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FOOD CONTENTS OF SIX COMMERCIAL FISHES FROM MISSISSIPPI SOUND¹

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ABSTRACT Specific dietary contents from six fishes collected in Mississippi Sound are recorded. In order of their importance, primary components grouped in major taxonomic categories were fishes, penaeid shrimps, and other crustaceans for *Cynoscion nebulosus*; crustaceans and fishes for *C. arenarius*; fishes and crustaceans for *C. nothus*; crustaceans, pelecypods, and polychaetes for *Pogonias cromis*; crustaceans, molluscs, polychaetes, and fishes for *Archosargus probatocephalus*; and fishes and penaeid shrimps for *Paralichthys lethostigma*. Principal items in the diets of most of the fishes included *Anchoa mitchilli*, *Penaeus aztecus*, *P. setiferus*, and *Callinectes sapidus*. Those crustaceans show that competition exists for commercial shellfishes in Mississippi Sound. Ratios among the different dietary items vary, according at least to species of fish, length of fish, season, specific location, and abundance of available prey. Some of these variations are documented and are additionally related to selected findings by other authors sampling different localities. We suggest that examination of food items in *Archosargus probatocephalus* can serve as a practical means to sample and assess seasonal prevalence and abundance of a wide range of invertebrates throughout different habitats in Mississippi Sound and elsewhere.

INTRODUCTION

Mississippi Sound offers a variety of habitats in which commercial fishes can feed. Examination of food contents of the red drum and Atlantic croaker (Overstreet and Heard 1978a, 1978b) has already indicated that those two fishes feed on organisms from a number of different habitats in and adjacent to the Sound. This paper lists specific food contents of the spotted seatrout, *Cynoscion nebulosus*; sand seatrout, *C. arenarius*; silver seatrout, *C. nothus*; black drum, *Pogonias cromis*; sheepshead, *Archosargus probatocephalus*; and southern flounder, *Paralichthys lethostigma*, for the first time from Mississippi Sound. Knowledge concerning the food of these fishes, based on ontogenetic, temporal, and spatial relationships, allows a better perception of predator biology and, consequently, provides a better means to manage the respective fisheries. Our information demonstrates that commercial finfishes competed for prey. Prey often constituted one of several commercially important fin- or shellfishes. We also present pertinent references that deal with food and feeding habits of the six fishes.

MATERIALS AND METHODS

Most of the fish were collected by trammel nets and examined specifically for food contents. Others were caught by trawl or by hook and line, and the contents were removed from some while examining those fish for other purposes. All fish were maintained on ice until examined. Their stand-

ard lengths (SL) were measured and their food contents either identified when removed or placed in 10% formalin for future identification. Rather than being restricted solely to environmentally derived, microbially degraded, organic matter, the term "detritus" in this paper may include also partially digested animals or plants.

RESULTS

The number of each fish species examined and the number containing food are listed in Table 1 along with the frequency of occurrence of specific dietary items for each fish. The sheepshead, which fed on a minimum of 113 identifiable items, had the most diverse diet. Specific data combined into general taxonomic groups, when sample size of the six predators was sufficient, reveal differences in food contents according to length of fish and season (Tables 2-6).

Fishes and crustaceans occurred frequently in the diets of all three seatrouts, with about twice as many fish as crustaceans in both *C. nebulosus* and *C. nothus* (Table 2). A greater percentage of *C. arenarius* had crustaceans present when compared with percentages for the other two seatrouts, and the percentage increased with fish-length.

Seasonality influenced the diet of *C. nebulosus* as exemplified by the presence of the often abundant bay anchovy, *Anchoa mitchilli*. The bay anchovy occurred infrequently in the seatrout's food contents during spring when other fishes were common prey (Table 3). The spotted seatrout, especially large individuals, contained more polychaetes during winter than during other seasons; "detritus" also occurred commonly in the seatrout's stomach and intestine during that period.

Both *Pogonias cromis* and *Archosargus probatocephalus* fed on a great variety of dietary items, especially benthic ones. The diet of *A. probatocephalus* was influenced by whether the sheepshead was feeding near barrier islands

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TABLE 1.
Percentage of occurrence of different food items in the digestive tracts of selected fishes from Mississippi Sound.

