COMMUNITY STRUCTURE AND DIETS OF FISHES ASSOCIATED WITH PELAGIC *SARGASSUM* AND OPEN-WATER HABITATS OFF NORTH CAROLINA

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ABSTRACT

The community structure and diets of fishes inhabiting *Sargassum* and open water lacking *Sargassum* were examined off North Carolina during annual summer or fall cruises, 1999-2003. Significantly more individual fishes (*n*= 18,799), representing at least 80 species, were collected in samples containing *Sargassum*, compared to 60 species (*n*=2706 individuals) collected in open water. The majority of fishes collected in both habitats were juveniles, and *Stephanolepis hispidus* dominated both communities. Regardless of sampling time (day or night), *Sargassum* habitat yielded significantly higher numbers of individuals and species compared with open water collections. Overall, fishes collected in *Sargassum* neuston net tows were significantly larger than fishes collected in open water neuston tows. A significant positive linear relationship existed between numbers of fishes and *Sargassum* quantity. Underwater video recordings indicated a layering structure of fishes among and below the algae, with smaller fishes being more tightly associated with the algae than larger fishes. Additional observations from underwater video recordings included schooling behaviors of filefish, dolphinfish and jacks, and fish-jellyfish associations.

The diets of the dominant fish species collected from *Sargassum* habitat were compared to the diets of the same species collected from open water, the diets of fishes collected during the day were compared to the diets of fishes collected at night within and across habitats, and the diets of each fish species across different size ranges were compared. Fishes collected from *Sargassum* consumed a higher diversity and volume of prey compared with fishes collected from open water. Fishes collected from *Sargassum* habitat had fewer empty stomachs than fishes collected from open water. Overall, fishes collected from *Sargassum* primarily consumed fishes that are closely associated with the algae (e.g., balistids, carangids, monacanthids) and endemic

shrimps (*Latruetes fucorum* and *Leander tenuicornis*). In contrast, open-water fishes primarily consumed copepods and fishes from the family Exocoetidae. Comparisons between the diets of *Sargassum*-associated fishes and fishes collected from open water indicated several species fed similarly in both habitats. Fishes belong to one or more of three trophic groups: zooplanktivores, crustacean feeders or piscivores. Overall, fishes collected from *Sargassum* and open-water habitats primarily fed during the day. It appears *Sargassum* habitat enhances early survival of pelagic fishes by providing protection and concentrating prey resources in an otherwise nutrient-poor area of the western North Atlantic Ocean. Efforts should be made to protect this unique pelagic habitat because these fishes are very closely tied to *Sargasssum* and may not be able to survive without *Sargassum*.

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I am especially grateful to Dr. Steve Ross who introduced me to the field of fish ecology and whose endless patience, enthusiasm and encouragement led to the completion of this study. I am also indebted to Dr. Lankford and Dr. Willey for their encouragement, patience, guidance and support. I would like to thank the staff, volunteers and interns who worked at Dr. Ross's lab over the years. A special thank you goes to Andrea Quattrini who has been a great support and friend over the years and I will always value her scientific knowledge and input. I would like to thank Matthew McIver for his enthusiasm, encouragement and support. Finally, I would like to thank my family for their continued encouragement and support.

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DEDICATION

I would like to dedicate this thesis to my grandfather, Robert Roy Cammann Senior, whose love and respect for nature and his dedication to the conservation of nature stimulated my appreciation for the environment and science. I have many fond memories of nature walks, canoe trips and long talks about the environment. He had an endless amount of patience and warmly welcomed any person for an itellectual discussion at his kitchen table. My grandfather set a very high standard for the type of person I strive to be.

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CHAPTER 1: COMPARISONS OF FISH COMMUNITIES ASSOCIATED WITH PELAGIC *SARGASSUM* AND OPEN-WATER HABITATS

INTRODUCTION

In the western North Atlantic Ocean pelagic brown algae of the genus *Sargassum* is abundant and forms a dynamic floating habitat that supports a diverse assemblage of marine organisms, including fishes, invertebrates, sea turtles, pelagic birds and marine mammals. The pelagic algal species *S. natans* and *S. fluitans* serve as a primary nursery area for many juvenile fishes, some of which are commercially or recreationally important species (e.g., *Coryphaena hippurus* [dolphinfish], *Caranx* spp. [jacks], *Seriola* spp. [amberjacks]), and concentrate sources of energy in an otherwise nutrient-poor environment. This floating habitat provides a source of food, shelter and substrata to more than 145 species of invertebrates, 100 species of fishes and four species of sea turtles (Fine, 1970; Dooley, 1972; Bortone et al., 1977; Butler et al., 1983; Coston-Clements et al., 1991; Settle, 1993; Moser et al., 1998; Wells and Rooker, 2004). *Sargassum* habitat appears to be particularly important for early survival of some fishes since the majority of fishes collected in *Sargassum* habitat in the Gulf of Mexico (Bortone et al., 1977; Wells and Rooker, 2004), off North Carolina (Fine, 1970; Dooley, 1972; Moser et al., 1998), and off Florida (Dooley, 1972) were juveniles.

The spatial distribution and quantity of *Sargassum* are highly variable. *Sargassum* habitat can range from small, widely dispersed clumps to large weedlines and rafts that continue for many kilometers. *Sargassum* distribution along the US East coast depends on the Gulf Stream, which entrains pelagic *Sargassum* from the Sargasso Sea and moves it northward. *Sargassum* habitat is dynamic due to variations in Gulf Stream flow, storms, tidal currents, and wind generated waves and currents. Although estimates of *Sargassum* biomass in the western North Atlantic have varied (Parr, 1939; Howard and Menzies, 1969; Stoner, 1983a; Butler and Stoner, 1984), the majority of pelagic *Sargassum* has lived and reproduced vegetatively in the open ocean for at least tens of years and probably hundreds to thousands of years (Parr, 1939).

Although several studies have documented fishes associated with *Sargassum*, some limitations were inherent in most of these. *Sargassum* habitat is extremely difficult to sample consistently, and no single methodology provides a completely accurate view of *Sargassum* community structure. Thus, Moser et al. (1998) proposed using multiple sampling methods to survey this ecosystem. However, most *Sargassum* community studies from the Gulf of Mexico (Bortone et al., 1977; Comyns et al., 2002; Wells and Rooker, 2004; Hoffmayer et al., 2005) and the western North Atlantic (Weis, 1968; Fine, 1970; Dooley, 1972; Butler et al., 1983; Stoner and Greening, 1984; Settle, 1993; Moser et al., 1998) were based on limited sampling methods. Kingsford (1992, 1993, 1995), Kingsford and Choat (1985, 1986), and Dempster and Kingsford (2004) suggested that a weakness in previous studies was a lack of open water control samples. To date, only one study in the western North Atlantic (Moser et al., 1998) compared fishes collected in *Sargassum* to fishes collected in open water lacking *Sargassum*. Additionally, most *Sargassum* related studies sampled during daytime only (Dooley, 1972; Moser et al., 1998; Wells and Rooker, 2004) or sampling times were not specified (Weis, 1968; Fine, 1970; Bortone et al., 1977; Stoner and Greening, 1984; Comyns at al., 2002). In some cases, explicit association of samples with *Sargassum* was unclear (e.g., Settle, 1993).

The relationships between the quantity of *Sargassum* and species richness and abundance or biomass of individuals is unclear. Dooley (1972) and Fedoryako (1980) found no correlation between numbers of fishes and quantity of *Sargassum*, but Fine (1970), Stoner and Greening (1984), Kingsford and Choat (1985), Settle (1993), Moser et al. (1998) and Wells and Rooker (2004) found significant positive correlations between fish abundances and quantity of algae.

Sampling methodology may substantially impact these results. Nevertheless, it is clear that floating structures, like *Sargassum*, in the open ocean attract and concentrate fauna (Kingsford, 1992).

Despite several surveys and the widespread occurrence of *Sargassum*, the fishes associated with this habitat have not been extensively documented along the US East coast. My objective was to describe fish community structure (species composition, day versus night species composition, sizes and habitat) within *Sargassum* and open-water habitats off North Carolina. In addition, behavioral observations of fishes within and below *Sargassum* habitat were documented to better describe the close associations of fishes to the habitat, the different types of habitat usage, and to provide a three dimensional view of the distribution of fishes within and beneath the *Sargassum*. My approach was to use consistent methodology (supplemented by other sampling) and extensive temporal (diel) and spatial sampling across ocean surface habitats grading from no *Sargassum* to high densities of *Sargassum* habitat to examine the relative contribution of *Sargassum* habitat to oceanic fish communities off the southeastern U.S.

MATERIALS AND METHODS

Data Collection

Surface waters were sampled during 2-7 August 1999, 20-27 July 2000, 22-28 August 2001, 20-26 September 2001, 6-15 August 2002, and 17-26 August 2003, in or near the Gulf Stream off Cape Hatteras, Cape Lookout, and Cape Fear, North Carolina (Figure 1). The primary sampling device, a 1.1 x 2.4-m neuston net (6.4-mm mesh body, 3.2-mm tailbag), was towed in the upper meter of the water column at slow speeds (<3.7 km/hr) for 30 minutes in 1999 and 15 minutes during 2000-2003. Sampling was conducted throughout the 24-hr period to compare daylight (0700-2000 hr EDT) and nighttime (2000-0700 hr EDT) collections. The neuston net was towed in both open-water without *Sargassum* and in waters with various amounts of *Sargassum* habitat. *Sargassum* is in constant motion in the Gulf Stream, and without aerial surveillance its distribution and density are unpredictable, especially at night. Being unable to consistently target particular habitat and thus balance sampling effort, the nets were pulled through unknown habitat, and the sample was classified later depending on whether *Sargassum* was present in the sample or not (see below). In most cases it was also not possible to determine the proximity of one habitat to another. When *Sargassum* was abundant, the neuston net was towed directly through the clumps, mats or weedlines, but on some occasions, *Sargassum* was collected opportunistically. Fishes were sorted from the algae in the neuston tow catches, and the *Sargassum* was wet weighed to the nearest 0.1 kg and discarded. Because neuston net tows in 1999 were longer and catches were not consistently handled, these data were not analyzed statistically (see below).

Additional collection methods supplemented the neuston nets, especially when *Sargassum* was too dense to use this net. When conditions were favorable (low wind and waves), nightlighting stations were occupied by allowing the vessel to drift with the current or maintain its slowest speed into the current. The vessel's deck lights, plus two 500-W and one 1000-W spotlights, were used to illuminate surface waters around the stern and both sides of the vessel, and fishes that swam near the vessel were collected by 5-6 persons using small mesh (6.4-mm mesh) dip nets. Each 30-minute segment of time during the drift represented a station. During nightlighting, the presence/absence of *Sargassum* within the field of view and whether it was collected in dip nets was recorded. Fishes were also opportunistically collected with dip nets during daylight when dense aggregations of *Sargassum* were encountered. Limited hook-and-line sampling occurred in *Sargassum* and open-water habitats, during the day and at night, and each station lasted from 15-160 minutes. One long line set was made in the Cape Hatteras study area. The line was about 366-m long and contained 104 baited hooks which fished within 1-2 m of the surface. The set was made at night, lasted for 501 min, and drifted for 30 km through open-water habitat.

In 1999, underwater video was recorded under a large *Sargassum* weedline at two stations off Cape Hatteras, North Carolina (Figure 1). Snorkelers using a handheld, color camcorder (SONY model DCR-TRV900) in a waterproof housing swam on and just below (< 3 m) the surface along the edge of and under the weedline. A total of 62 minutes of video was recorded during the two stations. Analyses of the underwater video included identification of species and documentation of behaviors and placements of fishes.

Specimens were preserved at sea in 10% formalin-seawater solution and later stored in 40% isopropanol. Larval fishes were included in previous *Sargassum* studies, implying an association with this habitat. However, since distributions of pelagic fish larvae are highly influenced by currents and they generally lack affinity for drift algae (Kingsford and Choat, 1985), their presence in *Sargassum* collections (Settle, 1993; Wells and Rooker, 2004) is probably coincidental. For this reason and because the neuston net mesh size was inappropriate for sampling larvae, larval fishes (classified following Richards, 2006) were excluded from this study. Fishes were identified to the lowest possible taxa, counted, measured to the nearest mm for standard length (SL), and wet weighed to the nearest 0.1 g. Damage to some fishes precluded identification to species and SL measurements. When more than 500 individuals of the same species were collected in a tow, a subsample (approximately 10% of the catch) was measured for SL and wet weight.

Data Analysis

Neuston net fish catches were statistically analyzed to assess differences between habitats, including diurnal differences. Neuston tows without *Sargassum* were designated as open-water (OW). Since clumps of algae as small as 0.005 kg could influence the distribution and abundance of fishes (Kingsford and Choat, 1985), samples were classified as *Sargassum* (S) if algae were collected regardless of the quantity. The numbers of individuals and numbers of species collected from *Sargassum* and open-water were log (x+1) transformed before analysis to correct for heterogeneity of variance and to reduce the influence of abundant species and enhance the contribution of rare species. If the assumptions of homogeneity of variance and normality were not satisfied after data transformation, a non-parametric Mann-Whitney test was applied to determine if there were differences in the numbers of individuals and species in open-water versus *Sargassum* habitat. A Kruskal-Wallis test was used to compare neuston net day and night fish catches within and across station types (i.e., S versus OW), and a Dunn's multiple comparison test was used to locate where significant differences occurred. The relationships of fish abundance and species richness to the quantity of *Sargassum* collected by neuston nets was evaluated with regression analysis. Length-frequency distributions for dominant species collected from *Sargassum* habitat were compared to the size structures of the same species collected from open-water habitat using a Kolmogorov-Smirnov test.

Habitat type sampled was also designated for supplemental methods. If *Sargassum* was collected by dip net, then that station was designated as S; otherwise it was OW. Whether hook-and-line gear was placed into *Sargassum* (S) or into unvegetated habitat (OW) determined the station habitat type.

RESULTS

Catch Composition

Combining all methods and cruises, most fishes were collected in samples containing *Sargassum* habitat. A total of 18,799 fishes, representing 80 species from 28 families, was collected in 162 *Sargassum* samples, and a total of 2706 fishes, representing 60 species from 23 families, was collected in 80 open-water samples (Figure 1, Table 1). Both *Sargassum* and open-water collections were dominated by the families Monacanthidae (75% of S total, 45% of OW total), Carangidae (13% S, 21 OW%) and Exocoetidae (6% S, 19% OW). Individuals of nine species comprised 93% of the total *Sargassum* catch (in decreasing order of abundance): *Stephanolepis hispidus*, *Caranx crysos*, *Cheilopogon melanurus*, *Balistes capriscus*, *Seriola rivoliana*, *Parexocoetus brachypterus*, *Monacanthus ciliatus*, *Decapterus punctatus* and *Coryphaena hippurus*. Individuals of 10 species comprised 92% of the total open-water catch (in decreasing order of abundance): *S. hispidus*, *C. crysos*, *Clupea harengus* (all from a single station), *C. melanurus*, *P. brachypterus*, *D. punctatus*, *Prognichthys occidentalis*, *Oxyporhamphus micropterus*, *Istiophorus platypterus* and *C. hippurus*. Combining all methods, 33 species were only collected in association with *Sargassum* habitat, and 13 species were unique to open-water habitat (Table 2).

There was a large discrepancy between *Sargassum* and open-water catches from the 2000-2003 neuston net samples. A total of 14,123 fishes, representing 65 species, was collected in 91 neuston tows in *Sargassum* habitat. Thirteen open-water tows produced no catch, while 14 open-water tows yielded 1393 fishes, representing 27 species (Table 3). Dominant families collected by neuston net in both *Sargassum* and open-water habitats were Monacanthidae (83% of S total, 79% of OW total), Carangidae (9% S, 13 OW%) and Exocoetidae (4% S, 6 OW%).

Table 1. Collection data for fishes off North Carolina during summer or fall of 1999-2003. Area: CH=Cape Hatteras, CL=Cape Lookout, CF=Cape Fear; S: (+)=presence of *Sargassum*; Gear: NL=nightlighting, NN= neuston net, HL=hook and line, DN=dip net, LL=longline, UWV= underwater video; Day/Night: D=0700-2000, N=2000-0700 EDT, *n* = number of fishes collected.

Station	Date	Area	S	Gear	Day/ Night	Start Latitude (N), Longitude (W)	*n*
DM-1999-002	02-Aug-99	CH		NN	D	35° 30.927', 74° 44.683'	3
DM-1999-003	02-Aug-99	CH		NN	D	35° 29.902', 74° 44.770'	2
DM-1999-005	02-Aug-99	CH		NN	N	35° 28.659', 74° 47.991'	35
DM-1999-007	03-Aug-99	CH		NN	N	35° 28.040', 74° 48.000'	16
DM-1999-008	03-Aug-99	CH		NN	N	35° 31.662', 74° 44.292'	53
DM-1999-009	03-Aug-99	CH		NN	N	35° 30.262', 74° 45.742'	78
DM-1999-018	04-Aug-99	CH	+	NL	N	35° 30.405', 74° 45.775'	4
DM-1999-019	04-Aug-99	CH	+	NN	N	35° 31.230', 74° 44.240'	25
DM-1999-020	04-Aug-99	CH		NN	N	35° 31.896', 74° 45.689'	12
DM-1999-022	04-Aug-99	CH		NN	D	35° 31.039', 74° 47.999'	30
DM-1999-025	04-Aug-99	CH	+	DN	D	35° 30.518', 74° 47.392'	109
DM-1999-026	04-Aug-99	CH		NN	D	35° 32.606', 74° 46.180'	40
DM-1999-028	04-Aug-99	CH	+	DN	D	35° 29.847', 74° 47.409'	38
DM-1999-029	04-Aug-99	CH	+	NN	D	35° 31.595', 74° 48.518'	199
DM-1999-031	05-Aug-99	CH	+	NL	N	35° 27.387', 74° 47.913'	114
DM-1999-032	05-Aug-99	CH	+	NL	N	35° 27.044', 74° 48.927'	4
DM-1999-034A	05-Aug-99	CH	+	NL	N	35° 26.756', 74° 49.445'	4
DM-1999-035	05-Aug-99	CH		NN	D	35° 32.999', 74° 50.130'	28
DM-1999-045A	05-Aug-99	CH	+	NL	N	35° 31.975', 74° 43.777'	56
DM-1999-046	06-Aug-99	CH		NN	N	35° 30.958', 74° 46.431'	98
DM-1999-047	06-Aug-99	CH		NN	N	35° 30.795', 74° 46.779'	32
DM-1999-050	06-Aug-99	CH	+	NN	N	35° 28.275', 74° 48.157'	1497
DM-1999-051A	06-Aug-99	CH	+	HL	D	35° 30.145', 74° 44.749'	2
DM-1999-051B	06-Aug-99	CH	+	UWV	D	35° 30.145', 74° 44.749'	-
DM-1999-052	06-Aug-99	CH	+	NN	D	35° 30.482', 74° 48.595'	638
DM-1999-059A	06-Aug-99	CH		NL	N	35° 20.145', 74° 57.846'	260
DM-1999-057A	06-Aug-99	CH		LL	N	35° 18.860', 74° 59.040'	11
DM-1999-059B	06-Aug-99	CH		HL	N	35° 20.145', 74° 57.846'	28
DM-1999-057B	07-Aug-99	CH	+	DN	D	35° 32.969', 74° 43.332'	12
DM-1999-057C	07-Aug-99	CH	+	UWV	D	35° 32.969', 74° 43.332'	-
DM-1999-062	07-Aug-99	CH	+	NL	N	35° 26.140', 74° 49.697'	18
EL-2000-003	20-Jul-00	CH		NN	D	35° 31.120', 74° 46.020'	82
EL-2000-004	20-Jul-00	CH		NN	D	35° 30.917', 74° 46.197'	455
EL-2000-006	20-Jul-00	CH		NN	D	35° 29.830', 74° 47.860'	16
EL-2000-008	20-Jul-00	CH	+	NN	D	35° 30.280', 74° 45.990'	213
EL-2000-009	20-Jul-00	CH	+	NN	D	35° 28.280', 74° 46.850'	125
EL-2000-011	20-Jul-00	CH	+	NN	D	35° 30.128', 74° 46.395'	1167
EL-2000-012	20-Jul-00	CH	+	NN	N	35° 27.481' 74° 46.099'	82

Table 1 cont.

EL-2000-015	20-Jul-00	CH	+	NN	N	35° 28.885' 74° 47.367'	1002
EL-2000-017	21-Jul-00	CH	+	NN	N	35° 29.610', 74° 46.310'	249
EL-2000-019	21-Jul-00	CH	+	NN	N	35° 30.400', 74° 44.600'	109
EL-2000-020	21-Jul-00	CH		HL	D	35° 30.508', 74° 47.187'	1
EL-2000-021	21-Jul-00	CH	+	HL	D	35° 29.530', 74° 46.300'	5
EL-2000-023	21-Jul-00	CH		NN	D	35° 30.980', 74° 46.040'	26
EL-2000-024	21-Jul-00	CH	+	NN	D	35° 30.430', 74° 46.260'	1259
EL-2000-026	21-Jul-00	CH	+	NN	D	35° 31.390', 74° 46.050'	3131
EL-2000-028	21-Jul-00	CH	+	NN	N	35° 31.650', 74° 45.700'	1095
EL-2000-030	21-Jul-00	CH	+	NN	N	35° 29.520', 74° 46.597'	522
EL-2000-034	23-Jul-00	CH		NN	N	35° 29.471', 74° 46.773'	31
EL-2000-035	23-Jul-00	CH	+	NN	N	35° 28.453', 74° 47.322'	463
EL-2000-039	24-Jul-00	CH	+	NL	N	35° 29.030', 74° 46.830'	17
EL-2000-041	24-Jul-00	CH	+	NL	N	35° 29.900', 74° 46.500'	28
EL-2000-042	24-Jul-00	CH	+	DN	D	35° 29.651', 74° 47.748'	55
EL-2000-044	24-Jul-00	CH	+	DN	D	35° 30.189', 74° 46.420'	19
EL-2000-045	24-Jul-00	CH	+	DN	D	35° 28.393', 74° 47.242'	25
EL-2000-046	24-Jul-00	CH	+	DN	D	35° 27.810', 74° 47.370'	31
EL-2000-047	24-Jul-00	CH	+	DN	D	35° 29.674', 74° 47.650'	50
EL-2000-049	25-Jul-00	CH	+	NL	N	35° 29.538', 74° 49.123'	54
EL-2000-051	25-Jul-00	CH	+	NL	N	35° 31.970', 74° 47.394'	46
EL-2000-053	25-Jul-00	CH	+	NL	N	35° 31.700', 74° 46.200'	47
EL-2000-055	25-Jul-00	CH		NN	D	35° 30.510', 74° 47.100'	249
EL-2000-056	25-Jul-00	CH	+	NN	D	35° 30.780', 74° 46.840'	1073
EL-2000-057	25-Jul-00	CH	+	DN	D	35° 30.737', 74° 47.055'	213
EL-2000-059	25-Jul-00	CH	+	NN	N	35° 29.600', 74° 46.300'	85
EL-2000-060	25-Jul-00	CH	+	NN	N	35° 27.760', 74° 46.980'	68
EL-2000-061	25-Jul-00	CH	+	NN	N	35° 26.190', 74° 48.270'	56
EL-2000-063	26-Jul-00	CH	+	NL	N	35° 30.110', 74° 46.610'	64
EL-2000-065	26-Jul-00	CH	+	NN	N	35° 28.400', 74° 47.000'	75
EL-2000-067	26-Jul-00	CH		HL	D	35° 31.156', 74° 49.126'	1
EL-2000-068	26-Jul-00	CH	+	NN	D	35° 30.260', 74° 47.920'	123
EL-2000-070	26-Jul-00	CH		HL	D	35° 29.632', 74° 48.086'	5
EL-2000-071	26-Jul-00	CH	+	DN	D	35° 31.556', 74° 46.754'	159
EL-2000-072	26-Jul-00	CH		HL	D	35° 30.200', 74° 47.800'	2
EL-2000-074	26-Jul-00	CH	+	NN	N	35° 31.180', 74° 46.430'	441
EL-2000-075	26-Jul-00	CH		NL	N	35° 28.847', 74° 47.702'	4
EL-2000-076	26-Jul-00	CH		NN	N	35° 27.860', 74° 48.270'	60
EL-2000-077	27-Jul-00	CH		NL	N	35° 31.372', 74° 46.990'	88
EL-2000-079	27-Jul-00	CH	+	NL	N	35° 31.765', 74° 46.939'	48
EL-2000-082	27-Jul-00	CH	+	DN	D	35° 32.290', 74° 45.560'	33
EL-2000-083	27-Jul-00	CH	+	DN	D	35° 35.169', 74° 44.001'	298

Table 1 cont.

CH-2001-004	22-Aug-01	CH +	NN	N	35° 29.950', 74° 47.210'	175
CH-2001-005	23-Aug-01	CH +	NN	N	35° 30.093', 74° 46.717'	38
CH-2001-007	23-Aug-01	CH +	NN	N	35° 29.835', 74° 47.058'	16
CH-2001-009	23-Aug-01	CH +	NN	N	35° 30.445', 74° 46.926'	52
CH-2001-010	23-Aug-01	CH +	NN	N	35° 28.916', 74° 47.680'	34
CH-2001-013	23-Aug-01	CH +	NN	D	35° 22.566', 74° 48.559'	47
CH-2001-016	23-Aug-01	CH +	DN	D	35° 32.139', 74° 47.371'	9
CH-2001-017	23-Aug-01	CH +	NN	D	35° 32.435', 74° 46.882'	3
CH-2001-019	23-Aug-01	CH +	NN	D	35° 32.342', 74° 50.414'	3
CH-2001-020	23-Aug-01	CH +	NN	D	35° 32.374', 74° 48.648'	21
CH-2001-022	23-Aug-01	CH +	NN	D	35° 29.305', 74° 46.941'	15
CH-2001-024	23-Aug-01	CH +	NN	N	35° 30.831', 74° 45.899'	155
CH-2001-026A	23-Aug-01	CH +	NN	N	35° 30.523', 74° 45.142'	20
CH-2001-027	24-Aug-01	CH +	NN	N	35° 30.762', 74° 44.308'	17
CH-2001-030	24-Aug-01	CH +	NN	N	35° 31.992', 74° 41.757'	19
CH-2001-031	24-Aug-01	CH +	NN	N	35° 31.370', 74° 43.066'	5
CH-2001-033	24-Aug-01	CH +	NN	N	35° 30.915', 74° 43.789'	16
CH-2001-034	24-Aug-01	CH +	NN	N	35° 31.459', 74° 44.709'	15
CH-2001-037	24-Aug-01	CH +	NN	D	35° 30.550', 74° 48.230'	25
CH-2001-039	24-Aug-01	CH +	NN	D	35° 31.370', 74° 48.430'	12
CH-2001-041	24-Aug-01	CH +	NN	D	35° 29.465', 74° 47.621'	44
CH-2001-043	24-Aug-01	CH +	NN	D	35° 30.433', 74° 47.455'	31
CH-2001-044	24-Aug-01	CH +	NN	D	35° 29.060', 74° 46.761'	3
CH-2001-045	24-Aug-01	CH +	NN	D	35° 28.777', 74° 47.540'	14
CH-2001-046	24-Aug-01	CH	NN	D	35° 27.946', 74° 46.524'	7
CH-2001-050	24-Aug-01	CH +	NN	N	35° 31.250', 74° 43.490'	42
CH-2001-055	25-Aug-01	CH +	NN	N	35° 30.939', 74° 44.501'	10
CH-2001-056	25-Aug-01	CH +	NN	N	35° 30.425', 74° 45.214'	19
CH-2001-060	25-Aug-01	CH +	DN	D	35° 37.550', 74° 48.403'	61
CH-2001-062	25-Aug-01	CH +	DN	D	35° 36.910', 74° 48.670'	34
CH-2001-063	25-Aug-01	CH +	NN	D	35° 36.971', 74° 48.380'	547
CH-2001-072	26-Aug-01	CH +	NN	D	35° 30.720', 74° 47.650'	30
CH-2001-075	26-Aug-01	CH +	NN	D	35° 27.169', 74° 48.272'	2
CH-2001-077	26-Aug-01	CH +	NN	D	35° 32.287', 74° 43.876'	57
CH-2001-078	26-Aug-01	CH +	NN	D	35° 30.583', 74° 45.708'	30
CH-2001-082A	27-Aug-01	CL	NL	N	34° 24.192', 75° 56.613'	19
CH-2001-083	27-Aug-01	CL	NL	N	34° 24.670', 75° 56.584'	42
CH-2001-084	27-Aug-01	CL	NL	N	34°25.240', 75° 56.550'	22
CH-2001-085	27-Aug-01	CL	NL	N	34° 25.781', 75° 56.486'	22
CH-2001-086	28-Aug-01	CL	NL	N	34° 26.290', 75° 56.370'	20
CH-2001-087	28-Aug-01	CL	NL	N	34° 26.885', 75° 56.213'	28
CH-2001-088	28-Aug-01	CL	NL	N	34° 26.885', 75° 56.213'	23
CH-2001-089	28-Aug-01	CL	NL	N	34° 28.005', 75° 55.813'	18

Table 1 cont.

CH-2001-091	28-Aug-01	CL		NL	N	34° 28.986', 75° 55.045'	7
CH-2001-093	28-Aug-01	CL	+	NN	D	34° 19.735', 75° 47.964'	56
CH-2001-095	28-Aug-01	CL	+	NN	D	34° 18.840', 75° 47.620'	24
CH-2001-098	28-Aug-01	CL	+	NN	D	34° 19.660', 75° 46.412'	69
CH-2001-099	28-Aug-01	CL	+	NN	D	34° 18.452', 75° 46.208'	11
CH-2001-101	28-Aug-01	CL	+	NN	D	34° 19.957', 75° 46.719'	24
SJII-2001-006	20-Sep-01	CH	+	NN	D	35° 28.891', 74° 44.637'	2
SJII-2001-009	20-Sep-01	CH	+	NN	D	35° 30.137', 74° 46.033'	69
SJII-2001-011	20-Sep-01	CH	+	NN	N	35° 31.333', 74° 44.230'	19
SJII-2001-014	21-Sep-01	CH	+	NN	N	35° 31.575', 74° 43.456'	7
SJII-2001-017	21-Sep-01	CH	+	NN	N	35° 31.718', 74° 44.742'	15
SJII-2001-020	21-Sep-01	CH	+	NN	N	35° 31.372', 74° 46.055'	6
SJII-2001-023	21-Sep-01	CH	+	NN	D	35° 30.815', 74° 46.447'	15
SJII-2001-025A	21-Sep-01	CH	+	NN	D	35° 30.551', 74° 46.745'	10
SJII-2001-025B	22-Sep-01	CL	+	HL	D	34° 19.781', 75° 47.260'	27
SJII-2001-026	22-Sep-01	CL	+	HL	D	34° 19.454', 75° 47.432'	6
SJII-2001-028	22-Sep-01	CL	+	NN	N	34° 20.924', 75° 46.384'	3
SJII-2001-030	22-Sep-01	CL		NN	N	34° 20.970', 75° 46.294'	1
SJII-2001-032	22-Sep-01	CL	+	NN	N	34° 20.886', 75° 46.333'	3
SJII-2001-034	23-Sep-01	CL	+	NN	N	34° 20.649', 75° 46.460'	2
SJII-2001-040	23-Sep-01	CL	+	NN	N	34° 19.806', 75° 47.180'	1
SJII-2001-047	24-Sep-01	CL		NL	N	34° 13.842', 75° 53.044'	5
SJII-2001-049	24-Sep-01	CL	+	NN	N	34° 13.842', 75° 53.044'	4
SJII-2001-051	24-Sep-01	CL	+	NN	N	34° 11.800', 75° 51.406'	2
SJII-2001-052	24-Sep-01	CL		NN	D	34° 11.245', 75° 54.045'	0
SJII-2001-059	25-Sep-01	CF		NN	D	33° 13.109', 77° 16.875'	0
SJII-2001-062	25-Sep-01	CF	+	NL	N	33° 10.408', 77° 16.784'	5
SJII-2001-066	26-Sep-01	CF		NN	N	33° 08.260', 77° 14.813'	0
SJ-2002-002	06-Aug-02	CF		NN	D	33° 13.397', 77° 22.227'	0
SJ-2002-003	06-Aug-02	CF		NN	D	33° 14.575', 77° 22.914'	0
SJ-2002-004	06-Aug-02	CF		NN	D	33° 12.382', 77° 22.199'	1
SJ-2002-005	06-Aug-02	CF	+	NN	D	33° 13.721', 77° 23.230'	1
SJ-2002-009	07-Aug-02	CF		HL	D	33° 16.118', 77° 19.740'	1
SJ-2002-016	09-Aug-02	CL	+	NN	D	34° 21.880', 75° 59.989'	41
SJ-2002-017	09-Aug-02	CL		NN	D	34° 22.907', 75° 59.257'	0
SJ-2002-018	09-Aug-02	CL		NN	D	34° 24.450', 75° 58.861'	1
SJ-2002-019	09-Aug-02	CL	+	NN	D	34° 21.094', 75° 58.687'	86
SJ-2002-020	09-Aug-02	CL	+	NN	D	34° 21.727', 75° 58.180'	130
SJ-2002-021	09-Aug-02	CL	+	NN	D	34° 22.571', 75° 58.034'	215
SJ-2002-022	09-Aug-02	CL	+	NN	D	34° 26.719', 75° 56.849'	1
SJ-2002-027	09-Aug-02	CL	+	NN	D	34° 23.553', 75° 58.961'	18
SJ-2002-029	09-Aug-02	CL		HL	D	34° 24.347', 75° 57.931'	17
SJ-2002-030	09-Aug-02	CL	+	NN	D	34° 24.639', 75° 57.647'	69

Table 1 cont.

