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research paper

Swordfish *Xiphias gladius* diet in the Florida Straits

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ABSTRACT.—Swordfish *Xiphias gladius* inhabit the Florida Straits year-round and provide a significant role in the food web as top-level predators. However, little is known about the diet composition and thus ecological role of swordfish in Florida. This study investigated swordfish diet by analyzing stomach contents of 131 swordfish in the Florida Straits from April 2007 to December 2008. Identifiable species included 13 teleost species, 3 cephalopod species, and 1 crustacean species. Cephalopods dominated the swordfish diet by weight (72.4%) and number (69.9%), and ranked highest in importance in the diet by the index of relative importance (IRI; 81.5%). Teleosts occurred the most (99.1%) but represented the second highest importance in diet by weight (25.2%), number (26.3%), and IRI (17.6%). *Illex* sp. was the prey with the greatest dietary importance, followed by unidentifiable ommastrephid squids. Stomach fullness index values ranged from 0 (empty) to 8.98 (mean = 0.37). A positive significant correlation between swordfish length and prey length was found ($r^2 = 0.104$, $P = 0.037$), and no significant correlations were found between swordfish weight and prey weight ($r^2 = -0.075$, $P = 0.065$). This is the first study to report a comprehensive diet of swordfish inhabiting waters in the Florida Straits region and suggests swordfish may be opportunistic feeders, altering their diet when abundance or presence of prey changes.

Swordfish *Xiphias gladius* is a large, pelagic teleost with a circumglobal distribution between latitudes 45°N and 45°S (Palko et al. 1981, Nakamura 1985). The species is highly sought in both commercial and recreational directed fisheries (Tibbo et al. 1961, Ward and Elscot 2000). As top predators, swordfish populations also serve a significant role in pelagic waters by transferring energy between trophic levels within the marine ecosystem (Wetherbee and Cortés 2004).

Swordfish exhibit vertical diel movements and feeding takes place at night near the surface at 0–90 m, with individuals returning to greater depths from 650 to 900 m by day (Carey and Robison 1981, Matsumoto et al. 2003, Takahashi et al. 2003, Canese et al. 2008). During the day, swordfish have been described swimming near the bottom feeding on demersal fishes (Carey and Robison 1981, Young et al. 2006), although individuals have also been observed resting on the bottom during daylight periods (Carey and Robison 1981). At night, swordfish feed on vertically migrating organisms such as squids, which concentrate near the surface at night (Carey and Robison 1981, Young et al. 2006).

Feeding is thought to be influenced by moon phase, temperature, salinity, productivity, and local habitat structure. Several studies have shown that swordfish swim at deeper depths in the presence of increasing moonlight intensity (Carey and Robison 1981, Draganik and Cholyst 1988, Bigelow et al. 1999, Damalas et al. 2007). Increased swordfish feeding activity may also occur where sharp temperature and salinity gradients exist, such as current boundaries and frontal zones where there are higher concentrations of prey species (Carey and Robison 1981, Ward and Elscot 2000, Sedberry and Loefer 2001, Young et al. 2006, Dimitrios et al. 2007). Swordfish were found to increase diversity in their prey selection, including prey on different trophic levels, in waters with high sea surface fluorescence (SSF) concentrations and more productivity (Young et al. 2006). Additionally, swordfish are often associated with complex subsurface structures such as seamounts, submarine canyons, and plateaus where there are large concentrations of pelagic fishes (Carey and Robison 1981, Sedberry and Loefer 2001, Young et al. 2006). These patterns and complexities in feeding behaviors of swordfish also directly influence diet and diet composition (Hernández-García 1995, Chancollon et al. 2006).

