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Feeding Habits of Juvenile Lane Snapper *Lutjanus synagris* from Mississippi Coastal Waters, with Comments on the Diet of Gray Snapper *Lutjanus griseus*

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FEEDING HABITS OF JUVENILE LANE SNAPPER *LUTJANUS SYNAGRIS* FROM MISSISSIPPI COASTAL WATERS, WITH COMMENTS ON THE DIET OF GRAY SNAPPER *LUTJANUS GRISEUS*

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ABSTRACT Stomach contents analysis was used to quantitatively describe the diets of juvenile lane snapper, *Lutjanus synagris*, and juvenile gray snapper, *Lutjanus griseus*, from the northern Gulf of Mexico. Juvenile snapper were collected by trawling at two estuarine, deep channel sites in Mississippi coastal waters from September 1996 to January 1997. Lane snapper (n = 53) and gray snapper (n = 12) both consumed a variety of prey organisms, but primary prey were amphipods, decapods (shrimp and crabs), and fishes. The most important prey items for lane snapper based on percent Index of Relative Importance (%IRI) were shrimp remains (44%IRI), the shrimp *Latreutes parvulus* (23%IRI) and fish remains (13%IRI). Fishes of the genus *Anchoa* (43%IRI), shrimp remains (21%IRI) and the amphipod *Corophium* sp. (13%IRI) dominated the gray snapper diet. Intraspecific comparisons of lane snapper diet revealed significant overlap between collection sites, seasons and fish sizes.

INTRODUCTION

Lane snapper (*Lutjanus synagris*) and gray snapper (*Lutjanus griseus*) occur in the western Atlantic from the mid-eastern coast of the United States and Bermuda southward to Brazil, including the Caribbean and the Gulf of Mexico (Gulf) (Hoese and Moore 1998). Although widespread throughout the northern Gulf, these 2 lutjanid species are generally less abundant than in the southern Gulf (Benson 1982, Pattillo et al. 1997). Adults of both species generally inhabit offshore reefs and other hard bottom features, whereas juveniles typically occur inshore and are often found in seagrass beds and over mud bottom (Randall 1967, Acosta and Appledoorn 1992, GMFMC 1981). In the northern Gulf, juveniles of both species consistently occur within the Mississippi Sound estuary (Wieland 1994, Warren and Perry 1996, Pattillo et al. 1997).

Temperature ranges for lane and gray snapper are similar; however, gray snapper are apparently more tolerant of low salinity waters. Lane snapper are found at temperatures between 15.0 and 27.5° C and salinities between19.0 and 35.0‰ (Springer and Woodburn 1960), whereas gray snapper are found between13.0 and 32.5° C (Springer and Woodburn 1960) and between 1.0 and 35.0 ‰ (Starck 1970). Juvenile lane (15–104 mm standard length, SL) and gray (11–113 mm SL) snapper have been reported from Mississippi coastal waters ranging from 11.5 to 31.5° C and 7 to 33‰ for lane and from 14.8 to 34° C and 5 to 33‰ for gray[a].

Both species support important commercial and recreational fisheries in the northern Gulf (GMFMC 1981). The combined annual commercial (1990–1997[b]) and recreational (1990–1998[c]) landings for lane and gray snapper from the Gulf averaged 225,000 kg and over 636,000 kg, respectively. Despite the commercial and recreational importance of lane and gray snapper in the Gulf, their life history and ecological roles in the northern Gulf require further study. Biological and ecological aspects of lane and gray snapper from southern Florida were studied by Springer and Woodburn (1960), Starck (1970), Manooch and Mason (1984), Bortone and Williams (1986), Rutherford et al. (1989a, b) and Chester and Thayer (1990). Dietary studies of gray snapper in south Florida were conducted by Croker (1962), Starck (1970), Rutherford et al. (1983), Hettler (1989) and Harrigan et al. (1989). In the northern Gulf, Shipp (1991) and Johnson et al. (1995) examined age and growth of lane snapper. There are no published life-history studies on gray snapper from the northern Gulf; however, the feeding habits of juvenile gray snapper from northwest Florida were examined by Koenig[d]. Information on feeding habits of lane and gray snapper in the northern Gulf is important for understanding the life history of these 2 species whose juveniles occupy estuarine habitat. Thus, the purpose of our study was to quantitatively describe the diet of juvenile lane and gray snapper from Mississippi coastal waters.

