# WORKING GROUP ON SOUTHERN HORSE MACKEREL, ANCHOVY AND SARDINE (WGHANSA)

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## WORKING GROUP ON SOUTHERN HORSE MACKEREL, ANCHOVY AND SARDINE (WGHANSA)

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# i Executive summary


The ICES Working Group on Southern horse mackerel, anchovy and sardine (WGHANSA) assessed the stock status and provided a draft catch advice for anchovy in Atlantic Iberian waters (ane.27.9a; western and southern components) and horse mackerel in Atlantic Iberian waters (hom.27.9a) in the May meeting. However, anchovy in Division 9a was split in two different stocks during the benchmark in September 2024. The advice for the stock in the Gulf of Cadiz and the southern coast of Portugal (originally the southern component of the stock in Division 9a) will be based on a calendar year from now on, and therefore a new assessment was carried out for this stock in November 2024. In addition, an error was found in the biomass index used to provide advice for anchovy in the western part of Division 9.a (originally the western component of anchovy in Division 9.a), and therefore the advice for this stock was reopened in November. Following the terms of reference of the working group, the status of anchovy in Bay of Biscay (ane.27.8), sardine in southern Celtic Seas and the English Channel (pil.27.7), sardine in Bay of Biscay (pil.27.8abd), sardine in Cantabrian Sea and Atlantic Iberian waters (pil.27.8c9a) and jack mackerel in the Azores grounds (jaa.10.a2) were also assessed in the November meeting.

**Anchovy in the Bay of Biscay (ane.27.8)** was benchmarked in 2024 and it is now assessed using a Stock Synthesis integrated model that incorporates catch data (including assumed catch for the interim year) along with data derived from acoustic, egg, and recruitment surveys. SSB is well above $B_{lim}$ and $B_{pa}$ (no other reference points have been defined for this stock), although a slight decrease is forecasted in 2025 due to a low 2024 recruitment. Fishing mortality has been stable since the fishery reopened in 2010. Overall, no rescaling of the assessment is perceived with the new model, and therefore the current management plan is likely to be still precautionary and it has been used to provide the 2025 catch advice. Nevertheless, a revaluation of the harvest control rule based on the updated stock history is needed.

**Anchovy in the Gulf of Cadiz and the southern coast of Portugal (southern part of Division 9a)** is a new stock as a result of the benchmark in 2024 for anchovy in Division 9a. The new stock is assessed using an age-based model in Stock Synthesis that incorporates catch data (including assumed catch for the interim year), together with data from acoustic, egg, and recruitment surveys. Reference points $B_{lim}$ and $B_{pa}$ were also estimated. Fishing mortality and SSB have oscillated over time, showing an increasing trend since 2019 the former, and a declining trend since 2021 the latter. Although the stock was identified as category 1 and a short-term forecast was produced, the MSY approach for category 1 short-lived species (i.e. MSY $B_{escapement}$ strategy) could not be applied to provide the 2025 catch advice because $F_{cap}$ has not been defined yet. Therefore, the 2025 catch advice is based on the ICES framework for category 3 short-lived stocks using the 1-over-2 rule. The SSB derived from the assessment model was used as the biomass index to apply the harvest control rule. The new advice covers the calendar year 2025, and replaces the advice provided in June 2024 for the period January-June 2025.

**Anchovy in the western Iberian waters (western part of Division 9a)** is also a new stock as a result of the benchmark in 2024 for anchovy in Division 9a. The assessment method has not been reviewed during the benchmark. It is a category 3 stock assessed using a constant harvest rate, same as when it was considered the western component of the stock in Division 9a. The catch advice for the period July 2024-June 2025 was released in June 2024. However, a post analysis of the acoustic survey PELAGO in November 2024 revealed an error in the processing data that led to an underestimation of the anchovy biomass provided for the assessment in May. A new advice with the corrected biomass was estimated in November 2024, and replaces the advice provided in June for the western component of anchovy in Division 9a.

**Sardine in the southern Celtic Seas and the English Channel (pil.27.7)** is a category 3 stock and the catch advice is based on the 1-over-2 rule. The biomass estimates derived from the acoustic survey PELTIC are used as the biomass index to apply the harvest control rule. The 2023 biomass was the highest of the time series (available since 2017) and the 2024 biomass was the second largest estimate.

**Sardine in the Bay of Biscay (pil.27.9abd)** is assessed using an age-based model in Stock Synthesis that incorporates commercial catches (including assumed catches for the interim year), and data derived from acoustic and egg surveys. The stock has been around $B_{lim}$ since 2021 and there is a continuous decreasing trend in weight at age for all ages and maturity at age 1. The SSB estimated in 2024 and forecasted in 2025 are below MSY $B_{trigger}$ and $B_{pa}$ but above $B_{lim}$.

**Sardine in the Cantabrian Sea and Atlantic Iberian waters (pil.28.8c9a)** is assessed using an age-based model in Stock Synthesis that incorporates commercial catches (including assumed catches for the interim year), and data derived from acoustic, egg, and recruitment surveys. The biomass (ages 1+) shows a declining trend for the period 2012-2015, but it has been stable and above MSY $B_{trigger}$ since 2020. 2025 SSB is forecasted to increase due to a high recruitment in 2024. Fishing mortality has declined since 2015, although it slightly increased in recent years and is now above $F_{MSY}$. ICES advice is based on the ICES MSY approach. The catch options explored for 2025 include several harvest control rules assessed by ICES as precautionary.

**Horse mackerel in Atlantic Iberian waters** (hom.27.9a) was benchmarked in April 2024. The new assessment model is performed in Stock Synthesis and includes revised biological information and additional indices. It can accommodate for changes in fisheries selectivity, and it is considered to provide more realistic and accurate estimates than the previous model. The reference points and the assumptions for the short-term forecast were also reviewed and updated. The estimated SSB shows an increasing trend since 2013 and is above MSY $B_{trigger}$. The fishing mortality has been relatively stable over the years although it has undergone a decreasing trend since 2017. Fishing mortality has been below $F_{MSY}$ for most of the time series. Recruitment in 2023 was lower than in 2022 but is still above the average of the time series.

**Jack mackerel in the Azores grounds (jaa.27.10a2)** is classified as a category 5 stock and the advice is biennial. The majority of the catches are fished by purse-seiners that target juveniles for human consumption. Catches from this fishery have been stable in the last decade. Fishing effort data and catches from other fleets (such as purse seine and longline catches for bait, or recreational catches) are not available for 2022 and 2023. The stock size and exploitation level remain unknown, but the precautionary buffer was not applied to provide advice for 2025 and 2026 because it was applied in the last assessment.

# ii Expert group information

| | |
|---|---|
| **Expert group name** | Working Group on Southern Horse Mackerel, Anchovy and Sardine (WGHANSA) |
| **Expert group cycle** | Annual |
| **Year cycle started** | 2024 |
| **Reporting year in cycle** | 1/1 |
| **Chair** | Rosana Ourens, UK |
| **Meeting venues and dates** | 27 – 31 May 2024, Online meeting (14 participants) |
| | 25 – 29 November 2024, Madrid (Spain) (19 participants) |

# 1 Introduction

## 1.1 Terms of reference (ToRs)

The Working Group on Southern Horse Mackerel Anchovy and Sardine (WGHANSA), chaired by Rosana Ourens (UK), met online on 27–31 May 2024 (WGHANSA-1). The terms of reference for the meeting were to address the generic ToRs for Regional and Species Working Groups for the stocks hom.27.9a and ane.27.9a. There will be a second meeting in Madrid, Spain (25-29 November 2024, WGHANSA-2) to address the generic ToRs for Regional and Species Working Groups for pil.27.7, pil.27.8abd, pil.27.8c9a, ane.27.8, and jaa.10.a2.

According to the generic ToRs, the working group should focus on:

a) Conduct an assessment on the stock(s) to be addressed in 2024 using the method (assessment, forecast or trends indicators) as described in the stock annex and documented in TAF; - complete and document an audit of the calculations and results; and produce a **brief** report of the work carried out regarding the stock, providing summaries of the following where relevant:

Quality control and quality assurance of input data. In the event of late, missing or inconsistent data document issues and deviations from the stock annex.

i) Where misreporting of catches is significant, provide qualitative and where possible quantitative information and describe the methods used to obtain the information;

ii) For relevant stocks (i.e., all stocks for NEAFC request advice), estimate the percentage of the total catch that has been taken in the NEAFC Regulatory Area in the most recent years.

iii) For category 2 and 3 stocks requiring new advice in 2024, implement the methods in guidance for harvest control rules and stock assessments for stocks in categories 2 and 3 . Replace the former 2 over 3 advice rule (2 over 5 for elasmobranchs) which is no longer considered precautionary.

iv) Evaluate spawning stock biomass, total stock biomass, fishing mortality, catches (projected landings and discards) using the method described in the stock annex;

1) for category 1 and 2 stocks, in addition to the other relevant model diagnostics, the recommendations and decision tree formulated by WKFORBIAS (see Annex 2 of https://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/Fisheries%20Resources%20Steering%20Group/2020/WKFORBIAS_2019.pdf) should be considered as guidance to determine whether an assessment remains sufficiently robust for providing advice.

2) If the assessment is deemed no longer suitable as basis for advice, provide advice using an appropriate Category 2-5 approach as described in ICES technical guidance for harvest control rules and stock assessments for stocks in categories 2 and 3 or in Advice on fishing opportunities (for Cat 5 & 6).

3) If the assessment has been moved to a Category 2-5 approach in the past year, consider what is necessary to move back to a Category 1 and develop proposal for the appropriate benchmark process.

v) Provide all requested catch scenarios for the year(s) beyond the terminal year of the data (These are listed in ICES Guidance for completing single-stock advice)

vi) Historical and analytical performance of the assessment and catch options with a succinct description of associated quality issues. For the analytical performance of category 1 and 2 age-structured assessments, report the mean Mohn's rho (assessment retrospective bias analysis) values for time series of recruitment, spawning stock biomass, and fishing mortality rate. The WG report should include a plot of this retrospective analysis. The values should be calculated in accordance with the "Guidance for completing ToR viii) of the Generic ToRs for Regional and Species Working Groups - Retrospective bias in assessment" and reported using the ICES application for this purpose.

b) Produce and quality assure a first draft of the advice for each stock according to ACOM guidelines.

c) Include non-fisheries conservation considerations in accordance with the "ICES Guidelines on Non-Fisheries Conservation Considerations".

d) Review progress on benchmark issues and processes of relevance to the Expert Group.

i) update the benchmark issues lists for the individual stocks in SID;

ii) review progress on benchmark issues and identify potential benchmarks to be initiated in 2025 for conclusion in 2026;

iii) determine the prioritization score for benchmarks proposed for 2025–2026;

iv) as necessary, document generic issues to be addressed by the Benchmark Oversight Group (BOG)

e) Prepare the data calls for the next year's update assessment and for planned data evaluation workshops;

f) Identify research needs of relevance to the work of the Expert Group.

g) Review and update information regarding operational issues and research priorities on the Fisheries Resources Steering Group SharePoint site.

h) Update TAF, SAG, ASD (Advice and Scenarios database) and SID with final assessment input and output and advice information.

i) Consider and comment on Ecosystem and Fisheries Overviews with a focus on:

i) identifying and correcting mistakes and errors (both in the text, tables and figures), and

ii) proposing concrete evidence-based input that is considered essential for the advice but is currently under-developed or missing (with references and Data Profiling Tool entries, as appropriate).

### 1.1.1 The WG work in relation to the ToRs

The generic ToRs for Regional and Species Working Groups were addressed for anchovy in Division 9.a (ane.27.9a) and horse mackerel in Division 9.a (hom.27.9a) in WGHANSA1; and for the remaining stocks (ane.27.8, pil.27.7, pil.27.8abd, pil.27.8c9a, jaa.10.a2) in WGHANSA2, as stated in the specific ToRs for this working group. However, anchovy in Division 9a was split in two different stocks during the benchmark in September 2024[1]. The advice for the stock in the Gulf of Cadiz and the southern coast of Portugal (originally the southern component of the stock in Division 9a) will be provided based on a calendar year from now on, and therefore a new assessment was carried out for this stock in WGHANSA-2. In addition, an error was found in the biomass index used to provide advice for anchovy in the western part of Division 9.a (originally the western component of anchovy in Division 9.a), and therefore the advice for this stock was reopened during WGHANSA-2.

The assessments were carried out on the basis of the stock annexes prior to and during the meeting and coordinated as indicated in the table below. Based upon these assessments and associated short-term forecasts (when applicable), the group produced draft advice sheets for both stocks. All draft advice sheets were agreed in plenary. Advice sheets and assessments were audited by group members assigned to each stock (Annex 4). WGHANSA1 and WGHANSA2 reported by 17 June 2024 and by 11 December 2024 respectively for the attention of ACOM.

| **Stock** | **Stock code** | **Stock coordinator 1** | | **Advice to be provided in 2024** | **Periodicity in years** | **Time period for releasing the advice** | **Category** | **Assessment method** | **Advice basis** |
|---|---|---|---|---|---|---|---|---|---|
| Anchovy (*Engraulis encrasicolus*) in the western part of Division 9.a (western Iberian waters) | ane.27.9aW | Susana Garrido | | Yes | 1 | June (reopened in December 2024) | 3 | Survey trends based | MSY, in-year advice |
| Anchovy (*Engraulis encrasicolus*) in the southern part of Division 9.a (Gulf of Cadiz and the southern coast of Portugal) | ane.27.9aS | María José Zuñiga | Fernando Ramos | Yes | 1 | December (since 2024) | 1 | Stock Synthesis | PA |
| Horse mackerel (*Trachurus trachurus*) in Division 9.a (Atlantic Iberian waters) | hom.27.9a | José Luis Cebrián | Hugo Mendes | Yes | 1 | June | 1 | Stock Synthesis | MSY |
| Anchovy (*Engraulis encrasicolus*) in Subarea 8 (Bay of Biscay) | ane.27.8 | Leire Citores | Leire Ibaibarriaga | Yes | 1 | December | 1 | Stock synthesis | Management plan |
| Sardine (*Sardina pilchardus*) in sub-area 7 (Southern Celtic Seas, and English Channel) | pil.27.7 | Susan Kenyon | | Yes | 1 | December | 3 | Survey trends based | PA |

[1] ICES. 2024. Benchmark Workshop on anchovy stocks (WKBANSP).

| Stock | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sardine (*Sardina pilchardus*) in divisions 8.a–b and 8.d (Bay of Biscay) | pil.27.8abd | Lionel Pawlowski | Maxime Olmos | Yes | 1 | December | 1 | Stock synthesis | MSY |
| Sardine (*Sardina pilchardus*) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters) | pil.27.8c9a | Isabel Riveiro | Laura Wise | Yes | 1 | December | 1 | Stock synthesis | MSY |
| Jack mackerel (*Trachurus picturatus*) in Subdivision 10.a.2 (Azores grounds) | jaa.27.10a2 | Wendell Medeiros | | Yes | 2 | December | 5 | No assessment | PA |

## 1.2 Report structure

*Ad hoc* and generic ToRs relative to the stocks for which assessment is required are dealt stock by stock in respective chapters of the report: anchovy in Subarea 8 (Section 2), anchovy in the western part of Division 9.a (Section 3), anchovy in subdivision 9.a.S (Section 4), sardine in divisions 8abd (Section 6), sardine in Subarea 7 (Section 7), sardine in divisions 8c and 9a (Section 8), horse mackerel in Division 9.a (Section 9), and blue jack mackerel in subdivision 10.a.2 (Section 10). The previous assessment carried out for anchovy in division 9a in June 2024 is provided in Annex 7.

The list of participants, working documents presented during the meetings, stock annexes, audits, summary sheets of the acoustic and egg surveys used in the assessments, and a summary of the joint WGACEGG-WGHANSA sessions conducted on the 28th May and the 18th and 20th December 2024 are provided as annexes.

## 1.3 Conduct of the meeting

### 1.3.1 List of participants

WGHANSA1 was attended by 12 participants from Spain, Portugal, and the UK, and 2 ICES officers. WGHANSA2 was attended by 16 participants from Spain, Portugal, France and the UK, as well as two ICES officers and one observer. The full list of participants is given in Annex 1.

All the participants abided with the ICES code of conduct, and none had conflicts of interest that prevented them acting with scientific independence, integrity, and impartiality.

### 1.3.2 Timing of the meeting

WGHANSA continues to have two meetings per year: in May, by correspondence, to address generic ToRs for the stocks of anchovy in the western part of the division 9.a and horse mackerel in 9.a; and in November, in a physical meeting, for the remaining stocks. The participants recognise that two meetings per year (one of them by correspondence) is not an ideal situation and it was agreed to make the May meeting one day shorter in 2025, considering that the anchovy stock in subdivision 9.a.S will be now evaluated in the November meeting.

The physical meeting in November is late in the year and the time to have the assessments and advice ready for publication is very tight. Unfortunately, many of the surveys that feed into the assessments are carried out in the autumn, and the survey data cannot be processed and reviewed earlier. Therefore, WGHANSA considers that the timing and duration of the meetings are as adequate as they can be under the circumstances.

### 1.3.3 Interactions with other expert groups

The Working Group on Acoustic and Egg Surveys for small pelagic fish in Northeast Atlantic (WGACEGG) is the main working group interacting with WGHANSA. Both working groups continue improving their interaction by creating dedicated time slots during their own meetings. On the second day of WGHANSA1, there was a joint session between the two groups where the results of the PELAGO and PELACUS spring surveys were presented and discussed (see Annex 5). Similarly, on the first and third of WGACEGG (18 and 20 December 2025) there was a joint session between the two working groups where the results of the acoustic and egg surveys of interest for WGHANSA were presented and discussed. Beyond improving communication and promoting joint discussions, these joint sessions allowed to have the acceptance of WGACEGG on the survey results before their inclusion in the stock assessment.

## 1.4 Quality of the fisheries data

Primary responsibility for the accuracy of national biological data lies with the national laboratories that submit such data. Each stock coordinator is responsible for combining, collating, and interpolating the national data where necessary to produce the input data for the assessments. A number of validation checks are already incorporated in the data submission procedure.

Overall, data quality has improved, and sampling deficiencies have been reduced compared to earlier years, partly due to the implementation of the EU sampling regulation for commercial catch data.

The differences between the WG estimates and official data in 2023 were minimal in most of the cases. As the usual procedure, estimates of the working group were used to perform the assessments

### 1.4.1 Overview of sampling activities

The 2023 sampling summary by stock on national basis is the following:

**Anchovy 9a W**

| Country | Official Catch | % of catch sampled | No. samples | No. measured | No. Aged |
|---|---|---|---|---|---|
| Spain | 215 | 100% | 8 | 549 | 639 |
| Portugal | 4 413 | 100% | 18 | 815 | 784 |
| Total | 4 628 | 100% | 26 | 1 364 | 1 423 |

**Anchovy 9a S**

| Country | Official Catch | % of catch sampled | No. samples | No. measured | No. Aged |
|---|---|---|---|---|---|
| Spain | 7 315 | 100% | 28 | 3 201 | 1 694 |
| Portugal | 155 | 0% | 0 | 0 | 0 |
| Total | 7 470 | 100% | 28 | 3 201 | 1 694 |

**Anchovy 8**

| Country | Official Catch | % of catch sampled | No. samples | No. measured | No. Aged |
|---|---|---|---|---|---|
| Spain | 27 667 | 100% | 271 | 21 274 | 4297 |
| France | 2703 | 100% | 0 | 0 | 1287 |
| Total | 30 370 | 100% | 271 | 21 274 | 4297 |

**Horse Mackerel 9a**

| Country | Official Catch | % of catch sampled | No. samples | No. measured | No. Aged |
|---|---|---|---|---|---|
| Portugal | 15 996 | 100% | 177 | 1 762 | 411 |
| Spain | 9 752 | 100% | 167 | 9 737 | 1 180 |
| Total | 25 747 | 100% | 344 | 11 499 | 1 591 |

**Sardine 8c9a**

| Country | Official Catch | % of catch sampled | No. samples | No. measured | No. Aged |
|---|---|---|---|---|---|
| Portugal | 25 986 | 100% | 138 | 12 587 | 2 360 |
| Spain | 21 987 | 100% | 194 | 16 061 | 4 077 |
| Total | 47 973 | 100% | 332 | 28 648 | 6 437 |

**Sardine 8abd**

| Country | Official Catch | % of catch sampled | No. samples | No. measured | No. Aged |
|---|---|---|---|---|---|
| Spain | | | | | |
| France | 21 012 | 100% | 16 | 789 | 799 |

## 1.5 Benchmarks and interbenchmarks

The working group updated the rolling issue list for the individual stocks, reviewed progress, and identified those stocks that required a benchmark. The working group is putting forward sardine in divisions 8abd for a benchmark in 2026-2027 to improve the assessment by including new input data, explore other model configurations, etc. (Table 1.5.1). Horse mackerel in subdivision 9a, anchovy in Subarea 8, and the two anchovy stocks in subdivision 9.a were benchmarked in 2024 and the new assessment models were used to provide catch advice for the next fishing season. The rolling issues list and the stock annexes have been updated (Annex 3).

**Table 1.5.1 History of benchmarks and proposals by WGHANSA.**

| Stock | Stock code | History of Benchmarks | Benchmark proposals for 2026/27 |
|---|---|---|---|
| Anchovy (*Engraulis encrasicolus*) in the western part of Division 9.a (Western Iberian waters) | ane.27.9aW | Full Benchmark 2018<br>Full benchmark 2024 | |
| Anchovy (*Engraulis encrasicolus*) in the subdivision 9.a.S (Gulf of Cadiz) | ane.27.9aS | Full Benchmark 2018<br>Full benchmark 2024 | |
| Horse mackerel (*Trachurus trachurus*) in Division 9.a (Atlantic Iberian waters) | hom.27.9a | Full benchmark 2011<br>Full benchmark 2017<br>Full benchmark 2024 | |
| Anchovy (*Engraulis encrasicolus*) in Subarea 8 (Bay of Biscay) | ane.27.8 | Full benchmark 2013<br>Full benchmark 2024 | |
| Sardine (*Sardina pilchardus*) in Subarea 7 (Southern Celtic Seas, and the English Channel) | pil.27.7 | Full benchmark 2013<br>Full benchmark 2017<br>Full benchmark 2021 | |
| Sardine (*Sardina pilchardus*) in divisions 8.a–b and 8.d (Bay of Biscay) | pil.27.8abd | Full benchmark 2013<br>Full benchmark 2017<br>Inter-benchmark 2019 | x |
| Sardine (*Sardina pilchardus*) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters) | pil.27.8c9a | Full benchmark 2013<br>Full benchmark 2017<br>Reference points updated in 2021<br>Inter-benchmark 2021 | |
| Jack mackerel (*Trachurus pictoratus*) in Subdivision 10.a.2 (Azores grounds) | jaa.27.10a2 | - | |

## 1.6 Mohn's rho

Mohn's rho values for Category 1 and 2 stocks have been uploaded at https://community.ices.dk/ExpertGroups/Lists/Retrobias/overview.aspx and they are summarised in Table 1.6.1. Further details and corresponding plots are provided in the respective chapters of the report.

**Table 1.6.1. Mohn's rho values calculated by WGHANSA for Category 1 and 2 stocks.**

| Stock | Stock code | Terminal year of catch data | Number of retrospective assessments used | $F_{bar}$ rho value | SSB rho: was the intermediate year used as the terminal year? | SSB rho value | R rho: was the intermediate year used as the terminal year? | R rho value |
|---|---|---|---|---|---|---|---|---|
| Horse mackerel (*Trachurus trachurus*) in Division 9a | hom.27.9a | 2023 | 5 | -0.11 | No | 0.05 | No | -0.12 |
| Anchovy (*Engraulis encrasicolus*) in Subarea 8 | ane.27.8 | 2024 | 5 | -0.25 | yes | 0.43 | yes | -0.30 |
| Anchovy (*Engraulis encrasilocus*) in subdivision 9aS | ane.27.9aS | 2024 | 5 | 0.33 | yes | -0.13 | yes | 0.04 |
| Sardine (*Sardina pilchardus*) in divisions 8a-b and 8d | pil.27.8abd | 2024 | 5 | -0.15 | yes | 0.26 | yes | 0.33 |
| Sardine (*Sardina pilchardus*) in divisions 8c and 9a | pil.27.8c9a | 2024 | 5 | 0.21 | yes | -0.24 | yes | -0.14 |

## 1.7 Transparent assessment framework (TAF)

The Transparent Assessment Framework (TAF) is an online open resource of ICES stock assessments for each assessment year. All data input and output are fully traceable and versioned using a sequence of R scripts. This allows anyone to easily find, reference, download, and run the assessment.

The Transparent Assessment Framework (TAF) is an online open resource of ICES stock assessments for each assessment year. All data input and output are fully traceable and versioned using a sequence of R scripts. This allows anyone to easily find, reference, download, and run the assessment.

WGHANSA continues making progress towards implementing the assessments into TAF, and currently all stocks except blue jack mackerel in the Azores grounds are available in TAF. Links for the 2024 assessment repositories are available on the corresponding advice sheet for each stock.

## 1.8 Ecosystem and Fisheries overviews

No additional progress has been made on these ToRs.

## 1.9 Research needs

Beyond the specific issues identified for each stock, the WG identified the following topics of general interest for future research:

- Further investigate the impact of the assessment bias when evaluating harvest control rules and when calculating reference points based on the MSE framework.
- Develop research models aimed at better representing the population dynamics of small pelagic fish, taking into account all stages of the life cycle and explicitly representing demographic rates such as growth, recruitment and mortality (fishing and natural mortality).
- Maturity and reproductive parameters of sardine need to be further studied.
- The exact boundaries of some of the stocks assessed by WGHANSA are unclear and further studies are needed. Studies using genetics and alternative methodologies to identify stock boundaries are needed to be able to apply a holistic approach in the delineation of the stocks. These complementary tools could include otolith-shape, otolith-microchemistry, isotope analysis, or the use of parasites as biological markers, to name a few.
- Some of the stocks assessed by WGHANSA (e.g. anchovy in Subarea 8 and sardine in divisions 8.a-b and 8.d) have shown clear trends in recent years in some biological parameters such as weight-at-age and maturity-at-age. While the underlying reasons have to be further studied, the potential continuation in time of these patterns need to be monitored in following years.
- Currently the recruitment index for sardine in divisions 8c and 9a is based on the age 0 biomass in the 9aCN from the IBERAS survey. Based on the most recent surveys, the representativeness of this area and the possibility to extent the index to a larger area needs to be evaluated.
- Sardine in divisions 8c and 9a is assumed to be in a low productivity regime. However, in the last years there are indications that the stock may be moving towards a higher productivity regime. More research is needed to re-assess the current productivity regime and to adjust the reference points and the advice accordingly.

The transition to the Regional Database and Estimation System (RDBES) will require substantial work from regional and species working groups, beyond the usual terms of reference. This work will need to be planned and coordinated in the ICES community to ensure a smooth and efficient transition.

# 2 Anchovy (*Engraulis encrasicolus)* in Subarea 8 (Bay of Biscay)

## 2.1 The ACOM advice, STECF advice and political decisions

In 2013 and 2014, the STECF evaluated a set of harvest control rules for the management of the Bay of Biscay anchovy stock (STECF, 2013, 2014). The European Commission, EU Member States and stakeholders chose harvest control rule named G4 with a harvest rate of 0.45. ICES reviewed this harvest control rule in 2015 and concluded that it was precautionary (Annex 5 in ICES (2015)). Subsequently, in December 2015, ICES advised that "when the management plan is applied, catches in 2016 should be no more than 25 000 tonnes". In January 2016 the Council established the TAC in 2016 for the Bay of Biscay anchovy stock at 25 000 tonnes (Council Regulation No 72/2016).

In May 2016, based on the good state of the stock, the South West Waters Advisory Council (SWWAC) asked for a change in the harvest control rule used for management to rule G3 with a rate of exploitation of 0.4 and an increase of the fishing opportunities for 2016 from 25 000 to 33 000 t (SWWAC Advice 101 released on 05/05/2016). In June, the Council increased the 2016 TAC to 33 000 t (Council Regulation No 891/2016), on the basis that "The stock biomass and recruitment of anchovy in the Bay of Biscay are among the highest in the historical time-series, thus allowing a higher precautionary TAC in 2016 in accordance with the management strategy assessed by the Scientific, Technical and Economic Committee for Fisheries (STECF) in 2014".

This new harvest control rule has formed the basis of the ICES advice and the TAC subsequently established by the Council from 2017 onwards (Sánchez *et al.*, 2019; Uriarte *et al.*, 2023).

In December 2023 ICES advised that "when the EU management plan is applied, catches in 2024 should be no more than 33 000 tonnes" (ICES, 2023).

In January 2024 the Council established the TAC in 2024 for the Bay of Biscay anchovy stock at 33 000 tonnes (Council Regulation (EU) 2024/257), from which 90% corresponded to Spain and 10% to France. However, these percentages may be modified due to bilateral agreements between countries.

Regarding the landing obligation regulation that aims at progressively eliminate discards in all Union fisheries, in October 2014 the European Commission established a discard plan for certain pelagic species in southwestern waters (No. 1394/2014). This included an exemption from the landing obligation for anchovy caught in artisanal purse-seine fisheries based on evidence of high survivability and de minimis exemptions both in the pelagic trawl fishery and the purse-seine fishery from 2015 to 2017. These exemptions have been extended several times through various delegated regulations (Commission Delegated Regulation 2018/188, Commission Delegated Regulation 2020/2015, Commission Delegated Regulation 2023/2623), the most recent one being for the period 2024-2027.

## 2.2 The fishery in 2023 and 2024

### 2.2.1 Fishing fleets

Two fleets operate on anchovy in the Bay of Biscay: Spanish purse-seines (operating mainly during spring) and the French fleet constituted of purse-seiners (the Basque ones operating mainly in spring and the Breton ones in autumn) and pelagic trawlers (operating mainly during the second half of the year but with decreasing catches along years).

Since the reopening of the fishery in 2010 the number of fishing licences for anchovy in Spain have been oscillating between 149 and 175. Since 2016, the number of French purse-seiners able to catch anchovy is around 28. The exact number of vessels is not fixed, due to important movements in this fleet. Most of them are based in Brittany. The number of Basque purse-seiners has decreased progressively and some of them have joined the North of the Bay of Biscay in the last years. The real target species of these vessels is sardine, and anchovy is more opportunistic in summer or autumn.

The number of French pelagic trawlers decreased drastically during the closure of anchovy fishery (2005–2009) because they were targeting mainly anchovy and tuna. Currently around 12 pairs of trawlers (~24 vessels) are able to target anchovy. In the last years a shift has occurred on the French anchovy fishery. Pair pelagic trawlers mainly targeted tuna between July and October, and single pelagic trawlers didn't catch anchovy. Due to a very low price (anchovies were too small for the market), vessels have displaced their fishing effort onto other species, particularly tuna and sardine.

A more complete description of the fisheries is available in the stock annex. The transformation of the anchovy fishery system after the fishery closure has also been analysed by Beckensteiner *et al.* (2024).

### 2.2.2 Catches

Historical catches are presented in Table 2.2.2.1 and Figure 2.2.2.1. Total catches in 2023 were 30 370 tonnes, from which 27 667 corresponded to Spain and 2703 to France. From the Spanish catches, 27 tonnes corresponded to anchovy used as live bait for tuna fishing. Discards were less than 0.1% of the total catch and they are considered negligible for this stock.

The series of monthly catches are shown in Table 2.2.2.2. In 2023, most of the catches occurred between April and May, where the bulk of the Spanish fishery occurred. However, catches were recorded in all the months.

The quarterly catches by division in 2023 are given in Table 2.2.2.3. Most of the catches took place in the second quarter (72%), followed by the third quarter (15%) and with lower catches in first and fourth quarters (12% and 1% respectively). The major fishing activity of the Spanish fleet occurred in the second quarter (79%) followed by the first quarter (13%), whereas the French fleet operated almost exclusively in the third quarter (99%). Regarding fishing areas, most of the Spanish catches in the first semester corresponded to ICES division 8.c East, whereas in the second semester catches occurred in division 8.c West. All the French catches corresponded to ICES divisions 8.a and 8.b.

In previous years, non-negligible catches originate in divisions 7.h and 7.e (statistical rectangles 25E5 and 25E4) have been reallocated to Division 8.a due to their very concentrated location at the boundary between 8.a, 7.h and 7.e in the same period. In 2023, a small number of catches declared in 25E5 and 25E4 have been reallocated to 8.a.

**Table 2.2.2.1: Bay of Biscay anchovy: Annual catches (in tonnes) as estimated by the Working Group members.**

| COUNTRY | FRANCE | SPAIN | SPAIN | UNALLOCATED | OTHER COUNTRIES | INTERNATIONAL |
|---|---|---|---|---|---|---|
| YEAR | VIIIab | VIIIbc | Live Bait Catches | | | VIII |
| 1960 | 1 085 | 57 000 | n/a | | | 58 085 |
| 1961 | 1 494 | 74 000 | n/a | | | 75 494 |
| 1962 | 1 123 | 58 000 | n/a | | | 59 123 |
| 1963 | 652 | 48 000 | n/a | | | 48 652 |
| 1964 | 1 973 | 75 000 | n/a | | | 76 973 |
| 1965 | 2 615 | 81 000 | n/a | | | 83 615 |
| 1966 | 839 | 47 519 | n/a | | | 48 358 |
| 1967 | 1 812 | 39 363 | n/a | | | 41 175 |
| 1968 | 1 190 | 38 429 | n/a | | | 39 619 |
| 1969 | 2 991 | 33 092 | n/a | | | 36 083 |
| 1970 | 3 665 | 19 820 | n/a | | | 23 485 |
| 1971 | 4 825 | 23 787 | n/a | | | 28 612 |
| 1972 | 6 150 | 26 917 | n/a | | | 33 067 |
| 1973 | 4 395 | 23 614 | n/a | | | 28 009 |
| 1974 | 3 835 | 27 282 | n/a | | | 31 117 |
| 1975 | 2 913 | 23 389 | n/a | | | 26 302 |
| 1976 | 1 095 | 36 166 | n/a | | | 37 261 |
| 1977 | 3 807 | 44 384 | n/a | | | 48 191 |
| 1978 | 3 683 | 41 536 | n/a | | | 45 219 |
| 1979 | 1 349 | 25 000 | n/a | | | 26 349 |
| 1980 | 1 564 | 20 538 | n/a | | | 22 102 |
| 1981 | 1 021 | 9 794 | n/a | | | 10 815 |
| 1982 | 381 | 4 610 | n/a | | | 4 991 |
| 1983 | 1 911 | 12 242 | n/a | | | 14 153 |
| 1984 | 1 711 | 33 468 | n/a | | | 35 179 |
| 1985 | 3 005 | 8 481 | n/a | | | 11 486 |
| 1986 | 2 311 | 5 612 | n/a | | | 7 923 |
| 1987 | 4 899 | 9 863 | 546 | | | 15 308 |
| 1988 | 6 822 | 8 266 | 493 | | | 15 581 |
| 1989 | 2 255 | 8 174 | 185 | | | 10 614 |
| 1990 | 10 598 | 23 258 | 416 | | | 34 272 |
| 1991 | 9 708 | 9 573 | 353 | | | 19 634 |
| 1992 | 15 217 | 22 468 | 200 | | | 37 885 |
| 1993 | 20 914 | 19 173 | 306 | | | 40 393 |
| 1994 | 16 934 | 17 554 | 143 | | | 34 631 |
| 1995 | 10 892 | 18 950 | 273 | | | 30 115 |
| 1996 | 15 238 | 18 937 | 198 | | | 34 373 |
| 1997 | 12 020 | 9 939 | 378 | | | 22 337 |
| 1998 | 22 987 | 8 455 | 176 | | | 31 617 |
| 1999 | 13 649 | 13 145 | 465 | | | 27 259 |
| 2000 | 17 765 | 19 230 | n/a | | | 36 994 |
| 2001 | 17 097 | 23 052 | n/a | | | 40 149 |
| 2002 | 10 988 | 6 519 | n/a | | | 17 507 |
| 2003 | 7 593 | 3 002 | n/a | | | 10 595 |
| 2004 | 8 781 | 7 580 | n/a | | | 16 361 |
| 2005 | 952 | 176 | 0 | | | 1 128 |
| 2006 | 913 | 840 | 0 | | | 1 753 |
| 2007** | 140 | 1 | 0 | | | 141 |
| 2008 | 0 | 0 | 0 | | | 0 |
| 2009 | 0 | 0 | 0 | | | 0 |
| 2010 | 4 573 | 5 744 | n/a | | | 10 317 |
| 2011 | 3 615 | 10 916 | n/a | | | 14 530 |
| 2012 | 5 975 | 7 896 | n/a | 531 | | 14 402 |
| 2013 | 2 392 | 11 801 | n/a | | | 14 192 |
| 2014 | 4 012 | 16 114 | n/a | | | 20 126 |
| 2015 | 4 261 | 23 992 | n/a | | 5 | 28 258 |
| 2016 | 2 300 | 18 060 | 310 | | | 20 670 |
| 2017 | 3 153 | 22 955 | 332 | 9 | | 26 450 |
| 2018 | 3 151 | 27 607 | 15 | | | 30 773 |
| 2019 | 2 048 | 24 802 | 7 | | | 26 857 |
| 2020 | 138 | 25 661 | 24 | | | 25 823 |
| 2021 | 64 | 27 917 | 1 | | | 27 982 |
| 2022 | 234 | 24 953 | 8 | | | 25 196 |
| 2023 | 2 703 | 27 640 | 27 | | | 30 370 |
| 2024 (Up to end of October) | 1 067 | 31 060 | | | | 32 127 |
| | | | | | | |
| AVERAGE (1960-2004) | 6 394 | 26 337 | | | | 32 824 |
| AVERAGE (2010-2023) | 2 759 | 19 718 | 91 | | | 22 568 |
| | | | | | | |
| ** : Experimental fishery | | | 27 667 | | | |

**Table 2.2.2.2: Bay of Biscay anchovy: Monthly catches (Subarea 8) (without live bait catches).**

| YEAR\MONTH | J | F | M | A | M | J | J | A | S | O | N | D | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1987** | 0 | 0 | 454 | 5246 | 5237 | 782 | 229 | 636 | 707 | 812 | 309 | 352 | 14763 |
| **1988** | 6 | 0 | 42 | 1657 | 4317 | 3979 | 584 | 1253 | 2423 | 445 | 136 | 246 | 15088 |
| **1989** | 706 | 73 | 36 | 588 | 4943 | 806 | 132 | 566 | 186 | 472 | 1619 | 301 | 10429 |
| **1990** | 80 | 6 | 2101 | 2658 | 11459 | 3083 | 1471 | 5132 | 5553 | 1570 | 652 | 92 | 33856 |
| **1991** | 1418 | 2175 | 626 | 2036 | 6913 | 1858 | 215 | 479 | 1621 | 822 | 238 | 882 | 19282 |
| **1992** | 2422 | 1864 | 1282 | 4241 | 13125 | 3448 | 719 | 1488 | 3291 | 3228 | 2489 | 89 | 37685 |
| **1993** | 1738 | 1864 | 3362 | 3260 | 7906 | 5927 | 2110 | 2979 | 4254 | 3342 | 3273 | 70 | 40086 |
| **1994** | 1972 | 1917 | 1591 | 5741 | 4761 | 7231 | 1796 | 2306 | 3382 | 3295 | 421 | 74 | 34487 |
| **1995** | 620 | 958 | 842 | 5967 | 12329 | 2764 | 439 | 1098 | 2155 | 1382 | 903 | 387 | 29843 |
| **1996** | 1132 | 647 | 752 | 1834 | 9763 | 6897 | 2449 | 2675 | 3617 | 2818 | 1575 | 17 | 34176 |
| **1997** | 2278 | 688 | 105 | 2782 | 2762 | 1985 | 1895 | 2400 | 3578 | 2381 | 921 | 185 | 21961 |
| **1998** | 1558 | 2363 | 1276 | 371 | 4839 | 2510 | 3943 | 5039 | 4298 | 2640 | 2500 | 104 | 31442 |
| **1999** | 2088 | 1360 | 626 | 4681 | 4282 | 2345 | 2052 | 948 | 4049 | 2130 | 2207 | 27 | 26794 |
| **2000** | 2219 | 948 | 925 | 1957 | 11922 | 4565 | 3148 | 3063 | 4043 | 2995 | 1210 | 0 | 36994 |
| **2001** | 960 | 565 | 479 | 2249 | 14428 | 4413 | 2514 | 3403 | 4435 | 3850 | 2852 | 1 | 40149 |
| **2002** | 1436 | 2561 | 1573 | 915 | 2506 | 2098 | 673 | 1034 | 2970 | 1152 | 578 | 0 | 17497 |
| **2003** | 39 | 2 | 0 | 1740 | 890 | 1403 | 294 | 2297 | 1602 | 1322 | 986 | 20 | 10595 |
| **2004** | 210 | 106 | 3 | 2377 | 3247 | 3241 | 902 | 2017 | 2886 | 557 | 813 | 2 | 16360 |
| **2005** | 363 | 17 | 35 | 4 | 183 | 525 | 0 | 0 | 0 | 0 | 0 | 0 | 1127 |
| **2006** | 1 | 0 | 33 | 124 | 630 | 870 | 95 | 0 | 0 | 0 | 0 | 0 | 1753 |
| **2007** | 0 | 0 | 0 | 39 | 57 | 45 | 0 | 0 | 0 | 0 | 0 | 0 | 141 |
| **2008** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **2009** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **2010** | 0 | 0 | 299 | 1324 | 2955 | 1532 | 75 | 632 | 2425 | 863 | 213 | 0 | 10317 |
| **2011** | 0 | 0 | 1586 | 4483 | 4492 | 351 | 2 | 176 | 815 | 1319 | 1258 | 47 | 14530 |
| **2012** | 0 | 0 | 68 | 1060 | 5663 | 1809 | 354 | 868 | 2352 | 1940 | 288 | 0 | 14402 |
| **2013** | 0 | 3 | 272 | 2226 | 5166 | 3269 | 312 | 316 | 1375 | 1069 | 185 | 1 | 14192 |
| **2014** | 0 | 0 | 0 | 3739 | 8604 | 1950 | 180 | 2081 | 2025 | 1188 | 357 | 0 | 20125 |
| **2015** | 0 | 0 | 1011 | 6089 | 4482 | 7833 | 505 | 1305 | 6331 | 590 | 106 | 0 | 28253 |
| **2016** | 41 | 11 | 1432 | 8746 | 3811 | 1339 | 657 | 1760 | 687 | 58 | 1758 | 62 | 20360 |
| **2017** | 21 | 16 | 1915 | 5854 | 9839 | 5118 | 559 | 937 | 1307 | 289 | 238 | 15 | 26108 |
| **2018** | 10 | 10 | 1498 | 8895 | 12956 | 2131 | 1736 | 1831 | 1166 | 508 | 9 | 8 | 30758 |
| **2019** | 7 | 8 | 2800 | 9743 | 8924 | 717 | 1863 | 1295 | 866 | 452 | 171 | 4 | 26850 |
| **2020** | 19 | 20 | 220 | 4090 | 9896 | 626 | 2670 | 3878 | 3729 | 224 | 405 | 24 | 25800 |
| **2021** | 1 | 1 | 7384 | 8512 | 7209 | 499 | 2632 | 1680 | 18 | 32 | 7 | 6 | 27981 |
| **2022** | 6 | 5 | 3164 | 10919 | 5973 | 1256 | 1582 | 1085 | 839 | 145 | 213 | 1 | 25188 |
| **2023** | 0.641 | 0.61451 | 3706.858 | 7016.456 | 13022.69 | 1827.815 | 1933.986 | 2037.957 | 557.0412 | 216.2958 | 18.48894 | 3.80013 | 30343 |

**Table 2.2.2.3: Bay of Biscay anchovy: Catches in the Bay of Biscay by country and divisions in 2023 (without live bait catches).**

| COUNTRIES | DIVISIONS | QUARTERS | | | | CATCH ( t ) | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | ANNUAL | % |
| SPAIN | 8abd | 714 | 1797 | 1 | 30 | 2542 | 9.2% |
| | 8cE | 2972 | 20020 | 743 | 81 | 23815 | 86.2% |
| | 8cW | 22 | 45 | 1088 | 128 | 1283 | 4.6% |
| | TOTAL | 3708 | 21862 | 1832 | 239 | 27640 | 100.0% |
| | % | 13.4% | 79.1% | 6.6% | 0.9% | 100.0% | |
| FRANCE | 8abd | 0 | 5 | 2697 | 0 | 2703 | 100.0% |
| | 8cE | | | | | 0 | 0.0% |
| | 8cW | | | | | 0 | 0.0% |
| | TOTAL | 0 | 5 | 2697 | 0 | 2703 | 100.0% |
| | % | 0.0% | 0.2% | 99.8% | 0.0% | 100.0% | |
| INTERNATIONAL | 8abd | 715 | 1802 | 2698 | 30 | 5245 | 17.3% |
| | 8cE | 2972 | 20020 | 743 | 81 | 23815 | 78.5% |
| | 8cW | 22 | 45 | 1088 | 128 | 1283 | 4.2% |
| | TOTAL | 3708 | 21867 | 4529 | 239 | 30343 | 100.0% |
| | % | 12.2% | 72.1% | 14.9% | 0.8% | 100.0% | |

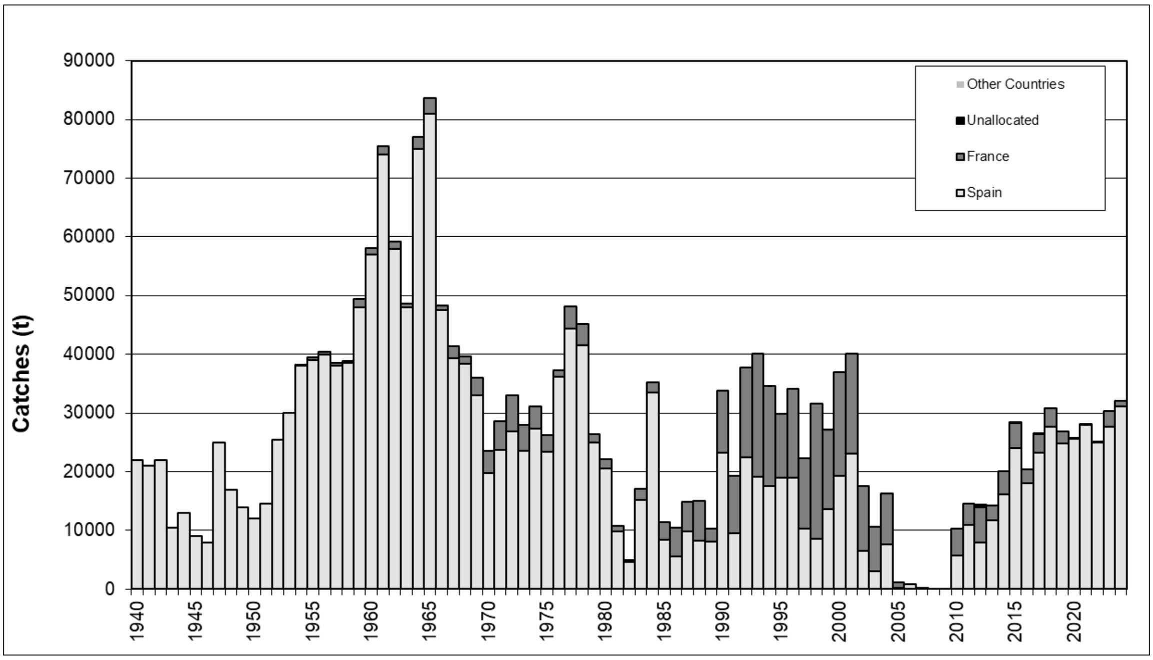



**Figure 2.2.2.1: Bay of Biscay anchovy: Historical evolution of catches in Subarea 8 by countries. 2024 data are preliminary.**

## 2.2.3 Catch numbers-at-age and length

In 2023 there were no length and age samples available from the French fishery due to the low level of catches. Catch numbers-at-age of the French catches were estimated assuming that the percentage of numbers-at-age per quarter were equal to the percentage of numbers-at-age of the Spanish catches in divisions 8.a and 8.b, where the French fishery occurs.

Catch numbers-at-age by quarter in 2023 are given in Table 2.2.3.1. Age 1 individuals were predominant in all the quarters, representing between 64% and 86% of the total per quarter. The percentage of individuals of age 2 was between 20% and 27% from quarter 1 to 3 and decreased to 1% in the last quarter. Age 0 individuals appeared in third and fourth quarters, being the 2% and 13% of the total of each quarter respectively.

The age composition of the international catches since 1987, on a half-yearly basis is shown in Table 2.2.3.2 and Figure 2.2.3.1. In the first semester most of the catches correspond to ages 1 or 2. In the second semester, age 0 individuals incorporate to the fishery and age 1 increases while older ages (age 2 and 3+) decrease. In 2023, the one-year-old anchovies dominated in the catches in both semesters, representing the 64% in the first semester and the 79% in the second semester.

Regardless interannual variations, strong cohorts can be tracked in the numbers-at-age and the mean age of the catches in the first semester (2.2.3.1). After the fishery closure, there seems to be an increase in the mean age of the catches, towards older individuals.

See the stock annex for methodological issues (annex 3).

**Table 2.2.3.1: Bay of Biscay anchovy: Catch-at-age in thousands for 2023 by country and quarter (without the catches from the live bait tuna fishing boats).**

| | QUARTERS | 1 | 2 | 3 | 4 | Annual total |
|---|---|---|---|---|---|---|
| | AGE | VIIIbc | VIIIbc | VIIIbc | VIIIbc | VIIIbc |
| SPAIN | 0 | 0 | 0 | 3 | 2012 | 2 015 |
| | 1 | 101806 | 542939 | 62732 | 13232 | 720 709 |
| | 2 | 38973 | 231954 | 19590 | 181 | 290 698 |
| | 3 | 15780 | 74476 | 0 | 0 | 90 255 |
| | 4 | 145 | 1326 | 0 | 0 | 1 470 |
| | 5 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | |
| | TOTAL(n) | 156 704 | 850 695 | 82 325 | 15 425 | 1 105 148 |
| | W MED. | 23.66 | 25.70 | 22.24 | 15.46 | 25.01 |
| | CATCH. (t) | 3708 | 21862 | 1832 | 239 | 27640 |
| | SOP | 3707 | 21861 | 1831 | 238 | 27638 |
| | VAR. % | 99.99% | 100.00% | 99.97% | 99.96% | 99.99% |

| | QUARTERS | 1 | 2 | 3 | 4 | Annual total |
|---|---|---|---|---|---|---|
| | AGE | VIIIab | VIIIab | VIIIab | VIIIab | VIIIab |
| FRANCE | 0 | 0 | 0 | 4515 | 1 | 4 516 |
| | 1 | 7 | 125 | 109567 | 3 | 109 702 |
| | 2 | 3 | 54 | 23362 | 0 | 23 419 |
| | 3 | 1 | 13 | 0 | 0 | 14 |
| | 4 | 0 | 1 | 0 | 0 | 1 |
| | 5 | | | | | |
| | | | | | | |
| | TOTAL(n) | 11 | 193 | 137 444 | 4 | 137 652 |
| | W MED. | 23.02 | 26.19 | 19.62 | 20.14 | 19.63 |
| | CATCH. (t) | 0 | 5 | 2697 | 0 | 2 703 |
| | SOP | 0 | 5 | 2697 | 0 | 2 702 |
| | VAR. % | 99.99% | 100.00% | 99.98% | 99.99% | 99.98% |

| | QUARTERS | 1 | 2 | 3 | 4 | Annual total |
|---|---|---|---|---|---|---|
| | AGE | VIIIabc | VIIIabc | VIIIabc | VIIIabc | VIIIabc |
| TOTAL Sub-area 8 | 0 | 0 | 0 | 4 518 | 2 013 | 6 531 |
| | 1 | 101 813 | 543 064 | 172 299 | 13 235 | 830 411 |
| | 2 | 38 976 | 232 008 | 42 951 | 181 | 314 117 |
| | 3 | 15 781 | 74 489 | 0 | 0 | 90 270 |
| | 4 | 145 | 1 326 | 0 | 0 | 1 471 |
| | 5 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | |
| | TOTAL(n) | 156 715 | 850 887 | 219 769 | 15 429 | 1 242 800 |
| | W MED. | 23.66 | 25.70 | 20.60 | 15.46 | 24.41 |
| | CATCH. (t) | 3708 | 21867 | 4529 | 239 | 30343 |
| | SOP | 3708 | 21866 | 4528 | 238 | 30340 |
| | VAR. % | 99.99% | 100.00% | 99.97% | 99.96% | 99.99% |

**Table 2.2.3.2: Bay of Biscay anchovy: Catches-at-age of anchovy of the fishery in the Bay of Biscay on half-year basis (including live bait catches up to 1999). Units: Thousands.**

| YEAR | 1987 | | 1988 | | 1989 | | 1990 | | 1991 | | 1992 | | 1993 | | 1994 | | 1995 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half |
| 0 | 0 | 38 140 | 0 | 150 338 | 0 | 180 085 | 0 | 16 984 | 0 | 86 647 | 0 | 38 434 | 0 | 63 499 | 0 | 59 934 | 0 | 49 771 |
| 1 | 218 670 | 120 098 | 318 181 | 190 113 | 152 612 | 27 085 | 847 627 | 517 690 | 323 877 | 116 290 | 1 001 551 | 440 134 | 794 055 | 611 047 | 494 610 | 355 663 | 522 361 | 189 081 |
| 2 | 157 665 | 13 534 | 92 621 | 13 334 | 123 683 | 10 771 | 59 482 | 75 999 | 310 620 | 12 581 | 193 137 | 31 446 | 439 655 | 91 977 | 493 437 | 54 867 | 282 301 | 21 771 |
| 3 | 31 362 | 1 664 | 9 954 | 596 | 18 096 | 1 986 | 8 175 | 4 999 | 29 179 | 61 | 16 960 | 1 | 5 336 | 0 | 61 667 | 1 325 | 76 525 | 90 |
| 4 | 14 831 | 58 | 1 356 | 0 | 54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 096 | 7 |
| 5 | 8 920 | 0 | 99 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total # | 431 448 | 173 494 | 398 971 | 529 130 | 294 445 | 219 927 | 915 283 | 615 671 | 663 677 | 215 579 | 1 211 647 | 510 015 | 1 239 046 | 766 523 | 1 049 714 | 471 789 | 885 283 | 260 719 |

| YEAR | 1996 | | 1997 | | 1998 | | 1999 | | 2000 | | 2001 | | 2002 | | 2003 | | 2004 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half |
| 0 | 0 | 109 173 | 0 | 133 232 | 0 | 4 075 | 0 | 54 357 | 0 | 5 298 | 0 | 749 | 0 | 267 | 0 | 7 530 | 0 | 11 184 |
| 1 | 683 009 | 456 164 | 471 370 | 439 888 | 443 818 | 598 139 | 220 067 | 243 306 | 559 934 | 396 961 | 460 346 | 507 678 | 103 210 | 129 392 | 50 327 | 133 083 | 254 504 | 252 887 |
| 2 | 233 095 | 53 156 | 138 183 | 40 014 | 128 854 | 123 225 | 380 012 | 142 904 | 268 354 | 64 712 | 374 424 | 98 117 | 217 218 | 77 128 | 44 546 | 87 142 | 85 679 | 20 072 |
| 3 | 31 092 | 499 | 5 580 | 195 | 5 596 | 3 398 | 17 761 | 525 | 84 437 | 18 613 | 19 698 | 5 095 | 37 886 | 3 045 | 34 133 | 11 459 | 12 444 | 1 153 |
| 4 | 2 213 | 42 | 0 | 0 | 155 | 0 | 108 | 0 | 0 | 0 | 4 948 | 0 | 76 | 0 | 887 | 1 152 | 4 598 | 16 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total # | 949 408 | 619 034 | 615 133 | 613 329 | 578 423 | 728 837 | 617 948 | 441 092 | 912 725 | 485 584 | 859 417 | 611 639 | 358 390 | 209 832 | 129 893 | 240 366 | 357 225 | 285 312 |

| YEAR | 2005 | | 2006 | | 2007 | | 2008 | | 2009 | | 2010 | | 2011 | | 2012 | | 2013 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 287 | 0 | 4 656 | 0 | 3 761 | 0 | 10 343 |
| 1 | 7 818 | 0 | 48 718 | 3 894 | 0 | 0 | 0 | 0 | 0 | 0 | 125 198 | 135 570 | 164 061 | 159 675 | 56 013 | 167 935 | 84 863 | 81 392 |
| 2 | 32 911 | 0 | 17 172 | 991 | 0 | 0 | 0 | 0 | 0 | 0 | 77 342 | 13 864 | 214 454 | 11 080 | 254 863 | 69 396 | 223 958 | 45 177 |
| 3 | 6 935 | 0 | 6 465 | 320 | 0 | 0 | 0 | 0 | 0 | 0 | 10 897 | 815 | 7 161 | 503 | 5 055 | 1 115 | 87 493 | 5 559 |
| 4 | 586 | 0 | 49 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 711 | 189 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total # | 48 250 | 0 | 72 405 | 5 207 | 0 | 0 | 0 | 0 | 0 | 0 | 215 149 | 166 725 | 385 677 | 175 914 | 315 932 | 242 207 | 396 315 | 142 471 |

| YEAR | 2014 | | 2015 | | 2016 | | 2017 | | 2018 | | 2019 | | 2020 | | 2021 | | 2022 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half |
| 0 | 0 | 37 068 | 0 | 443 | 0 | 63 356 | 0 | 6 349 | 0 | 1 770 | 0 | 373 | 0 | 62 514 | 0 | 3 744 | 0 | 63 027 |
| 1 | 228 729 | 187 159 | 560 920 | 251 508 | 259 758 | 121 873 | 469 609 | 71 163 | 682 918 | 178 348 | 305 170 | 87 158 | 527 627 | 544 756 | 556 251 | 148 372 | 239 858 | 88 306 |
| 2 | 336 224 | 12 181 | 357 044 | 128 579 | 363 465 | 58 740 | 425 906 | 48 549 | 399 932 | 37 574 | 543 415 | 77 355 | 235 637 | 51 618 | 514 673 | 60 779 | 550 011 | 55 094 |
| 3 | 53 703 | 3 035 | 27 236 | 6 914 | 45 212 | 2 287 | 92 731 | 7 660 | 39 483 | 1 210 | 52 579 | 6 673 | 30 559 | 1 601 | 37 413 | 167 | 124 967 | 6 775 |
| 4 | 4 271 | 0 | 173 | 0 | 231 | 0 | 2 339 | 0 | 292 | 0 | 440 | 0 | 171 | 3 | 862 | 0 | 296 | 0 |
| 5 | 0 | 0 | 0 | 0 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total # | 622 927 | 239 443 | 945 373 | 387 443 | 668 666 | 246 256 | 990 585 | 133 721 | 1 122 624 | 218 902 | 901 605 | 171 559 | 793 994 | 660 492 | 1 109 199 | 213 062 | 915 131 | 213 203 |

| YEAR | 2023 | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half |
| 0 | 0 | 6 531 | | | | | | | | | | | | | | | | |
| 1 | 644 877 | 185 534 | | | | | | | | | | | | | | | | |
| 2 | 270 984 | 43 132 | | | | | | | | | | | | | | | | |
| 3 | 90 270 | 0 | | | | | | | | | | | | | | | | |
| 4 | 1 471 | 0 | | | | | | | | | | | | | | | | |
| 5 | 0 | 0 | | | | | | | | | | | | | | | | |
| Total # | 1 007 602 | 235 198 | | | | | | | | | | | | | | | | |

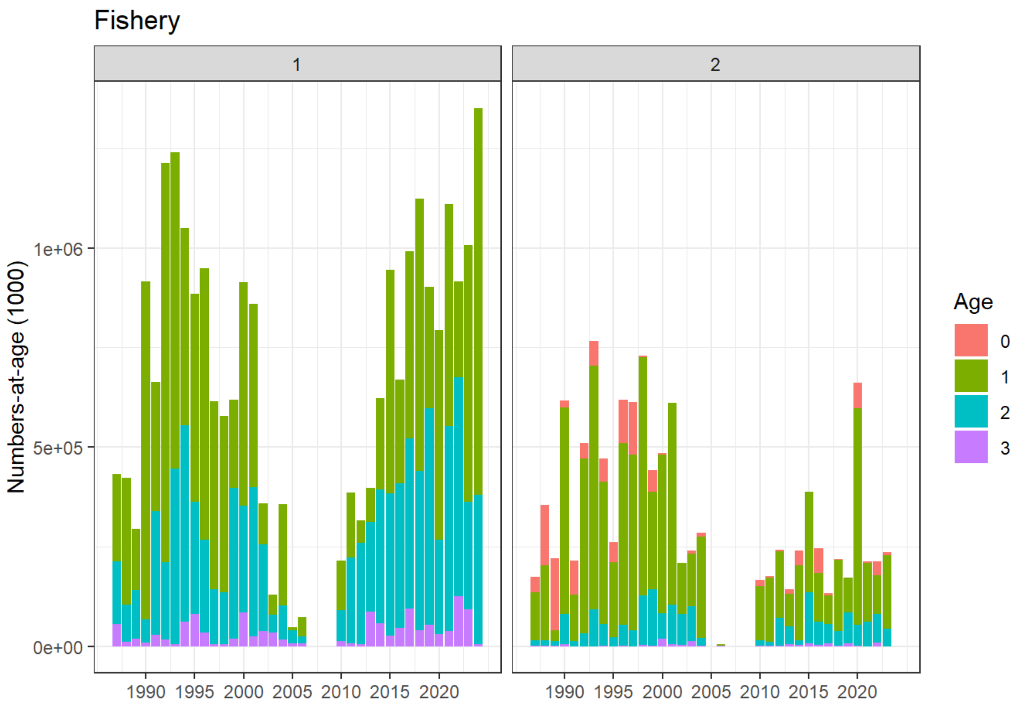



**Figure 2.2.3.1: Bay of Biscay anchovy: Numbers-at-age by semester. The age classes are 0, 1, 2 and 3+.**

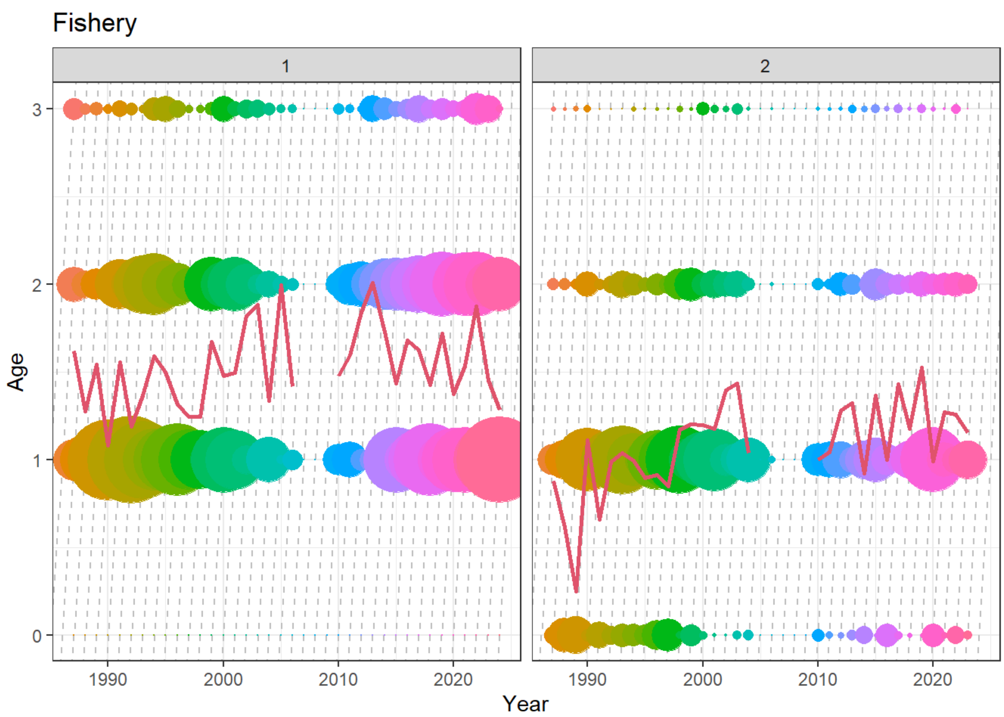



**Figure 2.2.3.2: Bay of Biscay anchovy: Bubble plot of catch-at-age by semester. The red lines represent the mean age in the catches for each of the semesters.**

## 2.2.4 Weights and lengths-at-age in the catch

The series of mean weight-at-age in the fishery by half year, from 1987 to 2023, are shown in Table 2.2.4.1 and Figure 2.2.4.1. Since 2010 there is a decreasing trend in the weight-at-age for all age classes in the first semester and for ages 1 and 2 in the second semester.

See the stock annex for methodological issues.

**Table 2.2.4.1: Bay of Biscay anchovy: Mean weight-at-age (grammes) in the international catches on half-year basis. Units: grammes.**

| YEAR | 1987 | | 1988 | | 1989 | | 1990 | | 1991 | | 1992 | | 1993 | | 1994 | | 1995 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sources | Anon. (1989 & 1991) | | Anon. (1989) | | Anon. (1991) | | Anon. (1991) | | Anon. (1992) | | Anon. (1993) | | Anon. (1995) | | Anon. (1996) | | Anon. (1997) | |
| Periods | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half |
| Age 0 | na | 11.7 | na | 5.1 | na | 12.7 | na | 7.4 | na | 14.4 | na | 12.6 | na | 12.3 | na | 14.7 | na | 15.1 |
| 1 | 21.0 | 21.9 | 20.8 | 23.6 | 19.5 | 24.9 | 20.6 | 23.8 | 18.5 | 25.1 | 19.6 | 23.0 | 15.5 | 20.9 | 16.8 | 25.3 | 22.5 | 26.9 |
| 2 | 32.0 | 34.2 | 30.3 | 30.4 | 28.5 | 35.2 | 28.5 | 27.7 | 25.2 | 29.0 | 30.9 | 28.8 | 27.0 | 29.4 | 26.8 | 28.1 | 32.3 | 31.3 |
| 3 | 37.7 | 39.2 | 34.5 | 44.5 | 29.7 | 42.7 | 44.8 | 40.8 | 28.2 | 39.0 | 37.7 | 27.4 | 30.5 | na | 30.7 | 30.0 | 36.4 | 36.4 |
| 4 | 41.0 | 40.0 | 37.6 | na | 27.1 | na | na | na | na | na | na | na | na | na | na | na | 37.3 | 29.1 |
| 5 | 42.0 | 0.0 | 48.5 | na | na | na | na | na | na | na | na | na | na | na | na | na | na | na |
| Total | 27.3 | 20.8 | 24.6 | 10.7 | 23.9 | 15.6 | 21.3 | 24.0 | 22.1 | 21.1 | 21.7 | 22.5 | 19.6 | 21.2 | 22.3 | 24.3 | 26.9 | 25.0 |

| YEAR | 1996 | | 1997 | | 1998 | | 1999 | | 2000 | | 2001 | | 2002 | | 2003 | | 2004 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sources: | Anon. (1998) | | Anon. (1999) | | Anon (2000) | | WG data | | WG data | | WG data | | WG data | | WG data | | WG data | |
| Periods | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half |
| Age 0 | na | 12.0 | na | 11.6 | na | 10.2 | na | 15.7 | na | 19.3 | na | 14.3 | na | 9.5 | na | 15.4 | na | 15.5 |
| 1 | 19.1 | 23.2 | 14.4 | 20.3 | 21.8 | 23.7 | 17.1 | 27.0 | 21.7 | 28.2 | 22.7 | 27.5 | 25.0 | 28.8 | 21.0 | 25.4 | 21.7 | 24.9 |
| 2 | 29.3 | 27.7 | 26.9 | 30.1 | 24.3 | 27.7 | 29.8 | 33.5 | 29.1 | 33.0 | 31.8 | 31.1 | 31.6 | 33.4 | 36.2 | 29.5 | 35.7 | 33.5 |
| 3 | 35.0 | 35.7 | 32.0 | 29.7 | 31.9 | 28.7 | 34.7 | 38.9 | 32.8 | 36.9 | 36.3 | 38.6 | 42.8 | 36.5 | 40.3 | 36.4 | 39.3 | 40.7 |
| 4 | 46.1 | 39.7 | na | na | 31.9 | na | 55.9 | na | na | na | 40.7 | na | 45.6 | na | 36.9 | 37.9 | 44.0 | 42.8 |
| 5 | na | na | na | na | na | na | na | na | na | na | na | na | na | na | na | na | na | na |
| Total | 22.2 | 21.6 | 17.3 | 19.1 | 22.5 | 24.3 | 25.4 | 27.7 | 24.9 | 29.0 | 27.1 | 28.2 | 30.9 | 30.6 | 31.4 | 27.1 | 26.0 | 25.2 |

| YEAR | 2005 | | 2006 | | 2007 | | 2008 | | 2009 | | 2010 | | 2011 | | 2012 | | 2013 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sources: | WG data | | WG data | | WG data | | WG data | | WG data | | WG data | | WG data | | WG data | | WG data | |
| Periods | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half |
| Age 0 | na | na | na | na | na | na | na | na | na | na | na | 14.4 | na | 8.9 | na | 12.6 | na | 12.0 |
| 1 | 19.3 | na | 20.3 | 17.8 | na | na | na | na | na | na | 25.0 | 25.9 | 22.5 | 20.5 | 16.7 | 22.3 | 20.8 | 21.9 |
| 2 | 24.5 | na | 27.7 | 19.7 | na | na | na | na | na | na | 32.1 | 27.4 | 32.4 | 27.3 | 28.9 | 25.9 | 28.8 | 28.7 |
| 3 | 27.6 | na | 31.3 | 19.7 | na | na | na | na | na | na | 43.7 | 43.2 | 36.4 | 34.8 | 38.7 | 26.5 | 31.5 | 31.6 |
| 4 | 24.5 | na | 37.3 | 34.3 | na | na | na | na | na | na | 43.0 | 44.4 | na | na | na | na | na | na |
| 5 | na | na | na | na | na | na | na | na | na | na | 55.7 | na | na | na | na | na | na | na |
| Total | 24.1 | na | 23.0 | 18.2 | na | na | na | na | na | na | 28.6 | 25.0 | 28.3 | 20.6 | 26.9 | 23.2 | 27.7 | 23.7 |

| YEAR | 2014 | | 2015 | | 2016 | | 2017 | | 2018 | | 2019 | | 2020 | | 2021 | | 2022 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sources: | WG data | | WG data | | WG data | | WG data | | WG data | | WG data | | WG data | | WG data | | WG data | |
| Periods | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half | 1st half | 2nd half |
| Age 0 | na | 16.1 | na | 9.4 | na | 15.6 | na | 15.2 | na | 12.5 | na | 11.9 | na | 9.3 | na | 13.7 | na | 14.6 |
| 1 | 18.3 | 26.3 | 17.0 | 19.9 | 19.3 | 20.5 | 19.8 | 23.9 | 20.7 | 22.1 | 20.2 | 21.0 | 16.5 | 16.8 | 19.9 | 20.0 | 15.5 | 17.5 |
| 2 | 25.1 | 33.3 | 25.5 | 28.1 | 24.5 | 24.1 | 25.1 | 26.8 | 25.0 | 28.3 | 27.4 | 26.0 | 21.6 | 21.9 | 22.3 | 22.2 | 23.2 | 20.1 |
| 3 | 28.9 | 45.8 | 28.7 | 38.5 | 31.7 | 32.8 | 28.8 | 30.7 | 33.7 | 28.8 | 32.2 | 33.6 | 28.4 | 28.7 | 27.6 | 36.3 | 31.2 | 23.2 |
| 4 | 26.0 | na | 25.5 | na | 32.6 | na | 29.9 | na | 27.8 | na | 27.7 | na | 29.3 | 29.4 | 32.4 | na | na | 33.2 |
| 5 | na | na | na | na | na | na | na | na | na | na | na | na | na | na | na | na | na | na |
| Total | 22.9 | 25.3 | 20.5 | 22.9 | 23.0 | 20.2 | 23.0 | 24.9 | 22.7 | 23.2 | 25.3 | 23.7 | 18.5 | 16.5 | 21.3 | 20.5 | 23.3 | 18.1 |

| YEAR | 2023 | |
|---|---|---|
| Sources: | WG data | |
| Periods | 1st half | 2nd half |
| Age 0 | na | 10.9 |
| 1 | 22.4 | 19.5 |
| 2 | 28.3 | 25.0 |
| 3 | 38.0 | na |
| 4 | 29.7 | na |
| 5 | na | na |
| Total | 25.4 | 20.3 |

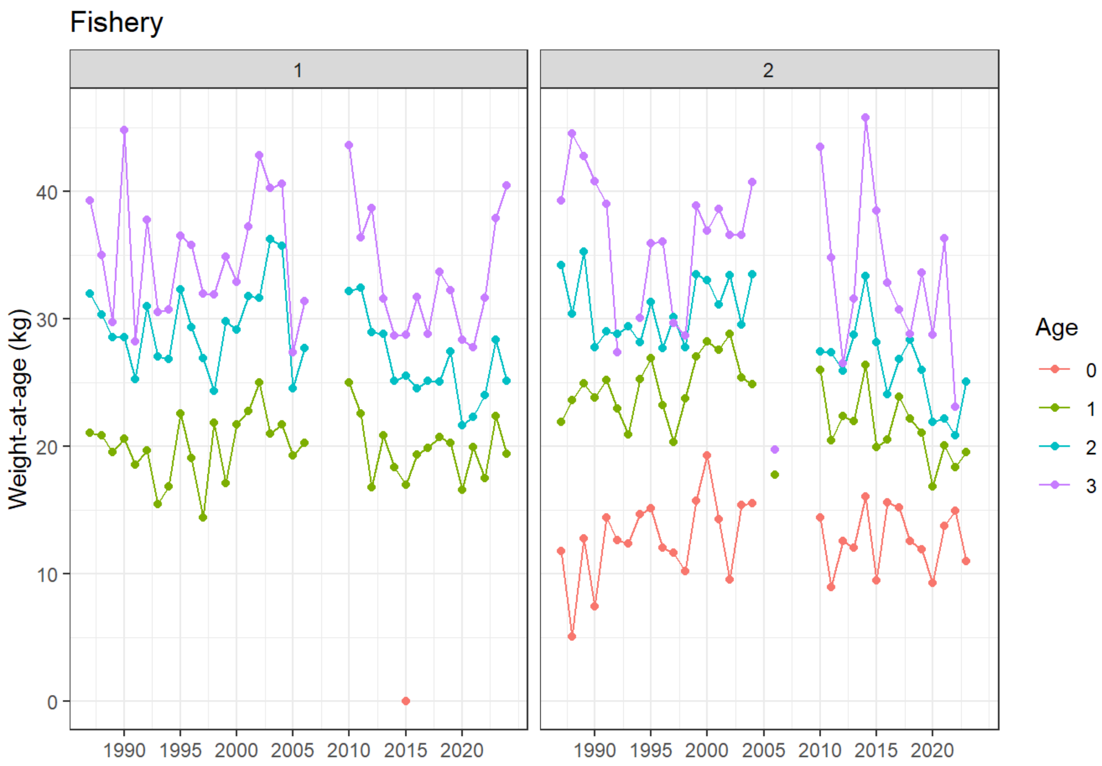



**Figure 2.2.4.1: Bay of Biscay anchovy: Mean weight-at-age (grammes) in the international catches on half-year basis. Units: grammes.**

### 2.2.5 Preliminary fishery data in 2024

The provisional catches during the first semester of 2024 were 28 071 t, from which 28 055 t corresponded to Spain and 16 t to France. During the first semester, 72% of the catches (in numbers) were age 1 and 28% corresponded to age 2. During the second semester provisional catches until the end of October were 4056 t, from which 3005 t corresponded to Spain and 1051 t to France. As in the most recent years, the total provisional catches in 2024 from France were low (1067 t).

It must be emphasised that 2024 fishery data are preliminary. No age structure was available yet for the French catches in the first half of the year, and they were assumed to have the same age composition as the Spanish catches in that quarter. For the assessment, 2024 November and December catches were assumed to be 2% of the total annual catch which is the average percentage of the catches in November and December in 2010–2023, after the re-opening of the fishery. Therefore, the total catch in November and December was estimated at 697 t, resulting in 4753 tonnes for the second semester 2024.

## 2.3 Fishery independent data

### 2.3.1 BIOMAN DEPM survey 2024

All the methodology for the survey and the estimates performance are described in detail in annex A.3_stock annex - Bay of Biscay Anchovy (Subarea 8). A detailed report of the survey and results 2024 is attached as a working document at ICES WGACEGG 2024 in annex 3 (Santos Mocoroa. M *et al*. BIOMAN 2024) and a summary of the survey is provided in annex 6 of this report.

#### 2.3.1.1 Survey description

The 2024 anchovy DEPM survey was carried out in the Bay of Biscay from the 30th to the 24th of May, covering the whole spawning area of the species, following the procedures described in the annex A.5_stock annex- Bay of Biscay Anchovy (Subarea 8). Two research vessels were used at the same time and place: the RV Vizconde de Eza to collect plankton and adult samples and the RV Emma Bardán to collect adult samples. Some specifications of the sampling are given in Table 2.3.1.1.

Total number of PairoVET samples (vertical sampling) obtained was 880. From those, 759 had anchovy eggs (86%) with an average of 320 eggs m-2 per station in the positive stations, and a maximum of 4490 eggs m-2 in a station. The number of CUFES samples (horizontal sampling) obtained was 1969. Frome those 1588 (81%) stations had anchovy eggs with an average of 17 eggs m-3 per station and a maximum of 258 eggs m-3 in a station in the positive stations.

This year 19% of the anchovy eggs abundance was found in the Cantabrian Sea, the eggs were distributed all over the area and beyond 200m depth isoline, the area surveyed limit was at 6º20'W. In the French platform there were eggs all over the platform and passed the 200 m depth isoline almost in all the area up to the limit of area ICES 8 (48ºN) (Figure 2.3.1.1). The total area covered was 121647Km2 and the spawning area for anchovy was 101890Km2, 84% of the total.

In relation with the adult samples, 44 hauls were selected for the application of the DEPM. The spatial distribution of the samples and their species composition is shown in Figure 2.3.1.2. The most abundant species in the trawls ware: anchovy, sardine, blue whiting and horse mackerel. Anchovy adults were found in the same places where the anchovy eggs were found. This year the biggest anchovy was found in the Cantabrian Sea. The smallest anchovy was found in the French coast from Arcachon to the North of the Gironde River. Spatial distribution of mean length and mean weight is shown in Figure 2.3.1.3.

This year the mean sea surface temperature of the survey, 15.2 °C similar to last year (15.5 °C), the minimum was 13.8 °C and the maximum 17.8 °C. The mean sea surface salinity (34.41) similar to last year (34.98) with a minimum of 28.05 and a maximum of 35.66. This year the discharge of the rivers was notable. Figure 2.3.1.4 shows the maps of sea surface salinity and temperature registered during the survey.

#### 2.3.1.2 Total daily egg production estimate

The estimates of daily egg production(P0), daily egg mortality rates (z) and total egg production (Ptot) are given in Table 2.3.1.2 and the mortality curve model adjusted is shown in Figure 2.3.1.5. Total egg production in 2024 was estimated at 1.00 E+13 with a CV of 0.0679, at the same level than last year and lower than the previous five but still above the historical mean. Figure 2.3.1.6 shows the historical series of P0, z, spawning area and Ptot.

#### 2.3.1.3 Daily fecundity and total biomass

To estimate the total Biomass following the DEPM a daily fecundity (*DF*) estimate is necessary. To estimate the *DF* the sex ratio (*R*), the female mean weight ($W_f$), the batch fecundity (*F*) and the spawning fraction (*S*) estimates are required. The anchovy adults from the survey were used to estimate those parameters. This year there were no problems in estimating those parameters. The results are showed in Table 2.3.1.3 and the historical series in Figure 2.3.1.7. The final total biomass obtained as the quotient between $P_{tot}$ and *DF* was 145608 t with a CV of 0.1015, lower than the last six years but still above the historical mean.

#### 2.3.1.4 Population at age

To estimate the numbers at age, the age readings based on 2786 otoliths from 44 samples, well distributed over the spawning area, were available. Six strata were defined based on the egg abundance, the adult distribution and the mean size, mean weight, and age of adult anchovy: Cantabrian Sea

(Ca), South (S), East €, Centre (C) and West (W) (Figure 2.3.1.8). 85% of the anchovy in numbers were estimated as individuals of age 1 (63% in mass), 14% of the individuals in numbers were of age 2 (33% in mass) and 0.5% of the individuals in numbers were of age 3 (1% in mass) (Table 2.3.1.4). This was a high year recruitment in relation with the historical series. The anchovy age composition by haul is showed in Figure 2.3.1.9. The time series of the numbers at age is shown in Figure 2.3.1.10. The historical series of the total biomass at age and weight at age that is downwards is showed in Figure 2.3.1.11 and those parameters for this year and the length at age are showed in Table 2.3.1.4.

**Table 2.3.1.1: Bay of Biscay anchovy: Details of the DEPM survey BIOMAN 2024.**

| Parameters | Anchovy DEPM survey |
|---|---|
| Surveyed area | (43°18' to 48°00'N & 7° 29' to 1°13' W) |
| R/V | *Vizcon de Eza* & *Emma Bardán* |
| Date | 30/04/2024 - 24/05/2024 |
| Eggs | RV Vizconde de Eza |
| PairoVET stations (plankton) | 880 |
| % st with anchovy eggs | 86% |
| Anchovy egg average by st | 320 eggs/m² |
| Max. anchovy eggs in a St | 4 490 eggs/m² |
| Total ANE egg collected&staged | 24 177 eggs |
| North spawning limit | 48°00'N |
| West spawning limit (Cantabrian Sea) | 6°20'W |
| Total area surveyed | 121 647 Km² |
| Spawning area for anchovy | 101 890 Km² |
| CUFES stations (plankton) | 1 967 (81% withanchovy) |
| Adults | RV E.Bardán,Vizconde,Thalassa& PSeines |
| Pelagic trawls | 43(EBardán)+5(thalassa)+3 (Vizconde) |
| Pelagic trawls with anchovy | 38(EBardán)+4(Thalassa)+1(Vizconde) |
| Selected for analysis | 43 |
| Hauls from purse seines | 1 |
| Total adult samples for analysis | 44 |

**Table 2.3.1.2: Bay of Biscay anchovy: 2024 estimates for daily egg production (P0) (egg/m²/day), daily mortality rates (z) and total daily egg production (Ptot)(eggs/day) with its Standard error (S.e) and coefficient of variation (CV).**

| Parameter | Value | S.e. | CV |
|---|---|---|---|
| $P_0$ | 98.67 | 6.70 | 0.0679 |
| z | 0.12 | 0.034 | 0.2798 |
| $P_{tot}$ | 1.01. E+13 | 6.8. E+11 | 0.0679 |

**Table 2.3.1.3: Bay of Biscay anchovy: estimates of adult parameters for applying the DEPM in the Bay of Biscay (ICES 8abcd): sex ratio (R) (% of females), spawning fraction (S) (% of females spawning per day), batch fecundity (F) (eggs/ batch/maturefemale), female mean weight (Wf)(g) and daily fecundity (DF) (eggs/g/day) and total biomass (B)(tons) with their standard error (S.e) and coefficient of variation (CV).**

| Parameter | estimate | S.e. | CV |
|---|---|---|---|
| R' (% of females) | 0.53 | 0.0026 | 0.0050 |
| S (% fem. spawning/day) | 0.35 | 0.0174 | 0.0489 |
| F (eggs/batch/mature female) | 5,917 | 546 | 0.0922 |
| Wf (female mean weight g.) | 15.98 | 0.97 | 0.0609 |
| DF (eggs/g/day) | 69.49 | 5.25 | 0.0755 |
| BIOMASS (Tons) | 145,608 | 14,785 | 0.1015 |

**Table 2.3.1.4: Bay of Biscay anchovy: Total biomass (B), percentage at age, numbers at age, percentage at age in mass, total biomass at age in mass, mean weight at age (g), mean length at age(mm), with the correspondent standard error (S.e.) and coefficient of variation (CV) from BIOMAN 2024.**

| Parameter | estimate | S.e. | CV |
|---|---|---|---|
| BIOMASS (Tons) | 145,608 | 14,785 | 0.1015 |
| Total mean weight (g.) | 13.37 | 0.71 | 0.0530 |
| Population (millions) | 10,931 | 1499 | 0.1372 |
| Percentage at age 1 | 0.85 | 0.026 | 0.0299 |
| Percentage at age 2 | 0.14 | 0.024 | 0.1710 |
| Percentage at age 3+ | 0.005 | 0.002 | 0.3876 |
| Numbers at age 1 | 9,359 | 1,487.2 | 0.1589 |
| Numbers at age 2 | 1,520 | 195.9 | 0.1289 |
| Numbers at age 3+ | 52 | 17.1 | 0.3304 |
| Percent. at age 1 in mass | 0.63 | 0.043 | 0.0691 |
| Percent. at age 2 in mass | 0.33 | 0.038 | 0.1143 |
| Percent. at age 3+ in mass | 0.01 | 0.004 | 0.3794 |
| Biomass at age 1 (Tons) | 91,437 | 12,979 | 0.1419 |
| Biomass at age 2 (Tons) | 48,068 | 5,794 | 0.1205 |
| Biomass at age 3+ (Tons) | 1,333 | 471 | 0.3529 |

| Biological features | estimate | S.e. | CV |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Weight at age 1 (g) | 12.3 | 0.57 | 0.0465 |
| Weight at age 2 (g) | 19.9 | 1.05 | 0.0527 |
| Weight at age 3 (g) | 24.3 | 1.60 | 0.0661 |
| Length at age 1 (mm) | 125.8 | 1.64 | 0.0130 |
| Length at age 2 (mm) | 146.3 | 2.31 | 0.0158 |
| Length at age 3 (mm) | 154.8 | 6.46 | 0.0417 |

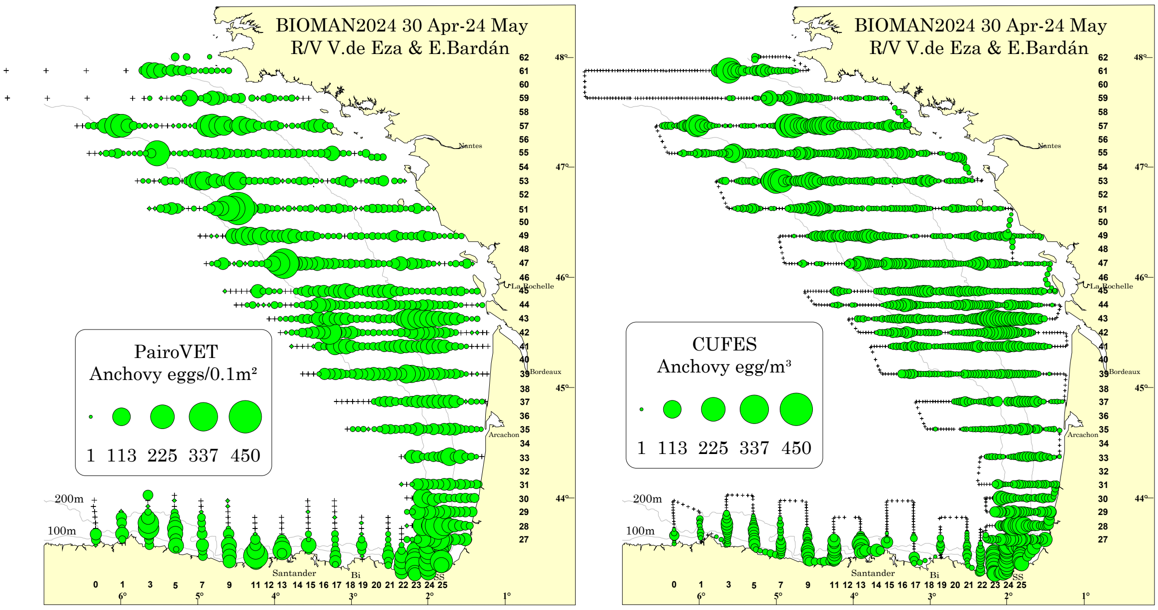



**Figure 2.3.1.1: Bay of Biscay anchovy: Spatial distribution and abundance of anchovy egg obtained with PairoVET (vertical sampling net) (eggs per 0.1 m²) (left) and CUFES (horizontal sampling net) (egg/m³) obtained during the DEPM survey BIOMAN2024.**

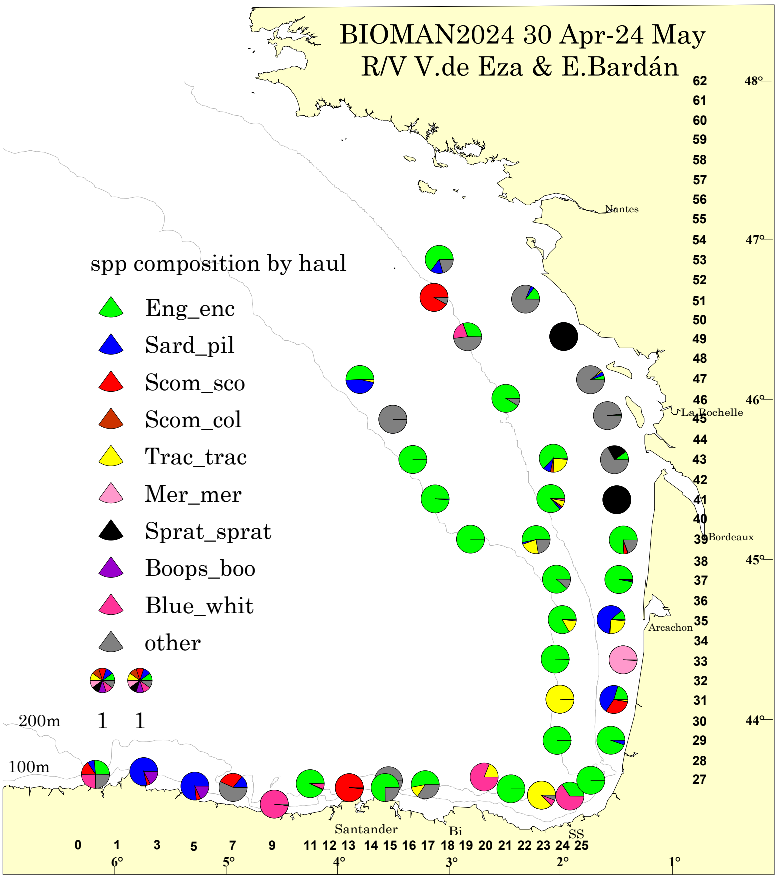



**Figure 2.3.1.2: Bay of Biscay anchovy: Species composition of the 44 hauls selected for the adult parameters analysis for the application of the DEPM.**

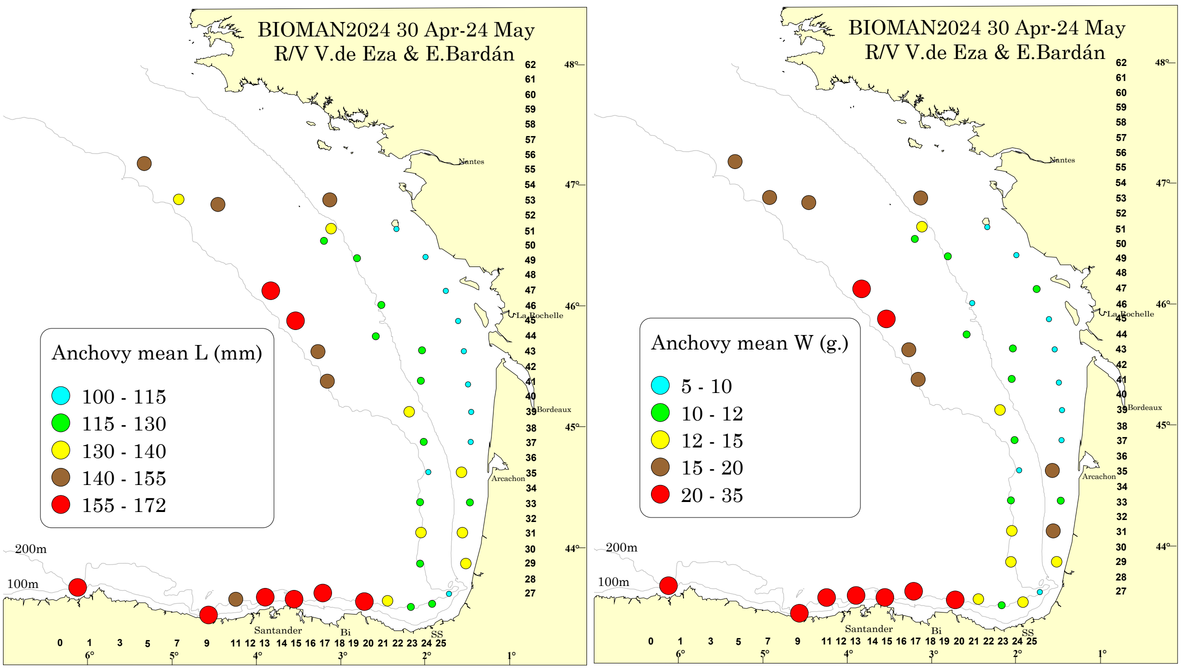



**Figure 2.3.1.3: Bay of Biscay anchovy: Spatial distribution of anchovy mean length (left) and mean weight (right) (males and females) by haul during BIOMAN2024.**

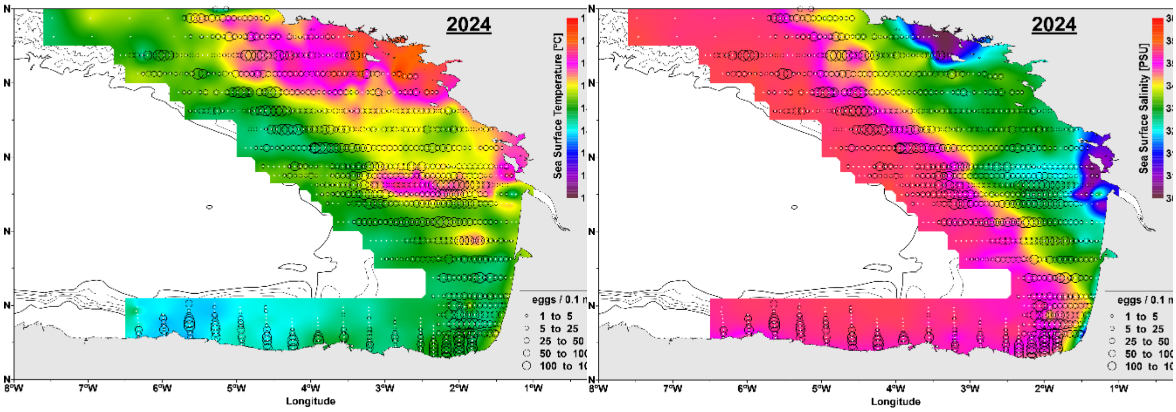



**Figure 2.3.1.4: Bay of Biscay anchovy: Spatial distribution of sea surface temperature (left) and sea surface salinity (right) during BIOMAN 2024 with the anchovy egg abundances spatial distribution.**

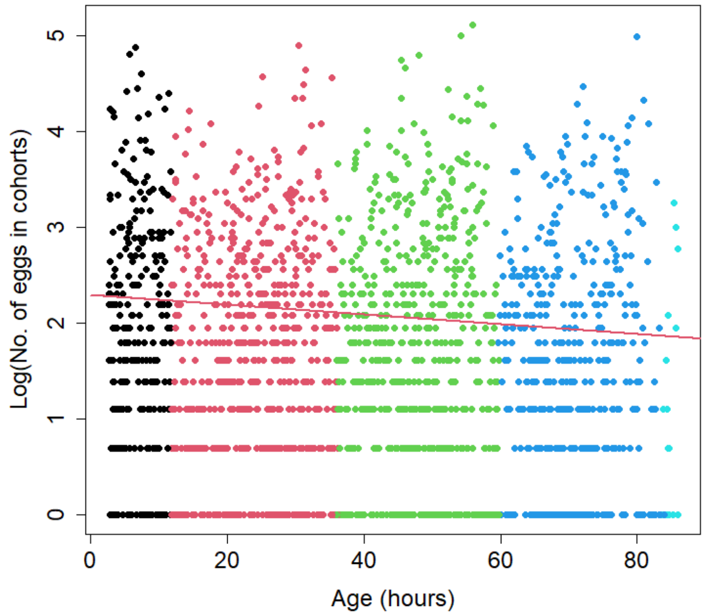



**Figure 2.3.1.5: Bay of Biscay anchovy: Exponential mortality model in log scale adjusted applying a GLM to the data obtained in the Bayesian egg ageing (spawning peak at 23:00h GMT). The red line is the adjusted line. The coloured dots represent the different cohorts.**

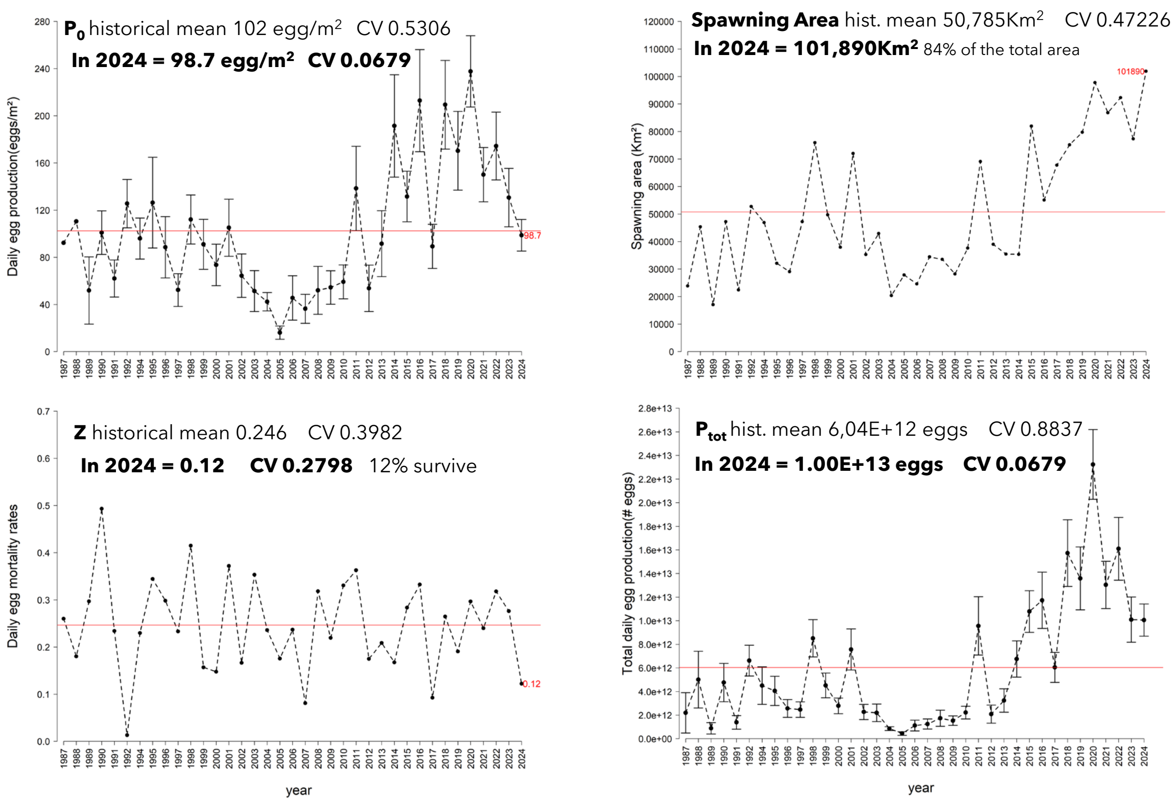



**Figure 2.3.1.6: Bay of Biscay anchovy: historical series including 2024 estimates for daily egg production (P0) (egg/m²/day), spawning area (Km²), daily mortality rates (z) and total daily egg production (Ptot)(eggs/day) in the Bay of Biscay (ICES 8abcd). The red line is the historical mean, the value showed in bold is the 2024 value. The historical mean is also shown with a CV as the coefficient of variation over time for each parameter.**

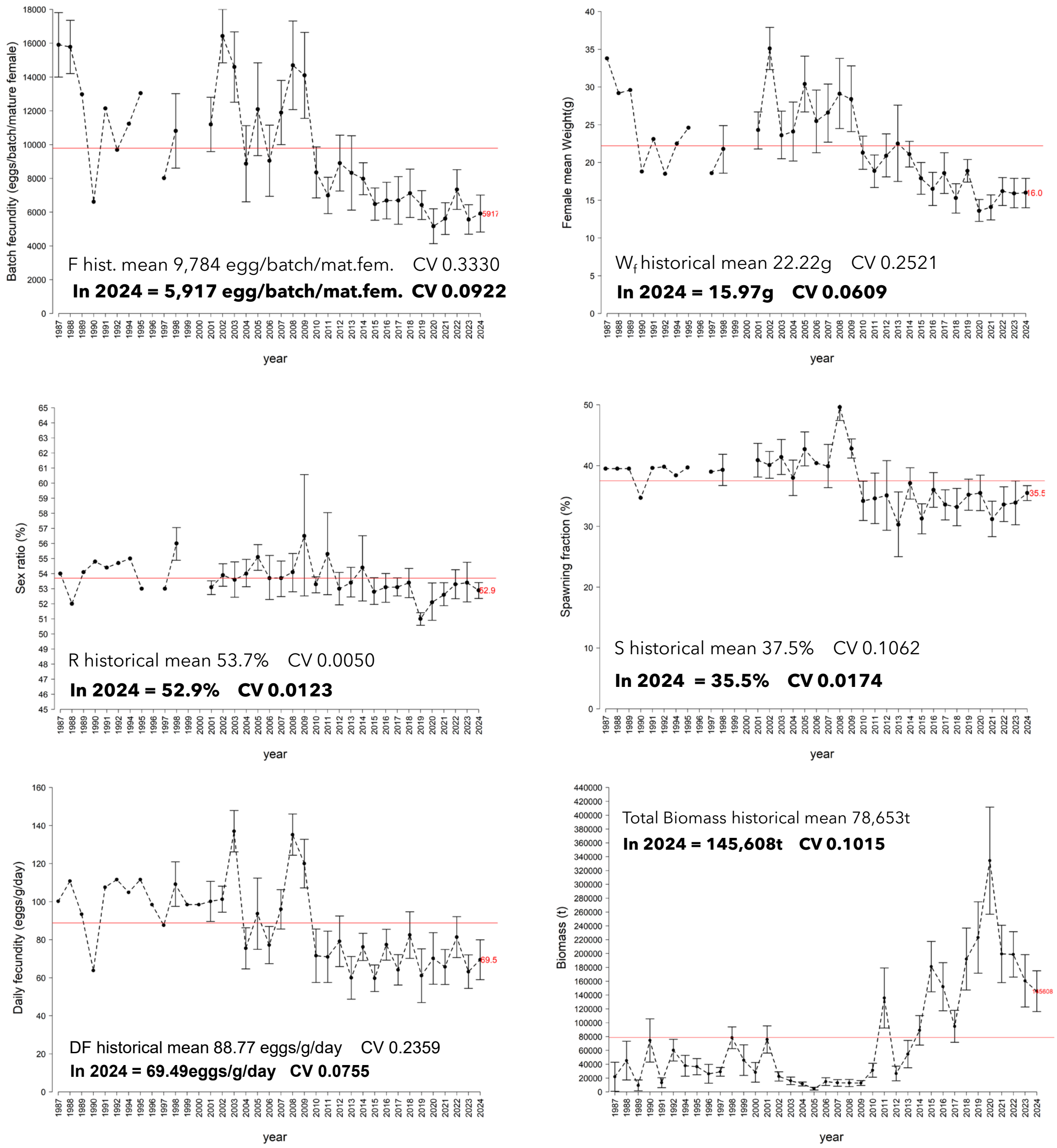



**Figure 2.3.1.7: Bay of Biscay anchovy: historical series including 2024 estimates of the adult parameters in the Bay of Biscay (ICES 8abcd): batch fecundity (F) (eggs/batch/mature female), female mean weight (Wf)(g), sex ratio (R) (% of females), spawning fraction (S) (% of females spawning per day), daily fecundity (DF) (eggs/g/day) for the application of the DEPM, and the total biomass (B)(tons). The red line is the historical mean, the value showed in bold is 2024 value. The historical mean is also shown with a CV as the coefficient of variation over time for each parameter.**

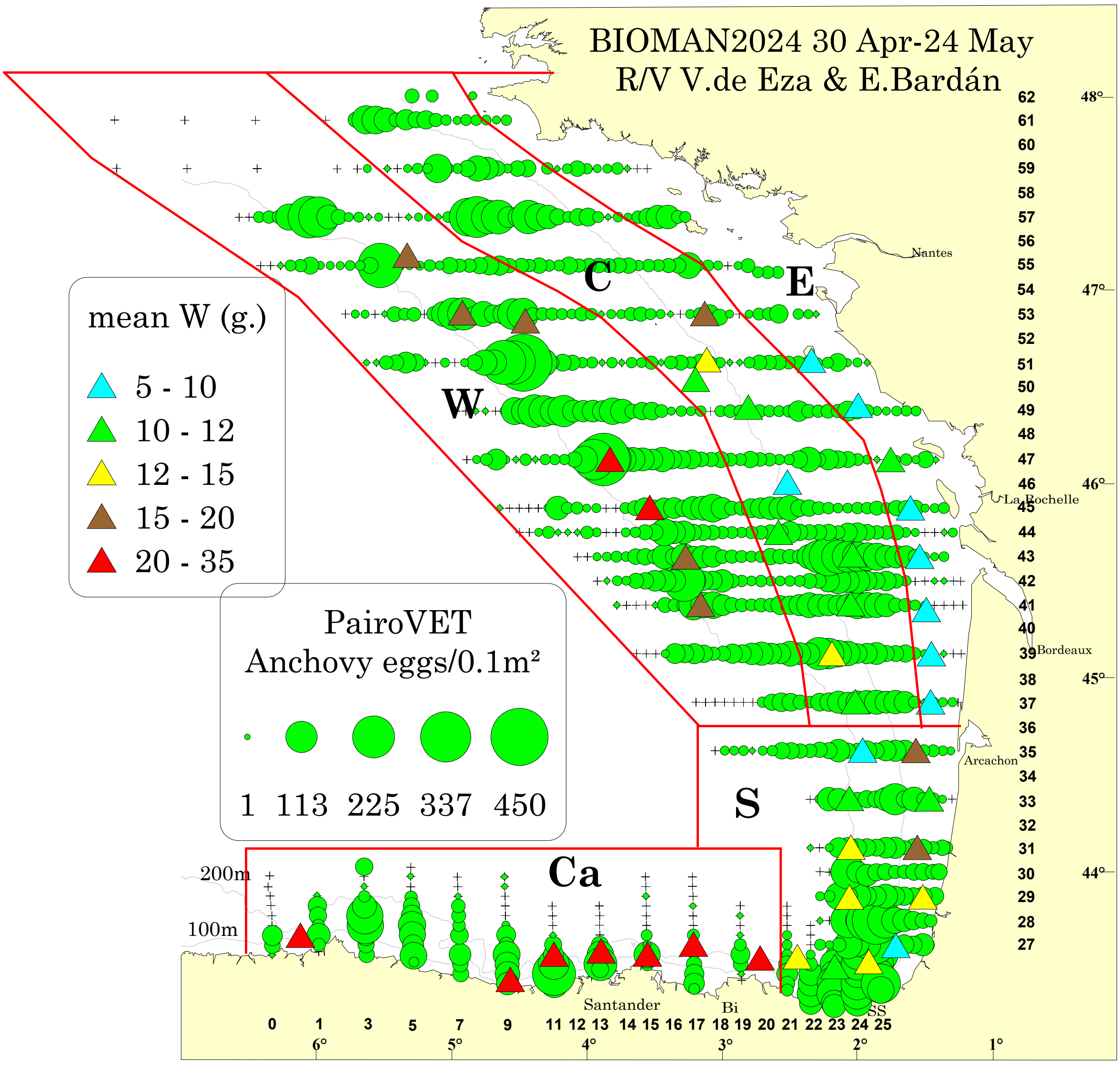



**Figure 2.3.1.8: Bay of Biscay anchovy: 5 regions were defined to weight the adult samples to estimate anchovy numbers at age in 2024: Cantabrian (Ca), South (S), East €, Centre (C) and West (W). The red lines represent the border of the regions, the green bubbles the abundance of anchovy eggs (egg/0.1m²) in each station and the colour triangles represent the mean weight (g) of individuals within each haul.**

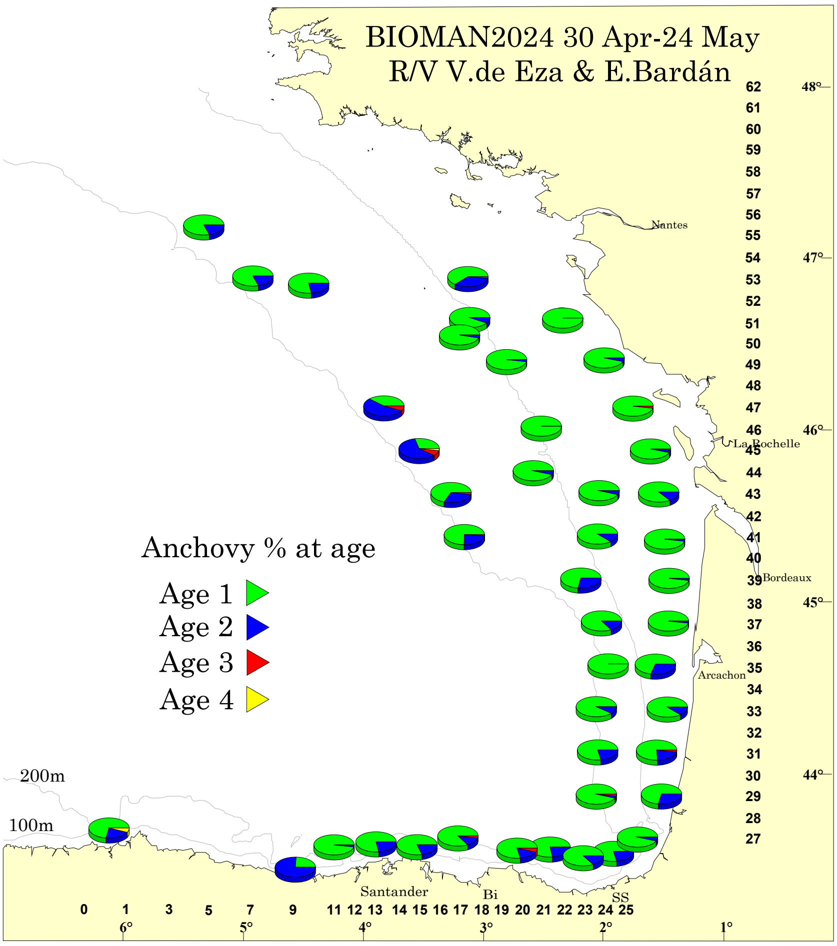



**Figure 2.3.1.9: Bay of Biscay anchovy: Age composition in space by haul during BIOMAN2024**

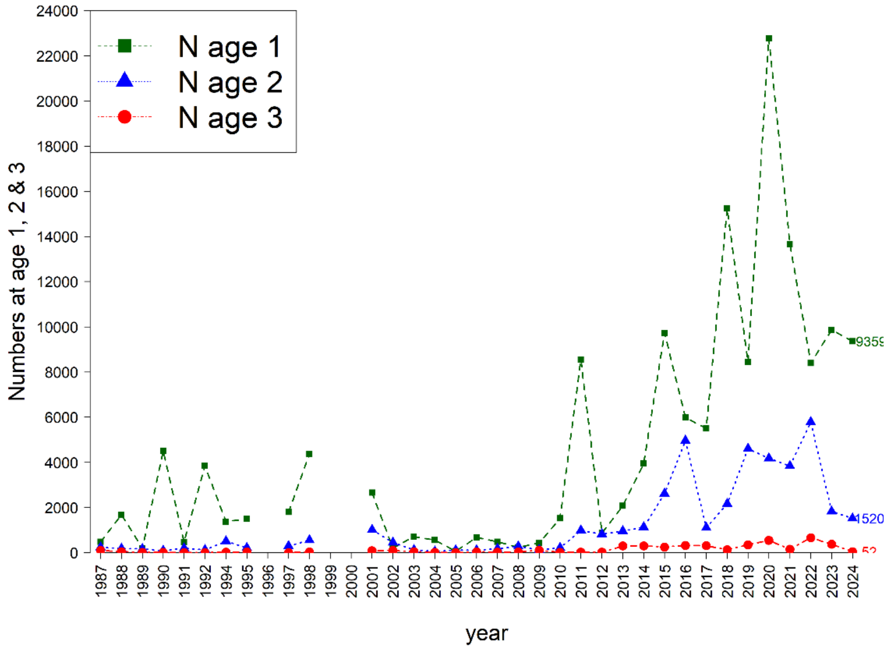



**Figure 2.3.1.10: Bay of Biscay anchovy: Historical series of numbers at age. 1987 to 2024 from BIOMAN surveys.**

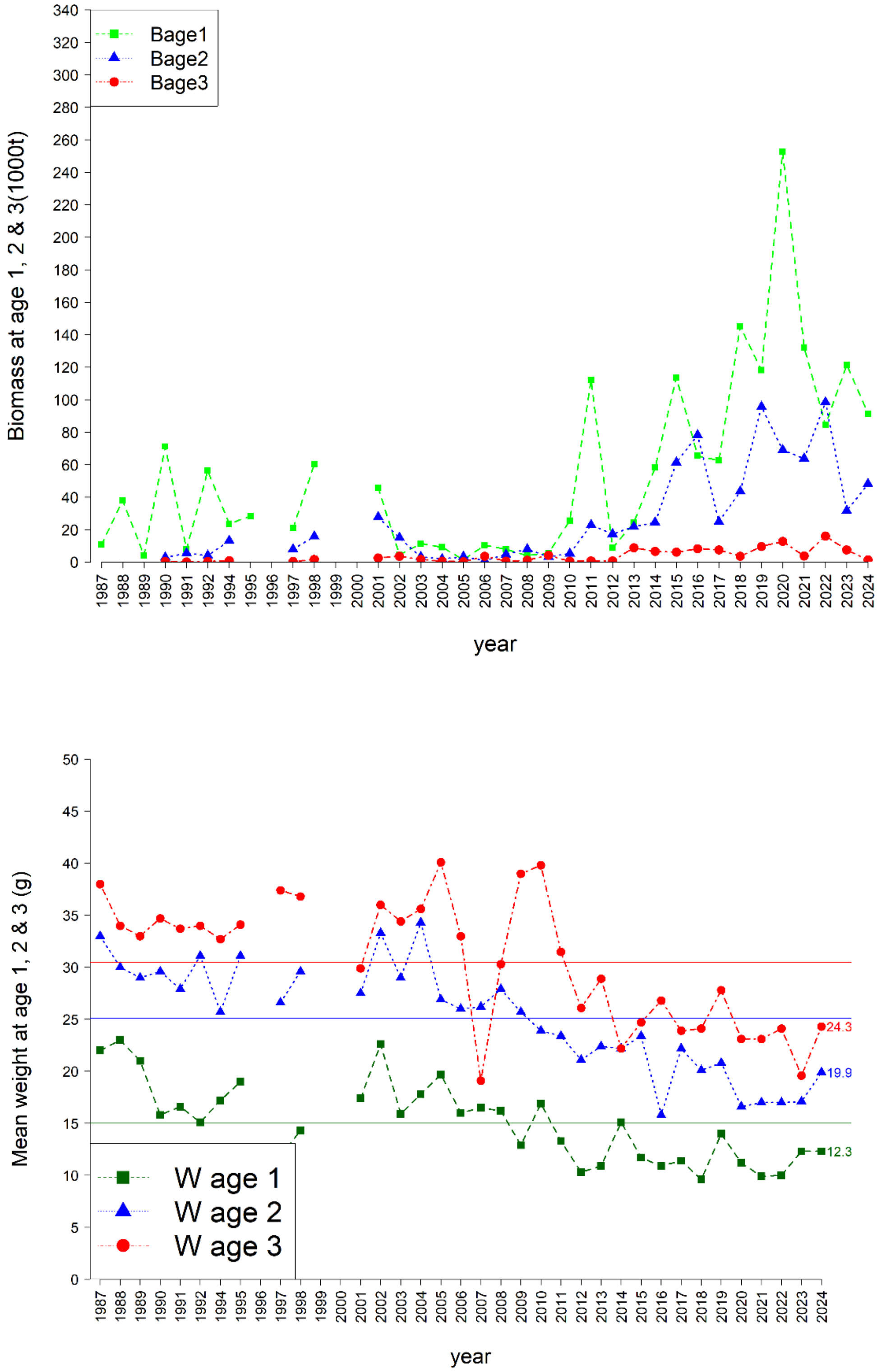



**Figure 2.3.1.11: Bay of Biscay anchovy: Historical series (1987-2024) of total biomass at age and mean weight at age. The lines are the historical means**

## 2.3.2 PELGAS spring acoustic survey 2024

The acoustic-trawl survey PELGAS has been carried out every year in the Bay of Biscay in spring onboard the French research vessel Thalassa since 2000. The objective is to monitor the abundance and distribution of small pelagic fish in the Bay of Biscay. The main target species are anchovy and sardine, considered in a multi-specific context and within an ecosystemic approach as they are key species in the ecosystem.

A consort survey has been annually conducted since 2007 with French commercial fishing vessels for 18 days. Commercial fishing vessels' hauls were used as for previous years for identifying fish acoustic echoes and collecting biological parameters, hence complementing identification hauls conducted by the R/V Thalassa.

Four commercial vessels (two pairs of pelagic trawlers) participated to PELGAS2024 survey:

A total of 97 trawl hauls have been carried out during the survey, comprising 54 hauls by the R/V Thalassa and 43 hauls by commercial vessels (see summary of the survey in Annex 6).

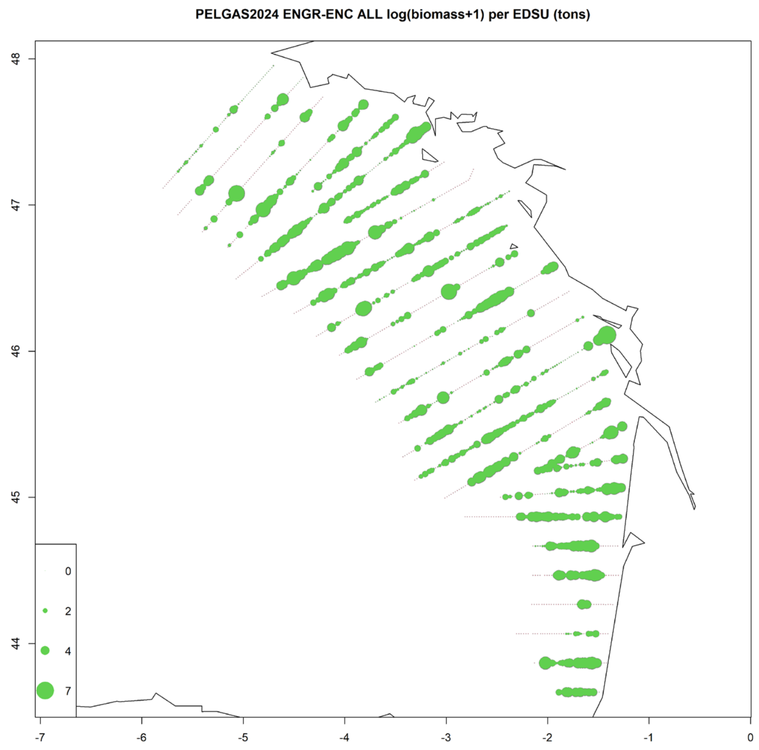



**Figure 2.3.2.1: Bay of Biscay anchovy: Map of anchovy biomass observed during the PELGAS2024 survey**

The anchovy biomass estimated during the PELGAS2024 survey was 187 591 tons, above series average, with a low estimation error (estimation CV = 9%, **Figure 2.3.2.2**). Details on acoustic biomass assessment can be found in Doray and Duhamel (2024).

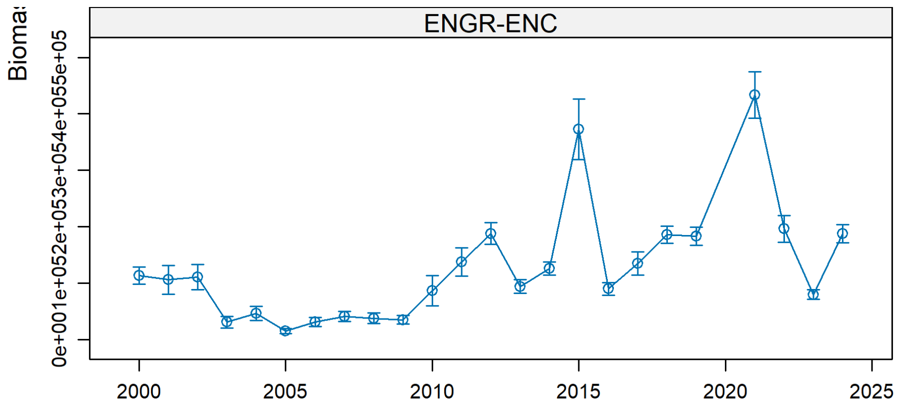



**Figure 2.3.2.2: Bay of Biscay anchovy: Time series of anchovy biomass and CV derived from PELGAS survey data.**

Anchovy schools were once again located closer to the surface than before 2020. Their distribution was however less shallow than in 2023. Due to technical issues with the lateral echosounder this year, anchovy biomass in the vertical echosounder blind zone could not be quantified this year. The lateral echosounder however allowed to control the majority of anchovy schools were located below the vertical echosounder blind zone. The negative bias related to the shallow anchovy distribution was hence considered negligible (Doray and Duhamel, 2024).

One-year-old anchovies were present near sea surface in coastal areas, sometimes mixed with older fish. Their average size has not varied much since 2016, after a sharp decrease between 2008 and 2015. Bigger (and older) fish appeared near sea surface in the central / offshore part of the Bay of Biscay.

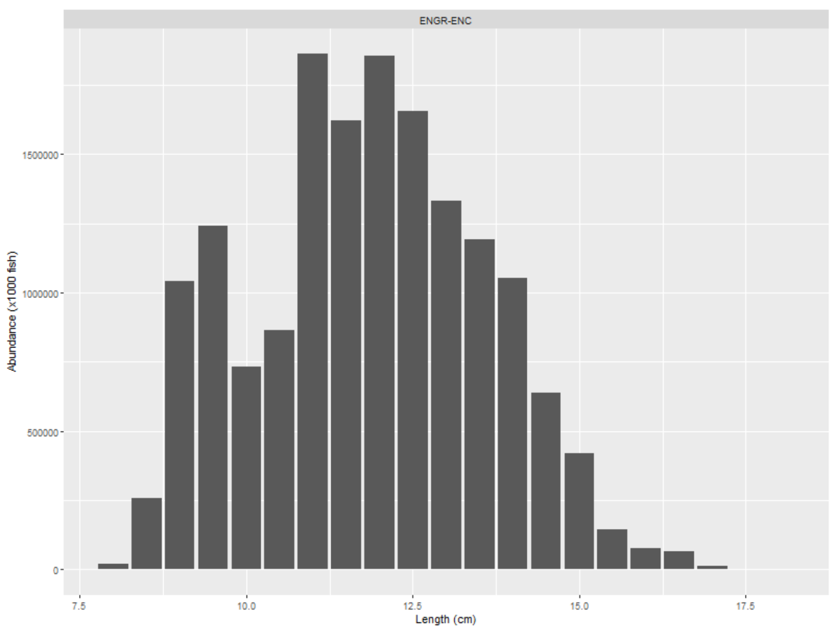



**Figure 2.3.2.3: Bay of Biscay anchovy: anchovy length distribution observed during the PELGAS2024 survey.**

Anchovy length structure was close to average, with fish from 9 to 18 centimetres (Figure 2.3.2.3). Even if some individuals were small (less than 12 cm), almost all fishes were mature and spawning, according to macroscopic observations.

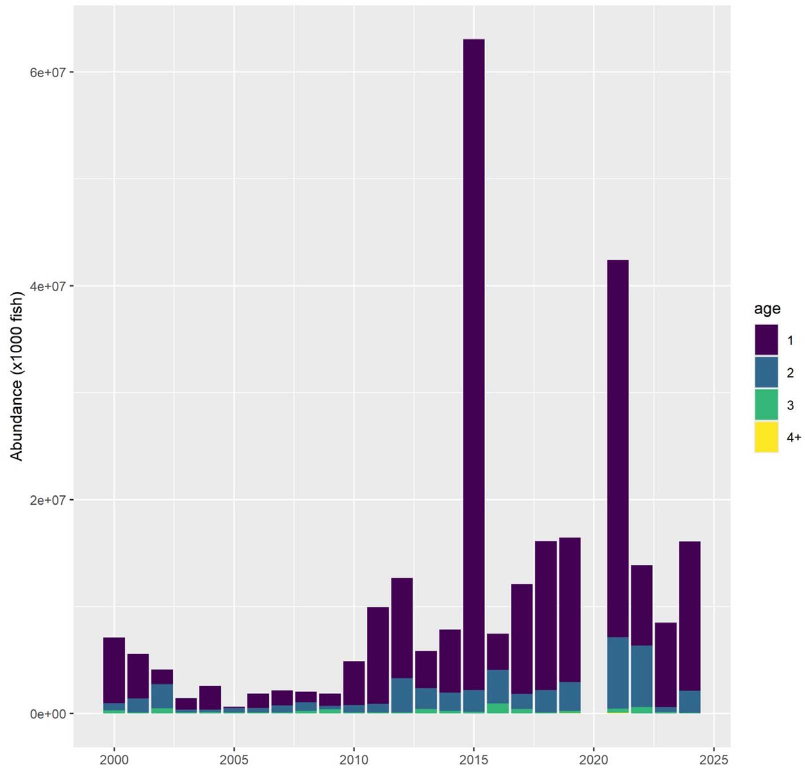



**Figure 2.3.2.4: Bay of Biscay anchovy: time series of anchovy abundances at age derived from PELGAS survey data.**

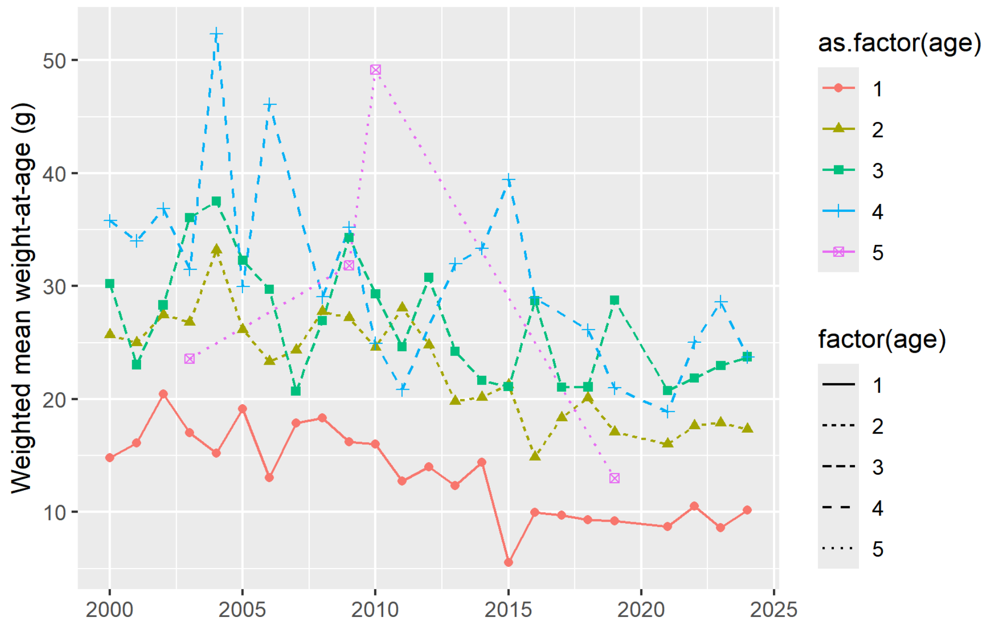



**Figure 2.3.2.5: Bay of Biscay anchovy: Time series of mean weight at age (g) derived from PELGAS survey data.**

Anchovy average weights at age have decreased since 2008, then stabilised in 2016 in the Bay of Biscay (Figure 2.3.2.5). This growth decrease was likely caused by a decrease in anchovy zooplanktonic prey quality, probably triggered by climate change (Grandrémy, 2023; Menu et al., 2023).

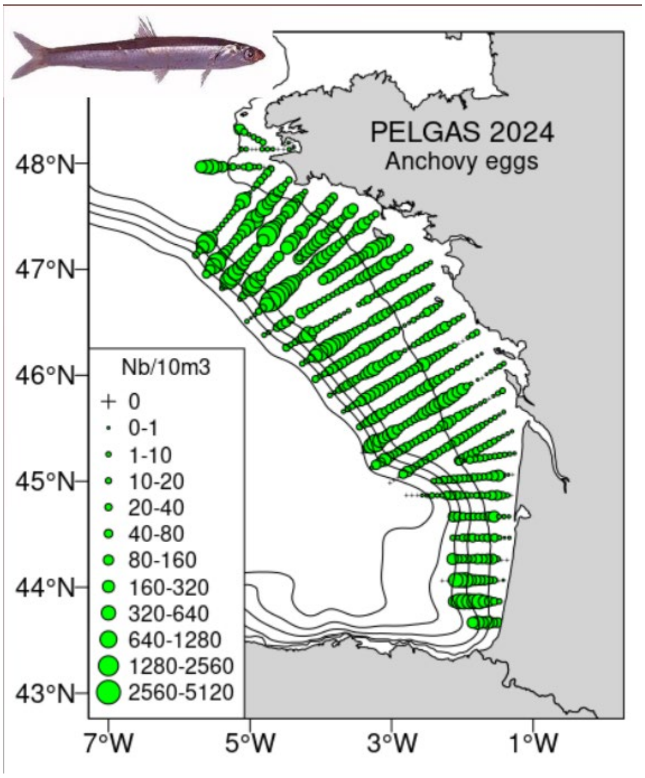



**Figure 2.3.2.6: Bay of Biscay anchovy: map of anchovy eggs observed with CUFES during PELGAS2024.**

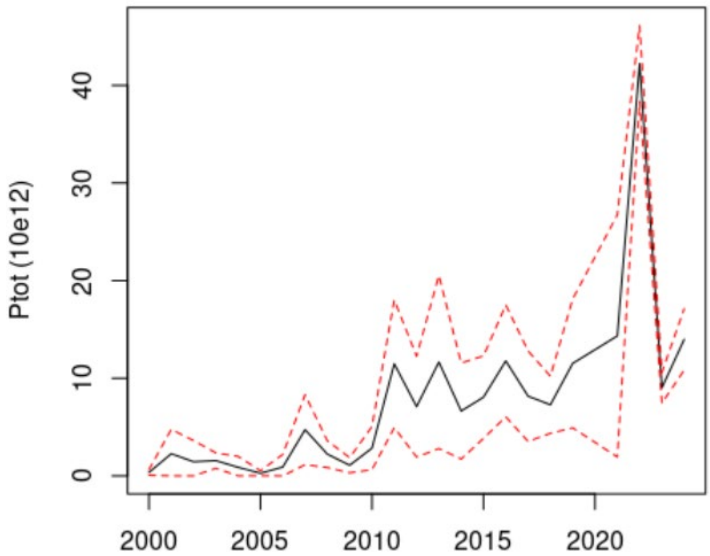



**Figure 2.3.2.7: Bay of Biscay anchovy: anchovy total daily egg production estimated during PELGAS surveys from 2000 to 2024.**

A total of 636 CUFES samples were collected and analysed, along with 60 vertical plankton net hauls and 90 CTD profiles. Eggs were sorted and counted automatically with the zoocam system, and staged during the survey.

Anchovy number of eggs and total daily production (Ptot) derived from PELGAS data have increased since 2010 in the Bay of Biscay. The 2024 Ptot estimate was within the high average values observed since 2010 (Figure 2.3.2.7). The egg distribution was unusual, with maximum densities observed off-shore and in the North West part of the Bay (Figure 2.3.2.6).

## 2.3.3 Autumn juvenile acoustic survey 2024 (JUVENA 2024)

The methodology of the autumn juvenile acoustic survey JUVENA is described in detail in the stock annex - Bay of Biscay Anchovy (Subarea 8). The results of the last survey in autumn 2024 were reported and discussed in ICES WGACEGG 2024 (Boyra et al., 2024, WD WGACEGG2023, ICES, 2024). Therefore, in this section only a short summary is provided, highlighting some issues of relevance for this assessment input. A summary of the survey can also be found in Annex 6 of this report.

The main objective of the JUVENA survey is estimating the abundance of the anchovy juvenile population and their growth condition at the end of the summer in the Bay of Biscay. In 2024, as in previous years, the survey was coordinated by AZTI and IEO. AZTI led the assessment studies whereas IEO led the ecological studies. The survey JUVENA 2024 took place between the 1st of September and 14th of October on board the chartered RV Angeles Alvariño and the RV Emma Bardán, both equipped with scientific echo sounders (Boyra et al., 2024; WD to WGACEGG). The sampling strategy followed an adaptive scheme with an inter-transect distance of 18 nm. The survey covered from 6º40′ W in the Cantabrian area to 48º N in the French coast, with a total of 71 hauls to identify the species detected by the acoustic equipment, 50 of which were positive of anchovy (Figure 2.3.3.1). This year, most of the biomass of juveniles was located close to the coast and mainly in the French area (Figure 3.3.3.2). The biomass of juveniles estimated for 2024 is around 255 000 tonnes (Table 2.3.3.1) which constitutes a medium-low estimate within the temporal series context, and ~245 000 tonnes for adult anchovy, three times higher than last year. The combination of both results foresees a healthy and sustainable status of the overall anchovy stock for the next year (Figure 2.3.3.3). The mean size of anchovy was 9.6 cm long with a mean weight of 7.95 gr, the second highest values of the time-series.

**Table 2.3.3.1: Bay of Biscay anchovy. Summary of the estimates obtained in JUVENA autumn acoustic surveys from 2003 to 2022.**

| Year | Biom_juv age0 (t) | Size juv (cm) | Area+ (nmi²) |
|---|---|---|---|
| 2003 | 98,601 | 7.89 | 3476 |
| 2004 | 5,564 | 10.57 | 1907 |
| 2005 | 134,131 | 6.70 | 7790 |
| 2006 | 86,714 | 8.09 | 7063 |
| 2007 | 13,763 | 5.36 | 5677 |
| 2008 | 15,846 | 7.38 | 6895 |
| 2009 | 178,028 | 9.32 | 12984 |
| 2010 | 599,990 | 8.29 | 21110 |
| 2011 | 207,625 | 6.01 | 21063 |
| 2012 | 142,507 | 6.39 | 14271 |
| 2013 | 105,844 | 7.41 | 18189 |
| 2014 | 724,653 | 5.86 | 37169 |
| 2015 | 462,341 | 6.82 | 21845 |
| 2016 | 363,058 | 7.26 | 16933 |
| 2017 | 728,008 | 6.84 | 19808 |
| 2018 | 489,708 | 6.29 | 26787 |
| 2019 | 112,487 | 6.12 | 20298 |
| 2020 | 228,879 | 6.10 | 29849 |
| 2021 | 209,699 | 5.45 | 26723 |
| 2022 | 481,893 | 8.64 | 24558 |
| 2023 | 530,986 | 7.21 | 13175 |
| 2024 | 255,434 | 9.61 | 8331 |

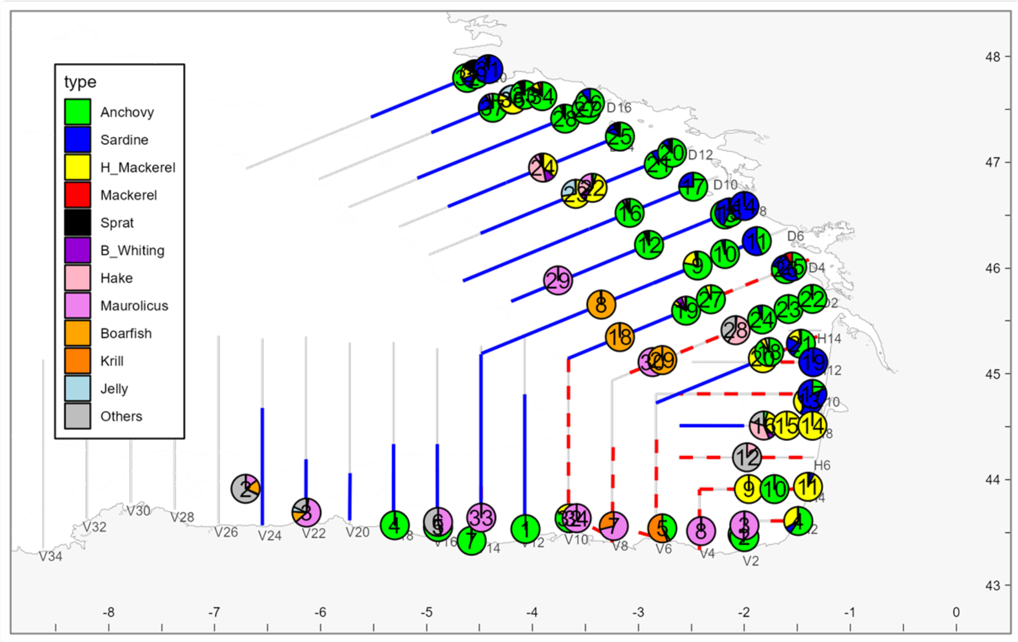



**Figure 2.3.3.1: Bay of Biscay anchovy. Survey transects and species composition of the pelagic hauls in JUVENA 2024.**

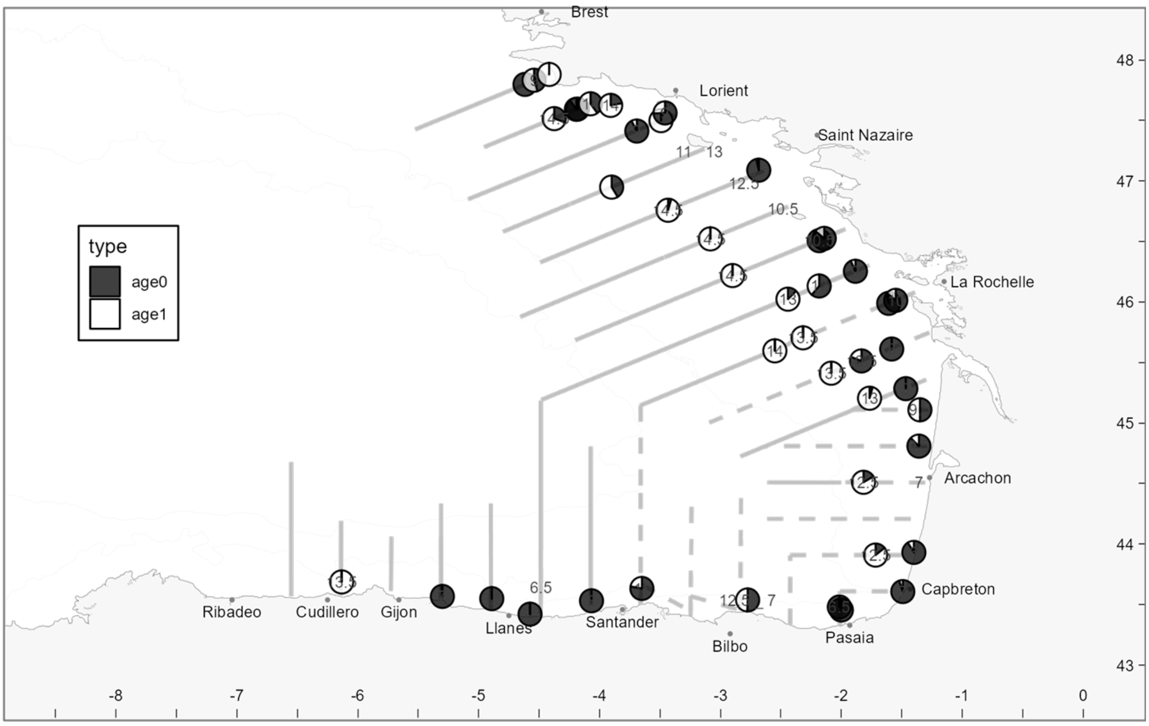



**Figure 2.3.3.2: Bay of Biscay anchovy. Positive area of anchovy in JUVENA 2024. The pie charts show the percentage of juveniles (black) and adults (white) in the fishing hauls.**

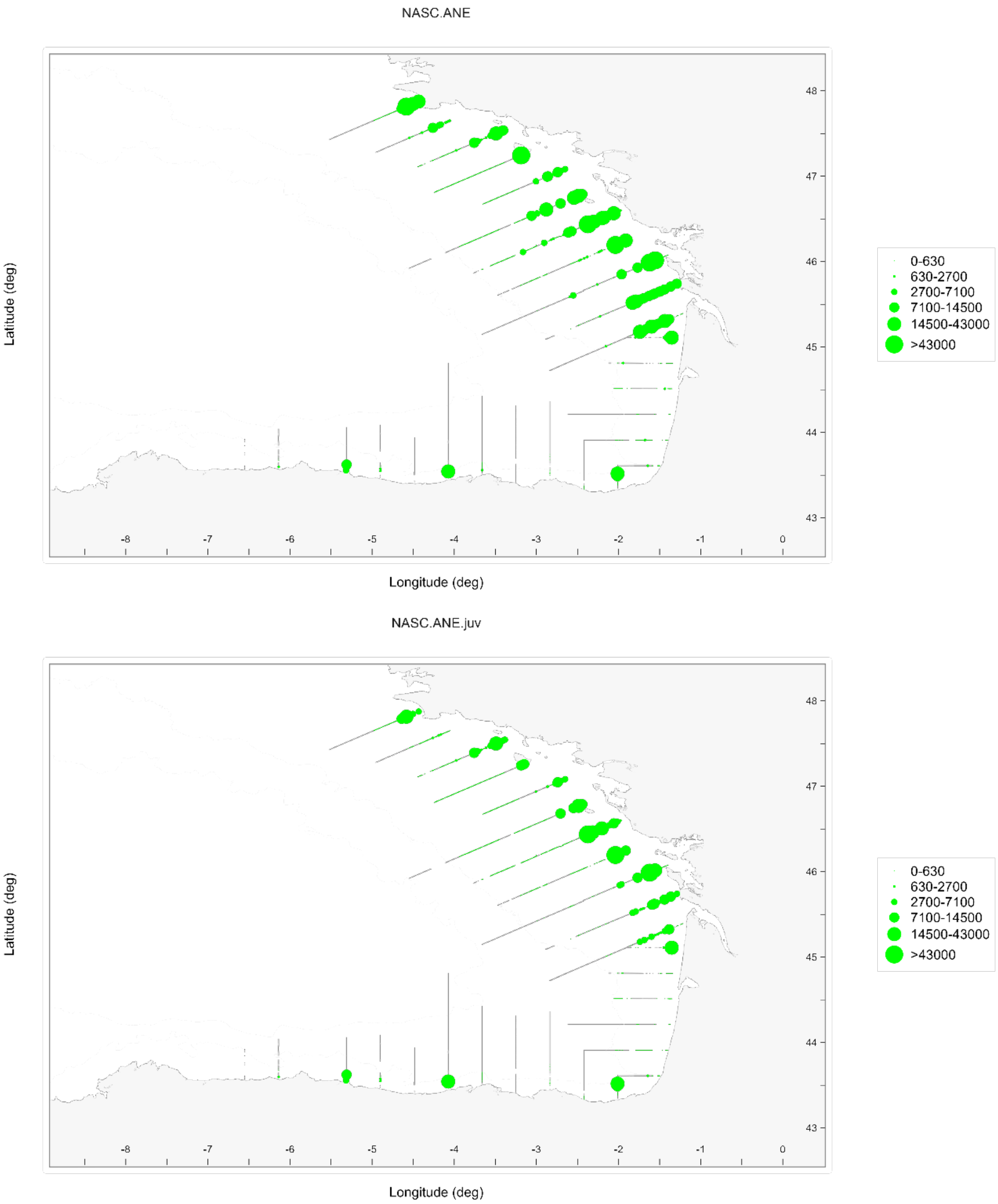



**Figure 2.3.3.3: Bay of Biscay anchovy. Bubble maps representing acoustic backscattering by ESDU of 0.1 nm for total anchovy (top) and age 0 anchovy (bottom).**

# 2.4 Biological data

## 2.4.1 Maturity-at-age

As reported in previous year reports, anchovies are fully mature as soon as they reach their first year of life, in spring the year after the hatch. Therefore, the maturity ogive is as follows:

| Age | Maturity |
|---|---|
| 0 | 0 |
| 1 | 1 |
| 2 | 1 |
| 3+ | 1 |

See stock annex - Bay of Biscay Anchovy (Subarea 8) for details.

## 2.4.2 Natural mortality

The natural mortality ($y^{-1}$) for Bay of Biscay anchovy is as follows:

| Age | M |
|---|---|
| 0 | 2.17 |
| 1 | 0.80 |
| 2 | 1.20 |
| 3+ | 2.26 |

Natural mortality rates for ages 1 and 2 are based on the study by Uriarte *et al.* (2016). Natural mortality for age 0 was back-calculated from age 1 based on the Gislason model for this stock, while natural mortality for age 3+ was estimated within the assessment model in the last benchmark (ICES 2024) and should be kept unchanged until the next benchmark process.

See stock annex - Bay of Biscay Anchovy (Subarea 8) for further information.

## 2.4.3 Weight-at-age in the stock

Weight-at-age in the stock correspond to weight-at-age at spawning time that are taken from the BIOMAN survey for the application of the Daily Egg Production Method.

See stock annex - Bay of Biscay Anchovy (Subarea 8) for further information.

# 2.5 Stock assessment

## 2.5.1 Input data

The input data used for the assessment of the Bay of Biscay anchovy consists of biological parameters, catch-at-age and weight-at-age from the commercial fishery by half year, total biomass and age structured indices from the BIOMAN and PELGAS surveys and a juvenile abundance index from JUVENA (Table 2.5.1.1 and Figure 2.5.1.1).

The historical series of spawning–stock biomass (SSB) from the DEPM and acoustic surveys are shown in Figure 2.5.1.2. The trends in biomass from both surveys are similar. From 2003 to 2018, a parallel trend but with larger biomass estimates from the acoustic surveys is apparent, except in 2016 and 2018 that the DEPM biomass estimate was larger than the acoustic biomass. In 2020, the DEPM SSB estimate (around 334 300 t) was the largest of the historical time-series, well above the second highest value (223 200t) observed in 2019. In 2021, the acoustic survey provided the largest SSB estimate of the historical time series (451 660 t) with a much higher value than the DEPM SSB estimate for 2021 (199 490 t). In 2022 and 2023 both surveys showed a decreasing trend in SSB, with a much more pronounced decrease in the acoustic survey. In 2024 these two surveys show a discrepancy in the trend, with an increasing acoustic biomass estimate and a decreasing DEPM biomass estimate. The largest discrepancy between the SSB estimates from the DEPM and acoustic surveys occurred in 1991, 2000, 2002, 2012, 2015, 2021 and 2023.

The agreement between both surveys is usually higher when estimating the relative age composition of the population. In 2024 the DEPM survey numbers at age proportions were around 0.86, 0.14, and 0.005, for ages 1, 2 and 3+ respectively, and for the acoustics the numbers at age proportions were around 0.87, 0.13, and 0.005 (Figure 2.5.1.1).

The historical series of the juvenile abundance index from the autumn acoustic survey JUVENA is shown in Figure 2.5.1.1. The 2024 survey index represents a low value, below the average of the temporal series being the lowest estimate in the last decade.

In 2019 due to the bad weather conditions the JUVENA survey could not cover the region to the north of 46.6ºN and the 2019 and 2020 juvenile abundance indices were considered likely underestimated. This has been confirmed in next years by the BIOMAN 2020 and 2021 and PELGAS 2021 surveys. Besides being among the largest SSB estimates of the BIOMAN and PELGAS surveys time series, the age 1 proportion estimates were above the average indicating large recruitments.

For French catches, due to the low total landing in 2023, length sampling was not available and age structure from Spanish catches in divisions 8.a and 8.b was used for catch-at-age calculations (see Section 2.2.3). Figure 2.5.1.1 shows the historical series of total catches by semester. In general, catches in the first semester are larger than in the second semester. The absence of catches from 2005 to 2009 corresponds to various consecutive fishery closures due to the low level of the population. The fishery was reopened in March 2010. In 2024, the preliminary total catch was around 28 071t in the first half of the year and 4753 t in the second half. The latter was under the assumptions described in Section 2.2.2. Definitive 2024 catch estimates will be provided in WGHANSA 2025. Regarding the age structure of the catches, age 1, 2 and 3+ proportions in the catches in the first semester in 2024 were 0.72, 0.28 and 0.003 respectively, which are above the average proportion in the time-series for age 1 and below for age 2 and 3+ (Figure 2.5.1.7).

**Table 2.5.1.1: Bay of Biscay anchovy: Input data for the stock assessment using Stock Synthesis. CV stands for the input coefficient of variation corresponding to each index estimate.**

| Year | Pelgas SSB | Pelgas CV | Bioman SSB | Bioman CV | Juvena N0 | Juvena CV | Catch sem1 | Catch sem2 |
|---|---|---|---|---|---|---|---|---|
| 1987 | | | 21,942.61 | 0.48 | | | 11,719 | 2,666 |
| 1988 | | | 45,229.98 | 0.31 | | | 10,002 | 4,404 |
| 1989 | 15,500.00 | 0.20 | 9,477.08 | 0.41 | | | 7,153 | 1,086 |
| 1990 | | | 74,371.08 | 0.21 | | | 19,386 | 14,347 |
| 1991 | 64,000.00 | 0.20 | 13,294.93 | 0.27 | | | 15,025 | 3,087 |

| Year | Pelgas SSB | Pelgas CV | Bioman SSB | Bioman CV | Juvena N0 | Juvena CV | Catch sem1 | Catch sem2 |
|---|---|---|---|---|---|---|---|---|
| 1992 | 89,000.00 | 0.20 | 60,331.70 | 0.13 | | | 26,381 | 10,829 |
| 1994 | 35,000.00 | 0.20 | 37,777.16 | 0.20 | | | 23,214 | 10,408 |
| 1995 | | | 36,432.44 | 0.16 | | | 23,479 | 5,629 |
| 1996 | | | 26,148.50 | 0.26 | | | 21,024 | 11,864 |
| 1997 | 63,000.00 | 0.20 | 29,021.52 | 0.11 | | | 10,600 | 9,852 |
| 1998 | 57,000.00 | 0.20 | 78,277.33 | 0.10 | | | 12,918 | 18,481 |
| 1999 | | | 45,931.52 | 0.24 | | | 15,381 | 10,617 |
| 2000 | 113,120.34 | 0.06 | 28,320.87 | 0.25 | | | 22,536 | 14,354 |
| 2001 | 105,800.58 | 0.14 | 75,826.37 | 0.13 | | | 23,095 | 17,043 |
| 2002 | 110,565.59 | 0.11 | 22,461.65 | 0.15 | | | 11,089 | 6,405 |
| 2003 | 30,632.44 | 0.13 | 16,108.52 | 0.17 | 33,640,891.0 | 0.25 | 4,074 | 6,405 |
| 2004 | 45,964.62 | 0.17 | 11,495.89 | 0.12 | 771,346.9 | 0.25 | 9,183 | 7,004 |
| 2005 | 14,643.36 | 0.17 | 4,831.92 | 0.20 | 71,945,329.0 | 0.25 | 1,127 | 0 |
| 2006 | 30,877.11 | 0.14 | 14,872.04 | 0.19 | 24,187,279.0 | 0.25 | 1,659 | 95 |
| 2007 | 40,876.22 | 0.10 | 13,059.93 | 0.18 | 10,327,969.0 | 0.25 | 141 | 0 |
| 2008 | 37,573.95 | 0.16 | 12,898.24 | 0.20 | 5,640,550.3 | 0.25 | 0 | 0 |
| 2009 | 34,855.00 | 0.11 | 12,831.56 | 0.14 | 34,073,446.0 | 0.25 | 0 | 0 |
| 2010 | 86,354.00 | 0.15 | 31,277.45 | 0.16 | 157,836,450.0 | 0.25 | 6,111 | 3,971 |
| 2011 | 142,601.00 | 0.08 | 135,732.00 | 0.16 | 155,215,290.0 | 0.25 | 10,913 | 3,576 |
| 2012 | 186,865.00 | 0.05 | 26,663.47 | 0.20 | 81,470,578.0 | 0.25 | 8,600 | 5,753 |
| 2013 | 93,854.10 | 0.13 | 54,686.42 | 0.18 | 37,122,320.0 | 0.25 | 10,928 | 3,144 |
| 2014 | 125,427.40 | 0.06 | 89,011.42 | 0.12 | 522,415,450.0 | 0.25 | 14,274 | 5,278 |
| 2015 | 372,916.12 | 0.07 | 181,063.44 | 0.10 | 218,763,960.0 | 0.25 | 19,416 | 8,838 |
| 2016 | 89,727.00 | 0.13 | 152,048.57 | 0.11 | 136,511,170.0 | 0.25 | 15,380 | 3,991 |
| 2017 | 134,499.92 | 0.15 | 94,758.56 | 0.12 | 338,702,680.0 | 0.25 | 22,763 | 3,248 |
| 2018 | 185,524.43 | 0.07 | 192,087.59 | 0.12 | 286,814,850.0 | 0.25 | 25,499 | 5,236 |
| 2019 | 183,165.70 | 0.05 | 223,210.03 | 0.12 | 72,203,393.0 | 0.25 | 22,760 | 4,085 |
| 2020 | | | 334,282.59 | 0.12 | 151,925,440.0 | 0.25 | 14,870 | 10,350 |
| 2021 | 451,660.11 | 0.10 | 199,489.92 | 0.10 | 182,622,120.0 | 0.25 | 23,606 | 4,323 |

| Year | Pelgas SSB | Pelgas CV | Bioman SSB | Bioman CV | Juvena N0 | Juvena CV | Catch sem1 | Catch sem2 |
|---|---|---|---|---|---|---|---|---|
| 2022 | 180,749.12 | 0.10 | 198,740.73 | 0.08 | 103,886,360.0 | 0.25 | 21,323 | 2,923 |
| 2023 | 78,941.14 | 0.09 | 160,548.91 | 0.12 | 227,312,880.0 | 0.25 | 25,575 | 4,696 |
| 2024 | 187,591.00 | 0.09 | 145,607.89 | 0.10 | 46,676,590.0 | 0.25 | 28,071 | 4,753 |

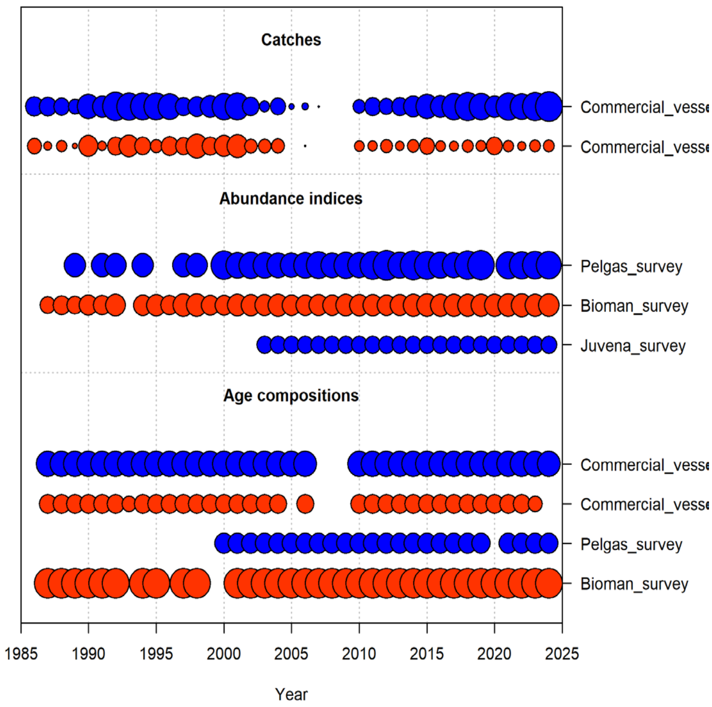



**Figure 2.5.1.1: Bay of Biscay anchovy: Summary of input data for SS assessment for Bay of Biscay anchovy, where circle area is relative within a data type. Circles are proportional to total catch for catches; to precision for indices; and to total sample size for age compositions observations.**

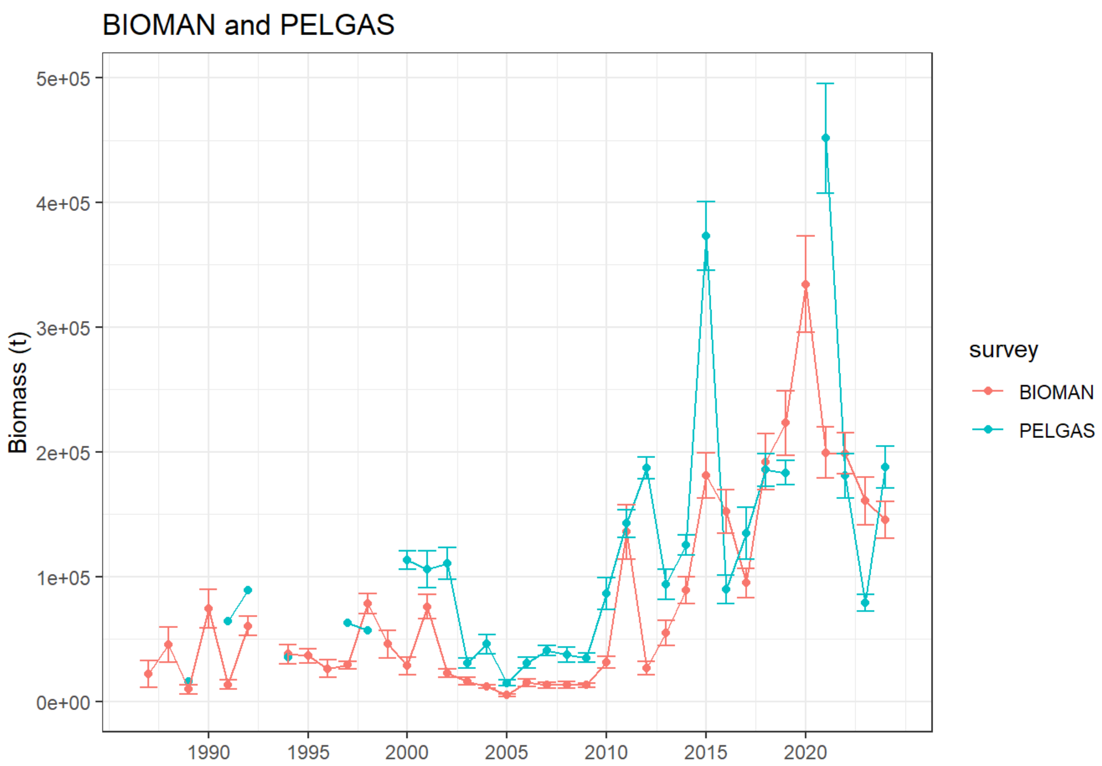



**Figure 2.5.1.2: Bay of Biscay anchovy: Historical series of spawning–stock biomass estimates and the corresponding confidence intervals from DEPM (red) and acoustics (blue).**

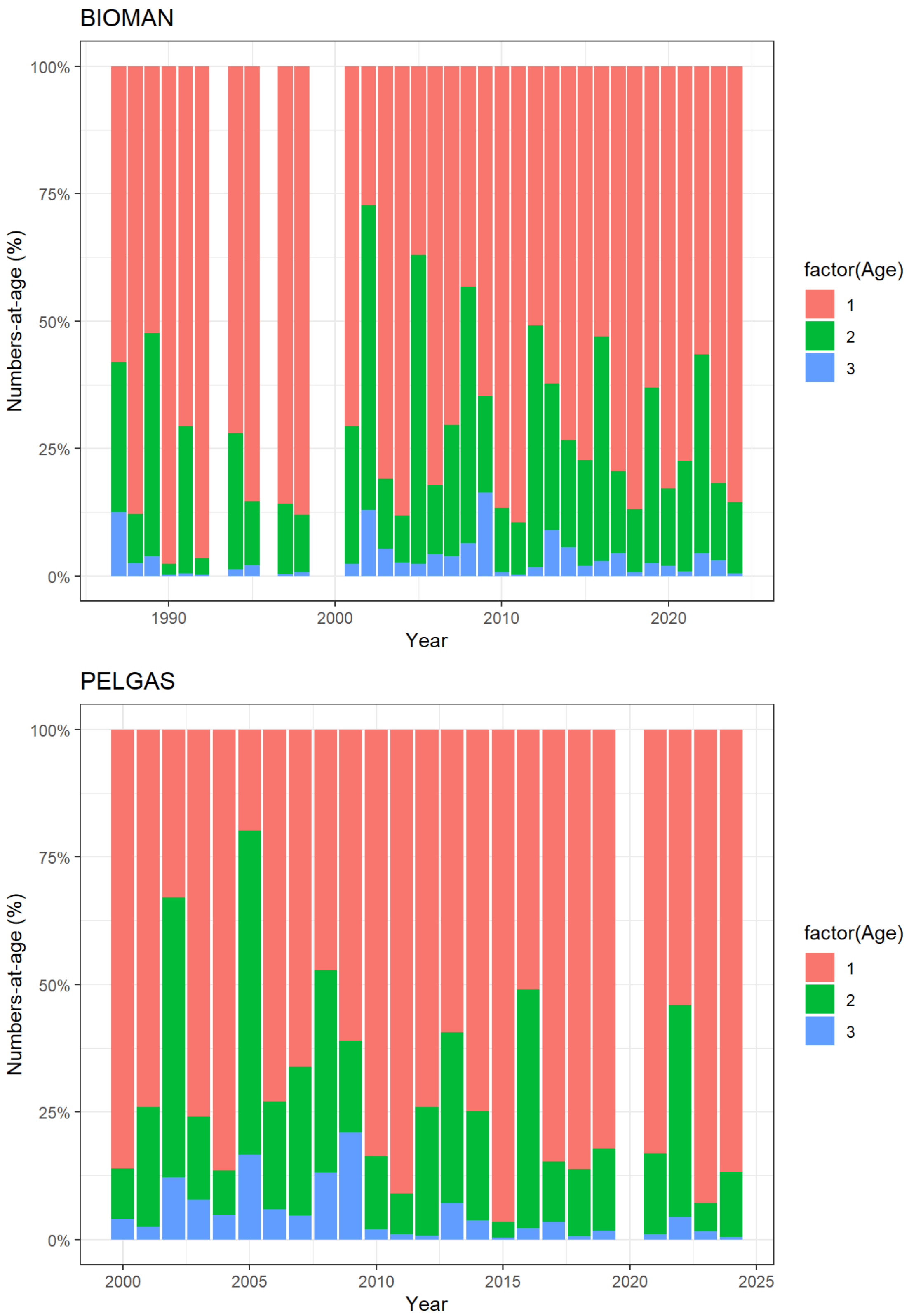



**Figure 2.5.1.3: Bay of Biscay anchovy: Historical series of numbers at age proportion estimates from DEPM (top) and acoustics (bottom).**

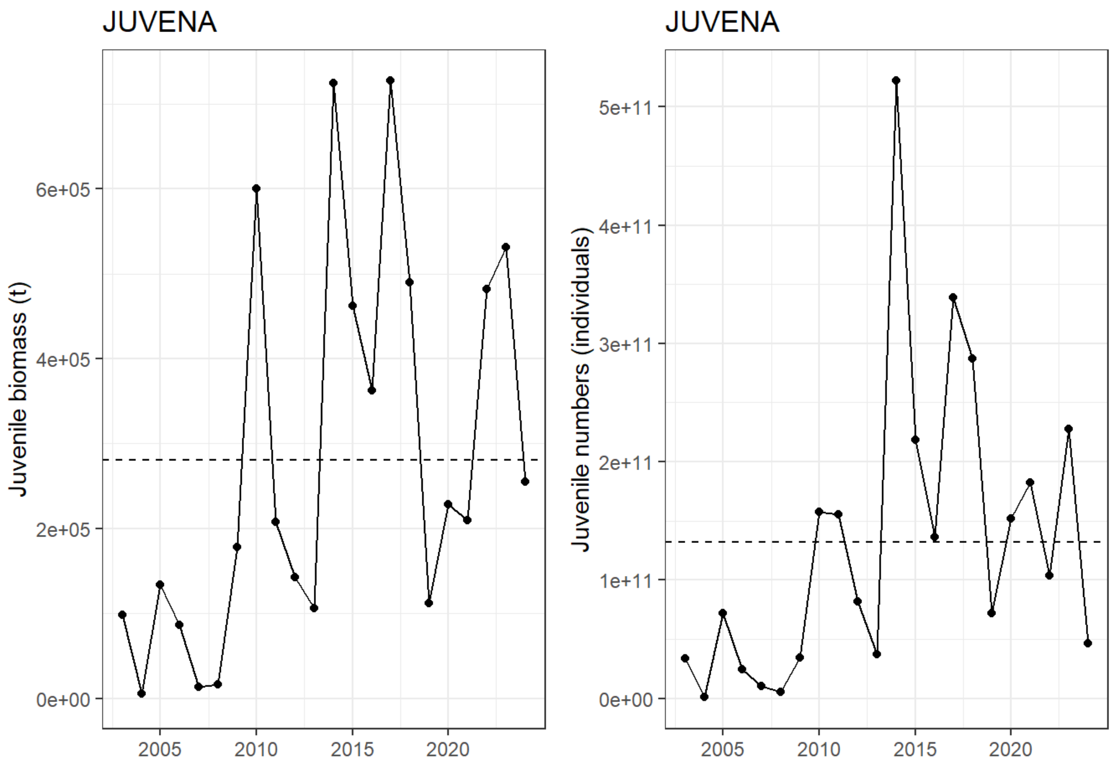



**Figure 2.5.1.4: Bay of Biscay anchovy: Historical series of the juvenile abundance index from the autumn acoustic survey JUVENA that is related to recruitment (age 0) in biomass (right) and in numbers (left).**

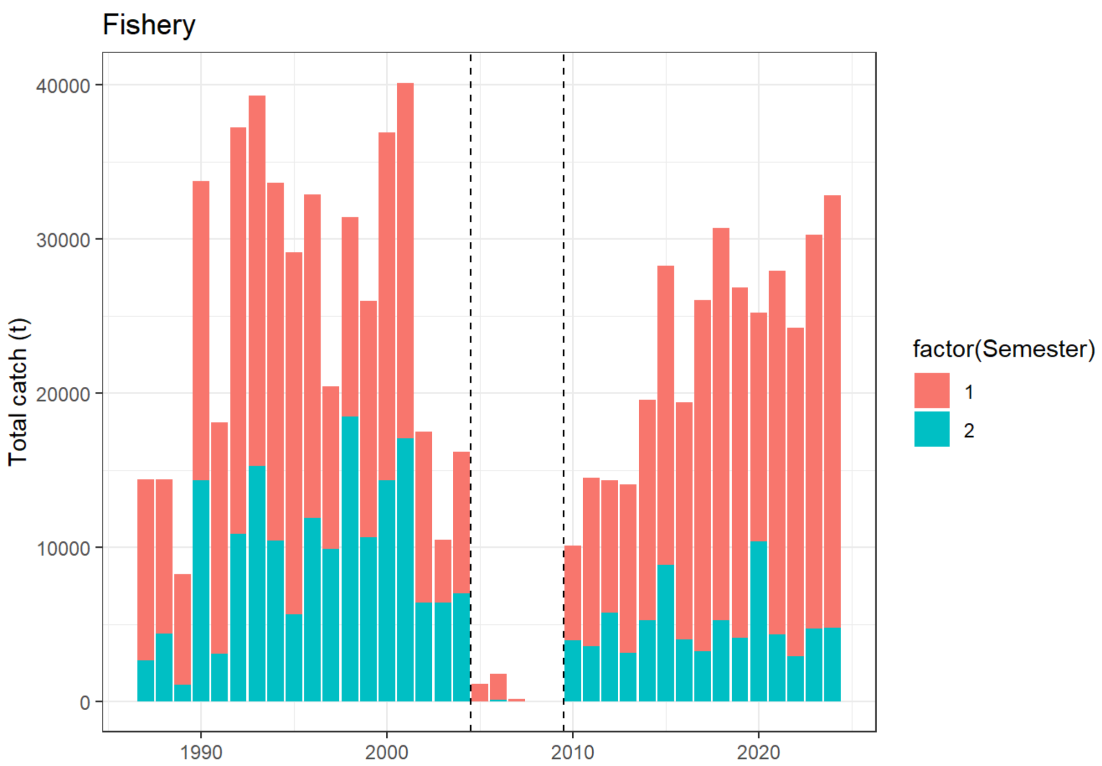



**Figure 2.5.1.5: Bay of Biscay anchovy: Historical series of total catch by semesters. Note that the catch in 2024 is provisional.**


**Figure 2.5.1.6: Bay of Biscay anchovy: Historical series catch at age proportions. The left panel corresponds to the first semester and the right panel to the second semester. Note that the catch in 2024 is provisional and that the catch at age 0 is not included in the assessment model.**

## 2.5.2 Model configuration

The assessment of anchovy in the Bay of Biscay was carried out using Stock Synthesis (SS) (Methot and Wetzel, 2013). This is an age-based analytical assessment with 4 age classes (0-3+) and two seasons. The model configuration is given in Table 2.5.1.1 and is described in detail in the stock annex - Bay of Biscay Anchovy (Subarea 8).

The model was run under the windows platform with SS version 3.30.22.beta, which was also used during WKBANSP (ICES, 2024). All analysis were performed in R version 4.3.2 (R Core Team, 2024) making use of SS related packages r4ss (Taylor *et al.*, 2021) and ss3diags Winker *et al.* (2024).

**Table 2.5.2.1: Bay of Biscay anchovy: Stock assessment model configuration in Stock Synthesis.**

| Input data | Assessment 2024 |
|---|---|
| Catch | Total catch biomass 1987-2024 by semester (age 0 catch not included) (tonnes) |
| | Catch-at age (ages 1,2, 3+) 1987-2024 by semester (except for assessment year's second semester that no catch-at-age data are available) (thousands of individuals) |
| PELGAS spring acoustic survey | Total SSB 1989-2023 (missing years: 1990, 1993-1996, 1999, 2020) (tonnes) |
| | Numbers-at-age (ages 1,2, 3+) 2000-2023 (missing years: 2020) (thousands of individuals) |
| BIOMAN DEPM survey | Total SSB 1987-2024 (missing years: 1993) (tonnes) |

| Input data | Assessment 2024 |
|---|---|
| | Numbers-at-age (ages 1,2, 3+) 1987-2024 (missing years: 1993, 1996, 1999 and 2000) (thousands of individuals) |
| JUVENA autumn acoustic survey | Numbers-at-age 0 2003-2024 (thousands of individuals) |
| Weight-at-age in the catch | Averages by year and semester 1987-2024 (except for assessment year's second semester) |
| Weight-at-age in the stock | From DEPM surveys, linear interpolation for missing years (kg) |
| Maturity-at-age | All individuals mature at age 1 (maturity at age 0=0) |

| Model structure and assumptions | Assessment 2024 |
|---|---|
| Starting year | 1987 |
| Ending year | 2024 |
| Equilibrium catches | 12 246 t in 1st semester and 8164 t in 2nd semester (average 1978-1986, 60% in 1st half-year) |
| Number of areas | 1 |
| Number of seasons | 2 (Jan-Jun, Jul-Dec) |
| Spawning time | 15th May |
| Recruitment settlement time | 1st July |
| Genders | 1 |
| Data age bins (for age structured fleets) | 0-3+ |
| Natural mortality | M-at-age 0=2.17, M-at-age 1=0.8, M-at-age 2=1.2, M-at-age 3+=2.26 |
| Recruitment | Density-dependent R model; annual recruitments are parameters, defined as lognormal deviations from Ricker stock–recruitment model, penalized by a sigma of 0.8, and an input steepness (SS parameterization) of 1.4. Constant bias correction for the whole time period (option -1 in SS)<br>Main recruitment deviates: 1987-2024, Early recruitment deviates: 1984-1986 |
| Initial population | N-at-age in the first year are parameters derived from an input initial equilibrium catch, equilibrium recruitment and selectivity in the first year and adjusted by recruitment deviations estimated from the data on the early years of the assessment. |

| Model structure and assumptions | Assessment 2024 |
|---|---|
| Fishery selectivity-at-age | Selectivity-at-age are independent parameters. Selectivity-at-age 0 fixed to 0, Selectivity-at-age 2 fixed to 1 (as reference) and Selectivity-at-ages 1 and 3+ estimated through random walks for the whole period 1987-2023. A different selectivity is estimated for each commercial fleet (i.e. by semester). |
| PELGAS spring acoustic survey selectivity-at-age | Selectivity-at-age are independent parameters. Selectivity-at-age 0 fixed to 0, Selectivity-at-age 2 and 3+ fixed to 1 and Selectivity-at-age 1 is estimated in two time blocks: 1987-2006 and 2007-2024. |
| BIOMAN DEPM survey selectivity-at-age | Selectivity-at-age are independent parameters. Selectivity-at-age 0 fixed to 0, Selectivity-at-ages 1, 2 and 3+ fixed to 1. |
| PELGAS Spring acoustic survey catchability | Linear catchability parameter with extra standard error parameter |
| BIOMAN DEPM catchability | Linear catchability parameter with extra standard error parameter |
| JUVENA autumn acoustic survey catchability | Linear catchability parameter with extra standard error parameter |
| Log-likelihood function: | |
| Weights of components | All components have equal weight |
| Data weights | Sample size of age composition data defined after one iteration of the Francis method: 39 for commercial fishery in semester 1, 23 for commercial fishery in semester 2, 24 for acoustic survey and 54 for DEPM survey.<br>CVs for aggregated indices: inputs from the surveys except for Juvena survey set to 0.25.<br>SD for total catches: 0.05 |

## 2.5.3 State of the stock

Estimated parameters from the final assessment, derived quantities and the corresponding standard deviations are reported in Table 2.5.3.1 and Table 2.5.3.1. Estimates by age, such as numbers at the beginning of the year and fishing mortalities are reported in Table 2.5.3.1 and Table 2.5.3.1.

Recruitment (age 0 in numbers at the beginning of the second semester), SSB (at spawning time, which is assumed to be 15th May), fishing mortality by semester and harvest rates (catch/biomass) from the final assessment are shown in Figure 2.5.3.1. The estimated level of SSB in 2024 is approximately 155 570t, which is the highest in the time-series, and the 95% probability interval is around 71 103t and 240 037t. This confidence interval is among the widest in the time-series, accounting for the discrepancies observed in the surveys of the last years. The estimated recruitment (age 0) in 2024 is around 10 573 100 thousand and the 95% probability interval is between 3 639 197 and 10 573 100. The confidence interval around the mean recruitment in 2024 is wide because only the JUVENA 2024 survey provides direct information about that recruitment level. This recruitment estimate is the lowest value since the reopening of the fishery, which represents a decrease from last year estimate (the second highest estimate in the time series). The annual fishing mortality (apical F) has shown to be relatively stable, around the value of 0.2, during the last decade. The fishing morality in most of the years is higher in the first semester, with an estimated value of 0.34 in the first semester of 2024 and 0.08 in the second semester of 2024. The harvest rate, computed as catch/SSB, is estimated at 0.46 for 2024, slightly lower than in 2023 but similar to the most recent values in the time series.

Estimated selectivities through a random walk for ages 1 and 3+ in the commercial fishery show an increasing trend for age 1 and a decreasing trend for age 3+ in the most recent years, mainly in the first semester, when most of the catches take place (Figure 2.5.3.1). Selectivities for surveys are constant in time, only being estimated the selectivity at age 1 for the acoustic survey, with an estimated value of 0.73 for the time block previous to 2007 and a selectivity of 1 for the time block since 2007 until now (Figure 2.5.3.1). These two time-blocks for the estimation of selectivity at age 1 account for the incorporation of commercial vessels to the spring acoustic survey.

The fitted Ricker stock-recruitment model is shown in Figure 2.5.3.1. The steepness parameter was fixed at 1.4 (estimated in the benchmark process) while R0 was estimated within the SS assessment model with a constant bias correction applied.

**Table 2.5.3.1: Bay of Biscay anchovy: Estimated parameters (excluding deviation parameters), minimum and maximum values, initial values, status and standard deviations as reported by SS output for Bay of Biscay anchovy final model configuration.**

| Label | Value | Parm_StDev | Min | Max | Init | Status |
|---|---|---|---|---|---|---|
| SR_LN(R0) | 16.80 | 0.11 | 1 | 20 | 17.0 | OK |
| InitF_seas_1_flt_1Commercial_vessels1 | 0.17 | 0.03 | 0 | 8 | 0.1 | OK |
| InitF_seas_2_flt_2Commercial_vessels2 | 0.15 | 0.02 | 0 | 8 | 0.1 | OK |
| LnQ_base_Pelgas_survey(3) | 0.52 | 0.16 | -7 | 5 | 0.0 | OK |
| Q_extraSD_Pelgas_survey(3) | 0.23 | 0.05 | 0 | 5 | 0.0 | OK |
| LnQ_base_Bioman_survey(4) | -0.05 | 0.14 | -7 | 5 | 0.0 | OK |
| Q_extraSD_Bioman_survey(4) | 0.36 | 0.08 | 0 | 5 | 0.0 | OK |
| LnQ_base_Juvena_survey(5) | 1.76 | 0.21 | -7 | 20 | 0.0 | OK |
| Q_extraSD_Juvena_survey(5) | 0.53 | 0.12 | 0 | 5 | 0.0 | OK |
| AgeSel_P2_Commercial_vessels1(1) | 11.44 | 0.78 | -5 | 20 | 9.0 | OK |
| AgeSel_P4_Commercial_vessels1(1) | 12.66 | 2.15 | -5 | 20 | 9.0 | OK |
| AgeSel_P2_Commercial_vessels2(2) | 14.03 | 1.46 | -5 | 20 | 9.0 | OK |
| AgeSel_P4_Commercial_vessels2(2) | 11.01 | 1.61 | -5 | 20 | 9.0 | OK |
| AgeSel_P2_Pelgas_survey(3) | 7.50 | 279.50 | -5 | 20 | 20.0 | OK |
| AgeSel_P2_Pelgas_survey(3)_BLK2repl_1986 | 11.99 | 0.57 | -5 | 20 | 20.0 | OK |
| AgeSel_P2_Pelgas_survey(3)_BLK2repl_2007 | 19.54 | 12.11 | -5 | 20 | 20.0 | OK |

**Table 2.5.3.2: Bay of Biscay anchovy: Summary of the stock assessment. Summary table of the WGHANSA 2024 assessment. Lower and upper values of the 95% confidence intervals are presented for SSB, Recruitment and Apical F (maximum F-at-age by year); biomass and landings in tonnes, recruits in thousands of individuals, F in year-1. Catches for 2024 are an assumption. HR stands for harvest rate (Landings/SSB)**

| Yr | Landings | Reclower | Rec | Recupper | SSBlower | SSB | SSBupper | Fvaluelower | F | Fvalueupper | HR |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,987 | 14,385 | 4,391,614 | 5,722,540 | 7,456,818 | 19,598 | 30,932 | 42,267 | 0.32 | 0.55 | 0.77 | 0.73 |
| 1,988 | 14,406 | 1,487,543 | 2,204,530 | 3,267,101 | 24,034 | 34,913 | 45,791 | 0.35 | 0.57 | 0.79 | 0.60 |
| 1,989 | 8,239 | 9,728,951 | 11,645,500 | 13,939,599 | 9,949 | 18,232 | 26,516 | 0.26 | 0.48 | 0.71 | 0.83 |
| 1,990 | 33,734 | 3,670,901 | 5,115,110 | 7,127,500 | 32,686 | 41,843 | 51,000 | 0.63 | 0.93 | 1.23 | 1.03 |
| 1,991 | 18,112 | 11,882,308 | 15,154,300 | 19,327,289 | 16,342 | 27,235 | 38,129 | 0.43 | 0.77 | 1.11 | 1.11 |
| 1,992 | 37,209 | 11,859,352 | 14,206,500 | 17,018,185 | 38,377 | 54,559 | 70,742 | 0.47 | 0.86 | 1.25 | 0.97 |

| Yr | Landings | Reclower | Rec | Recupper | SSBlower | SSB | SSBupper | Fvaluelower | F | Fvalueupper | HR |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,993 | 39,313 | 6,028,676 | 7,484,780 | 9,292,576 | 53,480 | 67,050 | 80,619 | 0.58 | 0.85 | 1.12 | 0.74 |
| 1,994 | 33,621 | 5,066,846 | 6,753,570 | 9,001,795 | 30,585 | 40,351 | 50,116 | 0.74 | 1.06 | 1.38 | 1.10 |
| 1,995 | 29,108 | 6,992,524 | 8,822,920 | 11,132,450 | 20,570 | 32,210 | 43,851 | 0.65 | 1.14 | 1.63 | 1.42 |
| 1,996 | 32,888 | 7,739,449 | 10,492,300 | 14,224,314 | 23,511 | 33,352 | 43,193 | 0.75 | 1.31 | 1.86 | 1.40 |
| 1,997 | 20,452 | 13,989,016 | 18,814,000 | 25,303,181 | 23,479 | 36,026 | 48,573 | 0.38 | 0.69 | 1.00 | 0.87 |
| 1,998 | 31,399 | 6,350,984 | 8,894,700 | 12,457,233 | 55,197 | 81,096 | 106,994 | 0.26 | 0.46 | 0.66 | 0.57 |
| 1,999 | 25,998 | 13,665,118 | 16,917,000 | 20,942,731 | 42,672 | 65,844 | 89,016 | 0.27 | 0.45 | 0.64 | 0.61 |
| 2,000 | 36,890 | 11,516,242 | 14,076,000 | 17,204,725 | 61,537 | 81,103 | 100,669 | 0.36 | 0.57 | 0.77 | 0.60 |
| 2,001 | 40,139 | 2,422,659 | 3,194,890 | 4,213,272 | 66,080 | 84,651 | 103,222 | 0.39 | 0.55 | 0.72 | 0.61 |
| 2,002 | 17,495 | 2,806,155 | 3,582,600 | 4,573,883 | 35,181 | 48,542 | 61,903 | 0.31 | 0.45 | 0.59 | 0.50 |
| 2,003 | 10,480 | 4,185,422 | 5,474,820 | 7,161,442 | 17,438 | 23,600 | 29,763 | 0.38 | 0.59 | 0.81 | 0.60 |
| 2,004 | 16,187 | 650,308 | 1,008,170 | 1,562,963 | 19,666 | 28,274 | 36,881 | 0.49 | 0.81 | 1.13 | 0.82 |
| 2,005 | 1,127 | 2,378,155 | 3,521,000 | 5,213,050 | 7,975 | 13,915 | 19,856 | 0.05 | 0.10 | 0.14 | 0.14 |
| 2,006 | 1,753 | 2,717,566 | 4,047,140 | 6,027,211 | 10,765 | 17,693 | 24,621 | 0.08 | 0.15 | 0.22 | 0.16 |
| 2,007 | 141 | 1,067,389 | 1,644,760 | 2,534,442 | 16,110 | 25,528 | 34,946 | 0.01 | 0.01 | 0.01 | 0.01 |
| 2,008 | 0 | 1,603,278 | 2,402,560 | 3,600,308 | 12,429 | 19,626 | 26,823 | | | | 0.00 |
| 2,009 | 0 | 5,892,856 | 8,420,660 | 12,032,793 | 9,885 | 15,183 | 20,481 | | | | 0.00 |
| 2,010 | 10,082 | 17,946,965 | 25,056,400 | 34,982,137 | 25,442 | 39,931 | 54,420 | 0.25 | 0.45 | 0.65 | 0.40 |
| 2,011 | 14,489 | 10,698,571 | 15,048,300 | 21,166,504 | 63,234 | 95,924 | 128,613 | 0.17 | 0.30 | 0.43 | 0.23 |
| 2,012 | 14,353 | 8,118,921 | 11,599,000 | 16,570,773 | 56,476 | 85,281 | 114,085 | 0.11 | 0.17 | 0.23 | 0.25 |
| 2,013 | 14,072 | 12,460,679 | 17,713,400 | 25,180,372 | 45,216 | 69,924 | 94,631 | 0.13 | 0.22 | 0.30 | 0.31 |
| 2,014 | 19,552 | 22,659,198 | 32,014,000 | 45,230,911 | 57,061 | 89,164 | 121,267 | 0.20 | 0.34 | 0.48 | 0.34 |
| 2,015 | 28,254 | 11,059,125 | 16,153,200 | 23,593,718 | 79,900 | 124,287 | 168,674 | 0.18 | 0.31 | 0.44 | 0.35 |
| 2,016 | 19,371 | 13,388,055 | 19,615,700 | 28,740,223 | 51,519 | 83,894 | 116,269 | 0.11 | 0.19 | 0.27 | 0.38 |
| 2,017 | 26,011 | 23,121,007 | 33,825,800 | 49,486,804 | 52,215 | 88,535 | 124,856 | 0.17 | 0.31 | 0.45 | 0.50 |
| 2,018 | 30,735 | 13,698,943 | 20,806,500 | 31,601,740 | 66,078 | 111,064 | 156,050 | 0.14 | 0.26 | 0.39 | 0.47 |
| 2,019 | 26,845 | 27,137,106 | 39,973,100 | 58,880,586 | 74,806 | 131,201 | 187,596 | 0.11 | 0.21 | 0.31 | 0.36 |
| 2,020 | 25,220 | 25,293,536 | 37,118,400 | 54,471,452 | 88,470 | 147,015 | 205,560 | 0.11 | 0.21 | 0.31 | 0.29 |
| 2,021 | 27,930 | 9,651,407 | 14,820,800 | 22,758,974 | 88,383 | 148,837 | 209,291 | 0.09 | 0.16 | 0.24 | 0.32 |
| 2,022 | 24,246 | 15,208,128 | 23,920,300 | 37,623,353 | 56,177 | 99,691 | 143,204 | 0.11 | 0.20 | 0.28 | 0.43 |
| 2,023 | 30,271 | 23,283,700 | 39,524,500 | 67,093,551 | 51,762 | 98,302 | 144,842 | 0.12 | 0.26 | 0.40 | 0.58 |
| 2,024 | 32,824 | 3,639,192 | 10,573,100 | 30,718,482 | 71,103 | 155,570 | 240,037 | 0.09 | 0.21 | 0.33 | 0.46 |

**Table 2.5.3.3: Bay of Biscay anchovy: Fishing mortality-at-age by semester (_s1 for semester 1 and _s2 for semester 2) estimated in the assessment. F apical is F at age 2.**

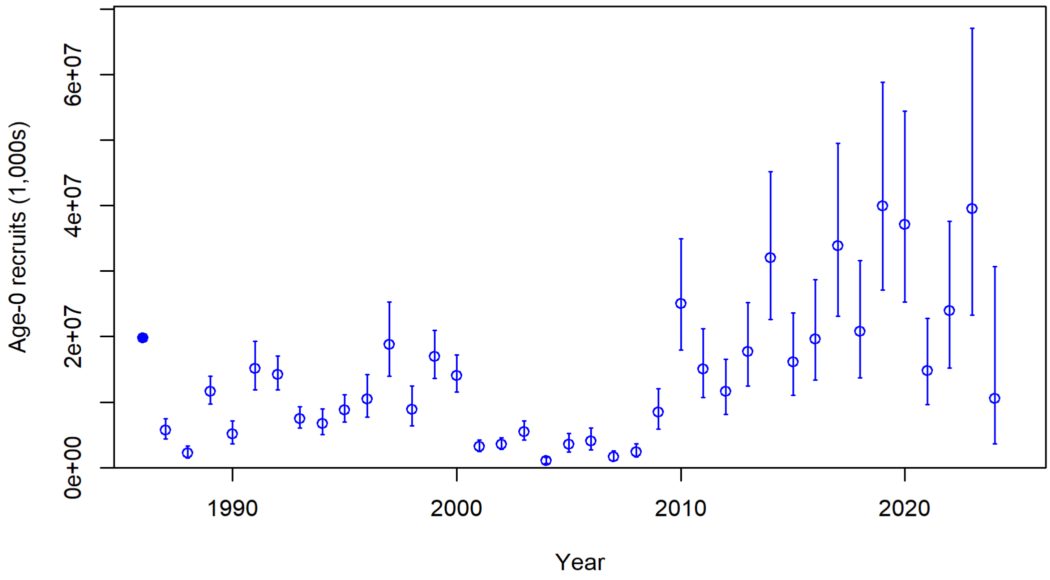
| Year | 0_s1 | 0_s2 | 1_s1 | 1_s2 | 2_s1 | 2_s2 | 3_s1 | 3_s2 |
|---|---|---|---|---|---|---|---|---|
| 1,987 | 0 | 0 | 0.47 | 0.30 | 0.78 | 0.32 | 0.65 | 0.16 |
| 1,988 | 0 | 0 | 0.44 | 0.40 | 0.72 | 0.42 | 0.61 | 0.22 |
| 1,989 | 0 | 0 | 0.50 | 0.16 | 0.80 | 0.17 | 0.68 | 0.09 |

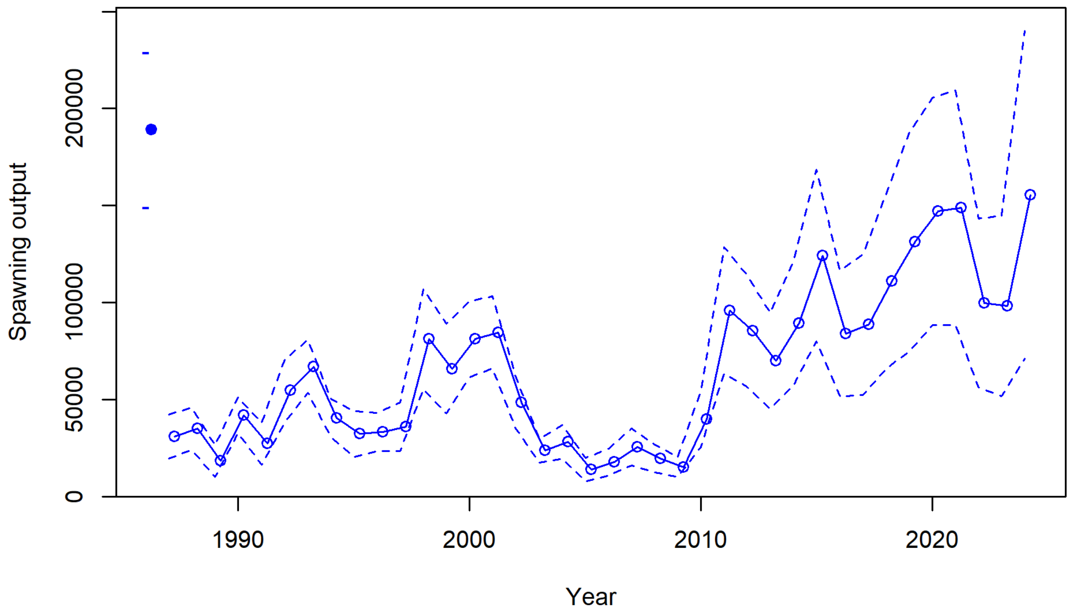
| Year | 0_s1 | 0_s2 | 1_s1 | 1_s2 | 2_s1 | 2_s2 | 3_s1 | 3_s2 |
|---|---|---|---|---|---|---|---|---|
| 1,990 | 0 | 0 | 0.55 | 0.84 | 0.97 | 0.88 | 0.84 | 0.48 |
| 1,991 | 0 | 0 | 0.58 | 0.27 | 1.25 | 0.29 | 1.09 | 0.16 |
| 1,992 | 0 | 0 | 0.53 | 0.45 | 1.24 | 0.48 | 1.08 | 0.26 |
| 1,993 | 0 | 0 | 0.42 | 0.63 | 1.03 | 0.67 | 0.90 | 0.36 |
| 1,994 | 0 | 0 | 0.54 | 0.69 | 1.38 | 0.74 | 1.22 | 0.40 |
| 1,995 | 0 | 0 | 0.68 | 0.45 | 1.80 | 0.49 | 1.59 | 0.27 |
| 1,996 | 0 | 0 | 0.64 | 0.94 | 1.58 | 1.03 | 1.40 | 0.57 |
| 1,997 | 0 | 0 | 0.33 | 0.57 | 0.75 | 0.63 | 0.67 | 0.36 |
| 1,998 | 0 | 0 | 0.17 | 0.47 | 0.40 | 0.53 | 0.35 | 0.31 |
| 1,999 | 0 | 0 | 0.20 | 0.35 | 0.51 | 0.39 | 0.45 | 0.23 |
| 2,000 | 0 | 0 | 0.27 | 0.34 | 0.74 | 0.39 | 0.66 | 0.24 |
| 2,001 | 0 | 0 | 0.24 | 0.44 | 0.60 | 0.51 | 0.53 | 0.31 |
| 2,002 | 0 | 0 | 0.19 | 0.39 | 0.45 | 0.45 | 0.40 | 0.27 |
| 2,003 | 0 | 0 | 0.13 | 0.69 | 0.36 | 0.82 | 0.32 | 0.51 |
| 2,004 | 0 | 0 | 0.33 | 0.63 | 0.86 | 0.76 | 0.76 | 0.47 |
| 2,005 | 0 | 0 | 0.07 | 0.00 | 0.19 | 0.00 | 0.17 | 0.00 |
| 2,006 | 0 | 0 | 0.10 | 0.01 | 0.28 | 0.02 | 0.24 | 0.01 |
| 2,007 | 0 | 0 | 0.01 | 0.00 | 0.02 | 0.00 | 0.02 | 0.00 |
| 2,008 | 0 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2,009 | 0 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2,010 | 0 | 0 | 0.11 | 0.19 | 0.65 | 0.25 | 0.54 | 0.16 |
| 2,011 | 0 | 0 | 0.06 | 0.07 | 0.51 | 0.09 | 0.42 | 0.06 |
| 2,012 | 0 | 0 | 0.03 | 0.11 | 0.19 | 0.14 | 0.16 | 0.09 |
| 2,013 | 0 | 0 | 0.05 | 0.08 | 0.33 | 0.11 | 0.26 | 0.07 |
| 2,014 | 0 | 0 | 0.11 | 0.10 | 0.55 | 0.14 | 0.43 | 0.09 |
| 2,015 | 0 | 0 | 0.13 | 0.12 | 0.43 | 0.19 | 0.33 | 0.12 |
| 2,016 | 0 | 0 | 0.10 | 0.07 | 0.27 | 0.10 | 0.20 | 0.07 |
| 2,017 | 0 | 0 | 0.18 | 0.06 | 0.52 | 0.09 | 0.38 | 0.06 |
| 2,018 | 0 | 0 | 0.15 | 0.06 | 0.43 | 0.10 | 0.31 | 0.06 |
| 2,019 | 0 | 0 | 0.12 | 0.06 | 0.33 | 0.09 | 0.23 | 0.06 |
| 2,020 | 0 | 0 | 0.09 | 0.14 | 0.23 | 0.19 | 0.16 | 0.12 |
| 2,021 | 0 | 0 | 0.11 | 0.04 | 0.27 | 0.06 | 0.18 | 0.04 |
| 2,022 | 0 | 0 | 0.13 | 0.06 | 0.32 | 0.08 | 0.22 | 0.05 |
| 2,023 | 0 | 0 | 0.19 | 0.09 | 0.40 | 0.12 | 0.27 | 0.07 |
| 2,024 | 0 | 0 | 0.17 | 0.06 | 0.34 | 0.08 | 0.22 | 0.05 |

**Table 2.5.3.4: Bay of Biscay anchovy: Numbers-at-age estimated in the assessment at the beginning of the year.**

| Year | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| 1,987 | 0 | 1,232,610 | 604,484 | 360,857 |
| 1,988 | 0 | 1,933,660 | 375,900 | 130,467 |
| 1,989 | 0 | 744,915 | 570,333 | 73,003 |
| 1,990 | 0 | 3,935,040 | 241,223 | 110,948 |
| 1,991 | 0 | 1,728,400 | 882,160 | 34,686 |
| 1,992 | 0 | 5,120,660 | 506,030 | 124,898 |
| 1,993 | 0 | 4,800,410 | 1,408,230 | 71,214 |
| 1,994 | 0 | 2,529,120 | 1,273,180 | 185,058 |
| 1,995 | 0 | 2,282,040 | 614,523 | 141,356 |
| 1,996 | 0 | 2,981,280 | 582,137 | 64,926 |
| 1,997 | 0 | 3,545,360 | 607,236 | 50,073 |
| 1,998 | 0 | 6,357,300 | 1,018,600 | 94,670 |
| 1,999 | 0 | 3,005,540 | 2,075,510 | 200,289 |
| 2,000 | 0 | 5,716,280 | 1,030,690 | 413,092 |
| 2,001 | 0 | 4,756,310 | 1,886,550 | 203,263 |
| 2,002 | 0 | 1,079,560 | 1,518,160 | 340,930 |
| 2,003 | 0 | 1,210,570 | 363,312 | 316,310 |
| 2,004 | 0 | 1,849,950 | 361,673 | 82,370 |
| 2,005 | 0 | 340,662 | 514,791 | 53,212 |
| 2,006 | 0 | 1,189,750 | 148,101 | 145,836 |
| 2,007 | 0 | 1,367,530 | 505,706 | 51,771 |
| 2,008 | 0 | 555,768 | 612,784 | 156,229 |
| 2,009 | 0 | 811,830 | 249,723 | 200,839 |
| 2,010 | 0 | 2,845,360 | 364,779 | 96,133 |
| 2,011 | 0 | 8,466,590 | 1,100,960 | 77,192 |
| 2,012 | 0 | 5,084,850 | 3,571,380 | 252,018 |
| 2,013 | 0 | 3,919,310 | 2,134,140 | 932,026 |
| 2,014 | 0 | 5,985,380 | 1,646,960 | 599,676 |
| 2,015 | 0 | 10,817,600 | 2,427,970 | 400,404 |
| 2,016 | 0 | 5,458,200 | 4,293,000 | 570,231 |
| 2,017 | 0 | 6,628,190 | 2,255,890 | 1,123,240 |
| 2,018 | 0 | 11,429,800 | 2,644,410 | 593,507 |
| 2,019 | 0 | 7,030,550 | 4,620,480 | 663,453 |
| 2,020 | 0 | 13,507,000 | 2,894,990 | 1,188,890 |
| 2,021 | 0 | 12,542,400 | 5,418,010 | 815,540 |
| 2,022 | 0 | 5,007,960 | 5,217,350 | 1,460,690 |

| Year | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| 2,023 | 0 | 8,082,700 | 2,046,440 | 1,425,000 |
| 2,024 | 0 | 13,355,400 | 3,161,650 | 600,123 |



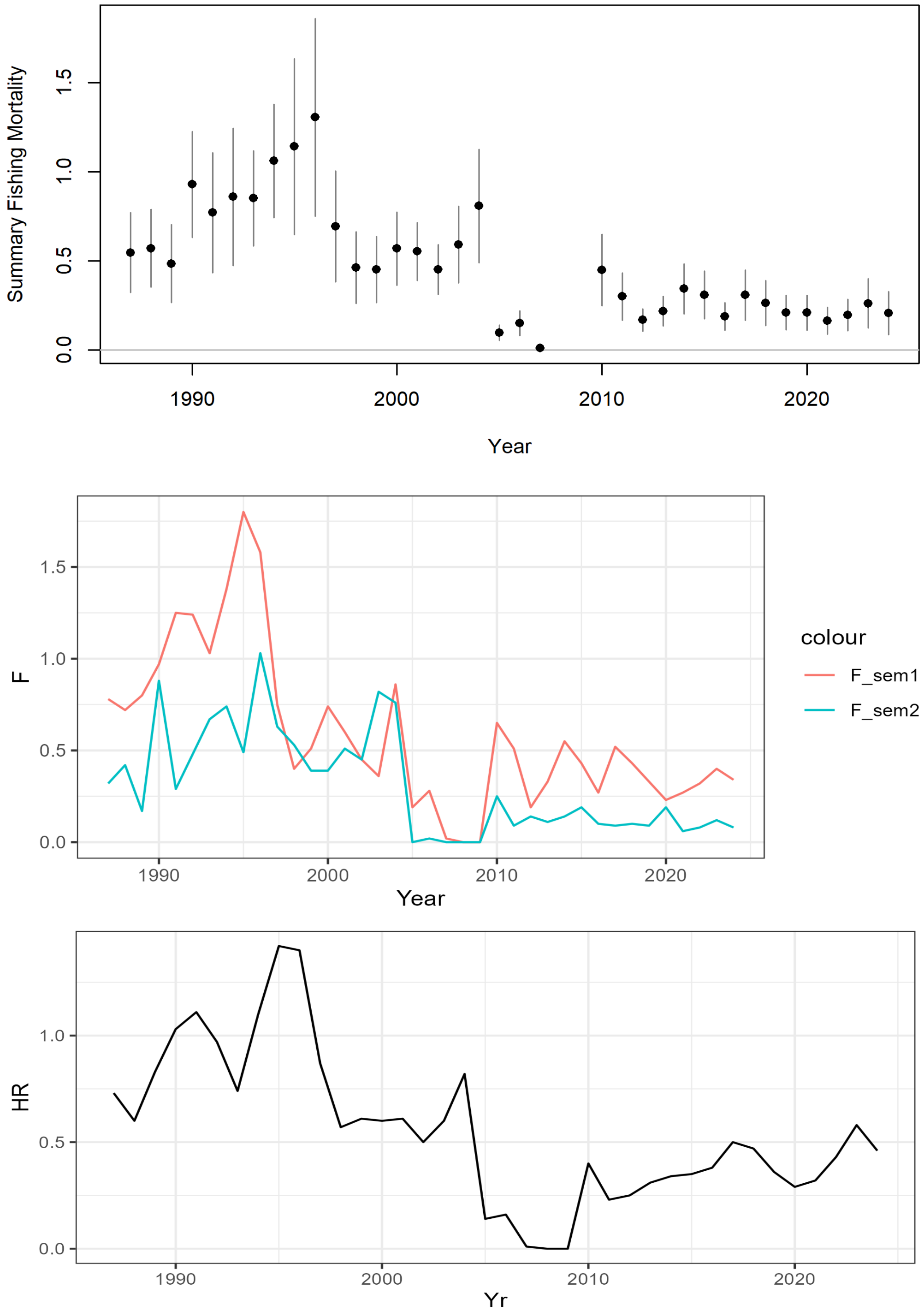



**Figure 2.5.3.1: Bay of Biscay anchovy: Time series, R, SSB, annual apical F, apical F by semester and harvest rate. F apical is F (age2).**

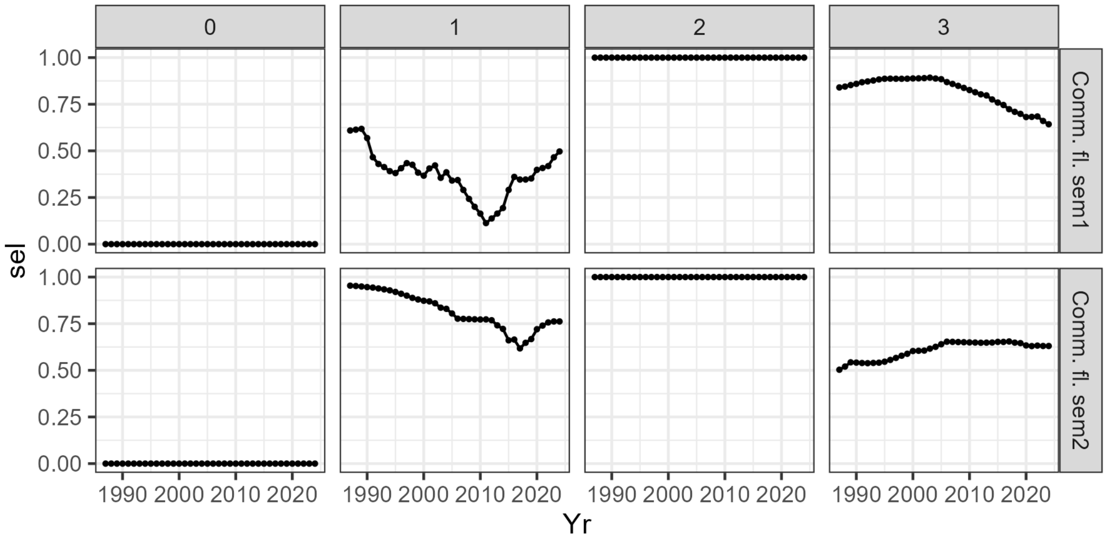



**Figure 2.5.3.2: Bay of Biscay anchovy: Estimated selectivities for commercial fleets.**

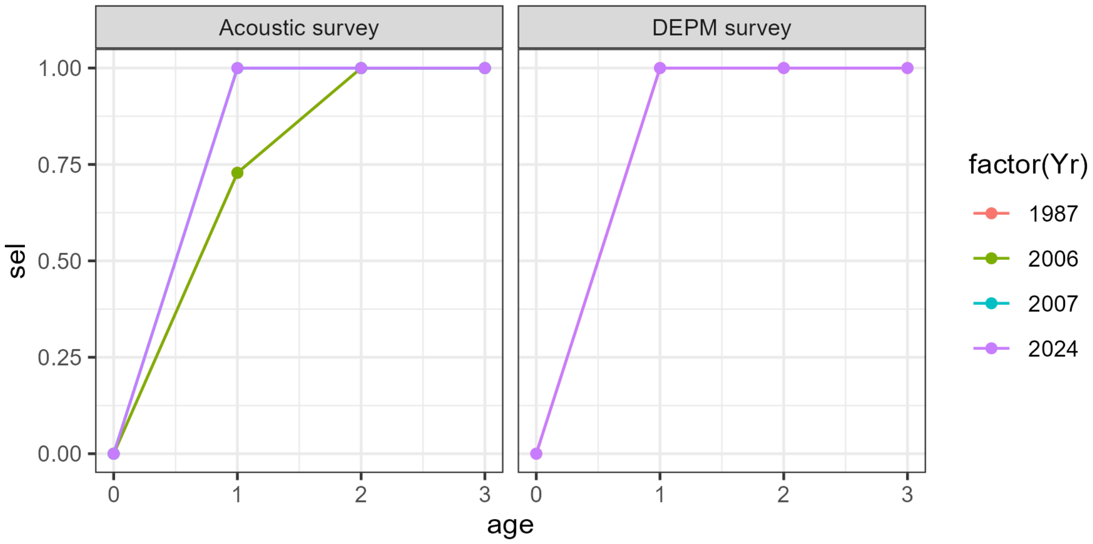



**Figure 2.5.3.3: Bay of Biscay anchovy: Estimated selectivities for Acoustic and DEPM surveys.**

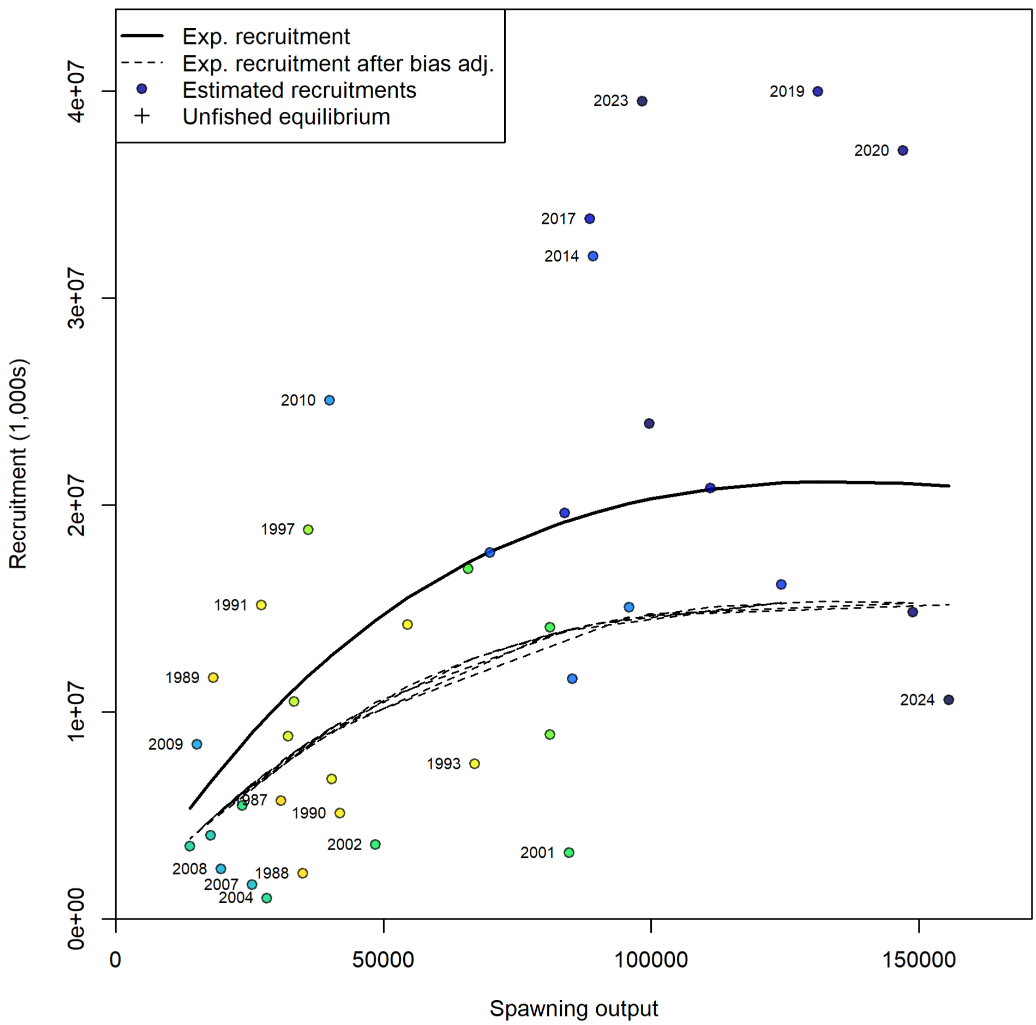



**Figure 2.5.3.4: Bay of Biscay anchovy: fitted SR model within the assessment model.**

## 2.5.4 Model diagnostics

The model was run using the latest SS version with a final gradient on the likelihood of 0.00013, very close to the recommended SS values of 0.0001. No parameters are estimated at the bounds, no highly correlated parameters were detected, and the Hessian was positive definite. No problems were identified on model convergence.

