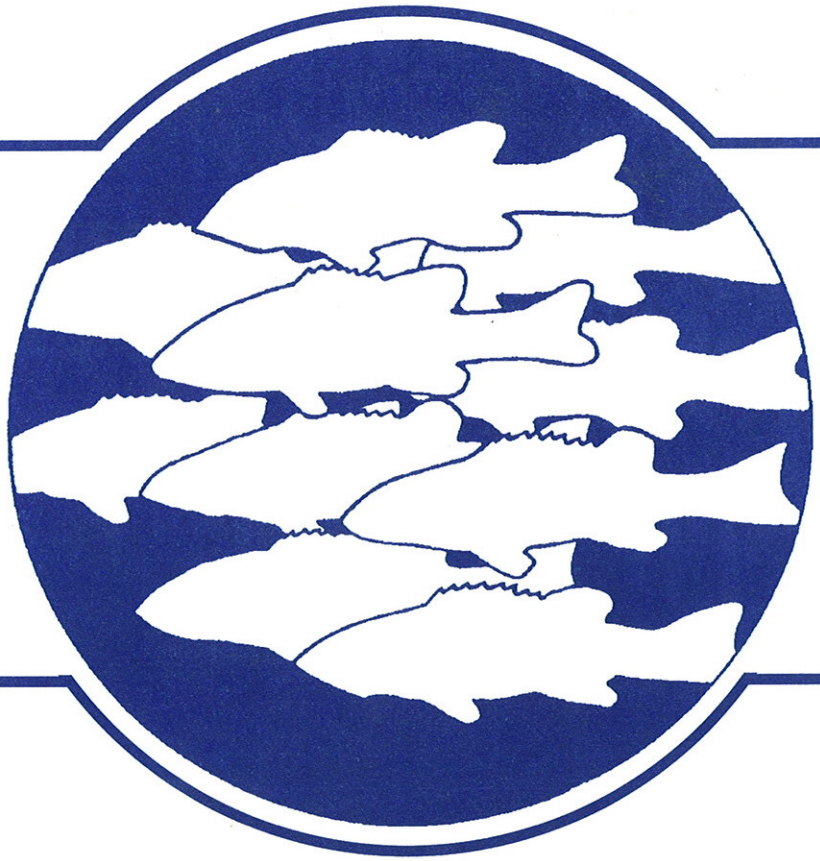

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Evaluation of a Differential - Black Bass Size Limit Regulation on Largemouth and Spotted Bass Populations at Cave Run Lake

by

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ABSTRACT

In 1985, a 15.0- in minimum-size limit on largemouth bass *Micropterus salmoides* was established, while the size limit on spotted bass *M. punctulatus* was removed at Cave Run Lake. A significant increasing trend has occurred in the total largemouth bass standing stock and in the electrofishing catch rate of <15.0 in largemouth bass. No statistically significant trends were found in the total, spotted bass, or gizzard shad *Dorosoma cepedianum* standing stocks. Significant trends were not detected in either the electrofishing catch rates of all sizes of spotted bass combined or in the numbers of ≥15.0 in largemouth bass. A significant declining trend was documented in the electrofishing catch rate of ≥12.0 in spotted bass. Condition of both largemouth and spotted bass declined with recent declines occurring in largemouth bass growth rates. Increases were detected in angler utilization of spotted bass and angler catch and release of 12.0-14.9 and ≥15.0 in largemouth bass. No changes were detected in the numbers of ≥15.0 in largemouth bass in either the population or the angler's creel and angler exploitation rates declined.

Largemouth bass population changes were attributed to both the more restrictive size limit and environmental changes associated with the cessation of a drought and increased nutrient levels. Most fishery management objectives were achieved except that the total number of spotted bass did not decline and the largemouth bass yield (pounds) did not equal the yield obtained with the previous 12.0-in size limit. Anglers surveyed in 1994 expressed dissatisfaction with the current bass fishery with nearly 50% desiring a size limit change. A protective 13.0-16.0 in slot limit has been proposed for the lake.

INTRODUCTION

Black bass (*Micropterus* spp.) populations have been managed in Kentucky primarily by size and creel limits. Size limits in Kentucky have gradually changed from a uniform statewide-size limit to reservoir specific size-limit regulations. This follows patterns common across the country in which size limits are matched with the biological characteristics of each black bass species in each reservoir (Redmond 1986).

Black bass at Cave Run Lake were managed from 1978-1984 with a 12.0-in minimum size limit and 10-fish creel limit. Studies during this time period showed that even though spotted bass *Micropterous punctulatus* were the lake's dominant black bass they accounted for only 8% of the black bass harvested by anglers in 1984 (Kornman 1985). Spotted bass in Cave Run Lake are slow growing and short-lived; some reach 12.0 in at age 5, but few exceed age 6 (Buynak 1983). A similar situation existed at Grayson Lake, Kentucky, where the black bass size limit was increased in 1982 from a 12.0-in to a 15.0-in minimum; subsequent creel surveys (1982-1986) showed that no spotted bass were harvested following the size-limit change (Kornman 1990).

Exploitation rates of 41% for largemouth bass *M. salmoides* at Cave Run Lake in 1978-1979 prompted concerns about overharvest. Graham (1974) reported that largemouth bass in research ponds could not maintain balanced populations if the annual exploitation rate exceeded 40%. To reduce the potential for overharvest, the minimum-length regulation for largemouth bass was changed in 1985 from 12.0 to 15.0 in, while the size limit was removed from spotted bass, allowing anglers the opportunity to harvest this abundant underutilized resource. Creel limits were reduced from a 10-fish creel (1985-1992) to a 6-fish creel limit in 1993.

Identification problems between spotted bass and largemouth bass were reduced by using the tongue tooth patch as a primary separation characteristic. Bass with this patch could be harvested at any size, while those without the patch had to be at least 15.0-in to be kept. Although about 10% of the lake's largemouth bass have a tooth patch, the method was presumed to be sufficiently accurate to meet management needs.

The specific objectives of this differential black bass harvest regulation included: 1). Increasing the standing stock of largemouth bass from 2.4 lb/acre under the 12.0-in size limit to 4-5 lb/acre under the 15.0-in regulation. 2). Doubling the numbers of quality-size (≥12.0 in) largemouth bass in the population. 3). Increasing angler catch rates of quality-size fish by a factor of 3-5 times the mean catch rate observed under the 12.0-in minimum size limit regulation. 4). Reducing the exploitation rate (41%) for largemouth bass. 5). Maintain or increase total yield of largemouth bass. 6). Reduce spotted bass abundance by increasing angler use.

