

Northeast Gulf Science

Volume 3
Number 1 *Number 1*

Article 1

6-1979

Trophic Resource Utilization by Three Species of Sciaenid Fishes in a Northwest Florida Estuary

Peter F. Sheridan
Florida State University

DOI: 10.18785/negs.0301.01

Follow this and additional works at: <https://aquila.usm.edu/goms>

Recommended Citation

Sheridan, P. F. 1979. Trophic Resource Utilization by Three Species of Sciaenid Fishes in a Northwest Florida Estuary. *Northeast Gulf Science* 3 (1).

Retrieved from <https://aquila.usm.edu/goms/vol3/iss1/1>

This Article is brought to you for free and open access by The Aquila Digital Community. It has been accepted for inclusion in *Gulf of Mexico Science* by an authorized editor of The Aquila Digital Community. For more information, please contact Joshua.Cromwell@usm.edu.

TROPHIC RESOURCE UTILIZATION BY THREE SPECIES OF SCIAENID FISHES IN A NORTHWEST FLORIDA ESTUARY

Peter F. Sheridan¹

Department of Biological Science
Florida State University
Tallahassee, FL 32306

ABSTRACT: Food habits of Atlantic croaker (*Micropogonias undulatus*), spot (*Leiostomus xanthurus*), and sand seatrout (*Cynoscion arenarius*) were examined in 1976 collections from Apalachicola Bay, Florida. Ontogenetic, spatial, and temporal aspects of diet were considered.

Polychaetes were the main food of croakers over all collections, followed in importance by detritus, fishes, insect larvae, mysids, and infaunal shrimp. Diet specialization occurred with growth of croakers, so that one or two food types dominated the diet. Intraspecific diet correlation using the Spearman Rank Correlation Coefficient, indicated three feeding groups: 10-39 mm fish, 40-89 mm fish, and 90-159 mm fish. Croaker feeding in shallow, low salinity sites in the estuary was distinct from feeding in deeper, more saline areas. Temporal analysis (January-September) of the croaker diet reflected four feeding patterns: (1) first entry into the estuary by small size classes; (2) area-wide distribution of many size classes, (3) concentration of mid-sized individuals in the upper estuarine areas, and (4) emigration of large size classes.

Polychaetes and harpacticoid copepods dominated the average spot diet, followed by detritus, bivalves and nematodes. Several distinctive patterns in feeding were noted on ontogenetic and spatial bases, but not on a temporal basis. Intraspecific diet correlation indicated similar feeding patterns in all but the smallest (20-29 mm) and largest (100-109 mm) size classes examined.

Juvenile fishes (mainly *Anchoa mitchilli*) dominated the sand seatrout diet, while mysids ranked a distant second. There was a clear sequence of ontogenetic changes in sand seatrout feeding (also indicated by intraspecific correlation), wherein smaller size classes preyed heavily on mysids followed by a switch to piscivory by larger individuals. Spatial analysis indicated heavy consumption of fishes by sand seatrout near high salinity passes to the estuary, grading into heavy consumption of mysids in shallow, low salinity areas. Temporal analysis (May-November) revealed relatively lower predation on fishes in late summer when various crustaceans were important diet components.

Interspecific diet comparisons indicated little overall trophic overlap among the three sciaenids, but diets of small croakers (10-59 mm) and spot (20-79 mm) were significantly correlated. Few correlations in diet were found between sand seatrout and either croaker or spot.

A sieve fractionation technique used to analyze food habits yielded a clear distinction in prey size between the two benthic feeders. While diets were superficially similar, croakers consumed larger polychaetes and larger food items in general than did spot.

There exist numerous studies of the food habits of estuarine and coastal marine fishes, but rarely have these investigations considered their results from the viewpoint of resource partitioning, an important means of reducing competition among coexisting species (Schoener, 1974). Several recent studies have addressed this important concept. Oviatt and Nixon (1973) found trophic

separation between two resident estuarine flatfishes and between two seasonal transients in Narragansett Bay. Haedrich and Haedrich (1974) revealed trophic partitioning among three estuarine fishes, which also exhibited temporal differences in abundance peaks, in a Massachusetts estuary. Temporal and size-related trophic partitioning were found by Stickney *et al.* (1974) for four Georgia estuarine flounders, and by Stickney *et al.* (1975) for five species of sciaenid fishes along the southeast U. S. coast. There are also several examples

¹Present address: U. S. Environmental Protection Agency, Bears Bluff Field Station, Box 368, Johns Island, SC 29455.

from offshore regions (Tyler, 1972; Kravitz *et al.*, 1976). However, Ross (1977) discovered that trophic partitioning among eight species of searobins only occurred in areas of high spatial overlap and that macrohabitat partitioning was the dominant force in resource allocation. Thus, in many cases estuarine and coastal marine species which overlap in time and/or space appear likely to utilize different portions of the available trophic spectrum. The present investigation explores this phenomenon with reference to three sciaenid fishes in a Gulf coast estuary.

The fish communities along the Gulf coast of the United States are heavily influenced by the family Sciaenidae. This paper examines the food habits of three sciaenids, Atlantic croaker (*Micropogonias undulatus*, nomenclature following Chao and Musick, 1977 and Chao, 1978), spot (*Leiostomus xanthurus*), and sand seatrout (*Cynoscion arenarius*), as they utilize the Apalachicola estuary of north-west Florida.

In the Apalachicola estuary, *M. undulatus* ranks second only to *Anchoa mitchilli* in numerical abundance, composing 26% of the total fish catch over six years of monthly sampling (Livingston *et al.*, 1976, 1977, and unpublished data). Postlarvae and early juveniles have been collected as early as October, with peak juvenile abundances occurring in February and March. Most individuals leave the estuary by early summer. *Leiostomus xanthurus* ranks third in numerical abundance, composing 13% of the total fish catch over six years of monthly sampling (Livingston *et al.*, 1976, 1977, and unpublished data). Postlarvae and juveniles are first noted in December and peak abundance occurs in February and March. Juveniles appear to move into the surrounding marshes until rapid

temperature changes in the fall precipitate offshore migration. *Cynoscion arenarius* ranks fourth in numerical abundance, composing 8% of the total fish catch over six years of monthly sampling (Livingston *et al.*, 1976, 1977, and unpublished data). Postlarvae and early juveniles are first found in April and reach peak abundance in the summer. Most sand seatrout leave the estuary by November.

Apalachicola Bay, Franklin County, Florida, is a relatively unpolluted, shallow, bar-built estuary dominated by the Apalachicola River. Much of the information concerning the Apalachicola drainage system has been reviewed by Livingston *et al.* (1974) and in Livingston and Joyce (1977).

MATERIALS AND METHODS

Fishes examined in this study were taken from collections made as part of a long-term program monitoring the fauna of the Apalachicola Bay-East Bay complex (Fig. 1) described by Livingston *et al.* (1976). Samples were taken from collections made monthly (January-November, 1976) by trawling with a 5 m (16') otter trawl (20 mm mesh wing and body, 6 mm mesh liner) employing the following set schedule: seven 2-minute trawls at stations 1, 5, and 6; two 2-minute trawls at stations 1A, 1B, 1C, 2, 3, 4, and 5A. Details of field methods and area descriptions are given in Livingston *et al.* (1976). Thus, the available sample sizes were limited both by the collection format and the seasonal fluctuations in population sizes, although the numbers of individuals used for trophic analyses were maximized within this framework.

