Changes in Shad and Largemouth Bass Dynamics and Sport Fishery Following a Disease-caused Fish Kill

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Abstract: During spring and summer 1986, a massive disease-caused fish kill occurred on Lake Walter F. George, Georgia, which resulted in significant and long-lasting changes in the fish populations of this reservoir. Prior to the fish kill, populations of both threadfin (*Dorosoma petenense*) and gizzard shad (*D. cepedianum*) were dominated by intermediate- and harvestable-size fish. Anglers reported largemouth bass (*Micropterus salmoides*) fishing was poor, and age analysis indicated poor recruitment for several years. Following the fish kill, shad populations were dominated by large numbers of fingerlings, and standing crops of intermediate- and harvestable-size shad were much reduced. Large numbers of largemouth bass were recruited to the fishery the year following the fish kill, and recruitment remained good for 8 of the 9 years following the kill. Electrofishing catch of largemouth bass >20 cm total length increased from an average of 26.7 fish/hour for 5 years prior to the fish kill to an average of 63.7 fish/hour from 1987 through 1995. Total harvest of largemouth bass, as estimated by creel surveys, increased 2–4 fold following the kill. Directed catch rates for all sizes of largemouth bass increased from 0.24 fish/hour in 1984 to 0.51 fish/hour in 1987 and remained above 0.40 fish/hour through 1991. By 1989, the 1986, 1987, and 1988 year classes represented 79.9% of the largemouth bass population by number.

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Lake Walter F. George is a 18,290-ha mainstream impoundment constructed in 1962 on the Chattahoochee River between Fort Gaines and Columbus, Georgia. The reservoir is operated by the U.S. Army Corps of Engineers for the purposes of navigation and hydropower generation (U.S. Army Corps of Engineers 1974). Following impoundment, Lake Walter F. George was widely acclaimed for outstanding largemouth bass fishing. Anecdotal information gathered from longtime anglers indicated the quality of the fishery has been variable throughout the life of the reservoir, with the bass fishery apparently cycling between several years of excellent fishing followed by several years of mediocre fishing. Similar cycles in other impoundments have been reported by

Swingle and Swingle (1967), Eschmeyer and Scott (1982), and Nelson and Walburg (1977). Fluctuations in the Lake Walter F. George fishery had not been well documented prior to 1986, mostly due to the lack of sufficient creel data. Cove rotenone data, while abundant, did not seem to provide a realistic picture of the bass population, particularly for larger fish.

Lake Walter F. George does have a well-documented history of disease-caused fish kills dating back to the early 1960s (Ga. Wildl. Resour. Div., unpubl. data). Fish kills were reported during 16 of the 31 years between 1964 and 1994. Kills were probably more frequent than this since anglers had become so accustomed to the sight of dead fish they were unlikely to report a kill unless large numbers of fish were involved. These fish kills appear to have been caused by bacterial infections involving *Aeromonas* and *Pseudomonas* spp. (Drs. W. Rogers and J. A. Plumb, pers. commun.). Prior to 1986, most of these fish kills appear to have been limited in scope.

Beginning in summer 1984, anglers fishing in Lake Walter F. George began complaining that fishing success for largemouth bass had declined sharply. Earlier that spring, anglers had experienced good success, but by mid-summer fishing reports indicated low catch rates for bass. Poor fishing continued through 1985, and in the spring of 1986 there were at least 2 major bass tournaments where the entrants had difficulty catching any fish at all. As a result of the publicity surrounding the poor success at these tournaments, there was continued public concern about the state of the bass fishery in this reservoir. As a result of these concerns, a comprehensive study of the bass population and fishery was planned. Coincidentally, during March 1986, just before this study was to begin, a massive fish kill began on Lake Walter F. George.

The 1986 fish kill, which occurred from 31 March through 15 July, appeared to be of greater severity and persisted over a longer time period than previous fish kills. The kill seemed to affect a variety of species, but threadfin and gizzard shad were killed in far greater numbers than other species. During 1 day in July, the U.S. Army Corps of Engineers observed an estimated 2 million dead shad on the surface of the reservoir. A total of 8 separate fish kill investigations were conducted during the time period, but the kill was continuous in nature. Because of the long duration of the kill, accurate estimates of the total number of fish killed are not available, but probably exceeded 10 million. A severe drought, which resulted in record low water levels, combined with high water temperatures, may have contributed to the severity of the kill.

The purpose of this paper is to examine the changes in shad populations that occurred following the 1986 fish kill and the resultant changes in the largemouth bass population and fishery.

