THE DECLINING LARGEMOUTH BASS FISHERY IN THE OCMULGEE RIVER, GEORGIA

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Abstract: The largemouth bass(*Micropterus salmoides*) fishery in the Ocmulgee River, Georgia was studied to address concerns about overexploitation. A significant decline occurred over time in overall success, fished-for success, and average weight of largemouth bass in the creel. The annual exploitation rate was calculated to be 0.11 and was estimated in the year of low bass harvest. The annual survival rate was calculated to be 0.47. A Kolmogorov-Smirnov two sample test showed a significant decrease in the percent frequency of larger bass in electrofishing samples from fall 1976 to fall 1978. The high bass harvest from spring 1976 to fall 1977 is believed to be the primary cause of decline in the bass fishery. Low bass recruitment to harvestable size also contributed to the decline. Management strategies for enhancing the bass fishery include stocking of advanced fingerlings and better enforcement of the 305 mm size limit.

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A recent survey on the Ocmulgee River indicated that high fishing pressure and associated high harvest may be causing a decline in the harvestable largemouth bass population (Coomer and Holder 1980). In addition, the number of bass tournaments has increased on Georgia's streams in recent years. Georgia B.A.S.S. Federation river tournaments alone increased from a combined total of 16 in 1976 and 1977 to 25 in 1978 (unpublished data compiled by Dr. Carl Quertermus, Environmental Chairman, Georgia B.A.S.S. Chapter Federation). Also an increase in tournament fishing by other organized bass clubs was observed during this period. The Ocmulgee River was one of the primary streams receiving the increased pressure from the organized bass clubs.

Considerable work has been carried out on the dynamics of largemouth bass in ponds, lakes and reservoirs of North America, but very little has been done in riverine environments. Most bass dynamic studies in lotic environments have been on smallmouth bass in several Missouri streams (Fajen 1975; Funk 1975; Pflieger 1975). Fajen (1975) stated that heavy exploitation of black bass in streams reduced fishing quality, increased total annual mortality, decreased the biomass of larger bass, and diminished the effectiveness of bass as predators. The situation of the Ocmulgee River provided an opportunity to examine the sport fishery, population structure, and growth of an apparently heavily exploited largemouth bass population in a riverine environment.

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METHODS

Description of Study Area

The study area is located in the Coastal Plain of southeast Georgia and consists of 98 river km that encompass approximately 864.8 ha of mainstream and oxbow habitats (Fig. 1). The Ocmulgee River's channel width generally averages 71 m with a floodplain width extending to 4.0 km. The mean discharge over 42 years (1936 - 1978) at the most downstream recording gage (Lumber City) was 160 m^3/s (USGS 1979). Although no commercial shipping or barge traffic exists on the Ocmulgee River, the U. S. Army Corps of Engineers maintains a navigation channel downstream from Macon, Georgia (USACE 1978). Periodic floodplain inundations have limited industrial and residential development along the river. Since no major impoundments exist nearby, the river serves as a major public fishing resource. In 1932, the world's record largemouth bass was caught in Lake Montgomery, an oxbow lake in the study area. Water quality in the study area has been described as healthy and water use classified as fishing (GDNREPD 1972).

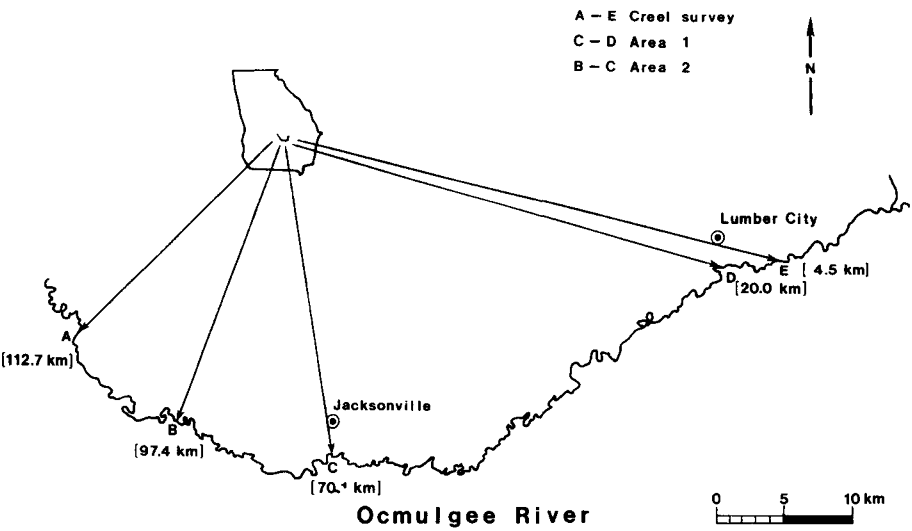

Fig. 1. Map of Ocmulgee River study area. Kilometers given are distances from mouth of river.

