in each treatment. No mortalities were observed among broodfish during the course of the experiment.

Final weights of bass and secchi disc measurements among stocking densities were compared using one-way analysis of variance and multiple comparison tests. Data means were compared using Scheffe's test for data sets of unequal size and Duncan's multiple range test for data sets of equal size (Ott, 1977). Results are reported significant with p set at the $\alpha \leq 0.05$ level for both one-way analysis of variance and multiple comparison tests. The correlation coefficient, R^2, is reported for significant, analysis of variance findings.

3. Results

The data presented in Table 1 indicate that, at harvest (Figure 1), bass in the high density ponds (988 and 1136 bass/ha) were significantly smaller (R^2 = 0.894) than those in low density ponds (124, 247, and 494/ha). Bass from the highest density pond had the highest survival (Table 1). Bass mortalities were observed during the first seven days following stocking. Gut contents of these fish revealed no food items.

Table 1. Data for largemouth bass in bass-tilapia polyculture ponds.

Bass density at stocking (fish/ha)	Bass density at harvest (fish/ha)	Survival (%)	Mean indiv. weight at stocking (g)	[a]Mean indiv. weight at harvest (g ±SD)	Total bass biomass at harvest (kg/ha)	Mean % weight gain
124	49	40.0	18.1	599.0 ± 117.7[xa]	29	3,209
247	124	50.0	18.1	613.5 ± 135.3[x]	76	3,289
494	296	60.0	15.9	565.4 ± 133.1[x]	167	3,456
988	642	65.0	17.0	109.4 ± 43.5[y]	70	543
1136	1013	89.1	60.6	130.5 ± 32.8[y]	132	115

[a]Means with the same superscripts were not significantly different using Scheffe's test with p set at the $\alpha \leq 0.05$ level.

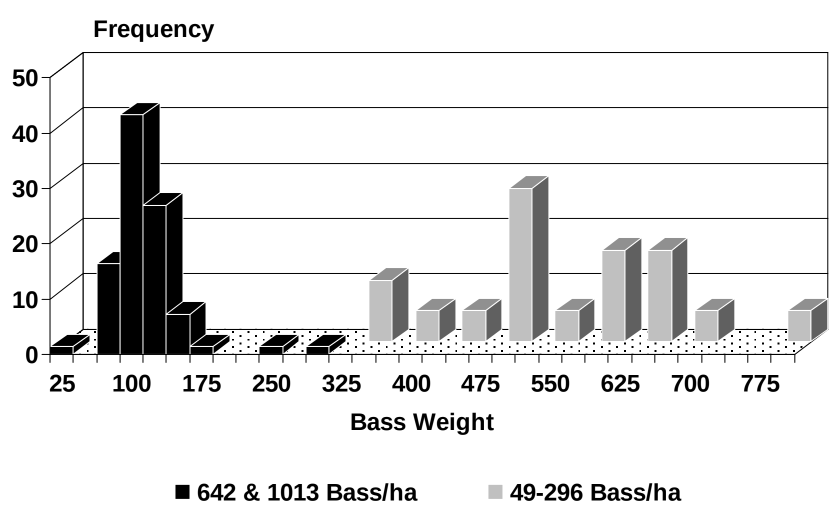

Figure 1. **Frequency (%) distribution of bass size (g) at harvest densities in ponds stocked with bass at low or high densities.**

Harvest weights of individual tilapia broodfish were greater in ponds stocked with high bass densities. Broodfish weights were similar in ponds stocked with bass densities of 124-494/ha (Table 2). Total tilapia biomass ranged from 655 to 907 kg/ha in low density bass ponds and from 442 to 840 kg/ha in high density bass ponds (Table 2). Numbers and biomass of unexploited tilapia were comparatively larger in low density bass ponds than in high density ponds (Table 2). In addition to many big juveniles, ponds stocked with bass densities at or below 494/ha had several kg of tilapia fry (819/kg). Each kilogram represented approximately 20,000 fry/ha.

Dissolved oxygen concentrations and temperatures ranged from 2.8 to 15.0 mg/1 and 8° to 31° C (Table 3). Secchi disc measurements were from 24 to 117 cm. Throughout the growing season, mean seechi disc values were significantly higher (R^2 = 0.65) in high density bass ponds (Table 3). The high density ponds had substantial filamentous algae blooms.

