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NOTES

PRELIMINARY SURVEY AND DIET ANALYSIS OF JUVENILE FISHES OF AN ESTUARINE CREEK ON ANDROS ISLAND, BAHAMAS

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Estuarine habitats are important nursery and feeding areas for a variety of fish and invertebrate species. Although numerous studies have investigated trophic linkages in temperate estuarine systems, few have empirically examined these relationships in tropical and subtropical estuaries (Colton and Alevizon, 1983; Heck and Weinstein, 1989; Warburton and Blaber, 1992; Ley et al., 1994; Crabtree et al., 1998). Without knowledge of dietary relationships among organisms, community structure and population interactions are difficult to deduce. To this end, a food web approach can be valuable in the study of natural communities (Polis and Winemiller, 1996).

Since many tropical and subtropical estuaries are numerically dominated by juvenile fishes (Arrivillaga and Baltz, 1999), the trophic role of these life stages is especially important. Juvenile fish utilization of mangrove and seagrass habitats has been documented in the Caribbean (Robblee and Zieman, 1984; Stoner, 1986; Rooker and Dennis, 1991; Sedberry and Carter, 1993) and Florida (Thayer et al., 1987; Sheridan, 1997; Ley et al., 1999), although few studies have analyzed feeding habitats of the juvenile fishes in these areas (Heck and Weinstein, 1989; Hettler, 1989; Ley et al., 1994). To our knowledge, there have been no published studies of the distribution and diet of fishes in estuarine creeks, and associated seagrass or mangrove areas, in the Bahamian Islands.

The purpose of our study was twofold: (1) identify fish species utilizing five major habitat types (sandflat, mangrove, seagrass, rocky structure and artificial structure) of an estuarine creek on Andros Island, Bahamas, and (2) provide a preliminary diet analysis of common juvenile fishes.

Materials and Methods

The study was conducted from 27 January to 3 February at Fresh Creek estuary on Andros Island, the largest of the Bahamian Islands (Fig. 1). Fresh Creek is approximately 50 m wide at its mouth, but substantially larger upstream, forming an estuarine lagoon. Although depths exceed 10 m in the main channel and in sink holes (locally known as 'blue holes') in the island interior, the majority of the creek is less than 2 m in depth. The salinity in the creek varies from 35–38‰ at its mouth to freshwater at the center of the island. This study was conducted in the lower portion of the creek where salinities varied from 25–38‰. A more detailed description of Fresh Creek is provided by Newell et al. (1951).

Five habitat types are common in Fresh Creek (in estimated order of abundance): sandflat, mangrove, seagrass, rocky structure, and artificial structure. Sandflat is the most common habitat type, and consists of a coarse substrate composed primarily of molluscan shell fragments (e.g., ceriths *Battillarium* spp. and *Cerithium* spp., the virgin nerite *Neritina virginea*, and the scorched mussel *Brachidontes exustus*). The majority of the creek is bordered by dwarf (<1.5 m tall) red mangrove, *Rhizophora mangle*, which remains inundated for a majority of the tidal cycle. Less common islands of mangroves (~10 m tall) also occur in the creek, and are inundated throughout the tidal