Methods

Fish Population Samples

Cove rotenone population samples were conducted annually on Lake Walter F. George from 1963 to 1967, 1975 to 1978, in 1984, and from 1986 to 1992.

Procedures used for collection of these data were similar to those used on previous surveys of reservoirs in southwest Georgia (Keefer 1980, 1988). All fish collected in rotenone samples were placed in fingerling, intermediate, or harvestable length categories (Surber 1959).

Beginning in 1982, standardized springtime electrofishing samples were collected from 5 fixed stations located on the Georgia side of Lake Walter F. George. Electrofishing samples were collected between 1 March and 1 June, with most being collected during March. Electrofishing stations were sampled for 30 minutes each and all largemouth bass encountered were collected. Catch per unit effort and length frequency were calculated and bass were placed in length groups according to Gablehouse (1984). Differences between electrofishing catches before and after the kill were tested for statistical significance using a 2-sample *t*-test.

Scale samples were collected from 10 largemouth bass of each 2-cm length group sampled during spring time electrofishing in 1986, 1988, and 1989. Age data were used to construct an age-length key for each year based on the proportion of fish of each age within 2-cm length classes. The age key was then used to develop an age-frequency for the entire population based on the length-frequency distribution of all bass captured in the electrofishing samples for that year.

Creel Surveys

Nonuniform probability, roving-type creel surveys designed by the Southeast Fish and Game Statistics Project at North Carolina State University were conducted on the reservoir during 1977, 1978, and 1984. A nonuniform probability, access-type creel survey was conducted during 1987 through 1991. Parameters examined included total fishing effort, directed effort, and directed harvest and catch by species. During the surveys conducted in 1984 and 1987–1991, the total catch of largemouth bass was estimated by asking anglers if they had released any bass during the course of their fishing day, and if so, how many were larger or smaller than 30.5 cm total length.

Results

Fish Populations

Cove rotenone data (Fig. 1) indicated the production of good year classes of gizzard shad (as reflected by the abundance of fingerlings) has been extremely variable, with 1966, 1986, and 1987 the best years for fingerling production. During most years, intermediate and harvestable gizzard shad dominated the population in Lake Walter F. George. Threadfin shad appear to have been more consistent producers of fingerlings with at least 5,000/ha collected during most years. The population consisted mainly of fingerlings during most years, except for 1976, 1984, and 1991, when intermediates dominated the threadfin shad population.

Numbers of largemouth bass observed in cove rotenone studies varied from

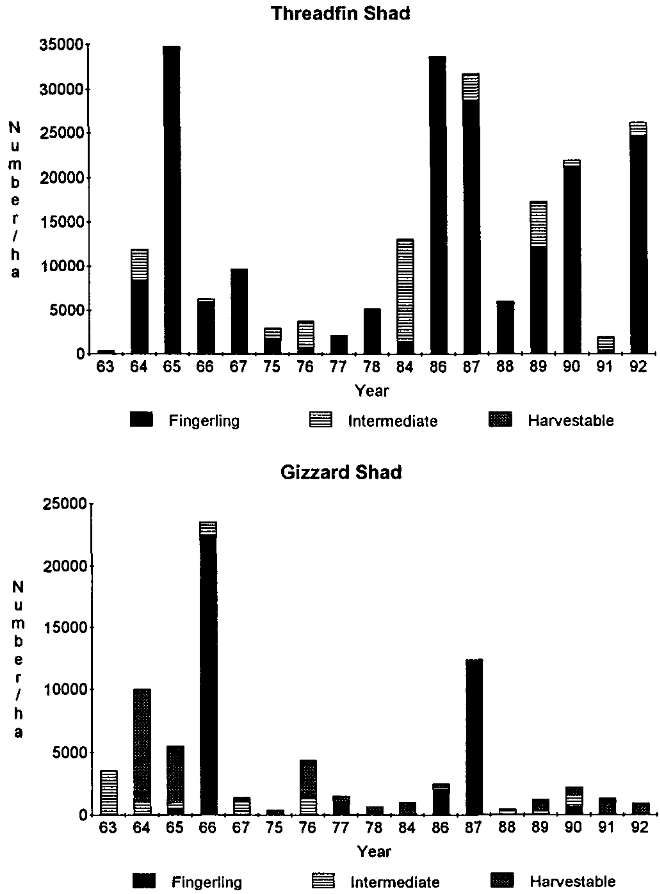

Figure 1. Abundance of threadfin and gizzard shad from summer cove rotenone surveys, Lake Walter F. George, Georgia. Data from 1963 through 1967 represent 1 cove. Data from 1975 through 1992 represent averages from 2 coves, except 1978 and 1984, which represent averages from 3 coves. Size classifications are according to Surber (1959).

