Food Related Problems in Bluegill Populations of West Point Reservoir

Ahyaudin B. Ali,[1] *Department of Fisheries and Allied Aquacultures, Auburn University, AL 36849*

David R. Bayne, *Department of Fisheries and Allied Aquacultures, Auburn University, AL 36849*

Abstract: This study was conducted to determine population structure, relative condition, food availability, and food habits of bluegills (*Lepomis macrochirus*) from West Point Reservoir in 1980 and 1981. Fish were collected with rotenone and by seining 3 times, weekly, from May through September. Zooplankton and benthic samples were collected at each fish sampling site. Scarcity, small size, relative old age, and poor physical condition of the fish indicated that the population was stunted. Results of fish food inventory and gut content analysis revealed a shortage of preferred food for bluegills of all sizes. The food shortage was attributed to competition with the abundant threadfin (*Dorosoma petenense*) and gizzard (*D. cepedianum*) shads and to the effects of the annual 3-m water level fluctuation which reduced standing stocks of benthic invertebrates. Fishery management alternatives were discussed.

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Bluegills are an important source of food for largemouth bass (*Micropterus salmoides*). Timmons and Pawaputanon (1980) found that at West Point Reservoir in Alabama-Georgia, bluegills were the major food items consumed by largemouth bass 30 to 150 mm long. Bass switched to shad only after attaining total lengths of ≥150 mm. Previous work at West Point Reservoir showed that high standing stocks of young-of-the-year (Y-O-Y) largemouth bass could be obtained through water level management during the spawning season (Ali 1981). However, Davies et al. (1982) concluded that a large majority of those Y-O-Y largemouth bass were not recruited into the adult population because the shortage of small-sized Y-O-Y bluegill was critical in determining the number of young bass recruited the following year as age 1+ fish.

Limited bluegill spawning occurs in West Point Reservoir during June and September. Relatively few of the spawning fish are of harvestable size and growth rates are considerably less than what is experienced in well managed farm ponds (Davies

[1]Present address: School of biological Sciences, Universiti Sains Malaysia, Penang, Malaysia.

et al. 1979). This study was undertaken to determine the population structure, relative condition, food availability, and food habits of West Point Reservoir bluegills during the growing seasons of 1980 and 1981.

Methods

This study was conducted at West Point Reservoir (WPR), a 10,480-ha impoundment of the Chattahoochee River, on the Alabama-Georgia border. Water level is maintained at 194 m from mid-May through September and is lowered to 191 m from October to mid-May, exposing about 2,900 ha of littoral habitat. A more complete description of the lake is presented by Bayne et al. (1983).

Fish were collected from the littoral areas of WPR from 9 May to 28 August 1980 and from 9 May to 3 October 1981. Three sites were randomly selected and sampled each week (Timmons et al. 1978). Fish were collected by seining with a 4.6-m seine and with rotenone. The rotenone collection was done using methodology described by Timmons et al. (1978). Fish were collected as they surfaced. Small fish were placed in ice water to prevent regurgitation (Doxtater 1963). Larger fish were placed directly on ice. All fish were later preserved in a 10% formalin solution. The collection was completed within 30 minutes.

Fish were measured (total length in mm) and weighed (g). Stomach contents were removed, blotted dry and total volume was measured by displacement (Laevastu 1965) using a centrifuge tube calibrated to the nearest 0.01 ml. Contents were identified with current and standard taxonomic references. Volumes of larger food items were measured by displacement while volumes of smaller items were estimated using the cubic standard unit method described by Welch (1948). Since no statistical difference in stomach content volume was detected between fish collected with rotenone and those collected with a seine (Ali et al. 1985), fish collected by both methods were combined for stomach content analysis. The total number of bluegill stomachs examined was 993 in 1980 and 1,141 in 1981. The average of the volume percentages method (Wallace 1981) was used to determine the relative importance of different food items in the diet. The relative condition factor (Kn) of fish (Le Cren 1951) was calculated using means for Alabama fish reported by Swingle and Shell (1971). A Kn >1.0 indicates a fish of better than average condition and <1.0, below average condition.

The electivity index (E) of Ivlev (1961) was used to establish bluegill preference for different types of food items. The index is represented as $E = (rl - pl)/(rl + pl)$, where rl is the percentage composition of the particular food item in the stomach and pl is the percentage composition of the same item in the environment. Values of E range from -1 for complete avoidance to $+1$ for complete selection with 0 indicating random selection. Estimates of the availability of food items were made from duplicate zooplankton and benthic macroinvertebrate samples collected at the same time and location of fish samples. Zooplankton were obtained by passing 40 liters of water through a standard Wisconsin style (80-μm mesh) plankton net.

Macrobenthos were collected with a Ponar dredge. Details of these studies are reported by Ali (1984).