MATERIALS AND METHODS

Juvenile lane and gray snapper were collected from the eastern Mississippi Sound with a 5 m otter trawl with 35 mm codend mesh. Lane snapper were collected between November 1996 and March 1997, and gray snapper were collected between September 1996 and January

1997. Trawling was conducted between 0700 and 1500 h, and upon removal from the net, snappers were placed on ice to minimize digestive activity. At the dock, specimens were placed in labeled plastic bags and frozen, then later provided to us for examination.

Specimens were collected at 2 sites: Site 1 was located at the mouth of the East Pascagoula River (30°21′N, 88°34′W) with depth ranging from 10 to12 m; Site 2 was located at the mouth of Bayou Casotte (30°0′N, 88°31′W), a large bayou located about 3 km east of Site 1, with depth ranging from 13 to14 m. Both collection sites were located within industrial shipping channels near their confluence with the Mississippi Sound. The dominant substratum at both sites was a mud and shell rubble mixture. Bottom temperatures ranged from 15 to 18° C at the East Pascagoula River site and from 16 to 20° C at the Bayou Casotte site, and salinities ranged from 25 to 30‰ at both sites.

In the laboratory, specimens were thawed, measured to the nearest 0.1 mm SL, blotted dry, and weighed to the nearest 0.01 g. Stomachs were removed and placed in labeled vials containing 95% ethanol. Stomachs were later opened, and the contents were sorted, identified to the lowest possible taxonomic level and counted. In each stomach, all remnants identified as the same taxa were scored as a single prey item unless items obviously came from multiple individuals. Prey which were finely digested were assigned to a higher taxonomic level as "remains" and were included in the contributions of those higher taxa to the diet. Prey items were sorted into pre-weighed aluminum pans, placed in a 55° C drying oven for 18 h, cooled in a desiccator, and weighed to the nearest 0.001 mg using a Cahn electronic microbalance. Parasitic isopods, nematodes and plant material found in stomachs were considered non-food items ingested incidentally in normal feeding and were not used in our description of the diets.

Prey were pooled for all stomachs of each species and were represented as percent numeric abundance (%N), percent of total weight (%W), and percent frequency of occurrence (%F). The above values were used to calculate an index of relative importance (IRI): IRI = (%N + %W) × %F (Pinkas et al. 1971). Percent IRI (%IRI) was also calculated by dividing the IRI value of each prey taxon by the sum of IRI values (Cortés 1997). Empty stomachs were excluded from the above calculations.

Both the simplified Morisita index of overlap (C_H, Horn 1966) and Horn's index of overlap (R_o, Horn 1966) were used to determine dietary overlap. These indices exhibit less bias than other overlap measures when sample size (n) and resources (number of prey types in diet) are not constant (Krebs 1989, Cortés 1997). Both indices range from 0.0 (no overlap) to 1.0 (complete overlap), and a value of 0.60 indicates a high degree of overlap (Krebs 1989). Juvenile lane snapper were separated into 3 groups to determine intraspecific diet overlap: collection site (Pascagoula River vs. Bayou Casotte); season (early winter vs. late winter); and fish size (< 75 mm SL vs. ≥75 mm SL).

RESULTS

A total of 94 juvenile lane snapper were collected at Site 1 (n = 61) and Site 2 (n = 33), whereas16 juvenile gray snapper were collected from Site 1. Lane (n = 53) and gray (n = 12) snapper with prey in their stomachs ranged from 63.7 to 86.5 mm SL and 71.2 to 151.1 mm SL, respectively. The percentage of empty stomachs was 44% for lane snapper (n = 41) and 25% for gray snapper (n = 4). Although prey varied between snapper species, most prey taxa in both diets could be grouped into 3 main prey groups: amphipods, decapods and fish.

Diet composition of lane snapper

The diet of juvenile lane snapper was predominately decapods (shrimp and crabs) which comprised 48% of the diet numerically and 78% of the diet by weight (Figure 1, Table 1). Furthermore, decapods occurred with the greatest frequency (70%F) among the main prey groups and exhibited a 69%IRI. Decapod prey consisted of 9 prey taxa; however, the Sargassum shrimp, *Latreutes parvulus* and unidentified shrimp remains together accounted for 88%N and 68%W of the entire decapod prey group (Table 1). Other decapod prey, e.g., palaemonid shrimp and portunid crabs, were of less importance in the diet (Table 1).

Fish and amphipods exhibited similar %IRI values (fish 13%; amphipods 18%), but varied substantially in weight and numeric contribution to the diet (Figure 1). While the total number of amphipods consumed was about 5 times greater than the number of fish consumed, the %W of amphipods (4%) was about 4 times less than that of fish (17%) (Table 1). The amphipod prey group consisted of 6 prey taxa. The combination of *Batea catharinensis* and amphipod remains accounted for 85%N and 88%W, respectively, for the group (Table 1). The %F of amphipods (40%) was nearly twice that of fish (22%), identified only as remains.

