



RESEARCH ARTICLE

Diet composition of bluefish *Pomatomus saltatrix* (Linnaeus, 1766) in the Sea of Marmara

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ABSTRACT

In this study, diet composition of bluefish *Pomatomus saltatrix* (Linnaeus, 1766) was investigated. A total of 512 bluefish samples were monthly collected from commercial fishing boats operating in the Sea of Marmara between January and December 2014. It was determined that the total length distribution of the samples varied between 12.3-47.3 cm. 367 of them (71.67%) were found to be the full of the stomach. The nutritional composition of stomach contents only two main prey groups (teleostei and crustacean) were identified. In evaluation, relative importance indexes (IRI) food groups were calculated. According to the relative importance index (IRI=91.8%) anchovy (*Engraulis encrasicolus*) has been found to be the most preferred food group. The number of individuals whose stomachs were found to be full was low in the winter months; it started to rise with spring and reached the highest level in the autumn months. It was determined that the increase in the total number of stomachs occurred between August and October in relation to the reproductive period. It was found that stomach fullness rates significantly relationship between sex and seasons ($p<0.01$).

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Introduction

Bluefish, *Pomatomus saltatrix* (Linnaeus, 1766), is a pelagic, migratory and cosmopolitan species which inhabits warm and

temperate waters of the Atlantic, Indian, Pacific Oceans, Mediterranean and Black Seas (Slastenenko, 1956; Briggs, 1960; Wilk, 1977; Tortonese, 1975). Bluefish, at the end of spring migrate to the Black Sea for feeding and spawning and stay

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along the summer. In early autumn they start to migrate back to the Marmara Sea and Aegean Sea (Ceyhan et al., 2007). Bluefish is a widely exploited and economically important species in coasts of Turkey.

For a good fisheries management, reproduction, nutrition and growth of the species should be well known. Studies on the analysis of fish and stomach contents play a key role in understanding fish biology, ecology, physiology and behavior (Arias, 1980). Stomach content analyzes, describe the nutritional habits of individuals belonging to the population as well as nutritional competition among species (Lawlor, 1980). In this way, the role of species in the food chain can be determined, contributing to fisheries modeling and fisheries planning (Hyslop, 1980). In addition, stomach contents gives information about the environment and diet composition of fish species (Wootton, 1990; Buckel et al., 2004).

There are very few studies on the stomach content and feeding regime of bluefish in the seas of Turkey (Türkan, 1959; Artüz, 2003).

In the present study, the effect of season and sex groups on the feeding habits of blue fish *Pomatomus saltatrix* was investigated. The result of the study can be a baseline data for fisheries biologists and also contributes scientifically to the sustainability of regional fisheries.

Material and Methods

A total of 512 bluefish samples were monthly collected from commercial fishing boats operating in the Sea of Marmara between January and December 2014 (approximately coordinate of sampling area: 40° 34' 16.6" N-27° 30' 01.3" E; 40° 31' 52.4" N 27° 30' 03.9" E).

Samples were preserved in iceboxes for examination in the laboratory. Specimens were measured to the nearest 0.1 cm for total length (TL). The abdominal region was opened for gonads and stomach contents examination. Stomach contents and gonads were examined by macroscopic observation. In evaluation, relative importance indexes (IRI) were calculated (Frost, 1946; Pinkas, 1971; Windell and Bowen, 1978; Hyslop, 1980). Samples whose stomach contents were completely digested were excluded from the evaluation. To determine the differences in gastric occupancy rate between sexes, seasons and length analysis of variance test was used.

Results

The nutritional composition of bluefish only two main prey groups (teleostei and crustacean) was determined. Samples whose stomach contents were completely digested were excluded from the evaluation. While a food organism was

found in the stomach of 367 of the examined samples, it was observed that a total of 145 stomachs, 67 female and 78 male samples were completely empty. 73.30% of females (n=184), 70.11% of males (n=183) and 71.67% of all individuals were found to have full stomach. Nutritional concentrations of bluefish have been found to reach their maximum levels in autumn months when they begin at the end of summer (Figure 1).

