

REPORT

Bottom Trawl Surveys In The Bulgarian Black Sea Area

Autumn 2018

Agricultural Academy

Institute of Fish Resources (IFR, Varna)

2019



ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА
МОРСКО ДЕЛО И РИБАРСТВО



МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО, ХРАНИТЕ И
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The present study was conducted by a team of specialists from the Institute of Fishery Resources (IFR) – Varna, Agricultural Academy, under contract № /D-156/16.05.2018г with the National Agency for Fisheries and Aquaculture (NAFA) - Burgas, for turbot stock assessment in the Bulgarian Black Sea waters during the autumn-winter period of 2018. The 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.

The study was performed in the period 21 - 30 December 2018 in the Bulgarian Black Sea waters on board of the "EGEO 2" fishing vessel.

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**BOTTOM TRAWL SURVEY FOR TURBOT STOCK ASSESSMENT IN BULGARIAN BLACK SEA SECTOR
DURING AUTUMN SEASON OF 2018**

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BOTTOM TRAWL SURVEY FOR TURBOT STOCK ASSESSMENT IN BULGARIAN BLACK SEA SECTOR DURING AUTUMN SEASON OF 2018

1. Results from the National Bottom Trawl Surveys in December 2018

During 21 - 30 December 2018, within the frames of the National Programme for Fisheries Data Collection, the research team from IFR - Varna has conducted a demersal trawl survey with the fishing ship "EGEO2" in the Bulgarian Black Sea waters - between Durankulak and Ahtopol, within the 100-meter isobath.

The filed survey has included the following main activities:

- Bottom trawl sampling;
- Qualitative and quantitative analysis of the catches, identification of biological diversity, biometric measurements;
- Collection of otoliths for turbot age determination;
- Sampling and analysis of stomach contents for identification of quantity and composition of the consumed food.

Through the filed survey and laboratory analysis, a dataset has been prepared, allowing assessment of the relative biomass and abundance of the reference species *Scophthalmus maximus* in Bulgarian Black Sea waters. The current report is focused on the estimation of turbot biomass indexes and density by depth strata and includes study on length/weight, age and sex structure of the turbot population.

This document contains a series of tables and figures that represent the distribution of relative abundance and analysis of turbot population - size/age and sex structure, estimation of the L-W relationship, calculations of growth rate and biological parameters, based on *Von Bertalanffy* equations and examination of turbot diet composition.

1.1. Fishing vessel and fishing gear

The trawl surveys were conducted on board the fishing ship "EGEO2" (picture 1) with the following parameters:

- Fishing vessel - TAKA;
- Fishing vessel length -17 m;

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- Maximum width - 6 m;
- The fishing vessel year of built - 2007;
- Engine power – 367.75 kW;
- Maximum tonnage – 38.24t;
- Net tonnage – 11.43 t;
- Speed – 9.5 Nd;
- Crew - 3 people;
- Research team - 3 people.



Picture 1. Fishing ship

During the studies, a fishing bottom trawl 22/27-34 was applied (picture 2), with following functional and technical parameters:

- Trawl vertical opening - 2 m;
- Horizontal opening between the otter boards - 9 m;
- Effective part of wing spread - 13 m;
- Trawling speed - 2.2 - 2.6 Nd;
- Trawling duration - 60 min.
- Mesh size - 200 mm.

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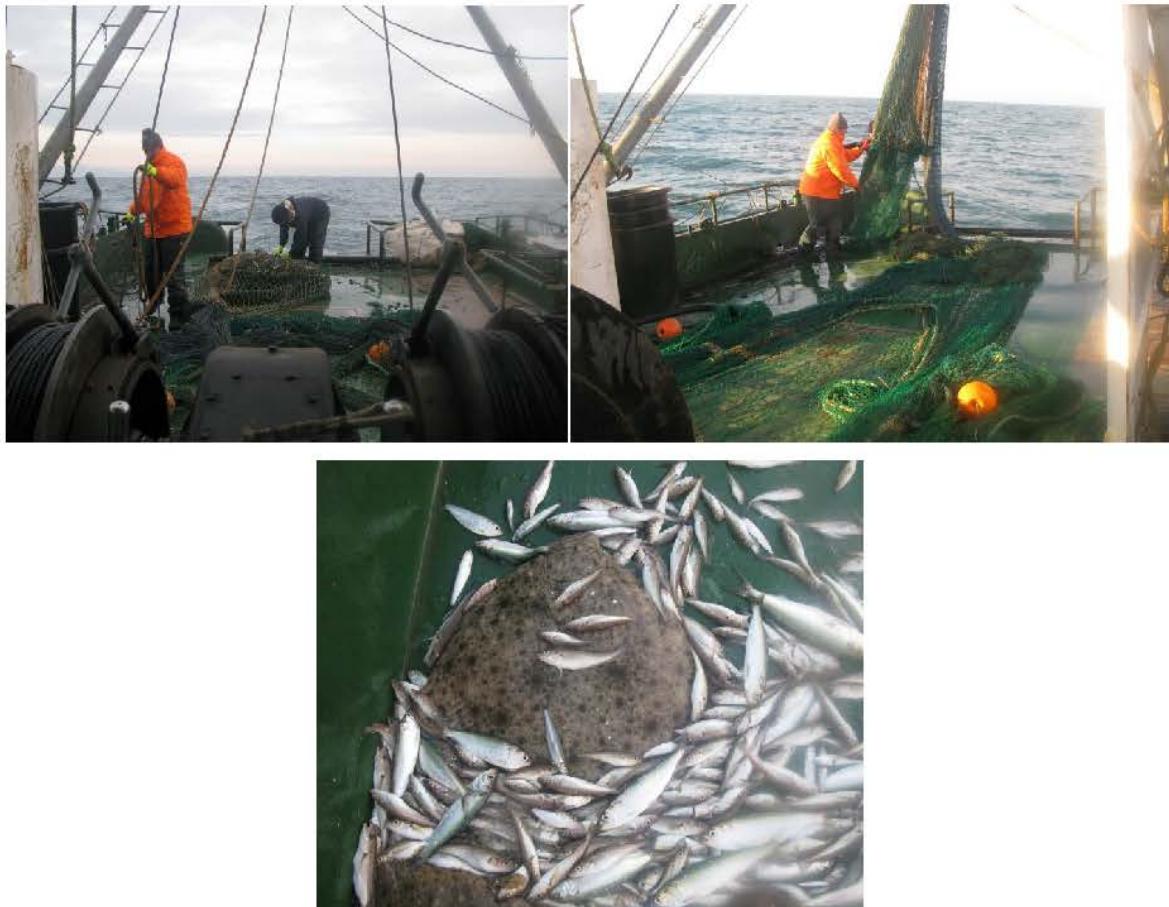
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Picture 2. Bottom trawl 22 / 27-34.

2. Material and methods

The target species of the demersal survey was turbot (*Scophthalmus maximus*), and the by-catch species - the spiny dogfish (*Squalus acanthias*), the thornback ray (*Raja clavata*) and the European flounder (*Platichthys flesus*) were also measured and analysed.

The methodology and techniques, used for data collection, verification, processing and analysis and for complete turbot stock assessment were following the generally applied methodology in the Bulgarian Black Sea zone.

The field data were collected by standard techniques - bottom trawl that remained constant through the surveys. The GPS system of the ship was connected to

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NAFA satellite system for monitoring of the fishing vessels (VMS) and the ship location was strictly controlled during the trawling.

2.1 Information collected through the bottom trawling

- Depth - measured with the echo-sounder;
- GPS coordinates of the trawling - starting and end points;
- Trawling duration;
- Abundance of fish species in the trawl;
- Weight of the total catch in the trawl;
- Absolute and standard length; weight of collected specimens;
- Collection of otoliths for age determination;
- Sex identification;
- By-catch species composition;
- Turbot stomachs for stomach content analysis;

For turbot biomass calculations, data for catch per unit effort (CPUE) (kg/h) and catch per unit area (CPUA) (kg/km²) were used.

The results are presented in the form of maps and tables that include data for:

- Catch per unit effort (kg/trawl)
- Catch per unit area (t/km²);
- Abundance index (individual/km²);
- Limits of variation of catches per unit area;
- Total biomass (t.) and abundance (ind).

2.2. Sampling scheme

To establish the abundance and biomass of the reference species *S. maximus* off the Bulgarian Black Sea coast, a standard methodology for stratified sampling (Gulland, 1966; Sparre, Venema, 1998; Sabatella, Franquesa, 2004) was applied. The zones, where trawling was performed, are presented in Figure 1.

The surveyed region was divided into four strata, depending on the depth – Stratum 1 (15 - 35 m), Stratum 2 (35 - 50 m), Stratum 3 (50 - 75 m) and Stratum 4 (75 - 100 m). For assessment of turbot abundance and biomass, the surveyed territory was divided into 143 squares, each of them with sides 5 x 5 Nm, area 25 Nm² (or 85.8569 m²). The sampling was carried out at 40 randomly chosen fields (rectangles), situated at depth between 15-100 m. Each rectangle is with sides 5'Lat x 5'Long, while the total

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area is 62.58 km^2 (measured by GIS). Each field was marked with letters and digits for better distinction.

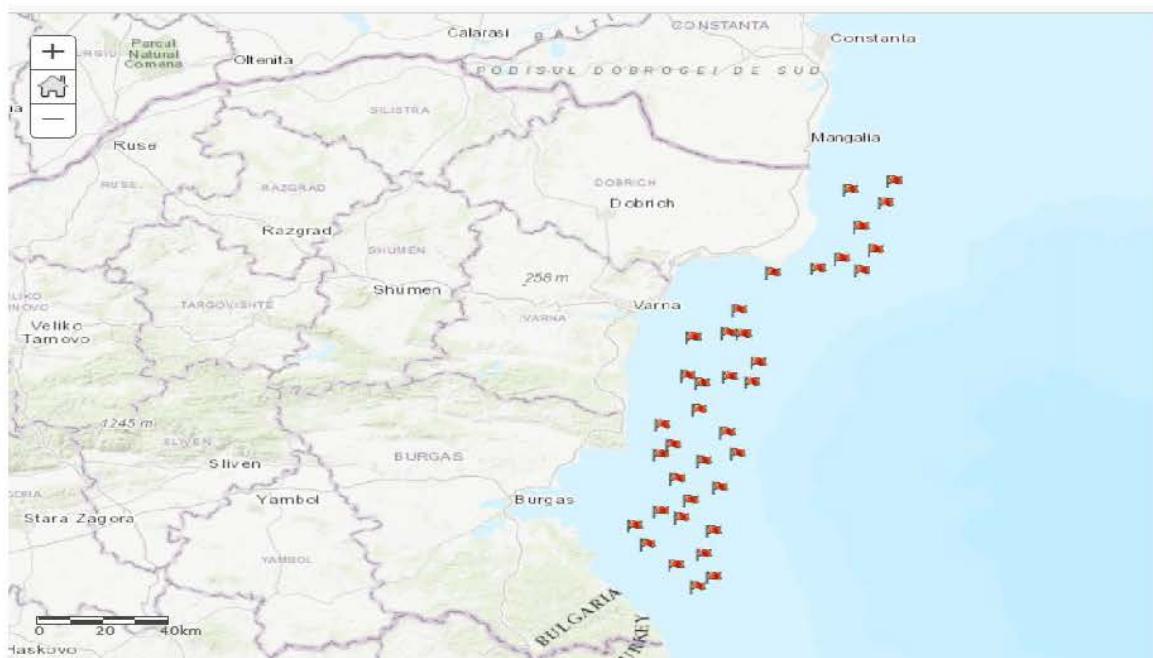


Fig. 1. Map of the surveyed sectors, XII/2018

The seabed area covered during a single haul represents a basic measurement unit, considered representative, as turbots do not aggregate in dense assemblages (Martino, Karapetkova, 1957).

The duration of each hauls was 60 min. at trawling speed of 2.5 knots.

On the ship board, the absolute and standard length, as well as the individual weight of each specimen were measured in order to determine the size and weight structure of the turbot stock and to estimate the share of specimens with length below the allowable fishing length in the catches.

2.3. Laboratory analyses

After collecting the samples on shipboard, the age, maturity of the reproductive system and stomach content composition were determined in laboratory.

The turbot age was established by otoliths reading under binocular microscope.

To identify the food composition, a total of 52 stomachs were collected in autumn 2018. The stomach content analysis included identification of the taxonomic

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composition and total number of food components, weight and frequency of occurrence of each food component. The index of relative importance (IRI) was used to determine the significance of each food component in the trophic spectrum (Pinkas et.al., 1971):

$$IRI = (C_N + C_W) * F,$$

C_N - percentage share of the food item i in total number; C_W - percentage share of the food item i in the total weight; F – frequency of occurrence.

