Food Habits of Striped Bass and Their Influence on Crappie in Weiss Lake, Alabama

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Abstract: A contingency of local anglers and guides from Weiss Lake, Alabama, has voiced concern that the natural reproduction of striped bass *(Morone saxatilis)* has negatively impacted the popular crappie (*Pomoxis* spp.) fishery. The objective of this study was to evaluate the impacts of naturally reproducing striped bass on the crappie population in Weiss Lake. Specifically, we examined striped bass food habits and compared crappie population characteristics before (1990–1992) and after (1993–1999) the establishment of the naturally reproducing bass population. Shad (*Dorosoma* spp.) accounted for 93% of the prey items consumed by striped bass whereas crappie accounted for 0.2%. Crappie growth, abundance, and size structure were variable among years, but were generally similar betwenn treatment periods. Conversely, crappie relative weight was less variable among years, and for stock- and preferred-length crappie, was higher during the post-natural reproduction period. Our results suggest that the crappie population in Weiss Lake has remianed essentially unchanged between 1990 and 1999, after accounting for the annual fluctuations associated with variable year-class strength, and has not been negatively impacted by the naturally reproducing striped bass population.

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The crappie fishery in Weiss Lake is perhaps the most renowned crappie fishery in Alabama. Local guides and resort owners promote Weiss Lake as "the crappie capital of the world." The crappie fishery also contributes substantially to the local economy with about $11.3 million (21% of the local economic input) derived from sportfishing on Weiss Lake (Bridges 1989). While crappie fishing remains quite popular at Weiss Lake, a contingency of local anglers and guides are concerned that the naturally reproducing striped bass population in Weiss Lake has negatively impacted the crappie fishery.

Striped bass have been introduced in over 100 reservoirs in the southern United States since the 1970s (Axon and Whitehurst 1985, Matthews 1985) resulting in the establishment of recreational fisheries for this species throughout the southeast. Most states conduct annual stockings to maintain these fisheries. However, there has been some incidence of the adults naturally reproducing in inland reservoirs in the Santee-Cooper river system in South Carolina (Scruggs 1955), the Roanoke River in Virginia (Mike Duval, Va. Dep. Of Game and Inland Fish. pers. commun.), Keystone Reservoir in Oklahoma (Combs 1980), Lake Powell in Utah/Arizona (Gustaveson et al. 1984), Lake Texoma in Oklahoma/Texas (Harper and Namminga 1986), and in Piney Run and Liberty Reservoir in Maryland (Enamait et al. 1991). This phenomenon has not previously been reported in Alabama reservoirs.

Numerous studies investigating striped bass diets have been published in the literature with the overwhelming conclusion that striped bass rely predominantly on clupeids (*Dorosoma* spp., *Alosa* spp.), and consume very few sportfish. Clupeids accounted for 89% of the number and 97% of the weight of prey consumed by striped bass in Smith Mountain Lake, Virginia (Moore et al. 1985). In Lake Hamilton, Arkansas, 116 adult striped bass consumed primarily clupeids (Filipek and Tommey 1984). Of 849 identifiable prey items, threadfish shad *(Dorosoma petenense)* and gizzard shad *(Dorosoma cepedianum)* accounted for 93% by number and 85% by weight, and no black bass (*Micropterus* spp.) or crappie were consumed. In the Santee-Cooper Reservoir system of South Carolina, nearly 1,100 striped bass stomachs that contained food were examined (Stevens 1958). Only 1 crappie was observed in a diet that consisted overwhelmingly of several species of clupeids.

The question of whether striped bass can negatively affect sportfish populations through competition for a limited resource has not been well studied and is inconclusive. Because most sportfish species rely to some degree on clupeids as forage where they are present, competition with striped bass is certainly a possibility. However, for competition to occur, the shared resource must be in limited supply (Miranda et al. 1998). This phenomenon is more likely to occur in less fertile systems where standing crops of shad are low (Nash et al. 1987). In Lake Wateree, a fertile South Carolina reservoir, no reduction in shad abundance was observed following the stocking and establishment of striped bass (Nash et al. 1987). Even when striped bass are sufficiently abundant to reduce clupeid populations, other sportfish species may be unaffected. In Keystone Reservoir, Oklahoma, a subsequent decline in clupeid abundance following the establishment of a striped bass population did not negatively affect sportfish populations (Combs 1980). These studies confirm the observations of Bailey (1974) that striped bass introductions in southeastern reservoirs generally had no adverse effects on resident sportfish populations.