STUDY AREA

Cave Run Lake, impounded in 1974, is an 8,270-acre reservoir on the Licking River in northeastern Kentucky. The lake has been classified as oligotrophic (Anonymous 1984) and more recently as mesotrophic (Anonymous 1988). A nutrient gradient progresses from eutrophic near the headwaters below the town of West Liberty, Kentucky to oligotrophic at the dam. This nutrient gradient affects the longitudinal distribution of black bass (Buynak et al. 1989). The lake stratifies during the summer months with thermocline depth usually ≥15.0 feet. It has a maximum depth of 89 ft and a mean depth of 27 ft. Watershed land usage consists primarily of silviculture (73%). The major sport fish include black bass, white crappie *Pomoxis annularis,* muskellunge *Esox masquinongy,* and bluegill *Lepomis macrochirus.*

METHODS

Spring and fall electrofishing studies, using pulse DC current, were conducted with boats equipped with Smith-Root electrofishing devices (Reynolds 1983). Samples were collected each year at night in the upper, mid-, and lower portions of the lake. All black bass collected were measured to the nearest 0.1 in; fish captured in fall studies were weighed to the nearest 0.01 lb. Electrofishing catch per unit effort data are reported as the mean number of fish collected per hour of electrofishing (fish\hour) in each year sampled. Population size structures of largemouth and spotted bass were assessed using spring electrofishing catch per unit effort data, proportional stock density (PSD), and relative stock density (RSD) (Anderson and Gutreuter 1983). Electrofishing catch rates were also examined for ≤ 8.0, 8.0-11.9, 12.0-14.9, and ≥ 15.0-in size-classes of largemouth and spotted bass. Trends in electrofishing catch rates of both spotted and largemouth bass were analyzed with Spearman rank correlations (SAS Institute 1988). Fall electrofishing data were collected to determine relative weight indices (Wr) in each year from 1985-1994 (Wege and Anderson 1978).

Largemouth and spotted bass year class strength was indexed annually. Numbers of young-of-year produced were estimated from cove-rotenone surveys at both age 0 and age 1 from fish collected during spring electrofishing studies (Buynak 1993). Mean length of young-of-year largemouth bass produced each year was obtained from fish collected in fall electrofishing samples.

Age and growth data were obtained for both largemouth and spotted bass from scales removed from the left side of each fish at the tip of the extended pectoral fin. Most scale samples were read with a microfiche reader; scales from fish too large to be accurately read with the microfiche were aged with an Eberbach scale viewer. Scale measurements were corrected for differences in magnification. Age and growth relationships were determined by the Fraser-Lee method (Ricker 1971). Confidence intervals (95%) were determined for data collected in 1985, 1991, and 1994. Survival was estimated by the Robson-Chapman method (Ricker 1975) from spring electrofishing data collected from 1985-1994.

Total standing stocks of fish were estimated from cove-rotenone samples (Davies and Shelton 1983). In 1985 and 1986, two cove sites totaling 4.9 acres were sampled. From 1987-1989, the area sampled was increased to 7.8 acres by moving the block net to the mouth of each cove. Rotenone data from 1991-1994 were collected from only one of the original coves and totaled 3.9 acres; no samples were collected in 1990. Rotenone data collected during this study was compared to historical data collected at the lake since impoundment. Trends in standing stock estimates obtained from 1974-1994 were analyzed with Spearman rank correlations (SAS Institute 1988).

Catch and harvest of black bass and fishing pressure from 1985-1989 and in 1993-1994 were estimated with a nonuniform probability creel survey conducted by a roving clerk (Malvestuto 1983). Each survey was conducted 4 days/week, 7.5 hours/day, from March to October. The creel clerk recorded the size of each fish and the number of each black bass species harvested. Anglers were also asked about the numbers and sizes of black bass they caught and released. Trends in creel statistics were analyzed with Spearmans rank correlations (SAS Institute 1988).

RESULTS

Population Size Structure

Electrofishing - Significant increasing trends were observed in the electrofishing catch rates of most size groups of largemouth bass; no trend existed in numbers of ≥15.0 in largemouth bass (Table 1). Low catch rates of largemouth bass in 1985 and 1986 (39.4 and 25.3 fish/hour) increased and stabilized between 79.9 and 97.5 fish/hour from 1987-1990 (Table 2). Catch per unit effort increased again from 1991-1994 with rates increasing to 130.3-198.8 fish/hour. Catch rates of ≤8.0 in bass increased from 7.5 fish/hour in 1985 to a high of 62.6 fish/hour in 1994 (Table 2). Electrofishing catch rates of 8.0-11.9 in largemouth bass increased from a low of 9.4 fish/hour in 1986 to 110.8 fish/hour in 1993; catch rates declined to 54.6 fish/hour in 1994. Numbers of 12.0-14.9 in largemouth bass increased from only 5.9 fish/hour in 1986 to 38.8 fish/hour in 1994. Initially, catch rates of ≥15.0 in largemouth bass increased from 2.9 fish/hour in 1985 to 12.1 fish/hour in 1987 and then declined each year to 3.4 fish/hour in 1990; densities have remained near this level through 1994.

Significant declining trends were observed in the numbers of 12.0-14.9 and ≥15.0 in spotted bass; no significant trends could be detected for the other size groups or in the total catch rates of spotted bass (Table 1). Electrofishing catch rates of 12.0-14.9 in fish declined from 1.71 fish/hour in 1985 to 0.08 fish/hour in 1994 (Table 3). Numbers of ≥15.0 in spotted bass, which were never very abundant, declined from 0.29 fish/hour in 1985 to 0 fish/hour in most years from 1989 to 1994.

Largemouth bass PSD increased from 36 in 1984 to 56 and then declined to ≤37 for all years except 1994 (Table 4). Declines in PSD values can be attributed to the larger increases in numbers of stock-size fish in relation to smaller increases in numbers of

quality-size fish. The RSD values for largemouth bass increased to a high of 21 in 1985 and subsequently declined to a value of 4 in 1994. Spotted bass PSD values were found to decline from 29 in 1984 to only 1 in 1994 (Table 4). RSD values of spotted bass were very low in all years samples.