IRI expressed as a percentage was calculated by the equation (Cortes, 1997):

$$\%IRI_i = \frac{100 * IRI_i}{\sum_i^n IRI_i}$$

n – total number of the taxonomic categories at a given taxonomic level

2.4. Statistical methods

Swept areas method

To determine the relative biomass of the reference species *S. maximus*, the "swept area method" was applied. According to this method, trawl sweeps a well-defined path, the area of which is the length of the path times the width of the trawl, called the "swept area" or the "effective path swept", thus the swept area can be estimated from equation:

$$a = D * hr * X2, D = V * t$$

V - is the velocity of the trawl over the ground when trawling, t - the time spent trawling, hr - the length of the head-rope. $X2$ is that fraction of the head-rope length, hr , which is equal to the width of the path swept by the trawl, the "wing spread", $hr * X2$, D - distance covered.

To calculate turbot biomass, the catch per unit area (CPUA) was used:

$$\frac{C_{w/t}}{a/t} = \frac{C_w}{a} kg/km^2$$

C_w/t – catch in units of weight per trawling hour, a/t – area swept per trawling hour.

The biomass for each stratum was obtained from equation:

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$$B = \overline{C_{w/a}} * A$$

$\overline{C_{w/a}}$ - mean catch per unit of area for all trawl sweeps in the stratum, A – stratum area.

The variance of biomass estimated for each stratum is:

$$VAR(B) = A^2 * \frac{1}{n} * \frac{1}{n-1} * \sum_{i=1}^n [Ca(i) - \overline{Ca}]^2$$

The total area of the surveyed region is equal to the sum of the areas of every stratum:

$$A = A_1 + A_2 + A_3$$

The mean catch for the entire survey area was obtained from equation:

$$\overline{Ca}(A) = \frac{Ca_1 * A_1 + Ca_2 * A_2 + Ca_3 * A_3}{A}$$

Ca1- catch per unit area in stratum 1; A1 – stratum 1 area, etc.; A – total water area.

The total biomass in the survey area is estimated by equation:

$$B = \overline{Ca}(A) * A$$

$\overline{Ca}(A)$ - mean weighted catch for the entire surveyed water area, A – total area surveyed.

Maximum sustainable yield

Gulland's formula for virgin stock is:

$$MSY = 0.5 * M * B_v$$

M – coefficient of natural mortality, B_v- biomass of virgin stock.

A generalized version of Gulland was proposed by Cadima (in Troadec, 1971) for exploited fish stocks for which only limited data are available for stock assessment:

$$MSY = 0.5 * Z * \overline{B}$$

\overline{B} - mean annual biomass, Z – total mortality.

Because Z = F + M and Y = F * \overline{B} , Cadima suggested that in the absence of data for Z, the equation can be rewritten:

$$MSY = 0.5 * (y + M * \overline{B})$$

y – total catch in one year, \overline{B} - mean biomass in the same year.

TAC - total allowable catch, Prediction models

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Beverton and Holt yield per recruit model (1957):

$$Y/R = F \cdot \exp[-M \cdot (T_c - T_r)] \cdot W_{\infty} \cdot \left[\frac{1}{Z} - \frac{3S}{Z+K} + \frac{3S^2}{Z+2K} - \frac{S^3}{Z+3K} \right]$$

$S = \exp[-K(T_c - t_0)]$, K = von Bertalanffy growth parameter, t_0 = von Bertalanffy growth parameter, T_c = age at first capture, T_r = age at recruitment, W_{∞} = asymptotic body weight, F = fishing mortality, M = natural mortality, $Z = F + M$, total mortality.

To evaluate the exploitation ratio, the formulae of Pauly (1983) was used: $E = F / Z$; E - exploitation ratio, F - fishing mortality, Z - total mortality;

Jones' Length-Based Cohort Analysis (1981)

Jones' length-based cohort analysis:

$$\exp\left(\frac{M}{2} \cdot \Delta t\right) = \exp\left[\frac{M}{2} \cdot \frac{1}{K} \cdot \ln\left(\frac{L_{\infty} - L_1}{L_{\infty} - L_2}\right)\right] = \exp\left[\ln\left(\frac{L_{\infty} - L_1}{L_{\infty} - L_2}\right)^{\frac{M}{2K}}\right] = \left[\frac{L_{\infty} - L_1}{L_{\infty} - L_2}\right]^{\frac{M}{2K}}.$$

Age and growth

For the estimation of turbot growth rate, the von Bertalanffy growth function (1938) was applied, (according to Sparre, Venema, 1998):

$$L_t = L_{\infty} \left\{ 1 - \exp[-k(t - t_0)] \right\}$$

$$W_t = W_{\infty} \left\{ 1 - \exp[-k(t - t_0)] \right\}^n$$

L_t , W_t are the length or weight of the fish at age t years; L_{∞} , W_{∞} - asymptotic length or weight; k - curvature parameter; t_0 - the initial condition parameter.

The length – weight relationship is obtained by the following equation:

$$W_t = qL_t^n$$

q -constant in length-weight relationship; n - constant in length-weight relationship.

Natural mortality (M)

Pauly's empirical formula (1979, 1980) was applied:

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МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО, ХРАНИТЕ И
ГОРИТЕ



$$\log M = -0.0066 - 0.279 * \log L_{\infty} + 0.6543 * \log k + 0.4634 * \log T^{\circ}\text{C}$$

$$\log M = -0.2107 - 0.0824 * \log W_{\infty} + 0.6757 * \log k + 0.4687 * \log T^{\circ}\text{C}$$

L^{∞} , W^{∞} and k – parameters in von Bertalanffy's equation; $T^{\circ}\text{C}$ - the annual average temperature of the seawater in the horizons of habitation and reproduction of the species.

Method of Richter si Efano (1976)

$$M = \frac{1.521}{(t_{mat.50\%})^{0.720}} - 0.155$$

t_{mat} – age at first maturation.

Stock exploitation (E)

is determined by Pauly (1983): $E = F/Z$,
where Z - total mortality, and F - fishing mortality.

3. Results

3.1. Population number and biomass

During the demersal trawl survey in XII/2018, the following activities were carried out:

- 37 hauls with a bottom trawl, with duration of 60 minutes for each trawl at depths between 15 m and 100 m, covering entirely the continental shelf of the Bulgarian Black Sea zone, between Durankulak and Ahtopol.

- for each haul, a qualitative and quantitative analysis of the catch was accomplished, including biometric measurements of 75 turbot specimens, 73 ind. spiny dogfish, 49 specimens of European flounder and 23 specimens thornback ray (*Raja clavata*) (Picture 3,4 and 5).

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Picture 3. Bottom trawling yield



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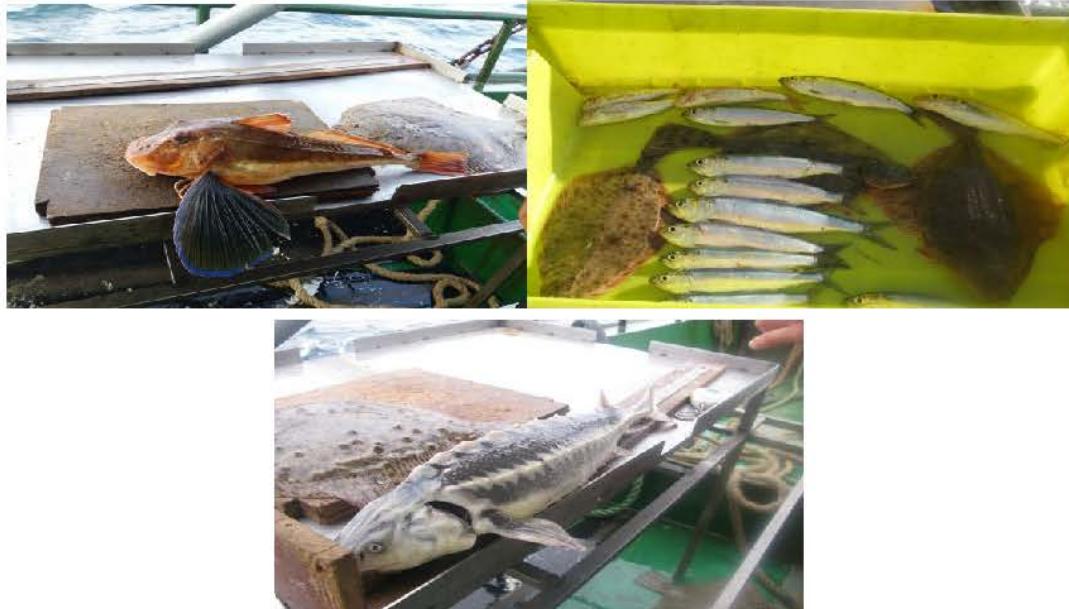
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Picture 4. Yield of turbot (*Scophthalmus maximus*) and associated species *Merlangius merlangus* (whiting), *Platichthys flesus* (European flounder), *Raja clavata* (thornback ray), spiny dogfish (*Squalus acanthias*), *Trigla lucerna* (tub gurnard), *A. immaculata* (Pontic shad), *M. b. ponticus* (red mullet), *Acipenseridae* (sturgeons).



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Picture 5. Conducting biometric measurements and sampling for study of the stomach contents.

Constant presence of *S. maximus* was established in almost all bottom trawls at a depth 50-75 m with yield - at least 1-6 individuals per haul (where catch ≠ 0).

At a depth between 50-75 m and 75-100 m, the average turbot catches were comparable. At nine fields, a high yield was obtained, with ranges between 10.00 to 19.03 kg/trawl.

Seventy three specimens of dogfish (*Sq. acanthias*) were captured during the survey, with size and weight that varied from - 76 см/1.68 kg to 154 см/16.20 kg.

The bycatch included whiting (*Merlangius merlangus euxinus*) (Picture 5), European flounder (*Platichthys flesus luscus* - 49 sp.) and thornback ray (*Raja clavata*). The main part of the catch was composed by a mixture of species - sprat (*Sprattus sprattus*) and red mullet (*Mullus barbatus ponticus*). Among the associated species were identified black scorpionfish (*Scopæna porcus*), black mussel (*Mytilus galloprovincialis*), common jellyfish (*Aurelia aurita*), sturgeons (*Acipenseridae*) Pontic shad (*A. immaculata*) and prawn (*Crangon crangon*).

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Large amounts of marine litter were not found during the current survey.

Comments on the biomass of *Scophthalmus maximus* in the Bulgarian waters by strata

Trawling at a depth of up to 30 m covered only three stations, and due to their small number, they were grouped together with the stations preformed up to 50 m, thus the statistical analysis was conducted for the stratum 15 - 50 m. The biomass of the three shallow stations (at a depth < 30 m) reached respectively 0.0 kg/km², 79.365 kg/km² and 92.813 kg/km², with abundance - 0 ind/km², 66 ind/km² and 66 ind/km². At these stations, the highest yield was found off the Kamchiya, while in front of the Shabla the turbot biomass attained low levels.

The relative turbot biomass ranged in narrow boundaries within the three main strata, and the highest biomass was detected in the stratum 50-75 m - 0.118 t/km², while the average abundance is found again in the same stratum - 42 ind/km² (Table 1, Fig 2 and 3).

The information about the yields by stratum is given below:

Stratum 15 - 50 m

The relative turbot biomass varied between 0 and 280.765 kg/km², 61.01 kg/km² on average (Table 1, Fig. 2). The abundance indices varied between 0 and 66 individuals/km², on average - 31 ind/km² (Table 2).

Stratum 50 - 75 m

In this stratum, the relative biomass was slightly higher than stratum 75-100 and the relative turbot biomass varied between 0 and 315.96 kg/km², 118.09 kg/km² on average (Table 1, Fig. 2 and 3). The abundance indices varied between 0 and 100 ind/km², with average value of 42 ind/km² (Table 2, Fig. 2 and 4).

Stratum 75 - 100 m

The relative turbot biomass varied from 0 to 284.916 kg/km², on average 77.907 kg/km² (Table 1, Fig. 2 and 4), with average abundance - 27 ind/km² (Table 2).