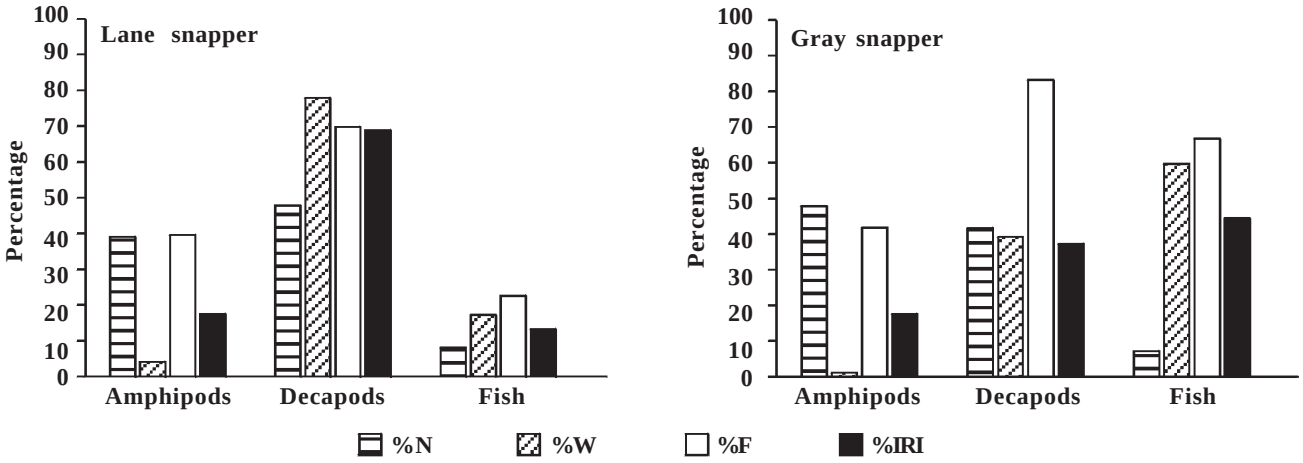

Figure 1. Percent numerical abundance (%N), percent total weight (%W), percent frequency of occurrence (%F), and percent index of relative importance (%IRI) for primary prey categories in the diet of juvenile lane snapper, *Lutjanus synagris*, and juvenile gray snapper, *Lutjanus griseus*, from Mississippi coastal waters.

Diet composition of gray snapper

The diet of juvenile gray snapper was primarily comprised of decapods (37%IRI) and fish (44%IRI) (Figure 1, Table 2). *Anchoa* sp. was the major component of the fish group in both numeric and weight contribution to the diet (Table 2). The decapod prey group (shrimp and crabs) included 11 taxa with shrimp remains the most dominant component (Table 2). Whereas amphipods were numerically abundant (48%N), with *Corophium* sp. and unidentified caprellids the most abundant members, their contribution to the diet by weight was only 1%W. Although *Corophium* sp. exhibited a 13%IRI, amphipods contributed moderately to the overall diet.

Diet Overlap

All 3 intraspecific comparisons of lane snapper showed high degrees of diet overlap (Table 3). Among these comparisons, the greatest dietary overlap occurred between size classes (C_H = 0.94; R_o = 0.91).

DISCUSSION

Our study provides fundamental information on the diet and food habits of juvenile lane and gray snapper from Mississippi coastal waters. The IRI showed decapods were important foods for both species (lane, 69%IRI; gray, 37%IRI); amphipods were of equal importance in both diets (17%IRI). Fish, comprised mostly of anchovies, were substantially more important in the diet of gray (44%IRI) than lane (13%IRI) snapper, primarily because of their high %W contribution (60%W) and %F (50%F) to the gray snapper's diet.

Many of the prey from snapper stomachs are organisms which comprise the macrobenthic and demersal communities within Mississippi Sound (Christmas and Langley 1973). The occurrence of small anchovies in the stomachs of gray snapper suggests some feeding occurred in the water column.

Among published studies from the Gulf, Springer and Woodburn (1960), Croker (1962), Starck (1970) and Hettler (1989) present the most detailed accounts of the diet of juvenile gray snapper. We found no published studies on the diet of lane snapper from the northern Gulf, and to the best of our knowledge, the only published information on the diet of lane snapper from US Gulf waters is that of Springer and Woodburn (1960). Therefore, our findings apparently represent the first account of diet and food habits of lane and gray snapper from the northern Gulf.

