POPULATION CHARACTERISTICS OF SMALLMOUTH BASS IN GLOVER CREEK, SOUTHEAST OKLAHOMA

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Smallmouth bass (*Micropterus dolomieui*) were collected from Glover Creek in 1977-79 to document growth patterns, age and length structure, and relative condition. Maximum age was 6 years, although the majority of fish were less than 3 years old. Annual survival of adults (age 2 and older) was estimated as 39% with 95% confidence limits from 32 to 47%. Proportional stock density was 19%. Growth was relatively slow compared to that of other stream populations. Relative weight was less than 100 for all age groups except age 0. Seasonal patterns in growth and condition indicated that growth slowed during late summer.

INTRODUCTION

The smallmouth bass (*Micropterus dolomieui*) is the primary sport fish in streams of eastern Oklahoma and western Arkansas. These streams are unique in being near the southern limit of the native range of smallmouth bass (1). Despite this uniqueness and the value of the smallmouth bass sport fishery in this region, few studies on growth and population characteristics have been reported (2,3,4) within this area. This lack of data makes it difficult to manage these populations and specifically to evaluate the efficacy of various creel and length-limit regulations for smallmouth bass fisheries in southern streams. At the same time, stream modifications and water use increasingly influences habitat and the well being of these smallmouth bass populations. In an effort to offset this paucity of information, the objectives of this study were to document the growth patterns, age and length structure, and relative condition of smallmouth bass in Glover Creek, Oklahoma. The study area has been previously described (5). Population characteristics were compared with those of populations in other streams, rivers, lakes, and reservoirs.

METHODS

Smallmouth bass were sampled from November 1977 through September 1979 using a boat-mounted, pulsed DC electrofishing unit with hand-held electrodes, and a pulsed DC backpack electrofisher (Smith-Root Type VII). Additional collections were made by angling. Most fish were collected from West Fork (54%) and the main stem (44%), and the remainder were collected from the East Fork.

Total length (mm) measurements and scale samples were obtained from all fish. Weights (g) were obtained only from fish collected by electroshocking. Scales were collected from above the lateral line near the tip of the pectoral fin, pressed on acetate slides, and examined with a Bausch and Lomb 40× projector. All scales were aged by at least two readers and where differences existed scales were re-read and differences were resolvd. Distances, magnified 40×, from the scale focus to each annulus and to the anterior scale margin were measured in millimeters. Length histories were back-calculated by fitting a functional regression line to the total length-scale radius relation by use of the computer program of Marquess et al. (6). The length-weight relation was derived by computing regression of $\log_{10}$ (weight) against $\log_{10}$ (length).

In addition to calculated annual growth increments, seasonal growth patterns were investigated for fish of ages 0, 1, and 2. Monthly mean lengths were determined for each age group. These means were used to derive a von Bertalanffy growth curve for each year's growth. Weighted nonlinear regression was used to fit the curve using Marquardt's method (7,8).

Body condition of smallmouth bass was measured in two ways. The traditional ap-

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proach used was Fulton's condition factor (K):

$$K = (W \times 10^5)/L$$

where W and L are weight (g) and total length (mm), respectively. In addition, relative weight, W_r, was computed according to Wege and Anderson (9):

$$W_r, = (W/W_s) \times 100$$

where W_s is a standard weight for smallmouth bass of a given length. The standard weights were computed from:

$$W_s = 0.014 \times 10^{-4} L^{3.055}$$

based on Anderson's (10) recommendation.

An index of length structure, proportional stock density, was also computed. Proportional stock density (PSD) was calculated from:

$$PSD = (\text{No. quality size fish/no. stock size fish}) \times 100$$

where quality size is greater than or equal to 279 mm in length and stock size is greater than or equal to 178 mm (11). Survival for fish of age 2 and older was estimated by the Robson-Chapman method (12, 13).