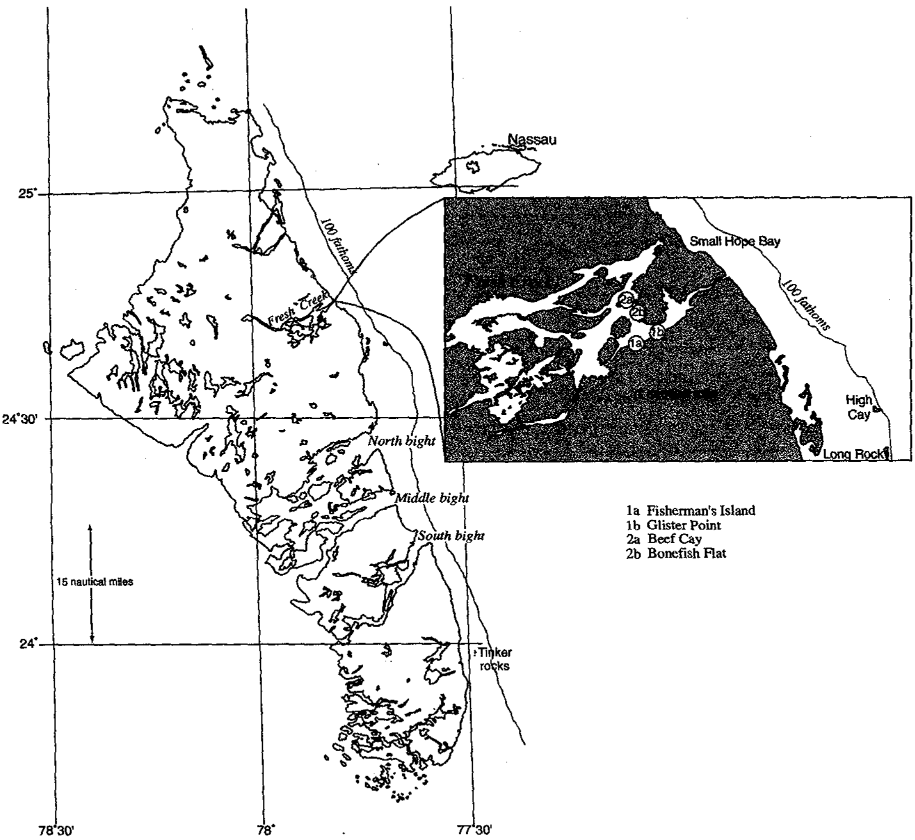

Figure 1. Fish collection sites in Fresh Creek. Sites designated with an "a" are mangrove sampling areas, and with a "b" sand flat areas. One nautical mile is equal to 1.85 km. Diagram by Robert L. Smith.

cycle. Seagrass beds are dominated by turtle grass, *Thallasia testudinum,* and natural rocky structure is commonly found along the creek shore and at the edges of sink holes. Sunken boats and other artifacts form an artificial reef-like habitat type.

Visual surveys of fish communities in the five habitat types were carried out by snorkeling over a 6 d period. Surveys were conducted along 10 m transects and all fishes within 1 m of each transect line were counted and identified. Four to 14 transects were completed in each habitat type, each at a different location within the creek. Transects were conducted on at least three different days for each habitat type. Eight of the most common fish species were collected for gut content analysis, from the habitat in which they were most common, to represent the fauna of the creek. Juveniles of the fishes were specifically targeted; the average size (standard length) of fishes ranged from 76 to 158 mm (Table 1). Sandflat fishes were collected using a cast net deployed from the bow of a small boat. Fishes in mangroves were collected using rotenone. Specimens were immediately placed in formalin. To determine potential invertebrate prey items available to fish in Fresh Creek, we made a survey of invertebrates in all five habitat types. Each habitat type (~10 × 10 m area) was surveyed four times for approximately 30 min periods by each author separately. Surveys were conducted on multiple days over the 1 wk time period. Representative specimens were collected by hand and fixed in formalin. All specimens were taken to the University of Virginia for identification and gut content analysis.

Table 1. Mean length of fish species analyzed for diet contents.

	Number analyzed	Mean length (± 1 S.D.) (mm)
Eucinostomus jonesi	70	87 (±10)
Lutjanus apodus	51	106 (±30)
Haemulon sciurus	47	107 (±29)
Haemulon parrai	15	103 (±18)
Lutjanus griseus	13	109 (±32)
Albula vulpes	10	138 (±4)
Gerres cinereus	5	158 (±8)
Haemulon flavolineatum	3	76 (±3)

Gut content analysis was carried out following the 'points method' of Hynes (1950), using the suggestions of Hyslop (1980). This approach was used by Ley et al.(1994) in assessment of the diets for fishes similar to those in our study. Total fish length was recorded before dissection, the stomach extracted, and then stomach contents quantified after being leveled in a petri dish. A 0.007 mm screen mesh was placed under the petri dish and number of squares covered by the prey item used to compute percent composition (Bowen, 1983).

