Distribution and Seasonal Movement of Atlantic Bonito (*Sarda sarda*) Populations in the Southern Black Sea Coasts

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Abstract

This study was carried out in the Southern Black Sea coasts during the autumn-winter migration of bonito (*Sarda sarda*) within the fishing periods of 2000-2001 and 2001-2002. Findings related to fishing gear and techniques were obtained from the commercial fishing vessels that mainly used purse seine and gill net as a means of catching bonito. The data concerning the bonito populations were obtained from the landed catch. It was found that the age composition of bonito consisted of zero and one year of age and that they had not reached their sexual maturity yet. The average length distribution of the population was found to be within the range of 15.1–47.5 cm. The catch per unit effort (CPUE) values for the landed catch were found to be 619.8 kg/vessel/operation for the purse-seiners, and 83.1 kg/vessel/operation for the gill-netters.

According to the long-term statistics, the amount of bonito catches was subject to variation of increase and decrease with the five years periods. It was estimated that this fluctuations were the results of excessive fishing power imposed upon the bonito stocks. Therefore, some recommendations relating to the sustainable fishing for the bonito stocks in the Southern Black Sea coasts were outlined.

Key words: Southern Eastern Black Sea coasts, Atlantic bonito, catch per unit effort (CPUE), length and age distribution, spawning and feeding migration

Introduction

Bonito is the most important species among the Black Sea fish in terms of commercial value. While total catches of bonito from the countries bordering the Black Sea reached the maximum of 20 thousand tons in 1969, thereafter no bonito catch was recorded from these countries except Turkey and Bulgaria. This was mainly due to pollution in the northwest Black Sea and migration problems occurred in the bonito stocks (BSEP, 2003).

Reports of last 20 years have shown that almost whole bonito catches, which were obtained from the Black Sea, have belonged to Turkish side (BSEP, 2003; Prodanov *et al.*, 1997). However, when considering the long-term statistics, Turkey's bonito catch from the Black Sea was also subject to important fluctuations. A maximum catch of 23 thousand tons in 1983 has never been reached. The amount of landed catch showed a variation from 20 thousand to 5 thousand tons in the last ten years.

For spawning and feeding migration, bonito starts to enter into Black Sea from the Aegean Sea and the Marmara Sea, from the end of April until the midst of August. By the end of September, it starts to return into the Aegean Sea. The highest level of migration takes place in November and December. During the winter, it hibernates in the Marmara Sea (Kutaygil, 1979). Studies conducted over the bonito catches during autumn/winter migration in the southern Black Sea coasts showed the evidence that while a stock of bonito was migrating, a small part of bonito remained in the Black Sea (Nümann, 1954). Bonito migration in the Black Sea is mainly governed by biological and oceanographic conditions (Demir, 1961). Bonito spawns from the end of May until the midst of July in the most northern parts of the Black Sea (Demir, 1957). It was reported that the most suitable water temperature for spawning is 18.0 (13.9-23.1)°C (Majorova and Tkacheva, 1960).

Existing studies on the Black Sea bonito mostly deal with taxonomic and bio-ecological features of the species (Akşiray, 1954; Nümann, 1954; Slastenenko, 1956; Acara, 1957; Nicolow, 1960; Demir, 1964). Early studies on bonito fishing in Turkish coasts of the Black Sea were carried out in 1990's by Oray and Karakulak (1997), and Zengin *et al.* (1998). In this paper, the bonito population and the specifications of landed catch were defined, and some comments on the management strategies were discussed.

Materials and Methods

Data related to fishing gear and the methods used to catch bonito were obtained from the commercial fishers. The vessels engaged in bonito fishing were classified into two groups; one used purse seine (large scale vessels) and others used gill nets (small scale vessels). Data concerning other catch parameters were collected by means of sample forms distributed in the main fishing centers. Entire data were recorded on those sample forms. Population

parameters were obtained from the landed catch. Biometric measures were carried on the samples taken from the landed catch. Fish lengths were measured as total lengths.