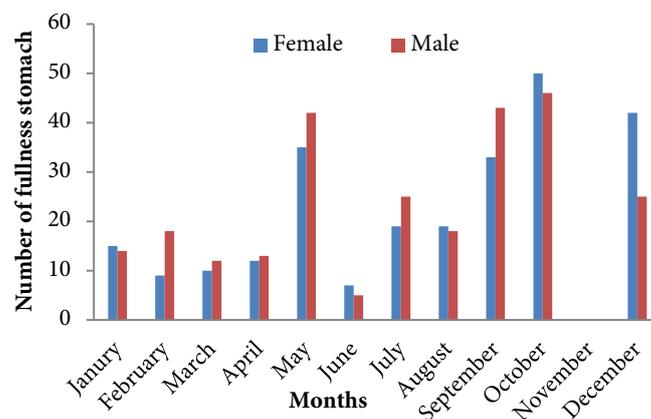


Figure 1. Monthly stomach fullness and distribution of samples

It was determined that the increase in the number of full stomachs occurred between August and October in relation to the reproductive period. As the stomach contents of the samples could not be examined in November, they were not included in the graph. With the Analysis of variance test, it was found that the difference between sex, seasons and length according to stomach fullness rates was important ($P < 0.01$). Stomach fullness status, sex, maximum length, minimum length, mean length values and standard deviation of the samples examined monthly were given in Table 1.

Stomach contents were shown in Figure 2. The majority of the prey groups identified were bony fishes (Osteichthyes), while a small number of them were found to be crustaceans (crab and shrimp). 63.81% of the bony fish anchovy (*Engraulis encrasicolus*), 14.52% horse mackerel (*Trachurus mediterraneus*), 8.83% whiting (*Merlangius merlangus*), 4.84% red mullet (*Mullus barbatus*), prey groups included in the crustacean class consisted of 4.30% of stomach contents. In addition to these results, 3.70% bluefish was detected in the stomach content of bluefish. With this result, cannibalism has been determined in population of study area (Figure 3).

According to the relative importance index (IRI=91.8%) anchovy (*Engraulis encrasicolus*) has been found to be the most preferred food group. The importance indexes of other food groups are as follows, *Trachurus mediterraneus* IRI=5.0%, *Merlangius merlangus* IRI=1.8%, *Mullus barbatus* IRI=0.5%, *Pomatomus saltatrix* IRI=0.3% and crustacean (crab and shrimp) IRI=0.6%.

Table 1. Monthly stomach fullness of sex groups

Months	Female (♀)					Male (♂)				
			Total Length (cm)					Total Length (cm)		
	N	NFS	NES	Min-Max	Mean±SD	N	NFS	NES	Min-Max	Mean±SD
January	15	10	5	12.3-31.0	20.7±0.75	14	7	7	22.0-33.0	14.4±1.84
February	9	5	4	20.0-32.0	24.3±0.91	18	9	9	18.5-32.0	23.3±0.73
March	10	1	9	15.4-19.4	17.2±1.32	12	3	9	15.8-19.0	17.1±1.05
April	12	5	7	22.0-33.0	24.5±0.40	13	3	10	22.0-28.0	24.1±1.71
May	35	19	16	15.0-36.7	25.2±0.53	42	23	19	15.0-47.3	21.8±0.56
June	7	7	0	21.6-29.0	23.0±2.59	5	5	0	22.3-23.1	22.6±0.29
July	19	9	10	22.0-23.9	22.6±0.56	25	14	11	19.9-23.4	22.1±0.81
August	19	14	5	24.3-32.0	26.8±2.66	18	15	3	22.3-32.3	26.1±3.09
September	33	23	10	14.6-33.4	20.5±0.38	43	33	10	14.9-34.0	21.9±0.26
October	50	50	0	13.1-28.7	16.4±1.41	46	46	0	12.7-31.7	16.6±0.12
November	-	-	-	-	-	-	-	-	-	-
December	42	41	1	17.4-23.6	19.9±1.52	25	25	0	18.0-22.7	20.1±1.44
Total	251	184	67	12.3-36.7	21.9±1.15	261	183	78	12.7-47.3	20.9±1.08