Sport Fishery

An access type creel survey with non-uniform probability sampling (Pfeiffer 1966) was designed with assistance from the Fish and Game Statistics Project staff at North Carolina State University and conducted for 3⅓ years on the Ocmulgee River. Year 1 was from 27 March 1976 to 25 March 1977; Year 2 from 26 March 1977 to 24 March 1978; and Year 3 from 25 March 1978 to 24 March

1979. The final survey period was from 25 March 1979 to 13 July 1979. Sample periods consisted of 2 week-intervals. In Years 1 and 2, 3 randomly selected weekdays and 2 weekend days were sampled each period with Independence Day and Labor Day included in the weekend frame. From 25 March 1978 to 13 July 1979 the sampling effort during each period was intensified to 6 randomly selected weekdays and all weekend days. The sampling day was divided into an AM and PM period with the AM period extending from sunrise to midday and the PM period from midday to sundown. Probabilities for access points and time of day were assigned based on observed fishing activity and adjusted at 6 month intervals. Fishermen were interviewed at the landing after completing their fishing trip. Information was collected on number in party, time fished, species fished-for, number and weight of each species harvested, method of fishing, bait used, distance traveled from origin, and location fished.

Age and Growth

Scale samples were taken from bass creeled and from bass collected by rotenone sampling and electrofishing. Total length (mm) was measured and recorded for each specimen from which a scale sample was obtained. Scales were cleaned using a 1N solution of potassium hydroxide and impressions on acetate slides made using a Carver Laboratory press. The impressions were read on an Eberbach Scale Projector for age and growth measurements. Both authors read the scales independently. Those that could not be agreed on after re-examination were rejected.

Using fish length on the Y-axis plotted against the scale radius on the X-axis, the body:scale relationship was examined graphically and determined to be linear. The length of each fish at each corresponding annulus was calculated using Lee's method in Lagler (1956). These calculated lengths were then used to determine the mean length of each year class of bass at annulus formation. The weighted mean length at annulus formation and the growth increment for the bass population as a whole were then calculated.

Exploitation

From 24 March 1978 to 4 May 1978, 657 largemouth bass ≥230 mm total length were captured, tagged and released in Area 1 (Fig. 1). The sampling effort, number of bass captured, and individual lengths of bass were recorded. The bass were tagged with numbered international Floy anchor tags printed with a return address. Each tag had a minimum reward of $2.00. Randomly selected tag numbers were assigned higher values (5 tags worth $100.00 each, 10 at $50.00 each, 50 at $25.00 each, and 150 at $10.00 each). The tagging project was publicized by local newspapers, radio stations and public notices posted at each access point. When a tag was returned, a questionnaire with a return envelope and reward check was mailed to the fisherman. Each fisherman was asked for information on when and where he caught the bass, bait used, disposition of the bass, and his affiliation with bass clubs.

Few tags were returned in the summer of 1978, so 409 bass ≥230 mm were tagged and released in Area 2 (Fig. 1) over a 4-week period in fall 1978. The same procedures were used as in the earlier tagging study.

Abundance and Population Structure

The relative abundance and size distribution of bass (all size and legal size) were examined using data collected by electrofishing over a 3-year period from the same section of the river (Areas 1-2, Fig. 1). For this analysis, we compared data from Coomer and Holder (1980) for fall 1976 and summer 1977 with the data collected in fall 1978. The bass were placed into 2-cm groups and the percent length frequencies determined. For comparative purposes legal bass were those fish in the 30 cm (291 mm - 310 mm) group or larger. Length frequency data were compared using the Kolmogorov-Smirnov one-tailed two sample test (Siegel 1956). Regression over time of the catch per unit effort (CPUE) was also tested (H_0:B= 0) for significance at $P < 0.05$ (Snedecor and Cochran 1967).

RESULTS

Sport Fishery

The Ocmulgee River is a heavily fished stream that supports a high harvest (Fig. 2). On a hectare basis the pressure estimates ranged from 223.1 h/ha to 280.7 h/ha over a 3-year period and resulted in annual harvest estimates ranging from 54.1 kg/ha to 100.5 kg/ha. The more common species in the creel included redbreast sunfish (*Lepomis auritus*), bluegill (*Lepomis macrochirus*), black crappie (*Pomoxis nigromaculatus*), largemouth bass, and channel catfish (*Ictalurus punctatus*). The largemouth bass estimate in Year 3 indicated a significant decline (Fig. 2). The bass harvest declined from 17.6 fish/ha weighing 19.0 kg in Year 1 to 2.8 fish/ha weighing 2.2 kg in Year 3. Redbreast sunfish and bluegill harvest also declined but not significantly.

With only 3 years of data it was difficult to clearly establish if the trends indicated are real changes or merely yearly fluctuations and sampling variability. We therefore collected creel data in the spring and early summer 1979 (24 Mar 1979 - 13 Jul 1979). This information was compared to creel data collected for the corresponding season in each of the previous 3 years and represented 40 - 50% of the total harvest in those years.

