

RECRUITMENT AND GROWTH OF EDISTO RIVER REDBREAST SUNFISH



STUDY COMPLETION REPORT

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Study Title: STATEWIDE FISHERY RESEARCH

Job Title: Recruitment and growth of Edisto River redbreast sunfish

Period Covered January 1, 2005 – December 31, 2005

Summary

I evaluated the hypothesis that a flood season would increase recruitment and growth of Edisto River redbreast sunfish, which were collected in 2004. Sagittal otoliths were used to age redbreast sunfish. The Fraser-Lee method of growth back-calculation was used to estimate length at age. A length-weight regression was developed. Results indicated that redbreast sunfish from the 2002 spawning cohort, a drought period, dominated the population. Additionally, mean individual growth rates (G) for age-1 to age-2 and age-2 to age-3 were greater during drought periods than in flood periods. For the period of study, high recruitment occurred during a period of drought and the redbreast population was protected from harvest during the flood season. The rapid decline in harvestable-sized redbreast during the 2004 fishing season suggests that a regulation that reduces daily harvest should be considered

Introduction

Redbreast sunfish *Lepomis auritus* are a highly valued sport species in the Edisto River, South Carolina. The 2000, 2001, and 2002 spawning cohorts were produced during a period of prolonged drought, while the 2003 cohort was produced during a drought-busting flood event that began in March 2003 and lasted through November of 2003 (Figure 1). This major hydrologic change in the system provided an opportunity to inspect the effect of this change on the recruitment and growth of redbreast sunfish during drought and flood periods. Our research hypotheses for redbreast sunfish were:

- Increased spawning success during flood as compared to a drought year
- Increased growth during a flood compared to a drought year.

The objective of this effort was to evaluate these hypotheses.

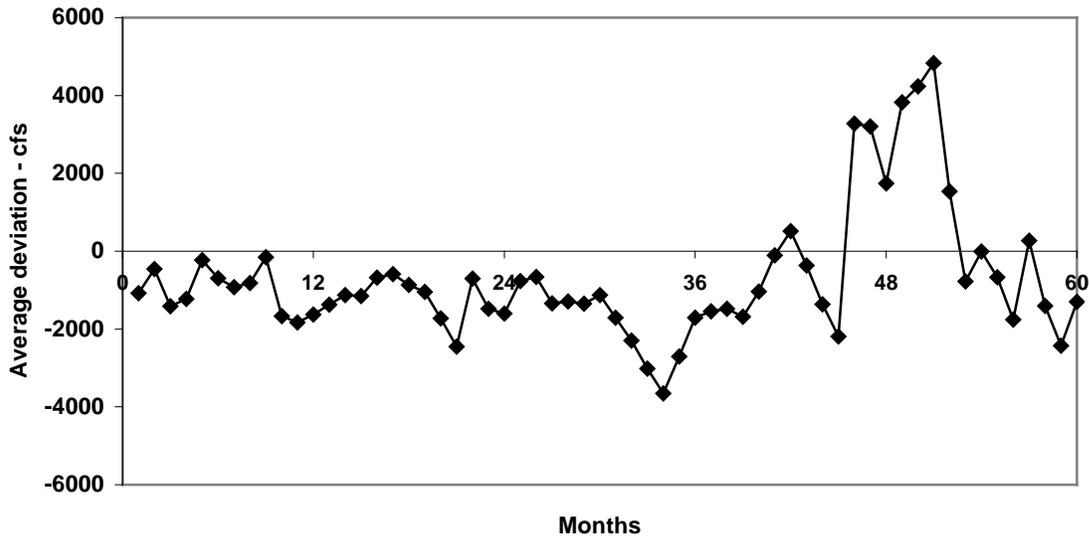


Figure 1. Deviation from historic monthly average discharge at U.S. Geological Survey gage 2175000, Edisto River near Givhans, SC., June 1999 through May 2004.

Materials and Methods

Redbreast sunfish were collected by boat electrofishing the main stem of the Edisto River. Collections were made during a spring and a summer collection period. The goal was to collect sagittal otoliths from 15 specimens from each centimeter length group. Total length in mm (TL) and weight in grams (WT) of collected specimens was recorded. When surplus fish were caught from a length group, lengths and weight were not recorded. All fish ≥ 195 mm were collected and measured.

Sagittal otoliths were used to age redbreast sunfish. Generally the whole left otolith was examined for annuli. If the reader had a question of the age based on the whole otolith, a transverse section was prepared and inspected under a dissecting microscope.