Food item	Species of fish						
	<i>Cynoscion nebulosus</i>	<i>Cynoscion arenarius</i>	<i>Cynoscion nothus</i>	<i>Pogonias cromis</i>	<i>Archosargus probatocephalus</i> Inshore	<i>Archosargus probatocephalus</i> Near islands	<i>Paralichthys lethostigma</i>
Number fish examined	373	108	25	15	77	65	212
Number fish with food	340	74	12	15	63	62	97
Food item	Percentage of occurrence in fish with food item						
Foraminiferan (unidentified)	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Cnidarians							
<i>Calliactis tricolor</i>	0.0	0.0	0.0	0.0	0.0	3.2	0.0
<i>Clione</i> sp.	0.0	0.0	0.0	0.0	0.0	1.6	0.0
Hydroid remains	0.3	0.0	0.0	0.0	15.9	6.5	0.0
Unidentifiable coelenterate	0.0	0.0	0.0	0.0	0.0	1.6	0.0
Sipunculoidean	0.0	1.4	0.0	0.0	0.0	0.0	0.0
Polychaetes							
<i>Chaetopterus variopedatus</i>	0.0	0.0	0.0	0.0	0.0	6.5	0.0
<i>Chaetopterus</i> tube remains	0.0	0.0	0.0	0.0	0.0	3.2	0.0
<i>Diopatra cuprea</i>	0.6	0.0	0.0	0.0	1.6	11.3	0.0
<i>Glycera americana</i>	0.9	0.0	0.0	0.0	0.0	0.0	0.0
<i>Nereis (Neanthes) succinea</i>	5.6	0.0	0.0	6.7	15.9	0.0	0.0
<i>Nereis</i> sp. (unidentifiable)	1.5	0.0	0.0	0.0	0.0	3.2	0.0
<i>Pectinaria gouldii</i>	0.0	0.0	0.0	0.0	1.6	3.2	0.0
<i>Polyodontes lupina</i>	0.0	0.0	0.0	0.0	0.0	1.6	0.0
<i>Spiochaetopterus ocellatus</i>	0.0	0.0	0.0	0.0	0.0	3.2	0.0
<i>Sthenelais boa</i>	0.0	0.0	0.0	0.0	0.0	3.2	0.0
Unidentifiable maldanid	0.0	0.0	0.0	0.0	1.6	9.7	0.0
Unidentifiable polychaete	0.6	0.0	0.0	13.3	3.2	6.5	2.1
Gastropods							
<i>Anachis</i> cf. <i>obessa</i>	0.0	0.0	0.0	0.0	0.0	1.6	0.0
<i>Anachis</i> sp.	0.0	0.0	0.0	0.0	0.0	3.2	0.0
<i>Cantharus cancellarius</i>	0.0	0.0	0.0	0.0	0.0	3.2	0.0
<i>Crepidula plana</i>	0.0	0.0	0.0	0.0	3.2	1.6	0.0
<i>Crepidula</i> sp.	0.0	0.0	0.0	0.0	3.2	0.0	0.0
<i>Nassarius acutus</i>	0.0	0.0	0.0	0.0	7.9	21.0	0.0
<i>Neritina usnea</i>	0.3	0.0	0.0	0.0	0.0	0.0	0.0
<i>Olivella mutica</i>	0.0	0.0	0.0	0.0	0.0	1.6	0.0
<i>Oliva sayana</i>	0.0	0.0	0.0	0.0	0.0	3.2	0.0
<i>Polinices duplicata</i> egg case	0.0	0.0	0.0	0.0	0.0	4.8	0.0
<i>Seila</i> cf. <i>adamsi</i>	0.0	0.0	0.0	0.0	0.0	1.6	0.0
<i>Turbonilla</i> sp.	0.0	0.0	0.0	0.0	0.0	1.6	0.0
<i>Tectonatica pusilla</i>	0.0	0.0	0.0	0.0	0.0	3.2	0.0
Unidentifiable nudibranch	0.0	0.0	0.0	0.0	0.0	1.6	0.0
Unidentifiable gastropod	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Gastropod operculum	0.0	0.0	0.0	0.0	1.6	0.0	0.0
Pelecypods							
<i>Abra aequalis</i>	0.0	0.0	0.0	0.0	1.6	8.1	0.0
<i>Amygdalum papyria</i>	0.0	0.0	0.0	6.7	4.8	0.0	0.0
<i>Anadara transversa</i>	0.0	0.0	0.0	6.7	0.0	1.6	0.0
<i>Anadara</i> sp.	0.0	0.0	0.0	0.0	3.2	4.9	0.0
<i>Astarte nana</i>	0.0	0.0	0.0	0.0	0.0	1.6	0.0
<i>Atrina</i> sp.	0.0	0.0	0.0	0.0	0.0	1.6	0.0
<i>Brachidontes exustus</i>	0.0	0.0	0.0	0.0	1.6	0.0	0.0
<i>Dinocardium robustum</i>	0.0	0.0	0.0	0.0	0.0	6.5	0.0
<i>Diplothyra smithii</i>	0.0	0.0	0.0	0.0	1.6	0.0	0.0
<i>Dosinia discus</i>	0.0	0.0	0.0	0.0	0.0	3.2	0.0
<i>Ensis minor</i>	0.0	0.0	0.0	13.3	1.6	1.6	0.0

TABLE 1 – Continued
 Percentage of occurrence of different food items in the digestive tracts of selected fishes from Mississippi Sound.