Swordfish diet consists mainly of squids, fishes, and crustaceans (Palko et al. 1981), a generalization supported by several swordfish diet composition studies conducted over many locations worldwide. Descriptions of swordfish diet have been conducted in the East Atlantic Ocean (Clarke et al. 1995, Hernández-García 1995, Chancollon et al. 2006), the Mediterranean Sea (Bello 1991, Salman 2004, Peristeraki et al. 2005), the Pacific Ocean (Ibanez and Gonzales Cubillos 2005, Markaida and Hochberg 2005, Young et al. 2006, Castillo et al. 2007), and the Indian Ocean (Potier et al. 2007). Within the northwest Atlantic, swordfish diet has been described from Cape Hatteras, North Carolina, to the Grand Banks, Newfoundland (Scott and Tibbo 1968, Toll and Hess 1981, Stillwell and Kohler 1985). However, little is known about the diet composition of swordfish south of North Carolina, and specifically within the Florida Straits, despite the presence of several important commercial and recreational fisheries in this relatively small geographic area. Although Toll and Hess (1981) examined stomach contents of swordfish from the Florida Straits, their results only described the cephalopod prey items, and thus is not a comprehensive analysis of swordfish diet.

Understanding feeding behavior and feeding ecology of swordfish is crucial in illuminating the species' ecological role in food webs. Identifying prey can highlight the trophic levels and species swordfish are directly influencing; as ecosystem structure changes due to natural or anthropogenic causes, the dynamics of energy flow through the food web also changes. These changes are often reflected in changes at the top of the food chain or with top predators, like swordfish (Boyd et al. 2006). A better understanding of the trophic dynamics of swordfish, and in diverse locations, would allow for increased insight into other trophic levels of these pelagic ecosystems. Specifically, studying seasonal differences in swordfish diets may indicate alterations in trophic levels when prey availability changes.

Stomach content analysis is a widely used and powerful tool in identifying diet composition and feeding ecology (Hyslop 1980). Feeding ecology is an important aspect of life history strategies (Wetherbee and Cortés 2004), and studying stomach contents may be the most straightforward way to describe ecosystem feeding interactions (Pauly et al. 2002). Specifically, the objectives of this study were to use swordfish stomachs collected from the Florida Straits to (1) identify prey species and the stomach fullness index for each individual, (2) calculate the index of relative importance for all prey, (3) investigate potential seasonal or ontogenetic diet shifts, and (4) investigate potential relationships between prey size and weight and swordfish size and weight.

Materials and Methods

Stomach Collection.—Specimens were obtained throughout southeast Florida from commercial buoy gear and pelagic longline vessels, swordfish-targeting recreational tournaments, and individual recreational anglers using rod-and-reel gear. *Scomber scombrus* and *Illex argentinus* were used as bait for all fishing methods, and all fish were targeted within the Florida Straits region (Fig. 1). Soak times varied greatly between fishing methods but did not exceed 14 hrs, and fishing took place throughout the day and night.

Lower jaw-fork length (LJFL), total length, total weight, and sex were recorded for each individual. Although gonads were examined upon dissection, juveniles and adults were distinguished using the Arocha and Lee (1996) size-at-maturity estimate in which 50% reach maturity at 179 cm LJFL for females and 129 cm LJFL for males.

Stomachs were removed by dissection immediately after capture or landing, placed in labeled plastic bags, and temporarily stored on salted ice to slow digestion (Bowen 1996). No more than 6 hrs after collection, individual stomachs were hand-wrapped in cheesecloth or placed in fabric soil sample bags (Hubco Inc., Hutchinson, KS), then fixed whole in 10% buffered formalin for 1 wk to minimize post-capture digestion and harden the prey tissues (Borgeson 1963). Stomachs were then soaked in 70% ethanol or isopropyl alcohol for up to 2 wks to remove residual formalin prior to examination (Bowen 1996). Additionally, when possible, muscle color of the swordfish was noted.

Stomach weights (g) were recorded before (full) and after examination (empty), as well as the lengths (cm) and weights (g) of individual stomach contents. For fish prey, standard length (SL) was the standard measurement and for cephalopod prey, mantle length (ML) was used. Lengths were only able to be taken from cephalopods that contained whole mantles or when entire teleost specimens were present. Parasites and small, loose hard parts such as beaks, eye capsules, exoskeletons, individual bones, and otoliths were noted and included in composition analysis, but considered negligible to the contributing weight of the stomach contents. Items that could be identified as bait (e.g., dyed or with holes consistent with bridles) were not included in the results.

Data Analysis.—Prey items were identified to the lowest possible taxonomic level using published keys and guides (e.g., Roper et al. 1984, Nakamura 1985, Collette and Klein-Macphee 2002), as well as Hess and Toll (1981) for cephalopods. Prey identification was made using both the naked eye and a standard stereomicroscope.