RESULTS

Out of our sample of 272 fish, 51 (19%) could not be aged because of regenerated scales. The maximum age of smallmouth bass in our sample was 6 years. However, the majority of fish in our sample (79%) were less than 3 years old (Table 1). Annual survival of fish aged 2 and older was estimated to be 39% (Robson-Chapman estimate). Proportional stock density was 19%.

Back-calculated lengths indicated that the smallmouth bass in Glover Creek took 2 - 3 years to reach stock size (178 mm) and 4 - 5 years to reach quality size (279 mm) (Table 2).

The von Bertalanffy growth curves accurately described seasonal growth patterns (Fig. 1). Age-0 fish grew steadily throughout their first growing season. Fish at ages 1 and 2, however, apparently grew fastest during the spring and early summer months (April through July).

The length-weight relation, based on 203 fish, was:

$$W = 0.141 \times 10^{-4} L^{2.951} \ (r^2 = 0.97)$$

Condition factors ranged from 1.06 for age 4 to 1.33 for age 0 (Table 1). Relative weights were less than 100 for all ages except age 0, for which it was 102 (Table 1). Relative weights for fish age 1 and older increased in spring, decreased in summer, increased again in fall and declined during winter (Fig. 2).

DISCUSSION

The longevity of smallmouth bass in Glover Creek (6 years) is similar to that observed in other streams in this latitude (2,14). Populations of smallmouth in northern waters typically live 10-11 years (15,16). Tate (17) rarely found small-

TABLE 1. *Sample characteristics of smallmouth bass collected from Glover Creek, 1977-79.*

	Age, years						
Parameter	0	1	2	3	4	5	6
Age composition							
Numbers	61	31	69	27	9	4	4
Percentage	30	15	34	12	4	2	2
Length at capture (mm)							
Mean	60	130	183	242	263	299	346
Range	36-115	63-201	116-256	160-336	238-335	279-340	311-379
Weight at capture (g)							
Mean	4	28	72	146	231	345	593
Range	1-61	2-82	14-192	32-440	125-474	284-406	530-681
Number	44	30	50	18	5	2	3
Condition factor							
Mean	1.33	1.07	1.13	1.07	1.06	1.15	1.28
Range	0.54-4.29	0.77-1.45	0.71-2.31	0.78-1.47	0.75-1.26	1.03-1.27	1.25-1.36
Relative weight							
Mean	102	79	82	76	75	81	89
Range	41-338	59-108	51-168	57-105	53-88	72-89	87-95

mouth bass over four years of age in small streams in Iowa and attributed this to movement from smaller to larger streams. In two streams in Missouri smallmouth bass live to 8 and 9 years (18,19).

Survival rate (age 2 and older) calculated from our Glover Creek sample was 39% with 95% confidence limits from 32 to 47%. This is similar to rates reported for other exploited stream populations (4,18,20,21). Reported annual survival rates ranged from 34% for Courtois Creek, Missouri (18) to 64% for Buffalo River, Arkansas (4). Over one-half of the total mortality has been attributed to fishing from six of seven populations where data were available (20). No exploitation rates are available for the Glover Creek population, although it seems to receive substantial fishing pressure. Fajen (22) estimated that survival of an unexploited population of smallmouth bass (ages 1-6) in Little Saline Creek, Missouri, to be 89%.

The proportional stock density (PSD) index has been proposed as an indicator of balance, the ability to provide satisfactory catch and harvest of game and panfish (11). However, the initial application of this index has been for small impoundments and little research has been done to establish an expected range for PSD in stream populations with balanced or satisfactory structure. On the basis of simple models, Anderson and Weithman (11) suggested that smallmouth bass populations would be balanced when PSD is near or within the range of 30 to 60%. The PSD for the smallmouth bass population of Glover Creek was 19%, which is below the suggested range. In this situation the low PSD results from the low growth rates and high mortality rates observed.