Table 2. Data for tilapia in bass-tilapia polyculture ponds.

Tilapia broodfish density at stocking (fish/ha)	Bass density at harvest (fish/ha)	Mean broodfish weight at stocking (g)	Mean broodfish weight at harvest (g)	Broodfish wt. range	Density of unexploited juveniles (fish/ha)	Unexploited juvenile biomass at harvest (kg/ha)	Total tilapia biomass at harvest (kg/ha)
590	49	150	377.4	257-549	>20,000	683	907
590	124	150	381.2	282-575	>20,000	661	887
590	296	150	475.7	182-650	>20,000	376	655
590	642	150	702.3	545-910	99	25	442
590	1013	340	1109.7	1020-1253	420	182	840

Table 3. General data for bass-tilapia polyculture ponds.

Bass density at harvest (fish/ha)	Mean D.O. (mg/l)	D. O. range (mg/1)	Temp. range (C)	Mean secchi disc value (cm)	Secchi disc range (cm)	Pond biomass at harvest (kg/ha)
49	5.5	3.5 - 8.9	8 – 29	35.7^{xa}	24 – 62	879
124	6.8	2.8 - 9.8	8 – 27	42.5^{x}	30 – 80	963
296	6.3	4.4 - 8.8	8 – 30	47.8^{x}	27 – 61	822
642	7.7	5.4 - 15.0	8 – 31	81.9^{y}	40 - >114	512
1013	6.1	3.6 - 9.6	8 – 31	83.0^{y}	35 - >117	972

[a]Means with same superscript were not significantly different using Duncan's multiple range test with p set at the $\alpha \leq 0.05$ level.

4. Discussion

In certain situations, tilapia have been shown to be an important source of forage for largemouth bass (Noble et al., 1975; Schramm and Zale, 1985). No tilapia or other food items were found in the stomachs of bass in this study. Presumably, this resulted from reduced intake in response to the 28-day period of cold weather preceding harvest. It appears that tilapia were consumed as is evidenced by the low densities of unexploited (juvenile) tilapia in high density bass ponds (Table 2). Ponds stocked with high densities of bass, which produced significantly smaller bass at harvest (Figure 1, Table 1), apparently did not have a sufficient forage base for optimum bass growth. Tilapia broodfish in ponds stocked with low bass densities were substantially smaller at harvest than broodfish in ponds with high bass densities. The tilapia-bass interactions observed in this study, with respect to number and size of tilapia at harvest, are similar to those (as discussed in the introduction) reported by Swingle (1960).

Since multiple spawns would be expected from tilapia broodfish and sexually mature offspring, ponds stocked with a fixed number of tilapia broodfish should supply a relatively stable forage base. The bass population that could be supported by a tilapia based forage system would depend on the rate of forage production (spawning) and the rate of forage consumption (predation). That is, a given number of bass should be capable of controlling the spawn of a given number of tilapia.

One might be tempted to define these interactions with Swingle's (1950) F/C (forage biomass/carnivore biomass) ratio. However, that relationship does not apply well in this example. It is the total spawn (tilapia juveniles) and therefore, the original density of female tilapia broodfish that is important. To avoid confusion, the tilapia-bass relationship in this study will be represented as the ratio of female forage broodfish (FB) to piscivore (P) densities (FB/P).

The optimum FB/P value is dependent upon production goals. If one's objective is to produce large tilapia and to reduce or eliminate unwanted spawn, bass should be stocked at high density. If bass size is to be maximized, bass should be stocked at low density. The results of this study suggest that a FB/P ratio of 1.4 is adequate for production of large bass. Values near 0.7 would produce large tilapia and minimize spawn.

Based on the results of this study, it seems feasible to maintain tilapia/bass ratios for one production cycle in a temperate climate. Tilapia could be marketed as a food fish crop. Bass harvested from such a system could be used for management of sport and recreational fisheries. The technique of culturing predatory fish with a prolific forage species has potential for other game fish, particularly species of high economic value and whose food requirements are not readily satisfied with commercial feeds.

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