Results

Fifty-seven fish species in 25 families were documented in Fresh Creek (Table 2). The most abundant fishes in the creek included forage species in the family Atherinidae. Gerreids, including *Eucinostomus jonesi*, *Eucinostomis lefroyi*, and *Gerres cinereus,* were also well represented in all habitat types. Haemulids and lutjanids were conspicuous members of the fish assemblages in most habitat types, although not as common as atherinds and gerreids. There was a clear gradient in the distribution of many common coral reef species; their abundance in the creek decreased substantially with distance from the creek mouth. For example, chaetodontids and scarids were very common in prop roots and artificial structures near the creek mouth, but were never observed more than 500 m into the creek, even though salinities varied little between the creek mouth (33–35‰) and our visual transect locations (28–34‰).

The abundance of several species differed among habitat types. Sandflats were dominated by two gerreids, *E. lefroyi* and *E. jonesi.* Bonefish *Albula vulpes* and yellowfin mojarra *G. cinereus* were less abundant over sandflats, but also common. Mangrove and seagrass habitat types were characterized by higher species diversity than sandflat areas. Mangrove sites were dominated by haemulids and lutjanids; *Haemulon sciurus, Lutjanus apodus,* and *Lutjanus griseus* were most abundant. A similar fish assemblage was found in seagrasses, where *Haemulon parrai*, *Lutjanus synagris,* and *Ocyurus chrysurus* were abundant. Diversity of invertebrates in Fresh Creek was low, but the abundance of individual species was high, relative to coral reefs (Table 3). Blue crabs, *Callinectes* spp., and black-clawed mud crabs, *Panopeus* spp., were the dominant invertebrate predators in the system. Gastropods (*Cerithium* spp., and *N. virginia*) and mussels (*B. exustus*, and the flat tree mussel, *Isognomon alatus*) were the most abundant primary consumers. The primary food of the dominant gastropods in this system is most likely dead or decaying organic material and microalgae (Abbott and Morris, 1995). This suggests the food web in this sub-tropical estuary is likely detrital/algal-based.

Table 2. The fish species identified in Fresh Creek, Andros Island, Bahamas. For each species the table designates whether adults, juveniles, or both were observed. The habitat type where each species was identified are listed with the most common habitat type first, second most common second, etc. (Mangrove = M; Sandflat = S; Seagrass = G; Rocky bottom = R; artificial structure, e.g. sunken barge, = A). Based on visual surveys the estimated total abundance of each species 100 m^{-2} was classified according to the following: <10 = Rare (R), 10–1,000 = Common (C), or 1,000+ = Abundant (A).

Habitat	Juvenile	Adult	Primary	Relative abundance
Acanthuridae (Surgeonfish)				
Acanthurus bahianus (Ocean)		*	M/A	R
Acanthurus chirugus (Doctorfish)		*	M/A	R
Acanthurus coeruleus (Blue tang)		*	A	R
Albulidae (Bonefish)				
Albula vulpes (Bonefish)	*	*	S	C
Atherinidae (Silversides)				
Atherinomorus stipes (Hardhead)	*	*	M/S/R	A
Balistidae (Leatherjackets)				
Monacanthus tuckeri (Slender)		*	G	R
Belonidae (Needlefish)				
Tylosurus crocodilus (Houndfish)	*	*	S	C
Carangidae (Jacks)				
Caranx hippos (Crevalle Jack)		*	S	R
Caranx ruber (Bar)	*	*	M/G/S/R/A	C
Trachinotus falcatus (Permit)		*	S	R
Chaetodontidae (Butterflyfish)				
Chaetodon capistratus (Foureye)	*		M/A	R
Chaetodon sedentarius (Reef)		*	A	R
Cliniidae (Blennies)				
Malacoctenus macropus (Rosy)		*	M	R
Malacoctenus triangulatus (Saddled)		*	M	R
Clupeidae (Herring)				
Harengula sp. (Sardine species)	*	*	M/S/R/G	A
Jenkinsia sp. (Herring species)	*	*	M/S/R/G	A
Dasyatidae (Stingrays)				
Dasyatis americana (Southern)		*	S	R
Diodontidae (Spiny puffers)				
Diodon hystrix (Porcupinefish)		*	S	R
Elopidae (Tarpon)				
Megalops atlanticus		*	S	R
Gerreidae (Mojarra)				
Eucinostomus jonesi (Slender)	*	*	S	A
Eucinostomus lefroyi (Mottled)	*	*	S	A
Gerres cinereus (Yellowfin)	*	*	S	A
Gobiidae (Gobies)				
Coryphopterus punctipectophorus (Spotted)		*	M/R	R
Coryphopterus glaucofraenum (Bridled)		*	M/R	R
Haemulidae (Grunts)				
Haemulon flavolineatum (French)	*	*	M/G	C
Haemulon parrai (Sailor's Choice)	*	*	M/R/G	A

