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Raj V. Kilambi
*University of Arkansas, Fayetteville*

Alex Zdinak Jr.
*University of Arkansas, Fayetteville*

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# THE BIOLOGY OF STRIPED BASS, *MORONE SAXATILIS*, IN BEAVER RESERVOIR, ARKANSAS

**RAJ V. KILAMBI and ALEX ZDINAK**
Department of Zoology
University of Arkansas
Fayetteville, Arkansas 72701

**ABSTRACT**

Growth, length - weight relationship, maturation and food habits of striped bass from Beaver Reservoir were studied. No significant difference in growth in length between sexes was found. Growth of the Beaver Reservoir striped bass was similar to that of anadromous and freshwater populations. Males and females showed significant difference in length - weight relationship, and females exhibited isometric growth.

The gonosomatic indices (GSI) of males ranged from 4.50 to 7.09 and were classified as mature fish. Female striped bass with GSI of 2.62 and above had three size groups of ova and were considered as maturing and mature. The food was primarily composed of gizzard shad. Both the possible impact of striped bass on the ecosystem of Beaver Reservoir and future research are discussed.

## INTRODUCTION

The striped bass (*Morone saxatilis*), was probably one of the first managed natural resources in colonial America (Pearson, 1938). Although generally regarded as an anadromous species, due to their ability to tolerate freshwater conditions, now landlocked freshwater populations exist (Scruggs, 1955). The striped bass was stocked into many Arkansas reservoirs by the Arkansas Game and Fish Commission (Pledger, 1976). The biology of this fish previously has not been investigated from Beaver Reservoir. This paper deals with the general biology of striped bass and presents data for spawning potential in Beaver Reservoir, Arkansas.

## METHODS AND MATERIALS

The 11,420 ha Beaver Reservoir was impounded in 1963 on the White River. Striped bass fingerlings were first released into the reservoir in 1970, and from 1975, stocking was carried out annually (Scott Henderson, Arkansas Game and Fish Commission, *pers. comm.*). The fish for this study were collected from the War Eagle (16 fish) and the Hickory Creek (33 fish) areas by gill nets during February-March of 1979 and 1981.

Fish were brought to the laboratory and measured for total length (mm), body weight (g) and gonad weight (g). Scale samples for age and growth studies were taken from just below the lateral line at the tip of the left pectoral fin. Fish were aged by the number of annuli, and since the fish were collected in the early spring, an annulus was presumed at the edge of the scale. Scale radius and distances to annuli were measured from the cellulose-acetate scale impressions at 24x magnification. A random sample of 100 ova from each fish was measured to the nearest 0.02 mm by stereoscopic microscope fitted with ocular micrometer. Morphological characteristics of the ova in various ovum size groups were recorded. Fecundity was estimated as the total number of maturing (Group 2) and mature (Group 3) ova in both the ovaries by the wet gravimetric proportional method. Significance of statistics was expressed at the 0.01 level.

## RESULTS AND DISCUSSION

**Length - Weight Relationship.**

The length - weight relationship was calculated as:

$$\log W = \log a + b \log L$$

where, W = fish weight (g), L = total length (mm), a = intercept, and b = regression coefficient. The estimated formulae for the males and females are:

| | |
|---|---|
| Male | $\log W = 2.699 \log L - 4.059$ |
| Female | $\log W = 2.903 \log L - 4.624$ |

There was significant difference between the sexes ($F_{2,45} = 5.91$), and the females exhibited isometric growth (b = 3.0).

**Age and Growth.**

Striped bass belonging to age groups IV - VIII were collected, and age groups IV and VI comprised 64% of the collections. Among the males age group VI was dominant (57%), while age group IV was abundant (37%) of the females (Table 1). Lengths at the end of each year of life, i.e. at the time of annulus formation, were back-calculated by the formula:

$$L' = C + (S'/S)(L - C)$$

where L' = estimated length at an annulus, L = fish length at capture, S = scale radius, S' = distance to annulus, and C = intercept.