Year-class strength of largemouth and spotted bass was indexed at age 1 using spring electrofishing data (Table 5). The mean number of age 1 largemouth bass collected was 21.8 fish/hour (SE=4.8) indicating that relatively strong year classes were produced from 1988 through at least 1992. The mean number of age 1 spotted bass was 7.4 fish/hour (SE=1.3) and indicated that above average year classes were produced in only 1988 and 1991.

Cove rotenone - Standing stocks have been estimated at Cave Run Lake in all but 3 years (1980,1983, and 1990) since the lake was impounded in 1974. No statistically significant trends (Table 6) were detected in either the total or gizzard shad standing stock; a non-significant declining trend (P=0.21) was detected in gizzard shad standing stocks from 1985-1994. Significant declining trends were observed in standing stock estimates of both largemouth and spotted bass from 1974-1985 (Table 6). Largemouth bass standing stock declined from 17.5 lb/acre in 1974 to 1.2 lb/acre in 1985 while spotted bass estimates declined from 9.2 lb/acre in 1975 to 1.5 lb/acre in 1985 (Table 7). Since 1985, the only significant trend detected was an increase in the standing stock estimate of largemouth bass from 1.2 lb/acre in 1985 to a high of 14.4 lb/acre in 1993 (Tables 6 and 7). Largemouth bass standing stocks were lowest from 1982 through 1986 ranging from 1.2-2.1 lb/acre.

Standing stock data collected under each black bass size limit at Cave Run Lake were summarized (Table 8). Largemouth bass standing stock declined from a mean of 8.2 lb/acre under the 10.0-in size limit to 2.4 lb/acre in years under a 12.0-in minimum size limit and then increased to a mean of 6.2 lb/acre under the 15.0-in size limit. Spotted bass estimates declined from 5.7 lb/acre under the 10.0-in size limit to 2.0 (12.0 in size limit) and 1.9 lb/acre (no-size limit). No major differences were detected in the total or gizzard shad standing stock under any of the three black bass size limits.

The number of largemouth bass collected per acre under the different black bass size limits are shown in Tables 9 and 10. Young-of-year largemouth bass (0-4 in group) were similar under the 10.0- and 12.0-in size limits (28.5 and 29.2 fish/acre), but increased to 48.7 fish/acre during years following the implementation of the 15.0-in size limit. Increases were also documented in the other size groups examined when the size limit was increased from 12.0 to 15.0 in (Tables 9 and 10).

Condition

Condition (Wr) of both largemouth and spotted bass declined since the implementation of the 15.0-in size limit (Table 11). Condition declined in 1985 for <12.0 in largemouth bass and in 1986 for 12.0-14.9 in fish. By 1987, condition had declined for all sizes of

largemouth bass. Since 1987, condition of all size groups have fluctuated but have remained below levels observed prior to the 15.0-in size limit.

Condition of spotted bass was depressed in 1985 following the removal of the size limit, and it continued to decline in 1986 (Table 11). Condition of spotted bass since 1985 has remained below levels documented prior to the removal of the spotted bass size limit which coincided with the 15.0-in size limit on largemouth bass.

Age and Growth

Largemouth bass growth rates increased initially and then declined for some ages of fish following the imposition of the 15.0-in size limit (Table 12). From 1985-1991 significant increases in growth rates were observed for ages 2 through 5 fish (Table 13). Growth rates for ages 4 and 5 fish recorded in 1994 were significantly less than values obtained in 1991; significant differences may also be occurring in ages 2 and 3 largemouth bass as 95% confidence intervals overlap just slightly. Back calculated lengths of age 1 largemouth bass declined from 6.0 inches in 1989 to 5.4 inches in 1994 (Table 12). Also, mean length at capture for young-of-year largemouth bass has declined since 1990 (Table 14).

No major changes were found in the back-calculated lengths of ≤3 year old spotted bass from 1985-1994 (Table 15). Back-calculated lengths for older fish increased between 1985 and 1987 before declining to 1985 levels.

Survival and Fishing Mortality

The estimated survival rates for both largemouth and spotted bass declined in 1994 (Table 16). It is not known if these observed declines are realistic or if they are a result of sampling problems associated with high spring water levels. Data collected in 1995 should indicate if values obtained in 1994 are realistic. Overall, significant declines have been detected in the survival rates of largemouth bass as estimates declined from 63% (95% CI= ±2.35) from 1985-1988 to 54% (95% CI=±5.96) from 1989-1994. Fishing mortality of largemouth bass was 41% under the 12.0-in minimum size limit regulation but declined to 17% in 1985 and 21% in 1986 (mean, 19%) after the implementation of the 15.0-in length limit. Fishing mortality for spotted bass was not determined while this species was under a 12.0-in size limit. Under the no-size limit regulation, fishing mortality for spotted bass was determined to be 21% in 1985 and 38% in 1986 (mean= 29%).

Creel Surveys

Creel survey data collected at Cave Run Lake indicate that significant declines have occurred in total fishing trips and total angler hours fished at the lake since 1984 (Table 17 and 18). Total fishing pressure declined from 16.4 trips/acre and 26.7 angler-hours/acre in 1984 to 3.0 trips/acre and 14.2 angler-hours/acre in 1994. Also, the

numbers of fishing trips for black bass declined from 3.6 to 0.9 trips/acre from 1984-1994 (Table 17). Fishing pressure for black bass initially increased from 8.0-11.2 angler-hours/acre following the implementation of the 15.0-in size limit before declining to 4.3 angler hours/acre in 1994.

Number of largemouth bass harvested/acre declined significantly following the imposition of the 15.0-in minimum size limit. Although not significant, the number of pounds of largemouth bass harvested/acre and harvest rates also declined (Table 17). In 1984, under the 12.0-in size limit, the number of largemouth bass harvested was estimated at 0.6 fish/acre and 1.0 lb/acre (Table 18). In all years creeled since the 15.0-in size limit was implemented, largemouth bass harvest was ≤0.3 fish/acre; number harvested in 1993 and 1994 was estimated at only 0.2 fish/acre. The number of pounds/acre harvested declined from 1.0 lb/acre in 1984 to 0.5 lb/acre in 1986, followed by an increase to 1.0 lb/acre in 1989. In 1993 and 1994 largemouth bass harvest declined to 0.5 and 0.4 lb/acre. The average size of largemouth bass harvested increased from 14.4 in to between 16.5 and 17.8 in after implementing the 15.0-in size limit. Harvest rates for largemouth bass anglers declined from 0.06 fish/hour under the 12.0-in size limit to ≤0.02 fish/hour in all years creeled since 1985.

