THE FOOD HABITS OF SIXTEEN SPECIES OF FISH COLLECTED IN THE REGION OF THE ARGO MERCHANT OIL SPILL

by

Richard W. Langton and Ray E. Bowman
Northeast Fisheries Center
Woods Hole, Massachusetts 02543

Northeast Fisheries Center
Woods Hole, Massachusetts 02543
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ABSTRACT

The impact of the ARGO MERCHANT oil spill on the food habits of 16 species of fish was assessed. The major food items differed little from data previously collected on the food habits of the same fish species. Of the 305 fish examined an oil like material was found in the stomachs of 3% of the Atlantic cod and 1.5% of the little skate. Since 1963 more than 38,000 stomachs, representing 82 species of fish, have been analyzed at the Northeast Fisheries Center. No oil like materials have previously been identified in the stomach contents.

INTRODUCTION

Following the ARGO MERCHANT oil spill (December, 1976) two cruises were organized by the Northeast Fisheries Center to assess the potential impact of the oil on the fish stocks in the Southern New England and Georges Bank region. The purpose of this report is to describe the feeding habits of various species of fish caught in and around the oil slick area.

METHODS

Stomachs were collected from fish caught with an otter trawl during the DELAWARE II cruises 76-13 and 77-01 (Figure 1, Tables 1 and 2). The fish stomachs were excised aboard the ship, labelled according to species, length, and station, and preserved in 10% Formalin[1]. A total of 305 stomachs were collected from 16 different species of fish.

At the laboratory of the Northeast Fisheries Center, NMFS, Woods Hole, Massachusetts, the preserved stomachs were opened and the contents washed onto a 0.25 mm mesh screen. The various food organisms were manually sorted, identified to the lowest taxa possible (using a dissecting microscope when necessary) and damp dried on bibulous paper. Each taxonomically distinct group was weighed to the nearest 0.01 g on a Mettler balance, model P1210, immediately after being dried. Parasites in the stomach were included as part of the stomach contents. Food items of little dietary significance or which were unidentifiable because of the degree of digestion were classified as miscellaneous.

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[1]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