Linear regression was employed to determine if a predictable relationship existed between total length (mm) of redbreast sunfish and otolith radius, allowing back-calculation of length at age estimates. Otolith radius was measured in a straight line from the core to a point approximately midway between the antirostrum and the dorsal peak of the left sagittal otolith. Distances from the core to annuli were made using Optimas software. We used the Fraser-Lee method (Devries and Frie 1996) of growth back-calculation to estimate length at age.

Two methods were employed to evaluate whether growth differences occurred during drought and flood periods. Using back-calculated lengths at age, I compared mean individual growth rates, G , (Ricker 1975) from age-1 to age-2 and from age-2 to age-3 for flood (June 1, 2003 to May 31, 2004) and drought periods (June 1, 2002 to May 31, 2003). The overall relationship between \log_{10} weight and \log_{10} total length was calculated to provide an estimate of b , the growth coefficient, where,

$$WT = a(TL^b).$$

Additionally, using back-calculated lengths at age for individual fish, I used the T-test to compare the absolute increase in total length from age-1 to age-2 and from age-2 to age-3 during flood and drought periods; normality of these distributions was checked using the Shapiro-Wilk statistic.

Results

Redbreast sunfish were collected from the main stem of the Edisto River during spring (April 13-30, 2004) and summer (June 28 to August 26, 2004) sampling periods. A total of 247 and 228 were collected during the spring and summer sampling periods. A highly significant relation existed between \log_{10} transformed weight and total length (Figure 2), yielding the equation:

$$\text{Log WT} = -5.31 + 3.27(\log \text{ TL}), N = 474, R^2 = 0.98.$$

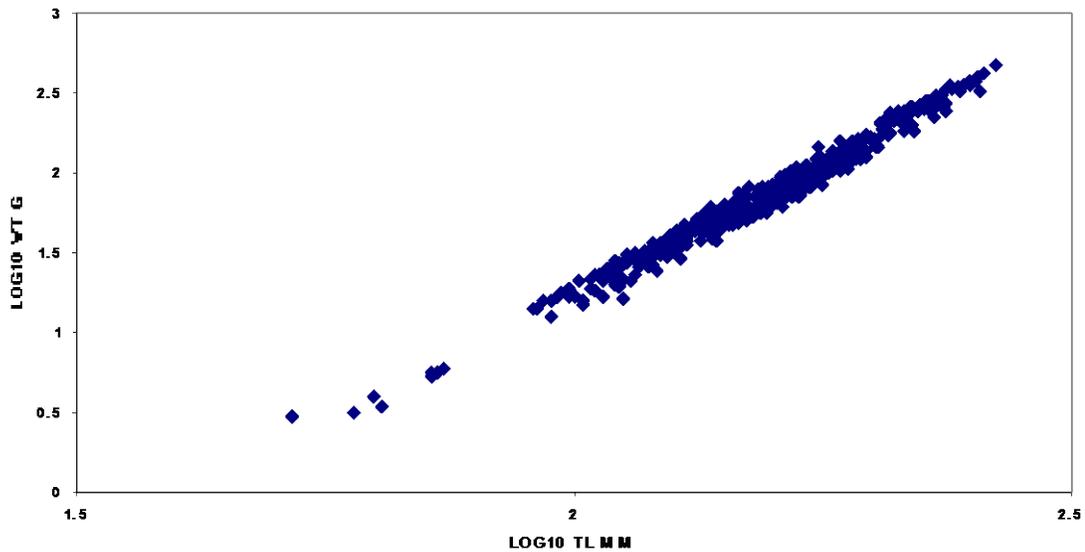


Figure 2. Log₁₀ transformed relation between total length (mm) and weight (g) for 474 redbreast sunfish collected from the mainstem of the Edisto River, South Carolina.

Based on 282 observations, a highly significant linear relationship existed between total length and otolith radius (Figure 3). The equation was:

$$\text{Otolith radius} = 0.4253 + (0.007163 * \text{TL}), R^2 = 0.93.$$

Initial inspection of redbreast sunfish from the early collection period (i.e. April) revealed that annulus formation for the preceding annual growth stanza had not been initiated or completed. However, all redbreast sunfish collected during the late collection period (i.e. June – August 2004) had initiated or completed annulus formation. From these observations, we assumed that the annual growth stanza, as denoted by annulus formation, started on June 1.