Table 1. Average back-calculated lengths of striped bass from Beaver Reservoir.

| | | Total length (mm) at annulus | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Age-group | Number of fish | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| | | | | | Males | | | | |
| IV | 4 | 187 | 222 | 315 | 390 | | | | |
| V | 2 | 139 | 204 | 296 | 359 | 394 | | | |
| VI | 12 | 167 | 270 | 367 | 461 | 539 | 593 | | |
| VII | 3 | 194 | 269 | 352 | 475 | 604 | 661 | 719 | |
| Weighted mean | | 168 | 254 | 348 | 440 | 533 | 618 | 719 | |
| | | | | | Females | | | | |
| IV | 10 | 148 | 229 | 315 | 377 | | | | |
| V | 6 | 138 | 221 | 308 | 396 | 447 | | | |
| VI | 5 | 158 | 273 | 378 | 455 | 523 | 580 | | |
| VII | 5 | 180 | 256 | 400 | 494 | 589 | 674 | 762 | |
| VIII | 1 | 145 | 256 | 409 | 563 | 727 | 819 | 864 | 878 |
| Weighted mean | | 153 | 282 | 343 | 428 | 527 | 644 | 779 | 878 |

Table 2. Comparison of striped bass growth (sexes combined) from various regions.

| | Calculated total length (mm) at annulus | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Locality and Reference | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Beaver Reservoir, Ar. (Present study) | 161 | 247 | 345 | 438 | 532 | 638 | 751 | 878 |
| California (Scofield 1931)* | 114 | 266 | 397 | 484 | 565 | 630 | 690 | |
| New England States (Merriman 1941) | 134 | 252 | 391 | 482 | | | | |
| Santee-Cooper Reservoir, South Carolina (Scruggs 1955) | 180 | 379 | 495 | 564 | 638 | 699 | 765 | 828 |
| Santee-Cooper Reservoir, South Carolina (Stevens 1957)* | 217 | 402 | 506 | 584 | 658 | 728 | 772 | |
| California (Robinson 1960) | 111 | 266 | 416 | 533 | 622 | 698 | 758 | 813 |
| Chesapeake Bay, Maryland (Mansueti 1961) | 139 | 315 | 412 | 481 | 565 | 661 | 764 | 822 |

* Data from Mansueti (1961)

The intercept (C) values for male and female were calculated from the scale radius - total length relationships ($L = C + bS$) and were 79.22 and 61.69, respectively. Back-calculated lengths by sex, age group, and weighted average are given in Table 1. There were no significant differences in the lengths between the sexes in the first six years of life; comparison among the seventh year of life was not made due to inadequate sample size.

Comparison from various sources (Table 2) of striped bass growth during the first eight years of life showed that, in general, an average annual length increment of 106 mm for freshwater populations (Present study; Scruggs, 1955; Stevens, 1957) was similar to that of the marine (anadromous) populations - 102 mm (Scofield, 1931; Merriman, 1941; Robinson, 1960; Mansueti, 1961). Differences in average size of the fish in relation to age (Table 2) were probably due to the type of gear used and the sample sizes. Overall striped bass growth was similar for all the regions (Mansueti, 1961).

**Food Habits.**

A total of 49 stomachs (21 males and 28 females) were examined, with 12 stomachs (24%) being empty. The food was mainly composed of fishes; most of the identifiable diet was gizzard shad (*Dorosoma cepedianum*), contributing 96.7% to the diet. A single stomach contained white crappie (*Poxomis annularis*). Partially digested fish remains were classified as gizzard shad based on body shape and ribs. The size of the gizzard shad ranged from 88 to 187 mm TL; the single white crappie was 155 mm TL.

It was reported that adult striped bass feed primarily on fishes, gizzard shad, threadfin shad (*D. petenense*), blueback herring (*Alosa aestivalis*), alewife (*A. pseudoharengus*), minnows, and young striped bass (Merriman, 1941; Trent and Hassler, 1966; Stevens, 1966). In Beaver Reservoir, gizzard shad is the most abundant forage for sportfishes. An investigation of the abundance and fluctuations of gizzard shad and of the predator-prey relationship of the fishes in the reservoir is needed to evaluate the effect of the stocking of striped bass on other sportfishes.

**Maturation.**

All the male striped bass, age groups IV-VII, had large whitish testes, and milt was extruded with pressure on the abdomen. The gonosomatic indices ranged from 4.50 to 7.09, and the fish were classified as mature. It was reported that some 2-year olds and all 3-year olds and older males attain sexual maturity (Merriman, 1941; Scruggs, 1955; Mansueti, 1961).

Ovum diameter frequencies from all the females used in this study (Fig. 1) showed three distinct groups of ova; 0.06 - 0.24 mm (average, 0.16 mm), 0.26 - 0.56 mm (0.36 mm), and 0.58 - 1.08 mm (0.73 mm). The ova in group 1 were translucent with visible nucleus; in group 2 the ova were granular to opaque in appearance due to yolk deposition; and the group 3 ova were completely opaque, with many lying free in the lumen of the ovary. These morphological features of the ova were similar to those reported by Lewis (1962).

