LIFE HISTORY OF THE REDBREAST SUNFISH IN THE SATILLA RIVER, GEORGIA

by

Jack T. Sandow, Jr.
Daniel R. Holder
Lawrence E. McSwain
Georgia Department of Natural Resources
Game and Fish Division
Waycross, Georgia

ABSTRACT

Life history data were collected from redbreast sunfish, *Lepomis auritus* (Linnaeus), in the Satilla River between 1 July 1970 and 30 June 1973. Spawning was observed in the Little Satilla River during May and June at water temperatures from 22.2°-24.4°C. Strong site preference was evident. Nests were associated with fallen trees, stumps, or logs. The average nest diameter was 93.5 cm and the preferred substrate was sand. Sex ratio was 1 male to 1.49 females. Fecundity estimates ranged from 322 to 9206 ova per female around a mean of 3302 ova. Fecundity increased with both length and weight. Average calculated total lengths at annulus I through VII were 59, 90, 125, 153, 181, 205, and 222 mm, respectively. The length-weight relationship of all redbreast examined was log W=-5.2810+3.2368 log L (r=.9759). Redbreast from the upper river were heavier per given length than specimens from the lower river. The length-weight relationship of male redbreast sunfish differed significantly from that of females in both the upper and lower reaches of the river. Major food items were terrestrial and aquatic insects.

INTRODUCTION

The redbreast sunfish ranges from Maine to Florida and along the coast of Texas (Eddy, 1957), and inhabits a wide range of ecological conditions from headwater streams to Coastal Plains rivers and lakes (Raney, 1965). Redbreast are found in all drainage systems in Georgia (Scott and Dahlberg, 1971).

This species is one of the principal game species in Georgia (Zeller, 1965). Fishing pressure for redbreast sunfish on 150 miles of the Satilla River from 1 July 1971-30 June 1972 accounted for 63.89 percent of the total fished for pressure. Redbreast sunfish comprised 27.23 percent (46,322 fish) of the total numbers and 20.77 percent (13368.53 lbs.) of the total weight of all fish harvested during that period (Sandow, 1973).

Due to a reported decline in the sport fishery of the Satilla River, research was initiated to obtain basic information on the existing fishery resource with the ultimate goal of improving the fishery through management practices. Because of the importance of the redbreast sunfish as a sport fish in this system, a life history study was included as part of the overall Satilla River project.

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MATERIALS AND METHODS

Description of the Study Area

The Satilla River originates in Ben Hill County four miles east of Fitzgerald, Georgia (Figure 1). The river flows 225 miles to the Atlantic Ocean at St. Andrew's Sound. The Satilla is one of only two rivers in Georgia that originate and flow to the Atlantic coast entirely within the Coastal Plain. It is a tannic-acid, blackwater stream with a pH range of 4.5 to 6.0. The river is bordered by numerous cypress swamps, lowlands, and pine forests. Development on its flood plain is limited due to widely fluctuating water levels. Its primary substrate is almost exclusively sand with limited sandstone outcroppings and rubble.

Collections were limited to the mainstream of the Satilla River from river mile 206 near Pearson, Georgia downstream to river mile 52 at Burnt Fort near Folkston, Georgia. Also, collections were taken from the Little Satilla River, the major tributary of the Satilla River, between U. S. Highway 82 and U. S. Highway 301.