There was a reduction of 37% in overall effort, 61% in fished-for effort, 79% in overall success, 70% in fished-for success, and 34% in average weight from spring 1976 to spring 1979 (Fig. 3). Each of these parameters declined significantly when regressed over time at $P < 0.05$ (Y = 115,508.5 – 11,048.7X, $r = -0.85$; Y = 9,504.5–1, 682.2X, $r = -0.86$; Y = 0.063 – 0.016X, $r = -0.96$; Y = 0.425 –0.077X, $r = -0.98$; and Y = 0.975 – 0.97X, $r = -0.99$, respectively).

Age and Growth

Scales were examined from 162 bass of which 140 were successfully aged. The calculated scale radius-body length relationship was:

$$L = 31.44 + 1.29\ S\ (r = 0.89,\ n = 140)$$

Eight age groups were represented; few bass were over 6 years old (Table 1). Bass on the average obtained the legal harvestable size of 305 mm (12 in) after

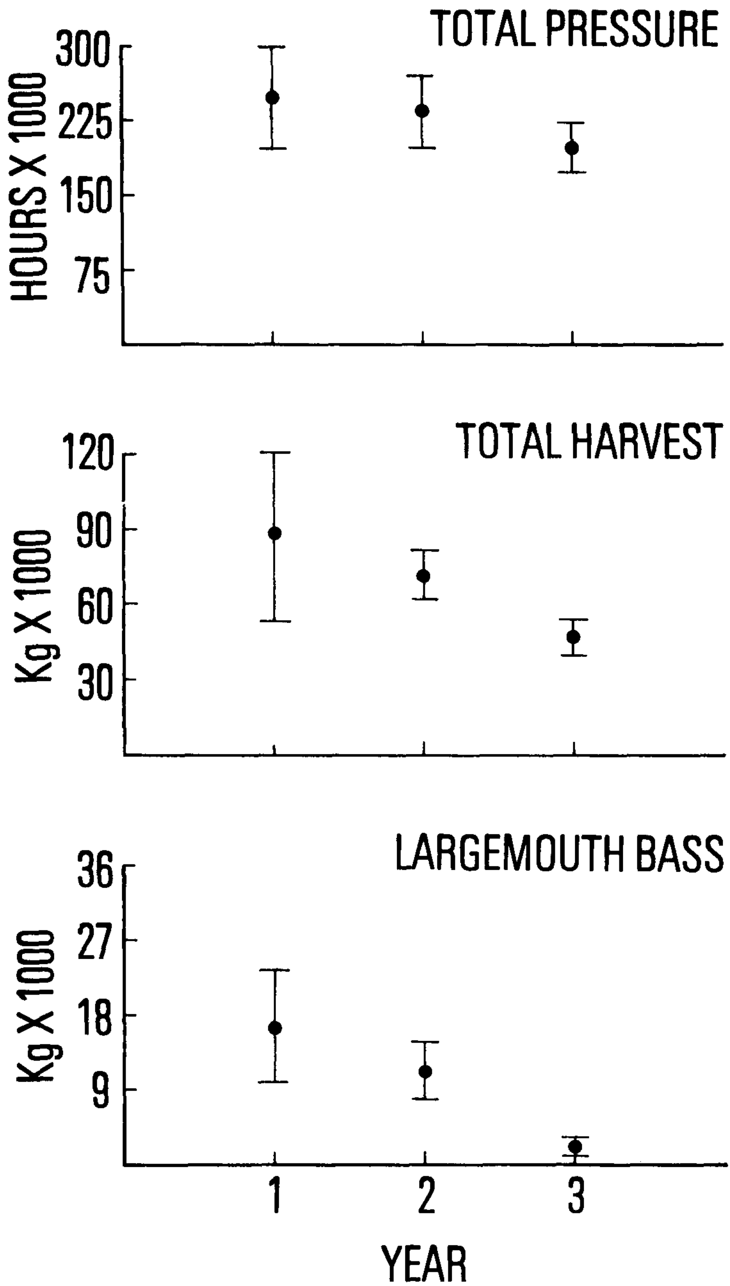

Fig. 2. Annual estimates (and 95% confidence intervals) of total pressure (angler hours), total harvest (kg) and largemouth bass harvest (kg) in the Ocmulgee River from 27 March 1976 to 23 March 1979.