	Species of fish						
	<i>Cynoscion nebulosus</i>	<i>Cynoscion arenarius</i>	<i>Cynoscion nothus</i>	<i>Pogonias cromis</i>	<i>Archosargus probatocephalus</i> Inshore	<i>Archosargus probatocephalus</i> Near islands	<i>Paralichthys lethostigma</i>
Number fish examined	373	108	25	15	77	65	212
Number fish with food	340	74	12	15	63	62	97
Food item	Percentage of occurrence in fish with food item						
<i>Gemma gemma</i>	0.0	0.0	0.0	0.0	0.0	1.6	0.0
<i>Geukensia demissa</i>	0.0	0.0	0.0	0.0	1.6	0.0	0.0
<i>Ischadium recurvum</i>	0.3	0.0	0.0	33.3	30.2	0.0	0.0
<i>Lyonsia hyalina</i>	0.0	0.0	0.0	0.0	0.0	3.2	0.0
<i>Martesia cuneiformis</i>	0.0	0.0	0.0	0.0	1.6	0.0	0.0
<i>Mercenaria</i> sp.	0.0	0.0	0.0	0.0	1.6	0.0	0.0
<i>Mulinia lateralis</i>	0.0	0.0	0.0	6.7	6.4	21.0	1.0
<i>Noetia ponderosa</i>	0.0	0.0	0.0	0.0	0.0	1.6	0.0
<i>Nuculana concentrica</i>	0.0	1.4	0.0	0.0	0.0	9.7	0.0
<i>Pandora trilineata</i>	0.0	0.0	0.0	6.7	0.0	9.7	0.0
<i>Semele proficua</i>	0.0	0.0	0.0	0.0	0.0	1.6	0.0
<i>Tagelus plebeius</i>	0.0	0.0	0.0	6.7	0.0	0.0	0.0
<i>Tellina</i> sp.	0.0	0.0	0.0	6.7	0.0	11.3	0.0
Unidentifiable bivalve parts	0.3	0.0	0.0	6.7	6.4	6.5	0.0
Squid							
<i>Lolliguncula brevis</i>	0.3	1.4	0.0	0.0	0.0	1.6	1.0
Barnacles							
<i>Balanus eburneus</i>	0.0	0.0	0.0	0.0	9.5	0.0	0.0
<i>Balanus</i> sp. (unidentifiable)	0.0	0.0	0.0	20.0	17.5	0.0	0.0
Unidentifiable barnacle	0.0	0.0	0.0	6.7	0.0	0.0	0.0
Stomatopod							
<i>Squilla empusa</i>	0.6	2.7	0.0	6.7	3.2	8.1	2.1
Mysidaceans							
<i>Bowmaniella</i> cf. <i>floridana</i>	0.6	0.0	0.0	0.0	0.0	0.0	0.0
<i>Mysidopsis almyra</i>	1.2	1.4	0.0	0.0	3.2	0.0	6.2
<i>Mysidopsis bahia</i>	0.0	0.0	0.0	0.0	1.6	0.0	0.0
Cumacean							
<i>Oxyurostylis</i> cf. <i>smithi</i>	0.0	0.0	0.0	0.0	0.0	1.6	0.0
Amphipods							
<i>Ampelisca</i> cf. <i>abdita</i>	0.3	0.0	0.0	0.0	0.0	0.0	0.0
<i>Ampelisca</i> sp.	0.9	0.0	0.0	0.0	0.0	3.2	2.1
<i>Ampithoe</i> sp.	0.6	0.0	0.0	0.0	0.0	1.6	0.0
<i>Cerapus benthophilus</i> with tubes	0.0	0.0	0.0	6.7	1.6	0.0	0.0
<i>Cerapus</i> sp. (unidentifiable)	0.3	0.0	0.0	0.0	3.2	0.0	1.0
<i>Corophium lacustre</i>	0.0	0.0	0.0	0.0	14.3	0.0	0.0
<i>Corophium louisiananum</i>	0.0	0.0	0.0	13.3	1.6	0.0	0.0
<i>Erichthonius brasiliensis</i>	0.0	0.0	0.0	0.0	0.0	1.6	0.0
<i>Lepidactylus</i> sp.	0.0	0.0	0.0	0.0	0.0	1.6	0.0
<i>Melita</i> spp.	0.3	0.0	0.0	6.7	1.6	1.6	2.1
<i>Microprotopus</i> cf. <i>raneyi</i>	0.0	0.0	0.0	0.0	0.0	1.6	0.0
<i>Monoculodes</i> sp.	0.0	0.0	0.0	0.0	0.0	1.6	0.0
<i>Paracaprella tenuis</i>	0.0	0.0	0.0	0.0	0.0	1.6	0.0
Unidentifiable amphipod remains	0.6	0.0	0.0	0.0	0.0	1.6	0.0
Unidentifiable haustorid	0.3	0.0	0.0	6.7	0.0	0.0	0.0
Tanaidaceans							
<i>Apseudes</i> sp.	0.6	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 1 - Continued

Percentage of occurrence of different food items in the digestive tracts of selected fishes from Mississippi Sound.

	Species of fish						
	<i>Cynoscion nebulosus</i>	<i>Cynoscion arenarius</i>	<i>Cynoscion nothus</i>	<i>Pogonias cromis</i>	<i>Archosargus probatocephalus</i> Inshore	<i>Archosargus probatocephalus</i> Near islands	<i>Paralichthys lethostigma</i>
Number fish examined	373	108	25	15	77	65	212
Number fish with food	340	74	12	15	63	62	97
Food item	Percentage of occurrence in fish with food item						
<i>Hargeria rapax</i>	0.6	0.0	0.0	0.0	0.0	0.0	0.0
Isopods							
<i>Aegathoa</i> sp.	0.3	0.0	0.0	0.0	0.0	0.0	0.0
<i>Erichsonella attenuata</i>	0.0	0.0	0.0	0.0	0.0	1.6	0.0
<i>Lironeca ovalis</i>	0.9	0.0	0.0	0.0	0.0	0.0	0.0
<i>Mothocya nana</i>	0.9	0.0	0.0	0.0	0.0	0.0	0.0
<i>Nerocila acuminata</i>	0.3	0.0	0.0	0.0	0.0	0.0	0.0
<i>Olencira praegustator</i>	0.6	0.0	0.0	0.0	0.0	0.0	0.0
Penaeids							
<i>Penaeus aztecus</i>	7.4	10.8	0.0	13.3	1.6	1.6	6.2
<i>Penaeus duorarum</i>	0.9	0.0	0.0	0.0	0.0	4.8	0.0
<i>Penaeus setiferus</i>	3.8	8.1	0.0	6.7	3.2	0.0	11.3
<i>Penaeus</i> (unidentifiable remains)	7.1	32.4	25.0	13.3	12.7	8.1	5.2
<i>Sicyonia dorsalis</i>	0.0	0.0	0.0	0.0	1.6	3.2	1.0
<i>Trachypenaeus constrictus</i>	0.0	0.0	8.3	0.0	0.0	3.2	0.0
<i>Trachypenaeus similis</i>	0.6	1.4	8.3	0.0	0.0	17.7	7.2
<i>Trachypenaeus</i> (unidentifiable remains)	0.9	0.0	0.0	0.0	0.0	0.0	1.0
Sergestid							
<i>Acetes americanus</i>	0.0	1.4	8.3	0.0	0.0	1.6	0.0
Carideans							
<i>Alpheus floridanus</i>	0.0	1.4	0.0	0.0	0.0	0.0	0.0
<i>Alpheus heterochaelis</i>	0.0	0.0	0.0	0.0	0.0	6.5	1.0
<i>Alpheus normanni</i>	1.2	0.0	0.0	0.0	0.0	0.0	0.0
<i>Alpheus</i> (unidentifiable remains)	0.0	0.0	0.0	0.0	0.0	3.2	0.0
<i>Latreutes parvulus</i>	0.0	0.0	0.0	0.0	0.0	1.6	0.0
<i>Ogyrides alphaerostris sensu</i> Williams, 1981	0.0	1.4	0.0	0.0	0.0	4.8	0.0
<i>Palaemonetes pugio</i>	3.5	4.1	0.0	6.7	1.6	1.6	1.0
<i>Palaemonetes vulgaris</i>	0.6	0.0	0.0	6.7	1.6	0.0	1.0
<i>Palaemonetes</i> (unidentifiable remains)	0.0	0.0	0.0	0.0	3.2	0.0	0.0
<i>Processa</i> cf. <i>hemphilli</i>	0.0	0.0	0.0	0.0	0.0	4.8	0.0
<i>Tozeuma carolinensis</i>	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Unidentifiable caridean	0.6	0.0	0.0	0.0	0.0	0.0	0.0
Anomurans							
<i>Callinassa jamaicense</i>	1.5	0.0	0.0	0.0	0.0	0.0	0.0
<i>Euceramus praelongus</i>	0.0	0.0	0.0	13.3	0.0	4.8	0.0
<i>Pagurus longicarpus</i>	0.0	0.0	0.0	0.0	0.0	1.6	0.0
<i>Pagurus pollicaris</i>	0.0	0.0	0.0	0.0	1.6	3.2	0.0
<i>Polyonyx gibbesi</i>	0.0	0.0	0.0	0.0	0.0	3.2	0.0
<i>Upogebia affinis</i>	2.3	0.0	0.0	0.0	0.0	0.0	0.0
Brachyurans							
<i>Callinectes</i> remains	0.9	0.0	0.0	6.7	0.0	11.3	0.0
<i>Callinectes sapidus</i>	8.8	5.4	0.0	13.3	9.5	1.6	2.1
<i>Callinectes similis</i>	0.9	0.0	0.0	0.0	1.6	3.2	0.0
<i>Eurypanopeus depressus</i>	0.0	0.0	0.0	0.0	6.4	0.0	0.0

