ESTIMATION OF BLACK BASS, *MICROPTERUS* SPP., POPULATION IN EUFAULA RESERVOIR, OKLAHOMA WITH DISCUSSION OF TECHNIQUES[1]

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The number of black bass in Eufaula Reservoir, Oklahoma, was estimated utilizing mark and recapture and cove rotenone techniques. The estimated number of bass longer than 10 inches varied from 55,115 to 418,200 as determined by four independent estimates. What were considered to be the most conservative and the most liberal estimating techniques did, in fact, give the lowest and highest values, respectively. Cove rotenone data indicated that the larger bass, *i.e.*, total length greater than 10 inches, represented only 5% of the black bass in this reservoir.

The size of the black bass population of Eufaula Reservoir, Oklahoma, was estimated by a variety of techniques during the period March through September, 1972. Two species of black bass, the largemouth bass, *Micropterus salmoides,* and spotted bass, *M. punctulatus,* occur in this reservoir. The largemouth, the dominant species, represented 92% of the black bass sampled during this investigation. Although black bass are considered to be one of the most important game fish in warm water reservoirs, attempts to estimate their numbers in larger impoundments are scarce. The number of largemouth bass in smaller impoundments have been estimated by the mark and recapture method, utilizing electro-fishing gear, by Lewis, Summerfelt, and Bender (1). Zweiacker (2) estimated the population of largemouth bass in a 1,996 acre Oklahoma reservoir using this technique. Bryant and Houser (3), investigating these species in Beaver and Bull Shoals Reservoirs, modified the procedure by estimating only the number of adult bass that occurred along a designated length of shoreline during the spawning season. The total spawning bass population in the reservoir was then calculated by multiplying the number of bass per mile in the sample area by the total length of shoreline. Both Petersen (4) and Schnabel (5) equations have been used to make these estimates.

Cove rotenone samples have been widely used as indicators of standing crop in warm water reservoirs. Hayne, *et al* (6) validated this technique; although results varied with species and age of fish, estimated standing crop, as determined by cove rotenone samples, and expressed as weight of fish, they did represent a valid estimate of fish in a 115-acre arm of Douglas Reservoir.

Eufaula Reservoir, the largest impoundment in Oklahoma, is located in the flood plains of the North and South Canadian and the Deep Fork rivers in east central Oklahoma. The dam is situated across the South Canadian River 12 miles east of Eufaula in McIntosh County. The reservoir which was impounded in 1964, has an area of 102,500 acres, a shore development ratio of 13.4 at normal pool elevation, and a shoreline length of 600 miles. The reservoir is relatively shallow with a maximum depth of 87 feet and an average depth of 23.2 feet.

METHODS

Three estimates of the number of bass larger than 10 inches, total length, were made by mark and recapture procedures. The number of bass in designated areas of the reservoir were estimated by two of these procedures. These values were expanded by the total shoreline length to derive an estimate of the total number of bass in Eufaula Reservoir. The six designated areas (Fig. 1) were widely separated, but each contained habitat types that were representative of the entire reservoir. Black bass

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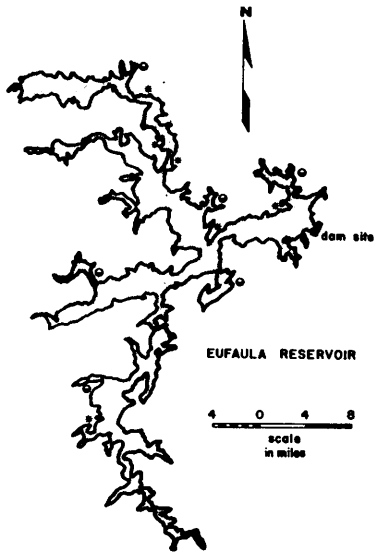

FIGURE 1. Map of Eufaula Reservoir, Oklahoma, with ⊖ representing electro-fishing sample sites, and ✳ representing cove rotenone sites.

were first collected in these areas during the period March 27-29, 1972. Collections were made with several electro-fishing boats, but all units were boom-type shockers, powered by either single- or three-phase, 230-volt AC generators. These units were designed to operate near the shoreline, in water that did not exceed 10 ft in depth.

Black bass were tagged with a Floy-type anchor tag and released at the location of capture. Fish less than 10 inches long were not considered in these mark and recapture estimates. During the period April 24-28, 1972, a second series of samples were taken at the established sites. Bass were again collected with electro-fishing gear, marked with anchor tags, and released. Data obtained from these samples were analyzed as the recapture segment of a Petersen estimate, and as an independent Schnabel (5) estimate.

The catch of tournament fishermen on Lake Eufaula during the month of September was inspected to determine the ratio of marked to unmarked black bass that were caught throughout the entire reservoir. A Petersen (4) estimate was derived utilizing the total number of recaptured bass observed in the catch. This estimate represented the number of large black bass in the entire reservoir.

