ECOLOGICAL ASPECTS OF THE REDBREAST SUNFISH, *LEPOMIS AURITUS*, IN FLORIDA

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ABSTRACT

An important element of the ichthyofauna of warmwater streams of the southeastern United States, the redbreast sunfish is the dominant species of the lower Suwannee and lower Santa Fe Rivers in Florida. Insects formed the bulk of the diet of both populations though opportunistic feeding is suggested by the wide variety of organisms taken. Spawning occurs from April through October, with a peak in late spring and summer. Fecundity ranged from 942 to 9968 ova per fish. Mean condition factor (K) was higher for Santa Fe redbreasts than for Suwannee specimens. Length-weight relationships for Santa Fe fish were log W = -4.20+2.89 (logL) and logW = -4.06+2.81 (logL).

INTRODUCTION

Warm-water streams support significant and valuable sport fisheries. However, sport fisheries of rivers and ecological aspects of riverine fish populations are poorly understood. The redbreast sunfish, *Lepomis auritus* (Linnaeus), is an important game fish in many southeastern streams. As part of a larger study of the sport fishery ecology of the Suwannee and Santa Fe Rivers in Florida, we have investigated life history aspects of the redbreast sunfish.

The redbreast sunfish ranges from New Brunswick to Florida and the coast of Texas (Eddy, 1969). Briggs (1957) lists distribution as Maine to central Florida. Carr and Goin (1955) give range as Maine to Texas, extending to central Florida. Habitat of the redbreast is streams (Carr and Goin, 1955).

MATERIALS AND METHODS

Sampling of ichthyofauna:

Samples were taken from the ichthyofauna of the lower 48 kilometers (30 miles) of the Santa Fe River and the lower 48 kilometers of the Suwannee River. Three stations were designated on each river and sampled bimonthly from January 1972 to June 1973 when water levels allowed; locations of sampling sites are illustrated by Figure 1. All samples were obtained by electrofishing at night.

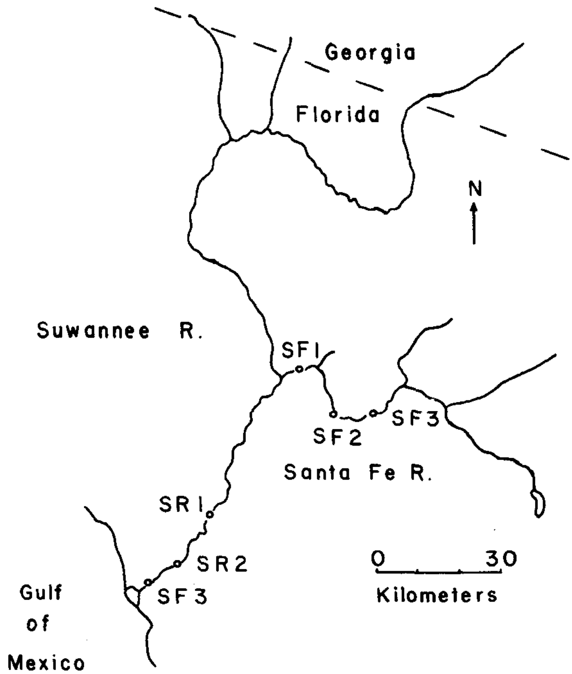

Figure 1. Ichthyofauna sampling sites on t e lower Santa Fe and lowbr Suwannee Rivers, 1972-1973.

Fish of all species taken were enumerated, weighed and identified. Redbreast sunfish were weighed to the nearest 0.1 gram and measured to the nearest millimeter (standard length) and preserved in formalin for later treatment in the laboratory.

Food habits:
Stomach contents were identified, enumerated and the percentage contribution by volume of each taxonomic group of food items estimated.

Reproduction:
Individual fish dissected for stomach analysis were identified to sex and reproductive status. Ovaries were removed from gravid females for analysis of fecundity. Ova counts were made gravimetrically. Aliquots of ova were taken from each set of ovaries and weighed; counts of ova were made for each aliquot. An estimation of the total number of ova was then calculated from the ratio of ova per aliquot and weight of remaining ovarian contents.

Condition and length-weight relationship:
A means of evaluating relative quality of ecosystems is evidence of condition or robustness of individual organisms produced. A condition index (K) may be calculated from the relationship $K=W \times 10^4/L^3$. Condition factor (K) was computed for three standard length classes of redbreast and these compared between river systems.

The length-weight relationship of fishes may be expressed by the regression line of length and weight; this relationship may be expressed by the general formula W=cLb, where W represents weight, c a constant, L length and b the exponential power of length (Ricker, 1958). Since the relationship is seldom linear, the logarithms of standard length and weight are usually used for calculation of the regression by the formula log W=log c + b(log L) (Lagler, 1956).

