

FOOD OF BLUEFISH

by

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<i>8/6/84</i>	
(DATE)	

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August 1984

MARMAP Contribution MED/NEFC 84-26

INTRODUCTION

The bluefish, Pomatomus saltatrix (Linnaeus), is the only member of the family Pomatomidae. It has strong jaws, sharp teeth, and is a powerful and rapid swimmer. Thus it is well adapted to feeding on fish and squid. Bluefish is a popular gamefish found worldwide in temperate and warm temperate zones (Briggs, 1960), with the exception of the eastern Pacific (Wheeler, 1975). In the Atlantic it is distributed from Cape Cod to Argentina in both inshore and offshore waters (Bigelow and Schroeder, 1953). Bluefish migrations seem to correspond with the migrations of fishes upon which it feeds (Wheeler, 1975). Much biological data on bluefish were summarized by Bigelow and Schroeder (1953), Leim and Scott (1966) and Wilk (1977). Large bluefish (>30 cm) are known to feed on both schooling and non-schooling fishes and squid. Bluefish less than 30 cm eat copepods, crustacean and molluscan larvae, and small fish. During recent years, overall estimates indicate a steady rise in bluefish population levels (Boreman, 1983) in Northwest Atlantic waters. As a consequence it is important to document the potential impact of bluefish predation on other fish and squid stocks. This paper presents the results of stomach content analyses of bluefish collected during spring, summer, and autumn for the years 1978, 1979 and 1980.

METHODS

Stomachs were collected from bluefish caught during 7 bottom trawl survey cruises conducted by the National Marine Fisheries Service (NMFS) from 1978 through 1980. Figure 1 shows the areas where stomachs were collected for this study. The cruise dates were as follows: 5 September - 22 November 1978; 21 March - 12 May 1979; 22 July - 31 August 1979; 18 September - 9 November 1979; 16 March - 8 May 1980; 11 July - 22 August 1980; and 17 September - 14 November 1980. A scheme of stratified random sampling was conducted in continental shelf waters from Cape Fear, South Carolina, to Nova Scotia, during the surveys. All bottom trawl tows were 30 minutes in duration and fishing continued over the 24 hours daily period. (Further details of survey techniques may be obtained from the Resource Survey Investigation, Northeast Fisheries Center, Woods Hole Laboratory, Woods Hole, MA 02543.) Bluefish were randomly selected from the trawl catches and their stomachs were excised and preserved in 3.7% formaldehyde (volume) with appropriate collection information. At the laboratory, the stomachs were individually opened and their contents emptied into a fine-meshed sieve (0.25 mm). They were flushed with tap water to remove the formaldehyde. Stomach contents were sorted, identified, blotted dry, and weighed to the nearest 0.001 gram. The percentage weight of the various prey groups are presented in all tables.

RESULTS

The stomach contents of 521 fish were examined. One hundred thirty-eight of these were empty. The mean stomach content weight was 18.61 grams. Fish was by far the most important prey identified (58% of all stomach content in terms of weight, Table 1). Round herring (Etrumeus teres - 10.5%) butterfish (Peprilus triacanthus - 7.1%), anchovies (Engraulidae and Anchoa sp. - 4.2%), menhaden (Brevoortia tyrannus - 2.4%), and flatfish (Pleuronectiformes 2.8%), were identified in the diet. A large percentage of the fish prey could not be identified (25.6%) because only pieces of flesh were found in the stomachs or digestion was well advanced. Squid (Cephalopoda - 41.0%) was the second most important prey identified. Loligo pealei (14.2%) and Illex illecebrosus (24.2%) made up almost all the squid portion of the diet. Remaining items noted in the stomachs, in total, only accounted for about 1.0% of the total stomach contents by weight.

Food according to predator size indicated that some combination of fish and squid was the principal prey of all bluefish sampled (Table 2). However, the stomachs of bluefish 61 to 80 cm in fork length (FL) contained larger quantities of squid than bluefish 11 to 50 cm. Small size fish such as anchovies (Engraulidae, Anchoa sp.) made up larger percentages of the food of small bluefish (up to 40 cm) and larger size fish (e.g. Atlantic mackerel, Scomber scombrus) were to some extent of more