TABLE 1 – Continued
 Percentage of occurrence of different food items in the digestive tracts of selected fishes from Mississippi Sound.

	Species of fish						
	<i>Cynoscion nebulosus</i>	<i>Cynoscion arenarius</i>	<i>Cynoscion nothus</i>	<i>Pogonias cromis</i>	<i>Archosargus probatocephalus</i> Inshore	<i>Archosargus probatocephalus</i> Near islands	<i>Paralichthys lethostigma</i>
Number fish examined	373	108	25	15	77	65	212
Number fish with food	340	74	12	15	63	62	97
Food item	Percentage of occurrence in fish with food item						
<i>Brevoortia patronus</i>	11.8	2.7	0.0	0.0	0.0	0.0	0.0
<i>Chloroscombrus chrysurus</i>	0.9	0.0	0.0	0.0	0.0	1.6	0.0
<i>Cynoscion arenarius</i>	1.5	0.0	0.0	0.0	0.0	0.0	0.0
<i>Cynoscion</i> sp.	0.0	0.0	0.0	0.0	1.6	0.0	2.1
<i>Cyprinodon variegatus</i>	0.3	0.0	0.0	0.0	0.0	0.0	0.0
<i>Dorosoma petenense</i>	1.5	0.0	0.0	0.0	0.0	0.0	0.0
<i>Etropus crossotus</i>	0.3	0.0	0.0	0.0	0.0	0.0	0.0
<i>Fundulus similis</i>	0.9	0.0	0.0	0.0	0.0	0.0	0.0
<i>Gobionellus hastata</i>	0.0	1.4	0.0	0.0	0.0	0.0	0.0
<i>Gobiosoma boscii</i>	1.2	0.0	0.0	13.3	0.0	0.0	0.0
<i>Harengula jaguana</i>	0.3	0.0	0.0	0.0	0.0	0.0	0.0
<i>Lagodon rhomboides</i>	0.3	0.0	0.0	0.0	0.0	0.0	0.0
<i>Leiostomus xanthurus</i>	0.3	0.0	0.0	0.0	0.0	0.0	0.0
<i>Membras martinica</i>	3.8	0.0	0.0	0.0	0.0	0.0	0.0
<i>Menidia beryllina</i>	0.6	0.0	0.0	0.0	0.0	0.0	1.0
<i>Micropogonias undulatus</i>	2.9	0.0	8.3	0.0	1.6	0.0	2.1
<i>Mugil cephalus</i>	1.5	0.0	0.0	0.0	0.0	0.0	0.0
<i>Myrophis punctatus</i>	0.3	0.0	0.0	6.7	0.0	0.0	0.0
<i>Sphoeroides</i> sp.	0.0	1.4	0.0	0.0	0.0	0.0	0.0
<i>Symphurus plagiusa</i>	0.6	0.0	0.0	0.0	0.0	0.0	1.0
Assumed bait	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Unidentifiable fish parts	38.8	37.8	66.7	0.0	6.4	3.2	53.6
Unidentifiable goby	0.0	1.4	8.3	6.7	0.0	0.0	0.0
Plants							
Detritus (may include some animal matter)	7.4	2.7	0.0	13.3	15.9	4.8	5.2
Filamentous algae	0.0	0.0	0.0	0.0	1.6	1.6	0.0
Unidentifiable plant matter	2.1	0.0	0.0	6.7	9.5	6.5	0.0
Unidentifiable animal remains	0.0	2.7	16.7	0.0	0.0	1.6	0.0
Manmade products	0.3	0.0	0.0	0.0	0.0	0.0	0.0

including passes to the Gulf of Mexico (Table 1), by length of fish sampled (Table 4), and by season in which fish were collected (Table 5). Feeding heavily on a variety of food items, the sheepshead most often contained crustaceans and molluscs. Polychaetes also occurred abundantly in the sheepshead's diet except during summer.