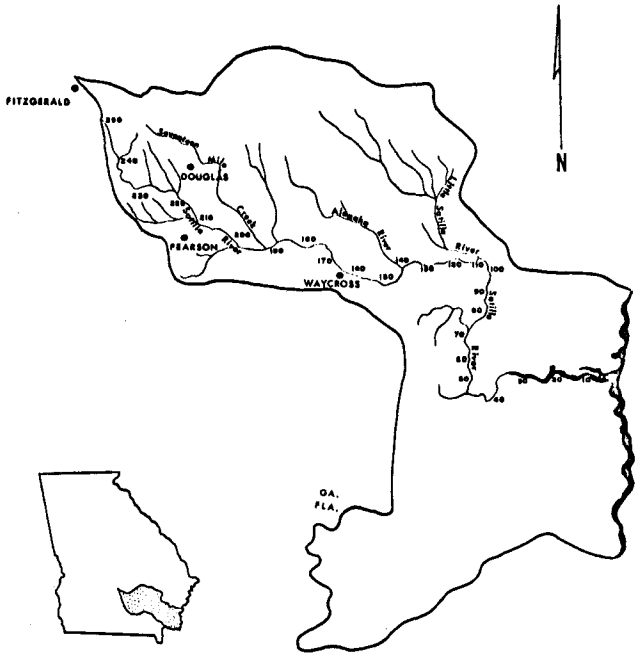

Figure 1. Map of the Satilla River basin.

Methods

A total of 893 redbreast sunfish from the Satilla and 69 redbreast from the Little Satilla Rivers were examined for life history information. One or all of the following were collected from each specimen: Total length (mm), weight (g), sex, stage of gonadal development, stomach contents, and scale samples. Collections were made on an irregular basis from 1 July 1970 through 30 June 1973 due to widely fluctuating water levels. The majority of specimens were collected during the fall months of 1971 and 1972.

Collecting gear included boat-mounted AC and DC electrofishing units, hook and line, wire traps, seines, and rotenone. The majority of specimens were collected with rotenone with the exception of those used for food habits analysis.

Fecundity was estimated using the Gravimetric method (Lagler, 1956). Ova diameter was determined using a 100 mm egg measuring trough.

Age and growth were determined from scale samples collected October 1971 through June 1972.

Because of suspected differences in the standing crops of redbreast sunfish in the upper and lower portions of the Satilla River, separate length-weight relationships

were determined for the upper and lower river specimens. Least squares regressions were determined and comparisons were made using analysis of covariance.

Condition factors were determined using the formula $K(TL)=100{,}000W/L^3$.

Three hundred eighty-five specimens were collected for food habits analysis from 7 October 1971 through 3 November 1972. Electrofishing gear, hook and line, and wire traps were used for collections. Stomach contents were removed and preserved in 10 percent formalin. The frequency of occurrence method (Lagler, 1956) was used in the analysis.

RESULTS AND DISCUSSION

Abundance and Distribution

Redbreast sunfish are present in the major tributaries and larger flowing streams throughout the Satilla River basin. They are less abundant in the headwater swamps and intermittent streams of the watershed. The average standing crop (per acre) of this species as determined by fifteen rotenone samples in the Satilla and Little Satilla Rivers was 259 fish weighing 34.4 pounds (Sandow, 1972, 1973). Redbreast sunfish made up from 11.0 to 60.8 percent by number and from 2.21 to 77.8 percent by weight of the estimated standing crop.

Reproduction

Four hundred sixty-seven redbreast sunfish collected from 7 October 1971 to 13 March 1973 were examined for sexual maturity (Table 1). The smallest sexually mature males examined were in the 4 inch class. Sixty percent of the 4 inch males (89-113 mm, 11-23 g) were mature, 74 percent of the 5 inch males (114-139 mm, 24-45 g) were mature, and 82 percent of the 6 inch males (140-164 mm, 46-77 g) were mature. All males in the 7 inch class (165-190 mm, 79-125 g) were sexually mature.

Table 1. Size at sexual maturity of Satilla River redbreast collected 7 October 1971 through 13 March 1973.