importance to bluefish >40 cm. Also of interest is that bluefish feed to some extent on other bluefish, as the 31-40 cm bluefish stomachs contained 4.9% bluefish. Polychaetes were noted as of some importance to bluefish 11 to 30 cm in length - 2.8% in 11 to 20 cm fish and 4.1% in 21 to 30 cm fish. The foods of bluefish caught north of Cape Hatteras during the spring, summer, and autumn are given separately in Table 3. Only 3 stomachs sampled during spring contained food. Fish, mostly engraulids at 47%, made up 87% of their food. In summer, squid accounted for 29% of the diet, most being Illex (24%), but fish was the prevalent food (71%). Fish species identified as principal prey were longhorn sculpin (15%) and butterfish (12%). During autumn, squid (principally Illex, 25%; and Loligo, 16%) and fish were both important as food (44% verses 55%, respectively). There was a greater variety of species identified as prey during autumn. Round herring (12%), butterfish (7%), engraulids (4%), and right eyed flounders (3%) comprised the major part of the fish identified in the diet.

South of Cape Hatteras (Table 4), fish made up a major portion of the bluefish diet during all three seasons (>75%). During spring most of the fish (90%) were unidentifiable except for engraulids which made up about 9% of the diet. In summer fish totaled 97% of the diet with striped anchovies (Anchoa hepsetus, 29%) and clupeids (25%) making up most of the identified prey. Fish accounted for 79% of the bluefish diet in autumn, with striped anchovy (35%) and butterfish (15%) comprising all of the identifiable portion. Squid (totally Loligo) were also an important prey during autumn (16%).

Table 5 summarizes the stomach content of bluefish according to year for 1978, 1979 and 1980. More squid were noted in the diet for 1979 and 1980 (both 44%) than in 1978 (28%). Butterfish (25%) round herring (10%) and anchovies (10%) comprised the major part of the diet in 1978. In 1979, round herring (13%), menhaden (3.7%), and butterfish (3.7%) were important prey. For 1980, it can be seen that longhorn sculpin (Myoxocephalus octodecemspinosus, 9%) and American sand lance (Ammodytes americanus, 2.7%) were the most important food.

DISCUSSION

Bluefish is clearly a pelagic piscivore which also feeds on squid. Other prey items combined make up only a small portion of its diet. In this study the principal identified fish prey were butterfish, round herring, and flatfish. Previous work established that small bluefish (<20 cm) feed on crustaceans and fish (Bigelow and Schroeder, 1953). Samples of small bluefish in this study showed fish to be the major prey (nearly 90%). Earlier studies showed that large bluefish feed extensively on various species of fish and squid (Wilk, 1977), and the data from this study confirm that pattern.

Bowman (1980) reported that fish and squid were the primary food of bluefish (99.4%) from a study conducted in 1978, but unidentified fish made up a substantial portion of the stomach contents (74.6%). The unidentified portion of fish prey was somewhat lower in this study but still made up a significant proportion.

The reason a large percentage of bluefish food cannot be identified is because of its feeding method. When bluefish feed they often bite pieces of their prey. More sophisticated methods of identifying fish flesh are needed to better describe the diet of bluefish.

Bluefish stocks at high levels probably cause significant predation mortality on other fish populations. Improved methods of identifying fish prey in stomach contents and more intensive sampling of bluefish stomachs are needed for more accurate estimates of the consumption of other fish by this major predator.

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Table 1. Percentage composition (wt) of stomach contents of bluefish (Pomatomus saltatrix) for years 1978, 1979, and 1980. ("+" indicates <0.1%).

Stomach Contents	Percentage Weight
COELENTERATA	0.2
Scyphozoa	0.2
POLYCHAETA	0.5
<u>Glycera americana</u>	+
<u>Glycera dibranchiata</u>	0.2
<u>Ophioglycera gigantea</u>	0.3
Unidentified Polychaeta	+
CRUSTACEA	0.4
Amphipoda	
<u>Gammarus</u> sp.	0.2
Hyperiid	+
MYSIDACEA	
<u>Neomysis</u> sp.	+
DECAPODA	
<u>Dichelopandalus</u> sp.	+
<u>Crangon septemspinosa</u>	+
<u>Ovalipes ocellatus</u>	0.2
<u>Cancer irroratus</u>	+
<u>Parapeneus longirustris</u>	+
<u>Palaemonetes pugio</u>	+
Unidentified Caridea	+
Unidentified Decapoda	+
Unidentified Crustacea	+
MOLLUSCA	41.3
Cephalopoda	
<u>Loligo pealei</u>	14.2
<u>Illex illecebrosus</u>	24.2
Unidentified Cephalopoda	2.8
Unidentified Octopoda	+
Unidentified Gastropoda	0.1
PISCES	57.5
<u>Brevoortia tyrannus</u>	2.4
<u>Clupea harengus harengus</u>	+
<u>Etrumeus teres</u>	10.5
Other Clupeidae	0.2
<u>Anchoa hepsetus</u>	1.7
<u>Anchoa mitchelli</u>	0.2
Other Engraulidae	2.3
<u>Osmerus mordax</u>	+
<u>Urophycis regia</u>	0.6
Other Gadidae	+
<u>Pomatomus saltatrix</u>	0.2
<u>Stenotomus chrysops</u>	0.5
<u>Cynoscion regalis</u>	0.1
<u>Leiostomus xanthurus</u>	+
Other Sciaenidae	0.5
<u>Ammodytes americanus</u>	1.0
<u>Scomber scombrus</u>	0.1
<u>Peprilus triacanthus</u>	7.1
<u>Myoxocephalus octodecemspinus</u>	1.7
Pleuronectiformes	2.8
Other Pisces	25.6
Fish bones	+
Fish scales	+
Animal remains	+
Miscellaneous (includes Rock)	+