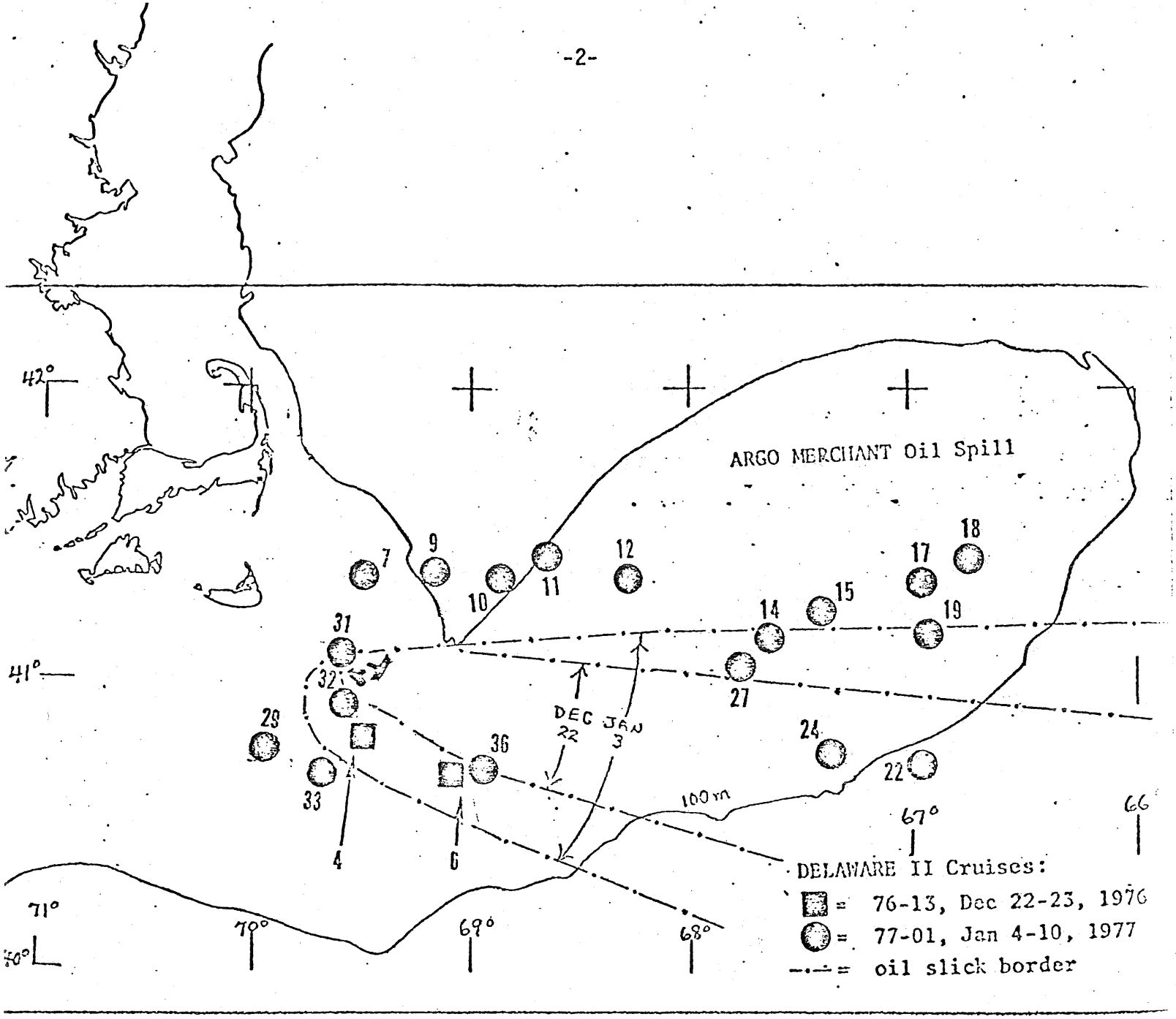

Figure 1. Stations where fish were collected for food habits analysis following the ARGO MERCHANT oil spill. An oil like material was found in the stomach of cod collected at station 29 and little skate collected at station 36.

Table 1. Station data for DELAWARE II cruises 76-13 and 77-01 where fish were collected for food habits analysis.

Station	Date			Time (EST)	Latitude	Longitude	Depth[1] (M)	Wind		Wave hgt (ft)	Air temp. (°C)	Surf.temp.[1] (°C)	Bot temp.[1] (°C)
	Day	Month	Year					Dir	Sp				
4	22	12	76	2380	40°49'	69°30'	44	24	18	6	4.4	5.7	5.7
6	23	12	76	0317	40°43'	69°05'	84	24	15	4	6.7	6.7	6.8
7	5	01	77	0835	41°22'	69°30'	32	36	24	5	2.8	4.7	4.7
9	5	01	77	1330	41°23'	69°10'	144	36	15	5	3.9	6.6	7.1
10	5	01	77	1608	41°22'	68°51'	126	36	14	4	4.4	6.7	7.1
11	5	01	77	1800	41°27'	68°39'	96	33	8	4	3.3	6.6	6.8
12	5	01	77	2112	41°22'	68°15'	50	32	15	2	3.3	5.4	5.8
14	6	01	77	0105	41°10'	67°38'	51	34	10	3	4.4	5.4	6.4
15	6	01	77	0250	41°15'	67°24'	49	35	16	3	3.9	5.7	5.8
17	6	01	77	0737	41°21'	66°57'	66	03	20	4	3.9	5.9	5.9
18	6	01	77	0945	41°27'	66°42'	66	01	20	3	2.8	6.3	6.5
19	6	01	77	1215	41°10'	66°55'	70	03	17	4	3.9	6.1	5.8
22	6	01	77	1742	40°43'	66°57'	143	05	10	4	2.2	8.4	9.1
24	6	01	77	2333	40°45'	67°21'	97	36	-	2	2.2	6.7	6.9
27	7	01	77	0505	41°04'	67°45'	54	10	8	2	3.9	5.3	6.1
29	8	01	77	2037	40°46'	69°57'	26	32	18	4	0.6	4.1	4.1
31	8	01	77	2353	41°06'	69°36'	31	31	18	4	-2.2	5.4	5.4
32	9	01	77	0153	40°56'	69°34'	39	31	20	4	-1.7	4.7	4.9
33	9	01	77	0405	40°41'	69°41'	52	30	18	4	-2.2	5.4	5.4
36	9	01	77	1030	40°42'	68°56'	67	29	20	4	0.0	5.9	5.9