90/ha in 1986 to 869/ha in 1967 (Fig. 2). Most of the variability appeared to occur in the fingerling portion of the population with the most dramatic change occurring between 1986 and 1987, when the number of fingerlings increased from 14 to 468/ha. A great deal of variability was observed in the numbers of intermediate and harvestable bass as well, with intermediates ranging from a low of 10/ha in 1966 to a high of 191/ha in 1990. Harvestables ranged from 7/ha in 1966 to 123/ha in 1990.

An examination of electrofishing catch rates between 1982 and 1995 (Fig. 3) indicates a tremendous change took place in the largemouth bass population

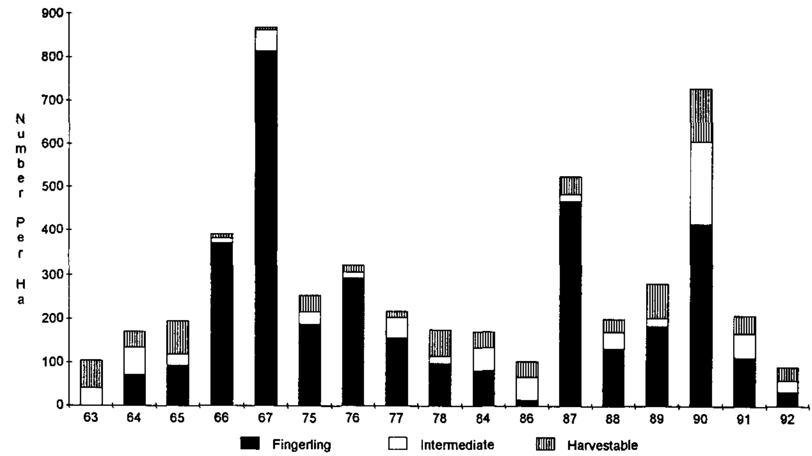

Figure 2. Abundance of largemouth bass from summer cove rotenone surveys, Lake Walter F. George, Georgia. Data from 1963 through 1967 represent 1 cove. Data from 1975 through 1992 represent averages from 2 coves, except 1978 and 1984, which represent averages from 3 coves. Size classifications are according to Surber (1959).

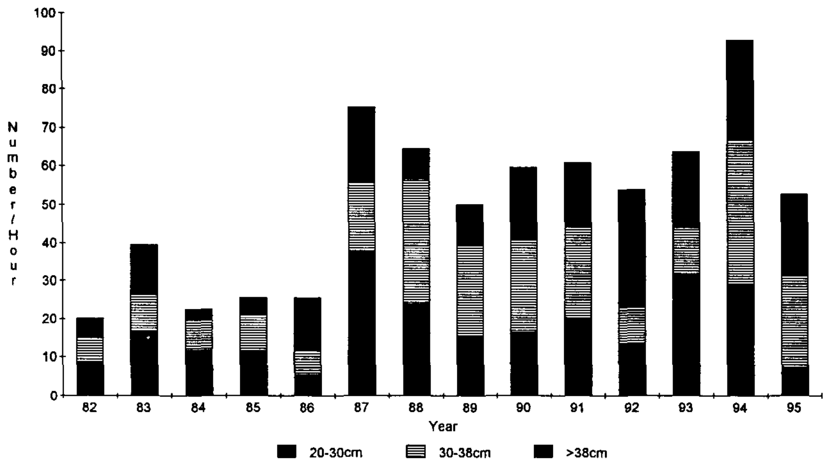

Figure 3. Mean catch rate of largemouth bass from spring electrofishing samples, Lake Walter F. George, Georgia. Data were collected at 5 fixed stations each year.

after 1986. Spring electrofishing catch rates from 1980 through 1986 averaged 33.8 fish/hour for all sizes of largemouth bass and 26.7 fish/hour for fish >20 cm. In contrast, catch rates from 1987 through 1995 averaged 79.2 fish/hour for all sizes and 63.7 fish/hour for fish >20 cm. These differences were significant at the 0.05 level. Catch rates for all years between 1987 and 1995 for fish >20 cm exceeded the highest observed catch rate for all years prior to 1987.

Analysis of age-frequency data indicated the largemouth bass population was dominated by age-3 and older fish in 1986 (Fig. 4). The 1984 and 1985 year classes represented only 16.0% and 2.5% of the population, respectively. By 1988, the situation had reversed with the abundant 1986 and 1987 year classes representing 36.4% and 34.6% of the sample, respectively, and age-3 and older fish representing only 29% of the sample. By 1989, the 1986, 1987, and 1988 year classes represented 79.9% of the sample collected. An examination of the size distribution of largemouth bass during the same periods (Fig. 3) revealed similar trends, indicating greater recruitment of bass to the population after 1986.