Table 2. Continued.

Habitat	Juvenile	Adult	Primary	Relative abundance
Haemulidae (Grunts)				
Haemulon plumieri (White)		*	M	R
Haemulon sciurus (Bluestriped)	*	*	M/R/G	A
Labridae (Wrasses)				
Halichoeres bivittatus (Slippery Dick)	*	*	M/G	C
Lachnolaimus maximus (Hogfish)	*		M	R
Thalassoma bifasciatum (Bluehead)	*	*	M/G/A	C
Lutjanidae (Snappers)				
Lutjanus analis (Mutton)	*	*	M/R	C
Lutjanus apodus (Schoolmaster)	*	*	M/R/G	A
Ocyurus chrysurus (Yellowtail)	*	*	M/G	C
Lutjanus cyanopterus (Cubera)	*	*	M/R/G	C
Lutjanus griseus (Gray)	*	*	M/R/G	A
Lutjanus mahogoni (Mahogony)		*	M/R	R
Lutjanus synagris (Lane)	*	*	M/R/G	C
Mullidae (Goatfish)				
Pseudupenes maculatus (Spotted)		*	M	R
Pomacanthidae (Angelfish)				
Holacanthus bermudensis (Blue)	*		A	R
Pomacanthus paru (French)	*		R	R
Pomacentridae (Damselfish)				
Abudefduf saxatilis (Sergeant major)	*	*	M/R/A/S/G	C
Stegastes leucostictus (Beaugregory)	*	*	M/R	C
Stegastes planifrons (Threespot)		*	M/R	C
Stegastes variabilis (Cocoa)	*	*	M/R	C
Scaridae (Parrotfish)				
Cryptotomus roseus (Bluelip)	*		M	R
Nicholsina utsa (Emerald)	*		M	R
Scarus guacamaia (Rainbow)	*		M	C
Sparisoma chrysopterum (Redtail)	*		M	C
Sparisoma radians (Bucktooth)	*	*	M/S	R
Sparisoma rubripinne (Redfin)	*		M	R
Serranidae (Seabass/Groupers)				
Epinephalus striatus (Nassau Grouper)	*		M	R
Mycteroperca bonaci (Black)	*		M	R
Sparidae (Porgies)				
Calamus sp. (Porgy species)		*	M	R
Sphyraenidae (Barracuda)				
Sphyraena barracuda (Great)	*	*	S/M/G	C
Tetradontidae (Puffers)				
Canthigaster rostrata (Sharpnose)	*	*	M/G/R	C
Spheroides testudineus (Checkered)	*	*	M/R/S/G	C

Table 3. The invertebrate species identified in Fresh Creek, Andros Island, Bahamas. For each taxa in the table, the habitat types where each group was identified are listed with the most common habitat type first, second most common second, etc. (Mangrove = M; Sandflat = S; Seagrass = G; Rocky bottom = R; Artificial structure, i.e. sunken barge, =A). The estimated total abundance of each taxa was classified according to the following: <10 = Rare (R), 10–1,000 = Common (C), 1,000 + = Abundant (A).