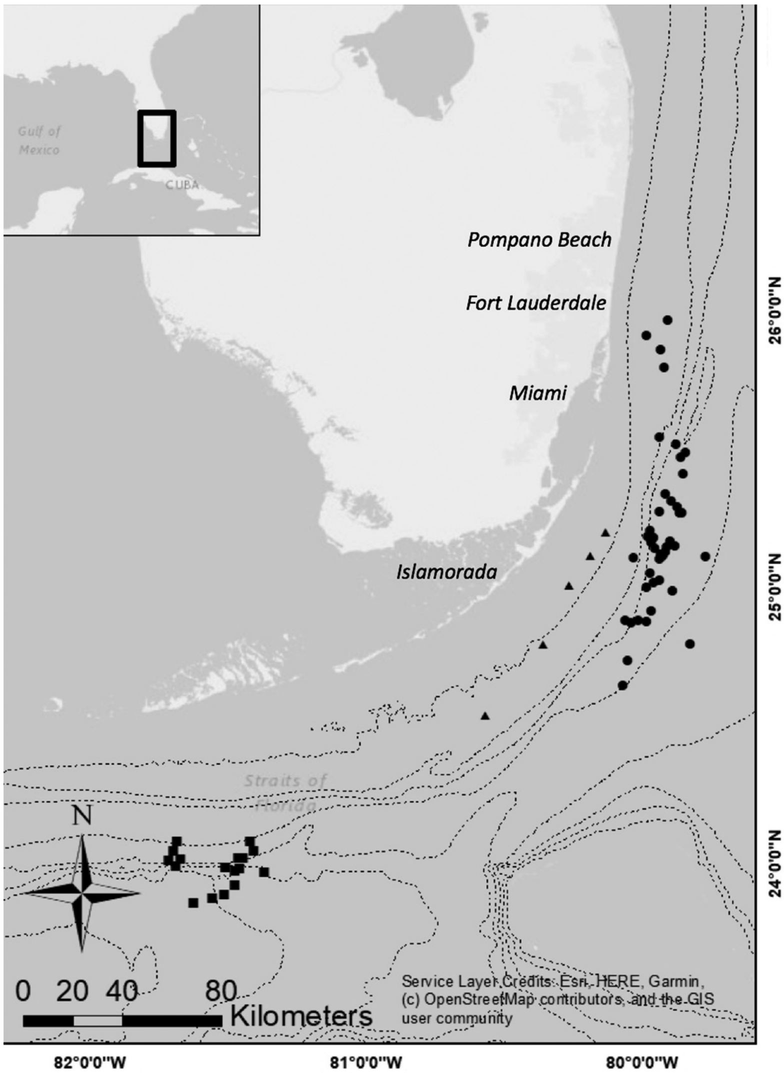

Figure 1. Map of individual swordfish *Xiphias gladius* capture locations by buoy gear (circles), pelagic longline gear (square), and tournaments (triangles). Although all swordfish were caught in the Florida Straits, GPS locations were not provided from all recreational rod-and-reel anglers providing stomachs for diet analyses. City names mark the tournament land locations. Contour lines depict 200 m isobaths and were obtained from NOAA's ETOPO1 bathymetry dataset.

Ommastrephid squids were initially identified by the presence of "t-shaped" funnel- and mantle-locking cartilage, which is unique to this family. Further, the absence of foveola in the funnel groove identified squids in the *Illex* genus. The identification of the *Histeoteuthis acturi* and *Onychoteuthis banksii* complex was made through physical characters. Squid of the family Histeoteuthidae were identified by the distinctive photophores that cover the surface of the mantle, head, and arms, while squids of the family Onychoteuthidae were identified by the presence of hooks on the tentacular clubs. Fishes were identified by external morphological features such as mouth positions, shapes of fins, and presence and number of photophores. Broader levels of classification, such as family, were used for cases where prey could not be identified to the specific genus or species.