[1]Depth, surface and bottom temperature as recorded from XBT trace.

Table 2. Stations and number of fish sampled for stomach content analysis (Delaware II cruises 76-13 and 77-01).

Fish species sampled	CRUISE																				Species totals
	DEL II 76-13									DEL II 77-01											
	Station									Station											
	4	6	7	9	10	11	12	14	15	17	18	19	22	24	27	29	31	32	33	36	
Spiny dogfish		9											10								19
Little skate	40						11	6												6	63
Winter skate	7																			2	9
Thorny skate						4															4
Alewife																				10	10
Red hake														6							6
Haddock				5					6						10						21
Pollock				2		4											4				10
Atlantic cod	26			5				3		1					2	20				8	65
Ocean pout		4									2	2				5			6		19
Windowpane	5						13								15						33
American plaice					5																5
Blackback			3															2			5
Yellowtail			7						3										9		19
Sea raven											5										5
Longhorn sculpin						12															12
																			Grand total		305

For the purpose of analysis all information was pooled by species, regardless of size, for comparison with existing food habits data. The data for each predator are presented as a percentage of the total stomach contents weight and as a mean weight per stomach. The mean weight per stomach was calculated by dividing the total stomach contents weight by the total number of stomachs examined.

RESULTS

Comparison of food habits between cruises

The food habits of six species of fish were investigated following the DELAWARE II cruise 76-13 (Table 3). The same six species plus an additional 10 species were sampled during the second, DELAWARE II 77-01, cruise (Table 4). The food habits of the six co-occurring species were generally similar between cruises. However, it is difficult to evaluate any differences observed because of the relatively small number of fish collected. For example, the winter skate collected on the first cruise (76-13) consumed a greater percentage of fish (50.3% vs 12.9%) while more polychaetes (60.7% vs 21.8%) had been eaten by the fish collected during the second cruise. The sample size was small, two and seven fish for the 76-13 and 77-01 cruises, respectively, and therefore these differences may only reflect sampling variance. Similarly small sample size also makes it difficult to accurately assess the differences in food habits between the windowpane and the ocean pout for the two cruises. The Atlantic cod also differed in its food habits but in this case the sampling size was larger; 26 for cruise 76-13 and 39 for cruise 77-01. The cod collected during cruise 76-13 ate more Crustacea (62.0% vs 38.7%) while the amount of fish in the diet decreased (27.6% vs 53.3%). The most striking difference was in the

quantity of food consumed. The mean weight per stomach was 3.90 gms for the 76-13 cruise versus 19.37 gms for the fish collected during the second, 77-01, cruise. The length range of the fish sampled on both cruises overlap (35-86 cm vs 33-100 cm) but the average length of the fish is slightly larger (44 cm vs 57 cm) for the 77-01 cruise. Little skate were also sampled in relatively large numbers during both cruises (Tables 3 and 4). Again there were some differences in the food habits; however, in both cases the major food items were crustaceans (84.2% and 48.1%). The mean weight per stomach was also similar although there was a difference in the length range of the fish examined (Tables 3 and 4).