The primary objective of this study was to evaluate the impacts of striped bass on the crappie population in Weiss Lake. Specifically, we compared relative abundance, growth, and condition of the crappie population in Weiss Lake before and after establishment of a naturally reproducing striped bass population. We also examined potential predatory effects on crappie in Weiss Lake by examining the food habits of the residential striped bass population.

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Methods

Weiss Lake is an 11,247-ha impoundment of the Coosa River in northeast Alabama. The reservoir is classified as eutrophic according to the criteria of Forsberg and Ryding (1980); long-term growing season (April–October) chlorophyll-a averaged 27μg/L (Maceina et al. 1996).

Striped bass were collected from fall 1995 to summer 1997 using experimental gill nets that consisted of 5 12.2-m panels with bar mesh sizes of 2.5, 3.8, 5.1, 6.4, and 7.6 cm. Sample sites were chosen that afforded the best chance to catch striped bass. Nets were run every 1.5–3.0 hours to minimize regurgitation and decomposition of stomach contents by digestion. Fish were measured for total length (TL, mm), weighed (g), and otoliths removed for aging according to the methods of Heidinger and Clodfelter (1987). Stomach contents were stored in 10% formalin. Food items were identified to the lowest practical taxon. When possible, total length or standard length was measured for each food item, and standard lengths converted to total lengths using the formulae presented in Carlander (1969).

From 1990 to 1999, crappie were collected with trapnets from 19 fixed stations during October and November. Fish were removed after 24 hours, nets were reset and fished for another night, and nets were removed after 48 hours. Hence, total trapnet effort was 76 net-nights each year. Crappie were measured in total length (TL, mm), weighed (g), and otoliths removed for aging according to the methods of Maceina and Betsill (1987). For the analysis, crappie were not distinguished between species except for the calculation of relative weights. Both black crappies *(P. nigromaculatus)* and white crappies *(P. annularis)* are sympatric in Weiss Lake, but natural hybridization between these 2 species resulted in about 20% of the crappies being first-generation or higher hybrids (Smith et al. 1994, Travnichek et al. 1996). Also, meristics do not reliably separate crappie species in Alabama (Smith et al. 1995).

The first large year-class of striped bass naturally reproduced in Weiss Lake occurred in 1993 (Smith and Catchings 1998). Hence, data were separated accordingly and pooled into pre-natural reproduction (1990–1992; hereafter referred to as period-1) and post-natural reproduction (1993–1999; hereafter referred to as period-2) periods. Mean total length-at-age of capture was used to describe crappie growth and 1-way analysis of variance (ANOVA) was used to identify age-specific differences in growth between the 2 periods. Additionally, covariate analysis was used to test for slope and intercept differences of the total length-to-$\log_{10}$age relations between periods. Catch-per-unit-effort (CPUE; *N*/net-night) was computed to index age-specific relative abundance of crappie. Since fixed stations were sampled repeatedly over time, a spilt-plot for repeated-measures ANOVA was used to investigate differences in relative abundance (Maceina et al. 1994). Differences in crappie condition between the 2 periods were examined using covariate analysis to test for slope and intercept differences of the respective weight-to-length relations. Only age-0 to age-3 crappies were used in these analyses since larger crappies were seldom caught in fall trapnets, resulting in small sample sizes for older fish.

Results

A total of 463 striped bass was collected from Weiss Lake. Age data revealed that at least 1 fish was collected from the 1988 and 1990–1997 year-classes. The strongest year-classes were from 1993 and 1995, with 270 and 135 striped bass collected from each year-class respectively. Total gill net effort was 299.5 hours with a CPUE of 1.4 per hour.

Of the 463 fish, we were able to examine 450 stomachs, of which 115 were empty (Table 1). The remaining 355 stomachs contained a total of 2,699 prey items; 2,522 were shad (93.4%), 160 were unidentifiable fish remains (5.9%), 6 were crappie (0.2%), 5 were sunfish (*Lepomis* spp.; 0.2%), 3 were cyprinids (0.1%), 2 were freshwater drum (*Aplodinotus grunniens;* 0.07%) and one was a crawfish (0.04%). Of the striped bass that consumed shad ($N = 293$), the number of shad consumed per fish was quite variable, ranging from 1 to 68 with a mean of 8.7 and a standard deviation of 10.7. Striped bass total length was related to the total length of shad they consumed ($P < 0.01$). Larger striped bass tended to consume not only larger shad, but a larger range of shad sizes (Fig. 1).

