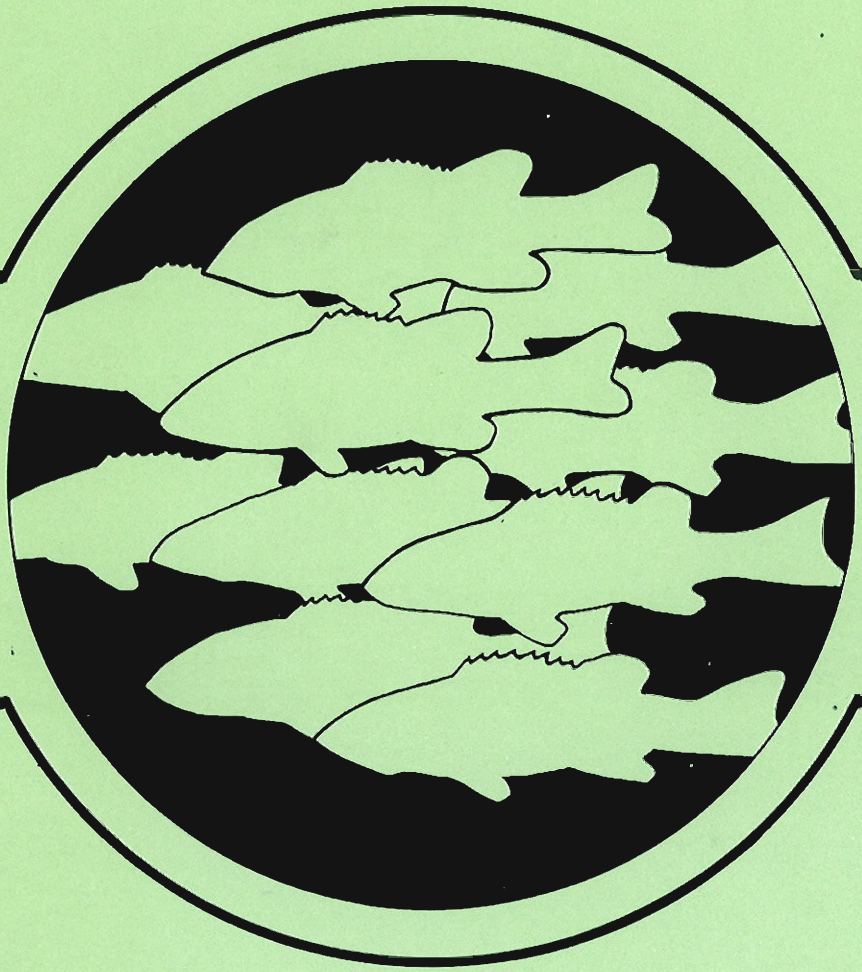

Fisheries Bulletin of the Kentucky Department of Fish and Wildlife Resources

Evaluation of the 12-inch Size Limit on Black Bass in Kentucky

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Bulletin No. 72 **September 1984**

Kentucky
Department of Fish and Wildlife Resources
Carl E. Kays, Commissioner

Division of Fisheries
Peter W. Pfeiffer, Director

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on

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This study was financed partially with
Federal Aid in Sport Fish Restoration Funds
Dingell-Johnson Project Number F-40(4-6)

1984

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ABSTRACT

As a result of an increasing demand placed on black bass fisheries statewide, the minimum length limit on black bass was changed from ten inches to twelve inches at the beginning of 1978. A five-year research project to evaluate the effect of the new limit on fish population structure, exploitation, natural mortality, survival, age and growth characteristics, and anglers creel, was initiated simultaneously. Cove rotenone, electrofishing, fish tagging, and creel surveys were employed to collect data from each of nine study sites annually. Fish population structure changes included increase in young-of-year bass numbers and increases in the biomass of intermediate-size bass after the 12-inch limit became effective. Exploitation, natural mortality, and survival rate changes displayed wide variations with no trends apparent. Growth rates slowed slightly under the new size limit. Fishing pressure increased as did the number and weight of bass harvested following an initial decrease during the first year. The overall quality of the black bass fishery in terms of larger fish harvested improved slightly while the anticipated over-exploitation of bass was reduced at some sites and increased at others following imposition of the 12-inch length limit.

INTRODUCTION

The increasing demand by Kentucky anglers for black bass fishing opportunities brought about several changes in the management strategy for these important sport fish. Creel surveys conducted in 1976 and 1977 had shown that nearly a third of the trips and hours spent on eight lakes were by black bass fishermen. Because of the probability of over-exploitation of bass populations, a statewide 12-inch minimum length limit was imposed on 1 January 1978.

A 5-year evaluation study of the 12-inch length limit and its impact on all species of black bass in lakes and streams was initiated in 1978. Of major concern were the changes in fish population structure, exploitation rate, mortality, growth, catch and harvest rates, and total harvest of black bass.

Nine bodies of water, including a pool of the Ohio River, two streams, two state-owned lakes, and four large impoundments, were selected as study sites. These waters represented wide geographical differences as well as a diversity in habitat and fish population dynamics.

The results of the evaluation of the 12-inch minimum size limit will form the basis for future management of black basses in Kentucky's waters.

Study Areas

Barkley Lake is a 57,920-acre (45,600 acres in Kentucky), U.S. Army Corps of Engineers (COE), impoundment on the Cumberland River in western Kentucky. The dam impounding this multi-purpose reservoir is located near Grand Rivers in Lyon County and became operational in 1966. Barkley Lake has a mean depth of 15 feet and a maximum depth of 75 feet at seasonal pool (359 ft above msl); the shoreline length is 1,004 miles at seasonal pool. Barkley Lake was classified as eutrophic by the U.S. Environmental Protection Agency (USEPA), National Eutrophication Survey (NES) in 1973. The Carlson Trophic State Index (TSI) for chlorophyll-a was calculated at a seasonally averaged value of 52 (Ky. Natural Resources and Environmental Protection Cabinet 1984). Thermal stratification occurs only occassionally for short periods of time.

Barren River Lake is a 10,000-acre COE impoundment on the Barren River in south central Kentucky. The dam is located about 10 miles east of Scottsville in Allen County and was completed in 1964. Barren River Lake has a mean depth of 26 feet and a maximum depth of 81 feet at seasonal pool (555 ft above msl). The seasonal average TSI is 43. The lake is classified as mesotrophic in the main lake to eutrophic in the Skaggs and Beaver Creek arms. The lake experiences annual stratification.

Beaver Lake is a 170-acre, Department-owned lake located in central Kentucky near Lawrenceburg in Anderson County. The lake has a mean depth of 17 feet, a maximum depth of 47 feet, and a shoreline length of 10.5 miles. The lake is classified as eutrophic with a mean TSI value of 58. This lake is also fertilized by the Department, which likely contributes to a higher TSI index than would normally occur.

Cave Run Lake is an 8,270-acre COE impoundment on the Licking River near Morehead in Rowan County. This eastern Kentucky lake has a mean depth of 27 feet at seasonal pool (734 ft above msl). The seasonal mean TSI value of 35 classifies the lake as oligotrophic. The dam was completed in 1974.

Grayson Lake is located in eastern Kentucky near Grayson in Carter County, and was impounded in 1968. The 1,500 acres impounded by the dam at seasonal pool level of 649 feet above msl has a mean depth of 19 feet and a maximum depth of 59 feet. This oligotrophic lake has a yearly mean TSI value of 37. The COE dam was completed in 1968.

Lake Malone, located in west central Kentucky near Greenville in Muhlenberg County, is a 692-acre Department-owned lake. This lake has a mean depth of 17 feet, a maximum depth of 40 feet, and a 34 mile long shoreline. This eutrophic lake is fertilized by the Department and has a TSI mean value of 54.

Markland Pool of the Ohio River extends from the Markland Locks and Dam at Ohio River Mile 532 upstream for a distance of 95 miles. It is locally referred to as the "Cincinnati Pool" because the dam provides a deep, stable pool in the metropolitan Cincinnati harbor area. The 21,700-acre pool, impounded by Markland Dam which was completed in 1964, includes several hundred acres of flooded creek channels and embayments. These "backwater" areas constitute a large portion of the area utilized for sport fishing. While the pool and, particularly, the inundated streams resemble a lacustrine environment, they are dynamic in terms of water quantity, quality, and fishery resources due to association with a riverine habitat.

Elkhorn Creek drains approximately 500 square miles of Kentucky's inner Bluegrass physiographic region. Headwaters of the North Fork and South Fork of Elkhorn Creek arise near Lexington. The South Fork flows north-westerly for 35 miles while the North Fork flows in the same direction for a distance of 45 miles, then flows toward the southwest approximately 10 miles to join the South Fork near Frankfort, Kentucky. The stream flows northwest for 16 miles where it enters the Kentucky River. North Fork and South Fork have an average gradient of 4 to 5 feet per mile while the main stream's gradient is 10 feet per mile (Jones 1968).

For the purposes of this study, the South Fork was excluded as a study site. Water quality deterioration resulting from effluent from a large metropolitan sewage treatment plant on the headwaters of South Fork has lead to a decline in the quality of the fishery on that tributary.