Food habits of phyletic groups--both cruises combined

In the following discussion the stomach samples of each predator species are considered utilizing data from both cruises. The major dietary components of each fish within a designated category (determined phyletically) are described.

The first group, the Chondrichthyes, is comprised of the spiny dogfish, *Squalus acanthias*, winter skate, *Raja ocellata*, thorny skate, *Raja radiata*, and little skate, *Raja erinacea*. Over 95% of the diet of the dogfish was fish. The major prey items of the winter skate were polychaete worms (21.8% and 60.7%) and the sand lance, *Ammodytes americanus* (50.3% and 3.0%). The stomach contents of the thorny skate were composed of a high percentage of fish (43.4%) and polychaete worms (29.5%). The little skate primarily consumed crustaceans (84.2% and 48.1%) and in particular gammarid amphipods (63.8% and 28.0%). In one sample from cruise 77-01, station 36, an oily material was found in one stomach on one caprellid amphipod. The sample consisted of the stomach contents from three male little skate ranging in length from 45 to 49 cm.

Table 3. Stomach contents of fish species, as percent weight, collected during DELAWARE II cruise 76-13.

Stomach contents	Spiny dogfish	Little skate	Winter skate	Atlantic cod	Ocean pout	Windowpane
HYDROZOA	+	+	-	+	0.4	0.1
NEMATODA	-	+	0.1	+	0.2	-
POLYCHAETA	-	8.0	21.8	4.0	16.9	-
Opheliidae	-	0.6	21.8	-	-	-
Aphroditidae	-	-	-	3.9	16.9	-
Glyceridae	-	0.6	-	-	-	-
Maldanidae	-	0.7	-	-	-	-
Other Polychaeta	-	6.1	-	0.1	-	-
CRUSTACEA	-	84.2	2.0	62.0	29.4	96.8
Cancridae	-	2.9	-	6.9	28.7	-
Crangonitae	-	4.5	-	4.3	-	3.3
Paguridae	-	12.5	-	0.3	-	-
Pandalidae	-	-	-	0.7	-	-
Other decapoda	-	-	-	1.5	-	3.3
Gammaridea	-	63.8	+	47.8	0.7	90.2
Caprellidea	-	+	-	-	-	-
Isopoda	-	0.5	2.0	0.5	+	-
MOLLUSCA	0.3	5.3	-	0.7	0.3	-
Pelecypoda	-	0.2	-	0.7	0.3	-
Cephalopoda	0.3	5.1	-	-	-	-
ECHINODERMATA	-	-	-	0.7	16.6	-
Strongylocentrotus	-	-	-	-	0.7	-
Echinarachnius	-	-	-	0.7	15.9	-
PISCES	99.7	-	50.3	27.6	-	2.9
Ammodytes amer.	7.6	-	50.3	25.7	-	-
Other Pisces	92.1	-	-	1.9	-	2.9
MISCELLANEOUS	-	2.5	25.8	5.0	4.1	0.2
SAND and ROCKS	-	-	-	-	32.1	-
# Stomachs	9	40	7	26	4	5
# Empty	6	2	0	1	0	0
$\bar{X}$ wt per stomach(g)	4.93	2.41	10.99	3.90	7.48	3.13
Length range (cm)	76-99	30-49	52-94	35.86	46-69	27-38

+ indicates <0.1%

Table 4.--Part I. Stomach contents of fish species, as percent weight, collected during DELAWARE II cruise 77-01.