SJ-2002-042	11-Aug-02	CL		NN	N	34° 17.764', 75° 47.295'	0
SJ-2002-043	11-Aug-02	CL		NN	N	34° 18.441', 75° 47.592'	0
SJ-2002-044	12-Aug-02	CL	+	NN	N	34° 17.031', 75° 47.225'	21
SJ-2002-046	12-Aug-02	CL	+	NN	N	34° 17.983', 75° 47.406'	13
SJ-2002-047	12-Aug-02	CL	+	NN	N	34° 17.230', 75° 46.752'	10
SJ-2002-048	12-Aug-02	CL	+	NN	N	34° 16.510', 75° 46.423'	4
SJ-2002-049	12-Aug-02	CL		NN	D	34° 20.760', 75° 46.254'	2
SJ-2002-050	12-Aug-02	CL		NN	D	34° 25.228', 75° 43.864'	0
SJ-2002-051	12-Aug-02	CL		NN	D	34° 19.730', 75° 47.458'	0
SJ-2002-056	13-Aug-02	CF		NN	N	33° 29.932', 76° 57.440'	0
SJ-2002-057	13-Aug-02	CF	+	NN	N	33° 29.519', 76° 56.760'	9
SJ-2002-058	13-Aug-02	CF		NL	N	33° 29.659', 76° 57.036'	9
SJ-2002-059	13-Aug-02	CF		NL	N	33° 30.107', 76° 57.884'	16
SJ-2002-060	13-Aug-02	CF		NL	N	33° 30.515', 76° 58.647'	7
SJ-2002-061	13-Aug-02	CF		NL	N	33° 30.940', 76° 59.344'	16
SJ-2002-062	13-Aug-02	CF		NL	N	33° 31.530', 77° 00.131'	11
SJ-2002-063	13-Aug-02	CF		NL	N	33° 31.953', 77° 00.658'	31
SJ-2002-064	14-Aug-02	CF	+	NL	N	33° 32.434', 77° 01.210'	15
SJ-2002-065	14-Aug-02	CF	+	NL	N	33° 32.842', 77° 01.606'	20
SJ-2002-066	14-Aug-02	CF		NL	N	33° 33.212', 77° 01.943'	23
SJ-2002-067	14-Aug-02	CF		NL	N	33° 33.494', 77° 02.159'	19
SJ-2002-068	14-Aug-02	CF		NL	N	33° 33.606', 77° 02.235'	6
SJ-2002-069	14-Aug-02	CF		NN	D	33° 24.643', 77° 05.127'	1
SJ-2002-070	14-Aug-02	CF	+	NN	D	33° 23.635', 77° 04.892'	1
SJ-2002-071	14-Aug-02	CF	+	NN	D	33° 22.379', 77° 04.447'	2
SJ-2002-073	14-Aug-02	CF		NN	D	33° 20.911', 77° 10.585'	0
SJ-2002-074	14-Aug-02	CF	+	NN	D	33° 20.035', 77° 10.172'	4
SJ-2002-075	14-Aug-02	CF	+	NL	N	33° 13.578', 77° 18.000'	8
SJ-2002-076	14-Aug-02	CF	+	NL	N	33° 13.474', 77° 17.732'	4
SJ-2002-077	14-Aug-02	CF		NL	N	33° 13.361', 77° 18.480'	14
SJ-2002-078	14-Aug-02	CF		NL	N	33° 13.258', 77° 19.457'	8
SJ-2002-079	14-Aug-02	CF		NL	N	33° 13.264', 77° 20.276'	7
SJ-2002-080	14-Aug-02	CF		NL	N	33° 13.291', 77° 21.412'	9
SJ-2002-081	14-Aug-02	CF		NL	N	33° 13.388', 77° 22.244'	8
SJ-2002-082	15-Aug-02	CF		NL	N	33° 13.521', 77° 23.007'	7
SJ-2002-083	15-Aug-02	CF		NL	N	33° 13.641', 77° 23.811'	20
SJ-2002-084	15-Aug-02	CF	+	NL	N	33° 13.726', 77° 24.498'	13
SJ-2002-085	15-Aug-02	CF	+	NL	N	33° 13.780', 77° 25.206'	4
SJ-2002-086	15-Aug-02	CF	+	NL	N	33° 13.747', 77° 26.420'	9
SJ-2002-087	15-Aug-02	CF	+	NN	D	33° 14.655', 77° 15.491'	1
SJ-2003-010	19-Aug-03	CF	+	NN	D	33° 30.405', 76° 33.967'	17
SJ-2003-011	19-Aug-03	CF	+	NN	D	33° 29.030', 76° 33.882'	27
SJ-2003-012	19-Aug-03	CF	+	NL	N	33° 24.986', 77° 05.489'	6

Table 1 cont.

SJ-2003-014A	19-Aug-03	CF	+	HL	N	33° 25.695', 77° 06.049'	2
SJ-2003-015A	19-Aug-03	CF	+	NL	N	33° 26.046', 77° 06.307'	6
SJ-2003-015B	19-Aug-03	CF	+	HL	N	33° 26.046', 77° 06.307'	1
SJ-2003-016	20-Aug-03	CF	+	NL	N	33° 25.691', 76° 50.176'	2
SJ-2003-020A	20-Aug-03	CF	+	DN	D	33° 24.745', 77° 05.026'	50
SJ-2003-020B	20-Aug-03	CF	+	HL	D	33° 24.745', 77° 05.026'	1
SJ-2003-021	20-Aug-03	CF	+	DN	D	33° 29.804', 76° 56.506'	62
SJ-2003-036	22-Aug-03	CF	+	NN	N	33° 34.305', 76° 27.640'	2
SJ-2003-037	22-Aug-03	CF		NN	D	33° 34.436', 76° 27.666'	0
SJ-2003-038	22-Aug-03	CF	+	NN	D	33° 34.384', 76° 27.792'	1
SJ-2003-039	22-Aug-03	CF	+	DN	D	33° 34.299', 76° 28.018'	27
SJ-2003-046	23-Aug-03	CL	+	NL	N	34° 19.191', 75° 45.486'	8
SJ-2003-047	24-Aug-03	CL	+	NL	N	34° 20.352', 75° 43.333'	35
SJ-2003-048	24-Aug-03	CL	+	NL	N	34° 21.437', 75° 41.677'	15
SJ-2003-049	24-Aug-03	CL	+	NL	N	34° 22.590', 75° 39.770'	38
SJ-2003-050	24-Aug-03	CL	+	NL	N	34° 23.409', 75° 38.460'	18
SJ-2003-056	25-Aug-03	CF	+	NL	N	33° 26.095', 77° 02.957'	34
SJ-2003-057	25-Aug-03	CF	+	NL	N	33° 26.973', 77° 02.751'	7
SJ-2003-060	25-Aug-03	CF	+	NL	N	33° 26.231', 77° 05.075'	69
SJ-2003-061	25-Aug-03	CF	+	NL	N	33° 26.524', 77° 05.210'	47
SJ-2003-062	25-Aug-03	CF	+	NL	N	33° 26.779', 77° 05.384'	23
SJ-2003-063	25-Aug-03	CF	+	NL	N	33° 26.983', 77° 05.565'	26
SJ-2003-064A	25-Aug-03	CF	+	NL	N	33° 27.200', 77° 05.788'	18
SJ-2003-065	26-Aug-03	CF	+	NL	N	33° 27.462', 77° 06.084'	16
SJ-2003-066	26-Aug-03	CF	+	NL	N	33° 27.649', 77° 06.290'	8
SJ-2003-067	26-Aug-03	CF		NL	N	33° 23.984', 77° 04.208'	13
SJ-2003-068	26-Aug-03	CF		NL	N	33° 24.090', 77° 04.487'	12
SJ-2003-069	26-Aug-03	CF		NL	N	33° 24.110', 77° 04.639'	6
SJ-2003-070	26-Aug-03	CF	+	NL	N	33° 24.134', 77° 05.023'	10
SJ-2003-071	26-Aug-03	CF	+	NL	N	33° 24.151', 77° 05.177'	4

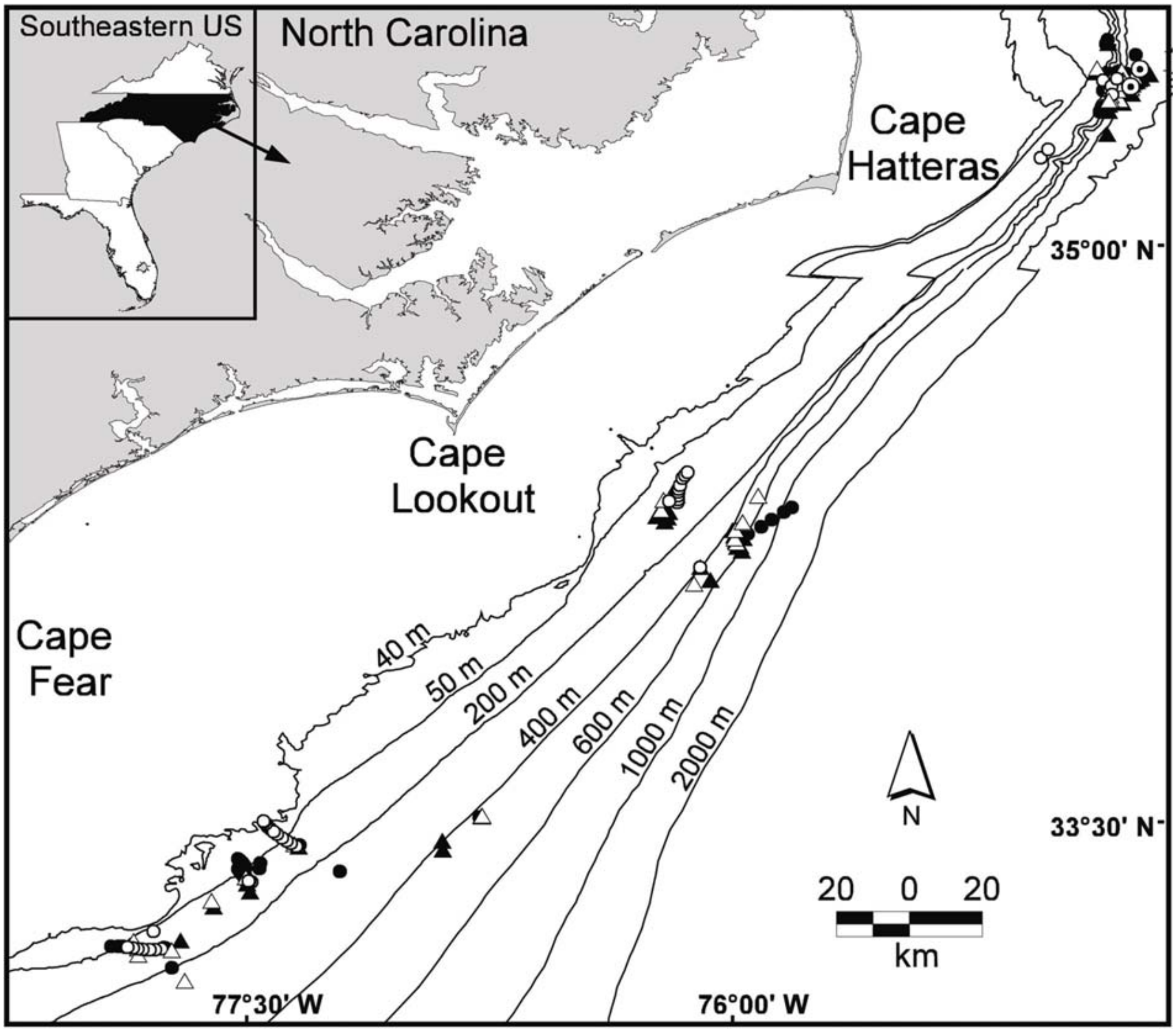

Figure 1. Surface sampling sites for fishes collected during summer or fall of 1999-2003 off North Carolina. Neuston net collections (triangles) and supplemental gears (circles) separated by *Sargassum* (closed symbols) and open-water (open symbols) collections. The white circles with a black center off Cape Hatteras represent underwater video recordings.

Table 2. Number of fishes followed by standard length (in mm) ranges in parentheses collected by method from *Sargassum* and open water habitats during summer or fall of 1999-2003 off North Carolina. NN=neuston net, DN=dip net, NL=nightlighting, HL=hook-and-line, LL=longline, number of stations is in parentheses under gear type. ' =total length in mm, N/A=length not available due to damage, *=species not previously collected in association with *Sargassum* , identification to species was not possible for some fishes due to damage. Species are listed in phylogenetic order.

	Sargassum					Open water				
Taxa	NN (95)	NL (42)	DN (18)	HL (7)	Total *n*	NN (39)	NL (33)	HL (7)	LL (1)	Total *n*
Carcharhinidae										
Carcharhinus falciformis				1 (890)	1					0
Ophichthidae										
*Ahlia egmontis**		4 (270-410)			4		1 (378)			1
Clupeidae										
Clupea harengus					0		216 (22-42)			216
Gonostomatidae										
Cyclothone sp.*	1 (N/A)				1					0
Sternoptychidae										
*Argyropelecus aculeatus**	1 (41)				1					0
Phosichthyidae										
Vinciguerria poweriae					0		1 (20)			1
Synodontidae										
Synodus synodus					0		1 (31)			1
Myctophidae										
*Diaphus dumerilii**	1 (61)				1					0
*Myctophum affine**	27 (13-27)				27					0
*Myctophum obtusirostre**	10 (13-53)				10					0
*Myctophum punctatum**	5 (39-51)				5					0
*Myctophum selenops**	1 (45)				1					0
Myctophum sp.	1 (18)				1					0
Antennariidae										
Histrio histrio	13 (9-45)	4 (7-36)	6 (12-46)		23					0
Mugilidae										
Mugil curema	1 (14)				1	4 (14-20)	4 (25-27)			8
Unidentified	2 (13-14)				2					0
Belonidae										
*Ablennes hians**	14 (33-374)	8 (90-393)			22	3 (40-126)	4 (351-466)			7
*Platybelone argalus**	2 (149-155)	3 (149-236)			5					0
Tylosurus acus	18 (53-336)	14 (63-481)			32		4 (202-285)			4
*Tylosurus crocodilus**		1 (201)			1					0
Tylosurus sp.	2 (44-57)				2					0
Exocoetidae										
*Cheilopogon cyanopterus**	6 (24-112)	3 (118-144)			9		8 (30-131)			8
*Cheilopogon exsiliens**	2 (31-115)	2 (112-122)			4		6 (20-108)			6
Cheilopogon furcatus	2 (19-30)	6 (35-120)			8		4 (35-112)			4

Table 2 cont.

Cheilopogon melanurus	399 (13-205)	157 (21-253)	2 (17-32)		558	57 (12-56)	147 (28-257)			204
Cheilopogon sp.	6 (19-23)				6					0
*Cypselurus comatus**	1 (72)				1		1 (107)			1
Exocoetus obtusirostris		1 (137)			1		3 (18-71)			3
Hirundichthys affinis	13 (17-95)	18 (56-164)			31	6 (17-47)	16 (49-105)			22
*Oxyporhamphus micropterus**	2 (64-95)	83 (33-183)			85		43 (12-110)			43
Parexocoetus brachypterus	160 (8-72)	86 (15-113)			246	46 (8-42)	112 (13-128)			158
*Prognichthys occidentalis**	36 (11-74)	45 (17-147)			81	7 (11-35)	62 (15-165)			69
Hemiramphidae										
*Euleptorhamphus velox**	11 (45-216)	3 (180-318)			14	9 (44-75)	6 (56-388)			15
Hemiramphus balao	10 (37-90)	20 (32-198)			30		2 (95-104)			2
*Hemiramphus brasiliensis**	22 (33-84)	7 (45-114)			29	2 (37-52)	3 (58-111)		4 (236-242)	9
Hemiramphus sp.	33 (31-75)				33		5 (24-110)			5
*Hyporhamphus unifasciatus**	1 (30)				1					0
Holocentridae										
Holocentrus sp.					0		1 (62)			1
Syngnathidae										
*Bryx dunckeri**	4 (28-47)		4 (35-42)		8	1 (32)				1
Hippocampus erectus	12 (17-143)'				12	2 (25-67)'				2
*Hippocampus reidi**	2 (72)'				2					0
Hippocampus sp.	1 (24)'				1					0
Syngnathus louisianae	1 (121)				1					0
Syngnathus pelagicus	1 (117)		15 (78-158)		16	1 (110)				1
Fistularidae										
*Fistularia tabacaria**	1 (69)				1					0
Fistularia sp.					0	1 (138)				1
Acropomatidae										
*Synagrops bellus**	1 (45)				1					0
Echeneidae										
*Echeneis naucrates**				2 (630-680)	2			1 (665)		1
*Remora osteochir**	1 (26)				1					0
Coryphaenidae										
*Coryphaena equiselis**	2 (26-32)	18 (28-68)			20	1 (30)	6 (37-91)			7
Coryphaena hippurus	99 (26-262)	22 (32-178)		41 (275-1020)	162	7 (26-112)	7 (27-188)	23 (370-623)	1 (286)	38
Carangidae										
Alectis ciliaris					0	4 (12-15)				4
Caranx bartholomaei	3 (20-61)	1 (34)			4					0
Caranx crysos	1646 (11-82)	91 (12-65)	96 (11-61)		1833	271 (11-72)	73 (12-99)			344
*Caranx lugubris**		3 (21-29)			3					0
Caranx ruber	57 (16-89)	2 (31-68)			59					0
Caranx sp.	20 (11-21)	3 (15-21)	18 (11-22)		41	12 (11-18)	2 (11-17)			14
Decapterus punctatus	144 (10-44)	19 (10-32)	3 (24-35)		166	150 (10-44)	1 (18)			151
Decapterus sp.	11 (16-30)		1 (20)		12		1 (28)			1
Elagatis bipinnulata	18 (17-81)	5 (24-43)			23		1 (19)			1
Selar crumenophthalmus	4 (17-29)				4	4 (15-21)	1 (28)			5

Table 2 cont.

*Selene setapinnis**			1 (19)	1	1 (13)				1
Selene vomer				0	3 (11-13)				3
Selene sp.				0	1 (14)				1
Seriola dumerili	7 (11-70)	3 (37-47)	1 (48)	11					0
Seriola fasciata	59 (12-107)	1 (26)	2 (29-32)	62	4 (23-30)				4
Seriola rivoliana	260 (12-95)	4 (16-57)	4 (20-36)	268	13 (21-47)	3 (14-34)			16
Seriola zonata	4 (23-37)			4	1 (16)				1
Seriola sp.	21 (12-66)	4 (13-71)	8 (11-22)	33	4 (11-16)	1 (12)	1 (N/A)		6
Trachinotus carolinus				0		2 (21-23)			2
Trachinotus falcatus				0	1 (14)				1
Lobotidae									
Lobotes surinamensis	11 (11-52)	2 (29-30)	1 (33)	14					0
Mullidae									
*Mulloidichthys martinicus**		1 (87)		1					0
Pseudupeneus maculatus		3 (37-43)		3		1 (26)			1
Kyphosidae									
Kyphosus incisor	2 (29-91)	4 (19-39)	1 (14)	7					0
Kyphosus sectatrix	30 (15-89)	2 (25-33)		32					0
Kyphosus sp.	1 (15)			1		2 (19-21)			2
Pomacentridae									
Abudefduf saxatilis	45 (16-29)	2 (18-19)	4 (16-20)	51					0
Sphyraenidae									
Sphyraena barracuda				0			1 (1219)		1
*Sphyraena borealis**	1 (31)			1					0
Gempylidae									
Gempylus serpens				0		3 (64-81)			3
Scombridae									
*Auxis thazard**		2 (62-86)		2					0
Katsuwonus pelamis				0			2 (438-485)		2
Scomber colias				0			27 (225-261)		27
Scomber scombrus				0				6 (243-268)	6
Istiophoridae									
*Istiophorus platypterus**	4 (22-41)	4 (32-118)		8	2 (17-24)	38 (20-204)			40
Makaira nigricans				0		1 (205)			1
Nomeidae									
Psenes cyanophrys	5 (35-52)			5					0
Balistidae									
Balistes capriscus	345 (10-74)	19 (12-113)	37 (11-63)	401	17 (10-35)	2 (19-25)			19
Canthidermis maculata	17 (11-24)		2 (14-22)	19					0
Canthidermis sufflamen	26 (11-18)		1 (45)	27	1 (13)				1
Xanthichthys ringens	1 (21)	1 (65)		2					0
Unidentified	2 (N/A)			2					0
Monacanthidae									
Aluterus heudelotii	69 (25-70)	1 (50)	4 (31-44)	74	1 (24)	2 (36-39)			3
Aluterus monoceros	34 (33-151)	6 (53-95)		40	1 (52)	1 (103)			2

Table 2 cont.

Aluterus schoepfii	21 (18-69)				21	9 (16-38)	1 (46)			10
Aluterus scriptus	42 (20-113)	5 (36-122)			47		1 (32)			1
Aluterus sp.	3 (15-26)				3					0
Cantherhines macrocerus	6 (30-60)	1 (96)			7					0
Cantherhines pullus	14 (30-67)	1 (59)			15	2 (42-60)				2
Monacanthus ciliatus	176 (10-26)		6 (16-27)		182	7 (12-17)	1 (21)			8
Monacanthus tuckeri	14 (16-24)		4 (17-25)		18					0
Monacanthus sp.	1 (14)				1	1 (13)				1
Stephanolepis hispidus	12,420 (8-65)	288 (8-57)	1064 (8-68)		13,772	1161 (8-49)	16 (10-76)			1177
Stephanolepis setifer	1 (40)				1					0
Stephanolepis sp.					0	2 (10-11)				2
Tetraodontidae										
*Lagocephalus lagocephalus**		1 (127)			1					0
Diodontidae										
Chilomycterus sp.	1 (22)				1					0
Diodon holocanthus	6 (15-55)	3 (46-75)			9		1 (51)			1
Diodon hystrix	2 (37-219)	1 (85)			3		2 (160-212)			2
TOTAL	16,482	988	1285	44	18,799	1820	820	55	11	2706

Individuals of eight species comprised 95% of the total *Sargassum* neuston net catches (in decreasing order of abundance): *S. hispidus*, *C. crysos*, *C. melanurus*, *B. capriscus*, *M. ciliatus*, *S. rivoliana*, *P. brachypterus* and *C. hippurus*. Individuals of four species comprised 93% of the total open-water neuston net catches (in decreasing order of abundance): *S. hispidus*, *D. punctatus*, *C. crysos* and *C. melanurus*. There were significantly more individuals (Mann-Whitney test: df=117, $P<0.001$) and numbers of species (Mann-Whitney test: df=117, $P<0.001$) in *Sargassum* habitat compared with open-water habitat. The three most abundant species in neuston net collections containing *Sargassum* habitat also exhibited the highest frequencies of occurrence: *S. hispidus* (70% of samples), *C. crysos* (64%) and *C. melanurus* (46%), whereas in open-water habitat these species occurred in 41%, 19% and 22% of samples, respectively. Forty of the total 65 species collected from 2000-2003 neuston net tows in *Sargassum* were unique to this habitat, whereas only two (*Fistularia* sp., *Selene setapinnis*) of the total 27 species collected in open-water habitat were unique (Table 3).

Day versus Night Catch Composition

Regardless of sampling time (day or night), *Sargassum* habitat yielded significantly (Kruskal-Wallis test: df=3, $P<0.05$) higher numbers of individuals and species compared with open-water collections. Daytime *Sargassum* neuston net samples (n=47) yielded 8869 fishes from 48 species, and nighttime *Sargassum* neuston net samples (n=44) yielded 5254 fishes from 56 species (Table 3); however, these differences were not statistically significant (Kruskal-Wallis test: df=3, P=0.924). Supplemental methods used in *Sargassum* habitat (dip nets, hook-and-line, 1999 neuston net) yielded different results with slightly more fishes (350 individuals) collected

Table 3. Number of fishes collected from *Sargassum* and open-water neuston net tows off North Carolina during 2000-2003, separated by day and night. Number of samples is in parentheses.

	Sargassum		Open water	
	Day	Night	Day	Night
Species	(47)	(44)	(19)	(8)
Cyclothone sp.	1	0	0	0
Argyropelecus aculeatus	1	0	0	0
Diaphus dumerilii	1	0	0	0
Myctophum affine	0	27	0	0
Myctophum obtusirostre	0	10	0	0
Myctophum punctatum	1	4	0	0
Myctophum selenops	0	1	0	0
Myctophum sp.	0	1	0	0
Histrio histrio	7	2	0	0
Mugilidae	0	2	0	0
Ablennes hians	6	8	1	2
Platybelone argalus	0	2	0	0
Tylosurus acus	1	2	0	0
Tylosurus sp.	0	2	0	0
Cheilopogon cyanopterus	0	6	0	0
Cheilopogon exsiliens	0	2	0	0
Cheilopogon furcatus	0	2	0	0
Cheilopogon melanurus	31	365	5	49
Cheilopogon sp.	0	6	0	0
Cypselurus comatus	0	1	0	0
Hirundichthys affinis	0	13	0	6
Oxyporhamphus micropterus	0	2	0	0
Parexocoetus brachypterus	19	140	2	17
Prognichthys occidentalis	9	26	1	6
Euleptorhamphus velox	1	10	0	2
Hemiramphus balao	3	7	0	0
Hemiramphus brasiliensis	0	21	1	0
Hemiramphus sp.	2	31	0	0
Hyporhamphus unifasciatus	0	1	0	0
Bryx dunckeri	2	1	1	0
Hippocampus erectus	3	8	0	1
Hippocampus reidi	1	1	0	0
Hippocampus sp.	1	0	0	0
Syngnathus louisianae	1	0	0	0
Syngnathus pelagicus	1	0	1	0
Fistularia sp.	0	0	1	0
Synagrops bellus	0	1	0	0

Table 3 cont.

Coryphaena equiselis	2	0	0	1
Caranx bartholomaei	2	1	0	0
Caranx crysos	342	468	31	43
Caranx ruber	23	33	0	0
Caranx sp.	2	18	1	1
Decapterus punctatus	9	44	78	1
Decapterus sp.	4	7	0	0
Elagatis bipinnulata	5	5	0	0
Selar crumenophthalmus	2	0	0	0
Selene setapinnis	0	0	1	0
Seriola dumerili	3	4	0	0
Seriola fasciata	30	21	4	0
Seriola rivoliana	125	35	13	0
Seriola sp.	12	9	3	1
Seriola zonata	0	4	1	0
Lobotes surinamensis	9	1	0	0
Kyphosus incisor	0	2	0	0
Kyphosus sectatrix	11	1	0	0
Kyphosus sp.	1	0	0	0
Abudefduf saxatilis	5	5	0	0
Istiophorus platypterus	1	3	1	1
Psenes cyanophrys	0	5	0	0
Balistes capriscus	120	109	9	5
Canthidermis maculata	9	1	0	0
Canthidermis sufflamen	23	3	0	1
Xanthichthys ringens	1	0	0	0
Balistidae	0	2	0	0
Aluterus heudelotii	48	17	0	0
Aluterus monoceros	1	3	0	1
Aluterus schoepfii	10	7	0	1
Aluterus scriptus	31	8	0	0
Aluterus sp.	0	1	0	0
Cantherhines macrocerus	2	3	0	0
Cantherhines pullus	3	9	2	0
Monacanthus ciliatus	75	97	1	6
Monacanthus tuckeri	9	4	0	0
Monacanthus sp.	1	0	0	0
Stephanolepis hispidus	7840	3541	681	408
Stephanolepis setifer	1	0	0	0
Chilomycterus sp.	0	1	0	0
Diodon holocanthus	1	5	0	0
Diodon hystrix	1	1	0	0
TOTAL	8869	5254	840	553

at night than during the day. This was likely due to the slightly higher effort at night and the attraction aspect of nightlighting.

As above, most fishes from open-water neuston net samples were collected during the day. Ten of the total 19 daytime open-water neuston net tows yielded 840 fishes, representing 20 species, and four of the total eight nighttime open-water neuston net samples yielded 553 fishes, representing 18 species (Table 3); however, these differences were not significant (Kruskal-Wallis test: df=3, P=0.843). Supplemental methods used in open-water habitat (dip nets, hook-and-line, 1999 neuston net, long line), as above, produced more fishes at night (213 more individuals), probably for the same reasons.

Size Distributions

Ninety-six percent of all fishes collected in surface waters during these summer and fall cruises were juveniles with most (88%) individuals ≤ 50 mm SL. The majority of *S. hispidus* (79% S, 87% OW), *C. crysos* (72% S, 61 % OW), *B. capriscus* (79% S, 95% OW), *M. ciliatus* (100% S, 100% OW) and *D. punctatus* (93% S, 86% OW) collected in both *Sargassum* and open-water habitats were ≤ 30 mm SL (Figure 2). *Cheilopogon melanurus* collected in *Sargassum* habitat ranged from 13-253 mm SL, but the majority (84%) were juveniles < 150 mm SL. *Cheilopogon melanurus* collected in open-water habitat ranged from 12-257 mm SL, and the majority (77%) were also juveniles < 150 mm SL (Figure 2). *Coryphaena hippurus* collected in *Sargassum* habitat ranged from 25-1020 mm SL with the majority (80%) in the juvenile stage (< 300 mm SL), and *C. hippurus* collected in open-water habitat ranged from 26-623 mm SL, 45% of which were juveniles (< 300 mm SL) (Figure 2).

Overall, fishes collected by neuston net tows containing *Sargassum* habitat (8-374 mm

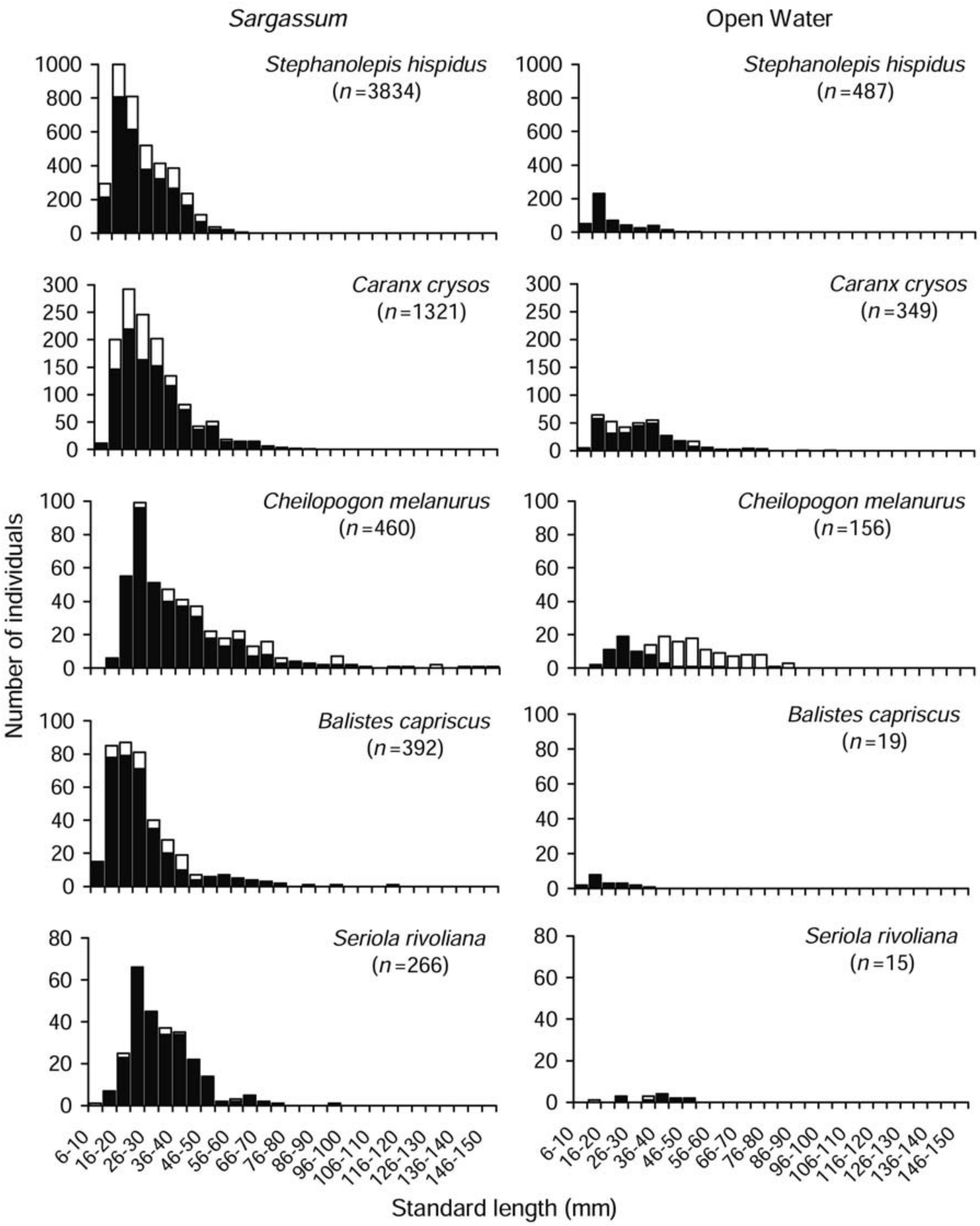

Figure 2. Length frequency distributions of the nine most abundant fishes collected in *Sargassum* and open-water habitats during summer or fall of 1999-2003 off North Carolina. Neuston net collections = black bars and supplemental gears = white bars. Only juvenile specimens were graphed for *Cheilopogon melanurus* (Atlantic flyingfish) and *Coryphaena hippurus* (dolphinfish). The scales in the y-axis differ.

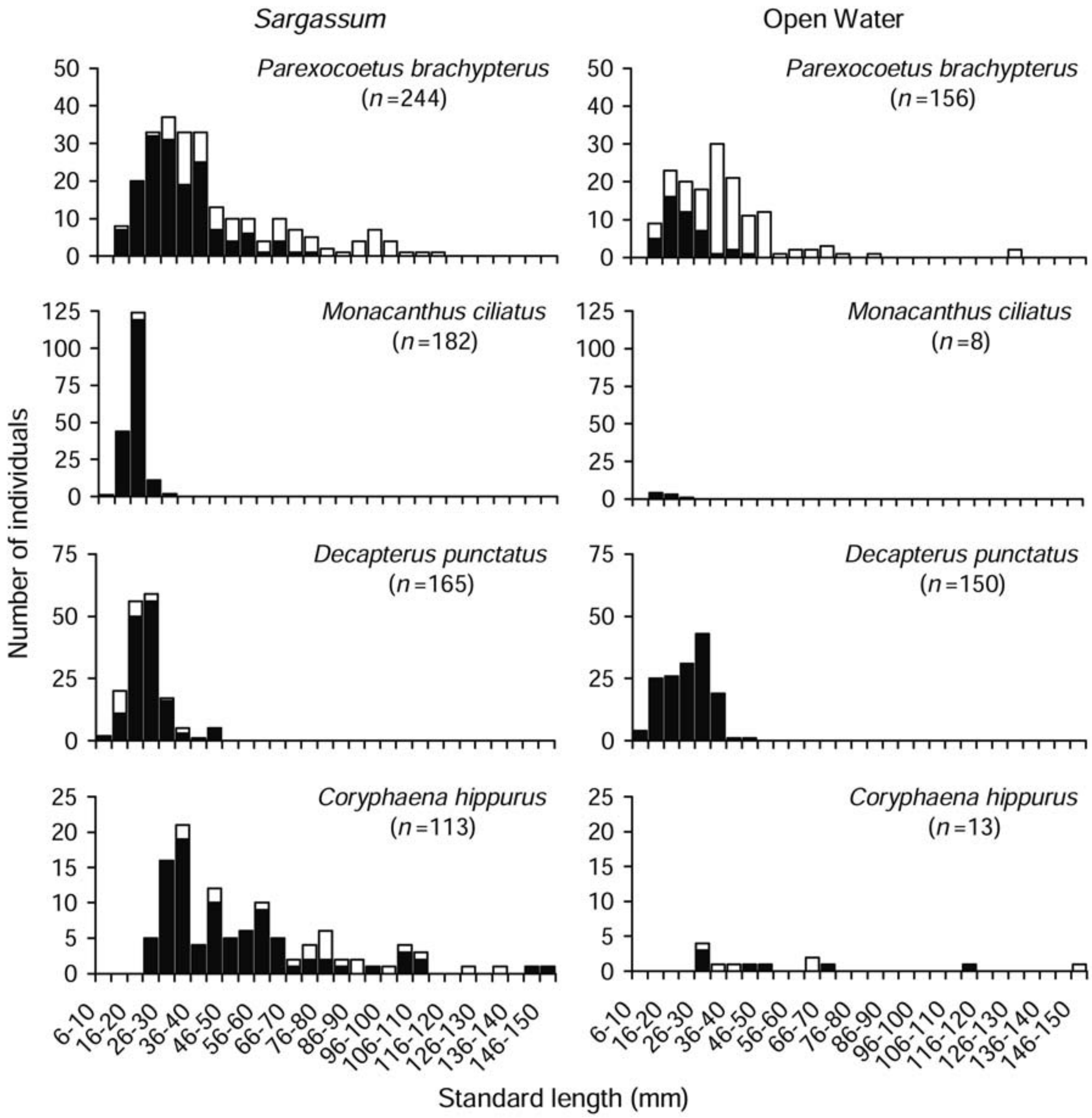

Figure 2 (cont.). Length frequency distributions of the nine most abundant fishes collected in *Sargassum* and open-water habitats during summer or fall of 1999-2003 off North Carolina. Neuston net collections = black bars and supplemental gears = white bars. Only juvenile specimens were graphed for *Cheilopogon melanurus* (Atlantic flyingfish) and *Coryphaena hippurus* (dolphinfish). The scales in the y-axis differ.