Slate Creek is a tributary of the Licking River flowing through Menifee, Montgomery, and Bath Counties in northeastern Kentucky. This stream arises in Menifee County near Means, Kentucky, and flows in a northerly direction for 50 miles to its confluence with the Licking River near Wyoming, Kentucky.

Slate Creek is normally a series of pools connected by sand and gravel bars through which the water slowly seeps. The bars are 2 to 30 feel long. Pools vary in depth from 2 to 10 feet and are from 20 feet to a mile or more in length. There are two dams on the stream.

METHODS

Fish Population Studies

Fish population surveys were conducted at all study waters annually. Cove-rotenone sampling was employed at Barkley, Barren River, Cave Run, and Grayson lakes and in Markland Pool of the Ohio River. Electrofishing samples were taken at Beaver and Malone lakes and at Slate and Elkhorn creeks. Additionally, stream-rotenone sampling was used at Slate and Elkhorn creeks. Some limited, supplemental, population data were collected with gill nets.

Cove-rotenone sampling techniques were those standardized by the Kentucky Department of Fish and Wildlife Resources, Division of Fisheries, as described by Charles (1969).

Electrofishing sampling was employed where the size of the lake or stream segment were judged to be too small to accommodate rotenone sampling. Areas sampled were the same from year to year; however, the time expended varied as a result of different sampling crews being utilized. All electrofishing data were expressed in terms of catch per standardized unit of effort to facilitate comparative data analysis.

All electrofishing samples were collected with a boat-mounted alternator in combination with a variable-output control box. Varying electrode arrays were used; however, in all cases, all electrodes were of the same length of 8 feet. Except in the streams where diurnal sampling was performed, both diurnal and nocturnal sampling were conducted.

Gill netting was employed in Cave Run Lake during the initial year of the study. Four experimental nets having four 50-foot panels to each net that included mesh sizes of 1/2, 1, 1-1/2, 2 and 2-1/2 inches, were fished for 6 net nights during July and October.

Tagged Fish Exploitation Studies

The percent of legal-size (greater than or equal to 12 inches) bass harvested (exploitation rate) was determined by the percent return of fish tags from creeled, tagged bass in each study lake and stream. All tags were assigned a monetary value from $1 to $100 in each of six lakes, two streams and a pool of the Ohio River. One tag was randomly picked from all tags and assigned a value of $1,000. Plans were to tag a maximum of 4,245 bass for 2 successive years. An attempt was made to tag 10% of the estimated standing crop of legal size bass, with the exception of Barkley Lake where the size of the lake precluded it.

Lakes and streams were selected as study waters based on the following: criteria:

1) Lakes of varying size and location were selected that had a continuing creel survey, thus allowing a comparison of harvest under the "old" 10-inch minimum size limit vs. harvest under the "new" 12-inch limit.

2) Two streams were selected that had viable smallmouth bass fisheries. One stream had relatively light fishing pressure, while the other had heavy pressure.

3) The Markland Pool of the Ohio River was selected since it was thought to have fishing pressure representative of the entire river.

Tag reward values were assigned by random draw from all numbers available as follows:

Value ($)	No./2,000 Tags	Percent
100	15	0.75
50	50	2.52
25	100	5.04
10	300	15.11
5	450	22.67
1	1,085	53.91

The mean tag value was $6.42, excluding the single $1,000 tag.

Through an extensive publicity campaign, anglers were introduced to the program and were asked to return any tags in pre-addressed, stamped envelopes that were provided. To avoid the possibility of influencing fishing pressure, the location of study waters was not publicized.

Actual tagging procedures involved capture of bass with A.C., boat-mounted, electrofishing units and the utilization of tournament caught bass from Barkley Lake and the Ohio River. A floy model FD-68B anchor tag was inserted in the musclature of the fishes' back just below the soft-rayed dorsal fin so that the "T" bar anchor locked between the fin ray bases. The tags were 2 inches long, with a 1-inch, brightly colored, coded portion. Species, total length, date, and tag number were recorded for each fish tagged.

All fish were tagged during the spring prior to most of the annual fishing pressure. This also reduced the chance of secondary infection resulting from injury associated with tag insertion and handling that would likely be greater when water temperatures were higher.

Additionally, to avoid displacement of fish, every effort was made to release tagged fish near the location of capture. This technique was not possible with the tournament caught bass tagged in Barkley Lake and the Markland Pool of the Ohio River.

Creel Surveys

Stratified, random, non-uniform probability creel surveys were conducted during 1978 and 1979 at Barkley, Barren River, Beaver, Cave Run, Grayson, and Malone lakes and at Elkhorn Creek. During the first quarter of 1980, a survey was also conducted at Barkley Lake and a modified survey was conducted at Elkhorn Creek in 1982. Except at Elkhorn Creek, all surveys were the roving type with fishermen counts and interviews conducted by bout. At Elkhorn Creek, a modified access-point type survey was employed.

The Barkley Lake survey was part of a cooperative survey conducted at Barkley and Kentucky lakes and their tailwater areas. Personnel from the Tennessee Valley Authority, Land-Between-the-Lakes Fisheries Section and Kentucky Department of Fish and Wildlife Resources' Western Fishery District conducted the survey in the Kentucky portion of Barkley Lake. This was a continuous 24-month survey conducted from 15 April 1978 through 31 March 1979. Each survey-day was divided into two segments (sunrise to noon and

noon to sunset). Fishermen counts and surveys were made during each survey period; five periods were scheduled each week. The 118-mile length of Barkley Lake dictated that the lake be divided into 10 sampling zones. Therefore; the entire lake was surveyed approximately once every two weeks.

At Beaver, Grayson, and Malone lakes, the entire lake was surveyed once per week. The survey-day at Beaver Lake was divided into four segments of 3 hours duration between 7 am and 7 pm. At Grayson and Malone lakes, three periods of 4 hours in length were used during the 7 am to 7 pm daylight hours. The survey at Grayson Lake was conducted from March through October each year; at Beaver and Malone lakes, it ran from April through October in 1978 and 1979.

The surveys at Barren and Cave Run lakes were run from March through October, one day per week, with the survey-day being divided into two segments that were 6 hours in length during daylight (7 am to 7 pm) hours. Two survey clerks were utilized on these larger lakes to ensure coverage of the entire lake each survey-day. During 1979, an access point survey was also conducted at Barren Lake.

Age-Growth Determinations

Scale samples utilized for age-growth determinations were obtained during the course of fish population sampling or tagging efforts. During the design phase of this study, I anticipated that scale samples returned by anglers who had caught tagged fish would provide an adequate sample of scales for age-growth determinations; however, the inconsistencies in measuring techniques by anglers led to the conclusion that length data were of limited value.

Date of collection, location, species, and total length to the nearest 0.1 inch were recorded for each scale sample. The four to six scales taken from each fish were removed from the area just below the lateral line and posterior to the distal end of the pectoral fin.

Scales were cleaned with water and liquid hand soap and placed between glass slides before reading. An Eberbach and Sons scale viewer and a microfiche reader were used for scale reading. Annulus and scale radius length were measured to the nearest 0.1 inch. Body-scale relationships were derived by fitting a straight line, by the least squares method, to the length of the fish and the projected scale radius (Ricker 1971). The formula was:

$$Ln - C = \frac{SN(L-C)}{S}$$

where Ln = length of the fish at annulus "n", S = total scale radius, and C = the intercept on the length axis. No differentation of sex was made.

Mean back-calculated lengths in inches at each annulus were determined as well as the range of lengths of bass at each age and the 95% confidence interval for each age group. The ranges of lengths for each age before and following the imposition of the 12-inch length were compared to determine the level of significance of any differences.

Tagged Fish Exploitation Surveys

Exploitation, natural mortality, and survival rates were determined at each study site using methodology discussed by Ricker (1975). Exploitation rate on each of the two groups of black bass tagged in 1978 and 1979 was determined using the formula:

$$u = \frac{R_1 + R_2 + \ldots + Rn}{M\,(1+S+S^2+\ldots+S^{n-1})}$$

where u = rate of exploitation
R_n = number of recaptures in successive years
M = number of fish marked
S = survival rate in successive years

This unbiased maximum estimate of exploitation was not adjusted for tag loss or tagging mortality as these data were not available.

Survival rate was determined by plotting the logarithms of recoveries against time. The antilog of the slope of the predictive regession line corresponds to the annual survival rate. These computations were electronically determined.

The natural mortality rate was determined using the formula:

$$v = 1 - (u + S)$$

where: v = natural mortality rate
u = exploitation rate
S = survival rate

Due to a lack of sufficient tag return data from Beaver Lake, Elkhorn Creek, and Slate Creek after the first year of tagging, the survival rate was determined from age frequency data using the formula:

$$S = \frac{N - N_o}{N}$$

where: S = survival rate
N_o = frequency (%) of youngest fish in sample
N = frequency (%) total of fish older than youngest

The exploitation rate for these lakes was determined for the first year following tagging only:

$$u = \frac{R}{M}$$

where: R = number of recaptures
M = number marked

FISH POPULATION SURVEYS

Barkley Lake

Cove-rotenone sampling conducted at Barkley Lake each year from 1974 through 1982 documents the changes that have occurred in the black bass population structure (Table 1) since the size limit on black bass was changed from 10 to 12 inches.