The catch per unit effort (CPUE) was used as an index to define the fishing intensity (Phiri and Shirakihara, 1999). Bhattacharya method, which is based on analysis of length sequence, was used to determine the age classes for bonito stocks. The ELEFAN computer program developed by Gayalino *et al.* (1998) was also used. This method is mostly applicable to the populations that present rapid growth and short life phenomenon (Sparre and Venama, 1992).

Results

Properties of Landed Catch

Fishing for bonito in the Black Sea generally takes place within August and February, and reaches the highest level in September and October (Figure 1). The earliest and the latest dates for the bonito catch

were recorded to be the August of 10 and the March of 7, respectively. During the fishing periods of 2000/01 and 2001/02, the monthly water surface temperatures of the Turkish coasts of the Black Sea were measured. In 2000, for the months of August, September, October, November and December, these values were 25.5, 20.5, 16.7, 13.6, 11.7°C, respectively. In 2001, for the months of January, February, August, September, October, November and December, the temperatures were 10.2, 10.1, 28.3, 24.5, 21.6, 16.9, 12.3°C, respectively.

Fishing for Gillnets

It was found that the bonito catch taken from the Black Sea by Turkish fishers by means of drift gill nets amounted to 15.4% of the total. In this fishing category, the vessels used were made of wood and were generally of 8.6 (6.30-13.8) m lengths and 44.8 (8-135) HP (Table 1). Depending on the weather conditions, daily average operation number with gillnets was found to be 2 (1-6), and the average duration time for the gear in the sea was 3.1 (0.8-7.0)
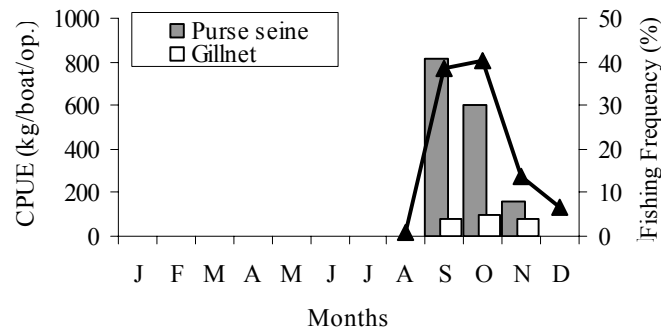

Figure 1. Distribution of fishing frequency and CPUE values of landed bonito by different gears.

Table 1. Some important parameters for the fishing gears used for bonito in Turkish Black Sea coasts

Parameters	Seine Nets	Gillnets
1-Vessel Length (m)	35 (20-48)	8.6 (6.3-13.8)
2-Engine Power (HP)	982 (449-1600)	44.8 (8-135)
3-Gear Main Particulars		
Length (m)	845.1 (600-1098)	-
Depth (m)	136.7 (90-164.7)	-
Part length (m)	-	219.6
Number of longitudinal parts	-	5-12
Part depth (m)	-	9.2
Number of vertical parts	-	1-6
4-Mesh Size (mm)	12,14, 30, 36, 54, 56	68, 72, 76 60, 64, 84 50, 56, 60,88, 96
5-Distance From Shore (m)	8688.7 (1852-32410)	3207.6 (5.5-16668)
6-Fishing Time (in 1 day period)	24 hours	18^{00}-24^{00} (16^{00}-02^{00})
7-Operation Number (daily)	1-3	2 (1-6)
8- Operation Duration (minute)	106.5 (60-240)	185 (45-720)
9-CPUE (kg/vessel/op.)	619.8 (31-2322)	83.1 (0.6-967)
10-Catch Distribution (%)	84.6	15.4

hours. It was observed that fishing operations started from the beginning of sunset and continued over the night, between the hours of 18^{00}-24^{00} being the most intensive (Figure 2). The CPUE values for this gillnets were found to be close to each other for the months of September, October and November, which formed the seasonal fishing period. The average value for the CPUE was 83.1 (0.6-967) kg/vessel/op. (Figure 1, 2).