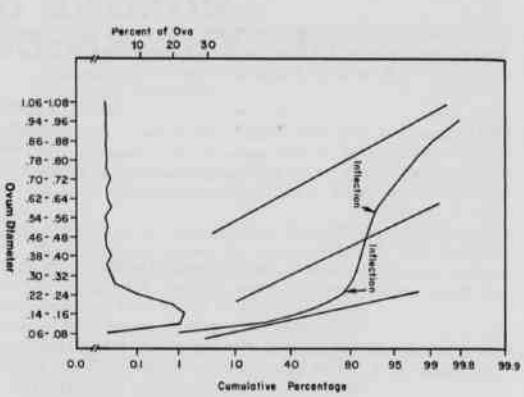


Figure 1. Ovum diameter frequencies and cumulative percentage distributions on probability scale.

Gonosomatic index and ovum distribution are given in Table 3. All the ovaries contained group I ova. The fish with group 2 and 3 ova were classified as maturing - mature and capable of spawning in spring. The fish with GSI from 2.62 to 4.86 contained group 2 and 3 ova; therefore, it was assumed that the fish 7-years old and older attain sexual maturity. Since these findings are based on few fish, large sample size, inclusive of various age and length groups, are needed to establish definite age and length at which striped bass reach maturity. Based in part on percentage of fish in spawning and non-spawning condition before and after the spawning season, Scofield (1931) considered striped bass with ova exceeding 0.29 mm as spawners in California. Jackson and Tiller (1952) stated that the Chesapeake Bay fish with ova averaging 0.75 mm or more in diameter in early spring could be expected to spawn that year. Lewis (1962) considered striped bass with type 2 (0.16 0.30) and type 3 (0.33 - 1.00 mm) ova as mature. The striped bass of our study with GSI of 2.62 or more conformed to the findings of Lewis (1962). Therefore, we presume that the fish collected in February and March with GSI of 2.62 or more and group 2 and 3 ova are potential spawners in the spring.

All the published literature indicated that striped bass spawn in spring (Scruggs, 1955; Lewis, 1962; Farley, 1966; Nichols and Miller, 1967; Turner, 1976). Regarding age of females, spawning varied in different regions. Merriman (1941) reported both spawners and non-spawners in age groups IV, V, and VI. Similar findings were reported

Table 3. Gonosomatic index (GSI) and ovum distribution by age groups for the Beaver Reservoir striped bass.

| Age group | Number of fish | GSI | Ovum distribution |
|---|---|---|---|
| IV | 8 | 0.76<br>(0.49-1.34) | Group 1 ova in 25% of fish<br>Group 2 ova in 75% of fish |
| V | 6 | 1.37<br>(0.34-1.37) | Group 1 ova in 50% of fish<br>Group 2 ova in 17% of fish<br>Group 2 & 3 ova in 33% of fish |
| VI | 5 | 0.59<br>(0.43-0.85) | Group 1 ova in 80% of fish<br>Group 2 ova in 20% of fish |
| VII | 5 | 2.32<br>(0.43-4.86) | Group 2 ova in 40% of fish<br>Group 2 & 3 ova in 60% of fish |
| VIII | 1 | 2.78 | Group 2 & 3 ova |

by Scofield (1931). These workers indicated spawning by all females in age group VII while Lewis (1962) reported it in age group V.

The striped bass is an anadromous fish that ascends rivers for spawning; however, freshwater populations were established due to impoundment (Scruggs, 1955) and by stocking practices. The question arises as to whether the fish has the ability to complete a full life cycle and to establish self-perpetuating populations in Beaver Reservoir. Striped bass were stocked in Beaver Reservoir in 1970 and annually since 1975. The gonosomatic indices and the presence of groups 2 and 3 ova with yolk indicate that the striped bass attain maturity and are capable of spawning in the Beaver Reservoir. The single age-group VIII fish (GSI = 2.78) belonged to the 1973 year-class, and the fish were not stocked in Beaver Reservoir in that year. It is probable that some fast growing fish stocked in 1970 spawned in 1973, resulting in age-group VIII fish in 1981. Future investigation of obtaining spent fish, eggs and larvae is recommended to evaluate spawning of striped bass in Beaver Reservoir. Scruggs (1955) reported on the natural reproduction of striped bass from the Santee-Cooper Reservoir, South Carolina, based on the occurrence of mature fish, eggs and larvae.

**Fecundity.**

Fecundity, total number of group 2 and 3 ova in both the ovaries, was estimated by wet gravimetric method from 5% of the total ovary weight (Table 4). Group 3 ova comprised 95% of the estimated fecundity. Based on hatchery records, Merriman (1941) reported the range of eggs per female as 11,000 - 1,215,000 with the majority of fish producing 100,000 - 700,000 eggs.

