RELATIONSHIPS OF WHITE CRAPPIE POPULATIONS TO LARGEMOUTH BASS AND BLUEGILL

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Abstract: During summer, 1976, fish population data were collected by gillnetting, electrofishing, and seining from 30 flood prevention lakes that maintained coexisting populations of white crappie (*Pomoxis annularis*), largemouth bass (*Micropterus salmoides*), and bluegill (*Lepomis macrochirus*). Abundance and size composition characteristics for white crappie were compared by simple correlation techniques to abundance and size composition characteristics for largemouth bass and bluegill. Total numbers of white crappie were not significantly correlated to total numbers of largemouth bass or bluegill. Numerous relationships existed between white crappie and largemouth bass/bluegill size structure variables. Flood prevention lakes that maintained balanced largemouth bass/bluegill populations, also maintained populations of white crappie having diverse size distributions. Largemouth bass/bluegill lakes dominated by intermediate-size bluegill (100 - 159 mm TL) supported large numbers and high proportions of stunted white crappie (100 - 199 mm TL) and low proportions of large white crappie (≥200 mm TL). White crappie populations with diverse size distributions might best be achieved in flood prevention lakes by proper management of largemouth bass/bluegill populations.

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White crappie normally are not included in stocking recommendations for small impoundments of the Southeast (Lewis 1980), and frequently are recommended against (Anonymous 1980, Gabelhouse undated). Nevertheless, white crappie are a highly desired fish by some fishermen (Noble et al. 1978).

The undesirability of white crappie stems from their tendency to stunt (Clark 1952, Rutledge and Barron 1972) and to compete with conventional pond sport fishes, largemouth bass (Bennett 1944, McConnell and Gerdes 1964) and bluegill (Swingle 1952). Crappie (*Pomoxis* spp.) compete with bass not only for food, but also for spawning sites, and in several cases have dominated lakes, reducing the population size and growth of bass, *Micropterus* spp. (Elser 1959). Crappie not only limit the survival of young bass by competing with them for food (Bennett 1944), but they also prey upon small bass (Swingle and Swingle 1967, Gabelhouse undated). Bennett (1944) suggested that bass are able to compete effectively only in lakes where fishing pressure for crappie is heavy. Stocking white crappie along with largemouth bass and bluegill is reported to lower the standing crop of largemouth bass (Swingle and Smith 1942). Contrary to this report, in a survey of 42

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Oklahoma ponds smaller than 4 ha, the presence of crappie had no measurable effect on largemouth bass standing crops (Jenkins 1958).

One physical factor which has been implicated in crappie management has been water level fluctuation. Apparently crappie cannot be successfully managed in ponds with uniform water levels all the year. Crappie usually overpopulate and reduce bass numbers, thereby upsetting the balance (Swingle 1950) between largemouth bass and bluegill. In southern reservoirs, Aggus and Lewis (1976) found that standing crops of crappie, bass, and sunfish (*Lepomis* spp.) were all negatively correlated to annual vertical water level fluctuation and also to storage ratio (average annual lake volume divided by total annual discharge).

Farquhar (1977) found white crappie to be a common inhabitant of flood prevention lakes in north-central Texas. Although more than 25% of the lakes containing white crappie had stunted populations (a high proportion of crappie with total length <200 mm), over 40% had populations of diverse size distribution (>200 mm total length difference between smallest and largest crappie). The majority of the lakes (55%) had abundant large crappie (total length >250 mm). These lakes are primarily built for flood control, impounding excess runoff in the upper watersheds and then releasing it slowly over a period of days. Constructed by the Soil Conservation Service, they are intermediate in size between small farm ponds and larger multi-purpose reservoirs. Since flood prevention lakes differ both in size and operation from ponds and large reservoirs, management opportunities are quite different (Noble et al. 1979). Dillon and Marriage (1973) indicated that periodic overflow of flood prevention lakes results in better fishing than present in ponds having static water levels. Because of their unique attributes, flood prevention lakes appear to offer a habitat in which white crappie can coexist with largemouth bass/bluegill populations in a balanced state.