RESULTS

Contribution to ichthyofauna:

The redbreast sunfish was the dominant species of the lower Suwannee and Santa Fe Rivers. Redbreast comprised 33.8 percent numerically of fish taken by electrofishing in the Santa Fe and 29.8 percent of those from the Suwannee. Spotted sunfish (*Lepomis* punctatus) were second in numerical importance in the Santa Fe, comprising 12.9 percent of the ichthyofauna, followed by the spotted sucker (*Minytrema melanops*), 12.2 percent; redear sunfish (*Lepomis microlophus*) 6.2 percent, and largemouth bass (*Micropterus salmoides*), 6.0 percent. The second most abundant species in the lower Suwannee was the spotfin mojarra (*Eucinostomus argenteus*), a marine species, 15.8 percent, followed by the spotted sunfish, 11.4 percent, largemouth bass, 5.8 percent, and bluegill (*Lepomis macrochirus*), 5.5 percent.

In terms of electrofishing catch per unit effort, more redbreast were taken from the lower Santa Fe than from the lower Suwannee. Catch per hour of electrofishing in the Santa Fe was 39.8 redbreast, against a catch rate of 34.0 per hour in the Suwannee.

Food habits:

Tables 1 and 2 summarize results of stomach analysis of redbreast sunfish from the lower Suwannee and lower Santa Fe Rivers. A mean number of 34.3 organisms per fish was observed for Santa Fe specimens; Suwannee redbreasts contained a mean 25.3 organisms.

Table 1. Stomach contents of 979 redbreast sunfish taken from the lower Suwannee River, Florida, during 1972-1973.

Food items	Number	Percentage by number	Percentage by volume
Nematoda	14	0.1	trace
Oligochaeta	25	0.1	0.4
Hirudinea (leeches)	2	trace	trace
Gastropoda (snails)	342	1.4	3.0
Pelecypoda (bivalves)	462	1.972.2	
Araneae (spiders)	58	0.2	0.6
Hydracarina (water mites)	112	0.5	0.3
Ostracoda (seed shrimp)	245	1.0	0.2
Cladocera (water fleas)	967	3.9	0.6
Copepoda	12	trace	0.1
Mysidacea	1	trace	trace
Cumacea	1	trace	trace
Isopoda (aquatic sow bugs)	3819	15.4	8.0
Amphipoda (scuds)	1209	4.9	4.5
Palaemonidae (freshwater shrimps)	16	0.1	0.2
Astacidae (crayfish)	113	0.5	2.2
Brachyura (marine crabs)	136	0.5	2.0
Insecta (emergent aquatics)	406	1.6	5.6
Collembola	5	trace	trace
Odonata, nymphs (dragonfly)	134	0.5	4.2
Ephemeroptera, nymphs (mayfly)	132	0.5	1.0
Megaloptera, larvae (hellgrammites)	12	trace	0.1
Trichoptera, larvae (caddisfly)	2894	11.7	9.0
Tendipedidae, larvae (midges)	12119	49.0	13.7
Culicidae, larva	1	trace	0.1
Ceratopogonidae, larvae (biting midge)	587	2.4	1.0
Tipulidae, larvae	9	trace	trace
Ptychopteridae, larva	1	trace	trace
Stratiomyiidae, larvae	36	0.1	0.2
Tabanidae, larvae	12	trace	0.1
Coleoptera, adults, larvae (beetles)	510	2.1	5.0
Lepidoptera, larva	1	trace	trace
Hemiptera, adul29	0.1	0.2	
Hymenoptera, adults (ants)	289	1.2	1.9
Diplopoda	21	0.1	0.2
Osteichthyes (fish and ova)	18	0.1	1.0
Vegetation and debris			32.2
TOTAL	24750	99.9%	99.8%
Mean number per fish	25.3		

Table 2. Stomach contents of 774 redbreast sunfish taken from the lower Santa Fe River, Florida, during 1972-1973.

