RESULTS OF A 45-CM (18-IN) MINIMUM SIZE REGULATION ON LARGEMOUTH BASS POPULATIONS

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Abstract: A 45-cm (18-in) minimum size limit was placed on largemouth bass (*Micropterus salmoides*) in January 1978 in 4 North Carolina reservoirs. Annual spring electrofishing samples were conducted to obtain size distribution information on each lake, length-weight information on 2 lakes, and largemouth bass population estimates on one of the study lakes. After a 4-year investigation, the proportion of quality size bass in the stock size distribution of 2 lakes increased. On a 3rd lake, a newly developing largemouth bass fishery was successfully protected from a reduction in quality size bass from initial heavy angling exploitation. Concurrently, bass length-weight relationships were unaffected. On a 4th lake, characterized by good recruitment and low forage levels, the proportion of quality did not increase and length-weight relationships remained undesirable. Estimates of largemouth bass population size indicated no change in the number of adult bass (TL > 30.0 cm) present in the lake.

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The largemouth bass is the most sought after game fish in Piedmont North Carolina. The growing popularity of bass fishing has contributed heavily to the total fishing pressure exerted on Piedmont impoundments. Some waters are annually subjected to angling pressures in excess of 250 hours/ha. Little information is available on how increasing fishing pressure has affected largemouth bass stocks in Piedmont lakes or the quality of largemouth bass fisheries.

Heavy fishing pressure may affect largemouth bass fisheries in several ways. Martin (1957) found an inverse relationship between fishing pressure and bass catch rates in Virginia lakes of 24 - 263 ha. Redmond (1974) observed that heavy exploitation reduced the number of larger bass inhabiting several study lakes in Missouri. Anderson (1974) has characterized overharvested largemouth bass populations as having few bass larger than 0.7 kg and inadequate recruitment to harvestable size.

One method of reducing harvest is to increase minimum size limits. Where overharvest is occurring, a more restrictive size regulation should increase the numbers and average size of adult largemouth bass. After modeling the Beaver Lake largemouth bass population, Anderson (1975) predicted a 45-cm (18-in) minimum size limit would increase the number, weight, and average size of bass caught in that lake.

Beginning in January 1978, the existing 30-cm (12-in) size limit was changed to a 45-cm (18-in) size limit for largemouth bass in 4 Piedmont impoundments. Lake Tillery is a 2100-ha hydroelectric impoundment of the Yadkin River located in Stanly and Montgomery counties. Lake Tom-A-Lex (318 ha) and Lake Higgins (114 ha) are city water supply reservoirs located in Davidson and Guilford counties, respectively. Cane Creek Lake is a 160-ha recreational lake operated by Union County. Cane Creek Lake was impounded in 1975 and had been opened to fishing only 3 months before the change in size regulations.

The objective of the regulation change at lakes Tillery, Thom-A-Lex, and Higgins was to increase the proportion of bass in the larger size groups of the stock distributions. At Cane Creek Lake the objective was to prevent the heavy exploitation of bass often associated with a newly developed fishery. A 4-year study was conducted to determine if the 45-cm minimum size limit for largemouth bass met these objectives.

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METHODS

Largemouth bass were sampled by electrofishing during April and May. Lakes Cane Creek, Thom-A-Lex and Tillery were electrofished during daylight hours while both day and night sampling was conducted at Lake Higgins. Electrofishing was conducted principally with 230-volt alternating current converted to pulsed direct current (270 - 720 volts) by a Smith-Root, Inc. Type VI Electrofisher. Approximately 2.5 - 4.0 amperes were delivered to the water. A 400-cycle generator (AC) was also used, although infrequently. Data collected with these 2-gear types were combined.

The entire shorelines were sampled at lakes Thom-A-Lex, Cane Creek, and Higgins. Eight stations representing upper, middle, and lower sections of the reservoir were sampled at Lake Tillery. Total lengths were recorded for all fish collected. Weights were collected from a subsample of largemouth bass at Cane Creek and Lake Higgins. All fish were fin clipped or tagged before release to avoid redundancy in succeeding samples.

Largemouth bass length-frequency distributions were constructed to represent the annual samples from each lake. Proportional stock density (PSD) and relative stock density (RSD) were calculated using the concept described by Anderson (1976) were stocks were defined as the number of bass greater than 20.0 cm. For the purpose of this study PSD is defined as that percentage of the largemouth bass stock longer than 30.0 cm and RSD is that percentage of the stock exceeding 37.5 cm.

Linear regressions of logarithmic transformations of total lengths and weights were used to determine weight-length relationships for largemouth bass collected at Cane Creek and Lake Higgins. Predicted weights for fish from the 2 study lakes were used to calculate Relative Weight (Wr) indices of condition (Wege and Anderson 1978) using a standard largemouth bass weight-length relationship based on Carlander's (1977) data.

Population densities of largemouth bass (TL $>$ 30.0 cm) at Lake Higgins were estimated utilizing standard mark and recapture techniques. Both day and night electrofishing were used and bass were marked with Floy anchor tags or fin clipped. Population estimates were calculated using Chapman's modification of the Petersen formula. Confidence intervals were obtained from tabulations provided by Ricker (1975).

RESULTS AND DISCUSSION

The PSD and RSD indices increased steadily at lakes Tillery and Thom-A-Lex until PSDs equaled or exceeded 80% and RSDs exceeded 40% (Table 1). Anderson (1980) suggested that largemouth bass populations with low annual reproduction and low, or indeterminate, rates of mortality for quality size bass will exhibit PSDs > 80% and possibly RSDs > 40%.

