ISSN 1314-3379

SIZE AND AGE STRUCTURE OF POPULATIONS ON THE BULGARIAN BLACK SEA SPRAT (*SPRATTUS SPRATTUS* L.) FOR 2011-2013

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Abstract: *On the basis of 3 year analysis (2011-2013) and the set of long-term data on the dynamics and size - age structure of the Black Sea sprat Sprattus sprattus L. in Bulgarian Black Sea coast to assess the population status in the region and possible changes. The results indicate that the biological status of the population of sprat to Bulgarian coast for the period 2011-2013 shall remain in an unstable position.*

***Key words*:** *Marine biology, Ichthtyology, sprat (Sprattus sprattus L), size – age, Bulgarian Black Sea Coast.*

Introduction

The Black Sea sprat *Sprattus sprattus* L. is one of the most common fish species in the Black Sea. Due to their large number, sprat (*Sprattus sprattus* L.) plays a very important role in the ecosystem of the Black Sea as an intermediary between zooplankton and representatives of higher trophic level. At the same time catches of sprat is an important issue that has traditionally been discussed in all Black Sea countries.

Catches of sprat *Sprattus sprattus* L in the Bulgarian and Romanian waters of the Black Sea is limited by the existence of quota that applies only to countries under the European flag. There is no limit to catch in other Black Sea countries.

According Daskalov et al. (2012), the use of the stock of this species at a regional level is unsustainable because the value of the coefficient of fishing mortality in 2011, F = 0.811, which corresponds to a coefficient of exploitation of E = 0.46, that exceeds the reference value of $E \leq 0.4$ (FMSY proxy) [2]. Catches of sprat *Sprattus sprattus* L by the Bulgarian coast of the Black Sea is of quoting a TAC of 8032.5 and Bulgaria uses 45% of this quantity.

Stock assessment of sprat *Sprattus sprattus* L the Bulgarian Black Sea coast by swept area method was performed in the period 2007 - 2010, from Raykov et. al (2007, 2008, 2009, 2010). The relative biomass of species varies between 29 189 -75 080.2 tons.

According to recent research Daskalov et al. (2012) spawning stock biomass (SSB) of sprat (*Sprattus sprattus* L.) in the Black Sea range in medium to high levels: 300 - 400 000 tons in the examined years. Provided that catch in the Black Sea does not exceed 64,000 tons and fishing mortality F stay in the same range the stock will be approximately the same level until 2014, but given that only Bulgaria and Romania have catch quotas for sprat assumptions about the specific catches cannot be given.

Material and methods

In 2011 – 2013 years 23630 sprat species were collected. The sampling was carried out by pelagic trawls, cast nets and traps from different regions on Bulgarian Black sea coast. For the determining the total number and biomass of sprat (*Sprattus sprattus*) and establishing population parameters annual surveys of catches of that species are carried out. The samples were collected in accordance with the theory of variation statistics. Analysis of size - age and sex structures is conducted to a standard method. Otoliths were observed under the microscope of the conductive light measured absolute length and data processing was done, both through the construction of a variation series with class interval 0.5 cm and as individuals. The samples represent the random sample of the total catch, particular specimen are not selected. Each sample contained at least 200 specimens. The conditioning factor (K) was determined by size classes, and also individually.

In this study were presented the following sprat population parameters: mean length and growth, Fulton’s condition factor [11].

Results and discussion

For study the structure and size of the population of sprat and its dynamics we use indicators of average length.

Tab.1 Average length by months and years of sprat (*Sprattus Sprattus*).

Months	Average length		
	2011	2012	2013
I	8,74	7.98	
II	7,83		
III	9.26	6.65	6.83
IV	9.19	9.24	7.66
V	8.55	8.28	7.83
VI	7.84	7.48	7.7
VII	7.84	7.17	6.99
VIII	7.9	7.46	7.3
IX	8.03	8.01	7.83
X	8.06		8.04
XI	8.86		
XII	8.83		

As you can be seen from Tab. 1, the average size decreased significantly during the three years. The reduction of the average weights and sizes can be connected to increase the population at the expense of weight and size of sprat. With the advancement of spring season - adult fish decreased in size, whereas the number of small and young fish in the catch increases [14].