Diet composition was calculated using several metrics for comparative purposes, including percent frequency of occurrence, percent by weight, and percent by number (Hyslop 1980). The Index of Relative Importance (IRI; Pinkas 1971) was calculated per prey item and for the four categories teleost, cephalopod, crustacean, and unknown.

$$\text{IRI} = (\%\text{N} + \%\text{W}) \times \%\text{F},$$

where %N = the percentage of prey by number, %W = the percentage of prey by weight, and %F = the percentage frequency of occurrence of prey.

The Stomach Fullness Index (SFI; Hureau 1969) was used to measure the amount of food that each individual swordfish consumed and was calculated for full and empty stomachs. Two-way ANOVAs were run for the effects of sex on stomach fullness index as well as for maturity status.

$$\text{SFI} = \text{stomach content weight/fish weight} \times 10.$$

Neither the IRI nor SFI could be calculated if data were missing. Length-weight conversions were used for all of the stomachs in the SFI analyses to standardize swordfish weights, since some individuals had round weights and some in the commercial fisheries only had dressed weights (Ehrhardt et al. 1996).

Cumulative prey curves were used to determine whether an adequate number of stomachs had been examined to sufficiently describe the diet. Using Primer 7 (PRIMER-E Ltd.; Ivybridge, UK), the mean number of new prey categories (*S*) found in the stomachs—using the family taxonomic level for prey categories, due to the number of unidentifiable fish fragments—was plotted for the total number of stomachs analyzed. Randomizing the order of stomachs to minimize potential bias, 999 permutations of cumulative prey curves were used to extrapolate a Michelis-Menton parametric estimator of *S*. Per Ferry and Caillet (1996), the asymptote of each curve—defined as a 1% rate of increase for new prey family taxa *S*—indicates the minimum sample size required to adequately describe the diet.

Pearson correlation analyses were conducted for prey length and weight relative to swordfish length and weight. Correlations were calculated for cases when both a specimen's and prey's length or weight were available; averages and sample sizes differ for the overall sample means because most specimens had multiple prey items in their stomachs. Statistical analyses were run in SPSS (v16.0; SPSS Inc.: Chicago, IL); significance was assessed at $\alpha = 0.05$ level.

Results

The stomachs of 131 swordfish were collected from the Florida Straits from April 2007 to December 2008 (Fig. 1). Upon dissection, the color of the body musculature was examined, and for all swordfish in this study was a standard grey-white. Specimens were obtained from commercial buoy gear ($n = 59$) and pelagic longline ($n = 20$) fishers, swordfish-targeting recreational angling tournaments throughout southeast Florida ($n = 46$), and individual recreational anglers using rod-and-reel gear (n = 6). GPS locations were not provided from all recreational rod-and-reel anglers, although all catches occurred within the Florida Straits.

The length of individual swordfish ranged from 53.3 to 264.2 cm LJFL [mean (SD) = 144.8 cm (34.5)], while the weights ranged from 12.7 to 247.6 kg [45.1 kg (36.4)]. For sex, a total of 27.7% of the collected stomachs were from females (n = 36), 48.5% from males (n = 63), and 23.8% were undetermined (n = 32). Of the sampled swordfish, 42.3% were adults (n = 55) and 43.1% were juveniles (n = 56). Because some individuals were not sexed, 14.6% had an undetermined maturity stage (n = 19) and were thus excluded from sex-based analyses.

Prey Composition.—The cumulative prey curve analyses showed an asymptote of S at only 31 individual swordfish, suggesting a sufficient number of stomachs were analyzed to describe prey species (Online Supplemental Fig. 1). Of the 131 stomachs, 16% lacked prey items (n = 21) and were therefore considered empty. The main prey items were cephalopods, followed by teleost fishes, and lastly crustaceans (Table 1). Pieces of the macroalgae *Sargassum* sp. (n = 2) and part of a plastic bag (n = 1) were found in the stomach contents. These items were considered negligible to the natural diet of swordfish and were therefore excluded from all subsequent data analyses. Prey length ranged from 8.50 to 360.00 mm [mean (SD) = 148.9 mm (47.7)] and prey weights from 0.55 to 1076.19 g [74.2 g (77.4)].