The catch and release component of the largemouth bass fishery changed while under the 15.0-in size limit. Total numbers of ≥15.0 in largemouth bass caught (release plus harvest) from 1985 through 1994 were relatively stable even though fishing pressure for black bass declined significantly (Table 19). Catch rates during this time period increased from 0.01 fish/hour in 1985 and 1986 to either 0.02 or 0.03 fish/hour since 1986. Angler catch and release of ≥15.0 in fish increased from 6 % in 1986 to 40% of the total number of ≥15.0 in largemouth bass caught by anglers in 1993 and 1994. Actual numbers of 8.0-11.9 and 12.0-14.9 in fish caught and released by anglers declined from 1985-1988 (Table 19); however, angler catch rates for both size groups remained stable during these years (Table 20). Since 1988, increases were observed in both the number of bass caught and the catch rates of largemouth bass in the 8.0-11.9 and 12.0-14.9 in size classes (Table 19 and 20).

No significant trends were found in harvest of spotted bass from 1984-1994 even though harvest did initally increase following the imposition of the no-size limit regulation (Table 17 and 18). In 1984, under the 12.0-in size limit, the number of spotted bass harvested was 0.1 fish/acre and 0.1 lb/acre (Table 18) and increased to 0.2 to 0.4 fish/acre and 0.1-0.2 lb/acre from 1985-1989. In 1993 and 1994, spotted bass harvest declined (0.02 lb/acre) to levels below that observed under the 12.0-in size limit. The average size of spotted bass harvested decreased from 13.0 in (1.07 lb) under the 12.0-in size limit to between 9.7 and 10.5 in (0.42-0.50 lb) following the imposition of the no-size limit regulation. Catch and release of spotted bass was low and was estimated at ≤0.06 fish/hour in all years creeled (Table 20).

In 1994, black bass anglers were asked their opinions regarding the black bass fishery at the lake (Table 21). Most anglers (59.2%) felt that the black bass fishery had not

changed and 26.5% felt that the fishery had actually declined during the past two years. Only 32% of the bass anglers were satisfied with the 15.0-in size limit with 45% having some level of dissatisfaction. Almost 60% were not satisfied with the current black bass fishery at the lake; only 23% had some level of satisfaction. Black bass anglers were most interested in either catching a lot of 12.0-14.9 in fish or in catching a few keepers. Most black bass anglers (63-69%) do not harvest any species of black bass from Cave Run Lake. To increase satisfaction, anglers desired to return to a 12.0-in size limit (24.3%), to increase law enforcement (18.9%), and stock bass(16.2%). Of the total number of black bass anglers questioned, 43.2% wanted black bass size limits at the lake changed.

DISCUSSION

The 15.0-in size limit achieved the study objective of reducing exploitation rates (41 to 19%) on largemouth bass, but failed to achieve the harvest objective in terms of pounds per acre. Numbers of largemouth bass harvested, as expected, declined but it was anticipated that an increase in the average size bass harvested under the 15.0-in size limit would offset changes in the total pounds of largemouth bass harvested. Pounds of largemouth bass harvested/acre equaled values obtained with the 12.0-in size limit in only one year. Although catch and release of legal-sized largemouth bass increased, the addition of the catch and release biomass would still not result in meeting the harvest objective of 1 pound/acre.

Another objective was to increase the angler catch rate of quality (12.0-14.9 in) sized largemouth bass by a factor of 3-5 times above rates observed under the 12.0-in size limit. Catch and release data was not an available creel statistic prior to 1985. However, angler catch rates of this sized fish under the 15.0-in size limit did not increase (mean=0.026 fish/hour) but remained relatively stable for the first five years of the 15.0-in size limit. In 1993 and 1994, 8-9 years after the size limit change, angler catch rates of 12.0-14.9 in largemouth bass averaged 0.095 fish/hour for a 3.7 fold increase.

A primary objective of the size-limit change was to improve the size structure of the largemouth bass population in Cave Run Lake. Proportional stock densities of largemouth bass improved initially but then declined after 1986; similar declines in RSD values were observed. Values for PSD and RSD alone are misleading, since significant increasing trends in electrofishing catch rates for most size classes of largemouth bass, except >15.0 in, were observed from 1985 to 1994 at Cave Run Lake. Catch rates were also found to increase after implementation of a 15.0-in minimum-size limit at Lake of the Woods, Missouri (Richards 1986) and in Pomme de Terre Lake, Missouri (Dent 1986). Electrofishing catch rates of ≥15.0-in fish initially increased but declined to their lowest levels in 1992. The recruitment of the strong 1988 and 1989 year classes to the ≥15.0-in size group only slightly improved the density of this size group. The reason these two strong year classes did not contribute more to the fishery at Cave Run Lake is not known. Possible factors in the failure to document a larger increase which were not measured in this study, included the importance of the night fishery in the harvest of

largemouth bass, catch and release mortality, and illegal harvest of fish. Possible contributing factors that were measured included declines in growth rates, condition, and survival rates of largemouth bass that have been detected at the lake during the course of the study.