Figure 2.5.4.1 shows the fits to the aggregated indices from the three surveys and Figure 2.5.4.1 the corresponding residuals. The three aggregated indices passed the runs test for residuals, indicating no evidence to reject the hypothesis of randomly distributed residuals, however, a pattern on the DEPM survey residuals can be observed, with negative residual from 1995 to 2013 and positive residuals from 2013 on. The RMSE value for these indices is higher than 30% (Figure 2.5.4.1) which may indicate data conflicts (Carvalho *et al.* (2021)).

The model showed a general good fit to age composition data with no large Pearson residuals or strong patterns (Figure 2.5.4.1). Residuals for mean age passed the run test for the commercial fleets and for the PELGAS spring acoustic survey, indicating no evidence to reject the hypothesis of randomly distributed residuals while the BIOMAN DEPM survey did not pass the test (Figure 2.5.4.1). The joint age composition residual plot (Figure 2.5.4.1) and the root mean square error (RMSE) of 6.4% indicated a good fit to the data.

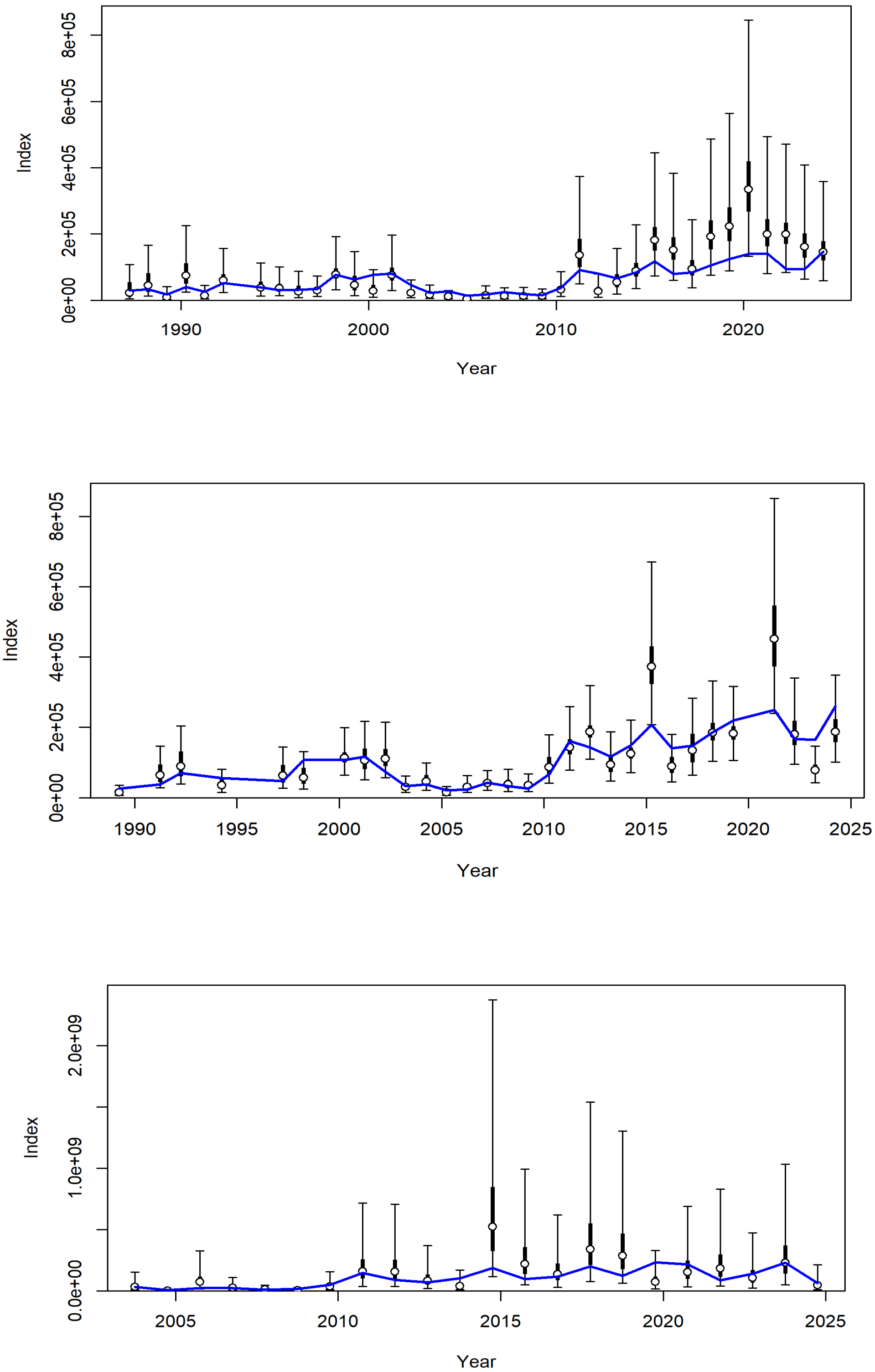



**Figure 2.5.4.1: Bay of Biscay anchovy: Fit (blue line) to index data for surveys. Vertical lines indicate 95% uncertainty interval around index values based on the model assumption of lognormal error. Thicker lines (if present) indicate input uncertainty before addition of estimated additional uncertainty parameter.**

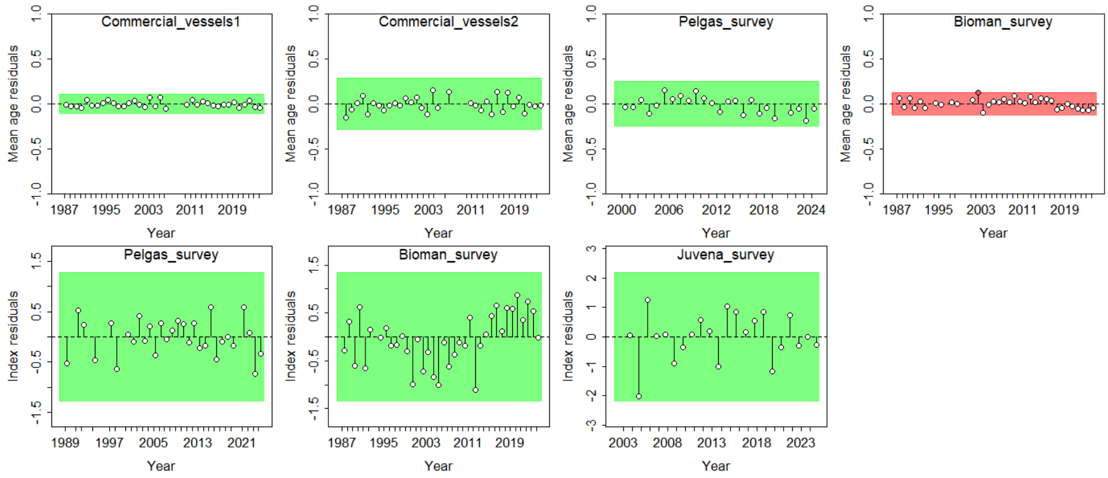



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**Figure 2.5.4.2: Bay of Biscay anchovy: Mean age and aggregated indices residuals for each fleet. Green shading indicates that the residual test is passes, red indicates the test is not passed.**

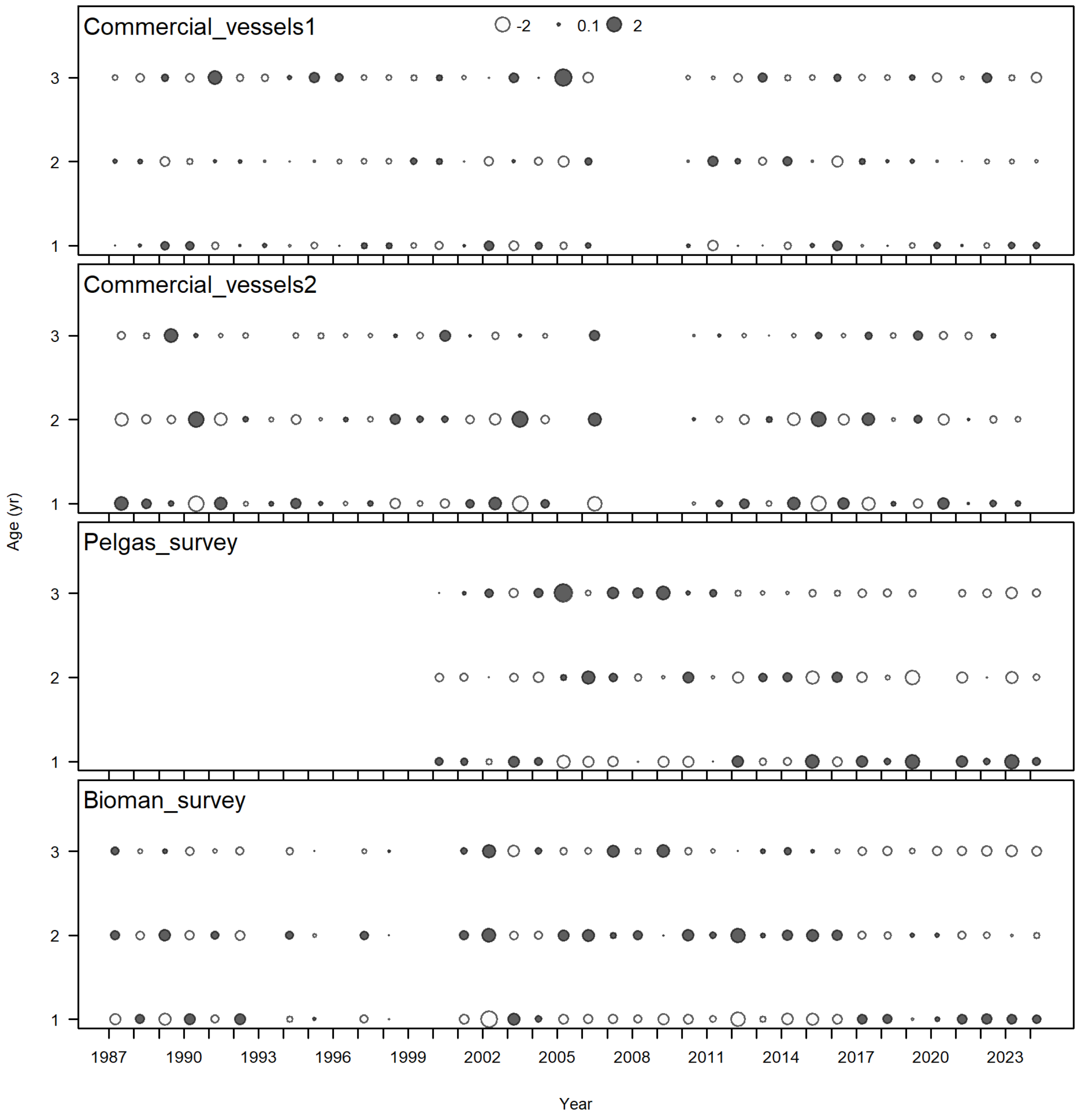


**Figure 2.5.4.3: Bay of Biscay anchovy: Pearson residuals. Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected).**

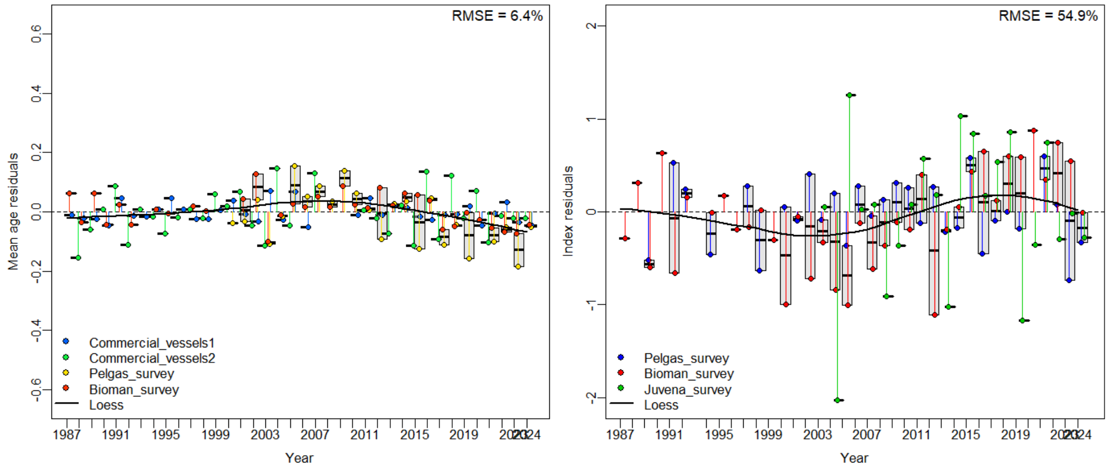


**Figure 2.5.4.4: Bay of Biscay anchovy: Joint residuals for all fleets and RMSE values. Age composition residuals on the right and aggregated indices residuals on the left.**

## 2.5.5 Retrospective pattern

The retrospective analysis for the final model was performed for a five-years period (Figure 2.5.5.1). Retrospective bias was measured in terms of the Mohn's rho (Mohn, 1999) using the function SSmohnsrho() in the R package r4ss.

Mohn's rho indicate an overestimation of SSB (Mohn's rho=0.43) and underestimation of recruitment and F (Mohn's rho -0.30 and -0.25 respectively). The Mohn's rho for SSB is above the critical value for short-lived species (0.3). As analysed during the benchmark (WKBANSP), the retrospective patterns have deteriorated in time and it should be further monitored and analysed.

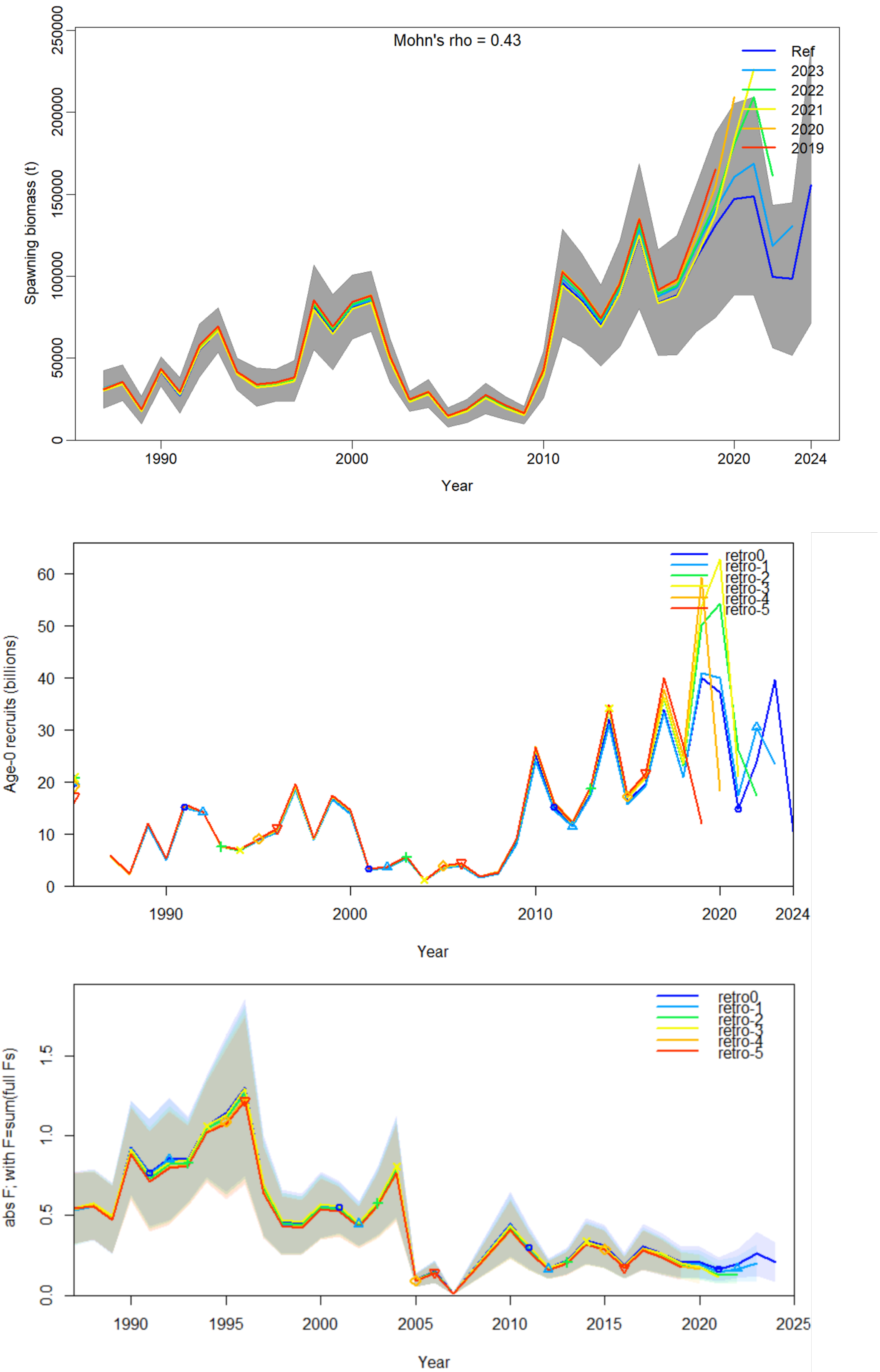


**Figure 2.5.5.1: Bay of Biscay anchovy: Retrospective patterns for SSB, recruitment and F with their corresponding Mohns rho values. Grey shaded area in the SSB plot represents the 95% confidence interval for the reference run.**

## 2.6 Short-term forecast

SS includes a forecast module that enables projections for a specified number of years, linked to the model ending conditions, associated uncertainties, and a specified level of fishing intensity. This tool was used to perform the short-term projections, following assumptions and settings agreed during the November WGHANSA meeting and described in the Stock Annex. Recruitment at the beginning of the second semester of 2024 is estimated within the SS assessment model and is mainly informed by the latest JUVENA juvenile abundance index and the parameters of the JUVENA observation equations. Average last 3 years previous to the assessment year (2021-2023) of selectivity, proportion of fishing mortality in the first semester and weight-at-age are assumed for the projection year (2025) and the fishing mortality level (F at age 2) of the terminal year is assumed to be F status quo. Natural mortality and maturity-at-age are time invariant and are assumed to be the same as in the assessment model. Forecast assumptions for the current projection are shown in Table 2.6.1.

Short-term forecast results including catch in 2025 and SSB in mid-May 2025 are predicted for the various levels of fishing mortality in 2025. Table 2.6.2 shows the management options table from the stochastic short-term forecasts at fishing mortality levels used for the different catch scenario options in the advice. In addition to the advice based on the harvest control rule in the management plan, the management options table include forecasts of SSB with no catch in 2025, catch at current fishing mortality, half of this fishing mortality, maximum value of F that will result in SSB ≥ Blim, or SSB ≥ Bpa, with a 95% probability and catches at the F level that produces SSB=Blim and SSB=Bpa.

In order obtain these catch options, several levels of fishing mortality were used to run the SS forecast module and get SSB and catch estimates in 2025. F multipliers for the current F level were defined from 0 to 20 and then linear interpolation was used to reach the defined management options. Figure 2.6.1 shows the resulting SSB and the corresponding 95% confidence intervals for all fishing mortality levels used for projections.

The forecasts are stochastic, allowing for estimates of uncertainty in SSB. Consequently, the probability of SSB falling below Blim in 2025 is also estimated.

**Table 2.6.1: Bay of Biscay anchovy: Forecast assumption.**

| Variable | Value | Notes |
|---|---|---|
| F_age2 (2024) | 0.21 | F (age 2) estimate from the stock assessment |
| SSB (2024) | 155570 | SSB estimate (in mid-May) from the stock assessment (tonnes) |
| $R_{age0}$ (2024) | 10573100 | Recruitment estimate (on 01 July 2024, from the stock assessment, in thousands) |
| Catch (2024) | 32824 | Catches to the end of October (32 127 tonnes) plus assumed catches for November and December, based on the average percentage 2010–2023 (2.1%). Preliminary value, used as input in the stock assessment (in tonnes). |
| Discards (2024) | Negligible | Discarding is negligible (< 0.1%) |

**Table 2.6.2: Bay of Biscay anchovy: Annual catch scenarios. All weights are in tonnes.**

| Basis | Total catch (2025) | SSB* (2025) | F** (2025) | % SSB change *** | % TAC change^ | % advice change^^ | Probability SSB < Blim in 2025 ^^^ |
|---|---|---|---|---|---|---|---|
| ICES advice basis | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Harvest control rule in the management plan | 30663 | 83156 | 0.270 | -47 | -7 | -7 | 0.0104 |
| Other scenarios | | | | | | | |
| F=0 | 0 | 94558 | 0.000 | -39 | -100 | -100 | 0.0067 |
| F=F2024 x 0.5 | 12487 | 89985 | 0.103 | -42 | -62 | -62 | 0.0079 |
| F=F2024 | 24076 | 85655 | 0.210 | -45 | -27 | -27 | 0.0093 |
| Catch (2025)=33000 | 33000 | 82261 | 0.290 | -47 | 0 | 0 | 0.0108 |
| p(SSB2025 <Bpa)=0.05 | 27601 | 84321 | 0.240 | -46 | -16 | -16 | 0.0099 |
| p(SSB2025<Blim)=0.05 | 100844 | 54438 | 1.190 | -65 | 206 | 206 | 0.050 |
| SSB (2025)=Bpa | 124741 | 43600 | 1.690 | -72 | 278 | 278 | 0.114 |
| SSB (2025)=Blim | 159552 | 26600 | 2.900 | -83 | 383 | 383 | 0.50 |

* SSB corresponds to mid-May estimate, with 80% of the catch assumed to be taken in the first six months of the year (average percentage from 2021-2023).
** F (age 2).
*** SSB (2025) relative to SSB (2024).
^ Catch (2025) relative to the 2024 TAC (33000 tonnes).
^^ Advice for 2025 relative to advice for 2024 (33000 tonnes).
^^^ The probability of SSB being below Blim in 2025. This probability relates to the short-term probability of SSB < Blim and is not comparable to the long-term probability of SSB < Blim tested in simulations when estimating fishing mortality reference points.

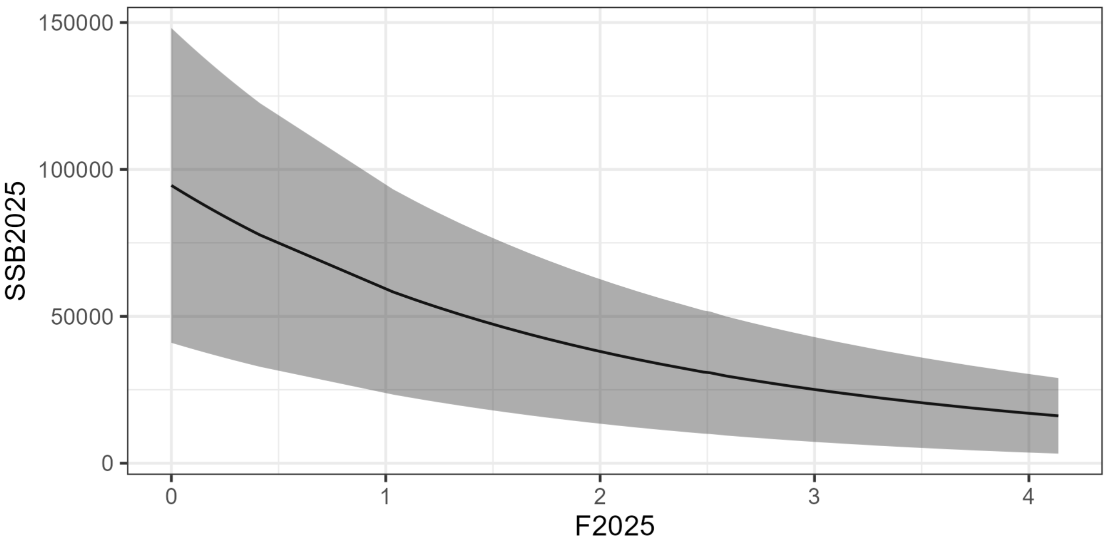


**Figure 2.6.1: Bay of Biscay anchovy: Short-term projections for SSB in terms of fishing mortality levels in 2025, the shaded grey area represents the 95% confidence interval estimated by the SS forecast model.**

## 2.6.1 Evidence for change in the advice

Due to changes in the stock assessment model and short-term forecast method, the current assumptions for the short-term forecast and the assumptions taken in the previous years are not comparable. Figure 2.6.1.1 shows the SSB estimated in 2023 with the CBBM model and the SSB estimated this year with the new SS model and Figure 2.6.1.1 shows analogously the relative recruitment estimates for each of the model. Note that the recruitment estimated by the CBBM is the recruitment at age 1 in biomass in the first semester of the following year, while the recruitment estimated by SS is the recruitment at age 0 in numbers in the second semester of the assessment year. These results are only shown as an illustration of the differences in estimates between assessment models. Overall, estimated stock status are consistent.

The advice for 2025 is lower than the advice for 2024 because the SSB projected for 2025 is below the upper trigger in the management plan due to low 2024 recruitment as shown in Figure 2.6.1.1, where the relative recruitment last year was well above the historical mean recruitment while this year the recruitment is below the historical mean.

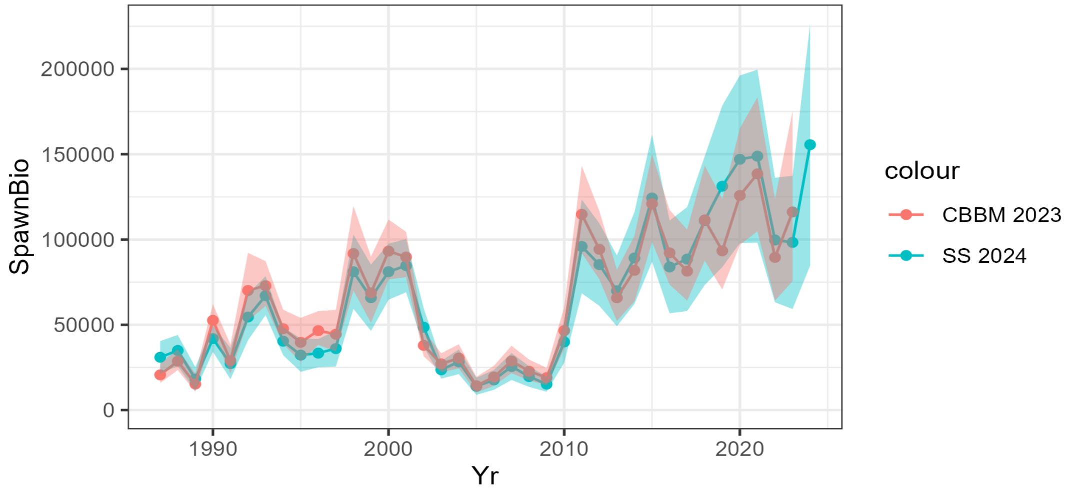


**Figure 2.6.1.1: Bay of Biscay anchovy: Estimated SSB by the CBBM model in the last WGHANSA 2023 (red) and by the final SS model in WGHANSA 2024 (blue). Points are medians for the CBBM and means for the SS model. Shaded areas represent the 90% probability interval for the CBBM and the 90% confidence interval for the SS model.**

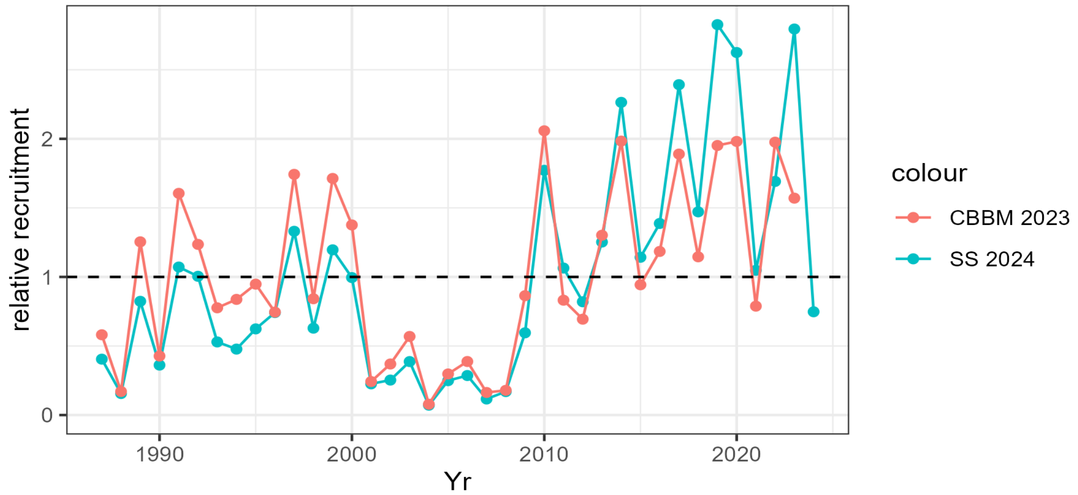


**Figure 2.6.1.2: Bay of Biscay anchovy: Estimated relative recruitment (recruitment/historical mean recruitment) by the CBBM model in the last WGHANSA 2023 (red) and by the final SS model in WGHANSA 2024 (blue).**

## 2.7 Reference points

The reference points for this stock were adopted during WKBANSP (ICES, 2024) and can be found in the stock annex of this stock.

Bay of Biscay anchovy is a short-lived species classified in category 1. According to the guide-lines, the classification of status of stock for short-lived species should be based directly on the distribution of SSB at spawning time relative to Blim. Blim is set at 26 600 tonnes and Bpa, a deterministic biomass limit below which a stock is considered to have reduced reproductive capacity, was set at 43 600 (Table 2.7.1). Alternatively, F precautionary approach (PA) reference points don't need to be defined, since ICES does not use F reference points to determine exploitation status for short-lived species.

ICES MSY approach for short-lived stocks is aimed at achieving a target escapement (MSY Bescapement, the amount of biomass left to spawn), which is more robust against low SSB and recruitment failure than a fishing mortality approach. In addition, fishing mortality is not allowed to be higher than Fcap, a limit fishing mortality that constraints the exploitation rate when biomass is high. This applies to the Bay of Biscay anchovy. Hence, defining an FMSY is irrelevant, and advice aiming at MSY is equivalent to the precautionary approach advice. ICES advice for this stock is based on a management plan and MSY Bescapement and Fcap have not been defined for this stock.

**Table 2.7.1: Bay of Biscay anchovy: Summary table of reference points.**

| Framework | Reference point | Value | Technical basis | Source |
|---|---|---|---|---|
| MSY approach | MSY $B_{escapement}$ | Not defined | | |
| | $F_{MSY}$ | Not defined | | |
| Precautionary approach | $B_{lim}$ | 26 600 t | Mean of the SSB estimates in the three years 1989, 1991 and 1996, which have the lowest SSB estimates resulting in recruitments with 95% confidence intervals including or being above the median recruitment (excluding 2009 within the closure period) | ICES WKBANSP (2024) |
| | $B_{pa}$ | 43 600 t | $B_{pa} = B_{lim} * \exp(1.645 * \sigma), \sigma = 0.3$ | ICES WKBANSP (2024) |
| | $F_{lim}$ | Not defined | | |
| | $F_{pa}$ | Not defined | | |
| Management plan | $SSB_{mgt}$ | 24000 t (lower trigger) 89000 t (upper trigger) | Precautionary HCR parameters evaluated by MSE. | STECF (2014) |
| | $F_{mgt}$ | Not defined | | |

## 2.8 Management considerations

A draft management plan was proposed by the EC in 2009 in cooperation between science (STECF) and stakeholders (Southwestern Waters AC). This plan was not formally adopted by the EU, but it was used from 2010 to 2014 for establishing the TAC for the period between 1st July and 30th June next year.

In February 2013, the Bay of Biscay anchovy stock was benchmarked in the Benchmark Workshop on Pelagic Stocks (WKPELA). The new stock annex for this stock was approved in October 2013 after further discussions held during WGHANSA 2013 and afterwards by correspondence.

Given that the 2009 long-term management plan proposal for the stock was based on the methods described in the previous stock annex (approved by WKSHORT 2009), STECF was requested to assess the harvest control rule and possible alternatives scoped with the stakeholders, and provide advice taking into account the long-term biological and economic objectives established in the plan. The STECF expert group met from 14 to 18 October 2013 and concluded that the change in the assessment methodology did not affect the usefulness of the LTMP proposal and that the HCR remained within the precautionary limits of risk.

In addition, the STECF expert group advised on a possible revision of the HCR (including changes regarding the HCR and the management calendar) and set the basis for conducting an impact assessment for the Bay of Biscay anchovy long-term management regulation (STECF, 2013).

The data analysis for support of the impact assessment for the management plan of Bay of Biscay anchovy was carried out by an STECF expert group that met from 10 to 14 March 2014 (STECF, 2014). A range of alternative HCR formulations were tested and they were considered to provide a sound base for developing options for fisheries management. In particular, for all the HCRs tested, the STECF noted that changing the management period to January–December reduced the risks of the stock falling below Blim, and leaded to a small increase in quantity and stability of catches compared with the management period July–June.

During the two expert group meetings, the STECF concluded that the HCR in the 2009 LTMP proposal remained appropriate as a basis for advising on TACs. Therefore, in July 2014, the TAC from July 2014 to June 2015 was set according to this draft plan.

In the second semester of 2014, managers and stakeholders agreed on adopting the HCR named G4 in the STECF report with a harvest rate of 0.45 (Figure 2.8.1). According to this rule, the TAC for the management period from January to December is set as:

$$TAC_{Jan_y-Dec_y} = \begin{cases} 0 & if \widehat{SSB}_y \leq 24000 \\ -3800 + 0.45\widehat{SSB}_y & if 24000 < \widehat{SSB}_y \leq 64000 \\ 25000 & if \widehat{SSB}_y > 64000 \end{cases}$$

where $\widehat{SSB}_y$ is the expected spawning–stock biomass in year $y$. In this rule, the TAC from January to December is based on the spawning biomass that will occur during the management year, which at the same time depends on the catches taken during the first semester of the management year. So, both parameters (catches and SSB) are interdependent and vary together. This leads to seek the value of fishing mortality during the first semester solving the system for the median values of incoming recruitment, biomass at-age 2+ at the beginning of the year, the growth rates at-age 1 and 2+ and the selectivity at-age 1 in the first semester. The % of annual catches taken in the first semester is assumed to be 0.6 according to STECF (2013; 2014).

Subsequently, the European Commission requested ICES to provide advice in December 2014 based on this new HCR, which was used to set a new TAC from January to December 2015. In 2015, ICES reviewed the selected harvest control rule and concluded that it was precautionary (Annex 5 in ICES, 2015a). Subsequently, ICES advice for year 2016 was again provided in accordance with this HCR. In May 2016, the SWWAC recommended to modify the management framework (SWW Opinion 101). Based on the good state of the stock, they asked to use the harvest control rule G3 with a rate of exploitation of 0.4 (Figure 2.8.1), which sets the TAC for the management period from January to December as:

$$TAC_{Jan_y-Dec_y} = \begin{cases} 0 & if \widehat{SSB}_y \leq 24000 \\ -2600 + 0.4\widehat{SSB}_y & if 24000 < \widehat{SSB}_y \leq 89000 \\ 33000 & if \widehat{SSB}_y > 89000. \end{cases}$$

This rule complies with the probability of risk of 5% as evaluated by STECF (2014) and has been assessed to conform to the ICES criteria for management plans (ICES, 2016, Annex 9). The SWWAC recommended an immediate application of this HCR and in June 2016 the European Commission increased the fishing opportunities for 2016 from 25 000 to 33 000 tonnes. The European Commission requested that this rule was used as the basis of the ICES advice from 2017 onwards.

Given that this stock has been benchmarked in September 2024 and the stock assessment model has changed, a full analysis to study the performance of the management plan conditioned on the new population dynamics and including the new stock assessment and short-term forecast in the management procedure should be conducted as soon as possible.

The methodological changes proposed during the benchmark workshop do not imply big changes in the historical perception of the stock (see the comparison of estimated SSB with the new SS model and the previous CBBM model based on the same data until 2023, Figure 2.8.2). Therefore, until a proper management strategy evaluation is conducted, the current management plan seems to be potentially applicable to set initial catch options for 2025.

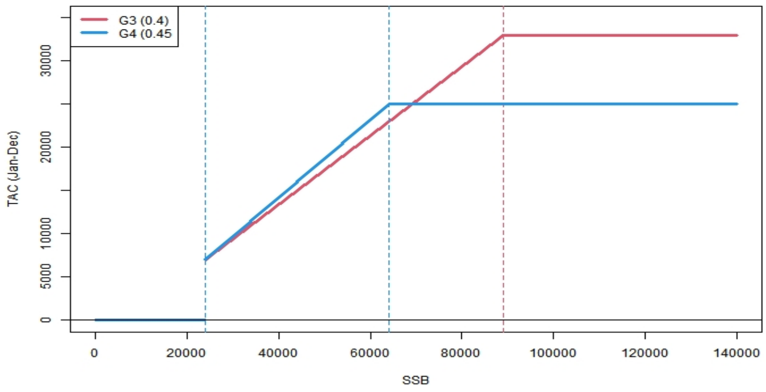


**Figure 2.8.1: Bay of Biscay anchovy: Harvest control rules G4 with harvest rate of 0.45 (in red) and G3 with harvest rate of 0.4 (in blue) according to which the TAC from January to December is set as a function of the expected spawning–stock biomass (on 15th May) in the management year.**

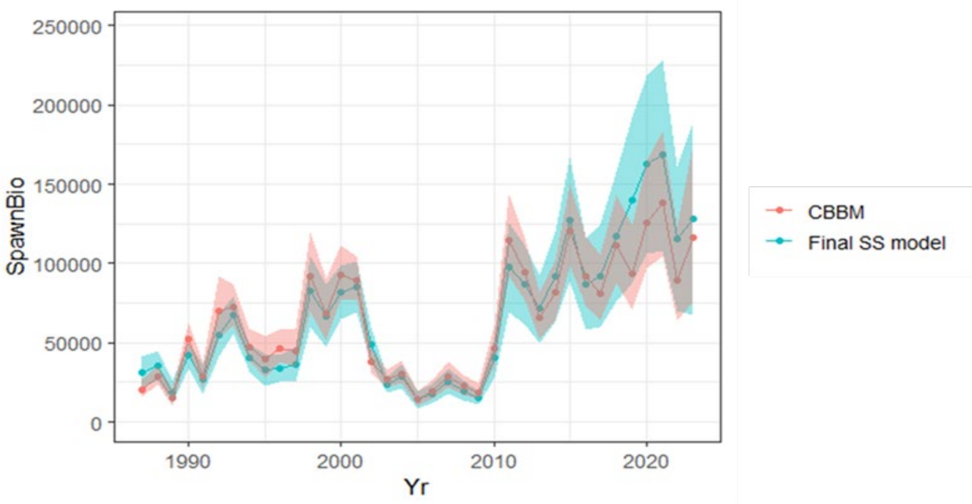


**Figure 2.8.2: Bay of Biscay anchovy: Estimated SSB by the CBBM model in the last WGHANSA 2023 (red) and by the final SS model (blue). Points are medians for the CBBM and means for the SS model. Shaded areas represent the 90% probability interval for the CBBM and the 90% confidence interval for the SS model.**

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# 3 Anchovy (*Engraulis encrasicolus)* in the western part of Division 9.a (western Iberian waters)

## 3.1 ACOM Advice Applicable to the management period July 2024–June 2025

The anchovy in Division 9a stock was benchmarked for the first time in February 2018 (WKPELA 2018 ICES, 2018). WKPELA 2018 supported the proposal of considering two different components of the stock (western and southern component), due to the different dynamics of their fisheries and populations. However, until the stock structure along the division were properly identified, the provision of advice will still be given for the whole stock, but with separate catch advice for each stock component. Given the high natural mortality experienced by this stock, its high dependence upon recruitment (the fishery depends largely on the incoming year class, the abundance of which cannot be properly estimated before it has entered the fishery), and the large inter-annual fluctuations observed in the spawning stock, ICES is aware that the state of this resource can change quickly. Therefore, an in-year monitoring and management, or alternative management measures should be considered. However, such measures should take into account the need for a reliable index of recruitment strength.

From the above reasons, the management calendar for the application of the advice was agreed to be the one from 1st July of year y to 30th June of year y+1 since 2018 onwards. After the WGHANSA-1 2024 meeting ICES advised for the period 1st July 2024 to 30th June 2025 that, when the precautionary approach is applied, catches from the western component should be no more than 8480 t and catches from the southern component should be no more than 969 t (no more than 9449 t for the whole stock). The TAC for this same management period was initially agreed in 9449 t (Portugal: 4930 t; Spain: 4519 t), but with the restriction that catches from the southern component may not exceed 969 t and the prohibition of quota swaps between the UE member states involved in the fishery.

The stock has recently been benchmarked again this year (ICES, 2024a), just before the ICES WGHANSA-2 2024 meeting. Issue list included in the benchmarked were the proposal of considering the separation of the former stock components (western and southern) in two separate stocks (based on the results from a multidisciplinary work on the stock identity), and to provide advice for the "new" southern stock as an ICES category 1 stock, based on a new integrated analysis model (Stock Synthesis), and in a management calendar based on calendar years. The new stock assessment model includes a new recruitment index not considered before.

During the WGHANSA intersessional period, a provisional TAC of 4997 t for the period 1st July to 30th September 2024 has been implemented for anchovy in Division 9a (4028 t- PT: 2102 t, ES: 1926 t - plus the 969 t allowed to be fished in the southern component) awaiting the resolutions adopted in the Benchmark assessment workshop and the resulting new advice which will be presented in the present report.

## 3.2 Population structure and stock identity

Major changes to the stock definition of anchovy in Division 9.a were made during the last benchmark process (ICES, 2024a). A summary of the evidences presented to the WKBANSP Benchmark on stock structure, the comments of the ICES SIMWG that reviewed the information and the decisions taken during the Benchmark are described in ICES (2024a). A full description of the results of the holistic approach undertaken to ascertain anchovy stock structure is found in Garrido et al. (2024) and in the Stock Annex.

Multidisciplinary work on the stock structure of anchovy off Iberian waters was carried out by members of WGHANSA, WGACEGG and others, and presented to the benchmark WKBANSP and to SIMWG (Garrido et al., 2024). The information contained data of the spatial distribution of anchovy in Division 9a (surveys and landings), showing a persistent discontinuity of the western and southern components of the stock (around 9aCS), for all the life stages (eggs, juveniles and adults) and seasons of the year covered by the surveys (spring, summer, fall). No significant correlation was found of anchovy abundance at age between the western and southern stock components, suggesting independent cohort dynamics and low or absent connectivity. Morphometric studies point to a separation of the Gulf of Cadiz anchovy population from that in western Iberia, although samples from the Algarve were absent in that study. Genetic studies conducted in the past were not conclusive as they might be confounded by the presence of a coastal and a marine ecotype. However, new genomic results taking these ecotypes into consideration show that the southern anchovy component is clearly differentiated from the western component and that the populations belong to two different genetic lineages. New larval dispersal results suggest it is unlikely that the eggs being spawned in the Gulf of Cadiz can disperse and survive to the north-western coast in any relevant numbers for all years tested (2013-2020), suggesting low to absent connectivity during the early life stages. New analyses on isotopic composition of the eye lenses of juvenile and adult anchovy collected during different years show a clear isolation of the western and southern populations.

The study of anchovy stock structure (Garrido et al. 2024) also included analysis of the potential connectivity of the western Iberian anchovy populations with the neighbouring anchovy stock in Division 8, in the Bay of Biscay. It was shown that the spatial distribution of the anchovy in the Cantabrian Sea (division 8c) varies from year to year but during some years of high abundance, there is a continuous distribution of anchovy eggs and adults between the 9a and 8c Divisions. During some years, high abundances in the westernmost tip of the Cantabrian Sea, contiguous to sub-division 9aN occur, particularly during the most recent years when anchovy peaked in western Iberia. Cohort analysis showed a significant correlation of anchovy abundance-at-age between western Iberia and the Cantabrian Sea for all ages groups (1 to 3). New results on larval dispersal modelling suggests high connectivity between the Biscay anchovy populations and the Western Iberian populations (Teles-Machado et al., 2024). Morphometric studies point to contrasting results, revealing either an intermediate population on western Iberia or similarity be-tween 9a west and the Bay of Biscay. New isotopic analysis shows an overlap of isotopic values between the juveniles and adult anchovy of western and northern Iberia which suggests either a strong connectivity of these populations or low baseline contrast between the two areas. Finally, recent genomic results show that the Bay of Biscay anchovy is genetically connected to the western populations.

WGHANSA requested SIMWG to review the information provided by Garrido et al. (2024) in preparation of the Benchmark Workshop (WKBANSP), particularly with the proposal to separate the two components within the 9.a stock. The SIMWG recognized that the analyses indicate that there is likely a population structure within the Division 9.a anchovy stock area, that aligns with the current components (western and southern) of the two assessments conducted on the 9a anchovy stock. However, there was no agreement within SIMWG (ICES, 2024b) regarding the support to separate both components. According to the report, one group believes more survey and catch data should be explored before recommending the separation, while another group support the separation of both components of the anchovy stock, mostly based on the clear signal of the genomic study showing a strong differentiation of the populations of the western and southern. SIMWG also suggested that a more comprehensive and holistic stock identification programme is introduced, addressing the issues identified in the review, including the connectivity of the anchovy western populations to anchovy in Subarea 8, followed by a specific workshop with all relevant stakeholders to review the data and to consider the implications for management.

WKBANSP agreed that further exploration was needed to ascertain the potential connectivity between western and northern anchovy populations but that should not delay the decision to separate the western and southern components of the Division 9a stock, for which there is already compelling evidence of strong population structure. Furthermore, the current management is not aligned with the current advice provided by ICES, which can risk the sustainability of the stocks, justifying the provision of management options separately. Consequently, based on the above mentioned extensive work on stock identification, WKBANSP decided to split the former anchovy stock in Division 9.a into two stocks, corresponding to the former western and southern components. In this way, the current anchovy (*Engraulis encrasicolus*) stock in the western part of Division 9.a (Western Iberian waters, ane.27.9.aW) corresponds to the former western component, comprising Sub-Divisions 9.a N, 9.a C-N, 9.a C-S, whereas the anchovy stock in the southern part of Division 9.a (Gulf of Cadiz and southern coast of Portugal, ane.27.9.aS) corresponds to the former southern component. Given that the advice on fishing opportunities was already given separately for the two components, such a change does not affect the current assessments or the provision of separate advice and catch opportunities.

## 3.3 The fishery in 2023

### 3.3.1 Fishing fleets

Anchovy harvesting throughout the Division 9.a West was carried out in 2023 by the following fleets:

- Portuguese purse-seine fleet (PS_SPF_0_0_0).
- Portuguese multipurpose fleet (although fishing with artisanal purse-seines) (MIS_MIS_0_0_0_HC).
- Portuguese trawl fleet for demersal fish species (OTB_DEF_>=55_0_0).
- Spanish purse-seine fleet (PS_SPF_0_0_0).
- Spanish trammel net directed to demersal fish (60-79 mm mesh size) (GTR_DEF_60-79_0_0).
- Spanish miscellaneous fleet (artisanal métiers accidentally fishing anchovy) (MIS_MIS_0_0_0_HC).
- Spanish trawl fleet for demersal fish species (OTB_DEF_>=55_0_0 anchovy discards).

The Spanish fleet fishing anchovy was composed in 2023 by a total of 77 vessels. From this total, 71 vessels (92%) were purse-seiners. No information on the number of Portuguese vessels fishing anchovy in 2023 was available to the working group, but it may be assumed that the fleet operating in 2023 should not be very different from the one in 2020. The Portuguese fleet targeting anchovy in 2020 was composed by a total of 113 vessels in the Subdivision 9.a Central North and 52 vessels in the Subdivision 9.a Central South (ICES, 2021).

### 3.3.2 Catches in Division 9.a West

#### 3.3.2.1 Catches in Division 9.a West

The updated historical series of anchovy catches by subdivision are shown in **Table 3.3.2.1.1** (see also **Figure 3.3.2.1.1**). **Table 3.3.2.2.2** shows the contribution of each fleet in the total annual catches by subdivision. The seasonal distribution of 2023 catches by subdivision is shown in **Table 3.3.2.1.3**.

The total catch in 2023 for this stock was estimated at 4631 t, which accounted for 31% increase with respect to the 2022 catch (3548 t) and is above the time-series average (2381 t). The fractions composing this total catch in 2023 were: 4631 t of official landings and 0.031 t of discards. Provisional official landings during the first semester in 2024 amounted to 48 t. Provisional catches during the current management period (July 2023–June 2024) amounted to 3923 t.

The distribution of these catches by subdivision is as follows:

#### *Subdivision 9a North*

In this Spanish subdivision a total of 218 t was caught in 2023, which accounted for 1353% increase in relation to the 2022 catches (15 t), 5% of the total catch estimated for the 9a West area. These catches are below the time-series average (376 t). Purse seiners were the main responsible for the fishery (98.3% of the total catch in the subdivision). The fishery was concentrated in the fourth quarter.

Provisional official landings during the first semester in 2024 amounted to 0.9 t (up to 16th May 2023). Those ones corresponding to the current management calendar amounted to 137 t.

#### *Subdivision 9a Central-North*

This subdivision concentrated the greatest part of the anchovy fishery in 2023 in the 9a west area (95%): a total catch of 4411 t was estimated (with all of these catches corresponding to official landings; no unallocated nor discarded catches were reported). These catches represented a 26% increase regarding the catches estimated the previous year (3509 t), and they are still well above the time-series average (1948 t). Purse-seiners practically harvested the whole fishery (96%), mainly during the third and fourth quarters in the year.

Provisional official landings during the first semester in 2024 amounted to 46 t (up to end of April). Official landings for the current management calendar were 3782 t.

#### *Subdivision 9a Central-South*

Anchovy catches from this subdivision were only 2 t (all of them official landings), accounting for a 91% decrease in relation to the catches in 2022 (24 t), being below the time-series average (56 t). Such catches accounted only for 0.05% of the total catch in the 9a West area. The fishery was mainly harvested by purse-seiners, mostly during the third quarter.

Provisional official landings during the first semester in 2024 (up to end of April) in this subdivision amounted to only 1 t. Official landings for the current management calendar were 3 t.

### 3.3.3 Discards

See the stock annex for previous available information on discards in the division.

General guidelines on appropriate discard sampling strategies and methodologies were established during the ICES Workshop on Discard Sampling Methodology and Raising Procedures (ICES, 2003).

Covid-19 disruption and the interruption of the IEO's on-shore and at-sea sampling programs during the first semester in 2020 because administrative and budgetary reasons prevented from estimating discards during that semester in the Spanish fisheries in subdivision 9a N. Sampling programs performed as planned in 2021.

Average discards estimates (in t) in subdivision 9a N for the available time-series (2014-2023) show that quarterly discards could be considered, for the time being, as negligible, almost null.

#### *Subdivision 9a North*

A total of only 0.03 t of discards fished by the trawl fleet have been recorded during 2023, accounting for an overall annual discard ratio for the Spanish fishery of 0.0001 (0.01%) in the subdivision 9a N.

***Subdivisions 9a Central-North and Central-south***

Regarding the Portuguese anchovy fishery of this stock, the official information provided to the WG states that there are no anchovy discards in the fishery.

## 3.3.4 Effort and landings per unit of effort

CPUE indices are not considered for this stock.

## 3.3.5 Catches by length and catches-at-age

Length–frequency distribution (LFD) of catches and catch-at-age data are only recently provided to this WG the Spanish fishery in Subdivision 9.a N and for the Portuguese subdivisions C-N and C-S because commercial landings used to be almost negligible in the past. Local increases of anchovy abundance in subdivisions 9.a N and C-N were recorded since 2014 and have led to an exploitation of the species by the fleets operating in those areas, and the respective national sampling programmes accounted for this event. A higher sampling effort has been made in the port of Matosinhos (9.a C-N) since 2017 to have monthly biological data of anchovy in that area that represents the bulk of catches of this stock.

Quarterly LFDs in 2023 have been provided for the Spanish fishery in subdivision 9.a N for all quarters but the third quarter because the low landings. Landings of that quarter were raised to the LFD in the second quarter in that year. Quarterly ALKs were based either on monthly commercial samples only (first and fourth quarters) or by combining *PELACUS* (April) survey samples and April and May commercial ones (for the second quarter ALK), and DEMERSALES (September) survey samples and September commercial ones (third quarter ALK).

LFDs from the Portuguese fishery provided to this WG are the ones from the anchovy purse-seine fishery in Subdivision 9.a Central-North, given that only 0.5% of the Portuguese catches occurred in the 9.a Central-South subdivision. Data was only available for the 3$^{rd}$ and 4$^{th}$ quarters.

Catch-at-age data in 2023 have only been provided for the Portuguese fishery from subdivision 9.a C-N for the 3$^{rd}$ and 4$^{th}$ Quarters. No age structure is available for 2023 Portuguese anchovy catches in subdivisions 9.a C-S, related to the low catches observed in those areas.

### 3.3.5.1 Length distributions

***Subdivision 9.a North***

Quarterly and annual size composition of anchovy catches for the whole fishery in the Subdivision 9.a North in 2023 are shown in **Table 3.3.5.1.1**. Size range in catches from the whole fishery varied between 12.0 and 17.5 cm size classes (a single mode at 13.5 cm size class), with the annual mean size and weight in catches being estimated at 14.0 cm and 20.2 g, respectively.

***Subdivision 9.a Central-North***

The size composition of 2023 anchovy catches from the Subdivision 9.a Central-North is shown in **Table 3.3.5.1.2**. These length–frequency distributions (LFDs) correspond to catches landed by purse-seiners throughout the year to obtain overall LFDs by quarters for purse-seiners, which account for 96% of all catches. Anchovy size composition in catches from the whole fishery in 2023 ranged between 10.5 and 19.0 cm size classes (main mode at 15.0 cm size class and a secondary mode at 17.5 cm size class), with a mean size and weight in catches being estimated at 15.3 cm and 25.6 g, respectively.

***Subdivision 9.a Central-South***

No length composition is available from the Portuguese fishery in this subdivision since the catches were very scarce.

#### 3.3.5.2 Catch numbers-at-age

***Subdivision 9.a North***

Estimates from the fishery in this subdivision in 2023 are shown in **Table 3.3.5.2.1**. These estimates are shown together with the age structure of catches in previous years with available data in **Table 3.3.5.2.2** and **Figure 3.3.5.2.1**. The estimated total catch in numbers in 2023 was of 11 million fish, composed by ages 0 (8% of the total catch in numbers), 1 (81%), 2 (10%) and 3 (0.3%) anchovies.

***Subdivision 9.a Central-North***

Estimates from the fishery in this subdivision in 2023 have been provided to the WG only for the third and fourth quarters (**Table 3.3.5.2.3**, **Figure 3.3.5.2.1**). During the second semester of the year 81% and 79% of fish were age 1 for 9aN and 9aCN, respectively. Age 2 individuals represented 15% and 20% for 9aN and 9aCN, respectively.

***Subdivision 9.a Central-South***

No estimate from this subdivision in 2023 has been provided to this WG since the catches were very scarce.

### 3.3.6 Mean length and mean weight-at-age in the catch

***Subdivision 9.a North***

The resulting estimates for the fishery in 2023 are shown in **Tables 3.3.6.1** and **3.3.6.2**. Anchovy mean length and weight in the catches were estimated at 14.0 cm and 20.2 g. The available series of estimates are shown in **Figure 3.3.6.1** and indicate that anchovies by age group from this subdivision are usually larger and heavier than those harvested in the southernmost areas. In 2023, all the age groups experienced a strong decrease in the mean length and weight in catches.

***Subdivision 9.a Central-North***

The available estimates for the fishery in 2023 are shown in **Tables 3.3.6.3** and **3.3.6.4**. A series of regular estimates is only available since 2017 in this subdivision. Anchovy mean length and weight in the catches from north-western Portugal in 2023 were estimated at 15.2 cm and 24.5 g (**Figure 3.3.6.2**).

***Subdivision 9.a Central-South***

No estimate from this subdivision is available.

## 3.4 Fishery-independent Information

**Table 3.4.1** shows the list of acoustic surveys providing direct estimates for anchovy in Division 9.a West.

### 3.4.1 Spring/summer acoustic surveys

**General**

A description of the available acoustic surveys providing estimates for anchovy in Division 9.a West is given in the stock annex. Survey's methodologies deployed by the respective national Institutes (IPMA and IEO) are also thoroughly described in Massé *et al*. (2018) and Doray *et al.* (2021).

A summary list of the available acoustic surveys providing direct estimates for anchovy in area 9.a West is given in **Table 3.4.1**.

***PELACUS* series**

***PELACUS 0424***

The Spanish *PELACUS* acoustic-trawl time-series started in 1984. Since 1998, survey strategies and methodologies, together with the Portuguese *PELAGO*, are standardized with the French one *PELGAS*. Moreover, since 2000 the three time-series are using CUFES to collect sub-surface sardine and anchovy eggs. *PELACUS* was carried out on board R/V *Thalassa* from 1997 to 2012 and since then is routinely conducted on board the Spanish R/V *Miguel Oliver*. An inter-calibration survey was done in April 2014 off Garonne mouth (*i.e.* at the spawning season and area of both sardine and anchovy). No significant changes in both fish availability (acoustic) or in fish accessibility, catchability or selectivity (trawl) were detected, and therefore similar performance for both vessels was assumed.

*PELACUS 0424* was conducted between 26$^{st}$ March and 16$^{th}$ April 2024 on board the R/V *Miguel Oliver*. The survey was conducted under rough weather conditions (storm Nelson and other storms). The bad weather is known to affect the distribution and behaviour of the fish. Sampling grid this year was based on acoustic transects separated 10 nm, between 20 and 1000 m depth, and with random start in each of the geographical strata, which correspond to the ICES subareas. Two different fishing gears were used: a HOD 352 -50 m wings was used for shallower waters (<40 m), sometimes with fences for trawling near surface, and a 63.5/51-100 m wings (>40 m), was used, sometimes with fences, for trawling in shallower waters. In total 35 pelagic fishing hauls were done. A summary of the survey can be found in Annex 6.

Total NASC suffered an important drop since last year (from 705 $*10^3$ to 437 $*10^3$ sA). NASC allocated to sardine was 85% of the total NASC while only 6 % was allocated to anchovy. Anchovy schools occurred throughout the Cantabrian Sea with higher densities in the inner part of the Bay of Biscay (subarea 8cEe) and in western Cantabrian (8cEwW). The occurrence of the species in the subdivision 9a N decreased 15% in number and 37% in biomass since last year. **Figure 3.4.1.1** shows the species contribution (% in number) in each of the valid hauls performed during the survey. A total of 0.3 t anchovies were caught in the whole surveyed area, corresponding to 205 317 specimens. Anchovy was caught in 57% of the trawl hauls and represented 15.4% of total catch number and had a mean length in the catches of 18.64 cm. **Figure 3.4.1.2** shows the distribution area and density derived from the NASC values attributed to this fish species in the surveyed area.

A total of 2015 t of anchovies, corresponding to 142 million fish were estimated in the subdivision 9.a N (**Table 3.4.1.1**). **Figure 3.4.1.3** shows the estimated abundance and biomass by length class, while in **Figure 3.4.1.4** the estimates are shown by age group. Modal size class of anchovy in sub-division 9aN was 15 cm, followed by a secondary mode at 12.5 cm. The population was structured by the Age-groups 1, 2 and 3, with the bulk of the biomass belonging to age group 1 (85% in biomass, 75% in number). **Figure 3.4.1.5** shows the time series (1996-2024) of anchovy biomass estimates from *PELACUS* in area 9.a N.

***PELAGO series***

***PELAGO 24***

The *PELAGO 24* survey was conducted from 1st to 24th March on board R/V *Miguel Oliver*. Seventy-one (71) transects were acoustically sampled between Caminha and Cape Trafalgar (30-200 m depth). A total of 26 pelagic trawl hauls were carried out by the research vessel; 29 additional hauls were done by 1 purse-seiner (see Annex 6 for more information about the survey 2024). The distribution and species composition of all of these hauls are shown in **Figure 3.4.1.6**. The mapping of acoustic energy off the Iberian western coast, anchovy was distributed throughout the 9.a CN and the northern part of 9.a CS around Lisbon, similarly to the previous year (**Figure 3.4.1.7)**.

The post processing scrutiny and integration was done by IEO and IPMA during a workshop in Vigo. The assessment of anchovy from PELAGO24 was delivered to WGHANSA in May as an input in the stock assessment models of the West and South components of the stock (Annex 7). The data processing for the others pelagic species proceeded before the WGACEGG meeting in November, after the anchovy advice was given. This analysis revealed a possible general underestimation in May of the NASC from the schools detection in ECHOVIEW. This underestimation was mainly due to the misuse of a virtual echogram with a too high threshold (-60 dB) that left part of the schools out of the scrutiny process. Also, the correction to use of an appropriate threshold led to an update of the scrutiny processes, which, in turn, revealed the need to perform small changes in the NASC allocation criteria to fish species using the fishing stations undertook in the surveyed area to those schools and aggregations recorded with the new threshold fixed at -70dB.

Facing this, the echogram analysis of the PELAGO24 was deeply revised, producing new integration files for the whole survey. A new assessment for anchovy was produced with the revised data yielding a significant increase in abundance and biomass estimations. All other species were also assessed using the revised NASC. In what follows, results after such correction are described.

In 9.a Central-North a total of 7190 million fish and 81890 t were estimated, which represents the second highest number and biomass of fish in this sub-division (138% and 20% increase in abundance and biomass in relation to the 2023 estimates, respectively; **Table 3.4.1.2**, **Figure 3.4.1.8**). The estimated population in this subdivision ranged between 9 and 18.5 cm size classes, with a mode at 11.5 cm size class (**Figure 3.4.1.9**). Age 1 fish accounted for 95% (6790 million) and 87% (71042 t) of the total estimated abundance and biomass in this subdivision, respectively (**Figure 3.4.1.10**). Age 2 fish represented 5.3% and 0.25% of the total abundance and biomass, while Age 3 fish accounted for <1% of the total abundance and biomass (**Figure 3.4.1.10**).

Anchovy population in 9a Central-South had 544 million fish and 6107 t, entailing 523% and 1568% increase of abundance and biomass in relation to the 2023 estimates and was the highest of the subdivision (**Table 3.4.1.2**, **Figure 3.4.1.8**). The population showed a size range between 10 and 16.5 size classes, with a 11.0 cm modal size class and a secondary one at 12.5 cm (**Figures 3.4.1.9**). Age 1 fish accounted for 96% (523 million) and 96% (5887 t) of the total estimated abundance and biomass in this subdivision, respectively (**Figure 3.4.1.10**). Age 2 fish represented 3% and 3% of the total abundance and biomass, while Age 3 fish was absent (**Figure 3.4.1.10**).

**Table 3.4.1.2** and **Figure 3.4.1.8** track the historical series of anchovy acoustic estimates from *PELAGO* surveys in the Division 9.a West. Anchovy experienced a huge outburst in 9.a Central-North in 2018, after the decreased biomass recorded in 2017, and reaching population levels even higher than the previous historical peaks recorded in the 2011 and 2016 outbursts. After a strong drop in 2019 the population has experienced consecutive increases in abundance and biomass, particularly in 2022 which was at the time the maximum numbers recorded in the region, decreasing in 2023 and increasing again in 2024 to the historical maximum. Anchovy in 9.a Central-South had low abundances in the past and had 3 order of magnitude increased in number and biomass.

**Figure 3.4.1.10** shows the age structure of the population estimates in the PELAGO survey series in subdivisions 9.a Central-North and 9.a Central-South. Age 1 anchovies constitute the bulk of the population in spring 2024 (94.6%), followed by age 2 (5.4%) and 3 (0.2%). Strong incoming recruitments seem to be inferred in in the period 2019-2022, in most noticeable in 2020 and 2024.

***Combined PELACUS 24 and PELAGO 24 – Anchovy 9a West***

Figure 3.4.2.12 tracks the historical series of anchovy acoustic estimates from PELACUS + PELAGO surveys in the Division 9.a West. Anchovy experienced a huge outburst in 9.a West in 2018, after the decreased biomass recorded in 2017, and reaching population levels even higher than the previous historical peaks recorded in the 2011 and 2016 outbursts. After a strong drop in 2019 the population has experienced consecutive increases in abundance and biomass which culminate in the historical maximum recorded in 2022, decreasing in 2023 and increasing again in 2024. The population of anchovy in Division 9a West showed a size range between 9.5 and 18.5 size classes, with a 11.5 cm modal size class (**Figures 3.4.1.11**). The age structure of the anchovy 9a West population estimates (**Figure 3.4.1.13**) shows that Age 1 anchovies constitute the bulk of the population in spring 2024 (87.2%), followed by age 1 (12.2%) and 3 (0.6%). Strong incoming recruitments seem to be inferred in in the period 2019-2022, and most noticeable in 2020 and 2024.

### 3.4.2 Recruitment surveys

***SAR*, *JUVESAR* and *IBERAS* autumn survey series**

The last survey in the *SAR* series (aimed to cover the sardine early spawning and recruitment season in the Division 9.a, but also covering the anchovy recruitment season) which provided anchovy estimates was carried out in 2007 (see **Table 3.4.2.1**). **Table 4.4.2.1** shows the historical series of anchovy acoustic estimates derived from this survey series in the Division 9.a available so far. The *JUVESAR* autumn survey series, an acoustic survey restricted to the Subdivision 9.a Central-North, the main recruitment area of sardine in Portuguese waters, started in 2013. The scarce presence and abundance of anchovy in the 2013 and 2014 surveys prevented the provision of acoustic estimates for the species. The last survey in this series was conducted in 2017 (*JUVESAR 17*), because in 2018 the *JUVESAR* acoustic sampling area was incorporated into the new *IBERAS* survey series, described below. Point estimates of anchovy abundance of the *JUVESAR*/*IBERAS* series are at present scarce but the trend is so far not consistent with spring survey series.

*IBERAS* is a new acoustic-trawl time-series aiming to get a synoptic coverage of the Atlantic waters of the Iberian Peninsula and the Bay of Biscay targeting on Young of the Year (YoY) of sardine and anchovy. Since 2017, both the Bay of Biscay (*JUVENA*) and the Gulf of Cadiz (*ECOCADIZ-RECLUTAS*) were routinely prospected by R/V *Ramón Margalef* and the Northwest coast of Portugal (*JUVESAR*) by R/V *Noruega* since 2013. The idea is to fill the gap between both *JUVENA* and *ECOCADIZ-RECLUTAS* surveys and incorporate the *JUVESAR* series, following the same radials in Subdivision 9.a Central-North. This new time-series is being conducted either in the vessel R/V *Ángeles Alvariño* or in R/V *Ramón Margalef*, twin of the former. Both vessels have similar shape, with slight changes in the main engine but using the same equipment (acoustic and trawling devices). Together with this synoptic coverage, using similar vessel equipment will limit both the vessel and trawling effects on the overall precision and accuracy of the estimates. In 2018, due to the lack of available vessel time in September, the survey was delayed until November, but in 2019 the survey was planned in September, at the same time of *JUVENA* and previous to *ECOCADIZ-RECLUTAS* one (see **Table 3.4.2.2**).

The rationale of this new time-series is to track and assess early juveniles for predicting the strength of the recruitment previously to the incoming fishing season (e.g. next year) as this will heavily depend on the incoming year class. This strategy is of special interest to manage the fisheries for short-lived species because of the short time between spawning and the exploitation of subsequent emerging recruits.

***IBERAS 0923***

The *IBERAS 0923* survey was carried out on board R/V *Ramón Margalef* from 12th to 25th September 2023. The survey covered the areas 9aN, 9aCN and 9aCs (*i.e.* western coast of the Iberian Peninsula) on a survey design consisting in parallel transects 6 nmi apart, with a random start, and covering from 20-15 m depth up to 100 m. This zone coincides with the main potential distribution area for sardine recruitment of the Ibero-Atlantic stock. Moreover, in the main recruitment area (*i.e.* middle part of 9aCN, observed historically) sampling intensity has been increased up to 4 nmi among transects to increment the sampling resolution (**Figure 3.4.2.1**). The vessel's acoustic equipment consisted of a *Simrad™ EK-80* scientific echosounder, operating at 18, 38, 70, 120 and 200 kHz, working in CW mode. All frequencies were calibrated according to the standard procedures (Demer *et al.*, 2015) at the start of the survey. The backscattering acoustic energy from marine organisms was measured continuously during daylight.

A total of 25 pelagic hauls and 12 purse-seine shots were done as shown in **Figure 3.4.2.1**. In 2023, anchovy assessment was divided between adult anchovy (length>12.0cm) and juvenile anchovy (length≤12.0cm). Anchovy occurred in 41% of the hauls, with adult anchovy accounting for 5% total NASC and juvenile anchovy accounting for 20% total NASC.

Anchovy was found in rather dense epi-pelagic schools, mainly outside the coastal area, and sometimes mixed with krill. Adult anchovy was found exclusively in 9aCN area, between 25 and 100 m, although some schools were found a little bit deeper (**Figure 3.4.2.2**).

Juveniles were mainly concentrated in the North, especially in the Rias Baixas, whereas adults were found in the northern part of the 9aCN, near Aveiro. The estimated biomass for adult anchovy increased significantly in 2023 when compared to the previous years, being 56 414 tonnes and 1696 million of fish, which is the historical maximum. Juvenile anchovy was majorly present in the North, in the Spanish side (9aN), with 16 090 million fish and 65 270 tonnes, representing 93% of the total number of fish (**Table 3.4.2.2**; **Figures 3.4.2.3** and 3.**4.2.4**).

# 3.5 Biological data

## 3.5.1 Weight-at-age in the stock

Weight-at-age in the stock estimated from the combined *PELACUS* and *PELAGO* surveys are shown in **Table 3.5.1.1**

## 3.5.2 Maturity-at-Age

Maturity stage assignment criteria were agreed between national institutes involved in the biological study of the species during the Workshop on Small Pelagics (*Sardina pilchardus*, *Engraulis encrasicolus*) maturity stages (WKSPMAT; ICES, 2008). See the stock annex for comments on computation of the maturity ogives.

The macroscopic maturity scale used by IPMA has been validated with histology (microscopic identification of macroscopic maturity stages). Results show that only histology allows the correct identification of mature and immature individuals macroscopically identified as stage 1 (Immature or Resting); therefore, the maturity ogive of this species must be obtained during the spawning season with histology.

### 3.5.3 Natural mortality

Natural mortality, M, is unknown for this stock. It has been suggested in WKPELA 2018 to follow the M pattern at-age used for the anchovy in the Bay of Biscay, which is 1.2 for age 0, 0.8 for age 1 and 1.2 for older ages, for further modelling exercises. Recent work on growth estimates (Wise *et al*., 2022) estimated other values for the natural mortality (M0= 1.285; M1= 1.028; M2= 0.827; M3= 0.703; M4= 0.724).

## 3.6 Stock Assessment

The stock assessment procedure is described in the stock annex. The stock is assessed following the ICES framework for category 3 stocks.

A stock-specific management strategy evaluation (MSE) process was conducted in 2023 to update the assessment method (see Wise *et al.,* WD 2023a,b). A constant harvest rate rule (*chr*, Method 3.2, ICES, 2022) was determined. The *chr* rule was tested alongside the *1over2* with 80% uncertainty cap rule.

The *chr* rule is based on the stock biomass indicator of the current year, $I_{current}$, multiplied by a sustainable harvest rate, $HR_{MSYproxy}$, as follows:

$$C_y = HR_{MSYproxy} * I_{current}$$

where $C_y$ and $I_{current}$, represent the catch advice for July to June of the following year, and the stock biomass indicator of the current ($y$) year, respectively. The stock biomass indicator input has been taken from the results of the acoustic spring surveys covering this area (by adding *PELAGO* and *PELACUS* estimates for areas 9a N, 9a C-N and 9a C-S). The *chr* rule was found to be more precautionary than the current *1over2* rule. The *chr* rule of 25% ($HR_{MSYproxy}$ =0.25) was the maximum value estimated for the stock.

The basis of this procedure was approved by WGHANSA-1 2023 and the methodology followed for its approval is described in Wise *et al.* (WD 2023a,b).

#### 3.6.1.1 Biomass survey trend as base of the advice

The anchovy biomass indicator for the 9a West anchovy is computed as the sum of *PELACUS* (9a N) and *PELAGO* (9a C-N and 9a C-S) acoustic estimates of biomass.

During the WGHANSA-1 2023 meeting (ICES, 2023), after the Workshop on the Management Strategy Evaluation of constant harvest rates strategies for anchovy in Division 9a (WKANEMSE) on May 5th 2023 (see annex 6 in ICES, 2023), it was agreed to switch from the current *1over2* advice rule to a Constant Harvest Rate, *chr*, advice rule, with a $HR_{MSYproxy}$ = 0.25. The catch advice, $C_y$, is defined as follows:

$$C_y = 0.25\ I_{current}$$

where $C_y$ and $I_{current}$, represent the catch advice for July to June of the following year and the stock biomass indicator of the current ($y$) year, respectively.

The adopted Constant Harvest Rate (*chr*) advice rule with HR=0.25 was shown to outperform the former *1over2* advice rule when uncertainty was included in the operating models, reducing the risk of falling below $B_{lim}$ in the short and medium terms, with higher relative yields in the medium and long term. The *chr* advice rule was tested under different operating models with uncertainty. Reference points are consistent with the dynamics of the different operating models. Values for $B_{lim}$ were adopted according to the re-estimation of the reference points. For the base case productivity (h = 0.75) a $B_{lim}$ = 16 279 t was assumed.

Although under the base case scenario, a harvest rate of 0.4 was considered to be precautionary by ICES standards in the medium and long terms, it was acknowledged that the *chr* advice rule is highly sensitive to the assumed value of catchability of the survey index (QIDX = 1.5). Therefore, to account for possible shifts in productivity, a harvest rate HR = 0.25 was adopted as the basis of advice for the *chr* advice rule to be applied to the Anchovy 9a West.

## 3.7 Reference points

A reference point for fishing pressure on the stock was defined as $HR_{MSYproxy}$ = 0.25. No reference points for stock size have been defined for this stock.

## 3.8 State of the Stock

The stock size indicator (a combined index from *PELAGO* and *PELACUS* estimates for the 9.a N, 9.a CN and 9.a CS) was obtained this year. Anchovy biomass estimated for the 9.a N area was 2015 t and the biomass estimated during the PELAGO survey for the 9.a CN and CS sub-divisions was 87 909 t. The combined index was 89 924 t, which represents an increase of 22% with respect to the combined index of the previous year. As a result, the catch advice for the anchovy 9a West for the period from 1 July 2024 to 30 June 2025 is 22 481 t, representing an increase of 22% in relation to the advice of the previous management year.

The stock size indicator is the second highest of the time series. The harvest rate of the previous management year was 0.06 (Fig. 3.8.1).

## 3.9 Catch advice

The ICES framework for category 3 stocks was applied (Method 2.2: Constant harvest rate, *chr*, rule; ICES, 2022). The combination of anchovy biomass estimated in the *PELACUS* and *PELAGO* acoustic surveys is used as the index of stock development. The advice is based on the product of the last index value (89 924 t) and the MSY proxy harvest rate (0.25).

## 3.10 Short-term projections

No short-term projections are presented for this stock.

## 3.11 Quality of the assessment

A MSE has been developed in 2023, resulting in a new assessment method that provides advice based on the application of constant harvest rate over the stock size indicator, as detailed in Wise *et al.* (WD 2023).

This stock is assessed based on survey trends. The acoustic spring surveys that cover the distribution area of the stock (*PELAGO* and *PELACUS*) were normally carried out and it was possible to have estimates for this year.

The PELAGO24 echogram analysis was revised after the provision of advice in May 2024, resulting in a 169% increase in the biomass index for 2024 (see explanation above and May assessment as Annex 7). The catch advice has been revised accordingly.

## 3.12 Management considerations

ICES has agreed with the clients that the catch advice will be framed in a management calendar set from 1st July (*y*) to the following 30th June (*y+1*), instead of calendar years.

Other management considerations and the current management situation are described in the stock annex.

## 3.13 Ecosystem considerations

Ecosystem considerations are described in the stock annex and there have not been remarkable changes in the last year.

## 3.14 Deviations from stock annex caused by missing information

For this year assessment there were no deviations from the stock annex. There were deviations in 2020 related to missing survey data associated to *PELACUS* survey, details which were provided at ICES (2020; WGHANSA 2020 report).

1. Missing or deteriorated survey data: Surveys took place as planned, although the weather conditions were particularly rough during the PELACUS survey.
2. Missing or deteriorated catch data: NO.
3. Missing or deteriorated biological data: Missing length frequency distribution (LFD) for Spanish commercial catches in the third quarter (Q3) in 2023 in 9a N. Missing LFD and ALK in Q1 and Q2 in 2022 for the Portuguese fishery in 9a CN. No data from the Portuguese fishery in 9a CS in 2023, but catches were very scarce in that subdivision.
   Brief description of methods explored to remedy the challenge: Q2 LFD for the Spanish commercial catches in 9a N was propagated to the Q3 catches. Quarterly ALKs for Spanish commercial catches in 9a N were based either on commercial samples only (Q1 and Q4) or in a combination of samples from commercial and research *PELACUS 0423* (Q2) and DEMERSALES 2023 (Q3) samples. Methods to remedy gaps of biological information in the Portuguese fishery have not been explored because the very low catches recorded in those quarters without biological data.
4. Suggested solution to the challenge, including reason for this selecting this solution: Q2 LFD for the Spanish commercial catches in 9a N was propagated to the Q3 catches from that subdivision. Quarterly ALKs for Spanish commercial catches in 9a N were based either on commercial samples only (Q1 and Q4) or in a combination of samples from commercial and research *PELACUS 0423* (Q2) and DEMERSALES 2023 (Q3) samples. Methods to remedy gaps of biological information in the Portuguese fishery have not been explored because the very low catches recorded in those quarters without biological data.
5. Was there an evaluation of the loss of certainty caused by the solution that was carried out? No.

## 3.15 Stock specific Management Strategy Evaluation

During WGHANSA meeting on May 2022, the working group agreed on proposing to conduct a dedicated workshop in 2023 to evaluate by Management Strategy Evaluation the performance of a constant harvest rate advice rule that could be used as an alternative to the current applied *1over2* advice rule.

The proposed draft Terms of Reference for such workshop were:

> The Workshop on the Management Strategy Evaluation of constant harvest rates strategies for anchovy in Division 9a (WKANEMSE), will meet to:
>
> a) develop a Management Strategy Evaluation framework to test alternative advice rules for anchovy in Division 9a (Iberian Atlantic waters);
> b) identify constant harvest rate rules that could be appropriate to provide advice for this stock and compare them with respect to the current basis for advice (*1over2* rule with 80% uncertainty cap and biomass safeguard)

On the 5th of May 2023, the results and conclusions of a first group of simulations conducted with FLBEIA MSE framework were presented by members of WGHANSA to the ICES designated external reviewers.

During the WGHANSA meeting from May 29th to June 2nd 2023 it was agreed to support the proposal, for the 27.9.a West anchovy, of a switch from the current *1over2* advice rule to a *chr* advice rule with a $HR_{MSYproxy}$=0.25.

## 3.16 References


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## 3.17 Tables

**Table 3.3.2.1.1. Anchovy in Division 9.a West. Recent historical series of annual catches (t) by subdivision, stock component and total division since 1989 on (the period with available data for all the subdivisions). (-) not available data; (0) less than 1 tonne (from Pestana, 1989, 1996 and WGMHSA, WGANC, WGANSA and WGHANSA members). The rest of the historical series of catches is shown in the stock annex. Discards are considered negligible in both the Portuguese (9.a C-N and 9.a C-S (PT)) and Spanish (9.a N (ES)) fisheries. Notwithstanding the above, the estimates for the Spanish fishery include estimates of discarded (and unallocated) catches since 2014 on. Discards estimates for the Spanish fishery are not available for the first semester 2020 because Covid-19 disruption and interruption of the IEO's observers at-sea sampling program. (*) Provisional official landings data for the 2024 first semester updated until 30th April (9a.CN, 9a.CS) –16th May (9a.N).**

| Year | 9.a N | 9.a C-N | 9.a C-S | Total 9a West |
|---|---|---|---|---|
| 1989 | 118 | 646 | 141 | 905 |
| 1990 | 220 | 431 | 4 | 655 |
| 1991 | 15 | 187 | 3 | 205 |
| 1992 | 33 | 136 | 1 | 170 |
| 1993 | 1 | 22 | 1 | 24 |
| 1994 | 117 | 236 | 8 | 361 |
| 1995 | 5329 | 2521 | 9 | 7859 |
| 1996 | 44 | 2711 | 13 | 2768 |
| 1997 | 63 | 610 | 8 | 682 |
| 1998 | 371 | 894 | 153 | 1419 |
| 1999 | 413 | 957 | 96 | 1466 |
| 2000 | 10 | 71 | 61 | 142 |
| 2001 | 27 | 397 | 19 | 444 |
| 2002 | 21 | 433 | 90 | 543 |
| 2003 | 23 | 211 | 67 | 301 |
| 2004 | 4 | 83 | 139 | 226 |
| 2005 | 4 | 82 | 6 | 92 |
| 2006 | 15 | 79 | 15 | 110 |
| 2007 | 4 | 833 | 7 | 844 |
| 2008 | 5 | 211 | 87 | 303 |
| 2009 | 19 | 35 | 5 | 59 |
| 2010 | 179 | 100 | 2 | 281 |
| 2011 | 541 | 3239 | 1 | 3782 |
| 2012 | 39 | 521 | 220 | 779 |

| Year | 9.a N | 9.a C-N | 9.a C-S | Total 9a West |
|---|---|---|---|---|
| 2013 | 69 | 192 | 131 | 392 |
| 2014 | 581 | 678 | 21 | 1281 |
| 2015 | 173 | 2533 | 10 | 2717 |
| 2016 | 222 | 6908 | 10 | 7140 |
| 2017 | 1069 | 8854 | 170 | 10094 |
| 2018 | 992 | 7871 | 370 | 9233 |
| 2019 | 991 | 5205 | 4 | 6200 |
| 2020 | 309 | 5327 | 2 | 5639 |
| 2021 | 747 | 9521 | 8 | 10276 |
| 2022 | 15 | 3509 | 24 | 3548 |
| 2023 | 218 | 4411 | 2 | 4631 |
| 2024* | 0.9 | 46 | 1 | 48 |

**Table 3.3.2.1.2. Anchovy in Division 9.a West. Catches (t) by gear and subdivision in 1989–2023. Discards are considered negligible in both the Portuguese (9.a C-N and 9.a C-S (PT)) and Spanish (9.a N (ES)) fisheries. Notwithstanding the above, the estimates for the Spanish fishery include estimates of discarded catches by gear since 2014 on. Discards estimates for the Spanish fishery are not available for the first semester 2020 because Covid-19 disruption and interruption of the IEO's observers at-sea sampling program. Portuguese landings by gear are not available by subdivision until 2009, and are therefore combined for subdivisions 9.a C-N, C-S and also 9a S (PT) during that period.**

| Subarea | Gear | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995* | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.a N | Artisanal | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Purse-seine | 118 | 220 | 15 | 33 | 1 | 117 | 5329 | 44 | 63 | 371 | 413 | 10 |
| 9.a C-N to 9.a S (PT) | Demersal Trawl | - | - | - | 4 | 9 | 1 | - | 56 | 46 | 37 | 43 | 6 |
| | P. seine polyvalent | - | - | - | 1 | 1 | 3 | - | 94 | 7 | 35 | 20 | 7 |
| | Purse-seine | - | - | - | 270 | 14 | 233 | - | 2621 | 579 | 1541 | 1346 | 297 |
| | Not different. By gear | 496 | 541 | 210 | - | - | - | 7056 | - | - | - | - | - |

| Subarea | Gear | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|
| 9.a N | Artisanal | 0 | 0 | 4 | 1 | 0 | 0 | 0 | 1 | 0.1 |
| | Purse-seine | 27 | 21 | 19 | 2 | 4 | 15 | 4 | 4 | 18 |
| 9.a C-N to 9.a S (PT) | Demersal Trawl | 16 | 13 | 7 | 5 | 7 | 27 | 14 | 9 | 4 |
| | P. seine polyvalent | 32 | 13 | 184 | 197 | 57 | 24 | 376 | 141 | 38 |
| | Purse-seine | 806 | 888 | 287 | 455 | 62 | 57 | 484 | 185 | 30 |
| | Not different. By gear | - | - | - | - | - | - | - | - | - |

| **Subarea** | **Gear** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.a N | Demersal trawl | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 7 | 0.6 | 0.6 | 0 | 0 | 0 | 0.03 |
| | Artisanal | 4 | 0 | 1 | 6 | 0 | 21 | 6 | 6 | 0.4 | 0.1 | 0.1 | 0.1 | 0.01 | 4 |
| | Purse-seine | 175 | 541 | 37 | 63 | 581 | 152 | 217 | 1057 | 991 | 990 | 309 | 747 | 15 | 215 |
| 9.a C-N | Demersal Trawl | 5 | 4 | 1 | 0.5 | 2 | 3 | 2 | 2 | 0,3 | 0.2 | 2 | 2 | 5 | 48 |
| | P. seine polyvalent | 45 | 1116 | 177 | 17 | 9 | 150 | 294 | 332 | 403 | 34 | 122 | 400 | 126 | 113 |
| | Purse-seine | 50 | 2119 | 342 | 175 | 668 | 2381 | 6613 | 8521 | 7468 | 5170 | 5203 | 9119 | 3379 | 4250 |
| 9.a C-S | Demersal Trawl | 1 | 1 | 0.4 | 1 | 3 | 2 | 1 | 0.2 | 1 | 0.02 | 0.02 | 0.01 | 0 | 0.3 |
| | P. seine polyvalent | 0 | 0.1 | 17 | 4 | 1 | 0.4 | 4 | 13 | 14 | 1 | 2 | 2 | 0.1 | 0.002 |

| Subarea | Gear | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Purse-seine | 1 | 0.4 | 202 | 127 | 18 | 8 | 5 | 157 | 355 | 4 | 0 | 5 | 24 | 2 |

**Table 3.3.2.1.3. Anchovy in Division 9.a West. Quarterly anchovy catches (t) by subdivision in 2023.**

| SUBDIVISION/ COMPONENT | QUARTER 1 | | QUARTER 2 | | QUARTER 3 | | QUARTER 4 | | ANNUAL (2023) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | C(t) | % | C(t) | % | C(t) | % | C(t) | % | C (t) | % |
| 9.a North | 64 | 29,5 | 18 | 8,0 | 10 | 4,4 | 127 | 58,1 | 218 | 1,8 |
| 9.a Central North | 669 | 15,2 | 5,6 | 0,13 | 2655 | 60,2 | 1081 | 24,5 | 4411 | 36,4 |
| 9.a Central South | 0 | 13,4 | 0,0 | 1,4 | 2 | 85,2 | 0 | 0,0 | 2 | 0,0 |
| TOTAL | 734 | 15,8 | 23 | 0,50 | 2667 | 57,6 | 1208 | 26,1 | 4631 | 38,3 |

**Table 3.3.5.1.1. Anchovy in Division 9.a. West. Subdivision 9.a North. Spanish fishery (all fleets). Seasonal and annual length distributions ('000) of anchovy catches in 2023. Discards were sampled but they were null, hence landings equals to catches.**

| 2023 | Q1 | Q2 | Q3 | Q4 | TOTAL |
|---|---|---|---|---|---|
| Length (cm) | 9.a N | 9.a N | 9.a N | 9.a N | 9.a N |
| 6 | 0 | 0 | 0 | 0 | 0 |
| 6.5 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 |
| 7.5 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 |
| 8.5 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 |
| 9.5 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 |
| 10.5 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 0 | 0 | 0 | 0 |
| 11.5 | 0 | 0 | 0 | 0 | 0 |
| 12 | 0 | 0 | 0 | 235 | 235 |
| 12.5 | 10 | 0 | 0 | 860 | 870 |
| 13 | 162 | 0 | 0 | 1876 | 2038 |
| 13.5 | 516 | 45 | 25 | 2189 | 2774 |
| 14 | 702 | 248 | 136 | 938 | 2024 |
| 14.5 | 484 | 327 | 179 | 469 | 1459 |
| 15 | 345 | 124 | 68 | 156 | 693 |
| 15.5 | 236 | 34 | 19 | 0 | 289 |
| 16 | 172 | 0 | 0 | 0 | 172 |
| 16.5 | 78 | 0 | 0 | 0 | 78 |
| 17 | 15 | 0 | 0 | 0 | 15 |
| 17.5 | 10 | 0 | 0 | 0 | 10 |
| 18 | 0 | 0 | 0 | 0 | 0 |
| 18.5 | 0 | 0 | 0 | 0 | 0 |
| 19 | 0 | 0 | 0 | 0 | 0 |

| 2023 | Q1 | Q2 | Q3 | Q4 | TOTAL |
|---|---|---|---|---|---|
| Length (cm) | 9.a N | 9.a N | 9.a N | 9.a N | 9.a N |
| 19.5 | 0 | 0 | 0 | 0 | 0 |
| 20 | 0 | 0 | 0 | 0 | 0 |
| 20.5 | 0 | 0 | 0 | 0 | 0 |
| 21 | 0 | 0 | 0 | 0 | 0 |
| 21.5 | 0 | 0 | 0 | 0 | 0 |
| Total N | 2730 | 779 | 426 | 6723 | 10657 |
| Catch (T) | 64 | 18 | 10 | 127 | 218 |
| L avg (cm) | 14.7 | 14.7 | 14.7 | 13.6 | 14.0 |
| W avg (g) | 22.6 | 22.4 | 22,9 | 18.7 | 20.2 |

**Table 3.3.5.1.2. Anchovy in Division 9.a. West. Subdivision 9.a Central North. Portuguese fishery (purse-seine fleet). Seasonal and annual length distributions ('000) of anchovy catches in 2023. Discards are null, hence landings correspond to catches. Length frequency distributions were not available for other métiers. Only data for the 3rd and 4th Quarter LFDs from the métier PS_SPF_0_0_0 are available.**

| 2023 | Q1 | Q2 | Q3 | Q4 | TOTAL |
|---|---|---|---|---|---|
| Length (cm) | 9.a CN | 9.a CN | 9.a CN | 9.a CN | 9.a CN |
| 6 | | | | | |
| 6.5 | | | | | |
| 7 | | | | | |
| 7.5 | | | | | |
| 8 | | | | | |
| 8.5 | | | | | |
| 9 | | | | | |
| 9.5 | | | | | |
| 10 | | | | | |
| 10.5 | | | | 50 | |
| 11 | | | | 302 | |
| 11.5 | | | | 201 | |
| 12 | | | | 352 | |
| 12.5 | | | | 101 | |

| **2023** | **Q1** | **Q2** | **Q3** | **Q4** | **TOTAL** |
|---|---|---|---|---|---|
| Length (cm) | 9.a CN | 9.a CN | 9.a CN | 9.a CN | 9.a CN |
| 13 | | | | 221 | |
| 13.5 | | | 1106 | 563 | |
| 14 | | | 4184 | 392 | |
| 14.5 | | | 14325 | 3171 | |
| 15 | | | 18404 | 3271 | |
| 15.5 | | | 14370 | 6029 | |
| 16 | | | 12029 | 7510 | |
| 16.5 | | | 6532 | 6412 | |
| 17 | | | 5914 | 2365 | |
| 17.5 | | | 6219 | 3876 | |
| 18 | | | 4574 | 171 | |
| 18.5 | | | 1217 | 926 | |
| 19 | | | 292 | | |
| 19.5 | | | | | |
| 20 | | | | | |
| 20.5 | | | | | |
| 21 | | | | | |
| 21.5 | | | | | |
| Total N | | | | | |
| Catch (T) | | | | | |
| L avg (cm) | | | | | |
| W avg (g) | | | | | |

**Table 3.3.5.2.1. Anchovy in Division 9.a. West. Subdivision 9.a North. Spanish catches (all fleets) in numbers-('000) at-age of Galician anchovy in 2023 on a quarterly (Q), half-year (HY) and annual basis.**

| 2023 | AGE | Q1 | Q2 | Q3 | Q4 | HY1 | HY2 | ANNUAL |
|---|---|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 0 | 866 | 0 | 866 | 866 |
| | 1 | 1972 | 521 | 321 | 5857 | 2492 | 6178 | 8670 |
| | 2 | 734 | 250 | 104 | 0 | 983 | 104 | 1087 |
| | 3 | 25 | 9 | 0 | 0 | 33 | 0 | 33 |
| | Total (n) | 2730 | 779 | 426 | 6723 | 3508 | 7149 | 10657 |
| | Catch (t) | 64 | 18 | 10 | 127 | 82 | 136 | 218 |
| | SOP | 62 | 17 | 10 | 126 | 79 | 136 | 215 |
| | VAR.% | 104 | 100 | 98 | 101 | 103 | 101 | 102 |

**Table 3.3.5.2.2. Anchovy in Division 9.a. West. Subdivision 9.a North. Spanish annual catches of anchovy in numbers ('000) at-age (only data for 2011–2012 and 2015–2023).**

| Year | Age 0 | Age 1 | Age 2 | Age 3 |
|---|---|---|---|---|
| 2011 | 2725 | 23903 | 380 | 0 |
| 2012 | 0 | 668 | 599 | 7 |
| 2013 | n.a | n.a | n.a | n.a |
| 2014 | n.a | n.a | n.a | n.a |
| 2015 | 0 | 1667 | 6667 | 66 |
| 2016 | 4677 | 9206 | 881 | 1 |
| 2017 | 14116 | 21150 | 10310 | 184 |
| 2018 | 0 | 33336 | 8551 | 354 |
| 2019 | 0 | 3274 | 5942 | 196 |
| 2020 | 0 | 4091 | 4170 | 1526 |
| 2021 | 12697 | 12148 | 4331 | 30 |
| 2022 | 0 | 279 | 152 | 30 |
| 2023 | 866 | 8670 | 1087 | 33 |

**Table 3.3.5.2.3. Anchovy in Division 9.a. West. Subdivision 9.a Central-North. Portuguese catches (all fleets) of anchovy in numbers ('000) at-age in 2023 on a quarterly (Q), half-year (HY) and annual basis.**

| 2023 | AGE | Q1 | Q2 | Q3 | Q4 | HY1 | HY2 | ANNUAL |
|---|---|---|---|---|---|---|---|---|
| | 0 | | | 0 | 0 | | 0 | |
| | 1 | | | 75494 | 24349 | | 99841 | |
| | 2 | | | 12683 | 11467 | | 24151 | |
| | 3 | | | 990 | 97 | | 1087 | |
| | Total (n) | | | 89167 | 35913 | | 125079 | |
| | Catch (t) | | | 2597 | 1043 | | 3640 | |
| | SOP | | | 2597 | 1043 | | 3640 | |
| | VAR.% | | | 100 | 100 | | 100 | |

**Table 3.3.6.1. Anchovy in Division 9.a. West. Subdivision 9.a North. Mean length (TL, in cm) at-age in the Spanish catches of Galician anchovy (all fleets) in 2023 on a quarterly (Q), half-year (HY) and annual basis.**

| 2023 | AGE | Q1 | Q2 | Q3 | Q4 | HY1 | HY2 | ANNUAL |
|---|---|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 0 | 13.0 | 14.5 | 13.0 | 13.0 |
| | 1 | 14.4 | 14.6 | 14.6 | 13.7 | 15.1 | 13.7 | 13.9 |
| | 2 | 15.2 | 14.8 | 14.8 | 0 | 16.9 | 14.8 | 15.0 |
| | 3 | 17.5 | 15.2 | 0 | 0 | 14.7 | 0 | 16.9 |
| | Total | 14.7 | 14.7 | 14.7 | 13.6 | 14.5 | 13.7 | 14.0 |

**Table 3.3.6.2. Anchovy in Division 9.a. West. Subdivision 9.a North. Mean weight (in kg) at-age in the Spanish catches of Galician anchovy (all fleets) in 2023 on a quarterly (Q), half-year (HY) and annual basis.**

| 2023 | AGE | Q1 | Q2 | Q3 | Q4 | HY1 | HY2 | ANNUAL |
|---|---|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 0 | 16.5 | 0 | 16.5 | 16.5 |
| | 1 | 21.6 | 22.1 | 22.8 | 19.0 | 21.7 | 19.2 | 19.9 |
| | 2 | 25.0 | 23.0 | 23.3 | 0 | 24.5 | 23.3 | 24.4 |
| | 3 | 37.0 | 25.1 | 0 | 0 | 34.0 | 0 | 34.0 |
| | Total | 22.6 | 22.4 | 22.9 | 18.7 | 22.6 | 19.0 | 20.2 |

**Table 3.3.6.3. Anchovy in Division 9.a. West. Subdivision 9.a Central-North. Mean length (TL, in cm) at-age in the Portuguese catches of Northwestern anchovy (all fleets) in 2023 on a quarterly (Q), half-year (HY) and annual basis.**

| 2023 | AGE | Q1 | Q2 | Q3 | Q4 | HY1 | HY2 | ANNUAL |
|---|---|---|---|---|---|---|---|---|
| | 0 | | | | | | | |
| | 1 | | | 15.7 | 16.0 | | 15.8 | |
| | 2 | | | 17.3 | 16.5 | | 16.9 | |
| | 3 | | | 17.7 | 17.8 | | 17.7 | |
| | Total | | | 16.0 | 16.1 | | 16.0 | |

**Table 3.3.6.4. Anchovy in Division 9.a. West. Subdivision 9.a Central-North. Mean weight (in kg) at-age in the Portuguese catches of Northwestern anchovy (all fleets) in 2023 on a quarterly (Q), half-year (HY) and annual basis.**

| 2023 | AGE | Q1 | Q2 | Q3 | Q4 | HY1 | HY2 | ANNUAL |
|---|---|---|---|---|---|---|---|---|
| | 0 | | | | | | | |
| | 1 | | | 27.6 | 28.1 | | 26.9 | |
| | 2 | | | 37.7 | 30.8 | | 33.6 | |
| | 3 | | | 40.4 | 38.4 | | 38.6 | |
| | Total | | | 29.2 | 29.0 | | 28.3 | |

**Table 3.4.1. Acoustic surveys providing direct estimates for anchovy in Division 9.a West.**

| **Method** | **Acoustics** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Survey** | **PELACUS** | | **PELAGO** | | **SAR** | **JUVESAR** | **IBERAS** | |
| **Institute (Country)** | **IEO (ES)** | | **IPMA (PT)** | | **IPMA (PT)** | **IPMA (PT)** | **IPMA-IEO (PT-ES)** | |
| **Subareas** | **9.a N** | | **9.a CN-9.a S** | | **9.a CN-9.a S** | **9.a CN** | **9.a N-9.a CS** | |
| **Year/Quarter** | **Q1** | **Q2** | **Q1** | **Q2** | **Q4** | **Q4** | **Q3** | **Q4** |
| 1998 | | | | | Nov | | | |
| 1999 | | | Mar | | | | | |
| 2000 | | | | | Nov | | | |
| 2001 | | | Mar | | Nov | | | |
| 2002 | | | Mar | | | | | |
| 2003 | | | Feb | | (Nov) | | | |
| 2004 | | | | (Jun) | | | | |
| 2005 | | | | Apr | (Nov) | | | |

| **Method** | **Acoustics** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Survey** | **PELACUS** | | **PELAGO** | | **SAR** | **JUVESAR** | **IBERAS** | |
| **Institute (Country)** | **IEO (ES)** | | **IPMA (PT)** | | **IPMA (PT)** | **IPMA (PT)** | **IPMA-IEO (PT-ES)** | |
| **Subareas** | **9.a N** | | **9.a CN-9.a S** | | **9.a CN-9.a S** | **9.a CN** | **9.a N-9.a CS** | |
| **Year/Quarter** | **Q1** | **Q2** | **Q1** | **Q2** | **Q4** | **Q4** | **Q3** | **Q4** |
| 2006 | | | | Apr | (Nov) | | | |
| 2007 | | | | Apr | Nov | | | |
| 2008 | | Apr | | Apr | (Nov) | | | |
| 2009 | | Apr | | Apr | | | | |
| 2010 | | Apr | | Apr | | | | |
| 2011 | | Apr | | Apr | | | | |
| 2012 | | Apr | | | | | | |
| 2013 | Mar | | | Apr | | (Nov) | | |
| 2014 | Mar | | | Apr | | (Nov) | | |
| 2015 | Mar | | | Apr | | Dec | | |
| 2016 | Mar | | | Apr | | Dec | | |
| 2017 | Mar | | | Apr | | Dec | | |
| 2018 | Mar | | | Apr | | | | Nov |
| 2019 | Mar | | | Apr | | | Sep | |
| 2020 | | No survey (Covid-19 disruption) | Mar | | | | Sep | |
| 2021 | | Apr | Mar | | | | Sep | |
| 2022 | | Apr | Mar | | | | Sep | |
| 2023 | | Apr | Mar | | | | Sep | |
| 2024 | Mar | Apr | Mar | | | | | |

**Table 3.4.1.1. Anchovy in Division 9.a. *PELACUS* survey series (spring Spanish acoustic survey in Subdivision 9.a North and Subarea 8.c). Historical series of acoustic estimates of anchovy abundance (N, millions) and biomass (B, tonnes) in Subdivision 9.a North.**

| Survey | Estimate | 9.a North |
|---|---|---|
| April 2008 | N | 10 |
| | B | 306 |
| April 2009 | N | 0.7 |
| | B | 26 |
| April 2010 | N | 0.03 |
| | B | 90 |
| April 2011 | N | 73 |
| | B | 1650 |
| April 2012 | N | 1 |
| | B | 45 |
| March 2013 | N | - |
| | B | - |
| March 2014 | N | - |
| | B | - |
| March 2015 | N | - |
| | B | - |
| March 2016 | N | 8 |
| | B | 205 |
| March 2017 | N | 124 |
| | B | 3566 |
| March 2018 | N | 771 |
| | B | 10660 |
| March 2019 | N | 7 |
| | B | 192 |
| March 2020 | N | No survey (Covid-19 disruption) |
| | B | |
| April 2021 | N | 358 |
| | B | 6075 |

| Survey | Estimate | 9.a North |
|---|---|---|
| April 2022 | N | 0.1 |
| | B | 2 |
| April 2023 | N | 168 |
| | B | 3223 |
| March/April 2024 | N | 142 |
| | B | 2015 |

**Table 3.4.1.2. Anchovy in Division 9.a. *PELAGO* survey series (spring Portuguese acoustic survey in Subdivisions 9.a Central-North to 9.a South). Historical series of overall and regional acoustic estimates of anchovy abundance (N, millions) and biomass (B, tonnes) for Subdivisions 9.a Central-North and 9.a Central-S.**

| Survey | Estimate | C-N | C-S | TOTAL |
|---|---|---|---|---|
| Mar. 99 | N | 22 | 15 | 37 |
| | B | 190 | 406 | 596 |
| Mar. 00 | N | - | - | - |
| | B | - | - | - |
| Mar. 01 | N | 25 | 13 | 38 |
| | B | 281 | 87 | 368 |
| Mar. 02 | N | 22 | 156 | 178 |
| | B | 472 | 1070 | 1542 |
| Feb. 03 | N | 0 | 14 | 14 |
| | B | 0 | 112 | 112 |
| Mar. 04 | N | - | - | - |
| | B | - | - | - |
| Apr. 05 | N | - | 59 | 59 |
| | B | - | 1062 | 1062 |
| Apr. 06 | N | - | - | - |
| | B | - | - | - |
| Apr. 07 | N | 0 | 103 | 103 |
| | B | 0 | 1945 | 1945 |
| Apr.08 | N | 69 | 252 | 321 |
| | B | 3000 | 2505 | 5505 |

| Survey | Estimate | C-N | C-S | TOTAL |
|---|---|---|---|---|
| Apr.09 | N | 127 | 0* | 127 |
| | B | 2089 | 0* | 2089 |
| Apr. 10 | N | 0 | 62 | 62 |
| | B | 0 | 1188 | 1188 |
| Apr. 11 | N | 1558 | 0 | 1558 |
| | B | 27050 | 0 | 27050 |
| Apr. 12 | N | - | - | - |
| | B | - | - | - |

***Possible underestimation: although no echo-traces attributable to the species were detected in this area, however, the loss of pelagic gear samplers prevented from confirming directly this.**

**Table 3.4.1.2. Anchovy in Division 9.a. *PELAGO* survey series (spring Portuguese acoustic survey) in Subdivisions 9.a Central-North and 9.a Central South). Cont'd.**

| Survey | Estimate | C-N | C-S | TOTAL |
|---|---|---|---|---|
| Apr. 13 | N | 251 | 0 | 251 |
| | B | 3955 | 0 | 3955 |
| Apr. 14 | N | 130 | 0 | 130 |
| | B | 1947 | 0 | 1947 |
| Apr. 15 | N | 645 | 0 | 645 |
| | B | 8237 | 0 | 8237 |
| Apr. 16 | N | 3198 | 0 | 3198 |
| | B | 38302 | 0 | 38302 |
| May 17 | N | 1015 | 0 | 1015 |
| | B | 15481 | 0 | 15481 |
| Apr. 18 | N | 4845 | 0 | 4845 |
| | B | 54437 | 0 | 54437 |
| Apr. 19 | N | 229 | 7 | 236 |
| | B | 3814 | 123 | 3937 |
| Apr. 20 | N | 3152 | 0.3 | 3152 |
| | B | 50282 | 9 | 50291 |

| Survey | Estimate | C-N | C-S | TOTAL |
|---|---|---|---|---|
| Mar. 21 | N | 3069 | 519 | 3588 |
| | B | 53513 | 6095 | 59608 |
| Apr. 22 | N | 4589 | 198 | 4796 |
| | B | 108571 | 3391 | 111962 |
| Apr. 23 | N | 3018 | 21 | 3039 |
| | B | 69825 | 366 | 70191 |
| Mar. 24 | N | 7190 | 544 | 7734 |
| | B | 81802 | 6107 | 87909 |

**Table 3.4.2.1. Anchovy in Division 9.a West. *SAR/JUVESAR* autumn survey series (autumn Portuguese acoustic survey in subdivisions 9.a Central–North and to 9.a South - SAR - or Subdivision 9.a Central-North and Central-South - *JUVESAR* -). Historical series of overall and regional acoustic estimates of anchovy abundance (N, millions) and biomass (B, tonnes). Juvenile fish (< 10.0 cm) estimates between parentheses in subdivisions 9.a Central–North and and 9.a Central- South.**

| Survey | Estimate | C-N | C-S | TOTAL |
|---|---|---|---|---|
| Nov. 98 | N | 30 | 122 | 152 |
| | B | 313 | 1951 | 2264 |
| Nov. 99 | N | - | - | - |
| | B | - | - | - |
| Nov. 00 | N | 4 | 20 | 24 |
| | B | 98 | 241 | 339 |
| Nov. 01 | N | 35 | 94 | 129 |
| | B | 1028 | 2276 | 3304 |
| Nov. 02 | N | - | - | - |
| | B | - | - | - |
| Nov. 03 | N | - | - | - |
| | B | - | - | - |
| Nov. 04 | N | - | - | - |
| | B | - | - | - |
| Nov. 05 | N | - | - | - |
| | B | - | - | - |
| Nov. 06 | N | - | - | - |
| | B | - | - | - |

| Survey | Estimate | C-N | C-S | TOTAL |
|---|---|---|---|---|
| Nov. 07 | N | 0 | 59 | 59 |
| | B | 0 | 1120 | 1120 |
| Nov. 13 | N | - | - | - |
| | B | - | - | - |
| Nov. 14 | N | - | - | - |
| | B | - | - | - |
| Dec. 15 | N | - | - | - |
| | B | - | - | - |
| Dec. 16 | N | 2836 | - | 2836 |
| | B | 14397 | - | 14397 |
| Dec 17 | N | 1745 | - | 1745 |
| | B | 30747 | - | 30747 |

**Table 3.4.2.2. Anchovy in Division 9.a West. *IBERAS* survey series (autumn Spanish-Portuguese acoustic survey in subdivisions 9.a North to Central-South). Historical series of overall and regional acoustic estimates of anchovy abundance (N, millions) and biomass (B, tonnes). Age 0 fish estimates between parentheses.**

| Survey | Estimate | Spain | Portugal | | | TOTAL |
|---|---|---|---|---|---|---|
| | | N | C-N | C-S | Total | |
| Nov. 18 | N | 0.04 (0.03) | 8836 (592) | 0.02 (0.001) | 8836 (592) | 8836 (592) |
| | B | 0.4 (0) | 181576 (5894) | 0.4 (0) | 181577 (5894) | 181577 (5894) |
| Sep. 19 | N | 0 (0) | 122 (0.3) | 42 (0) | 164 (0.3) | 164 (0.3) |
| | B | 0 (0) | 2981 (3) | 1232 (0) | 4212 (3) | 4212 (3) |
| Sep. 20 | N | 0 (570) | 12 (1) | 0 (0.7) | 583 (560) | 583 (572) |
| | B | 0 (4879) | 289 (20) | 0 (8) | 5176 (4669) | 5176 (4907) |
| Sep. 21 | N | 0 (0) | 1429 (664) | 2 (2) | 1431 (666) | 1431 (666) |
| | B | 0 (0) | 31206 (10591) | 29 (26) | 31236 (10617) | 31236 (10617) |
| Sep. 22 | N | 168 (159) | 244 (209) | 70 (0.1) | 314 (209) | 482 (368) |
| | B | 1925 (1718) | 3471 (2520) | 2243 (4) | 5714 (2524) | 7639 (4242) |
| Sep. 23 | N | 16090 (16090) | 7288 (5592) | 474 (474) | 7762 (6066) | 23852 (22156) |
| | B | 65270 (65270) | 77761 (21348) | 3948 (3948) | 81709 (25295) | 146979 (90566) |

**Table 3.5.1.1. Anchovy in Division 9.a. West. Subdivision 9.a North, 9.a Central North and 9.a Central South. Mean weight-at-age in the stock (in g).**

| Year | Age 0 | Age 1 | Age 2 | Age 3 |
|---|---|---|---|---|
| 2008 | | 14.6 | 37.2 | |
| 2009 | | 14.9 | 31.6 | 36.4 |
| 2010 | | 19.5 | 17.2 | 19.6 |
| 2011 | | 16.2 | 21.2 | 28.1 |
| 2012 | | | | |
| 2013 | | 14.3 | 22.7 | 34.1 |
| 2014 | | 13.6 | 23.4 | 27.7 |
| 2015 | | 12.0 | 25.6 | 29.9 |
| 2016 | | 11.5 | 12.5 | 16.2 |
| 2017 | | 15.4 | 30.0 | 34.3 |
| 2018 | | 11.3 | 24.0 | 36.6 |
| 2019 | | 13.8 | 19.0 | 30.0 |
| 2020 | | 13.0 | 22.0 | 25.0 |
| 2021 | | 15.2 | 22.6 | 28.8 |
| 2022 | | 20.9 | 28.7 | 30.7 |
| 2023 | | 19.8 | 27.7 | 30.1 |
| 2024 | | 10.54 | 25.87 | 30.80 |

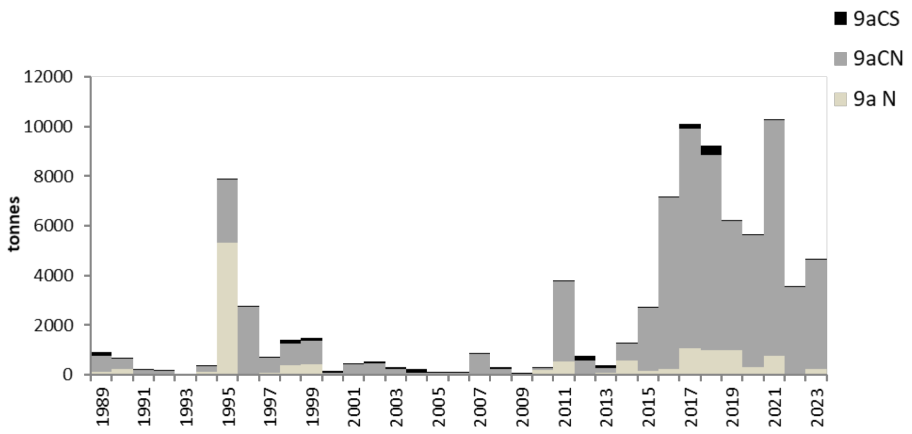



**Figure 3.3.2.1.1. Anchovy in Division 9.a West. Recent series of anchovy catches in Division 9.a (ICES estimates for 1989–2023, the period with data for all the subdivisions, all metiers are considered). Catches by Subdivision (ICES subdivisions 9.a North, Central-North and Central-South). Discards are considered as negligible all over the division, but since 2014 on estimates include the available discarded catches (see Section 3.3.3).**

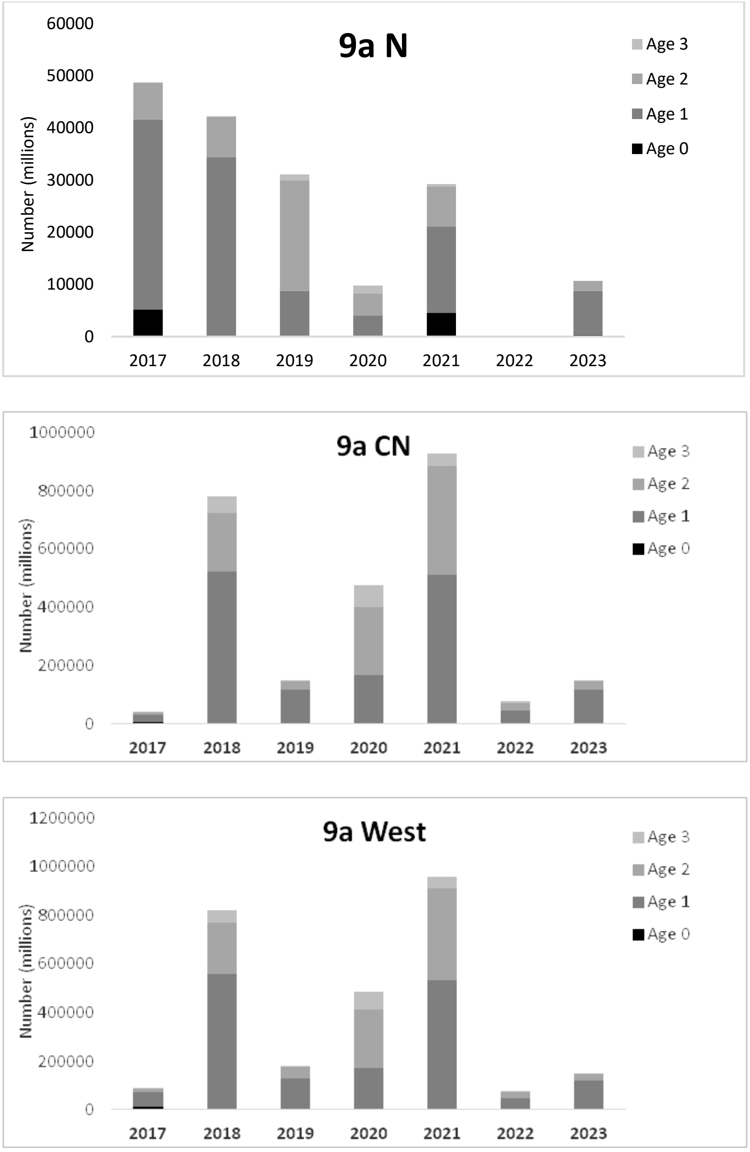
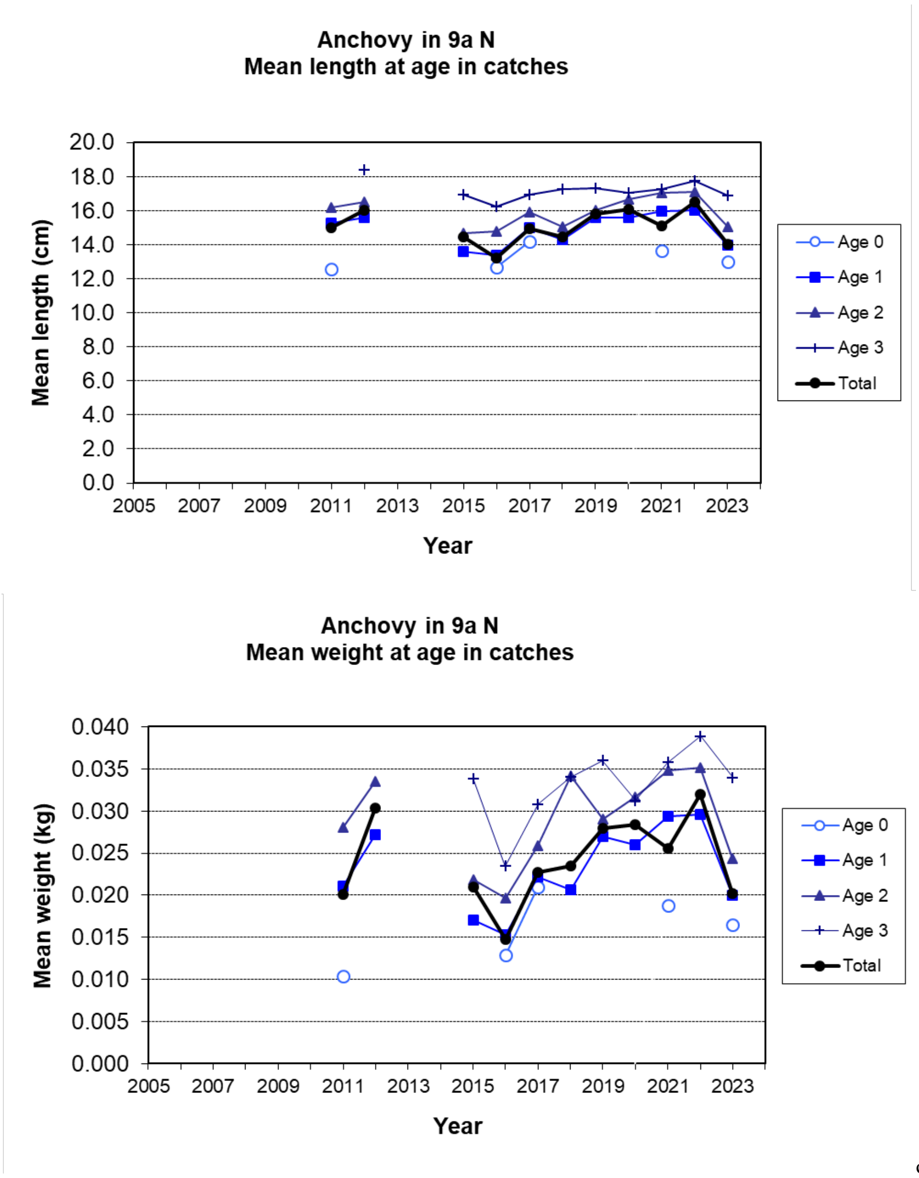



**Figure 3.3.5.2.1. Anchovy in Division 9.a. West. Subdivisions 9.a North and 9.a Central North. Spanish and Portuguese fisheries (all métiers). Age composition in Spanish catches of SW Galician anchovy (9.a North) and Portuguese catches of anchovy from northern Portugal (9.a Central North) (available data provided to the WG). Although discards are still considered as negligible (hence landings are assumed as equal to catches), data since 2014 include discards estimates for the Spanish fisheries (see Section 4.3.3). Data for 2021 and 2022 from the Portuguese fisheries are only available for the 3rd and 4th Quarters (represent 95% catches in 2021 and 70% catches in 2022).**




d

**Figure 3.3.6.1. Anchovy in Division 9.a. West. Subdivision 9.a North. Spanish fishery (all métiers). Annual mean length (TL, in cm) and weight (kg) at-age in the Spanish catches of Western Galicia anchovy (2011–2023).**

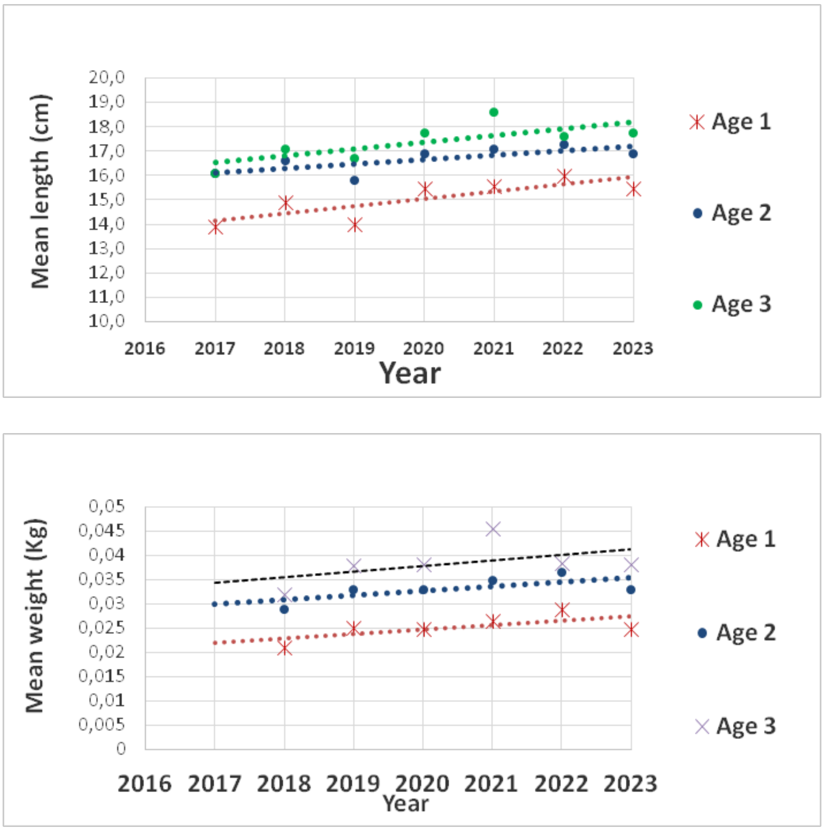



**Figure 3.3.6.2. Anchovy in Division 9.a. West. Subdivision 9.a Central North. Portuguese fishery (all métiers). Annual mean length (TL, in cm) and weight (kg) at-age in the Portuguese catches of Western anchovy (2017 to 2023). Data for 2021 and 2022 are only available for the 3rd and 4th Quarters (represent 95% catches in 2021 and 70% catches in 2022).**

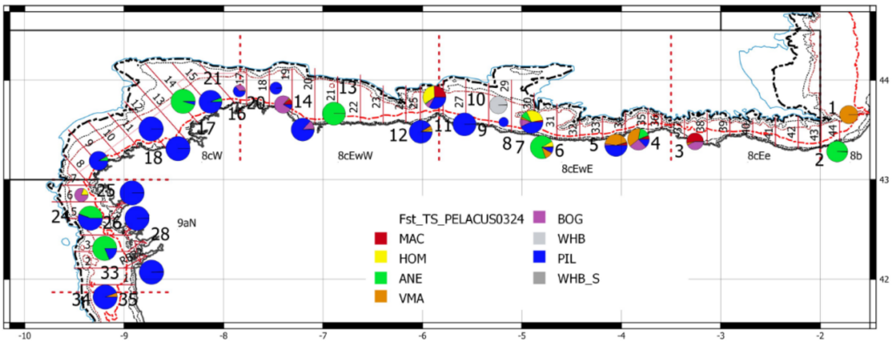



**Figure 3.4.1.1. Anchovy in Division 9.a. West. Subdivision 9.a North. *PELACUS 0424* survey (spring Spanish acoustic survey in Sub-division 9.a North and Sub-area 8c in 2024). Location of valid fishing stations with indication of their species composition (percentages in number).**

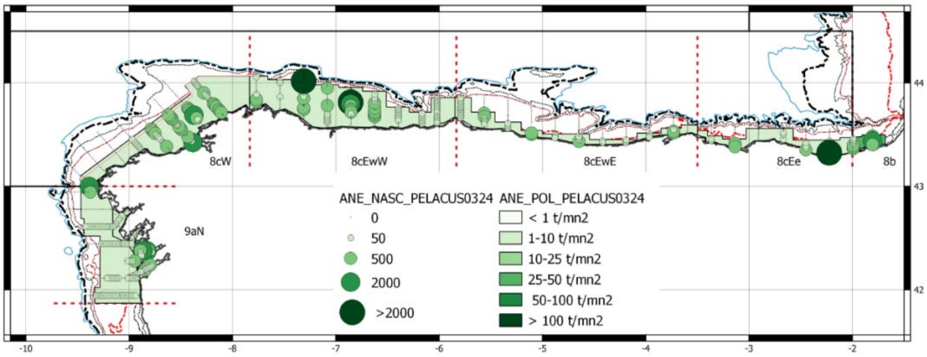



**Figure 3.4.1.2. Anchovy in Division 9.a. West. Subdivision 9.a North. *PELACUS 0424* survey (spring Spanish acoustic survey in Sub-division 9.a North and Sub-area 8c in 2024). Spatial distribution of energy allocated to anchovy (NASC coefficients in m²/mn²).**

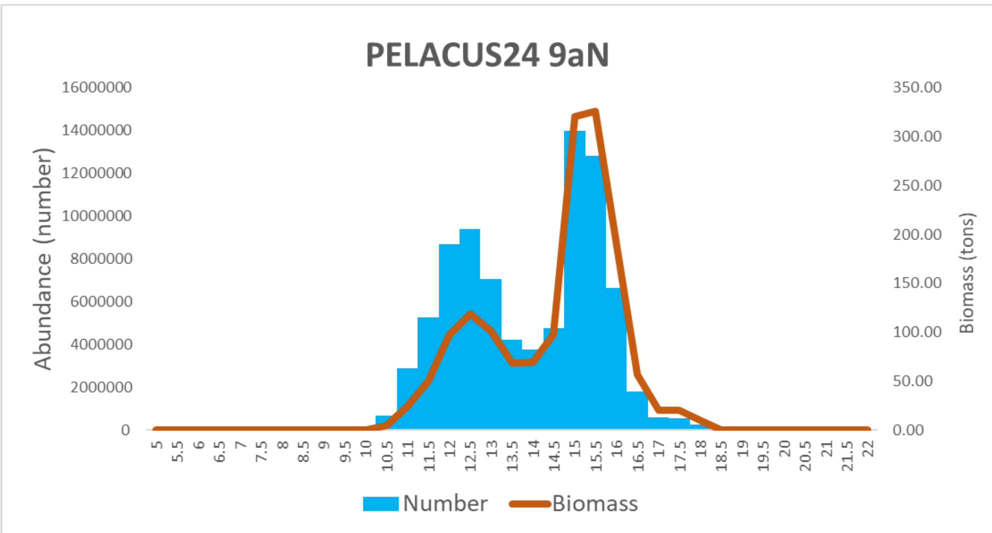



**Figure 3.4.1.3. Anchovy in Division 9.a. West. Subdivision 9.a North. *PELACUS 0424* survey (spring Spanish acoustic survey in Sub-division 9.a North and Sub-area 8c in 2024). Estimated abundances and biomasses (number of fish and thousand tonnes, respectively) in Sub-division 9.a North by length class (cm). Note the different scales in the y axis.**

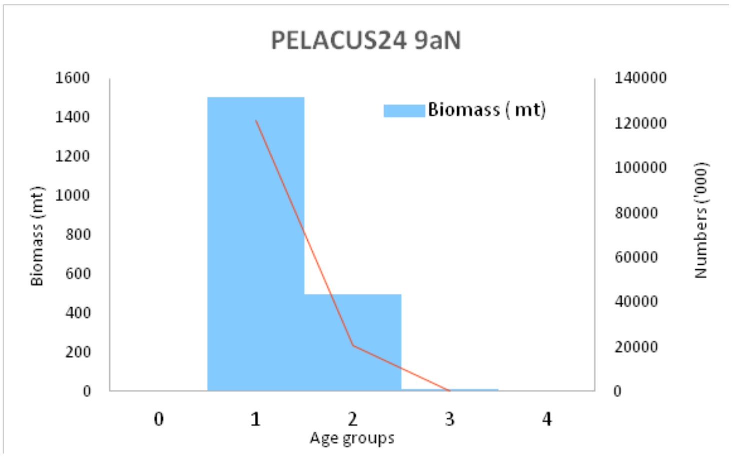



**Figure 3.4.1.4. Anchovy in Division 9.a. West. Subdivision 9.a North. *PELACUS 0424* survey (spring Spanish acoustic survey in Sub-division 9.a North and Sub-area 8c in 2024). Estimated abundances and biomasses (number of fish in thousands and tonnes, respectively) in Sub-division 9.a North by age group. Note the different scales in the y axis.**

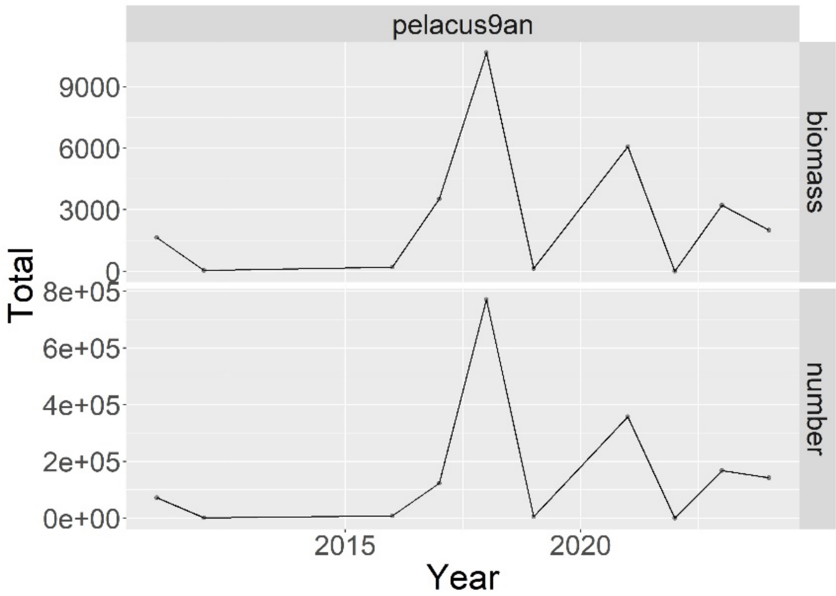



**Figure 3.4.1.5. Anchovy in Division 9.a. West. Subdivision 9.a North. *PELACUS* survey series (spring Spanish acoustic survey in Subdivision 9.a North and Subarea 8c). Historical series of acoustic estimates of anchovy abundance and biomass (t) in the Subdivision 9.a North.**

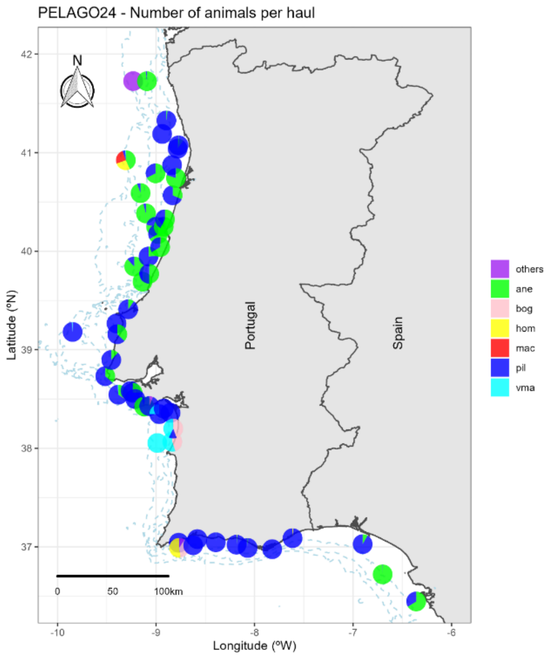



**Figure 3.4.1.6. Anchovy in Division 9.a. Western and Southern stocks. Subdivisions 9.a Central-North to 9.a South. *PELAGO* survey series (spring Portuguese acoustic survey in Subdivisions 9.a Central-North to 9.a South). *PELAGO 24* survey. Location of valid fishing stations with indication of their species composition (percentages in number).**

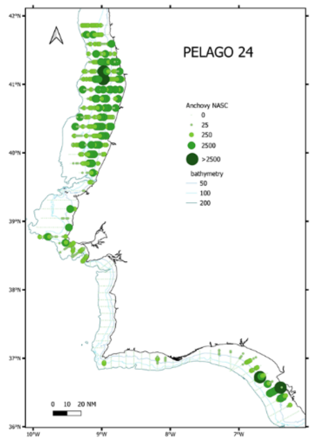



**Figure 3.4.1.7. Anchovy in Division 9.a. Western and Southern stocks. Subdivisions 9.a Central-North to 9.a South. *PELAGO* survey series (spring Portuguese acoustic survey in Subdivisions 9.a Central-North to 9.a South). *PELAGO 24* survey. Spatial distribution of energy allocated to anchovy (NASC coefficients in m²/mn²).**

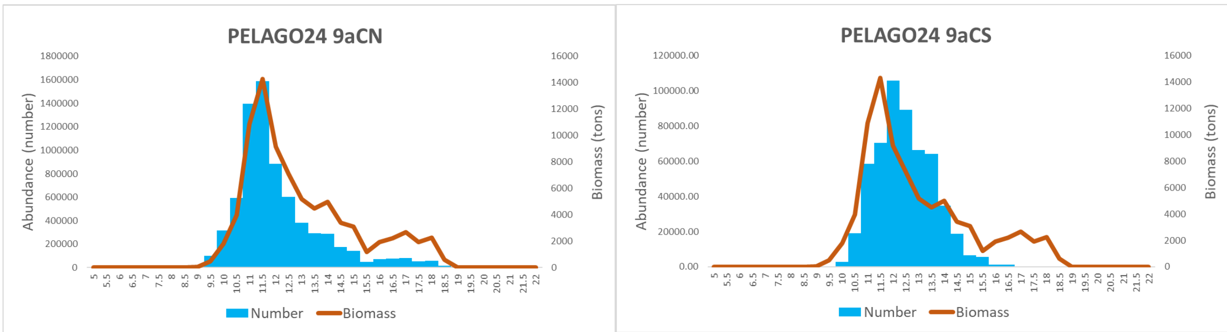



**Figure 3.4.1.8. Anchovy in Division 9.a West. Sub-divisions 9.a Central-North and 9.a Central South. *PELAGO* survey series (spring Portuguese acoustic survey in Sub-divisions 9.a Central-North to 9.a South). *PELAGO 24* survey. Estimated abundances and biomasses (number of fish in thousands and tonnes, respectively) for sub-divisions 9.a Central-North and 9.a Central South by length class (cm). Note the different scales in the y axis.**

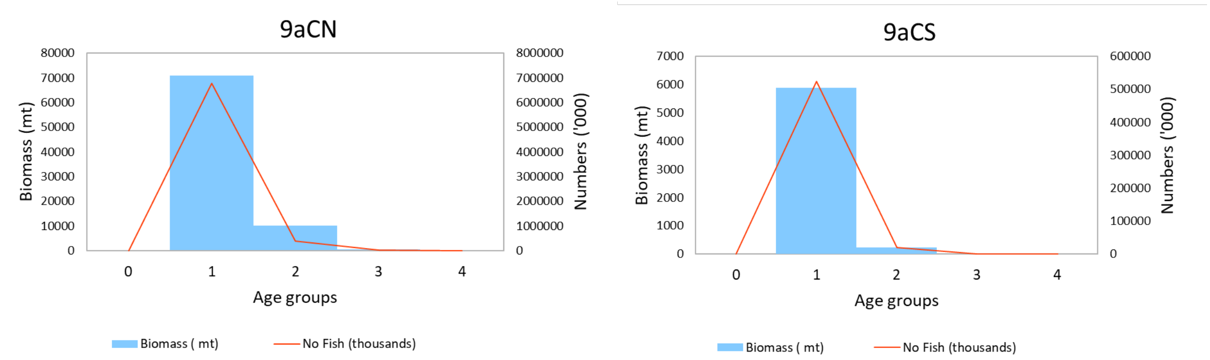



**Figure 3.4.1.9. Anchovy in Division 9.a. West. Sub-divisions 9.a Central-North and 9.a Central South. *PELAGO* survey series (spring Portuguese acoustic survey in Sub-divisions 9.a Central-North to 9.a South). *PELAGO 24* survey. Estimated abundances and biomasses (number of fish in thousands and tonnes, respectively) in Sub-division 9.a North by age group. Note the different scales in the y axis.**

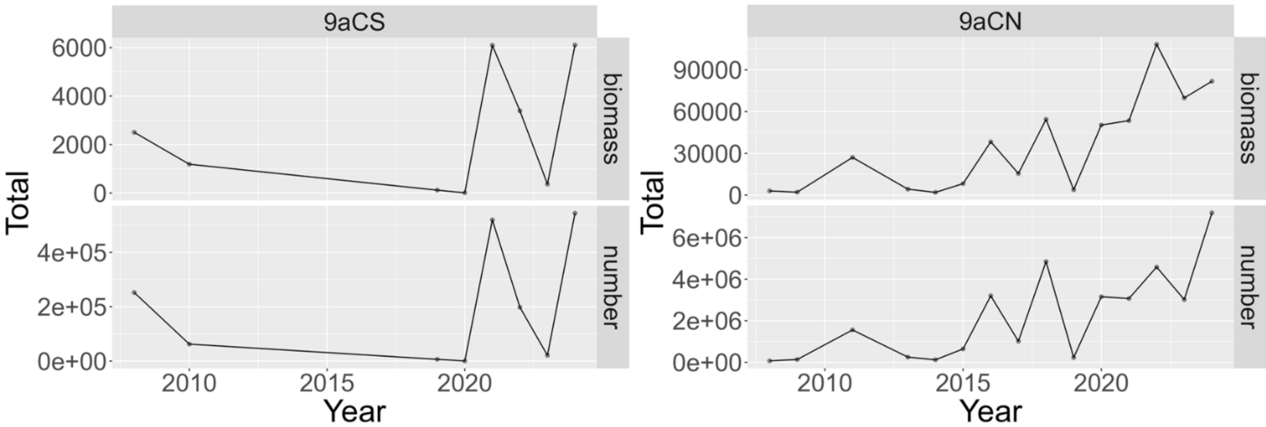



**Figure 3.4.1.10. Anchovy in Division 9.a West. Sub-divisions 9.a Central-North and 9.a Central South. PELAGO survey series (spring Portuguese acoustic survey in Sub-divisions 9.a Central-North to 9.a South). Historical series of regional acoustic estimates of anchovy biomass (t). Note the different scale of the y-axis.**

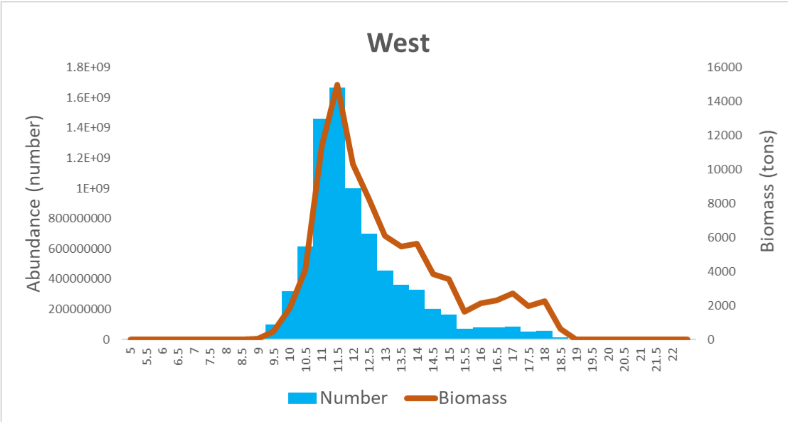



**Figure 3.4.1.11. Anchovy in Division 9.a West. Subdivisions 9.a North to Central-South. Annual trends of the estimated population by length class from the PELACUS (9a North) + PELAGO (9a Central-North and Central-South). Estimated abundances and biomasses (number of fish in thousands and tonnes, respectively) for anchovy in 9.a West by length class (cm). Note the different scales in the y axis.**

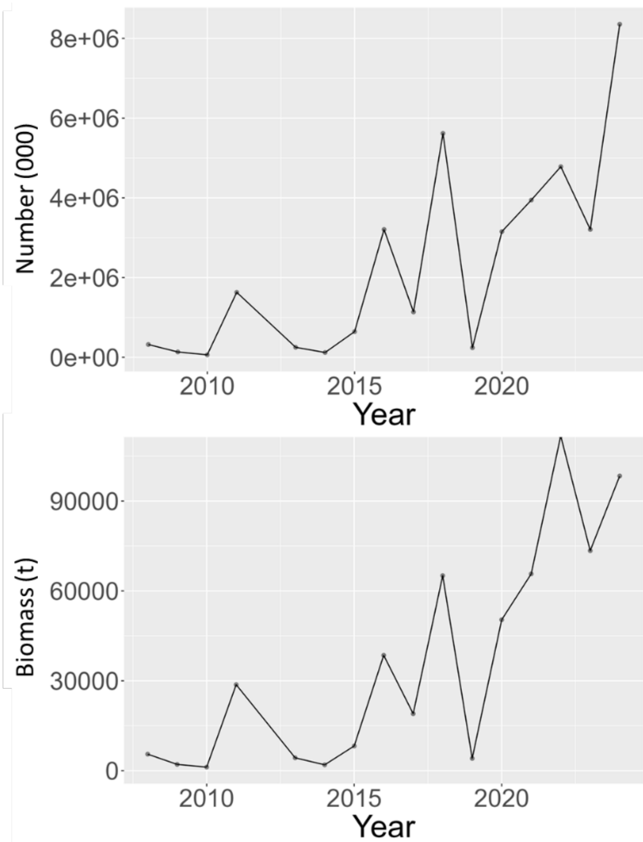



**Figure 3.4.1.12. Anchovy in Division 9.a West. Subdivisions 9.a North to Central-South. Annual trends of the estimated population by length class from the PELACUS (9a North) + PELAGO (9a Central-North and Central-South). Historical series of regional acoustic estimates for anchovy in 9.a West abundance and biomass (t). Note the different scale of the y-axis.**

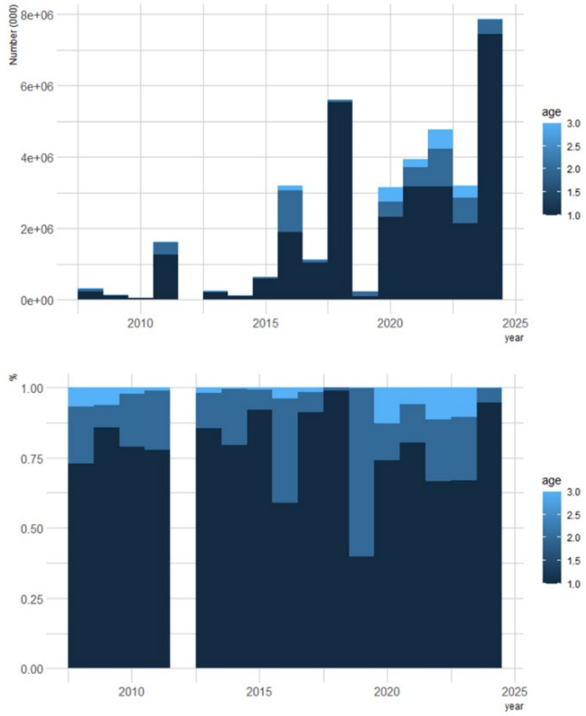



**Figure 3.4.1.13. Anchovy in Division 9.a. West. Subdivisions 9.a North to Central-South. Annual trends of the estimated population by age class from the *PELACUS* (9a North) + *PELAGO* (9a Central-North and Central-South) Spring acoustic surveys, number of individuals per age (upper panel) and percentage by number (lower panel). Age composition for 2020 only derived from the *PELAGO* survey given the *PELACUS* was not carried out.**

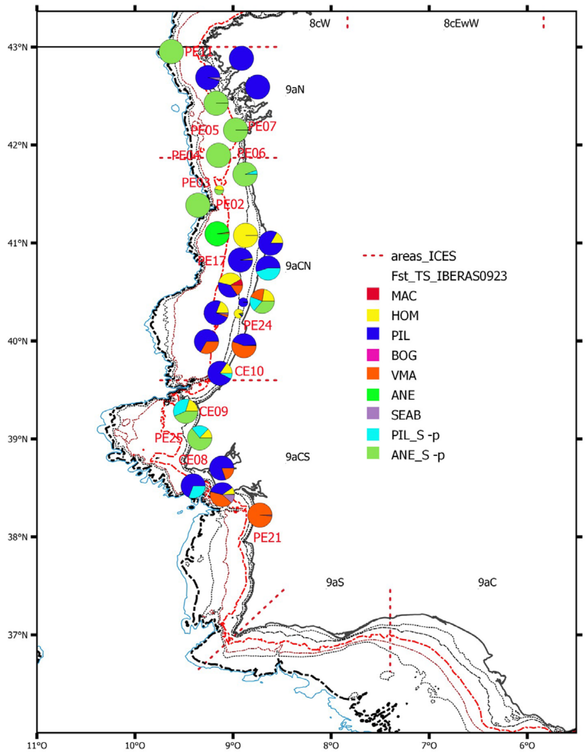



**Figure 3.4.2.1. Anchovy in Division 9.a. West. Subdivisions 9.aNorth, 9.a Central-North and 9.a Central-South. *IBERAS 0923* survey (autumn Spanish-Portuguese acoustic survey in Subdivisions 9.aNorth to Central-South). Location of valid fishing stations with indication of their species composition (percentages in number).**

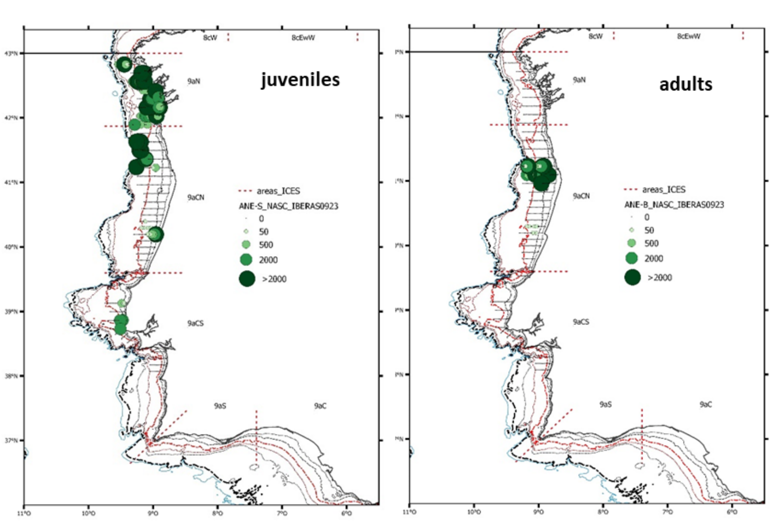



**Figure 3.4.2.2. Anchovy in Division 9.a. West. Subdivisions 9.a North, 9.a Central-North and 9.a Central-South. *IBERAS 0923* survey (autumn Spanish-Portuguese acoustic survey in Subdivisions 9.a North to Central-South). Distribution of the backscattering energy (Nautical area scattering coefficient, NASC, in m$^2$ nmi$^{-2}$) attributed to the species. Left: juveniles (≤12.0cm); right: adults (>12.0cm).**

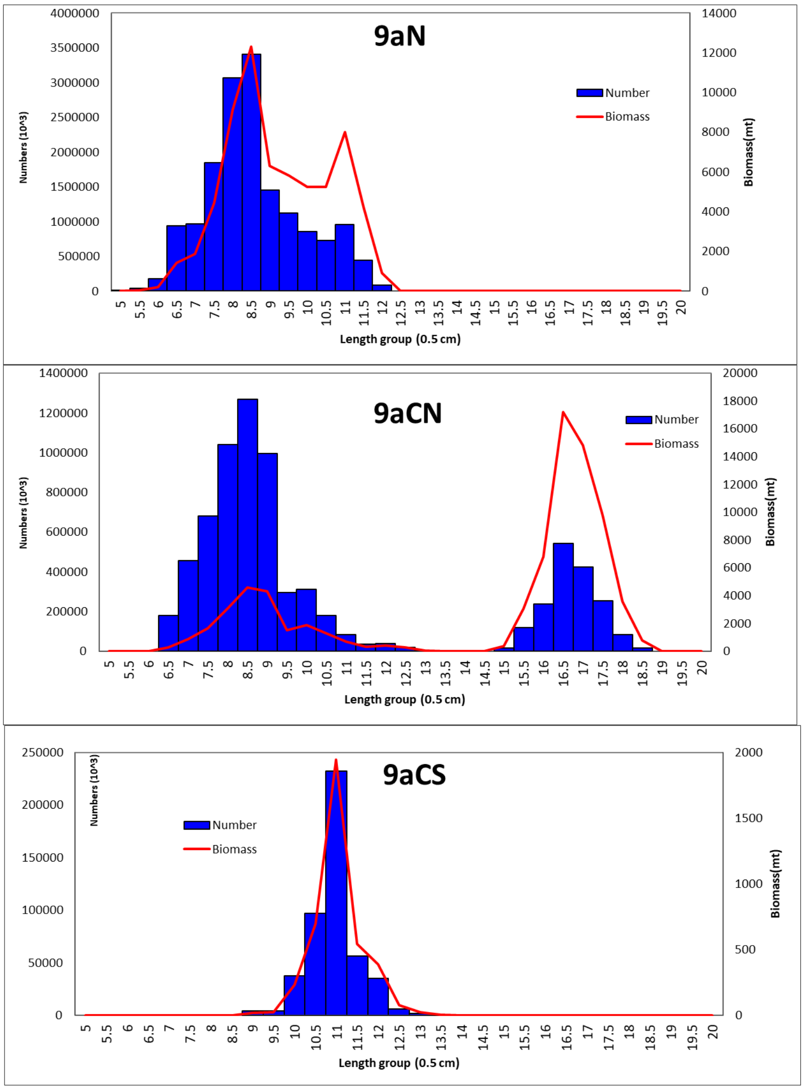



**Figure 3.4.2.3. Anchovy in Division 9.a. West. Subdivisions 9.aNorth, 9.a Central-North and 9.a Central-South. *IBERAS 0923* survey (autumn Spanish-Portuguese acoustic survey in Subdivisions 9.a North to Central-South). Estimated abundances and biomasses (number of fish in thousands and tonnes, respectively) for the surveyed area by length class (cm). Note the different scales in the y-axis.**

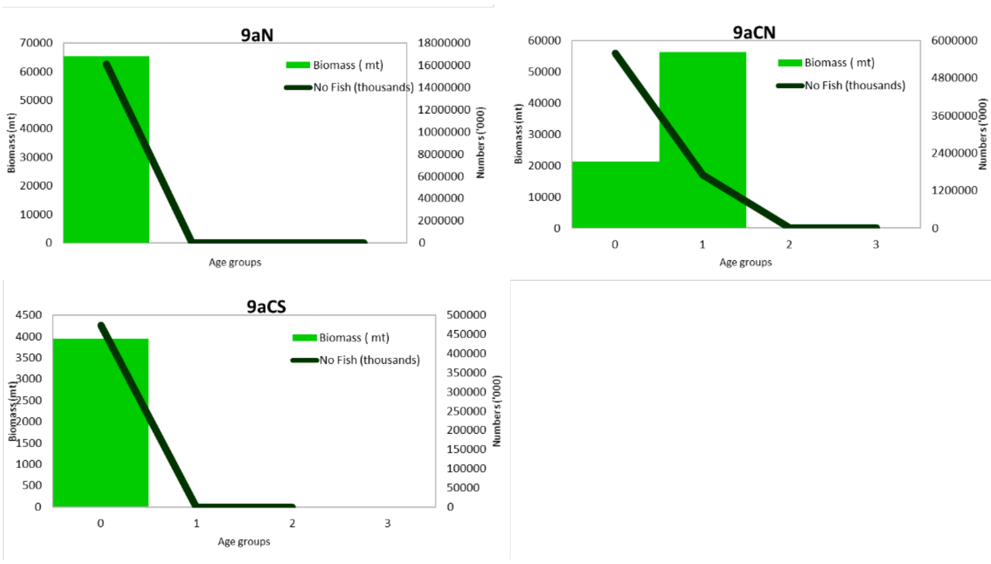



**Figure 3.4.2.4. Anchovy in Division 9.a. West. Subdivisions 9.a North, 9.a Central-North and 9.a Central-South. *IBERAS 0923* survey (autumn Spanish-Portuguese acoustic survey in Subdivisions 9.a North to Central-South). Estimated abundances and biomasses (number of fish in thousands and tonnes, respectively) for the surveyed area by age group, with indication of the mean size by age. Note the different scales in the y-axis.**

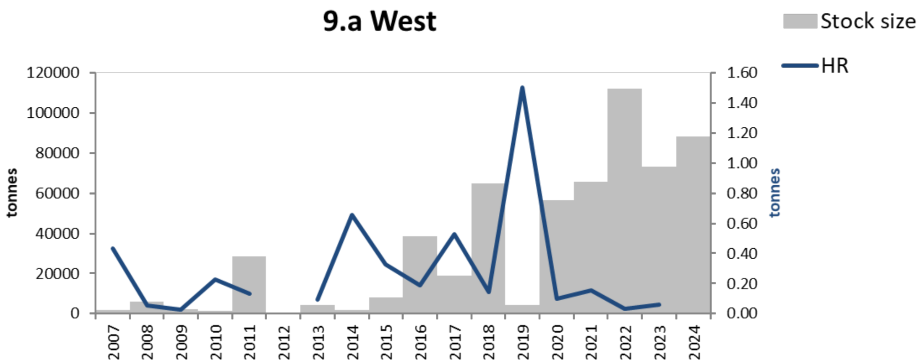



**Figure 3.8.1. Anchovy in Division 9.a. West. Stock biomass survey index and harvest rates. Harvest rates were estimated with the biomass of the surveys of a given year and the catches of the management period, i.e. 2007 corresponds to the period 07/2007 to 06/2008.**

# 4 Anchovy (*Engraulis encrasicolus)* in the southern part of Division 9.a (Gulf of Cadiz and southern coast of Portugal)

## 4.1 ACOM Advice in 2024

The anchovy in Division 9a stock was benchmarked for the first time in February 2018 (WKPELA 2018 ICES, 2018a). WKPELA 2018 supported the proposal of considering two different components of the stock (western and southern component), due to the different dynamics of their fisheries and populations. However, until the stock structure along the division were properly identified, the provision of advice will still be given for the whole stock, but with separate catch advice for each stock component. Given the high natural mortality experienced by this stock, its high dependence upon recruitment (the fishery depends largely on the incoming year class, the abundance of which cannot be properly estimated before it has entered the fishery), and the large inter-annual fluctuations observed in the spawning stock, ICES is aware that the state of this resource can change quickly. Therefore, an in-year monitoring and management, or alternative management measures should be considered. However, such measures should take into account the need for a reliable index of recruitment strength.

From the above reasons, the management calendar for the application of the advice was agreed to be the one from 1st July of year *y* to 30th June of year *y+1* since 2018 onwards. After the WGHANSA-1 2024 meeting ICES advised for the period 1st July 2024 to 30th June 2025 that, when the precautionary approach is applied, catches from the western component should be no more than 8480 t and catches from the southern component should be no more than 969 t (no more than 9449 t for the whole stock). The TAC for this same management period was initially agreed in 9449 t (Portugal: 4930 t; Spain: 4519 t), but with the restriction that catches from the southern component may not exceed 969 t and the prohibition of quota swaps between the UE member states involved in the fishery.

The stock has recently been benchmarked again this year (ICES, 2024a), just before the ICES WGHANSA-2 2024 meeting. Issues to be benchmarked were the proposals of considering the separation of the former stock western and southern components in two separate stocks (based on the results from a multidisciplinary work on the stock identity), as well as to provide advice for the "new" southern stock as an ICES category 1 stock, based on a new integrated analysis model (Stock Synthesis), and in a management calendar based on calendar years. The new stock assessment model includes a new recruitment index not considered before.

During the WGHANSA intersessional period, a provisional TAC of 4997 t for the period 1st July to 30th September 2024 has been implemented for anchovy in Division 9a (4028 t - PT: 2102 t, ES: 1926 t - plus the 969 t allowed to be fished in the southern component) awaiting the resolutions adopted in the Benchmark assessment workshop and the resulting new advice which will be presented in the present report. The available provisional official landings recorded during the period July-October 2024 amounted to 3129 t (PT: 0.6 t; ES: 3129 t).

## 4.2 Population structure and stock identity

Major changes to the stock definition of anchovy in Division 9.a were made during the last benchmark process (ICES, 2024a). A summary of the evidence presented to the WKBANSP Benchmark meeting on the stock definition, the comments of the ICES SIMWG that reviewed that information and the decisions taken during the Benchmark are described in ICES (2024a). A full description of the evidence on anchovy stock structure is found in Garrido *et al*. (2024) and in the Stock Annex (see Annex 3).

Multidisciplinary work on the stock structure of anchovy off Iberian waters was carried out by members of WGHANSA, WGACEGG and others, and presented to the benchmark WKBANSP and to SIMWG (Garrido *et al*., 2024). Thus, data of the spatial structure of anchovy in Division 9a (surveys and landings) shows a persistent discontinuity of the western and southern components of the stock (around 9aCS), for all the life stages (eggs, juveniles and adults) and seasons of the year covered by the surveys (spring, summer, fall; **Figure 4.2.1**). No significant correlation was found of anchovy abundance at age between the western and southern stock components, suggesting independent cohort dynamics and low or absent connectivity. Morphometric studies point to a separation of the Gulf of Cadiz anchovy population from that in western Iberia, although samples from the Algarve were absent. Genetic studies conducted in the past were not conclusive as they might be confounded by the presence of a coastal and a marine ecotype. However, new genomic results taking these ecotypes into consideration show that the southern anchovy component is clearly differentiated from the western component and that the populations belong to two different genetic lineages (**Figure 4.2.2**). New larval dispersal results suggest it is unlikely that the eggs being spawned in the Gulf of Cadiz can disperse and survive to the north-western coast in any relevant numbers for all years tested (2013-2020), suggesting low to absent connectivity during the early life stages. New analyses on isotopic composition of the eye lenses of juvenile and adult anchovy collected during different years show a clear isolation of the western and southern populations.

WGHANSA requested SIMWG to review the information provided by Garrido *et al*. (2024) in preparation of the recent Benchmark Workshop (WKBANSP), particularly with the proposal to separate the two components within the 9.a stock. The SIMWG recognized that the analyses indicate that there is likely a population structure within the Division 9.a anchovy stock area, that aligns with the current components (western and southern) of the two assessments conducted on the 9a anchovy stock. However, there was no agreement within SIMWG (ICES, 2024b) regarding the support to separate both components. According to the report, one group believes more survey and catch data should be explored before recommending the separation, while another group support the separation of both components of the anchovy stock, mostly based on the clear signal of the genomic study showing a strong differentiation of the populations of the western and southern (**Figure 4.2.2**). SIMWG also suggested that a more comprehensive and holistic stock identification programme is introduced, addressing the issues identified in the review, including the connectivity of the anchovy western populations to anchovy in Subarea 8, followed by a specific workshop with all relevant stakeholders to review the data and to consider the implications for management.

However, WKBANSP agrees that the further exploration needed to ascertain the potential connectivity between western and northern anchovy populations should not delay the decision to separate the western and southern components of the Division 9a stock, for which there is already compelling evidence of strong population structure. Furthermore, the current management is not aligned with the current advice provided by ICES, which can risk the sustainability of the stocks, justifying the provision of management options separately. Consequently, based on the above mentioned extensive work on stock identification, WKBANSP decided to split the former anchovy stock in Division 9.a into two stocks, corresponding to the former western and southern components. Therefore, the current anchovy (*Engraulis encrasicolus*) stock in the western part of Division 9.a (Western Iberian waters, ane.27.9.aW) corresponds to the former western component, comprising Sub-Divisions 9.a N, 9.a C-N, 9.a C-S, whereas the anchovy stock in the southern part of Division 9.a (Gulf of Cadiz and southern coast of Portugal, ane.27.9.aS) corresponds to the former southern component (**Figure 4.2.3**). Given that the advice on fishing opportunities was already given separately for the two components, such a change does not affect the current assessments or the provision of separate advice and catch opportunities.

# 4.3 The fishery in 2023 and 2024 (preliminary data)

## 4.3.1 Fishing fleets

Anchovy harvesting in the subdivision 9.a South was carried out in 2023 by the following fleets:

- Portuguese purse-seine fleet (PS_SPF_0_0_0).
- Spanish purse-seine fleet (PS_SPF_0_0_0).
- Spanish bottom otter trawl directed to demersal fish in 9.a South (OTB_MCD_>=55_0_0 anchovy discards).

Number and technical characteristics of the purse-seine vessels operated by Spain targeting anchovy in their national waters off GoC are summarised in **Table 4.3.1.1**. In 2023, the Gulf of Cadiz (GoC) anchovy fishing was practised by 51 purse-seiners, 3 vessels less targeting anchovy than in 2022, and still lower than in previous years (74-78 vessels for the period 2016-2018). Details of the dynamics of this fleet in terms of number of operative vessels over time in recent years are given in ICES (2008a; WGANC 2008 report) and subsequent WGHANSA reports. No information on the number of Portuguese vessels fishing anchovy in 2023 was available to the working group, but it may be assumed that the fleet operating in 2023 should not be very different from the one in 2020. The Portuguese fleet targeting anchovy and operating in the GoC in 2020 was composed of a total of 22 vessels (ICES, 2021a).

No updated information on the number of Spanish and Portuguese vessels fishing GoC anchovy in 2024 is available to the working group.

## 4.3.2 Catches

The updated historical series of GoC anchovy catches by country are shown in **Table 4.3.2.1** (see also **Figure 4.3.2.1**). **Table 4.3.2.2** shows the contribution of each fleet in the total annual catches by subdivision and country. The seasonal distribution of 2023 catches and 2024 provisional landings are shown in **Table 4.3.2.3**.

Historically, the Spanish fleet fishing in the GoC have targeted anchovy each year, whereas for the remaining purse-seine fleets in the Division 9a the target was mainly sardine and fished anchovy as a commercial by-catch or in particular years when the abundance was higher, such as 2011. In recent years (2014 to 2024), due to the increase in abundance of anchovy in the western Iberia, purse-seine fleets, mostly those operating in the 9.a CN subdivision, are also targeting anchovy.

Total catch in 2023 of this stock was estimated at 7470 t, which accounted for a 10% increase with respect to the 2022 catch (6795 t), staying above the time-series average (5156 t), and represented 62% of the total catch in the division. The fractions composing this total catch in 2023 were: 7236 t of official landings (Portugal: 155 t, Spain: 7082 t) and 233 t of (Spanish) discards.

Almost the whole of the total catch (97%) was captured by the purse-seine fleet.

The fishery was concentrated during the second and third quarters in the year.

Spanish official landings in 2024 were available for the whole fishing season (February-October; the Spanish GoC anchovy fishery was early closed the 1$^{st}$ of November). Portuguese anchovy official landings in 2024 were available only from the January-July period. The total (provisional) GoC anchovy landings in 2024 amounted to 8291 t (Portugal: 30 t, Spain: 8261 t). The provisional official landings from the second semester in 2024 were 3129 t (Portugal: 0.6 t; Spain: 3129 t).

As above commented for 2023, the GoC anchovy fishery was also concentrated during the second and third quarters in 2024.

## 4.3.3 Discards

See the stock annex for previous available information on discards in the division.

General guidelines on appropriate discard sampling strategies and methodologies were established during the ICES Workshop on Discard Sampling Methodology and Raising Procedures (ICES, 2003).

Covid-19 disruption and the interruption of the IEO's on-shore and at-sea sampling programs during the first semester in 2020 because administrative and budgetary reasons prevented from estimating discards during that semester in the Spanish fisheries in subdivisions 9a N and 9a S. Sampling programs performed as planned in 2021.

Average discards estimates (in t) in the Spanish fishery in 9aS for the available time-series (2014-2023) show that quarterly discards could be considered, for the time being, as negligible.

No anchovy discards have been reported from the Portuguese fishery in 2023, since they are also considered negligible.

Discards in the Spanish fishery in 2023 were recorded in the bottom-trawl fishery (233 t) mainly during the first semester. The estimated discards represented an annual discard ratio of 0.03 (3.3%) and may be considered as a very low ratio.

No discard estimates are yet available from both the Portuguese and Spanish fisheries in 2024.

## 4.3.4 Effort and landings per unit of effort

Annual standardised landings per unit of effort, lpue, series for the whole Spanish purse-seine fleet fishing GoC anchovy (Subdivision 9.a South) are routinely provided to this WG. An update of the available series (1988–2023) has been provided this year to this WG (**Figure 4.3.4.1**). Data from the 2024 fishery are not yet available to the working group. Details of data availability and the standardisation process are commented in the stock annex. At present, the series of commercial lpue indices is only used for interpreting the Spanish purse-seine fleets' dynamics in Subdivision 9a S. The recent dynamics of fishing effort and lpue for this fleet has been described in previous WG reports. Fishing effort experienced a strong decrease since 2017, which was coupled to a parallel decrease in catches. A relatively stable trend in effort (with some increase in 2020, 2021 and 2023) has been recorded during the 2017-2023 period, which was coupled with steeply increasing catches resulting in an increasing trend in lpue in the very recent years (from less than 1 t until 2014 to at around 1.2-1.9 t/fishing day in the most recent years). However, a probable overestimation of the annual estimates computed so far was suggested in previous WG reports because of a probable underestimation of the true exerted fishing effort on anchovy, since fishing trips targeting anchovy with zero anchovy catches are not considered in the effort measure.

## 4.3.5 Catches by length and catches-at-age

Length–frequency distribution (LFD) of catches and catch-at-age data from the whole Division 9.a are routinely provided to this WG from the Spanish fishery operating in the GoC (Subdivision 9.a S), since the anchovy fishery in the division was traditionally concentrated there. Data from the Spanish fishery in Subdivision 9.a N were usually not available since commercial landings used to be almost negligible. The same reason is also valid for the Portuguese subdivisions (included the Portuguese part of the 9.a S (Algarve), although in this case anchovy was also a group 3 species in its national sampling program for DCF. Nevertheless, the local increases of anchovy abundance in subdivisions 9.a N and C-N recorded since 2014 have led to a circumstantial exploitation of the species by the fleets operating in those areas. The respective national sampling programmes accounted for this event those years but in an accidental way. A higher sampling effort has been made in the port of

Matosinhos (9.a C-N) since 2017 to have monthly biological data of anchovy in that area that represents the bulk of catches in the western component.

Quarterly LFDs and ALKs from the Spanish fishery in subdivision 9.a S in 2023 were available and showed a relatively good coverage. Quarterly ALKs were based on commercial samples only (first and second quarters), survey samples only (*ECOCADIZ-RECLUTAS* survey for the fourth quarter) or by combining commercial and survey samples (*ECOCADIZ* survey for the third quarter). LFDs from bottom-trawl discards were available in all of the quarters when they were estimated.

LFDs from the Portuguese fishery in 2023 were not provided to this WG given that only 3% of the Portuguese catches occurred in the 9.a South (Algarve) subdivision.

No age structure is available for 2023 Portuguese anchovy catches in subdivision 9 a. S (Algarve), related to the low catches observed in that area.

Length data from the 2024 GoC anchovy fishery were not available to the WG. These data used to be provided by the corresponding national submitters the next year after being recorded (in this case in 2025) to comply with the WGHANSA Data Call requirements. As a proxy, averaged quarterly 2021-2023 LFDs of total landings of the whole fishery (Spanish and Portuguese) were estimated and used to derive the corresponding quarterly landings-at-age (**Figure 4.3.5.1**). Quarterly ALKs from the GoC Spanish fishery in 2024 were available and used to structure total landings making use the quarterly LFDs estimated as above mentioned.

### 4.3.5.1 Length distributions

Quarterly LFDs from the Spanish catches in 2023 for the whole fishery is shown in **Table 4.3.5.1.1**. Size range of the exploited stock (landings plus discards) in the whole fishery varied between 3.5 and 17.0 cm size classes, with the main modal class located at the 10.5 cm size class and very secondary modes at the 4.0 cm and 16.0 cm size classes. Anchovy mean length and weight in the Spanish 2023 annual catch (11.2 cm and 9.4 g) were lower than in previous years as a consequence of the increase of age 0 fish in the catches. In any case, they used to be the smallest anchovies in the division.

No length composition is available from the Portuguese fishery in this subdivision neither in 2023 nor 2024 since the catches were very scarce.

(Provisional) quarterly LFDs from the total landings in 2024 for the whole GoC fishery are shown in **Table 4.3.5.1.2**. Size range of landings varied between 8.0 and 16.5 cm size classes, with the modal class located at 10.5 cm size class and a mean length in 2024 annual landings estimated at 11.7 cm size class.

### 4.3.5.2 Catch numbers-at-age

**Table 4.3.5.2.1** shows the quarterly and annual anchovy catches-at-age in the Spanish fishery in 2023. Total catches in the Spanish fishery in 2023 were estimated at 779 million fish, which accounted for 47% increase in relation to the 530 million caught during the previous year. Such an increase resulted from 78% and 46% increases of ages 0 (the dominant age group) and 1 and 64% decrease of age 2, respectively. Age 1 group is the dominant age group (75% of the total catch in numbers). The occurrence of age group 3 anchovies in the fishery was incidental.

The recent historical series of annual landings-at-age in the Spanish fishery in 9.a South is shown in **Table 4.3.5.2.3** and **Figure 4.3.5.2.1**. Description of annual trends of landings-at-age data from the Spanish fishery through the available data series is given in previous WG reports.

No data are available from the Portuguese fishery in this subdivision since the catches were very low.

(Provisional) quarterly and annual anchovy landings-at-age in the whole fishery in 2024 is shown in **Table 4.3.5.2.2**.

### 4.3.6 Mean length and mean weight-at-age in the catch

The 2023 estimates of the mean length and weight-at-age of Gulf of Cadiz anchovy Spanish catches are shown in **Tables 4.3.6.1** and **4.3.6.2**, respectively. The same estimators for the provisional landings for the whole GoC fishery in 2024 are shown in **Tables 4.3.6.3** and **4.3.6.4**. **Figure 4.3.6.1** shows the recent history of the evolution of such estimates. Anchovy mean length and weight in the Spanish 2023 annual catches were estimated at 11.2 cm and 9.4 g, respectively. Such estimates were lower, especially the mean weight, than those ones recorded in the previous year. In 2023, all the age groups but age 0 experienced decreases in the mean length and weight in catches. Mean length and weight in the provisional landings in 2024 from the GoC whole fishery were estimated at 11.9 cm and 11.7 g, respectively, experiencing both variables a slight increase as compared with the previous year's estimates.

## 4.4 Fishery-independent Information

**Table 4.4.1** shows the list of acoustic and DEPM surveys providing direct estimates for anchovy in Division 9.a. The WG considers each of these survey series as an essential tool for the direct assessment of the population in their respective survey areas (subdivisions) and recommends their continuity in time, mainly in those series that are suffering from interruptions through its recent history.

### 4.4.1 DEPM-based SSB estimates

***BOCADEVA* series**

Anchovy DEPM surveys in the division are only conducted by IEO for the SSB estimation of Gulf of Cadiz anchovy (Subdivision 9.a-South, *BOCADEVA* survey series). The methods adopted for both the conduction of these surveys and the estimation of parameters are described in the stock annex and in ICES (2009) and Massé *et al*. (2018).

The series started in 2005 and their surveys are conducted with a triennial periodicity. Since 2014, this series has been financed by DCF. The last *BOCADEVA* survey has been conducted in summer 2023. The time-series of mean estimates and their associated variances for the egg and adult parameters, and the SSB are shown in **Table 4.4.1.1** and **Figures 4.4.1.2** and **4.4.1.3**.

***BOCADEVA 0723***

*BOCADEVA 0723* DEPM survey was carried out on board R/V *Ramón Margalef* (IEO) between 24$^{th}$ and 28$^{th}$ July 2023 surveying the Spanish and Portuguese waters of the Gulf of Cadiz between the 20 and 200 m isobaths. The survey was the DEPM component of a combined anchovy egg (*BOCADEVA*) and acoustic-trawl (*ECOCADIZ*) *ad hoc* survey (*ECO/BOCADEVA_0723* survey), which were performed one after the other, the egg survey first. PairoVET plankton samples, which were obtained from a grid of 21 parallel and 8 nm inter-spaced transects perpendicular to the coast, were utilised for the delimitation of the spawning area and the estimation of egg densities required for the estimate of the daily egg production. The fishing hauls providing samples for the estimation of adult parameters (sex ratio, female mean weight, batch fecundity and spawning fraction) were carried out during the *ECOCADIZ 2023-07* acoustic-trawl survey, a survey which was conducted just after the egg survey finished. A summary of the survey's results is given by Ramos *et al.* (Presentation 2024).

A total of 139 PairoVET stations were carried out, with 65 stations (47%) showing presence of anchovy eggs (positive stations), which yielded a total of 1736 anchovy eggs, with total and maximum egg densities estimated at 22 588 and 4260 eggs/m², respectively. Anchovy eggs presented a patched distribution along the area (**Figure 4.4.1.1**). In two stations were found more than 4000 eggs/m²; two stations with 1700-2500 eggs/m², and the rest of stations with less than 1000 eggs/m² (ranging between 0.8 and 943 egg/m²). The highest abundances were found in two stations located close to the Guadalquivir river mouth area (4260 eggs/m²), in Spanish waters, and in front of Portimão, in Portuguese waters (4023 eggs/m²). The 54.6% and the 45.4% of the eggs were caught to the East and West of Cape Sta. Maria, respectively. The station where the maximum abundance was registered was at 50 m depth, to west to Cape Sta. Maria, with the temperature and salinity being recorded at 21.15 ºC - 36.41 psu, respectively.

The total spawning area ($A$+) was estimated at 5662 km², experiencing a strong reduction in relation to the highest estimate in the time-series estimated in the previous survey in 2020 (10 058 km²), but only somewhat lower than the time-series average. Daily ($P_0$, 182 eggs/m²/day) and total egg production ($P_{total}$, 1.03 eggs x$10^{12}$/day) estimates also drop in relation to their respective historical maxima also achieved in the 2020 survey (**Figure 4.4.1.2**). Adult parameters estimated so far did not show significant differences with the more recent estimates. The values of the mean estimates and their associated variances for the egg and adult parameters, and the SSB estimates are summarized in **Table 4.4.1.1**. Given that the spawning fraction estimate ($S$) is not yet available (the histological analysis is still in progress) and the constancy of the point estimates throughout the time-series, a provisional SSB estimate has been derived by using the time-series average of $S$. The resulting provisional SSB estimate, 15 138 t (CV=0.62), is the second time-series historical minimum (**Figure 4.4.1.3**) and shows very close to those estimates provided by the acoustic surveys conducted in spring and summer 2023.

The time-series of mean estimates and their associated variances for the egg and adult parameters, and the SSB are shown in **Table 4.4.1.1** and **Figures 4.4.1.2** and **4.4.1.3**.

## 4.4.2 Spring/summer acoustic-trawl surveys

#### General

A description of the available acoustic surveys providing estimates for anchovy in Subdivision 9.a South is given in the stock annex. Survey's methodologies deployed by the respective national Institutes (IPMA and IEO) are also thoroughly described in Massé *et al.* (2018) and Doray *et al.* (2021).

A summary list of the available acoustic and DEPM surveys providing direct estimates for anchovy in Subdivision 9.a South is given in **Table 4.4.1**. Detailed information in the present section will be provided for those surveys carried out during the elapsed time between 2023 and 2024 WGHANSA meetings.

#### *PELAGO series*

#### *PELAGO 24*

The *PELAGO 24* survey was conducted from 1st to 24th March on board R/V *Miguel Oliver*. Seventy-one (71) transects were acoustically sampled between Caminha and Cape Trafalgar (30-200 m depth). A total of 26 pelagic trawl hauls were carried out by the research vessel; 29 additional hauls were done by 1 purse-seiner (see Annex 6 for a summary of the performance of the survey in 2024). The distribution and species composition of all of these hauls are shown in **Figure 4.4.2.1**.

Regarding the mapping of acoustic energy, anchovy was distributed throughout the 9.a CN and the northern part of 9.a CS around Lisbon and was also concentrated in the 9.a S (CAD). The distribution along the 9.a CN extending further south, in the northern 9.a CS area, is similar to the previous year (**Figure 4.4.2.1)**.

Anchovy acoustic estimates from this survey were provided to WGHANSA-1 in late May and used for the provision of the corresponding catch advice for the western and southern components of the former anchovy stock in Division 9a. Those estimates for the whole surveyed area were 4014 million fish and 44 401 t. For the Gulf of Cadiz those estimates were of 1968 million fish and 12 497 t (PT: 1 million fish, 4 t; ES: 1967 million fish, 12 493 t). However, right at the beginning of the WGHANSA-2 meeting, the group was informed by IPMA of an error detected in the final computation of such estimates. The following values described herein correspond to these new estimates.

Anchovy acoustic estimates for the whole surveyed area were 10 935 million fish and 105 997 t (**Table 4.4.2.1**).

In the Subdivision 9.a South, were estimated 3201 million fish and 18 088 t (**Table 4.4.2.1**; **Figure 4.4.2.2**). The Spanish waters concentrated most of the population (99.3% and 98.8% of abundance and biomass, respectively). The above 2024 estimates accounted for -10% and -32% decreases in abundance and biomass in relation to those estimated in the 2023 survey (3551 million fish, 26 785 t; **Table 4.4.2.1**; **Figure 4.4.2.3**). In Portuguese waters (Algarve) were estimated a total of 22 million fish and 211 t which accounted for +61% increase and -44% decrease of population levels in number and biomass, respectively, in relation to the last year (14 million fish, 374 t; **Tables 4.4.2.1** and **4.4.2.3**, **Figures 4.4.2.2**, **4.4.2.3** and **4.4.2.4**). The estimated population in the Algarve waters ranged between 10.0 and 15.0 cm size classes, with a mode at 11.5 cm size class (**Figure 4.4.2.2**). In the Spanish waters were estimated a total of 3179 million fish and 17 877 t, entailing a decrease of -10% and -32% in abundance and biomass, respectively, in relation to the previous year's estimates (3537 million fish, 26 411 t; **Table 4.4.2.2**, **Figure 4.4.2.5**). The estimated population in the GoC Spanish waters ranged between 7.0 and 15.0 cm size classes, with a main mode at 8.5 cm size class and a secondary mode at 11.5 cm size class (**Figure 4.4.2.2**).

Age 1 fish accounted for 74.2% (2376 million fish) and 54.7% (9895 t) of the total estimated abundance and biomass in this subdivision, respectively (**Table 4.4.2.3**; **Figure 4.4.2.2**). Age 2 fish represented 25.8% and 45.3% of the total abundance and biomass, while Age 3 fish were absent from 9aS (**Table 4.4.2.3**; **Figure 4.4.2.2**).

**Table 4.4.2.1** track the historical series of anchovy acoustic estimates from *PELAGO* surveys in the Division 9.a. Biomass levels in the subdivision 9.a South, after experiencing an increasing trend started in 2018 which peaked in 2020 have shown consecutive drops in 2021 and 2022 down to levels well below the historical average and an increase in 2023 followed by a slight decrease in 2024 (**Figure 4.4.2.3**).

Size composition and age structure of the population estimated in the southern stock through the time-series was described in previous reports. In **Table 4.4.2.3** and **Figure 4.4.2.4** we revisit the trends observed in the age structure of the population as estimated by the *PELAGO* and *ECOCADIZ* survey series. As described in previous reports, Portuguese acoustic estimates for anchovy until 2013 were not provided age-structured to the WG. The age readings of *PELAGO* since 2020 were revised this year and presented to the Benchmark (WKBANSP) data call, following the detection of some inconsistencies last year in the reading that led to an inter-calibration exercise between Spanish and Portuguese age readers.

The population age structure in previous years suggests strong 2000, (exceptionally) 2001, and 2006-year classes, with the last one still being present in 2009 (as age 3 anchovies). The strength of the 2007, 2008- and 2009-year classes decreased in relation to that observed for the 2006 year-class: population numbers of age 1 anchovies in 2008, 2009 and 2010 showed 49.7%, 43.3% and 68.9% decreases in relation those ones estimated in 2007. Notwithstanding the above, the extreme situation that the population reached in spring 2011, when no anchovy was detected in the *PELAGO* acoustic survey, seems uncertain because the observation of high egg densities during the survey is not consistent with the null detection of biomass with acoustics and with the estimates provided by the *BOCADEVA* DEPM survey (32.7 kt) some months later. These reasons led to the WG to consider the 2011 acoustic estimate with caution. The population age structure in 2013 suggests a failed recruitment, which, however, seems to show clear signs of progressive recovery in the three following years, especially in 2016. The decreased population levels in 2017 pointed again to a failed incoming recruitment. The situation in 2018 and 2019 seems to be quite similar to the one occurring in 2015–2016. Conversely, the 2020, 2021- and 2022-year classes show again a low strength.

#### *ECOCADIZ series*

#### *ECOCADIZ 2023-07*

The *ECOCADIZ 2023-07* Spanish (pelagic ecosystem-) acoustic-trawl survey was conducted by IEO between July 29th and August 8th 2023 in the Portuguese and Spanish shelf waters (20-200 m isobaths) off the Gulf of Cádiz (GoC) onboard the R/V *Ramón Margalef*. The survey was the acoustic component of a combined anchovy egg (*BOCADEVA*) and acoustic-trawl (*ECOCADIZ*) *ad hoc* survey (*ECO/BOCADEVA_0723* survey), which were performed one after the other, the egg survey first. This year's acoustic survey was marked by a reduction of 3-4 days to the usual survey length (ca. 14 days at sea), due to the R/V tight schedule.

The survey design consisted in a systematic parallel grid with 21 transects equally spaced by 8 nm, normal to the shoreline. A total of 16 valid fishing hauls (between 28-164 m depth) were carried out for echo-trace ground-truthing purposes. Four additional night trawls were conducted to collect anchovy females with hydrated ovaries (DEPM-adult *ad hoc* sampling) (**Figure 4.4.2.5**). CUFES sampling was not used in the survey because logistical problems. The census of top predators was not recorded during the survey because of the accommodation for at least one onboard observer was not available. A total of 74 CTD (with coupled altimeter, oximeter, fluorometer and transmissometer sensors) -LADCP casts, and sub-superficial thermosalinograph-fluorometer and VMADCP continuous sampling were carried out to oceanographically characterize the surveyed area. A detailed description of the *ECOCADIZ 2023-07* survey methods and results are given in Ramos *et al*. (WD 2024a).

Chub mackerel (69%) was the most frequent small pelagic species in the valid hauls, followed by anchovy, sardine and horse mackerel *Trachurus trachurus* (the three with 56% occurrences each). Mediterranean horse mackerel *T. mediterraneus*, longspine snipefish *Macroramphosus scolopax* and pearlside *Maurolicus muelleri* (13% each) showed an incidental occurrence in the hauls performed in the surveyed area. Chub mackerel, anchovy and longspine snipefish showed the highest yields in these hauls (**Figure 4.4.2.5**).

The estimate of total NASC allocated to the "pelagic fish species assemblage" (95 940 $m^2$ $nmi^{-2}$) has shown 63% lower than the maximum value recorded throughout the time-series, estimated in 2020 (229 241 $m^2$ $nmi^{-2}$), and 28% below the historical mean (118 395 $m^2$ $nmi^{-2}$). Sardine (46%), chub mackerel (17%), anchovy (16%) and Mediterranean horse-mackerel (12%) were the main contributors to the total NASC.

Gulf of Cadiz anchovy was widely distributed in the surveyed area, although it showed very low acoustic densities in the easternmost and westernmost waters. High densities were mainly recorded between Ayamonte and the Bay of Cadiz. Anchovy showed lower densities in Algarve waters than in previous years, and somewhat similar to what was recorded in the *PELAGO* 2023 spring survey (**Figure 4.4.2.5**).

Overall anchovy acoustic estimates in summer 2023 were of 1479 million fish and 9714 t (**Table 4.4.2.2**; **Figures 4.4.2.6** and **4.4.2.8**), which accounted for 71% and 78% decreases in abundance and biomass, respectively, as compared to 2020 estimates (5153 million, 44 886 t). Current overall estimates are also well below the time-series average (*i.e.* 2424 million, 26 368 t; see **Table 4.4.2.2** and **Figure 4.4.2.8**). By geographical strata, the Spanish waters yielded 82% (1216 million) and 81% (7933 t) of the total estimated abundance and biomass in the Gulf, highlighting the importance of these waters in the species' distribution, but also the noticeable regional decrease experienced by the species in the Spanish waters. The estimates for the Portuguese waters were 263 million and 1781 t (**Table 4.4.2.2**; **Figures 4.4.2.6** and **4.4.2.8**).

The size class range of the assessed anchovy population in summer 2023 ranged between the 2.0 and 19.0 cm size classes. The size distribution showed a mixed composition, with one main mode at 13.0 cm, and with a small proportion of individuals being observed at 2.0 cm. It is noticeable the occurrence of this last modal size during summer, as it is a consequence of the record of very tiny juveniles in the coastal waters located in front of Faro, Portugal. The size composition of anchovy throughout the surveyed area confirms the usual pattern exhibited by the species during the survey season, with the largest (and oldest) fish being distributed in the westernmost waters, although individuals belonging to the smallest size classes were also observed in the Algarve (**Figure 4.4.2.6**).

The population was composed by fishes not older than 2 years. Age 0 fish accounted for 75% (1069 million) and 58% (5710 t) of the total estimated abundance and biomass, respectively (**Table 4.4.2.3**; **Figure 4.4.2.7**). Spanish waters not only concentrated the bulk (88%) of this juvenile fraction, but also 79% (263 million) of age-1 group. The estimates of age-0 fish experienced a similar trend than the one showed by the whole population in relation to the historical peak recorded in 2019 and the values recorded in 2020. The recent strong decreasing trends for the whole population seem to have increased in 2023, with the 2023 estimates being well below their time-series averages (**Tables 4.4.2.2** and **4.4.2.3**; **Figure 4.4.2.8**). Age 1 fish represented 23% and 39% of the total abundance and biomass, while Age 2 fish accounted for <1% of the total abundance and biomass (**Table 4.4.2.3**; **Figure 4.4.2.7**).

The 2023 summer estimates of mean size and weight of the whole population (9.4 cm, 11.3 g) were somewhat lower than their respective time-series averages (12 cm, 12.2 g).

Time-series of available estimates so far are shown in **Table 4.4.2.2** and **Figure 4.4.2.8**. **Table 4.4.2.3** shows the time-series of population estimates at age in the southern component estimated by *PELAGO* and *ECOCADIZ* surveys (see also **Figure 4.4.2.4**).

The 2023 survey will be the last one in its series. No more *ECOCADIZ* surveys are planned to be conducted in the next years.

## 4.4.3 Recruitment acoustic-trawl surveys

#### ***ECOCADIZ-RECLUTAS*** **survey series**

#### ***ECOCADIZ-RECLUTAS 2023-10***

*ECOCADIZ-RECLUTAS 2023-10* Spanish (pelagic ecosystem-) acoustic-trawl survey was conducted by IEO between 29th September and 13th October 2023 in the Portuguese and Spanish shelf waters (20-200 m isobaths) off the Gulf of Cádiz (GoC) onboard the R/V *Ramón Margalef.* The survey design consisted in a systematic parallel grid with 21 transects equally spaced by 8 nm, normal to the shoreline. The survey's main objective is the acoustic assessment of anchovy, sardine and chub mackerel juveniles (age 0 fish) in the GoC recruitment areas. The surveys in this series have experienced a successive reduction in ship-time up to the 15-16 days in 2022-2023. Additionally, the 2023 survey invested half working day in picking up a spare pelagic trawl gear to the nearest port and it finished one day before the schedule due to logistic reasons. Furthermore, the start and direction of the acoustic sampling had to be shifted to a W to E direction because NATO naval maneuvers which entailed a shortening of the available time to sample Spanish waters. Results from this survey have been reported to this WG by Ramos *et al*. (WD 2024b).

The 21 foreseen acoustic transects were sampled. A total of 13 valid fishing hauls were carried out for echo-trace ground-truthing purposes. Horse mackerel, sardine and anchovy, were the most frequent captured species in the fishing hauls, followed by chub mackerel, Mediterranean horse mackerel, bogue, round sardinella and Atlantic mackerel. Longspine snipefish, boarfish and pearlside showed an incidental occurrence in the hauls performed in the surveyed area. Anchovy, sardine and chub mackerel showed the highest yields in these hauls, followed by Mediterranean horse mackerel and horse mackerel (**Figure 4.4.3.1**).

The estimate of total NASC allocated to the "pelagic fish species assemblage" in this survey (84 191 $m^2 nmi^{-2}$) was 21% lower than that recorded last year (107 026 $m^2$ $nmi^{-2}$) and 28% below the historical mean (118 395 $m^2$ $nmi^{-2}$). Such a decrease was more noticeable in Portuguese waters. By species, sardine accounted for 34% of this total back-scattered energy, followed by horse mackerel (26%), chub mackerel (14%) and anchovy (13%), with the remaining species showing relative contributions of acoustic energies lower than 10%.

GoC anchovy was widely distributed in the surveyed area in autumn 2023, although it showed low acoustic detections in the easternmost waters. Higher densities were mainly recorded in two areas: between Ayamonte and the Bay of Cadiz and between Cape San Vicente and Cape Santa Maria (**Figure 4.4.3.1**). Overall anchovy acoustic estimates in autumn 2023 were of 816 million fish and 8300 t (**Table 4.4.3.2**; **Figure 4.4.3.2**), accounting for 55% and 30% decreases in abundance and biomass, respectively, as compared to last year's estimates (1836 million, 11 912 t). Current overall estimates are also lower than the time-series average (*i.e.* 2686 million; 21 276 t), and this year's abundance estimate is the lowest of the time series (see **Table 4.4.3.2** and **Figure 4.4.3.7**). By geographical strata, the Spanish waters yielded 88% (716 million) and 73% (6073 t) of the total estimated abundance and biomass in the Gulf, highlighting the importance of these waters in the species' distribution. The estimates for the Portuguese waters were 100 million and 2227 t (**Table 4.4.3.2**; **Figure 4.4.3.2**).

The size class range of the assessed anchovy population in autumn 2023 ranged between the 5.5 and 17.5 cm size classes. The size distribution showed a mixed composition, with one main mode at 9.5 cm, a secondary mode at 13.0 cm, and with a small proportion of individuals being observed at 7.5 cm. The size composition of anchovy throughout the surveyed area confirms the usual pattern exhibited by the species during the survey season, with the largest (and oldest) fish being distributed in the westernmost waters and the smallest (and youngest) ones concentrated in the surroundings of the Guadalquivir river mouth and adjacent shallow waters (**Figure 4.4.3.2**).

The population was composed by fishes not older than 2 years. Age 0 fish accounted for 78% (639 million) and 57% (4723 t) of the total estimated abundance and biomass, respectively (**Table 4.4.3.2**; **Figure 4.4.3.3**). Spanish waters concentrated the bulk (97%, 623 million fish) of this juvenile fraction and 53% (90 million) of age-1 group. The estimates of age-0 fish experienced a similar trend than the one showed by the whole population in relation to the historical peak recorded in 2019 and the values recorded in 2020. The recent strong decreasing trends for the whole population and juveniles seem to have increased in 2023, with the 2023 estimates being well below their time-series averages (**Table 4.4.3.2**; **Figure 4.4.3.7**). Age 1 fish represented 20% and 40% of the total abundance and biomass, while age 2 fish accounted for <1% of the total abundance and biomass (**Figure 4.4.3.3**).

The 2023 autumn estimates of mean size and mean weight of the whole population were higher (11.0 cm, 12.7 g) than their respective time-series averages (11.1 cm, 9.5 g).

#### *ECOCADIZ-RECLUTAS 2024-10*

*ECOCADIZ-RECLUTAS 2024-10* survey was also conducted on board the Spanish IEO R/V *Ramón Margalef*. The adjustment of the survey to the R/V calendar entailed a reduction of ca. 3-4 days (12 days at sea) in relation to the usually planned days (15-16 days at sea). The survey was conducted between the 18$^{th}$ and 30$^{th}$ October, covering a survey area which comprised the GoC waters, both Spanish and Portuguese, between the 20 m and 200 m isobaths. Results from this survey have been reported to this WG by Ramos *et al*. (WD 2024c).

The complete grid (21 transects) was acoustically sampled. A total of twenty (20) fishing operations were performed during the survey for echo-trace ground-truthing, of which one was not valid due to problems with the performance of the fishing gear. The number of valid pelagic trawl fishing hauls was similar to usual one (usually ca. 20 hauls per survey) and reflected the high fish densities observed this year. Chub mackerel and horse mackerel were the most frequent small pelagic species in the valid hauls, followed by sardine, bogue, anchovy, Atlantic mackerel, Mediterranean horse mackerel, boarfish and blue jack mackerel. Transparent goby, longspine snipefish and round sardinella showed an incidental occurrence in the hauls performed in the surveyed area. Anchovy, sardine and chub mackerel showed the highest yields in these hauls, followed by horse mackerel (**Figure 4.4.3.4**).

The estimate of total NASC allocated to the "pelagic fish species assemblage" in this survey (98 860 $m^2$ $nmi^{-2}$) was 16% higher than that recorded last year (84 191 $m^2$ $nmi^{-2}$) and 16% below the historical mean (118 395 $m^2$ $nmi^{-2}$). By species, anchovy accounted for 35% of the total back-scattered energy, followed by sardine (26%) and chub mackerel (22%), with the remaining species showing relative contributions of acoustic energies lower than 10%.

GoC anchovy (35% of the total NASC attributed to fish) was widely distributed in the surveyed area, although it showed very low acoustic detections in the easternmost waters. Higher densities were mainly recorded in two areas: between Ayamonte and the Guadalquivir river mouth and between Rota and Sancti-Petri (**Figure 4.4.3.4**). Overall anchovy acoustic estimates in autumn 2024 were of 3183 million fish and 25 184 t (**Table 4.4.3.2**; **Figure 4.4.3.5**), accounting for 290% and 203% increases in abundance and biomass, respectively, as compared to last year's estimates (816 million, 8 300 t). Current overall estimates are slightly higher than the time-series average (*i.e.* 2920 million; 22 989 t), and this year's abundance estimate is the fifth highest of the time series (see **Table 4.4.3.2** and **Figure 4.4.3.7**). By geographical strata, the Spanish waters yielded 92% (2935 million) and 78% (19631 t) of the total estimated abundance and biomass in the Gulf, highlighting the importance of these waters in the species' distribution. The estimates for the Portuguese waters were 248 million and 5553 t (**Table 4.4.3.2**; **Figure 4.4.3.5**).

The size class range of the assessed anchovy population in autumn 2024 varied between the 8.0 and 18.0 cm size classes. The size distribution showed a mixed composition, with one main mode at 9.5 cm, a secondary mode at 13.0 cm, and with a small proportion of individuals being observed at 7.5 cm. The size composition of anchovy throughout the surveyed area confirms the usual pattern exhibited by the species during the survey season, with the largest (and oldest) fish being distributed in the westernmost waters and the smallest (and youngest) ones concentrated in the surroundings of the Guadalquivir river mouth and adjacent shallow waters (**Figure 4.4.3.5** and **4.4.3.6**).

The population was composed by fishes not older than 2 years. Age 0 fish accounted for 82% (2629 million) and 64% (15 842 t) of the total estimated abundance and biomass, respectively (**Table 4.4.3.2**; **Figure 4.4.3.6**). Spanish waters concentrated the bulk (99%) of this juvenile fraction and 69% (328 million) of age-1 group. The estimates of age-0 fish experienced a similar increasing trend than the one showed by the whole population in relation to the decreasing trend observed since 2021. This year sharp increase for the whole population and juveniles seems to have increased population levels to their time-series averages (**Table 4.4.3.2**). Age 1 fish represented 15% and 29% of the total abundance and biomass, while age 2 fish accounted for <1% of the total abundance and biomass (**Figure 4.4.3.6**).

The 2024 autumn estimates of mean size and mean weight of the whole population were slightly lower (10.7 cm, 7.9 g) than their respective time-series averages (11.1 cm, 9.5 g).

The time-series of survey estimates is shown in **Figure 4.4.3.7**. The time-series of the estimated biomass of age-0 fish from these autumn surveys become as the recruitment index used as input data in the SS3 assessment model. **Figure 4.4.3.8** shows the correspondence between acoustic estimates of abundance of age-0 anchovies from *ECOCADIZ-RECLUTAS* surveys in the autumn of the year *y* against the abundance of age-1 anchovies estimated in spring of the following year (*y+1*) by the

*PELAGO* survey and in summer by the *ECOCADIZ* survey. Some positive relationship seems to be suggested when the most recent *ECOCADIZ-RECLUTAS* and *PELAGO* surveys estimates are compared.

# 4.5 Biological data

## 4.5.1 Weight-at-age in the stock

GoC anchovy weight-at-age was estimated using quarterly data from the *SEINE* fleet and acoustic surveys (*PELAGO*, *ECOCADIZ*, and *ECOCADIZ-RECLUTAS*) through linear mixed-effects models. Log-transformed weight served as the dependent variable, with age as a fixed effect and year as a random effect to account for interannual variability. These estimates cover the period 1989–2024 for ages 0 to 3.

**Figure 4.5.1.1** illustrates the weight-at-age at the beginning of each season based on these estimates. The average weight differences among age groups remain relatively stable over time, with some quarterly variability. Individuals aged 3 exhibit greater variability in average weight compared to younger age groups. Further details on the calculations are provided in the stock annex.

