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# Stock Assessment of *Scophthalmus maximus* in Bulgarian Black Sea zone during autumn 2015

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## Резюме

Настоящата статия се базира на данни относно размерно - тегловния състав, възрастта, нарастването и половата структура на калкана (*Scophthalmus maximus*), събрани по време на трална снимка, проведена през м. декември 2015 г. Тези данни позволяват да се определи разпределението на относителната биомаса на калкана пред българския бряг на Черно море.

Извършени са биометрични измервания върху 121 екземпляра, чиято абсолютна дължина варира между 24 и 71 см, при тегло - 220 и 6750 гр.

Установен е темпът на нарастване и размерно - тегловното съотношение (общо за двата пола):  $W = 0.00347L^{3.48}$ . Изчислени са параметрите в уравнението на von Bertalanffy:  $L_{\infty} = 74.73$ ,  $k = 0.326$ ,  $t_0 = -0.188$ . Наблюдава се следното процентно съотношение между полове и възрастови стадии: 42.98% ювенилни: 38.02% женски: 19.00% мъжки екземпляри.

**Ключови думи:** *размер, тегло, нарастване, Scophthalmus maximus*

## Introduction

The species *Scophthalmus maximus* (Linnaeus, 1758) belongs to the family Scophthalmidae, widely distributed in the north-eastern Atlantic, the Baltic Sea, Mediterranean Sea, and the Black Sea (Nelson 2006).

In the Black Sea, anoxic conditions exist below 180 - 200 m depth, which limits the distribution of the demersal fishes (STECF, 2015). Thus, the turbot occurs in the shelf area up to 140-180 m depth, though the species could perform relative-

ly short distance migrations for spawning and feeding. The turbot spawns in the coastal area in spring (20-50 m depth), while in summer it inhabits zones with depth of 40-90 m and occupies depths 50-140 m during the winter period (Karapetkova, 1964). Turbot feeds on demersal and pelagic fish species, crustaceans and molluscs. The feeding rate increases in autumn and winter but it slows down during the spawning period (Slastenenko, 1956; Karapetkova, 1980; Ivanov and Beverton, 1985).

The turbot has been fished by all Black Sea riparian countries, as fisheries is based on stationary and mobile fishing gears (gillnets and bottom trawls) (STECF, 2015). The main fishing grounds cover the shelf zone up to 140 m depth. The turbot fishery takes place from the beginning of September until the end of April with peak in spring - from mid-March until the end of April. This period partly overlaps with the spawning season (Zengin, 2000).

The turbot is among the most valuable fish species in the Black Sea and has been subject of overfishing since 1980s. The amount of illegal, unregulated and unreported fisheries (IUU) of turbot is high (STECF, 2015). Since entering the EU in 2007, Bulgaria and Romania applied the system of total allowable catch (TAC) and quotas to preserve the turbot stock, Currently, the quota for turbot catch of the both countries is ~ 86 tons, distributed equally between Bulgaria and Romania. The other riparian countries use different regulatory measures - such as catch and mesh size control, time and area closures and minimum admissible size for catches (that varies between 40-45 cm total length).

In the present paper, information about the turbot population parameters and exploitation biomass in front of the Bulgarian Black Sea coast during the autumn season of 2015 is presenting. In Bulgaria, bottom trawl surveys for turbot stock assessment have been performed annually under the frame of National Fisheries Data Collection Program. During the surveys, data for abundance and weight of turbot specimens per trawl catch, absolute and standard length, sex ratio and otoliths for age determination are collected. The obtained results are applied for calculations of the relative biomass, spatial distribution analysis, estimations of total allowable catch (TAC) and annual quota.

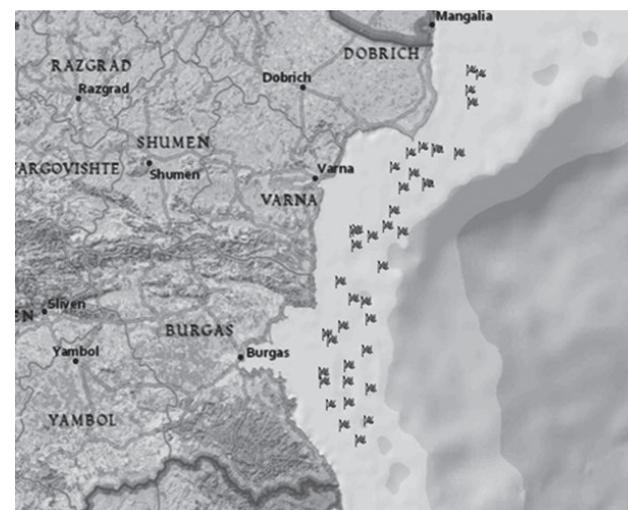
## Material and Methods

The bottom survey for turbot stock assessment along the Bulgarian Black Sea coast was executed during the 4th quarter of 2015 (XII/2015). Standard methodol-

ogy for stratified sampling (Gulland, 1966; Sparre, Venema, 1998,1992; Sabatella, Franquesa, 2004) was applied to assess the turbot relative abundance and biomass.