Inch Class	Size Interval (mm)	FEMALES				MALES				Total No. Examined
		Immature		Mature		Immature		Mature		
		No.	Percent	No.	Percent	No.	Percent	No.	Percent	
1	0-38									
2	39-64	1				2				3
3	65-89	10				5				15
4	90-114	33	57	25	43	8	40	12	60	78
5	115-140	25	37	42	63	9	26	25	74	101
6	141-165	6	15	34	85	4	18	82	82	62
7	166-191	1	3	28	97			17		46
8	192-216			43				17		60
9	217-267			32				32		64
10	268-292			7				29		36
11	293-318							2		2
12	319-343									
Total No. Examined		76		211		28		152		467

The smallest mature females examined were also in the 4 inch class. Forty-three percent of the 4 inch females (89-113 mm, 11-23 g), 63% of the 5 inch females (114-139 mm, 24-45 g), 85% of the 6 inch specimens (140-164 mm, 46-77 g), and 97% of the 7 inch class (165-190 mm, 79-125 g) were mature. All females in the 8 inch class (191-215 mm, 129-186 g) were sexually mature.

The sex ratio was 1 male to 1.49 females for the Satilla River. A Chi-square test indicated that there were significantly (P .01) more females than males present.

Davis (1972) reported redbreast spawning in North Carolina streams in June at water temperatures of 71° F (22° C) to 78° F (25° C). Each nest was located in or near a sheltered area such as a log, fallen tree, or stump. Bass and Hitt (1973) found spawning in North Florida to occur in May as water temperatures in the Santa Fe and Suwannee Rivers approached 21.2° C and 20.6° C, respectively. Peak spawning occurred from May through August. Hellier (1967) collected ripe females from the Santa Fe River, Florida, in April, June, and July. Redbreast were observed guarding nests in April. Late spring and early summer was found to be the peak of the spawning season. Wyatt, et. al. (1967) collected ripe females in samples from the Alapaha River, Georgia, in April.

Spawning in the Satilla River drainage appeared to conform to that previously reported. During the spring of 1972, spawning activity was observed in the Little Satilla River, a major tributary of the Satilla River. Nest construction began in June when water temperature reached 21.1° C (70° F). On 9 June 1972 (temperature 23.3° C-74° F) eight redbreast sunfish nests were examined. Twenty-five percent (2 of 8) of the nests contained eggs. Of sixteen additional nests examined 16 June, 69 percent (11) contained eggs. The water temperature on that date was 25.5° C (78° F). Few gravid females and no nests were noted after the month of July. These data in addition to data collected from female specimens throughout the summer indicate an initial spawning peak in the spring and early summer which decreases in intensity during mid-summer.

All 24 nests examined were located in the mainstream of the river and were associated with some form of natural obstruction such as a log, stump or tree root. Nests were usually found on the upstream side of the obstruction. Observations of habitat requirements and site preference agree with those of Davis (1972) and Bass and Hitt (1973). The average nest diameter was 93.5 cm, which was comparable to that reported for redbreast in North Carolina Coastal Plains streams (Davis, 1971), but were considerably larger than the 30-40 cm nests reported by Raney (1965) in New York waters. All nests observed were constructed in a substrate of medium to coarse sand. This suggests strong nest site preference for areas having these characteristics.

Fecundity was determined for 79 redbreast sunfish collected from the Satilla River drainage during May 1971 and May 1972. Specimens examined ranged from 115 to 265 mm in length and from 24 to 278 grams in weight.

The average number of eggs per female was 3302 and ranged from 322 to 9206. Ovary weights ranged from .93 to 25.83 g with an average weight of 5.87 g. Ova diameter ranged from .90 to 1.64 mm (averaged 1.20 mm).

Davis (1972) reported fecundity counts from 17 redbreast sunfish from the South River in North Carolina. Age II, III, IV, V, and VI year redbreast had mean egg counts of 963, 1000, 3563, 5620, and 8250, respectively. Bass and Hitt (1973) found fecundity of North Florida redbreast to range from 942 to 9968 ova per fish with a mean of 3175 ova per female. Fecundity estimates from the Satilla River were less than those reported by Davis (1972) but were comparable to ova counts reported by Bass and Hitt (1973).