Electrofishing and cove-rotenone data collected at Cave Run Lake indicated that the largemouth bass population initially increased, stabilized from 1987-1990, and increased again from 1991-1994. The study objective of increasing the standing stock from a mean of 2.4 lb/acre under the 12.0-in size limit to 4-5 lb/acre was not achieved until after the second increase. The reason for this pattern (increase-stabilize-increase) in largemouth bass abundance is not known but may be related to a combination of several factors. The first increase was probably due to reduction in fishing mortality and the protection of more largemouth bass by the size-limit change. The second increase was also a function of the size-limit change and possibly the cessation of the drought and a change in trophic status. Above average year classes (1988-1992) of largemouth bass coincided with increased rainfall following the drought that lasted from 1982-1988 (Anomyous 1984). Changes in largemouth bass populations due to changes in environmental conditions have been documented (Summerfelt 1975, Buynak et al. 1991). Cave Run Lake also changed from an oligotrophic rating in 1984 (Anomyous 1984) to mesotrophic from 1988 (Anomyous 1988) through 1994 (personal communications, Dr. Brian Reeder, Morehead State University). Jenkins (1975) found that largemouth bass populations were positively correlated with total standing stocks and suggested that basic fertility overrides the importance of species associations in reservoirs. Siler et al. (1986) found largemouth bass abundance to be greater in more fertile upper-lake areas of Lake Norman, North Carolina. Largemouth bass abundance at Cave Run Lake was significantly greater in the more fertile mid and lower lake (Buynak et al. 1989). In other Kentucky reservoirs, standing stocks of all fish and largemouth bass increased as nutrient levels increased (Buynak 1986). In summary, the increase in the size limit, cessation of the drought, and the recent eutrophication contributed to the strong year classes (1988-1992) of largemouth bass produced at Cave Run lake.

A 15.0-in minimum size limit was used successfully in Missouri to manage largemouth bass in several reservoirs (Novinger 1986, Richards 1986); however, Novinger (1986) stated that in one of these reservoirs, spotted bass would have been better managed with a lower minimum-length limit. The no-size limit regulation at Cave Run Lake met the objective of increasing the harvest of spotted bass for the first 5 years of the study. By 1993 and 1994, however, both numbers and pounds of spotted bass in the harvest declined to levels below that obtained under the 12.0-in size limit. This decline was due to declines in availability of acceptable sized (≥9.0 in) spotted bass in the population. The secondary objective of reducing the numbers of these slower growing bass was not achieved since no significant changes in total numbers of spotted bass were detected. A significant decline were observed in numbers of spotted bass ≥12.0 in.

The differential-harvest regulation at Cave Run Lake has generally been effective in managing black bass populations at the lake, despite the compounding factors of the

drought and an increase in nutrients. The regulation resulted in 1) reduced exploitation rates of largemouth bass, 2) increased abundance of <15.0 in fish, especially 12.0-14.9 in fish, 3) increased standing stocks of largemouth bass, 4) increased angler catch rates of 12.0-14.9 in largemouth bass and 5) increased harvest of spotted bass. The only objectives not met were 1) the harvest of largemouth bass under the 15.0-in size limit did not equal or exceed the weight of largemouth bass harvested under the 12.0-in size limit and 2) total spotted bass numbers did not decline at Cave Run Lake following implementation of the no-size limit regulation. Even with the positive effects documented in the black bass fishery, the majority of anglers questioned were not satisfied with the bass fishery at the lake. Anglers responded that the single most important thing that could be done to increase their level of satisfaction was to return to a 12.0-in size limit; nearly 50% of surveyed black bass anglers wanted size limits at the lake changed.

The quality of the Cave Run Lake black bass fishery would be immediately reduced with a return to a 12.0-in minimum size limit. Anglers would quickly overharvest the numbers of ≥12.0-in bass. It is recommended that a 13.0-16.0 in protective slot limit be considered as a regulatory strategy for largemouth and smallmouth bass at Cave Run Lake and the no-size limit be continued for spotted bass. The expected goals and benefits of the protective slot limit would include:

1) Growth rates of largemouth bass to improve significantly to levels obtained in 1991. Growth rates of smallmouth and spotted bass to remain at levels seen in 1994.

2) Condition (Wr) of all three species of black bass to improve to values ≥ 90.

3) Survival rates of largemouth bass to increase from the 54% observed from 1989-1994 to at least 60% under the proposed size limit. No changes are expected in survival of smallmouth or spotted bass.

4) Maintain electrofishing catch rates of 12.0-14.9 in largemouth bass at current levels (≥30.0 fish/hour).

5) Maintain electrofishing catch rates of 8.0-11.9 in largemouth bass at ≥35 fish/hour.

6) Increase electrofishing catch rates of ≥15.0-in largemouth bass by at least 1.5 times above 1992-1994 levels (mean=5.8 fish/hour).

7) Angler catch rates of ≥12.0-in largemouth bass which averaged 0.046 fish/hour under the 15.0-in size limit to catch rates ≥0.10 fish/hour.

8) Numbers of ≥12.0-in largemouth bass caught and released by anglers to increase from a mean of 7,565 fish while under the 15.0-in size limit to ≥10,000 largemouth bass per year average.

9) Pounds of largemouth harvested to increase from a mean of 0.6 lb/acre to at least 1.0 lb/acre.

10) Harvest of largemouth bass to increase from 0.26 fish/acre to at least 0.75 fish/acre.

11) Angler catch of smallmouth and spotted bass will not differ from the 15.0-in size limit with the exception that slightly more smallmouth bass will be harvested.

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Table 1. Spearman coefficients of rank correlation between year and spring electrofishing catches for each size group of largemouth bass and spotted bass collected from Cave Run Lake during 1985-1994. Positive values indicate increasing trends; negative values indicate decreasing trends. Asterisks denote $P \leq 0.10$*, $P \leq 0.05$**, or $P \leq 0.01$***.

Species	Size group (in)				Total
	<8.0	8.0-11.9	12.0-14.9	≥15.0	
Largemouth bass	0.94***	0.87***	0.87***	-0.02	0.96***
Spotted bass	0.27	-0.01	-0.98***	-0.57*	0.25

Table 2. Spring electrofishing catch-per-unit-effort (CPUE) for each size class of largemouth bass collected at Cave Run Lake. CPUE = no./h; numbers in parentheses are standard errors.