Petersen (4) estimates, utilizing modifications recommended by Bailey (7) to reduce sample bias, were derived by the formula

$$\hat{P} = \frac{M\ (C + 1)}{R + 1}$$

where $\hat{P}$ equals the estimated number of black bass larger than 10 inches in the sample area, M equals the number of marked bass, C equals the number of bass harvested during the second sample (both marked and unmarked), and R equals the number of marked bass in C.

The Schnabel (5) estimates were derived utilizing the formula

$$\hat{P} = \frac{\Sigma MC}{\Sigma R}$$

where $\hat{P}$ equals the estimated number of black bass larger than 10 inches in the sample area, M equals the number of marked bass in the lake during the specific sample period, C equals the number of bass harvested during the specific sample period, and R equals the number of marked bass in C.

Six coves, having a total area of 12.05 acres and ranging in size from 0.59 to 5.81 acres, were sampled by the cove rotenone technique. Four coves were sampled during June and two coves during September 1972. The locations of these coves are indicated in Figure 1. The procedure for analyzing data followed that recommended by Surber (8). Each cove was mapped utilizing transit and depth recorder to determine area and volume. The mouth of the cove was blocked with a ½-inch mesh net on the evening before the cover was to be sampled. Fish, which were collected outside the study area, were marked and introduced into the cove at a rate of 100 per acre to determine percent recovery. Rotenone was applied at a concentration of one part per million. Fish within the sample area were collected, sorted to species and inch-class, counted, and weighed during the first day of the sample. During the second day of the sample, fish were sorted to species and inch-class, and then counted, but weights were estimated

from data collected during the first sample day.

RESULTS

The lowest of the four estimates calculated for Eufaula Reservoir was derived by the Schnabel (5) mark-and-recapture technique during the period April 24-28. Data presented in Table 1 indicate that the estimated number of bass per mile of study area, as determined by this technique, was 91.86. Considering the combined length of the sample areas (19.02 miles) and the entire shoreline of Eufaula Reservoir (600 miles), it was estimated that a population of 55,116 black bass, larger than 10 inches, existed in Eufaula Reservoir during this time period.

TABLE 1. *Number of black bass, exceeding 10 inches in total length, as determined by Schnabel method using six sampling sites during April, 1972.*

Location	Length of shoreline in sample area (miles)	Estimated number of bass in sample area	Estimated number of bass per mile
Deep Fork	3.05	221.2	72.52
North Canadian	3.28	357.0	108.84
Mill Creek	3.09	214.0	69.26
Longtown Creek	3.16	235.9	74.65
Gaines Creek	2.66	77.7	29.21
Dutchess Creek	3.78	641.4	169.68
Total	19.02	1,747.2	

Estimated number per mile		miles of shoreline	=	Estimated total number in reservoir
91.86	X	600.0	=	55,116

A Petersen (4) estimate, utilizing fish marked during March and recaptured during April, was more liberal. Data presented in Table 2 indicate that 136.95 bass larger than 10 inches existed per mile in the sample sites. Multiplying this figure by the length of shoreline indicates a population of 82,170 large black bass.

A Petersen (4) estimate, utilizing black bass marked at the six sample sites during March and April and recaptured by tournament fishermen during September, was also calculated. Although the tournament fishermen recaptured only a small number of marked fish, an estimate of 142,222 large black bass, as indicated in Table 3, does fall within expectations of other estimates conducted during this investigation.

TABLE 3. *Number of black bass, exceeding 10 inches in total length, as determined by Petersen estimate, utilizing fish marked in March and April and recaptured by tournament fishermen in September.*

Number marked in March and April (R)[a]	Number harvested by fishermen in September (C)	Number recaptured in September (M)
534	798	2

[a] As used in equation:

$$\hat{P} = \frac{M\ (C + 1)}{R + 1} = \frac{534 \cdot (798 + 1)}{2 + 1} = 142{,}222$$

Standing crop of all sizes of black bass in Eufaula Reservoir was established by cove rotenone samples. The estimated number of black bass, as determined by six cove samples, varied from 11.8 to 145.1 per acre with a mean of 74.7 (Table 4). In these samples, the number of black bass larger

TABLE 2. *Number of bass, exceeding 10 inches in total length, as determined by Petersen estimate utilizing fish marked during March, 1792 and recaptured in April, 1972 by project personnel.*

Location	Length of shoreline in sample area in miles (L)[a]	Number of bass marked in March (M)	Number of bass in April sample (C)	Number of bass recaptured in April (R)
Deep Fork	3.05	15	64	1
North Canadian	3.28	34	122	9
Mill Creek	3.09	34	83	8
Longtown Creek	3.16	19	60	0
Gaines Creek	2.66	1	46	0
Duchess Creek	3.78	25	31	1
Total	19.02	128	406	19

[a] As used in equation:

$$\hat{P}/\text{mile} = \frac{M\ (C + 1)}{R + 1} \cdot \frac{1}{L} = \frac{128\ (406 + 1)}{19 + 1} \cdot \frac{1}{19.02} = 136.95$$

Estimated number per mile		Miles of shoreline	=	Estimated total number in reservoir
136.95	X	600.0	=	82,170