Note: N: sample size; NFS: number of fullness stomach; NES: number of empty stomach; Min: Minimum; Max: Maximum; SD: Standard Deviation



Figure 2. Stomach contents of the *P. saltatrix* in the Sea of Marmara

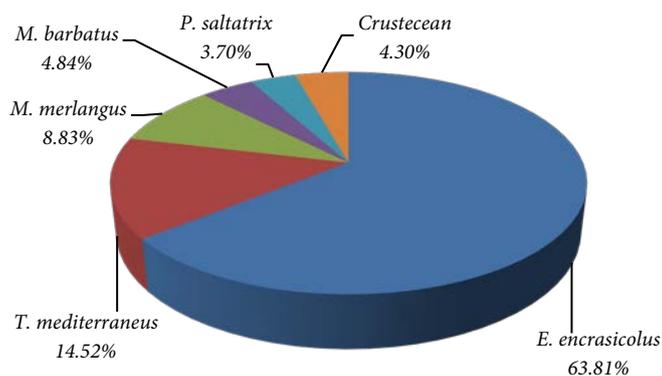


Figure 3. Distribution of prey groups in stomach contents (%)

Discussion

Although there are very few studies on determining diet of bluefish in the seas of Turkey, there are many research results related to the subject in different parts of the world (Buckel et al., 1999; Grant, 1962; Lassiter, 1962; Marks, 1993; Creaser and Perkins, 1994).

In a study carried out by Türgan (1959) it was reported that the bluefish migrated between the Black Sea and the Marmara Sea and they feed mainly on fish. In a different study, gastric contents of bluefish caught in the Bosphorus were examined and found to be feed on *Engraulis encrasicolus*, *Trachurus mediterraneus*, *Belone belone*, *Scomber scombrus*, *Scomber japonicus*, and *Sarda sarda* species (Artüz, 2003). In addition, the presence of bluefish, representing 3.70% of the food groups, shows that there is cannibalism (Bade, 1977). These results support the findings of the present study.

As a result of a similar study carried out in the shallow waters of estuaries on the Eastern coast of America, stomach contents of juvenile and adult bluefish were examined and it was found that anchovy was the dominant species (Buckel et al., 1999). Lassiter (1962) reported that nutrient ratios of invertebrates decrease with increasing length of predators.

In a different study, it was reported that the majority of gastric contents of young bluefish (10-20%) were invertebrates, whereas adult individuals were fed on fish and anchovy was preferred (Buckel et al., 1999). In a study conducted in the

estuaries in India, 40.5% of the stomach contents were reported to be small sea creatures, 15.8% herring, 13.9% silver fish and 8% anchovy (Grant, 1962).

However, there are also different results in the literature. Creaser and Perkins (1994) investigated the stomach contents of juvenile and adult bluefish in the Marsh River in Maine, USA and reported that the average of 0.7% terrestrial plants and 0.3% insect (Hymenoptera) group was found in the stomachs of the examined individuals. In another study, stomach contents of the juvenile bluefish in two different periods (spring and summer season) were examined by Marks (1993). Author reported that approximately 89% of the stomach contents found to be full and copepods were dominant.

It is determined that bluefish are generally fed on fish but depending on environmental conditions, in some periods they are fed on invertebrates. In addition, another important issue has been identified with cannibalism in the species with this study. It is estimated that the cause of cannibalism in the species is due to lack of nutrients depending on environmental conditions.

Conclusion

Analysis of fish diet, play a key role in understanding fish biology, ecology, physiology and behavior. Bluefish economically is one of the important species in coasts of Turkey. In this study, the role of bluefish in the food chain has been determined and results, may contribute to fisheries and fish biologists.

Conflict of Interest

The authors declare that there is no conflict of interest.

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