Redbreast sunfish from the 2002 spawning cohort dominated the catch during the late collection period (Figure 4). TL (mm) at capture of these age-2 fish varied greatly (mean TL = 154 mm, N = 159, standard deviation = 25.1, minimum TL = 95 mm, maximum TL = 201 mm). Due to

poor representation of age classes other than age-2, drought versus flood growth comparisons were not performed for fish from this collection period.

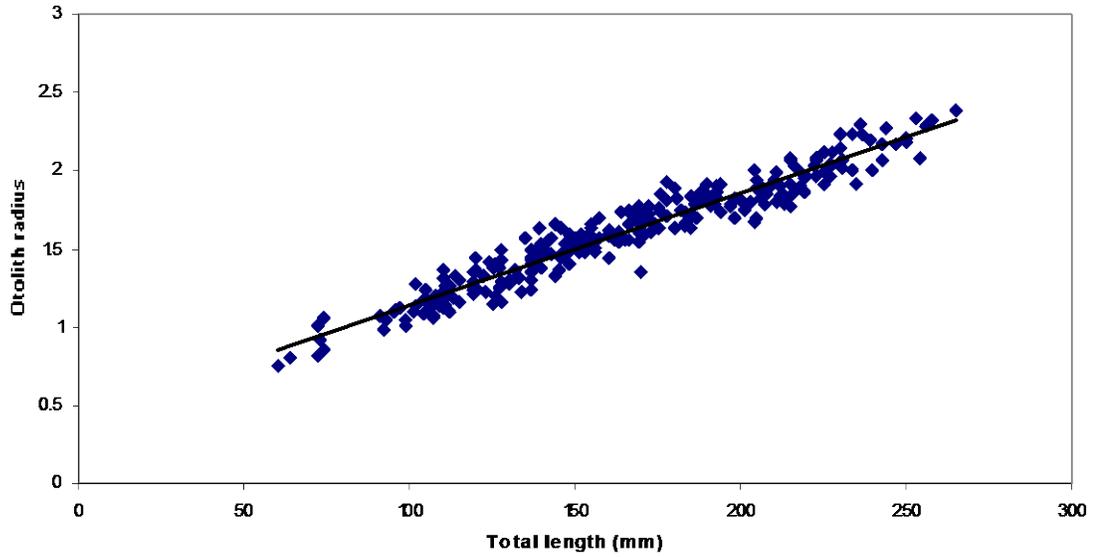


Figure 3. Linear regression of total length and otolith radius for redbreast sunfish from the Edisto River, South Carolina.

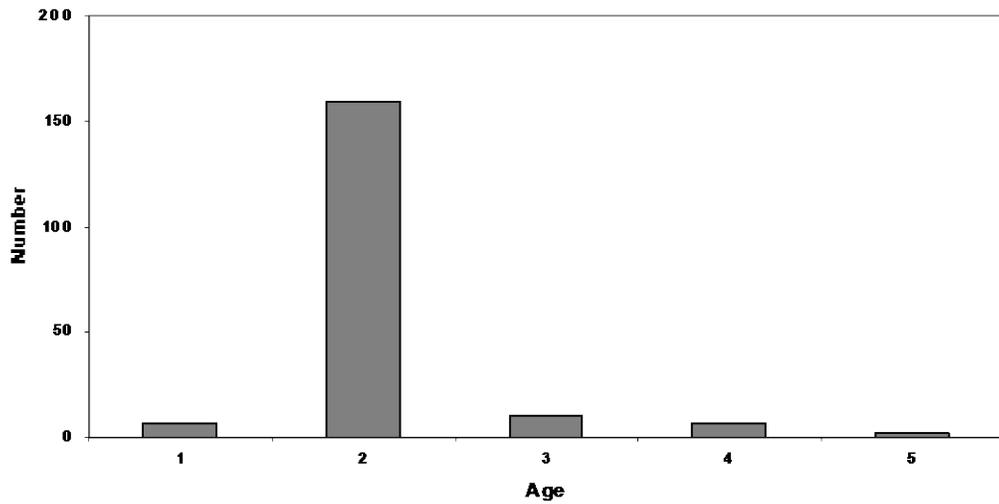


Figure 4. Numbers of redbreast sunfish collected during the June through August 2004, collection period on the Edisto River.

The age and back-calculated length at age of 97 redbreast sunfish from the early collection period were determined (Table 1). As annulus formation had not yet occurred, these estimates assumed that growth for the terminal stanza was complete. Mean individual growth rates for age-1 to age-2 and age-2 to age-3 were greater during drought periods (Table 2). For age-1 to age-2, the absolute increase in length was significantly greater ($P = 0.001$) in the drought (mean = 82.4 mm, $N = 27$) than in the flood (mean = 77.9, $N = 24$) period. For age-2 to age-3, the absolute increase in length was not significantly greater ($P = 0.053$) in the drought (mean = 71.9 mm, $N = 19$) as opposed to the flood (mean = 63.7, $N = 27$) period. In each comparison of absolute increase in length, the data were normally distributed and possessed equal variances.