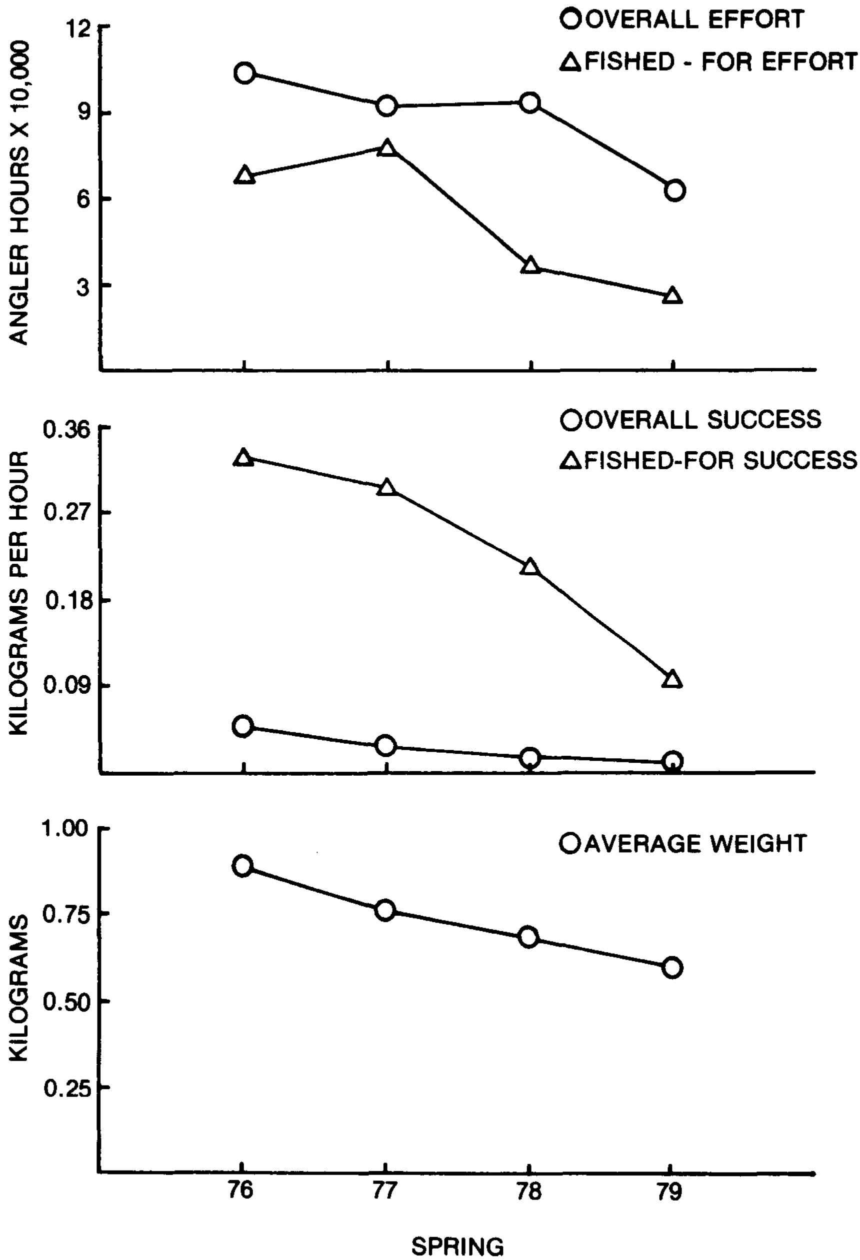

Fig. 3. Changes in overall and fished-for effort (angler hours), overall and fished-for success (kg per hour) and average weight (kg) of largemouth bass during 4 spring fishing seasons on the Ocmulgee River.

their 3rd growing season. Growth in length was greatest in the 1st year and declined afterwards, except for age VII to age VIII fish. Since only 2 bass aged were 8 years old, the age VII to VIII growth is probably a data artifact.

Exploitation

Total tag returns for all bass were low for both tagging experiments (Table 2). Returns were obtained from 11% of the sub-legal (<305 mm) bass tagged in the 1st experiment and from 4% of those tagged in the 2nd experiment. Since few tags from sub-legal bass were returned, the exploitation rates were calculated only for

Table 1. Weighted mean lengths and growth increments of largemouth bass collected from the Ocmulgee River between 8 October 1976 and 7 July 1979.

			Mean calculated total length (mm) at annulus formation							
Year class	Age class	No. of fish	1	2	3	4	5	6	7	8
1975	I	11	11	123						
1976		11	132							
1977		7	125							
1978		1	132							
1974	II	14	111	221						
1975		12	142	235						
1976		4	146	254						
1977		7	144	211						
1973	III	2	115	223	292					
1974		3	113	218	276					
1975		13	130	243	298					
1976		14	149	221	284					
1972	IV	2	114	216	267	308				
1973		5	118	223	301	347				
1974		9	140	251	313	348				
1975		7	122	214	285	333				
1971	V	1	110	240	336	380	429			
1973		6	127	198	280	328	365			
1974		3	102	189	257	312	368			
1972	VI	2	140	230	268	357	408	448		
1973		1	78	135	215	274	310	341		
1971	VII	3	129	217	272	321	377	414	448	
1969	VIII	1	87	151	269	314	358	407	431	483
1970		1	115	237	280	335	394	431	464	504
Weighted mean length			128	224	288	334	374	415	448	494
Weighted mean annual growth increments			128	96	64	46	40	41	33	46
Range of calculated length at annulus			64-224	135-315	215-369	274-397	293-444	341-489	415-506	483-504
Number of fish			140	110	73	41	18	8	5	2