Spotted bass comprise a small portion of the black bass population, particularly in the larger size groups. The changes in bass population structure that occurred following the implementation of the 12-inch size limit were, therefore, more significant in the largemouth bass population.

The most obvious change that occurred was a significant (40%) increase in the mean standing crop of young-of-year largemouth bass following implementation of the increased size limit. Numbers of intermediate-size (5-11 in) largemouth showed little change, but their biomass increased by nearly 30%. This indicates that a shift toward larger sizes within the intermediate group occurred.

The numbers of legal-size bass 12-inches and longer were lower in the first 2 years following the imposition of the 12-inch limit compared to 10-inch or larger bass before 1978. However, the population rebounded to pre-1978 levels in subsequent years with a noticeable increase in the biomass of this size group.

Barren River Lake

The bass population structure during 1966-1971, while a 10-inch size limit was in effect (Table 2), included a great number of young-of-year spotted bass, but the intermediate- and quality-size ranges were dominated by largemouth bass. With the increased protection by the increased size limit, increases in numbers of intermediate-size largemouth and spotted bass occurred. Significant increases (50%) in the numbers of young-of-year bass were also documented following the imposition of the 12-inch limit.

The biomass of quality-size (12 inches or larger) largemouth bass has continued to show increases since 1978. Spotted bass comprise a mean of 37% of the bass numbers but are confined within the young-of-year and intermediate-size groups; therefore, they contribute little to the harvest. Their value to the fishery is very limited.

Beaver Lake

Largemouth bass is the only species of bass found in Beaver Lake. Electrofishing samples taken there each year from 1974-1982 (Table 3) show the structure of the population. Changes that occurred in the population following imposition of the 12-inch limit include a 50% reduction in the mean number of young-of-year bass, an 18% increase in the number of intermediate-size bass, and a two-fold increase in the number of quality-size bass.

Cave Run Lake

Spotted bass have dominated the black bass population since Cave Run Lake was impounded in the fall of 1973 (Table 4). The structure of the spotted bass population has not changed noticeably since the 12-inch length limit became effective. This species continues to comprise more than 60% of the numbers of bass, with 53% of these being young-of-year fish. Intermediate-size spotted bass experienced a reduction in mean numbers; however, their average weight increased by 63%. They are providing an increased quality to the fishery, but less than 1% of the spotted bass are available for harvest under the 12-inch limit.

The number of young-of-year largemouth bass increased slightly (13%) since the imposition of the 12-inch limit. Intermediate-size largemouth numbers declined drastically but their average size has doubled.

Quality-size largemouth remained at low numbers, with little change in their average size.

Elkhorn Creek

Although largemouth, spotted, and smallmouth bass are present in Elkhorn Creek, the smallmouth comprised over 85% of the bass numbers taken in rotenone samples in 1978, 1979, and 1982 (Table 5).

Young-of-year smallmouth bass numbers increased following imposition of the 12-inch limit while intermediate and quality size smallmouth have shown little change. Some minor increases in the largemouth bass numbers also occurred with the largest increases being young-of-year fish.

There were no changes noted in the average sizes of any bass sampled from 1978 through 1982.

Electrofishing samples show some changes in the population structure since the 12-inch limit became effective (Table 6). The young-of-year smallmouth bass made up a slightly higher percentage of the smallmouth numbers in 1982 than in 1978. A small increase occurred with the number of quality size smallmouth. The percentage of 5-8 in smallmouth increased, while the 9-11 in fish showed a greater rate of decline.

Grayson Lake

Spotted bass comprised 72% of the numbers of bass in Grayson Lake from 1973 to 1982 (Table 7). Following the imposition of the 12-inch limit, the young-of-year spotted bass numbers have increased an average 51% and the intermediate numbers have decreased only slightly. The average size of intermediate-size spotted has increased by 11%. Quality size fish have occurred only rearely in all samples.

Largemouth bass young-of-year have increased 2.5 times since the 1978 size-limit change. Intermediate-size largemouth numbers increased by 50% since 1978; however, the stocking of 15,000 7-8 in bass in 1982 accounts for most of this increase. Quality-size largemouth have shown a slight change in the past 10 years, with a 19% increase in biomass since the increased limit was imposed.

Markland Pool of Ohio River

Largemouth bass totally dominated the backwater area samples taken from the Ohio River from 1978 to 1982 (Table 8). Although spotted and smallmouth bass are present in the pool, they are generally confined to the main stem of the river.

Since the increased size limit was imposed there has been an increase in the numbers and biomass of young-of-year largemouth bass. Intermediate size bass have increased in numbers as a result of the additional protection from harvest provided by the size limit; however, their average weight has steadily declined since 1978. This decline is probably due to the increased competition for available prey. Harvestable size bass numbers and biomass have fluctuated annually, with no definitive trends being evident.

Lake Malone

The largemouth is the only bass species occurring in Lake Malone. Table 9 indicates the relative structure of the bass population from 1973, when no size or creel limit was in effect through 1981 while influenced by a 10-inch and 12-inch minimum length limit and in 1982 when the size limit was again removed.

Since the 12-inch limit became effective, the number of young-of-year largemouth taken per hour of electrofishing effort has declined noticeably. Intermediate size fish numbers have increased an average of 82% since 1978, while the numbers of quality size fish have more than doubled in the same period. This drastic increase in the intermediate and quality size fish prompted the removal of all size limits in March of 1982.

Slate Creek

Stream rotenone sampling conducted in Slate Creek in 1978, 1979, and 1982 showed that, while all three bass species were present in the stream, the smallmouth bass is the only one occurring in all samples (Table 10).

Since the imposition of the 12-inch limit in 1978 the numbers of young-of-year smallmouth have declined significantly; however, there has been a concurrent increase in young-of-year largemouth. Conversely, the numbers of intermediate smallmouth have increased dramatically since 1978. Quality size smallmouth have steadily declined.

The average size of individual fish within each size group declined or remained unchanged following the imposition of the 12-inch limit.

TAGGED FISH EXPLOITATION SURVEYS

Barkley Lake

At the beginning of the first year of the study in 1978, 999 black bass 12-inches and longer were tagged. By December 31, 259 tags had been returned from anglers. Harvestable-size bass tagged in 1979 totaled 1,002, with 228 being returned by the end of the year. Recoveries of tags in subsequent years through 1982 (Table 11) provided the basis for determination of exploitation, natural mortality, and survival rates (Table 12).

The mean annual exploitation rate in 1978-1979 was 24.3%. Changes that occurred over the 2 years following the imposition of the 12-inch minimum length limit were a 17% decrease in exploitation, a 6% decrease in natural mortality, and a 92% increase in survival rate.

Barren River Lake

Bass tagged in 1978 and 1979 totaled 999 and 1,005 fish, respectively. Recovery of tags through the fifth year of the study are displayed in Table 11. The mean annual exploitation rate in 1978-1979 was 26.9%. Table 12 shows that changes in these two groups of adult bass include a 42% increase in the exploitation rate, an 18% increase in the natural mortality rate, and a 54% decrease in the rate of survival.

Beaver Lake

During the tagging phase of this survey, 50 bass were tagged in each of 2 years. No tag recoveries were made past the first of each year (Table 11). Natural mortality and survival rates (Table 12) were derived from age composition of the population captured in electrofishing studies.

The mean annual exploitation rate in 1978-1979 was 53.0%. Due largely to the publicity of the tag reward system, exploitation rate increased by 65% in the second year following imposition of the 12-inch limit. Concurrently, natural mortality decreased by 73% and the survival rate increased 250%.

Cave Run Lake

The inability to tag greater numbers of harvestable-size bass in Cave Run Lake, while frustrating, was not felt to be a hinderance to obtaining usable data. Numbers tagged and annual tag recoveries are presented in Table 11. The mean annual exploitation rate in 1978-1979 was 41.4%. In addition to the relatively high rate of exploitation documented for both groups of tagged fish, the changes noted following the implementation of the 12-inch limit regulation were a 6% reduction in exploitation, a 1% increase in natural mortality, and a 21% increase in survival rate (Table 12).

Elkhorn Creek

Relatively low numbers of fish available for tagging limited the tagging effort and conversely the tag recoveries (Table 11). Lack of recoveries beyond the year of tagging necessitated the use of age frequency data for determining natural mortality and survival rates.

The mean annual exploitation rate in 1978-1979 was 15.6%. Table 12 presents exploitation, natural mortality, and survival data. The comparatively low exploitation rate declined by 16% at the end of the second year after the size limit change. The natural mortality rate increased 12% and the survival rate decreased by 40%.

Grayson Lake

The initial year of tagging did not yield returns beyond the end of that first year; however, tag recoveries from the 1979 tagging provided adequate data for analysis (Table 11). The exploitation rate changed slightly (4% increase) by the end of the second year following the implementation of the 12-inch limit.

The mean annual exploitation rate in 1978-1979 was 36.9%. Recoveries of tags from fish tagged during the first year were not made past the end of that year; therefore, age composition of the tagged population was utilized for determination of natural mortality and survival data for that year. Table shows that natural mortality decreased by slightly less than 3% and survival rate decreased by slightly over 1%.

Lake Malone

The tagging goal was met in 1978 and 1979 with 151 and 150 bass tagged, respectively. Tags from both groups were recovered in each successive year through 1982 (Table 11).

