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Food of gag (*Mycteroperca microlepis*) from North Carolina and three areas of Florida

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ABSTRACT

Stomachs of 2,377 gag caught by hook and line from April 1979 through October 1981 from North Carolina, south Florida, west central Florida, and northwest Florida were examined. Data were analyzed for variations between area, size of fish, and season by using percentage volume and percentage frequency of occurrence. About 59% of the stomachs were empty. The percent volume of fish ranged from 95.1% in northwest Florida to 99.8% in south Florida. Twenty-five families of fish were represented in the diet. Six families were dominant: Clupeidae, Sparidae, Carangidae, Sciaenidae, Mugilidae, and Haemulidae. The dominant fish species were *Sardinella aurita*, *Lagodon rhomboides*, and *Decapterus punctatus*. Invertebrates never exceeded 5% of the total volume or 12% in occurrence in any area. Relatively minor differences in diet among size classes and among seasons were noted; however, between areas the diet varied considerably.

INTRODUCTION

The gag (Mycteroperca microlepis) is a demersal serranid distributed in the western Atlantic from New York to Brazil, including Bermuda and the Gulf of Mexico (Smith 1971). The gag is caught by both commercial and recreational fishermen. Its center of maximum abundance is the Gulf of Mexico coast of Florida (McErlean 1963). The gag is also prevalent along the southeast coast of the United States, as Huntsman and Dixon (1976) recorded recreational catches of 206 metric tons, which comprised 44% of their total grouper catch from 1972 to 1974. The relative importance of gag in the commercial fishery is unknown due to the lumping of grouper landings with no delineation of species.

Past studies on life history of gag have been conducted on: age and growth, length-weight relationship, and reproduction (McErlean 1963); hermaphroditism (McErlean and Smith 1964); age and growth (Manooch and Haimovici 1978); and recreational catches in North and South Carolina (Huntsman and Dixon 1976). Published information on food habits is absent. We report here the results of a comparative food study of gag from four locations, one off North Carolina and three off Florida. Analyses and comparisons were made between areas, and variations in food composition by size of fish and by season were examined for northwest and west central Florida.

MATERIALS AND METHODS

Hook-and-line-caught gag were obtained from the four areas (Fig. 1) from April 1979 through October 1981. Stomachs from 2,377 fish (86 from North Carolina, 134 from south Florida, 182 from west central Florida, and 1,975 from northwest Florida) comprised the study materials. Fork length (FL) was measured to the nearest millimeter for each fish before removing stomachs. Stomach samples were wrapped in gauze, labeled, and preserved in 10% formalin.

In the laboratory, stomachs were rinsed in tap water and cut lengthwise; stomach walls were scraped lightly with a spatula to remove fish scales, parasites, and small bones. The contents were placed in a glass dish and sorted into taxonomic groups, identified, drained of water and blotted dry. Volumes, to the nearest 0.1 ml, of stomach contents were obtained by measuring water displacement in a graduated cylinder. Numbers of individuals of each taxon could not always be accurately determined owing to partial digestion. Frequency of occurrence of each food type was obtained by counting every fish that contained the specific item. Relative frequency of occurrence (%) was calculated by dividing the number of fish that contained a specific food by the number of fish that had food in their stomach and multiplying by 100.

Variations in the diet by season and by size of predator were examined only for samples from west central Florida and northwest Florida, where sample sizes were sufficient.

RESULTS

Of the 2,377 stomachs obtained from the four geographic areas, 58.8% were empty (Table 1). The percent of empty stomachs varied from 12.1% in west central Florida to 68.6% in North Carolina.

The food consisted of fish and six phyla of invertebrates. The percent volume of fish (the dominant food category) ranged from 95.1% in northwest Florida to 99.8% in south Florida. Twenty-five families of fish were represented in the diet, with six families (Clupeidae, Sparidae, Carangidae, Sciaenidae, Mugilidae, and Haemulidae) being most prevalent. The most important fish prey were *Sardinella aurita*, *Lagodon rhomboides*, and *Decapterus punctatus* (Table 2). Invertebrates never exceeded 5% of the total volume in any area. Invertebrate prey consisted primarily of penaeid shrimp, portunid crabs, squid, pelecypods, and coral (which may have been incidentally ingested). Parasites, consisting of nematodes, trematodes, and cestodes, were present in gag only from northwest Florida (Table 2).

North Carolina

Twenty-seven (31.4%) of the 86 stomachs of gag from North Carolina contained food. The fish ranged in size from 346 to 903 mm fork length (Table 1).

Fish accounted for 96.4% of the volume with Clupeidae, Carangidae, and Sparidae comprising the identifiable fish families. These fish families accounted for 45.9% of the total volume (Table 2). The most important fish prey were *S. aurita*, *D. punctatus*, and *L. rhomboides*.

Invertebrates accounted for 3.6% of the total volume and had a frequency of occurrence of 11.1%. Mollusks, consisting of nudibranchs and pelecypods, and coral comprised the invertebrates (Table 2).

South Florida

Forty-four of the 134 stomachs of gag from south Florida contained food. The fish ranged in size from 315 to 960 mm fork length (Table 1).

Fish accounted for 99.8% of the volume with Sparidae, Sciaenidae, and Haemulidae comprising the identifiable fish families. These families accounted for 39.5% of the total volume (Table 2). The most important fish prey were *L. rhomboides*, *Leiostomus xanthurus*, *Orthopristis chrysoptera*, and *Haemulon plumieri*.

Invertebrates accounted for only 0.2% of the total volume and had a frequency of occurrence of 2.3%. *Penaeus* sp. was the only invertebrate in the stomachs of gag from south Florida (Table 2).

West Central Florida

Of the 182 stomachs of gag from west central Florida, 160 contained food. The fish ranged in size from 408 to 1,203 mm fork length (Table 1).

Fish accounted for 98.6% of the volume with Clupeidae and Mugilidae being the two most dominant of the 17 identified families. These two families accounted for 54.4% of the total volume (Table 2). The most important fish prey were *S. aurita* and *Mugil* sp.

Invertebrates accounted for 1.4% of the total volume, had a frequency of occurrence of 8.8%, and consisted of assorted crustaceans, squid, and a piece of coral (Table 2).