Table 1. Back-calculated length at age of redbreast sunfish collected from the mainstem of the Edisto River in April 2004. The end of an annual growth period during flood (F) and drought (D) conditions that were compared is noted.

Age	Number	Age-1 TL	Age-2 TL	Age-3 TL	Age-4 TL	Age-5 TL
1	25	104				
2	24	91	166(F)			
3	27	66	148(D)	212(F)		
4	19	73	118	190(D)	235	
5	2	53	114	160	212	252

Table 2. Mean individual growth rates (G) of Edisto River redbreast sunfish during flood and drought periods. A growth coefficient, b , of 3.27 was used for all calculations of G.

Age stanza	Flood		Drought	
	TL interval mm	G	TL interval mm	G
1 to 2	91.1 – 165.5	1.95	66.1 – 148.5	2.64
2 to 3	148.5 – 212.1	1.17	117.7 – 189.7	1.56

Discussion

This data suggested that a large year class was formed during drought conditions in 2002. This hypothesis is based on the dominance of age-2 redbreast sunfish in 2004 collections. Unfortunately, the collection protocol did not measure and age all collected fish, which would have provided a more unbiased representation of population structure. However, the collection protocol did attempt to collect equal numbers of specimens from each centimeter length group. This protocol quickly obtained the necessary specimens from the 135 to 194 mm TL size group and additional effort was placed to collect specimens < 135 mm TL and > 195 mm TL. The mean size of an age-2 redbreast sunfish during the summer of 2004 was 155 mm TL, strongly suggesting the age-2 cohort was the most abundant.

Growth comparisons during flood and drought periods are based on accurate length at age estimates through back-calculation. The highly significant linear relation between TL and otolith radius suggested that back-calculation was an appropriate method. However, the back-calculation estimates (Table 1) exhibited Lee's phenomenon, i.e. a smaller estimated size for fish of younger ages (Ricker 1975). One explanation for Lee's phenomenon is that the older fish had decreased vulnerability to predation or fishing mortality because they are the slower growing survivors of their year class (Devries and Frie 1996). The increasing paucity of larger (i.e. > 195 TL) individuals and high angler catch rates as the 2004 season progressed (Thomason, personal communication) suggests that fishing mortality is relatively high, supporting the above explanation.

Growth of redbreast sunfish was generally greater in the drought than in the flood year. But, this analytical result may have been influenced by an increased mortality rate of the fastest growing members of a cohort. For example, to compare growth from age-1 to age-2, I used the 2002 and 2001 cohorts for the flood and drought treatments. Mean TL at age-1 was 91 and 66 mm for the flood and

drought treatments. Thus, the drought treatment was beginning the growth stanza at a smaller size that had a higher growth potential. In any event, there was not any convincing evidence of increased growth during the high discharge period.

The highly variable growth rate of age-2 redbreast sunfish collected during the summer of 2004 may support the hypothesis that the high discharge conditions created highly variable habitat conditions that is correlated to highly variable growth within the cohort. Testing of this hypothesis would require comparing the variance in growth over several years under standard, unbiased collection methods.

The growth of redbreast sunfish in Edisto River appears relatively high. Length at age was greater in this study than any of the limited records reported by Carlander (1977). A more thorough review of the literature is needed.

Recommendations

1. Produce a peer-reviewed publication that incorporates all available information that would fully describe the dynamics of redbreast sunfish and the associated fishery in the Edisto River. Data presented in this report is only a partial presentation of available data. Standard fall centrarchid sampling and creel survey studies were also performed and would greatly complement the reported data.
2. Incorporate aging of redbreast sunfish into fall centrarchid survey to gain additional insights on growth variation within a cohort.
3. Consider a regulation that would decrease the harvest rate as study observations suggest that, the population was quickly exploited when access and fishing was supported by normal hydrological conditions.

Literature Cited

- Carlander, K. 1977. Handbook of freshwater fishery biology, volume two. The Iowa State University Press. Ames, Iowa.
- Devries, D. and R. Fries. 1996. Determination of age and growth. *In* Fisheries Techniques, B. Murphy and D. Willis editors. American Fisheries Society, Bethesda, Maryland.
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