The filed data were collected by application of a standard gear - bottom trawl (with vertical opening - 2 m and effective part of wing spread -13 m), by trawl speed - 2.2 -2.5 Nd, and trawling duration - 60 min.

A total of 38 hauls (Fig. 1) were performed at depths 15-100 m, including three main stratum - 15-50 m, 50-75 m, 75-100 m and covering the entire continental shelf between Durankulak (north) and Ahtopol (south).



*Fig.1 Map of the surveyed sectors, XII/2015.*

On the ship board, the absolute and standard length, as well as the individual weight of each specimen were measured to determine the size and weight structure of the turbot stock and to estimate the share of juveniles with total length < 45 cm, which is the allowable fishing length. A total of 121 turbot specimens were collected and biometric measurements were accomplished together with qualitative and quantitative analysis of the catches.

Data analysis was performed by the “swept area method” (Sparre and Venema, 1992, 1998). The biomass was presented as catch per unit area (CPUA) that is considered as a common index used in stock assessment and a measure of the relative fish abundance (Haggarty and King, 2006).

## Results and Discussion

### Trends in abundance and biomass

In December 2015, the turbot yields by stratum (Fig.2) were as follows:

- Stratum 15 - 50 m: The relative turbot biomass varied between 0 - 279.27 kg/km<sup>2</sup> and reached 111.54 kg/km<sup>2</sup> on average. In this stratum, the abundance indices varied between 0 - 149 ind/km<sup>2</sup>, with average value - 61 ind/km<sup>2</sup>. In the shallowest zones (at a depth up to 30 m, stations H5, G6 and D9), the biomass reached relatively high values - 279.27 kg/km<sup>2</sup>, 186.96 kg/km<sup>2</sup> and 77.54 kg/km<sup>2</sup>, with respective abundance - 116 ind/km<sup>2</sup>, 100 ind/km<sup>2</sup> and 50 ind/km<sup>2</sup>.
- Stratum 50 -75 m: The average turbot biomass reached the highest values in this stratum - 142.75 kg/km<sup>2</sup> (fluctuating between 43.17 - 276.61 kg/km<sup>2</sup>) with mean abundance of 66 ind/km<sup>2</sup> (varying from 17 to 116 ind/km<sup>2</sup>).
- Stratum 75 - 100 m: In this stratum, the individual catch (station F18) reached maximum of 311.32 kg/km<sup>2</sup>, however at most of the stations, turbot specimens were not gathered, thus the average value of biomass was the lowest - 50.31 kg/km<sup>2</sup>, besides the average abundance reached 18 ind/km<sup>2</sup>.

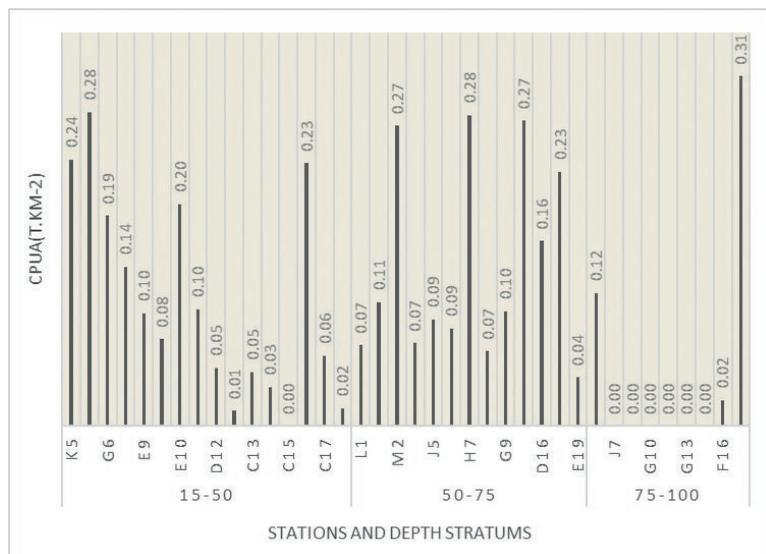


Fig.2. Relative biomass (t.km<sup>-2</sup>) of *S. maximus* by strata off the Bulgarian Black Sea coast, December 2015.