Fishing for Purse Seines

It was seen that the majority of the bonito catch (84.6%) were taken by purse seines, of which the maximum length and power were 48 m and 1600 HP, respectively. It was noticed that in purse seine fishing the seines could chase bonito shoals as far as 32 km from the shore (Table 1, Figure 2). For the months of September, October and November, in which the

bonito fishing is most dense, the values of CPUE were 818.3, 601.7 and 156.5 kg/vessel/op., respectively.

Population Features

By analyzing the landed catch composition for the fishing seasons of 2000/01 and 2001/02 the length distributions of bonito were found to be 15.5-46.0 (28.1±2.61, n=492) and 15.1-47.5 (31.2±3.33, n=1908) cm, respectively. Through the examination of length distribution, it was noticed that the length groups were formed in such a way that there were two distinct pick points. The average length values for these points were computed to be 26.4±3.68 and 35.4±3.57 cm (Figure 3). Each of these pick points referred to a year class group (Sparre and Venama, 1992).

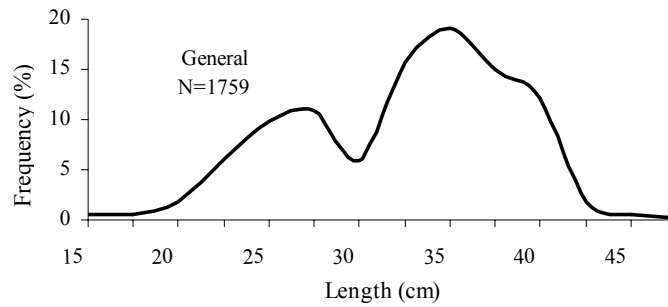The monthly length distributions for both fishing
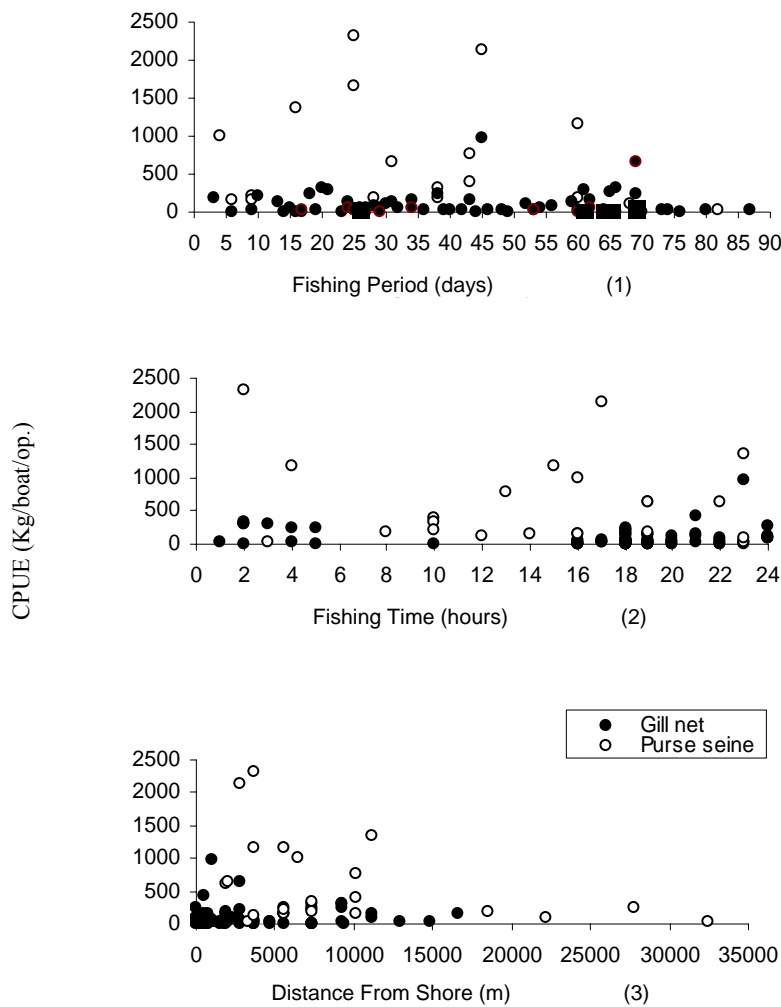
Figure 3. Length distribution of bonito taken from the southern Black Sea coasts for the years of 2000, 2001 and 2002. The pick points of the curve refer to the age groups.

seasons were presented in Figure 4.