Linear increase of sprat in the winter months of three years, declined significantly. During the summer months the three years show a fluctuation in linear dimensions and weight, but their values do not vary with large deviations.

According to Froese and Sampang (2012), the stock will have the necessary proportion of adult fish, if the average length in catches ranges Lopt +/- 10%, т.е 0.9 Lopt < Lmean < 1.1 Lopt. For the calculation of the equation Lopt is used: logLopt = 1.0421 * logL∞ - 0.2742 [4]. Where: L∞ - asymptotic length, Lopt is the length class giving highest yield. For the calculation of the reference value (Lopt) for sprat, are used values of parameters in the equation on Bertalannfy, calculated by Ivanov (1983) for the period 1976 – 1981 and Prodanov et.al. (1997) for 1977 – 1990. It is considered for these periods that the population of the species was in good condition and it is still no major negative impact of fishing. According to Ivanov (1983), asymptotic length of sprat in the period 1976 - 1981, was 13.41 cm and the estimated value of Lopt e 8.0 cm while Prodanov et.al. (1997) is estimated that asymptotic length of sprat in the period 1977 – 1990 ranging from 12.02 cm to 16.05 cm and the estimated values for Lopt vary between 7.1 and 10.1 cm, and the average value for the period was 7.99 cm. Reference value accept Lopt = 8 cm, with a tolerance of 10% of this value [3], or limits are respectively 7.20 cm < Lmean < 8.80 cm. The population levels of sprat in the Bulgarian Black Sea coast is assessed by applying a grading scale, which is based on the average lengths of catches to the reference value (Lopt) [15] – Tab.2.

Tab.2 Scale for the classification of the population status of sprat according to the average length of fish (Lmean), [15].

Status of the population (MSFD)	***S.sprattus* (Lopt=8.0 cm)**	
	Good	Low
Avg. values	8	<7.2
Limit values	7.2≤Lmean≤8.8	Lmean<7.2
EQR		

According to the calculations and performance in both tables tab.1 and tab.2, clearly distinguish 2013, tendentiously weight decreased.

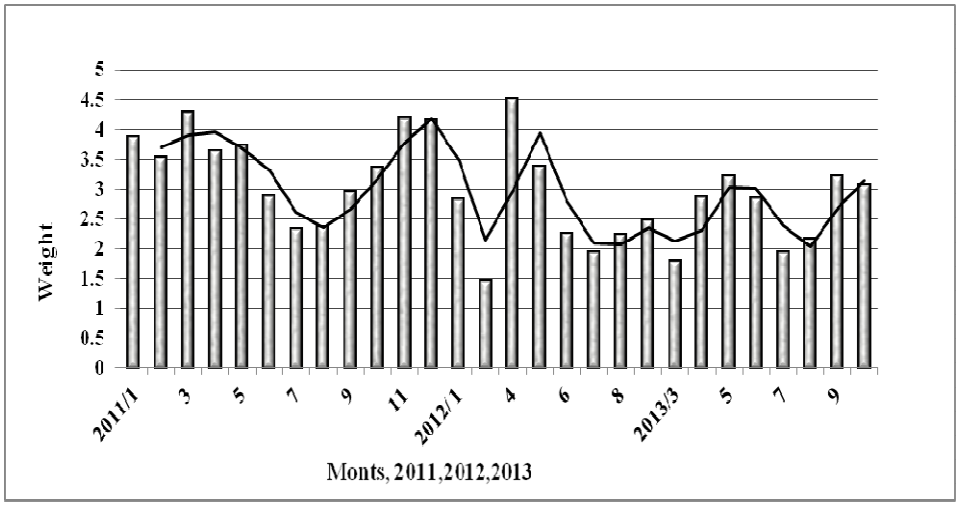

Fig.1 Weight sizes for 2011, 2012 and 2013.

The results obtained can make the following conclusions:

- Differences in the size structure of sprat may show diversity of population level and thus the possibility of the existence of not only one subspecies, but at least two.

- It's possible that the reduction of average size is due to over-exploitation of this species.