legal (≥305 mm) bass. Of the 307 legal bass tagged, 37 were returned in the 1st experiment for an exploitation rate of 0.12 (Ricker 1975). Forty-six percent of fishermen responding to the questionnaire reported releasing legal-sized bass. From these data, an adjusted exploitation rate of 0.07 was calculated. The true exploitation rate probably lies between these 2 estimates, but μ 0.07 was considered more accurate. Of the 151 legal size bass tagged in the 2nd experiment, 11 were returned. Since 45% of the fishermen reported releasing the bass, the exploitation rate in the 2nd tagging experiment was adjusted to 0.04.

The survival rate of legal size bass was determined using the age-frequency of bass captured in the 1st tagging experiment. An age-length key was constructed using the method described by Coomer (1975) and the bass placed in the appropriate age groups (Table 2). Annual rate of survival (S) was determined by the formula of Robson and Chapman (1961):

$$S = \frac{T}{n + T - 1}$$

where

$$T = N_1 + 2N_2 + 3N_3 + \ldots$$

and

$$n = N_0 + N_1 + N_2 + \ldots$$

The estimated rate of survival was computed to be S = 0.47 with a 95% confidence interval of 0.44 - 0.50.

Table 2. Data used to determine survival rate.

Age	Coded age	Number in catch
III	0	$N_0 = 240$
IV	1	$N_1 = 133$
V	2	$N_2 = 53$
VI	3	$N_3 = 32$
VII	4	$N_4 = 25$
		$n = 483$

Mortality rates for each experiment were calculated based on the relationships for a Type 2 fishery in which fishing and natural mortality act concurrently (Ricker 1975). The instantaneous rate of mortality (Z) was $Z = -\log_e S$ or 0.755 and the Z/n per week is 0.0145 where $n = 52$ (weeks in a year). The instantaneous rate of mortality for the 1st experiment (24 weeks) was $Z_1 = 0.348$. Actual total mortality rate (A_1) was $A_1 = 1 - e^{-Z_1}$ or 0.294. The instantaneous rate of fishing mortality (F_1) was $F_1 = Z_1\mu_1/A$, or 0.083.

In the 2nd experiment the instantaneous rate of mortality (Z_2) was 0.406. Total mortality rate (A_2) was $A_2 = 1 - e^{-Z_2}$ or 0.334. The instantaneous rate of fishing mortality (F_2) was $F_2 = Z_2\mu_2/A_2$ or 0.00487.

The instantaneous rates of fishing mortality for the experiments were summed ($F = F_1 + F_2$) to obtain an annual rate of fishing mortality of 0.132. Annual instantaneous rate of total mortality (A) was $A = A_1 + A_2$ or 0.628. Annual exploitation rate was $\mu = FA/Z$ or 0.11.

Ricker (1975) classified possible bias in the calculation of these rates as types A, B and C. Type A errors influence estimates of fishing mortality. Two possible sources of this error are initial mortality of tagged fish and incomplete reporting.

Davies et al. (1977), Ager (1978), and Folmar et al. (1979) reported no initial tagging mortality in studies in small ponds. This source of bias was considered negligible. The use of reward tags over non-reward tags improves fishermen response (Rawstron 1972; Coomer 1975; Folmar et al. 1979). Since a variable reward system and considerable publicity were used to encourage tag returns, non-reporting of tags was considered low.

Tag returns from bass released back into the river would over-estimate the exploitation rate. We compensated for this by subtracting these tags from the total returns. Later recapture and non-release of these bass would cause the exploitation rate to be underestimated, but since few bass were caught, this error is not serious.

Type B errors would result in a bias of the estimate of total mortality but not necessarily in the estimate of fishing mortality. Continuous tag loss would be the major cause of this error. Preliminary findings from a study of Par Pond, South Carolina showed a 79% retention rate of Floy internal anchor tags over 6 months (Ronnie Gilbert, personal communication, 11 December 1980, USFWS, University of Georgia School of Forestry Resources, Athens, GA). Rawstron and Pelzman (1978) concluded from their experiments that the Floy internal anchor tag can be successfully used in short term (≤1 year) studies of largemouth bass for estimating annual exploitation. Each of our tagging experiments was approximately 6 months. The bias from tag loss is considered to be negligible.

Movement of bass in and out of the study area could also result in a possible bias. Fishermen returning tags reported catching only 1 tagged bass outside the area released. Movement of bass into the study area may occur, but we have no data to evaluate this effect. Bass movement is considered to be an insignificant source of error.

Type C errors result from changes in behavior associated with the tagging process. They were assumed to be non-significant.