Food items	Number	Percentage by number	Percentage by volume
Oligochaeta	6	–	0.2
Gastropoda (snails)	115	0.4	1.6
Pelecypoda (bivalves)	117	0.4	1.1
Araneae (spiders)	22	0.1	0.3
Hydracarina (water mites)	70	0.3	0.1
Ostracoda (seed shrimp)	2	trace	trace
Copepoda	1	trace	trace
Isopoda	28	0.1	0.3
Amphipoda (scuds)	122	0.5	1.1
Palaemonidae (freshwater shrimps)	5	trace	0.2
Astacidae (crayfish)	36	0.1	1.9
Insecta (emergent aquatics)	934	3.5	9.1
Collembola (springtails)	3	trace	trace
Odonata, nymphs (dragonfly)	99	0.4	4.8
Ephemeroptera, nymphs (mayfly)	1024	3.9	3.7
Plecoptera, nymph (stonefly)	1	trace	trace
Megaloptera, larvae (hellgrammites)	29	0.1	0.7
Trichoptera, larvae (caddisfly)	10161	38.2	21.0
Tendipedidae, larvae (midges)	12915	48.6	10.0
Culicidae, larvae	7	trace	trace
Ceratopogonidae, larvae (biting midge)	85	0.3	0.2
Tipulidae, larva	1	trace	trace
Stratiomyiidae, larvae	3	trace	0.2
Tabanidae, larvae	5	trace	trace
Rhagionidae, larvae	13	trace	trace
Coleoptera, larvae, adults (beetles)	575	2.2	4.3
Lepidoptera, larva	1	trace	0.1
Hemiptera, adults	90	0.3	0.3
Hymenoptera, adults (ants)	65	0.2	0.7
Diplopoda	16	0.1	0.3
Osteichthyes (fish and ova)	21	0.1	1.7
Vegetation and debris			36.2
TOTAL	26572	99.8%	100.1%
Mean number per fish	34.3		

Major food items were arbitrarily defined as those taxonomic groups comprising one percent or greater of stomach contents by number or volume. Five groups numerically constituted 96.4 percent of the diet of Santa Fe River fish. These were emergent aquatic insects, 3.5 percent; Ephemeroptera (mayfly) nymphs, 3.9 percent; Trichoptera (caddis-fly) larvae, 38.2 percent; Tendipedidae (midge) larvae, pupae, 48.6 percent, and Coleoptera (beetle) larvae, adults, 2.2 percent. By volume, eleven groups appeared prominently, composing 60.3 percent of stomach contents. Vegetation and debris comprised 36.2 percent of the remainder. Major food items by volume were Gastropoda (snails), 1.6 percent; Pelecypoda (bivalves), 1.1 percent; Amphipoda (scuds), 1.1 percent; Astacidae (crayfish), 1.9 percent; emergent aquatic insects, 9.1 percent; Odonata (dragonfly and damselfly) nymphs, 4.8 percent; Ephemeroptera nymphs, 3.7 percent; Trichoptera larvae, 21.0 percent; Tendipedidae larvae, pupae, 10.0 percent, Coleoptera larvae, adults, 4.3 percent; and Osteichthyes (fish, fish ova), 1.7 percent.

Twelve groups numerically constituted 96.5 percent of food items of Suwannee River specimens. Gastropoda made up 1.4 percent by number, Pelecypoda, 1.9 percent; Ostracoda (seed shrimp), 1.0 percent; Cladocera (water fleas), 3.9 percent; Isopoda (aquatic sow bugs), 15.4 percent; Amphipoda, 4.9 percent; emergent aquatic insects, 1.6 percent; Trichoptera larvae, 11.7 percent; Tendipedidae larvae, pupae, 49.0 percent; Ceratopogonidae (biting midge) larvae, 2.4 percent; Coleoptera, larvae, adults, 2.1 percent and Hymenoptera (ants), 1.2 percent.

Volumetrically 15 groups comprised 64.3 percent of stomach contents. Vegetation and debris constituted 32.2 percent. Major food by volume were Gastropoda, 3.0 percent; Pelecypoda, 2.2 percent; Isopoda, 8.0 percent; Amphipoda, 4.5 percent; Astacidae, 2.2 percent; Brachyura (true crabs), 2.0 percent; emergent aquatic insects, 5.6 percent; Odonata nymphs, 4.2 percent; Ephemeroptera nymphs, 1.0 percent; Trichoptera larvae, 9.0 percent; Tendipedidae larvae, pupae, 13.7 percent; Ceratopogonidae larvae, 1.0 percent; Coleoptera, adults, larvae, 5.0 percent; Hymenoptera, 1.9 percent and Osteichthyes, 1.0 percent.

Reproduction:

Female redbreasts containing ripe ova were taken from April through October in both the lower Suwannee and lower Santa Fe Rivers. No ripe ova were observed during the balance of the year. Few gravid females were observed in October; reproductive activity appears to be maximal from May through August. Nests were usually constructed along shorelines in depths from 60 to 152 centimeters adjacent underwater objects such as fallen trees, stumps and snags. Males were observed to guard incubating ova in typical sunfish fashion.