Number of stomachs	521
Number empty	138
Mean stomach content weight	18.607 g
Mean fish FL (cm)	37.1

Stomach Contents	11-20 cm	21-30 cm	31-40 cm	41-50 cm	51-60 cm	61-70 cm	71-80 cm	>80 cm
COELENTERATA					0.28	1.07		
Scyphozoa					0.28	1.07		
POLYCHAETA	2.77	4.14			0.70			
<u>Glycera americana</u>			0.01					
<u>Glycera dibranchiata</u>			0.03		0.70			
<u>Ophioglycera gigantea</u>	2.77		4.04					
Unidentified Polychaeta			0.06					
CRUSTACEA	0.19	1.88	2.07		0.89		0.03	
Amphipoda								
<u>Gammarus sp.</u>	0.17	1.32	1.64					
Hyperiid								
Mysidacea								
<u>Neomysis sp.</u>								
Decapoda								
<u>Dichelopandalus leptocerus</u>							0.01	
<u>Crangon septemspinosus</u>			0.02				0.01	
<u>Ovalipes ocellatus</u>					0.80			
<u>Cancer irroratus</u>					0.09		0.01	
<u>Parapeneus longirostris</u>		0.01						
<u>Palaemonetes pugio</u>			0.41					
Unidentified Caridea			0.17					
Unidentified Decapoda	0.02		0.26					
Unidentified Crustacea			0.12					
MOLLUSCA	8.27	8.01	9.60	19.82	14.10	56.73	62.94	21.21
<u>Loligo pealei</u>	0.12	1.82	1.12	18.87	12.29	26.81	14.12	20.47
<u>Illex illecebrosus</u>		1.85				18.88	47.91	0.74
Unidentified Cephalopoda	8.15	4.34	8.48	0.95	1.81	11.02	0.65	
Unidentified Octopoda						0.02		
Unidentified Mollusca							0.26	
PISCES	88.78	85.67	88.11	80.10	83.99	41.75	37.00	78.78
<u>Brevoortia tyrannus</u>					11.78			
<u>Etrumeus teres</u>		5.09	10.78	15.25	35.85	0.03	2.05	
Other Clupeidae	0.04	2.77						
<u>Anchoa hepsetus</u>	5.03	12.99	1.30	4.37	0.64			
<u>Anchoa mitchelli</u>		0.22	2.17		0.25			
Other Engraulidae	12.48	17.92	8.14	0.22	1.79		0.26	
<u>Osmerus mordax</u>		0.17						
<u>Urophycis regia</u>				5.82				
Other Gadidae			0.79					
<u>Pomatomus saltatrix</u>			4.93					
<u>Stenotomus chrysops</u>		1.39		3.47		3.11		
<u>Cynoscion regalis</u>							0.19	
<u>Leiostomus xanthurus</u>		0.46						
Other Sciaenidae		3.72	5.69					
<u>Anodytes americanus</u>		0.09			0.38	5.98	0.53	
<u>Scomber scombrus</u>					0.44			
<u>Peprilus triacanthus</u>		17.17	12.73	8.54	8.01	9.94	2.90	22.51
<u>Myoxocephalus octodecemspinosus</u>							3.78	
Pleuronectiformes				6.75		18.07		
Unidentified Pisces	70.86	23.68	41.58	35.68	24.85	4.62	27.29	56.27
Fish Bones		0.09	0.18		0.01	0.03	0.01	
Fish Scales	0.02	0.01				0.01		
Animal Remains	0.35	0.17				0.05	0.01	
Miscellaneous				0.06		0.37		
Number examined	69	223	62	25	50	38	47	4
Number empty	23	70	21	0	7	9	5	2
Mean stomach content wt. (g)	0.752	3.466	6.577	3.585	39.289	30.656	93.085	10.832
Mean fish FL (cm)	17	26	34	46	55	66	74	82

Table 3. Prey composition (% wt) of stomach contents of bluefish collected north of Cape Hatteras during spring, summer, and autumn (1978-1980 combined).