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Table 1
Turbot biomass by strata, December, 2018

15 - 50 м		50 - 75 м		75-100 м	
No. station	t/km ²	No. station	t/km ²	No. station	t/km ²
1	0.093	6	0.130	14	0.227
2	0.001	7	0.138	15	0.285
3	0.000	8	0.103	16	0.206
4	0.281	12	0.000	17	0.000
5	0.122	13	0.120	18	0.044
9	0.041	20	0.000	19	0.044
10	0.016	22	0.059	23	0.310
11	0.000	25	0.185	24	0.000
21	0.040	29	0.047	33	0.085
26	0.118	30	0.206	34	0.023
27	0.002	31	0.178	35	0.000
28	0.079	32	0.316		
37	0	36	0.052		
Total	0.793	Total	1.535	Total	1.225
Average	0.061	Average	0.118	Average	0.111
Variance	0.0065		0.0080		0.015
Standard deviation	0.0805		0.0897		0.121
Relative standard deviation	1.3186		0.7596		1.088
Standard error	0.0223		0.0249		0.040

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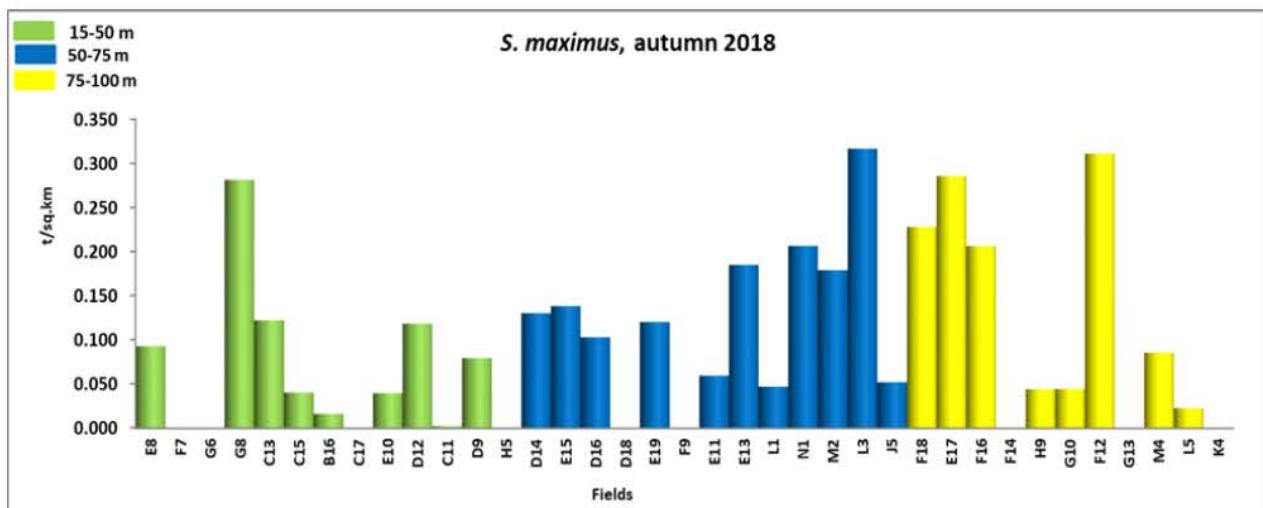
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*Fig. 2. Relative biomass (t/km²) of *S. maximus* by strata off the Bulgarian Black Sea coast, December 2018.*

Table 2 represents detailed data about turbot abundance by strata in December 2018.

Table 2

Abundance of *S. maximus* by strata December 2018.

15 - 50 м		50 - 75 м		75-100 м	
No. station	No. Ind./km²	No. station	No. Ind./km²	No. station	No. Ind./km²
1	66	6	50	14	66
2	17	7	50	15	50
3	17	8	50	16	50
4	66	12	0	17	0
5	33	13	33	18	17
9	17	20	0	19	17
10	17	22	33	23	66
11	0	25	83	24	0
21	17	29	17	33	17
26	50	30	50	34	17
27	33	31	66	35	0
28	66	32	100		
37	0	36	17		

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Total	398.48	Total	547.91	Total	298.86
Average	31	Average	42	Average	27
Variance	14.634		20.838		15.663
Standard deviation	3.825		4.565		3.958
Relative standard deviation	0.125		0.088		0.146
Standard error	0.174		0.200		0.190

3.2. Catch per unit effort (CPUE)

Catches from a total of 37 trawls were distributed as follows:

- 7 hauls (18.92% of total no. hauls), catch 0 кг.;
- 13 hauls (35.14%), catch 0.1 – 4.99 kg per haul;
- 8 hauls (21.62), catch 5.0 – 9.99 kg per haul;
- 5 hauls (13.51%), catch 10.0 – 14.99 kg per haul;
- 4 hauls (10.81%), catch 15.0 – 19.03 kg per haul;

Stratum < 30 м; 3 hauls:

- 1 haul, catch 0.00 kg per haul;
- 1 haul, catch 0.1 - 4.99 kg per haul;
- 1 haul, catch 5.00 - 9.99 kg per haul;

Stratum 31 – 50 м; 10 hauls:

- 1 haul, catch - 0 кг на трал;
- 6 haul, catch - 0.1 - 4.99 kg per haul;
- 2 haul, catch - 5.0 - 9.99 kg per haul;
- 1 haul, catch 10.0 – 16.99 kg per haul;

Stratum 50 – 75 м; 13 hauls:

- 2 haul, catch - 0 kg per haul;
- 3 haul, catch 0.1 – 4.99 kg per haul;;
- 4 haul, catch 5.0 – 9.99 kg per haul;
- 4 haul, catch 10.0 – 19.03 kg per haul;

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Stratum 75 – 100 m; 11 hauls:

- 3 haul, catch - 0 kg per haul;
- 3 haul, catch 0.1 – 4.99 kg per haul;
- 1 haul, catch 5.0 – 9.99 kg per haul;
- 4 haul, catch 10.0 – 18.99 kg per haul;

The CPUE distribution in December 2018 is shown in Table 3 and Fig. 4.

Table 3
The sampling stations, coordinates and CPUE (kg/trawl) in December 2018

№	Field	Starting coordinates		Depth (m)	Speed (Nm)	Trawling time (min) №	Catch turbot	
		Φ	λ				N	Kg
1	E8	43.04.630	28.06.220	24.5-29	2.5	60	4	5.59
2	F7	43.05.650	28.14.105	35-31	2.5	60	1	0.05
3	G6	43.10.710	28.16.310	31-40	2.5	60	1	0.02
4	G8	43.05.430	28.17.480	57-37.5	2.5	60	4	16.91
5	C13	42.38.800	27.59.108	40-44	2.5	60	2	7.34
6	D14	42.33.440	28.02.600	55-60	2.5	60	3	7.84
7	E15	42.28.840	28.05.458	67-67.5	2.5	60	3	8.32
8	D16	42.24.715	28.03.700	61-50	2.5	60	3	6.19
9	C15	42.26.154	27.59.030	47-39	2.5	60	1	2.44
10	B16	42.23.155	27.52.980	37-37.5	2.5	60	1	0.99
11	C17	42.18.990	27.56.090	38-41.5	2.5	60	0	0
12	D18	42.14.200	28.02.160	51-53.5	2.5	60	0	0
13	E19	42.09.470	28.07.300	61-65.5	2.5	60	2	7.24
14	F18	42.11.660	28.10.780	76-81	2.5	60	4	13.7
15	E17	42.16.790	28.08.520	74-69	2.5	60	3	17.16
16	F16	42.21.820	28.10.910	82-83	2.5	60	3	12.39
17	F14	42.31.470	28.12.000	85-84	2.5	60	0	0
18	H9	42.59.115	28.20.757	76-81	2.5	60	1	2.65
19	G10	42.54.700	28.19.370	83-82.5	2.5	60	1	2.67
20	F9	42.56.030	28.14.411	63-49	2.5	60	0	0

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21	E10	42.54.607	28.08.120	39-44	2.5	60	1	2.39
22	E11	42.48.783	28.07.694	52-64	2.5	60	2	3.58
23	F12	42.43.650	28.13.760	81.5-87.5	2.5	60	4	18.69
24	G13	42.39.160	28.16.180	90.5-89.5	2.5	60	0	0
25	E13	42.37.420	28.08.650	73.5-63.5	2.5	60	5	11.13
26	D12	42.41.030	28.01.460	43.5-40.5	2.5	60	3	7.12
27	C11	42.45.300	27.59.460	34.5-33	2.5	60	2	0.14
28	D9	42.56.140	28.04.870	31-28.5	2.5	60	4	4.78
29	L1	43.36.950	28.41.334	50.5-52	2.5	60	1	2.83
30	N1	43.38.945	28.51.526	60.5-64	2.5	60	3	12.42
31	M2	43.34.280	28.49.300	65-65.5	2.5	60	4	10.75
32	L3	43.28.990	28.43.800	64.5-69	2.5	60	6	19.03
33	M4	43.23.954	28.47.010	77-80.5	2.5	60	1	5.14
34	L5	43.19.400	28.44.030	82-81.5	2.5	60	1	1.37
35	K4	43.22.020	28.39.540	70.5-65.5	2.5	60	0	0
36	J5	43.19.750	28.34.112	58-63	2.5	60	1	3.13
37	H5	43.18.920	28.24.050	20-30	2.5	60	0	0

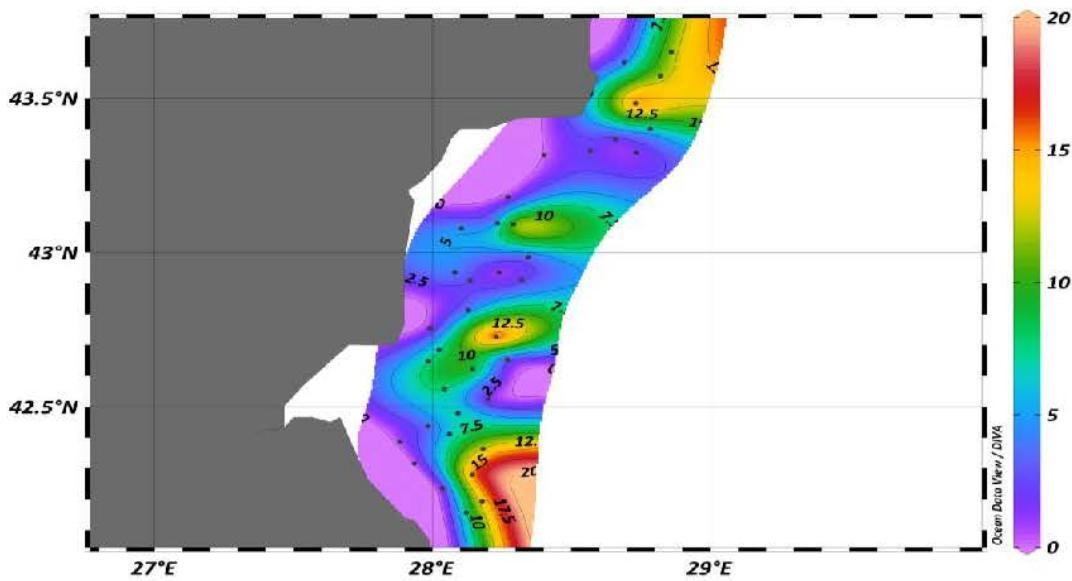


Fig. 3. Distribution of catch per unit effort (CPUE)

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3.3. Catch per unit area (CPUA)

The turbot abundance and biomass per unit area are presented at Table 4 and Fig 2 and 4. Distribution of the relative biomass (kg/km^2) and abundance (n/km^2) of *S. maximus* in December, 2018 at fig.5.

High relative biomass, between $0.18 - 0.32 \text{ t}/\text{km}^2$ was established in four sectors of the Bulgarian Black Sea zone:

- in north direction, between Durankulak and Shabla, at a depth of $60.5 - 69 \text{ m}$ (st. N1, M2 and L3);
- off the central part of the coast, near to the Kamchiya River mouth (st. G 8) at depths of 50 m ;
- in south direction, from the Cape Emine 81 m (st. F12) along Primorsko (st. F16 and E17 – $74-83 \text{ m}$) and Ahtopol (st. F18 - $76-81 \text{ m}$) (Fig.2 and 4).

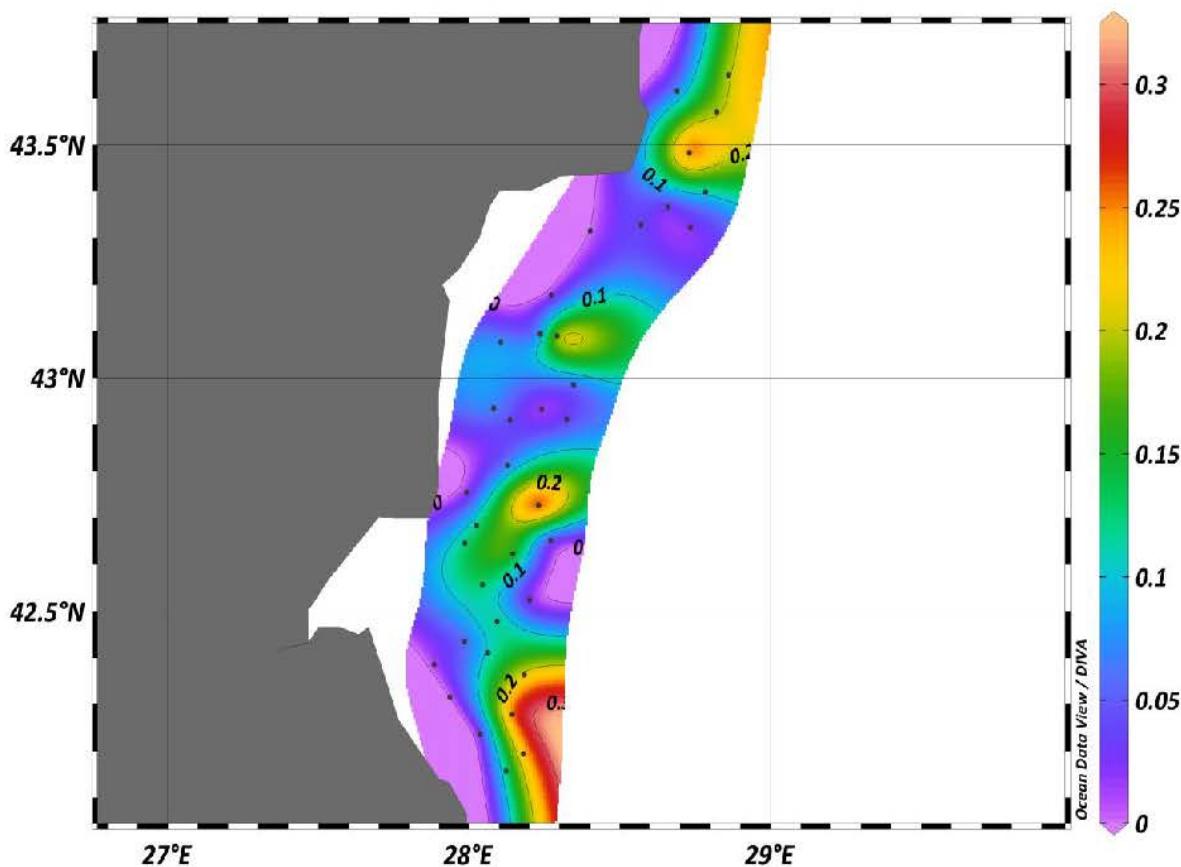


Fig. 4. Distribution of the relative biomass (t/km^2) of *S. maximus* in December 2018.