Fecundity analysis was made of 143 females from the Santa Fe River containing ripe ova and 38 from the Suwannee River. Gravid females were divided into three standard length size classes: 100.5 to 125.5 m.m., 125.5 to 150.5 m.m. and 150.5 to 175.5 m.m. Mature females were not taken above or below these size intervals.

Eight fish from the Santa Fe fell within the smallest size range (100.5 to 125.5 m.m. S.L.); these had mean ova counts ranging from 942 to 1953, about a mean of 1396. The majority of gravid females (103) fell within the 125.5 to 150.5 m.m. size interval. These individuals exhibited mean ova counts ranging from 1128 to 7574 with a mean of 2761 ova per fish. The largest size class, 150.5 to 175.5 m.m. S.L., contained 32 fish with ova counts ranging from 2335 to 8083, about a mean of 4138 ova.

The lower Suwannee River yielded 38 gravid females, five of which fell within the smallest size class (100.5-125.5 m.m. S.L.) with a range of 1392 to 4017 ova, about a mean of 2893 ova. Intermediate sizes (125.5-150.5 m.m. S.L.) had ova counts ranging from 1692 to 5396 with a mean ova count of 3320 ova per fish. Larger invidiuals (150.5-175.5 m.m. S.L.) contained from 2750 to 9968 ova with a mean of 5112 ova. Eighteen fish fell within the intermediate size interval and 15 into the largest size category.

Condition and Length-Weight Relationship:

Condition factor (K) has been computed for three length classes of redbreast sunfish and these compared between river systems. Figure 2 illustrates coefficients of condition (K) for redbreast populations of the lower Suwannee and lower Santa Fe Rivers. From Figure 2 it may be observed mean K factors are demonstrably greater for all size classes of redbreasts from the Santa Fe than the Suwannee.

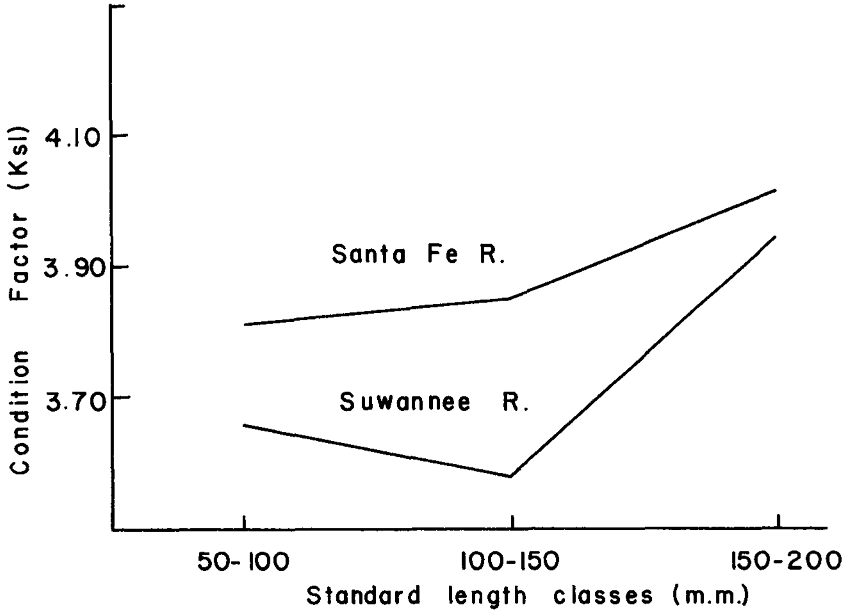

Figure 2. Mean K factors of two p
pulations of redbreast sunfish from the lower
Suwannee and lower Santa Fe Rivers, Florida.

Mean K factor for the 50.5 to 100.5 m.m. S.L. size class was 3.66 for Suwannee fish and 3.81 for Santa Fe individuals based upon sample sizes of 679 and 397 fish respectively. Values for the 100.5 to 150.5 m.m. interval were 3.58 for Suwannee redbreasts and 3.85 for Santa Fe specimens, with samples of 297 and 410 fish respectively. Coefficients of condition for the largest size interval, 150.5-200.5 m.m., were 3.94 for the Suwannee population and 4.01 for the Santa Fe, with samples of 89 and 136 fish, respectively. Overall condition of redbreast sunfish from the lower Santa Fe may be described as consistently greater than Suwannee individuals.

