Suppression of Largemouth Bass Production by Blue Tilapia in Ponds[1]

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Abstract: Suppression of largemouth bass (*Micropterus salmoides floridanus*) fingerling production in 0.01 ha ponds with high blue tilapia (*Tilapia aurea*) densities (760–1,900 kg/ha; 1,300–2,500 fish/ha) was studied to determine if the suppression is caused by direct competition for spawning sites. Bass spawned successfully in 8 of 9 ponds with tilapia but mean ($\bar{x} = 340$) production of bass fingerlings was 84% less than in ponds without tilapia ($\bar{x} = 2183$; N = 3). Difference in young-of-year bass production between ponds with and without tilapia was statistically significant; however, differences between young-of-year bass production in ponds with only male and only female tilapia were non-significant ($P \geq 0.05$). Since only male blue tilapia construct spawning depressions, reduced bass fingerling production was attributed primarily to interactions independent of direct competition for spawning sites or tilapia sex.

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Blue tilapia (*Tilapia aurea*) were brought to the United States in 1957 and introduced throughout the southeast for research purposes (Swingle 1960, Smith-Vaniz 1968). Since then, these fish have become established in several southern states and are now widespread in Florida. Blue tilapia support a limited commercial fishery in central Florida (Langford et al. 1978) and have become the dominant fish in some lakes, but not necessarily to the exclusion of other fishes (Ware 1973). Blue tilapia standing crop estimates in hypereutrophic lakes have exceeded 2,000 kg/ha in Florida and Texas (Chapman

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and Young 1973, Germany and Noble 1977); however, populations of this density are unusual.

The impact of blue tilapia on important gamefishes in Florida and elsewhere remains largely speculative. Buntz and Manooch (1969) collected sunfishes (*Lepomis* spp.) and blue tilapia from the same spawning areas, and Noble et al. (1976) demonstrated dense blue tilapia populations will suppress or even prohibit recruitment of largemouth bass. Tilapia spawning depressions are large and often concentrated together in shallow water making them readily apparent even to the casual observer. As a result, spawning site competition has often been suggested as a possible mechanism whereby blue tilapia could detrimentally affect reproduction of important native fishes (Buntz and Manooch 1969, Noble et al. 1976, Ware 1973).

The objective of this study was to evaluate the relative importance of spawning site competition by comparing young-of-year (YOY) bass production in ponds containing only male tilapia to production in ponds containing only female tilapia. If spawning site competition is critical, then bass production should be differentially suppressed by male and female tilapia, since only male tilapia construct spawning depressions.

Methods

Florida largemouth bass (*Micropterus salmoides floridanus*) and blue tilapia were kept in 0.01 ha hatchery ponds without macrophytes at the Non-Native Fish Research Laboratory from February to May in 1978 and 1979. Bass-to-tilapia numeric stocking rate was 5 : 16 in 1978 and 7 : 24 in 1979. Each year, pairs of ponds were stocked with all-male, all-female or equal numbers of male and female tilapia. Four of 140 male tilapia were mistakenly sexed as females. In addition, each year 2 ponds were stocked only with bass. Data were compiled from 12 ponds that yielded both sexes of bass at the conclusion of the study.

Ponds were observed daily for spawning activity, number and substrate type of nests, and presence of YOY fishes. Available spawning substrates were sand, gravel, or a mixture of sand and gravel. Because complete recovery of YOY largemouth bass was impractical, production of YOY fishes was sampled at the end of each trial by taking 2 standardized seine hauls around the entire pond perimeter using a 3.7 × 1.4 m (0.25 mm mesh) seine. The number of YOY bass caught was considered an accurate estimate of production, since each seine haul covered approximately 80% of the pond's surface area. Ponds were then drained and adult blue tilapia and largemouth bass were recovered, measured, and sexed. Extrapolated fish densities at the conclusion of each trial ranged from 760 to 1,900 kg/ha for tilapia and 138–546 kg/ha for bass (Table 1).

Fishes used in this study were collected from Polk, Broward, and Palm Beach counties using castnets and electrofishing gear. Replacement fish were

Table 1. Summary of harvest data from 12 0.01 ha study ponds used to evaluate suppression of largemouth bass production by high blue tilapia densities (M:F = number of male and female fish recovered; $\overline{W}$ = mean weight in kg; *N* = number; W = weight; HA = hectare; TL = mean total length; Range = minimum–maximum TL; all length measures in millimeters).

Blue tilapia		Largemouth bass		Total adult fish/ha		YOY bass recovered		
M:F	$\overline{W}$	M:F	$\overline{W}$	*N*	$\overline{W}$	*N*	$\overline{TL}$	Range
21:0	0.81	5:2	0.78	2,800	2,247	752	31.0	23–45
25:0	0.76	3:2	0.45	3,000	2,125	720	21.5	17–32
16:0	0.70	2:1	0.59	1,900	1,299	103	17.8	14–43
9:7	0.60	1:2	0.46	1,900	1,098	0		
8:5	0.53	1:2	0.59	1,600	859	241	22.6	8–30
8:8	0.55	3:3	0.83	2,200	1,372	408	25.1	13–49
1:16	0.57	1:3	0.66	2,100	1,233	499	32.5	27–48
0:16	0.53	2:1	0.65	1,900	1,038	134	23.3	20–32
0:17	0.45	2:1	1.25	2,000	1,134	207	25.0	17–52
		2:3	0.61	500	305	2,371	22.1	19–37
		2:1	0.58	300	173	3,571	15.4	7–22
		1:2	0.80	300	179	608	26.1	19–55

added for those found dead within 2 weeks of being stocked. Well-water stored in a 0.5 ha reservoir was used to fill and maintain pond water levels.