Farquhar (1977) and Farquhar et al. (1980) examined relationships among fish population characteristics in flood prevention lakes. Analysis of the data failed to identify causes of the great variation in white crappie populations. The analysis indicated that water level fluctuations were beneficial to white crappie numbers, but condition of white crappie decreased with increasing numbers and stunting usually became evident in the 160- to 180-mm length range. Further analysis indicated that dominance of white crappie in gillnet catches was associated with reduced largemouth bass and other sunfish populations. The objective of this paper is to relate variations in selected white crappie population parameters to selected largemouth bass/bluegill population parameters.

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METHODS

The Chambers, Grays, and Richland Creek watersheds of the upper Trinity River drainage in north-central Texas, located approximately 50 km south of Dallas, is one of the most extensively developed areas in the state, having over 250 floodwater retarding structures (Hobaugh and Teer 1981). During 1976, an extensive survey of fish populations was conducted at 56 flood prevention lakes (Farquhar 1977, Farquhar et al. 1980). Of these lakes, 42 supported white crappie populations. Largemouth bass or bluegill were absent in 5 of these 42 lakes. Seven of these 37 lakes which maintained populations of all 3 species were excluded from the analyses for this paper because of incomplete sampling.

The 30 lakes included in this study ranged in surface area at principal spillway level from 3.2 to 26.7 ha, with the majority of the lakes having an area less than 12 ha. Shoreline development ranged from 1.08 to 3.16, with values being normally distrubuted over this range. Mean depths were evenly distributed throughout the range of 0.88 to 2.77 m. The watershed area to surface area ratios (watershed ratios) range from 18.4 to 152.1, with the majority being less than 70.0. Age of lakes varied from 4 to 23 years.

Four of the lakes had been partially drawn down for maintenance of the dam since their construction. In 12 lakes, water levels had risen above the crest of the emergency spillway at least once since construction of the structure.

Although some lakes were not stratified, temperature oxygen profiles showed that most lakes were stratified at 1.5 to 2.5 m. Large surface areas, shallow water, and surface winds apparently kept several of the lakes from stratifying. Values of pH ranged from 7.4 to 9.8. Alkalinity ranged from 20 to 214 mg/liter and hardness ranged from 28 to 204 mg/liter. Secchi disc transparencies ranged from 10 to 270 cm; only 1 lake had a reading exceeding 90 cm. A complete list of physical and chemical data is presented in Farquhar (1977).

Fish populations were sampled once in each lake during the summer of 1976. Sampling was performed from 25 May to 10 August, the period when the most stable weather conditions and water levels were anticipated.

Sampling was conducted in each lake over a 2-day period using 3 techniques. Two 45.5-m experimental multifilament gillnets (6 panels ranging from 25- to 90-mm bar mesh) were set for 24 hours in each lake. Two daytime electrofishing transects were run on each lake using a 250-volt, nonpulsed D.C. apparatus. Three quadrant seine hauls were made at each lake with a 6.6-m long, 6-mm bar-mesh seine. Total lengths (TL) of all fish were measured to the nearest millimeter. Methods are described in detail in Farquhar et al. 1980.

Length data were pooled for the 3 gears. The total numbers of white crappie, largemouth bass, and bluegill from each lake were then subdivided by total length into several size classes. The proportion of the total catch within each size class was then calculated for each of the 3 species. Eight size classes were used for white crappie ($<$100, 100 - 199, 200 - 249, 250 - 299, 300 - 349, $\geq$350, $\geq$200, and $\geq$250 mm TL), 3 for largemouth bass ($<$100, 100 - 249, and $\geq$250 mm TL), and 3 for bluegill ($<$100, 100 - 159, $\geq$160 mm TL). Size classes for each of these species were chosen from previous observations of their length-frequency distributions and for comparison with other studies.