Stomachs of *Paralichthys lethostigma* most frequently contained ingested fishes (Table 6). About one third of the examined southern flounder had penaeid shrimps in their stomachs from spring through autumn, and in winter, when the frequency of penaeids was relatively low, the percentage with mysidaceans in their diet was high.

DISCUSSION

Cynoscion spp.

Cynoscion nebulosus contained a greater variety of food items (at least 60) than did *C. arenarius* (about 20, Table 1). We, however, examined 4.6 times as many fed individuals of the former. The slightly higher prevalence of fish and lower prevalence of crustaceans in the digestive tract of the spotted seatrout compared to those for the sand seatrout (Table 3) may have resulted from greater accessibility to menhaden and specific other fishes by the former shortly before being sampled. *Cynoscion nothus* rarely occurred in Mississippi Sound, but when it was collected,

TABLE 2.

Percentage of occurrence of general dietary groups in fed seatrouts of different lengths in Mississippi Sound.

	<i>Cynoscion nebulosus</i>				<i>Cynoscion arenarius</i>			<i>Cynoscion nothus</i>		
	Length of fish in mm SL				Length of fish in mm SL			Length of fish in mm SL		
	73-249	250-399	400-532	Total	59-249	250-320	Total	197-249	250-324	Total
Number of fish without food	11	19	3	33	26	8	34	3	10	13
Number of fish with food	100	224	16	340	60	14	74	5	7	12
Food items	Percentage of Occurrence									
Polychaetes	2.0	9.8	6.3	7.4	0.0	0.0	0.0	0.0	0.0	0.0
Molluscs	2.0	1.3	0.0	1.5	0.0	7.1	1.4	0.0	0.0	0.0
Crustaceans	47.0	34.4	31.3	37.9	55.0	71.4	58.1	0.0	71.4	41.7
Fishes	65.0	76.3	75.0	72.9	55.0	57.1	55.4	80.0	71.4	75.0
Other animals	1.0	0.9	6.3	1.2	1.7	7.1	2.7	0.0	0.0	0.0
Detritus	3.0	6.7	18.8	6.2	6.7	7.1	6.8	20.0	14.3	16.7

its stomach content of fishes and crustaceans was similar to that for *C. nebulosus*. Crustaceans in the diet of all three seatrouts consisted primarily of penaeid shrimps. Of those ingested fish that could be identified, *Anchoa mitchilli* and *Brevoortia patronus* were most prevalent. Most fishes had been digested beyond recognition.

As specimens of *Cynoscion nebulosus* from Mississippi Sound grew longer than 25 cm, the percentage of individuals that recently fed on fish increased slightly, concurrent with a slight decrease in frequency of crustaceans eaten (Table 2). The amount of "detritus" increased with length of fish.

The food contents of *C. nebulosus* obtained seasonally included a slightly greater percentage of fish during spring and summer than during autumn and winter, seasons when *A. mitchilli* was more common both in seatrout stomachs (Table 3) and in Mississippi Sound (Perry and Boyes 1978). Penaeids were less prevalent during autumn and winter when they were also less available in Mississippi Sound. During winter, however, the relative frequency of ingested polychaetes and crustaceans other than penaeids was notably high. The use of polychaetes as food during this period was especially notable in large *C. nebulosus*. Unlike seatrouts from some other regions and some other fishes in Mississippi Sound, seatrouts in Mississippi Sound fed throughout the year, albeit probably less so when spawning.

Similar to our findings, those of some other authors also showed that *C. nebulosus* from a variety of localities contained more fish than shrimp, but the percentages of those two prey-groups differed widely (e.g., Eigenmann 1901, Hildebrand and Schroeder 1928, Gunter 1945, Reid 1954, Breuer 1957, Darnell 1958, Miles 1949, Klima and Tabb 1959, Inglis 1959, Tabb 1961 and 1966, Lorio and Schafer 1966, Fontenot and Rogillio 1970, Carr and Adams 1973, Day et al. 1973, Mahood 1975, Burgess 1976). In fact,

Simmons (1957) found that of 200 fish longer than 500 mm TL in the upper Laguna Madre, Texas, 182 consumed mullet, 12 ate ladyfish, and 6 ate small trout. He noted that "on several occasions mullet 14 inches long were found partially ingested by trout only 21 inches long." He also noted that in a "landcut," trout preferred *Cyprinodon variegatus*. On the other hand, shrimps (usually penaeids) were more frequent than fishes in other collections (Pearson 1929, Baughman 1949, Knapp 1950, Kemp 1949, Miles 1950, Springer and Woodburn 1960, Stewart 1961, Diener et al. 1974). The frequency depended on the season (e.g., Gunter [1945] and Lorio and Schaefer [1966] noted a preference for shrimp in summer, and Moody [1950] noted a maximum of fish in autumn and winter and a maximum of crustaceans in spring and summer even though ingested fish were just as prevalent during spring and summer) as well as the locality and size of seatrout (e.g., Moody [1950] noted penaeids predominating in 150- to 275-mm-SL specimens, and fish, especially *Lagodon rhomboides*, predominating in larger fish). In any event, a notable relationship exists among commercial shrimps, commercial fishes, and seatrouts.