Variation with size. Comparisons of food items were made for three sizes of gag: small (400-599 mm FL), medium (600-999 mm FL), and large (1,000-1,299 mm FL). Numbers of stomachs for each size group were 5, 95, and 60, respectively (Table 3).

Stomachs of large gag contained a greater variety of food items. Fifteen fish families were identified in large gag, six more than in medium gag. Clupeids were the major source of food for all three size groups. Mugilids were of moderate importance to medium and large gag, as were invertebrates. Ostraciids and dasyatids also were of moderate importance to large gag. Invertebrates were not found in the few samples of small gag (Table 3).

Variation with season. For seasonal comparisons, the data were divided into spring (March, April, May) and summer (June, July, August). Data were not available for fall and winter. Number of stomach samples were 51 for spring and 109 for summer (Table 4).

Noteworthy differences in the food items between the two seasons were not evident. Despite the differences in numbers of stomach samples, the numbers of fish families were about equal (12 versus 13). Of the invertebrates, stomatopods and scyllarids were absent in spring, while shrimps were absent in summer (Table 4).

Northwest Florida

Of 1,975 stomachs of gag from northwest Florida, 748 contained food and 1,227 were empty. The fish ranged in size from 261 to 1,246 mm fork length (Table 1).

Fish accounted for 95.1% of the volume with Sparidae and Carangidae being the dominant fish families and accounting for 48.8% of the total volume (Table 2). The most important fish species were *L. rhomboides* and *D. punctatus*.

Invertebrates accounted for 4.9% of the volume and had a frequency of occurrence of 11.0% (Table 2). The most important invertebrates were crabs (3.0% by volume) and squid (1.0% by volume).

Variation with size. The data were divided into the three size categories as described earlier. The numbers of samples were 153 for small, 551 for medium, and 44 for large gag (Table 3).

The greatest variety of food items was found in medium gag. This may have been the result of the exceptionally numerous samples (551) for this size group. Sample size did not account for variety of fish families in the other two size groups, as large gag (n = 44) had nine and the small gag (n = 153) had only five. However, the more numerous small gag had eaten more invertebrates than did the less numerous large gag.

Two species were especially important as food for all three sizes of gag, namely *L. rhomboides* and *D. punctatus*. Also important as food for large gag were *Pagrus pagrus*, *Centropristis ocyurus*, dasyatids, and *Chilomycterus schoepfi*. The latter three fishes consisted of larger individuals than other food items (Table 3).

Variation with season. Data for three seasons were available for northwest Florida. The numbers of samples were 244 for spring, 413 for summer, and 91 for fall (Table 4).

Variations in varieties of food items may have been a function of sample sizes, as the greatest variety was found in summer and the least in fall. *L. rhomboides* and *D. punctatus* were important food sources in all three seasons. Of the invertebrates, crustaceans, especially crabs, appeared to be important in all three seasons. Squid appeared to be important especially in the fall (Table 4).

DISCUSSION AND CONCLUSION

Data on the stomach contents of gag from four geographical areas indicate that gag are primarily piscivorous. They prey mainly on schooling fishes in the families of Clupeidae, Carangidae, Sparidae, Sciaenidae, and Mugilidae. Invertebrates consisting mostly of penaeid shrimp, squid, and numerous crab species appeared in the gag diet in west central and northwest Florida. Moe (1969) noted that the red grouper (*Epinephelus morio*) had more invertebrates than fish as they increasd in size. Randall (1967) reported that with the exception of the jewfish (*Epinephelus itajara*) the larger groupers tend to feed more on fishes than crustaceans.

The high rate of empty stomachs (58.8%) was probably caused by inversion of stomachs and regurgitation as a result of being raised from deep water. Moe (1969) also noted red grouper having a high rate of empty stomachs as a result of regurgitation. A high rate of digestion was also a major factor, as evidenced by a frequency of occurrence of

digested fish remains above 55.6% in all four areas. A high rate of empty stomachs in other grouper species was noted by Randall and Brock (1960).

In food studies where fish are caught by hook and line, the bait that was used is of concern. In northwest Florida, the two commonly used baits are D. punctatus and live L. rhomboides. If these two species were deleted (44.2% of the volume), the composition of the stomach contents would be a mixture of numerous species of fish, crabs, shrimp, and squid with no dominant prey species. The commonly used baits in North Carolina, south Florida, and west central Florida vary by individual fishermen in each area.

In west central Florida, four gag had eaten stomachs of other fish. The consumed stomachs apparently had been cut from the remaining entrails as no other portions of the viscera had been eaten. These stomachs may have been used as bait by fishermen. Three gags had eaten one stomach each, while the fourth had eaten four stomachs. In the former, two of the consumed stomachs were empty, while one contained a squid and a Sardinella aurita. In the lattter, two of the consumed stomachs were empty and two contained one S. aurita each.

Analyses of stomach contents by size and season showed relatively minor differences. The major source of variation in food was attributed to area.