Stomach contents	Spiny dogfish	Little skate	Winter skate	Thorny skate
COELENTERATA	-	0.6	-	-
Cerianthidae	-	-	-	-
Other coelenterates	-	0.6	-	-
POLYCHAETA	-	19.5	60.7	29.5
Aphroditiae	-	1.1	-	2.3
Other polychaetes	-	18.4	60.7	27.2
CRUSTACEA	+	48.1	0.8	4.1
Caprellidea	-	-	-	-
Gammaridea	+	28.0	-	+
Hyperidea	-	-	-	-
Cancridae	-	5.1	-	-
Crangonidae	-	5.9	-	-
Paguridae	-	4.5	-	4.1
Pandalidae	-	-	0.7	-
Isopoda	-	3.6	-	-
Euphausiacea	+	-	-	-
Other Crustacea	-	1.0	0.1	-
MOLLUSCA	2.7	1.4	24.9	0.1
Pelecypoda	-	1.4	24.9	-
Gastropoda	-	-	-	-
Cephalopoda	2.7	-	-	0.1
ECHINODERMATA	-	-	-	-
Echinoidea	-	-	-	-
Ophiuroidea	-	-	-	-
PISCES	97.3	15.5	12.9	43.4
Cottidae	-	-	-	-
Gadidae	52.6	15.5	-	-
Ammodytidae	-	-	3.0	-
Other fish	44.7	-	9.9	43.4
MISCELLANEOUS	-	14.9	-	22.9
SAND and ROCKS	-	-	0.7	-
# Stomachs	10	23	2	4
# Empty	4	5	0	0
$\bar{X}$ wt. per stomach	5.28	1.38	19.41	17.28
length range(cm)	43-95	44-51	77-87	73-85

+ indicates <0.1%

Table 4.--Part II. Stomach contents of fish species, as percent weight, collected during DELAWARE II cruise 77-01.

Stomach contents	Red hake	Haddock	Pollock	Atlantic cod	Ocean pout
COELENTERATA	-	59.5	-	+	0.1
Cerianthidae	-	59.5	-	-	-
Other coelenterates	-	-	-	+	0.1
POLYCHAETA	-	24.2	-	2.8	9.0
Aphroditiae	-	-	-	2.7	9.0
Other polychaetes	-	24.2	-	0.1	-
CRUSTACEA	81.1	1.4	29.6	38.7	9.8
Caprellidea	-	+	-	-	-
Gammaridea	-	0.8	0.1	14.8	2.1
Hyperidea	-	-	0.1	+	-
Cancridae	23.7	-	-	6.6	6.0
Crangonidae	1.0	+	0.5	3.1	-
Paguridae	-	0.4	-	10.3	-
Pandalidae	-	-	7.0	0.4	0.2
Isopoda	-	0.2	-	0.3	0.1
Euphausiacea	-	-	0.3	-	-
Other Crustacea	56.4	+	21.6	3.2	1.4
MOLLUSCA	1.0	2.0	+	2.3	+
Pelecypoda	1.0	1.9	-	0.8	+
Gastropoda	-	0.1	-	1.5	-
Cephalopoda	-	-	+	-	-
ECHINODERMATA	-	1.3	-	-	79.6
Echinoidea	-	0.1	-	-	79.6
Ophiuroidea	-	1.2	-	-	-
PISCES	-	1.6	69.8	53.3	-
Cottidae	-	-	0.5	-	-
Gadidae	-	-	-	-	-
Ammodytidae	-	1.6	68.0	20.8	-
Other fish	-	-	1.3	32.5	-
MISCELLANEOUS	-	0.4	0.2	2.8	1.0
SAND and ROCKS	17.9	9.6	0.4	0.1	0.5
#Stomachs	6	21	10	39	13
#Empty	1	2	0	2	1
$\bar{X}$ wt. per stomach	1.75	11.33	22.95	19.37	13.93
length range(cm)	31-35	34-72	28-87	33-100	53-81

Table 4.--Part III. Stomach contents of fish species, as percent weight, collected during DELAWARE II cruise 77-01.