STOMACH CONTENTS	NORTH OF CAPE HATTERAS		
	Spring	Summer	Autumn
COELENTERATA			0.22
Scyphozoa			0.22
POLYCHAETA			0.55
<u>Glycera americana</u>			
<u>Glycera dibranchiata</u>			0.17
<u>Ophioglycera gigantea</u>			0.38
Other Polychaeta			
CRUSTACEA			0.46
Amphipoda			0.21
<u>Gammarus sp.</u>			0.21
Hyperiidia			
Mysidacea			
<u>Neomysis sp.</u>			0.23
Decapoda		0.03	0.23
<u>Dichelopandalus leptocerus</u>			
<u>Crangon septemspinosa</u>			
<u>Ovalipes ocellatus</u>			0.19
<u>Cancer irroratus</u>			0.02
<u>Parapeneus longirostris</u>			
<u>Palaemonetes pugio</u>			0.02
Caridea			0.02
Other Decapoda			
Other Crustacea			
MOLLUSCA	12.92	28.92	43.61
Cephalopoda	12.92	28.92	43.61
<u>Loligo pealei</u>		4.18	15.98
<u>Illex illecebrosus</u>		23.76	25.21
Other Cephalopoda	12.92	0.98	2.42
Other Octopoda			
Other Mollusca			
PISCES	87.08	71.07	54.89
<u>Brevoortia tyrannus</u>			2.81
<u>Clupea harengus</u>			
<u>Strumeus teres</u>			12.34
Other Clupeidae			
<u>Anchoa hepsetus</u>		1.51	1.20
<u>Anchoa mitchelli</u>			0.19
Other Engraulidae	46.81		2.50
<u>Osmerus mordax</u>			0.02
<u>Urophycis regia</u>			0.64
Other Gadidae			0.04
<u>Pomatomus saltatrix</u>			0.24
<u>Stenotomus chrysops</u>		0.98	0.82
<u>Cynoscion regalis</u>			0.10
<u>Leiostomus xanthurus</u>			0.04
Other Sciaenidae			0.63
<u>Ammodytes americanus</u>		1.07	0.89
<u>Scomber scombrus</u>			0.10
<u>Peprilus triacanthus</u>		11.76	6.61
<u>Myoxocephalus octodecemspinosus</u>		15.06	
Pleuronectiformes			3.30
Other Pisces	40.27	40.64	22.42
Bones		0.03	
Scales			0.02
Animal remains			0.01
Rock			0.06
Number examined	6	91	321
Number empty	3	33	62
Mean stomach content weight (g)	3.644	12.069	25.572
Mean fish FL (cm)	39	42	39

Table 4. Prey composition (% wt) of stomach contents of bluefish collected south of Cape Hatteras during spring, summer, and autumn (1978-1980 combined).