After field preservation in 10% formalin, fishes were rinsed and stored in 40% isopropanol until analysis. At

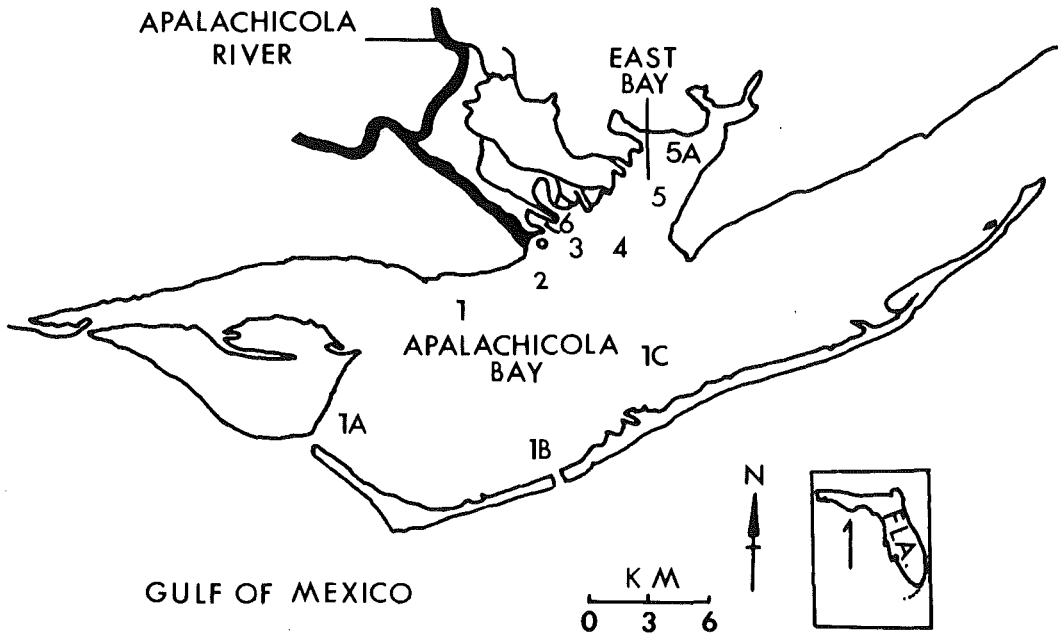


Figure 1. Map of the Apalachicola Bay system showing sampling location.

such time, fishes were sorted into 10 mm size classes (SL) by species, station, and date of collection. Stomachs of up to 35 individuals (as collections permitted) from each size class were resected and their contents pooled. Stomach contents were then analyzed as percent dry weight composition by a gravimetric procedure involving sieve fractionation described by Carr and Adams (1972, 1973).

Comparative analysis of intra- and interspecific diet similarities among fish size classes was conducted with the Spearman Rank Correlation Coefficient, corrected for ties (Sokal and Rohlf, 1969; Fritz, 1974).

RESULTS

Micropogonias undulatus

A total of 2,217 croaker stomachs, spanning January through September, 1976, was examined. These formed 163 samples after pooling by size classes.

Only 4.8% of the stomachs were empty. Polychaetes formed the basis of the croaker diet, averaging 32% by weight for all size classes (Table 1). Numerous polychaete species were identified but *Paraprionospio pinnata*, *Amphicteis gunneri*, and *Glycinde solitaria* predominated. Other important diet constituents included detritus (16%), juvenile fishes (8%), mysids (7%, predominately *Myxidopsis bahia* and *Taphromysis bowmani*), and shrimp (7%, primarily *Ogyrides limicola*). Smaller croakers (10-39 mm) supplemented the polychaetes with large amounts of insect larvae, amphipods, and harpacticoid and calanoid copepods. Mid-range croakers (40-89 mm) had a more diverse diet and consumed relatively more detritus and mysids than smaller croakers. Ration diversity of larger size classes (90-159 mm) decreased due to specialization upon one or two food items (polychaetes, crabs, infaunal shrimp, and/or juvenile fishes) which composed major portions

TABLE 1. Stomach contents (% of total dry weight) of *Micropogonias undulatus* relative to standard length groups.

| Food Item | Size (mm) | | | | | | | | | | | | | |
|-----------------------------------|-----------|-------|-------|-------|-------|-------|-------|-------|-------|---------|---------|---------|---------|-------------|
| | 10-19 | 20-29 | 30-39 | 40-49 | 50-59 | 60-69 | 70-79 | 80-89 | 90-99 | 100-109 | 110-119 | 120-129 | 150-159 | Avg. 10-159 |
| Sand grains | | <.1 | | | <.1 | 0.2 | 0.2 | | 0.3 | <.1 | 2.1 | | | 0.2 |
| Sediment masses | | | 0.2 | 2.4 | 1.5 | 3.3 | 3.3 | 8.2 | | | | | | 2.2 |
| Detritus | 7.1 | 6.5 | 12.9 | 19.4 | 17.5 | 19.2 | 19.0 | 15.0 | 19.5 | 10.3 | 6.8 | 14.1 | 9.7 | 15.9 |
| Plant remains | | <.1 | 0.3 | 0.4 | <.1 | 0.4 | 0.1 | <.1 | 0.6 | 0.7 | 1.1 | | 0.3 | 0.2 |
| Nematodes | 0.8 | 0.4 | <.1 | <.1 | <.1 | <.1 | | | | | 2.1 | | | 0.2 |
| Polychaete larvae | | <.1 | <.1 | | | | | | | | | | | <.1 |
| Gastropods | 26.2 | 31.5 | 35.6 | 36.6 | 29.6 | 31.7 | 28.1 | 48.4 | 54.7 | 32.8 | 4.4 | 40.1 | 34.0 | 32.4 |
| Bivalve siphons | | | 1.5 | 2.8 | 3.7 | 3.1 | 3.0 | 1.2 | 3.2 | | | | | <.1 |
| Bivalves | 0.8 | 1.0 | 0.9 | 0.6 | 0.1 | 0.3 | 0.1 | | | | | | | 0.3 |
| Cladocerans | | <.1 | <.1 | <.1 | | <.1 | | | | | | | | <.1 |
| Ostracods | 0.2 | 0.2 | <.1 | <.1 | | <.1 | <.1 | | | | | | | <.1 |
| Calanoid copepods | 10.0 | 7.1 | 4.2 | 6.0 | 9.1 | 7.8 | 7.1 | 1.6 | 2.1 | <.1 | 0.1 | | | 5.7 |
| Harpacticoid copepods | 12.2 | 8.6 | 2.7 | 1.9 | 4.3 | 2.4 | 0.7 | 0.1 | | | <.1 | | | 2.3 |
| Cumaceans | 1.4 | 0.6 | 0.4 | 0.2 | 0.1 | <.1 | <.1 | <.1 | | | | | | 0.2 |
| Isopods | | | 0.2 | 0.7 | 3.6 | 2.9 | 0.9 | 0.1 | | | | | | 1.4 |
| Amphipods | 5.3 | 16.9 | 13.6 | 6.8 | 3.7 | 4.6 | 3.8 | 2.3 | 0.3 | 0.1 | 1.8 | 0.2 | | 5.5 |
| Mysids | 8.0 | 5.7 | 5.0 | 8.2 | 10.4 | 11.3 | 11.0 | 2.3 | 5.6 | | 2.7 | 2.2 | | 7.4 |
| Shrimp postlarvae | | | <.1 | <.1 | | | | | | | | | | <.1 |
| Shrimp | | 0.1 | 1.4 | 0.9 | 2.9 | 4.8 | 10.3 | 10.1 | 2.1 | 1.8 | 46.0 | 43.3 | 10.9 | 6.8 |
| Crabs | | | | 0.8 | 0.6 | 0.4 | | | | 0.5 | | | 45.1 | 0.7 |
| Unassigned decapod larvae | | | | <.1 | | | | | | | | | | <.1 |
| Insect larvae | 27.9 | 20.9 | 20.8 | 11.6 | 11.9 | 5.0 | 0.5 | 0.2 | | | 1.2 | | | 8.2 |
| Ophiuroids | | | | | | | 1.0 | | | | | | | <.1 |
| Unassigned invertebrate eggs | 0.1 | | <.1 | <.1 | <.1 | <.1 | <.1 | <.1 | | | | | | <.1 |
| Fish eggs | | | <.1 | <.1 | <.1 | | | | | | | | | <.1 |
| Fish larvae | | 0.3 | 0.3 | 1.2 | | | | | | | | | | 0.2 |
| Fish | | | <.1 | 0.5 | 2.0 | 10.3 | 10.4 | 1.8 | 53.7 | 32.7 | | | | 8.2 |
| Number of individuals | 268 | 443 | 401 | 394 | 305 | 192 | 107 | 37 | 13 | 28 | 24 | 3 | 2 | 2217 |
| Number of samples (after pooling) | 9 | 20 | 24 | 24 | 24 | 22 | 16 | 8 | 4 | 6 | 4 | 1 | 1 | 165 |
| Number of dates (maximum = 9) | 3 | 4 | 5 | 4 | 5 | 5 | 5 | 3 | 3 | 4 | 3 | 1 | 1 | 9 |
| Number of stations (maximum = 10) | 6 | 9 | 9 | 9 | 9 | 9 | 8 | 4 | 4 | 4 | 3 | 1 | 1 | 10 |

of their diets. Small sample sizes of these large croakers may be responsible for this trend; unfortunately, larger fish were relatively less abundant and may have avoided the net.