Fecundity was regressed on length and weight after logarithmic transformation of the variables as recommended by Bagenal and Braum (1968). The regression equation for fecundity on length was log fecundity=-3.8786+3.1628 log length (sy x=5.1767, r=.8410) (Figure 2). The regression equation for fecundity on weight was log fecundity=.9551+1.1282 log weight (sy x=.1288, r=0.8658) (Figure 3). Regression analysis without logarithmic transformation of the variables yielded lower correlation coefficients than those just given. Fecundity increased with both fish length and weight. Ova diameter did not appear to be related to size of female.

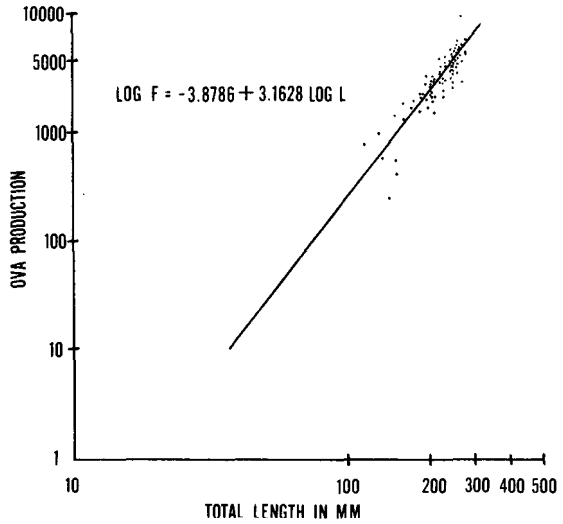

Figure 2. Graphical relationship between fecundity and length of 79 redbreast sunfish from the Satilla River drainage.

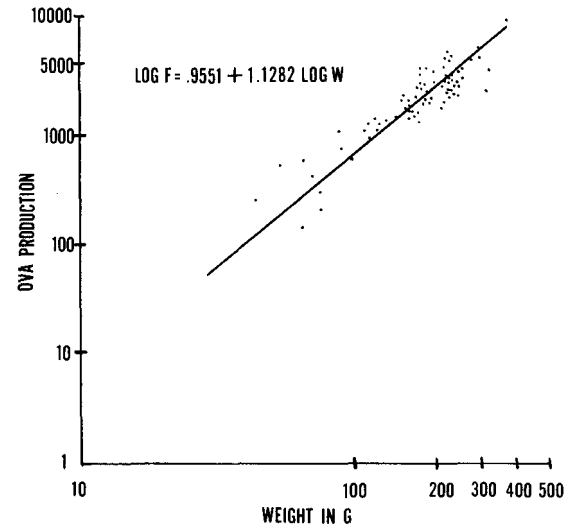

Figure 3. Graphical relationship between fecundity and weight of 79 redbreast sunfish from the Satilla River drainage.

Age and Growth

Plastic impressions of scales from 121 redbreast sunfish were examined using an Eberbach scale projector (magnification x 43). Those fish were collected from October 1971 to June 1972 and ranged in size from 68 mm to 269 mm at capture. At least two scales from each fish were examined by the senior author and another biologist. Annuli could be distinguished on scales from 70 fish (58%). Measurements were taken from a representative scale for back-calculating growth.

Annuli were characterized by cutting over of circuli in the lateral scale margins and in the posterior fields. An annulus was considered true if it could be followed from one lateral field through the anterior field to the posterior portion of the opposite lateral field. Both irregularities of circuli in the lateral fields and dark bands in the posterior field were used as supporting characteristics for determining the position of an annulus.

Checks (false annuli) were frequent and were generally characterized by cutting over in only one lateral field. Checks were common at calculated total lengths of 40 mm and 75 mm. These possibly resulted from a decrease in growth rate of age 0 and I fish during fall low water periods.

Annulus formation on redbreast scales occurred from March through May. The majority of annular marks were apparently laid down in late April, but an insufficient number of specimens were collected at that time of year to substantiate this. All scales collected from redbreast sunfish in early June possessed a newly formed annulus.

The body-scale relationship of all 121 fish examined, Y=17.0146+0.8638X was determined by the least squares regression method (Figure 4). The intercept of 17 mm was used as the correction factor for back calculating growth using a nomograph.

