GROWTH RATES AND FOOD HABITS OF ROANOKE BASS IN THE ENO AND TAR RIVERS, NORTH CAROLINA

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Abstract: Two hundred and thirty Roanoke bass *(Ambloplites cavifrons)* were collected from the Tar and Eno rivers in Piedmont, North Carolina. Seven age groups (1 to 7) were collected from the Tar River and 5 age groups (1 to 5) were collected from the Eno River. Mean back-calculated total lengths were similar in both rivers. Five-year old fish from the Tar River averaged 246 mm and from the Eno River 243 mm. Roanoke bass were generally opportunistic feeders, but larger individuals selectively fed on crayfish *(Cambarus* sp.) and fish. Feeding appeared to be concentrated in vegetated riffle areas.

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Roanoke bass, a sunfish closely resembling the rock bass *(Ambloplites rupestris)*, occurs naturally in the Tar and Neuse river systems in North Carolina (Smith 1971) and in the Roanoke River system in Virginia (Blair et al. 1957). The species has been introduced into other river systems in North Carolina, but no reproduction has been detected. Although the species is locally abundant in several streams in Piedmont, North Carolina, its restricted range has caused it to be classified as "special concern" in North Carolina and Virginia by the American Fisheries Society (Deacon et al. 1979).

Smith (1971) described the distribution in North Carolina, morphology, fecundity, food habits, and growth rates of the species. Much of this work was conducted in hatchery ponds, as he was able to collect only 116 wild Roanoke bass. Therefore, the growth and food habits data for wild fish were based on a relatively small sample of predominantly large fish, which may or may not be representative of the species.

To protect existing populations and possibly expand the range of the Roanoke bass, additional life history information for the fish was needed. Consequently, a life history evaluation of the species was begun in 1979. The purpose of this study was to determine growth rates and summer food habits of the Roanoke bass in Eno and Tar rivers, North Carolina.

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METHODS

Eno River is located in Orange and Durham counties and is a headwater tributary of Neuse River. It is approximately 67.5 km in length with average widths in the sample areas ranging from 9 to 12 m. The river is characterized by long riffle areas covered with river weed *(Podostemum* sp.) followed by shallow pools less than 1 m deep. The stream bed is composed primarily of large rubble (10 to 30 cm). Water quality is generally good.

Tar River originates in Person County and flows southeasterly for approximately 313.8 km to Washington, North Carolina where its name is changed to Pamlico River. The reaches studied in Person and Granville counties had average widths ranging from 9 to 15

m. In these sections it is similar to Eno River, except that it remains turbid for a longer time following heavy rains.

Fish samples were obtained by electrofishing during July and August 1979. Each Roanoke bass collected was weighed and the total length (T.L.) measured. Several scales were removed from the left side, below the lateral line at the tip of the extended pectoral fin. The stomach contents of fish greater than 100 mm were removed by pulsed gastric lavage (Foster 1977). Roanoke bass less than 100 mm were sacrificed and their stomachs excised. Stomach contents or whole stomachs were preserved individually in 10 percent formalin solutions.

Roanoke bass scales were impressed on acetate slides and examined using a Bauch and Lomb microprojector. Distances from the focus to the annuli and the scale margin were measured along the midline of the anterior field. Body scale relationships were obtained by utilizing functional regression equations (Ricker 1973).

Stomach contents were observed under a binocular microscope and items were identified to the lowest possible taxon using Pennak (1953) and Usinger (1956) as the primary keys. A combination of food analyses described by Lagler (1956) was used to delineate the diets of the Roanoke bass.

RESULTS AND DISCUSSION

Age and Growth

Age and growth determinations were made on 63 and 107 Roanoke bass from the Eno River and the Tar River, respectively. The body length-scale radius relationships were:

Eno River: FL = .5158 + .9013 SR (r = 0.97)

Tar River: FL = .5316 + .8804 SR (r = 0.98)

The average back-calculated total body lengths of the Roanoke bass collected from the Eno River and the Tar River are presented in Tables 1 and 2, respectively. Mean back-calculated total lengths of Roanoke bass for the first 5 years were similar in both

Table 1. Average back-calculated total lengths (mm) at the end of year of Roanoke bass collected from Eno River in summer 1979.