The mean annual exploitation rate in 1978-1979 was 32.2%. The most significant change that occurred in the parameters listed in Table 12 was the 86% increase in exploitation rate. I believe that, when anglers learned that a relatively large number of trophy-size (greater than 6 lb) largemouth bass were tagged or observed during tagging operations in both 1978 and 1979, additional fishing pressure was put on the population. The significant increase in the exploitation rate was accompanied by an expected decrease in the survival rate of 70%. The natural mortality rate also increased by 34%.

Ohio River of Markland Pool

As at Grayson Lake, the initial year of tagging failed to provide tag recovery data past the end of that year (Table 11); therefore, except for exploitation rates, there are no comparisons to be made between the groups of bass tagged following imposition of the 12-inch limit based on tag returns.

The mean annual exploitation rate in 1978-1979 was 23.7%. Using age frequency data from fish tagged in 1978 in combination with tag return data from 1979 and 1980, changes in the parameters were a 4% decrease in exploitation, a 3% increase in natural mortality, and a 6% decrease in survival rate (Table 12).

Slate Creek

As was found in Elkhorn Creek, few fish longer than 12 inches were available for tagging. The low number of fish tagged and apparently low fishing pressure lead to an expected low recovery of tags (Table 11).

The mean annual exploitation rate in 1978-1979 was 7.1%. Using population age composition, the natural mortality and survival rates for bass during the 2 years following implementation of the 12-inch length limit regulation were determined. Exploitation rate decreased by 52%, while natural mortality increased by just over 8%. Survival rate remained virtually unchanged with an increase of less than 1% (Table 12).

CREEL SURVEYS

Barkley Lake

During the first fishing season at Barkley Lake following the imposition of the 12-inch minimum length limit on black bass (April 15, 1978 - March 31, 1979), 553,797 fishing trips averaging 4.6 hours in duration were made. Table 13 shows data for the period.

The harvest of black bass, primarily largemouth bass, varied monthly, with nearly 90% of the harvest occurring during the April - August period. Harvest rates presented in Table 13 were derived from total fishing pressure data. The intent of individual anglers was not available, but harvest rates for those anglers seeking black bass would undoubtedly be higher. The data, however, are useful for comparative purposes.

The second full fishing season following implementation of the 12-inch black bass length limit (1 April 1979 - 31 March 1980) showed a 29% increase in man-hours of pressure and a 36% increase in the number of trips (Table 13). The same percentage of anglers (49.7%) were successful in catching at least one fish per trip as recorded during the first season.

Black bass harvest rate during the second year declined noticeably, with a ten-fold reduction in the harvest of spotted bass (Table 13). Without fishermen intent data it is not possible to determine if pressure was reduced on black bass. The assumption is that the reduced harvest rate on largemouth bass was a fact independent from changes in the total fishing pressure. This is reinforced by the fact that, even with the large increase in total pressure, the overall harvest rate for all species increased by nearly 17%, while the largemouth bass harvest rate declined 33% by number and 45% by weight.

Barren River Lake

During the two fishing seasons (March - October 1976-1977) immediately preceeding the imposition of the 12-inch length limit on black bass, when anglers were restricted to the harvest of 10-inch bass or longer, fishermen harvested an average of 26 fish/acre and 8.5 pounds/acre. Bass fishermen harvested 1.5 bass/acre and 1.7 pounds/acre. Bass fishing pressure averaged 7.2 man-hours/acre (Table 14).

Creel surveys conducted in 1978 and 1979, following the implementation of the 12-inch minimum bass length regulation, showed an average total fish harvest of 19 fish/acre and 8.5 pounds/acre. Bass fishermen harvest averaged 0.7 bass/acre and 1.3 pounds/acre. Table 14 includes fishing pressure and other harvest data from these 2 years.

The 1980 creel survey (Table 14) showed that harvest rates for black bass had increased and even exceeded rates recorded prior to the establishment of the increased length limit.

The reduction in bass fishing pressure and harvest following imposition of the new length limit occurred as expected but began rebounding to earlier levels by the end of 1979.

Beaver Lake

The largemouth bass fishery at Beaver Lake showed only a temporary change following the imposition of the 12-inch minimum length limit in January 1978. As Table 15 shows, there was a reduction in the number of bass harvested per acre in 1978, but the fishery quickly recovered in 1979. While bass fishing pressure increased during 1978 and the harvest per hour of effort declined by 35%, the fishery quickly rebounded in 1979 to levels above the pre-size limit season.

Cave Run Lake

Creel surveys conducted at Cave Run Lake from 1975 through 1979 showed the expected fluctuation in fishermen pressure and harvest, associated with the changing conditions in the reservoir (Table 16). The 1975 and 1976 data represent the status of the fishery in the second and third year following impoundment. Both pressure and harvest data are reflective of the "new lake" phenomenon and therefore, are artificially higher than would normally be expected in an impoundment of this type. By 1977, the combined effects of the high exploitation rate on black bass and the concomitant reduction in the expectations and success of anglers lead to a noticeable decrease in fishing pressure and harvest.

With the imposition of an increased minimum size-limit for black bass in 1978, bass fishing pressure and harvest further declined. By the end of 1979, after two fishing seasons under the influence of the 12-inch bass length limit, bass fishing pressure had rebounded to levels similar to those recorded in 1975 and 1976. More importantly, harvest of black bass in terms of pounds and numbers were increasing.

The additional protection afforded to the black bass population by the increased minimum length limit regulation obviously was a positive benefit; however, the fishermen, expecting these benefits, continued to exploit the population at a high level.

Elkhorn Creek

The history of black bass size limits in Elkhorn is long and varied. Prior to 1960, there was no size limit. In 1960, an 11-inch minimum length limit was established. This limit remained in effect through the completion of a research project in 1965. From 1965 through 1977 a 10-inch minimum length limit was in effect. Since 1 January 1978 Elkhorn Creek anglers have been restricted to the harvest of black bass 12-inches longer.

The varying size limits, in conjunction with changes in the fish population resulting from environmental influences, have lead to many fluctuations in the fishery. Angler pressure and harvest (Table 17) reflect these fluctuations.

Unfortunately, data generated from the 1978 access-point creel survey failed to reflect the nature of the bass fishery, since a vast majority of bass fishermen were waders who seldom showed up at the access areas. Consequently, in 1979 the survey was changed so that the wade and float fishermen would be better represented, with the thought that 1979 would serve as the base-line data year. The 1982 season was surveyed to determine changes in the bass fishery. In June of that year, a massive sodium cyanide spill in the stream caused a fish kill throughout 11 to 12 miles of

the stream. While the fish kill did not extend into the stretches of Elkhorn Creek that historically had provided the bulk of the fishery, anglers abandoned the stream through the summer and fall months. The 25% reduction in total fishing pressure and nearly two-fold reduction in bass fishing pressure drastically impacted the fishery and no comparative observations could be made.

Grayson Lake

Creel survey data collected at Grayson Lake (Table 18) from 1974 through 1977, while a 10-inch minimum length limit on black bass was in effect, showed a gradual but relatively steady decline in bass fishing pressure and harvest. With the imposition of 12-inch length limit in 1978, bass harvest declined more rapidly, but a slight increase in fishing pressure by bass anglers, whose expectations increased, was evident. With the stocking of some 15,000 9-inch largemouth bass and the imposition of a 15-inch length limit on black bass in 1982, bass harvest showed expected increases.

Lake Malone

Creel surveys conducted at Lake Malone each year from 1969 through 1979 reflect changes in the fishery resulting from the various management strategies employed there (Table 19).

During the years of 1969 - 1971, a 10-inch minimum length limit on black bass was in effect. Due to a stock-piling of bass in the 8 and 9 inch groups and the associated low recruitment and slow growth rate, the size limit was removed in January 1972. In 1974, following two seasons of no size limit, the 10-inch minimum length limit was re-established. On 1 January 1978, the 12-inch minimum length limit on black bass was imposed.

Following imposition of the increased length limit on black bass, a noticeable increase in black bass fishing pressure and bass harvest in terms of numbers and biomass occurred. The rate of bass harvest per hour did not change. Lake Malone may represent a case where the actual and rumored activities of this Department provided an incentive to fishermen that did not exist prior to the implementation of the research program there. At the time of our bass tagging program many local anglers became aware that a large percentage of the bass tagged were large (more than 17 inches) fish. I believe that this, in conjunction with the incentive provided by monetary rewords on tags, encouraged more fishermen. When some of the excellent early catches in 1978 were reported, anglers were even more encouraged to fish.

The expected decline in harvest following the implementation of more restrictive harvest regulations did not occur. In fact, the bass harvest numbers as well as weight increased as did the fishing pressure.

AGE AND GROWTH DETERMINATIONS

Barkley Lake

Largemouth bass growth rates in Barkley Lake prior to the 1 January 1978 imposition of the 12-inch minimum length limit were compared to growth after the limit was imposed. Scale samples taken during 1978 were considered to be indicative of growth rates influenced by the 10-inch limit. Growth rates exhibited by largemouth bass, as determined from scale samples taken during 1979 and 1982, were considered to be influenced by the increased minimum 12-inch length limit.