In total, 691 prey items were found in the stomachs: 483 cephalopods, 182 teleosts, 16 crustacea, and 10 unknown items (Table 1). Swordfish diet composition was composed of mainly cephalopods (70%), followed by teleosts (26%), and lastly crustaceans (1%) and unidentifiable specimens (1%). Cephalopods dominated the swordfish diet by weight (72.38%), number (69.9%), and IRI (81.45%), followed by teleost fishes, and lastly crustaceans (Table 1). Of the identifiable cephalopod prey, the most abundant species by weight and number were *Illex* sp. squids, with an occurrence of 40.91%. Of the identifiable teleost fishes, *Scomber colias* was greatest in weight, number, and occurrence. Only one species of crustacean was found, the royal red shrimp *Pleoticus robustus*; it contributed the least to the diet by weight, number, and occurrence.

Juvenile swordfish stomachs contained mainly cephalopods (75%), followed by teleosts (22%), and lastly crustaceans (1%). Adult swordfish stomachs contained mainly cephalopods (68%), followed by teleosts (28%), and lastly crustaceans (1%).

Index of Relative Importance (IRI).—Cephalopods were the most important dietary prey comprising 81.45% of the IRI, followed by teleosts which comprised 17.64%, and crustaceans having the least importance (<1%; Table 1).

Stomach Fullness Index (SFI).—The stomach fullness index was calculated for 93 of 131 stomachs. The stomach fullness index ranged from 0 (empty stomachs) to 8.98 (mean = 0.37). A two-way ANOVA showed no significant differences were found in stomach fullness between sexes (F = 2.428, P = 0.123) or maturity status (F = 1.652, P = 0.198).

Feeding Correlations.—A significant positive correlation was found between swordfish length and prey length (r^2 = 0.104, P = 0.037, N = 407). No significant correlations were found between swordfish weight and individual prey weight (r^2 = −0.075, P = 0.065, N = 597).

Table 1. List of prey taxa from swordfish *Xiphias gladius* stomach content analysis caught in the Straits of Florida from 2007 to 2008 (n = 110 stomachs with contents). Frequency of occurrence and associated percent (O%), number and the associated percent (N%), weight (g) and associated percent (W%), and percent of Index of Relative Importance (IRI%) are listed for each taxa. Any bait items were excluded as prey.

Prey	Occurence	O%	Number	N%	Weight (g)	W%	IRI	IRI%
Teleostei								
Order Aulopiformes	1	0.91	1	0.14	13.22	0.03	0.16	0.00
Family Bathysauridae								
Bathysaurus sp.	1	0.91	1	0.14	98.90	0.19	0.31	0.00
Family Notosudidae								
Scopelosaurus sp.	2	1.82	2	0.29	82.60	0.16	0.82	0.01
Order Perciformes	1	0.91	1	0.14	10.62	0.02	0.15	0.00
Family Bramidae								
Brama brama	7	6.36	16	2.32	806.04	1.57	24.76	0.33
Family Gempylidae	3	2.73	8	1.16	138.59	0.27	3.90	0.05
Gempylus serpens	1	0.91	4	0.58	230.07	0.45	0.93	0.01
Ruvettus pretiosus	1	0.91	1	0.14	101.80	0.20	0.31	0.00
Family Nomeidae	1	0.91	1	0.14	22.30	0.04	0.17	0.00
Family Scombridae								
Scomber colias	18	16.36	32	4.63	3,605.92	7.04	191.05	2.55
Family Scombrolabracidae								
Scombrolabax heterolepis	1	0.91	1	0.14	19.30	0.04	0.17	0.00
Family Gonostomatidae	1	0.91	3	0.43	212.00	0.41	0.77	0.01
Family Myctophidae	1	0.91	1	0.14	23.80	0.05	0.17	0.00
Family Polymixiidae								
Polymixia lowei	1	0.91	3	0.43	414.00	0.81	1.13	0.02
Family Regalecidae								
Regalecus sp.	1	0.91	1	0.14	128.20	0.25	0.36	0.00
Family Stomiidae	1	0.91	1	0.14	13.80	0.03	0.16	0.00
Idiacanthus sp.	1	0.91	1	0.14	5.1	0.01	0.14	0.00
Malacosteus niger	1	0.91	1	0.14	14.0	0.03	0.16	0.00
Trigonolampa miriceps	8	7.27	27	3.91	1,686.46	3.29	52.38	0.70
Family Himantolophidae								
Himantolophus sp.	1	0.91	1	0.14	311.84	0.61	0.69	0.01
Unidentifiable fish parts	56	50.91	75	10.85	4,938.46	9.65	1,043.70	13.92
Total	109	99.09	182	26.34	12,877.02	25.16	1,322.37	17.64
Cephalopoda								
Family Histioteuthidae	1	0.91	2	0.29	169.90	0.33	0.56	0.01
Histioteuthis arcturi	1	0.91	1	0.14	52.80	0.10	0.23	0.00
Family Ommastrephidae	48	43.64	155	22.43	10,838.86	21.17	1,902.78	25.38
Illex sp.	45	40.91	198	28.65	17,711.95	34.60	2,587.70	34.52
Family Onychoteuthidae								
Onychoteuthis banksii complex	2	1.82	2	0.29	65.80	0.13	0.76	0.01
Unidentifiable squid	52	47.27	125	18.09	8,212.14	16.04	1,613.53	21.53
Total	149	135.45	483	69.90	37,051.45	72.38	6,105.56	81.45
Crustacea								
Family Solenoceridae								
Pleoticus robustus	15	13.64	16	2.32	77.25	0.15	33.63	0.45
Total	15	13.64	16	2.32	77.25	0.15	33.63	0.45
Unknown	10	9.09	10	1.45	1,183.70	2.31	34.18	0.46