Table 1. Largemouth bass population size structure in the 4 study lakes from 1978-1981.

Reservoir	Year	Sample size TL > 20.0cm	PSD(%)	RSD(%)
Tillery	1978	836	69	21
	1979	927	72	29
	1980	913	80	35
	1981	594	80	43
Thom-A-Lex	1978	432	57	30
	1979	451	67	32
	1980	399	84	48
	1981	271	87	56
Cane Creek	1978	358	69	42
	1979	462	64	36
	1980	453	81	42
	1981	425	71	54
Higgins	1978	1,643	49	14
	1979	1,136	40	16
	1980	654	41	14
	1981	1,129	50	9

PSD and RSD values for Cane Creek Lake largemouth bass did not change in the same steadily increasing fashion (Table 1). PSD increased through the 1980 sample. During the next year a number of bass passed the 37.5-cm threshold raising RSD, while the number of fish in the 20.0 to 30.0-cm TL range increased disproportionaltely, lowering PSD. It is apparent from both PSD and RSD values that larger fish were well represented in the stock size distribution throughout the study. This was not unexpected since the experimental size limit was protecting the newly developed bass populaion from exploitation.

Lake Higgins largemouth bass had the lowest PSD and RSD values of the 4 study lakes in 1981.In 1981 PSD and RSD values indicated a drop had occurred in the percentage of quality size fish found in the lake. Anderson (1974) indicated that a 45.0-cm length limit might be useful where bass recruitment rates are low. Recruitment at Lake Higgins is adequate to high and may have contributed to the bass populations unfavorable response to the experimental size limit.

The Wr values for largemouth bass from Cane Creek Lake and Lake Higgins were calculated using predicted weights obtained from length-weight regressions done on the 2 study lakes bass populations (Table 2). Anderson (1980) suggests

Table 2. Relative weight (W_r) values for largemouth bass from Cane Creek and Higgins lakes based on regression predicted weights.

	Cane Creek			Higgins			
TL (cm)	1979	1980	1981	1978	1979	1980	1981
20.0	80	73	84	67	76	73	88
22.5	84	77	86	71	77	74	88
25.0	87	81	88	75	78	76	89
27.5	90	86	90	78	81	77	89
30.0	93	89	92	81	83	78	90
32.5	95	93	94	85	84	79	91
35.0	98	97	95	88	86	80	91
37.5	100	100	97	91	87	80	91
40.0	102	104	98	93	88	81	92
45.0	107	110	101	99	90	83	93
Average 20.0 cm $\leq$ TL $\leq$ 37.5 cm							
	91	87	91	79	81	77	90

that a good bass population will exhibit little change in Wr from 20.0-cm to 37.5-cm fish and Wr will average about 100 ± 5. The Wr's for largemouth bass in this size range from the 2 study lakes were below Anderson's standard. The condition of largemouth bass in Cane Creek Lake was better than that of Lake Higgins fish generally, although Wr improved at Lake Higgins in 1981. The contrast is particularly true for larger fish (TL > 30.0-cm). The higher Wr values for Cane Creek Lake bass are consistent with its newly created population. The Lake Higgins data suggest that insufficient prey are available to largemouth bass in that reservoir.

Population estimates were made at Lake Higgins to determine if the densities of largemouth bass (TL > 30.0-cm) were affected by the experimental size limit (Table 3). The final estimate ($\hat{N}$, 1981) was intermediate between the first 2 estimates. The 95% C.I.'s overlapped for all 4 estimates. Consequently, no changes in largemouth bass (TL > 30.0-cm) population densities were discernible during the 4-year study.

Table 3. Population estimates of largemouth bass (TL $\geq$ 30.0 cm) in Lake Higgins for 4 years.

Year	Total fish marked (m)	Unmarked fish in recapture sample (u)	Marked fish in recapture sample (r)	r/c[a]	Population estimate ($\hat{N}$)	95% Confidence intervals (C.I.)
1977	535	173	53	0.23	2,253	$1{,}727<\hat{N}<2{,}940$
1978	608	217	109	0.33	1,810	$1{,}513<\hat{N}<2{,}181$
1979	350	104	32	0.24	1,457	$1{,}143<\hat{N}<1{,}891$
1981	434	151	39	0.20	2,077	$1{,}647<\hat{N}<2{,}690$

[a] C = u + r.

CONCLUSIONS

A 45-cm minimum size limit was imposed on largemouth bass populations in 4 North Carolina reservoirs to meet 2 management objectives. On lakes Higgins, Tillery, and Thom-A-Lex the objective was to increase the proportion of large fish in the stock size distribution. The objective at Cane Creek Lake was to prevent the initial heavy exploitation of largemouth bass in this newly opened fishery. The 45-cm minimum size limit was successful in meeting these objectives on 3 of the 4 lakes. Largemouth bass weight-length studies done on Cane Creek Lake indicate the objective was met without sacrificing body condition. The exception was Lake Higgins. In addition to the absence of positive changes in PSD and RSD, fish condition remained poor, and the investigators were unable to measure any changes in largemouth bass (TL $>$ 30.0 cm) population density.

The results presented in this paper are a product of studying bass populations on study lakes for only 3 growing seasons. It is a certainty that additional changes in some or all of the study populations will occur if the experimental size limit remains intact. This study demonstrates that a 45.0-cm minimum size limit for largemouth bass may be useful in increasing PSD values for bass stocks which have been depressed by angling pressure and for protecting a newly developed fishery from heavy initial exploitation rates. Increasing size limits does not appear warranted where recruitment is excellent, prey are deficient, and Wr values are low.

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