Table 20 shows mean annual growth before the 12-inch length limit. If the assumption is made that annulus formation occurs during the winter (Dec-Feb) months, it appears that largemouth at Barkley Lake reached 12 inches in length during the spring or early summer of their fourth year of growth. Table 20 shows growth rates of largemouth bass sampled in 1979 and 1982, respectively. These fish also reached 12 inches in length before the end of their fourth year; however, the size attained indicates that they did not reach 12 inches until later in the year. This is particularly true of those fish in the 1982 sample, which includes 3 year classes spawned after the imposition of the 12-inch length limit.

While growth rates were the same or slightly slower for largemouth bass following the imposition of the increased minimum length limit, there was no statistically significant difference at the 95% confidence interval.

Barren River Lake

Largemouth, spotted, and smallmouth bass are present in Barren River Lake; however, owing to our inability to collect sufficient numbers of spotted and smallmouth bass, only largemouth bass age-growth data are presented in this discussion.

Table 20 shows the comparison between growth rates of largemouth bass under the influence of the 10-inch minimum length limit and the 12-inch limit. The comparison of length ranges attained at age at the 95% confidence interval shows considerable variability. Under the influence of the 12-inch limit, age 1 and 4 fish grew slower, age 2 fish displayed a faster growth rate, and age 3 and 5 fish grew at the same rates. The differential rates observed were in no cases significant.

Beaver Lake

The growth rate of largemouth bass at Beaver Lake was found to be slower following imposition of the increased minimum 12-inch length limit. Table 20 depicts the rates as influenced by the 10-inch limit and shows those rates under the 12-inch length limit. We were unable to obtain scale samples from any fish older than 3 years during the initial sampling year; therefore, a comparison of growth rates between older fish was not possible. There was no significance to the slower rates observed under the 12-inch limit.

Cave Run Lake

In Cave Run Lake, both largemouth and spotted bass occur in numbers great enough to be nearly co-equal in their contribution to the bass fishery. Age-growth data for both species are presented for comparison of the impact of an increased minimum length limit on growth rates.

The growth of largemouth bass showed slight, but not statistically significant, improvement following the establishment of the 12-inch minimum length limit. As Table 20 shows, specimens between ages 1 and 4 displayed faster growth under the influence of the 12-inch limit.

Conversely, spotted bass displayed slightly slower growth rates following imposition of the "new" limit. Table 21 compares rates under the 10-inch vs. 12-inch length limit. As with the largemouth bass, the difference in growth rates was found to be insignificant when the ranges of annual growth at the 95% confidence interval were compared.

Elkhorn Creek

The smallmouth is the predominant black bass in the population as well as in the creel at Elkhorn Creek. For this reason and our inability to collect meaningful samples of largemouth and spotted bass, the age-growth data here are for smallmouth bass only.

Scale samples were taken during 1978, 1979, and 1982 for use in determining smallmouth bass age-growth. Table 22 presents these data. Fish aged 1 year through 4 years show a slightly faster annual growth increase following the imposition of the 12-inch length limit. Older individuals indicated no difference or a slight reduction in growth under the 12-inch length limit influence. Again, none of the differences were found to be significant at the 95% confidence interval of growth ranges.

Grayson Lake

Largemouth and spotted bass contribute on a nearly equal basis to the black bass population and fishery in Grayson Lake. Age and growth data from both species are presented.

Largemouth bass displayed slower growth rates following the implementation of the 12-inch length limit (Table 20). The differences in growth, when comparisons of the ranges of growth at the 95% confidence interval were made, were found to be significantly slower in age 1 and age 5 individuals. All other ages showed no or insignificant differences.

Growth of spotted bass were documented from scale samples taken in 1978, 1979, 1980, and 1982. Table 21 shows that growth rates have been slower following the enactment of the 12-inch length limit regulation. None of the differences were found to be statistically signficant.

Markland Pool of Ohio River

While both smallmouth and spotted bass occur in the river, the largemouth vastly predominates the population and the fishery. Age-growth data presented are for largemouth bass only.

Growth characteristics have changed noticeable since the 12-inch size limit became effective. Samples taken in 1978, 1979, and 1982 show a general decrease in lengths of largemouth bass at ages 1 through 6 (Table 20). Comparisons of the ranges of growth at the 95% confidence interval showed no significance; however, the 1982 sample (Table 20) indicated that most individual largemouth bass did not reach harvestable size (12 inches) until their fifth year of growth. In previous years, the 12-inch plateau was attained during the fourth year.

Lake Malone

Growth patterns of largemouth bass in Lake Malone showed slight changes following the implementation of the 12-inch minimum length limit. As in most other study waters, growth rates slowed, but the decrease was not found to be significant. Table 20 displays mean lengths at age before and after the imposition of the increased minimum length limit.

Slate Creek

The smallmouth bass is the only bass species present in large enough numbers in Slate Creek to provide a viable fishery. The following age-growth data are for these fish only.

Table 22 shows that a reduction in growth rate occurred following the implementation of the 12-inch minimum length limit. As with the observations on other study waters, the differences were not found to be statistically significant.

CONCLUSIONS

The justification behind the change in the size limit for black bass was that such a change would have certain beneficial impacts on the fishery. While the impacts were of a complex nature in terms of the numbers of subtle differences observed and in the interrelationships among the changes, a brief discussion of the major impacts is warranted.

Fish population structure varied widely among the study sites before and after the 12-in limit was imposed. However, in nearly all cases, the number of young-of-year bass increased after the size limit changed from 10 to 12 in. The protection from exploitation of an additional year class of bass was probably responsible for this. The general increase in both numbers and biomass of intermediate-size bass at most sites further reinforces this statement. The expected decrease in the numbers of harvestable-size bass occurred immediately following the imposition of the increased limit, but, by the end of the 5-year study, the population had adjusted to similar numbers of harvestable-size bass as during the 10-inch limit. There was also a noticeable increase in the biomass of legal-size bass.

Exceptions noted to the above general observations were at Beaver Lake and Lake Malone, where the number of young-of-year bass decreased while the intermediate- and harvestable-size groups showed increases. No apparent explanation presents itself from the data collected. Likewise, largemouth bass in the Ohio River displayed an uncharacteristic population structure during the study. I believe that the variations observed there are largely due to the dynamic riverine environment, particularly in the relatively shallow backwater areas that were utilized as sample sites.

As was expected, the impacts on the exploitation, mortality, and survival rates of bass following implementation of the 12-in limit varied among the study sites. In spite of efforts to conceal the locations of study sites, fishermen quickly learned where the tagged fish were. The publicity generated by the rewarding of $1,000 for a single tag returned during the first year of the study piqued the interest of many fishermen, with the result generally being higher fishing pressure and exploitation.

Natural mortality rates showed wide variation; however, at 5 of the sites, the change after the 12-in size limit became effective was less than 10%, which was considered not significant. At Beaver Lake, where natural mortality declined drastically (73%), a concurrent increase in the exploitation (fishing mortality) rate occurred. The conversion of fish that died from natural causes to being harvested by anglers accounts for a large part of these changes. Further correlations between exploitation and natural mortality rates were unapparent.

Survival rates also showed great variability among study sites, with diverse changes in rates following the imposition of the 12-in limit. While the data, as presented, show what may be considered to be shockingly low rates of annual survival, it must be kpet in mind that these are mean rates among a number of age classes fluctuate considerably.

While the 12-in size limit obviously did effect the natural mortality and survival rate, the changes cannot be considered beneficial or harmful. Although the rate of exploitation decreased after the 12-in limit became effective, the

survival rate, which translates into recruitment to larger sizes, increased at some sites while at other sites the survival rate declined. Again, the impact was neither harmful nor beneficial.

The impact on the fishery as determined from angler creel surveys was also highly variable. It is my opinion that the measure of the impact on the fisherman's creel is the most important single measure that can be made. The translation of any fishery management program into its effect on those who use and enjoy the managed resource should be a high priority. While it is not possible to assess the psychology of the fishermen, the observed increase in fishing pressure following the implementation of the 12-in limit seems to indicate that the expectations of "something better" for the fishermen was a common perception. Undoubtedly, the attraction created by tag rewards also was a factor.

The number of fish harvested declined as expected after the increased size limit was imposed, but in succeeding years harvest increased and in some cases surpassed levels observed before the limit became effective. Only at Barkley Lake was there no turn-around reflected in the creel. The creel survey there terminated too early to allow for a conclusion to be drawn. Further data will need to be collected.

The weight of bass harvested declined immediately following the imposition of the 12-in limit, but quickly rebounded to levels above those reported from years prior to the 12-in limit. There was an observable improvement in the quality of harvested bass.

The rate of bass harvest, which measures the relative success of fishermen, showed a similar pattern, with early declines followed by rates greater than or equal to those found before the size limit was changed.

As a while, the impact of the increased limit on the anglers' creel was considered to be beneficial. More fishermen are now enjoying the harvest of equal numbers or more quality-size bass (larger size) at rates at least as good as before the limit was imposed.

Generally, growth rates of most bass showed slight declines after the 12-in limit became effective. The increased number and biomass of several size groups undoubtedly lead to increased competition for food, with slower growth rates being the result. While the decrease in growth rates was not found to be statistically significant, the impact of the 12-in limit on growth cannot be considered beneficial. Conversely, the magnitude of the decrease cannot be termed particularly detrimental either.