Abundance and Population Structure

The decline in average weight of creeled bass indicated a reduction in average size of harvestable bass in the population. Examination of changes in percent length-frequencies of bass collected in the study area by electrofishing over 3 consecutive years showed an apparent decline in the larger bass (Fig. 4). We then compared the frequency distribution of the legal bass (30 cm group and larger) only using a Kolmogorov-Smirnov 1-tailed 2 sample test. Comparison of fall 1976 to summer 1977 and of summer 1977 to fall 1978 show no significant differences between the frequency distributions. The comparison between fall 1976 and fall 1979 showed a significant increase at $P < 0.05$ in the percent occurrence of bass in the 30 – 40 cm groups, indicating a shift toward smaller bass.

The increase in percent frequency may have resulted from heavy recruitment into the 30 – 40 cm groups or from a decrease of larger bass. To investigate this, we compared the number per hour (CPUE) and 95% confidence intervals of all size bass and legal bass captured by electrofishing (Fig. 5). A significant decline in CPUE's of all bass occurred in the fall of 1978 from the previous year. A decline

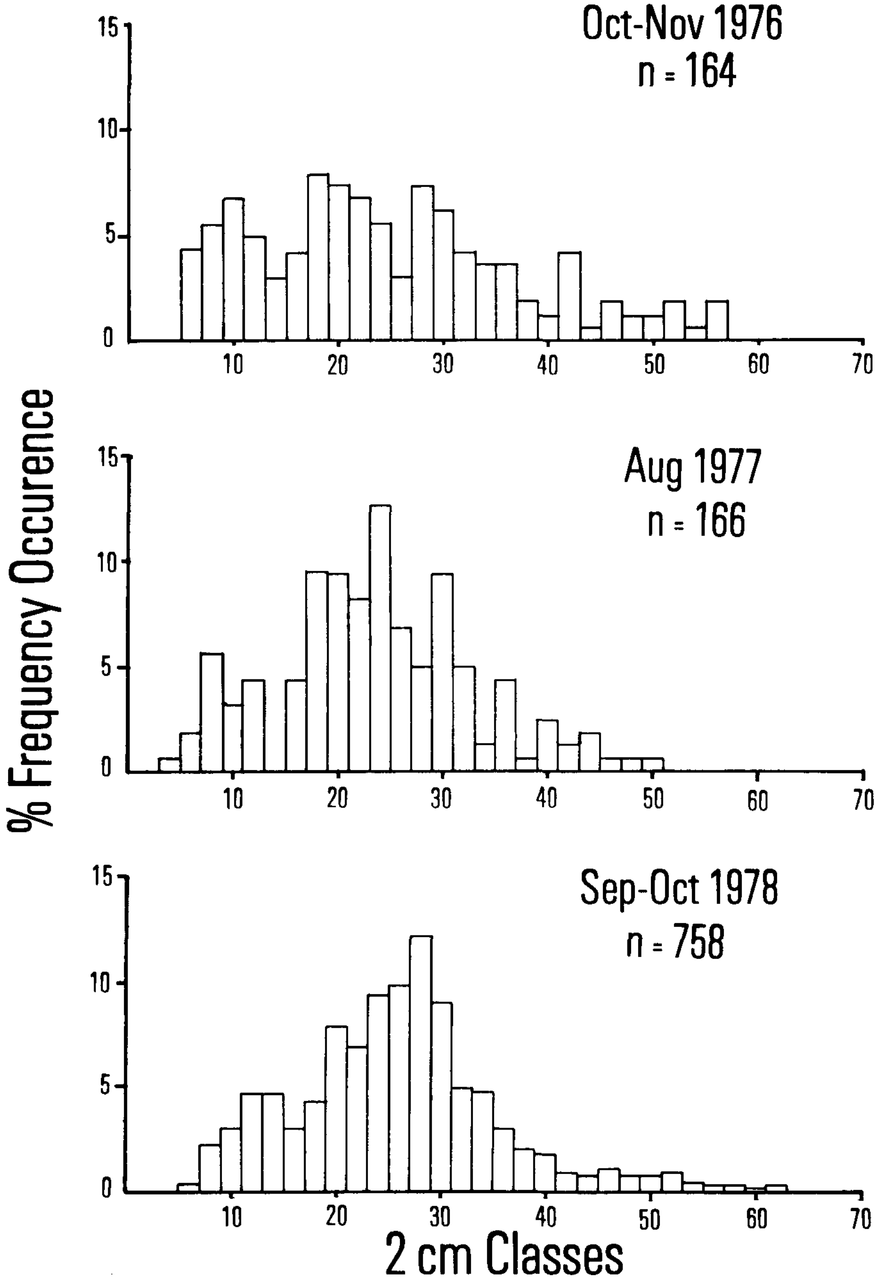

Fig. 4. Size-class histograms of largemouth bass collected by electrofishing from the Ocmulgee River.

in the average CPUE of legal bass was indicated; however the confidence intervals overlapped considerably. When we regressed CPUE's for all bass and for legal bass against year, a significant decline was indicated only for the legal bass ($Y = 4.98 - 0.9X$, $r = -0.998$). Since the CPUE data did not show an increase in the total number of legal bass and, in fact, indicated a decline, it is unlikely that the shift in length-frequency was caused by heavy recruitment into the 30 – 40 cm size group.

