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FEEDING HABITS OF COMMON SNOOK, *CENTROPOMUS UNDECIMALIS*, IN CHARLOTTE HARBOR, FLORIDA

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ABSTRACT We examined the feeding habits, ontogenetic and seasonal diet variations, and predator size–prey size relationships of common snook, *Centropomus undecimalis*, in Charlotte Harbor, Florida, through stomach contents analysis. A total of 694 stomachs were extracted from common snook (300–882 mm standard length [SL]) during a 24-month period (March 2000–February 2002); 432 stomachs contained prey items. At least 37 prey taxa were identified, including 19 that had not been previously reported. Fishes made up 71% of the prey by number and 90% by weight. Three prey items made up almost 50% of the diet numerically—*Lagodon rhomboides*, *Anchoa* spp., and *Farfantepenaeus duorarum*. Seven species made up more than 60% of the diet by weight—*L. rhomboides*, *Cynoscion nebulosus*, *Mugil gyrans, Bairdiella chrysoura*, *Synodus foetens*, *Orthopristis chrysoptera*, and *Mugil cephalus*. An ontogenetic shift in prey preference was identified in adult common snook at around 550 mm SL. Smaller individuals (300–549 mm SL) ate more *F. duorarum*, palaemonid shrimp, cyprinodontids, and *Eucinostomus* spp. than did larger individuals (550–882 mm SL), which ate more *S. foetens*, ariids, and sciaenids. Significant, positive relationships between predator size and prey size were observed between common snook and *L. rhomboides*, *O. chrysoptera*, portunid crabs, and all fish prey combined. Prey size selection contributed to some seasonal differences in their diet. For example, in winter when *L. rhomboides* are abundant in the estuary and small in size (mean = 23 mm SL), common snook ate few individuals, but they consumed many during summer when larger *L. rhomboides* (mean = 51 mm SL) were available. In summary, common snook are opportunistic predators that feed on a wide variety of prey and exploit specific-sized prey that are abundant in their environment.

INTRODUCTION

Common snook, *Centropomus undecimalis*, inhabit tropical and subtropical estuarine systems of the western Atlantic from about 34°N to about 25°S latitude (Rivas 1986). In Florida, they occur principally from Cape Canaveral on the Atlantic coast southward around the peninsula to Cedar Key on the Gulf of Mexico coast (Taylor et al. 2000). The Common snook is a euryhaline, diadromous species that is found in a wide variety of habitats but typically associates with mangrove shorelines (Marshall 1958). They are protandric hermaphrodites that attain ages of 21 years, grow to more than 1000 mm fork length (FL) (Taylor et al. 2000), and have an important ecological role as one of the top predators in the estuary.

Common snook are popular gamefish that support a large recreational fishery throughout much of coastal south and central Florida (Muller and Taylor 2002). Concerns of overfishing and habitat loss have stimulated considerable research on this species over the past 50 years. Much of the research has focused on understanding its life history in order to properly manage the stocks (Peters et al. 1998, Taylor et al. 1998, 2000).

One aspect of the common snook life history that requires further exploration is the feeding habits of adults (50% of common snook mature at 330 mm SL; Peters et al., 1998). Gilmore et al. (1983) and McMichael et al. (1989) collected principally juveniles from the Indian River Lagoon and Tampa Bay respectively, for stomach-content analysis. In contrast, Marshall (1958) and Fore and Schmidt (1973) examined the diet of adult common snook collected from the Ten Thousand Islands and from the Atlantic coast of Florida; however, these 2 studies were limited in sample size and duration. Fore and Schmidt (1973) analyzed ontogenetic shifts, but prey were grouped into 3 categories (fish, shrimp, and crabs), so the importance of individual species or taxa was not reported.

The previous diet studies on adult common snook provide a valuable foundation of information; however, a long-term, system-wide detailed analysis in an estuary would enable spatial and seasonal diet trends to be examined, as well as ontogenetic shifts in prey preference. A large sample size would also provide adequate prey length data for examining predator size-prey size relationships. The Fish and Wildlife Research Institute's Fisheries-Independent Monitoring (FIM) program collects long-term, comprehensive baseline data on relative abundances of fishes and selected macroinvertebrates in most of Florida's estuaries. Collections from this program provided year-round, estuary-wide random samples of common snook as well as their potential prey. In this paper, we describe the feeding habits of common snook from Charlotte Harbor, a relatively pristine estuary (~ 80% of shoreline protected from development; R. Repenning, Florida Department of Environmental Protection, pers. comm.) located along the Gulf of Mexico in southwestern

Florida. We assessed 1) ontogenetic, spatial, and seasonal variation in the prey composition, 2) predator size–prey size relationships, and 3) size-selective feeding patterns.

MATERIALS AND METHODS

Collections

We examined the stomachs of 694 common snook (300–882 mm standard length [SL]) collected from the estuarine waters of Charlotte Harbor during a 24-month period between March 2000 and February 2002 (Figure 1). Common snook were collected with a 183-m center-bag seine (38-mm stretched mesh) during the daylight hours of 0900–1600 by the FIM program. A standardized random sampling protocol was followed for all collections, and a total of 408 samples (17/mo) were collected along the shoreline in depths of 2.5-m or less (see Kupschus and Tremain (2001) for a detailed description of the survey design, deployment techniques, and sample processing). Samples came principally from mangrove and seagrass habitats, which are predominant within the Charlotte Harbor estuary (Poulakis et al. 2003). Common snook were selected for stomach-content analysis from 44% of the sampling sites, and a mean of 3 individuals were sampled from each site (range = 1–11 individuals). Common snook were iced immediately after capture in the field, and transported to the laboratory, where SL was measured to the nearest millimeter (mm) and stomachs were removed, sealed in bags, and frozen (Meyers and Franks 1996, Scharf and Schlicht 2000). Stomachs were thawed within one month of collection and the contents of each were sorted and identified to the lowest possible taxon. Pieces of prey items were counted as one, unless countable parts such as otoliths or eye lenses were found. A reference collection of otoliths from potential prey within the estuary was established and was used to identify badly decomposed fish prey items. All whole prey were measured to the nearest mm (SL for fish, post-orbital head length [POHL] for shrimp, and carapace width [CW] for crabs) and weighed to the nearest tenth of a gram (g).

To compare the diet of common snook with potential prey in the estuary, we examined availability, size, and seasonality of potential prey from 21.3-m and 183-m center-bag seine collections from shoreline areas throughout the estuary (183-m seine collections are described above). Each month 21.3-m seines (3-mm stretched mesh) were pulled along shorelines (depth < 1.5 m) at 12 random sites throughout the estuary. The collected fish were measured for SL, and shrimp were measured for POHL (see Poulakis et al. 2003) for a detailed description of sample processing). Stomach contents were evaluated as: 1) percent numerical abundance (*N*) = the number of individuals of each food type as a percentage of the total number of identifiable prey items, 2) percent weight (*W*) = wet weight (g) as a percentage of the total wet weight of all prey items, and 3) percent frequency of occurrence (*F*) = the percentage of stomachs containing prey in which a particular prey taxon occurred.

Data Analysis

Nonparametric multivariate techniques were used to analyze ontogenetic, spatial, and seasonal changes in the diet of common snook. To identify length-related differences in feeding, we used a hierarchical agglomerative cluster analysis (CLUSTER) based on square-root transformed Bray-Curtis similarity coefficients from prey-numeric data, which incorporated a group-average linking method (Clarke 1993, Clarke and Warwick 2001). We grouped common snook that ranged in size from 300 to 599 mm into 25-mm SL size intervals. Common snook ≥600 mm SL were not as abundant in our collections as those <600 mm, so larger individuals were grouped into 100-mm SL intervals to attain length-class sample sizes similar to those of smaller common snook. Only common snook that contained identifiable prey to at least the family level were used. Within a particular family or genus in which all prey items could not be identified to species, prey items were assigned to the lowest taxon (e.g., *Eucinostomus gula*, *Eucinostomus* spp. = *Eucinostomus* spp.; *Ariopsis felis*, UID Ariidae = UID Ariidae). Based on this cluster analysis, stomach contents of length-classes < 550 mm SL showed a level of similarity of > 55%, and this size class for this study is termed “small” (*n* = 293). Fish that were ≥ 550 mm SL are termed “large” (*n* = 51). To minimize the effects of length-related dietary shifts, only small common snook were used for the size-selective feeding, spatial, and seasonal analyses.