Results and Discussion

Small (<76 mm TL) and intermediate (76-149 mm TL) size bluegills were most numerous in samples taken in both years. Fish >149 mm TL made up <0.01% of the total. Cofer and Malvestuto (1983) in an independent study conducted at WPR in 1981 found that bluegills were relatively old for their size, suggesting slow growth. Bluegill numbers in littoral areas of WPR were <15% of those found in a nearby public fishing lake that was stocked and managed for largemouth bass-bluegill production (Park 1982). The relative condition (Kn) of WPR bluegills for the 2 years appears in Fig. 1. Mean Kn of both size groups was about normal (1.0) in 1980; however, in 1981 mean Kn's were 0.92 and 0.95 for small and intermediate bluegills, respectively. Conditions described here depict a typical population of stunted bluegills. Sustained growth in fishes is directly related to food availability (Martin 1970) as is fish abundance and general health (Poddubnyy and Bakanov 1980, Wallace 1982).

Young bluegills depend upon microcrustaceans as a primary food source (Keast 1978, Lemly and Dimmick 1982) prior to feeding on benthic macroinvertebrates and other insects. However, at WPR in both years, small bluegill fed primarily on chironomid larvae, with fish eggs and aquatic vegetation being consumed primarily in spring and early summer (Fig. 2). Microcrustaceans were consumed in small quantities in both years although ostracods did appear occasionally in high volumes.

Results of the zooplankton inventory revealed relatively large numbers of rotifers and small microcrustaceans (Ali 1984). Analysis of stomach contents, however, showed that small bluegills did not feed on rotifers. Previous works have

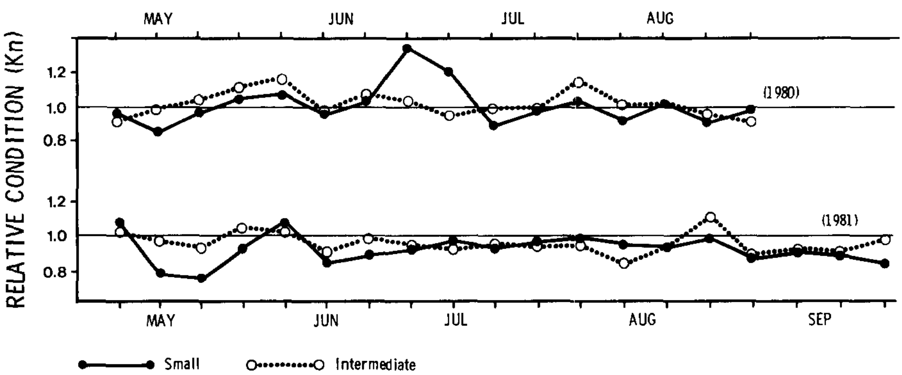

Figure 1. Relative condition factor (Kn) for small sized (<76 mm) and intermediate sized (76–149 mm) bluegills collected in West Point Reservoir in 1980 and 1981.

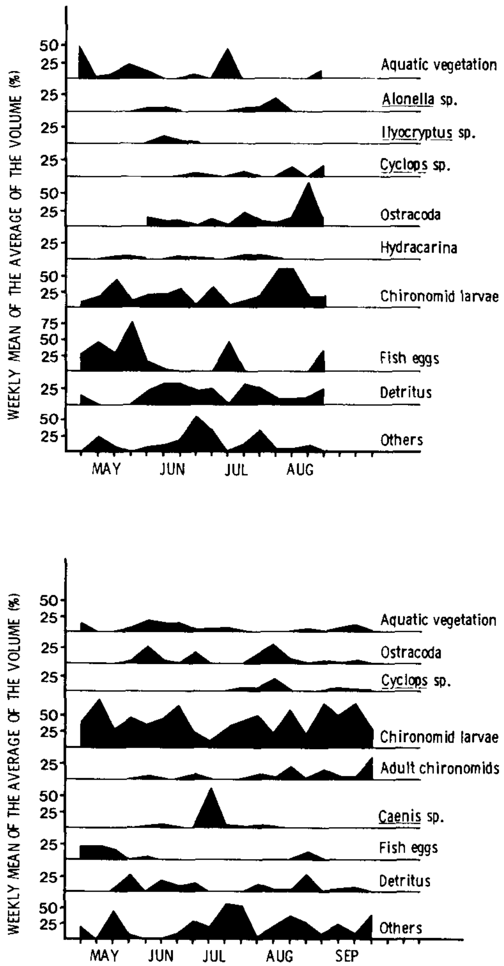

Figure 2. Volume of food items found in the gut of small sized (<76 mm) bluegills collected in West Point Reservoir in 1980 (top) and 1981 (bottom).

shown that bluegills select their prey on the basis of size, evasive capabilities of the prey, capture time and the energy content of the prey (O'Brien et al. 1976, Vinyard 1980, Werner and Mittlebach 1981). The small size of rotifers apparently makes them unacceptable prey for bluegills in terms of energy spent versus energy gained.