ACKNOWLEDGEMENTS

I extend thanks to Biologists Bill McLemore, David Bell, Bonny Laflin, Benjy Kinman, Ralph Jackson, and Lew Kornman, and to Technicians Mike Lyons, Dan Richardson, Ray Smith, Al Surmont, and Charlie Gorham for their valuable assistance with the tagging phase of this study. I also thank Gerard Buynak who

assumed the responsibility for data collection in the final year of the project and assisted with the data analysis along with Technician Rip Rhorer. Thanks also go to Jim Axon who provided assistance and encouragement from the inception of the project planning through the editing of the final report. Secretaries Mary Ann Damron and Karen Hukill graciously accepted the task of preparing the several drafts of the final report in addition to their myriad other duties. Finally, a special expression of gratitude to my technical assistant, Clark Boggs. Without his dedication, committment to success, and humor, this project would undoubtedly have been more difficult to complete.

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Table 1. Black bass population structure at Barkley Lake derived from cove-rotenone sampling.

	All bass (in)			Largemouth (in)			Spotted (in)		
	0-4	5-11	≥12	0-4	5-11	≥12	0-4	5-11	≥12
1974									
Number/acre	55	34	3	49	31	3	6	3	0
Pounds/acre	0.94	3.80	7.14	0.84	3.56	7.14	0.10	0.24	0
Percent	59.8	37.0	3.3	53.3	33.7	3.3	6.5	3.3	0
1975									
Number/acre	127	18	3	125	17	3	2	1	0
Pounds/acre	1.31	1.64	3.46	1.30	1.55	3.46	0.01	0.09	0
Percent	85.8	12.2	2.0	84.5	11.5	2.0	1.4	0.7	0
1976									
Number/acre	76	11	4	2	8	3	74	3	1
Pounds/acre	1.69	1.46	3.66	0.08	1.04	3.49	1.61	0.42	0.17
Percent	83.5	12.1	4.4	2.2	8.8	3.3	81.3	3.3	1.1
1977									
Number/acre	133	36	4	90	10	4	43	26	0
Pounds/acre	2.34	1.47	3.50	1.50	0.97	3.50	0.84	0.50	0
Percent	76.9	20.8	2.3	52.0	5.8	2.3	24.9	15.0	0
1978									
Number/acre	168	19	1	168	19	1			
Pounds/acre	1.57	1.64	0.50	1.57	1.64	0.50			
Percent	89.4	10.1	0.5	89.4	10.1	0.5			
1979									
Number/acre	102	11	1	83	10	1	19	1	0
Pounds/acre	1.60	0.98	0.83	1.43	0.96	0.83	0.17	0.02	0
Percent	89.5	9.6	0.9	72.8	8.8	0.9	16.7	0.9	0
1980									
Number/acre	141	12	2	101	10	2	40	2	1
Pounds/acre	2.89	3.75	2.92	2.29	3.40	2.45	0.60	0.35	0.47
Percent	91.0	7.7	1.3	65.2	6.5	1.3	25.8	1.3	0.6

Table 1 continued.

	All bass (in)			Largemouth (in)			Spotted (in)		
	0-4	5-11	≥12	0-4	5-11	≥12	0-4	5-11	≥12
1981									
Number/acre	91	9	3	44	8	3	46	1	0
Pounds/acre	1.25	2.35	4.55	0.55	2.12	4.55	0.70	0.23	0
Percent	88.3	8.7	2.9	42.7	7.8	2.9	44.7	1.0	0
1982									
Number/acre	228	9	3	226	9	3	3	<1	0
Pounds/acre	3.84	3.46	5.00	3.82	3.28	5.00	0.02	0.18	0
Percent	95.0	3.8	1.3	94.2	3.8	1.3	1.3	0.2	0

Table 2. Black bass population structure at Barren River Lake drived from cove-rotenone sampling.

	All bass (in)			Largemouth (in)			Spotted (in)		
	0-4	5-11	≥12	0-4	5-11	≥12	0-4	5-11	≥12
1966									
Number/acre	586	15	4	147	15	4	439	<1	0
Percent	96.8	2.5	0.7	24.3	2.5	0.7	72.6	0	0
1967									
Number/acre	218	43	2	30	43	2	188	<1	0
Percent	82.9	16.3	0.8	11.4	16.3	0.8	71.5	0.3	0
1968									
Number/acre	120	22	2	76	21	2	44	1	0
Percent	83.3	15.3	1.4	52.8	14.6	1.4	30.6	0.7	0
1969									
Number/acre	102	34	2	78	30	2	24	4	0
Percent	73.9	24.6	1.4	56.5	21.7	1.4	17.4	2.9	0
1970									
Number/acre	76	38	2	51	26	2	25	10	0
Percent	65.5	32.8	1.7	44.0	22.4	1.7	21.6	8.6	0
1971									
Number/acre	157	23	2	127	18	2	30	4	<1
Percent	86.3	12.6	1.1	69.8	9.9	1.1	16.5	2.2	0.2
1978									
Number/acre	473	13	1	346	10	1	126	3	0
Pounds/acre	3.26	1.76	0.68	2.62	1.03	0.68	0.64	0.73	0
Percent	97.1	2.7	0.2	71.0	2.1	0.2	25.9	0.6	0
1979									
Number/acre	114	46	1	83	33	1	31	13	0
Pounds/acre	1.51	8.28	2.08	1.18	6.70	2.08	0.33	1.58	0
Percent	70.8	28.6	0.6	51.6	20.5	0.6	19.3	8.1	0

Table 2 continued.

	All bass (in)			Largemouth (in)			Spotted (in)		
	0-4	5-11	≥12	0-4	5-11	≥12	0-4	5-11	≥12
1980									
Number/acre	263	28	3	119	20	3	133	7	<1
Pounds/acre	2.19	7.70	2.36	1.22	6.04	2.24	0.97	1.66	0.12
Percent	89.5	9.5	1.0	40.5	6.8	1.0	45.2	2.4	0.1
1981									
Number/acre	582	83	3	408	75	2	165	8	1
Pounds/acre	5.43	9.77	3.31	4.12	8.12	2.10	1.31	1.65	1.21
Percent	87.1	12.4	0.4	61.1	11.2	0.3	24.7	1.2	0.1
1982									
Number/acre	150	35	4	37	28	4	105	7	0
Pounds/acre	1.49	7.80	9.51	0.52	6.95	9.51	0.97	0.85	0
Percent	79.4	18.5	2.1	19.6	14.8	2.1	55.6	3.7	0

Table 3. Black bass population structure at Beaver Lake derived from electrofishing sampling.

	Largemouth (in)			Spotted (in)		
	0-4	5-11	≥12	0-4	5-11	≥12
1974						
Number/hour	38	29	6			
Percent	52.3	39.6	8.2			
1975						
Number/hour	114	66	3			
Percent	62.4	36.0	1.6			
1976						
Number/hour	32	75	15			
Percent	26.2	61.5	12.3			
1977						
Number/hour	37	73	18			
Percent	28.9	57.0	14.1			
1978						
Number/hour	15	135	22			
Percent	8.7	78.5	12.8			
1979						
Number/hour	92	116	56			
Percent	34.8	44.0	21.2			
1980						
Number/hour	8	62	24			
Percent	8.5	65.9	25.5			
1981						
Number/hour	14	17	26			
Percent	24.6	29.8	45.6			
1982						
Number/hour	6	32	46			
Percent	6.8	32.2	55.0			

Table 4. Black bass population structure at Cave Run Lake derived from cove-rotenone sampling.

	All bass (in)			Largemouth (in)			Spotted (in)		
	0-4	5-11	≥12	0-4	5-11	≥12	0-4	5-11	≥12
1974									
Number/acre	459	151	1	85	122	1	374	29	0
Pounds/acre	5.07	17.13	1.64	1.93	13.90	1.64	3.14	3.23	0
Percent	75.1	24.7	0.2	13.9	20.0	0.2	61.2	4.7	0
1975									
Number/acre	203	68	1	8	23	<1	195	45	<1
Pounds/acre	1.51	9.54	4.36	0.07	3.88	2.32	1.44	5.66	2.04
Percent	74.6	25.0	0.4	2.9	8.5	0.1	71.7	16.5	0.3
1976									
Number/acre	38	33	0	8	14	0	30	19	0
Pounds/acre	0.40	7.38	0	0.11	4.30	0	0.29	3.08	0
Percent	53.5	46.5	0	11.3	19.7	0	42.3	26.8	0
1977									
Number/acre	33	18	1	13	8	1	20	10	<1
Percent	63.5	34.6	1.9	25.0	15.4	1.9	38.5	19.2	0.2
1978									
Number/acre	95	18	1	45	10	1	50	8	0
Pounds/acre	0.30	3.06	0.47	0.11	1.93	0.47	0.19	1.13	0
Percent	83.3	15.8	0.9	39.5	8.8	0.9	43.9	7.0	0
1979									
Number/acre	87	10	1	30	5	1	57	5	0
Pounds/acre	1.70	8.50	2.76	0.49	5.99	2.76	1.21	2.51	0
Percent	88.8	10.2	1.0	30.6	5.1	1.0	58.2	5.1	0
1981									
Number/acre	67	21	1	22	13	<1	45	8	<1
Pounds/acre	1.05	3.03	1.87	0.39	1.64	1.72	0.66	1.39	0.15
Percent	75.3	23.6	1.1	24.7	14.6	0.9	50.6	9.0	0.2

Table 4 continued..