Comparative diet analysis (Table 2) also indicated these croaker feeding patterns. The diets of small croakers (10-69 mm) were closely related ($P < .01$, for 11/15 comparisons), and the three smallest classes (10-39 mm) generally were not correlated with the diets of fish larger than 70 mm. The diets of 40-89 mm croakers correlated with those of many other size classes (e.g., 60-69 mm class correlated with 10/12 remaining classes) and probably reflected a transition stage in the croaker diet. Larger size classes (90-159 mm) showed little diet correlation among themselves, as a result of increased specialization on a few locally abundant food items. One exception was the 120-129 mm class diet which was significantly correlated with

those of seven other classes.

Interstation comparison of croaker diets (Table 3) showed several distinctive feeding patterns in the estuary. Insect larvae, detritus, amphipods, and a variety of other small crustaceans dominated the croaker diet on stations 3, 5, 5A, and 6. These were shallow, low salinity sites fairly close to land. The ration on station 2, at the river mouth, was diverse and was characterized by consumption of juvenile fishes, mysids, and shrimp. The diets of fish from relatively deep, higher salinity sites (stations 1A, 1C, 1, 4) was dominated by polychaetes and lesser amounts of shrimp, fishes and detritus. Only one sample was from station 1B, where juvenile fishes composed 66% of the croaker diet.

Temporal diet analysis (Table 4) in essence tracked the movement of the croaker population as it utilized the estuary. January marked the first substantial appearance of croakers (10-39 mm) in the estuary and was the only month when harpacticoid and calanoid

TABLE 2. Intraspecific comparison of the diets of *Micropogonias undulatus* size classes using the Spearman Rank Correlation Coefficient (r_s). Size classes are given as the smallest size in a 10 mm (SL) range (e.g., 10=10-19 mm, 20=20-29 mm, etc.). Significance levels are denoted by * ($P<.05$) or ** ($P<.01$).

| | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 150 |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|-------|--------|--------|-------|
| 10 | .914** | .704** | .552* | .595** | .438* | .211 | .097 | .064 | -.189 | -.085 | .139 | -.102 |
| 20 | | .787** | .615** | .574** | .463* | .249 | .144 | .067 | -.106 | -.115 | .217 | -.061 |
| 30 | | | .851** | .793** | .732** | .439 | .351 | .438 | .111 | .228 | .603* | .151 |
| 40 | | | | .848** | .680** | .574** | .563* | .477* | .102 | .227 | .594* | .163 |
| 50 | | | | | .911** | .660** | .499 | .487* | .100 | .241 | .557* | .275 |
| 60 | | | | | | .805** | .805** | .657* | .371 | .482* | .727** | .371 |
| 70 | | | | | | | .917** | .718** | .529* | .598** | .618** | .337 |
| 80 | | | | | | | | .601* | .548* | .565* | .699* | .247 |
| 90 | | | | | | | | | .232 | .421 | .582 | .164 |
| 100 | | | | | | | | | | .517 | .167 | -.027 |
| 110 | | | | | | | | | | | .639* | .157 |
| 120 | | | | | | | | | | | | .179 |

TABLE 3. Stomach contents (% of total dry weight) of *Micropogonias undulatus* relative to collection site.

| Food Item | Station | | | | | | | | | | |
|-----------------------------------|---------|-------|--------|---------|--------|-------|-------|-------|-------|-------|--|
| | 1A | 1B | 1C | 1 | 2 | 3 | 4 | 5 | 5A | 6 | |
| Sand grains | | | | < .1 | 0.7 | < .1 | | 0.7 | | < .1 | |
| Sediment masses | 10.3 | | 3.2 | 0.2 | 0.8 | 7.3 | 0.6 | 2.5 | 3.2 | 0.7 | |
| Detritus | 17.0 | 9.6 | 11.4 | 20.4 | 12.0 | 12.6 | 13.2 | 28.6 | 20.6 | 18.0 | |
| Plant remains | < .1 | | < .1 | 0.1 | 0.5 | 0.1 | 0.8 | 0.2 | | 0.3 | |
| Nematodes | | | 1.2 | < .1 | 0.7 | < .1 | < .1 | < .1 | | | |
| Polychaete larvae | | | < .1 | | < .1 | | | | | | |
| Polychaetes | 33.8 | 3.1 | 44.9 | 54.2 | 6.4 | 14.5 | 67.8 | 6.8 | 9.9 | 3.0 | |
| Gastropods | | | | | < .1 | | | | 1.2 | | |
| Bivalve siphons | | | | | 6.6 | | 0.5 | 2.2 | | 10.8 | |
| Bivalves | | | 0.1 | | 0.1 | 0.2 | | 0.5 | 3.8 | 0.2 | |
| Cladocerans | | | | | < .1 | | | | | < .1 | |
| Ostracods | | | < .1 | < .1 | < .1 | < .1 | < .1 | | < .1 | 0.2 | |
| Calanoid copepods | 6.5 | 1.3 | 9.9 | 13.1 | 2.0 | < .1 | 0.7 | 2.8 | 3.5 | 1.7 | |
| Harpacticoid copepods | 2.0 | | 2.7 | 1.2 | 6.4 | 0.9 | 0.9 | 1.6 | 0.4 | < .1 | |
| Cumaceans | 0.2 | 0.4 | 0.5 | 0.1 | 0.1 | | | | | | |
| Isopods | | | | 0.1 | 0.7 | 11.4 | | 0.8 | 6.1 | 3.0 | |
| Amphipods | 0.1 | 0.2 | 0.2 | 2.1 | 7.5 | 13.4 | 3.0 | 8.3 | 16.1 | 15.7 | |
| Mysids | 5.5 | 8.2 | 1.2 | 4.2 | 19.1 | 1.3 | 0.5 | 2.4 | 8.5 | 26.9 | |
| Shrimp postlarvae | | | < .1 | | | | | | | | |
| Shrimp | 23.8 | 1.0 | 8.4 | 1.7 | 13.8 | 11.5 | 3.6 | | 1.3 | | |
| Crabs | | | | 2.2 | | | | 0.7 | 4.4 | | |
| Unassigned decapod larvae | | | | | < .1 | | | | < .1 | | |
| Insect larvae | | | | 0.1 | 2.5 | 23.2 | 7.1 | 42.6 | 21.1 | 19.4 | |
| Ophiuroids | | 9.8 | | | | | | | | | |
| Unassigned invertebrate eggs | | | | | 0.1 | < .1 | | | | | |
| Fish eggs | | | < .1 | < .1 | | | | | | | |
| Fish larvae | | | | | 0.2 | | 1.4 | | | | |
| Fish | 0.8 | 66.4 | 17.3 | 0.1 | 19.9 | 3.2 | | | | | |
| Number of individuals | 131 | 8 | 365 | 367 | 328 | 96 | 250 | 240 | 179 | 253 | |
| Number of samples (after pooling) | 16 | 1 | 30 | 27 | 22 | 9 | 14 | 16 | 11 | 17 | |
| Number of dates (maximum=9) | 4 | 1 | 7 | 6 | 6 | 4 | 4 | 5 | 3 | 5 | |
| Size classes examined (mm SL) | 20-129 | 70-79 | 10-119 | 10-109, | 10-119 | 20-69 | 10-79 | 10-79 | 20-69 | 10-79 | |
| | | | | 150-159 | | | | | | | |

copepods dominated the croaker diet. In February-April, a wide range of sizes of croakers was widespread throughout the estuary and fed mainly upon polychaetes, with additions of amphipods, insect larvae and detritus. In May and June, most fish were larger than 50 mm and a majority were collected in East Bay. Juvenile fishes and mysids became important food items as polychaete consumption decreased. Finally, croakers began emigrating from the estuary in July-September. These large fish fed mainly upon infaunal shrimp (*Ogyrides limicola*) and detritus.