Crappie catch rates were highly variable among years for all ages of fish (Fig. 2). Catch rates were most variable for age-0 fish, where the mean annual catch rate ranged from 0.47 to 9.81 fish/net-night. The split-plot ANOVA indicated that catch rates were similar between periods for age-0 and age-1 crappie ($P > 0.10$). However, catch rates were higher for age-2 crappie from period-1 ($P < 0.05$) and higher for age-3 fish from period-2 ($P < 0.01$).

Table 1. Number of stomachs retrieved from striped bass and their contents from Weiss Lake, Alabama.

	N	%
Stomachs		
With food	335	74.4
Empty	115	25.6
Total	450	100.0
Food items		
Dorosoma spp.	2,522	93.44
Unidentifiable remains	160	5.93
Pomoxis spp.	6	0.22
Lepomis spp.	5	0.18
Cyprinidae	3	0.11
Aplodinotus grunnuiens	2	0.07
Crawfish	1	0.04
Total	2,699	100.00

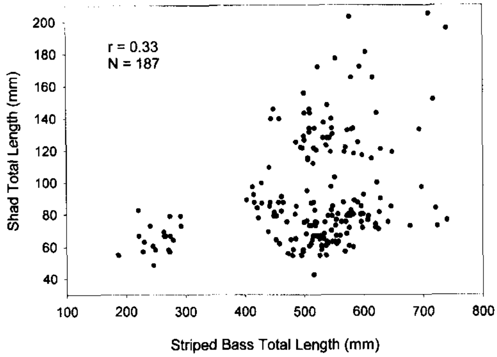

Figure 1. Correlation (r) between striped bass total length (mm) and total lenght (mm) of the shad they consumed in Weiss Lake, Alabama 1995–1997.

Crappie growth as measured by mean total length-at-age was variable among years for age-0 to age-3 fish, and displayed no obvious trends (Fig. 3). However, growth of age-0 crappie was greater for period-1 (87 mm) than for period-2 (82 mm, $P < 0.01$). Also, growth of age-3 crappie was higher for period-1 than for period-2 ($P < 0.01$), even though crappie exceeded the 254-mm minimum length in all years. Alternatively, growth of age-2 fish was higher from period-2, where age-2 crappie exceeded the 254-mm minimum length in 1995 and 1996 ($P < 0.01$). Growth of age-1 crappie was similar

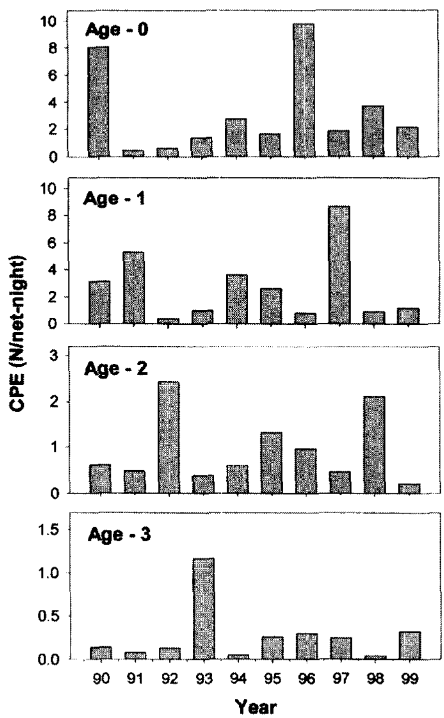

Figure 2. Catch-per-unit-effort (CPUE, Number/net-night) of age-0 to age-3 crappie captured in fall trapnets from Weiss Lake between 1990 and 1999. Natural reproduction of striped bass was first documented in 1993.

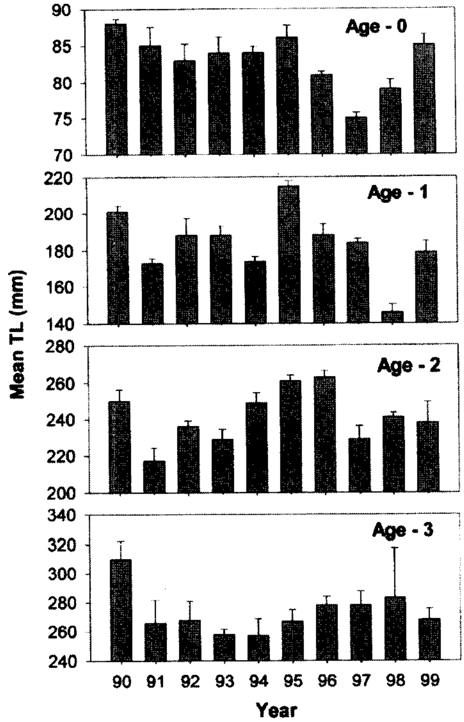

Figure 3. Mean total length (mm) at capture and associated standard errors of age-0 to age-3 crappies collected in the fall from Weiss Lake between 1990 and 1999. Natural reproduction of striped bass was first documented in 1993.