Although individuals in the bonito population generally reach the sexual maturity at two years of age, maturity differences observed even within the individuals of the same year class and as well as the variations occurred in water temperatures caused the spawning time to spread in a rather longer period. It was noticed that for the all months, in which the sampling took place, there were new individuals of zero age to join the stock.

Considering the long-term catch statistics of bonito taken from Turkish coasts, it was seen that the amount of catch tended to decrease especially starting from 1980 and that it presented fluctuations with approximately five-year intervals (Figure 5).

Discussion

Since the fishing with gillnets was generally limited to a rather shorter period of the day and the bonito stocks concentrated in the regions of about 3 km distance from the shore within this time, the CPUE values for gillnets were found considerably low in comparison to those of purse seines (Figure 1).

The migrated bonito populations in the Black Sea coasts during autumn/winter consist of zero and one year of individuals. The main lengths computed from these age groups were agreed by the previous studies carried out in the Black Sea. Nümann (1954) and Türgan (Artüz, 1957) showed that the length ranges for the bonito populations according to the age groups were 38-42 cm at the end of first year, 53-57 cm at the end of second year and 60-65 cm at the end of third year. In the study conducted in the northern Black Sea (Majorova and Tkacheva, 1960), the mean lengths were reported to be 37.7 cm for 1 year of age, 50.6 for 2 years of age, 59.8 cm for 3 years of age and 65.5 cm for 4 years of age. For the Bulgarian coasts, the mean lengths for age groups of 0^+, 1^+ and 2^+ were found to be 25.0 cm, 39.3 cm and 53.0 cm, respectively (BSEP, 2003).

The bonito reaches the first sexual maturity length at the end of its first year and at the beginning of its second year (Ivanov and Beverton, 1985). It is, therefore, possible to say that almost whole bonito population being in southern Black Sea coasts during the autumn/winter migration was composed of individuals that did not reach sexual maturity yet. During this study, only 5 individuals belonging to higher age groups were met. The fact that such individuals hardly existed in the population was closely related to the migration pattern. It was pointed out by Kutaygil (1979) that the bonito populations have a tendency to form shoals by being composed of the individuals of the same year.

The periodical variations in the amount of catch were also reported previously by Artüz (1957) and Artüz (1958). Those variations were estimated to take place due to the increasing fishing power imposed on the populations. A strong evidence of this was the fact that nearly the rest of the landed catch of 2000-2002 fishing period was composed of 1-year-old individuals. Therefore, there was not enough chance for the population to recruit. As shown in Figure 5, the picks formation in the catch and recoveries in the stocks required about 5 or 6 years. In order to sustain the reliable fishing in the Black Sea, the total amount of annual catch should not be over 10 thousands tons. Taking this figure as a basis, it is recommended that the CPUE values should not exceed 166 kg/day/vess. and 1240 kg/day/vess. for small and large fishing vessels, respectively.