Leiostomus xanthurus

A total of 903 spot stomachs, collected in April-June, August, October and

November, 1976, was examined. These formed 80 samples after pooling by size class. No empty stomachs were found and both stomach and intestine were usually partially filled. Polychaetes and harpacticoid copepods were the main constituents (24% and 21%, respectively), over all size classes (Table 5). Several polychaete species were identified, with *Amphicteis gunneri* and *Glycinde solitaria* predominating. Other important food items included detritus (16%), bivalves (11%), and nematodes (10%). Trends in diet were unclear across size classes. Chironomid insect larvae were most important to mid-range spot (40-69 mm). Polychaetes and detritus were relatively more important

TABLE 4. Stomach contents (% of total dry weight) of *Micropogonias undulatus* relative to month of collection.

| Food Item | Month | | | | | | | | |
|-----------------------------------|-------|-------|-------|--------|--------|-------------------|-------|--------------------|---------|
| | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. |
| Sand grains | | | < .1 | < .1 | | | 2.5 | 2.5 | |
| Sediment masses | | 1.2 | | 4.4 | 2.6 | 1.0 | 0.8 | | |
| Detritus | | 5.8 | 14.1 | 20.2 | 12.2 | 15.9 | 41.0 | 12.4 | 12.2 |
| Plant remains | | < .1 | < .1 | 0.5 | 0.1 | | | 1.2 | |
| Nematodes | 2.8 | 0.4 | < .1 | < .1 | 0.1 | < .1 | | 1.6 | |
| Polychaete larvae | | < .1 | < .1 | | | | | | |
| Polychaetes | 6.7 | 64.5 | 36.2 | 45.8 | 28.9 | 9.1 | 10.9 | 19.2 | 10.4 |
| Gastropods | | | | 0.2 | < .1 | < .1 | | | |
| Bivalve siphons | | | 4.1 | | | 8.4 | 11.0 | 0.7 | |
| Bivalves | < .1 | 0.8 | 0.3 | 0.4 | 0.4 | 0.2 | | | |
| Cladocerans | 0.7 | | < .1 | < .1 | | | | | |
| Ostracods | | | 0.1 | < .1 | | | | | |
| Calanoid copepods | 17.6 | | 1.2 | 4.8 | 12.6 | 2.0 | 3.7 | < .1 | 0.6 |
| Harpacticoid copepods | 35.7 | 4.6 | 1.0 | 2.0 | 1.5 | 6.2 | < .1 | < .1 | |
| Cumaceans | 6.4 | 0.5 | 0.4 | < .1 | < .1 | < .1 | | | |
| Isopods | | | 0.2 | 2.0 | 1.3 | 2.7 | | | |
| Amphipods | 3.8 | 12.4 | 14.5 | 5.0 | 1.8 | 2.8 | 4.5 | | |
| Mysids | 9.4 | 3.2 | 2.8 | 1.9 | 16.3 | 12.0 | 0.5 | | |
| Shrimp postlarvae | | | | < .1 | | | | | |
| Shrimp | 12.7 | 5.0 | 2.1 | 5.5 | 4.6 | 2.2 | 22.2 | 44.9 | 76.8 |
| Crabs | | | | | 0.9 | | 2.6 | 7.9 | |
| Unassigned decapod larvae | | | | < .1 | < .1 | | | | |
| Insect larvae | 4.0 | 1.5 | 21.6 | 6.1 | 5.1 | 4.8 | 0.4 | | |
| Ophiuroids | | | | | 0.4 | | | | |
| Unassigned invertebrate eggs | | | < .1 | < .1 | < .1 | | | | |
| Fish eggs | | | | < .1 | < .1 | | | | |
| Fish larvae | | | 1.1 | | | | | | |
| Fish | | | | 0.9 | 11.1 | 32.8 | | 9.6 | |
| Number of individuals | 138 | 128 | 686 | 552 | 501 | 153 | 20 | 32 | 7 |
| Number of samples (after pooling) | 6 | 9 | 34 | 44 | 46 | 15 | 3 | 5 | 1 |
| Number of stations (maximum=10) | 3 | 4 | 9 | 9 | 10 | 5 | 2 | 2 | 1 |
| Size classes examined (mm SL) | 10-39 | 10-59 | 10-79 | 20-109 | 30-129 | 50-59, 100-109 | 60-79 | 90-119, 150-159 | 100-109 |

TABLE 5. Stomach contents (% of total dry weight) of *Leiostomus xanthurus* relative to standard length groups.

| Food Item | Size (mm) | | | | | | | | | |
|-----------------------------------|-----------|-------|-------|-------|-------|-------|-------|-------|---------|-------------|
| | 20-29 | 30-39 | 40-49 | 50-59 | 60-69 | 70-79 | 80-89 | 90-99 | 100-109 | Avg. 20-109 |
| Sand grains | 0.3 | | 0.2 | 0.2 | | 0.3 | 2.1 | 1.6 | 0.3 | 0.2 |
| Sediment masses | | | | | 0.1 | < .1 | | | | 0.1 |
| Detritus | 19.7 | 21.4 | 14.5 | 12.5 | 11.8 | 27.2 | 33.4 | 33.0 | 14.4 | 16.3 |
| Plant remains | | | | | < .1 | | | | | < .1 |
| Rhynchocoels | | < .1 | | | | | | | | < .1 |
| Nematodes | 8.8 | 12.6 | 9.6 | 8.3 | 7.1 | 8.2 | 7.2 | 4.3 | 3.0 | 9.7 |
| Polychaetes | 37.2 | 12.4 | 12.3 | 12.4 | 15.6 | 23.2 | 22.6 | 17.4 | | 23.7 |
| Gastropods | | | | 0.3 | 0.4 | | | | | 0.2 |
| Bivalve siphons | | | 0.7 | 0.1 | | | | | 0.1 | < .1 |
| Bivalves | | 5.8 | 12.5 | 11.5 | 2.4 | 8.8 | 8.7 | 21.3 | 69.9 | 10.8 |
| Cladocerans | 0.2 | < .1 | | < .1 | | | | | | < .1 |
| Ostracods | | | | | < .1 | | | | | < .1 |
| Calanoid copepods | 5.2 | 5.6 | 1.1 | 3.6 | 5.1 | 3.8 | 7.0 | | | 4.7 |
| Harpacticoid copepods | 8.3 | 20.4 | 11.9 | 15.5 | 25.2 | 22.8 | 15.1 | 19.9 | 6.9 | 21.0 |
| Cumaceans | 0.2 | | | 0.3 | 0.6 | 0.4 | 1.4 | | | 0.4 |
| Isopods | | 0.2 | 0.1 | 0.3 | < .1 | | | | | 0.1 |
| Amphipods | 0.8 | 3.6 | 2.2 | 0.5 | 1.2 | 0.1 | < .1 | | 4.6 | 1.5 |
| Mysids | | 3.2 | 1.4 | 5.4 | 1.3 | 3.0 | 2.1 | 2.2 | 0.8 | 2.6 |
| Shrimp zoeae | | | | | < .1 | | | | | < .1 |
| Crab zoeae | | | < .1 | | < .1 | | | | | < .1 |
| Crab megalopae | | | < .1 | | | | | | | < .1 |
| Insect larvae | 19.3 | 12.9 | 32.8 | 28.8 | 28.3 | 2.0 | 0.6 | 0.2 | | 8.4 |
| Insects | | | 0.1 | < .1 | | | | | | < .1 |
| Unassigned invertebrate eggs | | < .1 | < .1 | < .1 | | | | | | < .1 |
| Fish eggs | | | < .1 | < .1 | < .1 | | | | | < .1 |
| Number of individuals | 62 | 175 | 237 | 184 | 91 | 96 | 37 | 15 | 6 | 903 |
| Number of samples (after pooling) | 4 | 11 | 15 | 17 | 11 | 13 | 5 | 3 | 1 | 80 |
| Number of dates (maximum = 6) | 1 | 2 | 3 | 3 | 3 | 6 | 4 | 3 | 1 | 6 |
| Number of stations (maximum = 10) | 4 | 7 | 7 | 9 | 6 | 7 | 4 | 2 | 1 | 10 |