Scarcity of large zooplankton and the abundance of rotifers at WPR were probably due to predation by planktivorous fishes (Hrbacek et al. 1961, Straskraba 1963). Heavy predation by planktivorous fish has been shown to increase abundance of small-size zooplankters such as *Bosmina longirostris* (Nilson and Pejler 1973, Stenson 1972) and rotifers (Geiger 1983). At WPR the high standing stock of the planktivorous gizzard shad, an estimated 260 and 900 kg/ha in 1980 and 1981

(Lawrence et al. 1982), respectively, contributed to a shift in the zooplankton, from larger forms, to rotifers and small-size cladocerans such as *B. longirostris* and *Chydorous sphaericus*.

Larger bluegills (>76 mm TL) being littoral inhabitants (Hall and Werner 1977) depend heavily upon benthic and periphytic insects as food (Gerking 1962, Keast 1978). Chironomid larvae and pupae are the most frequently utilized benthic invertebrates (Ball 1948, Gerking 1962, Etnier 1971, Keast 1978) and intense predation can reduce their abundance (Bohannon and Johnson 1983). Intermediate bluegill fed primarily on chironomid larvae and aquatic vegetation throughout the season in both years at WPR. Large numbers of fish eggs were also consumed in spring and early summer (Fig. 3). Ingested vegetation consisted mostly of algae, primarily *Spirogyra* and *Oedogonium*. Kitchell and Windell (1970) reported that bluegill ingest filamentous algae as a supplemental food source during periods of low invertebrate prey abundance. In our study, vegetation was consumed in spring and summer whereas in other studies most consumption occurred in summer and autumn (Ball 1948, Seaburg and Moyle 1964, Keast 1978). This may indicate that

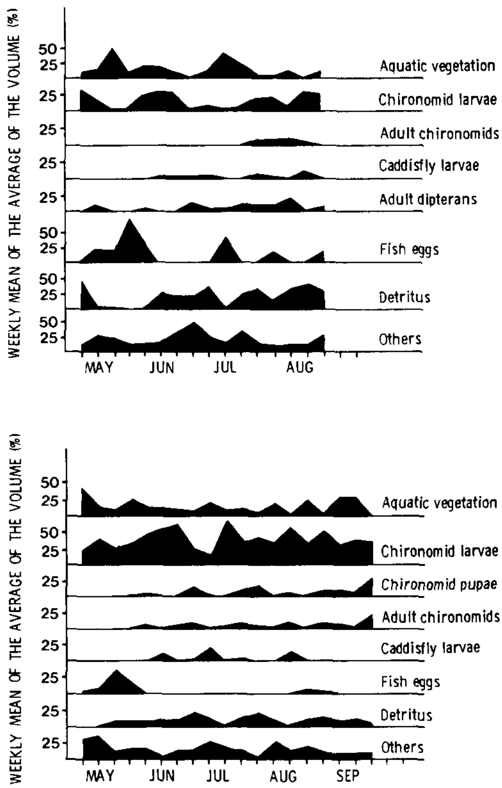

Figure 3. Volume of food items found in the gut of intermediate sized (76–149 mm) bluegills collected in West Point Reservoir in 1980 (top) and 1981 (bottom).

at WPR a food shortage existed thorughout the growing season. Further evidence for the lack of preferred food items is the egg consumption by bluegill. Swingle and Smith (1943) reported that bluegills eat their own eggs and those of other fishes during periods of food shortage.

The paucity of benthic and periphytic fauna available to WPR bluegills is attributable to water level management (Hale and Bayne 1980). They reported that 4 months were required for benthic macroinvertebrates to fully repopulate littoral sediments exposed during the annual winter drawdown in WPR. Similar findings were reported by Kaster and Jacobi (1978) in a Wisconsin reservoir. In addition, erosion of exposed littoral areas changed the physical composition of the soil to the detriment of benthic organism production (Grimas 1962, Hale and Bayne 1980). The lack of hydrophytes in the regulated littoral zone deprives micro and macroinvertebrates of valuable attachment and feeding substrates (Pennak 1966). Keith (1975) advised that drawdown should not be done annually, but every 3 to 4 years to allow littoral hydrophytes to grow and lessen the impact of erosion.