The data were analyzed using simple linear correlation (Barr et al. 1976). Crappie variables (total numbers, numbers and proportions of all crappie per size class) were correlated with all largemouth bass and bluegill variables (total numbers, numbers and proportions of each of these species per size class).

RESULTS AND DISCUSSION

Numbers of white crappie, largemouth bass, and bluegill collected in the 30 lakes showed a high degree of variation. A total of 1043 white crappie was collected. The total number of white crappie collected per lake ranged from 1 to 151. Largemouth bass numbers showed less variation, with lake totals varying from 1 to 68, representing a total of 423 fish. Bluegill numbers were most variable ranging from 5 to 255 fish per lake. A total of 1630 bluegills was caught. As found by Farquhar et al. (1980) for all lakes, the total number of white crappie was not significantly correlated to the total numbers of largemouth bass ($r = -0.244$, $P < 0.193$) or bluegill ($r = -0.100$, $P < 0.599$) (Table 1). This agrees with Jenkins (1958), who concluded that the presence of crappie had no measurable/effect on largemouth bass standing crops in 42 Oklahoma ponds. Consistent negative relationships in our data, however, seem to indicate that the abundance of one species may have reduced the abundance of the other. Swingle and Smith (1942) also showed that white crappie caused a reduction in the standing crops of largemouth bass in ponds.

Examination of correlations between catches of white crappie and largemouth bass of particular size groups revealed several significant relationships (Table 1). Number of small largemouth bass (TL < 100 mm) was positively correlated with only 1 white crappie variable, the proportion of white crappie ≥350 mm TL. White crappie populations, having high proportions of large individuals, often had small population size. White crappie have been known to control largemouth bass reproduction (Swingle and Swingle 1967). Reduced predation in lakes having high proportions of large white crappie, but small population size, likely accounts for the presence of larger numbers of young-of-the-year largemouth bass. Reproduction of largemouth bass can be suppressed in over-crowded lakes (Chew 1972). Number of intemediate-size largemouth bass (100 - 249 mm TL) was positively related to the proportions of intermediate-size white crappie (200 - 249 mm TL) and harvestable-size white crappie (TL ≥ 200 mm, 118 grams, Swingle 1950). The proportion of intermediate-size largemouth bass was also positively correlated to the proportion of intermediate-size white crappie. Intermediate-size bass may have limited the size of the white crappie populations through predation, allowing crappie to attain a larger size. Age I largemouth bass are the principal predator of age 0 white crappie in white crappie/largemouth bass/bluegill ponds (Swingle and Swingle 1967). Number of big largemouth bass (TL ≥ 250 mm) was positively correlated to both the number and proportion of small white crappie (TL < 100 mm), number of white crappie 250 - 299 mm TL, and proportion of white crappie 300 - 349 mm TL. Number of big largemouth bass was negatively correlated to the proportion of small adult, possibly stunted, white crappie (100 - 199 mm TL). Lakes with conditions suitable for rapid growth of largemouth bass (large fish) also produced large white crappie and a few small adult, stunted, white crappie. Young -of-the-year white crappie were also more abundant in lakes with large bass. White crappie reproduction is greater in lakes which maintain lower densities of adult white crappie (Rutledge and Barron 1972). Number of young-of-the-year white crappie in this study was negatively correlated to abundance of small adult, possibly stunted, white crappie.

Numerous significant relationships were found to exist between the bluegill and white crappie population parameters (Table 1). Total number of white crappie was

Table 1. Some significant relationships between white crappie (WC), largemouth bass (LMB), and bluegill (BG) population parameters in 30 flood prevention lakes of the Corsicana, Texas, area based on sampling during summer 1976. Signs indicate direction and significance level (0.05,0.01) of simple correlation. Size groups are for total lengths (mm).