TABLE 4. *Estimated number of black bass as determined by the cove rotenone technique.*

Cove	Area of cove (acres)	Number of bass collected from cove <10 inch	Number of bass collected from cove >10 inch	Recovery of marked bass (%)	Estimated number of bass in cove <10 inch	Estimated number of bass in cove >10 inch	Estimated number of bass per acre <10 inch	Estimated number of bass per acre >10 inch
Sandy Bass	0.59	36	2	44.4	81.1	4.5	137.5	7.6
Juniper Point	0.91	9	0	84.2	10.7	0.0	11.8	0.0
150 Bridge	0.95	78	2	69.6	112.1	2.9	118.0	3.1
Fountainhead	1.22	68	0	76.8	88.5	0.0	72.5	0.0
Porum Landing	2.57	66	7	38.0	173.7	18.4	67.6	7.2
Emerald Bay	5.81	45	19	47.2	95.3	40.3	16.4	6.9
					Average number/acre		70.6	4.1

	Estimated number per acre		Area of reservoir		Estimated total number in reservoir
< 10 inches	70.6	X	102,000	=	7,201,200
> 10 inches	4.1	X	102,000	=	418,200
Total	74.7	X	102,000	=	7,619,400

than 10 inches varied from 0 to 7.6 with a mean of 4.1 bass per acre. The mean number of black bass less than 10 inches was estimated as 70.6. An estimated 418,200 bass exceeding 10 inches and 7,201,200 bass less than 10 inches occurred in Eufaula Reservoir.

DISCUSSION

Although independent estimates of the number of black bass in Eufaula Reservoir varied considerably, much of the deviation is thought to have resulted from bias in sampling technique. The lowest estimate of 55,116 large bass, which was derived by the Schnabel equation, was considered to be the most conservative. The assumptions necessary to utilize this technique required that all black bass within the size range of the estimate would be located near the shoreline, sample sites would be representative of the entire reservoir, and electro-fishing units would not be selective for a particular segment of the population. However, we were not convinced that all spawning bass were located in the vicinity of the shoreline and we, therefore, estimated only a segment of the actual population. In addition, electro-fishing units employed in this study were most effective when used adjacent to the shoreline. If, as expected during the spawning season, a particular fish had established a territory close to the shoreline and remained at this location for an extended period of time, the probability of capturing this fish would be greater than that of capturing a fish that had established a territory farther from the shoreline. Because of this bias a larger number of marked fish would be recaptured and the estimated population would be lower than expected.

The Petersen (4) estimate of 82,170 large bass, which was based on fish marked during March and recaptured during April, was considered to be somewhat liberal. The most serious bias of this estimate resulted from the assumptions that spawning bass did not move from or into the study area and that no tags were lost during the period March 29 to April 24. Since these assumptions were not considered to be valid, the probability of recapturing a marked fish would be reduced accordingly. The estimated number of black bass would, therefore, be greater than that derived by the previous method.

The estimate derived from the catch of tournament fishermen was also considered to be liberal. The sample design for this estimate is probably the most valid, with less bias incorporated into the sampling technique, but the difficulty of marking and recapturing a significant portion of the black bass population in a 102,500-acre reservoir limited this technique under prevailing conditions. The reliability of an estimate in which only two of 534 fish are recaptured is certainly questionable. However, by design, in this estimate it must be assumed that the fishermen harvested black bass at random from the entire reservoir, *i.e.*, there was no reason to suspect that the fishermen had a preference for fishing in the areas where fish were marked. Negative tag loss from March until September must also be assumed in this estimate.

The estimate of standing crop as determined by the cove rotenone technique was

also considered to be liberal. The assumption that standing crop of black bass in coves is equal to the standing crop of black bass in the open water of Eufaula Reservoir is, in our opinion, not valid. It is anticipated that during the time of rotenone sampling, the majority of black bass were distributed near the shoreline. If this assumption was true, the number of black bass in the reservoir would be significantly over-estimated by this technique.

Although it is expected that the cove rotenone estimates were liberal, the relative number of black bass greater than and less than 10 inches was thought to be a valid relationship, and can, therefore, be considered when analyzing the size structure of the population. The length-frequency of black bass collected from rotenone samples (Fig. 2) indicate that 94.5% of the black

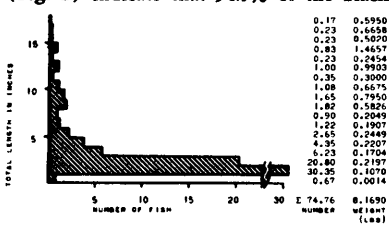

FIGURE 2. Length-frequency and weight of black bass per acre as estimated by the cove rotenone technique.

bass population in Eufaula Reservoir was less than 10 inches in total length. These data also indicate that 68.4% of the estimated 7.6 million black bass in Eufaula Reservoir were in the 2- or 3-inch class at the time of sampling.

These estimates indicate that the number of black bass greater than 10 inches in Eufaula Reservoir is probably between 55,115 and 418,200 and the percentage of bass larger than 10 inches is approximately 5% of the total black bass population.

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