A positive correlation was determined for the regression of length and weight. The correlation was significant at the 0.05 level of significance with a correlation coefficient (r) of 0.98 for 913 redbreast from the Santa Fe River and 0.89 for 974 fish from the Suwannee. Values for the constant c and exponent b were calculated for the general formula W=cLb. The constant c was determined to be -4.20 and b 2.89 for the Santa Fe population; while for the Suwannee c was -4.06 and b 2.81. These values give the general expressions:

logW = -4.20+2.89 (logL), for the Santa Fe River redbreast, and:

logW = -4.06+2.81 (logL), for Suwannee River redbreast.

Lines of regression were calculated from the equation for the line of best fit (least squares method) Ye=a+bX (Alder and Roessler, 1968). Calculated regression lines for the two populations are illustrated by Figure 3. A close relationship between these lines of regression is suggested by this figure, though values for the Santa Fe population are slightly higher than for the Suwannee.

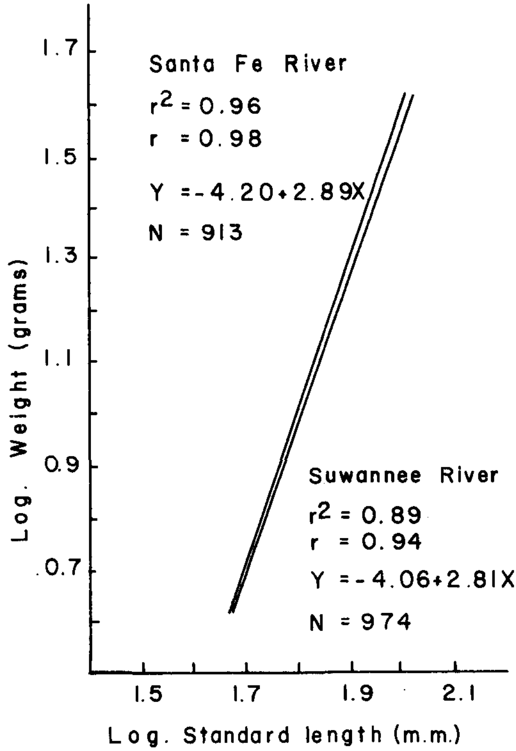

Figure 3. Length-weight regression of two populations of redbreast sunfish from the Santa Fe and Suwannee Rivers, Florida.

DISCUSSION

Contribution to ichthyofauna:

Hellier (1967) found the redbreast sunfish to be the dominant centrarchid of the Santa Fe River. Lake and Stream Survey Team No. 2 (1964), Cox (1969, 1970), and Cox and Auth (1971) and Bass and Hitt (1971) observed numerical dominance of the fish communities of the Suwannee and lower Santa Fe Rivers by this species. Our present data further illustrates the predominance of redbreast in the lower Suwannee and lower Santa Fe Rivers.

The species occupies a wide range of stream habitats in the Suwannee-Santa Fe system—limestone bottoms, vegetated sites and over sand or mud substrates. Physical and chemical factors as pH, hardness, water level and discharge fluctuate widely in these river systems, producing a constantly changing environment (Bass and Hitt, 1973). The adaptability of the species is pointed out by its ability to successfully occupy a wide range of habitats of the swfit stream (Santa Fe) and the broader river (lower Suwannee). Tolerance of this species for a wide range of ecological factors has been previously demonstrated by Shannon (1967) for North Carolina streams.

Chable (1947) found the redbreast to be predominantly a stream form, most abundant in larger rivers and calcareous streams, seldom occurring in smaller creeks. McLane (1955) considered the redbreast a stream fish and did not collect any from any landlocked lakes within the St. Johns watershed. The redbreast appears to be found most abundantly in streams of intermediate size between the small creek and larger river - eg.; the intermediate streams: Oklawaha River and Santa Fe River.

Food habits:

Chable (1947) found insects, primarily tendiped larvae, to be the most abundant food item of redbreasts, followed by crustaceans, primarily amphipods, and vegetation. McLane (1955) noted that decapod crustacea were negligible and other fish absent from the diet. However, in our study, we frequently observed the brachyurans (true crabs) *Uca* sp. (fiddler crabs) and *Callinectes sapidus* (blue crabs) in the diet of the redbreast from the lower Suwannee River near the Gulf of Mexico. Marine isopods and amphipods were also observed during the present investigation. Other fish were occasionally observed in the diet of Santa Fe River and Suwannee River redbreast. Redbreasts examined by McLane (1955) rarely ingested surface items; surface feeding was assumed to be insignificant. However, redbreasts in both Santa Fe and Suwannee River consumed considerable quantities of surface forms, primarily emergent aquatic insects. Primary food items numerically from St. Johns River redbreast stomachs were tendipeds, fish ova, amphipods, Cladocera, copepods, Trichoptera larvae, Ephemeroptera nymphs and isopods (McLane, 1955).