Type	Primary Habitat	Relative Abundance
Phylum Arthropoda		
Sub Phylum Crustacea		
Order Decapoda		
Family Portunidae		
Callinectes spp. (Blue Crabs)	M/G/S	C
Family Xanthidae		
Panopeus herbstii (The Black Clawed Mud Crab)	S/G/M	A
Family Majidae		
Mithrax sculptus (Green Clinging Crab)	S/G	R
Pitho aculeata (Gray Pitho)	G	R
Family Alpheidae		
Synalpheus spp.	G	C
Order Amphipoda	S/G	C
Phylum Mollusca		
Class Bivalvia		
Family Mytilidae		
Brachidontes exustus (Scorched Mussel)	S	A
Family Cardiidae		
Laevicardium mortomi (Morton's Egg Cockle)	S/M	C
Laevicardium leavigatum (Common Egg Cockle)	S/M	C
Chione cancellata (Cross-barred Venus)	S/M	C
Family Veneridae		
Anemalocardia auberiana (Pointed Venus)	S/M	C
Family Isognomonidae		
Isognomon alatus (Flat Tree Oysters)	R/A	C
Class Gastropoda		
Family Potamididae		
Battillarium minima (False Cerith)	S/G	A
Family Cerithidae		
Cerithium muscarum (Fly Specked Cerith)	S/G	A
Cerithium litteratum (Stocky Cerith)	S/G	A
Cerithium eburneum (Ivory Cerith)	S/G	A
Family Modulidae		
Modulus modulus (Atlantic Modulus)	S/M	R
Family Marginellidae		
Marginella apicina (Common Atlantic Marginella)	S	R
Family Neritidae		
Neritina virginea (Virgin Nerite)	G/S	A

Table 4. The frequency of occurrence of prey items. The percentage expresses the proportion of individuals containing that diet item. Species codes: EJ - *Eucinostomus jonesi*, LA - *Lutjanus apodus*, HS - *Haemulon sciurus*, HP - *Haemulon parrai*, LG - *Lutjanus griseus*, AV - *Albula vulpes*, GC - *Gerres cinereus*, HF - *Haemulon flavolineatum*.

	EJ	LA	HS	HP	LG	AV	GC	HF
Kingdom Protozoa								
Order Foraminiferida	18	5	50	–	65	30	20	66
Phylum Nematoda	–	4	–	–	8	30	–	–
Phylum Mollusca								
Unidentifiable mollusc	61	19	86	15	83	50	60	100
Class Bivalvia								
Brachidontes exustus	–	2	10	5	–	10	60	–
Laevicardium mortomi	–	–	10	–	–	10	20	33
Laevicardium leavigatum	–	–	14	–	–	20	40	66
Anemalocardia auberiana	7	–	48	5	–	10	20	66
Class Gastropoda								
Battiilarium minima	4	4	–	–	–	10	–	33
Cerithium muscarum	–	–	–	–	–	–	–	33
Cerithium eburneum	–	–	5	–	–	–	–	–
Modulus modulus	4	–	–	–	–	–	–	–
Neritina virginea	–	4	3	–	–	–	–	–
Phylum Arthropoda								
Class Insecta								
Unidentifiable insect	11	–	–	–	25	50	–	–
Diptera larva	36	–	5	–	–	70	–	–
Sub Phylum Crustacea								
Unidentified crustacean	57	15	10	–	83	90	40	–
Order Amphipoda	–	4	–	5	8	–	30	66
Order Decapoda								
Unidentifiable decapod	1	4	5	–	–	40	–	66
Unidentifiable shrimp	–	–	–	–	25	–	–	–
Callinectes sp.	–	–	–	–	–	8	–	–
Panopeus sp.	–	11	–	–	8	–	–	–
Mithrax sculptus	–	4	–	–	–	–	–	–
Fish Parts	11	2	–	–	8	–	–	–
Plant Material	16	17	24	20	23	10	80	33
Unidentifiable Material	57	71	90	95	100	60	100	100

Molluscs and crustaceans were major constituents of fish diets (Table 4). Molluscs were important prey items for all eight species of fish. Nine species of molluscs were identified in gut contents, but the majority of shell could not be identified. Molluscs were especially common in haemulids and gerrieds. Crustaceans were also common in gut contents. For example, 90% of *A. vulpes* and 83% of *L. griseus* had eaten a crustacean. Crustaceans were especially difficult to identify to species, as often only a single appendage or antenna remained in the fish stomachs. However, decapod crabs were identified in 40% of *A. vulpes* specimens and 66% of *Haemulon flavolineatum* (although these proportions must be interpreted cautiously due to low sample size). Plant material occurred in 10–80% of species' guts.

