

## STUDIES ON THE FOOD HABITS OF WHITING, REDFISH, AND POLLOCK IN THE GULF OF MAINE

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### I. INTRODUCTION

THE stomach contents of food-fishes landed at Gloucester, Massachusetts, by commercial trawlers were analyzed in the summers of 1959-61.<sup>1</sup> Periodic visits were made to the wharves at Gloucester Harbour to obtain stomachs from fishes landed by ground fishing vessels operating in the Gulf of Maine.<sup>2</sup> While the fishes were being processed, stomachs were removed and taken to the science laboratory at the Gloucester High School for volumetric analysis. Results are given in Tables 1-6.

The species of fishes and identified invertebrates referred to in the text and tables are as follows :

Osteichthyes (Names follow Bigelow and Schroeder, 1953)

Herring—*Clupea harengus*

Blueback—*Pomolobus aestivalis*

Eel—*Anguilla rostrata*

Conger eel (American Conger)—*Conger oceanica*

Whiting (Silver Hake)—*Merluccius bilinearis*

Cod—*Gadus callarias*

Haddock—*Melanogrammus aeglefinus*

Pollock—*Pollachius virens*

Hake—*Urophycis* spp.

Cusk—*Brosme brosme*

Blackbacked Flounder (Winter Flounder)—*Pseudopleuronectes americanus*

Sand Dab (Sand Flounder)—*Lophopsetta maculata*

Mackerel—*Scomber scombrus*

Butterfish—*Poronotus triacanthus*

Redfish (Rosefish)—*Sebastes marinus*

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<sup>2</sup> Fish stomachs were obtained from the following processors to whom thanks are given for their co-operation. Cape Ann Sea Foods, Adams and Son, Morning Star Fish Company, Empire Fish Company, Codinha Fishery, Favolora Fish Plant, Progressive Fish Company, and Cape Ann Fisheries.

Longhorn Sculpin—*Myoxocephalus octodecemspinosus*  
 Cunner—*Tautoglabrus adspersus*  
 Sand Launce—*Ammodytes americanus*  
 Shanny—*Leptoclinus maculatus*

## Crustacea

Euphausiids—*Meganyctiphanes norvegica*  
 Decapods—*Dichelopandalus leptocerus* ; *Crangon septemspinosus* ; *Pagurus pubescens* ; *Pandalus borealis* ; *P. montagui*

## Mollusca

Squid—*Illex illecebrosus*  
 Octopus—*Bathypolypus arcticus*

## II. FOOD OF THE WHITING

Studies on food habits of whiting (*Merluccius bilinearis*) have been published in recent years by Jensen and Fritz (1960) and Schaefer (1960). Both of these, however, are based upon small samples. The present study is based upon stomach analyses of over 13,000 whiting of commercial size (12-24 inches) from four areas in the southern portion of the Gulf of Maine.

In 1959 whiting fed largely on the sand launce (53.3%) with herring as the second most important food (13.8%). See table 1. The small whiting (less than

TABLE 1

*Analysis of Food of Whiting—Summers, 1959 and 1960—Gulf of Maine*

	No.	1959			No.	1960		
		Vol. (L.)	% Frequency	% Vol.		Vol. (L.)	% Frequency	% Vol.
Herring	22	2.245	7.6	13.8	241	27.620	32.5	44.5
Sand Launce	168	8.770	56.2	53.3	9	0.220	1.2	0.3
Whiting	14	0.925	4.6	5.7	244	19.630	32.9	31.6
Fish Remains	64	1.567	21.4	9.7	213	11.890	28.7	19.1
Squid	16	1.540	5.3	9.6	21	1.790	2.8	2.8
Euphausiids	32	0.918	10.7	5.6	8	0.052	1.0	0.0
Long-horned Sculpin	2	0.140	0.6	0.8	—	—	—	—
Haddock	2	0.115	0.6	0.7	—	—	—	—
Hake	—	—	—	—	7	0.455	0.9	0.7
Sand Dab	1	0.040	0.3	0.2	3	0.095	0.4	0.1
Butterfish	—	—	—	—	1	0.120	0.1	0.1
American Eel	—	—	—	—	2	0.075	0.2	0.1
Brittle Star	2	0.005	0.6	0.03	—	—	—	—
Amphipods	1	0.002	0.3	0.01	—	—	—	—
Black-backed Flounder	—	—	—	—	1	0.060	0.1	0.0
Decapod Shrimp	—	—	—	—	1	0.010	0.1	0.0
Mud Star	—	—	—	—	1	0.005	0.1	0.0

Total No. of Stomachs—299  
 Total Volume—16.267 L.

Total No. of Stomachs—740  
 Total Volume—62.022 L.