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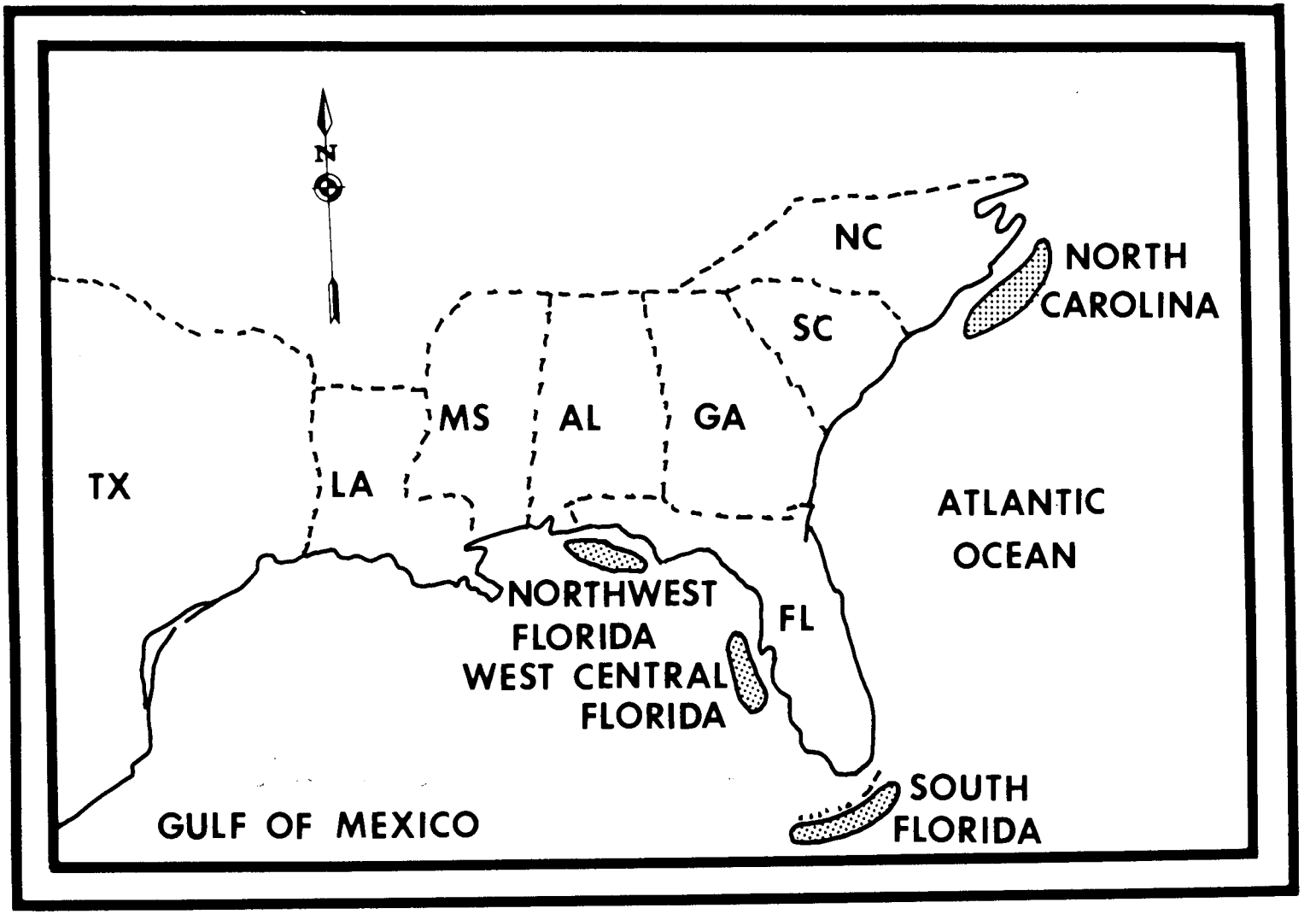

Figure 1. Sampling areas for gag food study during 1979-81.

Table 1. Summary of stomach samples of gag.

Length Group mm	North Carolina		South Florida		West Central Florida		Northwest Florida		Areas Combined	
	With food	Total	With food	Total	With food	Total	With food	Total	With food	Total
200-299	0	0	0	0	0	0	4	9	4	9
300-399	2	5	12	31	0	0	46	106	60	142
400-499	1	12	21	47	4	5	18	62	44	126
500-599	3	9	7	24	1	1	85	227	96	261
600-699	4	13	1	8	15	16	136	366	156	403
700-799	7	16	1	6	27	31	200	476	235	529
800-899	10	30	2	14	26	29	153	406	191	479
900-999	0	1	0	4	27	31	62	200	89	236
1000-1099	0	0	0	0	51	60	32	97	83	157
1100-1199	0	0	0	0	8	8	10	24	18	32
1200-1299	0	0	0	0	1	1	2	2	3	3
Total	27	86	44	134	160	182	748	1975	979	2377
% Empty	68.6		67.2		12.1		62.1		58.8	

Table 2. Food of gag from four areas.

Food Item	Percent frequency of occurrence				Percent volume			
	North Carolina	South Florida	West central Florida	Northwest Florida	North Carolina	South Florida	West central Florida	Northwest Florida
Vertebrates (fish)	96.3	100	100	92.5	96.4	99.8	98.6	95.1
CLUPEIDAE	22.2	0	47.5	1.1	20.6	0	43.1	1.3
Sardinella aurita	22.2	0	46.2	0.8	20.6	0	39.9	0.9
Brevoortia patronus	0	0	1.2	0	0	0	3.2	0
SPARIDAE	3.7	4.5	1.9	14.3	7.9	21.3	1.8	39.2
Lagodon rhomboides	3.7	4.5	1.2	13.6	7.9	21.3	0.9	34.6
Calamus bajonado	0	0	0.6	0	0	0	0.9	0
Calamus arctifrons	0	0	0	0.1	0	0	0	1.0
Calamus sp.	0	0	0	0.1	0	0	0	1.4
Pagrus pagrus	0	0	0	0.4	0	0	0	2.2
CARANGIDAE	18.5	0	2.5	9.8	17.4	0	1.8	9.6
Decapterus punctatus	14.8	0	2.5	9.5	13.5	0	1.8	9.6
SCIAENIDAE	3.7	4.5	0	0.1	6.9	12.5	0	0.3
Leiostomus xanthurus	0	2.3	0	0	0	9.5	0	0
MUGILIDAE	3.7	0	6.9	0	3.4	0	11.3	0
Mugil cephalus	0	0	1.2	0	0	0	3.0	0

Table 2. (cont.)

Food Item	Percent frequency of occurrence				Percent volume			
	North Carolina	South Florida	West central Florida	Northwest Florida	North Carolina	South Florida	West central Florida	Northwest Florida
Mugil sp.	0	0	5.6	0	0	0	8.3	0
OPHICHTHIDAE	0	0	2.5	1.2	0	0	1.0	1.2
Myrophis punctatus	0	0	0	0.1	0	0	0	0
Ophichthus gomesi	0	0	0	0.3	0	0	0	0.5
Echiophis intertinctus	0	0	0.6	0	0	0	0.2	0
SCORPAENIDAE	0	0	0.6	0.3	0	0	0.4	1.0
Neomerinthe hemingwayi	0	0	0	0.1	0	0	0	0.5
Scorpaena sp.	0	0	0.6	0.1	0	0	0.4	0.5
HAEMULIDAE	0	6.8	0	0.4	0	5.7	0	1.9
Orthopristis chrysoptera	0	2.3	0	0.1	0	2.6	0	1.1
Haemulon aurolineatum	0	0	0	0.3	0	0	0	0.9
Haemulon plumieri	0	2.3	0	0	0	2.5	0	0
SYNODONTIDAE	0	0	1.9	0.5	0	0	0.9	1.6
Synodus foetens	0	0	0.6	0.1	0	0	0.4	0.5
Synodus sp.	0	0	0	0.1	0	0	0	0.3
Trachinocephalus myops	0	0	0.6	0.1	0	0	0.4	0.9

Table 2. (cont.)