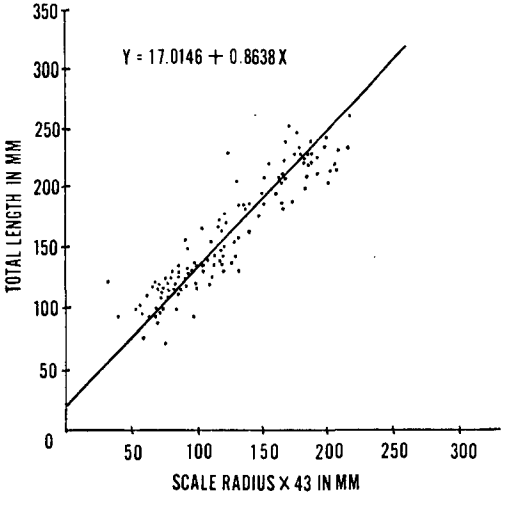

Figure 4. Body-scale relationship of 121 Satilla River redbreast sunfish derived from scale samples collected from October 1971 through June 1972.

The average back calculated total lengths for redbreast sunfish for age groups I through VII were 59, 90, 125, 153, 181, 205, and 222 mm, respectively (Table 2). These findings are comparable to calculated total lengths of 56, 94, 124, 152, and 173 for age groups I-V reported for Hickory Lake, North Carolina and are slightly lower in the first three years of growth than redbreast from Lookout Shoals Lake, North Carolina (Richardson and Ratledge, 1961). Growth of redbreast from the Satilla River was greater than growth reported for redbreast from New York lakes (Bernhardt, 1957).

Table 2. Average calculated total length in millimeters at the end of each year of life by age for 70 redbreast sunfish collected from the Satilla River October 1971 to June 1972.

Age Class	Number	Average Total Length at Capture	Observed Range at Capture	Average Calculated Total Length at End of Year 1	2	3	4	5	6	7	Calculated Range at End of Last Year
I	9	104	91-117	55							42-68
II	19	123	76-150	60	89						70-103
III	13	147	130-168	56	88	126					103-150
IV	5	167	146-186	60	92	115	146				135-158
V	8	191	165-210	56	89	125	152	176			158-195
VI	10	221	206-246	67	94	126	160	187	206		183-228
VII	6	238	218-255	61	93	127	150	176	204	222	205-235
Average Total Length (mm)				59	90	125	153	181	205	222	
Average Subtraction Increment (mm)				59	30	34	29	26	22	18	
Average Total Length (in)				2.3	3.5	4.9	6.0	7.1	8.1	8.7	

Table 3 summarizes growth of redbreast sunfish by year class. The 1964 year class appeared to exhibit a greater growth rate during years one and two but did not maintain this advantage past year three. In general, growth of all year classes appeared similar.

Length-Weight Relationships and Condition Factors

Least squares regression equations were calculated to determine the relationship between total length and weight for males, females, and combined sexes of redbreast sunfish collected from the upper and lower sections of the Satilla River.

The length-weight relationship of 79 male redbreast sunfish (81-269 mm) collected from the upper Satilla River (mile 165 to mile 206) was log W=-5.8173 +3.4870 log L (Sy x=2.7316, r=0.9959). The length-weight relationship of 113 female redbreast sunfish (82-245 mm) collected from that locality was log W=-5.1934+3.1982 log L (Sy x=4.3272, r=.9537). The regression equation for 223 redbreast sunfish (59-269 mm) of both sexes taken from the upper river was log W=-5.1771+3.1984 log L (Sy x=4.2960, r=.9793).

Table 3. Year class growth of 70 Satilla River redbreast sunfish.