Food for seatrout less than 50 mm long also varies. Copepods make up most of the diet in some localities (Moody 1950, Darnell 1958). Mysidaceans, amphipods, chironomid larvae, carideans, and fishes, however, compose equally or more important prey items in other localities (Reid 1954, Tabb 1961, Odum and Heald 1972, Carr and Adams 1973). In saltwater ponds in Texas, individuals less than 25 mm TL fed primarily on copepods, whereas fingerlings fed primarily on polychaetes, but also abundantly on palaemonid shrimp, amphipods, aquatic insects, and fish (Colura et al. 1976). Quality of diet influences growth in those fish. Taniguchi (1978) documented better growth of

TABLE 3.
Prevalence of *Cynoscion nebulosus* from Mississippi Sound
fed on various dietary groups relative to season

	Season				Total
	Winter	Spring	Summer	Autumn	
Number of fish examined	53	129	104	87	373
Number of fish with food	47	118	90	85	340
Food items	Percentage of occurrence				
Polychaetes	17.0	8.5	2.2	5.9	7.4
Molluscs	0.0	1.7	0.0	3.5	1.5
Penaeids	14.9	17.8	30.0	15.3	20.0
Palaemonids	4.3	1.7	7.8	4.7	4.4
<i>Callinectes</i> spp.	6.4	7.6	14.4	11.8	10.3
Other crustaceans	27.7	9.3	12.2	17.6	14.7
<i>Anchoa mitchilli</i>	19.1	2.5	13.3	30.6	14.7
Other fishes	44.7	79.7	64.4	42.4	61.5
Other animals	0.0	0.0	0.0	4.7	1.2
Detritus	12.8	5.9	4.4	4.7	6.2

larval seatrout when fed on wild copepods as compared to being fed on the laboratory-reared rotifer *Brachionus plicatilis*. Arnold et al. (1976) had used that rotifer followed by a diet of algal-fed artemia to obtain 30% survival at 30 days.

Literature reporting the food of *C. nothus* is lacking, and that for *C. arenarius* is more scarce than that for *C. nebulosus*. Nevertheless, Reid (1954, 1955), Reid et al. (1956), Darnell (1958), Springer and Woodburn (1960), Sheridan and Livingston (1979), and Sheridan (1979) all found that fish was the most abundant item in the diet of *C. arenarius*. Reid et al. (1956) stated that 8 of 15 seatrout longer than 100 mm from East Bay, Texas, had just fed on the Gulf menhaden. Hildebrand (1954) noted both fish and shrimp in the noneverted trout stomach in Texas, and Day et al. (1973) and Diener et al. (1974) found crustaceans, but not necessarily penaeids, important in this species of seatrout from Louisiana and Texas. Darnell (1958) and Inglis (1959) observed mysidaceans and other decapods commonly in fish shorter than 10 cm in other areas of Louisiana and Texas. The most comprehensive feeding study on *C. arenarius* dealt with 79% of 1,545 individuals from Apalachicola Bay, Florida (Sheridan and Livingston 1979, Sheridan 1979). Of those, 62% fed on fishes, primarily *A. mitchilli*, and 26% on mysidaceans, primarily *Mysidopsis bahia*. That mysid plus calanoid copepods constituted the principal diet of individuals smaller than 40 mm long, but the amount gradually tapered off as the seatrout grew and as fish in the diet increased in importance. Diets differed some according to location and season. Also, Sheridan and

Livingston (1979) found that fish were consumed heavily near passes of the estuary, whereas mysidaceans were eaten primarily in the low-salinity East Bay. Sheridan (1978) and Sheridan and Livingston (1979) considered *A. mitchilli* the only planktivore of consequence in the Apalachicola estuary during summer and autumn. They suggested that *C. arenarius* effectively kept the anchovy from utilizing the summer zooplankton peak by feeding heavily on that fish during that season. In Mississippi Sound, numerous fishes other than those discussed in our report feed heavily on *A. mitchilli*. To mention a few, they include *Trichurus lepturus*, *Strongylura marina*, *Bairdiella chrysura*, and probably *Sciaenops ocellata* (see Overstreet and Heard 1978a) and *Micropogonias undulatus* (see Overstreet and Heard 1978b). The squid *Lolliguncula brevis* also serves in that same capacity (Overstreet and Hochberg 1975:898). Near the barrier islands, *Scomberomorus maculatus*, *Synodus foetens*, *Elops saurus*, and other fishes feed heavily on anchovies.

Pogonias cromis

Only 15 specimens of the black drum were examined. Data in Table 1 for those few fish reveal that at least 30 items were consumed with no single item predominating. Of those items, however, 14 were crustaceans and 8 were bivalves.

Because of the drum's ability to crush oysters and other heavily shelled organisms with its pharyngeal teeth, it has been suspected and sometimes identified as destructive to oyster reefs. Most susceptible are single planted oysters, especially those weakened by burrowing pests. Accounts or comments on the drum's destructiveness have been cited by Moore (1899), Goode (1903), Smith (1907), Welsh and Breder (1924), Schlesselman (1955), Hofstetter (1965, 1977), Fontenot and Rogillio (1970), and others. Cave (1978) observed a captive 87-cm-long drum which ate 22 oysters (4 to 6 cm long) per day for a week and a 93-cm specimen which consumed 42 oysters (5 to 8 cm long) per day for the same period. Based on few specimens, he found that captive black drum collected from oyster reefs preferred oysters to other items, whereas drum collected from other habitats preferred *Ensis minor*.

Several other investigators have examined food contents and found molluscs and crustaceans as major food items with polychaetes, fishes, and other items occasionally also listed. These workers include Pearson (1929), Gunter (1945), Kemp (1949), Knapp (1950), Miles (1950), Reid (1955), Breuer (1957), Simmons (1957), Darnell (1958), Simmons and Breuer (1962), and Van Engel and Joseph (1968). Thomas (1971) found the young black drum from tidal creeks of the lower Delaware River in June ate mostly copepods (71%) and chironomids (38%), and in July it ate primarily amphipods (*Corophium* spp., 57%) and chironomids (44%). From August through October *Corophium* spp. made up more than 85% of the diet. In

TABLE 4.