Predator size-prey size relationships were examined by plotting common snook length against prey length. Spearman rank correlations were used to determine any significant relationship between common snook length and the length of their prey.

Size-selective feeding patterns of small common snook were examined for the 3 most abundant prey species. Length frequencies and abundances of these species were determined from 21.3-m seine collections. Combined catches from the 21.3-m and 183-m seines were used only for *Lagodon rhomboides* (pinfish), which had a broad size range (15–225 mm SL) and were not adequately sampled with only the 21.3-m seine. All abundance data for seines are reported as number·100 m^{-2}. Length frequencies of prey from common snook stomachs were compared to length frequencies from seine collections in the estuary

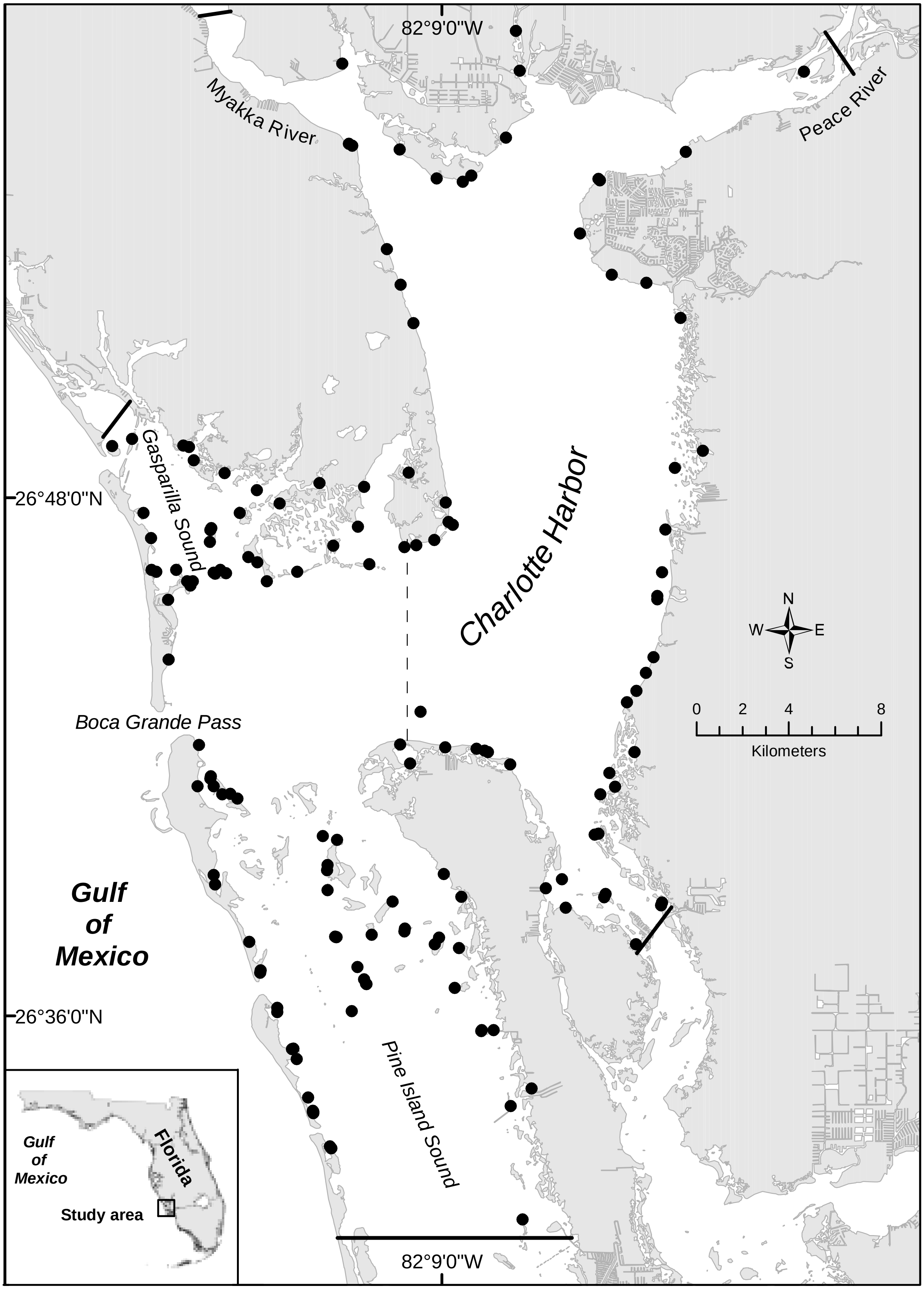

Figure 1. Map of Charlotte Harbor, Florida, showing the collection locations of common snook, *Centropomus undecimalis*, whose stomachs contained prey. The dark lines denote the Fisheries-Independent Monitoring program sampling universe boundaries, and the dotted vertical line denotes the separation between the "east area" and the "west area".

(Kolmogorov-Smirnov [KS] two-sample test, Sokal and Rohlf 1981).

Differences in the diet of small common snook were compared between the eastern half (i.e., "east area") and the western half (i.e., "west area") of the estuary (Figure 1). The east area is more influenced by freshwater inflow from major rivers, whereas the west area is more influenced by the Gulf of Mexico through 4 gulf passes (Rubec et al. 1999). To compare the prey composition of common snook from the 2 areas, prey-numeric data were square-root transformed, and an analysis of similarity (ANOSIM) permutation test was used and the R-value was used to determine significance (Clarke 1993, Clarke and Warwick 2001). To minimize confounding seasonal effects (unequal seasonal representation of the 2 areas) on the spatial analysis, some stomach samples were randomly eliminated from the west area. As a result, each area had 17 winter, 33 spring, 29 summer, and 37 fall samples.

To determine if there was any seasonal variation in the diet of small common snook, samples were grouped by season: winter (December–February; $n = 36$), spring (March–May; $n = 78$), summer (June–August; $n = 104$), and fall (September–November; $n = 75$) (Cortes et al. 1996, Crabtree et al. 1998). The prey community data (numeric) from each season were square-root transformed, and 6 pairwise comparisons were made among seasons using ANOSIM. Also, seasonal mean prey size and mean abundance determined from stomach-content and seine data were compared to illustrate how the size and availability of prey items are related to their seasonal consumption by common snook.

RESULTS

Stomachs of 432 common snook ranging from 300 to 822 mm SL contained prey, and those of 262 common snook were empty (Figure 2). Fishes and crustaceans made up virtually all of the prey by number (97%) and weight (98%) (Table 1). At least 37 different prey taxa were identified with 3 prey taxa comprising almost 50% of the diet numerically—*L. rhomboides* (pinfish; 20%), *Anchoa* spp. (anchovy; 16%), and *Farfantepenaeus duorarum* (pink shrimp; 13%). *Anchoa* spp. were eaten by common snook in high numbers but were consumed less frequently ($F = 7\%$) than *L. rhomboides* (32%) and *F. duorarum* (20%). Seven species made up more than 60% of the diet by weight—*L. rhomboides* (22%), *Cynoscion nebulosus* (spotted seatrout; 9%), *Mugil gyrans* (whirligig mullet; 8%), *Bairdiella chrysoura* (silver perch; 7%), *Synodus foetens* (inshore lizardfish; 6%), *Orthopristis chrysoptera* (pigfish; 6%), and *Mugil cephalus* (striped mullet; 6%).