SL, mean=26 mm ± 0.2) were significantly larger (Kolmogorov-Smirnov test: df=7464, $P<0.001$) than fishes collected from open-water habitat (8-138 mm SL, mean=23 mm ± 0.4) by the same method. Within seven of nine dominant species, individuals collected in *Sargassum* neuston net tows were significantly larger (Kolmogorov-Smirnov test, $P<0.05$) than individuals of the same species collected in open-water neuston tows (Table 4).

Sargassum Abundance and Fish Distribution

Despite variability, the quantity of *Sargassum* habitat was correlated with fish species richness and density. A significant positive linear relationship existed between overall numbers of fishes and *Sargassum* wet weight resulting from neuston net samples (Figure 3A). For five (*S. hispidus, C. melanurus, B. capriscus, S. rivoliana, P. brachypterus*) of the eight most abundant *Sargassum*-associated species collected by neuston net during 2000-2003, a significant positive relationship existed between numbers of individuals and *Sargassum* wet weight (Figure 4). Although a significant positive logarithmic relationship was observed between numbers of species and *Sargassum* wet weight (Figure 3B), similar numbers of species were often collected regardless of *Sargassum* quantities. For example, the maximum number of species (n=19) collected in one neuston tow coincided with a relatively low quantity of *Sargassum* habitat (6.8 kg) (Figure 3B).

Behavioral Observations

Underwater video recordings clarified the close association of juvenile fishes to structure compared with open water. Many juvenile fishes rapidly explored and associated with any new substrata introduced near the *Sargassum* mats (e.g., snorklers, vessel). As in our other collections, the two most abundant families of fishes observed in the video recordings were Monacanthidae (mostly *S. hispidus*) and Carangidae (*Caranx* spp. and *Seriola* spp.). Fishes

Table 4. Mean standard length (SL) ± SE in mm of abundant fish species collected from *Sargassum* (S) compared to open-water (OW) neuston net collections off North Carolina during 1999-2003. *n*=number of fishes, * = P<0.05 (Kolmogorov-Smirnov test).

	Mean SL (mm) ± SE			
Species	S	*n*	OW	*n*
Stephanolepis hispidus	22* (± 0.2)	2872	18 (± 0.4)	470
Caranx crysos	28* (± 0.4)	1007	27 (± 0.7)	276
Cheilopogon melanurus	35* (± 0.8)	392	27 (± 1.2)	57
Balistes capriscus	23* (± 0.7)	336	17 (± 1.7)	17
Seriola rivoliana	32 (± 0.7)	257	35 (± 2.6)	12
Monacanthus ciliatus	17* (± 0.2)	176	14 (± 0.8)	7
Parexocoetus brachypterus	31* (± 1.0)	158	22 (± 1.0)	44
Decapturus punctatus	21 (± 0.5)	143	23* (± 0.6)	149
Coryphaena hippurus	40* (± 2.6)	142	29 (± 5.1)	21

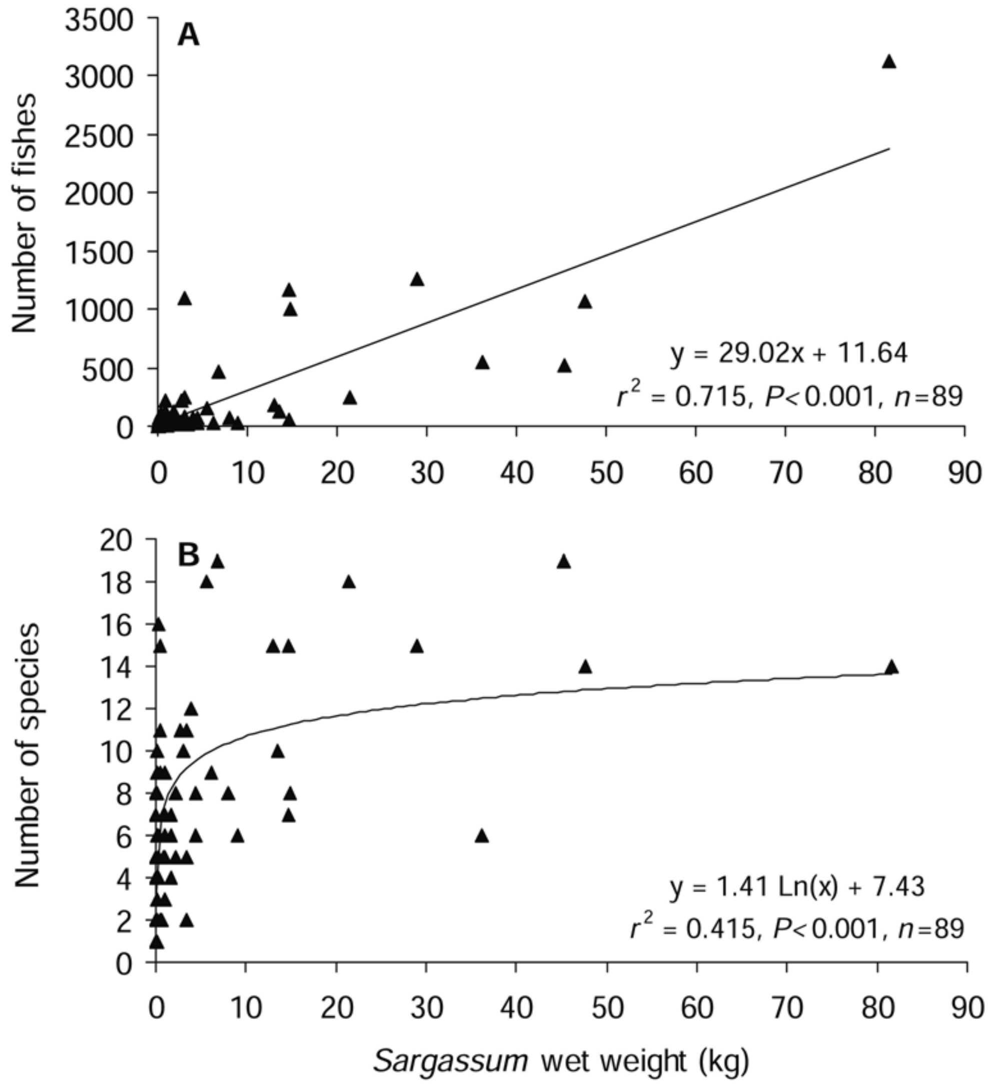

Figure 3. Relationships between number of individuals (A) and number of species (B) and *Sargassum* wet weight (kg) for all fishes collected by neuston net sampling in *Sargassum* habitat during summer or fall of 2000-2003 off North Carolina. The scales in the y-axis differ.

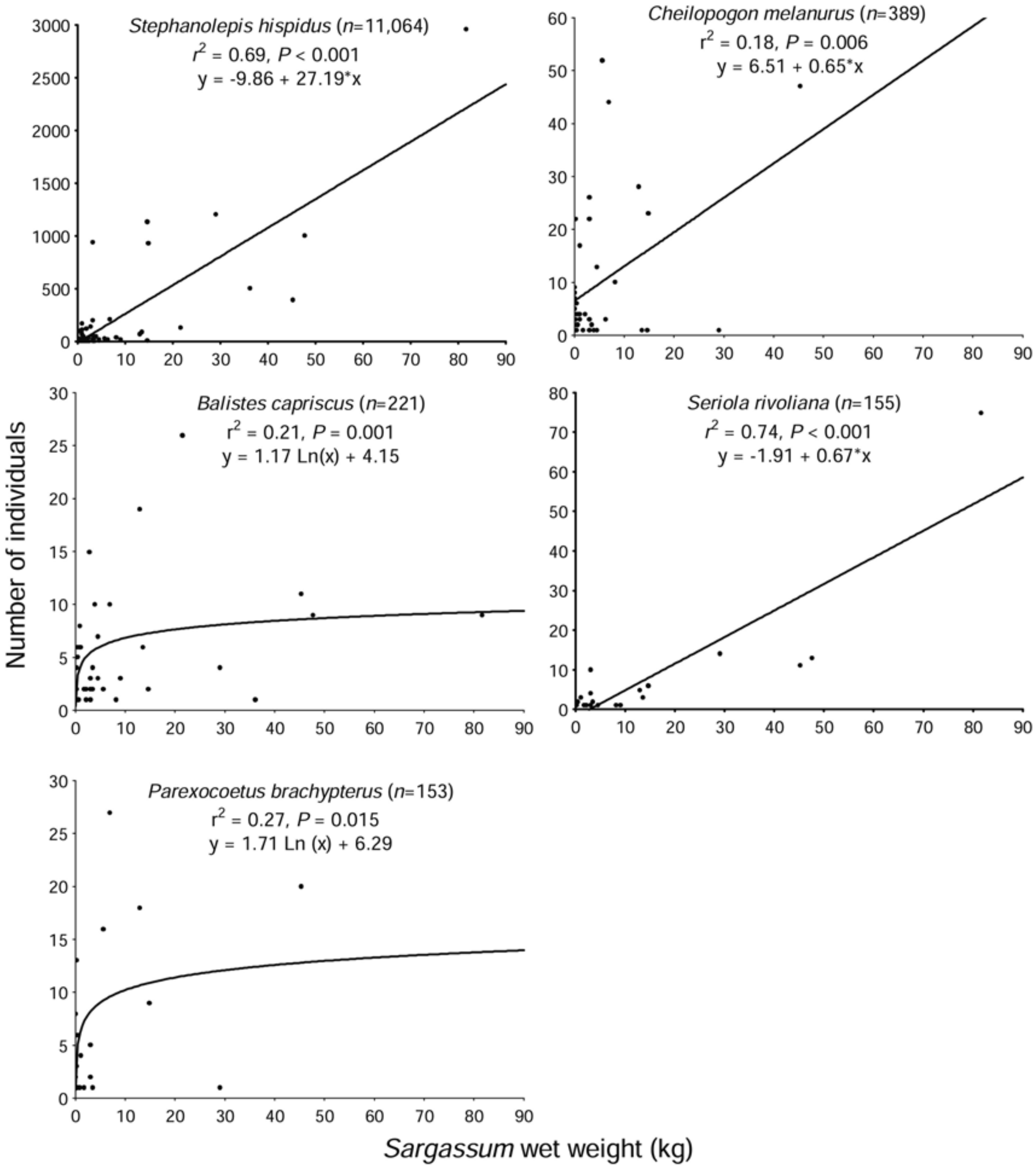

Figure 4. Relationships between number of individuals and *Sargassum* wet weight (kg) for five abundant fish species collected by neuston net sampling in *Sargassum* habitat during summer or fall of 2000-2003 off North Carolina. The scales in the y-axis differ.

exhibited a size related layering among and below the *Sargassum* (Plate 1A-C). Smaller juvenile fishes were usually very close to or within the *Sargassum* and were rarely observed more than one meter below the algae (Plate 1A), whereas larger, more mobile juvenile fishes (e.g., carangids and kyphosids) were further below the *Sargassum* (Plate 1B). Even deeper below the *Sargassum* (up to 3 m), larger predators (e.g., adult dolphinfish and jacks) were observed, usually in schools (Plate 1C). When large predators swam below the *Sargassum*, smaller fishes moved upward into the algae (Plate 1A).

Other behaviors were also observed from the underwater video recordings. Individuals and groups (7-10 individuals) of juvenile *Aluterus monoceros* (light to dark brown with a mottled pattern, Plate 1D) were observed hovering just below the *Sargassum* with heads down at a 45° angle, tails near the surface (Plate 1D). A school (about 65 individuals) of adult *A. monoceros* (silver body color) exhibited the same behavior under the hull of the vessel, which was adjacent to the weedline. On 15 occasions, small groups (2-15 individuals) of juvenile *S. hispidus* were observed pursuing and nipping at lobate ctenophores, *Mnemiopsis leidyi* (Plate 1E). These interactions took place about 1.5 m underneath the *Sargassum*, and *S. hispidus* was the only species observed displaying this behavior. A distinct boundary was observed between open-water and *Sargassum* habitats; the open water adjacent to the edge of the weedline was unpopulated, whereas a high density of juvenile fishes were underneath and within the *Sargassum* (Plate 1F).

Schools of adult dolphinfish (approximately 10-50 individuals) were observed swimming under the weedline on seven occasions. Most of these appeared to be females based on head shape and estimated sizes, but some may have been immature males. A female (295 mm SL), ripe with eggs, was collected by hook-and-line from the vessel during the video recording. On

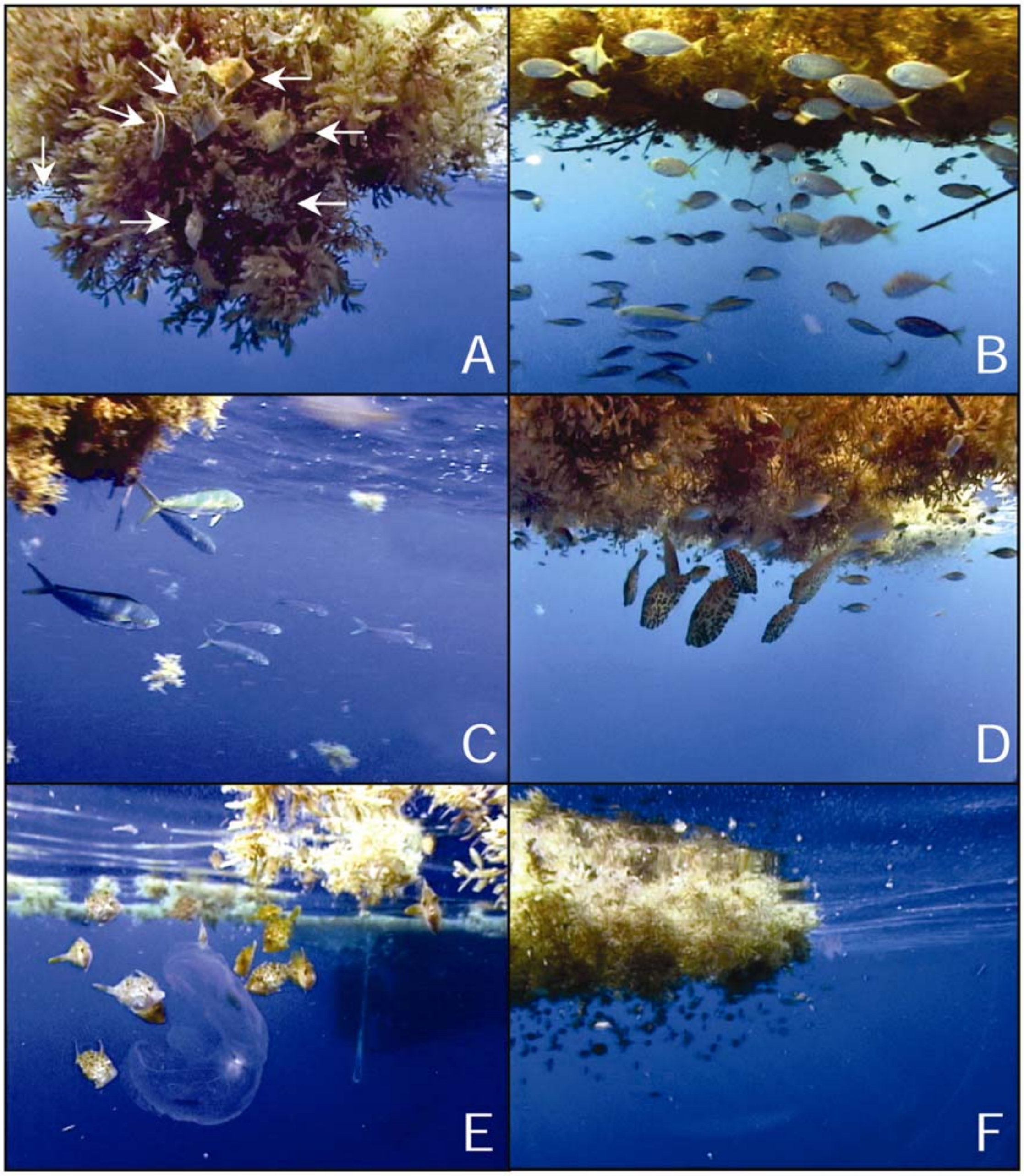

Figure 5. Fishes under a *Sargassum* weedline observed from underwater video recordings during August 1999, off Cape Hatteras, North Carolina. A) Small planehead filefish (*Stephanolepis hispidus*) amongst the *Sargassum*, B) larger, more mobile jacks (carangids) below the *Sargassum*, C) large predators (*Coryphaena hippurus* [dolphinfish]) using *Sargassum* habitat, D) schooling of *Aluterus monoceros* (unicorn filefish) at a 45º angle, E) *Stephanolepis hispidus* pursuing and picking at a lobate ctenophore (*Mnemiopsis leidyi*), and F) edge of a *Sargassum* weedline.

five of the seven occasions (see above), adult *Caranx bartholomaei* and *C. crysos* were mixed with the school of dolphinfish or swam closely behind them. On one occasion, a single large juvenile dolphinfish (approximately 300 mm SL) swam rapidly upward into the *Sargassum* with its mouth open, turned away at the weedline, and swam away; however, no small fishes were observed under the *Sargassum* in the vicinity of the strike, and it was not possible to determine the success of this apparent feeding attempt.

Additionally, two bottlenose dolphin *Tursiops truncatus* were observed swimming below the *Sargassum* weedline and juvenile loggerhead sea turtles *Caretta caretta* (*n*=21) were also observed within or adjacent to *Sargassum* weedlines.

DISCUSSION

Pelagic *Sargassum* habitat supports an abundant and diverse assemblage of juvenile fishes, providing structure and protection in relatively barren oceanic surface waters. Juvenile fishes dominate the *Sargassum* community, and the majority of fishes collected in this study from *Sargassum* habitat were comparable in size (< 50 mm SL) to those reported from other *Sargassum* studies (Dooley, 1972; Wells and Rooker, 2004). As with seagrass ecosystems (Stoner, 1983b), the strong association of small fishes with *Sargassum* and their behaviors around the algae suggests that this habitat provides shelter from predation. Schooling of *A. monoceros* to mimic floating seaweed (Crawford an Powers, 1953) and the camouflage coloration of juvenile monacanthids, balistids, and other taxa within *Sargassum* fronds help conceal them from predators (Plate 1A, D). The increasingly close association of fishes to the floating algae with decreasing fish size, further suggest a strong role of the habitat in mitigating predation. Larger fishes, like adult dolphinfishes and jacks, aggregating below the weedlines, appeared to use *Sargassum* primarily for feeding (Dooley, 1972; Moser et al., 1998; this study). *Sargassum* habitat seems to provide an ecological advantage as illustrated by the trend of several species exhibiting larger sizes in *Sargassum* habitat compared to open-water habitat, but it is not clear if this results from better food resources or lack of predation within the algal habitat.

As a result of intensive sampling, the number of fish species known to associate with *Sargassum* habitat in U.S. waters was substantially increased. Eighty fish species were collected in association with *Sargassum* in this study, forty-one percent of which had not been previously reported in association with pelagic *Sargassum*. Mesopelagic fishes spend most of their lives in a habitat lacking structure and have not been reported to seek structured habitats. Thus, the seven species of mesopelagic fishes representing three families (Gonostomatidae, Sternoptychidae, Myctophidae) collected with *Sargassum* likely resulted from combinations of their upward diel migrations, upwelling (reported from the Cape Hatteras study area: Lohrenz et al., 2002; Thomas et al., 2002), or convergent currents bringing them into contact with *Sargassum*, rather than attraction to the algae. The associations of many fish species with *Sargassum* appears to be facultative (Dooley, 1972; Wells and Rooker, 2004), and all studies to date have recorded fishes incidentally associated with *Sargassum* that are normally not considered to be structure associated species. It remains difficult to determine exactly why or how some species use this habitat and the degree to which it influences their life histories.

Despite methodological differences between studies, patterns of abundance for dominant species collected from *Sargassum* habitat were comparable to previous collections off North Carolina, Florida and in the Gulf of Mexico. *Stephanolepis hispidus* dominated all *Sargassum* collections in all areas, followed closely by *C. crysos* and *B. capriscus* (Dooley, 1972; Wells and Rooker, 2004). *Histrio histrio* was abundant in Gulf of Mexico (Bortone et al., 1977; Wells and Rooker, 2004) and Florida east coast (Dooley, 1972) *Sargassum* collections but was not abundant in collections off North Carolina (Dooley, 1972; Moser et al., 1998; this study). Since the majority of *H. histrio* occur in the Sargasso Sea and Caribbean Basin (Adams, 1960), their lower abundance off North Carolina may represent a winnowing of the population with northward or westward drift. Dooley (1972) suggested a progressive decrease in fish species richness from Florida to North Carolina and across the Atlantic to the Azores. This may be an artifact of limited collections off North Carolina and the Azores, since our more extensive sampling produced *Sargassum*-related species richness exceeding that reported in other areas. Although based on limited sampling, data suggest that fewer fish species are associated with *Sargassum* habitat in the Sargasso Sea compared with the Gulf of Mexico or the Gulf Stream

(Fine, 1970; Butler et al., 1983; Stoner and Greening, 1984). The great difference between the Sargasso Sea and U.S. continental shelf collections indicates that the majority of the *Sargassum* fish fauna recruits to the habitat after the algae is entrained into the Loop Current (Gulf of Mexico) and Florida/Gulf Stream currents.

Structural complexity of habitats strongly affects fish assemblages. The open-water samples contained fewer fishes compared with samples containing *Sargassum* habitat. Clearly, fishes that use *Sargassum* habitat also occur in open water without *Sargassum*, but the abundance is heavily skewed toward floating structured habitat (Kingsford, 1993). *Stephanopelis hispidus* dominated both habitats but was two orders of magnitude more abundant in *Sargassum* collections. Considering this, and that *S. hispidus* usually occupies structured habitat, it seems likely that *S. hispidus* collected from open-water habitat may have been displaced by disturbance to *Sargassum* mats, or they were caught in open-water because they had strayed away from the preferred habitat. If so, this indicates an even larger difference between open-water and *Sargassum* fish communities. The strong fidelity of fishes to floating *Sargassum* habitat is also illustrated by the distinct boundary observed between open-water and *Sargassum* habitats (Plate 1F). The open water adjacent to the edge of the weedline was unpopulated, compared with the high density of juvenile fishes underneath and within the *Sargassum*. Higher abundances and diversity of fishes in vegetated versus unvegetated habitats is a common theme (Weinstein et al., 1977; Orth and Heck, 1980) that results from increased structural complexity (Stoner, 1983b). Although fundamental differences exist between *Sargassum* and seagrass ecosystems, fish communities use the two habitats in similar ways. Both habitats are nursery areas for juvenile fishes and support diverse and abundant fish communities. Additionally, the abundance of fishes increases with increasing seagrass density (Orth and Heck, 1980; Thayer and Chester, 1989) and

Sargassum abundance (Moser et al., 1998; Wells and Rooker, 2004).

Juvenile fishes may seek drifting objects to improve future benthic settlement opportunities (Dempster and Kingsford, 2004), facilitating early survival and eventual recruitment to adult populations. Most of the juvenile fishes using *Sargassum* are species that ultimately occupy either inshore, benthic reef or complex structured habitats (demersal) or the open ocean (pelagic). However, the length of time juvenile fishes reside in *Sargassum* and the fates of juvenile fishes after leaving this habitat are unknown. Some fishes remain in the *Sargassum* longer than expected, perhaps because they missed a settlement opportunity. This appears to be the case for some unusually large juveniles (e.g., *Hippocampus* spp., *Mulloidichthys martinicus*, *Kyphosus* spp., *A. saxatilis*, balistids, monacanthids) collected in this study. Caribbean damselfishes, including *A. saxatilis*, settle between 10 and 12 mm SL (Robertson et al., 1993), yet *A. saxatilis* collected in this study from *Sargassum* habitat were 16-29 mm SL. The dominant *Sargassum* habitat fish, *S. hispidus*, may settle into North Carolina estuarine seagrass beds at 11-40 mm (Adams, 1976; Ross and Epperly, 1985), well below the sizes of some individuals collected offshore in this study. The movement of large quantities of *Sargassum* habitat across the continental shelf as far as the ocean beaches and estuaries transports vast numbers of associated juvenile fishes toward other habitats (e.g., seagrass beds, reefs), and probably facilitates recruitment to adult populations.

Young fishes entrained in the Gulf Stream that ultimately have demersal populations, including species utilizing *Sargassum*, have a more uncertain future once they drift north of Cape Hatteras where the Gulf Stream moves offshore (McBride and Able, 1998; Ross et al., 2007). Juveniles of demersal species that do not move from *Sargassum* before reaching the Cape Hatteras area may: 1) exit the Gulf Stream and settle north of North Carolina, 2) continue across the North Atlantic in the Gulf Stream and possibly settle in the eastern Atlantic, 3) complete a circuit of the North Atlantic until they return to the western North Atlantic, or 4) ultimately not contribute to their respective populations (McBride and Able, 1998; Ross et al., 2007). Even though *Sargassum* and associated fishes can be transported into the Middle Atlantic Bight or further north (Dooley, 1972), the first alternative is unlikely given that most demersal fish species utilizing *Sargassum* are of tropical or warm temperate origins and are not established as adults north of North Carolina (Winge, 1923; McBride and Able, 1998). The second alternative, also suggested by Dooley (1972), seems possible since fifty-three (66%) of the 80 total species collected off North Carolina are established in the eastern Atlantic (Hureau and Monod, 1973a, b), but the link (if any) between these fishes and those in the western Atlantic remains unclear. The third alternative seems least likely as most of the fishes collected in the surface waters do not have larval or juvenile periods long enough to complete a circuit of the Atlantic basin (Ross et al., 2007). It seems likely that many of the fishes remaining in the *Sargassum* north of Cape Hatteras eventually perish. Pelagic species (e.g., carangids, exocoetids, *Coryphaena* spp.) are probably not as restricted and can emigrate from *Sargassum* habitat to open-water habitat over a broader geographic area. Despite the fact that huge numbers of fishes use *Sargassum* habitat in the early life stages, data are lacking regarding its role in transporting juveniles to inshore habitats, settlement processes, and to what extent *Sargassum*-associated fishes contribute to their respective populations.

Sargassum is an unusual and difficult habitat to sample, and no ideal methodology has yet been applied. The algae and its medium (water) are in constant motion, with the density and structure of the habitat constantly changing. One cannot predict exactly when or where *Sargassum* will occur and, unlike static habitats, it cannot be mapped. Thus, it is generally difficult to collect a known number or type of samples from this habitat. Sampling in this study was balanced between day and night, but for the above reasons was not balanced between the two habitats. Sampling the *Sargassum* fauna includes collecting the habitat as well, and the density of the habitat coupled with the three dimensional layering of associated nekton reduce the efficiencies of most sampling gear (especially dip nets). The approach in this study of using a large neuston net to consistently encompass a substantial volume of surface water allowed for comparative samples over a wide range of algal densities.

There is little doubt that *Sargassum* habitat constitutes an important and unique marine ecosystem. It provides a feeding area for many large pelagic fishes, marine mammals, seabirds, and sea turtles. *Sargassum* may enhance early survival of many fishes by protecting them from predation and concentrating prey, thus providing a unique nursery habitat in an otherwise relatively barren area of the western North Atlantic Ocean. For these reasons, *Sargassum* was designated as Essential Fish Habitat by the South Atlantic Fisheries Management Council (SAFMC, 2002). The role of *Sargassum* in transporting juveniles to inshore habitats and subsequent impacts to population recruitment should be investigated.

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CHAPTER 2: DIETS OF JUVENILE FISHES ASSOCIATED WITH PELAGIC *SARGASSUM* AND OPEN-WATER HABITATS

INTRODUCTION

Two species of pelagic, brown algae, *Sargassum fluitans* and *S. natans*, provide an important nursery habitat for a large diversity of juvenile fishes by providing substrate and protection in an otherwise barren area of the western North Atlantic Ocean. *Sargassum* habitat constitutes an important and unique marine ecosystem that provides a feeding area for large pelagic fishes, marine mammals, seabirds and sea turtles. Pelagic *Sargassum* was designated as essential fish habitat for these reasons (SAFMC, 2002). Casazza and Ross (2008) documented 18,799 individual fishes representing at least 80 species associated with pelagic *Sargassum* off North Carolina, and the majority (96%) of fishes collected were juveniles. *Sargassum* habitat appears to be primarily important for early survival of some species since most fishes collected in the Gulf of Mexico (Bortone et al., 1977; Wells and Rooker, 2004) and off the southeastern United States (Dooley, 1972; Moser et al., 1998; Casazza and Ross, 2008) were juveniles.

Off the southeastern United States only two studies have documented the stomach contents of *Sargassum*-associated fishes. The diets of the eight most abundant *Sargassum*-associated fishes (*Stephanolepis hispidus*, *S. setifer*, *Balistes capriscus*, *Caranx crysos*, *C. ruber*, *Seriola rivoliana*, *Trachurus lathami* and *Histrio histrio*) collected from the Florida Current were analyzed, but most prey were identified only to higher taxonomic categories (Dooley, 1972). Three different feeding groups comprised of carangids, filefishes, and the sargassumfish were identified, and many of the prey identified in the stomachs are known to associate with *Sargassum* (Dooley, 1972). Additionally, *Sargassum* was frequently observed in the stomachs of *S. rivoliana*, *S. hispidus* and *S. setifer* indicating these fishes fed in *Sargassum* (Dooley, 1972). The stomach contents of post-larval and juvenile *H. histrio* (a *Sargassum* endemic) collected from the Florida Current were analyzed and fishes constituted the majority of the diet (Adams, 1960). The two taxa (Monacanthidae and *Psenes* sp.) that were identified from these stomachs are also known to associate with *Sargassum* (Adams, 1960).

The diets of some fish species known to associate with *Sargassum* have been analyzed, but it is unclear whether these fishes were collected from *Sargassum*. The diet of economically important *Coryphaena hippurus* (adults) has been well documented (Schuck, 1951; Gibbs and Collette, 1959; Lewis and Axelsen, 1967; Rose and Hassler, 1974; Palko et al., 1982; Manooch et al., 1984; Oxenford, 1999; Oxenford and Hunte, 1999), and *Sargassum*-associated fishes and *Sargassum* were frequently observed in the stomachs indicating that adult dolphinfish feed in *Sargassum* habitat (Gibbs and Collette, 1959; Rose and Hassler, 1974; Palko et al., 1982; Manooch et al., 1984). The diets of larval and juvenile *C. hippurus* and *C. equiselis* were examined and fishes comprised the majority of the diets of both species, and several of the families of fishes identified in these stomachs are known to associate with *Sargassum* (Shcherbachev, 1973).

The diets of 19 *Sargassum*-associated fishes collected from *Sargassum* in the Red Sea and the Caribbean were analyzed, and three trophic groups were identified: zooplanktivores, consumers of epibionts, and piscivores (Gorelova and Fedoryako, 1986). *Sargassum* was identified in the stomachs of *Diodon holacanthus*, *Cantherhines macroceros*, *C. pullus*, *Aluterus scriptus* and *S. hispidus* (Gorelova and Fedoryako, 1986), and these species were observed in close association with *Sargassum* off North Carolina (Casazza and Ross, 2008). The food web of the *Sargassum* community off Bermuda was described, but only two fish species (*H. histrio*, *Syngnathus pelagicus*) were analyzed, and shrimp, polychaete parts and copepods were the only prey identified in these stomachs (Butler et al., 1983).

In the northwestern Gulf of Mexico, pathways of energy flow in the *Sargassum* community were assessed using stable isotope analysis (Rooker et al., 2004) and fatty acid composition (Turner and Rooker, 2006). The only two sources of organic matter available to fishes in pelagic waters are phytoplankton and *Sargassum*. Stable isotope analysis indicated organic matter reaching top-level consumers was derived from phytoplankton and epiflora, and *Sargassum* was not a direct source of energy to pelagic fishes, thus the value of *Sargassum* may be limited to its role as refuge (Rooker et al., 2004). Fatty acid composition of *Sargassum*-associated fauna from the northwestern Gulf of Mexico indicated phytoplankton, not *Sargassum*, was the major source of organic matter in the *Sargassum* food web (Turner and Rooker, 2006). Although *Sargassum* did not directly contribute nutrients to the food web, Turner and Rooker (2006) suggested *Sargassum* may play an important role in nutrient recycling and aggregation mechanisms.

Whether *Sargassum* concentrates prey resources for juvenile fishes off North Carolina, thus further enhancing the importance of *Sargassum* as a nursery habitat, is unclear, but other *Sargassum*-related studies suggested *Sargassum* offers fishes both shelter and food (Ida et al., 1967; Dooley, 1972). Multi-species trophic relationships and feeding ecology within the *Sargassum* community are poorly studied, and no study has compared the diets of *Sargassum*-associated fishes to the diets of the same species collected from open water without *Sargassum*. The complex interactions of organisms in *Sargassum* are an important component of the pelagic food chain, as plankton are consumed by crustaceans, which are consumed by juvenile fishes, which in turn are consumed by large commercially and/or recreationally important fishes (Dooley, 1972). Assessments of the food web structure of this unique pelagic community are critical to understanding complex energetic relationships of *Sargassum*-associated fauna.

Determining the role of pelagic *Sargassum* for juvenile fishes is critical for managing this unique habitat. Traditionally, the approach to the conservation and management of fish stocks was based on single species management. Currently, the South Atlantic Fishery Management Council is transitioning from single species management to ecosystem based management to better understand and manage complex habitats and their associated fauna, and gut content analysis has been used extensively to determine natural pathways of energy flow through an ecosystem (Randall, 1967; Dooley, 1972; Adams, 1976). Thus, the objectives of the present study were to: 1) document the diets of the dominant fish species collected from *Sargassum* habitat and determine if they differed from the diets of the same fish species collected from open-water habitat by analyzing stomach contents, 2) determine if the diets of fishes collected during the day differed from the diets of fishes collected at night within and across habitats, and 3) compare the diets of each fish species analyzed across different size ranges to compare feeding at different sizes.

MATERIALS AND METHODS

Data Collection

See Casazza and Ross (2008) for collection methods of fishes. For the twelve most abundant (95%) species collected from *Sargassum* habitat (in order of decreasing abundance: *Stephanolepis hispidus, Caranx crysos, Cheilopogon melanurus, Balistes capriscus, Seriola rivoliana, Parexocoetus brachypterus, Coryphaena hippurus, Monacanthus ciliatus, Decapterus punctatus, Abudefduf saxatilis, Oxyporhamphus micropterus* and *Prognichthys occidentalis*) (Casazza and Ross, 2008), stomachs were removed for analysis. Additionally, the stomachs of *Coryphaena equiselis* (pompano dolphinfish), *Histrio histrio* (sargassumfish) and *Istiophorus platypterus* (sailfish) were removed for analysis. Stomach fullness was estimated using a scale of 100% (full), 75%, 50%, 25%, ≤5% (nearly empty) and 0% (empty). When possible, the stomachs of the same species collected from open-water without *Sargassum* were removed and analyzed for comparison between habitats. When numbers permitted, 30 individuals of each fish species were subsampled from the overall catch for gut content analysis for comparisons between feeding during the day and at night within each habitat (*Sargassum* and open-water). Additionally, fishes were subsampled over the entire size range collected for each fish species to compare the diets at different sizes.