In North Carolina, predominant food items were aquatic insects, Coleoptera, Odonata, and Ephemeroptera (Davis, 1972). Phillips (1967) determined that South Carolina redbreasts were primarily predaceous upon insects, mainly insect larvae.

Wyatt, et. al. (1967) reported stomach contents of redbreast from the Alapaha River in Georgia (tributary to the Suwannee River). A strong preference for insects was indicated.

Numerically dominant food items of redbreast from the Santa Fe River were aquatic insects. Most important item in the diet of redbreasts from the lower Suwannee were aquatic insects and crustaceans. In both river systems, redbreasts appeared to be feeding opportunistically, taking whatever prey available. Swift-stream invertebrate forms, thriving on the limestone substrate of the Santa Fe, such as Trichoptera, Ephemeroptera and Coleoptera, reflect the habitat of that river. Tendipeds were common in both systems. The slower currents, fine sand and mud substrates of nearshore areas, tidal swamps, and marine faunal influence of the lower Suwannee provide a greater diversity of food types. However, redbreasts from the Santa Fe contained larger numbers of food items than individuals from the lower Suwannee.

Vegetation and debris were usually mixed together as detritus in individual stomachs suggesting that vegetation is only incidentally taken. However, in some stomachs, vegetation was present in such quantities as to indicate intentional feeding upon plant matter. In general, however, we agree with Davis (1972) that vegetation is not a major food source of redbreast sunfish. Insects, primarily larvae and nymph stages, form the primary diet of redbreast sunfish. Where available, small crustaceans may be heavily utilized. This species is an opportunist, taking essentially any potential food item of proper size. In the lower Suwannee and lower Santa Fe Rivers, presence of significant quantities of emergent aquatic insects (winged adults of Trichoptera, Ephemeroptera and Tendipedidae) in the diet indicates surface feeding habit as well as benthic foraging though the latter is the primary mode.

Reproduction:

Davis (1972) reported redbreast spawning in North Carolina streams in June at water temperatures of 71°F (22°C) to 78°F (25°C). McLane (1955) observed males guarding nests during May 1948 in the Oklawaha River, Florida; length frequency data suggested spawning occurred throughout the summer. Hellier (1967) collected gravid 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 held to be the peak of the breeding season. Wyatt, et. al. (1967) reported ripe females from the Alapaha River in Georgia in April, 1966. Bass and Hitt (1971) observed small developing ova and ovarian sacs in redbreast from the south-central Suwannee River in January, 1971. Redbreast nests were noted in the Sun Springs canal system (south-central Suwannee River) on April 29, 1971; nests were also noted in the river proper in April. Redbreasts were observed on nests in Rock Bluff Spring run on August 3, 1971. In the present study, females containing ripe ova were taken from April through October in both lower Suwannee and lower Santa Fe Rivers. No ripe ova were observed during the balance of the year. Mean water temperature of the lower Santa Fe River in April, 1973 was 18.0°C and 16.8°C in the Suwannee. In May, water temperature means for the Santa Fe and Suwannee were 21.2°C and 20.6°C, respectively. Means for June were 24.5°C (Santa Fe) and 25.4°C (Suwannee). Records presented above are in agreement that redbreast spawning takes place from April to October, with a peak in late spring and summer. Our observations of habitat requirements for spawning agree in the main with those of Davis (1972). Typical sunfish nests, circular depressions, are located along the edges and quiet waters of streams, spring runs or canals adjacent to rivers. Nests typically are situated adjacent some type of cover as snags, trees or stumps.

Spawning was noted in t e mouth region of the Suwannee, well within the influence of tidal action and with marine faunal elements. Richmond (1940) observed redbreast nests in tidal reaches of the Chickahominy River in Virginia.

Davis (1972) reported fecundity analyses of redbreasts from North Carolina streams. Individuals 5.5 to 5.6 inches total length (140-142 m.m.) had mean ova counts of 963; fish in the size range of 5.9 to 6.1 inches total length (150-155 m.m.), 1,008 ova; 6.75 to 7.25 inches total length (171 to 184 m.m.), 3,563 ova; and 9.0 to 9.25 inches (228 to 235 m.m.) total length had ova counts of 8,250. Comparison of our data with the above is difficult due to our utilization of different size classes measured in metric standard length increments. Ova counts of 143 Santa Fe River redbreasts had mean values of 1,396 ova for the 100.5 to 125.5 m.m. S.L. interval; 2,761 ova for the 125.5 to 150.5 m.m. S.L. group, and 4,138 ova for the 150.5 to 175.5 m.m. S.L. class interval. Mean ova counts of 38 Suwannee River redbreasts were 2,893 ova for the smallest size interval; 3,320 ova for the intermediate size interval and 5,112 ova for the largest group.