	All bass (in)			Largemouth (in)			Spotted (in)		
	0-4	5-11	≥12	0-4	5-11	≥12	0-4	5-11	≥12
1982									
Number/acre	107	17	1	32	6	<1	75	11	<1
Pounds/acre	1.02	2.58	0.97	0.43	0.90	0.77	0.59	1.68	0.20
Percent	85.6	13.6	0.8	25.6	4.8	0.3	60.0	8.8	0.2

Table 5. Black bass population structure at Elkhorn Creek derived from rotenone sampling.

	All bass (in)			Largemouth (in)			Spotted (in)			Smallmouth (in)		
	0-4	5-11	≥12	0-4	5-11	≥12	0-4	5-11	≥12	0-4	5-11	≥12
1978												
Number/acre	1	37	3	0	1	0	0	0	0	1	36	3
Pounds/acre	0.03	9.77	2.36	0	0.08	0	0	0	0	0.03	9.69	2.36
Percent of bass no.	2.4	90.2	7.3	0	2.4	0	0	0	0	2.4	87.8	7.3
1979												
Number/acre	59	40	4	0	4	0	1	1	0	58	35	4
Pounds/acre	0.35	10.63	2.81	0	1.20	0	<.01	0.04	0	0.35	9.39	2.81
Percent of bass no.	57.3	38.8	3.9	0	3.9	0	1.0	1.0	0	56.3	34.0	3.9
1982												
Number/acre	26	33	4	7	1	1	0	0	0	19	32	3
Pounds/acre	0.24	6.90	3.52	0.05	0.21	1.18	0	0	0	0.19	6.69	2.34
Percent of bass no.	41.3	52.4	6.3	11.1	1.6	1.6	0	0	0	30.2	50.8	4.8

Table 6. Black bass population structure at Elkhorn Creek derived from electrofishing sampling.

	All bass (in)			Largemouth (in)			Spotted (in)			Smallmouth (in)		
	0-4	5-11	≥12	0-4	5-11	≥12	0-4	5-11	≥12	0-4	5-11	≥12
1978												
Number/hour	6	304	30	0	10	0	0	0	0	6	295	28
Percent	1.8	89.4	8.8	0	3.3	0	0	0	0	1.8	86.8	8.2
1979												
Number/hour	11	425	44	0	10	4	0	1	0	11	414	40
Percent	2.3	88.5	9.2	0	2.1	0.8	0	0.2	0	2.3	86.3	8.3
1982												
Number/hour	14	397	62	0	39	15	2	1	0	12	357	47
Percent	3.0	85.7	13.4	0	8.4	3.2	0.4	0.2	0	2.6	77.1	10.2

Table 7. Black bass population structure at Grayson Lake derived from cove-rotenone sampling.

	All bass (in)			Largemouth (in)			Spotted (in)		
	0-4	5-11	≥12	0-4	5-11	≥12	0-4	5-11	≥12
1973									
Number/acre	65	15	1	2	6	1	63	9	0
Pounds/acre	0.83	1.92	1.50	0.06	1.21	1.50	0.77	0.71	0
Percent	80.2	18.5	1.2	2.5	7.4	1.2	77.8	11.1	0
1974									
Number/acre	39	19	1	16	12	1	23	7	0
Pounds/acre	0.75	2.71	2.11	0.52	2.15	2.11	0.23	0.56	0
Percent	66.1	32.2	1.7	27.1	20.3	1.7	39.0	11.9	0
1975									
Number/acre	203	19	3	73	6	1	130	13	2
Pounds/acre	1.76	3.31	2.42	0.71	1.38	0.70	1.05	1.93	1.72
Percent	90.2	8.4	1.3	32.4	2.7	0.4	57.8	5.8	0.9
1976									
Number/acre	275	11	3	14	4	2	261	7	2
Pounds/acre	1.44	1.39	3.47	0.15	0.42	1.92	1.29	0.97	1.55
Percent	95.2	3.8	1.0	4.8	1.4	0.7	90.3	2.4	0.7
1977									
Number/acre	135	16	1	10	6	<1	126	9	<1
Pounds/acre	1.08	2.27	1.33	0.17	0.40	0.83	0.91	1.87	0.50
Percent	88.9	10.5	0.7	6.5	3.9	0.2	82.4	5.9	0.2
1978									
Number/acre	342	23	<1	129	4	0	213	19	<1
Pounds/acre	3.39	2.89	0.35	2.01	0.75	0	1.38	2.14	0.35
Percent	93.4	6.3	0.1	35.2	1.1	0	58.2	5.2	0.1
1979									
Number/acre	208	11	3	106	5	3	102	7	<1
Pounds/acre	1.82	2.56	3.92	1.14	1.21	3.35	0.68	1.34	0.56
Percent	93.7	5.0	1.4	47.7	2.3	1.4	45.9	3.2	0.3

Table 7 continued.

	All bass (in)			Largemouth (in)			Spotted (in)		
	0-4	5-11	≥12	0-4	5-11	≥12	0-4	5-11	≥12
1980									
Number/acre	269	9	1	52	4	<1	217	5	<1
Pounds/acre	1.02	1.71	0.56	0.34	0.55	0.29	0.68	1.16	0.27
Percent	96.4	3.2	0.4	18.6	1.4	0.1	77.8	1.8	0.1
1981									
Number/acre	161	15	2	44	9	1	117	6	1
Pounds/acre	0.70	2.65	2.12	0.40	1.64	1.60	0.30	1.01	0.52
Percent	90.4	8.4	1.1	24.7	5.1	0.6	65.7	3.4	0.6
1982									
Number/acre	332	34	2	71	29	1	261	6	<1
Pounds/acre	1.54	6.54	1.87	0.54	5.79	1.49	1.00	0.75	0.38
Percent	90.2	9.2	0.5	19.3	7.9	0.3	70.9	1.6	0.1

Table 8. Black bass population structure at Markland Pool Ohio River derived from rotenone sampling.

	Largemouth (in)		
	0-4	5-11	≥12
1978			
Number/acre	9	11	5
Pounds/acre	0.01	2.68	8.66
Percent of bass no.	35.8	42.7	21.5
1979			
Number/acre	14	10	4
Pounds/acre	0.07	2.86	4.25
Percent of bass no.	50.0	35.7	14.3
1980			
Number/acre	10	12	6
Pounds/acre	0.03	2.05	7.07
Percent of bass no.	36.8	43.0	20.2
1981			
Number/acre	64	21	5
Pounds/acre	0.36	2.90	4.53
Percent of bass no.	71.7	23.3	5.1
1982			
Number/acre	35	34	2
Pounds/acre	0.43	4.06	3.81
Percent of bass no.	49.2	48.2	2.5

Table 9. Black bass population structure at Lake Malone derived from electrofish sampling.

	All bass (in)			Largemouth (in)		
	0-4	5-11	≥12	0-4	5-11	≥12
1973						
Number/hour	12	17	3	12	17	3
Percent of bass no.	37.5	54.1	8.4	37.5	54.1	8.4
1974						
Number/hour	2	9	15	2	9	15
Percent of bass no.	6.7	34.5	58.7	6.7	34.5	58.7
1975						
Number/hour	2	31	15	2	31	15
Percent of bass no.	3.6	64.9	31.5	3.6	64.9	31.5
1976						
Number/hour	0	5	11	0	5	11
Percent of bass no.	0	29.8	10.1	0	29.8	70.1
1977						
Number/hour	5	79	9	5	79	9
Percent of bass no.	5.7	84.3	10.0	5.7	84.3	5.7
1978						
Number/hour	2	24	8	2	24	8
Percent of bass no.	5.1	72.0	23.0	5.1	72.0	23.0
1979						
Number/hour	3	31	5	3	31	5
Percent of bass no.	6.8	81.6	11.7	6.8	81.6	11.7
1980						
Number/hour	1	43	21	1	43	21
Percent of bass no.	1.9	66.1	32.0	1.9	66.1	32.0
1981						
Number/hour	2	111	56	2	111	56
Percent of bass no.	1.4	65.8	32.8	1.4	65.8	32.8
1982						
Number/hour	0	46	21	0	46	21
Percent of bass no.	0	69.0	31.0	0	69.0	31.0

Table 10. Black bass population structure at Slate Creek derived from rotenone sampling.