## 4.5.2 Maturity-at-Age

Due to some inconsistencies in the maturity ogives not noticed during WKPELA 2018, that still remain, it was assumed that all individuals with age 1 or higher (B1+), are mature, *i.e.* these abundance estimates result equivalent to spawning stock biomass (SSB) estimates. A description of the rationale and whole process for deriving the above estimates is shown in the stock annex.

## 4.5.3 Natural mortality

Natural mortality (M) for this stock is unknown. The following age-specific estimates of M were adopted during WKBANSP 2024 (ICES, 2024a): M0=2.97 (based on the Gislason methodology), M1=1.6, and M2=M3=2.48 (derived from likelihood profiles). The rationale and detailed process for deriving these estimates are provided in the stock annex.

# 4.6 Stock Assessment

## 4.6.1 Model assumptions and settings and parameter estimates

The assessment of the anchovy in ICES subdivision 9a South was performed in Stock Synthesis (SS3) (Methot and Wetzel, 2013). SS3 is a generalised age and/or length-based model that is very flexible regarding the types of data that may be included, the functional forms that are used for various biological processes, the level of complexity and number of parameters that may be estimated. The model is coded in C++ with parameter estimation enabled by automatic differentiation (www.admb-project.org) and available at the NOAA Fisheries integrated toolbox: https://noaa-fisheries-integrated-toolbox.github.io/SS3. A description and discussion of the model can be found in Methot and Wetzel (2013).

The stock assessment of anchovy in ICES subdivision 9a South was conducted for the period 1989–2024, following the methods and configurations agreed upon during the benchmark (ICES, 2024a). This quarterly, age-based, single-area model considers a population composed of four age classes (0–3 years, with age 3 as the maximum) and combines sexes (males and females are modelled together). Input data include total catch (in biomass) and age composition (in proportion) from the commercial *SEINE* fleet, as well as abundance (in biomass) and age composition (in proportion) from the *PELAGO* and *ECOCADIZ* surveys. Age composition data from *PELAGO* are included only for the period 2014–2024, during which age-length keys were available, as specified by WKPELA 2018. The biomass index from the *ECOCADIZ-RECLUTAS* survey, based on the biomass of age-0 individuals, provides a direct measure of recruitment, while spawning stock biomass (SSB) estimates are derived from the triennial *BOCADEVA* survey using the daily egg production method (DEPM). To account for seasonal variability in catches, the *SEINE* fleet was divided into four quarterly fleets. Following the new assessment calendar (annual WG assessment in November of year y), the data considered in the assessment correspond to year y, defined as the final year according to ICES terminology. **Figure 4.6.1.1** provides a visual representation of the input data used in the model, categorized into three main types: catches, abundance indices, and age compositions. These data are displayed over time (years) and are represented by circles, with the size of each circle reflecting the magnitude of the data.

Spawning occurs at the beginning of April, and settlement is set at the beginning of July. Age-specific natural mortality was fixed as M0=2.97 (Gislason methodology) and M1=1.6, M2=M3=2.48 (from likelihood profiles). All individuals were assumed to mature at age 1, with no maturity at age 0, and growth was not explicitly modelled. Recruitment was based on lognormal deviations from the Beverton-Holt curve, with equilibrium recruitment (R0) estimated, steepness (h) fixed at 0.8, and sigmaR = 0.33. Early recruitment deviations were estimated starting from 1962.8 with a recruitment bias adjustment ramp applied, and main period deviations were estimated for 1991–2024. The initial population, assumed to be in equilibrium, was calculated based on age composition data and average catches (1989–1994) for each season, with initial catches set as Q1=1208, Q2=2033, Q3=683, and Q4=223 tonnes. Fishing mortality was calculated using the hybrid F method, aligning observed catches with tuned F values. Surveys were treated as relative abundance indices, with catchability modelled via a q linear model, and selectivity was defined as logistic functions fixed over time, except for *BOCADEVA*, where selectivity was set at 1 from age-1, and *ECOCADIZ*, which was split into two periods (2004–2014 and 2015–2024) to account for differences in age patterns. Data weights were set with standard errors of 0.05 for catches and 0.3 for surveys, and age compositions were modelled using a multinomial error structure with a sample size of 100, adjusted iteratively using the Francis method (Francis, 2011) over five iterations.

A summary of the model key model assumptions and parameters for the Stock Synthesis as defined in ICES (2024a) is available in **Table 4.6.1.1**.

Variance estimates for all estimated parameters are calculated from the Hessian matrix. Minimisation of the likelihood is implemented in phases using standard ADMB processes. The phases in which estimation will begin for each parameter are shown in the control file available in the TAF repository for this stock (https://github.com/ices-taf/2024_ane.27.9a_south_assessment_new). The R packages r4ss (version 1.50.0; Taylor et al., 2021) and ss3diags (version 1.10.3; Carvalho et al., 2021) were employed to process and visualise the model outputs. All analyses were conducted in R version 4.4.1 (2024-06-14).

The summarized results of the stock assessment are shown in **Table 4.6.1.2**. The spawning stock biomass (SSB) has a historical mean of 14.16 thousand tonnes, with a maximum of 23.96 thousand tonnes recorded in 2001 and a minimum of 7.08 thousand tonnes in 2010. Confidence intervals range from 0.27 to 0.11, with an average of 0.19. In 2024, the SSB is estimated to be 24% below the historical mean and 5% higher than the 2023 estimate.

Recruitment (Rt) has a historical mean of 8.1 billion recruits, with a maximum of 11.98 billion recruits in 2000 and a minimum of 3.48 billion recruits in 2009. Confidence intervals vary from 0.26 to 0.1, with an average of 0.17. In 2024, recruitment is estimated to be 7% below the historical mean and 19% higher than the 2023 estimate

Fishing mortality (F) has a historical mean of 0.82, with a maximum of 1.79 recorded in 2024 and a minimum of 0.08 in 1995. Confidence intervals range from 0.35 to 0.22, with an average of 0.29. In 2024, F is estimated to be 118% above the historical mean and 1.7% higher than the 2023 estimate.

**Figure 4.6.1.2** provides a comparison between the Final Assessment (1989–2024) and the Last Year Assessment conducted during WKBANSP 2024 (ICES, 2024a) for the period 1989–2023. The updated data from the Final Assessment 2024 adjust the trends estimated in the Last Year Assessment for 2023, indicating a 31% reduction in fishing mortality (F), a 48% increase in recruitment, and a 17% increase in spawning stock biomass (SSB) for that year.

## 4.6.2 Reliability of the assessment

**Figure 4.6.2.1** presents the biomass data from the surveys used as input in the SS3 model, along with the estimated catchability parameters. The results indicate that catchability values greater than 1 are associated with the highest biomass levels recorded by the *BOCADEVA* survey, which consistently reports the highest biomass compared to other surveys conducted in the same years. The *PELAGO* survey follows, with elevated biomass values observed in 2016, 2020, and 2023, while the *ECOCADIZ* survey shows a peak in 2019. In contrast, the estimated catchability for the *ECOCADIZ-RECLUTAS* survey is below 1. Notably, the biomass data entered for *ECOCADIZ-RECLUTAS* corresponds exclusively to age-0 biomass rather than total biomass.

**Figure 4.6.2.2** compares biomass estimates from the SS3 model with data from surveys. The SS3 model estimates exhibit a stable trend with moderate fluctuations over time. In contrast, survey data show greater variability. The *PELAGO* survey demonstrates high variability, with notable peaks in specific years, such as 2020. *ECOCADIZ* reports a distinct peak in 2019, while *BOCADEVA* consistently records the highest biomass values, with significant increases in certain years. *ECOCADIZ-RECLUTAS*, representing age-0 biomass, consistently reports lower values compared to other surveys. Biomass values from the surveys differ in magnitude and scale from SS3 model estimates. *BOCADEVA* stands out with the highest biomass values, explaining its elevated catchability estimates. In comparison, *PELAGO* and *ECOCADIZ* align more closely with SS3 estimates in some years, despite occasional peaks in biomass.

The catch standard error is set at 0.05, assuming the catch is known. This ensures that the estimates from the SS3 model align with the input catch values. Consequently, the fits to the catch data (**Figure 4.6.2.3**) show no evidence of underfitting or overfitting, providing strong support for the appropriateness of the assessment scale.

The **Figure 4.6.2.4** shows that the abundance indices from the acoustic surveys exhibit a high level of variability, as reflected by the width of the assumed confidence intervals, with a maximum coefficient of variation of 30%. The model follows the overall trend of the indices, though it encounters some difficulties in accurately fitting the extreme biomass values, both the highest and lowest. However, it adequately reproduces the general trend of variability in biomass levels presented by the survey estimates.

**Figure 4.6.2.5** shows the estimated selectivity for the age composition of the commercial fleet, modeled as logistic and constant over time. To account for seasonal patterns, the fleet was divided into four independent quarterly fleets, each operating exclusively in a specific quarter, allowing adjustments for seasonal variations in age composition. **Figure 4.6.2.6** presents the estimated selectivity for the acoustic surveys *PELAGO* and *ECOCADIZ*, also modeled as logistic. For *ECOCADIZ*, selectivity was divided into two periods (2004–2014 and 2015–2023), improving the fit to the observed age composition during the first period.

The model achieves a good fit to the observed mean lengths, except in 2020, when the length distributions for commercial catches in the first and second quarters were derived from 2018–2019 data and the 2020 *PELAGO* age-length key. This resulted in a significant deviation in the estimated mean age for that year (approximately 1.5) compared to the average observed between 2011 and 2025 (close to 1) (**Figure 4.6.2.7**). For the *PELAGO* survey, the model shows a good fit from 2014 to 2019 but tends to overestimate age-1 and underestimate age-2 during the 2020–2024 period. For the *ECOCADIZ* survey, the overall fit is adequate, although in 2020 and 2023, there is a tendency to overestimate age-1 and underestimate age-0 (**Figure 4.6.2.8**).

**Figure 4.6.2.9** shows the estimated age compositions, aggregated over time, for the *SEINE* commercial fleet and the *ECOCADIZ* and *PELAGO* acoustic surveys. All data sources are characterized by a high proportion of young individuals (ages 0 and 1), with a marked decline in older age classes. The green lines represent the model fits, demonstrating good agreement and accurate reconstruction of the aggregated age compositions. However, certain years exhibit variability in the age compositions of *SEINE*, *PELAGO*, and *ECOCADIZ*, as detailed in **Figures 4.6.2.10** to **4.6.2.15**.

Bubble plots of the residuals from the *SEINE* data fit are presented in **Figure 4.6.2.16**, while those for the survey age data fit are shown in **Figure 4.6.2.17**.

The retrospective analysis of the assessment model indicates that, according to Mohn's rho (mean of retrospective anomalies), data reduction results in a pattern of overestimation of fishing mortality (rho = 0.3348545) and underestimation of spawning biomass (rho = -0.134405) (**Figure 4.6.2.18** and **Table 4.6.2.1**). Additionally, an overestimation pattern is observed for recruitment (rho = 0.04) (**Table 4.6.2.1**). These Mohn's rho values, while mostly within the recommended bounds proposed by Hurtado-Ferro et al. (2014) for short-lived species (between -0.22 and 0.30), show a slight deviation in fishing mortality when the 2019 peel is included.

# 4.7 Reference points

$B_{lim} = B_{pa} * \exp(-1.645 * SigmaB)$ = 4 721 tonnes, with $B_{pa} = B_{loss}$ and SigmaB = 0.2 (as used in other fisheries).

Reference points were calculated following ICES guidelines for calculation of reference points for category 1 and 2 stocks. In those guidelines, the S-R plot characteristics classify this stock as a "stock type 5" (i.e. stocks showing no evidence of impaired recruitment or with no clear relation between stock and recruitment (no apparent S-R signal). According to this classification, $B_{loss}$ estimation is possible according to the standard method and it corresponds to the estimated SSB in 2010, $B_{loss}$ = 6 561 tonnes. The fact that the methodology adopted $B_{loss}$ as $B_{pa}$ instead of as $B_{lim}$, corresponds more with the guidelines for Type 6 stocks (stocks with a narrow dynamic range of SSB and showing no evidence of past or present impaired recruitment).

This new methodology compared to the previous is justified by the fact that assuming $B_{lim}$ equal to $B_{loss}$, as previously, will imply $B_{lim}=0.4*B_0$ which is a very big proportion, thus suggesting the range of biomasses being covered by the assessment was rather narrow yet. Further details on the calculations are provided in the stock annex.

## 4.8 Catch advice

The stock was benchmarked in 2024 and classified as category 1 with a short-term forecast. However, the MSY Bescapement strategy for category 1 short-lived species could not be applied as Fcap has not yet been defined.

The 2025 catch advice follows the ICES framework for category 3 short-lived stocks, applying the 1-over-2 rule (ICES, 2024c). Short-term forecasts for this and other catch scenarios are presented in **Tables 4.8.1** and **4.9.2**.

The SSB estimated by the SS3 assessment model was used as the biomass index. The advice is based on the ratio of the most recent index value (index A) to the average of the two preceding values (index B), multiplied by the average catch for 2023–2024. The 1-over-2 rule, which incorporates an 80% uncertainty cap and a biomass safeguard, is considered precautionary; therefore, no additional precautionary buffer was applied (ICES, 2012, 2024c, 2020b). As index A shows an estimated decrease of 8%, the uncertainty cap was not triggered. Discards are considered negligible.

## 4.9 Short-term projections

The SS3 projection module was used to perform short-term forecasts, incorporating the model's final year conditions, associated uncertainties, and varying fishing intensities. The initial stock size was estimated based on the abundance of ages 0–3 as of January 1 of the final assessment year, while the spawning stock biomass (SSB) was calculated for April 1. Natural mortality and maturity rates were held constant, with selectivity and weight-at-age averaged over the last four years (2021–2024). Recruitment for the forecast year was modeled using the Beverton-Holt stock-recruitment relationship in Stock Synthesis, and the status quo fishing mortality ($F_{sq}$) was based on the apical F value (maximum F at age, which corresponds with F at age 3 in this case) estimated for 2024 (**Table 4.9.1**).

Multipliers of $F_{sq}$ ($F_{sq}$ × Mult) were evaluated with values of 0, 0.8, 1, and 1.2. Additional fishing mortality alternatives, such as the average apical F in the last 5 years ($F_{mean2020–2024}$) and the median historical apical F($F_{medianhistoric}$), were also analyzed. An iterative process was applied to identify the multiplier required to achieve a 2025 catch that would result in specific probabilities of the 2025 SSB falling below Blim and Bpa. These probabilities included p($SSB_{2025}$ ≤ Blim) = 0.05 and 0.5, as well as p($SSB_{2025}$ ≤ $B_{pa}$) = 0.05 and 0.5.

**Table 4.9.2** presents the management options derived from these short-term projections, evaluated under different levels of fishing mortality. The results include projected catches for 2025 (in tons), estimated SSB for 2025 (in tons), and the probabilities of $SSB_{2025}$ falling below $B_{lim}$.

## 4.10 Management considerations

The management of anchovy in Division 9a faces significant challenges due to the complexity of its population and fishery dynamics. In 2018, the stock assessment identified two distinct components (western and southern) based on their biological and fishery characteristics. However, until the stock structure was fully resolved, advice was provided for the entire stock, with separate recommendations for each component.

Due to the stock's high natural mortality, recruitment dependence, and significant fluctuations in spawning biomass, ICES recommended in-year monitoring and alternative management measures. This led to the adoption of a management calendar from July 1 to June 30. However, a single TAC for Division 9a limited the ability to control exploitation rates effectively, increasing the risk of overexploitation, particularly for the southern component. In the past two years, catches from the southern component exceeded the recommended levels by approximately five and three times, emphasizing the need for differentiated management.

In 2024, the benchmark process (WKBANSP, ICES 2024a) confirmed the separation of the western and southern components into two independent stocks. This process introduced a new assessment model (*Stock Synthesis*), incorporated a recruitment index, and transitioned to a management calendar based on calendar years (January 1 to December 31).

Further management considerations are detailed in the stock annex.

## 4.11 Ecosystem considerations

Ecosystem considerations are described in the stock annex and there have not been remarkable changes in the last year.

## 4.12 Deviations from stock annex caused by missing information

For this year assessment, there were some deviations for the southern stock, but they were not related to the Covid-19 disruption.

Stock: ane.27.9a.S. Anchovy in the southern part of Division 9.a (Gulf of Cadiz and the southern coast of Portugal).

1. Missing or deteriorated survey data: *ECO/BOCADEVA 0723* survey was planned and conducted in summer 2023 as a combined anchovy egg (*BOCADEVA*, first leg) and acoustic-trawl (*ECOCADIZ*, second leg) *ad hoc* survey. The acoustic part (also providing DEPM adult samples) was given fewer days (11) than usual (14) and in a different RV (*Ramón Margalef* instead of *Miguel Oliver*). Notwithstanding the above, the resulting estimates are considered as valid ones and used in the assessment model since sampling methods and acoustic-trawl equipment are considered as standard. In fact, the *ECOCADIZ-RECLUTAS* survey series is conducted onboard the *Ramón Margalef*. The number of ground-truthing fishing hauls, although lower than in previous surveys, was still considered adequate for the purpose of the acoustic estimation. *ECOCADIZ* series has finished in 2023: given that there are two other acoustic-trawl series covering the Gulf of Cadiz on an annual basis (*PELAGO* in spring time and *ECADIZ-RECLUTAS* in autumn) and the lack of available ship time, this series has been suspended by IEO, as long as the surveyed area doesn`t cover the entire stock distribution of the Iberian-Atlantic sardine nor both stock components of the anchovy stock in 9a but southern stock component. Although not considered so far in the assessment model, the DEPM-based SSB estimates in the last two triennial *BOCADEVA* surveys are preliminary because of a shortage of personnel involved in the histological sampling, especially in the estimation of spawning fraction, *S*. As an alternative, the corresponding time-series average values of this parameter have been used in these last two surveys to estimate the SSB. The potential use of the SSB estimates from this survey series in the stock assessment modeling of anchovy in the southern stock was explored during the current benchmark process. The available time-series has been included as input data in the new SS3 assessment model, but the series has also been ceased in 2023 because the abovementioned problems of shortage of personnel. Both *ECOCADIZ* and *BOCADEVA* surveys series have been considered as indices in the SS3 assessment model but only to inform the past (until 2023) history of the stock.

2. Missing or deteriorated catch data: NO for 2023 data. For 2024 only official landings were available, but with different length depending on the country. Official landings of the Spanish fishery were available for the whole 2024 fishing season (February-October), whereas for the Portuguese official landings, they were only available for the period January-July. Discards estimates in 2024 were not available to the WG, but they may be considered as negligible.
3. Missing or deteriorated commercial *LPUE*/*CPUE* data: NO.
4. Missing or deteriorated biological data: missing LFDs and ALKs for commercial catches from the Portuguese fishery in 2023, but landings were very low (2% of total catches from this stock in 2023). No LFD information was available for the respective national landings/discards. ALKs were only available for the Spanish commercial landings in 2024.
5. Brief description of methods explored to remedy the challenge: quarterly LFDs and ALKs from the Spanish fishery in 2023 (and 2024) were propagated to the very low quarterly catches from the Portuguese fishery. Average (2021-2023) quarterly LFDs were estimated to derive an age structure of the official landings available in 2024.
6. Suggested solution to the challenge, including reason for this selecting this solution: quarterly LFDs and ALKs from the Spanish fishery were propagated to the very low quarterly catches from the Portuguese fishery. The Gadget and SS3 assessment models for this year did not include the missing data corresponding to 2021 and 2022 in the *ECOCADIZ* time series. No further analysis was performed to understand the effect of this missing data, but considering that *PELAGO* survey estimates were available and that estimated biomass was consistent with the last year estimates, it was assumed that *PELAGO* and fishery information was enough to provide an accurate biomass index for this year.
7. Was there an evaluation of the loss of certainty caused by the solution that was carried out? A comparison with last year model implementation was performed where it can be observed that estimated biomass without *ECOCADIZ* 2021 and 2022 surveys was consistent with the previous estimated biomass time series.

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**Table 4.3.1.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Composition of the Spanish fleets operating in the Gulf of Cadiz (Subdivision 9.a-South) targeting anchovy in 2023. The categories include both single purpose purse-seiners, artisanal and trawl and artisanal vessels fishing with purse-seine in some periods through the year (multi-purpose vessels). Storage: catches are dry hold with ice (one fishing trip equals one fishing day). Similar tables for yearly data since 1999 are shown for the Gulf of Cadiz Spanish fleet in previous WG reports.**

| Subdivision 9.a South | | | | | | |
|---|---|---|---|---|---|---|
| 2023 | Vessels targeting anchovy | | | | | |
| | Engine (HP) | | | | | |
| Length (m) | 0–50 | 51–100 | 101–200 | 201-500 | >500 | Total |
| <10 | | | | | | |
| 10–<15 | 1 | 1 | 1 | 1 | | 4 |
| 15–<20 | | 5 | 19 | 9 | | 33 |
| ≥20 | | | 3 | 10 | 1 | 14 |
| Total | 1 | 6 | 23 | 20 | 1 | 51 |

**Table 4.3.2.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Recent historical series of annual catches (t) by country (Portuguese, PT, and Spanish, ES, waters) and total stock since 1989 on (the period with available data from both countries for the subdivision). (-) not available data; (0) less than 1 tonne (from Pestana, 1989, 1996 and WGMHSA, WGANC, WGANSA and WGHANSA members). (*) Discards are considered negligible in both the Portuguese and Spanish fisheries. (**) Notwithstanding the above, the estimates for the Spanish fishery include estimates of discarded (and unallocated) catches since 2014 on. In previous years, discards are considered negligible and landings are assumed equal to catch. Discards estimates for the Spanish fishery are not available for the first semester 2020 because Covid-19 disruption and interruption of the IEO's observers at-sea sampling program. (^) Provisional 2024 official landings data (updated until 31th July for the Portuguese fishery; Spanish data covered its entire fishery season, from 1st February to 31st October, because an early closure of the fishing season). (^^) Spanish discards estimates in 2024 not available.**

| Year | Official landings | | | ICES catch | | |
|---|---|---|---|---|---|---|
| | 9.a S (PT) | 9.a S (ES) | Total 9.a S | 9.a S (PT) * | 9.a S (ES) ** | Total 9.a S |
| 1943 | - | - | - | 2499 | - | 2499 |
| 1944 | - | - | - | 5376 | - | 5376 |
| 1945 | - | - | - | 7983 | - | 7983 |
| 1946 | - | - | - | 5515 | - | 5515 |
| 1947 | - | - | - | 3313 | - | 3313 |
| 1948 | - | - | - | 4863 | - | 4863 |
| 1949 | - | - | - | 2684 | - | 2684 |
| 1950 | 3316 | 11645 | 14961 | 3316 | - | 3316 |
| 1951 | 3567 | 13784 | 17351 | 3567 | - | 3567 |
| 1952 | 2877 | 13243 | 16120 | 2877 | - | 2877 |

| Year | Official landings | | | ICES catch | | |
|---|---|---|---|---|---|---|
| | 9.a S (PT) | 9.a S (ES) | Total 9.a S | 9.a S (PT) * | 9.a S (ES) ** | Total 9.a S |
| 1953 | 2710 | 17103 | 19813 | 2710 | - | 2710 |
| 1954 | 3573 | 16959 | 20532 | 3573 | - | 3573 |
| 1955 | 4387 | 27290 | 31677 | 4387 | - | 4387 |
| 1956 | 7722 | 23699 | 31421 | 7722 | - | 7722 |
| 1957 | 12501 | 23921 | 36422 | 12501 | - | 12501 |
| 1958 | 1109 | 28807 | 29916 | 1109 | - | 1109 |
| 1959 | 3775 | 22808 | 26583 | 3775 | - | 3775 |
| 1960 | 8384 | 32992 | 41376 | 8384 | - | 8384 |
| 1961 | 1060 | 30098 | 31158 | 1060 | - | 1060 |
| 1962 | 3767 | 37718 | 41485 | 3767 | - | 3767 |
| 1963 | 5565 | 22493 | 28058 | 5565 | - | 5565 |
| 1964 | 4118 | 27337 | 31455 | 4118 | - | 4118 |
| 1965 | 4452 | 44581 | 49033 | 4452 | - | 4452 |
| 1966 | 4402 | 41226 | 45628 | 4402 | - | 4402 |
| 1967 | 3631 | 36754 | 40385 | 3631 | - | 3631 |
| 1968 | 447 | 14078 | 14525 | 447 | - | 447 |
| 1969 | 582 | 12636 | 13218 | 582 | - | 582 |
| 1970 | 839 | 23127 | 23966 | 839 | - | 839 |
| 1971 | 67 | 91 | 158 | 67 | - | 67 |
| 1972 | - | 1563 | 1563 | - | - | - |
| 1973 | 120 | 2458 | 2578 | 120 | - | 120 |
| 1974 | 124 | 2845 | 2969 | 124 | - | 124 |
| 1975 | 340 | 3114 | 3454 | 340 | - | 340 |
| 1976 | 18 | 8703 | 8721 | 18 | - | 18 |
| 1977 | 233 | 11306 | 11539 | 233 | - | 233 |
| 1978 | 354 | 9023 | 9377 | 354 | - | 354 |

| Year | Official landings | | | ICES catch | | |
|---|---|---|---|---|---|---|
| | 9.a S (PT) | 9.a S (ES) | Total 9.a S | 9.a S (PT) * | 9.a S (ES) ** | Total 9.a S |
| 1979 | 453 | 20879 | 21332 | 453 | - | 453 |
| 1980 | 935 | 994 | 1929 | 935 | - | 935 |
| 1981 | 435 | 1370 | 1805 | 435 | - | 435 |
| 1982 | 512 | 715 | 1227 | 512 | - | 512 |
| 1983 | 332 | 1115 | 1447 | 332 | - | 332 |
| 1984 | 84 | 463 | 547 | 84 | - | 84 |
| 1985 | 83 | 2487 | 2570 | 83 | - | 83 |
| 1986 | 96 | 3223 | 3319 | 96 | - | 96 |
| 1987 | 414 | 3895 | 4309 | 414 | - | 414 |
| 1988 | 222 | 3281 | 3503 | 222 | 4263 | 4485 |
| 1989 | 36 | 5318 | 5354 | 36 | 5318 | 5354 |
| 1990 | 110 | 5708 | 5818 | 110 | 5708 | 5818 |
| 1991 | 22 | 5696 | 5718 | 22 | 5696 | 5718 |
| 1992 | 2 | 2995 | 2997 | 2 | 2995 | 2997 |
| 1993 | 0 | 1960 | 1960 | 0 | 1960 | 1960 |
| 1994 | 0 | 3035 | 3035 | 0 | 3035 | 3035 |
| 1995 | 0 | 570 | 570 | 0 | 570 | 570 |
| 1996 | 51 | 1781 | 1832 | 51 | 1781 | 1832 |
| 1997 | 14 | 4599 | 4613 | 14 | 4599 | 4613 |
| 1998 | 610 | 8972 | 9582 | 610 | 8972 | 9582 |
| 1999 | 355 | 5585 | 5940 | 355 | 5585 | 5940 |
| 2000 | 178 | 2175 | 2353 | 178 | 2175 | 2353 |
| 2001 | 439 | 8198 | 8637 | 439 | 8198 | 8637 |
| 2002 | 393 | 7851 | 8244 | 393 | 7851 | 8244 |
| 2003 | 200 | 4747 | 4947 | 200 | 4747 | 4947 |
| 2004 | 434 | 5147 | 5581 | 434 | 5147 | 5581 |

| Year | Official landings | | | ICES catch | | |
|---|---|---|---|---|---|---|
| | 9.a S (PT) | 9.a S (ES) | Total 9.a S | 9.a S (PT) * | 9.a S (ES) ** | Total 9.a S |
| 2005 | 38 | 4403 | 4441 | 38 | 4403 | 4441 |
| 2006 | 14 | 4375 | 4389 | 14 | 4375 | 4389 |
| 2007 | 34 | 5582 | 5616 | 34 | 5582 | 5616 |
| 2008 | 37 | 3183 | 3220 | 37 | 3183 | 3220 |
| 2009 | 32 | 2923 | 2955 | 32 | 2923 | 2955 |
| 2010 | 28 | 2900 | 2928 | 28 | 2900 | 2928 |
| 2011 | 78 | 6213 | 6291 | 78 | 6213 | 6291 |
| 2012 | 56 | 4782 | 4838 | 56 | 4782 | 4838 |
| 2013 | 67 | 5164 | 5231 | 67 | 5164 | 5231 |
| 2014 | 118 | 8798 | 8916 | 118 | 8928 | 9046 |
| 2015 | 2 | 6771 | 6774 | 2 | 6948 | 6950 |
| 2016 | 19 | 6567 | 6586 | 19 | 6723 | 6742 |
| 2017 | 26 | 4369 | 4395 | 26 | 4584 | 4610 |
| 2018 | 65 | 4343 | 4408 | 65 | 4434 | 4499 |
| 2019 | 113 | 4490 | 4603 | 113 | 4701 | 4814 |
| 2020 | 155 | 7058 | 7212 | 155 | 7162 | 7317 |
| 2021 | 109 | 7372 | 7481 | 109 | 7452 | 7561 |
| 2022 | 0,1 | 6503 | 6503 | 0 | 6615 | 6615 |
| 2023 | 155 | 7081 | 7236 | 155 | 7314 | 7469 |
| 2024 | 30^ | 8261 | 8291 | 30 | 8261^^ | 8291 |

**Table 4.3.2.2. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Catches (t) by gear and subdivision in 1989–2023. Discards are considered negligible in both the Portuguese (9.a C-N to 9.a S (PT)) and Spanish (9.a N, 9.a S (ES)) fisheries. Notwithstanding the above, the estimates for the Spanish fishery include estimates of discarded catches by gear since 2014 on. Discards estimates for the Spanish fishery are not available for the first semester 2020 because Covid-19 disruption and interruption of the IEO's observers at-sea sampling program. Landings by gear in subdivisions 9.a C-N to S (PT) are not available by subdivision until 2009.**

| Subarea | Gear | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995* | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.a N | Artisanal | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Purse-seine | 118 | 220 | 15 | 33 | 1 | 117 | 5329 | 44 | 63 | 371 | 413 | 10 |
| 9.a C-N to 9.a S (PT) | Demersal Trawl | - | - | - | 4 | 9 | 1 | - | 56 | 46 | 37 | 43 | 6 |
| | P. seine polyvalent | - | - | - | 1 | 1 | 3 | - | 94 | 7 | 35 | 20 | 7 |
| | Purse-seine | - | - | - | 270 | 14 | 233 | - | 2621 | 579 | 1541 | 1346 | 297 |
| | Not different. By gear | 496 | 541 | 210 | - | - | - | 7056 | - | - | - | - | - |
| 9.a S (ES) | Demersal Trawl | 0 | 0 | 0 | 0 | 330 | 152 | 75 | 224 | 190 | 1148 | 993 | 104 |
| | Purse-seine | 5336 | 5911 | 5696 | 2995 | 1630 | 2884 | 496 | 1556 | 4410 | 7830 | 4594 | 2078 |

| Subarea | Gear | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|
| 9.a N | Artisanal | 0 | 0 | 4 | 1 | 0 | 0 | 0 | 1 | 0.1 |
| | Purse-seine | 27 | 21 | 19 | 2 | 4 | 15 | 4 | 4 | 18 |
| 9.a C-N to 9.a S (PT) | Demersal Trawl | 16 | 13 | 7 | 5 | 7 | 27 | 14 | 9 | 4 |
| | P. seine polyvalent | 32 | 13 | 184 | 197 | 57 | 24 | 376 | 141 | 38 |
| | Purse-seine | 806 | 888 | 287 | 455 | 62 | 57 | 484 | 185 | 30 |
| | Not different. By gear | - | - | - | - | - | - | - | - | - |
| 9.a S (ES) | Demersal Trawl | 36 | 23 | 14 | 6 | 0.2 | 0.4 | 0.3 | 0.1 | 0.02 |
| | Purse-seine | 8180 | 7847 | 4754 | 5177 | 4385 | 4367 | 5575 | 3168 | 2922 |

| Subarea | Gear | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.a N | Demersal trawl | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 7 | 0.6 | 0.6 | 0 | 0 | 0 | 0.03 |
| | Artisanal | 4 | 0 | 1 | 6 | 0 | 21 | 6 | 6 | 0.4 | 0.1 | 0.1 | 0.1 | 0.01 | 4 |
| | Purse-seine | 175 | 541 | 37 | 63 | 581 | 152 | 217 | 1057 | 991 | 990 | 309 | 747 | 15 | 215 |
| 9.a C-N | Demersal Trawl | 5 | 4 | 1 | 0.5 | 2 | 3 | 2 | 2 | 0,3 | 0.2 | 2 | 2 | 5 | 48 |
| | P. seine polyvalent | 45 | 1116 | 177 | 17 | 9 | 150 | 294 | 332 | 403 | 34 | 122 | 400 | 126 | 113 |

| Subarea | Gear | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Purse-seine | 50 | 2119 | 342 | 175 | 668 | 2381 | 6613 | 8521 | 7468 | 5170 | 5203 | 9119 | 3379 | 4250 |
| 9.a C-S | Demersal Trawl | 1 | 1 | 0.4 | 1 | 3 | 2 | 1 | 0.2 | 1 | 0.02 | 0.02 | 0.01 | 0 | 0.3 |
| | P. seine polyvalent | 0 | 0.1 | 17 | 4 | 1 | 0.4 | 4 | 13 | 14 | 1 | 2 | 2 | 0.1 | 0.002 |
| | Purse-seine | 1 | 0.4 | 202 | 127 | 18 | 8 | 5 | 157 | 355 | 4 | 0 | 5 | 24 | 2 |
| 9.a S (PT) | Demersal Trawl | 8 | 13 | 16 | 2 | 5 | 1 | 3 | 6 | 1 | 0 | 0.1 | 0.1 | 0.04 | 0 |
| | P. seine polyvalent | 4 | 33 | 0.1 | 2 | 0.04 | 0.02 | 0.04 | 0 | 0 | 0 | 1 | 2 | 0 | 0 |
| | Purse-seine | 17 | 33 | 41 | 63 | 113 | 1 | 16 | 20 | 65 | 113 | 153 | 107 | 0.1 | 155 |
| 9.a S (ES) | Demersal Trawl | 0 | 0 | 2 | 0 | 99 | 33 | 118 | 204 | 90 | 209 | 105 | 66 | 110 | 233 |
| | Artisanal | 0 | 0 | 0 | 0 | 0 | 0.1 | 0.1 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Purse-seine | 2901 | 6216 | 4752 | 5172 | 8835 | 6845 | 6463 | 4381 | 4343 | 4492 | 7058 | 7387 | 6686 | 7082 |

**Table 4.3.2.3. Anchovy in subdivision 9.a South (Gulf of Cadiz). Upper table: quarterly anchovy catches (C, in t) by country in 2023. Lower table: provisional quarterly anchovy landings (L, in t) by country in 2024 (Portuguese landings from January to July; Spanish landings cover the whole fishery season; discards estimates not yet available).**

| COUNTRY | QUARTER 1 | | QUARTER 2 | | QUARTER 3 | | QUARTER 4 | | ANNUAL (2023) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | C(t) | % | C(t) | % | C(t) | % | C(t) | % | C (t) | % |
| 9.a South (PT) | 0 | 0,0 | 17 | 11,2 | 137 | 88,5 | 0,4 | 0,3 | 155 | 2,1 |
| 9.a South (ES) | 933 | 12,8 | 3609 | 49,3 | 2151 | 29,4 | 622 | 8,5 | 7315 | 97,9 |
| TOTAL | 933 | 12,5 | 3626 | 48,5 | 2288 | 30,6 | 623 | 8,3 | 7470 | 100 |

| COUNTRY | QUARTER 1 | | QUARTER 2 | | QUARTER 3 | | QUARTER 4 | | ANNUAL (2024) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | L(t) | % | L(t) | % | L(t) | % | L(t) | % | L(t) | % |
| 9.a South (PT) | 4 | 13,7 | 25 | 84,4 | 0,6 | 1,9 | - | - | 30 | 0,4 |
| 9.a South (ES) | 1312 | 15,9 | 3820 | 46,2 | 2880 | 34,9 | 249 | 3,0 | 8261 | 99,6 |
| TOTAL | 1316 | 15,9 | 3846 | 46,4 | 2881 | 34,7 | 249 | 3,0 | 8291 | 100 |

**Table 4.3.5.1.1. Anchovy in Subdivision 9.a. South (Gulf of Cadiz). Subdivision 9.a South (ES). Spanish fishery (all fleets). Seasonal and annual length distributions ('000) of anchovy catches in 2023. Discards were sampled and estimated.**

| 2023 | Q1 | Q2 | Q3 | Q4 | TOTAL |
|---|---|---|---|---|---|
| Length (cm) | 9.a S (ES) | 9.a S (ES) | 9.a S (ES) | 9.a S (ES) | 9.a S (ES) |
| 3 | 0 | 0 | 0 | 0 | 0 |
| 3.5 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 3 | 8 | 10 |
| 4.5 | 0 | 0 | 1 | 2 | 3 |
| 5 | 4 | 0 | 3 | 4 | 11 |
| 5,5 | 11 | 0 | 0 | 0 | 11 |
| 6 | 29 | 111 | 7 | 28 | 175 |
| 6.5 | 52 | 88 | 21 | 66 | 227 |
| 7 | 175 | 224 | 47 | 158 | 604 |
| 7.5 | 306 | 458 | 62 | 244 | 1070 |
| 8 | 1798 | 664 | 90 | 855 | 3408 |
| 8.5 | 3267 | 1192 | 289 | 712 | 5460 |
| 9 | 4743 | 8920 | 821 | 2345 | 16828 |
| 9.5 | 13214 | 42632 | 4695 | 5145 | 65685 |
| 10 | 15498 | 56114 | 10603 | 7264 | 89479 |
| 10.5 | 25709 | 91528 | 18667 | 26637 | 162542 |
| 11 | 18808 | 64853 | 20480 | 19121 | 123261 |
| 11.5 | 14190 | 58154 | 39594 | 13625 | 125564 |
| 12 | 9150 | 31334 | 40305 | 2325 | 83114 |
| 12.5 | 4957 | 21270 | 31803 | 1093 | 59123 |
| 13 | 1512 | 7424 | 13114 | 322 | 22371 |
| 13.5 | 1113 | 3146 | 10565 | 151 | 14975 |
| 14 | 91 | 509 | 2530 | 99 | 3229 |
| 14.5 | 67 | 471 | 348 | 21 | 906 |
| 15 | 26 | 0 | 87 | 46 | 158 |
| 15.5 | 5 | 0 | 83 | 14 | 102 |
| 16 | 14 | 0 | 467 | 12 | 494 |

| **2023** | **Q1** | **Q2** | **Q3** | **Q4** | **TOTAL** |
|---|---|---|---|---|---|
| Length (cm) | 9.a S (ES) | 9.a S (ES) | 9.a S (ES) | 9.a S (ES) | 9.a S (ES) |
| 16.5 | 4 | 0 | 0 | 2 | 6 |
| 17 | 4 | 0 | 0 | 0 | 4 |
| 17.5 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 0 | 0 | 0 | 0 |
| 18.5 | 0 | 0 | 0 | 0 | 0 |
| 19 | 0 | 0 | 0 | 0 | 0 |
| 19.5 | 0 | 0 | 0 | 0 | 0 |
| 20 | 0 | 0 | 0 | 0 | 0 |
| 20.5 | 0 | 0 | 0 | 0 | 0 |
| 21 | 0 | 0 | 0 | 0 | 0 |
| 21.5 | 0 | 0 | 0 | 0 | 0 |
| Total N | 114745 | 389092 | 194687 | 80298 | 778822 |
| Catch (T) | 933 | 3609 | 2151 | 622 | 7315 |
| L avg (cm) | 10.9 | 11.1 | 12.0 | 10.9 | 11.2 |
| W avg (g) | 8.1 | 9.3 | 11.0 | 7.8 | 9.4 |

**Table 4.3.5.1.2. Anchovy in Subdivision 9.a. South (Gulf of Cadiz). Whole fishery (all fleets). Provisional seasonal and annual length distributions ('000) of anchovy landings in 2024. Discards estimates not available.**

| 2024<br>Length (cm) | Q1<br>9.a S<br>(PT & ES) | Q2<br>9.a S<br>(PT & ES) | Q3<br>9.a S<br>(PT & ES) | Q4<br>9.a S<br>(PT & ES) | TOTAL<br>9.a S<br>(PT & ES) |
|---|---|---|---|---|---|
| 3 | 0 | 0 | 0 | 0 | 0 |
| 3.5 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 |
| 4.5 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 |
| 5,5 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 |
| 6.5 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 |
| 7.5 | 0 | 0 | 0 | 0 | 0 |
| 8 | 518 | 0 | 0 | 0 | 816 |
| 8.5 | 1181 | 122 | 1042 | 317 | 5317 |
| 9 | 1820 | 2948 | 6285 | 1124 | 18335 |
| 9.5 | 6354 | 17239 | 14028 | 2697 | 51848 |
| 10 | 7864 | 27497 | 17773 | 2380 | 59811 |
| 10.5 | 15058 | 56154 | 19521 | 5405 | 113021 |
| 11 | 12411 | 47983 | 18732 | 4217 | 93992 |
| 11.5 | 16173 | 52215 | 35184 | 3436 | 107535 |
| 12 | 13348 | 34285 | 34324 | 2213 | 82621 |
| 12.5 | 15314 | 32565 | 34408 | 2844 | 90107 |
| 13 | 10317 | 24847 | 21021 | 1908 | 60648 |
| 13.5 | 7811 | 18365 | 18304 | 649 | 40772 |
| 14 | 4203 | 8689 | 8775 | 359 | 20607 |
| 14.5 | 1870 | 5219 | 4658 | 139 | 10271 |
| 15 | 633 | 2495 | 2133 | 57 | 4350 |
| 15.5 | 299 | 998 | 814 | 13 | 1700 |

| **2024** | **Q1** | **Q2** | **Q3** | **Q4** | **TOTAL** |
|---|---|---|---|---|---|
| Length (cm) | 9.a S (PT & ES) | 9.a S (PT & ES) | 9.a S (PT & ES) | 9.a S (PT & ES) | 9.a S (PT & ES) |
| 16 | 0 | 0 | 834 | 0 | 600 |
| 16.5 | 0 | 97 | 44 | 0 | 84 |
| 17 | 0 | 0 | 0 | 0 | 0 |
| 17.5 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 0 | 0 | 0 | 0 |
| 18.5 | 0 | 0 | 0 | 0 | 0 |
| 19 | 0 | 0 | 0 | 0 | 0 |
| 19.5 | 0 | 0 | 0 | 0 | 0 |
| 20 | 0 | 0 | 0 | 0 | 0 |
| 20.5 | 0 | 0 | 0 | 0 | 0 |
| 21 | 0 | 0 | 0 | 0 | 0 |
| 21.5 | 0 | 0 | 0 | 0 | 0 |
| Total N | 115175 | 331719 | 237880 | 27758 | 762435 |
| Landings (T) | 1316 | 3845 | 2881 | 249 | 8291 |
| L avg (cm) | 11.9 | 11.8 | 12.0 | 11.1 | 11.9 |
| W avg (g) | 11.1 | 11.8 | 12.3 | 8.1 | 11.7 |

**Table 4.3.5.2.1. Anchovy in Subdivision 9.a. South (Gulf of Cadiz). Spanish catches (all fleets) in numbers ('000) at-age of Gulf of Cadiz anchovy in 2023 on a quarterly (Q), half-year (HY) and annual basis.**

| 2023 | AGE | Q1 | Q2 | Q3 | Q4 | HY1 | HY2 | ANNUAL |
|---|---|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 106055 | 78661 | 0 | 184715 | 184715 |
| | 1 | 114153 | 383564 | 85776 | 1626 | 497716 | 87402 | 585118 |
| | 2 | 570 | 5528 | 2856 | 12 | 6098 | 2867 | 8966 |
| | 3 | 22 | 0 | 0 | 0 | 22 | 0 | 22 |
| | Total (n) | 114745 | 389092 | 194687 | 80298 | 503837 | 274985 | 778822 |
| | Catch (t) | 933 | 3609 | 2151 | 622 | 4551 | 2774 | 7315 |
| | SOP | 933 | 3609 | 2151 | 622 | 4543 | 2773 | 7316 |
| | VAR.% | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

**Table 4.3.5.2.2. Anchovy in Subdivision 9.a. South (Gulf of Cadiz). Provisional landings (whole fishery, all fleets) in numbers ('000) at-age of Gulf of Cadiz anchovy in 2024 on a quarterly (Q), half-year (HY) and annual basis.**

| 2023 | AGE | Q1 | Q2 | Q3 | Q4 | HY1 | HY2 | ANNUAL |
|---|---|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 82961 | 21568 | 0 | 104529 | 104529 |
| | 1 | 99789 | 323149 | 144255 | 10381 | 422938 | 154635 | 577573 |
| | 2 | 15386 | 8570 | 10664 | 369 | 23956 | 11032 | 34988 |
| | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total (n) | 115175 | 331719 | 237880 | 32318 | 446894 | 270197 | 717091 |
| | Catch (t) | 1316 | 3845 | 2881 | 249 | 5162 | 3129 | 8291 |
| | SOP | 1278 | 3912 | 2923 | 260 | 5190 | 3183 | 8373 |
| | VAR.% | 103 | 98 | 99 | 96 | 99 | 98 | 99 |

**Table 4.3.5.2.3. Anchovy in Subdivision 9.a. South (Gulf of Cadiz). Spanish annual catches (all fleets) in numbers ('000) at-age of Gulf of Cadiz anchovy (1995–2023). Data for 2024 correspond to provisional data of landings (discards not yet available) for the whole GoC fishery (Portuguese and Spanish).**

| Year | Age 0 | Age 1 | Age 2 | Age 3 |
|---|---|---|---|---|
| 1995 | 34497 | 33961 | 189 | 0 |
| 1996 | 484540 | 162483 | 2053 | 0 |
| 1997 | 333758 | 279641 | 44823 | 0 |
| 1998 | 436307 | 1015535 | 13260 | 0 |
| 1999 | 124784 | 472348 | 32279 | 0 |
| 2000 | 118808 | 197497 | 3844 | 0 |
| 2001 | 158126 | 541331 | 23342 | 0 |
| 2002 | 74399 | 708070 | 17515 | 0 |
| 2003 | 71847 | 381407 | 13109 | 0 |
| 2004 | 105958 | 398862 | 2590 | 0 |
| 2005 | 37906 | 482256 | 3495 | 0 |
| 2006 | 11303 | 491307 | 5261 | 0 |
| 2007 | 61692 | 559217 | 7342 | 0 |
| 2008 | 57477 | 138295 | 30970 | 394 |
| 2009 | 9695 | 184941 | 20051 | 2673 |
| 2010 | 34462 | 210384 | 11118 | 257 |
| 2011 | 199191 | 406217 | 16117 | 0 |
| 2012 | 25265 | 335487 | 8348 | 0 |
| 2013 | 176169 | 300781 | 5950 | 0 |
| 2014 | 73210 | 808350 | 6155 | 0 |
| 2015 | 196337 | 460887 | 13667 | 0 |
| 2016 | 87979 | 460201 | 19758 | 0 |
| 2017 | 118554 | 402410 | 4339 | 8 |
| 2018 | 39467 | 316336 | 6450 | 0 |
| 2019 | 163216 | 265091 | 17311 | 0 |
| 2020 | 196225 | 373573 | 28237 | 1357 |

| Year | Age 0 | Age 1 | Age 2 | Age 3 |
|---|---|---|---|---|
| 2021 | 144927 | 444421 | 28745 | 0 |
| 2022 | 103884 | 401337 | 24877 | 0 |
| 2023 | 184715 | 585118 | 8966 | 22 |
| 2024 | 104529 | 577573 | 34988 | 0 |

**Table 4.3.6.1. Anchovy in Subdivision 9.a. South (Gulf of Cadiz). Mean length (TL, in cm) at-age in the Spanish catches of Gulf of Cadiz anchovy (all fleets) in 2023 on a quarterly (Q), half-year (HY) and annual basis.**

| 2023 | AGE | Q1 | Q2 | Q3 | Q4 | HY1 | HY2 | ANNUAL |
|---|---|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 11.7 | 10.9 | 0 | 11.3 | 11.3 |
| | 1 | 10.9 | 11.0 | 12.4 | 12.3 | 11.0 | 12.4 | 11.2 |
| | 2 | 13.8 | 13.5 | 12.0 | 14.7 | 13.5 | 12.1 | 13.1 |
| | 3 | 14.8 | 0 | 0 | 0 | 14.8 | 0 | 14.8 |
| | Total | 10.9 | 11.1 | 12.0 | 10.9 | 11.0 | 11.7 | 11.2 |

**Table 4.3.6.2. Anchovy in Subdivision 9.a. South (Gulf of Cadiz). Mean weight (in g) at-age in the Spanish catches of Gulf of Cadiz anchovy (all fleets) in 2023 on a quarterly (Q), half-year (HY) and annual basis.**

| 2023 | AGE | Q1 | Q2 | Q3 | Q4 | HY1 | HY2 | ANNUAL |
|---|---|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 10.1 | 7.7 | 0 | 9.1 | 9.1 |
| | 1 | 8.1 | 9.2 | 12.2 | 11.4 | 8.9 | 12.2 | 9.4 |
| | 2 | 15.4 | 17.4 | 11.8 | 20.2 | 17.2 | 11.8 | 15.5 |
| | 3 | 18.3 | 0 | 0 | 0 | 18.3 | 0 | 18.3 |
| | Total | 8.1 | 9.3 | 11.0 | 7.7 | 9.0 | 10.1 | 9.4 |

**Table 4.3.6.3. Anchovy in Subdivision 9.a. South (Gulf of Cadiz). Mean length (TL, in cm) at-age in the provisional landings of Gulf of Cadiz anchovy (whole fishery, all fleets) in 2024 on a quarterly (Q), half-year (HY) and annual basis.**

| 2024 | AGE | Q1 | Q2 | Q3 | Q4 | HY1 | HY2 | ANNUAL |
|---|---|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 10.8 | 11.0 | 0 | 10.8 | 10.8 |
| | 1 | 11.6 | 11.7 | 12.7 | 11.1 | 11.7 | 12.6 | 11.9 |
| | 2 | 13.6 | 13.5 | 13.3 | 12.7 | 13.6 | 13.3 | 13.5 |
| | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total | 11.9 | 11.8 | 12.0 | 11.1 | 11.8 | 11.9 | 11.9 |

**Table 4.3.6.4. Anchovy in Subdivision 9.a. South (Gulf of Cadiz). Mean weight (in g) at-age in the provisional landings of Gulf of Cadiz anchovy (whole fishery, all fleets) in 2024 on a quarterly (Q), half-year (HY) and annual basis.**

| 2024 | AGE | Q1 | Q2 | Q3 | Q4 | HY1 | HY2 | ANNUAL |
|---|---|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 8.3 | 8.0 | 0 | 8.3 | 8.3 |
| | 1 | 10.2 | 11.6 | 14.2 | 8.0 | 11.3 | 13.8 | 12.0 |
| | 2 | 16.7 | 18.7 | 17.0 | 12.7 | 17.4 | 16.8 | 17.2 |
| | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total | 11.1 | 11.8 | 12.3 | 8.1 | 11.6 | 11.8 | 11.7 |

**Table 4.4.1. Anchovy in Subdivision 9.a. South (Gulf of Cadiz). Acoustic and DEPM surveys providing direct estimates for anchovy in subdivision 9.a South. (1): *ECOCADIZ-COSTA 0709*, (pilot) Spanish survey surveying shallow waters <20 m depth and complementary to the standard survey; ((Month)): surveys that were carried out but did not provide any anchovy acoustic estimate because of its very low presence and/or for an incomplete geographical coverage (some areas were not covered: either the Spanish or the Portuguese part of the Gulf of Cadiz).**

| Method | Acoustics | | | | | | DEPM | |
|---|---|---|---|---|---|---|---|---|
| Survey | PELAGO | | SAR | ECOCADIZ | | ECOCADIZ-RECLUTAS | BOCADEVA | |
| Institute (Country) | IPMA (PT) | | IPMA (PT) | IEO (ES) | | IEO (ES) | IEO (ES) | |
| Subareas | 9.a CN-9.a S | | 9.a CN-9.a S | 9.a S | | 9.a S | 9.a S | |
| Year/Quarter | Q1 | Q2 | Q4 | Q2 | Q3 | Q4 | Q2 | Q3 |
| 1998 | | | Nov | | | | | |
| 1999 | Mar | | | | | | | |
| 2000 | | | Nov | | | | | |
| 2001 | Mar | | Nov | | | | | |
| 2002 | Mar | | | | | | | |
| 2003 | Feb | | (Nov) | | | | | |
| 2004 | | (Jun) | | Jun | | | | |
| 2005 | | Apr | (Nov) | | | | Jun | |
| 2006 | | Apr | (Nov) | Jun | | | | |
| 2007 | | Apr | Nov | | Jul | | | |
| 2008 | | Apr | (Nov) | | | | Jun | |
| 2009 | | Apr | | Jun | (Jul)(1) | (Oct) | | |

| Method | Acoustics | | | | | | DEPM | |
|---|---|---|---|---|---|---|---|---|
| Survey | PELAGO | | SAR | ECOCADIZ | | ECOCADIZ-RECLUTAS | BOCADEVA | |
| Institute (Country) | IPMA (PT) | | IPMA (PT) | IEO (ES) | | IEO (ES) | IEO (ES) | |
| Subareas | 9.a CN-9.a S | | 9.a CN-9.a S | 9.a S | | 9.a S | 9.a S | |
| Year/Quarter | Q1 | Q2 | Q4 | Q2 | Q3 | Q4 | Q2 | Q3 |
| 2010 | | Apr | | | (Jul) | | | |
| 2011 | | Apr | | | | | | Jul |
| 2012 | | | | | | Nov | | |
| 2013 | | Apr | | | Aug | | | |
| 2014 | | Apr | | | Jul | Oct | | Jul |
| 2015 | | Apr | | | Jul | Oct | | |
| 2016 | | Apr | | | Jul | Oct | | |
| 2017 | | Apr | | | Jul | Oct | | Jul |
| 2018 | | Apr | | | Jul | Oct | | |
| 2019 | | Apr | | | Jul | Oct | | |
| 2020 | Mar | | | | Aug | Oct | | Jul |
| 2021 | Mar | | | | No survey | Oct | | |
| 2022 | Mar | | | | No survey | Oct | | |
| 2023 | Mar | | | | Jul | Oct | | Jul |
| 2024 | Mar | | | | | Oct | | |

**Table 4.4.1.1. Anchovy in Subdivision 9.a. South (Gulf of Cadiz). *BOCADEVA* survey series (summer Spanish anchovy DEPM survey in Subdivision 9.a South). Historical series of eggs, adult and SSB estimates in Subdivision 9.a South. (1): time-series average**

| Year | 2005 | 2008 | 2011 | 2014 | 2017 | 2020 | 2023 |
|---|---|---|---|---|---|---|---|
| P0 (eggs/m$^2$/day) | 50.8 / 224.5 | 184 / 348 | 276 | 314 | 146 | 523 | 182 |
| Z (day$^{-1}$) | -0.039 | -1,43 | -0.29 | -0.33 | -0,16 | -1.11 | -0.12 |
| Ptotal (eggs/day) (x10$^{12}$) | 1,13 | 2,11 | 1,87 | 1,95 | 0,74 | 5,26 | 1.03 |
| Surveyed area (km$^2$) | 11982 | 13029 | 13107 | 14595 | 15556 | 16223 | 13261 |
| Positive area (km$^2$) | 6139 | 6863 | 6770 | 6214 | 5080 | 10058 | 5662 |
| Female Weight (g) | 25.2 / 16.7 | 23,7 | 15,2 | 18,2 | 16,2 | 16,6 | 17.64 |
| Batch Fecundity | 13820/ 11160 | 13778 | 7486 | 7502 | 7507 | 8212 | 9515 |
| Sex Ratio | 0.53 / 0.54 | 0,53 | 0,53 | 0,54 | 0,53 | 0,54 | 0.52 |
| Spawning Fraction | 0.26 / 0.21 | 0,218 | 0,276 | 0,276 | 0,243 | 0,241 (1) | 0.248 (1) |
| Spawning Biomass (tons) | 14673 | 31527 | 32757 | 31569 | 12392 | 81466 | 15138 |

**Table 4.4.2.1. Anchovy in Subdivision 9.a. South (Gulf of Cadiz). *PELAGO* survey series (spring Portuguese acoustic survey in Subdivisions 9.a Central-North to 9.a South). Historical series of overall and regional acoustic estimates of anchovy abundance (N, millions) and biomass (B, tonnes).**

| Survey | Estimate | Portugal | | | | Spain | S(Total) | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | | C-N | C-S | S(A) | Total | S(C) | | |
| Mar. 99 | N | 22 | 15 | * | 37 | 2079 | 2079 | 2116 |
| | B | 190 | 406 | * | 596 | 24763 | 24763 | 25359 |
| Mar. 00 | N | - | - | - | - | - | - | - |
| | B | - | - | - | - | - | - | - |
| Mar. 01 | N | 25 | 13 | 285 | 324 | 2415 | 2700 | 2738 |
| | B | 281 | 87 | 2561 | 2929 | 22352 | 24913 | 25281 |
| Mar. 02 | N | 22 | 156 | 92 | 270 | 3731 ** | 3823 ** | 4001 ** |
| | B | 472 | 1070 | 1706 | 3248 | 19629 ** | 21335 ** | 22877 ** |
| Feb. 03 | N | 0 | 14 | * | 14 | 2314 | 2314 | 2328 |
| | B | 0 | 112 | * | 112 | 24565 | 24565 | 24677 |
| Mar. 04 | N | - | - | - | - | - | - | - |
| | B | - | - | - | - | - | - | - |

| Survey | Estimate | Portugal | | | | Spain | S(Total) | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | | C-N | C-S | S(A) | Total | S(C) | | |
| Apr. 05 | N | - | 59 | - | 59 | 1306 | 1306 | 1364 |
| | B | - | 1062 | - | 1062 | 14041 | 14041 | 15103 |
| Apr. 06 | N | - | - | 319 | 319 | 1928 | 2246 | 2246 |
| | B | - | - | 4490 | 4490 | 19592 | 24082 | 24082 |
| Apr. 07 | N | 0 | 103 | 284 | 387 | 2860 | 3144 | 3247 |
| | B | 0 | 1945 | 4607 | 6552 | 33413 | 38020 | 39965 |
| Apr.08 | N | 69 | 252 | 213 | 534 | 1819 | 2032 | 2353 |
| | B | 3000 | 2505 | 4661 | 10166 | 29501 | 34162 | 39667 |
| Apr.09 | N | 127 | 0**** | 159 | 286 | 1910 | 2069 | 2196 |
| | B | 2089 | 0**** | 3759 | 5848 | 20986 | 24745 | 26834 |
| Apr. 10 | N | 0 | 62 | 0 | 62 | 963 | 963 | 1026 |
| | B | 0 | 1188 | 0 | 1188 | 7395 | 7395 | 8583 |
| Apr. 11 | N | 1558 | 0 | 0 | 1558 | 0 | 0 | 1558 |
| | B | 27050 | 0 | 0 | 27050 | 0 | 0 | 27050 |
| Apr. 12 | N | - | - | - | - | - | - | - |
| | B | - | - | - | - | - | - | - |

***Due to the distribution observed during the survey, the last transect (near the border with Spain) that normally belongs to the Algarve subarea was included in Cadiz.**

****Corrected estimates after detection of errors in the sA values attributed to the Cadiz area (Marques and Morais, 2003).**

******Possible underestimation: although no echo-traces attributable to the species were detected in this area, however, the loss of pelagic gear samplers prevented from confirming directly this.**

**Table 4.4.2.1. Anchovy in Subdivision 9.a. South (Gulf of Cadiz). *PELAGO* survey series (spring Portuguese acoustic survey in Subdivisions 9.a Central-North to 9.a South). Cont'd. Estimates from the *PELAGO* 2024 survey provided to the WGHANSA-1 2024 meeting have been corrected and updated after detecting errors.**

| Survey | Estimate | Portugal | | | | Spain | S(Total) | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | | C-N | C-S | S(A) | Total | S(C) | | |
| Apr. 13 | N | 251 | 0 | 263 | 514 | 634 | 897 | 1148 |
| | B | 3955 | 0 | 5044 | 8999 | 7656 | 12700 | 16655 |
| Apr. 14 | N | 130 | 0 | 26 | 156 | 2216 | 2241 | 2371 |
| | B | 1947 | 0 | 509 | 2456 | 28408 | 28917 | 30864 |
| Apr. 15 | N | 645 | 0 | 158 | 802 | 3531 | 3689 | 4334 |
| | B | 8237 | 0 | 2156 | 10393 | 30944 | 33100 | 41337 |

| Survey | Estimate | Portugal | | | | Spain | S(Total) | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | | C-N | C-S | S(A) | Total | S(C) | | |
| Apr. 16 | N | 3198 | 0 | 0 | 3198 | 9811 | 9811 | 13009 |
| | B | 38302 | 0 | 0 | 38302 | 65345 | 65345 | 103647 |
| May 17 | N | 1015 | 0 | 137 | 1152 | 1718 | 1855 | 2870 |
| | B | 15481 | 0 | 1208 | 16689 | 12589 | 13797 | 29278 |
| Apr. 18 | N | 4845 | 0 | 300 | 5145 | 1857 | 2157 | 7001 |
| | B | 54437 | 0 | 4328 | 58765 | 19145 | 23473 | 77910 |
| Apr. 19 | N | 229 | 7 | 0 | 236 | 3398 | 3398 | 3634 |
| | B | 3814 | 123 | 0 | 3937 | 29876 | 29876 | 33813 |
| Apr. 20 | N | 3152 | 0.3 | 89 | 3242 | 5550 | 5639 | 8791 |
| | B | 50282 | 9 | 1789 | 52080 | 47998 | 49787 | 100078 |
| Mar. 21 | N | 3069 | 519 | 9 | 3597 | 1485 | 1485 | 5082 |
| | B | 53513 | 6095 | 107 | 59715 | 13958 | 13958 | 73673 |
| Apr. 22 | N | 4589 | 198 | 196 | 4983 | 654 | 849 | 5637 |
| | B | 108571 | 3391 | 3535 | 115496 | 5438 | 8972 | 120934 |
| Apr. 23 | N | 3018 | 21 | 14 | 3053 | 3537 | 3551 | 6590 |
| | B | 69825 | 366 | 374 | 70565 | 26411 | 26785 | 96977 |
| Mar. 24 | N | 7190 | 544 | 22 | 7756 | 3179 | 3201 | 10935 |
| | B | 81802 | 6107 | 211 | 88120 | 17877 | 18088 | 105997 |

**Table 4.4.2.2. Anchovy in Subdivision 9.a. South (Gulf of Cadiz). *ECOCADIZ* survey series (summer Spanish acoustic survey in Subdivision 9.a South). Historical series of overall and regional acoustic estimates of anchovy abundance (N, millions) and biomass (B, tonnes).**

| Survey | Estimate | Portugal | Spain | TOTAL |
|---|---|---|---|---|
| | | S(A) | S(C) | S(Total) |
| Jun. 04*** | N | 125 | 1109 | 1235 |
| | B | 2474 | 15703 | 18177 |
| Jun. 05 | N | - | - | - |
| | B | - | - | - |
| Jun. 06 | N | 363 | 2801 | 3163 |
| | B | 6477 | 30043 | 36521 |
| Jul. 07 | N | 558 | 1232 | 1790 |

| Survey | Estimate | Portugal | Spain | TOTAL |
|---|---|---|---|---|
| | | S(A) | S(C) | S(Total) |
| | B | 11639 | 17243 | 28882 |
| Jul. 08 | N | - | - | - |
| | B | - | - | - |
| Jul. 09 | N | 35 | 1102 | 1137 |
| | B | 1075 | 20506 | 21580 |
| Jul. 10 | N | ? | 954+ | 954 + |
| | B | ? | 12339 + | 12339 + |
| Jul. 11 | N | - | - | - |
| | B | - | - | - |
| Jul. 12 | N | - | - | - |
| | B | - | - | - |
| Aug. 13 | N | 50 | 558 | 609 |
| | B | 1315 | 7172 | 8487 |
| Jul. 14 | N | 184 | 1778 | 1962 |
| | B | 4440 | 24779 | 29219 |
| Jul. 15 | N | 168 | 2506 | 2674 |
| | B | 2137 | 19168 | 21305 |
| Jul. 16 | N | 346 | 3341 | 3686 |
| | B | 5250 | 29051 | 34301 |
| Jul. 17 | N | 151 | 1354 | 1504 |
| | B | 2666 | 9563 | 12229 |
| Jul. 18 | N | 224 | 2839 | 3063 |
| | B | 4224 | 30683 | 34908 |
| Jul. 19 | N | 80 | 5405 | 5485 |
| | B | 1561 | 56139 | 57670 |
| Aug. 20 | N | 439 | 4714 | 5153 |
| | B | 7773 | 37114 | 44887 |
| Jul. 21 | N | - | - | - |

| Survey | Estimate | Portugal S(A) | Spain S(C) | TOTAL S(Total) |
|---|---|---|---|---|
| | B | - | - | - |
| Jul. 22 | N | - | - | - |
| | B | - | - | - |
| Jul. 23 | N | 263 | 1216 | 1479 |
| | B | 1781 | 7933 | 9714 |

*****Possible underestimation: shallow waters between 20 and 30 m depth were not acoustically sampled. + Partial estimate due to an incomplete coverage of the subdivision (only the Spanish part).**

**Table 4.4.2.3. Anchovy in Subdivision 9.a. South (Gulf of Cadiz). Historical series of overall acoustic estimates of anchovy abundance (N, millions) by age group estimated by *PELAGO* and *ECOCADIZ* acoustic surveys. The age structure estimated for the *PELAGO* surveys in 2020, 2021, 2022 and 2023 has been revised after an IPMA-IEO inter-calibration age reading exercise carried out in January 2024 because the previous detection of some inconsistencies in the age readings. Estimates from the *PELAGO* 2024 survey provided to the WGHANSA-1 2024 meeting have been corrected and updated after detecting errors. N.a.: not available.**

| **PELAGO** Year | **N (million)** Age 0 | **N (million)** Age 1 | **N (million)** Age 2 | **N (million)** Age 3 | **N (million)** Age 4 | **N (million)** TOTAL |
|---|---|---|---|---|---|---|
| 1999 | 0 | 2025 | 54 | 0 | 0 | 2079 |
| 2000 | - | - | - | - | - | - |
| 2001 | 0 | 2635 | 65 | 0 | 0 | 2700 |
| 2002 | 0 | 3774 | 49 | 0 | 0 | 3823 |
| 2003 | 0 | 2077 | 237 | 0 | 0 | 2314 |
| 2004 | - | - | - | - | - | - |
| 2005 | 0 | 1245 | 61 | 0 | 0 | 1306 |
| 2006 | 0 | 2197 | 48 | 2 | 0 | 2246 |
| 2007 | 0 | 3060 | 85 | 0 | 0 | 3144 |
| 2008 | 0 | 1540 | 485 | 7 | 0 | 2032 |
| 2009 | 0 | 1735 | 295 | 38 | 0 | 2069 |
| 2010 | 0 | 951 | 12 | 0 | 0 | 963 |
| 2011 | - | - | - | - | - | - |
| 2012 | - | - | - | - | - | - |
| 2013 | 0 | 157 | 900 | 201 | 6 | 1264 |
| 2014 | 0 | 1501 | 1327 | 63 | 0 | 2890 |

| PELAGO | N (million) | N (million) | N (million) | N (million) | N (million) | N (million) |
|---|---|---|---|---|---|---|
| Year | Age 0 | Age 1 | Age 2 | Age 3 | Age 4 | TOTAL |
| 2015 | 0 | 2999 | 311 | 0 | 0 | 3310 |
| 2016 | 0 | 6403 | 127 | 4 | 0 | 6535 |
| 2017 | 0 | 1142 | 117 | 0 | 0 | 1259 |
| 2018 | 0 | 2115 | 39 | 3 | 0 | 2157 |
| 2019 | 0 | 3105 | 289 | 0 | 0 | 3393 |
| 2020 | 0 | 4857 | 777 | 4 | 0 | 5639 |
| 2021 | 0 | 1241 | 246 | 7 | 0 | 1494 |
| 2022 | 0 | 727 | 104 | 18 | 0 | 849 |
| 2023 | 0 | 3433 | 111 | 7 | 0 | 3551 |
| 2024 | 0 | 2376 | 825 | 0 | 0 | 3201 |

| PELAGO | N (%) | N (%) | N (%) | N (%) | N (%) | N (%) |
|---|---|---|---|---|---|---|
| Year | Age 0 | Age 1 | Age 2 | Age 3 | Age 4 | TOTAL |
| 1999 | 0 | 97.4 | 2.6 | 0 | 0 | 100 |
| 2000 | - | - | - | - | - | - |
| 2001 | 0 | 97.6 | 2.4 | 0 | 0 | 100 |
| 2002 | 0 | 98.7 | 1.3 | 0 | 0 | 100 |
| 2003 | 0 | 89.7 | 10.3 | 0 | 0 | 100 |
| 2004 | - | - | - | - | - | - |
| 2005 | 0 | 95.3 | 4.7 | 0 | 0 | 100 |
| 2006 | 0 | 97.8 | 2.1 | 0.1 | 0 | 100 |
| 2007 | 0 | 97.3 | 2.7 | 0 | 0 | 100 |
| 2008 | 0 | 75.8 | 23.9 | 0.3 | 0 | 100 |
| 2009 | 0 | 83.9 | 14.3 | 1.9 | 0 | 100 |
| 2010 | 0 | 98.7 | 1.3 | 0 | 0 | 100 |
| 2011 | - | - | - | - | - | - |
| 2012 | - | - | - | - | - | - |
| 2013 | 0 | 12.4 | 71.2 | 15.9 | 0.5 | 100 |
| 2014 | 0 | 51.9 | 45.9 | 2.2 | 0 | 100 |
| 2015 | 0 | 90.6 | 9.4 | 0 | 0 | 100 |

| **PELAGO** | **N (%)** | **N (%)** | **N (%)** | **N (%)** | **N (%)** | **N (%)** |
|---|---|---|---|---|---|---|
| Year | Age 0 | Age 1 | Age 2 | Age 3 | Age 4 | TOTAL |
| 2016 | 0 | 98.0 | 1.9 | 0.1 | 0 | 100 |
| 2017 | 0 | 90.7 | 9.3 | 0 | 0 | 100 |
| 2018 | 0 | 98.1 | 1.8 | 0.1 | 0 | 100 |
| 2019 | 0 | 91.5 | 8.5 | 0 | 0 | 100 |
| 2020 | 0 | 86,1 | 13,8 | 0,1 | 0 | 100 |
| 2021 | 0 | 83,1 | 16,5 | 0,5 | 0 | 100 |
| 2022 | 0 | 85,6 | 12,3 | 2,1 | 0 | 100 |
| 2023 | 0 | 96,7 | 3,1 | 0,2 | 0 | 100 |
| 2024 | 0 | 74.2 | 25.8 | 0 | 0 | 100 |

**Table 4.4.2.3. Anchovy in Subdivision 9.a. South (Gulf of Cadiz). Cont'd.**

| ECOCADIZ | N (million) | N (million) | N (million) | N (million) | N (million) | N (million) |
|---|---|---|---|---|---|---|
| Year | Age 0 | Age 1 | Age 2 | Age 3 | Age 4 | TOTAL |
| 2004 | 0 | 1215 | 19 | 0 | 0 | 1235 |
| 2005 | - | - | - | - | - | - |
| 2006 | 0 | 3170 | 42 | 0.1 | 0 | 3211 |
| 2007 | 0 | 1619 | 167 | 5 | 0 | 1790 |
| 2008 | - | - | - | - | - | - |
| 2009 | 0 | 879 | 218 | 39 | 0 | 1137 |
| 2010 | 185 | 686 | 80 | 4 | 0 | 954 |
| 2011 | - | - | - | - | - | - |
| 2012 | - | - | - | - | - | - |
| 2013 | 169 | 394 | 33 | 0 | 0 | 596 |
| 2014 | 51 | 1873 | 36 | 0 | 0 | 1960 |
| 2015 | 1607 | 1053 | 13 | 0 | 0 | 2673 |
| 2016 | 1666 | 1665 | 354 | 0 | 0 | 3686 |
| 2017 | 892 | 447 | 149 | 0 | 0 | 1488 |
| 2018 | 1408 | 1609 | 46 | 0 | 0 | 3063 |
| 2019 | 2320 | 3031 | 134 | 0 | 0 | 5485 |

| ECOCADIZ<br>Year | N (million)<br>Age 0 | N (million)<br>Age 1 | N (million)<br>Age 2 | N (million)<br>Age 3 | N (million)<br>Age 4 | N (million)<br>TOTAL |
|---|---|---|---|---|---|---|
| 2020 | 3792 | 1326 | 35 | 0 | 0 | 5153 |
| 2021 | - | - | - | - | - | - |
| 2022 | - | - | - | - | - | - |
| 2023 | 1069 | 332 | 9 | 0 | 0 | 1409 |

| **ECOCADIZ**<br>Year | **N (%)**<br>Age 0 | **N (%)**<br>Age 1 | **N (%)**<br>Age 2 | **N (%)**<br>Age 3 | **N (%)**<br>Age 4 | **N (%)**<br>TOTAL |
|---|---|---|---|---|---|---|
| 2004 | 0 | 98.5 | 1.5 | 0 | 0 | 100 |
| 2005 | - | - | - | - | - | - |
| 2006 | 0 | 98.7 | 1.3 | 0.004 | 0 | 100 |
| 2007 | 0 | 90.4 | 9.3 | 0.3 | 0 | 100 |
| 2008 | - | - | - | - | - | - |
| 2009 | 0 | 77.3 | 19.2 | 3.4 | 0.02 | 100 |
| 2010 | 19.4 | 71.8 | 8.4 | 0.4 | 0 | 100 |
| 2011 | - | - | - | - | - | - |
| 2012 | - | - | - | - | - | - |
| 2013 | 28.4 | 66.1 | 5.5 | 0 | 0 | 100 |
| 2014 | 2.6 | 95.6 | 1.8 | 0 | 0 | 100 |
| 2015 | 60.1 | 39.4 | 0.5 | 0 | 0 | 100 |
| 2016 | 45.2 | 45.2 | 9.6 | 0 | 0 | 100 |
| 2017 | 60.0 | 30.0 | 10.0 | 0 | 0 | 100 |
| 2018 | 46.0 | 52.5 | 1.5 | 0 | 0 | 100 |
| 2019 | 42.3 | 55.3 | 2.4 | 0 | 0 | 100 |
| 2020 | 73.6 | 25.7 | 0.7 | 0 | 0 | 100 |
| 2021 | - | - | - | - | - | - |
| 2022 | - | - | - | - | - | - |
| 2023 | 75.8 | 23.6 | 0.6 | 0 | 0 | 100 |

**Table 4.4.3.1. Anchovy in Subdivision 9.a. South (Gulf of Cadiz).** ***SAR/JUVESAR*** **autumn survey series (autumn Portuguese acoustic survey in subdivisions 9.a Central–North to 9.a South - SAR - or Subdivision 9.a Central-North and Central-South**

**- *JUVESAR* -). Historical series of overall and regional acoustic estimates of anchovy abundance (N, millions) and biomass (B, tonnes). Juvenile fish (< 10.0 cm) estimates between parentheses.**

| Survey | Estimate | Portugal | | | | Spain | S (Total) | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | | C-N | C-S | S (PT) | Total | S (ES) | | |
| Nov. 98 | N | 30 | 122 | 50 | 203 | 2346 | 2396 | 2549 |
| | B | 313 | 1951 | 603 | 2867 | 30092 | 30695 | 32959 |
| Nov. 99 | N | - | - | - | - | - | - | - |
| | B | - | - | - | - | - | - | - |
| Nov. 00 | N | 4 | 20 | * | 23 | 4970 | 4970 | 4994 |
| | B | 98 | 241 | * | 339 | 33909 | 33909 | 34248 |
| Nov. 01 | N | 35 | 94 | - | 129 | 3322 | 3322 | 3451 |
| | B | 1028 | 2276 | - | 3304 | 25578 | 25578 | 28882 |
| Nov. 02 | N | - | - | - | - | - | - | - |
| | B | - | - | - | - | - | - | - |
| Nov. 03 | N | - | - | - | - | - | - | - |
| | B | - | - | - | - | - | - | - |
| Nov. 04 | N | - | - | - | - | - | - | - |
| | B | - | - | - | - | - | - | - |
| Nov. 05 | N | - | - | - | - | - | - | - |
| | B | - | - | - | - | - | - | - |
| Nov. 06 | N | - | - | - | - | - | - | - |
| | B | - | - | - | - | - | - | - |
| Nov. 07 | N | 0 | 59 | 475 | 534 | 1386 | 1862 | 1921 |
| | B | 0 | 1120 | 7632 | 8752 | 16091 | 23723 | 24843 |
| Nov. 13 | N | - | - | - | - | - | - | - |
| | B | - | - | - | - | - | - | - |
| Nov. 14 | N | - | - | - | - | - | - | - |
| | B | - | - | - | - | - | - | - |
| Dec. 15 | N | 3870 (3835) | - | - | - | - | - | - |
| | B | 30000 (29000) | - | - | - | - | - | - |
| Dec. 16 | N | 2836 (2835) | - | - | - | - | - | - |
| | B | 14397 (14367) | - | - | - | - | - | - |

| Survey | Estimate | Portugal | | | | Spain | S (Total) | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | | C-N | C-S | S (PT) | Total | S (ES) | | |
| Dec 17 | N | 2145 (570) | | - | - | - | - | - |
| | B | 38000 (4700) | | - | - | - | - | - |

*** Due to the distribution observed during the survey, the last transect (near the border with Spain) that normally belongs to the Algarve subarea was included in Cadiz.**

**Table 4.4.3.2. Anchovy in Subdivision 9.a. South (Gulf of Cadiz). *ECOCADIZ-RECLUTAS* survey series (autumn Spanish acoustic survey in Subdivision 9.a South). Historical series of overall and regional acoustic estimates of anchovy abundance (N, millions) and biomass (B, tonnes). Age 0 fish estimates between parentheses. Time-series of Age-0 biomass estimates conforms the Recruitment index used as input data in the SS3 assessment model.**

| Survey | Estimate | Portugal | Spain | TOTAL |
|---|---|---|---|---|
| | | S (PT) | S (ES) | S (Total) |
| Nov. 12* | N | - | 2649 (2619) | - |
| | B | - | 13680 (13354) | - |
| Oct. 14 | N | 111 (3) | 875 (811) | 986 (814) |
| | B | 2168 (25) | 5945 (5107) | 8113 (5131) |
| Oct. 15 | N | 115 (75) | 5113 (5042) | 5227 (5117) |
| | B | 1335 (430) | 29491 (28789) | 30827 (29219) |
| Oct. 16 | N | 177 (42) | 3490 (3404) | 3667 (3445) |
| | B | 3054 (463) | 16807 (15506) | 19861 (15969) |
| Oct. 17** | N | - | 1492 (1433) | - |
| | B | - | 7641 (7290) | - |
| Oct. 18 | N | 405 (96) | 548 (447) | 952 (543) |
| | B | 6259 (1005) | 4234 (2830) | 10493 (3834) |
| Oct. 19 | N | 1217 (763) | 4301 (4082) | 5518 (4845) |
| | B | 16089 (6613) | 32309 (29792) | 48398 (36405) |
| Oct. 20 | N | 145 (30) | 3051 (2355) | 3197 (2385) |
| | B | 3290 (512) | 32779 (20547) | 36070 (21060) |
| Oct. 21 | N | 211 (53) | 1763 (1575) | 1973 (1629) |
| | B | 4143 (923) | 13370 (11140) | 17512 (12063) |
| Oct. 22 | N | 11 (3) | 1825 (1703) | 1837 (1705) |
| | B | 193 (35) | 11719 (10761) | 11912 (10797) |
| Oct. 23 | N | 100 (16) | 716 (623) | 816 (639) |
| | B | 2227 (230) | 6073 (4432) | 8300 (4723) |

| Survey | Estimate | Portugal<br>S (PT) | Spain<br>S (ES) | TOTAL<br>S (Total) |
|---|---|---|---|---|
| Oct. 24 | N | 248 (36) | 2935 (2594) | 3183 (2629) |
| | B | 5553 (542) | 19631 (15301) | 25184 (15842) |

*** Partial estimate: only the Spanish waters were acoustically surveyed.**

**** Partial estimate only 70% of the Spanish waters was acoustically surveyed.**

**Table 4.6.1.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Input data type, model assumptions and settings for the assessment with data series 1989-2024.**

| Input data | Years and age range |
|---|---|
| Catch | Total catch biomass 1989-2024 by quarters (tonnes)<br><br>Catch-at-age 1989-2024 by quarters (proportion) |
| *PELAGO* spring acoustic survey | Total Biomass 1999-2024 (missing years: 2000, 2004, 2011, 2012) (tonnes)<br><br>Proportion-at-age 2014-2024 |
| *ECOCADIZ* summer acoustic survey | Total Biomass 2004-2023 (missing years: 2005, 2008, 2011, 2012, 2021, 2022) (tonnes)<br><br>Proportion-at-age 2004-2023 (missing years: 2005, 2008, 2011, 2012, 2021, 2022) |
| *BOCADEVA* DEPM survey | Total SSB 2005, 2008, 2011, 2014, 2017, 2020 and 2023 (tonnes) |
| *ECOCADIZ-RECLUTAS* autumn acoustic survey | Recruit Biomass 2014-2024 (missing year: 2017) |
| Weight-at-age in the catch and stock | The mean weight estimates by quarter and year (1989–2024) were obtained using a linear mixed-effects model that incorporated the entire dataset. |
| Maturity-at-age | All individual mature at age-1 (maturity at age-0=0) |

| Model structure and assumptions | |
|---|---|
| Starting year | 1989 |
| Ending year | 2024 |
| Equilibrium catches | 1208 t in 1st quarter, 2033 t in 2nd quarter, 683 t in 3rd quarter and 223 t in 4th quarter, assuming the average catch between 1989-1994 for each quarter. |
| Number of areas | 1 |
| Number of seasons | 4 (jan-mar, apr-jun, jul-sep, oct-nov) |
| Spawning time | 1st april |
| Recruitment settlement time | 1st july |
| Genders | 1 |
| Data age bins | age-0 to age- 3 |
| Natural mortality | M-at-age-0=2.97, M-at-age-1=1.6, M-at-age-2=2.48, M-at-age-3=2.48 |
| Recruitment | Annual recruitments are modelled as lognormal deviations from the Beverton-Holt recruitment curve. Equilibrium recruitment (R0) was estimated, while steepness (h) was fixed at 0.8 and sigmaR at 0.33. Main recruitment deviations were estimated for the period 1991–2024, while early recruitment deviations were estimated starting from 1962.8 |
| **Model structure and assumptions** | |

| | |
|---|---|
| Initial population | N-at-age in the first year are parameters derived from an input initial equilibrium catch, equilibrium recruitment and selectivity in the first year and adjusted by recruitment deviations estimated from the data on the early years of the assessment. |
| Fishery selectivity-at-age | Logistic functions fixed over time. |
| *PELAGO* spring acoustic survey selectivity-at-age | Logistic functions fixed over time. |
| *ECOCADIZ* summer acoustic survey selectivity-at-age | Logistic functions split into two periods: 2004-2014 and 2015-2023. |
| *BOCADEVA* DEPM survey selectivity-at-age | Fixed at 0 for age-0 and fixed at 1 for all ages, over time |
| *ECOCADIZ-RECLUTAS* autumn acoustic survey selectivity-at-age | Fixed at 1 for age-0 and fixed at 0 for all ages, over time |
| *PELAGO* spring acoustic survey catchability | Linear catchability parameter |
| *ECOCADIZ* summer acoustic survey catchability | Linear catchability parameter |
| *BOCADEVA* DEPM survey catchability | Linear catchability parameter |
| *ECOCADIZ-RECLUTAS* autumn acoustic survey catchability | Linear catchability parameter |
| Log-likelihood function: | |
| Weights of componentes | All components have equal weight |
| Data weights | The standard errors for Catch CV = 0.05 and all Surveys CVs = 0.30. The sample size of age composition data, determined after five iterations of the Francis method. |

**Table 4.6.1.2. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Final assessment (1989-2024). Stock summary table. All weights are in tonnes, recruitment in thousands.**

| Year | SSB | CV SSB | Recruits | CV Recruits | F age-3 | CV F | Input catch |
|---|---|---|---|---|---|---|---|
| 1989 | 15480 | 0.217 | 6587650 | 0.215 | 0.559 | 0.289 | 5354 |
| 1990 | 10608 | 0.255 | 9827390 | 0.218 | 0.975 | 0.355 | 5819 |
| 1991 | 16791 | 0.243 | 8125070 | 0.253 | 0.579 | 0.321 | 5717 |
| 1992 | 15099 | 0.273 | 5667520 | 0.258 | 0.276 | 0.317 | 2997 |
| 1993 | 12181 | 0.267 | 6671370 | 0.247 | 0.234 | 0.307 | 1960 |
| 1994 | 12445 | 0.253 | 7168470 | 0.261 | 0.360 | 0.296 | 3035 |
| 1995 | 14315 | 0.258 | 11475800 | 0.228 | 0.077 | 0.341 | 571 |
| 1996 | 19080 | 0.217 | 9492150 | 0.205 | 0.195 | 0.304 | 1831 |

| Year | SSB | CV SSB | Recruits | CV Recruits | F age-3 | CV F | Input catch |
|---|---|---|---|---|---|---|---|
| 1997 | 18906 | 0.199 | 11414100 | 0.157 | 0.494 | 0.279 | 4613 |
| 1998 | 17565 | 0.166 | 8263350 | 0.178 | 1.543 | 0.346 | 9582 |
| 1999 | 13733 | 0.203 | 7963360 | 0.218 | 0.902 | 0.313 | 5941 |
| 2000 | 14124 | 0.226 | 11976400 | 0.149 | 0.336 | 0.312 | 2353 |
| 2001 | 23960 | 0.152 | 8495700 | 0.136 | 0.894 | 0.275 | 8637 |
| 2002 | 14804 | 0.146 | 4910000 | 0.165 | 1.315 | 0.280 | 8244 |
| 2003 | 8863 | 0.183 | 6282940 | 0.156 | 1.134 | 0.289 | 4948 |
| 2004 | 10507 | 0.186 | 5777520 | 0.155 | 1.191 | 0.314 | 5581 |
| 2005 | 8738 | 0.190 | 10916600 | 0.168 | 0.779 | 0.254 | 4441 |
| 2006 | 18021 | 0.183 | 11904600 | 0.165 | 0.351 | 0.224 | 4389 |
| 2007 | 21687 | 0.172 | 6130410 | 0.183 | 0.465 | 0.253 | 5616 |
| 2008 | 15260 | 0.179 | 6539060 | 0.167 | 0.459 | 0.280 | 3220 |
| 2009 | 13332 | 0.170 | 3478680 | 0.167 | 0.424 | 0.250 | 2955 |
| 2010 | 7076 | 0.161 | 6232750 | 0.146 | 0.819 | 0.256 | 2927 |
| 2011 | 9164 | 0.170 | 6432530 | 0.178 | 1.502 | 0.313 | 6291 |
| 2012 | 10394 | 0.214 | 6297420 | 0.151 | 0.809 | 0.297 | 4838 |
| 2013 | 12086 | 0.165 | 10335800 | 0.119 | 0.909 | 0.276 | 5231 |
| 2014 | 15843 | 0.138 | 6979390 | 0.137 | 1.195 | 0.261 | 9046 |
| 2015 | 10429 | 0.159 | 10932100 | 0.135 | 1.357 | 0.292 | 6950 |
| 2016 | 14594 | 0.156 | 6285870 | 0.144 | 0.973 | 0.294 | 6742 |
| 2017 | 10410 | 0.169 | 9747510 | 0.159 | 0.728 | 0.250 | 4611 |
| 2018 | 16460 | 0.163 | 8775480 | 0.149 | 0.505 | 0.253 | 4499 |
| 2019 | 16137 | 0.150 | 11295200 | 0.138 | 0.641 | 0.272 | 4814 |
| 2020 | 19216 | 0.146 | 9317410 | 0.140 | 0.810 | 0.271 | 7317 |
| 2021 | 18174 | 0.148 | 6832240 | 0.135 | 0.980 | 0.268 | 7562 |
| 2022 | 12826 | 0.145 | 7059840 | 0.099 | 1.314 | 0.277 | 6615 |
| 2023 | 10633 | 0.114 | 7313180 | 0.120 | 1.705 | 0.251 | 7470 |
| 2024 | 10816 | 0.142 | 8667340 | 0.234 | 1.787 | 0.290 | 8291 |

**Table 4.6.2.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). The Monh's rho is the average of the five last year's relative biases.**

| Variable | Mohn's rho |
|---|---|

| | |
|---|---|
| spawning stock biomass (SSB) | -0.13 |
| Fishing mortality | 0.33 |
| Recruitment | 0.04 |

**Table 4.8.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). The basis for the catch scenarios*.**

| | Values |
|---|---|
| Index A (2024) | 10 816 tonnes |
| Index B (2022–2023) | 11 730 tonnes |
| Index ratio (A/B) | 0.92 |
| Biomass safeguard (Blim) | Not applied |
| Uncertainty cap | Not applied |
| Average catch for 2023-2024 | 7 880 tonnes |
| Discard rate | Negligible |
| Catch advice 2025** | 7 266 tonnes |
| % advice change*** | NA |

*** The figures in the table are rounded. Calculations were done with unrounded inputs, and computed values may not match exactly when calculated using the rounded figures in the table.**

****[Average catch for 2023-2024] × [index ratio].**

***** It cannot be estimated because of a change in the advice period.**

**Table 4.9.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Forecast assumptions in recruitment and F for current stock assessment forecast (2024).**

| Variable | Value | Notes |
|---|---|---|
| F age-3 (2024) | 1.79 | From the assessment based on observed catches until 2024 |
| SSB (2024) | 10 816 | SSB estimated (1st April) from the assessment; in tonnes |
| R age-0 (2024) | 8 667 340 | Recruitment (1st July) from the assessment; thousands |

| | | |
|---|---|---|
| Catch (2024) | 8 291 | Landings to the end of October of the Spanish fishery plus landings of Portuguese fishery to the end of July. Preliminary value, used as input in the stock assessment (in tonnes). |
| Discards (2024) | 0 | Discards estimates in 2024 not available but considered negligible. |

**Table 4.9.2. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Short-term forecast for management options. Catch and SSB in tonnes.**

| | Total catch (2025) | F (2025) | SSB (2025) | Probability SSB < $B_{lim}$ in 2025 |
|---|---|---|---|---|
| ICES advice basis | | | | |
| [Average catch for 2023-2024] × [index ratio] ^ | 7 266 | 1.15 | 13 234 | 0 |
| Other scenarios | | | | |
| F= 0 | 0 | 0 | 14 315 | 0 |
| $F=F_{2024}$ | 9 503 | 1.79 | 12 675 | 0 |
| $F=F_{2024}$ x 1.2 | 10 450 | 2.14 | 12 370 | 0 |
| $F=F_{2024}$ x 0.8 | 8 345 | 1.43 | 12 987 | 0 |
| | | | | |
| $F_{mean2020-2024}$ | 7 450 | 1.20 | 13 194 | 0 |
| $F_{medianhistoric\ (1989-2024)}$ | 5 173 | 0.72 | 13 626 | 0 |
| | | | | |
| $p(SSB_{2025}<B_{lim})=5\%$ | 14 653 | 5.45 | 7 796 | 0.05 |
| $p(SSB_{2025}<B_{pa})=5\%$ | 13 510 | 4.07 | 10 678 | |
| $SSB_{2025}=B_{lim}$ | 15 376 | 6.57 | 4 721 | 0.50 |
| $SSB_{2025}=B_{pa}$ | 14 936 | 5.84 | 6 561 | |

**^ICES framework for category 3 short-lived stocks using the 1-over-2 rule was applied (ICES, 2020a)**

**^^^The probability of SSB being below $B_{lim}$ in 2025. This probability relates to the short-term probability of SSB < $B_{lim}$**

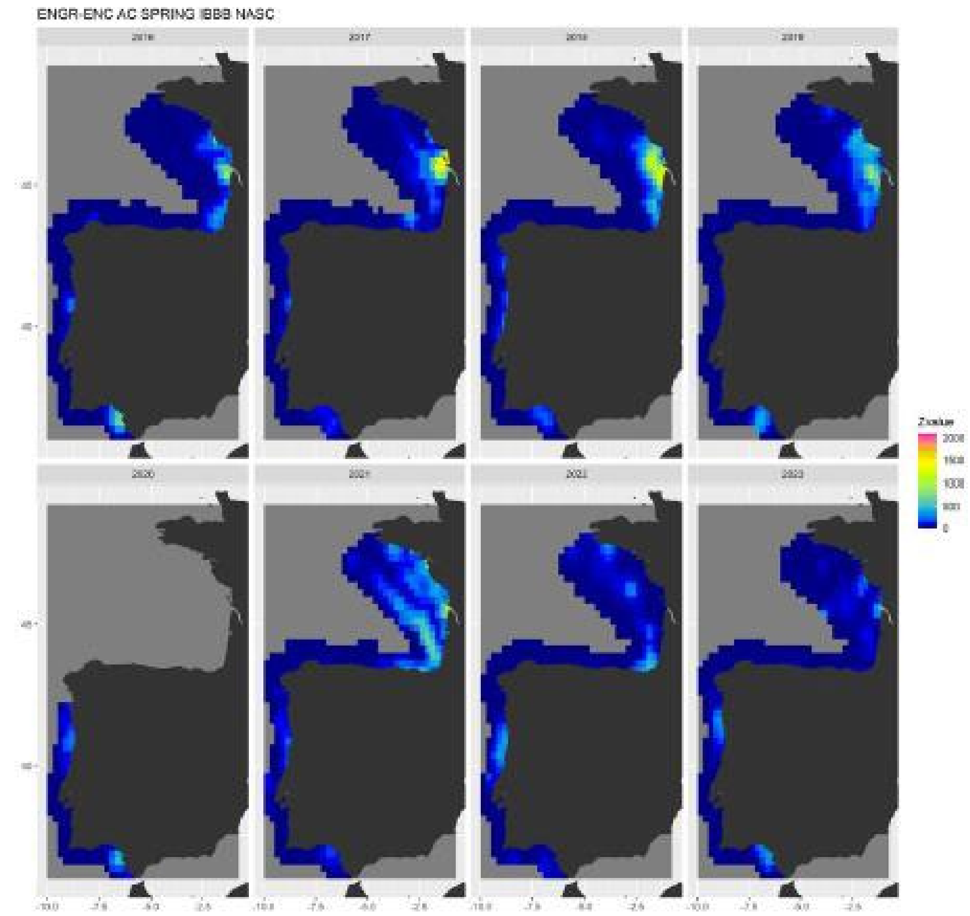



**Figure 4.2.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Adult anchovy mean acoustic density (NASC, m² nm-²) maps derived from the *PELGAS*, *PELACUS* and *PELAGO* spring acoustic-trawl surveys, years 2016–2023, 0.25° map cell. Source: ICES WGACEGG 2024 report.**

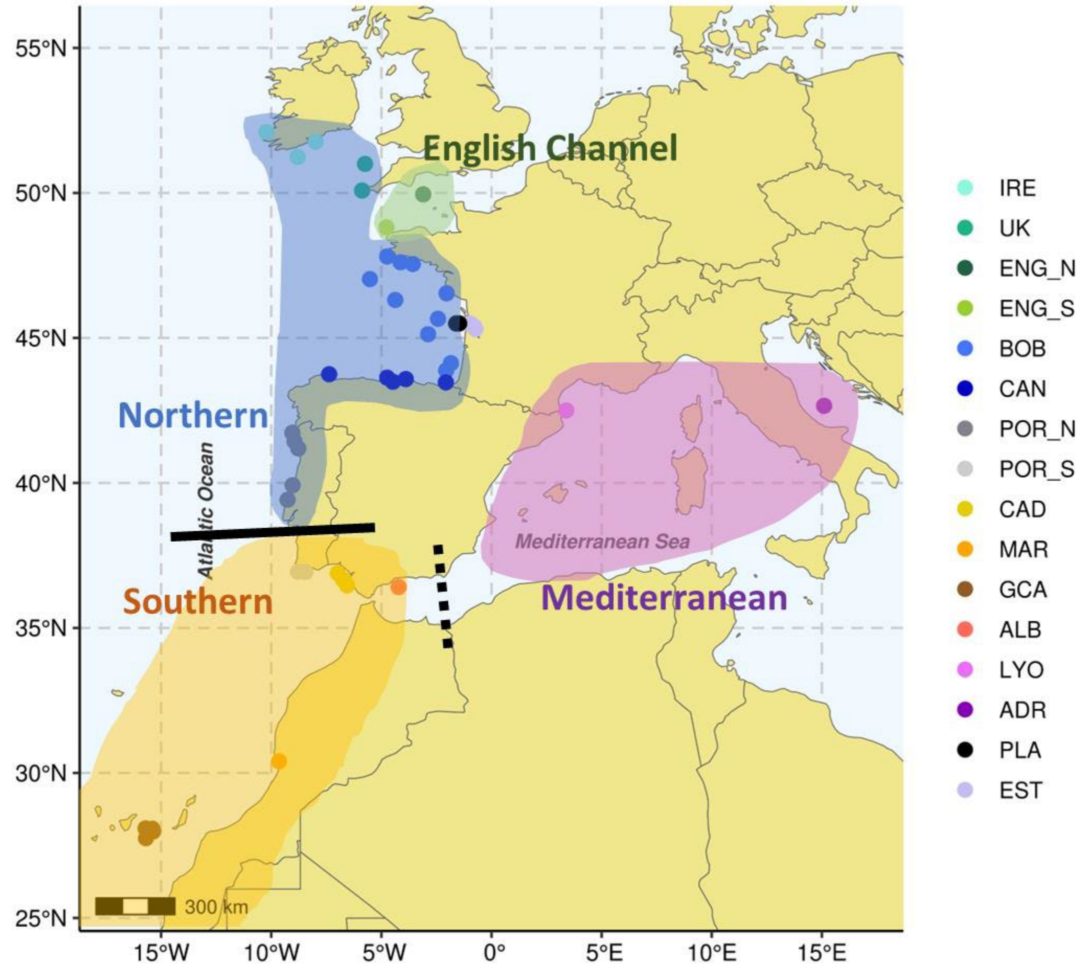



**Figure 4.2.3. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Summary of the conclusions based on the genetic analyses concerning the marine ecotypes showing the main identified groups. Source: Garrido *et al*. (2024).**

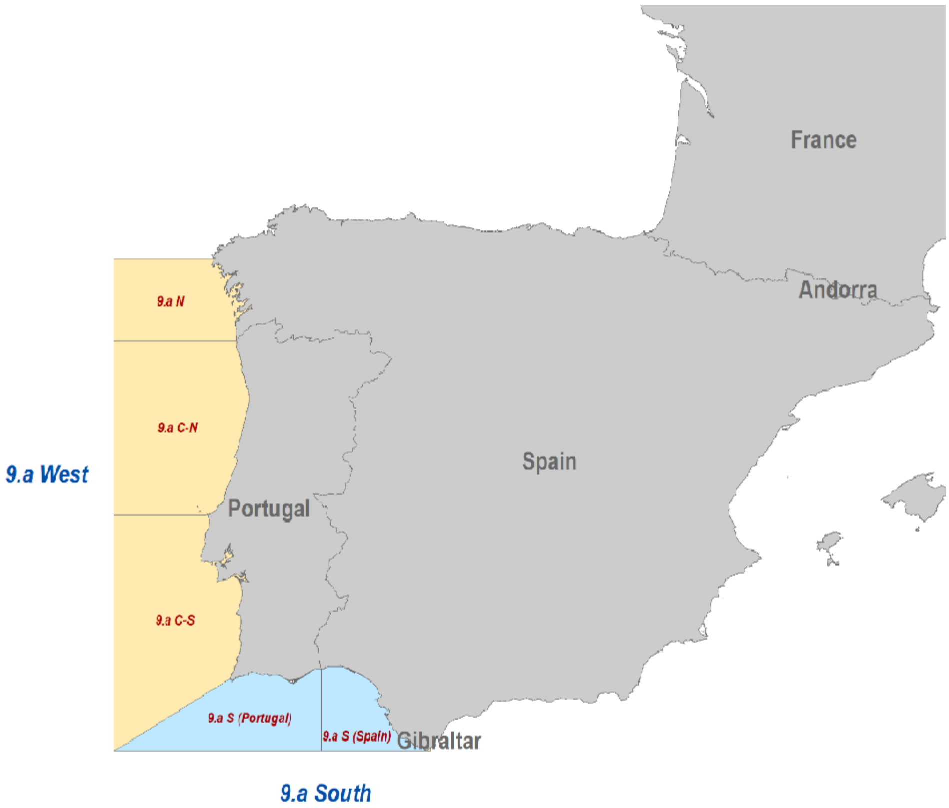



**Figure 4.2.3. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Map showing the split of the former anchovy in Division 9a stock into the new stocks of anchovy in 9a West (light orange) and in 9a South (light blue). Note that, in turn, the stock 9a South is divided into Portuguese and Spanish waters, whereas stock 9a West is divided into the subdivisions 9a North, 9a Central–North, and 9a Central–South.**

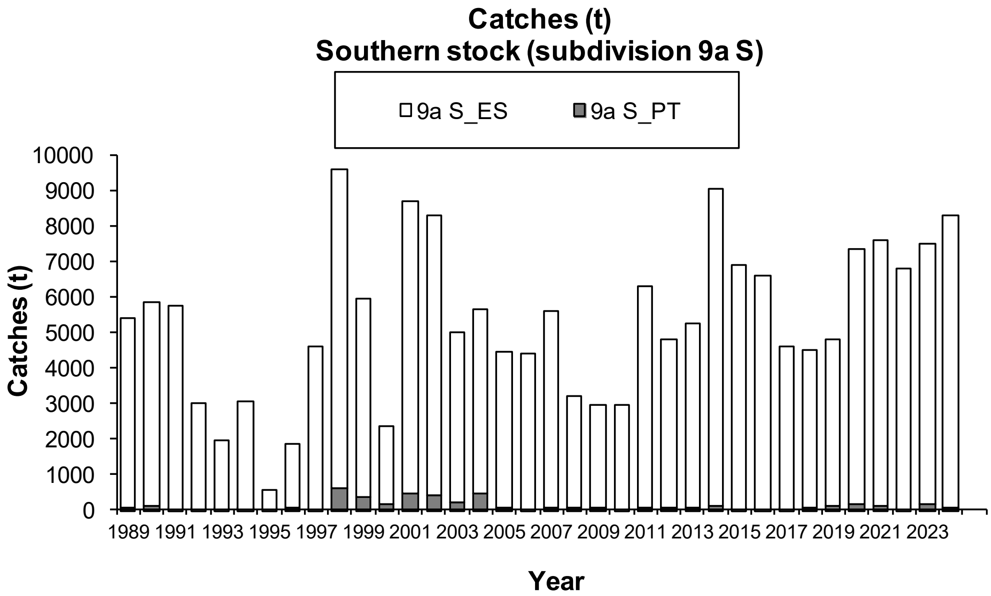



**Figure 4.3.2.1.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Recent series of anchovy catches (ICES estimates for 1989–2024, the period with data for the Portuguese and Spanish fisheries, all metiers are considered). Discards are considered as negligible all over the subdivision, but since 2014 on estimates include the available discarded catches (see Section 4.3.3). Data for 2024 correspond to provisional data of landings (discards not yet available).**

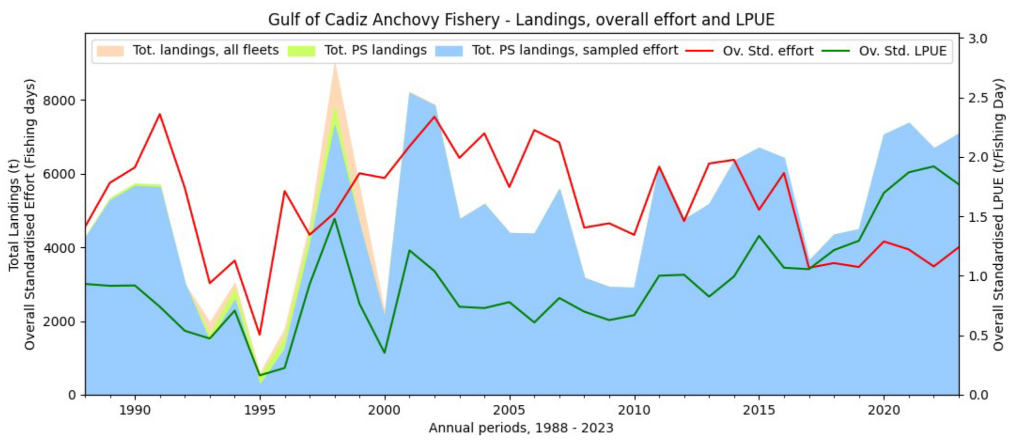



**Figure 4.3.4.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Spanish purse-seine fishery (métier PS_SPF_0_0_0). Trends in Gulf of Cadiz anchovy annual landings, and purse-seine fleets' standardised overall effort and lpue (1988–2023).**

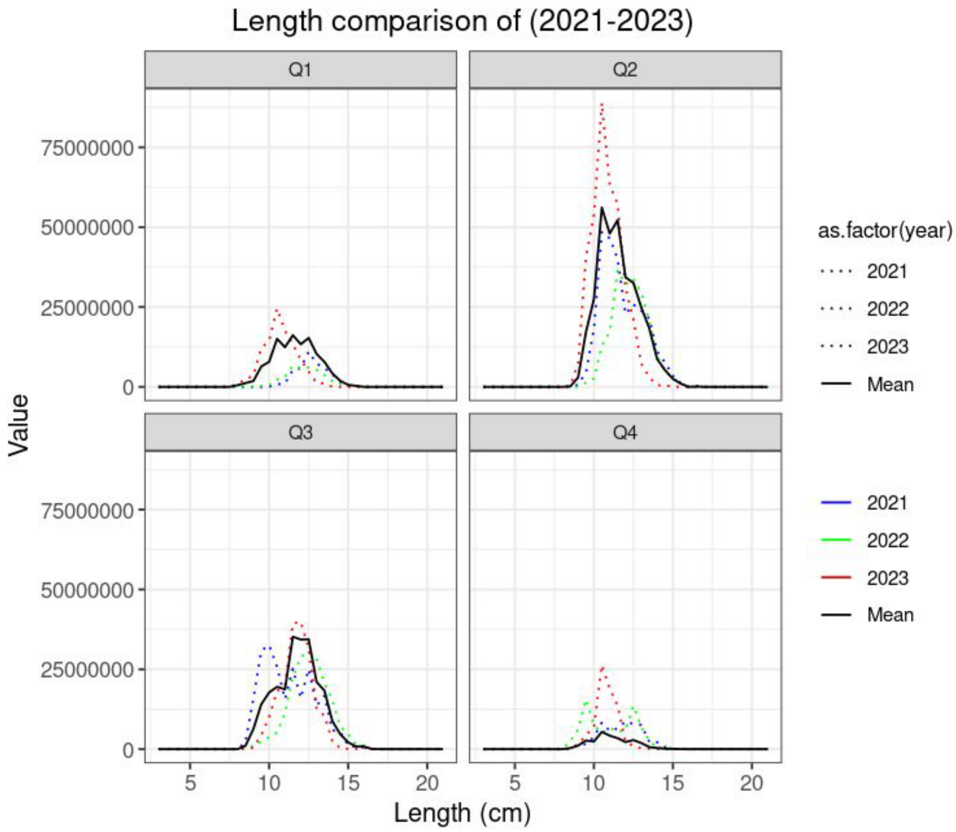



**Figure 4.3.5.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Quarterly length frequency distributions of catches in the whole fishery in 2021, 2022 and 2023 and the average for the 3 years period used as a proxy to fill the data gap in 2024.**

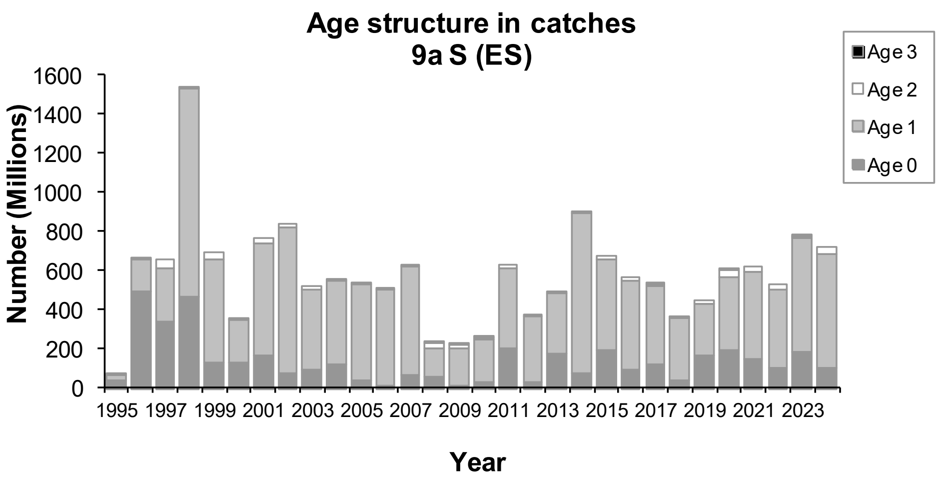
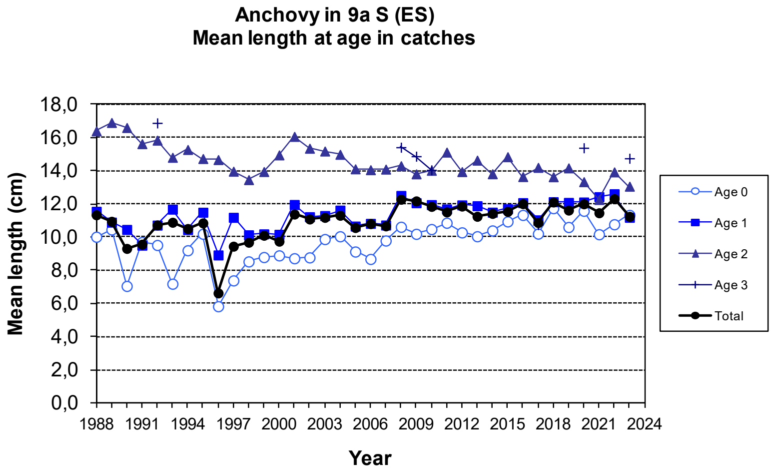



**Figure 4.3.5.2.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Spanish fishery (all métiers). Age composition in Spanish catches of Gulf of Cadiz anchovy (1995–2024). Discards are considered either very low or even negligible in this fishery, but since 2014 on estimates include the available discarded catches (see Section 4.3.3). Data for 2024 correspond to provisional data of landings (discards not yet available).**



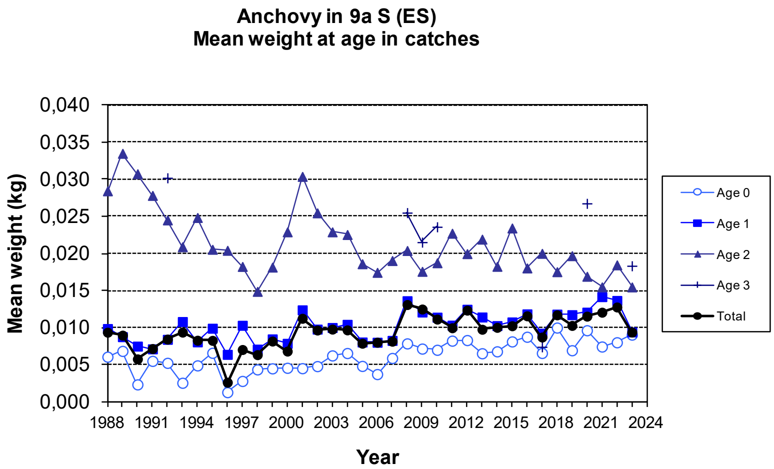




**Figure 4.3.6.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Spanish fishery (all métiers). Annual mean length (TL, in cm) and weight (kg) at-age in the Spanish catches of Gulf of Cadiz anchovy (1988–2023). Data for 2024 correspond to provisional data of landings (discards not yet available).**

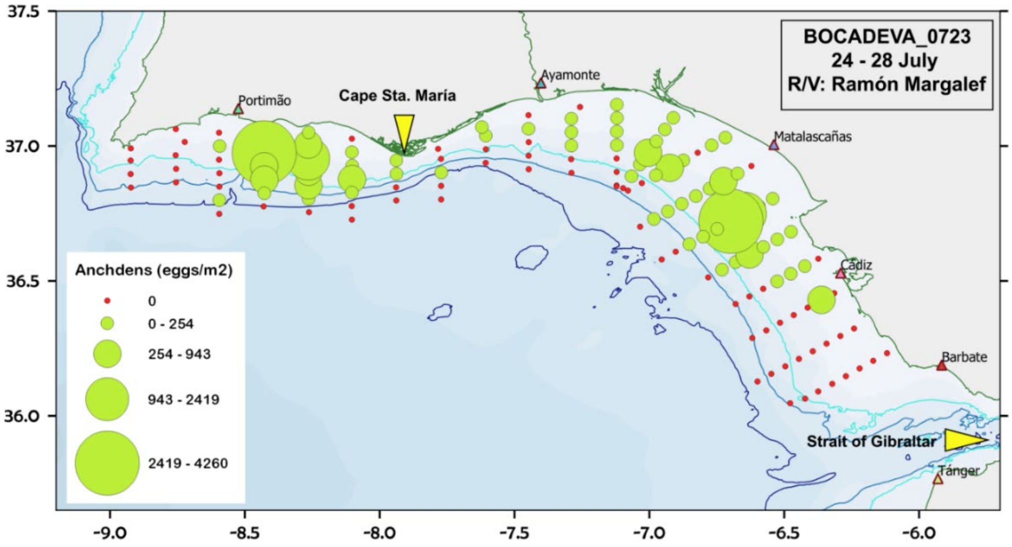



**Figure 4.4.1.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). *BOCADEVA 0723* survey (summer Spanish anchovy DEPM survey in Subdivision 9.a South in 2023). Mapping of anchovy eggs density (eggs/m²) sampled by PairoVET.**

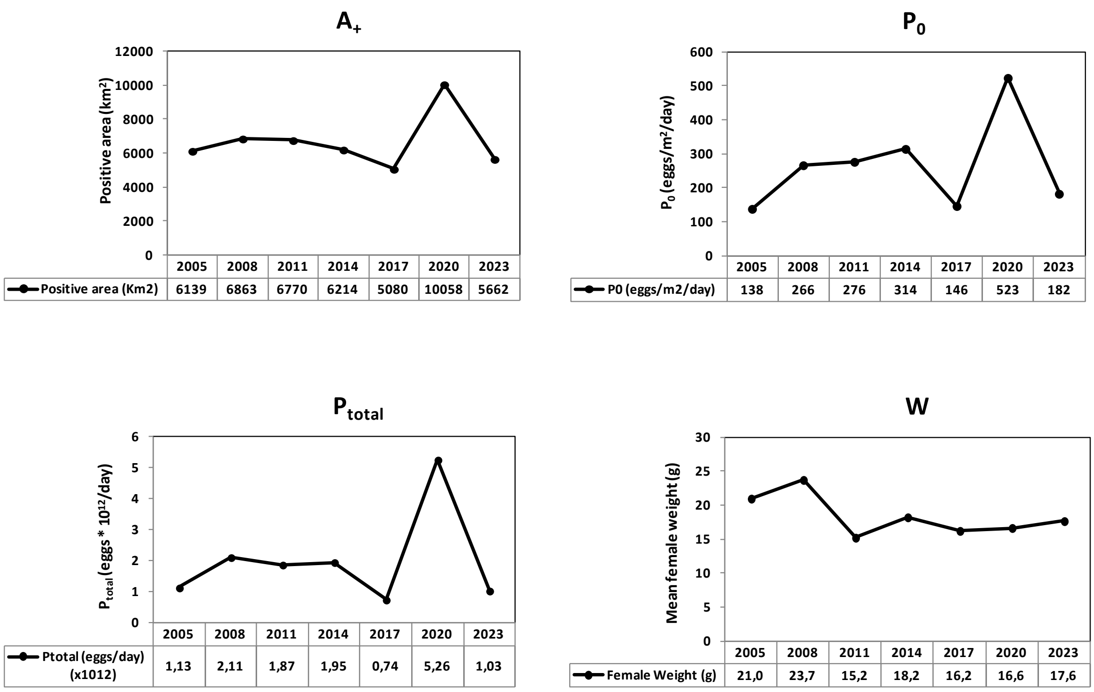



**Figure 4.4.1.2. Anchovy in Subdivision 9.a South (Gulf of Cadiz). *BOCADEVA* survey series (summer Spanish anchovy DEPM survey in Subdivision 9.a South). Time-series of eggs and adult parameters estimates. A+ (positive area, in km²), $P_0$ (daily egg production, in eggs/m²/day), $P_{total}$ (total egg production, in eggs $10^{12}$/day), W (mean female weight, in g).**

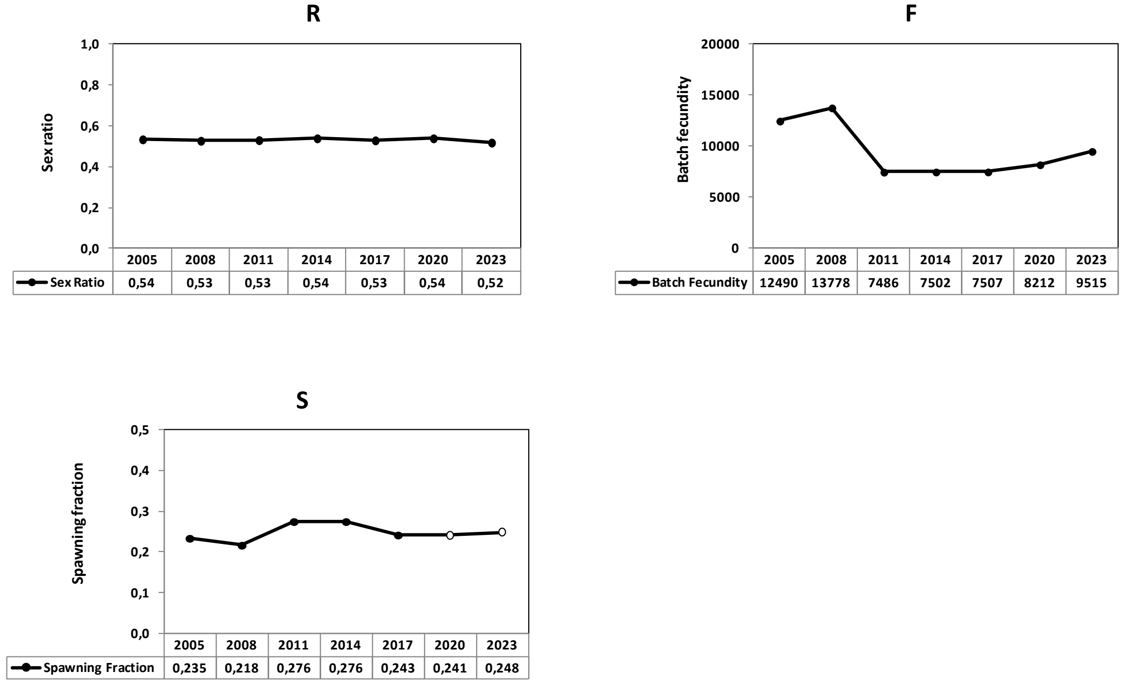



**Figure 4.4.1.2. Anchovy in Subdivision 9.a South (Gulf of Cadiz). *BOCADEVA* survey series (summer Spanish anchovy DEPM survey in Subdivision 9.a South). Time-series of eggs and adult parameters estimates. Cont'd. R (sex ratio), F (individual batch fecundity), S (spawning fraction; the 2020 and 2023 estimates are provisionally computed as the time-series average value).**

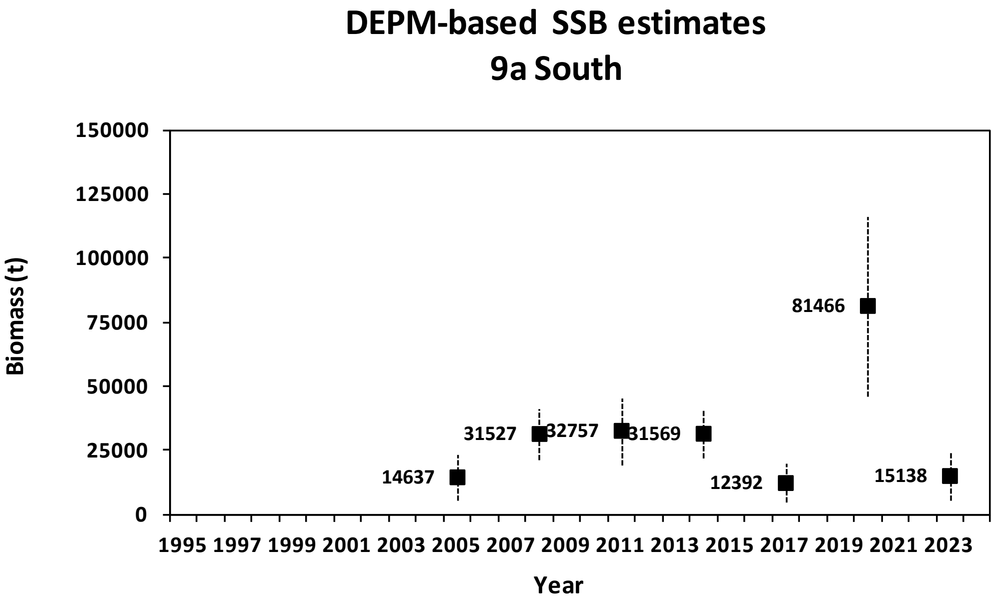



**Figure 4.4.1.3. Anchovy in Subdivision 9.a South (Gulf of Cadiz). *BOCADEVA* survey series (summer Spanish anchovy DEPM survey in Subdivision 9.a South). Series of SSB estimates (±SD) obtained from the survey series.**

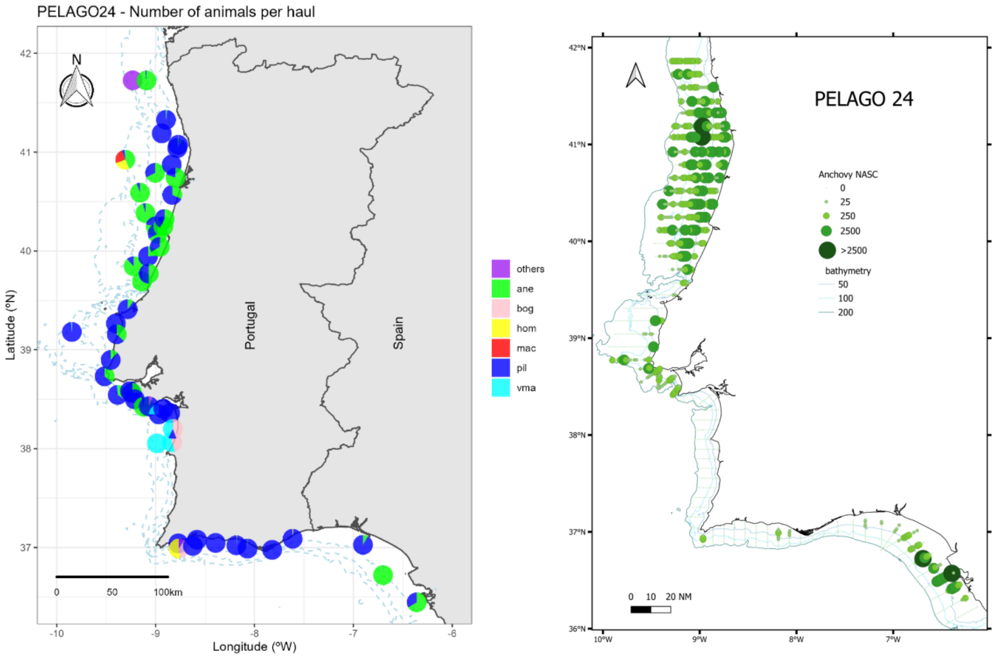



**Figure 4.4.2.1. Anchovy in Division 9.a. Western and Southern stocks. Subdivisions 9.a Central-North to 9.a South. *PELAGO* survey series (spring Portuguese acoustic survey in Subdivisions 9.a Central-North to 9.a South). *PELAGO 24* survey. Left: location of valid fishing stations with indication of their species composition (percentages in number). Right: Distribution of the backscattering energy (Nautical area scattering coefficient, NASC, in $m^2$ $nmi^{-2}$) attributed to the species.**

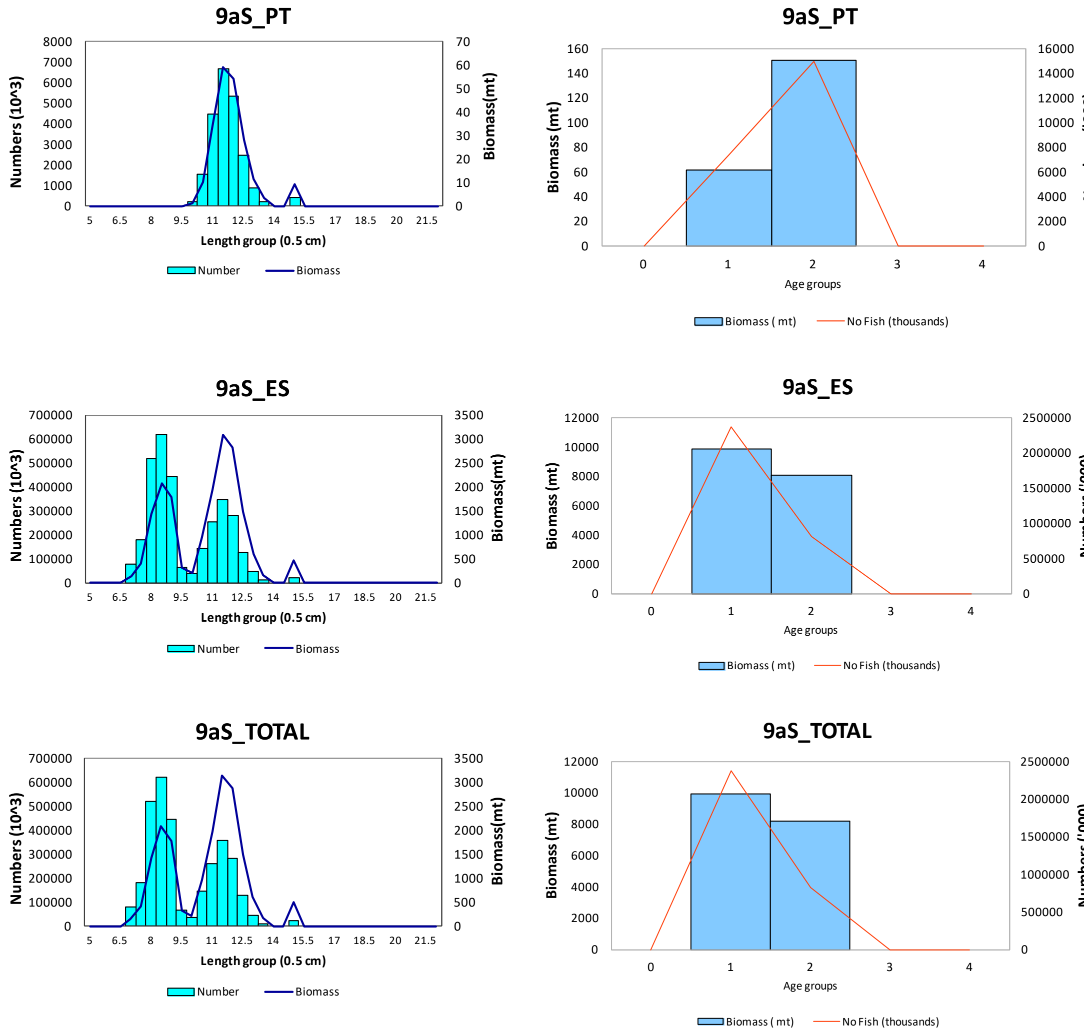



**Figure 4.4.2.2. Anchovy in Subdivision 9.a South (Gulf of Cadiz). *PELAGO* survey series (spring Portuguese acoustic survey in Sub-divisions 9.a Central-North to 9.a South). *PELAGO 24* survey. Estimated abundances and biomasses (number of fish in thousands and tonnes, respectively) for the Gulf of Cadiz by length class (cm). Note the different scales in the y axis.**

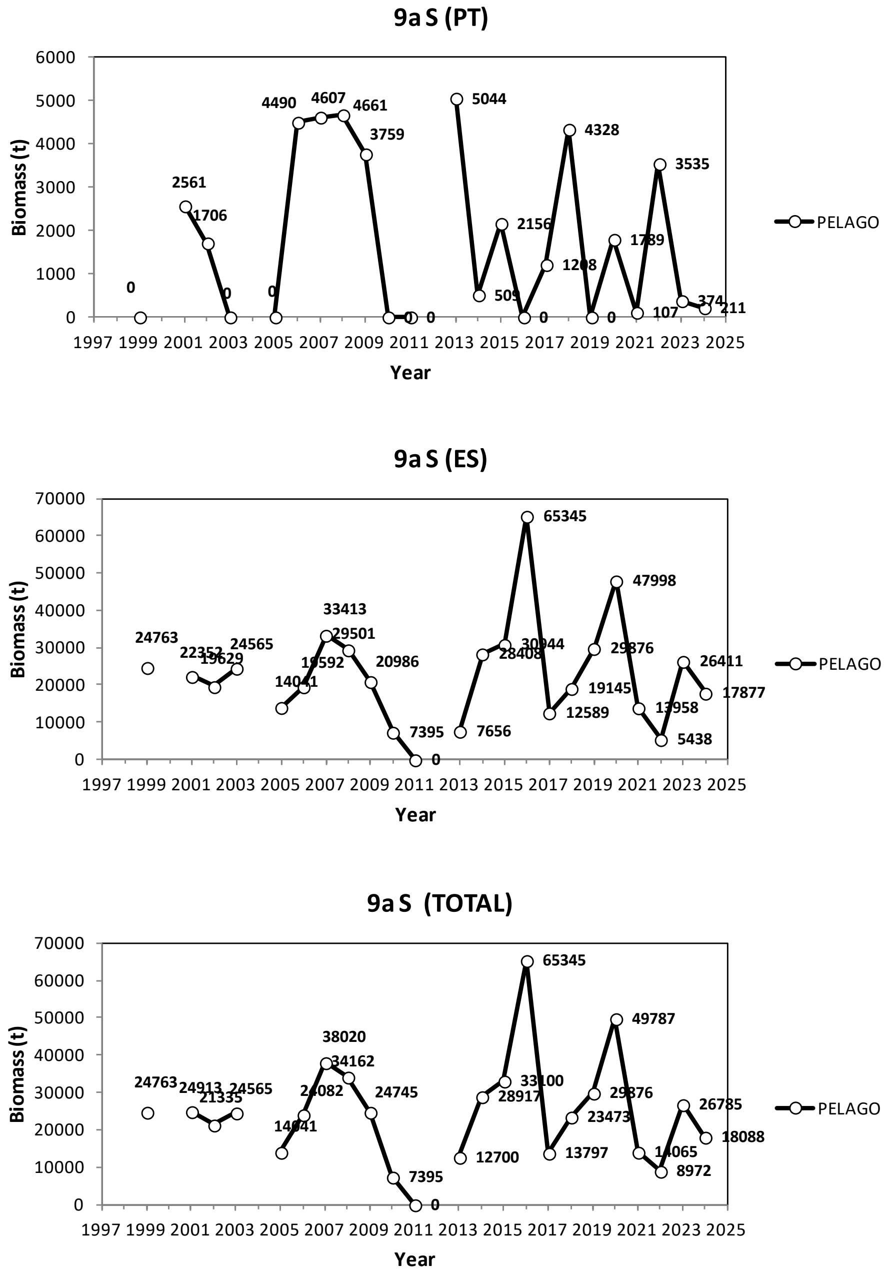
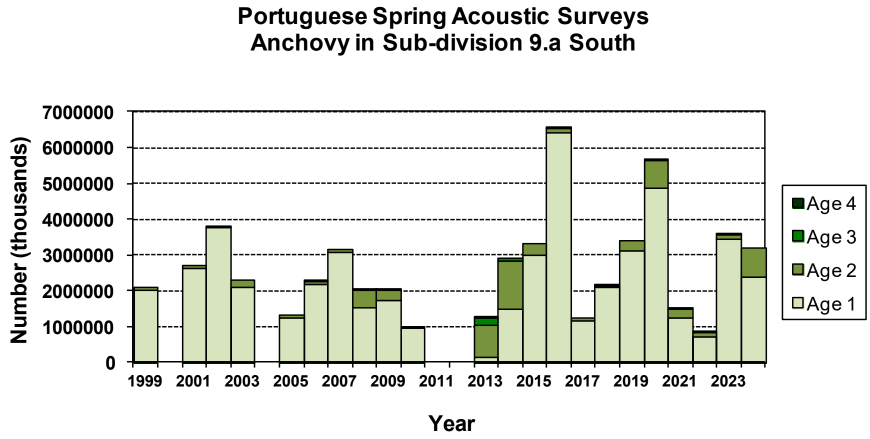



**Figure 4.4.2.3. Anchovy in Subdivision 9.a South (Gulf of Cadiz). *PELAGO* survey series (spring Portuguese acoustic survey in Sub-divisions 9.a Central-North to 9.a South). *PELAGO 24* survey. Acoustic estimates in the 9.a South differentiated by the whole Gulf of Cadiz, Portuguese (PT) and Spanish waters (ES). Note the different scale of the y-axis. Although estimates from Subdivision 9.a South in 2010 and 2014 were not separately provided for Algarve and Cadiz to this WG, the total estimated for the subdivision was assigned to the Cadiz area (by assuming some overestimation) according to the observed acoustic energy distribution in the area.**



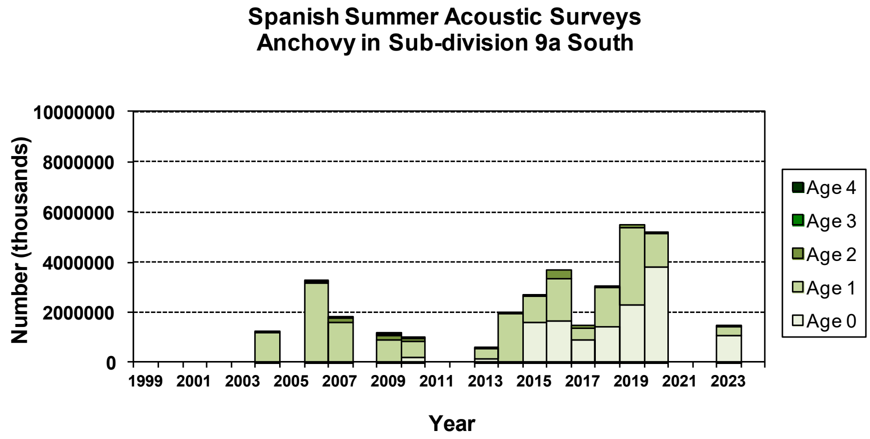




**Figure 4.4.2.4. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Annual trends of the estimated population by age class from the Algarve + Gulf of Cadiz areas by the *PELAGO* Portuguese Spring (upper plot) and *ECOCADIZ* Spanish summer (lower plot) acoustic surveys (*ECOCADIZ* surveys in 2021 and 2022 were not finally conducted). Portuguese estimates until 2012 have been age-structured using Spanish ALKs from the commercial fishery in the second quarter in the year. The age structure estimated for the *PELAGO* surveys in 2020, 2021, 2022 and 2023 has been revised and re-estimated after detecting some inconsistencies in the age readings.**

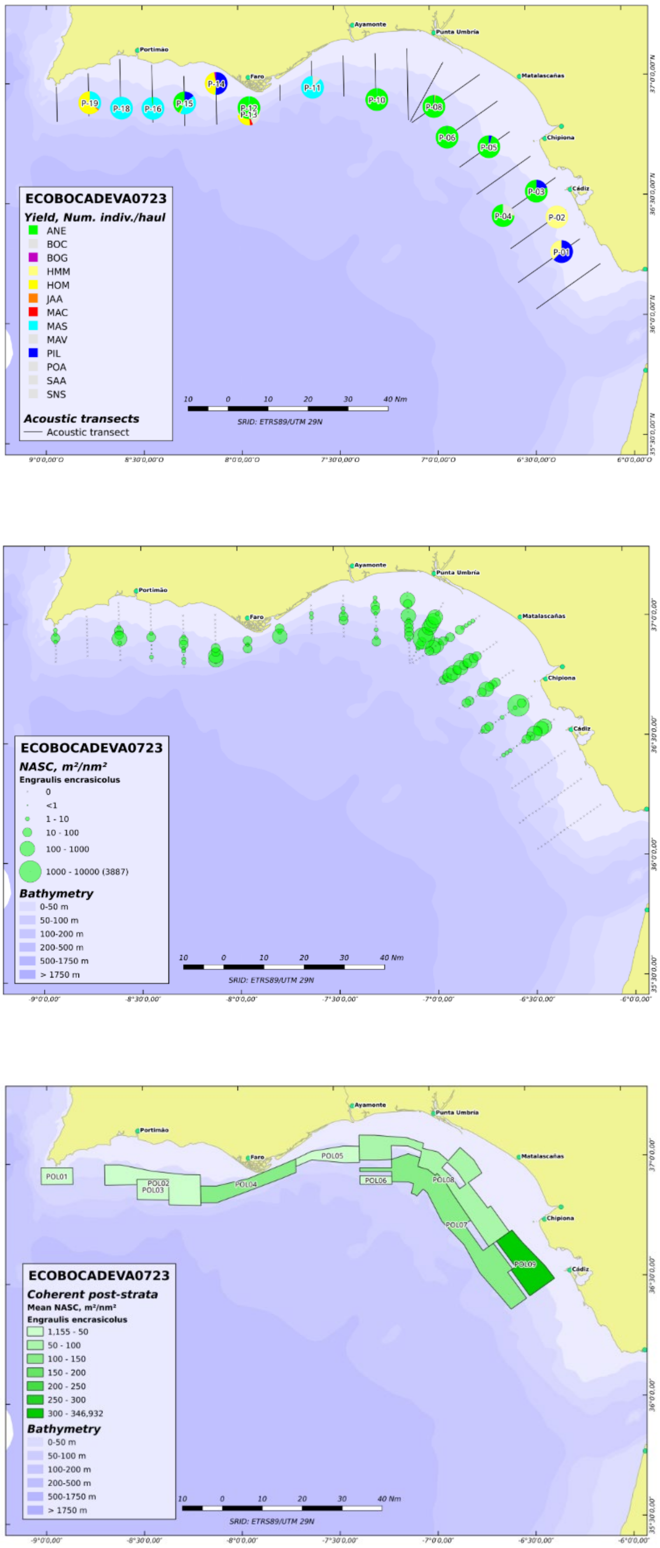



**Figure 4.4.2.5. Anchovy in Subdivision 9.a South (Gulf of Cadiz). *ECOCADIZ 2023-07* survey (summer Spanish acoustic survey in Subdivision 9.a South). Top: Location of valid fishing stations with indication of their species composition (percentages in number). Middle: Distribution of the backscattering energy (Nautical area scattering coefficient, NASC, in $m^2$ $nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.**

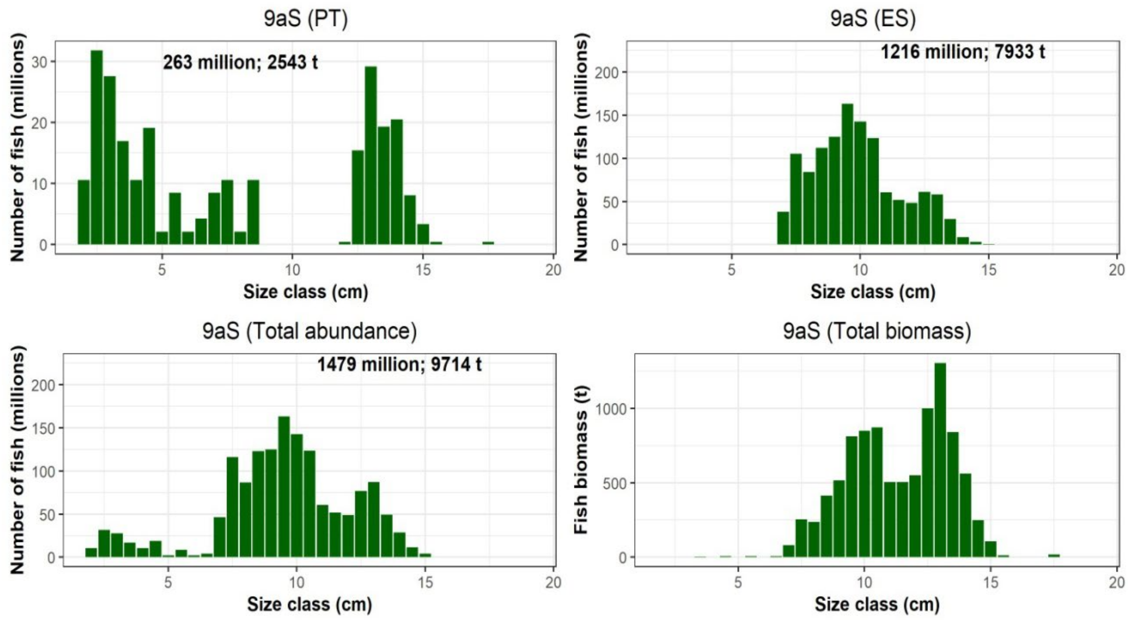



**Figure 4.4.2.6. Anchovy in Subdivision 9.a South (Gulf of Cadiz). *ECOCADIZ 2023-07* survey (summer Spanish acoustic survey in Subdivision 9.a South). Estimated abundances and biomasses (number of fish in millions and tonnes, respectively) for the surveyed area by length class (cm).Note the different scales in the y-axis.**

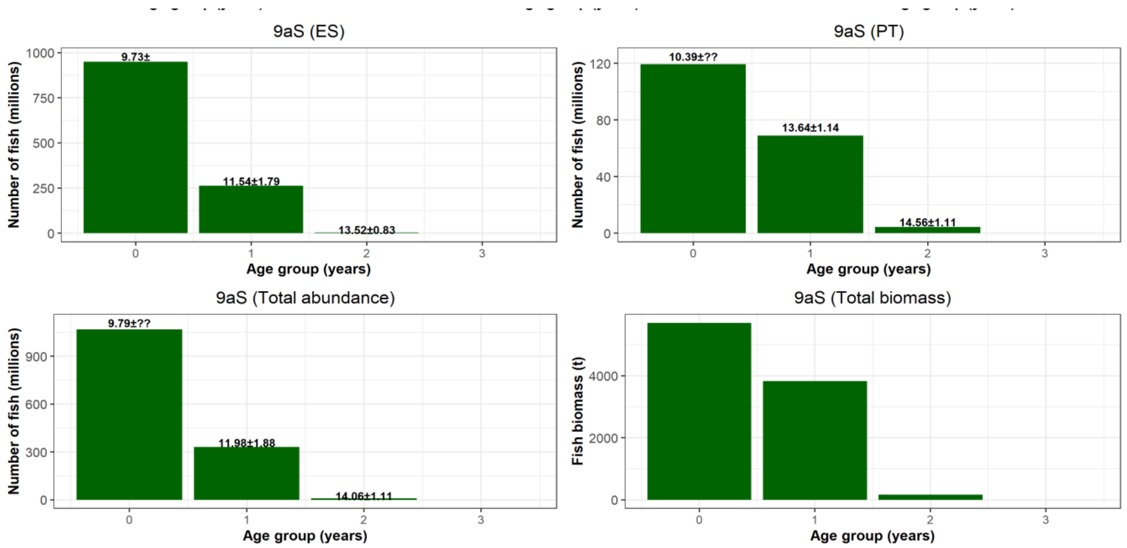



**Figure 4.4.2.7. Anchovy in Subdivision 9.a South (Gulf of Cadiz). *ECOCADIZ 2023-07* survey (summer Spanish acoustic survey in Subdivision 9.a South). Estimated abundances and biomasses (number of fish in millions and tonnes, respectively) for the surveyed area by age group, with indication of the mean size by age. Note the different scales in the y-axis.**

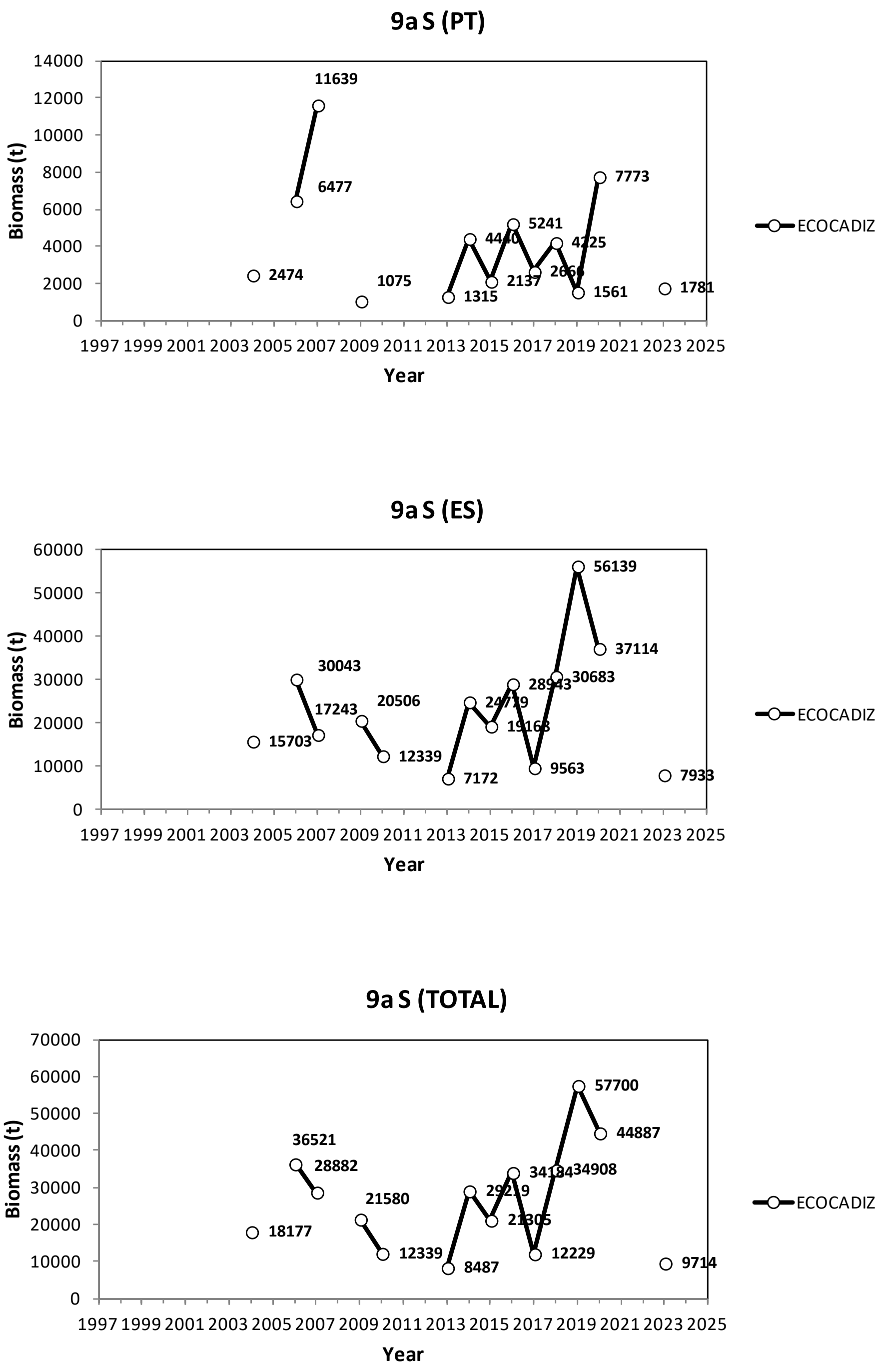



**Figure 4.4.2.8. Anchovy in Subdivision 9.a South (Gulf of Cadiz). *ECOCADIZ* survey series (summer Spanish acoustic survey in Subdivision 9.a South). Historical series of overall and regional (Portuguese, PT, and Spanish waters of the Gulf of Cadiz, ES) acoustic estimates of anchovy biomass (t). Note the different scale of the y-axis. *ECOCADIZ* 2021 and 2022 were not finally conducted.**

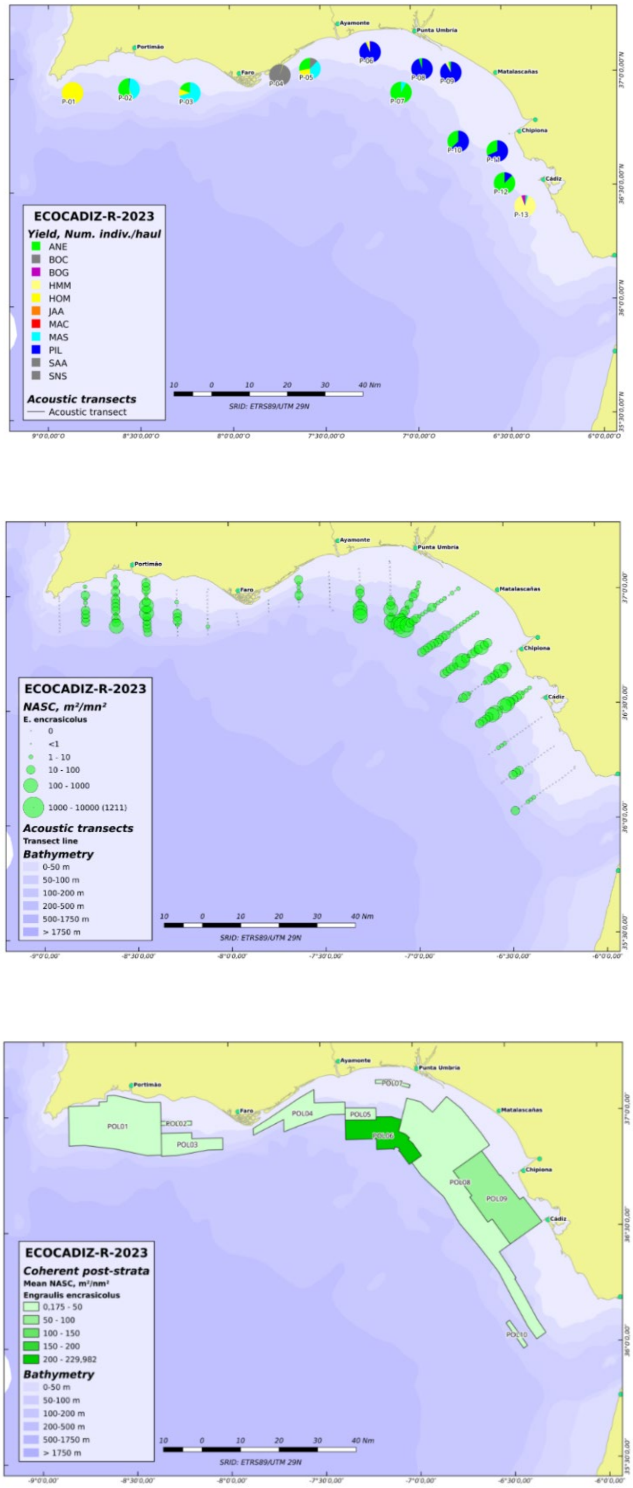



**Figure 4.4.3.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). *ECOCADIZ-RECLUTAS 2023-10* survey (autumn Spanish acoustic survey in Subdivision 9.a South). Top: Location of valid fishing stations with indication of their species composition (percentages in number).Middle: Distribution of the backscattering energy (Nautical area scattering coefficient, NASC, in $m^2$ $nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.**

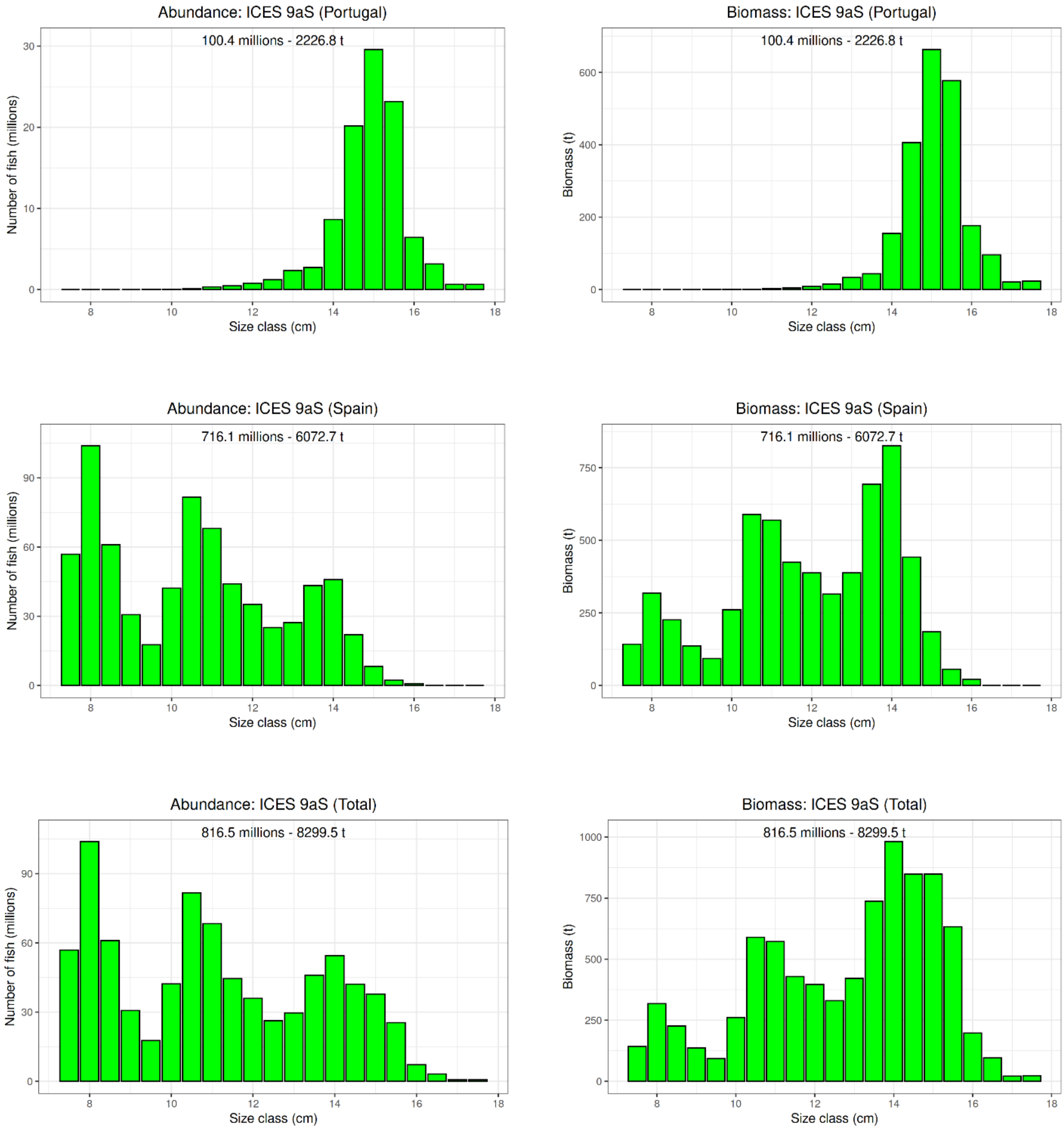



**Figure 4.4.3.2. Anchovy in Subdivision 9.a South (Gulf of Cadiz). *ECOCADIZ-RECLUTAS 2023-10* survey (autumn Spanish acoustic survey in Subdivision 9.a South). Estimated abundances and biomasses (number of fish in millions and tonnes, respectively) for the surveyed area by length class (cm). Note the different scales in the y-axis.**

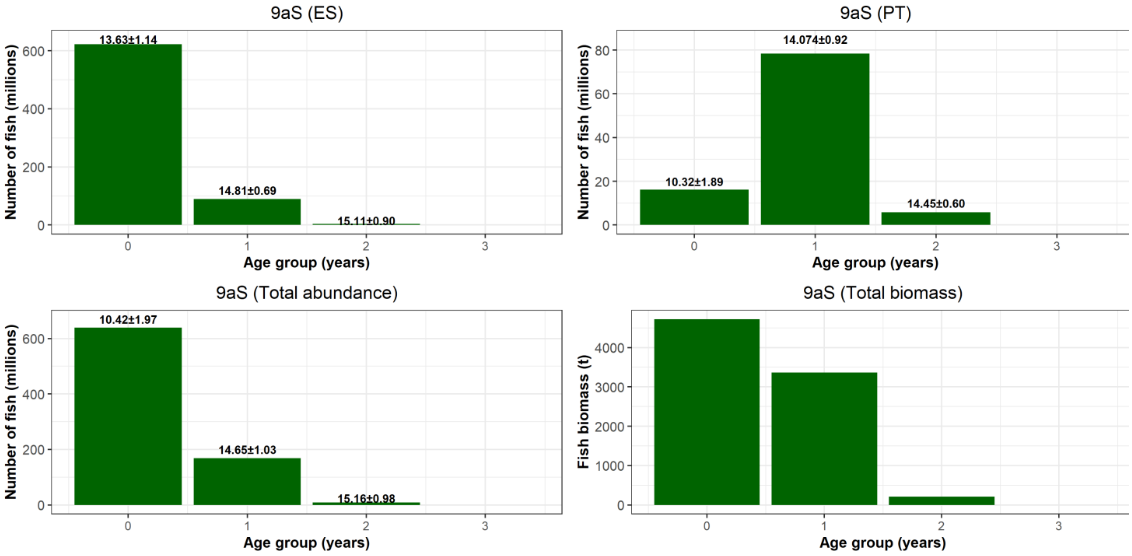



**Figure 4.4.3.3. Anchovy in Subdivision 9.a South (Gulf of Cadiz). *ECOCADIZ-RECLUTAS 2023-10* survey (autumn Spanish acoustic survey in Subdivision 9.a South). Estimated abundances and biomasses (number of fish in millions and tonnes, respectively) for the surveyed area by age group, with indication of the mean size by age. Note the different scales in the y-axis.**

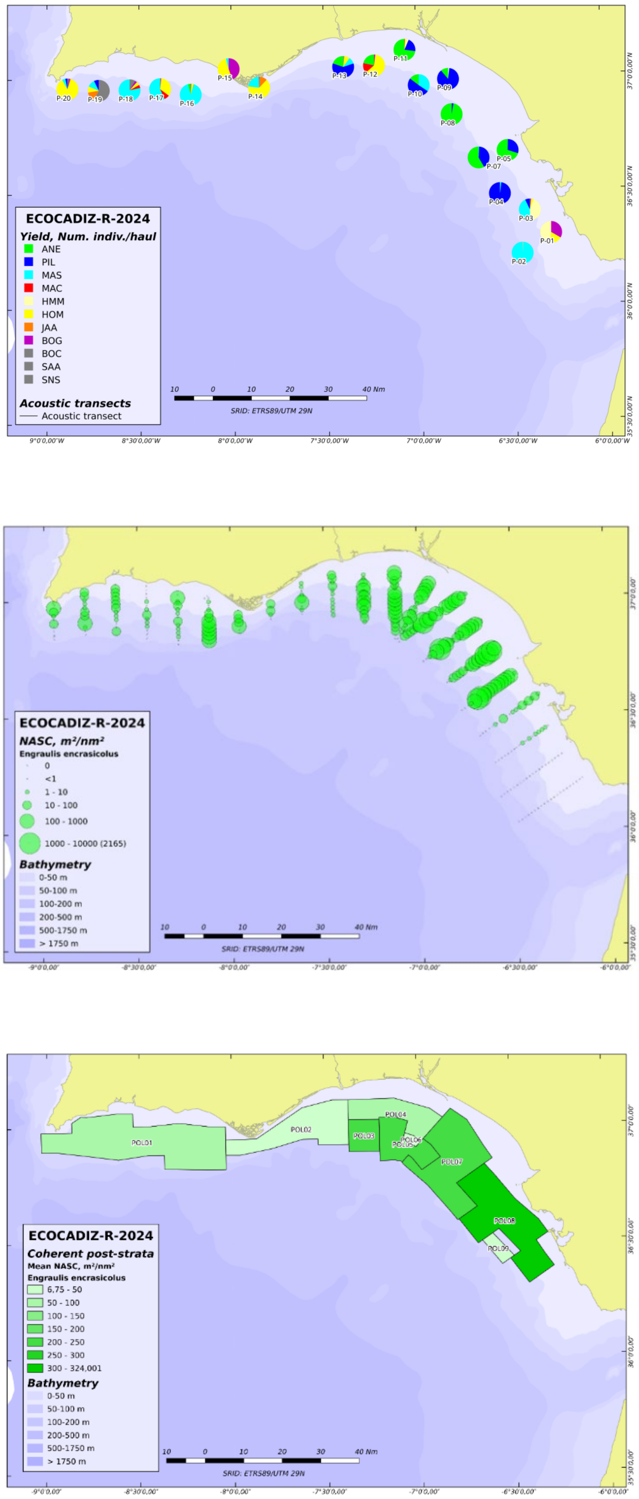



**Figure 4.4.3.4. Anchovy in Subdivision 9.a South (Gulf of Cadiz). *ECOCADIZ-RECLUTAS 2024-10* survey (autumn Spanish acoustic survey in Subdivision 9.a South). Top: Location of valid fishing stations with indication of their species composition (percentages in number).Middle: Distribution of the backscattering energy (Nautical area scattering coefficient, NASC, in m$^2$ nmi$^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.**

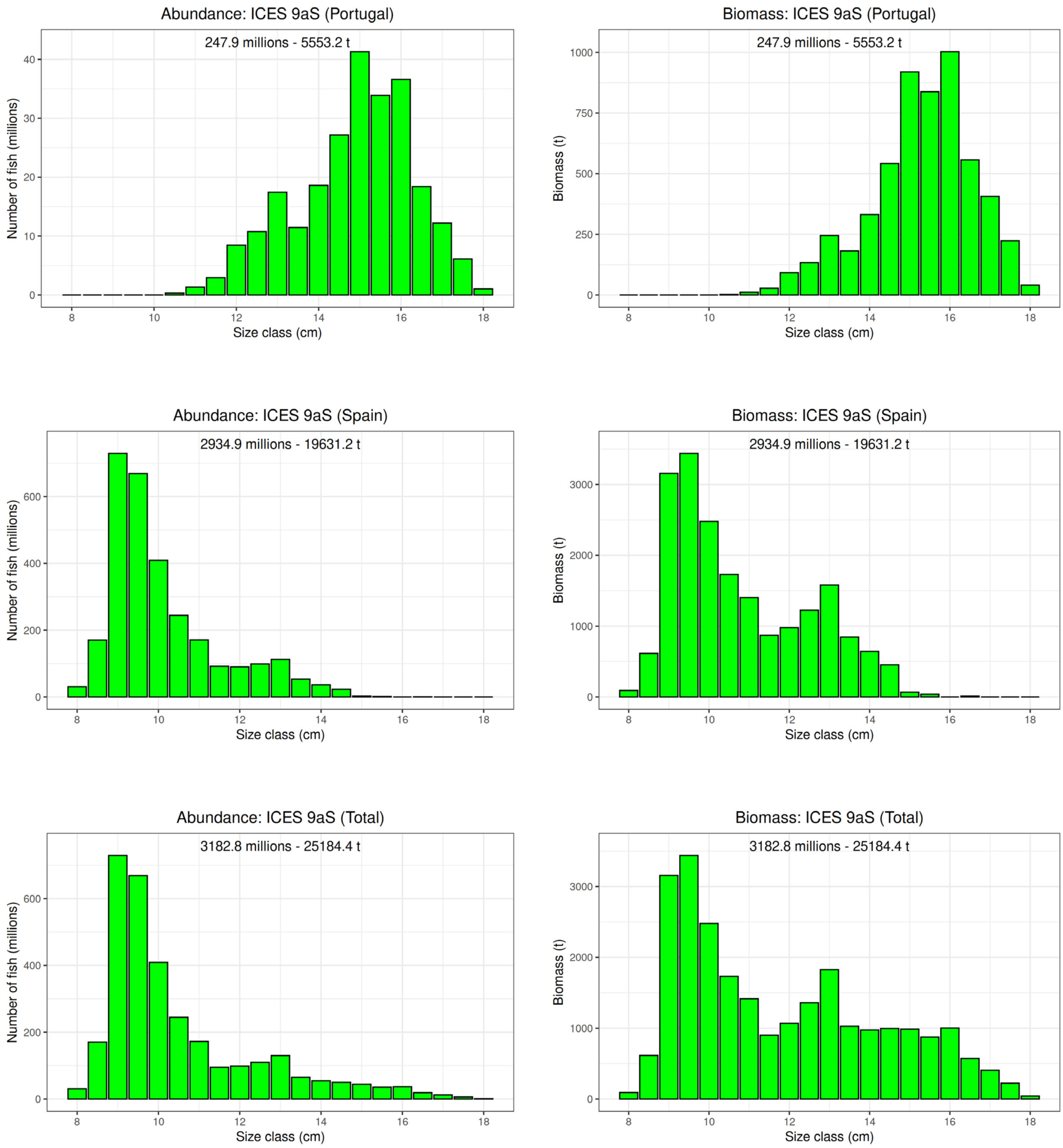



**Figure 4.4.3.5. Anchovy in Subdivision 9.a South (Gulf of Cadiz). *ECOCADIZ-RECLUTAS 2024-10* survey (autumn Spanish acoustic survey in Subdivision 9.a South). Estimated abundances and biomasses (number of fish in millions and tonnes, respectively) for the surveyed area by length class (cm). Note the different scales in the y-axis.**

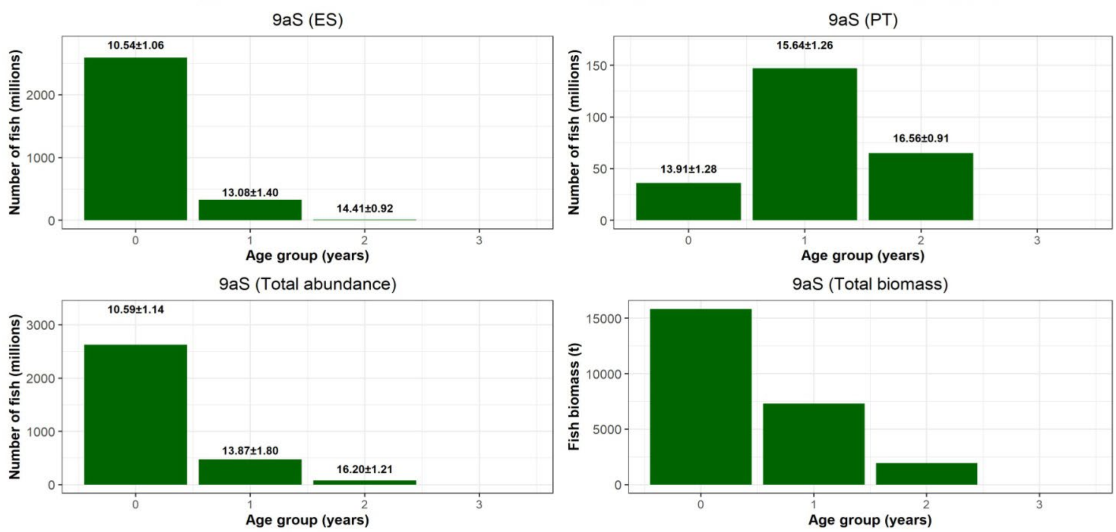



**Figure 4.4.3.6. Anchovy in Subdivision 9.a South (Gulf of Cadiz).** ***ECOCADIZ-RECLUTAS 2024-10*** **survey (autumn Spanish acoustic survey in Subdivision 9.a South). Estimated abundances and biomasses (number of fish in millions and tonnes, respectively) for the surveyed area by age group, with indication of the mean size by age. Note the different scales in the y-axis.**

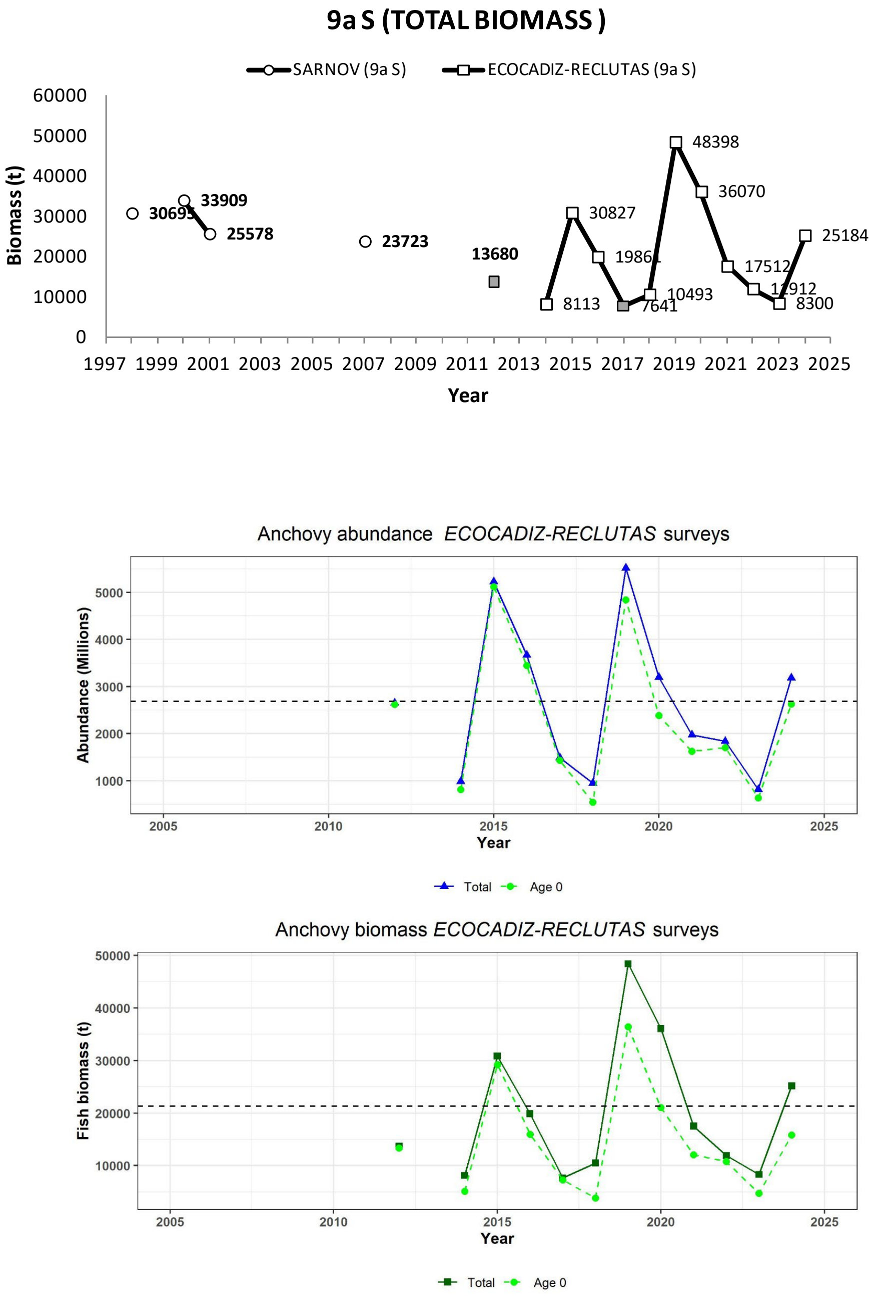



**Figure 4.4.3.7. Anchovy in Subdivision 9.a South (Gulf of Cadiz). *ECOCADIZ-RECLUTAS* survey series (autumn Spanish acoustic survey in Subdivision 9.a South). Top: historical series of overall acoustic estimates of anchovy biomass (t), (squares). The estimates from the older Portuguese *SARNOV* survey series are also included for comparison of trends (circles). The 2012 and 2017 estimates (in dark grey) are partial ones, since the surveys either covered the Spanish waters (2012) or the seven easternmost transects (2017). Middle and bottom: time-series estimates of abundance and biomass of the total population and Age 0 fish. In this case, the 2017 has not been included. The 2012 estimate is retained because the recruitment area was almost covered.**

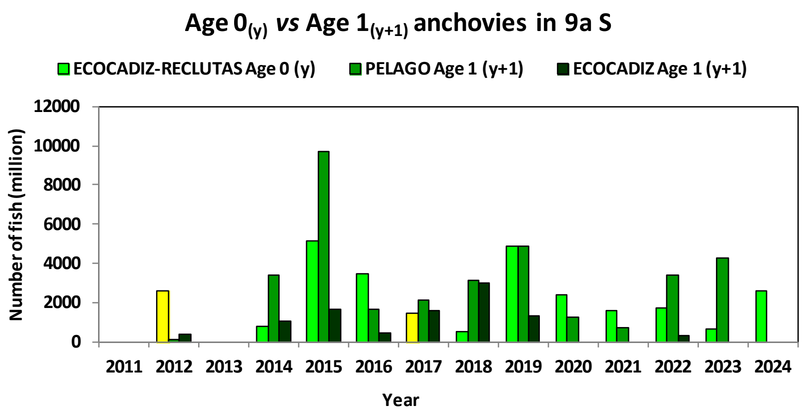



**Figure 4.4.3.8. Anchovy in Subdivision 9.a South (Gulf of Cadiz). *ECOCADIZ-RECLUTAS* survey series (autumn Spanish acoustic survey in Subdivision 9.a South). Correspondence between acoustic estimates of abundance of Age 0 anchovies from *ECOCADIZ-RECLUTAS* surveys in the autumn of the year *y* against the abundance of Age 1 anchovies estimated in spring of the following year (*y+1*) by the *PELAGO* survey and in summer by the *ECOCADIZ* survey. The *ECOCADIZ-RECLUTAS* 2012 and 2017 estimates (in yellow) are partial ones since the 2012 survey only covered the Spanish waters and the 2017 survey the seven easternmost transects. *ECOCADIZ* 2021, 2022 and 2024 surveys were not finally conducted.**

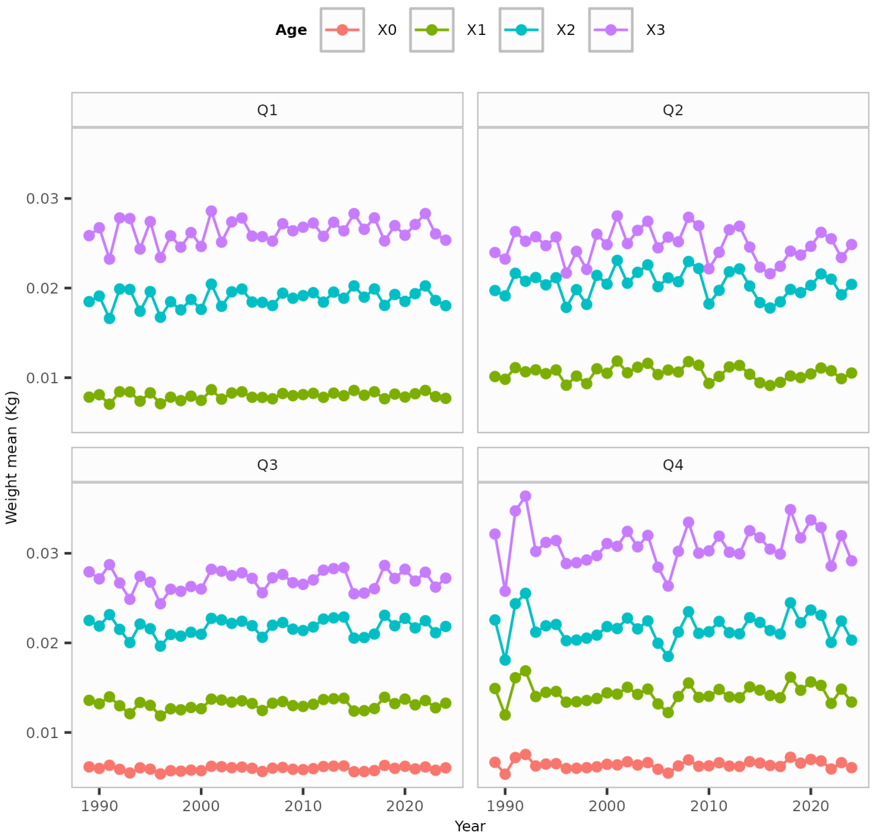



**Figure 4.5.1.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Estimated mean weights (in kilograms) by age group (0 to 3 years) for the four quarters over the period 1989 to 2024. indicate the linear mixed-effects model estimates. Each panel corresponds to a specific quarter.**

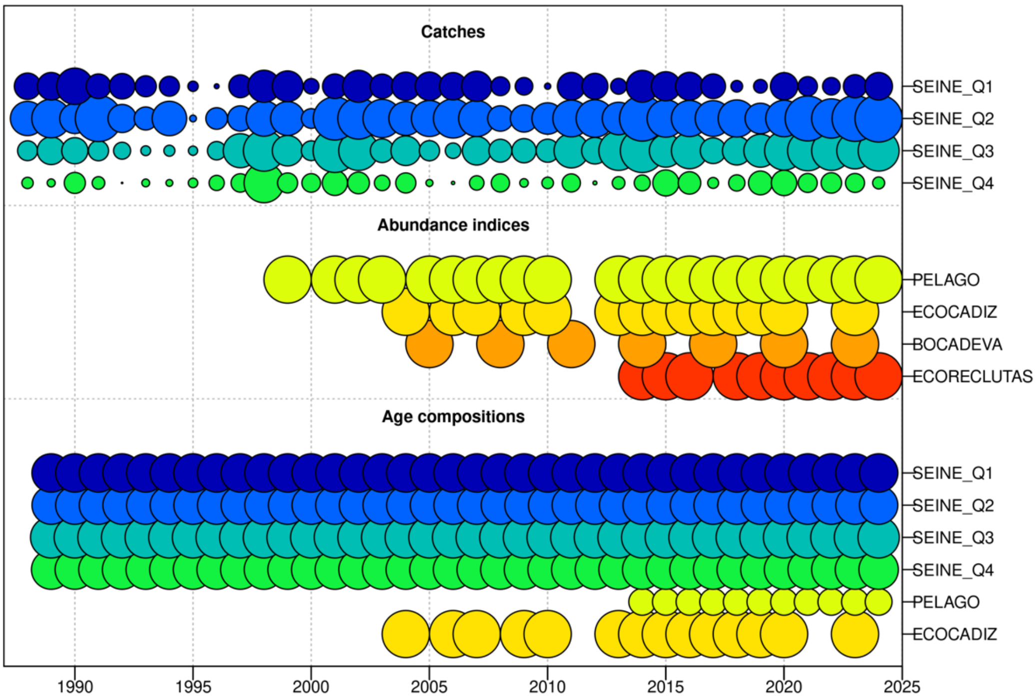



**Figure 4.6.1.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Summary of model data input by year, where circle area is relative within a data type. Circles are proportional to total catch for catches, to precision for indices and to total sample size for age compositions.**

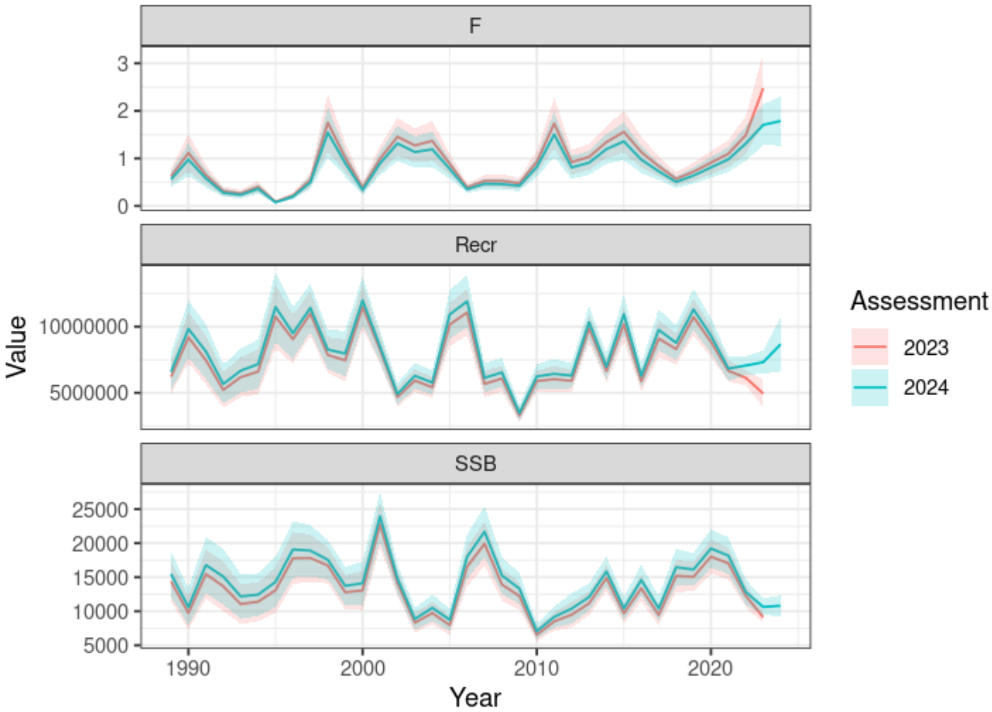



**Figure 4.6.1.2. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Comparison final assessment (1989-2024) and last year assessment performed in WKBANSP 2024 (ICES, 2024b) (1989-2023). Plots of Fishing mortality (F), Recruitment (age-0) (Recr) and Spawing biomass (SSB). Grey shaded area and bars in recruitment shows 95% confidence bounds. SSB in tonnes and recruitment in thousands.**

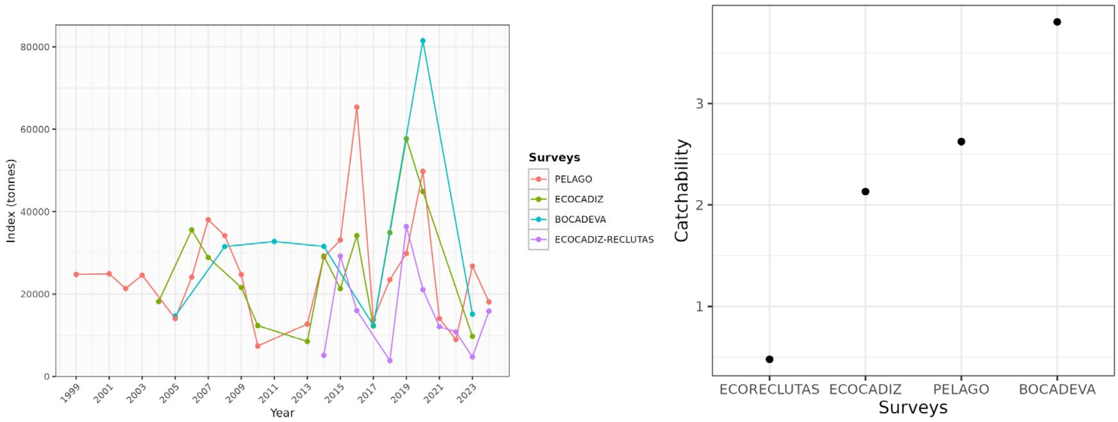



**Figure 4.6.2.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Left panel: Biomass estimates from the *PELAGO*, *ECOCADIZ*, *BOCADEVA*, and *ECOCADIZ-RECLUTAS* surveys. Right panel: Estimated catchability parameters for the different survey indices based on the corrected final run.**

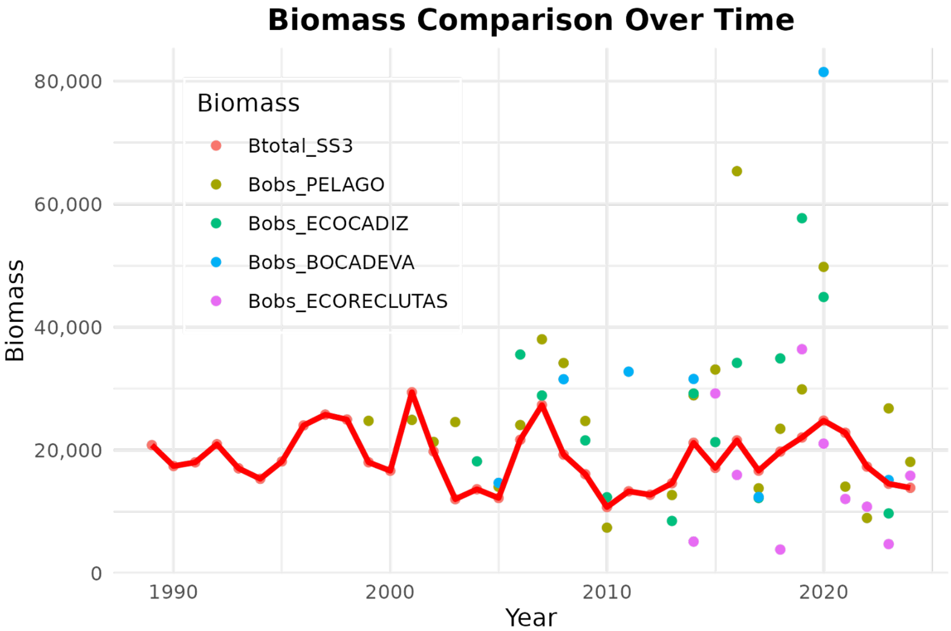



**Figure 4.6.2.2. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Comparison of biomass scales: total biomass estimated by the SS3 model (red line) versus observed biomass from surveys (points) (*PELAGO*, *ECOCADIZ*, *BOCADEVA*, and *ECOCADIZ-RECLUTAS*).**

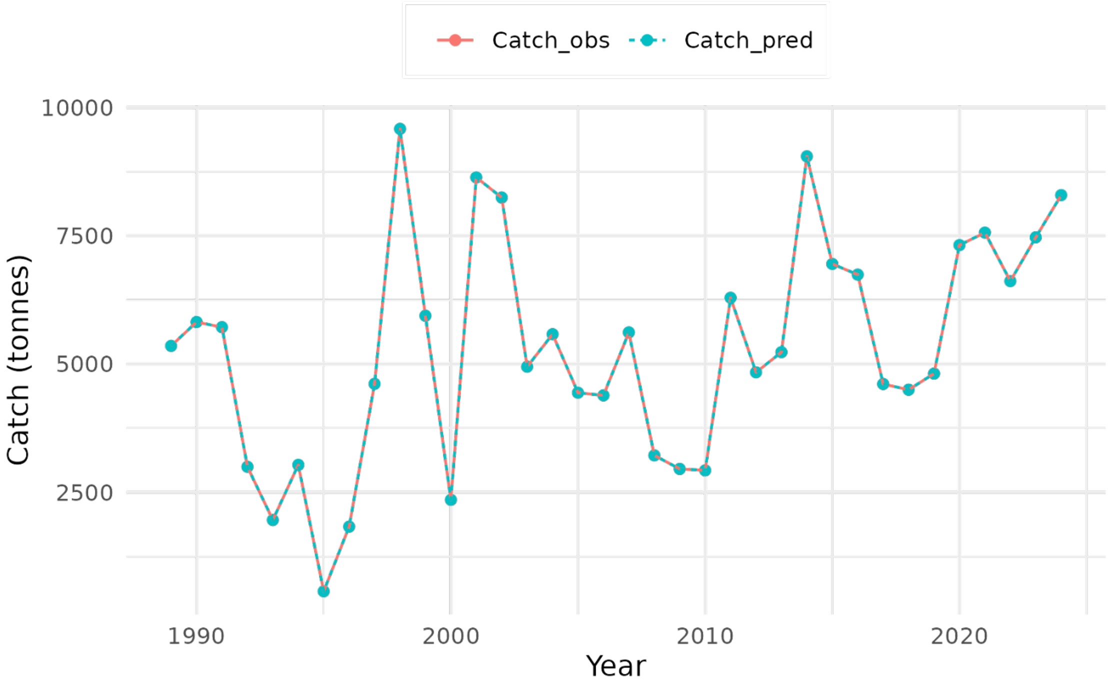



**Figure 4.6.2.3. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Comparison of catches scales: catch estimated by the SS3 model (light blue line) versus observed catch (red line).**

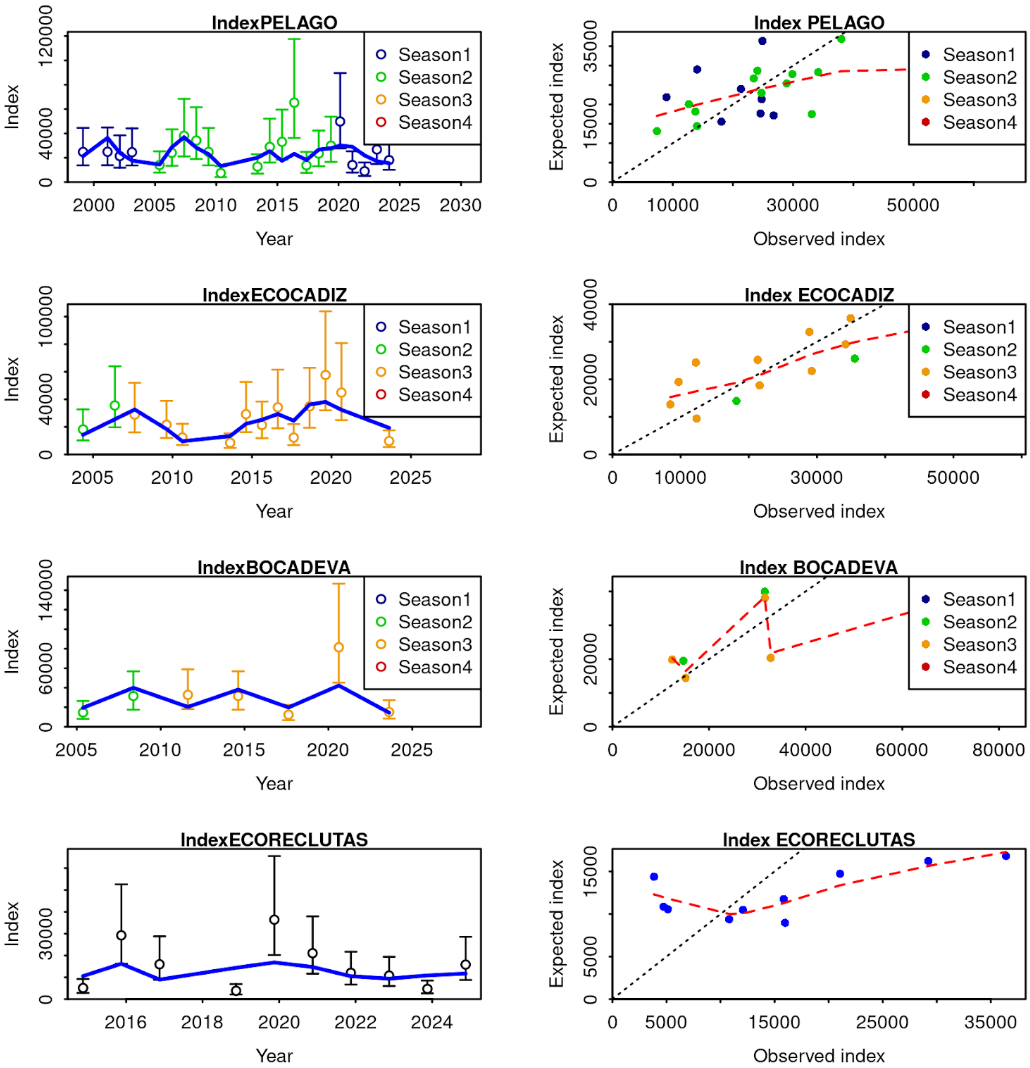



**Figure 4.6.2.4. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Model fit to the data (left panel) and observed versus expected values (right panel) of the indices from the surveys *PELAGO*, *ECOCADIZ*, *BOCADEVA* and *ECOCADIZ-RECLUTAS*. The lines indicate a 95% uncertainty interval around the index values based on the lognormal error model assumption.**

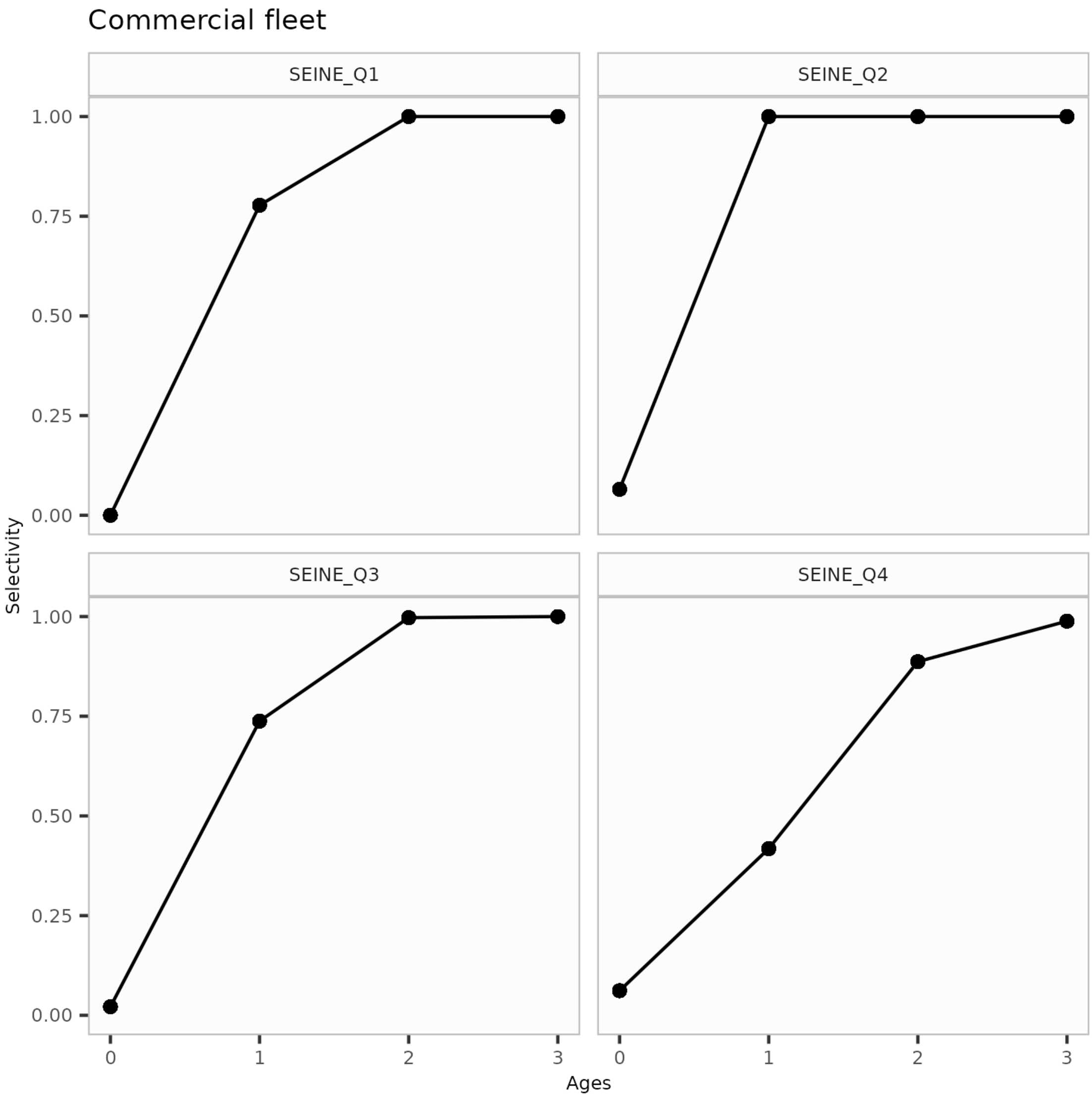



**Figure 4.6.2.5. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Estimated selectivity for catch-at-age of commercial fleet (logistic shaped fixed selectivity across all years).**

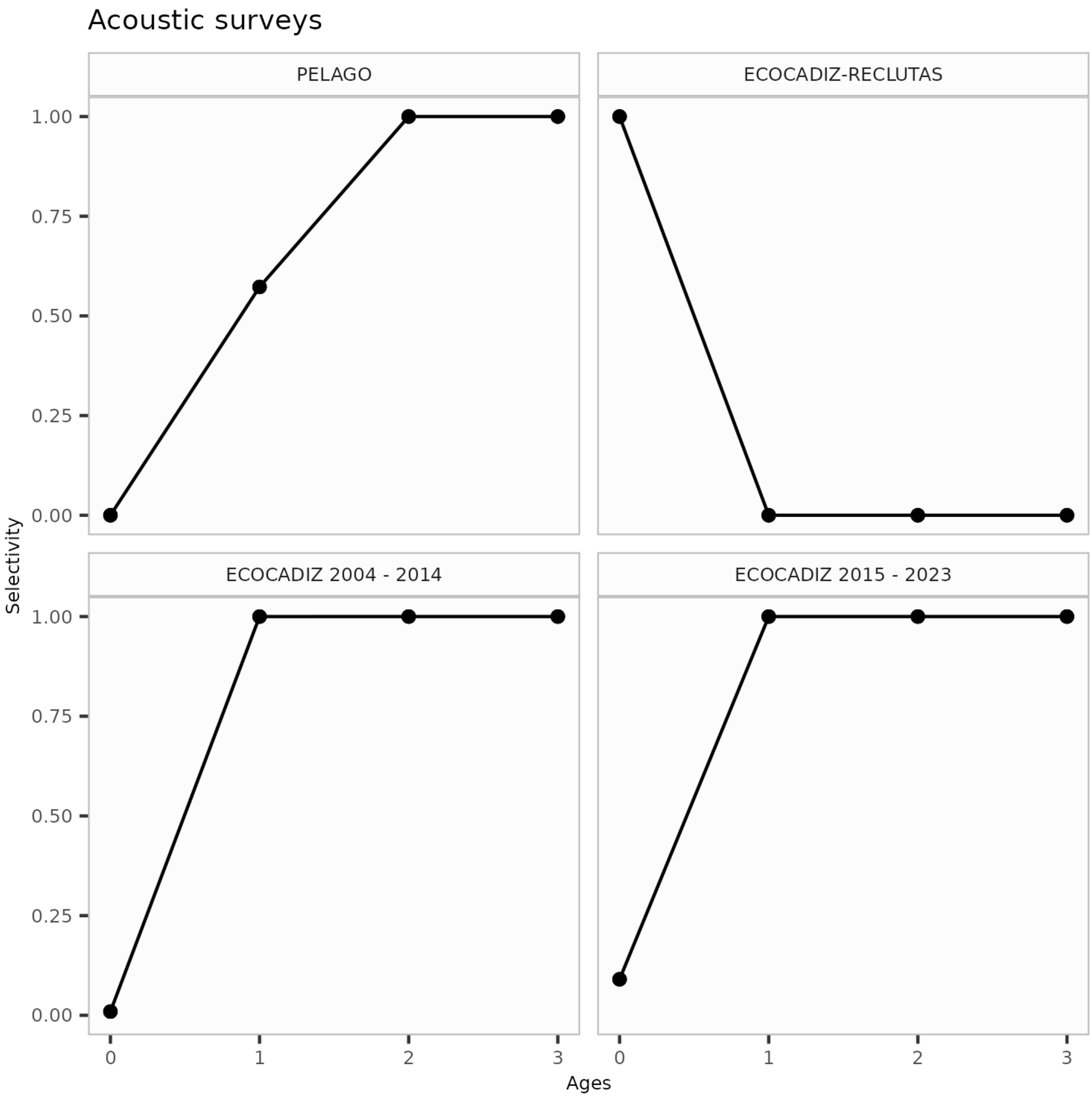



**Figure 4.6.2.6. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Estimated selectivity for catch-at-age of surveys (logistic shaped fixed selectivity across all years).**

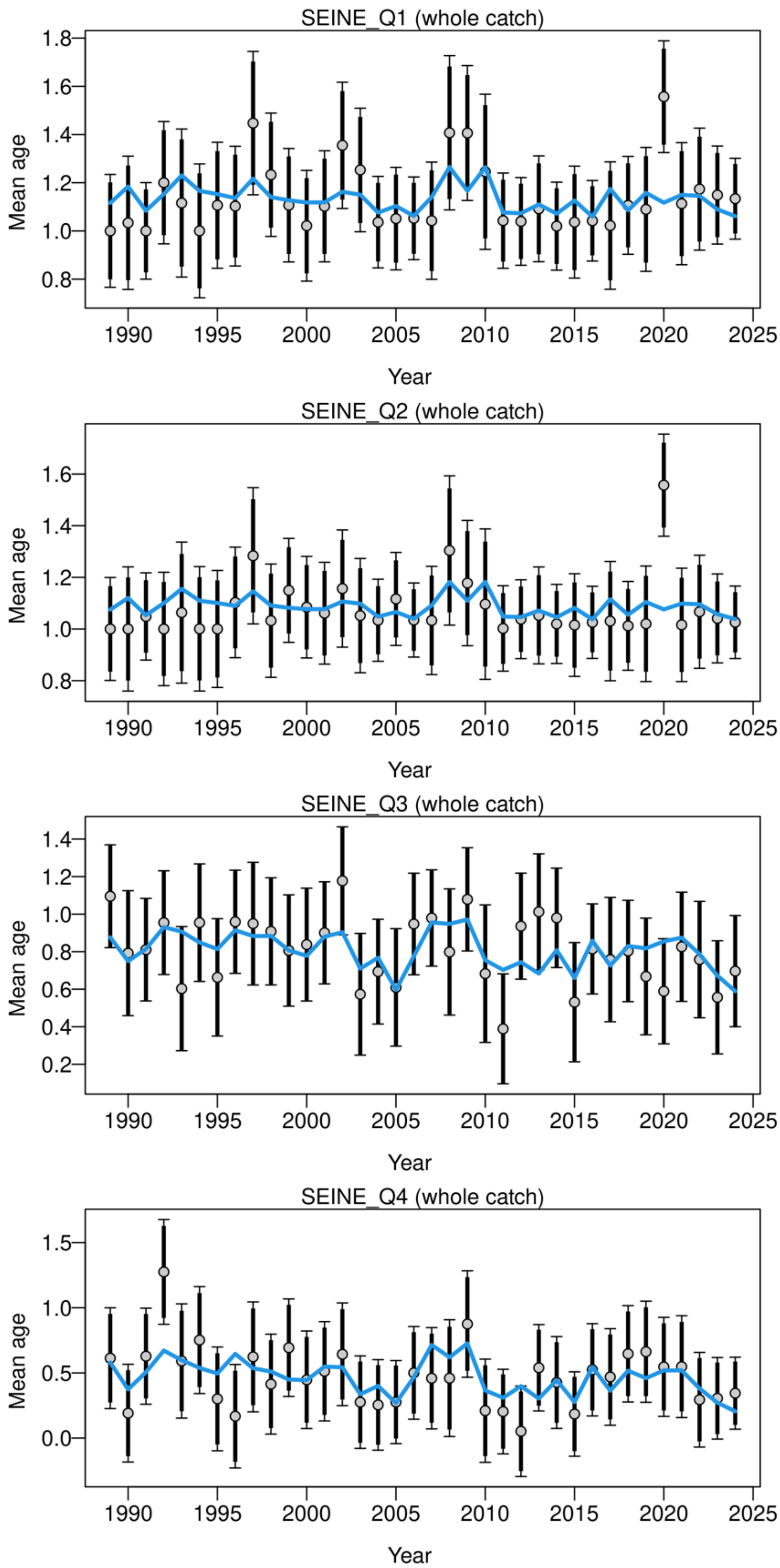



**Figure 4.6.2.7. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Mean age for commercial fleet by quarters with 95% confidence intervals based on current sample sizes. Francis data weighting method TA1.8: thinner intervals (with capped ends) show the result of further adjusting sample sizes based on the suggested multiplier (with 95% interval) for age data. The blue line corresponds to the estimated mean age.**