Year Class	Number Examined	Average Length at Capture	Calculated Average Length (mm) at Annulus						
			1	2	3	4	5	6	7
1964	3	243	68 (3)*	106 (3)	124 (3)	147 (3)	175 (3)	206 (3)	227 (3)
1965	9	225	65 (9)	96 (9)	128 (9)	156 (9)	182 (9)	203 (9)	218 (3)
1966	6	215	61 (6)	86 (6)	128 (6)	163 (6)	187 (6)	209 (4)	
1967	9	183	58 (9)	90 (9)	121 (9)	150 (9)	173 (6)		
1968	11	146	55 (11)	88 (11)	119 (11)	138 (2)			
1969	22	130	60 (22)	90 (22)	137 (4)				
1970	10	101	55 (10)	70 (1)					

*Number of fish having annulus in parentheses.

Analysis of covariance (Snedecor and Cochran, 1967) indicated that the length-weight relationships of male and female redbreast sunfish from the upper river were significantly different at the 1% level (F=6.90, d.f.=188) (Figure 5). Male redbreast sunfish weighed less per given length than female specimens up to 150 mm. Above 150 mm females weighed less per given length.

The regression equation for the length-weight relationship of 124 male redbreast sunfish (86-283 mm) collected from the lower Satilla River (mile 52 to mile 115) was log W=-5.6612+3.4047 log L (Sy x=4.6173, r=0.9957). The regression equation for 203 female redbreast sunfish (83-263 mm) collected from the lower Satilla River was log W=-5.3437+3.2497 log L (Sy x=4.2405, r=.9910). The length-weight relationship of 670 redbreast (35-283 mm) from the lower river was log W=-5.3505+3.2624 log L (Sy x=3.8017, r=.9737).

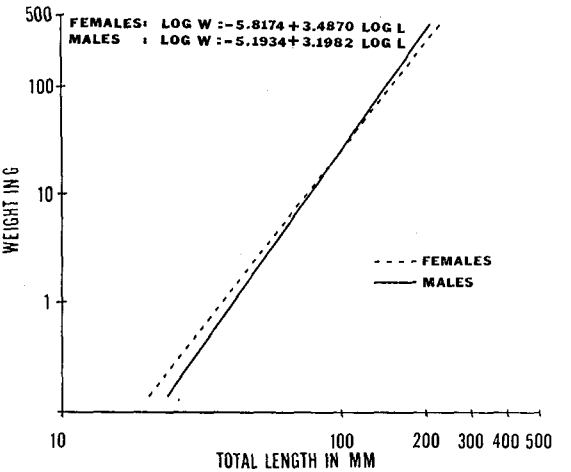

Figure 5. Length-weight relationship of 79 male and 113 female redbreast sunfish from the upper Satilla River collected from July 1970 through June 1973.

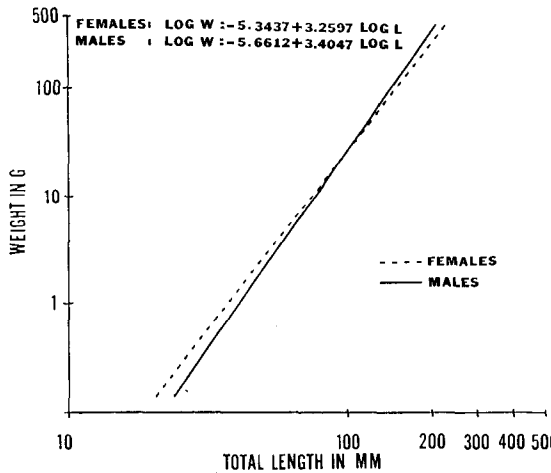

Figure 6. Length-weight relationship of 124 male and 203 female redbreast sunfish from the lower Satilla River collected from July 1970 through June 1973.