Since the percent frequency of occurrence of prey, in combination with, the percent volume of prey are valid indicators of dietary importance (Hyslop, 1980), stomach contents were quantified using these two methods. The contents of the stomach were placed in a Petri dish marked with 1 mm squares. Food items were identified to the lowest possible taxa and like food items were grouped together on the Petri dish and flattened to a uniform height (usually 1 mm). The volume (mm^3) of each food item equaled the total number of one mm squares occupied by the food item. The total food volume was the sum of the volume of all food items in a stomach. The percent volume of each food item was calculated for each fish species as the volume of a food item divided by the total volume of food items multiplied by 100. Percent frequency of occurrence was calculated for each fish species as the number of times a food item occurred divided by the total number of stomachs containing food multiplied by 100.

Empty stomachs were documented but not included in statistical analyses. Parasites that occurred in the stomachs were documented but not considered food items. Information on the food habits of fishes from previous studies is summarized in the *Remarks* section of the results for each individual species accounts. Food habit data are presented in phylogentic order by species.

Data Analysis

Habitat Comparisons

Multivariate analyses were used to determine differences in the diets of fishes collected from *Sargassum* and open-water habitats using PRIMER v6 (Clarke and Warwick, 2001; Clarke and Gorley, 2006). Organic material and parts of animals (e.g., amphipod parts, copepod parts, crustacean parts) were removed from the dataset for each species before analysis. Volumes of prey items were standardized per sample (one sample=one individual) by dividing the volume of each prey item by the total volume per sample. Standardization was employed because the fullness of each stomach was variable. Standardized volumes were square root transformed to down weight the most abundant species relative to the rare species. A Bray-Curtis similarity matrix was created to determine similarities between diets of each species within habitats (*Sargassum* and open-water). Due to the large number of overall samples (n=562 S, n=194 OW) for comparisons between the diets of the 15 fish species within each habitat, making for a cluttered multi-dimensional scaling (MDS) plot with a relatively high 2-d stress arising from the large number of points, the data were summarized by MDS on the volume means of prey for each fish species (Clarke and Gorley, 2006). A dendrogram with group average linking based on the Bray-Curtis similarity matrix was created using the volume means of prey for each fish species. For comparisons between the diets of each species within habitats, an MDS plot and a dendrogram with group average linking were created based on the Bray-Curtis similarity matrix for each fish species. A one-way analysis of similarities (ANOSIM) and post-hoc multiple comparison tests were used to determine whether there were significant differences between the diets of fishes collected from *Sargassum* and open-water habitats. A conservative approach was adopted for all ANOSIM tests, thus ANOSIM test statistic values $R>0.40$ with $p=0.001$ represented statistically significant differences between the diets of fishes (Clarke and Warwick, 2001). When significant differences in diets were observed, similarity percentages (SIMPER) analysis was used to determine which food items contributed to the dissimilarities between samples.

Day versus Night Comparisons

Multivariate analyses were used to determine differences in the diets of the 15 fish species collected during the day and at night within and across habitats (PRIMER v6). Organic material and parts of animals were removed from the dataset for each species before analysis. Volumes of prey items were standardized per sample by dividing the volume of each prey item by the total volume per sample. Standardized volumes were square root transformed, and a Bray-Curtis similarity matrix was created to determine similarities in diets for each fish species. An MDS plot and a dendrogram with group average linking were created based on the Bray-Curtis similarity matrix for each fish species. A two-way ANOSIM and post-hoc multiple comparison tests were used to determine whether there were significant differences between the diets of fishes collected during the day and at night within and across *Sargassum* and open-water habitats for each fish species. When significant differences in the diets were observed, SIMPER analysis was used to determine which food items contributed to the dissimilarities between samples.

Size Comparisons

Size classes (5 mm ranges) were constructed for each fish species within *Sargassum* and open-water habitats. Multivariate analyses were used to determine differences in the diets of each fish species at different sizes (PRIMER v6). Organic material and parts of animals were removed from the dataset for each species before analysis. Volumes of prey items were standardized per sample (one sample=one individual), and standardized volumes were square root transformed. A Bray-Curtis similarity matrix was created to determine similarities in diets of each fish species at different sizes within each habitat. An MDS plot and a dendrogram with group average linking were created based on the Bray-Curtis similarity matrix for each fish species. A one-way ANOSIM and post-hoc multiple comparison tests were used to determine whether significant differences existed between the diets of each fish species at different sizes within *Sargassum* and open-water habitats. When significant differences were observed between the diets at different sizes, SIMPER analysis was used to determine which food items contributed to the dissimilarities.

RESULTS

Habitat Comparisons

A total of 1,623 stomachs (15 fish species) were analyzed for diet composition, of which 619 (38%) were empty. Overall, 129 food items were identified and grouped into 11 general food categories: Bryozoa, Cnidaria, Mollusca, Copepoda, Amphipoda, Isopoda, Crustacea, Annelida, Chaetognatha, Fish and Other. Combining all fish species analyzed, the dominant food categories (fish, copepoda and crustacea) contributed 66, 15 and 14% of the total food volume, respectively. Although more types of prey were identified in the stomachs of fishes collected from *Sargassum* (118) compared to open water (69), and a higher overall volume of food was contained in the stomachs of fishes collected from *Sargassum* compared to open water, these differences were not significant (*t*-test, $P>0.05$). Eight food items were identified only in the stomachs of fishes collected from open-water habitat, whereas 55 food items were unique to fishes collected from *Sargassum* habitat. Parasites (digenetic trematodes and nematodes) occurred in 14% of the stomachs of 10 fish species analyzed.

A total of 1,061 stomachs were analyzed from fishes collected from *Sargassum* habitat, of which 344 (32%) were empty. The dominant food categories (fish, other, crustacea and copepoda) contributed 48, 18, 15 and 15% of the total food volume of *Sargassum*-associated fishes, respectively. A total of 562 stomachs were analyzed from fishes collected from open-water habitat of which 275 (49%) were empty. The dominant food categories (fish, other and copepoda) contributed 74, 10 and 7% of the total food volume in these stomachs, respectively.

Sargassum Habitat

MDS ordination of mean volumes of prey (118 species) of 562 *Sargassum* stomachs based on Bray-Curtis similarity matrix calculated from standardized, square root transformed data for the 15 fish species indicated eight groupings (four groupings consisted of one species each) at a 30% similarity level (Figure 6). Species that grouped together at a 30% similarity level were: *C. hippurus* and *C. equiselis*; *S. hispidus* and *B. capriscus*; *H. histrio* and *S. rivoliana*; *C. melanurus, D. punctatus, C. crysos, P. occidentalis,* and *A. saxatilis* (Figure 6). Fishes collected from *Sargassum* habitat fed similarly during the day and at night (ANOSIM, Global *R*=0.18, *p*=0.001) and overall, the 15 species collected from *Sargassum* habitat consumed similar prey (ANOSIM, Global *R*=0.28, *p*=0.001); however, post-hoc comparison tests revealed significant differences between the diets of several species (Table 5). The largest differences in diets occurred between *C. crysos* and *O. micropterus* (*R*=0.66), *O. micropterus* and *I. platypterus* (*R*=0.61), and *C. equiselis* and *O. micropterus* (*R*=0.62) (Table 5).

Open-water Habitat

MDS ordination of mean volumes of prey (69 species) of 194 stomachs from 12 fish species collected from open-water based on a Bray-Curtis similarity matrix calculated from standardized, square root transformed data indicated six groupings (three groupings consisted of one species each) at a 30% similarity level (Figure 7). Species that grouped together at a 30% similarity level were: *B. capriscus, D. punctatus* and *A. saxatilis*; *C. hippurus* and *C. equiselis*; *C. melanurus, P. brachypterus, P. occidentalis* and *C. crysos* (Figure 7). Fishes collected from open-water habitat fed similarly during the day and at night (ANOSIM, Global *R*=0.30, *p*=0.001) and overall, the 12 species collected from open water consumed similar prey (ANOSIM, Global *R*=0.30, *p*=0.001); however, post-hoc comparison tests revealed significant differences between the diets of several species (Table 6). The largest differences in diets occurred between *Seriola rivoliana* and *Parexocoetus brachypterus* (*R*=0.93), *S. rivoliana* and *Balistes capriscus* (*R*=0.85), and *S. rivoliana* and *Abudefduf saxatilis* (*R*=0.98) (Table 6).

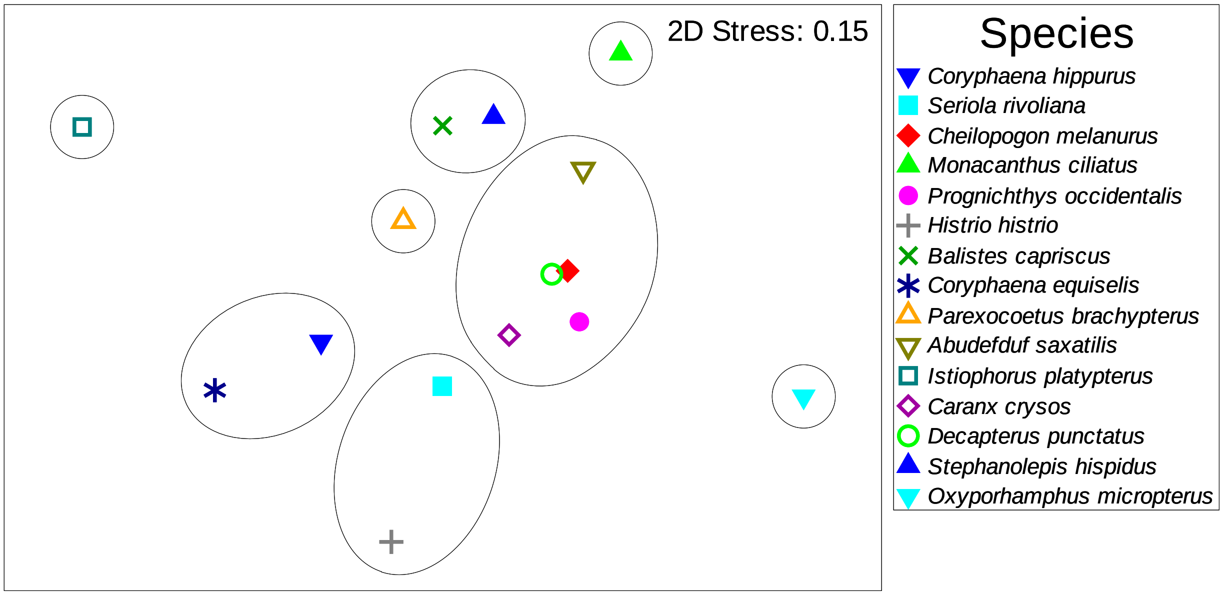

Figure 6. Multidimensional scaling (MDS) ordination of 562 *Sargassum* samples based on the Bray-Curtis similarity matrix calculated from standardized, square root transformed, mean volumes of prey (118 species). Clusters are defined at a 30% (black outlines) similarity level.

Table 5. Results of post-hoc comparison tests comparing similarities between the diets of fish species collected from *Sargassum* habitat off North Carolina during 1999-2003. Data were standardized and square root transformed before analysis. *=statistically significant at R>0.40 (ANOSIM).

Species	*Monacanthus ciliatus*	*Coryphaena hippurus*	*Seriola rivoliana*	*Cheilopogon melanurus*	*Prognichthys occidentalis*	*Histrio histrio*	*Balistes capriscus*	*Coryphaena equiselis*	*Parexocoetus brachypterus*	*Abudefduf saxatilis*	*Istiophorus platypterus*	*Caranx crysos*	*Decapterus punctatus*	*Stephanolepis hispidus*	*Oxyporhamphus micropterus*
Monacanthus ciliatus		0.408*	0.481*	0.382	0.479*	0.547*	0.367	0.574*	0.394	0.370	0.563*	0.537*	0.474*	0.246	-0.009
Coryphaena hippurus			0.181	0.226	0.192	0.245	0.254	0.049	0.247	0.271	0.066	0.297	0.247	0.261	0.301
Seriola rivoliana				0.241	0.217	0.169	0.345	0.258	0.309	0.311	0.442*	0.204	0.252	0.228	0.428*
Cheilopogon melanurus					-0.046	0.443*	0.308	0.343	0.179	0.124	0.425*	0.251	0.068	0.163	0.040
Prognichthys occidentalis						0.407*	0.268	0.502*	0.149	0.255	0.558*	0.156	-0.014	0.147	0.433*
Histrio histrio							0.186	0.446*	0.350	0.364	0.367	0.530*	0.571*	0.229	0.355
Balistes capriscus								0.345	0.294	0.214	0.299	0.506*	0.407*	0.121	0.394
Coryphaena equiselis									0.360	0.387	0.419*	0.524*	0.398	0.328	0.620*
Parexocoetus brachypterus										0.295	0.284	0.408*	0.311	0.226	0.276
Abudefduf saxatilis											0.333	0.223	0.118	0.159	0.269
Istiophorus platypterus												0.731*	0.457*	0.226	0.615*
Caranx crysos													0.204	0.333	0.665*
Decapterus punctatus														0.231	0.168
Stephanolepis hispidus															0.241
Oxyporhamphus micropterus															

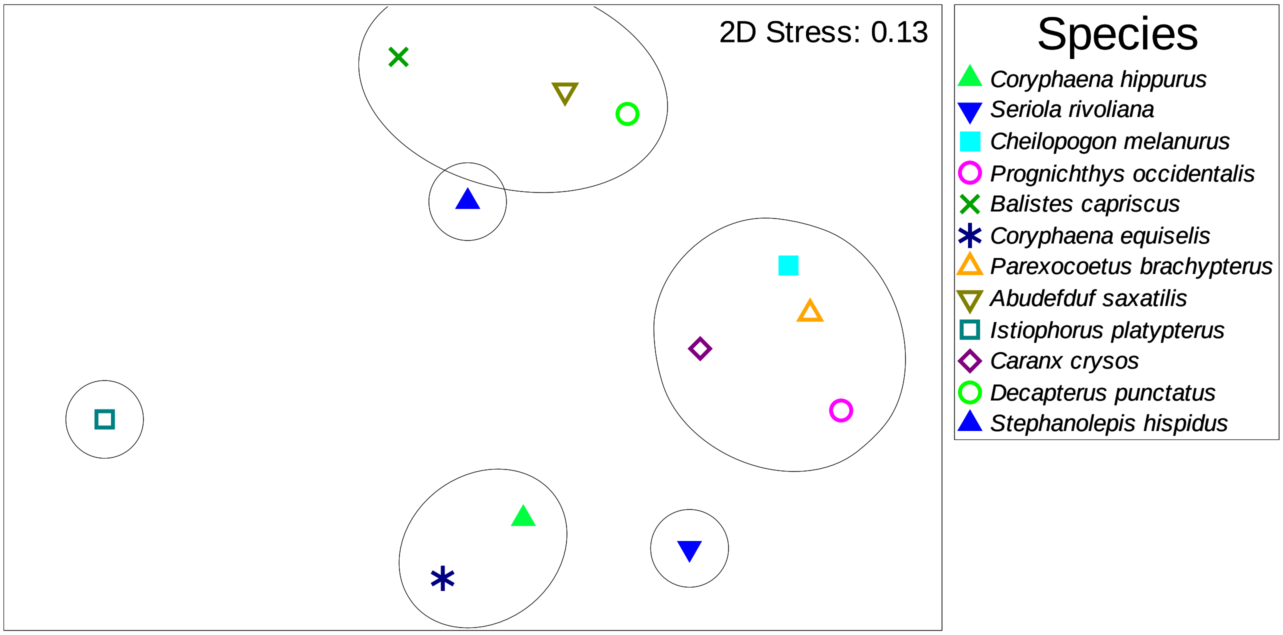

Figure 7. Multidimensional scaling (MDS) ordination of 194 open-water samples based on the Bray-Curtis similarity matrix calculated from standardized, square root transformed, mean volumes of prey (69 species). Clusters are defined at a 30% (black outlines) similarity level.

Table 6. Results of post-hoc comparison tests comparing similarities between the diets of fish species collected from open-water habitat off North Carolina during 1999-2003. Data were standardized and square root transformed before analysis. *=statistically significant at *R*>0.40 (ANOSIM).

Species	*Balistes capriscus*	*Istiophorus platypterus*	*Caranx crysos*	*Stephanolepis hispidus*	*Coryphaena hippurus*	*Parexocoetus brachypterus*	*Seriola rivoliana*	*Abudefduf saxatilis*	*Cheilopogon melanurus*	*Decapterus punctatus*	*Prognichthys occidentalis*	*Coryphaena equiselis*
Balistes capriscus		0.541*	0.593*	0.006	0.323	0.528*	0.859*	-0.009	0.306	0.201	0.275	-0.083
Istiophorus platypterus			0.517*	0.485*	0.457*	0.541*	0.550*	-	0.523*	0.543*	0.539*	0.510*
Caranx crysos				0.317	0.395	-0.173	0.165	0.287	0.149	0.163	-0.029	-0.286
Stephanolepis hispidus					0.188	0.091	0.131	-0.161	0.074	0.161	0.100	0.136
Coryphaena hippurus						0.162	0.448*	0.478*	0.290	0.566*	0.153	-0.129
Parexocoetus brachypterus							0.936*	-	0.004	-0.010	0.050	0.037
Seriola rivoliana								0.981*	0.578*	0.569*	0.682*	0.125
Abudefduf saxatilis									0.127	-0.106	-	-
Cheilopogon melanurus										0.192	-0.010	0.259
Decapterus punctatus											0.200	0.111
Prognichthys occidentalis												0.212
Coryphaena equiselis												

Species Food Habits

Histrio histrio (sargassumfish)

Thirteen individuals, 9-31 mm SL, were collected from nine *Sargassum* day stations. One individual had an empty stomach. Eight food items were identified from five food categories (Figure 8A, Table 7), and crustaceans were dominant in the diet. *Latreutes fucorum*, unidentified fish and *Stephanolepis hispidus* were the most important in overall percent volume (43, 19 and 13%, respectively), whereas *L. fucorum*, unidentified shrimp, *Leander tenuicornis* and calanoid copepods were the most frequently ingested food items (67, 25, 17 and 17% frequency, respectively) (Table 7).

Nine individuals, 7-45 mm SL, were collected from seven *Sargassum* night stations. One individual had an empty stomach. Ten food items were identified from five food categories (Figure 8A, Table 7), and fish were dominant in the diet. *Caranx* sp., *S. hispidus* and monacanthids were the most important in overall volume (37, 30 and 16%, respectively), whereas fish parts (spines, fin rays and operculum) were the most frequently ingested food items (38%) (Table 7).

The diets of *H. histrio* collected during the day versus at night from *Sargassum* habitat were similar (ANOSIM, Global R=0.16, p=0.05), and *H. histrio* fed both during the day and at night as evidenced from stomachs ≥50% full during the day and at night (Figure 9). The two individuals with empty stomachs were collected at 0321 and 1930 EDT. Additionally, the diet of *H. histrio* was similar at different sizes (ANOSIM, Global R=0.22, p=0.04). Parasites were not observed in the stomachs of *H. histrio*.

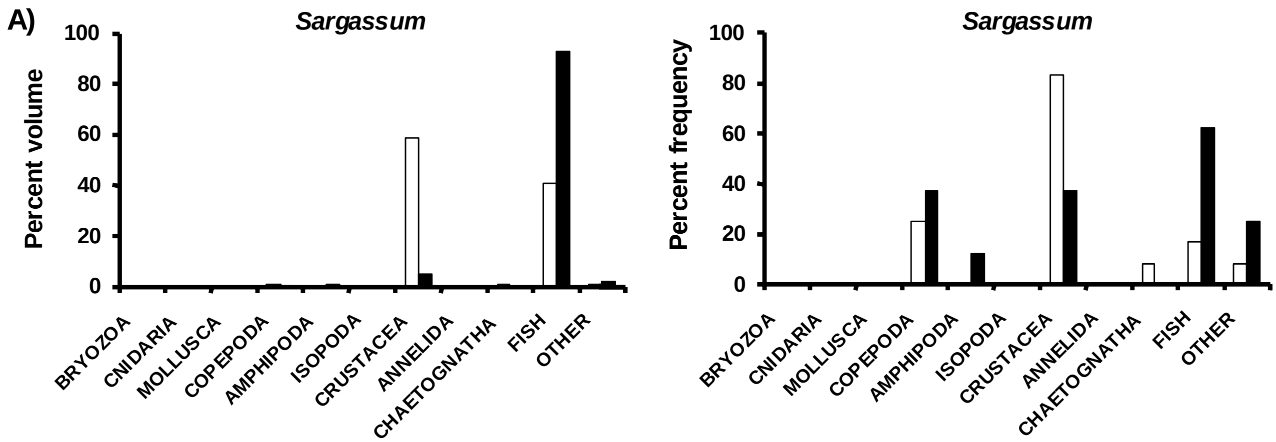

Figure 8. Percent volume and percent frequency of food categories separated by *Sargassum* and open water and day (white bars) and night (black bars) identified in the stomachs of A) *Histrio histrio*, B) juvenile *Cheilopogon melanurus*, C) adult *C. melanurus*, D) *Oxyporhamphus micropterus*, E) *Parexocoetus brachypterus*, F) *Prognichthys occidentalis*, G) *Coryphaena equiselis*, H) juvenile *C. hippurus*, I) adult *C. hippurus*, J) *Caranx crysos*, K) *Decapterus punctatus*, L) *Seriola rivoliana*, M) *Abudefduf saxatilis*, N) *Istiophorus platypterus*, O) *Balistes capriscus*, P) *Monacanthus ciliatus*, and Q) *Stephanolepis hispidus*.

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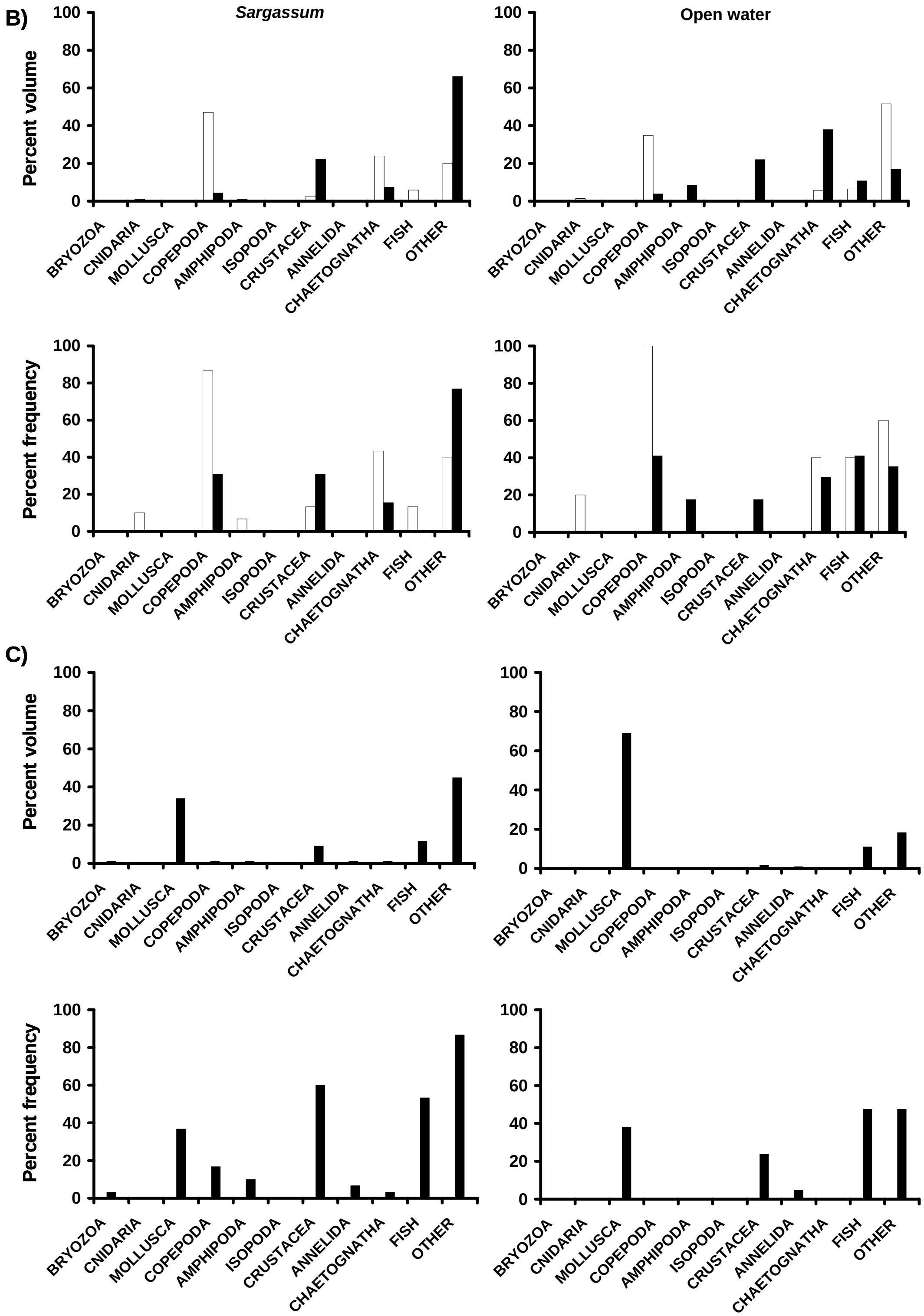
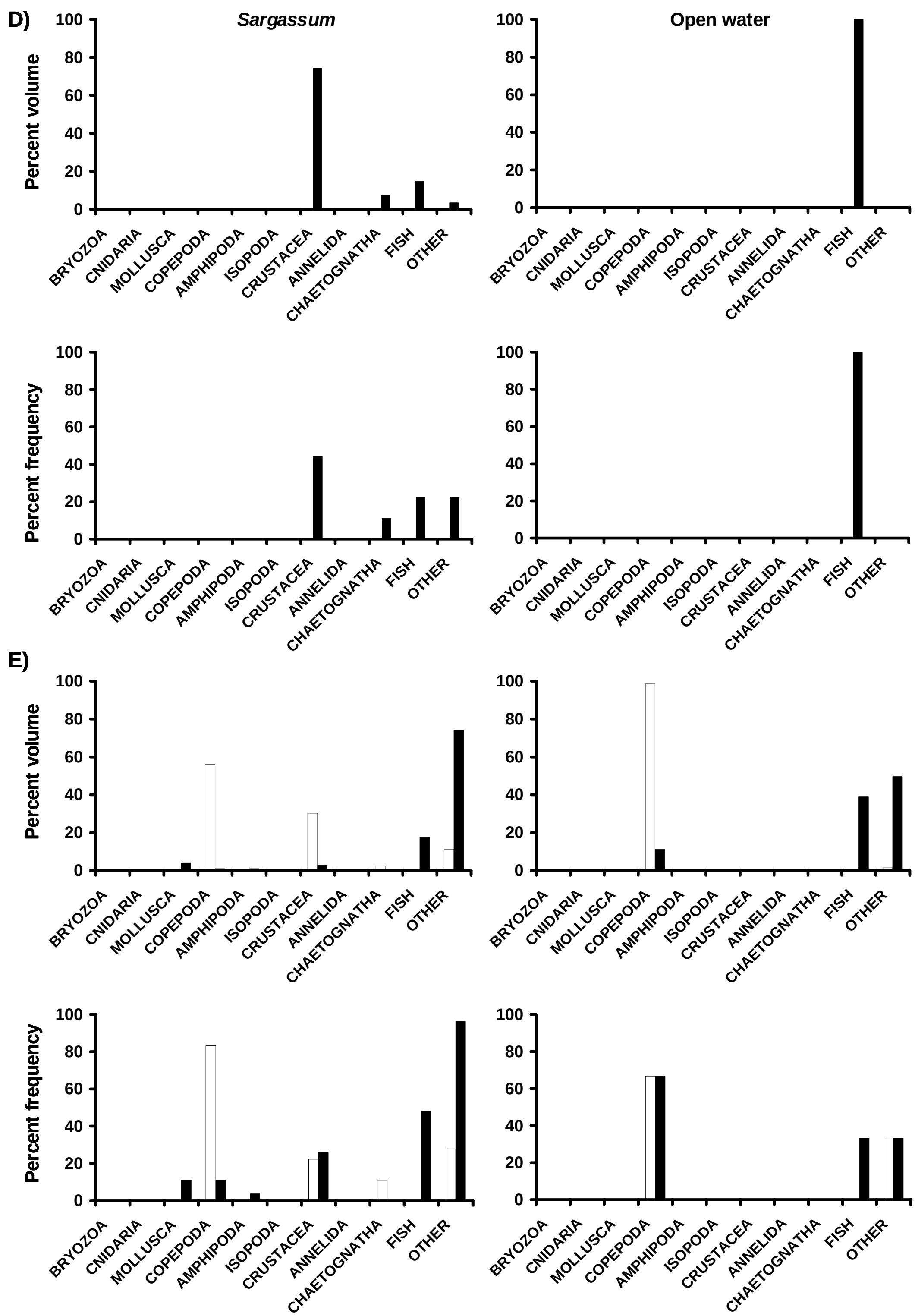


Figure 8 (cont.). Percent volume and percent frequency of food categories separated by *Sargassum* and open water and day (white bars) and night (black bars) identified in the stomachs of A) *Histrio histrio*, B) juvenile *Cheilopogon melanurus*, C) adult *C. melanurus*, D) *Oxyporhamphus micropterus*, E) *Parexocoetus brachypterus*, F) *Prognichthys occidentalis*, G) *Coryphaena equiselis*, H) juvenile *C. hippurus*, I) adult *C. hippurus*, J) *Caranx crysos*, K) *Decapterus punctatus*, L) *Seriola rivoliana*, M) *Abudefduf saxatilis*, N) *Istiophorus platypterus*, O) *Balistes capriscus*, P) *Monacanthus ciliatus*, and Q) *Stephanolepis hispidus*.



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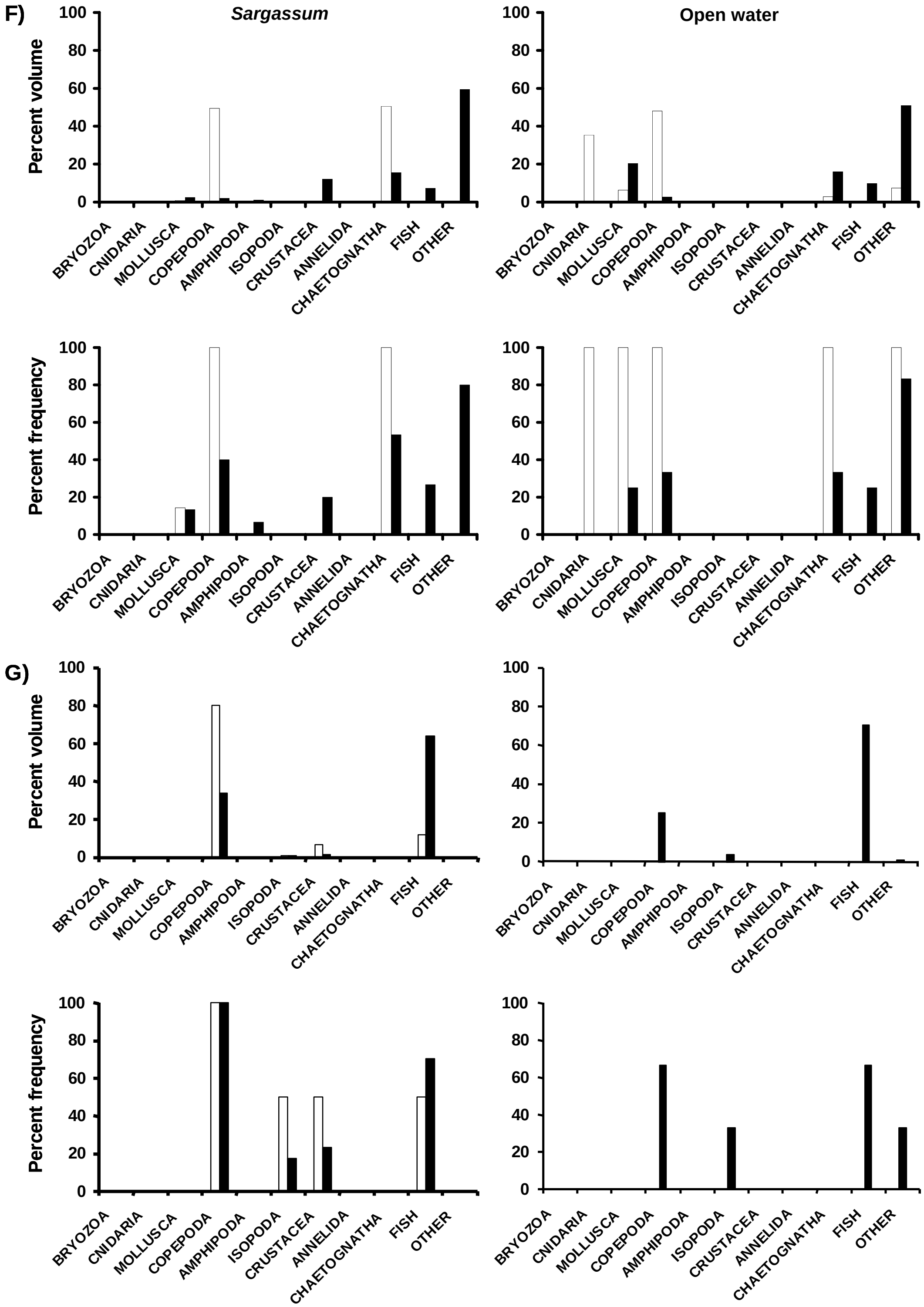