Year	Inch class				Total
	<8.0	8.0-11.9	12.0-14.9	≥15.0	
1994	62.6 (7.0)	54.6 (7.9)	38.8 (3.1)	3.8 (0.6)	159.6 (15.5)
1993	46.3 (5.4)	110.8 (10.3)	36.2 (94.8)	4.9 (0.8)	198.8 (15.3)
1992	52.0 (4.4)	77.8 (5.1)	21.9 (1.8)	2.8 (0.6)	154.6 (7.0)
1991	28.8 (3.8)	64.1 (4.8)	31.0 (2.1)	6.3 (1.0)	130.3 (7.3)
1990	23.3 (2.7)	42.4 (2.6)	18.5 (2.2)	3.4 (0.9)	87.6 (5.6)
1989	34.5 (9.0)	49.8 (8.8)	9.1 (1.0)	4.2 (1.0)	97.5 (18.7)
1988	14.3 (2.3)	50.7 (7.7)	8.5 (1.5)	7.5 (1.1)	81.0 (10.7)
1987	13.3 (2.2)	33.3 (3.5)	21.1 (2.9)	12.1 (1.5)	79.9 (6.3)
1986	6.3 (0.9)	9.4 (1.4)	5.9 (1.0)	3.7 (0.7)	25.3 (2.2)
1985	7.5 (2.6)	22.4 (4.7)	8.6 (1.1)	2.9 (0.4)	39.4 (5.9)

Table 3. Spring electrofishing catch-per-unit-effort (CPUE) for each size class of spotted bass collected at Cave Run Lake. CPUE = fish/hour; numbers in parentheses are standard errors.

Year	Inch class				Total
	<8.0	8.0-11.9	12.0-14.9	≥15.0	
1994	26.50 (2.96)	15.76 (1.98)	0.08 (0.08)	0.00 (0.00)	42.34 (4.56)
1993	33.50 (4.98)	14.76 (1.94)	0.16 (0.12)	0.08 (0.08)	48.50 (6.24)
1992	26.58 (4.44)	21.50 (2.50)	0.16 (0.12)	0.00 (0.00)	48.26 (6.60)
1991	11.50 (1.96)	15.50 (1.74)	0.26 (0.14)	0.00 (0.00)	27.26 (3.24)
1990	29.76 (3.68)	15.60 (2.72)	0.32 (0.14)	0.00 (0.00)	45.68 (6.04)
1989	42.00 (6.48)	17.18 (3.57)	0.45 (0.21)	0.00 (0.00)	59.64 (9.76)
1988	38.80 (5.46)	21.07 (3.22)	0.33 (0.16)	0.07 (0.07)	60.40 (8.14)
1987	24.40 (3.99)	12.47 (3.39)	0.67 (0.32)	0.13 (0.13)	37.73 (4.94)
1986	16.59 (2.28)	11.12 (1.57)	1.65 (0.35)	0.00 (0.00)	29.35 (2.66)
1985	15.64 (3.30)	22.07 (5.12)	1.71 (0.45)	0.29 (0.13)	39.71 (8.14)

Table 4. Proportional (PSD) and relative (RSD) stock densities for largemouth and spotted bass in Cave Run Lake. Numbers in parentheses are the (±) 95% confidence intervals around the indices.

	Largemouth bass		Spotted bass	
Year	PSD	RSD_{15}	PSD	RSD_{14}
1984	36 (4.0)	11 (2.6)	29 (3.7)	1
1985	52 (5.0)	21 (4.1)	15 (3.5)	0
1986	56 (3.7)	17 (3.7)	9 (3.6)	0
1987	24 (2.8)	11 (2.3)	3 (1.8)	0
1988	22 (3.0)	7 (1.8)	5 (2.0)	0
1989	21 (3.0)	7 (1.8)	5 (2.0)	0
1990	34 (3.3)	5 (1.5)	7 (2.5)	0
1991	37 (3.0)	6 (1.0)	4 (3.0)	0
1992	24 (2.0)	3 (1.0)	4 (2.0)	0
1993	27 (2.0)	3 (1.0)	3 (2.0)	1 (1.0)
1994	44 (3.0)	4 (1.0)	1 (1.0)	0

Table 5. Largemouth and spotted bass year class strength at age 1 (fish/hour) obtained from spring electrofishing studies at Cave Run Lake from 1985-1994.

Year class	Largemouth bass	Spotted bass
1985	3.9	5.6
1986	6.8	2.9
1987	10.1	8.4
1988	27.9	14.3
1989	18.8	5.4
1990	29.3	3.4
1991	43.5	10.4
1992	41.0	
1993	14.7	8.6
Mean	21.8	7.4
Std error	4.8	1.4

Table 6. Spearman coefficients of rank correlation between year and cove-rotenone standing stocks for each species or group of fish collected from Cave Run Lake from 1974-1994. Positive values indicate increasing trends; negative values indicate decreasing trends. Asterisks denote $P \leq 0.01$*.

Year	Total	Gizzard shad	Largemouth bass	Spotted bass
1974-1985	-0.10	0.16	-0.93*	-0.87*
1985-1994	-0.18	-0.47	0.93*	0.33

Table 7. Standing stock (lb/acre) obtained for the total fish population and selected species from cove-rotenone studies at Cave Run Lake from 1974-1994.

	Standing stock (lb/acre)			
Year	Total	Gizzard shad	Largemouth bass	Spotted bass
1974	157.5	33.9	17.5	7.2
1975	84.0	14.4	6.3	9.2
1976	93.2	19.7	5.6	3.4
1977	142.4	35.7	3.5	3.1
1978	87.4	3.3	2.6	2.7
1979	151.0	75.2	2.2	0.9
1980	----------NO DATA----------			
1981	93.4	43.3	3.8	2.2
1982	71.0	22.0	2.1	2.5
1983	----------NO DATA----------			
1984	104.1	21.0	1.4	1.9
1985	119.7	30.9	1.2	1.5
1986	77.5	16.7	1.7	1.4
1987	132.2	28.4	3.2	2.2
1988	102.7	25.6	3.0	2.5
1989	115.5	22.1	4.2	1.6
1990	----------NO DATA----------			
1991	106.2	24.1	7.8	2.8
1992	79.2	9.2	10.9	1.1
1993	104.1	29.8	14.4	1.6
1994	51.7	8.1	9.1	2.6

Table 8. Comparison of mean standing stock estimates under each size limit at Cave Run Lake. Standard errors are in parentheses.

Size limit (in)	Years	Standing stock (lb/acre) Total	Gizzard shad	Largemouth bass	Spotted bass
10	1974-1977	119.3 (18.1)	25.9 (5.3)	8.2 (3.2)	5.7 (1.5)
12	1978-1984	101.4 (13.5)	32.9 (12.3)	2.4 (0.4)	2.0 (0.3)
15	1985-1994	98.8 (8.3)	21.7 (2.8)	6.2 (1.5)	1.9[a] (0.2)

[a]No size limit on spotted bass during this period.