to 70-99 mm spot, while bivalves were important to 90-109 mm individuals. Harpacticoid copepods and nematodes were utilized by all size classes of spot.

Comparative diet analysis (Table 6) indicated that spot, with few exceptions, fed in a similar pattern in all size classes. The exceptions included 20-29 mm individuals whose diet (high in polychaetes, low in bivalves and harpacticoid copepods) was not significantly correlated with the diets of spot larger than 70 mm, and 100-109 mm individuals, whose diet (dominated by bivalves) was not significantly correlated with any other size class.

Interstation comparison of spot diets (Table 7) showed two feeding patterns in the estuary. Food items over shallow, low salinity, nearshore sites (stations 3, 5, 5A, 6) included mainly insect larvae, bivalves, and detritus. Spot fed primarily upon polychaetes and harpacticoid copepods at the deeper, higher

salinity sites (stations 1A, 1B, 1C, 1, 2, 4).

There were no obvious temporal trends in the spot diet (Table 8). June was the only month that insect larvae dominated the spot diet (63%), as fish were collected mainly in East Bay. Polychaetes were the major food items in April and August, harpacticoid copepods were important in April, May and October, and bivalves and detritus became important in October and November.

Cynoscion arenarius

A total of 1,545 sand seatrout stomachs, collected May-October, 1976, was examined. These formed 122 samples after pooling by size class. Twenty-one percent of the stomachs examined were empty. Trout fed mainly upon juvenile fishes (62%) and mysids (26%) (Table 9). Seventy-eight percent of the identifiable fishes were anchovies (*Anchoa mitchilli*). *Mysidopsis bahia* was the most frequently occurring mysid in sand seatrout stomachs. There was a clear trophic

TABLE 6. Intraspecific comparison of the diets of *Leiostomus xanthurus* size classes using the Spearman Rank Correlation Coefficient (r_s). Other information as in Table 2.

| | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|----|--------|--------|--------|--------|--------|--------|--------|------|
| 20 | .710** | .790** | .640* | .724** | .528 | .527 | .315 | .021 |
| 30 | | .888** | .938** | .901** | .767** | .636* | .627* | .373 |
| 40 | | | .870** | .802** | .733** | .615* | .721** | .503 |
| 50 | | | | .943** | .802** | .671** | .722** | .455 |
| 60 | | | | | .762** | .609* | .571* | .243 |
| 70 | | | | | | .952** | .836** | .364 |
| 80 | | | | | | | .836** | .407 |
| 90 | | | | | | | | .604 |

ontogeny in sand seatrout: mysids and calanoid copepods dominated the diet of small individuals but decreased in importance with growth as a rapid, concurrent switch to piscivory occurred.

Comparative diet analysis (Table 10) also indicated gradual changes in sand seatrout feeding patterns with growth. Diets of 10-19 mm fish (dominated by

mysids) correlated only with 20-39 mm diets, and 80-89 mm diets (dominated by fishes) correlated only with diets of fish larger than 40 mm, while other size classes generally graded into each other.

Interstation comparison of trout diets (Table 11) indicated a gradation from heavy utilization of mysids to heavy

TABLE 7. Stomach contents (% of total dry weight) of *Leiostomus xanthurus* relative to collection site.

| Food Item | Station | | | | | | | | | |
|-----------------------------------|---------|-------|-------|-------|-------|-------|-------|--------|-------|-------|
| | 1A | 1B | 1C | 1 | 2 | 3 | 4 | 5 | 5A | 6 |
| Sand grains | | | | | | 0.4 | | 0.3 | 1.2 | 0.6 |
| Sediment masses | 0.5 | | | | | | | | | |
| Detritus | 12.5 | 14.4 | 12.7 | 9.2 | 17.8 | 20.8 | 14.3 | 31.1 | 25.0 | 14.1 |
| Plant remains | | | | | | | | | | < .1 |
| Rhynchocoels | | | | | 0.2 | | | | | |
| Nematodes | 5.0 | 3.2 | 17.2 | 14.3 | 6.7 | 9.7 | 10.6 | 4.7 | 2.1 | 9.6 |
| Polychaetes | 40.5 | 47.5 | 6.8 | 36.7 | 18.9 | 28.9 | 55.5 | 4.0 | 24.0 | 4.2 |
| Gastropods | | | | | | < .1 | | 0.1 | 0.9 | 0.6 |
| Bivalve siphons | | | | | 1.7 | | | | | |
| Bivalves | | | 0.1 | 1.4 | < .1 | 1.6 | | 41.6 | 17.6 | 15.8 |
| Cladocerans | | | | | 0.2 | | | | | < .1 |
| Ostracods | | | | | | | | | | < .1 |
| Calanoid copepods | 6.4 | 1.9 | 5.2 | 5.6 | 4.1 | | 8.0 | 0.7 | 1.6 | 0.5 |
| Harpacticoid copepods | 33.0 | 29.2 | 57.3 | 27.4 | 25.2 | 9.0 | 9.1 | 10.0 | 10.3 | 4.3 |
| Cumaceans | 1.4 | 2.1 | < .1 | 0.7 | 0.2 | | 0.1 | | | < .1 |
| Isopods | | | | | 1.0 | | 0.4 | < .1 | < .1 | 0.2 |
| Amphipods | | 0.3 | 0.1 | 0.3 | 12.5 | 1.0 | | 2.1 | 0.8 | 2.3 |
| Mysids | 0.7 | 1.3 | 0.4 | 4.3 | 6.5 | 0.7 | | 1.0 | 0.9 | 3.8 |
| Shrimp zoeae | | | | | | | | | 0.2 | |
| Crab zoeae | | | | | | 0.4 | | | | |
| Crab megalopae | | | | | | 0.4 | | | | |
| Insect larvae | | | | | 4.2 | 27.1 | 2.0 | 4.2 | 15.5 | 43.4 |
| Insects | | | | | | | | | | 0.2 |
| Unassigned invertebrate eggs | | | | | 0.4 | | | | | |
| Fish eggs | | | 0.1 | | 0.4 | | | | | |
| Number of individuals | 43 | 31 | 58 | 84 | 61 | 68 | 15 | 167 | 160 | 216 |
| Number of samples (after pooling) | 6 | 4 | 5 | 9 | 6 | 6 | 3 | 14 | 14 | 13 |
| Number of dates (maximum = 6) | 2 | 3 | 3 | 2 | 2 | 3 | 1 | 4 | 4 | 4 |
| Size classes examined (mm SL) | 50-89 | 50-79 | 50-79 | 30-79 | 30-59 | 30-59 | 20-49 | 20-59, | 20-99 | 20-89 |
| | | | | | | | | 70-109 | | |