Prevalence of *Archosargus probatocephalus* from Mississippi Sound fed on various dietary groups relative to fish-length

	Length of fish in mm SL		
	145-350	353-449	Total
Number of fish examined	99	43	142
Number of fish with food	86	39	125
Food items	Percentage of occurrence		
Polychaetes	20.9	51.3	30.4
Molluscs	64.0	48.7	59.2
Crustaceans	55.8	71.8	60.8
Fishes	7.0	38.5	16.8
Other animals	51.2	59.0	53.6
Plant	12.8	2.6	9.6
Detritus	10.5	15.4	12.0

TABLE 5.

Prevalence of *Archosargus probatocephalus* from Mississippi Sound fed on various dietary groups relative to season

	Season				
	Winter	Spring	Summer	Autumn	Total
Number of fish examined	29	48	37	28	142
Number of fish with food	22	41	34	28	125
Food items	Percentage of occurrence				
Polychaetes	50.0	36.6	8.8	32.1	30.4
Molluscs	59.1	53.7	58.8	67.9	59.2
Crustaceans	59.1	75.6	47.1	57.1	60.8
Fishes	9.1	31.7	2.9	17.9	16.8
Other animals	54.6	41.5	61.8	60.7	53.6
Plants	0.0	4.9	20.6	10.7	9.6
Detritus	9.1	4.9	20.6	14.3	12.0

other regions, polychaetes or other organisms predominated (e.g., Pearson 1929).

Archosargus probatocephalus

Table 1 shows that the sheepshead has a diverse diet including over 113 species. It apparently even feeds on dead shells to obtain hydroids and other attached fouling organisms. Table 4 shows that a greater percentage of fish from 145 to 350 mm in length fed on molluscs and plants than did larger fish. More than 38% of the large fish contained crustaceans, polychaetes, molluscs, and fishes, whereas only molluscs and crustaceans occurred in that high a percentage of small individuals. Fishes were common only in large sheepshead, and those mostly in spring (Table 5). Even though common in the diet throughout the year, polychaetes occurred most frequently in summer and crustaceans most frequently in spring.

Species of animals in the diet reflected the habitat occupied by the sheepshead. Those fish near the islands contained at least 87 animals compared to 48 from about the same number of examined fish from estuarine habitats. Few prey species occurred in the stomachs of many individuals. Species occurring in more than three fish and indicating a near-island, higher-salinity habitat include *Chaetodipterus variopedatus*, *Dinocardium robustum*, *Nuculana concentrica*, *Pandora trilineata*, *Trachypenaeus similis*, *Hexapanopeus angustifrons*, and *Lucidia clathrata*. In contrast, *Nereis succinea*, *Ischadium recurvum*, *Balanus eburneus*, *Corophium lacustre*, and *Eurypanopeus depressens* were restricted to inshore collections. Some invertebrates such as *Nassarius acutus* and *Mulinia lateralis*, which inhabit sandy-mud areas off Deer Island, and *Molgula manhattensis*,

which colonizes pilings, occurred in the diet of fish from inshore, lower-salinity areas in addition to island locations.

Heavy infestations of parasites that had been present long enough to mature in their hosts, and which had apparently been acquired by the sheepshead from near the islands, indicate that some individual fish collected near the islands had either returned to or never left that general area. Examples include the ascaridoid nematode *Hysterothylacium reliquens* and the aspidogastrid trematode *Cotylogaster basiri* (see Deardorff and Overstreet 1981, Hendrix and Overstreet 1977).

The general feeding behavior of the sheepshead is fairly well understood though only a few studies based on few fish have been conducted; those studies treated a variety of regions. Fish from different regions do feed on different items. Even though not necessarily representative of the particular habits in Mississippi, the behavior documented by Odum and Heald (1972) is worth mentioning. In the Everglades, very small sheepshead lived in grass beds of Florida and Whitewater bays where they fed first on copepods and then on amphipods, chironomids, mysidaceans, and some algae. By the time those fish reached 35 mm, they moved to regions with a harder substratum where they fed on small molluscs and acquired a diversified diet consisting mostly of encrusting forms. In the dry season (January-May) when the water was especially salty, the fish (48 to 267 mm long) fed heavily on the mussel *Brachidontes exustus* and on hydroids. In the wet season when the water was fresher, the diet consisted primarily of the mussel *Congeria leucophaeta* and the crab *Rhithropanopeus harrisi*.

The sheepshead typically feeds on the bottom, but occasionally uses its sharp incisor teeth to graze off encrusted

TABLE 6.
Prevalence of *Paralichthys lethostigma* from Mississippi Sound
fed on various dietary groups relative to season

	Season				Total
	Winter	Spring	Summer	Autumn	
Number of fish examined	34	72	61	45	212
Number of fish with food	15	40	14	28	97
Mean SL (mm) of fish with food	179	227	235	247	
Range of fish length	125-290	168-359	157-320	150-410	
Food items	Percentage of occurrence				
Polychaetes	0.0	5.0	0.0	0.0	2.1
<i>Lolliguncula brevis</i>	0.0	0.0	7.1	0.0	1.1
Stomatopods	6.7	2.5	0.0	0.0	2.1
Mysids	33.3	0.0	0.0	0.0	5.2
Amphipods	13.3	0.0	14.3	0.0	4.2
Penaeids	20.0	30.0	35.7	39.3	32.0
Palaemonids	6.7	0.0	0.0	3.6	2.1
<i>Callinectes sapidus</i>	0.0	2.5	0.0	3.6	2.1
Other decapods	0.0	5.0	0.0	0.0	2.1
<i>Anchoa mitchilli</i>	0.0	42.5	0.0	7.1	19.6
Other fishes	60.0	65.0	71.4	50.0	60.9
Detritus	0.0	2.5	7.1	17.9	7.3

items from pilings and other structures. Unlike the superficially similar black drum which has large crushing pharyngeal teeth, it does not feed heavily on oysters. It feeds more on oyster pests such as mussels, crepidulas, barnacles, and crabs. When sea-grasses or algae are plentiful, the sheepshead will occasionally feed heavily on those plants. Even though they are not listed in the tables, we have commonly observed grass balls in 20-cm-long sheepshead in Fort Bayou of Ocean Springs, Mississippi. Vegetation was considered an important dietary item by Darnell (1958) and Fontenot and Rogillio (1970) in fish from Louisiana and by Gunter (1945) and Simmons (1957) in fish from Texas.