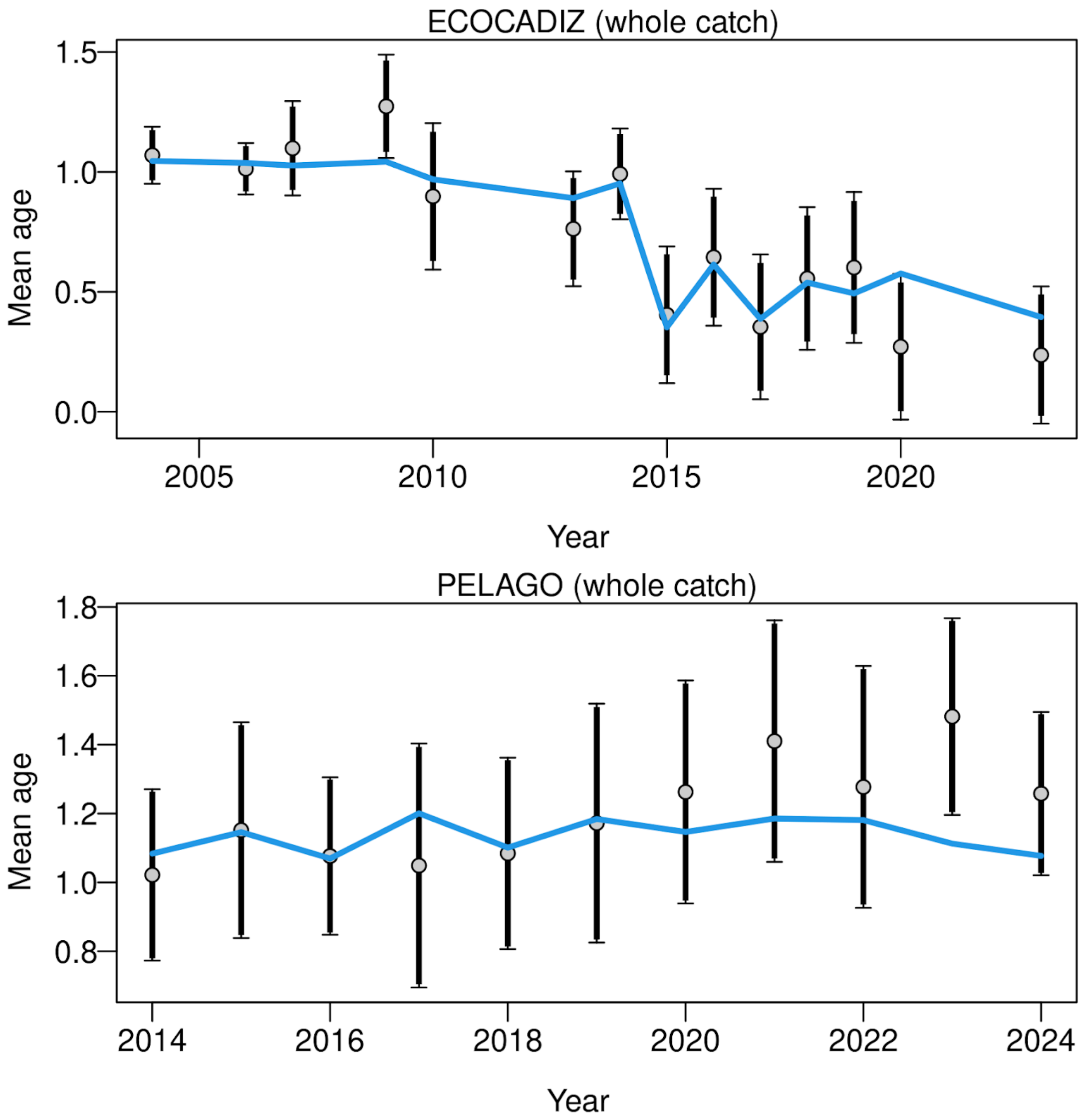



**Figure 4.6.2.8. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Mean age for *PELAGO*, *ECOCADIZ*, and *ECOCADIZ-RECLUTAS* with 95% confidence intervals based on current sample sizes. Francis data weighting method TA1.8: thinner intervals (with capped ends) show the result of further adjusting sample sizes based on the suggested multiplier (with 95% interval) for age data. The blue line corresponds to the estimated mean age.**

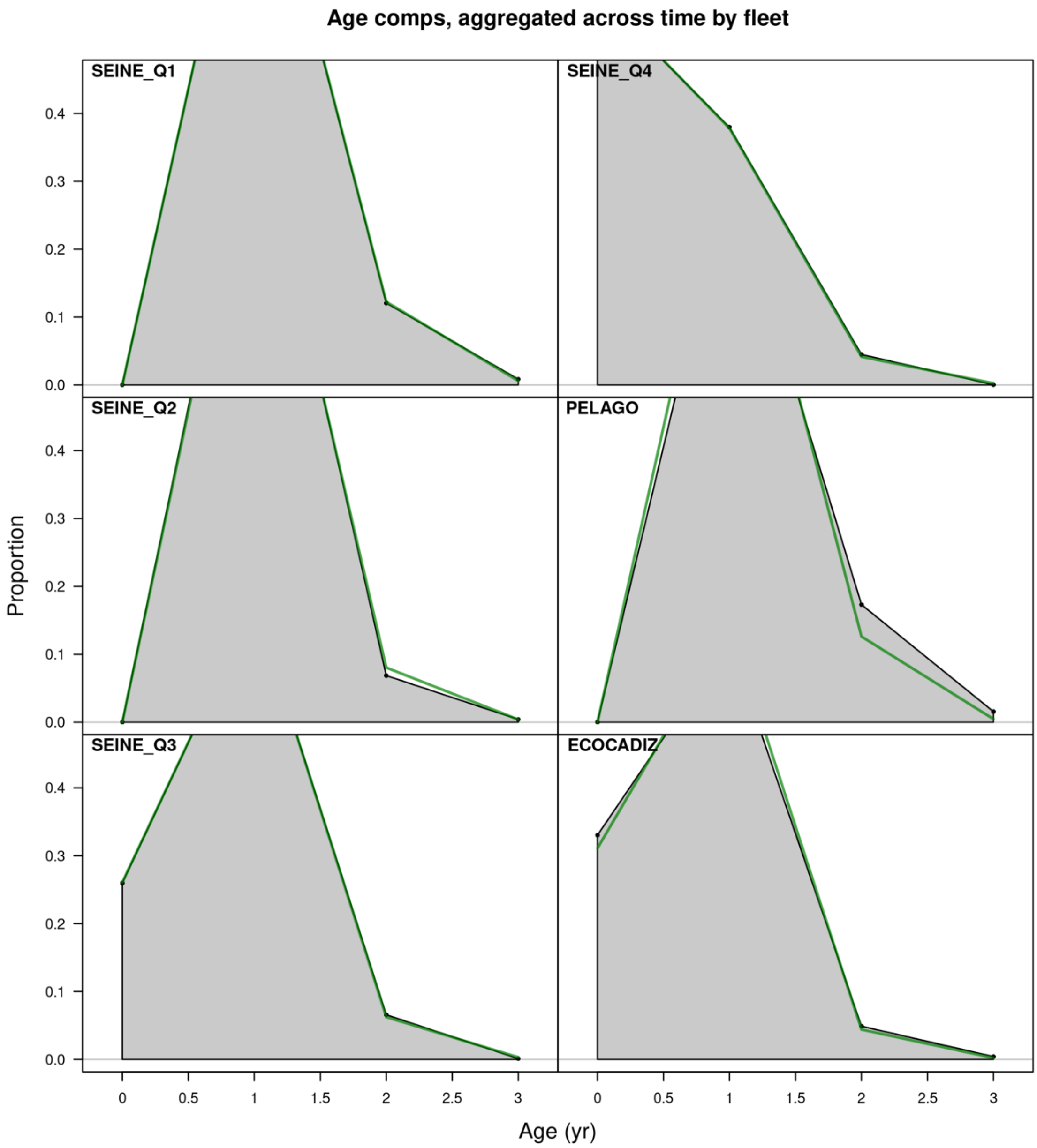



**Figure 4.6.2.9. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Model fit to the aggregated age composition data from the *SEINE* fishery, and the acoustic surveys *PELAGO* and *ECOCADIZ*. The green line represents the model estimates, while the shaded grey area shows the observed data.**

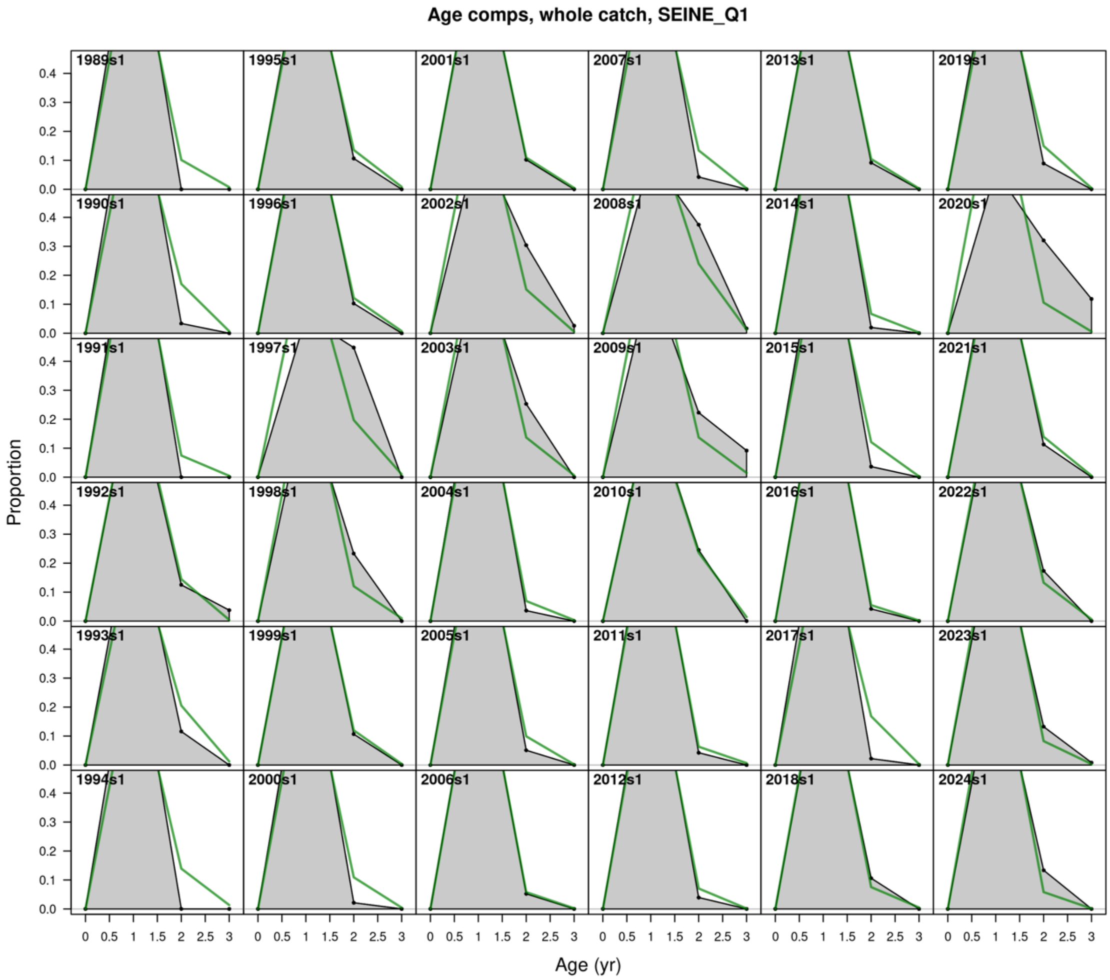



**Figure 4.6.2.10. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Model fit to the age composition data from the *SEINEQ1* fishery, by year and quarter. The green line represents the model estimates, while the shaded grey area shows the observed data.**

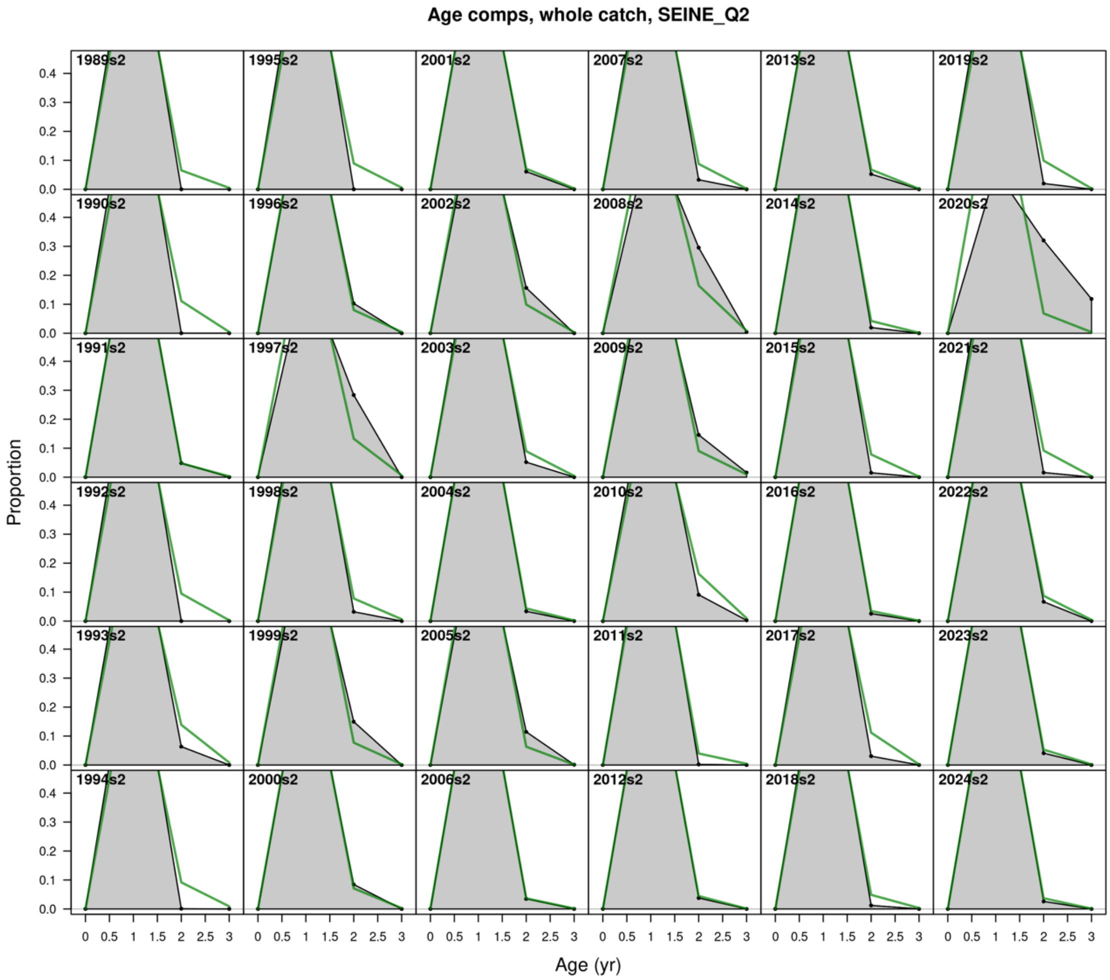



**Figure 4.6.2.11. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Model fit to the age composition data from the *SEINEQ2* fishery, by year and quarter. The green line represents the model estimates, while the shaded grey area shows the observed data.**

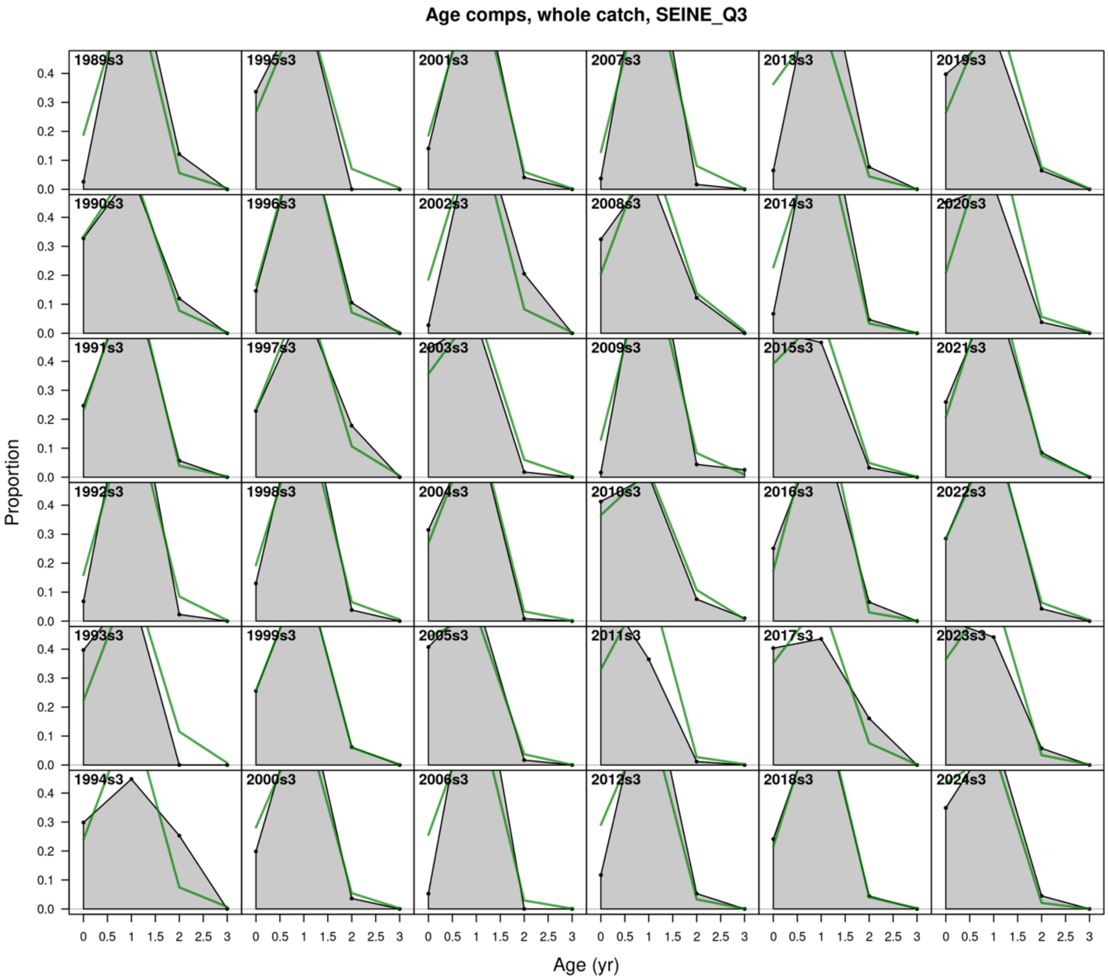



**Figure 4.6.2.12. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Model fit to the age composition data from the *SEINEQ3* fishery, by year and quarter. The green line represents the model estimates, while the shaded grey area shows the observed data.**

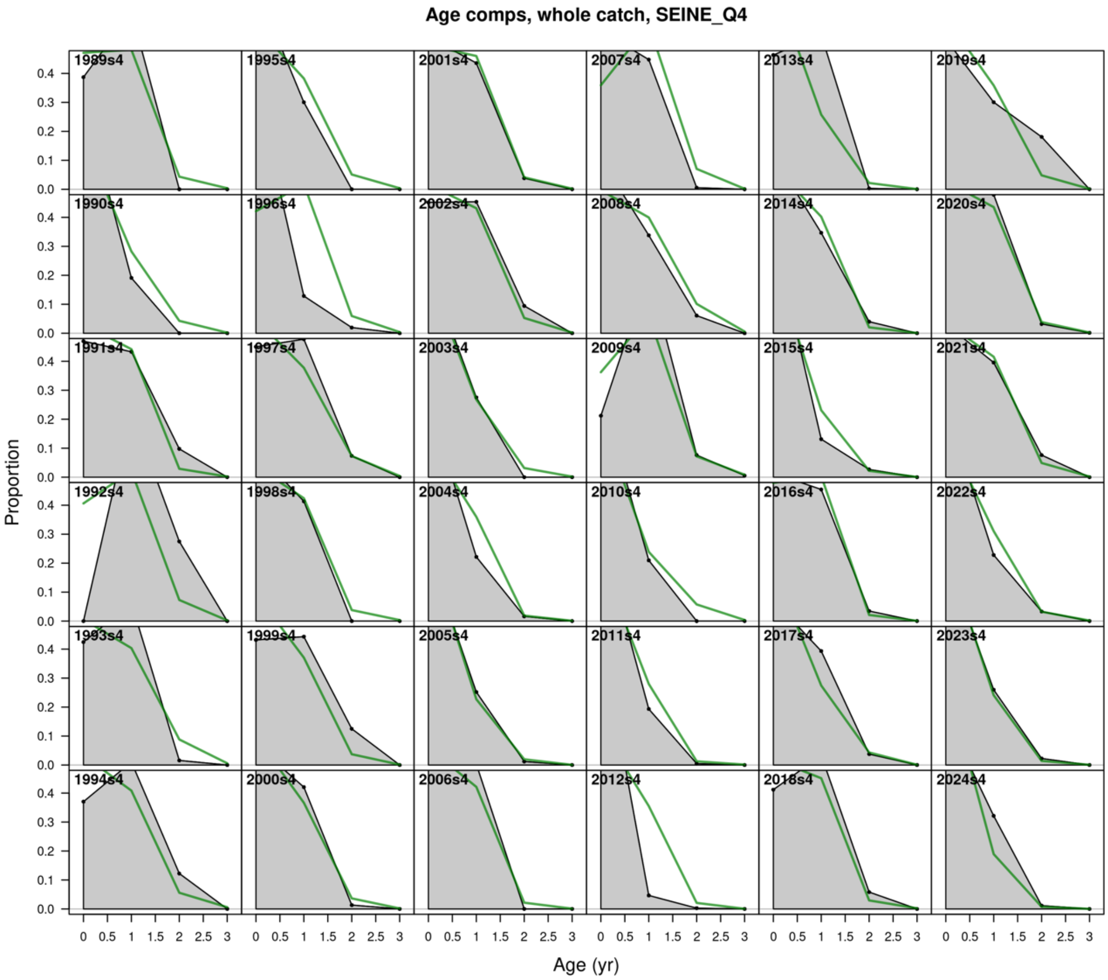



**Figure 4.6.2.13. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Model fit to the age composition data from the *SEINEQ4* fishery, by year and quarter. The green line represents the model estimates, while the shaded grey area shows the observed data.**

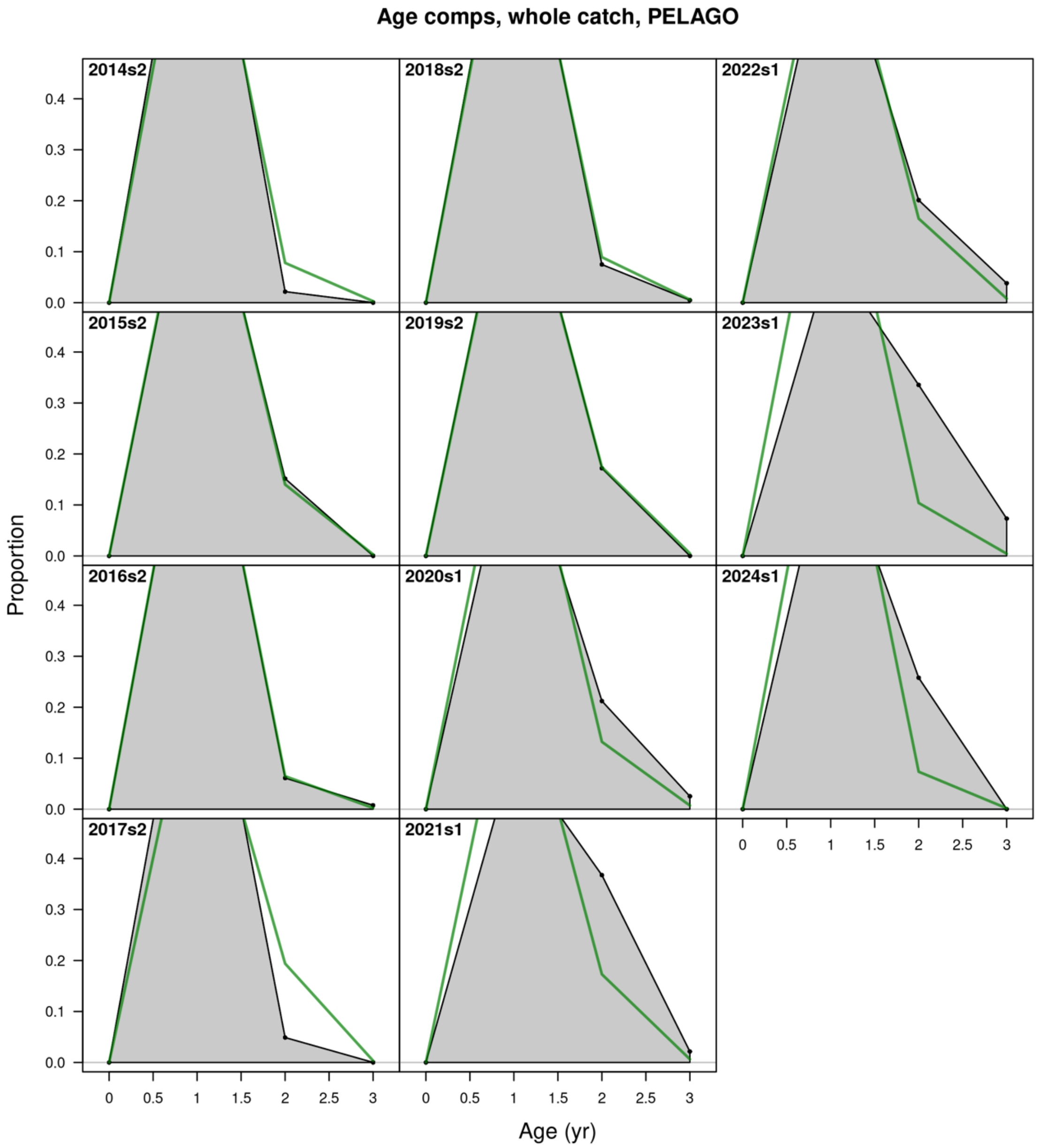



**Figure 4.6.2.14. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Model fit to the age composition data from the *PELAGO* spring survey by year. The green line represents the model estimates, while the shaded grey area shows the observed data.**

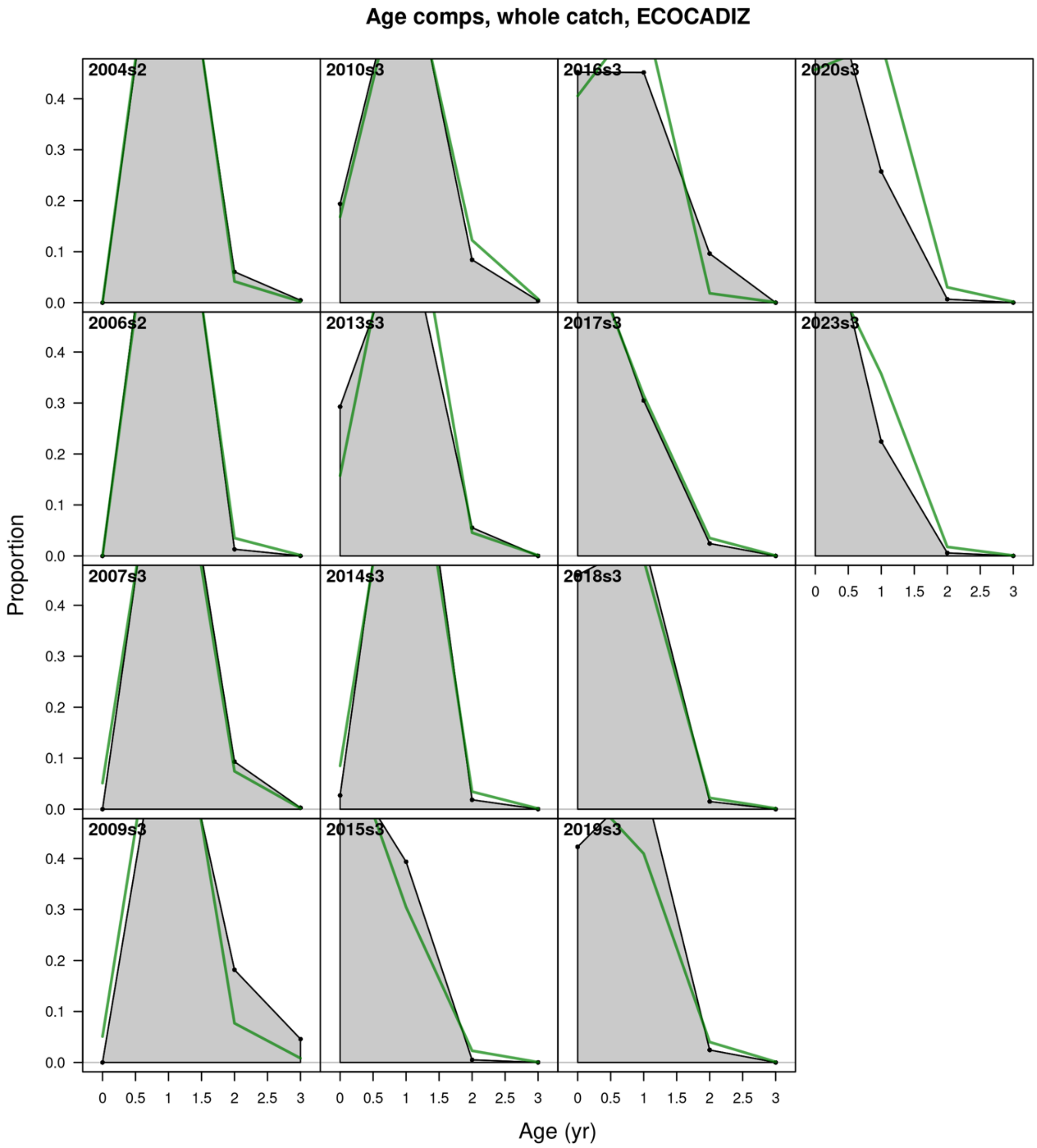



**Figure 4.6.2.15. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Model fit to the age composition data from the *ECO-CADIZ* summer survey by year. The green line represents the model estimates, while the shaded grey area shows the observed data.**

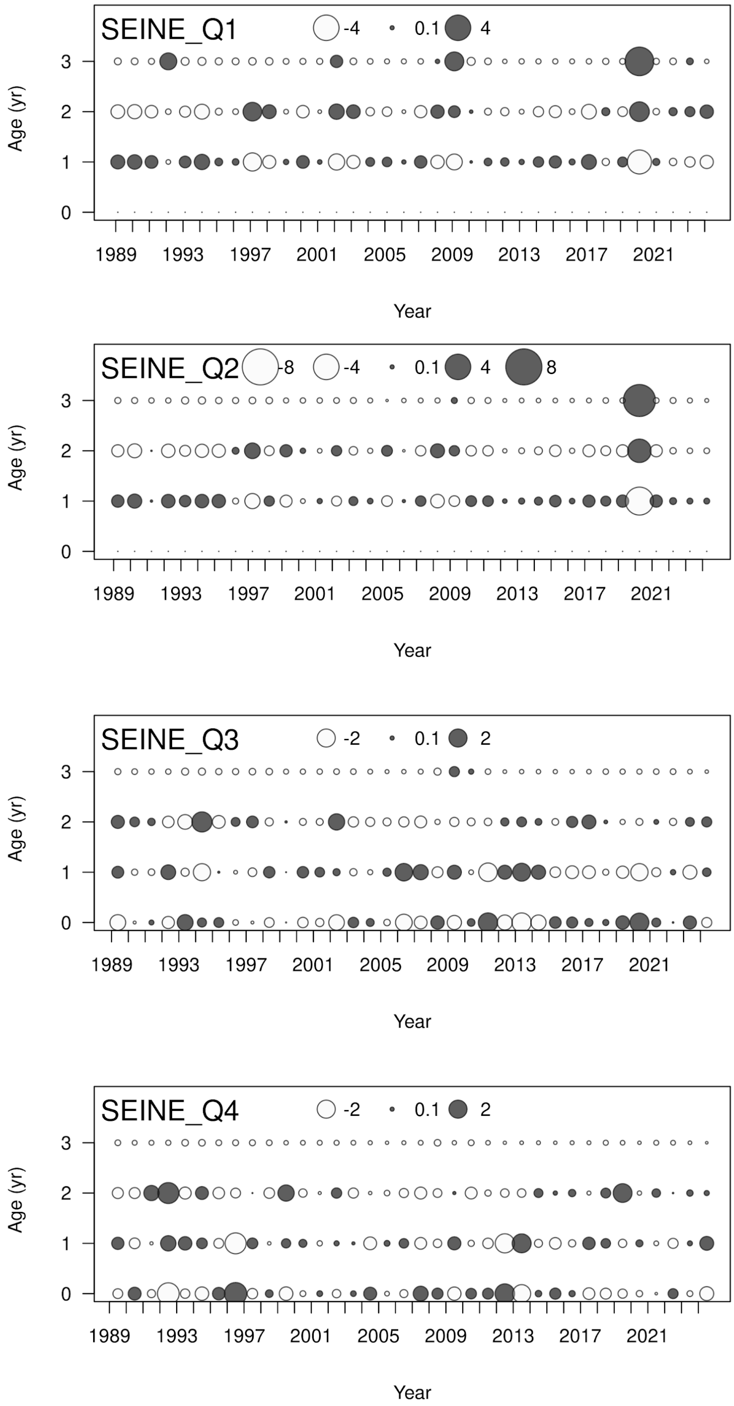



**Figure 4.6.2.16. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Pearson residuals, comparing across fleets. Closed bubbles are positive residuals (observed > expected) and open negative residuals (observed < expected).**

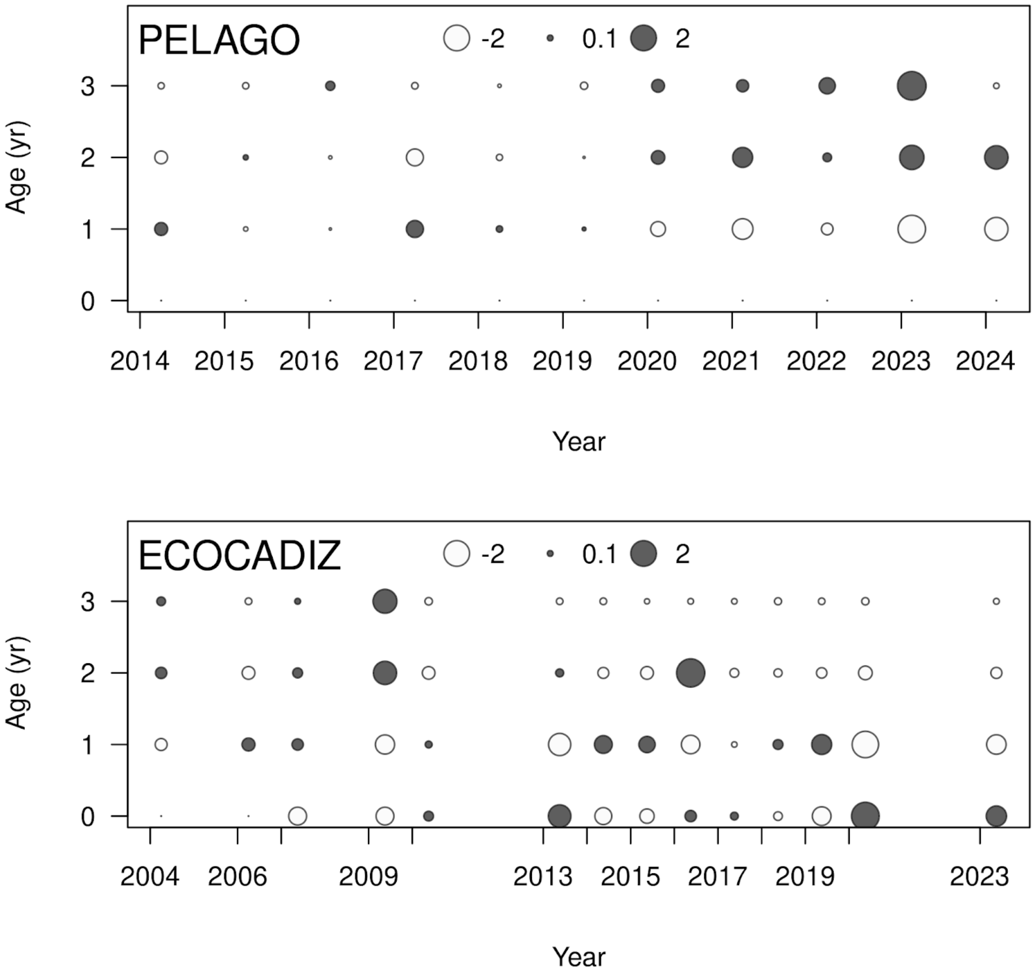



**Figure 4.6.2.17. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Pearson residuals, comparing across surveys. Closed bubbles are positive residuals (observed > expected) and open negative residuals (observed < expected).**

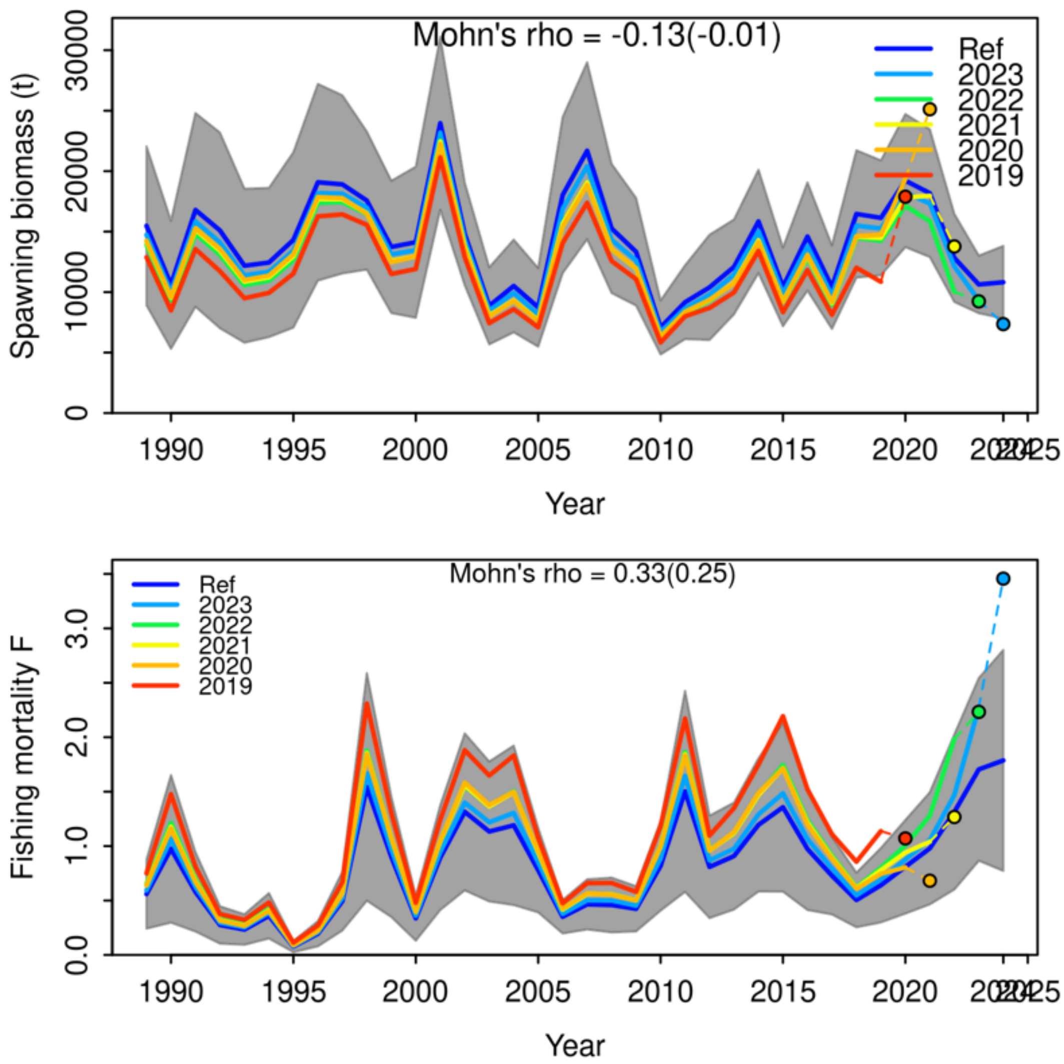



**Figure 4.6.2.18. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Retrospective analysis of spawning stock biomass (SSB) and fishing mortality (F). Models conducted by re-fitting the reference model (Ref) after removing five years of observations, one year at a time sequentially. The retrospective results are shown the entire time series. Mohn's rho statistic and the corresponding 'hindcast rho' values (in brackets) are printed at the top of the panels. One-year-ahead projections denoted by color-coded dashed lines with terminal points are shown for each model. Grey shaded areas are the 95% confidence intervals from the reference model.**

# 5 Horse Mackerel (*Trachurus trachurus)* in Subarea 9.a (Atlantic Iberian waters)

## 5.1 ACOM Advice applicable to 2024, 2023, STECF advice and political decisions

The fishing mortality (F) has been below $F_{MSY}$ over the whole time-series and the spawning–stock biomass (SSB) is above MSY $B_{trigger}$, relatively stable over the entire time-series and with a steep increase in the last years. Recruitment (R) in 2011–2022 has been estimated above the time-series average.

The ICES advice was based on the MSY approach with a revised $F_{MSY}$ = 0.15. ICES therefore recommended that catches in 2024 should not exceed 173 873t. ICES also recommended that the TAC for this stock should only apply to *Trachurus trachurus*. The TAC of 173 873 t in 2024 has been set for *Trachurus spp*.

In 2012, 2019 and 2020 the Portuguese bottom trawl survey was not carried out. Because this survey represents 87% of the total coverage and traverse the majority of the stock area, the combined survey index could not be estimated.

In the last few years, there has been a notable and substantial alteration in the proportional contribution of catch from bottom trawls to purse seines. This has resulted in a shift in the age structure of catches, with an increase in the proportion of age 1 individuals. This could lead to inconsistencies in the estimation of selectivity during the final assessment period.

## 5.2 The fishery in 2023

### 5.2.1 Fishing fleets in 2023

The southern horse mackerel fisheries in Division 9a are composed by six fleets. These fleets are defined by the gear type (**bottom trawl, purse-seine and artisanal**) and country (**Portugal and Spain**).

Portuguese bottom-trawl and purse-seine fleets as well as Spanish purse-seine fleet show a similar exploitation pattern with a great presence of juveniles and lower abundance of adults. In the last years the Spanish purse-seine fleet had a significant increase of individuals from ages 1 and 2 in the catches.

In 2023, the Spanish purse seine fleet experienced a slight increase in total landings and catches, amounting to approximately 5% more compared to the previous year. In contrast, the Portuguese purse-seiner fleet experienced a 24% decrease in catches by 2023 in comparison to the previous year.

The artisanal fleet of both countries is mainly composed by small size vessels (<15m), licensed to operate with more than one type of gear (gill and trammel-nets, purse-seine and lines), directly associated with coastal fishing areas extremely dependent on fishing. Catches of horse mackerel show the presence of larger/adult fish while the catches from trips operating with purse-seine show the presence of small/juveniles. Portuguese catches by artisanal fleet are generally small (8%) and Spanish catches are negligible (1%).

The Spanish trawl fleet in 9aN is composed by three different metiers:

1. Otter bottom trawl (OTB_DEF_>=55) which targets demersal species,
2. Otter bottom trawl (OTB_MPD_>=55) is a mixed pelagic and demersal fishery Horse mackerel (*Trachurus trachurus*) and mackerel (*Scomber scombrus*) are taken together with other species, mainly hake (*Merluccius merluccius*).
3. Pair bottom trawl species (PTB_DEF_>=55) defined as a highly mono-specific fleet, targeting mainly blue whiting.

These fleets catches mainly adults of HOM and show a significant increase in 2023 (after suffering a significant decrease in 2022).

Horse mackerel is also one of the main target species in the Portuguese bottom trawl fleet, representing almost half of this fleet catches. However in 2023 catches decreased and accounted for 28% of the horse mackerel Portuguese catches, while purse seine accounted for 64%. Description of the Portuguese and Spanish fleets is available in Stock Annex (see annex 3).

## 5.2.2 Catches by fleet and area

The catches of horse mackerel in Division 9.a comprise the following four subdivisions: 9.a.North (9.a.n: Spain - Galicia), 9.a.Central-North (9.a.c.n: Portugal – Caminha to Figueira da Foz), 9.a.Central-South (9.a.c.s: Portugal – Nazaré to Sines) and 9.a.South (9.a.s: Portugal – Sagres to V. Real Santo António) and are allocated to the Southern horse mackerel stock (hom.27.9a).

The definition of the ICES subdivisions was set in 1992 and some of the previous catch statistics came from an area that comprises more than one subdivision. In the years before 2004 the catches from Division 8.c were also considered to belong to the southern horse mackerel stock. These catches were removed from previous total catches to obtain the current historical series of stock catches.

Although Portuguese catches are available since 1927, in the case of Spanish catches the allocation of catches to Subdivision 9.a North and Subdivision 8.c West before 1992, has not yet been possible (Figure 5.2.2.1).

Spanish catches of horse mackerel from the Gulf of Cadiz (Sub-division 9a South) have been available since 2002. However, it is important to note that Spanish catches from subdiv.9a South prior to 2014 are not considered to be reliable.

It was decided to exclude Spanish catch data from Sub-division 9a South from the assessment in order to avoid potential bias in the assessment results. These catches represent on average less than 2 % of the total catch.


**Figure 5.2.2.1. ICES Statistical Subdivisions within Division 9.a where southern horse mackerel distributes.**

The catch time-series used in the assessment (1992–2023) shows a peak in 1998, of 41 564 t, a steady increase since 2011 to 2016 and in recent years a decrease is observed since 2019, with catches in 2023 of 25 747 tonnes, although being rather stable in the last three years (Table 5.2.2.1, Figure 5.2.2.2). The minimum catch, of 18 887 tonnes, was observed in 2003. The relative contribution of each gear to the total catch is given in Table 5.2.2.2.

Until 2011 the highest contribution to the total catches was, in general, from the trawl fleets but since 2012 there has been a continued and significant shift in relative catch contribution from bottom trawls to purse-seines. In recent years, and probably due to the lower catch opportunities for the Iberian sardine stock (pil27.8c9a), the relative importance in the annual catches of the purse-seine fleet has increased substantially from 33% in 2011 to 65% in 2023 (Table 5.2.2.1 and Figure 5.2.2.4).

The **Spanish purse seine** contributions to catches remained high with a slightly increase last year (+5%).

Catches from the **Spanish bottom trawlers** are relatively low, decreasing 50% between 2021 to 2022, and returning to 2021 levels in 2023 with 1156 tonnes.

Catches from the **Portuguese purse seine** showed a 24% increase whereas the bottom trawl catches decreased by 22% from 2022 to 2023.

The contribution of the artisanal fleet from both Portugal and Spain is very small, decreasing by 5% and 16% respectively in 2023 compared to 2022.

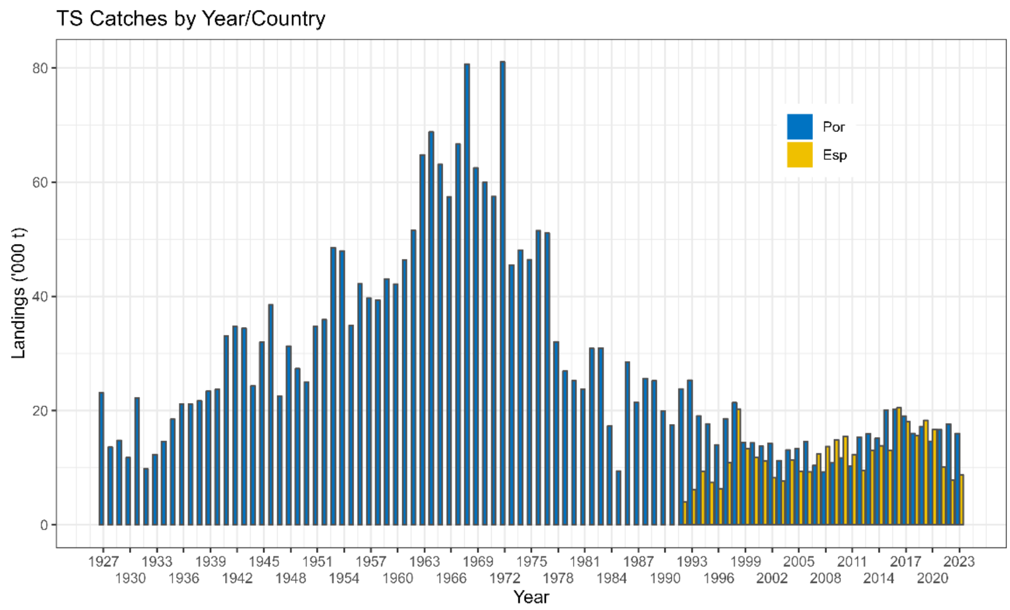



**Figure 5.2.2.2. Historical time series of landings (1927-2023) for southern horse mackerel (Div. 27.9.a). Blue bars are Portuguese landings and yellow bars are Spanish landings.**

**Table 5.2.2.1. Time-series of southern horse mackerel historical catches (in tonnes).**

| Year | Total Catch* |
|---|---|
| 1992 | 27,858 |
| 1993 | 31,521 |
| 1994 | 28,441 |
| 1995 | 25,147 |
| 1996 | 20,400[1] |
| 1997 | 29,491 |
| 1998 | 41,564 |
| 1999 | 27,733 |
| 2000 | 26,160 |
| 2001 | 24,910 |
| 2002 | 22,506 // (23,663) |
| 2003 | 18,887 // (19,566) |
| 2004 | 23,252 // (23,577) |
| 2005 | 22,695 // (23,111) |
| 2006 | 23,902 // (24,558) |
| 2007 | 22,790 // (23,424) |

| Year | Total Catch* |
|---|---|
| 2008 | 22,993 // (23,593) |
| 2009 | 25,737 // (26,497) |
| 2010 | 26,556 // (27,216) |
| 2011 | 21,875 // (22575) |
| 2012 | 24,868 // (25316) |
| 2013 | 28,993 // (29,382) |
| 2014 | 29,017 // (29,205) |
| 2015 | 32,723 // (33,178) |
| 2016 | 40,741 // (41,081) |
| 2017 | 36,946 // (37,088) |
| 2018 | 31,661 // (31,920) |
| 2019 | 35,520 // (36,536) |
| 2020 | 30,177 // (31,344) |
| 2021 | 26,320 // (26,745) |
| 2022 | 24,997 // (25,515) |
| 2023 | 24,765 // (25,747) |

**(*) In brackets: the Spanish catches from Subdivision 9a South are also included. These catches are only available since 2002 and are not included in the assessment.**

**Table 5.2.2.2. Southern horse mackerel landings by gear in the period 1992–2023 (in tonnes and in percentage, showing the contribution of each gear to total landings).**

| Year | Bottom trawl | Purse seine | Artisanal |
|---|---|---|---|
| 1992 | 14,651 | 9,763 | 3,445 |
| | 52.6% | 35.0% | 12.4% |
| 1993 | 20,660 | 7,004 | 3,841 |
| | 65.6% | 22.2% | 12.2% |
| 1994 | 13,121 | 12,093 | 3,202 |
| | 46.2% | 42.6% | 11.3% |
| 1995 | 15,611 | 7,387 | 2,137 |
| | 62.1% | 29.4% | 8.5% |
| 1996 | 13,379 | 5,727 | 1,228 |
| | 65.8% | 28.2% | 6.0% |

| Year | Bottom trawl | Purse seine | Artisanal |
|---|---|---|---|
| 1997 | 14,576 | 13,161 | 1,800 |
| | 49.3% | 44.6% | 6.1% |
| 1998 | 16,943 | 22,359 | 2,287 |
| | 40.7% | 53.8% | 5.5% |
| 1999 | 10,106 | 15,781 | 1,855 |
| | 36.4% | 56.9% | 6.7% |
| 2000 | 12,697 | 11,237 | 2,227 |
| | 48.5% | 43.0% | 8.5% |
| 2001 | 12,226 | 11,048 | 1,637 |
| | 49.1% | 44.3% | 6.6% |
| 2002 | 12,307 | 8,230 | 1,969 |
| | 54.7% | 36.6% | 8.7% |
| 2003 | 10,116 | 6,523 | 2,248 |
| | 53.6% | 34.5% | 11.9% |
| 2004 | 16,126 | 5,700 | 2,658 |
| | 65.9% | 23.3% | 10.9% |
| 2005 | 14,029 | 6,040 | 2,621 |
| | 61.8% | 26.6% | 11.6% |
| 2006 | 15,019 | 5,430 | 3,445 |
| | 62.9% | 22.7% | 14.4% |
| 2007 | 13,705 | 6,775 | 2,308 |
| | 60.1% | 29.7% | 10.1% |
| 2008 | 12,380 | 7,670 | 2,949 |
| | 53.8% | 33.3% | 12.8% |
| 2009 | 15,075 | 6,669 | 3,984 |
| | 58.6% | 25.9% | 15.5% |
| 2010 | 16,062 | 6,847 | 4,308 |
| | 59.0% | 25.2% | 15.8% |
| 2011 | 11,038 | 7,301 | 3,530 |
| | 50.40% | 33.30% | 16.40% |
| 2012 | 7,839 | 12,897 | 4,579 |

| Year | Bottom trawl | Purse seine | Artisanal |
|---|---|---|---|
| | 30.97% | 50.95% | 18.09% |
| 2013 | 9,221 | 16,774 | 2,687 |
| | 33.77% | 57.09% | 9.14% |
| 2014 | 12,573 | 14,114 | 2,330 |
| | 43.33% | 48.64% | 8.03% |
| 2015 | 13,310 | 16,937 | 2,932 |
| | 40.12% | 51.05% | 8.84% |
| 2016 | 19,172 | 19,083 | 2,485 |
| | 47.06% | 46.84% | 6.10% |
| 2017 | 16,931 | 18,038 | 2,120 |
| | 45.65% | 48.64% | 5.72% |
| 2018 | 9,824 | 20,187 | 1,651 |
| | 31.03% | 63.76% | 5.21% |
| 2019 | 9,542 | 24,190 | 1,788 |
| | 26.86% | 68.10% | 5.03% |
| 2020 | 10,961 | 17,588 | 1,617 |
| | 36.34% | 58.31% | 5.36% |
| 2021 | 8,074 | 16,869 | 1,378 |
| | 30.68% | 64.09% | 5.23% |
| 2022 | 5,310 | 18,139 | 1,549 |
| | 21.24% | 72.56% | 6.19% |
| 2023 | 7,220 | 16,00 | 1,46 |
| | 29.15% | 64.96% | 5.89% |

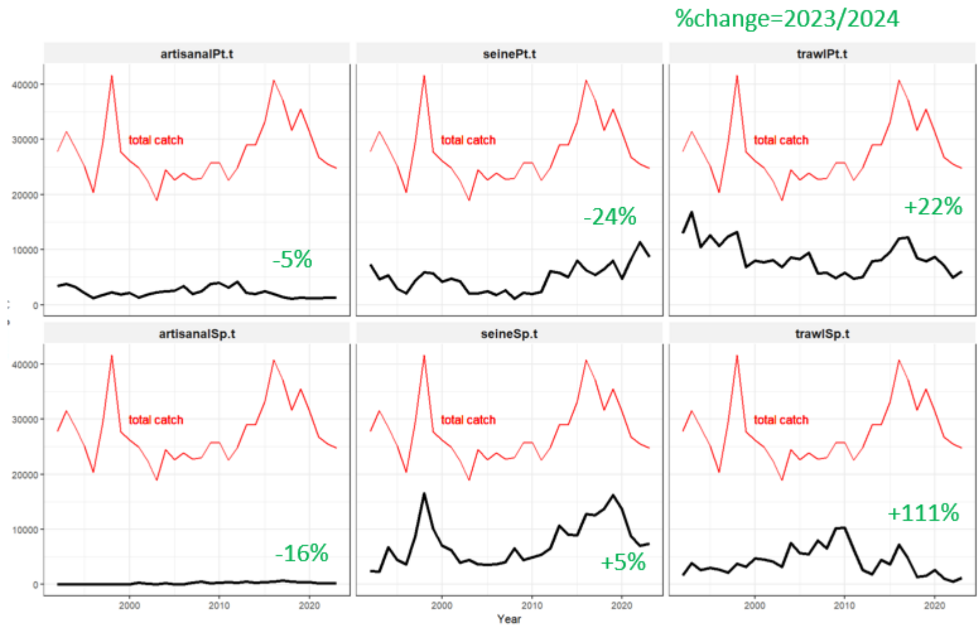



**Figure 5.2.2.3. Time-series (1992-2023) of southern horse mackerel catches (in tonnes) by country (Pt – Portugal; Sp – Spain) and gear (artisanal; purse seine, trawl).The green numbers in the plots represent the % change in catch between 2023 and 2022.**

There has been a continued and significant shift in relative catch contribution from bottom trawls to purse-seines in recent years. The relative importance in the annual catches of the purse-seine fleet has increased substantially from 33% in 2011 to around 70% in recent years. Changes in the relative contribution to the catch from bottom trawls and purse-seines (Figure 5.2.2.4) have led to changes in the age composition of catches.

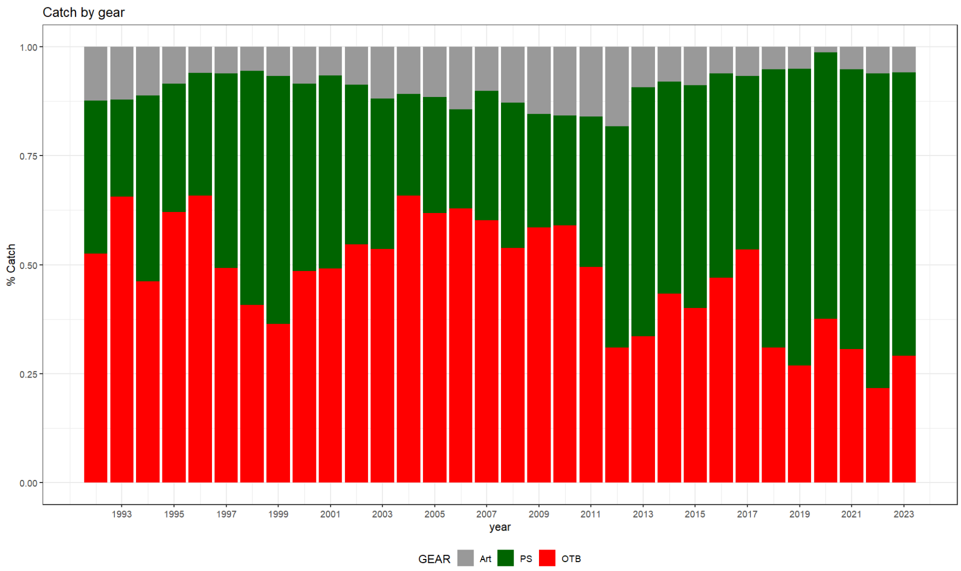



**Figure 5.2.2.4. Contribution of southern horse mackerel catches by gear (PS – Purse seine, OTB – bottom trawl, Art - Artisanal) from 1992-2023.**

Discards are estimated by both countries (Portugal since 2014, Spain since 2003) from national at-sea sampling programme (DCF) on board commercial vessels operating in ICES Division 9a. Discards for this species are usually very low and not frequent thus being considered negligible (Table 5.2.2.3).

The frequency of occurrence of horse mackerel discards is too low and is considered zero because such low frequency will result in highly biased estimates (Portuguese discards are usually estimated when frequency of species occurrence is above 30%). The horse mackerel Spanish discards come mainly from the bottom trawl fleet operating in ICES subdivision 27.9.a.s (OTB_MCD_>=55_0_0= 224.2 t), the total discards from the Spanish fleets in 2023 were estimated at 257,3t, very similar than in 2022.

**Table 5.2.2.3. Discard estimates (tonnes) of southern horse mackerel in 2023 by country (SP – Spain, PT - Portugal), fleet/metier, ICES subdivision and quarter.**

| Country | Fleet | Metier | Fishing Area | Quarter_1 | Quarter_2 | Quarter_3 | Quarter_4 | Total |
|---|---|---|---|---|---|---|---|---|
| SP | artisanal | GNS_DEF_80-99_0_0 | 27.9.a.n | 0.0 | 0.1 | 0.0 | 0.3 | 0.4 |
| SP | trawl | OTB_DEF_>=55_0_0 | 27.9.a.n | 2.0 | 3.3 | 16.0 | 7.1 | 28.3 |
| SP | trawl | OTB_MCD_>=55_0_0 | 27.9.a.s | 116.6 | 49.5 | 12.9 | 45.2 | 224.2 |
| SP | trawl | OTB_MPD_>=55_0_0 | 27.9.a.n | 0.0 | 2.3 | 0.6 | 0.1 | 3.0 |
| SP | trawl | PTB_MPD_>=55_0_0 | 27.9.a.n | 0.0 | 1.1 | 0.0 | 0.2 | 1.3 |
| SP | purse seine | PS_SPF_0_0_0 | 27.9.a.s | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| PT | trawl | OTB_CRU_>=55_0_0 (Loa >=12m) | 27.9.a | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| PT | trawl | OTB_DEF_>=55_0_0 (Loa >=24m) | 27.9.a | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

## 5.2.3 Effort and catch per unit of effort

A commercial CPUE (catch per unit effort) was developed using revised and compiled data from the Portuguese trawl logbooks provided by the Portuguese fisheries administration (Directorate-General for Natural Resources, Safety and Mari-time Services – DGRM) for the period 1988-2022 (Silva et al., 2022). A combined CPUE from multiple métier/areas was estimated to better capture the true abundance across several operational regions and have a broader coverage of the studied population. Several statistical models, including both GLM and GLM/GAM mixed models were analysed and discussed during the benchmark in 2024 (ICES, 2024) and a standardized CPUE index using the Tweedie Generalized Linear Model (GLM-tweedie) was considered adequate. GLM-tweedie was considered to be the most effective and parsimonious for standardizing CPUE, particularly in addressing the high occurrence of zero catches in some of the trawl métiers and areas. Detailed analyses are available in ICES (2024). The selected Tweedie model for standardizing the CPUE abundance index has the following formula:

GLM(CPUE ~ year + quarter + metier + zone + engine.power + log(total.catch), family = tweedie (link="log"))

The haul duration in hours per day was used as a measure of effort to calculate the CPUE (in kg h-1) and the best model was selected based on the explained deviance, the Akaike Information Criterion (AIC) and residual diagnostics. The CPUE index should be standardized according to the selected Tweedie model and fitted to each year's data. The input estimates used in the assessment and their comparison to last year's (benchmark run) are shown in Figure 5.2.3.1

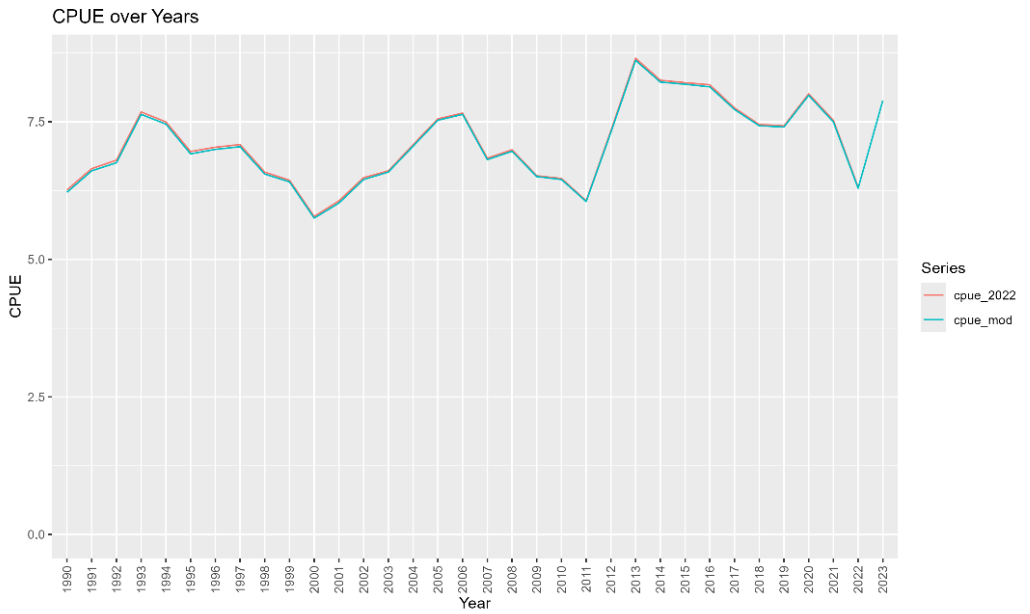



**Figure 5.2.3.1. Estimated CPUE index used in assessment (cpue_mod) and comparison to last year's estimate from the benchmark (cpue_2022).**

## 5.2.4 Catches by length and catches-at-age

Sampling method for the catches by length is described in the Stock Annex. Catch-at-age data have been obtained by applying a semester ALK to each of the catch length distribution estimated by fleet segment (bottom trawl, purse-seine and artisanal) and country from the samples of each subdivision. The catch in numbers-at-age used in the assessment is the combined Portuguese and Spanish catch-at-age from 1992–2023, with age range 0–11+.

In general, catches in number are dominated by juveniles and young adults in the available time series (1992-2023) with the exception of the years 2021 and 2022 (Table 5.2.4.1, Figures 5.2.4.1, and 5.2.4.2). The decrease of the catch for the young fish (age-0 to age-3) in these years could be a consequence of the steep decrease in Spanish purse seine catches (Table 5.2.4.2, Figure 5.2.4.3 and Figure 5.2.4.4). The rest of the ages show similar pattern over time, with a slight decrease of older ages (age-9 to age-11+) since 2018 (Table 5.2.4.1, Figures 5.2.4.1, and 5.2.4.2).

**Table 5.2.4.1. Southern horse mackerel catch-at-age data in the period 1992–2023 (thousands).**

| | **Ages** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11+ |
| 1992 | 11684 | 95186 | 145732 | 40736 | 12171 | 9102 | 5018 | 6864 | 5155 | 4761 | 13973 | 14354 |
| 1993 | 6480 | 66211 | 137089 | 100515 | 35418 | 13367 | 12938 | 10495 | 6597 | 5552 | 4497 | 14442 |
| 1994 | 12713 | 63230 | 86718 | 96253 | 28761 | 7628 | 4398 | 3433 | 5209 | 4834 | 6047 | 12264 |
| 1995 | 7230 | 55380 | 31265 | 52030 | 28199 | 11010 | 4003 | 3139 | 2720 | 3352 | 2530 | 31343 |
| 1996 | 69651 | 13798 | 14021 | 28125 | 33937 | 9861 | 6611 | 4501 | 4164 | 5504 | 3306 | 14243 |
| 1997 | 5056 | 295329 | 112210 | 26236 | 17168 | 12886 | 7780 | 7169 | 3938 | 3867 | 2425 | 8847 |
| 1998 | 22917 | 95950 | 320721 | 68438 | 18770 | 11317 | 9712 | 20627 | 12760 | 6686 | 6212 | 11323 |
| 1999 | 51659 | 29795 | 26231 | 66704 | 42960 | 15700 | 13840 | 7555 | 4175 | 4790 | 2475 | 7417 |

| | Ages | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11+ |
| 2000 | 12246 | 72936 | 23547 | 41618 | 35968 | 18643 | 17254 | 12118 | 7915 | 5227 | 3124 | 3557 |
| 2001 | 105759 | 77364 | 31261 | 24104 | 23721 | 16794 | 15391 | 14964 | 9795 | 3310 | 2023 | 3989 |
| 2002 | 18444 | 94402 | 84379 | 26482 | 13161 | 11396 | 10263 | 12501 | 10156 | 7525 | 3607 | 4433 |
| 2003 | 40033 | 6830 | 36754 | 28559 | 21931 | 12790 | 14751 | 13582 | 10631 | 6492 | 3531 | 2333 |
| 2004 | 7101 | 126797 | 58054 | 18243 | 8328 | 13586 | 11836 | 14878 | 10542 | 3876 | 5258 | 5318 |
| 2005 | 21015 | 108070 | 49197 | 24289 | 17877 | 11334 | 11179 | 7927 | 9124 | 7445 | 5502 | 11420 |
| 2006 | 3329 | 92563 | 92896 | 22665 | 6738 | 13176 | 11892 | 6029 | 7303 | 8070 | 8947 | 15322 |
| 2007 | 2885 | 16419 | 27667 | 44357 | 20534 | 8187 | 4459 | 3563 | 5975 | 4748 | 4943 | 30001 |
| 2008 | 48380 | 54167 | 31951 | 28058 | 16616 | 7194 | 4782 | 3660 | 4579 | 3975 | 4537 | 24990 |
| 2009 | 22618 | 85415 | 32416 | 8482 | 9774 | 7162 | 3289 | 2860 | 2791 | 3579 | 4236 | 39096 |
| 2010 | 81048 | 102016 | 33906 | 17496 | 11979 | 7569 | 3847 | 3942 | 2452 | 2671 | 2977 | 32284 |
| 2011 | 85973 | 23285 | 20987 | 19082 | 15047 | 7199 | 4272 | 3511 | 2885 | 5250 | 4639 | 22097 |
| 2012 | 201691 | 119136 | 30060 | 13964 | 14547 | 7693 | 5322 | 4373 | 2731 | 3218 | 4373 | 14562 |
| 2013 | 35849 | 123495 | 109557 | 30511 | 17468 | 9670 | 4085 | 3600 | 3123 | 2763 | 2488 | 17864 |
| 2014 | 22723 | 51727 | 89258 | 37772 | 18645 | 5573 | 2493 | 2899 | 1886 | 2137 | 2533 | 17588 |
| 2015 | 66497 | 92922 | 49067 | 50211 | 45753 | 16675 | 10529 | 5163 | 4253 | 4730 | 5149 | 13182 |
| 2016 | 15223 | 116079 | 122297 | 49145 | 28523 | 31170 | 14561 | 15087 | 11210 | 5823 | 7138 | 20703 |
| 2017 | 25212 | 192125 | 75227 | 48553 | 31124 | 12862 | 7701 | 9156 | 10323 | 4694 | 4846 | 19138 |
| 2018 | 71977 | 182113 | 69396 | 52508 | 26314 | 12485 | 11555 | 6753 | 6050 | 3463 | 2517 | 4554 |
| 2019 | 27706 | 146270 | 116225 | 48796 | 20638 | 25280 | 11293 | 9325 | 7943 | 4022 | 5208 | 4361 |
| 2020 | 18471 | 143836 | 57686 | 58352 | 24715 | 18078 | 8181 | 8553 | 5985 | 7025 | 3035 | 9365 |
| 2021 | 26901 | 60128 | 48825 | 46934 | 39919 | 17747 | 9263 | 6191 | 5077 | 10801 | 7100 | 8451 |
| 2022 | 7119 | 68831 | 44548 | 37500 | 28994 | 24289 | 13127 | 9842 | 6773 | 3021 | 1683 | 1958 |
| 2023 | 32391 | 147570 | 65500 | 26710 | 12275 | 5983 | 8697 | 6851 | 4275 | 6637 | 4348 | 4036 |

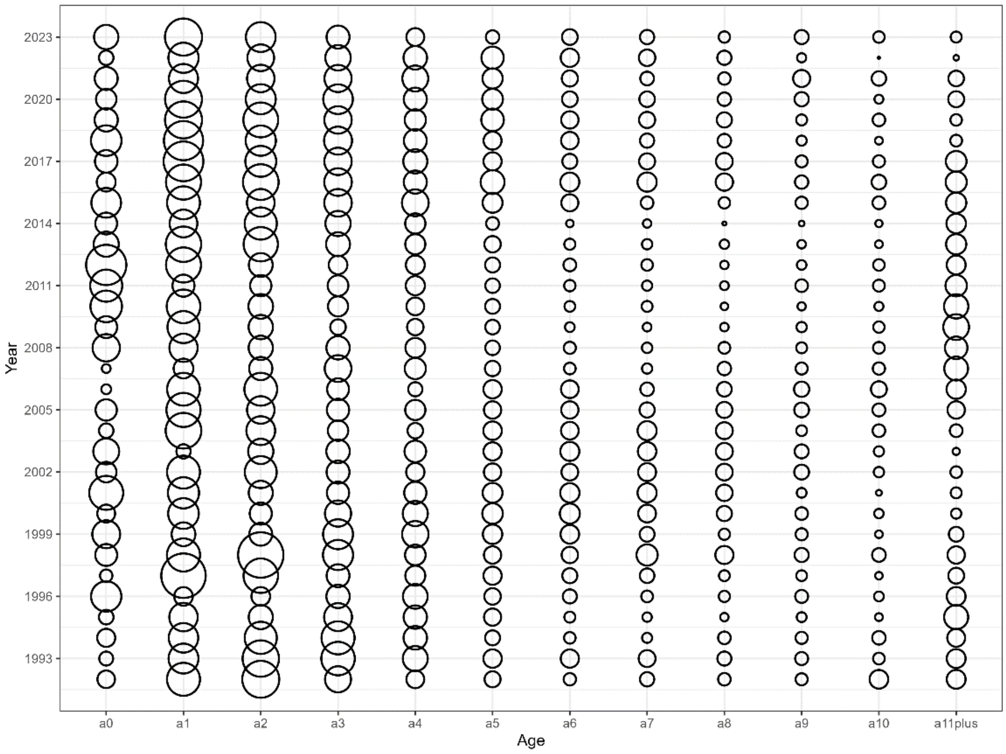



**Figure 5.2.4.1. Bubble plot of proportions of southern horse mackerel catch in numbers-at-age in each year (1992–2023).**

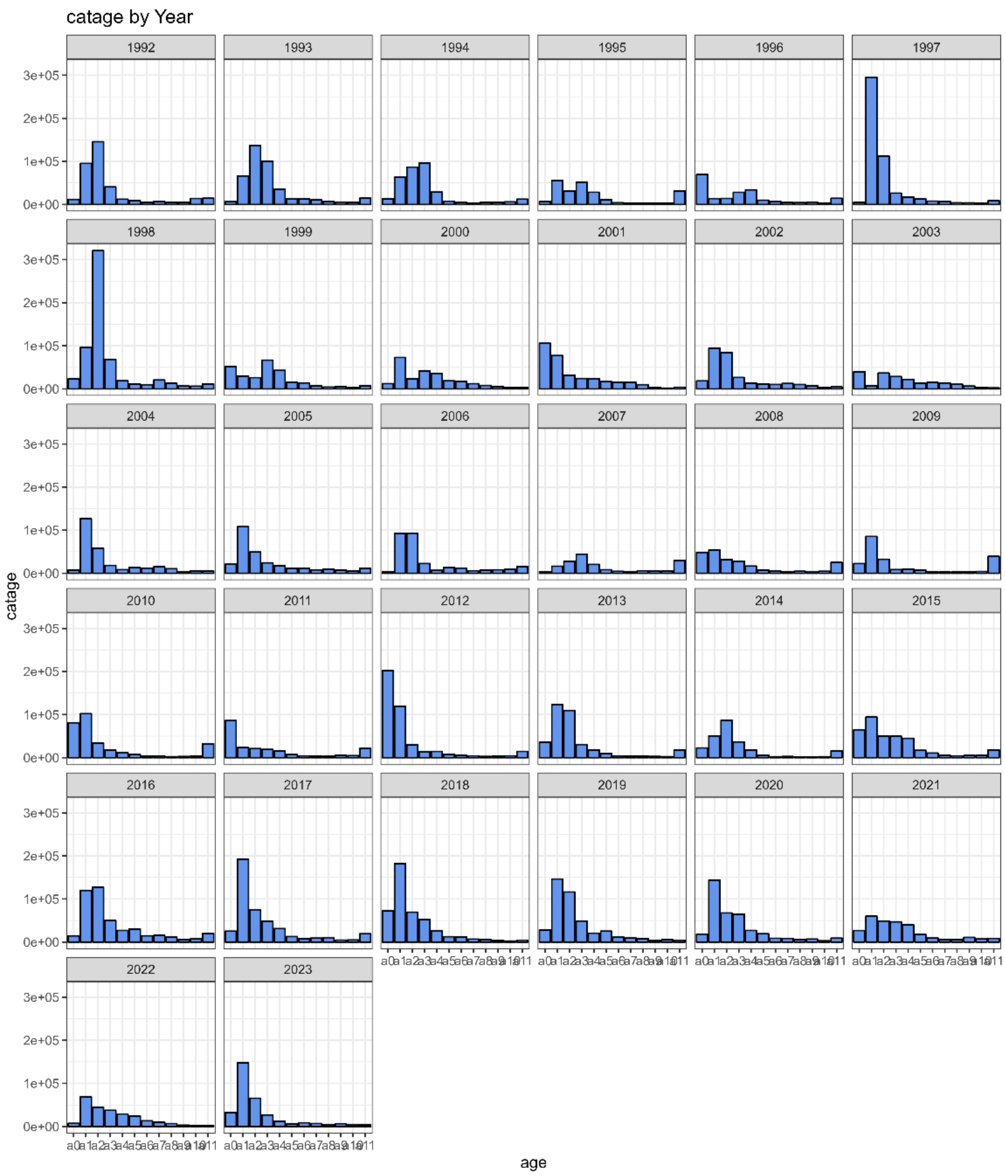


Figure 5.2.4.2. Southern horse mackerel catch in numbers-at-age in each year (1992–2023).

**Table 5.2.4.2. Southern horse mackerel catch in numbers-at-age (thousands) by fleet (bottom trawl, purse-seine and artisanal) in the period 1992–2023.**

| Bottom trawl | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AGES | | | | | | | | | | | |
| YEAR | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11+ |
| 1992 | 98 | 8739 | 40094 | 78016 | 28660 | 10904 | 10401 | 8174 | 5166 | 3923 | 3319 | 9412 |
| 1993 | 3413 | 16252 | 37679 | 55079 | 16322 | 3926 | 2138 | 1559 | 2530 | 2200 | 2207 | 5223 |
| 1994 | 3917 | 12983 | 18292 | 22807 | 11447 | 5375 | 2541 | 2280 | 2299 | 2739 | 2138 | 25610 |
| 1995 | 30763 | 10340 | 10123 | 19245 | 23331 | 6326 | 4524 | 3063 | 2772 | 3245 | 2211 | 8611 |
| 1996 | 2828 | 180543 | 68330 | 15055 | 7846 | 4536 | 2087 | 1216 | 811 | 801 | 608 | 4360 |
| 1997 | 4444 | 36544 | 205609 | 32994 | 7151 | 3427 | 2487 | 3562 | 3100 | 2418 | 2724 | 7225 |

| Bottom trawl | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AGES | | | | | | | | | | | |
| YEAR | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11+ |
| 1998 | 28176 | 11492 | 16059 | 23745 | 8653 | 2914 | 3643 | 2570 | 1650 | 1932 | 1614 | 5525 |
| 1999 | 1106 | 35946 | 13685 | 18085 | 10763 | 7890 | 9180 | 7657 | 5546 | 4146 | 2544 | 2516 |
| 2000 | 39871 | 25245 | 10861 | 9401 | 8291 | 6329 | 8686 | 10261 | 7644 | 2630 | 1556 | 2606 |
| 2001 | 3572 | 59041 | 49402 | 12288 | 4796 | 4461 | 5100 | 7280 | 6068 | 5197 | 2671 | 3156 |
| 2002 | 14581 | 2077 | 18079 | 12556 | 13025 | 7525 | 7410 | 6940 | 6045 | 3966 | 2255 | 1526 |
| 2003 | 1352 | 77529 | 44171 | 12649 | 4758 | 9114 | 7787 | 9616 | 6875 | 2366 | 3823 | 3958 |
| 2004 | 2956 | 50643 | 30389 | 15100 | 12246 | 6636 | 6997 | 6190 | 7047 | 5546 | 3710 | 6705 |
| 2005 | 1666 | 59477 | 61175 | 14915 | 3798 | 9822 | 9492 | 3762 | 3871 | 4302 | 4908 | 9981 |
| 2006 | 19 | 2444 | 14853 | 31470 | 10967 | 2932 | 1983 | 1461 | 2681 | 2644 | 3135 | 21375 |
| 2007 | 5512 | 12787 | 21078 | 21828 | 10408 | 2984 | 1695 | 1166 | 1918 | 1678 | 2373 | 16881 |
| 2008 | 4552 | 19630 | 14558 | 5033 | 4758 | 4463 | 1581 | 1070 | 1183 | 1830 | 2579 | 27993 |
| 2009 | 10832 | 46074 | 15193 | 11434 | 6888 | 3661 | 1723 | 1728 | 1417 | 1531 | 1897 | 25218 |
| 2010 | 5984 | 3440 | 9440 | 9357 | 6696 | 2999 | 1871 | 1655 | 1426 | 3414 | 2876 | 16256 |
| 2011 | 7674 | 20041 | 14102 | 4899 | 4089 | 1915 | 2101 | 1356 | 987 | 1094 | 1799 | 7586 |
| 2012 | 6928 | 23225 | 29279 | 11222 | 3625 | 1573 | 903 | 1283 | 1357 | 1233 | 1170 | 11420 |
| 2013 | 7734 | 14850 | 18232 | 8434 | 5210 | 2040 | 987 | 1207 | 888 | 1072 | 1726 | 13972 |
| 2014 | 7845 | 18476 | 19923 | 11544 | 12206 | 5060 | 3228 | 2033 | 2411 | 3671 | 4417 | 13825 |
| 2015 | 4707 | 43326 | 72194 | 19569 | 7265 | 6349 | 3562 | 4339 | 3125 | 2623 | 7008 | 6134 |
| 2016 | 2461 | 26151 | 47865 | 29405 | 9083 | 11260 | 6151 | 5604 | 4336 | 4022 | 6322 | 16970 |
| 2017 | 2044 | 15323 | 21678 | 22423 | 15581 | 6110 | 3779 | 5644 | 6386 | 3311 | 3584 | 14874 |
| 2018 | 2622 | 23258 | 19042 | 20477 | 8998 | 4346 | 5413 | 3186 | 3190 | 1885 | 1351 | 2775 |
| 2019 | 494 | 6704 | 24021 | 18825 | 5382 | 8234 | 4354 | 3588 | 3030 | 1533 | 2064 | 2593 |
| 2020 | 340 | 12702 | 19697 | 19380 | 7833 | 5031 | 3057 | 3304 | 2480 | 4485 | 2220 | 7690 |
| 2021 | 2004 | 10941 | 10811 | 14478 | 12692 | 4563 | 2702 | 2080 | 2222 | 4432 | 2789 | 3793 |
| 2022 | 1398 | 11245 | 10072 | 5932 | 6221 | 5072 | 2412 | 2570 | 2496 | 1311 | 917 | 942 |
| 2023 | 11610 | 44852 | 16153 | 6054 | 2617 | 1126 | 2566 | 2498 | 1898 | 2809 | 1958 | 1888 |

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|---|

| | AGES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11+ |
| 1992 | 6977 | 51859 | 73537 | 21162 | 4860 | 2677 | 1362 | 1973 | 1299 | 1204 | 2572 | 2402 |
| 1993 | 6293 | 51337 | 83236 | 16597 | 4355 | 795 | 512 | 819 | 544 | 862 | 667 | 1842 |
| 1994 | 7634 | 45429 | 45987 | 39236 | 11267 | 2838 | 1379 | 1036 | 1640 | 1691 | 2550 | 3530 |
| 1995 | 3311 | 42111 | 12457 | 27030 | 14822 | 4224 | 854 | 445 | 163 | 362 | 217 | 2247 |
| 1996 | 38888 | 3446 | 3801 | 8189 | 8955 | 2917 | 1621 | 1107 | 1022 | 2003 | 891 | 4301 |
| 1997 | 2211 | 114184 | 42908 | 9797 | 6407 | 5775 | 4380 | 5300 | 2707 | 2831 | 1539 | 3672 |
| 1998 | 18294 | 59225 | 112386 | 34393 | 9893 | 6028 | 5838 | 15381 | 8920 | 3621 | 2760 | 2041 |
| 1999 | 23481 | 18237 | 9440 | 41032 | 31471 | 10684 | 7777 | 3835 | 2092 | 2465 | 764 | 1328 |
| 2000 | 11068 | 35861 | 8832 | 22508 | 23779 | 9645 | 5890 | 2291 | 876 | 338 | 172 | 231 |
| 2001 | 65468 | 51105 | 20260 | 14164 | 14394 | 9020 | 5035 | 3008 | 1170 | 290 | 227 | 644 |
| 2002 | 13660 | 32185 | 34516 | 13604 | 7895 | 6041 | 3804 | 3510 | 2435 | 1141 | 359 | 116 |
| 2003 | 22915 | 4609 | 17093 | 15338 | 7464 | 3944 | 5188 | 3784 | 2554 | 1447 | 675 | 260 |
| 2004 | 5258 | 42114 | 12332 | 5137 | 2673 | 3042 | 2600 | 2603 | 958 | 489 | 980 | 929 |
| 2005 | 17856 | 56690 | 18512 | 8881 | 5272 | 3365 | 2539 | 799 | 904 | 848 | 600 | 1026 |
| 2006 | 1637 | 27295 | 29845 | 7133 | 2103 | 2210 | 1506 | 1225 | 1638 | 1804 | 2037 | 1514 |
| 2007 | 2863 | 13802 | 12416 | 11231 | 8019 | 3800 | 1912 | 1712 | 2799 | 1667 | 1323 | 4186 |
| 2008 | 42868 | 41050 | 9766 | 4672 | 3729 | 2223 | 2138 | 1918 | 2063 | 1877 | 1707 | 3544 |
| 2009 | 18016 | 65130 | 17157 | 2736 | 3551 | 2078 | 1139 | 1206 | 1041 | 1168 | 1136 | 3200 |
| 2010 | 70206 | 41433 | 11571 | 2766 | 2058 | 1531 | 1038 | 904 | 446 | 377 | 561 | 1598 |
| 2011 | 76225 | 18619 | 10553 | 7915 | 5197 | 1941 | 1480 | 719 | 315 | 707 | 723 | 1881 |
| 2012 | 193478 | 96833 | 12558 | 5530 | 7261 | 3945 | 1375 | 1991 | 1106 | 1282 | 1279 | 1268 |
| 2013 | 28908 | 98794 | 77552 | 17612 | 12427 | 7287 | 2665 | 1692 | 1196 | 1033 | 730 | 2644 |
| 2014 | 14794 | 35667 | 68564 | 27850 | 12383 | 3078 | 1272 | 1316 | 712 | 699 | 384 | 540 |
| 2015 | 56896 | 73247 | 28072 | 34914 | 28163 | 10304 | 6699 | 2790 | 1444 | 860 | 524 | 1110 |
| 2016 | 11898 | 93528 | 78720 | 19246 | 16407 | 17104 | 7090 | 8488 | 6186 | 1451 | 414 | 876 |
| 2017 | 18888 | 172613 | 50320 | 23723 | 13874 | 6068 | 3386 | 2839 | 3275 | 1080 | 880 | 2560 |
| 2018 | 61071 | 155490 | 48838 | 30137 | 15822 | 7290 | 5295 | 3079 | 2427 | 1288 | 911 | 1003 |
| 2019 | 22771 | 130029 | 88205 | 28013 | 14267 | 15732 | 6347 | 5175 | 4360 | 2087 | 2655 | 1407 |
| 2020 | 14992 | 127345 | 34698 | 35464 | 15550 | 12088 | 4628 | 4832 | 3191 | 1995 | 508 | 962 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2021 | 7867 | 30985 | 35744 | 30786 | 26247 | 12552 | 6161 | 3864 | 2678 | 6008 | 3993 | 4077 |
| 2022 | 2378 | 52118 | 30526 | 28618 | 20126 | 18011 | 10349 | 6901 | 4032 | 1511 | 640 | 696 |
| 2023 | 7792 | 93184 | 45748 | 18726 | 8819 | 4539 | 5693 | 4039 | 2189 | 3574 | 2176 | 1838 |
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| | AGES | | | | | | | | | | | |
| YEAR | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11+ |
| 1992 | 0 | 0 | 1 | 5 | 45 | 76 | 93 | 553 | 731 | 935 | 4393 | 5818 |
| 1993 | 89 | 6135 | 13760 | 5902 | 2402 | 1668 | 2025 | 1501 | 886 | 766 | 511 | 3187 |
| 1994 | 1666 | 1549 | 3052 | 1939 | 1171 | 863 | 882 | 839 | 1039 | 943 | 1290 | 3511 |
| 1995 | 2 | 286 | 516 | 2193 | 1929 | 1410 | 608 | 415 | 258 | 252 | 175 | 3485 |
| 1996 | 0 | 11 | 97 | 692 | 1651 | 618 | 465 | 331 | 370 | 255 | 205 | 1330 |
| 1997 | 17 | 602 | 972 | 1384 | 2915 | 2575 | 1313 | 653 | 420 | 235 | 278 | 814 |
| 1998 | 180 | 181 | 2726 | 1051 | 1726 | 1861 | 1387 | 1684 | 740 | 647 | 728 | 2056 |
| 1999 | 2 | 67 | 731 | 1927 | 2836 | 2102 | 2420 | 1151 | 433 | 394 | 98 | 564 |
| 2000 | 73 | 1129 | 1030 | 1024 | 1425 | 1108 | 2184 | 2171 | 1494 | 743 | 408 | 810 |
| 2001 | 420 | 1014 | 140 | 539 | 1036 | 1445 | 1671 | 1695 | 981 | 390 | 240 | 739 |
| 2002 | 1212 | 3176 | 461 | 591 | 471 | 895 | 1358 | 1711 | 1653 | 1187 | 578 | 1161 |
| 2003 | 2537 | 144 | 1581 | 665 | 1442 | 1320 | 2152 | 2858 | 2032 | 1079 | 601 | 547 |
| 2004 | 491 | 7154 | 1552 | 457 | 897 | 1429 | 1449 | 2659 | 2709 | 1021 | 455 | 431 |
| 2005 | 203 | 738 | 295 | 308 | 359 | 1332 | 1643 | 938 | 1174 | 1051 | 1193 | 3689 |
| 2006 | 26 | 5790 | 1875 | 617 | 837 | 1144 | 894 | 1041 | 1793 | 1964 | 2002 | 3826 |
| 2007 | 3 | 173 | 398 | 1656 | 1548 | 1456 | 563 | 390 | 496 | 438 | 486 | 4440 |
| 2008 | 0 | 330 | 1108 | 1557 | 2479 | 1987 | 948 | 576 | 599 | 420 | 456 | 4564 |
| 2009 | 49 | 654 | 701 | 713 | 1465 | 621 | 569 | 585 | 567 | 581 | 521 | 7903 |
| 2010 | 10 | 14509 | 7141 | 3295 | 3033 | 2378 | 1087 | 1309 | 589 | 763 | 519 | 5469 |
| 2011 | 3764 | 1226 | 992 | 1810 | 3153 | 2258 | 920 | 1137 | 1144 | 1126 | 1039 | 3156 |
| 2012 | 539 | 2263 | 3401 | 3535 | 3197 | 1833 | 1846 | 1026 | 637 | 843 | 1295 | 5708 |
| 2013 | 14 | 1477 | 2726 | 1677 | 1416 | 810 | 516 | 625 | 570 | 497 | 588 | 3800 |
| 2014 | 0 | 73 | 178 | 221 | 350 | 275 | 155 | 195 | 164 | 208 | 242 | 1399 |
| 2015 | 103 | 2468 | 2215 | 3186 | 4380 | 1564 | 773 | 404 | 449 | 378 | 424 | 3072 |
| 2016 | 69 | 200 | 520 | 1265 | 1511 | 2037 | 1391 | 1164 | 802 | 410 | 453 | 2431 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017 | 4280 | 4189 | 3229 | 2407 | 1669 | 683 | 537 | 673 | 663 | 302 | 382 | 1704 |
| 2018 | 8284 | 3365 | 1516 | 1894 | 1495 | 849 | 847 | 488 | 433 | 291 | 255 | 776 |
| 2019 | 4441 | 9536 | 3999 | 1959 | 989 | 1314 | 591 | 562 | 553 | 402 | 488 | 361 |
| 2020 | 3138 | 3789 | 3291 | 3508 | 1332 | 959 | 496 | 417 | 315 | 545 | 306 | 713 |
| 2021 | 17031 | 18202 | 2270 | 1670 | 980 | 632 | 400 | 247 | 177 | 361 | 317 | 582 |
| 2022 | 3343 | 5468 | 3949 | 2950 | 2647 | 1205 | 365 | 371 | 245 | 199 | 126 | 320 |
| 2023 | 12988 | 9533 | 3597 | 1928 | 836 | 313 | 432 | 307 | 179 | 245 | 203 | 299 |

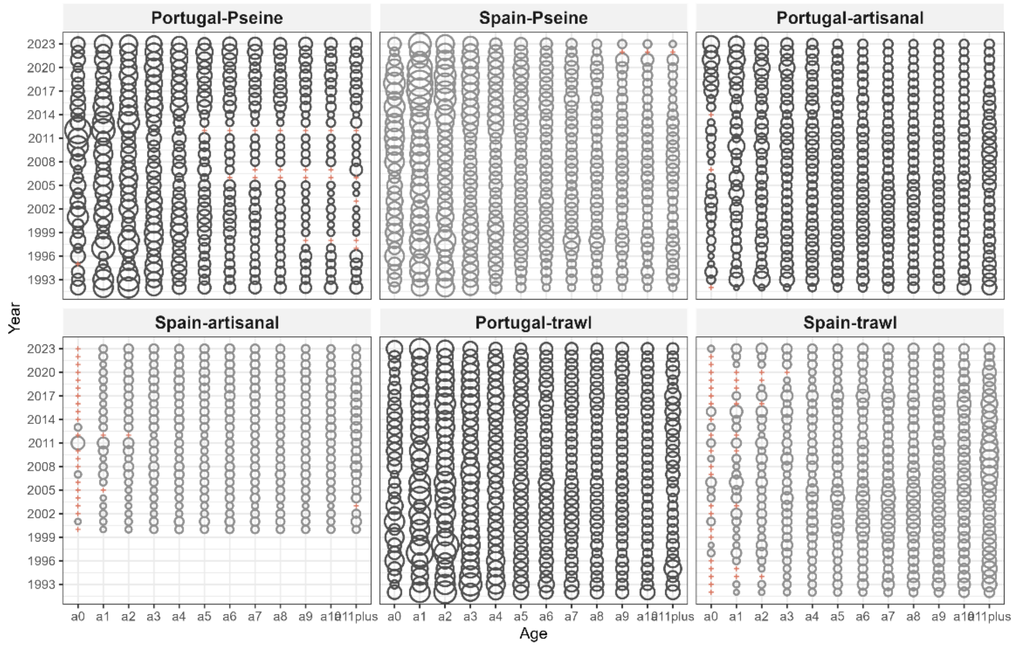


**Figure 5.2.4.3. Bubble plot of proportions of southern horse mackerel catch in numbers-at-age by country and fleet in each year (1992-2023).**

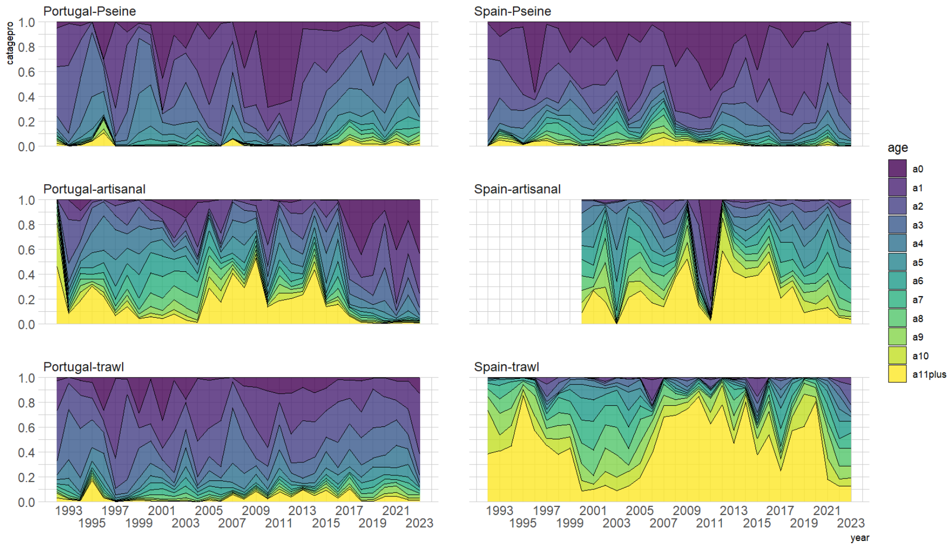


**Figure 5.2.4.4. Proportion of catch for southern horse mackerel by country and fleet in each year (1992-2023).**

## 5.2.5 Mean weight-at-age in the catch

Detailed information on how to calculate mean weight-at-age and mean length-at-age is provided in the Stock Annex. Tables 5.2.5.1 and 5.2.5.2 show the mean weight-at-age in the catch and the mean length-at-age in catch, respectively, from 1992 to 2023.

The mean weight-at-age is of a similar magnitude to previous years in all Figure 5.2.5.1, Table 5.2.5.1) and the variations of mean length-at-age are of a similar scale along the temporal series (Table 5.2.5.2). Otoliths from older fish become thicker with time and thus presenting more difficulties for age determination at groups older than 11. Mean length-at-age from 2019 onward is only shown for ages 0 to 11+ used for assessment.

**Table 5.2.5.1. Southern horse mackerel mean weight-at-age (kg) in the catch (1992-2023).**

| | AGES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11+ |
| 1992 | 0.03 | 0.03 | 0.04 | 0.07 | 0.1 | 0.13 | 0.15 | 0.17 | 0.19 | 0.2 | 0.23 | 0.3 |
| 1993 | 0.02 | 0.03 | 0.04 | 0.07 | 0.09 | 0.13 | 0.17 | 0.21 | 0.24 | 0.24 | 0.25 | 0.3 |
| 1994 | 0.04 | 0.04 | 0.06 | 0.07 | 0.09 | 0.13 | 0.16 | 0.19 | 0.23 | 0.25 | 0.27 | 0.34 |
| 1995 | 0.04 | 0.03 | 0.06 | 0.08 | 0.1 | 0.12 | 0.16 | 0.17 | 0.2 | 0.22 | 0.23 | 0.31 |
| 1996 | 0.02 | 0.05 | 0.07 | 0.09 | 0.11 | 0.14 | 0.17 | 0.19 | 0.22 | 0.24 | 0.26 | 0.31 |
| 1997 | 0.03 | 0.03 | 0.05 | 0.07 | 0.11 | 0.14 | 0.17 | 0.2 | 0.24 | 0.26 | 0.26 | 0.36 |
| 1998 | 0.03 | 0.03 | 0.04 | 0.07 | 0.1 | 0.13 | 0.17 | 0.21 | 0.17 | 0.24 | 0.25 | 0.35 |
| 1999 | 0.02 | 0.04 | 0.06 | 0.08 | 0.11 | 0.14 | 0.16 | 0.19 | 0.22 | 0.25 | 0.27 | 0.36 |
| 2000 | 0.02 | 0.03 | 0.05 | 0.09 | 0.11 | 0.13 | 0.16 | 0.19 | 0.22 | 0.24 | 0.25 | 0.31 |
| 2001 | 0.02 | 0.03 | 0.07 | 0.08 | 0.09 | 0.13 | 0.16 | 0.18 | 0.2 | 0.23 | 0.24 | 0.31 |
| 2002 | 0.03 | 0.03 | 0.04 | 0.07 | 0.1 | 0.12 | 0.15 | 0.17 | 0.2 | 0.23 | 0.25 | 0.31 |
| 2003 | 0.02 | 0.03 | 0.05 | 0.06 | 0.09 | 0.12 | 0.15 | 0.18 | 0.2 | 0.23 | 0.25 | 0.31 |
| 2004 | 0.04 | 0.03 | 0.05 | 0.08 | 0.12 | 0.16 | 0.18 | 0.21 | 0.23 | 0.25 | 0.27 | 0.33 |
| 2005 | 0.02 | 0.03 | 0.04 | 0.07 | 0.12 | 0.15 | 0.17 | 0.18 | 0.22 | 0.24 | 0.25 | 0.3 |
| 2006 | 0.03 | 0.03 | 0.05 | 0.06 | 0.09 | 0.13 | 0.14 | 0.17 | 0.19 | 0.23 | 0.25 | 0.33 |
| 2007 | 0.03 | 0.05 | 0.06 | 0.07 | 0.09 | 0.11 | 0.16 | 0.19 | 0.23 | 0.22 | 0.24 | 0.3 |
| 2008 | 0.02 | 0.05 | 0.06 | 0.08 | 0.11 | 0.13 | 0.15 | 0.17 | 0.20 | 0.21 | 0.23 | 0.32 |
| 2009 | 0.02 | 0.03 | 0.06 | 0.09 | 0.11 | 0.13 | 0.15 | 0.17 | 0.18 | 0.21 | 0.24 | 0.36 |
| 2010 | 0.02 | 0.04 | 0.06 | 0.08 | 0.11 | 0.14 | 0.16 | 0.18 | 0.19 | 0.2 | 0.24 | 0.38 |
| 2011 | 0.03 | 0.06 | 0.07 | 0.08 | 0.11 | 0.13 | 0.17 | 0.18 | 0.19 | 0.22 | 0.26 | 0.35 |
| 2012 | 0.02 | 0.03 | 0.07 | 0.10 | 0.13 | 0.16 | 0.18 | 0.19 | 0.21 | 0.24 | 0.28 | 0.37 |
| 2013 | 0.05 | 0.04 | 0.05 | 0.09 | 0.13 | 0.16 | 0.18 | 0.20 | 0.21 | 0.23 | 0.26 | 0.33 |
| 2014 | 0.03 | 0.05 | 0.06 | 0.09 | 0.12 | 0.15 | 0.18 | 0.19 | 0.21 | 0.23 | 0.27 | 0.36 |
| 2015 | 0.03 | 0.04 | 0.06 | 0.09 | 0.11 | 0.14 | 0.17 | 0.19 | 0.21 | 0.24 | 0.26 | 0.35 |
| 2016 | 0.02 | 0.04 | 0.06 | 0.08 | 0.11 | 0.13 | 0.16 | 0.18 | 0.19 | 0.22 | 0.26 | 0.38 |
| 2017 | 0.02 | 0.04 | 0.07 | 0.09 | 0.12 | 0.15 | 0.18 | 0.20 | 0.21 | 0.25 | 0.28 | 0.35 |
| 2018 | 0.02 | 0.04 | 0.06 | 0.09 | 0.12 | 0.15 | 0.19 | 0.24 | 0.27 | 0.30 | 0.34 | 0.44 |

| | AGES | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11+ |
| 2019 | 0.02 | 0.04 | 0.06 | 0.08 | 0.12 | 0.14 | 0.17 | 0.22 | 0.24 | 0.34 | 0.37 | 0.46 |
| 2020 | 0.02 | 0.04 | 0.06 | 0.07 | 0.10 | 0.13 | 0.16 | 0.20 | 0.22 | 0.25 | 0.30 | 0.39 |
| 2021 | 0.01 | 0.03 | 0.05 | 0.08 | 0.10 | 0.13 | 0.15 | 0.18 | 0.23 | 0.25 | 0.28 | 0.33 |
| 2022 | 0.016 | 0.047 | 0.062 | 0.09 | 0.115 | 0.143 | 0.177 | 0.207 | 0.224 | 0.274 | 0.325 | 0.408 |
| 2023 | 0.02 | 0.05 | 0.06 | 0.09 | 0.12 | 0.14 | 0.18 | 0.21 | 0.22 | 0.27 | 0.33 | 0.41 |

**Table 5.2.5.2. Southern horse mackerel mean length-at-age (cm) in the catch from 1992-2023 (age range: 0–11+ and older).**

| Year \ Age | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1992 | 14.9 | 15.6 | 17.5 | 19.8 | 23.2 | 25.8 | 27.4 | 28.6 | 29.6 | 31.2 | 31.5 | 32.6 | 33.3 | 33.9 | 34.7 | 36.8 |
| 1993 | 14.0 | 15.5 | 17.4 | 18.9 | 21.3 | 28.2 | 29.6 | 31.1 | 31.7 | 31.7 | 32.1 | 32.5 | 34.1 | 34.7 | 35.8 | 37.2 |
| 1994 | 13.4 | 14.6 | 18.1 | 21.1 | 22.7 | 24.8 | 27.0 | 29.5 | 31.2 | 31.7 | 32.4 | 32.2 | 33.3 | 34.2 | 34.4 | 36.5 |
| 1995 | 16.0 | 15.4 | 19.9 | 21.8 | 23.1 | 24.5 | 28.6 | 26.5 | 30.1 | 30.9 | 31.6 | 32.6 | 33.9 | 34.0 | 35.2 | 36.9 |
| 1996 | 13.3 | 19.0 | 19.7 | 21.8 | 24.7 | 26.3 | 28.0 | 28.6 | 30.3 | 30.7 | 31.5 | 32.0 | 33.4 | 32.5 | 36.2 | 37.0 |
| 1997 | 13.4 | 15.8 | 18.9 | 20.7 | 24.3 | 26.3 | 27.6 | 29.5 | 31.2 | 32.4 | 31.9 | 33.1 | 34.6 | 34.8 | 35.4 | 38.5 |
| 1998 | 14.5 | 13.9 | 15.9 | 20.4 | 23.5 | 25.5 | 28.3 | 30.3 | 26.9 | 31.7 | 32.0 | 32.7 | 33.4 | 34.5 | 36.4 | 39.1 |
| 1999 | 13.4 | 16.4 | 19.0 | 22.3 | 24.5 | 26.2 | 27.5 | 29.0 | 30.3 | 31.7 | 32.7 | 33.3 | 33.9 | 34.7 | 37.3 | 39.6 |
| 2000 | 13.6 | 16.4 | 18.4 | 21.7 | 24.8 | 26.0 | 27.2 | 28.6 | 30.2 | 30.8 | 31.5 | 32.3 | 32.7 | 34.2 | 34.5 | 35.0 |
| 2001 | 14.1 | 15.6 | 20.2 | 21.9 | 22.5 | 25.4 | 27.4 | 28.7 | 29.6 | 30.9 | 31.2 | 33.0 | 32.8 | 34.0 | 34.7 | 38.2 |
| 2002 | 15.0 | 15.7 | 17.5 | 20.3 | 23.1 | 25.4 | 26.6 | 28.0 | 29.6 | 30.9 | 31.8 | 32.6 | 34.2 | 34.7 | 35.4 | 36.9 |
| 2003 | 13.0 | 15.7 | 18.8 | 20.7 | 23.1 | 26.1 | 26.7 | 29.2 | 30.0 | 31.2 | 32.0 | 32.9 | 33.6 | 33.9 | 38.9 | 35.3 |
| 2004 | 16.2 | 14.4 | 17.2 | 21.2 | 24.0 | 26.7 | 28.1 | 29.4 | 30.5 | 31.6 | 32.3 | 32.2 | 33.0 | 32.2 | 36.4 | 35.9 |
| 2005 | 12.5 | 13.9 | 16.6 | 20.1 | 23.5 | 25.9 | 27.1 | 28.1 | 30.0 | 31.1 | 31.6 | 32.8 | 32.6 | 33.5 | 32.6 | 37.2 |
| 2006 | 14.6 | 14.7 | 17.0 | 19.2 | 22.2 | 24.6 | 25.6 | 27.2 | 28.7 | 30.3 | 31.5 | 33.2 | 34.0 | 35.9 | 36.7 | 37.0 |
| 2007 | 14.6 | 17.5 | 18.5 | 20.0 | 22.1 | 23.6 | 26.9 | 28.7 | 30.6 | 30.3 | 30.9 | 31.8 | 33.4 | 32.2 | 34.5 | 35.7 |
| 2008 | 13.0 | 17.3 | 20.5 | 22.3 | 24.0 | 25.4 | 26.5 | 27.7 | 28.8 | 29.6 | 30.5 | 31.3 | 32.2 | 33.5 | 35.6 | 37.2 |
| 2009 | 13.0 | 17.3 | 20.5 | 22.3 | 24.0 | 25.4 | 26.5 | 27.7 | 28.8 | 29.6 | 30.5 | 31.3 | 32.2 | 33.5 | 35.6 | 37.2 |
| 2010 | 13.1 | 15.8 | 18.4 | 20.8 | 23.4 | 25.4 | 26.9 | 27.8 | 28.6 | 29.2 | 31.2 | 31.7 | 33.5 | 34.7 | 36.7 | 38.0 |
| 2011 | 15.1 | 18.4 | 19.5 | 21.3 | 23.3 | 25.2 | 27.4 | 28.1 | 28.6 | 30.2 | 32.0 | 33.3 | 34.2 | 35.0 | 36.5 | 39.0 |
| 2012 | 15.7 | 15.8 | 18.4 | 22.8 | 24.9 | 26.5 | 27.8 | 28.8 | 29.9 | 31.1 | 33.2 | 34.4 | 35.5 | 36.7 | 39.4 | 39.8 |
| 2013 | 16.8 | 16.8 | 17.9 | 21.4 | 24.6 | 26.2 | 27.5 | 28.3 | 29.1 | 29.7 | 31.0 | 32.5 | 34.7 | 35.7 | 37.9 | 36.3 |
| 2014 | 13.9 | 18.7 | 20.4 | 21.4 | 23.0 | 25.2 | 26.5 | 27.5 | 28.5 | 28.9 | 31.2 | 32.9 | 34.5 | 35.4 | 36.6 | 38.0 |
| 2015 | 15.6 | 15.9 | 18.3 | 21.6 | 23.0 | 25.4 | 27.4 | 27.8 | 28.7 | 30.3 | 31.4 | 31.6 | 33.9 | 34.3 | 36.2 | 38.4 |
| 2016 | 13.8 | 16.1 | 18.7 | 20.6 | 23.1 | 25.0 | 26.5 | 28.0 | 28.5 | 30.1 | 31.9 | 33.7 | 36.2 | 36.8 | 37.1 | 39.3 |
| 2017 | 13.2 | 15.8 | 19.7 | 21.9 | 24.4 | 25.9 | 28.2 | 28.9 | 29.2 | 30.9 | 32.3 | 33.1 | 34.2 | 34.8 | 36.6 | 40.6 |
| 2018 | 12.9 | 16.2 | 19.4 | 22.1 | 24.1 | 25.9 | 28.4 | 30.7 | 31.7 | 33.0 | 34.4 | 37.3 | 37.9 | 38.9 | 38.5 | 39.2 |
| 2019* | 13.5 | 16.3 | 19.2 | 21.3 | 24.2 | 25.5 | 27.3 | 29.8 | 30.7 | 34.0 | 35.1 | 38.5 | - | - | - | - |
| 2020 | 13.7 | 16.6 | 19.2 | 20.9 | 23.1 | 25.1 | 26.6 | 28.7 | 29.9 | 30.8 | 32.3 | 36.1 | - | - | - | - |

| Year \ Age | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2021 | 12.1 | 14.5 | 18.4 | 20.9 | 22.7 | 25.0 | 26.5 | 28.2 | 30.1 | 31.1 | 32.4 | 34.3 | - | - | - | - |
| 2022 | 12.6 | 17.3 | 19.4 | 22.1 | 23.9 | 25.7 | 27.5 | 28.9 | 29.7 | 31.7 | 33.4 | 36.1 | - | - | - | - |
| 2023 | 13.3 | 16.2 | 20.2 | 23.2 | 25.1 | 26.4 | 27.8 | 29.1 | 30.8 | 31.5 | 33.3 | 36.4 | - | - | - | - |

* Mean length-at-age from 2019 onwards is only shown for 0 to 11+, plus group used for assessment.

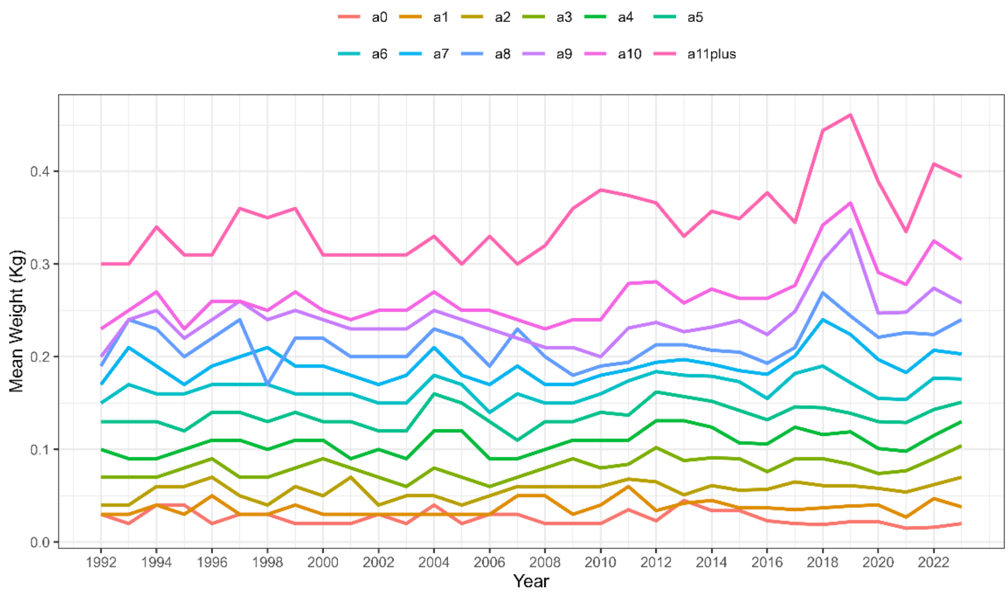


**Figure 5.2.5.1. Southern horse mackerel mean weight-at-age (kg) in the catch (age range: 0 to 11+, plus group) (1992-2023).**

## 5.3 Fishery-independent information

The survey datasets currently available for the assessment of southern horse mackerel are those from the bottom-trawl surveys carried out in the 4th quarter (October) by Portugal (Pt-GFS-WIBTS-Q4 - G8899) and Spain (Sp-GFS-WIBTS-Q4 - G2784) in ICES Division 9.a. Both IBTS surveys cover the bulk of the geographical distribution of the southern horse mackerel stock at the same time but do not cover the southernmost part of the stock distribution area, corresponding to the Spanish part of the Gulf of Cadiz. In that area another bottom-trawl survey is carried out (Sp-GFS-caut-WIBTS-Q4 - G4309), usually in November. The survey series is shorter in time (only since 1998) and the effect of merging it with the datasets from the other areas is not available.

A triennial DEPM egg survey for southern horse mackerel has been conducted in ICES Division 9.a since 2010, organised by Portugal and coordinated by the ICES Working Group on Methods of Egg Surveys (WGMEGS). The results of the DEPM surveys carried out in 2010, 2013, 2016, 2019 and 2022 were analysed during the last benchmark (ICES 2024) and the estimation of SSB are now used in the assessment.

During the benchmark procedures horse mackerel estimations from Portuguese spring acoustic surveys and IBTS were also discussed as a possible indicator of the recruitment strength for this species, which could prove to be useful for the assessment. This require further analysis to be used as auxiliary information for recruitment strength.

Figure 5.3.1. shows the combined standardized biomass indices used in the assessment (1992-2023)

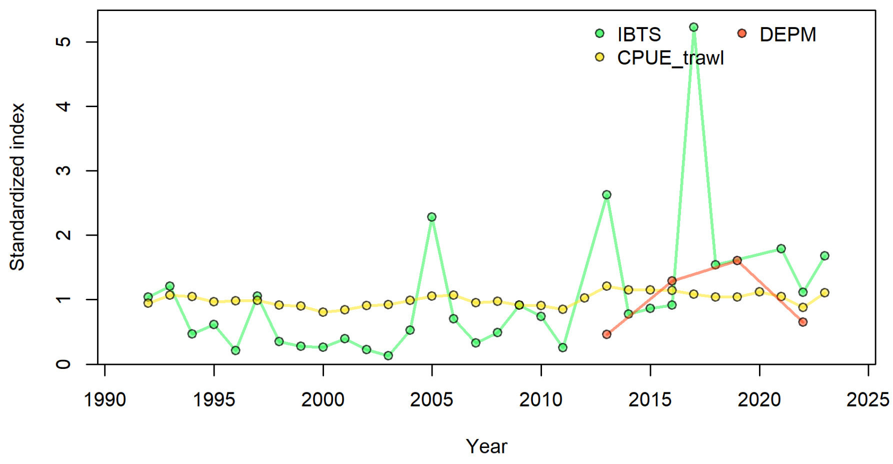


**Figure 5.3.1. Southern horse mackerel standardized biomass indices used in the assessment (1992-2023).**

## 5.3.1 Bottom-trawl surveys

IBTS data provides a good sampling of this species with valuable information on horse mackerel distribution, abundance, age–length distributions also providing a good signal of cohort dynamics (ICES, 2017). Several alternative methods for calculating indices of abundance-at-age were explored to improve the precision of the current survey tuning index, the diagnostics of stock assessment model fit, the uncertainty in the estimates of the key parameters fishing mortality, recruitment and spawning–stock biomass, as well as to evaluate the stock trends (ICES, 2017).

Different methods of obtaining an abundance index by age and year were explored. The "standard" stratified mean was an acceptable method to deal with the non-normal abundance distribution and the variability in the survey data. This estimator, described in the Stock Annex, was found adequate to deal with the data from the current classical stratified survey methodology applied in IBTS surveys and was thus adopted for tuning the assessment (ICES, 2024).

The abundance indices from both surveys are shown in Table 5.3.1.1. There is a strong variability of age 0 abundance that may be explained by the greater aggregation tendency of these small fish in dense shoals. This feature results in a rather noisy time-series at age 0. The abundance-at-age from 2022 onward is only shown for 0 to 11+, plus group used for assessment. The combined survey abundance-at-age for tuning the assessment excluding age 0 is presented in Table 5.3.1.2.

The Portuguese IBTS was not conducted in 2012, 2019 and 2020. Because this survey traverses the majority of the stock area, the combined survey abundance-at-age index could not be estimated for 2012, 2019 and 2020.

**Table 5.3.1.1. Southern horse mackerel CPUE-at-age (number/hour) by the Portuguese and Spanish surveys, in the period 1992–2023 (age range: 0 to 15+, plus group). The Portuguese IBTS (October) survey was not conducted in 2012, 2019 and 2020.**

**Portuguese October Survey**

| | AGES | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
| 1992 | 452.2 | 488.2 | 145.8 | 26.8 | 13.2 | 5.9 | 4.0 | 4.3 | 2.4 | 2.2 | 3.0 | 0.5 | 0.6 | 0.2 | 0.1 | 0.1 |
| 1993 | 1645.8 | 183.8 | 212.2 | 148.0 | 32.5 | 2.0 | 1.5 | 0.7 | 0.5 | 0.7 | 0.4 | 1.0 | 0.3 | 0.2 | 0.0 | 0.0 |
| 1994 | 3.7 | 8.0 | 62.9 | 36.1 | 15.2 | 4.2 | 2.0 | 1.7 | 0.8 | 0.5 | 0.3 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1995 | 15.8 | 61.2 | 89.7 | 49.7 | 23.9 | 6.5 | 1.4 | 1.2 | 0.5 | 0.2 | 0.2 | 0.3 | 0.3 | 0.5 | 0.1 | 0.1 |
| 1996* | 1214.1 | 6.3 | 8.7 | 13.5 | 14.0 | 3.6 | 1.7 | 0.6 | 0.1 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1997 | 2094.7 | 97.4 | 69.0 | 20.4 | 45.0 | 55.4 | 14.9 | 10.9 | 4.5 | 5.3 | 1.8 | 0.1 | 0.0 | 0.1 | 0.1 | 0.0 |
| 1998 | 86.4 | 33.2 | 161.7 | 17.4 | 2.2 | 1.4 | 0.9 | 0.9 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1999* | 159.5 | 20.2 | 31.8 | 34.8 | 2.8 | 1.0 | 0.5 | 0.2 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2000 | 2.4 | 13.7 | 17.1 | 19.8 | 11.9 | 6.6 | 4.0 | 1.3 | 0.7 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2001 | 1292.7 | 1.1 | 8.8 | 3.9 | 6.9 | 13.8 | 12.2 | 11.2 | 6.6 | 2.5 | 1.2 | 0.2 | 0.1 | 0.1 | 0.0 | 0.0 |
| 2002 ^ | 21.1 | 1.5 | 11.4 | 10.0 | 5.5 | 2.8 | 1.0 | 0.7 | 0.5 | 0.3 | 0.6 | 0.2 | 0.1 | 0.1 | 0.0 | 0.0 |
| 2003* | 56.5 | 9.1 | 8.2 | 10.2 | 8.8 | 3.3 | 2.3 | 1.2 | 0.7 | 0.4 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2004 | 58.6 | 37.1 | 111.8 | 38.0 | 6.7 | 3.0 | 1.4 | 3.5 | 5.0 | 0.9 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2005 | 351.9 | 1188.6 | 162.2 | 45.2 | 21.7 | 10.4 | 13.7 | 14.4 | 11.7 | 6.6 | 4.1 | 4.6 | 4.1 | 0.9 | 1.0 | 0.3 |
| 2006 | 65.1 | 84.6 | 181.8 | 46.6 | 3.4 | 10.3 | 7.4 | 6.6 | 2.7 | 1.4 | 0.4 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2007 | 36.2 | 2.0 | 22.6 | 31.5 | 25.1 | 9.2 | 2.5 | 1.2 | 0.1 | 0.4 | 1.3 | 1.1 | 0.5 | 0.2 | 0.2 | 0.4 |
| 2008 | 47.6 | 28.2 | 39.7 | 20.6 | 26.7 | 17.3 | 2.2 | 0.8 | 1.2 | 1.8 | 1.3 | 1.0 | 0.5 | 0.9 | 0.5 | 1.8 |
| 2009 | 1245.2 | 79.5 | 147.0 | 52.4 | 44.7 | 11.6 | 2.8 | 1.7 | 1.4 | 0.9 | 0.7 | 0.4 | 0.7 | 1.7 | 0.4 | 0.8 |
| 2010 | 83.3 | 36.8 | 32.8 | 25.6 | 38.3 | 14.1 | 5.2 | 7.0 | 4.7 | 4.6 | 1.6 | 1.8 | 1.5 | 1.9 | 2.1 | 3.0 |
| 2011 | 132.8 | 33.1 | 24.5 | 16.2 | 4.7 | 1.1 | 0.3 | 0.4 | 0.2 | 0.4 | 0.5 | 0.2 | 0.3 | 0.4 | 0.2 | 0.2 |
| 2012 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2013 | 12.5 | 363.7 | 820.0 | 105.4 | 18.9 | 3.0 | 2.5 | 2.7 | 2.2 | 2.2 | 1.5 | 0.8 | 1.2 | 0.4 | 0.3 | 0.2 |
| 2014 | 53.6 | 33.3 | 24.1 | 69.2 | 25.6 | 5.2 | 1.6 | 1.5 | 0.9 | 1.2 | 2.2 | 2.6 | 3.0 | 2.5 | 0.9 | 0.6 |
| 2015 | 900.2 | 160.3 | 112.5 | 46.6 | 38.0 | 4.5 | 2.3 | 1.0 | 0.8 | 0.9 | 0.7 | 0.5 | 0.4 | 0.5 | 0.3 | 0.5 |
| 2016 | 1.6 | 17.1 | 23.1 | 76.8 | 53.6 | 7.6 | 4.3 | 6.0 | 2.4 | 1.3 | 1.6 | 2.0 | 2.7 | 1.7 | 0.2 | 1.7 |
| 2017 | 68.2 | 440.0 | 584.2 | 263.0 | 177.1 | 27.9 | 3.5 | 13.5 | 19.2 | 2.4 | 2.1 | 1.6 | 1.0 | 0.9 | 0.0 | 0.0 |
| 2018 | 124.5 | 192.6 | 177.3 | 96.7 | 12.5 | 14.2 | 19.9 | 9.4 | 10.0 | 3.5 | 0.3 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 |
| 2019 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2020 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2021*** | 180.3 | 288.5 | 74.8 | 123.3 | 78.4 | 58.2 | 29.6 | 5.5 | 4.4 | 3.6 | 5.4 | 0.9 | 0.5 | 0.0 | 0.0 | 0.1 |
| 2022 | 122.4 | 101.9 | 70.0 | 42.1 | 56.4 | 34.6 | 12.9 | 2.3 | 0.4 | 1.2 | 0.7 | 2.3 | - | - | - | - |
| 2023 | 1481.9 | 288.5 | 212.0 | 63.0 | 26.1 | 7.7 | 14.5 | 6.4 | 2.1 | 1.1 | 0.4 | 0.3 | - | - | - | - |

**Spanish October Survey (only Subdivision 9a North)**

| | AGES | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15+ |
| 1992 | 2.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 1.0 | 0.4 | 0.5 | 0.3 | 0.1 | 0.6 |
| 1993 | 33.1 | 0.4 | 1.2 | 0.9 | 0.1 | 0.0 | 0.6 | 2.5 | 2.6 | 3.6 | 2.2 | 4.2 | 0.8 | 0.5 | 0.1 | 0.2 |
| 1994 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.3 | 0.6 | 0.0 | 3.7 | 3.0 | 0.3 | 1.5 |
| 1995 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.2 | 0.6 | 1.0 | 2.2 | 0.6 | 0.5 |
| 1996 | 8.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.7 | 0.2 | 0.1 | 0.5 | 0.7 | 0.3 | 1.1 |
| 1997** | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.3 | 0.3 | 0.5 | 0.2 | 0.1 | 0.1 | 0.2 | 0.3 | 0.7 |
| 1998 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1999 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.6 | 0.9 | 0.7 | 1.3 | 0.5 | 0.4 | 0.1 |
| 2000 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.8 | 1.0 | 0.9 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.2 |
| 2001 | 3.4 | 0.8 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.7 | 1.2 | 1.1 | 0.9 | 0.5 | 0.3 | 0.3 | 0.0 | 0.1 |
| 2002 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.4 | 2.1 | 2.0 | 2.5 | 2.9 | 1.0 | 1.2 | 0.4 | 0.6 |
| 2003 | 2.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.2 | 0.2 | 0.1 | 0.1 | 0.0 | 0.0 | 0.2 |
| 2004 | 24.1 | 0.3 | 0.7 | 4.3 | 1.4 | 1.2 | 0.5 | 0.4 | 0.2 | 0.1 | 0.2 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| 2005 | 938.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.2 | 0.1 | 0.1 | 0.0 | 0.0 |
| 2006 | 7.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.1 |
| 2007 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.3 | 0.3 | 0.4 | 0.2 | 0.2 | 0.2 | 0.0 | 0.1 | 0.1 | 0.0 |
| 2008 | 5.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 |
| 2009 | 23.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.2 | 0.1 |
| 2010 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.1 | 0.2 | 0.3 | 0.3 |
| 2011 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.1 | 0.3 | 0.3 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 |
| 2012 | 12.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.2 |
| 2013 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2014 | 0.3 | 7.5 | 1.2 | 8.5 | 8.0 | 2.6 | 0.4 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.9 | 0.0 | 0.0 | 0.0 |
| 2015 | 6.6 | 0.0 | 0.1 | 1.9 | 2.8 | 1.0 | 0.1 | 0.2 | 0.0 | 0.1 | 0.2 | 0.0 | 0.1 | 0.0 | 0.1 | 0.2 |
| 2016 | 11.9 | 2.8 | 20.0 | 3.2 | 4.0 | 11.0 | 4.6 | 2.2 | 0.5 | 0.3 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 |
| 2017 | 4.9 | 27.1 | 171.7 | 84.1 | 48.6 | 13.4 | 17.7 | 0.4 | 0.7 | 0.1 | 0.4 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2018 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2019 | 0.6 | 0.3 | 0.1 | 0.1 | 0.4 | 2.1 | 0.3 | 0.1 | 0.1 | 0.0 | 0.5 | 0.2 | 0.2 | 0.0 | 0.0 | 0.1 |
| 2020 | 12.5 | 37.4 | 121.3 | 32.8 | 5.1 | 0.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 |
| 2021 | 0.9 | 0.0 | 0.1 | 0.0 | 0.6 | 0.8 | 0.8 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2022 | 5.5 | 0.2 | 0.5 | 0.5 | 0.0 | 0.2 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | - | - | - | - |
| 2023 | 48.3 | 76.4 | 12.8 | 5.3 | 1.5 | 0.3 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | - | - | - | - |

**(*) The surveys were carried out with a different research vessel.**
**(**) Since 1997 another stratification design in the Spanish surveys.**
**(***) Since 2021 hte Portuguese survey is carried out with a new research vessel (R/V Mário Ruivo)**
**(^) In 2002 the duration of the trawling hauls changed from one hour to 30 minutes.**

**Table 5.3.1.2. Southern horse mackerel. Stratified mean abundance-at-age (number/hour) in the period 1992–2023. There were no Portuguese surveys in 2012, 2019 and 2020 and therefore the combined survey indices for 2012, 2019 and 2020 are not estimated.**

| | **AGES** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | **0*** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11+** |
| 1992 | 454.5 | 488.2 | 145.8 | 26.8 | 13.2 | 5.9 | 4.0 | 4.4 | 2.4 | 2.3 | 4.0 | 3.4 |
| 1993 | 1678.9 | 184.2 | 213.3 | 148.8 | 32.6 | 2.0 | 2.1 | 3.2 | 3.1 | 4.3 | 2.6 | 7.3 |
| 1994 | 3.8 | 8.0 | 63.0 | 36.1 | 15.2 | 4.2 | 2.0 | 1.7 | 0.9 | 0.8 | 0.9 | 8.7 |
| 1995 | 15.8 | 61.2 | 89.7 | 49.7 | 23.9 | 6.5 | 1.4 | 1.2 | 0.6 | 0.3 | 0.4 | 6.2 |
| 1996 | 1222.5 | 6.3 | 8.7 | 13.5 | 14.0 | 3.6 | 1.7 | 0.6 | 0.4 | 0.8 | 0.2 | 2.8 |
| 1997 | 2095.3 | 97.4 | 69.0 | 20.4 | 45.0 | 55.4 | 15.0 | 11.2 | 4.8 | 5.8 | 2.1 | 1.7 |
| 1998 | 86.6 | 33.2 | 161.7 | 17.4 | 2.2 | 1.4 | 1.0 | 1.2 | 0.3 | 0.1 | 0.0 | 0.1 |
| 1999 | 159.5 | 20.2 | 31.8 | 34.8 | 2.8 | 1.0 | 0.6 | 0.2 | 0.2 | 0.7 | 0.9 | 3.0 |
| 2000 | 2.5 | 13.7 | 17.1 | 19.8 | 11.9 | 6.6 | 4.1 | 2.1 | 1.7 | 1.0 | 0.3 | 0.9 |
| 2001 | 1296.1 | 1.8 | 8.8 | 3.9 | 6.9 | 13.8 | 12.3 | 11.9 | 7.8 | 3.7 | 2.1 | 1.6 |
| 2002 | 21.2 | 1.5 | 11.4 | 10.0 | 5.5 | 2.8 | 1.2 | 1.1 | 2.6 | 2.3 | 3.1 | 6.6 |
| 2003 | 58.9 | 9.1 | 8.2 | 10.2 | 8.8 | 3.3 | 2.4 | 1.3 | 0.7 | 0.6 | 0.4 | 0.5 |
| 2004 | 82.7 | 37.4 | 112.4 | 42.4 | 8.1 | 4.2 | 1.9 | 3.8 | 5.1 | 1.0 | 0.4 | 0.2 |
| 2005 | 1290.0 | 1188.6 | 162.2 | 45.2 | 21.8 | 10.5 | 13.8 | 14.5 | 11.8 | 6.7 | 4.1 | 11.3 |
| 2006 | 72.6 | 84.6 | 181.8 | 46.6 | 3.4 | 10.4 | 7.4 | 6.7 | 2.7 | 1.4 | 0.5 | 0.3 |
| 2007 | 36.6 | 2.0 | 22.6 | 31.5 | 25.1 | 9.2 | 2.7 | 1.6 | 0.6 | 0.6 | 1.4 | 2.9 |
| 2008 | 52.6 | 28.2 | 39.7 | 20.6 | 26.8 | 17.3 | 2.2 | 0.8 | 1.3 | 1.9 | 1.4 | 5.0 |
| 2009 | 1268.3 | 79.5 | 147.0 | 52.4 | 44.7 | 11.6 | 2.8 | 1.7 | 1.4 | 0.9 | 0.7 | 4.6 |
| 2010 | 83.4 | 36.8 | 32.8 | 25.6 | 38.3 | 14.1 | 5.2 | 7.0 | 4.7 | 4.6 | 1.8 | 11.6 |
| 2011 | 133.2 | 33.1 | 24.5 | 16.2 | 4.7 | 1.2 | 0.4 | 0.6 | 0.4 | 0.7 | 0.8 | 1.6 |
| 2012 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2013 | 12.6 | 363.8 | 820.0 | 105.4 | 18.9 | 3.0 | 2.5 | 2.7 | 2.2 | 2.2 | 1.5 | 2.9 |
| 2014 | 53.9 | 40.8 | 25.4 | 77.7 | 33.6 | 7.8 | 2.1 | 1.7 | 1.2 | 1.4 | 2.4 | 10.5 |
| 2015 | 906.8 | 160.3 | 112.6 | 48.5 | 40.9 | 5.5 | 2.4 | 1.2 | 0.9 | 1.0 | 0.9 | 2.6 |
| 2016 | 13.6 | 19.9 | 43.1 | 80.0 | 57.6 | 18.6 | 8.8 | 8.1 | 3.0 | 1.6 | 1.7 | 8.6 |
| 2017 | 73.04 | 467.1 | 755.9 | 347.1 | 225.7 | 41.3 | 21.1 | 13.9 | 19.9 | 2.5 | 2.5 | 3.7 |
| 2018 | 124.5 | 192.6 | 177.3 | 96.7 | 12.5 | 14.2 | 19.9 | 9.4 | 10.0 | 3.5 | 0.3 | 0.1 |
| 2019 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

| | AGES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | **0*** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11+** |
| 2020 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2021 | 178.6 | 276.6 | 92.5 | 120.2 | 79.00 | 59.01 | 30.4 | 5.4 | 4.4 | 4.3 | 5.2 | 1.6 |
| 2022 | 127.9 | 102.1 | 70.6 | 42.5 | 56.4 | 34.8 | 12.9 | 2.3 | 0.4 | 1.1 | 0.7 | 2.3 |
| 2023 | 1530.2 | 364.8 | 224.7 | 68.24 | 27.5 | 8.1 | 14.7 | 6.5 | 2.1 | 1.1 | 0.4 | 0.3 |

***age 0 is not used in the stock assessment.**

## 5.3.2 DEPM egg survey

An historic overview of the Egg Production survey developments was analyzed at the ICES benchmark (ICES, 2024). The major change since the beginning of the series was undertaken in 2007, when the DEPM (Daily Egg Production Method) methodology started to be adopted, in place of the AEPM (Annual Egg Production Method). Since then improvements were reached in several aspects, including issues related to surveying (plankton surveying grid and gear), laboratorial analysis (egg identification, egg development rates and histological spawning markers) and data analyses (spawning time and synchronicity, fecundity pattern, and statistical analysis for parameter estimations).

A triennial DEPM egg survey for the southern horse mackerel is conducted on the spawning area of southern horse mackerel stock since 2010. This survey is organised by Portugal and coordinated by the ICES Working Group on Methods of Egg Surveys (ICES WGMEGS). The main purpose of the DEPM surveys is to support the management of their target stocks by providing fisheries independent information on biomass, which can be incorporated into the stock assessment process. There are three main ways DEPM are used in the assessment process:

(i) direct use as an index of biomass,

(ii) monitoring trends or status of stocks,

(iii) providing information on spatial or temporal variations in distribution patterns. (Bernal et al., 2012).

The horse mackerel SSB estimate is derived from the ratio between the daily egg production and the daily specific fecundity of the adult population:

$$SSB = \frac{P_0 \cdot A+}{R \cdot F \cdot S /\, W_f}$$

Where,

**SSB** = Spawning–stock biomass in metric tons

**$P_0$**= daily egg production per surface unit in the sampled area

**A+** = Spawning area, in sampling units

**$W_f$** = Average weight of mature females in the population (grams),

**R** = Sex ratio, fraction of population that are mature females, by weight.

**F** = Batch fecundity, numbers of eggs spawned per mature females per batch

**S**= Spawning fraction, proportion of mature females spawning each day

**k** = Conversion factor to convert grams to metric tons ($10^6$)

The methodology for processing horse mackerel egg and adult data is based on the general plan agreed upon in previous surveys (ICES, 2023) and presented in Figure 4.3.2.1. The WGMEGS SISP manuals (SISP 5 and 6) provides a comprehensive outline of the sampling methodology, laboratory processing, and parameter estimation.

The manual offers a standardised approach that ensures consistency and accuracy of the results obtained from these processes. Data analyses are performed using adapted versions of the R packages (geofun, eggsplore, and shachar) available at ichthyoanalysis 5 (*http://sourceforge.net/projects/ichthyoanalysis*) and routines developed in R (*www.r-project.org*).

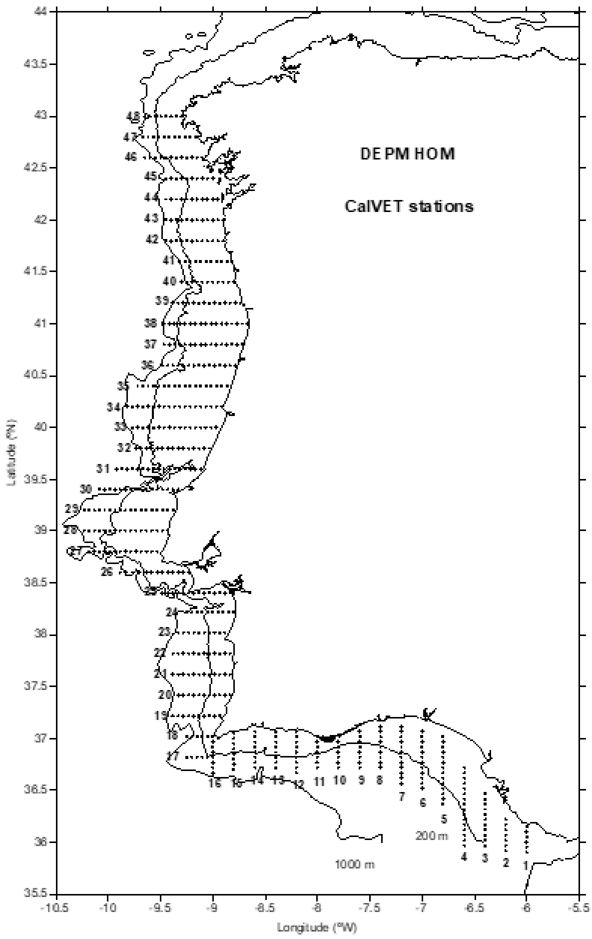


**Figure 5.3.2.1. Planned plankton stations (CalVET) in the Portuguese DEPM HOM survey. On the outer shelf and beyond surveying is adaptive depending on egg presence and therefore the final number of samples in each transect may vary.**

Table 4.3.2.1 summarizes the main adult parameters estimated during the 2010, 2013, 2016, 2019 and 2022. In 2010, it was not possible to estimate the spawning fraction, so SSB could not be estimated for that year. Figure 4.3.1 shows the estimated SSB from the DEPM method.

**Table 5.3.2.1 Summary of egg production and fecundity parameters in 2010, 2013, 2016, 2019 and 2022 egg surveys. Numbers in brackets are coefficient of variation**

| survey | spawning area A (Km$^2$) | tot egg production P (eggsx10$^{11}$) | female weight W (g) | batch fecundity F (eggs/g) | sex ratio R | spawning fraction S | Spawning Stock Biomass SSB (x10$^3$) |
|---|---|---|---|---|---|---|---|
| 2010 | 18286 | 11.62 (27.2) | 155.3 (6.7) | 36115 (8.5) | 0.48 | | |
| 2013 | 19009 | 7.67 (29.6) | 202.6 (7.6) | 41101 (10.7) | 0.53 | 0.134 (17.3) | 52.91 (37.1) |
| 2016 | 23560 | 5.27 (26.9) | 121.71 (10.7) | 15991 (17.9) | 0.55 | 0.049 (25.3) | 148.81 (42.6) |
| 2019 | 21360 | 8.25 (36.6) | 118.1 (7.8) | 17762 (10.2) | 0.52 | 0.057 (28.2) | 185.49 (48.2) |
| 2022 | 26885 | 5.18 (26.8) | 120.3 (8.9) | 18433 (14.5) | 0.52 | 0.086 (20.2) | 75.26 (38.0) |

## 5.3.3 Mean length and mean weight-at-age in the stock

Taking into consideration that the spawning season is very long, from September to June, and that the whole length range of the species has commercial interest in the Iberian Peninsula, with scarce discards, there is no special reason to consider that the mean weight-at-age in the catch is significantly different from the mean weight-at-age in the stock.

## 5.3.4 Maturity-at-age

The maturity ogive corresponds to females. Horse mackerel is a multiple spawner (ICES, 2008). The last benchmark ICES (2024) agreed to use macroscopic data from revised biological data collected in the stock area during the period 2004 to 2022. Maturity ogive estimation methodology is available in ICES (2024). The predicted proportion-at-age given in the text table below (11+: age 11 and older fish) is time invariant and was adopted for the assessment period (1992–2023).

| Age | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Prop. mature | 0.00 | 0.12 | 0.39 | 0.76 | 0.93 | 0.99 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

## 5.3.5 Natural mortality

The ontogenic changes in diet, observed mean life span and growth rate in southern horse mackerel supported the use of the method developed by Gislason et al. (2010) to reflect the age dependent natural mortality for this species (ICES, 2024). The updated natural mortality-at-age was estimated using growth parameters for horse mackerel from length-at-age sampling data in the stock area from 2004-2022. These parameters were estimated by nonlinear least-squares estimates of the von Bertallanfy curve, where $L_{inf}$ = 41.8 and k=0.11. The adopted mortality-at-age values is presented in the text table below (11+: age11 and older fish).

| Age | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M | 0.62 | 0.45 | 0.35 | 0.29 | 0.25 | 0.22 | 0.20 | 0.18 | 0.17 | 0.16 | 0.15 | 0.14 |

# 5.4 Stock assessment

## 5.4.1 Model assumptions and settings and parameter estimates

The assessment of the southern horse mackerel was performed in Stock Synthesis software, version 3.30.22 (Method et al., 2023) under the windows platform. SS is a generalized age and/or length-based model that is very flexible with regard to the types of data that may be included, the functional forms that are used for various biological processes, the level of complexity and number of parameters that may be estimated. The model is coded in C++ with parameter estimation enabled by automatic differentiation (www.admb-project.org) and available at the NOAA Fisheries integrated toolbox: https://noaa-fisheries-integrated-toolbox.github.io/SS3. A description and discussion of the model can be found in Methot and Wetzel (2013).

The stock assessment has been performed for the period 1992–2023 with the method and settings agreed during the benchmark (ICES, 2024). The southern horse mackerel assessment model is a one area, annual, age-based model where the population is comprised of 11+ age-classes (with age 11 representing a plus group) with sexes combined (male and females are modelled together).

Input data include total catch (in biomass), age composition of the catch (in numbers), abundance (in biomass) and age composition from an annual IBTS survey, a commercial CPUE standardized index (in biomass) and spawning–stock biomass (SSB) from a triennial DEPM survey. Considering the current assessment calendar (annual assessment WG in May in year y+1), all data included in the assessment are up to year y. According to the ICES terminology, year y is the final year.

Natural mortality are age-specific input values and Weights-at-age and maturity-at-age in the beginning of the year are input values estimated from external data (Sections 5.3.3 to 5.3.5). Growth is not modelled explicitly. Annual recruitments are parameters, defined as lognormal deviations from a Beverton–Holt stock–recruitment model with steepness fixed at 0.81 and standard deviation of log number of recruits was set to 0.74, the same as in the previous model and based on literature for similar species. Fishing mortality is applied as the hybrid method (option 3) that performs best when the catch is known with high precision. This method does a Pope's approximation to provide initial values for iterative adjustment of the continuous F values to closely approximate the observed catch. Total catch biomass by year is assumed to be accurate and precise. The F values are tuned to match this catch. The IBTS survey, commercial CPUE and the DEPM survey are assumed to be relative indices of abundance. The catchability of the IBTS survey, the CPUE and the DEPM surveys are modelled with a simple $q$ linear model.

The fishery selectivity was set as a double normal function but allowed to vary over time in the first two parameters (Figure 5.4.2.2). In the IBTS survey, a fixed empirical age-based selectivity is used, such that the parameter for each age is estimated as a random walk from the previous age (Figure 5.4.2.2). A standard error of 0.05 was assumed for all years of catches and 0.3 for the IBTS surveys, reflecting the accurate sampled catches and the CV level of the IBTS (same as in previous model). A standard error of 0.14 is assumed for all years for the CPUE index based on the estimates of the GLM model and a standard error of 0.4 is assumed for all years for the DEPM index based on the uncertainty of the SSB estimates.

The Dirichlet-multinomial error distribution was selected for age data weighting in catches and IBTS data. The initial population is calculated by estimating an initial equilibrium population modified by age composition data in the first year of the assessment (Methot and Wetzel, 2013). The model starts in 1992 and the equilibrium population age structure was assumed to be in an exploited state with an initial catch of 30 000 tonnes – corresponding to the average Portuguese catches previous 5 years (1987-91) + average Spain catches first 5 years of data (1992-96). Variance estimates for all estimated parameters are calculated from the Hessian matrix. Minimisation of the likelihood is implemented in phases using standard ADMB process. The phases in which estimation will begin for each parameter is shown in the control file available in the TAF repository for this stock (https://github.com/ices-taf/2024_hom.27.9a_assessment). The R packages r4ss version 1.49.2 (Taylor et al., 2021) and ss3diags version 1.10.2 (Carvalho et al., 2021) were used to process and view model outputs. All analyses were conduction in R version 4.2.2

Figure 5.4.1.1 summarises data presence by year, where circle area is relative within a data type. Circles are proportional to total catch for catches, to precision for indices and to total sample size for compositions.

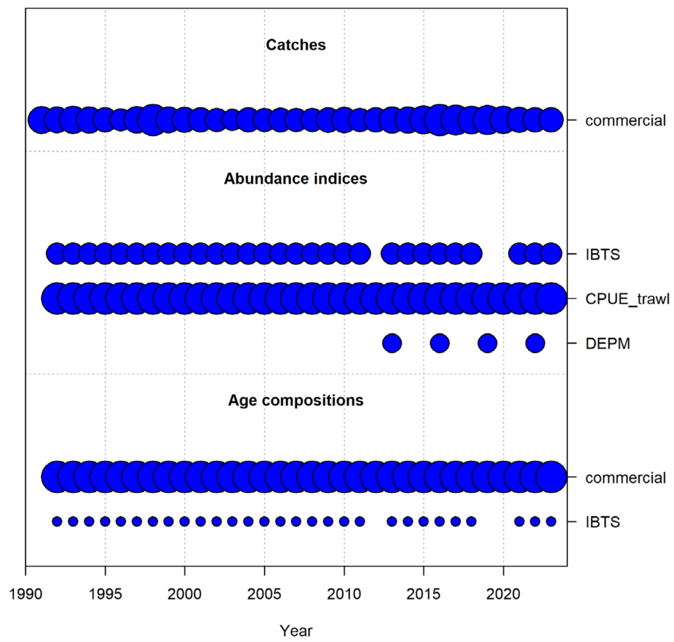


**Figure 5.4.1.1. Summary of inputs and data year ranges for assessment (1992-2023).**

A summary of the model key model assumptions and parameters for the Stock Synthesis is available in Table 5.4.1.1

**Table 5.4.1.1. Input data type, model assumptions and settings for the assessment of southern horse mackerel with data series 1992-2023.**

| Data | Years and age range |
|---|---|
| Catch | Catch biomass 1992 to 2023. Combined Spanish and Portuguese fleets |
| Catch-at-age | Numbers-at-age 1992 to 2023 [0 to 11+]. Combined Spanish and Portuguese fleets |
| IBTS survey | Biomass 1992 to 2023 |
| IBTS numbers-at-ge | Numbers-at-age 1992 to 2023 [1 to 11+]. Cochran stratified mean. Combined Spanish-Portuguese IBTS surveys |
| DEPM survey | Spawning stock biomass. Triennal survey since 2010 covering all stock area |
| Commercial CPUE | Standardized index (in biomass) from Portuguese trawl logbooks |
| Weight at age in the catch in kg | 1992 to 2023 [0 to 11+]. mean weighted by the catch over the mean weights obtained by Subdivision |
| Weight at age in the stock in kg | 1992 to 2023 [0 to 11+]. Same as in Weight at age in the catch |
| Maturity at age | Proportion-at-age [0 to 11+]. Estimated at ICES WKBHMB from macroscopic data 2011-2022 |
| Natural mortality | Age specific [0 to 11+]. Estimated at ICES WKBHMB from VBGF and Gislasson method |
| **Structure and assumptions** | |
| Recruitment | Beverton-Holt stock recruitment model, sigmaR = 0.74, input steepness = 0.8 |
| Initial population | Starting equilibrium population age structure |
| Fishery selectivity-at-age | Age based. Double normal. Time varying selectivity in 2 params |
| Survey selectivity-at-age | Age based. dome shaped. Fixed |
| IBTS catchability | Simple q linear model |
| DEPM catchability | Simple q linear model |
| CPUE catchability | Simple q linear model |
| **Log-likelihood function** | |
| Minimisation of the likelihood | Implemented in phases using standard ADMB process |
| Data weights | Catch CV = 0.05 , IBTS = 0.30; DEPM = 0.40 CPUE = 0.14 |
| Age data weights | Dirichlet-multinomial error distribution was selected for age data weighting in catches and IBTS data. Age reading uncertainty included. |

The summarised results of the stock assessment are shown in Table 5.4.1.2.

**Table 5.4.1.2 Southern horse mackerel final assessment (1992-2023). Stock summary table. All weights are in tonnes, recruitment in thousands**

| Year | SSB | CV SSB | Recruits | CV recruits | F(1-10) | CV F | FApical | Input catch |
|---|---|---|---|---|---|---|---|---|
| 1992 | 343625 | 0.147 | 3213740 | 0.136 | 0.091 | 0.113 | 0.106 | 27858 |
| 1993 | 360959 | 0.148 | 2031720 | 0.148 | 0.097 | 0.110 | 0.114 | 31521 |
| 1994 | 384162 | 0.149 | 1864980 | 0.150 | 0.080 | 0.111 | 0.089 | 28451 |
| 1995 | 364253 | 0.146 | 2382470 | 0.139 | 0.075 | 0.114 | 0.081 | 25132 |
| 1996 | 383642 | 0.144 | 5486320 | 0.100 | 0.050 | 0.105 | 0.055 | 20360 |
| 1997 | 397991 | 0.145 | 2070690 | 0.136 | 0.075 | 0.097 | 0.087 | 29491 |
| 1998 | 376564 | 0.143 | 1374550 | 0.153 | 0.121 | 0.095 | 0.142 | 41661 |
| 1999 | 395372 | 0.142 | 1929310 | 0.131 | 0.075 | 0.094 | 0.090 | 27768 |
| 2000 | 368833 | 0.140 | 2036500 | 0.134 | 0.080 | 0.098 | 0.094 | 26161 |
| 2001 | 343997 | 0.142 | 1920500 | 0.129 | 0.076 | 0.097 | 0.091 | 24911 |
| 2002 | 320891 | 0.145 | 1230360 | 0.162 | 0.080 | 0.108 | 0.091 | 22506 |
| 2003 | 307629 | 0.147 | 2303590 | 0.131 | 0.069 | 0.115 | 0.075 | 18887 |
| 2004 | 339364 | 0.144 | 2983530 | 0.126 | 0.079 | 0.117 | 0.085 | 24485 |
| 2005 | 302506 | 0.144 | 1800730 | 0.144 | 0.076 | 0.120 | 0.079 | 22689 |
| 2006 | 288523 | 0.148 | 1068290 | 0.181 | 0.084 | 0.128 | 0.085 | 23895 |
| 2007 | 285287 | 0.146 | 1630170 | 0.158 | 0.079 | 0.134 | 0.081 | 22787 |
| 2008 | 283952 | 0.150 | 2069870 | 0.149 | 0.077 | 0.134 | 0.077 | 22993 |
| 2009 | 284293 | 0.155 | 1989380 | 0.157 | 0.089 | 0.141 | 0.089 | 25727 |
| 2010 | 282280 | 0.160 | 1864420 | 0.161 | 0.088 | 0.139 | 0.089 | 27217 |
| 2011 | 283821 | 0.162 | 4310670 | 0.135 | 0.062 | 0.137 | 0.063 | 22575 |
| 2012 | 302367 | 0.160 | 4040590 | 0.130 | 0.063 | 0.124 | 0.064 | 24868 |
| 2013 | 300724 | 0.156 | 2487540 | 0.157 | 0.078 | 0.123 | 0.079 | 28988 |
| 2014 | 338460 | 0.155 | 3300890 | 0.148 | 0.075 | 0.123 | 0.076 | 29017 |
| 2015 | 345285 | 0.156 | 3054370 | 0.148 | 0.084 | 0.121 | 0.087 | 33179 |
| 2016 | 347156 | 0.161 | 3582330 | 0.147 | 0.113 | 0.125 | 0.119 | 40741 |
| 2017 | 371396 | 0.164 | 4370690 | 0.144 | 0.092 | 0.114 | 0.101 | 37088 |
| 2018 | 423194 | 0.171 | 3304980 | 0.152 | 0.067 | 0.103 | 0.080 | 31662 |
| 2019 | 443154 | 0.171 | 3097780 | 0.160 | 0.076 | 0.103 | 0.092 | 35520 |

| Year | SSB | CV SSB | Recruits | CV recruits | F(1-10) | CV F | FApical | Input catch |
|---|---|---|---|---|---|---|---|---|
| 2020 | 404251 | 0.170 | 2322270 | 0.183 | 0.074 | 0.103 | 0.090 | 31333 |
| 2021 | 395532 | 0.170 | 2855130 | 0.189 | 0.069 | 0.106 | 0.084 | 26320 |
| 2022 | 467453 | 0.173 | 4321060 | 0.214 | 0.055 | 0.109 | 0.068 | 24997 |
| 2023 | 487255 | 0.171 | 3297230 | 0.082 | 0.050 | 0.111 | 0.062 | 24766 |

The estimated SSB shows an increase from 2013 to 2023 from 300 thousand tonnes to 487 thousand tonnes. Confidence intervals of SSB are in the range 14-17% with an average 15%.

The fishing mortality has been relatively stable over the whole time-series and after the slight increase in 2016, showed a decrease in 2017-2023. $F_{1-10}$ in 2023 was estimated at 0.050 lower than the observed value in 2022 (0.055). Confidence intervals of F with an average of 14%.

The uncertainty in SSB in the most recent years is around 17%. The lack of the combined survey IBTS index could add uncertainty in the present spawning biomass estimates. However, the new assessment shows lower uncertainty when compared to previous model. The slight decrease in catches observed in 2023 and the increase in estimated stock abundance resulted in a lower estimate of F in 2023 than in the previous year. The uncertainty in the estimated $F_{bar}$ is of similar magnitude around 11% for the entire period.

The stock shows a strong recruitment in 1996 and average recruitments in the most recent years, with some peaks in 2011, 2012, 2017 and 2022.

Recruitment estimates in the more recent years presents uncertainty as showed in the confidence bars. In 2023, recruitment showed a decrease and was estimated at 330 million individuals.

a)

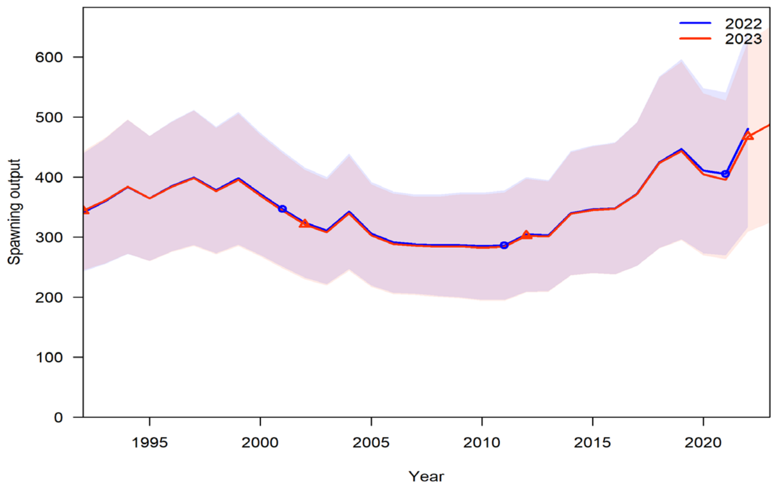


**Figure 5.4.1.2. Southern horse mackerel final assessment (1992-2023) and last year assessment performed in ICES, 2024 (1992-2022). Plots of SSB (a), Fishing mortality (b), Recruitment (c). Grey shaded area and bars in recruitment shows 95% confidence bounds. SSB and are in thousand tonnes and recruitment in thousands.**

b)


c)

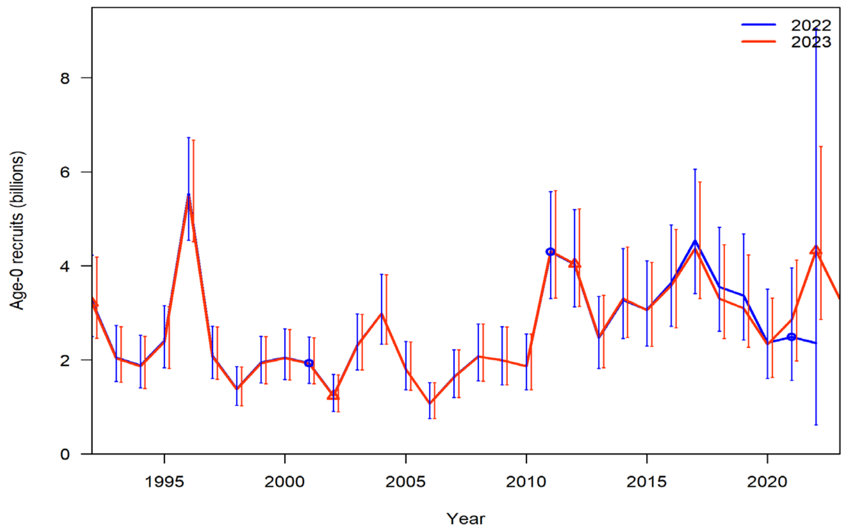


**Figure 5.4.1.2. continued. Southern horse mackerel final assessment (1992-2023) and last year assessment performed in ICES, 2024 (1992-2022). Plots of SSB (a), Fishing mortality (b), Recruitment (c). Grey shaded area and bars in recruitment shows 95% confidence bounds. SSB and are in thousand tonnes and recruitment in thousands.**

## 5.4.2 Reliability of the assessment

The landings of this stock are believed to be fairly accurate, given the good sampling coverage, few discards (according to on-board observers) and the existence of well-defined ageing criteria. Therefore, a higher weight is given to the data series of landings in weight, which was very well fitted by the model.

The assessment is also tuned with the stratified mean abundance-at-age estimated for the combined Portuguese and Spanish IBTS surveys, the SSB estimated from the DEPM egg survey and a commercial CPUE. The 2013 and 2017 IBTS index were the highest in the time series which might have contributed for a small increase of the biomass index from 2013 to 2018, reaching values 2 times above the average (Figure 5.4.2.1). In 2012, 2019 and 2020 the survey was not carried out in the Portuguese area of Division 9.a. As this part of the survey covers 87% of the total stock area, the combined survey index could not be estimated for these years contributing to an increased uncertainty of these year-classes in the present spawning biomass estimates. However, the new assessment shows lower uncertainty when compared to previous model. The fit for the IBTS and DEPM follows the general trend of the indices. The fit for the CPUE index appears to be variable, aligning with the overall trend only within certain assessment years (Figure 5.4.2.1)

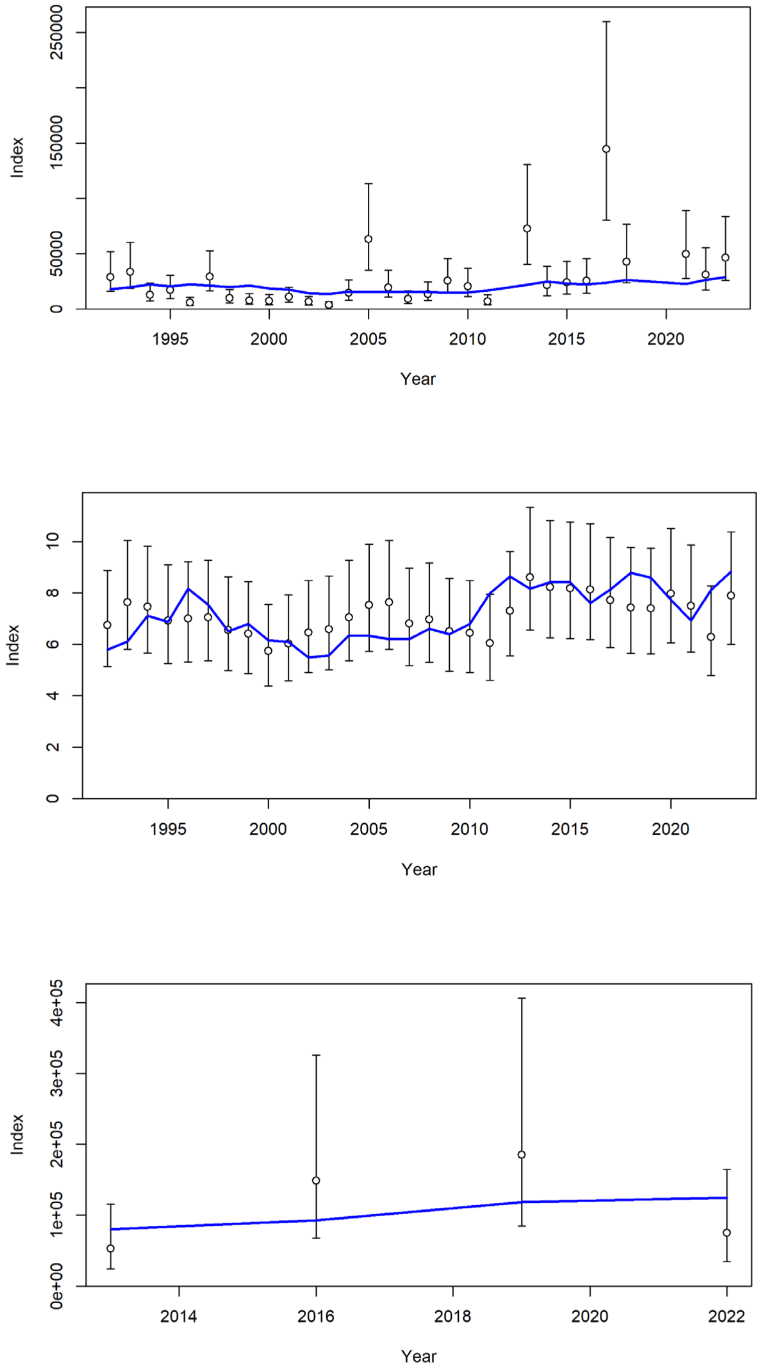


**Figure 5.4.2.1. Fit to biomass abundance indices (blue line). IBTS (top), commercial CPUE (middle) and DEPM (bottom). Lines indicate 95% uncertainty interval around index values based on lognormal error.**

Figure 5.4.2.2. shows the estimated selectivity for the catch-at-age (dome shaped time varying selectivity) and for the IBTS stratified mean abundance-at-age (fixed).

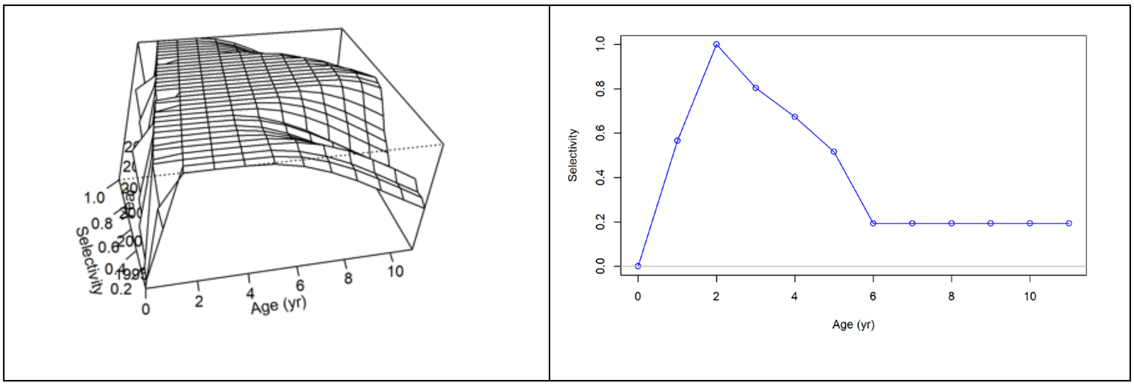


**Figure 5.4.2.2. Southern horse mackerel. Estimated selectivity for the catch-at-age (dome shaped time varying selectivity) and for the IBTS combined stratified mean abundance-at-age (fixed).**

Figure 5.4.2.3. shows the observed mean age in the catch and survey age data with 95% confidence intervals and the mean age fitted by the assessment model (SS3, blue line) from 1992-2023. The mean age composition in the survey shows lower variability than the catch as catchability from the survey is more consistent. The mean age fluctuates around ages 2-4 and age 2-3 in the catch and IBTS time series, respectively.

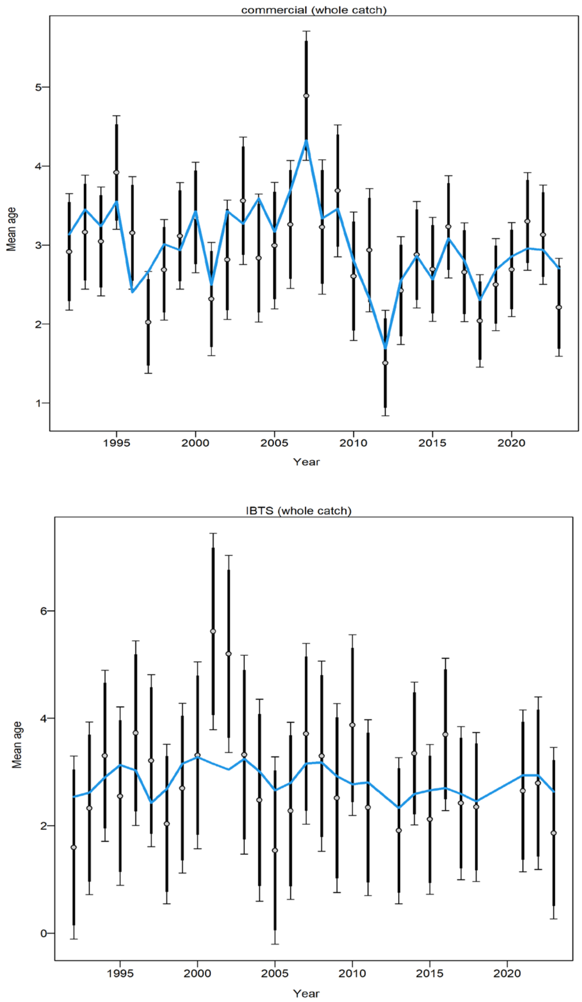


**Figure 5.4.2.3. continued. Southern horse mackerel mean age in the catch (top) and IBTS survey (bottom) in the period 1992–2022 and estimated values (blue line).**

A good fit was obtained for the overall proportions-at-age from catch and IBTS survey age data (Figure 4.4.2.4). While yearly fits generally show good alignment, some years exhibit large variability in catch numbers, resulting in poorer fits. This effects is clear in the fit to yearly IBTS data (Figure 4.4.2.5 and Figure 4.4.2.6). The bubble plots of the residuals corresponding to the fitting of those data are shown in Figure 4.4.2.7.

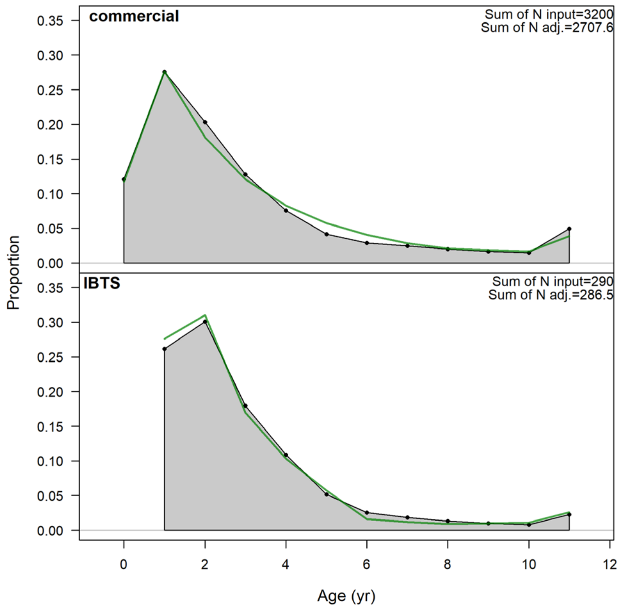


**Figure 5.4.2.4. Aggregated (1992-2023) proportions-at-age for the observed and fitted (green line) catch and IBTS survey.**

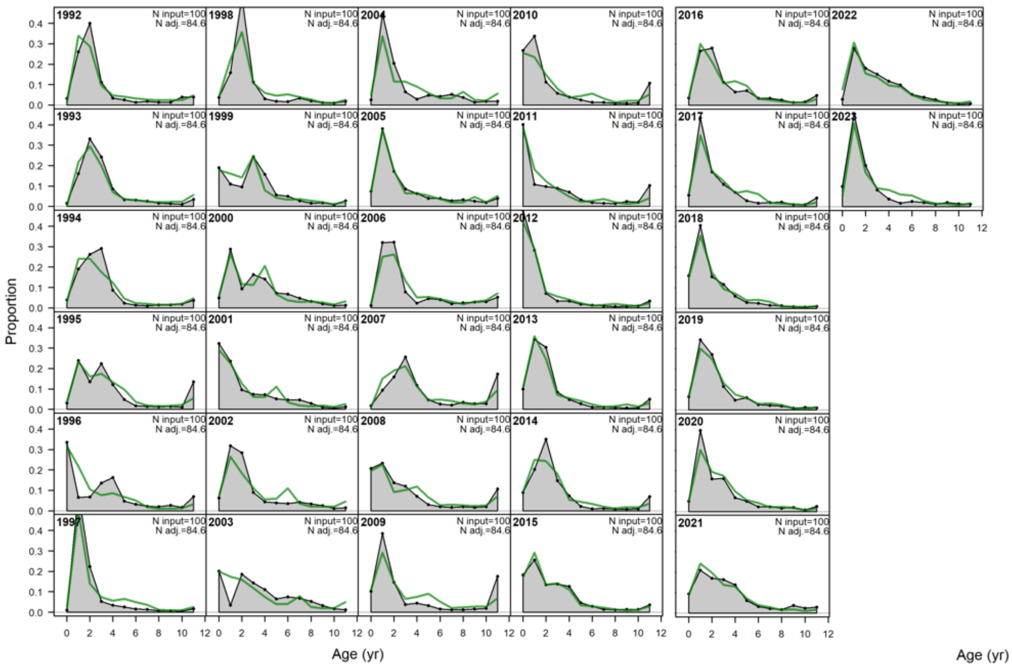


**Figure 5.4.2.5. Southern horse mackerel (1992-2023). Comparison of proportions-at-age of the observed and fitted catch data (fitted values=green line).**

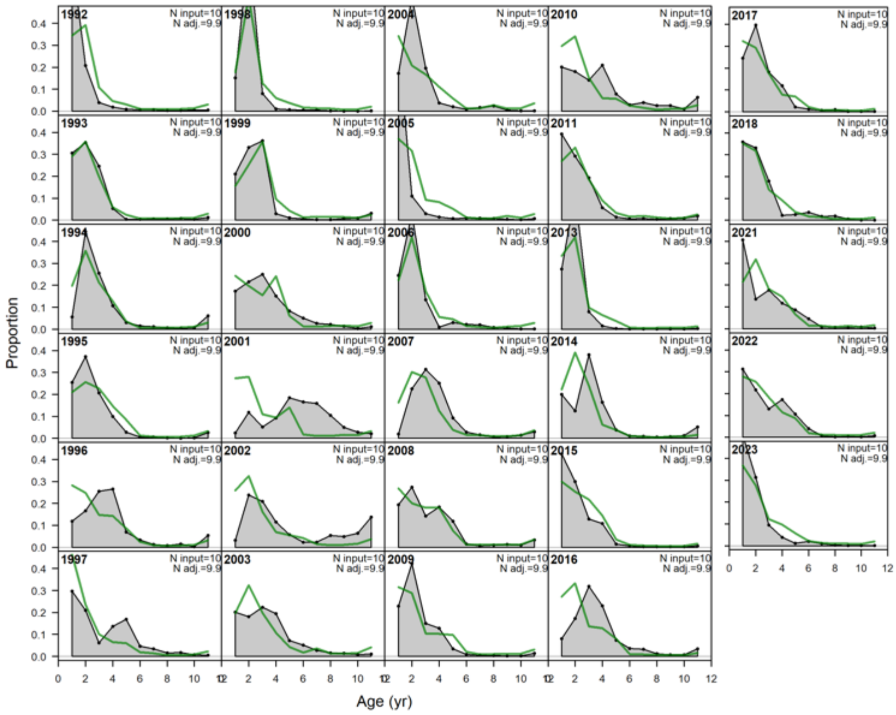


**Figure 5.4.2.6. Southern horse mackerel (1992-2023). Comparison of proportions-at-age of the observed and fitted IBTS data (fitted values=green line). In 2012, 2019 and 2020 there was no survey.**

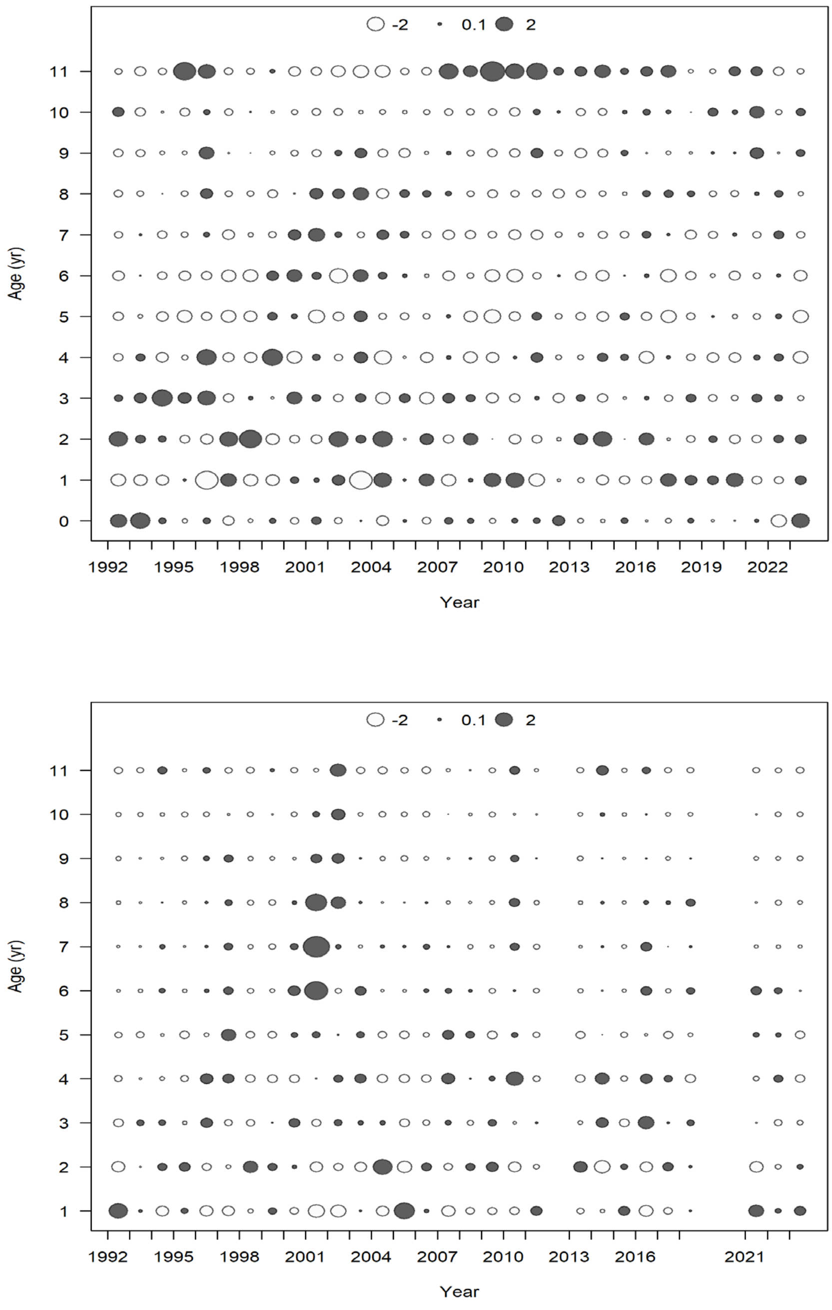


**Figure 5.4.2.7. Southern horse mackerel (1992-2023). Bubble plot of catch (top, age range 0–11+) and survey (bottom, age range: 1–11+) proportion-at-age residuals (positive residual=black; negative residuals=white).**

The retrospective analysis on SSB, recruitment and F was performed for a five-year period, from 1992–2018 to 1992–2023 time-series. The Mohr´s rho estimated for the 5-year average Mohr´s rho are shown in Table 4.4.2.1 and indicate a minor overestimation of the SSB(0.05) and overestimation of F(-0.11) and Recruitment(-0.12). The Mohn´s rho results are below the suggested critical value (± 0.30).

**Table 5.4.2.1 The Monh´s rho is the average of the five last year relative bias.**

| Variable | Mohn´s rho |
|---|---|

| | |
|---|---|
| **SSB** | 0.05 |
| **F** | -0.11 |
| **Recruitment** | -0.12 |

Figure 5.4.2.8 shows the observed retrospectives for SSB and F across the available time series (1992-2023) and in more recent years (2014-2023). The retrospective peels fall within the confidence bounds of the latest assessment estimates.

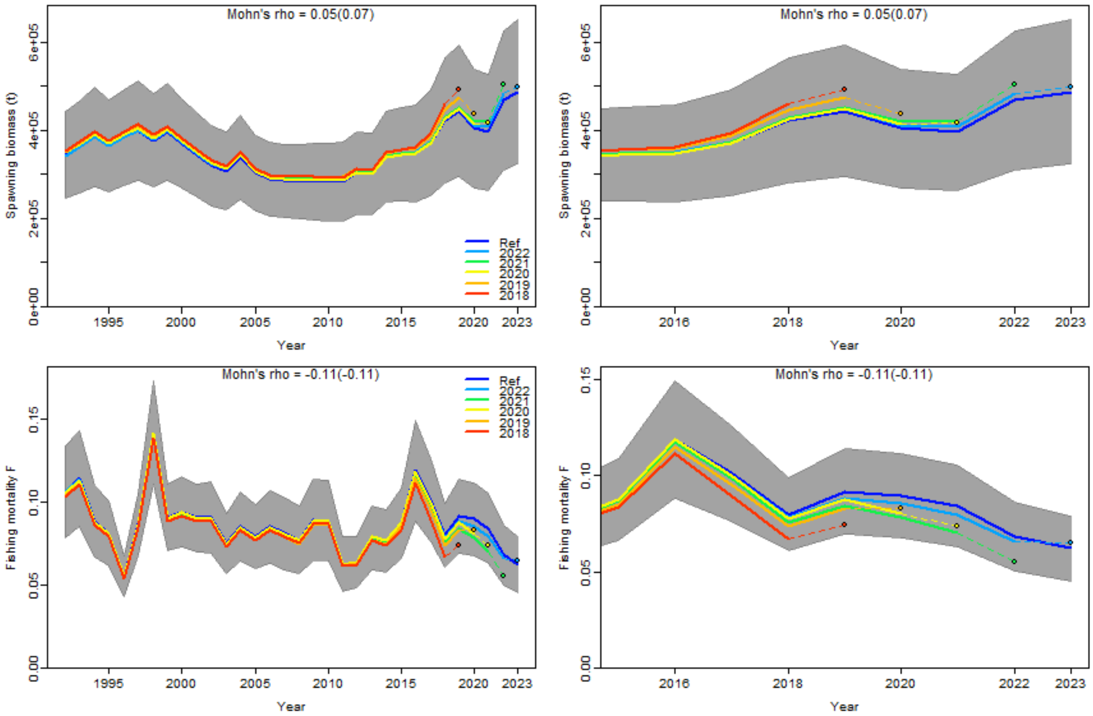


**Figure 5.4.2.8. Retrospective analysis results. Trajectories of SSB, and F (grey=95% confidence intervals) for the current assessment and the retrospective assessments. The observed retrospectives for SSB and F in the available time series (1992-2023, right panels) and in more recent years (2014-2023, left panels).**

## 5.5 Short-term predictions

SS includes a forecast module that enables projections for a specified number of years, linked to the model ending conditions, associated uncertainties, and a specified level of fishing intensity. This tool was used to perform the short-term projections, following assumptions and settings agreed during the benchmark (ICES, 2024) and described in the Stock Annex. Recruitment is predicted from Stock Synthesis stock–recruit relationship for 2024 and 2025, corresponding to Recruitment in the intermediate and forecast years. Average last 3 years of selectivity and weight-at-age are used and fishing mortality level ($F_{1\text{-}10}$) of the terminal year is assumed for the interim year (Table 5.5.1). Natural mortality and maturity-at-age are time invariant and the same as in the assessment model.

For the current projection, corresponding to $F_{1\text{-}10}$ = 0.050. Recruitment estimates values are 3309 millions in 2024 and 3325 millions in 2025 (Table 5.5.1). Table 5.5.1 also describe the differences in the recruitment, catch and F levels assumed for the short term forecast years between the previous assessment and current assessment. Due to changes in the stock perspective between models and short-term forecast method, the results are not comparable and serve only to illustrate the differences in estimates between assessment models.

**Table 5.5.1. Forecast assumptions in recruitment and F for last year assessment forecast (2023) and current stock assessment forecast (2024).**

| | year | Previous assessment (2023) | Current assessment (2024) |
|---|---|---|---|
| Assumed recruitment (millions) | interim year | 5310 | 3309 |
| | forecast year | 5310 | 3325 |
| Catch (tonnes) | interim year | 24997 | 25 886 |
| F | interim year | 0.020 | 0.050 |
| Target F for TAC | advice year | 0.15 | 0.115 |

Short term forecast results including catch in 2025 and SSB in 2026 are predicted for the various levels of fishing mortality in 2025. Table 5.5.2 shows the management options table from the stochastic short-term forecasts at fishing mortalities levels used for the different catch scenario options in the advice. The management options table include forecasts of SSB and catch at current fishing mortality ($F_{bar}$ of 0.050), $F_{MSY}$, $F_{lim}$ and $F_{pa}$ as the maximum value of F applied when SSB > MSY Btrigger that will result in SSB ≥ Blim with a 95% probability in a stochastic long term simulation. Forecast of catches at the F level that produces SSB=$B_{lim}$ and SSB=MSY $B_{trigger}$ are also showed.

The forecasts are stochastic, allowing for estimates of uncertainty in SSB. Consequently, the probability of SSB falling below $B_{lim}$ in 2026 is also estimated. This probability relates to the short-term probability of SSB < $B_{lim}$ and is not comparable to the long-term probability of SSB < $B_{lim}$ tested in simulations when estimating biological reference points.

**Table 5.5.2. Short-term forecast for southern horse mackerel management options. Catch and SSB in tonnes.**

| | F 1-10 (2025) | Catches (2025) | SSB (2025) | SSB (2026) | *Probability SSB < Blim (%) |
|---|---|---|---|---|---|
| $F_{MSY}$ | 0.115 | 59266 | 533 917 | 522221 | 0.0043 |
| F = 0 | 0 | 0 | 533 917 | 577806 | 0.0009 |
| $F_{sq}$= $F_{2023}$ | 0.050 | 26618 | 533 917 | 552803 | 0.0018 |
| F = $F_{sq}$ × 1.2 | 0.060 | 31787 | 533 917 | 547955 | 0.0021 |
| F = $F_{sq}$ × 1.6 | 0.080 | 41974 | 533 917 | 538407 | 0.0027 |
| F = $F_{sq}$ × 2.0 | 0.100 | 51963 | 533 917 | 529053 | 0.0036 |
| $F_{pa}$ | 0.146 | 74168 | 533 917 | 508295 | 0.0065 |
| $F_{lim}$ | 0.158 | 79802 | 533 917 | 503037 | 0.0076 |
| SSB (2026) = $B_{lim}$ | 1.322 | 412704 | 533 917 | 201000 | 50 |
| SSB (2026) = $B_{pa}$ = MSY $B_{trigger}$ | 0.879 | 324189 | 533 917 | 279000 | 8 |

*The probability of SSB being below $B_{lim}$ in 2026. This probability relates to the short-term probability of SSB < $B_{lim}$ and is not comparable to the long-term probability of SSB < $B_{lim}$ tested in simulations when estimating fishing mortality reference points.

## 5.6 Biological reference points

Biological Reference Points for southern horse mackerel ($B_{lim}$, $B_{pa}$, MSY $B_{trigger}$, $F_{lim}$, $F_{pa}$ and $F_{MSY}$) were estimated in ICES (2024) and adopted in 2024 for advice.

Estimation of reference points was done following the ICES guidelines for Category 1 and 2 reference points (ICES, 2021). The standard EQSIM software (ICES, 2014) was used to fit stock-recruit relationships and conduct the required simulations with stochasticity using the observed historical stock variation in population, productivity parameters and assessment error as proposed in recent state-of-the-art workshops. Details on the methodology are available in ICES (2024) and the Stock Annex.

**Table 5.6.1 Biological Reference points for southern horse mackerel. Values and the technical basis (weights in thousand tonnes).**

| BRP | Value | Technical basis |
|---|---|---|
| $B_{lim}$ | 201000 | $B_{lim} = B_{pa} * \exp(-1.645\ \sigma)$<br>$\sigma = 0.20$ |
| $B_{pa}$ | 279000 | $B_{pa} = B_{loss}$ |
| MSY $B_{trigger}$ | 279000 | MSY $B_{trigger} = B_{pa}$ |
| $F_{lim}$ | 0.158 | Equilibrium scenarios with stochastic recruitment: F corresponding to 50% probability of (SSB < Blim) |
| $F_{pa}$ | 0.146 | F that leads to SSB ≥ Blim with 95% probability |
| $F_{MSY}$ | 0.115 | Stochastic long-term simulations using a segmented regression with breakpoint at $B_{lim}$ |

## 5.7 Management considerations

The traditional fishery across several fleets has for a long time targeted all age components of the stock. This exploitation pattern combined with a fishing mortality below $F_{MSY}$ does not seem to have been detrimental to the dynamics of the stock. Spawning–stock biomass has been above MSY $B_{trigger}$ over the assessment period.

The basis for the advice is the same as last year: the MSY approach (F=0.115) and gives estimated catches in 2024 of 59266 tonnes. The catch advice for 2025 under the MSY approach, represents a significant decrease (-66%) in comparison with the catch advice for 2024 because of the different stock perspective given by a new assessment model.

The difference between the advised TAC (under the previous model) and the observed catches was notably dissimilar in recent years (Figure 5.7.1). The new proposed advice is significantly lower than previous recommendations, but it is nearly double the catches observed in 2023.

The advice pertains to *T. trachurus*, while the total allowable catch (TAC) is set for all *Trachurus* species, including *T. picturatus* (blue jack mackerel) and *T. mediterraneus* (Mediterranean horse mackerel). Part of the catches consist of other *Trachurus* spp. than *T. trachurus*, and this percentage can vary from year to year. Estimates indicate that in 2023, 10% of the catch consisted of *Trachurus* spp. (2639 tonnes, mostly *T. picturatus*) other than *T. trachurus*. ICES considers that management of several species under a combined TAC prevents effective control of the single-species exploitation rates, and could lead to overexploitation of any of the species.

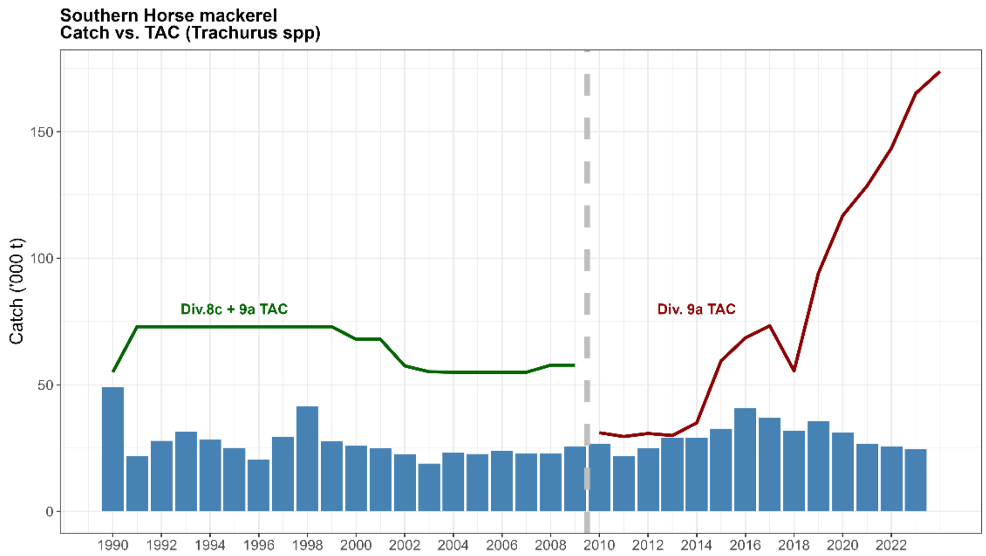


**Figure 5.7.1. Catch (1990-2023) and TAC (1990-2024) for southern horse mackerel. Blue bars show catches for southern horse mackerel, green line shows combined TAC for horse mackerel in division 8c and 9a and red line shows TAC for horse mackerel in division 9a.**

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# 6 Sardine (*Sardina pilchardus*) in divisions 8.a-b and 8.d (Bay of Biscay)

## 6.1 Population structure and stock identity

Sardine in Celtic Seas (7a, b, c, f, g, j, k), English Channel (7d, e, h) and in Bay of Biscay (8a, b, d) are considered to belong to the same stock from a genetic point of view.

Therefore, it has been previously considered that the sardine stock in divisions 8a, b, d and in Subarea 7 as a single-stock unit. The assessment of this stock as a single unit assumed that the trends derived from the observations made in the Bay of Biscay through the scientific surveys (PELGAS, BIOMAN) could be extended to the Subarea 7.

Information from the ICES WKSAR workshop (ICES, 2016) suggests higher growth rates for the populations of the English Channel and Celtic Seas than for the Bay of Biscay but it is unknown if this results from different oceanographic conditions or from population characteristics. Furthermore, there is no information on connectivity between the Bay of Biscay and English Channel/Celtic Sea. Bordering catches in Subarea 7 (statistical rectangles 25E4, 25E5) to the Bay of Biscay are generally considered to be taken from sardine populations in the Bay of Biscay. The recent PELTIC surveys (abundance of eggs, larvae, recruits and adults in the Channel) and results from the calorimetry/growth analysis suggest that Channel/Celtic Sea can be a self-sustained population. In fact, there are historical (Wallace and Pleasants, 1972) and recent evidence (Coombs *et al.*, 2009) that a significant spawning takes place regularly in Subarea 7. In a recent acoustic survey series in this area (PELTIC surveys) relevant concentrations of all life stages (eggs, juveniles and adults) have been found as well (van der Kooij *et al*. Presentation to WKSAR report ICES CM 2016/ACOM:41). Furthermore, the Cornish fisheries has been operating there for more than a century.

In terms of stock assessment, the availability of data strongly differs between the northern (Celtic Seas, English Channel) and the southern areas (Bay of Biscay). Additionally, each area presents different historical exploitation patterns. Therefore, analysis and management advice between the areas may differ.

The workshop concluded that in the absence of evidence of connectivity between the Bay of Biscay and Subarea 7 sardine populations, and taking into account the indications of shelf-sustained populations in each area (whereby all stages are found in substantial amounts in both regions) it would be preferable to deal with the Bay of Biscay and Subarea 7 separately.

## 6.2 Input data in 8.a, b, d

### 6.2.1 Catch data in divisions 8.a, b, d

Official landings per country are given in Table 6.2.1.1. Working group estimates are provided in Table 6.2.1.2. Differences are generally related to unallocated catches. Most of the landings correspond to France and Spain. As part of the interbenchmark process in 2019, French landings have been revised from 2013 to 2017 (ICES, 2019).

As in previous years, French sardine landings have been corrected for notorious misallocations between 7e,h and 8a. A substantial part of the French catches originates from divisions 7h and 7e, but these catches have been assigned to division 8a due to their very concentrated location at the boundary between 8a, 7h and 7e. French sardine landings declared in 25E5 and 25E4 have hence been reallocated to 8a. Those two rectangles use to typically account for 25% of the French sardine catches reported in the Bay of Biscay. In 2023, they accounted for 25%.

The Spanish fishery takes place mainly during March and April and in the fourth quarter of the year. Spanish vessels are purse-seines from the Basque Country and other regions of the north of Spain, which operate mostly in division 8b. Spanish landings averaged around 4000 tonnes in the late 1990s early 2000s with peaks in 1998 and 1999 at almost 8 thousand tonnes. Catches have then decreased until 2010 to below 1 thousand tonnes. Since 2011, catches have raised again, reaching 16 237 tonnes in 2014. Landings in 2023 were 2 108 tonnes.

French catches consistently increased from 1983 to 2008, with values ranging from 4367 tonnes in 1983 to 21 104 tonnes in 2008. Since 2009, French landings displayed an increasing trend which stopped in 2013 with 20 066 tonnes landed, which is close to the time-series maximum. In 2018, landings reached a new maximum with 25 195 tonnes. In 2023, 21 012 tonnes were landed. About 71% of French catches are taken by purse-seiners while the remaining 29% is reported by pelagic trawlers (mainly pair-trawlers). Both purse-seiners and pelagic trawlers target sardine in French waters. Average vessel length is about 18 m. Purse-seiners and trawlers operate mainly in coastal areas (<10 nautical miles. Both pair-trawlers and purse-seiners operate close to their base harbour when targeting sardine. The highest catches are usually taken in summer, even if sometimes catches can be important during winter. Almost all the catches are taken in southwest Brittany.

**Table 6.2.1.1. Sardine in 8abd. Official landings (in tons) reported to ICES (1989–2022).**

| | 8 a.,b,d | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| year | France | Spain | Netherlands | Ireland | UK | Denmark | Germany | Lithuania | Belgium | Total |
| 1989 | 8811 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8811 |
| 1990 | 8543 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8543 |
| 1991 | 12482 | 35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12517 |
| 1992 | 8847 | 43 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8890 |
| 1993 | 8805 | 45 | 0 | 0 | 0 | 308 | 0 | 0 | 0 | 9158 |
| 1994 | 8604 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8604 |
| 1995 | 9877 | 0 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 9901 |
| 1996 | 8604 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8604 |
| 1997 | 10706 | 0 | 26 | 0 | 0 | 0 | 0 | 0 | 0 | 10732 |
| 1998 | 9778 | 873 | 0 | 0 | 0 | 0 | 68 | 0 | 0 | 10719 |
| 1999 | 0 | 2384 | 0 | 0 | 0 | 124 | 11 | 0 | 0 | 2519 |
| 2000 | 10615 | 3158 | 34 | 0 | 0 | 0 | 38 | 0 | 0 | 12505 |
| 2001 | 10004 | 3720 | 333 | 0 | 0 | 0 | 135 | 0 | 0 | 10589 |
| 2002 | 11977 | 4428 | 23 | 19 | 276 | 0 | 4 | 0 | 0 | 15519 |
| 2003 | 9809 | 1113 | 68 | 1750 | 68 | 0 | 0 | 0 | 0 | 14925 |
| 2004 | 11155 | 342 | 6 | 1401 | 0 | 0 | 0 | 0 | 0 | 13231 |
| 2005 | 10975 | 898 | 1 | 974 | 0 | 0 | 54 | 0 | 0 | 17694 |
| 2006 | 10884 | 825 | 2 | 49 | 0 | 12 | 78 | 5 | 0 | 16986 |

| year | 8 a.,b,d<br>France | Spain | Netherlands | Ireland | UK | Denmark | Germany | Lithuania | Belgium | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 2007 | 13231 | 1263 | 0 | 0 | 0 | 48 | 0 | 0 | 0 | 16814 |
| 2008 | 18071 | 717 | 0 | 0 | 1 | 39 | 0 | 0 | 0 | 23133 |
| 2009 | 15847 | 228 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21229 |
| 2010 | 12877 | 642 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22432 |
| 2011 | 12469 | 5283 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 25155 |
| 2012 | 10854 | 14948 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33100 |
| 2013 | 13614 | 12423 | 445 | 0 | 252 | 0 | 0 | 0 | 0 | 37291 |
| 2014 | 14730 | 16237 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 39829 |
| 2015 | 13132 | 13055 | 0 | 25 | 7 | 0 | 1 | 0 | 0 | 31574 |
| 2016 | 14320 | 6824 | 65 | 0 | 0 | 0 | 0 | 0 | 0 | 30122 |
| 2017 | 17265 | 6380 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30249 |
| 2018 | 18161 | 7094 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 32289 |
| 2019 | 21099 | 3250 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24349 |
| 2020 | 24596 | 6746 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 31342 |
| 2021 | 20239 | 5922 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 26161 |
| 2022 | 12907 | 3117 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16024 |
| 2023 | 13571 | 2108 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15679 |

**Table 6.2.1.2. Sardine in 8abd. Sardine landings (in tons) by France (1983–2020) and Spain (1996–2020) in ICES divisions 8a,b,d as estimated by the WG.**

| Year | France | Spain | Total |
|---|---|---|---|
| 1983 | 4367 | n/a | |
| 1984 | 4844 | n/a | |
| 1985 | 6059 | n/a | |
| 1986 | 7411 | n/a | |
| 1987 | 5972 | n/a | |
| 1988 | 6994 | n/a | |
| 1989 | 6219 | n/a | |
| 1990 | 9764 | n/a | |
| 1991 | 13965 | n/a | |
| 1992 | 10231 | n/a | |
| 1993 | 9837 | n/a | |
| 1994 | 9724 | n/a | |
| 1995 | 11258 | n/a | |
| 1996 | 9554 | 2053 | 11607 |

| Year | France | Spain | Total |
|---|---|---|---|
| 1997 | 12088 | 1608 | 13696 |
| 1998 | 10772 | 7749 | 18521 |
| 1999 | 14361 | 7864 | 22225 |
| 2000 | 11939 | 3158 | 15097 |
| 2001 | 11285 | 372 | 11657 |
| 2002 | 13849 | 4428 | 18277 |
| 2003 | 15494 | 1113 | 16607 |
| 2004 | 13855 | 342 | 14197 |
| 2005 | 15462 | 898 | 16360 |
| 2006 | 15916 | 825 | 16741 |
| 2007 | 16060 | 1263 | 17323 |
| 2008 | 21104 | 717 | 21821 |
| 2009 | 20627 | 228 | 20855 |
| 2010 | 19485 | 642 | 20127 |
| 2011 | 17925 | 5283 | 23208 |
| 2012 | 15952 | 14948 | 30900 |
| 2013 | 20515 | 12423 | 32938 |
| 2014 | 19467 | 16237 | 35704 |
| 2015 | 15701 | 13055 | 28756 |
| 2016 | 22930 | 6824 | 29754 |
| 2017 | 24055 | 6380 | 30435 |
| 2018 | 25195 | 7104 | 32299 |
| 2019 | 21300 | 3279 | 24579 |
| 2020 | 24593 | 6747 | 31340 |
| 2021 | 20370 | 5828 | 26198 |
| 2022 | 23299 | 3061 | 26360 |
| 2023 | 21012 | 2241 | 23253 |

## 6.2.2 Surveys in divisions 8abd

### 6.2.2.1 DEPM surveys in Divisions 8abd

The DEPM survey BIOMAN takes place annually in spring in the Bay of Biscay with the main objective of estimate the total biomass and distribution of anchovy as well as the numbers at age, percentage at age, length at age, weight at age and anchovy biomass at age in the Bay of Biscay (8abcd) and the egg abundance of sardine in 8abd. Triennially, the SSB of sardine is also included as an assessment index since 2011. Since 2020 the SSB for sardine is estimated annually as well as the numbers at age, percentage at age, weight at age and length at age to be available as inputs for future assessments. The daily egg production ($P_0$) (eggs /m²), daily mortality rates ($z$) and total daily egg production ($P_{tot}$)(eggs) parameters were as well estimated for this year and for the historical series in all the area surveyed, in 8abd and in 8abd without part of the Northwest. Currently, the input used for the assessment is the total egg abundance in the 8abd without the

Northwest part to be consistent with the historical series and the triennial biomass estimates by the DEPM since 2011.

The survey took place from the 30th to the 24th of May. All the methodology concerning the survey and the estimates performance are described in detail in the stock annex (Annex 3). A detailed report of the survey 2024 and results are attached as a working document at ICES WGACEGG 2024 in annex 3 (Santos Mocoroa. M *et al*. BIOMAN 2024) and a summary is presented in Annex 6 of this report.

This year the sardine eggs were scarce in the Cantabrian Sea without reaching the 200m depth isoline. In the French platform, there were sardine eggs from South to North all along the East of the 100m depth isoline area. This distribution was similar to the last two years. (**Figure 6.2.2.1.1**)

In the sampling with the PairoVET net (vertical sampling) from 880 stations a total of 208 (24%) had sardine eggs with an average of 80 eggs $m^{-2}$ per station in the positive stations, a maximum of 780 egg $m^{-2}$ in a station and a total number of 17 420 eggs $m^{-2}$. In the sampling with CUFES (horizontal sampling at 3m depth) a total of 555 stations (28%) had sardine from 1969 stations with an average of 2.3 eggs $m^{-3}$ per station in the positive stations and a maximum of 61 egg $m^{-3}$ in a station.

Total egg abundance for sardine was estimated as the sum of the number of eggs in each station multiplied by the area each station represents. This year sardine egg abundance estimates for assessment was 1.62 E+12 eggs, considering the 8abd and removing part of the Northwest, to be consistent with the historical series. This estimate was below the time series average (5.32E+12) (**Figure 6.2.2.1.2, Table 6.2.2.1.2**).

To estimate the reproductive parameters for sardine in the Bay of Biscay from BIOMAN survey, 22 adult hauls were available. Mean weight and mean length are showed in **Figure 6.2.2.1.3**. Age composition is showed in **Figure 6.2.2.1.4**. BIOMAN survey produced DEPM spawning Biomass, it was reported in WGACEGG 2024 (Santos Mocoroa M. *et al*. BIOMAN survey 2024), and for the purpose of independent shelf documentation they are summarized in the **Table 6.2.2.1.3**. The age composition of the stock was estimated as well (**Table 6.2.2.1.4**). All the estimates were obtained from the mature population of the 22 samples that represent 75 % of the individuals in 8abd. The immature part of the population was added to estimate the total biomass as well. This year a percentage of 4 hauls were immature and were eliminated for the SSB estimated but added for the total biomass estimated. (**Table 6.2.2.1.5**).