TABLE 8. Stomach contents (% of total dry weight) of *Leiostomus xanthurus* relative to month of collection.

| Food Item | Month | | | | | |
|-----------------------------------|-------|-------|-------|-------|-------|--------|
| | Apr. | May | June | Aug. | Oct. | Nov. |
| Sand grains | < .1 | | 0.4 | 2.0 | 2.0 | 0.3 |
| Sediment masses | | 0.1 | | | | |
| Detritus | 11.0 | 18.7 | 11.1 | 20.9 | 31.2 | 32.0 |
| Plant remains | | | < .1 | | | |
| Rhynchocoels | < .1 | | | | | |
| Nematodes | 11.7 | 9.5 | 1.4 | 0.4 | 11.8 | 6.2 |
| Polychaetes | 38.6 | 3.9 | 1.3 | 62.0 | 6.2 | 0.3 |
| Gastropods | 0.2 | 0.4 | 0.1 | | | |
| Bivalve siphons | 0.2 | | | | | |
| Bivalves | 2.8 | 10.8 | 12.0 | 8.4 | 21.8 | 44.9 |
| Cladocerans | < .1 | | < .1 | | | |
| Ostracods | | < .1 | | | | |
| Calanoid copepods | 2.0 | 10.3 | 1.5 | | | |
| Harpacticoid copepods | 26.0 | 25.6 | 7.6 | 5.1 | 19.4 | 12.3 |
| Cumaceans | 0.5 | 0.7 | < .1 | | | |
| Isopods | 0.1 | 0.1 | 0.2 | | | |
| Amphipods | 1.4 | 1.9 | 0.3 | | | 2.8 |
| Mysids | < .1 | 9.2 | 0.9 | | 3.8 | 1.3 |
| Shrimp zoeae | | < .1 | | | | |
| Crab zoeae | | < .1 | | | | |
| Crab megalopae | | < .1 | | | | |
| Insect larvae | 5.3 | 8.3 | 62.9 | 1.2 | 3.8 | |
| Insects | | 0.1 | | | | |
| Unassigned invertebrate eggs | < .1 | | | | | |
| Fish eggs | < .1 | < .1 | | | | |
| Number of individuals | 396 | 322 | 91 | 23 | 46 | 25 |
| Number of samples (after pooling) | 31 | 27 | 10 | 3 | 5 | 4 |
| Number of stations (maximum = 10) | 10 | 9 | 5 | 1 | 2 | 1 |
| Size classes examined (mm SL) | 20-79 | 30-89 | 40-79 | 70-99 | 70-99 | 70-109 |

utilization of fishes. Calanoid copepods (*Acartia* spp.) were important to small trout feeding at stations 3 and 4, while crab zoeae (*Rhithropanopeus harrisi*) were significant diet additions on station 5A. Highest fish consumption by trout occurred near the passes of the estuary (stations 1A, 1B, 1C), while mysids were relatively more important in low salinity East Bay (stations 3, 5A, 6) as well as mesohaline stations 1 and 4.

Temporal diet analysis (Table 12) revealed that during August and September trout consumed less juvenile fishes and relatively more mysids, shrimp, crab zoeae, and calanoid copepods than during other months. Sand seatrout collected during these two months were mainly taken in East Bay, where crustaceans were evidently more

abundant or more susceptible to predation than fishes.

Interspecific Diet Comparisons

To examine the extent of trophic overlap, the average diet over all size classes and the diets of individual size classes were compared among the three sciaenids. The overall correlation coefficients (based on the final columns of Tables 1, 5, and 9) were as follows: croaker vs spot, $r_s = 0.160$; croaker vs sand seatrout, $r_s = -0.202$; spot vs sand seatrout, $r_s = -10.427$. None of the coefficients was significant ($P < .05$), indicating little trophic overlap in the broad sense. However, this analysis gave no indication of the relationships among the various size classes and species.

Some degree of trophic similarity

TABLE 9. Stomach contents (% of total dry weight) of *Cynoscion arenarius* relative to standard length groups.

| Food Item | Size (mm) | | | | | | | | |
|-----------------------------------|-----------|-------|-------|-------|-------|-------|-------|-------|------------|
| | 10-19 | 20-29 | 30-39 | 40-49 | 50-59 | 60-69 | 70-79 | 80-89 | Avg. 10-89 |
| Detritus | | | < .1 | | | | | | < .1 |
| Polychaetes | | | < .1 | | | | | | < .1 |
| Calanoid copepods | 18.7 | 14.7 | 6.1 | 2.9 | 0.8 | 0.2 | | | 2.9 |
| Parasitic copepods | | | 0.1 | | < .1 | | 0.3 | | < .1 |
| Isopods | | | < .1 | < .1 | 0.2 | | | | < .1 |
| Amphipods | | 1.7 | 1.4 | 1.5 | 1.2 | 0.5 | 0.3 | | 1.1 |
| Mysids | 72.9 | 65.3 | 46.0 | 33.1 | 14.2 | 10.7 | 7.8 | | 25.7 |
| Shrimp zoeae | | 0.2 | 0.8 | 1.7 | 0.3 | 0.2 | | | 0.6 |
| Shrimp postlarvae | 8.4 | 0.9 | 3.2 | 0.6 | 0.3 | 0.2 | | | 0.8 |
| Shrimp | | | 3.4 | 3.1 | 7.9 | 2.7 | | | 4.0 |
| Crab zoeae | | 0.9 | 3.6 | 4.2 | 1.4 | 0.6 | | | 2.0 |
| Crab megalopae | | | 0.1 | < .1 | 0.2 | < .1 | 0.6 | | 0.1 |
| Crabs | | | < .1 | 0.3 | 0.2 | < .1 | | | 0.2 |
| Unassigned decapod larvae | | < .1 | | | | | | | < .1 |
| Insect larvae | | < .1 | 0.3 | 0.2 | < .1 | | | | 0.1 |
| Insects | | | | 0.1 | < .1 | | | | < .1 |
| Fish larvae | | 0.2 | < .1 | < .1 | | | | | < .1 |
| Fish | | 16.2 | 34.2 | 52.0 | 73.3 | 84.9 | 91.0 | 100.0 | 62.1 |
| Number of individuals | 56 | 404 | 544 | 286 | 181 | 49 | 21 | 4 | 1545 |
| Number of samples (after pooling) | 5 | 30 | 34 | 25 | 18 | 6 | 3 | 1 | 122 |
| Number of dates (maximum = 7) | 4 | 6 | 7 | 7 | 6 | 4 | 3 | 1 | 7 |
| Number of stations (maximum = 10) | 2 | 9 | 9 | 9 | 7 | 4 | 3 | 1 | 10 |

between croakers and spot was suspected since polychaetes were the dominant food of both species (Tables 1 and 5). The sieve fractionation technique employed herein indicated that not only do croakers eat larger food items in general but also eat larger polychaetes (Table 13). Interspecific comparison by size classes (Table 14) demonstrated significant ($P < .05$) diet correlation between 10-59 mm croakers and 20-79 mm spot in 22/30 comparisons, but no correlation among larger size classes. The results of other

interspecific size class comparisons demonstrated only one significant correlation (of a possible 104) between sand seatrout and croaker (80-89 mm and 100-109 mm, respectively, $P < .05$), and no significant correlations (of a possible 64) between sand seatrout and spot size classes.