The sheepshead depends heavily on crustaceans and molluscs for food in most regions. It additionally feeds on other items, but Mississippi Sound seems to offer a wider range of items than other regions that have been studied. In fact, we suggest that analysis of the sheepshead's diet in particular is a practical procedure to assess prevalence and abundance of numerous species of invertebrates by season and specific habitat. Presumably, based on the large number of different food items and the relatively few specimens of the sheepshead examined, the fish feeds on nearly anything it can get into its mouth. Probably, a few items are avoided (e.g., Prezant 1980).

In addition to the references cited above, Brooks (1894),

Linton (1905), Smith (1907), Hildebrand and Schroeder (1928), Miles (1950), Viosca (1954), Reid et al. (1956), Springer and Woodburn (1960), and Mook (1977) provided some data on food contents. Springer and Woodburn (1960) looked at fish less than 50 mm long in Tampa Bay, Florida, and found them to feed on amphipods, copepods, and polychaetes rather than on molluscs and barnacles like the larger individuals, and Viosca (1954) presented an informative article for someone attracted to sportsfishing for the sheepshead.

Henwood et al. (1978) reported specific dietary items for the related *Stenotomus caprinus* from several localities offshore from the barrier islands where the sheepshead was collected. They noted that the porgy, similarly to the sheepshead in our study, browsed opportunistically on a diverse diet. It, however, fed on fewer molluscan prey than the sheepshead; the invertebrate prey characterized the offshore substratum-types from where the fish were collected.

Paralichthys lethostigma

Tables 1 and 6 show that fishes, primarily *Anchoa mitchilli* at least during spring, and penaeid shrimps comprised primary dietary items of *Paralichthys lethostigma*. Of the specific items, over 20 in number, some differed seasonally (Table 6), but the overall frequency of ingested fishes and shrimps remained roughly the same throughout the year. Mysidaceans were prevalent in the diet during winter only, the period when penaeids were relatively scarce.

Most papers discussing the southern flounder's diet concern data on few specimens. Three extensive ones report findings involving 234, 171, and 343 fish with food in their stomachs. Those treat individuals from Pamlico Sound, North Carolina (Powell and Schwartz 1979); from Barataria Bay, Louisiana (Fox and White 1969); and from Aransas Bay, Texas (Stokes 1977), respectively. Powell and Schwartz (1979) found fishes (mostly anchovies and sciaenids) and crustaceans (mostly the mysidacean *Neomysis americana*) to comprise nearly the entire diet. Similar to that which we noted, fish occurred more frequently in the diet during spring and summer and more frequently in large individuals. In the stomachs of numerous, unrecorded, small specimens of *P. lethostigma* in Mississippi Sound, we noted an abundance of mysidaceans throughout the year. They consisted primarily of *Mysidopsis almyra*. Fox and White (1969) found that fishes, especially the bay anchovy and striped mullet, constituted the major portion of the diet. By volume, 94% of the food items was fish and 6% was crustaceans. Those authors also noted a seasonal change in species-composition: the fish *Dormitator maculatus* was the common food item in autumn, but was absent during the rest of the year. Rather than eating larger items as it increased in length, the flounder ate more individuals of the same size items. Stokes (1977) did not group data seasonally, but flounder 10 to 150 mm TL fed primarily on

mysidaceans and those over 150 mm fed on fishes (primarily *Anchoa* sp., *Mugil* sp., *Brevoortia* sp., and *Micropogonias undulatus*) and *Penaeus* sp. Other workers found different proportions of ingested fish to crustaceans to miscellaneous items, but these proportions probably reflect the availability of those items at the time the specimens were collected (Hildebrand and Schroeder 1928, Gunter 1945, Knapp 1950, Miles 1950, McLane 1948, Kemp 1949, Reid 1954, 1955; Reid et al. 1956, Darnell 1958, Inglis 1959, Diener et al. 1974, and Burgess 1976).

Several factors in addition to those we discuss above influence growth of fishes. A laboratory investigation by Peters and Kjelson (1975) determining feeding and growth rates of small individuals of *P. lethostigma* exemplify this. They found a higher growth rate at 30°C than at lower temperatures. The conversion efficiency depended on salinity concentration; as salinity decreased, the temperature for maximal efficiency increased. This efficiency was greatest when the flounder ate between 70 and 90% of the maximal amount of food offered. This amount, however, decreased with decreasing temperature. Peters and Kjelson (1975) suggested that, no matter what stimulated migration of the

flounder to low-salinity estuarine water in summer and back to high-salinity water in winter, migration placed it in a salinity that maximized growth and conversion efficiency. Stickney and White (1974) also found that fish 0.15 g grew faster for 6 weeks at 5 ppt, but that those 0.50 g grew faster for the same period at 25 ppt. When in the natural environment, the flounder and most other fishes have these factors plus others regulating growth. Some of those factors confined to controlling the feeding rate—in addition to fish size, prey density, temperature, and salinity—include stomach volume, volume of previously consumed food, state of maturation, genetic characteristics, prey species, prey size, time of day, length of day, and moon phase.

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