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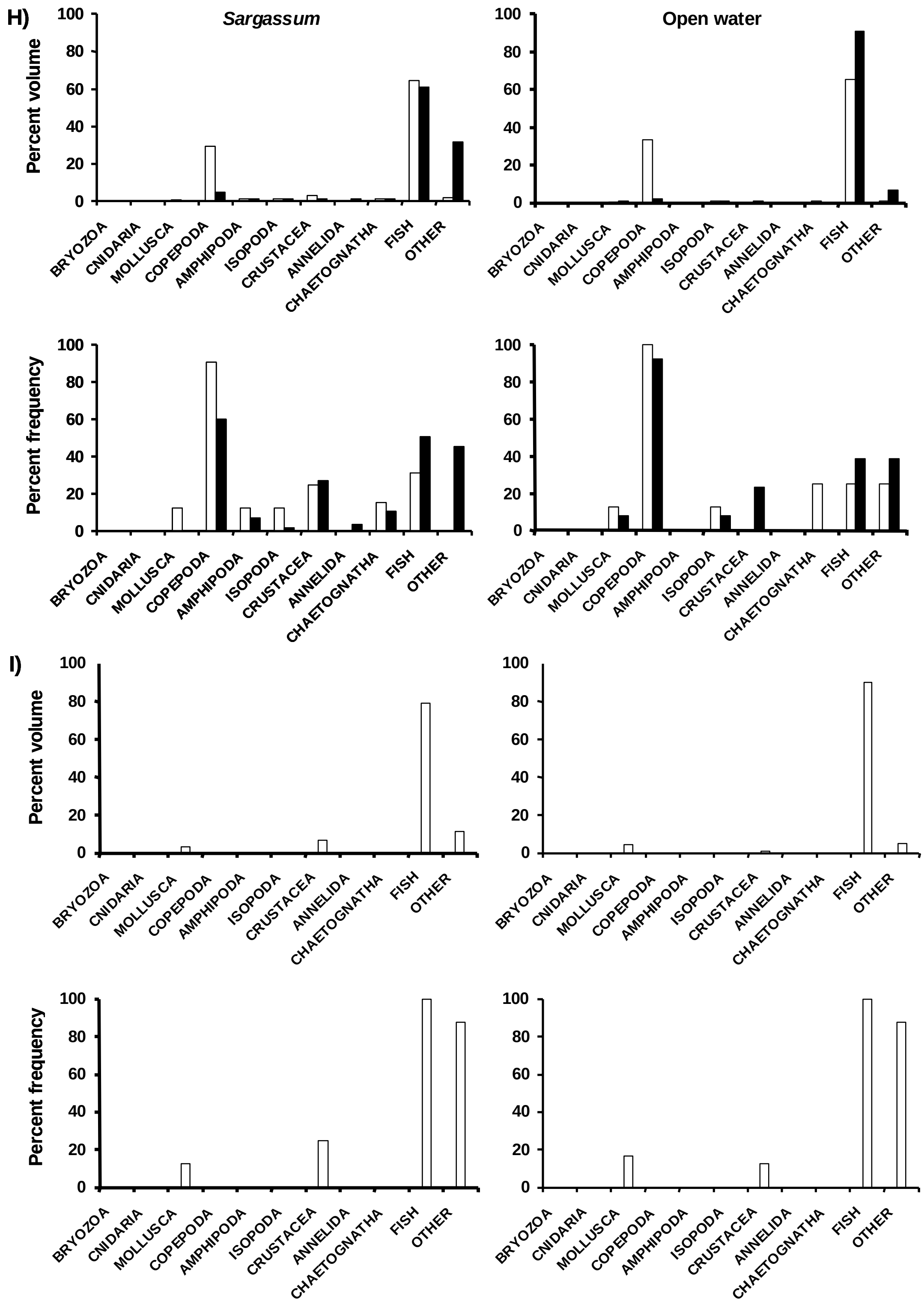

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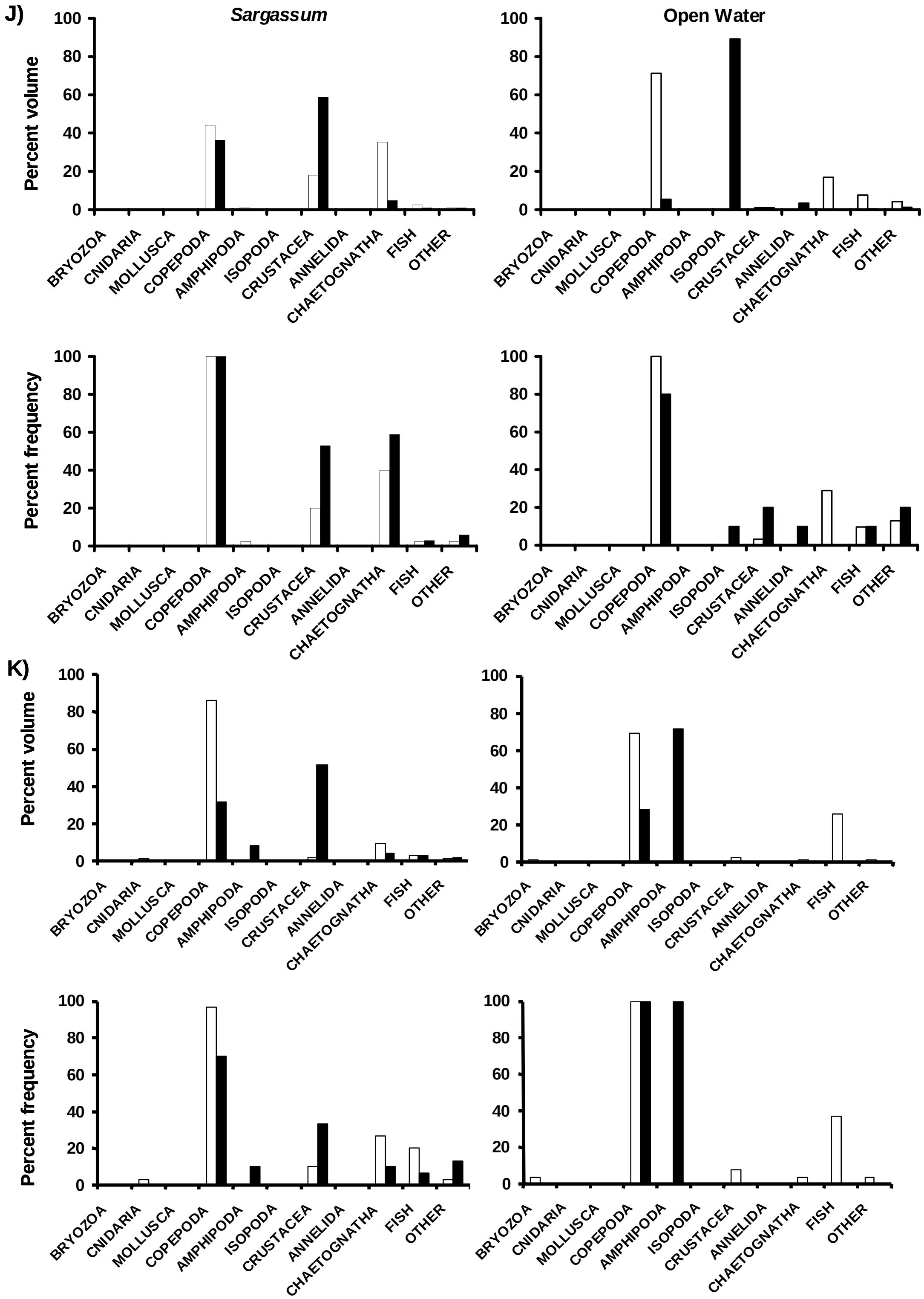

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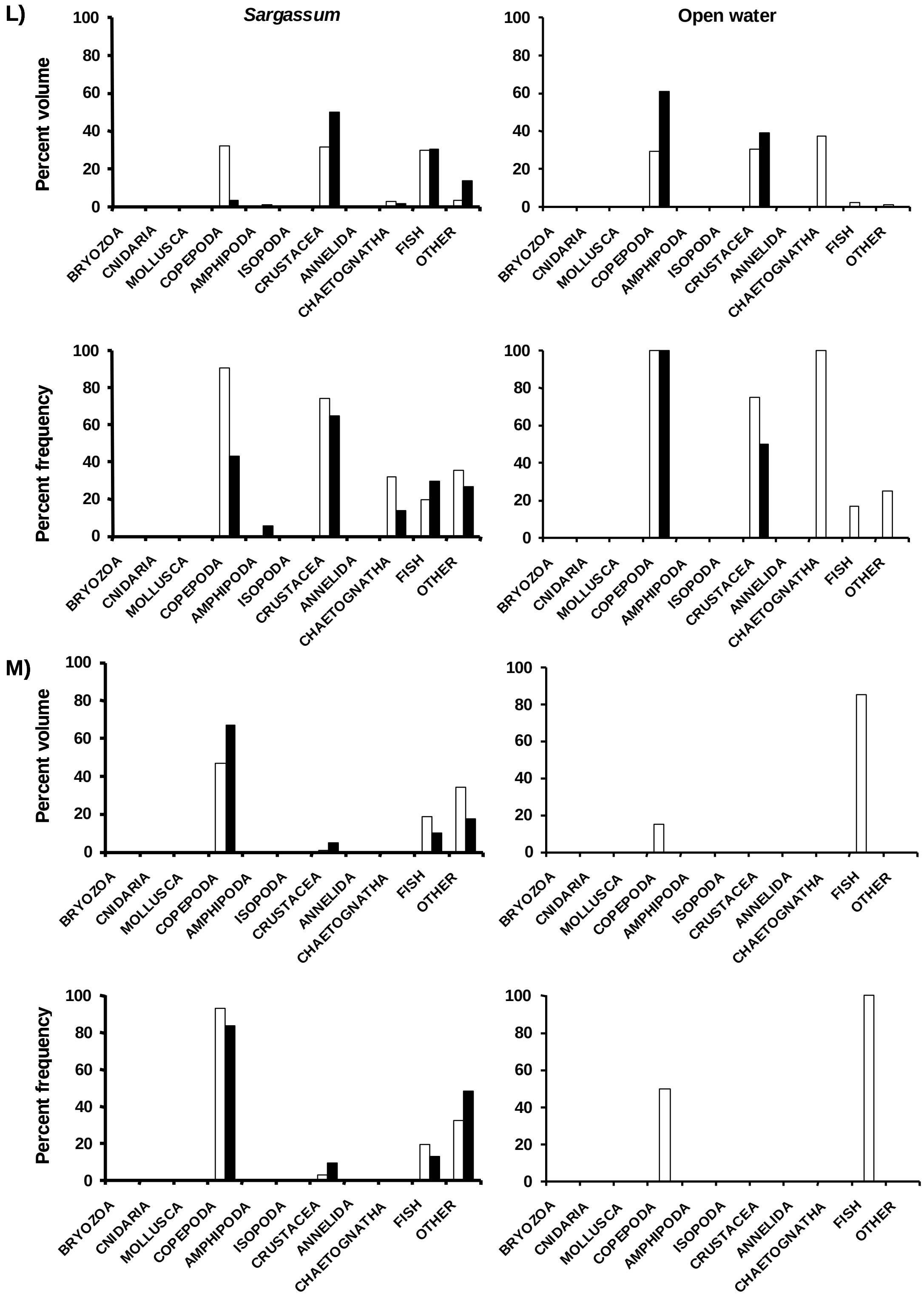

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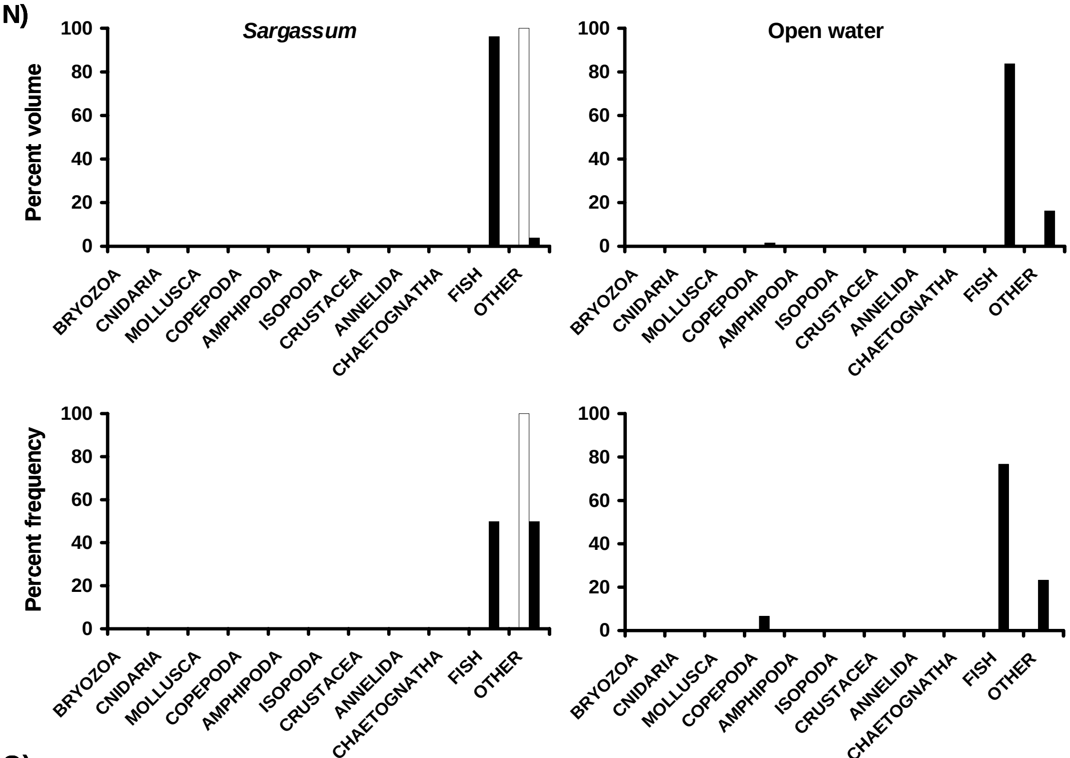

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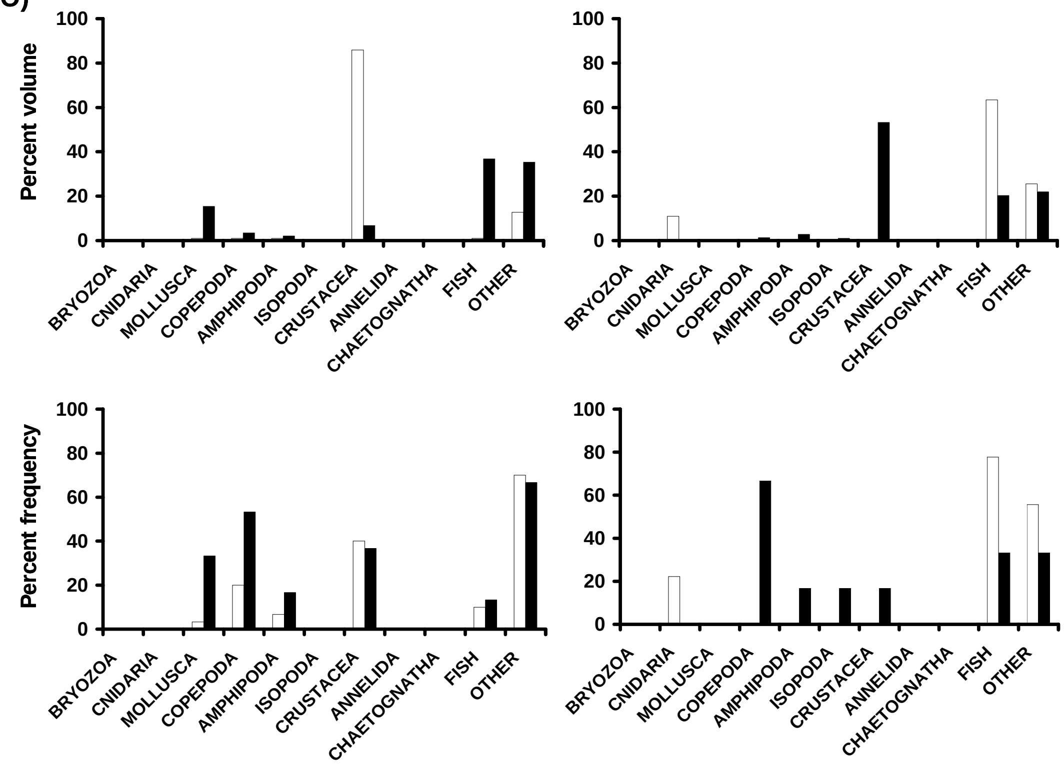

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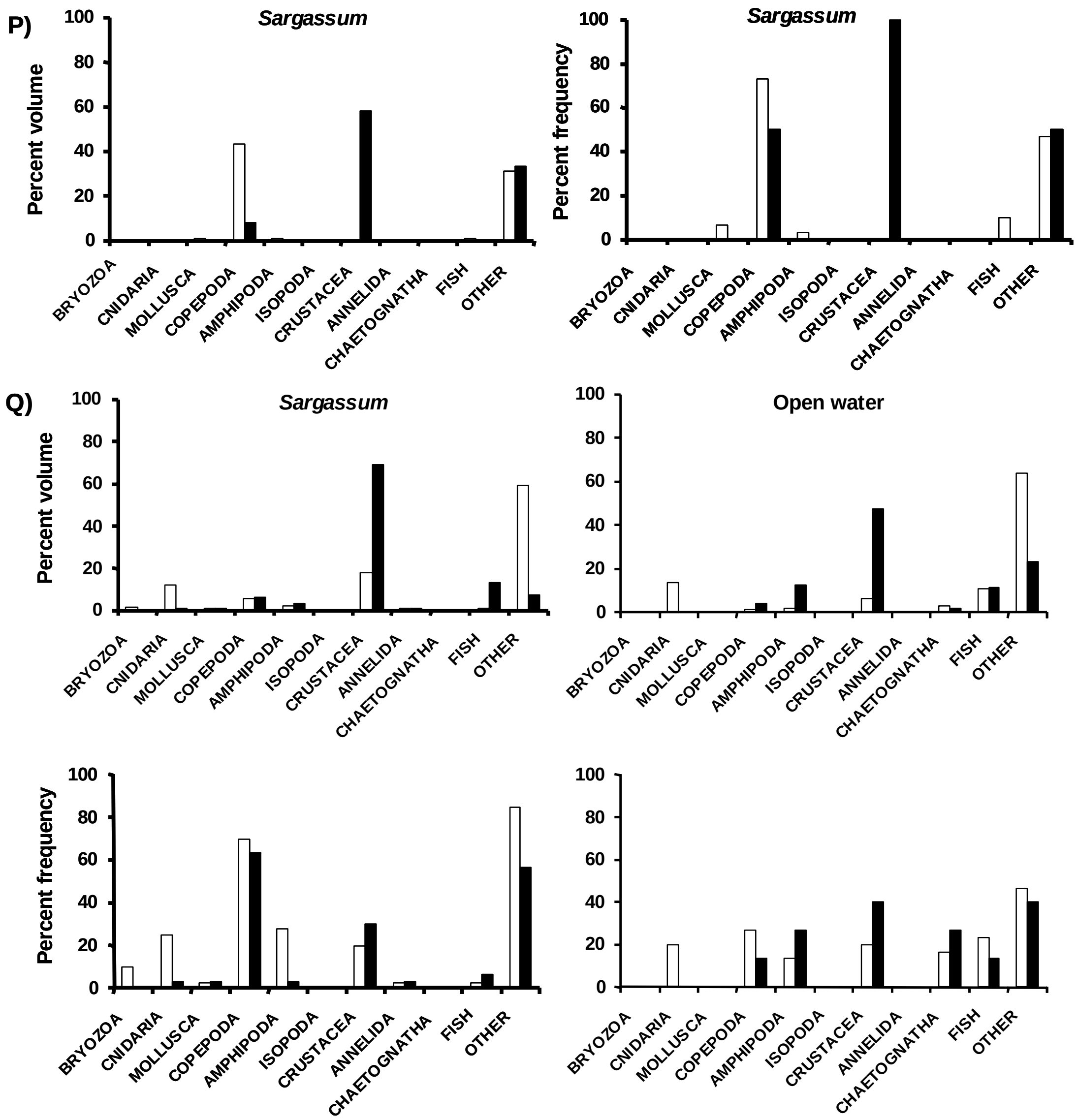

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Table 7. Percent volume (%V) and percent frequency (%F) of prey consumed by *Histrio histrio* collected from *Sargassum* habitat off North Carolina separated by day and night. *n* = number of full stomachs, MF=mean percent fullness of all stomachs.

	Sargassum			
	Day (*n* =12) MF=82%		Night (*n* =8) MF=73%	
Food Item	% V	% F	% V	% F
COPEPODA	0.2	25.0	0.2	37.5
Corycaeus sp.			<0.1	12.5
Unidentified calanoid copepod	0.1	16.7	0.2	25.0
Unidentified parts	0.1	8.3		
AMPHIPODA			<0.1	12.5
Hyperiidean amphipod			<0.1	12.5
CRUSTACEA	58.6	83.3	5.2	37.5
Latreutes fucorum	42.9	66.7	3.3	25.0
Leander tenuicornis	9.1	16.7	1.9	25.0
Unidentified shrimp	6.6	25.0		
CHAETOGNATHA	0.1	8.3		
Sagitta sp.	0.1	8.3		
FISH	40.9	16.7	92.7	62.5
Carangidae			7.9	12.5
Caranx sp.			36.5	12.5
Monacanthidae			16.3	25.0
Stephanolepis hispidus	12.5	8.3	30.4	12.5
Unidentified fish	19.1	8.3		
Unidentified parts	9.4	8.3	1.6	37.5
OTHER	0.2	8.3	1.9	25.0
Organic material	0.2	8.3	1.9	25.0

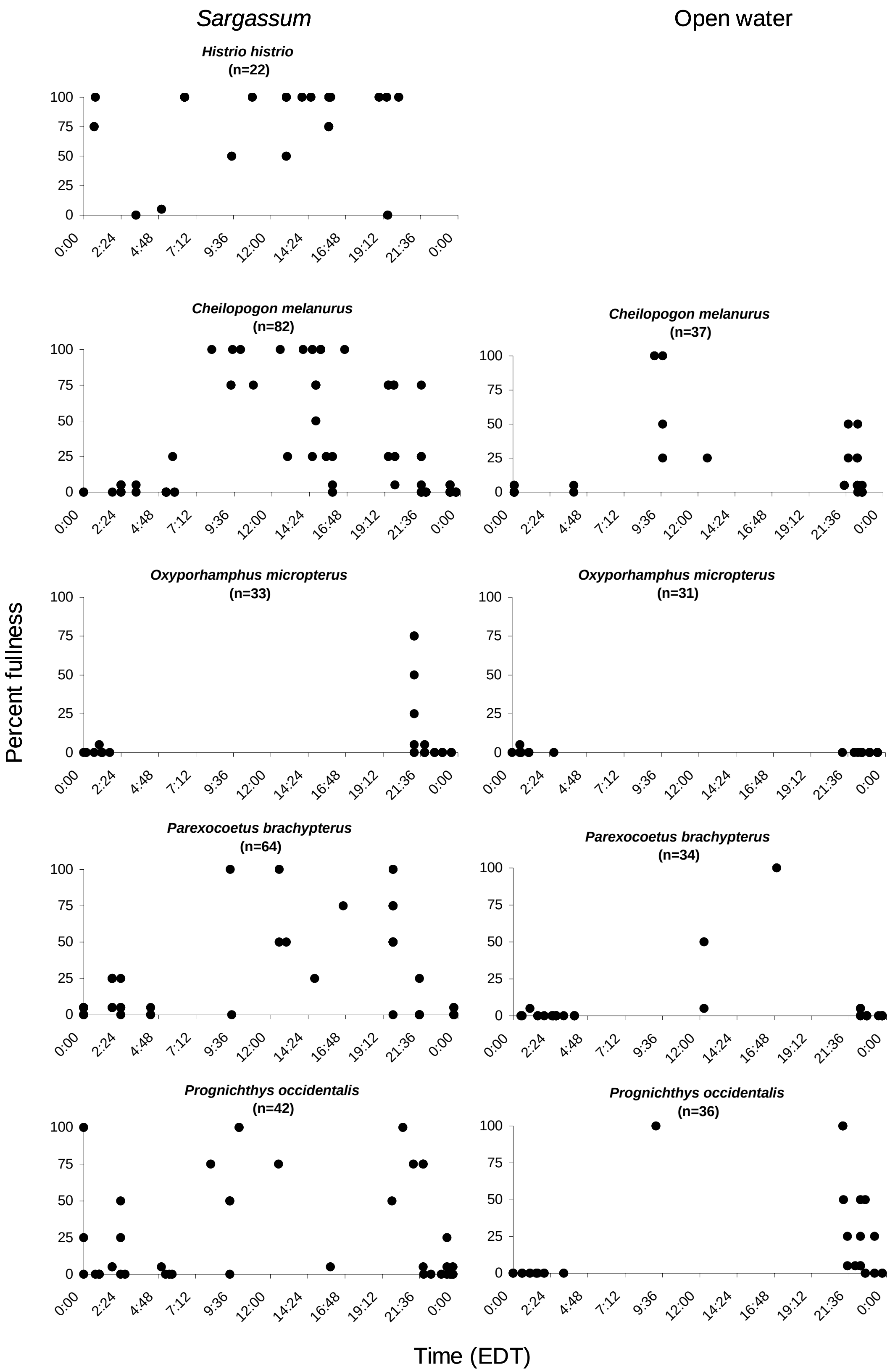

Figure 9. Percent fullness of stomachs over time separated by *Sargassum* and open-water habitats for the dominant fish species analyzed. *n*=total number of stomachs analyzed. Species are listed in phylogenetic order.

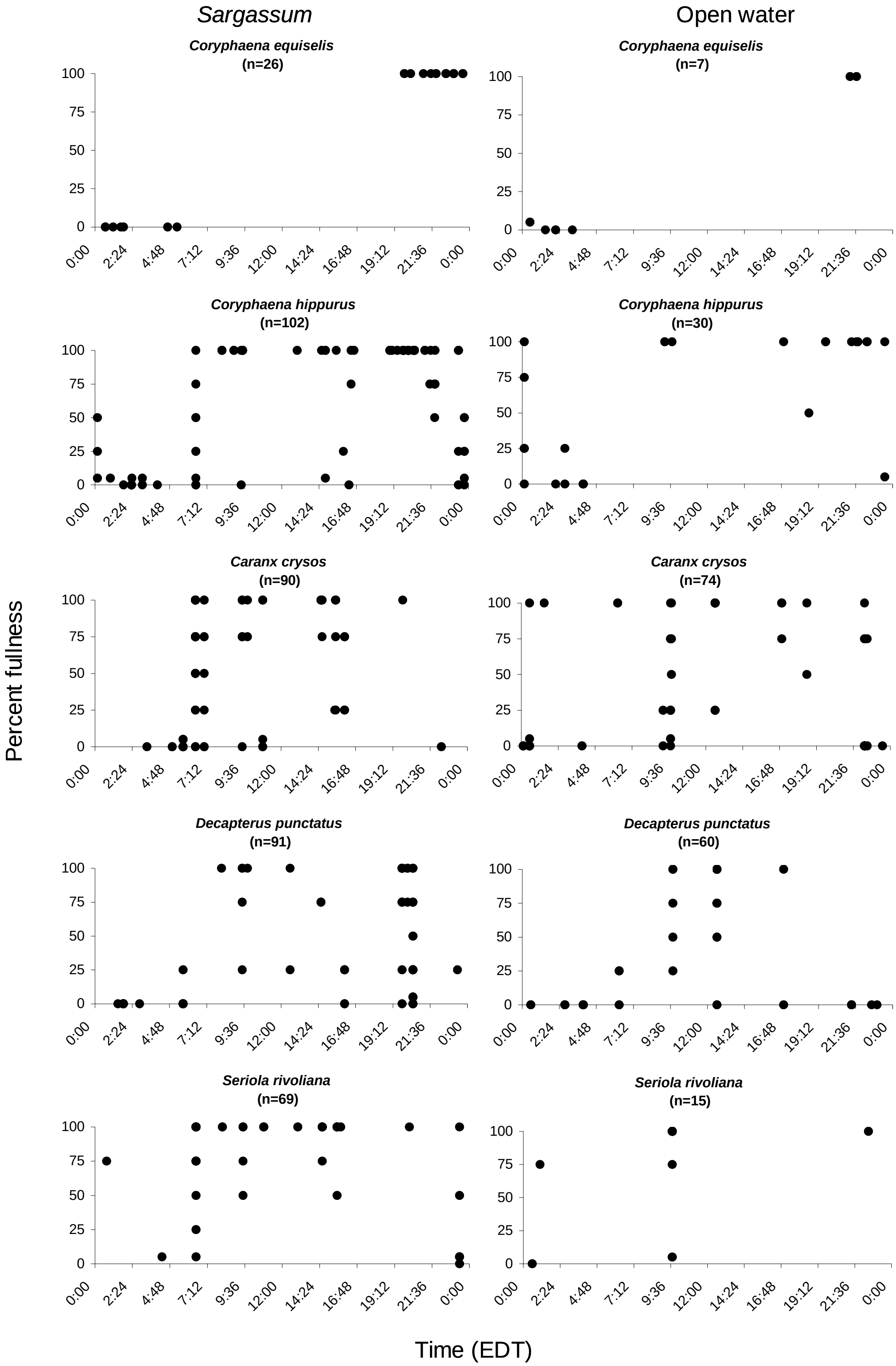

Figure 9 (cont.). Percent fullness of stomachs over time separated by *Sargassum* and open-water habitats for the dominant fish species analyzed. *n*=total number of stomachs analyzed. Species are listed in phylogenetic order.

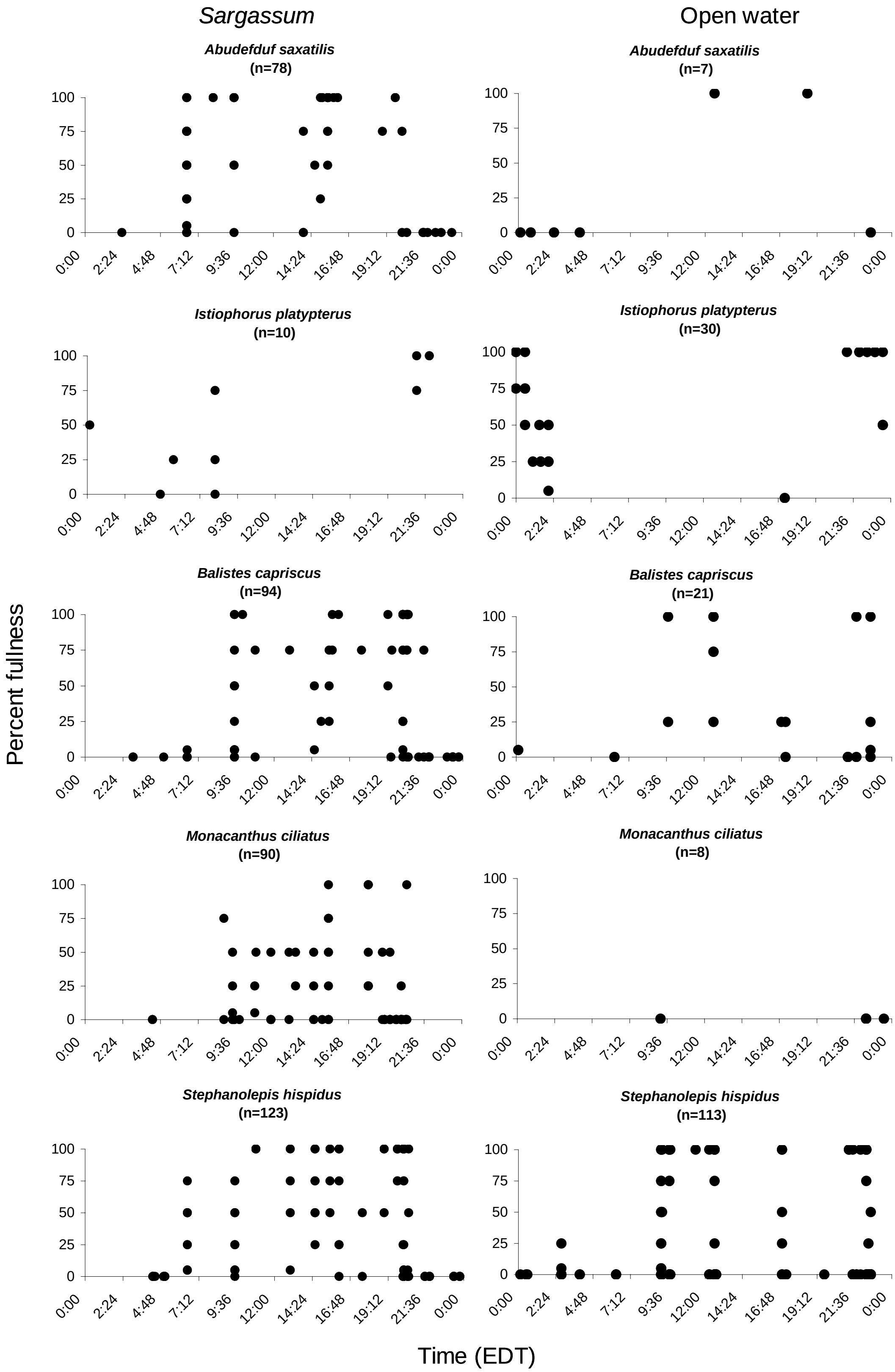

Figure 9 (cont.). Percent fullness of stomachs over time separated by *Sargassum* and open-water habitats for the dominant fish species analyzed. *n*=total number of stomachs analyzed. Species are listed in phylogenetic order.

Remarks- *Histrio histrio*, an ambush predator in the *Sargassum* community, consumes large calanoid copepods (Pontellidae), amphipods, decapods, mysid shrimp, euphausids, *Sargassum*, *L. tenuicornis*, *L. fucorum*, carangids, monacanthids, balistids, *Scomber japonicus*, *H. histrio*, *Psenes* sp., *Kyphosus* sp. and fish eggs (Adams, 1960; Dooley, 1972; Gorelova and Fedoryako, 1986). *Histrio histrio* is capable of consuming larger prey at smaller sizes than most other fishes due to its large mouth and the distensibility of the stomach (Adams, 1960).

Cheilopogon melanurus (Atlantic flyingfish)

Thirty-two individuals (juveniles), 13-58 mm SL, were collected from 19 *Sargassum* day stations. Two individuals had empty stomachs. Of the stomachs containing food, 18 food items were identified from seven food categories (Figure 8B, Table 8). Chaetognaths, organic material and cyclopoid copepods were important in overall percent volume (24, 19 and 14%, respectively),whereas *Farranula gracilis*, copepod parts and chaetognaths were the most frequently ingested food items (60, 50 and 43% frequency, respectively) (Table 8). Parasites (nematodes and digenetic trematodes) were identified in the stomachs of 16% of juvenile *C. melanurus* collected from *Sargassum* during the day.

Fifty individuals (juveniles), 17-84 mm SL, were collected from five *Sargassum* night stations. Thirty-seven individuals had empty stomachs. Of the stomachs containing food, eight food items were identified from four food categories (Figure 8B, Table 8). Organic material and unidentified crustaceans were important both in overall percent volume (64 and 14 %, respectively) and percent frequency (69 and 31%, respectively) (Table 8). Parasites (digenetic trematodes) were identified in the stomachs of 24% of juvenile *C. melanurus* collected from *Sargassum* at night.

Table 8. Percent volume (%V) and percent frequency (%F) of prey consumed by juvenile *Cheilopogon melanurus* collected from *Sargassum* and open-water habitats off North Carolina separated by day and night. *n* =number of full stomachs, MF=mean percent fullness of all stomachs.