We report palaemonid shrimp (*Palaemonetes*), miscellaneous decapod crustaceans and fishes as being prey of lane snapper, prey that were also recorded for a similar size of juvenile lane snapper from Tampa Bay (Springer and Woodburn 1960). Among studies on lane snapper outside the US Gulf region, Rodriguez-Pino (1962), Randall (1967), Claro (1981) and Rivera-Arriaga et al. (1993) also reported diets primarily of crustaceans and fish for specimens examined from Cuba, the West Indies, Caribbean and Campeche, Mexico, respectively.

We found copepods, amphipods, palaemonid shrimp, mysids, portunid crabs and fishes in juvenile gray snapper stomachs, prey that were also reported by Starck (1970) and Hettler (1989) for juvenile gray snapper from south Florida. Our findings that juvenile gray snapper from 75–150 mm SL preyed heavily upon shrimp and fish are consistent with Starck (1970), Hettler

TABLE 1

Prey items found in stomachs of juvenile lane snapper, *Lutjanus synagris*, from Mississippi coastal waters. Percent frequency of occurrence is based on stomachs containing prey (*n* = 53). Unid. = unidentified.

Prey Items	Number of prey	% Number of prey	Prey weight (mg)	% Prey weight	% Frequency occurrence	Index of Relative Importance	% Index of Relative Importance
Arthropoda							
Copepoda	4	2.51	0.15	0.05	5.66	14.54	0.33
Amphipoda							
Bateacatha rinensis	28	17.61	6.03	2.02	18.87	370.82	8.56
Corophium sp.	4	2.51	0.25	0.08	7.55	19.35	0.45
Erichthonius brasiliensis	2	1.26	0.67	0.22	1.89	2.70	0.06
Unid. Caprellidae	1	0.63	0.06	0.02	1.89	1.18	0.03
Paracaprella tenuis	2	1.26	0.36	0.12	3.77	5.02	0.12
Amphipod remains	25	15.72	4.88	1.63	20.75	360.46	8.32
Mysidacea							
Americamysis sp.	3	1.89	1.53	0.51	3.77	9.16	0.21
Unid. Mysidae	1	0.63	0.74	0.25	1.89	1.62	0.04
Decapoda							
Palaemonetes sp.	1	0.63	3.26	1.09	1.89	3.21	0.07
Palaemonetes vulgaris	1	0.63	41.50	13.90	1.89	27.55	0.64
Latreutes parvulus	33	20.75	94.70	31.72	18.87	992.44	22.90
Alpheus sp.	1	0.63	4.10	1.37	1.89	3.74	0.09
Shrimp remains	33	20.75	63.15	21.15	45.28	1,900.34	43.85
Unid. Portunidae	1	0.63	3.95	1.32	1.89	3.65	0.08
Callinectes sapidus	2	1.26	15.92	5.33	3.77	24.81	0.57
Crab remains	3	1.89	2.95	0.99	5.66	16.47	0.38
Decapoda remains	1	0.63	3.17	1.06	1.89	3.15	0.07
Chordata							
Osteichthyes							
Fish remains	13	8.18	51.23	17.16	22.64	573.14	13.23
Totals	159		298.60			4,333.35	
Stomachs analyzed = 94		Stomachs (%) with prey = 53 (56%)			Stomachs (%) empty = 41 (44%)		

(1989) and Koenig[d]. In agreement with Springer and Woodburn (1960), we found juvenile gray snapper stomachs to contain copepods, annelids and small fishes. Croker (1962) and Rutherford et al. (1983) reported that gray snapper consumed shrimp, crabs and fish, including anchovies which were prevalent in the stomachs of our specimens.

Various studies on the feeding habits of juvenile gray snapper suggest an association with and feeding in seagrasses (Randall 1967, Starck 1970, Odum and Heald 1972, Koenig[d]). Although several prey reported here may occur in seagrasses, no submerged vegetation currently occurs or has occurred previously at our study sites (Christmas and Eleuterius 1973). The bryozoan *Amathia alternata* was occasionally collected in large mats or found attached to shell fragments in trawls at Site 2 (Bayou Casotte). *Amathia alternata* possibly served as habitat for juvenile lane snapper and provided refuge for potential prey organisms.

High levels of dietary overlap were found between lane snapper compared by catch location (Site 1 and Site 2), season (early winter and late winter), and size (4.1–6.0 and 6.1–8.6 mm SL). The 2 study sites were located only 5 km apart, and water temperatures, salinities and depths were similar during collecting. Christmas and Eleuterius (1973) reported the persistence of a "wedge" of high saline, eastern Mississippi Sound water along the bottom in both areas. The similarity between sites might account for the high dietary overlap for specimens of lane snapper from both sites. The limited collection months and the narrow size range of specimens probably account for the high dietary overlap

TABLE 2

Prey items found in stomachs of juvenile gray snapper, *Lutjanus griseus*, from Mississippi coastal waters. Percent frequency of occurrence is based on stomachs containing prey (*n* = 12). Unid. = unidentified; T = trace amount (< 0.01).