Age group	Number of fish	Mean calculated total length in mm at annulus formation (growth increment in parentheses)				
		1	2	3	4	5
I	13	41 (41)				
II	12	43 (43)	125 (82)			
III	26	45 (45)	120 (75)	156 (36)		
IV	1	48 (48)	122 (74)	187 (65)	234 (47)	
V	1	35 (35)	87 (52)	155 (68)	204 (49)	243 (39)
Mean calculated total length		42	114	166	219	243
Mean calculated annual growth increment		42	71	56	48	39
Range of calculated lengths at annulus formation		31-66	87-153	123-219	217-250	243

Table 2. Average back-calculated total lengths (mm) at the end of year of Roanoke bass collected from Tar River in summer 1979.

Age group	Number of fish	Mean calculated total length in mm at annulus formation (growth increment in parentheses)						
		1	2	3	4	5	6	7
I	15	45 (45)						
II	15	46 (46)	116 (70)					
III	46	50 (50)	112 (62)	169 (57)				
IV	24	49 (49)	114 (65)	166 (52)	210 (44)			
V	3	50 (50)	121 (71)	165 (44)	209 (44)	247 (38)		
VI	2	53 (53)	115 (62)	153 (38)	192 (39)	238 (46)	258 (20)	
VII	1	45 (45)	118 (73)	184 (66)	222 (38)	252 (30)	275 (23)	288 (13)
Mean calculated total length		48	116	167	208	246	266	288
Mean calcu-lated annual growth increment		48	67	51	41	38	22	13
Range of calculated lengths at annulus formation		32-70	82-143	130-210	186-239	237-255	250-275	288

rivers. The mean calculated total length for 5-year old fish from the Eno River was 243 mm and from the Tar River 246 mm.

Mean back-calculated total lengths of fish from this study were consistently less than those found by Smith (1971). The larger discrepancies between the 2 studies occurred in age groups 1 through 3. However, growth rates from these studies may not be comparable, since Smith utilized the direct proportion, zero intercept method for back-calculating growth increments.

For the first 3 age groups, growth rates of Roanoke bass from the Eno and Tar rivers were similar to average growth rates of rock bass from North Carolina, Virginia, Oklahoma, and Tennessee streams (Carlander 1977). However, in subsequent years, growth of Roanoke bass exceeded that reported for rock bass. After 5 years, rock bass averaged 198 mm in length while Roanoke bass averaged 245 mm.

The von Bertalanffy growth equation (Ricker 1974) was calculated for Tar River Roanoke bass to estimate the maximum attainable length ($L\infty$) and the age at which 95 percent $L\infty$ is attained. $L\infty$ was 349 mm and the time required to reach 95 percent $L\infty$ was 11.5 years. The oldest fish collected was age 7 and was estimated to have been 288 mm long at that annulus formation. Insufficient numbers of older fish were collected from Eno River to generate meaningful estimates for the von Bertalanffy parameters.

Examination of the age structure of Roanoke bass populations in both rivers revealed that fish older than age 4 were rare. Only 1 fish was collected that was greater than age 6. Since electrofishing has been shown to be selective for larger individuals (Sullivan 1956), it is doubtful that the scarcity of older fish was due to negative gear selectivity. Carlander (1977) summarized data showing similar age structures for rock bass populations in streams. Therefore, we inferred that the longevity of Roanoke bass was similar to that of rock bass.

Weight-Length Relationships

Weight-length regressions based upon 80 fish from Eno River and 150 fish from Tar River were:

Eno River: $\log W = -4.622 + 2.945 \log L$ ($r = .99$)

Tar River: $\log W = -4.901 + 3.065 \log L$ ($r = .99$)

Calculated weights were similar for fish from both streams over the range of lengths observed (Fig. 1).

Food Habits

A total of 217 Roanoke bass was used for food habit analysis. These fish ranged in total length from 61 to 330 mm in Tar River and from 64 to 279 mm in Eno River. The percentages of stomachs containing food items in the Tar and Eno rivers were 75 percent and 80 percent, respectively. The percent of empty stomachs generally increased with increasing fish size.

The number of taxa represented in the diet of Roanoke bass ranged from 11 in Eno River to 16 in Tar River (Table 3). Frequently occurring groups were crayfish, fish (*Etheostoma* spp., *Notropis* spp., and *Ictalurus* spp.) and aquatic insects. Important insect taxa were caddisfly larvae (*Trichoptera*), midge and blackfly larvae (*Diptera*), and mayfly nymphs (*Ephemeroptera*). Crayfish and caddisfly larvae were present in nearly 50 percent of all stomachs from both rivers. The higher frequency of Coleoptera in stomachs from Eno River fish was due to an emergence of Japanese beetles (*Papillia japonica*) during sampling.

Numerically, caddisfly larvae and mayfly nymphs were important in Roanoke bass diets. These organisms comprised 38 percent and 50 percent, respectively, of all food items found in fish from the Eno and Tar rivers.