between periods ($P > 0.10$). Also, covariate analysis indicated that the slopes of the length-to-$\log_{10}$age relations were not different between periods ($P < 0.05$).

Crappie condition was greater during period-2 than period-1. The weight-to-length relation of $\log_{10}$weight $= 3.49 * \log_{10}$length $- 6.01$ for period-2 had a significantly greater slope ($P < 0.01$) and elevation ($P = 0.02$) than that of period-1 ($\log_{10}$-weight $= 3.42 * \log_{10}$length $- 5.86$).

Discussion

The establishment of a naturally reproducing striped bass population did not appear to have any impact on the crappie population in Weiss Lake. The reduction in the relative abundance of crappie perceived by local anglers was not detectible from our analysis. Few crappie were consumed by striped bass in Weiss Lake and striped bass fed predominantly on shad, with larger striped bass generally consuming larger shad.

Although age-2 crappie catch rates were higher from the pre-natural reproduction period, age-3 catch rates were higher from the post-natural reproduction period. This difference was easily explained by the variable recruitment pattern of crappie observed in Weiss Lake. Relatively strong year-classes were produced in 1990, 1993, and 1996 (Fig. 2), and these strong year-classes, particularly those produced in 1990 and 1996, exerted a tremendous influence on the mean catch rates of crappie during the periods in which they predominated the trapnet catch. In addition, Maceina et al. (1998) reported angler catch and harvest of crappie increased 4-and 2-fold by 1993 compared to 1988–1991. This increase coincided with the production of strong year-classes starting in 1990 and possibly the effects of the 254-mm minimum length limit imposed in 1990.

Competition between striped bass and crappie for a limited food source should have manifested itself in a reduction in crappie condition, growth, or perhaps both. Although we were unable to adequately test for interspecific competition between these 2 species due to the lack of data on shad abundance or crappie diets, we were able to show that neither growth nor condition of crappie were negatively impacted by the increased abundance of striped bass. In fact, crappie were slightly heavier for a given length during period-2 than during period-1. Growth of age-1 and age-2 crappie, while variable, displayed no decline between pre- and post-naturally reproducing striped bass. Although growth of age-3 crappie was lower for the post-naturally reproducing striped bass period, the comparison was highly influenced by the extremely fast growth evident from 1990. Since 1992, however, a trend of increasing growth appeared evident for age-3 crappie.

The slight reduction in growth evident for the 1997 year-class of crappie at age-0 and age-1, while engimatic, was not likely caused by competition with striped bass. Although we were unable to definitively test for competitive interactions, the literature suggests that diet overlap of age-0 crappie and striped bass is minimal. Age-0 crappie are particulate-feeding zooplanktivores (Overmann et al. 1980, O'Brien et al. 1984), whereas age-0 striped bass primarily consume large invertebrates and fish larvae (Boynton et al. 1981, Van Den Avyle et al. 1983). Because a requirement for competition between 2 species is that they share the same resource and that the shared resource is in short supply (Miranda et al. 1998), it is not likely that the observed reduction in first year growth for the 1997 year-class of crappie was due to competition for zooplankton with striped bass. Moreover, the conspicuously slow growth of the 1997 year-class was not evident once this cohort reached age-2.

In summary, the naturally reproducing striped bass population in Weiss Lake has not exhibited a negative influence on the resident crappie population. Although strong striped bass year-classes were produced in 1993 ad 1995 (Smith and Catchings 1998), the crappie population appeared essentially unchanged between 1990 and 1999, after accounting for the annual fluctuations associated with variable crappie year-class strength. Also, angler catch rates of crappie increased after 1992 (Maceina et al. 1998). Predation by striped bass on crappie was quite minimal, with crappie comprising only 0.2% of the striped bass diet in Weiss Lake. These results will add to the growing body of literature providing evidence that striped bass do not adversely affect sportfish populations, especially in large water bodies where clupeids are abundant.

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