Seasonality.—A total of 49 stomachs were collected in winter (Oct–Feb), 3 in spring (March–May), and 41 in summer (June–Sept). Only three stomachs were collected in spring due to the extremely limited recreational fishing, and lack of commercial pelagic longline fishing and fishing tournaments during those months. The three stomachs collected in spring were comprised of mainly teleosts (58%), whereas their diet was mainly composed cephalopods during summer (70%) and winter (75%; Online Supplemental Fig. 2).

Discussion

This work represents the first swordfish diet study conducted in the Florida Straits since 1979 and is the only study in this area to explicitly account for all prey items, not solely cephalopods. Results confirmed that swordfish consumed greater amounts of cephalopods than teleosts, similar to the findings of Toll and Hess (1981). However, this study revealed the importance of teleosts in the diet of swordfish and may suggest swordfish could be opportunistic feeders, altering their food choices when abundance or presence of prey changes.

Within the Florida Straits, swordfish diet was composed mainly of cephalopods, followed by teleosts, and lastly, crustaceans. Similar to previous studies (Toll and Hess 1981, Stillwell and Kohler 1985, Bello 1991, Markaida and Hochberg 2005, Young et al. 2006, Castillo et al. 2007), the diet of swordfish in Florida was dominated by cephalopods, and differed from studies where teleosts were in greatest abundance (Scott and Tibbo 1968, Salman 2004, Chancollon et al. 2006, Potier et al. 2007). Other studies have suggested that the composition of the swordfish diet can be dependent on water column feeding location, potentially accounting for this disparity between major prey taxa (Hernández-García 1995, Chancollon et al. 2006).

Cephalopods were the most important taxa to the diet of swordfish in the Florida Straits by occurrence, weight, number, and IRI. The two prey taxa with the greatest dietary importance were *Illex* sp. and ommastrephid squids, similar to previous diet studies (Toll and Hess 1981, Scott and Tibbo 1968, Stillwell and Kohler 1985, Hernández-García 1995, Markaida and Hochberg 2005, Peristeraki et al. 2005, Young et al. 2006, Castillo et al. 2007). As in Toll and Hess (1981), *Illex* squids were the most abundant prey group. These cephalopods were unable to be identified to species, although two species are common in the northwestern Atlantic Ocean: *Illex coindetii* and *Illex illecebrosus*. Ommastrephid and *Illex* sp. squids may be dominant prey items due to their abundance and presumed spawning throughout the Florida Straits (Cairns 1976, Goldman and McGowan 1991). Swordfish also inhabit similar oceanic habitats following the same vertical migration pattern as ommastrephids (Roper and Young 1975, Roper et al. 1984).