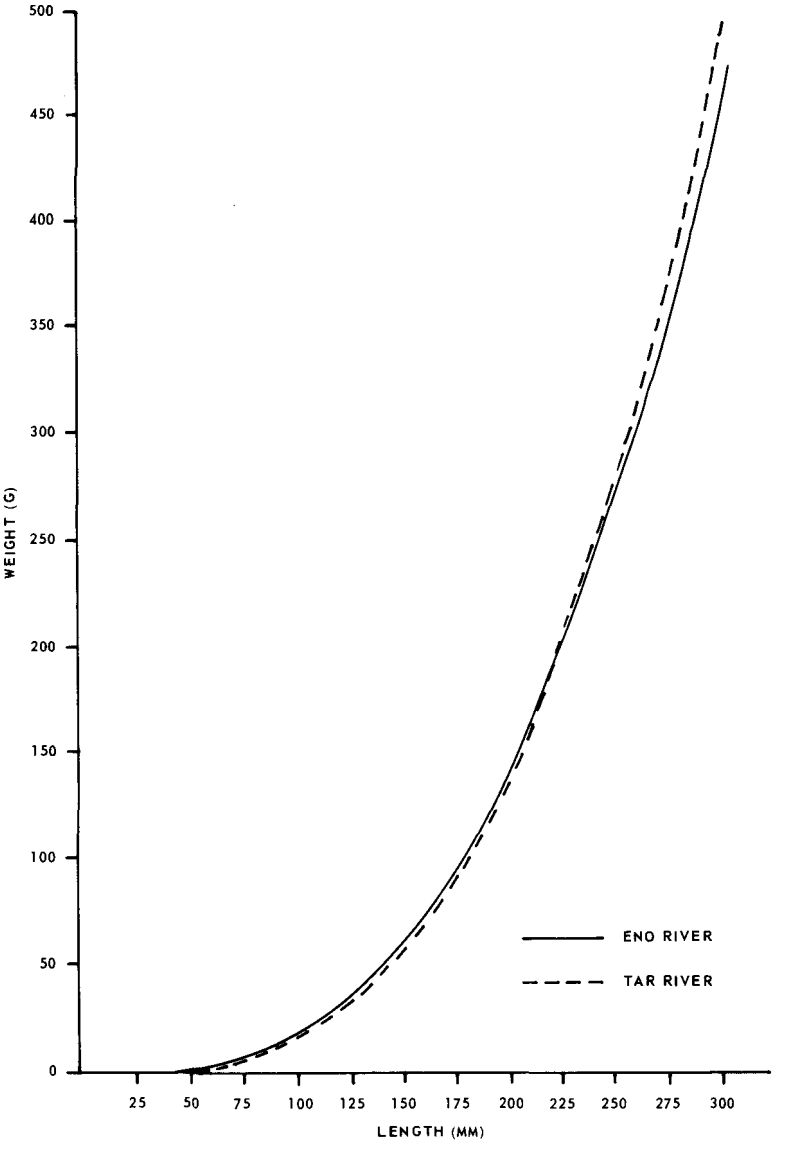

Fig. 1. Weight-length relationships of Roanoke bass in Eno and Tar rivers, N.C.

Fish and crayfish made up over 80 percent of the total volume of food organisms in Roanoke bass from both rivers. Members of both these groups have relatively large body sizes and either bony or chitinous body parts. Undoubtedly fish and crayfish were digested slowly, thus exaggerating their importance.

Roanoke bass exhibited both qualitative and quantitative variations in selection of food items with changing size (Figs. 2 and 3). Crayfish and fish were more abundant in larger Roanoke bass ($>$ 150 mm) of both rivers. Aquatic insects varied in importance in the diet

Table 3. Food items identified from Roanoke bass stomachs collected from the Tar and Eno rivers in summer 1979.

	Percent Occurrence		Percent Number		Percent Volume	
Food Item	Tar R.	Eno R.	Tar R.	Eno R.	Tar R.	Eno R.
Osteichthyes	38.0	24.0	7.0	5.0	37.0	20.0
Arachnida						
Hydracarina	4.0	10.0	0.70	5.0	0.40	0.04
Crustacea						
Decapoda	50.0	46.0	10.0	12.0	55.0	65.0
Insecta						
Coleoptera	8.0	30.0	2.0	20.0	0.65	7.0
Diptera	24.0	21.0	25.0	13.0	0.20	0.04
Ephemeroptera	33.0	30.0	27.0	12.0	0.42	0.30
Hemiptera	3.0	0.0	0.50	0.0	trace	0.0
Homoptera	1.0	0.0	0.20	0.0	trace	0.0
Hymenoptera	3.0	0.0	0.50	0.0	0.02	0.0
Megaloptera	10.0	0.0	2.0	0.0	0.55	0.0
Odonata	6.0	18.0	1.0	5.0	0.10	1.0
Orthoptera	1.0	0.0	0.20	0.0	trace	0.0
Plecoptera	3.0	3.0	0.50	1.0	0.20	0.04
Trichoptera	40.0	46.0	23.0	26.0	0.54	0.70
Gastropoda	4.0	2.0	0.70	0.04	0.40	0.04
Unidentified						
insect remains	25.0	35.0	-	-	1.0	2.0
Podostemaccae						
(river weed)	56.0	35.0	-	-	3.0	3.0