Food Item	Percent frequency of occurrence				Percent volume			
	North Carolina	South Florida	West central Florida	Northwest Florida	North Carolina	South Florida	West central Florida	Northwest Florida
TRIGLIDAE	0	0	1.9	0.4	0	0	0.9	1.3
Prionotus sp.	0	0	1.9	0.3	0	0	0.9	1.1
SERRANIDAE	0	0	1.2	0.4	0	0	1.0	1.2
Mycteroperca sp.	0	0	0.6	0	0	0	0.6	0
Centropristis ocyurus	0	0	0	0.3	0	0	0	1.0
Centropristis sp.	0	0	0	0.1	0	0	0	0.2
Diplectrum bivittatum	0	0	0.6	0	0	0	0.3	0
LUTJANIDAE	0	0	0.6	0.5	0	0	0.5	1.9
Rhomboplites aurorubens	0	0	0.6	0.3	0	0	0.5	1.4
Lutjanus griseus	0	0	0	0.3	0	0	0	0.5
OSTRACIIDAE	0	0	3.1	0.1	0	0	2.8	0
Lactophrys quadricornis	0	0	0.6	0	0	0	1.5	0
Lactophrys sp.	0	0	1.9	0	0	0	1.0	0
NETTASTOMATIDAE	0	0	0	0.7	0	0	0	0.7
Hoplunnis macrurus	0	0	0	0.5	0	0	0	0.6
OPISTOGNATHIDAE(*Opistognathus lonchurus*)	0	0	0	0.1	0	0	0	0

Table 2. (cont.)

Food Item	Percent frequency of occurrence				Percent volume			
	North Carolina	South Florida	West central Florida	Northwest Florida	North Carolina	South Florida	West central Florida	Northwest Florida
ENGRAULIDAE (*Anchoa* sp.)	0	0	0	0.1	0	0	0	0
DASYATIDAE	0	0	0.6	0.1	0	0	3.2	3.3
RAJIDAE	0	0	0.6	0.1	0	0	0.3	0.4
CHAETODONTIDAE	0	0	0.6	0	0	0	0.3	0
SCOMBRIDAE	0	0	0.6	0	0	0	1.1	0
BOTHIDAE	0	0	0	0.3	0	0	0	0.7
POMATOMIDAE (*Pomatomus saltatrix*)	0	0	0	0.3	0	0	0	0.7
BALISTIDAE (*Monacanthus ciliatus*)	0	0	0.6	0	0	0	0.1	0
POMACENTRIDAE	0	0	0.6	0	0	0	0.1	0
DIODONTIDAE (*Chilomycterus schoepfi*)	0	0	0	0.4	0	0	0	2.8
Digested fish remains	55.6	88.6	73.8	72.0	40.2	60.3	24.7	26.2
Fish stomachs	0	0	2.5	0	0	0	3.0	0
Invertebrates	11.1	2.3	8.8	11.0	3.6	0.2	1.4	4.9
CRUSTACEA	0	2.3	5.6	7.5	0	0.2	1.2	3.5
Shrimp	0	2.3	0.6	0.8	0	0.2	0	0.1
Penaeus sp.	0	2.3	0	0.3	0	0.2	0	0

Table 2. (cont.)

Food Item	Percent frequency of occurrence				Percent volume			
	North Carolina	South Florida	West central Florida	Northwest Florida	North Carolina	South Florida	West central Florida	Northwest Florida
Penaeus aztecus	0	0	0	0.1	0	0	0	0
Trachypenaeus similis	0	0	0	0.1	0	0	0	0
Sicyonia brevirostris	0	0	0	0.1	0	0	0	0
Sicyonia sp.	0	0	0.6	0.1	0	0	0	0
Crab	0	0	3.1	6.3	0	0	1.0	3.0
Portunus sp.	0	0	0	1.9	0	0	0	0.5
Portunus spinimanus	0	0	0	0.5	0	0	0	0.2
Portunus gibbesii	0	0	1.9	2.5	0	0	0.2	1.1
Callinectes similis	0	0	0	0.1	0	0	0	0.1
Arenaeus cribrarius	0	0	0	0.1	0	0	0	0.1
Ovalipes ocellatus	0	0	0	0.1	0	0	0	0
Ovalipes guadulpensis	0	0	0	0.3	0	0	0	0.5
XANTHIDAE	0	0	0	0.1	0	0	0	0
Menippe mercenaria	0	0	0	0.1	0	0	0	0
Hepatus epheliticus	0	0	0	0.1	0	0	0	0.1
Calappa flammea	0	0	1.2	0.3	0	0	0.8	0.4

Table 2. (cont.)

Food Item	Percent frequency of occurrence				Percent volume			
	North Carolina	South Florida	West central Florida	Northwest Florida	North Carolina	South Florida	West central Florida	Northwest Florida
STOMATOPODA	0	0	0.6	0.3	0	0	0.1	0.4
Lysiosquilla acabricauda	0	0	0.6	0.1	0	0	0.1	0.1
Lysiosquilla campechiensis	0	0	0	0.1	0	0	0	0.3
Lobster (SCYLLARIDAE)	0	0	1.2	0	0	0	0	0
Isopoda	0	0	0	0.1	0	0	0	0
MOLLUSCA	7.4	0	1.9	2.5	3.6	0	0.2	1.1
Squid	0	0	1.2	2.0	0	0	0.1	1.0
Loligo pealeii	0	0	0	0.3	0	0	0	0.5
Lolliguncula brevis	0	0	0.6	0	0	0	0.1	0
Octopus	0	0	0	0.3	0	0	0	0
Nudibranchia	3.7	0	0	0	3.0	0	0	0
Pelecypoda	3.7	0	0	0.3	0.6	0	0	0.1
Siliqua sp.	3.7	0	0	0	0.6	0	0	0
Dinocardium robustum	0	0	0	0.1	0	0	0	0
Macrocallista maculata	0	0	0	0.1	0	0	0	0.1
POLYCHAETA	0	0	0	0.3	0	0	0	0

Table 2. (cont.)