Creel Surveys

Creel survey statistics indicated there was a large increase in angler effort directed at largemouth bass since the late 1970s (Table 1). Total angler effort expended for largemouth bass was 63,044 hours in 1977 and 62,289 hours in

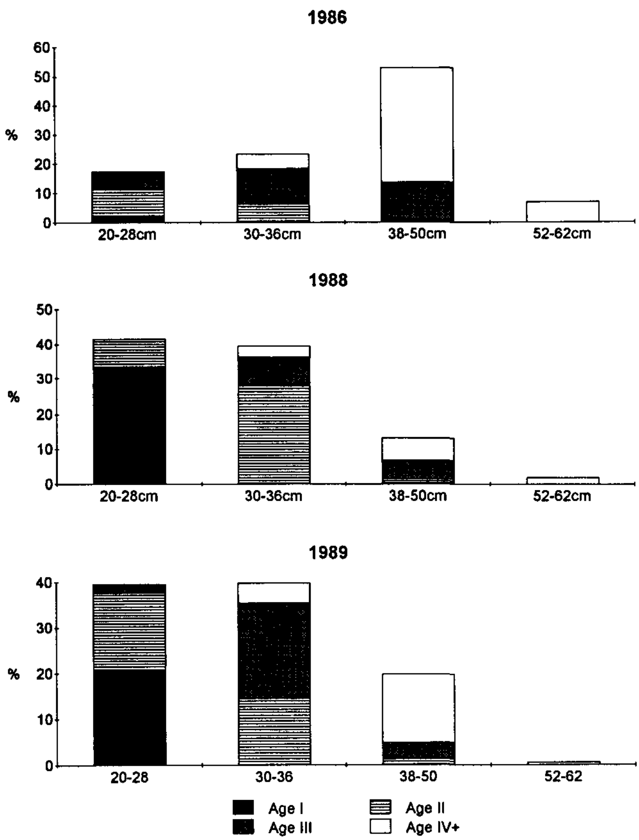

Figure 4. Age frequency of largemouth bass in Lake Walter F. George, Georgia, by total length groups.

Table 1. Annual summaries of creel surveys conducted on Lake Walter F. George, Georgia, for largemouth bass.

Parameter	1977	1978	1984	1987	1988	1989	1990	1991
Effort								
Directed effort (hours × 1,000)	63	62	194	266	258	259	221	271
% total effort	36	79	50	58	45	57	51	57
Directed catch[a]								
Bass/hour >30.5 cm			0.16	0.28	0.38	0.30	0.29	0.32
Bass/hour all sizes			0.24	0.51	0.49	0.42	0.42	0.40
Harvest								
Total *N*	8,488	9,778	11,060	45,021	39,643	30,665	25,101	29,818
Bass/hour	0.18	0.18	0.14	0.17	0.14	0.11	0.13	0.11
Catch and release[a]								
% release of legal-length bass			12.5	39.3	63.2	63.3	55.2	65.6

[a]Data needed to calculate catch parameters not collected prior to 1984.

1978. This increased to 194,159 hours in 1984 and increased further by 1987 to 265,543 hours. Directed pressure remained high through 1991, when it peaked at 271,009 hours. The proportion of total fishing effort directed at largemouth bass also increased over time, from 25.3% in 1977 to 45.8% in 1984 (Table 1). From 1987 to 1991, effort for largemouth bass ranged between 44% and 55% of total effort.

The total harvest of largemouth bass also increased from 8,488 fish in 1977 to a peak of 45,021 in 1987 (Table 1). A 4-fold increase in harvest was observed between 1984 and 1987, when harvest increased from 11,060 to 45,021 fish. By 1990, harvest declined to 25,101 fish, but this was still twice the level observed in 1984. Directed harvest and catch rates also changed over time, but in different ways (Table 1). The highest harvest rate was observed in 1977 and 1978, when anglers caught an average of 0.18 fish/hour. By 1984, this had declined to 0.14 fish/hour. In 1987, 1 year after the fish kill, harvest rate increased to 0.17 fish/hour. Harvest rates declined to 0.11 fish/hour in 1989 and 1991. Based on harvest rate alone, it appears the fishery declined after 1987, but the perspective changes dramatically when released fish are included. Using these data, the catch rate in 1984 was 0.16 fish/hour for fish >30.5 cm and increased to 0.28 fish/hour in 1987. Catch rates remained at this level or higher through 1991 (Table 1). Catch rates for all sizes of bass increased from 0.24 fish/hour in 1984 to 0.51 fish/hour in 1987, the year after the fish kill. The catch rate for all sizes of bass remained ≥0.40 fish/hour throughout the rest of the survey.