The length frequency data in Fig. 4 also gave some indication of low recruitment. Although electrofishing is negatively selective for fingerling bass, size selectivity would have been the same for all years. With this low level of recruitment, it is doubtful that an increase in the number of legal size bass will occur in the near future unless strong year classes enter the population.

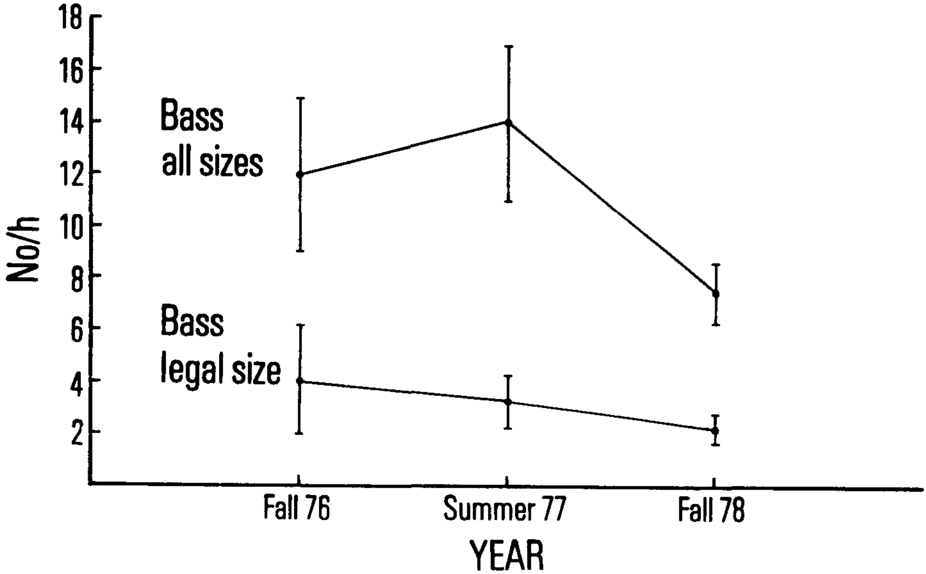

Fig. 5. CPUE's (and 95% confidence intervals) for all bass and legal sized bass captured by electrofishing in the Ocmulgee River over a 3-year period.

DISCUSSION

The annual rates of exploitation and natural mortality estimated for the Ocmulgee River bass population were low compared to other studies. Ager (1978) reported an exploitation rate on Lake Tobesofkee of $\mu = 0.56$ and felt it would lead to relatively poor bass fishing due primarily to upcoming weak year classes. Rawstron and Hashagen (1972) reported overharvest in Merle Collins Reservoir, California when exploitation rates ranged from 36% to 65% and natural mortality ranged from 11% to 56% over a 5-year period. An estimated annual exploitation rate of 20% and a mortality rate of 36% did not result in an overharvest of bass in Clear Lake, California (Kimsey 1957).

The rate of bass exploitation (0.11) in the Ocmulgee River in our study obviously does not indicate overharvest. However, the annual exploitation rate was estimated in the same year in which bass harvest by number was 1/5 or less the level reported for each of the previous 2 years. The CPUE's of harvestable bass by electrofishing did not reflect a decline in the population of that magnitude. This implies that a higher percentage of the population was harvested in Years 1 and 2 than in Year 3.

Our findings have documented a decline in the bass fishery as exemplified by reductions in overall catch rate, fished-for success and average weight of bass creeled. These declines occurred in addition to reductions in total and fished-for pressure. A population shift toward smaller legal bass was documented as well as an indication of fewer harvestable bass. Growth was slow but similar to that reported from other coastal plain streams (Guier et al. 1978). The lack of data on fishing and mortality rates prior to and during the periods of high harvest in previous years limited our ability to determine the exact cause of the decline. We can, however, postulate a cause and effect relationship. High harvest of bass in 1976 and 1977 re-structured the bass population toward lower numbers and smaller size fish, resulting in the declining catches and low exploitation measured during this study. The decline in total and fished-for pressure was probably in response to the declining quality of the bass fishery. Recruitment and growth were inadequate to maintain the harvest levels that occurred in 1976 - 77.

Management steps have already been initiated to enhance the bass population in the Ocmulgee River. In an attempt to increase year-class strength, bass were stocked in an experimental area in summer 1979 (13 - 15 cm TL at 37/ha) and summer 1980 (7 - 10 cm TL at 49/ha). Strong natural year classes occurred in the bass population of both experimental and control areas during both years stocked. No significant effect of the stocking has been found to date.