**Table 6.2.2.1.1. Sardine in 8abd.** Daily egg production ($P_0$) (eggs $m^{-2}$), daily mortality rates (z) and total daily egg production ($P_{tot}$)(eggs) estimates and their corresponding standard error (S.e.) and coefficient of variation (CV) for all the area surveyed area, 8abd and 8abd without NW from BIOMAN 2024.

| | ALL AREA | | | 8abd | | | 8abdwithoutNW | | |
|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Value** | **S.e.** | **CV** | **Value** | **S.e.** | **CV** | **Value** | **S.e.** | **CV** |
| P0 | 44.37 | 6.92 | 0.1559 | 47.18 | 7.57 | 0.1604 | 37.42 | 6.34 | 0.1694 |
| z | 0.17 | 0.105 | 0.6248 | 0.21 | 0.108 | 0.5078 | 0.11 | 0.112 | 1.0113 |
| Ptot | 1.2.E+12 | 1.9.E+11 | 0.1559 | 1.1.E+12 | 1.7.E+11 | 0.1604 | 7.5.E+11 | 1.3.E+11 | 0.1694 |

**Table 6.2.2.1.2. Sardine in 8abd.** Time-series for sardine, total egg abundances (Σ(egg St*area st)) in numbers of eggs, without the Northwest, the one adopted as an input for the assessment of sardine in 8abd.

| year | totAb8abdwithoutNW |
|---|---|
| 1999 | 1.06E+12 |
| 2000 | 5.03E+12 |
| 2001 | 2.20E+12 |
| 2002 | 7.82E+12 |
| 2003 | 3.26E+12 |
| 2004 | 7.83E+12 |
| 2005 | 1.09E+13 |
| 2006 | 3.84E+12 |
| 2007 | 2.33E+12 |
| 2008 | 9.37E+12 |
| 2009 | 6.05E+12 |
| 2010 | 1.03E+13 |
| 2011 | 4.29E+12 |
| 2012 | 5.60E+12 |
| 2013 | 5.47E+12 |
| 2014 | 8.21E+12 |
| 2015 | 5.52E+12 |
| 2016 | 8.56E+12 |
| 2017 | 5.99E+12 |
| 2018 | 4.67E+12 |
| 2019 | 4.49E+12 |
| 2020 | 3.75E+12 |
| 2021 | 4.02E+12 |
| 2022 | 3.29E+12 |
| 2023 | 2.88E+12 |
| 2024 | 1.62E+12 |
| **Mean** | 5.32E+12 |
| **Std Dev** | 2.67E+12 |
| **CV** | 0.5018 |

**Table 6.2.2.1.3: Sardine in 8abd. Sardine spawning stock biomass (SSB) in Division 8abd, with the estimates of adult parameters for applying the DEPM: sex ratio (R) (% of females), spawning fraction (S) (% of females spawning per day), batch fecundity (F) (eggs/batch/mature female), female mean weight (Wf)(g) and daily fecundity (DF) (eggs/g/day) for the application of the DEPM with their standard error (S.e) and coefficient of variation (CV). Total egg production ($P_{tot}$)(eggs) estimate is showed as well.**

| Parameter | estimate | S.e. | CV |
|---|---|---|---|
| Ptot | 1.08E+12 | 1.73E+11 | 0.1604 |
| R' | 0.52 | 0.004 | 0.0084 |
| S | 0.11 | 0.011 | 0.0934 |
| F | 15,778 | 1,774 | 0.1125 |
| Wf | 38.56 | 3.28 | 0.0850 |
| DF | 24.15 | 2.53 | 0.1048 |
| **SSB** | **45,272** | 8,674 | 0.1916 |

**Table 6.2.2.1.4: Sardine in 8abd.** Sardine spawning stock biomass (SSB) and total biomass in Division 8abd, with information on the percentage at age, numbers at age, percentage at age in mass, total biomass at age in mass with the correspondent standard error (S.e.) and coefficient of variation (CV) from BIOMAN 2024. As well as the biological features mean weight at age(g) and mean length at age(mm).

| | | | |
|---|---|---|---|
| **SSB** | **45,272** | 8,674 | 0.1916 |
| Mature population | 0.93 | 0.0332 | 0.0356 |
| **Total biomass** | **48,567** | 9,679 | 0.1993 |
| Wt | 31.33 | 2.96 | 0.0946 |
| Population (millions) | 1,571 | 395 | 0.2512 |
| Percentage at age 1 | 0.55 | 0.109 | 0.1988 |
| Percentage at age 2 | 0.15 | 0.031 | 0.2095 |
| Percentage at age 3 | 0.18 | 0.046 | 0.2610 |
| Percentage at age 4 | 0.11 | 0.037 | 0.3321 |
| Percentage at age 5 | 0.01 | 0.004 | 0.4222 |
| Percentage at age 6+ | 0.01 | 0.004 | 0.5533 |
| Numbers at age 1 | 882 | 363.3 | 0.4120 |
| Numbers at age 2 | 229 | 46.7 | 0.2036 |
| Numbers at age 3 | 266 | 59.1 | 0.2224 |
| Numbers at age 4 | 167 | 46.2 | 0.2772 |
| Numbers at age 5 | 16 | 6.2 | 0.3947 |
| Numbers at age 6+ | 11 | 5.5 | 0.4873 |
| Perc. at age 1 in mass | 0.37 | 0.101 | 0.2730 |
| Perc. at age 2 in mass | 0.18 | 0.027 | 0.1508 |
| Perc. at age 3 in mass | 0.25 | 0.046 | 0.1851 |
| Perc. at age 4 in mass | 0.17 | 0.045 | 0.2574 |
| Perc. at age 5 in mass | 0.02 | 0.007 | 0.3651 |
| Perc. at age 6+ in mass | 0.01 | 0.007 | 0.4648 |
| B at age 1 (Tons) | 18,682 | 7,436 | 0.3980 |
| B at age 2 (Tons) | 8,542 | 1,690 | 0.1978 |
| B at age 3 (Tons) | 11,632 | 2,539 | 0.2183 |
| B at age 4 (Tons) | 8,202 | 2,282 | 0.2783 |
| B at age 5 (Tons) | 846 | 330 | 0.3905 |
| B at age 6+ (Tons) | 665 | 300 | 0.4518 |

| Biological Features | estimate | S.e. | CV |
|---|---|---|---|
| Weight at age 1 (g) | 21.6 | 0.82 | 0.0379 |
| Weight at age 2 (g) | 37.1 | 1.10 | 0.0296 |
| Weight at age 3 (g) | 43.4 | 1.70 | 0.0393 |
| Weight at age 4 (g) | 48.5 | 2.15 | 0.0444 |
| Weight at age 5 (g) | 53.1 | 3.17 | 0.0597 |
| Weight at age 6+ (g) | 56.1 | 6.21 | 0.1107 |
| Lenght at age 1 (cm) | 145.7 | 1.98 | 0.0136 |
| Lenght at age 2 (cm) | 174.8 | 1.08 | 0.0062 |
| Lenght at age 3 (cm) | 185.1 | 1.43 | 0.0077 |
| Lenght at age 4 (cm) | 190.8 | 1.50 | 0.0078 |
| Lenght at age 5 (cm) | 198.8 | 1.88 | 0.0094 |
| Lenght at age 6+ (cm) | 196.1 | 5.68 | 0.0290 |

**Table 6.2.2.1.5: Sardine in 8abd.** Percentage of mature population within the 22 samples used for the DEPM estimates.

| %mature in numbers 8abd | age 1 | age 2 | age 3 | age 4 | age 5 | age 6 |
|---|---|---|---|---|---|---|
| | 75% | 100% | 100% | 100% | 100% | 100% |

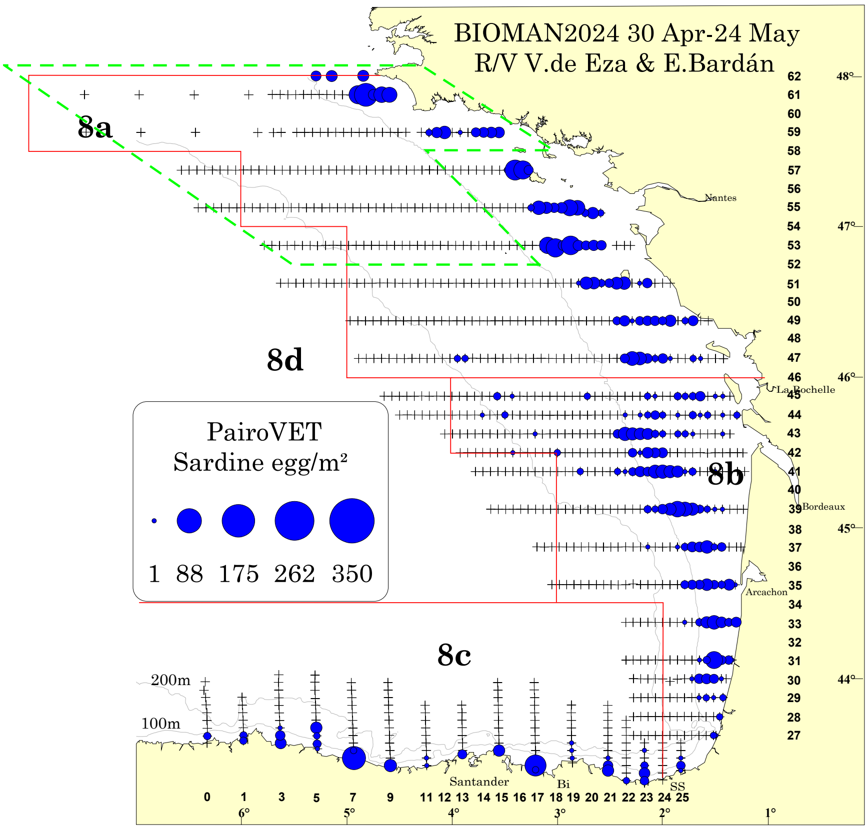



**Figure 6.2.2.1.1. Sardine in 8abd**. Spatial distribution and abundance of sardine eggs per 0.1m$^2$ from the DEPM survey BIOMAN2024 obtained with PairoVET (vertical sampling). The dash green line represents the stations removed for assessment propose in 8abd to be consistent with the historical series. Red lines represent the limits of 8abcd.

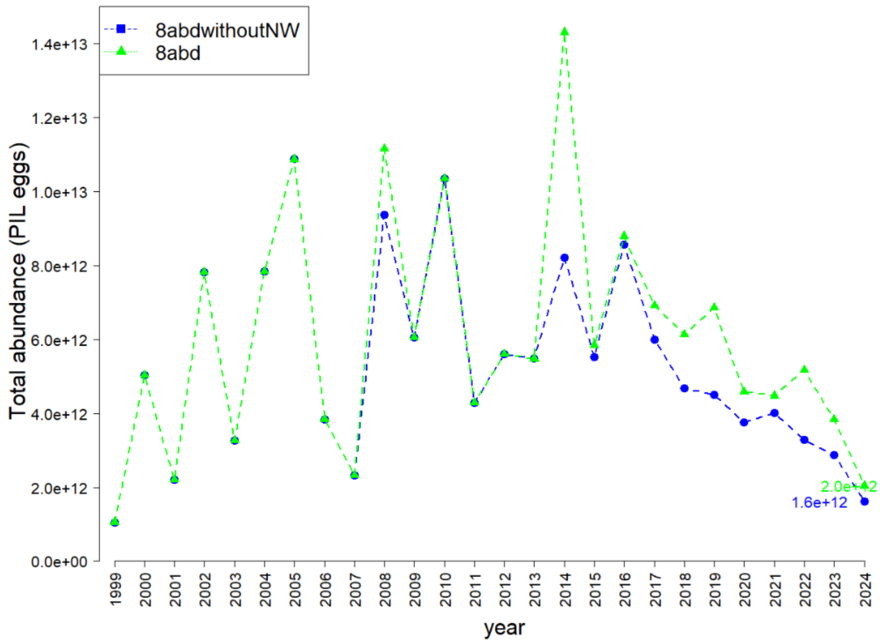



**Figure 6.2.2.1.2. Sardine in 8abd.** historical series for sardine egg abundances in 8abd with and without Northwest stations including 2024 values.

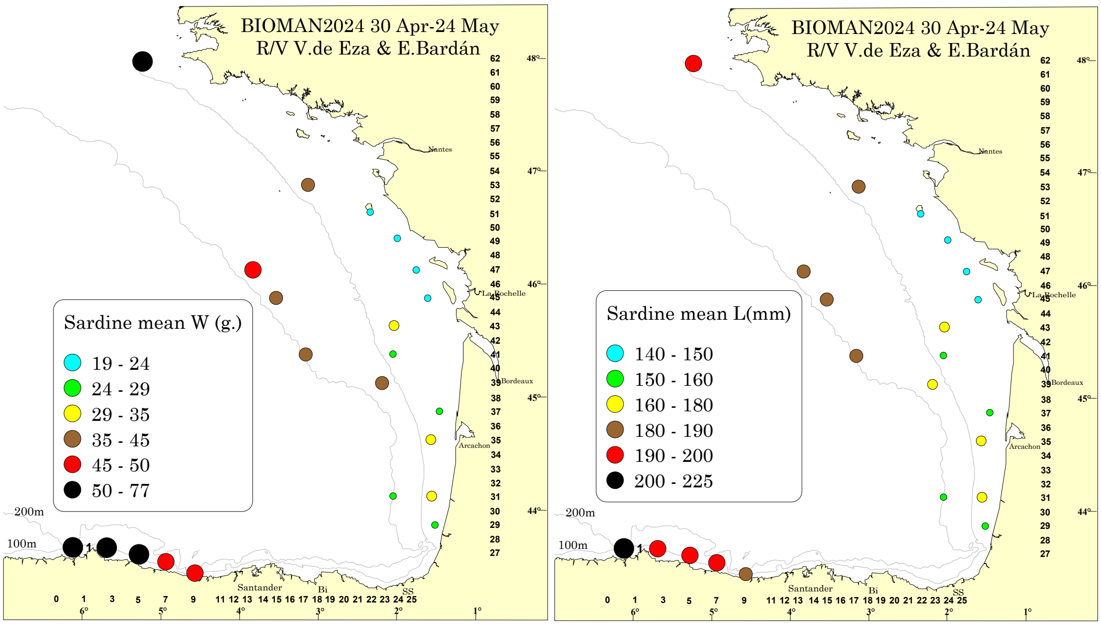



**Figure 6.2.2.1.3. Sardine in 8abd.** Sardine spatial distribution of mean weight (left) and mean length (right) in the Bay of Biscay from BIOMAN 2024 survey.

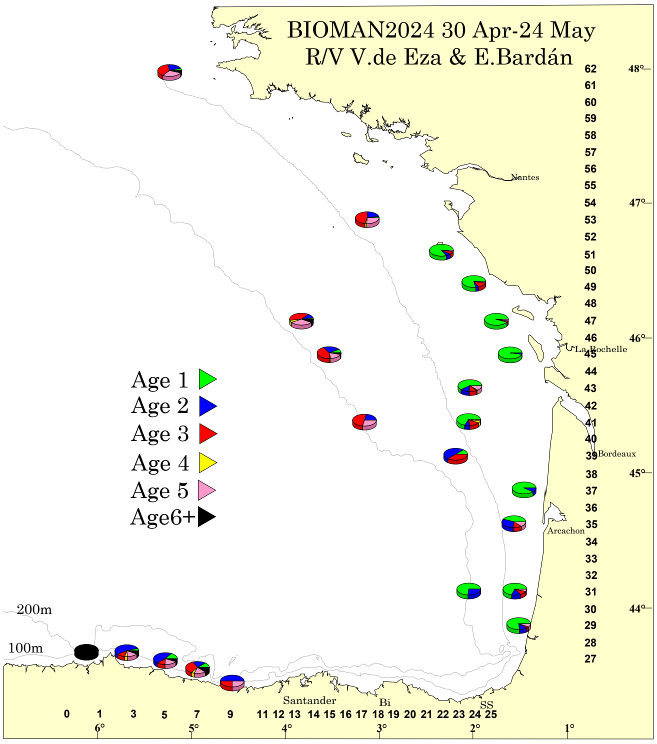



**Figure 6.2.2.1.4. Sardine in 8abd.** Sardine spatial distribution of percentage at age by haul in the Bay of Biscay from BIOMAN 2024 survey. The different colours are the different ages.

### 6.2.2.2 Acoustic spring survey (PELGAS): 8ab

The biomass of sardine estimated during PELGAS24 is 208 949 tonnes, which is a decrease compared the 2023 estimate. It must be noticed that the sardine abundance index is very variable, and it could be explained that this survey doesn't cover the total area of potential presence of sardine, and it is possible that some years, this stock could be present up to the North, in the Celtic sea, SW of Cornouailles or Western Channel where some fishery (and the PELTIC survey) occurs. It is also possible that sometimes, a part of the population could be present in very coastal waters, when the R/V Thalassa is unable to operate in those waters. The estimate is representative of the sardine present in the survey area at the time of the survey and can be therefore considered as an estimate of the Bay of Biscay (8ab) sardine population. A summary of the 2024 survey can be found in Annex 6.

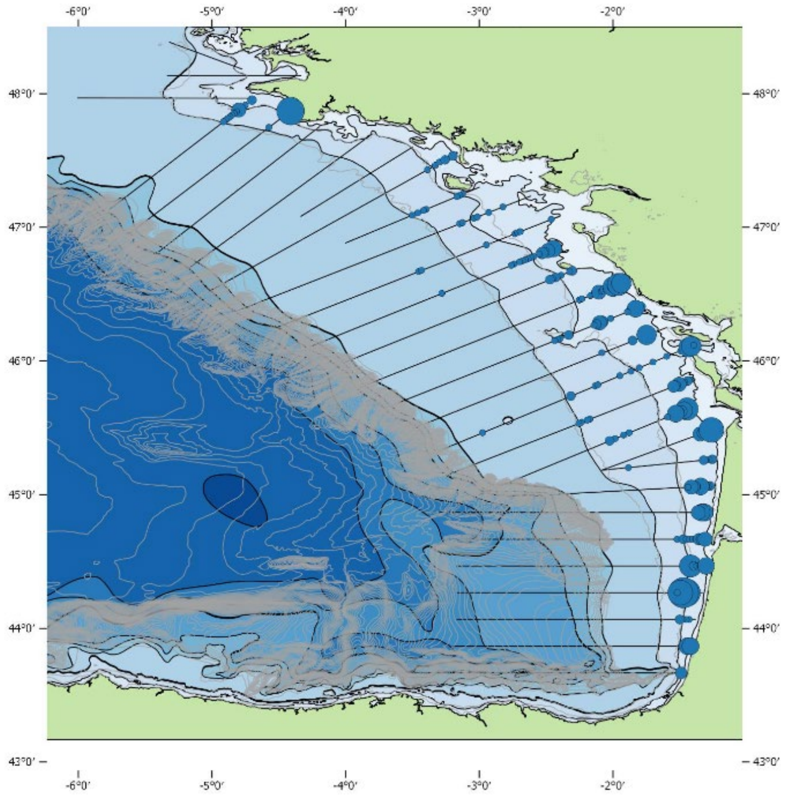



**Figure 6.2.2.2.1. Sardine in 8abd. distribution of sardine observed by acoustics during PELGAS24.**

Sardine was distributed all along the French coast of the Bay of Biscay, from the South to the Loire river (Figure 6.2.2.2.1). The small sardine was present this year, sometimes pure, and regularly mixed with anchovy. Once again, no sardines were detected along the edge of the plateau.

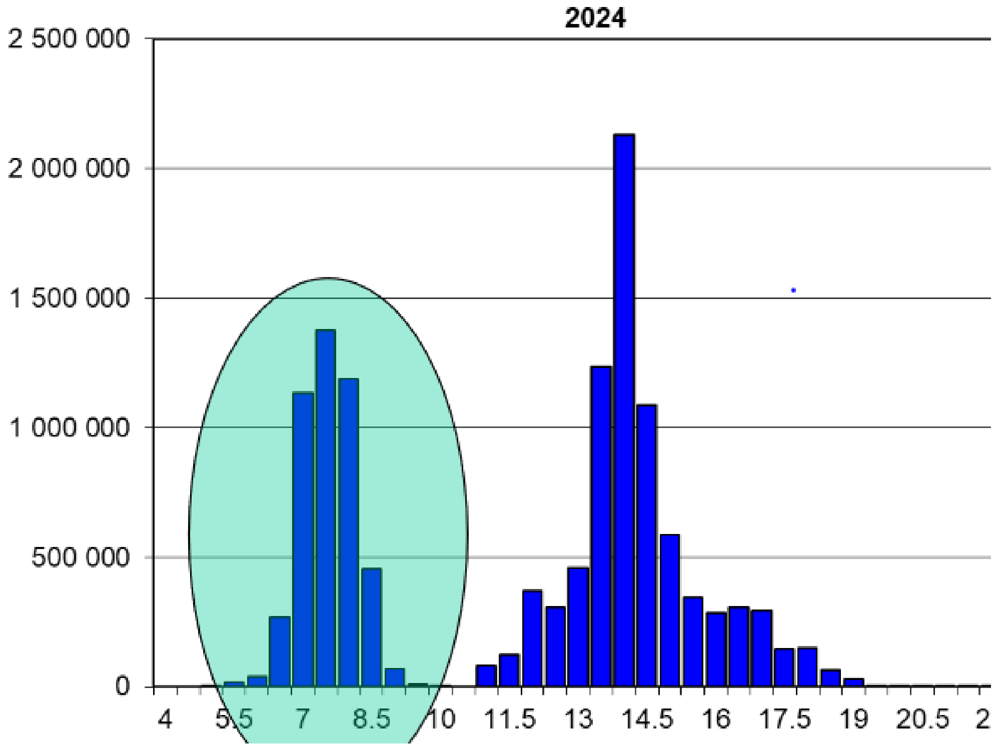



**Figure 6.2.2.2.2. Sardine in 8abd. Length distribution of sardine as observed during PELGAS24. Light blue bubble represent age 0+ sardines (not included in the assessment)**

Length distributions in the trawl hauls were estimated from random samples. The population length distributions have been estimated by a weighted average of the length distribution in the hauls. Weights used are the acoustic biomass estimated in the post-stratification regions comprising each trawl haul. The global length distribution of sardine is shown in Figure 6.2.2.2.2. We can see that this year, a mode about 7.5 centimetre is visible. It corresponds to juveniles, detected and caught particularly along the Brittany coast, at the end of the survey. Some of these fish have been aged by the daily ring method, and their age have been determined between 80 and 90 days, so with a probable birth at the end of February. These juveniles, largely underestimated because of the low catchability of the vessel on so small individuals, have been removed to keep the abundance index on adults (age 1+).

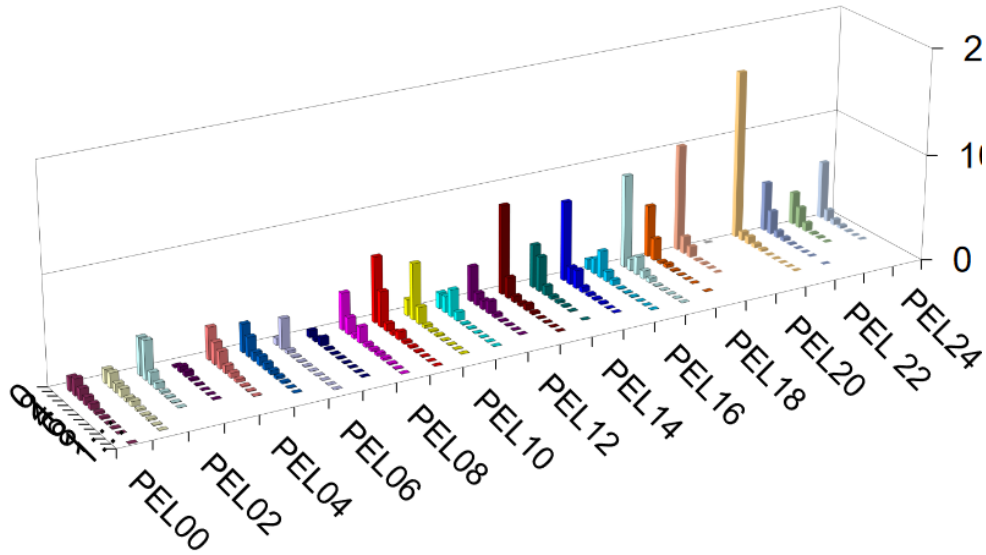


**Figure 6.2.2.2.3. Sardine in 8abd. Age composition of sardine as estimated by acoustics since 2000**

PELGAS series of sardine abundance at age (2000-2024) is shown in Figure 4.1.7. Cohorts can be visually tracked on the graph particularly in the past : the respectively very low and very high 2005 and 2008 cohorts denote atypical years in terms of environmental conditions, and therefore fish (and particularly sardine) distributions. This is no more true in recent years, with the good recruitment in 2013 which doesn't profit to incoming years, or the 2017 year class which seems to be one of the best recruitment ever and who seems to contribute not that much to the total abundance of sardine in 2018 (and 2019) in the bay of Biscay. 2021 seemed to be the best recruitment ever and the population appeared more and more young (88% of the fish were 1 year old). 2022 showed that this very strong cohort doesn't profit in 2022 to the population with an abundance at age 2 which is around the level of the series, and it is confirmed this year with only 13% of age 3. The population of sardine is still very young, with an age distribution largely dominated by age 1 and 2 groups (sum about 82% in numbers).

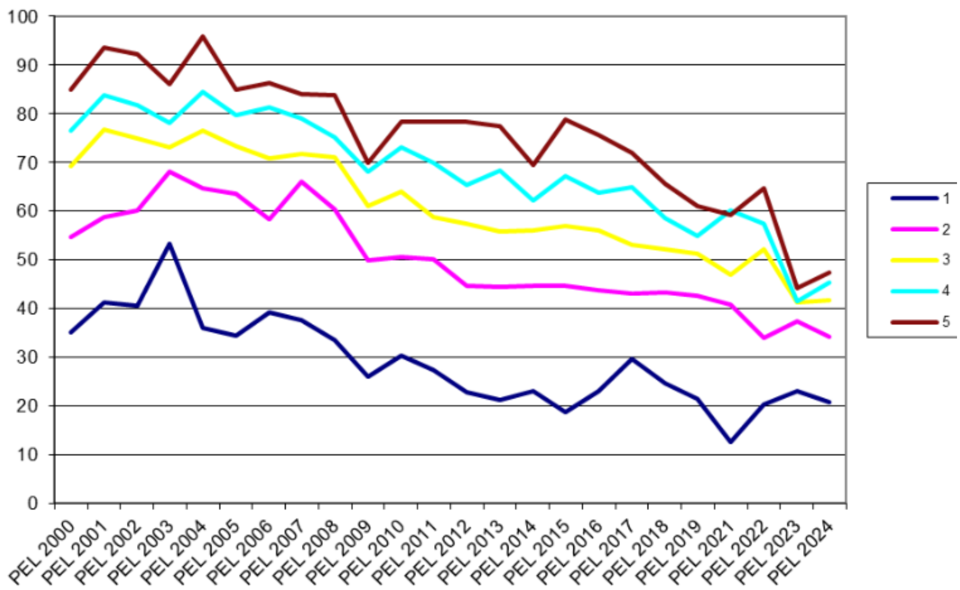



**Figure 6.2.2.2.4. Sardine in 8abd. Evolution of mean weight at age (g) of sardine along PELGAS series.**

The PELGAS sardine mean weights at age series (Figure 6.2.2.2.4) shows a clear decreasing trend, whose biological determinant is still poorly understood. Further studies are conducted, particularly on the nutritive quality of plankton. One year old sardines were about 40 grams in the beginning of the series, and reach only 20 grams this year, with a strong minimum value in 2021 with 12.5 grams. Further work must be conducted to explore the causes of the fluctuation of mean weights at ages but recent works suggest that it could be caused by a modification of the plankton composition.

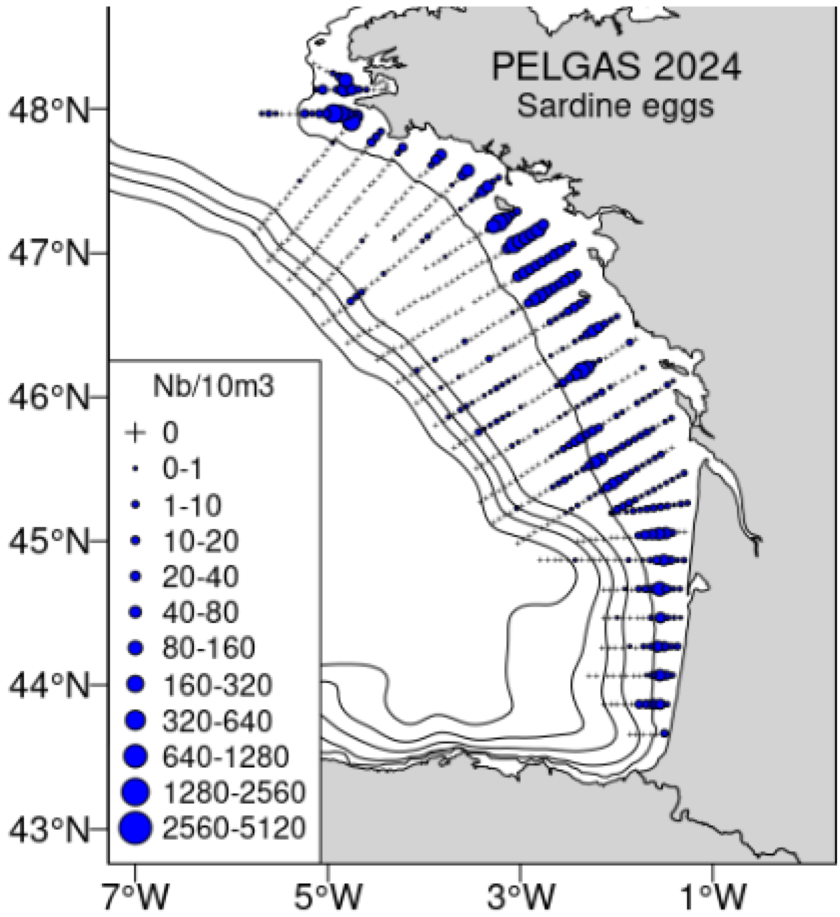



**Figure 6.2.2.2.5. Sardine in 8abd. Distribution of sardine eggs observed with CUFES during PELGAS24.**

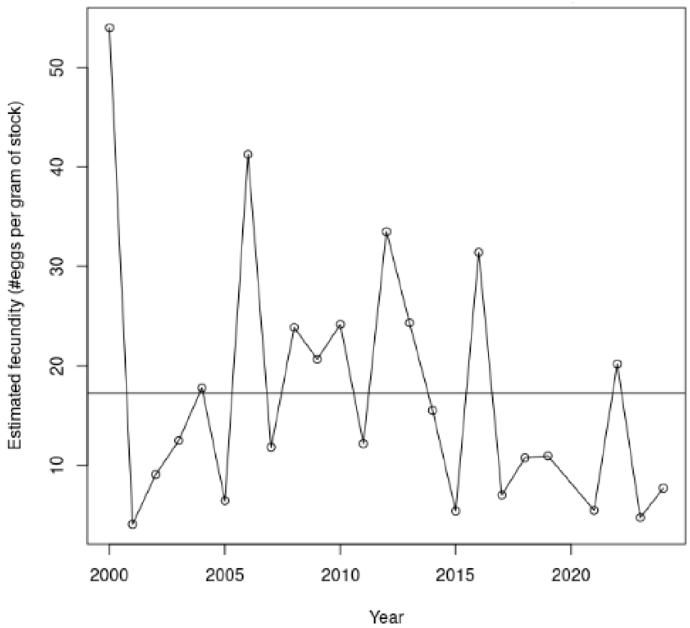



**Figure 6.2.2.2.6. Sardine in 8abd. Eggs fecundity (number of eggs per gram of the stock) surveys from 2000 to 2024**

2024 was marked by a low abundance of sardine eggs as compared to the PELGAS time-series (Figure 6.2.2.2.5 and Figure 6.2.2.2.6). It must be noticed that this year the one-year-old individuals were not fully mature: 47 % of the age 1 were totally immature (stage1). Almost all of the older individuals (age 2 and more) were spawning.

## 6.2.3 Biological data

### 6.2.3.1 Catch numbers-at-length and age

Catches in 2023 were sampled, and numbers by length class for divisions 8a, b, d by quarter are shown in Tables 6.2.3.1.1 and 6.2.3.1.2, for France and Spain, respectively. Sardine caught in divisions 8a, b, d ranges from 11.5 to 24 cm (half cm bin). In 2023, a peak is observed in the catch-at size distributions around -17 cm length (half cm bin).

Table 6.2.3.1.3 and Table 6.2.3.1.4 shows the catch-at-age in numbers for each quarter of 2023 for Spanish and French landings respectively. In France age 1-3 dominated the fishery whereas in Spain it is mostly age 2-3.

### 6.2.3.2 Mean length and mean weight-at-age

Mean length and mean weight-at-age by quarter in 2023 for France and Spain are shown in Tables 6.2.3.2.1 to 6.2.3.2.4.

**Table 6.2.3.1.1. Sardine in 8abd. French Sardine catch at length composition (thousands) in ICES divisions 8a,b in 2023.**

| Length * (half cm) | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 | All year |
|---|---|---|---|---|---|
| 10 | | | | | |
| 10.5 | | | | | |
| 11 | | | | | |
| 11.5 | | | | | |
| 12 | | 472 | | | 472 |
| 12.5 | | | | | |
| 13 | 162 | 472 | | 284 | 919 |
| 13.5 | 162 | 1 416 | | | 1 578 |
| 14 | 325 | 3 775 | 2 086 | 284 | 6 470 |
| 14.5 | 1 136 | 4 247 | 1 147 | 284 | 6 815 |
| 15 | 1 639 | 9 438 | 1 774 | 569 | 13 420 |
| 15.5 | 3 349 | 9 271 | 3 548 | 853 | 17 021 |
| 16 | 3 998 | 27 831 | 16 070 | 6 824 | 54 723 |
| 16.5 | 2 652 | 34 943 | 40 479 | 16 776 | 94 850 |
| 17 | 3 612 | 27 025 | 48 398 | 23 884 | 102 920 |
| 17.5 | 2 815 | 6 273 | 52 880 | 18 482 | 80 449 |
| 18 | 2 907 | 1 096 | 34 002 | 14 501 | 52 506 |
| 18.5 | 5 428 | 1 568 | 29 412 | 7 961 | 44 369 |
| 19 | 7 484 | 1 096 | 16 689 | 2 559 | 27 828 |
| 19.5 | 7 562 | 2 193 | 6 049 | 3 981 | 19 785 |
| 20 | 6 681 | 472 | 3 234 | 1 137 | 11 524 |
| 20.5 | 4 454 | 1 096 | | 853 | 6 403 |
| 21 | 2 876 | 548 | | | 3 424 |
| 21.5 | 982 | 1 644 | | | 2 626 |
| 22 | 951 | | | 284 | 1 236 |
| 22.5 | 131 | | | | 131 |
| 23 | 263 | | | | 263 |
| 23.5 | | | | | |
| 24 | | | | | |
| 24.5 | | | | | |
| 25 | | | | | |
| Total number | 59 732 | 134 878 | 255 768 | 99 518 | 549 896 |
| | | | | | |
| Official catch (t) | 3 135 | 4 875 | 11 026 | 4 263 | **23 299** |

**Table 6.2.3.1.2. Sardine in 8abd. Spanish sardine catch-at-length composition (thousands) in ICES Division 8b in 2023.**

| Length * (half cm) | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 | All year |
|---|---|---|---|---|---|
| 10 | | | | | |
| 10.5 | | | | | |
| 11 | | | | | |
| 11.5 | 3 | | | | 3 |
| 12 | 9 | | | | 9 |
| 12.5 | 66 | | | | 66 |
| 13 | 359 | | | | 359 |
| 13.5 | 709 | | | 5 | 714 |
| 14 | 1 426 | | | 48 | 1 475 |
| 14.5 | 2 023 | | | 19 | 2 043 |
| 15 | 2 641 | 1 | | 100 | 2 742 |
| 15.5 | 2 617 | 3 | | 487 | 3 107 |
| 16 | 3 476 | 4 | | 2 558 | 6 039 |
| 16.5 | 4 890 | 9 | | 5 789 | 10 688 |
| 17 | 4 895 | 26 | 39 | 8 002 | 12 963 |
| 17.5 | 3 155 | 37 | 59 | 7 217 | 10 468 |
| 18 | 2 212 | 33 | 138 | 7 521 | 9 905 |
| 18.5 | 1 627 | 32 | 296 | 5 137 | 7 092 |
| 19 | 1 093 | 30 | 315 | 2 709 | 4 147 |
| 19.5 | 658 | 11 | 296 | 1 530 | 2 495 |
| 20 | 348 | 10 | 197 | 1 162 | 1 717 |
| 20.5 | 239 | 2 | 99 | 581 | 921 |
| 21 | 75 | 3 | 59 | 271 | 408 |
| 21.5 | 15 | 1 | 20 | 161 | 196 |
| 22 | 20 | | 20 | 55 | 94 |
| 22.5 | 5 | | | | 5 |
| 23 | 1 | | 20 | | 21 |
| 23.5 | | | | | |
| 24 | | | | | |
| 24.5 | | | | | |
| 25 | | | | | |
| 28 | | | | | |
| Total number | 32 563 | 202 | 1 557 | 43 354 | 77 676 |
| | | | | | |
| Official catch (t) | 1 066 | 8 | 84 | 1 898 | **3 056** |

**Table 6.2.3.1.3. Sardine in 8abd. Spanish 2023 landings in ICES Division 8ab: Catch in numbers (thousands) -at-age.**

| Age | First Quarter | Second Quarter | Third quarter | Fourth Quarter | Whole Year |
|---|---|---|---|---|---|
| 0 | 0,00 | 0,00 | 0,41 | 63,09 | 63,50 |
| 1 | 4682,78 | 127,30 | 13,16 | 4769,10 | 9592,34 |
| 2 | 15498,56 | 767,59 | 15,18 | 5711,78 | 21993,11 |
| 3 | 13229,18 | 926,74 | 9,48 | 3177,21 | 17342,62 |
| 4 | 4992,55 | 282,83 | 3,67 | 1119,87 | 6398,92 |
| 5 | 815,72 | 34,25 | 1,67 | 477,20 | 1328,84 |
| 6 | 483,10 | 29,60 | 0,22 | 70,47 | 583,39 |
| 7 | 63,70 | 1,83 | 0,00 | 0,00 | 65,53 |
| 8 | 2,97 | 0,09 | 0,00 | 0,00 | 3,05 |
| 9 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |

**Table 6.2.3.1.4. Sardine in 8abd. French 2023 landings in ICES Division 8b: Catch in numbers (thousands) -at-age.**

| Age | First Quarter | Second Quarter | Third quarter | Fourth Quarter | Whole Year |
|---|---|---|---|---|---|
| 0 | | | 21503,27 | 21255,12 | 42758,39 |
| 1 | 1943,51 | 40920,90 | 113893,75 | 19726,13 | 176484,28 |
| 2 | 11618,98 | 45785,27 | 56488,28 | 14135,07 | 128027,61 |
| 3 | 15520,44 | 29430,27 | 43102,98 | 23596,13 | 111649,82 |
| 4 | 12778,62 | 11066,46 | 5878,29 | 10269,40 | 39992,77 |
| 5 | 6126,68 | 5387,36 | 2035,37 | 2511,75 | 16061,16 |
| 6 | 3266,22 | 2997,30 | 724,86 | 764,04 | 7752,42 |
| 7 | 304,34 | 183,99 | | | 488,33 |
| 8 | | | | | 0,00 |
| 9 | | | 1,55 | 191,01 | 192,56 |

**Table 6.2.3.2.1. Sardine in 8abd. Spanish 2023 landings in divisions 8a,b: Mean length (cm) -at-age.**

| | First Quarter | Second Quarter | Third quarter | Fourth Quarter | Whole Year |
|---|---|---|---|---|---|
| 0 | 0,00 | 0,00 | 12,78 | 13,92 | 13,91 |
| 1 | 14,46 | 14,73 | 17,04 | 17,16 | 15,81 |
| 2 | 16,32 | 16,65 | 18,18 | 18,13 | 16,81 |
| 3 | 18,12 | 18,02 | 19,12 | 18,98 | 18,27 |
| 4 | 19,65 | 19,18 | 19,83 | 19,60 | 19,62 |
| 5 | 20,92 | 20,11 | 20,12 | 19,94 | 20,55 |
| 6 | 19,96 | 19,60 | 19,89 | 19,96 | 19,94 |
| 7 | 23,21 | 23,21 | 0,00 | 0,00 | 23,21 |
| 8 | 23,75 | 23,75 | 0,00 | 0,00 | 23,75 |
| 9 | 0,00 | 0,00 | 0,00 | 0,00 | |

**Table 6.2.3.2.2. Sardine in 8abd. Spanish 2023 landings in divisions 8a,b: Mean weight (kg) -at-age.**

| | First Quarter | Second Quarter | Third quarter | Fourth Quarter | Whole Year |
|---|---|---|---|---|---|
| 0 | 0,00 | 0,00 | 0,02 | 0,02 | 0,02 |
| 1 | 0,02 | 0,02 | 0,04 | 0,04 | 0,03 |
| 2 | 0,03 | 0,03 | 0,04 | 0,04 | 0,03 |
| 3 | 0,04 | 0,04 | 0,05 | 0,05 | 0,04 |
| 4 | 0,06 | 0,05 | 0,06 | 0,06 | 0,06 |
| 5 | 0,07 | 0,06 | 0,06 | 0,06 | 0,07 |
| 6 | 0,06 | 0,05 | 0,06 | 0,06 | 0,06 |
| 7 | 0,10 | 0,10 | 0,00 | 0,00 | 0,10 |
| 8 | 0,11 | 0,11 | 0,00 | 0,00 | 0,11 |
| 9 | | | | | |

**Table 6.2.3.2.3. Sardine in 8abd. French 2023 landings in ICES Division 8a,b: mean length (cm) -at-age.**

| Age | First Quarter | Second Quarter | Third quarter | Fourth Quarter | Whole Year |
|---|---|---|---|---|---|
| 0 | | | 15,05 | 13,95 | 14,51 |
| 1 | 15,86 | 15,26 | 16,11 | 16,36 | 15,94 |
| 2 | 17,36 | 16,99 | 17,08 | 17,59 | 17,13 |
| 3 | 18,66 | 17,84 | 17,40 | 18,17 | 17,86 |
| 4 | 19,70 | 18,85 | 18,48 | 18,90 | 19,08 |
| 5 | 19,65 | 18,68 | 18,34 | 18,80 | 19,02 |
| 6 | 20,57 | 20,32 | 18,50 | 18,50 | 20,08 |
| 7 | 20,5 | 20,5 | | | 20,5 |
| 8 | | | | | |
| 9 | | | 21 | 21 | 21 |

**Table 6.2.3.2.4. Sardine in 8abd. French 2023 landings in ICES Division 8a,b: mean weight (kg) -at-age.**

| Age | First Quarter | | Third quarter | Fourth Quarter | Whole Year |
|---|---|---|---|---|---|
| 0 | | | 0,03 | 0,02 | 0,02 |
| 1 | 0,03 | 0,03 | 0,03 | 0,04 | 0,03 |
| 2 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 |
| 3 | 0,05 | 0,05 | 0,04 | 0,05 | 0,05 |
| 4 | 0,06 | 0,05 | 0,05 | 0,05 | 0,06 |
| 5 | 0,06 | 0,05 | 0,05 | 0,05 | 0,06 |
| 6 | 0,07 | 0,07 | 0,05 | 0,05 | 0,07 |
| 7 | 0,07 | 0,07 | | | 0,07 |
| 8 | | | | | |
| 9 | | | 0,08 | 0,08 | 0,08 |

### 6.2.3.3 Maturity

The maturity ogive is provided yearly by the PELGAS survey, carried out in May, from the visual examination of gonads according a maturity scale (stage 1- 5). Age 1 is the only age group which has partial maturity, and usually it has been assessed to be about 0.7580 (mean of maturity in 2017-2019). In 2024 about 47% (57% in 2023) of age 1 fishes were immature (a value corresponding to the unweighted mean of the proportion age 1 fishes in stage 1 of maturity). This implies that only about 53%% of age 1 fishes were mature.

# 6.3 Stock assessment

## 6.3.1 Historical stock development

Model used: SS3

Since 2019 this stock is assessed using SS3. The procedure is described in the stock annex following the WKPELA benchmark (2017). It was updated in 2019 following the IBPSardine interbenchmark (ICES, 2019). The interbenchmark took place in 2019 and was tasked with evaluating the stock assessment focusing on retrospective bias, data revisions and updating reference points. Standard model diagnostics were used to evaluate a series of interventions designed to evaluate the models and to determine causes of and corrections for the retrospective bias.

The retrospective bias could be corrected by several straightforward interventions. First, fixing selectivity at asymptotic improved model fit and reduced bias. Second, invoking a very weak stock–recruitment relationship (steepness=0.99) and commensurate bias correction ramping on recruitment deviations coupled with not estimating terminal year recruitment, further reduced the bias. Such a treatment of terminal year recruitment and penalizing poorly informed recruitment deviations is common assessment practice.

Additional concerns were raised by the estimated catchability coefficients above one for the PELGAS and BIOMAN surveys. There are a number of reasons why these surveys could estimate higher abundance than the assessment model. These include mismatch of timing given the rapid population dynamics, overestimation of acoustic biomass, mismatch of assumed selectivity of the survey as well as many other common issues that support the standard practice of treating most surveys as relative rather than absolute. Once the decision to use these indices as relative inputs, the absolute value of catchability is meaningless as the index could simply be scaled to a mean of one with the same impact in the model.

Given the substantial reduction in retrospective bias achieved through straightforward model interventions and the solid diagnostic performance of the WG-preferred model, it was recommended the assessment be upgraded from category 2 to category 1.

Nonetheless, the model cannot estimate MSY-based reference points and this requires proxies. Based on considerations of life history, the WG recommends a proxy of SPR35% for $B_{lim}$. Recommendations for future work include explicitly modelling variability of growth reflecting the declines in mean weight-at-age, incorporating length composition and considering a management procedure approach as the majority of catch comes from ages 1 and 2 which are very poorly informed in catch projection due to the time-lag between the assessment and the provision of management advice.

This assessment is the sixth one following the interbenchmark in 2019.

### 6.3.2 State of the stock

Summary of the assessment is shown in Table 6.3.2.1 and in Figures 6.3.2.1–6.3.2.2.

The spawning–stock biomass (SSB) is above $B_{lim}$ in 2024. SSB has decreased strongly from 2010 to 2012 to the lower value of the series and has been stable until 2017. SSB has since then had a decreasing trend with 2021 the lowest value of the time-series (50 141.7 t). In 2022, SSB showed a very small increase with a value of 62 534 tons. In 2024 SSB is still low (62981.5t), between $B_{lim}$ and $B_{pa}$. Landings were above 30 kt between 2012 and 2014, dropping for two years and then raising up again to 32 kt in 2018 for four consecutive years. Fishing mortality has been above 0.4 and above $F_{MSY}$ since 2012. For the first time since 2013, fishing mortality in 2023 is below $F_{MSY}$. Recruitment has been variable over time. Recruitment in 2023 is higher than in 2022.

**Table 6.3.2.1. Sardine in 8abd. Summary of the sardine 8abd stock assessment.**

| Year | Recruitment (thousand) | SSB (tonnes) | Total Catch (tonnes) | F(2–5) |
|---|---|---|---|---|
| 2000 | 4290030 | 137578 | 15097 | 0.142 |
| 2001 | 5227380 | 155359 | 15005 | 0.146 |
| 2002 | 3470250 | 167928 | 18277 | 0.173 |
| 2003 | 3832600 | 176504 | 16607 | 0.139 |
| 2004 | 7057100 | 147445 | 14197 | 0.133 |
| 2005 | 2319760 | 175062 | 16360 | 0.131 |
| 2006 | 3548700 | 154087 | 16741 | 0.143 |
| 2007 | 6894300 | 137943 | 17323 | 0.152 |
| 2008 | 8414940 | 157804 | 21821 | 0.22 |
| 2009 | 3443730 | 134569 | 20855 | 0.175 |
| 2010 | 2629670 | 150215 | 20127 | 0.173 |
| 2011 | 4296990 | 120889 | 23208 | 0.23 |
| 2012 | 7484450 | 88524.1 | 30900 | 0.41 |
| 2013 | 5203720 | 94557.8 | 32938 | 0.45 |
| 2014 | 6949080 | 98218.1 | 35704 | 0.56 |
| 2015 | 2582810 | 88061.1 | 28756 | 0.47 |
| 2016 | 6306190 | 80702.7 | 29754 | 0.57 |
| 2017 | 4673040 | 101188 | 30435 | 0.56 |
| 2018 | 5130830 | 87297.9 | 32299 | 0.63 |
| 2019 | 4591480 | 70062 | 24579 | 0.48 |
| 2020 | 6520900 | 83179.2 | 31368 | 0.62 |
| 2021 | 4503390 | 50791.1 | 26198 | 0.56 |
| 2022 | 3524840 | 63018.6 | 26360 | 0.55 |
| 2023 | 7252410 | 51693.7 | 23253 | 0.35 |
| 2024 | 4708340* | 62981.5 | 19398** | 0.22*** |

***Geometric mean (2002–2023). ** Preliminary catches *** Resultant estimated F based on preliminary catches**

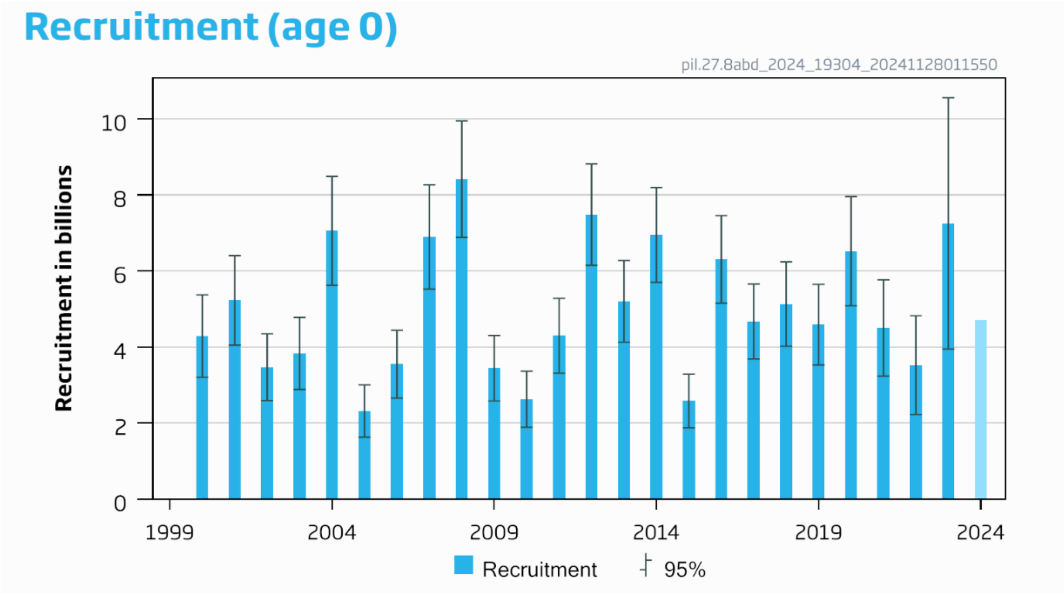



**Figure 6.3.2.1. Sardine in 8abd. Recruitment estimates from SS3 outputs for sardine 8abd. Last year's value is estimated from the geometric mean (2002-2023).**

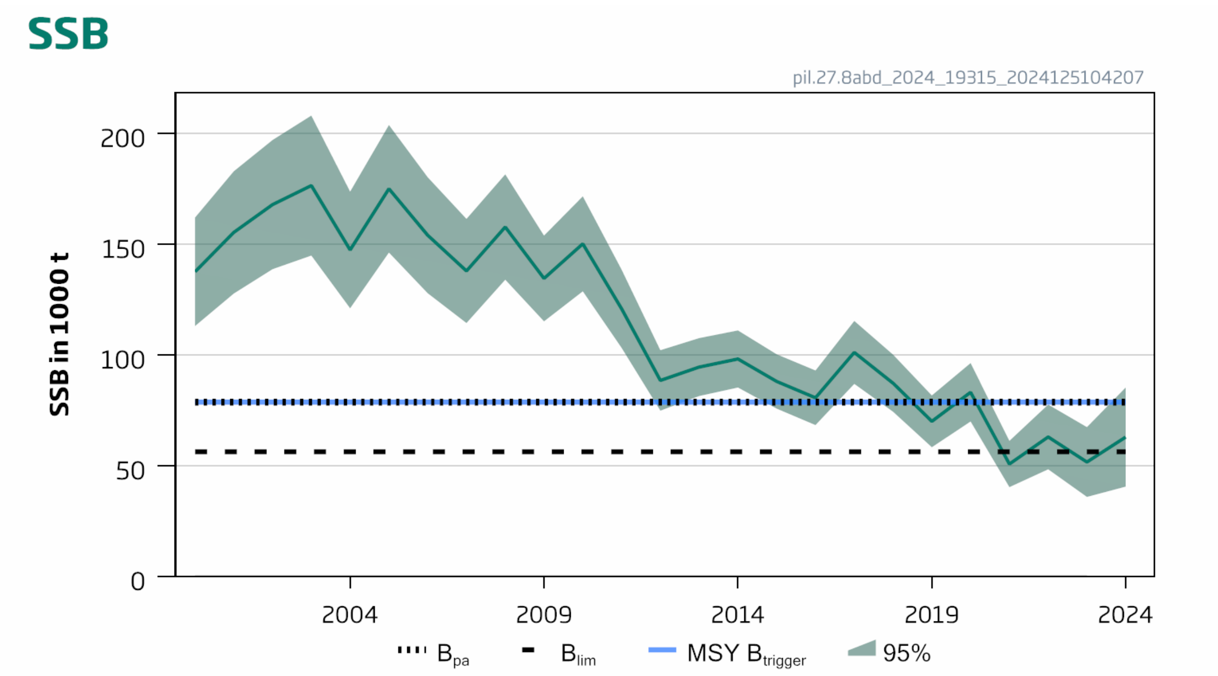



**Figure 6.3.2.2. Sardine in 8abd. Spawning–stock biomass from SS3 outputs for sardine 8abd. Last year's value is estimated from the model.**

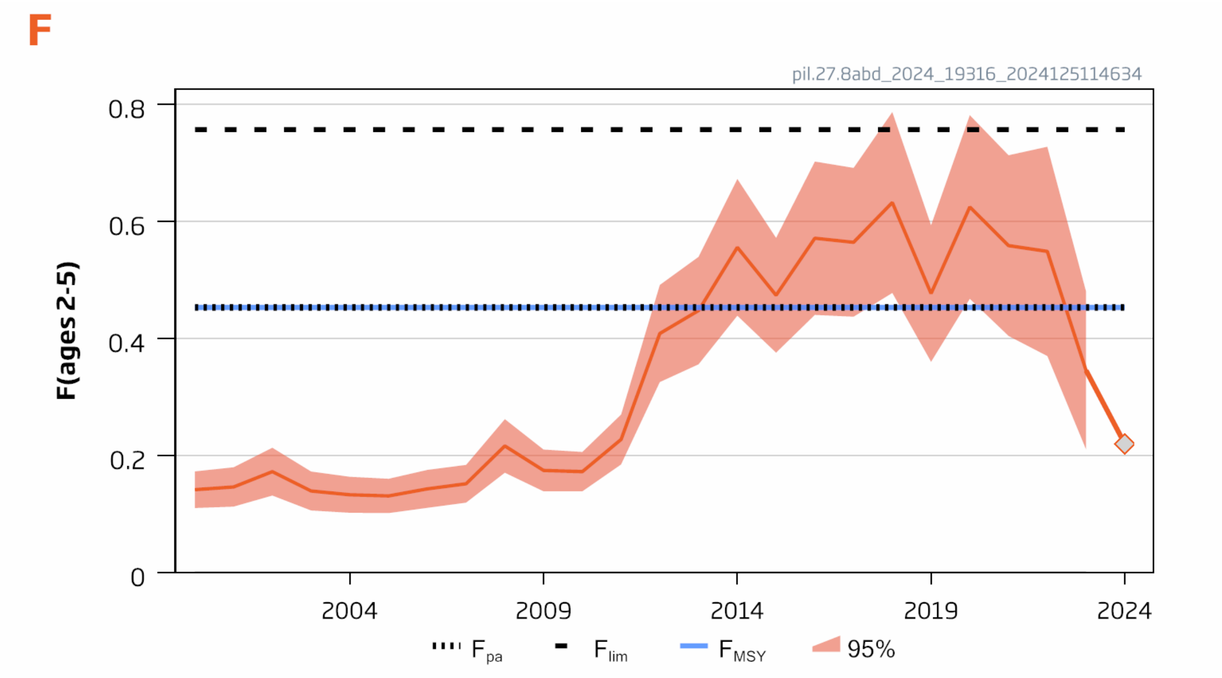



**Figure 6.3.2.3. Sardine in 8abd. Fishing mortality for ages 2 to 5 derived from SS3 outputs for sardine 8abd.**

### 6.3.3 Diagnostics

Residuals (Figures 6.3.3.1–6.3.3.2) and diagnostics do not highlight any problem regarding the input data and model fit. Some cohorts lead to some model over or underestimations. This phenomenon appears on some years for the PELGAS survey. For PELGAS, age 1 has positive residuals since 2011 and negative in earlier years.

For the commercial vessels, the cohort effect is less visible, but some years appears to have larger residuals than other (e.g. 2009). The model fit to the survey indices is within the confidence intervals of those indices.

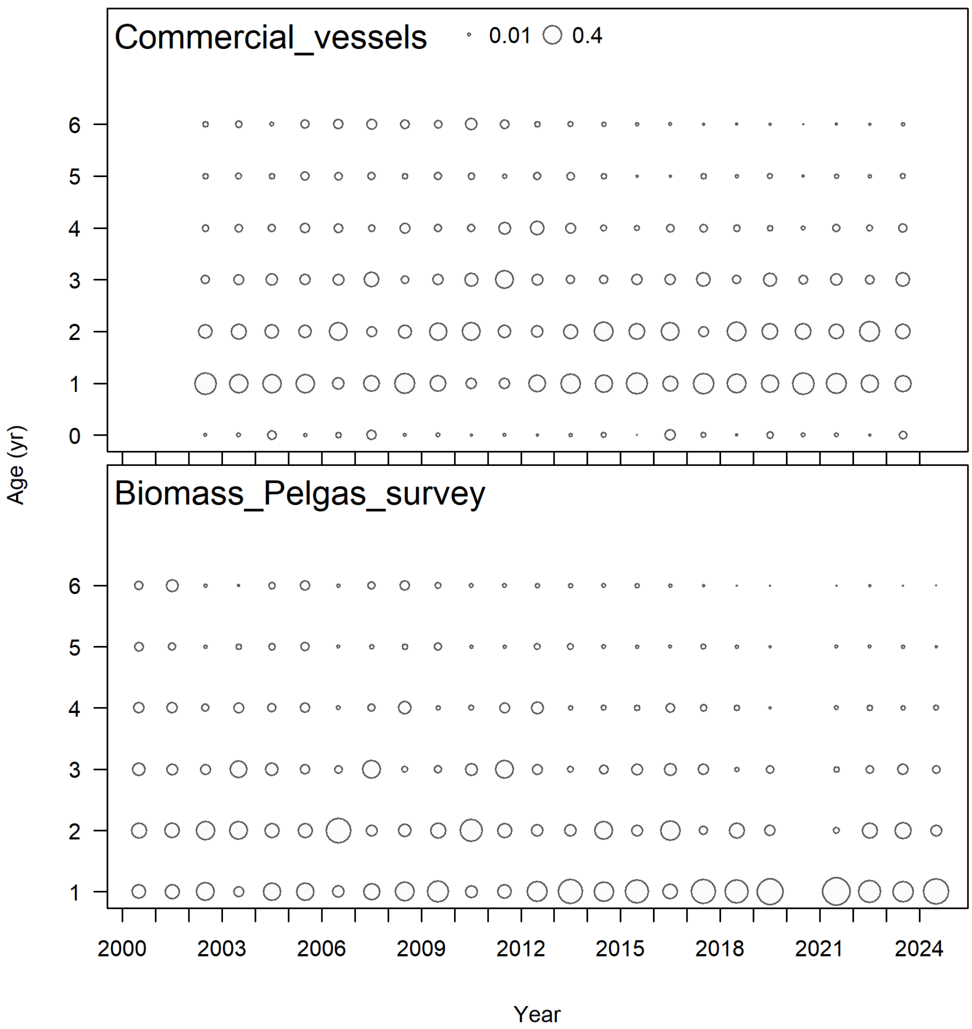
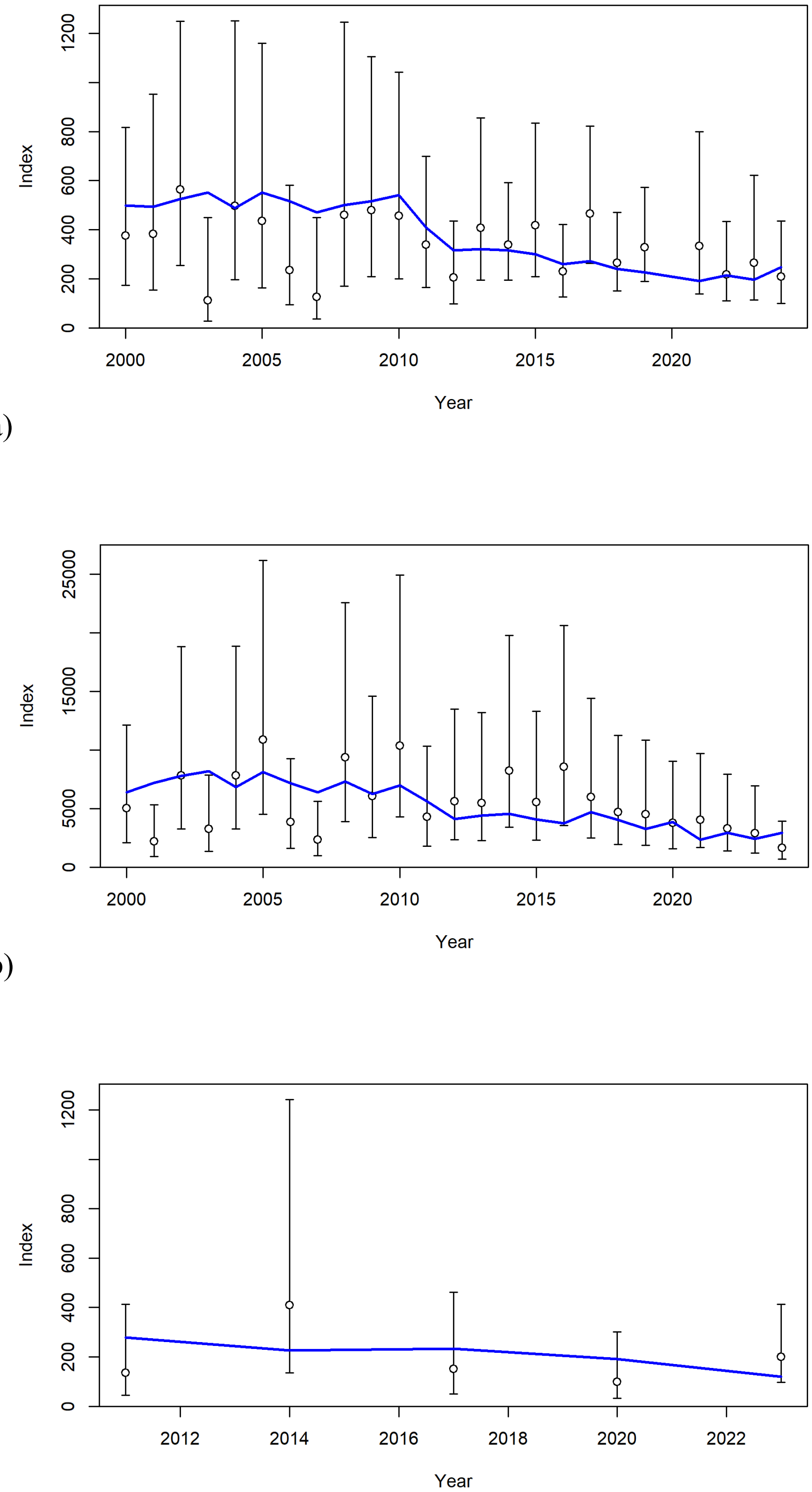



**Figure 6.3.3.1. Sardine in 8abd. Fit between model and age composition from the PELGAS survey (bottom) and commercial vessels (top) up to 2023.**




a)

b)

c)

**Figure 6.3.3.2. Sardine in 8abd. Fit between model and survey indices: a - Acoustic (PELGAS), b - egg count (BIOMAN), c - DEPM.**

### 6.3.4 Retrospective pattern

Retrospective patterns for SSB, $F_{bar}$(2–5), apical F and recruitment were computed for years 2015–2023 (Figure 6.3.4.1) using the r4ss *do_retro()* function and Mohn's rho estimates were calculated using the same approach carried out during the interbenchmark and therefore values can be compared to the work made during the interbenchmark. For each run, assessment was performed including survey data until the last retrospective year and catch data until previous year, as done in the current assessment (2024).

Overall, SSB tends to be overestimated while F is underestimated. There is no clear patterns regarding recruits although the magnitude of sporadic stronger recruitment events tend to increase Mohn's rho estimates for recruits.

Absolute values of Mohn's rho estimates was quite similar compared with previous assessment (especially for R) :

- Mohn's rho for SSB is 0.255 (previously 0.24).
- Mohn's rho for F is -0.15 (previously -0.14).
- Mohn's rho for R is 0.33 (previously 0.29).

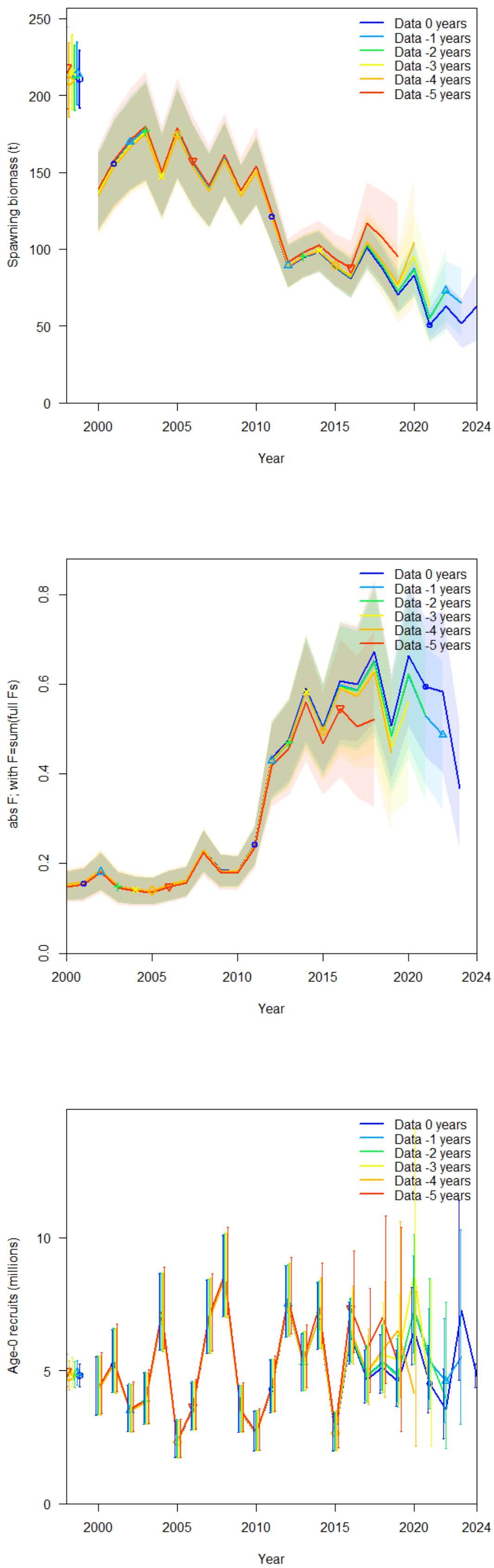



**Figure 6.3.4.1. Sardine in 8abd. Summary of retrospective plots.**

## 6.4 Short-term projections

The recruitment of sardine for the intermediate year is assumed to be the geometric mean of the time-series of recruitment. Short-term projections were performed using FLR libraries using the *fwd* function. The initial stock size corresponds to the assessment estimates for ages 1–6+ at the final year of the assessment. The maturity ogive for the interim year is estimated as the average of PELGAS survey for the last three years. F and M before spawning are zero, which correspond to the beginning of the year when the SSB is estimated by the model. Weights-at-age in the stock are provided during the interim year by the average of the PELGAS survey for the last 3 years. Weights-at-age in the catch are calculated as the arithmetic mean value of the last 3 years. The exploitation pattern is equal to the last year of the assessment.

Recruitment in the interim year and forecast year is set equal to the geometric mean of the time-series (2002-2023). Recruitment for 2024 was assumed to be 4 708 million individuals. Assumptions for the intermediate year are presented in Table 6.4.1.

Preliminary catches are estimated and used as assumption for the interim year. The *fwd* function is set to use the preliminary catch estimates (instead of F estimates). Preliminary catches were available for quarter 1 to 3. The assumption for the catch in 2024 relies on preliminary catch statistics available from Q1-Q3 of 2024. Q4 is estimated from the average catches of Q4 catches in last 3 years (2021-2023). The assumed catches for 2024 are 19 398 tonnes. The catch assumption was also included as preliminary catches in the stock assessment model this year.

Input data for the short-term forecast are provided in Table 6.4.2. Table 6.4.3 provides alternative catch options for 2025.

**Table 6.4.1. Sardine in 8abd. Assumptions for the intermediate year.**

| Variable | Value | Notes |
|---|---|---|
| $F_{ages}$ 2–5 (2024) | 0.48 | Based on assumed catches for 2024 |
| SSB (2025) | 72 870 | Short term forecast; tonnes |
| $R_{age}$ 0 (2024) | 4 708 | Geometric mean (2002–2023); millions |
| Total catch (2024) | 19 398 | Preliminary value based on reported catches in Quarters 1 to 3 and assumed catches for Quarter 4; tonnes |
| Discards (2024) | 0 | Negligible; tonnes |

**Table 6.4.2. Sardine in 8abd. Input data for the short-term forecast.**

| Year | Age | stock.n | stock.wt | catch.wt | Mat | M | F |
|---|---|---|---|---|---|---|---|
| 2023 | 0 | 4767.25 | 0.00 | 0.02 | 0.00 | 1.07 | 0.01 |
| | 1 | 1639.55 | 0.02 | 0.04 | 0.55 | 0.69 | 0.22 |
| | 2 | 762.09 | 0.04 | 0.04 | 0.98 | 0.55 | 0.39 |
| | 3 | 379.83 | 0.05 | 0.05 | 1.00 | 0.48 | 0.50 |
| | 4 | 87.43 | 0.06 | 0.06 | 0.99 | 0.44 | 0.50 |
| | 5 | 36.30 | 0.06 | 0.06 | 0.99 | 0.41 | 0.50 |
| | 6+ | 20.12 | 0.07 | 0.07 | 1.00 | 0.40 | 0.50 |
| 2024 | 0 | | 0.00 | 0.02 | 0.00 | 1.07 | 0.01 |
| | 1 | | 0.02 | 0.03 | 0.46 | 0.69 | 0.22 |
| | 2 | | 0.04 | 0.04 | 0.97 | 0.55 | 0.40 |
| | 3 | | 0.05 | 0.05 | 1.00 | 0.48 | 0.51 |
| | 4 | | 0.06 | 0.06 | 0.99 | 0.44 | 0.51 |
| | 5 | | 0.06 | 0.06 | 0.99 | 0.41 | 0.51 |
| | 6+ | | 0.07 | 0.06 | 1.00 | 0.40 | 0.51 |
| 2025 | 0 | | 0.00 | 0.02 | 0.00 | 1.07 | 0.01 |
| | 1 | | 0.02 | 0.03 | 0.46 | 0.69 | 0.22 |
| | 2 | | 0.04 | 0.04 | 0.97 | 0.55 | 0.40 |
| | 3 | | 0.05 | 0.05 | 1.00 | 0.48 | 0.51 |
| | 4 | | 0.06 | 0.06 | 0.99 | 0.44 | 0.51 |
| | 5 | | 0.06 | 0.06 | 0.99 | 0.41 | 0.51 |
| | 6+ | | 0.07 | 0.06 | 1.00 | 0.40 | 0.51 |

**Table 6.4.3. Sardine in 8abd. Catch option table for 2024.**

| Basis | Catch (2025) | F (2025) | SSB (2026) | % SSB change * | % catch change ** | % advice change *** |
|---|---|---|---|---|---|---|
| **ICES advice basis** | | | | | | |
| MSY approach: $F = F_{MSY} * SSB(2024)/ MSY\ B_{trigger}$ | 23667 | 0.42 | 67869 | -6.9 | 1.78 | 19.5 |
| **Other scenarios** | | | | | | |
| F = 0 | 0 | 0.00 | 86497 | 18.7 | -100 | -100 |
| $F = F_{pa} = F_{MSY}$ | 25281 | 0.45 | 66628 | -8.6 | 8.7 | 28 |
| $F = F_{lim}$ | 38406 | 0.76 | 56718 | -22 | 65 | 94 |
| $SSB(2025) = B_{lim}$ | 38971 | 0.77 | 56300 | -23 | 68 | 97 |
| $SSB(2025) = B_{pa} = MSY\ B_{trigger}$ | 9789 | 0.159 | 78700 | 8.0 | -58 | -51 |
| F = F(2024) | 26766 | 0.484 | 65491 | -10 | 15 | 35 |

*** SSB 2026 relative to SSB 2025.**

**** Advised catch for 2025 relative to catch in 2023 (23 253 tonnes).**

***** Advised catch for 2025 relative to advised catch for 2024 (19 811 tonnes).**

The advice for 2025 is higher than the advice for 2024 because of a slight increase in SSB due to a high recruitment in 2023. This increase in SSB led to a higher F value used in the MSY approach (0.42 vs. 0.37 used for the 2024 advice). Also, there has been a decrease in F.

Based on the GM recruitment and *catch assumption* in 2024, SSB in 2026 will stay above $B_{lim}$ but is only above MSY $B_{trigger}$ in the case of targets of closure of the fishery (F=0). SSB in 2026 is expected to decrease compared with the one of 2025 for $F=F_{pa}$. $F=F_{lim}$. F=F(2025). $B_{lim}$ target SSB expected to increase when catch options are the most limiting for 2025: closure and $B_{pa}$ target.

## 6.4.1 Evidence for changes in advice

A comparison of the input data used in the forecast from the current and previous assessments is provided in this section. In Figures 6.4.1.1–6.4.1.3 estimated time series for recruitment, SSB and fishing mortalities for previous and current assessments are shown.

Uncertainties are generally higher for the last two years because the available data of the assessment year are limited to an assumption on preliminary catches and survey data. The data of the previous year are fully consolidated in terms of number and weight-at-age for the commercial fleets. The catches are also final rather than assumed.

This year, the run does not differ substantially from last year's run in terms of SSB, F and R. This is generally what has been observed in previous WGHANSA reports except in 2021 where the lack of PELGAS survey in 2020 was suspected to have a strong impact on the assessment. This year, the runs start to slightly diverge in 2020 for R.

Forecast assumptions from previous and current advice sheets are shown in Table.6.4.1.1.

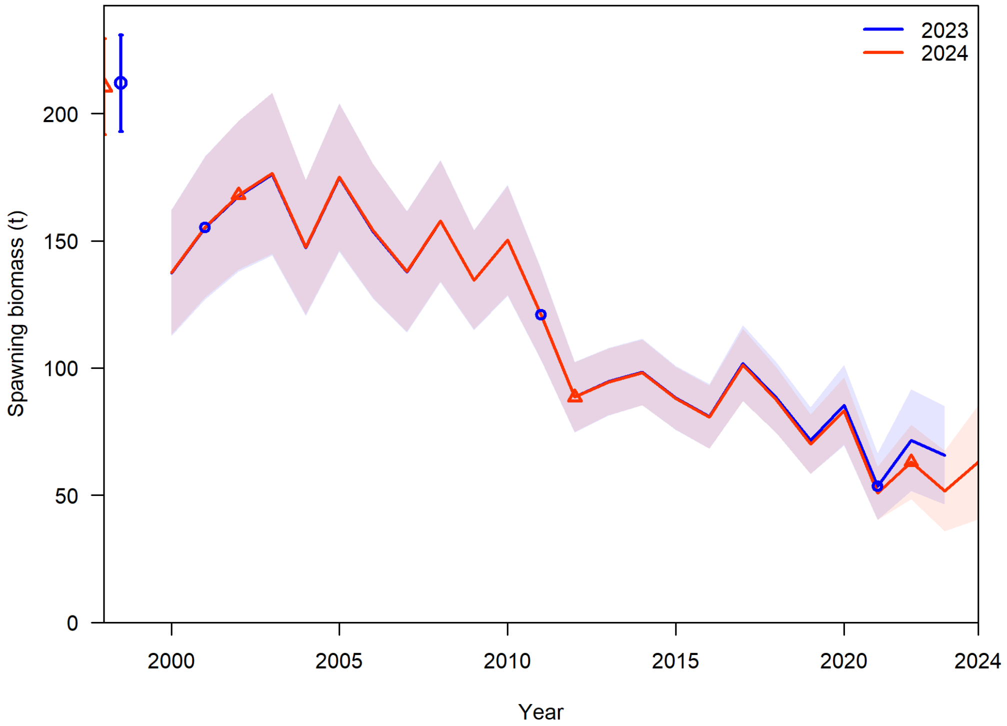



**Figure 6.4.1.1. Sardine in 8abd. Comparison of SSB estimates between this year and the 2023 run.**

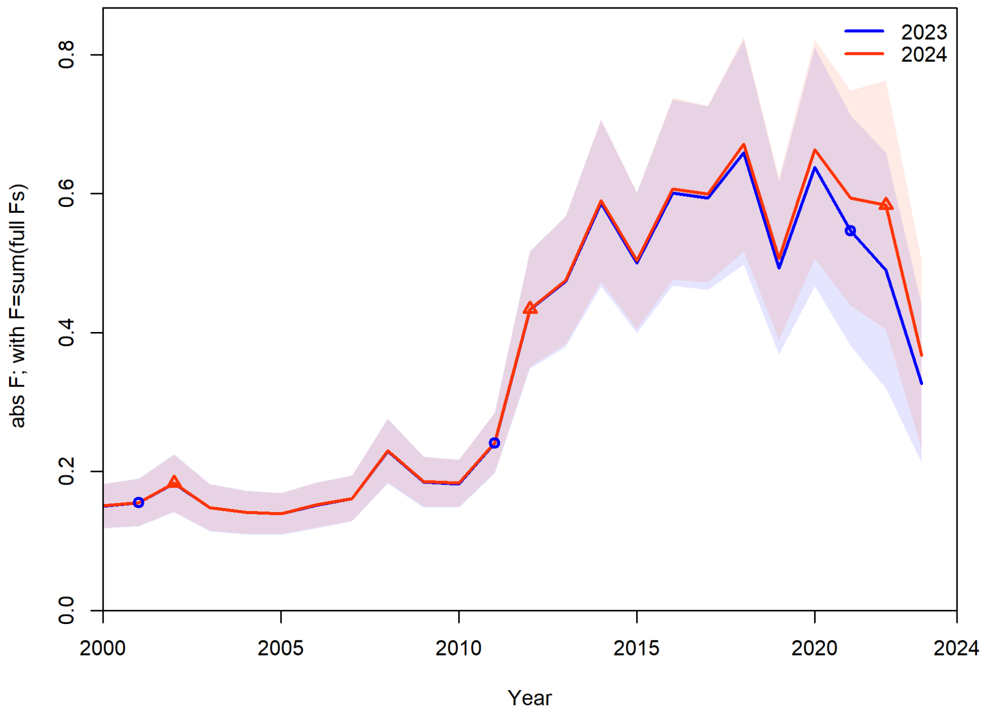



**Figure 6.4.1.2. Sardine in 8abd. Comparison of fishing mortality estimates between this year and the 2023 run.**

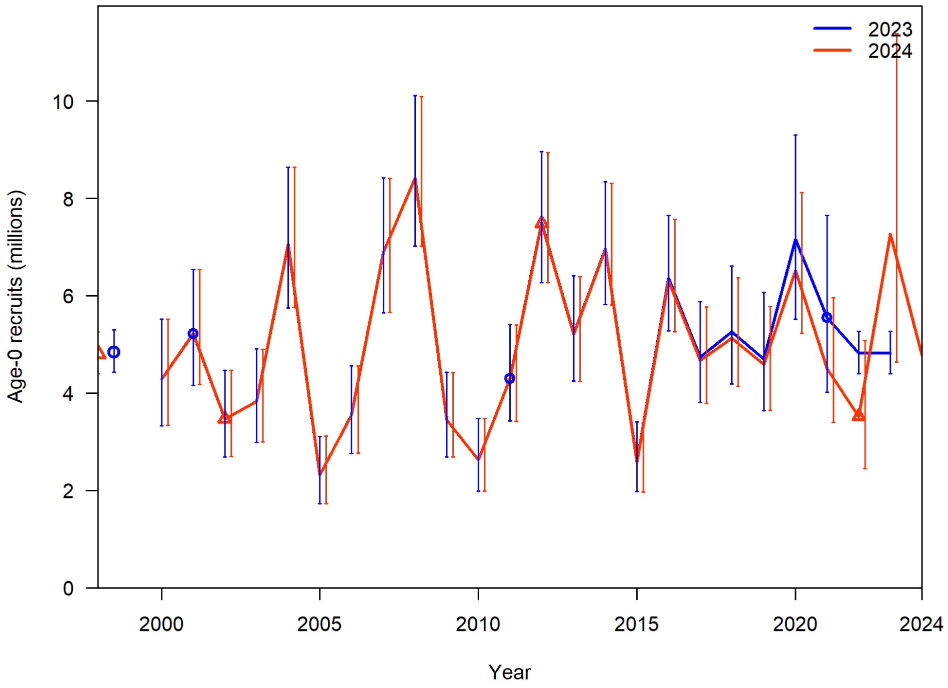



**Figure 6.4.1.3. Sardine in 8abd. Comparison of Recruitment estimates between this year and the 2023 run.**

**Table 6.4.1.1. Sardine in 8abd. Forecast assumptions from previous and current assessments.**

| | Year* | Current assessment (2024) | Previous assessment (2023) |
|---|---|---|---|
| Assumed recruitment | 2023-2024 | 7 252 410 | 4 767 249 |
| | 2024-2025 | 4 708 340 | |
| Catch | 2023 | 23 253 | 26 441 |
| F | 2022 | 0.55 | 0.46 |
| | 2021 | 0.56 | 0.52 |
| Target F for TAC | 2024 | | 0.37 |
| | 2025 | 0.42 | |

***'2023' = Intermediate year in the previous assessment; '2024' = advice year in the previous assessment**

# 6.5 Medium-term projection

No medium-term projections were carried out.

## 6.6 MSY and Biological reference points

As a result of the Inter-benchmark carried out in October 2019. the assessment of this sardine has been upgraded to category 1 and a set of new Biological reference points have been defined. In particular. $B_{lim}$ has been proposed at 35%SBR (ICES 2019). based on considerations of life history and precautionary reference points (Myers *et al*.. 1999; Mace. 1994; Mace and Sissenwine. 1993) and proxies for $F_{MSY}$ based on natural mortality rate (Zhou *et al*.. 2012).

The Inter-benchmark preferred this approach because for this stock 18 pairs of stock and recruitment estimates (2000–2017) covering a narrow range of biomasses (Min/Max=51%) and with no clear indications of impaired recruitment (Figure 6.6.1). Setting $B_{pa}$=$B_{loss}$ led to infer $B_{lim}$ (63 328 t) and afterwards $F_{MSY}$ (0.27) which seemed to be respectively a bit high and low value respectively. On the one hand. such $B_{lim}$ would be above the expected biomass at $F_{0.1}$ (as calculated for this stock in the deterministic yield-per-recruit) and on the other hand $F_{MSY}$ at 0.27 results in a 61%SBR. which is well below the typical $F_{MSY}$ proxies at %SBR of 40% or 50% (Mace. 1994; Horbowy and Luzenczyk. 2012). below $F_{0.1}$. and also below the alternative $F_{MSY}$ proxy of 0.87*M (= 0.44). For these reasons. an alternative definition of $B_{lim}$ from which derived $F_{MSY}$ was looked for. based on %SPR.

Mace (1994) and Mace and Sissenwine (1993) pointed out that for stocks of unknown resilience a more prudent approach would be using F30%B0. Furthermore. in their analysis Mace and Sissenwine (1993) found that pelagic species that reach relatively small maximum size and/or mature at small size. seem to have high replacement %SPR. and the analysis by taxonomic groups suggested a mean replacement %SPR for cupleoids of about 37.5% higher than for other taxonomic groups. Myers *et al*. (1999) also found that the median steepness of cupleoids and engraulidae were intermediate (not in the upper range of values). Therefore. it can be deduced or presumed from a precautionary approach that small pelagic fish may have relatively lower resilience to fishing (Mace and Sinsenwine. 1993). This led the IBP group to set $B_{lim}$ at 35%B0. which was equal to 56 300 t.

Following the ICES guidelines for stocks in Category 1 and 2, the remaining reference points were derived from the former value of $B_{lim}$ (= 56 300 t). Bpa was derived as $B_{pa} = B_{lim} \times \exp(1.645\ \sigma B)$. where $\sigma B$ is the standard deviation of ln(SSB) in the terminal year (2018) ($\sigma B$ = 0.204 rounded to 0.2). Thus. $B_{pa}$ was set at 78 700 tonnes. As unconstrained $F_{MSY}$ in Eqsim resulted in a value (0.621) conditioned to a hockey stick S–R relationship with inflection point at $B_{lim}$ (Figure 6.6.2). Because this $F_{MSY}$ value was higher than $F_{pa}$ (0.539) and higher than $F_{p0.05}$ (0.453) the $F_{MSY}$ value was reduced to $F_{p0.05}$. The final estimate of $F_{MSY}$ (over ages 2–5) (= 0.453) has the property of being consistent with the ideas of Zhou *et al*. (2012) of setting $F_{MSY}$ equal to 0.87·Natural Mortality (=0.44 for this sardine stock).

In 2021, ICES has been revising the definition of reference points. Fpa is now equal to $F_{p0.05}$. Therefore, that value has been updated and used in the short-term forecast this year.

The updated biological and MSY reference points in absolute terms are:

**Table 6.6.1. Sardine in 8abd. Biological Reference points for sardine in 8abd as estimated in ICES 2019.**

| Framework | Reference point | Absolute value | Technical basis |
|---|---|---|---|
| MSY approach | MSY $B_{trigger}$ | 78 700 | $B_{pa}$ |
| | $F_{MSY}$ | 0.453 | $F_{MSY} = F_{p.05}$ . i.e. the F that leads to SSB >$B_{lim}$ with probability 0.95 when including the ICES MSY advice rule |
| Precautionary approach | $B_{lim}$ | 56 300 | 35%SPR. i.e. equilibrium biomass at F that leads to 35% of spawner of recruit without fishing |
| | $B_{pa}$ | 78 700 | $B_{pa} = B_{lim} \times \exp(+1.645 \times \text{sigma})$. where sigma=0.2 |
| | $F_{lim}$ | 0.757 | F that results in 50% probability that SSB is above $B_{lim}$ in the long term. using segmented regression with $B_{lim}$ (EqSim) |
| | $F_{pa}$ | 0.453 | $F_{p0.5}$. The F that leads to SSB ≥ $B_{lim}$ with 95% probability |
| Management plan | $SSB_{MGT}$ | Not applicable | |
| | $F_{MGT}$ | Not applicable | |

All details of the calculations are described in the Inter-benchmark report (ICES, 2019) and in the stock annex. These values are expected to be updated every benchmark or after relevant changes in the selectivity of the fishery are detected.

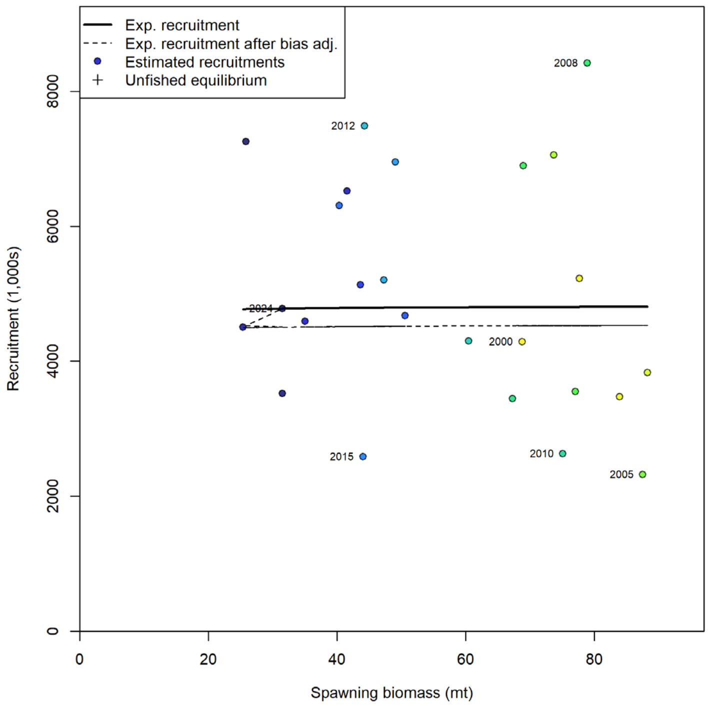



**Figure 6.6.1. Sardine in 8abd. Stock–recruitment relationship for sardine in 8abd used to estimate reference points during the interbenchmark**

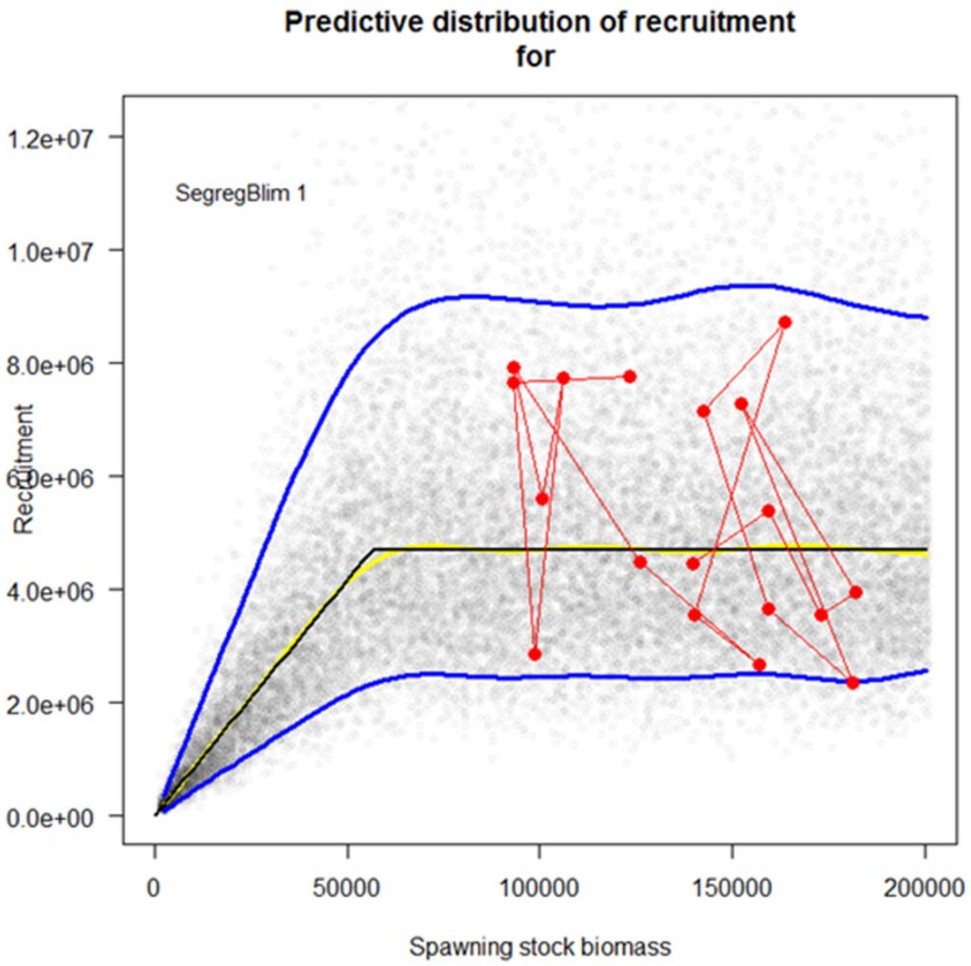



**Figure 6.6.2. Sardine in 8abd. Segmented regression model with the breakpoint fixed at $B_{lim}$ for sardine in 8abd as estimated during the interbenchmark.**

## 6.7 Management plan

There are no specific management objectives or a management plan for this stock at the moment. There is ongoing discussion about a management plan or TAC through the SWWAC for this stock, but the plan has not been formalised yet.

## 6.8 Uncertainties and bias in assessment and forecast

Uncertainties in the assessment relate to the retrospective pattern and relative changes in the perception of the most recent years.

Most of the uncertainties in the forecast comes from the assumption in the intermediate year although the fishery is not expected to increase over the next years.

## 6.9 Management considerations

No TAC is currently set for this stock.

## 6.10 References

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# 7 Sardine (*Sardina pilchardus*) in Subarea 7 (southern Celtic Seas and the English Channel)

## 7.1 Population structure and stock identity

Sardine in Subarea 7 has historically been assessed together with the southern population in the Bay of Biscay (Divisions 8.a, b and d) because no genetic differences were found between both areas (Shaw *et al*., 2012). However, research presented at ICES WKSAR workshop (ICES, 2016) showed that growth rates in the English Channel and Celtic Sea were higher than in the Bay of Biscay; there were separate spawning grounds; and all ages were present in significant abundance in both areas. This research suggests that sardine in the English Channel and Celtic Seas is a self-sustained population, and consequently sardine in Subarea 7 has been considered an independent stock since 2017 (ICES, 2017).

Nevertheless, the degree of mixing occurring with the Bay of Biscay, as well as the boundary between both stocks is still unknown. Similarly, little is known about the extension of the stock in the Eastern Channel and the North Sea. Until new insights are put forward, modelling the population in Subarea 7 as an independent stock seems to be the most appropriate option.

## 7.2 The fishery

### 7.2.1 Analysis of the catch

Sardine landing data in Subarea 7 are available since 1970 but their reliability is doubtful given their high variability across years and nations. Catch data were revised for the period 2002-2019 (ICES, 2021) and therefore data prior 2002 has been excluded from assessment. It must also be noted that French catches from ICES rectangles 25E5 and 25E4 (Subarea 7) have been allocated to Division 8.a, as they occur on the boundary between divisions and are considered to be more closely associated with the sardine stock in divisions 8.a-b and 8.d.

Below minimum size (BMS) landing data have been reported by some countries since 2015. They increased in 2019 and since continue to represent <7% of the total catch. Reported discards represent less than 1% of the catch, and are considered negligible (Figure 7.2.1.1).

Annual landings (i.e. landings and BMS landings) have fluctuated between 6 157 and 29 287 t since 2002, with the highest values being reported at the beginning of the reviewed time-series (Figure 7.2.1.2, Table 7.2.1.1). This large temporal fluctuation in landings is primarily explained by shifts in fleets activity and species targeted over the years (ICES, 2021). Sardine landings were dominated by France, followed by England, Netherlands, and Ireland in the 2000s. However, French landings decreased significantly since 2009 because of the closure of the fishery intended for human consumption in the Seine bay (Eastern Channel) due to PCB contamination. Landings remained lower than 10 000 t between 2009 and 2015 and increased again in 2016 due to a higher contribution from England, Netherlands, and Denmark. Landings from England remain quite stable since then (average English landings since 2016 is 8320t), whereas the contribution from the other countries has are more irregular/opportunistic. Landings in 2022 were 75% higher than in 2021, as UK, Irish and French landings were slightly higher and because the Danish sardine fishery was operating in 2022. Total landings in 2023 were similar to that reported in 2022, however, there was an increase in Irish landings and a decrease in Danish landings.

The fleet and seasonality of the fishery has also changed over the years. The main fleet in the 2000s was midwater otter trawlers, which fished in 7d throughout the whole year (Figures 7.2.1.3, 7.2.1.4. Table 7.2.1.2). Currently it is a seasonal fishery, and most of the sardine landings are caught by purse-seiners in the third and fourth quarters, mainly from 7e. A detailed description of the temporal evolution of the fishery can be found in the stock annex.

UK (England) has reported a minimum of 1483 tonnes caught each year since 2010 under the gear code "GNS_DEF_all_0_0_all", a gillnet gear code. Gillnets would catch at best a negligible quantity of sardine due to the low catchability of sardine with this gear. This is a known error caused during the automated mapping in UK catch reporting databases and as such landings under this gear have been interpreted instead as purse seine landings for the purposes of the ICES advice and reporting.

# 7.3 Biological data

## 7.3.1 Size composition of the catch

Historically, reported biological sampling of sardine from commercial catches has been almost non-existent. Dutch pelagic freezer trawlers operating in the English Channel provided length distribution in 1994, 1996 and annually from 2000; despite these vessels capturing substantial amounts of sardine, the species is not their main target, and the size composition of their catches may not be representative for the sardine population. Other countries have not provided regular comprehensive length or age information due to the lack of national biological sampling scheme and no DCF (data collection framework) requirement regarding the species in Subarea 7.

In 2017, the UK started a self-sampling programme involving the Cornish ringnet fleet, whose catches contribute to more than half of the total landings in recent years. Since fishing season 2017–2018, these vessels have recorded fishing trip information (haul locations, total catches, bycatch, discard, and effort) on dedicated logbooks. In addition, they were asked to collect individual lengths of a subsample approximately four times per month. In parallel, the main processors were asked to provide biological information (length and weight) for every catch.

Some of the data provided by the processors is measured with 1 cm precision whilst some is measured at 0.5 cm precision, which creates a sawtooth pattern in the distribution with multiple peaks in the length distributions for years 2017, 2019 and 2020. Figure 7.3.1.1 shows the combined size distribution provided by the fishing industry without applying a correction for this artefact. The mean size of fish in the landings between 2017 and 2024 ranged from 17.9 cm to 19.9 cm. On average, 16533 length measurements have been provided each year by the industry. The number of sardine samples provided in 2021 and 2022 was fewer than usual (mean 4364) from both fishers and processors.

# 7.4 Fishery-independent information

## 7.4.1 The PELTIC survey

The PELTIC, Pelagic Ecosystem Survey in the western Channel and Celtic Sea, is an autumn acoustic survey conducted by Cefas (UK) and provides biomass estimates for sardine and other small pelagics in Subarea 7. The first surveys (2012-2016) covered only the English waters of ICES areas 7e and all of 7f, but from 2017 survey coverage expanded to include the French waters as well as one-off coverage of waters further north of the core area (2017), part of the eastern English Channel (2018) and Cardigan Bay in the southern Irish Sea (2020 and 2021). The survey follows a typical acoustic survey design with parallel equidistant transects which are covered during daylight only from 2014 onwards. A pelagic trawl is used opportunistically to validate the species and size composition of the acoustic marks detected on the echogram. The methodology used to estimate sardine biomass is described in the stock annex and ICES (2021).

Two biomass indices are calculated from PELTIC (Figure 7.4.1.1): one representing the consistently sampled “Core” Area of the whole time-series (2013 onwards): English waters of the western Channel (excluding the Isles of Scilly) and ICES division 7f (Bristol Channel in the Celtic Sea). The second time-series, called ‘Total area’, is available from 2017 and represents full coverage of ICES divisions 7e (including the Isles of Scilly) and 7f.

The time-series of biomass estimated in the Core area significantly increased between 2017 and 2019, reaching the highest biomass in 2019 with 273 708 tonnes of sardine (Figure 7.4.1.2, Table 7.4.1.1). Biomass dropped in 2020 and 2021 but they are still the second highest values of the time-series. The temporal series of the biomass in the total area (including French side of division 7.e) was very similar, although it showed a slight drop in 2018 compared to 2017 and a 32% decline in 2021 that was not found in the Core area (Figure 7.4.1.2, Table 7.4.1.1).

In 2022 the survey coverage for the PELTIC survey was severely reduced for technical reasons (see Figure 7.4.1.1c). In addition, a survey transect was not covered in the stratum in the west of the survey area. To account for this missing transect a new survey stratum was created, departing slightly from the standard strata used in previous years. The area covered in 2022 is termed the restricted area and constitutes <30% of the standard survey area adopted for the assessment. The area covered is the area where a large proportion of the stock has been found in previous years. The estimated biomass in this restricted area was 175 896 t (CV=0.26). There were a limited number of trawl hauls in this survey which limited the quantity of biological data available. However, the quantity of hauls was considered adequate.

Subsequent PELTIC cruises in 2023 and 2024 were completed with full coverage. In 2024, sardine biomass in the total area was the second highest in the time series (410 861 t). In the core area, sardine biomass was estimated to be 254 761 t which is the third highest value in the 11 year time series.

## 7.5 Stock assessment

The stock was benchmarked in 2021 and upgraded from category 5 to category 3 as the time-series of biomass derived from PELTIC are considered reliable indicators of trends in stock biomass (ICES, 2021). Following the assessment methods described in the stock annex, a surplus production model in continuous time (SPiCT, Pedersen and Berg, 2017) has been run to provide an indication of the status of the stock. The catch advice has then been provided based on the 1-over-2 rule (ICES, 2020a).

### 7.5.1 SPiCT

As for each assessment year since the 2021 benchmark, a quarterly SPiCT model was again run using the settings described in the stock annex. The input data included the time-series of landings (landings and BMS landing) from 2013 to 2023 and the biomass derived from PELTIC for the core area from 2013 to 2024 (Figure 7.5.1.1, Table 7.5.1.1). A prior on the initial depletion level was added to inform the model that the fishery was operating before the beginning of the input data to the model.

A summary of the SPiCT outputs is given in Figure 7.5.1.2 and Table 7.5.1.2. The model indicates that fishing mortality is likely to be below $F_{MSY}$ proxy and the biomass is above the reference $B_{MSY}$* 0.5 proxy. The confidence intervals of both reference points and the absolute values of biomass and fishing mortality remain high, as was the case when the model was run in the 2023 WGHANSA-2 meeting, and therefore these values are still not considered reliable.

The checklist described in Mildenberger et al. (2021) for acceptance of the assessment was followed. The diagnosis of the residuals shows the assumptions of the model are met: the catch and biomass data have normal distributions, and there are not autocorrelation or bias in the data (Figure 7.5.1.3). The retrospective patterns of the model could not be properly analysed given the short time time-series of data. Although the retrospective trajectories for the relative biomass and fishing mortality were inside of the confidence intervals and the Mohn's rho values were small (0.115 and 0.275, respectively), there is a tendency to overestimate biomass and underestimate the fishing mortality (Figure 7.5.1.4). Parameter estimates were influenced by initial values.

### 7.5.2 1-over-2 rule

Following the methods described in the stock annex, the catch advice for this stock is based on the 1-over-2 rule with a symmetric 80% uncertainty cap and a biomass safeguard (ICES, 2020a; ICES, 2020b, ICES, 2024). This harvest control rule is defined as:

$$C_y = \left\{ \begin{Bmatrix} 0.2C_{y-1} & if \ \frac{I_y}{(I_{y-1}+I_{y-2})/2} < 0.2 \\ C_{y-1}\frac{I_y}{(I_{y-1}+I_{y-2})/2} & if \ \ 0.2 \le \frac{I_y}{(I_{y-1}+I_{y-2})/2} \le 1.8 \\ 1.8C_{y-1} & if \ \frac{I_y}{(I_{y-1}+I_{y-2})/2} > 1.8 \end{Bmatrix} \cdot \left[ min\left(1, \frac{Icurrent}{Istat}\right)\right] \right.$$

where $C_y$ and $I_y$ represent the advised catch and the biomass indicator for year $y$, respectively. The first and third cases of the formula correspond to the application of an 80% symmetrical uncertainty cap. The last term in the equation refers to the biomass safeguard based on a trigger index value ($I_{stat}$). If the biomass index falls below $I_{stat,}$ the advised catch will be reduced in proportion to the drop of the biomass index in relation to $I_{stat}$. The biomass estimates derived from PELTIC in the total area were used as the biomass index and the $I_{stat}$ has been estimated as 120 751 t (see section 7.7).

An overview of the application of the 1-over-2 rule is shown in Table 7.5.2.1. The index is estimated to have decreased by 10% and thus the uncertainty cap was not applied. The biomass was estimated to be above $I_{stat}$ and the biomass safeguard was not applied. The resulting catch advice for 2025 is 13 950 tonnes, a 3.6% increase from advised catch in 2024.

## 7.6 Short-term projections

No projections have been carried out for this stock.

## 7.7 Reference points

Table 7.1.1 summarizes the reference points for sardine in Subarea 7 and their technical basis. MSY reference points were not defined for this stock. The $I_{stat}$ reference point represents the biomass safeguard trigger applied into the 1-over-2 rule and is estimated using the biomass index in the total area from 2017 to 2021 (ICES, 2022).

## 7.8 Quality of the assessment

This stock was benchmarked in 2021 and the ICES framework for category 3 short-lived stocks using the 1-over-2 rule with an uncertainty cap of 80% and a biomass safeguard (ICES, 2020a) was considered the most appropriate method to provide advice. However, this harvest control rule leads to a decreasing trend of catch options in time after repeated applications and therefore should be considered as a provisional management approach (ICES, 2020a, ICES, 2020b).

The PELTIC survey in October 2022 only covered approximately 30% of the total area used for the estimation of sardine biomass due to technical issues. The total area accepted for use in the assessment has been sampled since 2017. The 2022 coverage was also slightly smaller than the 'core' area which has been sampled since 2013. An estimate of the biomass in the total area was undertaken by raising the area covered in 2022 to the 'core' area and then raising the core area estimate to the total area. This estimate utilized the available information to the WG and remains consistent with the PELTIC biomass increase seen between 2021 and 2023.

French catches from ICES rectangles 25E5 and 25E4 (Subarea 7) have been traditionally allocated to division 8.a, as they occur on the boundary between divisions, and are considered to be more closely associated with the sardine stock in divisions 8.a-b and 8.d. In 2023, 7359 t were reallocated to Subarea 8, which was 48% of the remaining total catches in Subarea 7. However, the boundary between sardine stocks in Subarea 7 and 8 is unclear and further studies are needed to support this procedure to allocate catches. Results presented at WGACEGG indicate that the genetic identity of Sardine across subareas 7 and 8 is an active area of research, however it is expected that a multidisciplinary approach may also help improve certainty over stock boundaries. This process may benefit from studies on otolith microchemistry, drift modelling, morphometrics (including growth rates and life history parameters) or other similar indicative evidence.

## 7.9 Management considerations

This is a non-quota stock and there are no management measures implemented at international level. Nevertheless, the Cornish Sardine Management Association (a partnership between the owners of 15 vessels and four local seafood processors in England) has agreed specific regulations since 2018 for the sardine fishery around the Cornwall coast (UK) as it is subject to an MSC (Marine Stewardship Council) certification.

The 1-over-2 rule performs the best when there is no time-lag between the survey producing the biomass estimate and the TAC implementation (ICES, 2020a, ICES, 2020b). This is especially important for short-lived species, as part of the observed stock will not be available for the fishery when there is a large lag in time. The PELTIC survey is conducted in October and the biomass estimate is already incorporated in the catch advice for the following year, with a time-lag of only two months. Since 2021 the catch advice is provided annually.

## 7.10 References

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## 7.11 Tables

**Table 7.2.1.1. Sardine in Subarea 7. Landings reported by country (tonnes)***

| | France** | UK | Nether-lands | Ireland | Germany | Denmark | Lithuania | Belgium | Spain | Poland | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1970 | 1014 | 890 | 38 | 0 | 2112 | 0 | 0 | 0 | 0 | 0 | 4054 |
| 1971 | 1350 | 1242 | 108 | 0 | 3362 | 0 | 0 | 0 | 0 | 0 | 6062 |
| 1972 | 1297 | 2190 | 54 | 0 | 1553 | 0 | 0 | 0 | 0 | 0 | 5094 |
| 1973 | 1603 | 2375 | 17 | 0 | 2577 | 0 | 0 | 0 | 0 | 0 | 6572 |
| 1974 | 833 | 1280 | 15 | 0 | 1826 | 0 | 0 | 0 | 0 | 0 | 3954 |
| 1975 | 678 | 6 | 561 | 0 | 4043 | 0 | 0 | 0 | 0 | 0 | 5288 |
| 1976 | 1284 | 3 | 127 | 0 | 2346 | 0 | 0 | 0 | 0 | 0 | 3760 |
| 1977 | 3544 | 10778 | 623 | 0 | 183 | 0 | 0 | 0 | 0 | 0 | 15128 |
| 1978 | 2773 | 549 | 1523 | 0 | 1463 | 0 | 0 | 0 | 0 | 0 | 6308 |
| 1979 | 3247 | 46 | 1321 | 0 | 1188 | 0 | 0 | 0 | 0 | 0 | 5802 |
| 1980 | 3573 | 753 | 1131 | 0 | 79 | 0 | 0 | 0 | 0 | 0 | 5536 |
| 1981 | 1125 | 35 | 553 | 0 | 0 | 4471 | 0 | 0 | 0 | 0 | 6184 |
| 1982 | 908 | 141 | 928 | 0 | 0 | 1311 | 0 | 0 | 0 | 0 | 3288 |
| 1983 | 802 | 6 | 795 | 0 | 19 | 4743 | 0 | 0 | 0 | 0 | 6365 |
| 1984 | 817 | 1 | 0 | 0 | 0 | 1210 | 0 | 0 | 0 | 0 | 2028 |
| 1985 | 2089 | 20 | 0 | 0 | 0 | 3111 | 0 | 0 | 0 | 0 | 5220 |
| 1986 | 2570 | 30 | 0 | 0 | 0 | 3602 | 0 | 0 | 0 | 0 | 6202 |
| 1987 | 965 | 124 | 0 | 0 | 0 | 1573 | 0 | 0 | 0 | 0 | 2662 |
| 1988 | 2586 | 0 | 0 | 0 | 0 | 3234 | 0 | 0 | 0 | 0 | 5820 |
| 1989 | 1219 | 1660 | 11 | 0 | 0 | 4667 | 0 | 0 | 0 | 0 | 7557 |
| 1990 | 1128 | 2078 | 6 | 0 | 107 | 6113 | 0 | 0 | 0 | 0 | 9432 |
| 1991 | 1963 | 2952 | 0 | 0 | 8 | 4462 | 0 | 0 | 0 | 0 | 9385 |
| 1992 | 1777 | 4493 | 41 | 0 | 4 | 17843 | 0 | 0 | 0 | 0 | 24158 |
| 1993 | 1135 | 4917 | 109 | 0 | 0 | 13395 | 0 | 0 | 0 | 0 | 19556 |
| 1994 | 1285 | 2081 | 20 | 0 | 2 | 20804 | 0 | 0 | 0 | 0 | 24192 |
| 1995 | 1282 | 7133 | 107 | 0 | 66 | 9603 | 0 | 0 | 0 | 0 | 18191 |
| 1996 | 1563 | 7304 | 48 | 0 | 0 | 1396 | 0 | 0 | 0 | 0 | 10311 |
| 1997 | 3346 | 7280 | 411 | 0 | 13 | 1124 | 0 | 0 | 0 | 0 | 12174 |
| 1998 | 1974 | 6873 | 1647 | 192 | 100 | 14316 | 0 | 0 | 0 | 0 | 25102 |
| 1999 | 119 | 4815 | 5166 | 2375 | 146 | 3490 | 0 | 0 | 8 | 0 | 16119 |
| 2000 | 4074 | 4353 | 6586 | 354 | 436 | 1682 | 0 | 0 | 0 | 0 | 17485 |
| 2001 | 8589 | 10375 | 6609 | 1060 | 454 | 0 | 0 | 0 | 0 | 0 | 27087 |
| 2002 | 7977 | 7858 | 1905 | 11417 | 130 | 0 | 0 | 0 | 10 | 0 | 29297 |
| 2003 | 8186 | 4150 | 6897 | 4030 | 13 | 0 | 0 | 0 | 0 | 0 | 23276 |
| 2004 | 7807 | 2389 | 2187 | 2046 | 60 | 0 | 0 | 0 | 0 | 0 | 14489 |
| 2005 | 10605 | 3457 | 2231 | 922 | 140 | 0 | 0 | 0 | 5 | 0 | 17360 |
| 2006 | 11120 | 1925 | 2287 | 2416 | 246 | 0 | 0 | 0 | 2 | 0 | 17996 |

| | France** | UK | Nether-lands | Ireland | Germany | Denmark | Lithuania | Belgium | Spain | Poland | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2007 | 7315 | 2655 | 1106 | 28 | 0 | 4 | 0 | 0 | 0 | 0 | 11108 |
| 2008 | 8562 | 3470 | 2073 | 473 | 43 | 53 | 0 | 0 | 0 | 0 | 14674 |
| 2009 | 3918 | 2568 | 3406 | 65 | 0 | 0 | 0 | 0 | 0 | 0 | 9957 |
| 2010 | 706 | 2540 | 6645 | 50 | 62 | 13 | 0 | 0 | 0 | 0 | 10016 |
| 2011 | 237 | 3614 | 513 | 1966 | 5 | 3 | 0 | 0 | 0 | 0 | 6338 |
| 2012 | 372 | 4423 | 1637 | 16 | 587 | 40 | 0 | 0 | 0 | 0 | 7075 |
| 2013 | 1703 | 3722 | 1739 | 473 | 214 | 40 | 0 | 0 | 0 | 0 | 7891 |
| 2014 | 1100 | 3893 | 193 | 0 | 18 | 953 | 0 | 0 | 0 | 0 | 6157 |
| 2015 | 1208 | 4301 | 1171 | 555 | 1551 | 1011 | 0 | 0 | 0 | 0 | 9797 |
| 2016 | 925 | 9389 | 4697 | 464 | 1941 | 2286 | 1 | 1 | 0 | 0 | 19704 |
| 2017 | 820 | 7596 | 0 | 329 | 1475 | 2460 | 0 | 0 | 0 | 0 | 12680 |
| 2018 | 606 | 8143 | 811 | 89 | 758 | 263 | 0 | 1 | 0 | 0 | 10671 |
| 2019 | 671 | 7050 | 90 | 33 | 53 | 0 | 40 | 0 | 0 | 0 | 7937 |
| 2020 | 592 | 9500 | 185 | 58 | 0 | 3217 | 0 | 0 | 0 | 1 | 13553 |
| 2021 | 743 | 7074 | 111 | 509 | 0 | 89 | 0 | 0 | 0 | 743 | 8524 |
| 2022 | 1393 | 8549 | 89 | 993 | 2 | 3151 | 0 | 1 | 0 | 0 | 14178 |
| 2023 | 1762 | 9260 | 925 | 3094 | 0 | 278 | 0 | 0 | 0 | 0 | 15319 |

***Catch data prior 2002 has not been revised and they are not used in the assessment.**

****French catches from ICES rectangles 25E5 and 25E4 are not included.**

**Table 7.2.1.2. Sardine in Subarea 7. Landings by ICES division (tonnes).**

| | 7.d | 7.e | 7.f | 7.g | 7.h | 7.j | 7.a | 7.b | Unallocated |
|---|---|---|---|---|---|---|---|---|---|
| 2002 | 9756 | 18035 | 35 | 164 | 1253 | 44 | 0 | 0 | 0 |
| 2003 | 15478 | 6815 | 2 | 321 | 255 | 123 | 279 | 4 | 0 |
| 2004 | 10001 | 2450 | 158 | 552 | 90 | 36 | 856 | 346 | 0 |
| 2005 | 12561 | 3464 | 204 | 64 | 182 | 636 | 224 | 20 | 0 |
| 2006 | 14116 | 1950 | 395 | 250 | 394 | 786 | 78 | 24 | 0 |
| 2007 | 8480 | 1592 | 993 | 0 | 14 | 28 | 0 | 0 | 0 |
| 2008 | 9395 | 3225 | 1579 | 365 | 1 | 100 | 0 | 10 | 0 |
| 2009 | 6389 | 2568 | 932 | 0 | 2 | 63 | 0 | 2 | 0 |
| 2010 | 7123 | 1706 | 1083 | 0 | 55 | 36 | 14 | 0 | 0 |
| 2011 | 759 | 1639 | 1884 | 1394 | 89 | 129 | 443 | 0 | 0 |
| 2012 | 943 | 3609 | 1555 | 0 | 952 | 0 | 16 | 0 | 0 |
| 2013 | 2431 | 3549 | 1095 | 473 | 342 | 0 | 0 | 0 | 0 |
| 2014 | 1442 | 3018 | 1698 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2015 | 1476 | 6635 | 1604 | 10 | 66 | 6 | 0 | 0 | 0 |
| 2016 | 1478 | 9868 | 3026 | 163 | 169 | 301 | 0 | 0 | 4697 |
| 2017 | 3226 | 7421 | 1704 | 281 | 1 | 48 | 0 | 0 | 0 |
| 2018 | 1335 | 6013 | 2413 | 79 | 10 | 10 | 0 | 0 | 811 |
| 2019 | 888 | 5009 | 2007 | 34 | 0 | 0 | 0 | 0 | 0 |
| 2020 | 640 | 7615 | 3638 | 58 | 1601 | 0 | 0 | 0 | 0 |
| 2021 | 867 | 3737 | 3305 | 76 | 97 | 441 | 0 | 0 | 0 |
| 2022 | 1981 | 6255 | 4227 | 379 | 718 | 616 | 1.8 | 0 | 0 |
| 2023 | 2681 | 5372 | 4172 | 1063 | 0 | 1673 | 358 | 0 | 0 |

**Table 7.4.1.1. Sardine in Subarea 7. Time-series of biomass (t) and abundance (1000s individuals) estimated from the acoustic survey PELTIC in the core and total area.**

| | Core Area | | | | Total Area | | | |
|---|---|---|---|---|---|---|---|---|
| | Biomass | | Abundance | | Biomass | | Abundance | |
| | Estimate | CV | Estimate | CV | Estimate | CV | Estimate | CV |
| 2013 | 48391 | 0.33 | 924300 | 0.18 | | | | |
| 2014 | 121171 | 0.32 | 3072930 | 0.23 | | | | |
| 2015 | 134907 | 0.22 | 3332244 | 0.41 | | | | |
| 2016 | 89918 | 0.34 | 2121684 | 0.23 | | | | |
| 2017 | 95298 | 0.11 | 4101091 | 0.13 | 174637 | 0.20 | 10163984 | 0.16 |
| 2018 | 123003 | 0.14 | 3317972 | 0.14 | 145514 | 0.12 | 4300528 | 0.12 |
| 2019 | 273708 | 0.21 | 11256581 | 0.18 | 374617 | 0.19 | 15409434 | 0.15 |
| 2020 | 178781 | 0.31 | 3713016 | 0.29 | 332098 | 0.20 | 6476230 | 0.18 |
| 2021 | 174375 | 0.28 | 5977676 | 0.28 | 227117 | 0.19 | 8714354 | 0.26 |
| 2022* | 222889 | | | | 336306 | | | |
| 2023 | 265223 | 0.22 | | | 456482 | 0.19 | | |
| 2024 | 254761 | 0.21 | | | 410861 | 0.13 | | |

***Biomass estimate raised from the restricted area coverage for the 2022 PELTIC survey and uncertainty estimates are not available.**

**Table 7.4.2.1. Sardine in Subarea 7. PELTIC survey biomass estimates and raising factors and used to estimate the core and total area for Sardine in Subarea 7 in 2022.**

| Year | Survey biomass (t) in core area | Survey biomass (t) in full area | Survey biomass (t) in restricted area | Multiplier (average 2020-2021) for restricted area to core area | Multiplier (average 2017-2021) for core area to total area |
|---|---|---|---|---|---|
| 2013 | 48 391 | | | | |
| 2014 | 121 171 | | | | |
| 2015 | 134 907 | | | | |
| 2016 | 89 918 | | | | |
| 2017 | 95 298 | 174 637 | | | |
| 2018 | 123 003 | 145 514 | | | |
| 2019 | 273 708 | 374 617 | | | |
| 2020 | 178 781 | 332 098 | 157 799 | | |
| 2021 | 174 375 | 227 117 | 124 433 | | |
| 2022 | 222 889* | 336 306* | 175 896 | 1.267 | 1.509 |

***Estimated values**

**Table 7.5.1.1. Sardine in Subarea 7. Assessment summary. The high and low columns represent the 95% confidence intervals of the biomass index. All values are in tonnes.**

| Year | Biomass index (total area) | High | Low | Landings | Discards | BMS landing |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| 2002 | | | | 29287 | 190 | |
| 2003 | | | | 23276 | 10 | |
| 2004 | | | | 14488 | 737 | |
| 2005 | | | | 17354 | 377 | |
| 2006 | | | | 17994 | 785 | |
| 2007 | | | | 11108 | 15 | |
| 2008 | | | | 14675 | 51 | |
| 2009 | | | | 9957 | 40 | |
| 2010 | | | | 10017 | 4 | |
| 2011 | | | | 6337 | 275 | |
| 2012 | | | | 7075 | 342 | |
| 2013 | | | | 7891 | 91 | |
| 2014 | | | | 6157 | 0 | |
| 2015 | | | | 9783 | | 15 |
| 2016 | | | | 19634 | | 68 |
| 2017 | 176696 | 248358 | 105035 | 12662 | 28 | 18 |
| 2018 | 143845 | 178548 | 109141 | 10670 | 16 | 1 |
| 2019 | 358028 | 490975 | 225081 | 7317 | 111 | 620 |
| 2020 | 285564 | 402929 | 168200 | 12852 | | 701 |
| 2021 | 212772 | 292836 | 132707 | 8155 | | 370 |
| 2022 | 336306* | ** | ** | 14178 | | |
| 2023 | 456482 | 627206 | 285757 | 15309 | 11 | 10 |
| 2024 | 410861 | 502285 | 325829 | | | |

*** Raised estimate.**

**** No uncertainty estimates were available.**

**Table 7.5.1.2. Sardine in Subarea 7. Summary outputs of the SPiCT model.**

```
Convergence: 0  MSG: relative convergence (4)
Objective function at optimum: 51.0412452
Euler time step (years):  1/16 or 0.0625
Nobs C: 44,  Nobs I1: 12

Priors
 logbkfrac  ~  dnorm[log(0.5), 0.5^2]
      logn  ~  dnorm[log(2), 2^2]
  logalpha  ~  dnorm[log(1), 2^2]
   logbeta  ~  dnorm[log(1), 2^2]

Model parameter estimates w 95% CI
            estimate       cilow        ciupp    log.est
 alpha  5.340372e+00   0.6255432 4.559169e+01  1.6752953
 beta   2.366216e+00   0.3944923 1.419287e+01  0.8612920
 r      9.352495e-01   0.0102736 8.513977e+01 -0.0669420
 rc     4.451751e-01   0.0113826 1.741081e+01 -0.8092877
 rold   2.921089e-01   0.0074359 1.147501e+01 -1.2306288
 m      2.375926e+04 696.0975982 8.109528e+05 10.0757275
 K      1.671277e+05 124.7758572 2.238548e+08 12.0265135
 q      1.501997e+00   0.0008302 2.717254e+03  0.4067958
 n      4.201716e+00   0.4163776 4.240001e+01  1.4354929
 sdb    5.359900e-02   0.0064148 4.478493e-01 -2.9262258
 sdf    2.065664e-01   0.0392550 1.086988e+00 -1.5771332
 sdi    2.862383e-01   0.1800803 4.549768e-01 -1.2509305
 sdc    4.887808e-01   0.3778232 6.323239e-01 -0.7158413
 phi1   2.367891e-01   0.0772693 7.256318e-01 -1.4405853
 phi2   2.921280e-02   0.0155396 5.491690e-02 -3.5331480
 phi3   8.613894e-01   0.2981127 2.488964e+00 -0.1492086

Deterministic reference points (Drp)
           estimate       cilow        ciupp   log.est
 Bmsyd 1.067412e+05  83.9139553 1.357781e+08 11.578162
 Fmsyd 2.225875e-01   0.0056913 8.705407e+00 -1.502435
 MSYd  2.375926e+04 696.0975982 8.109528e+05 10.075727
Stochastic reference points (Srp)
           estimate       cilow        ciupp   log.est rel.diff.Drp
 Bmsys 1.061983e+05  83.7682971 1.346341e+08 11.573063 -0.005112488
 Fmsys 2.203241e-01   0.0055088 8.811805e+00 -1.512656 -0.010273165
 MSYs  2.339680e+04 705.8097046 7.755779e+05 10.060355 -0.015491610

States w 95% CI (inp$msytype: s)
                    estimate      cilow        ciupp    log.est
 B_2024.75      1.482022e+05 81.1434390 2.706797e+08 11.9063326
 F_2024.75      8.838540e-02  0.0000582 1.343417e+02 -2.4260488
 B_2024.75/Bmsy 1.395524e+00  0.8222523 2.368478e+00  0.3332697
 F_2024.75/Fmsy 4.011607e-01  0.0097493 1.650676e+01 -0.9133931

Predictions w 95% CI (inp$msytype: s)
                  prediction        cilow        ciupp    log.est
 B_2026.00      1.460585e+05   65.0725159 3.278354e+08 11.8917622
 F_2026.00      8.838550e-02    0.0000573 1.362308e+02 -2.4260477
 B_2026.00/Bmsy 1.375338e+00    0.6860137 2.757312e+00  0.3186993
 F_2026.00/Fmsy 4.011612e-01    0.0094853 1.696620e+01 -0.9133919
 Catch_2025.00  1.307336e+04 6388.4364724 2.675345e+04  9.4783318
 E(B_inf)       1.543650e+05           NA           NA 11.9470750
```

**Table 7.5.2.1. Sardine in Subarea 7. The basis for the catch scenarios*.**

| | |
|---|---|
| **Index A (2024)** | 410861 tonnes |
| **Index B (2022–2023)** | 396394 tonnes |
| **Index ratio (A/B)** | 1.036 |
| **Biomass safeguard (Istat)** | Not applicable |
| **Uncertainty cap** | Not applied |
| **Catch advice 2024** | 13459 tonnes |
| **Discard rate** | Negligible |
| **Catch advice 2025 **** | 13950 tonnes |
| **% advice change** | +3.6 % |

***The figures in the table are rounded. Calculations were done with unrounded inputs, and computed values may not match exactly when calculated using the rounded figures in the table.**
****[Advice for 2024] x [Index ratio]**

**Table 7.7.1. Sardine in divisions 8.a–b and 8.d. Reference points, values, and their technical basis.**

| Framework | Reference point | Value | Technical basis | Source |
|---|---|---|---|---|
| MSY approach | MSY $B_{trigger}$ | Not defined | | |
| | $F_{MSY}$ | Not defined | | |
| Precautionary approach | $I_{stat}$ | 120 751 tonnes | Geomean(Ihist) × exp(−1.645 × sd(log(Ihist)); Ihist is the available historical series of the abundance index (2017–2021) | (ICES, 2022) |
| | $B_{lim}$, $B_{pa}$ | Not de- | | |
| | $F_{lim}$ | Not defined | | |
| | $F_{pa}$ | Not defined | | |
| Management plan | $SSB_{MGT}$ | Not defined | | |
| | $F_{MGT}$ | Not defined | | |

## 7.12 Figures

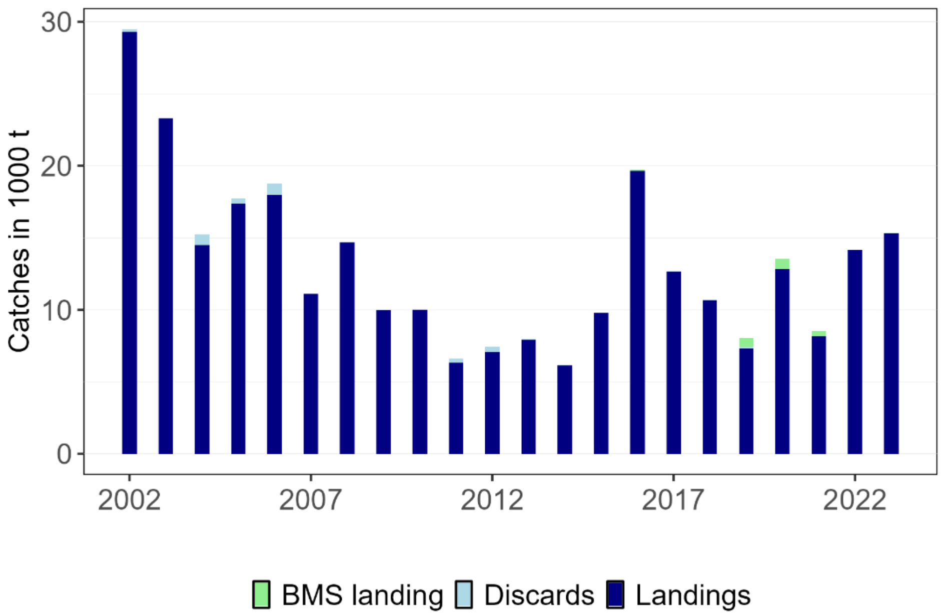


**Figure 7.2.1.1. Sardine in Subarea 7. Catches by category (tonnes).**

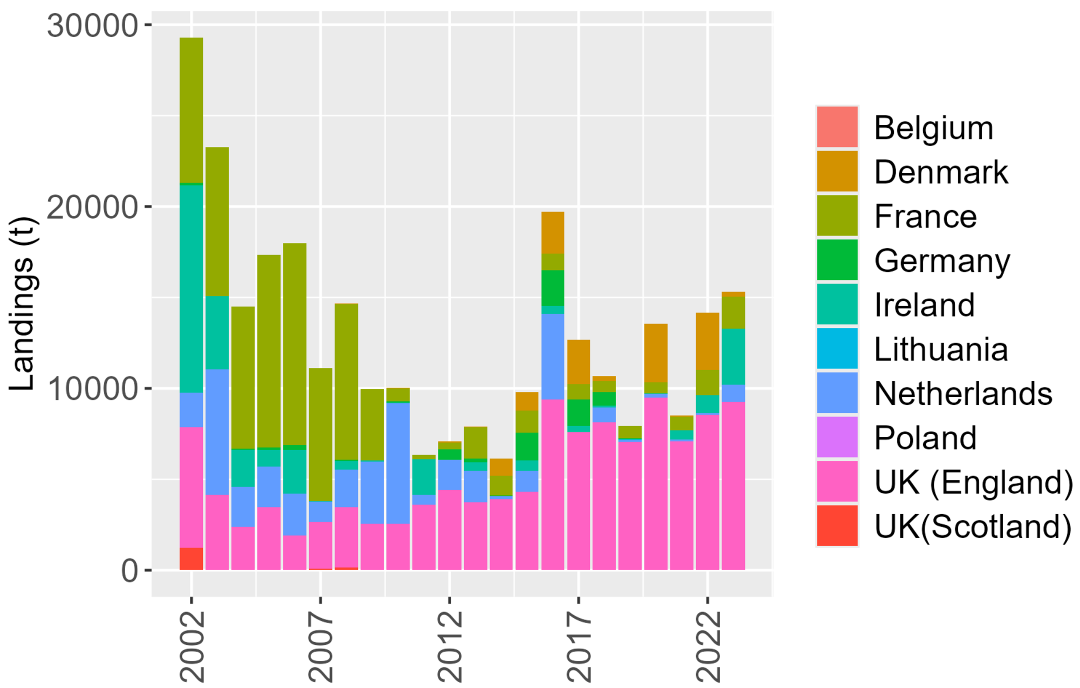


**Figure 7.2.1.2. Sardine in Subarea 7. Landings reported by country (tonnes).**

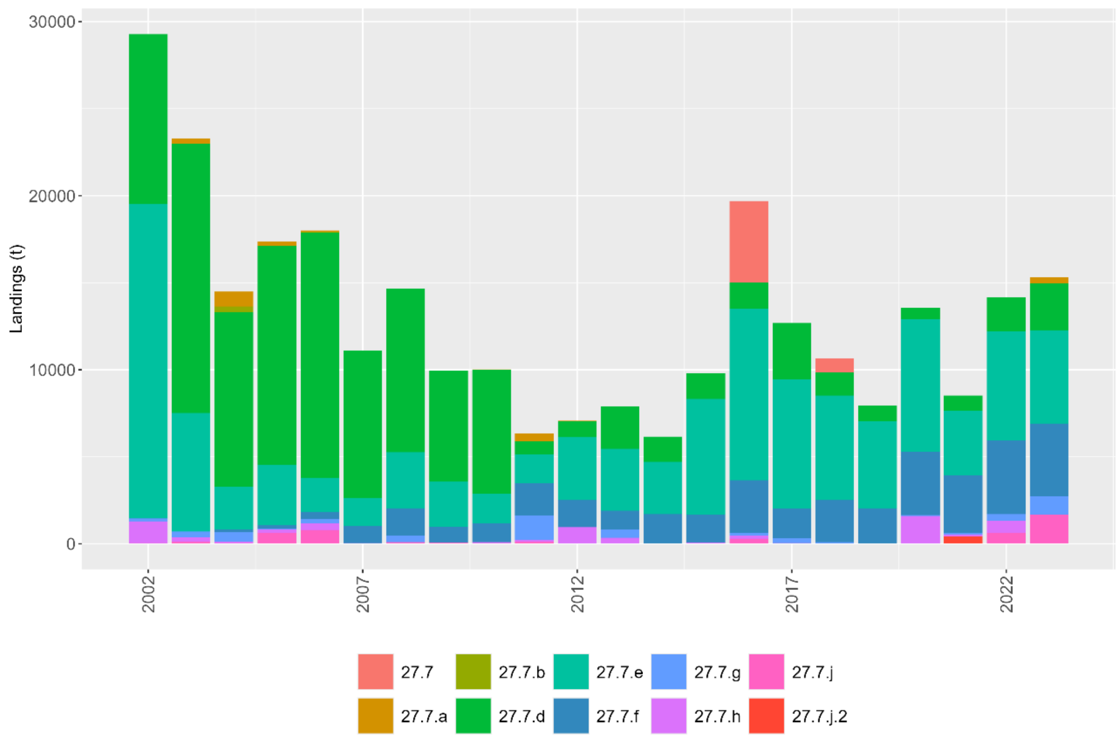


**Figure 7.2.1.3. Sardine in Subarea 7. Landings by ICES division (tonnes).**

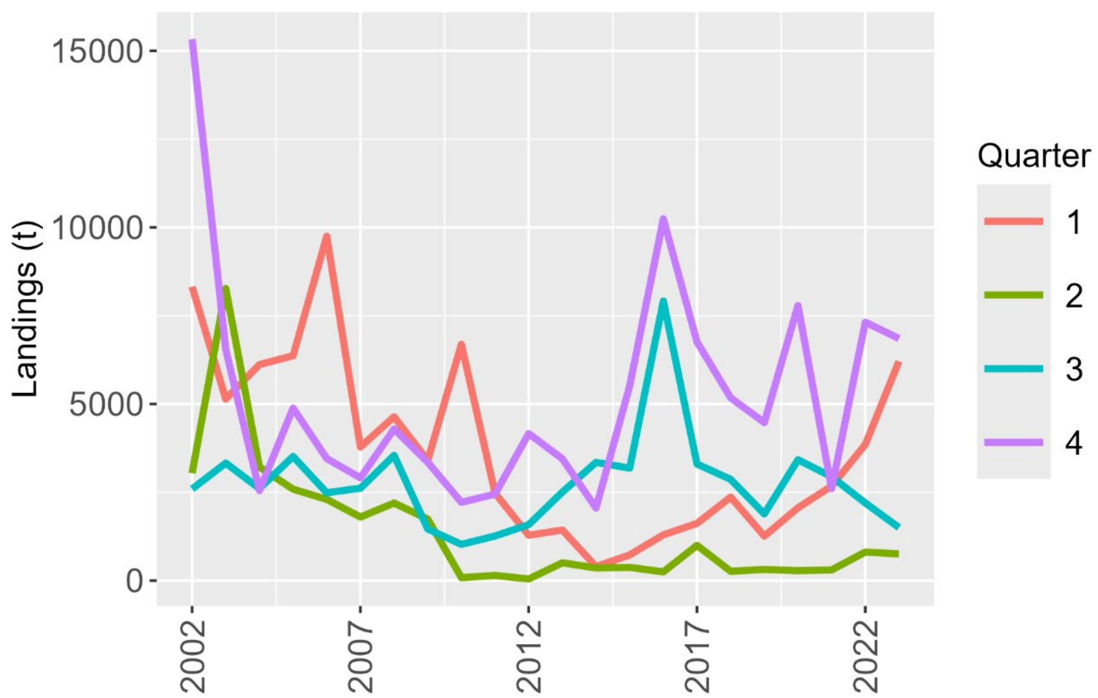


**Figure 7.2.1.4. Sardine in Subarea 7. Landings by quarter (tonnes).**

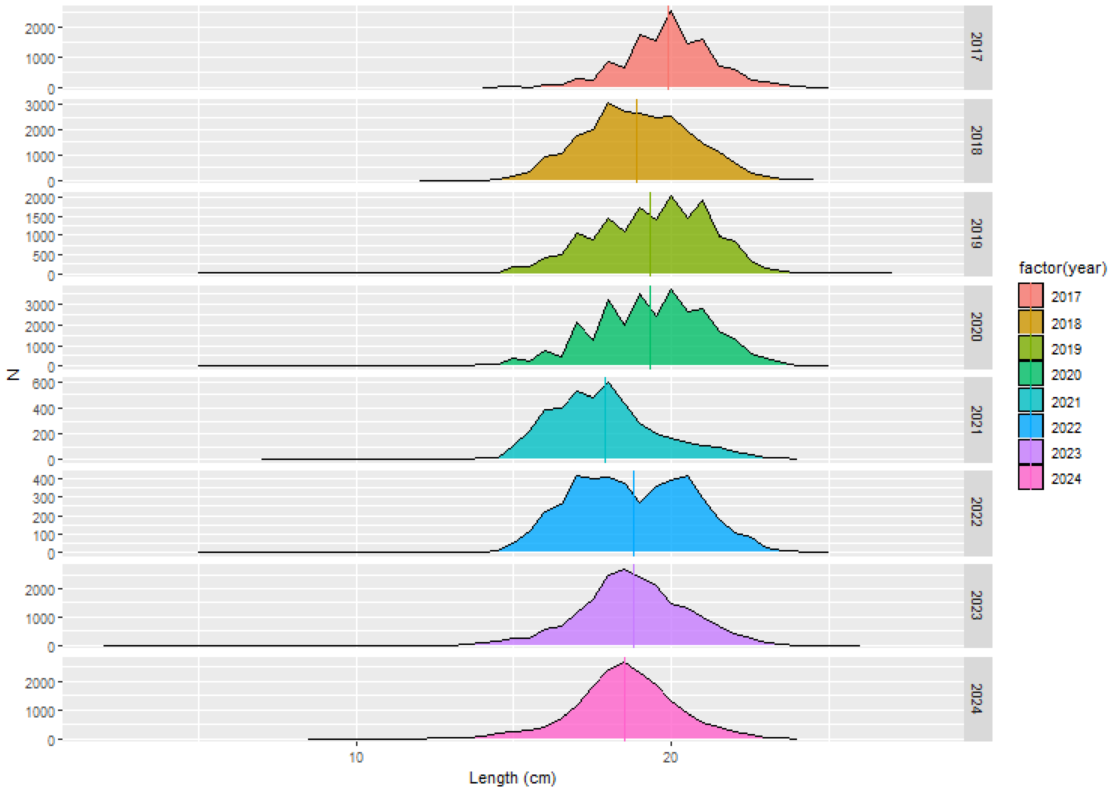


**Figure 7.3.1.1. Sardine in Subarea 7. Length distribution of landings provided by the English fishing industry.**

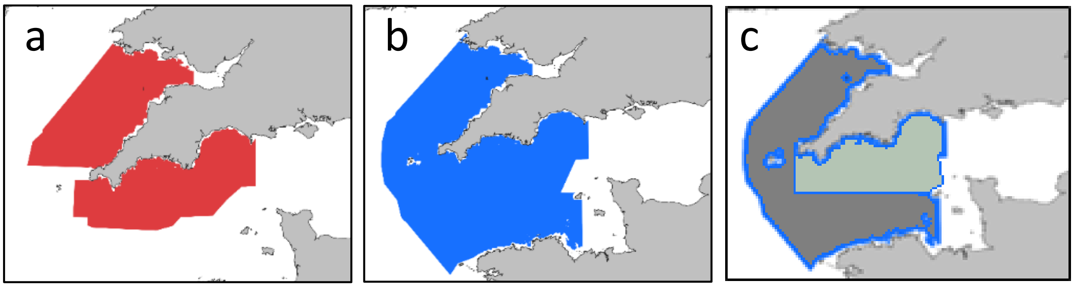


**Figure 7.4.1.1. Sardine in Subarea 7. a) PELTIC coverage of core area 2013-2023; b) PELTIC coverage of total area 2017-2023 and; c) PELTIC coverage of reduced survey extent in 2022.**

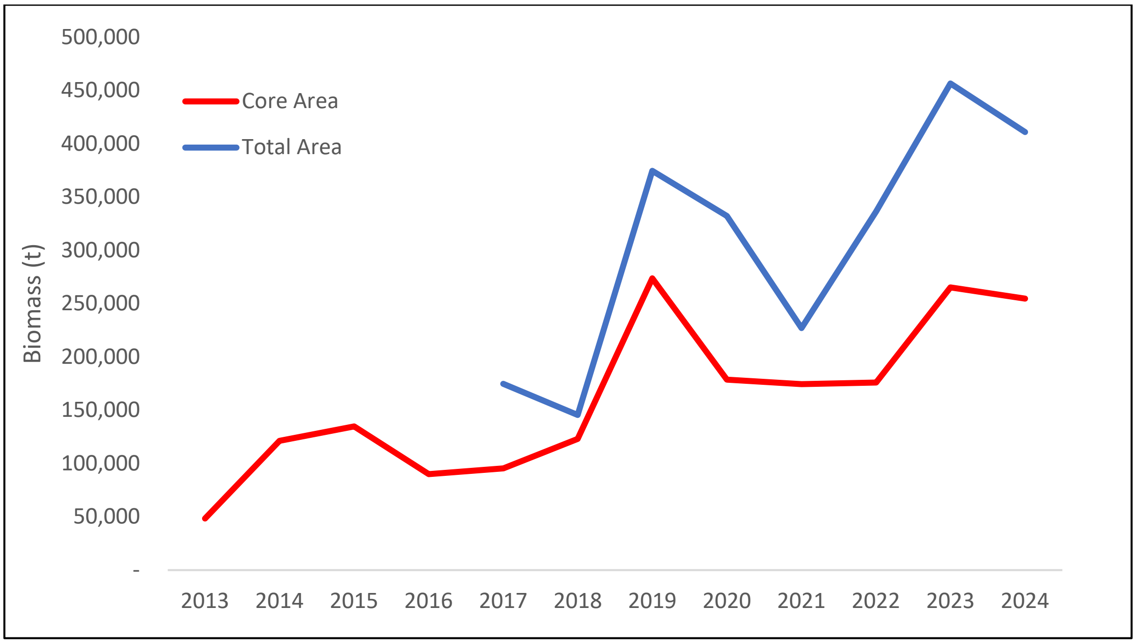


**Figure 7.4.1.2. Sardine in Subarea 7. Sardine biomass in tonnes estimated from PELTIC survey in the core area (red line), covering division 7.f and English waters of 7.e and in the total area (blue line), covering division 7.f and 7.e (also French side). Biomass for both the core and total areas in 2022 are raised estimates using the biomass index for the restricted area sampled in 2022.**

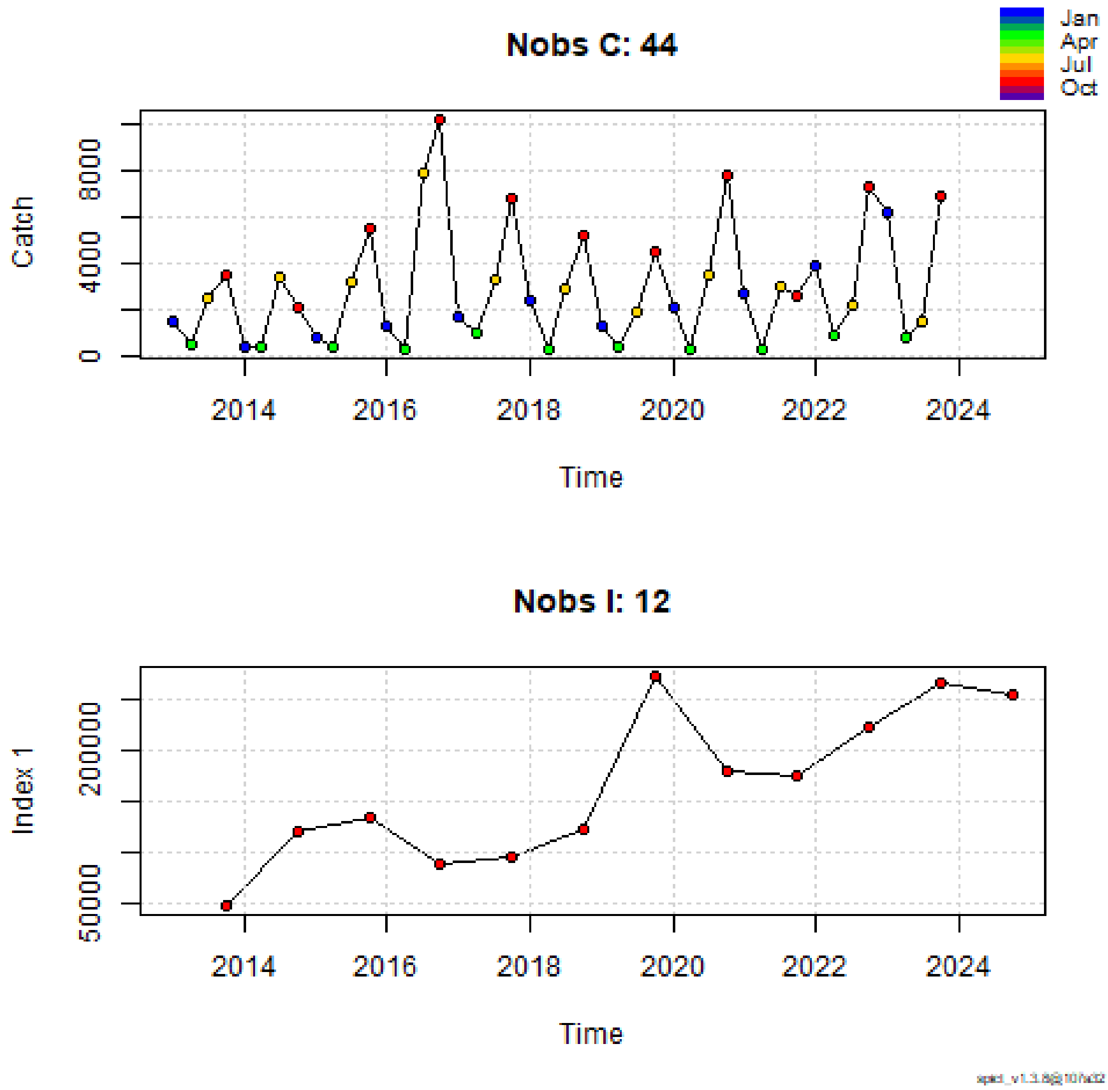


**Figure 7.5.1.1. Sardine in Subarea 7. Input data of the SPiCT model. Top: landings by quarter (2013-2023). Bottom: biomass estimates in the core area (2013-2024). Blue represents quarter 1, green represents quarter 2, yellow represents quarter 3, and red represents quarter 4.**

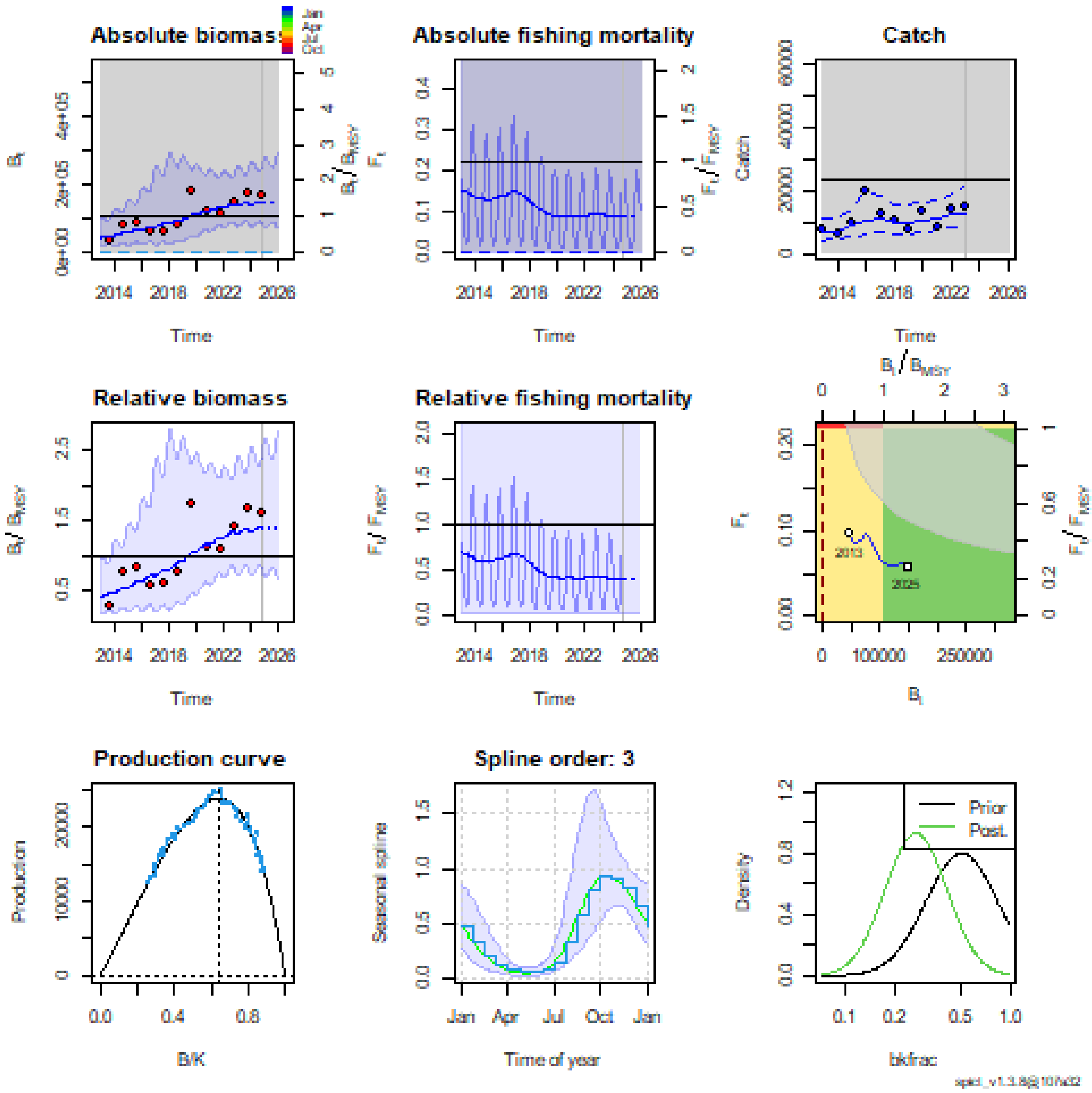


**Figure 7.5.1.2. Sardine in Subarea 7. SPiCT model results. Top row: absolute biomass, absolute F estimates, and fitted catch. Middle row: relative biomass, relative F, and a Kobe plot comparing biomass and F. The grey area in the Kobe plot represents the uncertainty in the relative biomass and F estimates. Bottom row: production curve, seasonality of fishing mortality, and prior and posterior parameter distributions. The dashed lines are 95% CI bounds for absolute estimated values, shaded blue regions are 95% CIs for relative estimates, shaded grey regions are 95% CIs for estimated absolute reference points (horizontal lines).**

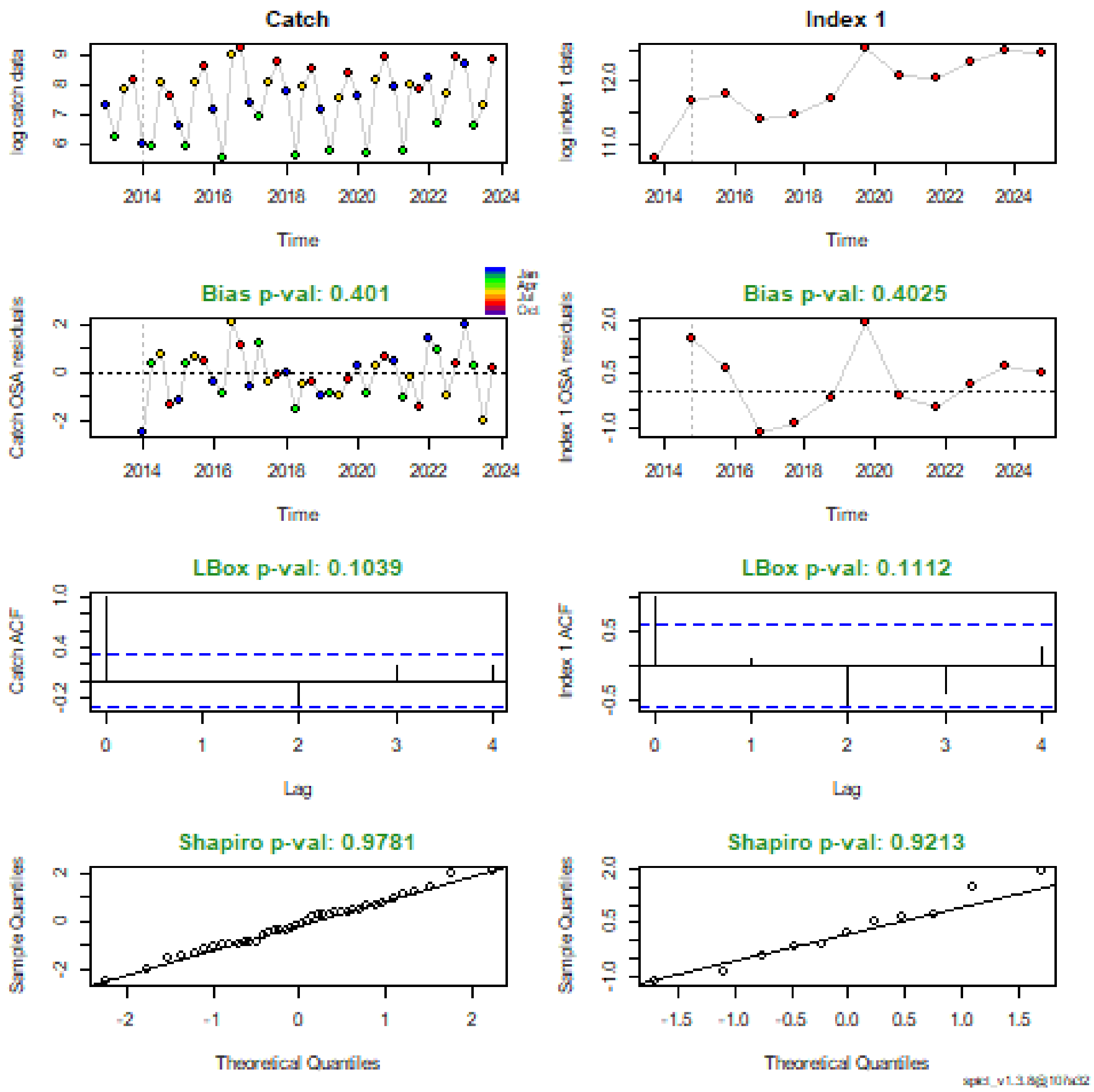


**Figure 7.5.1.3. Sardine in Subarea 7. SPiCT model diagnosis.**

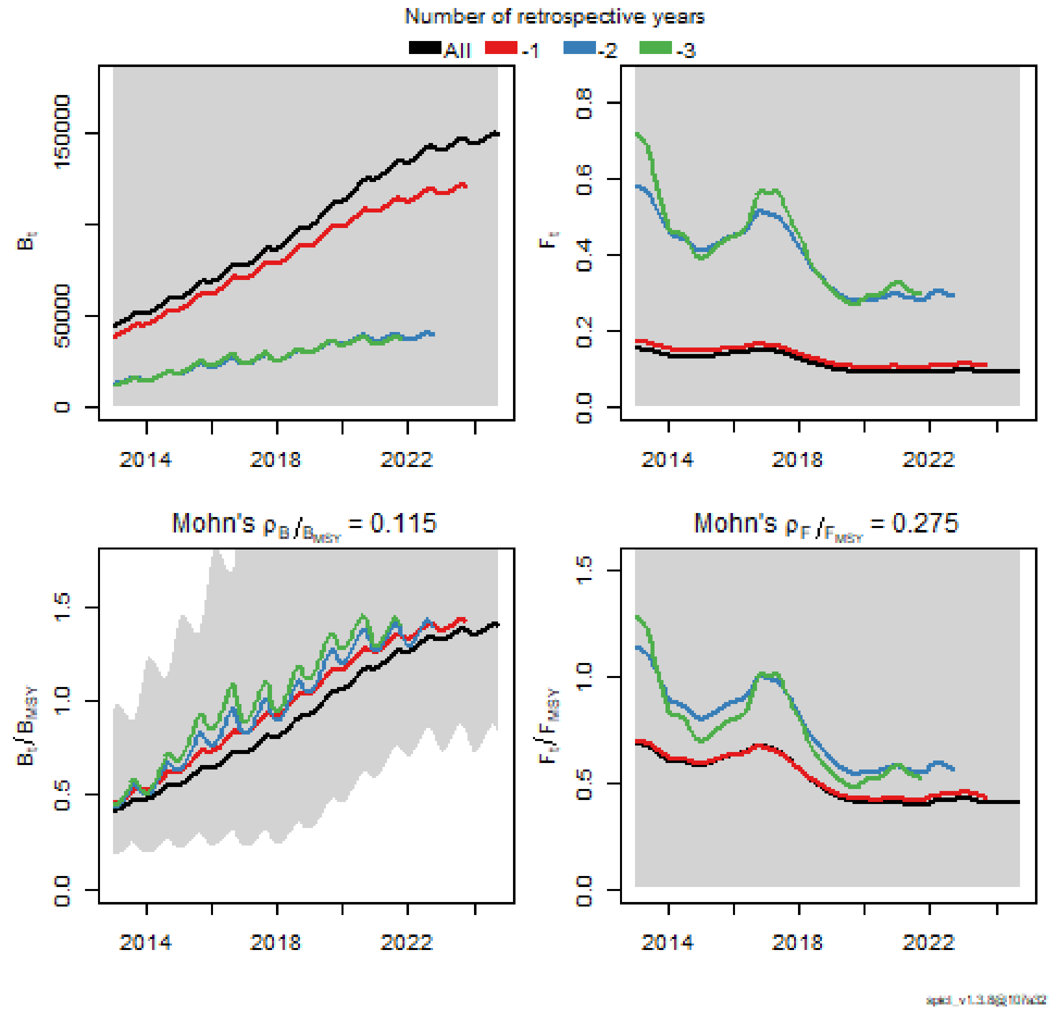


**Figure 7.5.1.4. Sardine in Subarea 7. Retrospective analysis of the SPiCT model. Top row: absolute biomass and absolute F; bottom row: relative biomass and relative F.**

# 8 Sardina pilchardus in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters)

## 8.1 ACOM Advice Applicable to 2024, STECF advice and Political decisions

ICES advises that when the MSY approach is applied, catches in 2024 should be no more than 38 992 tonnes (ICES, 2023).

In 2024 the fishery was managed according to a bilateral agreement between Portugal and Spain (Despacho n. º 4702-A/2024; BOE-A-2024-3919). Portugal and Spain agreed to implement a total catch of 44 450 tonnes, based on the harvest control rules assessed as precautionary by ICES (ICES, 2021a) and within the Management Plan. The distribution of the catches agreed upon between both countries is 33.5% for Spain (14 891 tonnes) and 66.5% for Portugal (29 560 tonnes), in order to prevent exceeding the fishing possibilities for this resource, as defined in the exploitation rule.

In 2024, the Spanish fishery in the Gulf of Cádiz opened on March 1st (BOE-A-2024-3920) and on March 18th in the Cantabrian Sea (BOE-A-2024-5468), considering that spawning occurs earlier in the South and the species also disappears earlier from the fishing grounds in Cadiz.

In September, as part of the regular negotiations between Member States, 2 700 tonnes of Portugal's sardine quota were exchanged for Spain's sea bream, swordfish and monkfish quota, a practice known as quota swapping. The sardine fishery in Spain was closed on the 27th November.

In Portugal, the purse-seine sardine fishery was closed since the 20th of December 2023 (Despacho n.º 43/DG/2023) despite the fact that the quota was not reached. However, 10% of accessory catches was allowed while targeting other species from until the 1st of May 2024 (Despacho n.º 15/DG/2024). In 2024, the sardine fishery opened on May 2nd with a quota allowing a total catch of 29 560 tonnes (Despacho n.º 4702-A/2024). If we take into account the quota swapping with Spain, this represents a decrease in the Portuguese quota of 29%.

Preliminary catch information reported to the WGHANSA24 meeting indicated that 46 095 tonnes had been taken by the two countries.

## 8.2 The fishery in 2023

### 8.2.1 Fishing fleets in 2023

Sardine is taken in purse-seine throughout the stock area and the fleet has remained relatively constant in recent years.

In Spain (Gulf of Cadiz and northern waters), data from 2023 indicates that the number of purse-seiners taking sardine were 271, with mean power of 200 Kw. This number might appear to be much lower than the number reported for the Spanish purse seine fleet in 2022 (446 vessels), but this is an issue related to the calculation methodology used.

Prior to 2023, the total number of vessels per LOA was calculated separately for each Iberian subdivision in Spanish waters and then summed up. This procedure results in the same vessel being counted multiple times across the different geographical areas where it operates, which often occurs due to the mobility of this type of fleet. Therefore in 2023, the data extraction process was revised and it was decided to provide the real total number of vessels. This represents a more realistic picture of the Spanish sardine fishery. Using this revised calculation method, the number of purse-seiners operating in 2022 would be similar to 2023, 269 ships (Nogueira and Castro WD presented to this WG).

The Portuguese fleet started the year 2023 with 172 vessels, but by the end of the year, the number of boats had decreased to 165, with a mean vessel tonnage of 41 GT and engine power of 206 kw.

## 8.2.2 Catches by fleet and area

The WG estimates of landings and catches are shown in Tables 8.2.2.1 and 8.2.2.2.

Total sardine landings in 2023 are shown in Tables 8.2.2.1, 8.2.2.2 and Figure 8.2.2.1. Total 2023 catches in divisions 8c and 9a were of 48 399 tonnes, showing a 20% increase compared to the previous year (40 429 tonnes). The bulk of the landings (99%) were made by purse-seiners.

In Spain, sardine catches, 22 412 tonnes, represent a 42% increase in relation to values from 2022 (15 764 tonnes). Catches showed an increase in northern areas (by 41% in 8c and 75% in 9aNorth) but were considerably lower in 9aSouth-Cadiz than in the previous year, with a decrease by 26%.

In Portugal, sardine landings were of 25 986 tonnes, which represents a slight increase (by 5%) compared to 2022 landings (24 665 tonnes). As in the Spanish catches, in Portugal, area 9aSouth-(Algarve) showed a significant decrease (by 30%), while in 9aCN and 9aCS subdivisions, catches were considerably higher than in 2022 (with an increase of 5% and 22% respectively).

Table 8.2.2.1 summarises the quarterly landings and their relative distribution by ICES subdivisions. In 2023, due to management regulations implemented in Spain and Portugal the sardine fishery opened late in the first quarter (in March in Spain and in the second quarter in Portugal). For that reason, the sums of the second and third quarter landings represent almost 70% of the annual catches.

The relative contribution of the different areas to the total catch was similar to 2022, being the western Portuguese Atlantic coast (9aCN and 9aCS subdivisions), together with Spanish 9aN subdivision, the areas that obtained 71% of the total catches of the stock.

Figure 8.2.2.2 shows the historical relative contribution of the different subareas to the total catches.

Discards are negligible for this stock.

## 8.2.3 Effort and catch per unit of effort

No new information on fishing effort has been presented to the WG.

## 8.2.4 Catches by length and catches-at-age

Tables 8.2.4.1.a, b, c and d show the quarterly length distributions of landings from each subdivision. Annual length distributions in Spain (Table 8.2.4.1.) were unimodal in 8cE subdivision, with a mode at 18 cm. In 8cW, 9aN and 9aS-Cadiz subdivisions, size distributions had a main mode at 17, 16 and 14.5 cm and a secondary, smaller mode at 20, 20.5 and 17.5 cm, respectively.

For Portugal, sardine annual length distributions were unimodal in 9aCN, with mode at 16 cm. For the remaining areas, length distributions were bimodal, with modes at 16 and 19 cm in 9aS-Algarve and at 17 and 19 cm in 9aCS subdivision.

Table 8.2.4.2 shows the catch-at-age in numbers for each quarter and subdivision and Table 8.2.4.3. shows the historical catch-at-age data. In Table 8.2.4.4 and Figure 8.2.4.1. the relative contribution of each age group in each subdivision is shown as well as their relative contribution to the catches.

In Cadiz, unlike the previous years where the most important age was age 0, the most representative age was age 1, as in the 8cE subdivision. For 8cW and 9aN subdivisions, age 3 cohort was the predominant age.

For Portugal, 9aCN subdivision was almost entirely composed of age 1 individuals (87%), while in 9aCS and 9aS-Algarve subdivisions, the most important age was age 2. By areas, age-0 showed a clear predominance in 9aS-Cádiz and older individuals (age-5 and age-6+) were mainly landed in the 9aCS subdivision.

### 8.2.5 Mean length and mean weight-at-age in the catch

Mean length and mean weight-at-age by quarter and subdivision are shown in Tables 8.2.5.1 and 8.2.5.2.

## 8.3 Fishery-independent information

Figures 8.3.1, 8.3.2 and 8.3.3 show the time-series of fishery-independent information for the sardine stock.

### 8.3.1 Iberian DEPM survey (PT-DEPM-PIL+SAREVA)

As part of the Iberian DEPM survey, surveys are carried out every three years by Portugal (IPMA) and Spain (IEO). As described in the Stock Annex, the total spawning biomass (SSB) from the two surveys is used in the assessment.

The DEPM surveys comprise ichthyoplankton, fish and hydrographic sampling. Plankton samples are collected, along a grid of parallel transects perpendicular to the coast, for spawning area estimation and daily egg production calculation. Concurrently, fishing hauls are carried out for estimation of daily fecundity (sex ratio, female weight, batch fecundity and spawning fraction) for the mature sardines in the population.

Survey design, laboratory and estimation analyses are described in detail in the TIMES survey manual (*in press*) and in Massé *et al*. 2018.

The latest available data in the DEPM time series is for the 2023 surveys, extensively described in the 2023 WGACEGG report (ICES, 2024), and the next survey is planned for 2026.

### 8.3.2 Spring Iberian acoustic survey (PELACUS-PELAGO)

As part of the Iberian acoustic survey, surveys are carried out each year by Portugal and Spain to estimate small pelagic fish abundance in divisions 8c and 9a. The Iberian acoustic survey is planned and discussed within WGACEGG (e.g, WGACEGG, 2024). As described in the Stock Annex, the total numbers of individuals and numbers-at-age from the two surveys are used as input to the assessment.

There are two annual surveys carried out to estimate small pelagic fish abundance in 9a and 8c using acoustic methods: PELAGO and PELACUS. For the first time, in 2021, both surveys were carried out on the same vessel, R/V Miguel Oliver. The PELAGO survey was carried out in March, followed by the PELACUS survey.

Both surveys were conducted following the methodology applied in previous years and agreed and revised at the WGACEGG.

### 8.3.2.1 Portuguese spring acoustic survey

The PELAGO acoustic surveys have sampled the Portuguese and Bay of Cadiz continental shelves, since 1995 and until 2019 with the R/V Noruega, a 49 m trawl vessel. Since 2020 this survey was planned on-board R/V Miguel Oliver.

PELAGO survey was carried out by IPMA on board R/V Miguel Oliver, between the 1th of March 2024 and the 24th of March 2024, for a total of 21 days at sea, without major issues. A total of 1134 nautical miles were tracked over the foreseen 71 sampling tracks and 51 fishing hauls were carried out for echo-trace ground-truthing purposes.

Survey effort, timing and area coverage were comparable to previous years and the same vessel and sampling equipment (transducers and trawl) were used (see summary of the 2024 survey in annex 6).

Figure 8.3.2.1.1 shows the acoustic transect along the surveyed area and Figure 8.3.2.1.2 shows the fishing operations conducted during the survey and the proportion of species in each fishing station. No fishing stations were carried out in the southern part of 9aCS, because very few schools were detected and were located in bad grounds for fishing. Sardine was present in most of the fishing hauls (94%) and the energy attributed to this species was distributed throughout the coast, with the highest concentrations in the north, in 9aCN subdivision (between Porto and Figueira da Foz) and in Algarve (9aS subdivision) (Figure 8.3.2.1.3).

Figures 8.3.2.1.4., 8.3.2.1.5. and Table 8.3.2.1.1. show the abundance in number and biomass by length and age class, respectively.

During 2024 PELAGO survey, age 0 sardine individuals were not detected. For the total area sampled, age 2 accounted for 38% in abundance, corroborating the strong recruitment of 2022. 2023 recruitment represents 34% of the sardine abundance in the survey and was detected mainly in Cadiz and in the 9aCN subdivision.

In 2024 biomass decreased 42% and abundance decreased 44% in relation to PELAGO23, to 251 thousand tons, corresponding to 7723 million fish.

### 8.3.2.2 Spanish spring acoustic survey

PELACUS0324 was conducted between the 26th of March and the 16th of April 2024 onboard the R/V Miguel Oliver. Sampling grid this year was based on acoustic transects separated 10nmi, between 20 and 1000 m depth, and with random start in each of the geographical strata, which corresponds to the ICES subareas (Figure 8.3.2.2.1).

Weather conditions during the first leg were poor, with the Iberian Peninsula under the influence of the Nelson storm, so it was decided to start on the eastern part of the survey tracks in order to have working conditions at sea. This decision was crucial in order to avoid the storm and to be able to cover the whole of the expected survey area. After the storm had passed, the weather conditions improved and it was possible to work as usual during the second leg (see summary of the 2024 survey in annex 6).

35 pelagic stations were conducted during the survey. Sardine was present at 30 of the stations, accounting for 85% of the total catch (Figure 8.3.2.2.2). Figure 8.3.2.2.3. shows the distribution area and the NASC values attributed to sardine. A total of 189.518 thousand tonnes, corresponding to 4372 million fish were estimated (Table 8.3.2.2.). The presence of sardine this year was much lower than the one found last year, in total 61% less backscatter energy was allocated to this species on 2024. It is important to highlight that no small sardine was found this year, contrary to what happened last year. The low recruitment value detected in the IBERAS 2023 survey

was corroborated in PELACUS, where age 1 was represented with only 2.5% of the total abundance. The most representative cohort, with 68% of the abundance (and 61% of the biomass), was age 2, corresponding to the strong recruitment of 2022 (Figure 8.3.2.2.4.).

The distribution of sardine was mostly coastal with high presence south of Cabo Fisterra (9aN area).

## 8.3.3 Autumn acoustic survey index

For the major recruitment area in Portugal, from 1997 (SAR-PT-AUT time series) and in the recent period, from 2013 (JUVESAR time series) juvenile surveys were carried out from Lisbon to the Portuguese–Spanish border, to assess the abundance of recruits in that particular area. Since 2018, as a result of a collaboration between IPMA and IEO, the survey IBERAS estimates a recruitment index in Atlantic waters of the Iberian Peninsula, aiming to improve the estimation of the strength of the recruitment for both Ibero-Atlantic sardine and the western component of the south anchovy population.

In October 2021, an Inter-benchmark (ICES, 2021b) was accomplished for this stock and the juvenile index from autumn acoustic surveys since 1997, for the 9aCN subdivision, was decided to be included in the assessment model. At the time of the inclusion of this recruitment index in the assessment model it was decided not to use age-0 estimates from ECOCADIZ-RECLUTAS that covers the second recruitment area of the stock because the correlation with age-1 estimates of the spring acoustic survey the next year was poor and the lack of estimates for a couple of years of the then short-time series of this survey. In addition, the recruitment hot spot in the eastern Gulf of Cadiz seems to be not connected with the rest (Silva *et al.*, 2019) and oceanographic conditions driving the recruitment distribution in this area are different from the Northern Portuguese shelf (Rodríguez-Climent *et al.*, 2017). It was also discussed the inclusion of a larger area covering 9aCN+9aCS subdivision by the IBERAS survey. Ecologically the best option would be to include at least the northern part of 9aCS, where the bulk of the juvenile distribution within 9aCS occurs. However, due to vessel availability, it couldn't be warranted that the whole 9aCS zone would be covered. The irregular coverage of 9aCS area of the autumn acoustic surveys along the time-series supposes an additional challenge that couldn’t be solved during the Inter-benchmark due to the lack of time and lack of data at the beginning of the time-series. Since then both autumn acoustic surveys ECOCADIZ-RECLUTAS and IBERAS have taken place so the time series is longer. Also, in most of the years it was possible to cover the 9aCS subdivision and so it would be useful to consider the inclusion of all the area covered by IBERAS and consider the inclusion of the ECOCADIZ_RECLUTAS in the recruitment index.

Last IBERAS survey, in 2024, was carried out between 1st and 15th October, on board Ramón Margalef R/V, with the collaboration of a purse seiner for additional samples in 9aCN and 9aCS.

Survey methodology was similar to that of the previous surveys and is summarised in ICES Cooperative Research Report No. 332. 268 pp. https://doi.org/10.17895/ices.pub.4599. The backscattering acoustic energy from marine organisms was measured continuously during daylight except in the northern area where some tracks were steamed at night. Pelagic trawls were carried out whenever possible to help identify the species (and size classes) that reflect the acoustic energy (see annex 6 for a summary of the 2024 survey).

During the survey a series of deep storms stopped the vessel activity for 6 days. During the first leg (1st to 6th October) 9aN Platform up to 41º30 in 9aCN together with the area comprehended between Figueira da Foz and north Aveiro (between 40º15'N and 41º 8'N in 9aCN) were covered whilst in the second leg (11th to 14th) covered the remained parts of the 9aCN and the 9aCS between Nazaré and Espichel cape (Figure 8.3.3.1). These adverse weather conditions resulted in a very short survey that led to focus all the survey effort only to assess the strength of the anchovy and sardine recruitment. In that sense, results on other fish species should be regarded with caution since the survey only targeted on young of the year sardine and anchovy abundance.

This explain the large presence of sardine in the fishing stations carried out (up to 95% of 22 valid fishing station) (Figures 8.3.3.2). Besides, as in 2023, juvenile anchovy was mostly observed in epipelagic schools.

Sardine occurred in very dense schools, near coast, mainly between 20-40 m depth (Figure 8.3.3.3). In some of those schools the sV max achieved up to -14dB, which is the first time this thickness is recorded (Figure 8.3.3.4).

The recruitment index, obtained from the estimation of the fish abundance at age 0 in 9aCN, is shown in figure (Figure 8.3.3.5, Table 8.3.3.1.). The new value for the index is $6.5x10^9$ fish, the third highest one of the time series. In general terms, it seems the recruitment is showing an increasing trend, but with significant differences between high values ($6.7x10^9$ fish as mean value for those recruitment above average of the time series, estimated at $4.4x10^9$ fish) and low values ($1.4x10^9$ fish as mean value for those recruitment below average of the time series). In this context, 2024 recruitment index estimate in near the mean value of high recruitment estimate group. Since 2018, recruitment index was above mean value in 4 times while 3 times was below that value.

## 8.3.4 Mean weight-at-age in the stock and in the catch

Mean weight-at-age in the catch are shown in Table 8.3.5.1a.

According to the stock annex, mean weights-at-age in the stock (Table 8.3.5.1b) come from the DEPM surveys. See Annex 3.

- For years with no DEPM survey, a linear interpolation of the data from two consecutive surveys is carried out to obtain the estimates of mean weight-at-age.
- For the period 1978–1998 (before the DEPM series started) it was decided to consider the two closest DEPM surveys, and assume for that period the average between 1999 and 2002 estimates.
- For the years after the last DEPM survey, the estimates of the last DEPM survey are assumed.

## 8.3.5 Maturity-at-age

Following the stock annex, maturity ogive from the stock comes from the DEPM surveys.

- For years with no DEPM survey, a linear interpolation of the data between two consecutive surveys is carried out to obtain the estimates of maturity-at-age.
- For the period 1978–1998 (years before starting the DEPM series), constant proportions of maturity-at-age were assumed, based on the average of the estimates obtained from the six DEPM surveys of the 1999–2014 period, thus including both years of strong year classes and years of low recruitment.
- For the years after the last DEPM survey, the estimates of the last DEPM survey are assumed.

## 8.3.6 Natural mortality

Following the stock annex, natural mortality is:

| M, year$^{-1}$ |
| --- |

| | |
|---|---|
| Age 0 | 0.98 |
| Age 1 | 0.61 |
| Age 2 | 0.47 |
| Age 3 | 0.40 |
| Age 4 | 0.36 |
| Age 5 | 0.35 |
| Age 6 | 0.32 |

### 8.3.7 Catch-at-age and abundance-at-age in the spring acoustic survey

The historical series of catches-at-age and abundance-at-age in the spring acoustic survey are presented in Figure 8.3.8.1.

## 8.4 Assessment Data of the state of the stock

### 8.4.1 Stock assessment

The table below presents an overview of the assessment model settings. Additional details on the input data used in the stock assessment model can be found in the stock annex (See Annex 3).

| Input data | WGHANSA 2024 |
|---|---|
| Catch | Catch biomass 1978–2024 (tonnes) |
| | Catch-at-age 1978–2023 (thousands of individuals) |
| Spring acoustic survey (Joint SP+PT) * | Total numbers 1996–2024 (thousands of individuals) |
| | Numbers-at-age 1996–2024 (thousands of individuals) |
| DEPM survey (Joint SP+PT) | SSB 1997, 1999, 2002, 2005, 2008, 2011, 2014, 2017, 2020, 2023 (tonnes) |
| Autumn acoustic survey (Recruitment index) | Total numbers of age-0 individuals in the 9aCN subdivision 1997-2024 (thousands of individuals) |
| Weight-at-age in the catch | Yearly averages 1978–2023 (constant up to 1989), kg |
| Weight-at-age in the stock | From DEPM surveys in DEPM years, linear interpolation for years in-between (constant 1978–1998), kg |
| Maturity-at-age | From DEPM surveys in DEPM years, linear interpolation for years in-between (constant 1978–1998), proportions |
| Model structure and assumptions: | |
| M | M-at-age 0=0.98, M-at-age 1=0.61, M-at-age 2=0.47, M-at-age 3=0.40, M-at-age 4=0.36, M-at-age 5=0.35, M-at-age 6+=0.32 |

| Input data | WGHANSA 2024 |
|---|---|
| Recruitment | Density-dependent R model; annual recruitments are parameters, defined as lognormal deviations from Beverton–Holt stock–recruitment model, penalized by a sigma of 0.74, and an input steepness of 0.71. |
| Initial population | N-at-age in the first year are parameters derived from an input initial equilibrium catch of 135 000 tons, equilibrium recruitment and selectivity in the first year and adjusted by recruitment deviations estimated from the data on the first years of the assessment. Equilibrium assumed to take place in 1972. |
| Fishery selectivity-at-age | S-at age are parameters, each estimated as a random walk from the previous age; S-at-age 0 used as the reference; S-at-ages 4 and 5 assumed to be equal to S-at-age 3. |
| Fishery selectivity over time | Three periods: 1978–1987, 1988–2005 and 2006–onwards. Selectivity-at-age is estimated for each period and within each period assumed to be fixed over time. |
| Spring acoustic survey selectivity-at-age | Selectivity assumed to be equal at all ages. |
| Autumn acoustic survey selectivity-at-age | Selectivity tailored to young fish (age 0) |
| Fishery catchability | Scaling factor, median unbiased |
| Spring acoustic survey catchability | Simple model with extra standard error parameter |
| DEPM catchability | Simple model with extra standard error parameter |
| Autumn acoustic survey catchability | Power model with extra standard error parameter |
| Log-likelihood function: | |
| Weights of components | All components have equal weight |
| Data weights | Sample size of age compositions by year (50 in 1978-1990 and 75 in 1991-onwards for the fishery, 25 for the acoustic survey; Acoustic and DEPM abundance observations with equal weight = CV = 25%; age reading uncertainty; user input sample sizes and survey CV are used as inverse weights of likelihood components. |

Table 8.4.1.1 shows the parameters estimated by the assessment model. Fishing mortality-at-age and numbers-at-age are presented in Tables 8.4.1.2 and 8.4.1.3. Virgin recruitment was estimated to be $R_{0,2024}$ = 20 302 500 (CV = 4%) and the initial F was estimated as $initF_{2024}$ = 0.41 $year^{-1}$. Catchability parameters are close to 1 for both the acoustic (Q = 1.36, RMSE = 0.32) and the DEPM (Q=1.23, RMSE=0.28) surveys. Catchability parameter for the recruitment index is 2.8e-08 (RMSE = 1). The extra standard deviation parameters are low for the spring acoustic and the DEPM surveys (0.073 and 0.034 respectively) but higher for the recruitment index (1.06). Correlations between the assessment parameters range from -0.99 to 0.45 although the majority are very close to zero. Negative correlations below -0.50 are observed between the two parameters of the power model of $Q_{recruitment\ index}$ (-0.99), $R_0$ and $Q_{acoustic\ survey}$ (-0.60) and between selectivity parameters from the first period (four cases) and one case in the last period.

The assumed standard error for the acoustic and the DEPM index, all years = 0.25, is consistent with the residual mean square errors estimated by the model, 0.32 and 0.28. The harmonic mean of the fishery age composition sample size, 71, is consistent with the current assumption of 75. In the case of the spring acoustic survey survey, the sample size of 25 is consistent with the precision indicated by the model (the harmonic mean for the acoustic survey is estimated to be 21).

Figures 8.4.1.1, 8.4.1.2 and 8.4.1.3 show the fit of the model to the three indices of abundance. The assessment of 2024 shows a poor fit to the 2022 and the 2023 point estimates of the acoustic survey index. It is observed that in previous years, high values of the point estimate of the acoustic surveys have poorer fits, i.e., positive residuals for the estimates in the surveys. It seems that the model has a tendency to underestimate abundance in years when the survey index is large.

Figure 8.4.1.4 shows the model residuals from the fit to the catch-at-age composition (top panel) and the acoustic survey age composition (bottom panel). Catch-at-age residuals in 2023 have decreased for the younger ages (until age 2) and increased for the older ages. Residuals are positive for ages 1, 2 and 3 and negative for all the other ages. The acoustic survey residuals in 2024 are positive for age one, two and four and negative for all other ages.

The fishery selectivity patterns estimated in the present assessment show less abrupt changes over time and through ages (particularly at the age-6+ group) (Figure 8.4.1.5). The patterns over age are dome-shaped in the three periods with the early (1978–1987) and recent periods (2006–2023) showing higher selectivity at ages 1–2 than the middle period (1988–2005), in agreement with the higher fraction of the catches coming from recruitment areas in those periods. The increase of age 0 selectivity estimated in the most recent period is consistent with large catches of this age group in a period that recruitment is at a very low level.

The summary of the 2024 assessment results is shown in Table 8.4.1.4 and Figure 8.4.1.5 (in the Figure compared to the 2023 assessment model results). The estimate of B1+ in 2024 assumes stock weights are equal to the mean in the last six years, the same assumption taken in the short term forecast, and in accordance to the stock annex. By the end of October, preliminary catch information indicates that the two EU Member states had taken all the quota reaching 46 095 tonnes. This was the assumption for the interim year (see Section 8.1). The model estimates standard errors of SSB, recruitment and Apical F (maximum F over age within years). We assume the CVs of SSB and Apical F apply to B1+ and F(2–5), respectively.

B1+ in 2024 is predicted to be 423 591 t (CV = 16%), assuming that the stock weights are equal to the mean of the last six years. This represents a decrease of 16% when compared with B1+ in 2023 = 502 765 t (CV = 14%). B1+ is above $B_{lim}$ = 196 334 t, $B_{pa}$ = 252 523 t and MSY $B_{trigger}$ = 252 523 t of the current low productivity regime of the stock (see Section 8.7).

$F_{bar\ 2–5}$ in 2023 is estimated to be 0.114 $year^{-1}$ (CV = 15%) which represents an increase of 33% when compared to $F_{bar\ 2-5}$ in 2022. $F_{bar\ 2–5}$ is above $F_{MSY}$ and $F_{pa}$ .

In summary, the stock is not overfished and is in a healthy condition.

The series of historical recruitments 1978–2024 shows a marked downward trend until 2006 and from then had been fluctuating around historically low values. Since 2018 that recruitment estimates had been above the mean values of the low productivity regime (since 2006). The 2024 recruitment estimate ($R_{2024}$ = 18 112 500, CV = 49%) represents an increase of 3% when compared to the recruitment estimate of 2023.

## 8.5 Retrospective pattern

Retrospective patterns for Biomass 1+, $F_{ages2\text{-}5}$ and recruitment were computed for years 2020–2024. For each run, assessment was performed including survey data until the terminal year and catch data until the previous year, as done in the current assessment (2024). This range of runs include runs prior and after the Inter-benchmark (ICES, 2021b). The potential retrospective bias in the assessment was quantified using an approach based on the Mohn's rho (Mohn, 1999), following ICES guidelines, and was computed using the function mohn() available in the R package called icesAdvice.

Results are shown in absolute terms (Figure 8.5.1). The model underestimates Biomass 1+ (Mohn's rho of -0.238) and recruitment (Mohn's rho of -0.136) while it overestimates $F_{ages2–5}$ (Mohn's rho of 0.207). Differences in the estimation of these parameters between runs are more pronounced for recruitment and, in all cases, in the last portion of the time-series. Most probably, changes in the most recent years are a consequence of the model fit to the most recent data. Overall, trends do not change between runs with the exception of some recruitment data points in the most recent part of the time series. This might be a consequence of the changes in the model after the Inter-benchmark Finally, the retrospective plots indicate that the model is robust.

## 8.6 Short-term predictions

The short-term forecast assumptions were updated in 2021 after Inter-benchmark of October 2021 (ICES, 2021b) and are specified in the stock annex (Annex 3).

Catch predictions were carried out following the stock annex, Annex 3. Recruitment in the interim year (2024) is now the estimate from the assessment model and in the forecast year (2025) recruitment is assumed to be the geometric mean of the last five years (2020–2024), $R_{2025}$ = 11 673 330 thousand individuals. Fishing mortality in the interim year is the fishing mortality that corresponds to a catch constrain. The catch assumption for 2024 was assumed to be 46 095 tonnes based on the total catches reported by the end of October and is equivalent to a $F_{ages2–5}$, 2024 = 0.104.

Table 8.6.1 shows input data of the short-term forecast. Table 8.6.2 shows the results of the short-term forecast. The complete set of results for fine steps of F scenarios is stored in file pil.27.8c9a_scenarios in the TAF github.

### 8.6.1 Evidence for change in advice

A comparison of the input data used in the forecast from the current and the previous assessments is presented in this sub-section. In Figure 8.6.1.1 input data used for the short-term forecast on last year's advice is compared with the input data used for this year's short-term forecast and in Figure 8.4.1.5 it was already showned the summary for the previous and current assessments.

Figure 8.6.1.2 compares the predicted stock numbers at age at the start of the advice year from the previous advice and the estimate of stock numbers at age for the same year from the current assessment. Table 8.6.1.1 shows the numbers and biomass at age estimated in the current assessment divided by the numbers and biomass at age estimated in the previous assessment for the years 2020, 2021 and 2022.

Forecast assumptions from previous and current assessments are shown in Table.8.6.1.2

## 8.7 Reference points

Reference Points for this stock were re-evaluated at the beginning of 2021, during the Workshop for the evaluation of the Iberian sardine HCR (WKSARHCR; ICES, 2021c).

ICES adopted new reference points for the stock based on data from the period 2006–2019 which is considered representative of a low productivity state. The recomputed values, using the management strategy evaluation framework, are presented in Table 8.7.1.

**Table 8.7.1. Sardine in 8c and 9a. Reference Points. The biological reference points were estimated during WKSARHCR (ICES, 2021c) based on the state of low productivity (2006–2019). Weights are in tonnes.**

| BRP | 2006-2019 | Technical basis |
| --- | --- | --- |
| $B_{lim}$ | 196 334 | $B_{lim}$ = Hockey-stick change point |
| $B_{pa}$ | 252 523 | $B_{pa} = B_{lim} * \exp(1.645 * \sigma)$, $\sigma = 0.17$ (ICES, 2021a) |
| $F_{lim}$ | 0.26 | Stochastic long-term simulations (50% probability SSB < $B_{lim}$) (MSE) |
| $B_{trigger}$ | 252 523 | $B_{trigger} = B_{pa}$ |
| $F_{pa}$ | 0.092 | $Fp_{.05}$; the F that leads to SSB ≥ $B_{lim}$ with 95% probability (MSE). |
| $F_{MSY}$ | 0.22 | Median $F_{target}$ which maximizes yield without $B_{trigger}$ (MSE) |
| Adopted $F_{MSY}$ | 0.092 | If $F_{pa} < F_{MSY}$ then $F_{MSY} = F_{pa}$ |

## 8.8 Management considerations

A new management plan for the Iberian sardine stock (divisions 8.c and 9.a) (Multiannual Management Plan for the Iberian Sardine 2021–2026) was developed by Spain and Portugal. In February 2021, ICES received a request from Portugal and Spain EU members to evaluate a generic harvest control rule (HCR) within that management plan. The new HCR is defined by three reference levels for fishing mortality, F = 0, F = 0.064 and F = 0.12 and, three reference levels for B1+, $B_{low}$ = 112 943 t, defined as the lowest observed time series B1+ according to the 2018 assessment (ICES, 2018), MSY $B_{trigger}$ = 252 523 t, under a low productivity regime and MSY $B_{trigger}$ = 446 331 t, under a medium productivity regime (Figure 8.8.1.).

The proposed HCR was described as follows:

i) If B1+ ≤ 112943 t, then F = 0
ii) If 112943 t < B1+ ≤ 252 523 t, then F increases linearly from 0 to 0.064
iii) If 252 523 t < B1+ ≤ 446 331 t, then F increases linearly from 0.064 to 0.12
iv) If B1+ > 446 331 t, then F = 0.12

Conditions ii) to iv) are overridden if the forecast catch in any given year exceeds the maximum allowed catches of 30 to 50 kt.

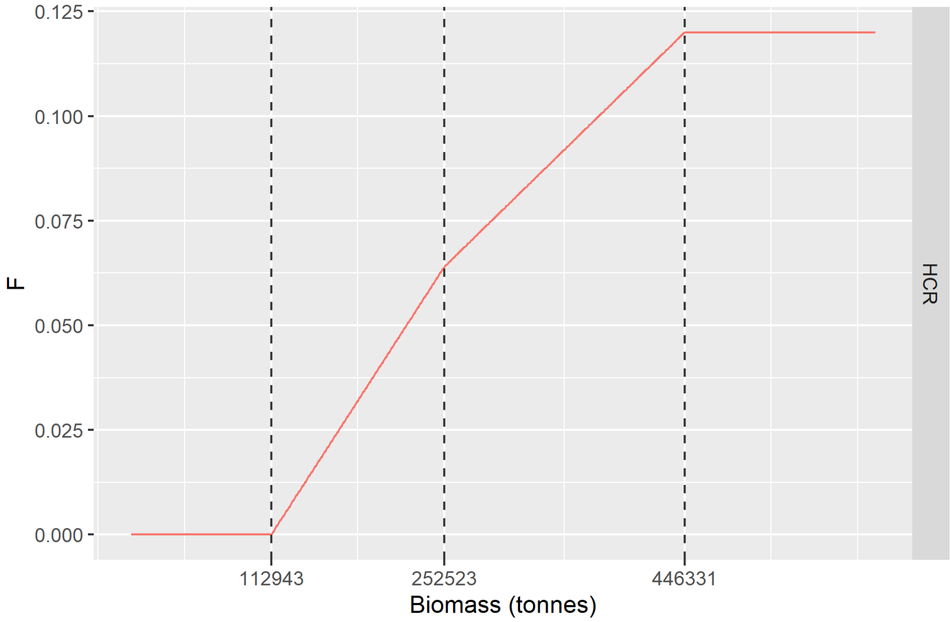


**Figure 8.8.1. Proposed HCR. The biomass reference levels of biomass (B1+) reported correspond to $B_{loss(2018)}$ = 112 943 t, MSY $B_{trigger\_low}$ = $B_{pa\_low}$ = 252 523 t and MSY $B_{trigger\_medium}$ = $B_{pa\_medium}$ = 446 331 t.**

ICES found that the generic harvest control rule was precautionary in a persistent low productivity regime with maximum allowed catches between 30 and 50 kt (ICES, 2021a). For 2023, the EU Commission requested ICES to provide advice based on the MSY approach. The precautionary generic harvest control rule should be included in the catch scenario table of the Advice Sheet.