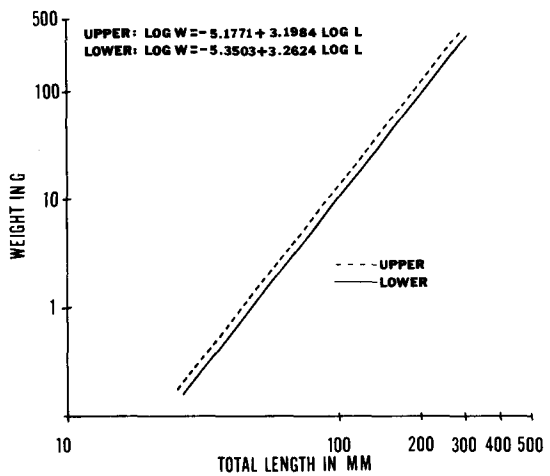

Figure 7. Length-weight relationship of 223 redbreast sunfish from the upper Satilla River and 670 redbreast sunfish from the lower Satilla River collected from July 1970 through June 1973.

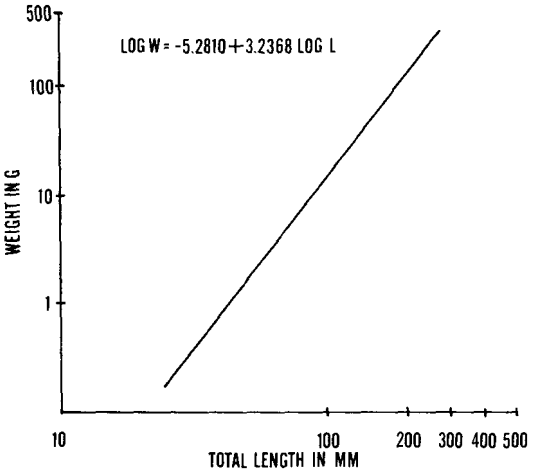

Figure 8. Length-weight relationship of 893 redbreast sunfish from the Satilla River collected from July 1970 through June 1973.

Analysis of covariance showed that the length-weight relationships of male and female redbreast sunfish populations from the lower river were also different at the 1% level (F=11.29, d.f.=323) (Figure 6).

These data indicate that male redbreast sunfish from both localities became plumper as they grow than do females.

Analysis of covariance showed that the slopes of the length-weight regressions of redbreast from the upper and lower Satilla River did not differ significantly at the 5% level (F=3.26, d.f.=889). However, a test of adjusted means was significant at the 1% level (F=70.65, d.f.=890). This indicated that upper river fish were heavier per given length than those from the lower river (Figure 7). This may be due to the differences in the redbreast populations existing between the upper and lower Satilla River (Sandow, 1974). The estimated standing crop of redbreast sunfish was greater in the lower river than in the upper river.

The length-weight relationship of all 893 specimens collected from the Satilla River was log W=-5.2810+3.2368 log L (Sy x=3.9940, r=.9959) (Figure 8). The regression slope of Satilla River fish is greater than the slope of 3.01 reported by Swingle (1965) for redbreast in Alabama waters, and slopes of 2.89 and 2.81 reported by Bass and Hitt (1973) for redbreast from the Santa Fe and Suwannee Rivers, respectively.

The mean K(TL) for males, females, and all redbreast sunfish from the upper Satilla River was 1.93, 1.90, and 1.99, respectively. The mean K(TL) for males, females, and all redbreast sunfish from the lower Satilla was 1.72, 1.67, and 1.67, respectively. The mean K(TL) for all males, all females, and all specimens collected was 1.80, 1.76, and 1.79, respectively. Condition was substantially lower in the Satilla River than the mean K(TL) of 2.61 (C=94.4 for fish 1-8 in. or 25-203 mm) calculated from Swingle's (1965) data for Alabama waters.

Food Habits

A total of 385 redbreast sunfish from 63 mm to 283 mm were examined for food habits. Most specimens were obtained during low water periods in the fall of 1971 and

the spring of 1972. Of the stomachs examined, 45.45% contained food (Table 4). Terrestrial and aquatic insect forms were the most frequently consumed food items as was found by Davis (1971), Bass and Hitt (1973), Flemer and Woolcott (1966), Chable (1947), Phillips (1967), and Wyatt, et. al. (1967).