TABLE 2  
*Analysis of Food of Whiting—Summer, 1961—Gulf of Maine*  
 Comparison by Time Sequence

Food	7-27/8-4			8-8/8-18			8-22/9-1			Total			
	No.	Vol. (L)	% Fre- quency	No.	Vol. (L)	% Fre- quency	No.	Vol. (L)	% Fre- quency	No.	Vol. (L)	% Fre- quency	
Herring	178	18.122	12.3	26.0	129.858	42.5	60.4	46.104	24.8	1803	194.084	29.8	46.8
Herring													
Sardines	2	0.006	0.1	0.0	1.225	0.2	0.5	21.582	22.2	433	22.813	7.1	5.5
Whiting	507	27.074	35.2	38.8	54.001	31.9	25.1	45.317	49.0	2304	126.392	38.0	30.5
Euphausiids	906	21.311	62.9	30.5	8.468	17.3	3.9	0.774	2.3	1419	30.553	23.4	7.3
Blueback	1	0.004	0.0	0.0	9.688	4.6	4.5	1.140	0.5	137	10.832	2.2	2.6
Butterfish													
Squid	6	0.365	0.4	0.5	25	1.485	0.9	0.6	74	8.775	3.8	6.7	2.4
Hake	11	0.733	0.7	1.0	3.340	1.1	1.5	2.783	1.8	73	6.488	1.2	1.5
Pollock	7	0.860	0.4	1.2	1.845	1.0	0.8	1.090	0.9	57	3.668	0.9	0.8
Fish Remains	21	0.506	1.4	0.7	2.620	1.5	1.2	0.295	0.5	48	3.480	0.7	0.8
Sand Lance	31	0.353	2.1	0.5	1.598	2.3	0.7	0.727	1.2	94	2.399	1.5	0.5
Sand Dab	2	0.035	0.1	0.0	0.214	0.2	0.0	0.352	1.1	62	1.294	1.0	0.3
Haddock	1	0.115	0.0	0.1	0.217	0.4	0.0	0.070	0.0	36	0.604	0.5	0.1
Mackerel								0.070	0.0	3	0.245	0.0	0.0
Decapod								0.245	0.2	4	0.245	0.0	0.0
Shrimp	8	0.051	0.5	0.0	0.024	0.1	0.0	0.124	1.3	38	0.199	0.6	0.0
Cusk								0.145	0.2	4	0.145	0.0	0.0
Conger Eel								0.140	0.0	1	0.140	0.0	0.0
Sea													
Cucumber	1	0.040	0.0	0.0				0.075	0.1	3	0.115	0.0	0.0
Cod	1	0.020	0.0	0.0				0.060	0.1	4	0.080	0.0	0.0
Amphipods	11	0.50	0.7	0.0				0.008	0.3	17	0.058	0.2	0.0
Shanny	1	0.005	0.0	0.0	0.005	0.0	0.0	0.006	0.1	4	0.016	0.0	0.0
Decapod													
Crabs								0.001	0.1	3	0.013	0.0	0.0
Isopods								0.001	0.0	1	0.005	0.0	0.0
Polychaetes	2	0.003	0.1	0.0				0.001	0.0	3	0.004	0.0	0.0

Total No. of Stomachs—1439 Total No. of Stomachs—2704 Total No. of Stomachs—1908 Total No. of Stomachs—6049  
 Total Vol.—69,653 L. Total Vol.—214,657 L. Total Vol.—129,824 L. Total Vol.—414,134 L.

TABLE 3  
Analysis of Food of Whiting—Summer, 1961—Gulf of Maine  
Comparison by Area