Ivlev's electivity index showed that in both years, small and intermediate bluegills avoided chironomid larvae (Fig. 4) whereas chironomid pupae were selected by interemediate bluegill in both years. This apparent avoidance of the larvae, however, was probably due to low accessibility since the majority of them live in the bottom substrate and thus escape bluegill predation. Strong selection for chironomid pupae was probably due to increased vulnerability as they migrate to the surface during emergence. During both years of the study, small and intermediate bluegills selected fish eggs during the spawning period in spring and early summer when eggs were present in high density (Fig. 4). Most eggs eaten were sunfish eggs. In both years, intermediate bluegills positively selected caddisfly larvae throughout the season (Fig. 4). At different times, ostracods were both strongly selected and strongly avoided by bluegills during both years.

Management Implications

The relatively low condition and poor population structure of bluegill in WPR can be explained by the scarcity of appropriate-sized food items. Park (1982) reported increased bluegill reproduction and growth to larger size classes following the elimination of shad with rotenone from a public fishing lake. Growth and recruitment of largemouth bass also improved. An alternative in large impoundments where the selective use of rotenone is not cost effective would be to severely restrict the harvest of largemouth bass. This would allow bass predation to beneficially affect prey population dynamics by reducing the abundance and competitive edge of the larger, slow-growing prey. Management inputs would be based on regulating predator harvest by lengths as indicated by the condition and relative abundance of the functional size groups in populations of predator and prey (Anderson 1980).

Mitigation of the effects of the late fall and winter drawdown on bluegill food organisms production is a difficult management problem to address. Maintenance of lake water levels as close to full pool as possible throughout the growing season (end

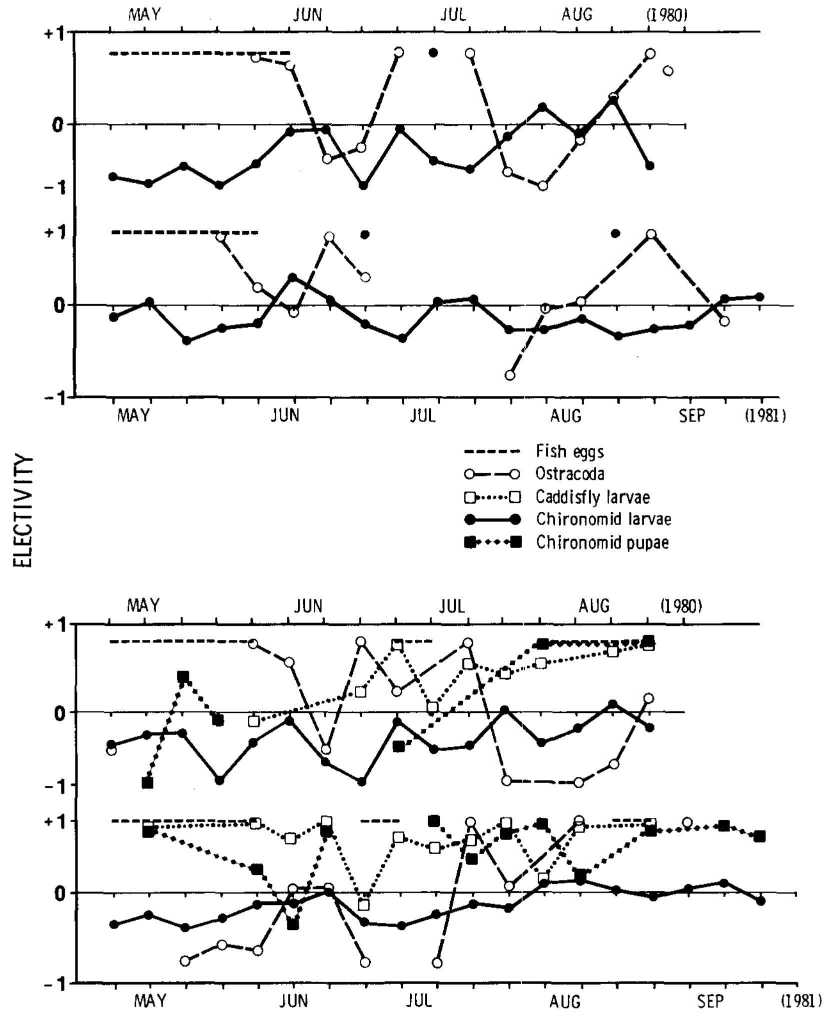

Figure 4. Ivlev's electivity index of common food items found in the gut of small sized (<76 mm) and intermediate sized (76–149 mm) bluegills collected in West Point Reservoir during 1980 and 1981.

of October at WPR) would increase utilization of the fish food organisms recolonizing the regulated littoral areas. The progressive deterioration in soil composition of the exposed littoral zone (Hale and Bayne 1980) might be slowed by planting annual winter grasses on these areas. The remains of these plants when flooded the following spring would provide valuable food and attachment substrate for micro- and macroinvertebrates thereby increasing bluegill food supply early in the spawning season when it is most needed.

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