Glover Creek smallmouth bass had slower growth than those typically found in

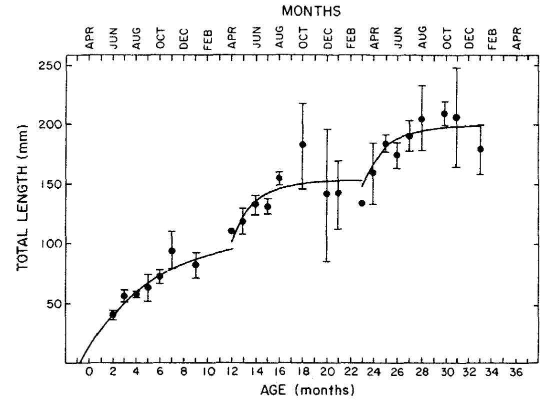

FIGURE 1. Seasonal growth curves for smallmouth bass in Glover Creek. Observed data are monthly means (± 2 SE). Curves represent fitted von Bertalanffy growth curves for each age group.

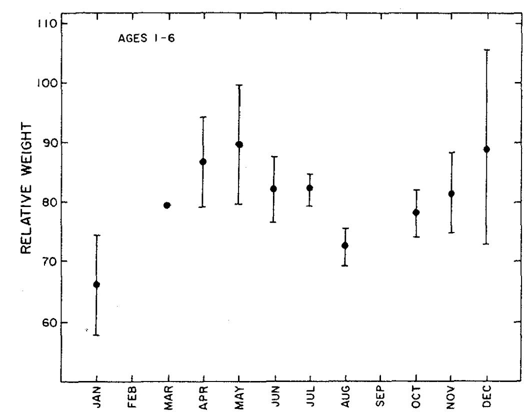

FIGURE 2. Seasonal changes in monthly mean relative weights (± 2 SE) for smallmouth bass in Glover Creek.

TABLE 2. *Back-calculated lengths at annuli formation of smallmouth bass from Glover Creek, 1977-79.*

Age at capture, years	Number	Back-calculated lengths at age (mm)[a] 1	2	3	4	5	6
1	31	95					
2	69	91	161				
3	27	94	167	225			
4	9	90	151	194	237		
5	4	94	145	205	250	294	
6	4	85	158	218	266	305	342
Pooled	144	92	161	216	247	300	342

[a]Lengths were estimated from the functional regression $L = 18.806 + 1.9379 \times S$ ($r^2 = 0.96$), where S = scale radius (magnified 40×).

larger rivers, lakes or reservoirs (15,16,20, 23). However, growth rates were comparable to those observed for smallmouth bass in the nearby Mountain Fork River and Little River (3) as well as the Illinois River in Oklahoma (2). Growth during the first 3 years of life was also comparable to that of fish in streams in Maryland (21) and Missouri (14,18,19). However, after age 3 Glover Creek smallmouth grew more slowly than those in Maryland and Missouri.

The relatively slow growth and decreased relative weight during summer were apparently not due to excessive summer temperatures since observed summer temperatures in Glover Creek were often within the optimum range for growth (24,25,26). Although we collected no data on food habits, it is possible that smallmouth bass in Glover Creek became foodlimited in late summer. Glover Creek is a softwater stream (hardness: 36 mg/*l*) with an average benthic invertebrate biomass of only 13 g/m^2 (27), which puts it into an intermediate food grade (28). Other fish species grow faster in hard than in soft water (29,30).

Population characteristics of the smallmouth bass in Glover Creek indicate that the population is exploited at levels comparable to other smallmouth bass populations in streams. However, because of the relatively slow growth, the population cannot withstand this same intensity of exploitation without significantly reducing the percentage of quality size fish in the population, hence the low PSD. The smallmouth bass (age 1 and older) in Glover Creek are apparently food limited and, therefore, minimum length limit regulations would probably not be successful. Rather imposition of a minimum length limit would probably further reduce growth rates among sublegal-size smallmouth bass. Efforts should be made to evaluate alternative solutions to regulating exploitation, such as slot-length limits.

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