	Sargassum				Open Water			
	Day (*n* =30) MF=64%		Night (*n* =13) MF=4%		Day (*n* =5) MF=60%		Night (*n* =17) MF=7%	
Food Item	% V	% F	% V	% F	% V	% F	% V	% F
CNIDARIA	0.3	10.0			1.4	20.0		
Unidentified siphonophore	0.3	10.0			1.4	20.0		
COPEPODA	47.1	86.7	4.4	30.8	34.8	100.0	3.8	41.2
Centropages furcatus	0.4	3.3						
Corycaeus lautus	0.5	13.3						
Corycaeus sp.	0.1	3.3						
Corycaeus speciosus	<0.1	3.3						
Farranula gracilis	9.8	60.0	0.7	15.4	6.4	80.0		
Oncaea mediterranea			0.5	7.7				
Oncaea sp.	0.2	13.3					0.1	5.9
Temora stylifera			0.7	7.7	0.4	20.0		
Unidentified calanoid copepod	8.2	30.0	0.1	7.7			0.7	17.6
Unidentified copepod					0.9	20.0	<0.1	5.9
Unidentified cyclopoid copepod	14	20.0			7.2	40.0	0.3	5.9
Unidentified parts	13.9	50.0	2.4	7.7	19.9	80.0	2.6	17.6
AMPHIPODA	<0.1	6.7					8.6	17.6
Phronimopsis sp.							3.4	5.9
Unidentified amphipod							0.9	5.9
Unidentified parts	<0.1	6.7					4.2	5.9
CRUSTACEA	2.7	13.3	22.1	30.8			22.0	17.6
Unidentified crustacean			14.1	15.4				
Unidentified crustacean parts	2.7	10.0	4.2	15.4			22.0	17.6
Unidentified decapod larva	<0.1	3.3						
Unidentified shrimp			3.8	7.7				
CHAETOGNATHA	23.9	43.3	7.3	15.4	5.7	40.0	37.9	29.4
Sagitta sp.	7.1	23.3	3.0	7.7	5.7	40.0		
Unidentified parts	16.8	20.0	4.3	7.7			37.9	29.4
FISH	5.9	13.3			6.5	40.0	10.8	41.2
Fish scale							6.1	35.3
Unidentified fish egg	5.9	13.3			6.5	40.0		
Unidentified parts							4.7	11.8
OTHER	20.1	40.0	66.1	76.9	51.6	60.0	17	35.3
Inorganic material	0.6	20.0						
Organic material	19.2	40.0	64.4	69.2	51.6	60.0	10.9	29.4
Unidentified animal	0.1	3.3	1.7	15.4				
Unidentified egg	0.2	6.7					0.5	5.9
Unidentified gelatinous material							5.6	5.9
Unidentified larva	<0.1	3.3						

The diets of juvenile *C. melanurus* collected during the day versus at night from *Sargassum* habitat were similar (ANOSIM, Global *R*=0.23, *p*=0.04); however, these fishes primarily fed during the day and the majority (92%) of the stomachs from fishes collected between 2000 and 0700 EDT were ≤5% full or empty (Figure 9). Additionally, the diets of juvenile *C. melanurus* collected from *Sargassum* were similar at different sizes (ANOSIM, Global *R*=0.20, *p*=0.03).

Five juvenile *C. melanurus*, 19-29 mm SL, were collected from three open-water day stations. No individual had an empty stomach. Eight food items were identified from five food categories (Figure 8B, Table 8). Organic material and copepod parts were dominant in overall percent volume (52 and 20%, respectively), whereas *F. gracilis*, copepod parts and organic material occurred most frequently in these stomachs (80, 80 and 60% frequency, respectively) (Table 8). Parasites were not identified in the stomachs of juvenile *C. melanurus* collected from open water during the day.

Thirty-two juvenile *C. melanurus*, 15-85 mm SL, were collected from seven open-water night stations. Fifteen individuals had empty stomachs. Of the stomachs containing food, 13 food items were identified from six food categories (Figure 8B, Table 8). Chaetognath parts and crustacean parts were important in overall percent volume (38 and 22%, respectively), whereas fish scales, organic material and chaetognath parts occurred most frequently in these stomachs (35, 29 and 29% frequency, respectively) (Table 8). Parasites (digenetic trematodes) were identified in the stomachs of 46% of juvenile *C. melanurus* collected from open-water at night.

The diets of juvenile *C. melanurus* collected during the day versus at night from open-water habitat were similar (ANOSIM, Global *R*=0.13, *p*=0.15); however, these fishes primarily fed during the day and the majority (84%) of the stomachs of fishes collected between

2000 and 0700 EDT were ≤5% full or empty (Figure 9). Juvenile *C. melanurus* collected from open-water habitat consumed similar prey across all size ranges (ANOSIM, Global *R*=0.23, *p*=0.06). The diets of juvenile *C. melanurus* collected from *Sargassum* and open-water habitats were similar (ANOSIM, Global *R*=-0.04, *p*=0.55).

All adult *C. melanurus* were collected at night. Thirty individuals, 178-253 mm SL, were collected from nine *Sargassum* stations and no individual had an empty stomach. Twenty-eight food items were identified from nine food categories (Figure 8C, Table 9). Organic material and pteropod parts were dominant in overall percent volume (45 and 25%, respectively), whereas organic material, fish scales and crustacean parts occurred most frequently in these stomachs (83, 67 and 50% frequency, respectively) (Table 9). Parasites (nematodes and digenetic trematodes) were identified in the stomachs of 80% of adult *C. melanurus* collected from *Sargassum* at night.

Thirty adult *C. melanurus*, 166-242 mm SL, were collected from nine open-water stations and nine individuals had empty stomachs. Of the stomachs containing food, 13 food items were identified from five food categories (Figure 8C, Table 9). Pteropod parts, organic material and fish scales were dominant both in overall percent volume (69, 18 and 10%, respectively) and percent frequency (33, 48 and 48%, respectively) (Table 9). Parasites (digenetic trematodes) were identified in the stomachs of 7% of adult *C. melanurus* collected from open-water at night.

Adult *C. melanurus* collected from *Sargassum* habitat consumed similar prey across all size ranges (ANOSIM, Global *R*=0.10, *p*=0.18), and adult *C. melanurus* collected from open-water habitat consumed similar prey across all size ranges (ANOSIM, Global *R*=-0.03, *p*=0.54). The diets of adult *C. melanurus* collected from *Sargassum* and open-water habitats were similar (ANOSIM, Global *R*=0.00, *p*=0.44). Significant differences were observed between the diets of

Table 9. Percent volume (%V) and percent frequency (%F) of prey consumed by adult *Cheilopogon melanurus* collected from *Sargassum* and open-water habitats off North Carolina at night. *n* =number of full stomachs, MF=mean percent volume of all stomachs.

	Sargassum		Open Water	
	Night (*n* =30) MF=19%		Night (*n* =21) MF=13%	
Food Item	% V	% F	% V	% F
BRYOZOA	<0.1	3.3		
Bryozoan colony	<0.1	3.3		
MOLLUSCA	33.9	36.7	69.0	38.1
Cavolinia sp.	6.2	3.3		
Diacavolinia sp.	2.2	3.3		
Unidentified cephalopod	0.1	3.3		
Unidentified cephalopod parts	0.1	6.7	0.3	4.8
Unidentified heteropod	0.2	6.7		
Unidentified pteropod parts	25.1	20.0	68.7	33.3
COPEPODA	<0.1	16.7		
Farranula gracilis	<0.1	3.3		
Unidentified calanoid copepod	<0.1	13.3		
AMPHIPODA	<0.1	10.0		
Hyperiidean amphipod	<0.1	6.7		
Unidentified amphipod	<0.1	3.3		
CRUSTACEA	9.1	60.0	1.6	23.8
Latreutes fucorum	0.1	3.3	0.9	4.8
Unidentified crustacean	0.9	16.7		
Unidentified crustacean parts	7.1	50.0	0.4	9.5
Unidentified decapod larva	0.6	6.7		
Unidentified mysid shrimp	0.2	3.3		
Unidentified shrimp	0.1	3.3	0.3	9.5
ANNELIDA	0.4	6.7	<0.1	4.8
Unidentified polychaete	0.4	6.7		
Unidentified polychaete parts			<0.1	4.8
CHAETOGNATHA	<0.1	3.3		
Unidentified parts	<0.1	3.3		
FISH	11.6	53.3	11.0	47.6
Fish scale	5.0	66.7	10.3	47.6
Parexocoetus brachypterus	6.6	3.3		
Unidentified fish parts	<0.1	3.3	<0.1	9.5
Unidentified fish remains	0.1	3.3	0.7	4.8
OTHER	44.9	86.7	18.3	47.6
Inorganic material	<0.1	13.3	<0.1	4.8
Organic material	44.6	83.3	18.2	47.6
Sargassum sp.	0.1	10.0		
Unidentified animal	<0.1	3.3		
Unidentified animal part			<0.1	9.5
Unidentified egg	0.1	13.3		
Unidentified gelatinous material	<0.1	3.3		
Unidentified plant piece	<0.1	3.3	<0.1	4.8

juvenile and adult *C. melanurus* collected from *Sargassum* habitat (ANOSIM, Global *R*=0.46, *p*=0.001), and the diets of juvenile and adult *C. melanurus* were 96% dissimilar (SIMPER). Food items driving the differences were: fish scales (adults), pteropods (adults), *F. gracilis* (juveniles) and *Sagitta sp.* (juveniles). In contrast, the diets of juvenile and adult *C. melanurus* collected from open-water habitat were similar (ANOSIM, Global *R*=0.14, *p*=0.002).

Remarks- Larval and juvenile *C. melanurus* collected from open water consume calanoid and cyclopoid copepods, euphausids and crustaceans (Breder, 1938; Lipskaya, 1987), whereas adult *C. melanurus* collected from open water consume small fishes and zooplankton (Carpenter, 2002). Juvenile and adult *C. melanurus* primarily feed during the day which is attributed to increased visual acuity during the day (Gorelova, 1980; Lipskaya, 1987).

Oxyporhamphus micropterus (smallwing flyingfish)

All *O. micropterus* were collected at night. Thirty-five individuals, 38-147 mm SL, were collected from nine *Sargassum* stations. Twenty-six individuals had empty stomachs. Of the stomachs containing food, four food items were identified from four food categories (Figure 8D, Table 10). Crustacean parts and fish eggs were important both in overall percent volume (74 and 15%, respectively) and percent frequency (44 and 33%, respectively). Parasites were not identified in the stomachs of *O. micropterus* collected from *Sargassum*.

The majority (88%) of the stomachs of *O. micropterus* collected from *Sargassum* between 2000 and 0700 EDT were empty or ≤5% full (Figure 9). *Oxyporhamphus micropterus* collected from *Sargassum* habitat consumed similar prey across all size ranges (ANOSIM, Global *R*=0.01, *p*=0.54).

Table 10. Percent volume (%V) and percent frequency (%F) of prey consumed by *Oxyporhamphus micropterus* collected from *Sargassum* and open-water habitats off North Carolina at night. *n* =number of full stomachs, MF=mean percent fullness of all stomachs.

	Sargassum		Open Water	
	Night (*n* =9) MF=7%		Night (*n* =1) MF=<1%	
Food Item	% V	% F	% V	% F
CRUSTACEA	74.4	44.4		
Unidentified crustacean parts	74.4	44.4		
CHAETOGNATHA	7.4	11.1		
Sagitta sp.	7.4	11.1		
FISH	14.7	22.2	100.0	100.0
Unidentified fish egg	14.7	22.2		
Unidentified parts			100.0	100.0
OTHER	3.5	22.2		
Organic material	3.5	22.2		

Thirty-one *O. micropterus*, 15-110 mm SL, were collected from 12 open-water stations. Thirty individuals had empty stomachs. Fish parts (fin rays) were the only food item identified in the stomach (Figure 8D, Table 10). Parasites were not identified in the stomachs of *O. micropterus* collected from open-water habitat.

All of the stomachs of *O. micropterus* collected from open water between 2000 and 0700 EDT were empty or ≤5% full (Figure 9). ANOSIM analysis was not employed to compare the diets of *O. micropterus* collected from *Sargassum* and open-water due to the low number of individuals with full stomachs collected from open-water habitat.

Remarks- Being a visual feeder, *Oxyporamphus micropterus* feeds during the day (Gorelova, 1980; Lipskaya, 1981). Larval and juvenile *O. micropterus* collected from open-water habitat consume siphonophores, calanoid, cyclopoid (mostly *Farranula* sp. and *Oncaea* sp.) and harpacticoid copepods, gastropods, pteropods and appendicularians (Gorelova, 1980; Lipskaya, 1981).

Parexocoetus brachypterus (sailfin flyingfish)

Twenty individuals, 8-59 mm SL, were collected from seven *Sargassum* day stations. Two individuals had empty stomachs. Of the stomachs containing food, 12 food items were identified from four food categories (Figure 8E, Table 11). Copepod parts, crustacean parts and calanoid copepods were important in overall percent volume (32, 30 and 13%, respectively), and copepod parts, calanoid copepods and *F. gracilis* were the most frequently (61, 33 and 28% frequency, respectively) ingested food items (Table 11). Parasites (digenean trematodes) were identified in the stomachs of 20% of *P. brachypterus* collected from *Sargassum* habitat during the day.

Table 11. Percent volume (%V) and percent frequency (%F) of prey consumed by *Parexocoetus brachypterus* collected from *Sargassum* and open-water habitats off North Carolina separated by day and night. *n* =number of full stomachs, MF= mean percent fullness of all stomachs.

	Sargassum				Open Water			
	Day (*n* =18) MF=60%		Night (*n* =27) MF=7%		Day (*n* =3) MF=52%		Night (*n* =3) MF=<1%	
Food Item	% V	% F	% V	% F	% V	% F	% V	% F
MOLLUSCA			4.2	11.1				
Unidentified gastropod			1.3	3.7				
Unidentified heteropod			2.8	7.4				
COPEPODA	56.0	83.3	0.7	11.1	98.5	66.7	11.2	66.7
Centropages furcatus	0.4	11.1						
Corycaeus sp.	2.7	22.2						
Farranula gracilis	1.3	27.8			11.7	66.7		
Labidocera sp.	4.1	5.6						
Oncaea mediterranea	0.6	11.1						
Oncaea sp.	1.1	22.2			0.6	33.3		
Unidentified calanoid copepod	13.3	33.3			1.9	33.3	7.0	33.3
Unidentified copepod			0.6	7.4				
Unidentified parts	32.4	61.1	0.1	3.7	84.3	66.7	4.2	33.3
AMPHIPODA			0.7	3.7				
Gammeridean amphipod			0.7	3.7				
CRUSTACEA	30.3	22.2	2.8	25.9				
Unidedentified crustacean			0.6	7.4				
Unidentified crustacean parts	30.3	22.2	0.9	14.8				
Unidentified shrimp			1.3	3.7				
CHAETOGNATHA	2.4	11.1						
Sagitta sp.	2.4	11.1						
FISH			17.5	48.1			39.2	33.3
Fish scale			15.7	40.7			39.2	33.3
Unidentified fish remains			1.7	7.4				
Unidentified parts			0.1	11.1				
OTHER	11.3	27.8	74.2	96.3	1.5	33.3	49.6	33.3
Inorganic material			<0.1	7.4				
Organic material	7.7	22.2	72.2	96.3	1.5	33.3		
Plastic piece			0.1	3.7				
Sand grain			<0.1	3.7				
Sargassum sp.							49.6	33.3
Unidentified animal	3.0	5.6	<0.1	3.7				
Unidentified egg	0.6	5.6	<0.1	3.7				
Unidentified gelatinous material			1.8	11.1				

Forty-four individuals, 14-113 mm SL, were collected from six *Sargassum* night stations. Seventeen individuals had empty stomachs. Of the stomachs containing food, 15 food items were identified from six food categories (Figure 8E, Table 11). Organic material and fish scales were important in both overall percent volume (72 and 16%, respectively) and percent frequency (96 and 41%, respectively) (Table 11). Parasites (digenetic trematodes) were identified in the stomachs of 5% of *P. brachypterus* collected from *Sargassum* at night.

Parexocoetus brachypterus collected from *Sargassum* habitat fed primarily during the day and the majority (82%) of the stomachs of fishes collected between 2000 and 0700 EDT were ≤5% full or empty (Figure 9). Significant differences were observed between the diets of *P. brachypterus* collected during the day versus at night in *Sargassum* habitat (ANOSIM, Global R=0.43, p=0.001), and the diets of *P. brachypterus* collected during the day and at night were 99% dissimilar (SIMPER). Species of prey driving the differences were: calanoid copepods (day), *Corycaeus* sp. (day), *Sagitta* sp. (day), fish scales (night) and heteropods (night). *Parexocoetus brachypterus* collected from *Sargassum* habitat consumed similar prey across all size ranges (ANOSIM, Global R=0.03, p=0.001).

Three *P. brachypterus*, 13-22 mm SL, were collected from two open-water day stations. No individual had an empty stomach. Four food items were identified from two food categories (Figure 9E, Table 12). Copepod parts and *F. gracilis* were important in both overall percent volume (84 and 12%, respectively) and percent frequency (67 and 67%, respectively) (Table 11). Parasites were not identified in the stomachs of *P. brachypterus* collected during the day from open-water habitat.

Thirty-one *P. brachypterus*, 8-128 mm SL, were collected from fourteen open-water night stations. Twenty-eight individuals had empty stomachs. Of the stomachs containing food, four food items were identified from three food categories (Figure 8E, Table 11). *Sargassum* and fish scales were the most important in overall percent volume (50 and 39%, respectively), and all of the food items identified in these stomachs were equally important in overall percent frequency (Table 11). Parasites were identified in the stomachs of 7% of *P. brachypterus* collected from open-water habitat at night.

Parexocoetus brachypterus collected from open-water habitat fed primarily during the day, and all of the stomachs of fishes collected between 2000 and 0700 EDT were ≤5% full or empty (Figure 9). The diets of *P. brachypterus* collected during the day and at night from open-water habitat were similar (ANOSIM, Global R=-0.12, p=0.70). *Parexocoetus brachypterus* collected from open-water habitat consumed similar prey across all size ranges (ANOSIM, Global R=0.20, p=0.22). Additionally, the diets of *P. brachypterus* collected from *Sargassum* and open-water habitats were similar (ANOSIM, Global R=0.01, p=0.42).

Remarks- *Parexocoetus brachypterus* collected from open water consume calanoid and cyclopoid copepods, small fishes (Myctophidae), amphipods, siphonophores, isopods, fish scales and decapod crustaceans, and the most abundant copepods identified in the stomachs were *Undinula vulgaris*, *Candacia pachydactyla* and *Corycaeus obtusus* (Lewis, 1961).

Prognichthys occidentalis (bluntnose flyingfish)

Eight individuals, 13-60 mm SL, were collected from six *Sargassum* day stations. One individual had an empty stomach. Of the stomachs containing food, six food items were identified from three food categories (Figure 8F, Table 12). *Sagitta* sp. and *F. gracilis* were dominant both in overall percent volume (51 and 25%, respectively) and percent frequency (100 and 71%, respectively) (Table 12). Parasites were not identified in the stomachs of *P. occidentalis* collected from *Sargassum* during the day.

Table 12. Percent volume (%V) and percent frequency (%F) of prey consumed by *Prognichthys occidentalis* collected from *Sargassum* and open-water habitats off North Carolina separated by day and night. *n* =number of full stomachs, MF= mean percent fullness of all stomachs.

	Sargassum				Open Water			
	Day (*n* =7) MF=56%		Night (*n* =15) MF=18%		Day (*n* =1)		Night (*n* =12) MF=13%	
Food Item	% V	% F	% V	% F	% V	% F	% V	% F
MOLLUSCA	<0.1	14.3	2.4	13.3	6.3	100.0	20.4	25.0
Limacina sp.	<0.1	14.3						
Unidentified cephalopod parts			2.4	13.3				
Unidentified gastropod							0.1	8.3
Unidentified heteropod					6.3	100.0	0.2	8.3
Unidentified pteropod parts							20.2	8.3
CNIDARIA					35.4	100.0		
Unidentified siphonophore					35.4	100.0		
COPEPODA	49.5	100.0	2.0	40.0	48.0	100.0	2.7	33.3
Corycaeus lautus	0.3	14.3						
Farranula gracilis	28.5	71.4			28.6	100.0	0.1	8.3
Oncaea sp.	0.1	14.3						
Paracandacia simplex	6.9	14.3						
Unidentified calanoid copepod			1.4	26.7	5.1	100.0	1.1	8.3
Unidentified cyclopoid copepod			0.2	20.0			1.5	25.0
Unidentified parts	13.7	85.7	0.4	6.7	14.3	100.0		
AMPHIPODA			1.1	6.7				
Hyperiidean amphipod			1.1	6.7				
CRUSTACEA			12.1	20.0				
Cancer sp.			4.6	6.7				
Unidentified crustacean parts			7.4	20.0				
Unidentified shrimp parts			0.1	6.7				
CHAETOGNATHA	50.5	100.0	15.6	53.3	2.9	100.0	16.0	33.3
Sagitta sp.	50.5	100.0	11.0	13.3			11.8	8.3
Unidentified parts			4.6	40.0	2.9	100.0	4.3	25.0
FISH			7.2	26.7			9.8	25.0
Fish scale			7.1	26.7			9.8	25.0
Unidentified parts			0.1	6.7				
OTHER			59.5	80.0	7.4	100.0	51.0	83.3
Inorganic material							0.1	8.3
Organic material			59.3	80.0	7.4	100.0	50.9	91.7
Unidentified animal			0.2	6.7				
Unidentified hard part			<0.1	6.7				
Unidentified rods			0.1	6.7				

Thirty-three individuals, 14-147 mm SL, were collected from 20 *Sargassum* night stations. Eighteen individuals had empty stomachs. Of the stomachs containing food, 13 food items were identified from seven food categories (Figure 8F, Table 12). Organic material and *Sagitta* sp. were important both in overall percent volume (59 and 53%, respectively) and percent frequency (80 and 53%, respectively) (Table 12). Parasites were not identified in the stomachs of *P. occidentalis* collected from *Sargassum* at night.

Prognichthys occidentalis collected from *Sargassum* habitat primarily fed during the day, and the majority (75%) of the stomachs of fishes collected between 2000 and 0700 EDT were ≤5% full or empty (Figure 9). Significant differences were observed between the diets of *P. occidentalis* collected during the day versus at night in *Sargassum* habitat (ANOSIM, Global R=0.42, p=0.001), and SIMPER exploratory analysis indicated the diet of *P. occidentalis* collected during the day and at night were 86% dissimilar. Species of prey driving the differences were: *Sagitta* sp. (day), *F. gracilis* (day), cyclopoid copepods (night) and calanoid copepods (night). *Prognichthys occidentalis* collected from *Sargassum* habitat consumed similar prey across all size ranges (ANOSIM, Global R=0.37, p=0.007).

One individual, 17 mm SL, was collected from one open-water day station. Six food items were identified from five food categories (Figure 8F, Table 12). Siphonophores and *F. gracilis* were the most important food items in overall percent volume (35 and 29%, respectively) and all food items occurred in equal frequency (Table 12). Parasites were not identified in the stomach of *P. occidentalis* collected from open-water habitat during the day.

Thirty-five individuals, 11-165mm SL, were collected from 16 open-water night stations. Twenty-three individuals had empty stomachs. Of the stomachs containing food, 10 food items were identified from five food categories (Figure 8F, Table 12). Organic material and pteropod remains were important in overall percent volume (51 and 20%, respectively), whereas organic material, fish scales, chaetognath parts and cyclopoid copepods occurred the most frequently in these stomachs (92, 25, 25 and 25% frequency, respectively) (Table 12). Parasites were not identified in the stomachs of *P. occidentalis* collected from open-water at night.

ANOSIM analysis was not employed to compare the diets of *P. occidentalis* collected during the day and at night from open-water habitat due to the low number of individuals collected during the day. It is unclear when *P. occidentalis* feeds due to the low number of individuals collected during the day and the majority (77%) of the stomachs of fishes collected from open-water habitat between 2000 and 0700 EDT were ≤5% full or empty (Figure 9). *Prognichthys occidentalis* collected from open-water habitat consumed similar prey across all size ranges (ANOSIM, Global R=0.31, p=0.40). The diets of *P. occidentalis* collected from *Sargassum* and open-water habitats were similar (ANOSIM, Global R=0.10, p=0.17).

Remarks- Schekter (1971) identified cyclopoid copepods (*F. gracilis*, *Ocaea* sp.), calanoid copepods (*Paracalanus aculeatus*), siphonophores and pteropods in the stomachs of *P. occidentalis* collected from open water in the Florida Current.

Coryphaena equiselis (pompano dolphinfish)

Two individuals, 26-32 mm SL, were collected from one *Sargassum* day station. No individual had an empty stomach. Seven food items were identified from four food categories (Figure 8G, Table 13). Calanoid copepods and *Pontella atlantica* were the most important food items both in overall percent volume (58 and 17%, respectively) and percent frequency (100 and 100%, respectively) (Table 13). Parasites (digenetic trematodes) were identified in the stomachs of 50% of *C. equiselis* collected from *Sargassum* during the day.

Table 13. Percent volume (%V) and percent frequency (%F) of prey consumed by *Coryphaena equiselis* collected from *Sargassum* and open-water habitats off North Carolina separated by day and night. *n* =number of full stomachs, MF=mean percent fullness of all stomachs.

	Sargassum				Open Water	
	Day (*n* =2) MF=100%		Night (*n* =17) MF=71%		Night (*n* =3) MF=29%	
Food Item	% V	% F	% V	% F	% V	% F
COPEPODA	80.4	100.0	34.1	100.0	25.2	66.7
Corycaeidae					0.1	33.3
Farranula gracilis					0.3	33.3
Labidocera acutifrons	5.8	50.0				
Labidocera minuta			0.4	5.9		
Paracandacia bispinosa			0.6	11.8		
Pontella atlantica	17.1	100.0	13.7	52.9	7.2	66.7
Pontella securifer			4.4	29.4		
Pontella sp.			2.2	17.6	3.1	33.3
Pontellidae			3.1	23.5	2.1	33.3
Unidentified calanoid copepod	57.5	100.0	5.0	35.3	8.1	33.3
Unidentified parts			4.7	35.3	4.3	33.3
ISOPODA	0.9	50.0	0.2	17.6	3.9	33.3
Paradynamene benjamensis	0.9	50.0	0.2	17.6	3.9	33.3
CRUSTACEA	7.0	50.0	1.7	23.5		
Latreutes fucorum			1.0	5.9		
Lucifer faxoni			0.1	5.9		
Unidentified decapod larva			0.6	11.8		
Unidentified shrimp larva	5.9	50.0				
Unidentified shrimp parts	1.1	50.0				
FISH	11.7	50.0	64.0	70.6	70.5	66.7
Carangidae			7.4	5.9	3.9	11.3
Cheilopogon sp.			10.8	11.8		
Clupeidae	11.7	50.0				
Exocoetidae			15.3	17.6	28.4	33.3
Monacanthidae			4.5	11.8		
Unidentified fish			25.3	47.1	38.2	66.7
Unidentified fish egg			0.7	5.9		
OTHER					0.3	33.3
Unidentified animal					0.3	33.3

Twenty-four individuals, 20-68 mm SL, were collected from 13 *Sargassum* night stations. Seven individuals had empty stomachs. Of the stomachs containing food, 17 food items were identified from four food categories (Figure 8G, Table 13). Unidentified fishes, exocoetids and *P. atlantica* were the most important in overall percent volume (25, 15 and 14%, respectively), whereas *P. atlantica*, unidentified fishes and calanoid copepods were the most frequently ingested food items (53, 47 and 35% frequency, respectively) (Table 13). Parasites (digenetic trematodes and nematodes) were identified in the stomachs of 71% of *C. equiselis* collected from *Sargassum* at night.

The diets of *C. equiselis* collected during the day and at night from *Sargassum* habitat were similar (ANOSIM, Global R=-0.08, p=0.43), and *C. equiselis* fed both during the day and at night since all of the stomachs from fishes collected from *Sargassum* during the day were 100% full and 71% of the stomachs from fishes collected at night were 100% full (Figure 9). ANOSIM analysis indicated *C. equiselis* collected from *Sargassum* consumed similar prey across all size ranges (Global R=0.34, p=0.003), but post-hoc comparison tests indicated *C. equiselis* $\leq$25 mm SL consumed different prey (calanoid copepods) than *C. equiselis* $\geq$55 mm SL (fishes) (R=0.61, p=0.001).

Seven individuals, 22-91 mm SL, were collected from six open-water night stations. Four individuals had empty stomachs. Of the stomachs containing food, 11 food items were identified from five food categories (Figure 8G, Table 13), and fishes were the most important food. Unidentified fishes and exocoetids were the most important food items in overall percent volume (38 and 28%, respectively). In contrast, *P. atlantica* and unidentified fishes occurred the most frequently in these stomachs (67 and 67% frequency, respectively) (Table 13). Parasites (digenetic trematodes) were identified in the stomachs of 57% of *C. equiselis* collected from open-water at night.

ANOSIM analysis was not employed to compare the diets of *C. equiselis* collected during the day and at night from open-water since no individuals were collected during the day. It is unclear when *C. equiselis* feeds since no individuals were collected during the day, and 29% of the stomachs of fishes collected at night from open-water habitat were 100% full (Figure 9). ANOSIM analysis was not employed to compare the diets of *C. equiselis* at different sizes due to the low number of individuals with full stomachs collected from open water. The diets of *C. equiselis* collected from *Sargassum* and open-water habitats were similar (ANOSIM, Global R=0.01, p=0.43).

Remarks- Cyclopoid copepods (*F. gracilis, Oncaea venusta*) and calanoid copepods (*Labidocera nerii, P. atlantica, Paracalanus aculeatus, Temora* sp.) were identified in the stomachs of *C. equiselis* collected from open water in the Florida Current (Schekter, 1971). Shcherbachev (1973) identified pontellid copepods and fishes representing seven families (Gonostomatidae, Myctophidae, Synodontidae, Hemiramphidae, Exocoetidae Gempylidae, Coryphaenidae) in the stomachs of *C. equiselis* collected from open water.

Coryphaena hippurus (dolphinfish)

Thirty-four individuals (juveniles), 16-103 mm SL, were collected from 18 *Sargassum* day stations. Two individuals had empty stomachs. Of the stomachs containing food, 42 food items were identified from eight food categories (Figure 8H, Table 14). *Decapterus* sp. and *P. atlantica* were the dominant food items in total percent volume (41 and 11%, respectively). In contrast, copepod parts, calanoid copepods and *P. atlantica* were important in overall percent

Table 14. Percent volume (%V) and percent frequency (%F) of prey consumed by juvenile *Coryphaena hippurus* collected from *Sargassum* and open-water habitats off North Carolina separated by day and night. *n* =number of full stomachs, MF= mean percent fullness of all stomachs.

	Sargassum				Open Water			
	Day (*n* =32) MF=88%		Night (*n* =55) MF=58%		Day (*n* =8) MF=94%		Night (*n* =13) MF=48%	
Food Item	% V	% F	% V	% F	% V	% F	% V	% F
MOLLUSCA	0.6	12.5			0.3	12.5	<0.1	7.7
Scyllaea pelagica					0.3	12.5		
Unidentified cephalopod	0.4	3.1						
Unidentified cephalopod parts	0.1	6.3						
Unidentified mollusc								
Unidentified squid	0.1	3.1					<0.1	7.7
COPEPODA	29.5	90.6	4.9	60.0	33.2	100.0	2.3	92.3
Caligus sp.			<0.1	1.8				
Candacia curta	0.1	6.3						
Candacia sp.	<0.1	3.1	<0.1	1.8				
Candaciidae			0.1	1.8				
Centropages furcatus	0.1	6.3						
Corycaeus catus			<0.1	1.8				
Corycaeus lautus	<0.1	3.1	<0.1	3.6				
Corycaeus sp.	<0.1	6.3			0.1	25.0		
Euchaeta marina					0.3	12.5		
Farranula gracilis	<0.1	15.6	0.1	14.5	0.2	12.5		
Labidocera acutifrons	1.1	15.6	0.1	5.5				
Labidocera fluviatilis	0.3	6.3	<0.1	3.6				
Labidocera minuta	0.3	6.3						
Labidocera nerii			<0.1	1.8			<0.1	7.7
Labidocera sp.	0.1	3.1	0.3	9.1				
Nannocalanus minor			<0.1	1.8				
Oncaea sp.			<0.1	3.6				
Paracandacia bispinosa	<0.1	6.3	<0.1	5.5				
Pontella atlantica	11.4	37.5	0.6	10.9	19.0	50.0	0.3	15.4
Pontella securifer	2.1	18.8					<0.1	7.7
Pontella spinipes			0.5	16.4				
Pontella sp.	0.4	6.3	<0.1	16.4	0.9	12.5	0.5	15.4
Pontellidae	4.4	25	0.5	1.8	4.6	50.0		
Pontellina plumata	0.5	18.8	<0.1	1.8				
Pontellopsis villosa	0.4	12.5	<0.1	1.8	2.3	25.0	0.1	23.1
Sapphirina sp.			<0.1	1.8				
Temora stylifera	<0.1	6.3						
Unidentified calanoid copepod	4.7	46.9	1.8	27.3	4.4	50.0	0.1	23.1
Unidentified copepod			0.1	1.8				
Unidentified cyclopoid copepod			<0.1	1.8			<0.1	15.4
Unidentified parts	3.6	56.3	0.7	40.0	1.5	37.5	1.3	76.9
AMPHIPODA	0.2	12.5	<0.1	7.3				
Cyllopus magellanicus	<0.1	3.1						
Hyperiidean amphipod	0.2	9.4	<0.1	7.3				

Table 14 cont.

ISOPODA	<0.1	12.5	<0.1	1.8	<0.1	12.5	<0.1	7.7
Paradynamene benjamensis	<0.1	12.5	<0.1	1.8	<0.1	12.5	<0.1	7.7
CRUSTACEA	3.1	25.0	1.5	27.3			0.3	23.1
Latreutes fucorum	1.5	9.4	0.3	3.6			0.1	15.4
Leander tenuicornis	1	6.3	0.1	3.6			0.2	7.7
Lucifer faxoni	0.1	3.1	0.2	7.3				
Unidentified crustacean parts	0.1	3.1						
Unidentified decapod	<0.1	3.1	0.4	5.5				
Unidentified decapod larva			<0.1	3.6				
Unidentified mysid shrimp	0.1	3.1						
Unidentified panaeid shrimp			0.4	5.5				
Unidentified shrimp	0.2	3.1	<0.1	1.8			<0.1	7.7
Unidentified shrimp parts			<0.1	1.8				
ANNELIDA			0.1	3.6				
Unidentified polychaete			0.1	3.6				
CHAETOGNATHA	0.6	15.6	0.9	10.9	0.5	25.0		
Sagitta sp.	0.6	15.6	0.9	10.9	0.5	25.0		
FISH	64.4	31.3	60.7	50.9	65.1	25.0	90.7	38.5
Balistidae			0.7	1.8				
Carangidae	3.5	3.1	0.4	5.5			29.0	7.7
Cheilopogon sp.	1.0	3.1	0.7	1.8				
Clupeidae	2.4	3.1			9.8	12.5		
Coryphaena hippurus			1.1	1.8				
Decapterus sp.	40.8	3.1	1.3	3.6				
Exocoetidae			0.1	3.6			59.3	7.7
Monacanthidae			0.5	1.8			0.6	7.7
Monacanthus ciliatus			0.2	1.8				
Scombridae	4.6	3.1	0.3	1.8				
Stephanolepis hispidus	1.2	3.1						
Tetraodontiformes	0.6	3.1	0.1	1.8				
Unidentified fish	8.3	18.8	1.6	5.5	55.3	12.5	0.5	15.4
Unidentified fish egg	0.1	3.1						
Unidentified fish remains	2.0	6.3	53.5	30.9			1.1	7.7
Unidentified parts			0.2	7.3			0.2	7.7
OTHER	1.6	21.9	31.9	45.5	0.9	25.0	6.7	38.5
Organic material	1.5	21.8	24.9	34.5	0.9	25.0	1.0	23.1
Sargassum sp.			6.9	9.1			5.7	15.4
Unidentified animal			0.2	12.7				
Unidentified animal part			<0.1	1.8				
Unidentified egg	<0.1	3.1	<0.1	7.3				

frequency (56, 47 and 38%, respectively) (Table 14). Parasites (digenetic trematodes) occurred in 44% of the stomachs of juvenile *C. hippurus* collected from *Sargassum* during the day.