Food	No.	Off Maine Coast Vol.	%Fre- quency	% Vol.	No.	Ipswich Bay Vol.	%Fre- quency	% Vol.	No.	Off Cape Cod Vol.	%Fre- quency	% Vol.	No.	Cultivator Shoal Vol.	%Fre- quency	% Vol.
Herring	523	57.529	45.7	63.2	137	15.197	20.4	34.0	520	52.963	27.0	42.1	121	11.565	11.4	21.2
Herring Sardines	6	1.125	0.5	1.2	209	8.425	31.1	18.8	205	12.561	10.6	9.9	489	28.471	46.3	52.3
Whiting	319	20.939	27.8	23.0	148	6.771	22.0	15.1	776	41.614	40.3	33.1	416	8.111	39.3	14.9
Euphausiids	274	6.524	23.9	7.1	149	2.085	22.2	4.6	420	9.630	21.8	7.6	33	2.799	3.1	5.1
Blueback	21	1.365	1.8	1.5	25	2.818	3.7	6.3	28	1.685	1.4	1.3	2	0.035	0.1	0.0
Butterfish	9	0.770	0.7	0.8	8	8.103	7.8	18.1	15	0.557	0.7	0.4	8	0.545	0.7	1.0
Squid	14	0.965	1.2	1.0	2	0.354	1.1	0.7	22	1.900	1.1	1.5	9	0.593	0.8	1.0
Hake	15	0.985	1.3	1.0	1	0.070	0.2	0.1	21	1.500	1.0	1.1	16	1.305	1.5	2.4
Pollock	22	0.554	1.9	0.6	6	0.040	0.1	0.0	12	0.810	0.6	0.6	26	0.696	2.4	1.2
Fish remains	7	0.095	0.6	0.1	18	0.175	0.8	0.3	28	0.704	1.4	0.5	5	0.084	0.4	0.1
Sand Lance	2	0.035	0.1	0.0	3	0.085	0.4	0.1	20	0.342	1.0	0.2	1	0.025	0.0	0.0
Sand Dab	..	..	..	..	..	..	..	..	2	0.175	0.1	0.1	..	..	..	..
Haddock	..	..	..	..	2	0.175	0.2	0.3	2	0.070	0.1	0.0	..	..	..	..
Mackerel	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Decapod	2	0.010	0.1	0.0	7.7	0.048	1.0	0.1	21	0.112	1.0	0.0	4	0.012	0.3	0.0
Shrimp	..	..	..	..	..	..	..	..	2	0.085	0.1	0.0	..	..	..	..
Cusk	..	..	..	..	..	..	..	..	1	0.140	0.0	0.1	..	..	..	..
Conger Eel	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sea Cucum- ber	..	..	..	..	..	..	..	..	..	..	..	..	1	0.040	0.0	0.0
Cod	1	0.001	0.0	0.0	1	0.001	0.1	0.0	3	0.060	0.1	0.0	1	0.020	0.0	0.0
Amphipods	..	..	..	..	..	..	..	..	4	0.009	0.2	0.0	9	0.044	0.8	0.0
Shanney	..	..	..	..	..	..	..	..	2	0.006	0.1	0.0	1	0.005	0.0	0.0
Decapod Crabs	..	..	..	..	..	..	..	..	2	0.003	0.1	0.0	..	..	..	..
Isopods	1	0.005	0.0	0.0	..	..	..	..	1	0.002	0.0	0.0	1	0.001	0.0	0.0
Polychaetes	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Total No. of Stomachs—1144  
Total Vol. 90.902 L.

Total No. of Stomachs—671  
Total Vol.—44.620 L.

Total No. of Stomachs—1922  
Total Vol.—125.622 L.

Total of No. Stomachs—1056  
Total Vol.—54.353 L.

1 foot in total length) fed almost exclusively on euphausiid shrimps. The larger fish consumed a great many of its own species.

In 1960 herring was the most important food (44.5%), and its own species was second (31.6%). Squid and hake were also important. In 1961 herring (46.8%) and whiting (30.5%) remained the most important food, but with a variety of 26 other species including the blueback, butterfish, hake, and pollock among the fishes, and euphausiid shrimp and squid among the invertebrates. See table 2.

In the early summer cannibalism was very high (38.8%) and euphausiids and herring ran second and third in volume. By middle summer, however, herring (60.4%) composed the bulk of the diet. Euphausiids dropped from about one-third of the diet in early summer to a small amount by middle summer.

In the late summer herring (35.5%) and smaller whiting (34.9%) made up the bulk of the diet and herring sardines were becoming of increasing importance while the euphausiids continued to drop in volume except for the small whiting.

Comparing the areas from which whiting were taken, herring was found to be the bulk of food off the Maine Coast, in Ipswich Bay, and off Cape Cod. On Cultivator Shoal the whiting was primarily cannibalistic. In that area herring was second and euphausiids were third in importance. Whiting and euphausiids were secondary off the Coast of Maine; sardines and butterfish were secondary in Ipswich Bay; and whiting and sardines were secondary off Cape Cod. See table 3.

In 1961 whiting under 12 inches fed almost entirely on euphausiids with occasional other crustaceans. Whiting from 12-18 inches fed largely (67.6%), but not entirely on euphausiids, while whiting 18-24 inches in length fed predominantly on herring. See table 4.

### III. FOOD OF THE REDFISH

Information on food of redfish (*Sebastes marinus*) is available in the publications of Anon (1954), Steele (1957), and Lambert (1960).

Because the vast majority of stomachs of redfish examined in the present study were either empty or everted, having come from considerable depths, little quantitative data could be obtained. Those with food remaining in the stomach fed largely on euphausiids, decapod shrimps, hyperiidean amphipods, and the sand lance. See table 5.