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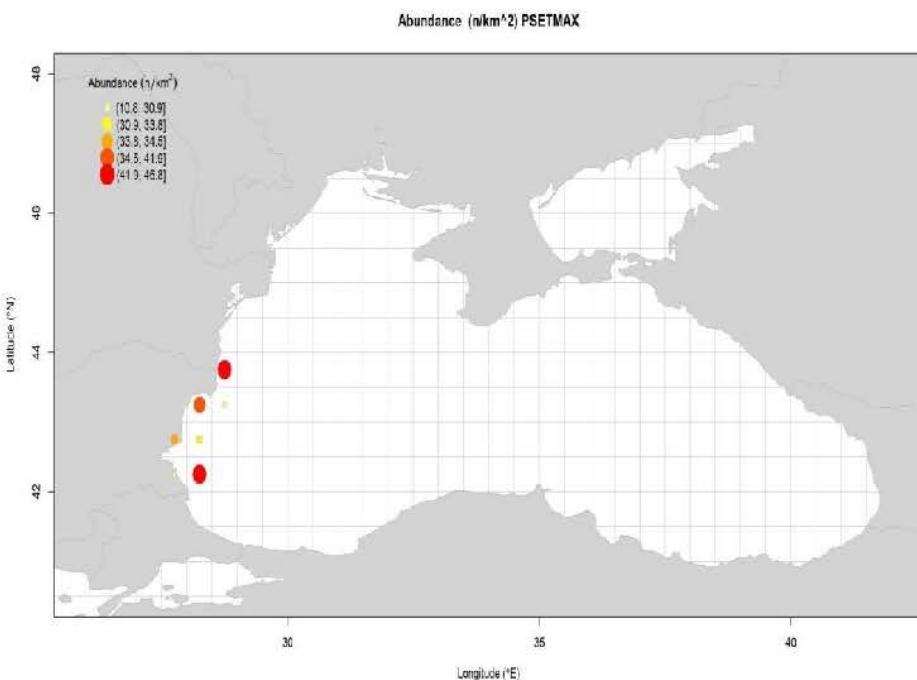
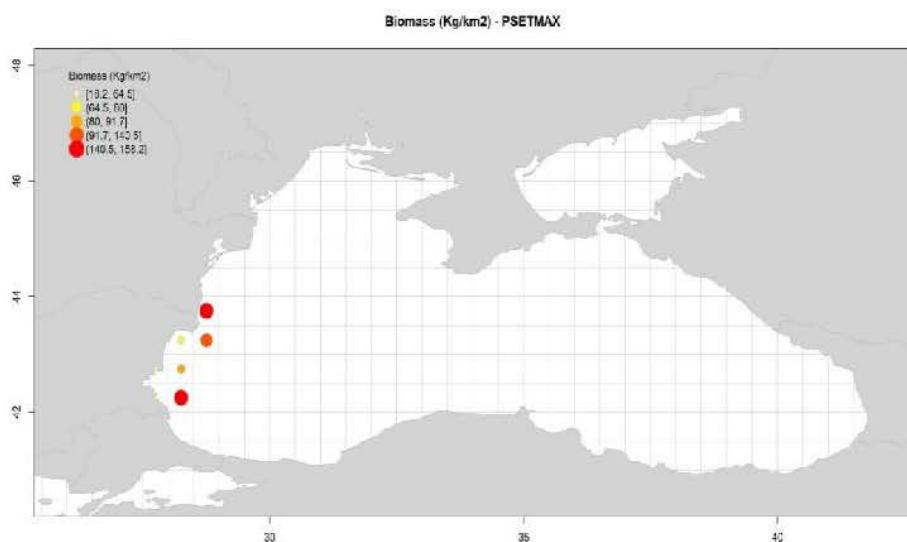


Fig. 5 Distribution of the relative biomass (kg / km²) and abundance (n / km²) of *S. maximus* in December, 2018

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МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО, ХРАНИТЕ И
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Table 4

Turbot abundance and biomass observed in the Bulgarian waters in December 2018

No. <i>Station</i>	Field	No. ind./km ²	t/km ²
1	E8	66	0.093
2	F7	17	0.001
3	G6	17	0
4	G8	66	0.281
5	C13	33	0.122
6	D14	50	0.130
7	E15	50	0.138
8	D16	50	0.103
9	C15	17	0.041
10	B16	17	0.016
11	C17	0	0
12	D18	0	0
13	E19	33	0.120
14	F18	66	0.227
15	E17	50	0.285
16	F16	50	0.206
17	F14	0	0
18	H9	17	0.044
19	G10	17	0.044
20	F9	0	0
21	E10	17	0.040
22	E11	33	0.059
23	F12	66	0.310
24	G13	0	0.000
25	E13	83	0.185
26	D12	50	0.118
27	C11	33	0.002
28	D9	66	0.079
29	L1	17	0.047

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30	N1	50	0.206
31	M2	66	0.178
32	L3	100	0.316
33	M4	17	0.085
34	L5	17	0.023
35	K4	0	0
36	J5	17	0.052
37	H5	0	0
Total		1245.261	3.553
Average		33.6557	0.0960
Total in the Bulgarian area		390 092 Ind.	1113.06 tonnes

	<i>No ind./km²</i>	<i>t/km²</i>
Variance	727.27	0.0096
Standard deviation	26.97	0.0980
Relative standard deviation	0.80	1.0208
Standard error	4.43	0.0161

The calculated turbot biomass in the Bulgarian Black Sea waters amounted to **1113.06** tons, by abundance - **390 092** individuals (Table 4).

3.4. Size structure

The information about the size structure of turbot population was based on biometric measurements of 75 turbot specimens, and included data on the absolute and standard length, and individual weight (pic.4).

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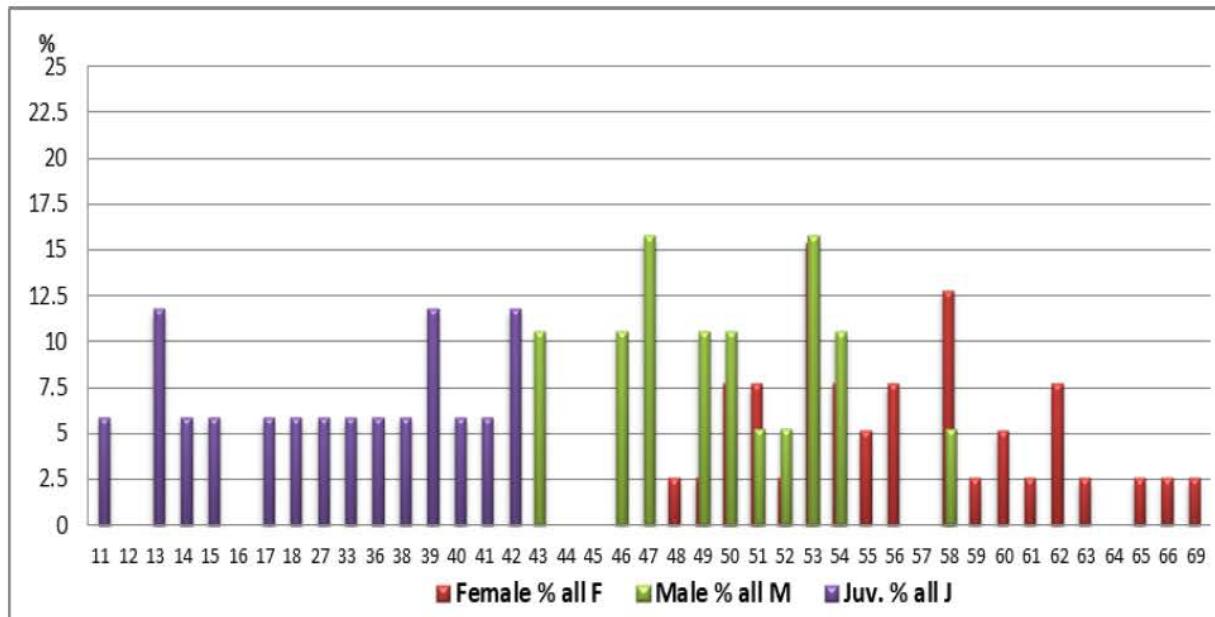


Fig. 6. Length structure of *S. maximus*.

The absolute length of the measured individuals varied between 11.00 and 69.00 cm, by weight - between 30 and 6460 g. The total turbot catch reached 214 kg. Distribution of the length classes was as follows: eight individuals were of sizes between 11-27 cm (10.67 %), 6 individuals - between 33-40 cm (8.00 %), 14 - in the range between 41-49 cm (18.67%) 37 individuals - between 50-59 cm (49.33%) and 10 individuals - between 60-69 cm (13.33%) (Fig. 6).

Sexually mature individuals dominated in the total catch – 77.33 % (58 specimens), while juveniles (< 45 cm) were presented by 17 specimens and formed 22.67 %. With a percent share of 57.14 % (36 specimens), the females outnumbered the males - 12.7 % (9 specimens).

The size structure was analysed in compliance with the national regulations, setting out the minimum permissible length of the individuals for fishing purpose. Thus, the individuals with absolute length under 45 cm are marked as undersized, and those with length > 45 cm - as standard.

Fig. 7 shows the total turbot abundance (ind/km^2) and the distribution of the ratio between the undersized individuals and those of standard length.

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Fig. 7. Distribution of the *S. maximus* abundance (ind/km^2) and ratio between the undersized individuals and those with standard length.

The relative turbot biomass by size classes is given in Fig. 8, presenting high biomass for two size classes - those of 53-58 cm and 62-63 cm.

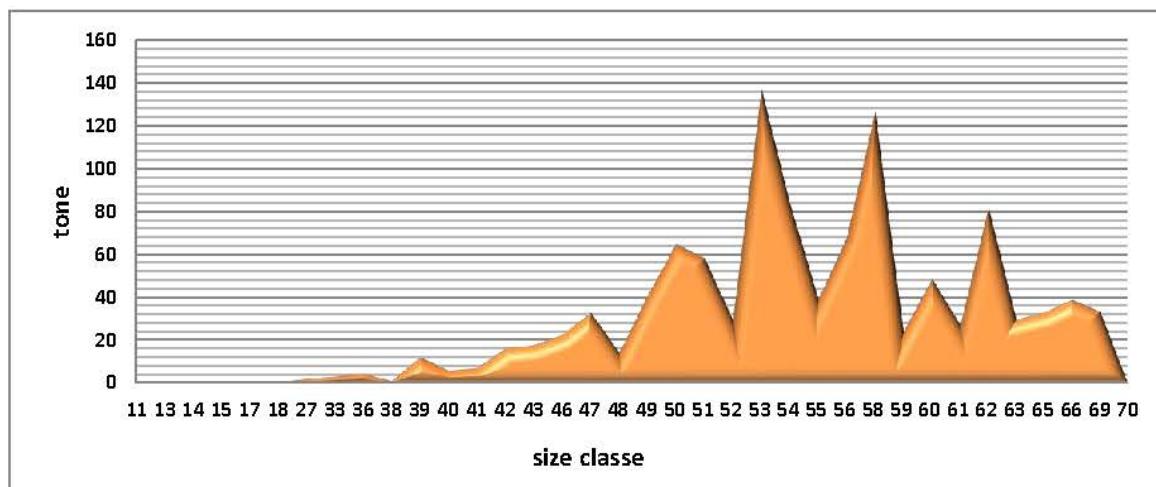


Fig. 8. Biomass by mean size classes of *S. maximus*.

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3.5. Age structure

The turbot age composition was determined through analysis of 58 pairs of otoliths. The age structure included 1 - to 9 - years classes, with domination of the 5 (29.33 %) and 6 (21.33 %) years (50.66 % in total), followed by 7 - year class – 13.33 % (Fig. 9).