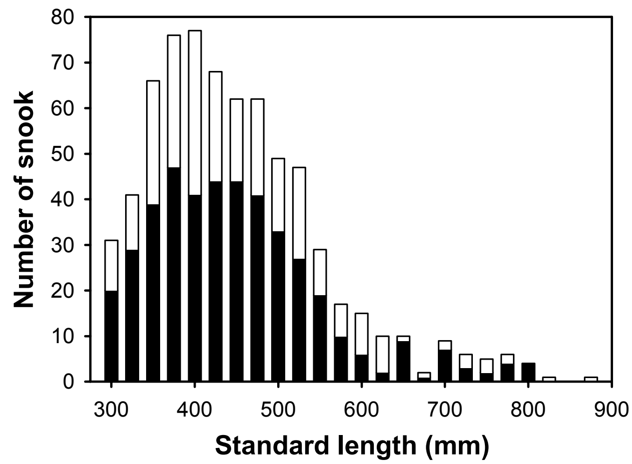

Figure 2. Length-frequency distribution of 694 common snook, *Centropomus undecimalis*, collected in Charlotte Harbor. Common snook with prey found in the stomachs are represented by black bars ($n = 432$), and common snook with empty stomachs are represented by white bars ($n = 262$).

Cynoscion nebulosus, *M. gyrans*, *S. foetens*, and *M. cephalus* were generally large prey items that were neither abundant in the diet nor frequent in occurrence ($N < 0.4\%$; $F < 0.6\%$).

Fish were the principal prey both numerically and by weight for all sizes of common snook examined (Figure 3). Fish made up almost 100% of the diet by weight of common snook ≥ 575 mm SL. Shrimp were more important in the diet of common snook 300–499 mm SL, both numerically and by weight, than in that of common snook ≥ 500 mm SL. Crabs were principally consumed by common snook 425–724 mm SL (*N* range 5–20%) but made up only < 0.1–7% of the diet by weight for common snook ≥ 575 m SL.

Small common snook (< 550 mm SL) had prey compositions with a high level of similarity (> 55%) and were grouped together in the cluster analysis (Figure 4). Prey compositions among large common snook (≥ 550 mm SL) length groups varied and were 5–25% different from those of small common snook. Small common snook ate more shrimp, small crabs, and small forage fish than did large common snook (Table 2). Palaemonid shrimp (grass shrimp), grapsid crabs (marsh crabs), cyprinodontids (killifishes), atherinopsids (silversides), and *Eucinostomus* spp. (mojarras) were found in the stomachs of only small common snook. Large common snook consumed more *S. foetens*, ariids (sea catfishes), and sciaenids (drums) than did small common snook. Both size-groups fed on clupeids (herrings), *O. chrysoptera*, *L. rhomboides*, and *B. chrysoura*, and stomach contents of both groups had a high frequency of occurrence of seagrasses ($F > 25\%$) (*Thalassia testudinum* [turtle grass], *Halodule wrightii*

TABLE 1

Prey items (*n* = 1133; total weight = 4913 g) found in stomachs of common snook (*n* = 432) collected in Charlotte Harbor, Florida. *N* = percent numerical abundance, *W* = percent weight, *F* = percent frequency of occurrence, UID = unidentified prey.

Prey category	*N*	*W*	*F*
Stomatopoda	0.3	0.2	0.2
Squilla empusa	0.3	0.2	0.2
Decapoda	25.9	7.5	34.7
Penaeidae			
Farfantepenaeus duorarum	12.6	3.1	20.1
Palaemonidae			
UID Palaemonidae	4.3	< 0.1	5.8
Alpheidae			
UID Alpheidae	0.4	< 0.1	0.9
UID shrimp	1.2	< 0.1	2.1
Majidae			
UID Majidae	< 0.1	0.2	0.2
Portunidae			
UID Portunidae	0.4	< 0.1	0.9
Callinectes sapidus	0.9	2.2	2.1
Portunus spp.	0.9	0.6	2.1
Xanthidae			
UID Xanthidae	0.2	< 0.1	0.5
Grapsidae			
UID Grapsidae	0.6	< 0.1	0.5
Armases mierii	0.8	0.3	0.2
Ocypodidae			
Uca spp.	1.4	0.4	1.9
Uca thayeri	< 0.1	< 0.1	0.2
UID crabs	2.1	0.2	3.7
Teleostei	71	90	84.3
Elopidae			
Elops saurus	< 0.1	1.5	0.2
Engraulidae			
Anchoa spp.	15.7	1.5	7.4
Clupeidae			
UID Clupeidae	2.7	3.3	3.9
Harengula jaguana	0.5	2.8	1.2
Brevoortia spp.	< 0.1	3.4	0.2
Opisthonema oglinum	< 0.1	0.1	0.2
Ariidae			
UID Ariidae	0.4	0.3	0.7
Ariopsis felis	0.3	0.7	0.5
Synodontidae			
Synodus foetens	0.3	6.1	0.7
Mugilidae			
Mugil cephalus	< 0.1	5.5	0.2
Mugil gyrans	0.2	7.8	0.5
Mugil spp.	0.6	< 0.1	0.5
Atherinopsidae			
UID Atherinopsidae	*0.5*	*< 0.1*	*1.2*
Fundulidae			
Fundulus similis	0.2	< 0.1	0.5
Fundulus grandis	0.3	0.5	0.5
Fundulus spp.	0.4	0.2	0.7
Lucania parva	0.2	< 0.1	0.5
Poeciliidae			
Poecilia latipinna	0.3	0.1	0.7
Cyprinodontidae			
Cyprinodon variegatus	1.2	0.3	1.6
Floridichthys carpio	0.7	0.3	0.9
Opistognathidae			
Opistognathus robinsi	< 0.1	0.2	0.2
Gerreidae			
Eucinostomus gula	0.4	0.3	0.9
Eucinostomus spp.	2.6	0.9	4.6
Diapterus/*Eugerres* spp.	< 0.1	0.2	0.2
Haemulidae			
Orthopristis chrysoptera	1.5	5.8	3.9
Sparidae			
Lagodon rhomboides	19.6	22.2	31.5
Sciaenidae			
Cynoscion nebulosus	0.2	9.2	0.5
Cynoscion spp.	0.4	0.5	0.9
Bairdiella chrysoura	2.8	6.6	6.5
Leiostomus xanthurus	< 0.1	2.3	0.2
Sciaenops ocellatus	< 0.1	4.7	0.2
Gobiidae			
Microgobius gulosus	1.6	< 0.1	1.2
UID fish	16.8	2.3	31.3
Incidentals	2.8	2.3	40.6
Plant Material			
Algae	-	0.3	9.3
Leaf Litter	-	0.1	3.5
Thalassia testudinum	-	1.3	21.9
Halodule wrightii	-	0.1	16.7
Syringodium filiforme	-	0.3	8.3
Gastropoda	1.6	< 0.1	2.9
Bivalvia	0.6	< 0.1	1.6
Isopoda	0.4	< 0.1	1.2
Miscellaneous material			
Fishing hook	0.2	< 0.1	0.5

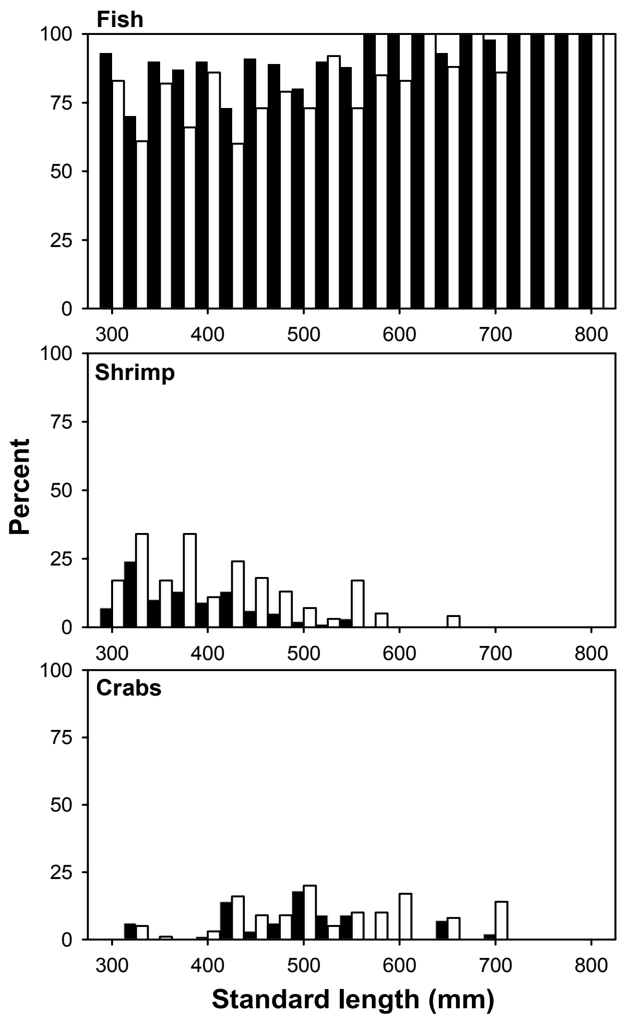

Figure 3. Percentages of weight (black) and number (white) of prey groups for each 25-mm size-class of common snook, *Centropomus undecimalis*, collected in Charlotte Harbor.