Food Item	Percent frequency of occurrence				Percent volume			
	North Carolina	South Florida	West central Florida	Northwest Florida	North Carolina	South Florida	West central Florida	Northwest Florida
NEMERTINA	0	0	0	0.1	0	0	0	0
ECHINODERMATA	0	0	0	0.1	0	0	0	0
Sea urchin	0	0	0	0.1	0	0	0	0
Hard coral	3.7	0	1.2	0.8	0	0	0	0.2
Helminths	0	0	0	1.1	0	0	0	0
Nematoda	0	0	0	0.1	0	0	0	0
Trematoda	0	0	0	0.7	0	0	0	0
Cestoda	0	0	0	0.3	0	0	0	0

Table 3. Frequency of occurrence and volume of food in small, medium, and large gag from west central Florida and northwest Florida. Numbers in parentheses following size indicate sample size.

Food Item	WEST CENTRAL FLORIDA					
	SMALL (5) (400-599 mm FL)		MEDIUM (95) (600-999 mm FL)		LARGE (60) (1,000-1,299 mm FL)	
	% Occurrence	% Volume	% Occurrence	% Volume	% Occurrence	% Volume
Vertebrates (fish)	100	100	100	99.2	100	97.9
CLUPEIDAE	16.7	62.8	46.3	43.9	51.7	42.2
Sardinella aurita	16.7	62.8	44.2	37.3	51.7	42.2
Brevoortia patronus	0	0	2.1	6.5	0	0
SPARIDAE	0	0	1.0	0.8	3.3	2.8
Lagodon rhomboides	0	0	1.0	0.8	1.7	1.0
Calamus bajonado	0	0	0	0	1.7	1.8
CARANGIDAE	0	0	2.1	0.4	3.3	3.1
Decapterus punctatus	0	0	2.1	0.4	3.3	3.1
MUGILIDAE	0	0	8.4	18.1	5.0	4.7
Mugil cephalus	0	0	1.0	5.4	1.7	0.8
Mugil sp.	0	0	7.4	12.8	3.3	3.9
OPHICHTHIDAE	0	0	3.2	1.1	1.7	1.0
Echiophis intertinctus	0	0	1.0	0.4	0	0
SCORPAENIDAE	0	0	0	0	1.7	0.9

Table 3. (cont.)

Food Item	WEST CENTRAL FLORIDA					
	SMALL (5) (400-599 mm FL)		MEDIUM (95) (600-999 mm FL)		LARGE (60) (1,000-1,299 mm FL)	
	% Occurrence	% Volume	% Occurrence	% Volume	% Occurrence	% Volume
Scorpaena sp.	0	0	0	0	1.7	0.9
SYNODONTIDAE	0	0	2.1	1.6	1.7	0.3
Synodus foetens	0	0	1.0	0.8	0	0
Trachinocephalus myops	0	0	1.0	0.7	0	0
TRIGLIDAE	0	0	2.1	1.6	1.7	0.2
Prionotus sp.	0	0	2.1	1.6	1.7	0.2
SERRANIDAE	0	0	0	0	3.3	2.0
Mycteroperca sp.	0	0	0	0	1.7	1.3
Diplectrum bivittatum	0	0	0	0	1.7	0.7
LUTJANIDAE	0	0	0	0	1.7	1.0
Rhomboplites aurorubens	0	0	0	0	1.7	1.0
OSTRACIIDAE	0	0	0	0	8.3	5.6
Lactophrys quadricornis	0	0	0	0	1.7	3.0
Lactophrys sp.	0	0	0	0	5.0	2.0
DASYATIDAE	0	0	0	0	1.7	6.4
RAJIDAE	0	0	0	(	1.7	0.6

Table 3. (cont.)

Food Item	WEST CENTRAL FLORIDA					
	SMALL (5) (400-599 mm FL)		MEDIUM (95) (600-999 mm FL)		LARGE (60) (1,000-1,299 mm FL)	
	% Occurrence	% Volume	% Occurrence	% Volume	% Occurrence	% Volume
CHAETODONTIDAE	0	0	1.0	0.7	0	0
SCOMBRIDAE	0	0	1.0	2.3	0	0
BALISTIDAE(*Monacanthus ciliatus*)	0	0	0	0	1.7	0.2
POMACENTRIDAE	0	0	0	0	1.7	0.2
Digested fish remains	83.3	37.2	79.0	23.8	63.3	25.5
Fish stomachs	0	0	3.2	5.1	1.7	1.1
Invertebrates	0	0	8.4	0.8	13.3	2.1
Crustacea	0	0	7.4	0.5	8.3	1.9
Shrimp	0	0	1.0	0.1	0	0
Sicyonia sp.	0	0	1.0	0.1	0	0
Crab	0	0	3.2	0.1	6.7	1.9
Portunus gibbesii	0	0	3.2	0.1	3.3	0.3
Calappa flammea	0	0	0	0	3.3	1.6
Stomatopoda	0	0	1.0	0.3	0	0
Lysiosquilla scabricauda	0	0	1.0	0.3	0	0
Lobster (SCYLLARIDAE)	0	0	1.0	0	1.7	0

Table 3. (cont.)

Food Item	WEST CENTRAL FLORIDA					
	SMALL (5) (400-599 mm FL)		MEDIUM (95) (600-999 mm FL)		LARGE (60) (1,000-1,299 mm FL)	
	% Occurrence	% Volume	% Occurrence	% Volume	% Occurrence	% Volume
Mollusca	0	0	2.1	0.3	1.7	0.1
Squid	0	0	2.1	0.3	1.7	0.1
Lolliguncula brevis	0	0	1.0	0.2	0	0
Hard coral	0	0	0	0	3.3	0.1

Table 3. (cont.)