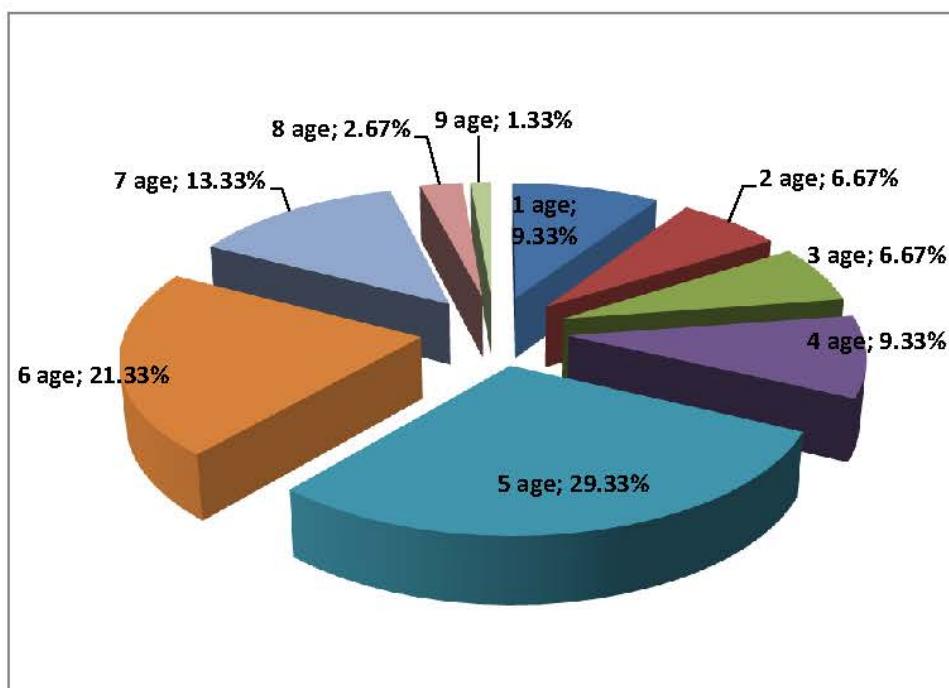


Fig. 9. Age structure of turbot in December 2018.

In the autumn season of 2018, the share of the replenishment of 1 and 2 - year class reached 16 %. During the XII/2017 replenishment is within the same limits - 16.03 %, during XI-XII/2016, 1 and 2 - year class reached a total of 27.18%, while in XII/2017, and 2018, the percent share of the group was almost half. Although having small frequency of occurrence, specimens from 8 - to 9 - years classes were registered in the yield.

The distribution of the age composition of *S. maximus* in the surveyed area is shown in Fig.10.

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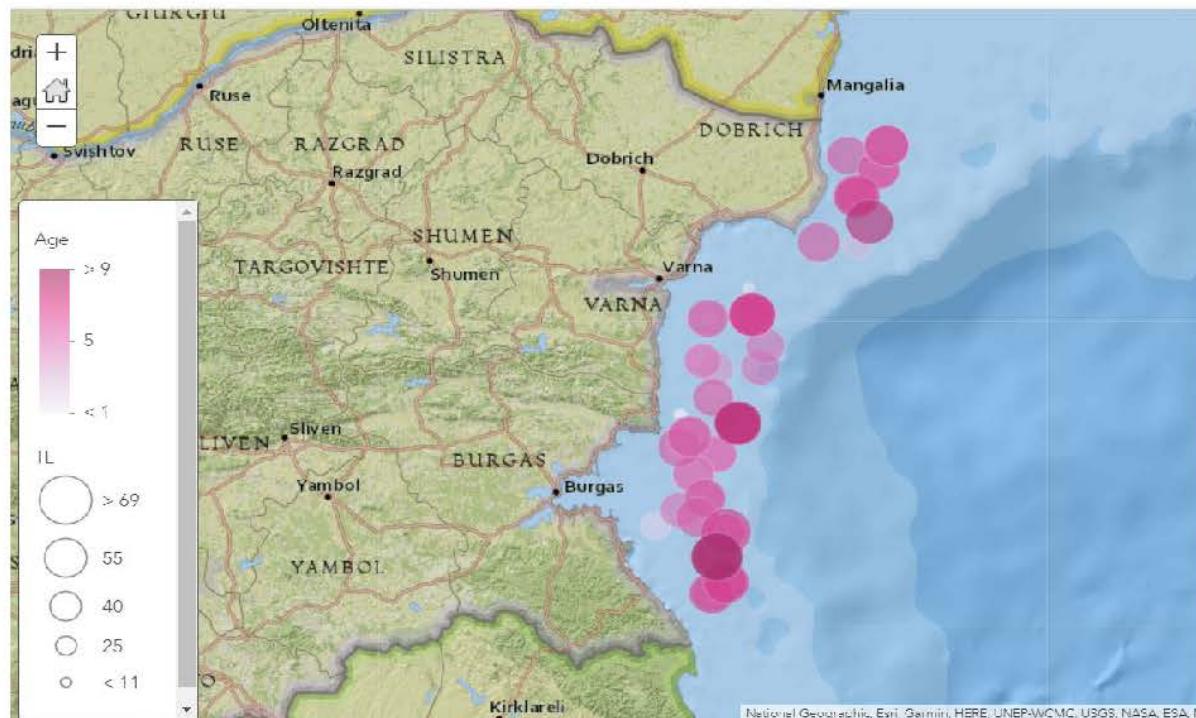


Fig. 10. Spatial distribution and age structure of *S. maximus* in December 2018.

3.6. Biological parameters of *S. maximus*

To estimate the turbot growth rate, the data about the average length and weight by age groups for the two sexes were combined.

The calculated values of the parameters in *von Bertalanffy's* and L-W equation were as follows:

$$a = 0.013$$

$$b = 3.12$$

$$q = -1.883$$

$$L_{\infty} = 72.63$$

$$k = 0.354$$

$$t_o = -0.36$$

The turbot length-weight relationship, based on the autumn survey data is shown in Fig.11.

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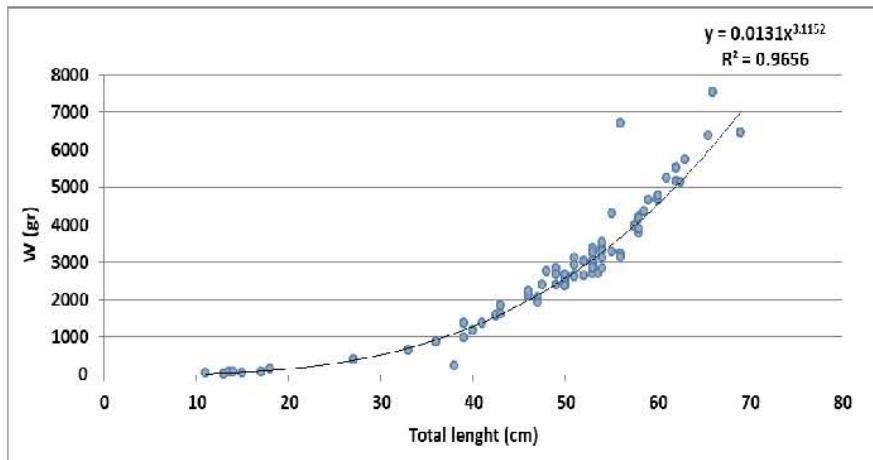


Fig. 11. *S. maximus*: Length-weight relationships in December 2018.

The coefficient of natural mortality (M) was calculated according to Pauly's formula (1980), describing the natural mortality as a function of k, L_∞ , W_∞ and water temperature at the bottom layer.

$$L_\infty = L_{t \max} / 0.95$$

$$k = 1/(t_2 - t_1) * \ln(L_\infty - L_1) / (L_\infty - L_2)$$

$$\log(-t_0) = -0.3922 - 0.2752 * \log L_\infty - 1.038 * \log k$$

$$\ln M = -0.0152 - 0.279 \ln L_\infty + 0.6543 \ln k + 0.463 \ln t_0$$

Considering, that the water temperature was 8-10 °C during the study, the coefficient of natural mortality (M) for both sexes was equal to 0.38.

Fulton's condition factor (K)

This factor is used as a proxy for the "physiological condition" of individuals. The collected data show that the Fulton coefficient varies in small limits with changes in size and age of turbot (Fig. 12).



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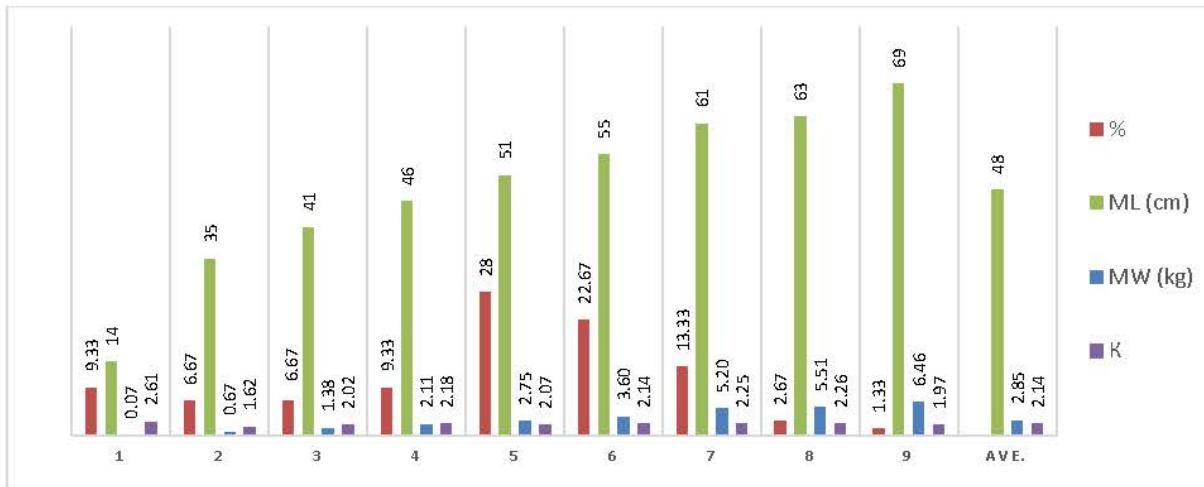


Fig. 12. Relationship between length, age, average size and weight of turbot and coefficient of Fulton by age.

3.7. Sex structure

Sex ratio

The results of the turbot sex structure analysis in autumn 2018 are shown in Fig.12.

The total share of sexually immature individuals formed 22.67 % of the total yield, the female individuals formed 52 %, and the share of males was 25.33 %.

From a total of 37 fields, studied off the Bulgarian coast in December 2018, female specimens were not identified in 17 fields, in 25 fields - males were not estimated, and in 4 field - only young forms were found, while adult specimens were absent (Fig.13).

Male and female specimens are found all over the depths of 40 to 82 meters. The juveniles were concentrated in the section Shabla (81 m), in front of Varna (35-41 m) and between Cape Emine - Primorsko they were observed at different depths (34 and 37 m). The females were established mainly in the regions Duranculak – c. Kaliakra, Varna - Kamchia and between Cape Emine - Primorsko and Ahtopol, while high concentrations of males were detected in the region of Kamchia - Cape Emine.

The average weight of females was 3954.36 g, with average length TL = 55.23 cm and standard-length SL = 43.71 cm. The maximum weight of females reached 7540 g, besides the minimum weight was 2760 g.



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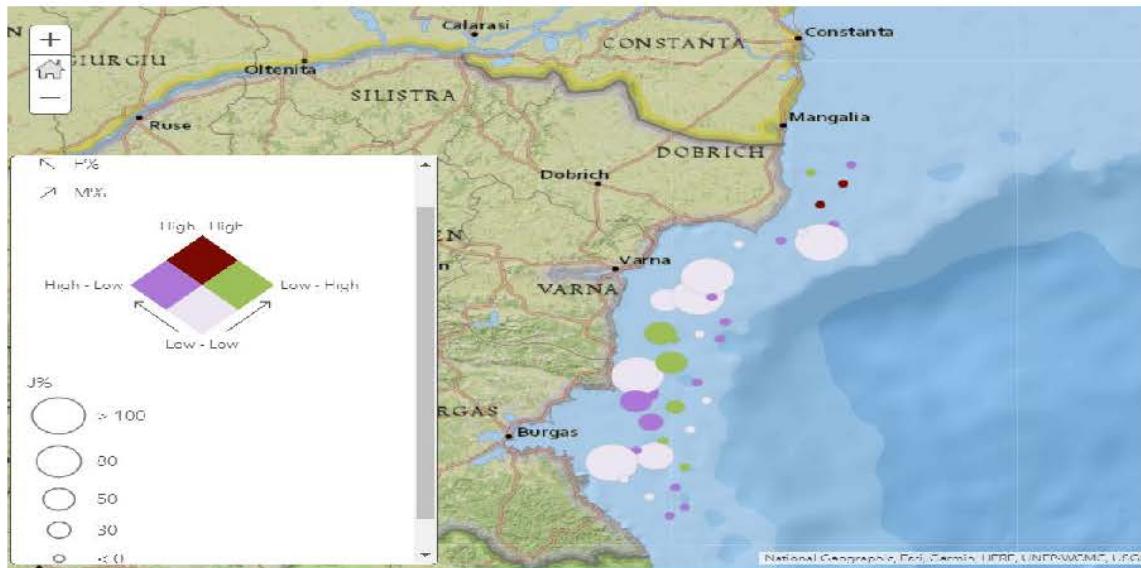


Fig.13. Sex structure of *S. maximus* in December 2018: distribution by stations (female, male and juvenile specimens are indicated by: purple, green and white, red color - equal share of females and males).