[shoal grass], or *Syringodium filiforme* [manatee grass]). Seagrasses were most consistently ingested (51–65%) with *L. rhomboides*, *O. chrysoptera*, and *Cynoscion* spp. (seatrout).

Common snook ranging from 300 to 822 mm SL ate fishes ranging from 12 to 307 mm SL, shrimp 4–36 mm POHL, and crabs 9–76 mm CW. A significant predator size-prey size relationship was observed between common snook and fish prey (Spearman Rank Correlation, R=0.41, $P < 0.0001$; Figure 5A). Common snook ate fish prey that averaged 14% of their own body length. The smallest fish prey consumed in relation to predator size was a 12-mm *Eucinostomus* spp. consumed by a 382-mm common snook (3% body length), and the largest was a 214-mm *M. gyrans* consumed by a 472-mm common snook (45% body length). Mean SL of fish prey for common snook 300–449 mm was between 45 and 47 mm and increased to 70 mm for common snook 450–549 mm (Figure 5B). Mean fish prey SL increased substantially to 110–179 mm in common snook 550–749 mm but dropped slightly to 140–164 mm for common snook 750–822 mm. Prey that were numerous and grew to large sizes, such as *L. rhomboides*, *O. chrysoptera*, and portunid crabs (swimming crabs), had a significant predator size-prey size relationship ($P < 0.03$; Figure 6). Small prey, such as *Eucinostomus* spp. and *F. duorarum*, were generally consumed by common snook < 500 mm and did not show a significant predator size–prey size relationship.

When comparing the sizes of prey eaten by small common snook to the sizes of the same prey species collected in the estuary, we found a significantly larger size distribution of *L. rhomboides* (45–75 mm SL) and *Anchoa* spp. (35–55 mm SL) in the stomachs of common snook than was collected in the estuary (KS test, $P < 0.0001$; Figure 7). There was no significant difference in the size distributions of *F. duorarum* collected in the estuary and those eaten by common snook (KS test, $P > 0.3$).

No significant difference was found between the diet of small common snook collected from the east and the west areas of the estuary (ANOSIM, R = 0.01; $P = 0.039$). Therefore, the diets of small common snook ($n = 293$) throughout the estuary were used for the seasonal diet comparisons.

Seasonal variation in the diet of small common snook was most evident between summer and winter (ANOSIM, R = 0.2; $P = 0.001$); all other seasonal pairwise tests had an R value of < 0.1. Common snook ate more than 10 times more *L. rhomboides* in summer (1.1 fish·stomach^{-1}) than in winter (0.1 fish·stomach^{-1}) (Figure 8). Young-of-the-year *L. rhomboides* (mean SL = 23 mm) recruited to the estuary during winter and were abundant (234 fish·100 m^{-2}). By summer, *L. rhomboides* grew to a mean size of 51-mm SL, and their abundance in the estuary dropped to 69 fish·100 m^{-2}. Common snook preyed upon *F. duorarum* consistently each season (0.33–0.64 shrimp·stomach^{-1}), with the highest rate of consumption occurring during winter (Figure 9). The mean size of *F. duorarum* collected in the estuary varied only slightly among the different seasons (12–15 mm POHL) but abundance was variable (5–44 shrimp·100 m^{-2}).

DISCUSSION

Common snook collected in Charlotte Harbor had a higher percentage of stomachs that contained prey (62%) compared to other studies. Marshall (1958) and Fore and Schmidt (1973) studied the diet of common snook (224–1020 mm FL) from the Ten Thousand Islands in

Table 2

Prey items found in stomachs of small (< 550 mm) and large (≥ 550 mm) common snook. Numbers in bold indicate taxa proportionally more important (both *N* and *W* varied by more than 50% between diets) in the diet of either small or large common snook. Only common snook with prey items identified to at least the family level were used (*n* = 344; UID = unidentified prey). *N* = percent numerical abundance, *W* = percent weight, *F* = percent frequency of occurrence.

	< 550 mm SL (*n* = 293)			≥ 550 mm SL (*n* = 51)		
Prey category	***N***	***W***	***F***	***N***	***W***	***F***
Decapoda						
Penaeidae						
Farfantepenaeus duorarum	**17.4**	**6.8**	**27.6**	7.8	0.4	11.8
UID Palaemonidae	**6.3**	**0.2**	**8.5**	0.0	0.0	0.0
UID Alpheidae	**0.5**	**0.2**	**1.4**	0.0	0.0	0.0
UID Grapsidae	**2.0**	**1.0**	**1.0**	0.0	0.0	0.0
Teleostei						
UID Clupeidae	4.3	11.6	4.4	5.6	7.4	9.8
Ariidae						
UID Ariidae	0.3	< 0.01	1.0	**6.7**	**1.4**	**11.8**
Synodontidae						
Synodus foetens	0.1	0.1	0.3	**2.2**	**11.9**	**3.9**
Atherinopsidae						
UID Atherinopsidae	**0.8**	**0.1**	**1.7**	0.0	0.0	0.0
Fundulidae						
Fundulus spp.	**1.1**	**1.8**	**1.0**	0.0	0.0	0.0
Cyprinodontidae						
Cyprinodon variegatus	**1.8**	**0.8**	**2.4**	0.0	0.0	0.0
Floridichthys carpio	**1.0**	**0.7**	**1.4**	0.0	0.0	0.0
Gerreidae						
Eucinostomus spp.	**4.3**	**2.9**	**6.8**	0.0	0.0	0.0
Haemulidae						
Orthopristis chysoptera	1.3	5.5	3.4	7.8	6.7	13.7
Sparidae						
Lagodon rhomboides	25.7	33.2	39.2	23.3	15.6	41.1
Sciaenidae						
Cynoscion spp.	0.5	1.2	0.7	**2.2**	**17.9**	**3.9**
Bairdiella chrysoura	3.2	11.0	7.2	7.8	3.6	13.7
Leiostomus xanthurus	0.0	0.0	0.0	**1.1**	**4.5**	**2.0**
Sciaenops ocellatus	0.0	0.0	0.0	**1.1**	**9.2**	**2.0**
Incidentals						
Plant Material						
Seagrasses	–	2.6	25.7	–	0.7	35.3

southwest Florida and reported that 48% and 46% of the stomachs of common snook had prey, respectively. An even greater difference is noted when we compare the percentage of common snook stomachs containing prey during summer in Charlotte Harbor (75%) with the percentages from Fore and Schmidt, who collected only during summer. Both of the previous studies used hook-and-line gear for most of the sample collections. This gear has the advantage of sampling habitats that cannot be sampled with a net; however, it selects fish that are actively feeding, which may possibly increase the number of fish collected with empty stomachs. Regurgitation of prey items caused by stress during capture is also a factor that may contribute to a higher occurrence of fish with empty stomachs. On