As it is known [16], the age structure of the population (species), which is characterized by the presence of different age groups (different generations) it is one of the biological structures of the population, with the gender, which reflects the intensity of the reproduction, mortality and the rate of change of generations. Age structure depends on the genetic characteristics of the population and the specific conditions of existence, the type changes and thus allows successfully adapting and surviving in the new environment. Age structure is an indicator of the state of the population, based on the rate of change a forecast is possible and early identification and development of measures for management of the species concerned can be made [17].

In the 2011-2013 year age composition of the population of sprat *S.sprattus* to the Bulgarian Black Sea coast was represented by three annual class (generations). As is evident from Fig. 2 in 2011 0, 0+ annual 0.5% in 2012 increased to 2.09% to reach the 5.13% in 2013. For 1,1+ annual is observed a tendency to increase as from 37.82% in 2011, they reached 76.77 percent in 2013, and for 2,2+ annual negative trend as from 56.21% in 2011 to 18.09% for 2013.

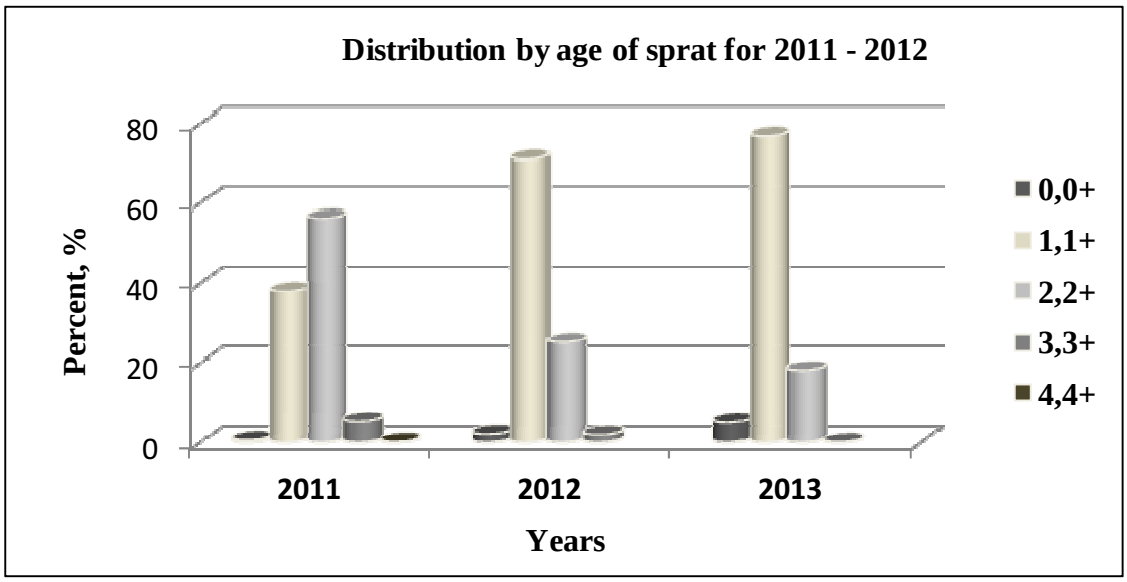

Fig. 2 Percentage distribution of age groups for 2011, 2012 and 2013.

In 2011-2013 the age composition of sprat was represented by only three generations with a strong predominance of one-year, to reach almost 80% in 2013. This should be indicated as „deterioration" of the quality of the population, its rejuvenation. As a result, the average age of the population is reduced.

In the period 2011-2013, the rate of conditioning factor varies in a narrow range, while at the senior age groups it marks the highest values. Average (0.55) is close to the average multiannual values (Fig. 3), indicating relatively good condition of sprat in the period.