of the Roanoke bass. Mayfly nymphs were prominent in fish < 100 mm in both rivers and decreased in abundance with increasing size. Caddisfly larvae and midge and blackfly larvae varied in importance with the different size groups. Smith (1971) found aquatic insects were the major food of fingerling Roanoke bass, but crayfish and fish were the only food in stomachs of adult fish.

Based on diversity of food items, smaller Roanoke bass were opportunistic feeders. However, as fish sizes increased, selectivity for crayfish tended to increase while the number of taxa consumed decreased. The data further suggested that Roanoke bass were selective for feeding habitat. The invertebrate grazers consumed were closely associated with the vegetation found in both rivers. River weed occurred in 56 percent of the fish stomachs from the Tar River and 35 percent of the fish stomachs from the Eno River. This was attributed to the incidental ingestion of vegetation while capturing prey.

LITERATURE CITED

BLAIR, W. F., A. P. BLAIR, P. BRODKORB, F. R. CAGLE, and G. A. MOORE. 1957. Vertebrates of the United States. McGraw-Hill Book Co., N.Y. 172pp.

CARLANDER, K. D. 1977. Handbook of freshwater fishery biology, Vol. 2. The Iowa State Univ. Press, Ames. 431pp.

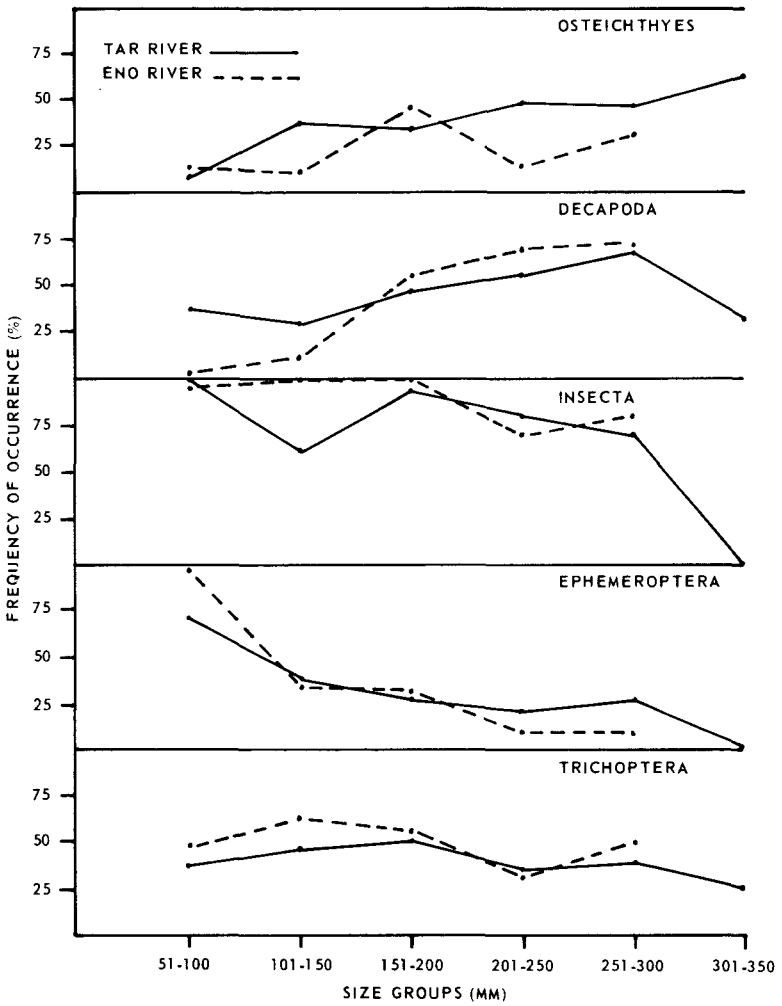

Fig. 2. Size variation in frequency of occurrence for major food items in Roanoke bass stomachs from the Tar and Eno rivers.