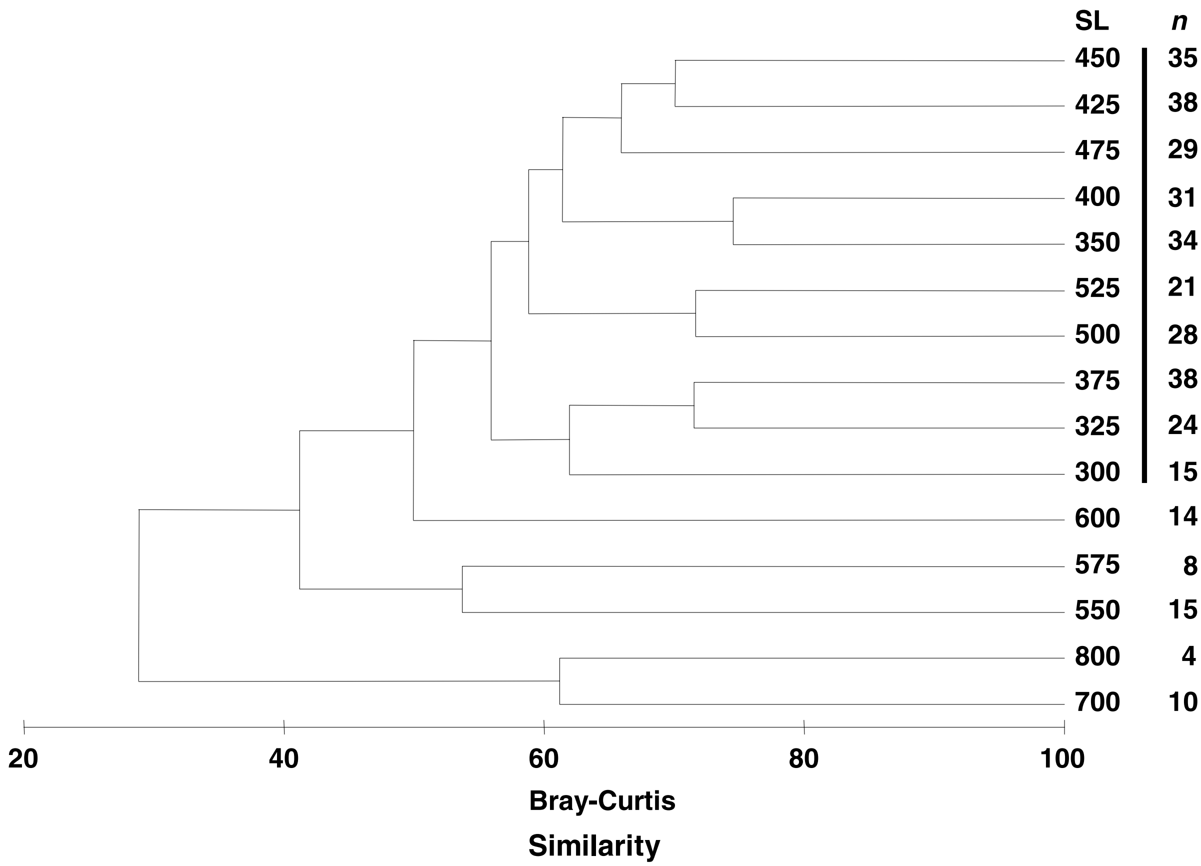

Figure 4. Cluster dendogram showing the percent similarities of prey composition in the different size-classes of common snook, *Centropomus undecimalis*. Common snook < 600 mm were grouped into 25-mm SL intervals and common snook ≥ 600 mm into 100-mm SL intervals. SL = lowest standard length of the length interval; *n* = number of common snook in each size-class. The dark vertical line denotes size-classes of common snook that have a > 55% similarity in diet.

only a few occasions did we observe regurgitated material within our nets, although small prey or pieces of prey could have gone through the mesh and would not have been detected. The use of a large bag seine, which allowed common snook to swim and move freely during retrieval, may have minimized capture stress and the likelihood of regurgitation.

The composition of fish (71%), shrimp (19%), and crabs (7%) in the diet of common snook in Charlotte Harbor was similar to that reported by Marshall (1958) (50% fish, 38% shrimp, 6% crabs), but differed with Fore and Schmidt (1973) (48% crabs, 26% shrimp, and 25% fish). The high percentage of crabs found by Fore and Schmidt may be partially attributed to their collections occurring exclusively in summer in the passes and cuts leading to the Gulf of Mexico during early-morning and late-evening, and at night under artificial lights. The most abundant prey found in their study was *Portunus gibbesii* (iridescent swimming crab; *N* = 24%), which are found in large numbers during summer as they migrate through the passes and cuts to the open gulf to spawn (Rouse 1970, Dudley and Judy 1971). Our collections were made within the estuary during the daytime only, generally in areas with slower currents, and *Portunus* spp. were not a major component of the diet (*N* < 1%). More in-depth trophic studies are needed to determine how estuarine location, habitat types within an estuary, diel periodicity, and lunar phase (related to tidal influence and light intensity at night) affect the diet of common snook.

A wide variety of prey was collected from the stomachs of common snook from Charlotte Harbor, suggesting that common snook have diverse feeding habits. Thirty-seven taxa were recorded, 19 of which had not yet been reported as prey (Marshall 1958, Fore and Schmidt 1973, Gilmore et al. 1983). Common snook fed on taxa that are pelagic, such as *Anchoa* spp. and clupeids (Jones et al. 1978) but also fed on taxa that are demersal, such as xanthid crabs (mud crabs), ariids, and *S. foetens* (Robins and

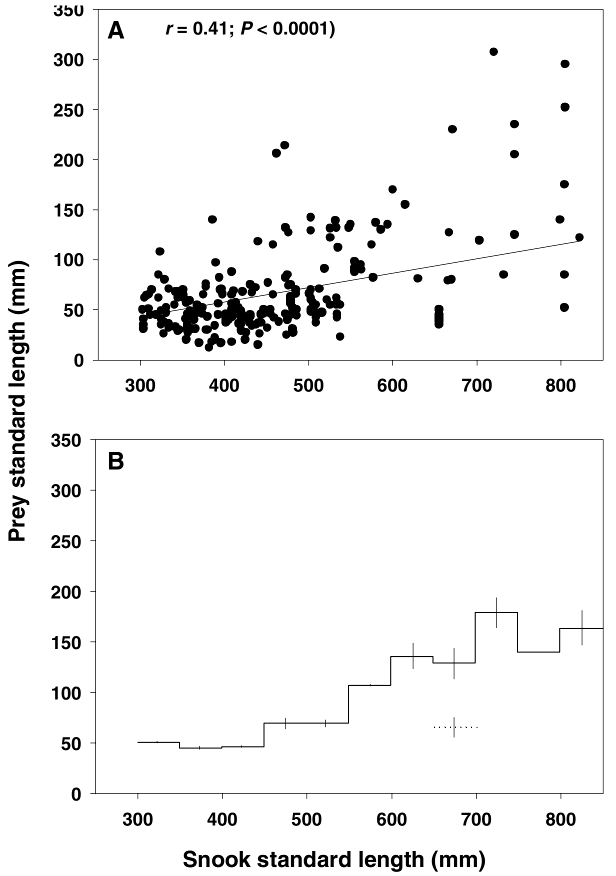

Figure 5. (A) Scatter diagram showing the relationship of prey size to the size of common snook, *Centropomus undecimalis*, for all teleost prey combined. Spearman rank correlation coefficient = *r*, and probability = *P*. (B) Horizontal line plot showing the mean prey size for each 50-mm size-class of common snook. Vertical lines represent ± standard error. The dotted horizontal line at size-class 675–699 mm SL includes one additional common snook that consumed 10 small *Anchoa* spp.