Stomach contents	Windowpane flounder	American plaice	Winter flounder	Yellowtail flounder
COELENTERATA	-	-	-	-
Cerianthidae	-	-	-	-
Other coelenterates	-	-	-	-
POLYCHAETA	4.5	93.5	-	12.5
Aphroditiae	-	93.5	-	-
Other polychaetes	4.5	-	-	12.5
CRUSTACEA	43.1	-	-	66.1
Caprellidea	-	-	-	-
Gammaridea	0.4	-	-	4.9
Hyperidea	-	-	-	-
Cancridae	-	-	-	-
Crangonidae	41.6	-	-	60.8
Paguridae	-	-	-	0.4
Pandalidae	-	-	-	-
Isopoda	0.1	-	-	-
Euphausiacea	1.0	-	-	-
Other Crustacea	-	-	-	-
MOLLUSCA	-	-	-	4.1
Pelecypoda	-	-	-	4.1
Gastropoda	-	-	-	-
Cephalopoda	-	-	-	-
ECHINODERMATA	-	6.5	-	-
Echinoidea	-	-	-	-
Ophiuroidea	-	6.5	-	-
PISCES	28.2	-	-	0.3
Cottidae	-	-	-	-
Gadidae	-	-	-	-
Ammodytidae	28.2	-	-	-
Other fish	-	-	-	0.3
MISCELLANEOUS	24.2	-	-	9.5
SAND and ROCKS	-	-	-	7.5
#Stomachs	28	5	5	19
#Empty	17	3	5	1
$\bar{X}$ wt. per stomach	0.38	0.43	0	0.39
length range (cm)	27-38	28-48	33-46	26-41

Table 4.--Part IV. Stomach contents of fish species, as percent weight, collected during DELAWARE II cruise 77-01.

Stomach contents	Alewife		Sea raven		Longhorn sculpin	
COELENTERATA	+		0.1		-	
Cerianthidae		-		-		-
Other coelenterates		+		0.1		-
POLYCHAETA	-		-		0.5	
Aphroditiae		-		-		-
Other polychaetes		-		-		0.5
CRUSTACEA	99.1		0.4		98.5	
Caprellidea		-		-		-
Gammaridea		96.4		-		0.1
Hyperidea		0.2		-		-
Cancridae		-		-		-
Crangonidae		-		0.4		5.5
Paguridae		-		-		-
Pandalidae		-		-		65.6
Isopoda		-		-		-
Euphausiacea		2.2		-		-
Other Crustacea		0.5		-		27.3
MOLLUSCA	-		0.2		-	
Pelecypoda		-		-		-
Gastropoda		-		-		-
Cephalopoda		-		0.2		-
ECHINODERMATA	-		-		-	
Echinoidea		-		-		-
Ophiuroidea		-		-		-
PISCES	-		99.3		0.3	
Cottidae		-		60.8		-
Gadidae		-		2.0		-
Ammodytidae		-		-		-
Other fish		-		36.5		0.3
MISCELLANEOUS	0.9		-		0.7	
SAND and ROCKS	-		-		-	
#Stomachs	10		5		12	
#Empty	0		2		2	
$\bar{X}$ wt. per stomach	2.54		15.34		0.95	
length range (cm)	22-49		22-49		18-22	

The gadids included red hake, Urophycis chuss, haddock, Melanogrammus aeglefinus, pollock, Pollachius virens, ocean pout, Macrozoarces americanus, and Atlantic cod, Gadus morhua. The red hake diet consisted primarily of mud crabs (Axius serratus) and rock crabs (Cancer) which made up over 50% of the crustaceans (81.1%) eaten. Haddock consumed polychaete worms (24.2%) and ceriantharian anemones (59.5%). The major component of the stomach contents of the pollock was the sand lance, Ammodytes americanus (69.8%), while the prey of the ocean pout was primarily sand dollars, Echinarachnius parma (47.7%). The Atlantic cod preyed on a variety of Crustacea (62.0% and 38.7%), rock crabs, Cancer irroratus and C. borealis, caridean shrimp, Crangon septemspinosa and Dichelopandalus leptocerus, the hermit crab, Pagurus acadianus, gammarid amphipods, Gammarus annulatus, and the isopod, Cirolina polita. The sand lance, A. americanus, was the major species of fish identified in the cod stomachs (25.7% and 20.8%). In two samples from cruise 77-01, station 29, an oily material was found mixed in with the stomach contents. In the first sample of nine fish, ranging in length from 41-45 cm, the oily substance was found in one stomach on the gammarid amphipod, Gammarus annulatus. In the second sample of six fish, ranging in length from 49-87 cm, the oily material was found in one stomach on the gammarid amphipod, Anonyx sarsi.