Sixty-eight individuals (juveniles), 10-262 mm SL, were collected from 20 *Sargassum* night stations. Thirteen individuals had empty stomachs. Of the stomachs containing food, 50 food items were identified from eight food categories (Figure 8H, Table 14). Fish remains and organic material were the dominant food items both in total percent volume (54 and 25%, respectively) and percent frequency (35 and 31%, respectively) (Table 14). *Sargassum* was identified in the stomachs of five juvenile *C. hippurus* (82-262 mm SL). Parasites (digenean trematodes, nematodes and flatworms) occurred in the stomachs of 58% of juvenile *C. hippurus* collected from *Sargassum* habitat at night.

The diets of juvenile *C. hippurus* collected during the day versus at night from *Sargassum* habitat were similar (ANOSIM, Global R=0.07, p=0.005), and the majority (87%) of stomachs of juvenile *C. hippurus* collected from *Sargassum* between 0000 and 0400 EDT were empty or $\leq$5% full (Figure 9). Although juvenile *C. hippurus* collected from *Sargassum* consumed similar prey across all size ranges (ANOSIM, Global R=0.29, p=0.001), post-hoc comparison tests indicated juveniles $\leq$35 mm SL consumed different prey (copepods) than juveniles $\geq$100 mm SL (shrimps and fishes) (R=0.54, p=0.001).

Eight juvenile *C. hippurus*, 13-112 mm SL, were collected from five open-water day stations. No individual had an empty stomach. Fourteen food items were identified from seven food categories (Figure 8H, Table 14). Unidentified fish and *P. atlantica* were important in total percent volume (55 and 19%, respectively), whereas *P. atlantica,* unidentified pontellids and calanoid copepods were equally important in total percent frequency (50%) (Table 14). Parasites (digenetic trematodes and nematodes) were identified in the stomachs of 25% of juvenile *C. hippurus* collected from open-water during the day.

Twenty-two juvenile *C. hippurus*, 8-188 mm SL, were collected from 11 open-water night stations. Nine individuals had empty stomachs. Of the stomachs containing food, 18 food items were identified from six food categories (Figure 8H, Table 14). Exocoetids and carangids were dominant in total percent volume (59 and 29%, respectively), whereas copepod parts, *Pontellopsis villosa*, calanoid copepods and organic material were important in overall percent frequency (77, 23, 23 and 23%, respectively) (Table 14). *Sargassum* was identified in the stomachs of two juvenile *C. hippurus* (147 and 188 mm SL). Parasites (digenean trematodes and nematodes) were identified in the stomachs of 77% of juvenile *C. hippurus* collected from open-water at night.

The diets of juvenile *C. hippurus* collected during the day versus at night from open-water habitat were similar (ANOSIM, Global R=0.03, p=0.32), and the majority (62%) of stomachs of juvenile *C. hippurus* collected from open water between 0000 and 0400 EDT were empty (Figure 9). Juvenile *C. hippurus* collected from open water consumed similar prey across all size ranges (ANOSIM, Global R=0.14, p=0.16). Additionally, the diets of juvenile *C. hippurus* collected from *Sargassum* and open-water habitats were similar (ANOSIM, Global R=0.02, p=0.37).

All adult *C. hippurus* were collected during the day. Eight adult *C. hippurus*, 316-1020 mm SL, were collected from three *Sargassum* day stations. No individual had an empty stomach. Twelve food items were identified from four food categories and fishes comprised the majority (79%) of the diet (Figure 8I, Table 15). Exocoetids and unidentified fishes were dominant in total percent volume, and *Sargassum* and exocoetids were dominant in overall percent frequency

Table 15. Percent volume (%V) and percent frequency (%F) of prey consumed by adult *Coryphaena hippurus* collected from *Sargassum* and open-water habitats off North Carolina during the day. *n* =number of full stomachs, MF=mean percent fullness of all stomachs.

	Sargassum		Open Water	
	Day (*n* =8) MF=24%		Day (*n* =24) MF=47%	
Food Item	% V	% F	% V	% F
MOLLUSCA	3.1	12.5	4.7	16.7
Unidentified squid			4.4	8.3
Unidentified squid parts	3.1	12.5	0.3	16.7
CRUSTACEA	6.6	25.0	0.3	12.5
Leander tenuicornis			0.3	8.3
Portunus sayi	6.6	25.0	<0.1	4.2
FISH	78.7	100.0	89.7	100.0
Aluterus sp.	0.2	12.5		
Blenniidae			<0.1	4.2
Carangidae	6.4	12.5		
Caranx sp.			4.1	16.7
Dactylopterus volitans larva	<0.1	12.5	0.1	12.5
Decapterus punctatus			6.7	12.5
Diodon sp.			3.6	4.2
Exocoetidae	0.2	12.5		
Exocoetid remains	32.7	37.5	1.0	4.2
Hemiramphidae			0.2	4.2
Prognichthys occidentalis			3.9	8.3
Sphoeroides sp.			0.1	4.2
Stephanolepis hispidus	0.9	12.5	1.7	4.2
Stephanolepis sp.	5.3	25.0	4.3	4.2
Unidentified fish	19.2	25.0	10.2	20.8
Unidentified fish parts			0.3	<0.1
Unidentified fish remains	13.8	12.5	53.3	<0.1
OTHER	11.6	87.5	5.3	87.5
Organic material	0.3	<0.1	0.4	<0.1
Plastic piece			0.3	4.2
Sargassum sp.	11.3	87.5	4.6	75.0
Unidentified seagrass blade			0.1	8.3
Zostera pieces			<0.1	4.2

(88 and 38%, respectively) (Table 15). *Sargassum* was identified in the stomachs of 88% of adult *C. hippurus* collected from *Sargassum* habitat. Parasites (digenean trematodes) were identified in the stomachs of 50% of adult *C. hippurus* collected from *Sargassum*.

Twenty-six adult *C. hippurus*, 370-625 mm SL, were collected from seven open-water day stations. Two individuals had empty stomachs. Of the stomachs containing food, 20 food items were identified from four food categories and fishes dominated (90%) the diet (Figure 8I, Table 15). Fish remains were dominant in total percent volume (53%), but *Sargassum* and unidentified fishes were dominant in overall percent frequency (75 and 21%, respectively) (Table 15). *Sargassum* was identified in the stomachs of 77% of adult *C. hippurus* collected from open-water habitat. Parasites (digenean trematodes) were identified in the stomachs of 46% of adult *C. hippurus* collected from open-water habitat.

Adult *C. hippurus* collected from *Sargassum* consumed similar prey across all size ranges (ANOSIM, Global R=0.30, p=0.11), and adult *C. hippurus* collected from open-water habitat consumed similar prey across all size ranges (ANOSIM, Global R=0.08, p=0.26). The diets of adult *C. hippurus* collected from *Sargassum* and open-water habitats were similar (ANOSIM, Global R=-0.04, p=0.62). The diets of juvenile dolphinfish were significantly different from the diets of adult dolphinfish (ANOSIM, Global R=0.4, p=0.001), and SIMPER analysis indicated the diets of juvenile and adult *C. hippurus* were 92% dissimilar. Species of prey driving the differences were: unidentified fishes (adults), calanoid copepods (juveniles) and *P. atlantica* (juveniles).

Remarks- Schekter (1971) documented juvenile *C. hippurus* collected from open water in the Florida Current consumed calanoid copepods (Pontellidae, *Undinula vulgaris*, *Paracalanus aculeatus*), cyclopoid copepods (*F. gracilis*), invertebrate eggs and unidentified fishes.

Shcherbachev (1973) identified calanoid copepods (Pontellidae), cephalopods, and fishes from the families Hemiramphidae, Exocoetidae, Coryphaenidae and Myctopidae in the stomachs of larval and juvenile *C. hippurus* collected from open water. Pontellid copepods were the main food item identified in the stomachs of juvenile dolphinfish collected from *Sargassum* habitat in the Red Sea (Gorelova and Fedoryako, 1986). Adult *C. hippurus* consume decapods, cephalopods and fishes from the families Myctophidae, Hemiramphidae, Exocoetidae, Holocentridae, Carangidae, Gempylidae, Coryphaenidae, Acanthuridae, Balistidae, Monacanthidae and Lagocephalidae (Gibbs and Collette, 1959; Shcherbachev, 1973; Rose and Hassler, 1974; Manooch et al., 1984).

Caranx crysos (blue runner)

Forty-five individuals, 8-86 mm SL, were collected from 10 *Sargassum* day stations. Five individuals had empty stomachs. Of the stomachs containing food, 25 food items were identified from six food categories (Figure 8J, Table 16). *Sagitta* sp., *Labidocera acutifrons* and *L. fucorum* were important in total percent volume (35, 14 and 11%, respectively), whereas *F. gracilis*, *Sagitta* sp. and calanoid copepods occurred most frequently in these stomachs (68, 40 and 33% frequency, respectively) (Table 16). Parasites (digenean trematodes) were identified in the stomachs of 9% of *C. crysos* collected from *Sargassum* during the day.

Forty-five individuals, 25-60 mm SL, were collected from two *Sargassum* night stations. Eleven individuals had empty stomachs. Of the stomachs containing food, 20 food items were identified from five food categories (Figure 9J, Table 17). *Latruetes fucorum*, copepod parts and *L. tenuicornis* were important in overall volume (29, 18 and 17%, respectively) (Table 17). In contrast, copepod parts, *Candacia* sp., and *Sagitta* sp. were the most frequently ingested food items (91, 77 and 59%, respectively) (Table 17). Parasites (digenetic trematodes) were identified

Table 16. Percent volume (%V) and percent frequency (%F) of prey consumed by *Caranx crysos* collected from *Sargassum* and open-water habitats off North Carolina separated by day and night. *n* =number of full stomachs, MF=mean percent fullness of all stomachs.

	Sargassum				Open Water			
	Day (*n* =40) MF=70%		Night (*n* =34) MF=60%		Day (*n* =31) MF=65%		Night (*n* =10) MF=18%	
Food Item	% V	% F	% V	% F	% V	% F	% V	% F
COPEPODA	44.1	100.0	36.4	100.0	71.2	100.0	5.4	80.0
Candacia sp.	1.0	2.5	12.6	76.5				
Centropages furcatus	0.6	10.0			8.7	22.6		
Corycaeus flaccus	<0.1	2.5						
Corycaeus lautus	0.1	12.5	1.4	32.4	2.7	6.5		
Corycaeus longistylus	<0.1	2.5						
Corycaeus sp.	<0.1	5.0	0.8	11.8	<0.1	3.2	<0.1	10.0
Eucalanus attenuatus			0.2	5.9				
Euchaeta marina	0.2	2.5						
Farranula gracilis	1.3	67.5	0.3	29.4	6.4	74.2	<0.1	20.0
Farranula rostrata					0.2	3.2		
Labidocera acutifrons	14.0	7.5					0.5	10.0
Labidocera sp.			<0.1	5.9				
Nannocalanus minor	0.3	5.0			15.5	32.3	0.3	10.0
Oncaea sp.	<0.1	7.5			<0.1	6.5	<0.1	10.0
Paracandacia bispinosa	2.6	7.5	<0.1	2.9				
Paracandacia simplex	2.9	15.0						
Pontella atlantica			1.6	5.9			1.8	20.0
Pontella spinipes	1.2	2.5						
Pontellidae			0.2	5.9				
Pontellina plumata	0.1	2.5						
Sapphirina sp.	<0.1	2.5	0.6	11.8				
Temora stylifera	0.1	5.0						
Unidentified calanoid copepod	2.1	32.5	0.2	11.8	30.8	29.0	0.3	20.0
Unidentified parts	17.7	47.5	18.4	91.2	7.0	9.7	2.5	30.0
AMPHIPODA	<0.1	2.5						
Hyperiidean amphipod	<0.1	2.5						
ISOPODA							89.2	10.0
Paradynamene benjamensis							89.2	10.0
CRUSTACEA	18.0	20.0	58.6	52.9	0.1	3.2	0.4	20.0
Hippolyte sp.			0.8	2.9				
Latreutes fucorum	10.8	10.0	29.3	26.5				
Leander tenuicornis	0.9	2.5	16.6	14.7				
Lucifer faxoni	0.4	7.5	1.4	17.6				
Unidentified crustacean parts	3.5	5.0	1.8	11.8			<0.1	10.0
Unidentified decapod larva	2.3	5.0	0.6	11.8	0.1	3.2		
Unidentified shrimp			8.1	11.8			0.4	10.0

Table 16 cont.

ANNELIDA							3.4	10.0
Unidentified polychaete							3.4	10.0
CHAETOGNATHA	35.3	40.0	4.8	58.8	16.9	29.0		
Sagitta sp.	35.3	40.0	4.8	58.8	16.7	22.6		
Unidentified parts					0.2	6.5		
FISH	2.5	2.5	<0.1	2.9	7.6	9.7	0.4	10.0
Exocoetidae	2.5	2.5					0.4	10.0
Unidentified fish egg					7.6	9.7		
Unidentified parts			<0.1	2.9				
OTHER	0.1	2.5	0.1	5.9	4.2	12.9	1.2	20.0
Organic material	0.1	2.5	0.1	5.9	4.2	12.9	1.2	20.0

in the stomachs of 18% of *C. crysos* collected from *Sargassum* at night.

Caranx crysos collected from *Sargassum* primarily fed during the day, and all of the stomachs of *C. crysos* collected between 0300 and 0600 EDT were empty or ≤5% full (Figure 9). The diets of *C. crysos* collected during the day versus at night from *Sargassum* habitat were significantly different (ANOSIM, Global R=0.40, p=0.001). SIMPER exploratory analysis indicated that food items identified from individuals collected during the day versus at night from *Sargassum* habitat were 87% dissimilar. Species of prey driving the differences included: *F. gracilis* (day), *Candacia* sp. (night), and *Sagitta* sp. (day). *Caranx crysos* collected from *Sargassum* consumed similar prey across all size ranges (ANOSIM, Global R=0.08, p=0.04), but post-hoc comparison tests indicated *C. crysos* 16-20 mm SL consumed different prey (chaetognaths and copepods) than *C. crysos* 51-55 mm SL (shrimps) (R=0.59, p=0.001).

Thirty-three *C. crysos*, 6-35 mm SL, were collected from six open-water day stations. Two individuals had empty stomachs. Of the stomachs containing food, 12 food items were identified from five food categories (Figure 8J, Table 16). Calanoid copepods, *Sagitta* sp. and *Nannocalanus minor* were important in overall percent volume (31, 17 and 16%, respectively), whereas *F. gracilis*, *N. minor* and calanoid copepods were the most frequently ingested food items (74, 32 and 31% frequency, respectively) (Table 16). Parasites were not identified in the stomachs of *C. crysos* collected from open-water habitat during the day.

Forty-three *C. crysos*, 6-99 mm SL, were collected from six open-water stations at night. Thirty-three individuals had empty stomachs. Of the stomachs containing food, 12 food items were identified from five food categories (Figure 8J, Table 16). The isopod *Paradynamene benjamensis* was dominant in overall percent volume (89%), whereas copepod parts, calanoid copepods, *P. atlantica* and *F. gracilis* were ingested the most frequently (30, 20, 20 and

20% frequecy, respectively) (Table 16). Parasites (digenetic trematodes) were identified in the stomachs of 5% of *C. crysos* collected from open-water at night.

Caranx crysos collected from open water primarily fed during the day, and the majority (81%) of the stomachs of fishes collected between 2000 and 0700 EDT were empty (Figure 9). Significant differences were observed between the diets of *C. crysos* collected during the day versus at night from open-water habitat (ANOSIM, Global *R*=0.4, *p*=0.1%). SIMPER analysis indicated that food items identified from individuals collected during the day versus at night were 88% dissimilar. Species of prey driving the differences included: *F. gracilis* (day), *P. atlantica* (night), and *N. minor* (day). Additionally, *C. crysos* collected from open-water consumed similar prey across all size ranges (ANOSIM, Global *R*=0.03, *p*=0.31), and the diets of *C. crysos* collected from *Sargassum* and open-water habitats were similar (ANOSIM, Global *R*=0.28, *p*=0.001).

Remarks- Dooley (1972) identified phylosoma larvae, copepods, *Sargassum*, *L. tenuicornis* and *Synodus* larvae in the stomachs of *C. crysos* collected from *Sargassum* habitat in the Florida Current, whereas Schekter (1971) identified calanoid and cyclopoid copepods, chaetognaths and amphipods in the stomachs of *C. crysos* collected from open water in the Florida Current.

Decapterus punctatus (round scad)

Thirty-three individuals, 12-44 mm SL, were collected from seven *Sargassum* day stations. Three individuals had empty stomachs. Of the stomachs containing food, 15 food items were identified from six food categories (Figure 8K, Table 17), and copepods were the most important food both in overall percent volume (86%) and percent frequency (97%). Copepod parts and the calanoid copepod *Undinula vulgaris* were dominant food items in percent volume (29 and 26%, respectively), whereas *F. gracilis* and copepod parts were the most frequently

Table 17. Percent volume (%V) and percent frequency (%F) of prey consumed by *Decapterus punctatus* collected from *Sargassum* and open-water habitats off North Carolina separated by day and night. *n* =number of full stomachs, MF=mean percent fullness of all stomachs.

	Sargassum				Open Water			
	Day (*n* =30) MF=73%		Night (*n* =30) MF=25%		Day (*n* =27) MF=78%		Night (*n* =2) MF=2%	
Food Item	% V	% F	% V	% F	% V	% F	% V	% F
BRYOZOA					1.0	3.7		
Bryozoan colony					1.0	3.7		
CNIDARIA	0.1	3.3						
Unidentified hydroid	0.1	3.3						
COPEPODA	86.1	96.7	31.7	70.0	69.4	100.0	28.2	100.0
Candacia sp.	8.7	10.0						
Centropages furcatus			3.6	13.3				
Corycaeus lautus	0.3	16.7	0.3	3.3	0.1	3.7		
Corycaeus sp.			0.2	10.0				
Eucalanus attenuatus	0.2	3.3						
Farranula gracilis	7.3	86.7	0.8	10.0	2.4	51.9	1.1	50.0
Oncaea sp.	<0.1	6.7	0.1	10.0	<0.1	3.7		
Paracandacia simplex	9.1	6.7	2.5	3.3				
Temora stylifera	0.4	3.3						
Temora turbinata			0.3	3.3				
Undinula vulgaris	26.3	30.0						
Unidentified calanoid copepod	5.2	26.7	7.9	16.7	1.2	11.1		
Unidentified parts	28.6	73.3	16.1	36.7	65.7	85.2	27.1	50.0
AMPHIPODA			8.3	10.0			71.8	100.0
Hyperiidean amphipod			4.7	6.7				
Unidentified parts			3.6	3.3			71.8	100.0
CRUSTACEA	1.5	10.0	51.6	33.3	2.5	7.4		
Lucifer faxoni	0.8	6.7	0.5	3.3	2.5	7.4		
Unidentified crustacean parts			51.1	30.0				
Unidentified shrimp	0.7	3.3						
CHAETOGNATHA	9.5	26.7	4.1	10.0	0.9	3.7		
Sagitta sp.	9.5	26.7	4.1	10.0	0.9	3.7		
FISH	2.8	20.0	2.6	6.7	25.8	37.0		
Unidentified fish egg	2.8	16.7	2.6	6.7	25.8	37.0		
Unidentified parts	<0.1	3.3						
OTHER	<0.1	3.3	1.7	13.3	0.4	3.7		
Egg mass					0.4	3.7		
Organic material			1.7	13.3				
Plastic piece	<0.1	3.3						

ingested food items (87 and 73% frequency, respectively) (Table 17). Parasites were not observed in the stomachs of *D. punctatus* collected from *Sargassum* habitat during the day.

Fifty-eight individuals, 8-34 mm SL, were collected from seven *Sargassum* night stations. Twenty-eight individuals had empty stomachs. Of the stomachs containing food, 14 food items were identified from six food categories (Figure 8K, Table 17), and crustaceans were the most important food in overall percent volume (52%), and copepods were the most frequently (70%) ingested food. Crustacean parts and copepod parts were dominant in both percent volume (51 and 16%, respectively) and percent frequency (30 and 37%, respectively) (Table 18). Parasites were not observed in the stomachs of *D. punctatus* collected from *Sargassum* habitat at night.

Decapterus punctatus collected from *Sargassum* primarily fed between 0800 and 2000 EDT, and the majority (96%) of stomachs of *D. punctatus* collected between 0100 and 0600 EDT were empty (Figure 9). The diets of *D. punctatus* collected during the day versus at night from *Sargassum* habitat were significantly different (ANOSIM, Global R=0.40, p=0.001), and SIMPER exploratory analysis indicated the food items of *D. punctatus* collected during the day and at night were 87% dissimilar. Species of prey driving the differences were: *F. gracilis* (day), *Sagitta* sp. (day), *U. vulgaris* (day) and *C. furcatus* (night). *Decapterus punctatus* collected from *Sargassum* habitat consumed similar prey across all size ranges (ANOSIM, Global R=0.14, p=0.009).

Thirty individuals, 10-44 mm SL, were collected from three open-water day stations. Three individuals had empty stomachs. Of the stomachs containing food, nine food items were identified from six food categories (Figure 8K, Table 17), and copepods were the most important food in both overall percent volume (69%) and percent frequency (100%). Copepod parts and fish eggs were dominant in total percent volume (66 and 26%, respectively), and copepod parts, *F. gracilis* and fish eggs were the most frequently ingested food items (85, 52 and 37% frequency, respectively) (Table 17). Parasites were not observed in the stomachs of *D. punctatus* collected from open-water habitat during the day.

Thirty individuals, 6-36 mm SL, were collected from seven open-water stations at night. Twenty-eight individuals had empty stomachs. Of the stomachs containing food, three food items were identified from two food categories (Figure 8K, Table 17). Amphipod parts were dominant both in overall percent volume (72%) and percent frequency (100%) (Table 17). Parasites were not observed in the stomachs of *D. punctatus* collected from open-water habitat at night.

Decapterus punctatus collected from open water primarily fed between 0945 and 1700 EDT, and all of the stomachs from *D. punctatus* collected between 2100 and 0400 were empty (Figure 9). ANOSIM analysis was not employed to compare the diets of *D. punctatus* collected from open water during the day and at night due to the low number of individuals with full stomachs collected at night. *Decapterus punctatus* collected from open-water consumed similar prey across all size ranges (ANOSIM, Global R=0.32, p=0.002), and the diets of *D. punctatus* collected from *Sargassum* versus open-water habitat were similar (ANOSIM, Global R=0.13, p=0.009).

Remarks-Donaldson and Clavijo (1994) reported calanoid, cyclopoid and harpacticoid copepods, and fish scales were the most important prey identified in the stomachs of round scad collected from open-water habitat off North Carolina. Hales (1987) reported small (40-89 mm FL) round scad collected from open water consume copepods almost exclusively.

Seriola rivoliana (almaco jack)

Thirty-one individuals, 12-64 mm SL, were collected from seven *Sargassum* day stations. No individual had an empty stomach. Thirty-one food items were identified from six food categories (Figure 8L, Table 18). *Decapterus* sp., *L. fucorum* and *L. tenuicornis* were the most important in overall percent volume (19, 17 and 13%, respectively), whereas calanoid copepods, *F. gracilis* and *L. fucorum* occurred most frequently in these stomachs (55, 52 and 39% frequency, respectively) (Table 18). Parasites (digenetic trematodes) were identified in the stomachs of 19% of *S. rivoliana* collected from *Sargassum* during the day.

Thirty-eight individuals, 10-95 mm SL, were collected from six *Sargassum* night stations. One individual had an empty stomach. Of the stomachs containing food, 19 food items were identified from six food categories (Figure 8L, Table 18). *Latreutes fucorum, L. tenuicornis* and organic material were important in both total percent volume (32, 16 and 14%, respectively) and percent frequency (49, 30 and 24%, respectively) (Table 18). Parasites (digenetic trematodes) were identified in the stomachs of 24% of *S. rivoliana* collected from *Sargassum* at night.

Seriola rivoliana collected from *Sargassum* habitat fed both during the day and at night, and the only empty stomach was from an individual collected at 2322 EDT (Figure 9). The diets of *S. rivoliana* collected from *Sargassum* habitat during the day versus at night were similar (ANOSIM, Global R=0.14, p=0.001), and *S. rivoliana* collected from *Sargassum* habitat consumed similar prey across all size ranges (ANOSIM, Global R=0.15, p=0.001).

Twelve individuals, 21-47 mm SL, were collected from one open-water station during the day. No individual had an empty stomach. Nineteen food items were identified from five food categories (Figure 8L, Table 18). *Sagitta* sp. and *L. tenuicornis* were important in total percent volume (37 and 27%, respectively), whereas *Sagitta* sp., calanoid copepods and *F.*

Table 18. Percent volume (%V) and percent frequency (%F) of prey consumed by *Seriola rivoliana* collected from *Sargassum* and open-water habitats off North Carolina separated by day and night. *n* =number of full stomachs, MF=mean percent fullness of all stomachs.

	Sargassum				Open Water			
	Day (*n* =31) MF=95%		Night (*n* =37) MF=79%		Day (*n* =12) MF=82%		Night (*n* =2) MF=58%	
Food Item	% V	% F	% V	% F	% V	% F	% V	% F
BRYOZOA	<0.1	3.2						
Bryozoan colony	<0.1	3.2						
COPEPODA	32.0	90.3	3.4	43.2	29.2	100.0	61.1	100.0
Candacia sp.					0.7	8.3		
Centropages furcatus	0.3	12.9			0.8	25.0		
Corycaeus lautus	0.4	22.6			0.1	8.3		
Corycaeus sp.	<0.1	12.9	<0.1	5.4	<0.1	8.3		
Corycaeus speciosus	<0.1	3.2						
Euchaeta marina	0.2	3.2			4.3	17.0		
Farranula gracilis	2.2	51.6			0.6	83.0	0.2	50.0
Labidocera acuta	1.2	3.2						
Labidocera acutifrons	10.8	19.4			3.3	8.3		
Labidocera fluviatilis	0.8	9.7	0.2	2.7	0.8	8.3		
Labidocera sp.	0.1	3.2			0.2	8.3		
Macrostella gracilis	<0.1	3.2						
Nannocalanus minor	0.7	12.9	<0.1	2.7				
Paracandacia bispinosa	0.3	6.5			0.8	8.3		
Paracandacia simplex	0.1	6.5						
Pontella atlantica	1.2	6.5						
Pontella securifer	1.1	6.5						
Pontella spinipes	0.5	3.2	0.2	5.4				
Pontella sp.					1.7	17.0	20.4	50.0
Pontellidae	3.1	12.9						
Rhincalanus sp.					0.2	8.3		
Sapphirina angusta	0.2	3.2						
Sapphirina stellata	0.1	3.2						
Sapphirina sp.	<0.1	3.2	0.2	13.5	0.1	8.3		
Unidentified calanoid copepod	6.4	54.8	2.6	32.4	15.5	92.0		
Unidentified cyclopoid copepod	0.1	9.7						
Unidentified parts	2.2	12.9	0.2	2.7			40.5	50.0
AMPHIPODA			0.2	5.4				
Hyperiidean amphipod			0.2	2.7				
Unidentified parts			<0.1	2.7				

Table 18 cont.

CRUSTACEA	31.8	74.2	50.2	64.9	30.3	75.0	38.9	50.0
Latreutes fucorum	17.1	38.7	31.8	48.6	27.2	50.0	15.6	50.0
Leander tenuicornis	13.3	25.8	16.1	29.7				
Lucifer faxoni	0.4	9.7			2.8	33.0		
Unidentified crustacean parts	0.2	6.5	0.9	2.7			23.3	50.0
Unidentified decapod larva	0.1	6.5						
Unidentified shrimp			1.3	16.2				
Unidentified shrimp larva	0.8	9.7			0.2	17.0		
CHAETOGNATHA	2.9	32.3	1.7	13.5	37.3	100.0		
Sagitta sp.	2.9	32.3	1.7	13.5	37.3	100.0		
FISH	29.8	19.4	30.4	29.7	2.3	16.7		
Abudefduf saxatilis			7.1	2.7				
Carangidae			11.3	8.1	0.7	8.3		
Caranx sp.	5.4	3.2						
Decapterus sp.	18.5	9.7	0.9	2.7				
Exocoetidae	2.8	3.2						
Kyphosus sp.			5.2	2.7				
Unidentified fish	3.1	3.2	5.5	2.7				
Unidentified fish larva			0.1	2.7				
Unidentified fish remains			0.3	5.4	1.2	8.3		
Unidentified parts			<0.1	5.4	0.3	8.3		
OTHER	3.5	35.5	14.1	27.0	0.9	25.0		
Endeis spinosa					0.1	8.3		
Glass			<0.1	2.7				
Organic material	3.0	29.0	14.1	24.3	0.9	17.0		
Unidentified egg	<0.1	3.2						
Unidentified gelatinous material	0.5	3.2						

gracilis were the most frequently (100, 92 and 83% frequency, respectively) ingested food items (Table 18). Parasites (digenetic trematodes and nematodes) were identified in the stomachs of 50% of *S. rivoliana* collected from open-water during the day.

Three individuals, 14-34 mm SL, were collected from three open-water stations at night. One individual had an empty stomach. Of the stomachs containing food, three food items were identified from two food categories (Figure 8L, Table 18). Copepod parts, crustacean parts and *Pontella* sp. were important in overall percent volume (41, 23 and 20%, respectively), and all food items identified in these stomachs occurred in similar percent frequency (50%) (Table 18). Parasites (digenetic trematodes) were identified in the stomachs of 33% of *S. rivoliana* collected from open water at night.

Although *S. rivoliana* collected from open-water habitat fed during the day, only three *S. rivoliana* were collected at night and two of these fish had full stomachs (Figure 9). The diets of *S. rivoliana* collected from open-water habitat during the day compared to at night were similar (ANOSIM, Global R=0.37, p=0.01), and *S. rivoliana* collected from open-water habitat consumed similar prey across all size ranges (ANOSIM, Global R=-0.04, p=0.61). Additionally, the diets of *S. rivoliana* collected from *Sargassum* and open-water habitats were similar (ANOSIM, Global R=0.01, p=0.41).

Remarks-Dooley (1972) identified *Sargassum*, *L. tenuicornis*, *Coryphaena* sp., *Syngnathus* sp., *Caranx crysos*, *Caranx* sp., *Cantherhines pullus*, *Canthidermis* sp., balistids and unidentified fishes in the stomachs of *S. rivoliana* collected from *Sargassum* in the Florida Current.

Abudefduf saxatilis (sergeant major)

Thirty-four individuals, 8-22 mm SL, were collected from 12 *Sargassum* day stations. Three individuals had empty stomachs. Of the stomachs containing food, eight food items were identified from four food categories (Figure 8M, Table 19), and copepods were the most important food in both overall percent volume (47%) and percent frequency (94%). Copepod parts, organic material and fish eggs were dominant in overall percent volume (32, 23 and 19%, respectively), whereas copepod parts and *F. gracilis* were the most frequently ingested food items (61 and 48% frequency, respectively) (Table 19). Parasites (digenetic trematodes) were identified in the stomachs of 3% of *A. saxatilis* collected from *Sargassum* during the day.

Forty-five individuals, 7-29 mm SL, were collected from 10 *Sargassum* night stations. Fourteen individuals had empty stomachs. Of the stomachs containing food, 12 food items were identified from four food categories (Figure 8M, Table 19), and copepods were the most important food in both overall percent volume (67%) and percent frequency (44%). Copepod parts and organic material were dominant in overall percent volume (33 and 13%, respectively), whereas organic material, *Corycaeus* sp. and copepod parts occurred the most frequently (45, 32 and 29% frequency, respectively) (Table 19). Parasites (digenetic trematodes) were identified in the stomachs of 7% of *A. saxatilis* collected from *Sargassum* at night.

Abudefduf saxatilis collected from *Sargassum* habitat primarily fed between 0630 and 1945 EDT, and all of the stomachs of *A. saxatilis* collected from *Sargassum* between 2030 and 0230 EDT were empty (Figure 9). The diets of *A. saxatilis* collected during the day versus at night from *Sargassum* habitat were similar (ANOSIM, Global R=0.08, p=0.02), and *A. saxatilis* collected from *Sargassum* consumed similar prey across all size ranges (ANOSIM, Global R=0.01, p=0.20).

Two individuals, 12-13 mm SL, were collected from two open-water day stations. No individual had an empty stomach. Three food items were identified from two food categories (Figure 8M, Table 19). Fish eggs were dominant both in overall percent volume (85%) and

Table 19. Percent volume (%V) and percent frequency (%F) of prey consumed by *Abudefduf saxatilis* collected from *Sargassum* and open-water habitats off North Carolina separated by day and night. *n* =number of full stomachs, MF= mean percent fullness of all stomachs.

	Sargassum				Open Water	
	Day (*n* =31) MF=43%		Night (*n* =31) MF=38%		Day (*n* =2) MF=100%	
Food Item	% V	% F	% V	% F	% V	% F
COPEPODA	46.8	93.5	67.2	83.9	15.0	50.0
Candacia sp.			2.4	12.9		
Corycaeus flaccus			0.5	3.2		
Corycaeus lautus			7.3	25.8		
Corycaeus sp.	0.9	9.7	9.4	32.3		
Farranula gracilis	13.1	48.4	2.7	25.8	2.4	50.0
Oncaea sp.	<0.1	3.2				
Pontellidae			0.3	3.2		
Sapphirina sp.			9.1	6.5		
Unidentified calanoid copepod	0.5	9.7	2.6	9.7	12.6	50.0
Unidentified parts	32.3	61.3	32.8	29.0		
CRUSTACEA	0.3	3.2	4.9	9.7		
Unidentified crustacean parts			4.4	6.5		
Unidentified decapod	0.3	3.2	0.6	3.2		
FISH	18.7	19.4	10.0	12.9	85.0	100.0
Unidentified fish egg	18.7	19.4	10.0	12.9	85.0	100.0
OTHER	34.1	32.3	17.8	48.4		
Organic material	22.9	32.3	12.6	45.2		
Unidentified egg	11.2	9.7	5.2	9.7		

percent frequency (100%) (Table 19). Parasites were not observed in the stomachs of *A. saxatilis* collected from open water during the day.

Five individuals, 10-11 mm SL, were collected from five open-water night stations and all individuals had empty stomachs. Parasites were not observed in the stomachs of *A. saxatilis* collected from open water at night.

Although *A. saxatilis* collected from open-water habitat fed during the day, and all of the stomachs from *A. saxatilis* collected at night were empty, this is based on a limited number of samples (*n*=7) (Figure 9). ANOSIM analysis was not used to compare the diets of *A. saxatilis* collected from open water due to the low number of individuals collected.

Remarks- Calanoid copepods (Pontellidae, *Paracalanus* sp., *Acrocalanus* sp.), cyclopoid copepods (*Farranlua* sp., *Corycaeus* sp., *Oncaea* sp.) amphipods, decapods and appendicularians were identified in the stomachs of sergeant major collected from *Sargassum* habitat in the Red and Caribbean Seas (Gorelova and Fedoryako, 1986). Emery (1973) identified benthic algae, nemerteans, copepods and isopods in the stomachs of *A. saxatilis* collected from open-water in the Florida Keys.

Istiophorus platypterus (sailfish)

Three individuals, 10-22 mm SL, were collected from one *Sargassum* day station. One individual had an empty stomach. Two food items were identified from one food category (Figure 8N, Table 20). Organic material and unidentified eggs were important both in overall percent volume (95 and 5%, respectively) and percent frequency (100 and 50%, respectively) (Table 20). Parasites were not observed in the stomachs of *I. platypterus* collected from *Sargassum* habitat during the day.

Table 20. Percent volume (%V) and percent frequency (%F) of prey consumed by *Istiophorus platypterus* collected from *Sargassum* and open-water habitats off North Carolina separated by day and night. *n* =number of full stomachs, MF=mean percent fullness of all stomachs.