Anglers released approximately 12.5% of the legal-size largemouth bass they caught in 1984 (Table 1). Release rates increased dramatically to 39.3% in 1987 and increased to 65.5% by 1991.

Discussion

Dramatic changes in the dynamics of shad populations took place following the 1986 fish kill. It cannot be stated with absolute certainty the fish kill caused the changes observed, but it is a reasonable inference. The available data also suggest the changes observed in the largemouth bass populations resulted because of the changes in the shad populations. Catch rates for largemouth bass in spring electrofishing samples increased dramatically in 1987 (Fig. 3), 1 year after a large increase of fingerling shad was observed (Fig. 1). Other changes observed in electrofishing catch rates seemed to be related to changes observed in the shad population. For example, extremely low threadfin shad fingerling production in 1991 (Fig. 1) was followed in 1992 and 1993 by the lowest catch rates for stock size (20–30 cm) bass observed since 1986 (Fig. 3) indicating poor survival for that size group. In addition, in 1994, 2 years after a very strong 1992 year class of shad, catch rates for stock size bass were at their highest level since 1987.

Another factor that contributed significantly to the dramatic recovery of the bass population was the high rate of voluntary release of bass by anglers. The release of legal bass increased from 12.5% in 1984 to an average of 57.3% from 1987 through 1991. These release rates compare favorably with the release rates of legal-size tagged bass by anglers on this reservoir (Keefer and Wilson 1993). Release rates averaged 52.0% between 1987 and 1991 and ranged from 40.9% to 62.3%. If anglers had not voluntarily released these bass, the harvest of bass would have more than doubled, and the recovery of the bass population would not have been as dramatic.

The dramatic changes in the age structure of the bass population that occurred after 1986 are further evidence of changes in the dynamics of the bass population. It appears the tremendous increase in the abundance and availability of fingerling shad observed after 1986 allowed a dramatic increase in the survival of young bass and the subsequent recruitment to the fishery of these bass resulted in substantially improved angler catch rates. The preponderance of evidence suggests the recruitment of strong year classes of largemouth bass is dependent on the availability of abundant fingerling shad in Lake Walter F. George. Goldstein and Anderson (1992), in a study of the food habits of largemouth bass <20 cm total length on Lake Walter F. George, found shad were by far the most common food item in the stomachs of bass, regardless of size. They reported experienced bass (10–20 cm total length) were selectively feeding on shad during 70% of the months sampled and centrarchids were rarely eaten. Gilliland and Clady (1981) found gizzard shad were preferred by largemouth bass in Sooner Lake, Oklahoma, over sunfishes (*Lepomis* spp.), crappie (*Pomoxis* spp.), and silversides (Atherinidae).

The relationship between the abundance of shad and bass appears quite variable among reservoirs. Zeller and Wyatt (1967) reported increases in largemouth bass populations following a selective shad kill. Applegate and Mullan

(1967) found bass grew faster in Beaver Reservoir, Arkansas, with an adequate forage base of threadfin shad than they did in Bull Shoals Reservoir, Arkansas, which had a more limited abundance of forage. Range (1972), however, found no differences in bass growth after threadfin shad were stocked in Dale Hollow Reservoir, Tennessee.

Reservoirs have poorly developed predator-prey systems compared to natural lakes (Noble 1986), and the complex inter-relationships between prey and predator are poorly understood. Factors such as the trophic state and age of the reservoir, climate, water level fluctuations, the genetics of the fish stocks involved, and the differences in complex multi-species interactions could all have significant impacts on the relationships between a given predator and prey species. Efforts to manage established predator-prey relationships can be divided into 2 basic approaches, manipulating the prey species or manipulating the predators. At one time, the use of selective rotenone treatments to reduce excessive shad populations was fairly popular in the Southeast (Zeller and Wyatt 1967), but this technique seems to have fallen into disfavor. Currently, stocking of predators is the technique used by most fishery managers to control prey populations, usually with highly variable results between reservoirs and from year to year within reservoirs. The results of the present study indicate large-scale reductions in adult shad populations could have long-term, desirable effects on largemouth bass populations of. A re-examination of the potential methods to reduce shad populations may produce an effective and acceptable technique for fishery managers to utilize.

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