Table 4. Fecundity estimates for the Beaver Reservoir striped bass.

| Age group | Total length (mm) | Weight (g) | GSI | Fecundity |
|---|---|---|---|---|
| V | 405 | 985 | 3.05 | 85,800 |
| V | 417 | 980 | 3.37 | 94,220 |
| VII | 753 | 5,920 | 4.86 | 1,086,040 |
| VII | 770 | 5,675 | 3.10 | 548,700 |
| VII | 806 | 6,220 | 2.62 | 516,840 |
| VIII | 878 | 9,852 | 2.78 | 957,700 |

**General Remarks.**

The impact of the striped bass on the ecosystem of Beaver Reservoir needs to be studied more. If the females are capable of producing viable ova, it may be possible for natural reproduction to occur since mature males are readily found. Also, Pledger (1976) states that some of the striped bass in Beaver Reservoir may be of the Santee-Cooper Reservoir stock, which includes a landlocked, naturally reproducing population. If the fish from Beaver Reservoir are from this population, they are genetically similar and may be able to reproduce in a totally freshwater environment. Further studies need to be conducted on Beaver Reservoir to determine if females with spent ovaries are present and to find if any larvae are present in the tributaries of Beaver Reservoir.

It is also important to determine the impact of striped bass on the shad population. The food habits of this study show that striped bass consume primarily shad. It is important to fisheries management to determine both how effectively these fish are feeding on shad and what effect it has on other sport fish also utilizing shad as forage.

Another aspect of striped bass biology warranting further investigation is the survival of this species in Beaver Reservoir. Stocking of the reservoir has been done annually since 1975, but it is not known how well these fish are surviving. Thus, a study is needed on the mortality, due to natural causes and sport fishing, of the stocked individuals. Also, if these fish are reproducing in the reservoir, larval survival and percent of larvae reaching adult size need to be investigated.

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## LITERATURE CITED

FARLEY, T. C. 1966. Striped bass spawning in the Sacramento-San Joaquin River system during 1963 and 1964. Calif. Dept. Fish and Game, Fish. Bull. 136:28-43.

JACKSON, H. W. and R. E. TILLER. 1952. Preliminary observations on spawning potential in the striped bass (*Roccus saxatilis* Walbaum). Maryland Dept. Res. and Educ., Publ. No. 93, 16 pp.

LEWIS, R. M. 1962. Sexual maturity as determined from ovum diameters in striped bass from North Carolina. Trans. Am. Fish. Soc. 91:279-282.

MANSUETI, R. J. 1961. Age, growth, and movements of striped bass, *Roccus saxatilis*, taken in size selective fishing gear in Maryland. Chesapeake Sci. 2:9-36.

MERRIMAN, D. 1941. Studies on the striped bass (*Roccus saxatilis*) of the Atlantic Coast. U. S. Fish & Wildl. Serv., Fish. Bull. 50:1-77.

NICHOLS, P. R. and R. V. MILLER. 1967. Seasonal movements of striped bass, *Roccus saxatilis* (Walbaum), tagged and released in the Potomac River, Maryland, 1959-1961. Chesapeake Sci. 8:102-124.

PEARSON, J. C. 1938. The life history of the striped bass or rockfish, *Roccus saxatilis* (Walbaum). Bull. U. S. Bur. Fish. XLIX: 825-851.

PLEDGER, M. 1976. A commissioner's dream come true. Ark. Game and Fish. 8:9-11.

ROBINSON, J. B. 1960. The age and growth of striped bass (*Roccus saxatilis*) in California. Calif. Fish and Game. 46:279-290.

SCOFIELD, E. C. 1931. The striped bass of California (*Roccus saxatilis*). Calif. Div. Fish and Game, Fish. Bull. 29, 84 pp.

SCRUGGS, G. D., JR. 1955. Reproduction of resident striped bass in Santee-Cooper Reservoir, South Carolina. Trans. Am. Fish. Soc. 85:144-159.

STEVENS, R. E. 1957. The striped bass of the Santee-Cooper Reservoir. South Carolina Wildl. Resources Dept. Rept. 21 pp. (Mimeo).

STEVENS, D. E. 1966. Food habits of striped bass, *Roccus saxatilis*, in the Sacramento-San Joaquin Delta. Calif. Dept. Fish and Game, Fish. Bull. 136:68-96.

TRENT, L. and W. W. HASSLER. 1966. Feeding behavior of adult striped bass, *Roccus saxatilis*, in relation to stages of sexual maturity. Chesapeake Sci. 7:189-192.

TURNER, J. L. 1976. Striped bass spawning in the Sacramento and San Joaquin Rivers in central California from 1963 to 1972. Calif. Fish and Game 62:106-118.