



EUROPEAN UNION
EUROPEAN MARITIME
AND FISHERIES FUND



MINISTRY OF AGRICULTURE, FOOD AND FORESTRY



BIOLOGICAL MONITORING OF TURBOT (SCOPHTHALMUS MAXIMUS) LANDINGS AT THE BULGARIAN BLACK SEA IN THE SECOND QUARTER OF 2018

Institute of Fisheries and Aquaculture, Plovdiv

Agricultural Academy, Sofia

2018

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.



EUROPEAN UNION
EUROPEAN MARITIME
AND FISHERIES FUND



MINISTRY OF AGRICULTURE, FOOD AND FORESTRY



Working group from IFA, Plovdiv



Prof. Tania Hubenova, PhD;

Prof. Angel Zaikov, PhD;

Assoc. Prof. Angelina Ivanova, PhD;

Georgi Rusenov, PhD

Assis. Prof. Vasilka Krasteva

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.



EUROPEAN UNION
EUROPEAN MARITIME
AND FISHERIES FUND



MINISTRY OF AGRICULTURE, FOOD AND FORESTRY



Contents

1. Aim and objectives

2. Material and methods

2.1. Collection of biological data from landings

2.1.1. Ports for collection of biological data

2.1.2. Vessels for sample collection

2.1.3. Number of collected samples

2.1.4. Number of measured turbots

2.1.5. Geographical data of the catch locations of turbot

2.1.6. Determining the size-weight structure of the turbot landings

2.1.7. Characteristics of the reproductive biology of turbot

3. Results

3.1. Number of fish caught

3.2. Weight structure of the fish catches

3.3. Body size structure (total and standard body lengths) of turbot catches

3.4. Characteristics of the reproductive biology of turbot

3.4.1. Gonadosomatic index (GSI, %)

3.4.2. Fecundity of female fish

3.4.3. Determination of the maturity stage of the gonads

3.4.4. Age structure

4. Conclusions and recommendations

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.



EUROPEAN UNION
EUROPEAN MARITIME
AND FISHERIES FUND



MINISTRY OF AGRICULTURE, FOOD AND FORESTRY



1. Aim and objectives

The aim of the biological monitoring of the turbot catches at the Bulgarian Black Sea is to collect biological data which will be used for analysis of the catches and for the development of database for tracking the changes in their structure over the years.

The collection of biological samples, from landings of turbot, during the second quarter of 2018, included the following main objectives:

1. Collecting data for landing ports, vessels selected for sampling, number of collected samples, number of studied specimens, geographical data for the catches;
2. Determination of size-weight structure of the landings of turbot;
3. Characteristics of the reproductive biology of turbot;
4. Determination of the age structure of the turbot landings.

2. Material and methods

2.1. Collection of biological data from landings

The biological data collection is performed in the second quarter of 2018, after the prohibition period for fishing turbot (15-30.06.2018) at the Bulgarian Black Sea coastal zone.

2.1.1. Ports for collection of biological data

Ports where landings of turbot are permitted (Varna, Nesebar and Pomorie ports) are used for biological data collection.



EUROPEAN UNION
EUROPEAN MARITIME
AND FISHERIES FUND



MINISTRY OF AGRICULTURE, FOOD AND FORESTRY



2.1.2. Vessels for sample collection

Biological data is collected from 13 landings from 9 vessels listed in **Table 1.**

Table 1. Ports and vessels used for monitoring and biological data collection from landings of turbot in the second quarter of 2018.

Nº	Ships
Port Varna	
1.	Diana/Vn7668
2.	Sigma/Vn7180
3.	Hermes/Vn8080
4.	Egeo 2/Vn8339
5.	Trigona/Vn8579
6.	Ival/Vn8194
7.	Hermes 3/Vn4986
Port Nesebar	
8.	Vn8112
Port Pomorie	
9.	Admiral III

2.1.3. Number of collected samples

The biological data is collected from 13 turbot landings from vessels at the ports Varna, Nesebar and Pomorie.

2.1.4. Number of measured turbots

The total number of fish used for biological data collection is 123, with required minimum of 100 specimens under contract № 160/25.05.2018 with EAFA, Burgas.

2.1.5. Geographical data of the turbot catch locations

www.eufunds.bg



EUROPEAN UNION
EUROPEAN MARITIME
AND FISHERIES FUND



MINISTRY OF AGRICULTURE, FOOD AND FORESTRY



The coordinates and depth of the catch locations for each ship are shown in **Table 2.**

Table 2. Coordinates and depth of the turbot catch locations.

№	Ship	Coordinates of catch locations		Depth of catch locations (m)
		latitude	longitude	
1.	Diana/Vn7668			55-60
2.	Sigma/Vn7180			62
3.	Hermes/Vn8080			60-66
4.	Egeo 2/Vn8339			64-65
5.	Trigona/Vn8579			60
6.	Ival/Vn8194			
7.	Hermes 3/Vn4986			
8.	Vn8112			
9.	Admiral III	43°06'00"N	28°15'36"E	

2.1.6. Determination of the size-weight structure of turbot landings

The measurements of the fish are made on board of the ships, immediately after docking at the port, on fresh ice-cooled subjects. The weight measurements are done with a precision of 0.1 g and the measurements of the total and standard lengths – with a precision of 0.1 cm.



EUROPEAN UNION
EUROPEAN MARITIME
AND FISHERIES FUND



MINISTRY OF AGRICULTURE, FOOD AND FORESTRY



2.1.7. Characteristics of the reproductive biology of turbot

In the second quarter of 2018, based on samples of reproductive organs of 32 specimens, the gonadosomatic index, fecundity and maturation of sex organs was determined. From the same specimens, otoliths were collected for determination of fish age. Correlations between the following parameters were established:

- **Gonadosomatic index (GSI, %)**

The gonadosomatic index (GSI, %) is determined based on 32 female specimens caught in May 2018. GSI is calculated as % of weight for each sex, using the data for body weight and the gonads of female and male fish, applying Wootton formula (1998):

$$GSI = 100W_G \cdot BW^{-1}, \text{ where:}$$

W_G – weight of the gonads, g;

BW – body weight, g;

- **Fecundity of female fish**

Fecundity was determined based on 32 female fish caught in May 2018. Data on the absolute and relative fecundity of the specimens is provided.

www.eufunds.bg



EUROPEAN UNION
EUROPEAN MARITIME
AND FISHERIES FUND



MINISTRY OF AGRICULTURE, FOOD AND FORESTRY



PROGRAMME
MARITIME AFFAIRS
AND FISHERIES

- **Determination of the maturity stage of the reproductive organs in relation to the season at the time of the study**

The organs are removed and fixed in formaldehyde for further processing in order to establish the maturity of the ovaries and the testes. Paraffin sections were prepared for determination of the stage of maturity.

- **Determination of fish age**

The age of the fish was determined by counting the concentric circles (zones) of the otoliths, corresponding to the periods of growth. The otoliths were removed through the gills of the fish without opening the skull, carefully separating each pair without breaking. The otoliths were cleaned and stored until observation, which was performed using a stereomicroscope with appropriate magnification and light.

3. Results

3.1. Number of fish caught

The total number of fish, used for biological data collection, is 123. The number of fish caught from each vessel is presented in Fig. 1. An average of 9 fish were caught from each ship or 20.18 kg/ship. The maximum catch for a ship was 23 fish (40.06 kg) and the minimum - 3 fish (8.10 kg).



EUROPEAN UNION
EUROPEAN MARITIME
AND FISHERIES FUND



MINISTRY OF AGRICULTURE, FOOD AND FORESTRY

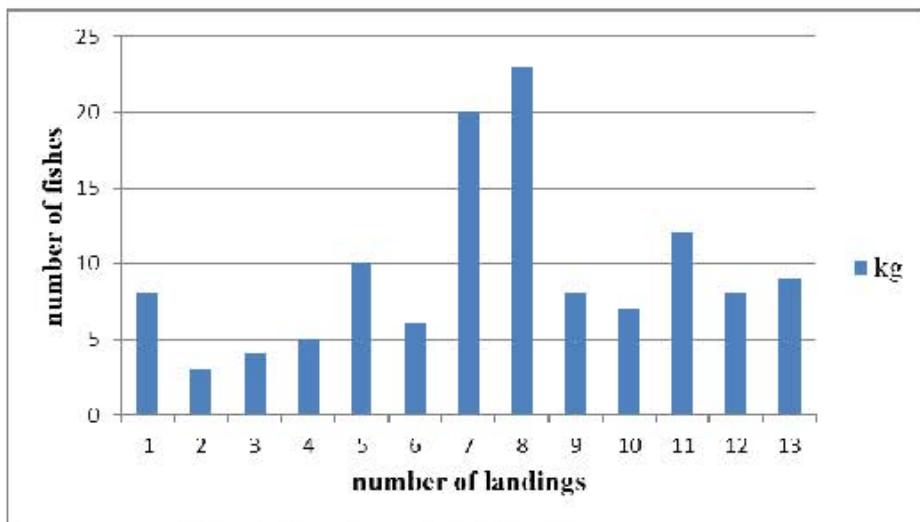


Fig. 1. Number of fish landings at ports.

3.2. Weight structure of the fish catches

The average weight of the measured specimens is 2.13 kg, the maximum measured weight is 5.50 kg and the minimum measured weigh is 1.35 kg.

In **Figure 2** is presented the percentage distribution of the fish weight. It can be observed that 68 specimens, or 55% of the total number of individuals, have weight up to 2 kg, and 45 individuals, or 37%, are fish with weight from 2 kg to 3 kg. Therefore, in the landings of the monitored ports, 92% of all turbots weigh up to 3 kg within the study period. The weight group of 3 kg to 4 kg is represented by 7% and that of over 4 kg is represented by 2%.



EUROPEAN UNION
EUROPEAN MARITIME
AND FISHERIES FUND



MINISTRY OF AGRICULTURE, FOOD AND FORESTRY

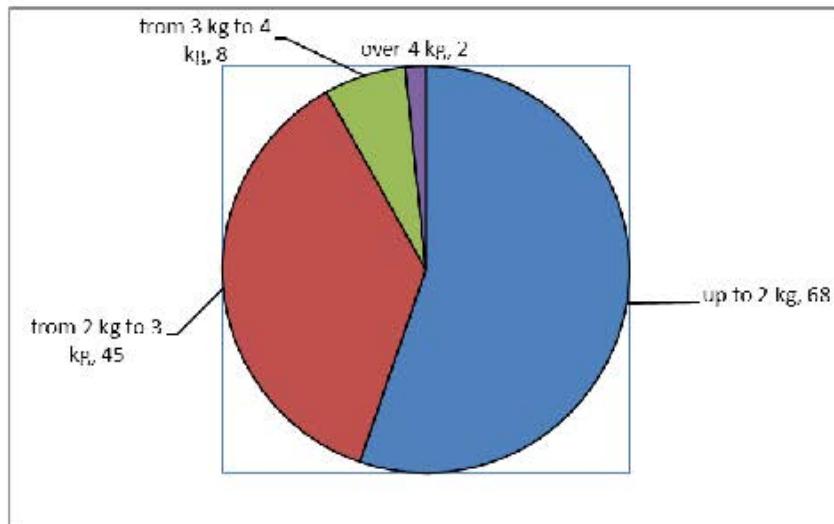


Fig. 2. Distribution of landings according to the weight of the measured fish.

3.3. Body size structure (total and standard body lengths) of turbot catches

The average total length of the measured fish is 49.58 cm, the maximum is 67.00 cm and the minimum - 45.0 cm. The dynamics of the distribution of the values of the total length (TL, cm) of the measured specimens (at 3.0 cm intervals) is presented in **Figure 3**.



EUROPEAN UNION
EUROPEAN MARITIME
AND FISHERIES FUND



MINISTRY OF AGRICULTURE, FOOD AND FORESTRY

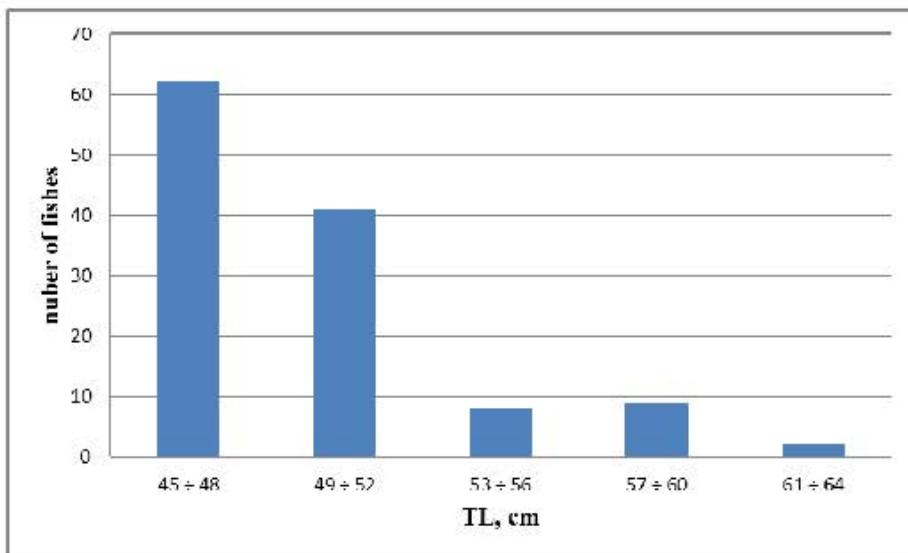


Fig. 3. Distribution of fish in different size groups (3 cm intervals) by total body lengths (TL, cm).

From the distribution of the specimens by size groups (at 3 cm intervals), it is established that the most represented is the size group of 45-48 cm. This group represents 50.41% of the studied specimens, followed by the 49-52 cm – 33.33%. Individuals with total body length in the 45-52 cm range are 103 specimens, representing 83.74% of all measured fish.

The dynamics of distribution of the average standard length (SL, cm) of the measured specimens is presented in **Figure 4**. The average value of the standard body length (SL, cm) is 39.43 cm. The maximum measured standard length is 56.50 cm and the minimum measured standard length - 35.00 cm.



EUROPEAN UNION
EUROPEAN MARITIME
AND FISHERIES FUND



MINISTRY OF AGRICULTURE, FOOD AND FORESTRY

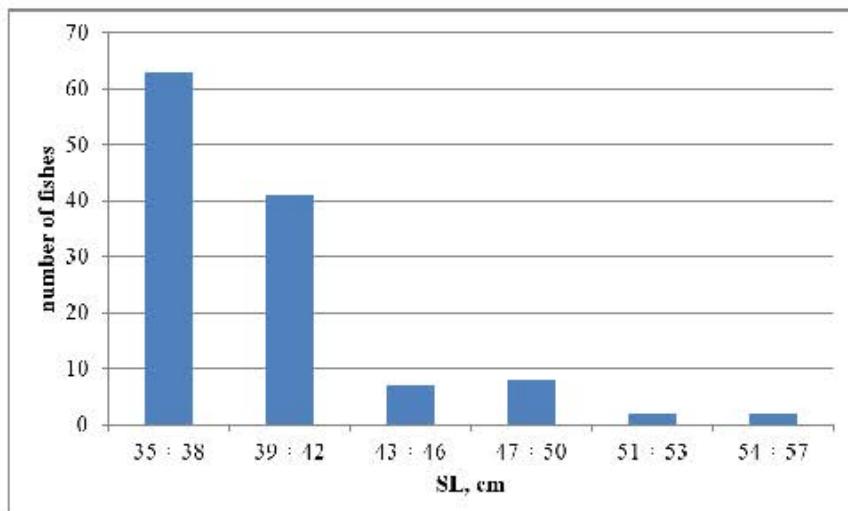


Fig. 4. Distribution of specimens in different size groups (at 3 cm intervals) by standard body length (SL, cm).

From the distribution of the specimens by size groups (at 3.0 cm) by standard lengths, it is established that the most frequently encountered is the size 35-38 cm. The largest group is the one of specimens with standard body length (SL, cm) in the range of 35-38 cm - 51.22% of the fish measured, followed by the group 39-42 cm (33.33%). Specimens, with standard body lengths in the 35-46 cm range, are 104 (84.55%).

From the results, it can be concluded that the total body length (TL, cm) of the measured fish ranged from 45.0-67.0 cm and the body weight from 1.35-5.50 kg (Fig. 5). The dominant group has a total body length from 45.0 cm to 48.0 cm and a body weight from 1.33-2.13 kg.



EUROPEAN UNION
EUROPEAN MARITIME
AND FISHERIES FUND



MINISTRY OF AGRICULTURE, FOOD AND FORESTRY

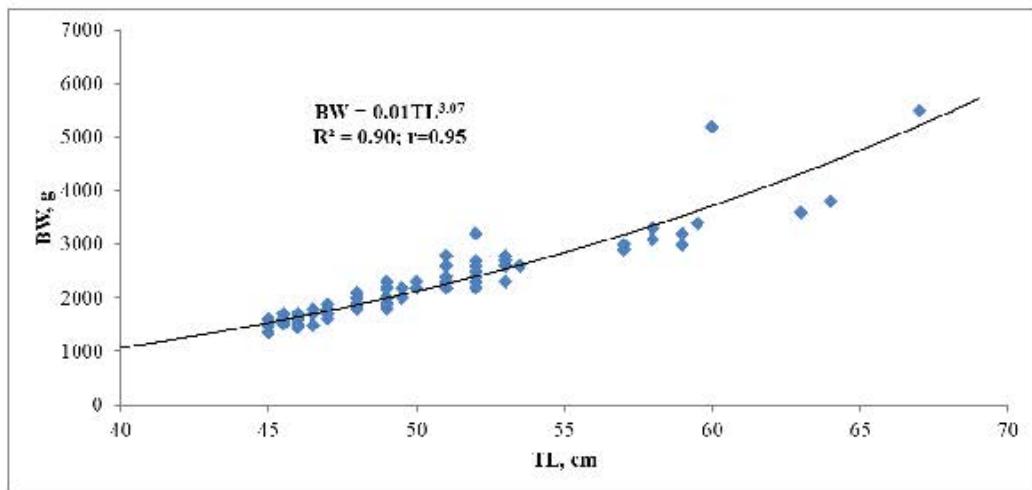


Fig. 5. Correlation between total body length (TL, cm) and weight (BW, g) of turbot (n=123).

The correlation between the total body length and weight of the turbot landings is expressed with the equation: $BW = 0.01 TL^{3.07}$.

3.4. Characteristics of turbot reproductive biology

3.4.1. Sex ratio

The studied specimens from the second quarter of 2018 are only females.

3.4.2. Gonadosomatic index (GSI, %)

The average weight of female fish in May 2018 is 3.34 kg and is in the range 1.37-6.21 kg.

The weight of the gonads is between 0.06 kg and 0.74 g, with an average value of 0.28 g. The

gonadosomatic index (GSI, %) for female specimens in May 2018 has an average value

8.65%, with the highest value being 27.51% and the lowest - 3.02% (Table 3).



EUROPEAN UNION
EUROPEAN MARITIME
AND FISHERIES FUND



MINISTRY OF AGRICULTURE, FOOD AND FORESTRY



Table 3. Body weight (BW, kg), total (TL, cm) and standard (SL, cm) body lengths, testes weight (WG, kg), GSI,% and age of female specimens in May 2018.

Nº	BW, kg	TL, cm	SL, cm	WG, kg	GSI,%	Age
1	2.69	52.0	40.0	0.74	27.51	5
2	5.15	63.0	49.0	0.74	14.37	8
3	2.56	48.0	37.0	0.30	11.72	4
4	2.28	54.0	42.0	0.24	10.53	6
5	1.72	46.0	36.0	0.22	12.79	4
6	2.73	54.0	42.0	0.15	5.49	5
7	2.12	49.0	39.0	0.22	10.38	4
8	3.71	62.0	48.0	0.17	4.58	7
9	3.63	56.0	44.0	0.48	13.22	6
10	3.35	57.0	45.0	0.18	5.37	6
11	3.35	55.0	44.0	0.48	14.33	6
12	1.37	43.0	34.0	0.11	8.03	3
13	4.44	62.0	48.0	0.38	8.56	7
14	4.33	63.0	50.0	0.16	3.70	8
15	1.99	48.0	38.0	0.060	3.02	4
16	3.47	58.0	45.0	0.18	5.19	6
17	2.86	56.0	44.0	0.27	9.44	6
18	5.10	65.0	49.0	0.29	5.69	8
19	2.96	57.0	44.0	0.24	8.11	6
20	4.20	59.0	46.0	0.62	14.76	7
21	2.78	58.0	46.0	0.16	5.76	7
22	3.54	56.0	43.0	0.16	4.52	6
23	2.68	56.0	44.0	0.13	4.85	6
24	3.16	59.0	46.0	0.12	3.80	7
25	6.21	71.0	56.0	0.68	10.95	10
26	3.73	61.0	49.0	0.12	3.22	8
27	4.62	62.0	49.0	0.17	3.68	7
28	3.98	61.0	48.0	0.16	4.02	7



EUROPEAN UNION
EUROPEAN MARITIME
AND FISHERIES FUND



MINISTRY OF AGRICULTURE, FOOD AND FORESTRY



29	2.14	48.0	37.0	0.32	14.95	4
30	3.40	59.0	45.0	0.20	5.88	6
31	2.99	57.0	44.0	0.25	8.36	6
32	3.56	58.0	45.0	0.36	10.11	7
min	1.37	43.0	34.0	0.06	3.02	3
max	6.21	71.0	56.0	0.74	27.51	10
average	3.34	56.7	44.3	0.28	8.65	6

GSI,% values are in the range between 27.51% and 3.02%, which is specific characteristic of the ovaries during the breeding season in which fish is spawning and is actively involved in reproduction processes.

3.4.3. Fecundity of female fish

The female fish (32 specimens), whose fecundity is determined in May 2018, have an average body weight of 3.34 kg. The average total body length is 56.66 cm and the average age is 6 years (Fig. 6).

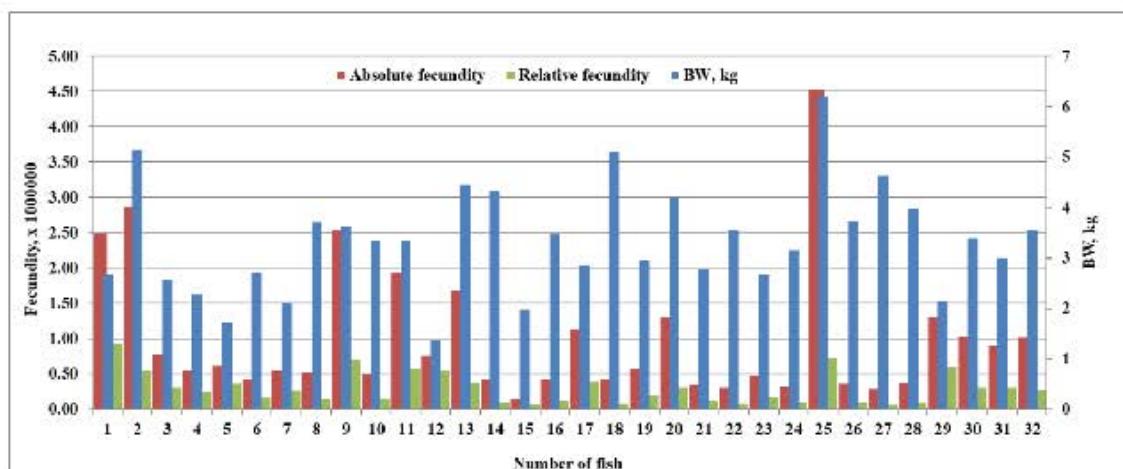


Fig. 6. Weight of female fish, absolute and relative fecundity in May 2018.



EUROPEAN UNION
EUROPEAN MARITIME
AND FISHERIES FUND



MINISTRY OF AGRICULTURE, FOOD AND FORESTRY



The absolute fecundity, established in May 2018, is 996 644 eggs and the relative fecundity - 298 625 eggs (**Table 4**).

Table 4. Values for absolute and relative fecundity of turbot in May 2018.

Parameters	Average values
Number of female fish	32
Total length, TL (cm)	56.66
Body weight, BW (g)	3338
Absolute fecundity ($\times 10^3$), number of eggs/individual	997
Relative fecundity ($\times 10^3$), number of eggs/BW, kg	297
Age, years	6

The established fecundity is almost 2.5 times lower compared to the fecundity in other studies of turbot - 5-6 Mill., but it is comparable to the fecundity established in our previous research. This difference is due to the fact that fecundity over 5 Mill. egg is observed in fish weighing more than 5-6 kg, whose presence in our catches is low. This is shown in Fig. 7, in which the correlation between absolute fecundity and total body length is expressed – fecundity increases with the increase of body length.



EUROPEAN UNION
EUROPEAN MARITIME
AND FISHERIES FUND



MINISTRY OF AGRICULTURE, FOOD AND FORESTRY

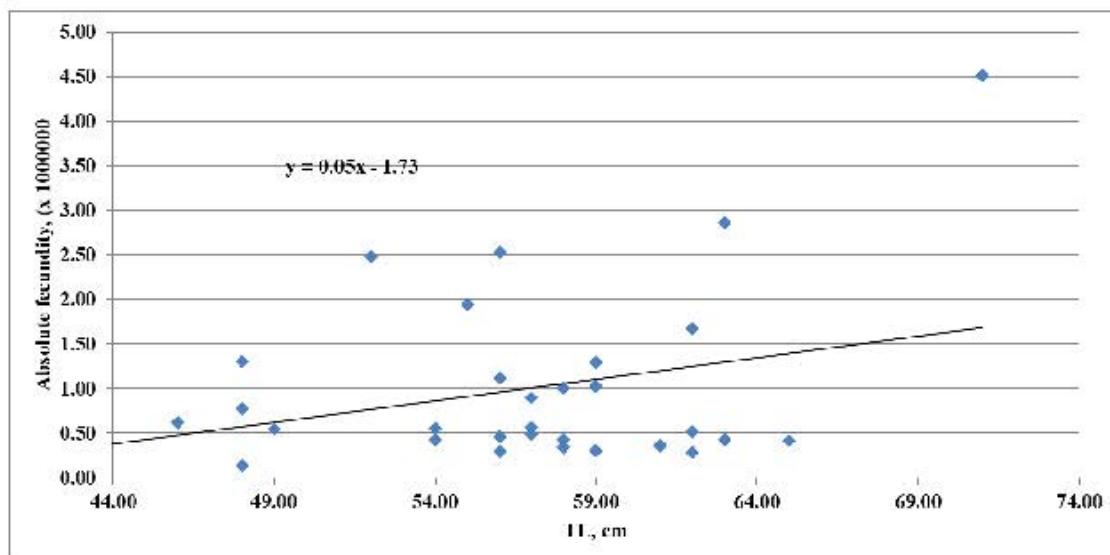


Fig 7. Correlation between absolute fecundity and total body length (TL, cm).

The correlation between absolute fecundity and weight of female specimens is presented in Fig. 8.

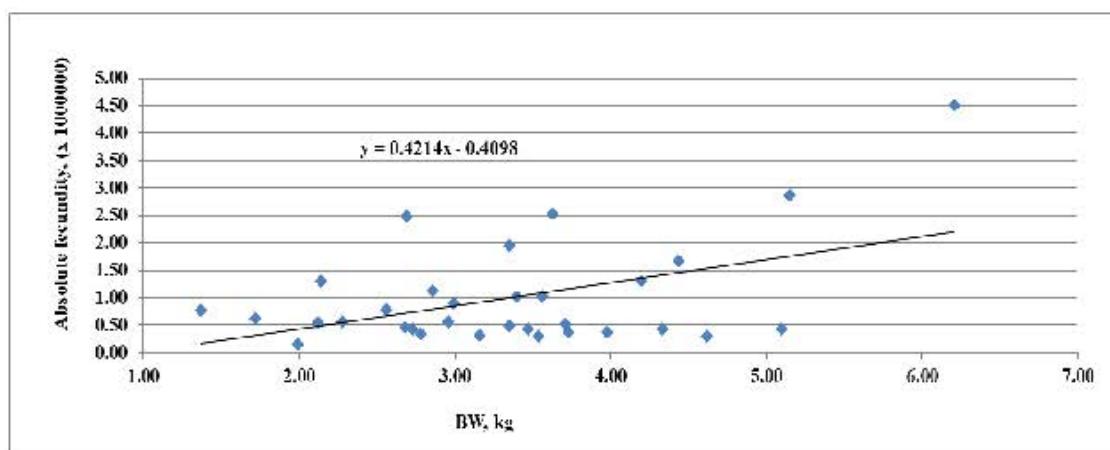


Fig. 8. Correlation between absolute fecundity and weight of female fish in May 2018.



EUROPEAN UNION
EUROPEAN MARITIME
AND FISHERIES FUND



MINISTRY OF AGRICULTURE, FOOD AND FORESTRY



The correlation between absolute fecundity and age of female fish in May 2019 is presented in **Fig. 9.**

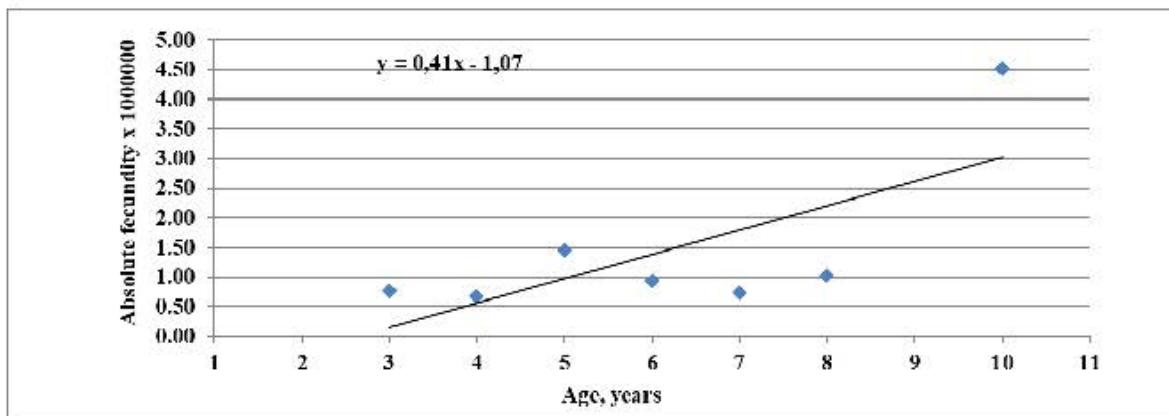


Fig. 9. Correlation between absolute fecundity and age of female fish in May 2018.

3.4.4. Determination of the maturity stage of the gonads

At the beginning of April, the ovaries undergo a process of active vitellogenesis leading to the accumulation of vitellogenin in the oocytes. Big fraction is vitellogenic oocytes of different size and the ovaries are at stage III-IV of maturity.

At the beginning of May, the ovaries of the examined female specimens reached stage IV. In the prereproduction period, several phases of oocyte development are observed in the ovaries, which is a result of the group-portion nature of their maturation. Several structural elements have been identified, mainly represented by full-sized vitellogenic oocytes, in the process of finalizing vitellogenesis, as well as small-sized vitellogenic oocytes forming for the next ovulation.



EUROPEAN UNION
EUROPEAN MARITIME
AND FISHERIES FUND



MINISTRY OF AGRICULTURE, FOOD AND FORESTRY



3.4.5. Age

The age structure of the 32 studied female specimens ranged from 3 to 10-year-old fish, with 5-year-old specimens being predominant (**Fig. 10**). They make up 59.38% of the total number of studied female fish. Most specimens are 6-year-old - 34.38%, followed by 7-year-old - 25%.

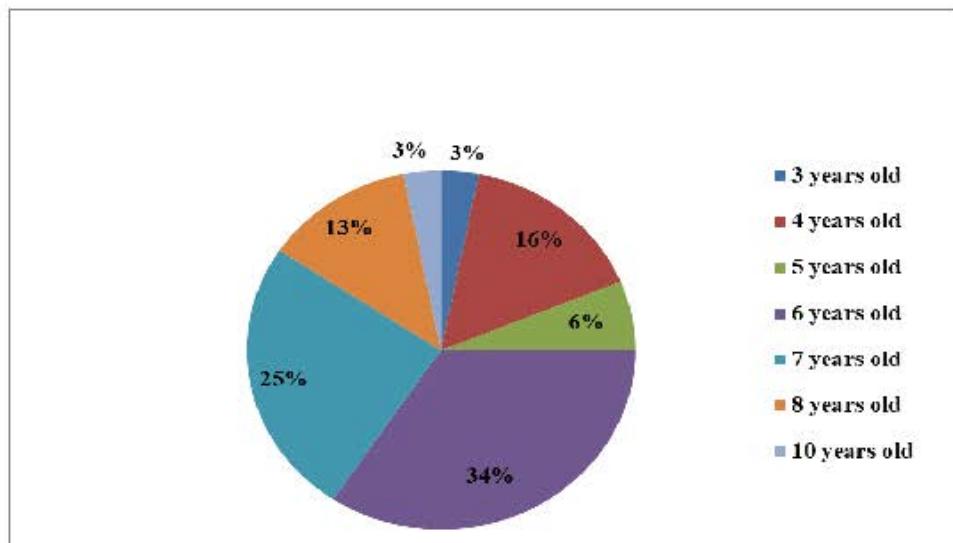


Fig. 10. Percentage distribution of age of female turbot in May 2018 (n=32).
Based on the average values, the correlation between linear growth and the age of turbot, caught in May 2018, is presented in **Fig. 11**.



EUROPEAN UNION
EUROPEAN MARITIME
AND FISHERIES FUND



MINISTRY OF AGRICULTURE, FOOD AND FORESTRY

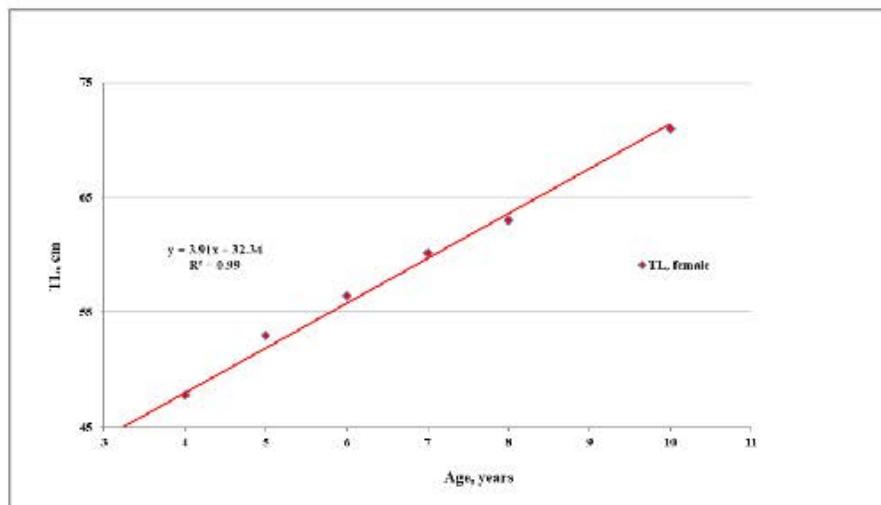


Fig. 11. Correlation between total length (TL, cm) and age (years) of female turbot in May 2018.

The weight gain of turbot in correlation to age is presented in Fig. 12.

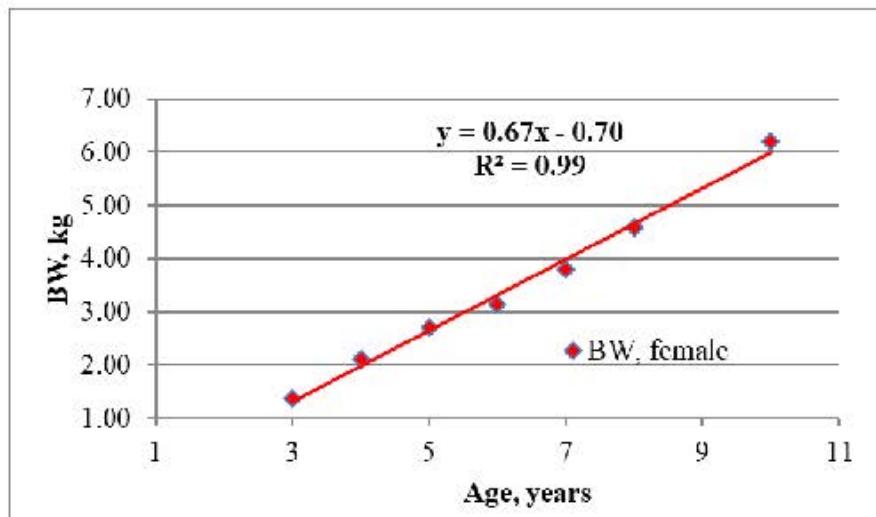


Fig. 12. Correlation between weight (BW, kg) and age (years) of female turbot in May 2018.

4. Conclusions and recommendations

www.eufunds.bg



EUROPEAN UNION
EUROPEAN MARITIME
AND FISHERIES FUND



MINISTRY OF AGRICULTURE, FOOD AND FORESTRY



Based on the results of the biological monitoring of turbot landings, carried out at the Bulgarian Black Sea coast in the second quarter of 2018, we can make the following conclusions and suggest the following recommendations:

1. During the study period in 2018, the fishing ships landings have an average value of 9 specimens of turbot and an average of 20.18 kg per day. The maximum number of fish from the landings of the monitored ports is 23 fish and the minimum is 3 fish.
2. From a total of 13 landings of the monitored ports, 123 specimens are measured with an average weight of 2.13 kg, an average total body length of 48.58 cm and an average standard body length of 39.43 cm.
3. The maximum measured weight is 5.50 kg and the minimum measured - 1.35 kg.
4. The maximum measured total length is 67.00 cm and standard length – 56.50 cm. The minimum measured total length and standart length are respectively 45.00 cm and 35.00 cm.
5. 68 specimens, or 55% of the total number of fish, have weight up to 2 kg and 45 specimens, or 37% of all studied fish, have weight from 2 kg to 3 kg. 8 specimens, or 7% of all studied fish, have weight from 3 kg to 4 kg. Specimens with weight over 4 kg represent 2%. Therefore, from the landings of the monitored ports, around 92% of all turbots weigh up to 3 kg during the carried out monitoring.
6. From the distribution of the fish by size groups (at 3 cm), it is established that the largest size group is that of 45-48 cm. This group represented 50.41% of all studied specimens, followed by the 49-52 cm group – 33.33%. 103 fish are with total body lengths in the 45-52 cm range, representing 83.74% of all specimens measured.
7. The average value of the standard body length (SL, cm) is 39.43 cm. The maximum standard length measured is 56.50 cm and the minimum measured - 35.00 cm.
8. The correlation between the size and the weight structure of the turbot landings is described with the equation: $BW = 0.01 TL^{3.07}$.

www.eufunds.bg



EUROPEAN UNION
EUROPEAN MARITIME
AND FISHERIES FUND



MINISTRY OF AGRICULTURE, FOOD AND FORESTRY



PROGRAMME
MARITIME AFFAIRS
AND FISHERIES

9. The age structure of the caught female specimens include3 to 10-year-old fish, with 6 and 7-year-old specimens being predominant.
10. The gonadosomatic index (GSI, %) for female turbot in May 2018 has an average value of 8.65%, with maximum and minimum values of 27.51% and 3.02%.
11. In May, the ovaries of the studied specimens is at stage IV-V of maturity, which is distinctive characteristic for reproductive period.

We express our gratitude to EAFA, Burgas, Agricultural Academy, Sofia and the commercial fishing sector for their assistance during the research activities under contract № 160/25.05.2018 c. with EAFA.