The share of the females from classes 53 to 56 cm and 58 to 63 cm was dominant, and this size group has formed 69.23 % of all studied females (Fig. 14). For the length classes over > 55 cm (up to 69 cm), all specimens were only females, comprising 53.85 % of the total abundance.

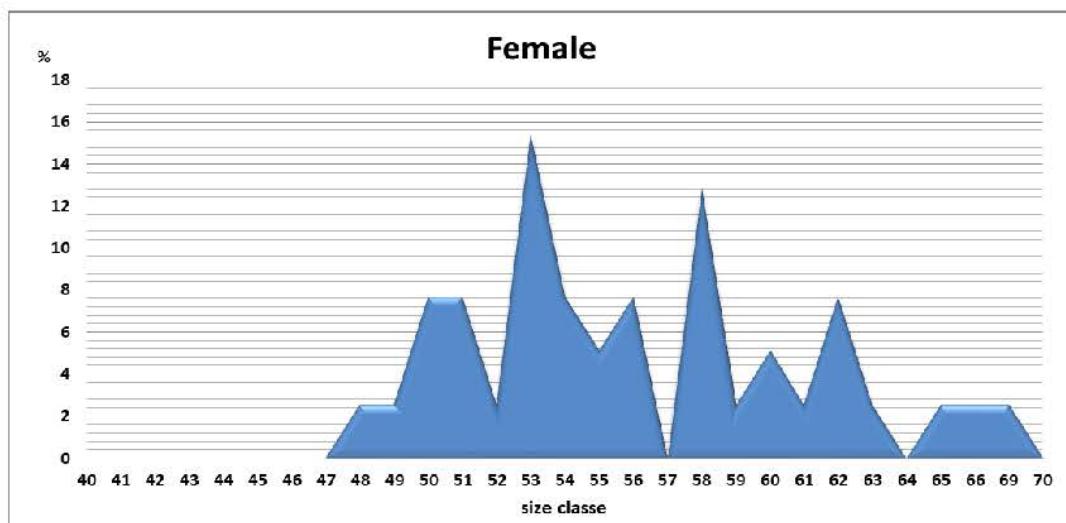


Fig.14. Females' specimens: Percentage distribution by length classes.

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For males (Fig.15), the most significant proportion of total abundance – 84.21 % belonged to the length class 46 - 54 cm, followed by the size class 58 cm – 5.26 %.

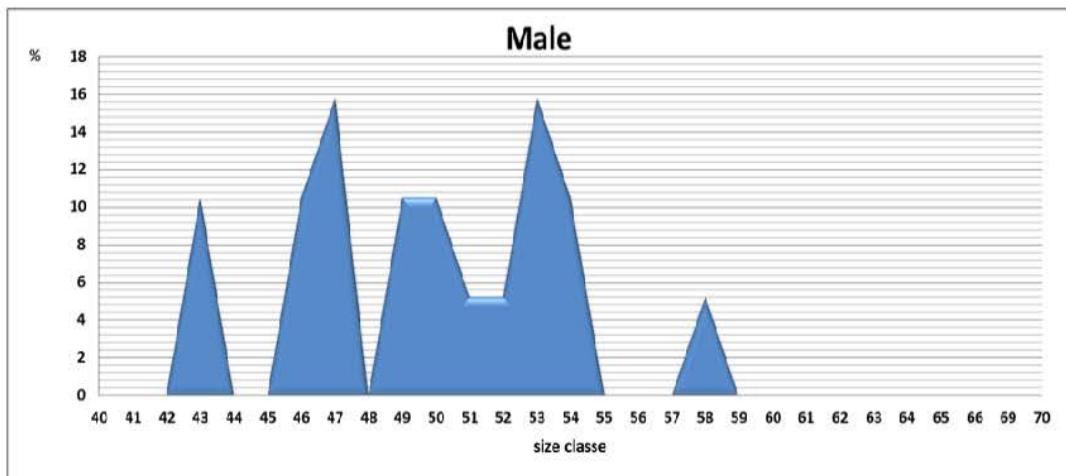


Fig.15. Male specimens: Percentage distribution by length classes.

The results demonstrate sexual dimorphism regarding the body length, with high presence of large size classes of females (Fig. 14 and 15).

3.8. Fecundity

Female specimens (38 specimens), that were a subject on fecundity study in May 2018 were characterised by following parameters: mean body weight - 3.34 kg, average total length = 56.66 cm and mean age of 6 years.

The measured absolute fecundity has reached the mean value of 996 644 eggs in May 2018, while the relative fecundity attained 298 625 eggs (Fig.16).

The estimated fecundity was almost 2.5 times lower in comparison with the previous studies – 5-6 Mill. eggs, but was similar with data in previous year. Such levels of fecundity could be obtained for specimens with weight 5-6 kg, but their share in samples is relatively low. The fecundity has increased with the increase of turbot body weight.

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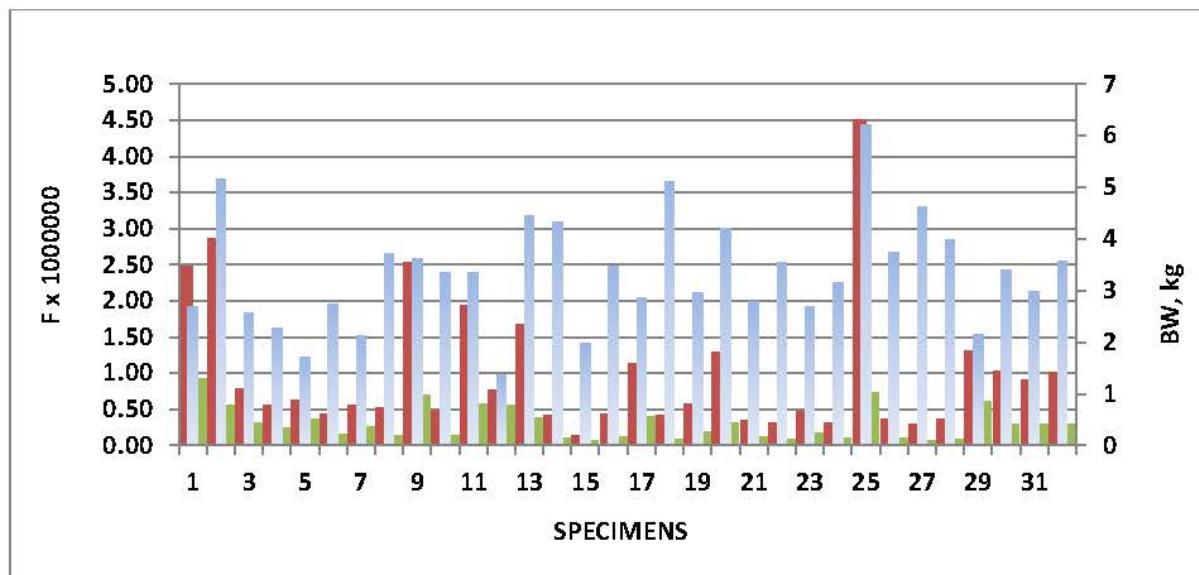


Fig. 16. Turbot body weight (kg, blue bar), absolute fecundity (red bar) and relative fecundity (green bar) in 2018.

3.9. Accompanying species

During the trawl survey, as a bycatch were collected seventy-three specimens of dogfish (*Squalus acanthias*), 23 specimens of thornback ray (*Raja clavata*) and 49 individuals of European flounder (*Platichthys flesus*) (Table 5).

Table 5
Data on species composition and biological characteristics of the bycatch species

Bycatch species	N	Size (cm)			Weight (kg)		
		Min.	Max.	Ave.	Min.	Max.	Ave.
<i>Squalus acanthias</i>	73	76	154	117.96	1.68	16.20	7.348
<i>Raja clavata</i>	23	41	72	62.28	0.47	3.9	2.013
<i>Platichthys flesus luscus</i>	49	15	38	22.30	0.07	0.68	0.218

Map, showing the location of stations with bycatch is presented in Fig. 17., *Squalus acanthias* and thornback ray specimens were observed in the region under the Cape

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Kaliakra and Kamchia - Ahtopol at depth 50-87 m. *Pl. flesus* was caught in front of north direction Duranculak - Shabla.

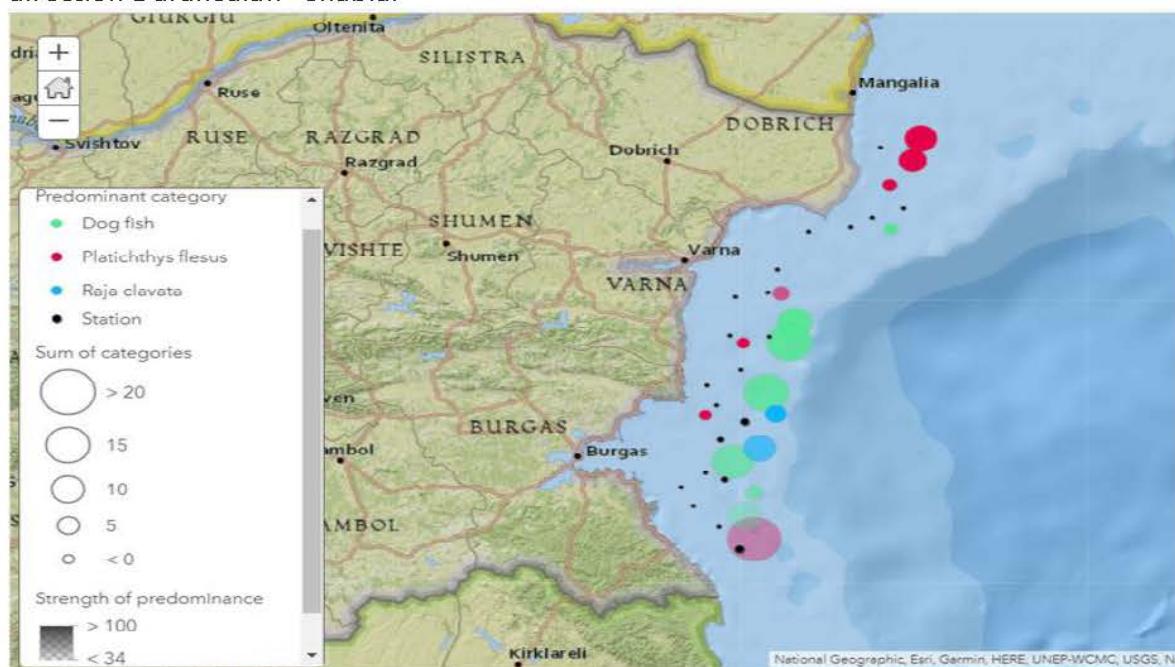


Fig. 17. Location of stations with bycatch from spiny dogfish (*S. acanthias*, circles with green colour), thornback ray (*R. clavata*, circles with blue colour) and flounder (*Pl. flesus* circles with red colour).

4. Food composition

In the autumn season of 2018, a total of 51 stomachs were gathered to determine the dietary spectrum of turbot. The food components were found in 58.82 % of the examined specimens and 41.18 % were with empty stomachs.

Full description of the collected data and some statistical parameters are given in Tables 6 and 7.