Results

Largemouth bass spawned successfully in 11 of 12 ponds overall and in 8 of 9 ponds containing blue tilapia but mean production of YOY bass was 84% less in ponds with tilapia than in ponds without tilapia. Mean ($N = 3$) number of YOY bass recovered from ponds without tilapia and ponds with all-male, all-female, or equal numbers of male and female tilapia were 2,183, 525, 280, and 216, respectively. Difference in YOY bass production between ponds with and without tilapia was statistically significant ($P < 0.05$); however, differences between YOY bass produced in the 3 tilapia treatments were non-significant (one-way ANOVA, Duncan's new multiple range test, $P \geqq 0.05$).

Blue tilapia YOY ($\bar{x} = 571$, range = 8 to 1,181) were recovered from the 3 ponds stocked with both tilapia sexes and 1 female tilapia treatment pond wherein 1 adult male tilapia was recovered. Mean number of YOY bass recovered from ponds with YOY tilapia ($N = 4$) and without YOY tilapia ($N = 5$) were 287 and 383, respectively; however, this difference was statistically non-significant (Student's *t*-test, $P \geqq 0.05$).

Of the 40 largemouth bass nests observed, 20 were in ponds stocked with only female blue tilapia. Total number of bass nests observed in male only and male/female tilapia treatments were 8 and 6, respectively, with 6 also being observed in ponds without tilapia. Total number of tilapia spawning depressions observed in ponds with only male and ponds with both tilapia sexes were 53 and 55, respectively.

In ponds with and without blue tilapia, largemouth bass selected gravel substrates for 79% (27 of 34) and 83% (5 of 6) of their observed nests, respectively. Blue tilapia exhibited the opposite substrate preference by selecting sand or a mixture of sand and gravel for 74% (81 of 110) and 13% (14 of 110) of their spawning depressions, respectively, and only 13% (15 of 110) were constructed in areas with a gravel substrate.

Discussion

These results suggest multiple mechanisms of suppression exist, some of which appear to be sex related. Blue tilapia suppression of largemouth bass production in the absence of male tilapia obviously involves an interaction other than direct competition for spawning sites, since only male tilapia construct spawning depressions. Observation of 2.5 times as many bass nests in female versus male tilapia treatments (20 : 8) suggests male and female tilapia differentially affect nest construction by bass; however, this interaction appears to be of secondary importance since bass production in male and female tilapia treatments was similarly suppressed. Furthermore, the number of observed bass nests was not correlated to bass production.

Spawning largemouth bass and blue tilapia exhibit several different spatiotemporal preferences associated with substrate, water temperature and sociality within spawning territories (McBay 1961, Heidinger 1975). In Florida, substrates other than sand or muck occur sparingly (Bishop 1967), and differences in water temperatures suitable for spawning are insufficient to prevent overlapping of bass/tilapia spawning seasons. As a result, these different preferences likely inconsequentially affect spawning site competition in nature.

Noble et al. (1976) reported laregmouth bass failed to recruit in a pond with 2,200 kg/ha blue tilapia, and bass production was reduced in a pond with 1,100 kg/ha tilapia. The minimum blue tilapia density which suppressed bass production in the current study was about 760 kg/ha and 1,300 fish/ha. Sunfish densities $\geqq$350 kg/ha and 92,0000 fish/ha have prohibited bass recruitment in Florida ponds without aquatic macrophytes, and densities of 149–250 kg/ha were thought to suppress bass spawning (Chew 1973, Barwick and Holcomb 1976, Smith 1976, Smith and Crumpton 1977). If individual species effects are additive, blue tilapia may aggravate bass recruitment problems known to have existed for sometime in certain Florida lakes overcrowded with sunfishes (Horel 1964 as cited by Chew 1973).

Density dependent mechanisms causing reduced largemouth bass recruitment clearly exist. These mechanisms may involve: (1) behavioral interactions as simple as chance encounters during critical stages in the reproductive cycle (similar to the harassment hypothesis of Barwick and Holcomb 1976),

(2) predation by typically non-piscivorous fishes (e.g., bluegill, possibly tilapia) which may eat fish eggs or early larval stages when crowded (Swingle and Smith 1943, Bennett 1954), (3) competition for food between YOY fishes, and/or (4) chemical suppressive factors (Swingle 1956, Chew 1973). Density independent factors suppressing bass production also exist (Bennett 1954, Swingle 1956, Dean and Bailey 1977) and need to be considered when investigating non-recruiting bass populations.

In Florida, biologists have sequentially considered absence of suitable spawning sites (Horel 1964 as cited by Chew 1973), chemical repressive factors (Chew 1973), and harassment of spawning bass (Barwick and Holcomb 1976, Smith 1976, Smith and Crumpton 1977) as the most likely causes whereby largemouth bass recruitment is suppressed by dense sunfish populations. We feel blue tilapia suppressed largemouth bass production in a manner similar to the harassment hypothesis of Barwick and Holcomb (1976) and suggest harassing interactions may be as simple as passive encounters occurring during critical stages in the bass reproductive cycle. Future experimental studies should be designed to definitively elucidate the mechanism(s) of suppression.

Largemouth bass reproduced successfully in small ponds with dense blue tilapia populations; however, mean production of YOY bass was 84% less than in ponds without tilapia. Suppression of bass spawning success was attributed to behavioral interferences other than direct competition for nesting sites. Due to their ability to sustain dense natural populations, these results suggest blue tilapia may aggravate bass recruitment problems known to exist in some lakes. More research is needed to determine minimum tilapia densities effecting suppression of largemouth bass production, whether additive effects exist in multi-species communities, the mitigating effect of aquatic macrophytes, and the importance of these interactions in natural populations.

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