It will be noted from our data that redbreast from the Suwannee River had higher mean ova counts than comparable sizes from the Santa Fe. Explanations for this phenomenon are presently unavailable; however, the sample size (38) from the Suwannee population is much lower than that from the Santa Fe (143) and may account for observed differences.

Condition and Length-Weight Relationship:

The only condition factors we have seen for redbreast sunfish are those of Barron (1967) from Texas. Barron (1967) utilized smoothed mean K factors of various species, statistically treated, to measure relative productivity of several lakes. We have used empirical means of this major riverine species to illustrate relative production of two river systems. We consider that the greater degree of robustness or condition exhibited by Santa Fe River redbreasts represents a real difference in the ability of these two systems to produce the major species of both systems.

We are not familiar with other expressions of length-weight regression for redbreast sunfish. A close relationship between regression lines for the two populations is suggested by our data. For the general expression $W=cL^b$, the data indicates a growth form approximately the cube of length for redbreasts in these river systems.

Our data on condition factor and length-weight relationship of redbreast populations may be considered representative of populations inhabiting relatively unpolluted ecosystems. In as much as demonstrable differences appear between these two redbreast populations in the same watershed, care must be taken when comparing these data with populations in other bodies of water. Genetic differences as well as differential growth patterns may distinguish various populations. The behavior of populations of redbreast in artificially altered environments has been investigated by others. O'Rear (1970), studying growth of redbreast and bluegill populations in a thermally influenced Goergia lake, found that redbreast populations from the thermally influenced sample area did not show increased growth over other areas. Tsai (1970) found that increased sewage pollution in the Little Patuxent River, Maryland, caused changes in fish movements, abundance and community; redbreast sunfish showed a change in abundance without reduction in distribution ranges.

CONCLUSIONS

Although the redbreast sunfish is the dominant fish of both the lower Suwannee and lower Santa Fe Rivers, the Santa Fe is the more productive ecosystem. Santa Fe redbreasts are better fed and exhibit a higher degree of individual robustness (K factor).

The species is primarily an insectivore, feeding upon benthic larval and nymphal stages as well as emergent aquatic insects from the surface. Santa Fe redbreasts preyed primarily upon aquatic insects, while redbreasts from the lower Suwannee took significant quantities of crustaceans as well as insects. Aquatic vegetation formed approximately one-third of stomach contents by volume in both populations. Usually vegetation appears as detritus and does not form a preferred food item. A wide variety of other aquatic organisms is ingested, suggesting opportunistic feeding; food items found in redbreast stomachs tend to reflect availability of potential prey. Spawning occurs from April through October, with a peak in late spring and summer. Mean ova counts of Santa Fe redbreasts ranged from 1396 for the 100.5 to 125,5 m.m, S.L. size interval to 4138 ova for the 150.5 to 175.5 m.m. interval. Mean fecundity of Suwannee specimens was 2893 ova for the smallest size class to 5112 for the largest group. The observed differential between fecundity of these two populations may be due to sample size. Gravid females fell within the size range of 100.5 to 175.5 m.m. S.L.; mature females were not taken above or below these limits.

Length-weight regression lines for the two populations are closely related. The growth pattern of redbreast sunfish in these ecosystems approaches the isometric form.

LITERATURE CITED

Alder, H. L. and E. B. Roessler. 1968. Introduction to Probability and Statistics. 4th Ed. W. H. Freeman and Co., San Francisco. 333p.

Barron, J. C. 1967. The K factor index, KI: A qualitative measure of fish populations. D.-J. Proj. F-6-R-14. Job No. B-26(Seg. 3). Job Completion Rept. Texas. 10p.

Bass, D. G., Jr. and V. G. Hitt. 1971. Sport fishery of the Suwannee River. Report I. December, 1971. Fla. Game and Fresh Water Fish Comm. 115p.

Bass, D. G., Jr. and V. G. Hitt. 1973. Sport fishery ecology of the Suwannee and Santa Fe Rivers, Florida. Report I. Fla. Game and Fresh Water Fish Comm. 187 p.

Briggs, J. C. 1958. A list of Florida fishes and their distribution. Bull. Fa. State Mus. Biol. Sci. 2(8):223-318.

Carr, A. F., Jr. and C. J. Goin. 1955. Guide to the Reptiles, Amphibians and Fresh-Water Fishes of Florida. Univ. Fla. Press, Gainesville, Fla. 341p.