The stomach contents of four species of Pleuronectiformes (flatfish), the American plaice, Hippoglossoides platessoides, winter flounder, Pseudopleuronectes americanus, windowpane, Scophthalmus aquosus, and yellowtail, Limanda ferruginea were examined. Over 90% of the diet of the American plaice consisted of polychaete worms of the family Aphroditidae. The five winter flounder stomachs examined were empty. The windowpane was collected on both cruises and in each

case crustaceans were the major prey item being either primarily gammarid amphipods (90.2%) on cruise 76-13 or the caridean shrimp, Crangon septemspinosa (41.6%) on cruise 77-01. The stomach contents of the yellowtail was also comprised of a high percentage of Crustacea with the major prey item being C. septemspinosa (60.8%).

Alewives, Alosa pseudoharengus, the only clupeid examined, fed almost exclusively on gammarid amphipods (96.4%) of the genus Gammarus.

The last group of fish examined were the cottids, the sea raven, Hemitripterus americanus, and the longhorn sculpin, Myoxocephalus octodecemspinosus. The sea raven almost exclusively ate fish (99.3%). Over 98% of the stomach contents of the longhorn sculpin were decapod crustaceans with the major prey item being the pandalid shrimp, Dichelopandalus leptocherus (65.6%).

DISCUSSION

The food habits of the 16 fish examined in this survey differ little from data previously collected on the food habits of these same species (Maurer and Bowman, 1975; Bowman,1975 and Bowman et al., 1976). Only the data collected on the American plaice and haddock appear to differ in terms of the major prey item categories.

The stomach contents of the American plaice consisted almost exclusively of polychaete worms, however, only five fish were examined of which three had empty stomachs and one of the two remaining had eaten polychaetes. In a larger sample of fish from Southern New England and Georges Bank, Bowman et al. (1976) have shown that the major food items are usually crustaceans or

echinoderms. Annelids are also a smaller part of the diet of these fish, especially in Southern New England, and it is likely that a larger sample would have reduced the apparent significance of polychaetes in the diet of American plaice.

In the Georges Bank area haddock have generally been found to eat crustaceans, molluscs, echinoderms, annelids, and fish (Wigley, 1956; Wigley and Theroux, 1965). The occurrence of large quantities of coelenterates in the diet, as reported here, is apparently rare. The stomach contents of 21 haddock, collected from three stations, were examined. The coelenterates occurred in the stomachs of the fish at only one station and probably reflect a local abundance of this prey item.

The impact of the oil spill on the food habits of various species of groundfish was assessed by surveying the stomach contents. Of the 305 fish stomachs examined three samples, representing the stomach contents of two species of fish, contained an oil-like material. In two different samples of Atlantic cod, collected at station 29 which was 25-30 miles southwest of the wreck site, oily gammarid amphipods comprised part of the stomach contents of two fish. At station 36 a sample of the stomach contents collected from little skate contained one oily caprellid amphipod. Since 1963 more than 38,000 stomachs, representing 82 species of fish, have been analyzed at the Northeast Fisheries Center and no oil-like materials have previously been reported. Since 1969 a total of 393 little skate and 1,706 cod have been examined as part of the routine assessment of fish food habits and, again, no oil-like materials have been identified in the stomach contents (Maurer and Bowman, 1969).

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