Another management strategy has been to promote enforcement of the existing 305-mm (12-in) legal size limit on largemouth bass. Examination of the size distribution of bass creeled on the Ocmulgee River has shown that 22% were illegal size. Bass do not reach legal size (305 mm) until after their 3rd year; illegal harvest prior to this time can reduce their survival and thus the quality of the bass fishery.

Two strong year classes moving through the population should reach legal size in 1982 and 1983. If survival is good, the population structure should shift to a higher percentage of bass in the harvestable size range. Since fishing pressure on bass has declined in recent years, the bass population may recover on its own. Should the pressure increase, then a 36-cm (14-in) size limit may be necessary to regulate the harvest.

LITERATURE CITED

Ager, L. M. 1978. Exploitation and mortality of largemouth bass in Lake Tobesofkee, Georgia. Proc. Ann. Conf. S.E. Assoc. Fish and Wildl. Agencies 32:429-436.

Coomer, C. E., Jr. 1975. Population dynamics of black bass in Center Hill Reservoir, Tennessee. Tenn. Wildl. Agency, Technical Report No. 76-54.

__________, and D. R. Holder. 1980. A fisheries survey of the Ocmulgee River. Ga. Dept. Nat. Res., Game and Fish Div. Final Rept., Fed. Aid Project F-29.

Davies, W. D., W. L. Shelton, R. Bayne, and J. M. Lawrence. 1977. Fisheries and limnological studies, West Point Reservoir, Alabama-Georgia. Final Rept. Waterways Exper. Sta., Corps of Engineers, Vicksburg, Miss.

Fajen, O. 1975. The standing crop of smallmouth bass and associated species in Courtois Creek. Pages 240-249 *in* H. Clepper, ed. Black bass biology and management. Sport Fish. Inst., Washington, D.C.

Folmar, H. G., W. D. Davies, and W. L. Shelton. 1979. Factors affecting estimates of fishing mortality of largemouth bass in a Southeastern reservoir. Proc. Ann. Conf. S.E. Assoc. Fish and Wildl. Agencies 33:402-407.

Funk, J. L. 1975. Evaluation of the smallmouth bass population and fishery in Courtois Creek. Pages 257-269 *in* H. Clepper, ed. Black bass biology and management. Sport Fish. Inst., Washington, D.C.

GDNREPD (Georgia Department of Natural Resources, Environmental Protection Division). 1972. Ocmulgee River Basin Study. Ga. Dept. Nat. Res., Environ. Protection Div., Atlanta.

Guier, C. R., W. G. Miller, A. W. Mullis, and L. E. Nichols. 1978. Comparison of growth rates and abundance of largemouth bass in selected North Carolina coastal rivers. Proc. Ann. Conf. S.E. Assoc. Fish and Wildl. Agencies 32:391-400.

Kimsey, J. B. 1957. Largemouth bass tagging at Clear Lake, Lake County, California. Calif. Fish and Game 43:111-118.

Lagler, K. F. 1956. Freshwater Fishery Biology. 2nd ed. Wm. C. Brown Co., Dubuque, Iowa.

Pfeiffer, P. W. 1966. The results of a non-uniform probability creel survey on a small state-owned lake. Proc. Ann. Conf. S.E. Assoc. Fish and Wildl. Agencies 20:409-412.

Pflieger, W. L. 1975. Reproduction and survival of the smallmouth bass in Courtois Creek. Pages 231-239 *in* H. Clepper, ed. Black bass biology and management. Sport Fish. Inst., Washington, D.C.

Rawstron, R. R. 1972. Non-reporting of tagged largemouth bass 1966-1969. Calif. Fish and Game 58(2):145-146.

__________, and K. A. Hashagen, Jr. 1972. Mortality and survival rates of tagged largemouth bass (*Micropterus salmoides*) at Merle Collins Reservoir. Calif. Fish and Game 58(3):221-230.

__________, and R. J. Pelzman. 1978. Comparison of Floy internal anchor and disk dangler tags on largemouth bass in Merle Collins Reservoir. Calif. Fish and Game 64(2):121-123.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Dept. of the Environ., Fish. and Marine Serv., Ottawa, Canada.

Robson, D. S., and D. G. Chapman. 1961. Catch curves and mortality rates. Trans. Am. Fish. Soc. 90:181-189.

Siegel, S. 1956. Nonparametric statistics of the behavorial sciences. McGraw-Hill Book Co., New York, N.Y.

Snedecor, T. W., and W. G. Cochran. 1967. Statistical methods, sixth edition. Iowa State Univ. Press. Ames.

USACE (United States Army Corps of Engineers). 1978. Special flood hazard report, Ocmulgee River. U. S. Army Engineer District, Savannah Corps of Engineers, Savannah, Ga.
USGS (U. S. Geological Survey). 1979. Water resources data for Georgia water year 1978. U. S. Dept. Interior.