## 8.9 References

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# 8.10 Tables

**Table 8.2.2.1: Sardine in 8c and 9a: Quarterly distribution of sardine catches in 2023 by ICES Subdivision. Above absolute values (t); below, relative numbers.**

| Sub-Div | 1st | 2nd | 3rd | 4th | Total |
|---|---|---|---|---|---|
| **8cE** | 501 | 126 | 387 | 301 | **1315** |
| **8cW** | 182 | 2651 | 3223 | 963 | **7020** |
| **9aN** | 232 | 2984 | 5547 | 2993 | **11756** |
| **9aCN** | | 2254 | 5047 | 3553 | **10854** |
| **9aCS** | | 3317 | 5040 | 3603 | **11960** |
| **9aS-Algarve** | | 911 | 1395 | 865 | **3172** |
| **9aS-Cadiz** | 566 | 546 | 429 | 781 | **2322** |
| **Total** | **1482** | **12792** | **21067** | **13059** | **48399** |

| Sub-Div | 1st | 2nd | 3rd | 4th | Total |
|---|---|---|---|---|---|
| **8cE** | 1.04 | 0.26 | 0.80 | 0.62 | **3** |
| **8cW** | 0.38 | 5.48 | 6.66 | 1.99 | **15** |
| **9aN** | 0.48 | 6.17 | 11.46 | 6.19 | **24** |
| **9aCN** | 0.00 | 4.66 | 10.43 | 7.34 | **22** |
| **9aCS** | 0.00 | 6.85 | 10.41 | 7.45 | **25** |
| **9aS-Algarve** | 0.00 | 1.88 | 2.88 | 1.79 | **7** |
| **9aS-Cadiz** | 1.17 | 1.13 | 0.89 | 1.61 | **5** |
| **Total** | **3.06** | **26.43** | **43.53** | **26.98** | |

**Table 8.2.2.2. Sardine in 8c and 9a: Iberian sardine landings (tonnes) by subdivision for the period 1940-2023.**

| Year | Subdivision | | | | | |
|---|---|---|---|---|---|---|
| | 8c | 9a North | 9a Central North | 9a Central South | 9a South Algarve | 9a South Cadiz |
| 1940 | 66816 | | 42132 | 33275 | 23724 | |
| 1941 | 27801 | | 26599 | 34423 | 9391 | |
| 1942 | 47208 | | 40969 | 31957 | 8739 | |
| 1943 | 46348 | | 85692 | 31362 | 15871 | |
| 1944 | 76147 | | 88643 | 31135 | 8450 | |
| 1945 | 67998 | | 64313 | 37289 | 7426 | |
| 1946 | 32280 | | 68787 | 26430 | 12237 | |
| 1947 | 43459 | 21855 | 55407 | 25003 | 15667 | |
| 1948 | 10945 | 17320 | 50288 | 17060 | 10674 | |
| 1949 | 11519 | 19504 | 37868 | 12077 | 8952 | |
| 1950 | 13201 | 27121 | 47388 | 17025 | 17963 | |
| 1951 | 12713 | 27959 | 43906 | 15056 | 19269 | |

| Year | Subdivision | | | | | |
|---|---|---|---|---|---|---|
| | 8c | 9a North | 9a Central North | 9a Central South | 9a South Algarve | 9a South Cadiz |
| 1952 | 7765 | 30485 | 40938 | 22687 | 25331 | |
| 1953 | 4969 | 27569 | 68145 | 16969 | 12051 | |
| 1954 | 8836 | 28816 | 62467 | 25736 | 24084 | |
| 1955 | 6851 | 30804 | 55618 | 15191 | 21150 | |
| 1956 | 12074 | 29614 | 58128 | 24069 | 14475 | |
| 1957 | 15624 | 37170 | 75896 | 20231 | 15010 | |
| 1958 | 29743 | 41143 | 92790 | 33937 | 12554 | |
| 1959 | 42005 | 36055 | 87845 | 23754 | 11680 | |
| 1960 | 38244 | 60713 | 83331 | 24384 | 24062 | |
| 1961 | 51212 | 59570 | 96105 | 22872 | 16528 | |
| 1962 | 28891 | 46381 | 77701 | 29643 | 23528 | |
| 1963 | 33796 | 51979 | 86859 | 17595 | 12397 | |
| 1964 | 36390 | 40897 | 108065 | 27636 | 22035 | |
| 1965 | 31732 | 47036 | 82354 | 35003 | 18797 | |
| 1966 | 32196 | 44154 | 66929 | 34153 | 20855 | |
| 1967 | 23480 | 45595 | 64210 | 31576 | 16635 | |
| 1968 | 24690 | 51828 | 46215 | 16671 | 14993 | |
| 1969 | 38254 | 40732 | 37782 | 13852 | 9350 | |
| 1970 | 28934 | 32306 | 37608 | 12989 | 14257 | |
| 1971 | 41691 | 48637 | 36728 | 16917 | 16534 | |
| 1972 | 33800 | 45275 | 34889 | 18007 | 19200 | |
| 1973 | 44768 | 18523 | 46984 | 27688 | 19570 | |
| 1974 | 34536 | 13894 | 36339 | 18717 | 14244 | |
| 1975 | 50260 | 12236 | 54819 | 19295 | 16714 | |
| 1976 | 51901 | 10140 | 43435 | 16548 | 12538 | |
| 1977 | 36149 | 9782 | 37064 | 17496 | 20745 | |
| 1978 | 43522 | 12915 | 34246 | 25974 | 23333 | 5619 |
| 1979 | 18271 | 43876 | 39651 | 27532 | 24111 | 3800 |
| 1980 | 35787 | 49593 | 59290 | 29433 | 17579 | 3120 |

| Year | Subdivision | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| | 8c | 9a North | 9a Central North | 9a Central South | 9a South Algarve | 9a South Cadiz |
| 1981 | 35550 | 65330 | 61150 | 37054 | 15048 | 2384 |
| 1982 | 31756 | 71889 | 45865 | 38082 | 16912 | 2442 |
| 1983 | 32374 | 62843 | 33163 | 31163 | 21607 | 2688 |
| 1984 | 27970 | 79606 | 42798 | 35032 | 17280 | 3319 |
| 1985 | 25907 | 66491 | 61755 | 31535 | 18418 | 4333 |
| 1986 | 39195 | 37960 | 57360 | 31737 | 14354 | 6757 |
| 1987 | 36377 | 42234 | 44806 | 27795 | 17613 | 8870 |
| 1988 | 40944 | 24005 | 52779 | 27420 | 13393 | 2990 |
| 1989 | 29856 | 16179 | 52585 | 26783 | 11723 | 3835 |
| 1990 | 27500 | 19253 | 52212 | 24723 | 19238 | 6503 |
| 1991 | 20735 | 14383 | 44379 | 26150 | 22106 | 4834 |
| 1992 | 26160 | 16579 | 41681 | 29968 | 11666 | 4196 |
| 1993 | 24486 | 23905 | 47284 | 29995 | 13160 | 3664 |
| 1994 | 22181 | 16151 | 49136 | 30390 | 14942 | 3782 |
| 1995 | 19538 | 13928 | 41444 | 27270 | 19104 | 3996 |

**Table 8.2.2.2 (cont.). Sardine in 8c and 9a: Iberian sardine landings (tonnes) by subdivision for the period 1940-2023.**

| Year | Subdivision | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| | 8c | 9aNorth | 9a Central North | 9a Central South | 9a South Algarve | 9a South Cadiz |
| 1996 | 14423 | 11251 | 34761 | 31117 | 19880 | 5304 |
| 1997 | 15587 | 12291 | 34156 | 25863 | 21137 | 6780 |
| 1998 | 16177 | 3263 | 32584 | 29564 | 20743 | 6594 |
| 1999 | 11862 | 2563 | 31574 | 21747 | 18499 | 7846 |
| 2000 | 11697 | 2866 | 23311 | 23701 | 19129 | 5081 |
| 2001 | 16798 | 8398 | 32726 | 25619 | 13350 | 5066 |
| 2002 | 15885 | 4562 | 33585 | 22969 | 10982 | 11689 |
| 2003 | 16436 | 6383 | 33293 | 24635 | 8600 | 8484 |
| 2004 | 18306 | 8573 | 29488 | 24370 | 8107 | 9176 |
| 2005 | 19800 | 11663 | 25696 | 24619 | 7175 | 8391 |
| 2006 | 15377 | 10856 | 30152 | 19061 | 5798 | 5779 |

| Year | Subdivision | | | | | |
|---|---|---|---|---|---|---|
| | 8c | 9aNorth | 9a Central North | 9a Central South | 9a South Algarve | 9a South Cadiz |
| 2007 | 13380 | 12402 | 41090 | 19142 | 4266 | 6188 |
| 2008 | 13636 | 9409 | 45210 | 20858 | 4928 | 7423 |
| 2009 | 11963 | 7226 | 36212 | 20838 | 4785 | 6716 |
| 2010 | 13772 | 7409 | 40923 | 17623 | 5181 | 4662 |
| 2011 | 8536 | 5621 | 37152 | 13685 | 6387 | 9023 |
| 2012 | 13090 | 4154 | 19647 | 9045 | 2891 | 6031 |
| 2013 | 5272 | 2128 | 15065 | 9084 | 4112 | 10157 |
| 2014 | 4344 | 1924 | 6889 | 6747 | 2398 | 5635 |
| 2015 | 1916 | 1946 | 7117 | 4848 | 1812 | 2956 |
| 2016 | 2886 | 2887 | 7695 | 4031 | 1972 | 3233 |
| 2017 | 2251 | 2225 | 5182 | 6676 | 2836 | 2742 |
| 2018 | 2764 | 856 | 3579 | 4759 | 1400 | 1704 |
| 2019 | 1608 | 1076 | 3520 | 4290 | 1986 | 1280 |
| 2020 | 2822 | 1950 | 5049 | 7560 | 2807 | 1955 |
| 2021 | 4918 | 5109 | 13031 | 8767 | 5052 | 3808 |
| 2022 | 5922 | 6701 | 10374 | 9769 | 4522 | 3141 |
| 2023 | 8335 | 11756 | 10854 | 11960 | 3172 | 2323 |

**Table 8.2.4.1: Sardine in 8c and 9a: Sardine length composition (thousands), mean length (cm) by ICES subdivision in 2023.**

| Length | 8c E | 8c W | 9a N | 9a CN | 9a CS | 9a S | 9a S (Ca) | Total |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| 6.5 | | | | | | | 12 | 12 |
| 7 | | | | | | | | |
| 7.5 | | | | | | | 23 | 23 |
| 8 | | | | | | | 2 | 2 |
| 8.5 | | | | | | | | |
| 9 | | | | | | | 19 | 19 |
| 9.5 | | | | | | | 44 | 44 |
| 10 | 1 | 0 | 0 | | 120 | | 357 | 478 |
| 10.5 | | 4 | | | | | 1104 | 1108 |
| 11 | 1 | 4 | 2 | | | | 1975 | 1982 |
| 11.5 | | 6 | 2 | 253 | | | 2294 | 2555 |
| 12 | | 2 | 73 | 618 | | | 2762 | 3454 |
| 12.5 | 1 | | 192 | 881 | | | 5505 | 6579 |
| 13 | 5 | | 435 | 2168 | | 245 | 5671 | 8525 |
| 13.5 | 35 | | 605 | 4814 | 184 | 95 | 6255 | 11989 |
| 14 | 300 | 134 | 1145 | 10258 | 22 | 408 | 5804 | 18071 |
| 14.5 | 528 | 382 | 1686 | 14324 | 334 | 787 | 6646 | 24688 |
| 15 | 1435 | 842 | 4668 | 27655 | 2896 | 1198 | 4363 | 43056 |
| 15.5 | 1049 | 1747 | 8766 | 45205 | 4304 | 1812 | 3405 | 66286 |
| 16 | 1062 | 5145 | 10345 | 66998 | 14047 | 2803 | 1373 | 101773 |
| 16.5 | 1249 | 3942 | 10042 | 53467 | 18538 | 2482 | 2168 | 91889 |
| 17 | 2400 | 9351 | 8401 | 33481 | 19860 | 1734 | 3263 | 78490 |
| 17.5 | 3178 | 6607 | 9620 | 13061 | 16548 | 2762 | 5094 | 56870 |
| 18 | 3735 | 7775 | 8324 | 8470 | 20068 | 5979 | 4377 | 58729 |
| 18.5 | 2545 | 3590 | 8088 | 7702 | 25182 | 9672 | 4380 | 61159 |
| 19 | 2103 | 8090 | 11827 | 5155 | 28646 | 9793 | 3892 | 69506 |
| 19.5 | 2012 | 7298 | 18071 | 2662 | 19603 | 5173 | 2065 | 56885 |
| 20 | 2060 | 18717 | 20527 | 2744 | 13834 | 4850 | 709 | 63440 |
| 20.5 | 1388 | 14279 | 23882 | 1282 | 5281 | 3387 | 596 | 50095 |

| Length | 8c E | 8c W | 9a N | 9a CN | 9a CS | 9a S | 9a S (Ca) | Total |
|---|---|---|---|---|---|---|---|---|
| 21 | 910 | 15900 | 20054 | 1307 | 1502 | 1691 | 67 | 41430 |
| 21.5 | 405 | 4686 | 14997 | | 622 | 343 | 65 | 21118 |
| 22 | 205 | 4887 | 8902 | 128 | 259 | 67 | 58 | 14507 |
| 22.5 | 35 | 691 | 3770 | | 170 | 12 | 0 | 4678 |
| 23 | 10 | 987 | 1664 | | 73 | | | 2734 |
| 23.5 | | 280 | 243 | | | | | 523 |
| 24 | | 181 | 56 | | | | | 236 |
| 24.5 | | | | | | | | |
| 25 | | | | | | | | |
| 25.5 | | | | | | | | |
| 26 | | | | | | | | |
| 26.5 | | | | | | | | |
| 27 | | | | | | | | |
| 27.5 | | | | | | | | |
| 28 | | | | | | | | |
| 28.5 | | | | | | | | |
| Total | 26650 | 115529 | 196385 | 302633 | 192094 | 55294 | 74346 | 962931 |
| | | | | | | | | |
| Mean L | 18.3 | 19.6 | 19.4 | 16.4 | 18.3 | 18.6 | 15.4 | 17.9 |
| sd | 1.8 | 1.8 | 2.2 | 1.3 | 1.4 | 1.6 | 2.6 | 2.3 |

**Table 8.2.4.1a: Sardine in 8c and 9a: Sardine length composition (thousands) , mean length (cm) by ICES subdivision in the first quarter 2023.**

| | | | | First Quarter | | | | |
|---|---|---|---|---|---|---|---|---|
| **Length** | **8c E** | **8c W** | **9a N** | **9a CN** | **9a CS** | **9a S** | **9a S (Ca)** | **Total** |
| | | | | | | | | |
| **6.5** | | | | | | | | |
| **7** | | | | | | | | |
| **7.5** | | | | | | | | |
| **8** | | | | | | | | |
| **8.5** | | | | | | | | |
| **9** | | | | | | | | |

| | | | | First Quarter | | | | |
|---|---|---|---|---|---|---|---|---|
| **Length** | **8c E** | **8c W** | **9a N** | **9a CN** | **9a CS** | **9a S** | **9a S (Ca)** | **Total** |
| **9.5** | | | | | | | 7 | 7 |
| **10** | 1 | | | | | | 219 | 220 |
| **10.5** | | | | | | | 231 | 231 |
| **11** | 1 | | | | | | 382 | 383 |
| **11.5** | | | | | | | 270 | 270 |
| **12** | | | | | | | 410 | 410 |
| **12.5** | 1 | | | | | | 230 | 231 |
| **13** | 2 | | 87 | | | | 328 | 417 |
| **13.5** | 27 | | 251 | | | | 133 | 411 |
| **14** | 259 | | 633 | | | | 224 | 1 116 |
| **14.5** | 461 | | 1 188 | | | | 244 | 1 893 |
| **15** | 1 320 | | 793 | | | | 118 | 2 231 |
| **15.5** | 926 | | 351 | | | | 62 | 1 339 |
| **16** | 794 | | 96 | | | | 143 | 1 033 |
| **16.5** | 638 | | | | | | 929 | 1 567 |
| **17** | 933 | | 1 | | | | 1 925 | 2 859 |
| **17.5** | 484 | | 4 | | | | 2 172 | 2 660 |
| **18** | 479 | 49 | 8 | | | | 2 594 | 3 130 |
| **18.5** | 363 | 51 | 34 | | | | 1 334 | 1 782 |
| **19** | 422 | 150 | 53 | | | | 873 | 1 498 |
| **19.5** | 725 | 82 | 89 | | | | 642 | 1 538 |
| **20** | 1 140 | 689 | 39 | | | | 376 | 2 244 |
| **20.5** | 942 | 358 | 62 | | | | 183 | 1 545 |
| **21** | 561 | 791 | 212 | | | | 62 | 1 626 |
| **21.5** | 222 | 119 | 461 | | | | 63 | 865 |
| **22** | 129 | 119 | 545 | | | | 57 | 850 |
| **22.5** | 15 | 31 | 261 | | | | | 307 |
| **23** | | 85 | 44 | | | | | 128 |
| **23.5** | | | | | | | | |

| | | | | First Quarter | | | | |
|---|---|---|---|---|---|---|---|---|
| **Length** | **8c E** | **8c W** | **9a N** | **9a CN** | **9a CS** | **9a S** | **9a S (Ca)** | **Total** |
| **24** | | | 22 | | | | | 22 |
| **24.5** | | | | | | | | |
| **25** | | | | | | | | |
| **25.5** | | | | | | | | |
| **26** | | | | | | | | |
| **26.5** | | | | | | | | |
| **27** | | | | | | | | |
| **27.5** | | | | | | | | |
| | | | | | | | | |
| **Total** | 10 843 | 2 523 | 5 233 | | | | 14 212 | 32 811 |
| | | | | | | | | |
| **Mean L** | 17.9 | 20.8 | 17.2 | | | | 17.1 | 17.7 |
| **sd** | 2.26 | 0.96 | 3.40 | | | | 2.54 | 2.71 |

**Table 8.2.4.1b: Sardine in 8c and 9a: Sardine length composition (thousands), mean length (cm) by ICES subdivision in the second quarter 2023.**

| | | | | Second Quarter | | | | |
|---|---|---|---|---|---|---|---|---|
| **Length** | **8c E** | **8c W** | **9a N** | **9a CN** | **9a CS** | **9a S** | **9a S-C** | **Total** |
| | | | | | | | | |
| **6.5** | | | | | | | 12 | |
| **7** | | | | | | | | |
| **7.5** | | | | | | | 23 | 23 |
| **8** | | | | | | | | |
| **8.5** | | | | | | | | |
| **9** | | | | | | | 19 | 19 |
| **9.5** | | | | | | | | |
| **10** | | | | | 120 | | 58 | 177 |
| **10.5** | | 4 | | | | | 308 | 312 |
| **11** | | 4 | 2 | | | | 397 | 403 |
| **11.5** | | 6 | 2 | | | | 339 | 347 |

| | | | | Second Quarter | | | | |
|---|---|---|---|---|---|---|---|---|
| **Length** | **8c E** | **8c W** | **9a N** | **9a CN** | **9a CS** | **9a S** | **9a S-C** | **Total** |
| **12** | | 2 | 3 | | | | 865 | 870 |
| **12.5** | | | 1 | | | | 1 255 | 1 256 |
| **13** | | | | | | | 1 558 | 1 558 |
| **13.5** | | | 12 | 69 | | | 1 893 | 81 |
| **14** | | 134 | 213 | 4 812 | | | 2 460 | 5 160 |
| **14.5** | 5 | 382 | 447 | 9 565 | 76 | | 4 373 | 10 475 |
| **15** | | 808 | 3 838 | 17 299 | 22 | 103 | 3 386 | 21 968 |
| **15.5** | 13 | 1 650 | 7 989 | 20 270 | 152 | 482 | 2 814 | 30 074 |
| **16** | 82 | 4 492 | 7 987 | 12 965 | 2 235 | 592 | 1 171 | 27 761 |
| **16.5** | 149 | 3 151 | 4 492 | 2 760 | 2 651 | 771 | 434 | 13 202 |
| **17** | 309 | 6 622 | 1 944 | 364 | 7 339 | 420 | 24 | 16 577 |
| **17.5** | 450 | 3 691 | 1 052 | 279 | 5 697 | 846 | 147 | 11 169 |
| **18** | 556 | 2 742 | 702 | 1 335 | 4 072 | 2 303 | 65 | 9 407 |
| **18.5** | 366 | 1 310 | 1 540 | 2 693 | 3 306 | 4 089 | | 9 215 |
| **19** | 186 | 2 745 | 2 482 | 1 908 | 4 849 | 4 002 | 82 | 12 170 |
| **19.5** | 186 | 2 420 | 4 133 | 611 | 6 061 | 1 926 | 5 | 13 412 |
| **20** | 118 | 6 608 | 5 728 | 755 | 8 520 | 748 | 9 | 21 728 |
| **20.5** | 55 | 4 281 | 6 255 | 315 | 5 714 | 224 | | 16 619 |
| **21** | 44 | 5 123 | 4 382 | | 4 352 | 65 | | 13 967 |
| **21.5** | 50 | 888 | 2 812 | | 1 178 | | | 4 929 |
| **22** | 10 | 1 582 | 1 596 | | 525 | 27 | | 3 741 |
| **22.5** | | 254 | 570 | | 196 | | | 1 020 |
| **23** | | 494 | 374 | | 22 | | | 890 |
| **23.5** | | 80 | 53 | | | | | 133 |
| **24** | | 131 | 29 | | 22 | | | 182 |
| **24.5** | | | | | | | | |
| **25** | | | | | | | | |
| **25.5** | | | | | | | | |
| **26** | | | | | | | | |

| | | | | Second Quarter | | | | |
|---|---|---|---|---|---|---|---|---|
| **Length** | **8c E** | **8c W** | **9a N** | **9a CN** | **9a CS** | **9a S** | **9a S-C** | **Total** |
| **26.5** | | | | | | | | |
| **27** | | | | | | | | |
| **27.5** | | | | | | | | |
| | | | | | | | | |
| **Total** | 2 579 | 49 606 | 58 638 | 75 999 | 57 110 | 16 600 | 21 684 | 248 846 |
| | | | | | | | | |
| **Mean L** | 18.4 | 18.9 | 18.4 | 15.9 | 19.1 | 18.6 | 14.5 | 17.8 |
| **sd** | 1.22 | 2.05 | 2.38 | 1.26 | 1.63 | 1.12 | 1.41 | 2.38 |

**Table 8.2.4.1c: Sardine in 8c and 9a: Sardine length composition (thousands) , mean length (cm) by ICES subdivision in the third quarter 2023.**

| | | | | Third Quarter | | | | |
|---|---|---|---|---|---|---|---|---|
| **Length** | **8c E** | **8c W** | **9a N** | **9a CN** | **9a CS** | **9a S** | **9a S-C** | **Total** |
| | | | | | | | | |
| **6.5** | | | | | | | | |
| **7** | | | | | | | | |
| **7.5** | | | | | | | | |
| **8** | | | | | | | 2 | 2 |
| **8.5** | | | | | | | | |
| **9** | | | | | | | | |
| **9.5** | | | | | | | 38 | 38 |
| **10** | | | | | | | 79 | 79 |
| **10.5** | | | | | | | 565 | 565 |
| **11** | | | | | | | 1 170 | 1 170 |
| **11.5** | | | | 253 | | | 1 660 | 1 913 |
| **12** | | | | 470 | | | 1 462 | 1 932 |
| **12.5** | | | | 466 | | | 3 820 | 4 286 |
| **13** | | | | 874 | | 245 | 3 630 | 4 749 |
| **13.5** | | | | 1 287 | | 95 | 3 920 | 5 302 |
| **14** | | | | 1 819 | | 408 | 2 920 | 5 147 |
| **14.5** | | | | 3 339 | 108 | 469 | 1 780 | 5 696 |

| | | | | Third Quarter | | | | |
|---|---|---|---|---|---|---|---|---|
| **Length** | **8c E** | **8c W** | **9a N** | **9a CN** | **9a CS** | **9a S** | **9a S-C** | **Total** |
| **15** | | 34 | | 7 656 | | 988 | 788 | 9 466 |
| **15.5** | | 56 | 240 | 17 408 | 36 | 1 330 | 463 | 19 533 |
| **16** | 65 | 451 | 1 208 | 38 450 | 39 | 2 104 | 46 | 42 364 |
| **16.5** | 284 | 411 | 2 593 | 31 061 | 260 | 1 605 | 136 | 36 350 |
| **17** | 833 | 1 741 | 1 632 | 17 113 | 2 477 | 996 | 45 | 24 837 |
| **17.5** | 1 590 | 1 745 | 2 028 | 6 178 | 5 005 | 1 598 | 45 | 18 190 |
| **18** | 1 630 | 3 316 | 2 601 | 3 456 | 8 978 | 3 464 | | 23 446 |
| **18.5** | 1 030 | 1 337 | 3 313 | 2 926 | 7 007 | 4 767 | | 20 379 |
| **19** | 856 | 4 164 | 6 840 | 855 | 8 765 | 4 008 | | 25 489 |
| **19.5** | 573 | 4 027 | 10 871 | 22 | 12 959 | 1 510 | | 29 962 |
| **20** | 376 | 9 768 | 11 374 | 22 | 14 065 | 1 036 | | 36 642 |
| **20.5** | 155 | 8 059 | 13 522 | | 7 667 | 383 | | 29 786 |
| **21** | 125 | 7 987 | 11 400 | | 4 690 | 230 | | 24 432 |
| **21.5** | 42 | 2 743 | 7 213 | | 2 081 | 43 | | 12 123 |
| **22** | 10 | 2 054 | 4 165 | | 433 | | | 6 663 |
| **22.5** | | 150 | 1 911 | | 185 | | | 2 246 |
| **23** | | 235 | 858 | | | | | 1 093 |
| **23.5** | | 135 | 119 | | 148 | | | 402 |
| **24** | | 8 | | | | | | 8 |
| **24.5** | | | | | | | | |
| **25** | | | | | | | | |
| **25.5** | | | | | | | | |
| **26** | | | | | | | | |
| **26.5** | | | | | | | | |
| **27** | | | | | | | | |
| **27.5** | | | | | | | | |
| | | | | | | | | |
| **Total** | 7 569 | 48 419 | 81 890 | 133 656 | 74 903 | 25 280 | 22 570 | 394 288 |

| | | | | Third Quarter | | | | |
|---|---|---|---|---|---|---|---|---|
| **Length** | **8c E** | **8c W** | **9a N** | **9a CN** | **9a CS** | **9a S** | **9a S-C** | **Total** |
| **Mean L** | 18.5 | 20.1 | 20.2 | 16.4 | 19.6 | 18.0 | 13.3 | 18.2 |
| **sd** | 1.05 | 1.37 | 1.48 | 1.01 | 1.18 | 1.62 | 1.21 | 2.38 |

**Table 8.2.4.1d: Sardine in 8c and 9a: Sardine length composition (thousands) by ICES subdivision in the fourth quarter 2023.**

| | | | | Fourth Quarter | | | | |
|---|---|---|---|---|---|---|---|---|
| **Length** | **8c E** | **8c W** | **9a N** | **9a CN** | **9a CS** | **9a S** | **9a S-C** | **Total** |
| | | | | | | | | |
| **6.5** | | | | | | | | |
| **7** | | | | | | | | |
| **7.5** | | | | | | | | |
| **8** | | | | | | | | |
| **8.5** | | | | | | | | |
| **9** | | | | | | | | |
| **9.5** | | | | | | | | |
| **10** | | | | | | | 1 | 2 |
| **10.5** | | | | | | | | |
| **11** | | | | | | | 26 | 26 |
| **11.5** | | | | | | | 25 | 25 |
| **12** | | | 69 | 147 | | | 25 | 242 |
| **12.5** | | | 190 | 415 | | | 200 | 805 |
| **13** | 4 | | 348 | 1 294 | | | 155 | 1 801 |
| **13.5** | 7 | | 343 | 3 458 | | | 309 | 4 118 |
| **14** | 41 | | 298 | 3 627 | | | 199 | 4 165 |
| **14.5** | 62 | | 51 | 1 420 | | 318 | 249 | 2 101 |
| **15** | 115 | | 36 | 2 700 | | 106 | 70 | 3 027 |
| **15.5** | 110 | 41 | 185 | 7 527 | 147 | | 66 | 8 076 |
| **16** | 121 | 201 | 1 055 | 15 583 | 622 | 106 | 13 | 17 701 |
| **16.5** | 178 | 380 | 2 957 | 19 647 | 1 392 | 106 | 669 | 25 330 |
| **17** | 325 | 988 | 4 824 | 16 005 | 4 232 | 318 | 1 269 | 27 961 |

| Fourth Quarter | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Length** | **8c E** | **8c W** | **9a N** | **9a CN** | **9a CS** | **9a S** | **9a S-C** | **Total** |
| **17.5** | 654 | 1 171 | 6 536 | 6 604 | 7 836 | 318 | 2 729 | 25 848 |
| **18** | 1 070 | 1 668 | 5 012 | 3 679 | 6 809 | 212 | 1 718 | 20 169 |
| **18.5** | 786 | 892 | 3 200 | 2 084 | 6 235 | 817 | 3 046 | 17 059 |
| **19** | 639 | 1 031 | 2 453 | 2 392 | 6 454 | 1 782 | 2 937 | 17 688 |
| **19.5** | 528 | 770 | 2 977 | 2 029 | 6 162 | 1 738 | 1 419 | 15 621 |
| **20** | 426 | 1 652 | 3 386 | 1 989 | 6 061 | 3 066 | 324 | 16 903 |
| **20.5** | 236 | 1 582 | 4 043 | 967 | 6 223 | 2 779 | 412 | 16 242 |
| **21** | 180 | 1 999 | 4 060 | 1 285 | 4 792 | 1 396 | 5 | 13 716 |
| **21.5** | 91 | 936 | 4 511 | | 2 021 | 300 | 1 | 7 860 |
| **22** | 55 | 1 131 | 2 595 | 128 | 544 | 40 | 1 | 4 495 |
| **22.5** | 20 | 256 | 1 029 | | 240 | 12 | | 1 558 |
| **23** | 10 | 173 | 388 | | 259 | | | 831 |
| **23.5** | | 64 | 71 | | | | | 136 |
| **24** | | 42 | 5 | | 51 | | | 98 |
| **24.5** | | | | | | | | |
| **25** | | | | | | | | |
| **25.5** | | | | | | | | |
| **26** | | | | | | | | |
| **26.5** | | | | | | | | |
| **27** | | | | | | | | |
| **27.5** | | | | | | | | |
| | | | | | | | | |
| **Total** | 5 658 | 14 980 | 50 624 | 92 978 | 60 081 | 13 414 | 15 869 | 253 604 |
| | | | | | | | | |
| **Mean L** | 18.7 | 19.8 | 19.2 | 16.8 | 19.3 | 19.8 | 18.2 | 18.3 |
| **sd** | 1.53 | 1.75 | 2.06 | 1.58 | 1.45 | 1.38 | 1.61 | 2.06 |

**Table 8.2.4.2: Sardine in 8c and 9a: Catch in numbers (thousands) at age by quarter and by subdivision in 2023.**

| | | | | | | | First Quarter | |
|---|---|---|---|---|---|---|---|---|
| **Age** | **8c-E** | **8c-W** | **9a-N** | **9a-CN** | **9a-CS** | **9a-S** | **9a-C** | **Total** |
| 0 | | | | | | | | |
| 1 | 3 965 | 8 | 3 104 | | | | 3 934 | 11 011 |
| 2 | 2 280 | 79 | 318 | | | | 7 446 | 10 122 |
| 3 | 2 089 | 151 | 68 | | | | 1 312 | 3 621 |
| 4 | 1 994 | 1 891 | 1 029 | | | | 868 | 5 784 |
| 5 | 442 | 243 | 303 | | | | 652 | 1 639 |
| 6 | 68 | 140 | 291 | | | | | 499 |
| 7 | 4 | 12 | 120 | | | | | 136 |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | |
| 11 | | | | | | | | |
| 12 | | | | | | | | |
| Total | 10 843 | 2 523 | 5 233 | | | | 14 212 | 32 811 |

| | | | | | | | Second Quarter | |
|---|---|---|---|---|---|---|---|---|
| **Age** | **8c-E** | **8c-W** | **9a-N** | **9a-CN** | **9a-CS** | **9a-S** | **9a-C** | **Total** |
| 0 | | | | | | | | |
| 1 | 355 | 6 226 | 17 175 | 56 950 | 3 987 | 312 | 13 678 | 98 683 |
| 2 | 1 061 | 18 059 | 11 825 | 12 191 | 26 505 | 4 296 | 7 952 | 81 889 |
| 3 | 821 | 1 928 | 3 667 | 690 | 5 305 | 7 699 | 42 | 20 153 |
| 4 | 268 | 19 781 | 22 546 | 5 498 | 6 108 | 2 370 | 8 | 56 580 |
| 5 | 68 | 2 151 | 1 622 | 669 | 5 908 | 1 405 | 15 | 11 837 |
| 6 | 6 | 1 307 | 1 378 | | 5 314 | 469 | | 8 473 |
| 7 | | 154 | 426 | | 3 867 | 49 | | 4 497 |
| 8 | | | | | 117 | | | 117 |
| 9 | | | | | | | | |
| 10 | | | | | | | | |
| 11 | | | | | | | | |
| 12 | | | | | | | | |
| Total | 2 579 | 49 606 | 58 638 | 75 999 | 57 110 | 16 600 | 21 696 | 282 229 |

| | | | | | | | Third Quarter | |
|---|---|---|---|---|---|---|---|---|
| **Age** | **8c-E** | **8c-W** | **9a-N** | **9a-CN** | **9a-CS** | **9a-S** | **9a-C** | **Total** |
| 0 | 33 | 34 | 48 | 3 617 | 54 | | 21 595 | 25 380 |
| 1 | 3 703 | 13 019 | 14 879 | 122 439 | 21 198 | 7 603 | 960 | 183 801 |
| 2 | 1 756 | 5 708 | 6 398 | 2 009 | 26 815 | 11 435 | 11 | 54 131 |
| 3 | 1 400 | 23 307 | 50 579 | 5 378 | 8 832 | 3 624 | 3 | 93 124 |
| 4 | 533 | 4 237 | 7 126 | 213 | 13 455 | 2 061 | | 27 624 |
| 5 | 78 | 1 151 | 1 154 | | 2 669 | 456 | | 5 507 |
| 6 | 68 | 528 | 1 198 | | 1 881 | 56 | | 3 731 |
| 7 | | 202 | 508 | | | 45 | | 755 |
| 8 | | 234 | | | | | | 234 |
| 9 | | | | | | | | |
| 10 | | | | | | | | |
| 11 | | | | | | | | |
| 12 | | | | | | | | |
| Total | 7 569 | 48 419 | 81 890 | 133 656 | 74 903 | 25 280 | 22 570 | 394 288 |

| | | | | | | | Fourth Quarter | |
|---|---|---|---|---|---|---|---|---|
| **Age** | **8c-E** | **8c-W** | **9a-N** | **9a-CN** | **9a-CS** | **9a-S** | **9a-C** | **Total** |
| 0 | 345 | | 1 392 | 10 858 | | 318 | 1 530 | 14 443 |
| 1 | 2 103 | 6 268 | 22 606 | 71 755 | 16 774 | 1 424 | 5 842 | 126 772 |
| 2 | 1 279 | 1 293 | 2 400 | 5 494 | 20 760 | 2 477 | 5 093 | 38 797 |
| 3 | 1 166 | 5 362 | 19 168 | 4 785 | 9 923 | 4 618 | 1 696 | 46 719 |
| 4 | 561 | 1 029 | 3 485 | 86 | 8 698 | 3 135 | 1 122 | 18 114 |
| 5 | 109 | 468 | 687 | | 2 528 | 906 | 306 | 5 005 |
| 6 | 96 | 259 | 642 | | 1 398 | 535 | 279 | 3 209 |
| 7 | | 129 | 244 | | | | | 373 |
| 8 | | 171 | | | | | | 171 |
| 9 | | | | | | | | |
| 10 | | | | | | | | |
| 11 | | | | | | | | |
| 12 | | | | | | | | |
| Total | 5 658 | 14 980 | 50 624 | 92 978 | 60 081 | 13 414 | 15 869 | 253 604 |

| | | | | | | | Whole Year | |
|---|---|---|---|---|---|---|---|---|
| **Age** | **8c-E** | **8c-W** | **9a-N** | **9a-CN** | **9a-CS** | **9a-S** | **9a-C** | **Total** |
| 0 | 377 | 34 | 1 440 | 14 475 | 54 | 318 | 23 125 | 39 824 |
| 1 | 10 126 | 25 521 | 57 764 | 251 144 | 41 959 | 9 339 | 24 415 | 420 267 |
| 2 | 6 375 | 25 139 | 20 940 | 19 695 | 74 079 | 18 208 | 20 502 | 184 939 |
| 3 | 5 477 | 30 749 | 73 483 | 10 853 | 24 059 | 15 942 | 3 054 | 163 616 |
| 4 | 3 356 | 26 938 | 34 186 | 5 796 | 28 262 | 7 565 | 1 998 | 108 101 |
| 5 | 696 | 4 013 | 3 765 | 669 | 11 105 | 2 767 | 973 | 23 988 |
| 6 | 238 | 2 233 | 3 509 | | 8 592 | 1 060 | 279 | 15 912 |
| 7 | 4 | 497 | 1 299 | | 3 867 | 94 | | 5 761 |
| 8 | | 405 | | | 117 | | | 522 |
| 9 | | | | | | | | |
| 10 | | | | | | | | |
| 11 | | | | | | | | |
| 12 | | | | | | | | |
| Total | 26 650 | 115 529 | 196 385 | 302 633 | 192 094 | 55 294 | 74 346 | 962 931 |

**Table 8.2.4.3: Sardine 8c and 9a: Historical catch-at-age data.**

| Year | Age0 | Age1 | Age2 | Age3 | Age4 | Age5 | Age6+ |
|---|---|---|---|---|---|---|---|
| 1978 | 869437 | 2296650 | 946698 | 295360 | 136661 | 41744 | 16468 |
| 1979 | 674489 | 1535560 | 956132 | 431466 | 189107 | 93185 | 36038 |
| 1980 | 856671 | 2037400 | 1561970 | 378785 | 156922 | 47302 | 30006 |
| 1981 | 1025960 | 1934840 | 1733730 | 679001 | 195304 | 104545 | 76466 |
| 1982 | 62000 | 795000 | 1869000 | 709000 | 353000 | 131000 | 129000 |
| 1983 | 1070000 | 577000 | 857000 | 803000 | 324000 | 141000 | 139000 |
| 1984 | 118000 | 3312000 | 487000 | 502000 | 301000 | 179000 | 117000 |
| 1985 | 268000 | 564000 | 2371000 | 469000 | 294000 | 201000 | 103000 |
| 1986 | 304000 | 755000 | 1027000 | 919000 | 333000 | 196000 | 167000 |
| 1987 | 1437000 | 543000 | 667000 | 569000 | 535000 | 154000 | 171000 |
| 1988 | 521000 | 990000 | 535000 | 439000 | 304000 | 292000 | 189000 |
| 1989 | 248000 | 566000 | 909000 | 389000 | 221000 | 2.00E+05 | 245000 |
| 1990 | 258000 | 602000 | 517000 | 707000 | 295000 | 151000 | 248000 |
| 1991 | 1580580 | 477368 | 436081 | 406886 | 265762 | 74726 | 105186 |
| 1992 | 498265 | 1001860 | 451367 | 340313 | 186234 | 110932 | 80579 |
| 1993 | 87808 | 566221 | 1081820 | 521458 | 257209 | 113871 | 120282 |
| 1994 | 120797 | 60194 | 542163 | 1094440 | 272466 | 112635 | 72091 |
| 1995 | 30512 | 189147 | 280715 | 829707 | 472880 | 70208 | 64485 |
| 1996 | 277053 | 101267 | 347690 | 514741 | 652711 | 197235 | 46607 |
| 1997 | 208570 | 548594 | 453324 | 391118 | 337282 | 225170 | 70268 |
| 1998 | 449115 | 366176 | 501585 | 352485 | 233672 | 178735 | 105884 |
| 1999 | 246016 | 475225 | 361509 | 339691 | 177170 | 105518 | 72541 |
| 2000 | 489836 | 354822 | 313972 | 255523 | 194156 | 97693 | 64373 |
| 2001 | 219973 | 1172300 | 256133 | 195897 | 126389 | 75145 | 49547 |
| 2002 | 106882 | 587354 | 753897 | 181381 | 112166 | 55650 | 40219 |
| 2003 | 198412 | 318695 | 446285 | 518289 | 114035 | 61276 | 51172 |
| 2004 | 589910 | 180522 | 263521 | 386715 | 377848 | 78396 | 55312 |
| 2005 | 169229 | 1005530 | 266213 | 206657 | 191013 | 116628 | 46087 |
| 2006 | 18347 | 250200 | 777315 | 128695 | 108244 | 121043 | 81149 |
| 2007 | 199364 | 82084 | 313453 | 535706 | 80348 | 82713 | 120821 |
| 2008 | 298405 | 219205 | 182636 | 370253 | 411611 | 65397 | 108832 |
| 2009 | 378304 | 353839 | 195618 | 125324 | 251973 | 197185 | 83887 |
| 2010 | 278311 | 516544 | 263334 | 136037 | 82831 | 129434 | 182722 |
| 2011 | 341535 | 452259 | 383353 | 122136 | 87976 | 40949 | 110734 |
| 2012 | 220164 | 193884 | 168105 | 122976 | 94143 | 48700 | 52645 |
| 2013 | 280544 | 232934 | 155842 | 87924 | 48492 | 26591 | 27635 |
| 2014 | 63949 | 189093 | 109802 | 54550 | 35237 | 19462 | 21688 |
| 2015 | 68371 | 98936 | 84313 | 47069 | 20960 | 13656 | 11242 |
| 2016 | 172202 | 215051 | 58288 | 40726 | 15422 | 9815 | 8424 |
| 2017 | 35329 | 198627 | 126003 | 39727 | 15971 | 8393 | 10853 |
| 2018 | 37222 | 49140 | 88410 | 33715 | 19257 | 9003 | 9140 |
| 2019 | 53515 | 85035 | 49870 | 40297 | 13422 | 4307 | 3429 |
| 2020 | 41356 | 270602 | 83327 | 36914 | 20026 | 5690 | 5725 |

| Year | Age0 | Age1 | Age2 | Age3 | Age4 | Age5 | Age6+ |
|---|---|---|---|---|---|---|---|
| 2021 | 87950 | 153333 | 393524 | 55831 | 38306 | 21632 | 4755 |
| 2022 | 87950 | 153333 | 393524 | 55831 | 38306 | 21632 | 4755 |
| 2023 | 39823 | 420207 | 184918 | 163531 | 108086 | 23984 | 22192 |

**Table 8.2.4.4: Sardine 8c and 9a: Relative distribution of sardine catches. Upper panel relative contribution of each age group within each subdivision. Lower panel, relative contribution of each subdivision within each age group.**

| Age | 8c-E | 8c-W | 9a-N | 9a-CN | 9a-CS | 9a-S | 9a-S-C | Total |
|---|---|---|---|---|---|---|---|---|
| 0 | 1% | 0% | 1% | 5% | 0% | 1% | 31% | 4% |
| 1 | 38% | 22% | 29% | 83% | 22% | 17% | 33% | 44% |
| 2 | 24% | 22% | 11% | 7% | 39% | 33% | 28% | 19% |
| 3 | 21% | 27% | 37% | 4% | 13% | 29% | 4% | 17% |
| 4 | 13% | 23% | 17% | 2% | 15% | 14% | 3% | 11% |
| 5 | 3% | 3% | 2% | 0% | 6% | 5% | 1% | 2% |
| 6+ | 1% | 3% | 2% | 0% | 7% | 2% | 0% | 2% |
| | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

| Age | 8c-E | 8c-W | 9a-N | 9a-CN | 9a-CS | 9a-S | 9a-S-C | Total |
|---|---|---|---|---|---|---|---|---|
| 0 | 1% | 0% | 4% | 36% | 0% | 1% | 58% | 100% |
| 1 | 2% | 6% | 14% | 60% | 10% | 2% | 6% | 100% |
| 2 | 3% | 14% | 11% | 11% | 40% | 10% | 11% | 100% |
| 3 | 3% | 19% | 45% | 7% | 15% | 10% | 2% | 100% |
| 4 | 3% | 25% | 32% | 5% | 26% | 7% | 2% | 100% |
| 5 | 3% | 17% | 16% | 3% | 46% | 12% | 4% | 100% |
| 6+ | 1% | 14% | 22% | 0% | 57% | 5% | 1% | 100% |

**Table 8.2.5.1: Sardine 8c and 9a: Sardine Mean length (cm) at age by quarter and by subdivision in 2023.**

| | First Quarter | | | | | | |
|---|---|---|---|---|---|---|---|
| Age | 8c-E | 8c-W | 9a-N | 9a-CN | 9a-CS | 9a-S | 9a-S-C |
| 0 | | | | | | | |
| 1 | 15.7 | 18.5 | 14.7 | | | | 14.3 |
| 2 | 17.6 | 18.8 | 15.8 | | | | 17.8 |
| 3 | 19.3 | 20.2 | 20.1 | | | | 18.3 |
| 4 | 20.6 | 20.7 | 21.4 | | | | 19.4 |
| 5 | 21.0 | 21.6 | 22.3 | | | | 20.2 |
| 6 | 20.6 | 22.4 | 22.3 | | | | |
| 7 | 22.8 | 21.8 | 23.0 | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |
| 12 | | | | | | | |

| | Second Quarter | | | | | | |
|---|---|---|---|---|---|---|---|
| Age | 8c-E | 8c-W | 9a-N | 9a-CN | 9a-CS | 9a-S | 9a-S-C |
| 0 | | | | | | | |
| 1 | 17.2 | 16.5 | 16.1 | 15.5 | 16.5 | 17.3 | 13.9 |
| 2 | 18.0 | 17.2 | 16.5 | 15.9 | 18.1 | 17.5 | 15.4 |
| 3 | 18.7 | 20.0 | 20.0 | 19.1 | 19.7 | 19.0 | 18.1 |
| 4 | 20.1 | 20.4 | 20.5 | 19.1 | 20.4 | 19.1 | 19.3 |
| 5 | 20.5 | 21.5 | 21.6 | 18.4 | 20.4 | 19.7 | 19.6 |
| 6 | 20.3 | 22.5 | 22.1 | | 20.8 | 19.8 | |
| 7 | | 22.8 | 23.1 | | 20.7 | 19.8 | |
| 8 | | | | | 22.0 | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |
| 12 | | | | | | | |

| | Third Quarter | | | | | | |
|---|---|---|---|---|---|---|---|
| Age | 8c-E | 8c-W | 9a-N | 9a-CN | 9a-CS | 9a-S | 9a-S-C |
| 0 | 16.3 | 15.3 | 16.8 | 13.3 | 14.8 | | 13.2 |
| 1 | 17.9 | 18.4 | 18.0 | 16.4 | 18.4 | 17.0 | 15.2 |
| 2 | 18.8 | 20.1 | 20.1 | 18.4 | 19.6 | 17.8 | 17.2 |
| 3 | 19.2 | 20.8 | 20.6 | 18.4 | 20.0 | 19.2 | 17.8 |
| 4 | 19.8 | 21.0 | 21.4 | 17.8 | 20.7 | 19.6 | |
| 5 | 20.4 | 21.7 | 22.2 | | 20.5 | 20.5 | |
| 6 | 20.0 | 22.1 | 22.8 | | 21.0 | 20.4 | |
| 7 | | 22.4 | 23.3 | | | 21.0 | |
| 8 | | 22.6 | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |
| 12 | | | | | | | |

| | Fourth Quarter | | | | | | |
|---|---|---|---|---|---|---|---|
| Age | 8c-E | 8c-W | 9a-N | 9a-CN | 9a-CS | 9a-S | 9a-S-C |
| 0 | 15.2 | 10.3 | 13.7 | 14.0 | | 15.3 | 14.4 |
| 1 | 17.9 | 18.1 | 17.7 | 16.8 | 17.9 | 17.5 | 17.8 |
| 2 | 19.1 | 20.3 | 20.0 | 19.6 | 18.9 | 19.7 | 18.9 |
| 3 | 19.5 | 21.0 | 20.6 | 19.8 | 20.3 | 20.2 | 19.1 |
| 4 | 20.1 | 21.2 | 21.5 | 22.3 | 20.9 | 20.5 | 19.8 |
| 5 | 20.9 | 22.0 | 22.2 | | 20.7 | 20.4 | 19.9 |
| 6 | 20.9 | 22.4 | 22.8 | | 21.6 | 20.8 | 19.9 |
| 7 | | 22.8 | 23.4 | | | | |
| 8 | | 22.8 | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |
| 12 | | | | | | | |

**Table 8.2.5.2: Sardine 8c and 9a: Sardine Mean weight (kg) at age by quarter and by subdivision in 2023.**

| | | | | | | First Quarter | |
|---|---|---|---|---|---|---|---|
| **Age** | **8c-E** | **8c-W** | **9a-N** | **9a-CN** | **9a-CS** | **9a-S** | **9a-S-C** |
| 0 | | | | | | | |
| 1 | 0.028 | 0.048 | 0.022 | | | | 0.024 |
| 2 | 0.041 | 0.052 | 0.029 | | | | 0.043 |
| 3 | 0.057 | 0.066 | 0.065 | | | | 0.047 |
| 4 | 0.070 | 0.071 | 0.080 | | | | 0.058 |
| 5 | 0.075 | 0.082 | 0.091 | | | | 0.065 |
| 6 | 0.069 | 0.093 | 0.091 | | | | |
| 7 | 0.097 | 0.084 | 0.101 | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |
| 12 | | | | | | | |

| | | | | | | Second Quarter | |
|---|---|---|---|---|---|---|---|
| **Age** | **8c-E** | **8c-W** | **9a-N** | **9a-CN** | **9a-CS** | **9a-S** | **9a-S-C** |
| 0 | | | | | | | |
| 1 | 0.040 | 0.036 | 0.033 | 0.027 | 0.039 | 0.046 | 0.022 |
| 2 | 0.046 | 0.040 | 0.036 | 0.030 | 0.050 | 0.047 | 0.030 |
| 3 | 0.051 | 0.061 | 0.061 | 0.051 | 0.063 | 0.057 | 0.047 |
| 4 | 0.062 | 0.065 | 0.066 | 0.051 | 0.069 | 0.058 | 0.056 |
| 5 | 0.067 | 0.075 | 0.076 | 0.045 | 0.069 | 0.062 | 0.058 |
| 6 | 0.063 | 0.086 | 0.081 | | 0.072 | 0.064 | |
| 7 | | 0.089 | 0.092 | | 0.071 | 0.063 | |
| 8 | | | | | 0.083 | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |
| 12 | | | | | | | |

| | | | | | | Third Quarter | |
|---|---|---|---|---|---|---|---|
| **Age** | **8c-E** | **8c-W** | **9a-N** | **9a-CN** | **9a-CS** | **9a-S** | **9a-S-C** |
| 0 | 0.034 | 0.028 | 0.037 | 0.021 | 0.032 | | 0.019 |
| 1 | 0.046 | 0.050 | 0.047 | 0.037 | 0.057 | 0.047 | 0.028 |
| 2 | 0.053 | 0.066 | 0.065 | 0.051 | 0.067 | 0.054 | 0.041 |
| 3 | 0.057 | 0.073 | 0.071 | 0.051 | 0.071 | 0.065 | 0.045 |
| 4 | 0.063 | 0.074 | 0.079 | 0.046 | 0.078 | 0.069 | |
| 5 | 0.069 | 0.083 | 0.089 | | 0.075 | 0.078 | |
| 6 | 0.065 | 0.087 | 0.097 | | 0.080 | 0.077 | |
| 7 | | 0.092 | 0.103 | | | 0.084 | |
| 8 | | 0.094 | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |
| 12 | | | | | | | |

| | | | | | | Fourth Quarter | |
|---|---|---|---|---|---|---|---|
| **Age** | **8c-E** | **8c-W** | **9a-N** | **9a-CN** | **9a-CS** | **9a-S** | **9a-S-C** |
| 0 | 0.028 | 0.008 | 0.021 | 0.023 | | 0.031 | 0.025 |
| 1 | 0.046 | 0.048 | 0.045 | 0.038 | 0.048 | 0.045 | 0.045 |
| 2 | 0.056 | 0.068 | 0.065 | 0.056 | 0.056 | 0.063 | 0.054 |
| 3 | 0.060 | 0.075 | 0.072 | 0.059 | 0.069 | 0.068 | 0.056 |
| 4 | 0.066 | 0.078 | 0.080 | 0.079 | 0.074 | 0.070 | 0.062 |
| 5 | 0.074 | 0.087 | 0.089 | | 0.073 | 0.069 | 0.064 |
| 6 | 0.075 | 0.092 | 0.096 | | 0.082 | 0.073 | 0.064 |
| 7 | | 0.097 | 0.104 | | | | |
| 8 | | 0.096 | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |
| 12 | | | | | | | |

**Table 8.3.2.1. Sardine in 8c and 9a: sardine abundance in number (millions of fish) and biomass (tons) by age groups and ICES subdivision in PELAGO2024. Mean Weight in grams and Mean Length in cm.**

| AREA 9aCN | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| AGE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | TOTAL |
| Biomass (ton) | 25881 | 43262 | 5834 | 14913 | 6245 | 193 | | | 96327 |
| %Biomass | 27 | 45 | 6 | 15 | 6 | 0 | | | |
| Abundance (N in $10^3$) | 1379068 | 1413705 | 117435 | 302916 | 123940 | 3231 | | | 3340294 |
| %Abundance | 41 | 42 | 4 | 9 | 4 | 0 | | | |
| Mean Weight (g) | 17.7 | 29.1 | 47.7 | 47.3 | 48.4 | 57.4 | | | |
| Mean Length (cm) | 13.8 | 16.4 | 19.5 | 19.5 | 19.6 | 20.8 | | | |
| AREA 9aCS | | | | | | | | | |
| AGE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | TOTAL |
| Biomass (ton) | 6446 | 33081 | 12082 | 3812 | 3689 | 609 | | | 59719 |
| %Biomass | 11 | 55 | 20 | 6 | 6 | 1 | | | |
| Abundance (N in $10^3$) | 456043 | 816024 | 245588 | 66605 | 66414 | 9207 | | | 1659881 |
| %Abundance | 27 | 49 | 15 | 4 | 4 | 1 | | | |
| Mean Weight (g) | 13.1 | 38.5 | 47.0 | 55.0 | 53.2 | 63.6 | | | |
| Mean Length (cm) | 12.7 | 18.0 | 19.2 | 20.2 | 20.0 | 21.2 | | | |
| AREA 9aS-Algarve | | | | | | | | | |
| AGE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | TOTAL |
| Biomass (ton) | 526 | 6090 | 10944 | 16107 | 7855 | 4726 | 695 | 90 | 47033 |
| %Biomass | 1 | 13 | 23 | 34 | 17 | 10 | 1.5 | 0.2 | |
| Abundance (N in $10^3$) | 17661 | 138419 | 217229 | 289226 | 139844 | 78007 | 11770 | 1117 | 893272 |
| %Abundance | 2 | 15 | 24 | 32 | 16 | 9 | 1.3 | 0.1 | |
| Mean Weight (g) | 28.2 | 41.9 | 48.3 | 53.6 | 53.9 | 58.3 | 56.9 | 78.0 | |
| Mean Length (cm) | 15.6 | 17.9 | 18.9 | 19.6 | 19.7 | 20.2 | 20.1 | 22.5 | |
| AREA 9aS-Cádiz | | | | | | | | | |
| AGE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | TOTAL |
| Biomass (ton) | 11565 | 13892 | 11460 | 7859 | 2081 | 1150 | | 396 | 48402 |
| %Biomass | 23.9 | 28.7 | 23.7 | 16.2 | 4.3 | 2.4 | | 0.0 | |
| Abundance (N in $10^3$) | 801247 | 560311 | 240936 | 162262 | 38326 | 20034 | | 6097 | 1829214 |
| %Abundance | 43.8 | 30.6 | 13.2 | 8.9 | 2.1 | 1.1 | | 0.0 | |
| Mean Weight (g) | 14.0 | 22.9 | 47.4 | 48.3 | 54.1 | 57.2 | | 64.9 | |
| Mean Length (cm) | 12.6 | 14.9 | 19.1 | 19.2 | 20.0 | 20.4 | | 21.3 | |
| TOTAL PELAGO | | | | | | | | | |
| AGE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | TOTAL |
| Biomass (ton) | 44417 | 96325 | 40321 | 42690 | 19870 | 6678 | 695 | 486 | 251481 |
| %Biomass | 17.7 | 38.3 | 16.0 | 17.0 | 7.9 | 2.7 | 0.3 | 0.2 | |
| Abundance (N in $10^3$) | 2654019 | 2928460 | 821188 | 821009 | 368523 | 110479 | 11770 | 7214 | 7722661 |
| %Abundance | 34.4 | 37.9 | 10.6 | 10.6 | 4.8 | 1.4 | 0.2 | 0.1 | |
| Mean Weight (g) | 18.6 | 36.5 | 54.8 | 58.3 | 60.5 | 65.9 | 63.5 | 75.0 | |
| Mean Length (cm) | 13.2 | 16.6 | 19.1 | 19.5 | 19.7 | 20.3 | 20.1 | 21.2 | |

**Table 8.3.2.2. Sardine in 8c and 9a: sardine abundance in number (millions of fish) and biomass (tons) by age groups and ICES subdivision in PELACUS0424. Mean Weight in grams and Mean Length in cm.**

AREA 8cE

| AGE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| Biomass (ton) | 998 | 12447 | 3414 | 5907 | 1529 | 723 | 41 | | 25059 |
| %Biomass | 4 | 50 | 14 | 24 | 6 | 3 | 0 | | |
| Abundance (N in 103) | 33028 | 298201 | 68848 | 104191 | 24856 | 11001 | 653 | | 540778 |
| % Abundance | 6.1 | 55.1 | 12.7 | 19.3 | 4.6 | 2.0 | 0.1 | | |
| Mean Weight (gr) | 28.9 | 39.9 | 47.6 | 54.5 | 59.2 | 63.3 | 60.4 | | |
| Mean Lenght (cm) | 15.6 | 17.6 | 18.8 | 19.7 | 20.3 | 20.9 | 20.5 | | |

AREA 8cW

| AGE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| Biomass (ton) | | 3223 | 842 | 3629 | 3150 | 102 | 105 | 82 | 11133 |
| %Biomass | | 29 | 8 | 33 | 28 | 1 | 1 | 1 | |
| Abundance (N in 103) | | 75384 | 16489 | 61959 | 49596 | 1480 | 1387 | 986 | 207281 |
| % Abundance | | 36.4 | 8.0 | 29.9 | 23.9 | 0.7 | 0.7 | 0.5 | |
| Mean Weight (gr) | | 41.0 | 49.2 | 56.5 | 61.4 | 66.8 | 73.1 | 80.8 | |
| Mean Lenght (cm) | | 17.8 | 19.0 | 20.0 | 20.6 | 21.3 | 22.0 | 22.8 | |

AREA 9aN

| AGE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| Biomass (ton) | 2043 | 100459 | 14674 | 22678 | 11023 | 1064 | 1072 | 315 | 153328 |
| %Biomass | 1 | 66 | 10 | 15 | 7 | 1 | 1 | 0 | |
| Abundance (N in 103) | 75253 | 2584845 | 317051 | 423181 | 190613 | 15010 | 14220 | 3662 | 3623835 |
| % Abundance | 2.1 | 71.3 | 8.7 | 11.7 | 5.3 | 0.4 | 0.4 | 0.1 | |
| Mean Weight (gr) | 25.8 | 37.3 | 44.4 | 51.6 | 55.8 | 68.7 | 73.1 | 83.4 | |
| Mean Lenght (cm) | 15.0 | 17.1 | 18.3 | 19.3 | 19.9 | 21.5 | 22.0 | 23.1 | |

TOTAL PELACUS24

| AGE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| Biomass (ton) | 3041 | 116129 | 18930 | 32214 | 15702 | 1889 | 1218 | 397 | 189520 |
| %Biomass | 2 | 61 | 10 | 17 | 8 | 1 | 1 | 0 | |
| Abundance (N in 103) | 108281 | 2958430 | 402388 | 589331 | 265065 | 27491 | 16260 | 4648 | 4371894 |
| % Abundance | 2.5 | 67.7 | 9.2 | 13.5 | 6.1 | 0.6 | 0.4 | 0.1 | |
| Mean Weight (gr) | 26.7 | 37.6 | 45.1 | 52.6 | 57.1 | 66.4 | 72.6 | 82.8 | |
| Mean Lenght (cm) | 15.2 | 17.2 | 18.4 | 19.5 | 20.1 | 21.2 | 21.9 | 23.0 | |

**Table 8.3.3.1. Sardine in 8c and 9a: sardine abundance in number (millions of fish) and biomass (tons) by age groups and ICES subdivision in IBERAS1024. Mean Weight in grams and Mean Length in cm. In red, values of recruitment index used in the assessment (age-0 in 9aCN).**

| AREA 9aN | | | | | | | |
|---|---|---|---|---|---|---|---|
| AGE | 0 | 1 | 2 | 3 | 4 | 5 | TOTAL |
| Biomass (ton) | 5631 | 7466 | 8643 | 425 | 368 | | 22533 |
| %Biomass | 25 | 33 | 38 | 2 | 2 | | |
| Abundance (N in $10^3$) | 288485 | 179488 | 183190 | 5901 | 4446 | | 661509 |
| %Abundance | 44 | 27 | 28 | 1 | 1 | | |
| Mean Weight (gr) | 18.2 | 39.2 | 44.7 | 66.2 | 78.3 | | |
| Mean Length (cm) | 13.4 | 16.7 | 17.4 | 19.5 | 20.5 | | |
| AREA 9aCN | | | | | | | |
| AGE | 0 | 1 | 2 | 3 | 4 | 5 | TOTAL |
| Biomass (ton) | 120881 | 78350 | 64752 | 2117 | 1073 | | 267172 |
| %Biomass | 45.2 | 29.3 | 24.2 | 0.8 | 0.4 | | |
| Abundance (N in $10^3$) | 6023276 | 1995836 | 1432674 | 37835 | 14793 | | 9504415 |
| %Abundance | 63.4 | 21.0 | 15.1 | 0.4 | 0.2 | | |
| Mean Weight (gr) | 19.9 | 38.8 | 44.9 | 53.9 | 71.5 | | |
| Mean Length (cm) | 13.7 | 16.7 | 17.4 | 18.4 | 20.0 | | |
| AREA 9aCS | | | | | | | |
| AGE | 0 | 1 | 2 | 3 | 4 | 5 | TOTAL |
| Biomass (ton) | 4340 | 11099 | 6258 | 1172 | 517 | 176 | 23562 |
| %Biomass | 18.4 | 47.1 | 26.6 | 5.0 | 2.2 | 0.7 | |
| Abundance (N in $10^3$) | 194020 | 299095 | 143746 | 16903 | 6388 | 1894 | 662046 |
| %Abundance | 29.3 | 45.2 | 21.7 | 2.6 | 1.0 | 0.3 | |
| Mean Weight (gr) | 20.8 | 35.0 | 40.7 | 64.7 | 77.0 | 87.2 | |
| Mean Length (cm) | 13.9 | 16.2 | 16.9 | 19.4 | 20.4 | 21.2 | |

**Table 8.4.1a. Sardine in 8c and 9a: Mean weights-at-age (kg) in the catch. Weights-at-age in 1978-1990 are fixed.**

| Year | Age | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6+ |
| 1990 | 0.020 | 0.039 | 0.054 | 0.060 | 0.066 | 0.073 | 0.090 |
| 1991 | 0.020 | 0.030 | 0.053 | 0.058 | 0.070 | 0.071 | 0.094 |
| 1992 | 0.018 | 0.044 | 0.052 | 0.061 | 0.066 | 0.077 | 0.089 |
| 1993 | 0.017 | 0.038 | 0.053 | 0.058 | 0.065 | 0.070 | 0.084 |
| 1994 | 0.020 | 0.036 | 0.057 | 0.060 | 0.067 | 0.072 | 0.089 |
| 1995 | 0.025 | 0.046 | 0.057 | 0.064 | 0.065 | 0.078 | 0.093 |
| 1996 | 0.019 | 0.037 | 0.048 | 0.054 | 0.062 | 0.070 | 0.082 |
| 1997 | 0.023 | 0.031 | 0.049 | 0.059 | 0.064 | 0.070 | 0.079 |
| 1998 | 0.024 | 0.041 | 0.055 | 0.061 | 0.064 | 0.067 | 0.073 |
| 1999 | 0.025 | 0.043 | 0.056 | 0.065 | 0.070 | 0.073 | 0.077 |
| 2000 | 0.025 | 0.037 | 0.056 | 0.066 | 0.071 | 0.074 | 0.077 |
| 2001 | 0.023 | 0.042 | 0.059 | 0.067 | 0.075 | 0.079 | 0.085 |
| 2002 | 0.027 | 0.045 | 0.057 | 0.068 | 0.074 | 0.079 | 0.082 |
| 2003 | 0.024 | 0.044 | 0.059 | 0.067 | 0.079 | 0.084 | 0.091 |
| 2004 | 0.020 | 0.040 | 0.056 | 0.066 | 0.072 | 0.082 | 0.089 |
| 2005 | 0.023 | 0.037 | 0.055 | 0.068 | 0.074 | 0.075 | 0.087 |
| 2006 | 0.031 | 0.042 | 0.056 | 0.068 | 0.073 | 0.078 | 0.082 |
| 2007 | 0.028 | 0.054 | 0.071 | 0.074 | 0.085 | 0.086 | 0.089 |
| 2008 | 0.025 | 0.043 | 0.066 | 0.074 | 0.075 | 0.083 | 0.085 |
| 2009 | 0.020 | 0.041 | 0.065 | 0.075 | 0.079 | 0.082 | 0.090 |
| 2010 | 0.026 | 0.046 | 0.061 | 0.075 | 0.082 | 0.084 | 0.081 |
| 2011 | 0.024 | 0.045 | 0.064 | 0.073 | 0.077 | 0.077 | 0.079 |
| 2012 | 0.031 | 0.056 | 0.065 | 0.078 | 0.083 | 0.086 | 0.090 |
| 2013 | 0.025 | 0.052 | 0.069 | 0.077 | 0.085 | 0.090 | 0.094 |
| 2014 | 0.030 | 0.046 | 0.061 | 0.076 | 0.080 | 0.089 | 0.093 |
| 2015 | 0.025 | 0.049 | 0.073 | 0.079 | 0.089 | 0.090 | 0.097 |
| 2016 | 0.018 | 0.046 | 0.062 | 0.074 | 0.084 | 0.092 | 0.098 |
| 2017 | 0.022 | 0.039 | 0.058 | 0.072 | 0.083 | 0.086 | 0.095 |
| 2018 | 0.031 | 0.047 | 0.062 | 0.080 | 0.088 | 0.094 | 0.099 |
| 2019 | 0.028 | 0.050 | 0.059 | 0.074 | 0.084 | 0.094 | 0.097 |
| 2020 | 0.031 | 0.042 | 0.057 | 0.065 | 0.075 | 0.084 | 0.095 |
| 2021 | 0.034 | 0.044 | 0.055 | 0.065 | 0.077 | 0.080 | 0.100 |
| 2022 | 0.021 | 0.052 | 0.059 | 0.068 | 0.077 | 0.084 | 0.089 |
| 2023 | 0.021 | 0.038 | 0.021 | 0.068 | 0.069 | 0.073 | 0.080 |

**Table 8.4.1b. Sardine in 8c and 9a: Mean weights-at-age (Kg) in the stock. Weights-at-age in 1978-1998 are fixed (see Stock Annex, annex 3).**

| Year | Age | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6+ |
| 1978 | 0 | 0.027 | 0.041 | 0.050 | 0.059 | 0.060 | 0.063 |
| 1979 | 0 | 0.027 | 0.041 | 0.050 | 0.059 | 0.060 | 0.063 |
| 1980 | 0 | 0.027 | 0.041 | 0.050 | 0.059 | 0.060 | 0.063 |
| 1981 | 0 | 0.027 | 0.041 | 0.050 | 0.059 | 0.060 | 0.063 |
| 1982 | 0 | 0.027 | 0.041 | 0.050 | 0.059 | 0.060 | 0.063 |
| 1983 | 0 | 0.027 | 0.041 | 0.050 | 0.059 | 0.060 | 0.063 |
| 1984 | 0 | 0.027 | 0.041 | 0.050 | 0.059 | 0.060 | 0.063 |
| 1985 | 0 | 0.027 | 0.041 | 0.050 | 0.059 | 0.060 | 0.063 |
| 1986 | 0 | 0.027 | 0.041 | 0.050 | 0.059 | 0.060 | 0.063 |
| 1987 | 0 | 0.027 | 0.041 | 0.050 | 0.059 | 0.060 | 0.063 |
| 1988 | 0 | 0.027 | 0.041 | 0.050 | 0.059 | 0.060 | 0.063 |
| 1989 | 0 | 0.027 | 0.041 | 0.050 | 0.059 | 0.060 | 0.063 |
| 1990 | 0 | 0.027 | 0.041 | 0.050 | 0.059 | 0.060 | 0.063 |
| 1991 | 0 | 0.027 | 0.041 | 0.050 | 0.059 | 0.060 | 0.063 |
| 1992 | 0 | 0.027 | 0.041 | 0.050 | 0.059 | 0.060 | 0.063 |
| 1993 | 0 | 0.027 | 0.041 | 0.050 | 0.059 | 0.060 | 0.063 |
| 1994 | 0 | 0.027 | 0.041 | 0.050 | 0.059 | 0.060 | 0.063 |
| 1995 | 0 | 0.027 | 0.041 | 0.050 | 0.059 | 0.060 | 0.063 |
| 1996 | 0 | 0.027 | 0.041 | 0.050 | 0.059 | 0.060 | 0.063 |
| 1997 | 0 | 0.027 | 0.041 | 0.050 | 0.059 | 0.060 | 0.063 |
| 1998 | 0 | 0.027 | 0.041 | 0.050 | 0.059 | 0.060 | 0.063 |
| 1999 | 0 | 0.030 | 0.043 | 0.050 | 0.054 | 0.059 | 0.062 |
| 2000 | 0 | 0.027 | 0.041 | 0.050 | 0.059 | 0.060 | 0.063 |
| 2001 | 0 | 0.024 | 0.039 | 0.051 | 0.064 | 0.061 | 0.064 |
| 2002 | 0 | 0.022 | 0.037 | 0.052 | 0.069 | 0.062 | 0.066 |
| 2003 | 0 | 0.021 | 0.041 | 0.054 | 0.068 | 0.065 | 0.072 |
| 2004 | 0 | 0.020 | 0.045 | 0.056 | 0.067 | 0.068 | 0.079 |
| 2005 | 0 | 0.019 | 0.049 | 0.058 | 0.066 | 0.072 | 0.086 |

| Year | Age | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6+ |
| 2006 | 0 | 0.024 | 0.052 | 0.060 | 0.067 | 0.072 | 0.084 |
| 2007 | 0 | 0.029 | 0.054 | 0.062 | 0.069 | 0.072 | 0.081 |
| 2008 | 0 | 0.033 | 0.057 | 0.064 | 0.070 | 0.072 | 0.079 |
| 2009 | 0 | 0.030 | 0.054 | 0.063 | 0.070 | 0.069 | 0.075 |
| 2010 | 0 | 0.027 | 0.051 | 0.062 | 0.070 | 0.067 | 0.072 |
| 2011 | 0 | 0.024 | 0.048 | 0.061 | 0.070 | 0.064 | 0.068 |
| 2012 | 0 | 0.027 | 0.048 | 0.062 | 0.068 | 0.068 | 0.073 |
| 2013 | 0 | 0.030 | 0.049 | 0.063 | 0.067 | 0.073 | 0.077 |
| 2014 | 0 | 0.032 | 0.049 | 0.065 | 0.066 | 0.077 | 0.081 |
| 2015 | 0 | 0.030 | 0.048 | 0.063 | 0.066 | 0.073 | 0.077 |
| 2016 | 0 | 0.029 | 0.046 | 0.062 | 0.065 | 0.070 | 0.072 |
| 2017 | 0 | 0.027 | 0.045 | 0.060 | 0.065 | 0.066 | 0.068 |
| 2018 | 0 | 0.027 | 0.044 | 0.056 | 0.063 | 0.066 | 0.071 |
| 2019 | 0 | 0.027 | 0.043 | 0.053 | 0.060 | 0.067 | 0.074 |
| 2020 | 0 | 0.027 | 0.042 | 0.050 | 0.058 | 0.068 | 0.078 |
| 2021 | 0 | 0.026 | 0.043 | 0.051 | 0.058 | 0.065 | 0.074 |
| 2022 | 0 | 0.024 | 0.043 | 0.052 | 0.058 | 0.062 | 0.071 |
| 2023 | 0 | 0.023 | 0.044 | 0.053 | 0.058 | 0.060 | 0.068 |
| 2024 | 0 | 0.023 | 0.044 | 0.053 | 0.058 | 0.060 | 0.068 |

**Table 8.4.1.1. Parameters and asymptotic standard deviations estimated in the 2024 assessment model.**

| Label | Value | Parm_StDev | Phase | Min | Max | Init |
|---|---|---|---|---|---|---|
| SR_LN(R0) | 16.826 | 0.038 | 1 | 1 | 20 | 16.82 |
| Early_InitAge_4 | 0.076 | 0.538 | 2 | -5 | 5 | 0.00 |
| Early_InitAge_3 | 0.149 | 0.444 | 2 | -5 | 5 | 0.00 |
| Early_InitAge_2 | 0.360 | 0.289 | 2 | -5 | 5 | 0.00 |
| Early_InitAge_1 | 0.806 | 0.197 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_1978 | 0.972 | 0.164 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_1979 | 1.084 | 0.158 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_1980 | 1.182 | 0.148 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_1981 | 0.662 | 0.174 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_1982 | −0.002 | 0.240 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_1983 | 1.528 | 0.112 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_1984 | 0.255 | 0.187 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_1985 | 0.127 | 0.180 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_1986 | −0.020 | 0.193 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_1987 | 0.812 | 0.127 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_1988 | 0.196 | 0.161 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_1989 | 0.165 | 0.159 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_1990 | 0.227 | 0.155 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_1991 | 1.328 | 0.090 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_1992 | 0.878 | 0.101 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_1993 | 0.030 | 0.143 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_1994 | −0.095 | 0.137 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_1995 | −0.318 | 0.138 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_1996 | 0.060 | 0.112 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_1997 | −0.354 | 0.130 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_1998 | −0.028 | 0.114 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_1999 | −0.293 | 0.134 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_2000 | 0.891 | 0.088 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_2001 | 0.310 | 0.109 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_2002 | −0.254 | 0.144 | 2 | -5 | 5 | 0.00 |

| Label | Value | Parm_StDev | Phase | Min | Max | Init |
|---|---|---|---|---|---|---|
| Main_RecrDev_2003 | −0.459 | 0.159 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_2004 | 0.974 | 0.079 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_2005 | −0.081 | 0.112 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_2006 | −1.270 | 0.169 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_2007 | −0.886 | 0.134 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_2008 | −0.602 | 0.114 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_2009 | −0.419 | 0.101 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_2010 | −0.933 | 0.124 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_2011 | −1.030 | 0.130 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_2012 | −0.830 | 0.117 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_2013 | −0.682 | 0.112 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_2014 | −0.984 | 0.135 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_2015 | −0.349 | 0.113 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_2016 | −0.170 | 0.117 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_2017 | −1.025 | 0.156 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_2018 | −0.290 | 0.132 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_2019 | 0.830 | 0.108 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_2020 | −0.138 | 0.145 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_2021 | −0.256 | 0.167 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_2022 | 0.343 | 0.160 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_2023 | −1.255 | 0.305 | 2 | -5 | 5 | 0.00 |
| Main_RecrDev_2024 | 0.171 | 0.412 | 2 | -5 | 5 | 0.00 |
| InitF_seas_1_flt_1purse_seine | 0.407 | 0.059 | 1 | -1 | 2 | 0.41 |
| LnQ_base_Acoustic_survey(2) | 0.310 | 0.092 | 1 | -3 | 3 | 0.27 |
| Q_extraSD_Acoustic_survey(2) | 0.073 | 0.053 | 1 | 0 | 1 | 0.11 |
| LnQ_base_DEPM_survey(3) | 0.205 | 0.113 | 1 | -3 | 3 | 0.18 |
| Q_extraSD_DEPM_survey(3) | 0.034 | 0.070 | 1 | 0 | 1 | 0.02 |
| LnQ_base_Rec_survey(4) | −17.398 | 6.238 | 1 | -30 | 3 | -16.87 |
| Q_power_Rec_survey(4) | 1.060 | 0.407 | 1 | 0 | 3 | 1.02 |
| Q_extraSD_Rec_survey(4) | 0.751 | 0.179 | 1 | 0 | 3 | 0.83 |

| Label | Value | Parm_StDev | Phase | Min | Max | Init |
|---|---|---|---|---|---|---|
| AgeSel_P2_purse_seine(1) | 1.637 | 0.153 | 2 | -3 | 3 | 1.64 |
| AgeSel_P3_purse_seine(1) | 0.741 | 0.137 | 2 | -4 | 4 | 0.74 |
| AgeSel_P4_purse_seine(1) | −0.246 | 0.169 | 2 | -4 | 4 | -0.24 |
| AgeSel_P7_purse_seine(1) | −0.659 | 0.443 | 2 | -4 | 4 | -0.65 |
| AgeSel_P2_purse_seine(1)_BLK1delta_1988 | −0.329 | 0.183 | 2 | -4 | 4 | -0.33 |
| AgeSel_P2_purse_seine(1)_BLK1delta_2006 | 0.136 | 0.135 | 2 | -4 | 4 | 0.10 |
| AgeSel_P3_purse_seine(1)_BLK1delta_1988 | −0.004 | 0.167 | 2 | -4 | 4 | -0.01 |
| AgeSel_P3_purse_seine(1)_BLK1delta_2006 | −0.148 | 0.129 | 2 | -4 | 4 | -0.14 |
| AgeSel_P4_purse_seine(1)_BLK1delta_1988 | 0.891 | 0.191 | 2 | -4 | 4 | 0.89 |
| AgeSel_P4_purse_seine(1)_BLK1delta_2006 | −0.618 | 0.131 | 2 | -4 | 4 | -0.61 |

**Table 8.4.1.2. Sardine in 8c and 9a: Fishing mortality-at-age estimated in the assessment. RefF is equal to $F_{bar(2–5)}$, the reference fishing mortality, corresponding to the average F of ages 2 to 5 years.**

| Year | refF[1] | Age 0 | Age 1 | Age 2 | Age 3 | Age 4 | Age 5 | Age 6 |
|---|---|---|---|---|---|---|---|---|
| 1978 | 0.273 | 0.030 | 0.155 | 0.326 | 0.255 | 0.255 | 0.255 | 0.132 |
| 1979 | 0.226 | 0.025 | 0.129 | 0.271 | 0.212 | 0.212 | 0.212 | 0.110 |
| 1980 | 0.231 | 0.026 | 0.132 | 0.276 | 0.216 | 0.216 | 0.216 | 0.112 |
| 1981 | 0.227 | 0.025 | 0.130 | 0.272 | 0.213 | 0.213 | 0.213 | 0.110 |
| 1982 | 0.226 | 0.025 | 0.129 | 0.270 | 0.211 | 0.211 | 0.211 | 0.109 |
| 1983 | 0.231 | 0.026 | 0.132 | 0.276 | 0.216 | 0.216 | 0.216 | 0.112 |
| 1984 | 0.234 | 0.026 | 0.133 | 0.280 | 0.219 | 0.219 | 0.219 | 0.113 |
| 1985 | 0.219 | 0.024 | 0.125 | 0.262 | 0.205 | 0.205 | 0.205 | 0.106 |
| 1986 | 0.284 | 0.032 | 0.162 | 0.340 | 0.266 | 0.266 | 0.266 | 0.138 |
| 1987 | 0.332 | 0.037 | 0.189 | 0.396 | 0.310 | 0.310 | 0.310 | 0.160 |
| 1988 | 0.403 | 0.031 | 0.115 | 0.240 | 0.458 | 0.458 | 0.458 | 0.209 |
| 1989 | 0.391 | 0.030 | 0.111 | 0.233 | 0.443 | 0.443 | 0.443 | 0.202 |
| 1990 | 0.425 | 0.033 | 0.121 | 0.253 | 0.483 | 0.483 | 0.483 | 0.220 |
| 1991 | 0.392 | 0.030 | 0.112 | 0.233 | 0.444 | 0.444 | 0.444 | 0.203 |
| 1992 | 0.288 | 0.022 | 0.082 | 0.171 | 0.327 | 0.327 | 0.327 | 0.149 |
| 1993 | 0.277 | 0.021 | 0.079 | 0.165 | 0.315 | 0.315 | 0.315 | 0.144 |
| 1994 | 0.233 | 0.018 | 0.066 | 0.139 | 0.265 | 0.265 | 0.265 | 0.121 |
| 1995 | 0.233 | 0.018 | 0.066 | 0.139 | 0.264 | 0.264 | 0.264 | 0.121 |
| 1996 | 0.315 | 0.024 | 0.090 | 0.187 | 0.357 | 0.357 | 0.357 | 0.163 |
| 1997 | 0.425 | 0.033 | 0.121 | 0.253 | 0.483 | 0.483 | 0.483 | 0.220 |
| 1998 | 0.482 | 0.037 | 0.137 | 0.287 | 0.547 | 0.547 | 0.547 | 0.250 |
| 1999 | 0.442 | 0.034 | 0.126 | 0.263 | 0.502 | 0.502 | 0.502 | 0.229 |
| 2000 | 0.394 | 0.030 | 0.112 | 0.234 | 0.447 | 0.447 | 0.447 | 0.204 |
| 2001 | 0.372 | 0.029 | 0.106 | 0.222 | 0.422 | 0.422 | 0.422 | 0.193 |
| 2002 | 0.311 | 0.024 | 0.089 | 0.185 | 0.353 | 0.353 | 0.353 | 0.161 |
| 2003 | 0.278 | 0.021 | 0.079 | 0.165 | 0.315 | 0.315 | 0.315 | 0.144 |
| 2004 | 0.308 | 0.024 | 0.088 | 0.183 | 0.349 | 0.349 | 0.349 | 0.160 |
| 2005 | 0.306 | 0.024 | 0.087 | 0.182 | 0.347 | 0.347 | 0.347 | 0.158 |
| 2006 | 0.180 | 0.023 | 0.098 | 0.176 | 0.181 | 0.181 | 0.181 | 0.145 |
| 2007 | 0.219 | 0.028 | 0.119 | 0.214 | 0.220 | 0.220 | 0.220 | 0.176 |
| 2008 | 0.351 | 0.045 | 0.191 | 0.344 | 0.353 | 0.353 | 0.353 | 0.282 |
| 2009 | 0.397 | 0.051 | 0.216 | 0.390 | 0.400 | 0.400 | 0.400 | 0.320 |
| 2010 | 0.496 | 0.064 | 0.270 | 0.486 | 0.499 | 0.499 | 0.499 | 0.399 |
| 2011 | 0.592 | 0.076 | 0.322 | 0.580 | 0.596 | 0.596 | 0.596 | 0.477 |

| Year | refF[1] | Age 0 | Age 1 | Age 2 | Age 3 | Age 4 | Age 5 | Age 6 |
|---|---|---|---|---|---|---|---|---|
| 2012 | 0.478 | 0.061 | 0.260 | 0.469 | 0.481 | 0.481 | 0.481 | 0.385 |
| 2013 | 0.454 | 0.058 | 0.247 | 0.445 | 0.457 | 0.457 | 0.457 | 0.365 |
| 2014 | 0.289 | 0.037 | 0.157 | 0.283 | 0.291 | 0.291 | 0.291 | 0.232 |
| 2015 | 0.174 | 0.022 | 0.095 | 0.171 | 0.176 | 0.176 | 0.176 | 0.140 |
| 2016 | 0.171 | 0.022 | 0.093 | 0.167 | 0.172 | 0.172 | 0.172 | 0.137 |
| 2017 | 0.138 | 0.018 | 0.075 | 0.136 | 0.139 | 0.139 | 0.139 | 0.111 |
| 2018 | 0.073 | 0.009 | 0.040 | 0.072 | 0.074 | 0.074 | 0.074 | 0.059 |
| 2019 | 0.051 | 0.006 | 0.028 | 0.050 | 0.051 | 0.051 | 0.051 | 0.041 |
| 2020 | 0.059 | 0.008 | 0.032 | 0.058 | 0.060 | 0.060 | 0.060 | 0.048 |
| 2021 | 0.090 | 0.012 | 0.049 | 0.088 | 0.091 | 0.091 | 0.091 | 0.072 |
| 2022 | 0.086 | 0.011 | 0.047 | 0.084 | 0.086 | 0.086 | 0.086 | 0.069 |
| 2023 | 0.114 | 0.015 | 0.062 | 0.111 | 0.114 | 0.114 | 0.114 | 0.092 |
| 2024 | 0.104 | 0.013 | 0.057 | 0.102 | 0.105 | 0.105 | 0.105 | 0.084 |

**1: refF is equal to Fbar(2-5), the reference fishing mortality, corresponding to the average F of ages 2 to 5 years.**

**Table 8.4.1.3. Sardine in 8c and 9a: Numbers-at-age, in thousands, at the beginning of the year estimated in the assessment. Estimates of survivors in 2023 are also shown.**

| Year | Age | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6+ |
| 1978 | 39511200 | 12617700 | 3729510 | 1322710 | 631545 | 337890 | 450807 |
| 1979 | 45471100 | 14387400 | 5868740 | 1682210 | 686994 | 341399 | 471372 |
| 1980 | 51220600 | 16643000 | 6871390 | 2798320 | 912505 | 387864 | 501470 |
| 1981 | 30888900 | 18737800 | 7927760 | 3258310 | 1511370 | 512958 | 545870 |
| 1982 | 15825900 | 11304600 | 8944500 | 3775960 | 1765940 | 852564 | 647381 |
| 1983 | 71521200 | 5792900 | 5401030 | 4268130 | 2049470 | 997610 | 907936 |
| 1984 | 20645800 | 26164100 | 2759270 | 2560860 | 2305060 | 1152010 | 1155970 |
| 1985 | 17964400 | 7550260 | 12441700 | 1303720 | 1379240 | 1292140 | 1401840 |
| 1986 | 15177100 | 6580430 | 3620680 | 5983220 | 711927 | 783905 | 1657300 |
| 1987 | 33940500 | 5519440 | 3040610 | 1610720 | 3074190 | 380717 | 1472200 |
| 1988 | 18445900 | 12278700 | 2482650 | 1278420 | 791842 | 1572970 | 1107360 |
| 1989 | 17631500 | 6711150 | 5947300 | 1220520 | 542252 | 349573 | 1353880 |
| 1990 | 18476300 | 6421070 | 3262280 | 2945780 | 525133 | 242826 | 961075 |
| 1991 | 54709800 | 6710770 | 3090540 | 1582800 | 1218460 | 226074 | 665420 |
| 1992 | 37186900 | 19923000 | 3261300 | 1530010 | 680343 | 545111 | 496629 |
| 1993 | 16174700 | 13650500 | 9972450 | 1717300 | 739745 | 342364 | 587721 |

| Year | Age | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6+ |
| 1994 | 14077500 | 5942220 | 6853440 | 5284460 | 840360 | 376767 | 545786 |
| 1995 | 11016200 | 5189400 | 3021200 | 3728480 | 2718950 | 450026 | 555028 |
| 1996 | 15567600 | 4060990 | 2638650 | 1643890 | 1918970 | 1456490 | 600727 |
| 1997 | 10053100 | 5702580 | 2017100 | 1367210 | 770744 | 936431 | 1088420 |
| 1998 | 13351100 | 3651440 | 2744890 | 978781 | 565651 | 331892 | 1041370 |
| 1999 | 10185000 | 4828230 | 1729470 | 1287820 | 379761 | 228426 | 724516 |
| 2000 | 31892000 | 3694560 | 2312920 | 830857 | 522738 | 160439 | 515894 |
| 2001 | 19071300 | 11611900 | 1794430 | 1143640 | 356299 | 233316 | 377834 |
| 2002 | 10954400 | 6955310 | 5674340 | 898644 | 502488 | 162939 | 334012 |
| 2003 | 8917830 | 4013940 | 3458610 | 2947080 | 423232 | 246313 | 287117 |
| 2004 | 36476900 | 3276120 | 2015050 | 1832340 | 1441550 | 215470 | 307215 |
| 2005 | 13048300 | 13369200 | 1630510 | 1048470 | 865973 | 709087 | 297236 |
| 2006 | 4177830 | 4783220 | 6658350 | 849603 | 496869 | 427134 | 537502 |
| 2007 | 5967080 | 1532270 | 2357150 | 3490130 | 475343 | 289338 | 589002 |
| 2008 | 7577460 | 2177550 | 739202 | 1189100 | 1877300 | 266117 | 522274 |
| 2009 | 8531930 | 2718770 | 977720 | 327661 | 560027 | 920233 | 417726 |

| Year | Age | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6+ |
| 2010 | 4887320 | 3042870 | 1190000 | 413928 | 147204 | 261865 | 654870 |
| 2011 | 3994060 | 1721230 | 1262640 | 457617 | 168473 | 62359 | 431107 |
| 2012 | 4332700 | 1389290 | 677624 | 441651 | 168977 | 64748 | 218513 |
| 2013 | 4842690 | 1529340 | 582000 | 265091 | 182952 | 72855 | 136170 |
| 2014 | 3662020 | 1714730 | 649254 | 233208 | 112551 | 80847 | 101143 |
| 2015 | 6717600 | 1324420 | 796328 | 305821 | 116909 | 58725 | 100822 |
| 2016 | 8966350 | 2465370 | 654473 | 419494 | 171979 | 68427 | 98335 |
| 2017 | 4161560 | 3292270 | 1220810 | 346056 | 236810 | 101047 | 102847 |
| 2018 | 8577580 | 1534380 | 1659120 | 666230 | 201798 | 143729 | 128752 |
| 2019 | 27463600 | 3189080 | 801075 | 964986 | 414777 | 130762 | 182197 |
| 2020 | 12326800 | 10240600 | 1685720 | 476439 | 614707 | 275001 | 214584 |
| 2021 | 11129600 | 4591220 | 5387280 | 993978 | 300823 | 403964 | 331078 |
| 2022 | 20158100 | 4129120 | 2375520 | 3082990 | 608605 | 191709 | 483642 |
| 2023 | 4327290 | 7482950 | 2141550 | 1365320 | 1896070 | 389575 | 451769 |
| 2024 | 18112500 | 1600560 | 3822130 | 1197410 | 816268 | 1179840 | 544218 |

**Table 8.4.1.4. Sardine in 8c and 9a: Summary table of the WGHANSA 2024 assessment. Coefficient of variation (CV) are presented for SSB, Recruitment and Apical F (maximum F-at-age by year); biomass and landings in tonnes, recruits in thousand of individuals, F in year-1. Catches for 2024 are an assumption based on the Member States agreement.**

| Year | Biomass 1+ | SSB | CV SSB | Recruits | CV Recruits | F (2-5) | F Apical | CV F Apical | Landings |
|---|---|---|---|---|---|---|---|---|---|
| 1978 | 645658 | 591458 | 0.170 | 39511200 | 0.178 | 0.273 | 0.326 | 0.167 | 145609 |
| 1979 | 803901 | 740483 | 0.169 | 45471100 | 0.169 | 0.226 | 0.271 | 0.159 | 157241 |
| 1980 | 979707 | 906263 | 0.159 | 51220600 | 0.156 | 0.231 | 0.276 | 0.148 | 194802 |
| 1981 | 1148210 | 1065330 | 0.149 | 30888900 | 0.180 | 0.227 | 0.272 | 0.138 | 216517 |
| 1982 | 1056880 | 1002710 | 0.149 | 15825900 | 0.246 | 0.226 | 0.270 | 0.130 | 206946 |
| 1983 | 829232 | 800660 | 0.158 | 71521200 | 0.108 | 0.231 | 0.276 | 0.126 | 183837 |
| 1984 | 1225550 | 1118130 | 0.111 | 20645800 | 0.187 | 0.234 | 0.280 | 0.121 | 206005 |
| 1985 | 1026370 | 983730 | 0.107 | 17964400 | 0.179 | 0.219 | 0.262 | 0.093 | 208439 |
| 1986 | 818728 | 788786 | 0.107 | 15177100 | 0.191 | 0.284 | 0.340 | 0.119 | 187363 |
| 1987 | 651195 | 626076 | 0.110 | 33940500 | 0.122 | 0.332 | 0.396 | 0.121 | 177696 |
| 1988 | 708094 | 656497 | 0.096 | 18445900 | 0.160 | 0.403 | 0.458 | 0.109 | 161531 |
| 1989 | 624329 | 591537 | 0.096 | 17631500 | 0.159 | 0.391 | 0.443 | 0.107 | 140961 |
| 1990 | 560511 | 531565 | 0.098 | 18476300 | 0.157 | 0.425 | 0.483 | 0.106 | 149429 |
| 1991 | 514418 | 484484 | 0.104 | 54709800 | 0.088 | 0.392 | 0.444 | 0.108 | 132587 |
| 1992 | 852269 | 769316 | 0.081 | 37186900 | 0.100 | 0.288 | 0.327 | 0.099 | 130250 |
| 1993 | 964511 | 899937 | 0.071 | 16174700 | 0.143 | 0.277 | 0.315 | 0.094 | 142495 |
| 1994 | 812226 | 781604 | 0.071 | 14077500 | 0.136 | 0.233 | 0.265 | 0.080 | 136582 |
| 1995 | 672793 | 649015 | 0.072 | 11016200 | 0.138 | 0.233 | 0.264 | 0.075 | 125280 |
| 1996 | 538480 | 519598 | 0.075 | 15567600 | 0.110 | 0.315 | 0.357 | 0.080 | 116736 |
| 1997 | 475262 | 450434 | 0.075 | 10053100 | 0.132 | 0.425 | 0.483 | 0.081 | 115814 |
| 1998 | 378962 | 361611 | 0.081 | 13351100 | 0.114 | 0.482 | 0.547 | 0.088 | 108924 |
| 1999 | 362509 | 351123 | 0.082 | 10185000 | 0.135 | 0.442 | 0.502 | 0.092 | 94091 |
| 2000 | 309095 | 292004 | 0.089 | 31892000 | 0.085 | 0.394 | 0.447 | 0.094 | 85786 |
| 2001 | 468210 | 396744 | 0.075 | 19071300 | 0.109 | 0.372 | 0.422 | 0.091 | 101957 |
| 2002 | 476516 | 415199 | 0.074 | 10954400 | 0.143 | 0.311 | 0.353 | 0.092 | 99673 |
| 2003 | 450701 | 415131 | 0.077 | 8917830 | 0.158 | 0.278 | 0.315 | 0.084 | 97831 |

| Year | Biomass 1+ | SSB | CV SSB | Recruits | CV Recruits | F (2-5) | F Apical | CV F Apical | Landings |
|---|---|---|---|---|---|---|---|---|---|
| 2004 | 394316 | 366092 | 0.083 | 36476900 | 0.072 | 0.308 | 0.349 | 0.082 | 98020 |
| 2005 | 528491 | 419907 | 0.070 | 13048300 | 0.107 | 0.306 | 0.347 | 0.079 | 97345 |
| 2006 | 621202 | 569620 | 0.061 | 4177830 | 0.169 | 0.180 | 0.181 | 0.094 | 87023 |
| 2007 | 489450 | 477899 | 0.062 | 5967080 | 0.130 | 0.219 | 0.220 | 0.074 | 96469 |
| 2008 | 381927 | 374655 | 0.064 | 7577460 | 0.108 | 0.351 | 0.353 | 0.076 | 101464 |
| 2009 | 289030 | 282615 | 0.067 | 8531930 | 0.095 | 0.397 | 0.400 | 0.087 | 87740 |
| 2010 | 243511 | 240468 | 0.064 | 4887320 | 0.122 | 0.496 | 0.499 | 0.095 | 89571 |
| 2011 | 174930 | 173209 | 0.074 | 3994060 | 0.129 | 0.592 | 0.596 | 0.107 | 80403 |
| 2012 | 129264 | 127875 | 0.094 | 4332700 | 0.125 | 0.478 | 0.481 | 0.122 | 54857 |
| 2013 | 119160 | 117631 | 0.109 | 4842690 | 0.130 | 0.454 | 0.457 | 0.144 | 45818 |
| 2014 | 123689 | 123689 | 0.126 | 3662020 | 0.161 | 0.289 | 0.291 | 0.160 | 27937 |
| 2015 | 116989 | 116193 | 0.141 | 6717600 | 0.144 | 0.174 | 0.176 | 0.165 | 20595 |
| 2016 | 150659 | 150659 | 0.138 | 8966350 | 0.153 | 0.171 | 0.172 | 0.165 | 22704 |
| 2017 | 193646 | 192425 | 0.142 | 4161560 | 0.185 | 0.138 | 0.139 | 0.169 | 21911 |
| 2018 | 187421 | 185762 | 0.149 | 8577580 | 0.163 | 0.073 | 0.074 | 0.164 | 15062 |
| 2019 | 218826 | 212448 | 0.143 | 27463600 | 0.138 | 0.051 | 0.051 | 0.149 | 13759 |
| 2020 | 442210 | 421729 | 0.127 | 12326800 | 0.166 | 0.059 | 0.060 | 0.147 | 22143 |
| 2021 | 469923 | 460740 | 0.127 | 11129600 | 0.190 | 0.090 | 0.091 | 0.147 | 40686 |
| 2022 | 443085 | 438956 | 0.134 | 20158100 | 0.184 | 0.086 | 0.086 | 0.141 | 40429 |
| 2023 | 502765 | 502765 | 0.142 | 4327290 | 0.325 | 0.114 | 0.114 | 0.150 | 48399 |
| 2024 | 423591 | 423591 | 0.156 | 18112500 | 0.425 | | | | 46095 |

**Table 8.6.1. Sardine in 8c and 9a: Input data for short-term catch predictions. Number-at-age for 2024 and recruitment for 2025. Input values for stock weight, catch weight, natural mortality (M) and fishing mortality (F) at-age. Input units are thousands and kg.**

| **Year = 2024** | | | | | | |
|---|---|---|---|---|---|---|
| Age | Numbers | Stock weights | Catch weights | Maturity | M | F |
| 0 | 18112500 | 0.000 | 0.025 | 0.000 | 0.98 | 0.013 |
| 1 | 1600560 | 0.023 | 0.045 | 0.956 | 0.61 | 0.057 |
| 2 | 3822130 | 0.044 | 0.055 | 0.996 | 0.47 | 0.102 |
| 3 | 1197410 | 0.053 | 0.067 | 1.000 | 0.40 | 0.105 |
| 4 | 816268 | 0.058 | 0.074 | 1.000 | 0.36 | 0.105 |
| 5 | 1179840 | 0.060 | 0.079 | 1.000 | 0.35 | 0.105 |
| 6 | 544218 | 0.068 | 0.090 | 1.000 | 0.32 | 0.084 |
| Recruitment in 2025 = 13 330 753 | | | | | | |
| Stock weights, catch weights, maturity and mortality are the same as in 2024 | | | | | | |

**Table 8.6.2. Sardine in 8.c and 9.a: Output data for short-term catch predictions.**

| **B1+ 2025 = 453 035 tonnes; Catch 2024 = 46 095 tonnes ; F 2024 = 0.104** | | | | | | |
|---|---|---|---|---|---|---|
| Catch (2025) | F (2025) | Biomass 1+ (2026) | Catch2026 | % Biomass 1+ change[1] | % Quota change[2] | % Advice change[3] |
| 40073 | 0.092 | 454384 | 40712 | 0 | −10 | 3 |
| 51738 | 0.120 | 446398 | 51625 | −1 | 16 | 33 |
| 106615 | 0.260 | 409044 | 97430 | −10 | 140 | 173 |
| 344439 | 1.106 | 252587 | 200676 | −44 | 675 | 783 |
| 435452 | 1.616 | 196260 | 206802 | −57 | 880 | 1017 |
| 45205 | 0.104 | 450869 | 45564 | 0 | 2 | 16 |
| 40073 | 0.092 | 454384 | 40712 | 0 | −10 | 3 |
| 106615 | 0.260 | 409044 | 97430 | −10 | 140 | 173 |
| 30000 | 0.068 | 461292 | 30000 | 2 | −33 | −23 |
| 35000 | 0.080 | 457862 | 35000 | 1 | −21 | −10 |
| 40000 | 0.092 | 454434 | 40000 | 0 | −10 | 3 |
| 45000 | 0.104 | 451010 | 45000 | 0 | 1 | 15 |
| 50000 | 0.116 | 447588 | 50000 | −1 | 12 | 28 |

[1] Biomass 1+ in 2026 relative to Biomass 1+ in 2025 (453 035 tonnes).

[2] Advised catches in 2025 compared to advised catches in 2024 (38 992 tonnes)

[3] Advised catches in 2025 compared to sum quotas in SP+PT in 2024 (44 450 tonnes)

# 9 Blue jack mackerel (*Trachurus picturatus*) in Subdivision 10.a.2 (Azores grounds)

Blue jack mackerel, *Trachurus picturatus* Bowdich, 1825 (*Carangidae*), is the only species of genus Trachurus that occurs in the Azores region (northeastern Atlantic). It is a pelagic species found around the islands' shelves, banks, and seamounts up to 300 m deep. However, a different size structure was observed between the islands' shelf and offshore areas. The island shelf areas seem to function as nursery or growth zones, while the seamount/bank offshore areas act as feeding zones where adults predominate (Menezes et al., 2006).

In the Azores, *T. picturatus* is exploited by different fleets and métiers. The main catches are those of the artisanal fleet that operates with several types of surface nets, the most important being purse-seines. Also, bottom longline and handline fisheries catch this species, but not as a target species. Purse-seines are also used by the tuna bait boat fleet, which targets *T. picturatus* to be used as live bait for tuna. Blue jack mackerel is also popular among recreational anglers who fish along the islands' coast.

The *T. picturatus* landings were considerably high during the 1980s. However, changes in the local markets lead to a substantial reduction in the catches afterward. This reduction was accompanied by a sharp decrease in the fleet targeting small pelagic fishes. Since then, the yields have maintained a low level due to a voluntary auto regulation adopted by the fishermen's associations and later (since 2014) limited by local regulations with conditioned daily catch limits. Despite these landing reductions, this fishery still strongly impacts some fisher communities, which directly depend on this fishery's income.

## 9.1 Blue Jack Mackerel in ICES areas

Blue jack mackerel has a broad geographical distribution within the Eastern Atlantic waters and can be found from the southern Bay of Biscay to south Morocco, including the Macaronesia archipelagos, Tristan de Cunha and Gough Islands and also in the western part of the Mediterranean Sea and the Black Sea (Smith-Vaniz, 1986). It is a pelagic fish species whose characteristic habitat includes the neritic zones of island shelves, banks, and seamounts (Smith-Vaniz, 1986). It has a shoal behavior and preys mainly on crustaceans-common in Madeira, the Azores, the Canaries, and Portuguese continental waters.

So far, no studies have been attempted to address distinct populations in this species' distribution range. Some studies on growth and biological characteristics from Madeira, Azores, and the Canary Islands (Garcia et al., 2015; Isidro, 1990; Jesus, 1992; Gouveia, 1993; Vasconcelos et al., 2006; Jurado-Ruzafa & Santamaría, 2013) indicated similar growth-rates and reproductive season. However, biological differences in age at first maturity seem to exist between individuals from the Azores and those from the Madeira and the Canary Islands (Jesus, 1992; Jurado-Ruzafa & Santamaría, 2013). The morphometric studies on *T. picturatus* from the Azores archipelago (Isidro, 1990), the west coast of Portugal (Mendes et al., 2004), and the western Mediterranean (Merella et al., 1997) revealed similar population parameters for the estimated relationships. On the contrary, some variation was found between different geographic areas in the number of soft spines from the second dorsal fin (Shaboneyev & Kotlyar 1979; Smith-Vaniz, 1986). However, meristic characters are heavily influenced by the environmental conditions experienced by the fish while in the larval stages. Therefore, in the case of migratory oceanic species, such as *T. picturatus*, they are usually considered of reduced utility for identifying stock units.

Several studies have successfully used parasites as biological markers. Gaevskaya & Kovaleva (1985) conducted a research survey on the parasites of *T. picturatus* from the Azores and Western Sahara. Their study identified some protozoan and helminth parasites showing differences in prevalence. The myxosporean Kudoa nova was found in Western Sahara samples but not in the Azores archipelago banks. Similarly, some digeneans (Platyhelminths: Digenea) found in the Azores banks were not observed in the samples from Western Sahara and vice-versa. The apicomplexan, Goussia cruciata, which is common in *T. picturatus* from the Mediterranean (Kalfa-Papaioannou & Athanassopoulou-Raptopoulou, 1984) and more recently from Madeira waters (Gonçalves, 1996), was not found in the Azores or Western Sahara. These variations in the occurrence of parasites could indicate the existence of different populations of *T. picturatus*. Further studies on helminth parasite occurrence showed differences in species diversity and parasitic infection levels (Costa et al. 2000, 2003).

Blue jack mackerel is an economically vital resource, especially in the Macaronesian islands of Azores and Madeira, where it is the main pelagic fish species caught by the local (artisanal) fisheries. The hypothesis that the fluctuations in landings can be due to changes in availability or abundance, and not just by changes in fishing effort, is supported for the Portuguese mainland by observing fluctuations in the abundance indices obtained from demersal research surveys.

## 9.2 The fishery in 2022 and 2023

Official landings for 2022 and 2023 include commercial landings from small purse-seiners (and other surrounding nets), landings from hooks and lines métiers, and unsold purse-seine landings withdrawn at the port (daily catch limits).

Other catches include longline bait, tuna (live) bait and bait on longline and handline fisheries was not available for the period. Estimates of recreational catches for boat fishing are available only for 2022, but estimates for 2023 and shore recreational anglers are still unavailable.

### 9.2.1 Fishing Fleets

*Trachurus picturatus* is mostly landed by the artisanal fleet, using purse seines and other surrounding nets, targeting juveniles. In 2021, the total number of vessels licensed to small pelagic fish was 179, and the landings of this fleet represented around 85% of total blue jack mackerel (official) landings in the Azores. However, data with the total number of vessels licensed was not available for 2022 and 2023.

Despite having a license to fish small pelagics, many of these vessels carry out multipurpose artisanal fishing, which varies between lifting gears, hook gears and, often, even traps and gillnets. They are often (and for this reason) classified as polyvalent vessels and not as vessels mainly using purse seines.

The artisanal purse seines fleet comprises small open deck vessels, mostly with less than 12 meters of overall length, targeting juveniles of *T. picturatus*. Included in this group of vessels (licensed for this fishing gear) is the proper "mackerel fleet" – vessels dedicated exclusively to capturing small pelagics and of which the blue jack mackerel is the predominant target species. The active "Mackerel fleet" composition shows a regular decrease in recent years, from around 50 vessels in 2010 to 24 in 2021. The number of small purse seine vessels and the number of vessels of the "Mackerel fleet" for the last twenty-five years is shown in Figure 9.2.1.1.

The longline and handline fleets catch around 14% of the total official landings of *T. picturatus* in 2023. These fleets catch the adult stock mainly to use it as bait to catch other demersal species with high economic value. Only the excedent is landed.

## 9.2.2 Catches

Catches of blue jack mackerel, including landings (from artisanal purse seines, longliners & handliners) and other catches (longline bait plus discards from the longline fishery, tuna live bait, and recreational catches) from 1978 to 2023, are presented in Table 9.2.2.1, but with only data for official landings (from artisanal purse seines, longliners & handliners) available for 2022-2023. Estimates of recreational catches are available for 2022, and not estimate yet for 2023 (Table 9.2.2.1.). Purse seine catches over daily sales limits are withdrawn from the human consumption market and recorded as fish for bait (but also with daily limits). These catches have been included in official landings only since 2018.

Total average yearly catches of blue jack mackerel in the Azores for the period 1978-2023 are shown in Figure 9.2.2.1. The average annual catches of blue jack mackerel in the Azores for the last 20 years (2003-2023) are around 1540 tonnes, while official landings in the same period are, on average, 905 tonnes. Despite this relative stability, there has been a downward trend in official landings over the last ten years, which average is around 800 tons.

In the tuna fleet, live bait catches (*T. picturatus*) are related to the occurrence of tuna – years with a shortage of tuna will reflect small catches of live bait. Concerning longliners, the changes in yields observed in recent years are mainly related to the use and even preference of this species for bait (since the quality of the bait is high) and not to landings (since the market price for adults tends to be lower).

The year 2019 stands out as a year in which a value was higher than the average of the last ten years, which is due, in particular, to the great abundance of juveniles that year. This resulted in significant landings exceeding the established daily sales limits, so excedent catches were withdrawn from the human consumption market and stored as bait fish. Some decrease that occurred in 2020 is justified by the pandemic experienced worldwide caused by COVID-19, which caused several stoppages in the fisheries sector. In 2021, this situation seems to have been overcome, with the values regularising to the last decade's average values. The detailed data for these catches are not available for 2022-2023.

## 9.2.3 Effort

The nominal fishing effort (number of fishing days) for the main fleet (active artisanal purse seiners – "Mackerel fleet") for 2010 – 2021 is presented in Figure 9.2.3.1. In 2021, the number of trips of only 21 of these vessels represented 95% of the total number of official landings of blue jack mackerel in the Azores. The landings of these 21 vessels represented about 70% of the value and weight (official) of blue jack mackerel landed. There are no data available for 2022-2023.

Nominal LPUE (landings per unit effort) for the Sao Miguel and Terceira islands purse seine fleet, which represents, on average, 90% of the landings of the artisanal purse seine fleet, has increased slightly in the last years (Figure 9.2.3.2). However, the validity of these indices needs to be further studied, through a standardization process and updated to 2023.

## 9.3 Basis of the advice

Since 2018, the stock category of *Trachurus picturatus* in 10.a.2 changed from category 3 to category 5, and a precautionary buffer of 20% has been applied to the advised catches every three years. The reasons pointed out were that:

(i) Different length-based reference points were explored but were not found appropriate since catches from the different fisheries do not represent the full-length composition of the stock;

(ii) stock size indicators previously used (directed fishery from artisanal purse seiners and bait for tuna fishery) target only juveniles, thus probably are not reflecting the whole dynamics of the stock;

(iii) handliners and longliners were targeting adults, although they seem minor compared to purse seiners;

(iv) and no data available from tuna bait, recreational fishery, and longline (bait) fisheries were available in the previous assessment for 2016 and 2017.

Since then, the advice for blue jack mackerel in Azores grounds is based on the ICES framework for category 5 stocks (ICES, 2012) and it is provided every two years.

## 9.4 Catch scenarios for 2025 and 2026

The advice for this stock is biennial, so the 2024 advice is valid for 2025 and 2026: *ICES advises that when the precautionary approach is applied, catches should be no more than 702 tonnes in each of the years 2025 and 2026.*

ICES framework for category 5 stocks was applied (ICES, 2012). For stocks without information on abundance or exploitation, ICES considers that a precautionary reduction of catches should be implemented where there is no ancillary information clearly indicating that the current level of exploitation is appropriate for the stock. The PA buffer was applied in 2022 and therefore was not applied this year.

## 9.5 Management considerations

The Azores Administration put in place in October 2014 (and last updated in 2018) a specific management measure (local regulations with daily catch limits) for the purse seine fleet and human consumption, primarily to regulate markets. This measure allows only 200kg or 300kg of catch per vessel, per day, depending on the island (Sao Miguel or Terceira islands – once the landings of juvenile blue jack mackerel on these islands represent more than 95% of the total landings of the artisanal purse seine fleet). It also states that fishing and consequent landings shall be forbidden on weekends and set quantities for unsold purse-seine landings withdrawn at the port.

## 9.6 Suggested inter-seasonal work

In 2019, the Working Group discussed different (or complementary) approaches that could have been taken into account for the 2020 assessment and proposed inter-sessional work. However, due to COVID-19, much of the work was not put into practice. The 2022 Working Group updated the suggestions for inter-sessional work:

- Continue track of (Catch, effort) CPUE indexes of different fleets;
- Explore the standardization process for the fishery-dependent index (LPUE and CPUE);
- Explore alternative indicators for the purse seiners, e.g. the number of times the maximum daily catches were reached, etc.;
    - Use the market selling records of the small purse seiners targeting blue jack mackerel to compute indicators of availability as the number of days when the maximum daily allowable catch of blue jack mackerel is landed by the vessels (per month or annually) in relation to the number of fishing days by month of every particular vessel;
    - Relate the former to the maximum catch of other species being landed so that some definition of metier might be derived or inferred for the daily fishing trips. This can potentially distinguish the number of fishing days targeting blue jack mackerel from those targeting other species.
- Monitor and track in time catch length distributions (for any purpose, including landings or selling as live bait, bait for hooks or discards) of different fleets;
- To assess growth (Von Bertalanffy) parameters of blue Jack mackerel;
- Try length-based methods, but with some changes from what has been done in the past: for example, (i) using the longline length distribution series to verify stability in the length or age distribution; (ii) use any trends in mean length or age composition as an indicator of overall population mortality; (iii) use these series as an indicator of global (medium-term) changes in overall exploitation on the stock.
- Check whether other fisheries may or may not serve as an overall mortality indicator or an alarm indicator if normal series variability deviates.
- Explore the applicability of surplus production models such as SPiCT, based on the catches and standardized abundance index.

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# 9.8 Tables

**Table 9.2.2.1. Blue jack mackerel in Azores grounds. History of catches (in tonnes) of blue jack mackerel (*Trachurus picturatus*) in Subdivision 10.a.2.**

| | Official landings | | | Additional catches | | | | Total |
|---|---|---|---|---|---|---|---|---|
| Year | Purse seine (human consumption) | Purse seine (withdrawn at the port and used for bait)* | Longline + handline | Recreational** | Longline (discards and used for bait) | Tuna bait | Purse seine (withdrawn at the port and used for bait)* | ICES catches |
| 1978 | 2657 | | 78 | 129 | 15 | 115 | 0 | 2995 |
| 1979 | 4114 | | 61 | 130 | 15 | 118 | 0 | 4439 |
| 1980 | 2920 | | 70 | 132 | 22 | 210 | 0 | 3354 |
| 1981 | 2104 | | 39 | 135 | 9 | 229 | 0 | 2516 |
| 1982 | 2429 | | 43 | 142 | 10 | 239 | 0 | 2862 |
| 1983 | 3711 | | 67 | 142 | 21 | 231 | 0 | 4172 |
| 1984 | 3180 | | 62 | 135 | 17 | 295 | 0 | 3689 |
| 1985 | 3442 | | 60 | 136 | 11 | 303 | 0 | 3952 |
| 1986 | 3282 | | 58 | 135 | 9 | 433 | 0 | 3918 |
| 1987 | 2974 | | 53 | 139 | 8 | 491 | 0 | 3666 |
| 1988 | 3032 | | 55 | 143 | 8 | 586 | 0 | 3824 |
| 1989 | 2824 | | 50 | 138 | 9 | 352 | 0 | 3373 |
| 1990 | 2472 | | 48 | 117 | 11 | 345 | 584 | 3577 |
| 1991 | 1247 | | 33 | 115 | 6 | 242 | 421 | 2064 |
| 1992 | 1226 | | 35 | 121 | 6 | 249 | 486 | 2123 |
| 1993 | 1684 | | 70 | 130 | 22 | 375 | 742 | 3023 |
| 1994 | 1745 | | 59 | 125 | 18 | 264 | 636 | 2847 |
| 1995 | 1769 | | 79 | 119 | 24 | 474 | 688 | 3153 |
| 1996 | 1642 | | 123 | 110 | 38 | 351 | 656 | 2920 |
| 1997 | 1849 | | 72 | 110 | 31 | 259 | 599 | 2920 |
| 1998 | 1387 | | 120 | 111 | 52 | 308 | 606 | 2584 |
| 1999 | 609 | | 84 | 119 | 37 | 141 | 565 | 1555 |
| 2000 | 602 | | 53 | 117 | 23 | 83 | 521 | 1399 |

| Year | Official landings | | | Additional catches | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | Purse seine (human consumption) | Purse seine (withdrawn at the port and used for bait)* | Longline + handline | Recreational** | Longline (discards and used for bait) | Tuna bait | Purse seine (withdrawn at the port and used for bait)* | ICES catches |
| 2001 | 1046 | | 55 | 121 | 24 | 59 | 376 | 1681 |
| 2002 | 1387 | | 63 | 132 | 28 | 82 | 371 | 2063 |
| 2003 | 1455 | | 47 | 128 | 21 | 140 | 510 | 2301 |
| 2004 | 1148 | | 98 | 111 | 19 | 208 | 528 | 2112 |
| 2005 | 1111 | | 120 | 120 | 236 | 124 | 536 | 2247 |
| 2006 | 1145 | | 96 | 111 | 40 | 264 | 501 | 2157 |
| 2007 | 1032 | | 122 | 115 | 58 | 370 | 562 | 2259 |
| 2008 | 980 | | 139 | 110 | 75 | 205 | 428 | 1937 |
| 2009 | 1023 | | 98 | 119 | 115 | 230 | 157 | 1742 |
| 2010 | 1021 | | 57 | 114 | 75 | 313 | 152 | 1732 |
| 2011 | 920 | | 62 | 118 | 79 | 510 | 319 | 2008 |
| 2012 | 467 | | 94 | 42 | 41 | 399 | 422 | 1465 |
| 2013 | 592 | | 123 | 147 | 54 | 237 | 441 | 1594 |
| 2014 | 852 | | 91 | 112 | 49 | 134 | 410 | 1648 |
| 2015 | 714 | | 160 | 103 | 67 | 116 | 402 | 1562 |
| 2016 | 428 | | 174 | 32 | 61 | 48 | 421 | 1164 |
| 2017 | 511 | | 95 | N/A | 37 | 96 | 385 | 1124 |
| 2018 | 643 | 132 | 77 | 4 | 31 | 381 | | 1268 |
| 2019 | 720 | 241 | 83 | 5 | 26 | 156 | | 1231 |
| 2020 | 613 | 119 | 127 | 5 | 21 | 77 | | 962 |
| 2021 | 609 | 145 | 135 | 81 | 57 | 143 | | 1170 |
| 2022 | 589 | N/A | 106 | 2 | N/A | N/A | | 697 |
| 2023 | 598 | N/A | 100 | N/A | N/A | N/A | | 698 |

***Purse-seine catches in excess of daily sales limits are withdrawn from the human consumption market but are recorded as fish for bait. Starting in 2018, these catches are included in official landings.**

**** Since 2018 the estimation of recreational fishing from boats only; data from shore anglers are not available.**

**N/A: Not available**

## 9.9 Figures

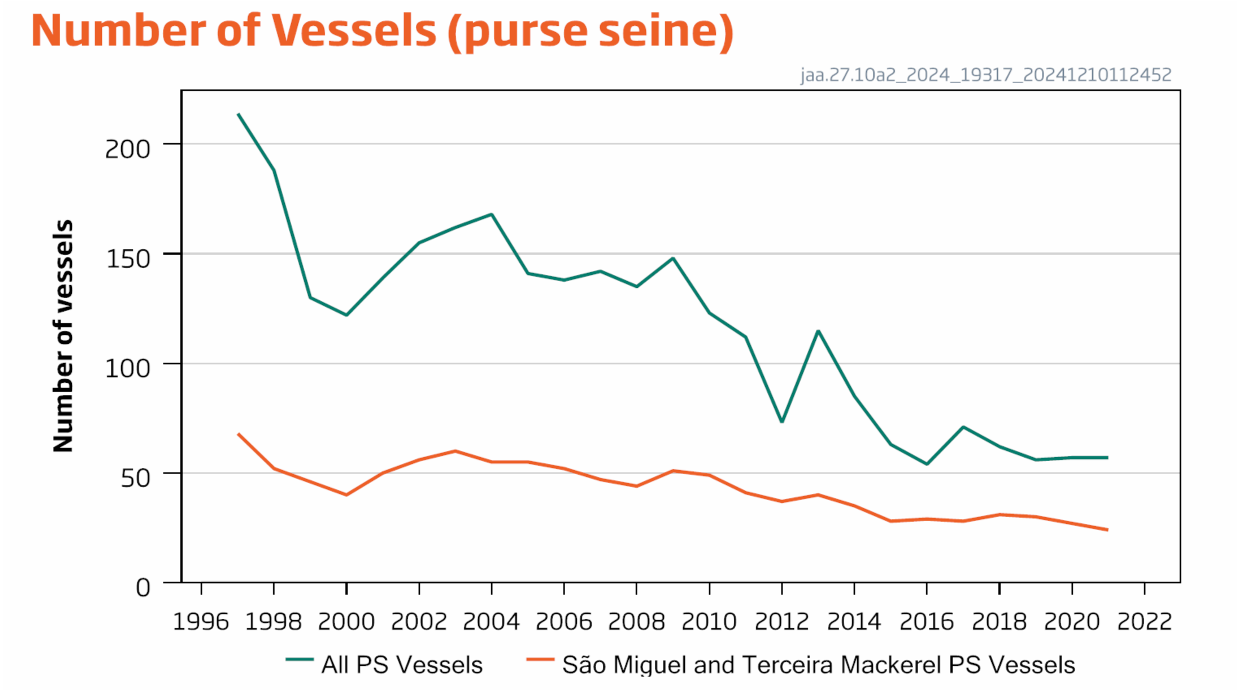


**Figure 9.2.1.1. Blue jack mackerel in Azores grounds. Number of small purse seine vessels and the number of vessels of the "Mackerel fleet" in the Azores (ICES Subdivision 10.a2) from 1997 to 2021. No new information is available for 2022-2023.**

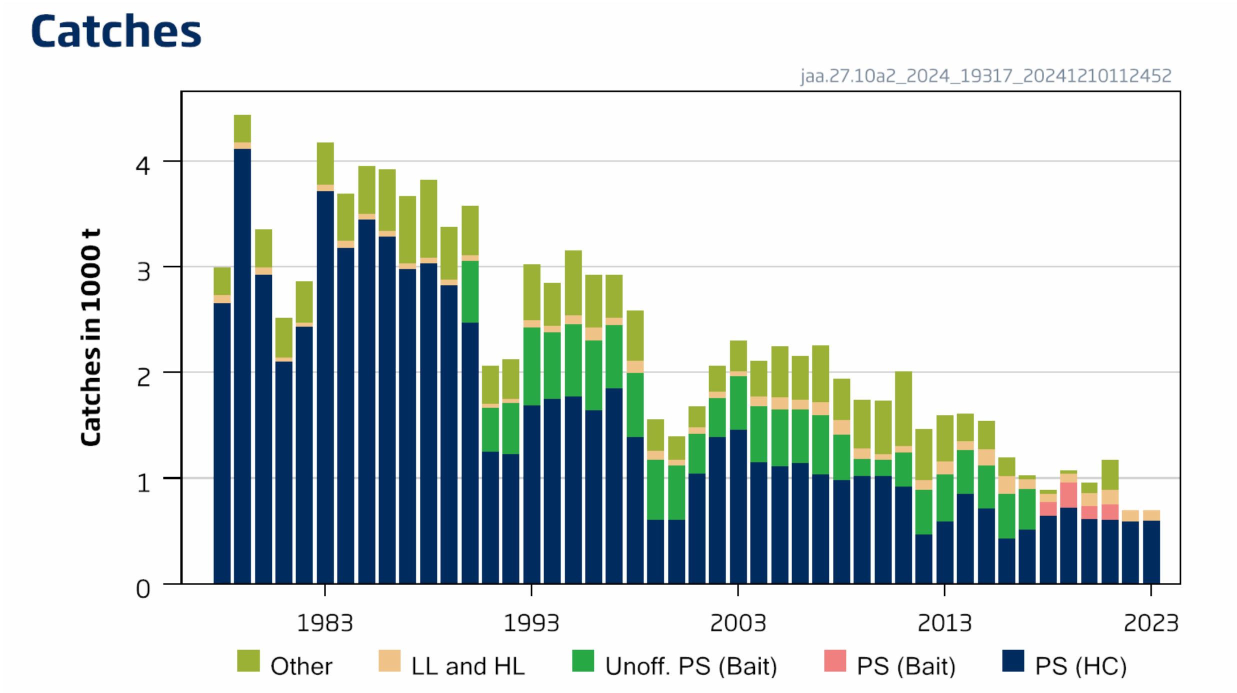


**Figure 9.2.2.1. Blue jack mackerel in Azores grounds. Landings and other catches. Landings include purse seine catches for human consumption – PS (HC) – purse seine catches for bait – PS (Bait) – and have unsold purse seine landings with-drawn at the port as well as longline and handline landings (LL & HL). Other catches include recreational catches, dis-cards/longline bait, and tuna live bait (incomplete in 2017-2020) and not available for 2022-2023.**

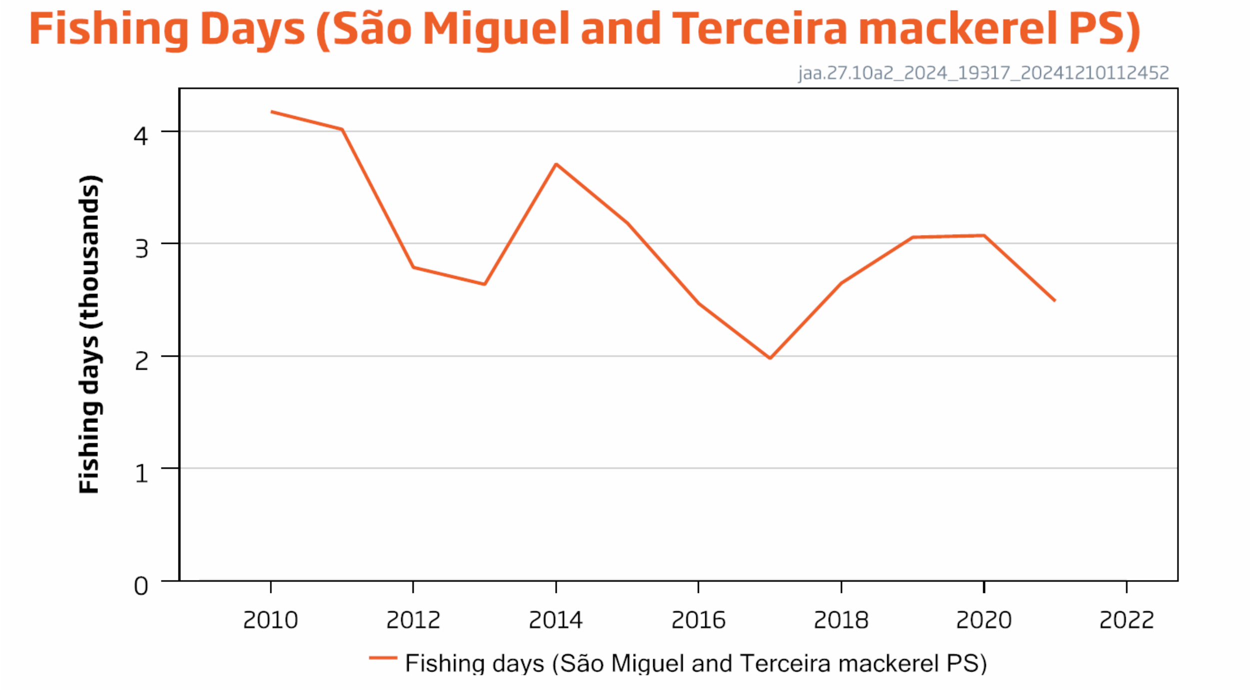


**Figure 9.2.3.1. Blue jack mackerel in Azores grounds. Nominal effort (number of Fishing days) of the "Mackerel fleet" for 2010 – 2021. No new information is available for 2022-2023.**

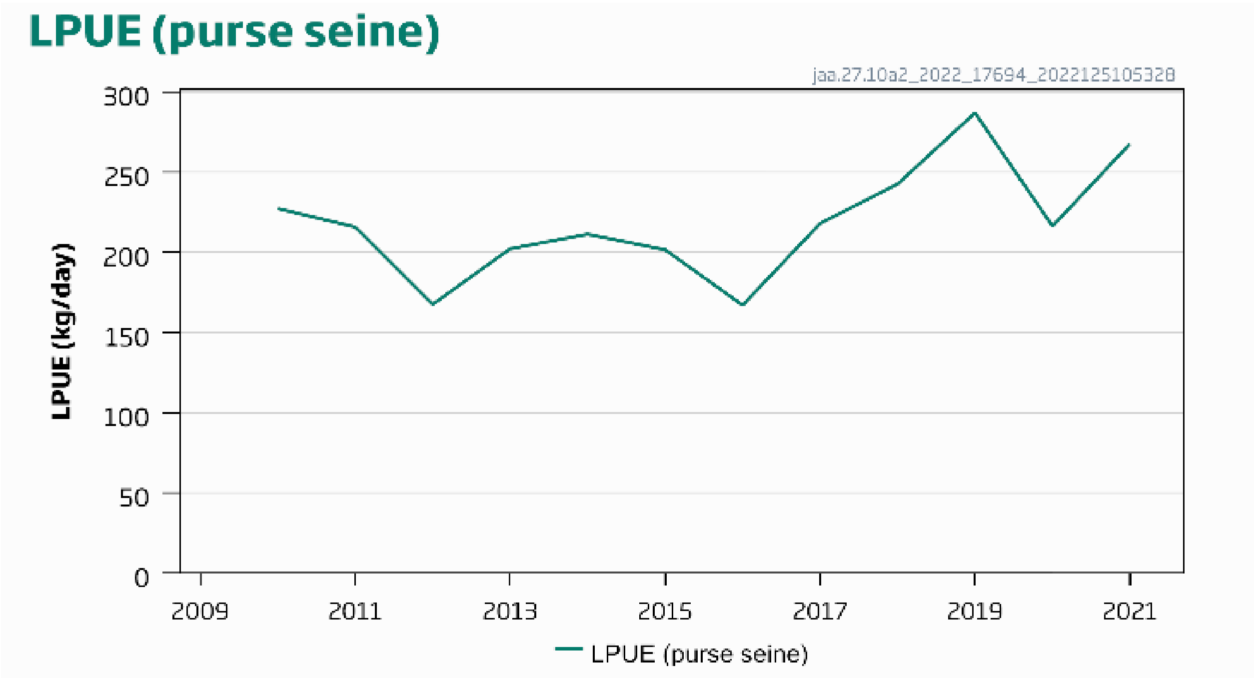


**Figure 9.2.3.2. Blue jack mackerel in Azores grounds. Nominal LPUE (kg/day) of the "Mackerel fleet" for 2010 – 2021. No new information is available for 2022-2023.**

# Annex 1: List of participants

**WGHANSA-1 (Online): 27 – 31 May 2024**

| Name | Institution | Country |
|---|---|---|
| Leire Citores | AZTI | Spain |
| José Luis Cebrián | Centro Oceanográfico de Cádiz (IEO, CSIC) | Spain |
| Gersom Costas | Centro Oceanográfico de Cádiz (IEO, CSIC) | Spain |
| Susana Garrido | Portuguese Institute for the Sea and the Atmosphere-IPMA | Portugal |
| Leire Ibaibarriaga | AZTI | Spain |
| Hugo Mendes | Portuguese Institute for the Sea and the Atmosphere-IPMA | Portugal |
| David Miller | ICES | Denmark |
| Rosana Ourens (chair) | CEFAS | UK |
| Fernando Ramos | Centro Oceanográfico de Cádiz (IEO, CSIC) | Spain |
| Margarita Rincón | Centro Oceanográfico de Cádiz (IEO, CSIC) | Spain |
| Isabel Riveiro | Centro Oceanográfico de Cádiz (IEO, CSIC) | Spain |
| Laura Wise | Portuguese Institute for the Sea and the Atmosphere-IPMA | Portugal |
| Maria José Zúñiga | Centro Oceanográfico de Cádiz (IEO, CSIC) | Spain |

**WGHANSA-2 (Madrid, Spain): 25 – 29 Nov 2024**

| Name | Institution | Country |
|---|---|---|
| Leire Citores | AZTI | Spain |
| Leire Ibaibarriaga | AZTI | Spain |
| Rosana Ourens | Cefas | UK |
| Susan Kenyon | Cefas | UK |
| David Miller | ICES | Denmark |
| Ryan Dunne | ICES | Denmark |
| Fernando Ramos | IEO (CSIC) | Spain |
| Isabel Riveiro | IEO (CSIC) | Spain |
| José Luis Cebrián | IEO (CSIC) | Spain |
| Itsaso Carmona | IEO (CSIC) | Spain |
| María José Zúñiga | IEO (CSIC) | Spain |
| Maxime Olmos | IFREMER | France |
| Erwan Duhamel | IFREMER | France |
| Lionel Pawlowski | IFREMER | France |
| Hugo Mendes | IPMA | Portugal |
| Laura Wise | IPMA | Portugal |
| Susana Garrido | IPMA | Portugal |
| Wendell Medeiros | Universidade dos Açores | Portugal |
| Amanda Perez-Perera (observer) | DGMARE | Other |

# Annex 2: Joint sessions WGACEGG-WGHANSA

## Joint session in May 2024

On the second day of WGHANSA-1, 28th May 2024, a joint WGACEGG-WGHANSA session took place. The objective was to present and discuss the abundance indices of the PELAGO and PELACUS acoustic surveys before their inclusion in the stock assessment of anchovy in division 9a.

The following talks were presented:

- "PELAGO 24 Acoustic survey. Preliminary Results"
- "PELACUS 24: Preliminary results"

The main results of these presentations are briefly summarised in the stock assessment input data sections of the WGHANSA report.

The estimates from the surveys were not fully available during the presentations but were made available during WGHANSA-1. Overall, the estimates were considered sufficiently reliable and the abundance indices from PELAGO and PELACUS 2024 surveys were accepted for their inclusion in the stock assessment. These surveys will be discussed more extensively within WGACEGG in the meeting that will take place in November 2024 and a detailed description will be available in the corresponding WGACEGG report.

## Joint session in November 2024

A second joint session WGACEGG-WGHANSA took place on the 18th and 20th November 2024 to discuss some of the topics of interest for both working groups. This included a summary of the benchmark for anchovy in the Bay of Biscay and Iberian waters and a summary of the acoustic and egg surveys carried out in 2024. New approaches to improve the communication between both working groups were also discussed. 29 participants attended the joint session (16 members of WGACEGG, 10 members of WGHANSA, and 3 members of both working groups).

The following talks were presented during the joint session:

- ICES/PICES WGSPF 2024-2027
- 2024 Benchmark anchovy
- PELGAS 2024, 8cbd
- BIOMAN 2024, 8abcd
- ECOCÁDIZ RECLUTAS 2024, 9aS
- JUVENA 2024, 8cbd
- PELTIC 2024, 7ef
- WESPAS 2024, 7j-k6a
- CSHAS 2024, 7j-g,aS
- PELAGO 2024, 9aS,W
- PELACUS 2024, 9aN8c
- IBERAS 2024, 9aW

# Annex 3: Stock Annexes

The table below provides an overview of the WGHANSA Stock Annexes. Stock Annexes for other stocks are available on the ICES website library under the publication type "Stock Annexes". Use the search facility to find a particular Stock Annex, refining your search in the left-hand column to include the *year*, *ecoregion*, *species*, and *acronym* of the relevant ICES expert group.

| Stock ID | Stock name | Last updated | Link |
|---|---|---|---|
| ane.27.8 | Anchovy (*Engraulis encrasicolus*) in Subarea 8 (Bay of Biscay) | December 2024* | https://doi.org/10.17895/ices.pub.28053440 |
| ane.27.9a | Anchovy (*Engraulis encrasicolus*) in Division 9.a (Atlantic Iberian waters) ¤ | June 2024 | https://doi.org/10.17895/ices.pub.26004166 |
| ane.27.9aS | Anchovy (*Engraulis encrasicolus*) in the southern part of Division 9.a (Gulf of Cadiz and southern coast of Portugal) | December 2024* | https://doi.org/10.17895/ices.pub.28053362 |
| ane.27.9aW | Anchovy (*Engraulis encrasicolus*) in the western part of Division 9.a (Western Iberian waters) | December 2024* | https://doi.org/10.17895/ices.pub.28053386 |
| hom.27.9a | Horse mackerel (*Trachurus trachurus*) in Division 9.a (Atlantic Iberian waters) | June 2024 | https://doi.org/10.17895/ices.pub.26004166 |
| jaa.27.10a2 | Blue jack mackerel (*Trachurus picturatus*) in Subdivision 10.a.2 (Azores grounds) | June 2015 | https://doi.org/10.17895/ices.pub.18622022 |
| pil.27.7 | Sardine (*Sardina pilchardus*) in Subarea 7 (Bay of Biscay, southern Celtic Seas, and the English Channel) | November 2021 | https://doi.org/10.17895/ices.pub.20032127 |
| pil.27.8abd | Sardine (*Sardina pilchardus*) in divisions 8.a–b and 8.d (Bay of Biscay) | December 2022 | https://doi.org/10.17895/ices.pub.18623198 |
| pil.27.8c9a | Sardine (*Sardina pilchardus*) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters) | November 2021 | https://doi.org/10.17895/ices.pub.18623345 |

**¤ Stock annex for ane.27.9a has been obsoleted by new stock annexes for components ane.27.9aS and ane.279aW**

***Stock has recently undergone benchmarking; an updated stock annex has been produced but may not be available in library at time of WGHANSA publication**

# Annex 4: Audits

## Review of ICES Scientific Report, WGHANSA-1 2024

Expert group Chair: Rosana Ouréns

Secretariat representative: David Miller

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**Audit of** Anchovy in Division 9.a. Western component
Date: 05/06/2024
Auditor: Jose Luis Cebrian

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**General**
Since 2018, ICES has provided catch options separately for the two stock components of anchovy in Division 9.a: the western component (distributed in areas 9.a North, Central-North, and Central-South) and the southern component (distributed in area 9.a South).
The western component (as well as the southern) are classified as ICES category 3 and Catch advice has been based on the recently approved ICES-guidelines for short lived species category 3 stocks, whereby catch advice is changed from year to year according to the 1-over-2 rule subject to an uncertainty cap of +/- 80% (maximum relative allowable change between years). However, before WGHANSA 2023, there was an ICES workshop to evaluate the performance of a constant harvest rate (CHR) simulated with a management strategy evaluation (MSE) for both components independently.
WGHANSA welcomed the updates and suggests using a CHR (25% for the western component) to provide advice for the period July 2023-June 2024. Although under a base case scenario a harvest rate of 0.4 was considered to be precautionary by ICES standards in the medium and long terms, it was acknowledged that the CHR advice rule is highly sensitive to the assumed value of catchability of the survey index (QIDX = 1.5). Therefore, to account for possible shifts in productivity, an harvest rate HR = 0.25 was adopted as the basis of advice for the CHR advice rule to be applied to the Anchovy 9a western component. The rule was used for the first time.

Audit for the Western component:

1. Assessment type: Updated. The stock was benchmarked in 2018 (ICES, 2018).
2. Assessment: Accepted
3. Forecast: not required. The advice follows the catch advice rule for category 3 short-lived stocks
4. Assessment model: There is no assessment model. This stock component is assessed based on survey trends. The acoustic spring surveys that cover the distribution area of this component (PELAGO and PELACUS) were normally carried out and it was possible to have estimates for this year.
5. Consistency: The biomass index for 2024 was estimated as stated in the stock annex (CHR) and the Advice Sheet.
6. Stock status: The stock status is unknown because reference points are undefined. In 2024 the index decreased by 54%, although fish number was similar to last year (wich was the second highest value of the time series (2007-2024)).
7. Management plan: ICES is not aware of any agreed precautionary management plan for anchovy in this area.

**Technical comments**

The new information from PELAGO 2024 + PELACUS 2024, and the commercial catch in the second half of year 2023 and the first half of the year 2024 catches (assuming catches in May and June) were

presented (although the information from Pelacus must be treated carefully since the bad weather had a lot of influence on the development of the survey).
Catches* for the west coast (4.641**) were higher than 2022 (3.564) but significantly lower than 2021 (10.276 ton ,2nd lowest since 2015).

*Catches are from 1 July to 30 June in the following year to match the advised period
** Catch estimates of the first two quarters of 2024 are provisional

**General comments**

The advised value of catches is the same as presented in the catch scenarios table (8370t for 1 July 2024 30 June 2025).
The method described in the Stock Annex is the same as that in the Advice (CHR).
All units used in the plots are correct
The legend of the plots is consistent with what is shown in the plots (in the SA and the Advice).

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**Audit of** Anchovy in Division 9.a. Southern component
Date: 05/06/2024
Auditor: Leire Ibaibarriaga

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**General**

The stock of anchovy in 9.a is divided into the western and southern components. Since 2018, ICES conducts separate stock assessments and provides different catch options for each of the components. Both components are classified as ICES Category 3 stocks. Until 2022, following the guidelines for short lived species category 3 stocks, the advice was based on the 1-over-2 rule with an uncertainty cap (maximum relative allowable change between years) of +/- 80%. In 2023, constant harvest rate (CHR) rules were developed and tested by simulation for each of the components independently. The final simulation work addressing the comments from external reviewers, was presented to WGHANSA-1. Based on these results, WGHANSA suggested using a CHR rule (25% without biomass safeguard for the western component and 50% with biomass safeguard for the southern component) to provide advice for the period July 2023-June 2024. This year the advice for the period July 2024-June 2025 is also based on the CHR rules for each of the components. The stock annex has been updated accordingly during WGHANSA-1 2024.

In 2023, some inconsistencies in anchovy ageing by Spanish and Portuguese readers were detected during WGHANSA-1. In 2024, IPMA and IEO carried out an anchovy age reading inter-calibration exercise, after which the age compositions of the PELAGO surveys from 2020 to 2023 have been revised and updated.

There is additional information on the southern component of the stock from ECOCADIZ-RECLUTAS autumn acoustic survey and from triennial BOCADEVA Daily Egg Production Method survey that are not currently used in the stock assessment and the advice for this stock. Their potential utility of this information should be considered in the future.

This stock is currently being benchmarked (WKBANSP, Benchmark workshop on anchovy). The data compilation workshop took place in March and the assessment workshop will take place in September. As part of the benchmark process, a working document on the stock ID of anchovy stocks has been submitted to the Stock Identification Methods Working Group (SIMWG). This benchmark process may imply changes in the stock definition (e.g. separation into two different stocks) and the procedures used to provide advice for next years.

Although ICES provides separate advice for each of the components, the stock is managed by a single TAC for the whole division. This prevents effective control of single component exploitation rates and could lead to overexploitation of either component. In particular, in the two management years, the landings for the southern component have largely exceeded the advice for that component.

**For single-stock summary sheet advice**

Stock: Anchovy (*Engraulis encrasicolus*) in Division 9.a (Atlantic Iberian waters) Southern component (ane.27.9a.S)

Short description of the assessment as follows:

1) Assessment type: Update (last benchmarked in 2018 and stock annex updated in 2024).
2) Assessment: Accepted. This is a category 3 stock. The advice is based on a CHR rule with a 50% harvest rate that includes an $I_{trigger}$ value. The stock size indicator is the SSB estimated from the Gadget model.
3) Forecast: Not required. The advice follows the catch advice rule for category 3 short-lived stocks.
4) Assessment model: Gadget model in quarterly time step that uses data from landings (length frequency distributions and age-length keys) and from PELAGO and ECOCADIZ surveys (biomass indices, length frequency distributions and age-length keys).
5) Consistency: The basis for the advice is the same as last year and follows the updated stock annex. After two years (2021 and 2022) in which the ECOCADIZ was missing, ECOCADIZ 2023 was included in the stock assessment. The PELAGO age distribution from 2020 to 2023 has been updated after an otolith age reading intercalibration exercise. The relative stock size indicators from the Gadget model are quite consistent with those estimated last year.
6) Stock status: the spawning-stock size is above $B_{lim}$ (which is defined as $B_{loss}$ from the Gadget model and is recalculated every year) and below $B_{pa}$ ($B_{lim}*e^{1.645*\sigma}$ where $\sigma$ = 0.3, recalculated every year). The harvest rate is above $HR_{MSY\ proxy}$ (0.5).
7) Management plan: there is no management plan for this stock.

**General comments**

The assessment was well documented and was carried out following the updated stock annex.

Given the short time frame between the WG and the ADG, the WG report was not available at the time of the audit. Therefore, the audit was based on the draft advice sheet, the presentations done during the WG and the stock assessment working document uploaded to the TAF repository.

**Technical comments**

It is acknowledged that the stock size indicator (SSB from the Gadget model) is updated every year. Therefore, the biomass reference points ($B_{lim}$ and $B_{pa}$) are also updated every year.

The biomass safeguard included in the CHR rule as proposed by WGHANSA-1 last year is equal to 1194.132 t. This value was calculated as exp(mean(log($I_y$))-1.645*sd(log($I_y$))) where $I_y$ denotes the stock size indicator from the Gadget model used for the conditioning of the operating model of the simulations. This value is considered as fixed in the CHR rule, and was tested as such in the simulations performed. The inclusion or not of this biomass safeguard was assessed to have a minimal impact on the performance of the rule in terms of risks and catches. This was possibly due to the low value of the biomass safeguard. This year the stock size indicator was above the biomass safeguard and above Blim, therefore it was not necessary to reduce the catch advice resulting from the CHR rule. However, it is noted that having a fixed biomass safeguard may lead to contradictions with the stock size indicators and the biological reference points that are recalculated every year. The application or not of the biomass safeguard in the current procedure may require further considerations in the future.

**Conclusions**

- The stock assessment has been conducted correctly SALY.

- This is the second year in which the advice for the southern component is based on a CHR rule (50% exploitation rule with biomass safeguard).
- The stock size indicator shows a decreasing trend in the last years, but it is still above $B_{lim}$.
- A single TAC for the whole division may prevent effective control of single component exploitation rates and could lead to overexploitation of either component. This seems to be affecting to the southern component in the last years.

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**Audit of** Southern Horse Mackerel (hom.27.9a)
Date: 06/06/2023
Auditor: Laura Wise

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**General**

Assessment made according to the benchmarked assessment procedure agreed in this year's benchmark (WKBHMB 2024). There was a transition from the AMISH assessment method to a SS model which is thought to bring significant improvements and estimates in agreement with the historical perspective of the stock. However, it was noted by the benchmark group that further work should continue to improve the analysis capabilities and diagnostics, trying to assess conflicts in the input data and improve the issues found during the development of the model.

The new assessment model is a one area, annual, age-based model where the population is comprised of 11+ age-classes with sexes combined. New input data was added such as a commercial CPUE standardized index (in biomass) and a spawning–stock biomass (SSB) from a triennial DEPM survey and biological data were revised and updated (natural mortality and maturity ogive). There were also changes in the setting of selectivity

Following the new assessment model, reference points were re-estimated. Estimation of reference points was done following the ICES guidelines for Category 1 and 2 reference points (ICES, 2021). The standard EQSIM software (ICES, 2014) was used to fit stock-recruit relationships and conduct the required simulations with stochasticity using the observed historical stock variation in population, productivity parameters and assessment. The reference points $B_{lim}$ and MSY $B_{trigger}$ were revised upwards while reference points $F_{lim}$, $F_{pa}$ and $F_{MSY}$ were revised downwards.

**For single-stock summary sheet advice**

Stock: hom.27.9a

1) Assessment type: new assessment model used for the first time to provide advice (SS3 model from benchmark)
2) Assessment: accepted
3) Forecast: accepted
4) Assessment model: SS3 (Stock Synthesis)– as in stock annex – tuning by time-series of total catch (biomass), age composition of the catch (in numbers), abundance (in biomass) and age composition from an annual IBTS survey, a commercial CPUE standardized index (in biomass) and spawning–stock biomass (SSB) from a triennial DEPM survey.
5) Consistency: The assessment is consistent with the benchmark run; small differences in the last years (up until 2017 for recruitment and 2018 for SSB and

F). Retrospective peels are very consistent with small calculated Mohn's rho values.

6) Stock status: SSB >> MSY $B_{trigger}$, $B_{pa}$ and $B_{lim}$; F << $F_{MSY}$;
7) Management plan: A management plan (MP) was proposed for this stock and was evaluated as precautionary by ICES based on the previous assessment (ICES, 2018). However, the stock has been benchmarked resulting in a different perception of the stock and reference points. The MP should be re-evaluated. As a result, no catch scenario is presented based on this MP.

**General comments**

Given the short time frame between the WG and the ADG, the WG report was not available at the time of the audit. Moreover, the new procedure short-term forecast was only finalised during the WG and there was no stock annex available. Therefore, the audit was based on the draft advice sheet, the presentations done during the WG and the TAF repository. Input data for stock assessment and short-term forecast was checked by confronting the report tables and the input and output data files.

**Technical comments**

Some discrepancies were found between the catch input data for the SS3 model and the catch data in the advice sheet tables. Differences are small and considered that it does not affect the outputs of the model and main state of the stock. Also they will not affect the TAC advised.
Some short term scenarios were not available in the TAF repository but checks were made and data presented during the WG and the Advice sheet match.

**Conclusions**

- The assessment has been performed correctly and following the benchmark procedure agreed on the benchmark.
- The assessment gives a valid basis for advice.
- Despite the use of a new model, the estimates are in agreement with the historical perspective of the stock. Therefore, the perception of the stock is still consistent with previous years with fishing mortalities below $F_{MSY}$ and SSB above MSY$B_{trigger}$

# Review of ICES Scientific Report, WGHANSA-2 2024

Expert group Chair: Rosana Ouréns

Secretariat representative: David Miller

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**Audit of Anchovy in Subarea 8 (Bay of Biscay), Ane.27.8.**

Date: 29/11/2024
Auditor: Fernando Ramos

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**General**

Recent studies on anchovy stock identity (WD Garrido *et al*., 2024) suggest potential connectivity between anchovy in the Bay of Biscay (Subarea 8) and the Western Iberian waters (Subdivision 9a west), which should be further explored in the future.

Assessment made according to the benchmarked assessment procedure agreed in this year's benchmark (WKBANSP 2024). There was a transition from a Bayesian two-stage biomass-based model (CBBM) to a Stock Synthesis (SS) model which is thought to bring significant improvements and estimates in agreement with the historical perspective of the stock. This entailed changes in the underlying assumptions and estimation procedure. Overall, no rescaling of the assessment is perceived when comparing results from both models. The SS model included changes in catchability and selectivity along time and was considered an improvement over the CBBM.

The new assessment model is a SS age-based model where the population is comprised of 4 age groups (0-3+), with sexes combined and two seasons. Input data include total catch in biomass and catch at age by semester, SSB and numbers at age from two spring surveys, BIOMAN DEPM survey and PELGAS spring acoustic survey, and numbers at age 0 from the JUVENA autumn acoustic survey. Although the bulk of the population is assumed to be well covered by the current surveys, WKBANSP suggests to study the information provided by other surveys like e.g. the PELACUS acoustic survey covering the division 8c in spring. The time series of the juvenile abundance index from JUVENA was updated, including a revision of the index in terms of biomass, although changes were very minor. Stock weights at age and maturity at age are also input values for the model. Natural mortality is age specific. No other changes to the data were made during the benchmark process and during the WGHANSA meeting.

A retrospective pattern was consistently found in the previous CBBM model and in all the SS models attempted during the benchmark. This retrospective pattern was found to have deteriorated in the last years regardless the model used. Although the retrospective pattern was alleviated by including a random walk for the fishery selectivity and a (Ricker) stock-recruitment relationship in the final SS model, the resulting Mohn's rho for SSB is on the borderline of the limits established in ICES for short-lived species. As in the previous CBBM model, there is still a pattern in the residuals of the DEPM index. A revision of the time-series of SSB estimates needs to be further explored because the conflicting signals in the survey trends and the change in the assessment model. Therefore, this retrospective pattern needs to continue to be monitored and analysed in the near future.

The reference points were re-estimated based on the new stock assessment results and following ICES technical guidelines for fisheries management reference points for category 1 and 2 stocks (ICES, 2021). Short-term forecasts were carried out with the SS model using its forecasts options. The specific assumptions for the short-term forecast and the range of catch options were set up during WGHANSA as it was not possible to do it within the benchamark process.

The advice is based on the Management Plan (MP) agreed for this stock and evaluated as precautionary by ICES (2016). The historical population status with the new SS model is similar to the previous stock assessment with CBBM, therefore the current MP seems to be potentially applicable to set the catch options for 2025. However, a re-evaluation of the current MP according to the most recent changes should be undertaken as soon as possible within a MSE framework.
The advice for 2025 is lower than the advice for 2024 because the SSB projected for 2025 is below the upper trigger in the management plan due to low 2024 recruitment.

**For single-stock summary sheet advice**

Stock: Ane.27.8.

- Assessment type: benchmark.
- Assessment: accepted.
- Forecast: accepted.
- Assessment model: Age-based analytical assessment (Stock Synthesis) –as in Stock Annex– that uses commercial catches (international landings, ages and length frequencies from catch sampling) in the model and in the forecast; tuning by three surveys (BIOMAN [I9143] 1987–2024, PELGAS [A4150] 1989–2023, JUVENA [A6767] 2003–2024); annual maturity data from DEPM survey (BIOMAN [I9143], 1987-2024) and constant natural mortalities by age.

- Consistency: this year's assessment accepted, although a retrospective pattern in SSB was consistently found in the final SS model. There is still a pattern in the residuals of the DEPM index which needs to be further explored.
- Stock status: Spawning-stock size is above Blim and Bpa; no reference points for MSY Btrigger or fishing pressure have been defined for this stock.
- Management plan: agreed in 2014 (STECF, 2014) and evaluated by ICES as precautionary (ICES, 2016): SSBmgt between 24 000 t (lower trigger) and 89 000 t (upper trigger); Fmgt not defined. Precautionary HCR parameters evaluated with MSE.

**General comments**

Given the short time frame between the WG and the ADG, neither the WG report nor Stock Annex were available at the time of the audit. Therefore, the audit was based on the draft advice sheet, the presentations done during the WG and Benchmark WK and the TAF repository. Input data for stock assessment and short-term forecast were checked by confronting the report tables and the input and output data files.

**Technical comments**

Data presented during the WG and the Advice sheet match.

**Conclusions**

- The assessment has been performed correctly and following the benchmark procedure agreed on the benchmark.
- The assessment gives a valid basis for advice.
- The new model provides estimates that still are in agreement with the historical perspective of the stock. Therefore, the perception of the stock is still consistent with previous years with SSB above $B_{lim}$ and $B_{pa}$. No MSY reference points have been defined for this stock and, therefore, no MSY advice is provided.

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**Audit of Anchovy in Subarea 8 (Bay of Biscay), Ane.27.8.**

Date: 29/11/2024
Auditor: Susan Garrido

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**For single-stock summary sheet advice**

Stock: Anchovy in Subarea 8 (Bay of Biscay), Ane.27.8.

Short description of the assessment as follows:

Assessment type: benchmark
Assessment: accepted
Forecast: accepted.

Assessment model: The stock was recently benchmarked in September 2024 and changed the assessment model to an age-based analytical assessment (Stock Synthesis).

Input data are: catch and age and length composition of landings and 3 survey, one DEPM (BIOMAN), and two acoustic surveys, one for juveniles (JUVENA) and one for age 1+ (PELGAS).

Consistency: The assessment model was accepted in the benchmark and this first assessment was accepted although there was a retrospective pattern for the SSB estimate (Mhon's Rho = 0.43). The residual pattern of the BIOMAN survey needs to be further explored. The retrospective pattern was also detected with the previous model (Bayesian two-stage biomass-based model (CBBM) and has got worst in the last years.

Stock status: Spawning-stock size is above Blim and Bpa; no reference points for MSY Btrigger or fishing pressure have been defined for this stock. No MSY reference points have been defined for this stock and, therefore, no MSY advice is provided. Recruitment decreased significantly comparing to the previous year.

Management plan: Adopted in 2014 (STECF, 2014) and evaluated by ICES as precautionary (ICES, 2016): SSBmgt between 24 000 t (lower trigger) and 89 000 t (upper trigger); Fmgt not defined. Precautionary HCR parameters evaluated with MSE. The historical population status with the new SS model is similar to the previous stock assessment with CBBM, suggesting the current management plan seems to be applicable to set the catch options for 2025, although a re-evaluation of the current management plan according to recent changes should be undertaken shortly.

**General comments**

Given the short time frame between the WG and the ADG, neither the WG report nor Stock Annex were available at the time of the audit. Therefore, the audit was based on the draft advice sheet, the presentations done during the WG and Benchmark WK and the TAF repository.

Recent studies on anchovy stock identity (WD Garrido *et al.*, 2024) suggest potential connectivity between anchovy in the Bay of Biscay (Subarea 8) and the Western Iberian waters (Subdivision 9a west), which should be further explored in the future.

**Technical comments**

The advice sheet, report section, and the TAF repository for the stock were used for this audit.

**Conclusions**

- The assessment has been performed correctly and following the benchmark procedure agreed on the benchmark.
- The assessment gives a valid basis for advice.
- The new model provides estimates that still are in agreement with the historical perspective of the stock. Therefore, the perception of the stock is still consistent with previous years with SSB above $B_{lim}$ and $B_{pa}$. No MSY reference points have been defined for this stock and, therefore, no MSY advice is provided.

**Audit of Anchovy in the southern part of Division 9a (Gulf of Cadiz and the southern coast of Portugal), Ane.27.9aS.**

Date: 29/11/2024
Auditor: Leire Ibaibarriaga

**General**

In June, ICES provided advice for anchovy in division 9a for the period from July 2024 to June 2025. Although the advice was provided in a single advice sheet, ICES provided separate advice for the western and southern components. Furthermore, given that the stock was managed under a single TAC for the whole division, in its advice ICES highlighted that a single TAC can prevent effective control of single component exploitation rates and could lead to overexploitation of either component.

The stock of anchovy in division 9a has been benchmarked in 2024 (WKBANSP, Benchmark workshop on anchovy). The data compilation workshop took place in March and the assessment workshop took place in September. During this benchmark process, the stock ID of anchovy stocks has been analysed and discussed extensively. As a result, it was decided to consider the western and southern components as separated stocks. Furthermore, anchovy in 9aS was upgraded from Category 3 to Category 1 and the stock assessment in nowadays conduced using Stock Synthesis.

During WGHANSA-2, the assessment and short-term forecast of anchovy in 9aS were made according to the procedure agreed during WKBANSP 2024. The new stock assessment model is one area, by quarter, age-based model with the population comprised of 3+ age classes with sexes combined. The input data includes now a recruitment index from the ECOCADIZ-RECLUTAS autumn acoustic surveys. This allows to estimate recruitment (age 0) in the assessment year, which will be the larger part of the population in the management year. This has entailed a change in the advice and management calendars. The stock assessment can now be conducted in WGHANSA-2, as soon as the results from the recruitment index are available, and the management advice calendar was changed from July-June to January-December. This allowed to base the management advice on the most complete and updated information.

Although the stock assessment and short-term forecast were agreed during WKBANSP, the basis for advice was not discussed during the benchmark. ICES guidelines state that the advice for short-lived species in Category 1 should be based on the escapement strategy. This requires the calculation of MSY Bescapement and Fcap. However, these reference points have to be calculated using simulations that can be computationally expensive and require additional coding (management strategy evaluation). During the benchmark it was not possible to conduct this work. WGHANSA-2 planned to do it along 2025. Until these reference points are available, WGHANSA-2 decided to provide advice based on precautionary considerations and the heading catch option was based on the ICES 1-over-2 rule using the SSB index estimated in Stock Synthesis. WGHANSA-2 carried out stochastic short-term forecast for this and other alternative catch options in order to evaluate the probability of stock being below Blim for each of them.

The week before WGHANSA, revised estimates of the 2024 PELAGO acoustic survey were presented to WGACEGG. Furthermore, the first day of WGHANSA-2, new revised estimates of the 2024 PELAGO survey were provided after an error detection. Given that the 2024 PELAGO survey estimates were used in the advice provided in June for the period July 2024-June 2025, the update of these estimates could affect the already published advice. During WGHANSA, the advice for the western anchovy stock was updated, but it was not possible to update the advice for the southern anchovy stock due to lack of resources to run the GADGET model. Alternatively, the new PELAGO estimates were used to run the methodology adopted in the benchmark and provide advice for 2025 in a calendar year basis. Since the information from the surveys forms one of the pillars of the stock assessment of anchovy in 9aS, the timing and the reliability of the survey estimates affects directly the quality of the stock assessment and management advice of this stock. Acknowledging that the time frames between the surveys and the stock assessment working groups for this stock are very tight, multiple revisions of the estimates, as occurred this year, should be avoided to the extent possible.

**For single-stock summary sheet advice**

Stock: ane.27.9aS

Short description of the assessment as follows (examples in grey text):

- Assessment type: new assessment model used for the first time to provide advice (SS3 model from benchmark)
- Assessment: accepted
- Forecast: accepted
- Assessment model: Stock Synthesis (SS3) - tuning by time-series of total catch (in mass) and age composition of the catch (in numbers) by quarter, abundance (in biomass) and age composition from PELAGO and ECOCADIZ acoustic surveys, recruitment index fom ECOCADIZ-RECLUTAS survey and spawning–stock biomass (SSB) from BOCADEVA survey.
- Consistency: The assessment is consistent with the benchmark run. Mohn's rho are a bit larger than the Mohn's rho from the benchmark, because the benchmark values included only 4 retrospective peels (instead of five).
- Stock status: B > Blim and B > Bpa in the whole time series. No reference points for fishing pressure have been defined for this stock.
- Management plan: There is no agreed precautionary management plan.

General comments

The assessment was well documented and was carried out following the updated stock annex.

Given the short time frame between the WG and the ADG, the WG report was not available at the time of the audit. Furthermore, the benchmark report was accepted the week before the WG and the stock annex was not available either. Therefore, the audit was based on the draft advice sheet, the presentations done during the WG and the TAF repository.

Technical comments

There are no technical comments.

Conclusions

- This is the first year of application of the methods adopted during WKBANSP 2024. Anchovy in 9aS is now considered a separate stock, it has been upgraded from Category 3 to Category 1, and the advice is provided for the calendar year (January-December 2025) instead of the previous advice (July-June next year).
- The assessment has been performed correctly and following the procedures agreed on the benchmark.
- The assessment gives a valid basis for advice.
- The lack of MSY Bescapment and Fcap prevented the use of the escapement strategy to provide advice as established by ICES for short-lived species of Category 1 and 2. Therefore, the advice was based on precautionary considerations using the 1-over-2 rule where the index is the SSB resulting from the stock assessment. The catch options table provides estimates of fishing mortality, SSB and probability of SSB being below Blim for each of the catch options explored. This table was based on the stochastic short-term forecast that was conducted following the procedures adopted during the benchmark.

**Audit of Anchovy in the western part of Division 9a (western Iberian waters), Ane.27.9aW.**

Date: 02/12/2024
Auditor: Susan Kenyon, Rosana Ourens

**General**

Recommendations, general remarks for expert groups, etc. (use bullet points and subheadings if needed)

Since 2018, ICES has provided catch options separately for the two stock components of anchovy in Division 9.a: the western component (distributed in areas 9.a North, Central-North, and Central-South) and the southern component (distributed in area 9.a South). Advice for these components has been given on a single advice sheet, however, the WKBANSP benchmark in September 2024 concluded that the western and southern components should be treated as separate stocks and as such the advice sheets were separated. Since 2018, the advice year for the western stock runs from 1st July to 30th June.

An MSE was conduced in 2023 and, in WGHANSA-1 in May 2023 and May 2024 a constant harvest rate of 0.25 was used as the basis on which to provide advice. A combined biomass index estimated from the PELAGO and PELACUS acoustic spring surveys (conducted in the same year as advice is given) is used as the stock size indicator to which the constant harvest rate is applied. In WGHANSA-1, the biomass index from PELAGO was 31 904 t while the index from PELACUS was 2015 t, resulting in a total index of 33 919 t and catch advice of 8480 t. The assessment passed the audit and the advice was subsequently published on 21st June 2024.

However, further analysis of the PELAGO echogram revealed a possible general underestimationof the NASC from schools detected in the echoview. This underestimation was mainly due to the misuse of a virtual echogram with a too high threshold (-60 dB) that left part of the schools out of the scrutiny process. Furthermore the use of an appropriate threshold led to updated scrutiny processes which revealed the need to make small changes in the NASC allocation criteria to fish species. This revised analysis resulted in a substantial increase in anchovy abundance and biomass estimates.

The revised analysis and new estimates were presented in WGHANSA-2 in November 2024, where a new assessment for anchovy in 9a west was conducted and it was concluded that the advice issues in June 2024 would need to be reopened and updated using the new PELAGO biomass index.

**For single-stock summary sheet advice**

Stock**: ane.9aW**

- Assessment type: Updated. The stock was benchmarked in September 2024.
- Assessment: Accepted
- Forecast: Not required. The advice follows the catch advice rule for category 3 short-lived stocks
- Assessment model: There is no assessment model. This stock is assessed based on acoustic survey trends and advice is provided using a constant harvest rate of the survey biomass index.
- Consistency: The updated PELAGO biomass index presented in WGHANSA-2 matches that stated in the new advice sheet. The PELACUS index remains unchanged and is stated correctly in the new advice sheet.
- Stock status: The stock status is unknown because reference points are not defined for this stock. The revised biomass index is slightly higher than last year.
- Management plan: ICES is not aware of any agreed precautionary management plan for anchovy in this area.

**General comments**

This audit was completed using presentations given during the WG and the draft advice sheet. An updated stock annex could not be found on the figshare system and the TAF repository was not up to date. Survey data presented during the WG and the draft advice sheet match. Catch data remains unchanged.

The revised PELAGO biomass index for anchovy in this area is 87 909 t, resulting in a total index of 89 924 t and subsequent advised catch of 22 481 t.

**Technical comments**

- Stock size indicator plot still to be updated with revised biomass index
- Link to TAF included in advice sheet but the excel data sheet in the repository needs to be updated with the revised PELAGO biomass index.

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**Audit of Sardine in subdivisions 8.ab and d (western Iberian waters), pil.27.8abd.**

Date: 02/12/2024

Reviewers: Isabel Riveiro

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**General**

The stock is assessed using an age-based model in Stock Synthesis 3.

The French catches originating from rectangles 25E5 and 25E4 (in Subarea 7) are spatially continuous with catches in Division 8.a and have been allocated by ICES to this division as they are considered to be part of the sardine stock in divisions 8.a–b and 8.d. These catches have, therefore, been included in this assessment; typically representing 35% of the total stock catches, they should be taken into consideration when managing the fishery. In 2022 and 2023 these catches constituted 39% and 25% of the total stock catches, respectively.

Inputs from the 2024 surveys give negative signals in relation to SSB (high proportion of age 1 individuals, but very few mature individuals, lower weight-at-age, poor recruitment, lower egg count,…).

The residuals do not reveal major problems with the input data and model fit, although there is a slight tendency to overestimate the SSB and underestimate the F.

The spawning biomass shows a decreasing trend since 2012. In the last few years, there was also observed a decreasing trend in the weight-at-age and maturity-at-age. The spawning biomass is below MSY $B_{trigger}$, $B_{pa}$, and although it was below Blim in 2023, it is above Blim in 2024. Fishing pressure on the stock is below $F_{MSY}$.

The stock assessment and short term forecast followed the methodology described in the stock annex.
During the working group a problem was identified in the methodology used in 2023 and 2022 for the assumption of R in the STF. In those years, recruitment in the interim year and in the forecast year were set as the geometric mean of the historical series, a single, equal value for both years. In 2024, this issue was detected and R was calculated following the stock annex.
Catches for 2024 were calculated on the basis of the preliminary catches up to the third quarter of 2024 and the average of the fourth quarter catches of the last three years (instead of the method described in the stock annex: catches for the fouth quarter are calculated on the basis of the percentage of this quarter in the last three years, because this method is more precautionary).
The advised catch for 2025 is calculated based on the deterministic projection (*fwd* function from FLR) with F = $F_{MSY}$ * SSB(2025)/ MSY $B_{trigger}$ = 0.42. As a result, the advice for 2025 (23 667 tonnes) is 19.5% higher than the advice for 2024.

Stock **Sardine in Bay of Biscay (pil.27.8abd)**

- Assessment type: update
- Assessment: accepted
- Forecast: accepted
- Assessment model: The stock was last benchmarked in 2019. Model: Age-structured model implemented in Stock Synthesis Stock Synthesis -SS-V3.24S - ADMB_10,1, assuming a single fishery, single area, yearly season and genders combined. Inputs included in the model: Commercial catches (international landings; age composition from catch sampling). Three survey indices: PELGAS acoustic biomass and age composition, BIOMAN egg count and DEPM Triennal surveys. Total catch for 2024 is an assumption (calculated on the basis of the preliminary catches up to the third quarter of 2024 and the average of the fourth quarter catches of the last three years).
- Consistency: The retrospective analysis shows that there is a tendency to overestimate biomass and underestimate F, although the values of recent assessments have been very consistent (since 2019). Mohn's rho values for F and SSB are very similar to those of last year (-0.15 and 0.26, respectively).
- Stock status: The biomass of the stock has shown a decreasing trend in the recent period, with the biomass around Blim in recent years. Currently, the spawning-stock size is below MSY Btrigger and Bpa but above Blim. F is is below $F_{MSY}$ , with a decreasing trend in recent years.
- Management plan: There is no management plan and no official TAC is set for this stock. ICES advice is based on the MSY approach.

**General comments**

This audit has been carried out on the basis of the stock annex, the presentations (in sharepoint) and the report section of this stock.

The assessment follows the agreed methodology in the 2019 interbenchmark and described in the stock annex (last amended in December 2022).

**Technical comments**

No issues were detected during the audit.

**Conclusions**

The assessment and projections have been carried out following the stock annex. All the information is available in the TAF ICES github (https://github,com/ices-taf/2024_pil.27.8abd_assessment).

**Audit of Sardine (Sardina pilchardus) in Subarea 7 (southern Celtic Seas and the English Channel) (pil.27.7)**

Date: 02/12/2024

Reviewers: Erwan Duhamel

**For single-stock summary sheet advice**

Stock: Sardine (Sardina pilchardus) in Subarea 7 (southern Celtic Seas and the English Channel)

Short description of the assessment as follows:

- Assessment type: update
- Assessment: accepted
- Forecast: No short-term projections have been carried out for this stock.
- Assessment model: The stock was benchmarked in 2021 and upgraded from category 5 to category 3. Stock indicator is a time-series of biomass derived from the PELTIC acoustic survey. A surplus production model in continuous time (SPiCT) is used to provide indication of the status of the stock. The catch advice is then provided based on the 1-over-2 rule with a symmetric 80% uncertainty cap and a biomass safeguard.
- Consistency: Assumptions of the model are met, namely the catch and biomass data have normal distributions, and there is no autocorrelation or bias in the data. Although the time-series is short and therefore the retrospective patterns of the model could not be properly analysed, the retrospective trajectories for the relative biomass and fishing mortality were inside of the confidence intervals and the Mohn's rho values were small. However, there is a tendency to overestimate biomass and underestimate the fishing mortality and parameter estimates are influenced by initial values.
- Stock status: The survey index showed in 2024 the second highest value in the time series (for the total area). The stock size was estimated to be above Istat (index trigger value for biomass safeguard, a precautionary approach reference point) and the biomass safeguard was not applied. MSY reference points are undefined.
- Management plan: This stock doesn't have a management plan.

**General comments**

The French catches originating from rectangles 25E5 and 25E4 (in Subarea 7) are spatially continuous with catches in Division 8.a and have been allocated by ICES to this division as they are considered to be part of the sardine stock in divisions 8.a–b and 8.d. These catches have, therefore, been excluded in this assessment.

The index is estimated to have decreased by 10% and thus the uncertainty cap was not applied. The biomass was estimated to be above Istat and the biomass safeguard was not applied. The resulting catch advice for 2025 is 13 950 tonnes, a 3.6% increase from advised catch in 2024.

**Technical comments**

The 2024 guidance and checklist for audits in ICES expert groups was followed. The advice sheet, report section, and the TAF repository for the stock were used for this audit.

The assessment follows the methodology described in the stock annex. No issues in the advice sheet and in the report were detected during the audit and were amended accordingly.

**Conclusions**

The assessment has been performed correctly following the stock annex. Everything was well documented and included the necessary generic information needed for an ICES category 3 assessment and producing the advice sheet.

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**Audit of Sardine in division 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters) (pil.27.8c9a)**

Date: 02/12/2024

Reviewers: Hugo Mendes

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**General**

Sardine in divisions 8.c and 9.a is a Category 1 stock that is assessed using an age-structured assessment model implemented in Stock Synthesis, version 3.30.22. The assessment was done based on the benchmark procedure agreed in 2017 (WKPELA) and updated in an inter-benchmark in 2021 (WKIBIS) with the inclusion of a interim year recruitment index (IBERAS survey). The model uses information on abundance and age structure from acoustic, DEPM surveys and a recruitment index and preliminary catches were estimated for the interim year altough using the observed catches already up to November.

The recruitment index represents the age-0 abundance in the 9aCN area as estimated from the IBERAS survey which is assumed to cover the main recruitment area of the stock. However, recent variability in this index and potential changes in the spatial distribution should be further analyzed to determine whether expanding the recruitment survey to include 9aCS area is necessary in the near future.

The stock is assumed to have been in a low productivity regime since 2006. However, recent recruitments have been higher than in previous years, suggesting that the stock may be shifting to a higher productivity regime. This potential change could have implications for future assessments and biological reference points.

The model produced very good results with a strong fit to catches and survey indices (abundance and age structure). The retrospective analysis improved and was very consistent for the key parameters in the assessment. Although recruitment has the issues identified above, the recruitment retrospective showed a notable and robust pattern.

**For single-stock summary sheet advice**

Sardine (Sardina pilchardus) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters Stock

Short description of the assessment as follow:

- Assessment type: update
- Assessment: accepted
- Forecast: accepted
- Assessment model: Age-structured model implemented in Stock Synthesis version 3.30.22 (V3.30.22.00). The model uses information on abundance and age structure from acoustic, DEPM surveys and a recruitment index and catches up to the interim year (total catches in 2024 are preliminary but using observed catches up to November). Maturity-at-age and stock weight-at-age correspond to estimates from the DEPM that are conducted every three years. A 3-block

estimated selectivity, age specific natural mortality and a Beverton-Holt stock recruitment model.

- Consistency: The model produced very good results with a strong fit to catches and survey indices (abundance and age structure). The retrospective analysis was consistent and improved this year compared to recent assessments. Although the model slightly underestimates biomass (B1+) and overestimates Fishing mortality (F), with Mohn's rho values of -0.238 and 0.207, respectively they remain below the recommended threshold of 0.3. Additionally, the retrospective Mohn's rho value for recruitment was low with value of -0.136
- Stock status: F is slightly above FMSY and B1+ is above MSY Btrigger, Bpa, and Blim.
- Management plan: agreed in 2006: This stock does not have an TAC and it is managed by the national legislations under a management plan. ICES evaluated an HCR that is proposed to be part of a management plan for 2021–2026 and found it to be precautionary with maximum allowed catches between 30 000 and 50 000 tonnes.

General comments

Given the short time between the WG and the ADG, the WG report was not available at the time of the audit. The audit was based on the draft advice sheet, the presentations done during the WG and the TAF repository. Input data for stock assessment and short-term forecast was checked by confronting the report tables and the input and output data files. Some minor comment was made in Table 1 of the advice sheet

Technical comments

The assessment model and deterministic short-term forecast are available and operational in TAF (https://github.com/ices-taf/2024_pil.27.8c9a_assessment). Some difficulties were found in the package versions used in TAF, resolved with the help of the stock assessor.

Conclusions

The assessment and short-term forecast have been performed correctly and following the stock annex. The model produced very good results with a strong fit to catches and survey indices (abundance and age structure) and improved retrospective. The assessment gives a valid basis for advice.

**Blue jack mackerel (*Trachurus picturatus*) in Subdivision 10.a.2 (Azores grounds) (jaa.27.10a2)**

Date: 29.11.2024
Auditor: Jose Luis Cebrian

**General**

In the Azores, T. picturatus is targeted by various fishing fleets and methods. Artisanal fishers primarily use purse seines and bottom longlines to catch juveniles on the continental shelf and adults around seamounts, respectively. Additionally, tuna bait boats employ purse seines to capture T. picturatus as live bait. This species is also popular among recreational anglers along the Azores coast.

**For single stock summary sheet advice:**

- Assessment type: No assessment
- Assessment: Precautionary approach

- Forecast: not presented
- Assessment model: No assessment
- Data issues: Reported recreational catches have accounted for about 10% of the total catch, but this does not include catches from shore anglers. ICES advice pertains to the total stock catch, encompassing both commercial and recreational fishing. No new information is available for 2022-2023.
- Consistency: undefined
- Stock status: undefined.
- Management Plan: ICES is not aware of any agreed precautionary management plan for blue jack mackerel in this area.
- Reference Points: There are no reference points defined for this stock.

**General comments**

The advice for blue jack mackerel in Azores grounds is based on the ICES framework for category 5 stocks (ICES, 2012) and it's provided every two years. The advice for 2025–2026 is equal to that advised for 2023–2024 because the precautionary buffer was not applied

**Technical comments**

There are no indices available which would reflect the development of the stock.
Recreational catches do not include catches by anglers from the shore.
There are no additional catches data available for 2022 and 2023.

**Conclusions**

The combined biomass index appears to be correctly computed. There is no assessment for this stock. Furthermore, there is no advice for in 2024.

# Annex 5: Working Documents

The following working documents were presented to WGHANSA-1 2024 and are included in Annex 4:

Ramos, F., Canseco, J. A., Tornero, J., Córdoba, P., Cojan, M., Bruno, I., González, C., Martínez Cedeira, J. A., Pita, V., Sánchez-Leal, R., Sánchez, M. J., Navarro, R. Acoustic assessment and distribution of the main pelagic fish species in ICES Subdivision 9a South during the ECOCADIZ-RECLUTAS 2023-10 Spanish acoustic-trawl survey (September-October 2023).

Ramos, F., Tornero, J., Canseco, J.A., Juárez, A., Franco, I., Sánchez-Leal, R. Acoustic assessment and distribution of the main pelagic fish species in ICES Subdivision 9a South during the ECOCADIZ 2023-07 Spanish acoustic-trawl survey (July-August 2023).

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Nogueira, A., Castro, J. Number of vessels by LOA (length overall) ranges for Spanish purse-seiners fishing the sardine stock in ICES Divisions 8c and 9a.

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# Acoustic assessment and distribution of the main pelagic fish species in ICES Subdivision 9a South during the *ECOCADIZ-RECLUTAS 2023-10* Spanish acoustic-trawl survey (September-October 2023).

By

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## ABSTRACT

This working document summarizes the main results obtained during the *ECOCADIZ-RECLUTAS 2023-10* Spanish (pelagic ecosystem-) acoustic-trawl survey, conducted by IEO between 29th September and 13th October 2023 in the Portuguese and Spanish shelf waters (20-200 m isobaths) off the Gulf of Cádiz (GoC) onboard the R/V *Ramón Margalef.* The surveys in this series have experienced a successive reduction in ship-time up to the 15-16 days in 2022-2023. Additionally, the 2023 survey invested half working day in picking up a spare pelagic trawl gear to the nearest port and it finished one day before the schedule due to logistic reasons. Furthermore, the start and direction of the acoustic sampling had to be shifted to a W to E direction because NATO naval manoeuvres which entailed a shortening of the available time to sample Spanish waters. The survey's main objective is the acoustic assessment of anchovy, sardine and chub mackerel juveniles (age 0 fish) in the GoC recruitment areas. The 21 foreseen acoustic transects were sampled. A total of 13 valid fishing hauls were carried out for echo-trace ground-truthing purposes. Horse mackerel, sardine and anchovy, were the most frequent captured species in the fishing hauls, followed by chub mackerel, Mediterranean horse mackerel, bogue, round sardinella and Atlantic mackerel. Longspine snipefish, boarfish and pearlside showed an incidental occurrence in the hauls performed in the surveyed area. Anchovy, sardine and chub mackerel showed the highest yields in these hauls, followed by Mediterranean horse mackerel and horse mackerel. The estimate of total NASC allocated to the "pelagic fish species assemblage" in this survey was 21% lower than that recorded last year. GoC anchovy was mainly found in Spanish waters, with areas of high densities observed between Ayamonte and Bay of Cádiz. Anchovy acoustic estimates in autumn 2023, 816 million fish and 8300 t, in abundance and biomass, respectively, were 55% and 30% lower than last year's estimates and they continue to be lower than their time-series averages. Anchovy population age structure was composed mainly by zero and one year old individuals. As usual, the bulk of the population, including juveniles, was located in Spanish waters. Age-0 anchovies accounted for 78% (639 million) and 56% (4723 t) of the total estimated abundance and biomass, respectively. The age-0 decreasing trend in relation to the historical peak recorded in 2019 still persists, but this time with even lower values than previous years and well below the time-series average. GoC sardine was mainly distributed in Spanish waters (also avoiding the easternmost waters) in autumn 2023, with high density areas recorded between Ayamonte and Bay of Cádiz. Abundance (2125 million fish) and biomass (27 373 t) estimates showed a relative increase (96% in abundance and 30% in biomass) when compared to last year estimates (1084 million

and 20 909 t). This year, the oldest age group observed for sardine population was the age-6 group, although the occurrence of fishes older than 2 years was rare. The population was mainly composed by fishes belonging to the age-0 with a low abundance of age-1 and age-2 groups. This year, juvenile sardines (age-0 group) were the dominant group, accounting for 98% (2092 million) and 94% (25 876 t) of the total abundance and biomass, respectively. Chub mackerel was restricted to the area between Cape San Vicente and Punta Umbria, where high density areas were recorded, whereas in the rest of the surveyed areas was almost absent. Chub mackerel estimated biomass and abundance were 8451 t and 118 million, respectively, which were 52% and 45% lower than last year estimates. This year's abundance and biomass estimates were below the time series average. The population was composed by fishes not older than 3 years, with the age-0 group being the dominant one (83% in numbers, 98 million, and 69% in biomass, 5865 t).

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## INTRODUCTION

The abundance of Gulf of Cádiz (GoC) anchovy and sardine recruits started to be acoustically assessed by the IEO in autumn 2009. However, that survey was considered a pilot experience due to a series of events that vastly reduced the area covered, making it impossible to achieve the survey's main objectives (Ramos *et al*., 2010). This autumn survey was conducted again in 2012 as *ECOCADIZ-RECLUTAS 1112;* it was financed by the Spanish Fisheries Secretariat and planned and conducted by the IEO to obtain an autumn estimate of GoC anchovy biomass and abundance. That survey was carried out onboard R/V *Emma Bardán*, but restricted to the Spanish waters only (Ramos *et al*., 2013). *ECOCADIZ-RECLUTAS 2014-10* re-started the series two years later, with the surveys being conducted with the R/V *Ramón Margalef* and covering both the GoC Portuguese and Spanish waters as the agreed standard sampling scheme. Since 2014 on the series should therefore be considered as the standard one. The 2017 survey is not included in the series since it suffered from an unexpected breakdown of the research vessel, leading to an earlier survey's ending and an incomplete coverage of the survey area (only the seven easternmost transects were sampled). The 2023 survey was conducted on board R/V *Ramón Margalef*.

The general objective of these surveys is the acoustic assessment by vertical echo-integration and mapping of the abundance and biomass of recruits of small pelagic species (especially anchovy, sardine and chub mackerel), as well as the mapping of both the oceanographic and biological conditions featuring the recruitment areas of these species in ICES Sub-division 9a south. The long-term objective of the surveys is to assess the strength of the incoming recruitment to the fishery of these species the following year.

The present Working Document reports the main results from the *ECOCADIZ-RECLUTAS 2023-10* survey (the tenth survey within its standard series), namely the size-based acoustic estimates of abundance and biomass (age-structured estimates for anchovy, sardine and chub mackerel) and the spatial distribution of the assessed species.

## MATERIAL AND METHODS

The *ECOCADIZ-RECLUTAS 2023-10* survey was conducted on board Spanish IEO R/V *Ramón Margalef.* The adjustment of the survey to the R/V calendar entailed a reduction of 4 days (15 days at sea) in relation to the usually planned days (19 days at sea). The survey was conducted between 29th September and 13th October covering a survey area which comprised the GoC waters, both Spanish and Portuguese, between the 20 m and 200 m isobaths. The survey design consisted in a systematic parallel grid with 21 transects equally spaced by 8 nm, normal to the shoreline (**Figure 1**). In addition, and because of NATO naval maneouvres, there was a shift in the start and direction of the acoustic sampling, namely, instead of sampling from Spanish waters towards Portuguese waters, the opposite direction was taken. Half a day of the planned survey had to be employed in going to the port of Cadiz to pick up a spare pelagic trawl gear. Furthermore, the ending of the survey had to be anticipated one day for logistic reasons.

Acoustic equipment was calibrated during the survey in front of Portimão (R18) following the ICES standard procedures (Demer *et al*., 2015; see also Foote *et al*., 1987). The evaluation of vessel's self-noise was also performed during the survey. Echo-integration was carried out with a *Simrad™ EK80* echo-sounder working in the multi-frequency fashion (18, 38, 70, 120, 200, 333 kHz) and in CW mode. Average survey speed was about 10 knots and the acoustic signals were integrated over 1-nm intervals (EDSU). Raw acoustic data were stored for further post-processing using the *Echoview™* software package.

Survey execution and abundance estimation followed the methodologies firstly adopted by the *ICES Planning Group for Acoustic Surveys in ICES Sub-Areas VIII and IX* (ICES, 1998) and the recommendations given later by the *Working Group on Acoustic and Egg Surveys for Small Pelagic Fish in NE Atlantic* (WGACEGG; ICES, 2006a,b; see also ICES TIMES 64 report, Doray *et al*., 2021).

Fishing hauls for echo-trace ground-truthing were opportunistic, according to the echogram information. The first haul was carried out using a *Gloria HOD 352* pelagic trawl gear (ca. 10 m-mean vertical opening net), but it had to be replaced by breakage by a *Gran Hermano* pelagic trawl gear (ca. 15 m-mean vertical opening net), for the remaining hauls, at an average speed of 4-4.5 knots. Gear performance and geometry during the effective fishing was monitored with *Simrad™ Mesotech FS20* trawl sonar and *Scanmar™* trawl door sensors for inter-doors distance and depth. Trawl sonar data from each haul were recorded and stored for further analyses.

Ground-truthing haul samples provided biological data on species and they were also used to identify fish species and to allocate the back-scattering values into fish species according to the proportions found at the fishing stations (Nakken and Dommasnes, 1975).

Length frequency distributions (LFD) by 0.5-cm class were obtained for all the fish species in trawl samples (either from the total catch or from a representative random sample of 100-200 fish). Only those LFDs based on a minimum of 30 individuals and showing a normal distribution were considered for the purpose of the acoustic assessment.

Individual biological sampling (length, weight, sex, maturity stage, stomach fullness, and mesenteric fat content) was performed in each haul for anchovy, sardine, mackerel (2 spp.) and horse-mackerel species (3 spp.), and bogue. Otoliths were extracted from anchovy, sardine and chub mackerel sampled specimens.

**Table 2** shows the TS/length relationships used for the acoustic estimation of the assessed species (IEO standards after ICES, 1998 and recommendations by ICES, 2006a,b; see Doray *et al*., 2021).

The *PESMA* software (J. Miquel, IEO, unpublished) has got implemented the needed procedures and routines for the acoustic assessment following the above approach and it has been the software package used for the acoustic estimation.

A *Sea-bird Electronics*™ *SBE 21 SEACAT* thermosalinograph and a *Turner*™ *10 AU 005 CE Field* fluorometer were used during the acoustic tracking to continuously collect some hydrographical variables (sub-surface sea temperature, salinity, and *in vivo* fluorescence). Vertical profiles of hydrographical variables were also recorded by night from 140 $CTDO_2$-LADCP casts over 19 transects (from the 23-transect planned grid) using a *Sea-bird Electronics™ SBE 911+ SEACAT* (with coupled *Teledyne Benthos* altimeter, *SBE 43* oximeter and *WetLabs ECO-FL-NTU* fluoro-turbidimeter sensors) profiler and a *LADCP T-RDI WH Sentinnel* 300 kHz current profiler (**Figure 2**). *VMADCP RDI 150 kHz* records were also continuously recorded by night between CTD stations. The GD hydrography transect (in front of the Guadalquivir river mouth) included this year the conduction of 3 stations of mesozooplankton sampling with Bongo 40 and neuston sledge hauls. Six stations in this same transect also included the water column sampling at different depths with a carousel water sampler.

Census of top predators was recorded by one onboard observer using the Distance Sampling method (Buckland *et al*., 1993). For cetaceans sightings a picture with maximum zoom including the animals and the horizon was taken for the further estimation of distances with photogrammetry (Leaper & Gordon., 2001; Leaper *et al*., 2010). R01 was not sampled due to bad weather.

## RESULTS

### Acoustic sampling

The acoustic sampling was accomplished during the period comprised between the $29^{th}$ of September and $12^{th}$ October. The complete grid (21 transects) was acoustically sampled (**Table 4**, **Figure 1**). The first five acoustic transects were covered before the acoustic sampling was partially interrupted the $5^{th}$ October in order to pick up a spare pelagic trawl gear in the nearest port. In order to perform the acoustic sampling with daylight, the acoustic sampling started at 06:40-06:45 UTC, although this time might vary depending on the duration of the works related with the hydrographic sampling the previous night.

### Groundtruthing hauls

A total of thirteen (13) fishing operations were performed during the survey for echo-trace ground-truthing, of which all were valid (**Table 5**, **Figure 3**). The number of pelagic trawl fishing hauls was somewhat lower than usual (usually ca. 20 hauls per survey) as a consequence of time constraints and the very low recorded acoustic densities. Because of many echo-traces usually occurred close to the bottom, all the pelagic hauls were carried out like a bottom-trawl haul, with the ground rope working over or very close to the bottom. All the hauls were performed over the acoustic transects. According to the above, the sampled depth range in the valid hauls oscillated between 35 and 138 m.

During the survey were captured 3 Chondrichthyan, 32 Osteichthyes, 3 Cephalopod, 2 Echinoderm, and several Cnidarian and Ascidian species. The percentage of occurrence of the fish species (sharks excluded) in the hauls is shown **Table 1** (see also **Figure 4**). The pelagic ichthyofauna was both the most frequently captured species set and the one composing the bulk of the overall yields of the catches. Within this pelagic fish species set horse mackerel (85% presence index), sardine *Sardina pilchardu*s (77%) and anchovy *Engraulis encrasicolus* (77%) were the most frequent small pelagic species in the valid hauls, followed by chub mackerel *Scomber colias* (67%), Mediterranean horse mackerel *Trachurus mediterraneus* (31%), bogue *Boops boops* (31%) and Atlantic mackerel *S. scombrus* (31%). No individuals of blue jack mackerel *T. picturatus*, transparent goby *Aphia minuta* and blue whiting *Micromesistus poutassou* were observed. Boarfish *Capros aper*, longspine snipefish *Macroramphosus scolopax* and pearlside *Maurolicus muelleri* (8%) showed an incidental occurrence in the hauls performed in the surveyed area.

For the purposes of the acoustic assessment, anchovy, sardine, round sardinella *Sardinella aurita*, mackerel species, horse & Mediterranean horse mackerel (*T. trachurus*, *T. mediterraneus*) species, bogue, boarfish, longspine snipefish and pearlside were initially considered as the survey target species. All the invertebrates, skates, rays and benthic fish species were excluded from the computation of the total catches in weight and in number from those fishing stations where they occurred. Catches of the remaining non-target fish species were included in an operational category termed as “Others”.

According to the above premises, during the survey were captured a total of 3073 kg and 192 thousand fish (**Table 6**). Forty-four per cent (44%) of this “total” of fished biomass corresponded to sardine, 28% to anchovy, 12% to chub mackerel, 5% to Mediterranean horse mackerel, 3% to boarfish, 2% to horse mackerel and contributions lower than 1% for the remaining species. The most abundant species in ground-truthing trawl hauls was anchovy (52%), followed by sardine (39%), boarfish (4%) and chub mackerel (2%), with each of the remaining species accounting for equal to or less than 1%.

The species composition of these fishing hauls (as expressed in terms of percentages in number) is shown in **Figure 4**.

**Back-scattering energy attributed to the “pelagic assemblage” and individual species**

A total of 299 nmi (ESDU) from 21 transects were acoustically sampled by echo-integration for assessment purposes. **Table 3** provides the nautical area-scattering coefficients, NASC, attributed to each of the selected target species and for the whole “pelagic fish assemblage”.

For this “pelagic fish assemblage” we estimated a total of 84 191 $m^2$ $nmi^{-2}$, 63% lower than the maximum value recorded throughout the time-series, estimated in 2020 (229 241 $m^2$ $nmi^{-2}$), and 28% below the historical mean (118 395 $m^2$ $nmi^{-2}$). The highest NASC value (5357 $m^2$ $nmi^{-2}$) was observed in the mid-shelf waters (50-70 m) in front of the Guadalquivir river mouth (transect R06, **Figure 5**), with relatively high values being also recorded in the middle- and outer-shelf waters (50-150 m depth) of transects R08, R13, R16, R19 and R20. By species, sardine accounted for 34% of this total back-scattered energy, followed by horse mackerel (26%), chub mackerel (14%) and anchovy (13%), with the remaining species showing relative contributions of acoustic energies lower than 10%.

According to the resulting values of integrated acoustic energy and the availability and representativeness of the length frequency distributions in fishing hauls, the species acoustically assessed in the present survey finally were anchovy, sardine, round sardinella, mackerel, chub mackerel, horse mackerel, Mediterranean horse mackerel, bogue, pearlside, longspine snipefish and boarfish.

__Spatial distribution and abundance/biomass estimates__

**Anchovy *Engraulis encrasicolus***

Parameters of the survey's length-weight relationship for anchovy are given in **Table 7**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 7**. The mapping of the backscattering energy (nautical area scattering coefficient, NASC, in $m^2nmi^{-2}$) attributed to the species and the coherent strata considered for the acoustic estimation are shown in **Figure 8**. The estimated abundance and biomass by size class are given in **Table 8** and **Figure 9**. **Table 9** shows the time-series of estimates for the whole population and Age-0 fish.

Gulf of Cádiz anchovy (13% of the total NASC attributed to fish) was widely distributed in the surveyed area, although it showed low acoustic detections in the easternmost waters. Higher densities were mainly recorded in two areas: between Ayamonte and the Bay of Cadiz and between Cape San Vicente and Cape Santa Maria (**Figure 8**). The whole size class range for the pooled catches varied between the 7.5 and 17.5 cm size classes, with 2 modal classes, the main mode at 9.5 cm and a secondary one at 13.0 cm.

Ten (10) coherent post-strata have been differentiated according to the $S_A$ value distribution and the size composition in the representative fishing hauls (**Figure 8**). Overall anchovy acoustic estimates in autumn 2023 were of 816 million fish and 8300 t (**Table 8**; **Figure 9**), accounting for 55% and 30% decreases in abundance and biomass, respectively, as compared to last year's estimates (1836 million, 11 912 t). Current overall estimates are also lower than the time-series average (*i.e.* 2686 million; 21 276 t), and this year's abundance estimate is the lowest of the time series (see **Table 9** and **Figure 43**). By geographical strata, the Spanish waters yielded 88% (716 million) and 73% (6073 t) of the total estimated abundance and biomass in the Gulf, highlighting the importance of these waters in the species' distribution. The estimates for the Portuguese waters were 100 million and 2227 t (**Table 8; Figure 9**).

The size class range of the assessed anchovy population in autumn 2023 varied between the 5.5 and 17.5 cm size classes. The size distribution showed a mixed composition, with one main mode at 9.5 cm, a secondary mode at 13.0 cm, and with a small proportion of individuals being observed at 7.5 cm. The size composition of anchovy throughout the surveyed area confirms the usual pattern exhibited by the species during the survey season, with the largest (and oldest) fish being distributed in the westernmost waters and the smallest (and youngest) ones concentrated in the surroundings of the Guadalquivir river mouth and adjacent shallow waters (**Figures 8** and **9**).

The population was composed by fishes not older than 2 years. Age 0 fish accounted for 78% (639 million) and 57% (4723 t) of the total estimated abundance and biomass, respectively (**Table 9; Figure 10**). Spanish waters concentrated the bulk (97%) of this juvenile fraction whereas 53% (90 million) of age-1 group was also concentrated in Spain. The estimates of age-0 fish experienced a similar trend than the one showed by the whole population in relation to the historical peak recorded in 2019 and the values recorded in 2020. The recent strong decreasing trends for the whole population and juveniles seem to have increased in 2023, with the 2023 estimates being well below their time-series averages (**Table 9**). Age 1 fish represented 20% and 40% of the total abundance and biomass, while age 2 fish accounted for <1% of the total abundance and biomass (**Figure 10**).

The 2023 autumn estimates of mean size and mean weight of the whole population were higher (11.0 cm, 12.7 g) than their respective time-series averages (11.1 cm, 9.5 g).

**Sardine *Sardina pilchardus***

Size-weight relationship parameters for sardine derived from the survey's biological sampling are detailed in **Table 7**. Spatially explicit size distribution and mean length (±SD) are shown in **Figure 10**. The mapping of the backscattering energy (NASC, in $m^2nmi^{-2}$) attributed to the species and the coherent post-strata considered for the acoustic estimation are shown in **Figure 11**. Estimated abundance and biomass by size class are given in **Table 10** and **Figure 12**. **Table 11** shows time-series of estimates for the whole population and Age-0 fish.

GoC sardine showed a high acoustic echo-integration in autumn 2023 (34% of the total NASC attributed to pelagic fish species assemblage). High sardine densities were observed from dense mid-water schools in the coastal and inner shelf waters (40-57 m) found between Ayamonte and the Bay of Cadiz, with small densities also observed between Portimão and Faro (20-70 m; **Figure 11**). This year's sardine population, contrary to the usually observed distribution pattern, was mostly restricted to Spanish waters.

The size distribution observed for the pooled catches from hauls ranged between 9.5 and 22.0 cm size classes. One main modal size class was observed at 12.5 cm and a secondary mode at 18.5 cm. The size composition of sardine pooled catches throughout the surveyed area showed the occurrence of the largest fish in 2 spots located in western Algarve and in front of Bay of Cádiz, and the smallest fish in the coastal waters of the central part of the Spanish waters (**Figures 10** and **11**).

Eleven (11) coherent post-strata were differentiated according to the $S_A$ value distribution and the size distribution sampled in the fishing hauls (**Figure 11**). GoC sardine abundance and biomass in autumn 2023 were estimated at 2125 million fish and 27 372 t, which respectively were 96% and 30% higher than last year estimates (1084 million and 20 909 t, the second lowest record in the series; **Table 11**, **Figure 43**). Spanish waters comprised the 96% and 93% of the total estimated abundance and biomass, respectively (2041 million and 25 474 t). The estimates for Portuguese waters were 84 million and 1898 t.

Sizes of the assessed sardine population in autumn 2023 ranged between 9.5 and 22.0 cm size classes, showing a bimodal length frequency distribution, with one main mode at 12.5 cm size class and a secondary one at 18.5 cm (**Table 10**; **Figure 11**).

Age-6 group was the oldest age group occurring in the population, although the occurrence of fishes older than Age-0 juveniles was rare. Thus, the population was mainly composed by these juvenile fishes, accounting for 98% (2092 million) and 94% (25 876 t) of the total abundance and biomass, respectively. The abundance and biomass of this juvenile fraction was concentrated in Spanish waters (96% of both abundance and biomass), while only a residual fraction was observed in Portuguese waters (4% of both abundance and biomass) (**Table 10; Figures 12** and **14**).

The 2023 autumn estimates of mean length and weight of the whole population (11.8 cm, 12.3 g), were slightly lower than last year's estimates, but noticeably lower than the time-series averages (*i.e.* 15.2 cm, 34.1 g).

**Round sardinella *Sardinella aurita***

Parameters of the survey's length-weight relationship are shown in **Table 7**. Size distribution and mean (±SD) size in the fishing hauls are spatially explicit represented in **Figure 15**. The NASC mapping (in $m^2nmi^{-2}$) attributed to the species and the coherent post-strata considered for the acoustic estimation are shown in **Figure 16**. Estimated abundance and biomass by size class are given in **Table 12** and **Figure 17**.

Round sardinella (0.1% of the total NASC) was scarcely distributed between Faro and Cape Trafalgar, recording very low acoustic densities except just east Faro (**Figure 16**). The largest fish seemed to be found in easternmost Spanish waters, with smaller fish occurring in Portuguese waters, although the species' positive hauls did not show a clear spatial pattern in (mean) size (**Table 12**; **Figures 16** and **17**).

Four (4) coherent post-strata have been differentiated according to the $S_A$ value distribution and the size composition in the fishing stations (**Figure 16**). Round sardinella abundance and biomass in the surveyed area were estimated in 1 million fish and 219 t (**Table 12**, **Figure 17**). Portuguese waters accounted for 38% of both the total abundance (0.4 million) and 39% of the total biomass (88 t), respectively. Spanish waters yielded a population of 1 million and 132 t.

The size distribution of the assessed population of round sardinella ranged between 25.0 and 34.0 cm size classes, with a modal class at 32.0 cm. Given that most of round sardinella was found in Spanish waters, no regional size pattern could be detected, although larger (older) fish were observed in Spanish waters while smaller (younger) were observed in Portuguese waters.

**Mackerel *Scomber scombrus***

Parameters of the survey's length-weight relationship are shown in **Table 7**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 18**. The mapping of the backscattering energy (NASC, in $m^2nmi^{-2}$) attributed to the species and the coherent post-strata considered for the acoustic estimation are shown in **Figure 19**. Estimated abundance and biomass by size class are given in **Table 13** and **Figure 20**.

Atlantic mackerel (<0.01% of the total NASC) was barely observed in the gulf of Cadiz, with no detectable high density areas, given its low acoustic detection (**Figure 19**).

Two (2) coherent post-strata were differentiated according to the $S_A$ value distribution and the size composition in the fishing hauls (**Figure 19**). Mackerel abundance and biomass in autumn 2023 in the GoC shelf waters were estimated at only *c.a.* 0.5 million fish and 117 t (**Table 13**; **Figure 20**). Almost the whole estimated population (62% and 84% of the total abundance and biomass) was located in Portuguese waters (0.3 million, 99 t). The estimates for the Spanish waters were *c.a.* 0.2 million and 18 t.

The size composition of the mackerel estimated population in autumn 2023 ranged between 19.5 and 35.5 cm size classes; no dominant mode was observed since the size distribution was patchy (**Table 13**; **Figure 20**). No clear spatial pattern in mean size was observed; perhaps the smallest fish were more common in Portuguese waters.

**Chub mackerel *Scomber colias***

Parameters of the survey's length-weight relationship are shown in **Table 7**. Size distribution and mean (±SD) size in the fishing hauls are spatially explicit represented in **Figure 21**. The NASC mapping (in $m^2nmi^{-2}$) attributed to the species and the coherent post-strata considered for the acoustic estimation are shown in **Figure 22**. Estimated abundance and biomass by size class are given in **Table 14** and **Figure 23**. **Table 15** shows the time-series of estimates for the whole population and Age-0 fish.

Chub mackerel (14% of the total NASC) was mainly distributed between Punta Umbría and Cape San Vicente, recording the highest acoustic densities between the Cape San Vicente and Cape Santa Maria area, and between Punta Umbría and Tavira (**Figure 22**). The largest fish were commonly captured in Portuguese waters, with smaller fish occurring in Spanish waters, although the species' positive hauls did not show a clear spatial pattern in (mean) size (**Table 14**; **Figures 21** and **23**).

Ten (10) coherent post-strata have been differentiated according to the $S_A$ value distribution and the size composition in the fishing stations (**Figure 22**). Chub mackerel abundance and biomass in the surveyed area were estimated in 118 million fish and 8451 t, which were 52% and 45% lower than last year estimates (246 million, 15 499 t; **Table 15**, **Figure 43**). Portuguese waters accounted for 82% and 72% of the total abundance (98 million) and biomass (6162 t), respectively. Spanish waters yielded a population of 20 million and 2290 t.

The size distribution of the assessed population of chub mackerel ranged between 17.5 and 36.0 cm size classes, with a dominant modal class at 23.0 cm and a small, secondary mode at 32.0 cm. Larger (older) fish were observed in Spanish waters while smaller (younger) were observed in Portuguese waters.

The population was composed by fishes not older than 3 years, with the age-0 group being the dominant one (83%, 98 million, and 69%, 5865 t, of the total abundance and biomass estimated in the surveyed area, respectively; **Figure 24**). Age-1 fish was the second most important age group in the estimated population (14%, 17 million fish, and 19%, 1611 t, of the total abundance and biomass estimates). Age-0 fish were almost exclusively recorded in the Portuguese waters (89% and 87% in terms of numbers and biomass, *i.e*. 88 million fish, 5147 t).

**Horse mackerel *Trachurus trachurus***

Length-weight relationship parameters estimated for this species are shown in **Table 7**. Size composition and mean (±SD) size in the fishing hauls are mapped in **Figure 25**. The NASC mapping (in $m^2nmi^{-2}$) attributed to the species and the coherent post-strata considered for the acoustic estimation are shown in **Figure 26**. Estimated abundance and biomass by size class are given in **Table 16** and **Figure 27**.

Horse mackerel (27% of the total NASC) was observed between Cape San Vicente and Punta Umbría, with areas of higher acoustic densities located mainly in the western Algarve and just east of Faro (**Figure 26**).

The size distribution observed in positive hauls was comprised between 4.5 and 26.5 cm size classes, with three dominant modal size classes at 7.5, 11.5 and 18.0 cm. Small fish were recorded in Portuguese waters (**Figure 25**).

Eight (8) coherent post-strata were differentiated according to the $S_A$ value distribution and the size distribution observed in the fishing hauls (**Figure 26**). Horse mackerel abundance and biomass in the surveyed area were estimated at 326 million fish and 18 538 t (**Table 16**, **Figure 27**). Portuguese waters accounted for 98% (303 million) and 93% (18 303 t) of the total abundance and biomass, respectively. Spanish waters yielded a population of 23 million and 235 t.

The size range recorded for the estimated population was comprised between 4.5 and 26.5 cm size classes, with two dominant modes, at 10.5 cm and at 6.5 cm size classes (both in Portuguese waters; **Table 16**, **Figure 27**). Population in Spanish waters was dominated by small fish around 7.0 cm modal class.

**Mediterranean horse-mackerel *Trachurus mediterraneus***

The survey's length-weight relationship for this species is shown in **Table 7**. Size composition and mean size in the fishing hauls are mapped in **Figure 28**. The mapping of NASC (in $m^2nmi^{-2}$) attributed to the species and the coherent post-strata considered for the acoustic estimation are shown in **Figure 29**. Estimated abundance and biomass by size class are given in **Table 17** and **Figure 30**.

Mediterranean horse mackerel (8% of the total NASC) was observed in autumn 2023 from Cape Trafalgar to Vila Real de Sto. Antonio. The species was mainly distributed all over the Spanish waters, mainly over the inner-mid shelf (**Figure 29**). The size classes for the pooled catches ranged between 16.0 and 39.0 cm size classes, with one main modal class at 29.0 cm and a secondary, smaller one, at 23.0 cm. No clear spatial pattern in mean size was observed, although the largest fish occurred in the easternmost Spanish waters (**Figure 28**).

Four (4) coherent post-strata have been differentiated according to the $S_A$ value distribution and the size composition in the fishing hauls (**Figure 29**). The estimated abundance and biomass estimated for Mediterranean horse mackerel was 34 million fish and 7435 t, with the bulk of the population (98% of abundance and biomass; 33 million, 7321 t) located in Spanish waters, as commonly observed in previous surveys (**Table 17**, **Figure 30**). Portuguese waters yielded a population of 1 million and 113 t.

The size distribution of the estimated population of Mediterranean horse mackerel inhabiting the GoC ranged between 16.0 and 39.0 cm size classes, with two clearly distinct modes at 33.0 and 28.0 cm size classes. No clear spatial pattern regarding fish size was observed (**Table 17**, **Figure 28**).

**Bogue *Boops boops***

Length-weight relationship parameters estimated from survey data for this species is shown in **Table 7**. Size composition and mean (SD) size in the fishing hauls are represented in the spatial context in **Figure 31**. The mapping of NASC (in $m^2nmi^{-2}$) attributed to the species and the coherent post-strata considered for the acoustic estimation are shown in **Figure 32**. Estimated abundance and biomass by size class are given in **Table 18** and **Figure 33**.

Bogue (1% of the total NASC) showed a scattered distribution throughout the GoC, with higher acoustic densities located in inner shelf waters (25-50 m), between Punta Umbría and Ayamonte and in the easternmost part of the gulf of Cadiz (**Figure 32**).

The size distribution for the pooled catches varied between the 11.5 and 34.0 cm size classes, with one modal class at 23.0 cm. Larger fish occurred in the easternmost Spanish waters whereas smaller fish were observed in Portuguese waters (**Figure 31**).

Five (5) coherent post-strata have been differentiated according to the $S_A$ value distribution and the size composition in the representative fishing hauls (**Figure 32**). Bogue abundance and biomass in the surveyed area were estimated at 5 million fish and 736 t (**Table 18**, **Figure 33**). Spanish waters accounted for 92% of both total abundance (4 million) and biomass (677 t), respectively. Portuguese waters yielded a population of 0.4 million and 59 t.

The size range recorded for the estimated population was comprised between 11.5 and 31.0 cm size classes, showing a very mixed composition and notably outstanding the mode at 23.0 cm size class (**Table 18**, **Figure 31**).

**Pearlside *Maurolicus muelleri***

Parameters of the survey's length-weight relationship are shown in **Table 7**. Size distribution and mean (±SD) size in the fishing hauls are spatially explicit represented in **Figure 34**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 34**. The mapping of the backscattering energy (NASC, in $m^2nmi^{-2}$) attributed to the species and the coherent post-strata considered for the acoustic estimation are shown in **Figure 35**. Estimated abundance and biomass by size class are given in **Table 19** and **Figure 36**.

Pearlside (3% of total NASC) was commonly observed over the shelf break all over the gulf of Cadiz (**Figure 35**). Only the size class of 4.5 cm was observed in the positive fishing hauls.

Seven (7) coherent post-strata were differentiated according to the $S_A$ value distribution and based on expert knowledge (**Figure 35**). Pearlside abundance and biomass in the surveyed area were 974 million fish and 1034 t. Portuguese waters accounted for 72% (797 million, 846 t) of the total abundance and biomass, respectively. Spanish waters yielded a population of 177 million and 188 t. (**Table 19**, **Figure 36**). The size composition recorded for the estimated population was comprised between 3.5 and 5.5 cm size classes, with a dominant mode at 4.5 cm size class (**Table 19**, **Figure 34**).

**Longspine snipefish *Macroramphosus scolopax***

Parameters of the survey's length-weight relationship are shown in **Table 7**. Size distribution and mean (±SD) size in the fishing hauls are spatially explicit represented in **Figure 37**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 37**. The mapping of the backscattering energy (NASC, in $m^2nmi^{-2}$) attributed to the species and the coherent post-strata considered for the acoustic estimation are shown in **Figure 38**. Estimated abundance and biomass by size class are given in **Table 20** and **Figure 39**.

Longspine snipefish (<0.01% of total NASC) was almost absent of the gulf of Cadiz as evidenced by its low acoustic density (**Figure 38**). The size distribution for the pooled catches varied between 8.5 and 15.5 cm size classes with no clear modal size class.

One (1) coherent post-stratum was differentiated according to the $S_A$ value distribution and the size composition in the representative fishing hauls (**Figure 38**). Snipefish abundance and biomass in the surveyed area were estimated at 0.4 million fish and 4 t. Portuguese waters accounted for the total abundance and biomass of the population. (**Table 20**, **Figure 39**). The size composition recorded for the estimated population was comprised between 8.5 and 15.5

cm size classes, with a dominant modal class at 12.5 cm size class and a secondary smaller one at 9.5 cm size class (**Table 20**, **Figure 37**).

**Boarfish *Capros aper***

Parameters of the survey's length-weight relationship are shown in **Table 7**. Size distribution and mean (±SD) size in the fishing hauls are spatially explicit represented in **Figure 40**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 40**. The mapping of the backscattering energy (NASC, in $m^2nmi^{-2}$) attributed to the species and the coherent post-strata considered for the acoustic estimation are shown in **Figure 41**. Estimated abundance and biomass by size class are given in **Table 21** and **Figure 42**.

Boarfish (<0.2% of total NASC) was only located with very high acoustic density in front of Faro (**Figure 41**). The size distribution for the pooled catches varied between the 6.0 and 8.5 cm with a dominant size class at 7.5 cm.

One (1) coherent post-stratum was differentiated according to the $S_A$ value distribution and the size composition in the representative fishing hauls (**Figure 41**). Boarfish abundance and biomass in the surveyed area were 8 million fish and 79 t. Portuguese waters accounted for the total abundance and biomass of the population. (**Table 19**, **Figure 42**). The size composition recorded for the estimated population was comprised between 6.0 and 8.5 with a dominant size class at 7.5 cm. (**Table 21**, **Figure 40**).

## Census of top predators

During the survey a total of 80 legs were carried out, accounting for a total of 803 km during 43 h and 18 minutes of observation. Almost the whole of planned transects was sampled but R01, because bad weather (**Figure 44**).

***Sightings of cetacean species***

A total of 15 sightings of cetaceans belonging to two different species were recorded: 6 sightings of common dolphin (*Delphinus delphis*), 8 of bottlenose dolphin (*Tursiops truncatus*) (**Figure 45**) and 1 unidentified humpback whale species (*Baleonoptera spp.*).

***Sightings of sea bird species***

A total of 214 sightings of sea bird species of 14 different species were recorded during the survey.

**Northern gannet (*Morus bassanus*)**

Sightings (105) of northern gannet were mainly registered in two main areas, one in front of the Guadalquivir river mouth and the other in Algarve waters (**Figure 46**).

**Scopoli's shearwater (*Calonectris diomedea*)**

Sightings (51) of Scopoli's shearwater followed the same pattern as northern gannet sightings (**Figure 46**).

**Great shearwater (*Puffinus gravis*)**

Conversely, great shearwater sightings (18) were just recorded in the zone where the Scopoli's shearwater was not detected, between Punta Umbría and Cape San Vicente (**Figure 47**).

**Balearic shearwater (*Puffinus mauritanicus*)**

Balearic shearwater sightings (8) did not show a clear pattern of spatial distribution (**Figure 47**).