Using the points method of Hynes (1950), we found consistent patterns in the diets for some species. Molluscs made up at least 75% of the total gut contents in each of the three haemulid species. Almost 83% of the gut contents of *G. cinereus* were molluscs; 50% of the total contents was *B. exustus*, the scorched mussel. Diptera larvae and unidentified crustaceans composed a significant portion of the diet of *E. jonesi*. Decapod crabs were important prey items of lutjanids. *Panopeus* sp. accounted for 35% and 14% of the diets of *L. apodus* and *L. griseus,* respectively. *Callinectes* sp. made up 35% of the diet of *L. griseus*. Molluscs, foramineferans, amphipods, insects, and other unidentifiable crustaceans were important components in the diet of *A. vulpes*.

Discussion

The fishes documented in Fresh Creek are very similar to species reported in similar estuarine habitats in Florida (Thayer et al., 1987; Ley et al., 1994; Sheridan, 1997; Ley et al., 1999) and Central America (Weinstein and Heck, 1979; Robblee and Zieman, 1984; Stoner, 1986; Rooker and Dennis, 1991; Sedberry and Carter, 1993; Arrivillaga and Baltz, 1999). There appears to be a distinct gradient in species composition from the mouth landward, as has been reported in other estuarine systems (Sheaves, 1992; Sheaves, 1998; Ley et al., 1999). The area within 0.5 km of the creek mouth seems to be frequented by non-resident species that move into estuaries at early life stages or to utilize food resources. The creek may provide a nursery area for some marine species, including those that are common on coral reefs; for example, juvenile *Epinephalus striatus* (Nassau Grouper), *Chaetodon capistratus* (foureye butterflyfish), and *Pomacanthus paru* (French angelfish), conspicuous members of Bahamian coral reefs, were observed in Fresh Creek. The results of this study indicate that the creek mouth and adjacent habitat types are an important conduit of interchange between the creek fauna and fauna of marine habitat types, which explains increased diversity in the lower reaches of the estuary.

There was also clear segregation of species among sandflat, seagrass, and mangrove habitat types, as has been reported in numerous other studies (Robertson and Duke, 1987; Sedberry and Carter, 1993; Laegdsgaard and Johnson, 1995; Gray et al., 1996; Gray et al., 1998; Jenkins and Wheatley, 1998; Guidetti, 2000). Species diversity was higher in seagrass and mangroves, in large part because of the presence of fish species common on nearby coral reefs (e.g., haemulids, lutjanids, and scarids). Thus, preservation of seagrass and mangrove may be essential for protection of coral reef fauna. These estuarine habitats serve as nurseries for fish species that move to the reefs as adults, as well as providing source populations of juvenile recruits to reefs. Although characterized by lower species diversity, sandflats also supported high fish biomass. This high biomass, coupled with the predominance of this habitat in Fresh Creek, suggests that trophic interactions on sandflats account for a large component of overall energy flow within the estuary.

The diet data reported in our study is largely in agreement with that from previous stomach analyses; all species examined in our study displayed characteristics typical of estuarine fishes, including omnivory and broad dietary overlap. The importance of crustaceans in the diet of lutjanids agrees with findings in similar habitats (Harrigan et al., 1989; Hettler, 1989; Heck and Weinstein, 1989). However, haemulids in Fresh Creek relied heavily on molluscs. In a Panamanian seagrass meadow, Heck and Weinstein (1989) found that crustaceans were more important than molluscs for juvenile haemulids. Fishes

Table 5. The percentage of species' total gut content attributable to each prey item, as quantified by the 'points' approach (see methods). Species codes: EJ - *Eucinostomus jonesi*, LA - *Lutjanus apodus*, HS - *Haemulon sciurus*, HP - *Haemulon parrai*, LG - *Lutjanus griseus*, AV - *Albula vulpes*, GC - *Gerres cinereus*, HF - *Haemulon flavolineatum*.