Food Item	NORTHWEST FLORIDA					
	SMALL (153) (200-599 mm FL)		MEDIUM (551) (600-999 mm FL)		LARGE (44) (1,000-1,299 mm FL)	
	% Occurrence	% Volume	% Occurrence	% Volume	% Occurrence	% Volume
Vertebrates (fish)	82.4	92.6	94.0	94.9	90.9	97.5
CLUPEIDAE	1.3	1.9	0.9	1.4	2.3	0.7
Sardinella aurita	1.3	1.9	0.5	0.8	2.3	0.7
SPARIDAE	5.9	20.2	17.1	44.5	13.6	21.2
Lagodon rhomboides	5.9	20.2	16.3	40.0	11.4	12.9
Calamus arctifrons	0	0	0.2	1.3	0	0
Calamus sp.	0	0	0.2	1.8	0	0
Pagrus pagrus	0	0	0.4	1.3	2.3	8.4
CARANGIDAE	9.2	22.6	10.3	9.4	4.6	3.5
Decapterus punctatus	9.2	22.6	10.0	9.3	4.6	3.5
SCIAENIDAE	0	0	0.2	0.4	0	0
OPHICHTHIDAE	0.6	0.2	1.4	1.5	2.3	0.6
Myrophis punctatus	0	0	0.2	0	0	0
Ophichthus gomesi	0.6	0.2	0.2	0.6	0	0
SCORPAENIDAE	0	0	0.4	1.2	0	0
Neomerinthe hemingwayi	0	0	0.2	0.6	0	0

Table 3. (cont.)

Food Item	NORTHWEST FLORIDA					
	SMALL (153) (200-599 mm FL)		MEDIUM (551) (600-999 mm FL)		LARGE (44) (1,000-1,299 mm FL)	
	% Occurrence	% Volume	% Occurrence	% Volume	% Occurrence	% Volume
Scorpaena sp.	0	0	0.2	0.6	0	0
HAEMULIDAE	0	0	0.5	2.5	0	0
Orthopristis chrysoptera	0	0	0.2	1.4	0	0
Haemulon aurolineatum	0	0	0.4	1.1	0	0
SYNODONTIDAE	0	0	0.7	2.1	0	0
Synodus foetens	0	0	0.2	0.6	0	0
Synodus sp.	0	0	0.2	0.4	0	0
Trachinocephalus myops	0	0	0.2	1.1	0	0
TRIGLIDAE	0	0	0.5	1.7	0	0
Prionotus sp.	0	0	0.4	1.4	0	0
SERRANIDAE	0.6	2.1	0	0	4.6	7.4
Centropristis ocyurus	0	0	0	0	4.6	7.4
Centropristis sp.	0.6	2.1	0	0	0	0
LUTJANIDAE	0	0	0.5	1.7	2.3	4.5
Rhomboplites aurorubens	0	0	0.2	1.0	2.3	4.5
Lutjanus griseus	0	0	0.4	0.7	0	0

Table 3. (cont.)

Food Item	NORTHWEST FLORIDA					
	SMALL (153) (200-599 mm FL)		MEDIUM (551) (600-999 mm FL)		LARGE (44) (1,000-1,299 mm FL)	
	% Occurrence	% Volume	% Occurrence	% Volume	% Occurrence	% Volume
OSTRACIIDAE	0	0	0.2	0.1	0	0
NETTASTOMATIDAE	0	0	0.5	0.5	2.3	1.8
Hoplunnis macrurus	0	0	0.5	0.5	2.3	1.8
OPISTOGNATHIDAE	0	0	0.2	0.1	0	0
Opistognathus lonchurus	0	0	0.2	0.1	0	0
ENGRAULIDAE	0	0	0.2	0	0	0
Anchoa sp.	0	0	0.2	0	0	0
DASYATIDAE	0	0	0	0	2.3	23.4
RAJIDAE	0	0	0.2	0.5	0	0
BOTHIDAE	0	0	0.4	0.9	0	0
POMATOMIDAE	0	0	0.2	0.2	0	0
Pomatomus saltatrix	0	0	0.2	0.2	0	0
DIODONTIDAE	0	0	0.2	1.0	4.6	14.4
Chilomycterus schoepfi	0	0	0.2	1.0	4.6	14.4
Digested fish remains	78.4	45.6	70.4	25.2	65.9	20.0

Table 3. (cont.)

Food Item	NORTHWEST FLORIDA					
	SMALL (153) (200-599 mm FL)		MEDIUM (551) (600-999 mm FL)		LARGE (44) (1,000-1,299 mm FL)	
	% Occurrence	% Volume	% Occurrence	% Volume	% Occurrence	% Volume
Invertebrates	13.7	7.4	10.5	5.1	11.4	2.5
Crustacea	11.1	6.2	7.3	0.4	6.8	2.2
Shrimp	0.6	0.2	1.4	0.1	2.3	0.1
Penaeus sp.	0	0	0.2	0	2.3	0.1
Penaeus aztecus	0	0	0.2	0	0	0
Trachypenaeus similis	0	0	0.2	0	0	0
Sicyonia brevirostris	0.6	0.2	0	0	0	0
Sicyonia sp.	0	0	0.2	0	0	0
Crab	10.5	6.0	5.3	2.9	4.6	2.1
Portunus sp.	4.6	1.2	0.9	0.3	2.3	0.8
Portunus spinimanus	0	0	0.7	0.2	0	0
Portunus gibbesii	2.6	2.7	2.5	1.0	2.3	1.3
Callinectes similis	0.6	0.8	0	0	0	0
Arenaeus cribrarius	0.6	1.0	0	0	0	0
Ovalipes ocellatus	0.6	0.3	0	0	0	0
Ovalipes guadulpensis	0	0	0.4	0.7	0	0

Table 3. (cont.)

Food Item	NORTHWEST FLORIDA					
	SMALL (153) (200-599 mm FL)		MEDIUM (551) (600-999 mm FL)		LARGE (44) (1,000-1,299 mm FL)	
	% Occurrence	% Volume	% Occurrence	% Volume	% Occurrence	% Volume
XANTHIDAE	0.6	0	0.2	0	0	0
Menippe mercenaria	0.6	0	0	0	0	0
Hepatus epheliticus	0	0	0.2	0.2	0	0
Calappa flammea	0	0	0.4	0.5	0	0
STOMATOPODA	0	0	0.4	0.5	0	0
Lysiosquilla scabricauda	0	0	0	0	0	0
Lysiosquilla campechiensis	0	0	0.4	0.5	0	0
ISOPODA	0	0	0.2	0	0	0
MOLLUSCA	2.0	0.8	3.3	2.0	0	0
Squid	2.0	0.8	2.2	1.3	0	0
Loligo pealeii	0	0	0.4	0.7	0	0
Octopus	0	0	0.4	0	0	0
Pelecypoda	0	0	0.4	0.1	0	0
Dinocardium robustum	0	0	0.4	0.1	0	0
Macrocallista maculata	0	0	0	0	0	0
POLYCHAETA	0	0	0.4	0	0	0

Table 3. (cont.)