	Sargassum				Open Water	
	Day (*n* =2) MF=33%		Night (*n* =6) MF=64%		Night (*n* =30) MF=71%	
Food Item	% V	% F	% V	% F	% V	% F
COPEPODA					0.1	6.7
Farranula gracilis					<0.1	3.3
Unidentified parts					0.1	3.3
FISH			96.2	50.0	83.7	76.7
Carangidae					2.4	3.3
Exocoetidae					4.3	6.7
Istiophoridae c.f.					18.0	3.3
Unidentified fish			73.0	16.7	4.0	6.7
Unidentified fish remains			23.2	33.3	55.0	60.0
OTHER	100.0	100.0	3.8	50.0	16.2	23.3
Organic material	95.0	100.0	3.8	50.0	16.1	23.3
Sargassum sp.					<0.1	3.3
Unidentified egg	5.0	50.0				

Seven individuals, 24-118 mm SL, were collected from five *Sargassum* night stations. One individual had an empty stomach. Of the stomachs containing food, three food items were identified from two food categories (Figure 8N, Table 20). Unidentified fishes and fish remains were important in overall percent volume (73 and 23%, respectively), and organic material occurred the most frequently in these stomachs (50% frequency) (Table 20). Parasites were not observed in the stomachs of *I. platypterus* collected from *Sargassum* habitat at night.

It is unclear when *I. platypterus* collected from *Sargassum* feed since most individuals were collected at night and the two individuals with empty stomachs were collected at 0010 and 0810 EDT (Figure 9). ANOSIM analysis was not employed to compare the diets of *I. platypterus* collected from *Sargassum* habitat during the day versus at night due to the low number of individuals collected during the day. *Istiophorus platypterus* collected from *Sargassum* habitat consumed similar prey across all size ranges (ANOSIM, Global R=-0.2, p=0.90).

One individual, 17 mm SL, was collected from one open-water day station and the stomach was empty. Thirty individuals, 20-240 mm SL, were collected from 12 open-water night stations. No individual had an empty stomach. Eight food items were identified from three food categories and fishes were a dominant component of the diet (Figure 8N, Table 20). Fish remains and an istiophorid were important in overall percent volume (55 and 18%, respectively), whereas fish remains and organic material occurred the most frequently in these stomachs (60 and 23% frequency, respectively) (Table 20). Parasites (nematodes) were identified in the stomachs of 3% of *I. platypterus* collected from open water at night.

Istiophorus platypterus collected from open-water fed between 2100 and 0200 EDT, but it is unclear if *I. platypterus* also feed during the day due to a low number of samples (n=1) (Figure 9). ANOSIM analysis was not employed to compare the diets of *I. platypterus* collected from open water during the day versus at night due to the low number of individuals collected during the day. *Istiophorus platypterus* collected from open water consumed similar prey items across all size ranges (ANOSIM, Global R=0.09, p=0.16). The diets of *I. platypterus* collected from *Sargassum* and open-water habitats were similar (ANOSIM, Global R=0.0, p=58.8%). Remarks- Schekter (1971) identified cyclopoid copepods (*F. gracilis, F. carinata*), holocentrid larvae and hemiramphids in the stomachs of *I. platypterus* collected from open water. Llopiz and Cowen (2008) identified *Limacina* sp., cladocera, *Farranula* sp., *Corycaeus* sp., *Oncaea* sp., calanoid and harpacticoid copepods, ostracods and larval fishes in the stomachs of larval sailfish collected from open water. The smallest piscivorous sailfish was 5 mm BL, and the diet was dominated by species from the families Exocoetidae, Hemiramphidae and Carangidae (Llopiz and Cowen, 2008).

Balistes capriscus (gray triggerfish)

Thirty-three individuals, 9-75 mm SL, were collected from 12 *Sargassum* day stations. Three individuals had empty stomachs. Of the stomachs containing food, 15 food items were identified from six food categories (Figure 8O, Table 21). *Latreutes fucorum* and *Portunus sayi* were important in overall percent volume (44 and 29%, respectively), whereas organic material and crustacean parts occurred the most frequently in these stomachs (60 and 20% frequency, respectively) (Table 21). Parasites were not observed in the stomachs of *B. capriscus* collected from *Sargassum* habitat during the day.

Sixty-one individuals, 10-47 mm SL, were collected from five *Sargassum* night stations. Thirty-one individuals had empty stomachs. Of the stomachs containing food, 18 food items were identified from six food categories (Figure 8O, Table 21). Organic material, exocoetid eggs and cephalopod larvae were dominant in overall percent volume (35, 32 and 14%, respectively),

Table 21. Percent volume (%V) and percent frequency (%F) of prey consumed by *Balistes capriscus* collected from *Sargassum* and open-water habitats off North Carolina separated by day and night. *n* =number of full stomachs, MF=mean percent fullness of all stomachs.

	Sargassum				Open Water			
	Day (*n* =30) MF=45%		Night (*n* =30) MF=36%		Day (*n* =9) MF=55%		Night (*n* =6) MF=21%	
Food Item	% V	% F	% V	% F	% V	% F	% V	% F
CNIDARIA					11.0	22.2		
Jellyfish pieces					11.0	22.2		
MOLLUSCA	<0.1	3.3	15.5	33.3				
Atlantidae			14.2	26.7				
Limacina sp.			0.2	3.3				
Unidentified cephalopod parts			1.1	3.3				
Unidentified pteropod	<0.1	3.3						
COPEPODA	0.2	20.0	3.5	53.3			1.3	66.7
Corycaeus lautus	<0.1	3.3	<0.1	6.7				
Corycaeus sp.	<0.1	3.3	0.1	6.7				
Farranula gracilis	<0.1	3.3	2.4	30.0				
Macrostella gracilis			<0.1	3.3				
Miracia efferata			0.2	16.7				
Oncaea sp.			<0.1	13.3				
Paracandacia simplex							1.1	16.7
Sapphirina sp.			0.1	10.0				
Temora stylifera			0.1	3.3				
Unidentified calanoid copepod			0.5	10.0				
Unidentified copepod	<0.1	3.3						
Unidentified cyclopoid copepod							<0.1	16.7
Unidentified harpacticoid copepod								
Unidentified parts	0.1	10.0	<0.1	3.3			0.2	33.3
AMPHIPODA	0.3	6.7	2.1	16.7			2.8	16.7
Hyperiidean amphipod	0.3	3.3	1.9	16.7				
Unidentified amphipod							2.8	16.7
Unidentified parts	<0.1	3.3	0.2	3.3				
ISOPODA							0.4	16.7
Paradynamene benjamensis							0.4	16.7
CRUSTACEA	85.9	40.0	6.8	36.7			53.2	16.7
Latreutes fucorum	44.0	13.3	2.2	6.7				
Portunus sayi	28.5	6.7						
Unidentified crustacean parts	12.9	20.0	4.6	26.7			53.2	16.7
Unidentified decapod larva			<0.1	3.3				
Unidentified shrimp	0.6	3.3						
FISH	0.8	10.0	36.8	13.3	63.4	77.8	20.3	33.3
Exocoetid egg			32.0	10.0				
Exocoetidae			4.9	3.3				
Unidentified parts							<0.1	16.7
Unidentified fish	0.2	3.3			34.8	11.1	20.3	16.7
Unidentified fish egg	0.6	6.7			28.6	66.7		

Table 21 cont.

OTHER	12.8	70.0	35.3	66.7	25.6	55.6	22.0	33.3
Organic material	11.4	60.0	35.3	66.7	25.6	55.6	22.0	33.3
Sargassum sp.	0.3	6.7						
Unidentified egg	0.2	10.0						
Unidentified gelatinous material	0.9	3.3						

whereas organic material, *F. gracilis* and crustacean parts occurred the most frequently in these stomachs (67, 30 and 27% frequency, respectively) (Table 21). Parasites were not observed in the stomachs of *B. capriscus* collected from *Sargassum* habitat at night.

Balistes capriscus collected from *Sargassum* habitat primarily fed between 0930 and 2030 EDT, and the majority (93%) of the stomachs of *B. capriscus* collected between 2100 and 0630 EDT were empty (Figure 9). The diets of *B. capriscus* collected from *Sargassum* habitat during the day and at night were similar (ANOSIM, Global R=0.23, p=0.001), and *B. capriscus* collected from *Sargassum* consumed similar prey across all size ranges (ANOSIM, Global R=0.06, p=0.05).

Ten individuals, 12-35 mm SL, were collected from four open-water stations during the day. One individual had an empty stomach. Of the stomachs containing food, four food items were identified from three food categories (Figure 8O, Table 21). Unidentified fishes and fish eggs were important in overall percent volume (35 and 29%, respectively), whereas fish eggs and organic material were important in overall percent frequency (67 and 56%, respectively) (Table 21). Parasites were not observed in the stomachs of *B. capriscus* collected from open-water habitat during the day.

Eleven individuals, 8-26 mm SL, were collected from three open-water stations at night. Five individuals had empty stomachs. Of the stomachs containing food, seven food items were identified from six food categories (Figure 8O, Table 21). Crustacean parts, organic material and unidentified fishes were important in overall percent volume (53, 22 and 20%, respectively), whereas organic material and copepod parts occurred the most frequently in these stomachs (33 and 33% frequency, respectively) (Table 22). Parasites were not observed in the stomachs of *B. capriscus* collected from open-water habitat at night.

Balistes capriscus collected from open-water habitat primarily fed between 0945 and 1715 EDT, and the majority (73%) of the stomachs of *B. capriscus* collected between 2100 and 0000 EDT were empty or ≤5% full (Figure 9). The diets of *B. capriscus* collected during the day and at night from open-water habitat were similar (ANOSIM, Global *R*=0.20, *p*=0.06), and *B. capriscus* collected from open water consumed similar prey across all size ranges (ANOSIM, Global *R*=0.05, *p*=0.008). Additionally, the diets of *B. capriscus* collected from *Sargassum* and open-water habitats were similar (ANOSIM, Global *R*=0.24, *p*=0.003).

Remarks- *Balistes capriscus* collected from *Sargassum* habitat consume *Sargassum*, hydroids, copepods, *L. tenuicornis*, *P. sayi*, pycnogonids, barnacles, polychaetes and gastropods (Dooley, 1972).

Monacanthus ciliatus (fringed filefish)

Sixty-five individuals, 9-27 mm SL, were collected from 12 *Sargassum* day stations. Thirty-five individuals had empty stomachs. Of the stomachs containing food, 14 food items were identified from six food categories (Figure 8P, Table 22). Copepod parts, organic material and jellyfish pieces were dominant food items both in total percent volume (39, 29 and 22%, respectively) and percent frequency (63, 40 and 27%, respectively) (Table 22). Parasites (digenetic trematodes) were identified in the stomachs of 8% of *M. ciliatus* collected from *Sargassum* during the day.

Thirty individuals, 10-21 mm SL, were collected from five *Sargassum* night stations. Twenty-eight individuals had empty stomachs. Of the stomachs containing food, three food items were identified from three food categories (Figure 8P, Table 22). Crustacean parts and organic material were important in total percent volume (58 and 34%, respectively), whereas

Table 22. Percent volume (%V) and percent frequency (%F) of prey consumed by *Monacanthus ciliatus* collected from *Sargassum* habitat off North Carolina separated by day and night. *n* =number of full stomachs, MF=mean percent fullness of all stomachs.

	Sargassum			
	Day (*n* =30) MF=22%		Night (*n* =2) MF=5%	
Food Item	% V	% F	% V	% F
CNIDARIA	23.4	33.3		
Jellyfish pieces	21.7	26.7		
Unidentified hydroid	1.6	6.7		
MOLLUSCA	0.6	6.7		
Atlantidae	0.5	3.3		
Unidentified heteropod	0.1	3.3		
COPEPODA	43.2	73.3	8.0	50.0
Corycaeus sp.	0.6	6.7		
Farranula gracilis	2.4	23.3		
Miracia efferata	0.4	3.3		
Oncaea sp.	<0.1	3.3		
Unidentified calanoid copepod	0.8	3.3		
Unidentified parts	39.0	63.3	8.0	50.0
AMPHIPODA	0.2	3.3		
Unidentified parts	0.2	3.3		
CRUSTACEA			58.3	100.0
Unidentified crustacean parts			58.3	100.0
FISH	1.0	10.0		
Unidentified fish egg	1.0	10.0		
OTHER	31.6	46.7	33.7	50.0
Egg mass	3.0	3.3		
Organic material	28.6	40.0	33.7	50.0
Unidentified egg	<0.1	3.3		

crustacean parts occurred in all stomachs (Table 22). Parasites were not identified in the stomachs of *M. ciliatus* collected from *Sargassum* habitat at night.

Monacanthus ciliatus collected from *Sargassum* habitat primarily fed between 0845 and 1900 EDT, and the majority (93%) of the stomachs of *M. ciliatus* collected 1900 and 0430 EDT were empty (Figure 9). ANOSIM analysis was not used to compare the diets of *M. ciliatus* collected during the day versus at night from *Sargassum* habitat due to the low number of individuals with full stomachs collected at night. *Monacanthus ciliatus* collected from *Sargassum* habitat consumed similar prey across all size ranges (ANOSIM, Global R=0.00, p=0.47).

One individual, 17 mm SL, was collected from one open-water day station and the stomach was empty. Parasites were not identified in the stomach of *M. ciliatus* collected from open-water habitat during the day.

Seven individuals, 12-21 mm SL, were collected from two open-water night stations and all individuals had empty stomachs. Parasites were not identified in the stomachs of *M. ciliatus* collected from open-water habitat at night.

It is unclear when *M. ciliatus* collected from open-water habitat feed due to the low number of samples and all of the stomachs were empty (Figure 9). ANOSIM analysis was not employed to compare the diets of *M. ciliatus* collected from open-water habitat since all the stomachs were empty.

Remarks-No literature exists regarding the diet of juvenile *M. ciliatus*.

Stephanolepis hispidus (planehead filefish)

Forty-three individuals, 5-58 mm SL, were collected from nine *Sargassum* day stations. Three individuals had empty stomachs. Of the stomachs containing food, 26 food items were identified from nine food categories (Figure 8Q, Table 23). *Sargassum*, *L. fucorum*, and jellyfish pieces were important in overall percent volume (23, 15 and 12%, respectively), whereas the cyclopoid copepod *F. gracilis*, *Sargassum*, hyperiid amphipods and jellyfish pieces occurred most frequently in these stomachs (30, 23, 20 and 18% frequency, respectively) (Table 23). Parasites (digenetic trematodes) were identified in the stomachs of 2% of *S. hispidus* collected from *Sargassum* during the day.

Eighty individuals, 6-65 mm SL, were collected from five *Sargassum* night stations. Fifty individuals had empty stomachs. Of the stomachs containing food, 19 food items were identified from eight food categories (Figure 8Q, Table 23). *Latruetes fucorum*, organic material, flyingfish larvae and flyingfish eggs were important in overall percent volume (52, 8, 7 and 6%, respectively), whereas organic material, *F. gracilis* and *L. fucorum* were ingested the most frequently (57, 30 and 23% frequency, respectively) (Table 23). Parasites (digenetic trematodes) were identified in the stomachs of 3% of *S. hispidus* collected from *Sargassum* at night.

Stephanolepis hispidus collected from *Sargassum* habitat primarily fed between 0630 and 2015 EDT, and the majority (95%) of the stomachs of *S. hispidus* collected between 2030 and 0500 EDT were empty (Fiure 9). The diets of *S. hispidus* collected from *Sargassum* habitat during the day and at night were similar (ANOSIM, Global R=0.12, p=0.007), and *S. hispidus* collected from *Sargassum* consumed similar prey across all size ranges (ANOSIM, Global R=0.14, p=0.002).

Sixty-two *S. hispidus*, 8-49 mm SL, were collected from eight open-water day stations. Thirty-two individuals had empty stomachs. Of the stomachs containing food, 13 food items were identified from eight food categories (Figure 8Q, Table 23). Organic material, jellyfish pieces and fish eggs were dominant in both overall percent volume (52, 14 and 11%,

Table 23. Percent volume (%V) and percent frequency (%F) of prey consumed by *Stephanolepis hispidus* collected from *Sargassum* and open-water habitats off North Carolina separated by day and night. *n* =number of full stomachs, MF=mean percent fullness of all stomachs.

	Sargassum				Open Water			
	Day (*n* =40) MF=59%		Night (*n* =30) MF=20%		Day (*n* =30) MF=34%		Night (*n* =15) MF=23%	
Food Item	% V	% F	% V	% F	% V	% F	% V	% F
BRYOZOA	1.6	10.0						
Bryozoan colony	1.6	10.0						
CNIDARIA	12.2	27.5	0.1	3.3	13.6	20.0		
Jellyfish pieces	12.0	17.5			13.6	20.0		
Juvenile jellyfish			0.1	3.3				
Unidentified hydroid	0.2	10.0						
MOLLUSCA	<0.1	2.5	0.3	3.3				
Atlantidae			0.3	3.3				
Unidentified heteropod	<0.1	2.5						
COPEPODA	5.5	90.0	6.0	93.3	1.3	30.0	4.0	20.0
Candacia sp.	0.6	5.0						
Copilia mirabilis	0.1	2.5						
Corycaeus latus					0.1	3.3		
Corycaeus lautus	0.3	10.0						
Corycaeus sp.	<0.1	2.5						
Eucalanus attenuatus	0.1	2.5						
Farranula gracilis	1.4	30.0	0.7	30.0	0.3	13.3		
Miracia efferata			0.1	10.0				
Oncaea sp.			0.2	10.0				
Paracandacia sp.	<0.1	2.5						
Pontella atlantica			0.6	3.3				
Pontellina plumata					0.1	3.3		
Sapphirina nigromaculata			<0.1	3.3				
Sapphirina opalina	0.1	5.0						
Sapphirina sp.	0.1	2.5	<0.1	3.3				
Temora stylifera	<0.1	2.5					2.7	13.3
Unidentified calanoid copepod					0.8	6.7	1.3	6.7
Unidentified cyclopoid copepod	1.1	10.0	0.8	10.0				
Unidentified copepod			2.7	16.7				
Unidentified parts	1.7	15.0	0.9	6.7	<0.1	3.3		
AMPHIPODA	1.9	32.5	3.3	3.3	1.6	13.3	12.2	26.7
Hyperia luzoni					0.6	3.3		
Hyperiidae	<0.1	2.5						
Hyperiidean amphipod	0.9	20.0			0.6	6.7	12.2	26.7
Phronimopsis sp.			3.3	3.3				
Pseudolycaea pachypoda c.f.	0.5	5.0						
Unidentified amphipod	0.4	5.0						
Unidentified parts					0.3	3.3		

Table 23 cont.

CRUSTACEA	18.0	22.5	68.9	36.7	6.0	20.0	47.6	40.0
Latreutes fucorum	14.9	7.5	52.1	23.3			30.1	13.3
Lucifer faxoni			<0.1	6.7				
Portunus sayi							4.6	6.7
Unidentified crustacean parts	2.3	10.0	16.8	6.7	6.0	20.0	1.4	13.3
Unidentified decapod larva	0.1	2.5						
Unidentified shrimp	0.7	2.5					11.5	6.7
ANNELIDA	1.2	2.5	0.5	3.3				
Unidentified polychaete	1.2	2.5	0.5	3.3				
CHAETOGNATHA					3.0	16.7	1.6	26.7
Sagitta sp.					3.0	16.7	1.6	26.7
FISH	0.1	2.5	13.2	10.0	10.7	23.3	11.2	13.3
Carangidae							11.1	6.7
Cheilopogon sp. egg			6.3	3.3				
Cheilopogon sp. larva			6.8	3.3				
Unidentified fish egg	0.1	2.5	0.2	3.3	10.7	23.3	<0.1	6.7
OTHER	59.4	100.0	7.6	63.3	63.9	53.3	23.4	40.0
Organic material	29.8	62.5	7.6	56.7	51.8	43.3	23.4	40.0
Sargassum sp.	22.6	22.5			12.0	10.0		
Unidentified egg	0.3	10.0	<0.1	6.7				
Unidentified gelatinous material	6.6	15.0						

respectively) and percent frequency (43, 20 and 23%, respectively) (Table 23). Parasites were not identified in the stomachs of *S. hispidus* collected from open-water habitat during the day.

Fifty-one individuals, 9-76 mm SL, were collected from seven open-water night stations. Thirty-six individuals had empty stomachs. Of the stomachs containing food, nine food items were identified from six food categories (Figure 8Q, Table 23). *Latruetes fucorum*, organic material, hyperiid amphipods and carangids were dominant in overall percent volume (30, 23, 12 and 11%, respectively), whereas organic material, hyperiid amphipods and *Sagitta* sp. occurred most frequently in these stomachs (40, 27 and 27% frequency, respectively) (Table 23). Parasites (digenetic trematodes) were identified in the stomachs of 6% of *S. hispidus* collected from open-water at night.

Stephanolepis hispidus collected from open-water habitat primarily fed between 0900 and 2220 EDT, and the majority (90%) of the stomachs of *S. hispidus* collected between 2230 and 0615 EDT were empty (Figure 9). The diets of *S. hispidus* collected during the day and at night from open-water habitat were similar (ANOSIM, Global R=0.14, p=0.004), and *S. hispidus* collected from open water consumed similar prey across all size ranges (ANOSIM, Global R=0.08, p=0.08). Additionally, the diets of *S. hispidus* collected from *Sargassum* and open-water habitats were similar (Global R=0.18, p=0.001).

Remarks-The principal food items consumed by *S. hispidus* collected from *Sargassum* habitat in the Florida Current were *Sargassum* fragments, hydroids, barnacles and copepods while the remainder of the diet was comprised of *L. fucorum*, *P. sayi*, pycnogonids, tunicates, polychaetes and bivalves (Dooley, 1972).

DISCUSSION

There is little doubt that *Sargassum* habitat constitutes an important and unique marine ecosystem. Fishes collected from *Sargassum* habitat consumed a higher diversity of prey and higher volumes of prey compared with fishes collected from open-water habitat. Additionally, fewer empty stomachs were encountered in fishes collected from *Sargassum* compared to open water. Fishes collected from pelagic waters off North Carolina belong to one or more of three trophic groups: zooplanktivores, crustacean feeders and piscivores. Zooplanktivorous fishes primarily consumed one or more of the following prey: copepods, amphipods, isopods, chaetognaths, jellyfish, pteropods, fish eggs or fish scales. Crustacean feeders primarily consumed crabs and shrimps. Stomach content analysis indicated six fish species were almost exclusively zooplanktivorous, two fish species were almost exclusively crustacean feeders and three fish species were almost exclusively piscivorous. Seven fish species consumed prey from multiple trophic groups. Although differences occurred between the diets of fishes collected from *Sargassum* and open-water habitats for some species, almost 50% of the prey identified in the stomachs of fishes collected from *Sargassum* and open-water habitats were similar, indicating several of these fishes are direct competitors for many prey.

Zooplanktivores

Fishes that primarily consumed zooplanktonic prey were adult (OW) and juvenile (S and OW) *C. melanurus*, *P. brachypterus* (S), *P. occidentalis* (OW), *A. saxatilis* (OW), *D. punctatus* (S and OW) and *M. ciliatus* (S). Copepods comprised the majority of the diet in juvenile *C. melanurus* (S), *P. brachypterus* (OW), *A. saxatilis* (S) and *D. punctatus* (S and OW). Copepods were identified in the stomachs of all of the fish species analyzed with the exception of *O. micropterus*. The two most abundant copepods identified in the stomachs of fishes collected from both habitats were the cyclopoid copepod, *Farranula gracilis*, and calanoid copepods from the family Pontellidae. Copepods are the most abundant marine zooplankton in pelagic waters, and some copepod species are known to associate with *Sargassum* (Yeatman, 1962). Seven species of copepods were identified from *Sargassum* collections in the Atlantic Ocean, yet none of these copepod species were collected in open-water plankton tows (Yeatman, 1962). Littoral copepods that cling to *Sargassum* in the open ocean obtain a source of food, and *Sargassum*-associated copepods, in turn, provide a food source for juvenile fishes (Yeatman, 1962). In the present study, 37 species of copepods were identified in the stomachs of fishes collected from *Sargassum* habitat which were not previously collected in association with *Sargassum* (Butler et al., 1983; Coston-Clements et al., 1991). Additionally, a higher diversity of copepods were identified in the stomachs of fishes collected from *Sargassum* (37 species) compared to open water (21 species). Copepods may become entrained in *Sargassum* due to converging currents or upwelling; nevertheless, *Sargassum* habitat supports a higher diversity of copepods than open-water habitat, and Deevey (1956) suggested areas with increased copepod populations function as important nurseries for fishes.

Two flyingfish species (adult *C. melanurus,* S and OW and *P. occidentalis,* OW) primarily consumed pteropods. *Prognichthys occidentalis* and adult *C. melanurus* had large numbers of pteropods in their stomachs which may be attributed to the behavior of pteropods. Pteropods are small pelagic gastropods that form swarms in surface waters (Randall, 1967). In addition to pteropods, *P. occidentalis* (OW) primarily consumed chaetognaths. Chaetognaths were identified in the stomachs of nine fish species collected from *Sargassum* habitat which included all of the carangid species, all of the exocoetid species, *H. histrio* and juvenile *C. hippurus*. Casazza and Ross (2008) documented that most of these fish species were closely associated with *Sargassum*. Since they are poor swimmers, chaetognaths may become passively entrained in *Sargassum* by currents. Seven fish species, which included all of the carangid species, two exocoetid species, juvenile *C. hippurus* and *S. hispidus*, collected from open-water habitat consumed chaetognaths. The number of fishes that feed on chaetognaths and the volume of chaetognaths in the stomachs may be underestimated because chaetognaths are soft-bodied organisms that digest quickly (Randall, 1967).

In addition to cyclopoid copepods, of which the majority were *F. gracilis*, *P. brachypterus* (S) and *M. ciliatus* (S) primarily consumed fish scales. Cyclopoid copepods are relatively small copepods, barely visible to the naked eye, and Randall (1967) suggested fish scales in the stomachs of reef fishes were probably eaten after the scales were detached from schooling fishes. It was impossible to determine whether the fish scales identified in the stomachs of *P. brachypterus* were detached from *P. brachypterus* or from another fish species, but the scales identified in the stomachs of *M. ciliatus* were from another species because monacanthid scales are unique. It is unclear whether fish scales are a source of nutrition to fishes. From the prey identified in the stomachs of *P. brachypterus* and *M. ciliatus*, it appears these fish species are generalist feeders.

In addition to copepods from the family Pontellidae, *C. crysos* (OW) primarily consumed the isopod *Paradynamene benjamensis* which is known to associate with *Sargassum* (Butler et al., 1983; Coston-Clements et al., 1991). *Paradynamene benjamensis* was the only isopod identified in the present study, and only two other fish species (*B. capriscus* and juvenile *C. hippurus*) consumed *P. benjamensis*.

Crustacean Feeders

Only two fish species exclusively consumed crustaceans. *Balistes capriscus* (S) primarily consumed the slender sargassum shrimp, *Latruetes fucorum*, and the Sargassum swimming crab, *Portunus sayi*. *Oxyporhamphus micropterus* (S) primarily consumed crustaceans which could not be identified. It is not surprising that the diet of *B. capriscus* (S) was primarily comprised of two crustaceans that are endemic to *Sargassum* since *B. capriscus* rarely leaves the vicinity of the *Sargassum* and spends the majority of time among the algae (Casazza and Ross, 2008). Even though both crustaceans have coloring that camouflages them in *Sargassum*, it appears the close association of *B. capriscus* with *Sargassum* is advantageous when feeding.

Piscivores

Fishes that were primarily piscivorous were *H. histrio* (S), adult and juvenile *C. hippurus* (S and OW) and *I. platypterus* (S and OW). *Histrio histrio* mainly consumed carangids and the planehead filefish, *S. hispidus*. *Histrio histrio* exhibits a lie-in-wait feeding strategy within the *Sargassum* and it appears this species selectively feeds on fishes. Adult *C. hippurus* collected from *Sargassum* primarily consumed fishes from the family Exocoetidae, whereas adult *C. hippurus* collected from open water primarily consumed fishes from the family Carangidae. In contrast, juvenile *C. hippurus* collected from *Sargassum* primarily consumed carangids, and juvenile *C. hippurus* collected from open water mainly consumed exocoetids. *Istiophorus platypterus* collected from open water consumed exocoetids, carangids and istiophorids. These species may selectively feed on fishes for one or more of the following: 1) they may require a higher energy intake, 2) it may be attributed to morphological adaptations (e.g., large mouth, lures, camouflage coloration), or 3) it may be attributed to the behavior of the fish (e.g., ambush predators).

Multiple Trophic Groups

The majority of the fish species analyzed were generalist feeders and consumed prey from multiple trophic groups. Juvenile *C. melanurus* (OW), *P. occidentalis* (S), *C. crysos* (S) and *S. rivoliana* (OW) were zooplanktivorous and crustacean feeders. *Coryphaena equiselis* (S and OW) was both zooplanktivorous and piscivorous. *Balistes capriscus* (OW) was a crustacean feeder and piscivorous. *Stephanolepis hispidus* (S and OW) was zooplanktivorous and a crustacean feeder. Dooley (1972) reported filefishes and triggerfishes consumed mainly hydroids and encrusting bryozoans, which differed from the present study. *Seriola rivoliana* collected from *Sargsassum* habitat was zooplanktivorous, a crustacean feeder and piscivorous. These fish species appear to exhibit generalist feeding behaviors, consuming a wide diversity of prey, which may be due to one or more of the following: 1) greater resource availability, 2) an improved nutrient balance, 3) small mouth size and poor swimming capabilities, 4) poor vision, or 5) they may filter prey from the water.

Habitat Comparisons

Almost twice as many prey were identified in the stomachs of fishes collected from *Sargassum* compared to open-water habitat. Overall, fishes collected from *Sargassum* habitat primarily consumed fishes and endemic shrimps (*L. fucorum* and *L. tenuicornis*), and many of the fishes identified in the stomachs were fishes that are closely associated with the algae (e.g., balistids, carangids, monacanthids). In contrast, open-water fishes primarily consumed copepods and fishes from the family Exocoetidae (flyingfishes). Comparisons between the diets of *Sargassum*-associated fishes and fishes collected from open water indicated several species fed similarly in both habitats, indicating these fishes compete for food. The major predatory components of both the *Sargassum* and open-water communities were *Coryphaena hippurus*, *C.*

equiselis, H. histrio and *S. rivoliana*; the closely related balistids and filefishes (*Balistes capriscus, M. ciliatus* and *S. hispidus*); the jacks and seargent major (*Decapterus punctatus, C. crysos* and *A. saxatilis*); and the flyingfishes (*C. melanurus, P. occidentalis* and *P. brachypterus*). These groupings are not surprising since many of the species possess similar mouth and body morphologies, their behavior in *Sargassum* habitat is similar, or they exhibit similar feeding strategies.

Day versus Night Comparisons

Overall, fishes collected from *Sargassum* and open water habitats primarily fed during the day, and a large number of stomachs from fishes collected at night from both habitats were empty. It is possible fishes collected at night consumed soft-bodied prey that were digested quickly, but it seems unlikely that 15 fish species collected from two different habitats only consume soft-bodied prey at night. The majority of fishes associated with *Sargassum* in the Red and Caribbean Seas, and the Pacific and Indian Oceans fed only during the day which was attributed to poor vision at night (Gorelova, 1980; Lipskaya, 1981; Gorelova and Fedoryako, 1986). Interestingly, hyperiid amphipods were identified in the stomachs of seven fish species collected from both habitats at night and four species collected from both habitats during the day. Hyperiid amphipods migrate from midwater to the surface at night, providing an additional food source to surface fishes as well as a trophic link between midwater and the surface.

Interesting Observations

Some fishes incidentally ingest *Sargassum* while feeding on *Sargassum*-associated fauna since *Sargassum* fragments were identified in the stomachs of adult *C. melanurus* (S), *P. brachypterus* (OW), juvenile and adult *C. hippurus* (OW and S), *I. platypterus* (OW), *B. capriscus* (S) and *S. hispidus* (OW and S). Dooley (1972) frequently observed *Sargassum* in the stomachs of *S. rivoliana*, *S. hispidus* and *S. setifer* collected from *Sargassum* indicating these species fed in the algae. Although Rooker et al. (2004) and Turner and Rooker (2006) suggested *Sargassum* did not directly contribute nutrients to the food web, other studies suggested *Sargassum* does serve as a source of nutrition to *Sargassum*-associated fauna (Ida et al., 1967, Dooley, 1972; Lapointe, 1986). Further research is needed to determine whether *Sargassum* directly contributes nutrition to *Sargassum*-associated fauna.

Sargassum pieces were identified in the stomachs of fishes collected from open water indicating these fishes had also fed in *Sargassum*. *Sargassum* pieces were identified in the stomachs of *P. brachypterus*, juvenile *C. hippurus*, *S. hispidus* and *I. platypterus* collected from open-water habitat. The presence of *Sargassum* in the stomachs of open-water fishes provides evidence that open-water fishes feed in *Sargassum* habitat, and it is possible that open-water fishes target *Sargassum* to feed. The occurrence of the endemic Sargassum shrimps in the stomachs of open-water fishes also suggests open-water fishes feed in *Sargassum* habitat.

Casazza and Ross (2008) documented planehead filefish (*S. hispidus*) pursuing and picking at lobate ctenophores, and it appears *B. capriscus* and *M. ciliatus* may exhibit the same fish-jellyfish association as *S. hispidus*. Jellyfish pieces were identified in the stomachs of *B. capriscus*, *M. ciliatus* and *S. hispidus* collected from both *Sargassum* and open-water habitats. These fishes may be removing zooplanktonic prey from the jellyfish or they may be consuming the jellyfish itself, and either possibility provides these fishes with an additional source of nutrition.

Conclusions

Fishes that associate with *Sargassum* habitat benefit not only from protection (Dooley, 1972; Wells and Rooker, 2004; Casazza and Ross, 2008), but also from an increased concentration of food (Ida, 1967; Dooley, 1972; this study). The increased concentration of food associated with *Sargassum* habitat may be due to converging currents that passively bring the algae and planktonic prey together, or prey may seek *Sargassum* because it also provides food and protection for them. Two shrimp species and one crab species are endemic to *Sargassum* and comprised a large component of the diets of several fish species collected from *Sargassum*. The complex interactions of organisms in *Sargassum* are an important component of the pelagic food chain, as plankton are consumed by crustaceans, which are consumed by juvenile fishes, which in turn are consumed by large economically important fishes. Many of the juvenile fish species that associate with *Sargassum* (monacanthids, balistids, carangids, exocoetids, coryphaenids) constitute an important component of the diets of commercially and/or recreationally important fishes (dolphinfish, jacks and amberjacks, tunas, sailfish) (Gibbs and Collette, 1959; Lewis and Axelsen, 1967; Batts, 1972; Manooch and Haimovici, 1983; Manooch et al., 1984; Morgan et al., 1985). Assessments of the food web structure of this unique pelagic community are critical for managing *Sargassum* habitat. Regardless of whether *Sargassum* itself serves as a direct source of nutrition, it is clear that *Sargassum* habitat concentrates food resources in the open ocean, thus, enhancing the importance of *Sargassum* habitat as a nursery area and essential fish habitat. Efforts should be made to protect this unique pelagic habitat because these fishes are very closely tied to the *Sargassum* and may not be able to survive without *Sargassum*, in which case, if we lose *Sargassum* habitat, these fishes won't go somewhere else, they will disappear.

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