Table 9. Comparison of mean numbers of each size group of largemouth bass taken in cove-rotenone studies (fish/acre) at Cave Run Lake under each black bass size limit. Standard errors are in parentheses.

Size limit	Years	Inch group (fish/acre) 0-4	5-11	12-14	≥15
10	1974-1977	28.5 (18.9)	39.0 (27.5)	0.4 (0.2)	0.03 (0.03)
12	1978-1984	29.2 (4.8)	7.4 (1.8)	0.5 (0.1)	0.08 (0.05)
15	1985-1994	48.7 (10.9)	14.9 (3.8)	1.9 (0.6)	0.27 (0.09)

Table 10. Numbers of each size group of largemouth bass collected at Cave Run Lake in cove-rotenone study from 1974-1994.

Year*	Inch group (fish/acre) 0-4	5-11	12-14	≥15
1974	85	121	1.1	0.0
1975	8	18	0.3	0.0
1976	8	12	0.0	0.0
1977	13	5	0.3	0.1
1978	45	10	0.6	0.0
1979	30	5	0.7	0.0
1980	----------NO DATA----------			
1981	22	13	0.2	0.2
1982	32	6	0.2	0.2
1983	----------NO DATA----------			
1984	17	3	0.6	0.0
1985	41	4	0.0	0.0
1986	25	5	0.2	0.0
1987	11	6	0.9	0.4
1988	39	6	0.9	0.1
1989	126	11	0.8	0.3
1990	----------NO DATA----------			
1991	52	33	2.1	0.0
1992	56	19	3.9	0.5
1993	59	31	5.1	0.8
1994	29	19	3.3	0.3

t = < 0.05 fish/a.
* = 10.0 in size limit (1974-1977), 12.0 in size limit (1978-1984), 15.0 in size limit (1985-1994).

Table 11. Relative weight (Wr) of the various size groups of largemouth and spotted bass from Cave Run Lake.

Year	Largemouth bass (in) 8.0-11.9	12.0-14.9	≥15.0	Spotted bass (in) 7.0-10.9	11-13.9	≥14.0
1982	100	100	108	91	94	
1983	96	95	96	93	84	
1984	100	113	105	102	102	
1985	81	99	105	81	86	
1986	84	84	98	81	83	81
1987	82	84	89	82		
1988	84	87	98	80		
1989	94	83	91	82	79	
1990	87	83	89	81	94	
1991	89	84	89	90	86	
1992	84	85	93	83		
1993	94	88	89	86	83	
1994	93	91	87	86	81	

Table 12. Back-calculated length (in) at annulus for largemouth bass collected from Cave Run Lake, 1985-1994.

Year	fish	Age 1	2	3	4	5	6	7	8	9	10	11
1985	41	5.5	8.0	10.3	12.2	13.4	15.0	16.9	19.2			
1986	38	5.2	7.7	9.4	11.8	12.9	14.6	15.9	17.1			
1987	147	5.6	8.9	11.3	13.3	14.9	16.2	17.4	18.8	19.5		
1988	120	5.3	8.4	10.8	12.5	14.1	15.6	16.9	18.0	19.1	19.6	20.3
1989	83	6.0	8.9	11.3	13.0	14.6	15.6	16.8	17.5	18.8	20.7	21.5
1990	124	5.8	9.0	11.4	13.4	14.9	16.0	17.2	18.3	19.6	20.5	
1991	130	5.7	9.1	11.7	13.5	14.9	16.4	17.7	18.6	19.6	20.3	20.3
1992	108	5.6	8.8	11.3	13.2	14.6	15.8	17.4	18.5	19.5	21.1	
1993	127	5.4	8.9	11.7	13.5	14.9	16.4	17.6	18.6	19.2		
1994	132	5.5	8.8	11.3	13.0	14.1	15.6	16.8	18.4	19.6	21.0	22.6

Table 13. Back-calculated lengths (in) for age 1 through age 7 largemouth bass collected from Cave Run Lake in 1985, 1991, and 1994. Numbers in parentheses are 95% confidence intervals.

Age	1985	1991	1994
1	5.5 (5.3-5.7)	5.7 (5.5-5.8)	5.5 (5.3-5.7)
2	8.0 (7.6-8.3)	9.1 (9.0-9.3)	8.8 (8.6-9.0)
3	10.3 (9.9-10.6)	11.7 (11.5-11.9)	11.3 (11.1-11.5)
4	12.2 (11.4-12.9)	13.5 (13.2-13.8)	13.0 (12.6-13.4)
5	13.4 (12.6-14.2)	14.9 (14.7-15.1)	14.1 (13.7-14.5)
6	15.0 (13.8-16.3)	16.4 (16.1-16.7)	15.6 (15.2-16.0)
7	16.9 (15.7-18.0)	17.7 (17.3-18.1)	16.8 (16.2-17.4)

Table 14. Mean length at capture and 95% confidence intervals for young-of-year largemouth bass collected at Cave Run Lake during fall electrofishing studies.

Year	No. of fish	Mean length
1990	182	5.0 ± 0.11
1991	183	5.0 ± 0.11
1992	58	4.8 ± 0.18
1993	268	4.6 ± 0.12
1994	165	4.7 ± 0.12

Table 15. Back-calculated length (in) at annulus for spotted bass collected from Cave Run Lake in each year.

Year	No. fish	Age 1	2	3	4	5	6	7
1985	58	5.0	7.0	9.0	10.4	11.3	12.8	14.8
1986	55	4.9	7.2	9.2	10.5	12.2	13.6	14.7
1987	85	5.1	7.2	9.1	10.9	13.3	15.0	16.9
1988	69	5.0	7.0	8.8	10.1	11.7	13.4	14.9
1989	44	4.7	7.1	8.9	10.1	11.4	12.0	
1990	63	5.0	7.0	8.7	9.8	10.7	12.5	
1994	62	4.7	7.2	9.0	10.2	11.5		

Table 16. Survival estimate (%) for each species of black bass collected at Cave Run Lake from 1985-1994.

Year	Species: Largemouth bass	Spotted bass
1985	61	60
1986	62	51
1988	65	60
1989	56	53
1990	59	61
1991	49	
1992	62	
1993	58	
1994	42	36

Table 17. Spearman coefficients of rank correlation between each angler statistic and year at Cave Run Lake during 1985–1994. Positive values indicate increasing trends; negative values indicate decreasing trends. Asterisks denote $P \leq 0.10$*, $P \leq 0.05$**, or $P \leq 0.01$***.