Food Item	NORTHWEST FLORIDA					
	SMALL (153) (200-599 mm FL)		MEDIUM (551) (600-999 mm FL)		LARGE (44) (1,000-1,299 mm FL)	
	% Occurrence	% Volume	% Occurrence	% Volume	% Occurrence	% Volume
NEMERTINEA	0	0	0.2	0	0	0
ECHINODERMATA	0.6	0.1	0	0	0	0
Sea urchins	0.6	0.1	0	0	0	0
Hard coral	0.6	0.4	0.5	0.2	4.6	0.3

Table 4. Frequency of occurrence and volume of food in gag caught during the spring, summer, and fall from west central Florida and northwest Florida. Numbers in parentheses following seasons indicate sample sizes.

Food Item	WEST CENTRAL FLORIDA			
	SPRING (51) (March-April-May)		SUMMER (109) (June-July-August)	
	% Occurrence	% Volume	% Occurrence	% Volume
Vertebrates (fish)	100	99.1	100	98.2
CLUPEIDAE	54.9	57.1	44.0	34.3
Sardinella aurita	51.0	48.8	44.0	34.3
Brevoortia patronus	3.9	8.3	0	0
SPARIDAE	3.9	3.2	0.9	0.8
Lagodon rhomboides	2.0	1.0	0.9	0.8
Calamus bajonado	2.0	2.3	0	0
CARANGIDAE	3.9	0.8	1.8	2.4
Decapterus punctatus	3.9	0.8	1.8	2.4
MUGILIDAE	2.0	6.8	9.2	14.2
Mugil cephalus	2.0	6.8	8.3	13.5
Mugil sp.	0	0	0.9	0.6
OPHICHTHIDAE	5.9	1.4	0.9	0.8
Echiophis intertinctus	2.0	0.5	0	0
SCORPAENIDAE	2.0	1.2	0	0
Scorpaena sp.	2.0	1.2	0	0

Table 4. (cont.)

Food Item	WEST CENTRAL FLORIDA			
	SPRING (51) (March-April-May)		SUMMER (109) (June-July-August)	
	% Occurrence	% Volume	% Occurrence	% Volume
SYNODONTIDAE	2.0	1.1	1.8	0.8
Synodus foetens	2.0	1.1	0	0
Trachinocephalus myops	0	0	0.9	0.6
TRIGLIDAE	3.9	2.0	0.9	0.2
Prionotus sp.	3.9	2.0	0.9	0.2
SERRANIDAE	3.9	2.5	0	0
Mycteroperca sp.	2.0	1.6	0	0
Diplectrum bivittatum	2.0	0.9	0	0
LUTJANIDAE	0	0	0.9	0.8
Rhomboplites aurorubens	0	0	0.9	0.8
OSTRACIIDAE	5.9	5.4	1.8	1.1
Lactophrys quadricornis	2.0	3.9	0	0
Lactophrys sp.	2.0	0.8	1.8	1.1
DASYATIDAE	0	0	0.9	5.2
RAJIDAE	0	0	0.9	0.5
CHAETODONTIDAE	0	0	0.9	0.6

Table 4. (cont.)

Food Item	WEST CENTRAL FLORIDA			
	SPRING (51) (March-April-May)		SUMMER (109) (June-July-August)	
	% Occurrence	% Volume	% Occurrence	% Volume
SCOMBRIDAE	0	0	0.9	1.9
BALISTIDAE	2.0	0.3	0	0
Monacanthus ciliatus	2.0	0.3	0	0
POMACENTRIDAE	2.0	0.3	0	0
Digested fish remains	72.6	17.0	73.4	29.6
Fish stomachs	0	0	3.7	5.0
Invertebrates	5.9	0.9	9.2	1.8
CRUSTACEA	3.9	0.4	5.5	1.6
Shrimp	2.0	0.1	0	0
Sicyonia sp.	2.0	0.1	0	0
Crab	2.0	0.6	2.8	1.3
Portunus gibbesii	2.0	0.2	1.8	0.2
Calappa flammea	2.0	0.3	0.9	1.1
STOMATOPOA	0	0	0.9	0.2
Lysiosquilla scabricauda	0	0	0.9	0.2
LOBSTER	0	0	1.8	0.1

Table 4. (cont.)

Food Item	WEST CENTRAL FLORIDA			
	SPRING (51) (March-April-May)		SUMMER (109) (June-July-August)	
	% Occurrence	% Volume	% Occurrence	% Volume
Scyllaridae	0	0	1.8	0.1
MOLLUSCA	2.0	0.3	1.8	0.2
Squid	2.0	0.3	1.8	0.2
Lolliguncula brevis	2.0	0.3	0	0
Hard Coral	0	0	1.8	0.1

Table 4. (cont.)

Food Item	NORTHWEST FLORIDA					
	SPRING (244) (March-April-May)		SUMMER (413) (June-July-August)		FALL (91) (September-October-November)	
	% Occurrence	% Volume	% Occurrence	% Volume	% Occurrence	% Volume
Vertebrates (fish)	95.5	96.6	91.5	94.4	90.1	91.9
CLUPEIDAE	0.8	1.2	1.0	1.4	2.2	1.1
Sardinella aurita	0.4	0.2	1.0	1...4	1.1	0.8
SPARIDAE	21.7	48.1	10.6	28.1	12.1	64.6
Lagodon rhomboides	20.5	43.9	10.2	25.1	11.0	47.4
Calamus arctifrons	0	0	0.2	2.0	0	0
Calamus sp.	0	0	0	0	1.1	17.1
Pagrus pagrus	1.2	4.2	0.2	0.9	0	0
CARANGIDAE	9.0	7.4	10.9	11.9	6.6	6.4
Decapterus punctatus	9.0	74	10.4	11.8	6.6	6.4
SCIAENIDAE	0	0	0	0	1.1	3.7
OPHICHTHIDAE	0.8	1.5	1.4	1.2	1.1	0.2
Myrophis punctatus	0	0	0.2	0.1	0	0
Ophichthus gomesi	0.4	1.2	0	0	1.1	0.2
SCORPAENIDAE	0.4	1.2	0.2	1.0	0	0
Neomerinthe hemingwayi	0.4	1.2	0	0	0	0

Table 4. (cont.)