	All bass (in)			Largemouth (in)			Spotted (in)			Smallmouth (in)		
	0-4	5-11	≥12	0-4	5-11	≥12	0-4	5-11	≥12	0-4	5-11	≥12
1978												
Number/acre	60	43	5	0	0	0	0	0	0	60	43	5
Pounds/acre	0.11	12.19	6.92	0	0	0	0	0	0	0.11	12.19	6.92
Percent of bass no.	55.0	40.0	5.0	0	0	0	0	0	0	55.0	40.0	5.0
1979												
Number/acre	74	40	3	60	0	0	0	5	0	14	35	3
Pounds/acre	0.40	8.81	2.32	0.08	0	0	0	0.27	0	0.32	8.54	2.32
Percent of bass no.	63.2	34.2	2.6	51.3	0	0	0	4.3	0	12.0	29.9	2.6
1982												
Number/acre	58	83	0	42	0	0	0	0	0	16	83	0
Pounds/acre	0.61	15.02	0	0.58	0	0	0	0	0	0.03	15.02	0
Percent of bass no.	41.1	58.9	0	29.8	0	0	0	0	0	11.3	58.9	0

Table 11. Tag return data from size limit evaluation study sites in 1978-1982 from fish tagged in 1978 (first line) and 1979 (second line).

Study site	Number tagged	Number of tags returned				
		1978	1979	1980	1981	1982
Barkley Lake	999	259	12	2	0	1
	1,002	-	228	9	2	1
Barren River Lake	999	223	36	23	6	1
	1,005	-	316	24	4	0
Beaver Lake	50	20	0	0	0	0
	50	-	33	0	0	0
Cave Run Lake	80	33	3	0	0	0
	198	-	82	2	1	0
Elkhorn Creek	53	9	0	0	0	0
	56	-	8	0	0	0
Grayson Lake	37	13	0	0	0	0
	85	-	32	2	1	0
Lake Malone	151	37	4	6	2	1
	150	-	60	3	1	1
Markland Pool of Ohio River	199	50	0	0	0	0
	231	-	52	10	0	0
Slate Creek	9	1	0	0	0	0
	19	-	1	0	0	0

Table 12. Annual exploitation, natural mortality, and survival rates for tagged bass at the size limit evaluation study sites in 1978 and 1979.

Study site	Annual exploitation rate(%)	Mean exploitation rate(%)	Natural mortality(%)	Survival rate(%)
Barkley Lake	25.0	24.3	66.2	8.8
	20.7		62.4	16.9
Barren River Lake	21.6	26.9	46.1	32.3
	30.7		54.4	14.9
Beaver Lake	40.0	53.0	54.6	5.4
	66.0		15.1	18.9
Cave Run Lake	42.7	41.4	48.2	9.1
	40.1		48.9	11.0
Elkhorn Creek	17.0	15.6	68.4	14.6
	14.3		76.8	8.9
Grayson Lake	35.1	36.9	47.0	17.9
	36.6		45.7	17.7
Lake Malone	21.5	32.2	35.1	43.4
	39.9		47.2	12.9
Markland Pool of Ohio River	25.1	23.7	60.1	14.8
	24.0		62.1	13.9
Slate Creek	11.1	7.1	66.7	22.2
	5.3		72.3	22.4

Table 13. Barkley Lake black bass creel survey data before and after the imposition of a 12-inch minimum length limit.

Year	Man-hours/ acre[a]	Fish/ acre	Pounds/ acre	Fish/ hour[b]
1978	44.2	2.9	4.9	0.06
1979	56.9	2.2	3.7	0.04

[a]These data represent total fishing pressure. Pressure by anglers seeking black bass was not determined.

[b]These data represent bass harvest per hour by all anglers.

Table 14. Barren River Lake black bass creel survey data before and after the imposition of a 12-inch minimum length limit.

Year [a]	Man-hours/ acre	Fish/ acre	Pounds/ acre	Fish/ hour
1976	8.6	2.0	2.3	0.22
1977	5.7	1.0	1.1	0.16
1978	4.7	0.6	1.1	0.11
1979	6.0	0.7	1.5	0.11
1980	-	3.2	4.3	-

[a]Ten-inch minimum length limit in 1976-1977 and a 12-inch minimum limit in 1978-1980.

Table 15. Beaver Lake black bass creel survey data before and after the imposition of a 12-inch minimum length limit.

Year [a]	Man-hours/ acre	Fish/ acre	Pounds/ acre	Fish/ hour
1977	63.7	18.0	13.4	0.23
1978	83.4	17.1	22.0	0.15
1979	66.8	19.6	23.3	0.29

[a]Ten-inch minimum length limit in 1977 and a 12-inch minimum length limit in 1978-1979.

Table 16. Cave Run Lake black bass creel survey data before and after the imposition of a 12-inch minimum length limit.

Year[a]	Man-hours/ acre	Fish/ acre	Pounds/ acre	Fish/ hour
1975	10.9	6.4	4.4	0.35
1976	15.3	2.9	2.3	0.12
1977	6.8	1.7	1.4	0.16
1978	6.0	0.8	0.9	0.08
1979	11.3	1.4	1.3	0.10

[a]A ten-inch minimum length limit in 1975-1977 and a 12-inch minimum length limit in 1978-1979.

Table 17. Elkhorn Creek black bass creel survey data before and after the imposition of a 12-inch minimum length limit.

Year[a]	Man-hours/ mile[b]	Fish/ acre	Pounds/ acre	Fish/ hour
1960	477	31	25	0.05
1961	355	14	15	0.04
1962	343	22	20	0.05
1965	286	7	6	0.02
1978	514	6	6	-
1979	478	36	60	0.25
1980	136	0.4	3	0.09

[a]Eleven-inch minimum length limit in 1960-1965 and a 12-inch minimum length limit in 1978-1980.

[b]These data represent total angler pressure.

Table 18. Grayson Lake black bass creel survey data before and after the imposition of a 12-inch minimum length limit.

Year[a]	Man-hours/ acre	Fish/ acre	Pounds/ acre	Fish/ hour
1974	12.7	2.7	3.0	0.20
1975	6.3	2.0	2.0	0.27
1976	9.0	1.4	1.4	0.13
1977	6.3	0.7	0.7	0.09
1978	3.9	0.3	0.4	0.05
1979	7.5	0.2	0.3	0.02
1982	5.4	0.4	0.6	0.10

[a]Ten-inch minimum length limit in 1974-1977, 12-inch minimum length limit in 1978-1979 and a 15-inch minimum length limit in 1982.

Table 19. Lake Malone black bass creel survey data before and after the imposition of a 12-inch minimum length limit.

Year[a]	Man-hours/ acre	Fish/ acre	Pounds/ acre	Fish/ hour
1969	-	2.0	3.6	0.02
1970	-	0.8	2.5	-
1971	-	0.3	0.6	-
1972	48.3	75.3	34.4	0.34
1973	43.0	24.3	23.6	0.48
1974	36.4	8.5	9.6	0.20
1975	30.1	4.6	8.1	0.15
1976	27.7	3.2	6.1	0.11
1977	21.3	3.6	5.1	0.14
1978	39.7	5.5	8.6	0.13
1979	43.3	6.2	9.9	0.13

[a]Ten-inch minimum length limit in 1969-1971 and 1974-1977, no minimum length limit in 1972-1973, and a 12-inch minimum length limit in 1978-1979.

Table 20. Age and mean growth (in) for largemouth bass before (first line) and after (second line) the imposition of the 12-inch size limit at each study site.

Study site	Age									
	1	2	3	4	5	6	7	8	9	10
Barkley Lake	6.5	9.3	11.2	12.9	14.5	16.5	18.2			
	5.9	8.8	10.9	12.8	15.1	15.7				
Barren River Lake	5.1	8.0	10.2	12.7	14.4	17.6				
	5.0	8.3	10.3	12.3	14.8	17.1	19.4	20.0		
Beaver Lake	5.7	9.2	10.8							
	4.4	7.9	10.1	12.1	13.7					
Cave Run Lake	5.1	7.7	9.9	11.4	14.9	19.3				
	5.3	8.1	10.2	11.8	13.4	14.1	15.2	16.5		
Grayson Lake	5.2	8.2	10.0	12.8	16.2	18.0				
	4.8	7.6	9.9	12.1	14.8	16.8	18.5	19.5	20.2	21.1
Ohio River - Markland Pool	4.9	7.8	10.3	12.7	14.2	16.0	17.0	17.2	18.4	
	4.7	7.9	10.2	12.1	14.2	15.9	16.9	17.6		
Lake Malone	4.7	7.5	10.7	12.9	16.4	18.8	21.1	21.9		
	3.8	7.3	10.0	12.6	14.7	16.8	18.5	19.7	20.8	21.2

Table 21. Age and mean growth (in) for spotted bass before (first line) and after (second line) the imposition of the 12-inch size limit at each study site.

Study site	Age					
	1	2	3	4	5	6
Cave Run Lake	5.0	7.8	9.5	11.0		
	4.5	7.2	9.3	10.9	12.3	13.3
Grayson Lake	3.7	6.7	9.7	11.4	13.3	14.9
	2.9	5.8	7.9	9.3	11.0	13.0

Table 22. Age and mean growth (in) for smallmouth bass before (first line) and after (second line) the imposition of the 12-inch size limit at each study site.

Study site	Age								
	1	2	3	4	5	6	7	8	9
Elkhorn Creek	2.7	4.3	6.0	8.1	10.1	12.0	13.1	14.0	
	2.9	5.1	6.9	8.6	10.3	11.6	12.9	14.0	15.0
Slate Creek	5.0	6.8	8.4	10.1	11.2	12.7			
	5.0	6.4	7.9	9.1	10.3	12.2	14.4	15.4	