The values of the coefficient, increased after spring, which is associated with the completion of the breeding season and the increase in summer, which is associated with the active, grow out. In the coming autumn and winter months the value is retained due to preparation for the breeding. (Fig. 3)

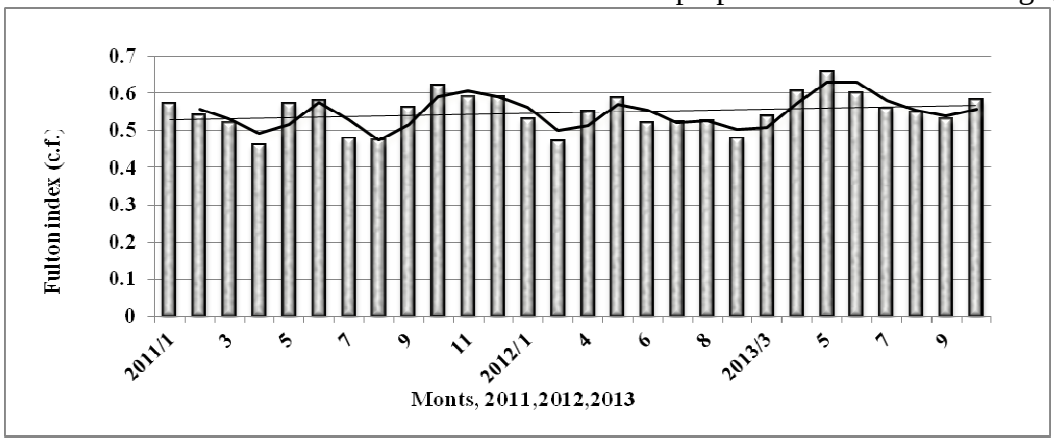

Fig.3 Fulton index by months for 2011, 2012 and 2013.

Among the many factors that can affect the size and structure of sprat and the amount of catch, three main are considered - climate, trophy base and overfishing. The greatest impact of the first two factors can be expressed in weight change, seasonal and annual dynamics (average weight, fatty content and nutritional status). In reality, climate change and food supply can lead to inhibition or acceleration of growth, and thus to change the length of the fish in the catches. But identifying these effects requires special studies [14].

Conclusions

Based on the analysis of the most important biological indicators of sprat (*Sprattus sprattus*) for the period 2011-2013 the following conclusions can be made:

1. There is a shortening of the size and age structure, as older age groups - 4 years and 5 years, maximum age of the species are missing. Fluctuations in the size and age structure of the species, most probably due to the combined effects of the biology of the species, the peculiarities of reproduction, fishing pressure and environmental factors.

2. Sprat (*Sprattus sprattus*) stocks in the Black Sea are at risk of overexploitation. Save fishing status quo would involve catch in a range of 75,000 to 85,000 tons in 2011 to 2013, which are above the recommended catch of 64,000 tons of F msy [2].

3. As a whole improvements in the nutritional status of sprat in the study period.

4. According to recent research Daskalov et al. (2012) spawning stock biomass (SSB) of sprat (*Sprattus sprattus*) in the Black Sea varies in medium to high levels: 300-400 000 tones in recent years. Provided that the catch in the Black Sea does not exceed 64,000 tons and fishing mortality F remain in the same range the stock will be approximately the same level until 2014, but given that only Bulgaria and Romania have catch quotas for sprat assumptions for specific quantities catch cannot be given.

5. Commercial catch in Bulgaria is composed of 1-1 + 2-2 + and age specimens. Samples taken from Turkish pelagic trawlers operating in shallow water (40-60 m) confirm the trend that 3-3 + 4-4 + and annual sprat spreads mostly in deeper waters [2].

The analysis of the basic parameters of the population of sprat *Sprattus sprattus* indicates that the stock has recovered from depression in 1990 thanks to the best addition in 1999 -2001 and biomass and catches are increasing gradually in the 1990s and in the 2000s to levels comparable to the previous period of high abundance from 1975 to 1989. Stock assessments show cyclical nature and dynamics of the population. The years with high recovery followed by the years with low to medium addition, which leads to corresponding changes in spawning biomass (SSB). High fishing mortality (F1-3) is observed during the collapse of the stock at the beginning of 1990, in 2004-2005 and 2009-2011. In 2011, the highest total catches of 120,710 tons mainly due to the intensive development of the Turkish fishing. Over the past four years the levels of additions, biomass and catch are comparable with the highest reported figure, but in 2009-2011 there was a decrease [2].

Disintegration of the population of sprat, which is observed by at least one decade, can result in a change in the "quality" of the population, which in turn changes the genotype and lead to evolutionary changes [13].

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