Table 6
**Survey area, length and weight of specimens, the weight of stomachs (filled, empty),
stomach contents and index of stomach fullness (ISF).**

Investigated area	L (cm)	W (kg)	Full stomach (g)	Empty stomach (g)	Food content (g)	ISF
C13/2	56	6.70	56	6.7	49.00	0.73

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C15/1	50	2.44	50	2.44	22.50	0.92
D9/3	43	1.85	43	1.85	37.50	2.03
D9/4	49	2.38	49	2.38	13.50	0.57
D12/2	54	3.11	54	3.11	33.00	1.06
D12/3	58	3.77	58	3.77	6.00	0.16
D14/1	53	2.95	53	2.95	29.00	0.98
D14/2	54	3.32	54	3.32	30.00	0.90
D16/3	56	3.21	56	3.21	13.50	0.42
E8/3	54	3.42	54	3.42	24.50	0.72
E10/1	47.5	2.39	47.5	2.39	23.00	0.96
E11/1	53	2.71	53	2.71	26.00	0.96
E13/2	47	1.93	47	1.93	9.00	0.47
E13/3	48	2.76	48	2.76	9.00	0.33
E13/4	52	2.65	52	2.65	12.50	0.47
E13/5	51	2.61	51	2.61	21.00	0.80
E15/1	46	2.13	46	2.13	8.50	0.40
E15/2	49	2.67	49	2.67	26.00	0.97
E15/3	54	3.52	54	3.52	6.00	0.17
E17/1	55	4.31	55	4.31	30.50	0.71
E17/2	69	6.46	69	6.46	52.50	0.81
E17/3	65.5	6.39	65.5	6.39	45.50	0.71
E19/1	59	4.67	59	4.67	33.50	0.72
E19/2	50	2.57	50	2.57	25.50	0.99
F12/1	58	4.01	58	4.01	1.50	0.04
F12/2	60	4.78	60	4.78	9.00	0.19
F12/3	63	5.74	63	5.74	31.50	0.55
F12/4	57.5	3.96	57.5	3.96	30.50	0.77
F16/1	50	2.48	50	2.48	3.00	0.12
F16/2	50	2.37	50	2.37	2.00	0.08
F16/3	66	7.54	66	7.54	2.50	0.03
F18/1	53	2.76	53	2.76	12.00	0.43
F18/2	60	4.65	60	4.65	11.00	0.24
F18/3	53	3.25	53	3.25	29.00	0.89
F18/4	52	3.04	52	3.04	5.50	0.18
G8/1	49	2.85	49	2.85	28.00	0.98
G8/2	53	3.36	53	3.36	4.50	0.13
G8/3	68	5.53	68	5.53	26.00	0.47

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G8/4	62	5.17	62	5.17	6.00	0.12
G10/1	50	2.67	50	2.67	74.00	2.77
H9/1	51	2.65	51	2.65	48.00	1.81
J5/1	56	3.13	56	3.13	22.00	0.70
L1/1	54	2.83	54	2.83	18.50	0.65
L3/1	51	3.10	51	3.1	3.50	0.11
M1/1	62.5	5.14	62.5	5.14	9.50	0.18
M2/1	43	1.61	18.5	14.5	4.00	0.25
M2/2	53	3.03	24.5	0	24.50	0.81
M2/3	53	2.84	16	0	16.00	0.56
M2/4	55	3.27	32	24	8.00	0.24
N1/1	58	4.17	36.5	28.5	8.00	0.19
N1/3	58.5	4.37	110	27	83.00	1.90

Table 7

General statistical data for the measured parameters in stomach content analysis.

	L (cm)	W (kg)	St. content (g)	ISF (% BW)
Mean	54.36	3.55	21.73	0.654
Standard Error	0.82	0.19	2.48	0.076
Median	53.00	3.11	21.00	0.570
Mode	53.00	2.76	6.00	0.470
Standard Deviation	5.88	1.34	17.68	0.545
Sample Variance	34.59	1.81	312.51	0.297
Kurtosis	0.22	0.91	2.66	4.262
Skewness	0.56	1.19	1.44	1.760
Range	26.00	5.93	81.50	2.740
Minimum	43.00	1.61	1.50	0.030
Maximum	69.00	7.54	83.00	2.770
Sum	2772.50	181.22	1108.00	33.350
Count	51.00	51.00	51.00	51.000
Confidence Level (95.0%)	1.65	0.38	4.97	0.153

The average stomach fullness index reached $0.65 \% \text{ BW} \pm 0.08 \text{ SE}$ (Table 7) and showed an increase of 47.6 % compared to the data for the autumn season of 2017. Relatively high values of the stomach fulness index (~1.5% BW) were recorded in front of

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the whole coast - in the north direction and in the central part - in the near coastal zone, and in the south - in the area with a depth of about 50 m (Fig. 18).

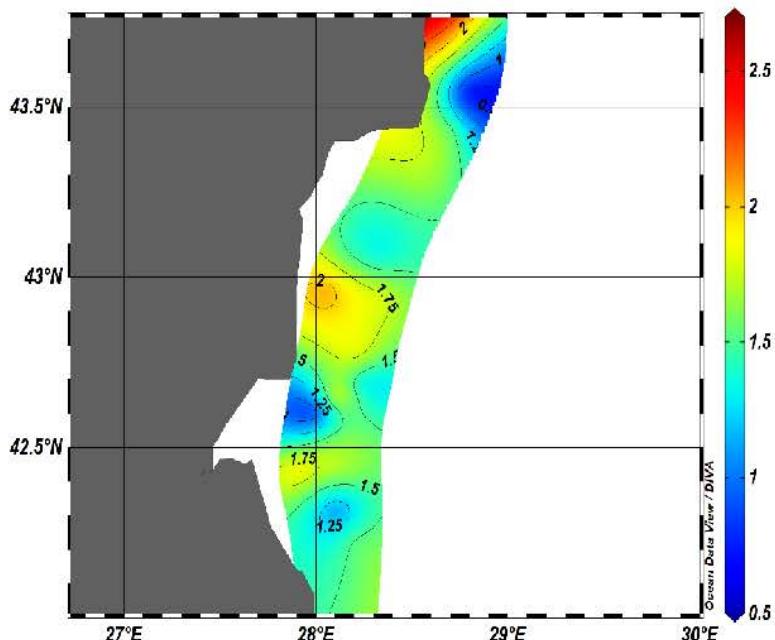


Fig. 18. Spatial distribution of ISF (% BW) during the autumn season of 2018.

The qualitative composition of the turbot food included mostly fish (*Pisces*) and decapod crabs (*Decapoda*) (Table 8).

Table 8
Diet spectrum of turbot in the autumn season of 2018. (Data for feeding individuals).

Species composition of food	CN (% by abundance)	CW (% by biomass)	FQ (Frequency of occurrence)	IRI	Species composition of food
<i>Pisces</i>	89.30	84.34		10924.55	99.20
<i>Merlangius merlangus</i>	69.89	66.00	76.67	10418.42	94.61
<i>Engraulis encrasicolus</i>	0.81	0.77	3.33	5.26	0.05
<i>Mullus barbatus</i>	4.17	3.94	13.33	108.16	0.98
<i>Alosa pontica</i>	5.41	5.11	10.00	105.13	0.95
<i>Gobiidae</i>	7.60	7.18	6.67	98.49	0.89

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Unidentified fish	1.42	1.34	68.33	189.09	1.72
Decapoda	10.7	15.66	3.33	87.78	0.80
Decapoda spp.	10.7	15.66	3.33	87.78	0.80

The turbot feeds mainly on fish, and the percentage of this component is 89.30 % of the total number of food components in the stomachs of the feeding specimens and 84.34 % of the food mass. A relatively low presence was detected for the *Decapods*, which occupies 10.73 % by the number and 15.66 % of the food mass.

In the autumn season of 2018, the turbot food was mainly formed by *Merlangius merlangus* - IRI = 10418 (94.6 % IRI) by low presence of anchovy, pontic shad, red mullet, gobies and decapods (Fig 19).

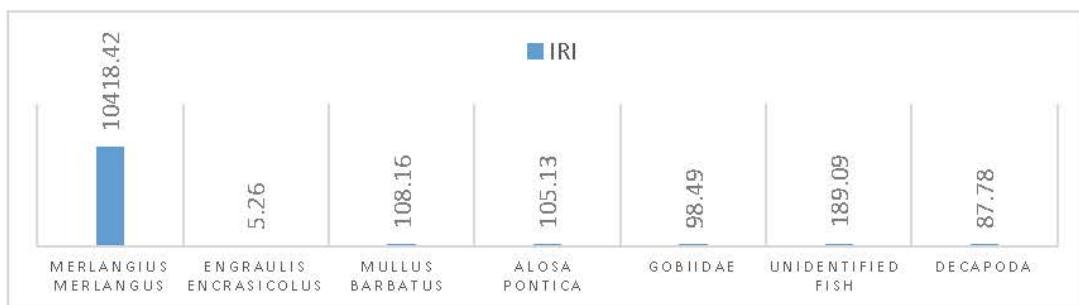


Fig. 19. Specific IRI values of different species in turbot food during autumn 2018.

The percentage proportions of IRI by species were distributed as follows: 94.6 % whiting, 2 % - unidentified fish remains, ~1 % - pontic shad, gobies, red mullet and Decapoda, <1 % - anchovy (Fig 20).



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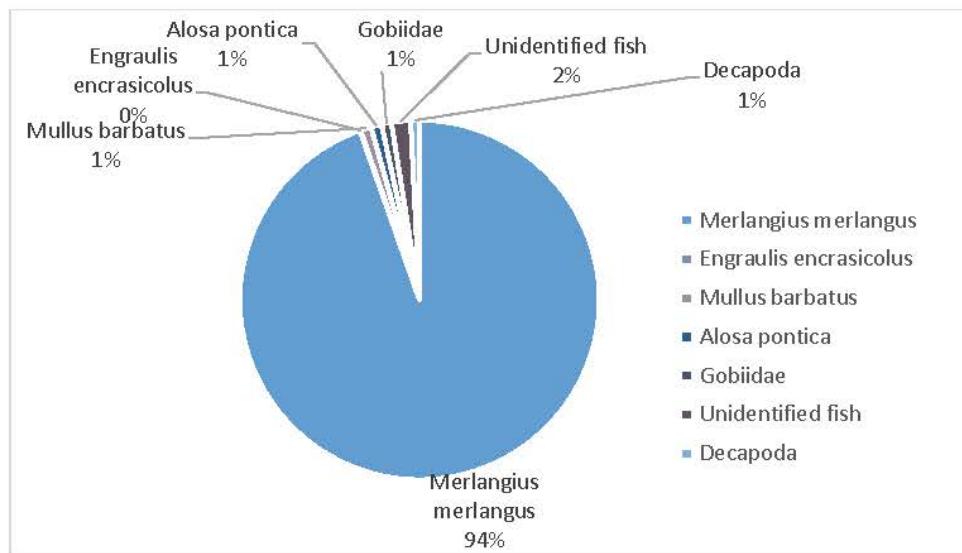


Fig. 20. Percentages by species (%), IRI in the turbot food spectrum in autumn 2018.

5. Forecasts and opportunities for exploitation

The estimation of **maximum sustainable yield (MSY)** is based on the Gulland formula (1971): $MSY = 0.5 * M * Bv$, and the natural mortality coefficient (M) is calculated using the Pauly's empirical formula (1979, 1980). At a value of $M = 0.2$, the quantity of MSY by the Gulland method amounts to **111.31 t** for the autumn season of 2018.

The exploitation of the stocks (E) is determined by the formula $E = F / Z$ (Pauly, 1983) and varies according to the intensity of the fishing activities (Avşar, 1998), so the population is under exploited at $E < 0.5$, $E = 0.5$ is an optimal level of exploitation, and $E > 0.5$ certifies of over-exploitation of the stock. The calculated value of $E = 0.57$ in 2018 is an indication of the near to optimal level of turbot stock exploitation.

TAC (Total Allowable Catch)

The Beverton and Holt yield per recruit model (Y/R model, 1957) is used for calculations of the maximum sustainable yield and total allowable catch. To calculate the yield per recruit, the following parameters are applied: W_{∞} , κ , M , t_0 , t_r , while the model allows inputs of various F and T_c parameters and assessment of their effects on the yield per recruit. It should be mentioned, that both parameters - F and T_c can be controlled by fishery management, because F is proportional to effort and T_c is a function of gear selectivity. The calculations show that Y/P increase at $F = 0.2$ (Fig. 21), thus the value

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of fishing mortality should not exceed 0.25, aiming at a maximal sustainable yield of adult specimens.

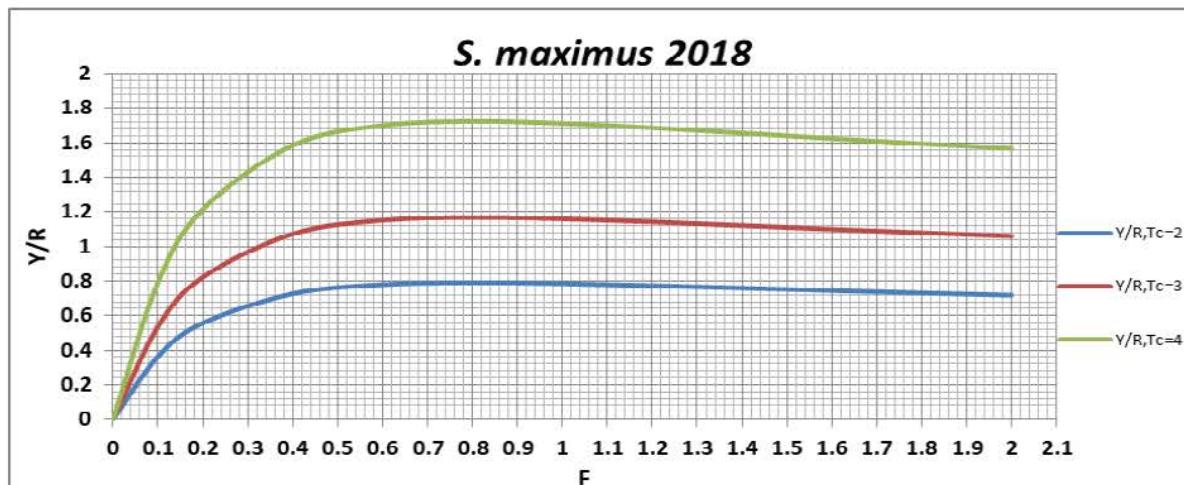


Fig. 21. Yield per recruit curves with different ages of first capture (T_c) - 2,3,4

The Jones method (1981) is based on linear cohort analysis and allows calculation of sustainable yield and exploitation biomass, and applying it to the data from the two surveys - in the spring and autumn of 2018, we have estimated the exploitation biomass - 202.25 t. for the entire 2018. When applying constant operational strategies, TAC (National Research Council 1998), the simplified strategy rule is adopted - $TAC = F \times EB$, where F fishing mortality (e.g. F_{max} , $F 0.1$, $FX\%$) and EB is the exploitation biomass. Hence, by calculated exploitation biomass of 202.25 t and $F = 0.25$, the total allowable catch reaches 51 tonnes, based on a spring and autumn season data in 2018.