Food Item	NORTHWEST FLORIDA					
	SPRING (244) (March-April-May)		SUMMER (413) (June-July-August)		FALL (91) (September-October-November)	
	% Occurrence	% Volume	% Occurrence	% Volume	% Occurrence	% Volume
Scorpaena sp.	0	0	0.2	1.0	0	0
HAEMULIDAE	0	0	1.0	3.8	0	0
Orthopristis chrysoptera	0	0	0.5	2.1	0	0
Haemulon aurolineatum	0	0	0.5	1.7	0	0
SYNODONTIDAE	0.4	0	0.7	3.2	0	0
Synodus foetens	0	0	0.2	0.9	0	0
Synodus sp.	0	0	0.2	0.6	0	0
Trachinocephalus myops	0	0	0.2	1.7	0	0
TRIGLIDAE	0	0	0.7	2.6	0	0
Prionotus sp.	0	0	0.5	2.2	0	0
SERRANIDAE	0.8	2.6	0.2	0.3	0	0
Centropristis ocyurus	0.8	2.6	0	0	0	0
Centropristis sp.	0	0	0.2	0.3	0	0
LUTJANIDAE	0.8	3.1	0.5	1.4	0	0
Rhomboplites aurorubens	0.4	1.9	0.2	1.2	0	0
Lutjanus griseus	0.4	1.2	0.2	0.1	0	0

Table 4. (cont.)

Food Item	NORTHWEST FLORIDA					
	SPRING (244) (March-April-May)		SUMMER (413) (June-July-August)		FALL (91) (September-October-November)	
	% Occurrence	% Volume	% Occurrence	% Volume	% Occurrence	% Volume
OSTRACIIDAE	0.4	0.1	0	0	0	0
NETTASTOMATIDAE	0.8	0.8	0.7	0.7	0	0
Hoplunnis macrurus	0.8	0.8	0.5	0.6	0	0
OPISTOGNATHIDAE	0.4	0.1	0	0	0	0
Opistognathus lonchurus	0.4	0.1	0	0	0	0
ENGRAULIDAE	0.4	0	0	0	0	0
Anchoa sp.	0.4	0	0	0	0	0
DASYATIDAE	0.4	8.2	0	0	0	0
RAJIDAE	0.4	1.0	0	0	0	0
BOTHIDAE	0	0	0.5	1.4	0	0
POMATOMIDAE	0	0	0.2	0.4	0	0
Pomatomus saltatrix	0	0	0.2	0.4	0	0
DIODONTIDAE	0	0	0.7	5.5	0	0
Chilomycterus schoepfi	0	0	0.7	5.5	0	0
Digested fish remains	69.7	21.3	73.4	31.7	72.5	15.8

Table 4. (cont.)

Food Item	NORTHWEST FLORIDA					
	SPRING (244) (March-April-May)		SUMMER (413) (June-July-August)		FALL (91) (September-October-November)	
	% Occurrence	% Volume	% Occurrence	% Volume	% Occurrence	% Volume
Invertebrates	7.8	3.4	13.6	5.6	13.2	8.1
CRUSTACEA	5.7	2.8	9.2	4.4	6.6	1.7
Shrimp	0.8	0.1	1.0	0.1	0	0
Penaeus sp.	0	0	0.5	0	0	0
Penaeus aztecus	0.4	0.1	0	0	0	0
Trachypenaeus similis	0	0	0.2	0	0	0
Sicyonia brevirostris	0.4	0.1	0	0	0	0
Sicyonia sp.	0	0	0.2	0.1	0	0
Crab	4.5	2.4	7.8	3.8	6.6	1.7
Portunus sp.	1.2	0.4	1.9	0.6	3.3	0.8
Portunus spinimanus	0	0	1.0	0.4	0	0
Portunus gibbesii	1.2	0.2	3.9	2.0	2.2	0.9
Callinectes similis	0.4	0.2	0	0	0	0
Arenaeus cribrarius	0	0	0.2	0.2	0	0
Ovalipes ocellatus	0.4	0.1	0	0	0	0
Ovalipes guadulpensis	0.8	1.4	0	0	0	0

Table 4. (cont.)

Food Item	NORTHWEST FLORIDA					
	SPRING (244) (March-April-May)		SUMMER (413) (June-July-August)		FALL (91) (September-October-November)	
	% Occurrence	% Volume	% Occurrence	% Volume	% Occurrence	% Volume
XANTHIDAE	0	0	0	0	1.1	0.1
Menippe mercenaria	0	0	0.2	0	0	0
Hepatus epheliticus	0.4	0.3	0	0	0	0
Calappa flammea	0	0	0.5	0.8	0	0
STOMATOPODA	0.4	0.4	0.2	0.5	0	0
Lysiosquilla scabricauda	0.4	0.4	0	0	0	0
Lysiosquilla campechiensis	0	0	0.2	0.5	0	0
ISOPODA	0	0	0.2	0	0	0
MOLLUSCA	0.8	0.3	2.9	0.9	5.5	6.3
Squid	0.8	0.3	2.2	0.8	4.4	6.2
Loligo pealeii	0	0	0	0	2.2	6.1
Octopus	0	0	0.2	0	1.1	0.1
Pelecypoda	0	0	0.5	0.2	0	0
Dinocardium robustum	0	0	0.2	0	0	0
Macrocallista maculata	0	0	0.2	0.1	0	0
POLYCHAETA	0	0	0.5	0	0	0

Table 4. (cont.)

Food Item	NORTHWEST FLORIDA					
	SPRING (244) (March-April-May)		SUMMER (413) (June-July-August)		FALL (91) (September-October-November)	
	% Occurrence	% Volume	% Occurrence	% Volume	% Occurrence	% Volume
NEMERTINEA	0	0	0.2	0	0	0
ECHINODERMATA	0	0	0	0	1.1	0.1
Sea urchins	0	0	0	0	1.1	0.1
Hard coral	1.2	0.3	0.7	0.2	0	0