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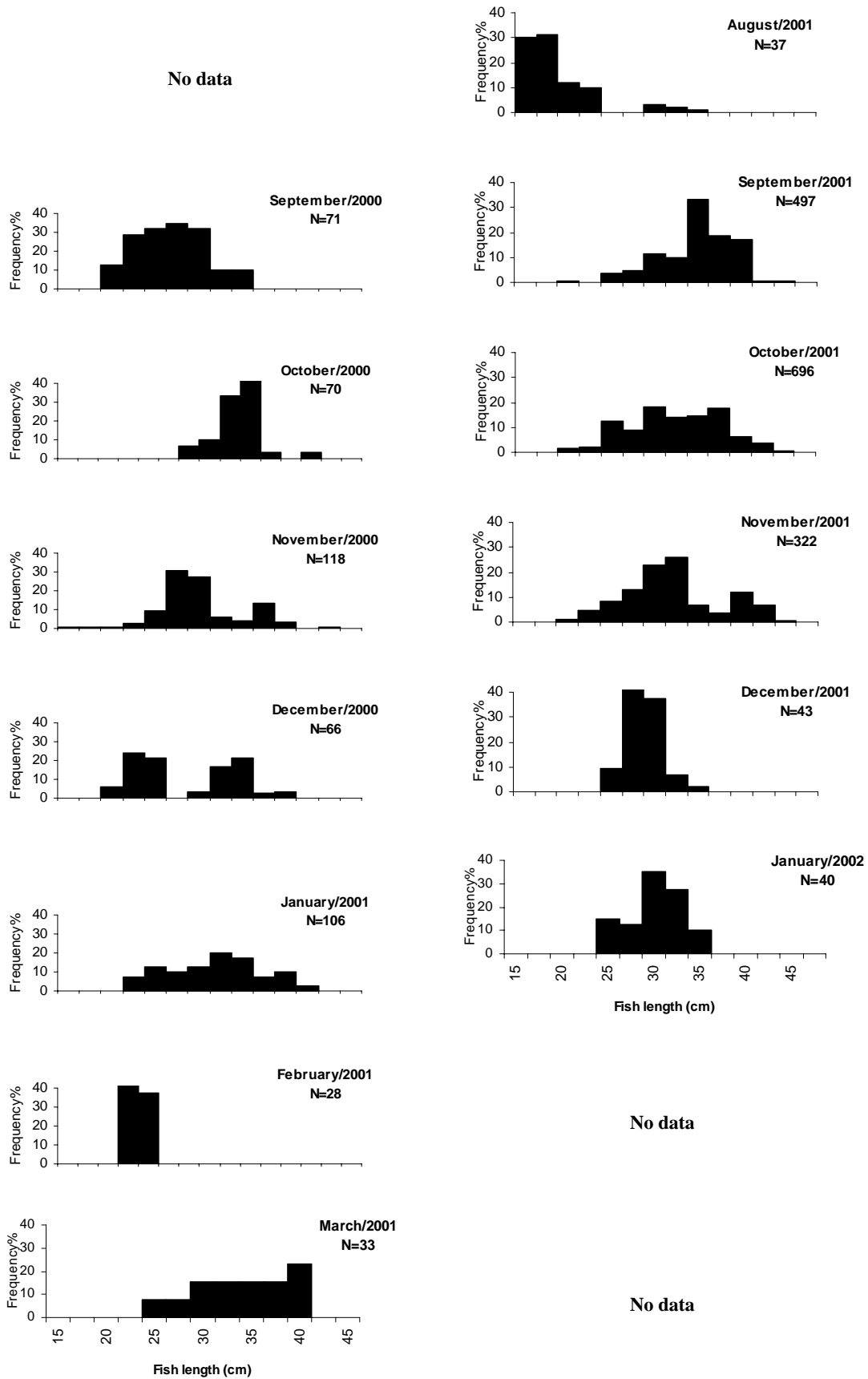Artüz, M.İ. 1958. Torik-Palamut (*Sarda sarda*) ların Mevsim ve Senelere Bağlı Av Periyotları. Et ve Balık

Figure 4. Monthly length variation of landed bonito for the periods of 2000/01 and 2001/2002 (Total lengths were taken).
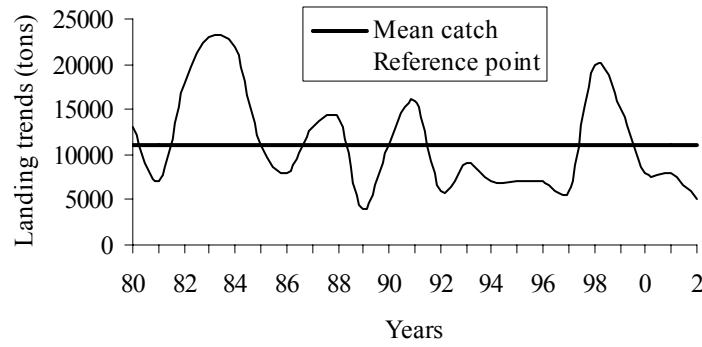
Figure 5. Variations in the landed bonito catch from Turkish coasts of the Black Sea in last 20 years.

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