The diversity in cephalopod prey items found reflects findings from Toll and Hess (1981) in which 12 species of cephalopods and two species of octopods were identified. This observed diversity may reflect the opportunistic behavior of swordfish feeding (Scott and Tibbo 1968, Beckett 1974, Stillwell and Kohler 1985). It also may reflect the relative abundance of cephalopod prey as suggested by Markaida and Hochberg (2005). Unlike onychoteuths and histioteuths, which were found in low numbers, ommastrephids are shoaling species (Rodhouse and Nigmatullin 1996), thus making it energetically advantageous for swordfish to feed on large aggregations when encountered.

Mesopelagic teleost fishes were only moderately important to the diet of swordfish in the Florida Straits. The scombrid *S. colias*, stomiid *Trigonolampa miriceps*, and bramid *Brama brama* were the principal teleosts represented in the diet, similar to other studies in the Atlantic Ocean (Scott and Tibbo 1968, Stillwell and Kohler 1985). The present study found that scombrids represent the most important teleost prey species for swordfish in the Florida Straits. In other studies, bramids were present, but not in high abundances (Young et al. 2006, Potier et al. 2007), except for Chancollon et al. (2006). This is also the second study to report stomiids in the swordfish diet (Collette and Klein-Macphee 2002). The teleosts found in Toll and Hess (1981) were not, unfortunately, identified to lower taxonomic levels, eliminating potential comparisons.

Crustaceans were least important to the diet of swordfish by weight, number, occurrence, and IRI, with only one crustacean species found, *P. robustus*. This shrimp species contributed little to the weight of the diet (0.15%), yet it occurred in 13.64% of stomachs and represented 2.32% of the contents by number. Chancollon et al. (2006) suggested that crustaceans were probably a prey item of secondary importance to swordfish, noting that crustaceans were always found in the stomach in association with teleost prey. In this study, *P. robustus* was similarly found in association with teleosts in 13 of 15 swordfish stomachs. Local fishers in the Florida Straits anecdotally report that the so-called "pumpkin" swordfish with pinkish-orange musculature obtain this coloration from foraging on deep-water crustaceans, but no such individuals were seen in this study for further dietary assessment.

Feeding seasonality has never been examined for swordfish in the Florida Straits and only rarely examined in other swordfish diet studies. The three stomachs collected in spring may indicate that swordfish consume teleosts predominantly in the spring and cephalopods during the summer and winter months. These results were based on a limited sampling during spring, and thus additional samples are needed to further investigate this potential seasonal diet shift. Many local fishes spawn during the winter and spring seasons, and higher abundances of fish in the diets of Florida Straits swordfish may be present due to these spring spawning events (Yoder et al. 1981). Although the high teleost abundance observed in the swordfish diet may be an artefact of low sampling in the spring, it could also indicate alterations in trophic levels of the swordfish diet when food availability changes.

Correlation results suggested a positive relationship between overall swordfish size and prey size, whereas diet composition suggested no ontogenetic shift in prey composition. These results suggest swordfish do not shift their prey composition, but rather start to eat larger prey as they grow from juveniles to adults. Although Chancollon et al. (2006) also found a positive correlation between predator and prey length, Stillwell and Kohler (1985) showed that small, medium, and large swordfish fed on the same size range of squid and migrating fish species. These differences may result from dissimilar oceanic regions where there may be variability in prey size and food availability.

Overall, this study furthers the findings of Toll and Hess (1981) to show a comprehensive diet of swordfish inhabiting the Florida Straits. By also identifying the teleost and crustacean prey items, this study documented the occurrence of mesopelagic and bathypelagic species in swordfish diets and is the first to report stomiids. The swordfish fishery in the Florida Straits has changed dramatically since the Toll and Hess (1981) study, including the elimination of the commercial pelagic longline fishery in 2000 (NMFS 2006), the decline in the buoy gear fishery (NMFS 2019), and the replacement of the recreational nighttime drift fishery with the daytime deep-drop fishery (Kerstetter et al. 2017). Thus, these results also represent a documentation of the swordfish nighttime feeding behaviors unlikely to be easily replicated using fishery-dependent sampling methods. Regardless, a better understanding of swordfish diet in the Florida Straits should assist the development of regional ecological models that incorporate swordfish and their prey.

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