Table 4. Food habits of 385 redbreast sunfish collected from the Satilla and Little Satilla Rivers 15 July 1971-5 January 1972.

Food Item	Frequency of Occurrence	
	Number of Stomachs	Percentage of Stomachs
Decapoda	14	8.00
freshwater shrimp	4	2.29
crayfish	10	5.71
Insecta	119	68.00
Isoptera	1	.57
Orthoptera	1	.57
Odonata	16	9.14
Hemiptera	4	2.29
Coleoptera	8	4.57
Tricoptera	7	4.00
Diptera	21	12.00
Hymenoptera	1	.57
Unidentifiable	75	42.86
Osteichthyes	4	2.29
Notropis sp.	1	.57
fish scales	3	1.71
Annelida	2	.57
Vegetation	46	26.29
Miscellaneous	22	12.57
organic matter & detritus	12	6.86
sand	12	6.86
Stomachs containing food	175	45.45
Empty stomachs	210	54.55
Total number fish examined	385	100.00

Insects and insect remains were present in 68.0 percent of the stomachs containing food items. Dipteran larvae were the most frequently encountered of the identifiable insects. Chable (1947) and Bass and Hitt (1973) reported similar findings. Odonata larvae and Trichoptera larvae were second and third in frequency of occurrence. The ingestion of vegetation, sand, and a wide variety of organisms suggests opportunitistic feeding by Satilla River redbreast. Bass and Hitt (1973) reported this species as ".....an opportunist, taking essentially any potential food item of proper size." They also reported the presence of vegetation, debris, and detritus suggesting incidental ingestion; vegetation was encountered in some stomachs in such quantities as to indicate intentional feeding on plant material. Davis (1972) found redbreast sunfish frequently ingested plant material in the form of detritus, but assumed this was incidental to feeding on aquatic insects. Ingestion of vegetation by Satilla River redbreast appeared to be incidental to feeding upon insects.

The diet of 13 fingerling redbreast sunfish specimens (0-75 mm) consisted of small insect larvae such as dipterans, organic matter, detritus, and vegetation (Table 5). None of the larger insects, larvae or crustaceans were ingested. The diet of 46 intermediate redbreast sunfish (86-125 mm) consisted of most forms of insects and larvae with the exception of larger forms such as naiads of the order Odonata. Small crustaceans such as freshwater shrimp were ingested, as well as young crayfish, organic matter, detritus, and vegetation. One-hundred sixteen harvestable size redbreast sunfish (126 mm and above) ingested all sizes of insects and insect larvae. Larger terrestrial insects, larger crustaceans such as crayfish, and small minnows were more frequently consumed by these larger fish.

Table 5. Percent frequency of occurrence (FO) of food items by size group of 175 redbreast sunfish collected from the Satilla and Little Rivers 15 July 1971-5 January 1972.

	Fingerling (0-75 mm)		Intermediate (76-125 mm)		Harvestable (126+ mm)	
	NS	FO	NS	FO	NS	FO
Decapoda						
freshwater shrimp	0		1	1.59	3	2.05
crayfish	1		1	1.59	9	6.16
Insecta						
Isoptera	0		1	1.59	0	
Orthoptera	0		0		1	.68
Odonata	0		0		16	10.95
Hemiptera	0		3	4.76	1	.68
Coleoptera	0		2	3.17	6	4.11
Trichoptera	1	6.67	3	4.76	3	2.05
Diptera	3	20.00	3	4.76	15	10.27
Hymenoptera	0		0		1	.67
Unidentifiable	6	40.00	22	34.92	47	32.18
Osteichthyes						
Notropis spp.	0		0		1	.68
fish scales	0		0		3	2.05
Annelida	0		0		2	1.37
Vegetation	3	20.00	18	28.57	25	17.11
Miscellaneous						
organic matter & detritus	2	13.33	5	7.94	5	3.42
sand	0		4	6.35	8	5.48
TOTAL	15	100.00	63	100.00	146	100.00

NS=Number of stomachs containing food items.

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