During the survey, the relative biomass varied between 0 kg/km<sup>2</sup> - 311.32 kg/km<sup>2</sup>. The spatial distribution of the estimated CPUA indexes of the turbot abundance is presented in Fig. 3.

High relative biomass was established in five main sectors of the Bulgarian Black Sea zone - off the Cape Shabla (60-70 m depth), in the region between Kaliakra and Albena (27-37 m depth), in the sector Varna - Byala at a depth of 46 - 60 m, between Sozopol and Duni (56-72 m), and in the zone between Ahtopol and Tsarevo (77-80 m).

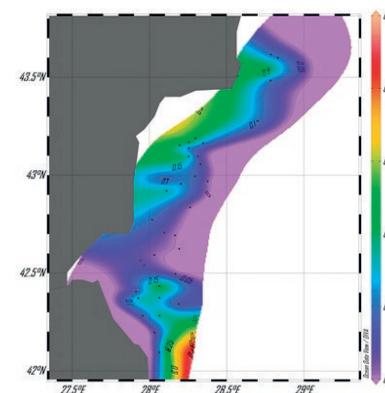


Fig 3. Distribution of the relative biomass (CPUA, t.km<sup>-2</sup>) of *S. maximus* along the Bulgarian Black Sea coast in December 2015. (The zones with high relative turbot biomass are shown in green and yellow).

The turbot biomass in the Bulgarian Black Sea waters was assessed at 1248.516 tons. The recommended maximum sustainable yield (MSY) for Bulgaria should not exceed 124.85 t., thus it is assumed that the total allowable catch (TAC) of turbot in the Bulgarian waters could comprise 50 tons as a relatively acceptable quantity.

### Trends in abundance by length, age and sex ratio

The absolute length of the measured specimens fluctuated between 24 - 71 cm, with weight - 220 - 6.750 g. Out of the total number of 121 specimens, 1.65 % were with length < 30 cm, 19.84% belong to the size group 30 - 40 cm, 42.15% - between 40-50 cm, 32.23% - in the range 51-60 cm and 4.13% - between 61-71 cm (Fig.4). Hence, the dominating size groups, forming together 74% from the total abundance were two - 40-50 cm (including juveniles) and 51-60 cm. In the turbot

length structure, the undersized individuals, with length < 45 cm, formed 42.98% from the total number, while those of standard length made up 57.02%.

Simultaneously, the age structure included 1+ to 9+ years classes, with domination of the 3+ (33.83%) and 4+ (20.66 %) – years (54.49 % in total), followed by 5+ year class – 17.36 %. The share of the replenishment - 2+ years class was 19.01 % (Fig.5). Although having small frequency of occurrence, specimens from 6+ to 9+ years classes were registered in the yield.

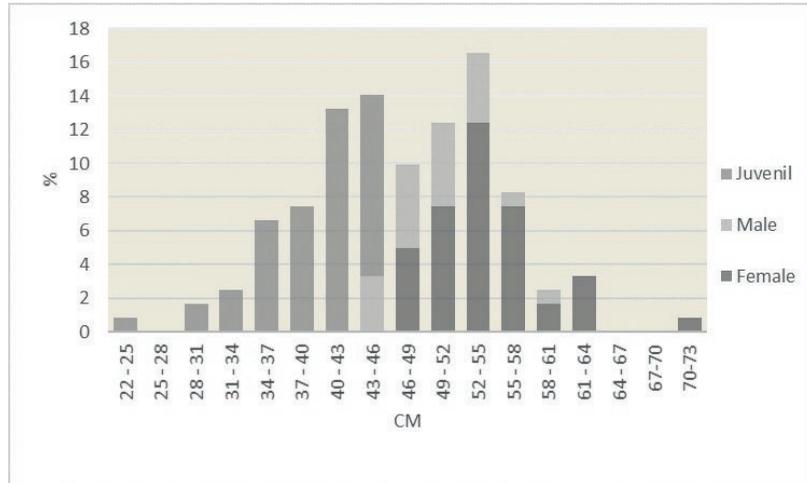


Fig.4. Length structure (%) of *S. maximus* in autumn 2015.