DISCUSSION

The food habits of the three sciaenid fishes examined in this study are in general agreement with results of pre-

TABLE 10. Intraspecific comparison of the diets of *Cynoscion arenarius* size classes using the Spearman Rank Correlation Coefficient (r_s). Other information as in Table 2.

| | 20 | 30 | 40 | 50 | 60 | 70 | 80 |
|----|-------|--------|--------|--------|--------|------|-------|
| 10 | .619* | .639* | .395 | .377 | .024 | .009 | -.400 |
| 20 | | .774** | .668* | .666* | .483 | .348 | .583 |
| 30 | | | .891** | .864** | .866** | .227 | .577 |
| 40 | | | | .913** | .936** | .257 | .625* |
| 50 | | | | | .993** | .364 | .636* |
| 60 | | | | | | .324 | .690* |
| 70 | | | | | | | .775* |

TABLE 11. Stomach contents (% of total dry weight) of *Cynoscion arenarius* relative to collection site.

| Food Item | Station | | | | | | | | | |
|-----------------------------------|---------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | 1A | 1B | 1C | 1 | 2 | 3 | 4 | 5 | 5A | 6 |
| Detritus | | | | | < .1 | | | | | |
| Polychaetes | | | | | | | 3.3 | | | |
| Calanoid copepods | 3.0 | | 0.3 | 2.5 | 2.4 | 23.8 | 14.0 | 1.8 | 2.9 | 2.6 |
| Parasitic copepods | | | | | < .1 | | < .1 | < .1 | < .1 | |
| Isopods | | | < .1 | | < .1 | | | 0.2 | | 0.1 |
| Amphipods | < .1 | | | 0.2 | 2.0 | 5.9 | 0.2 | 0.8 | 1.6 | 1.3 |
| Mysids | 17.5 | 1.3 | 2.0 | 62.1 | 26.3 | 57.5 | 47.4 | 16.0 | 35.2 | 39.8 |
| Shrimp zoeae | | | | | 0.1 | 1.4 | 1.0 | 0.1 | 4.6 | |
| Shrimp postlarvae | 0.7 | 2.6 | .1 | 0.8 | 1.3 | 2.2 | | | < .1 | 5.5 |
| Shrimp | | | 2.0 | | 2.7 | | 2.3 | 7.3 | 8.9 | 0.4 |
| Crab zoeae | | | | | | | 0.9 | 1.1 | 16.1 | |
| Crab megalopae | 0.2 | | | | 0.3 | | | 0.1 | | < .1 |
| Crabs | | | | | 0.5 | | | < .1 | 0.2 | |
| Unassigned decapod larvae | | | | | | < .1 | | | | |
| Insect larvae | | | | | 0.2 | 1.4 | | < .1 | < .1 | |
| Insects | | | | | | | | < .1 | | 0.5 |
| Fish larvae | | | 0.2 | | | | | 0.1 | | |
| Fish | 78.4 | 96.1 | 95.4 | 34.4 | 64.0 | 7.8 | 30.8 | 72.1 | 30.4 | 51.2 |
| Number of individuals | 24 | 6 | 85 | 137 | 237 | 134 | 209 | 360 | 165 | 188 |
| Number of samples (after pooling) | 5 | 1 | 9 | 9 | 22 | 11 | 16 | 24 | 9 | 16 |
| Number of dates (maximum = 7) | 2 | 1 | 3 | 3 | 6 | 4 | 6 | 7 | 3 | 5 |
| Size classes examined (mm SL) | 20-59 | 60-69 | 20-79 | 20-49 | 20-89 | 20-49 | 20-59 | 10-79 | 20-69 | 10-59 |

vious investigations in other estuaries. Qualitative and quantitative studies on the food of *M. undulatus* indicate that this species preys mainly upon epibenthic and infaunal organisms (polychaetes, molluscs, amphipods, mysids, decapods, fishes) but has initial planktivorous stages (Roelofs, 1954; Darnell, 1958; Springer and Woodburn, 1960; Fontenot and Rogillio, 1970; Parker,

1971). Stickney *et al.* (1975) found harpacticoid copepods to be very important to croakers smaller than 100 mm in length along the southeastern U. S. coast. The present study found harpacticoids important only to 10-29 mm croakers. *L. xanthurus* has feeding habits similar to those of croakers although smaller food items are apparently consumed (Roelofs, 1954;

TABLE 12. Stomach contents (% of total dry weight) of *Cynoscion arenarius* relative to month of collection.

| Food Item | Month | | | | | | |
|-----------------------------------|-------|-------|-------|-----------------|-------|-----------------|-------|
| | May | June | July | Aug. | Sept. | Oct. | Nov. |
| Detritus | | | < .1 | | | | |
| Polychaetes | | | | 0.6 | | | |
| Calanoid copepods | 0.7 | 1.0 | 3.0 | 6.1 | 6.9 | 3.2 | |
| Parasitic copepods | | | < .1 | < .1 | 0.2 | 0.2 | |
| Isopods | | < .1 | | 0.3 | | | |
| Amphipods | 0.2 | 0.6 | 2.4 | 1.9 | 2.0 | 0.3 | |
| Mysids | 38.5 | 11.1 | 19.9 | 29.5 | 58.7 | 33.8 | 12.2 |
| Shrimp zoeae | | | | 2.8 | 0.2 | | |
| Shrimp postlarvae | 0.3 | 1.0 | 3.2 | | 0.2 | | |
| Shrimp | | 2.3 | 2.9 | 12.2 | 4.7 | 0.5 | |
| Crab zoeae | 0.2 | | | 9.3 | | | |
| Crab megalopae | < .1 | | | < .1 | 0.4 | 0.7 | |
| Crabs | | | | 0.1 | 1.6 | | |
| Unassigned decapod larvae | | < .1 | | | | | |
| Insect larvae | 0.2 | 0.2 | | < .1 | | | |
| Insects | | | < .1 | 0.2 | | | |
| Fish larvae | | | | < .1 | | 0.4 | |
| Fish | 59.8 | 83.6 | 68.4 | 36.5 | 25.1 | 60.9 | 87.8 |
| Number of individuals | 162 | 407 | 161 | 341 | 106 | 357 | 11 |
| Number of samples (after pooling) | 15 | 29 | 15 | 24 | 10 | 27 | 2 |
| Number of stations (maximum = 10) | 7 | 9 | 5 | 6 | 4 | 8 | 1 |
| Size classes examined (mm SL) | 20-69 | 20-79 | 10-59 | 10-69, 80-89 | 10-79 | 10-59, 70-79 | 30-49 |

Reid, 1954; Darnell, 1958; Springer and Woodburn, 1960; Parker, 1971; Kjelson *et al.*, 1975; Stickney *et al.*, 1975). Previous studies of *C. arenarius* are almost identical with the results of the present investigation. Sand seatrout consumed copepods, mysids, and larval fishes when small and primarily fishes when larger (Reid, 1954; Darnell, 1958; Springer and Woodburn, 1960). Darnell also found that trout prey heavily upon bay anchovies (*A. mitchilli*).

Examination of stomach contents of fishes by the sieve fractionation technique, developed by Carr and Adams (1972, 1973), yields not only quantitative analysis of food habits but information on the food particle size spectra ingested by the fishes, particularly in fishes which swallow their prey whole or do not masticate their prey to any great extent. This was found to be quite useful in comparing the food habits of the two benthic feeders (croaker and spot) in Apalachicola Bay. Both species had similar spatial and temporal patterns in utilization of the estuary and relied upon polychaetes as their main food item, thus giving the appearance of classic exploitative competitors. However, major differences in food type and size were documented by this investigation even though the smaller size classes of these

two fishes have similar diets. Sand seatrout were found to be water-column predators whose diet rarely correlates with those of the benthic feeders. Thus, trophic resource partitioning, based on food type and food particle size, may be the principal factor in allowing three closely related species of fishes to co-exist in the estuary.

ACKNOWLEDGMENTS

I would like to thank Dr. Robert J. Livingston, Department of Biological Science, Florida State University, for his support during this study and for permitting access to unpublished data. Portions of the data collected were funded by NOAA, Office of Sea Grant, Department of Commerce, under Grant No. 04-3-158-43, while data analysis was supported by EPA Program Element No. 1BA025 under Grant No. R-803339, both to Dr. R. J. Livingston.