Chable, A. C. 1947. A study of the food habits and ecological relationships of the sunfishes of northern Florida. M.S. Thesis, Univ. Fla., Gainesville. 98p.

Cox, D. T. 1969. Stream Investigations. Ann. Progr. Repr. Res. Proj. F-25-2. Fla. Game and Fresh Water Fish Comm. 130p.

Cox, D. T. 1970. Stream Investigations. Ann. Progr. Rept. Res. Proj. F-25-3. Fla. Game and Fresh Water Fish Comm. 109p.

Cox, D. T. and D. Auth. 1971. Stream Investigations. Ann. Progr. Rept. Invest. Proj. F-25-4. Fla. Game and Fresh Water Fish Comm.: 26-47.

Davis, J. R. 1972. The spawning behavior, fecundity rates and food habits of the redbreast in southeastern North Carolina. Proc. S. E. Assoc. Game and Fish Comm. 25:556-560.

Hellier, T. R., Jr. 1967. The fishes of the Santa Fe River system. Bull. Fla. State Mus. Biol. Sci. 11(1):1-37.

Lagler, K. F. 1956. Freshwater Fishery Biology. Wm. C. Brown, Co., Dubuque, Iowa. 421p.
Lake and Stream Survey Team No. 2, 1964. The Suwannee watershed. Fla. Game and Fresh Water Fish Comm. 105p.
McLane, W. M. 1955. The fishes of the St. Johns River system. Ph.D. Thesis, University of Florida, Gainesville.
O'Rear, R. S. 1970. A growth study of redbreast, *Lepomis auritus* (Gunther), and bluegill, *Lepomis macrochirus* (Rafinesque), populations in a thermally influenced lake. Proc. S. E. Assoc. Game and Fish Comm. 23:545-552.
Phillips, H. A. 1968. Fisheries investigations in lakes and streams. Progr. Rept., S. C. Wildlife Res. Dept. 19p.
Ricker, W. E. 1958. Handbook of computations for biological statistics of fish populations. Fish Res. Bd. Canada. Bull. 19. 300p.
Richmond, N. D. 1940. Nesting of the sunfish, *Lepomis auritus* (Linnaeus), in tidal waters. Zoologica, N.Y., 25(3):329-330.
Shannon, E. E. 1967. Geographical distribution and habitat requirements of the redbreast sunfish, *Lepomis auritus*, in North Carolina. Proc. S. E. Assoc. Game and Fish Comm. 20:319-323.
Tsai, Chu-Fa. 1970. Changes in fish populations and migration in relation to increased sewage pollution in Little Patuxent River, Maryland. Chesapeake Science, 11:34-41.
Wyatt, H. N., C. B. O'Neal, Jr., M. Norton and P. M. Loska. 1967. Life history studies. D.-J. Proj. F-19-R-2, Work Plan II, Job No. 5. Ann. Progr. Rept. July 1, 1966 to June 30, 1967. Georgia. 81p.

SOME RELATIONSHIPS BETWEEN FOOD HABITS AND GROWTH OF LARGEMOUTH BASS IN LAKE BLACKSHEAR, GEORGIA[1]

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ABSTRACT

The food habits and growth of 1,062 largemouth bass, *Micropterus salmoides* (Lacepede), collected from Lake Blackshear during the period 31 March 1970-19 December 1972 were examined. Mean lengths of bass at Age I, II, III, IV, and V were 106, 253, 350, 418, and 473 mm total length, respectively. Young-of-year and yearling bass showed great variation in growth rates. Threadfin shad, *Dorosoma petenense* (Gunther), and gizzard shad, *Dorosoma cepedianum* (LeSueur), were identified as the most important forage species to bass beginning their piscivorous feeding habits. The great variation in growth of young-of-year bass resulted from the timing of bass reproduction with respect to shad spawning activity. A specific goal and methods for managing largemouth bass are recommended for Lake Blackshear.

INTRODUCTION

Fish population estimates for Lake Blackshear based on cove sampling with rotenone have been made yearly for more than 15 years. This sampling showed that largemouth bass, *Micropterus salmoides* (Lacepede), reproduction was quite successful. However, length-frequency distributions indicated that growth of bass for the first three years was exceptionally slow. It was felt that recruitment to the catchable largemouth bass stock was significantly reduced because slow growing bass were subject to predation for a longer time than were faster growing bass.

A study of certain aspects of the life histories of largemouth bass and the principal species preyed on by bass was begun in 1968. It was hoped the study would delineate the extent and expose the causes of the bass growth problem.

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