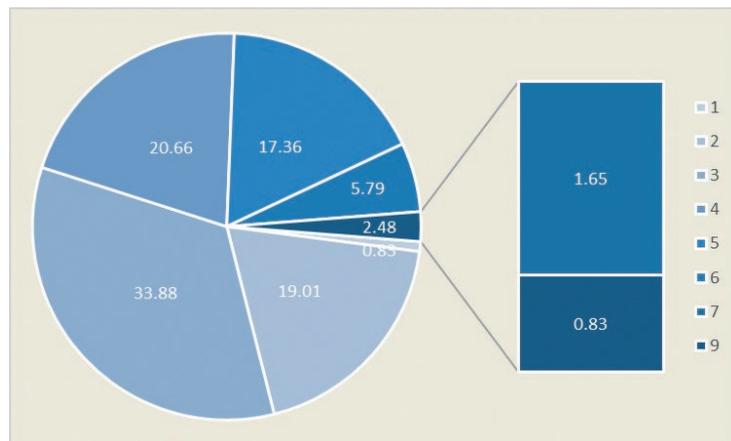


Fig.5. Age structure (%) of *S. maximus* in autumn 2015.

The calculated values of the parameters in von Bertalanffy's and L-W equation are as follows:  $W = 0.00347 * L^{3.41}$ ,  $L_{\infty} = 74.73$ ,  $k = 0.326$  and  $t_0 = -0.188$ .

The sexually immature individuals were 42.98%, females - 38.02%, and males 19.00% (Fig 6.), and from the total abundance the females contributed with 40.7 %, while males formed 28.6 % respectively.

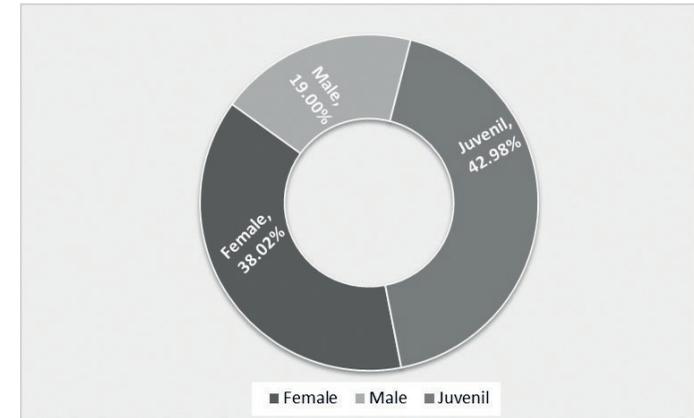


Fig.6. Sex structure (%) of *S. maximus* along the Bulgarian Black Sea waters in December 2015.

During the autumn season of 2014, the share of sexually immature individuals formed 30.80 % of the entire yield (Tserkova et al, 2014, 2015). Therefore, the sexually mature individuals prevailed by number in 2014-2015, with share of 69.3% from the total abundance in 2014, and 57.02% in 2015, with a certain decrease by 1.21 folds.

## Conclusions:

- The turbot biomass in the Bulgarian Black Sea waters was assessed at 1248.516 tons. The average biomass reached the highest values in the stratum 50-75 m - 142.75 kg/km<sup>2</sup>, followed by the stratum 15-50 m - 111.54 kg/km<sup>2</sup>. At the deepest stratum (75-100 m), the mean biomass attained the lowest levels - 50.31 kg/km<sup>2</sup>, in spite of the fact that the maximal individual catch during the survey - 311.32 kg/km<sup>2</sup> occurred at this depth.
- The size structure of the turbot population in the Bulgarian Black Sea zone included length classes from 24 cm to 71 cm, with weight between 220 g and 6750 g and the average turbot weight was estimated as 2037.43 g. In

the length structure, the undersized individuals, with length < 45 cm, formed 42.98% from the total number of collected specimens, while those of standard length made up 57.02%.

- The age composition of the population included age classes from 1+ to 9+ years of age, with domination of the 3+ (31.40%) and 4+ (23.14%) - year classes.
- The established ratio between female, male and sexually immature individuals in the yield was 38.02%: 19.00%: 42.98%.
- The recommended MSY (maximum sustainable yield) for Bulgaria should not exceed 124.851 t., it is assumed that the total allowable catch (TAC) of turbot in the Bulgarian Black Sea waters could comprise 50 tons as a relatively acceptable quantity

## Acknowledgement:

This study was conducted owing to the financial support of the European Commission in compliance with Council Regulation No. 199/2008 and Commission Decision 2010/93/EU, aimed to help the member states for creating a common frame for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy.

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