LITERATURE CITED

- Carr, W. E. S. and C. A. Adams. 1972. Food habits of juvenile marine fishes: evidence of the cleaning habit in the leatherjacket, *Oligoplites saurus*, and the spottail pinfish, *Diplodus holbrooki*. Fishery Bull. 70:1111-1120.
- 1973.

TABLE 13. Mean particle size distribution (% of total dry weight) of stomach contents of *Micropogonias undulatus* and *Leiostomus xanthurus* over all collections.

| | Particle size (μ) | | | | | |
|---------------------|-------------------------|------|------|------|------|------|
| | 2000 | 850 | 425 | 250 | 150 | 75 |
| | All Food Items | | | | | |
| <i>M. undulatus</i> | 28.2 | 28.5 | 17.8 | 11.0 | 8.3 | 6.2 |
| <i>L. xanthurus</i> | 2.6 | 14.5 | 26.4 | 25.6 | 20.6 | 10.3 |
| | Polychaetes Only | | | | | |
| <i>M. undulatus</i> | 44.1 | 39.7 | 14.4 | 1.6 | 0.2 | 0.0 |
| <i>L. xanthurus</i> | 11.5 | 38.3 | 44.4 | 5.6 | 0.2 | 0.0 |

TABLE 14. Interspecific comparison of the diets of *Micropogonias undulatus* and *Leiostomus xanthurus* size classes using the Spearman Rank Correlation Coefficient (r_s). Other information as in Table 2.

| | <i>L. xanthurus</i> | | | | | | | | | |
|---------------------|---------------------|-------|-------|--------|--------|--------|-------|-------|-------|-------|
| | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | |
| <i>M. undulatus</i> | 10 | .614* | .633* | .653* | .796** | .845** | .588* | .385 | .268 | -.011 |
| | 20 | .635* | .670* | .693** | .760** | .803** | .582* | .410 | .329 | .191 |
| | 30 | .459 | .510* | .601* | .568* | .569* | .507* | .343 | .318 | .200 |
| | 40 | .379 | .463 | .535* | .432 | .444 | .378 | .275 | .285 | .085 |
| | 50 | .430 | .504* | .524* | .508* | .488* | .395 | .306 | .285 | .070 |
| | 60 | .303 | .386 | .361 | .316 | .426 | .294 | .229 | .173 | .012 |
| | 70 | .132 | .113 | .059 | .109 | .133 | .133 | .185 | .162 | -.025 |
| | 80 | .053 | -.199 | -.130 | -.059 | -.059 | -.034 | -.037 | -.089 | -.213 |
| | 90 | -.029 | -.121 | -.016 | -.085 | -.204 | .047 | .095 | -.026 | -.367 |
| | 100 | .012 | -.224 | -.216 | -.051 | -.196 | -.138 | -.106 | -.185 | -.441 |
| | 110 | -.107 | -.273 | -.182 | -.076 | -.133 | -.234 | -.169 | -.189 | -.346 |
| | 120 | .091 | -.139 | .107 | .172 | .027 | -.098 | .098 | -.064 | -.446 |
| | 150 | -.015 | -.151 | -.071 | .011 | -.016 | -.007 | -.026 | -.189 | -.466 |

Food habits of juvenile marine fishes occupying seagrass beds in the estuarine zone near Crystal River, Florida. *Trans. Amer. Fish. Soc.* 102:511-540.

_____ 1978. A basis for classifying Western Atlantic Sciaenidae (Teleostei: Perciformes). NOAA Tech. Rep. NMFS Circ. 415:1-64.

Chao, L. N. and J. A. Musick. 1977. Life history, feeding habits, and functional morphology of juvenile sciaenid fishes in the York River estuary, Virginia. *Fishery Bull.* 75: 657-702.

Darnell, R. M. 1958. Food habits of fishes and larger invertebrates of Lake Ponchartrain, Louisiana, an estuarine community. *Publ. Mar. Sci. Univ. Texas* 5:353-416.

Fontenot, B. J. and H. E. Rogillio. 1970. A study of estuarine sport fishes in the Biloxi marsh complex, Louisiana. *La. Wildl. Fish. Comm., F-8 Compl. Rept.* 172 p.

Fritz, E. S. 1974. Total diet comparison in fishes by Spearman Rank Correlation Coefficients. *Copeia* 1974: 210-214.

Haedrich, R. L. and S. O. Haedrich. 1974. A seasonal survey of the fishes in the Mystic River, a polluted estuary in downtown Boston, Massachusetts. *Est. Coastal Mar. Sci.* 2:59-73.

Kjelson, M. A., D. S. Peters, G. W. Thayer, and G. N. Johnson. 1975. The general feeding ecology of post-larval fishes in the Newport River estuary. *Fishery Bull.* 73:137-144.

Kravitz, M. J., W. G. Pearcy, and M. P. Guin. 1976. Food of five species of co-occurring flatfishes on Oregon's continental shelf. *Fishery Bull.* 74: 984-990.

Livingston, R. J., R. L. Iverson, R. H. Estabrook, V. E. Keys, and J. Taylor, Jr. 1974. Major features of the Apalachicola Bay system: physiography, biota, and resource management. *Fla. Scientist* 37:245-271.

_____, and E. A. Joyce, Jr. 1977. Proceedings of the conference on the Apalachicola drainage system. *Fla. Dept. Nat. Res., Mar. Res. Publ.* 26. 177 p.

_____, G. J. Kobylinski, F. G. Lewis, III, and P. F. Sheridan. 1976. Long-term fluctuations of epibenthic fish and invertebrate populations in Apalachicola Bay, Florida. *Fishery Bull.* 74:311-321.

_____, P. F. Sheridan, B. G. McLane, F. G. Lewis, III, and G. J. Kobylinski. 1977. The biota of the Apalachicola Bay system: functional relationships. *In* Livingston, R. J. and E. A. Joyce (eds.), *Proceedings of*

- the conference on the Apalachicola drainage system. Fla. Dept. Nat. Res., Mar. Res. Publ. 26:75-100.
- Oviatt, C. A. and S. W. Nixon. 1973. The demersal fish of Narragansett Bay: an analysis of community structure, distribution, and abundance. Est. Coastal Mar. Sci. 1: 361-378.
- Parker, J. C. 1971. The biology of the spot, *Leiostomus xanthurus* Lacepede, and Atlantic croaker, *Micropogon undulatus* (Linnaeus), in two Gulf of Mexico nursery areas. Texas A & M Univ., Sea Grant Publ. No. TAMU-SG-71-210. 182 p.
- Reid, G. K., Jr. 1954. An ecological study of the Gulf of Mexico fishes in the vicinity of Cedar Key, Florida. Bull. Mar. Sci. Gulf Caribb. 4:1-94.
- Roelofs, E. W. 1954. Food studies of young sciaenid fishes, *Micropogon* and *Leiostomus*, from North Carolina. Copeia 1954:151-153.
- Ross, S. T. 1977. Patterns of resource partitioning in searobins (Pisces: Tri- glidae). Copeia 1977:561-571.
- Schoener, T. W. 1974. Resource partitioning in ecological communities. Science 185:27-39.
- Sokal, R. R. and F. J. Rohlf. 1969. Biometry. W. H. Freeman and Co., San Francisco. 776 p.
- Springer, V. G. and K. D. Woodburn. 1960. An ecological study of the fishes of the Tampa Bay area. Fla. Dept. Nat. Res., Mar. Res. Lab. Prof. Papers Ser., No. 1. 104 p.
- Stickney, R. R., G. L. Taylor, and R. W. Heard, III. 1974. Food habits of Georgia estuarine fishes. I. Four species of flounders (Pleuronectiformes: Bothidae). Fishery Bull. 72:515-525.
- _____, G. L. Taylor, and D. B. White. 1975. Food habits of five species of young Southeastern United States estuarine Sciaenidae. Chesapeake Sci. 16:104-114.
- Tyler, A. V. 1972. Food resource division among northern, marine demersal fishes. J. Fish. Res. Bd. Can. 29: 997-1003.