	EJ	LA	HS	HP	LG	AV	GC	HF
Kingdom Protozoa								
Order Foraminiferida	4	<1	18	–	2	2	5	11
Phylum Nematoda	–	1	–	–	8	4	–	–
Phylum Mollusca								
Unidentifiable mollusc	20	6	67	70	8	12	20	68
Class Bivalvia								
Brachidontes exustus	–	2	<1	<1	–	1	50	–
Laevicardium mortomi	–	–	<1	–	–	1	1	1
Laevicardium leavigatum	–	–	<1	–	–	2	11	<1
Anemalocardia auberiana	2	–	8	12	–	1	<1	1
Class Gastropoda								
Battillarium minima	2	6	–	–	–	1	–	<1
Cerithium muscarum	–	–	–	–	–	–	–	<1
Cerithium eburneum	–	–	<1	–	–	–	–	–
Modulus modulus	1	–	–	–	–	–	–	–
Neritina virginea	–	6	6	–	–	–	–	–
Phylum Arthropoda								
Class Insecta								
Unidentifiable insect	3	–	–	–	2	12	–	–
Diptera larva	18	–	1	–	–	6	–	–
Sub Phylum Crustacea								
Unidentified crustacean	17	6	1	–	9	26	1	–
Order Amphipoda	–	4	–	5	1	22	–	1
Order Decapoda								
Unidentifiable decapod	1	12	1	–	–	6	–	2
Unidentifiable shrimp	–	–	–	–	5	–	–	–
Callinectes spp.	–	–	–	–	35	–	–	–
Panopeus sp.	–	21	–	–	14	–	–	–
Mithrax sculptus	–	16	–	–	–	–	–	–
Fish Parts	2	7	–	–	5	–	–	–
Plant Material	10	1	3	3	3	–	2	2
Unidentifiable Material	20	17	5	10	8	4	10	14

collected by Heck and Weinstein (1989) were from seagrass beds; haemulids in Fresh Creek were collected from mangrove sites. Haemulids are known to utilize coral reefs by day, then migrate to feed in other areas at night (Ogden and Ehrlich, 1977; Helfman et al., 1982; Burke, 1995). A similar migration may occur in Fresh Creek between mangroves and sandflats, where molluscs are extremely abundant. Differences may also reflect a temporal resource pattern, as prey items may vary greatly in abundance seasonally (Colton and Alevizon, 1983). The mollusc diet component is especially interesting considering that the link between estuarine fish predators and molluscs generally has been regarded as weak (Beumer, 1978; Pollard, 1984; Heck and Weinstein, 1989; Warburton and Blaber, 1992).

It is acknowledged that this preliminary study is limited in both spatial and temporal scope; it is a 'snapshot' view of the diet of the fish species. It is limited spatially (only a single creek is sampled) raising questions of pseudreplication (Hulbert, 1984). Logistically we were unable to sample other creeks, but made every effort to sample multiple sites for each habitat type within Fresh Creek. We conducted visual surveys and fish and invertebrate collections each day during the week, but were unable to replicate the study in other seasons. Possible seasonal variation in fish fauna and prey availability would influence the results given here. Despite these obvious limitations, our study provides important baseline data for future investigations.

When examining community structure and population interactions in future studies of subtropical and tropical estuarine habitats, we recommend examining the feeding relationship of all organisms. In particular, diets of primary consumers should be examined to determine: (1) if energy flow is concentrated in a detritus or grazing based food web and (2) the indirect linkages between primary producers and top-order predators. Further, it is essential to include all age classes of organisms in food web approaches. The abundance of juvenile fishes necessitates their inclusion in food web analyses, as there can be significant ontogenetic feeding shifts in aquatic organisms (Brooks and Dodson, 1965; Werner and Gilliam, 1984). Finally, care should be taken to include temporal variation in food web analyses, as significant diet shifts, and thus changes in food web structure, can occur seasonally (Brooks and Dodson, 1965; Winemiller, 1990; Winemiller, 1996). Conservation of dynamic, interconnected, nearshore communities must go beyond individual species or habitat types. Expanding the food web approach taken in the present study will demonstrate the complexity of these systems and the challenges faced to preserve them.

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