Prey Item	Number of prey	% Number of prey	Prey weight (mg)	% Prey weight	% Frequency occurrence	Index of Relative Importance	% Index of Relative Importance
ANNELIDA							
Polychaeta							
Unid. Nereidae	1	0.89	0.04	T	8.33	7.46	0.12
MOLLUSCA							
Bivalvia							
Unid. Bivalvia	1	0.89	0.02	T	8.33	7.44	0.12
ARTHROPODA							
Amphipoda							
Batea catharinensis	4	3.54	1.43	0.19	16.67	62.18	1.00
Corophium sp.	37	32.74	5.54	0.73	25.00	836.75	13.41
Unid. Caprellidae	10	8.84	0.90	0.12	16.67	149.36	2.39
Amphipod remains	3	2.65	0.29	0.04	16.67	44.84	0.72
Mysidacea							
Americamysis sp.	2	1.77	0.24	0.03	16.67	30.01	0.48
Decapoda							
Palaemonetes sp.	6	5.31	15.16	2.00	25.00	182.75	2.93
Latreutes parvulus	7	6.19	13.90	1.84	16.67	133.86	2.15
Alpheus sp.	1	0.89	5.11	0.68	8.83	13.08	0.21
Shrimp remains	14	12.39	74.56	9.86	58.33	1,297.84	20.81
Callinectes sapidus	3	2.65	48.18	6.37	25.00	225.56	3.62
Callinectes sp.	1	0.89	10.53	1.39	8.33	18.99	0.30
Eurypanopeus depressus	5	4.42	74.83	9.90	8.33	119.28	1.91
Mennipe adina	1	0.89	5.72	0.76	8.33	13.74	0.22
Unid. Xanthidae	5	4.42	35.66	4.72	25.00	228.50	3.66
Crab remains	3	2.65	2.56	0.34	25.00	74.75	1.20
Decapoda remains	1	0.89	9.97	1.32	8.33	18.41	0.30
CHORDATA							
Osteichthyes							
Anchoa sp.	6	5.31	361.95	47.88	50.00	2,659.50	42.64
Unid. Triglidae	1	0.89	84.04	11.12	8.33	100.04	1.60
Fish remains	1	0.89	5.30	0.70	8.33	13.24	0.21
TOTALS	115		755.93			6,237.52	
Total stomachs analyzed = 16		No. (%) containing food = 12 (75%)			No. (%) empty = 4 (25%)		

of lane snapper between seasons and size groups, respectively.

Information on age, growth, term of residency and patterns of movement of juvenile lane and gray snapper within the Mississippi Sound estuary is lacking. Additionally, there is no information on the size and age of lane and gray snapper at the time of their emigration from the Mississippi Sound estuary to open Gulf waters. Both of our study sites were located within shipping channels which were substantially deeper than adjacent waters. The channels may serve as "conduits" for the movement of sub-adult lane and gray snapper out of the estuary into offshore waters.

Our findings show that some juvenile lane and gray snapper utilized Mississippi's estuarine habitat as nursery area. Documentation of juvenile habitat and monitoring the juvenile snapper population along the northern Gulf coast will enhance the ability to assess relationships between habitat and early life history stages of these important fishes, and ultimately may provide indicators useful in assessing recruitment and status of the stocks. Identification of the food habits of juvenile

TABLE 3

Dietary overlap among juvenile lane snapper, *Lutjanus synagris*, from Mississippi coastal waters. Site 1 (Pascagoula River, *n* = 25), Site 2 (Bayou Casotte, *n* = 28). Early winter (Nov./Dec., *n* = 26), Late winter (Jan./Feb./Mar., *n* = 27). Size class A (< 75 mm SL, *n* = 24), Size class B (> 75 mm SL, *n* = 29). The simplified Morisita (C_H) and Horn's (R_o) indices range from 0 = no overlap to 1.0 = complete overlap.

Comparison Group	C_H	R_o
Site 1 vs. Site 2	0.77	0.82
Early winter vs. Late winter	0.71	0.73
Size class A vs. Size class B	0.94	0.91

lane and gray snapper is an important step in developing a better understanding of the life history requirements, estuarine ecology and trophic role of these 2 species within the Mississippi Sound estuarine ecosystem.

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