**Yellow-legged gull (*Larus michahelis*)**

Sightings of yellow-legged gull (9) did not show a clear pattern of spatial distribution. (**Figure 48**).

**European storm petrel (*Hydrobates pelagicus*)**

Sightings of European storm petrel (10) were distributed over the central and eastern zones of the study area, between Isla Antilla and Albufeira (**Figure 49**).

**Great skua (*Stercorarius skua*)**

Great skua (1 sighting) was observed in front of Matalascañas (**Figure 49**).

**Other sea bird species**

Lesser black-backed gull (*Larus fuscus*; 11 sightings), parasitic jaeger (*Stercorarius parasiticus*; 1 sighting) and Audouin's gull (*Larus audouinii*; 4 sightings) were also observed during the survey. Additionally, 16 sightings of unidentified sea bird species, 5 sightings of unidentified seagulls, 13 sightings of unidentified terns and 1 sighting of an unidentified shearwater species were also recorded.

**(SHORT) DISCUSSION**

Trends of anchovy, sardine and chub mackerel time series abundance and biomass estimates from this survey series are described in **Tables 9**, **11**, and **15** and **Figure 43**.

The anchovy population inhabiting the GoC during autumn 2023 was the lowest of the time series and it showed a large decrease in abundance (55%) and in biomass (38%) when compared to last year's estimates **(Table 9**; **Figure 43**). Most, if not all, of the population was concentrated in the Spanish waters, highlighting the importance of this geographical area in the species distribution. The current estimates (816 million fish, 8300 t) are lower than the time-series average (*i.e.* 2686 million; 21 276 t). The bulk (97 and 93% in terms of abundance and biomass, respectively) of age 0 fish was concentrated almost exclusively in Spanish waters. The estimates of age-0 fish (639 million, 4723 t) also experienced a strong decreasing trend compared to last year's estimates and the peak observed in 2019 and the values recorded in 2020, with values well below the time series average (**Table 9**). The recent strong decreasing trend for the whole population and juveniles still continued in 2023 with a strong decrease in abundance and biomass and, consequently, the population should be closely monitored.

The abundance and biomass of the sardine population inhabiting the GoC in autumn 2023 were 2125 million fish and 27 372 t which were 96% and 30% higher than last year estimates The 2023 estimates reflect a recovery of the population when compared to last year, when one of the lowest abundance and biomass estimates were estimated (**Table 11**, **Figure 43**). Sardine was observed in Spanish and Portuguese waters, which was similar from last year's distribution pattern; however, this year a higher percentage of the population was concentrated in Spanish waters. Sardine population inhabiting the Gulf of Cádiz seems to follow an increasing trend, although comprised of smaller individuals, as observed from the mean length and weight. The age structure of sardines in the GoC was mainly composed of age-0 fish, accounting for more than 98% of the abundance (2092 million fish) and 94% of the biomass (25 876 t) of the total population. In contrast, the abundance and biomass of the rest of the cohorts were residual. Larger (older) fish seemed more frequent in Portuguese waters, while smaller (younger) fish were almost exclusively found in Spanish waters (**Table 10; Figures 11 and 14**). Contrary to the situation of anchovy population, sardine population inhabiting the Gulf of Cádiz increased its abundance and biomass by 95 and 31% compared to last years' estimates, respectively.

Chub mackerel abundance (118 million fish) and biomass (8 451 t) were 52% and 45% lower than last year estimates (246 million, 15 499 t), and remained below their respective time-series averages (*i.e*. 195 million, 14 443 t; **Table 15**, **Figure 43**). Portuguese waters concentrated the bulk of the total population abundance and biomass. The population was composed by fishes not older than 3 years, with the age-0 group being the dominant one (83%, 98 million, and 69%, 5865 t, of the total abundance and biomass estimated in the surveyed area, respectively; **Figure 24**). Age-1 fish was the second most important age group in the estimated population (17 million fish, 1 611 t). This year's age-0 estimates of abundance and biomass were 39% and 28% lower than last year estimates, but three times higher than 2021 estimates.


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**Table 1**. *ECOCADIZ-RECLUTAS 2023-10* survey. Percentage of occurrence, total weight (in kg) and total number of individuals of the fish species (sharks excluded) in the fishing hauls.

| Species | OCCURENCE (Number of valid hauls) | OCCURENCE (% over total valid hauls) | Total weight (kg.) | Total Number |
|---|---|---|---|---|
| *Merluccius merluccius* | 12 | 92.31 % | 21.760 | 177 |
| *Trachurus trachurus* | 11 | 84.62 % | 39.454 | 827 |
| *Sardina pilchardus* | 10 | 76.92 % | 1342.307 | 82985 |
| *Engraulis encrasicolus* | 10 | 76.92 % | 873.072 | 100124 |
| *Scomber colias* | 9 | 69.23 % | 357.588 | 4119 |
| *Pagellus erythrinus* | 5 | 38.46 % | 13.312 | 92 |
| *Trachurus mediterraneus* | 4 | 30.77 % | 176.870 | 895 |
| *Boops boops* | 4 | 30.77 % | 24.265 | 149 |
| *Sardinella aurita* | 4 | 30.77 % | 5.615 | 24 |
| *Scomber scombrus* | 4 | 30.77 % | 2.780 | 19 |
| *Spondyliosoma cantharus* | 4 | 30.77 % | 2.665 | 22 |
| *Trachinus draco* | 4 | 30.77 % | 0.395 | 6 |
| *Spicara flexuosa* | 3 | 23.08 % | 63.035 | 1205 |
| *Mola mola* | 3 | 23.08 % | 26.905 | 11 |
| *Caranx rhonchus* | 3 | 23.08 % | 8.545 | 27 |
| *Alosa fallax* | 3 | 23.08 % | 1.495 | 7 |
| *Diplodus bellottii* | 3 | 23.08 % | 1.045 | 15 |
| *Pagellus bellottii bellottii* | 2 | 15.38 % | 2.305 | 20 |
| *Pomatomus saltatrix* | 2 | 15.38 % | 1.990 | 6 |
| *Pagellus acarne* | 2 | 15.38 % | 1.905 | 16 |
| *Diplodus annularis* | 2 | 15.38 % | 0.335 | 6 |
| *Diplodus vulgaris* | 2 | 15.38 % | 0.305 | 3 |
| *Remora brachyptera* | 2 | 15.38 % | 0.133 | 2 |
| *Lepidopus caudatus* | 2 | 15.38 % | 0.046 | 4 |
| *Capros aper* | 1 | 7.69 % | 85.095 | 8596 |
| *Macroramphosus scolopax* | 1 | 7.69 % | 3.830 | 390 |
| *Sarda sarda* | 1 | 7.69 % | 2.755 | 4 |
| *Stromateus fiatola* | 1 | 7.69 % | 2.285 | 3 |
| *Zeus faber* | 1 | 7.69 % | 1.290 | 1 |
| *Trachinotus ovatus* | 1 | 7.69 % | 0.975 | 3 |
| *Microchirus boscanion* | 1 | 7.69 % | 0.002 | 1 |
| *Maurolicus muelleri* | 1 | 7.69 % | 0.001 | 1 |

**Table 2.** *ECOCADIZ-RECLUTAS 2023-10* survey. TS/length relationships used for acoustic estimation of assessed species. Boarfish $b_{20}$ estimate following to Fässler *et al*. (2013). Between parentheses the usual IEO value considered in previous surveys.

| Species | b20 |
|---|---|
| Sardine (*Sardina pilchardus*) | -72.6 |
| Round sardinella (*Sardinella aurita*) | -72.6 |
| Anchovy (*Engraulis encrasicolus*) | -72.6 |
| Chub mackerel (*Scomber japonicus*) | -68.7 |
| Mackerel (*S. scombrus*) | -84.9 |
| Horse mackerel (*Trachurus trachurus*) | -68.7 |
| Mediterranean horse-mackerel (*T. mediterraneus*) | -68.7 |
| Blue jack mackerel (*T. picturatus*) | -68.7 |
| Bogue (*Boops boops*) | -67.0 |
| Transparent goby (*Aphia minuta*) | -67.5 |
| Atlantic pomfret (*Brama brama*) | -67.5 |
| Blue whiting (*Micromesistius poutassou*) | -67.5 |
| Silvery lightfish/pearlside (*Maurolicus muelleri*) | -72.2 |
| Longspine snipefish (*Macroramphosus scolopax*) | -80.0 |
| Boarfish (*Capros aper*) | -66.2* (-72.6) |

**Table 3.** *ECOCADIZ-RECLUTAS 2023-10* survey. Total and regional NASC values by species. FAO codes for the species: ANE: *Engraulis encrasicolus*; PIL*: Sardina pilchardus*; SAA: *Sardinella aurita*; VAM: *Scomber colias*; MAC*: S. scombrus*; HOM: *T. trachurus*; HMM: *T. mediterraneus*; BOG: *Boops boops*; SNS: *Macroramphosus scolopax*; MAV: *Maurolicus muelleri;* BOC: *Capros aper*.

| $S_{A(m^2\ nmi^{-2})}$ | TOTAL | PIL | ANE | SAA | MAC | VAM | HOM | HMM | BOG | MAV | SNS | BOC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **TOTAL AREA** | 84190 | 28889 | 11253 | 96 | 2 | 11827 | 22460 | 6438 | 889 | 2142 | 0.8 | 191 |
| **%** | 100 | 34.3 | 13.3 | 0.1 | 0.003 | 14.0 | 26,6 | 7.6 | 1.0 | 2.5 | 0.0001 | 0.2 |
| **Portugal** | 36076 | 1421 | 2078 | 36 | 1.8 | 8551 | 21979 | 102 | 86 | 1626 | 0.8 | 191 |
| **%** | 42.9 | 4.9 | 17.4 | 37.2 | 70.9 | 72.3 | 97.8 | 1.5 | 9.6 | 75.9 | 100 | 100 |
| **Spain** | 48115 | 27468 | 9175 | 60 | 0.7 | 3275 | 480 | 6335 | 803 | 516 | 0 | 0 |
| **%** | 57.1 | 95.0 | 81.5 | 62.7 | 27.0 | 27.6 | 2.1 | 98.4 | 90.3 | 24.0 | 0.0 | 0.0 |

**Table 4.** *ECOCADIZ-RECLUTAS 2023-10* survey. Descriptive characteristics of the acoustic tracks.

| Acoustic Track | Location. | Date | Start | | | | End | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Latitude | Longitude | UTC time | Mean depth (m) | Latitude | Longitude | UTC time | Mean depth (m) |
| **1** | **Trafalgar** | 12/10/23 | 36°02.2411′ N | 6°28.8083′ W | 06:47 | 198 | 36°13.0253′ N | 6°08.9195′ W | 08:59 | 24 |
| **2** | **Sancti-Petri** | 11/10/23 | 36°19.5488′ N | 6°14.4917′ W | 16:21 | 22 | 36°08.7493′ N | 6°34.1153′ W | 18:16 | 200 |
| **3** | **Cádiz** | 11/10/23 | 36°17.3766′ N | 6°36.7050′ W | 11:44 | 198 | 36°26.9714′ N | 6°18.6136′ W | 15:30 | 19 |
| **4** | **Rota** | 11/10/23 | 36°34.4714′ N | 6°22.6507′ W | 06:46 | 20 | 36°24.5639′ N | 6°40.8119′ W | 10:55 | 201 |
| **5** | **Chipiona** | 09/10/23 | 36°40.4126′ N | 6°29.4663′ W | 11:12 | 22 | 36°31.1850′ N | 6°46.3540′ W | 14:37 | 201 |
| **6** | **Doñana** | 09/10/23 | 36°38.0487′ N | 6°51.6115′ W | 06:48 | 200 | 36°46.6788′ N | 6°35.6071′ W | 10:21 | 21 |
| **7** | **Matalascañas** | 08/10/23 | 36°54.3224′ N | 6°39.3674′ W | 15:09 | 18 | 36°43.9993′ N | 6°58.3355′ W | 17:02 | 201 |
| **8** | **Mazagón** | 08/10/23 | 36°49.4175′ N | 7°06.1203′ W | 09:54 | 202 | 37°01.1299′ N | 6°44.5815′ W | 14:15 | 20 |
| **9** | **Punta Umbría** | 08/10/23 | 37°03.0905′ N | 6°57.5995′ W | 06:43 | 31 | 36°49.7260′ N | 7°06.5257′ W | 09:50 | 200 |
| **10** | **El Rompido** | 07/10/23 | 36°50.1299′ N | 7°07.2231′ W | 11:02 | 199 | 37°07.9572′ N | 7°07.2021′ W | 14:54 | 18 |
| **11** | **Isla Cristina** | 07/10/23 | 37°07.0317′ N | 7°17.2431′ W | 06:46 | 23 | 36°53.4532′ N | 7°17.1251′ W | 10:09 | 206 |
| **12** | **Vila Real do Santo Antonio** | 05/10/23 | 37°06.6825′ N | 7°27.1788′ W | 06:44 | 19 | 36°56.3005′ N | 7°27.0941′ W | 07:46 | 201 |
| **13** | **Tavira** | 06/10/23 | 36°56.9838′ N | 7°37.2317′ W | 09:22 | 203 | 37°04.5357′ N | 7°37.1522′ W | 10:08 | 20 |
| **14** | **Fuzeta** | 06/10/23 | 36°59.5185′ N | 7°47.0496′ W | 06:51 | 25 | 36°55.4658′ N | 7°47.0160′ W | 07:16 | 204 |
| **16** | **Cuarteira** | 04/10/23 | 36°56.0631′ N | 7°57.5798′ W | 13:32 | 54 | 36°52.0955′ N | 7°56.9591′ W | 13:58 | 207 |
| **16** | **Cuarteira** | 04/10/23 | 36°56.0631′ N | 7°57.5798′ W | 13:32 | 54 | 37°01.6069′ N | 8°07.0451′ W | 12:31 | 20 |
| **17** | **Albufeira** | 03/10/23 | 37°01.7894′ N | 8°16.9941′ W | 06:45 | 26 | 36°49.3496′ N | 8°16.8716′ W | 10:28 | 201 |
| **18** | **Alfanzina** | 02/10/23 | 36°50.2004′ N | 8°26.6472′ W | 10:55 | 210 | 37°04.6362′ N | 8°27.0500′ W | 12:24 | 19 |
| **19** | **Portimao** | 02/10/23 | 37°06.0569′ N | 8°37.0424′ W | 06:57 | 22 | 36°51.2350′ N | 8°36.6941′ W | 08:28 | 200 |
| **20** | **Burgau** | 01/10/23 | 36°51.9847′ N | 8°46.6835′ W | 11:15 | 193 | 37°02.6321′ N | 8°46.9752′ W | 12:19 | 44 |
| **21** | **Ponta de Sagres** | 01/10/23 | 37°00.2914′ N | 8°55.4211′ W | 06:55 | 20 | 36°50.7889′ N | 8°55.2786′ W | 07:57 | 201 |

**Table 5.** *ECOCADIZ-RECLUTAS 2023-10* survey. Descriptive characteristics of the fishing hauls.

| FISHING STATION | DATE | POSITION | | | | | | TIMING | | | | TRAWLED DISTANCE (Nmi) | ACOUSTIC TRANSECT | ZONE/LANDMARK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | START | | | END | | | | | | | | | |
| | | LAT. | LON. | DEPTH | LAT. | LON. | DEPTH | START | END | EFFECTIVE TRAWLING | TOTAL MANEOUVRE | | | |
| 1 | 01-10-2023 | 36º 52.2681 N | 8º 55.3469 W | 129.02 | 36º 54.9726 N | 8º 55.7670 W | 111.5 | 08:34 | 09:16 | 00:42 | 01:35 | 2.722 | R21 | Ponta de Sagres |
| 2 | 02-10-2023 | 36º 53.6703 N | 8º 36.9126 W | 106.04 | 36º 55.5153 N | 8º 36.9532 W | 93.96 | 08:57 | 09:24 | 00:27 | 01:07 | 1.843 | R19 | Portimao |
| 3 | 04-10-2023 | 36º 52.5392 N | 8º 16.8997 W | 106.76 | 36º 54.4144 N | 8º 16.8482 W | 94.8 | 09:02 | 09:29 | 00:27 | 01:00 | 1.873 | R17 | Albufeira |
| 4 | 06-10-2023 | 36º 57.2295 N | 7º 47.0825 W | 84.18 | 36º 58.7072 N | 7º 47.0956 W | 65.36 | 07:47 | 08:09 | 00:21 | 01:01 | 1.476 | R14 | Fuzeta |
| 5 | 06-10-2023 | 37º 00.6922 N | 7º 37.1160 W | 93.52 | 36º 58.3702 N | 7º 37.1851 W | 114.39 | 11:14 | 11:48 | 00:33 | 01:18 | 2.32 | R13 | Tavira |
| 6 | 07-10-2023 | 37º 02.4748 N | 7º 17.1570 W | 52.69 | 37º 04.8475 N | 7º 17.2000 W | 30.55 | 07:56 | 08:30 | 00:33 | 01:08 | 2.37 | R11 | Isla Cristina |
| 7 | 07-10-2023 | 36º 54.1292 N | 7º 07.1995 W | 108.63 | 36º 51.5834 N | 7º 07.2050 W | 138.07 | 12:00 | 12:36 | 00:36 | 01:19 | 2.543 | R10 | El Rompido |
| 8 | 08-10-2023 | 36º 58.0414 N | 7º 00.6698 W | 62.19 | 36º 59.8272 N | 6º 59.5925 W | 49.27 | 07:42 | 08:10 | 00:27 | 00:59 | 1.981 | R09 | Punta Umbría |
| 9 | 08-10-2023 | 36º 58.4927 N | 6º 49.4822 W | 35.31 | 36º 57.2235 N | 6º 51.8280 W | 43.61 | 12:32 | 13:05 | 00:33 | 01:34 | 2.267 | R08 | Mazagón |
| 10 | 09-10-2023 | 36º 40.4077 N | 6º 47.3398 W | 100.69 | 36º 38.8489 N | 6º 50.1336 W | 129.19 | 07:41 | 08:19 | 00:38 | 01:04 | 2.734 | R06 | Doñana |
| 11 | 09-10-2023 | 36º 36.0679 N | 6º 37.4007 W | 64.47 | 36º 37.6258 N | 6º 34.5139 W | 44.33 | 12:17 | 12:57 | 00:39 | 01:09 | 2.797 | R05 | Chipiona |
| 12 | 11-10-2023 | 36º 27.5170 N | 6º 35.3525 W | 90.65 | 36º 29.2198 N | 6º 32.3368 W | 68.33 | 08:35 | 09:16 | 00:41 | 01:21 | 2.968 | R04 | Rota |
| 13 | 11-10-2023 | 36º 22.9702 N | 6º 25.7832 W | 57.68 | 36º 21.4102 N | 6º 28.9169 W | 74.24 | 13:12 | 13:54 | 00:42 | 01:19 | 2.972 | R03 | Cádiz |

**Table 6.** *ECOCADIZ-RECLUTAS 2023-10* survey. Catches by species in number (upper panel) and weight (in kg, lower panel) from valid fishing hauls.

| FISHING HAUL | CATCH IN NUMBERS | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***Anchovy*** | ***Boarfish*** | ***Bogue*** | ***Medit. Horse-mack.*** | ***Horse-mack.*** | ***Mackerel*** | ***Chub mack.*** | ***Pearlside*** | ***Sardine*** | ***Round sardinella*** | ***Snipefish*** | **OTHERS** | **TOTAL** |
| **1** | | | | | 3 | | | | | | | 2 | **5** |
| **2** | 856 | | 3 | | 61 | 3 | 707 | 1 | 14 | | | 31 | **1676** |
| **3** | 358 | | | | 198 | 1 | 1331 | | 3 | | | 23 | **1914** |
| **4** | 4 | 8596 | | | 58 | | | | 5 | | 390 | 24 | **9077** |
| **5** | 24 | | | | 20 | | 32 | | | 11 | | 36 | **123** |
| **6** | | | 133 | 463 | 456 | | 89 | | 15295 | 5 | | 1263 | **17704** |
| **7** | 22734 | | | | 1 | 14 | 1926 | | 9 | | | 18 | **24702** |
| **8** | 203 | | | | 1 | | | | 4012 | | | 9 | **4225** |
| **9** | 249 | | 8 | 318 | 2 | | 15 | | 6532 | | | 120 | **7244** |
| **10** | 7167 | | | | 5 | 1 | 16 | | 12129 | | | 25 | **19343** |
| **11** | 17392 | | | 32 | | | | | 37700 | | | 43 | **55167** |
| **12** | 51137 | | | | 22 | | 1 | | | | | 23 | **51183** |
| **13** | | | 5 | 82 | | | 2 | | 0 | 2 | | 10 | **101** |
| **TOTAL** | **100124** | **8596** | **149** | **895** | **827** | **19** | **4119** | **1** | **75699** | **18** | **390** | **1627** | **192464** |

| FISHING HAUL | CATCH IN WEIGHT (kg) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***Anchovy*** | ***Boarfish*** | ***Bogue*** | ***Medit. Horse-mack.*** | ***Horse-mack.*** | ***Mackerel*** | ***Chub mack.*** | ***Pearlside*** | ***Sardine*** | ***Round sardinella*** | ***Snipefish*** | **OTHERS** | **TOTAL** |
| **1** | | | | | 0.343 | | | | | | | 1.695 | **2.038** |
| **2** | 20.200 | | 0.280 | | 7.415 | 0.865 | 40.510 | 0.001 | 0.520 | | | 2.830 | **72.621** |
| **3** | 5.355 | | | | 2.515 | 0.235 | 83.760 | | 0.065 | | | 1.785 | **93.715** |
| **4** | 0.033 | 85.095 | | | 3.465 | | | | 0.125 | | 3.830 | 3.380 | **95.928** |
| **5** | 0.335 | | | | 0.165 | | 7.545 | | | 2.845 | | 3.400 | **14.290** |
| **6** | 0.000 | | 20.075 | 84.005 | 24.680 | | 26.100 | | 216.000 | 1.135 | | 71.125 | **443.120** |
| **7** | 355.416 | | | | 0.004 | 1.295 | 193.684 | | 0.235 | | | 7.378 | **558.012** |
| **8** | 1.680 | | | | 0.025 | | | | 45.220 | | | 5.330 | **52.255** |
| **9** | 2.120 | | 1.815 | 66.570 | 0.102 | | 3.715 | | 62.390 | 1.025 | | 17.000 | **154.737** |
| **10** | 56.467 | | | | 0.020 | 0.385 | 1.070 | | 219.858 | | | 17.990 | **295.790** |
| **11** | 60.340 | | | 6.805 | | | | | 458.485 | | | 9.715 | **535.345** |
| **12** | 371.126 | | | | 0.720 | | 0.079 | | 339.409 | | | 7.440 | **718.774** |
| **13** | | | 2.095 | 19.490 | | | 1.125 | | | 0.610 | | 13.070 | **36.390** |
| **TOTAL** | **873.072** | **85.095** | **24.265** | **176.870** | **39.454** | **2.780** | **357.588** | **0.001** | **1342.307** | **5.615** | **3.830** | **162.138** | **3073.015** |

**Table 7.** *ECOCADIZ-RECLUTAS 2023-10* survey. Parameters of the size-weight relationships for the survey's target species susceptible of being assessed. FAO codes for the species: ANE: *Engraulis encrasicolus*; PIL*: Sardina pilchardus*; VAM: *Scomber colias*; MAC*: S. scombrus*; BOC: *Capros aper*; HOM: *Trachurus trachurus*; HMM: *T. mediterraneus*; BOG: *Boops boops;* SAA*: Sardinella aurita.*

| Parameter | BOG | BOC | ANE | SNS | PIL | VAM | MAC | HMM | HOM | SAA |
|---|---|---|---|---|---|---|---|---|---|---|
| **Size range (mm)** | 187 - 341 | 72 - 86 | 59 - 198 | 93 - 152 | 102 - 221 | 181 - 381 | 198 - 356 | 161 - 390 | 48 - 267 | 223 – 349 |
| **n** | 66 | 100 | 433 | 99 | 322 | 255 | 20 | 182 | 262 | 345 |
| **a** | 0.0056 | 0.0100 | 0.0033 | 0.0031 | 0.0034 | 0.0019 | 0.0036 | 0.0140 | 0.0117 | 0.0270 |
| **b** | 3.1900 | 3.3301 | 3.2414 | 3.2383 | 3.2950 | 3.4682 | 3.2399 | 2.8356 | 2.8862 | 2.6215 |
| **$r^2$** | 0.9885 | 0.9062 | 0.9893 | 0.9756 | 0.9905 | 0.9947 | 0.9932 | 0.9400 | 0.9938 | 0.8912 |

(*****) For the acoustic assessment, size-weight relationships parameters for MAV were derived from *ECOCADIZ-RECLUTAS-2020* (a=0.0108.; b=2.8308; n=43; size range=32-63 mm; $r^{2=}$=0.9081).

**Tabla 8.** *ECOCADIZ-RECLUTAS 2023-10* survey. Anchovy (*E. encrasicolus*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 8.**

| ***ECOCADIZ-RECLUTAS 2023-10. Engraulis encrasicolus.* ABUNDANCE (in numbers and million fish)** | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **POL03** | **POL04** | **Portugal** | **POL05** | **POL06** | **POL07** | **POL08** | **POL09** | **POL10** | **Spain** | **TOTAL** | **Millions** | | |
| | | | | | | | | | | | | | | **Portugal** | **Spain** | **Total** |
| **7.5** | 0 | 0 | 0 | 0 | 0 | 23910 | 0 | 103 | 1488707 | 55372441 | 9094 | 56894255 | 56894255 | 0 | 56.894255 | 56.894255 |
| **8** | 0 | 0 | 0 | 0 | 0 | 40387 | 0 | 175 | 2514659 | 101354234 | 15361 | 103924816 | 103924816 | 0 | 103.924816 | 103.924816 |
| **8.5** | 0 | 0 | 0 | 0 | 0 | 72094 | 0 | 312 | 4488840 | 56417482 | 27421 | 61006149 | 61006149 | 0 | 61.006149 | 61.006149 |
| **9** | 0 | 0 | 0 | 0 | 0 | 72094 | 0 | 312 | 4488840 | 26126019 | 27421 | 30714686 | 30714686 | 0 | 30.714686 | 30.714686 |
| **9.5** | 0 | 0 | 0 | 34496 | 34496 | 72817 | 1498816 | 315 | 4533868 | 11495448 | 27696 | 17628960 | 17663456 | 0.034496 | 17.62896 | 17.663456 |
| **10** | 0 | 0 | 0 | 34496 | 34496 | 590158 | 1498816 | 2554 | 36745348 | 3135122 | 224466 | 42196464 | 42230960 | 0.034496 | 42.196464 | 42.23096 |
| **10.5** | 0 | 0 | 0 | 103487 | 103487 | 1195512 | 4496447 | 5174 | 74436916 | 1045041 | 454711 | 81633801 | 81737288 | 0.103487 | 81.633801 | 81.737288 |
| **11** | 0 | 186 | 15631 | 310678 | 326495 | 840945 | 13498708 | 3639 | 52360294 | 1045041 | 319852 | 68068479 | 68394974 | 0.326495 | 68.068479 | 68.394974 |
| **11.5** | 0 | 1300 | 109418 | 345174 | 455892 | 456834 | 14997523 | 1977 | 28444148 | 0 | 173756 | 44074238 | 44530130 | 0.455892 | 44.074238 | 44.53013 |
| **12** | 0 | 4271 | 359517 | 414165 | 777953 | 270010 | 17995154 | 1169 | 16811775 | 0 | 102698 | 35180806 | 35958759 | 0.777953 | 35.180806 | 35.958759 |
| **12.5** | 0 | 10399 | 875345 | 327926 | 1213670 | 170316 | 14248116 | 737 | 10604502 | 0 | 64780 | 25088451 | 26302121 | 1.21367 | 25.088451 | 26.302121 |
| **13** | 0 | 20798 | 1750691 | 569612 | 2341101 | 40128 | 24749192 | 174 | 2498499 | 0 | 15263 | 27303256 | 29644357 | 2.341101 | 27.303256 | 29.644357 |
| **13.5** | 629630 | 13185 | 1109813 | 966529 | 2719157 | 20129 | 41994939 | 87 | 1253281 | 0 | 7656 | 43276092 | 45995249 | 2.719157 | 43.276092 | 45.995249 |
| **14** | 7030870 | 6685 | 562722 | 1035521 | 8635798 | 14086 | 44992570 | 61 | 877064 | 0 | 5358 | 45889139 | 54524937 | 8.635798 | 45.889139 | 54.524937 |
| **14.5** | 19098782 | 6685 | 562722 | 500405 | 20168594 | 3522 | 21742193 | 15 | 219266 | 0 | 1339 | 21966335 | 42134929 | 20.168594 | 21.966335 | 42.134929 |
| **15** | 29277803 | 1300 | 109418 | 189943 | 29578464 | 0 | 8252853 | 0 | 0 | 0 | 0 | 8252853 | 37831317 | 29.578464 | 8.252853 | 37.831317 |
| **15.5** | 22981501 | 1671 | 140680 | 51744 | 23175596 | 0 | 2248223 | 0 | 0 | 0 | 0 | 2248223 | 25423819 | 23.175596 | 2.248223 | 25.423819 |
| **16** | 6401240 | 0 | 0 | 17248 | 6418488 | 0 | 749408 | 0 | 0 | 0 | 0 | 749408 | 7167896 | 6.418488 | 0.749408 | 7.167896 |
| **16.5** | 3148151 | 0 | 0 | 0 | 3148151 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3148151 | 3.148151 | 0 | 3.148151 |
| **17** | 629630 | 0 | 0 | 0 | 629630 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 629630 | 0.62963 | 0 | 0.62963 |
| **17.5** | 629630 | 0 | 0 | 0 | 629630 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 629630 | 0.62963 | 0 | 0.62963 |
| **TOTAL n** | 89827237 | 66480 | 5595957 | 4901424 | 100391098 | 3882942 | 212962958 | 16804 | 241766007 | 255990828 | 1476872 | 716096411 | 816487509 | **100** | **716** | **816** |
| **Millions** | **90** | **0.1** | **6** | **5** | **100** | **4** | **213** | **0.02** | **242** | **256** | **1** | **716** | **816** | | | |

**Table 8.** *ECOCADIZ-RECLUTAS 2023-10* survey. Anchovy (*E. encrasicolus*). Cont'd

| ***ECOCADIZ-RECLUTAS 2023-10. Engraulis encrasicolus.* BIOMASS (t)** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **POL03** | **POL04** | **Portugal** | **POL05** | **POL06** | **POL07** | **POL08** | **POL09** | **POL10** | **Spain** | **TOTAL** |
| **7.5** | 0 | 0 | 0 | 0 | 0 | 0.060 | 0 | 0 | 3.720 | 138.380 | 0.023 | 142.183 | 142.183 |
| **8** | 0 | 0 | 0 | 0 | 0 | 0.124 | 0 | 0.001 | 7.696 | 310.193 | 0.047 | 318.061 | 318.061 |
| **8.5** | 0 | 0 | 0 | 0 | 0 | 0.267 | 0 | 0.001 | 16.625 | 208.946 | 0.102 | 225.941 | 225.941 |
| **9** | 0 | 0 | 0 | 0 | 0 | 0.320 | 0 | 0.001 | 19.906 | 115.856 | 0.122 | 136.205 | 136.205 |
| **9.5** | 0 | 0 | 0 | 0.181 | 0.181 | 0.383 | 7.883 | 0.002 | 23.846 | 60.461 | 0.146 | 92.721 | 92.902 |
| **10** | 0 | 0 | 0 | 0.213 | 0.213 | 3.650 | 9.270 | 0.016 | 227.277 | 19.391 | 1.388 | 260.992 | 261.205 |
| **10.5** | 0 | 0 | 0 | 0.747 | 0.747 | 8.629 | 32.454 | 0.037 | 537.263 | 7.543 | 3.282 | 589.208 | 589.955 |
| **11** | 0 | 0.002 | 0.131 | 2.598 | 2.731 | 7.033 | 112.898 | 0.030 | 437.923 | 8.740 | 2.675 | 569.299 | 572.030 |
| **11.5** | 0 | 0.013 | 1.054 | 3.324 | 4.391 | 4.399 | 144.421 | 0.019 | 273.907 | 0 | 1.673 | 424.419 | 428.810 |
| **12** | 0 | 0.047 | 3.963 | 4.565 | 8.575 | 2.976 | 198.348 | 0.013 | 185.305 | 0 | 1.132 | 387.774 | 396.349 |
| **12.5** | 0 | 0.130 | 10.984 | 4.115 | 15.229 | 2.137 | 178.791 | 0.009 | 133.069 | 0 | 0.813 | 314.819 | 330.048 |
| **13** | 0 | 0.296 | 24.886 | 8.097 | 33.279 | 0.570 | 351.802 | 0.002 | 35.515 | 0 | 0.217 | 388.106 | 421.385 |
| **13.5** | 10.092 | 0.211 | 17.788 | 15.492 | 43.583 | 0.323 | 673.096 | 0.001 | 20.088 | 0 | 0.123 | 693.631 | 737.214 |
| **14** | 126.523 | 0.120 | 10.126 | 18.635 | 155.404 | 0.253 | 809.657 | 0.001 | 15.783 | 0 | 0.096 | 825.790 | 981.194 |
| **14.5** | 384.337 | 0.135 | 11.324 | 10.070 | 405.866 | 0.071 | 437.532 | 0 | 4.412 | 0 | 0.027 | 442.042 | 847.908 |
| **15** | 656.406 | 0.029 | 2.453 | 4.259 | 663.147 | 0 | 185.028 | 0 | 0 | 0 | 0 | 185.028 | 848.175 |
| **15.5** | 572.040 | 0.042 | 3.502 | 1.288 | 576.872 | 0 | 55.961 | 0 | 0 | 0 | 0 | 55.961 | 632.833 |
| **16** | 176.322 | 0 | 0 | 0.475 | 176.797 | 0 | 20.642 | 0 | 0 | 0 | 0 | 20.642 | 197.439 |
| **16.5** | 95.666 | 0 | 0 | 0 | 95.666 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 95.666 |
| **17** | 21.047 | 0 | 0 | 0 | 21.047 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21.047 |
| **17.5** | 23.090 | 0 | 0 | 0 | 23.090 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 23.090 |
| **TOTAL** | **2065.523** | **1.025** | **86.211** | **74.059** | **2226.818** | **31.195** | **3217.783** | **0.133** | **1942.335** | **869.510** | **11.866** | **6072.822** | **8299.640** |

**Tabla 9.** *ECOCADIZ-RECLUTAS* surveys series. Anchovy (*E. encrasicolus*). Acoustic estimates of biomass (t) and abundance (million fish) for the whole Gulf of Cádiz anchovy population and for the juvenile fraction (*i.e.* age 0 fish, between parentheses). Note that the 2012 survey only surveyed the Spanish waters. The 2017 estimates correspond to an incomplete coverage (only the seven easternmost transects) of the standard surveyed area due to a research vessels' breakdown. n.a.: Not available.

| Estimate/Year | Total Population (Recruits at age 0) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2012 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
| Biomass (t) | 13680 (13354) | 8113 (5131) | 30827 (29219) | 19861 (15969) | 7642 (7290) | 10493 (3834) | 48357 (36405) | 36070 (21060) | 17512 (12063) | 11912 (10797) | 8300 (4723) |
| Abundance (millions) | 2469 (2619) | 986 (814) | 5227 (5117) | 3667 (3445) | 1492 (1433) | 953 (543) | 5505 (4845) | 3197 (2385) | 1973 (1629) | 1837 (1705) | 816 (639) |

**Table 10.** *ECOCADIZ-RECLUTAS 2023-10* survey. Sardine (*Sardina pilchardus*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 12**.

| ***ECOCADIZ-RECLUTAS 2023-10. Sardina pilchardus.* ABUNDANCE (in numbers and million fish)** | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **Portugal** | **POL03** | **POL04** | **POL05** | **POL06** | **POL07** | **POL08** | **POL09** | **POL10** | **POL11** | **Spain** | **TOTAL** | **Millions** | | |
| | | | | | | | | | | | | | | | **Portugal** | **Spain** | **Total** |
| **9.5** | 0 | 0 | 0 | 0 | 412803 | 0 | 1826443 | 5569201 | 11685308 | 0 | 0 | 808 | 19494563 | 19494563 | 0 | 19.494563 | 19.494563 |
| **10** | 0 | 0 | 0 | 0 | 2064017 | 0 | 9132217 | 28983799 | 35055924 | 0 | 0 | 4040 | 75239997 | 75239997 | 0 | 75.239997 | 75.239997 |
| **10.5** | 0 | 0 | 0 | 0 | 10292565 | 0 | 45539323 | 46809235 | 84693726 | 0 | 0 | 20145 | 187354994 | 187354994 | 0 | 187.354994 | 187.354994 |
| **11** | 0 | 290290 | 290290 | 1174349 | 31318019 | 0 | 138566175 | 36209788 | 227789234 | 0 | 0 | 61296 | 435118861 | 435409151 | 0.29029 | 435.118861 | 435.409151 |
| **11.5** | 0 | 3765812 | 3765812 | 15234366 | 29254002 | 1680556 | 129433958 | 7804866 | 245317196 | 0 | 0 | 57256 | 428782200 | 432548012 | 3.765812 | 428.7822 | 432.548012 |
| **12** | 75785 | 19401684 | 19477469 | 78488356 | 25951575 | 12284061 | 114822410 | 3333536 | 140174182 | 33587 | 798 | 50793 | 375139298 | 394616767 | 19.477469 | 375.139298 | 394.616767 |
| **12.5** | 0 | 31852325 | 31852325 | 128856678 | 8641351 | 16195354 | 38233549 | 1676749 | 61323110 | 0 | 0 | 16913 | 254943704 | 286796029 | 31.852325 | 254.943704 | 286.796029 |
| **13** | 154727 | 5213283 | 5368010 | 21090026 | 2476820 | 40213293 | 10958661 | 0 | 46716475 | 68574 | 1629 | 4848 | 121530326 | 126898336 | 5.36801 | 121.530326 | 126.898336 |
| **13.5** | 691536 | 290290 | 981826 | 1174349 | 0 | 25138310 | 0 | 0 | 32159354 | 306483 | 7282 | 0 | 58785778 | 59767604 | 0.981826 | 58.785778 | 59.767604 |
| **14** | 1462014 | 0 | 1462014 | 0 | 0 | 16195354 | 0 | 0 | 26589027 | 647953 | 15396 | 0 | 43447730 | 44909744 | 1.462014 | 43.44773 | 44.909744 |
| **14.5** | 1537799 | 0 | 1537799 | 0 | 0 | 6142030 | 0 | 0 | 6461579 | 681540 | 16194 | 0 | 13301343 | 14839142 | 1.537799 | 13.301343 | 14.839142 |
| **15** | 770478 | 0 | 770478 | 0 | 0 | 3351108 | 0 | 0 | 9135336 | 341470 | 8114 | 0 | 12836028 | 13606506 | 0.770478 | 12.836028 | 13.606506 |
| **15.5** | 770478 | 0 | 770478 | 0 | 0 | 0 | 0 | 0 | 6090224 | 341470 | 8114 | 0 | 6439808 | 7210286 | 0.770478 | 6.439808 | 7.210286 |
| **16** | 615751 | 0 | 615751 | 0 | 0 | 0 | 0 | 0 | 24757 | 272896 | 6484 | 0 | 304137 | 919888 | 0.615751 | 0.304137 | 0.919888 |
| **16.5** | 539966 | 0 | 539966 | 0 | 0 | 0 | 0 | 0 | 24757 | 239309 | 5686 | 0 | 269752 | 809718 | 0.539966 | 0.269752 | 0.809718 |
| **17** | 1537799 | 0 | 1537799 | 0 | 0 | 30010 | 0 | 0 | 0 | 681540 | 16194 | 0 | 727744 | 2265543 | 1.537799 | 0.727744 | 2.265543 |
| **17.5** | 1386230 | 0 | 1386230 | 0 | 0 | 10003 | 0 | 0 | 24757 | 614365 | 14598 | 0 | 663723 | 2049953 | 1.38623 | 0.663723 | 2.049953 |
| **18** | 3460838 | 7953 | 3468791 | 32174 | 0 | 20007 | 0 | 0 | 0 | 1533814 | 36446 | 0 | 1622441 | 5091232 | 3.468791 | 1.622441 | 5.091232 |
| **18.5** | 4847067 | 0 | 4847067 | 0 | 0 | 10003 | 0 | 0 | 0 | 2148180 | 51044 | 0 | 2209227 | 7056294 | 4.847067 | 2.209227 | 7.056294 |
| **19** | 2924029 | 0 | 2924029 | 0 | 0 | 30010 | 0 | 0 | 74271 | 1295905 | 30793 | 0 | 1430979 | 4355008 | 2.924029 | 1.430979 | 4.355008 |
| **19.5** | 1462014 | 0 | 1462014 | 0 | 0 | 0 | 0 | 0 | 0 | 647953 | 15396 | 0 | 663349 | 2125363 | 1.462014 | 0.663349 | 2.125363 |
| **20** | 539966 | 0 | 539966 | 0 | 0 | 20007 | 0 | 0 | 0 | 239309 | 5686 | 0 | 265002 | 804968 | 0.539966 | 0.265002 | 0.804968 |
| **20.5** | 154727 | 0 | 154727 | 0 | 0 | 0 | 0 | 0 | 0 | 68574 | 1629 | 0 | 70203 | 224930 | 0.154727 | 0.070203 | 0.22493 |
| **21** | 75785 | 0 | 75785 | 0 | 0 | 0 | 0 | 0 | 0 | 33587 | 798 | 0 | 34385 | 110170 | 0.075785 | 0.034385 | 0.11017 |
| **21.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **22** | 0 | 0 | 0 | 0 | 0 | 10003 | 0 | 0 | 0 | 0 | 0 | 0 | 10003 | 10003 | 0 | 0.010003 | 0.010003 |
| **TOTAL n** | 23006989 | 60821637 | 83828626 | 246050298 | 110411152 | 121330109 | 488512736 | 130387174 | 933339217 | 10196509 | 242281 | 216099 | 2040685575 | 2124514201 | **84** | **2041** | **2125** |
| **Millions** | **23** | **61** | **84** | **246** | **110** | **121** | **489** | **130** | **933** | **10** | **0.2** | **0.2** | **2041** | **2125** | | | |

**Table 10.** *ECOCADIZ-RECLUTAS 2023-10* survey. Sardine (*Sardina pilchardus*). Cont'd.

| ***ECOCADIZ-RECLUTAS 2023-10. Sardina pilchardus.* BIOMASS (t)** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **Portugal** | **POL03** | **POL04** | **POL05** | **POL06** | **POL07** | **POL08** | **POL09** | **POL10** | **POL11** | **Spain** | **TOTAL** |
| **9.5** | 0 | 0 | 0 | 0 | 2.536 | 0 | 11.221 | 34.215 | 71.791 | 0 | 0 | 0.005 | 119.768 | 119.768 |
| **10** | 0 | 0 | 0 | 0 | 14.952 | 0 | 66.156 | 209.966 | 253.954 | 0 | 0 | 0.029 | 545.057 | 545.057 |
| **10.5** | 0 | 0 | 0 | 0 | 87.231 | 0 | 385.954 | 396.717 | 717.794 | 0 | 0 | 0.171 | 1587.867 | 1587.867 |
| **11** | 0 | 2.858 | 2.858 | 11.561 | 308.318 | 0 | 1364.150 | 356.476 | 2242.529 | 0 | 0 | 0.603 | 4283.637 | 4286.495 |
| **11.5** | 0 | 42.785 | 42.785 | 173.084 | 332.366 | 19.093 | 1470.549 | 88.674 | 2787.144 | 0 | 0 | 0.651 | 4871.561 | 4914.346 |
| **12** | 0.988 | 252.874 | 253.862 | 1022.986 | 338.242 | 160.106 | 1496.549 | 43.448 | 1826.974 | 0.438 | 0.01 | 0.662 | 4889.415 | 5143.277 |
| **12.5** | 0 | 473.645 | 473.645 | 1916.101 | 128.497 | 240.825 | 568.533 | 24.933 | 911.876 | 0 | 0 | 0.251 | 3791.016 | 4264.661 |
| **13** | 2.612 | 87.997 | 90.609 | 355.986 | 41.807 | 678.775 | 184.975 | 0 | 788.544 | 1.157 | 0.027 | 0.082 | 2051.353 | 2141.962 |
| **13.5** | 13.188 | 5.536 | 18.724 | 22.395 | 0 | 479.400 | 0 | 0 | 613.294 | 5.845 | 0.139 | 0 | 1121.073 | 1139.797 |
| **14** | 31.364 | 0 | 31.364 | 0 | 0 | 347.427 | 0 | 0 | 570.395 | 13.900 | 0.330 | 0 | 932.052 | 963.416 |
| **14.5** | 36.959 | 0 | 36.959 | 0 | 0 | 147.616 | 0 | 0 | 155.296 | 16.380 | 0.389 | 0 | 319.681 | 356.640 |
| **15** | 20.667 | 0 | 20.667 | 0 | 0 | 89.891 | 0 | 0 | 245.048 | 9.160 | 0.218 | 0 | 344.317 | 364.984 |
| **15.5** | 22.985 | 0 | 22.985 | 0 | 0 | 0 | 0 | 0 | 181.687 | 10.187 | 0.242 | 0 | 192.116 | 215.101 |
| **16** | 20.362 | 0 | 20.362 | 0 | 0 | 0 | 0 | 0 | 0.819 | 9.024 | 0.214 | 0 | 10.057 | 30.419 |
| **16.5** | 19.731 | 0 | 19.731 | 0 | 0 | 0 | 0 | 0 | 0.905 | 8.745 | 0.208 | 0 | 9.858 | 29.589 |
| **17** | 61.911 | 0 | 61.911 | 0 | 0 | 1.208 | 0 | 0 | 0 | 27.439 | 0.652 | 0 | 29.299 | 91.210 |
| **17.5** | 61.319 | 0 | 61.319 | 0 | 0 | 0.442 | 0 | 0 | 1.095 | 27.176 | 0.646 | 0 | 29.359 | 90.678 |
| **18** | 167.762 | 0.386 | 168.148 | 1.560 | 0 | 0.970 | 0 | 0 | 0 | 74.350 | 1.767 | 0 | 78.647 | 246.795 |
| **18.5** | 256.843 | 0 | 256.843 | 0 | 0 | 0.530 | 0 | 0 | 0 | 113.831 | 2.705 | 0 | 117.066 | 373.909 |
| **19** | 168.978 | 0 | 168.978 | 0 | 0 | 1.734 | 0 | 0 | 4.292 | 74.890 | 1.780 | 0 | 82.696 | 251.674 |
| **19.5** | 91.938 | 0 | 91.938 | 0 | 0 | 0 | 0 | 0 | 0 | 40.746 | 0.968 | 0 | 41.714 | 133.652 |
| **20** | 36.871 | 0 | 36.871 | 0 | 0 | 1.366 | 0 | 0 | 0 | 16.341 | 0.388 | 0 | 18.095 | 54.966 |
| **20.5** | 11.450 | 0 | 11.450 | 0 | 0 | 0 | 0 | 0 | 0 | 5.074 | 0.121 | 0 | 5.195 | 16.645 |
| **21** | 6.066 | 0 | 6.066 | 0 | 0 | 0 | 0 | 0 | 0 | 2.688 | 0.064 | 0 | 2.752 | 8.818 |
| **21.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **22** | 0 | 0 | 0 | 0 | 0 | 0.932 | 0 | 0 | 0 | 0 | 0 | 0 | 0.932 | 0.932 |
| **TOTAL** | **1031.994** | **866.081** | **1898.075** | **3503.673** | **1253.949** | **2170.315** | **5548.087** | **1154.429** | **11373.437** | **457.371** | **10.868** | **2.454** | **25474.583** | **27372.658** |

**Table 11.** *ECOCADIZ-RECLUTAS* surveys series. Sardine (*Sardina pilchardus*). Acoustic estimates of biomass (t) and abundance (million fish) for the whole Gulf of Cádiz anchovy population and for the juvenile fraction (*i.e.* age 0 fish, between parentheses). Note that the 2012 survey only surveyed the Spanish waters. The 2017 estimates correspond to an incomplete coverage (only the seven easternmost transects) of the standard surveyed area due to a research vessels' breakdown. n.a.: Not available.

| Estimate/Year | Total Population (Recruits at age 0) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2012 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
| Biomass (t) | 22119 (9182) | 36571 (705) | 30992 (8645) | 35173 (21899) | 12119 (8778) | 20679 (15224) | 36465 (7858) | 208400 (49259) | 151320 (12854) | 20909 (16177) | 27372 (25876) |
| Abundance (millions) | 603 (359) | 507 (26) | 861 (509) | 2379 (1940) | 591 (483) | 1134 (1036) | 937 (384) | 5451 (2454) | 2986 (638) | 1085 (992) | 2125 (2092) |

**Tabla 12.** *ECOCADIZ-RECLUTAS 2023-10* survey. Round sardinella (*Sardinella aurita*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 14**.

| ***ECOCADIZ-RECLUTAS 2023-10. Sardinella aurita*. ABUNDANCE (in numbers and million fish)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **Portugal** | **POL02** | **POL03** | **POL04** | **Spain** | **TOTAL** | **Millions** | | |
| | | | | | | | | **Portugal** | **Spain** | **Total** |
| **25** | 0 | 0 | 0 | 19257 | 0 | 19257 | 19257 | 0 | 0.019257 | 0.019257 |
| **25.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **26** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **26.5** | 0 | 0 | 0 | 19257 | 0 | 19257 | 19257 | 0 | 0.019257 | 0.019257 |
| **27** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **27.5** | 0 | 0 | 0 | 38514 | 0 | 38514 | 38514 | 0 | 0.038514 | 0.038514 |
| **28** | 49493 | 49493 | 8599 | 0 | 54668 | 63267 | 112760 | 0.049493 | 0.063267 | 0.11276 |
| **28.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **29** | 0 | 0 | 0 | 19257 | 0 | 19257 | 19257 | 0 | 0.019257 | 0.019257 |
| **29.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **30** | 11248 | 11248 | 1954 | 0 | 12425 | 14379 | 25627 | 0.011248 | 0.014379 | 0.025627 |
| **30.5** | 22497 | 22497 | 3909 | 0 | 24849 | 28758 | 51255 | 0.022497 | 0.028758 | 0.051255 |
| **31** | 33745 | 33745 | 5863 | 19257 | 37274 | 62394 | 96139 | 0.033745 | 0.062394 | 0.096139 |
| **31.5** | 83239 | 83239 | 14462 | 0 | 91941 | 106403 | 189642 | 0.083239 | 0.106403 | 0.189642 |
| **32** | 35995 | 35995 | 6254 | 0 | 39758 | 46012 | 82007 | 0.035995 | 0.046012 | 0.082007 |
| **32.5** | 61867 | 61867 | 10749 | 0 | 68335 | 79084 | 140951 | 0.061867 | 0.079084 | 0.140951 |
| **33** | 11248 | 11248 | 1954 | 0 | 12425 | 14379 | 25627 | 0.011248 | 0.014379 | 0.025627 |
| **33.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **34** | 61867 | 61867 | 10749 | 0 | 68335 | 79084 | 140951 | 0.061867 | 0.079084 | 0.140951 |
| **TOTAL n** | 371199 | 371199 | 64493 | 115542 | 410010 | 590045 | 961244 | **0.4** | **1** | **1** |
| **Millions** | **0.4** | **0.4** | **0.1** | **0.1** | **0.4** | **1** | **1.0** | | | |

**Table 12.** *ECOCADIZ-RECLUTAS 2023-10* survey. Round sardinella (*Sardinella aurita*). Cont'd.

| *ECOCADIZ-RECLUTAS 2023-10. Sardinella aurita*. BIOMASS (t) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **Portugal** | **POL02** | **POL03** | **POL04** | **Spain** | **TOTAL** |
| **25** | 0 | 0 | 0 | 2.466 | 0 | 2.466 | 2.466 |
| **25.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **26** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **26.5** | 0 | 0 | 0 | 2.868 | 0 | 2.868 | 2.868 |
| **27** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **27.5** | 0 | 0 | 0 | 6.316 | 0 | 6.316 | 6.316 |
| **28** | 8.506 | 8.506 | 1.478 | 0 | 9.395 | 10.873 | 19.379 |
| **28.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **29** | 0 | 0 | 0 | 3.625 | 0 | 3.625 | 3.625 |
| **29.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **30** | 2.313 | 2.313 | 0.402 | 0 | 2.555 | 2.957 | 5.270 |
| **30.5** | 4.829 | 4.829 | 0.839 | 0 | 5.333 | 6.172 | 11.001 |
| **31** | 7.556 | 7.556 | 1.313 | 4.312 | 8.346 | 13.971 | 21.527 |
| **31.5** | 19.430 | 19.430 | 3.376 | 0 | 21.461 | 24.837 | 44.267 |
| **32** | 8.753 | 8.753 | 1.521 | 0 | 9.668 | 11.189 | 19.942 |
| **32.5** | 15.664 | 15.664 | 2.722 | 0 | 17.302 | 20.024 | 35.688 |
| **33** | 2.963 | 2.963 | 0.515 | 0 | 3.273 | 3.788 | 6.751 |
| **33.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **34** | 17.615 | 17.615 | 3.061 | 0 | 19.457 | 22.518 | 40.133 |
| **TOTAL** | **87.629** | **87.629** | **15.227** | **19.587** | **96.790** | **131.604** | **219.233** |

**Table 13.** *ECOCADIZ-RECLUTAS 2023-10* survey. Atlantic mackerel (*Scomber scombrus*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.,* coherent or homogeneous post-strata) numbered as in **Figure 19.**

| ***ECOCADIZ-RECLUTAS 2023-10. Scomber scombrus.*** **ABUNDANCE (in numbers and million fish)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **Portugal** | **POL02** | **Spain** | **TOTAL** | **Millions** | | |
| | | | | | | **Portugal** | **Spain** | **Total** |
| **19.5** | 0 | 0 | 13580 | 13580 | 13580 | 0 | 0.01358 | 0.01358 |
| **20** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **20.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **21** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **21.5** | 0 | 0 | 13580 | 13580 | 13580 | 0 | 0.01358 | 0.01358 |
| **22** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **22.5** | 0 | 0 | 13580 | 13580 | 13580 | 0 | 0.01358 | 0.01358 |
| **23** | 0 | 0 | 54318 | 54318 | 54318 | 0 | 0.054318 | 0.054318 |
| **23.5** | 0 | 0 | 81478 | 81478 | 81478 | 0 | 0.081478 | 0.081478 |
| **24** | 0 | 0 | 13580 | 13580 | 13580 | 0 | 0.01358 | 0.01358 |
| **24.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **25** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **25.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **26** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **26.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **27** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **27.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **28** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **28.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **29** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **29.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **30** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **30.5** | 107352 | 107352 | 0 | 0 | 107352 | 0.107352 | 0 | 0.107352 |
| **31** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **31.5** | 35784 | 35784 | 0 | 0 | 35784 | 0.035784 | 0 | 0.035784 |
| **32** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **32.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **33** | 35784 | 35784 | 0 | 0 | 35784 | 0.035784 | 0 | 0.035784 |
| **33.5** | 35784 | 35784 | 0 | 0 | 35784 | 0.035784 | 0 | 0.035784 |
| **34** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **34.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **35** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **35.5** | 107352 | 107352 | 0 | 0 | 107352 | 0.107352 | 0 | 0.107352 |
| **TOTAL n** | 322056 | 322056 | 190116 | 190116 | 512172 | **0.3** | **0.2** | **1** |
| **Millions** | **0.3** | **0.3** | **0.2** | **0.2** | **1** | | | |

**Tabla 13.** *ECOCADIZ-RECLUTAS 2023-10* survey. Atlantic mackerel (*Scomber scombrus*). Cont'd.

| *ECOCADIZ-RECLUTAS 2023-10. Scomber scombrus.* **BIOMASS (t)** | | | | | |
|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **Portugal** | **POL02** | **Spain** | **TOTAL** |
| **19.5** | 0 | 0 | 0.771 | 0.771 | 0.771 |
| **20** | 0 | 0 | 0 | 0 | 0 |
| **20.5** | 0 | 0 | 0 | 0 | 0 |
| **21** | 0 | 0 | 0 | 0 | 0 |
| **21.5** | 0 | 0 | 1.053 | 1.053 | 1.053 |
| **22** | 0 | 0 | 0 | 0 | 0 |
| **22.5** | 0 | 0 | 1.218 | 1.218 | 1.218 |
| **23** | 0 | 0 | 5.229 | 5.229 | 5.229 |
| **23.5** | 0 | 0 | 8.404 | 8.404 | 8.404 |
| **24** | 0 | 0 | 1.498 | 1.498 | 1.498 |
| **24.5** | 0 | 0 | 0 | 0 | 0 |
| **25** | 0 | 0 | 0 | 0 | 0 |
| **25.5** | 0 | 0 | 0 | 0 | 0 |
| **26** | 0 | 0 | 0 | 0 | 0 |
| **26.5** | 0 | 0 | 0 | 0 | 0 |
| **27** | 0 | 0 | 0 | 0 | 0 |
| **27.5** | 0 | 0 | 0 | 0 | 0 |
| **28** | 0 | 0 | 0 | 0 | 0 |
| **28.5** | 0 | 0 | 0 | 0 | 0 |
| **29** | 0 | 0 | 0 | 0 | 0 |
| **29.5** | 0 | 0 | 0 | 0 | 0 |
| **30** | 0 | 0 | 0 | 0 | 0 |
| **30.5** | 25.568 | 25.568 | 0 | 0 | 25.568 |
| **31** | 0 | 0 | 0 | 0 | 0 |
| **31.5** | 9.454 | 9.454 | 0 | 0 | 9.454 |
| **32** | 0 | 0 | 0 | 0 | 0 |
| **32.5** | 0 | 0 | 0 | 0 | 0 |
| **33** | 10.979 | 10.979 | 0 | 0 | 10.979 |
| **33.5** | 11.523 | 11.523 | 0 | 0 | 11.523 |
| **34** | 0 | 0 | 0 | 0 | 0 |
| **34.5** | 0 | 0 | 0 | 0 | 0 |
| **35** | 0 | 0 | 0 | 0 | 0 |
| **35.5** | 41.656 | 41.656 | 0 | 0 | 41.656 |
| **TOTAL** | **99.180** | **99.180** | **18.173** | **18.173** | **117.353** |

**Table 14.** *ECOCADIZ-RECLUTAS 2023-10* survey. Chub mackerel (*Scomber colias*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 19.**

| ***ECOCADIZ-RECLUTAS 2023-10. Scomber colias.* ABUNDANCE (in numbers and million fish)** | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **POL03** | **Portugal** | **POL04** | **POL05** | **POL06** | **POL07** | **POL08** | **POL09** | **POL10** | **Spain** | **TOTAL** | **Millions** | | |
| | | | | | | | | | | | | | | **Portugal** | **Spain** | **Total** |
| **17.5** | 600579 | 0 | 0 | 600579 | 0 | 0 | 0 | 1017 | 0 | 0 | 0 | 1017 | 601596 | 0.600579 | 0.001017 | 0.601596 |
| **18** | 4452053 | 0 | 0 | 4452053 | 0 | 0 | 0 | 7542 | 0 | 0 | 0 | 7542 | 4459595 | 4.452053 | 0.007542 | 4.459595 |
| **18.5** | 17742023 | 0 | 0 | 17742023 | 0 | 0 | 0 | 30058 | 0 | 0 | 0 | 30058 | 17772081 | 17.742023 | 0.030058 | 17.772081 |
| **19** | 19231625 | 0 | 0 | 19231625 | 0 | 0 | 0 | 32581 | 0 | 0 | 0 | 32581 | 19264206 | 19.231625 | 0.032581 | 19.264206 |
| **19.5** | 21875466 | 0 | 0 | 21875466 | 0 | 801923 | 0 | 37060 | 519 | 0 | 1 | 839503 | 22714969 | 21.875466 | 0.839503 | 22.714969 |
| **20** | 10994286 | 0 | 0 | 10994286 | 0 | 1530107 | 0 | 18626 | 991 | 0 | 2 | 1549726 | 12544012 | 10.994286 | 1.549726 | 12.544012 |
| **20.5** | 7651457 | 0 | 0 | 7651457 | 0 | 2193767 | 0 | 12963 | 1421 | 0 | 3 | 2208154 | 9859611 | 7.651457 | 2.208154 | 9.859611 |
| **21** | 5415641 | 0 | 0 | 5415641 | 0 | 2120027 | 0 | 9175 | 1373 | 0 | 3 | 2130578 | 7546219 | 5.415641 | 2.130578 | 7.546219 |
| **21.5** | 3562721 | 0 | 0 | 3562721 | 0 | 2774470 | 0 | 6036 | 1797 | 0 | 4 | 2782307 | 6345028 | 3.562721 | 2.782307 | 6.345028 |
| **22** | 2780484 | 0 | 0 | 2780484 | 0 | 2479510 | 0 | 4711 | 1606 | 0 | 3 | 2485830 | 5266314 | 2.780484 | 2.48583 | 5.266314 |
| **22.5** | 1261025 | 0 | 0 | 1261025 | 0 | 949403 | 0 | 2136 | 615 | 0 | 1 | 952155 | 2213180 | 1.261025 | 0.952155 | 2.21318 |
| **23** | 600579 | 0 | 0 | 600579 | 0 | 1023144 | 0 | 1017 | 663 | 0 | 1 | 1024825 | 1625404 | 0.600579 | 1.024825 | 1.625404 |
| **23.5** | 0 | 0 | 0 | 0 | 0 | 442440 | 0 | 0 | 287 | 0 | 1 | 442728 | 442728 | 0 | 0.442728 | 0.442728 |
| **24** | 0 | 0 | 0 | 0 | 0 | 1023144 | 0 | 0 | 663 | 0 | 1 | 1023808 | 1023808 | 0 | 1.023808 | 1.023808 |
| **24.5** | 273593 | 0 | 0 | 273593 | 0 | 949403 | 0 | 464 | 615 | 0 | 1 | 950483 | 1224076 | 0.273593 | 0.950483 | 1.224076 |
| **25** | 0 | 0 | 0 | 0 | 0 | 801923 | 0 | 0 | 519 | 0 | 1 | 802443 | 802443 | 0 | 0.802443 | 0.802443 |
| **25.5** | 0 | 0 | 4133 | 4133 | 42779 | 442440 | 10654 | 0 | 287 | 21913 | 1 | 518074 | 522207 | 0.004133 | 0.518074 | 0.522207 |
| **26** | 273593 | 0 | 4133 | 277726 | 42779 | 221220 | 10654 | 464 | 143 | 21913 | 0 | 297173 | 574899 | 0.277726 | 0.297173 | 0.574899 |
| **26.5** | 0 | 0 | 2755 | 2755 | 28519 | 0 | 7102 | 0 | 0 | 14608 | 0 | 50229 | 52984 | 0.002755 | 0.050229 | 0.052984 |
| **27** | 0 | 0 | 2755 | 2755 | 28519 | 0 | 7102 | 0 | 0 | 14608 | 0 | 50229 | 52984 | 0.002755 | 0.050229 | 0.052984 |
| **27.5** | 0 | 37130 | 0 | 37130 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 37130 | 0.03713 | 0 | 0.03713 |
| **28** | 0 | 111391 | 0 | 111391 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 111391 | 0.111391 | 0 | 0.111391 |
| **28.5** | 0 | 185651 | 0 | 185651 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 185651 | 0.185651 | 0 | 0.185651 |
| **29** | 0 | 334173 | 2755 | 336928 | 28519 | 0 | 7102 | 0 | 0 | 14608 | 0 | 50229 | 387157 | 0.336928 | 0.050229 | 0.387157 |
| **29.5** | 0 | 185651 | 0 | 185651 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 185651 | 0.185651 | 0 | 0.185651 |
| **30** | 0 | 185651 | 4133 | 189784 | 42779 | 0 | 10654 | 0 | 0 | 21913 | 0 | 75346 | 265130 | 0.189784 | 0.075346 | 0.26513 |
| **30.5** | 0 | 111391 | 5511 | 116902 | 57038 | 0 | 14205 | 0 | 0 | 29217 | 0 | 100460 | 217362 | 0.116902 | 0.10046 | 0.217362 |
| **31** | 0 | 37130 | 19287 | 56417 | 199635 | 0 | 49716 | 0 | 0 | 102258 | 0 | 351609 | 408026 | 0.056417 | 0.351609 | 0.408026 |
| **31.5** | 0 | 0 | 15154 | 15154 | 156856 | 0 | 39063 | 0 | 0 | 80346 | 0 | 276265 | 291419 | 0.015154 | 0.276265 | 0.291419 |
| **32** | 0 | 0 | 23420 | 23420 | 242413 | 0 | 60370 | 0 | 0 | 124171 | 0 | 426954 | 450374 | 0.02342 | 0.426954 | 0.450374 |
| **32.5** | 0 | 0 | 16532 | 16532 | 171115 | 0 | 42614 | 0 | 0 | 87650 | 0 | 301379 | 317911 | 0.016532 | 0.301379 | 0.317911 |
| **33** | 0 | 0 | 11021 | 11021 | 114077 | 0 | 28409 | 0 | 0 | 58433 | 0 | 200919 | 211940 | 0.011021 | 0.200919 | 0.21194 |
| **33.5** | 0 | 0 | 2755 | 2755 | 28519 | 0 | 7102 | 0 | 0 | 14608 | 0 | 50229 | 52984 | 0.002755 | 0.050229 | 0.052984 |
| **34** | 0 | 0 | 5511 | 5511 | 57038 | 0 | 14205 | 0 | 0 | 29217 | 0 | 100460 | 105971 | 0.005511 | 0.10046 | 0.105971 |
| **34.5** | 0 | 0 | 1378 | 1378 | 14260 | 0 | 3551 | 0 | 0 | 7304 | 0 | 25115 | 26493 | 0.001378 | 0.025115 | 0.026493 |
| **35** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **35.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **36** | 0 | 0 | 1378 | 1378 | 14260 | 0 | 3551 | 0 | 0 | 7304 | 0 | 25115 | 26493 | 0.001378 | 0.025115 | 0.026493 |
| **TOTAL n** | 96715125 | 1188168 | 122611 | 98025904 | 1269105 | 17752921 | 316054 | 163850 | 11499 | 650071 | 23 | 20163523 | 118189427 | **98** | **20** | **118** |
| **Millions** | **97** | **1** | **0.1** | **98** | **1** | **18** | **0.3** | **0.2** | **0.01** | **1** | **0.00002** | **20** | **118** | | | |

**Tabla 14.** *ECOCADIZ-RECLUTAS 2023-10* survey. Chub mackerel (*Scomber colias*). Cont'd.

| ***ECOCADIZ-RECLUTAS 2023-10. Scomber colias.* BIOMASS (t)** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **POL03** | **Portugal** | **POL04** | **POL05** | **POL06** | **POL07** | **POL08** | **POL09** | **POL10** | **Spain** | **TOTAL** |
| **17.5** | 24.295 | 0 | 0 | 24.295 | 0 | 0 | 0 | 0.041 | 0 | 0 | 0 | 0.041 | 24.336 |
| **18** | 198.309 | 0 | 0 | 198.309 | 0 | 0 | 0 | 0.336 | 0 | 0 | 0 | 0.336 | 198.645 |
| **18.5** | 867.956 | 0 | 0 | 867.956 | 0 | 0 | 0 | 1.470 | 0 | 0 | 0 | 1.470 | 869.426 |
| **19** | 1030.743 | 0 | 0 | 1030.743 | 0 | 0 | 0 | 1.746 | 0 | 0 | 0 | 1.746 | 1032.489 |
| **19.5** | 1281.491 | 0 | 0 | 1281.491 | 0 | 46.978 | 0 | 2.171 | 0.030 | 0 | 0 | 49.179 | 1330.670 |
| **20** | 702.398 | 0 | 0 | 702.398 | 0 | 97.755 | 0 | 1.190 | 0.063 | 0 | 0 | 99.008 | 801.406 |
| **20.5** | 531.985 | 0 | 0 | 531.985 | 0 | 152.527 | 0 | 0.901 | 0.099 | 0 | 0 | 153.527 | 685.512 |
| **21** | 408.949 | 0 | 0 | 408.949 | 0 | 160.089 | 0 | 0.693 | 0.104 | 0 | 0 | 160.886 | 569.835 |
| **21.5** | 291.630 | 0 | 0 | 291.630 | 0 | 227.107 | 0 | 0.494 | 0.147 | 0 | 0 | 227.748 | 519.378 |
| **22** | 246.266 | 0 | 0 | 246.266 | 0 | 219.609 | 0 | 0.417 | 0.142 | 0 | 0 | 220.168 | 466.434 |
| **22.5** | 120.637 | 0 | 0 | 120.637 | 0 | 90.826 | 0 | 0.204 | 0.059 | 0 | 0 | 91.089 | 211.726 |
| **23** | 61.955 | 0 | 0 | 61.955 | 0 | 105.546 | 0 | 0.105 | 0.068 | 0 | 0 | 105.719 | 167.674 |
| **23.5** | 0 | 0 | 0 | 0 | 0 | 49.137 | 0 | 0 | 0.032 | 0 | 0 | 49.169 | 49.169 |
| **24** | 0 | 0 | 0 | 0 | 0 | 122.143 | 0 | 0 | 0.079 | 0 | 0 | 122.222 | 122.222 |
| **24.5** | 35.057 | 0 | 0 | 35.057 | 0 | 121.653 | 0 | 0.059 | 0.079 | 0 | 0 | 121.791 | 156.848 |
| **25** | 0 | 0 | 0 | 0 | 0 | 110.137 | 0 | 0 | 0.071 | 0 | 0 | 110.208 | 110.208 |
| **25.5** | 0 | 0 | 0.608 | 0.608 | 6.289 | 65.041 | 1.566 | 0 | 0.042 | 3.221 | 0 | 76.159 | 76.767 |
| **26** | 42.994 | 0 | 0.649 | 43.643 | 6.723 | 34.764 | 1.674 | 0.073 | 0.022 | 3.444 | 0 | 46.700 | 90.343 |
| **26.5** | 0 | 0 | 0.462 | 0.462 | 4.785 | 0 | 1.192 | 0 | 0 | 2.451 | 0 | 8.428 | 8.890 |
| **27** | 0 | 0 | 0.493 | 0.493 | 5.102 | 0 | 1.271 | 0 | 0 | 2.613 | 0 | 8.986 | 9.479 |
| **27.5** | 0 | 7.075 | 0 | 7.075 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7.075 |
| **28** | 0 | 22.581 | 0 | 22.581 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22.581 |
| **28.5** | 0 | 39.997 | 0 | 39.997 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 39.997 |
| **29** | 0 | 76.431 | 0.63 | 77.061 | 6.523 | 0 | 1.624 | 0 | 0 | 3.341 | 0 | 11.488 | 88.549 |
| **29.5** | 0 | 45.032 | 0 | 45.032 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 45.032 |
| **30** | 0 | 47.712 | 1.062 | 48.774 | 10.994 | 0 | 2.738 | 0 | 0 | 5.632 | 0 | 19.364 | 68.138 |
| **30.5** | 0 | 30.302 | 1.499 | 31.801 | 15.516 | 0 | 3.864 | 0 | 0 | 7.948 | 0 | 27.328 | 59.129 |
| **31** | 0 | 10.682 | 5.549 | 16.231 | 57.432 | 0 | 14.303 | 0 | 0 | 29.418 | 0 | 101.153 | 117.384 |
| **31.5** | 0 | 0 | 4.606 | 4.606 | 47.679 | 0 | 11.874 | 0 | 0 | 24.423 | 0 | 83.976 | 88.582 |
| **32** | 0 | 0 | 7.515 | 7.515 | 77.789 | 0 | 19.372 | 0 | 0 | 39.846 | 0 | 137.007 | 144.522 |
| **32.5** | 0 | 0 | 5.596 | 5.596 | 57.919 | 0 | 14.424 | 0 | 0 | 29.668 | 0 | 102.011 | 107.607 |
| **33** | 0 | 0 | 3.932 | 3.932 | 40.696 | 0 | 10.135 | 0 | 0 | 20.846 | 0 | 71.677 | 75.609 |
| **33.5** | 0 | 0 | 1.035 | 1.035 | 10.715 | 0 | 2.668 | 0 | 0 | 5.488 | 0 | 18.871 | 19.906 |
| **34** | 0 | 0 | 2.179 | 2.179 | 22.55 | 0 | 5.616 | 0 | 0 | 11.551 | 0 | 39.717 | 41.896 |
| **34.5** | 0 | 0 | 0.573 | 0.573 | 5.928 | 0 | 1.476 | 0 | 0 | 3.037 | 0 | 10.441 | 11.014 |
| **35** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **35.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **36** | 0 | 0 | 0.663 | 0.663 | 6.864 | 0 | 1.709 | 0 | 0 | 3.516 | 0 | 12.089 | 12.752 |
| **TOTAL** | **5844.665** | **279.812** | **37.051** | **6161.528** | **383.504** | **1603.312** | **95.506** | **9.900** | **1.037** | **196.443** | **0.000** | **2289.702** | **8451.230** |

**Table 15.** *ECOCADIZ-RECLUTAS* surveys series. Chub mackerel (*Scomber colias*). Acoustic estimates of biomass (t) and abundance (million fish) for the whole Gulf of Cádiz anchovy population and for the juvenile fraction (*i.e.* age 0 fish, between parentheses). Note that the 2012 survey only surveyed the Spanish waters. The 2017 estimates correspond to an incomplete coverage (only the seven easternmost transects) of the standard surveyed area due to a research vessels' breakdown. n.a.: Not available.

| Estimate/Year | Total Population (Recruits at age 0) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2012** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** |
| **Biomass (t)** | 11155 (n.a.) | 17471 (n.a.) | 5683 (n.a.) | 13689 (n.a.) | 11726 (n.a.) | 6950 (n.a.) | 26212 (5265) | 22918 (2759) | 13115 (1689) | 15500 (8198) | 8451 (5865) |
| **Abundance (millions)** | 157 (n.a.) | 148 (n.a.) | 65 (n.a.) | 297 (n.a.) | 86 (n.a.) | 108 (n.a.) | 367 (88) | 295 (51) | 106 (26) | 246 (163) | 118 (98) |

**Table 16.** *ECOCADIZ-RECLUTAS 2023-10* survey. Horse mackerel (*Trachurus trachurus*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 23**.

***ECOCADIZ-RECLUTAS 2023-10. Trachurus trachurus.* ABUNDANCE (in numbers and million fish)**

| SIZE CLASS (cm) | POL01 | POL02 | POL03 | POL04 | Portugal | POL05 | POL06 | POL07 | POL08 | Spain | TOTAL | Millions | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | Portugal | Spain | Total |
| 4.5 | 0 | 0 | 1355985 | 0 | 1355985 | 0 | 0 | 0 | 0 | 0 | 1355985 | 1.355985 | 0 | 1.355985 |
| 5 | 0 | 0 | 1355985 | 152055 | 1508040 | 1127422 | 0 | 0 | 0 | 1127422 | 2635462 | 1.50804 | 1.127422 | 2.635462 |
| 5.5 | 0 | 0 | 1355985 | 152055 | 1508040 | 1127422 | 8506 | 0 | 0 | 1135928 | 2643968 | 1.50804 | 1.135928 | 2.643968 |
| 6 | 0 | 1843830 | 1355985 | 608220 | 3808035 | 4509687 | 0 | 0 | 0 | 4509687 | 8317722 | 3.808035 | 4.509687 | 8.317722 |
| 6.5 | 1636658 | 1229220 | 4067954 | 760275 | 7694107 | 5637109 | 0 | 0 | 0 | 5637109 | 13331216 | 7.694107 | 5.637109 | 13.331216 |
| 7 | 0 | 1843830 | 0 | 760275 | 2604105 | 5637109 | 17012 | 0 | 0 | 5654121 | 8258226 | 2.604105 | 5.654121 | 8.258226 |
| 7.5 | 0 | 1229220 | 0 | 304110 | 1533330 | 2254844 | 8506 | 0 | 0 | 2263350 | 3796680 | 1.53333 | 2.26335 | 3.79668 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 8506 | 0 | 0 | 8506 | 8506 | 0 | 0.008506 | 0.008506 |
| 8.5 | 0 | 614610 | 0 | 0 | 614610 | 0 | 0 | 0 | 0 | 0 | 614610 | 0.61461 | 0 | 0.61461 |
| 9 | 0 | 614610 | 0 | 0 | 614610 | 0 | 0 | 0 | 0 | 0 | 614610 | 0.61461 | 0 | 0.61461 |
| 9.5 | 0 | 3073050 | 0 | 0 | 3073050 | 0 | 0 | 0 | 0 | 0 | 3073050 | 3.07305 | 0 | 3.07305 |
| 10 | 0 | 22740567 | 0 | 0 | 22740567 | 0 | 0 | 1326 | 29 | 1355 | 22741922 | 22.740567 | 0.001355 | 22.741922 |
| 10.5 | 0 | 32574326 | 0 | 0 | 32574326 | 0 | 0 | 0 | 0 | 0 | 32574326 | 32.574326 | 0 | 32.574326 |
| 11 | 0 | 30730496 | 0 | 0 | 30730496 | 0 | 0 | 0 | 0 | 0 | 30730496 | 30.730496 | 0 | 30.730496 |
| 11.5 | 0 | 19052908 | 0 | 0 | 19052908 | 0 | 0 | 1326 | 29 | 1355 | 19054263 | 19.052908 | 0.001355 | 19.054263 |
| 12 | 0 | 3073050 | 0 | 0 | 3073050 | 0 | 0 | 0 | 0 | 0 | 3073050 | 3.07305 | 0 | 3.07305 |
| 12.5 | 0 | 1229220 | 0 | 0 | 1229220 | 0 | 0 | 0 | 0 | 0 | 1229220 | 1.22922 | 0 | 1.22922 |
| 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2651 | 58 | 2709 | 2709 | 0 | 0.002709 | 0.002709 |
| 13.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3977 | 87 | 4064 | 4064 | 0 | 0.004064 | 0.004064 |
| 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3977 | 87 | 4064 | 4064 | 0 | 0.004064 | 0.004064 |
| 14.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1326 | 29 | 1355 | 1355 | 0 | 0.001355 | 0.001355 |
| 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3977 | 87 | 4064 | 4064 | 0 | 0.004064 | 0.004064 |
| 16.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1326 | 29 | 1355 | 1355 | 0 | 0.001355 | 0.001355 |
| 17 | 0 | 0 | 1355985 | 0 | 1355985 | 0 | 0 | 3977 | 87 | 4064 | 1360049 | 1.355985 | 0.004064 | 1.360049 |
| 17.5 | 0 | 0 | 1355985 | 0 | 1355985 | 0 | 0 | 1326 | 29 | 1355 | 1357340 | 1.355985 | 0.001355 | 1.35734 |
| 18 | 0 | 0 | 2711969 | 0 | 2711969 | 0 | 0 | 2651 | 58 | 2709 | 2714678 | 2.711969 | 0.002709 | 2.714678 |
| 18.5 | 0 | 0 | 10847876 | 0 | 10847876 | 0 | 0 | 1326 | 29 | 1355 | 10849231 | 10.847876 | 0.001355 | 10.849231 |
| 19 | 0 | 0 | 8135907 | 0 | 8135907 | 0 | 0 | 0 | 0 | 0 | 8135907 | 8.135907 | 0 | 8.135907 |
| 19.5 | 0 | 0 | 16271814 | 0 | 16271814 | 0 | 0 | 0 | 0 | 0 | 16271814 | 16.271814 | 0 | 16.271814 |
| 20 | 0 | 0 | 5423938 | 0 | 5423938 | 0 | 0 | 0 | 0 | 0 | 5423938 | 5.423938 | 0 | 5.423938 |
| 20.5 | 3273316 | 0 | 6779923 | 152055 | 10205294 | 1127422 | 0 | 0 | 0 | 1127422 | 11332716 | 10.205294 | 1.127422 | 11.332716 |
| 21 | 0 | 0 | 5423938 | 152055 | 5575993 | 1127422 | 0 | 0 | 0 | 1127422 | 6703415 | 5.575993 | 1.127422 | 6.703415 |
| 21.5 | 1636658 | 0 | 4067954 | 0 | 5704612 | 0 | 0 | 0 | 0 | 0 | 5704612 | 5.704612 | 0 | 5.704612 |
| 22 | 3273316 | 0 | 0 | 0 | 3273316 | 0 | 0 | 0 | 0 | 0 | 3273316 | 3.273316 | 0 | 3.273316 |
| 22.5 | 6546633 | 614610 | 2711969 | 0 | 9873212 | 0 | 0 | 0 | 0 | 0 | 9873212 | 9.873212 | 0 | 9.873212 |
| 23 | 9819949 | 0 | 1355985 | 0 | 11175934 | 0 | 0 | 0 | 0 | 0 | 11175934 | 11.175934 | 0 | 11.175934 |
| 23.5 | 11456607 | 0 | 1355985 | 0 | 12812592 | 0 | 0 | 0 | 0 | 0 | 12812592 | 12.812592 | 0 | 12.812592 |
| 24 | 9819949 | 614610 | 1355985 | 0 | 11790544 | 0 | 0 | 0 | 0 | 0 | 11790544 | 11.790544 | 0 | 11.790544 |
| 24.5 | 18003240 | 0 | 0 | 0 | 18003240 | 0 | 0 | 0 | 0 | 0 | 18003240 | 18.00324 | 0 | 18.00324 |
| 25 | 6546633 | 614610 | 0 | 0 | 7161243 | 0 | 0 | 0 | 0 | 0 | 7161243 | 7.161243 | 0 | 7.161243 |
| 25.5 | 6546633 | 0 | 0 | 0 | 6546633 | 0 | 0 | 0 | 0 | 0 | 6546633 | 6.546633 | 0 | 6.546633 |
| 26 | 14729923 | 0 | 0 | 0 | 14729923 | 0 | 0 | 0 | 0 | 0 | 14729923 | 14.729923 | 0 | 14.729923 |
| 26.5 | 6546633 | 0 | 0 | 0 | 6546633 | 0 | 0 | 0 | 0 | 0 | 6546633 | 6.546633 | 0 | 6.546633 |
| **TOTAL n** | 99836148 | 121692767 | 78647107 | 3041100 | 303217122 | 22548437 | 42530 | 29166 | 638 | 22620771 | 325837893 | **303** | **23** | **326** |
| **Millions** | **100** | **122** | **79** | **3** | **303** | **23** | **0.04** | **0.03** | **0.001** | **23** | **326** | | | |

**Tabla 16.** *ECOCADIZ-RECLUTAS 2023-10* survey. Horse mackerel (*Trachurus trachurus*). Cont'd.

| ***ECOCADIZ-RECLUTAS 2023-10. Trachurus trachurus.* BIOMASS (t)** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **POL03** | **POL04** | **Portugal** | **POL05** | **POL06** | **POL07** | **POL08** | **Spain** | **TOTAL** |
| **4.5** | 0 | 0 | 1.430 | 0 | 1.430 | 0 | 0 | 0 | 0 | 0 | 1.430 |
| **5** | 0 | 0 | 1.909 | 0.214 | 2.123 | 1.587 | 0 | 0 | 0 | 1.587 | 3.710 |
| **5.5** | 0 | 0 | 2.482 | 0.278 | 2.760 | 2.064 | 0.016 | 0 | 0 | 2.080 | 4.840 |
| **6** | 0 | 4.293 | 3.157 | 1.416 | 8.866 | 10.500 | 0 | 0 | 0 | 10.500 | 19.366 |
| **6.5** | 4.759 | 3.574 | 11.828 | 2.211 | 22.372 | 16.390 | 0 | 0 | 0 | 16.390 | 38.762 |
| **7** | 0 | 6.589 | 0 | 2.717 | 9.306 | 20.144 | 0.061 | 0 | 0 | 20.205 | 29.511 |
| **7.5** | 0 | 5.325 | 0 | 1.317 | 6.642 | 9.768 | 0.037 | 0 | 0 | 9.805 | 16.447 |
| **8** | 0 | 0 | 0 | 0 | 0 | 0 | 0.044 | 0 | 0 | 0.044 | 0.044 |
| **8.5** | 0 | 3.779 | 0 | 0 | 3.779 | 0 | 0 | 0 | 0 | 0 | 3.779 |
| **9** | 0 | 4.437 | 0 | 0 | 4.437 | 0 | 0 | 0 | 0 | 0 | 4.437 |
| **9.5** | 0 | 25.824 | 0 | 0 | 25.824 | 0 | 0 | 0 | 0 | 0 | 25.824 |
| **10** | 0 | 220.770 | 0 | 0 | 220.770 | 0 | 0 | 0.013 | 0 | 0.013 | 220.783 |
| **10.5** | 0 | 362.839 | 0 | 0 | 362.839 | 0 | 0 | 0 | 0 | 0 | 362.839 |
| **11** | 0 | 390.296 | 0 | 0 | 390.296 | 0 | 0 | 0 | 0 | 0 | 390.296 |
| **11.5** | 0 | 274.342 | 0 | 0 | 274.342 | 0 | 0 | 0.019 | 0 | 0.019 | 274.361 |
| **12** | 0 | 49.904 | 0 | 0 | 49.904 | 0 | 0 | 0 | 0 | 0 | 49.904 |
| **12.5** | 0 | 22.405 | 0 | 0 | 22.405 | 0 | 0 | 0 | 0 | 0 | 22.405 |
| **13** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.054 | 0.001 | 0.055 | 0.055 |
| **13.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.090 | 0.002 | 0.092 | 0.092 |
| **14** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.100 | 0.002 | 0.102 | 0.102 |
| **14.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.037 | 0.001 | 0.038 | 0.038 |
| **15** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **15.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **16** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.146 | 0.003 | 0.149 | 0.149 |
| **16.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.053 | 0.001 | 0.054 | 0.054 |
| **17** | 0 | 0 | 59.138 | 0 | 59.138 | 0 | 0 | 0.173 | 0.004 | 0.177 | 59.315 |
| **17.5** | 0 | 0 | 64.222 | 0 | 64.222 | 0 | 0 | 0.063 | 0.001 | 0.064 | 64.286 |
| **18** | 0 | 0 | 139.165 | 0 | 139.165 | 0 | 0 | 0.136 | 0.003 | 0.139 | 139.304 |
| **18.5** | 0 | 0 | 601.825 | 0 | 601.825 | 0 | 0 | 0.074 | 0.002 | 0.076 | 601.901 |
| **19** | 0 | 0 | 486.989 | 0 | 486.989 | 0 | 0 | 0 | 0 | 0 | 486.989 |
| **19.5** | 0 | 0 | 1048.797 | 0 | 1048.797 | 0 | 0 | 0 | 0 | 0 | 1048.797 |
| **20** | 0 | 0 | 375.758 | 0 | 375.758 | 0 | 0 | 0 | 0 | 0 | 375.758 |
| **20.5** | 243.307 | 0 | 503.956 | 11.302 | 758.565 | 83.802 | 0 | 0 | 0 | 83.802 | 842.367 |
| **21** | 0 | 0 | 431.845 | 12.106 | 443.951 | 89.764 | 0 | 0 | 0 | 89.764 | 533.715 |
| **21.5** | 139.355 | 0 | 346.371 | 0 | 485.726 | 0 | 0 | 0 | 0 | 0 | 485.726 |
| **22** | 297.606 | 0 | 0 | 0 | 297.606 | 0 | 0 | 0 | 0 | 0 | 297.606 |
| **22.5** | 634.641 | 59.581 | 262.902 | 0 | 957.124 | 0 | 0 | 0 | 0 | 0 | 957.124 |
| **23** | 1013.607 | 0 | 139.964 | 0 | 1153.571 | 0 | 0 | 0 | 0 | 0 | 1153.571 |
| **23.5** | 1257.438 | 0 | 148.828 | 0 | 1406.266 | 0 | 0 | 0 | 0 | 0 | 1406.266 |
| **24** | 1144.602 | 71.638 | 158.052 | 0 | 1374.292 | 0 | 0 | 0 | 0 | 0 | 1374.292 |
| **24.5** | 2225.758 | 0 | 0 | 0 | 2225.758 | 0 | 0 | 0 | 0 | 0 | 2225.758 |
| **25** | 857.463 | 80.500 | 0 | 0 | 937.963 | 0 | 0 | 0 | 0 | 0 | 937.963 |
| **25.5** | 907.390 | 0 | 0 | 0 | 907.390 | 0 | 0 | 0 | 0 | 0 | 907.390 |
| **26** | 2158.153 | 0 | 0 | 0 | 2158.153 | 0 | 0 | 0 | 0 | 0 | 2158.153 |
| **26.5** | 1012.863 | 0 | 0 | 0 | 1012.863 | 0 | 0 | 0 | 0 | 0 | 1012.863 |
| **TOTAL** | **11896.942** | **1586.096** | **4788.618** | **31.561** | **18303.217** | **234.019** | **0.158** | **0.958** | **0.020** | **235.155** | **18538.372** |

**Tabla 17.** *ECOCADIZ-RECLUTAS 2023-10* survey. Mediterranean horse mackerel (*Trachurus mediterraneus*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 26**.

| ***ECOCADIZ-RECLUTAS 2023-10. Trachurus mediterraneus.* ABUNDANCE (in numbers and million fish)** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **Portugal** | **POL02** | **POL04** | **POL05** | **POL06** | **Spain** | **TOTAL** | **Millions** | | |
| | | | | | | | | | **Portugal** | **Spain** | **Total** |
| **16** | 0 | 0 | 0 | 0 | 639429 | 0 | 639429 | 639429 | 0 | 0.639429 | 0.639429 |
| **16.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **17** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **17.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **18** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **18.5** | 0 | 0 | 0 | 0 | 639429 | 0 | 639429 | 639429 | 0 | 0.639429 | 0.639429 |
| **19** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **19.5** | 0 | 0 | 0 | 0 | 1278858 | 0 | 1278858 | 1278858 | 0 | 1.278858 | 1.278858 |
| **20** | 0 | 0 | 0 | 0 | 1278858 | 0 | 1278858 | 1278858 | 0 | 1.278858 | 1.278858 |
| **20.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **21** | 0 | 0 | 0 | 0 | 639429 | 0 | 639429 | 639429 | 0 | 0.639429 | 0.639429 |
| **21.5** | 0 | 0 | 0 | 0 | 1278858 | 0 | 1278858 | 1278858 | 0 | 1.278858 | 1.278858 |
| **22** | 2530 | 2530 | 26780 | 3652 | 639429 | 0 | 669861 | 672391 | 0.00253 | 0.669861 | 0.672391 |
| **22.5** | 12650 | 12650 | 133900 | 18262 | 0 | 0 | 152162 | 164812 | 0.01265 | 0.152162 | 0.164812 |
| **23** | 18975 | 18975 | 200850 | 27393 | 0 | 0 | 228243 | 247218 | 0.018975 | 0.228243 | 0.247218 |
| **23.5** | 12650 | 12650 | 133900 | 18262 | 0 | 0 | 152162 | 164812 | 0.01265 | 0.152162 | 0.164812 |
| **24** | 6325 | 6325 | 66950 | 9131 | 0 | 0 | 76081 | 82406 | 0.006325 | 0.076081 | 0.082406 |
| **24.5** | 2530 | 2530 | 26780 | 3652 | 0 | 0 | 30432 | 32962 | 0.00253 | 0.030432 | 0.032962 |
| **25** | 3795 | 3795 | 40170 | 5479 | 0 | 0 | 45649 | 49444 | 0.003795 | 0.045649 | 0.049444 |
| **25.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **26** | 921 | 921 | 9748 | 1329 | 0 | 0 | 11077 | 11998 | 0.000921 | 0.011077 | 0.011998 |
| **26.5** | 5525 | 5525 | 58486 | 7977 | 0 | 0 | 66463 | 71988 | 0.005525 | 0.066463 | 0.071988 |
| **27** | 12771 | 12771 | 135184 | 18437 | 0 | 0 | 153621 | 166392 | 0.012771 | 0.153621 | 0.166392 |
| **27.5** | 26807 | 26807 | 283758 | 38700 | 0 | 0 | 322458 | 349265 | 0.026807 | 0.322458 | 0.349265 |
| **28** | 77836 | 77836 | 823904 | 112367 | 0 | 68289 | 1004560 | 1082396 | 0.077836 | 1.00456 | 1.082396 |
| **28.5** | 100150 | 100150 | 1060102 | 144581 | 0 | 68289 | 1272972 | 1373122 | 0.10015 | 1.272972 | 1.373122 |
| **29** | 126158 | 126158 | 1335397 | 182127 | 0 | 341446 | 1858970 | 1985128 | 0.126158 | 1.85897 | 1.985128 |
| **29.5** | 66395 | 66395 | 702805 | 95851 | 0 | 478024 | 1276680 | 1343075 | 0.066395 | 1.27668 | 1.343075 |
| **30** | 46834 | 46834 | 495745 | 67612 | 639429 | 1502363 | 2705149 | 2751983 | 0.046834 | 2.705149 | 2.751983 |
| **30.5** | 28882 | 28882 | 305717 | 41695 | 0 | 1434073 | 1781485 | 1810367 | 0.028882 | 1.781485 | 1.810367 |
| **31** | 9553 | 9553 | 101120 | 13791 | 2557717 | 1092627 | 3765255 | 3774808 | 0.009553 | 3.765255 | 3.774808 |
| **31.5** | 10818 | 10818 | 114509 | 15617 | 0 | 409735 | 539861 | 550679 | 0.010818 | 0.539861 | 0.550679 |
| **32** | 4028 | 4028 | 42633 | 5814 | 4476005 | 68289 | 4592741 | 4596769 | 0.004028 | 4.592741 | 4.596769 |
| **32.5** | 3684 | 3684 | 38991 | 5318 | 1278858 | 68289 | 1391456 | 1395140 | 0.003684 | 1.391456 | 1.39514 |
| **33** | 2763 | 2763 | 29243 | 3988 | 639429 | 68289 | 740949 | 743712 | 0.002763 | 0.740949 | 0.743712 |
| **33.5** | 921 | 921 | 9748 | 1329 | 0 | 0 | 11077 | 11998 | 0.000921 | 0.011077 | 0.011998 |
| **34** | 0 | 0 | 0 | 0 | 1918288 | 0 | 1918288 | 1918288 | 0 | 1.918288 | 1.918288 |
| **34.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **35** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **35.5** | 921 | 921 | 9748 | 1329 | 0 | 0 | 11077 | 11998 | 0.000921 | 0.011077 | 0.011998 |
| **36** | 1265 | 1265 | 13390 | 1826 | 0 | 0 | 15216 | 16481 | 0.001265 | 0.015216 | 0.016481 |
| **36.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **37** | 0 | 0 | 0 | 0 | 639429 | 0 | 639429 | 639429 | 0 | 0.639429 | 0.639429 |
| **37.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **38** | 0 | 0 | 0 | 0 | 1278858 | 0 | 1278858 | 1278858 | 0 | 1.278858 | 1.278858 |
| **38.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **39** | 0 | 0 | 0 | 0 | 639429 | 0 | 639429 | 639429 | 0 | 0.639429 | 0.639429 |
| **TOTAL n** | 585687 | 585687 | 6199558 | 845519 | 20461732 | 5599713 | 33106522 | 33692209 | **1** | **33** | **34** |
| **Millions** | **1** | **1** | **6** | **1** | **20** | **6** | **33** | **34** | | | |

**Tabla 17.** *ECOCADIZ-RECLUTAS 2023-10* survey. Mediterranean horse mackerel (*Trachurus mediterraneus*). Cont'd.

| ***ECOCADIZ-RECLUTAS 2023-10. Trachurus mediterraneus.* BIOMASS (t)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **Portugal** | **POL02** | **POL04** | **POL05** | **POL06** | **Spain** | **TOTAL** |
| **16** | 0 | 0 | 0 | 0 | 24.368 | 0 | 24.368 | 24.368 |
| **16.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **17** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **17.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **18** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **18.5** | 0 | 0 | 0 | 0 | 36.564 | 0 | 36.564 | 36.564 |
| **19** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **19.5** | 0 | 0 | 0 | 0 | 84.736 | 0 | 84.736 | 84.736 |
| **20** | 0 | 0 | 0 | 0 | 90.962 | 0 | 90.962 | 90.962 |
| **20.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **21** | 0 | 0 | 0 | 0 | 52.142 | 0 | 52.142 | 52.142 |
| **21.5** | 0 | 0 | 0 | 0 | 111.394 | 0 | 111.394 | 111.394 |
| **22** | 0.235 | 0.235 | 2.488 | 0.339 | 59.405 | 0 | 62.232 | 62.467 |
| **22.5** | 1.252 | 1.252 | 13.249 | 1.807 | 0 | 0 | 15.056 | 16.308 |
| **23** | 1.997 | 1.997 | 21.137 | 2.883 | 0 | 0 | 24.020 | 26.017 |
| **23.5** | 1.414 | 1.414 | 14.968 | 2.041 | 0 | 0 | 17.009 | 18.423 |
| **24** | 0.750 | 0.750 | 7.939 | 1.083 | 0 | 0 | 9.022 | 9.772 |
| **24.5** | 0.318 | 0.318 | 3.365 | 0.459 | 0 | 0 | 3.824 | 4.142 |
| **25** | 0.505 | 0.505 | 5.342 | 0.729 | 0 | 0 | 6.071 | 6.576 |
| **25.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **26** | 0.137 | 0.137 | 1.447 | 0.197 | 0 | 0 | 1.644 | 1.781 |
| **26.5** | 0.865 | 0.865 | 9.160 | 1.249 | 0 | 0 | 10.409 | 11.274 |
| **27** | 2.108 | 2.108 | 22.315 | 3.043 | 0 | 0 | 25.358 | 27.466 |
| **27.5** | 4.659 | 4.659 | 49.318 | 6.726 | 0 | 0 | 56.044 | 60.703 |
| **28** | 14.231 | 14.231 | 150.636 | 20.544 | 0 | 12.485 | 183.665 | 197.896 |
| **28.5** | 19.245 | 19.245 | 203.706 | 27.782 | 0 | 13.122 | 244.610 | 263.855 |
| **29** | 25.457 | 25.457 | 269.464 | 36.751 | 0 | 68.899 | 375.114 | 400.571 |
| **29.5** | 14.057 | 14.057 | 148.799 | 20.294 | 0 | 101.208 | 270.301 | 284.358 |
| **30** | 10.396 | 10.396 | 110.039 | 15.008 | 141.932 | 333.476 | 600.455 | 610.851 |
| **30.5** | 6.716 | 6.716 | 71.088 | 9.695 | 0 | 333.465 | 414.248 | 420.964 |
| **31** | 2.325 | 2.325 | 24.614 | 3.357 | 622.579 | 265.958 | 916.508 | 918.833 |
| **31.5** | 2.754 | 2.754 | 29.156 | 3.976 | 0 | 104.326 | 137.458 | 140.212 |
| **32** | 1.072 | 1.072 | 11.347 | 1.547 | 1191.305 | 18.175 | 1222.374 | 1223.446 |
| **32.5** | 1.024 | 1.024 | 10.840 | 1.479 | 355.551 | 18.986 | 386.856 | 387.880 |
| **33** | 0.802 | 0.802 | 8.487 | 1.157 | 185.580 | 19.819 | 215.043 | 215.845 |
| **33.5** | 0.279 | 0.279 | 2.951 | 0.402 | 0 | 0 | 3.353 | 3.632 |
| **34** | 0 | 0 | 0 | 0 | 605.542 | 0 | 605.542 | 605.542 |
| **34.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **35** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **35.5** | 0.328 | 0.328 | 3.475 | 0.474 | 0 | 0 | 3.949 | 4.277 |
| **36** | 0.469 | 0.469 | 4.965 | 0.677 | 0 | 0 | 5.642 | 6.111 |
| **36.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **37** | 0 | 0 | 0 | 0 | 256.110 | 0 | 256.110 | 256.110 |
| **37.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **38** | 0 | 0 | 0 | 0 | 552.180 | 0 | 552.180 | 552.180 |
| **38.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **39** | 0 | 0 | 0 | 0 | 297.052 | 0 | 297.052 | 297.052 |
| **TOTAL** | **113.395** | **113.395** | **1200.295** | **163.699** | **4667.402** | **1289.919** | **7321.315** | **7434.710** |

**Table 18.** *ECOCADIZ-RECLUTAS 2023-10* survey. Bogue (*Boops boops*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 32.**

| ***ECOCADIZ-RECLUTAS 2023-10. Boops boops.* ABUNDANCE (in numbers and million fish)** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **Portugal** | **POL03** | **POL04** | **POL05** | **Spain** | **TOTAL** | **Millions** | | |
| | | | | | | | | | **Portugal** | **Spain** | **Total** |
| **11.5** | 1549 | 1338 | 2887 | 14418 | 1378 | 17605 | 33401 | 36288 | 0.002887 | 0.033401 | 0.036288 |
| **12** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **12.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **13** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **13.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **14** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **14.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **15** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **15.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **16** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **16.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **17** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **17.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **18** | 1549 | 1338 | 2887 | 14418 | 1378 | 17605 | 33401 | 36288 | 0.002887 | 0.033401 | 0.036288 |
| **18.5** | 6198 | 5352 | 11550 | 57670 | 5514 | 70420 | 133604 | 145154 | 0.01155 | 0.133604 | 0.145154 |
| **19** | 4648 | 4014 | 8662 | 43253 | 4135 | 52815 | 100203 | 108865 | 0.008662 | 0.100203 | 0.108865 |
| **19.5** | 3099 | 2676 | 5775 | 28835 | 2757 | 35210 | 66802 | 72577 | 0.005775 | 0.066802 | 0.072577 |
| **20** | 10846 | 9365 | 20211 | 100923 | 9649 | 123234 | 233806 | 254017 | 0.020211 | 0.233806 | 0.254017 |
| **20.5** | 13945 | 12041 | 25986 | 129758 | 12406 | 158444 | 300608 | 326594 | 0.025986 | 0.300608 | 0.326594 |
| **21** | 12395 | 10703 | 23098 | 115340 | 11027 | 140839 | 267206 | 290304 | 0.023098 | 0.267206 | 0.290304 |
| **21.5** | 12395 | 10703 | 23098 | 115340 | 11027 | 140839 | 267206 | 290304 | 0.023098 | 0.267206 | 0.290304 |
| **22** | 21692 | 18730 | 40422 | 201845 | 19298 | 246469 | 467612 | 508034 | 0.040422 | 0.467612 | 0.508034 |
| **22.5** | 7747 | 6689 | 14436 | 72088 | 6892 | 88025 | 167005 | 181441 | 0.014436 | 0.167005 | 0.181441 |
| **23** | 17044 | 14717 | 31761 | 158593 | 15162 | 193654 | 367409 | 399170 | 0.031761 | 0.367409 | 0.39917 |
| **23.5** | 6198 | 5352 | 11550 | 57670 | 5514 | 70420 | 133604 | 145154 | 0.01155 | 0.133604 | 0.145154 |
| **24** | 9296 | 8027 | 17323 | 86505 | 8270 | 105630 | 200405 | 217728 | 0.017323 | 0.200405 | 0.217728 |
| **24.5** | 4648 | 4014 | 8662 | 43253 | 4135 | 52815 | 100203 | 108865 | 0.008662 | 0.100203 | 0.108865 |
| **25** | 7747 | 6689 | 14436 | 72088 | 6892 | 88025 | 167005 | 181441 | 0.014436 | 0.167005 | 0.181441 |
| **25.5** | 3099 | 2676 | 5775 | 28835 | 2757 | 35210 | 66802 | 72577 | 0.005775 | 0.066802 | 0.072577 |
| **26** | 6198 | 5352 | 11550 | 57670 | 5514 | 70420 | 133604 | 145154 | 0.01155 | 0.133604 | 0.145154 |
| **26.5** | 9296 | 8027 | 17323 | 86505 | 8270 | 105630 | 200405 | 217728 | 0.017323 | 0.200405 | 0.217728 |
| **27** | 7747 | 6689 | 14436 | 72088 | 6892 | 88025 | 167005 | 181441 | 0.014436 | 0.167005 | 0.181441 |
| **27.5** | 4648 | 4014 | 8662 | 43253 | 4135 | 52815 | 100203 | 108865 | 0.008662 | 0.100203 | 0.108865 |
| **28** | 3099 | 2676 | 5775 | 28835 | 2757 | 35210 | 66802 | 72577 | 0.005775 | 0.066802 | 0.072577 |
| **28.5** | 4648 | 4014 | 8662 | 43253 | 4135 | 52815 | 100203 | 108865 | 0.008662 | 0.100203 | 0.108865 |
| **29** | 6198 | 5352 | 11550 | 57670 | 5514 | 70420 | 133604 | 145154 | 0.01155 | 0.133604 | 0.145154 |
| **29.5** | 10846 | 9365 | 20211 | 100923 | 9649 | 123234 | 233806 | 254017 | 0.020211 | 0.233806 | 0.254017 |
| **30** | 3099 | 2676 | 5775 | 28835 | 2757 | 35210 | 66802 | 72577 | 0.005775 | 0.066802 | 0.072577 |
| **30.5** | 1549 | 1338 | 2887 | 14418 | 1378 | 17605 | 33401 | 36288 | 0.002887 | 0.033401 | 0.036288 |
| **31** | 4648 | 4014 | 8662 | 43253 | 4135 | 52815 | 100203 | 108865 | 0.008662 | 0.100203 | 0.108865 |
| **TOTAL n** | 206071 | 177941 | 384012 | 1917535 | 183327 | 2341458 | 4442320 | 4826332 | **0.4** | **4** | **5** |
| **Millions** | **0.2** | **0.2** | **0.4** | **2** | **0.2** | **2** | **4** | **5** | | | |

**Table 18.** *ECOCADIZ-RECLUTAS 2023-10* survey. Bogue (*Boops boops*). Cont'd.

| ***ECOCADIZ-RECLUTAS 2023-10. Boops boops.* BIOMASS (t)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **Portugal** | **POL03** | **POL04** | **POL05** | **Spain** | **TOTAL** |
| **11.5** | 0.023 | 0.020 | 0.043 | 0.210 | 0.020 | 0.257 | 0.487 | 0.530 |
| **12** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **12.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **13** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **13.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **14** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **14.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **15** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **15.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **16** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **16.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **17** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **17.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **18** | 0.092 | 0.080 | 0.172 | 0.858 | 0.082 | 1.047 | 1.987 | 2.159 |
| **18.5** | 0.402 | 0.347 | 0.749 | 3.739 | 0.357 | 4.565 | 8.661 | 9.410 |
| **19** | 0.328 | 0.283 | 0.611 | 3.050 | 0.292 | 3.724 | 7.066 | 7.677 |
| **19.5** | 0.237 | 0.205 | 0.442 | 2.206 | 0.211 | 2.694 | 5.111 | 5.553 |
| **20** | 0.899 | 0.776 | 1.675 | 8.364 | 0.800 | 10.213 | 19.377 | 21.052 |
| **20.5** | 1.249 | 1.079 | 2.328 | 11.623 | 1.111 | 14.193 | 26.927 | 29.255 |
| **21** | 1.198 | 1.034 | 2.232 | 11.147 | 1.066 | 13.612 | 25.825 | 28.057 |
| **21.5** | 1.290 | 1.114 | 2.404 | 12.006 | 1.148 | 14.660 | 27.814 | 30.218 |
| **22** | 2.428 | 2.096 | 4.524 | 22.590 | 2.160 | 27.584 | 52.334 | 56.858 |
| **22.5** | 0.931 | 0.804 | 1.735 | 8.661 | 0.828 | 10.575 | 20.064 | 21.799 |
| **23** | 2.195 | 1.895 | 4.090 | 20.421 | 1.952 | 24.936 | 47.309 | 51.399 |
| **23.5** | 0.854 | 0.738 | 1.592 | 7.947 | 0.760 | 9.705 | 18.412 | 20.004 |
| **24** | 1.369 | 1.182 | 2.551 | 12.740 | 1.218 | 15.557 | 29.515 | 32.066 |
| **24.5** | 0.731 | 0.631 | 1.362 | 6.799 | 0.650 | 8.302 | 15.751 | 17.113 |
| **25** | 1.298 | 1.121 | 2.419 | 12.078 | 1.155 | 14.748 | 27.981 | 30.400 |
| **25.5** | 0.553 | 0.477 | 1.030 | 5.143 | 0.492 | 6.280 | 11.915 | 12.945 |
| **26** | 1.175 | 1.015 | 2.190 | 10.937 | 1.046 | 13.355 | 25.338 | 27.528 |
| **26.5** | 1.872 | 1.617 | 3.489 | 17.423 | 1.666 | 21.275 | 40.364 | 43.853 |
| **27** | 1.655 | 1.429 | 3.084 | 15.403 | 1.473 | 18.808 | 35.684 | 38.768 |
| **27.5** | 1.052 | 0.909 | 1.961 | 9.794 | 0.936 | 11.959 | 22.689 | 24.650 |
| **28** | 0.743 | 0.641 | 1.384 | 6.912 | 0.661 | 8.440 | 16.013 | 17.397 |
| **28.5** | 1.178 | 1.018 | 2.196 | 10.964 | 1.048 | 13.388 | 25.400 | 27.596 |
| **29** | 1.660 | 1.433 | 3.093 | 15.446 | 1.477 | 18.860 | 35.783 | 38.876 |
| **29.5** | 3.066 | 2.648 | 5.714 | 28.532 | 2.728 | 34.839 | 66.099 | 71.813 |
| **30** | 0.924 | 0.798 | 1.722 | 8.597 | 0.822 | 10.498 | 19.917 | 21.639 |
| **30.5** | 0.487 | 0.420 | 0.907 | 4.529 | 0.433 | 5.531 | 10.493 | 11.400 |
| **31** | 1.537 | 1.328 | 2.865 | 14.306 | 1.368 | 17.468 | 33.142 | 36.007 |
| **TOTAL** | **31.426** | **27.138** | **58.564** | **292.425** | **27.960** | **357.073** | **677.458** | **736.022** |

**Table 19.** *ECOCADIZ-RECLUTAS 2023-10* survey Pearlside (*Maurolicus muelleri*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 35**.

| ***ECOCADIZ-RECLUTAS 2023-10. Maurolicus muelleri*. ABUNDANCE (in numbers and million fish)** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **POL03** | **POL04** | **Portugal** | **POL05** | **POL06** | **POL07** | **Spain** | **TOTAL** | **Millions** | | |
| | | | | | | | | | | | **Portugal** | **Spain** | **Total** |
| **3.5** | 8907663 | 1362698 | 3181156 | 2617357 | 16068874 | 1567642 | 1206038 | 793009 | 3566689 | 19635563 | 16.068874 | 3.566689 | 19.635563 |
| **4** | 55541902 | 8496823 | 19835441 | 16319988 | 100194154 | 9774706 | 7519999 | 4944647 | 22239352 | 122433506 | 100.194154 | 22.239352 | 122.433506 |
| **4.5** | 193086706 | 29538484 | 68956228 | 56735054 | 348316472 | 33980936 | 26142637 | 17189647 | 77313220 | 425629692 | 348.316472 | 77.31322 | 425.629692 |
| **5** | 143308586 | 21923407 | 51179181 | 42108649 | 258519823 | 25220586 | 19403015 | 12758123 | 57381724 | 315901547 | 258.519823 | 57.381724 | 315.901547 |
| **5.5** | 40870456 | 6252379 | 14595891 | 12009048 | 73727774 | 7192708 | 5533584 | 3638514 | 16364806 | 90092580 | 73.727774 | 16.364806 | 90.09258 |
| **TOTAL n** | 441715313 | 67573791 | 157747897 | 129790096 | 796827097 | 77736578 | 59805273 | 39323940 | 176865791 | 973692888 | 797 | 177 | 974 |
| **Millions** | 442 | 68 | 158 | 130 | 797 | 78 | 60 | 39 | 177 | 974 | | | |

| ***ECOCADIZ-RECLUTAS 2023-10. Maurolicus muelleri*. BIOMASS (t)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **POL03** | **POL04** | **Portugal** | **POL05** | **POL06** | **POL07** | **Spain** | **TOTAL** |
| **3.5** | 5.316 | 0.813 | 1.898 | 1.562 | 9.589 | 0.935 | 0.720 | 0.473 | 2.128 | 11.717 |
| **4** | 43.033 | 6.583 | 15.368 | 12.644 | 77.628 | 7.573 | 5.826 | 3.831 | 17.230 | 94.858 |
| **4.5** | 188.672 | 28.863 | 67.379 | 55.438 | 340.352 | 33.204 | 25.545 | 16.797 | 75.546 | 415.898 |
| **5** | 172.546 | 26.396 | 61.620 | 50.699 | 311.261 | 30.366 | 23.362 | 15.361 | 69.089 | 380.350 |
| **5.5** | 59.493 | 9.101 | 21.246 | 17.481 | 107.321 | 10.470 | 8.055 | 5.296 | 23.821 | 131.142 |
| **TOTAL** | **469.060** | **71.756** | **167.511** | **137.824** | **846.151** | **82.548** | **63.508** | **41.758** | **187.814** | **1033.965** |

**Table 20.** *ECOCADIZ-RECLUTAS 2023-10* survey Longspine snipefish (*Macroramphosus scolopax*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 35**.

| ***ECOCADIZ-RECLUTAS 2023-10. Macroramphosus scolopax*. ABUNDANCE (in numbers and million fish)** | | | | | |
|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **Portugal** | **TOTAL** | **Millions** | |
| | | | | **Portugal** | **Total** |
| **8.5** | 7738 | 7738 | 7738 | 0.007738 | 0.007738 |
| **9** | 19345 | 19345 | 19345 | 0.019345 | 0.019345 |
| **9.5** | 38690 | 38690 | 38690 | 0.03869 | 0.03869 |
| **10** | 34821 | 34821 | 34821 | 0.034821 | 0.034821 |
| **10.5** | 34821 | 34821 | 34821 | 0.034821 | 0.034821 |
| **11** | 36755 | 36755 | 36755 | 0.036755 | 0.036755 |
| **11.5** | 27083 | 27083 | 27083 | 0.027083 | 0.027083 |
| **12** | 34821 | 34821 | 34821 | 0.034821 | 0.034821 |
| **12.5** | 46427 | 46427 | 46427 | 0.046427 | 0.046427 |
| **13** | 34821 | 34821 | 34821 | 0.034821 | 0.034821 |
| **13.5** | 29017 | 29017 | 29017 | 0.029017 | 0.029017 |
| **14** | 13541 | 13541 | 13541 | 0.013541 | 0.013541 |
| **14.5** | 13541 | 13541 | 13541 | 0.013541 | 0.013541 |
| **15** | 1934 | 1934 | 1934 | 0.001934 | 0.001934 |
| **15.5** | 3869 | 3869 | 3869 | 0.003869 | 0.003869 |
| **TOTAL n** | 377224 | 377224 | 377224 | **0.4** | **0.4** |
| **Millions** | **0.4** | **0.4** | **0.4** | | |

| ***ECOCADIZ-RECLUTAS 2023-10. Macroramphosus scolopax*. BIOMASS (t)** | | | |
|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **Portugal** | **TOTAL** |
| **8.5** | 0.027 | 0.027 | 0.027 |
| **9** | 0.080 | 0.080 | 0.080 |
| **9.5** | 0.189 | 0.189 | 0.189 |
| **10** | 0.200 | 0.200 | 0.200 |
| **10.5** | 0.233 | 0.233 | 0.233 |
| **11** | 0.285 | 0.285 | 0.285 |
| **11.5** | 0.242 | 0.242 | 0.242 |
| **12** | 0.356 | 0.356 | 0.356 |
| **12.5** | 0.540 | 0.540 | 0.540 |
| **13** | 0.459 | 0.459 | 0.459 |
| **13.5** | 0.431 | 0.431 | 0.431 |
| **14** | 0.226 | 0.226 | 0.226 |
| **14.5** | 0.252 | 0.252 | 0.252 |
| **15** | 0.040 | 0.040 | 0.040 |
| **15.5** | 0.089 | 0.089 | 0.089 |
| **TOTAL** | **3.649** | **3.649** | **3.649** |

**Table 21.** *ECOCADIZ-RECLUTAS 2023-10* survey Boarfish (*Capros aper*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 35**.

| ***ECOCADIZ-RECLUTAS 2023-10. Capros aper. ABUNDANCE (*in numbers and million fish*)*** | | | | | |
|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **Portugal** | **TOTAL** | **Millions** | |
| | | | | **Portugal** | **Total** |
| **6** | 54912 | 54912 | 54912 | 0.054912 | 0.054912 |
| **6.5** | 109823 | 109823 | 109823 | 0.109823 | 0.109823 |
| **7** | 1425774 | 1425774 | 1425774 | 1.425774 | 1.425774 |
| **7.5** | 3564435 | 3564435 | 3564435 | 3.564435 | 3.564435 |
| **8** | 2906459 | 2906459 | 2906459 | 2.906459 | 2.906459 |
| **8.5** | 219646 | 219646 | 219646 | 0.219646 | 0.219646 |
| **TOTAL n** | 8281049 | 8281049 | 8281049 | **8** | **8** |
| **Millions** | **8** | **8** | **8** | | |

| ***ECOCADIZ-RECLUTAS 2023-10. Capros aper. BIOMASS (t)*** | | | |
|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **Portugal** | **TOTAL** |
| **6** | 0.244 | 0.244 | 0.244 |
| **6.5** | 0.632 | 0.632 | 0.632 |
| **7** | 10.403 | 10.403 | 10.403 |
| **7.5** | 32.476 | 32.476 | 32.476 |
| **8** | 32.611 | 32.611 | 32.611 |
| **8.5** | 2.998 | 2.998 | 2.998 |
| **TOTAL** | **79.364** | **79.364** | **79.364** |

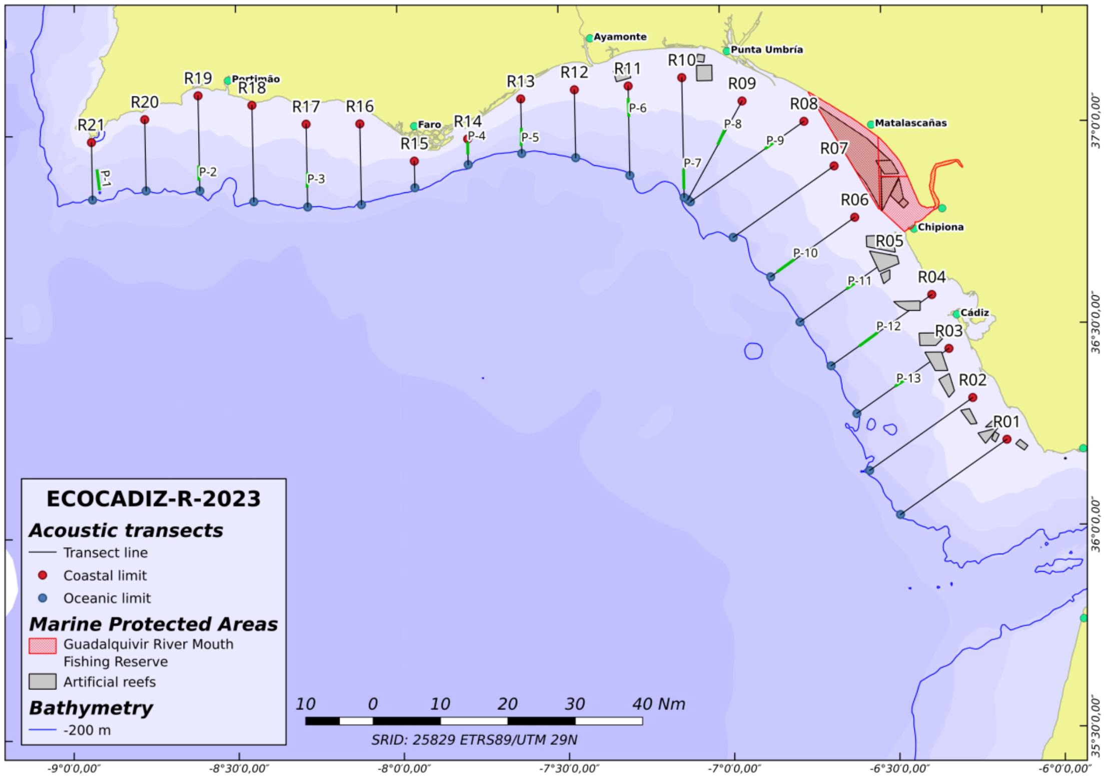



**Figure 1.** *ECOCADIZ-RECLUTAS 2023-10* survey. Location of the acoustic transects sampled during the survey. The different protected areas inside the Guadalquivir river mouth Fishing Reserve and artificial reef polygons are also shown.

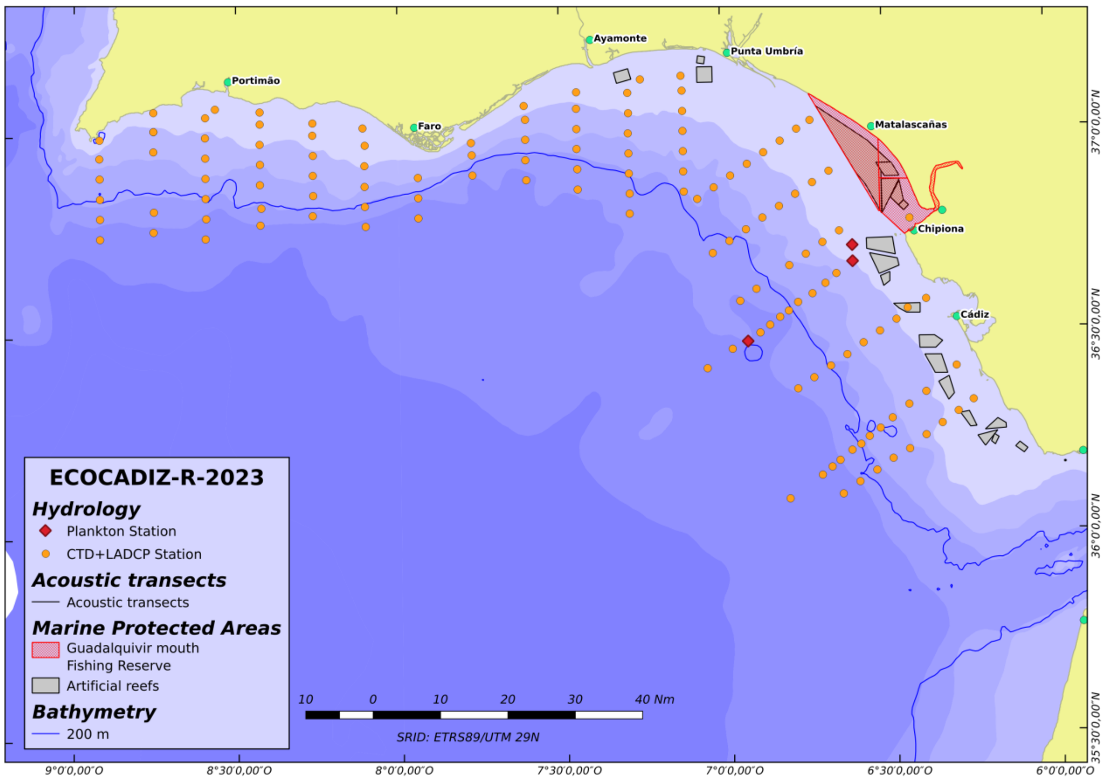



**Figure 2.** *ECOCADIZ-RECLUTAS 2023-10* survey. Location of CTD-LADCP, Bongo 40, Neuston sledge and water sampling stations.

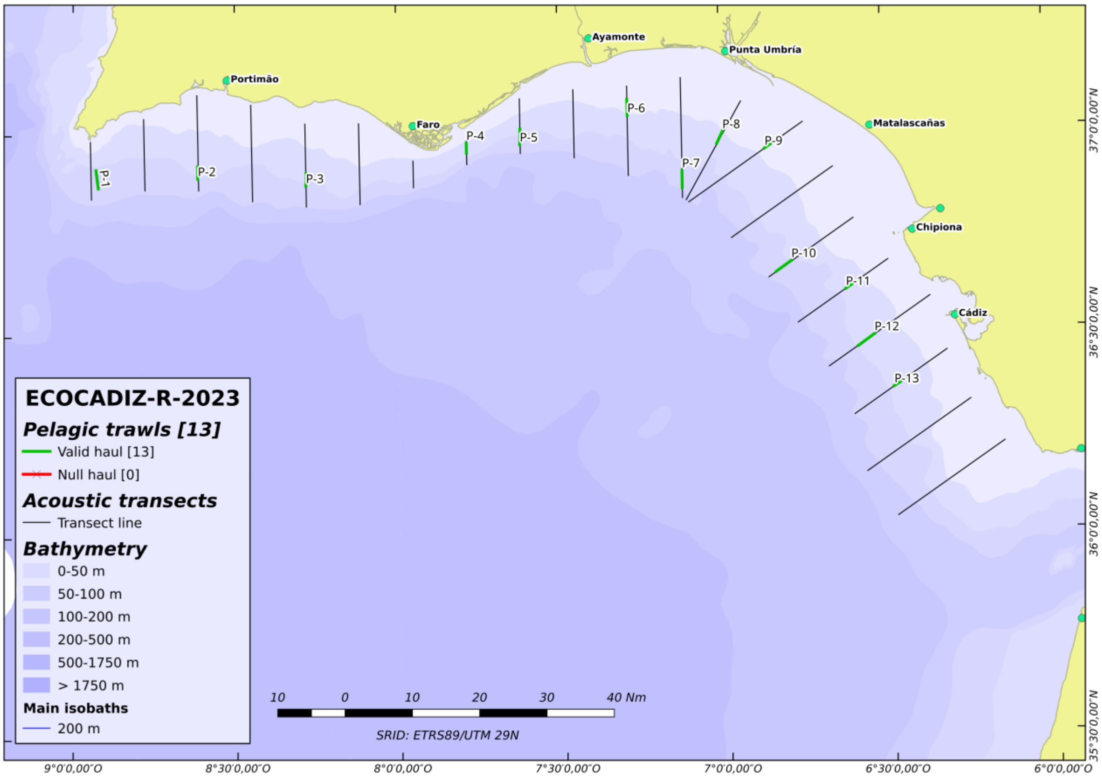



**Figure 3.** *ECOCADIZ-RECLUTAS 2023-10* survey. Location of ground-truthing fishing hauls.

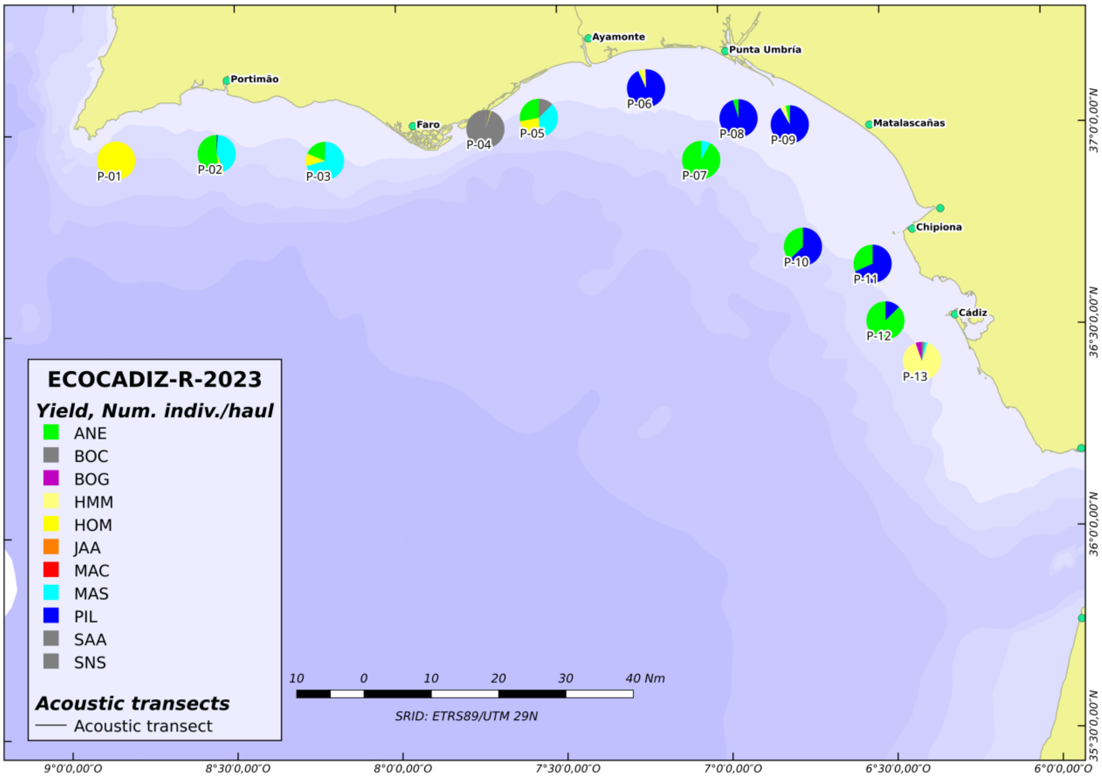



**Figure 4.** *ECOCADIZ-RECLUTAS 2023-10* survey. Species composition (percentages in number) in valid hauls.

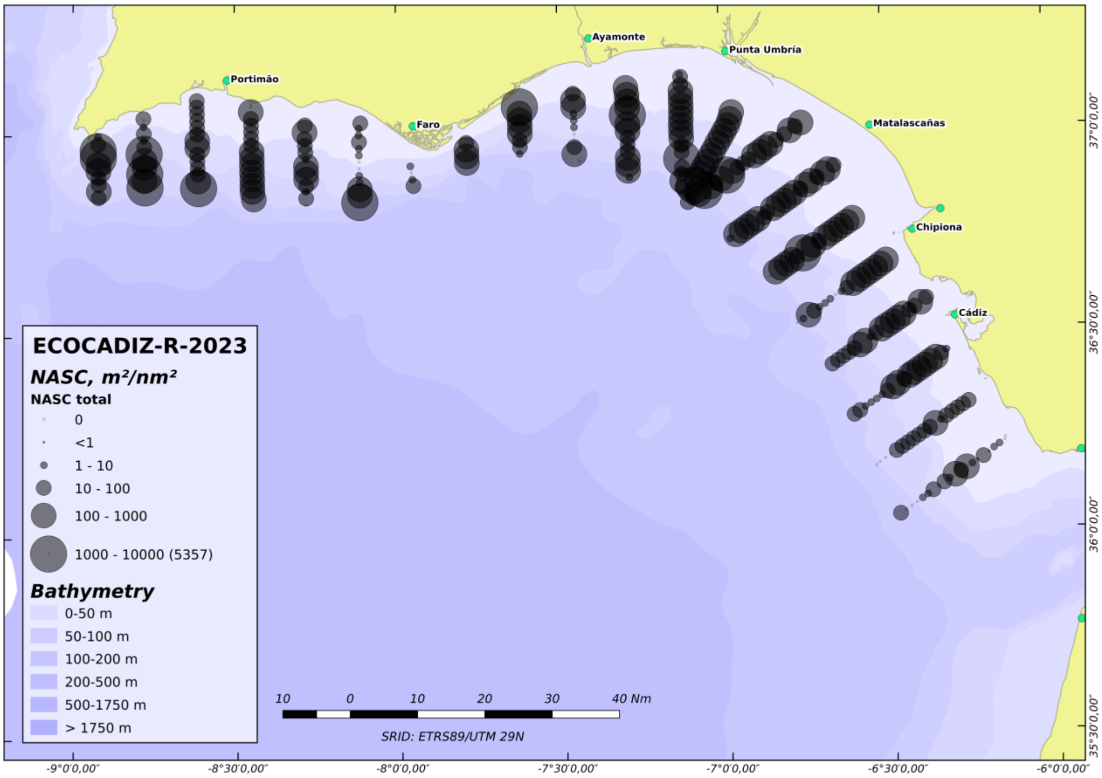



**Figure 5.** *ECOCADIZ-RECLUTAS 2023-10* survey. Distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2nmi^{-2}$) attributed to the pelagic fish species assemblage.

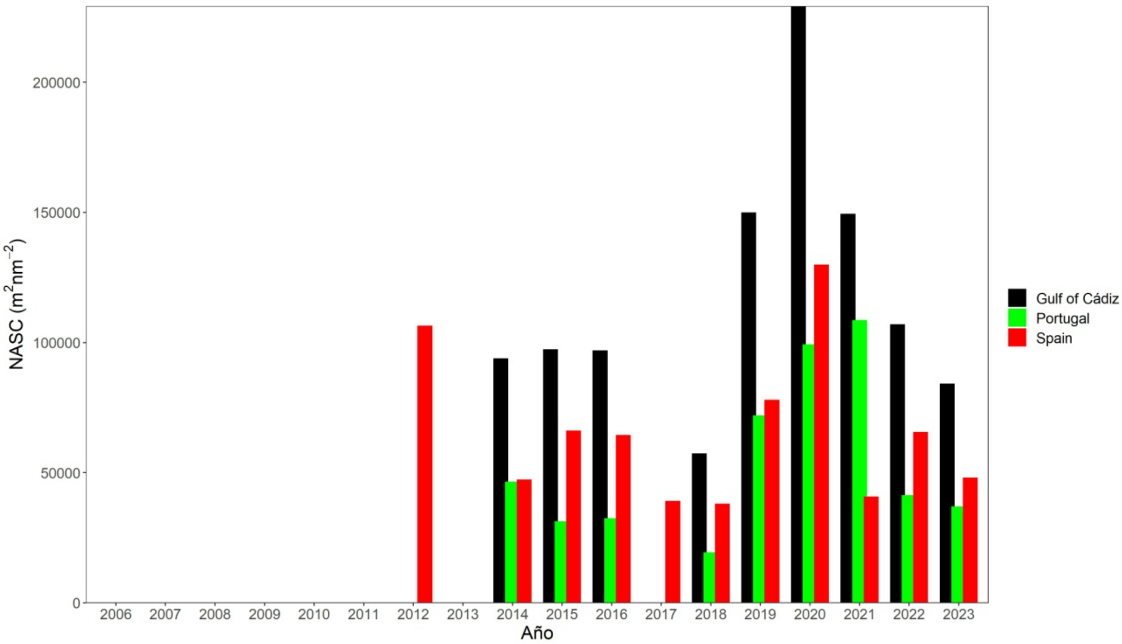



**Figure 6.** *ECOCADIZ-RECLUTAS 2023-10* survey. Time-series of NASC by total area, Spain and Portugal.

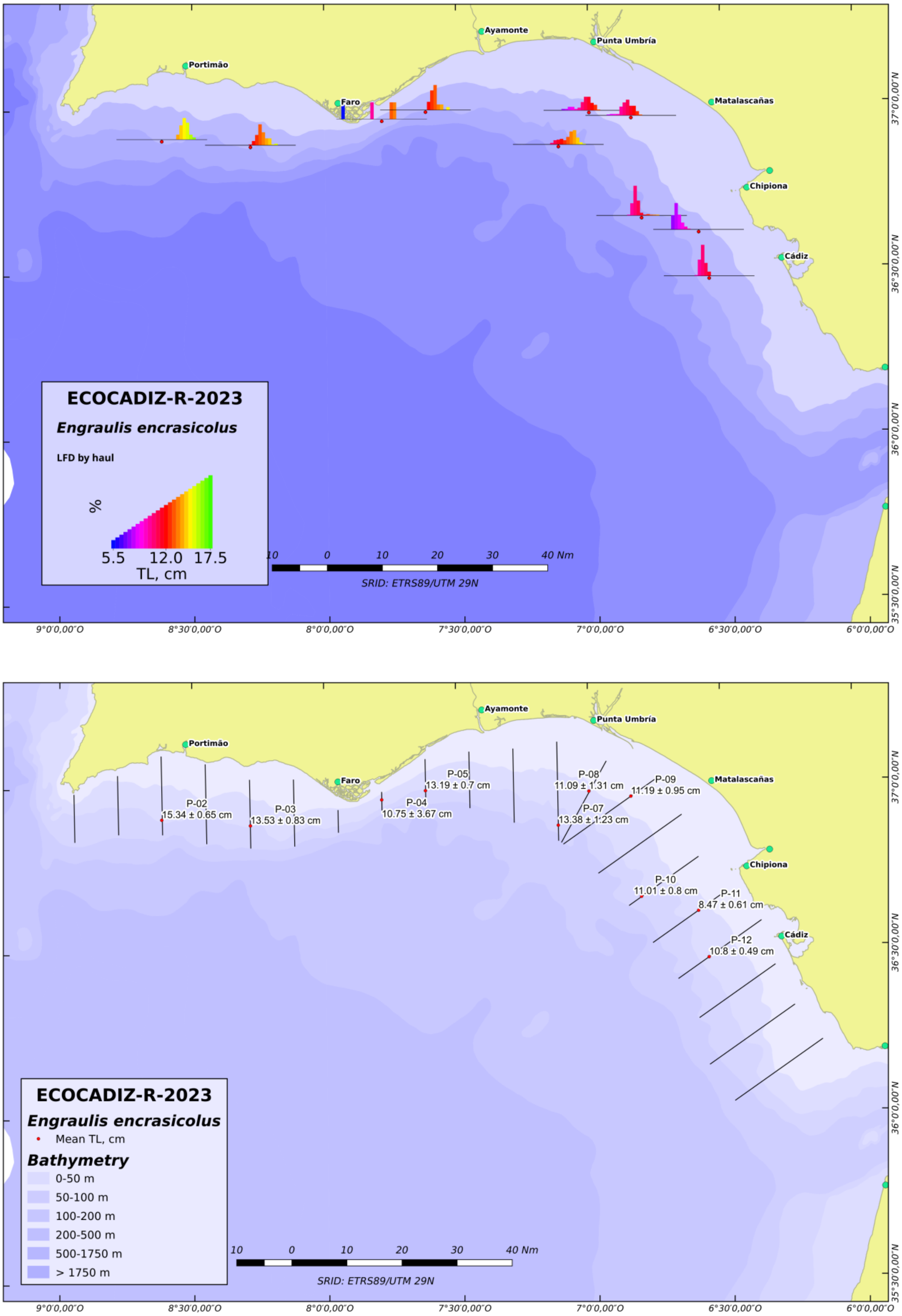
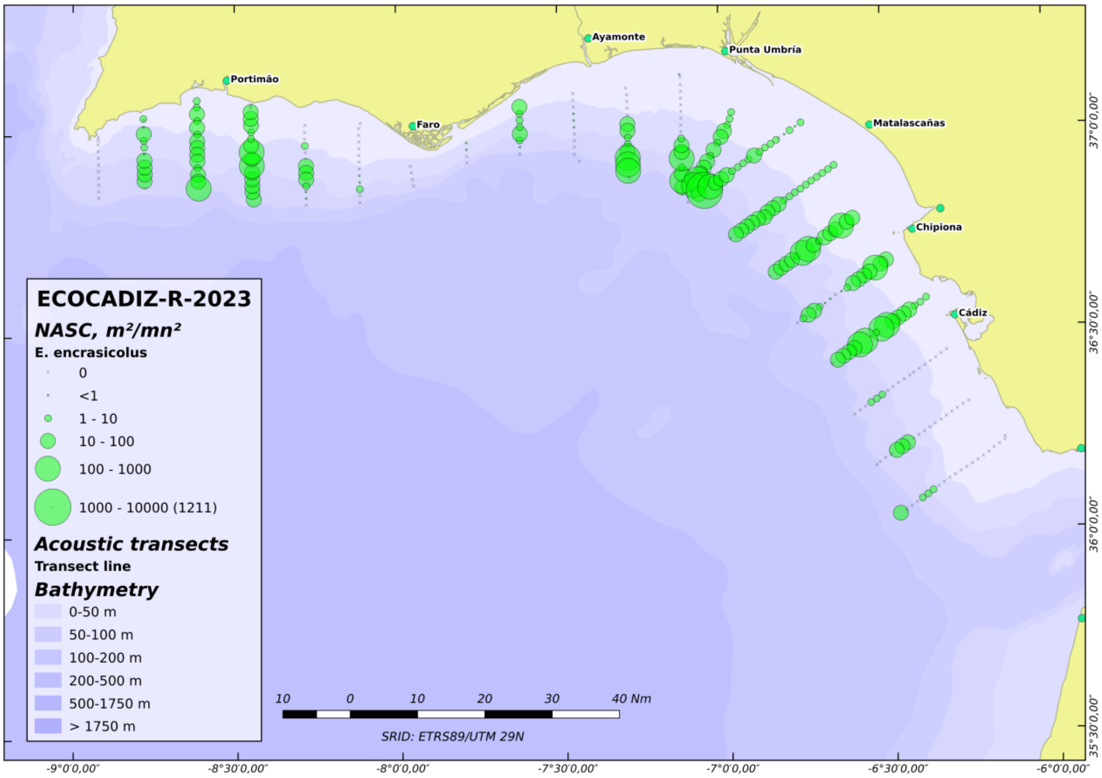



**Figure 7.** *ECOCADIZ-RECLUTAS 2023-10* survey. Anchovy (*Engraulis encrasicolus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.



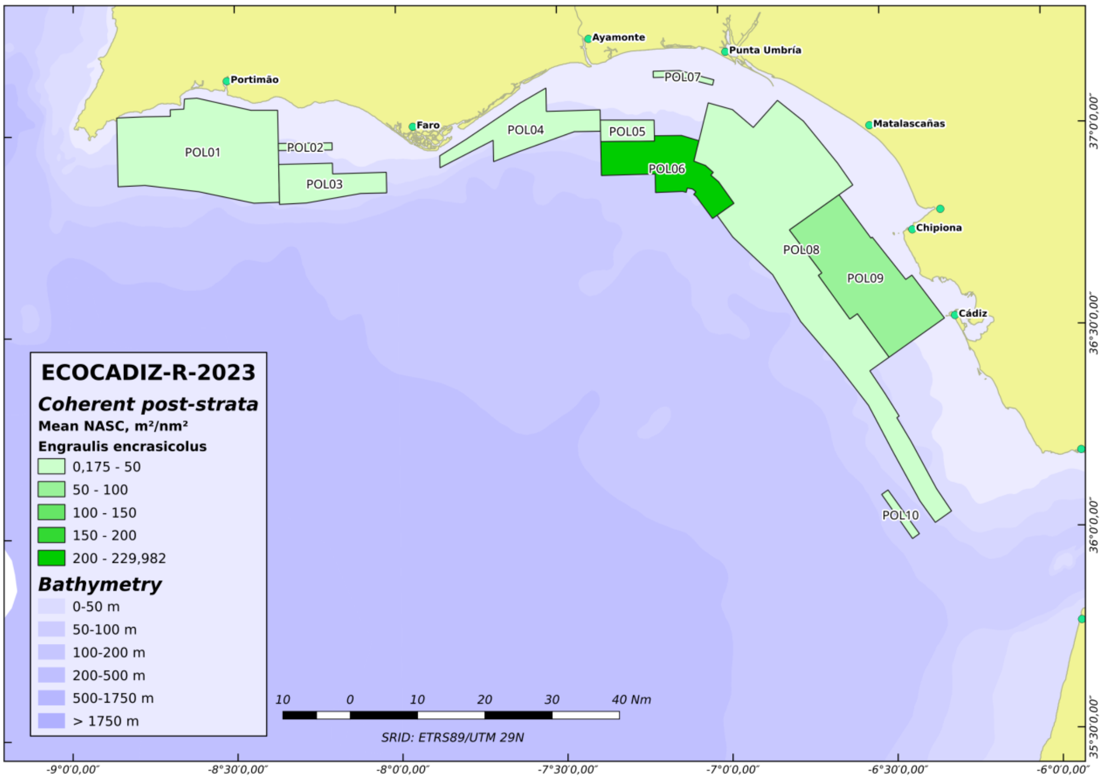




**Figure 8.** *ECOCADIZ-RECLUTAS 2023-10* survey. Anchovy (*Engraulis encrasicolus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

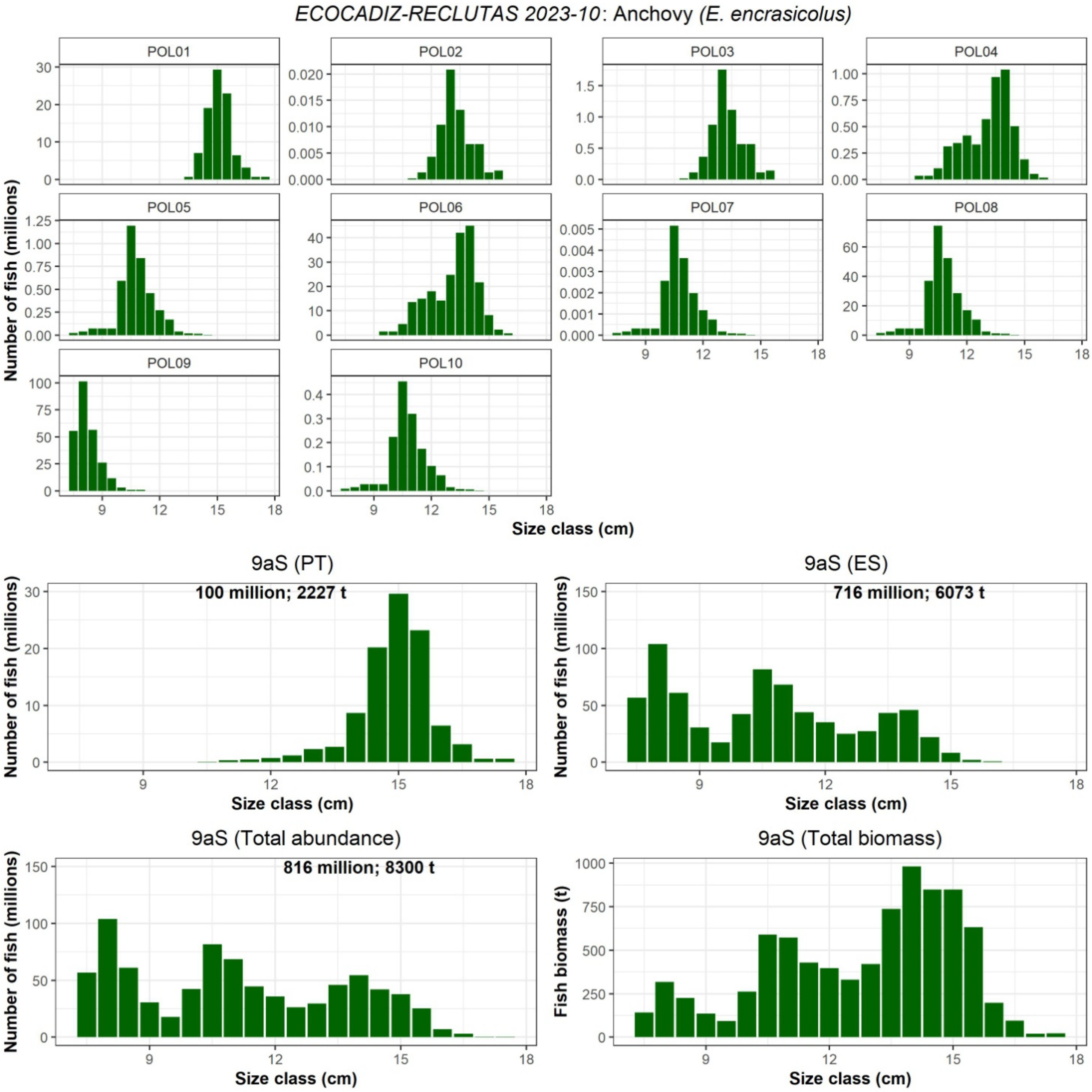



**Figure 9.** *ECOCADIZ-RECLUTAS 2023-10* survey. Anchovy *(Engraulis encrasicolus)*. Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 8**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the *y* axis.

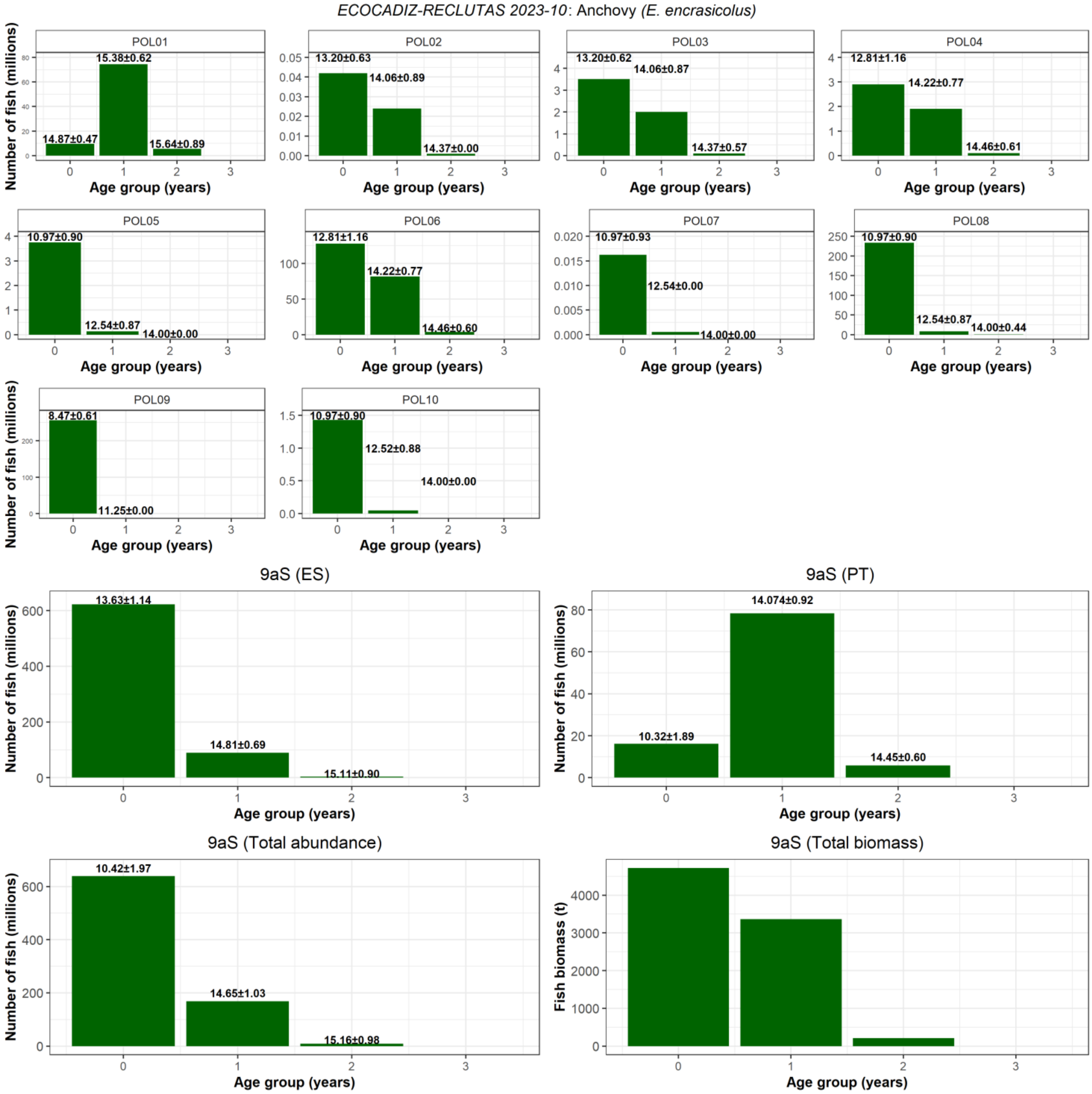



**Figure 10.** *ECOCADIZ-RECLUTAS 2023-10* survey. Anchovy (*Engraulis encrasicolus*). Estimated abundances (number of fish in millions) by age group (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 8**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by age group for the whole sampled area is also shown for comparison. Note the different scale in the *y* axis.

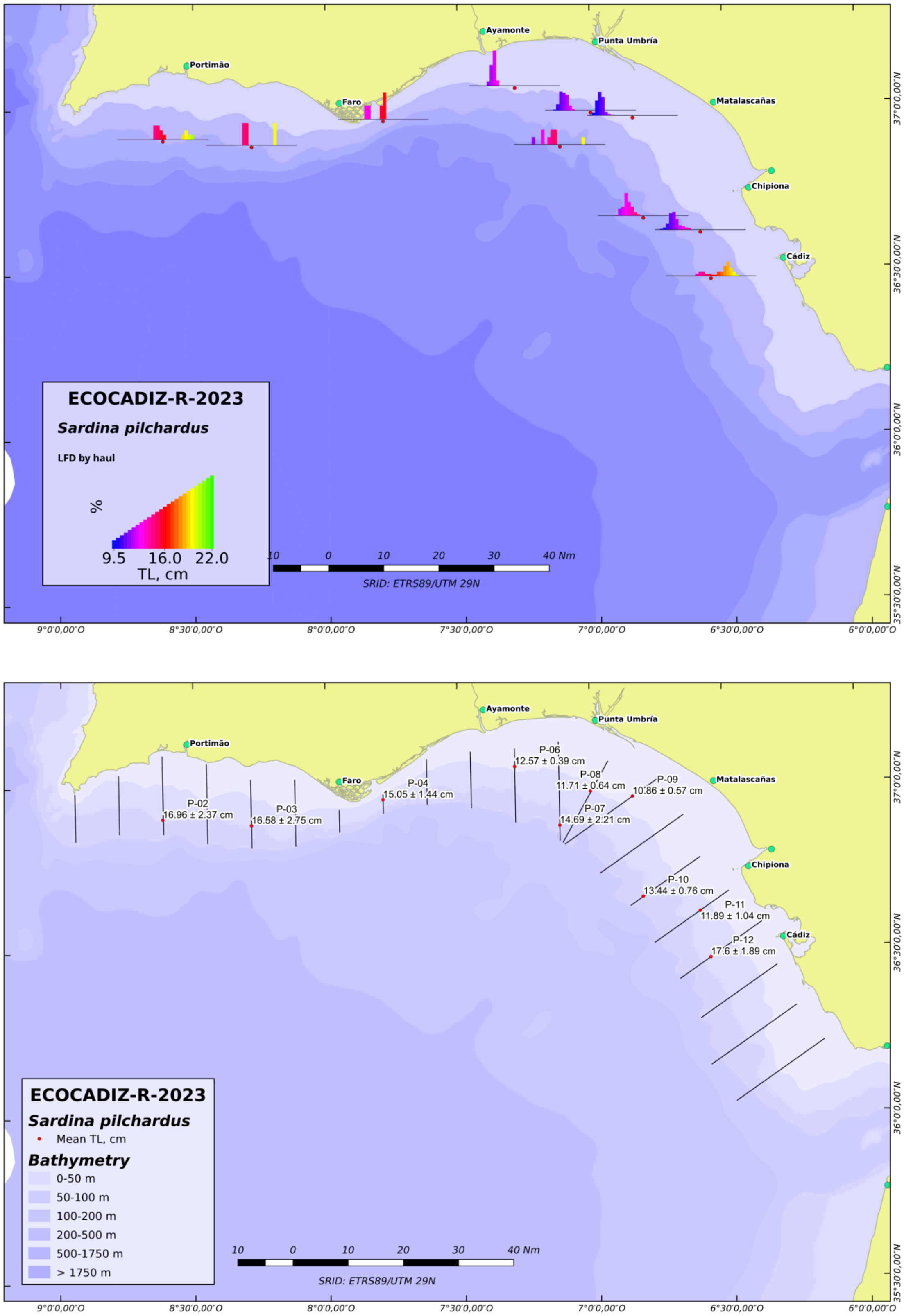
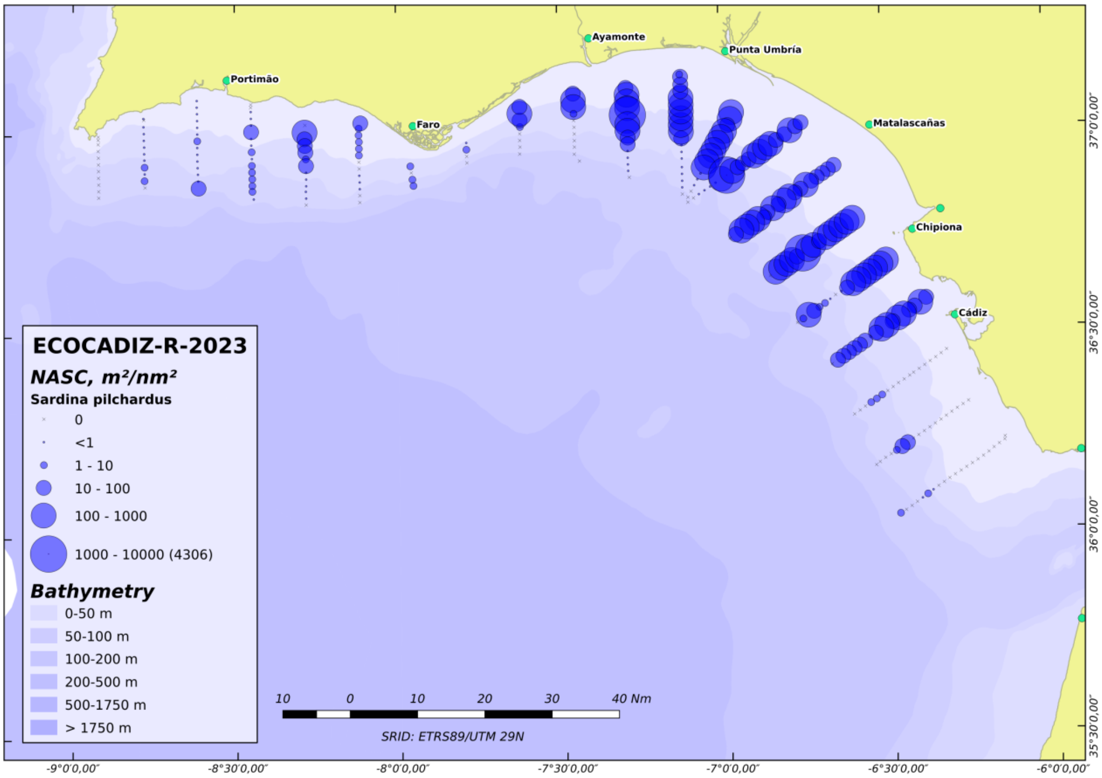



**Figure 11.** *ECOCADIZ-RECLUTAS 2023-10* survey. Sardine (*Sardina pilchardus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.



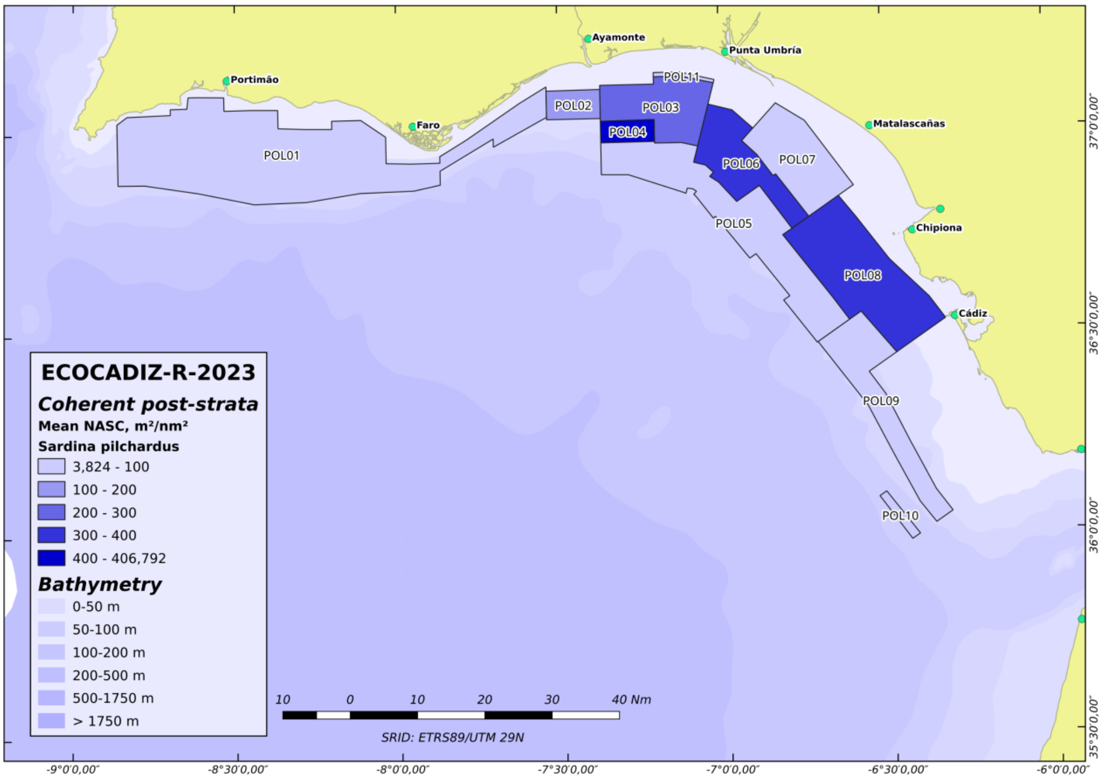




**Figure 12.** *ECOCADIZ-RECLUTAS 2023-10* survey. Sardine (*Sardina pilchardus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

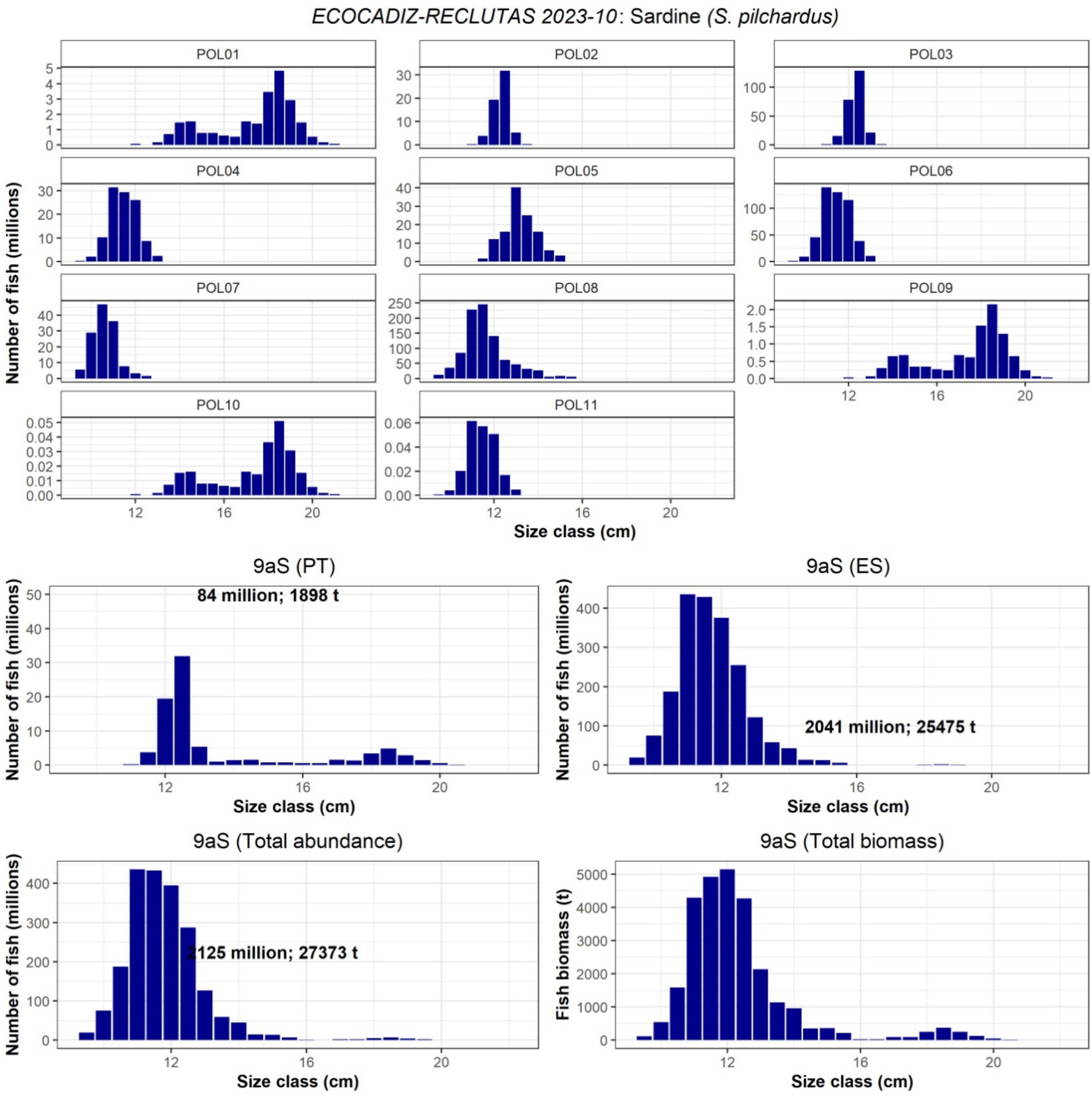



**Figure 13**. *ECOCADIZ-RECLUTAS 2023-10* survey. Sardine *(Sardina pilchardus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 12**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the *y* axis.

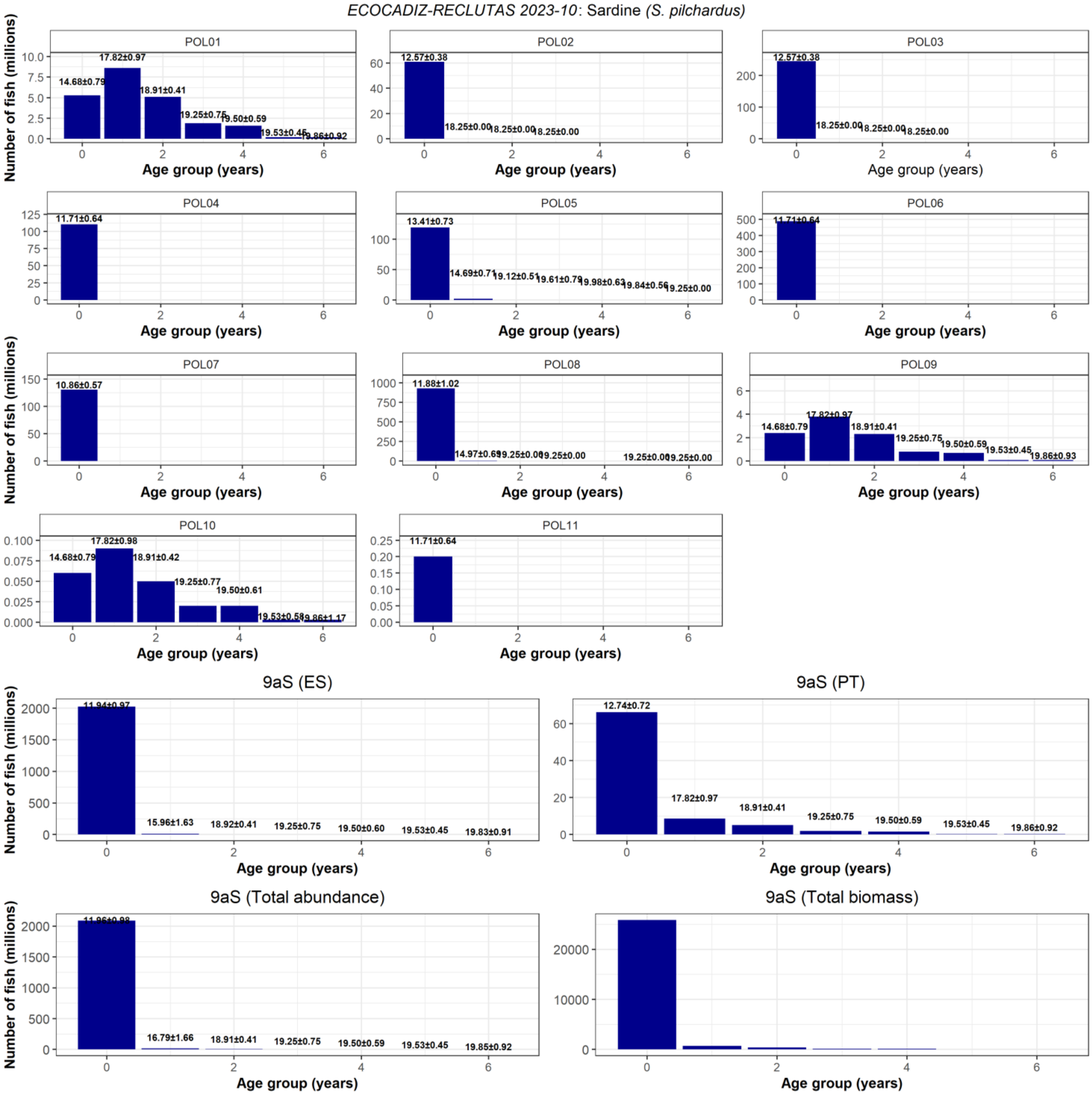
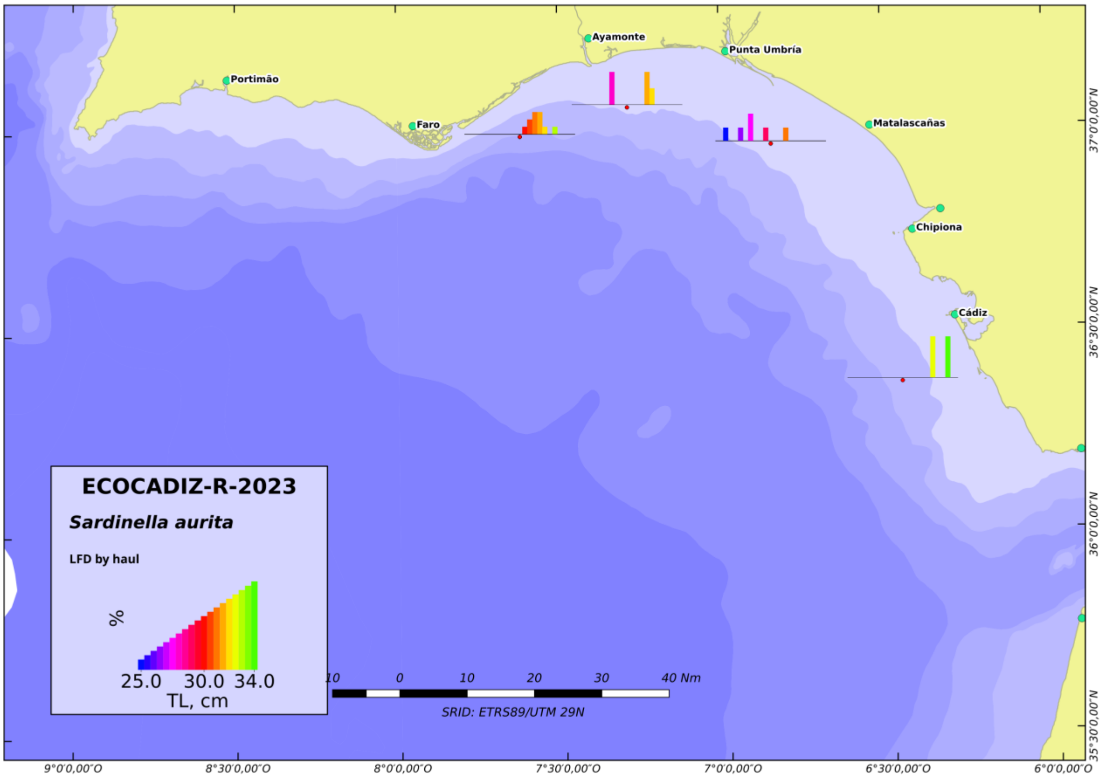



**Figure 14**. *ECOCADIZ-RECLUTAS 2023-10* survey. Sardine *(Sardina pilchardus*). Estimated abundances (number of fish in millions) by age group (years) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 12**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by age group for the whole sampled area is also shown for comparison. Note the different scale in the *y* axis.



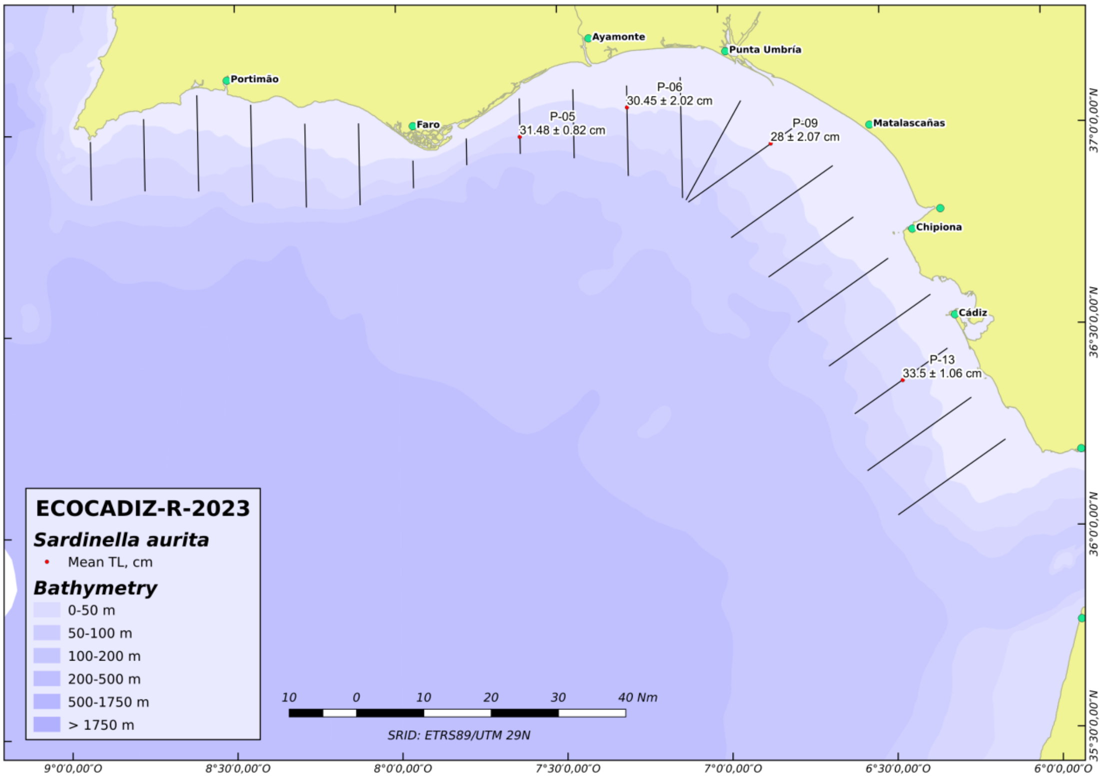
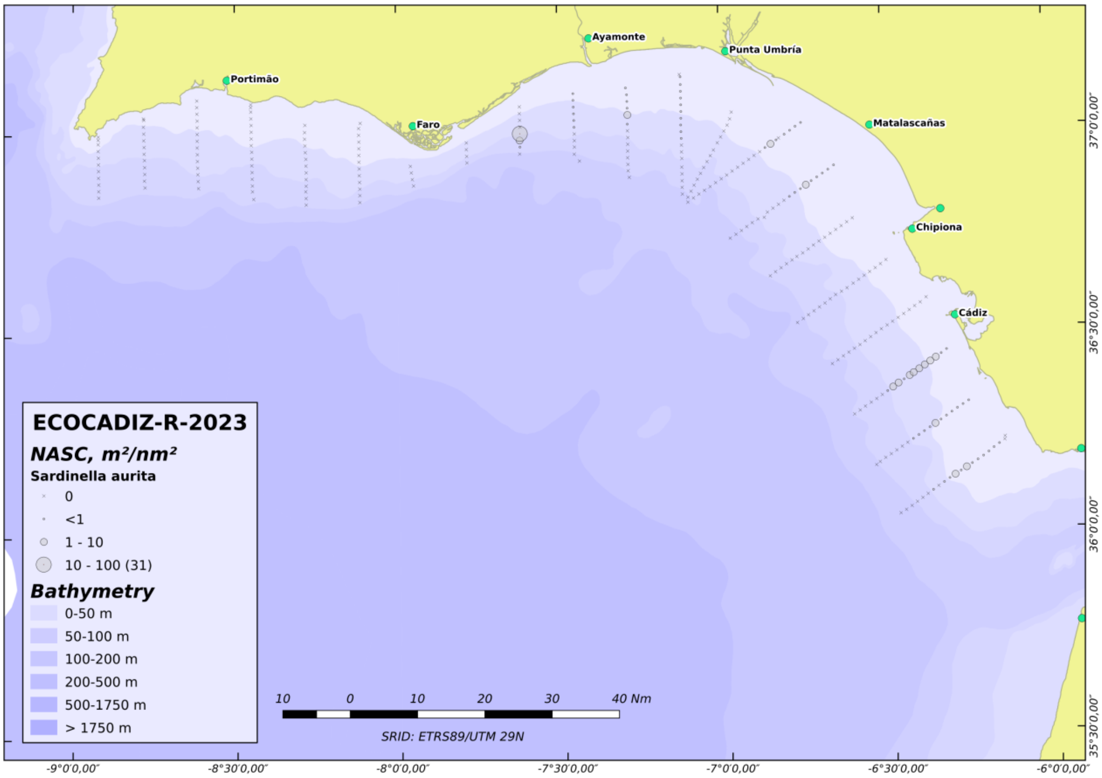




**Figure 15.** *ECOCADIZ-RECLUTAS 2023-10* survey. Round sardinella (*Sardinella aurita*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.



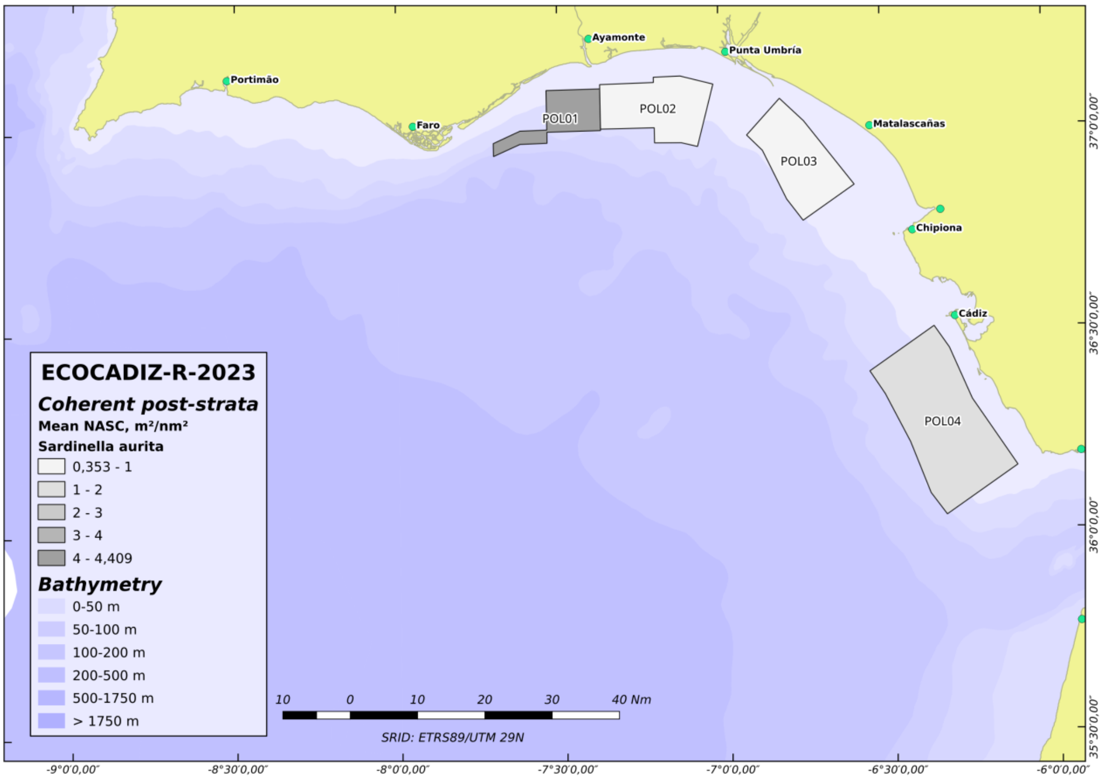




**Figure 16.** *ECOCADIZ-RECLUTAS 2023-10* survey. Round sardinella (*Sardinella aurita*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Color scale according to the mean value of the backscattering energy attributed to the species in each stratum.

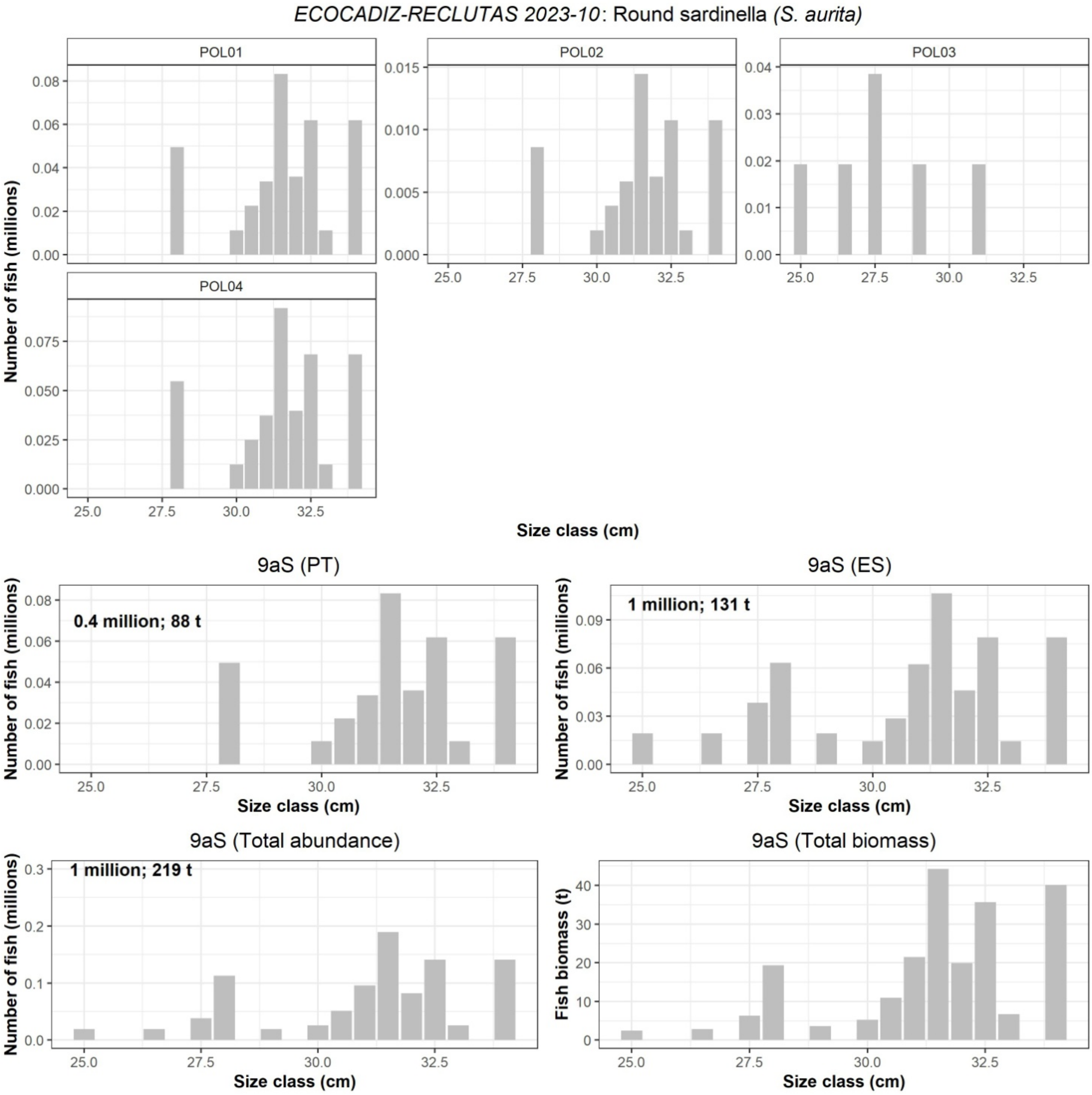
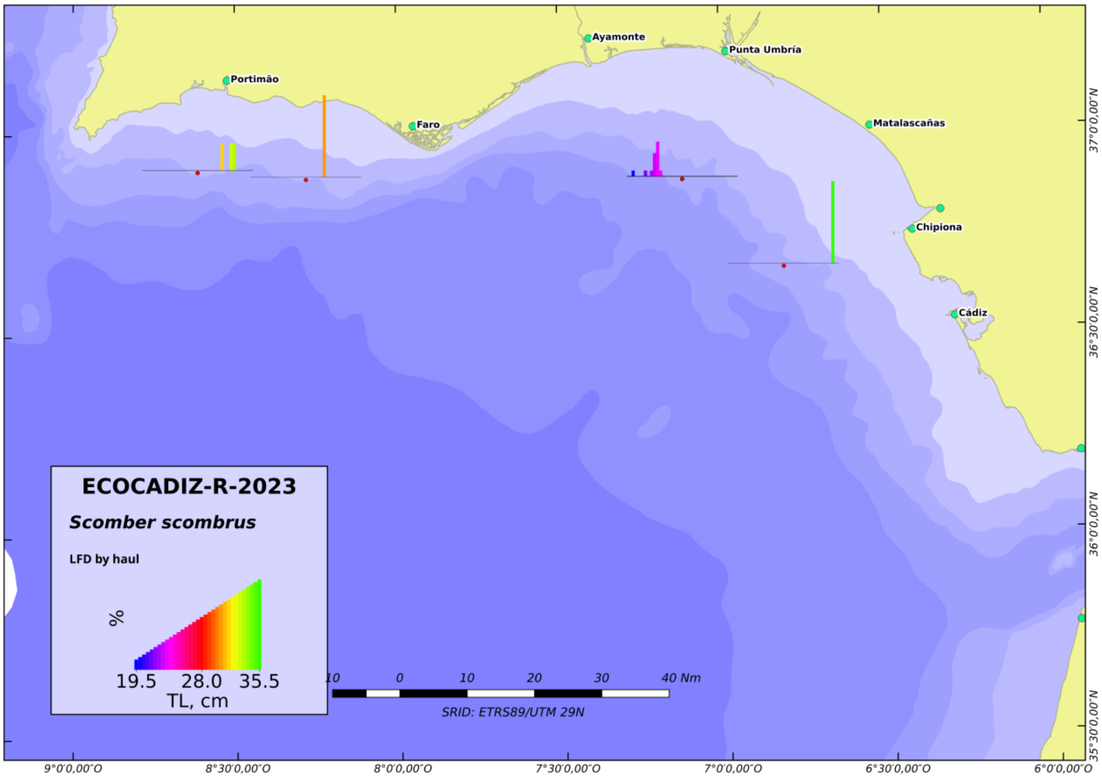



**Figure 17.** *ECOCADIZ-RECLUTAS 2023-10* survey. Round sardinella *(Sardinella aurita*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 16**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the *y* axis



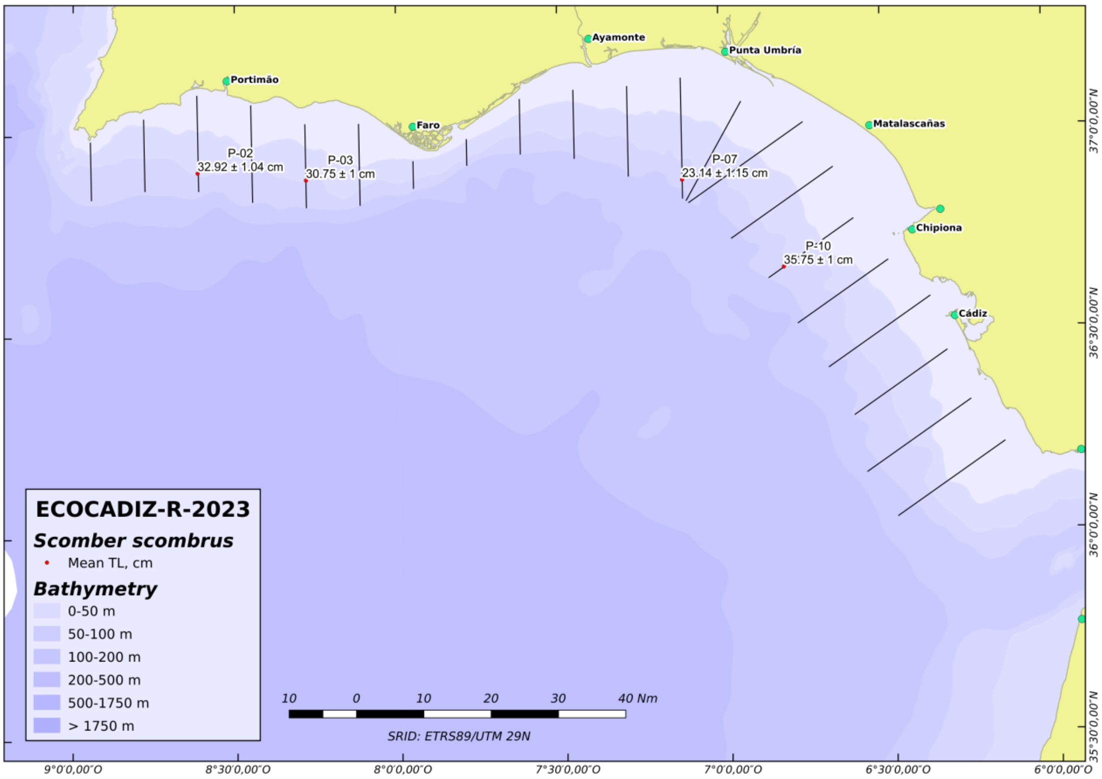




**Figure 18.** *ECOCADIZ-RECLUTAS 2023-10* survey. Atlantic mackerel (*Scomber scombrus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

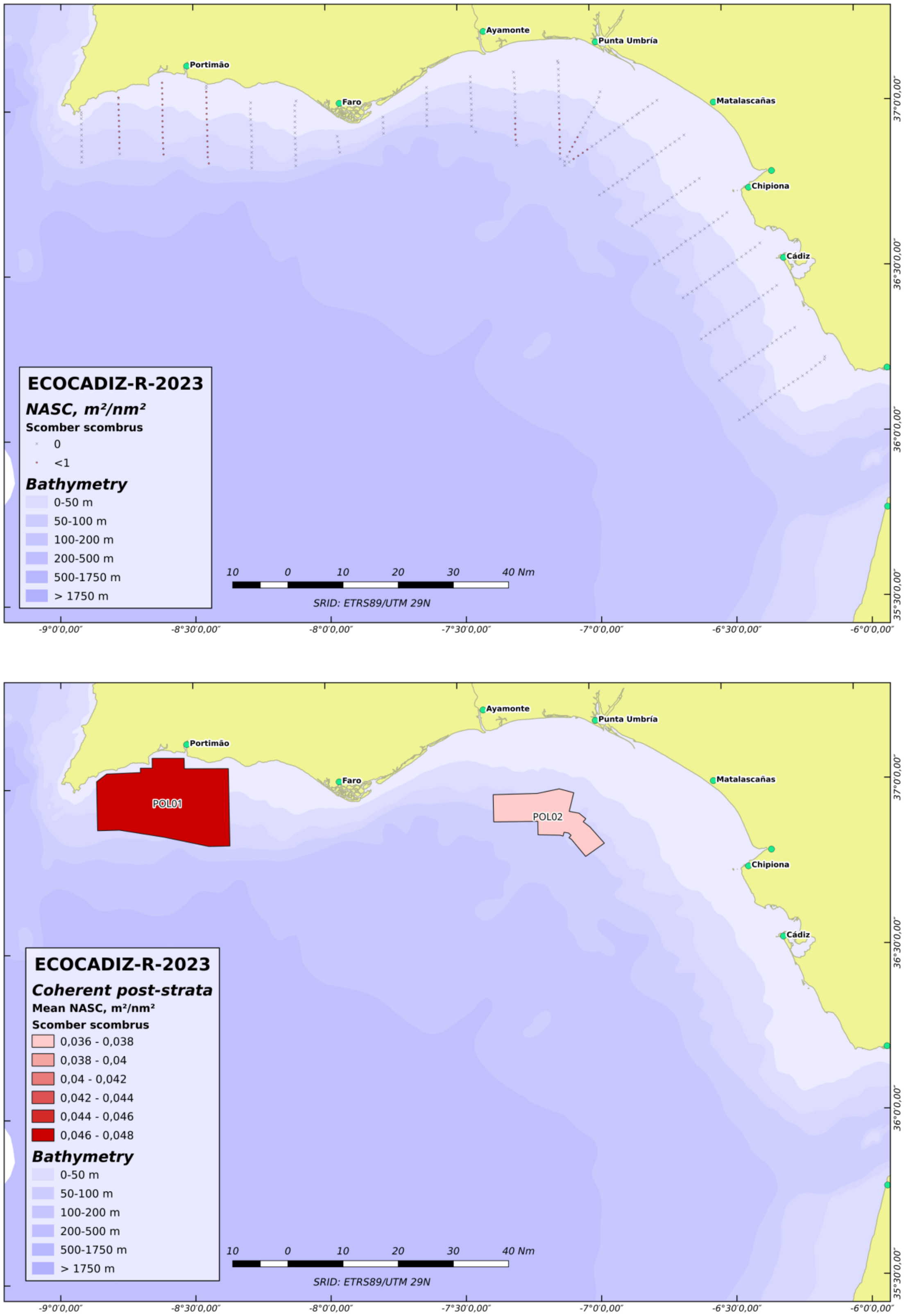



**Figure 19.** *ECOCADIZ-RECLUTAS 2023-10* survey. Atlantic mackerel (*Scomber scombrus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

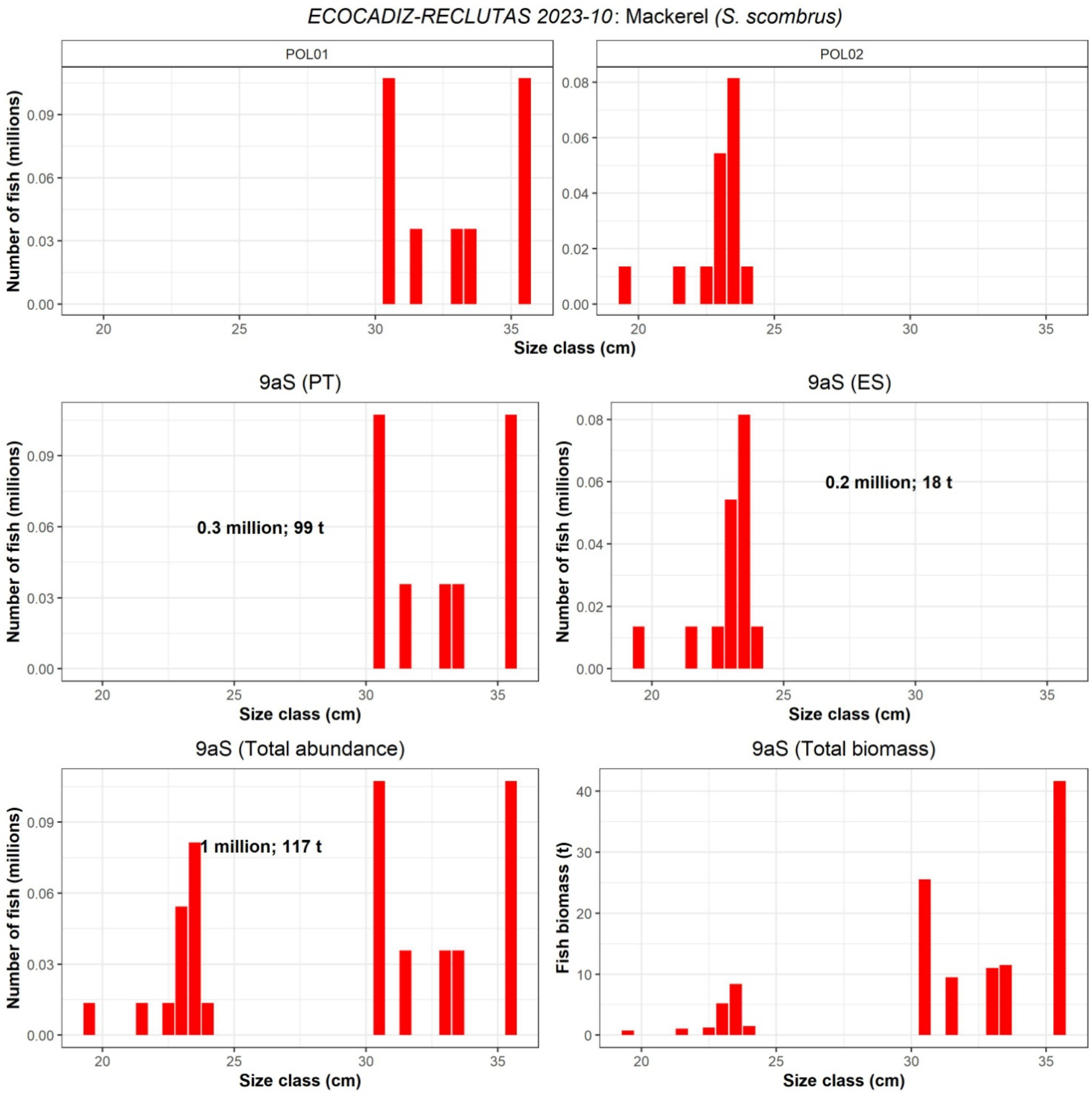
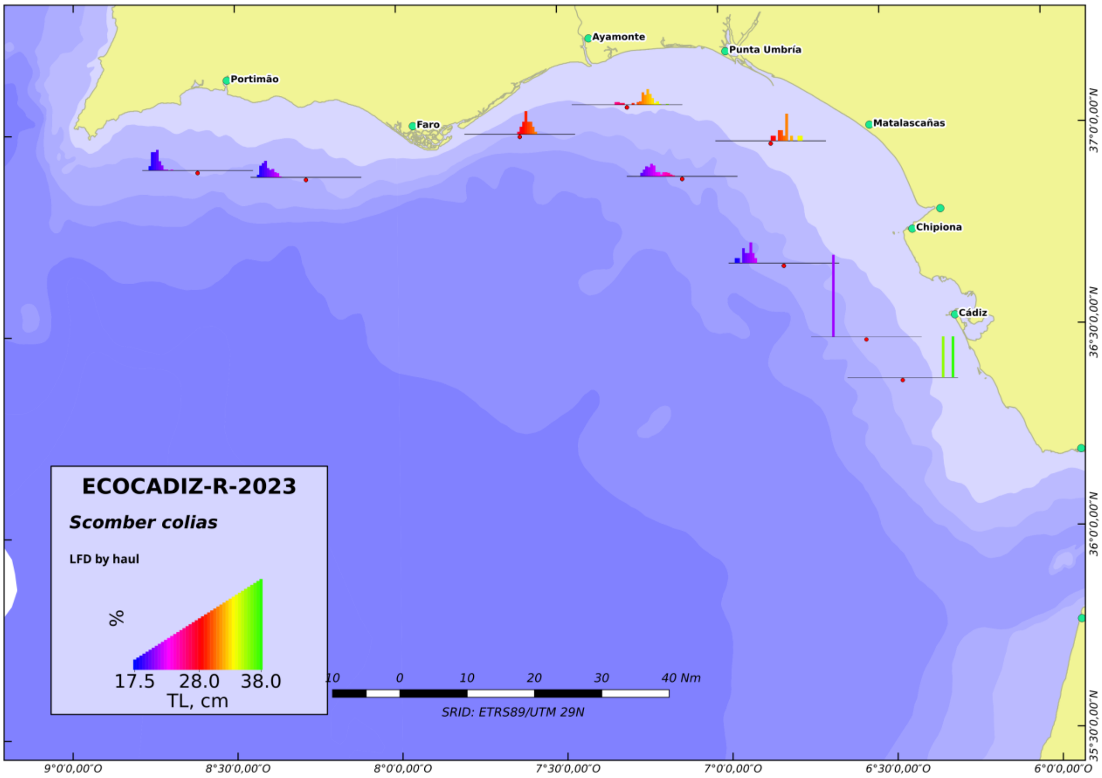



**Figure 20**. *ECOCADIZ-RECLUTAS 2023-10* survey. Atlantic mackerel (*Scomber scombrus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 19**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the *y*-axis.



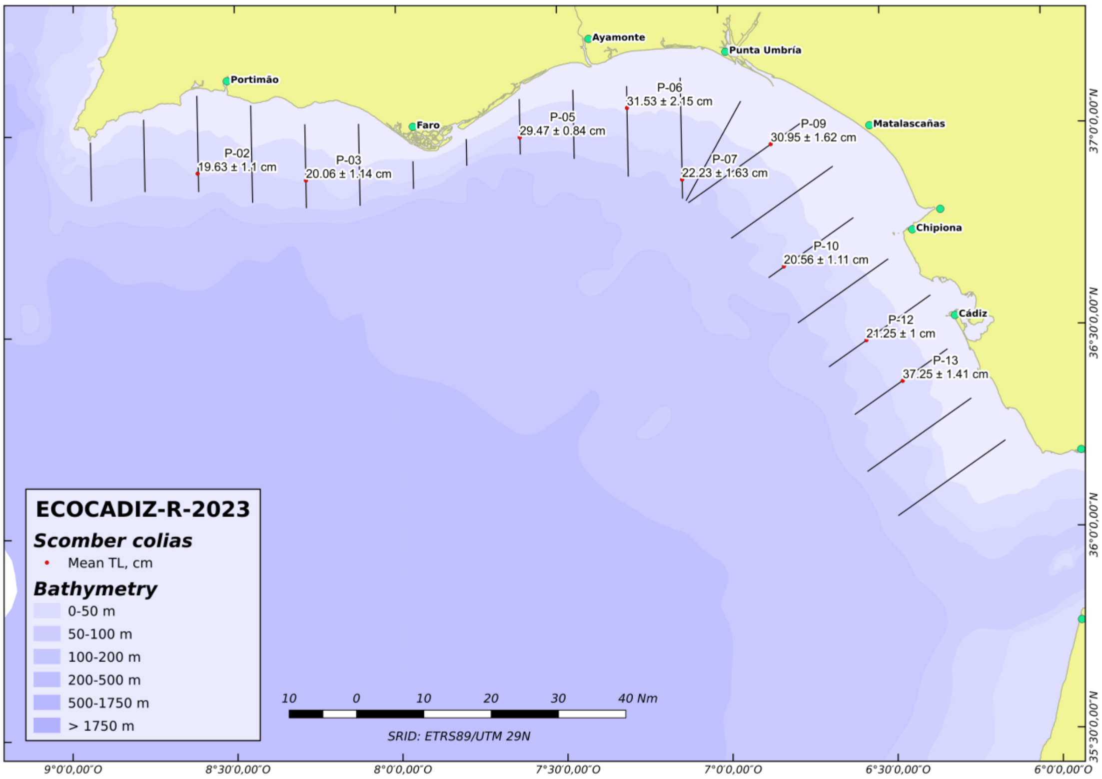
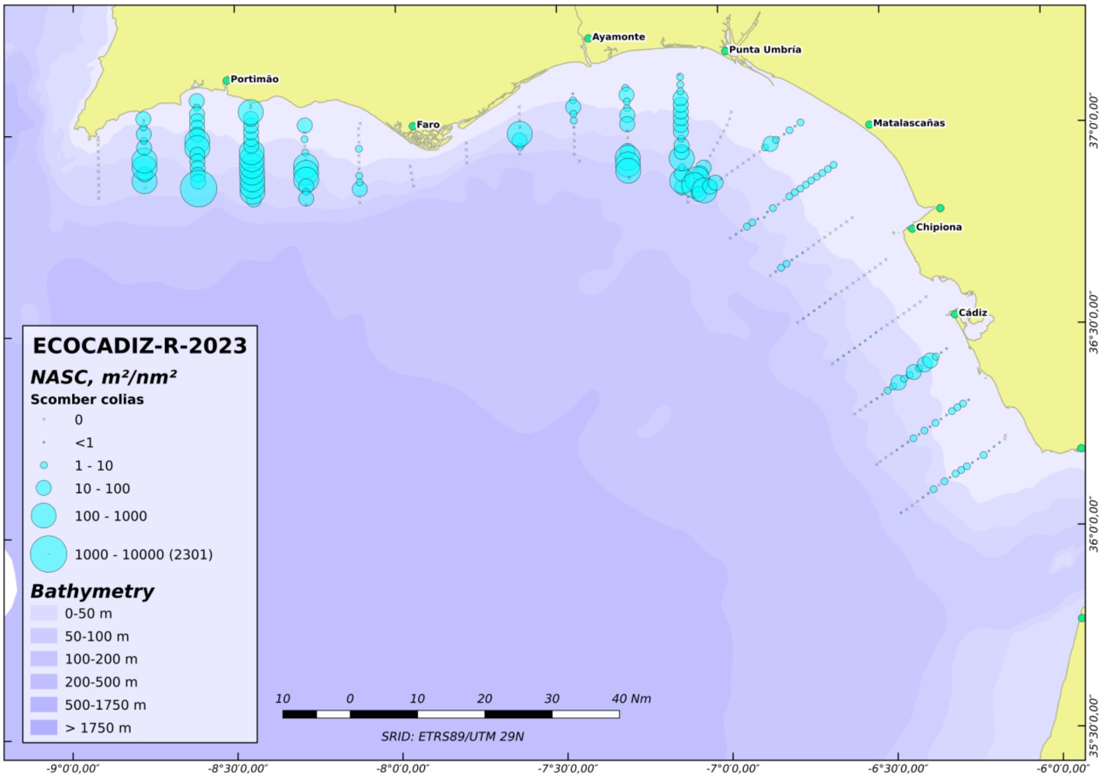




**Figure 21.** *ECOCADIZ-RECLUTAS 2023-10* survey. Chub mackerel (*Scomber colias*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.