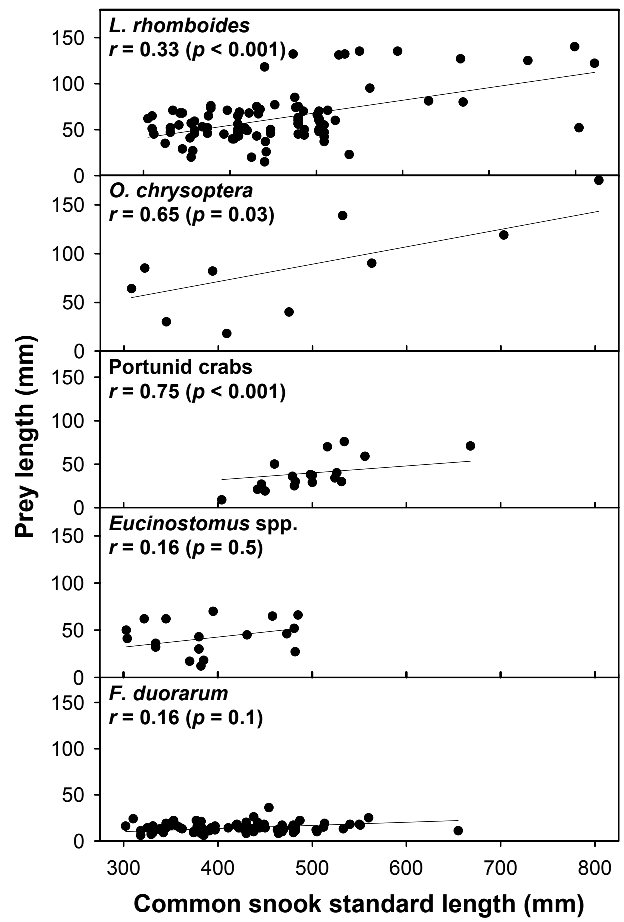

Figure 6. Scatter diagram showing the relationship between prey size and size of common snook, *Centropomus undecimalis*, for 5 important prey taxa. Spearman rank correlation coefficient = *r*, and probability = *P*.

Ray 1986, Pattillo 1997). They also fed on 5 taxa that are burrowers—*Squilla empusa* (mantis shrimp), alpheids (snapping shrimp), *Uca* spp. (fiddler crabs), *O. robinsi* (*spotfin jawfish*), and *Microgobius gulosus* (clown goby). Other taxa that common snook preyed on are both pelagic and demersal, such as *F. duorarum*, *Callinectes sapidus* (blue crab), and *Portunus* spp. Evidence suggests that common snook fed among the extensive intertidal prop roots and low branches of *Rhizophora mangle* (red mangrove) and *Avicennia germinans* (black mangrove), which dominate the shorelines of Charlotte Harbor. Prey items such as *Floridichthys carpio* (goldspotted killifish), *Poecilia latipinna* (sailfin molly), atherinopsids, and *Uca* spp. are highly associated with mangrove habitats (Thayer et al. 1987, Sheridan 1992, Poulakis et al. 2003). Common snook also appear to have fed in seagrass beds because seagrasses were present in the stomach along with prey items 37% of the time. Common snook ingest prey in a manner similar to other centropomids, such as *Lates calcarifer* (barramundi) (Hamblyn 1966, Davis 1985), which have no cutting or macerating teeth—the prey is drawn into the mouth by a powerful sucking action affected by the expansion of the buccal cavity and then swallowed whole. This mechanism can cause vegetation (i.e., seagrass, algae, leaf litter), gastropods, or shell material to be ingested along with the intended prey item. Taxa that prefer seagrass habitats, such as *L. rhomboides*, *O. chrysoptera*, and *Cynoscion* spp. (Nelson 1998, Nelson and Leffler 2001, Poulakis et al. 2003), were most often found in conjunction with seagrasses in the stomachs of common snook in Charlotte Harbor. Other species that common snook consumed are also associated with seagrass habitats during a portion of their life cycle (e.g., *F. duorarum*, *C. sapidus*, *B. chrysoura*) (Sheridan 1992, Poulakis et al. 2003). Common snook also appear to have fed over unvegetated

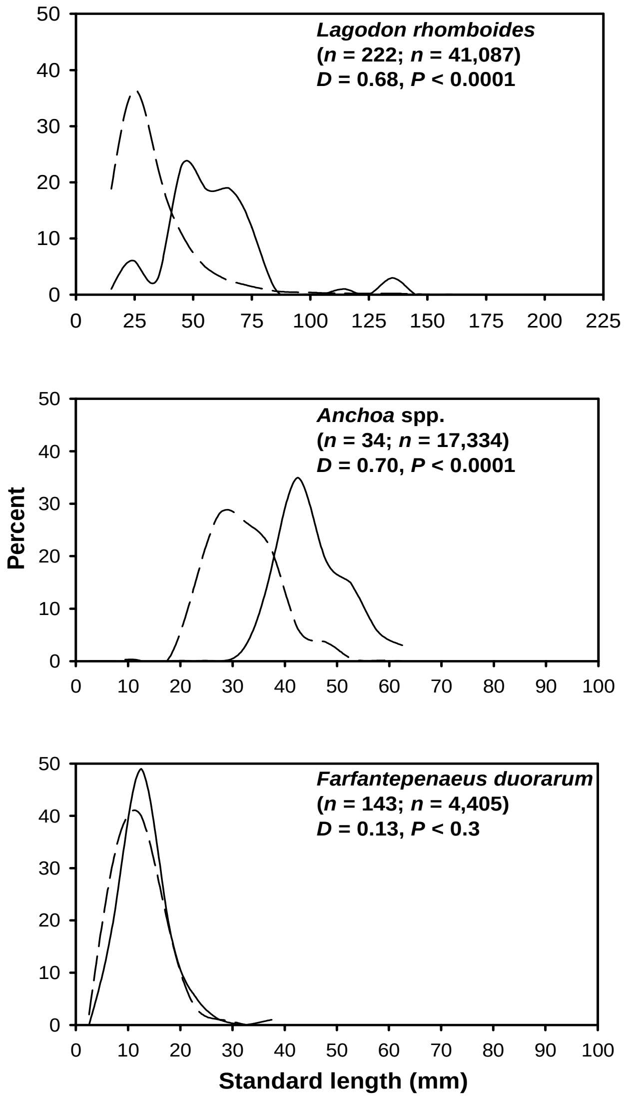

Figure 7. Length-frequency distributions of the top 3 numerically abundant prey taxa found in the stomachs of common snook, *Centropomus undecimalis.* The solid line represents the individuals consumed by common snook, and the first *n* value is the total number of individuals consumed. The dashed line represents the individuals collected in the estuary with the 21.3-m and 183-m shoreline seines, and the second *n* value is the total number of individuals collected from the estuary. The Kolmogorov-Smirnov (KS) two-sample test was used to compare length frequencies of prey collected in the estuary with prey consumed by common snook; *D* = maximum unsigned difference; *P* = probability.

bottom, as all ariids and *S. foetens* that were found in stomachs contained no fragments of seagrass, and these taxa are known to prefer open sand or mud bottoms (Springer and Woodburn 1960, Pattillo 1997). In summary, common snook in Charlotte Harbor appear to have fed on prey throughout the water column and in various habitats.

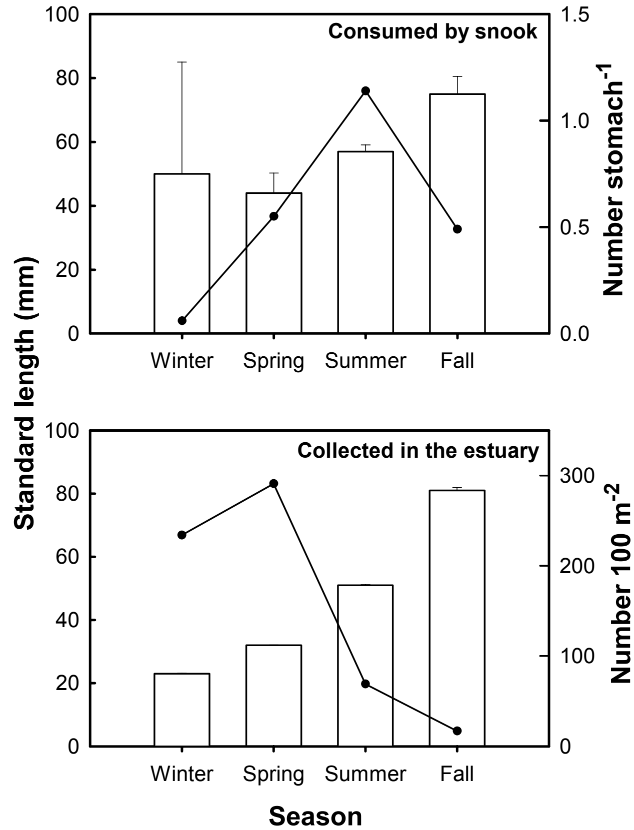

Figure 8. Plot of mean (± standard error) seasonal length (white bars) and abundance (points) for *Lagodon rhomboides* consumed by small common snook (< 550 mm SL), *Centropomus undecimalis*, and collected in the estuary with 21.3-m and 183-m shoreline seines. Some SE are too small to be seen.