DEACON, J. E., G. KOBETICH, J. D. WILLIAMS and S. CONTRERAS. 1979. Fishes of North America endangered, threatened, or of special concern. Fisheries 4(2):29-44.

FOSTER, J. R. 1977. Pulsed gastric lavage: an efficient method of removing the stomach contents of live fish. Prog. Fish-Cult. 39:166-169.

LAGLER, K. F. 1956. Freshwater fishery biology. W. C. Brown Co., Dubuque, Iowa. 421pp.

PENNAK, R. W. 1953. Freshwater invertebrates of the United States. Round Press Co., N.Y. 769pp.

RICKER, W. E. 1973. Linear regressions in fishery research. J. Fish. Res. Board. Can. 30:409-434.

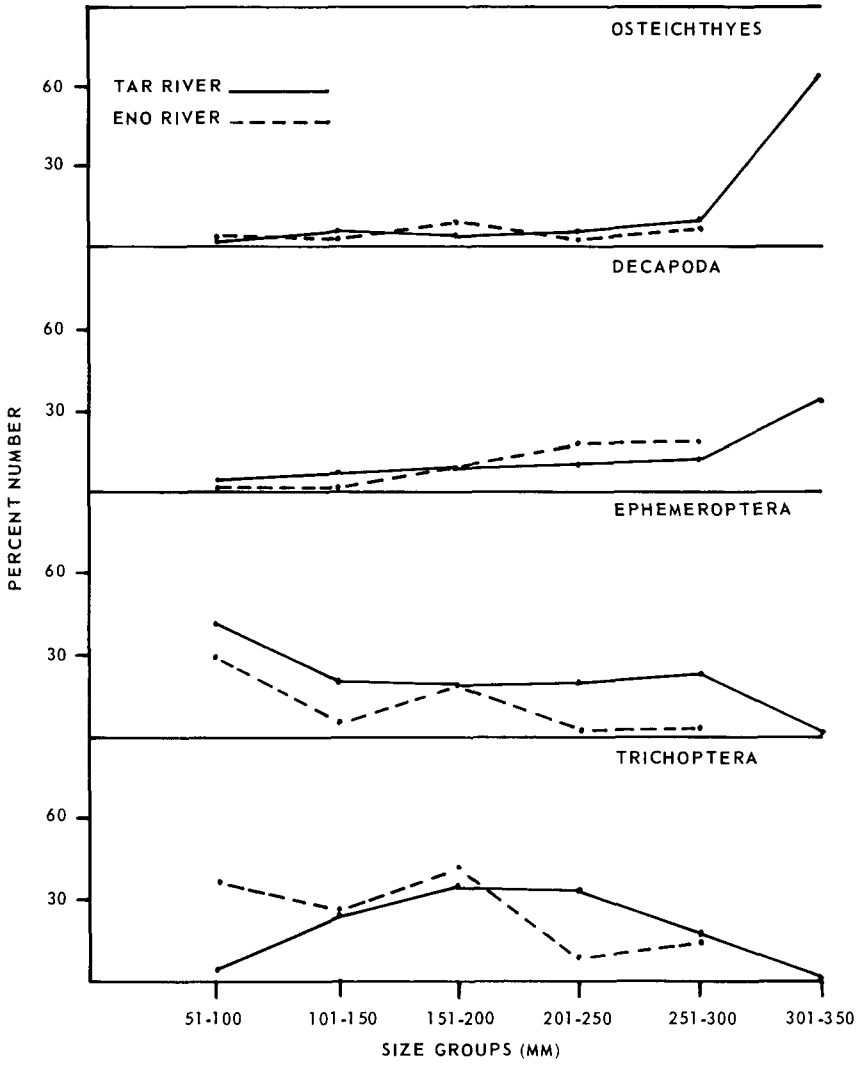

Fig. 3. Size variation in percent number of major food items in Roanoke bass from the Tar and Eno rivers.

_____. 1975. Computation and interpretation of biological statistics of fish populations. Bull. 191. Fish Res. Board. Can. 382pp.

SMITH, W. 1971. The biology of the Roanoke bass *Ambloplites cavifrons* Cope in North Carolina. Proc. Ann. Conf. S.E. Assoc. Game & Fish Comm. 25:561-570.

SULLIVAN, C. 1956. The importance of size grouping in population estimates employing electric shockers. Prog. Fish-Cult. 18:188-190.

USINGER, R. L. 1956. Aquatic insects of California. Berkeley, Univ. Calif. Press. 508pp.