### IV. FOOD OF POLLOCK

Kendall (1898) and Steele (1963) give data on food of the Pollock (*Pollachius virens*).

The number analyzed by us was not great. See table 6 for results. Those that were analyzed fed largely on euphausiids, herring, squid, and whiting.

TABLE 4

*Analysis of Food of Whiting—Summer, 1961—Gulf of Maine*  
Comparison by Size

	No.	Size 12-18 inches			No.	Size 18-24 inches		
		Vol. (L.)	% Fre- quency	% Vol.		Vol. (L.)	% Fre- quency	% Vol.
Euphausiids	774	13.906	85.6	67.6	645	16.647	12.5	4.2
Herring	21	1.540	2.3	7.4	1782	192.544	34.6	48.9
Herring Sardines	41	1.051	4.5	5.1	392	21.762	7.6	5.5
Whiting	139	3.649	15.3	17.7	2165	122.743	42.0	31.1
Blueback	1	0.035	0.1	0.1	136	10.897	2.6	2.7
Butterfish	1	0.010	0.1	0.04	98	10.250	1.9	2.6
Squid	—	—	—	—	97	6.488	1.8	1.6
Hake	1	0.050	0.1	0.2	56	3.618	1.0	0.9
Sand Launce	17	0.163	1.8	0.7	44	1.131	0.8	0.2
Fish remains	5	0.086	0.5	0.4	89	2.313	1.7	0.5
Pollock	—	—	—	—	37	3.480	0.7	0.8
Decapod Shrimp	8	0.054	0.8	0.2	30	0.135	0.5	0.0
Amphipods	8	0.022	0.8	0.1	9	0.036	0.1	0.0
Sand Dab	—	—	—	—	34	0.604	0.6	0.1
Polychaetes	2	0.003	0.2	0.01	—	—	—	—
Mackerel	—	—	—	—	4	0.245	0.0	0.0
Haddock	—	—	—	—	3	0.245	0.0	0.0
Cusk	—	—	—	—	1	0.140	0.0	0.0
Conger Eel	—	—	—	—	1	0.140	0.0	0.0
Sea Cucumber	—	—	—	—	3	0.115	0.0	0.0
Cod	—	—	—	—	4	0.080	0.0	0.0
Shanney	—	—	—	—	4	0.016	0.0	0.0
Decapod Crabs	—	—	—	—	3	0.013	0.0	0.0
Isopods	—	—	—	—	1	0.005	0.0	0.0

Total Number of Stomachs—904

Total Volume—20.569 L.

Total Number of Stomachs—5145

Total Volume—393.654 L.

TABLE 5

*Analysis of Food of Redfish—Summers, 1959 and 1960—Gulf of Maine*

Food	No.	1959			No.	1960		
		Vol. (L.)	% Fre- quency	% Vol.		Vol. (L.)	% Fre- quency	% Vol.
Euphausiids with copepods	36	0.296	49.3	57.4	385	1.522	99.4	86.5
Decapod shrimp	27	0.145	36.9	28.1	9	0.059	2.3	3.3
Hyperiid amphipods	29	0.050	39.7	9.6	42	0.141	10.8	8.0
Sand Launce	2	0.015	2.7	2.9	1	0.005	0.2	0.2
Fish fry	1	0.010	1.4	1.9	2	0.020	0.5	1.1
Octopus	—	—	—	—	1	0.010	0.2	0.5
Isopods	—	—	—	—	1	0.001	0.2	0.0

Total No. of Stomachs—73

Total Volume—0.516 L.

Total No. of Stomachs—387

Total Volume—1.758 L.

TABLE 6

*Analysis of Food of Pollock—Summers, 1959 and 1960—Gulf of Maine*

Food	1959				1960			
	No.	Vol. (L.)	% Frequency	% Vol.	No.	Vol. (L.)	% Frequency	% Vol.
Euphausiids with copepods	291	8.112	98.9	91.1	149	92.90	83.7	78.2
Herring	..	—	—	—	24	2.205	13.4	18.5
Squid	.. 9	0.565	3.1	6.3	—	—	—	—
Fish remains	.. 24	0.146	8.1	1.6	5	0.047	2.8	0.3
Whiting	..	—	—	—	5	0.220	2.8	1.8
Hyperiid amphipods	39	0.046	13.3	0.5	—	—	—	—
Cunner	..	—	—	—	1	0.060	0.5	0.5
Sand Lance	.. 1	0.030	0.3	0.3	—	—	—	—
Isopods	..	—	—	—	1	0.001	0.5	0.0
Total Number of Stomachs—294				Total Number of Stomachs—178				
Total Vol.—8.901 L.				Total Vol.—11.868 L.				

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