In Charlotte Harbor, the most abundant prey in the diet of common snook was *L. rhomboides* (19.6%), which may be attributed to the frequent occurrence of seagrasses along the shoreline. The shallow bottom of this estuary is dominated by seagrasses (262 km^2; Sargent et al. 1995) that juvenile *L. rhomboides* use as refuge and forage areas (Stoner 1982, 1983). Stomachs of 25 common snook (170–350 mm SL) collected in seagrass habitats in the Indian River Lagoon contained *A. mitchilli*, *L. rhomboides*, and penaeid shrimp as the 3 most abundant prey taxa (Gilmore et al. 1983). These 3 taxa were also the predominant prey consumed by common snook in Charlotte Harbor. In contrast, very few *L. rhomboides* (< 1% of the recorded number of prey) were consumed by common snook in the Ten Thousand Islands (Marshall 1958, Fore and Schmidt 1973), where seagrass is not a predominant habitat type (Sargent et al. 1995).

Common snook were collected from shorelines throughout the Charlotte Harbor estuary; however, we found no significant differences between the diets of small common snook from the east area versus the west area.

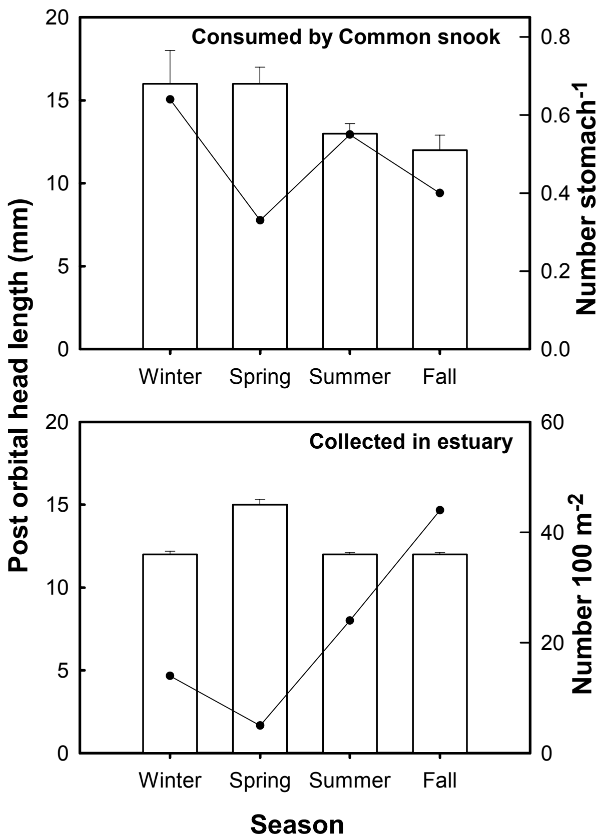

Figure 9. Plot of mean (± standard error) seasonal length (white bars) and abundance (points) for *Farfantepenaeus duorarum* consumed by small common snook (< 550 mm), *Centropomus undecimalis*, and collected in the estuary with 21.3-m shoreline seine. Some SE are too small to be seen.

This may reflect similarities in the shoreline and bottom vegetation—mangrove shorelines and seagrass bottoms dominate the entire western area and cover a majority of the eastern area. These habitats have been shown to support similar fish assemblages throughout Charlotte Harbor (Poulakis et al. 2003). Spatial differences in the diet of common snook between these 2 areas might have been greater if any extraordinary weather events (i.e., hurricanes, floods) had occurred during our sampling period that would have pushed freshwater species into the upper harbor (P.W.S., unpubl. data). Common snook also inhabit rivers, creeks, and backwater marshes, as well as the beaches, inlets, and offshore reefs of the Gulf of Mexico (Volpe 1959, Taylor et al. 1998, R. Novak, University of Florida, pers. comm.) and their diet may differ considerably in these areas, requiring future studies. For example, diet examination from the upper portions of the rivers noted both native and exotic freshwater species as prey for adult common snook (D.A.B., unpubl. data). Also, adult common snook habitat may overlap with those of juveniles in backwater creeks and remote tidal ponds during winter, which can result in low rates of cannibalism (A. Adams, Mote Marine Laboratory, unpubl. data). Our current study, which sampled along estuarine shorelines, did not document any native or exotic freshwater species as prey, nor did it note cannibalism.

This study best describes the diet of common snook 300–550 mm SL; however, adequate data on prey lengths from throughout the size range of common snook were examined to show a significant positive relationship between predator size and prey size. This relationship helps explain why we observed changes in the diet through ontogeny, which has also been observed in juvenile common snook (McMichael et al. 1989, Luczkovich et al. 1995). Small common snook (< 550 mm SL) generally fed on prey of 50–70 mm SL, which coincides with the sizes of some of the most abundant forage fish and small invertebrates collected in the estuary (e.g., cyprinodontids, *Eucinostomus* spp., *F. duorarum*). These abundant small fishes and invertebrates that small common snook are exploiting are apparently too small for larger common snook (≥ 550 mm SL) to consider as prey. The differences we observed between the prey composition of large and small common snook reflect an absence of these small forage fish and invertebrates in the diet of large snook and an increased presence of larger prey, such as *S. foetens*, ariids, and sciaenids, which are abundant in the estuary. Although this was the general pattern we observed, common snook are opportunistic predators that can take advantage of an “easy opportunity” to feed on many small prey items at one time. For example, a 655 mm SL common snook was found with 10 small *Anchoa* spp. in its stomach, which were most likely consumed during an encounter with an entire school. In the estuary, abundant prey that have a wide size range (~ 20–200 mm SL), such as clupeids, *O. chrysoptera*, *L. rhomboides*, and *B. chrysoura* (Nelson 1998, Kupschus and Tremain 2001, Poulakis et al. 2003), were a consistent part of the diets of both small and large common snook.

Differences in the diet of small common snook during winter and summer were strongly linked to their prey-size selectivity. For example, *L. rhomboides* were most important in the diet during summer but virtually absent from the diet during winter. This finding coincides with the recruitment and growth patterns of juvenile *L. rhomboides* in the estuary. *Lagodon rhomboides* recruit to shallow seagrass beds between January and March, at which time they may be too small for common snook to consider as prey. These pinfish reside in the shallow seagrass beds until reaching a size of ca. 80 mm SL between late summer and early winter and then move to deeper water in the bay before migrating offshore to spawn (Nelson 1998). During summer, the majority of *L. rhomboides* reached a size of ca. 50 mm SL, and it was during this season and at this size when *L. rhomboides* were consumed the most. *Farfantepenaeus duorarum* were important in the diet during all seasons but were most frequently consumed during winter. This species of shrimp has a protracted spawning period and is available throughout the year at sizes of ca. 12–15 mm POHL. *Farfantepenaeus duorarum* may have been more frequent in the diet during winter because of the decreased availability of *L. rhomboides* between 40–75 mm SL. Also, colder water temperatures, which slow the movements of *F. duorarum*, may increase their susceptibility to predation (Fuss and Ogren 1966).

In conclusion, common snook have diverse feeding habits and feed on a wide variety of prey. Evidence shows that they feed throughout the water column and in a variety of habitats, such as mangroves, seagrasses, and unvegetated bottoms. Common snook are opportunistic and exploit prey that are abundant in their environment, yet they appear to be selective in the sizes of prey they consume. Availability of certain-sized prey in the estuary influences what types of prey common snook consume during different stages of their ontogeny, as well as what types of prey they consume seasonally.

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LITERATURE CITED

Clarke, K.R. 1993. Non-parametric multivariate analyses of changes in community structure. Australian Journal of Ecology 18:117–143.

Clarke, K.R. and R.M. Warwick. 2001. Change in marine communities: An approach to statistical analysis and interpretation. 2nd ed. (PRIMER v5.2). Natural Environmental Research Council, Plymouth, UK.