The strategy of dynamic MSY model does not consider yearly variations in recruitment and should be combined with other analytical models, including linear or age virtual population analysis. Therefore, the so-called "ad hoc" special approaches could be applied, such as TAC implementation as a part of MSY - up to 2/3 of MSY (Raykov, 2011). Using the "ad hoc" method, it could be assumed, that the total allowable catch of turbot (specimens with $L > 45$ cm) in the Bulgarian Black Sea area shouldn't exceed 55 tons.

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Observed other particular problems

During the expedition activity, the dominant wind direction was - West, Northwest and North by force between 1-2° BF - along the coast and 2-4° BF - at sea.

In the autumn-winter season of 2018, the conditions in the field were normal for conducting the research activities for turbot stock assessment in the Bulgarian Black Sea waters.

6. Conclusions and recommendations

By the collected information and obtained results from the trawl survey in December 2018, the following conclusions and recommendations can be made:

- The **turbot biomass** in the Bulgarian Black Sea waters was assessed at **1113.06 tons** and the **turbot abundance** was estimated at **310 719 individuals**.
- The recommended **MSY (maximum sustainable yield)** for Bulgaria should not exceed **111 t.**, and it is assumed that the total allowable catch (TAC) of turbot in the Bulgarian Black Sea waters could comprise **55 tons** as a relatively acceptable quantity.
- The **size structure** of the turbot population in the Bulgarian Black Sea zone included length classes from **11 cm to 69 cm**, with a weight between **30 g and 6460 g**. The average turbot weight was estimated as 2853 g. In the turbot length structure, the undersized individuals, with length < 45 cm, formed 22.67 % from the total number, while those of standard length made up 77.33 %.
- The **age composition** of the population included age classes from **1 to 9- years** of age, with the domination of the 5 (29.33 %), 6 (21.33 %) and 7 (13.33 %) year classes.
- The **established ratio between female, male and sexually immature individuals**

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in the yield were **52%: 25.33%: 22.67%**.

- Of the studied 51 turbot specimens, in **58.82 % were found food components** and 41.18% were with empty stomachs. In the autumn season of 2018, the average stomach fullness index was $0.65 \% \text{ BW} \pm 0.08 \text{ SE}$, showing an increase with 47.6 % in comparison to the autumn of 2017. In the current year, the turbot food spectrum was mainly formed by ***Merlangius merlangus* - IRI = 10418 (94.6 % IRI)** by the low presence of pontic shad, anchovy, red mullet, gobies and Decapods.

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7. References

- Alverson, D. L., 1971.** Manual of methods for fisheries resource survey and appraisal. Part 1. Survey and charting of fisheries resources. *FAO Fish. Tech. Pap.*, (102): 80 p.
- Avşar, D., 1998.** Balıkçılık Biyolojisi ve Populasyon Dinamiği. Çukurova Üniversitesi, Su Ürünleri Fakültesi. Ders Ders Kitabı No: 5, Baki Kitap Evi, Adana, 303s.
- Bertalanffy, L. Von, 1934.** Untersuchungen über die Gesetzlichkeiten des Wachstums. 1. Allgemeine Grundlagen des Theorie. *Roux'Arch. Entwicklungs-mech. Org.*, 131: 613-653.
- Beverton, R. J. H. and S. J. Holt, 1957.** On the dynamics of exploited fish populations. *Fish. Invest. Minist. Agric. Fish. Food. G.B. (2 Sea Fish.)*, 19: 533 p.
- Beverton, R. J. H. and S. J. Holt, 1966.** Manual of methods for fish stock assessment. Part 2. Tables of yield functions. Manuel sur les méthodes d'évaluation des stocks ichtyologiques. Partie 2. Tables de fonctions de rendement. Manual de métodos para la evaluacion de los stocks de peces. Parte 2. Tablas de funciones de rendimiento. *FAO Fish.Tech.Pap./FAO Doc.Tech.Pêches/FAO Doc Téc.Pesca*, (38) Rev. 1: 67 p.
- Beverton, R. J. H., and S. J. Holt, 1956.** A review of methods for estimating mortality rates in exploited fish populations, with special reference to sources of bias in catch sampling. *Rapp.P.-V.Réun.CIEM*, 140:67-83.
- Cadima, E. L., 2003.** Fish stock assessment manual. *FAO Fisheries Technical Paper*. No. 393. Rome, 161p.
- Gulland, J. A., 1966.** Manual of sampling and statistical methods for fisheries biology. Part I: Sampling methods. *FAO Manuals in Fisheries Science No. 3*, Rome.
- Gulland, J. A., 1969.** Manual of Methods for Fish Stock Assessment - Part 1. Fish Population Analysis. *FAO Manuals in Fisheries Science No.4*:154p.
- Jones R., 1981.** The use of length composition data in fish stock assessment (with notes on VPA and cohort analysis). *FAO Fish.Circ.No 734*, 55 pp.
- Martino, K., M. Karapetkova, 1957.** Distribution of turbot during the first months of 1955. Scientific annals of Research Institute of Fisheries and fish industry. – Varna, vol.I, Publ. Zemizdat, Sofia, 45-51 pp.
- Nash, R.D.M., Valencia, A.H., Geffen, A. J. 2006.** The origin of Fulton's condition factor – setting the record straight. *Fisheries* 31:5, 236-238.

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National Research Council 1998. Improving Fish Stock Assessments. Washington, DC: The National Academies Press. <https://doi.org/10.17226/5951>.

Pauly, D., 1980. On the interrelationships between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks. *J.Cons.Int.Explor. Mer*, 39:175-192.

Pauly, D., 1983., Some simple methods for the assessment of tropical fish stocks. FAO Fisheries Technical Paper No. 234, 52 p.

Pavlova E., S. Stoykov, V. Mihneva, D. Gerdjikov, Klisarova D., S. Valchev, F. Tserkova, 2017. "Stock assessment of turbot (*Scophthalmus maximus*) by swept area method in front of Bulgarian Black Sea coast during autumn – winter 2016". Project report for the National Agency of Fisheries and Aquaculture of Bulgaria to National Data Collection program for 2017, 36 pp.

Pavlova E., S. Stoykov, V. Mihneva, D. Gerdjikov, Petrova D., F. Tserkova, S. Valchev T. Hubenova, A. Zaikov, L. Hadjinikolova, A. Ivanova, M. Gevezova, G. Rusenov, V. Maximov, G. Radu., 2016. "Stock assessment of turbot (*Scophthalmus maximus*) by swept area method in front of Bulgarian Black Sea coast during autumn – winter 2015". Project report for the National Agency of Fisheries and Aquaculture of Bulgaria to National Data Collection program for 2016, 66 pp.

Pavlova E., S. Stoykov, V. Mihneva, Klisarova D., D. Gerdjikov, F. Tserkova, S. Valchev, V. Maximov, G. Radu., 2017. "Stock assessment of turbot (*Scophthalmus maximus*) by swept area method in front of Bulgarian Black Sea coast during spring 2016". Project report for the National Agency of Fisheries and Aquaculture of Bulgaria to National Data Collection program for 2016, 44 pp.

Pavlova E., S. Stoykov, V. Mihneva, Klisarova D., D. Gerdjikov, F. Tserkova, S. Valchev, V. Maximov, G. Radu., 2017. "Stock assessment of turbot (*Scophthalmus maximus*) by swept area method in front of Bulgarian Black Sea coast during spring 2016". Project report for the National Agency of Fisheries and Aquaculture of Bulgaria to National Data Collection program for 2017, 44 pp.

Pavlova E., S. Stoykov, V. Mihneva, S. Valchev, P. Penchev, D. Gerdjikov, Klisarova D., , F. Tserkova, 2017. "Stock assessment of turbot (*Scophthalmus maximus*) by swept area method in front of Bulgarian Black Sea coast during spring 2017". Project report for the National Agency of Fisheries and Aquaculture of Bulgaria to National Data Collection program for 2017, 40 pp.

Pavlova E., S. Stoykov, V. Mihneva, S. Valchev, P. Penchev, D. Gerdjikov, Klisarova D., , F. Tserkova, 2018. "Stock assessment of turbot (*Scophthalmus maximus*) by swept area

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method in front of Bulgarian Black Sea coast during autumn 2017". Project report for the National Agency of Fisheries and Aquaculture of Bulgaria to National Data Collection program for 2017, 40 pp

Pavlova E., S. Stoykov, V. Mihneva, S. Valchev, P. Penchev, D. Gerdjikov, Klisarova D., F. Tserkova, 2018. "Stock assessment of turbot (*Scophthalmus maximus*) by swept area method in front of Bulgarian Black Sea coast during spring 2018". Project report for the National Agency of Fisheries and Aquaculture of Bulgaria to National Data Collection program for 2018, 43 pp

Pinkas, L., M. S. Oliphant, I. L. K. Iverson. 1971. Food habits of albacore, bluefin tuna and bonito in Californian waters. California Fish Game 152:1-105.

Raykov, 2011. Status, trends and environmental aspects of population dynamics of sprat (*Sprattus Sprattus L.*) Bulgarian sector of the Black Sea. PhD thesis, 210 p.

Ricker, W. E., 1975. Computation and interpretation of biological statistics of fish populations. *Bull.Fish.Res.Board Can.*, (191):382 p.

Rikhter, J. A. V. N. Efanov, 1976 - On one of the approaches to estimation of natural mortality of fish population. *ICNAF 76/VI/8*, 12p.

Sabatella, E., R. Franquesa, 2004. Manual for fisheries sampling surveys: Methodologies for estimation of socio-economic indicators in the Mediterranean Sea. General Fisheries Commission for the Mediterranean. Studies and Reviews, No.73, FAO Rome, ISBN 1020-7236, 38 pp.

Sparre, P., S. C. Venema, 1992. Introduction to tropical fish stock assessment. Part1. *FAO Fisheries Technical Paper* No 306.1, Rome, 376 p.

Sparre, P., S. C. Venema, 1998. Introduction to tropical fish stock assessment. Part I: Manual. *FAO Fisheries Technical Paper*, 306/1, rev.2, DANIDA, Rome FAO. 407p. ISBN 92-5-103996-8.

Troadec, J. P., 1977. Méthodes semi-quantitatives d'évaluation. *FAO circ.Pêches*, (701) :131-141.

Tserkova, F., D. Petrova, E. Pavlova, S. Stoykov, V. Mihneva, T. Hubenova, A. Zaikov, L. Hadjinikolova, D. Terziyski, A. Ivanova, M. Gevezova, V. Maximov, G. Radu., 2015. "Stock assessment of turbot (*Psetta maxima*) by swept area method in front of Bulgarian Black Sea coast during autumn – winter 2014". Project report for the National Agency of Fisheries and Aquaculture of Bulgaria to National Data Collection program for 2014, 56 pp.

Tserkova, F., D. Petrova, E. Pavlova, S. Stoykov, V. Mihneva, V. Maximov, G. Radu., 2015.

www.eufunds.bg

Проектно предложение № BG14MFOP001-3.003-0001, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2017-2019 г.”, финансирано от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство.



ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА
МОРСКО ДЕЛО И РИБАРСТВО



МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО, ХРАНИТЕ И
ГОРИТЕ



Abundance of Turbot (*Psetta maxima* L.) along the Bulgarian Black Sea Coast in Autumn 2014. Ozhan, E.(Editor), 2015, *Proceedings of Twelfth International Conference on the Mediterranean Coastal Environment, MEDCOAST, 15, 06-10 October 2015, Varna, Bulgaria, MEDCOAST, Mediterranean Coastal Foundation, Dalyan, Mugla, Turkey, vol 1, 419-430 p. ISBN: 978-605-85652-4-1.*

Walford, L. A., 1946. A new graphic method of describing the growth of animals. Biol. Bull. Mar. Biol. Lab. Woods. Hole, 90:141-147.

Zengin, M., 2005. Report of the Assessment Methodologies for the Turbot Stock in the Black Sea; Proposals for Standardized Methodology and Implementation at the Regional Level. AG FOMR, BSC.

www.eufunds.bg

Проектно предложение № BG14MFOP001-3.003-0001, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2017-2019 г.“, финансирано от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство.