BIOLOGICAL MONITORING OF LANDINGS OF COMMERCIALLY IMPORTANT SPECIES

Scientific report under contract N157/13/03/2023 covering the results for I-XII 2024

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MINISTRY OF AGRICULTURE AND FOOD

MARITIME, FISHERIES AND AQUACULTURE PROGRAMME

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BULGARIAN ACADEMY OF SCIENCES
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Table of Contents

I. BIOLOGICAL MONITORING OF SPRAT (*SPRATTUS SPRATTUS*) LANDINGS 5
I.1 OBJECTIVES 5
I.2 SAMPLING 5
I.2.1 GEOGRAPHIC AREA COVERAGE 5
I.2.2 SAMPLING PERIOD 5
I.2.3 STATISTICAL ANALYSIS OF DATA 6
I.3 RESULTS 7
I.3.1 LANDINGS STATISTICS 7
I.3.2 LENGTH STRUCTURE OF LANDINGS 7
I.3.3 AGE STRUCTURE OF LANDINGS 8
I.3.4 CONDITION FACTOR 16
I.3.5 WEIGHT STRUCTURE OF SPRAT 18
I.3.6 SIZE STRUCTURE OF SPRAT BY AGE GROUP 19
I.3.7 LENGTH- WEIGHT RELATIONSHIP 19
I.3.8 SEX RATIO 21
I.3.9 FERTILITY 22
I.3.10 SEXUAL MATURITY 24
I.3.11 CATCH NUMBERS AND BIOMASS BY AGE AND LENGTH 25
I.3.12 CONCLUSIONS 27
II. BIOLOGICAL MONITORING OF HORSE MACKEREL (*TRACHURUS MEDITERRANEUS*) LANDINGS 29
II.1 OBJECTIVES 29
I.2 SAMPLING 29
II.2.1 GEOGRAPHIC AREA COVERAGE 29
II.2.2 SAMPLING PERIOD 29
II.2.3 STATISTICAL ANALYSIS OF DATA 30
II.3 RESULTS 30
II.3.1 LANDINGS STATISTICS 30
II.3.2 LENGTH STRUCTURE OF LANDINGS 31
II.3.3 AGE STRUCTURE OF LANDINGS 31
II.3.4 CONDITION FACTOR 40
II.3.5 WEIGHT STRUCTURE OF HORSE MACKEREL 41
II.3.6 SIZE STRUCTURE OF HORSE MACKEREL BY AGE GROUP 43
II.3.7 LENGTH- WEIGHT RELATIONSHIP 43
II.3.8 SEX STRUCTURE 44
II.3.9 FERTILITY 45
II.3.10 SEXUAL MATURITY 48
II.3.11 CATCH NUMBERS AND BIOMASS BY AGE AND LENGTH 49
II.3.12 CONCLUSIONS 51
III. BIOLOGICAL MONITORING OF WHITING (*MERLANGIUS MERLANGUS*) LANDINGS 53
III.1 OBJECTIVES 53
III. 2 SAMPLING 53

Project No. BG14MFOP001-1.002-0001 "Collection, management and use of data for the purposes of scientific analysis and implementation of the Common Fisheries Policy for the period 2023-2024", financed by the Maritime, Fisheries and Aquaculture Programme, co-financed by the European Union through the European Fund for maritime, fisheries and aquaculture fund.

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III. 2.1 GEOGRAPHIC AREA COVERAGE 53
III. 2.2 SAMPLING PERIOD 53
III. 2.3 STATISTICAL ANALYSIS OF DATA 54
III.3 RESULTS 54
III.3.1 LANDINGS STATISTICS 54
III.3.2 LENGTH STRUCTURE OF LANDINGS 54
III.3.3 AGE STRUCTURE OF LANDINGS 55
III.3.4 CONDITION FACTOR 63
III.3.5 WEIGHT STRUCTURE OF WHITING 65
III.3.6 SIZE STRUCTURE OF WHITING BY AGE GROUP 66
III.3.7 LENGTH- WEIGHT RELATIONSHIP 67
III.3.8 SEX STRUCTURE 67
III.3.9 FERTILITY 69
III.3.10 SEXUAL MATURITY 71
III.3.11 CATCH NUMBERS AND BIOMASS BY AGE AND LENGTH 72
III.3.12 CONCLUSIONS 74
IV. BIOLOGICAL MONITORING OF RED MULLET (*MULLUS BARBATUS*) LANDINGS 76
IV.1 OBJECTIVES 76
IV.2 SAMPLING 76
IV.2.1 GEOGRAPHIC AREA COVERAGE 76
IV.2.2 SAMPLING PERIOD 76
IV.2.3 STATISTICAL ANALYSIS OF DATA 77
SEE SECTION STATISTICAL ANALYSIS OF SPRAT 77
IV.3 RESULTS 77
IV.3.1 LANDINGS STATISTICS 77
IV.3.2 LENGTH STRUCTURE OF LANDINGS 77
IV.3.3 AGE STRUCTURE OF LANDINGS 78
IV.3.4 CONDITION FACTOR 87
IV.3.5 WEIGHT STRUCTURE OF RED MULLET 88
IV.3.7 LENGTH-WEIGHT RELATIONSHIP 89
IV.3.8 SEX RATIO 91
IV. 3.9 FECUNDITY 92
IV.3.10 SEXUAL MATURITY 94
IV.3.11 CATCH NUMBERS AND BIOMASS BY AGE AND LENGTH 96
IV. 3.12 CONCLUSIONS 98
V. BIOLOGICAL MONITORING OF ANCHOVY (*ENGRAULIS ENCRASICOLUS*) 100
V.1 OBJECTIVES 100
V.2 SAMPLING 100
V.2.1 GEOGRAPHIC AREA COVERAGE 100
V.2.2 SAMPLING PERIOD 100
V.2.3 STATISTICAL ANALYSIS OF DATA 101
V.3 RESULTS 101
V.3.1 LANDINGS STATISTICS 101
V.3.2 LENGTH STRUCTURE OF LANDINGS 101
V.3.3 AGE STRUCTURE OF LANDINGS 102
V. 3.4 CONDITION FACTOR 109

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V3.5 WEIGHT STRUCTURE OF ANCHOVY 110
V.3.6 SIZE STRUCTURE OF WHITING BY AGE GROUP 112
V.3.7 LENGTH- WEIGHT RELATIONSHIP 112
V.3.8 SEX RATIO....113
V.3.9 FERTILITY....115
V.3.10 SEXUAL MATURITY 116
V.3.11 CATCH NUMBERS AND BIOMASS BY AGE AND LENGTH 117
V.3.12 CONCLUSIONS 118
VI. BIOLOGICAL MONITORING OF PICKED DOGFISH (*SQUALUS ACANTHIAS*) LANDINGS 121
VI.1 OBJECTIVES 121
VI.2 SAMPLING....121
VI.2.1 GEOGRAPHIC AREA COVERAGE....121
VI.2.2 SAMPLING PERIOD....121
VI.3. LANDINGS STATISTICS OF SPINY DOGFISH....121
VI.4 RESULTS 123
VI.4.1 SEX, SIZE AND WEIGHT STRUCTURE....123
VI.4.2 GENDER STRUCTURE AND SIZE-WEIGHT RELATIONSHIP 126
VI.4.3 SEXUAL MATURITY 129
VI.5 CONCLUSION....129
VII. ANEX....130
SPRATTUS SPRATTUS 130
TRACHURUS MEDITERRANEUS PONTICUS 130
MERLANGIUS MERLANGUS EUXINUS....130
MULLUS BARBATUS 131
ENGRAULIS ENCRASICOLUS....131
SQUALUS ACANTHIAS 132

In connection with the implementation of **Contract No. 157 of 13.03.2023**, sampling was done for inclusion in the biological monitoring from the northern and southern coasts. The data of this analysis are collected from the landings in the ports of the Bulgarian Black Sea coast of the Black Sea.

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I. Biological monitoring of sprat (*Sprattus sprattus*) landings

I.1 Objectives

The purpose of biological monitoring is to collect data that will be used to analyze sprat catches, as well as to form a database. The collection of biological samples of sprat catches in 2024 includes the **following tasks:**

1. *To collect and analyze the dynamics of length, weight and age distribution.*
2. *To determine the state of the sprat using the so-called state factor (Ricker, 1975).*
3. *Characteristics of the reproductive biology of sprat.*
4. *Collection of data on ports of landing, sampling vessels, number of samples collected, number of specimens tested, geographical catch data.*

I.2 Sampling

The sampling was carried out by the actively operating fishing fleet in Bulgaria.

I.2.1 Geographic area coverage

The data from the current analysis is collected directly from the landings in the ports of the Bulgarian Black Sea coast. During the period of 2024 were collected **10 samples with 1385 specimens.** Information on the size of the catches was also collected.

I.2.2 Sampling period

The biological data on sprat were collected from a total of **10 landings at the ports of Sozopol and Nessebar**. Information on the size of the catches was also collected. Ports and ships from which monitoring was carried out to collect biological data from landings are presented in **Table I.2.2.1.**

Table I.2.2.1 Ports and ships from which monitoring was carried out to collect biological data from sprat discharges.

№	Date	Harbour	Species code SPR	Fishing vessel	External marking	Fishing gear	Catch	Coordinates
1	17.1.2024	Nessebar	SPR	R/K 40	BS288	OTM	1100	42.6604614258 27.7332077026
2	9.2.2024	Sozopol	SPR	RK 27	BS 290	OTM	960	42.3398 27.9051
3	11.4.2024	Nessebar	SPR	SVETI	BS 175	OTM	660	42.6604309082 27.7332210541

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4	29.5.2024	Nessebar	SPR	ISHTAR	NS 1182	OTM	120	42.4930000305 27.9638881683
5	25.6.2024	Nessebar	SPR	NICO	BS152	OTM	1000	42.6702690125 27.8198375702
6	18.7.2024	Nessebar	SPR	ISHTAR	NS 1182	OTM	1700	42.646200 27.727300
7	12.8.2024	Sozopol	SPR	MEDUSA 3	BS 288	OTM	20	42.426200 27.737700
8	4.9.2024	Sozopol	SPR	Xerson	BS 210	OTM	40	42.504700 28.011300
9	23.10.2024	Sozopol	SPR	MEDUSA 3	BS 288	OTM	2148	42.423000 27.691800
10	1.11.2024	Sozopol	SPR	Xerson	BS 210	OTM	2325	42.422300 27.691300

I.2.3 Statistical analysis of data

All samples were collected according to variation statistics from significant catches where possible. Samples were collected randomly. Samples are processed in laboratory conditions. Length is measured to the nearest 0.5 cm, and only the total length is taken into account. Weight is measured to the nearest gram (0.1 gram). Age determination was performed under an Olympus CX 31RTSF-6 microscope. Thus, the annual rings stand out as transparent zones, followed by darker zones (opaque) - zones of stagnation (stagnation) in growth. The Fulton index is estimated according to Ricker equation, (1975):

$$K = \frac{W}{L^3} * 100$$

"Length-age keys" are created for all samples. In this way, the average values of length, weight and condition factor are determined. The share (in %) of individuals from the respective age groups is determined.

Fecundity: All fish were measured to the nearest 1 mm in total length (TL) and weighed to the nearest 1 gram. The gonads of the fish are examined under a microscope for external characteristics such as hardness and color to determine the stage of maturity.

The sex ratio was also calculated in this study (i.e, number of males ♂/ number of females♀ (Simon *et al*., 2012). Females were determined by macroscopic observation of a mature ovary (Laevastu, 1965a).

Batch fecundity rates can vary greatly during the short spawning season, being low at the beginning, peaking during the heaviest spawning and declining again towards the end.
The fecundity rate of sprat was determined by the "hydrated oocyte method" (Hunter *et al* 1985). Oilly hydrated females were used. After sampling their body cavity was opened and they ovary were 'preserved in a buffered formalin solution (Hunter *et al* 1985). The ovary free female weight and the ovary weight were determined. Three tissue samples of -50 mg were removed from different parts of the ovary and their exact weights were determined. Under a binocular microscope, the number of hydrated oocytes in each of the three subsamples was determined. Hydrated oocytes can be easily distinguished from all other types of oocytes due to their large size and translucent appearance and their wrinkled surface due to formalin

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preservation. Batch fecundity was estimated based on the average number of hydrated oocytes per unit weight of the three samples. The gonadosomatic index (GSI) was calculated as:

$$GSI = \frac{GW}{SW} X\ 100$$

where, GW is gonad weight and SW is somatic weight (represents BW without GW).

The length – weight relationship is obtained by the following equation: $W_t = qL_t^n$
where: q – parameter, n – parameter of the relationship between length and weight.

I.3 Results

I.3.1 Landings statistics

In March, June and July 2024, the discharges from the sprat were the highest, while the decrease was recorded in January and October-November **(Fig.I.3.1.1).**

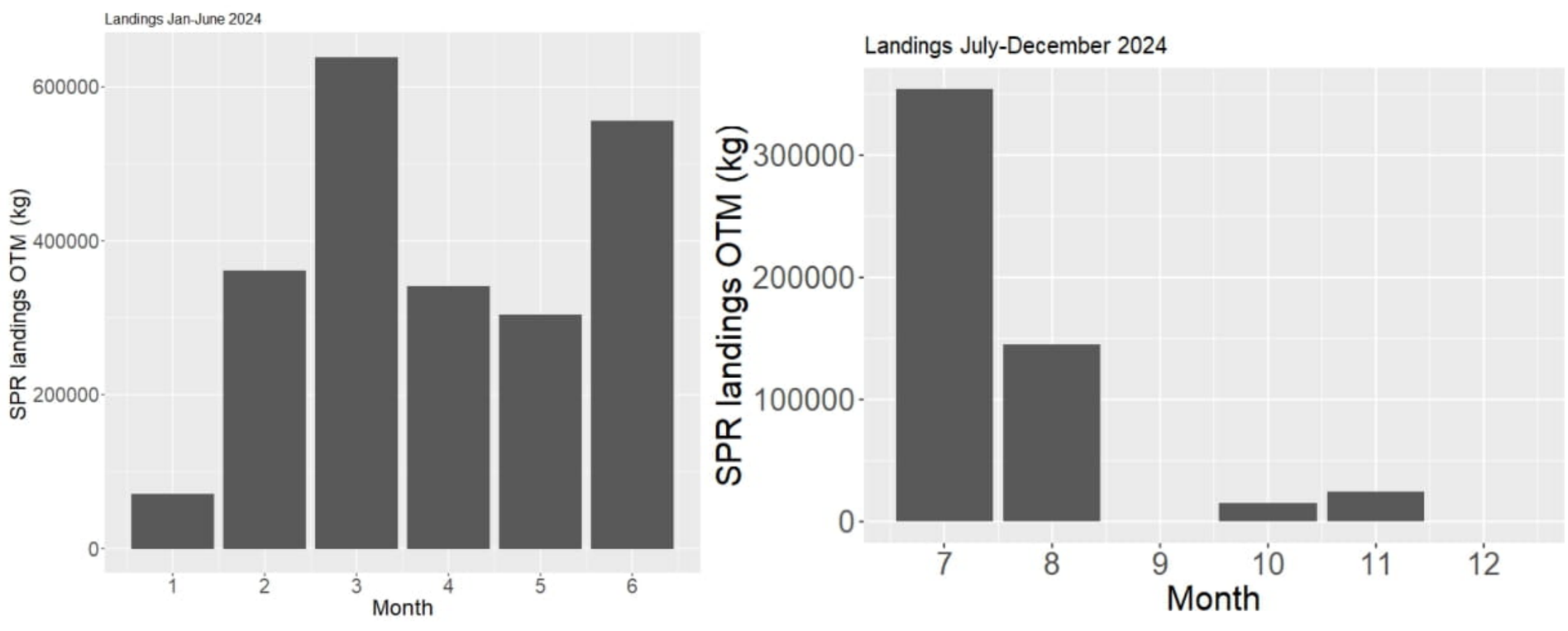


Fig I.3.1.1 Official statistics records for sprat landings.

I.3.2 Length structure of landings

The size structure of the sprat during the first quarter of 2024, shows a bimodal distribution with a peak of size group 8.0 and 8.5 cm participating with one share - 21.36% and prevailing significantly above the others. An increase in the percentage (20%) of individuals from the 9.00 cm size group is also noted. In the first quarter, equal participation of size groups 7.5cm, 9.5cm and 10.0 cm was established in the catches, which participated with 10.45% and 10%,

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respectively. A sharp drop in attendance marks the 10.5 cm and 11 cm groups with 3.64% and 2.73%, respectively. In the second quarter, the size groups 7.5 and 8 cm participated with the highest percentage with 13.44% and 12.90% respectively. The lowest prevalence in the the second quarter is observed in size groups 11 - 11.5cm, which are represented by 4.3% and 3.23% in the catch **(Fig.I.3.2.1).**

The size composition in the 3rd and 4th quarters covers size groups from 7 to 11 cm, with the percentage participation of individuals from each size group in the number is presented in **Fig. I.3.2.2.** The distribution of fish by size classes for the third quarter shows that the smallest size groups 7.5 cm with 1.13% and 8 cm with 0.849 are the least represented. The highest percentage is represented by 9.5-10 cm with 64.02% of the total number of caught sprat specimens. In the fourth quarter, over 44.77% of the individuals have an absolute length of 8.5 cm and 9 cm and these size groups are the most represented. In the fourth quarter, the least represented are the size classes 7 cm and 11 cm, which are equally represented in the catch with 0.45%

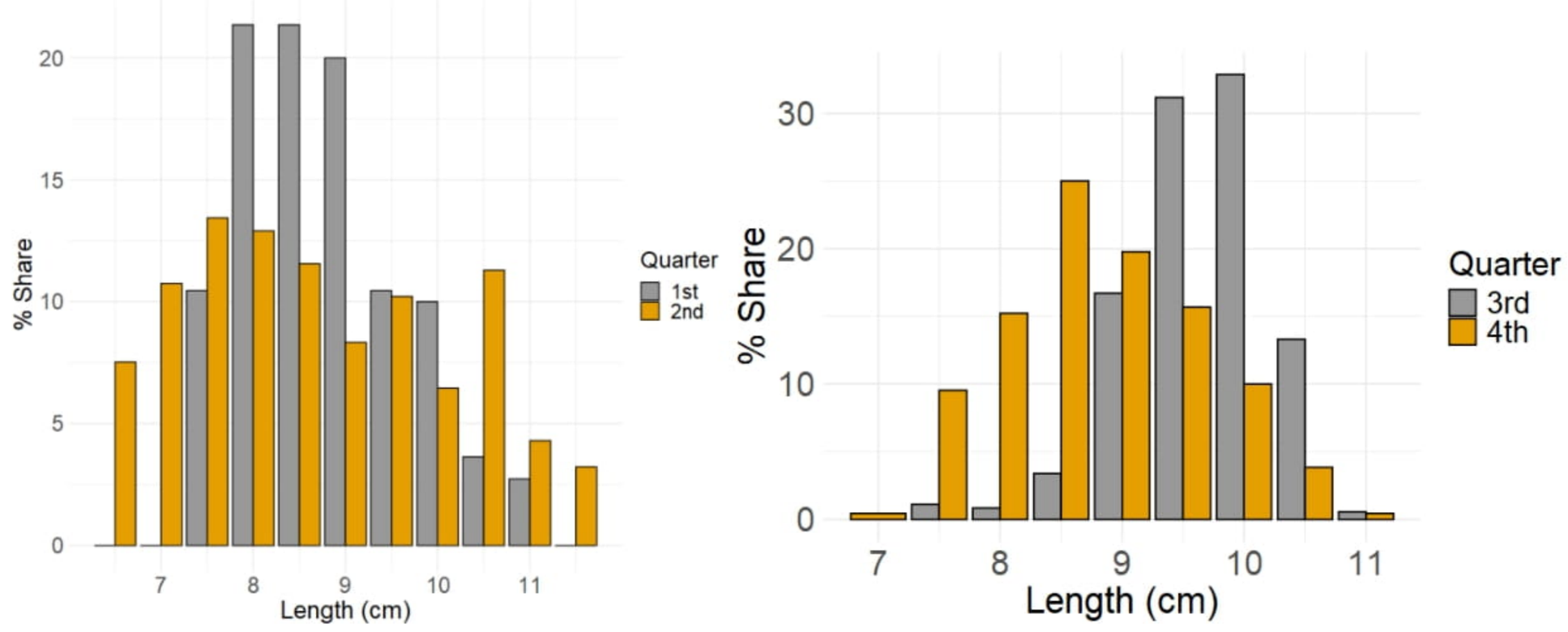


Fig I.3.2.1 Size structure and percentage share of length classes in the catch composition.

I.3.3 Age structure of landings

The three experts determined the age of the otoliths, and assessor 1 looked at all otoliths twice Samples **n = 1385 (n=592 specimens in the first half of the year and n=793 specimens in the second half of the year**) were used to determine age. In the first and second quarters, the

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highest percentage share is occupied by individuals in the age group 2-2+, followed by 3-3+. In the first quarter of 2024, in terms of the age of the sprat, the age group 2-2 + reached 51.82 %. The age group of 1-1+ and 3-3+ year olds are represented by 19.09% and 27.72%, respectively. The oldest age groups 4-4+ are represented by 1.36%. In the second quarter, the participation of 2-2 + age groups reached 36.83%, followed by 3-3 + with 29.57%. The presence of 0 +, 4-4+ and 5-5 + age groups is small with 7.53%, 2.69% and 3.23% respectively.

In the third and fourth quarters, the highest percentage share is again occupied by individuals in the age group 2-2+, followed by 3-3+. The oldest age groups 4-4+ have the lowest participation rate -0.57% in the third and 0.45% in the fourth quarter. In the fourth quarter, one-year-olds significantly predominate with 14.32%.

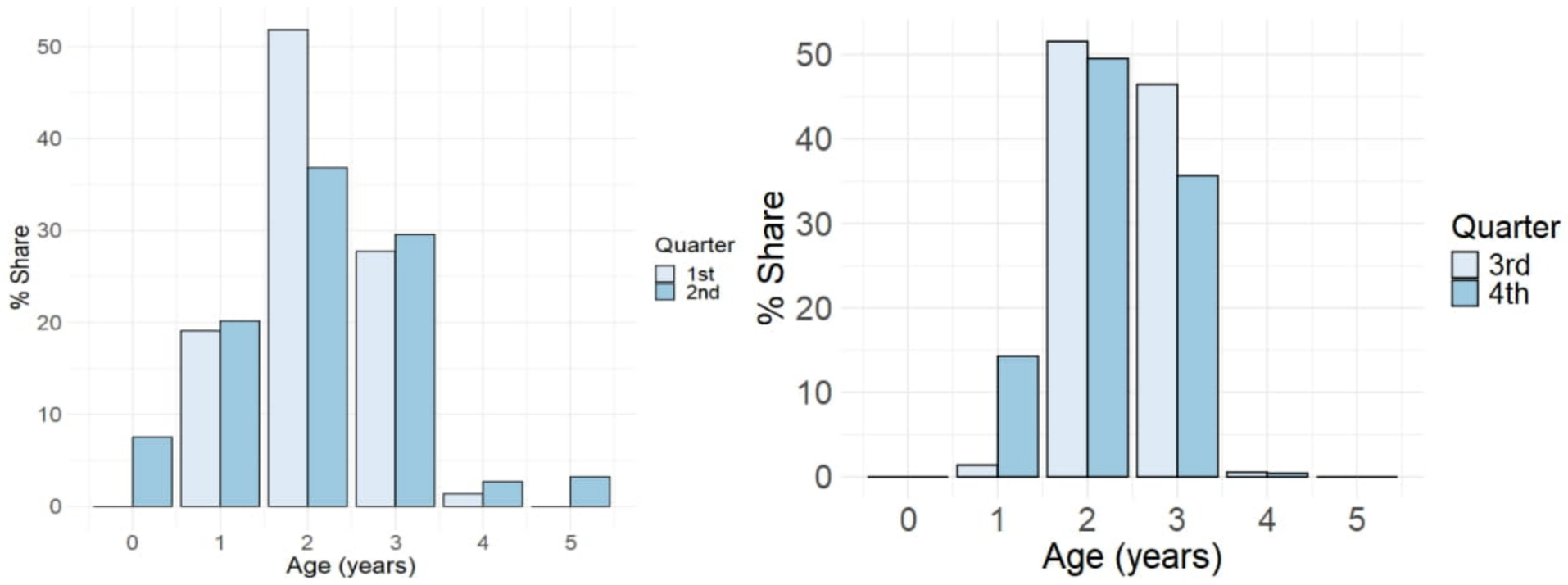


Fig. I.3.3.1 Age structure of the sprat and % presentation of the size classes in the catches.

Results of age slicing methods – analyzes were performed in the R programming environment (Program Language for Statistical Modeling and Analysis) using ELEFAN functions (ELectronic LEngth Frequency Analysis).

ELEFAN is a size-frequency sampling analysis method that is used in fish stock research to estimate growth and other biological parameters of research species based on measured lengths of individuals of different age groups.

The samples are restructured for analysis purposes to follow the evolution of the cohorts over time (**Fig. I.3.3.2-3** - the first and second frequency diagram shows the size structure of the collected specimens in the respective months, and the second - the restructured data with a moving average MA = 7).

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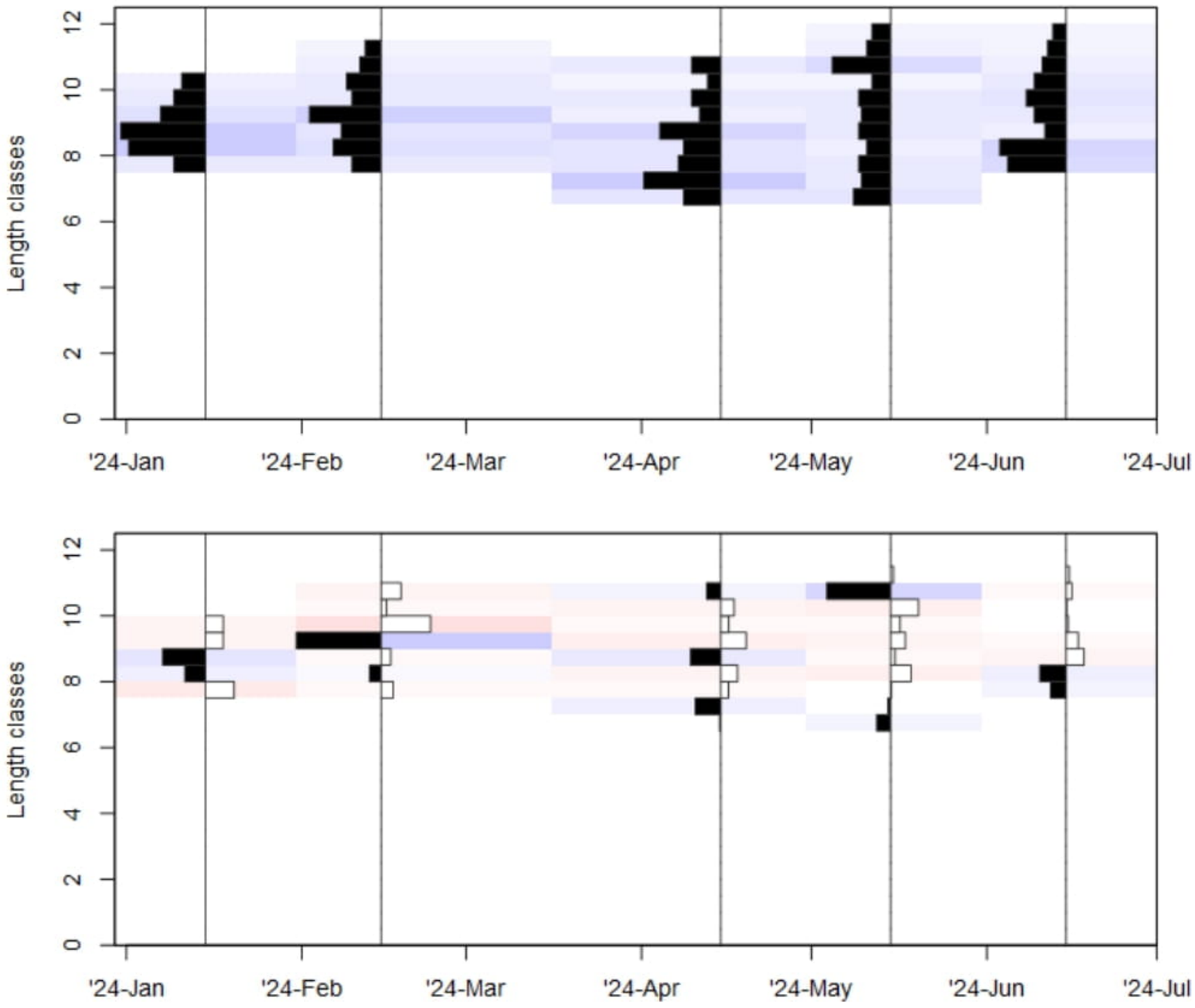


Fig.I.3.3.2 Size-frequency samples **for the first half of the year** visualized as (diagram above) number of individuals in a size class and (diagram below) the restructured data with moving average MA = 7 for the purposes of frequency analysis and determination of growth parameters.

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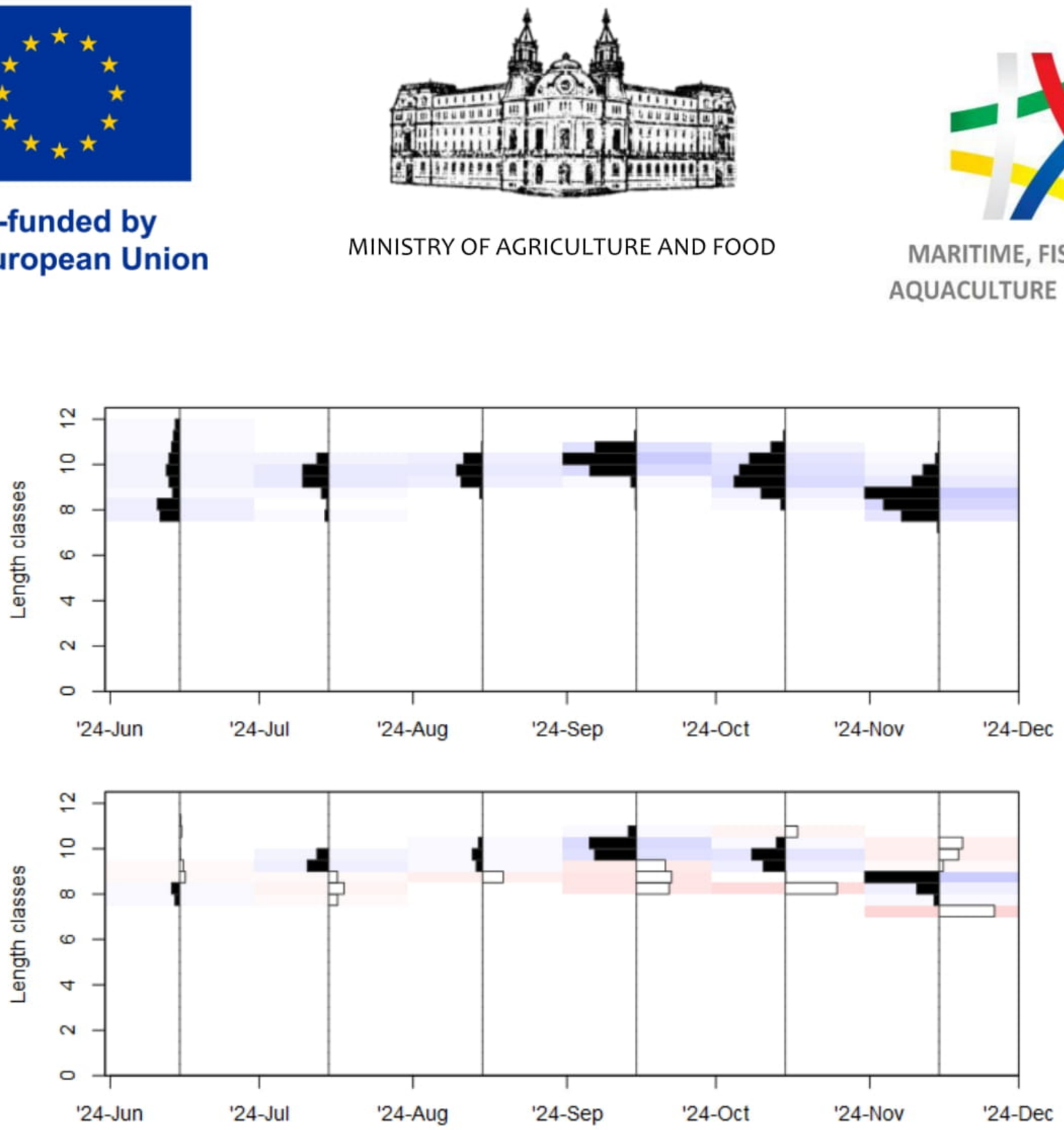


Fig.I.3.3.3 Size-frequency samples **for the second half of the year**, visualized as (diagram above) number of individuals in size class and (diagram below) the restructured data with a moving average MA = 7 for the purposes of frequency analysis and determination of growth parameters.

I.1.3.3.1 Frequency analysis RSA – response surface analysis

Growth parameters determined by RSA with initial conditions: conditional interval of for the asymptotic length L_∞ in the sample [11;13.5cm] and the parameter that determines the rate of growth to L_∞ - K = exp ($seq(from\ log(0.1), to\ \log(2))$ at an upper limit for L_∞ = 13.5 cm

The parameters in the von Bertalanffy model are calculated as follows **for the first semester: L_∞=12.35 cm; K= 0.5 and t_0=-0.53**. According to the latter, the ages with their corresponding lengths were calculated (**Table I.1.3.3.3.1**). A disadvantage of the method is the difficult optimization of L_∞ and K and the need for a priori expertise to define the interval for the expected asymptotic length, which is expected to be overcome by applying genetic algorithms for age slicing.

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The parameters in the von Bertalanffy model were calculated as follows **for the second semester: L_∞=12.42 cm; K = 0.5 and t_0=-0.54**. The ages with their corresponding lengths were calculated using the latter (**Table I.1.3.3.3.2**). A disadvantage of the method is the difficult optimization in terms of L_∞ and K and the need for a priori expertise to define the interval for the expected asymptotic length, which is expected to be overcome by applying genetic algorithms for age slicing.

I.1.3.3.2 Frequency analysis ELEFAN with simulated annealing (ELEFAN SA)

The simulated annealing method in the context of ELEFAN (Electronic Length Frequency Analysis for estimating fish stock parameters) is a technique used for optimization. The advantages over RSA are: avoidance of local optima: the algorithm explores a wider range of possible solutions and thus avoids local minima that may not be optimal. Accordingly, this approach increases the chances of finding a globally optimal solution, which is especially important when analyzing complex ecological data such as those on fish stocks.

The growth parameters determined under initial conditions: a conditional interval of for the asymptotic length $[\![L_\infty]\!]_{guess}$=12.25 cm and a search for the value of L_∞ in the interval $[L_{(\infty guess)}*0.8 \div L_{(\infty guess)}*1.2]$, and for K in the interval [0÷1].

The parameters in the von Bertalanffy model were calculated as follows **for the first semester**: **L_∞=12.73 cm; K = 0.48 and t_0=-0.51**. The ages with their corresponding lengths were calculated using the latter (**Table I.1.3.3.3.1**).

The parameters in the von Bertalanffy model **for the second semester** were calculated as follows: **L_∞=12.06 cm; K = 0.41 and t_0=-0.22**. The ages with their corresponding lengths were calculated using the latter (**Table I.1.3.3.3.2**).

I.1.3.3.3 Frequency analysis ELEFAN – Genetic algorithm (ELEFAN GA)

Growth parameters determined under initial conditions: conditional interval of for the asymptotic length $[\![L_\infty]\!]$ guess=12.25 cm and search for value L_∞ in the interval $[L_{(\infty guess)}*0.8 \div L_{(\infty guess)}*1.2]$, and for K in the interval [0÷1].
The parameters in the von Bertalanffy model **for the first semester** are calculated as follows: **L_∞=12.68 cm; K = 0.49 and t_0=-0.44**. The latter were used to calculate the ages with their corresponding lengths (**Table I.1.3.3.3.1**).

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The parameters in the von Bertalanffy model **for the second semester** were calculated as follows: **L_∞=12.10 cm; K = 0.46 and t_0=-0.88**. The latter were calculated in the ages with their corresponding lengths **(Table I.1.3.3.3.2).**

Table I.1.3.3.3.1 Ages with their corresponding lengths for the studied species calculated using von Bertalanffy parameters, obtained with RSA, ELEFAN with simulated annealing, ELEFAN with genetic algorithm and compared with experimentally determined ages from otoliths **for the first semester.**

	ELEFAN RSA	**ELEFAN SA**	**ELEFAN GA**	**Experimentally determined**
age	La	La	La	Lmean
0	2.9	2.7	2.9	n/a
0.5	5	4.9	4.9	6.5
1	6.6	6.5	6.5	7.5
1.5	7.9	7.9	7.8	
2	8.9	8.9	8.8	8.25
2.5	9.6	9.7	9.7	
3	10.2	10.4	10.3	10
3.5	10.7	10.9	10.9	
4	11.1	11.3	11.3	11
4.5	11.3	11.6	11.7	
5	11.6	11.8	12	11.5

Table I.1.3.3.3.2 Ages with their corresponding lengths for the studied species calculated using von Bertalanffy parameters, obtained with RSA, ELEFAN with simulated annealing, ELEFAN with genetic algorithm and compared with the experimentally determined ages from otoliths **for the second semester**.

	ELEFAN RSA	**ELEFAN SA**	**ELEFAN GA**	**Experimentally determined**
age	La	La	La	L average
0	2.9	1.0	4.1	n/a
0.5	5	3.1	5.7	n/a
1	6.7	4.7	7.1	7.75
1.5	7.9	6.1	8.1	
2	8.9	7.2	8.9	8.5
2.5	9.7	8.1	9.6	
3	10.3	8.8	10.1	9.75
3.5	10.8	9.4	10.5	
4	11.1	9.9	10.9	11
4.5	11.4	10.3	11.1	
5	11.6	10.6	11.3	n/a

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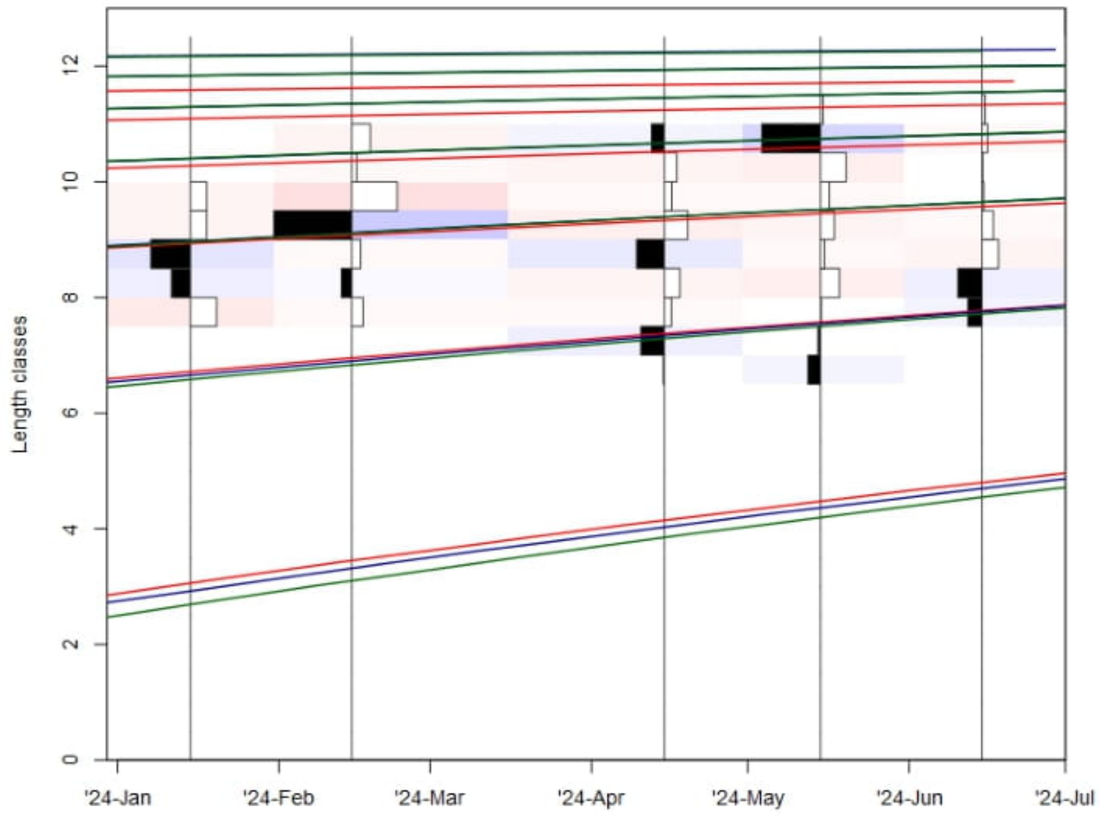


Fig. I.1.3.3.3.1 Growth curves (in red for growth parameters determined with ELEFAN RSA, in blue for ELEFAN SA, and in green for ELEFAN GA), visualized on the restructured data for the purpose of visualizing the tracking of cohorts over time **for the first semester**.

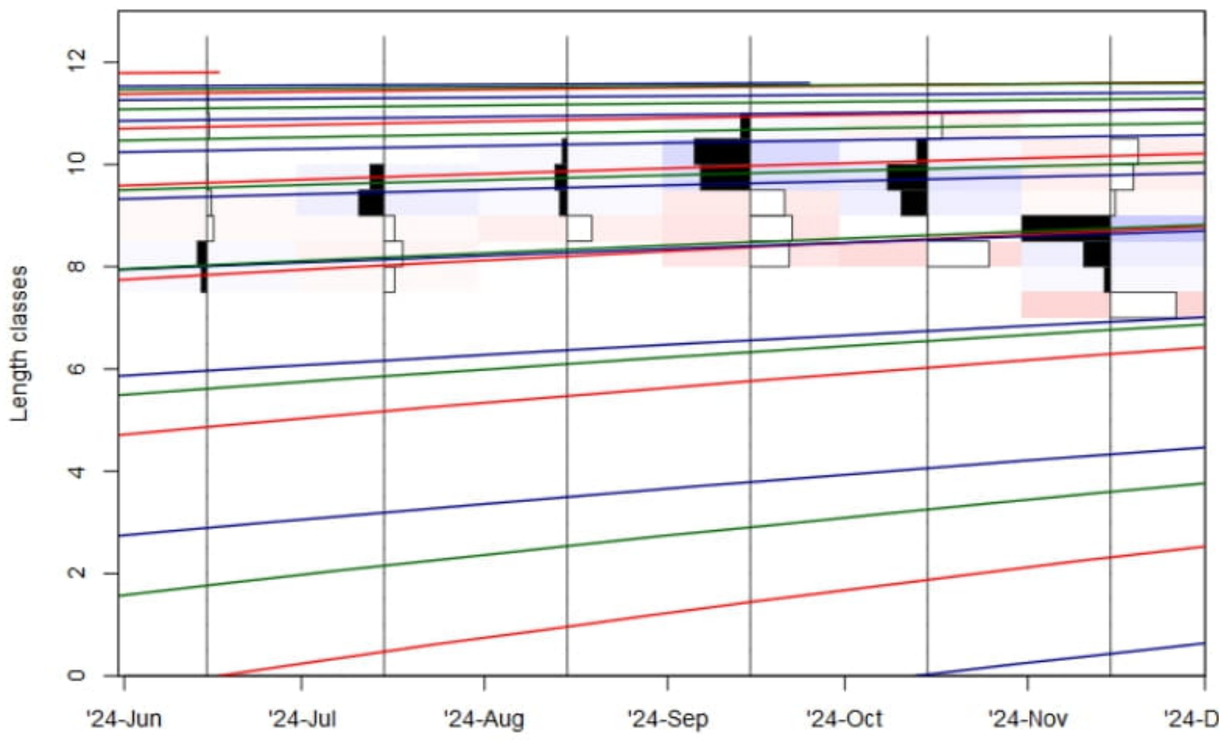


Fig. I.1.3.3.3.2 Growth curves (in red for growth parameters determined with ELEFAN RSA, in blue for ELEFAN SA, and in green for ELEFAN GA), visualized on the restructured data for the purpose of visualizing the tracking of the cohorts over time **for the second semester**.

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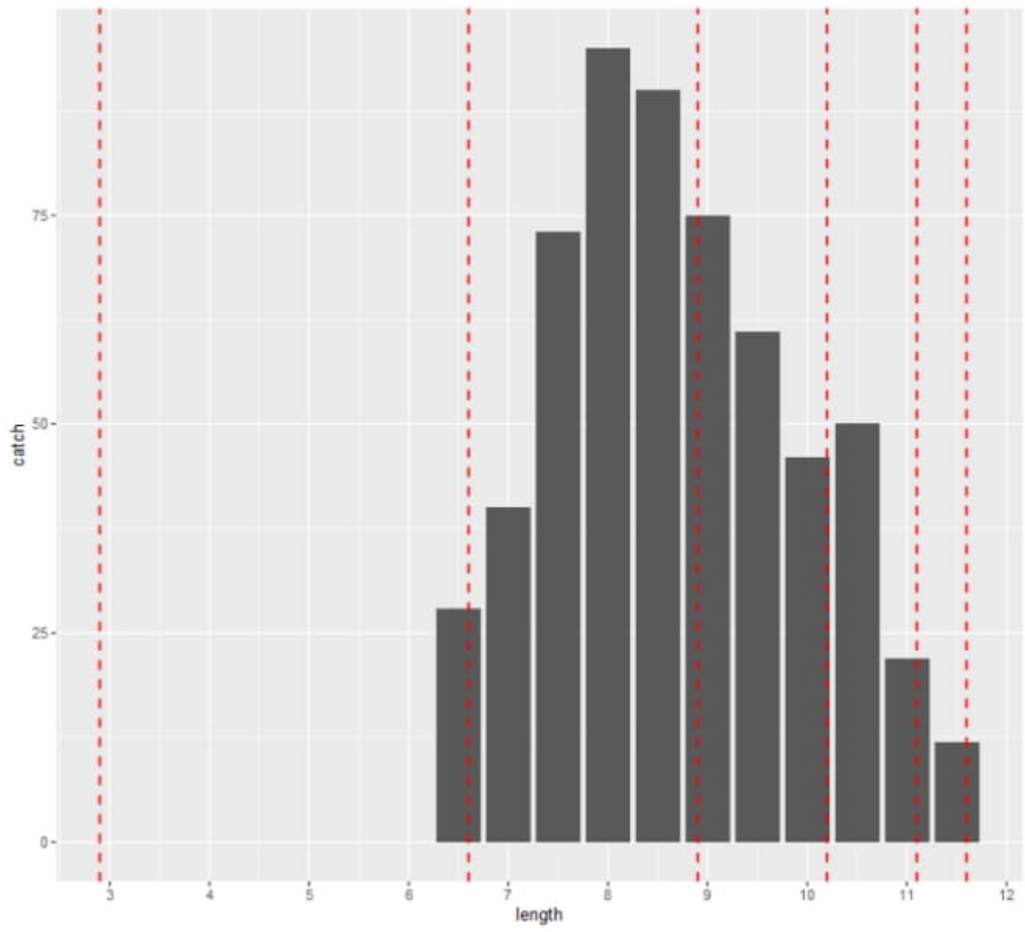


Fig. I.1.3.3.3.3 The ages represented with dashed lines, calculated based on the growth parameters determined by ELEFAN RSA, are overlaid on the cumulative sample of the composition of commercial catches of sprat, aiming to visualize the range of size classes represented in a specific age group (0-5 years) **for the first half of 2024**.

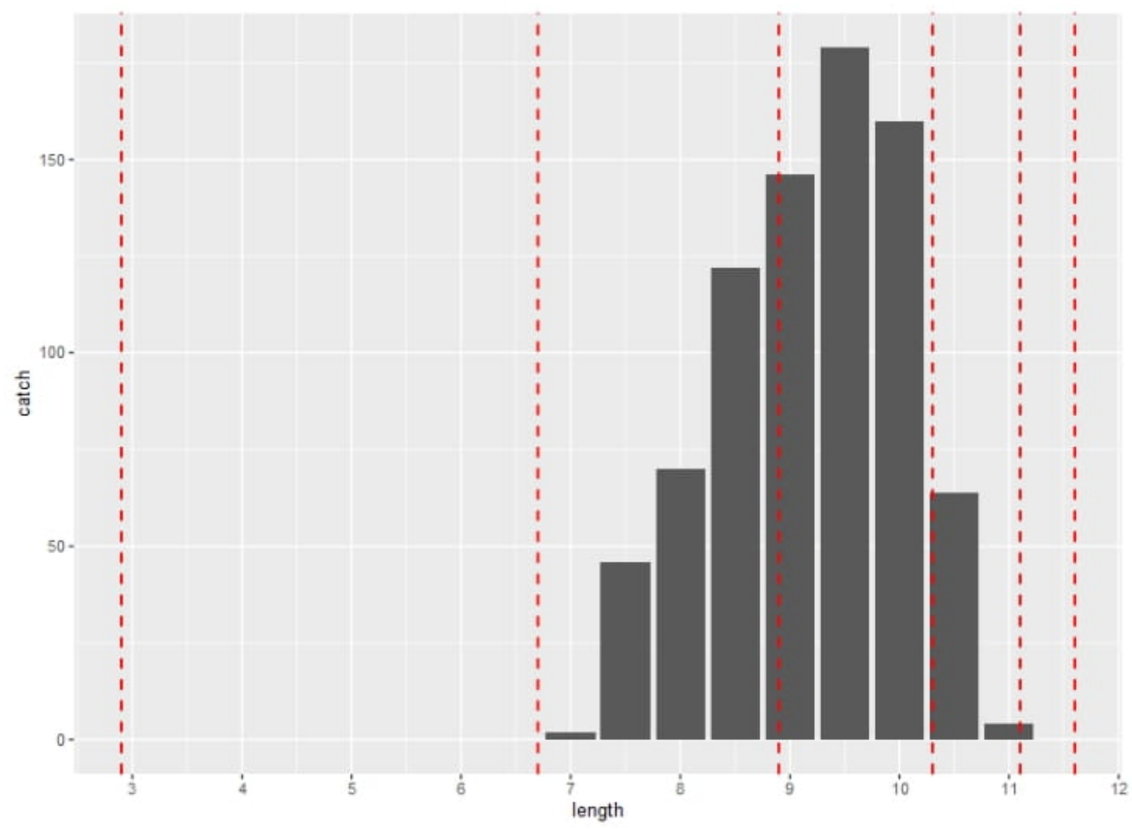


Fig. I.1.3.3.3.4 Ages, represented by dotted lines, calculated from growth parameters determined with ELEFAN GA superimposed on the cumulative sample of the composition of

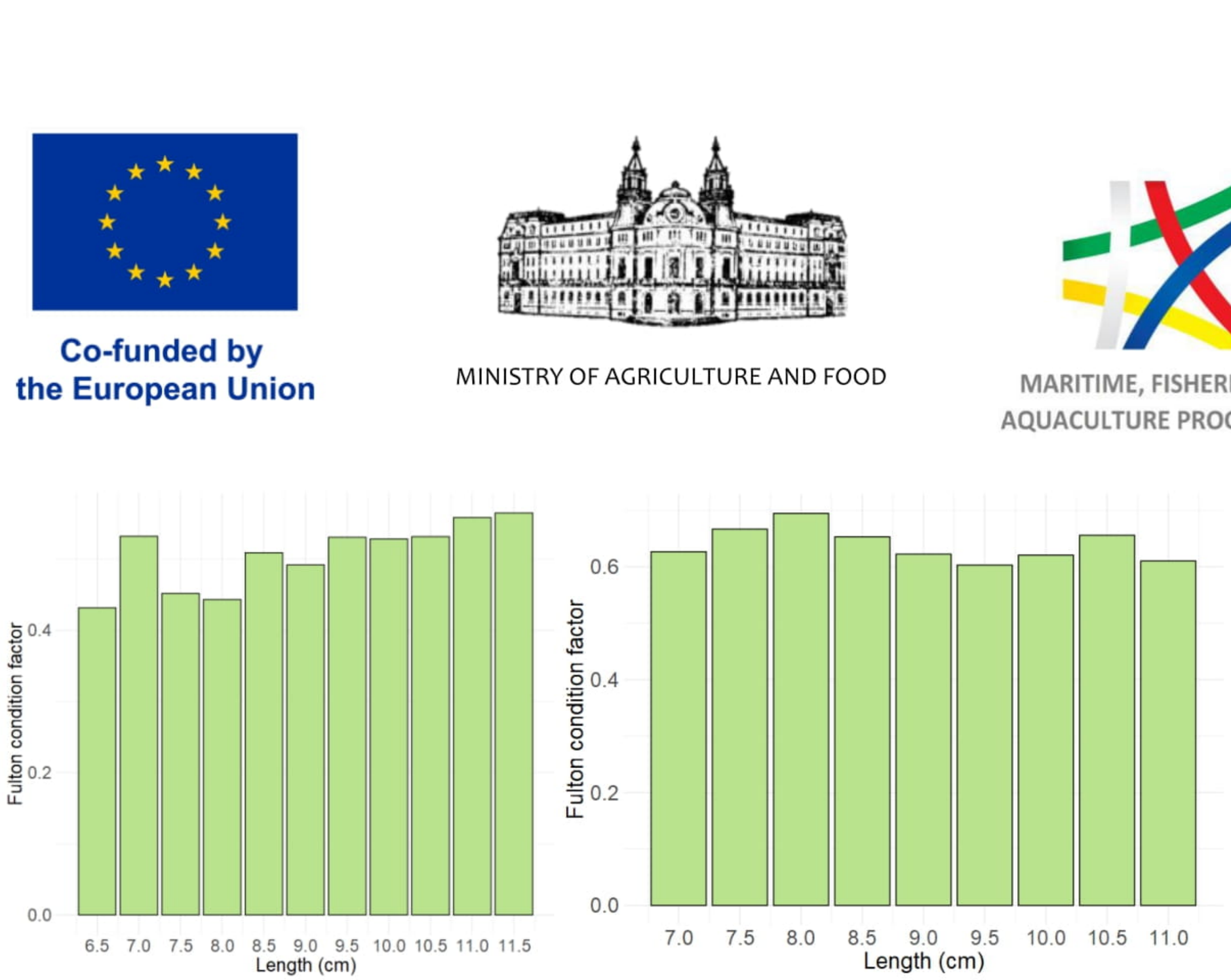
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commercial catches of sprat to visualize the range of size classes represented in a specific age group (0-5 years) **for the second semester of 2024**.

In the first semester the results from ELEFAN with the three applied methods are consistent and applicable also to the experimentally determined ages with small discrepancies for the age group 1-1+, the probable reason for this being limiting factors such as the sample size and the consideration of growth parameters for an inflow of less than a year. Another serious problem is the selectivity, which leads to an incomplete representation of the size composition of the stock in the samples, which in turn affects the calculation of biological potentials.
Based on the analysis conducted, ELEFAN RSA gives results closest to those experimentally determined during the aging of the individuals in the samples and, accordingly, the growth parameters of the S. sprattus stock for the first half of 2024 can be determined as follows: **L_∞=12.35 cm; K = 0.5 and t_0=-0.53.**
In the second semester, the results from ELEFAN with the three applied methods show comparability with the experimentally determined ages only in ELEFAN RSA and ELEFAN GA, the likely reason for this being limiting factors such as the sample size and the consideration of growth parameters for a period of less than a year. Another serious problem is selectivity, which leads to an incomplete representation of the size composition of the stock in the samples, which in turn affects the calculation of biological potentials. Based on the analysis conducted, ELEFAN GA gives results closest to those experimentally determined during the aging of the individuals in the samples and, accordingly, the growth parameters of the S. sprattus stock for the second half of 2024 can be determined as follows: **L_∞=12.10 cm; K = 0.46 and t_0=-0.88.**

I.3.4 Condition factor

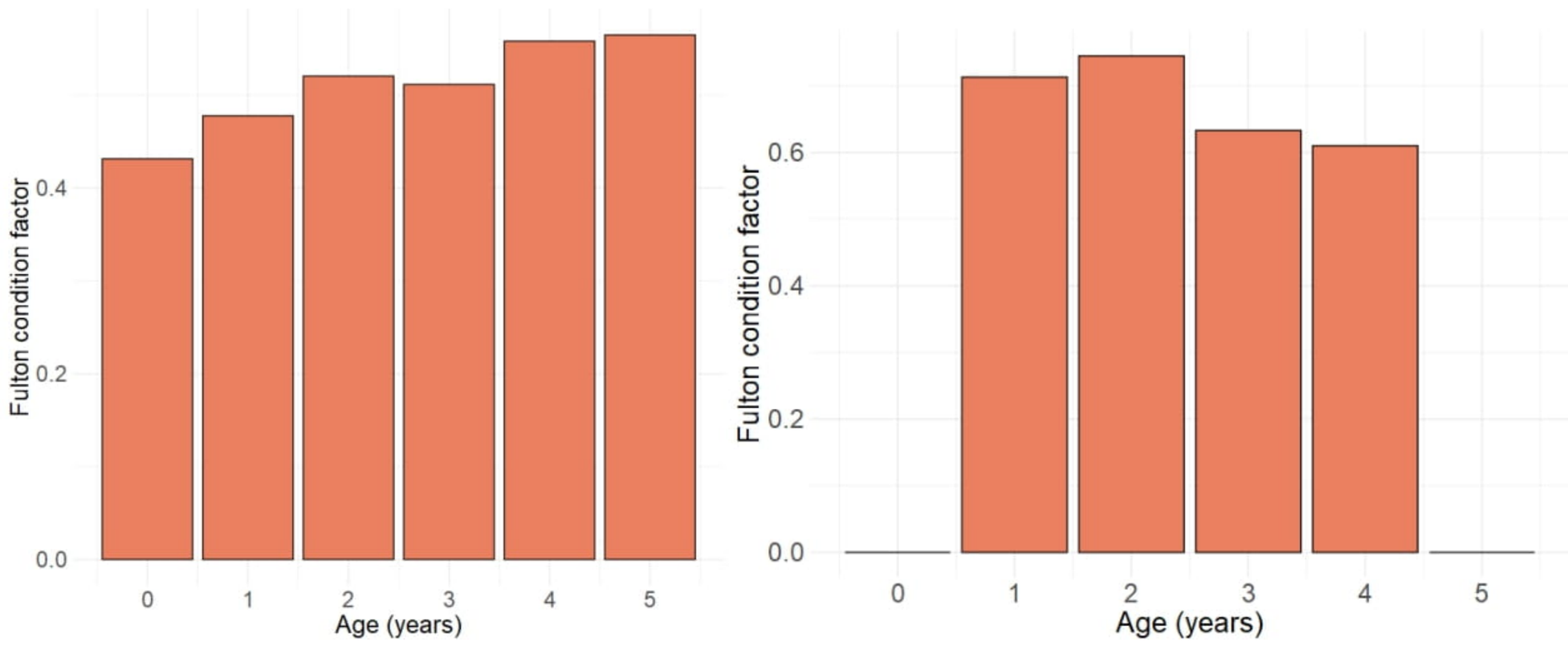
The graph (**Fig.I.3.4.1**) shows that the size groups are in good condition, which indicates food supply and good physiological condition. The condition of sprat by age shows a predominance of 4-4+ and 5-5+ year olds in the first six months, with condition varying among different age groups. During the second semester, the condition of the sprat by age group is in line with expectations that younger individuals grow in weight and length more intensively compared to the older age groups (3-3+ and 4-4+).



a b

Fig. I.3.4.1 Fulton condition coefficient values of sprat by length classes for the first (a) and second semester (b) of 2024.

The condition of the three-zone by age shows a predominance of 4-4+ and 5-5+ year olds in the first six months, with the condition varying among different age groups (**Fig. I.3.4.2**).



a **b**

Fig. I.3.4.2 Fulton condition coefficient values of sprat by age groups classes for the first (a) and second semester (b) of 2024.

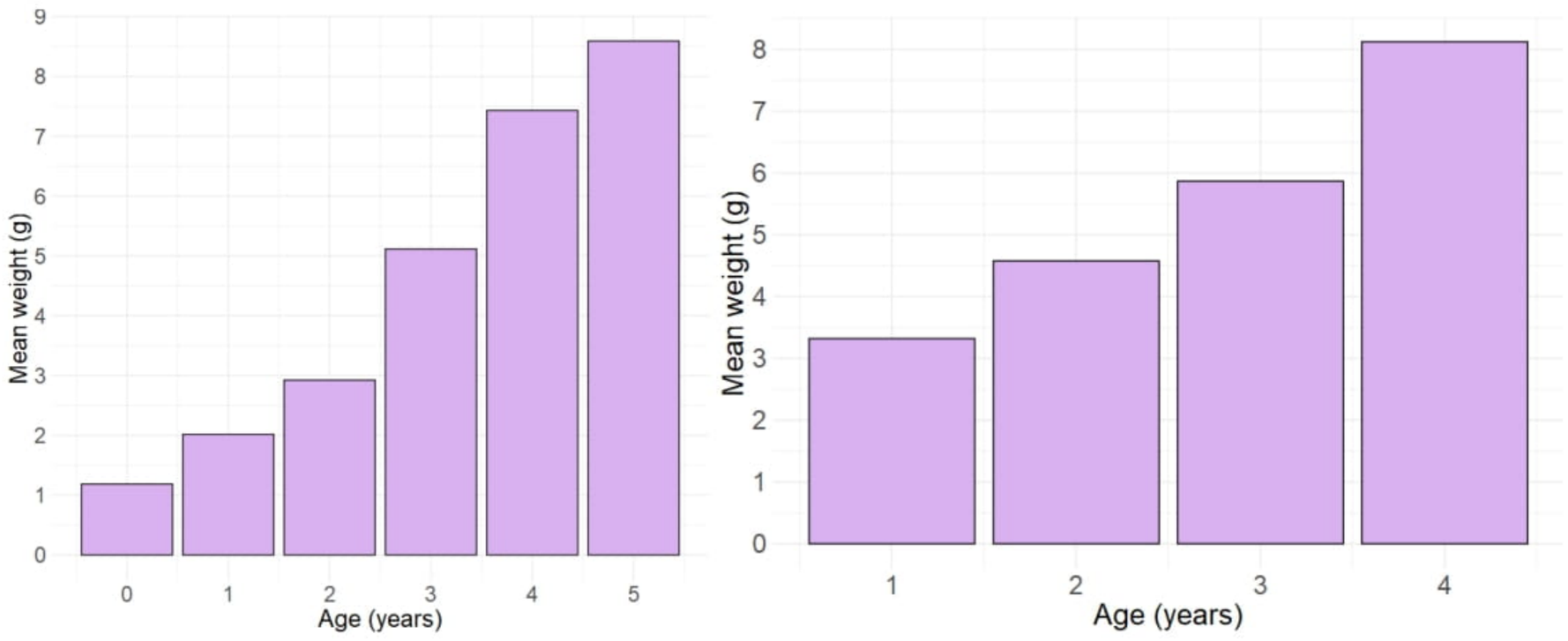
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I.3.5 Weight structure of sprat

The weight of **1385 specimens** was measured (**592 specimens** in I-VI and **793 specimens** in VII-XII).For age group 0-0+, the lowest average weight is observed, and for group 5-5+, the highest average weight is observed (**Fig. I. 3.5.1**). The graph shows the distribution of the average weight of the sprat by age groups for two quarters. A gradual increase in the average weight is observed in relation to the age groups for both quarters. For the age group 0-0+ the lowest average weight is -1.18g (28 number), and for the group 5-5+ the highest average weight is observed -8.59g (12 number). For the other age groups the weights are as follows: 1-1+ -2.02g (110 number); 2-2+ -2.92g (250 number); 3-3+ -5.12g (177 number); 4-4+ -7.43g (15 number).

In the third and fourth trimesters, the age group 1-1+ had the lowest average weight -3.32 g (8.58%), and the age group 4-4+ had the highest average weight -8.12 g (0.50%). The distribution of weights for the remaining age groups is as follows: 2-2+ -4.57g (50.44%); 3-3+ -5.86g (40.48%); 4-4+ -8.12g (0.50 %).



a **b**

Fig.I.3.5.1 Average weights by age groups for the first (a) and second semester (b) of 2024.

The most widely distributed size groups 8-8.5cm represent 16.05% and 15.20% and for them average weights of 2.26g and 3.12g were measured. During the second semester, the most widely distributed size groups 9.5-10 cm accounted for 22.57% and 20.18% and average weights of 4.53g and 5.17g were measured for them (**Fig. I. 3.5.2**).

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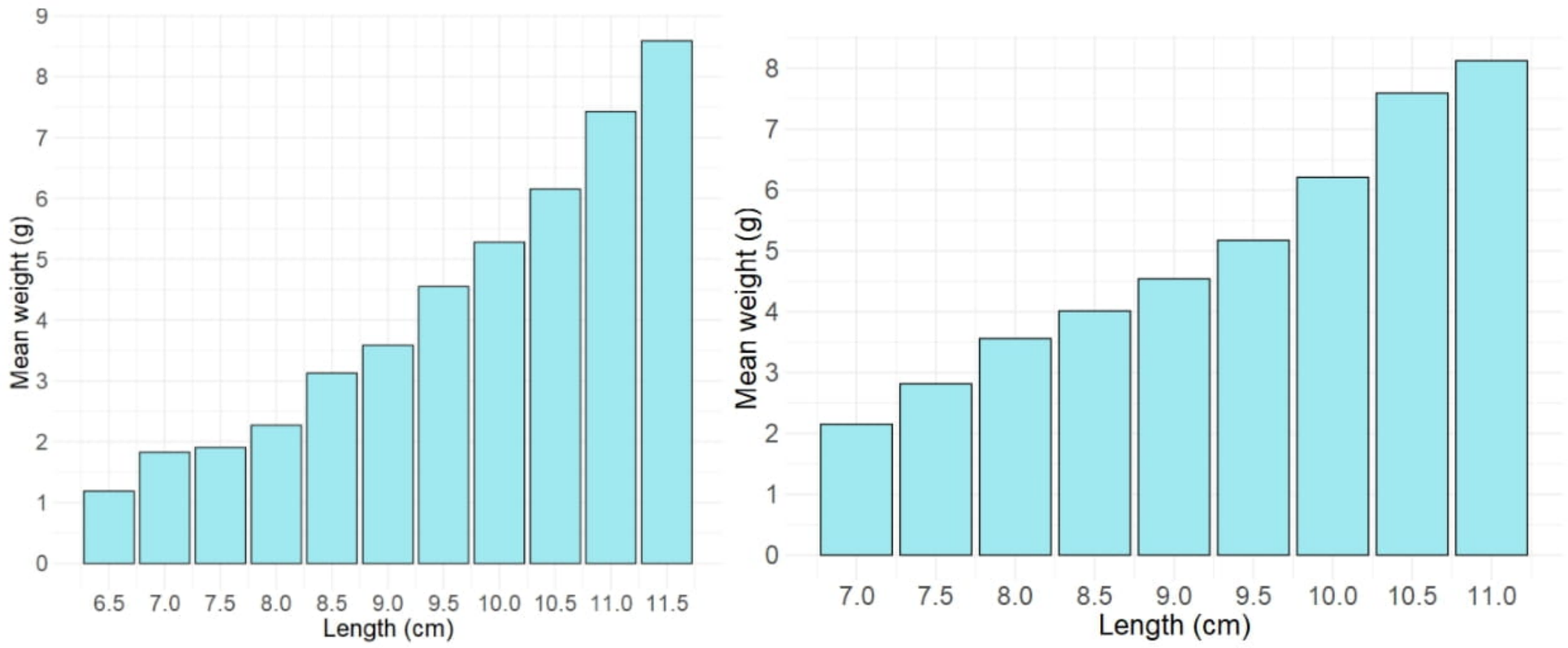


Fig. I. 3.5.2 Distribution of the average weight of the sprat by size groups for the first (a) and second (b) half of 2024.

I.3.6 Size structure of sprat by age group

The length of **1385 specimens** was measured (**592 specimens** in I-VI and **793 specimens** in VII-XII).

Table I.3.6.1 Size structure of the sprat by age groups.

I-VI		VII-XII	
Age	**Lmean/cm**	**Age**	**Lmean/cm**
0-0+	6,50	0-0+	
1-1+	7,55	1-1+	7,85
2-2+	8,37	2-2+	8,94
3-3+	9,87	3-3+	9,76
4-4+	11,00	4-4+	11,00
5-5+	12,2		

I.3.7 Length- weight relationship

To calculate the length-weight relationship, a linear model was used on the logarithmically transformed values for the average weights and lengths **for the first half of 2024**. The modeling results are presented in **Table I.3.7.1**.

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Table I.3.7.1 Results from modeling the length-weight relationship of sprat.

```
Call:
lm(formula = logW ~ logL, data = weight_l)
Residuals:
      Min        1Q    Median        3Q       Max
-0.090598 -0.034778 -0.000891  0.020566  0.143258

Coefficients:
            Estimate Std. Error t value       Pr(>|t|)
(Intercept)  -6.1253     0.2297  -26.66 0.000000000711 ***
logL          3.3833     0.1050   32.23 0.000000000131 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.06252 on 9 degrees of freedom
Multiple R-squared:  0.9914,    Adjusted R-squared:  0.9905
F-statistic:  1039 on 1 and 9 DF,  p-value: 0.0000000001309
```

The resulting model is statistically significant, the value of the scaling coefficient a in the length-weight relationship model is: $\boldsymbol{W_i = aL_i^b}$ **e: a=0.0022**, and the allometry coefficient **b=3.38**, which indicates positive/allometric growth of the species **in the first half of the year**, or the increase in weight is proportional to or greater than the increase in length. To calculate the length-weight relationship, a linear model was used on the logarithmically transformed values for the average weights and lengths **for the second half of 2024**. The modeling results are presented in **Table I.3.7.2**.

Table I.3.7.2 Results from modeling the length-weight relationship of the sprat.

```
Call:
lm(formula = logW ~ logL, data = weight_l)
Residuals:
      Min        1Q    Median        3Q       Max
-0.090598 -0.034778 -0.000891  0.020566  0.143258

Coefficients:
Estimate Std. Error t value       Pr(>|t|)
Intercept)  -6.1253     0.2297  -26.66 0.000000000711 ***
 logL          3.3833     0.1050   32.23 0.000000000131 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
Residual standard error: 0.06252 on 9 degrees of freedom
 Multiple R-squared:  0.9914,    Adjusted R-squared:  0.9905
F-statistic:  1039 on 1 and 9 DF,  p-value: 0.0000000001309
```


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The resulting model is statistically significant (**Table I.3.7.2**), the value of the scaling coefficient a in the length-weight relationship model $\boldsymbol{W_i = aL_i^b}$ is: **a=0.0086**, and the allometry coefficient **b=2.8663**, which indicates negative/negative allometric growth of the species **in the second half of the year**, or the increase in weight is disproportionate / less than the increase in length.

I.3.8 Sex ratio

The sex ratio was determined **for 500 individuals** (**250** in the first and **250** in the second semesters of 2024). Females ♀ predominate over males♂ in 2024.

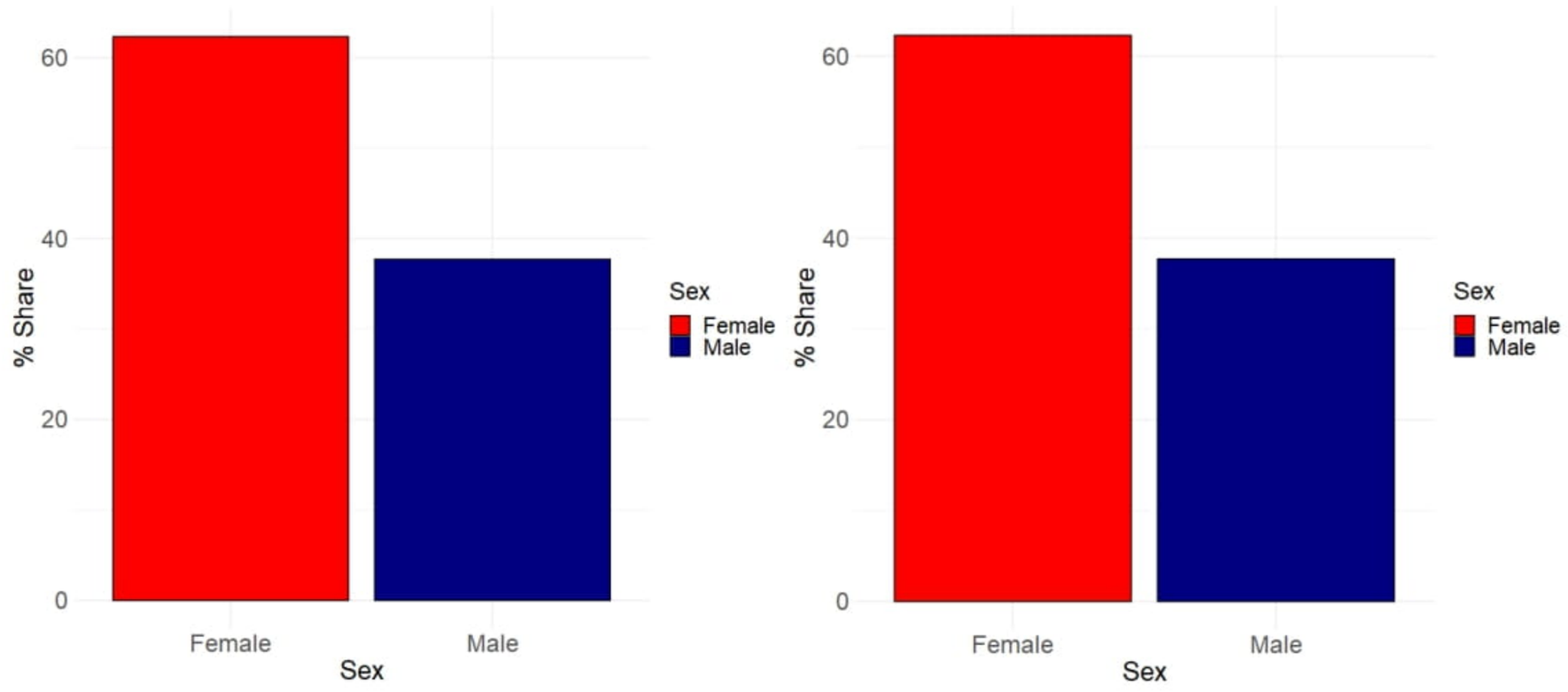


Fig.I.3.8.1 Sex-ratio distribution of sprat.

The average lengths of females ♀ are higher in all age groups (**Figure I 3.8.2**).

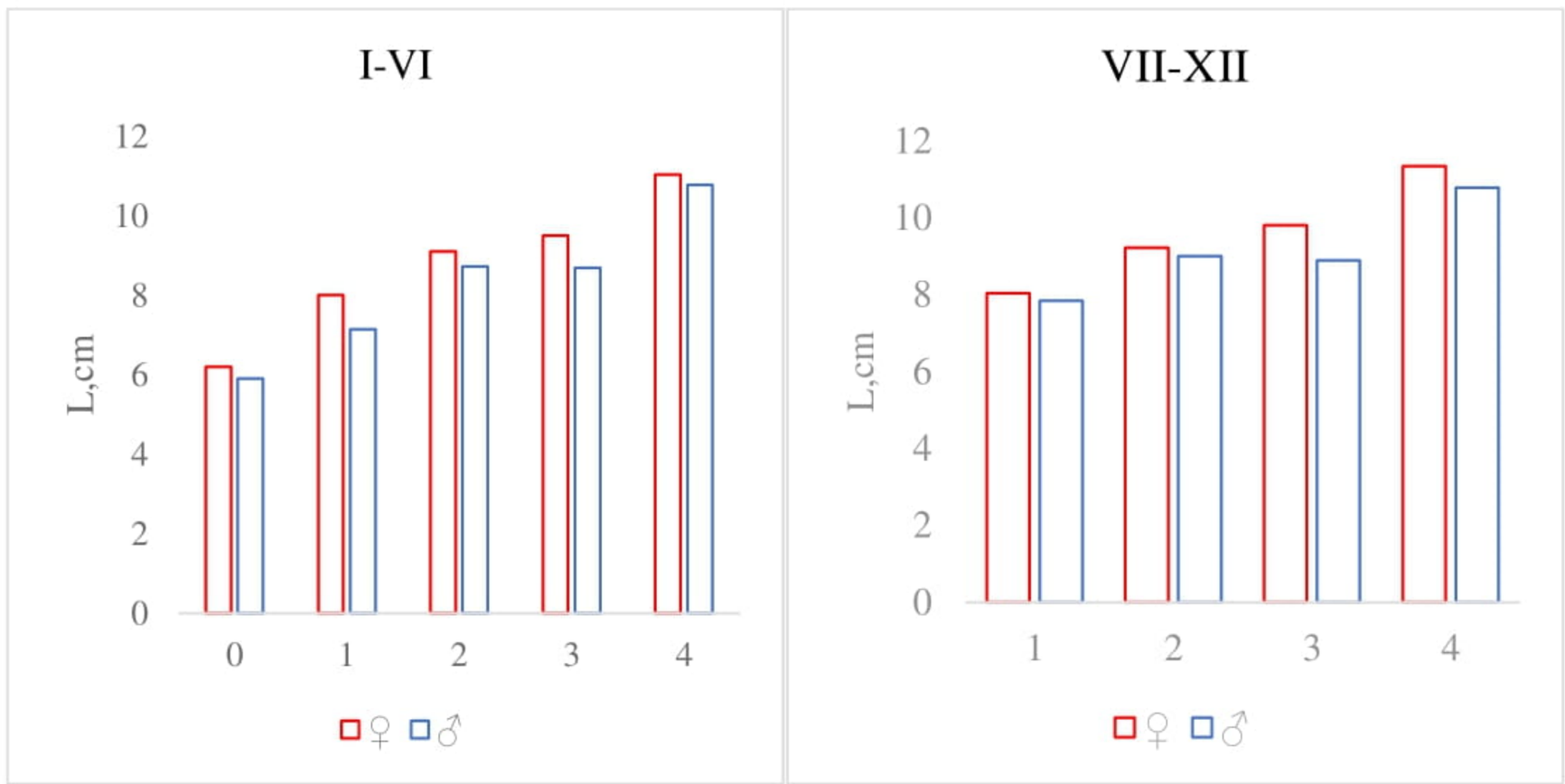


Fig. I. 3.8.2 Sex ratio (♂♀) by size and age.

I.3.9 Fertility

Fertility is determined at **500 specimens (250 specimens in the first and 250 specimens in the second semester).** Portion fecundity (Log F) versus sprat weight (Log W) showed a strong relationship (R^2 =0.942 for I-VI and R^2 =0.951 for VII-XII), which proved a strong dependence of fecundity on individual weights.

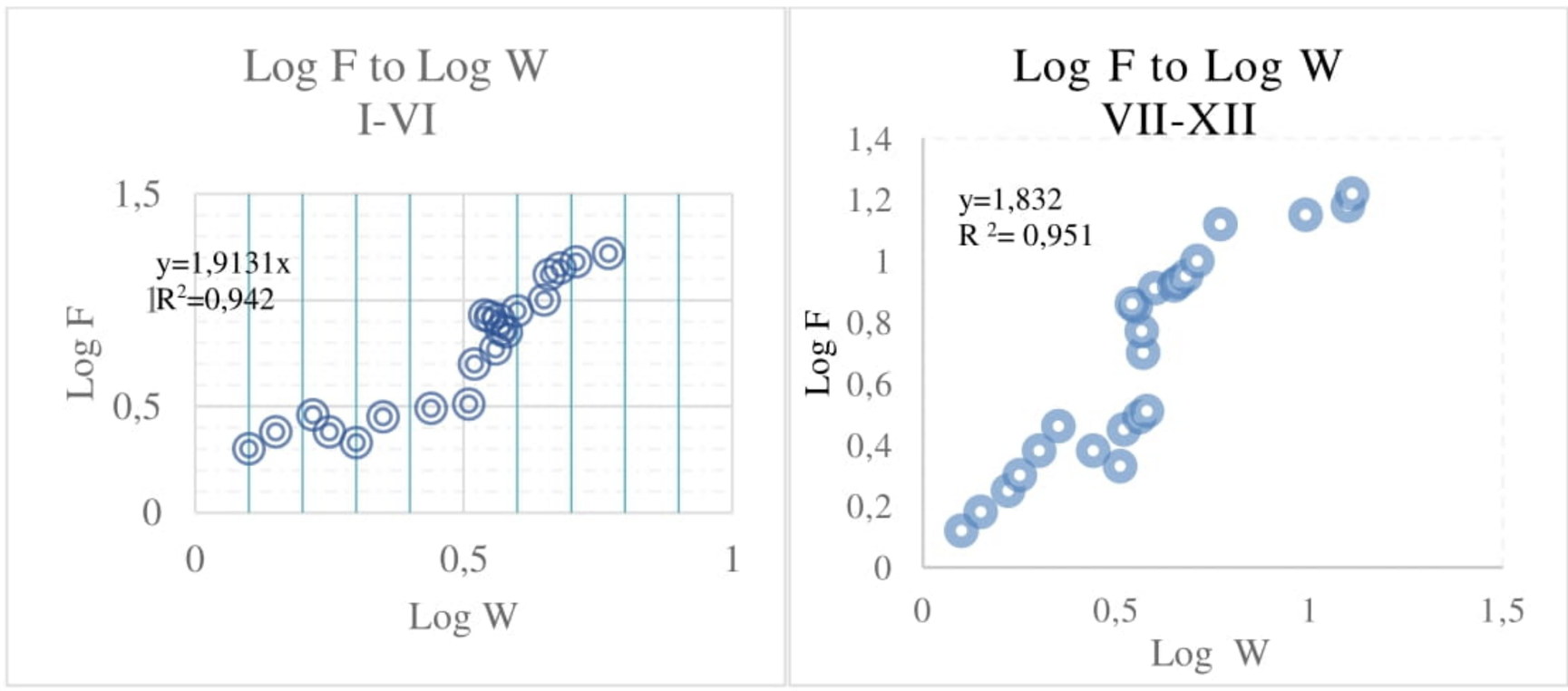


Fig. I.3.9.1 Log dependence of fertility on individual weights.

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The gonadosomatic index depends strongly on individual weights during the first ($R^2 = 0.912$) and second six months ($R^2 = 0.952$).

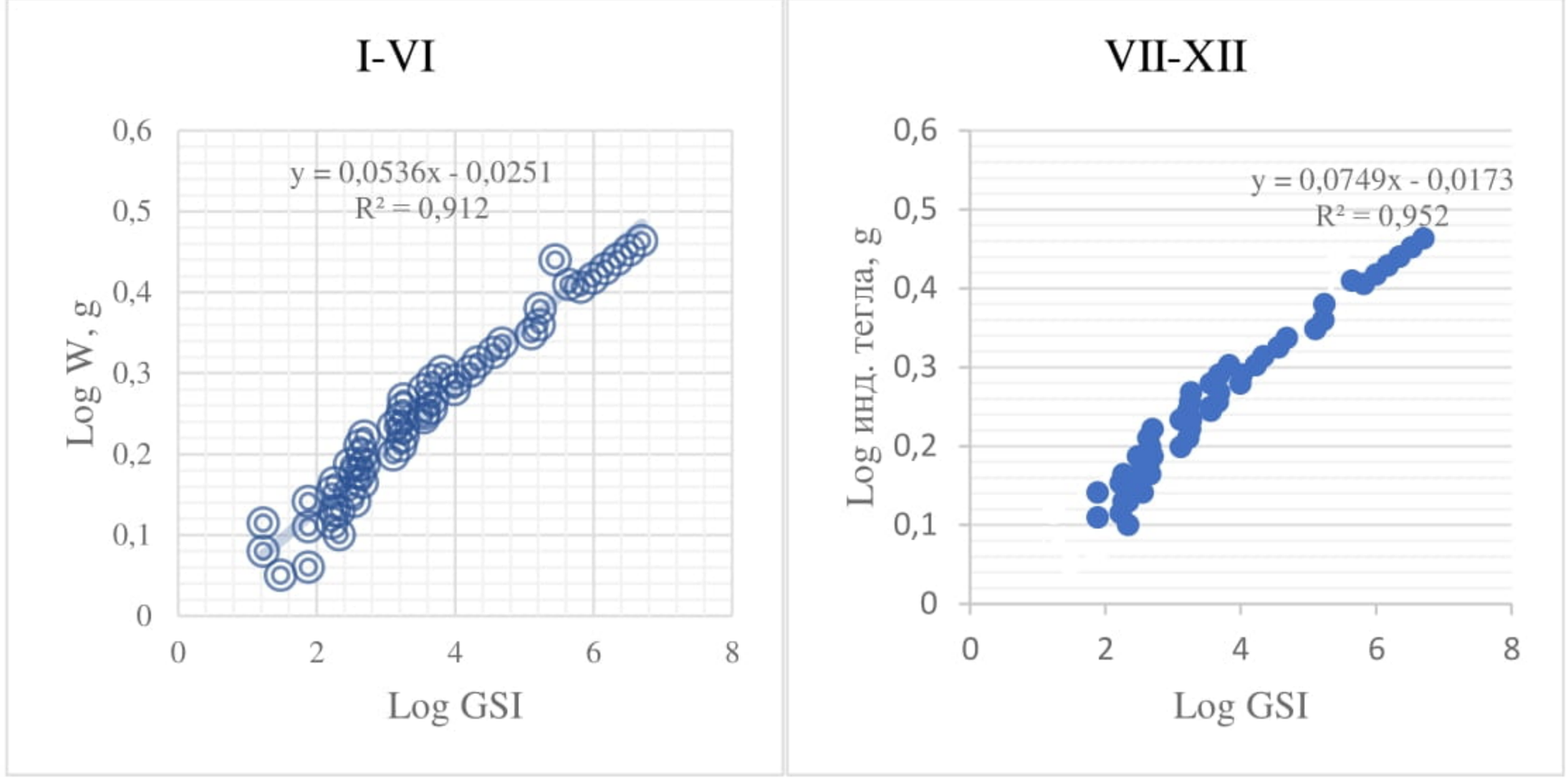


Fig. I.3.9.2 Log dependence between GSI and individual weights (g).

Table I.3.9.1 describes the absolute and relative fecundity of sprats with average lengths and weights. The average value of absolute fecundity was estimated at 33101,55 (I-VI) and 31289,17 (VII-XII) spawn grains. The average value of relative fertility is 9473,67 and 6709,21.

Table I.3.9.1 Absolute and relative fecundity of the sprat.

I-VI					VII-XII				
Lengths class, cm	**Mean weight,w,g)**	**Absolute fecundity F, (cav.grains)**	**Relative fecundity**	**N♀**	**Lengths class, cm**	**Mean weight,w,g)**	**Absolute fecundity F, (cav.grains)**	**Relative fecundity**	**N♀**
6,5	1,11	16878,00	15205,41	23		2,15	16878,00	7850,23	33
7	1,39	20498,00	14746,76	28	**7,5**	2,81	20498,00	7287,33	28
7,5	2,11	23609,50	11189,34	45	**8**	3,56	23609,50	6637,48	45
8	2,81	29935,50	10653,20	29	**8,5**	4,01	29935,50	7463,99	29
8,5	3,23	34407,25	10652,40	18	**9**	4,54	34407,25	7583,15	18
9	3,67	36174,25	9856,74	28	**9,5**	5,17	36174,25	6994,23	28
9,5	4,99	37507,50	7516,53	34	**10**	6,21	37507,50	6043,69	37

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10	5,65	41184,25	7289,25	23	**10,5**	7,59	41184,25	5424,78	23
10,5	6,11	41408,25	6777,13	9		8,12	41408,25	5097,97	9
11	7,55	41228,00	5460,66	7					
11,5	8,49	41286,50	9473,674862,96	6					
		33101,55		250			31289,17	6709,21	250

I.3.10 Sexual maturity

500 specimens (**250 specimens for the first and 250 specimens for the second semester**) were examined to determine sexual maturity. The degree of sexual maturity of the sprat by size groups is presented in **Fig. I.3.10.1**. The predominant maturity stage is IV-V (actively breeding), as the oldest groups have VI-I (resting) stages of sexual maturity (3 and 4 years old).



Figure I.3.10.1 Degrees of maturity by age of sprat.

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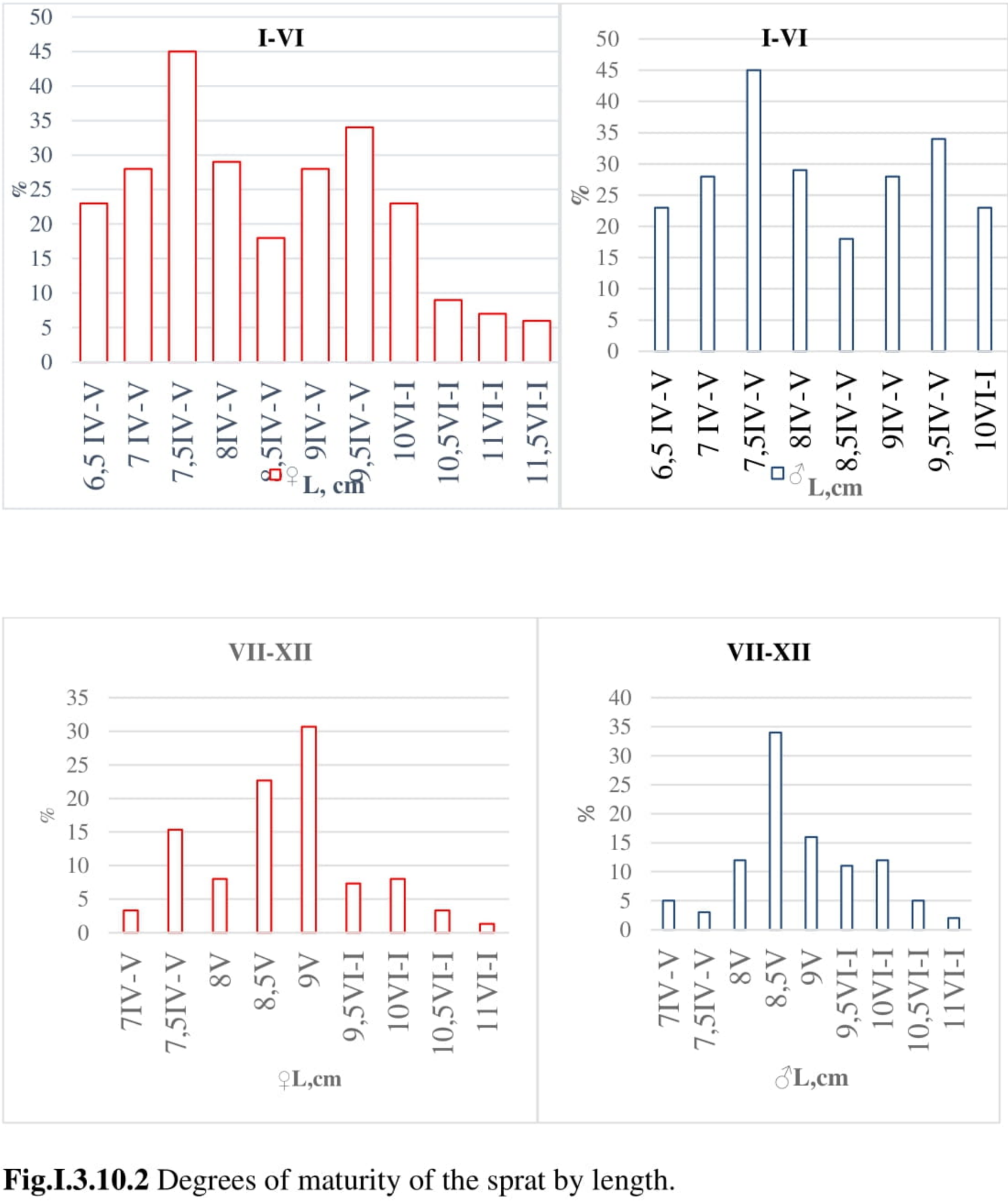


Fig.I.3.10.2 Degrees of maturity of the sprat by length.

I.3.11 Catch numbers and biomass by age and length

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Monthly OTM catches (in kilograms) together with average weights were used to obtain the abundance and biomass of the species by quarter in the reported catches (**Table I.3.11.1-2).**

Table I.3.11.1 Catch at age (10^{-6}) with OTM matrix and biomass (kg) of the of sprat.

Catch at age				
Age groups (yr)	***Ist quarter***	***IInd quarter***	***III rd quarter***	***IVth quarter***
0-0+	42749	47949.8		
1-1+	98727	110739.5		
2-2+	154744	173571.5	12903.9	1030.7
3-3+	62597	70213.3	55076.9	4399.3
4-4+	3653	4097.6	34469.9	2753.3
5-5+	2527	2834.9	310.2	24.8
∑	364997	409406.7	102761	8208.1
Biomass (kg)				
Age groups (yr)	***Ist quarter***	***IInd quarter***	***III rd quarter***	***IVth quarter***
0-0+	50657.0	56820.6		
1-1+	199009.7	223224		
2-2+	452294.8	507326	42838.7	3421.781
3-3+	320224.7	359187	251992.4	20128.12
4-4+	27137.7	30439.6	202223.9	16152.82
5-5+	21710.1	24351.7	2519.9	201.2812
	1071034.0	1201349	499575.0	39904

Table I.3.11.2 Number of individuals ($x10^{-6}$) in the catch by size class (for OTM) and biomass of the of the sprat.

Catch in numbers 2024				
Length classes (cm)	***Ist quarter***	***IInd quarter***	***III rd quarter***	***IVth quarter***
6,5	42749	47949.8		
7,0	39653	44477.9	583.9	46.6
7,5	69321	77755.0	10298.8	822.6
8	75403	84577.8	11141.9	890.0
8,5	52097	58435.7	19163.4	1530.7
9	34922	39171.1	20271.2	1619.2

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9,5	22761	25530.1	21802.4	1741.5
10	12094	13565.5	15235.2	1216.9
10,5	10104	11333.4	4035.2	322.3
11	4021	4510.1	229.1	18.3
11,5	1872	2100.2		
∑	364997	409406.7	102761	8208.1
Biomass (kg)				
Length classes (cm)	***Ist quarter***	***IInd quarter***	***III rd quarter***	***IVth quarter***
6,5	50657.0	56820.6		
7,0	72367.2	81172.2	1260.0	100.6
7,5	132070.1	148139	28979.1	2314.7
8	171872.0	192784	44098.7	3522.4
8,5	162826.1	182638	76857.7	6139.1
9	135688.4	152198	91977.2	7346.8
9,5	110359.9	123788	112766.6	9007.3
10	83222.2	93348.1	100797.0	8051.2
10,5	90459.0	101465	40318.8	3220.5
11	39801.9	44644.7	2519.9	201.3
11,5	21710.1	24351.7		
∑	1071034.0	1201349	499575	39904

I.3.12 Conclusions

The analysis of the biological parameters of the sprat makes it possible to draw the following **conclusions:**

1) The size structure of the sprat during the in the first quarter of 2024, showed a bimodal distribution with a peak at size group 8.00 - 9.0 cm. The size composition in the second half of the year covers size groups from 7 to 11 cm. The highest percentage is occupied by 9.5-10 cm with 64.02% of the total number of caught sprat specimens. In the fourth quarter, over 44.77% of the individuals have an absolute length of 8.5 cm and 9 cm and these size groups are the most strongly represented.

2) In 2024, the highest percentage share is occupied by individuals in the age group 2-2+, followed by 3-3+.

3) The results from ELEFAN with the three applied methods are consistent and applicable also to the experimentally determined ages with small discrepancies for the age group 1-1+, the probable reason for this being limiting factors such as the sample

size and the consideration of growth parameters for an inflow of less than a year. Another serious problem is the selectivity, which leads to an incomplete representation of the size composition of the stock in the samples, which in turn affects the calculation of biological potentials.

4) Based on the analysis conducted, ELEFAN RSA gives results closest to those experimentally determined during the aging of the individuals in the samples and, accordingly, the growth parameters of the *S. sprattus* stock for the first half of 2024 can be determined as follows**: L_∞=12.35 cm; K = 0.5 and t_0=-0.53** and for the second half of 2024 can be determined as follows: **L_∞=12.10 cm; K = 0.46 and t_0=-0.88**

5) The condition of the sprat by age shows a predominance of 4-4+ and 5-5+ year olds, with the condition varying in different age groups.

6) The resulting model is statistically significant, the value of the scaling coefficient a in the length-weight relationship model is $W_i = aL_i^b$: **a=0.0022**, and the allometry coefficient **b=3.38**, which indicates positive / allometric growth of the species in the first half of the year, or the increase in weight is proportional to or greater than the increase in length. the length-weight relationship model $W_i = aL_i^b$: **a=0.0086**, and the allometry coefficient **b=2.8663**, which indicates negative/negative allometric growth of the species in the second half of the year, or the weight gain is disproportionate / less than the length gain.

7) Portion fertility (Log F) versus litter weight (Log W) show a strong relationship (R^2 =0.942 for I-VI) and (R^2 =0.951 for VII-XII), which proves a strong dependence of fertility on individual weights.

8) The predominant maturity stage of the sprat is IV-V (actively breeding), as the oldest groups have VI-I stages (resting) of sexual maturity (3 and 4 years old).

II. Biological monitoring of horse mackerel (*Trachurus mediterraneus*) landings

II.1 Objectives

The purpose of biological monitoring is to collect data that will be used to analyze horse mackerel catches, as well as to form a database. The collection of biological samples of horse mackerel catches in **2024** includes the following tasks:

1. *To collect and analyze the dynamics of length, weight and age distribution.*
2. *To determine the state of the of horse mackerel using the so-called state factor (Ricker, 1975).*
3. *Characteristics of the reproductive biology of horse mackerel.*
4. *Collection of data on ports of landing, sampling vessels, number of samples collected, number of specimens tested, geographical catch data.*

I.2 Sampling

The sampling was established from catches declared by the actively operating fishing fleet of the Republic of Bulgaria.

II.2.1 Geographic area coverage

Data of present analysis were collected from landing ports of Bulgarian Black Sea coast**. In 2024, 9 samples with 1500 specimens** were collected and processed. Information on the size of the catches was also collected.

II.2.2 Sampling period

In 2024, the biological data on sprat were collected from a total of **9 landings at the ports of Nesebar, Sozopol, Varna, Balchik, Kavarna and Tsarevo**. Information on the size of the catches was also collected. Ports and ships from which monitoring was carried out to collect biological data from landings are presented in **Table II. 2.1.1.**

Table II. 2.2.1 Ports and ships from which monitoring was carried out to collect biological data from horse mackerel discharges.

№	Date	Sampling ports	HMM	Fishing vessel	External marking	Fishing gear	Coordinate	Catch,kg
1	3.1.2024	Sozopol	HMM	MEDUZA 3	BS 288	OTM	42.3064 27.9862	1335
2	25.4.2024	Nesebar	HMM	RK 29	BS 222	OTM	42.6604309082 27.7332210541	140
3	8.6.2024	Tsarevo	HMM	CIKLAMA V	AH215	OTM	42.244533538828.0178565979	30
4	22.7.2024	Varna	HMM	LEFER	VN 03	OTM	43.366200 28.386800	50
5	20.8.2024	Balchik	HMM	DELTA	VN390	OTM	43.40390028.167800	200
6	4.9.2024	Nesebar	HMM	RK 29	BS222	OTM	42.422600 27.691300	15
7	3.10.2024	Sozopol	HMM	RK 37	BS255	OTM	42.422600, 27.691300	60
8	2.11.2024	Varna	HMM	EGEO 3	VN 8195	OTM	43.366200 28.386800	50
9	12.12.2024	Kavarna	HMM	NEPTUNE-70	KV 6321	OTM	43.367000, 28.379500	32

II.2.3 Statistical analysis of data

See section statistical analysis of sprat

II.3 Results

II.3.1 Landings statistics

The highest catch of Black Sea horse mackerel with OTM was achieved in May and November in the Bulgarian waters of the Black Sea **Figure II. 3.1.1.**

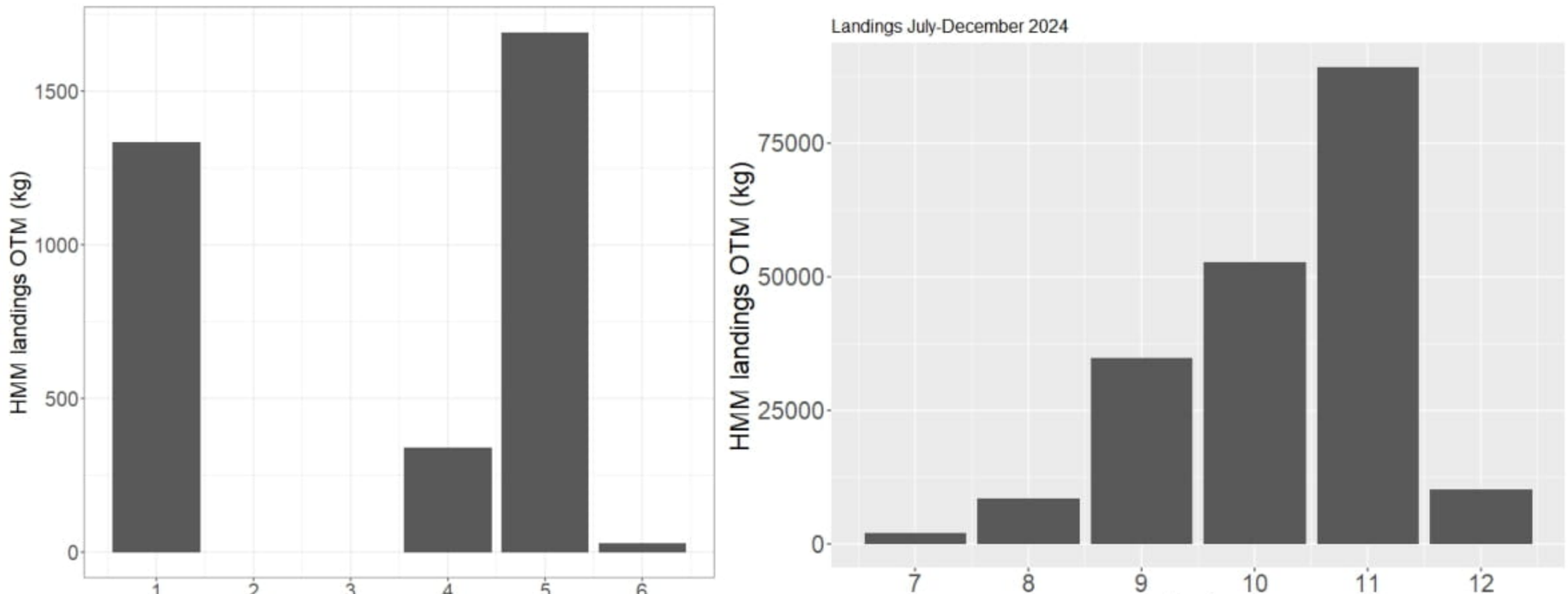


Figure II. 3.1.1 Landings statistics of horse mackerel.

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II.3.2 Length structure of landings

In the first quarter, the size structure showed a normal distribution, with a predominance of the 12cm size group by 17%. Length classes 13-14 cm are represented by an equal percentage - 9.09%, with smaller (11-11.5cm) and larger lengths (15 cm) being insignificantly represented in the catch by 6.29%, 7.69% and 6.29%. In the second quarter, the percentage share for horse mackerel is in favor of the 13.5 cm length class, which accounts for 14.47% of all groups. The size classes 10.5-11-11.5cm are represented by a small share of participation in the catches. The participation of 13cm (11.44%)-14 (11.45%) and 14.5 cm (11.87%) is almost equal.

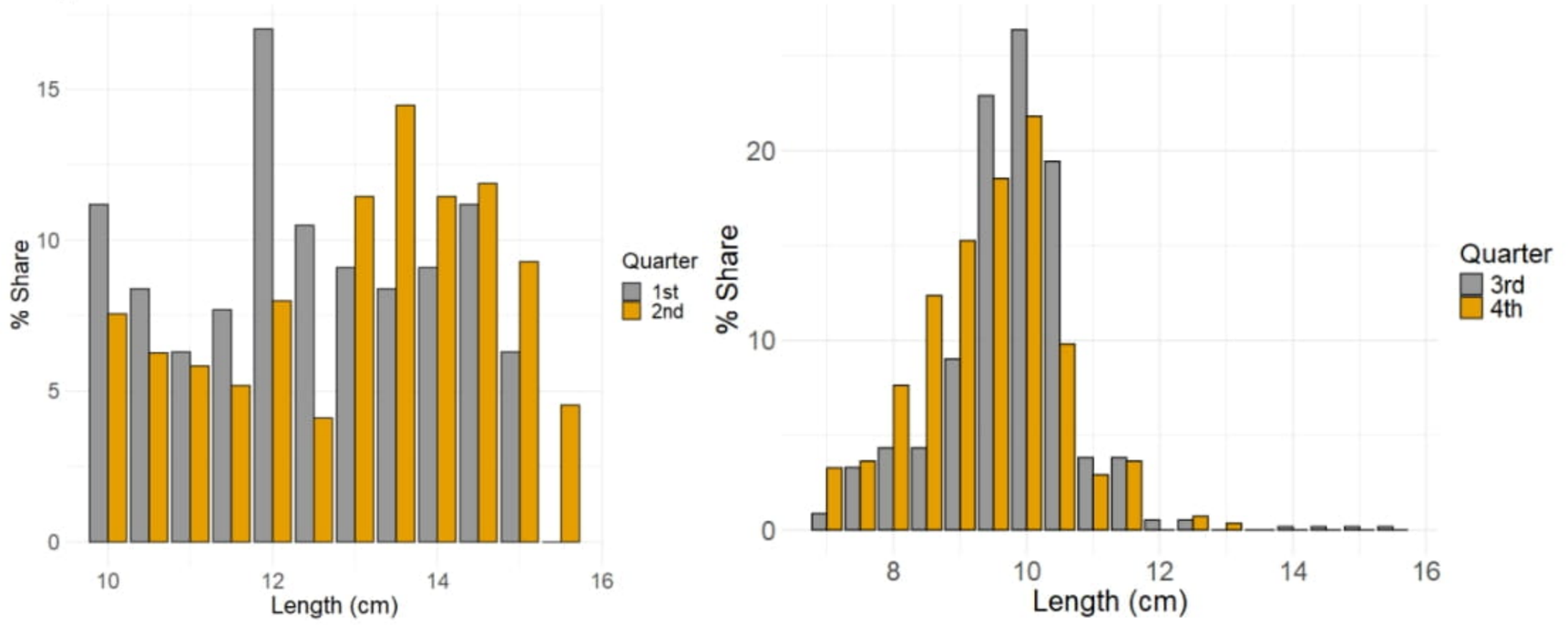


Figure II. 3.2.1 Percentage representation in the composition of catches in the first and second half of 2024.

The graph shows that in the third and fourth quarters the percentage distribution of catches by size classes is uneven. In the third quarter, the highest values are for individuals in the size classes of 9.5 cm, 10 and 10.5 cm., and the lowest percentage is for size classes of 14-15.5 cm. In the fourth quarter, the highest values are for individuals in the size classes of 9.5 -10 cm, and the lowest percentage is for size class 13 cm.

II.3.3 Age structure of landings

The three readers determined the age of horse mackerel otoliths, and reader 1 read all otoliths twice. The age **of 1500 horse mackerel (649 in the first and 851 in the second semester)** was determined. Three-year-olds dominate the age structure in the first quarter of 2024 with 36.26%. Two- and four-year-olds are represented with 25.17% and 26.57%. The least represented in the catch are five-year-olds with 11.89%. Three- and four-year-old fish participate with the highest percentage in the catches of the second half of the year with

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25.92% and 39.09% respectively, followed by the lower representation of two (17.93%) and five-year-old fish (17.06%).
The graph shows a gradual increase in the percentage of horse mackerel in the composition of catches with increasing age groups, and this trend continues in the third and fourth quarters. The age group 0-0+ has the lowest percentage representation values in the composition of the catches, while 1-1+ and 2-2+ have the highest percentage representation, the latter being due to the selectivity of fishing techniques.

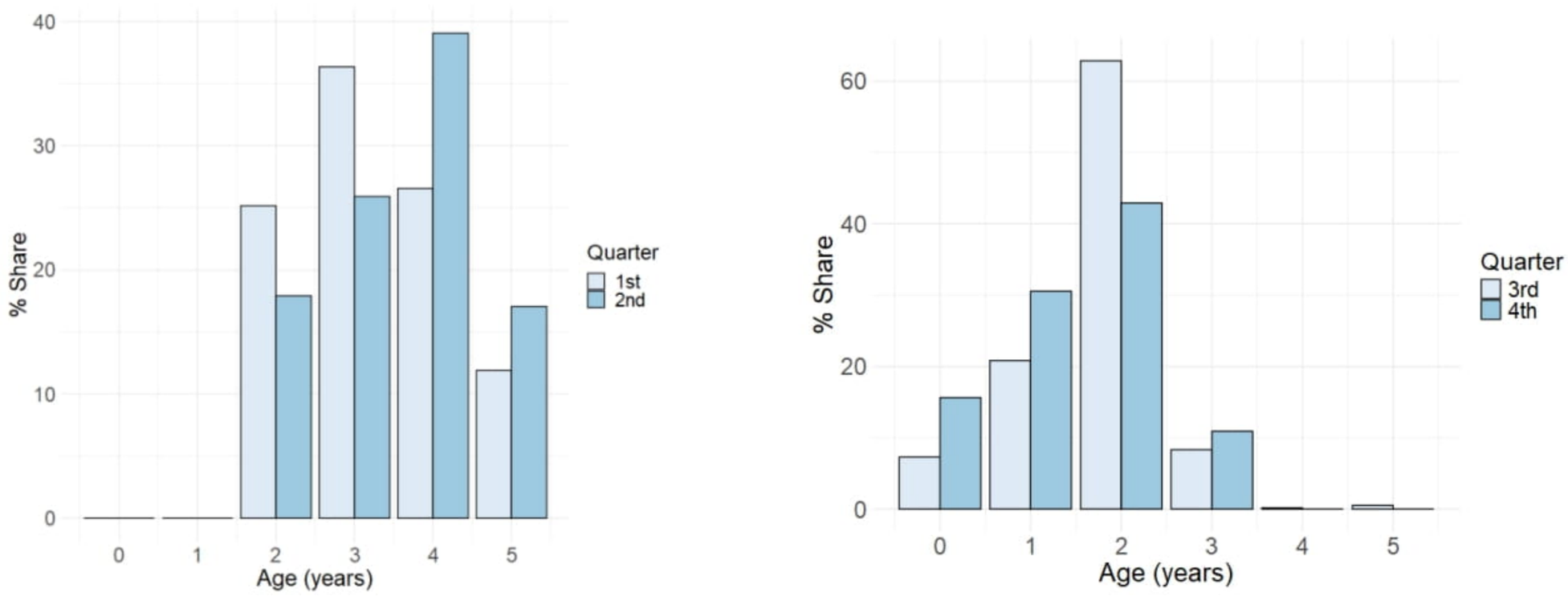


Figure II.3.3.1 Age distribution of horse mackerel.

Results of analytical age slicing methods – similar to the analysis of the age structure of the sprat, the analyzes were made in the R programming environment (Program Language for Statistical Modeling and Analysis) using the ELEFAN functions (ELectronic LEngth Frequency Analysis) and the growth and other biological parameters of the studied species were evaluated based on the measured lengths of individuals of different age groups. The samples are restructured for the purposes of the analysis in order to track the evolution of the cohorts over time (Figure II.3.3.2 - the first frequency diagram shows the size structure of the collected specimens in the corresponding months, and the second - the restructured data with a moving average MA = 7).

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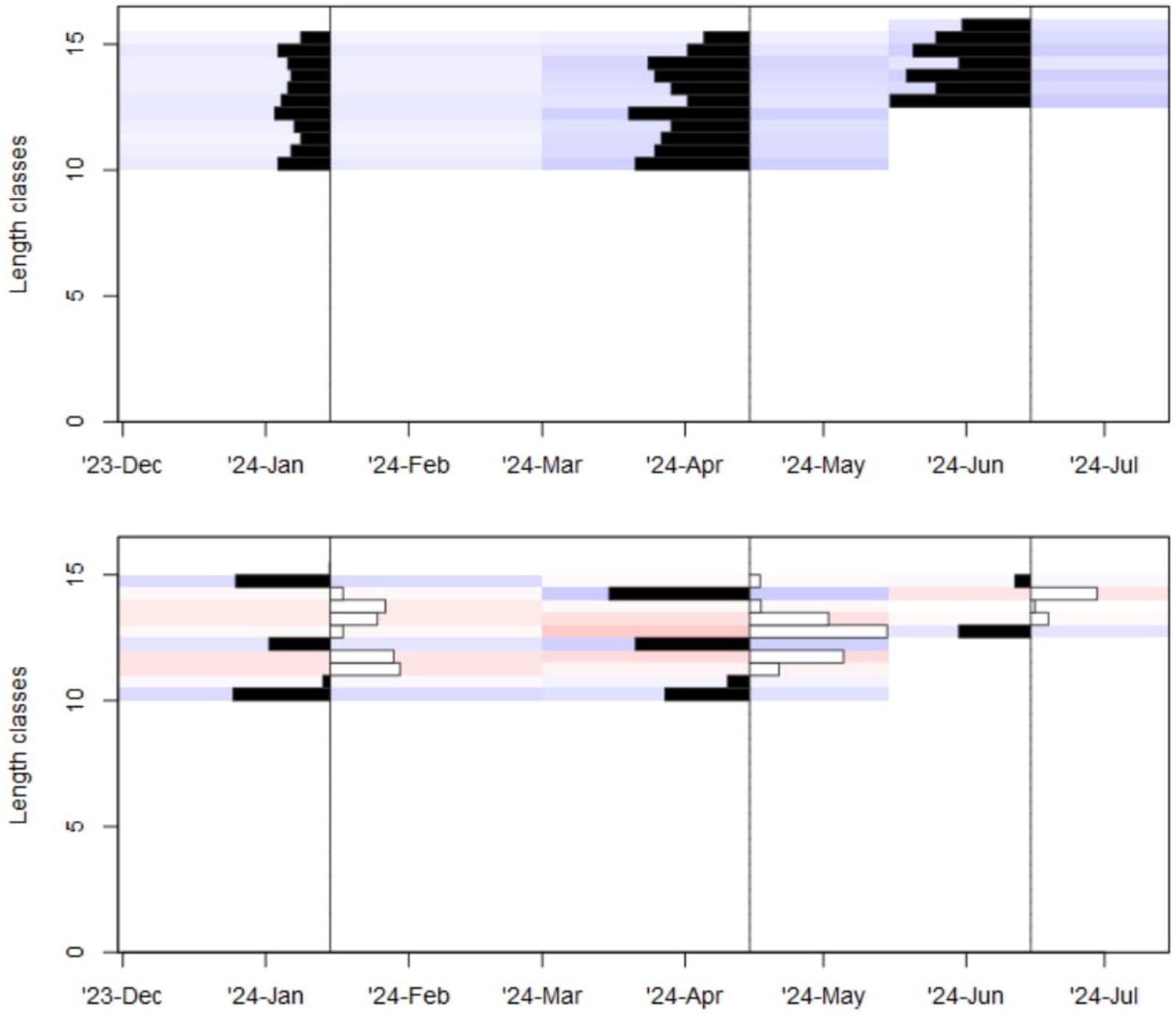


Figure II.3.3.2 Size-frequency samples **for the first half of the year**, visualized as (top diagram) number of individuals in size class and (bottom diagram) the restructured data with moving average MA = 7 for the purposes of frequency analysis and determination of growth parameters.

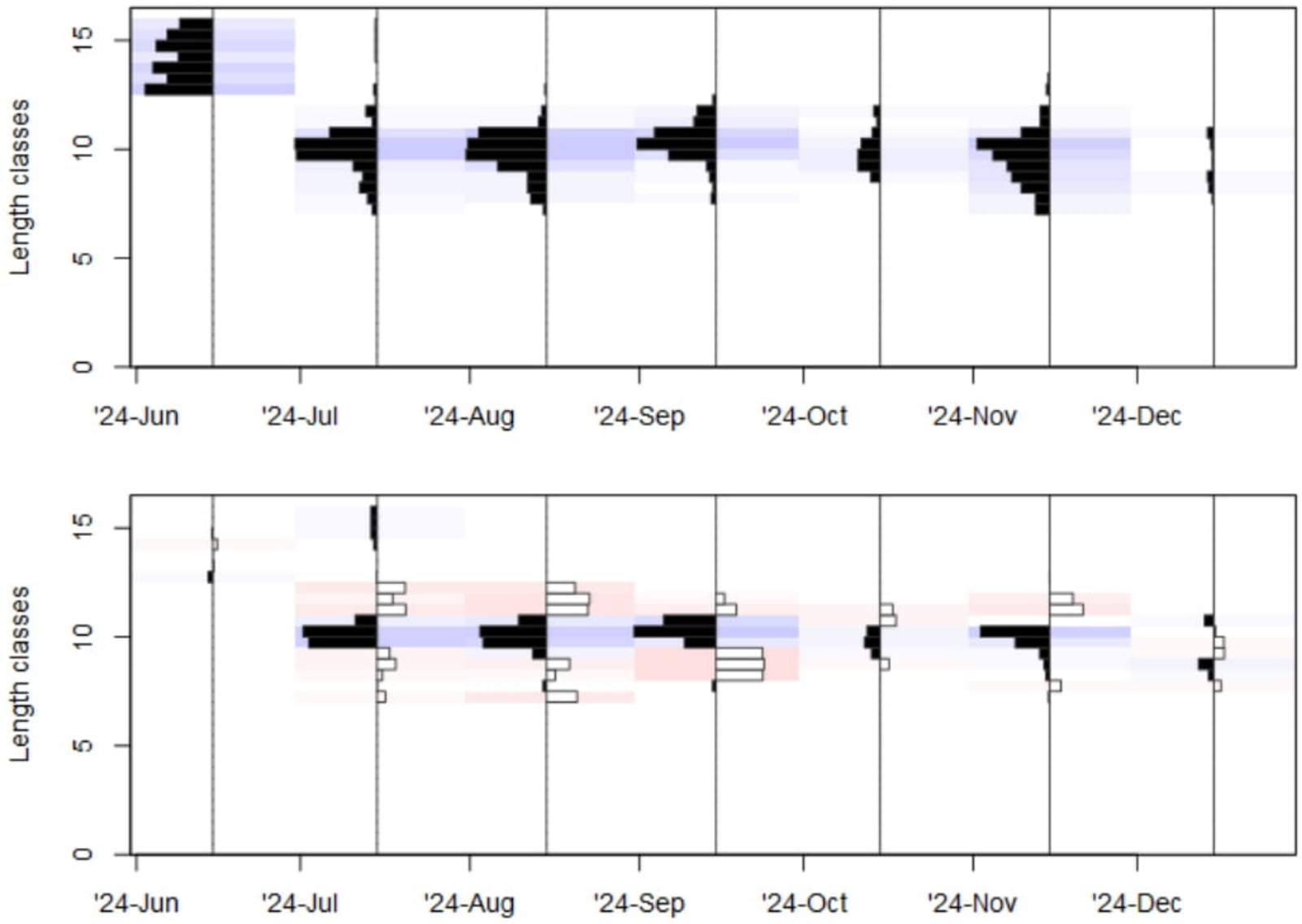


Figure II.3.3.3 Size-frequency samples **for the second half of the year**, visualized as (top diagram) number of individuals in size class and (bottom diagram) the restructured data with a moving average MA = 7 for the purposes of frequency analysis and determination of growth parameters.

II.1.3.3.1 Frequency analysis RSA – response surface analysis

Growth parameters determined by RSA with initial conditions: conditional interval of for the asymptotic length L_∞ in the sample [14;19 cm] (based on a literature review on the characteristics and biological potentials of the species for the Black Sea) and the parameter that determines the growth rate to L_∞ - $K = \exp(seq(from\ log(0.1), to \log(1))$ with an upper limit for L_∞ = 19 cm. The parameters in the von Bertalanffy model were calculated as follows **for the first six months: L_∞=17.61 cm; K = 0.24 and t_0=-0.75.** The ages with their corresponding lengths were calculated using the latter (**Table II.1.3.3.3.1).**

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The parameters in the von Bertalanffy model were calculated as follows **for the second semester: L_∞=16.22 cm; K = 0.36 and t_0=-0.71.** The ages with their corresponding lengths were calculated using the latter (**Table II.1.3.3.3.2**).
A disadvantage of the method is the difficult optimization in terms of L_∞ and K and the need for a priori expertise to define the interval for the expected asymptotic length, which is expected to be overcome by applying genetic algorithms for age slicing.

II.1.3.3.2 Frequency analysis ELEFAN with simulated annealing (ELEFAN SA)

The growth parameters determined under initial conditions: a conditional interval for the asymptotic length $[\![L_\infty]\!]$ guess=17.10 cm and a search for the value of L_∞ in the interval [$L(_{\infty guess})$*0.8 ÷$L(_{\infty guess})$*1.2], and for K in the interval [0÷1]. **The parameters in the von Bertalanffy model were calculated as follows: L_∞=16.09 cm; K = 0.4 and t_0=-0.47.** The ages with their corresponding lengths were calculated using the latter (**Table II.1.3.3.3.1).**

The growth parameters determined under initial conditions: a conditional interval for the asymptotic length $[\![L_\infty]\!]$guess=16.25 cm and a search for the value of L_∞ in the interval [L(∞guess)*0.8 ÷L(∞guess)*1.2], and for K in the interval [0÷1]. **The parameters in the von Bertalanffy model were calculated for the second semester as follows: L_∞=17.17 cm; K = 0.27 and t_0=-0.63.** The ages with their corresponding lengths were calculated using the latter (**Table II1.3.3.3.2).**

II.1.3.3.3 Frequency analysis ELEFAN – Genetic algorithm (ELEFAN GA)

The growth parameters determined under initial conditions: a conditional interval of for the asymptotic length $[\![L_\infty]\!]_{guess}$=17.10 cm and a search for the value of L_∞ in the interval [$L(_{\infty}$guess)*0.8 ÷$L(_{\infty}$guess)*1.2], and for K in the interval [0÷1]. The parameters in the von Bertalanffy **for the first semester** model were calculated as follows: **L_∞=16.48 cm; K = 0.35 and t_0=-0.72.** The ages with their corresponding lengths were calculated using the latter (**Table II.1.3.3.3.1**).
The growth parameters determined under initial conditions: a conditional interval of for the asymptotic length $[\![L_\infty]\!]$guess=16.62 cm and a search for the value of L_∞ in the interval [$L(_{\infty}$guess)*0.8 ÷$L(_{\infty}$guess)*1.2], and for K in the interval [0÷1]. The parameters in the von Bertalanffy model **for the second semester** were calculated as follows: **L_∞=16.61 cm; K = 0.43 and t_0=-0.44.** The heights with their corresponding lengths were calculated using the latter (**Table 1.3.3.3.2**).
Table II.1.3.3.3.1 Ages with their corresponding lengths for the studied species calculated using von Bertalanffy parameters, obtained with RSA, ELEFAN with simulated annealing,

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ELEFAN with genetic algorithm and compared with experimentally determined ages from otoliths **for the first semester**.

	ELEFAN RSA	**ELEFAN SA**	**ELEFAN GA**	**Experimentally determined**
age	La	La	La	L_{mean}
0	3.7	2.7	3.7	
0.5	5.7	5.2	5.7	n/a
1	7.5	7.1	7.5	n/a
1.5	8.9	8.7	8.9	
2	10.1	10.1	10.1	10.75
2.5	11.1	11.2	11.2	
3	12.0	12.0	12.0	12
3.5	12.7	12.8	12.7	
4	13.2	13.4	13.3	13.75
4.5	13.7	13.9	13.8	
5	14.1	14.3	14.3	15

Table II.1.3.3.3.2 Ages with their corresponding lengths for the studied species calculated using von Bertalanffy parameters, obtained with RSA, ELEFAN with simulated annealing, ELEFAN with genetic algorithm and compared with experimentally determined ages from otoliths **for the second semester**.

	ELEFAN RSA	**ELEFAN SA**	**ELEFAN GA**	**Experimentally determined**
age	La	La	La	$L_{average}$
0	3.0	2.7	2.9	
0.5	4.7	4.5	5.5	7.75
1	6.2	6.1	7.7	8.75
1.5	7.5	7.5	9.4	
2	8.7	8.7	10.8	10.25
2.5	9.7	9.7	11.9	
3	10.6	10.7	12.8	11.75
3.5	11.4	11.5	13.6	
4	12.1	12.2	14.2	14
4.5	12.7	12.8	14.6	
5	13.2	13.4	15	15

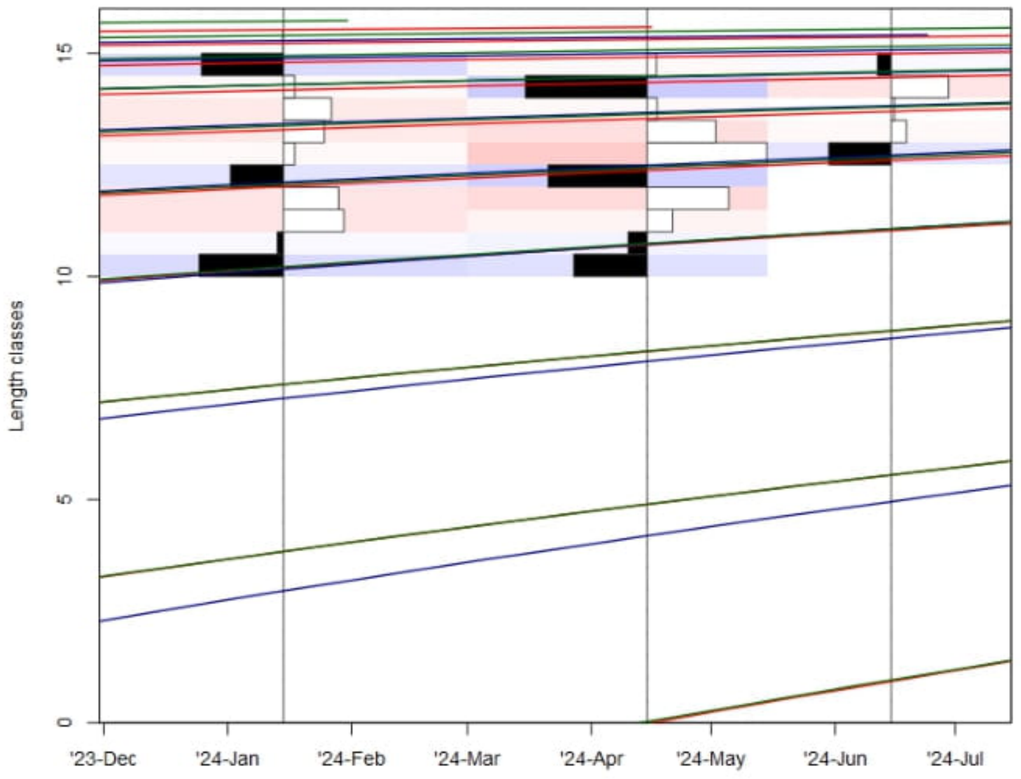


Figure II.1.3.3.3.1 Growth curves (in red for growth parameters determined with ELEFAN RSA, in blue for ELEFAN SA, and in green for ELEFAN GA), visualized on the restructured data for the purpose of visualizing the tracking of cohorts over time **for the first semester** .

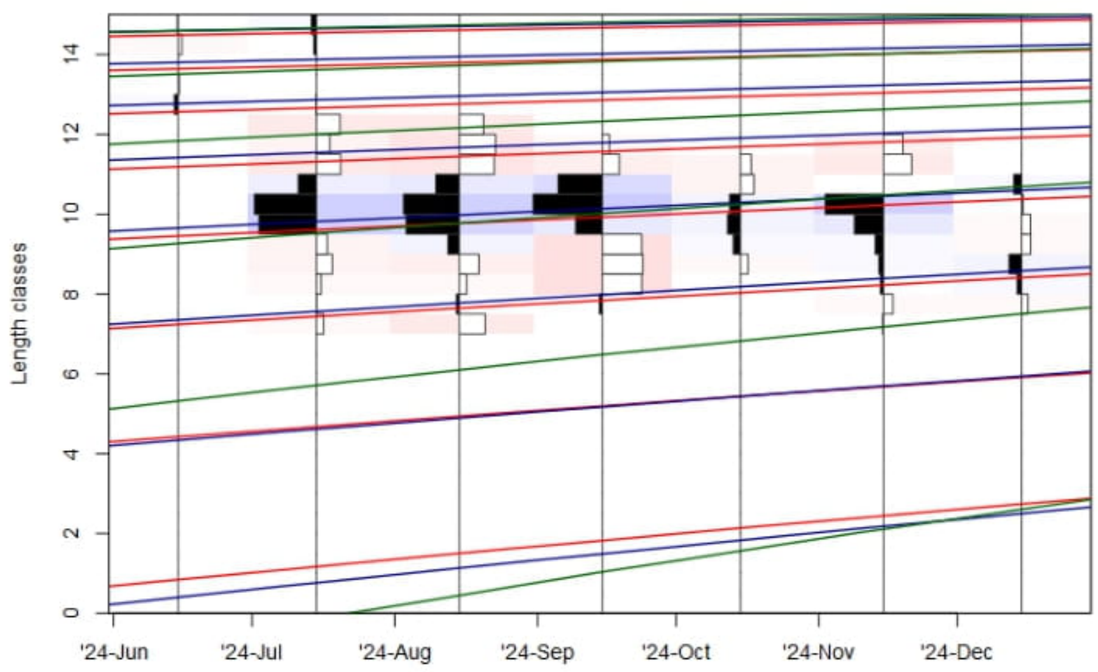


Figure II.1.3.3.3.2 Growth curves (in red for growth parameters determined with ELEFAN RSA, in blue for ELEFAN SA, and in green for ELEFAN GA), visualized on the restructured data for the purpose of visualizing the tracking of cohorts over time **for the second semester** .

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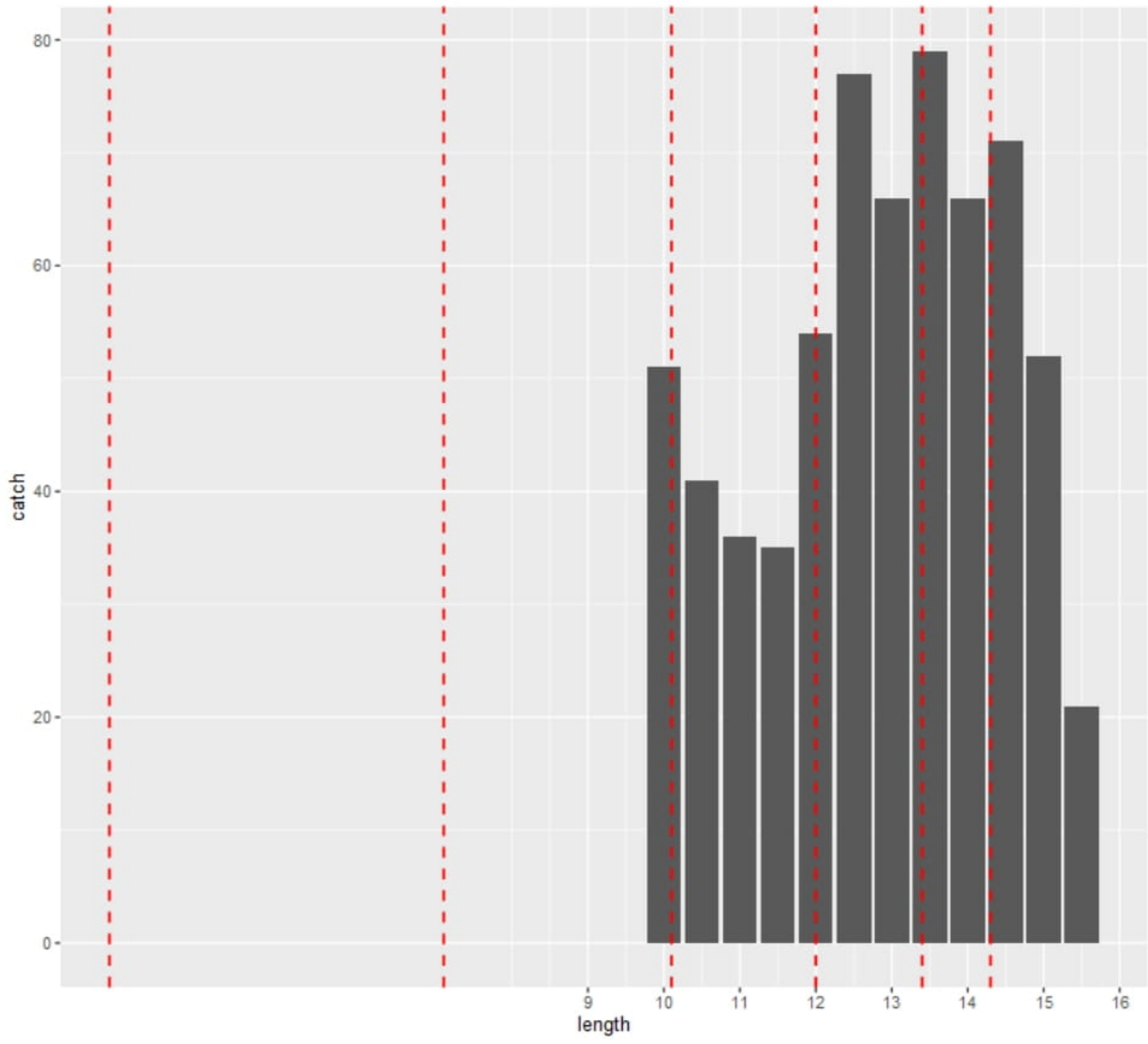


Figure II.1.3.3.3.3 The ages represented with dashed lines, calculated based on the growth parameters determined by ELEFAN SA, are overlaid on the cumulative sample of the composition of commercial catches of horse mackerel, aiming to visualize the range of size classes represented in a specific age group (0-5 years) **for the first half of 2024**.

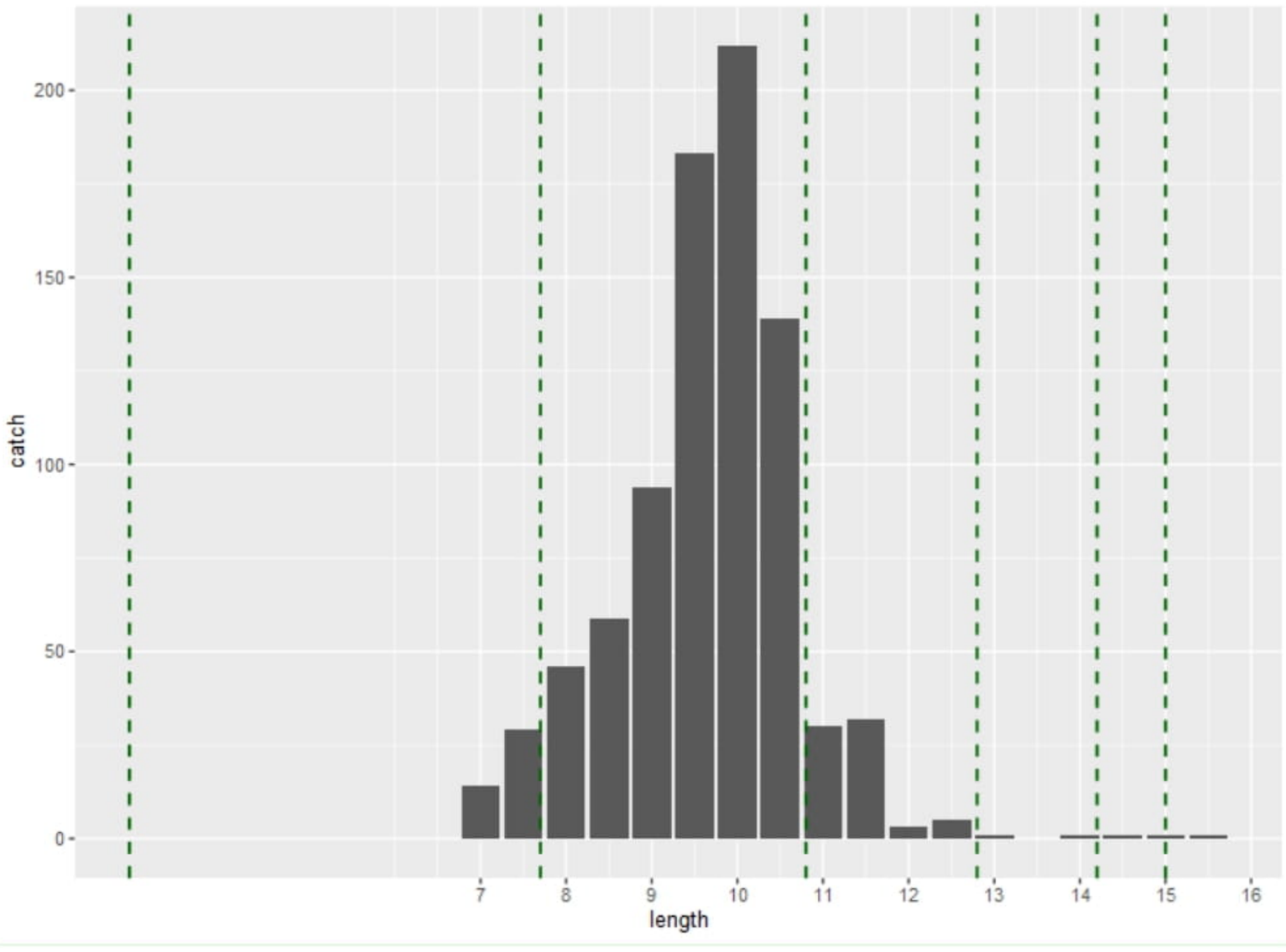


Figure II.1.3.3.3.4 The ages represented with dashed lines, calculated based on the growth parameters determined by ELEFAN SA, are overlaid on the cumulative sample of the composition of commercial catches of horse mackerel, aiming to visualize the range of size classes represented in a specific age group (0-5 years) **for the second half of 2024**.

The results of ELEFAN with the three applied methods are consistent and applicable to the experimentally determined ages. The sample size and the consideration of growth parameters for a period of less than a year generally have an impact on the accuracy of determination. ELEFAN SA is very close to the experimentally determined ages and, accordingly, the biological potentials of horse mackerel **for the first half of 2024** are best described by the following analytically determined parameters: **L_∞=16.09 cm; K = 0.4 and t_0=-0.47.**

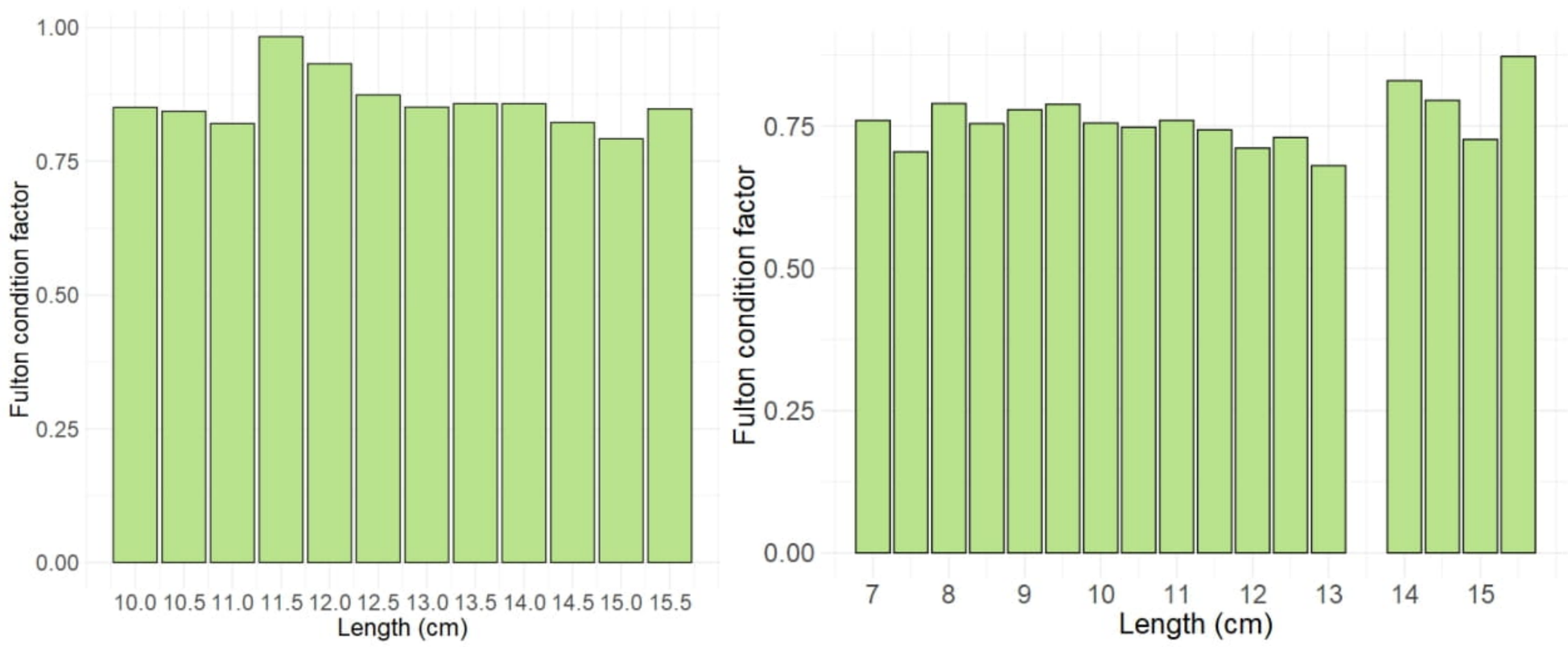
The results from ELEFAN with the three applied methods are consistent and applicable to the experimentally determined ages only with ELEFAN GA. The sample size and the consideration of growth parameters for a period of less than a year generally have an impact on the accuracy of determination. ELEFAN GA is closest to the experimentally determined ages and, accordingly, the biological potentials of horse mackerel **for the second half of 2024** are best described by the following analytically determined parameters: **L_∞=16.61 cm; K = 0.43 and t_0=-0.44.**

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Since the calculated asymptotic length is smaller than that reported in the literature, it is likely that some or all of the samples represent the small-sized population. The latter is difficult to identify without genetic findings and therefore the application of such for the sustainable management of horse mackerel stocks is necessary.

II.3.4 Condition factor

The condition of the horse mackerel by size shows a predominance of 11.5-12.0 cm. specimens (**Fig. II.3.4.1**).The highest value of the condition factor was shown by three-year-old fish, and the lowest by two- and five-year-old fish, respectively.



a **b**

Fig.II.3.4.1 Condition factor of horse mackerel by size classes for the first (a) and second semester (b) of 2024.

High values are observed throughout the spring season, at all ages. The values in June varied between 0.75-0.99, with an average for the month of 0.87. Similar coefficients were again registered in July: 0.75-0.90. Thus, in the two six-month periods, K did not show fluctuations from the average multi-year data.

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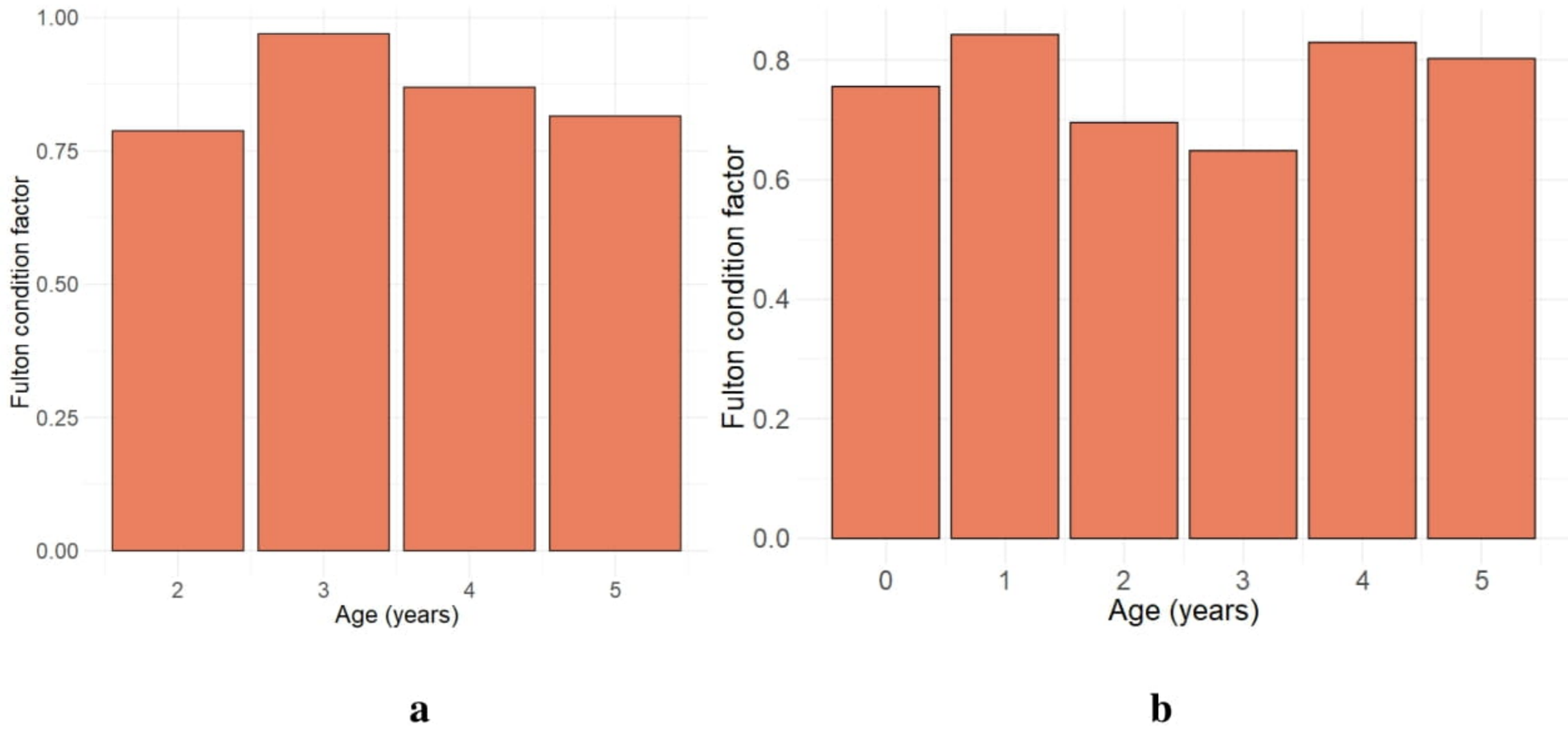


Fig. II.3.4.2 Fulton condition coefficient values of horse mackerel by age groups for the first (a) and second semester (b) of 2024.

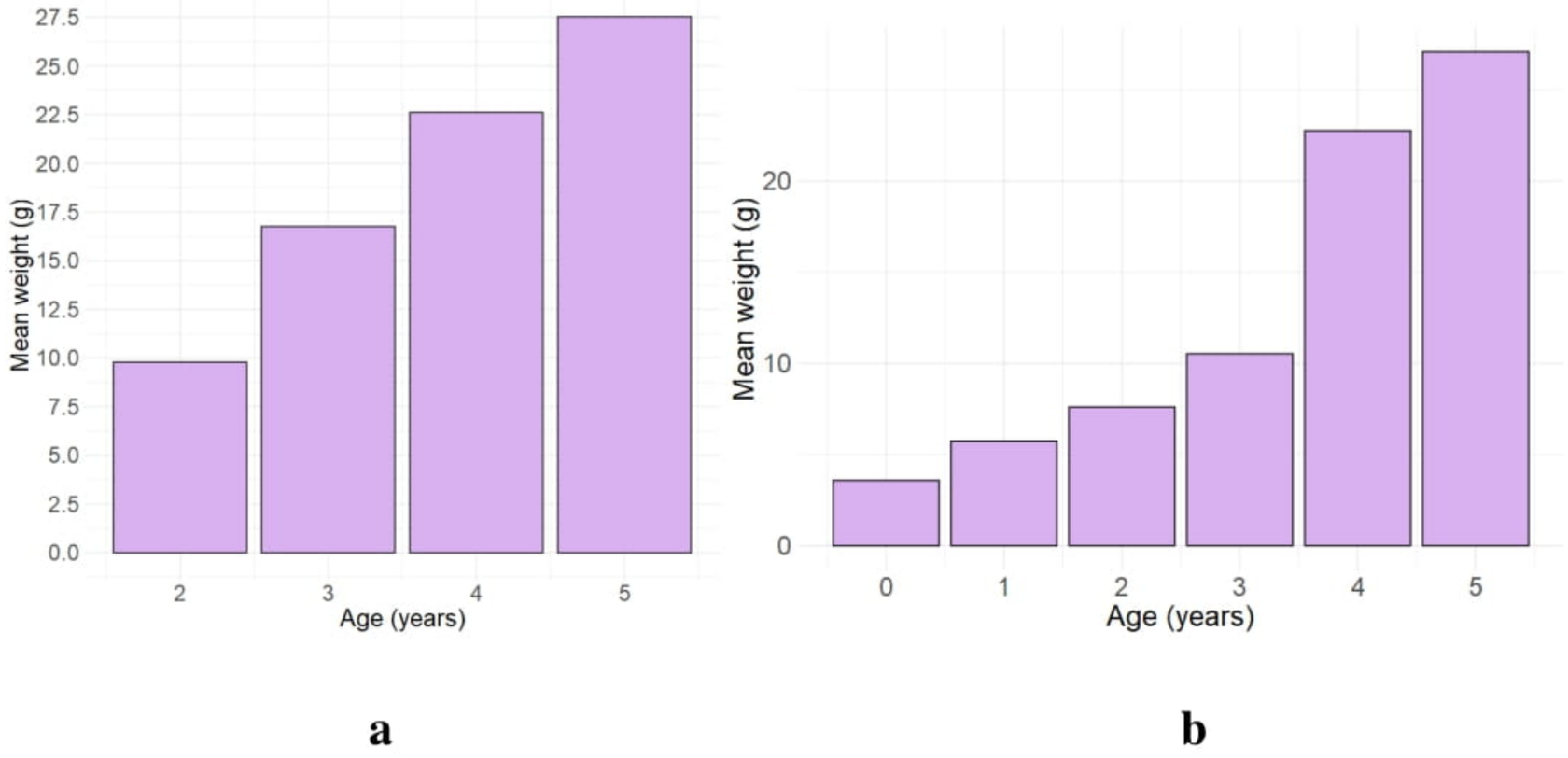
II.3.5 Weight structure of horse mackerel

The weight of **1500 specimens (649 specimens in the first and 851 specimens in the second semester)** was measured. A gradual increase in the average weight is observed by age group for both the first and second trimesters. The average weight is lowest for age group 2+, and the highest average weight is observed for group 5+ (Fig. II. 3.5.1).

The graph shows the distribution of the average weight of horse mackerel by age group for two quarters. A gradual increase in the average weight is observed in relation to the age groups for both quarters. For the age group 2-2+ the lowest average weight is -9.78g (129 number of horse mackerel), and for the group 5-5+ the highest average weight is observed - 27.53g (91 number of horse mackerel). For the other age groups the weights are as follows: 3-3+-16.76g (212 number of horse mackerel); 4-4+-22.61g (217 number of horse mackerel).

In the second half of the year, the average weight for the age group 0-0+ was the lowest - 3.58g (85 number of horse mackerel), and for the group 5-5+ the highest average weight was observed - 27.08g (3 number of horse mackerel). For the other age groups, the weights were as follows: 1-1+ - 5.74g (204 number of horse mackerel); 2-2+ - 7.59g (480 number of horse mackerel); 3-3+ - 10.52g (78 number of horse mackerel); 4-4+ - 22.76g (1 number of horse mackerel).

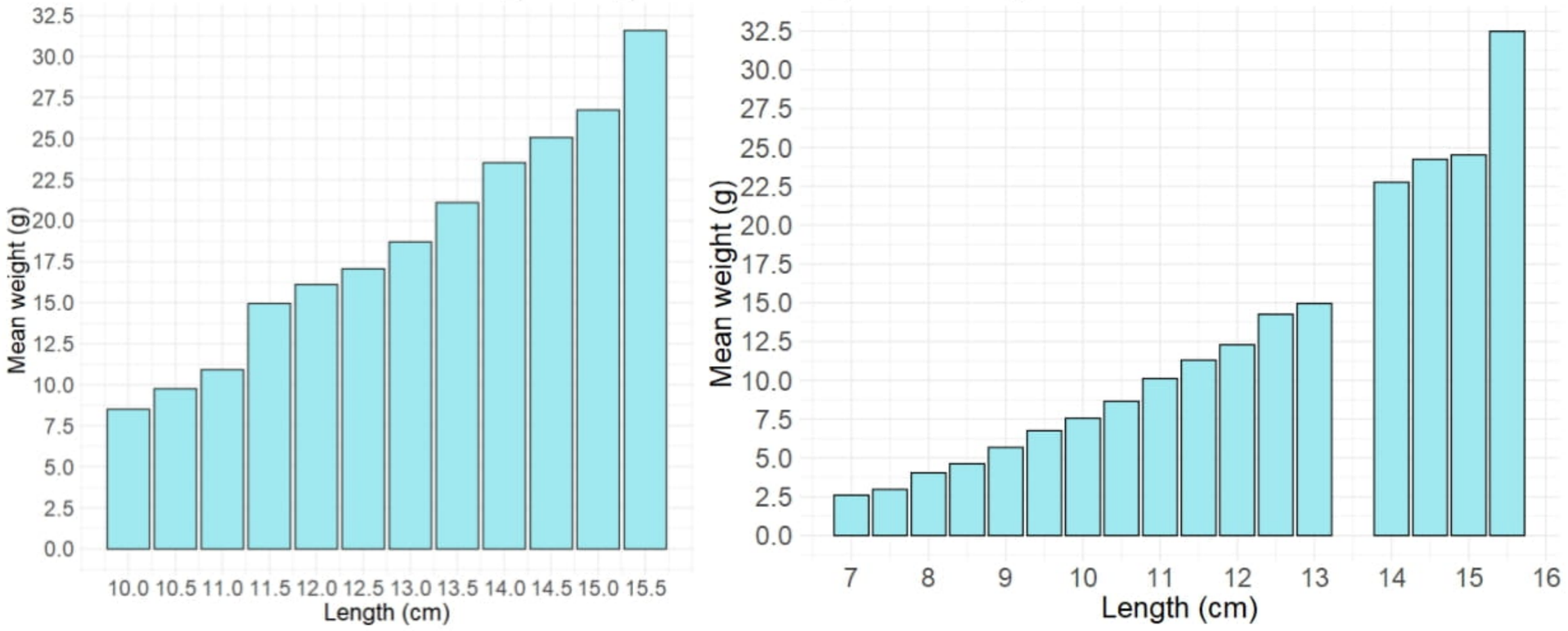
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a b

Fig. II. 3.5.1 Distribution of average weight of horse mackerel by age groups for the first (a) and second semester (b) of 2024.

During the first semester the most widely distributed size groups 13.5-14.5cm represent 12.17% and 10.94% and for them average weights of 21.10g and 25.07g were measured.
During the second semester, the most widely distributed size groups 9.5-10 cm accounted for 21.50% and 24.91% and average weights of 6.76 g and 7.55 g were measured for them.



a b

Fig. II. 3.5.2 Distribution of average weight of horse mackerel by size groups for the first (a) and second semester (b) of 2024.

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II.3.6 Size structure of horse mackerel by age group

The fish length was measured on **1500 specimens (649 specimens in the first and 851 specimens in the second semester).**

Table III.3.6.1 Size structure of horse mackerel by age groups.

I-VI		VII-XII	
Age	**L_{mean}/cm**	**Age**	**L_{mean}/cm**
0-0+		0-0+	7,79
1-1+		1-1+	9,00
2-2+	11,69	2-2+	9,98
3-3+	13,05	3-3+	11,19
4-4+	14,35	4-4+	14,00
5-5+	15,14	5-5+	15,00

II.3.7 Length- weight relationship

To calculate the length-weight relationship, a linear model was used on the logarithmically transformed values for the average weights and lengths **for the first half of 2024**. The modeling results are presented in **Table II.3.7.1.**

Table II.3.7.1 Results of modeling the length-weight relationship.

Call:
lm(formula = logW ~ logL, data = weight_l)
Residuals:
Min 1Q Median 3Q Max
-0.063806 -0.040394 -0.000302 0.012688 0.122337
Coefficients:
Estimate Std. Error t value Pr(>|t|)
(Intercept) -4.4402 0.3069 -14.47 0.00000004947 ***
--- logL 2.8755 0.1208 23.80 0.00000000039 ***
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
Residual standard error: 0.0574 on 10 degrees of freedom
Multiple R-squared: 0.9826, Adjusted R-squared: 0.9809
F-statistic: 566.3 on 1 and 10 DF, **p-value: 0.0000000003901**

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The resulting model is statistically significant, the value of the scaling coefficient a in the length-weight relationship model, $\mathbf{W_i = aL_i^b}$ **e:** $\mathbf{a = 0.012}$, and the allometry coefficient **b=2.88,** which indicates negative allometric growth of the species in the first half of the year, or the increase in weight is not proportional to the increase in length.

To calculate the length-weight relationship, a linear model was used on the logarithmically transformed values for the average weights and lengths **for the second semester of 2024.** The modeling results are presented in **Table II 3.7.2.**

Table II.3.7.2 Results of modeling the length-weight relationship.

Call:
lm(formula = logW ~ logL, data = weight_l)
Residuals:
Min 1Q Median 3Q Max
-0.063806 -0.040394 -0.000302 0.012688 0.122337
Coefficients:
Estimate Std. Error t value Pr(>|t|)
Intercept-4.99224 0.14814 -33.7 0.00000000000000149 ***
logL 3.04677 0.06192 49.2 < 0.00000000000000002 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Residual standard error: 0.06157 on 15 degrees of freedom
Multiple R-squared: 0.9938, Adjusted R-squared: 0.9934
F-statistic: 2421 on 1 and 15 DF, **p-value: < 0.00000000000000022**

The resulting model is statistically significant (**Table II 3.7.1),** the value of the scaling coefficient a in the length-weight relationship model $W_i = aL_i^b$ is: **a=0.0068**, and the allometry coefficient **b=3.04,** which indicates positive allometric growth of the species **in the second half of the year**, or the increase in weight is not proportional to the increase in length.

II.3.8 Sex structure

The sex ratio in the first six months was determined on **150 specimens**. Males ♂ predominate over females♀. The sex ratio was determined in **100 specimens** during the second semester. Females♀ predominated over males♂.

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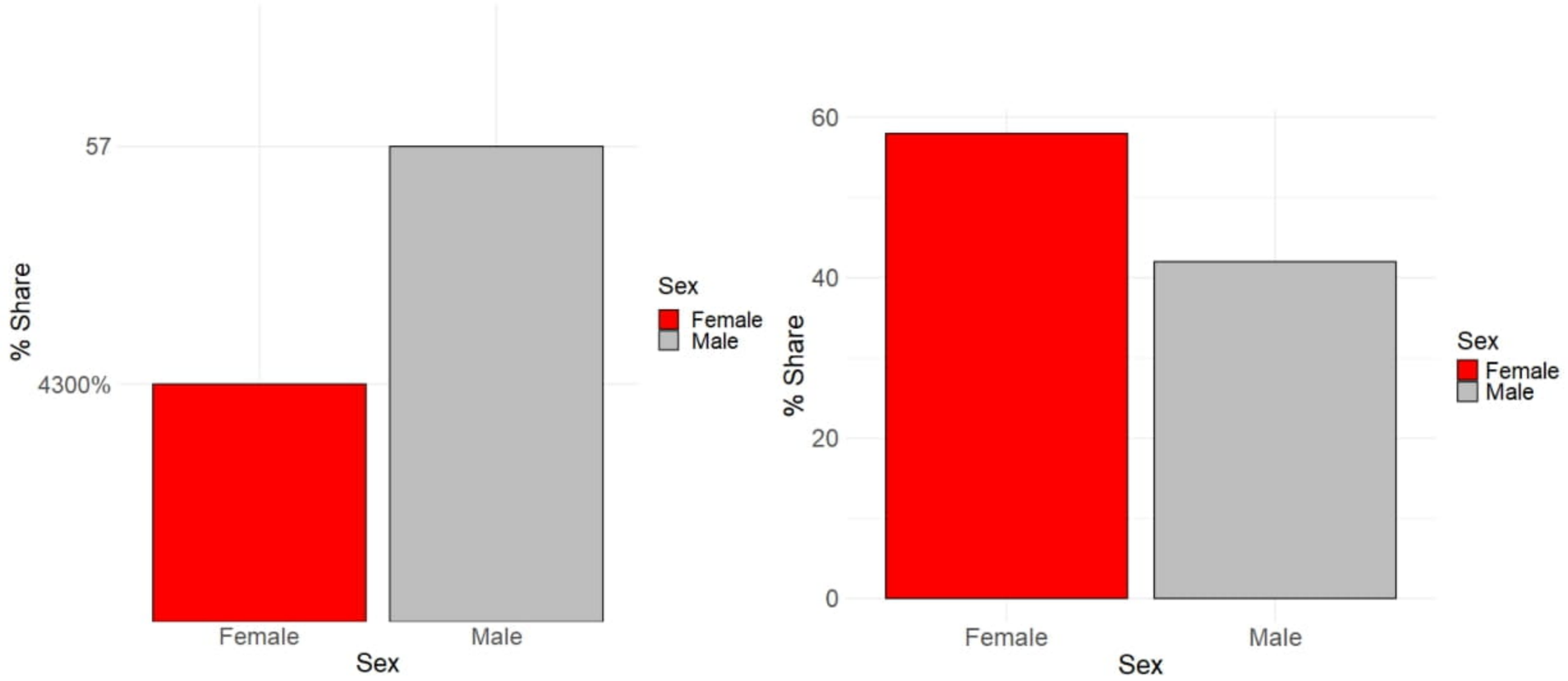


Figure II. 3.8.1 Sex ratio of horse mackerel.

Average lengths of female ♀ are higher in all year old fish (**Figure II.3.8.2).**

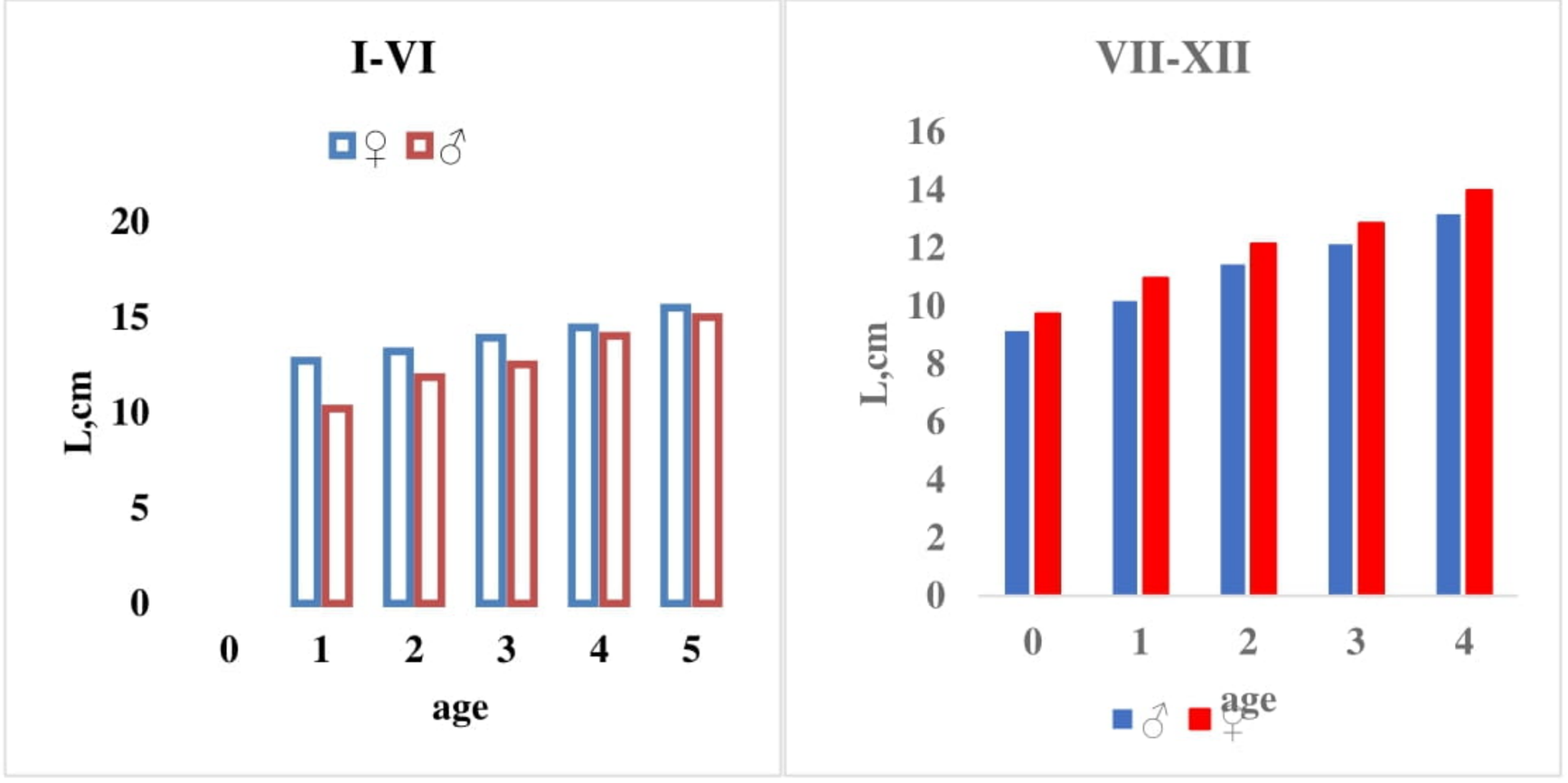


Figure II.3.8.2 Sex ratio(♂♀) by size and age of horse mackerel.

II.3.9 Fertility

The fertility of **130 specimens was determined (100 specimens in the first semester and 30 specimens in the second).** The portion fertility (Log F) versus the weight of the horse

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mackerel (Log W) showed a strong relationship (R^2 =0.89 for the first semester and R^2 =0.989 for the second semester), which proves a strong dependence of fertility on individual weights.

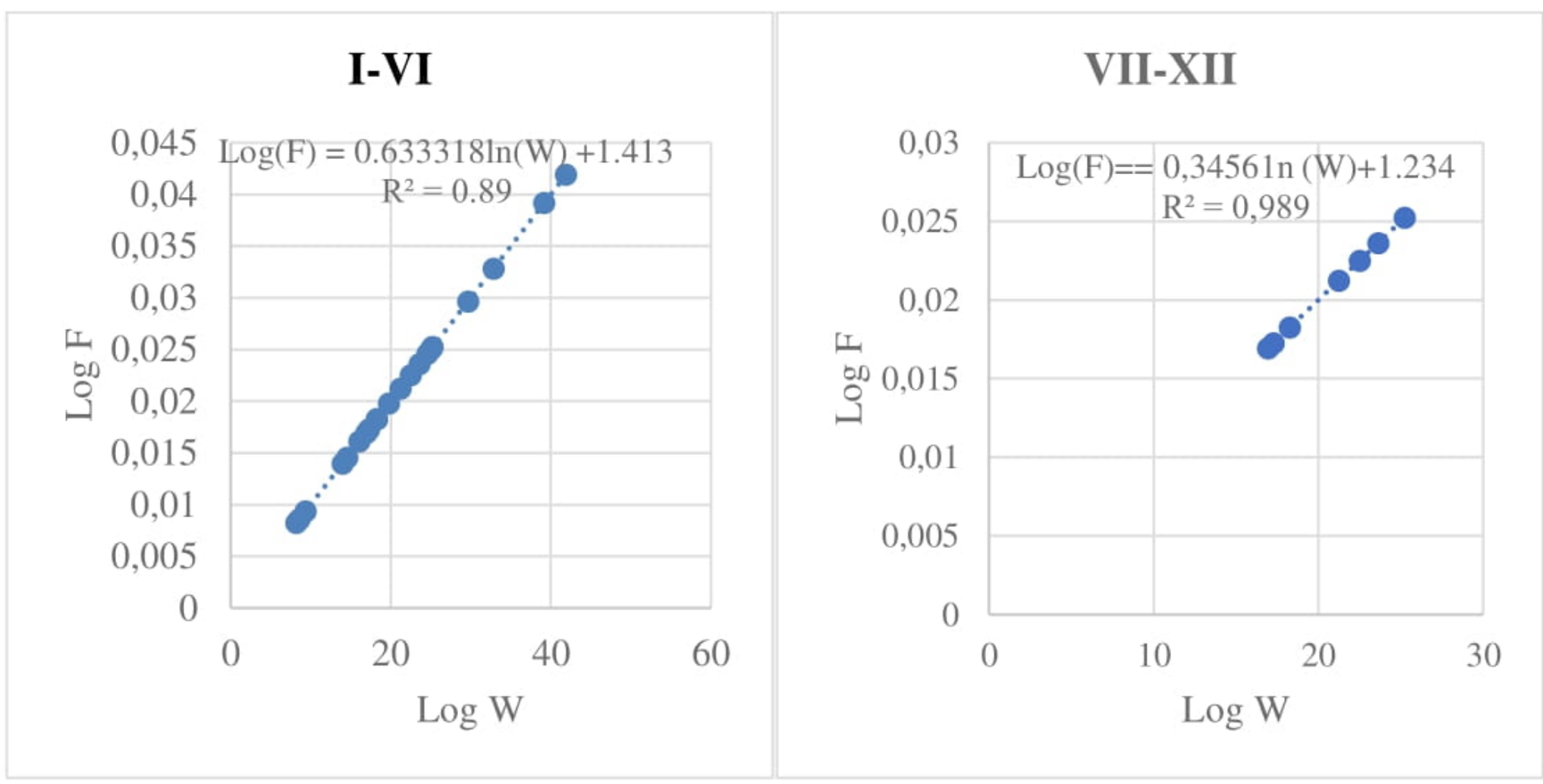


Figure II.3.9.1 Dependence of portion fertility on horse mackerel weight.

The relationship between weight and fecundity of horse mackerel showed a weaker relationship (R^2=0.5802) in the first semester and a stronger relationship in the second semester (R^2=0.8931), on the Gonado-somatic index and the weight of the gland (ovaries) **(Figure II. 3.9.2).**

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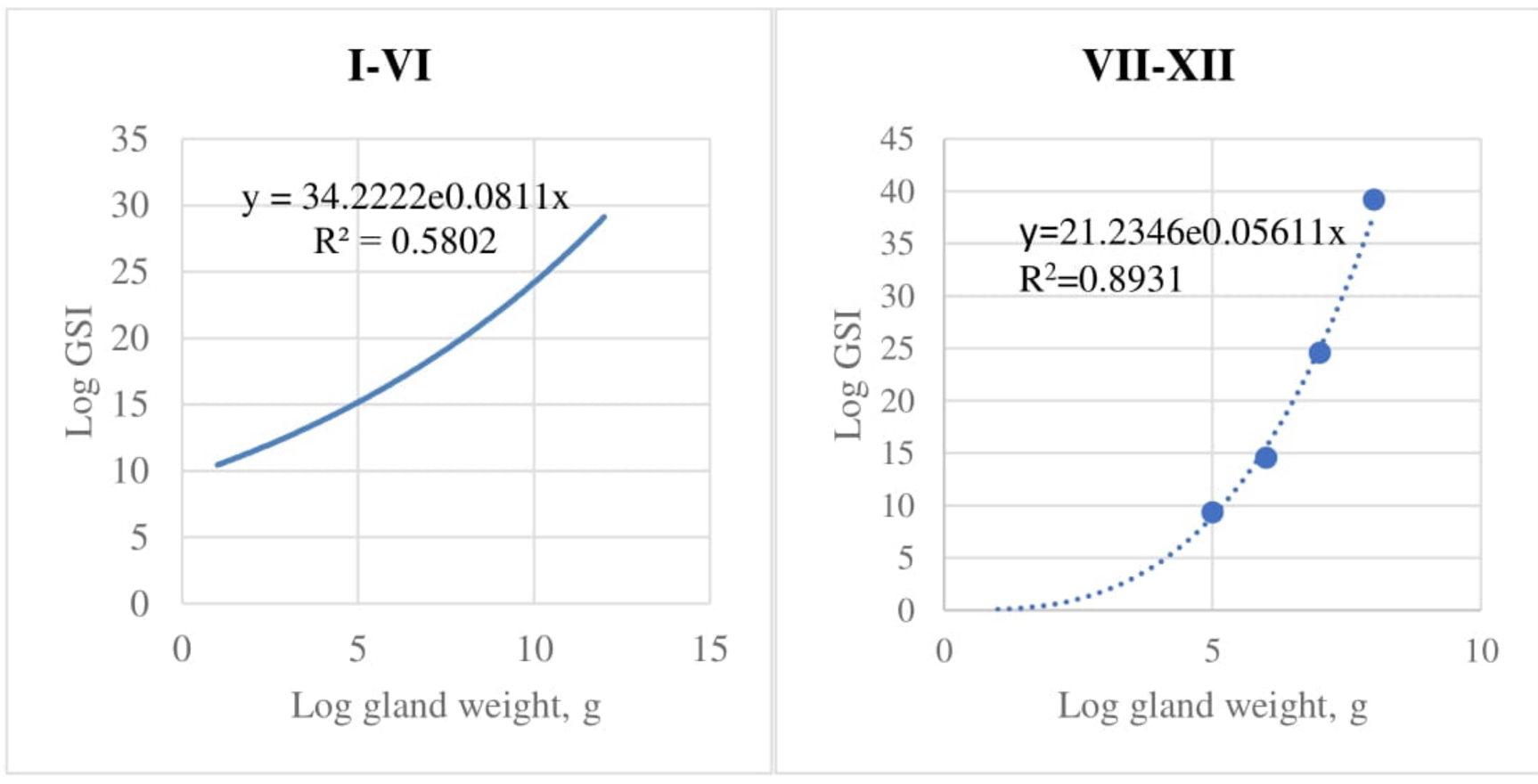


Figure II.3.9.2 Dependence of gland weight on gonadosomatic index (GSI).

Absolute fecundity is with an average weighted fecundity of 7135.29 eggs for the first and 2455.06 for the second semester. Absolute fecundity increases with increasing length, mass and age. The average weighted relative fecundity is 3384.23 for the first and 3638.61 for the second semester **(Table II. 3.9.1).**

Table II.3.9.1 Absolute and relative fertility.

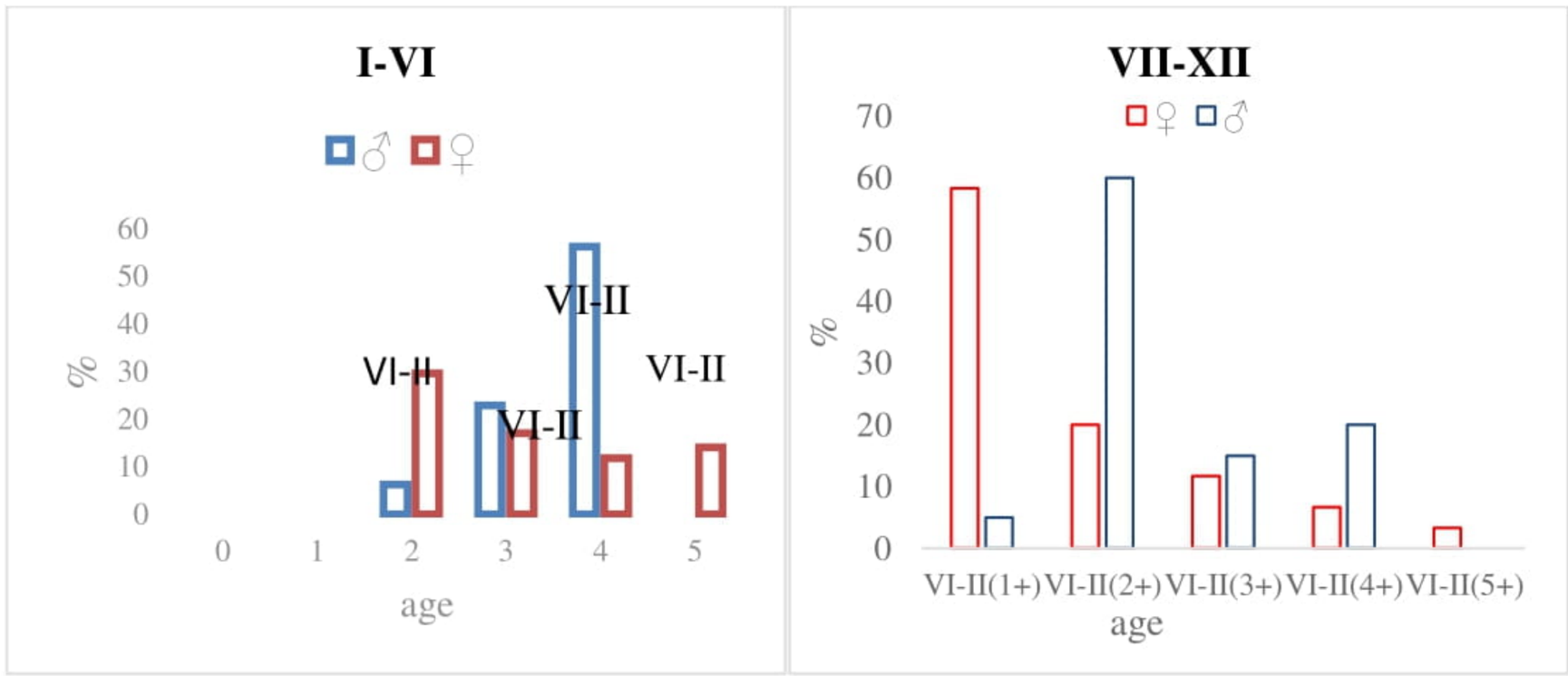
I-VI					VII-XII				
Size class	**Average body weight (W, g)**	**Absolute fertility F, caviar grains)**	**Relative fertility**	**N♀**	**Size class**	**Average body weight (W, g)**	**Absolute fertility F, caviar grains)**	**Relative fertility**	**N♀**
12,5	16,11	4422,20	2744,21	20	**7**	2,61	5973,00	22885,06	2
13	17,08	6311,40	3696,18	17	**7,5**	2,97	1219,00	4104,377	2
13,5	18,70	9542,00	5101,76	24	**8**	4,04	1240,00	3069,307	1
14	21,11	9668,00	4580,23	9	**8,5**	4,63	1833,10	3959,179	3
14,5	23,54	6336,30	2691,94	15	**9**	5,68	3110,11	5475,546	2
15	25,08	6675,10	2661,88	10	**9,5**	6,76	2352,25	3479,66	2
15,5	31,59	6992,00	2213,36	5	**10**	7,55	2352,30	3115,629	1
					10,5	8,66	2325,25	2685,046	2
					11	10,11	2134,25	2111,029	1

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					11,5	11,31	1672,40	1478,691	2
					12	12,29	2345,78	1908,69	4
					12,5	14,25	3561,30	2499,158	3
					13	14,95	2140,25	1431,605	1
					14	22,77	1617,25	710,2547	1
					14,5	24,24	2501,50	1031,972	1
					15	24,52	2618,19	1067,777	1
					15,5	32,49	2740,01	843,3395	1
		7135,29	3384,23	100			2455,06	3638,607	30

II.3.10 Sexual maturity

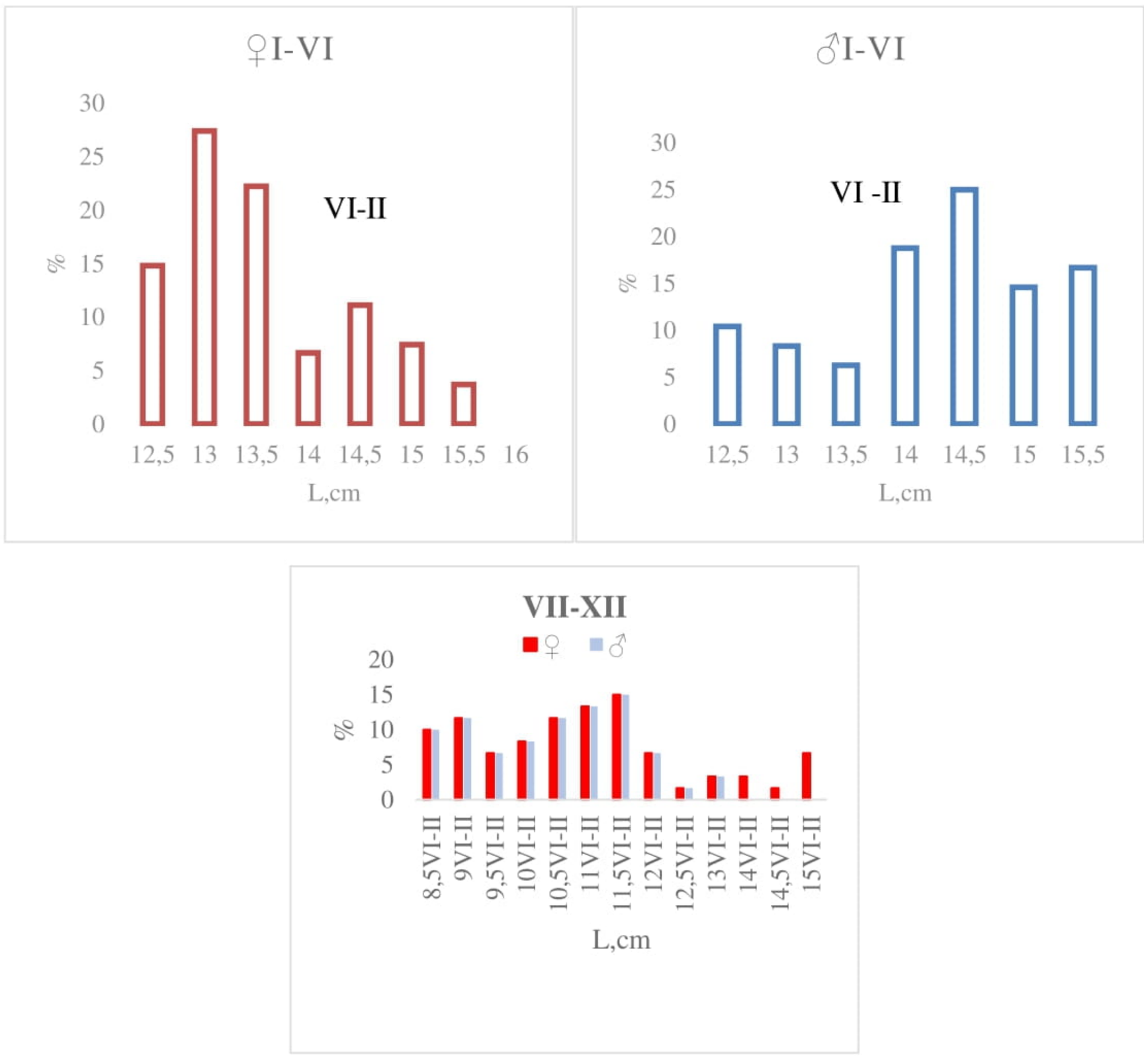
Sexual maturity was determined in **250 specimens (150 specimens in the first and 100 specimens in the second semester).** Examined specimens showed a degree of flowing gonads (VI-II).



Figute II.3.10.1 Sexual maturity by age of horse mackerel - female ♀ and male ♂.

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Figute II. 3.10.2 Sexual maturity by length(cm) of horse mackerel - female ♀ and male ♂.

II.3.11 Catch numbers and biomass by age and length

Monthly OTM catches (in kilograms) together with average weights were used to obtain the abundance and biomass of the species by quarter in the reported catches (**Table II.3.11.1-2**).

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Table II.3.11.1 Catch at age (10^{-6}) with OTM, matrix and biomass (kg) of horse mackerel.

Catch at age				
Age groups (yr)	***Istquarter***	***II ndquarter***	***III rd quarter***	***IVth quarter***
0-0+			1169.49	4240.28
1-1+			1752.99	6355.89
2-2+	27.110	41.833	3117.06	11301.67
3-3+	26.025	40.158	365.74	1326.07
4-4+	19.746	30.469	2.17	7.86
5-5+	6.799	10.492	5.47	19.82
∑	79.680	122.952	6413	23252
Biomass (kg)				
Age groups (yr)	***Istquarter***	***II ndquarter***	***III rd quarter***	***IVth quarter***
0-0+			4194.07	15206.61
1-1+			10065.76	36495.86
2-2+	265.354	409.461	23684.14	85872.62
3-3+	436.086	672.912	3848.67	13954.30
4-4+	446.371	688.783	49.34	178.90
5-5+	187.188	288.844	148.03	536.70
∑	1335	2060	41990	152245

Table II.3.11.2 Number of individuals ($x10^{-6}$) in the catch by size class (for OTM) and biomass of the horse mackerel.

*Catch-at-length *10^{-6} 2024*				
Length groups (cm)	***Istquarter***	***II ndquarter***	***III rd quarter***	***IVth quarter***
7			265.061	961.044
7,5			481.321	1745.146
8			561.633	2036.337
8,5			628.559	2278.993
9			776.048	2813.753
9,5			1298.015	4706.272
10	12.301	18.98076	1315.620	4770.102

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10,5	8.638	13.32888	789.636	2863.019
11	6.778	10.45932	134.818	488.815
11,5	4.814	7.42876	132.614	480.823
12	6.889	10.62984	8.714	31.593
12,5	9.281	14.32173	12.364	44.830
13	7.255	11.19477	1.978	7.172
13,5	7.695	11.87394	1.830	6.634
14	5.431	8.37999	1.648	5.975
14,5	5.618	8.66890	1.596	5.786
15	3.582	5.52749	1.496	5.424
15,5	1.398	2.15765		
∑	79.680	122.952	6413	23252
Biomass (kg)				
Length groups (cm)	***Istquarter***	***II ndquarter***	***III rd quarter***	***IVth quarter***
7			690.79	2504.62
7,5			1430.92	5188.14
8			2269.73	8229.46
8,5			2911.18	10555.18
9			4638.14	16816.72
9,5			9029.58	32738.94
10	104.908	161.880	10460.49	37927.07
10,5	84.337	130.139	6858.53	24867.28
11	74.052	114.268	1480.26	5367.04
11,5	71.995	111.094	1578.94	5724.84
12	111.079	171.402	148.03	536.70
12,5	158.390	244.407	246.71	894.51
13	135.763	209.492	49.34	178.90
13,5	162.504	250.755	49.34	178.90
14	135.763	209.492	49.34	178.90
14,5	146.048	225.362	49.34	178.90
15	106.965	165.054	49.34	178.90
15,5	43.197	66.656		
∑	1335	2060	41990	152245

II.3.12 Conclusions

The analysis of the biological parameters of the horse mackerel makes it possible to draw the following **conclusions:**

1) In the first quarter, the highest percentage is the size class 12 cm, and in the second quarter it is 13.5 cm. In the third quarter, the highest values are the individuals in the size classes of 9.5 cm, 10 and 10.5 cm., and with the lowest percentage value are the size classes of 14-15.5 cm. In the fourth quarter, the highest values are the individuals

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in the size classes of 9.5 -10 cm, and with the lowest percentage is the size class 13 cm.

2) In the first and second quarters, the highest percentage share is occupied by individuals in the age group 3-3+, followed by 2-2+. The age group 0-0+ has the lowest possible catch values in the third quarter, while 1-1+ and 2-2+ have the highest percentage performance in catches. Results for catches in the fourth quarter are also best represented in groups 1-1+ and 2-2+.

3) The results of ELEFAN with the three applied methods are consistent and applicable to the experimentally determined ages. The sample size and the consideration of growth parameters for a period of less than a year generally have an impact on the accuracy of determination. ELEFAN SA is very close to the experimentally determined ages and, accordingly, the biological potentials of horse mackerel for the first half of 2024 are best described by the following analytically determined parameters: L_∞=16.09 cm; K = 0.4 and t_0=-0.47.

4) Since the calculated asymptotic length is smaller than that reported in the literature, it is likely that some or all of the samples represent the small-sized population. The latter is difficult to identify without genetic findings and therefore the application of such for the sustainable management of horse mackerel stocks is necessary.

5) A gradual increase in average weight is observed across age groups.

6) The resulting model is statistically significant, the value of the scaling coefficient a in the length-weight relationship model, $W_i = aL_i^b$:**a=0.012**, and the allometry coefficient **b=2.88**, which indicates negative allometric growth of the species **in the first half of the year,** or the increase in weight is not proportional to the increase in length. The resulting model is statistically significant, the value of the scaling coefficient a in the length-weight relationship model $W_i = aL_i^b$ is: **a=0.0068**, and the allometry coefficient **b=3.04**, which indicates positive allometric growth of the species **in the second half of the year**, or the increase in weight is not proportional to the increase in length.

7) Males ♂ predominate over females ♀ during the first semester and females ♀ predominated over males ♂ during the second semester.

8) Portion fecundity (Log F) versus horse mackerel weight (Log W) show a strong relationship (R^2 =0.89 for the first semester and R^2 =0.989 for the second semester), which proves a strong dependence of fecundity on individual weights.

9) Absolute fecundity is with an average weighted fecundity of 7135.29 eggs per 1st and 2455.06 per 2nd semester. Absolute fecundity increases with increasing length, mass and age. Average weighted relative fecundity is 3384.23 for 1st and 3638.61 for 2nd semester.

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III. Biological monitoring of whiting (*Merlangius merlangus*) landings

III.1 Objectives

The purpose of biological monitoring is to collect data that will be used to analyze whiting catches, as well as to form a database. The collection of biological samples of whiting catches in **2024** includes the following tasks:

1. To collect and analyze the dynamics of length, weight and age distribution.
2. To determine the state of the of whiting using the so-called state factor (Ricker, 1975).
3. Characteristics of the reproductive biology of whiting.
4. Collection of data on ports of landing, sampling vessels, number of samples collected, number of specimens tested, geographical catch data.

III. 2 Sampling

The sampling was carried out by the actively operating fishing fleet in Bulgaria.

III. 2.1 Geographic area coverage

Data of present analysis were collected from Bulgarian Black Sea coast. In **2024, 4 samples with 250 specimens** were collected and processed. Information on the size of the catches was also collected.

III. 2.2 Sampling period

In 2024, the biological data for the species were collected from a total of **4 landings at the ports of Nesebar Sozopol and Varna**. Information on the size of the catch was also collected. Ports and ships from which monitoring was carried out to collect biological data from landings are presented in **Table III.2.2.1.**

Table III.2.2.1 Ports and ships from which monitoring was carried out to collect biological data of whiting landings.

№	Date	Sampling ports	WHG	Fishing vessel	External marking	Fishing gear	Catch/ kg	Coordinates
1	20.2.2024	Nesebar	WHG	BUREVESTNIK	BS 032	OTM	22	42.6846847534 27.9002037048
2	28.5.2024	Sozopol	WHG	Sveti Nikola	BS 265	OTM	98	42.3398 27.9051
3	20.8.2024	Nesebar	WHG	NIKO	BS152	OTM	100	42.656100 27.731000
4	10.12.2024	Varna	WHG	VN 7822	VN 7822	OTM	20	43.366200 28.386800

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III. 2.3 Statistical analysis of data

See section statistical analysis of sprat.

III.3 Results

III.3.1 Landings statistics

The highest catches were achieved in February, July and August 2024 (**Figure III.3.1.1**).

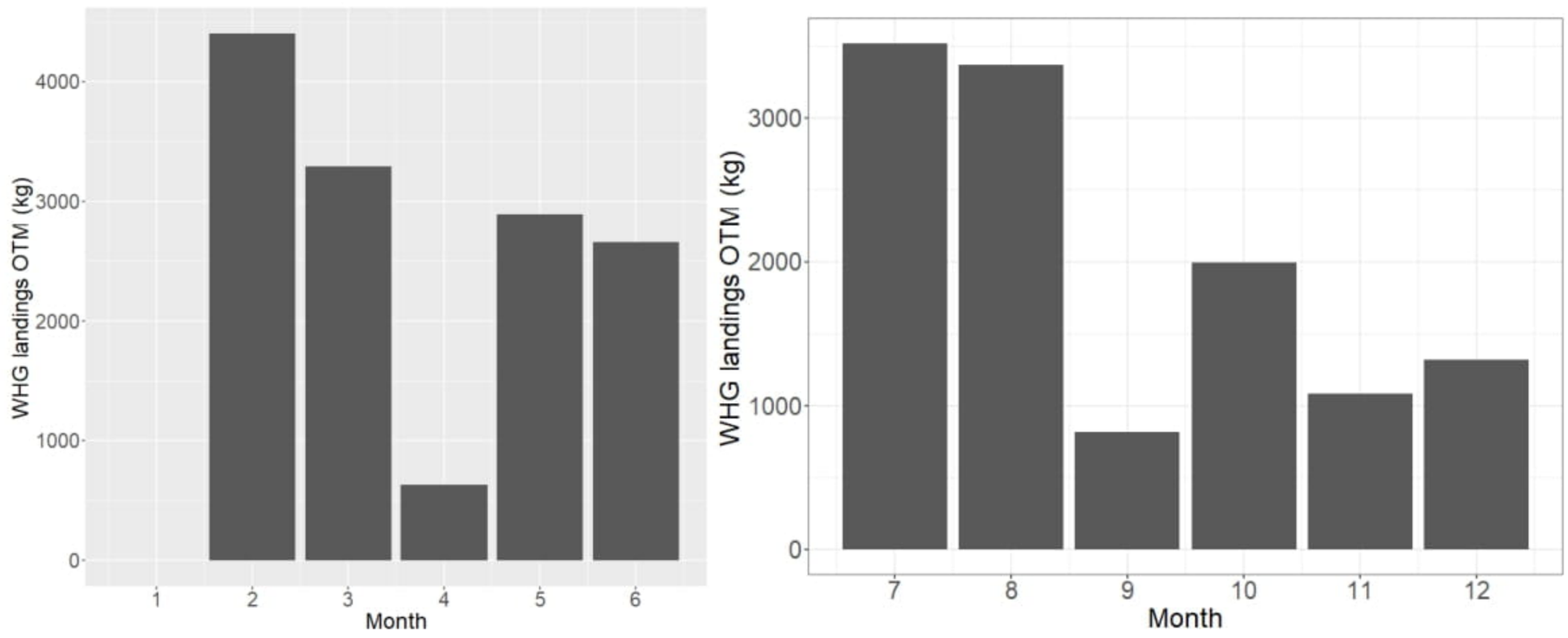


Figure III.3.1.1 Landings statistics of whiting.

III.3.2 Length structure of landings

In the first and second quarters of 2024 the length distribution follows a normal distribution with predominant classes 10.0 and 13.0 cm (I-III) and 12.5 – 14.5 cm (IV-VI).
For the first quarter, the classes in the range of 14.5 to 17 cm have the lowest share in the landings - under 3%. The size groups of 13.5 cm and 10 cm occupy a relatively higher percentage share in the landings - respectively 13.33 % and 12.22 %. The size class 11.5 cm is also represented with a high percentage of 11.11%. For the second quarter, the size classes with the lowest percentage are 13.5 cm (4.35%), 11.5 cm (5.79%) and 13 cm (7.25%). In the second quarter, the size class 14 cm predominates, followed by the size class 12.5 cm, and 10.5 cm and 15 cm participating with 17.39%, 13.04% and 11.59%. The size classes 12 and

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17 cm participate equally in the catches with 10.14%. In the second quarter, the size class 10.5 cm also performed well with 11.59% (**Figure III.3.2.1**).

In the catches from the Bulgarian Black Sea waters in the 3rd and 4th quarters of 2024, the size composition is represented by individuals with a body length of 10 cm to 17.5 cm. The graph shows that the percentage distribution of catches by size classes is uneven. In the third quarter, the highest values are for individuals in the size classes 13 cm and 16.5 cm, and the lowest percentage value is for the size classes of 10.5 cm. In the fourth quarter, the individuals with the highest values were in the size classes 10.5 (14.29%) cm, and the size classes of 10 cm (2.86%) had the lowest percentage value.

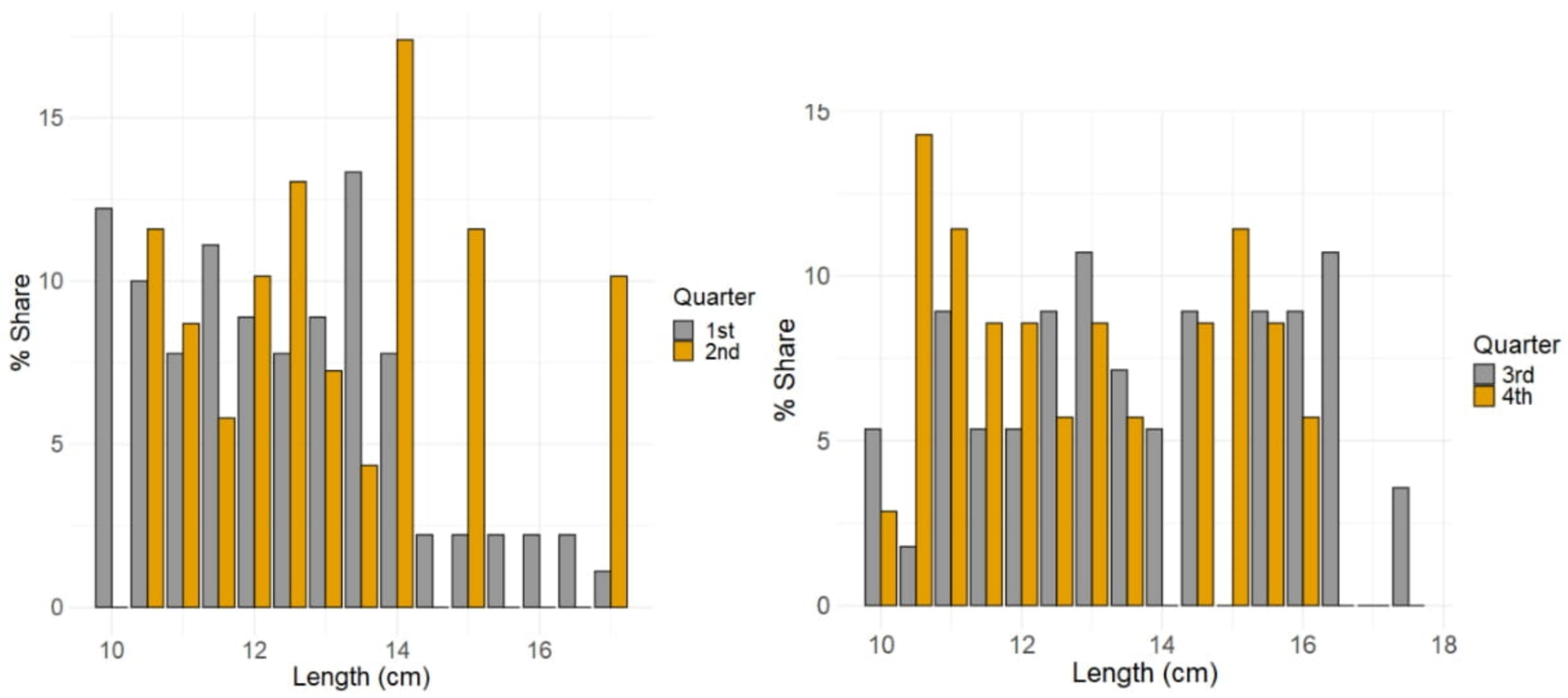


Figure III.3.2.1 Whiting length frequency from landings.

III.3.3 Age structure of landings

The three readers determined the age of whiting otoliths, and reader 1 read all otoliths twice. **250 specimens (159 specimens in the first and 91 specimens in the second quarter) were used for age determination.** The age structure of the whiting is represented by 4 age classes- 1,2,3 and 4 years old (**Figures III.3.3.1**).

In the first quarter, the highest percentage share – 45.55% is occupied by individuals in the age group 1-1+, followed by 2-2+ (41.11%). With the lowest share – about 3.33% are the age

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groups 4-4+. The second quarter shows that the age groups 1-1+ and 2-2+ have the highest share – 30.43% and 44.93% and significantly prevail over the others. Below 3% are the age group 4-4+ (2.89%). In the second quarter of 2024, 3-3+ year-old individuals reach 21.74%. The graph shows a smooth increase in whiting catch values (%) for both quarters, with the age group 4+ having the lowest possible catch values, and 2+ and 3+ having the highest percentage performance in catches in the third quarter and 1+ and 2+ for the fourth quarter respectively.

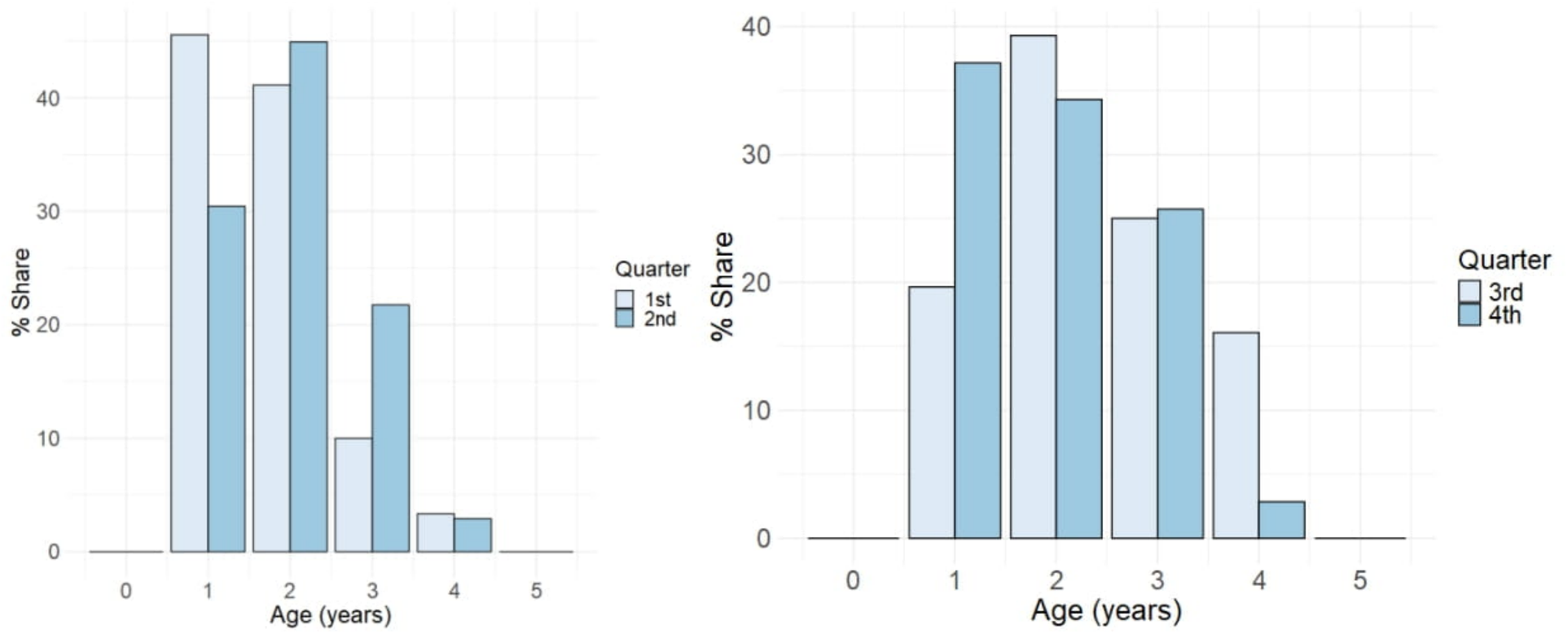


Figure III.3.3.1 Age distribution of whiting.

During the first semester results of analytical age slicing methods – similar to the analysis of the age structure of the sprat, the analyzes were made in the R programming environment (Program Language for Statistical Modeling and Analysis) using the ELEFAN functions (ELectronic LEngth Frequency Analysis). and the growth and other biological parameters of the studied species were evaluated based on the measured lengths of individuals of different age groups. The samples are restructured for the purposes of the analysis in order to track the evolution of the cohorts over time (**Fig. III.3.3.2** - the first frequency diagram shows the size structure of the collected specimens in the corresponding months, and the second - the restructured data with a moving average MA = 7).

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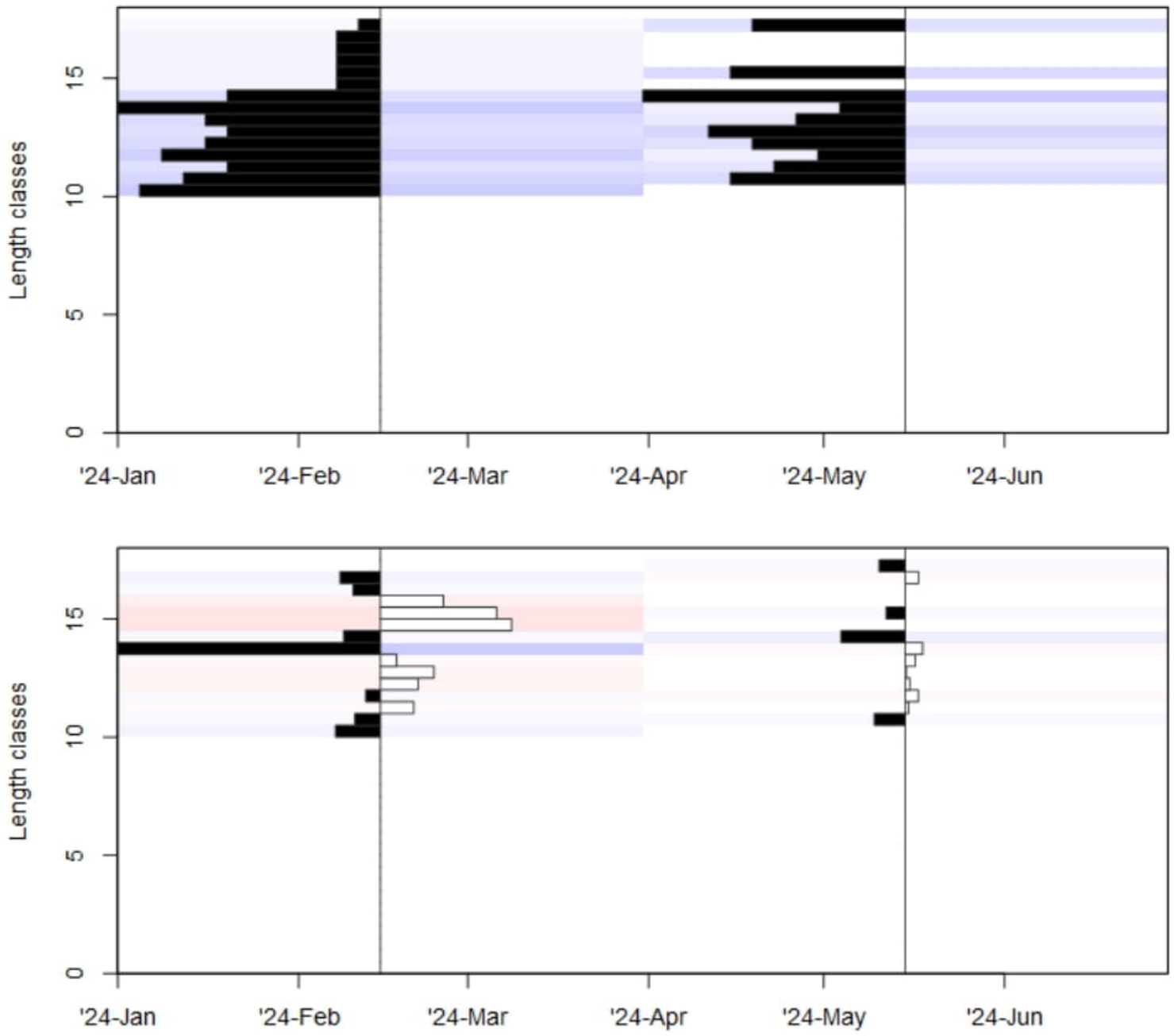


Fig. III.3.3.2 Size-frequency samples visualized as (diagram above) number of individuals in a size class and (diagram below) restructured data with a moving average MA = 7 for the purposes of frequency analysis and determination of growth parameters.

In the second semester, results of the methods for analytical determination of age (Age slicing) - analogous to the analysis of the age structure of the whiting, the analyses were performed in the R programming environment (Programming Language for Statistical Modeling and Analysis) using the ELEFAN functions (ELectronic LEngth Frequency Analysis) and the growth and other biological parameters of the studied species were estimated based on measured lengths of individuals from different age groups. The samples were restructured for the purposes of the analysis in order to track the evolution of the cohorts over time (**Fig. III.3.3.3** - the first frequency diagram shows the size structure of the collected specimens in the corresponding months, and the second - the restructured data with a moving average MA = 5).

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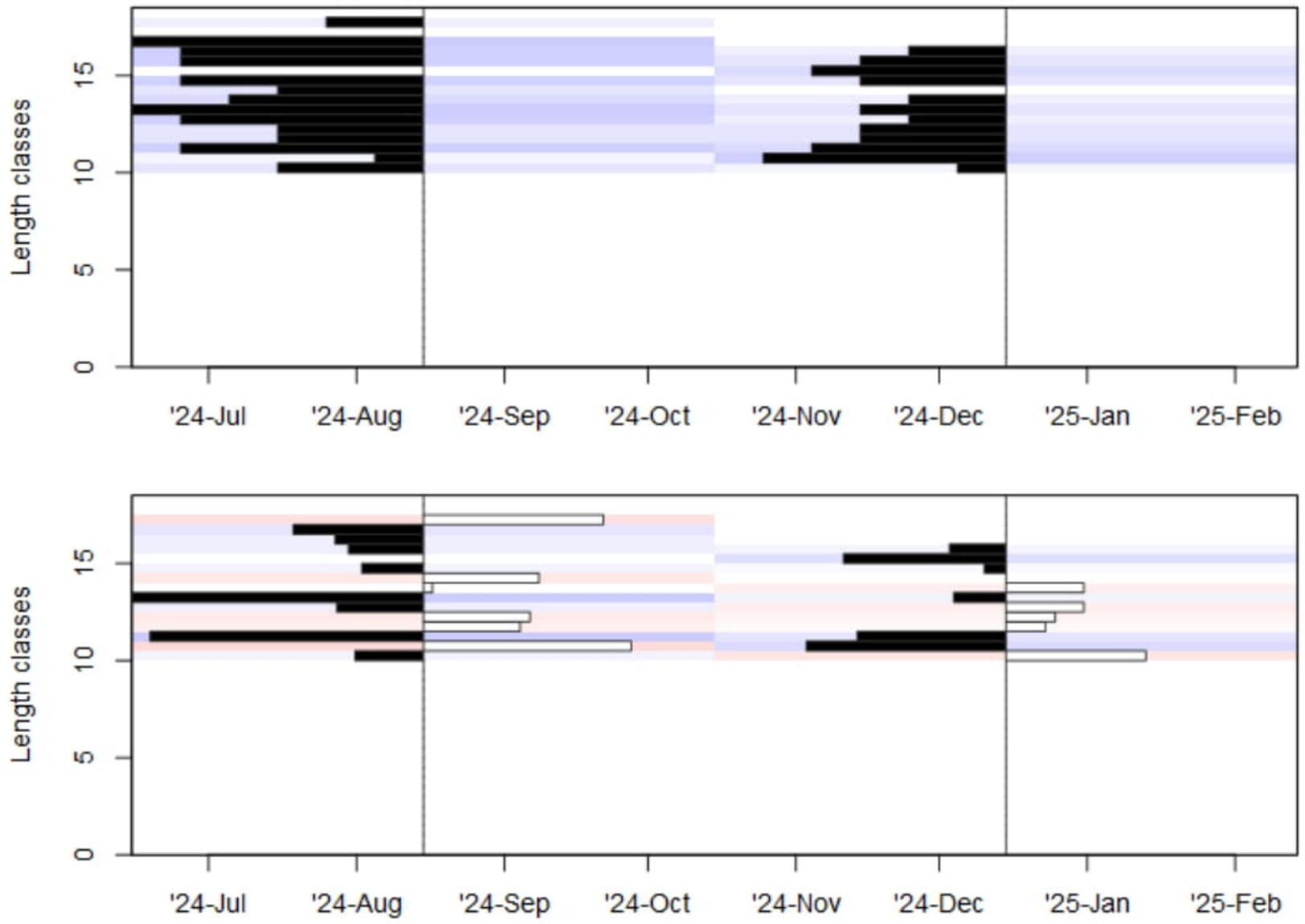


Fig. III.3.3.3 Size-frequency samples, visualized as (top diagram) number of individuals in a size class and (bottom diagram) the restructured data with a moving average MA = 5 for the purposes of frequency analysis and determination of growth parameters.

III.1.3.3.1 Frequency analysis RSA – response surface analysis

Growth parameters determined by RSA with initial conditions: conditional interval of for the asymptotic length L_∞ in the sample [17;22 cm] (based on a literature review of the characteristics and biological potentials of the species for the Black Sea) and the parameter that determines the growth rate to L_∞ - $K = \exp(seq(from\ log(0.1), to\ \log(1)$with an upper limit for L_∞ = 22 cm. The parameters in the von Bertalanffy model are calculated as follows: **L_∞=19.68 cm; K = 0.23 and t_0=-0.11**. The ages with their corresponding lengths were calculated from the latter, as the calculated values do not correspond to the characteristics of the species and the experimentally determined ages, probably due to an

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incorrectly identified coefficient of the growth rate to the asymptotic length, and for this reason they were not taken into account in the analysis of the growth parameters.
All samples for 2024 were used for the frequency analysis, as using samples for only the second semester yielded unreliable results when calculating the average age groups due to insufficient sample size.

Growth parameters determined by RSA with initial conditions: conditional interval of for the asymptotic length L_∞ in the sample [17;25 cm] (based on a literature review of the characteristics and biological potentials of the species for the Black Sea) and the parameter that determines the growth rate to to L_∞ - $K = \exp(seq(from\ log(0.1), to\ \log(1)$ with an upper limit for L_∞ = 25 cm. The parameters in the von Bertalanffy model were calculated as follows: **L_∞=19.00 cm; K = 0.29 and t_0=-0.52**. The ages with their corresponding lengths were calculated using the latter (**Table III.1.3.3.3.2, Figure III.1.3.3.3.3**).

III.1.3.3.2 Frequency analysis ELEFAN with simulated annealing (ELEFAN SA)

The growth parameters determined under initial conditions: a conditional interval for the asymptotic length $[\![L_\infty]\!]_{guess}$=18.68 cm and a search for the value of L_∞ in the interval [$L_{(\infty guess}$)*0.8 ÷$L_{(\infty guess}$)*1.2], and for K in the interval [0÷1]. The parameters in the von Bertalanffy model were calculated as follows: **L_∞=22.36 cm; K = 0.4 and t_0=-0.25**. The heights with their corresponding lengths were calculated using the latter (**Table III.1.3.3.3.1, Figure III.1.3.3.3.1**).

In the second semester, the growth parameters determined under initial conditions: a conditional interval for the asymptotic length [[L_∞]] guess=18.25 cm and a search for the value of L_∞ in the interval [L(∞guess)*0.8 ÷L(∞guess)*1.2], and for K in the interval [0÷1]. The parameters in the von Bertalanffy model were calculated as follows: **L_∞=17.83 cm; K = 0.33 and t_0=-0.56.** The heights with their corresponding lengths were calculated using the latter (**Table III.1.3.3.3.2, Figure III.1.3.3.3.3**).

III.1.3.3.3 Frequency analysis ELEFAN – Genetic algorithm (ELEFAN GA)

The growth parameters determined under initial conditions: a conditional interval of for the asymptotic length $[\![L_\infty]\!]_{guess}$=18.68 cm and a search for the value of L_∞ in the interval [$L_{(\infty guess}$)*0.8 ÷$L_{(\infty guess}$)*1.2], and for K in the interval [0÷1]. The parameters in the von

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Bertalanffy model were calculated as follows: **L_∞=18.65 cm; K = 0.5 and t_0=-0.515**. The ages with their corresponding lengths were calculated using the latter (**Table III.1.3.3.3.1**, **Figure III.1.3.3.3.2**).

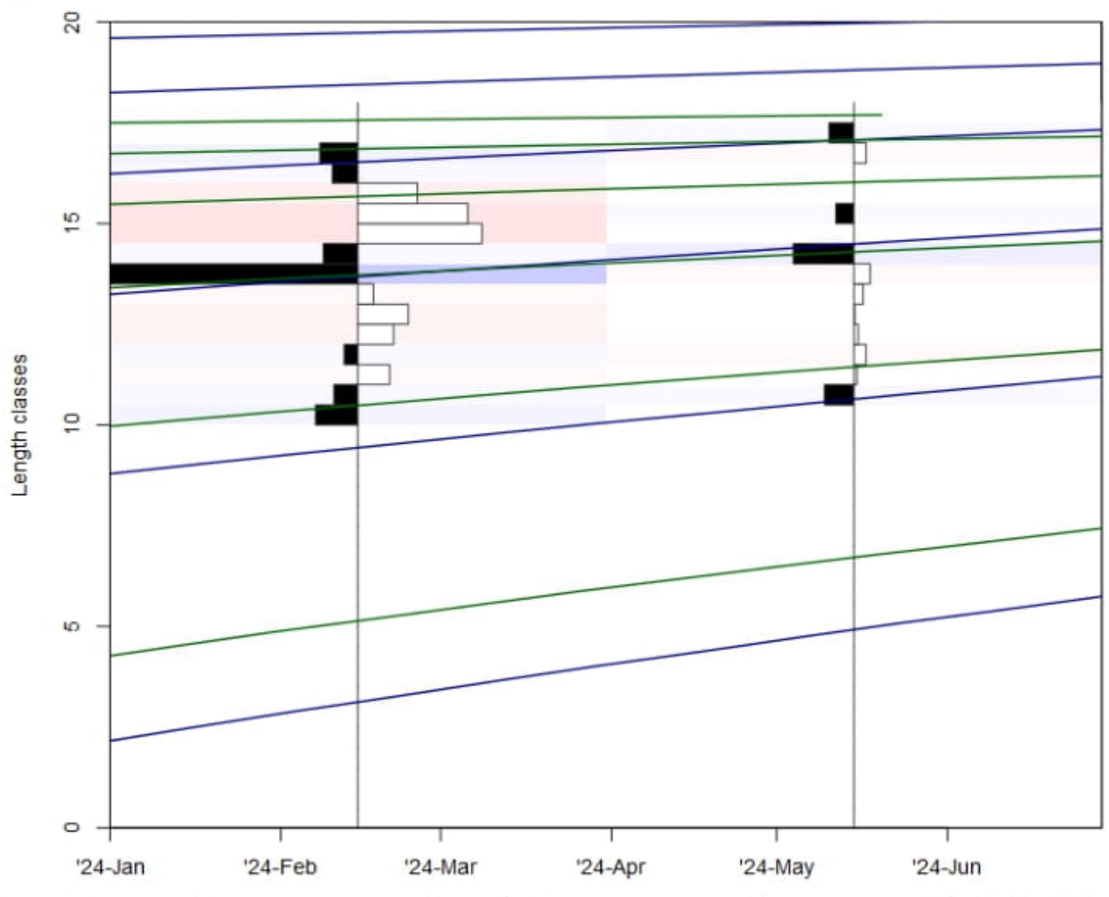


Figure III.1.3.3.3.1 Growth curves (in blue according to ELEFAN SA, and in green according to ELEFAN GA), visualized on the restructured data for the purpose of visualizing the tracking of cohorts over time.

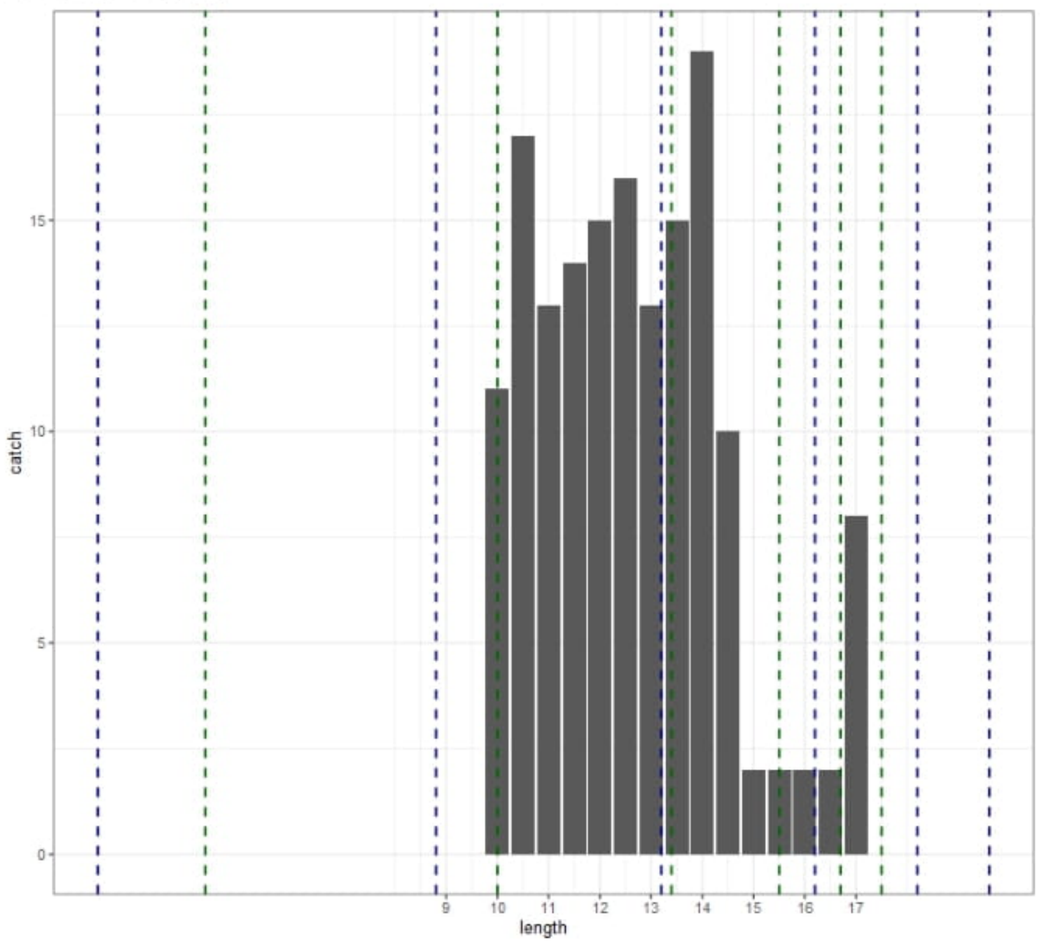


Figure III.1.3.3.3.2 The ages represented with dashed lines, calculated based on the growth parameters determined by ELEFAN SA (in blue) and ELEFAN GA (in green), are overlaid on

the cumulative sample of the composition of commercial catches of whiting, aiming to visualize the range of size classes represented in a specific age group (0-5 years) **for the first half of 2024**.

Table III.1.3.3.3.1 Ages with their corresponding lengths for the studied species calculated using von Bertalanffy parameters, obtained with RSA, ELEFAN with simulated annealing, ELEFAN with genetic algorithm and compared with experimentally determined ages from otoliths.

	ELEFAN SA	**ELEFAN GA**	**Experimentally determined**
age	La	La	L_{mean}
0	2.2	4.3	
0.5	5.8	7.5	n/a
1	8.8	10.0	11
1.5	11.2	11.9	
2	13.2	13.4	13.25
2.5	14.9	14.6	
3	16.2	15.5	15.5
3.5	17.3	16.2	
4	18.2	16.7	16.5
4.5	19.0	17.2	
5	19.6	17.5	n/a

The result from ELEFAN GA is closest to the experimentally determined ages and, accordingly, the biological potentials of horse mackerel **for the first half of 2024** are best described by the following analytically determined parameters: **L_∞=18.65 cm; K = 0.5 and t_0=-0.515.**

In the second semester, the growth parameters determined under initial conditions: a conditional interval of for the asymptotic length $[\![L_\infty]\!]$ guess=18.25 cm and a search for the value of L_∞ in the interval [$L(_\infty$guess)*0.8 ÷$L(_\infty$guess)*1.2], and for K in the interval [0÷1]. The parameters in the von Bertalanffy model were calculated as follows: **L_∞=17.97 cm; K = 0.32 and t_0=-0.57**. The heights with their corresponding lengths were calculated using the latter (**Table III.1.3.3.3.2, Figure III.1.3.3.3.2**).

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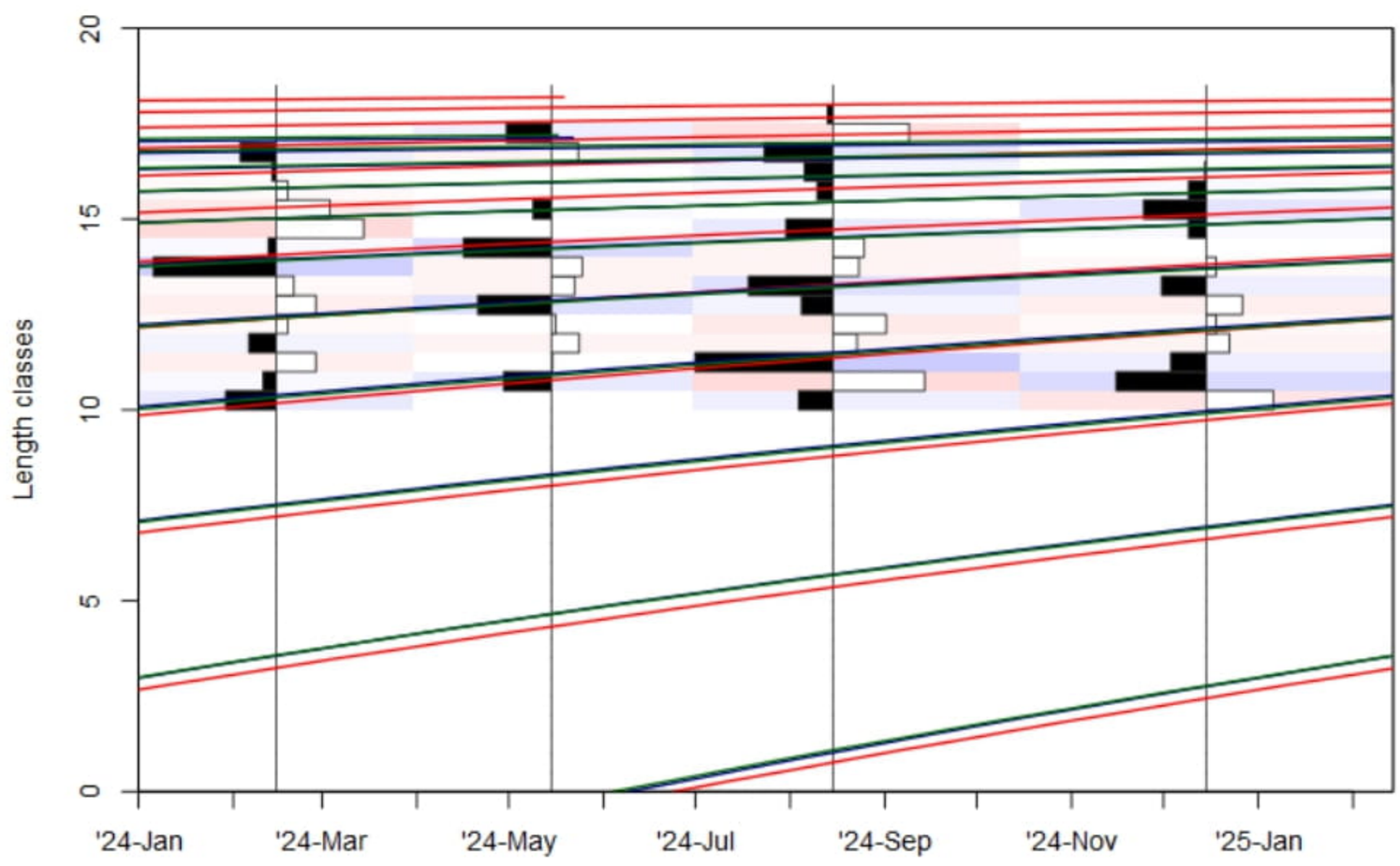


Figure III.1.3.3.3.2 Growth curves (in red according to ELEFAN RSA, blue according to ELEFAN SA and green according to ELEFAN GA), visualized on the restructured data for the purpose of visualizing the tracking of cohorts over time.

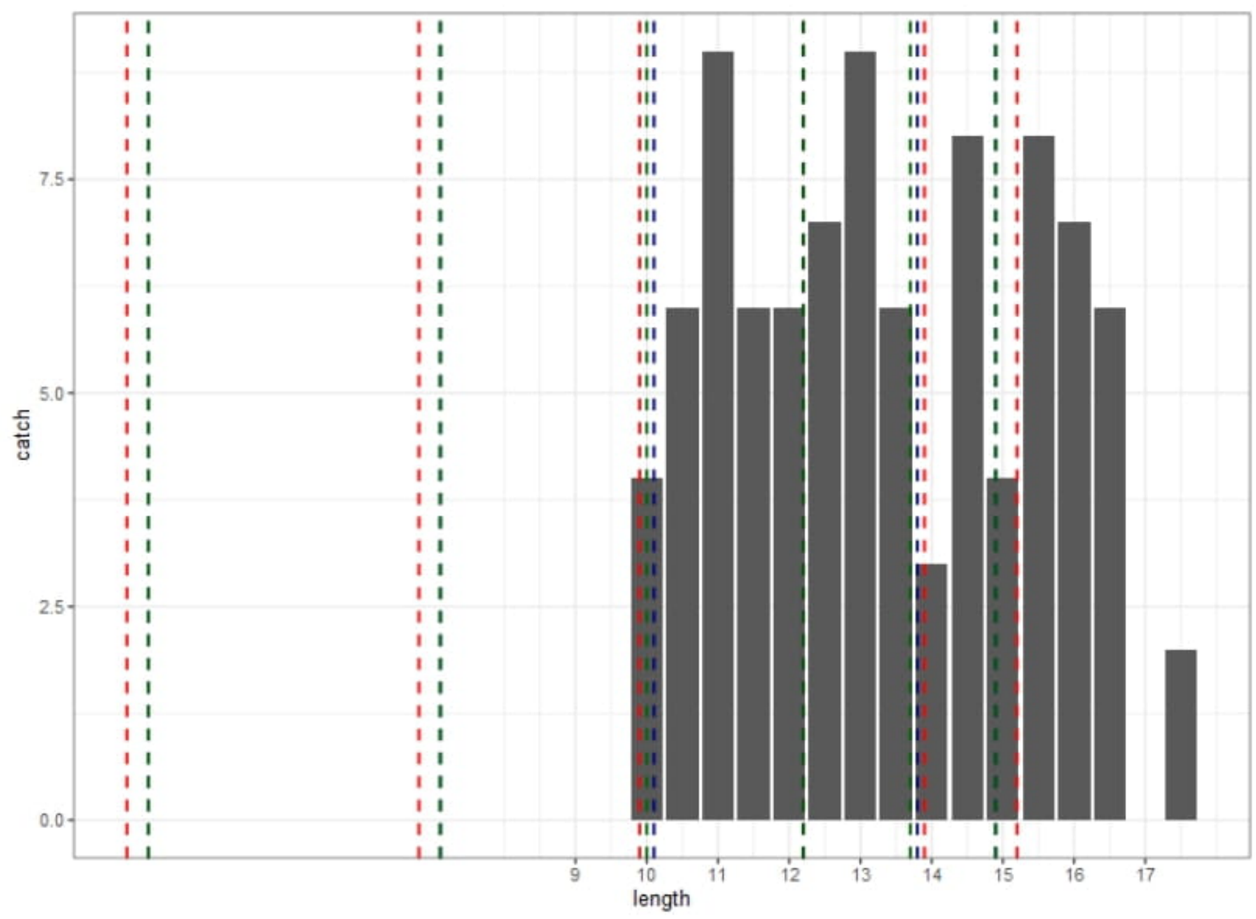


Figure III.1.3.3.3.3 The ages represented by the dotted line, calculated from the growth parameters determined with ELEFAN RSA (in red), ELEFAN RSA (in blue) and ELEFAN

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GA (in green) superimposed on the cumulative sample of the composition of the commercial whiting catches to visualize the range of size classes represented in a specific age group (0-5 years) for the second semester of 2024.

Table III.1.3.3.3.2 Ages with their corresponding lengths for the studied species calculated using von Bertalanffy parameters, obtained with RSA, ELEFAN with simulated annealing, ELEFAN with genetic algorithm and compared with experimentally determined ages from otoliths.

	ELEFAN RSA	**ELEFAN SA**	**ELEFAN GA**	**Experimentally determined**
age	La	La	La	$L_{средно}$
0	2.7	3.0	3.0	
0.5	4.9	5.2	5.2	n/a
1	6.8	7.1	7.1	n/a
1.5	8.4	8.7	8.7	
2	9.9	10.1	10.0	11
2.5	11.1	11.2	11.2	
3	12.2	12.2	12.2	13.25
3.5	13.1	13.1	13.0	
4	13.9	13.8	13.7	15.25
4.5	14.6	14.4	14.4	
5	15.2	14.9	14.9	16.67

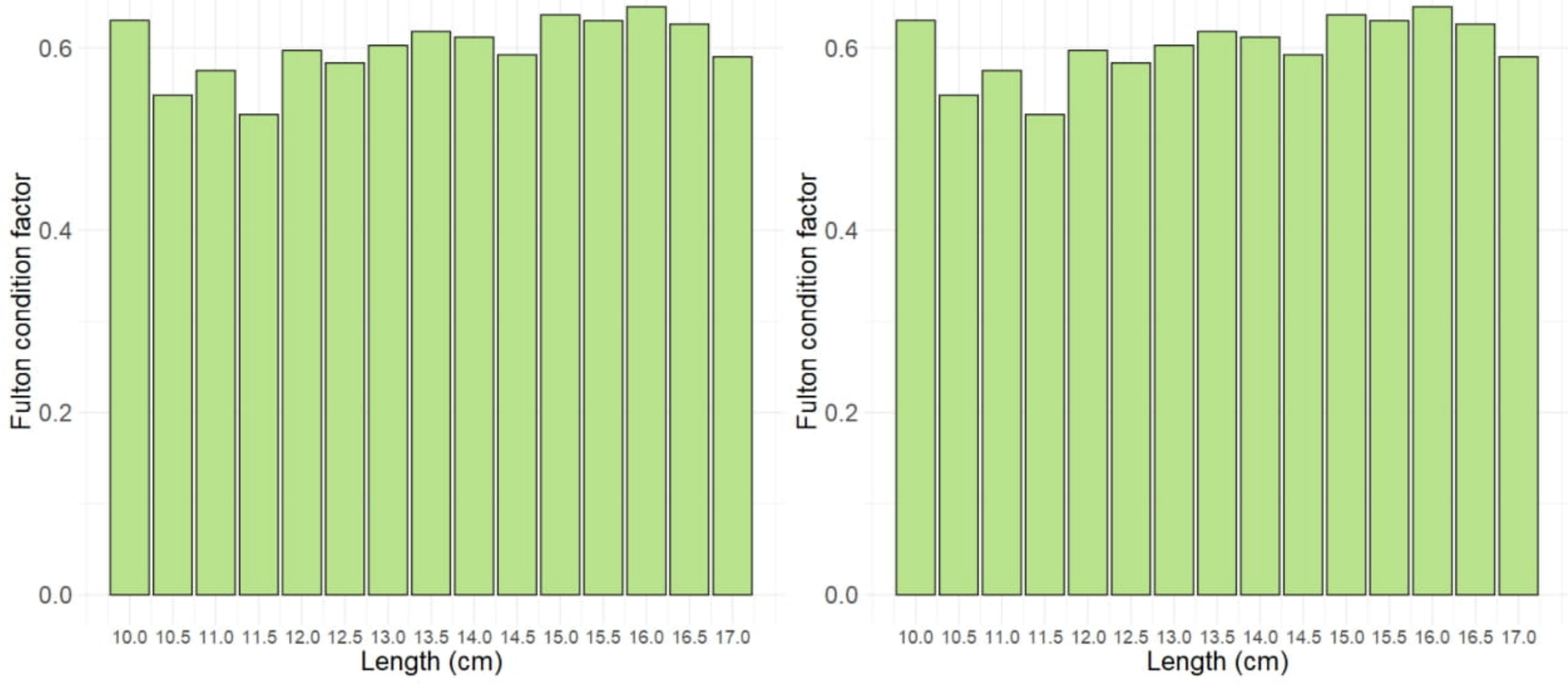
The result from ELEFAN SA is closest to the experimentally determined ages and, accordingly, the biological potentials of whiting for the second half of 2024 are best described by the following analytically determined parameters: L_∞**=17.83 cm; K = 0.33 and** t_0**=-0.56**, which should be refined on an annual basis.

III.3.4 Condition factor

The graph shows that during the first and second semester Fulton's condition factor is highest for the 10.0 cm size class and for 4 year old specimens (**Fig.III.3.4.1-2**). For the others it is approximately similar, varying in different values between 0.50 to 0.67.

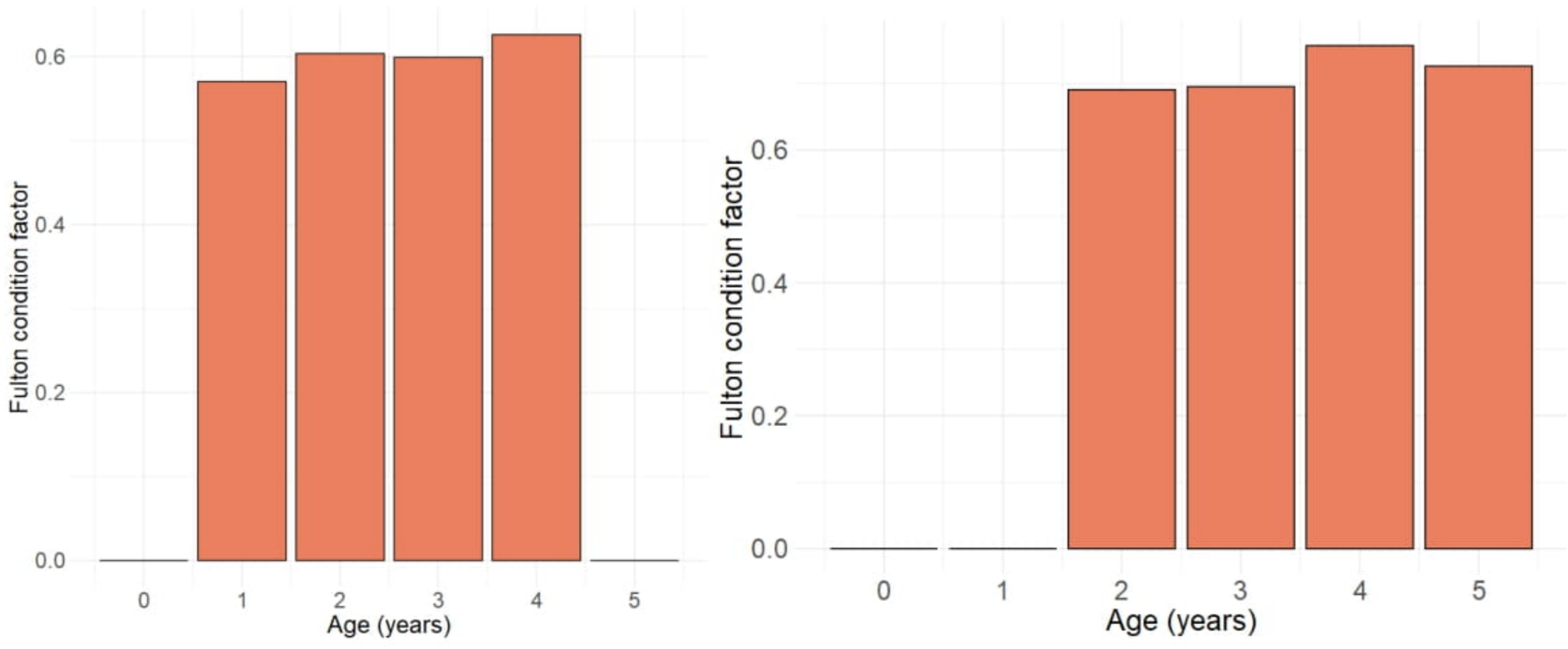
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a **b**

Figure III.3.4.1 Condition factor by size classes of whiting for the first(a) and second (b) semester of 2024.



a **b**

Figure III.3.4.2 Condition factor by age group of whiting for the first(a) and second (b) semester of 2024.

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III.3.5 Weight structure of whiting

The weight was measured on **250 specimens (159 specimens in the first and 91 specimens in the second quarter)**. In terms of weight, the largest age groups 3-3 + and 4-4 + year-old individuals have the largest contribution (highest average weights on average) to the catch **(Fig. III.3.5.1**). The graph shows the distribution of the average weight of whiting by age groups for two quarters. A gradual increase in the average weight is observed in relation to the age groups for both quarters. For age group 1-1+ the lowest average weight is -7.59g (63 number of whiting), and for group 4-4+ the highest average weight is observed -28.13g (4 number of whiting). For the remaining age groups the weights are as follows: 2-2+-14.04g (71 number); 3-3+-22.31g (21 number).

In the second half of the year, the average weight for the age group 2-2+ was the lowest - 9.19g (26.37%), and for the group 5-5+ the highest average weight was observed - 32.33g (8.79% whiting). For the other age groups, the weights were as follows: 3-3+ - 16.17g (37.36%); 4-4+ - 24.70g (27.47%) and 5-5+ - 32.33g (8.79%).

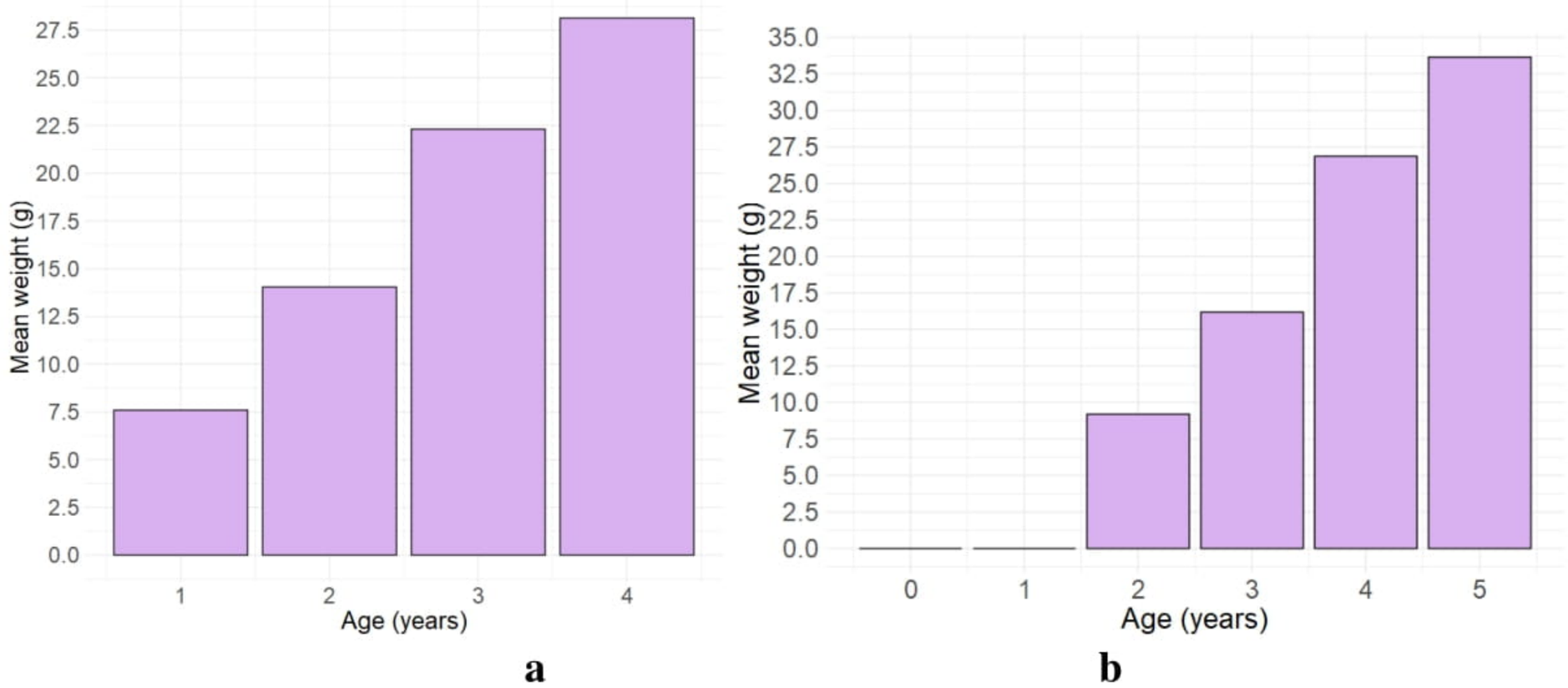


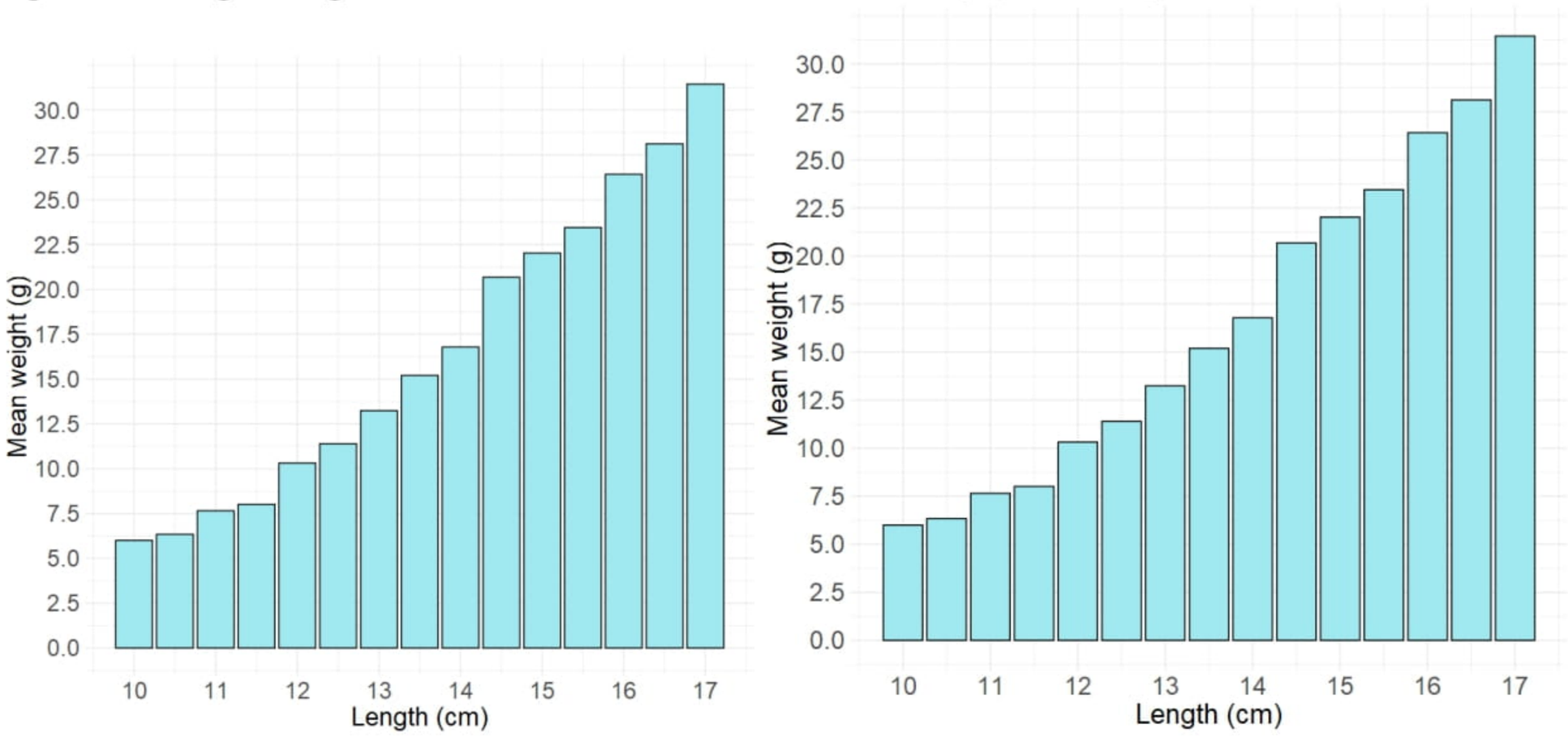
Fig. III. 3.5.1 Weight by age group for the first(a) and second (b) semester of 2024.

The most common size group -14cm represents 11.95% and has a measured average weight of 16.78g. The largest average weight is measured at 17cm-28.99g (8 number).

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During the second semester, the most widely distributed size group - 11cm and 13cm - represented 9.89% and had an average weight of 9.768 g and 16.57 g, respectively. The highest average weight was measured at 17.5 cm - 38.88 g (2 whiting).



a **b**

Fig. III. 3.5.2 Weight by size classes for the firs(a)t and second (b)semester of 2024.

III.3.6 Size structure of whiting by age group

The length of the fish was measured **on 250 individuals (159 individuals in the first and 91 individuals in the second quarter).**The length of the fish was measured on 159 specimens. No large fluctuations were registered in the considered period of 2024 in relation to the average lengths by age for 2024 (**Table IV.3.6.1**).

Table III.3.6.1 Mean size of the whiting by age groups.

I-VI		VII-XII	
Age	L_{mean}/cm	Age	Lcp/cm
1-1+	10,95		
2-2+	13,22	2-2+	12,96
3-3+	15,33	3-3+	15,24
4-4+	16,63	4-4+	16,50
5-5+		5-5+	17,20

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III.3.7 Length- weight relationship

The resulting model (**Table III.3.7.1**) is statistically significant, the value of the scaling coefficient a in the length-weight relationship model $W_i = aL_i^b$ e: $a = 0.003$, and of the allometry coefficient b=3.17, which indicates a positive allometric growth of the species in the first half of the year, or the increase in weight is proportional to or greater than the increase in length.

Table III.3.7.1 Results of modeling the length L-weight W relationship.

```
Call:
Lm (formula = logW ~ logL, data = weight_l)

Residuals:
     Min       1Q   Median       3Q      Max
-0.104004 -0.022177  0.008837  0.024567  0.099281

Coefficients:
            Estimate Std. Error t value           Pr(>|t|)
(Intercept) -5.57007    0.20517  -27.15 0.0000000000007807 ***
logL         3.17527    0.07907   40.16 0.0000000000000051 ***

Signif. Codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.04991 on 13 degrees of freedom
Multiple R-squared:  0.992,          Adjusted R-squared:  0.9914
F-statistic:  1613 on 1 and 13 DF,  p-value: 0.000000000000005097
```

III.3.8 Sex structure

The sex ratio was determined on **100 specimens** (**50 specimens** in the first and **50 specimensin** the second half of 2024) . Females ♀ predominated over males ♂ in the first half of 2024, and males predominated in the second half of 2024. (**Figure III3.8.2**).

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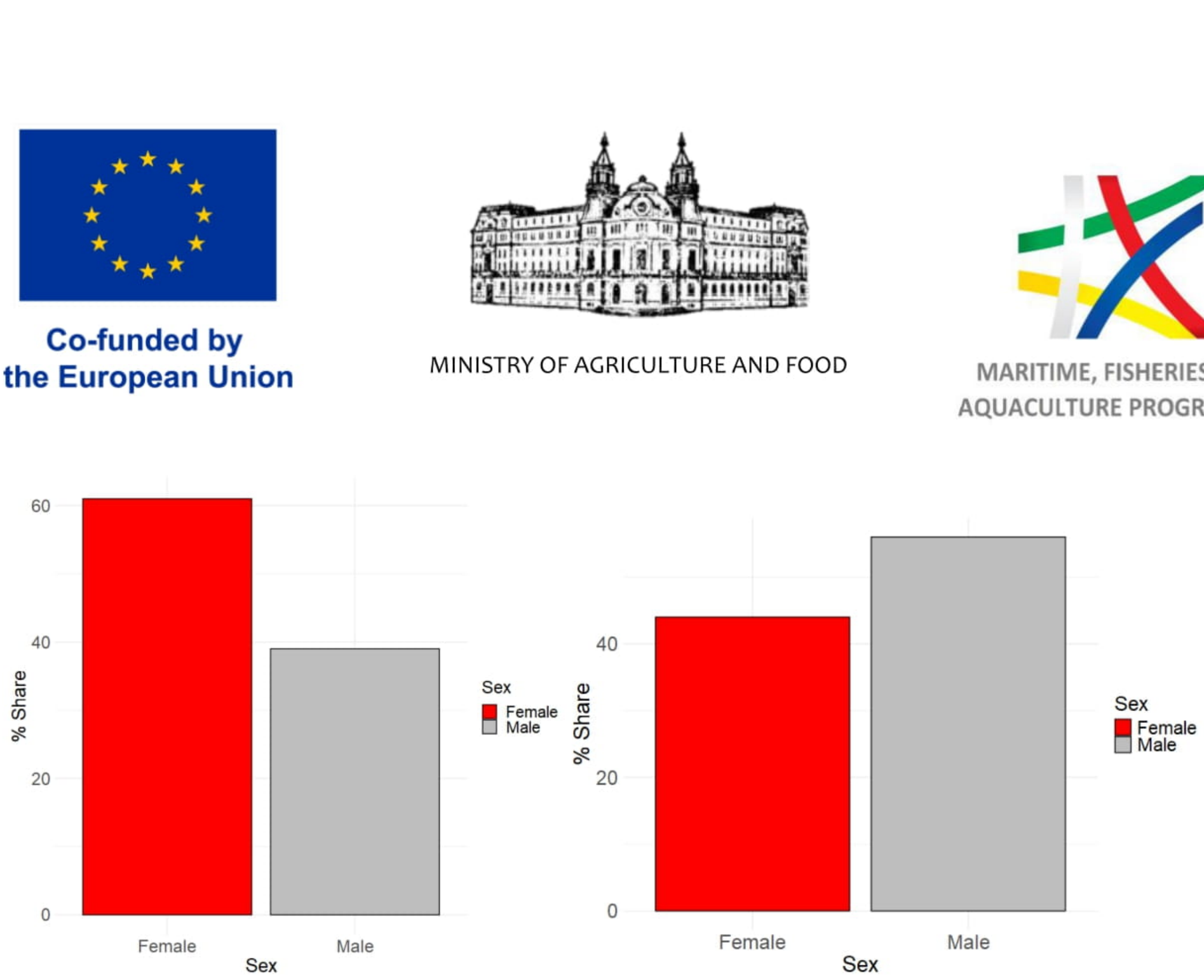


Figure III.3.8.1 Percentage ratio between the sexes of whiting.

The average lengths of females♀ by age group are higher (**Figure 3.8.2**).

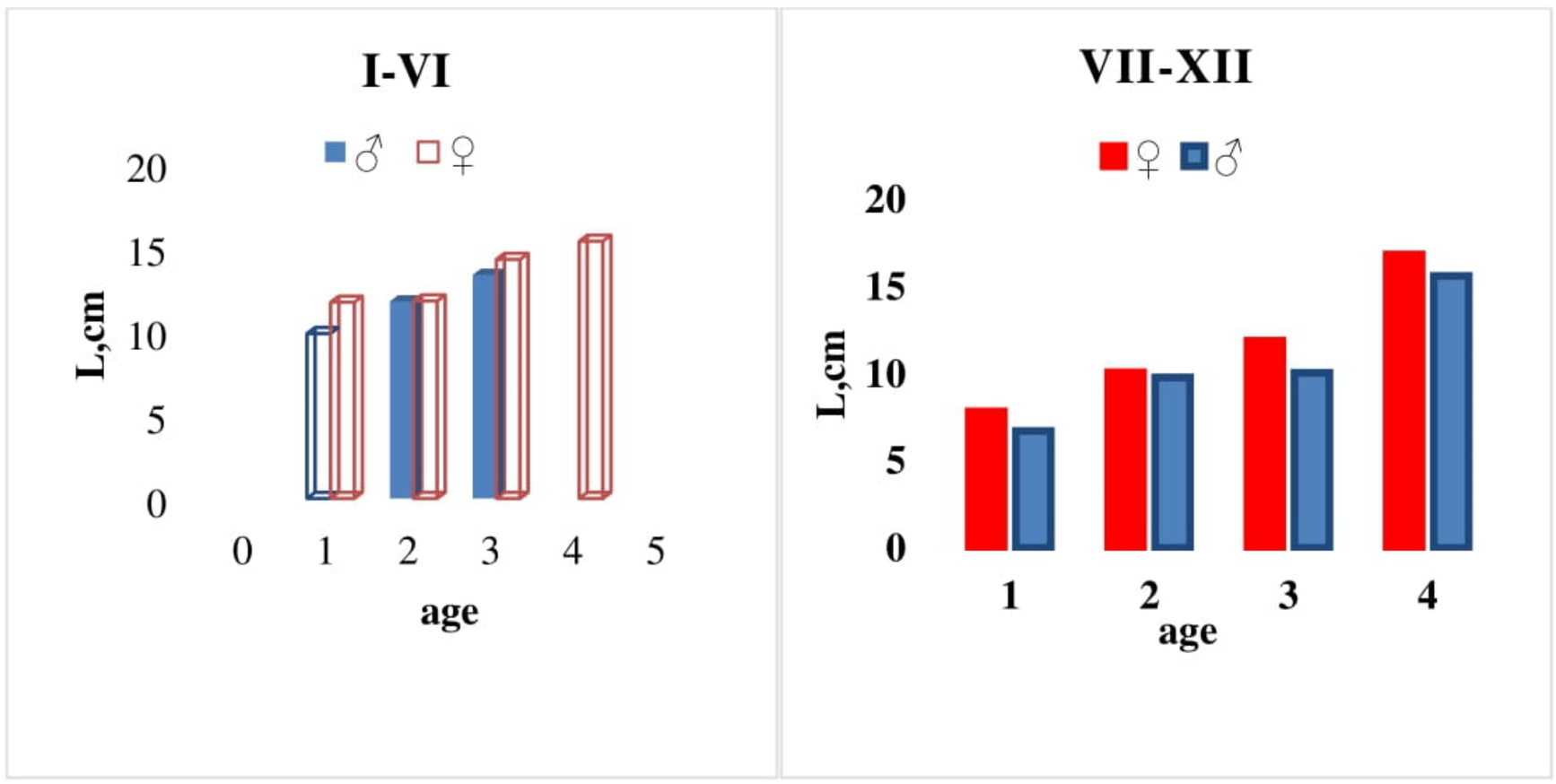


Figure III. 3.8.2 Sex ratio (♂♀) by size and age of whiting.

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III.3.9 Fertility

Fertility was determined on **100 specimens**. The gonad-somatic index is strongly dependent on the weight of the gonads (R^2=0.8145 in the first semester and R^2=0.997 in the second semester), which is associated with the high rate of maturation of females in late spring and the reproductive process of whiting (Figure III3.9.1).

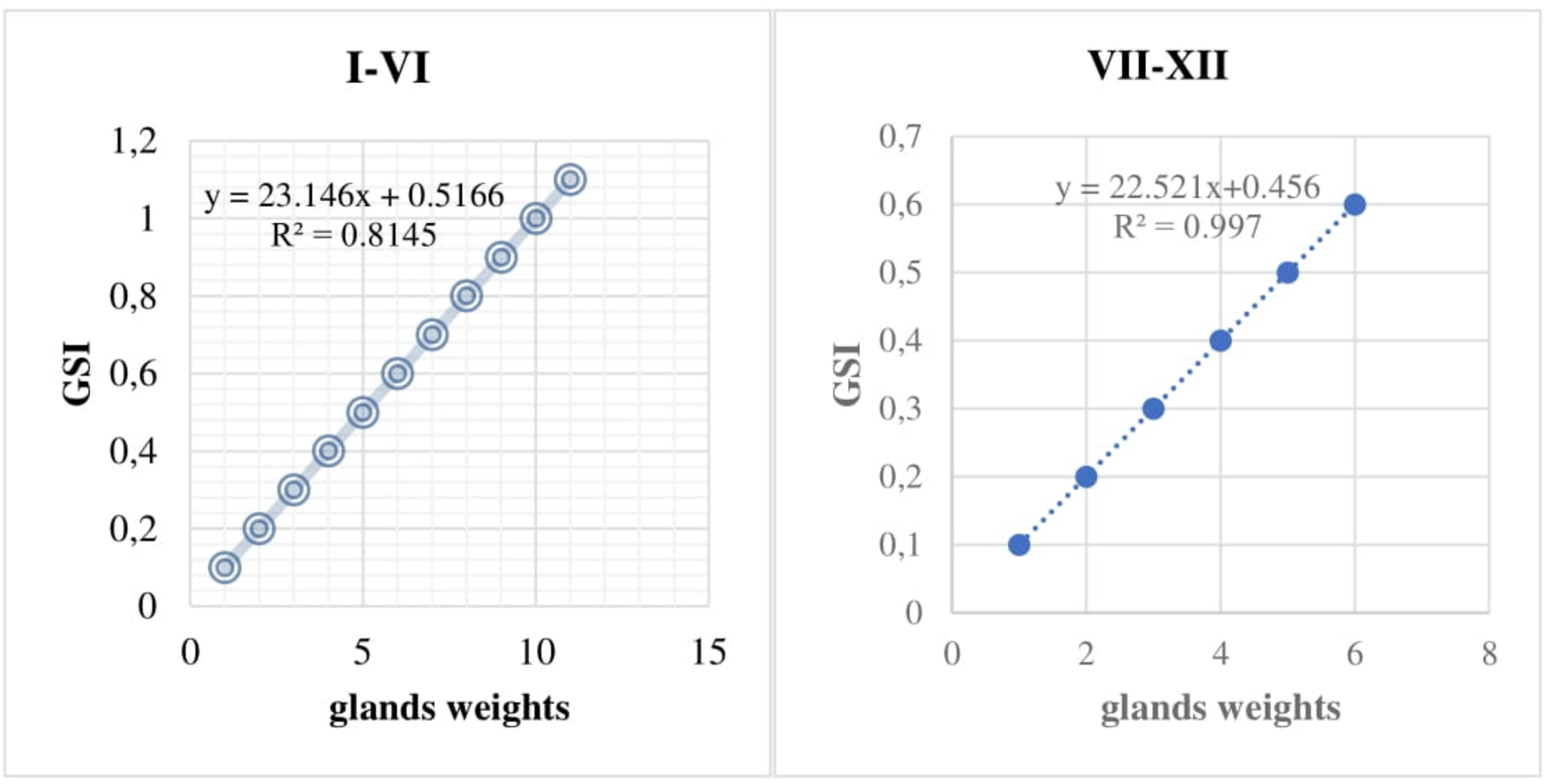


Figure III.3.9.1 Glandule weight (g) vs.GSI for whiting.

Portion fecundity (Log F) vs GSI (Log GSI) show a very strong relationship (R^2=0.9210 and R^2=0.8795), which proves a very strong dependence of fecundity on GSI of whiting.

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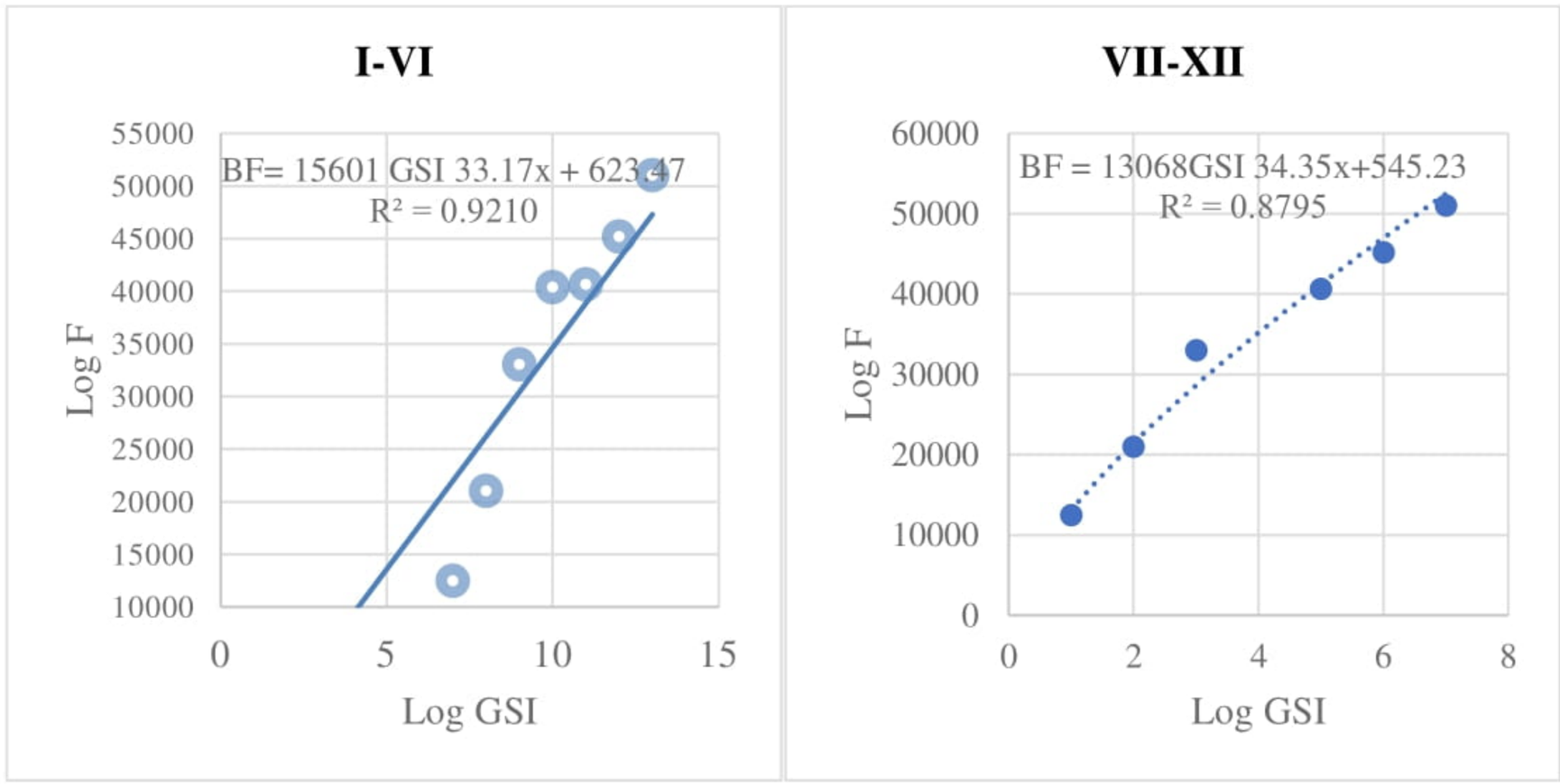


Figure III.3.9.2 Log relationship between portion fecundity and GSI of whiting.

Absolute fertility increases with increasing length, mass and age. The average weighted relative fertility is 1680,206 for the first semester and 2105,42 for the second semester (**Table III3.9.1**).

Table III.3.9.1 Absolute and relative fertility.

I-VI					VII-XII				
Size class	**W average, g**	**Absolute fertility F, caviar grains)**	**Relative fertility**	**N♀**	**Size class**	**W average, g**	**Absolute fertility F, caviar grains)**	**Relative fertility**	**N♀**
10	6, 47	8400	1298,3	5	**10**	6,86	3420,00	498,34	6
10,5	7, 12	8512	1195,506	5	**10,5**	8,04	2812,00	349,95	5
11	8,057	9835	1220,678	4	**11**	9,68	3002,00	309,99	3
11,5	10,18	11706	1149,902	5	**11,5**	11,40	2001,00	175,46	5
12	11, 38	14800	1300,527	5	**12**	11,83	1080,00	91,30	2
12,5	13, 23	28120	2125,472	6	**12,5**	13,27	2082,00	156,90	7
13	15,27	36035	2359,856	5	**13**	16,57	1212,00	73,14	5
13,5	16, 36	44200	2701,711	5	**13,5**	18,28	2112,00	115,56	4
14	18,12	56834	3136,534	5	**14**	19,48	2321,00	119,17	3
14,5	21,44	6723	313,5728	5	**14,5**	22,35	3311,00	148,13	8
15					**15**	30,08	2030,00	67,48	2
		22516,5	1680,206	50			25383,00	2105,42	50

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III.3.10 Sexual maturity

Sexual maturity was determined on **100 specimens**. During this period it is actively used in sexual products, with 100% of the degree of maturity being IV-VI.

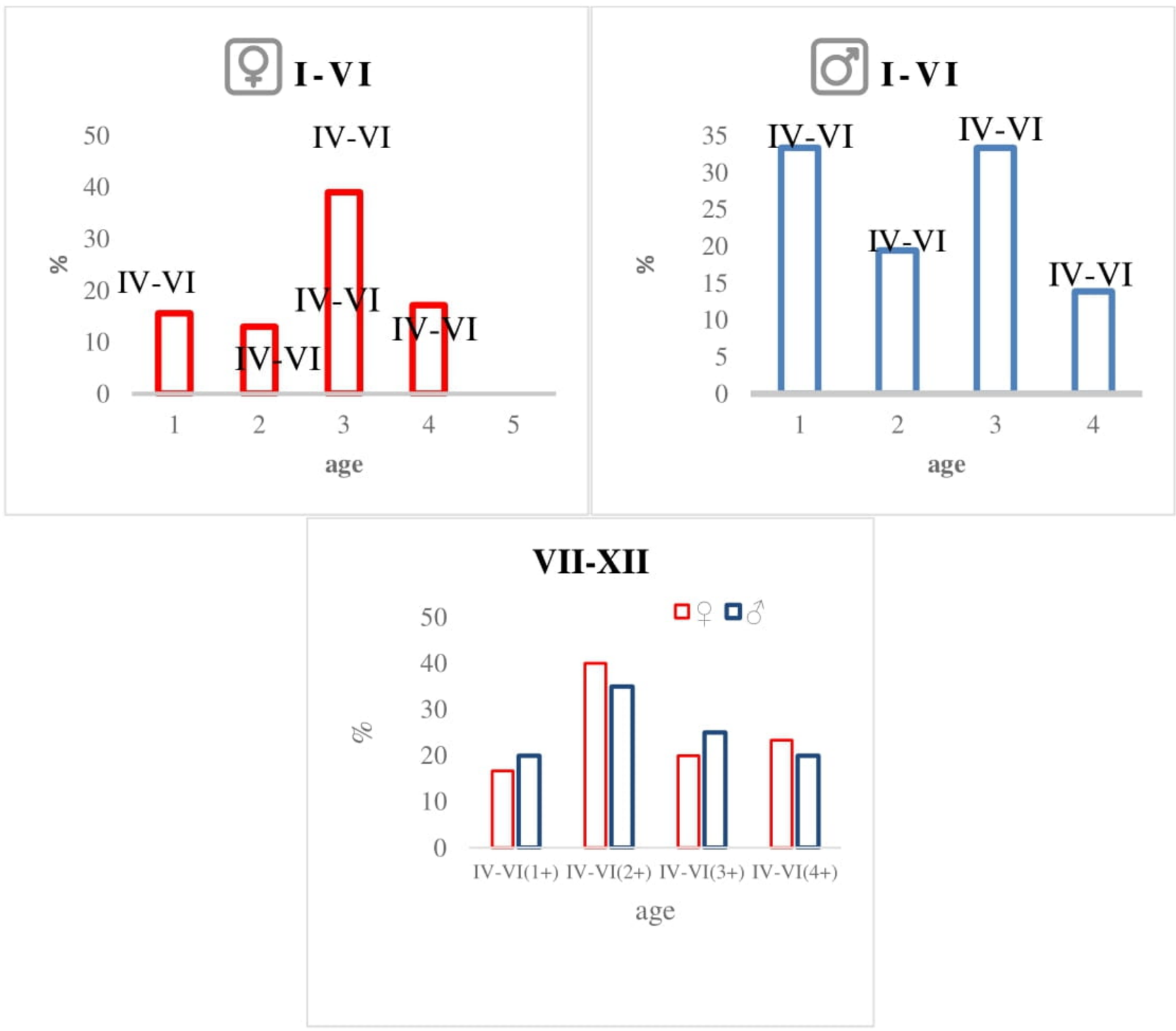


Figure III.3.10.1 Sexual maturity by age of **whiting** - female♀ and male ♂.

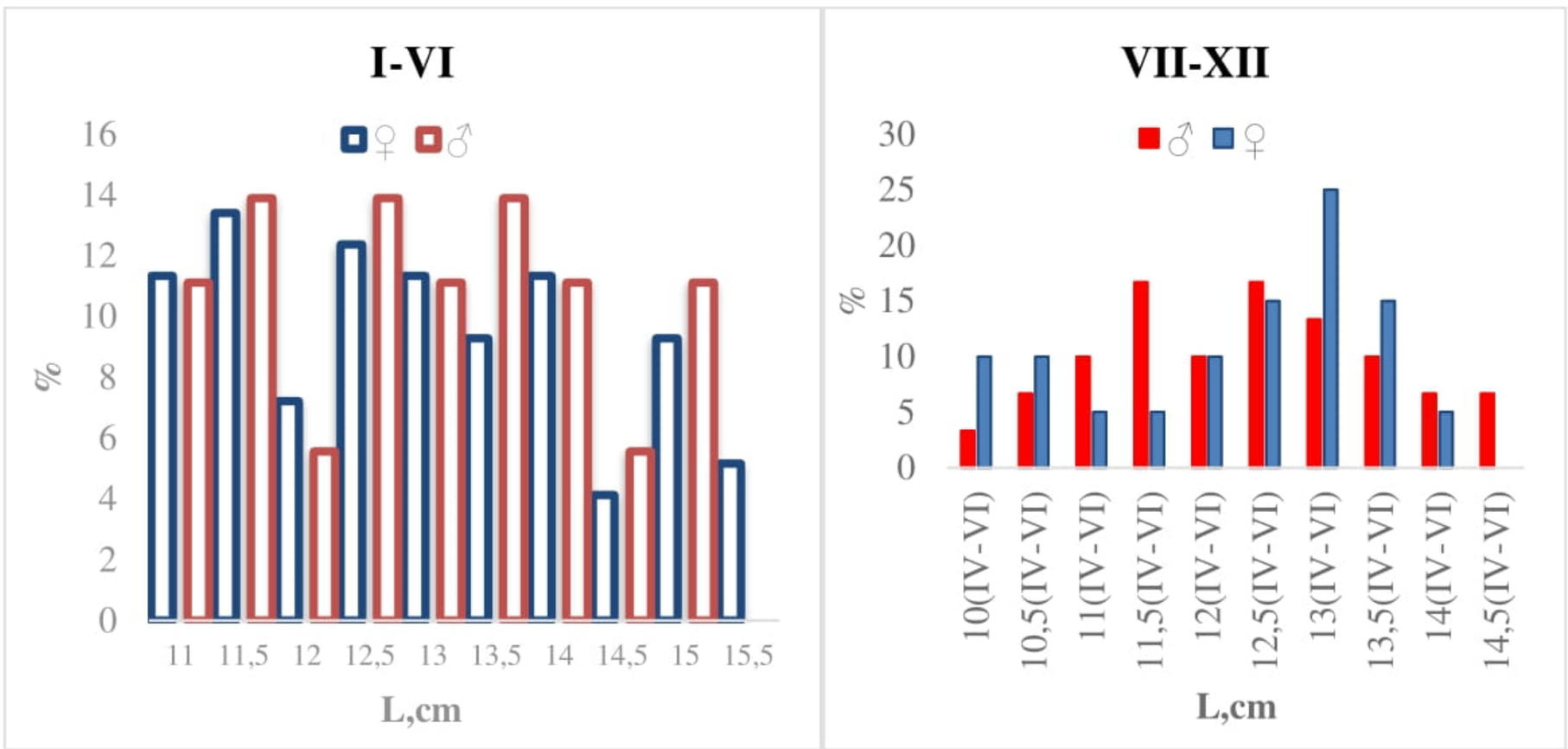


Figure III.3.10.2 Sexual maturity along the length (cm) of whiting - female ♀ and male ♂.

III.3.11 Catch numbers and biomass by age and length

Monthly OTM catches (in kilograms) together with average weights were used to obtain the abundance and biomass of the species by quarter in the reported catches (**Table III.3.11.1-2**).

Table III.3.11.1 Catch at age (10^{-6}) matrix and biomass (kg) of whiting with OTM.

Catch at age				
Age groups	***Ith quarter***	***IInd quarter***	***III rd quarter***	***IVthquarter***
1-1+	179.16	143.80		
2-2+	225.22	180.78	221.07	128.807
3-3+	142.29	114.21	178.09	103.761
4-4+	97.57	78.31	85.73	49.948
5-5+	23.28	18.69	20.96	12.211
∑	667.51	535.78	505.85	294.727
Biomass(kg)				
Age groups	***Ith quarter***	***IInd quarter***	***III rd quarter***	***IVthquarter***
1-1+	1403.86	1126.81		

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2-2+	2275.21	1826.20	2032.88	1184.440
3-3+	1694.31	1359.94	2879.91	1677.956
4-4+	1645.90	1321.08	2117.58	1233.791
5-5+	677.72	543.97	677.63	394.813
∑	7697	6178	7708.00	4491

Table III.3.11.2 Number of individuals ($x10^{-6}$) in the catch by size class (for OTM) and biomass of the of the whiting.

Catch in numbers*10^{-6} 2024				
Length group (cm)	***Ith quarter***	***IInd quarter***	***III rd quarter***	***IVthquarter***
10	88.75	71.23	49.37	28.765
10,5	129.75	104.14	63.25	36.851
11	82.22	66.00	78.72	45.865
11,5	82.32	66.07	44.56	25.965
12	63.60	51.04	39.62	23.082
12,5	53.44	42.89	41.55	24.209
13	38.75	31.10	46.00	26.804
13,5	39.90	32.02	27.78	16.184
14	44.25	35.52	13.03	7.593
14,5	19.62	15.75	30.26	17.632
15	3.85	3.09	11.32	6.596
15,5	3.53	2.83	22.52	13.120
16	3.39	2.72	18.53	10.796
16,5	3.21	2.58	14.99	8.735
17	10.92	8.77		
17,5			4.34	2.531
∑	667.51	535.78	505.85	294.727
Biomass(kg)				
Length group (cm)	***Ith quarter***	***IInd quarter***	***III rd quarter***	***IVthquarter***
10	532.50	88.75	338.81	197.407
10,5	822.95	129.75	508.22	296.110
11	629.31	82.22	762.33	444.165
11,5	677.72	82.32	508.22	296.110
12	726.13	63.60	508.22	296.110
12,5	774.54	53.44	592.92	345.462
13	629.31	38.75	762.33	444.165
13,5	726.13	39.90	508.22	296.110
14	919.77	44.25	254.11	148.055
14,5	484.09	19.62	677.63	394.813

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15	96.82	3.85	338.81	197.407
15,5	96.82	3.53	677.63	394.813
16	96.82	3.39	592.92	345.462
16,5	96.82	3.21	508.22	296.110
17	387.27	10.92		
17,5			169.41	98.703
∑	7697	667.51	7708.00	4491.000

III.3.12 Conclusions

The analysis of the biological parameters of the whiting makes it possible to draw the following **conclusions**:

1) In the first and second quarters of 2024 the length distribution follows a normal distribution with predominant classes 10.0 and 13.0 cm (I-III) and 12.5 – 14.5 cm (IV-VI). The remaining length classes are represented by lower percentages. In the third quarter, the highest values were for individuals in the size classes 13 cm and 16.5 cm, and the lowest percentage value was for the size classes of 10.5 cm. In the fourth quarter, the highest values were for individuals in the size classes of 10.5 (14.29%) cm, and the lowest percentage value was for the size classes of 10 cm (2.86%).

2) The age structure of the whiting is represented by 4 age classes- 1,2,3 and 4 years old. In the first quarter, the highest percentage share – 45.55% was occupied by individuals in the age group 1-1+, followed by 2-2+ (41.11%). The second quarter shows that the age groups of 1-1+ and 2-2+ have the highest share – 30.43% and 44.93% and significantly prevail over the others. The age group 4+ has the lowest possible catch values, while 2+ and 3+ have the highest percentage performance in catches in the third quarter and 1+ and 2+ for the fourth quarter.

3) The result from ELEFAN GA is closest to the experimentally determined ages and, accordingly, the biological potentials of horse mackerel for the first half of 2024 are best described by the following analytically determined parameters: L_{∞}=18.65 cm; K = 0.5 and t_0=-0.515.

4) Fulton's condition factor showed the highest values for the 10 cm size class and for 4-year-old specimens.

5) In terms of weight, the largest age groups 3-3 + and 4-4 + year-old individuals have the largest contribution (highest average weights on average) to the catch.

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6) No large fluctuations were registered in the considered period of 2024 in relation to the average lengths by age.

7) The resulting model is statistically significant, the value of the scaling coefficient a in the length-weight relationship model $W_i = aL_i^b$:**a=0.003,** and of the allometry coefficient **b=3.17,** which indicates a positive allometric growth of the species in the first half of the year, or the increase in weight is proportional to or greater than the increase in length.

8) The gonad-somatic index is highly dependent on the weight of the gonads (R^2=0.8145 in the first semester and R^2=0.997 for the second semester), which is related to the high rate of maturation of females in late spring and the reproductive process of whiting.

IV. Biological monitoring of red mullet (*Mullus barbatus*) landings

IV.1 Objectives

The purpose of biological monitoring is to collect data that will be used to analyze red mullet catches, as well as to form a database. The collection of biological samples of red mullet catches in **2024** includes the following tasks:

1. *To collect and analyze the dynamics of length, weight and age distribution.*
2. *To determine the state of the of red mullet using the so-called state factor (Ricker, 1975).*
3. *Characteristics of the reproductive biology of red mullet.*
4. *Collection of data on ports of landing, sampling vessels, number of samples collected, number of specimens tested, geographical catch data.*

IV.2 Sampling

The sampling was carried out by the actively operating fishing fleet in Bulgaria.

IV.2.1 Geographic area coverage

Data of present analysis were collected from landing ports of Bulgarian Black Sea coast. **In 2024**, **6 samples of red mullet containing 505 specimens** were collected. Information on the size of the catches was also collected.

IV.2.2 Sampling period

In 2024, the biological data on species were collected from a total of **6 landings** at the ports of **Tsarevo, Varna, Balchik and Sozopol** . Information on the size of the catches was also collected. Ports and ships from which monitoring was carried out to collect biological data from landings are presented in **Table IV.2.1.1.**

Table IV.2.1.1 Ports and vessels from which monitoring was carried out to collect biological data from red mullet landings.

№	Date	Harbor	Species code MUT	Fishing vessel	External marking	Fishing gear	Catch	Coordinates
1	19.2.2024	Balchik	MUT	ElIS	BCH5322	OTM	5	43.2879 28.401
2	26.3.2024	Varna	MUT	TESI	VN 7750	OTM	70	43.0079 27.9123

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3	23.5.2024	Tsarevo	MUT	CYCLAMA	AH215	OTM	20	42.251319885327.9131641388
4	24.6.2024	Varna	MUT	IVA - 1	VN 8194	OTM	72	43.0216 28.0127
5	5.7.2024	Varna	MUT	LEFER	VN 03	OTM	80	43.139600 28.102100
6	14.12.2024	Sozopol	MUT	LUBAKA	BS 1212	OTM	30	42.423000 27.691800

IV.2.3 Statistical analysis of data

See section statistical analysis of sprat.

IV.3 Results

IV.3.1 Landings statistics

The highest catches were achieved in March and September-November 2024 **(Figure IV.3.1.1).**

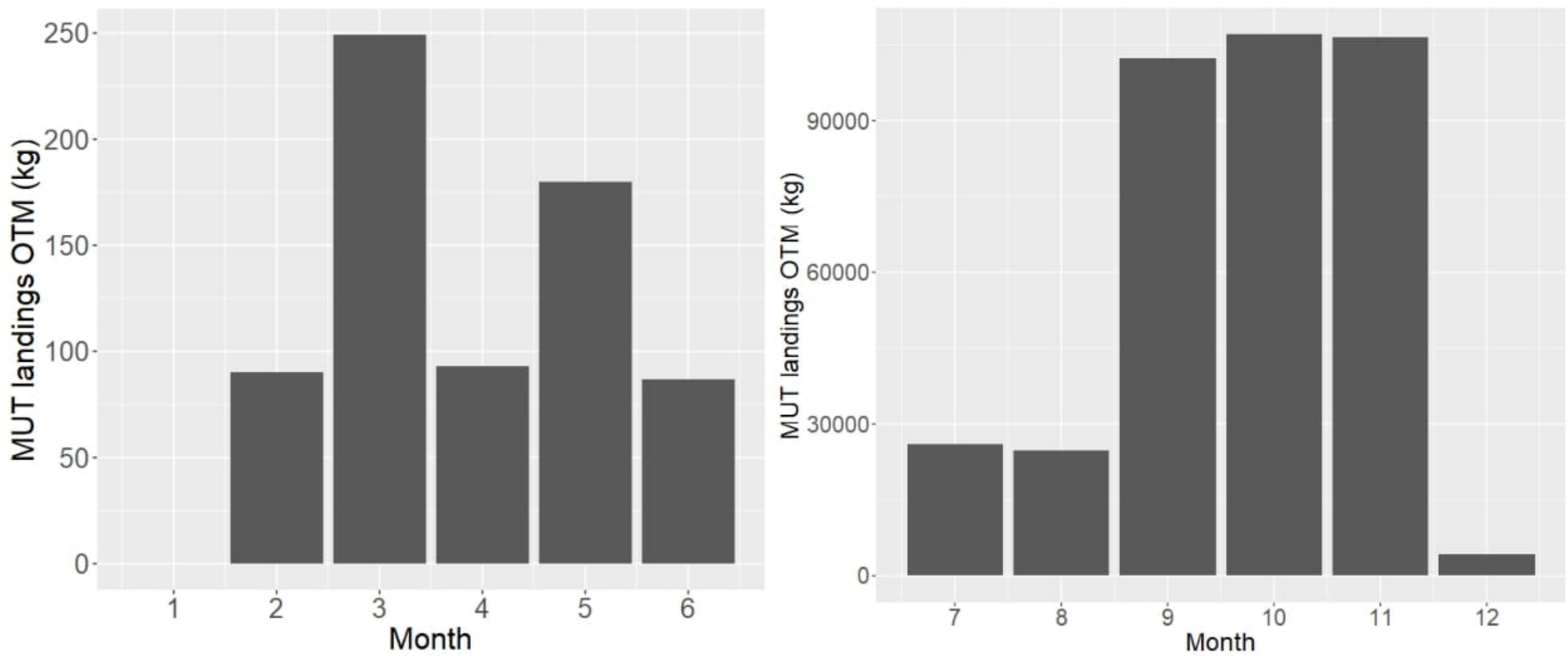


Fig. IV.3.1.1 Official statistics records for red mullet landings.

IV.3.2 Length structure of landings

The size structure showed a multimodal distribution with a peak in size group 9.0 representing 15.44%. An increase in the percentage of individuals from the size groups 10 cm and 11 -

11.5 cm representing 13.24% 11.03% and 12.50% is also noted. A sharp decline in the presence is noted by the group 12.5 and 13 cm participating with 2.21 and 2.94%. For the first quarter, the classes with a length of 13.5 cm and 14 cm have a low share in the landings - 4.41% and 5.15%. For the second quarter, the lowest percentage is the size class 12.5 cm and 13.5 cm participating with the same percentage 2.31%. In the second quarter, the size class 10.5 cm predominated, followed by size class 9, participating with 18.46 and 15.38%. The classes in the range 8 - 8.5 cm occupied a relatively higher percentage share in the landings - 6.92 % and 5.38%, respectively. For the third quarter, the classes with a length of 9-9.5 cm have the lowest share in landings - below 5%. The class in the range of 12 cm occupies the relatively highest percentage share in landings - respectively 20.95%. For the fourth quarter, the lowest percentage is the size class 14 cm (7.46%), and the highest is the class with 10.5 cm (17.16%). The remaining classes fall in the range between 8% and 11%.

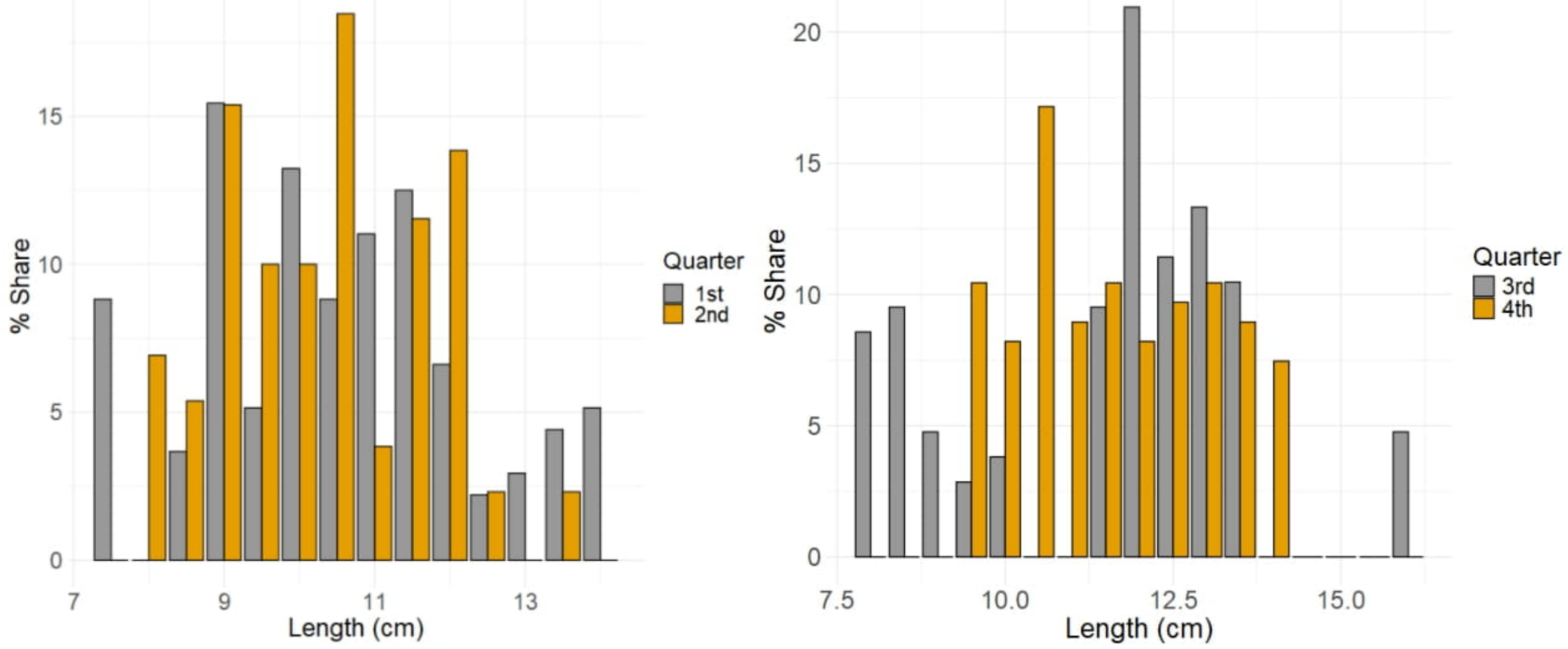


Fig.IV.3.2.1 Size structure and percentage share of length classes in the catch composition.

IV.3.3 Age structure of landings

The three age readers determine the age of the red mullet otoliths, and determinant 1 reads all otoliths twice. **Samples n=505 (n=266 for the first semester and n=239 for the second**

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semester) were used to determine age. During the first six months, the highest percentage share was occupied by individuals in the age group 3-3+, followed by 2-2+. In the first quarter, the highest percentage share – 38.97% was occupied by individuals in the age group 3-3+, followed by 2-2+ with 23.53%. With the lowest share – 10.29% and 11.76% were the age groups: 0-0+ and 4-4+. The second quarter shows that the age groups 3-3+ have the largest share – 40% and significantly prevail over the others. In the second quarter of 2024, a good participation of individuals aged 2-2+ was also registered, with 2-2+ individuals reaching 23.08% **(Figure IV.3.3.1).** The second semester shows that the age groups of 2-2+ and 3-3+ have an equal share - 40% and significantly prevail over the others. The age groups 0-0+ and 1-1+ are under 5%. During this semester we observe an increase in older individuals compared to the previous one.

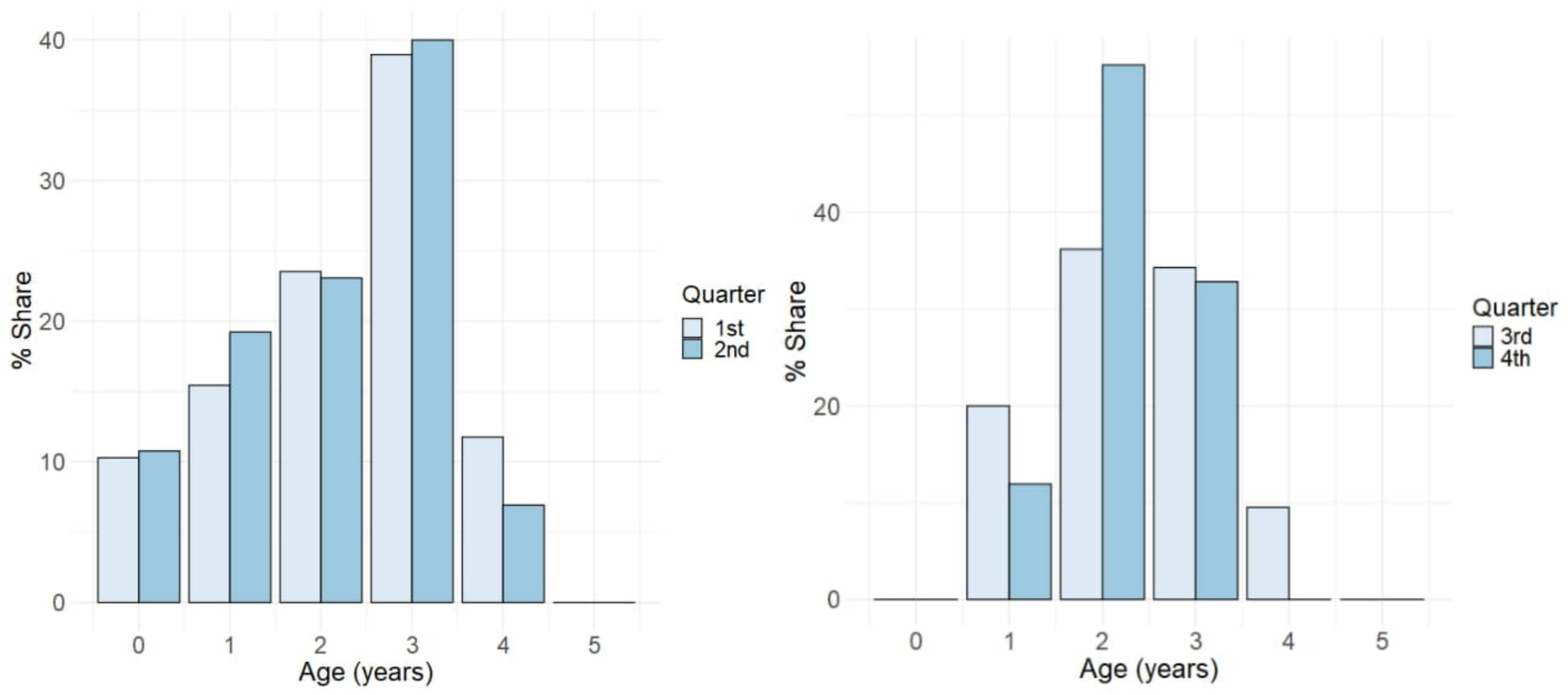


Figure IV.3.3.1. Age structure and percentage share of age groups in the catch composition.

In the analysis (*age slicing*) of size-frequency samples for determining the growth parameters of the red mullet, only ELEFAN RSA gave relatively good results, the results of the other two methods showed average lengths for 5-year-old specimens of the order of 10 cm, which is not typical for the species and the probable reason is an insufficient number of measurements and poor representation of the size structure in the samples. The latter is expected when determining growth parameters based on samples that do not represent the development of the species on an annual basis.

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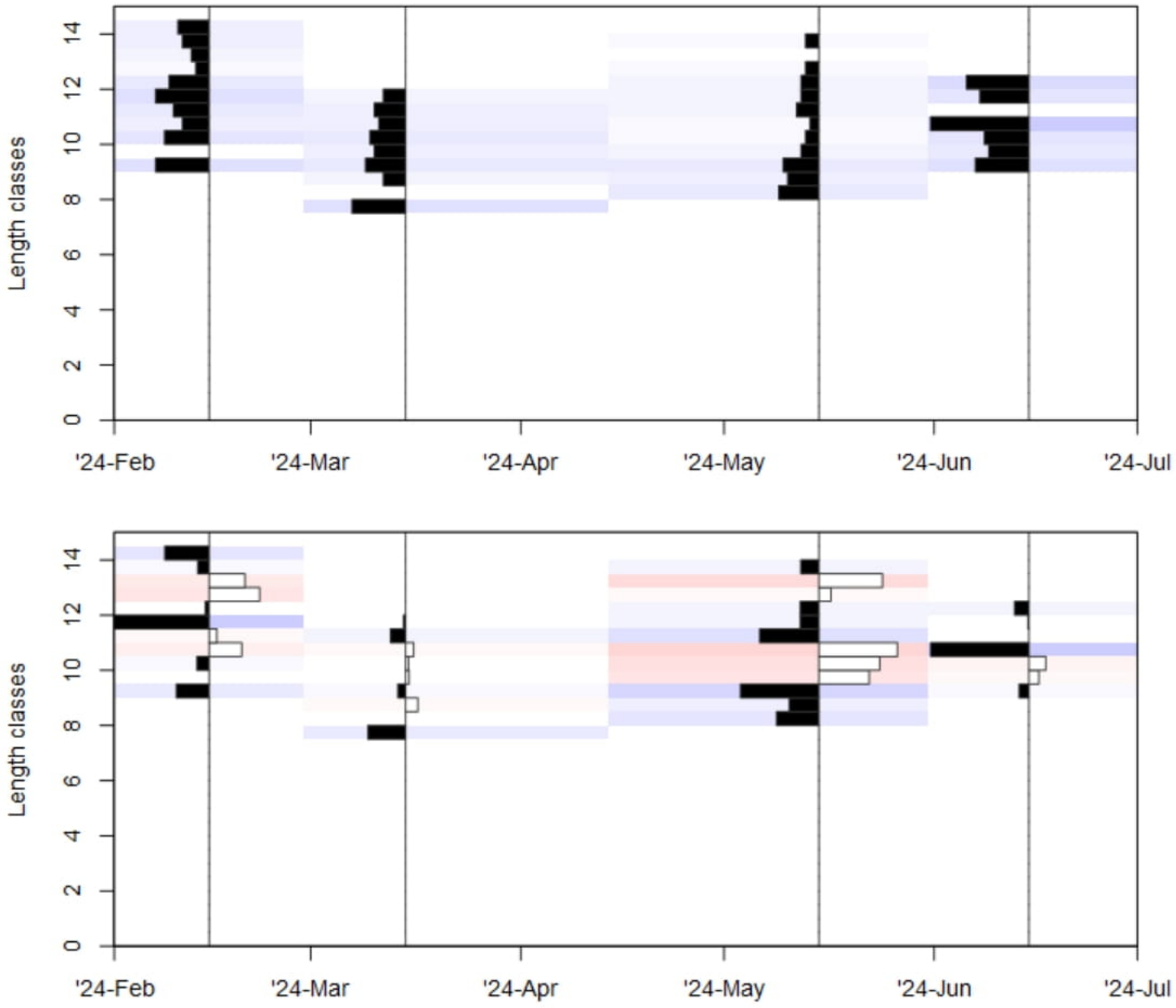


Figure IV.3.3.2 Size-frequency samples, visualized as (top diagram) number of individuals in size class and (bottom diagram) the restructured data with moving average MA = 5 for the purposes of frequency analysis and determination of growth parameters.

IV. 1.3.3.1 Frequency analysis RSA – response surface analysis

The growth parameters determined by RSA with initial conditions: a conditional interval of for the asymptotic length L_∞ in the sample [14;17.5 cm] (based on a literature review of the characteristics and biological potentials of the species for the Black Sea) and the parameter that determines the growth rate to L_∞ - $K = \exp(seq(from\ log(0.1), to \log(1)$ with an upper limit for L_∞ = 17.5 cm **(Fig. IV. 1.3.3.1.1)**.

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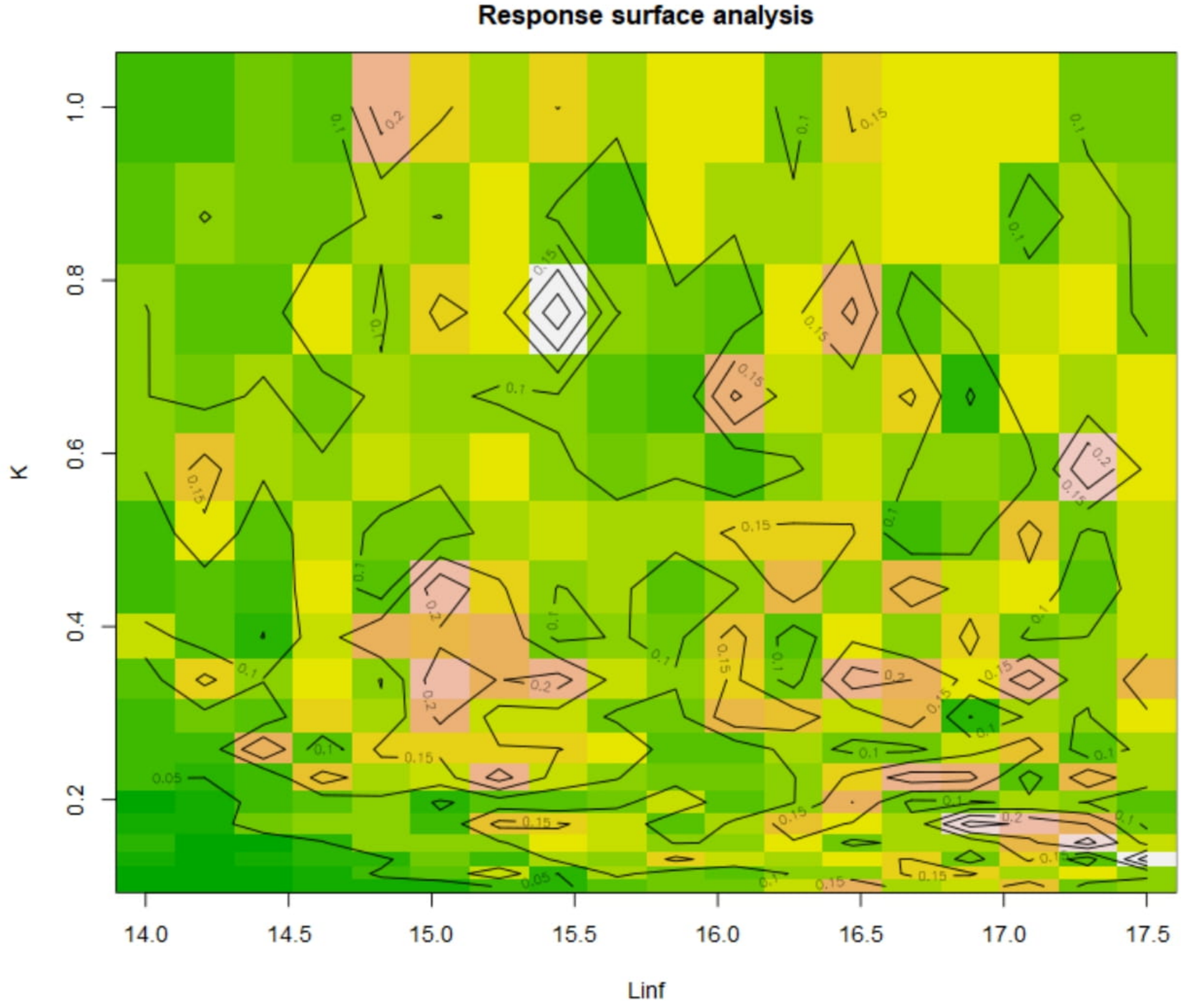


Figure IV. 1.3.3.1.1 Contour plot visualizing the identified asymptotic length L_∞ and the corresponding value of the parameter K in the defined intervals.

The parameters in the von Bertalanffy model were calculated as follows: **L_∞=15.44 cm; K = 0.76 and t_0=-0.67.** The ages with their corresponding lengths were calculated using the latter (**Table IV. 1.3.3.1.1, Figure IV. 1.3.3.1.2**) and compared with the experimentally determined ones.

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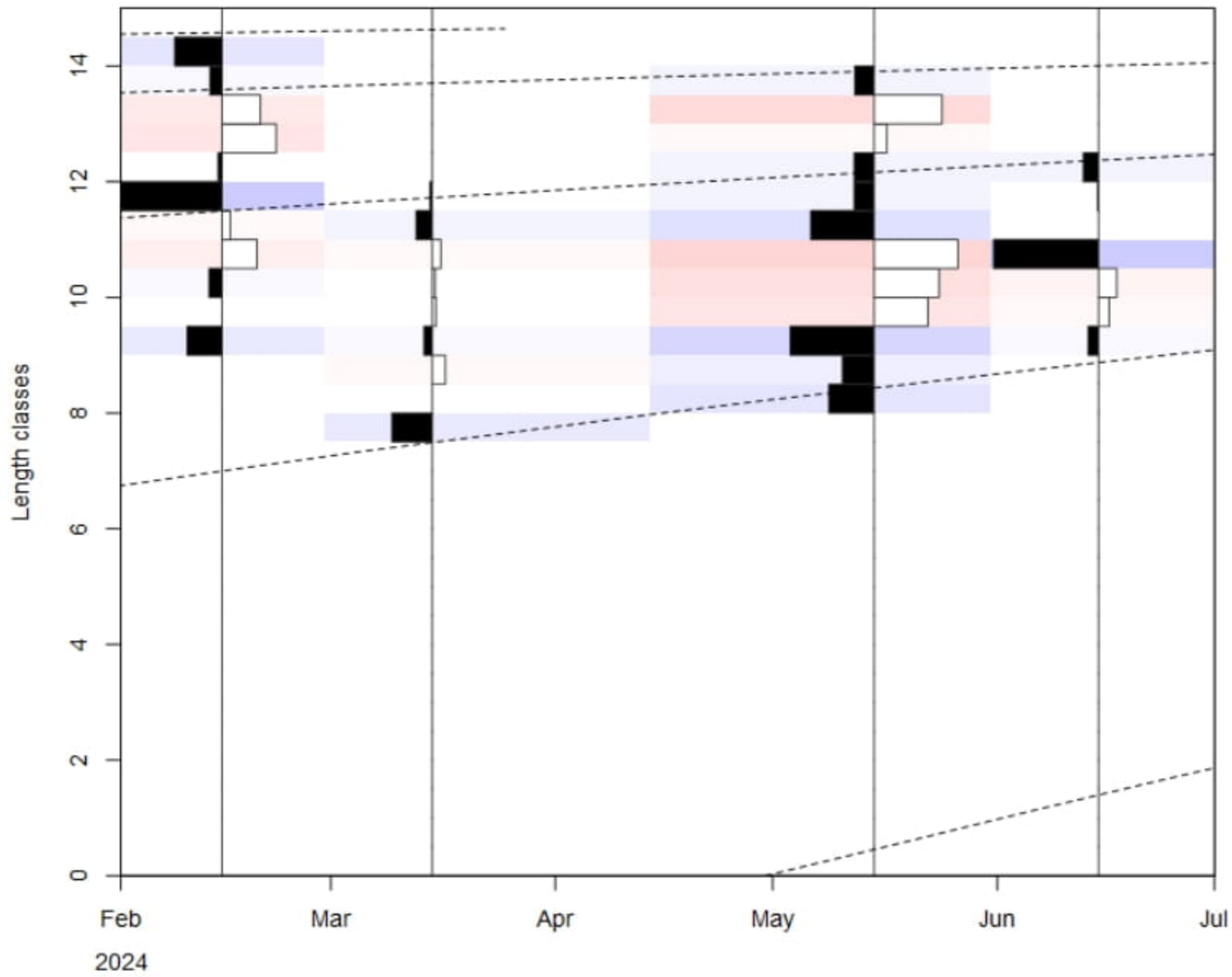


Figure IV. 1.3.3.1.2 Growth curves determined with ELEFAN RSA, visualized on the restructured data for the purpose of visualizing the tracking of cohorts over time **за първо шестмесечие**.

Table IV.1.3.3.1.1 Ages with their corresponding lengths for the studied species calculated using von Bertalanffy parameters obtained with RSA and compared with experimentally determined ages from otoliths **за първо шестмесечие**..

	ELEFAN RSA	Experimentally determined
age	La	L_{mean}
0	6.2	
0.5	9.1	8.0
1	11.1	9.25
1.5	12.5	
2	13.4	10.5
2.5	14.1	
3	14.5	11.5
3.5	14.8	
4	15.0	13
4.5	15.1	
5	15.2	-

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Given the results obtained, the analysis of growth parameters should be repeated again at the end of the year, when richer biological information about the species will be available.

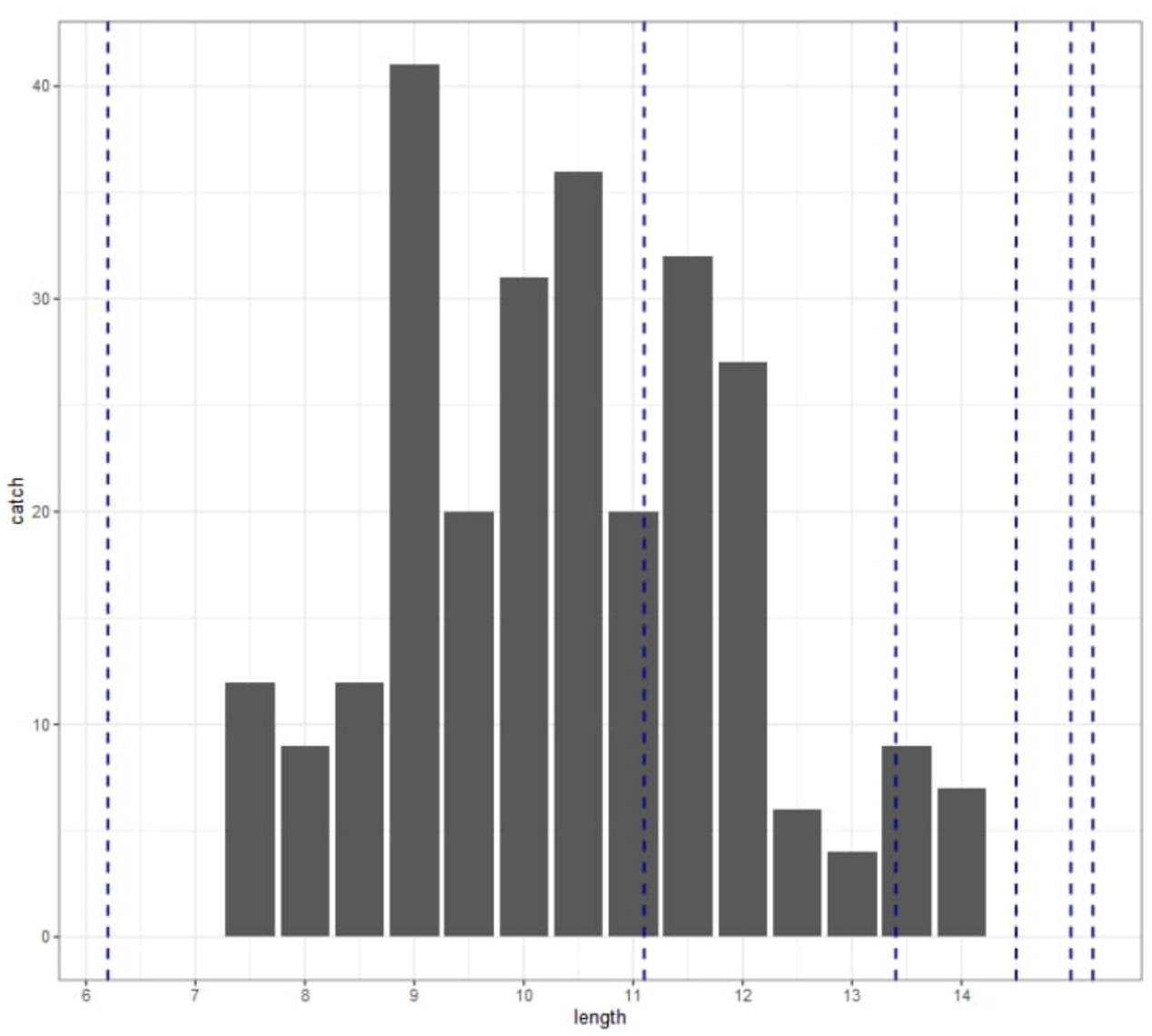


Figure IV. 1.3.3.1.3 The ages represented with dashed lines, calculated based on the growth parameters determined by ELEFAN RSA, are overlaid on the cumulative sample of the composition of commercial catches of red mullet, aiming to visualize the range of size classes represented in a specific age group (0-5 years) **for the first half of 2024.**

Growth parameters determined by RSA with initial conditions: conditional interval of for the asymptotic length L_∞ in the sample [15.5;19 cm] (based on a literature review of the characteristics and biological potentials of the species for Black sea – 17.5 cm, and in this particular case the upper limit is fixed at 19 cm to provide the possibility of a wider range of solution for biological potential (L_∞)) and and the parameter that determines the growth rate to L_∞ - K = exp ($seq(from\ log(0.1), to\ \log(1)$with an upper limit for L_∞ = 19 cm **(Fig. IV. 1.3.3.1.4).** To determine the growth parameters, annual information was used - all growth-frequency samples for the period 01-12.2024, due to the high uncertainty in the growth parameters calculated **for the second half of 2024.**

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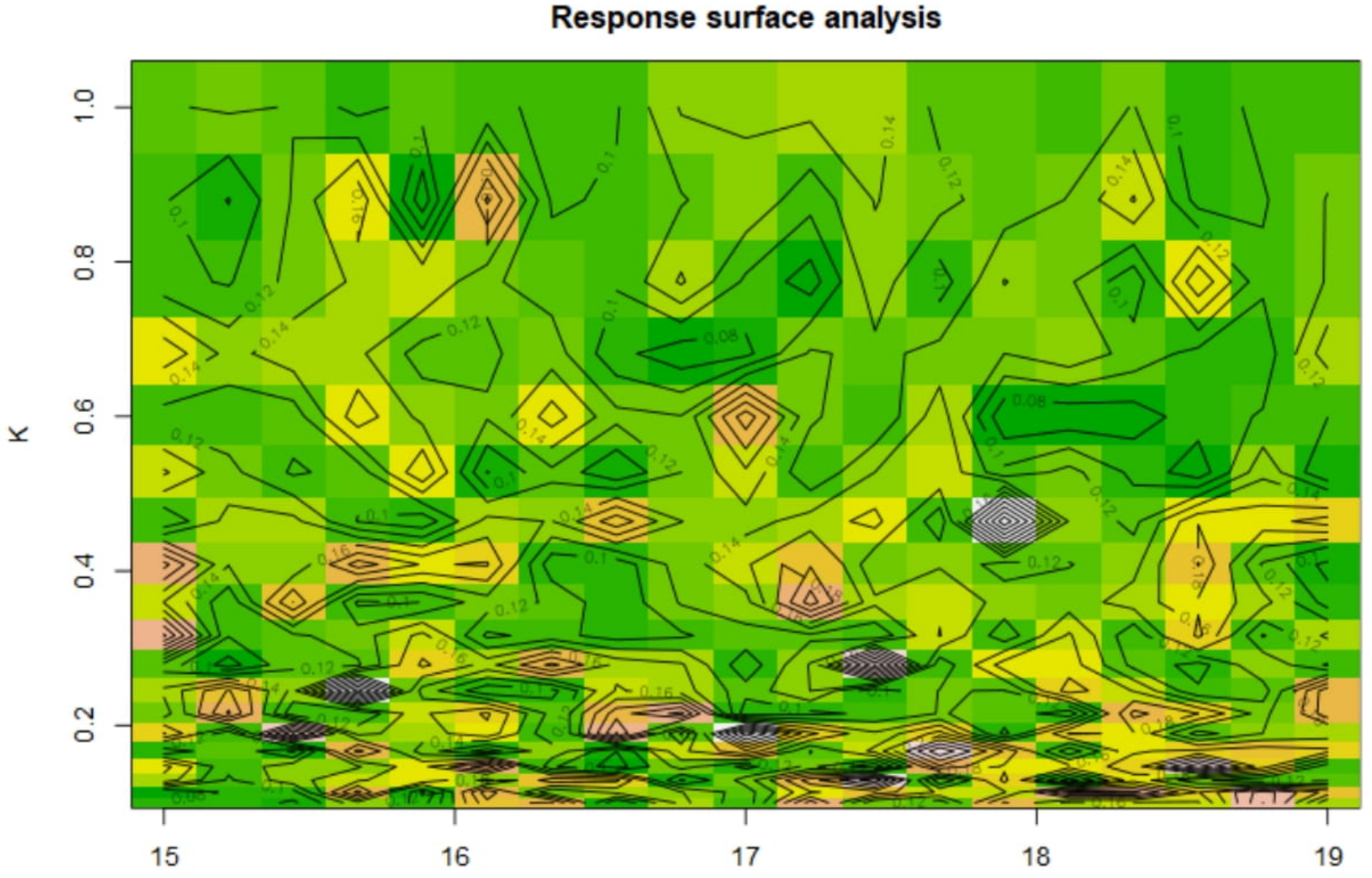


Figure IV. 1.3.3.1.4 Contour plot visualizing the identified asymptotic length L_∞ and the corresponding value of the parameter K in the defined intervals.

The parameters in the von Bertalanffy model were calculated as follows: **L_∞=17.05 cm; K = 0.5 and t_0=-0.4.** The ages with their corresponding lengths were calculated using the latter (**Table IV. 1.3.3.1.2, Figure IV. 1.3.3.1.5**) and compared with the experimentally determined ones.

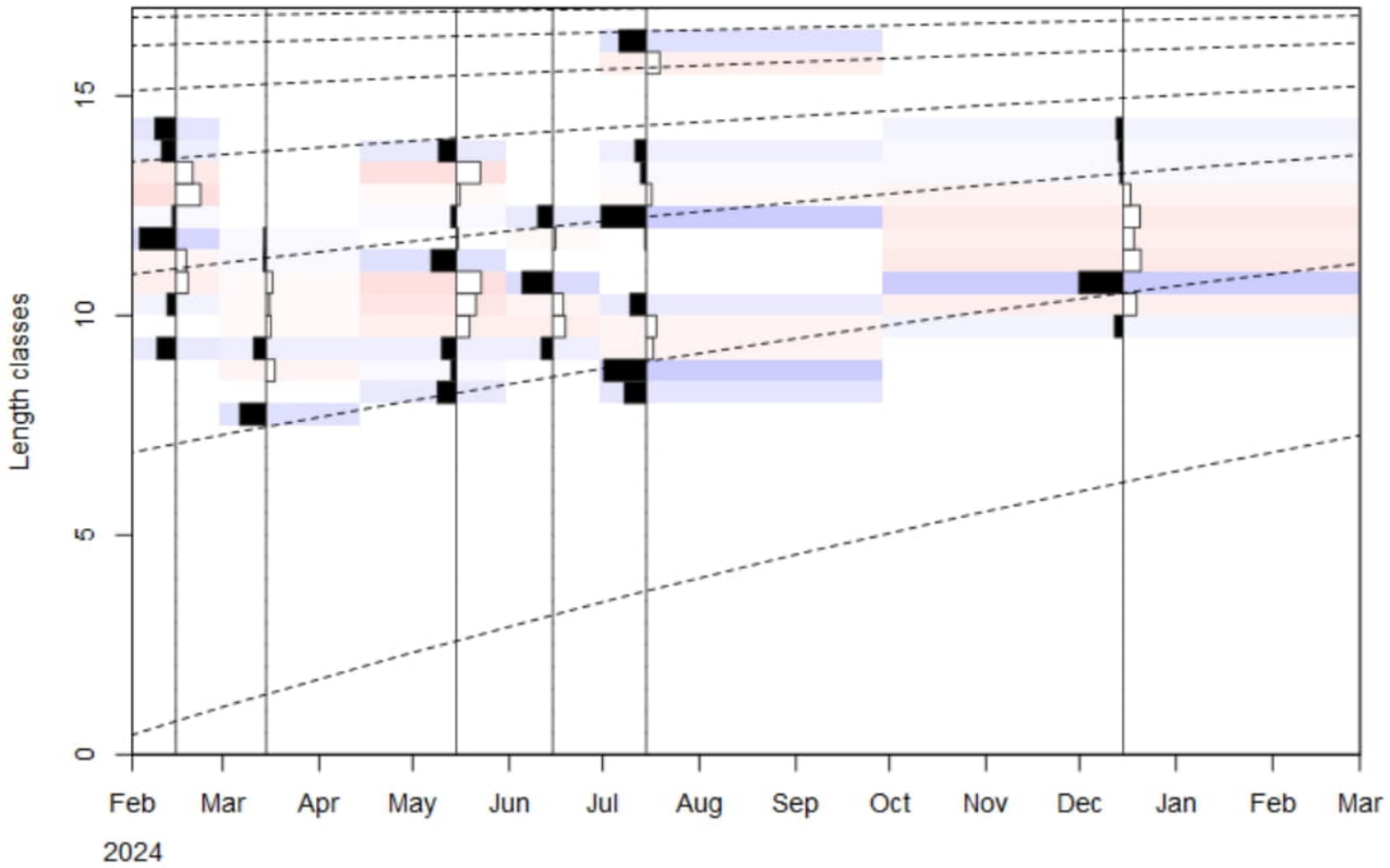


Figure IV. 1.3.3.1.5 Growth curves determined with ELEFAN RSA, visualized on the restructured data for the purpose of visualizing the tracking of cohorts over time.

Table IV. 1.3.3.1.2 Ages with their corresponding lengths for the studied species calculated using von Bertalanffy parameters, obtained with RSA and compared with experimentally determined ages from otoliths.

	ELEFAN RSA	**Experimentally determined**
age	La	$L_{average}$
0	3.4	
0.5	4.0	n/a
1	6.9	9.00
1.5	9.2	
2	10.9	10.75
2.5	12.3	
3	13.3	13
3.5	14.1	
4	14.8	14.6
4.5	15.3	
5	15.7	n/a

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Given the results obtained, the analysis of growth parameters should be repeated again at the end of the year, when richer biological information about the species will be available.

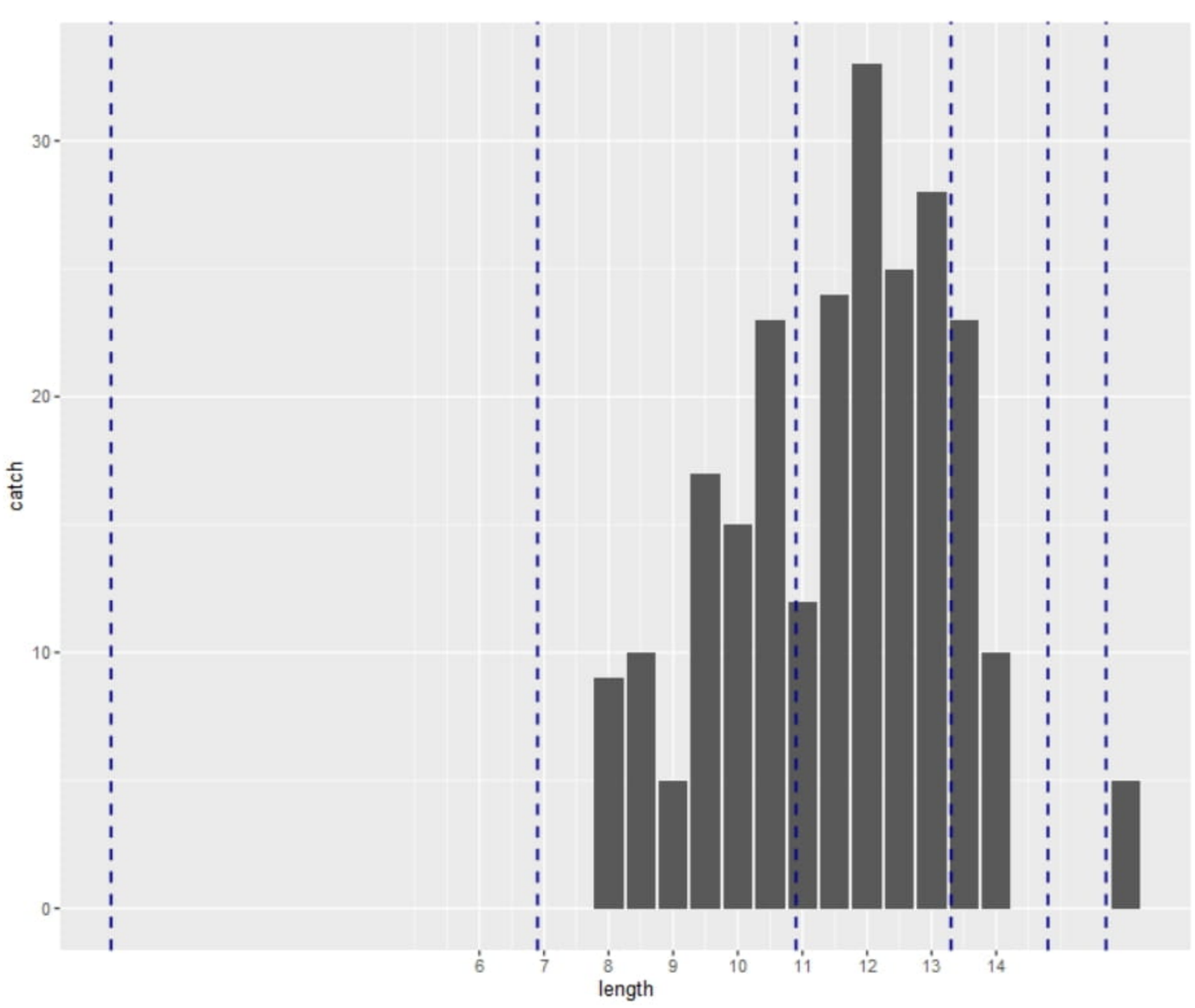


Figure IV. 1.3.3.1.6 Ages represented by dotted lines calculated from growth parameters determined with ELEFAN RSA superimposed on the cumulative sample of the composition of the commercial red mullet catches to visualize the range of size classes represented in a specific age group (0-5 years) **for the second semester of 2024.**

IV.3.4 Condition factor

The graph (**Fig.I.3.4.1**) shows that during the first six months K is highest for size classes 13.0-13.5-14.0 cm. The remaining size groups also have good condition, which indicates food security and good physiological condition.

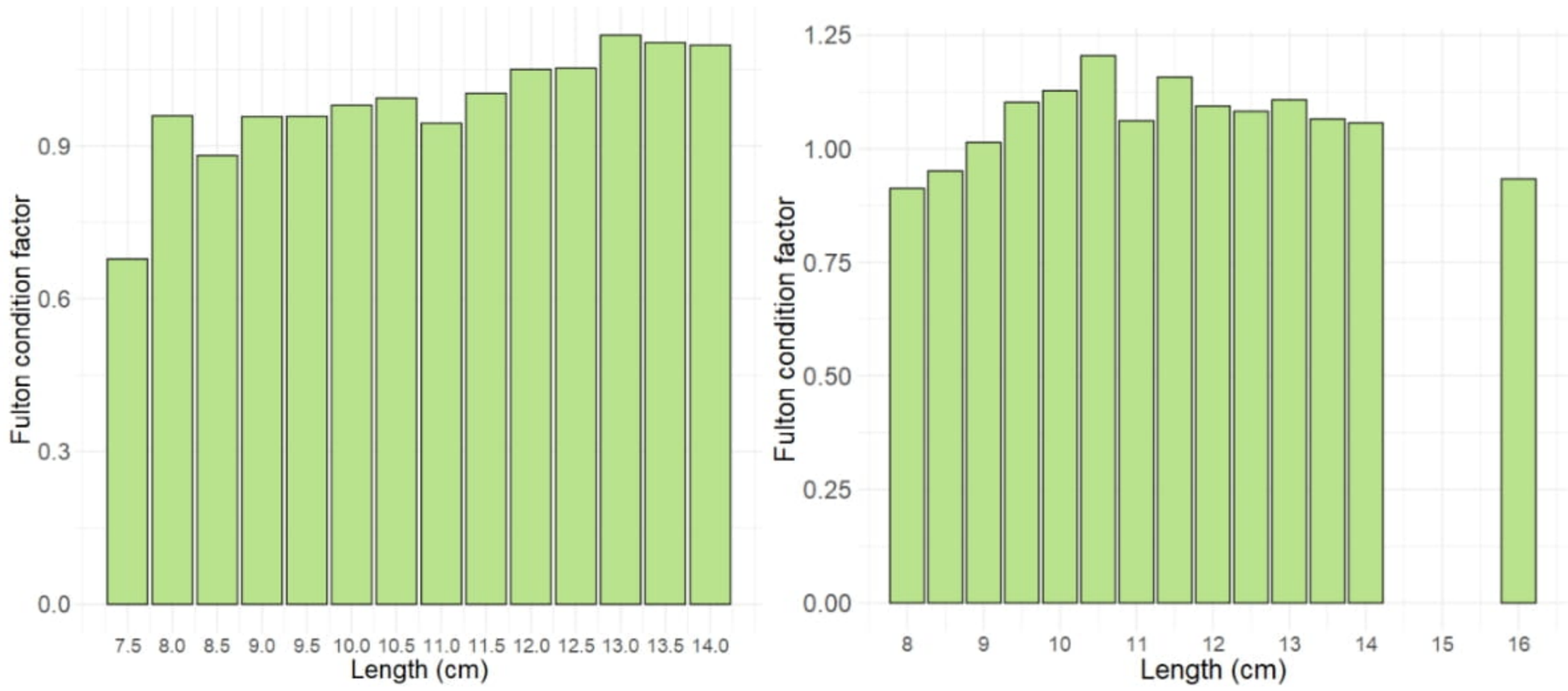


Figure IV.3.4.1 Fulton coefficient of red mullet by length classes.

The condition of the red mullet by age shows a predominance of 4-4+ year olds **(Fig. IV.3.4.3).**

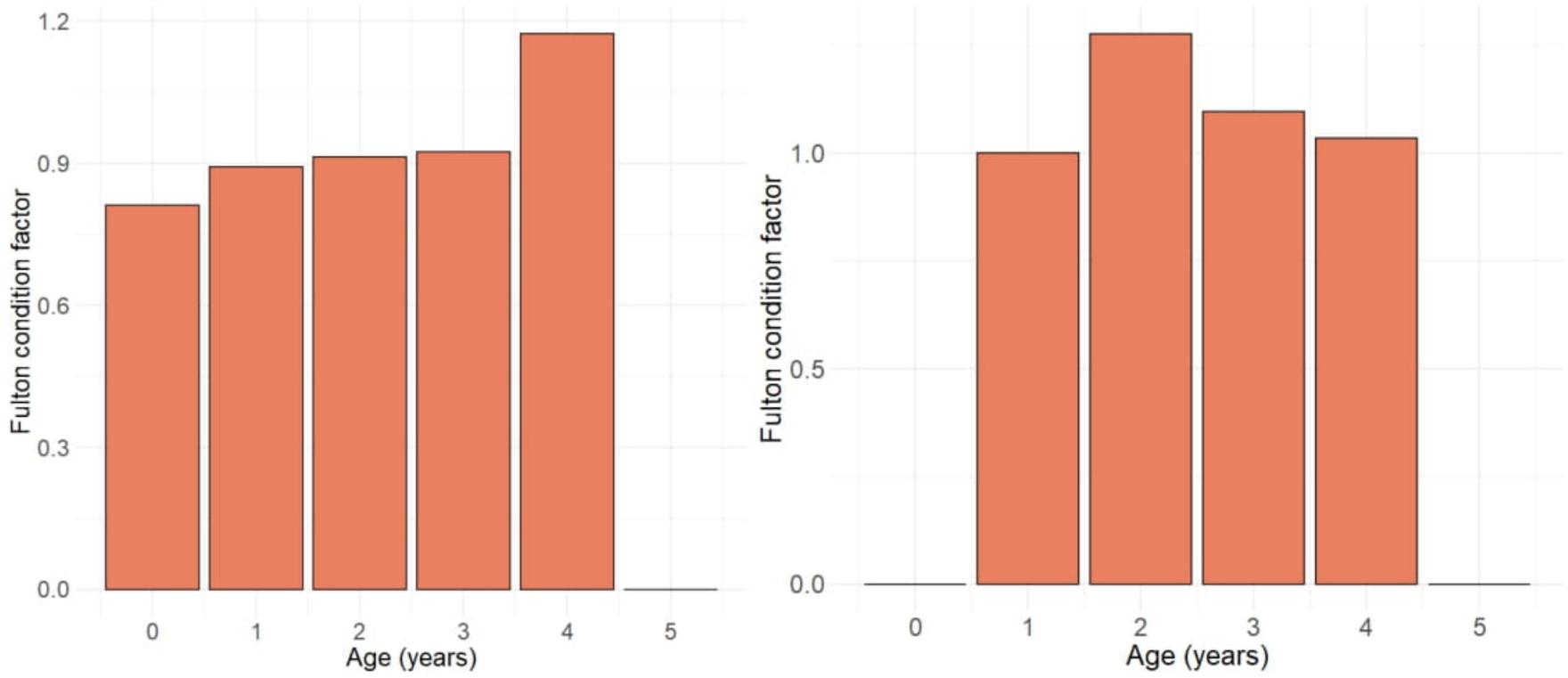


Figure IV.3.4.3 Condition factor of red mullet by age group.

IV.3.5 Weight structure of red mullet

The weight was measured at **505 (266 specimens for the first semester and 239 for the second semester).** A gradual increase in average weight is observed across age groups. For the age group 0-0+ the lowest average weight is 4.15g (28 number of red mullet), and for the group 4-4+ the highest average weight is observed of 25.79g (25 number). For the other age groups the weights are as follows: 1-1+-7.07g (46 number); 2-2+-10.58g (62 number); 3-3+-14.06g (105 number of red mullet). In the second half of the year, the average weight for the age group 1-1+ was the lowest - 7.29g (37 number), and for the group 4-4+ the highest average weight of 32.22g (10 number) was observed. For the other age groups, the weights were as follows: 2-2+ - 15.86g (112 number) ; 3-3+ - 24.09g (80 number)

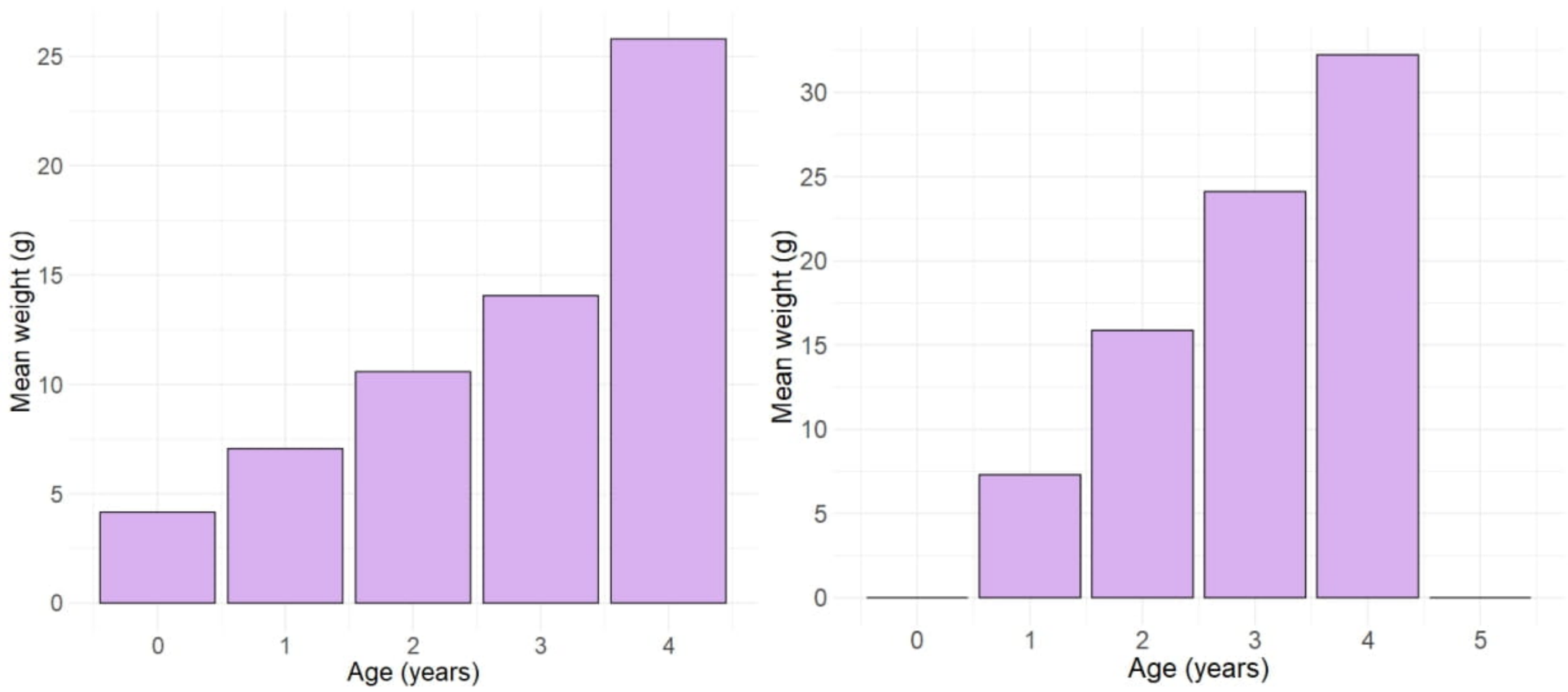


Figure IV.3.5.1 Average weights by age groups for the first and second semester of 2024.

The most numerous size classes 10-10.5cm participated in the catch with 11.65% and 13.53% and weighed 9.80g and 11.51g.During the second half of the year, the most numerous size classes 12 cm and 13 cm participated in the catch with 13.81% and 11.72% and weighed 18.90g and 24.33g.

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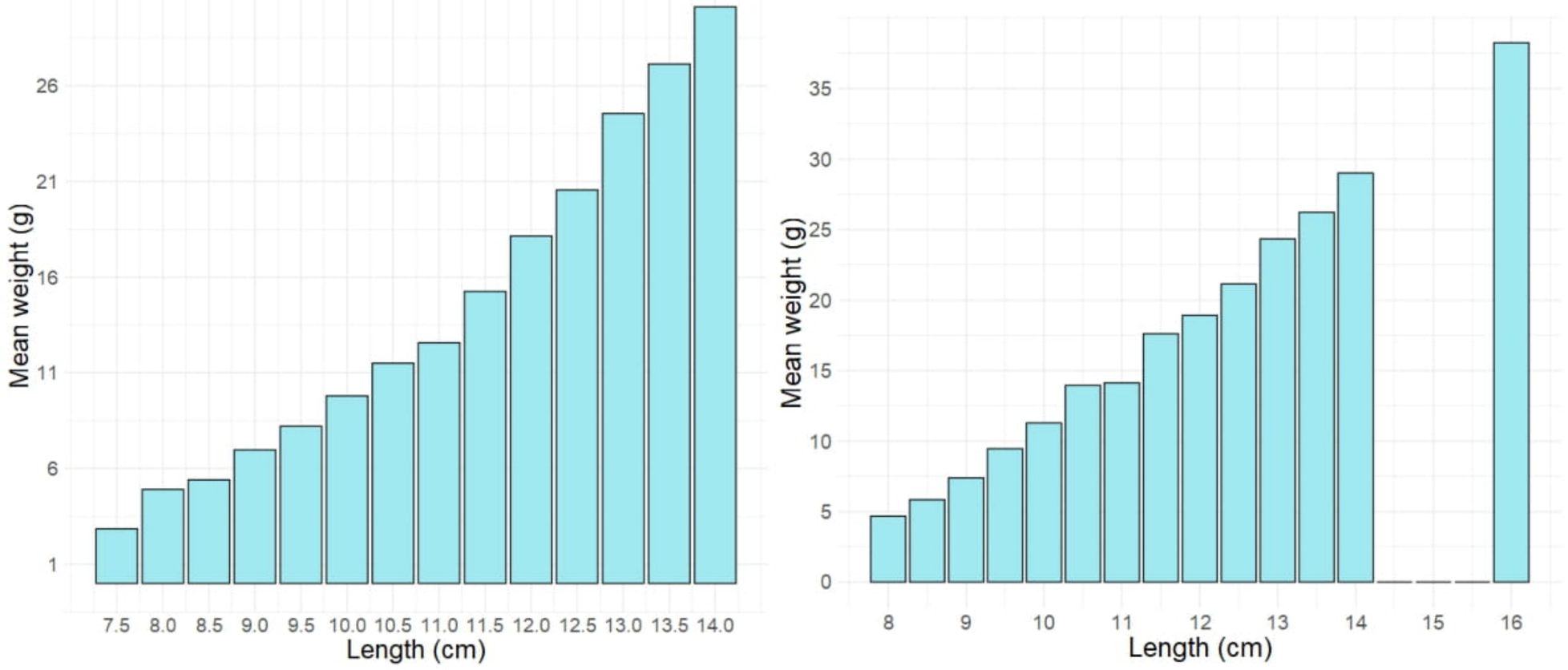


Figure IV.3.5.2 Average weights of red mullet by size classes for the first and second semester of 2024.

IV.3.6 Weight structure of red mullet by age groups

The length was measured at **505 (266 specimens for the first semester and 239 for the second semester).**

Table IV.3.6.1 Size structure by age groups.

I-VI		VII-XII	
Age	**L_{mean}/cm**	**Age**	**L_{mean}/cm**
0-0+	7,91	0-0+	
1-1+	9,04	1-1+	8,86
2-2+	10,18	2-2+	11,15
3-3+	11,13	3-3+	13,03
4-4+	13,28	4-4+	14,75

IV.3.7 Length-weight relationship

The resulting model **(Table IV.3.7.1)** is statistically significant, the value of the scaling coefficient a in the length-weight relationship model $W_i = aL_i^b$: **a=0.002** and the allometry coefficient **b=3.52,** which indicates positive allometric growth of the species **in the first half of the year**, or the increase in weight is proportional to or greater than the increase in length.

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Table IV.3.7.1 Results from modeling the length-weight relationship for the first semester.

```
Call:
lm(formula = logW ~ logL, data = weight_l)

Residuals:
      Min        1Q    Median        3Q       Max
-0.186878 -0.017504  0.007273  0.029429  0.126176

Coefficients:
            Estimate Std. Error t value          Pr(>|t|)
(Intercept)  -5.8617     0.2377  -24.66 0.0000000000011968 ***
logL          3.5234     0.1005   35.05 0.000000000000186 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.07235 on 12 degrees of freedom
Multiple R-squared:  0.9903,        Adjusted R-squared:  0.9895
F-statistic:  1228 on 1 and 12 DF,  p-value: 0.000000000000186
```

The resulting model (**Table IV.3.7.2)** is statistically significant, the value of the scaling coefficient a in the length-weight relationship model $W_i = aL_i^b$ is: **a=0.009**, and the allometry coefficient **b=3.06**, which indicates positive allometric growth of the species **in the second half of the yea**r, or the increase in weight is proportional to the increase in length.

Table IV.3.7.1 Results from modeling the length-weight relationship for the second semester.

```
Call:
 lm(formula = logW ~ logL, data = weight_l)
Residuals:
      Min        1Q    Median        3Q       Max
Coefficients:
-0.150936 -0.026219  0.008639  0.046544  0.132921

            Estimate Std. Error t value          Pr(>|t|)
 (Intercept)   -  4.7133     0.2749  -17.15 0.00000000083443 ***
logL           3.0686     0.1136   27.00 0.00000000000409 ***
---
Signif. codes 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘’ 1

Residual standard error: 0.08296 при 12 степени на свобода
Multiple R-squared: 0.9838,         Adjusted R-squared:  0.9825
F-statistic:  729.1 на 1 и 12 DF, p-стойност: 0,000000000004095
```


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IV.3.8 Sex ratio

The sex ratio is set at **250 individuals(150** in the first and **100** in the second semester). Males ♂ dominate over females ♀ in the first and females dominate in the second semester of 2024.

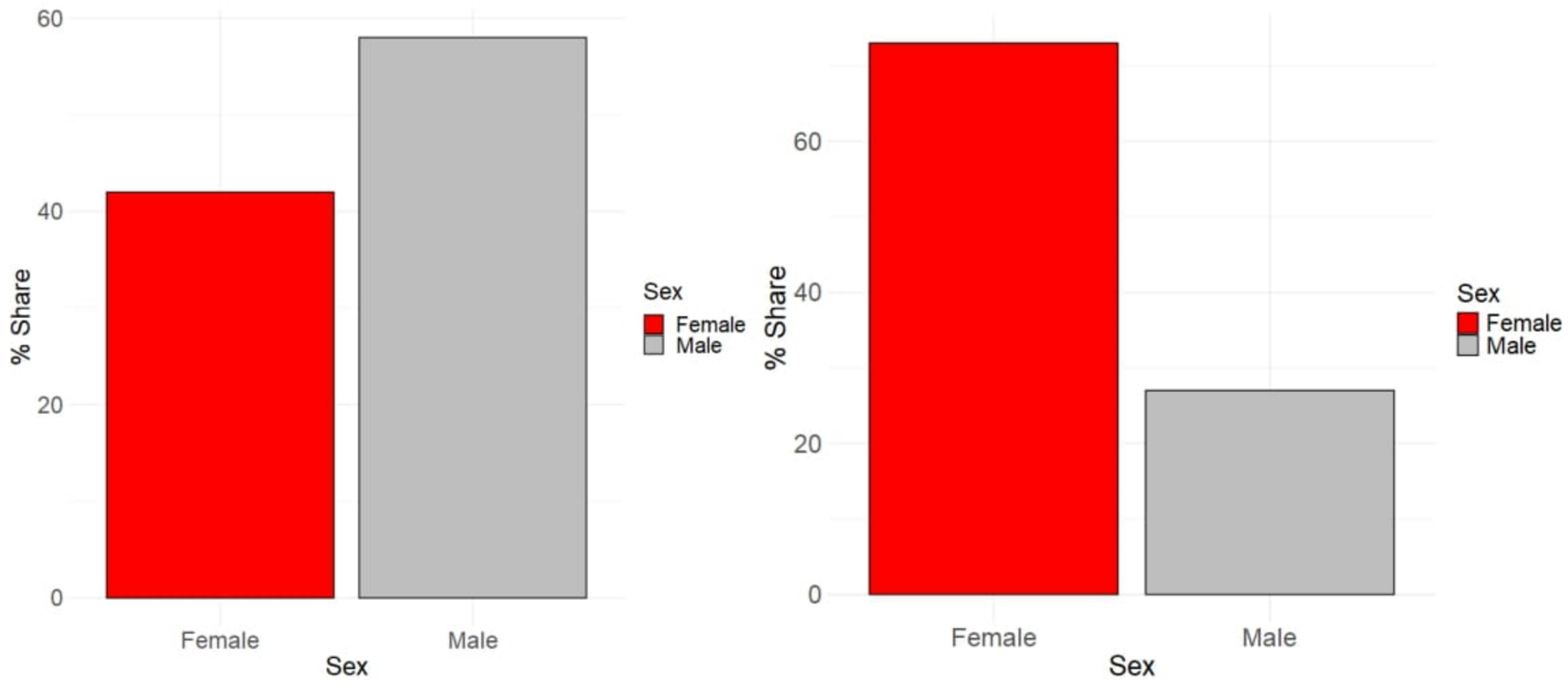
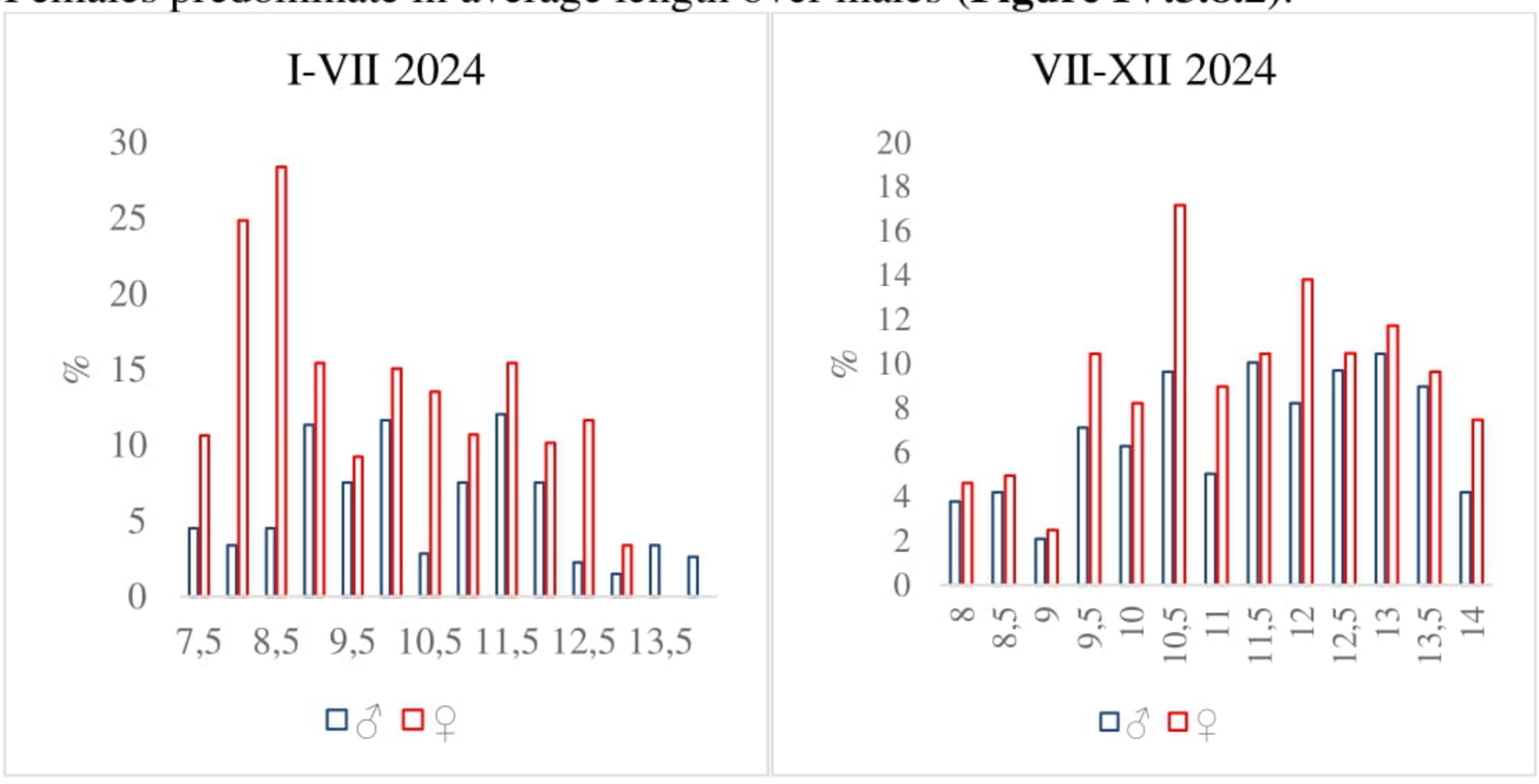


Figure IV.3.8.1 Percentage ratio between sex.

Females predominate in average length over males **(Figure IV.3.8.2)**.



Фигура IV.3.8.2 Съотношение на пола на барбуна по дължина - женски ♀ и мъжки ♂.

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IV. 3.9 Fecundity

100 red mullet fecundity specimens were studied. During the first semester the production rate during the study period shows a very weak level of determinism (R^2 = 0.10), which is directly dependent on the resting period of the reproductive process (**Fig. IV.3.9.1).** During the second semester, the portion fecundity (Log F) versus the weight of the red mullet (Log W) show a very strong relationship (R^2=0.9093), which proves a very strong dependence of fecundity on individual weights. This fact is indicative of the fact that the species is in an active phase of reproduction and portion ejection of the sexual products.

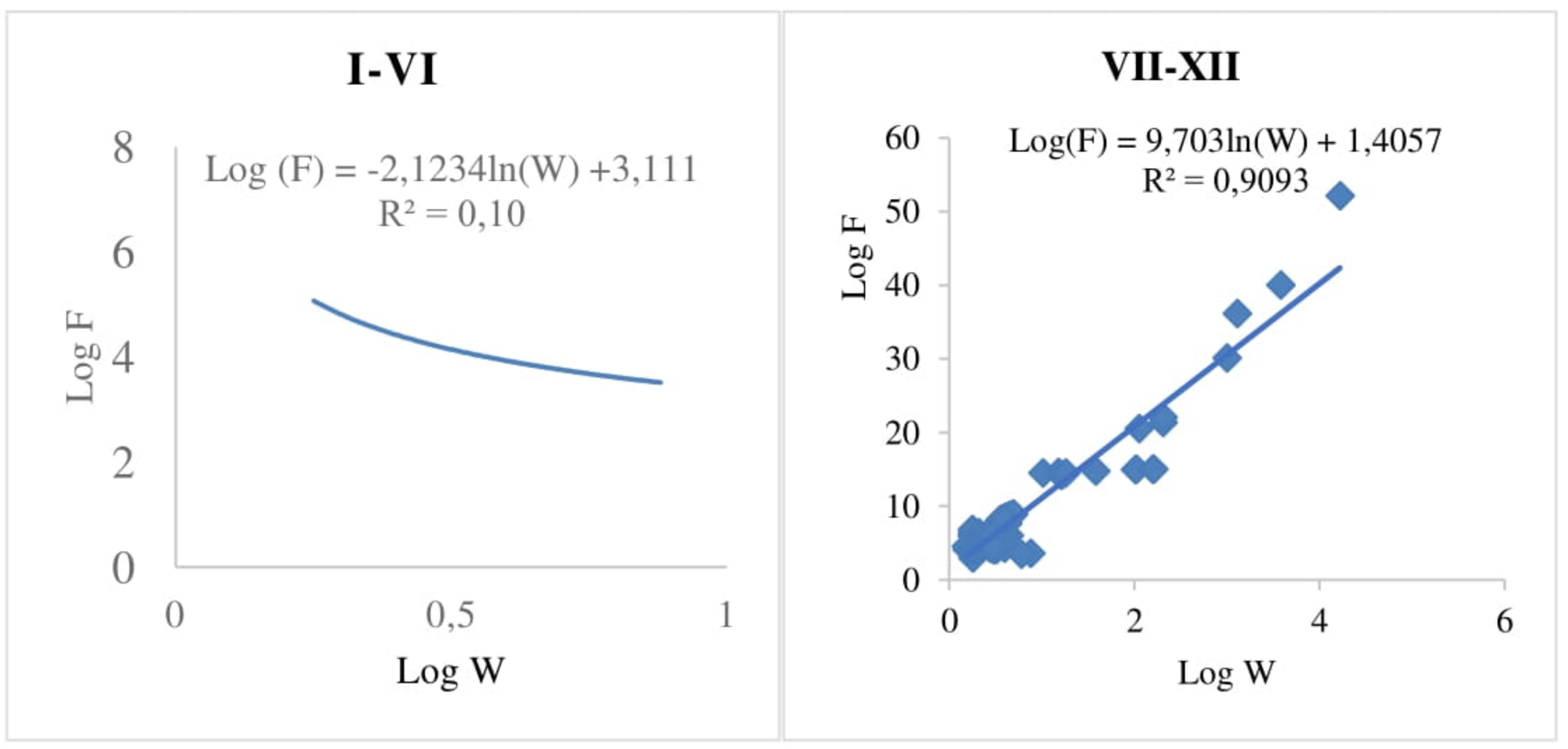


Figure IV. 3.9.1 Dependence of portion fertility on red mullet weight.

The relationship between the weight and the fertility of the turbot showed a weak relationship (R^2=0.128), of the Gonado-somatic index and the weight of the gland (ovaries) (**Figure IV. 3.9.2**). The coefficient of reproduction during the studied period shows a very weak level of determinism, which is directly related to the active reproductive processes during the considered period **(Fig. IV.3.9.2).** In the second half of 2024, high batch reproduction of the species was observed, as it is a summer-breeding species.

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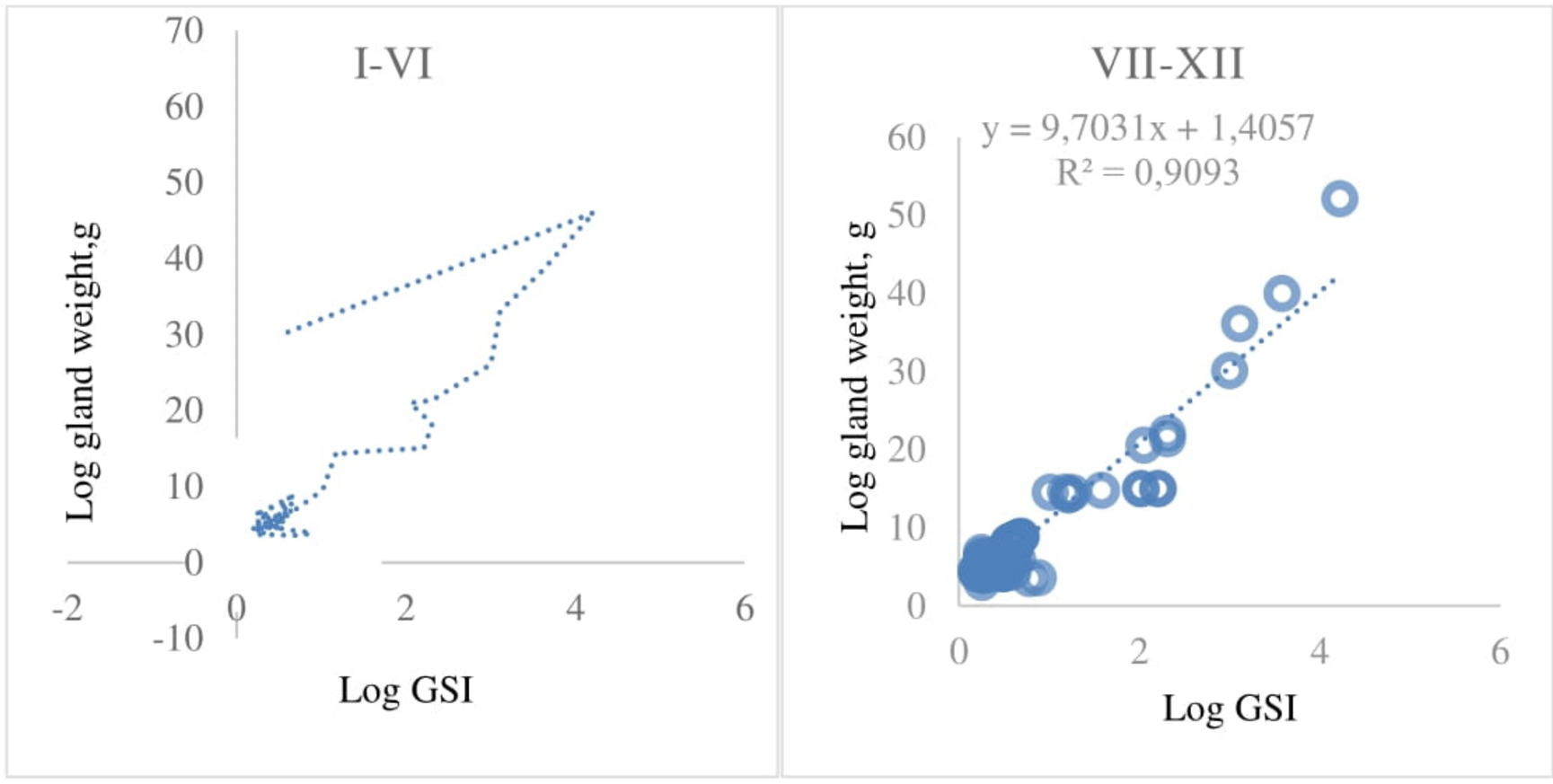


Figure IV.3.9.2 Dependence of log gland weight on log gonadosomatic index (GSI).

Table IV.3.9.1 describes the absolute and relative fecundity with average lengths and weights. The average value of the absolute fecundity was estimated at 7844.4 eggs for the first and 7336.15 for the second semester. The average value of the relative fecundity was 4944.25 for the first and 6185.96 for the second semester.

Table IV.3.9.1 Absolute and relative fertility of red mullet.

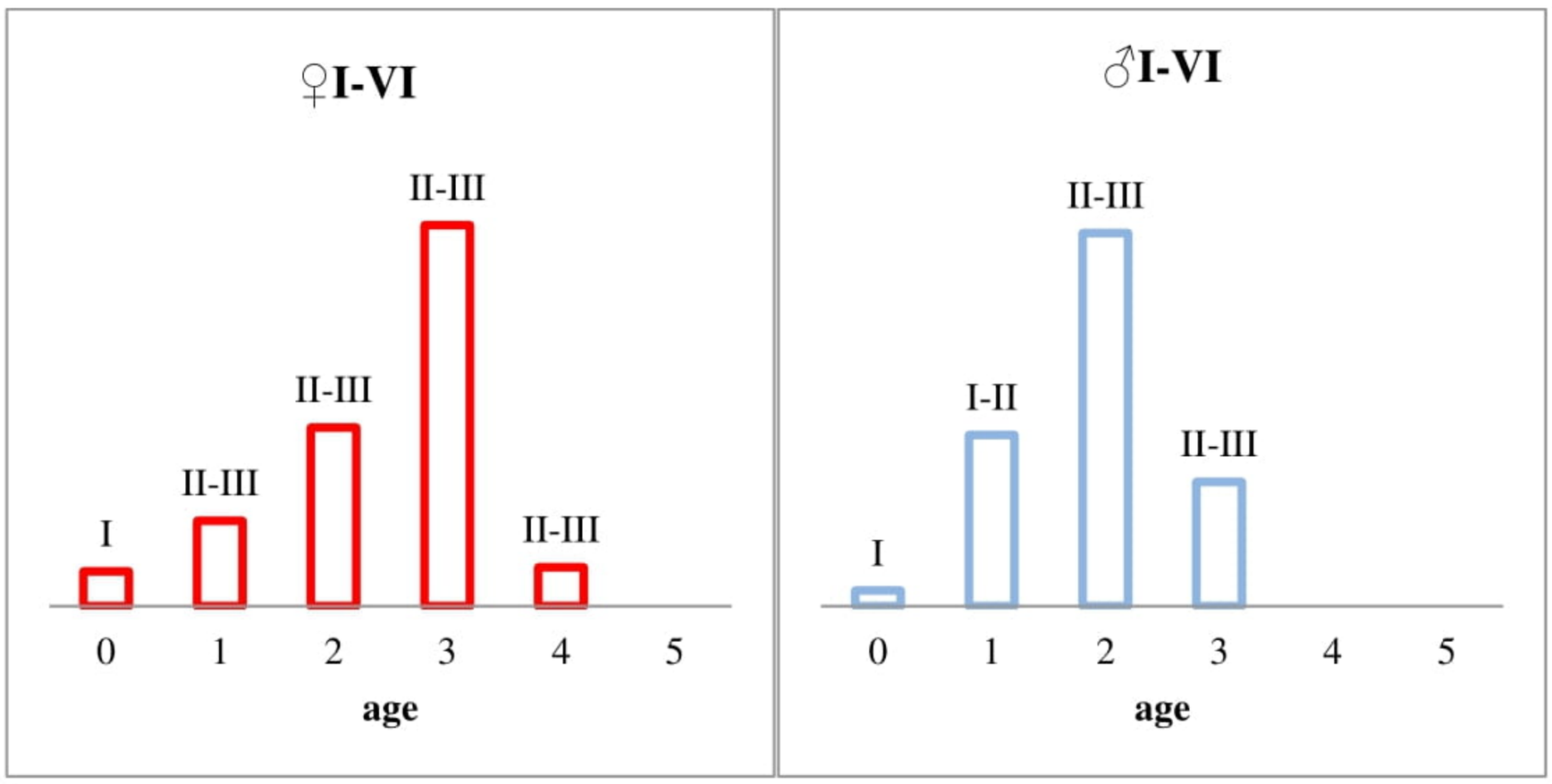
I-VI					VII-XII				
Size class	**W average, g**	**Absolute fertility F, caviar grains)**	**Relative fertility**	**N♀**	**Size class**	**W average, g**	**Absolute fertility F, caviar grains)**	**Relative fertility**	**N♀**
					8	4,91	5221	10633,51	6
					8,5	5,41	5911	10926,16	9
					9	6,98	6099	8736,98	6
9,5	9,234	6220	6735,98	12	**9,5**	8,21	6649	8095,27	4
10	9,902	6922	6990,51	6	**10**	9,80	6888	7029,55	6
10,5	11,53	7144	6196,01	11	**10,5**	11,51	7099	6170,11	4
11	13,325	7901	5929,46	1	**11**	12,58	7151	5686,04	2
11,5	15,55	7099	4565,27	3	**11,5**	15,26	7740	5072,43	3
12	19,12	7923	4143,83	3	**12**	18,15	7851	4325,38	3
12,5	20,26	8456	4173,74	4	**12,5**	20,56	8099	3939,22	3

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13	22,92	8096	3532,29	3	**13**	24,55	8211	3344,62	2
13,5	25,23	9453	3746,73	2	**13,5**	27,14	9119	3360,00	1
14	26,92	9230	3428,68	5	**14**	30,12	9332	3098,29	1
		7844,4	4944,25	50			7336,15	6185,96	50

IV.3.10 Sexual maturity

250 specimens were used to determine maturity. The red mullet is a summer-breeding species. Males (**Figure IV.3.10.1-2)** have fewer age groups and a mature gland at age 2-2 + y^{-1}, and an average length of 10.00 cm. Females have a greater range of ages, as replenishment was observed only for them, and correspondingly the greatest range of mean lengths. In the 3rd and 4th quarters, the senior age groups 3-3+ and 4-4+ years old were at maturity levels V-VI and V-VII. At age 1+ years: stages III; 2-2+ stages III-IV. In the 4th quarter, the glands of female individuals continued their mass maturation, with leaking glands observed in older age groups, a clear sign of already reproduced specimens gradually entering dormancy. In males, the trends are similar, with the final maturation of the glands in older groups starting in the third quarter and continuing until the end of 2024.



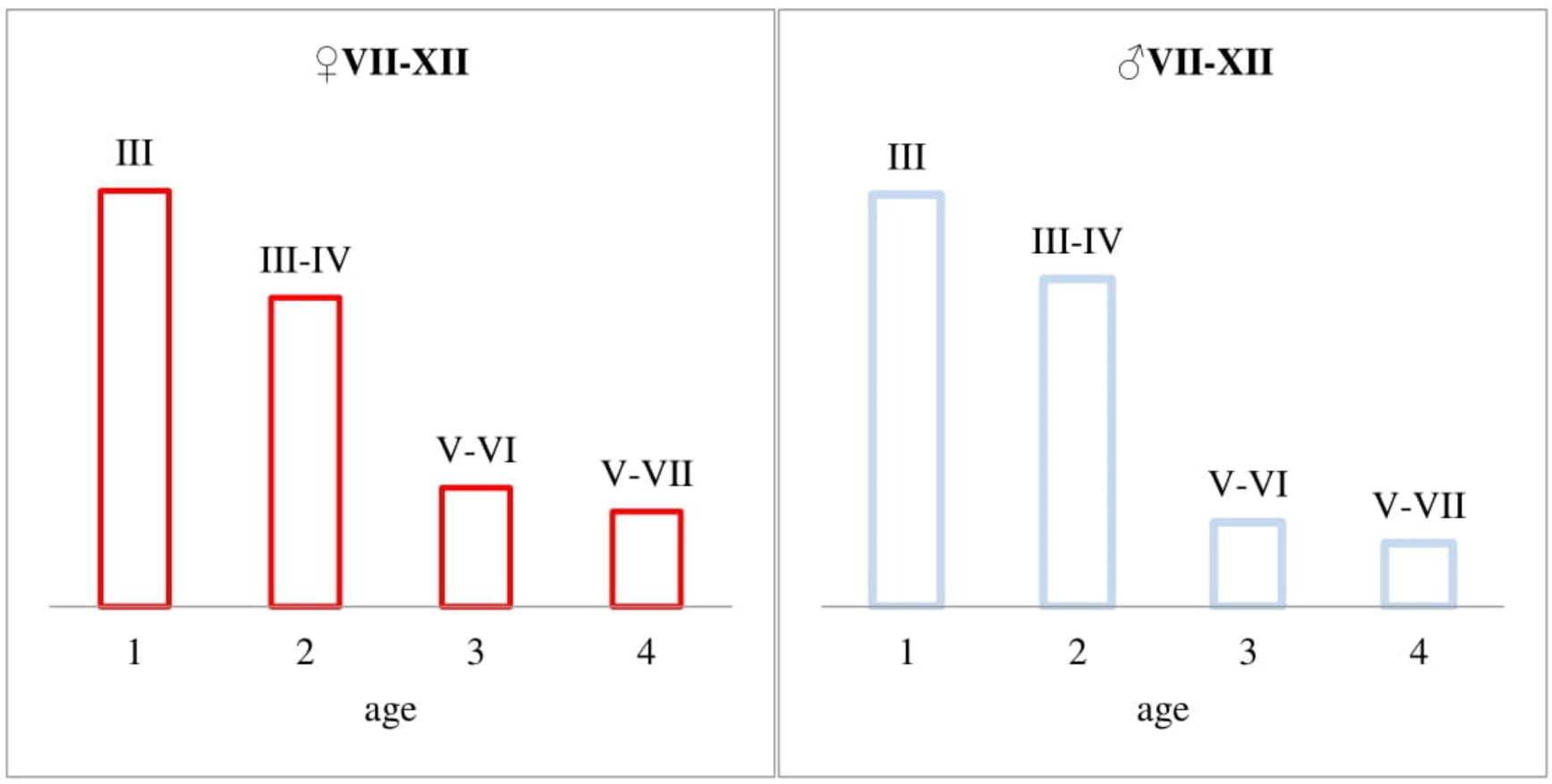
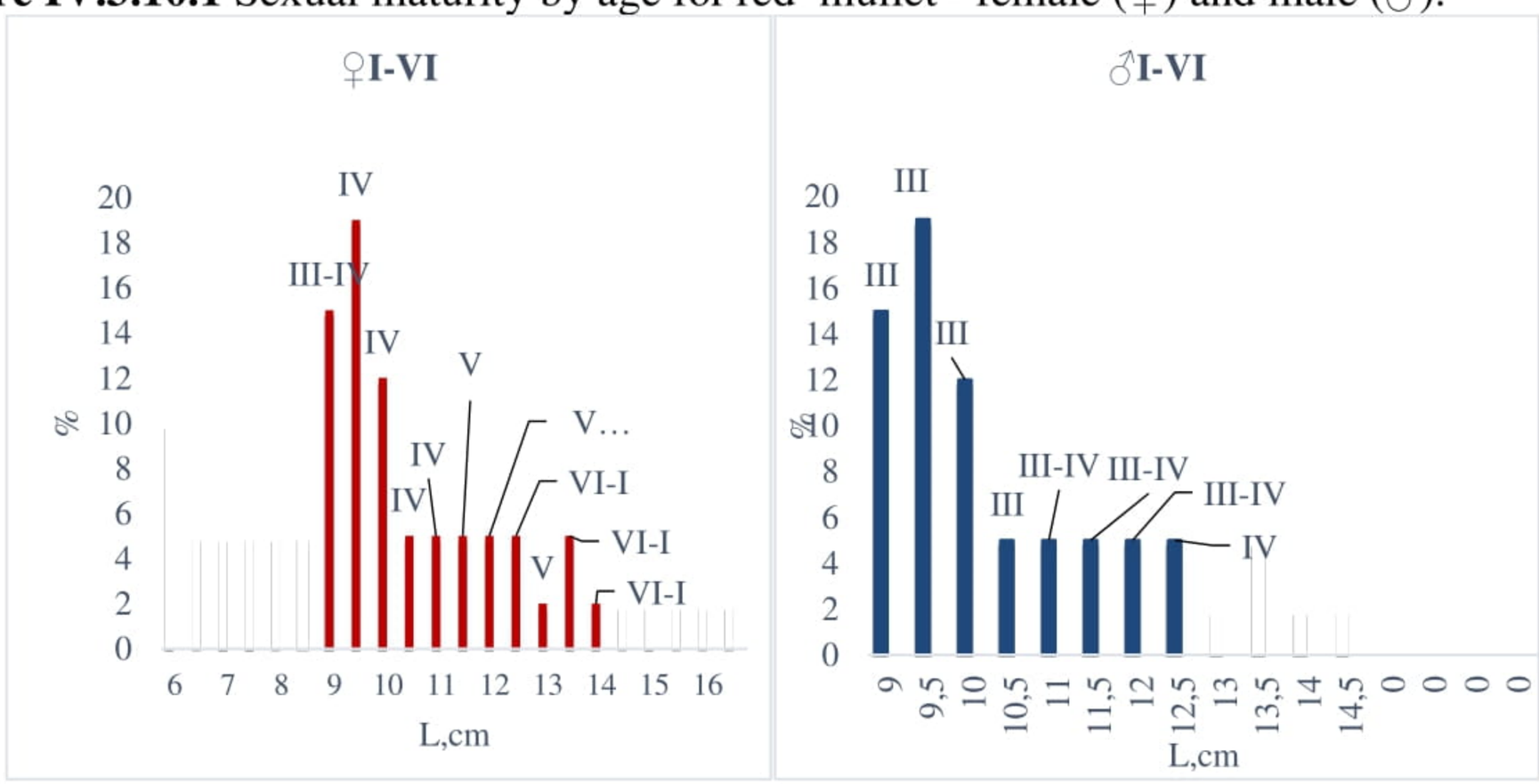


Figure IV.3.10.1 Sexual maturity by age for red mullet - female (♀) and male (♂).



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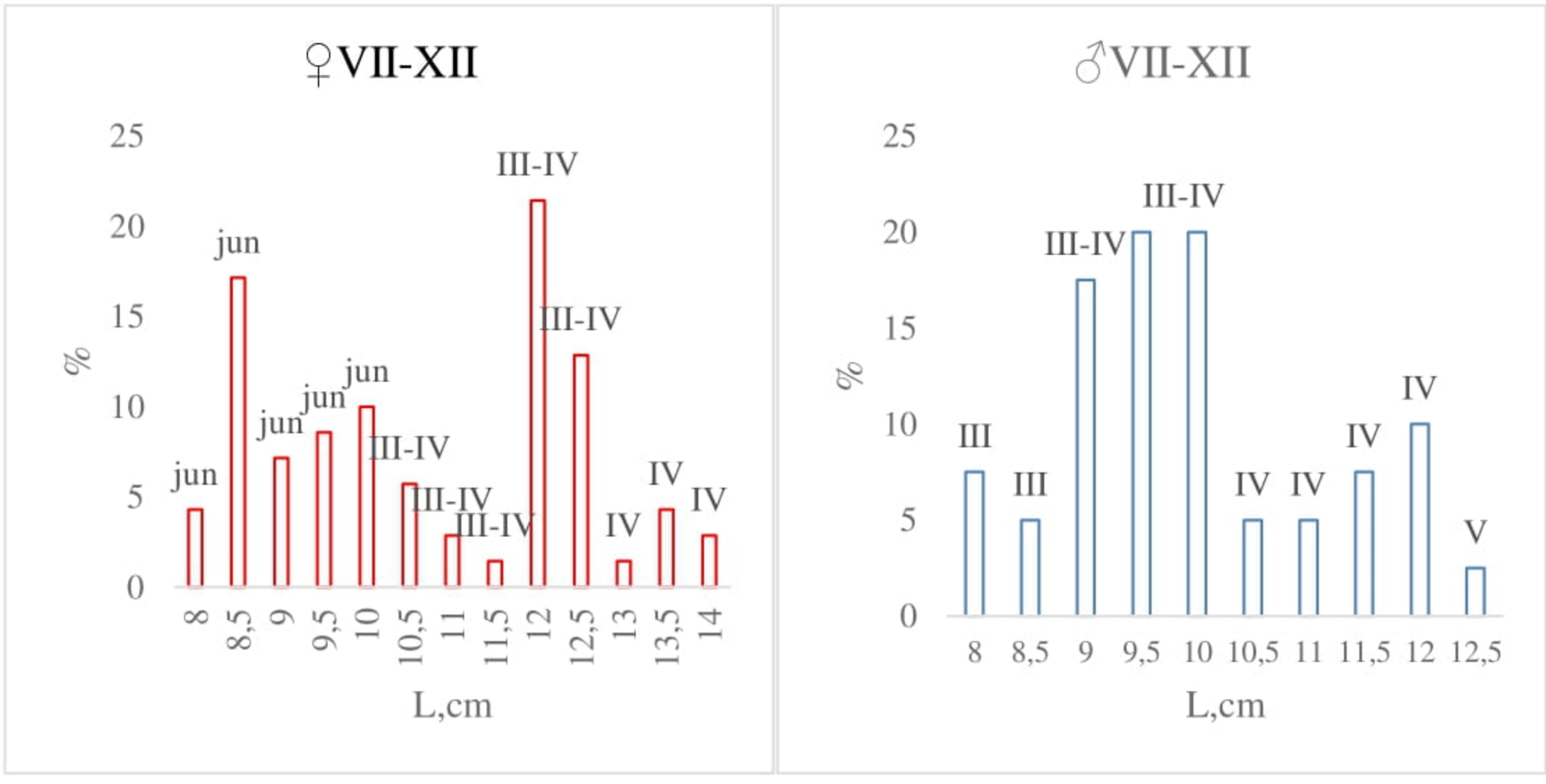


Figure IV.3.10.2 Sexual maturity by length (cm) of red mullet - female (♀) and male (♂).

IV.3.11 Catch numbers and biomass by age and length

Monthly OTM catches (in kilograms) together with average weights were used to obtain the abundance and biomass of the species by quarter in the reported catches (**Table IV.3.11.1-2**).

Table IV.3.11.1 Catch at age (10^{-6}) with OTM matrix and biomass (kg) of red mullet.

Catch at age				
Age groups (yr)	***I-st quarter***	***II-nd quarter***	***III quarter***	***IV quarter***
0-0+	8.585	9.117		
1-1+	8.296	8.810	3168.29	4620.01
2-2+	7.469	7.932	4411.46	6432.79
3-3+	9.518	10.108	2074.64	3025.25
4-4+	1.235	1.312	193.94	282.81
∑	35.104	37.278	9848.33	14360.85
Biomass (kg)				
Age groups (yr)	***I-st quarter***	***II-nd quarter***	***III quarter***	***IV quarter***
0-0+	35.684	37.895		
1-1+	58.624	62.256	23124.38	33720
2-2+	79.015	83.910	69998.13	102071
3-3+	133.816	142.105	49998.66	72908.1
4-4+	31.861	33.835	6249.83	9113.51
∑	339	360	149371	217813

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Table IV.3.11.2 Number of individuals (x10^{-6}) in the catch by size class (for OTM) and biomass of the of red mullet.

*Catch in numbers *10^{-6} 2024*				
Length classes (cm)	***I^{-st} quarter***	***II^{-nd} quarter***	***III quarter***	***IV quarter***
7,5	3.962	4.207		
8	2.299	2.441	1203.49	1754.93
8,5	2.827	3.002	1052.30	1534.47
9	7.485	7.949	372.48	543.16
9,5	3.103	3.296	1124.63	1639.94
10	4.032	4.282	763.58	1113.46
10,5	3.988	4.235	961.88	1402.61
11	1.877	1.994	464.95	677.98
11,5	2.673	2.838	806.27	1175.70
12	1.687	1.791	985.31	1436.78
12,5	0.299	0.318	647.33	943.94
13	0.185	0.196	690.92	1007.50
13,5	0.394	0.418	514.94	750.89
14	0.294	0.312	178.57	260.39
16			81.69	119.12
∑	35.104	37.278	9848.33	14360.84
Biomass (kg)				
Length classes (cm)	***I^{-st} quarter***	***II^{-nd} quarter***	***III quarter***	***IV quarter***
7,5	15.293	16.241		
8	11.470	12.180	5624.85	8202.16
8,5	15.293	16.241	6249.83	9113.51
9	52.252	55.489	3124.92	4556.76
9,5	25.489	27.068	10624.72	15493
10	39.508	41.955	9374.75	13670.3
10,5	45.880	48.722	14374.62	20961.1
11	25.489	27.068	7499.80	10936.2
11,5	40.782	43.308	14999.60	21872.4
12	34.410	36.541	20624.45	30074.6
12,5	7.647	8.120	15624.58	22783.8
13	5.098	5.414	17499.53	25517.8
13,5	11.470	12.180	14374.62	20961.1
14	8.921	9.474	6249.83	9113.51
16			3124.92	4556.76
∑	339	360	149371	217813

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IV. 3.12 Conclusions

The analysis of the biological parameters allows us to draw the following **conclusions:**

1) The size structure showed a bimodal distribution with a peak in the size group 9.0 and 10.5 cm. A slight increase in the percentage of individuals from the size group 10.0 and 11.5 cm is also noted. A sharp decrease in the presence is noted in the group 12.5 and 13 cm. For the third quarter, the classes with a length of 9-9.5 cm have the lowest share in landings - under 5%. The class in the range of 12 cm occupies the relatively highest percentage share in landings - respectively 20.95%. For the fourth quarter, the lowest percentage is the size class 14 cm (7.46%), and the highest is the class with 10.5 cm (17.16%).

2) During the first six months, the highest percentage share was occupied by individuals in the age group 3-3+, followed by 2-2+. The second semester shows that the age groups of 2-2+ and 3-3+ have an equal share - 40% and significantly prevail over the others. The age groups 0-0+ and 1-1+ are under 5%. During this semester we observe an increase in older individuals compared to the previous one.

3) In the analysis (age slicing) of size-frequency samples for determining the growth parameters of the red mullet, only ELEFAN RSA gave relatively good results, the results of the other two methods showed average lengths for 5-year-old specimens of the order of 10 cm, which is not typical for the species and the probable reason is an insufficient number of measurements and poor representation of the size structure in the samples. The latter is expected when determining growth parameters based on samples that do not represent the development of the species on an annual basis.

4) The graph shows that during the first six months K is highest for size classes 13.0-13.5-14.0 cm.

5) A gradual increase in average weight is observed across age groups. The 0-0+ age group has the lowest average weight, while the 4-4+ age group has the highest average weight.

6) The resulting model is statistically significant, the value of the scaling coefficient a in the length-weight relationship model $W_i = aL_i^b$ is: **a=0.00** and the allometry coefficient **b=3.52**, which indicates positive allometric growth of the species **in the first half of the year**, or the increase in weight is proportional to or greater than the

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increase in length. The resulting model is statistically significant, the value of the scaling coefficient a in the length-weight relationship model $W_i = aL_i^b$ is: **a=0.009**, and the allometry coefficient **b=3.06**, which indicates positive allometric growth of the species **in the second half of the year**, or the increase in weight is proportional to the increase in length.

7) In the first half of 2024, there was no portion reproduction of the species, as it is a summer breeder. During the second half of the year, the portion fecundity (Log F) versus the weight of the red mullet (Log W) showed a very strong relationship (R^2=0.9093), which proves a very strong dependence of fecundity on individual weights. This fact is indicative of the fact that the species is in an active phase of reproduction and portion ejection of the sexual products.

V. Biological monitoring of anchovy (*Engraulis encrasicolus*)

V.1 Objectives

The purpose of biological monitoring is to collect data that will be used to analyze anchovy catches, as well as to form a database. The collection of biological samples of anchovy catches in **2024** includes the following tasks:

1. To collect and analyze the dynamics of length, weight and age distribution.
2. To determine the state of the of anchovy using the so-called state factor (Ricker, 1975).
3. Characteristics of the reproductive biology of anchovy.
4. Collection of data on ports of landing, sampling vessels, number of samples collected, number of specimens tested, geographical catch data.

V.2 Sampling

The sampling was carried out by the actively operating fishing fleet in Bulgaria.

V.2.1 Geographic area coverage

Data of present analysis were collected from Bulgarian Black Sea coast. In **2024, 4 samples with 505 specimens** were collected and processed. Information on the size of the catches was also collected.

V.2.2 Sampling period

In **2024**, the biological data for the species were collected from a total of **4 landings at the ports of Nesebar Burgas, Balchik and Sozopol**. Ports and ships from which monitoring was carried out to collect biological data from landings are presented in **Table V.2.2.1.**

Table V.2.2.1 Ports and ships from which monitoring was carried out to collect biological data of anchovy landings.

№	Date	Sampling ports	ANE	Fishing vessel	External marking	Fishing gear	Catch/kg	Coordinates
1	4.1.2024	Nesebar	ANE	R/K 40	BS258	OTM	470	42.6438 27.7598
2	3.6.2024	Burgas	ANE	VALNOBOR	BS390	OTM	200	42.3667 27.85625
3	2.8.2024	Balchik	ANE	VN 3341	VN 3341	OTM	30	43.410400 28.349600
4	10.12.2024	Sozopol	ANE	RK 28	BS221	OTM	2352	42.449600 27.638300

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V.2.3 Statistical analysis of data

See section statistical analysis of sprat.

V.3 Results

V.3.1 Landings statistics

Anchovy landings are highest in January and December 2024. No OTM catches are observed in February, March, April and May (**Fig. I.3.1.2).**

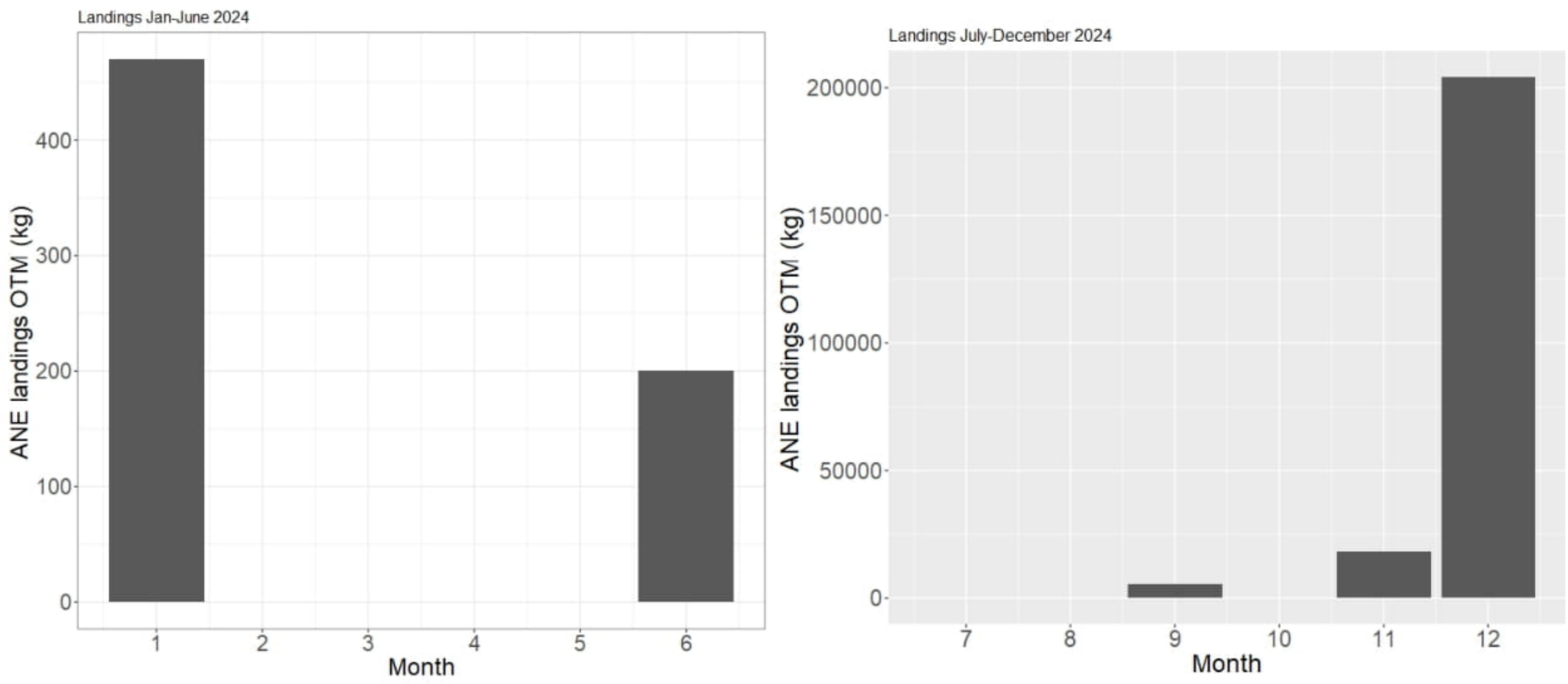


Figure V.3.1.1 Anchovy landing statistics.

V.3.2 Length structure of landings

The size structure during the period I-III month of 2024. would show a bimodal distribution with a peak at size group 9.5 and 10.0 cm. An increase in the percentage of individuals from the size group 11.00 cm is also noticed. During the months IV-VI, an increase in the percentage of size groups 9.5 and 12.0 cm was found in the catches (Figure V.3.2.1).

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From the distribution of individuals by size groups in the first quarter of 2024, it is found that the groups 9.5 cm and 10 are represented most massively with 21.64% and 19.40%. Fish with a body length in the range of 11 cm represent 17.91% of the catch, followed by 10.5 cm with 13.43%. Anchovy with a body length in the range of 12 cm are 9 pieces, which represents 6.72%. The graph shows that in both quarters the percentage distribution of catches by size classes is uneven. In the second half of the year, the individuals with the highest values are in the size classes of 9.5 cm (15.70%) and 12 cm (16.53%), and the size classes of 10 and 11 cm with the lowest percentage value are, respectively, with 9.91% and 9.09%.

In the second half of the year, the graph shows that in both quarters the percentage distribution of catches by size class is uneven. In the third quarter, the highest values were for individuals in the size classes of 9.5 cm (24.82%) and 11.5 cm (12.05%), and the lowest percentage value was for the size classes 12-12.5 cm below 3%. In the fourth quarter, the highest values were for individuals in the size classes 11 (20.18%) and 12 cm (22.94%), and the lowest percentage value was for the size classes 9 (3.66%) and 13 cm (0.92%).

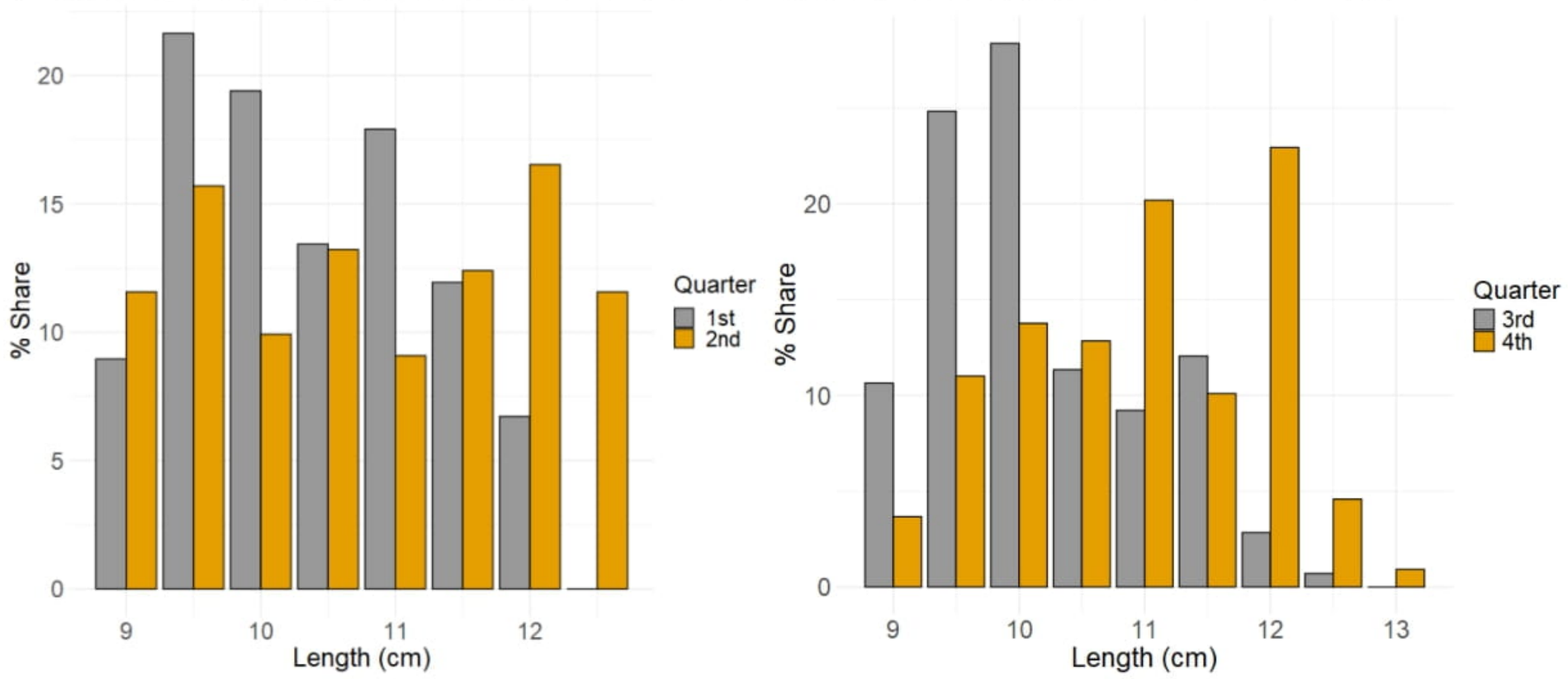


Figure V.3.2.1 Percentage representation of anchovy size classes in the composition of catches in the in the first and second semesters of 2024.

V.3.3 Age structure of landings

505 fish (255 in the first and 250 in the second semester) were used for age determination.

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In the first quarter, the highest percentage is occupied by individuals in the age group 2-2+, followed by 3-3+. The age group 4-4+ has the lowest share. The second quarter shows that the age groups of 3-3+ and 4-4+ significantly prevail over the others (Figure V.3.3.1).
The graph shows a gradual increase in the catch values for anchovy (%) for the first quarter, with the age group 1-1+ having the lowest possible catch values of 22.39%, and 3-3+ having the highest percentage performance in catches - 37.31%. In the second half of the year, catch results are best represented in the groups 3-3+, and 4-4+ with 29.75% and 30.57% respectively. In the second quarter, the distribution by age showed the presence of age groups 1-1+ with 16.53% and 2-2+ with 23.14%. In the third quarter, the highest percentage share – 42.55% is occupied by individuals in the age group 3-3+, followed by 2-2+ with 32.62%. With the lowest share – about 7% is the age group: 4-4+. The fourth quarter shows that again the age group of 3-3+ has the highest – 50.46% and significantly prevails over the others. Below 8% are the age groups 1-1+. In this quarter, we observe equal participation of 2+ and 4+ year olds with 20.18% and 22.02% respectively.

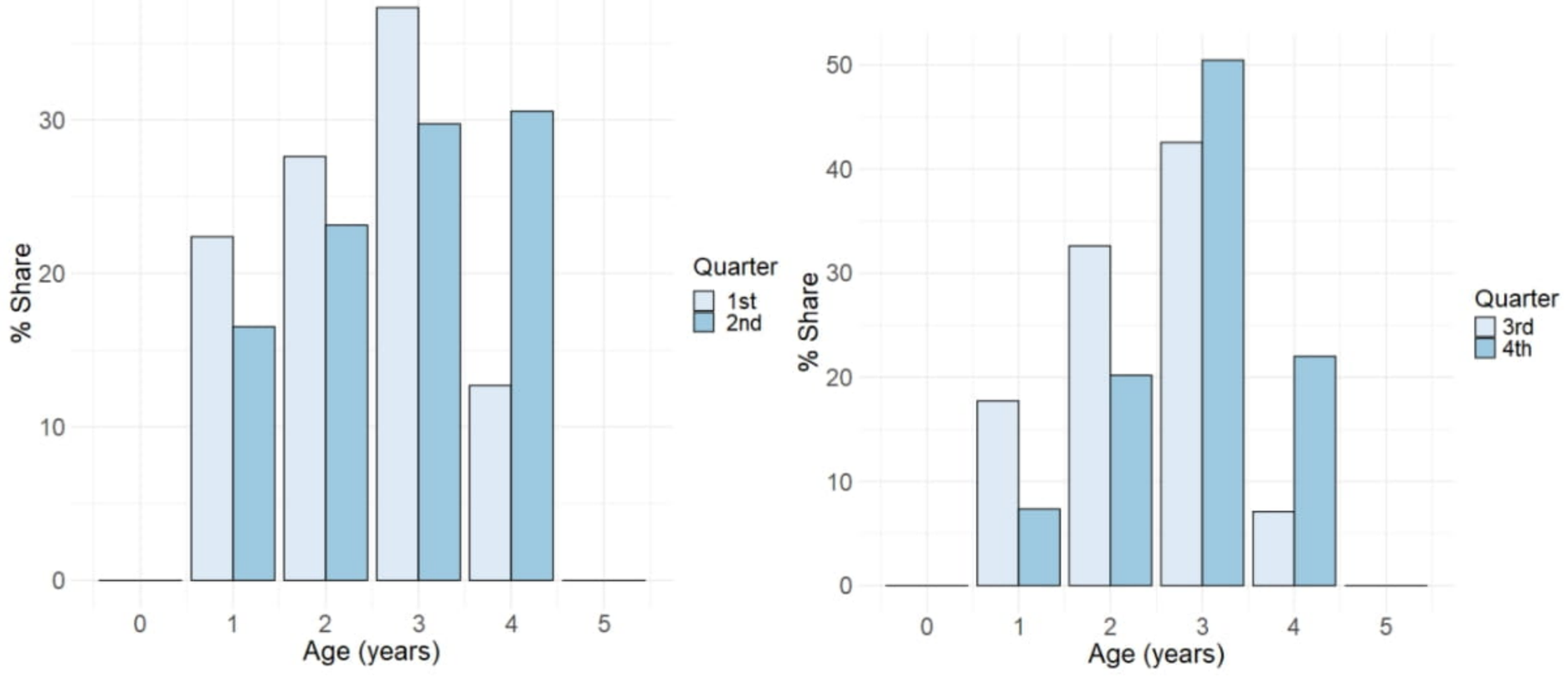


Figure V.3.3.1 Percentage representation of anchovy age groups in the catch composition in the in the first and second semesters of 2024.

In the analysis (age slicing), the size-frequency samples for determining the growth parameters of the anchovy gave relatively good results only ELEFAN RSA, the results of the other two methods showed an average length for 5-year-old specimens of the order of 9 cm, which is not characteristic of species and the probable cause is insufficient measurement of the number and poor representation of the size structure in the samples. The latter is expected

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when determining growth parameters based on samples that do not represent the development of the species on an annual basis.

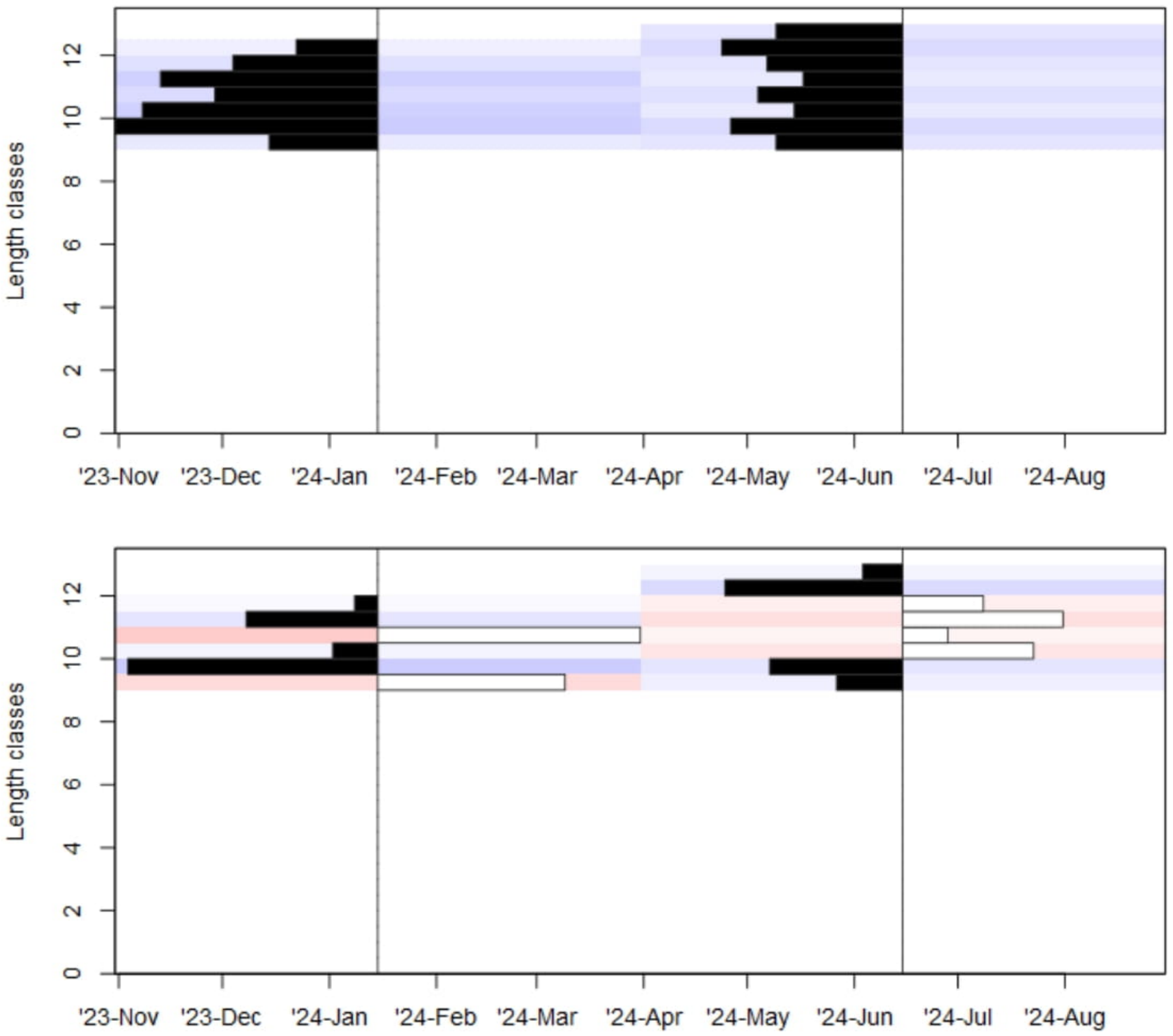


Figure V.3.3.2 Size-frequency samples, visualized as (top diagram) number of individuals in size class and (bottom diagram) the restructured data with moving average MA = 5 for the purposes of frequency analysis and determination of growth parameters.

V.1.3.3.1 Frequency analysis RSA – response surface analysis

Growth parameters determined by RSA with initial conditions: conditional interval of for the asymptotic length L_∞ in the sample [12;15 cm] (based on a literature review on the characteristics and biological potentials of the species for the Black Sea) and the parameter

that determines the growth rate to L_∞ - $K = \exp(seq(from\ log(0.1), to\ \log(1))$ with an upper limit for $L_\infty = 15$ cm (**Figure V.1.3.3.1.1**).

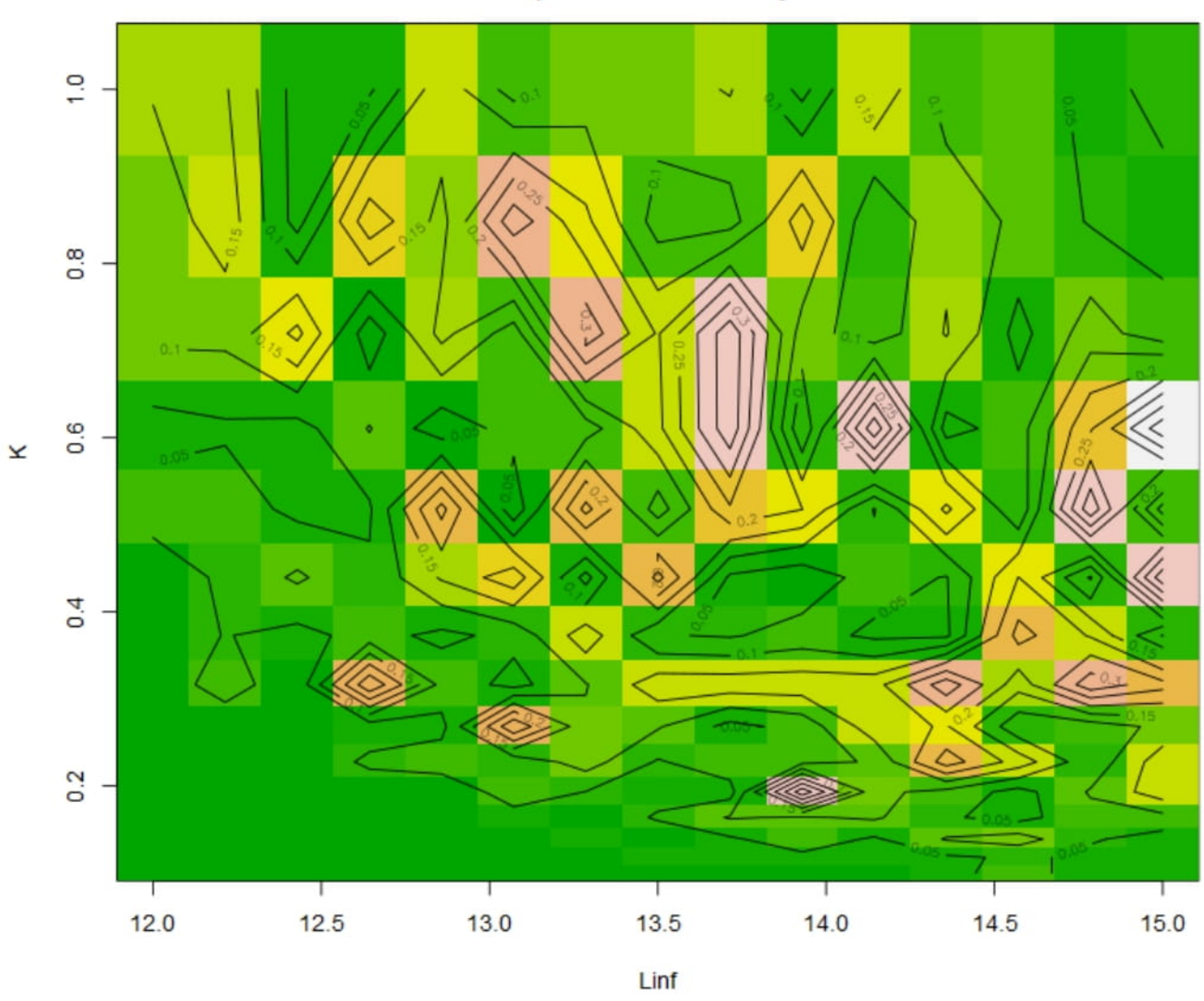


Figure V.1.3.3.1.1 Contour plot visualizing the identified asymptotic length L_∞ and the corresponding value of the parameter K in the defined intervals.

The parameters in the von Bertalanffy model were calculated as follows: **L_∞=15.00 cm; K = 0.61 and t_0=-0.33.** The ages with their corresponding lengths (**Table V.1.3.3.1.1**) were calculated using the latter and compared with the experimentally determined ones.

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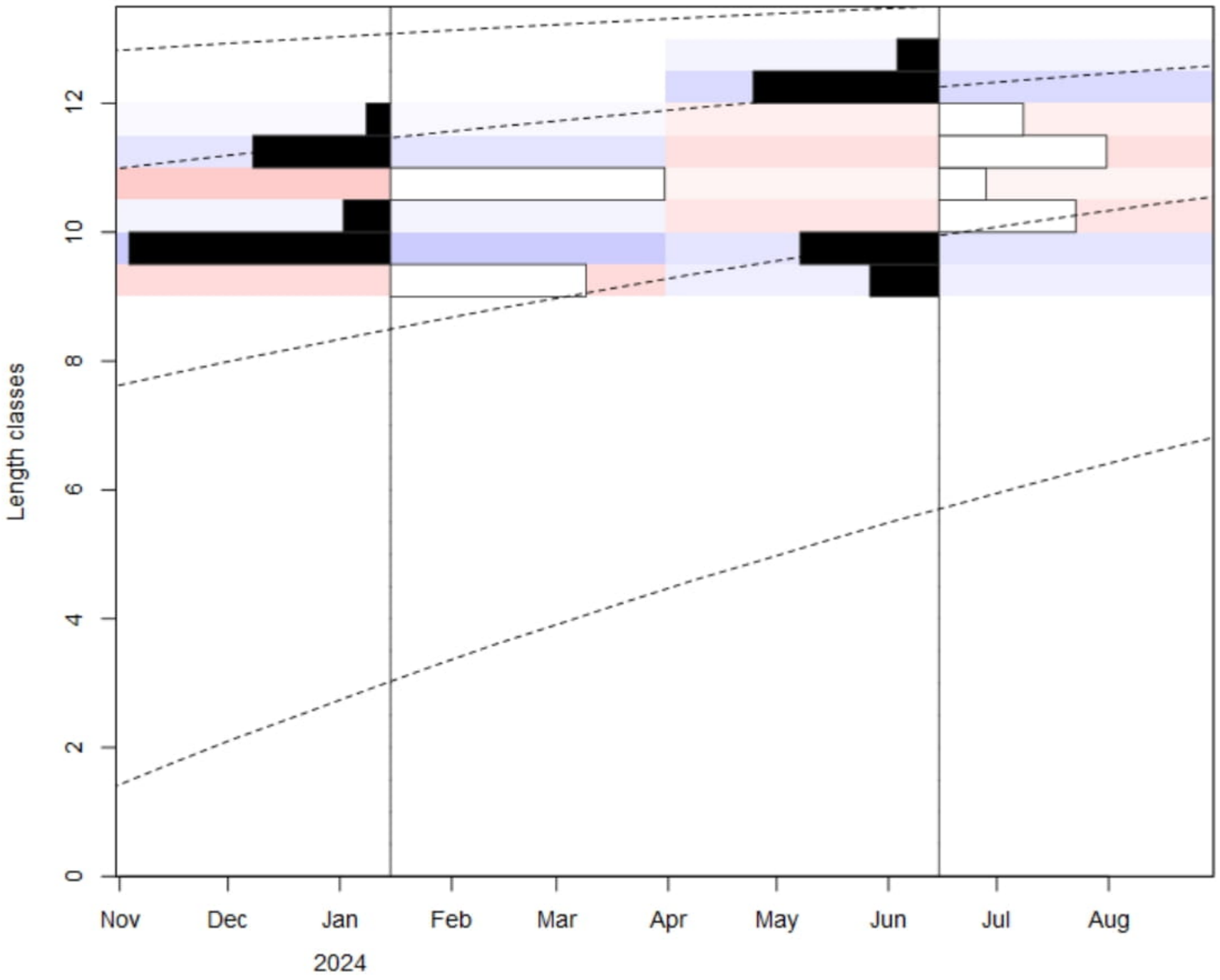


Figure V.1.3.3.1.2 Growth curves determined with ELEFAN RSA, visualized on the restructured data for the purpose of visualizing the tracking of cohorts over time.

Table V.1.3.3.1.1 Ages with their corresponding lengths for the studied species calculated using von Bertalanffy parameters, obtained with RSA and compared with experimentally determined ages from otoliths.

	ELEFAN RSA	**Experimentally determined**
age	La	L_{mean}
0	2.7	
0.5	6.0	-
1	8.3	
1.5	10.1	9.25
2	11.4	9.75

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2.5	12.3	
3	13.0	
3.5	13.5	11
4	13.9	
4.5	14.2	12
5	14.4	-

Given the results obtained, the analysis of growth parameters should be repeated again at the end of the year, when richer biological information about the species will be available.

V.1.3.3.2 Честотен анализ ELEFAN with simulated annealing (ELEFAN SA)

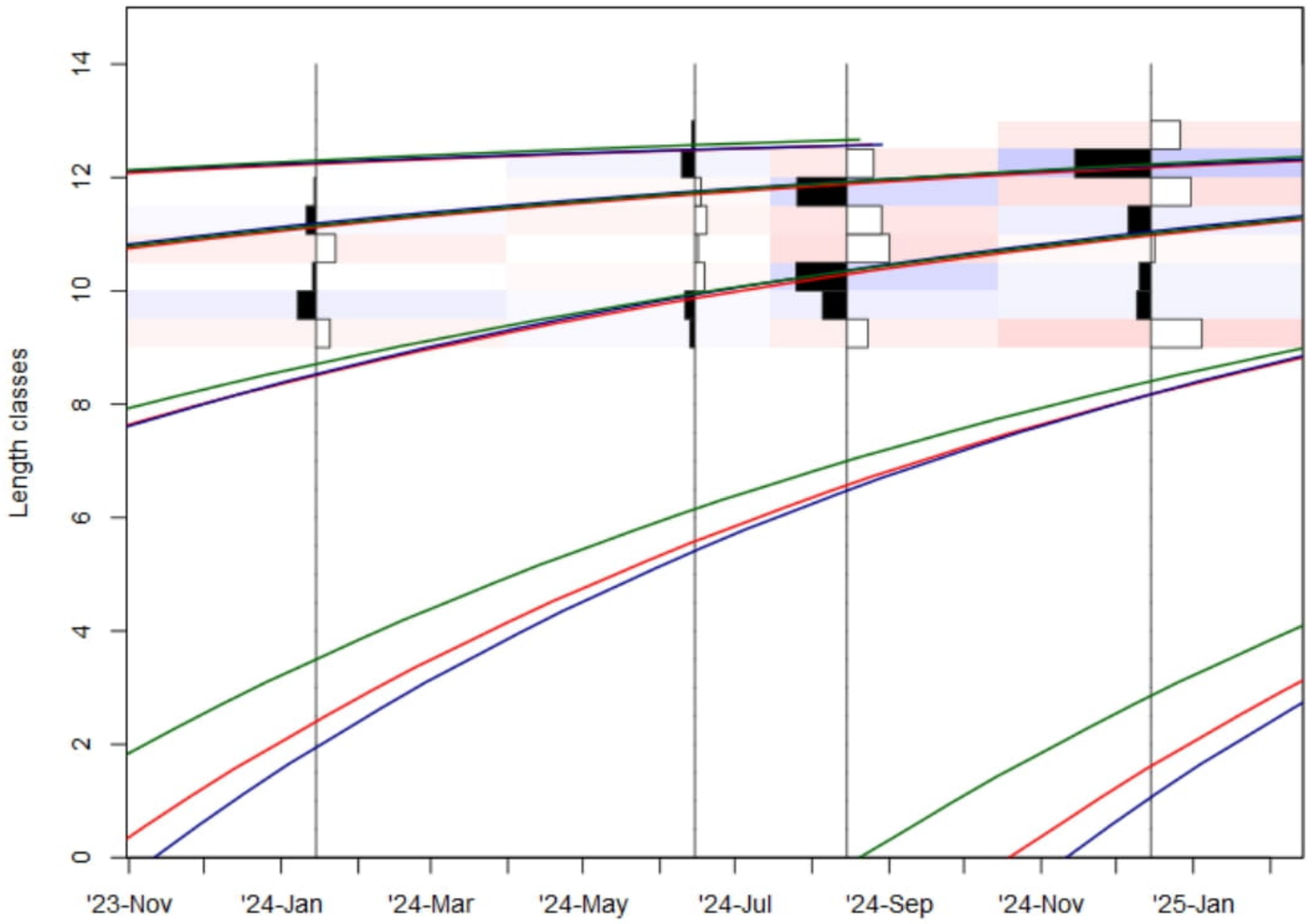
Параметрите на растежа, опредеделени при начални условия: условен интервал на за асимптотичната дължина $L_{\infty_{guess}} = 13.75$ см и търсене на стойност L_∞ в интервала $[L_{\infty_{guess}} * 0.8 \div L_{\infty_{guess}} * 1.2]$, а за K в интервала $[0 \div 1]$.

Параметрите в модела на фон Берталанфи са изчислени както следва: $\mathbf{L_\infty = 12.99}$ **см;** $\mathbf{K = 0.91}$ **и** $\mathbf{t_0 = -0.14}$. По последните са изчислени възрастите със съответстващите им дължини (**Таблица V.1.3.3.3.1**).

V.1.3.3.3 Честотен анализ ELEFAN – Genetic algorithm (ELEFAN GA)

Параметрите на растежа, опредеделени при начални условия: условен интервал на за асимптотичната дължина $L_{\infty_{guess}} = 12.25$ см и търсене на стойност L_∞ в интервала $[L_{\infty_{guess}} * 0.8 \div L_{\infty_{guess}} * 1.2]$, а за K в интервала $[0 \div 1]$.

Параметрите в модела на фон Берталанфи са изчислени както следва: $\mathbf{L_\infty = 13.31}$ **см;** $\mathbf{K = 0.76}$ **и** $\mathbf{t_0 = -0.36}$. По последните са изчислени възрастите със съответстващите им дължини **(Таблица V.1.3.3.3.1).**



Фигура V.1.3.3.3.1 Растежни криви (с червено по растежните параметри, определени с ELEFAN RSA, със синьо по ELEFAN SA, и със зелено по ELEFAN GA), визуализирани върху реструктурираните данни с цел визуализация на проследяването на кохортите във времето.

Таблица V.1.3.3.3.1 Възрасти с кореспондиращите им дължини за изследвания вид изчислени по параметрите на фон Берталанфи, получени с RSA и съпоставени с експериментално определените възрасти по отолити.

	ELEFAN RSA	**ELEFAN SA**	**ELEFAN GA**	**Експериментално определени**
възраст	La	La	La	$L_{средно}$
0	2.0	3.2	1.5	
0.5	5.9	6.4	5.7	n/a
1	8.4	8.6	8.4	
1.5	10.0	10.1	10.1	9.25

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2	11.1	11.1	11.1	
2.5	11.8	11.8	11.8	9.75
3	12.2	12.3	12.2	
3.5	12.5	12.6	12.5	11
4	12.7	12.8	12.7	
4.5	12.8	13.0	12.8	12.25
5	12.9	13.1	12.9	n/a

V. 3.4 Condition factor

The graph **(Fig.V.3.4.1)** shows that K is highest for size classes 11-12.5 cm. The remaining size groups also have good condition, which indicates food security and good physiological condition.

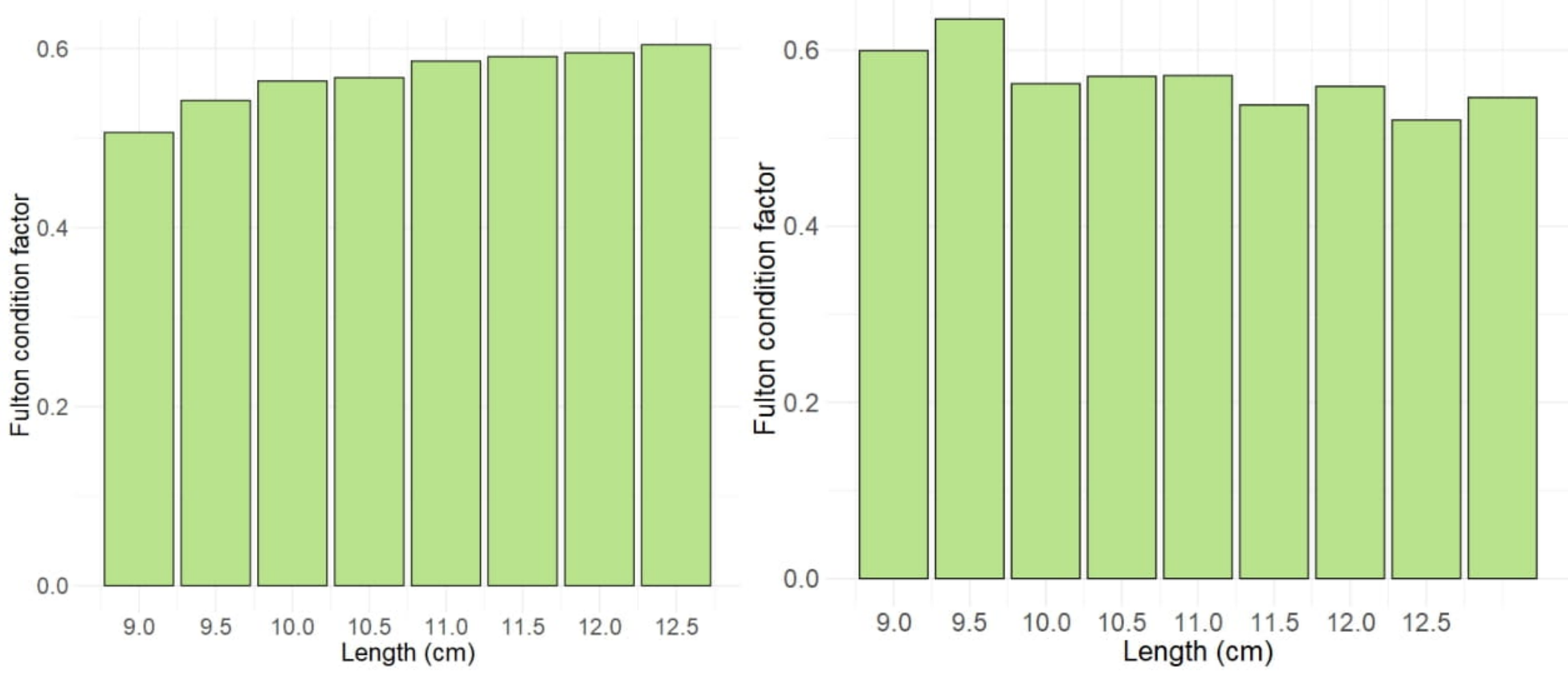


Figure V.3.4.1 Fulton condition factor by anchovy size classes for the for the first and second semester of 2024.

Fig. V.3.4.2 shows that the second and fourth age groups have the highest values. It is necessary to note the extremely high values throughout the spring season, at all ages. The values in June varied between 0.57-0.59, with an average for the month of 0.58. Similar coefficients were again recorded in July: 0.48-0.65, with an average of 0.52. Thus, in both six

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months, K did not show fluctuations from the average multi-year data. These values are even higher than those recorded in the previous year of 2023 – 0.51.

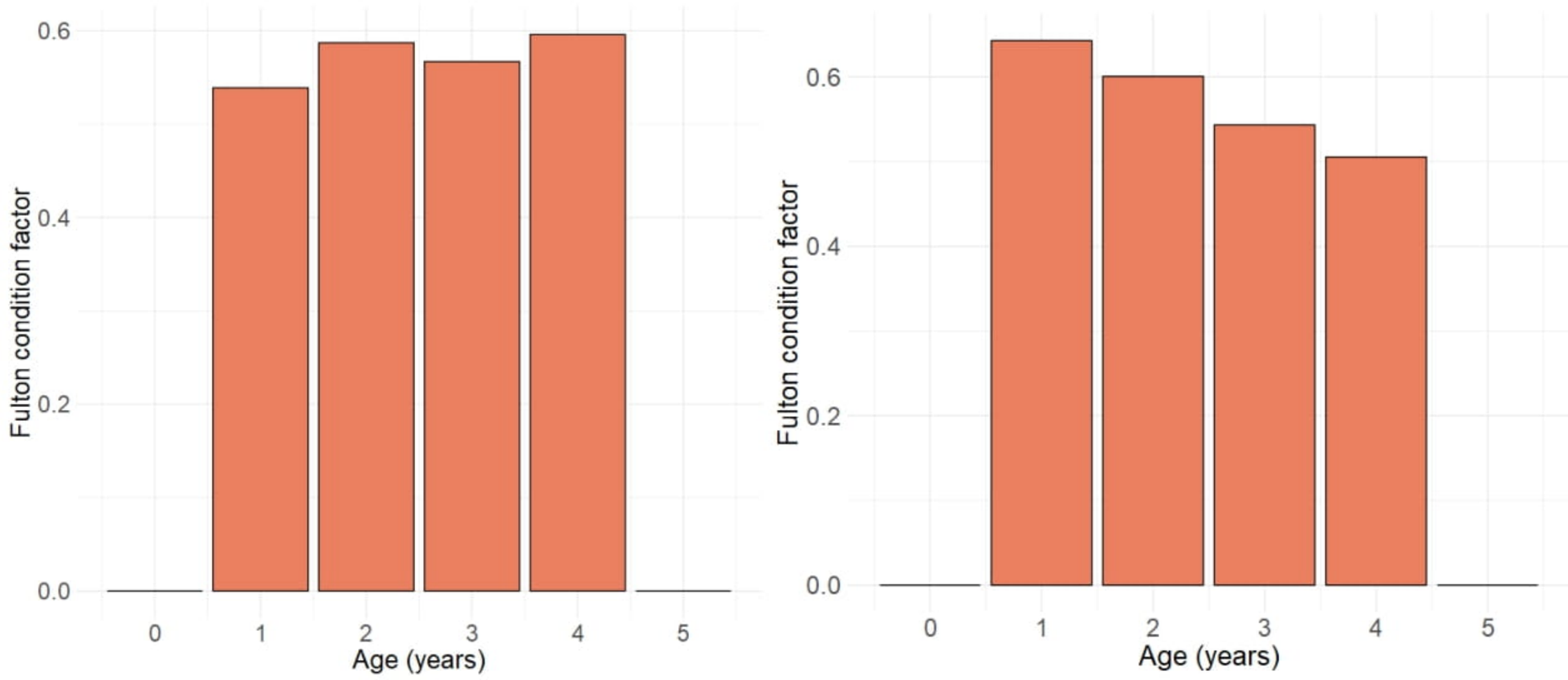


Figure V.3.4.2 Fulton condition factor by age group of anchovy for the first and second semester of 2024.

V3.5 Weight structure of anchovy

The weight of 505 fish (255 in the first and 250 in the second semester) was measured.
There was a smooth increase in average weight across age groups for both the first and second trimesters. For age group 1-1+, the lowest average weight is 4.26g (50 number of anchovy), and for group 4-4+, the highest average weight is observed -10.29g (54 number). For the other age groups, the weights are as follows: 2-2+-5.44g (65 number); 3-3+-7.55g (86 number)(**Fig. V. 3.5.1**). In the second half of the year, the age group 1-1+ had the lowest average weight - 5.08g (33 anchovies), while the 4-4+ group had the highest average weight - 9.29g (34 anchovies). For the other age groups, the weights were as follows: 2-2+ -5.57g (68 anchovies); 3-3+ -7.23g (46 anchovies).

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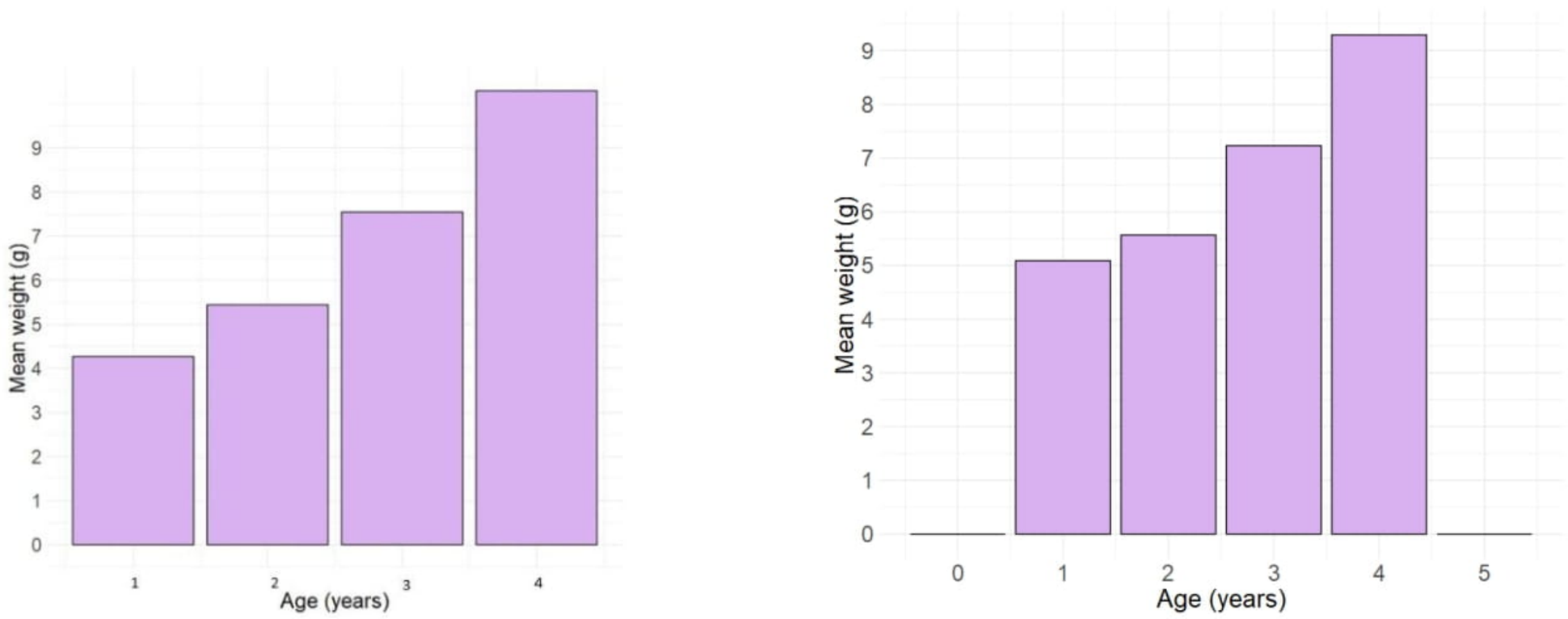


Figure V.3.5.1 Distribution of average anchovy weight by age groups for first and second semester of 2024.

The 9.5cm size class, which is the most numerous and is represented by 48 number of anchovy (18.82%), has a measured weight of 4.65g, with the highest weight recorded at 12.5 cm (participating with 5.49%) - 11.8 g.

During the second semester, the 10 cm size class, which is the most numerous and is represented by 55 pieces (22%), measured a weight of 6.60 g, with the highest weight recorded at 13 cm (participating with 0.4%) - 12 g.

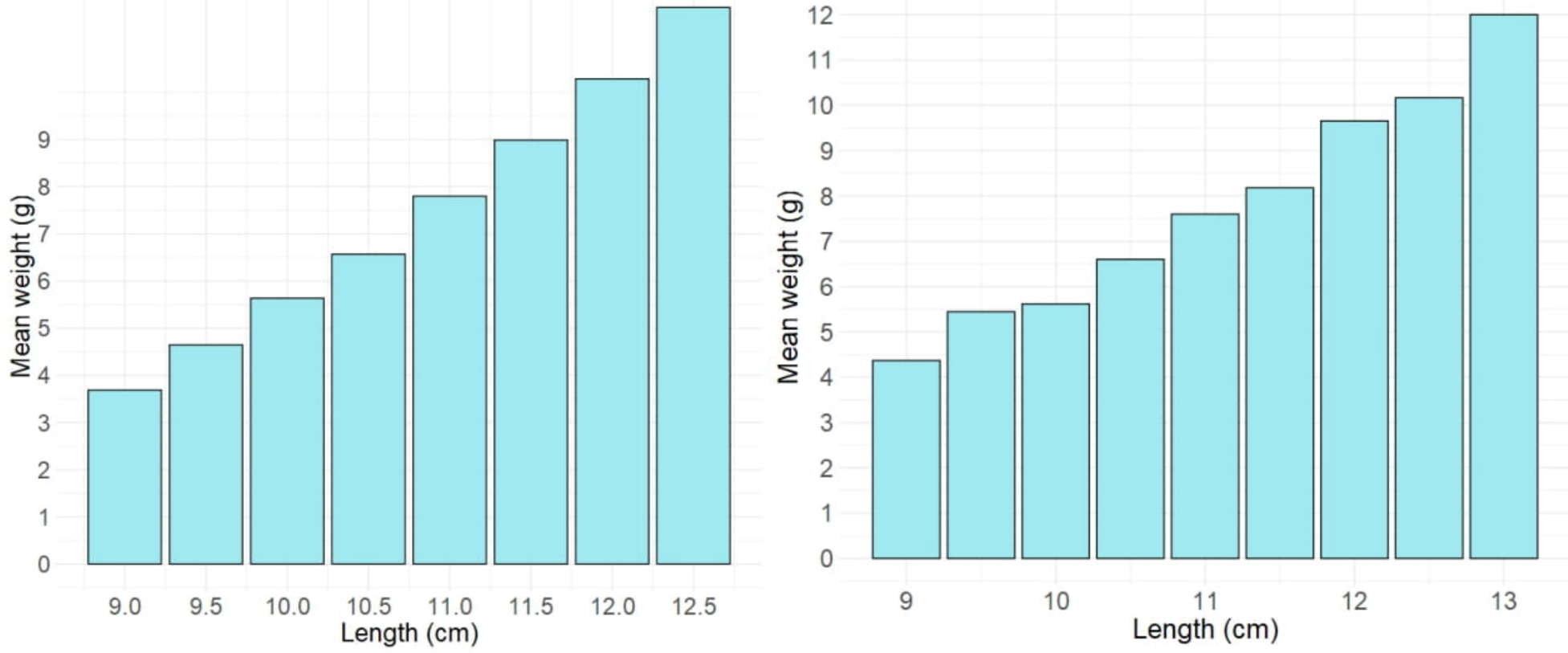


Fig. V.3.5.2 Distribution of average anchovy weight by size groups for first and second semester of 2024.

V.3.6 Size structure of whiting by age group

The length of **505 fish (255 in the first and 250 in the second semester)** was measured. A gradual increase in the average length values is observed across age groups. The lowest average length value is in the age group 1-1+, and the highest is in the group 4-4+ years (**Table III.3.6.1).**

Table III.3.6.1 Size structure of anchovy by age groups.

Age	L_{mean}/cm	Age	L_{mean}/cm
I-VI		**VII-XII**	
1-1+	9,30	1-1+	9,33
2-2+	9,91	2-2+	9,78
3-3+	10,88	3-3+	10,84
4-4+	11,98	4-4+	11,94

V.3.7 Length- weight relationship

The resulting model (**Table V.3.7.1**) is statistically significant, the value of the scaling coefficient a in the length-weight relationship model $W_i = aL_i^b$ e: **a=0.002**, and the allometry coefficient **b=3.49**, which indicates positive allometric growth of the species **in the first half of the year**, or the increase in weight is proportional and greater than the increase in length.

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Table V.3.7.1 Results of modeling the length-weight relationship during the second semester.

```
Call:
lm(formula = logW ~ logL, data = weight_1)

Residuals:
      Min        1Q    Median        3Q       Max
-0.032928 -0.011526  0.004883  0.010963  0.023397

Coefficients:
            Estimate Std. Error t value      Pr(>|t|)
(Intercept) -6.31886    0.15513  -40.73 0.00000001464 ***
logL         3.48504    0.06541   53.28 0.00000000293 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.01987 on 6 degrees of freedom
Multiple R-squared:  0.9979, Adjusted R-squared:  0.9975
F-statistic:  2839 on 1 and 6 DF,  p-value: 0.000000002935
```

The resulting model (**Table V.3.7.2**) is statistically significant, the value of the scaling coefficient a in the length-weight relationship model $W_i = aL_i^b$: **a=0.014**, and the allometry coefficient **b=2.61**, which indicates positive allometric growth of the species **in the second half of the year**, or the increase in weight is proportional and greater than the increase in length.

Table V.3.7.2 Results of modeling the length-weight relationship during the second half of the year.

V.3.8 Sex ratio

The sex ratio was determined on **250 specimens(100** in the first and **150** in the second half of the year). Females predominate over males.

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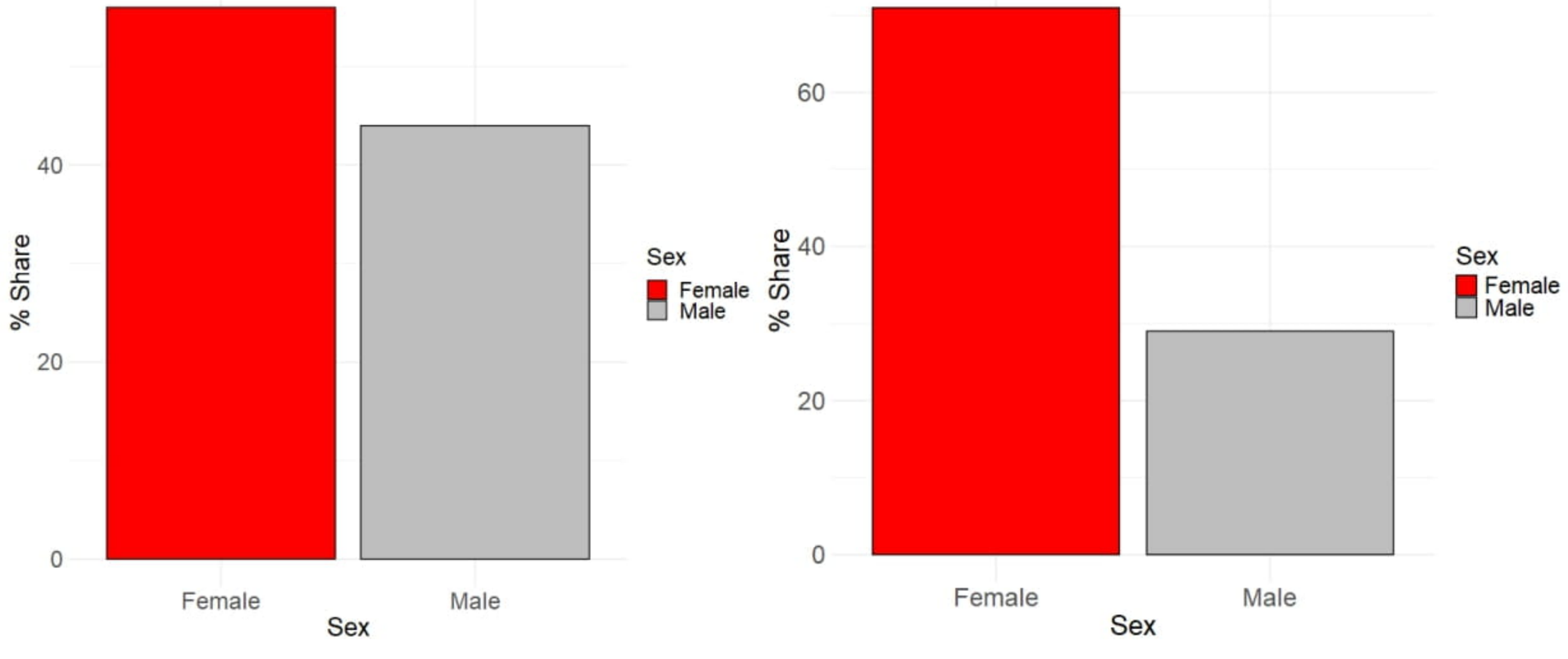


Figure V3.8.1 Anchovy sex structure.

The average lengths of females♀ by age group are higher (**Figure V.3.8.2**).

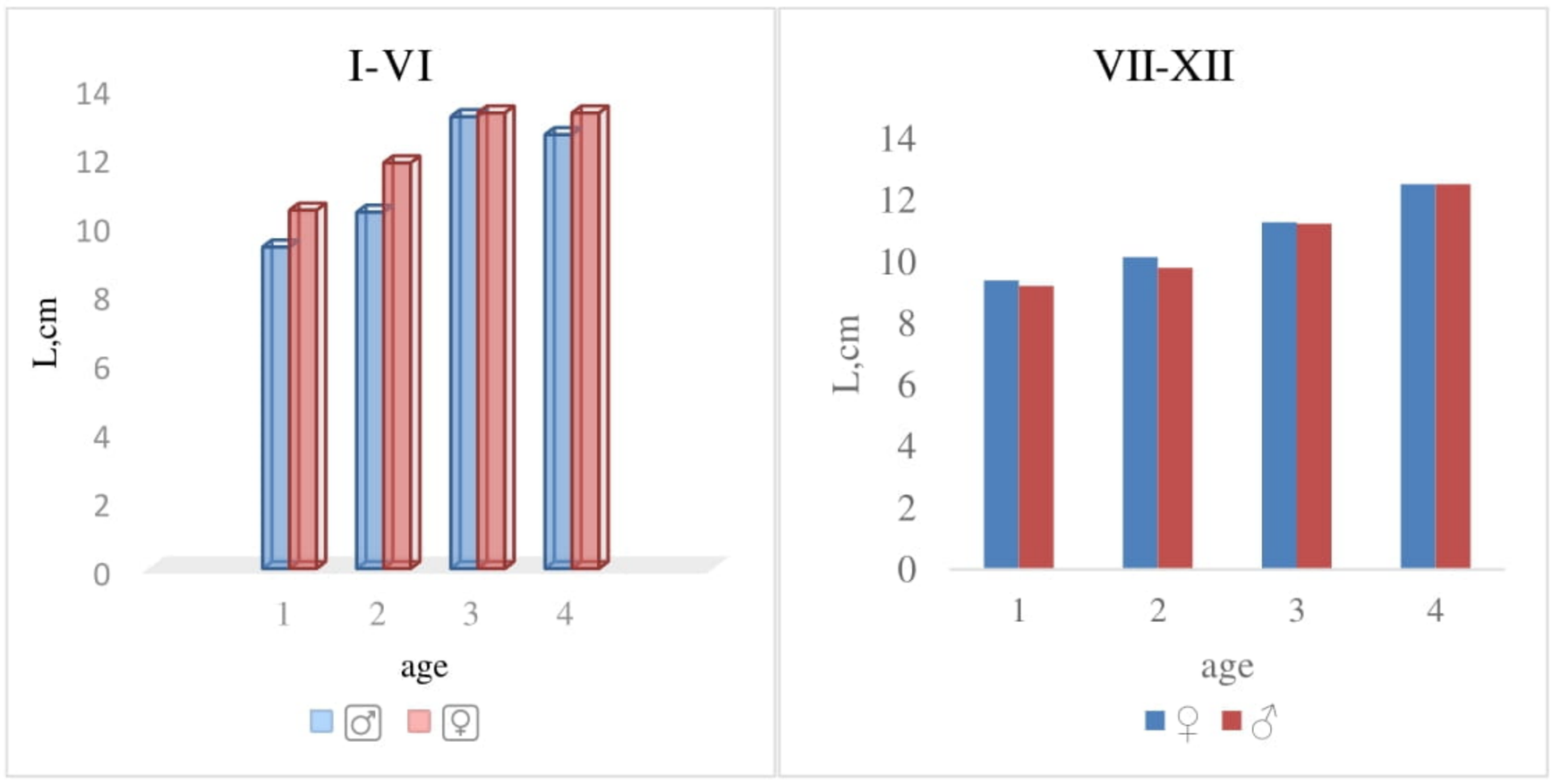


Figure V.3.8.2 Sex ratio(♂♀) by size and age of anchovy.

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V.3.9 Fertility

Fertility was determined on **100 specimens**. During the first semester the gonadosomatic index is not strongly dependent on the weight of the gonads (R^2=0.6271), which is associated with the not-high rate of maturation of the females **(Figure V.3.9.1).**

During the second semester, the gonadosomatic index for anchovy varied within narrow limits, with a pronounced correlation between the gland weight of the measured specimens (R^2 = 0.8945) **(Fig.V.3.9.1).**

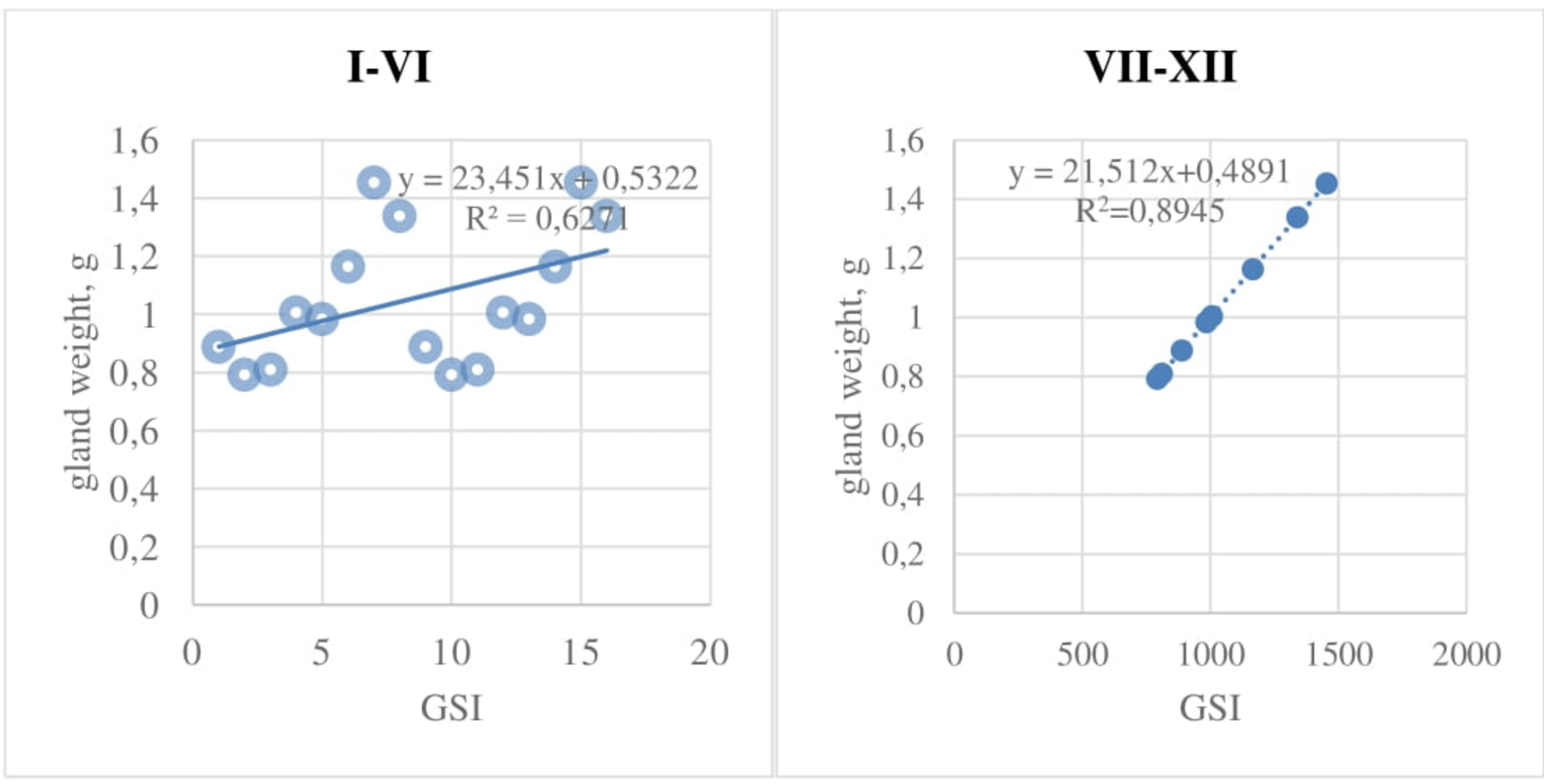


Figure V. 3.9.1 Dependence of gland weight on gonadosomatic index (GSI).

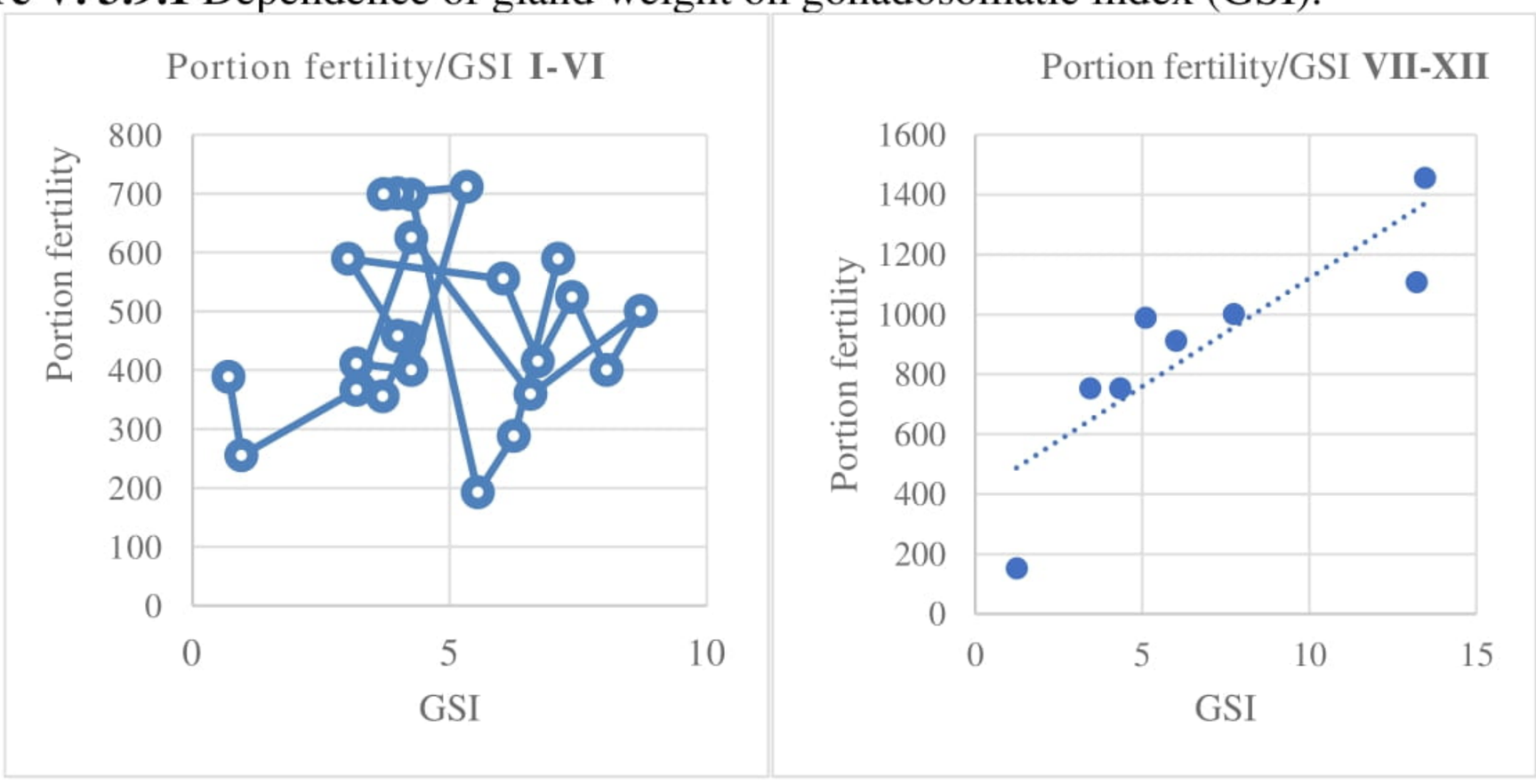


Figure V.3.9.2 Portion fertility to GSI of anchovy.

The average absolute fecundity was estimated at 6814.19 eggs in the first and 8882.556 in the second semester. The average relative fecundity was 890.236 in the first and 1117.955 in the second semester **(Table V.3.9.1).**

Table V.3.9.1 Absolute and relative fertility.

I-VI					VII-XII				
Size class	**W average, g**	**Absolute fertility F, caviar grains)**	**Relative fertility**	**N♀**	**Size class**	**W average, g**	**Absolute fertility F, caviar grains)**	**Relative fertility**	**N♀**
9	4,57	3440	752,735	10	**9**	4,37	3620	828,675	2
9,5	5,75	4331	753,217	10	**9,5**	5,45	4815	884,004	12
10	5,16	5103	988,953	7	**10**	5,62	6122	1089,676	11
10,5	6,58	6002	912,158	7	**10,5**	6,60	7201	1091,061	8
11	7,73	7732	1000,26	7	**11**	7,60	8102	1066,053	7
11,5	8,12	1235,5	152,155	3	**11,5**	8,18	11860	1450,131	3
12	9,25	13459	1455,03	3	**12**	9,66	14211	1471,854	2
12,5	11,93	13211	1107,38	3	**12,5**	10,17	11921	1172,557	2
					13	12,00	12091	1007,583	3
		6814,19	890,236	50			8882,556	1117,955	50

V.3.10 Sexual maturity

Sexual maturity was determined on **250 specimens**. All examined specimens showed degree of gonad discharge (V- III) grade.

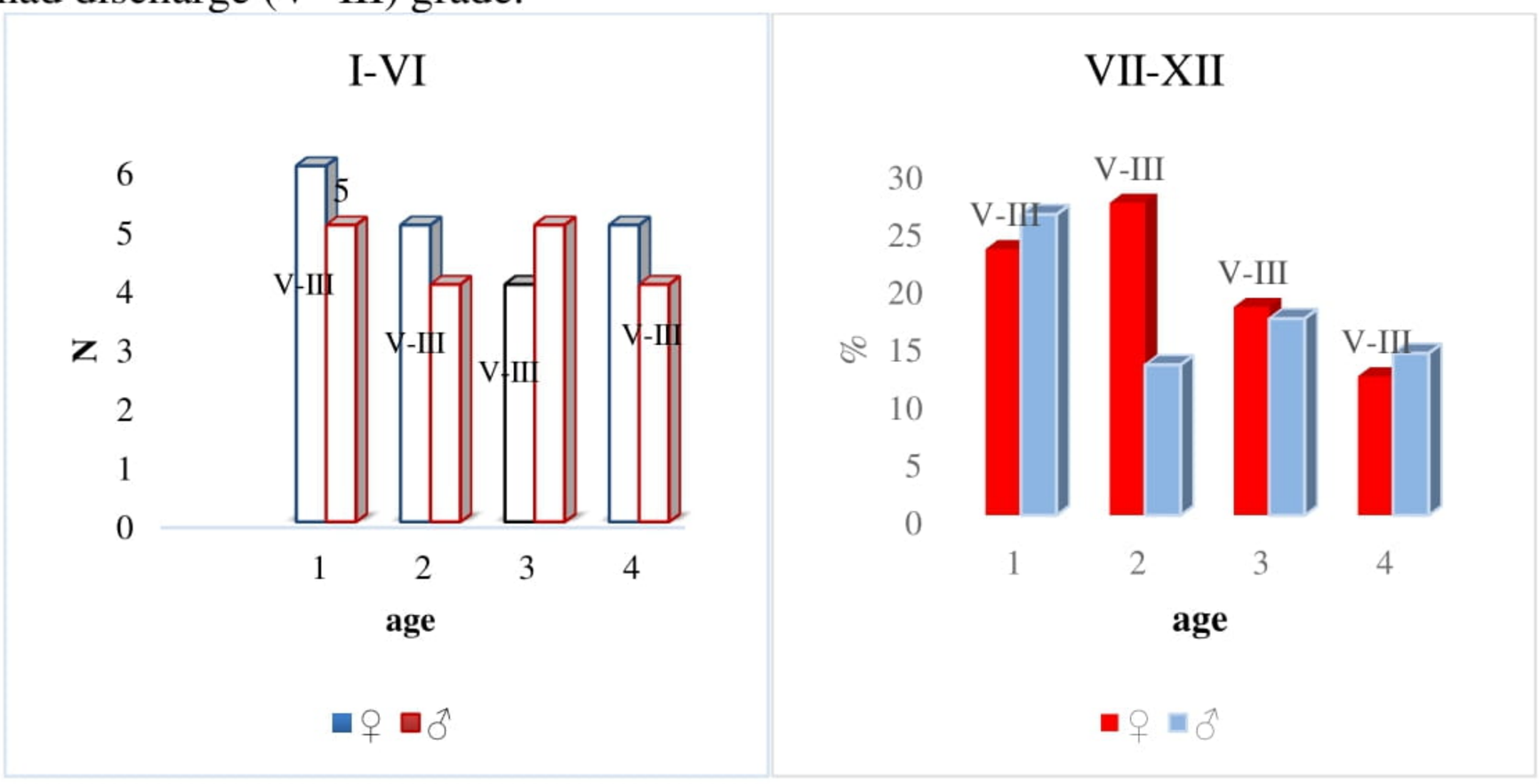


Figure V.3.10.1 Sexual maturity by age of anchovy - female (♀) and male (♂).

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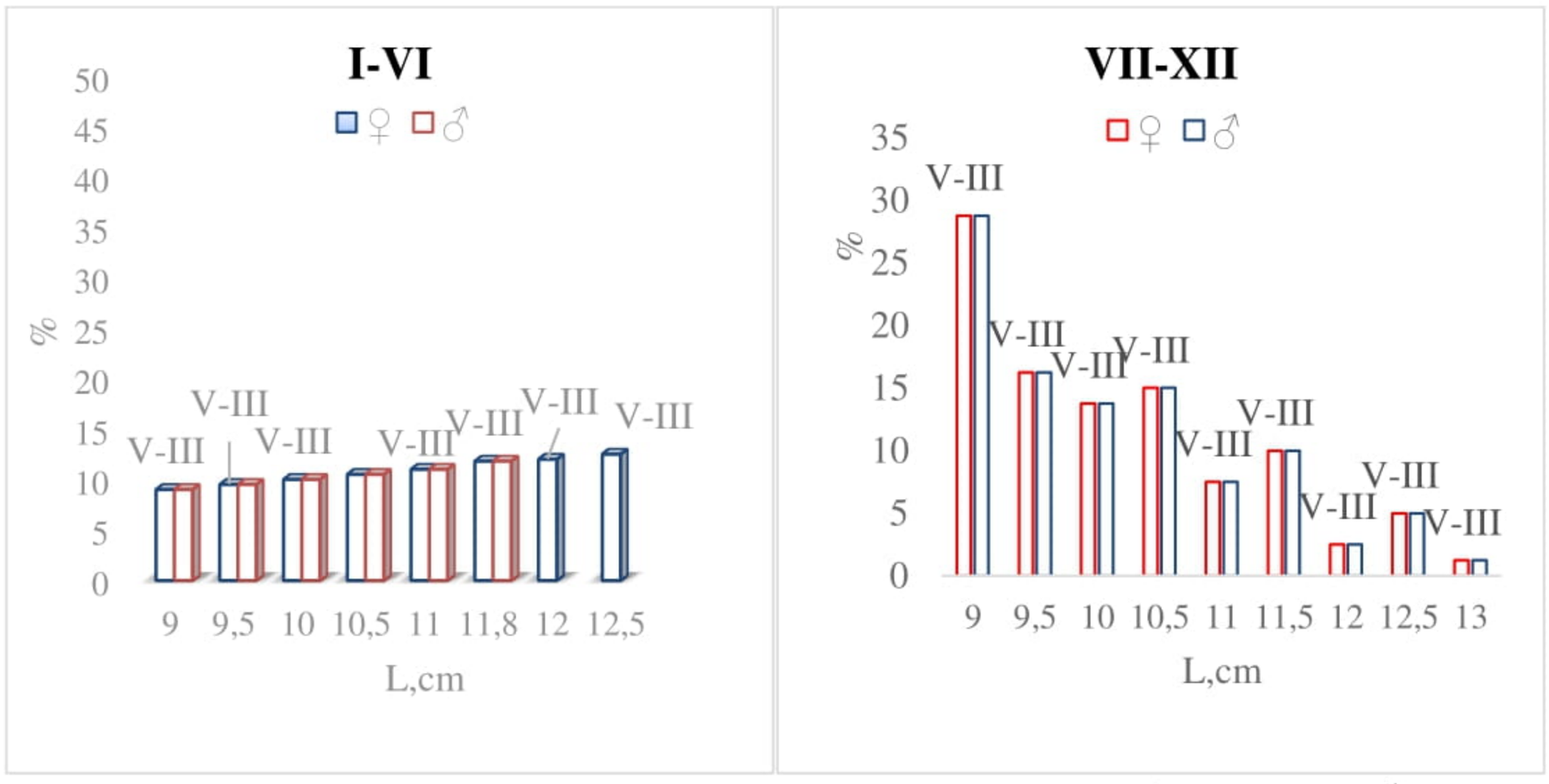


Figure V.3.10.2 Sexual maturity in length (cm) of anchovies - female ♀ and male ♂.

V.3.11 Catch numbers and biomass by age and length

Monthly OTM catches (in kilograms) together with average weights were used to obtain the abundance and biomass of the species by quarter in the reported catches (**Table V.3.11.1-2**).

Table V. 3.11.1 Catch matrix by age (10^{-6}) and biomass (kg) of anchovy with OTM.

Catch at age				
Age groups	***Ith quarter***	***IInd quarter***	***III rd quarter***	***IVth quarter***
1-1+	21.61	9.1964	156.900	5779.17
2-2+	22.02	9.3698	295.454	10882.60
3-3+	21.01	8.9399	384.667	14168.61
4-4+	9.67	4.1142	88.493	3259.52
∑	74.31	31.6202	925.51	34090
Biomass (kg)				
Age groups	***Ith quarter***	***IInd quarter***	***III rd quarter***	***IVth quarter***
1-1+	92.157	39.2157	798.204	29400.624
2-2+	119.804	50.9804	1644.78	60583.104
3-3+	158.510	67.451	2781.620	102456.72
4-4+	99.529	42.3529	822.392	30291.552
∑	470	200	6047	222732

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Table V.3.11.2. Number of individuals (x10^{-6}) in the catch by size class (for OTM) and biomass of the of the anchovy.

*Catch in numbers*10^{-6} 2024*				
Length group (cm)	***Ith quarter***	***IInd quarter***	***III rd quarter***	***IVth quarter***
9.0	12.987	5.526	92.50	3407.045
9.5	18.637	7.931	208.72	7687.734
10.0	11.799	5.021	232.65	8569.339
10.5	8.979	3.821	109.95	4049.673
11.0	8.272	3.520	111.39	4102.958
11.5	6.350	2.702	82.81	3050.164
12.0	5.102	2.171	72.65	2675.966
12.5	2.183	0.929	12.98	478.236
13			1.86	68.557
∑	74.31	31.620	925.51	34090
Biomass (kg)				
Length group (cm)	***Ith quarter***	***IInd quarter***	***III rd quarter***	***IVth quarter***
9.0	47.92	20.39	459.57	16927.63
9,5	88.47	37.65	1136.84	41873.62
10	70.04	29.80	1330.34	49001.04
10,5	62.67	26.67	725.64	26727.84
11	64.51	27.45	846.58	31182.48
11,5	57.14	24.31	677.26	24945.98
12	53.45	22.75	701.45	25836.91
12,5	25.80	10.98	145.13	5345.57
			24.19	890.93
∑	470	200	6047	222732

V.3.12 Conclusions

The analysis of the biological parameters of the anchovy makes it possible to draw the **following conclusions:**

1) The size structure during the period January-March of 2024 showed a bimodal distribution with a peak in the size group 9.5 and 10.0 cm. An increase in the percentage of individuals from the size group 11.00 cm is also noted. During the months IV-VI, an increase in the percentage of size groups 9.5 and 12.0 cm was found

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in the catches. In the third quarter, the highest values were for individuals in the size classes of 9.5 cm (24.82%) and 11.5 cm (12.05%), and the lowest percentage value was for the size classes 12-12.5 cm below 3%. In the fourth quarter, the highest values were for individuals in the size classes 11 (20.18%) and 12 cm.

2) In the first quarter, the highest percentage share is occupied by individuals in the age group 2-2+, followed by 3-3+. The second quarter shows that the age groups of 3-3+ and 4-4+ significantly prevail over the others. In the third quarter, the highest percentage share – 42.55% is occupied by individuals in the age group 3-3+, followed by 2-2+ with 32.62%. With the lowest share – about 7% is the age group: 4-4+. The fourth quarter shows that again the age group of 3-3+ has the highest – 50.46% and significantly prevails over the others.

3) In the analysis (*age slicing*) of size-frequency samples for determining the growth parameters of anchovy, only ELEFAN RSA gave relatively good results, the results of the other two methods showed average lengths for 5-year-old specimens of the order of 9 cm, which is not typical for the species and the probable reason is an insufficient number of measurements and poor representation of the size structure in the samples. The latter is expected when determining the growth parameters based on samples that do not represent the development of the species on an annual basis.

4) Condition factor K is highest for size classes 11-12.5 cm. The remaining size groups also have good condition, which indicates food security and good physiological condition.

5) A gradual increase in average weight and size is observed by age group for both the first and second trimesters. The age group 1-1+ has the lowest average weight and size, while the group 4-4+ has the highest average weights and sizes.

6) The resulting model is statistically significant, the value of the scaling coefficient a in the length-weight relationship model $W_i = aL_i^b$: **a=0.002**, and the allometric coefficient **b=3.49**, which indicates positive allometric growth of the species **in the first half of the year**, or the increase in weight is proportional and greater than the increase in length. The resulting model is statistically significant, the value of the scaling coefficient a in the length-weight relationship model $W_i = aL_i^b$: **a=0.014**, and the allometry coefficient **b=2.61**, which indicates positive allometric growth of the species **in the second half of the year**, or the increase in weight is proportional and greater than the increase in length.

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7) Females ♀ predominate over males ♂. The average lengths of females♀by age group are higher.

8) The gonadosomatic index is not strongly dependent on the weight of the gonads (R^2=0.6271), which is related to the not-high rate of maturation of the females. During the second semester, the gonadosomatic index for anchovy varied within narrow limits, with a pronounced correlation between the gland weight of the measured specimens (R^2 = 0.8945).

VI. Biological monitoring of picked dogfish (*Squalus acanthias*) landings

VI.1 Objectives

The study examines the population structure of specimens caught by Bulgarian fishermen.

VI.2 Sampling

The sampling was carried out by the actively operating fishing fleet in Bulgaria.

VI.2.1 Geographic area coverage

Shark specimens were measured and weighed on board fishing vessels.

VI.2.2 Sampling period

In 2024, to study the population dynamics of the shark, **100 specimens** were collected and processed, to establish the size, weight and gender composition of the catches. Ports and ships from which monitoring was carried out to collect biological data from picked dogfish landings are presented in **Table VI. 2.2.1**.

Table VI.2.2.1 Ports and vessels from which monitoring was carried out to collect biological data from spiny dogfish landings .

№	Date	Sampling ports	ANE	Fishing vessel	External marking	Fishing gear	Catch/ kg	Coordinates
1	5.2.2024	Kavarna	**DGS**	R/K 40	VN4601	**LLS**	52	43.622900,28.864700
2	11.3.2024	Balchik	**DGS**	VALNOBOR	VN 8112	**LLS**	110	43.2879 28.401
3	23.8.2024	Kavarna	**DGS**	Hishnik	KV 6262	**LLS**	24	43.425100 28.560900
4	29.9.2024	Varna	**DGS**	TRIGONA	VN 8579	**LLD**	110	43.184100 27.899000
5	20.12.2024	Kavarna	**DGS**	Neptun-70	KV 6321	**LLS**	65	43.367000 28.379500

VI.3. Landings statistics of spiny dogfish

Official shark catch statistics for 2024 are presented in **Figure VI. 3.1**. The highest catches are in March and June.

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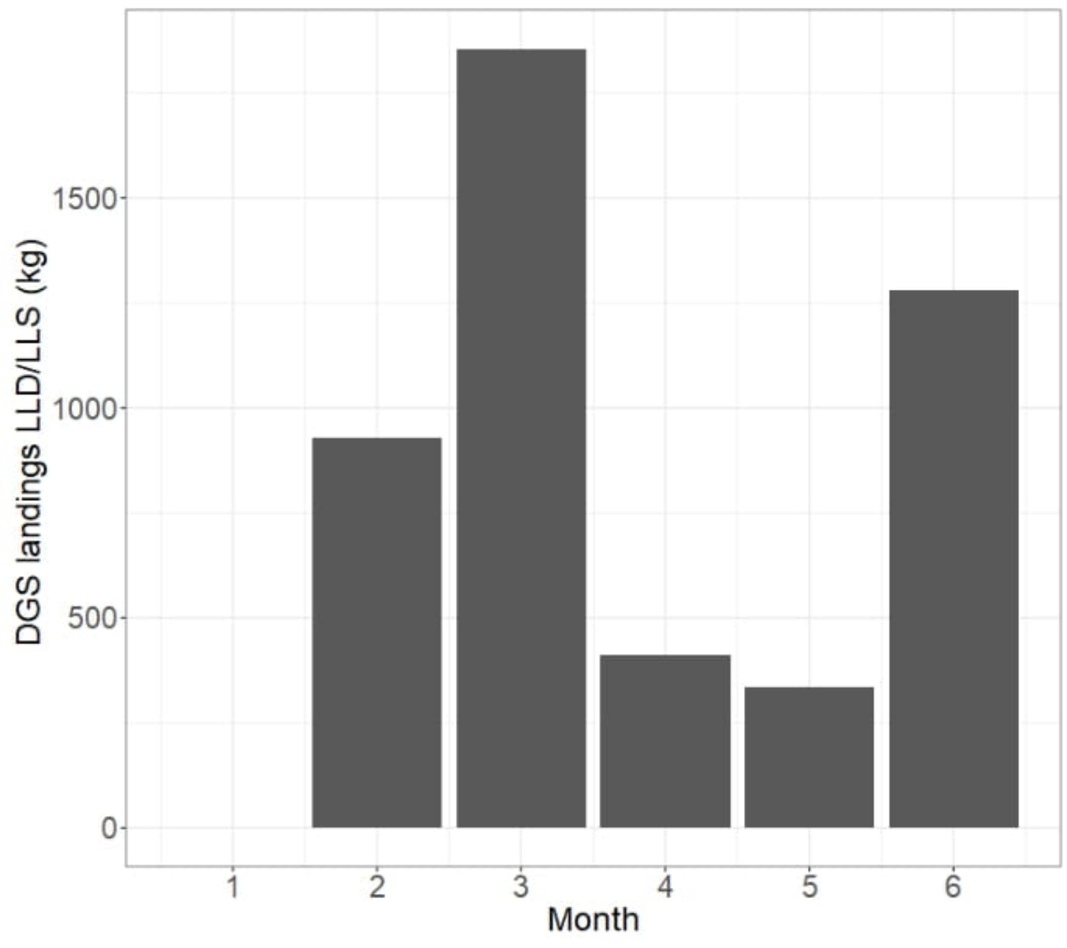


Figure VI.3.1 Official statistics on shark landings (LLS and LLD) for the first half of 2024.

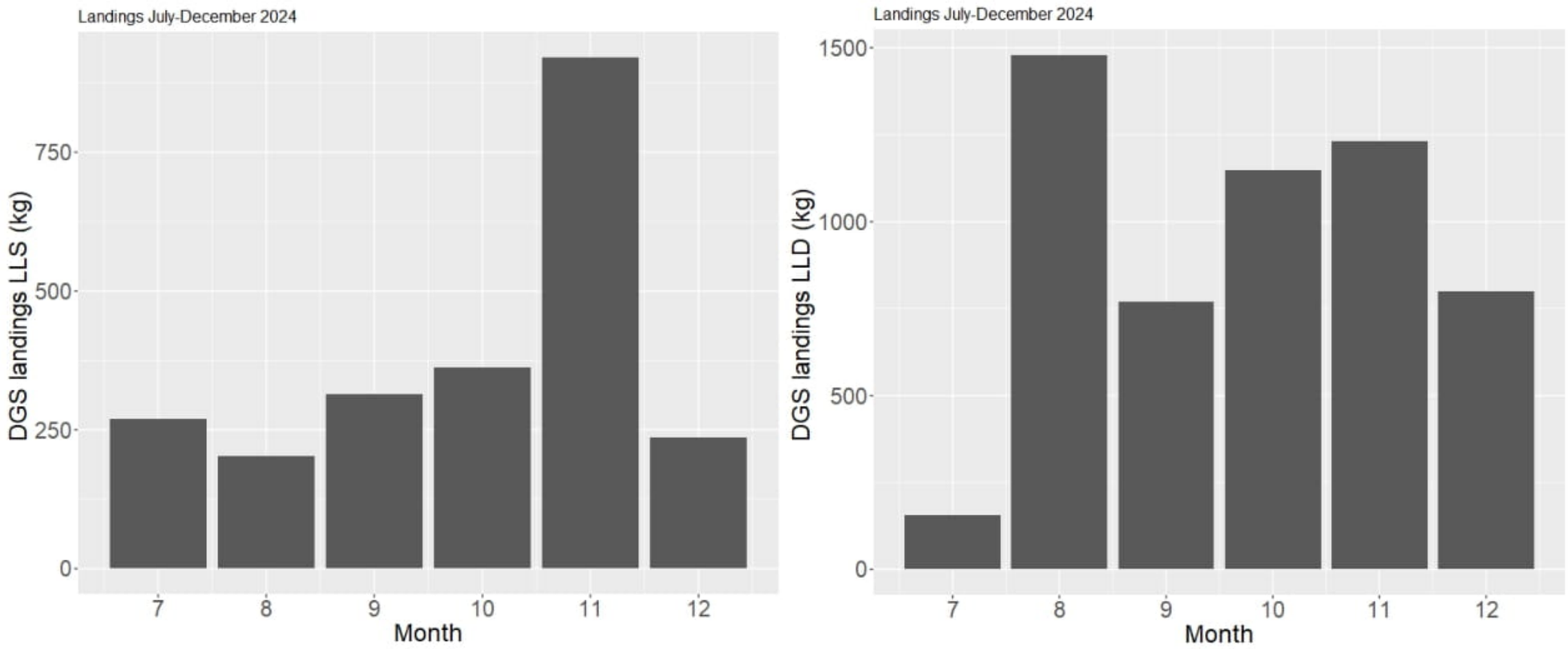


Figure VI.3.2 Official statistics of shark landings (LLS and LLD) for the second half of 2024.

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VI.4 Results

VI.4.1 Sex, size and weight structure

The average size of a male shark is 117 cm, and the average length of females is 118 cm, **(Table VI. 4.1.1-2).** Average weights of 6.323 kg have been recorded for females, while the average weights measured for males are 6.389 kg **(Table VI. 4.1.1-2).**

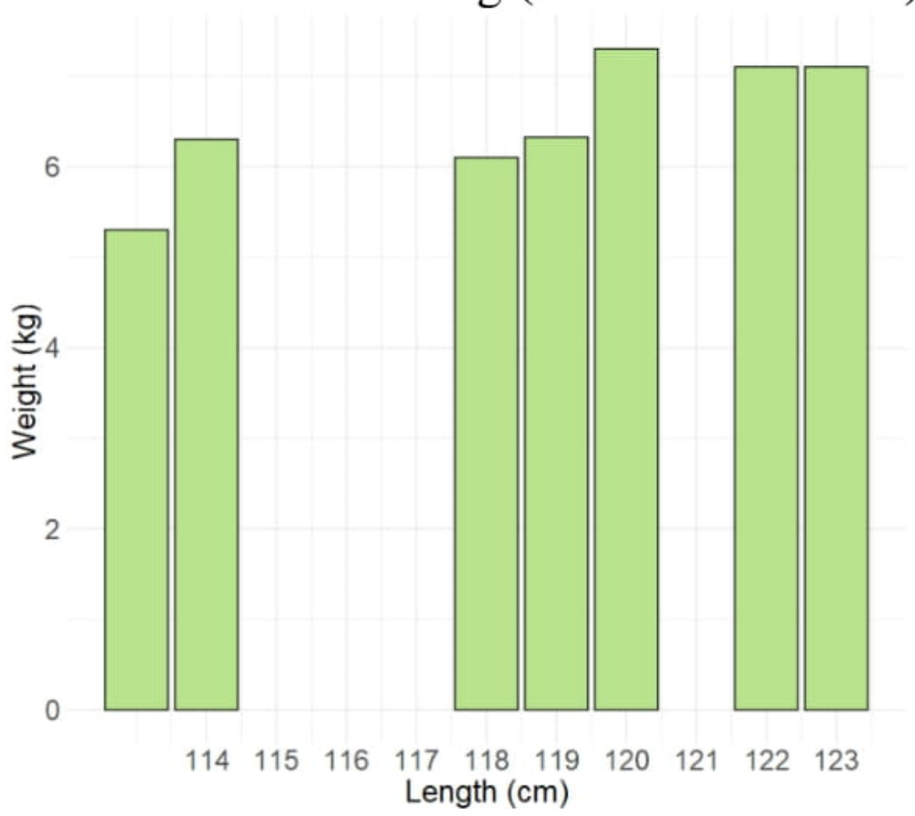


Figure VI.4.1.1 Distribution of weights by length of female♀ specimens in the sample) for the first half of 2024.

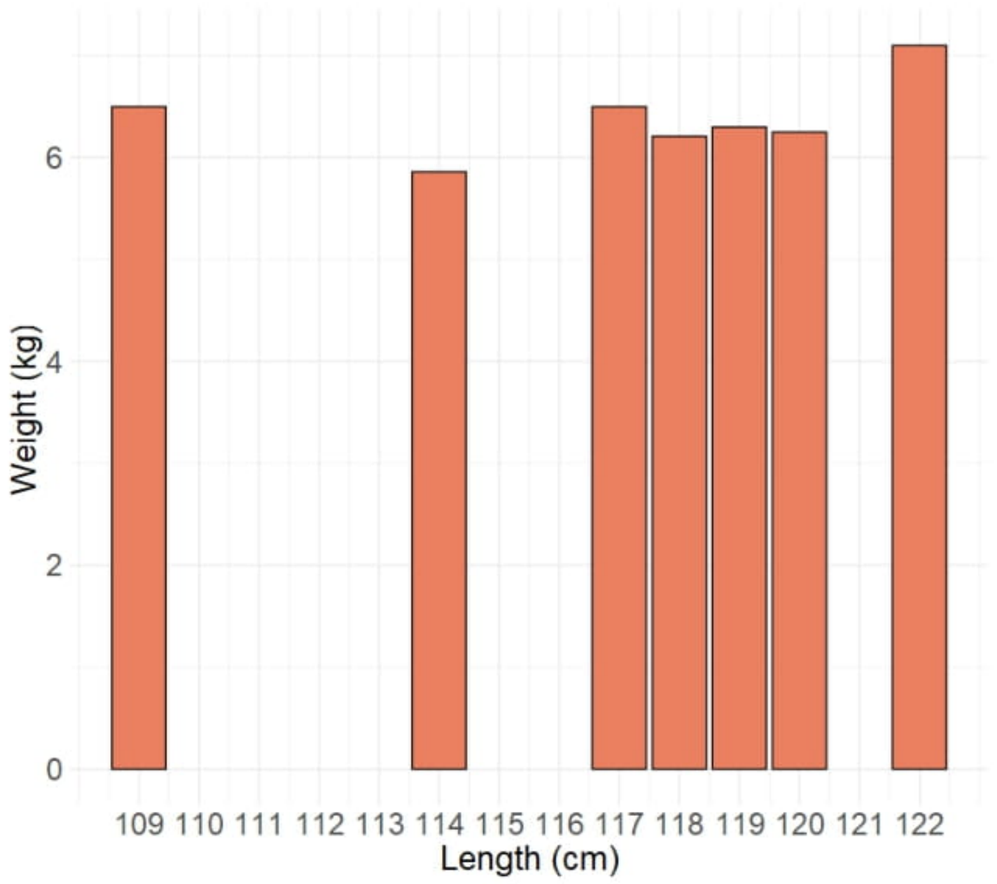


Figure VI.4.1.2 Weight distribution by length of male ♂ specimens in the sample) for the first half of 2024.

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Slightly higher average sizes of 119 cm for females and 123 cm for males were observed in the second half of 2024. Average weights of 6.05 kg were recorded for females, while average weights measured for males were 5.96 kg.

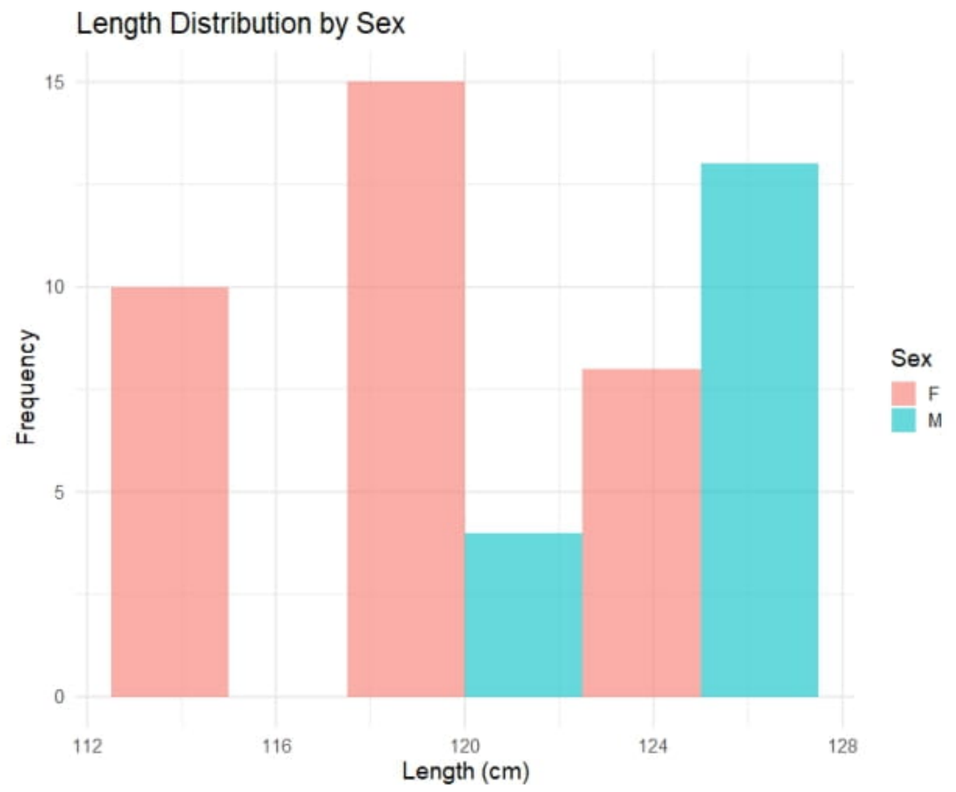


Figure VI.4.1.3 Length distribution by sex of specimens in the sample in the second half of 2024.

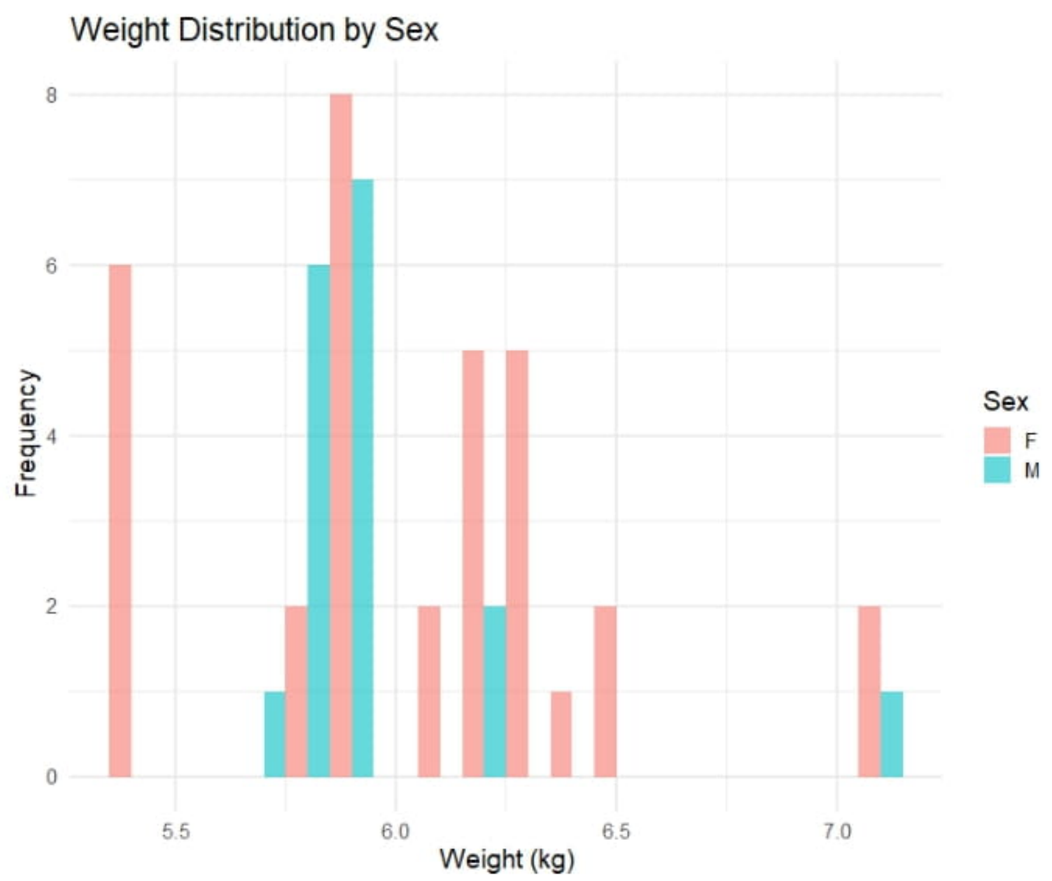


Figure VI.4.1.4 Distribution of weights by sex of specimens in the sample in the second half of 2024.

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Table VI.4.1.1 Descriptive statistics of the biological parameters (weights and lengths) of the female specimens in the sample (minimum, maximum, mean and median of the total length and weight of the specimens in the samples **during the first 6 months of 2024.**

Sex Female♀	
length	weight
Min. :113	Min. :5.300
1st Qu.:118	1st Qu.:6.200
Median :118	Median :6.200
Mean :118	Mean :6.323
3rd Qu.:119	3rd Qu.:6.325
Max. :123	Max. :7.300

Table VI.4.1.2 Descriptive statistics of the biological parameters (weights and lengths) of the male specimens in the sample (minimum, maximum, mean and median mean and median of the total length and weight of the specimens in the samples **during the first 6 months of 2024.**

Sex Male ♂	
length	weight
Min. :109.0	Min. :5.860
1st Qu.:115.5	1st Qu.:6.230
Median :118.0	Median :6.300
Mean :117.0	Mean :6.389
3rd Qu.:119.5	3rd Qu.:6.500
Max. :122.0	Max. :7.100

Table VI.4.1.3 Descriptive statistics of the biological parameters (weights and lengths) of the male specimens in the sample (minimum, maximum, mean and median mean and median of the total length and weight of the specimens in the samples during the second 6 months of 2024.

	Sex	Number	L_{mean} (cm)	L_{SD} (cm)	L_{min} (cm)	L_{max} (cm)	W_{mean} (g)	W_{SD} (g)	W_{min} (g)	W_{max} (g)
1	F ♀	33	119	3.6	114	124	6.05	0.435	5.4	7.1
2	M ♂	17	123	0.983	122	125	5.96	0.322	5.7	7.1

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VI.4.2 Gender structure and size-weight relationship

The sex ratio was determined on **30 specimens** (January-June). Male specimens predominated with 70%, and females were represented with 30% **(Figure VI.4.2.1).** The sex ratio was determined on **50 specimens** (July-December). In the second half (July-December) males predominated (the ratio of males to females was 0.66 to 0.34).

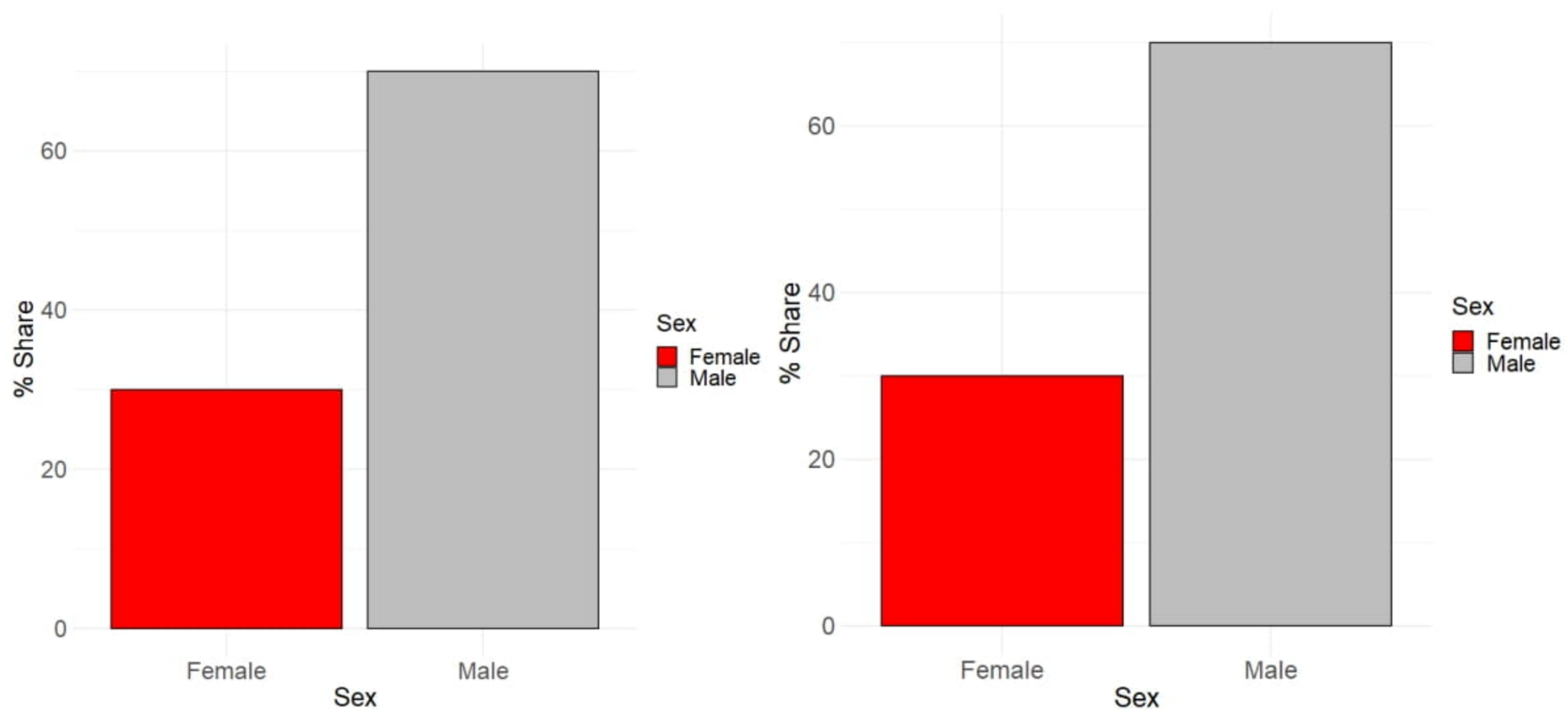


Figure VI.4.2.1 Sex ratio of sharks from the Bulgarian sector of the Black Sea in the first and second semesters of 2024.

During the first semester an attempt was made to determine the length-weight relationship - the resulting model has a very low determinism $\boldsymbol{R^2_{adj} = 0.23}$, which means that it is not statistically significant. It is possible to describe the relationship with a high-order olynomial, which is not realistic, since the full size structure of the species is not represented in the samples due to the selectivity of the fishing gear.

The frequency of female and male specimens by length (**Figure VI.4.2.2**) shows a higher frequency of female specimens in the size range from 114 to 124 cm and a higher frequency of males in the size range 122 to 125 cm or males have a greater total length than females, which, however, is not valid for weight - females show higher weights than males.

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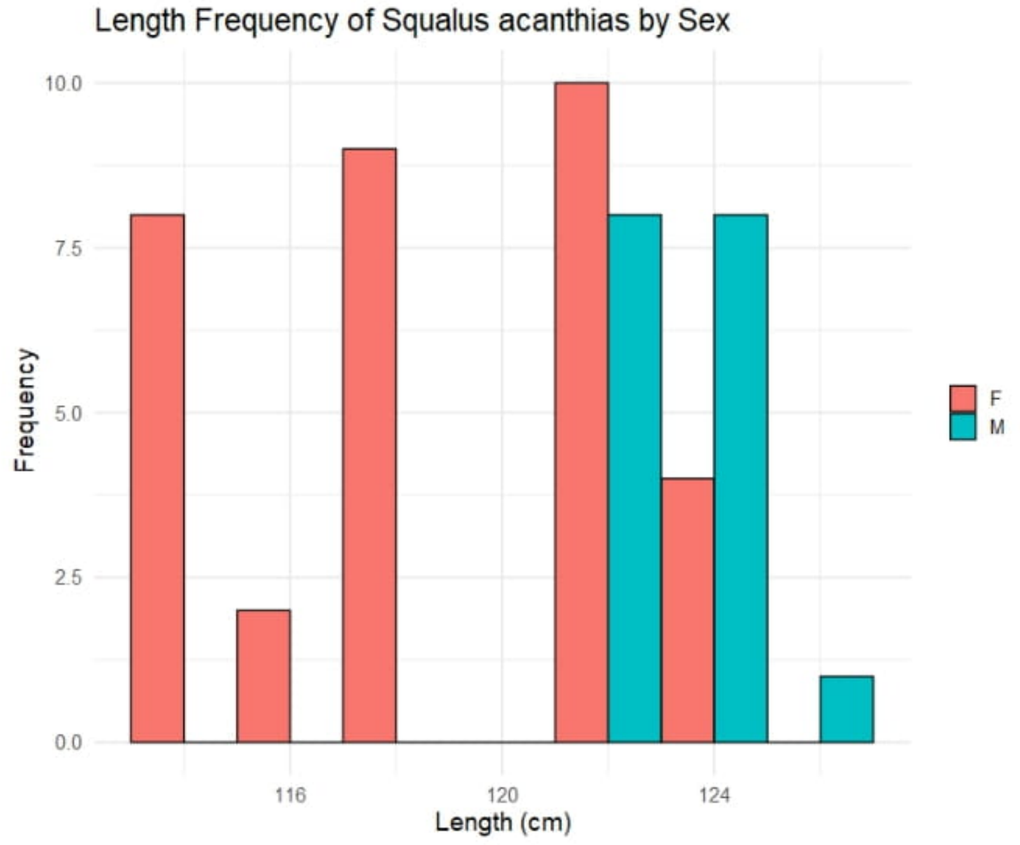


Figure VI.4.2.2 Histogram of distribution by sex and total length of specimens in the sample from the Bulgarian sector of the Black Sea **for the second semester of 2024.**

The Fulton condition factor (condition) of the specimens in the sample shows better condition of females compared to males, which is expected for the species.

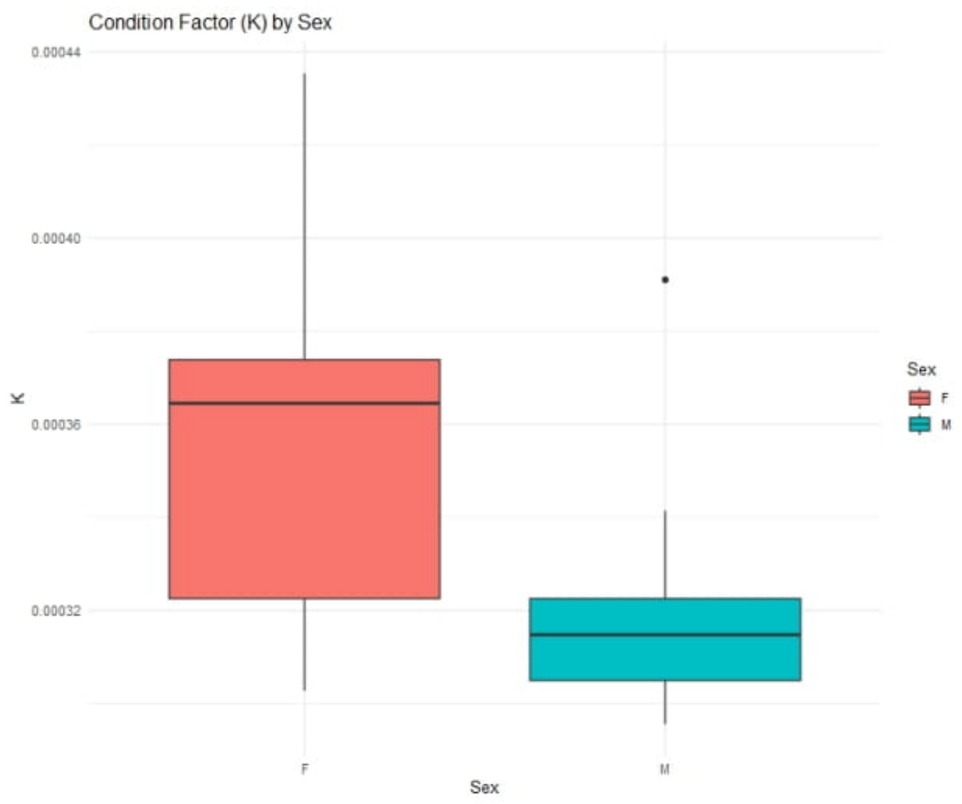


Figure VI.4.2.3 Fulton condition factor (condition) of the specimens in the sample.

In the second semester, an attempt was made to determine the length-weight relationship – the resulting model has a very low determinism $\boldsymbol{R^2_{adj} = 0.5}$, which means that it is not statistically significant. It is possible to describe the relationship with a high-order polynomial or additive model (**Figure VI.4.2.4**), which is not realistic, since the full size structure of the species is not represented in the samples due to the selectivity of the fishing gear.

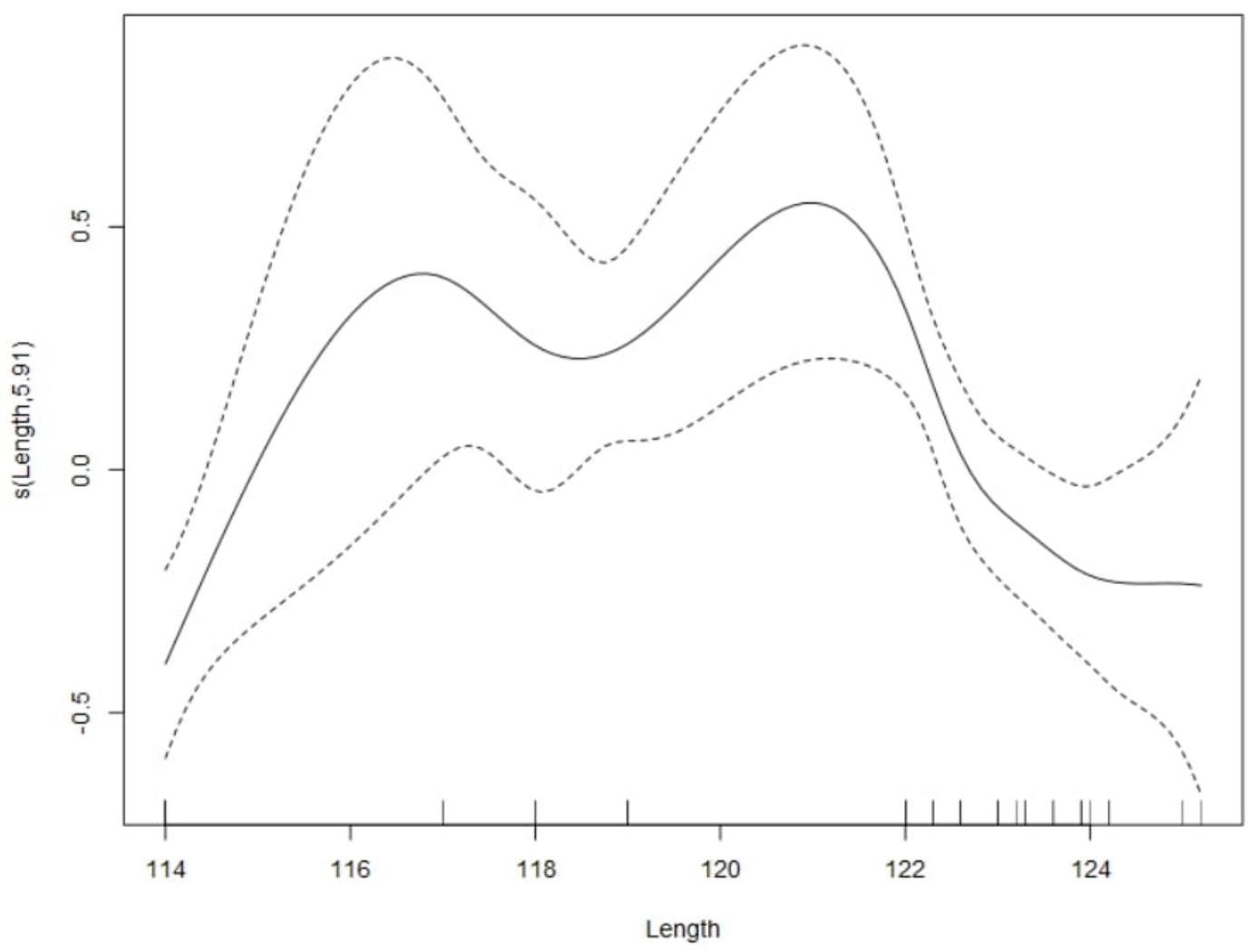


Figure VI.4.2.4 Length-weight relationship of *Squalus acanthias* using Generalized Additive Model (GAM).

The graph shows the smoothed length-weight relationship (LWR) curve for Squalus acanthias in the Black Sea, modeled using a generalized additive model (GAM). The smoothed curve represents the relationship between the total length of the individuals in the sample (cm) and weight (kg). The dashed curves show the standard error around the predicted curve, which reflects the uncertainty in the model predictions

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VI.4.3 Sexual maturity

Sexual maturity was determined in **60 specimens (30 in the first and 30 in the second semester of 2024)**. During the study period, females were observed to be sexually mature with visible embryos.

VI.5 Conclusion

1) The average size of a male shark is 117 cm, and the average length of females is 118 cm. Average weights of 6.323 kg have been recorded for females, while the average weight measured for males is 6.389 kg in the first half of 2024. The second half of 2024 saw slightly higher average sizes of 119 cm for females and 123 for males. Average weights of 6.05 kg have been recorded for females, while the average weight measured for males is 5.96 kg.

2) In the second half of 2024, males predominated with 70%, while females represented 30%. In the second half (July-December) males predominated (the ratio of males to females was 0.66 to 0.34).

3) An attempt was made to determine the length-weight relationship – the resulting model **for the first six months** has a very low determinism $\boldsymbol{R^2_{adj} = 0.23}$, which means that it is not statistically significant. A description of the relationship with a high-order polynomial is possible, which is not realistic, since the full size structure of the species is not represented in the samples, due to the selectivity of the fishing gear. **In the second six months**, an attempt was again made to determine the length-weight relationship – the resulting model has a very low determinism $\boldsymbol{R^2_{adj} = 0.5}$, which means that it is not statistically significant. A description of the relationship with a high-order polynomial or additive model is possible, which is not realistic, since the full size structure of the species is not represented in the samples, due to the selectivity of the fishing gear.

4) During the study period, females were sexually mature with visible embryos.

5) The *Fulton* condition factor of the specimens in the sample shows better condition of females compared to males, which is expected for the species.

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VII. Anex

Sprattus sprattus

	Number of specimens from the study I-VI,2024	Number of specimens from the study VII-XII,2024	Number of specimens from the study I-XII,2024	Number of specimens Contract 157/13/03/2023 EAFA/IO-BAS
length	592	793	**1385**	1250
weight	592	793	**1385**	1250
age	592	793	**1385**	1250
sex ratio ♀♂	250	250	**500**	500
fecundity	250	250	**500**	500
sexual maturity	250	250	**500**	500

Trachurus mediterraneus ponticus

	Number of specimens from the study I-VI,2024	Number of specimens from the study VII-XII,2024	Number of specimens from the study I-XII,2024	Number of specimens Contract 157/13/03/2023 EAFA/IO-BAS
length	649	851	**1500**	1500
weight	649	851	**1500**	1500
age	649	851	**1500**	500
sex ratio ♀♂	150	100	**250**	250
fecundity	100	30	**130**	100
sexual maturity	150	100	**250**	250

Merlangius merlangus euxinus

	Number of specimens from the	Number of specimens from the	Number of specimens from the	Number of specimens Contract

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	study I-VI,2024	study VII-XII,2024	study I-XII,2024	157/13/03/2023 EAFA/IO-BAS
length	159	91	**250**	250
weight	159	91	**250**	250
age	159	91	**250**	250
sex ratio ♀♂	50	50	**100**	100
fecundity	50	50	**100**	100
sexual maturity	50	50	**100**	100

Mullus barbatus

	Number of specimens from the study I-VI,2024	Number of specimens from the study VII-XII,2024	Number of specimens from the study I-XII,2024	Number of specimens Contract 157/13/03/2023 EAFA /IO-BAS
length	266	239	**505**	500
weight	266	239	**505**	500
age	266	239	**505**	500
sex ratio ♀♂	150	100	**250**	250
fecundity	50	50	**100**	не по-малко от 100
sexual maturity	150	100	**250**	250

Engraulis encrasicolus

	Number of specimens from the study I-VI,2024	Number of specimens from the study VII-XII,2024	Number of specimens from the study I-XII,2024	Number of specimens Contract 157/13/03/2023 EAFA/IO-BAS
length	255	250	**505**	500
weight	255	250	**505**	500
age	255	250	**505**	250
sex ratio	100	150	**250**	250
fecundity	50	50	**100**	100
sexual maturity	100	150	**250**	250

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Squalus acanthias

	Number of specimens from the study I-VI,2024	Number of specimens from the study VII-XII,2024	Number of specimens from the study I-XII,2024	Number of specimens Contract 157/13/03/2023 EAFA/IO-BAS
length	50	50	**100**	100
weight	50	50	**100**	100
sex ratio ♀♂	30	50	**80**	30
sexual maturity	30	30	**60**	30

ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА МОРСКО ДЕЛО И РИБАРСТВО

МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО

ПРОГРАМА ЗА МОРСКО ДЕЛО И РИБАРСТВО

ДВУСТРАНЕН ПРОТОКОЛ

Днес 17.1.2024 във връзка с изпълнение на чл.7, ал. 6 от Договор N157 от 13/03/2023 за осъществяване на биологичен мониторинг от промишлените улови от трицона, хамсия, сафрид, барбун, меджид и черноморска акула на риболовния флот на Р България в рамките на една календарна година (2024 година) между Изпълнителна агенция по рибарство и аквакултури ИАРА и Институт по океанология-БАН

Йордан Раев — съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност гл. инспектор в ИАРА

Доцент д-р Виолин Стоянов Райков

Име, презиме и фамилия — съгласно ЗЗЛД

на длъжност доцент в ИО-БАН

Удостоверяваме с подписите си, че е осъществено събиране на биологични проби на пристанище

Несебър

Проект BG14MFPR001-1.002-0001 „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2023-2024 г.“, финансиран от Програмата за морско дело, рибарство и аквакултури, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело, рибарство и аквакултури.

ДВУСТРАНЕН ПРОТОКОЛ

Днес 9.2.2024 във връзка с изпълнение на чл.7, ал. 6 от Договор N157 от 13/03/2023 за осъществяване на биологичен мониторинг от промишлените улови от трицона, хамсия, сафрид, барбун, меджид и черноморска акула на риболовния флот на Р България в рамките на една календарна година (2024 година) между Изпълнителна агенция по рибарство и аквакултури ИАРА и Институт по океанология-БАН

Румун Янакиев

Име, презиме и фамилия съгласно ЗЗЛД

на длъжност гл. инспектор в ИАРА

Доцент д-р Виолин Стоянов Райков

Име, презиме и фамилия съгласно ЗЗЛД

на длъжност доцент в ИО-БАН

Удостоверяваме с подписите си, че е осъществено събиране на биологични проби на пристанище

Созопол

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Проект BG14MFPR001-1.002-0001 „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2023-2024 г.“, финансиран от Програмата за морско дело, рибарство и аквакултури, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело, рибарство и аквакултури.

ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА МОРСКО ДЕЛО И РИБАРСТВО

МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО

ПРОГРАМА ЗА МОРСКО ДЕЛО И РИБАРСТВО

ДВУСТРАНЕН ПРОТОКОЛ

Днес 11.4.2024 във връзка с изпълнение на чл.7, ал. 6 от Договор N157 от 13/03/2023 за осъществяване на биологичен мониторинг от промишлените улови от трицона, хамсия, сафрид, барбун, меджид и черноморска акула на риболовния флот на Р България в рамките на една календарна година (2024 година) между Изпълнителна агенция по рибарство и аквакултури ИАРА и Институт по океанология-БАН

Йордан Раев — съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност гл. инспектор в ИАРА

Доцент д-р Виолин Стоянов Райков — съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност доцент в ИО-БАН

Удостоверяваме с подписите си, че е осъществено събиране на биологични проби на пристанище Несебър

ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА
МОРСКО ДЕЛО И РИБАРСТВО

МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО

ПРОГРАМА ЗА
МОРСКО ДЕЛО И
РИБАРСТВО

ДВУСТРАНЕН ПРОТОКОЛ

Днес 29.5.2024 във връзка с изпълнение на чл.7, ал. 6 от Договор N157 от 13/03/2023 за осъществяване на биологичен мониторинг от промишлените улови от трицона, хамсия, сафрид, барбун, меджид и черноморска акула на риболовния флот на Р България в рамките на една календарна година (2024 година) между Изпълнителна агенция по рибарство и аквакултури ИАРА и Институт по океанология-БАН

Йордан Раев

Име, презиме и фамилия

съгласно ЗЗЛД

на длъжност гл. инспектор в ИАРА

Доцент д-р Мария Христова Янкова

съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност доцент в ИО-БАН

Удостоверяваме с подписите си, че е осъществено събиране на биологични проби на пристанище

Несебър

Проект BG14MFPR001-1.002-0001 „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2023-2024 г.“, финансиран от Програмата за морско дело, рибарство и аквакултури, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело, рибарство и аквакултури.

ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА МОРСКО ДЕЛО И РИБАРСТВО

МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО

ПРОГРАМА ЗА МОРСКО ДЕЛО И РИБАРСТВО

ДВУСТРАНЕН ПРОТОКОЛ

Днес 25.6.2024 във връзка с изпълнение на чл.7, ал. 6 от Договор N157 от 13/03/2023 за осъществяване на биологичен мониторинг от промишлените улови от трицона, хамсия, сафрид, барбун, меджид и черноморска акула на риболовния флот на Р България в рамките на една календарна година (2024 година) между Изпълнителна агенция по рибарство и аквакултури ИАРА и Институт по океанология-БАН

Йордан Раев

Име, презиме и фамилия

на длъжност гл. инспектор в ИАРА

съгласно ЗЗЛД

Доцент д-р Виолин Стоянов Райков

Име, презиме и фамилия

на длъжност доцент в ИО-БАН

съгласно ЗЗЛД

Удостоверяваме с подписите си, че е осъществено събиране на биологични проби на пристанище

Несебър

Проект BG14MFPR001-1.002-0001 „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2023-2024 г.“, финансиран от Програмата за морско дело, рибарство и аквакултури, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело, рибарство и аквакултури.

ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА МОРСКО ДЕЛО И РИБАРСТВО

МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО

ПРОГРАМА ЗА МОРСКО ДЕЛО И РИБАРСТВО

ДВУСТРАНЕН ПРОТОКОЛ

Днес 18.7.2024 във връзка с изпълнение на чл.7, ал. 6 от Договор N157 от 13/03/2023 за осъществяване на биологичен мониторинг от промишлените улови от трицона, хамсия, сафрид, барбун, меджид и черноморска акула на риболовния флот на Р България в рамките на една календарна година (2024 година) между Изпълнителна агенция по рибарство и аквакултури ИАРА и Институт по океанология-БАН

Йордан Раев — съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност гл. инспектор в ИАРА

Доцент д-р Виолин Стоянов Райков — съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност доцент в ИО-БАН

Удостоверяваме с подписите си, че е осъществено събиране на биологични проби на пристанище

Несебър

Проект BG14MFPR001-1.002-0001 „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2023-2024 г.“, финансиран от Програмата за морско дело, рибарство и аквакултури, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело, рибарство и аквакултури.

ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА МОРСКО ДЕЛО И РИБАРСТВО

МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО

ПРОГРАМА ЗА МОРСКО ДЕЛО И РИБАРСТВО

ДВУСТРАНЕН ПРОТОКОЛ

Днес 12.8.2024 във връзка с изпълнение на чл.7, ал. 6 от Договор N157 от 13/03/2023 за осъществяване на биологичен мониторинг от промишлените улови от трицона, хамсия, сафрид, барбун, меджид и черноморска акула на риболовния флот на Р България в рамките на една календарна година (2024 година) между Изпълнителна агенция по рибарство и аквакултури ИАРА и Институт по океанология-БАН

Румен Янакиев

Име, презиме и фамилия

на длъжност гл. инспектор в ИАРА

съгласно ЗЗЛД

Доцент д-р Виолин Стоянов Райков

Име, презиме и фамилия

на длъжност доцент в ИО-БАН

съгласно ЗЗЛД

Удостоверяваме с подписите си, че е осъществено събиране на биологични проби на пристанище Созопол

Проект BG14MFPR001-1.002-0001 „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2023-2024 г.“, финансиран от Програмата за морско дело, рибарство и аквакултури, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело, рибарство и аквакултури.

ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА МОРСКО ДЕЛО И РИБАРСТВО

МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО

ПРОГРАМА ЗА МОРСКО ДЕЛО И РИБАРСТВО

ДВУСТРАНЕН ПРОТОКОЛ

Днес 4.9.2024 във връзка с изпълнение на чл.7, ал. 6 от Договор N157 от 13/03/2023 за осъществяване на биологичен мониторинг от промишлените улови от трицона, хамсия, сафрид, барбун, меджид и черноморска акула на риболовния флот на Р България в рамките на една календарна година (2024 година) между Изпълнителна агенция по рибарство и аквакултури ИАРА и Институт по океанология-БАН

Румен Янакиев — съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност гл. инспектор в ИАРА

Доцент д-р Виолин Стоянов Райков

съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност доцент в ИО-БАН

Удостоверяваме с подписите си, че е осъществено събиране на биологични проби на пристанище Созопол

Проект BG14MFPR001-1.002-0001 „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2023-2024 г.“, финансиран от Програмата за морско дело, рибарство и аквакултури, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело, рибарство и аквакултури.

ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА МОРСКО ДЕЛО И РИБАРСТВО

МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО

ПРОГРАМА ЗА МОРСКО ДЕЛО И РИБАРСТВО

ДВУСТРАНЕН ПРОТОКОЛ

Днес 23.10.2024 във връзка с изпълнение на чл.7, ал. 6 от Договор N157 от 13/03/2023 за осъществяване на биологичен мониторинг от промишлените улови от трицона, хамсия, сафрид, барбун, меджид и черноморска акула на риболовния флот на Р България в рамките на една календарна година (2024 година) между Изпълнителна агенция по рибарство и аквакултури ИАРА и Институт по океанология-БАН

Румен Янакиев — съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност гл. инспектор в ИАРА

Доцент д-р Виолин Стоянов Райков — съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност доцент в ИО-БАН

Удостоверяваме с подписите си, че е осъществено събиране на биологични проби на пристанище Созопол

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Проект BG14MFPR001-1.002-0001 „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2023-2024 г.“, финансиран от Програмата за морско дело, рибарство и аквакултури, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело, рибарство и аквакултури.

ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА МОРСКО ДЕЛО И РИБАРСТВО

МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО

ПРОГРАМА ЗА МОРСКО ДЕЛО И РИБАРСТВО

ДВУСТРАНЕН ПРОТОКОЛ

Днес 1.11.2024 във връзка с изпълнение на чл.7, ал. 6 от Договор N157 от 13/03/2023 за осъществяване на биологичен мониторинг от промишлените улови от трицона, хамсия, сафрид, барбун, меджид и черноморска акула на риболовния флот на Р България в рамките на една календарна година (2024 година) между Изпълнителна агенция по рибарство и аквакултури ИАРА и Институт по океанология-БАН

Стоян Гечев

Име, презиме и фамилия

на длъжност гл. инспектор в ИАРА

Доцент д-р Виолин Стоянов Райков

Име, презиме и фамилия

на длъжност доцент в ИО-БАН

съгласно ЗЗЛД

съгласно ЗЗЛД

Удостоверяваме с подписите си, че е осъществено събиране на биологични проби на пристанище Созопол

Проект BG14MFPR001-1.002-0001 „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2023-2024 г.“, финансиран от Програмата за морско дело, рибарство и аквакултури, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело, рибарство и аквакултури.

ДВУСТРАНЕН ПРОТОКОЛ

Днес 3.1.2024 във връзка с изпълнение на чл.7, ал. 6 от Договор N157 от 13/03/2023 за осъществяване на биологичен мониторинг от промишлените улови от трицона, хамсия, сафрид, барбун, меджид и черноморска акула на риболовния флот на Р България в рамките на една календарна година (2024 година) между Изпълнителна агенция по рибарство и аквакултури ИАРА и Институт по океанология-БАН

Румун Янакиев — съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност гл. инспектор в ИАРА

Доцент д-р Виолин Стоянов Райков

съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност доцент в ИО-БАН

Удостоверяваме с подписите си, че е осъществено събиране на биологични проби на пристанище

Созопол

Проект BG14MFPR001-1.002-0001 „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2023-2024 г.“, финансиран от Програмата за морско дело, рибарство и аквакултури, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело, рибарство и аквакултури.

ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА МОРСКО ДЕЛО И РИБАРСТВО

МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО

ПРОГРАМА ЗА МОРСКО ДЕЛО И РИБАРСТВО

ДВУСТРАНЕН ПРОТОКОЛ

Днес 25.4.2024 във връзка с изпълнение на чл.7, ал. 6 от Договор N157 от 13/03/2023 за осъществяване на биологичен мониторинг от промишлените улови от трицона, хамсия, сафрид, барбун, меджид и черноморска акула на риболовния флот на Р България в рамките на една календарна година (2024 година) между Изпълнителна агенция по рибарство и аквакултури ИАРА и Институт по океанология-БАН

Йордан Раев — съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност гл. инспектор в ИАРА

Доцент д-р Мария Христова Янкова

съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност доцент в ИО-БАН

Удостоверяваме с подписите си, че е осъществено събиране на биологични проби на пристанище Несебър

Проект BG14MFPR001-1.002-0001 „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2023-2024 г.“, финансиран от Програмата за морско дело, рибарство и аквакултури, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело, рибарство и аквакултури.

ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА МОРСКО ДЕЛО И РИБАРСТВО

МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО

ПРОГРАМА ЗА МОРСКО ДЕЛО И РИБАРСТВО

ДВУСТРАНЕН ПРОТОКОЛ

Днес 20.8.2024 във връзка с изпълнение на чл.7, ал. 6 от Договор N157 от 13/03/2023 за осъществяване на биологичен мониторинг от промишлените улови от трицона, хамсия, сафрид, барбун, меджид и черноморска акула на риболовния флот на Р България в рамките на една календарна година (2024 година) между Изпълнителна агенция по рибарство и аквакултури ИАРА и Институт по океанология-БАН

Здравко Георгиев — съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност гл. инспектор в ИАРА

Доцент д-р Мария Христова Янкова

съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност доцент в ИО-БАН

Удостоверяваме с подписите си, че е осъществено събиране на биологични проби на пристанище Балчик

Проект BG14MFPR001-1.002-0001 „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2023-2024 г.“, финансиран от Програмата за морско дело, рибарство и аквакултури, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело, рибарство и аквакултури.

ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА МОРСКО ДЕЛО И РИБАРСТВО

МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО

ПРОГРАМА ЗА МОРСКО ДЕЛО И РИБАРСТВО

ДВУСТРАНЕН ПРОТОКОЛ

Днес 4.9.2024 във връзка с изпълнение на чл.7, ал. 6 от Договор N157 от 13/03/2023 за осъществяване на биологичен мониторинг от промишлените улови от трицона, хамсия, сафрид, барбун, меджид и черноморска акула на риболовния флот на Р България в рамките на една календарна година (2024 година) между Изпълнителна агенция по рибарство и аквакултури ИАРА и Институт по океанология-БАН

Йордан Раев

Име, презиме и фамилия

на длъжност гл. инспектор в ИАРА

съгласно ЗЗЛД

Доцент д-р Мария Христова Янкова

Име, презиме и фамилия

на длъжност доцент в ИО-БАН

съгласно ЗЗЛД

Удостоверяваме с подписите си, че е осъществено събиране на биологични проби на пристанище Несебър

Проект BG14MFPR001-1.002-0001 „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2023-2024 г.“, финансиран от Програмата за морско дело, рибарство и аквакултури, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело, рибарство и аквакултури.

ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА МОРСКО ДЕЛО И РИБАРСТВО

МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО

ПРОГРАМА ЗА МОРСКО ДЕЛО И РИБАРСТВО

ДВУСТРАНЕН ПРОТОКОЛ

Днес 3.10.2024 във връзка с изпълнение на чл.7, ал. 6 от Договор N157 от 13/03/2023 за осъществяване на биологичен мониторинг от промишлените улови от трицона, хамсия, сафрид, барбун, меджид и черноморска акула на риболовния флот на Р България в рамките на една календарна година (2024 година) между Изпълнителна агенция по рибарство и аквакултури ИАРА и Институт по океанология-БАН

Румен Янакиев — съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност гл. инспектор в ИАРА

Доцент д-р Мария Христова Янкова

съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност доцент в ИО-БАН

Удостоверяваме с подписите си, че е осъществено събиране на биологични проби на пристанище

Созопол

Проект BG14MFPR001-1.002-0001 „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2023-2024 г.“, финансиран от Програмата за морско дело, рибарство и аквакултури, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело, рибарство и аквакултури.

ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА МОРСКО ДЕЛО И РИБАРСТВО

МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО

ПРОГРАМА ЗА МОРСКО ДЕЛО И РИБАРСТВО

ДВУСТРАНЕН ПРОТОКОЛ

Днес 20.02.2024 във връзка с изпълнение на чл.7, ал. 6 от Договор N157 от 13/03/2023 за осъществяване на биологичен мониторинг от промишлените улови от трицона, хамсия, сафрид, барбун, меджид и черноморска акула на риболовния флот на Р България в рамките на една календарна година (2024 година) между Изпълнителна агенция по рибарство и аквакултури ИАРА и Институт по океанология-БАН

Йордан Раев — съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност гл. инспектор в ИАРА

Доцент д-р Мария Христова Янкова — съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност доцент в ИО-БАН

Удостоверяваме с подписите си, че е осъществено събиране на биологични проби на пристанище Несебър

Проект BG14MFPR001-1.002-0001 „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2023-2024 г.“, финансиран от Програмата за морско дело, рибарство и аквакултури, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело, рибарство и аквакултури.

ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА МОРСКО ДЕЛО И РИБАРСТВО

МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО

ПРОГРАМА ЗА МОРСКО ДЕЛО И РИБАРСТВО

ДВУСТРАНЕН ПРОТОКОЛ

Днес 28.05.2024 във връзка с изпълнение на чл.7, ал. 6 от Договор N157 от 13/03/2023 за осъществяване на биологичен мониторинг от промишлените улови от трицона, хамсия, сафрид, барбун, меджид и черноморска акула на риболовния флот на Р България в рамките на една календарна година (2024 година) между Изпълнителна агенция по рибарство и аквакултури ИАРА и Институт по океанология-БАН

Йордан Раев — съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност гл. инспектор в ИАРА

Нели Николаева Вълчева — съгласно ЗЗЛД

Име, презиме и фамилия

Специалист в ИО-БАН

Удостоверяваме с подписите си, че е осъществено събиране на биологични проби на пристанище

Созопол

Проект BG14MFPR001-1.002-0001 „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2023-2024 г.“, финансиран от Програмата за морско дело, рибарство и аквакултури, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело, рибарство и аквакултури.

ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА МОРСКО ДЕЛО И РИБАРСТВО

МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО

ПРОГРАМА ЗА МОРСКО ДЕЛО И РИБАРСТВО

ДВУСТРАНЕН ПРОТОКОЛ

Днес 20.08.2024 във връзка с изпълнение на чл.7, ал. 6 от Договор N157 от 13/03/2023 за осъществяване на биологичен мониторинг от промишлените улови от трицона, хамсия, сафрид, барбун, меджид и черноморска акула на риболовния флот на Р България в рамките на една календарна година (2024 година) между Изпълнителна агенция по рибарство и аквакултури ИАРА и Институт по океанология-БАН

Йордан Раев — съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност гл. инспектор в ИАРА

Нели Николаева Вълчева — съгласно ЗЗЛД

Име, презиме и фамилия

Специалист в ИО-БАН

Удостоверяваме с подписите си, че е осъществено събиране на биологични проби на пристанище

Несебър

Проект BG14MFPR001-1.002-0001 „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2023-2024 г.“, финансиран от Програмата за морско дело, рибарство и аквакултури, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело, рибарство и аквакултури.

ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА МОРСКО ДЕЛО И РИБАРСТВО

МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО

ПРОГРАМА ЗА МОРСКО ДЕЛО И РИБАРСТВО

ДВУСТРАНЕН ПРОТОКОЛ

Днес 19.02.2024 във връзка с изпълнение на чл.7, ал. 6 от Договор N157 от 13/03/2023 за осъществяване на биологичен мониторинг от промишлените улови от трицона, хамсия, сафрид, барбун, меджид и черноморска акула на риболовния флот на Р България в рамките на една календарна година (2024 година) между Изпълнителна агенция по рибарство и аквакултури ИАРА и Институт по океанология-БАН

Здравко Георгиев — съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност гл. инспектор в ИАРА

Нели Николаева Вълчева — съгласно ЗЗЛД

Име, презиме и фамилия

Специалист в ИО-БАН

Удостоверяваме с подписите си, че е осъществено събиране на биологични проби на пристанище

Балчик

Проект BG14MFPR001-1.002-0001 „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2023-2024 г.“, финансиран от Програмата за морско дело, рибарство и аквакултури, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело, рибарство и аквакултури.

ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА МОРСКО ДЕЛО И РИБАРСТВО

МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО

ПРОГРАМА ЗА МОРСКО ДЕЛО И РИБАРСТВО

ДВУСТРАНЕН ПРОТОКОЛ

Днес 23.05.2024 във връзка с изпълнение на чл.7, ал. 6 от Договор N157 от 13/03/2023 за осъществяване на биологичен мониторинг от промишлените улови от трицона, хамсия, сафрид, барбун, меджид и черноморска акула на риболовния флот на Р България в рамките на една календарна година (2024 година) между Изпълнителна агенция по рибарство и аквакултури ИАРА и Институт по океанология-БАН

Тодор Нанчев — съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност гл. инспектор в ИАРА

Нели Николаева Вълчева — съгласно ЗЗЛД

Име, презиме и фамилия

Специалист в ИО-БАН

Удостоверяваме с подписите си, че е осъществено събиране на биологични проби на пристанище

Царево

Проект BG14MFPR001-1.002-0001 „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2023-2024 г.“, финансиран от Програмата за морско дело, рибарство и аквакултури, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело, рибарство и аквакултури.

ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА МОРСКО ДЕЛО И РИБАРСТВО

МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО

ПРОГРАМА ЗА МОРСКО ДЕЛО И РИБАРСТВО

ДВУСТРАНЕН ПРОТОКОЛ

Днес 14.12.2024 във връзка с изпълнение на чл.7, ал. 6 от Договор N157 от 13/03/2023 за осъществяване на биологичен мониторинг от промишлените улови от трицона, хамсия, сафрид, барбун, меджид и черноморска акула на риболовния флот на Р България в рамките на една календарна година (2024 година) между Изпълнителна агенция по рибарство и аквакултури ИАРА и Институт по океанология-БАН

Румен Янакиев — съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност гл. инспектор в ИАРА

доцент д-р Виолин Стоянов Райков — съгласно ЗЗЛД

Име, презиме и фамилия

Доцент в ИО-БАН

Удостоверяваме с подписите си, че е осъществено събиране на биологични проби на пристанище

Созопол

Проект BG14MFPR001-1.002-0001 „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2023-2024 г.“, финансиран от Програмата за морско дело, рибарство и аквакултури, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело, рибарство и аквакултури.

ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА МОРСКО ДЕЛО И РИБАРСТВО

МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО

ПРОГРАМА ЗА МОРСКО ДЕЛО И РИБАРСТВО

ДВУСТРАНЕН ПРОТОКОЛ

Днес 4.1.2024 във връзка с изпълнение на чл.7, ал. 6 от Договор N157 от 13/03/2023 за осъществяване на биологичен мониторинг от промишлените улови от трицона, хамсия, сафрид, барбун, меджид и черноморска акула на риболовния флот на Р България в рамките на една календарна година (2024 година) между Изпълнителна агенция по рибарство и аквакултури ИАРА и Институт по океанология-БАН

Йордан Раев — съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност гл. инспектор в ИАРА

доцент д-р Виолин Стоянов Райков — съгласно ЗЗЛД

Име, презиме и фамилия

доцент в ИО-БАН

Удостоверяваме с подписите си, че е осъществено събиране на биологични проби на пристанище

Несебър

Проект BG14MFPR001-1.002-0001 „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2023-2024 г.“, финансиран от Програмата за морско дело, рибарство и аквакултури, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело, рибарство и аквакултури.

ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА МОРСКО ДЕЛО И РИБАРСТВО

МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО

ПРОГРАМА ЗА МОРСКО ДЕЛО И РИБАРСТВО

ДВУСТРАНЕН ПРОТОКОЛ

Днес 2.8.2024 във връзка с изпълнение на чл.7, ал. 6 от Договор N157 от 13/03/2023 за осъществяване на биологичен мониторинг от промишлените улови от трицона, хамсия, сафрид, барбун, меджид и черноморска акула на риболовния флот на Р България в рамките на една календарна година (2024 година) между Изпълнителна агенция по рибарство и аквакултури ИАРА и Институт по океанология-БАН

Здравко Георгиев — съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност гл. инспектор в ИАРА

доцент д-р Виолин Стоянов Райков — съгласно ЗЗЛД

Име, презиме и фамилия

доцент в ИО-БАН

Удостоверяваме с подписите си, че е осъществено събиране на биологични проби на пристанище Балчик

Проект BG14MFPR001-1.002-0001 „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2023-2024 г.“, финансиран от Програмата за морско дело, рибарство и аквакултури, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело, рибарство и аквакултури.

ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА МОРСКО ДЕЛО И РИБАРСТВО

МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО

ПРОГРАМА ЗА МОРСКО ДЕЛО И РИБАРСТВО

ДВУСТРАНЕН ПРОТОКОЛ

Днес 10.12.2024 във връзка с изпълнение на чл.7, ал. 6 от Договор N157 от 13/03/2023 за осъществяване на биологичен мониторинг от промишлените улови от трицона, хамсия, сафрид, барбун, меджид и черноморска акула на риболовния флот на Р България в рамките на една календарна година (2024 година) между Изпълнителна агенция по рибарство и аквакултури ИАРА и Институт по океанология-БАН

Румен Янакиев — съгласно ЗЗЛД

Име, презиме и фамилия

на длъжност гл. инспектор в ИАРА

доцент д-р Виолин Стоянов Райков — съгласно ЗЗЛД

Име, презиме и фамилия

доцент в ИО-БАН

Удостоверяваме с подписите си, че е осъществено събиране на биологични проби на пристанище Созопол

Проект BG14MFPR001-1.002-0001 „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2023-2024 г.“, финансиран от Програмата за морско дело, рибарство и аквакултури, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело, рибарство и аквакултури.