	Number of LMB				Proportion of LMB			Number of BG				Proportion of BG		
Variables	Total	<100	100-249	≥250	<100	100-249	≥250	Total	<100	100-159	≥160	<100	100-159	≥160
Number of WC														
Total Number												–	+	
<100				+[a]				+	++[b]			+		
100-199												–	++	
250-299				+										
≥350											+			
Proportion of WC														
<100				++					+			++	–	
100-199				–				–	–		–		++	–
200-249			+			+								+
250-299								++	++		++		–	
300-349				+										
≥350		+									++			+
≥200			+								++		–	++
≥250								+	+		++			++

[a] + or – $P \leq 0.05$.
[b] ++ or – $P \leq 0.01$.

negatively correlated to the proportion of small bluegill (TL $<$ 100 mm) and positively correlated to the proportion of intermediate-size bluegill (100 - 159 mm TL). Competition between these 2 species (Swingle 1952) and predation by the white crappie upon the small bluegill was likely responsible for the low proportion of small bluegill and high proportion of intermediate-size bluegill. Total number of bluegill was positively related to the number of small white crappie (TL $<$ 100 mm) and proportions of large white crappie (250 - 299 mm TL and TL $\geq$ 250 mm), and negatively correlated with the proportion of small adult, possibly stunted, white crappie (100 - 199 mm TL). The number of small bluegill (TL $<$ 100 mm) followed the same relationships as for total number of bluegill, but in addition was also positively related to the proportion of small white crappie. The proportion of small bluegill was positively correlated to the number and proportion of small white crappie, and negatively related to the number of small adult crappie.

Lake conditions that were suitable for successful spawning and survival of bluegill were likewise suitable for white crappie as indicated by the close relationship between the abundance of the young-of-the-year of these 2 species. Young of both species were negatively affected by an abundance of small, possibly stunted, adult white crappie which likely preyed upon the small fish and suppressed their spawning.

The proportion of intermediate-size bluegill was positively related to the number and proportion of small adult white crappie, and negatively related to the proportions of 3 white crappie size groups (TL $<$ 100 mm, 250 - 299 mm TL, and TL $\geq$ 250 mm). Low levels of predation by bass resulted in prey populations characterized by high proportions of intermediate-size bluegill and small adult crappie, with low proportions of large crappie. High densities of these species resulted in poor survival of young crappie.

The number of large bluegill (TL $\geq$ 160 mm) was negatively related to the proportion of small adult crappie, and positively related to the proportion of the large crappie (250 - 299 mm TL, TL $\geq$ 350 mm, TL $\geq$ 200 mm, and TL $\geq$ 250 mm) and number of large crappie (TL $\geq$ 350 mm). The proportion of large bluegill was positively correlated to the proportion of 4 size groups of white crappie (200 - 249 mm TL, TL $\geq$ 350 mm, TL $\geq$ 200 mm, and TL $\geq$ 250 mm), and negatively related to the proportion of small adult, possibly stunted, white crappie (100 - 199 mm TL). Conditions that were suitable for the production of large bluegill, the presence of a strong bass population, also resulted in the production of high proportions of large white crappie.

Certain limitations arise from the extensive nature of this study. These 3 species did not occur alone in these 30 lakes. Other species were present. These other species, along with varying physical-chemical characteristics of the lakes likely have an important part in determining the size structure of white crappie populations coexisting with largemouth bass/bluegill populations. For example, number of white crappie over 250 mm TL was positively related to lake area. Cichra and Noble (1980) indicated that extended summer drawdown in flood prevention lakes diversified size composition of white crappie populations and increased condition of adults, while having no apparent long-term effect on largemouth bass and bluegill populations.

Our data suggest that management of white crappie may be attained through management directed at largemouth bass and bluegill. Nevertheless, other factors obviously must be taken into consideration before a more refined management of fish populations can be attained in flood prevention lakes. Therefore, an intensive study is presently being conducted in Texas at 12 of these lakes to further define the interrelationships presented in this paper and to determine the influence of other biological and physical-chemical characteristics that affect white crappie populations.

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