Cortes, E., C.A. Manire, and R.E. Hueter. 1996. Diet, feeding habits, and diel feeding chronology of the bonnethead shark, *Sphyrna tiburo*, in southwest Florida. Bulletin of Marine Science 58(2):353–367.

Crabtree, R.E., C. Stevens, D. Snodgrass, and F.J. Stengard. 1998. Feeding habits of bonefish, *Albula vulpes*, from the waters of the Florida Keys. Fishery Bulletin, US 96:754–766.

Davis, T.L.O. 1985. The food of barramundi, *Lates calcarifer* (Bloch), in coastal and inland waters of Van Diemen Gulf and the Gulf of Carpentaria, Australia. Journal of Fish Biology 26:669–682.

Dudley, D.L., and M.H. Judy. 1971. Occurrence of larval, juvenile, and mature crabs in the vicinity of Beaufort Inlet, North Carolina. SSRF Rep. No. 637. NOAA Technical Report. National Marine Fisheries Service, Seattle, WA, USA, 10 p.

Fore, P.L. and T.W. Schmidt. 1973. Biology of juvenile and adult snook, Centropomus undecimalis, in the Ten Thousand Islands, Florida, Chap. 16. In Ecosystems analysis of the Big Cypress Swamp and Estuaries. US Environmental Protection Agency, Region IV, Athens, Georgia, 18 p.

Fuss, C.M. and L.H. Ogren. 1966. Factors affecting activity and burrowing of the pink shrimp, *Penaeus duorarum* Burkenroad. Biological Bulletin 130:170–191.

Gilmore, R.G., C.J. Donahoe, and D. W. Cooke. 1983. Observations on the distribution and biology of the common snook, *Centropomus undecimalis* (Bloch). Florida Scientist 46:313–336.

Hamblyn, E.L. 1966. The food and feeding habits of nile perch *Lates niloticus* (Linne) (Pisces: Centropomidae). Journal of African Botany and Zoology 74:1–28.

Jones, P.W., F.D. Martin, and J.D. Hardy Jr. 1978. Development of fishes of the Mid-Atlantic Bight—An atlas of egg, larval and juvenile stages, Vol.1, Acipenseridae through Ictaluridae. US Fish and Wildlife Service. FWS/OBS-78/12. 366 p.

Kupschus, S. and D. Tremain. 2001. Associations between fish assemblages and environmental factors in nearshore habitats of a subtropical estuary. Journal of Fish Biology 58:1383-1403.

Luczkovich, J.J., S.F. Norton, and R.G. Gilmore. 1995. The influence of oral anatomy on prey selection during the ontogeny of two perciod fishes, *Lagodon rhombiodes* and *Centropomus undecimalis*. Environmental Biology of Fishes 44(1-3):79–95.

Marshall, A.R. 1958. A survey of the snook fishery of Florida, with studies of the biology of the principal species, *Centropomus undecimalis* (Bloch). Florida State Board of Conservation Technical Series No. 22, Marine Laboratory, Miami, FL, USA.

McMichael, R.H., Jr., K.M. Peters, and G.R. Parsons. 1989. Early life history of the snook, *Centropomus undecimalis* in Tampa Bay, Florida. Northeast Gulf of Science 10(2):113–126.

Meyer, G.H. and J.S. Franks. 1996. Food of cobia, *Rachycentron canadum*, from the northcentral Gulf of Mexico. Gulf Research Reports 9(3):161–167.

Muller, R.G. and R.G. Taylor. 2002. The 2002 stock assessment update of common snook, *Centropomus undecimalis*. Report to the Florida Marine Fisheries Commission. Florida Marine Research Institute, Florida Fish and Wildlife Conservation Commission. St. Petersburg, FL, USA.

Nelson, G.A. 1998. Abundance, growth, and mortality of young-of-the-year pinfish, *Lagodon rhomboides*, in three estuaries along the gulf coast of Florida. Fishery Bulletin, US 96:315–328.

Nelson, G.A. and D. Leffler. 2001. Abundance, spatial distribution, and mortality of young-of-the-year spotted seatrout (*Cynoscion nebulosus*) along the Gulf Coast of Florida. Gulf of Mexico Science 1:30–42.

Pattillo, M.E., T.E. Czapla, D.M. Nelson, and M.E. Monaco. 1997. Distribution and abundance of fishes and invertebrates in Gulf of Mexico estuaries, Vol. II: Species life history summaries. ELMR Rep. No. 11. NOAA/NOS Strategic Environmental Assessments Division, Silver Spring, MD, USA, 377 p.

Peters, K.M., R.E. Matheson, Jr., and R.G. Taylor. 1998. Reproduction and early life history of the common snook, *Centropomus undecimalis* (Bloch), in Florida. Bulletin of Marine Science 62(2):509–529.

Poulakis, G.R., D.A. Blewett, and M.E. Mitchell. 2003. The effects of season and proximity to fringing mangroves on seagrass-associated fish communities in Charlotte Harbor, Florida. Gulf of Mexico Science 21:171–184.

Rivas, L.R. 1986. Systematic review of the perciform fishes of the genus *Centropomus*. Copeia 1986:579–611.

Robins, C.R. and G.C. Ray. 1986. A field guide to Atlantic coast fishes of North America. Houghton Mifflin Co., New York, NY, USA, 354 p.

Rouse, W.L. 1970. Littoral crustacea from southwest Florida. Quarterly Journal of the Florida Academy of Sciences 32(for 1969)(2):127–152.

Rubec, P.J., J.C.W. Bexley, H. Norris, M.S. Coyne, M.E. Monaco, S.G. Smith, and J.S. Ault. 1999. Suitability modeling to delineate habitat essential to sustainable fisheries. American Fisheries Society Symposium 22:108–133.

Sargent, F.J., T.J. Leary, D.W. Crewz, and C.R. Kruer. 1995. Scarring of Florida's seagrasses: Assessment and management options. FMRI Technical Report TR-1. Florida Marine Research Institute, St. Petersburg, FL, USA, 46p.

Scharf, F.S. and K.K. Schlicht. 2000. Feeding habits of red drum (*Sciaenops ocellatus*) in Galveston Bay, Texas: Seasonal diet variation and predator-prey size relationships. Estuaries 23(1):128–139.

Sheridan, P.F. 1992. Comparative habitat utilization by estuarine macrofauna within the mangrove ecosystem of Rookery Bay, Florida. Bulletin of Marine Science 50(1):21–39.

Sokal, R.R. and F.J. Rohlf. 1981. Biometry. W.H. Freeman, New York, NY. USA, 859 p.

Springer, V.G. and K.D. Woodburn. 1960. An ecological study of the fishes of the Tampa Bay area. Professional Paper Series No. 1. Florida State Board Conservation Marine Laboratory, St. Petersburg, FL, USA, 104 p.

Stoner, A.W. 1982. The influence of benthic macrophytes on the foraging behavior of pinfish, *Lagodon rhomboides* (Linnaeus). Journal of Experimental Marine Biology and Ecology 58:271–284.

Stoner, A.W. 1983. Distribution of fishes in seagrass meadows: Role of macrophyte Biomass and species composition. Fishery Bulletin, US 81(4):837–846.

Taylor, R.G., H.J. Grier, and J.A. Whittington. 1998. Spawning rhythms of common snook in Florida. Journal of Fish Biology 53:502–520.

Taylor, R.G., J.A. Whittington, H.J. Grier, and R.E. Crabtree. 2000. Age, growth, maturation, and protandric sex reversal in common snook, *Centropomus undecimalis*, from the east and west coasts of South Florida. Fishery Bulletin, US 98:612–624.

Thayer, G.W., D.R. Colby, and W. F. Hettler, Jr. 1987. Utilization of the red mangrove prop root habitat by fishes in south Florida. Marine Ecology Progress Series 35:25–38.

Volpe, A.V. 1959. Aspects of the biology of the common snook, *Centropomus undecimalis* (Bloch) of southwest Florida. Florida State Board of Conservation Technical Series No. 31, Marine Laboratory, Miami, FL, USA.