STOMACH CONTENTS	SOUTH OF CAPE HATTERAS		
	Spring	Summer	Autumn
COELENTERATA			
Scyphozoa			
POLYCHAETA			2.33
<u>Glycera americana</u>			
<u>Glycera dibranchiata</u>			
<u>Ophioglycera gigantea</u>			
Other Polychaeta			2.33
CRUSTACEA	1.69		2.53
Amphipoda			
<u>Gammarus sp.</u>			
Hyperiidea			
Mysidacea			
<u>Neomysis sp.</u>			
Decapoda			0.07
<u>Dichelopandalus leptocerus</u>			
<u>Crangon septemspinosa</u>			
<u>Ovalipes ocellatus</u>			
<u>Cancer irroratus</u>			
<u>Parapeneus longirostris</u>			0.07
<u>Palaemonetes pugio</u>			
Caridea			
Other Decapoda			2.46
Other Crustacea		1.69	
MOLLUSCA	0.96	1.33	15.66
Cephalopoda	0.96	1.33	15.66
<u>Loligo pealei</u>			0.11
<u>Illex illecebrosus</u>			15.66
Other Cephalopoda	0.96	1.22	
Other Octopoda			
Other Mollusca			
PISCES	99.04	96.97	79.20
<u>Brevoortia tyrannus</u>			
<u>Clupea harengus</u>			
<u>Etrumeus teres</u>			
Other Clupeidae		25.45	
<u>Anchoa hepsetus</u>		29.42	35.18
<u>Anchoa mitchelli</u>			
Other Engraulidae	8.61		
<u>Osmerus mordax</u>			
<u>Urophycis regia</u>			
Other Gadidae			
<u>Pomatomus saltatrix</u>		1.24	
<u>Stenotomus chrysops</u>			
<u>Cynoscion regalis</u>			
<u>Leiostomus xanthurus</u>			
Other Sciaenidae			
<u>Ammodytes americanus</u>			
<u>Scomber scombrus</u>			
<u>Peprilus triacanthus</u>			15.45
<u>Myoxocephalus octodecemspinosus</u>			
Pleuronectiformes			
Other Pisces	90.43	40.86	28.57
Bones			
Scales			0.10
Animal remains			0.18
Rock			
Number examined	15	46	42
Number empty	6	19	15
Mean stomach content weight (g)	8.899	1.230	1.917
Mean fish FL (cm)	.45	.32	.34

Table 5. Stomach contents of bluefish (Pomatomus saltatrix) collected in the Northwest Atlantic during 1978, 1979, and 1980. Data presented as a percentage of the total stomach contents weight.

STOMACH CONTENTS	1978	1979	1980
COELENTERATA	1.0		
Scyphozoa	1.0		
POLYCHAETA	2.6		
<u>Glycera americana</u>			
<u>Glycera dibranchiata</u>	0.8		
<u>Ophioglycera gigantea</u>	1.8		
Unidentified Polychaeta			
CRUSTACEA	1.5	0.1	0.6
Amphipoda			
<u>Gammarus</u> sp.	0.1		0.6
Hyperiid			
Mysidacea			
<u>Neomysis</u> sp.			
Decapoda			
<u>Dichelopandalus</u> sp.			
<u>Crangon septemspinosa</u>			
<u>Ovalipes ocellatus</u>	0.9		
<u>Cancer irroratus</u>		0.1	
<u>Parapeneus longirostris</u>			
<u>Palaemonetes pugio</u>	0.1		
Caridea	0.1		
Unidentified Decapoda			
Unidentified Crustacea			
MOLLUSCA	28.2	44.0	43.8
Cephalopoda			
<u>Loligo pealei</u>	25.8	8.7	21.7
<u>Illex illecebrosus</u>	0.8	33.2	14.8
Unidentified Cephalopoda	1.6	1.9	7.3
Unidentified Octopoda			
Unidentified Mollusca		0.2	
PISCES	66.5	55.8	55.6
<u>Brevoortia tyrannus</u>		3.7	
<u>Clupea harengus</u>			
<u>Etrumeus teres</u>	10.1	13.0	1.7
Other Clupeidae	0.4		0.8
<u>Anchoa hepsetus</u>	1.1	1.9	1.3
<u>Anchoa mitchelli</u>		0.3	
Other Engraulidae	8.9	1.2	
<u>Osmerus mordax</u>	0.1		
<u>Urophycis regia</u>	3.0		
Other Gadidae	0.2		
<u>Pomatomus saltatrix</u>	1.2		
<u>Stenotomus chrysops</u>	2.9	0.3	0.6
<u>Cynoscion regalis</u>		0.1	
<u>Leiostomus xanthurus</u>	0.2		
Other Sciaenidae	3.0		
<u>Ammodytes americanus</u>	1.1	0.6	2.7
<u>Scomber scombrus</u>		0.1	
<u>Peprilus triacanthus</u>	25.1	3.7	1.0
<u>Myoxocephalus octodecemspinosus</u>			9.3
Pleuronectiformes		4.4	
Other Pisces	9.1	26.5	38.2
Bones	0.1		
Scales			
Miscellaneous	0.2	0.1	
Animal remains	0.1		
Rock	0.1	0.1	
Number examined	123	275	123
Number empty	26	79	33
Mean stomach content wt (g)	14.105	22.445	14.272
Mean fish fork length (cm)	32	38	40



Figure 1. Dark-shaded areas indicate locations of bluefish (*Pomatomus saltatrix*) stomach collection for this study during 1978, 1979, and 1980.