Statistic	Spearman coefficients (r)
Total fishing trips	
Trips/acre	-0.67*
Angler hours/acre	-0.76**
Black bass fishing trips	
Trips/acre	-0.95***
Angler hours/acre	-0.86***
Largemouth bass	
Fish harvested/acre	-0.64*
Lb harvested/acre	-0.45
Fish/hour harvested	-0.37
Spotted bass	
Fish harvested/acre	-0.42
Lb harvested/acre	-0.03
Fish/hour harvested	-0.19

Table 18. Largemouth and spotted bass harvest statistics obtained from creel surveys conducted at Cave Run Lake.

Statistic	1984	1985	1986	1987	1988	1989	1993	1994
Fishing effort								
Fishing trips/acre	16.4	6.4	6.4	4.2	3.4	4.5	3.3	3.0
Angler-hours/acre	26.7	31.3	30.4	17.4	17.7	18.9	16.9	14.2
Fishing trips for black bass/acre	3.6	2.3	2.1	1.4	1.3	1.4	0.9	0.9
Angler-hours/acre for bass	8.0	11.2	10.0	5.7	6.6	5.8	4.9	4.3
Largemouth bass harvest								
No. harvested/acre	0.6	0.3	0.2	0.3	0.3	0.3	0.2	0.2
Lb harvested/acre	1.0	0.6	0.5	0.7	0.8	1.0	0.5	0.4
Fish/hour harvested	0.06	0.01	0.01	0.02	0.02	0.02	0.01	0.01
Fish/hour ≥15.0 in caught		0.01	0.01	0.03	0.02	0.03	0.02	0.02
Mean length (in)	14.4	16.6	16.5	17.4	17.4	17.8	17.3	16.8
Mean weight (lb)	1.56	2.37	2.31	2.75	2.75	2.94	2.69	2.45
Spotted bass harvest								
No. harvested/acre	0.1	0.4	0.2	0.3	0.4	0.3	0.05	0.04
Lb harvested/acre	0.1	0.2	0.1	0.1	0.2	0.1	0.02	0.02
Fish/hour harvested	t	0.01	0.01	0.02	0.02	0.01	t	t
Mean length (in)	13.0	9.7	10.5	9.8	10.2	10.4	10.3	10.0
Mean weight (lb)	1.07	0.42	0.52	0.42	0.48	0.50	0.49	0.45

t < 0.005 fish/hour.

Table 19. Harvest and catch-and-release data obtained for largemouth bass caught by all anglers at Cave Run Lake.

		Catch and release (in)				≥15.0 (in)	
Year	Harvest	8.0-11.9	12.0-14.9	≥15.0	Total	Total caught	% released
1984[a]	5,185						
1985	2,128	6,353	4,537	258	11,148	2,386	10.8
1986	1,815	5,865	4,799	115	10,779	1,930	6.0
1987	2,191	2,158	3,597	748	6,503	2,939	25.5
1988	2,430	3,772	2,963	506	7,241	2,936	17.2
1989	2,839	6,410	6,409	709	13,528	3,548	19.9
1993	1,478	5,261	15,784	1,005	22,050	2,483	40.5
1994	1,456	5,781	10,557	970	17,308	2,426	40.0

a = 12.0 in size limit, catch-and-release data not kept.

Table 20. Angler catch rates (fish/hour) for each size group of largemouth and spotted bass that were caught and released at Cave Run Lake in each year creeled.

	Largemouth bass (in)			Spotted bass (in)	
Year	8.0-11.9	12.0-14.9	≥15.0	8.0-14.9	≥15.0
1985	0.035	0.025	t	0.05	
1986	0.022	0.018	t	0.01	
1987	0.015	0.025	0.010	0.01	
1988	0.028	0.022	t	0.01	t
1989	0.040	0.040	0.005	0.06	
1993	0.035	0.105	0.007	t	
1994	0.046	0.084	0.008	t	

t < 0.005 fish/hour.

Table 21. Results of an angler questionnaire conducted at Cave Run Lake in 1994.

1)	Do you take home any largemouth or smallmouth bass from Cave Run Lake?	Some - 33.3% None - 62.5% All - 4.2%
2)	Do you take home any Kentucky spotted bass from Cave Run Lake?	Some - 31.3% None - 68.7% All - 0.0%
3)	One purpose of the 15-inch size limit on largemouth and smallmouth bass is to improve the numbers of ≥12.0 in bass in the population. During the past 2 years, how would you describe the bass fishery at Cave Run Lake?	Improving - 14.3% No change - 59.2% Declining - 26.5%
4)	On a scale of 1 to 5 with 1 = low satisfaction, 3 = neutral, and 5 = high level of satisfaction, how would you rank your level of satisfaction with the 15-inch size limit on largemouth bass and smallmouth bass and the no-size limit on spotted bass?	1 - 42.6% 2 - 2.1% 3 - 23.4% 4 - 10.6% 5 - 21.3%
5)	On a scale of 1 to 5 with 1 = low satisfaction, 3 = neutral, and 5 = high level of satisfaction, how would you rank your degree of satisfaction with black bass fishing at Cave Run Lake?	1 - 46.8% 2 - 12.8% 3 - 17.0% 4 - 17.0% 5 - 6.4%

6) Which of the following would you prefer to expect from the bass fishery at Cave Run Lake that would make your bass fishing experiences the most satisfying?

a) catch a lot of small bass (less than 12 inches)	- 3.2%
b) catching a lot of 12-14.9 inch bass	- 35.5%
c) catching a few keepers	- 35.5%
d) catching an occasional trophy fish	- 25.8%

7) Which is the single most important thing (i.e. changes in size limit, etc.) that could be done or changed to increase your level of satisfaction with the black bass fishery at Cave Run Lake?

stock fewer musky	- 8.1%
stock bass	- 16.2%
stock shad	- 2.7%
more law enforcement	- 18.9%
remove 15-in size limit	- 8.1%
go to 12-in size limit	- 24.3%
lower size limit	- 5.4%
go to a slot limit	- 5.4%
improve quality of fish	- 2.7%
don't know	- 2.7%
let as is	- 5.4%