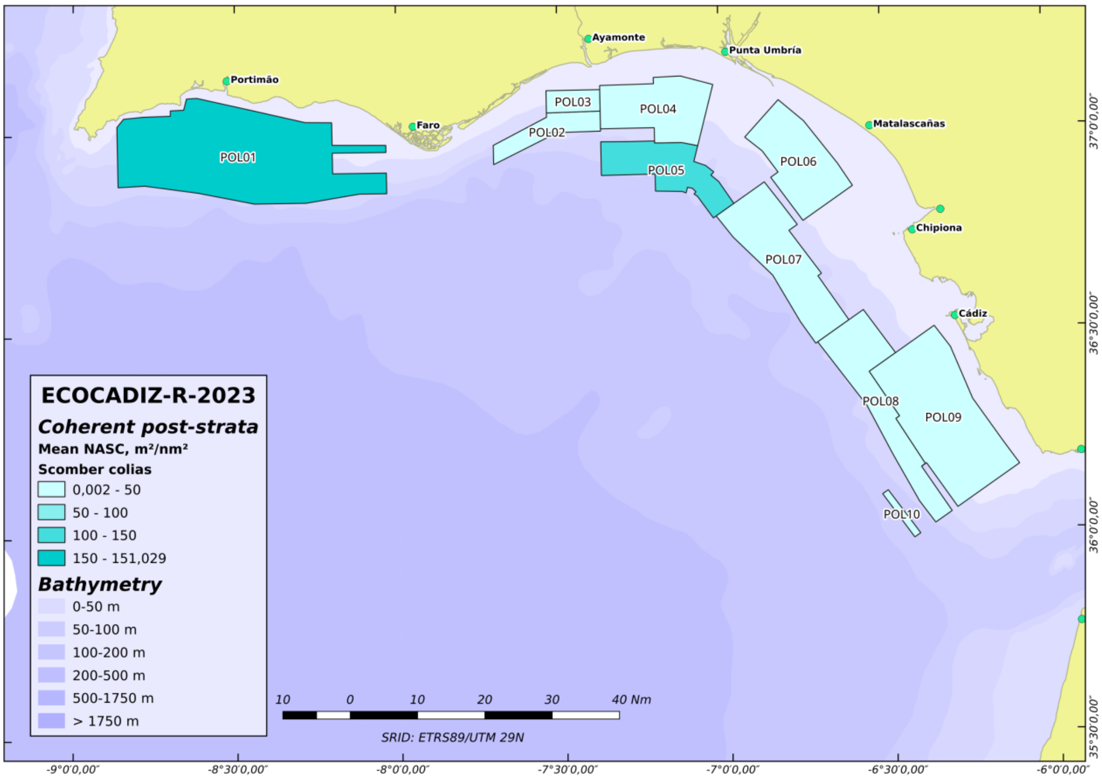




**Figure 22.** *ECOCADIZ-RECLUTAS 2023-10* survey. Chub mackerel (*Scomber colias*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

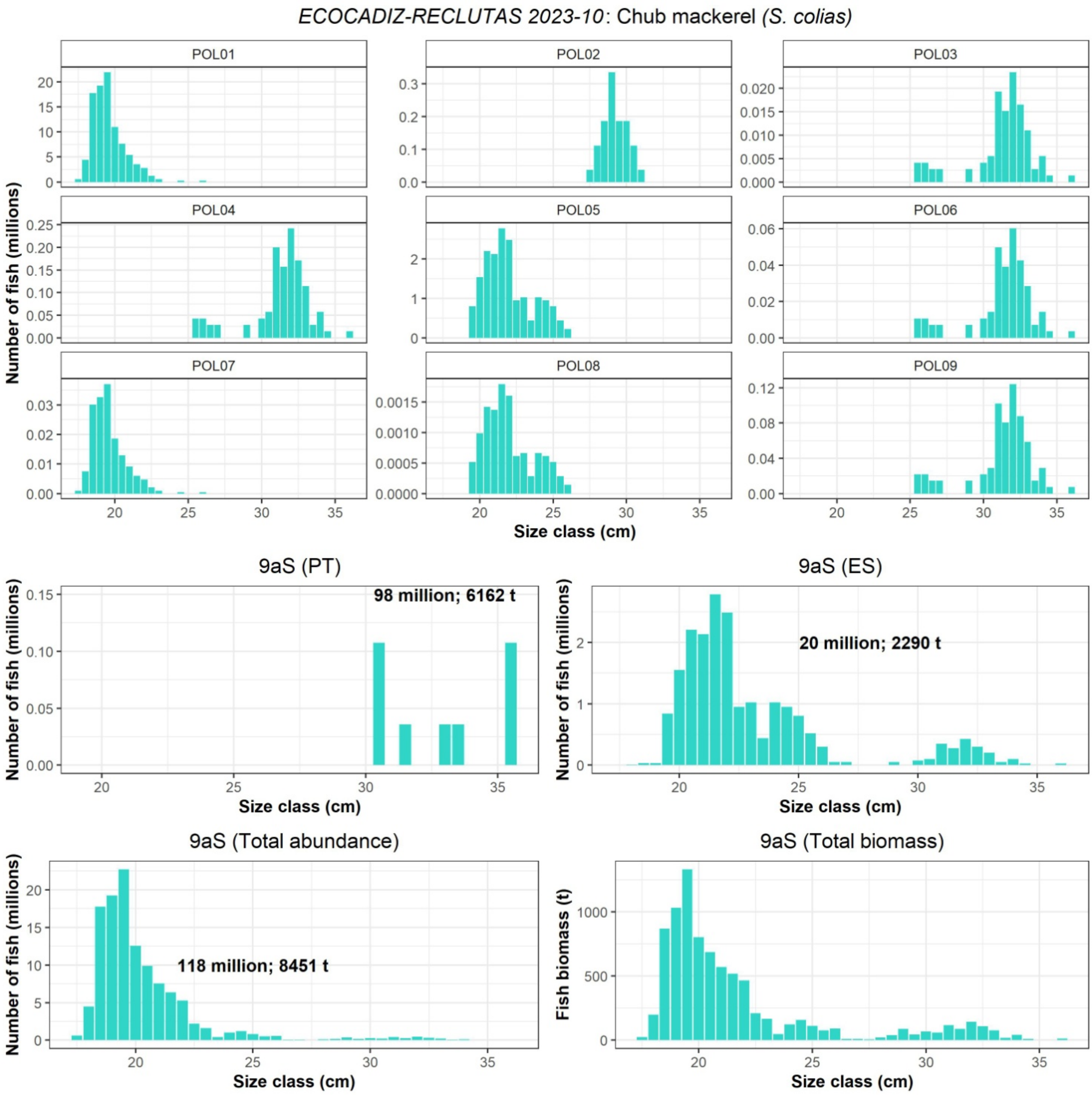



**Figure 23**. *ECOCADIZ-RECLUTAS 2023-10* survey. Chub mackerel (*Scomber colias*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 22**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the *y*-axis.

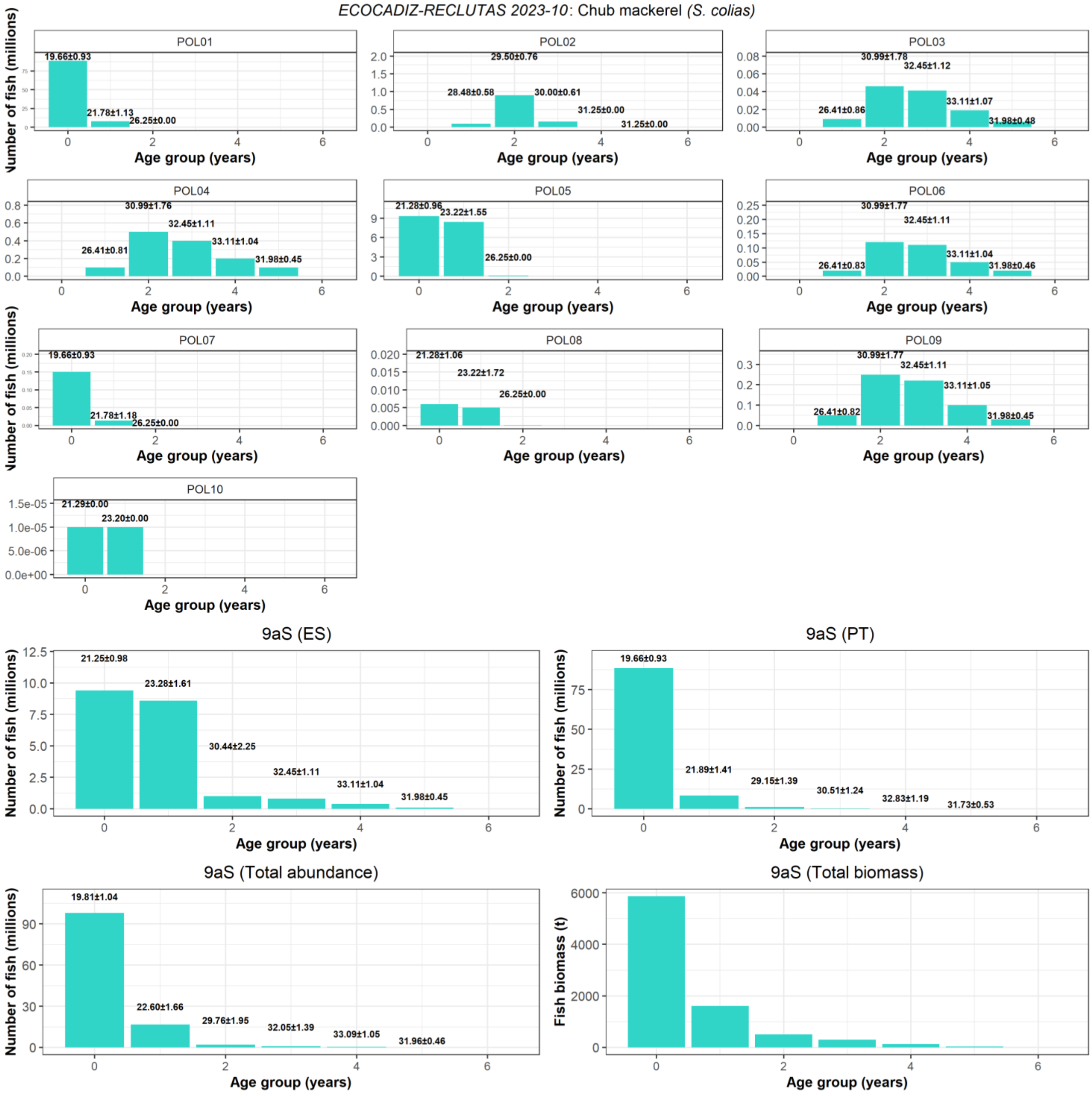



**Figure 24**. *ECOCADIZ-RECLUTAS 2023-10* survey. Chub mackerel (*Scomber colias*). Estimated abundances (number of fish in millions) by age group (years) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 22**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by age group for the whole sampled area is also shown for comparison. Note the different scale in the *y*-axis.

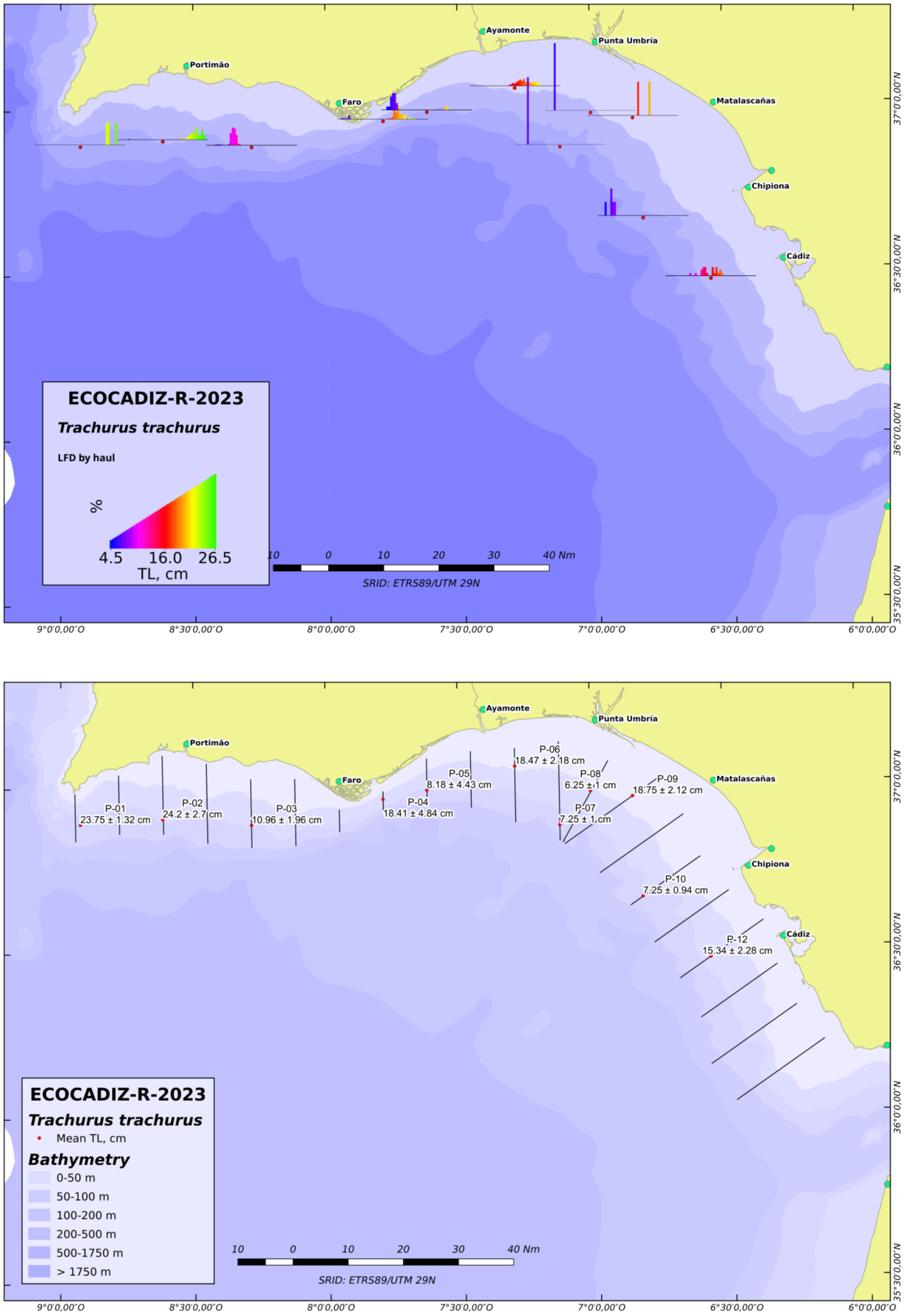
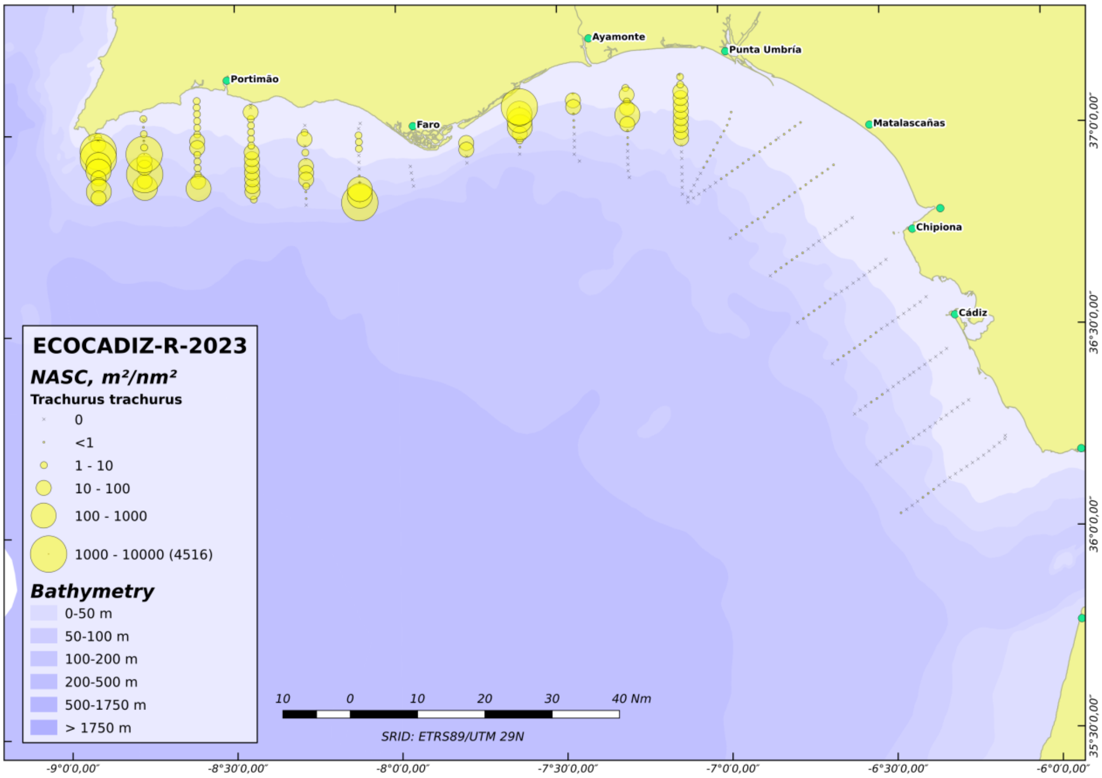



**Figure 25.** *ECOCADIZ-RECLUTAS 2023-10* survey. Horse mackerel (*Trachurus trachurus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.



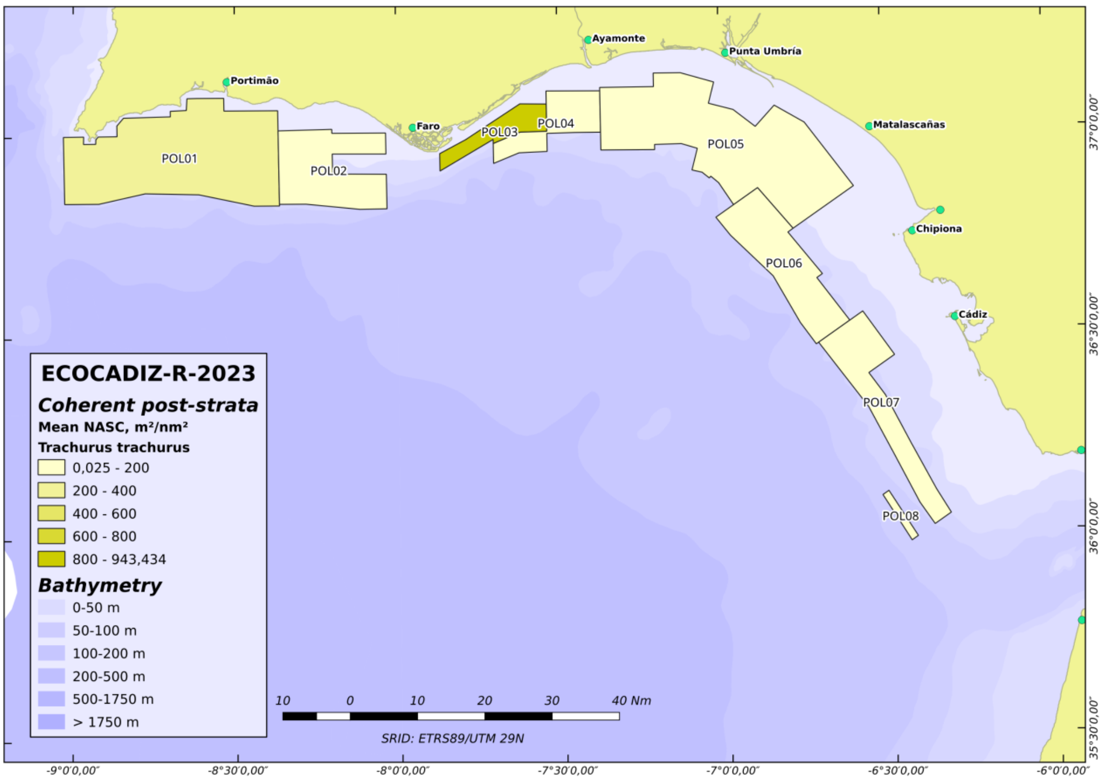




**Figure 26.** *ECOCADIZ-RECLUTAS 2023-10* survey. Horse mackerel (*Trachurus trachurus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

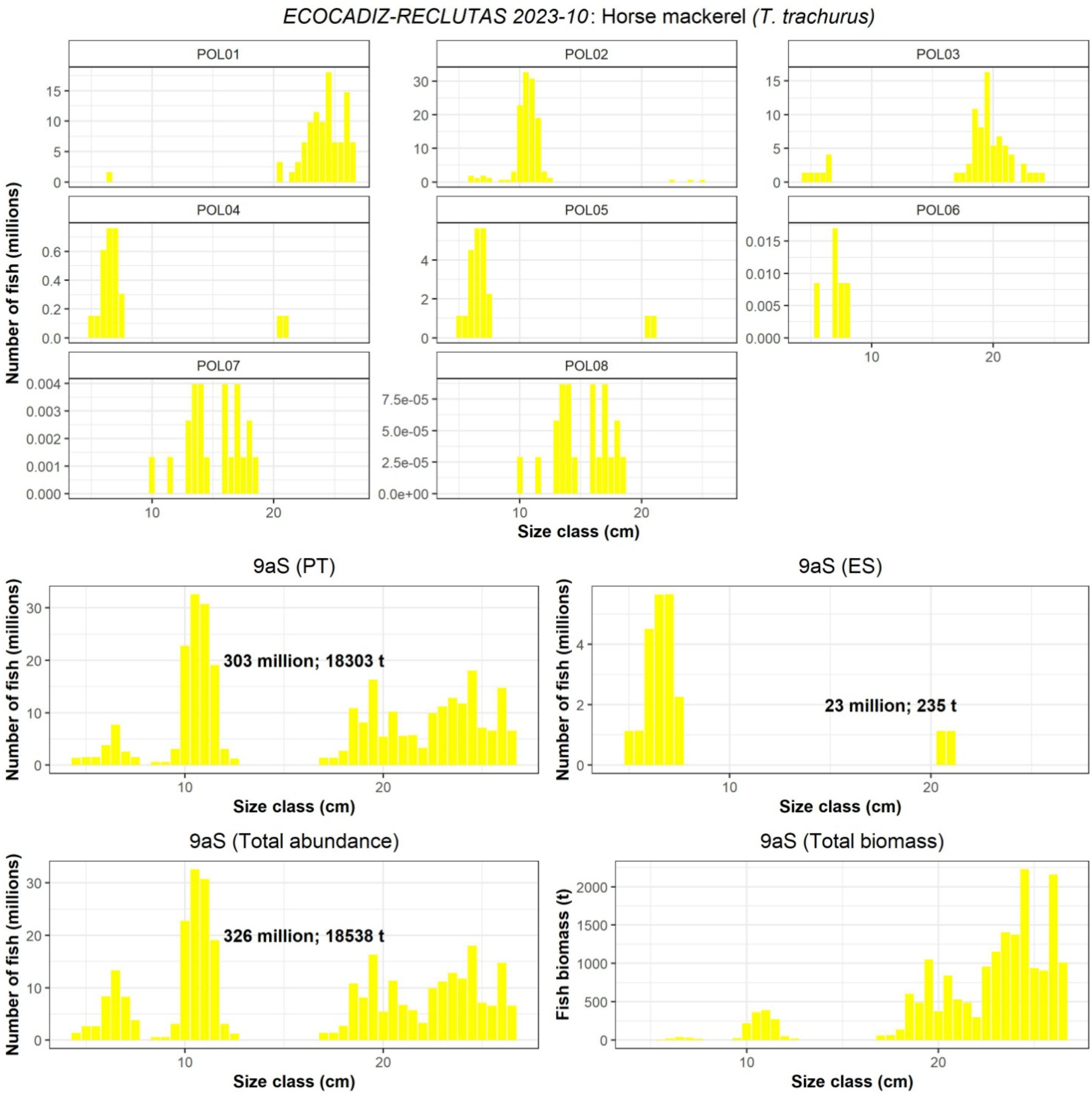



**Figure 27.** *ECOCADIZ-RECLUTAS 2023-10* survey. Horse mackerel (*Trachurus trachurus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 26**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the *y*-axis.

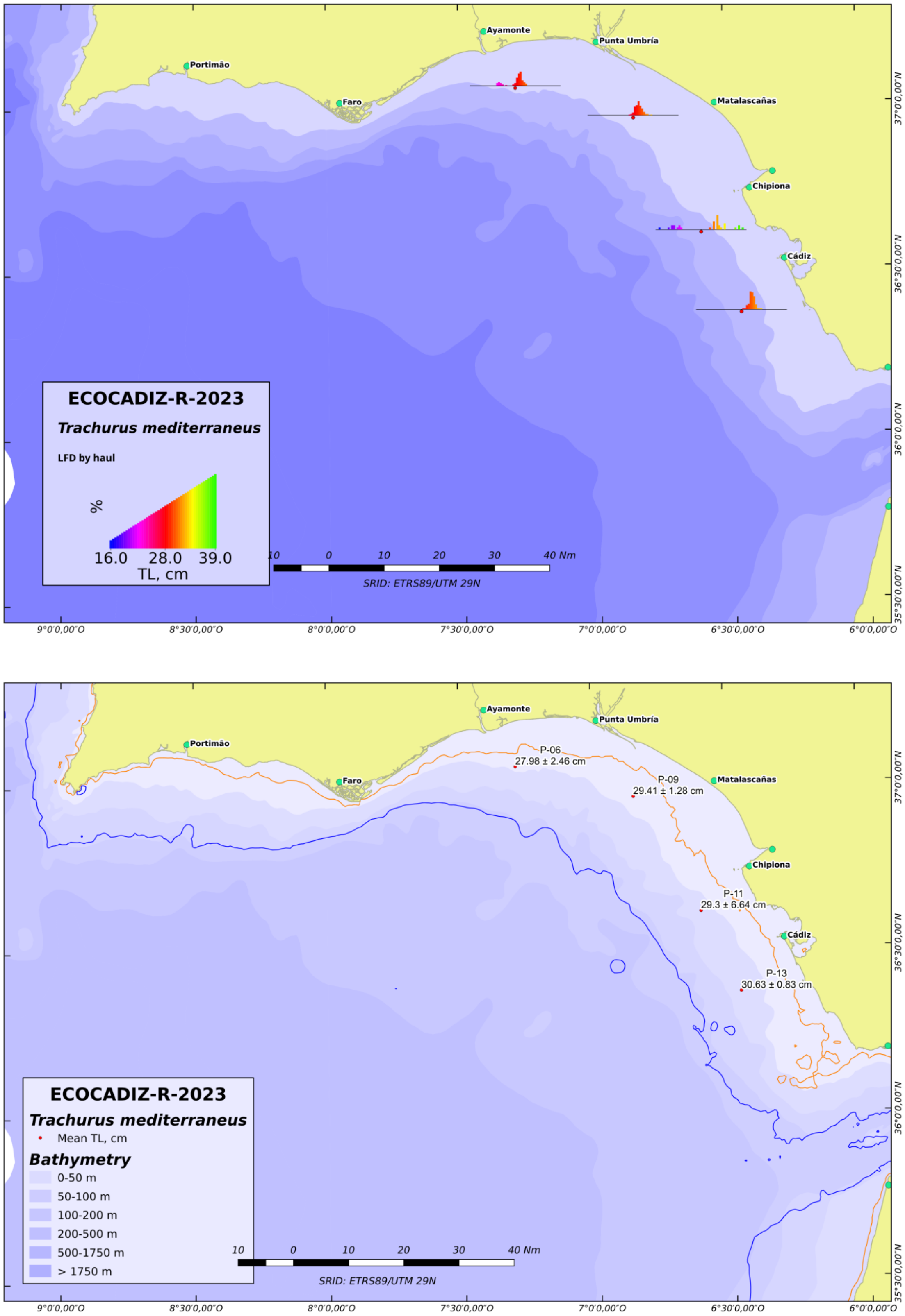



**Figure 28.** *ECOCADIZ-RECLUTAS 2023-10* survey. Mediterranean horse mackerel (*Trachurus mediterraneus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

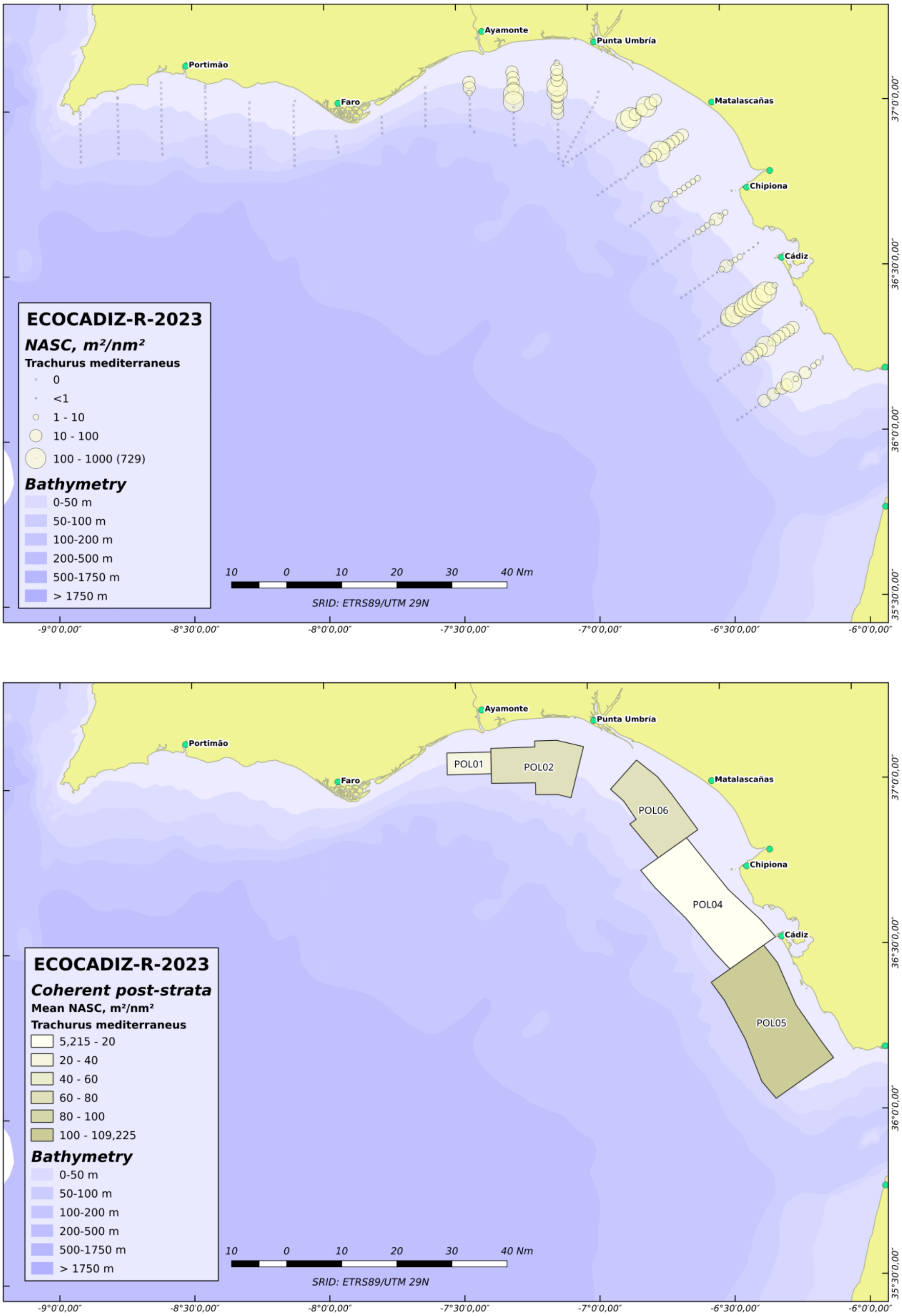



**Figure 29.** *ECOCADIZ-RECLUTAS 2023-10* survey. Mediterranean horse mackerel (*Trachurus mediterraneus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

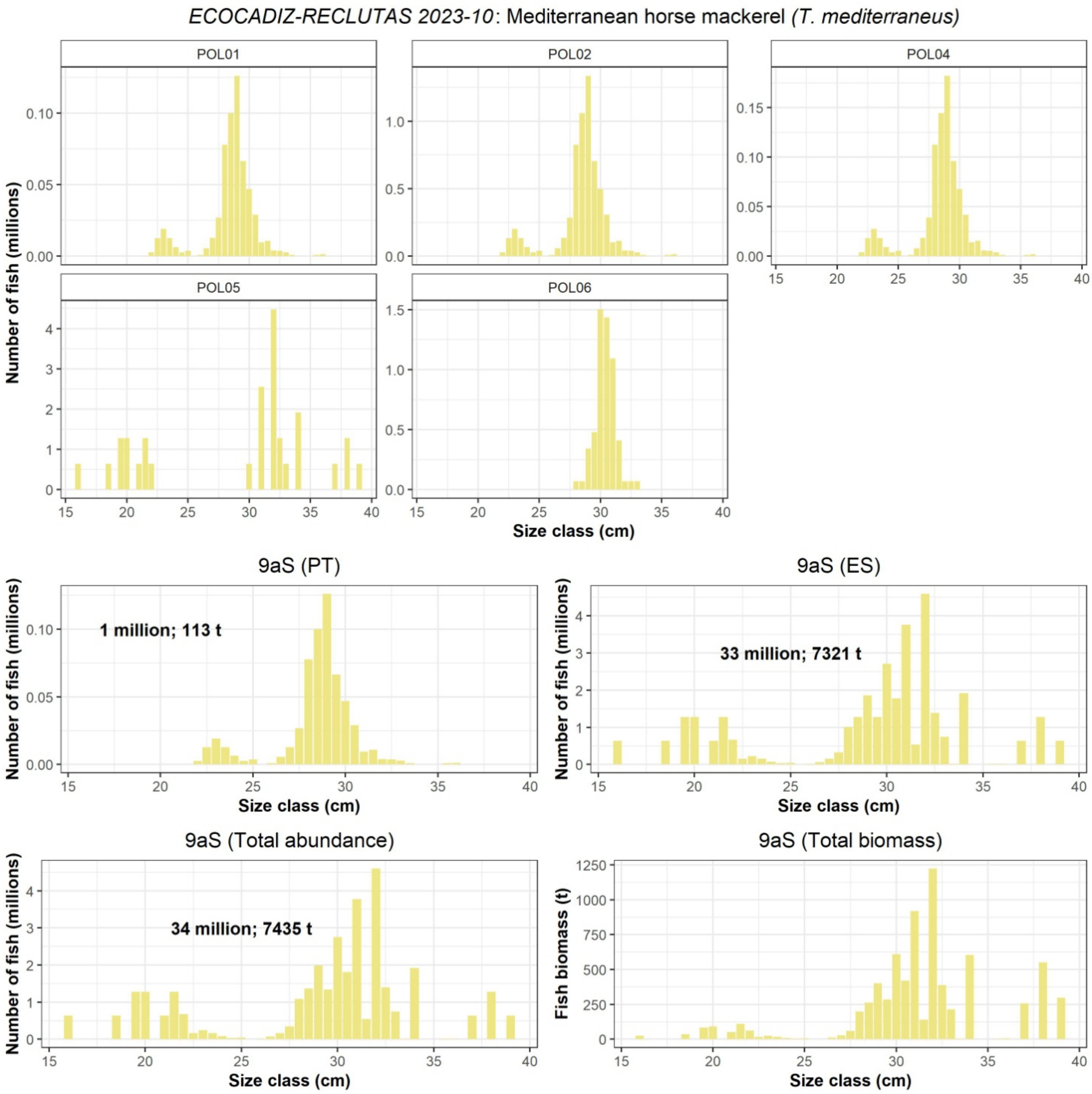
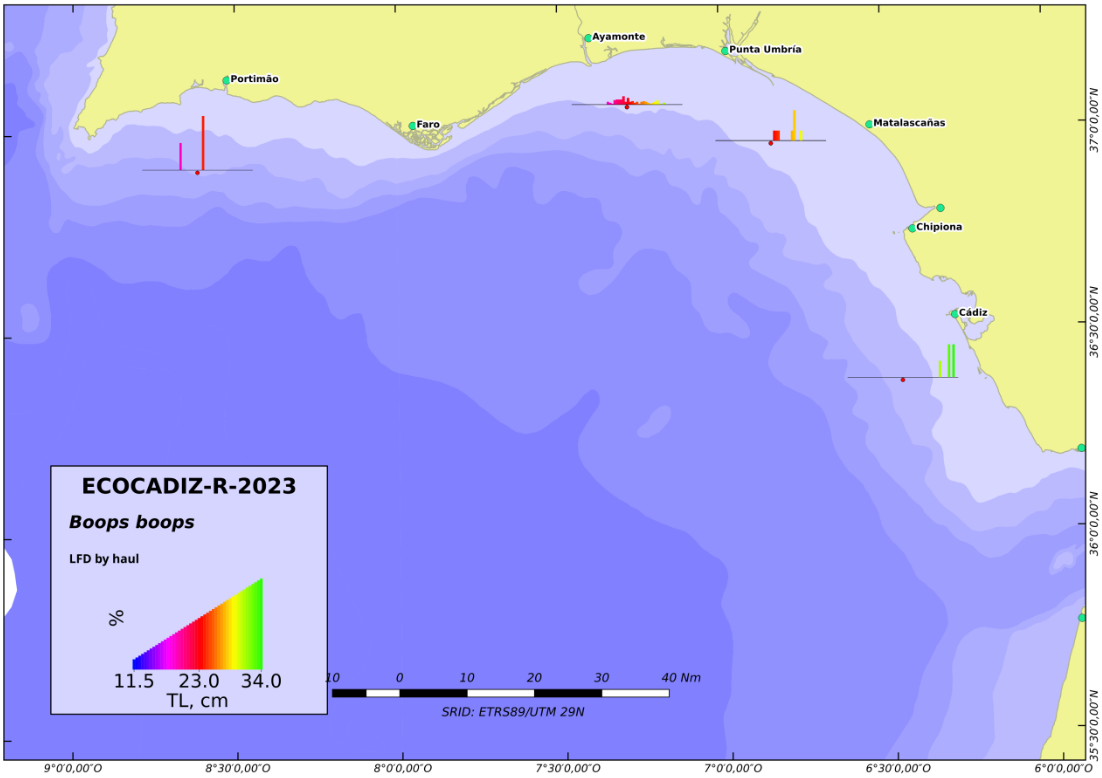



**Figure 30.** *ECOCADIZ-RECLUTAS 2023-10* survey. Mediterranean horse mackerel (*Trachurus mediterraneus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 29)** and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the *y*-axis.



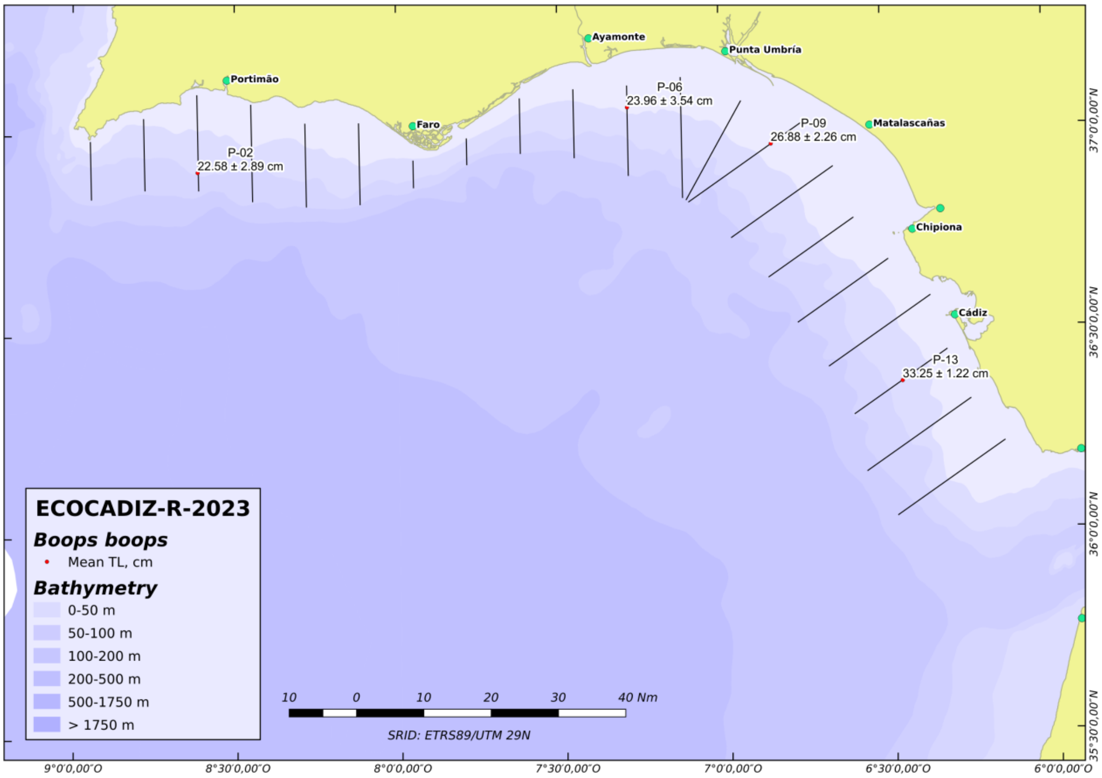
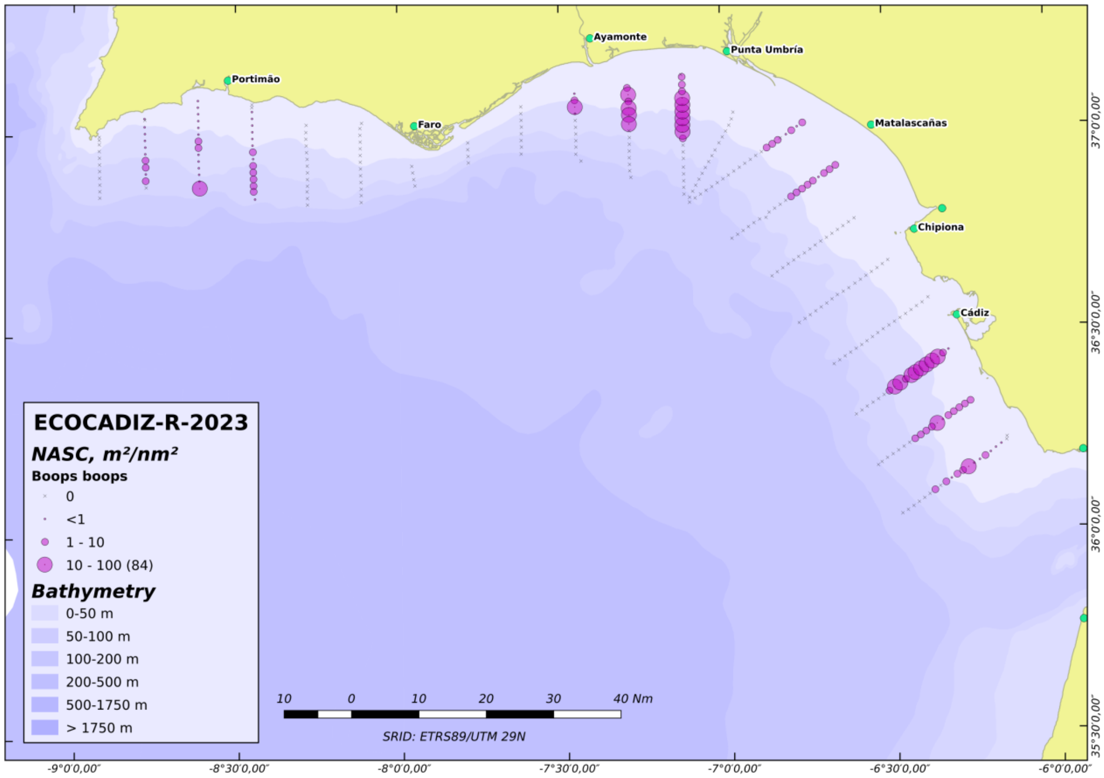




**Figure 31.** *ECOCADIZ-RECLUTAS 2023-10* survey. Bogue (*Boops boops*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.



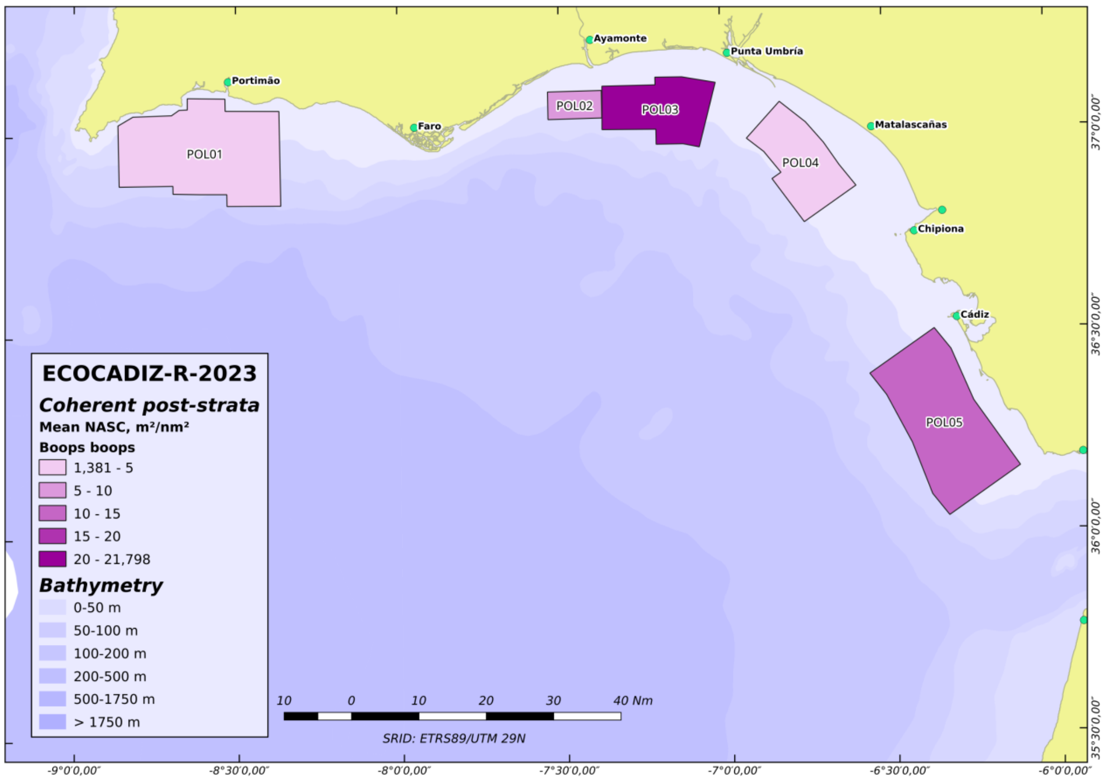




**Figure 32.** *ECOCADIZ-RECLUTAS 2023-10* survey. Bogue (*Boops boops*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

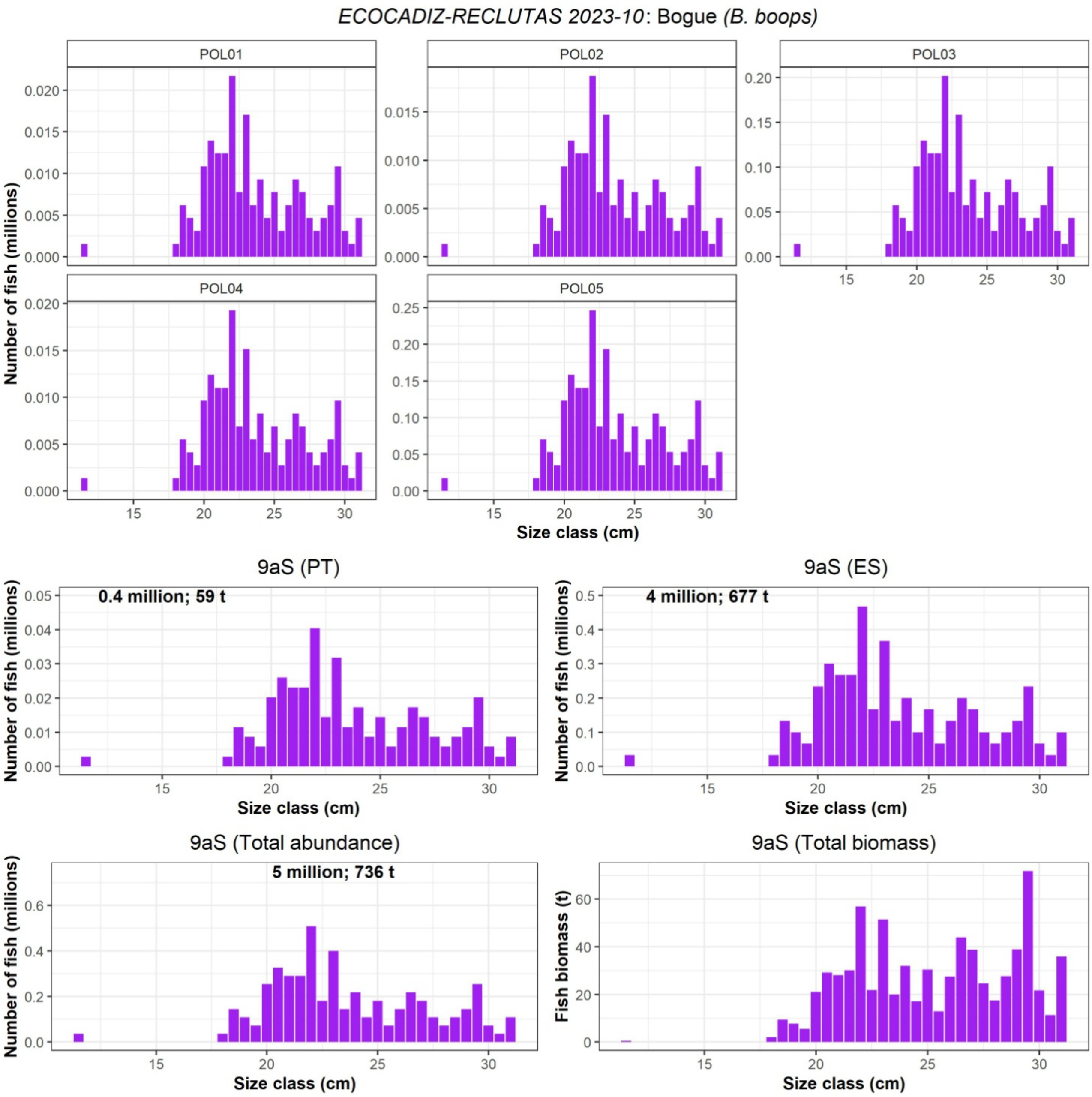



**Figure 33.** *ECOCADIZ-RECLUTAS 2023-10* survey. Bogue (*Boops boops*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 32**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the *y*-axis.

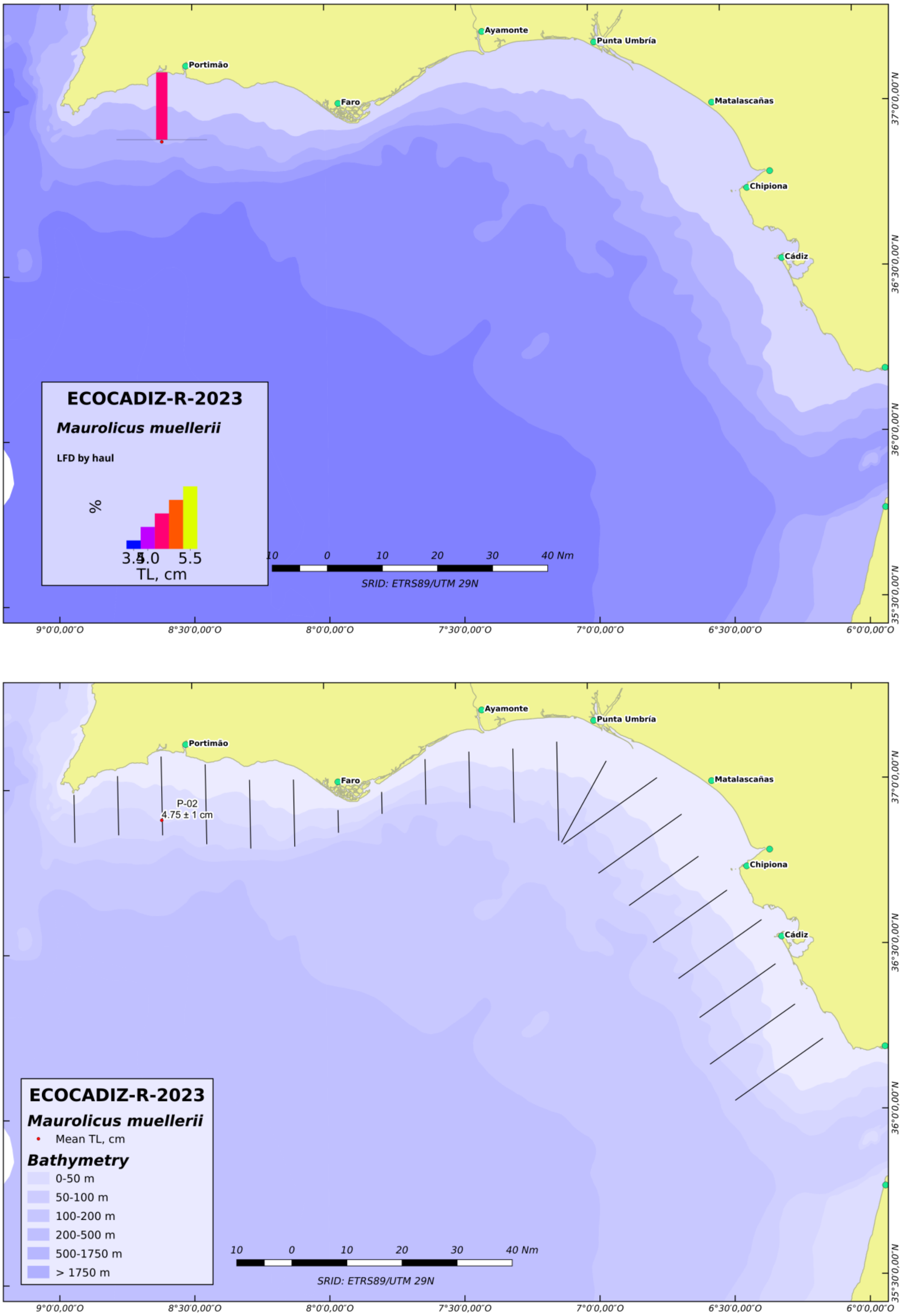
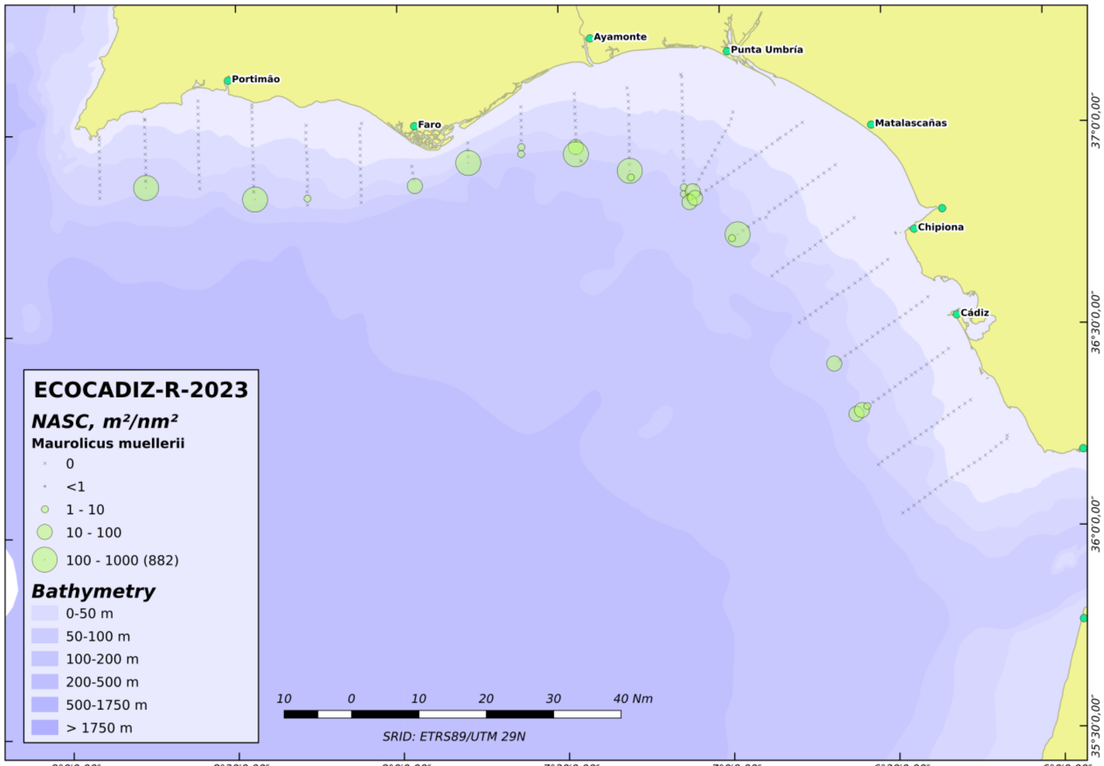



**Figure 34.** *ECOCADIZ-RECLUTAS 2023-10* survey. Pearlside (*Maurolicus muelleri*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.



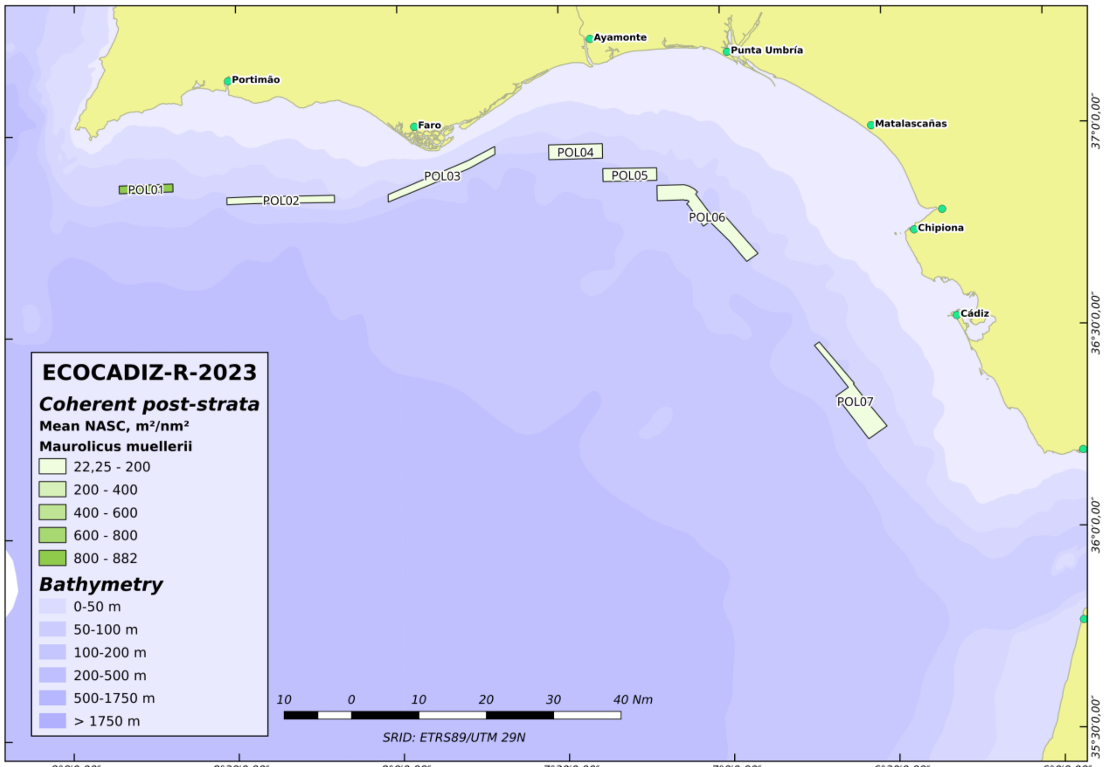




**Figure 35.** *ECOCADIZ-RECLUTAS 2023-10* survey. Pearlside (*Maurolicus muelleri*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

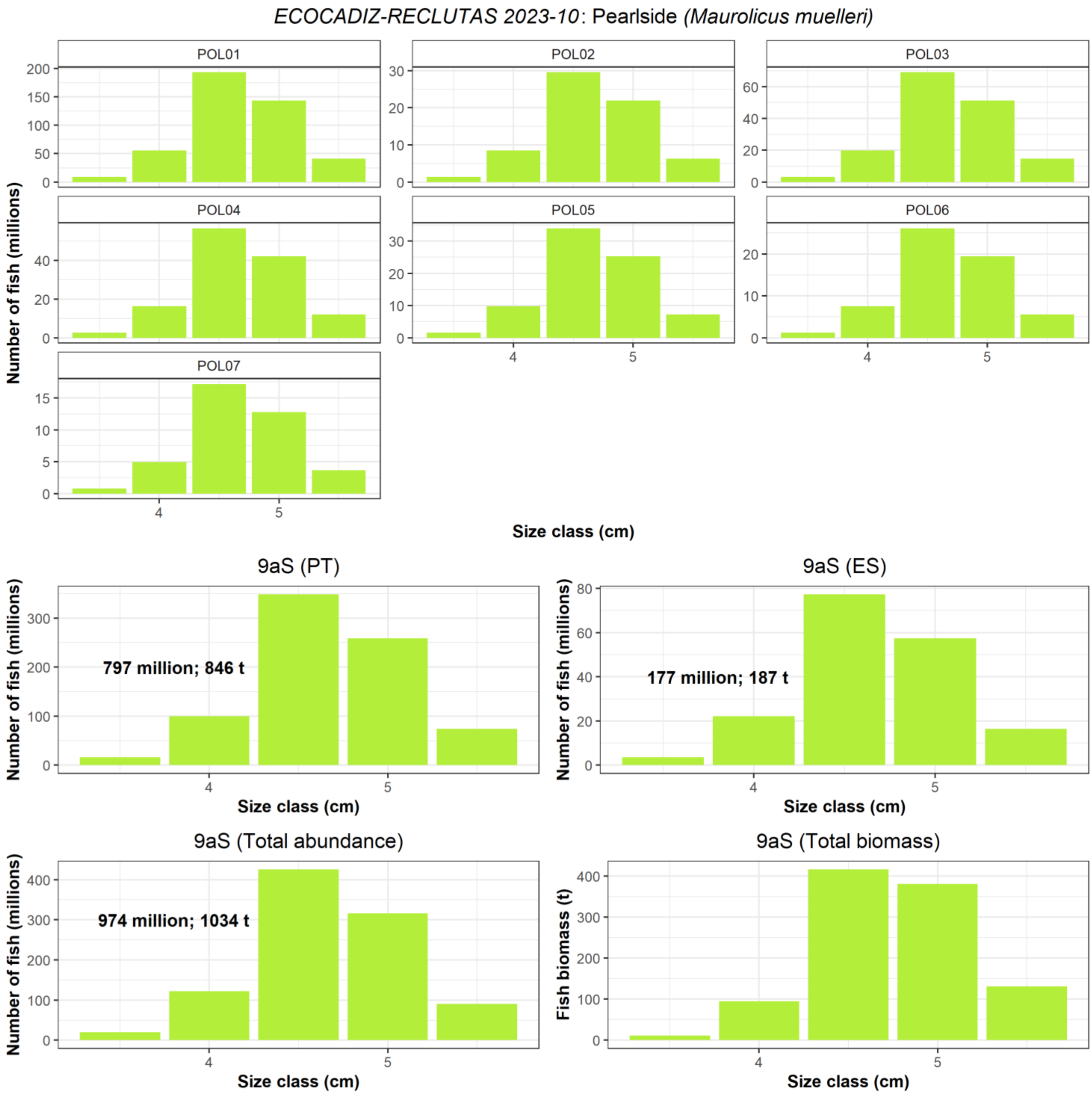
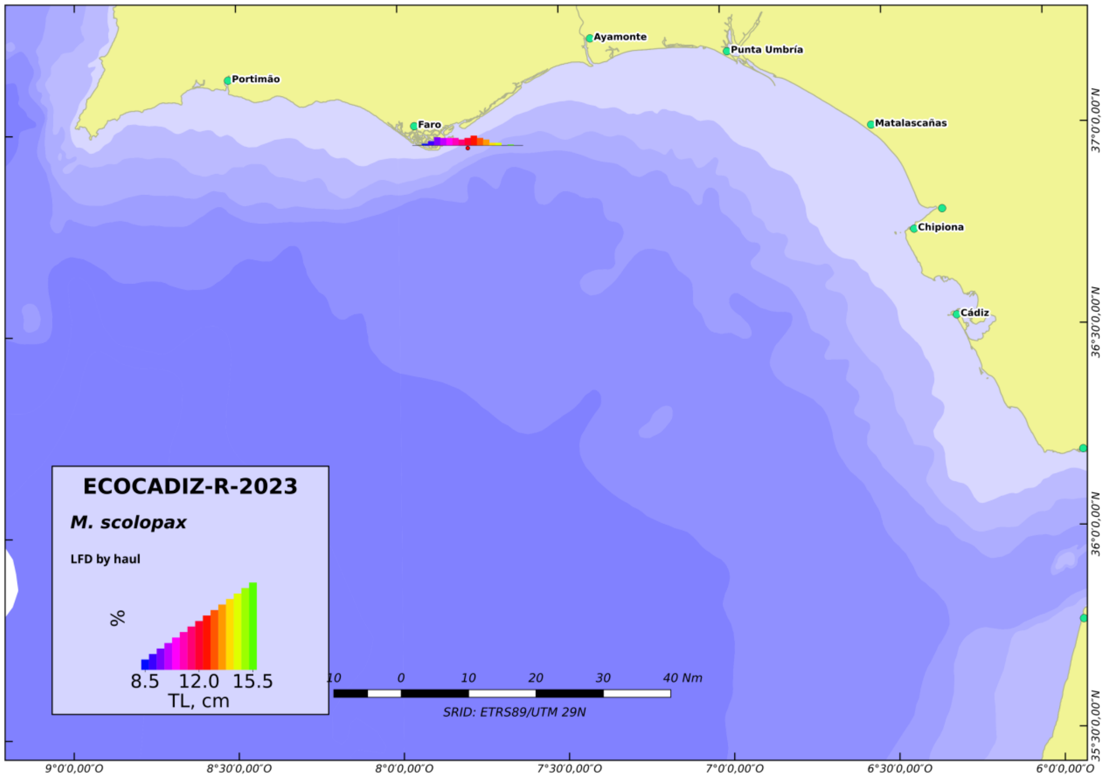



**Figure 36.** *ECOCADIZ-RECLUTAS 2023-10* survey. Pearlside (*Maurolicus muelleri*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 35**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the *y*-axis.



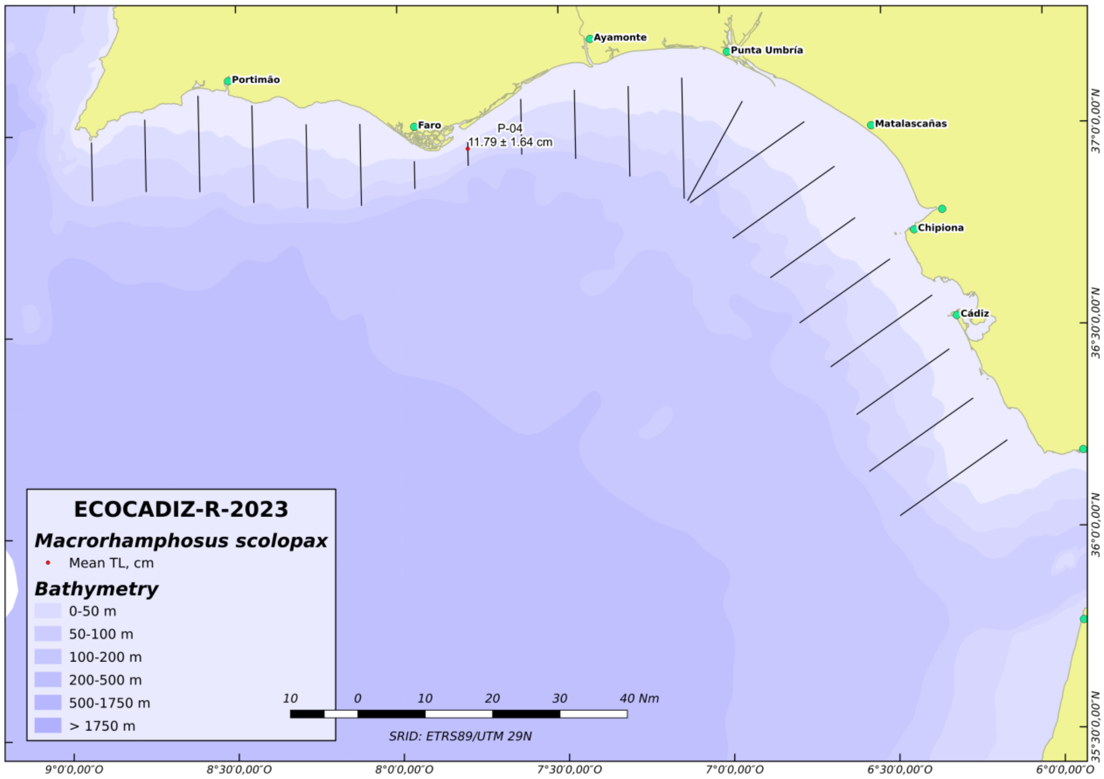
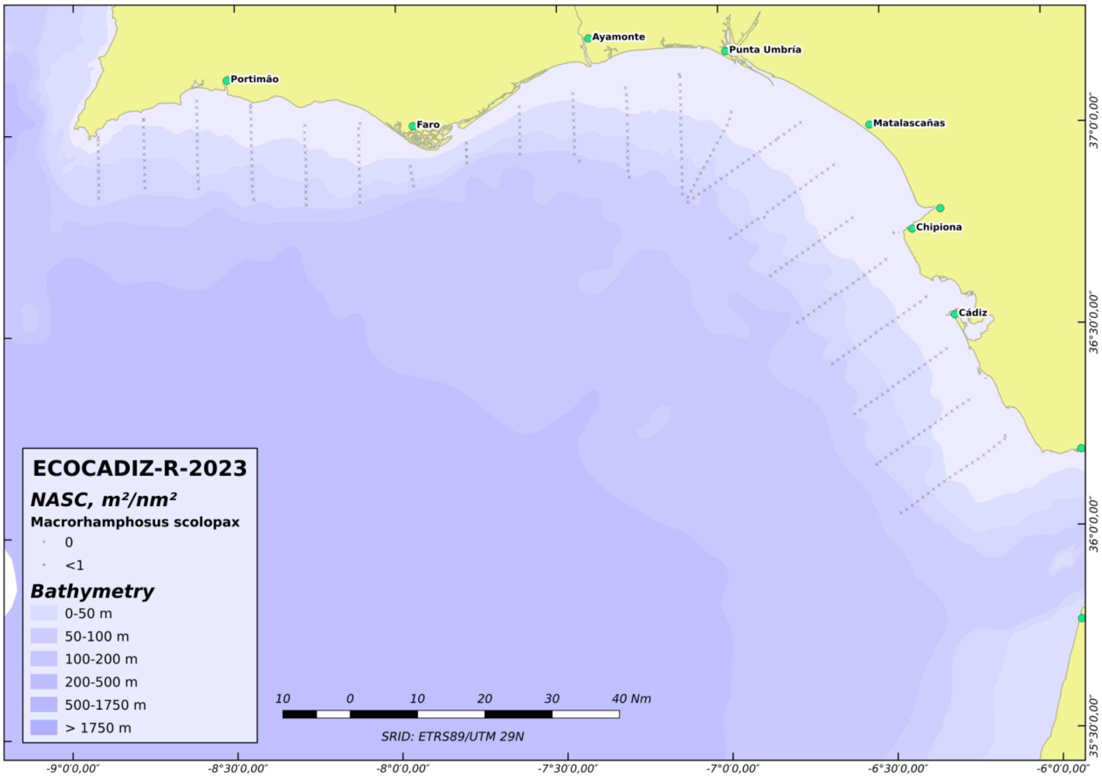




**Figure 37.** *ECOCADIZ-RECLUTAS 2023-10* survey. Longspine snipefish (*Macroramphosus scolopax*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.



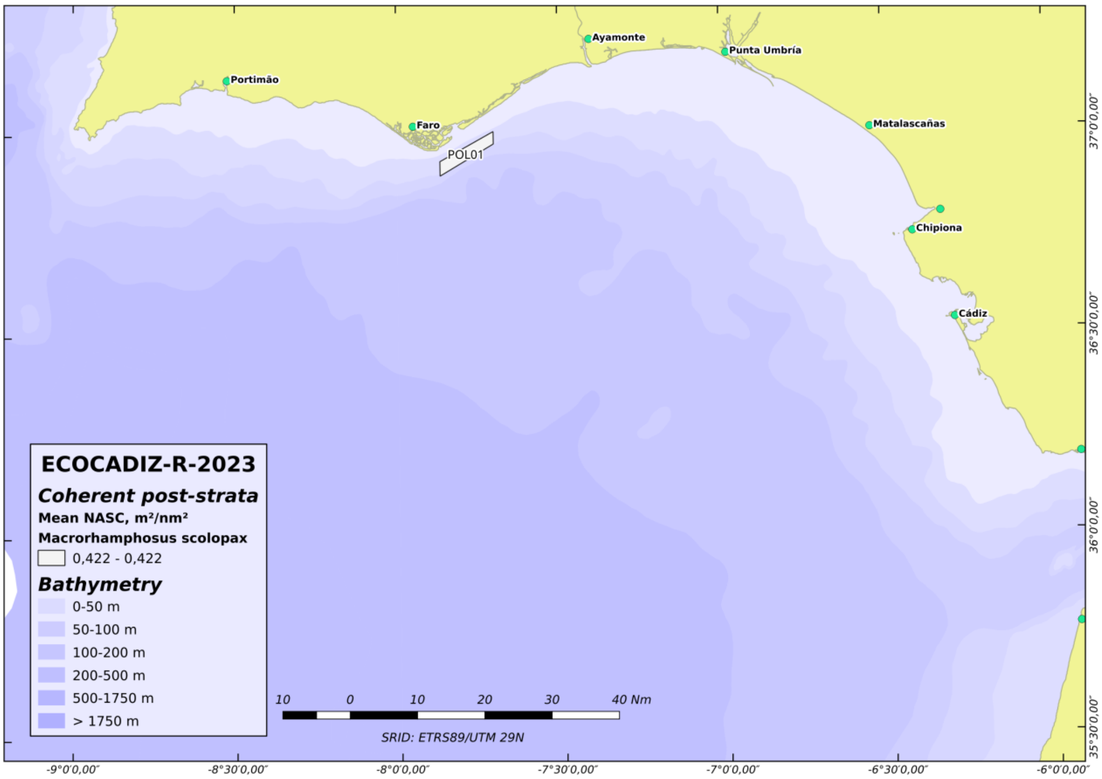




**Figure 38.** *ECOCADIZ-RECLUTAS 2023-10* survey. Longspine snipefish (*Macroramphosus scolopax*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

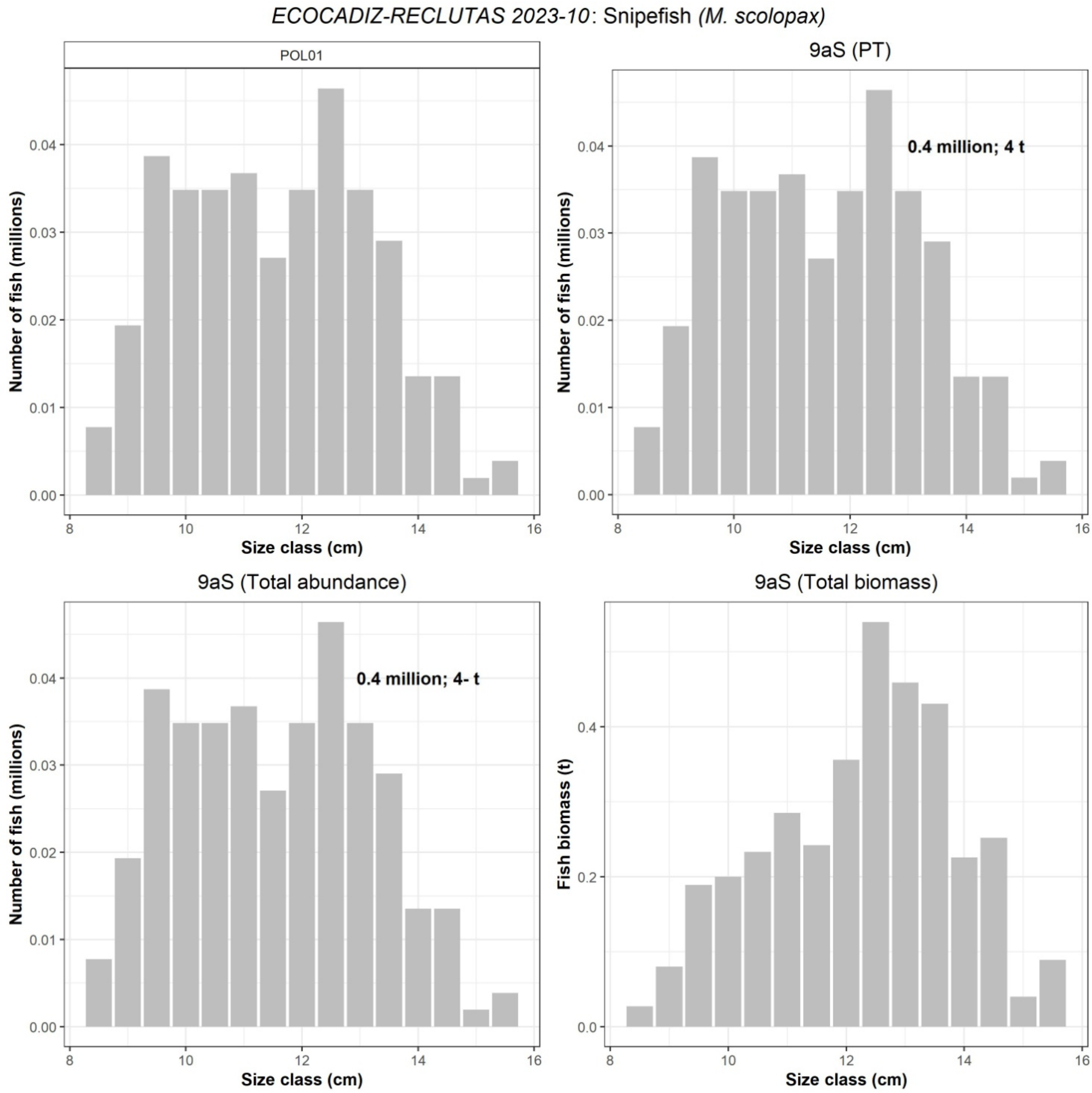



**Figure 39.** *ECOCADIZ-RECLUTAS 2023-10* survey. Longspine snipefish (*Macroramphosus scolopax*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 38**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the *y*-axis.

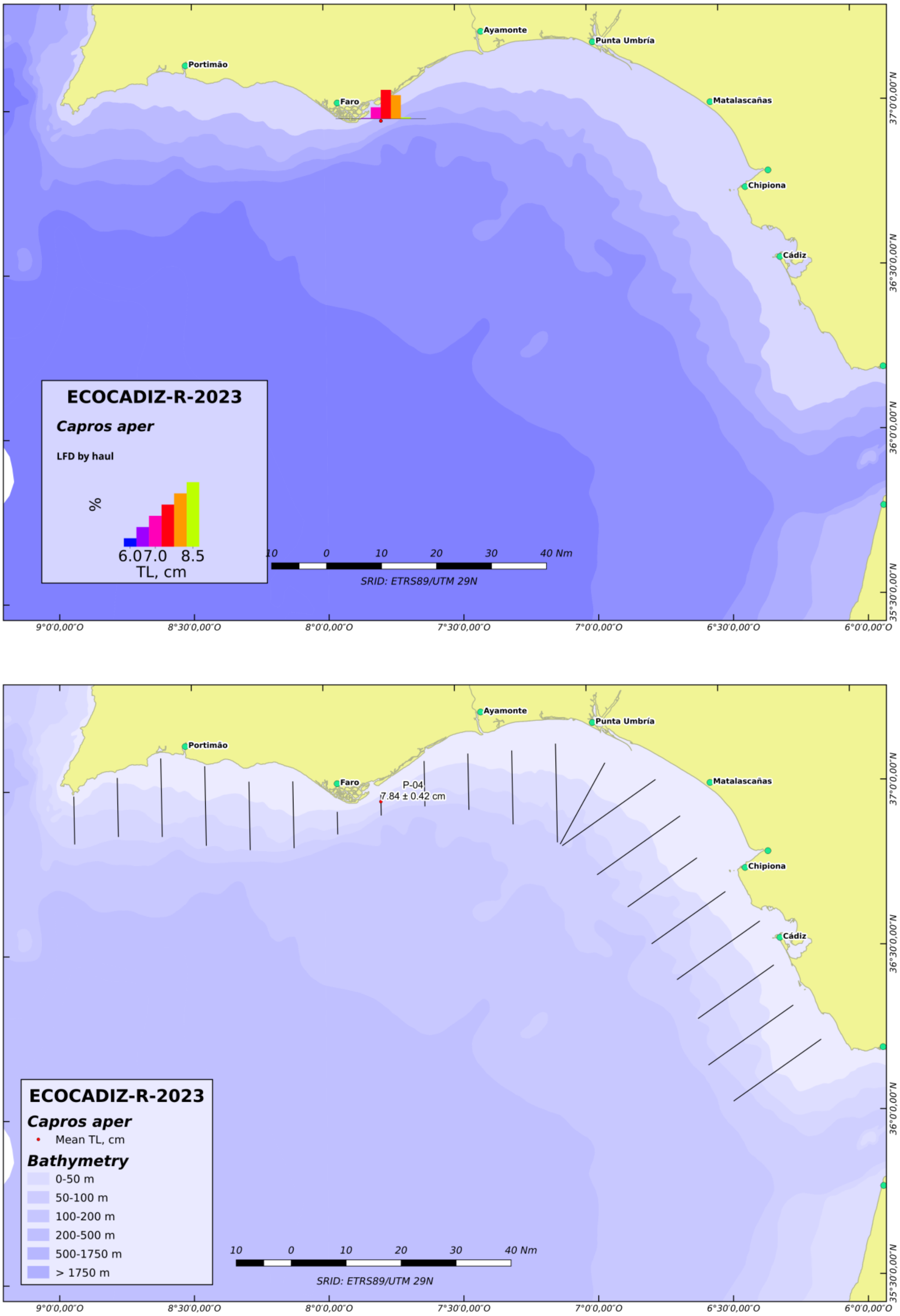



**Figure 40.** *ECOCADIZ-RECLUTAS 2023-10* survey. Boarfish (*Capros aper*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

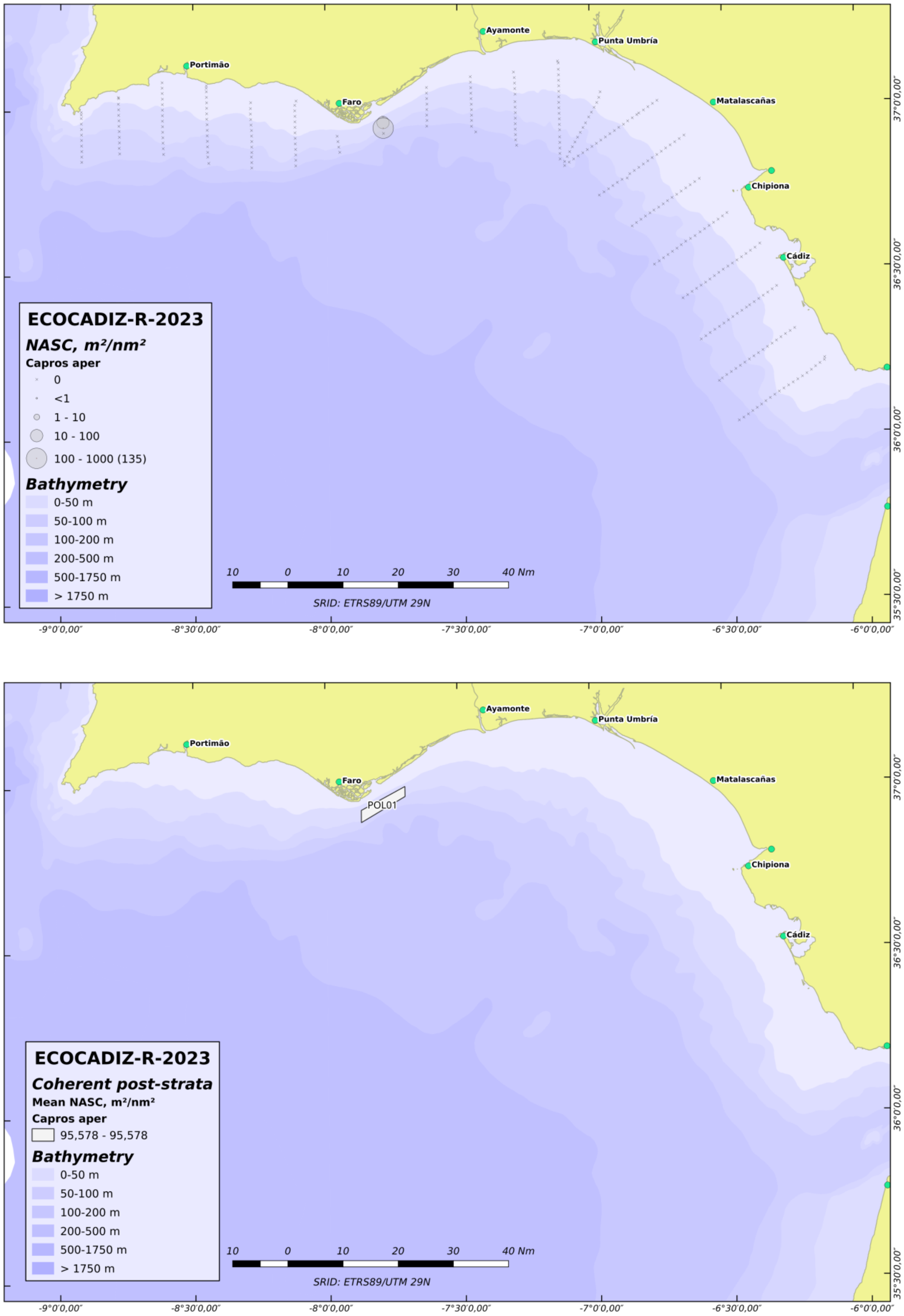



**Figure 41.** *ECOCADIZ-RECLUTAS 2023-10* survey. Boarfish (*Capros aper*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

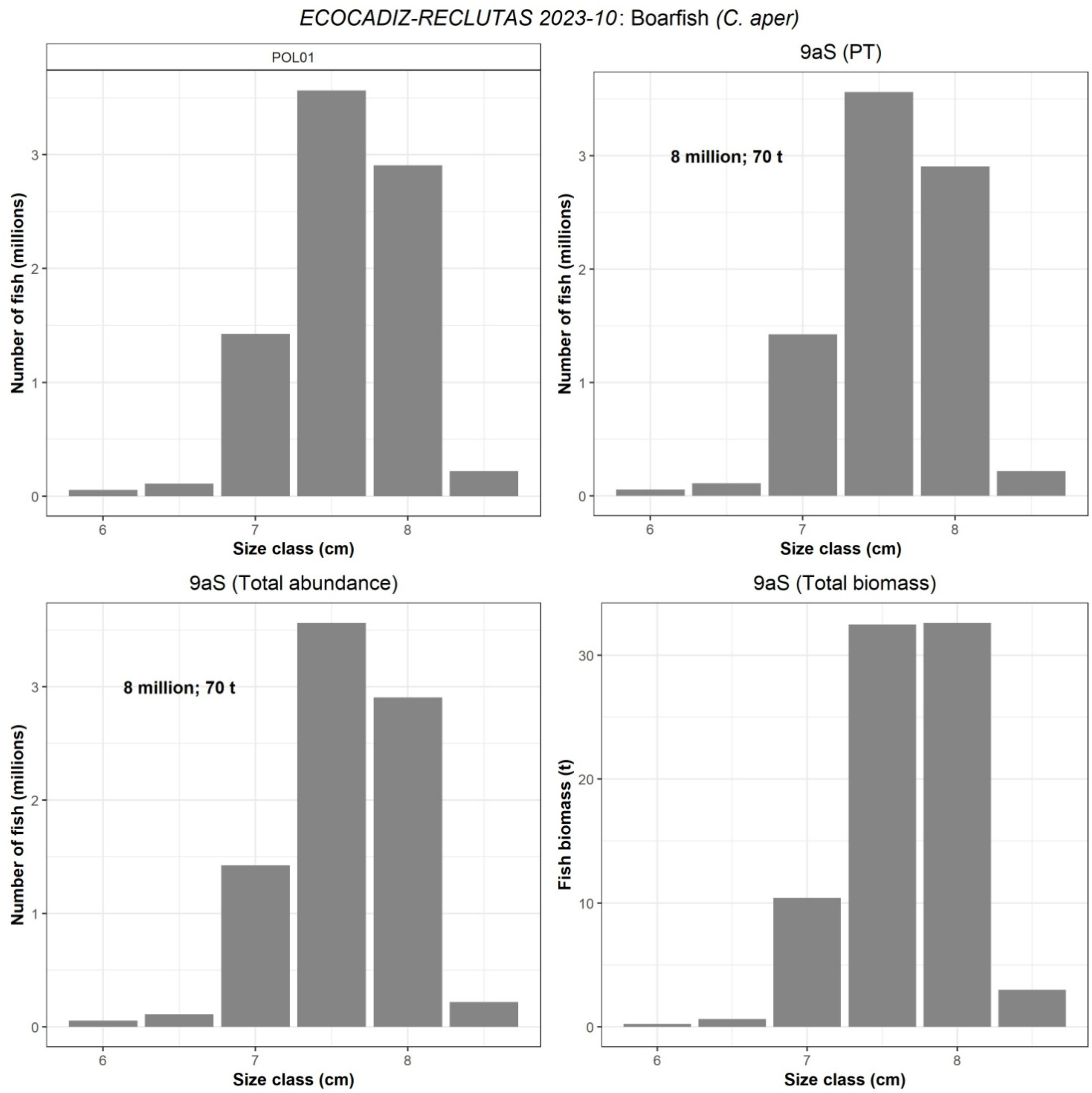



**Figure 42.** *ECOCADIZ-RECLUTAS 2023-10* survey. Boarfish (*Capros aper*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 41**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the *y*-axis.

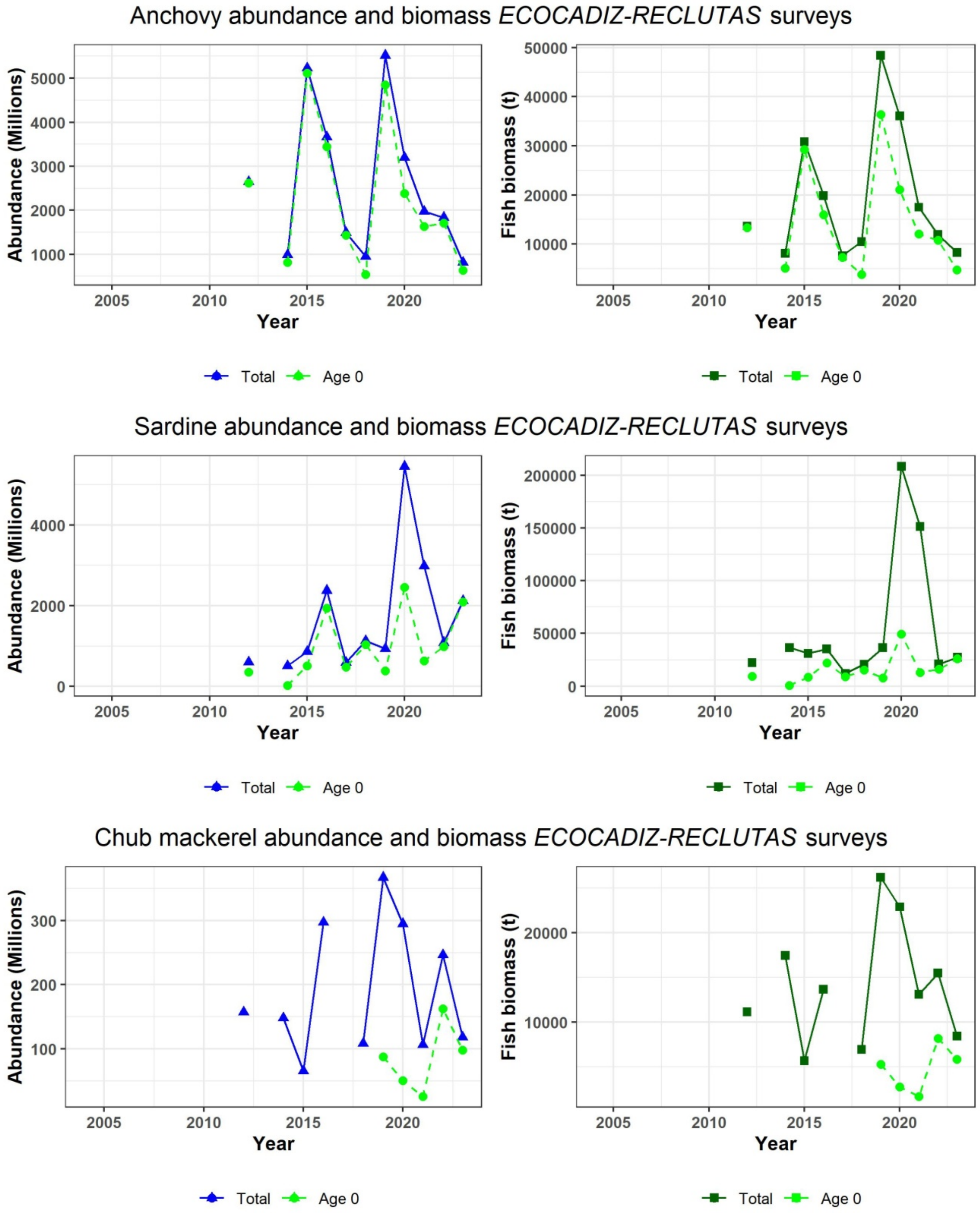



**Figure 43.** *ECOCADIZ-RECLUTAS* surveys series. Historical series of autumn acoustic estimates of anchovy, sardine and chub mackerel abundance (million) and biomass (t) in Sub-division 9.a South. The estimates correspond to the total population and age 0 fish. The 2012 survey only surveyed the Spanish waters. No survey was conducted in 2013. Although a survey was conducted in 2017, the survey was interrupted for a serious breakdown of the vessel's propulsion system and no estimates were computed. The 2018 estimates should be considered with caution because a possible under-estimation. Age data for chub mackerel started to be available since 2019 on.

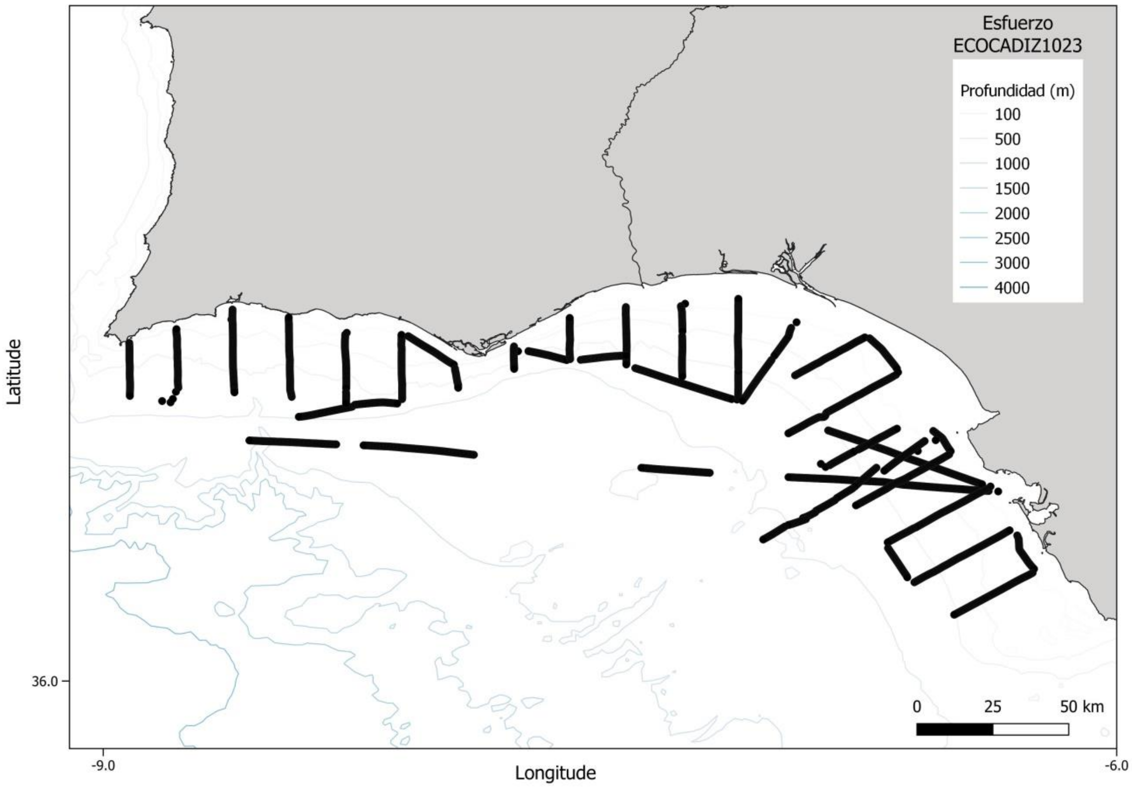
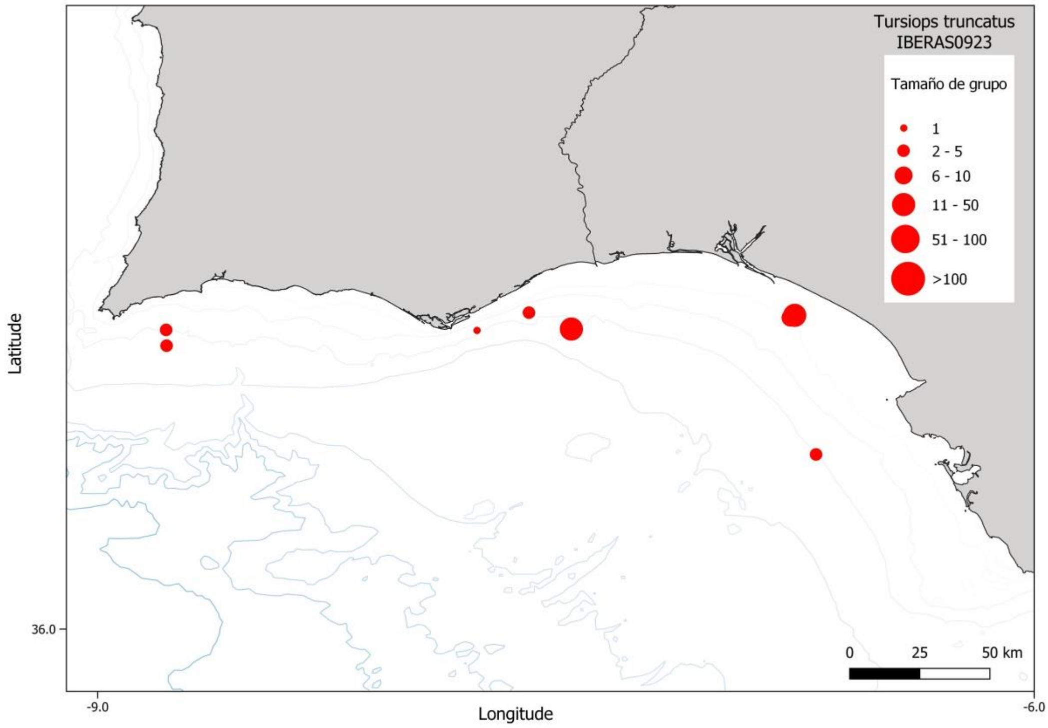



**Figure 44.** *ECOCADIZ-RECLUTAS 2023-10* survey. Spatial distribution of the sampling effort (black lines) performed by the observer of top predator during the *ECOCADIZ-RECLUTAS 2023-10* survey



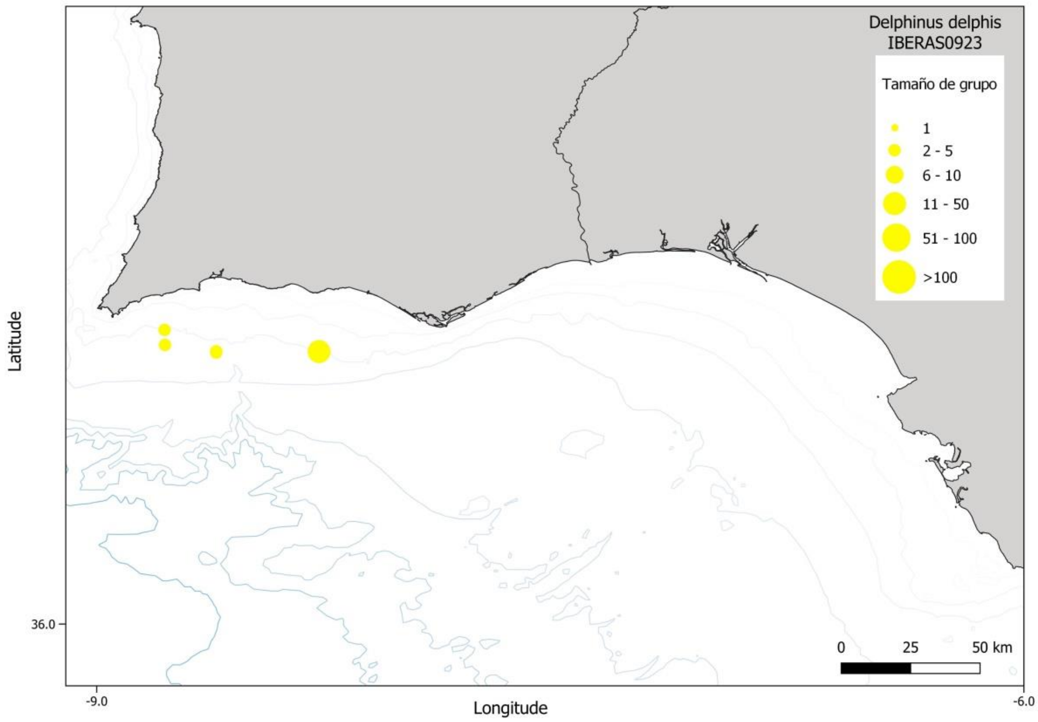
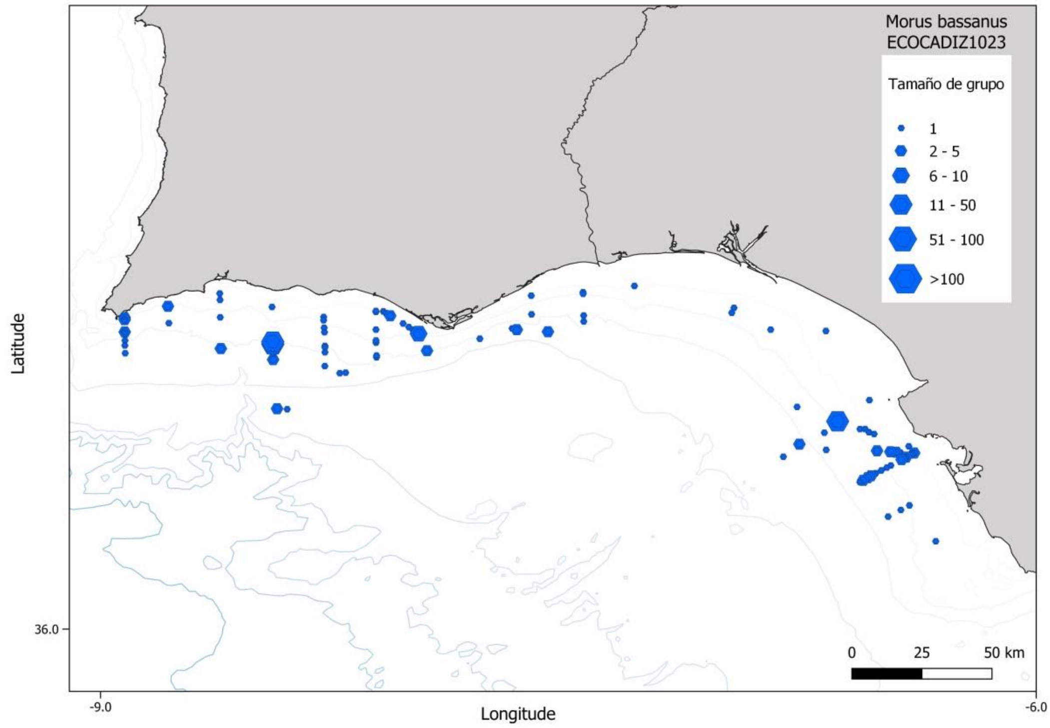




**Figure 45.** *ECOCADIZ-RECLUTAS 2023-10* survey. Sightings of marine mammals. Top: Bottlenose dolphin (*Tursiops truncatus*); bottom: Common dolphin (*Delphinus delphis*).



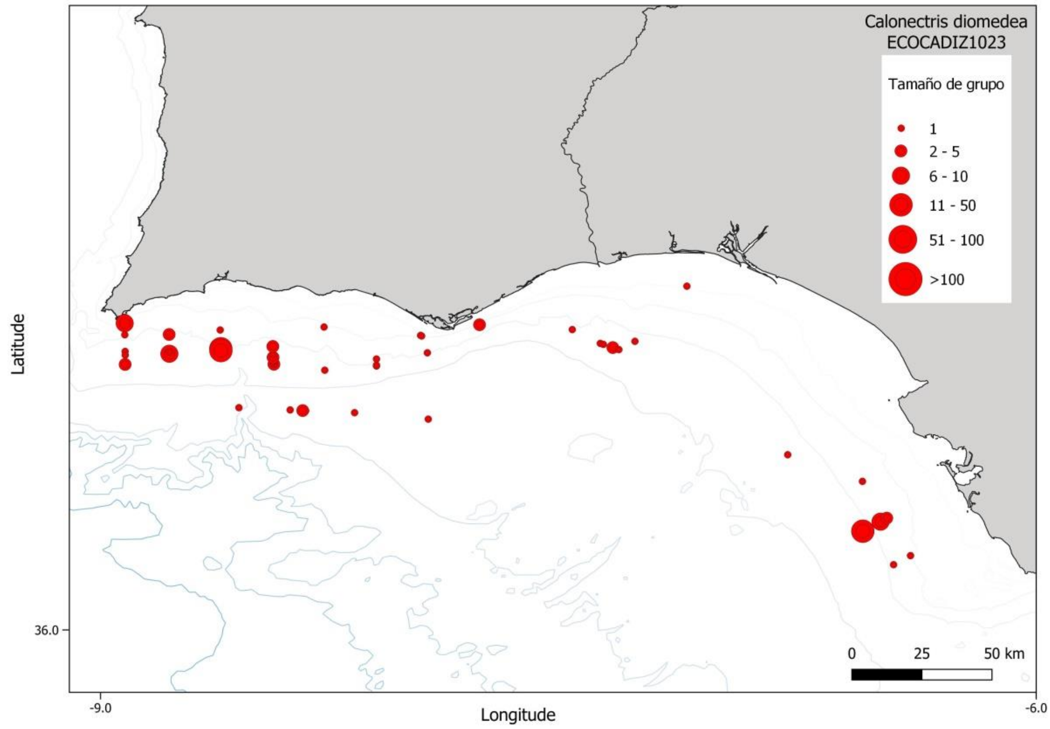




**Figure 46.** *ECOCADIZ-RECLUTAS 2023-10* survey. Sightings of sea bird species. Top: northern gannet (*Morus bassanus*); bottom: Scopoli's shearwater (*Calonectris diomedea*).

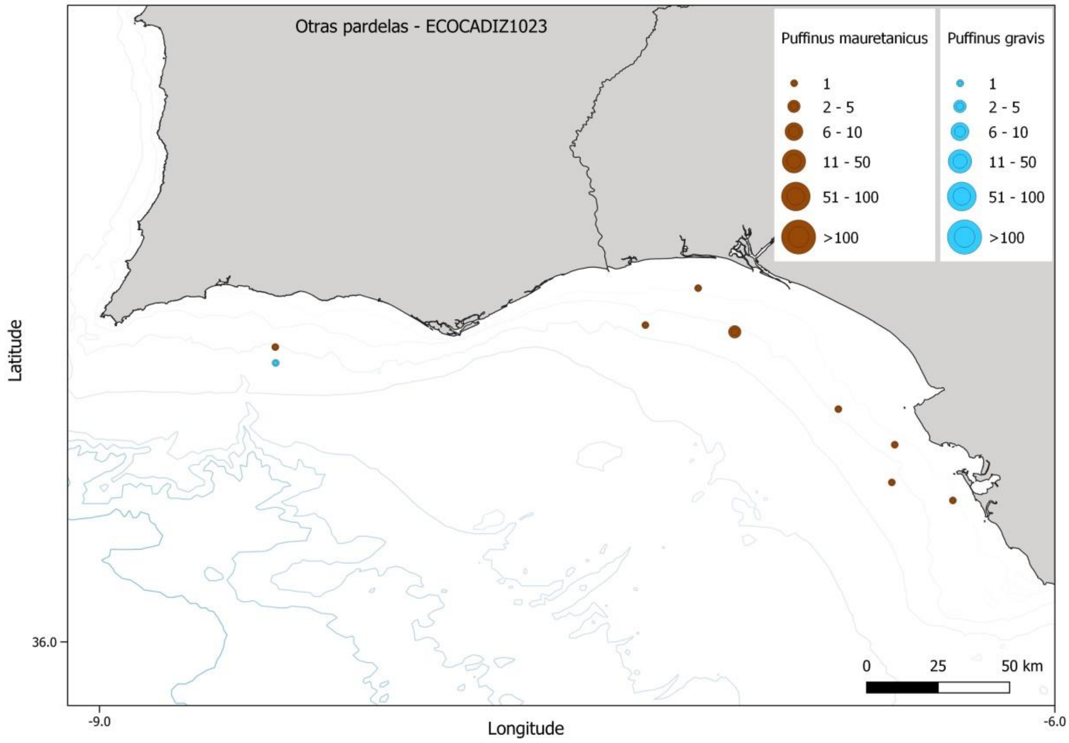



**Figure 47.** *ECOCADIZ-RECLUTAS 2023-10* survey. Sightings of great shearwater (*Puffinus gravis*) and shadowy shearwater (*Puffus mauritanicus*).

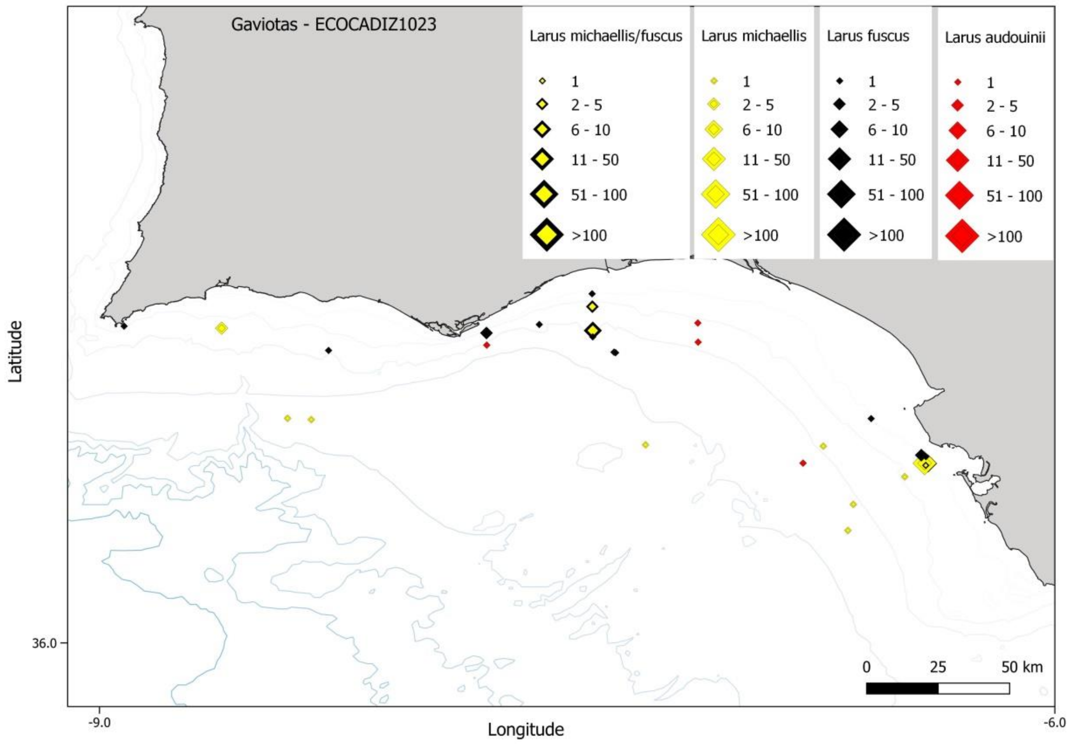



**Figure 48.** *ECOCADIZ-RECLUTAS 2023-10* survey. Sightings of seagull species registered during the survey.

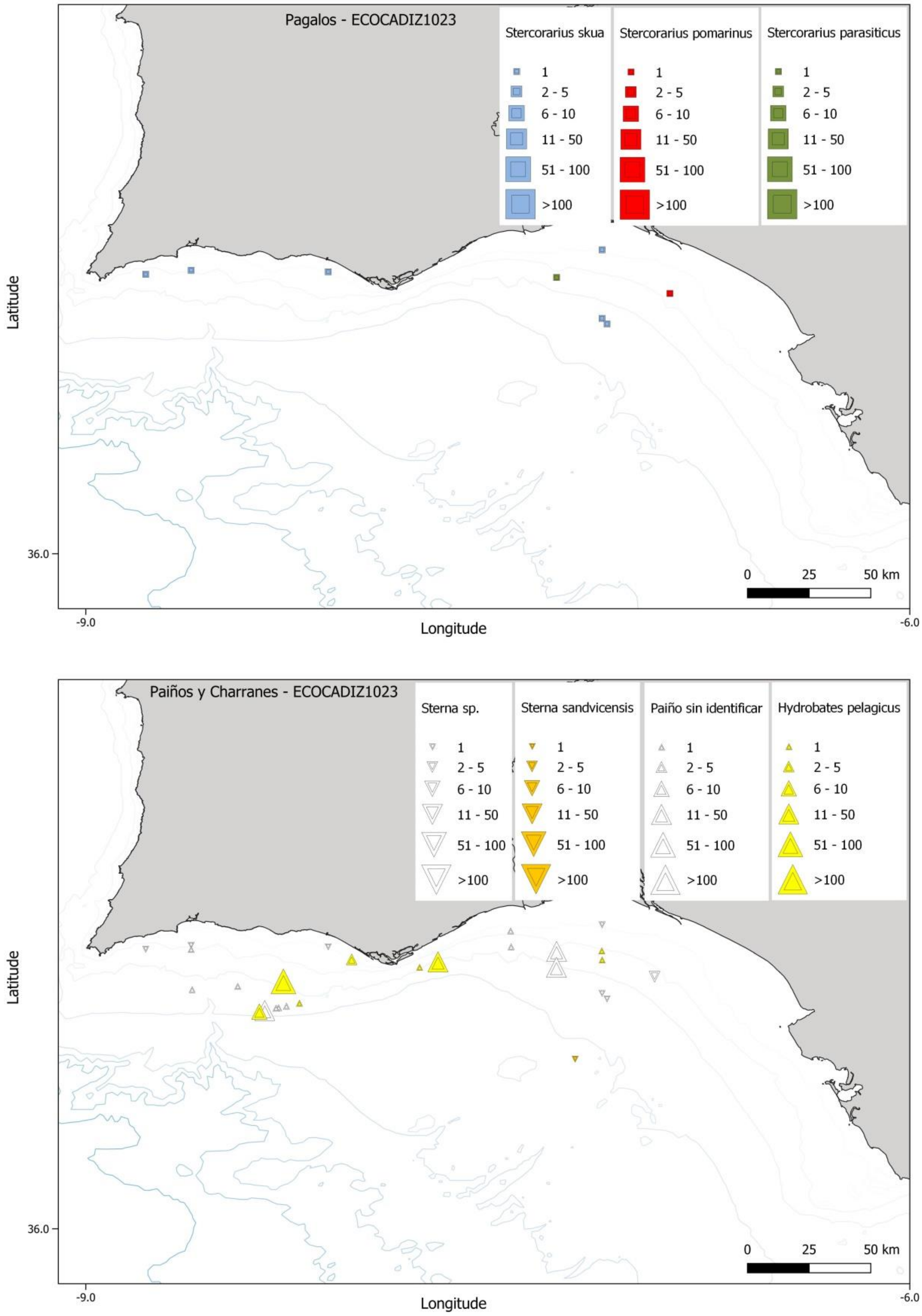



**Figure 49.** *ECOCADIZ-RECLUTAS 2023-10* survey. Sightings of tern species registered during the survey.

Working document presented in the ICES Working Group on Southern Horse Mackerel, Anchovy and Sardine (WGHANSA-1). On-line, 27-31 May 2024.

# Acoustic assessment and distribution of the main pelagic fish species in ICES Subdivision 9a South during the *ECOCADIZ 2023-07* Spanish acoustic-trawl survey (July-August 2023).

By

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## ABSTRACT

This working document summarizes the main results obtained during the *ECOCADIZ 2023-07* Spanish (pelagic ecosystem-) acoustic-trawl survey, conducted by IEO between July 29th and August 8th 2023 in the Portuguese and Spanish shelf waters (20-200 m isobaths) off the Gulf of Cádiz (GoC) onboard the R/V *Ramón Margalef*. The survey was the acoustic component of a combined anchovy egg (*BOCADEVA*) and acoustic-trawl (*ECOCADIZ*) *ad hoc* survey (*ECO/BOCADEVA_0723* survey), which were performed one after the other, the egg survey first. This year's survey was marked by a reduction of 3-4 days to the usual survey length (ca. 14 days at sea), due to the R/V tight schedule. The survey's main objective is the acoustic assessment and mapping of the main pelagic resources and the biological and oceanographic conditions of the GoC continental shelf. The 21 foreseen acoustic transects were sampled. A total of 16 valid fishing hauls were carried out for echo-trace ground-truthing purposes. Four (4) additional fishing hauls were performed at night to collect anchovy females with hydrated ovaries (DEPM-based adult sampling).Chub mackerel, anchovy and sardine were the most frequent captured species in the fishing hauls, followed by horse mackerel and Atlantic mackerel. Mediterranean horse mackerel and pearlside showed an incidental occurrence in the hauls performed in the surveyed area. Chub mackerel and anchovy showed the highest yields in these hauls, followed by sardine, horse mackerel and longspine snipefish. Total estimates of total NASC allocated to the "pelagic fish species assemblage" in this survey were 47% lower than those recorded in the last survey in this seriesin 2020. GoC anchovy was found more frequently in Spanish waters, with the areas of high densities being observed between Punta Umbría and Bay of Cádiz. Anchovy acoustic estimates in summer 2023 were of 1479 million fish and 9714 tonnes, accounting for 71% and 78% decreases in abundance and biomass, respectively, as compared to 2020 estimates and they are slightly below their time-series averages. Anchovy population age structure was composed mainly by zero and one year old individuals. As observed in previous years, the bulk of the population, including juveniles, was located in Spanish waters. Age-0 anchovies accounted for 75% (1069 million) and 58% (6710 t) of the total estimated abundance and biomass, respectively. GoC sardine was widely distributed all over the surveyed area in summer 2023, with high density areas being recorded in the inner-shelf parts of the GoC. Sardine abundance (2294 million fish) and biomass (62 216 t) estimates increased (19% in abundance and 22% in biomass), when compared to 2020 estimates, but with no increasing or decreasing trend clearly detected. Spanish waters

recorded relatively low population levels, mainly supported by small sardines. This year, the oldest age group observed for sardine population was the age-5 group and the occurrence of fishes older than 2 years was uncommon. The population was mainly composed by fishes belonging to the age-0, age-1, age-2 and age-3 groups. This year, juvenile sardines (age-0 group) were the most abundant group, accounting for 65% (1 503 million), but it was not the age group contributing the most in terms of biomass, accounting only for 31% (19 462 t) of the total biomass, respectively. Chub mackerel was restricted to the area between Cape San Vicente and Cape Santa María, where high density areas were recorded, whereas in the rest of the surveyed areas was almost absent. Chub mackerel estimated biomass and abundance were 189 million fish and 11 762 t, which were 57% and 64% lower than 2020 estimates. The 2023 abundance and biomass estimates were well below the time series average. The population was composed by fishes not older than 2 years, with the age-0 group being the dominant one (72%, 137 million, and 60%, 7083 t).

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## INTRODUCTION

The *ECOCADIZ* surveys constitute a series of yearly integrated acoustic-trawl surveys conducted since 2004 by IEO in the Subdivision 9a South (Algarve and Gulf of Cadiz, between 20 – 200 m depth) under the "pelagic ecosystem survey" approach. However, the first survey, called *BOCADEVA 0604*, was a pilot experience combining acoustics - anchovy DEPM (Ramos *et al*., 2010). The summer survey was conducted again in 2006 as *ECOCADIZ-2006;* it was financed by the Spanish Fisheries Secretariat and planned and conducted by the IEO to obtain summer estimates of GoC anchovy (*Engraulis encrasicolus*) and sardine (*Sardina pilchardus*) biomass and abundance. That survey was carried out onboard R/V *Cornide de Saavedra*, but restricted to the Spanish waters only (Ramos *et al*., 2013). It was not until the *ECOCADIZ 2007* that abundance estimates were obtained for small and mid size pelagic species, in both the GoC Portuguese and Spanish waters, following an agreed standard sampling scheme. In recent years, the 2021 survey was canceled due to an unexpected breakdown of the research vessel, and in 2022 there was a temporary suspension of the same. The 2023 survey was conducted on board R/V *Ramón Margalef,* instead of the commonly (since 2014 to 2020) used vessel R/V *Miguel Oliver*. The 2023 survey has been the last survey in its series.

Results from the *ECOCADIZ* series are routinely reported to ICES Expert Groups on both stock assessment (formerly in WGMHSA, WGANC, WGANSA, at present in WGHANSA) and acoustic and egg surveys on anchovy and sardine (WGACEGG). The general objective of these surveys is the acoustic assessment by vertical echo-integration and mapping of the abundance and biomass of pelagic species (especially anchovy, sardine and chub mackerel *Scomber colias*), as well as the mapping of both the oceanographic and biological conditions in ICES sub-division 9a South.

The present Working Document reports the main results from the *ECOCADIZ 2023-07* survey (the thirteen survey within its standard series), namely the acoustic size-based estimates of abundance and biomass (age-structured estimates for anchovy, sardine and chub mackerel) and the spatial distribution of the assessed species.

## MATERIAL AND METHODS

The *ECOCADIZ 2023-07* survey was conducted by IEO between July 29th and August 8th 2023 in the Portuguese and Spanish shelf waters (20-200 m isobaths) off the Gulf of Cádiz (GoC) onboard the R/V *Ramón Margalef*. The survey was the acoustic component of a combined anchovy egg (*BOCADEVA*) and acoustic-trawl (*ECOCADIZ*) *ad-hoc* survey (*ECO/BOCADEVA_0723* survey), which were performed one after the other, the egg survey first. Such a planning entailed a 3-4 days reduction in the available ship-time (11 days) for the summer acoustic survey as compared with its usual schedule (ca. 14 days). The survey design consisted in a systematic parallel grid with 21 transects equally spaced by 8 nm, normal to the shoreline (**Figure 1**).

Because the above mentioned shortage of days, the acoustic equipment was not calibrated during the survey itself, but several weeks before, taking the advantage of the presence of the R/V in the study area, following the ICES standard procedures (Demer *et al*., 2015; see also Foote *et al*., 1987). For the same above reasons, neither the evaluation of vessel's self-noise was carried out. The number of pelagic trawl fishing hauls was also somewhat lower than usual.

Echo-integration was carried out with a *Simrad™ EK80* echo-sounder working in the multi-frequency fashion (18, 38, 70, 120, 200, 333 kHz) and in CW mode. Average survey speed was about 10 knots and the acoustic signals were integrated over 1-nm intervals (EDSU). Raw acoustic data were stored for further post-processing using the *Echoview™* software package.

Survey execution and abundance estimation followed the methodologies firstly adopted by the *ICES Planning Group for Acoustic Surveys in ICES Sub-Areas VIII and IX* (ICES, 1998) and the recommendations given later by the *Working Group on Acoustic and Egg Surveys for Small Pelagic Fish in NE Atlantic* (WGACEGG; ICES, 2006a,b; see also ICES TIMES 64 report, Doray *et al*., 2021).

Fishing hauls for echo-trace ground-truthing were opportunistic, according to the echogram information, and they were carried out using a *Gloria HOD 352* pelagic trawl gear (ca. 10 m-mean vertical opening net) at an average speed of 4-4.5 knots. Gear performance and geometry during the effective fishing was firstly monitored with a *Simrad™ Mesotech FS20* trawl sonar, but a malfunctioning of the sonar during the hauls PE08 to PE14 forced to replace it by a combination of *Scanmar™* Trawl Sounder, Trawl Eye and Door sensors. Trawl sonar data from each haul were recorded and stored for further analyses.

Ground-truthing haul samples provided biological data on species and they were also used to identify fish species and to allocate the back-scattering values into fish species according to the proportions found at the fishing stations (Nakken and Dommasnes, 1975).

Length frequency distributions (LFD) by 0.5-cm class were obtained for all the fish species in trawl samples (either from the total catch or from a representative random sample of 100-200 fish). Only those LFDs based on a minimum of 30 individuals and showing a normal distribution were considered for the purpose of the acoustic assessment.

A complete individual biological sampling (length, weight, sex, maturity stage, stomach fullness, and mesenteric fat content) was performed in each haul for anchovy, sardine, and chub mackerel only. For the remaining survey's target species only individual size and weight was recorded. Otoliths were extracted from anchovy, sardine and chub mackerel sampled specimens.

**Table 2** shows the TS/length relationships used for the acoustic estimation of the assessed species (recent IEO standards after ICES, 1998 and recommendations by ICES, 2006a,b; see Doray *et al*., 2021).

The *PESMA* software (J. Miquel, IEO, unpublished) has got implemented the needed procedures and routines for the acoustic assessment following the above approach and it has been the software package used for the acoustic estimation.

A *Sea-bird Electronics*™ *SBE 21 SEACAT* thermosalinograph and a *Turner*™ *10 AU 005 CE Field* fluorometer were used during the acoustic tracking to continuously collect some hydrographical variables (sub-surface sea temperature, salinity, and *in vivo* fluorescence). Vertical profiles of hydrographical variables were also recorded by night from 74 $CTDO_2$-LADCP casts over 12 transects (from the 23-transect planned grid) using a *Sea-bird Electronics™ SBE 911+ SEACAT* (with coupled *Teledyne Benthos* altimeter, *SBE 43* oximeter and *WetLabs ECO-FL-NTU* fluoro-turbidimeter sensors) profiler and a *LADCP T-RDI WH Sentinnel* 300 kHz current profiler (**Figure 2**). *VMADCP RDI 150 kHz* records were also continuously recorded by night between CTD stations.

For logistical reasons CUFES sampling was not previously carried out during the anchovy egg survey and neither during its acoustic counterpart.

Census of top predators was not recorded during the survey because of the accommodation for at least one onboard observer was not available.

**RESULTS**

**<u>Acoustic sampling</u>**

The acoustic sampling was accomplished during the period comprised between the 29$^{th}$ of July and the 7$^{th}$ August. The complete grid (21 transects) was acoustically sampled (**Table 4**, **Figure 1**). All acoustic transects were covered after the anchovy egg survey was finished. In order to perform the acoustic sampling with daylight, the acoustic sampling started at 06:10-06:20 UTC, although this time might vary depending on the duration of the works related with the hydrographic sampling the previous night.

**<u>Groundtruthing hauls</u>**

A total of sixteen (16) fishing operations for echo-trace ground-truthing, all of them valid, were performed during the survey (**Table 5**, **Figure 3**). Additionally, four (4) “extra” hauls were performed at nightfall to collect females with hydrated oocytes (as a part of the DEPM-based adult anchovy sampling of the *BOCADEVA* egg survey counterpart). Because of many echo-traces usually occurred close to the bottom, all the pelagic hauls were carried out like a bottom-trawl haul, with the ground rope working over or very close to the bottom. Two hauls were performed over a determined isobath instead of being conducted over the acoustic transect. According to the above, the sampled depth range in the valid hauls oscillated between 28 and 164 m.

During the survey were captured 1 Chondrichthyan, 36 Osteichthyes, 10 Cephalopod, 7 Echinoderm, and several Cnidarian and Ascidian species. The percentage of occurrence of the fish species (sharks excluded) in the hauls is shown **Table 1** (see also **Figure 4**). The pelagic ichthyofauna was both the most frequently captured species set and the one composing the bulk of the overall yields of the catches. Within this pelagic fish species set chub mackerel

(69%) was the most frequent small pelagic species in the valid hauls, followed by anchovy, sardine and horse mackerel *Trachurus trachurus* (the three with 56% occurrences each). Mediterranean horse mackerel *T. mediterraneus*, longspine snipefish *Macroramphosus scolopax* and pearlside *Maurolicus muelleri* (13% each) showed an incidental occurrence in the hauls performed in the surveyed area.

For the purposes of the acoustic assessment, anchovy, sardine, mackerel species (*Scomber scombrus* and *S. colias*), horse & jack mackerel species (*T. trachurus*, *T. mediterraneus*, *T. picturatus*)s, bogue (*Boops boops*), boarfish (*Capros aper*), longspine snipefish, transparent goby (*Aphia minuta*) and pearlside were initially considered as the survey target species. All the invertebrates, skates, rays and benthic fish species were excluded from the computation of the total catches in weight and in number from those fishing stations where they occurred. Catches of the remaining non-target fish species were included in an operational category termed as "Others".

According to the above premises, during the survey were captured a total of 3736 kg and 108 thousand fish (**Table 6**). Seventy-nine per cent (79%) of this "total" of fished biomass corresponded to chub mackerel, 16% to anchovy, 1% to longspine snipefish, while the remaining species had contributions lower than 1%. The most abundant species in ground-truthing trawl hauls was anchovy (47%), followed by chub mackerel (46%), longspine snipefish (3%) and sardine (2%), with each of the remaining species accounting for equal to or less than 1%.

The species composition of these fishing hauls (as expressed in terms of percentages in number) is shown in **Figure 4**.

**<u>Back-scattering energy attributed to the "pelagic assemblage" and individual species</u>**

A total of 303 nmi (ESDU) from 21 transects were acoustically sampled by echo-integration for assessment purposes. **Table 3** provides the nautical area-scattering coefficients, NASC, attributed to each of the selected target species and for the whole "pelagic fish assemblage".

A total of 95 940 $m^2$ $nmi^{-2}$ was estimated for this "pelagic fish assemblage", 62% lower than the maximum value recorded throughout the time-series, estimated in 2019 (259 503 $m^2nmi^{-2}$), and 21% below the historical mean (153 181 $m^2nmi^{-2}$). The highest NASC value (7269 $m^2nmi^{-2}$) was recorded in the middle-shelf waters (100 m) between Punta Umbría and Matalascañas (transect R08, **Figure 5**), with relatively high values being also recorded in the inner- and mid-shelf waters (20-123 m depth) of transects R18, R5, R13 and R19. By species, sardine accounted for 46% of this total back-scattered energy, followed by chub mackerel (17%), anchovy (16%), and Mediterranean horse mackerel (12%), with the remaining species showing relative contributions of acoustic energies lower than 10%.

According to the resulting values of integrated acoustic energy and the availability and representativeness of the length frequency distributions in fishing hauls, the species acoustically assessed in the present survey finally were anchovy, sardine, mackerel, chub mackerel, blue jack mackerel, horse mackerel, Mediterranean horse mackerel, bogue, pearlside, longspine snipefish, boarfish and transparent goby.

## Spatial distribution and abundance/biomass estimates

### Anchovy *Engraulis encrasicolus*

Parameters of the survey's length-weight relationship for anchovy are given in **Table 7**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 7**. The mapping of the backscattering energy (nautical area scattering coefficient, NASC, in $m^2nmi^{-2}$) attributed to the species and the coherent strata considered for the acoustic estimation are shown in **Figure 8**. The estimated abundance and biomass by size class are given in **Table 8** and **Figure 9**. The estimated abundance and biomass by age group are given in **Table 9** and **Figure 10**.

Gulf of Cádiz anchovy (16% of the total NASC attributed to fish) was widely distributed in the surveyed area, although it showed very low acoustic densities in the easternmost and westernmost waters. High densities were mainly recorded between Ayamonte and the Bay of Cadiz (**Figure 8**). The whole size class range for the pooled catches varied between the 2.0 and 19.0 cm size classes, with one main modal class at 13.0 cm (**Figure 7**).

Nine (9) coherent post-strata have been differentiated according to the $S_A$ value distribution and the size composition in the representative fishing hauls (**Figure 8**). Overall anchovy acoustic estimates in summer 2023 were of 1479 million fish and 9714 t (**Table 8**; **Figure 9**), accounting for 71% and 78% decreases in abundance and biomass, respectively, as compared to 2020 estimates (5153 million, 44 886 t). Current overall estimates are also well below the time-series average (*i.e.* 2424 million, 26 368 t; see **Table 10** and **Figure 46**). By geographical strata, the Spanish waters yielded 82% (1216 million) and 81% (7933 t) of the total estimated abundance and biomass in the Gulf, highlighting the importance of these waters in the species' distribution, but also the noticeable regional decrease experienced by the species in the Spanish waters. The estimates for the Portuguese waters were 263 million and 1781 t (**Table 8; Figure 9**).

The size class range of the assessed anchovy population in summer 2023 varied between the 2.0 and 19.0 cm size classes. The size distribution showed a mixed composition, with one main mode at 13.0 cm, and with a small proportion of individuals being observed at 2.0 cm. It is noticeable the occurrence of this last modal size during summer, as it is a consequence of the record of very tiny juveniles in the coastal waters located in front of Faro, Portugal. The size composition of anchovy throughout the surveyed area confirms the usual pattern exhibited by the species during the survey season, with the largest (and oldest) fish being distributed in the westernmost waters, although individuals belonging to the smallest size classes were also observed in the Algarve (**Table 8; Figures 7** and **9**).

The population was composed by fishes not older than 2 years. Age 0 fish accounted for 75% (1069 million) and 58% (5710 t) of the total estimated abundance and biomass, respectively (**Table 9; Figure 10**). Spanish waters not only concentrated the bulk (88%) of this juvenile fraction, but also 79% (263 million) of age-1 group. The estimates of age-0 fish experienced a similar trend than the one showed by the whole population in relation to the historical peak recorded in 2019 and the values recorded in 2020. The recent strong decreasing trends for the whole population seem to have increased in 2023, with the 2023 estimates being well below their time-series averages (**Table 10**, **Figure 46**). Age 1 fish represented 23% and 39% of the total abundance and biomass, while Age 2 fish accounted for <1% of the total abundance and biomass (**Table 9**; **Figure 10**).

The 2023 summer estimates of mean size and weight of the whole population (9.4 cm, 11.3 g) were somewhat lower than their respective time-series averages (12 cm, 12.2 g).

**Sardine *Sardina pilchardus***

Size-weight relationship parameters for sardine derived from the survey's biological sampling are detailed in **Table 7**. Spatially explicit size distribution and mean length (±SD) are shown in **Figure 11**. The mapping of the backscattering energy (NASC, in $m^2nmi^{-2}$) attributed to the species and the coherent post-strata considered for the acoustic estimation are shown in **Figure 12**. Estimated abundance and biomass by size class are given in **Table 11** and **Figure 13**. The estimated abundance and biomass by age group are given in **Table 12** and **Figure 14**.

Comparatively speaking, GoC sardine showed a relatively very high acoustic echo-integration in summer 2023 (46% of the total NASC attributed to pelagic fish species assemblage). Sardine was widely distributed all over the surveyed area, except between Faro and Ayamonte, and, as a consequence of the abovementioned occurrence of dense schools in coastal waters, withshowing very high densities in the inner-middle shelf waters. Thus, high sardine densities were recorded from dense mid-water schools in the Algarve coastal and inner shelf waters (20-60 m), and between Punta Umbría and Cape Trafalgar (20-40 m; **Figure 12**).

The size distribution observed for the pooled catches from hauls ranged between 9.5 and 20.5 cm size classes. Two modal size classes were observed, the main mode at 10.5 cm and a secondary mode at 18.5 cm. The size composition of sardine pooled catches throughout the surveyed area followed the usual pattern observed by the species during the survey season and area. Small (younger) sardine individuals were distributed in Spanish waters, between Sancti Petri and Doñana, whereas large (older) individuals were distributed between Cape San Vicente and Cape Santa Maria, in Portuguese waters (**Figure 13**).

Six (6) coherent post-strata were differentiated according to the $S_A$ value distribution and the size distribution sampled in the fishing hauls (**Figure 12**). GoC sardine abundance and biomass in summer 2023 were estimated at 2294 million fish and 62 216 t. Spanish waters comprised the 65% and 30% of the total estimated abundance and biomass, respectively (1481 million and 18 973 t). The estimates for Portuguese waters were 813 million and 43 243 t (**Table 11**, **Figure 13**). This year's values were 19% and 22% higher than 2020 estimates (1923 million and 50 720 t; **Table 13**, **Figure 46**).

Sizes of the assessed sardine population in summer 2023 ranged between 9.5 and 20.5 cm size classes, showing a clearly mixed length frequency distribution, with one main mode at 10.5 cm size class, a secondary one at 18.0 cm and a third smaller mode at 13.0 cm (**Table 11**; **Figures 11** and **13**). It is noteworthy that the relatively low biomass and abundance estimates in the Spanish waters are mainly supported by small sardines (9.5-13.0 cm).

Age-5 group was the oldest age group occurring in the population, although the occurrence of fishes older than age-3 juveniles was uncommon. Thus, the population abundance was mainly composed by age-0 juveniles, accounting for 65% (1 503 million) of the total abundance, whereas the population biomass was mainly composed of age-2 juveniles, accounting for 32% (20 515 t) of the total biomass. The abundance and biomass of the age-0 juvenile fraction was concentrated in Spanish waters (96% and 89% of both abundance and biomass, respectively) while only a residual fraction was observed in Portuguese waters (4% and 11% of both abundance and biomass; **Table 12; Figures 12** and **14**). Contrary to the age-0 group, the age-2 group was concentrated in Portuguese waters (96% of both abundance and biomass, respectively; **Table 12; Figures 12** and **14**).

The 2023 summer estimates of mean length and weight of the whole population (13.8 cm, 16.4 g), are lower than 2020 estimates and than the time-series averages (*i.e.* 14.9 cm, 22.4 g).

**Transparent goby *Aphia minuta***

Length-weight relationship parameters derived from the survey hauls are presented in **Table 7**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 15**. The mapping of the backscattering energy (NASC, in $m^2nmi^{-2}$) attributed to the species and the coherent post-strata considered for the acoustic estimation are shown in **Figure 16**. Estimated abundance and biomass by size class are given in **Table 14** and **Figure 17**.

Transparent goby (0.01% of total NASC) was only observed over the inner-shelf in front of Punta Umbría (**Figure 16**). The size distribution for the pooled catches varied between the 3.0 and 5.0 cm size classes, with one modal class detected at 4.5 cm. No clear spatial pattern in mean size was observed (**Figure 15**).

Only two (2) coherent post-strata were differentiated according to the $S_A$ value distribution and the size distribution observed in the representative fishing hauls (**Figure 16**). Transparent goby abundance and biomass in the surveyed area were 2 million fish and 1 t, with the whole estimated population observed within Spanish waters (**Table 14**, **Figure 17**). The size composition recorded for the estimated population was comprised between 3.0 and 5.0 cm size classes, with one modal class detected at 4.5 cm (**Table 14, Figures 15** and **17**).

**Mackerel *Scomber scombrus***

Parameters of the survey's length-weight relationship are shown in **Table 7**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 18**. The mapping of the backscattering energy (NASC, in $m^2nmi^{-2}$) attributed to the species and the coherent post-strata considered for the acoustic estimation are shown in **Figure 19.** Estimated abundance and biomass by size class are given in **Table 15** and **Figure 20**.

Atlantic mackerel (<0.1% of the total NASC) showed two main density core areas, one in front of Faro and another between Punta Umbría and Chipiona, near the central zone of the surveyed area (**Figure 19**).

Three (3) coherent post-strata were differentiated according to the $S_A$ value distribution and the size composition in the fishing hauls (**Figure 19**). Mackerel abundance and biomass in summer 2023 in the GoC shelf waters were estimated at only *c.a.* 6 million fish and 615 t (**Table 15**; **Figure 20**). Almost the whole estimated population (73% of the total abundance) was located in Portuguese waters (5 million, 220 t). In contrast, a larger biomass was observed in the Spanish waters with *c.a.* 2 million and 395 t.

The size composition of the mackerel estimated population in autumn 2022 ranged between 17.0 and 36.5 cm size classes; no dominant mode was observed given the size distribution was patchy (**Table 15**; **Figures 18** and **20**). Smaller (younger) fish were more common in Portuguese waters, whereas larger fish were more commonly observed in Spanish waters.

**Chub mackerel *Scomber colias***

Parameters of the survey's length-weight relationship are shown in **Table 7**. Size distribution and mean (±SD) size in the fishing hauls are spatially explicit represented in **Figure 21**. The

NASC mapping (in $m^2nmi^{-2}$) attributed to the species and the coherent post-strata considered for the acoustic estimation are shown in **Figure 22**. Estimated abundance and biomass by size class are given in **Table 16** and **Figure 23**. The estimated abundance and biomass by age group are given in **Table 17** and **Figure 24**.

Chub mackerel (17% of the total NASC) was mainly distributed over the Portuguese waters, recording higher acoustic densities between the Cape San Vicente and Cape Santa Maria area, whereas it was practically absent of Spanish waters (**Figure 22**). The few fish caught in Spanish waters were small individuals, while larger fish were observed in Portuguese waters, although the species' positive hauls did not show a clear spatial pattern in (mean) size (**Table 16**; **Figures 21** and **23**).

Seven (7) coherent post-strata have been differentiated according to the $S_A$ value distribution and the size composition in the fishing stations (**Figure 22**). Chub mackerel abundance and biomass in the surveyed area were estimated in 189 million fish and 11 763 t, which were 57% and 64% lower than 2020 estimates (448 million, 32 853 t; **Table 18**, **Figure 46**). Portuguese waters accounted for 99% of both the total abundance (189 million) and biomass (11 753 t), respectively. Spanish waters yielded a population of 0.1 million and 10 t.

The size distribution of the assessed population of chub mackerel ranged between 9.0 and 30.5 cm size classes, with a dominant modal class at 18.5 cm and a secondary mode at 23.5 cm. Given that most of chub mackerel was found in Portuguese waters, no regional size pattern could be detected, although larger (older) fish were observed in Portuguese waters while smaller (younger) were observed in Spanish waters (**Table 16**, **Figures 21** and **23**).

The population was composed by fishes not older than 2 years, with the age-0 group being the dominant one (72%, 137 million, and 60%, 7 083 t, of the total abundance and biomass estimated in the surveyed area, respectively; **Table 17**, **Figure 24**). Age-1 fish was the second most important age group in the estimated population (26%, 51 million fish, and 37%, 4 465 t, of the total abundance and biomass estimates). All observed age groups were exclusively recorded in the Portuguese waters (>99% in numbers and weight; 189 million fish, 11 752 t; **Table 17**, **Figure 24**).

**Horse mackerel *Trachurus trachurus***

Length-weight relationship parameters estimated for this species are shown in **Table 7**. Size composition and mean (±SD) size in the fishing hauls are mapped in **Figure 25**. The NASC mapping (in $m^2nmi^{-2}$) attributed to the species and the coherent post-strata considered for the acoustic estimation are shown in **Figure 26**. Estimated abundance and biomass by size class are given in **Table 19** and **Figure 27**.

Horse mackerel (7% of the total NASC) distribution was observed mainly in Portuguese waters with areas of high acoustic density located between Cape San Vicente and Cape Santa Maria and a small area between Punta Umbria and Matalascañas in the Spanish waters (**Figure 26**).

The size distribution observed in positive hauls was comprised between 7.0 and 28.0 cm size classes, with two dominant modal size classes at 11.0 and 18.5 cm, and a small, secondary mode at 24.0 cm. Spanish waters were occupied almost exclusively by small fish (**Figure 25**).

Five (5) coherent post-strata were differentiated according to the $S_A$ value distribution and the size distribution observed in the fishing hauls (**Figure 26**). Horse mackerel abundance and biomass in the surveyed area were 102 million fish and 4836 t (**Table 19**, **Figure 27**).

Portuguese waters accounted for 94% (96 million) and 98% (4778 t) of the total abundance and biomass, respectively. Spanish waters yielded a population of 6 million and 58 t.

The size range recorded for the estimated population was comprised between 7.0 and 28.0 cm size classes, with two dominant modes, one at 11 cm and at 18 cm size class (both in Portuguese waters; **Table 19**, **Figures 25** and **27**).

**Mediterranean horse-mackerel *Trachurus mediterraneus***

The survey's length-weight relationship for this species is shown in **Table 7**. Size composition and mean size in the fishing hauls are mapped in **Figure 28**. The mapping of NASC (in $m^2nmi^{-2}$) attributed to the species and the coherent post-strata considered for the acoustic estimation are shown in **Figure 29**. Estimated abundance and biomass by size class are given in **Table 20** and **Figure 30**.

Mediterranean horse mackerel (12% of the total NASC) was observed in summer 2023 only in the easternmost waters of the Gulf of Cadiz, from the Bay of Cadiz to Cape Trafalgar. The species was absent from the most part of the Gulf (**Figure 29**). The narrow size class range for the pooled catches varied between the 29.0 and 31.0 cm size classes, with one modal class at 30.0 cm. An evident spatial pattern was observed given the species was only present south east of the Bay of Cadiz (**Figure 28**).

One (1) coherent post-stratum have been differentiated according to the $S_A$ value distribution and the size composition in the fishing hauls (**Figure 29**). The estimated abundance and biomass estimated for Mediterranean horse mackerel was 59 million fish and 11 998 t, with all the population located in Spanish waters, as commonly observed in previous surveys (**Table 20**, **Figure 30**).

The size distribution of the estimated population of Mediterranean horse mackerel inhabiting the GoC ranged between 29.0 and 31.0 cm size classes, with only one mode at 30.0 cm size class. No clear spatial pattern regarding fish size was observed since the population was restricted to a reduced, specific area (**Table 20**, **Figure 28**).

**Blue jack mackerel *Trachurus picturatus***

The survey's length-weight relationship for this species is shown in **Table 7**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 31**. The mapping of the backscattering energy (NASC, in $m^2nmi^{-2}$) attributed to the species and the coherent post-strata considered for the acoustic estimation are shown in **Figure 32**. Estimated abundance and biomass by size class are given in **Table 21** and **Figure 33**.

Blue jack mackerel (0.03% of the total NASC) was restricted almost exclusively to the Portuguese waters, showing the highest acoustic densities in Cape San Vicente shelf waters, while a small density area was observed just east of Cape Santa Maria (**Figure 32**). The size class range for the pooled catches varied between the 13.5 and 26.0 cm size classes. No clear spatial pattern was observed in size composition (**Figure 31**).

Three (3) coherent post-strata have been differentiated according to the $S_A$ value distribution and the size distribution observed in the fishing hauls (**Figure 32**). Blue Jack mackerel abundance and biomass in the surveyed area were estimated at 0.2 million fish and 16 t, with the bulk of the estimated population located in Portuguese waters (0.2 million and 16 t; **Table 21, Figure 33**). Spanish waters yielded a population of 0.001 million and 0.06 t.

The size range recorded for the estimated population was comprised between 13.5 and 26.0 cm size classes, no dominant mode was observed given the size distribution was patchy. No clear pattern regarding fish was observed in size distribution (**Table 21**, **Figures 31** and **33**).

**Bogue *Boops boops***

Length-weight relationship parameters estimated from survey data for this species is shown in **Table 7**. Size composition and mean (SD) size in the fishing hauls are represented in the spatial context in **Figure 34**. The mapping of NASC (in $m^2nmi^{-2}$) attributed to the species and the coherent post-strata considered for the acoustic estimation are shown in **Figure 35**. Estimated abundance and biomass by size class are given in **Table 22** and **Figure 36**.

Bogue (0.5% of the total NASC) was restricted to inner shelf waters (20-40 m), between Cape San Vicente and Cape Santa Maria (**Figure 35**). The species was absent of Spanish shelf waters.

The size distribution for the pooled catches varied between the 19.5 and 26.5 cm size classes, with no modal classes detected given the patchiness of the data. A clear spatial pattern in mean size was observed, given the population was restricted to Portuguese inner-shelf waters (**Figure 34**).

Three (3) coherent post-strata have been differentiated according to the $S_A$ value distribution and the size composition in the representative fishing hauls (**Figure 35**). Bogue abundance and biomass in the surveyed area were estimated at 3 million fish and 318 t with all the population located in Portuguese waters (**Table 22**, **Figure 36**).

The size range recorded for the estimated population was comprised between 19.5 and 26.5 cm size classes, showing a very mixed composition (**Table 22**, **Figures 34** and **36**).

**Pearlside *Maurolicus muelleri***

Length-weight relationship parameters derived from the survey hauls are presented in **Table 7**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 37**. The mapping of the backscattering energy (NASC, in $m^2nmi^{-2}$) attributed to the species and the coherent post-strata considered for the acoustic estimation are shown in **Figure 38**. Estimated abundance and biomass by size class are given in **Table 23** and **Figure 39**.

Pearlside (1% of total NASC) was commonly observed over the shelf break all over the GoC (**Figure 38**). The size distribution for the pooled catches varied between the 0.5 and 6.5 cm size classes, with one modal class detected at 4.5 cm. No clear spatial pattern in mean size was observed (**Figure 37**).

Six (6) coherent post-strata were differentiated according to the $S_A$ value distribution and the size distribution observed in the representative fishing hauls (**Figure 38**). Pearlside abundance and biomass in the surveyed area were 314 million fish and 364 t. Portuguese waters accounted for 8% (27 million, 32 t) of the total abundance and biomass, respectively. Spanish waters yielded a population of 287 million and 332 t (**Table 23**, **Figure 39**). The size composition recorded for the estimated population was comprised between 0.5 and 6.5 cm size classes, with a dominant mode at 4.5 cm size class (**Table 23**, **Figures 37** and **39**).

**Snipefish *Macroramphosus scolopax***

Length-weight relationship parameters derived from the survey hauls are presented in **Table 7**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 40**. The mapping of the backscattering energy (NASC, in $m^2nmi^{-2}$) attributed to the species and the coherent post-strata considered for the acoustic estimation are shown in **Figure 41**. Estimated abundance and biomass by size class are given in **Table 24** and **Figure 42**.

Snipefish (0.2% of total NASC) was commonly observed over the shelf break of Algarve waters (**Figure 41**). The size distribution for the pooled catches varied between the 7.0 and 16.5 cm size classes, with one modal class detected at 13.5 cm. No clear spatial pattern in mean size was observed (**Figure 40**).

Only one (1) coherent post-stratum was differentiated according to the $S_A$ value distribution and the size distribution observed in the representative fishing hauls (**Figure 41**). Snipefish abundance and biomass in the surveyed area were 58 million fish and 895 t, all with the population observed within Portuguese waters (**Table 24**, **Figure 42**). The size composition recorded for the estimated population was comprised between 7.0 and 16.5 cm size classes, with one modal class detected at 13.5 cm (**Table 24**, **Figures 40** and **42**).

**Boarfish *Capros aper***

Length-weight relationship parameters derived from the survey hauls are presented in **Table 7**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 43**. The mapping of the backscattering energy (NASC, in $m^2nmi^{-2}$) attributed to the species and the coherent post-strata considered for the acoustic estimation are shown in **Figure 44**. Estimated abundance and biomass by size class are given in **Table 25** and **Figure 45**.

Boarfish (0.8% of total NASC) was commonly observed over the shelf break of Algarve waters between Portimão and Faro, with a small fraction of the population also detected in mid-shelf Spanish waters (40-60 m) in front of Punta Umbría (**Figure 44**). The size distribution for the pooled catches varied between the 5.0 and 10.5 cm size classes, with two modal classes detected at 5.0 cm and 6.5 cm. No clear spatial pattern in mean size was observed (**Figure 43**).

Two (2) coherent post-strata were differentiated according to the $S_A$ value distribution and the size distribution observed in the representative fishing hauls (**Figure 44**). Boarfish abundance and biomass in the surveyed area were 26 million fish and 452 t. The bulk of the population was located in Portuguese waters accounting for 99% (26 million, 446 t) of the total abundance and biomass, respectively. Spanish waters yielded a population of 0.3 million and 6 t. (**Table 25, Figure 45**). The size composition of the estimated population was comprised between 5.0 and 10.5 cm size classes, with a dominant mode at 5.0 cm size class (**Table 25, Figures 43** and **45**).

**(SHORT) DISCUSSION**

The time series of anchovy, sardine and chub mackerel abundance and biomass estimates are described in **Tables 10, 13, 18** and **Figure 46**.

The anchovy population inhabiting the GoC during summer 2023 showed a very large decrease in both, abundance (71%) and biomass (78%) when compared to 2020 summer estimates (**Ta-**

**ble 10**, **Figure 46**). A big part of the population was concentrated in the Spanish waters, highlighting the importance of this geographical area in the species distribution. The current estimates are slightly lower than the time-series average (*i.e.* 2424 million; 26 368 t). The recent decreasing trend for the whole population seems to have stopped and abundances and biomass seem to be increasing in 2023, as evidenced, at least, by the spring Portuguese survey series. However, such a recovery not seems to be evidenced by the summer surveys' estimates that suggest a more alarming scenario. Such recent fluctuations should therefore be conveniently monitored. The bulk (99.8%) of age 0 fish was concentrated almost exclusively in Spanish waters (**Table 9, Figure 10**). The estimates of age-0 fish experienced a similar trend to the one shown by the whole population concerning the historical peak recorded in 2019 and the values recorded in 2020, and with values still well below to the time-series average (**Table 10**). The recent strong decreasing trends for the whole population and juveniles seem to have increased in 2023, although such recent fluctuations should be conveniently monitored as no surveys took place in 2021 and 2022 (**Table 10**).

The abundance and biomass of the sardine population inhabiting the GoC in summer 2023 were 2294 million fish and 62 216 t. These abundance and biomass estimates were 19% and 22% higher than 2020 estimates (1923 million and 50 720 t). The 2023 estimates seemed to follow the same pattern observed in previous years that reflect an increasing trend in sardine population biomass (**Table 13**, **Figure 46**). Sardine was observed mainly in the inner-shelf waters of Portugal and Spain; however, a higher percentage of the population, in terms of abundance was concentrated in Spanish waters, although mainly composed by small sardines, whereas larger, heavier sardines were observed in Portuguese waters. Sardine population inhabiting the Gulf of Cádiz seems to be increasing following with the positive trend in recent years, although the regional differences should also be monitored, since the estimates from the Spanish waters and the population composition there (*i.e.* the almost absence of larger/older fish) not seem to follow this relatively increasing trend. The age structure of sardines in the GoC was mainly composed of age-0 to age-2 fish, accounting for more than 90% of the abundance (2 175 million fish) and 80% of the biomass (54 689 t) of the total population (**Table 12, Figure 14**). In contrast, the abundance and biomass of the rest of the cohorts were residual. Larger (older) fish seemed more frequent in Portuguese waters, while smaller (younger) fish were more frequent in Spanish waters (**Table 12; Figures 11 and 14**). Sardine population inhabiting the Gulf of Cádiz seems to have stabilized from the decreasing trend observed in 2020 and its biomass increased by 23% (**Table 13**).

Chub mackerel abundance (189 million fish) and biomass (11 763 t) in summer 2023 were 57% and 64% lower than 2020 estimates (448 million, 32 853 t; **Table 18**, **Figure 46**), and remained below their respective time-series averages (*i.e*. 408 million, 30 584 t; **Table 18**, **Figure 46**). Portuguese waters concentrated the bulk of the total population abundance and biomass. The above population levels and the restricted distribution area should be taken into account from the resource's sustainability point of view. The population was composed by fishes not older than 2 years, with the age-0 group being the dominant one (72%, 137 million, and 60%, 7083 t, of the total abundance and biomass estimated in the surveyed area, respectively; **Table 17**, **Figure 24**). Age-1 fish was the second most important age group in the estimated population (51 million fish, 4465 t). The population of chub mackerel continues to show the same trend of a distributional shift towards Portuguese waters given that this year the population inhabiting Spanish waters was residual (<1% for both, abundance and biomass).

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**Table 1**. *ECOCADIZ 2023-07* survey. Percentage of occurrence, total weight (in kg) and total number of individuals of the fish species (sharks excluded) in the fishing hauls.

| Species | OCCURRENCE (Number of valid hauls) | OCCURENCE (% over Total valid hauls) | Total weight (kg) | Total number |
|---|---|---|---|---|
| *Merluccius merluccius* | 12 | 75.00 % | 8.030 | 122 |
| *Scomber colias* | 11 | 68.75 % | 2965.435 | 49748 |
| *Engraulis encrasicolus* | 9 | 56.25 % | 602.080 | 51185 |
| *Sardina pilchardus* | 9 | 56.25 % | 31.585 | 1937 |
| *Trachurus trachurus* | 9 | 56.25 % | 19.355 | 669 |
| *Spondyliosoma cantharus* | 5 | 31.25 % | 11.269 | 112 |
| *Scomber scombrus* | 5 | 31.25 % | 6.175 | 38 |
| *Capros aper* | 5 | 31.25 % | 1.295 | 81 |
| *Aphia minuta* | 5 | 31.25 % | 0.011 | 29 |
| *Pagellus erythrinus* | 4 | 25.00 % | 14.050 | 62 |
| *Trachurus picturatus* | 4 | 25.00 % | 1.255 | 13 |
| *Trachinus draco* | 4 | 25.00 % | 0.760 | 7 |
| *Diplodus vulgaris* | 3 | 18.75 % | 16.480 | 136 |
| *Alosa fallax* | 3 | 18.75 % | 5.110 | 11 |
| *Diplodus bellottii* | 3 | 18.75 % | 1.975 | 26 |
| *Mullus barbatus* | 3 | 18.75 % | 1.940 | 15 |
| *Boops boops* | 3 | 18.75 % | 0.715 | 7 |
| *Pagellus bellottii bellottii* | 3 | 18.75 % | 0.500 | 4 |
| *Serranus cabrilla* | 3 | 18.75 % | 0.415 | 5 |
| *Lepidotrigla cavillone* | 3 | 18.75 % | 0.305 | 10 |
| *Zeus faber* | 3 | 18.75 % | 0.280 | 4 |
| *Serranus hepatus* | 3 | 18.75 % | 0.240 | 11 |
| *Macroramphosus scolopax* | 2 | 12.50 % | 41.770 | 2986 |
| *Trachurus mediterraneus* | 2 | 12.50 % | 3.370 | 16 |
| *Maurolicus muelleri* | 2 | 12.50 % | 0.840 | 743 |
| *Pagellus acarne* | 2 | 12.50 % | 0.795 | 8 |
| *Spicara smaris* | 1 | 6.25 % | 4.190 | 68 |
| *Lepidotrigla dieuzeidei* | 1 | 6.25 % | 0.460 | 10 |
| *Chelidonichthys lastoviza* | 1 | 6.25 % | 0.450 | 6 |
| *Alosa alosa* | 1 | 6.25 % | 0.220 | 1 |
| *Mullus surmuletus* | 1 | 6.25 % | 0.125 | 1 |
| *Lepidopus caudatus* | 1 | 6.25 % | 0.080 | 15 |
| *Diplodus annularis* | 1 | 6.25 % | 0.060 | 1 |
| *Cepola macrophthalma* | 1 | 6.25 % | 0.050 | 1 |
| *Symphurus nigrescens* | 1 | 6.25 % | 0.002 | 1 |

**Table 2.** *ECOCADIZ 2023-07* survey. TS/length relationships used for acoustic estimation of assessed species. (*) Boarfish $b_{20}$ estimate following to Fässler *et al*. (2013). Between parentheses the usual IEO value considered in previous surveys.

| Species | b20 |
|---|---|
| Sardine (*Sardina pilchardus*) | -72.6 |
| Round sardinella (*Sardinella aurita*) | -72.6 |
| Anchovy (*Engraulis encrasicolus*) | -72.6 |
| Chub mackerel (*Scomber japonicus*) | -68.7 |
| Mackerel (*S. scombrus*) | -84.9 |
| Horse mackerel (*Trachurus trachurus*) | -68.7 |
| Mediterranean horse-mackerel (*T. mediterraneus*) | -68.7 |
| Blue jack mackerel (*T. picturatus*) | -68.7 |
| Bogue (*Boops boops*) | -67.0 |
| Transparent goby (*Aphia minuta*) | -67.5 |
| Atlantic pomfret (*Brama brama*) | -67.5 |
| Blue whiting (*Micromesistius poutassou*) | -67.5 |
| Silvery lightfish/pearlside (*Maurolicus muelleri*) | -72.2 |
| Longspine snipefish (*Macroramphosus scolopax*) | -80.0 |
| Boarfish (*Capros aper*) | -66.2* (-72.6) |

**Table 3.** *ECOCADIZ 2023-07* survey. Total and regional NASC values by species. FAO codes for the species: ANE: *Engraulis encrasicolus*; PIL*: Sardina pilchardus*; VAM: *Scomber colias*; MAC*: S. scombrus*; JAA: *Trachurus picturatus*; HOM: *T. trachurus*; HMM: *T. mediterraneus*; BOG: *Boops boops*; SNS: *Macroramphosus scolopax*; MAV: *Maurolicus muelleri;* FIM: *Aphia minuta*; BOC: *Capros Aper.*

| $S_A$ ($m^2nmi^{-2}$) | TOTAL | PIL | ANE | MAC | VAM | HOM | HMM | JAA | BOG | MAV | FIM | SNS | BOC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **TOTAL AREA** | 95940 | 43804 | 15360 | 18 | 16179 | 6420 | 11626 | 24 | 458 | 1112 | 14 | 147 | 776 |
| **%** | 100 | 45.6 | 16.0 | 0.01 | 16.8 | 6.6 | 12.1 | 0.02 | 0.4 | 1.1 | 0.01 | 0.1 | 0.8 |
| **Portugal** | 49405 | 23535 | 1994 | 7 | 16165 | 6262 | 0 | 24 | 458 | 53 | 0 | 147 | 757 |
| **%** | 51 | 53.7 | 12.9 | 44.4 | 99.9 | 97.5 | 0 | 99.7 | 100 | 4.7 | 0 | 100 | 100 |
| **Spain** | 46534 | 20268 | 13383 | 9 | 14 | 158 | 11626 | 0.06 | 0 | 1059 | 14 | 0 | 0 |
| **%** | 48 | 46.2 | 87.0 | 55.5 | 0.08 | 2.4 | 100 | 0.2 | 0 | 95.2 | 100 | 0 | 0 |

**Table 4.** *ECOCADIZ 2023-07* survey. Descriptive characteristics of the acoustic tracks.

| Acoustic Track | Location | Date | Start | | | | End | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Latitude | Longitude | UTC time | Mean depth (m) | Latitude | Longitude | UTC time | Mean depth (m) |
| 1 | Trafalgar | 29/07/23 | 36º 13,840' N | 06º 07,220' W | 17:34 | 23 | 36º 20,020' N | 06º 28,900' W | 19:40 | 243 |
| 2 | Sancti-Petri | 30/07/23 | 36º 19,550' N | 06º 14,490' W | 06:10 | 22 | 36º 08,740' N | 06º 34,000' W | 10:47 | 201 |
| 3 | Cádiz | 30/07/23 | 36º 17,230' N | 06º 36,600' W | 11:43 | 196 | 36º 27,040' N | 06º 18,430' W | 13:30 | 20 |
| 4 | Rota | 31/07/23 | 36º 34,440' N | 06º 22,600' W | 06:11 | 20 | 36º 24,560' N | 06º 40,840' W | 10:28 | 202 |
| 5 | Chipiona | 31/07/23 | 36º 31,210' N | 06º 46,320' W | 13:27 | 200 | 36º 40,930' N | 06º 28,400' W | 15:12 | 20 |
| 6 | Doñana | 01/08/23 | 36º 46,720' N | 06º 35,410' W | 06:19 | 20 | 36º 37,950' N | 06º 51,600' W | 10:24 | 203 |
| 7 | Matalascañas | 01/08/23 | 36º 44,010' N | 06º 58,260' W | 11:20 | 198 | 36º 54,090' N | 06º 39,840' W | 15:12 | 21 |
| 8 | Mazagón | 02/08/23 | 37º 01,040' N | 06º 44,630' W | 06:11 | 21 | 36º 52,410' N | 07º 00,570' W | 10:42 | 101 |
| 9 | Punta Umbría | 02/08/23 | 36º 49,730' N | 07º 06,580' W | 11:22 | 200 | 37º 05,990' N | 06º 54,980' W | 13:12 | 20 |
| 10 | El Rompido | 02/08/23 | 37º 07,150' N | 07º 07,140' W | 14:14 | 23 | 36º 49,920' N | 07º 06,890' W | 15:55 | 201 |
| 11 | Isla Cristina | 03/08/23 | 37º 07,010' N | 07º 17,150' W | 06:28 | 23 | 36º 53,430' N | 07º 17,010' W | 17:48 | 205 |
| 12 | Vila Real do Santo Antonio | 03/08/23 | 36º 56,300' N | 07º 27,110' W | 10:12 | 199 | 37º 06,480' N | 07º 27,090' W | 11:13 | 19 |
| 13 | Tavira | 03/08/23 | 37º 04,730' N | 07º 37,170' W | 12:29 | 20 | 36º 56,950' N | 07º 37,090' W | 13:17 | 208 |
| 14 | Fuzeta | 04/08/23 | 36º 59,640' N | 07º 47,040' W | 06:12 | 20 | 36º 55,450' N | 07º 46,980' W | 06:37 | 202 |
| 15 | Cabo de Santa María | 04/08/23 | 36º 52,140' W | 07º 56,980' W | 07:34 | 199 | 36º 57,060' N | 07º 57,010' W | 08:03 | 20 |
| 16 | Cuarteira | 04/08/23 | 36º 49,730' N | 08º 06,900' W | 12:33 | 199 | 37º 02,060' N | 08º 07,040' W | 13:47 | 20 |
| 17 | Albufeira | 05/08/23 | 37º 02,220' N | 08º 16,980' W | 06:21 | 22 | 37º 49,350' N | 08º 16,800' W | 10:23 | 201 |
| 18 | Alfanzina | 05/08/23 | 36º 50,180' N | 08º 26,770' W | 11:15 | 199 | 37º 04,660' N | 08º 27,030' W | 12:42 | 20 |
| 19 | Portimao | 06/08/23 | 37º 06,210' N | 08º 37,030' W | 06:13 | 20 | 36º 51,260' N | 08º 36,500' W | 07:43 | 200 |
| 20 | Burgau | 06/08/23 | 36º 51,960' N | 08º 46,680' W | 10:48 | 200 | 37º 03,530' N | 08º 46,940' W | 14:22 | 20 |
| 21 | Ponta de Sagres | 07/08/23 | 36º 59,430' N | 08º 56,580' W | 05:35 | 24 | 36º 50,680' N | 08º 56,500' W | 06:28 | 200 |

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**Table 5.** *ECOCADIZ 2023-07* survey. Descriptive characteristics of the fishing hauls. Fishing hauls 7, 9, 17 and 20 were carried out at dusk for collecting anchovy females with hydrated eggs.

| FISHING STATION | DATE | POSITION | | | | | | TIMING | | | | TRAWLED DISTANCE (Nmi) | ACOUSTIC TRANSECT | ZONE/LANDMARK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | START | | | END | | | | | | | | | |
| | | LAT. | LON. | DEPTH | LAT. | LON. | DEPTH | START | END | EFFECTIVE TRAWLING | TOTAL MANEOUVRE | | | |
| 1 | 30-07-2023 | 36º 15.4753 N | 6º 22.1575 W | 50.05 | 36º 17.1270 N | 6º 19.0440 W | 42.46 | 07:26 | 08:11 | 00:45 | 01:26 | 3.01 | R02 | Sancti-Petri |
| 2 | 30-07-2023 | 36º 25.6725 N | 6º 20.6973 W | 39.31 | 36º 24.3085 N | 6º 22.8510 W | 48.43 | 14:12 | 14:45 | 00:33 | 01:02 | 2.208 | R03 | Cádiz |
| 3 | 30-07-2023 | 36º 30.8809 N | 6º 29.1510 W | 49.81 | 36º 32.2710 N | 6º 26.7060 W | 40.22 | 07:14 | 07:50 | 00:36 | 01:13 | 2.41 | R04 | Rota |
| 4 | 31-07-2023 | 36º 25.0872 N | 6º 39.6126 W | 162 | 36º 26.2549 N | 6º 37.2568 W | 106.5 | 11:00 | 11:33 | 00:33 | 00:-38 | 2.23 | R04 | Rota |
| 5 | 01-08-2023 | 36º 42.2560 N | 6º 43.5637 W | 64.13 | 36º 43.6608 N | 6º 41.0725 W | 41.85 | 07:32 | 08:08 | 00:36 | 01:13 | 2.445 | R06 | Doñana |
| 6 | 01-08-2023 | 36º 46.4337 N | 6º 53.7858 W | 104.7 | 36º 44.7760 N | 6º 56.7010 W | 128.6 | 12:17 | 12:59 | 00:42 | 01:27 | 2.868 | R07 | Matalascañas |
| 7 | 01-08-2023 | 36º 46.8075 N | 6º 53.0623 W | 97.75 | 36º 46.2031 N | 6º 54.1873 W | 103.1 | 18:08 | 18:24 | 00:16 | 00:58 | 1.087 | R07 | Matalascañas |
| 8 | 02-08-2023 | 36º 52.6923 N | 7º 00.2223 W | 98.86 | 36º 53.9827 N | 6º 58.0471 W | 82.5 | 08:14 | 08:46 | 00:32 | 01:19 | 2.169 | R08 | Mazagón |
| 9 | 02-08-2023 | 36º 53.5641 N | 6º 58.2627 W | 86.45 | 36º 51.4311 N | 7º 00.8433 W | 106.1 | 19:00 | 19:42 | 00:42 | 01:25 | 2.971 | R08 | Mazagón |
| 10 | 03-08-2023 | 36º 54.4915 N | 7º 16.9393 W | 134.9 | 36º 56.2156 N | 7º 16.8357 W | 111.6 | 08:16 | 08:42 | 00:26 | 01:12 | 1.724 | R11 | Isla Cristina |
| 11 | 03-08-2023 | 36º 57.4609 N | 7º 36.9436 W | 164.4 | 36º 59.9091 N | 7º 36.7837 W | 99.89 | 14:55 | 15:29 | 00:34 | 02:04 | 2.448 | R13 | Tavira |
| 12 | 03-08-2023 | 36º 54.6973 N | 7º 56.8729 W | 73.46 | 36º 52.8627 N | 7º 56.7249 W | 104.1 | 08:31 | 08:57 | 00:26 | 01:08 | 1.836 | R15 | Cabo de Santa María |
| 13 | 04-08-2023 | 36º 52.3915 N | 7º 56.8845 W | 110 | 36º 52.0092 N | 7º 56.8779 W | 20.5 | 11:03 | 11:09 | 00:06 | 00:52 | 0.382 | R15 | Cabo de Santa María |
| 14 | 04-08-2023 | 37º 01.0012 N | 8º 07.0014 W | 28.38 | 36º 58.8751 N | 8º 06.9075 W | 43.25 | 14:21 | 14:53 | 00:32 | 01:21 | 2.125 | R16 | Cuarteira |
| 15 | 05-08-2023 | 36º 53.5420 N | 8º 16.8766 W | 104.4 | 36º 56.7001 N | 8º 16.7917 W | 70.99 | 07:48 | 08:34 | 00:46 | 01:42 | 3.155 | R17 | Albufeira |
| 16 | 05-08-2023 | 36º 55.1500 N | 8º 26.8006 W | 109.1 | 36º 52.4971 N | 8º 26.6340 W | 130.6 | 14:49 | 15:26 | 00:37 | 01:29 | 2.653 | R18 | Alfanzina |
| 17 | 05-08-2023 | 36º 56.4024 N | 8º 16.8568 W | 75.12 | 36º 53.5534 N | 8º 16.6024 W | 101.3 | 19:02 | 19:39 | 00:37 | 01:20 | 2.853 | R17 | Albufeira |
| 18 | 06-08-2023 | 36º 52.6908 N | 8º 36.4438 W | 113.3 | 36º 55.1329 N | 8º 36.6369 W | 98.83 | 08:13 | 08:48 | 00:35 | 01:26 | 2.444 | R19 | Portimao |
| 19 | 06-08-2023 | 36º 56.5425 N | 8º 46.5877 W | 110.2 | 36º 54.0225 N | 8º 46.2861 W | 108.5 | 12:14 | 12:49 | 00:35 | 01:36 | 2.528 | R20 | Burgau |
| 20 | 06-08-2023 | 36º 55.3900 N | 8º 26.8531 W | 108 | 36º 52.4050 N | 8º 26.7207 W | 131.1 | 18:48 | 19:29 | 00:41 | 01:29 | 2.983 | R18 | Alfanzina |

**Table 6.** *ECOCADIZ 2023-07* survey. Catches by species in number (upper panel) and weight (in kg, lower panel) from valid fishing hauls.

| Fishing haul | CATCH IN NUMBER | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Anchovy* | *Boarfish* | *Bogue* | *Transp. Goby* | *Medit. Horse-mack.* | *Horse-mack.* | *Blue jack mack.* | *Mackerel* | *Chub mackerel* | *Pearlside* | *Sardine* | *Snipefish* | *OTHERS* | *TOTAL* |
| **1** | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 47 | **65** |
| **2** | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **9** |
| **3** | 5553 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1369 | 0 | 12 | **6936** |
| **4** | 2310 | 7 | 0 | 6 | 0 | 19 | 0 | 0 | 5 | 739 | 0 | 0 | 53 | **3139** |
| **5** | 1754 | 0 | 0 | 16 | 0 | 4 | 0 | 2 | 0 | 0 | 81 | 0 | 12 | **1869** |
| **6** | 9984 | 0 | 0 | 1 | 0 | 0 | 0 | 6 | 0 | 0 | 24 | 0 | 6 | **10021** |
| **8** | 25641 | 2 | 0 | 5 | 0 | 396 | 0 | 16 | 5 | 0 | 201 | 0 | 15 | **26281** |
| **10** | 4901 | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 31 | 4 | 1 | 0 | 11 | **4956** |
| **11** | 0 | 1 | 1 | 0 | 0 | 16 | 7 | 0 | 20916 | 0 | 0 | 2874 | 7 | **23822** |
| **12** | 104 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | **107** |
| **13** | 0 | 68 | 0 | 0 | 0 | 64 | 0 | 10 | 0 | 0 | 0 | 112 | 5 | **259** |
| **14** | 0 | 0 | 4 | 0 | 0 | 68 | 0 | 0 | 1 | 0 | 76 | 0 | 345 | **494** |
| **15** | 455 | 0 | 2 | 0 | 0 | 22 | 0 | 0 | 464 | 0 | 156 | 0 | 42 | **1141** |
| **16** | 483 | 3 | 0 | 0 | 0 | 45 | 0 | 0 | 26847 | 0 | 18 | 0 | 7 | **27403** |
| **18** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1458 | 0 | 0 | 0 | 0 | **1459** |
| **19** | 0 | 0 | 0 | 0 | 0 | 35 | 1 | 0 | 19 | 0 | 0 | 0 | 6 | **61** |
| **TOTAL** | **51185** | **81** | **7** | **29** | **16** | **669** | **13** | **38** | **49748** | **743** | **1937** | **2986** | **570** | **108022** |

**Table 6.** *ECOCADIZ 2023-07* survey. Cont'd.

| Fishing haul | CATCH IN WEIGTH | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***Anchovy*** | ***Boarfish*** | ***Bogue*** | ***Transp. Goby*** | ***Medit. Horse-mack.*** | ***Horse-mack.*** | ***Blue jack mack.*** | ***Mackerel*** | ***Chub mackerel*** | ***Pearlside*** | ***Sardine*** | ***Snipefish*** | ***OTHERS*** | ***TOTAL*** |
| **1** | 0 | 0 | 0 | 0 | 1.47 | 0 | 0 | 0 | 0 | 0 | 0.24 | 0 | 7.09 | **8.79** |
| **2** | 0 | 0 | 0 | 0 | 1.91 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **1.91** |
| **3** | 24.97 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.05 | 0 | 12.72 | 0 | 0.99 | **38.72** |
| **4** | 30.04 | 0.03 | 0 | 0 | 0 | 0.52 | 0 | 0 | 0.17 | 0.83 | 0 | 0 | 1.28 | **32.85** |
| **5** | 9.05 | 0 | 0 | 0.01 | 0 | 0.02 | 0 | 0.55 | 0 | 0 | 1.65 | 0 | 1.06 | **12.33** |
| **6** | 112.7 | 0 | 0 | 0 | 0 | 0 | 0 | 1.38 | 0 | 0 | 0.51 | 0 | 0.56 | **115.14** |
| **8** | 316.25 | 0.01 | 0 | 0 | 0 | 3.79 | 0 | 3.52 | 0.49 | 0 | 3.3 | 0 | 3.94 | **331.27** |
| **10** | 82.2 | 0 | 0 | 0 | 0 | 0 | 0.09 | 0.19 | 2.79 | 0.01 | 0.03 | 0 | 1.52 | **86.81** |
| **11** | 0 | 0.01 | 0.18 | 0 | 0 | 1.69 | 1.01 | 0 | 1110.5 | 0 | 0 | 39.93 | 1.43 | **1154.72** |
| **12** | 0.45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.05 | 0 | 0 | 0 | 0.05 | **0.54** |
| **13** | 0 | 1.16 | 0 | 0 | 0 | 0.81 | 0 | 0.55 | 0 | 0 | 0 | 1.85 | 0.21 | **4.56** |
| **14** | 0 | 0 | 0.31 | 0 | 0 | 4.48 | 0 | 0 | 0.15 | 0 | 4.27 | 0 | 38.83 | **48.04** |
| **15** | 8.1 | 0 | 0.23 | 0 | 0 | 1.92 | 0 | 0 | 22.48 | 0 | 7.77 | 0 | 4.74 | **45.23** |
| **16** | 18.35 | 0.1 | 0 | 0 | 0 | 4.06 | 0 | 0 | 1707.86 | 0 | 1.12 | 0 | 0.81 | **1732.29** |
| **18** | 0 | 0 | 0 | 0 | 0 | 0 | 0.13 | 0 | 119.96 | 0 | 0 | 0 | 0 | **120.08** |
| **19** | 0 | 0 | 0 | 0 | 0 | 2.09 | 0.04 | 0 | 0.97 | 0 | 0 | 0 | 0.57 | **3.67** |
| **TOTAL** | **602.08** | **1.3** | **0.72** | **0.01** | **3.37** | **19.36** | **1.26** | **6.18** | **2965.44** | **0.84** | **31.59** | **41.77** | **63.04** | **3736.93** |

**Table 7.** *ECOCADIZ 2023-07* survey. Parameters of the size-weight relationships for the survey's target species susceptible of being assessed. FAO codes for the species: ANE: *Engraulis encrasicolus*; PIL*: Sardina pilchardus*; VAM: *Scomber colias*; MAC*: S. scombrus*; JAA: *Trachurus picturatus*; HOM: *T. trachurus*; HMM: *T. mediterraneus*; BOG: *Boops boops*; MAV: *Maurolicus muelleri*; FIM: *Aphia minuta*;. BOC: *Capros aper.*

| **Parameter** | FIM | BOG | BOC | ANE | SNS | MAV | PIL | VAM | MAC | HMM | JAA | HOM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Size range (mm)** | 31 - 52 | 195 - 265 | 53 - 108 | 78 - 188 | 71 - 165 | 34 - 66 | 97 - 206 | 92 - 308 | 171 - 366 | 290 - 314 | 135 - 263 | 70 - 281 |
| **n** | 35 | 7 | 77 | 567 | 226 | 96 | 302 | 264 | 38 | 16 | 13 | 479 |
| **a** | 0.004 | 0.030 | 0.016 | 0.001 | 0.007 | 0.012 | 0.002 | 0.002 | 0.002 | 0.001 | 0.004 | 0.009 |
| **b** | 3.119 | 2.606 | 3.164 | 3.591 | 2.957 | 2.817 | 3.428 | 3.424 | 3.356 | 3.738 | 3.274 | 2.986 |
| **$r^2$** | 0.675 | 0.854 | 0.989 | 0.970 | 0.925 | 0.914 | 0.989 | 0.971 | 0.992 | 0.680 | 0.995 | 0.996 |

**Tabla 8.** *ECOCADIZ 2023-07* survey. Anchovy (*Engraulis encrasicolus*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 8.**

| ***ECOBOCADEVA0723. Engraulis encrasicolus.* ABUNDANCE (in numbers and million fish)** | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **POL03** | **POL04** | **POL05** | **Portugal** | **POL06** | **POL07** | **POL08** | **POL09** | **Spain** | **TOTAL** | **Millions** | | |
| | | | | | | | | | | | | | **Portugal** | **Spain** | **TOTAL** |
| **2** | 0 | 0 | 0 | 10594844 | 0 | 10594844 | 0 | 0 | 0 | 0 | 0 | 10594844 | 10.594844 | 0 | 10.594844 |
| **2.5** | 0 | 0 | 0 | 31784533 | 0 | 31784533 | 0 | 0 | 0 | 0 | 0 | 31784533 | 31.784533 | 0 | 31.784533 |
| **3** | 0 | 0 | 0 | 27546595 | 0 | 27546595 | 0 | 0 | 0 | 0 | 0 | 27546595 | 27.546595 | 0 | 27.546595 |
| **3.5** | 0 | 0 | 0 | 16951751 | 0 | 16951751 | 0 | 0 | 0 | 0 | 0 | 16951751 | 16.951751 | 0 | 16.951751 |
| **4** | 0 | 0 | 0 | 10594844 | 0 | 10594844 | 0 | 0 | 0 | 0 | 0 | 10594844 | 10.594844 | 0 | 10.594844 |
| **4.5** | 0 | 0 | 0 | 19070720 | 0 | 19070720 | 0 | 0 | 0 | 0 | 0 | 19070720 | 19.07072 | 0 | 19.07072 |
| **5** | 0 | 0 | 0 | 2118969 | 0 | 2118969 | 0 | 0 | 0 | 0 | 0 | 2118969 | 2.118969 | 0 | 2.118969 |
| **5.5** | 0 | 0 | 0 | 8475875 | 0 | 8475875 | 0 | 0 | 0 | 0 | 0 | 8475875 | 8.475875 | 0 | 8.475875 |
| **6** | 0 | 0 | 0 | 2118969 | 0 | 2118969 | 0 | 0 | 0 | 0 | 0 | 2118969 | 2.118969 | 0 | 2.118969 |
| **6.5** | 0 | 0 | 0 | 4237938 | 0 | 4237938 | 0 | 0 | 0 | 0 | 0 | 4237938 | 4.237938 | 0 | 4.237938 |
| **7** | 0 | 0 | 0 | 8475875 | 0 | 8475875 | 0 | 0 | 0 | 37909775 | 37909775 | 46385650 | 8.475875 | 37.909775 | 46.38565 |
| **7.5** | 0 | 0 | 0 | 10594844 | 0 | 10594844 | 0 | 0 | 0 | 105492661 | 105492661 | 116087505 | 10.594844 | 105.492661 | 116.087505 |
| **8** | 0 | 0 | 0 | 2118969 | 0 | 2118969 | 0 | 0 | 0 | 84373009 | 84373009 | 86491978 | 2.118969 | 84.373009 | 86.491978 |
| **8.5** | 0 | 0 | 0 | 10594844 | 0 | 10594844 | 0 | 0 | 27979899 | 84373009 | 112352908 | 122947752 | 10.594844 | 112.352908 | 122.947752 |
| **9** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 95449159 | 29567512 | 125016671 | 125016671 | 0 | 125.016671 | 125.016671 |
| **9.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 95449159 | 67477287 | 162926446 | 162926446 | 0 | 162.926446 | 162.926446 |
| **10** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3647128 | 75803698 | 63253357 | 142704183 | 142704183 | 0 | 142.704183 | 142.704183 |
| **10.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12496216 | 39290922 | 71701218 | 123488356 | 123488356 | 0 | 123.488356 | 123.488356 |
| **11** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 28251534 | 11311023 | 21119652 | 60682209 | 60682209 | 0 | 60.682209 | 60.682209 |
| **11.5** | 0 | 0 | 0 | 0 | 29218 | 29218 | 16584 | 39215760 | 0 | 12671791 | 51904135 | 51933353 | 0.029218 | 51.904135 | 51.933353 |
| **12** | 16930 | 408251 | 0 | 0 | 29218 | 454399 | 16584 | 39728739 | 0 | 8447861 | 48193184 | 48647583 | 0.454399 | 48.193184 | 48.647583 |
| **12.5** | 182847 | 4409112 | 0 | 10594844 | 235135 | 15421938 | 133462 | 58244438 | 2778146 | 0 | 61156046 | 76577984 | 15.421938 | 61.156046 | 76.577984 |
| **13** | 538383 | 12982386 | 0 | 14832782 | 822973 | 29176524 | 467118 | 57436502 | 0 | 0 | 57903620 | 87080144 | 29.176524 | 57.90362 | 87.080144 |
| **13.5** | 382624 | 9226476 | 0 | 8475875 | 1234808 | 19319783 | 700875 | 29143196 | 0 | 0 | 29844071 | 49163854 | 19.319783 | 29.844071 | 49.163854 |
| **14** | 277657 | 6695319 | 1753 | 12713813 | 822973 | 20511515 | 467118 | 7919386 | 0 | 0 | 8386504 | 28898019 | 20.511515 | 8.386504 | 28.898019 |
| **14.5** | 60949 | 1469704 | 8763 | 6356907 | 205917 | 8102240 | 116878 | 3127293 | 0 | 0 | 3244171 | 11346411 | 8.10224 | 3.244171 | 11.346411 |
| **15** | 47405 | 1143103 | 17526 | 2118969 | 29218 | 3356221 | 16584 | 889204 | 0 | 0 | 905788 | 4262009 | 3.356221 | 0.905788 | 4.262009 |
| **15.5** | 16930 | 408251 | 35490 | 0 | 0 | 460671 | 0 | 0 | 0 | 0 | 0 | 460671 | 0.460671 | 0 | 0.460671 |
| **16** | 0 | 0 | 38995 | 0 | 0 | 38995 | 0 | 0 | 0 | 0 | 0 | 38995 | 0.038995 | 0 | 0.038995 |
| **16.5** | 0 | 0 | 54768 | 0 | 0 | 54768 | 0 | 0 | 0 | 0 | 0 | 54768 | 0.054768 | 0 | 0.054768 |
| **17** | 0 | 0 | 24536 | 0 | 0 | 24536 | 0 | 0 | 0 | 0 | 0 | 24536 | 0.024536 | 0 | 0.024536 |
| **17.5** | 16930 | 408251 | 10515 | 0 | 0 | 435696 | 0 | 0 | 0 | 0 | 0 | 435696 | 0.435696 | 0 | 0.435696 |
| **18** | 0 | 0 | 8763 | 0 | 0 | 8763 | 0 | 0 | 0 | 0 | 0 | 8763 | 0.008763 | 0 | 0.008763 |
| **18.5** | 0 | 0 | 8763 | 0 | 0 | 8763 | 0 | 0 | 0 | 0 | 0 | 8763 | 0.008763 | 0 | 0.008763 |
| **19** | 0 | 0 | 1753 | 0 | 0 | 1753 | 0 | 0 | 0 | 0 | 0 | 1753 | 0.001753 | 0 | 0.001753 |
| **TOTAL n** | 1540655 | 37150853 | 211625 | 220372760 | 3409460 | 262685353 | 1935203 | 280099396 | 348062006 | 586387132 | 1216483737 | 1479169090 | **263** | **1216** | **1479** |
| **Millions** | **2** | **37** | **0** | **220** | **3** | **263** | **2** | **280** | **348** | **586** | **1216** | **1479** | | | |

**Table 8.** *ECOCADIZ 2023-07* survey. Anchovy (*E. encrasicolus*). Cont'd.

| ***ECOBOCADEVA0723. Engraulis encrasicolus.* BIOMASS (t)** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **POL03** | **POL04** | **POL05** | **Portugal** | **POL06** | **POL07** | **POL08** | **POL09** | **Spain** | **TOTAL** |
| **2** | 0 | 0 | 0 | 0.272 | 0 | 0.272 | 0 | 0 | 0 | 0 | 0 | 0.272 |
| **2.5** | 0 | 0 | 0 | 1.678 | 0 | 1.678 | 0 | 0 | 0 | 0 | 0 | 1.678 |
| **3** | 0 | 0 | 0 | 2.649 | 0 | 2.649 | 0 | 0 | 0 | 0 | 0 | 2.649 |
| **3.5** | 0 | 0 | 0 | 2.726 | 0 | 2.726 | 0 | 0 | 0 | 0 | 0 | 2.726 |
| **4** | 0 | 0 | 0 | 2.671 | 0 | 2.671 | 0 | 0 | 0 | 0 | 0 | 2.671 |
| **4.5** | 0 | 0 | 0 | 7.167 | 0 | 7.167 | 0 | 0 | 0 | 0 | 0 | 7.167 |
| **5** | 0 | 0 | 0 | 1.141 | 0 | 1.141 | 0 | 0 | 0 | 0 | 0 | 1.141 |
| **5.5** | 0 | 0 | 0 | 6.326 | 0 | 6.326 | 0 | 0 | 0 | 0 | 0 | 6.326 |
| **6** | 0 | 0 | 0 | 2.134 | 0 | 2.134 | 0 | 0 | 0 | 0 | 0 | 2.134 |
| **6.5** | 0 | 0 | 0 | 5.626 | 0 | 5.626 | 0 | 0 | 0 | 0 | 0 | 5.626 |
| **7** | 0 | 0 | 0 | 14.544 | 0 | 14.544 | 0 | 0 | 0 | 65.051 | 65.051 | 79.595 |
| **7.5** | 0 | 0 | 0 | 23.100 | 0 | 23.100 | 0 | 0 | 0 | 230.009 | 230.009 | 253.109 |
| **8** | 0 | 0 | 0 | 5.783 | 0 | 5.783 | 0 | 0 | 0 | 230.271 | 230.271 | 236.054 |
| **8.5** | 0 | 0 | 0 | 35.719 | 0 | 35.719 | 0 | 0 | 94.331 | 284.454 | 378.785 | 414.504 |
| **9** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 392.874 | 121.701 | 514.575 | 514.575 |
| **9.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 474.637 | 335.542 | 810.179 | 810.179 |
| **10** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21.704 | 451.108 | 376.421 | 849.233 | 849.233 |
| **10.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 88.238 | 277.439 | 506.293 | 871.970 | 871.970 |
| **11** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 234.869 | 94.034 | 175.578 | 504.481 | 504.481 |
| **11.5** | 0 | 0 | 0 | 0 | 0.284 | 0.284 | 0.161 | 381.125 | 0 | 123.153 | 504.439 | 504.723 |
| **12** | 0.191 | 4.608 | 0 | 0 | 0.33 | 5.129 | 0.187 | 448.444 | 0 | 95.356 | 543.987 | 549.116 |
| **12.5** | 2.383 | 57.458 | 0 | 138.068 | 3.064 | 200.973 | 1.739 | 759.021 | 36.204 | 0 | 796.964 | 997.937 |
| **13** | 8.055 | 194.245 | 0 | 221.931 | 12.313 | 436.544 | 6.989 | 859.375 | 0 | 0 | 866.364 | 1302.908 |
| **13.5** | 6.539 | 157.690 | 0 | 144.861 | 21.104 | 330.194 | 11.979 | 498.087 | 0 | 0 | 510.066 | 840.260 |
| **14** | 5.395 | 130.091 | 0.034 | 247.032 | 15.991 | 398.543 | 9.076 | 153.875 | 0 | 0 | 162.951 | 561.494 |
| **14.5** | 1.340 | 32.322 | 0.193 | 139.801 | 4.529 | 178.185 | 2.570 | 68.775 | 0 | 0 | 71.345 | 249.530 |
| **15** | 1.175 | 28.336 | 0.434 | 52.527 | 0.724 | 83.196 | 0.411 | 22.043 | 0 | 0 | 22.454 | 105.650 |
| **15.5** | 0.471 | 11.363 | 0.988 | 0 | 0 | 12.822 | 0 | 0 | 0 | 0 | 0 | 12.822 |
| **16** | 0 | 0 | 1.214 | 0 | 0 | 1.214 | 0 | 0 | 0 | 0 | 0 | 1.214 |
| **16.5** | 0 | 0 | 1.902 | 0 | 0 | 1.902 | 0 | 0 | 0 | 0 | 0 | 1.902 |
| **17** | 0 | 0 | 0.947 | 0 | 0 | 0.947 | 0 | 0 | 0 | 0 | 0 | 0.947 |
| **17.5** | 0.724 | 17.457 | 0.450 | 0 | 0 | 18.631 | 0 | 0 | 0 | 0 | 0 | 18.631 |
| **18** | 0 | 0 | 0.414 | 0 | 0 | 0.414 | 0 | 0 | 0 | 0 | 0 | 0.414 |
| **18.5** | 0 | 0 | 0.456 | 0 | 0 | 0.456 | 0 | 0 | 0 | 0 | 0 | 0.456 |
| **19** | 0 | 0 | 0.100 | 0 | 0 | 0.100 | 0 | 0 | 0 | 0 | 0 | 0.100 |
| **TOTAL** | **26.273** | **633.570** | **7.132** | **1055.756** | **58.339** | **1781.070** | **33.112** | **3535.556** | **1820.627** | **2543.829** | **7933.124** | **9714.194** |

**Tabla 9.** *ECOCADIZ 2023-07* survey. Anchovy (*E. encrasicolus*). Estimated abundance (thousands of individuals) and biomass (t) by age group (years). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 8** and ordered from west to east.

| Age class | POL 01 | POL 02 | POL 03 | POL 04 | POL 05 | POL 06 | POL 07 | POL 08 | POL 09 | PT | ES | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | N | N | N | N | N | N | N | N | N | N | N |
| 0 | 429 | 10336 | 0 | 107774 | 869 | 493 | 131219 | 316000 | 501557 | 119409 | 949269 | 1068678 |
| I | 1048 | 25276 | 115 | 40039 | 2399 | 1362 | 144941 | 32062 | 84679 | 68878 | 263044 | 331922 |
| II | 64 | 1538 | 97 | 2633 | 141 | 80 | 3940 | 0 | 151 | 4473 | 4170 | 8643 |
| III | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 1541 | 37151 | 212 | 150447 | 3409 | 1935 | 280099 | 348062 | 586387 | 192759 | 1216484 | 1409243 |

| Age class | POL 01 | POL 02 | POL 03 | POL 04 | POL 05 | POL 06 | POL 07 | POL 08 | POL 09 | PT | ES | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B | B | B | B | B | B | B | B | B | B | B | B |
| 0 | 7 | 160 | 0 | 323 | 14 | 8 | 1505 | 1613 | 2082 | 503 | 5207 | 5710 |
| I | 18 | 438 | 3 | 676 | 42 | 24 | 1965 | 208 | 460 | 1177 | 2657 | 3834 |
| II | 1 | 36 | 4 | 53 | 3 | 2 | 65 | 0 | 2 | 97 | 68 | 165 |
| III | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 26 | 634 | 7 | 1051 | 58 | 33 | 3535 | 1821 | 2544 | 1776 | 7933 | 9709 |

**Tabla 10.** *ECOCADIZ 2023-07* survey. Anchovy (*E. encrasicolus*). Acoustic estimates of biomass (t) from the *PELAGO* spring and *ECOCADIZ* summer survey series, and *BOCADEVA DEPM* survey series for the whole Gulf of Cádiz anchovy population. NA refers to when no survey was performed due to several technical or financial issues.

| **Estimate/Year** | **Total Population Biomass (t)** | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** |
| ***BOCADEVA*** | NA | NA | NA | NA | NA | NA | 14637 | NA | NA | 31527 | NA | NA | 30037 | NA | NA | 31569 | NA | NA | 12392 | NA | NA | 81466 | NA | NA | 15138 |
| ***ECOCADIZ*** | NA | NA | NA | NA | NA | 18177 | NA | 35539 | 28882 | NA | 21580 | 12339 | NA | NA | 8487 | 29219 | 21305 | 34184 | 12229 | 34908 | 57700 | 44887 | NA | NA | 9714 |
| ***PELAGO*** | 24763 | NA | 24913 | 21335 | NA | NA | 14041 | 24082 | 38020 | 34200 | 24800 | 7395 | 0 | NA | 12700 | 28408 | 33100 | 65345 | 13797 | 23473 | 29876 | 49787 | 14065 | 8972 | 26785 |

**Table 11.** *ECOCADIZ 2023-07* survey. Sardine (*Sardina pilchardus*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 11**.

| ***ECOBOCADEVA0723. Sardina pilchardus.*** **ABUNDANCE (in numbers and million fish)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **POL03** | **Portugal** | **POL04** | **POL05** | **POL06** | **Spain** | **TOTAL** | **Millions** | | |
| | | | | | | | | | | **Portugal** | **Spain** | **TOTAL** |
| **9.5** | 0 | 0 | 0 | 0 | 0 | 0 | 16319991 | 16319991 | 16319991 | 0 | 16.319991 | 16.319991 |
| **10** | 0 | 0 | 0 | 0 | 0 | 1460585 | 193228691 | 194689276 | 194689276 | 0 | 194.689276 | 194.689276 |
| **10.5** | 0 | 0 | 0 | 0 | 0 | 1460585 | 313996622 | 315457207 | 315457207 | 0 | 315.457207 | 315.457207 |
| **11** | 0 | 0 | 0 | 0 | 0 | 7302926 | 265689449 | 272992375 | 272992375 | 0 | 272.992375 | 272.992375 |
| **11.5** | 0 | 0 | 0 | 0 | 0 | 27751119 | 80294355 | 108045474 | 108045474 | 0 | 108.045474 | 108.045474 |
| **12** | 0 | 0 | 0 | 0 | 0 | 80223996 | 16319991 | 96543987 | 96543987 | 0 | 96.543987 | 96.543987 |
| **12.5** | 0 | 0 | 0 | 0 | 0 | 151954960 | 7833596 | 159788556 | 159788556 | 0 | 159.788556 | 159.788556 |
| **13** | 0 | 0 | 0 | 0 | 0 | 176460334 | 0 | 176460334 | 176460334 | 0 | 176.460334 | 176.460334 |
| **13.5** | 0 | 0 | 0 | 0 | 0 | 61182292 | 0 | 61182292 | 61182292 | 0 | 61.182292 | 61.182292 |
| **14** | 0 | 0 | 0 | 0 | 0 | 20448193 | 0 | 20448193 | 20448193 | 0 | 20.448193 | 20.448193 |
| **14.5** | 0 | 0 | 0 | 0 | 0 | 23315268 | 0 | 23315268 | 23315268 | 0 | 23.315268 | 23.315268 |
| **15** | 7069 | 10090629 | 327483 | 10425181 | 3 | 7302926 | 0 | 7302929 | 17728110 | 104.25181 | 7.302929 | 17.72811 |
| **15.5** | 19440 | 27749231 | 900577 | 28669248 | 8 | 6545586 | 0 | 6545594 | 35214842 | 286.69248 | 6.545594 | 35.214842 |
| **16** | 28277 | 40362517 | 1309930 | 41700724 | 11 | 0 | 0 | 11 | 41700735 | 417.00724 | 0.000011 | 41.700735 |
| **16.5** | 22975 | 32794545 | 1064318 | 33881838 | 9 | 0 | 0 | 9 | 33881847 | 338.81838 | 0.000009 | 33.881847 |
| **17** | 24928 | 35582746 | 1154807 | 36762481 | 10 | 3624415 | 0 | 3624425 | 40386906 | 367.62481 | 3.624425 | 40.386906 |
| **17.5** | 60740 | 86699749 | 2813764 | 89574253 | 24 | 0 | 0 | 24 | 89574277 | 895.74253 | 0.000024 | 89.574277 |
| **18** | 120177 | 171540699 | 5567203 | 177228079 | 47 | 0 | 0 | 47 | 177228126 | 1772.28079 | 0.000047 | 177.228126 |
| **18.5** | 163243 | 233013875 | 7562261 | 240739379 | 64 | 10873246 | 0 | 10873310 | 251612689 | 2407.39379 | 10.87331 | 251.612689 |
| **19** | 73855 | 105420522 | 3421331 | 108915708 | 29 | 3624415 | 0 | 3624444 | 112540152 | 1089.15708 | 3.624444 | 112.540152 |
| **19.5** | 7162 | 10223401 | 331792 | 10562355 | 3 | 0 | 0 | 3 | 10562358 | 105.62355 | 0.000003 | 10.562358 |
| **20** | 16278 | 23235002 | 754072 | 24005352 | 6 | 3624415 | 0 | 3624421 | 27629773 | 240.05352 | 3.624421 | 27.629773 |
| **20.5** | 7255 | 10356172 | 336100 | 10699527 | 3 | 0 | 0 | 3 | 10699530 | 106.99527 | 0.000003 | 10.69953 |
| **TOTAL n** | 551399 | 787069088 | 25543638 | 813164125 | 217 | 587155261 | 893682695 | 1480838173 | 2294002298 | **8132** | **1481** | **2294** |
| **Millions** | **1** | **787** | **26** | **813** | **0.0002** | **587** | **894** | **1481** | **2294** | | | |

**Table 11.** *ECOCADIZ 2023-07* survey. Sardine (*S. pilchardus*). Cont'd.

| ***ECOBOCADEVA0723. Sardina pilchardus.* BIOMASS (t)** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **POL03** | **Portugal** | **POL04** | **POL05** | **POL06** | **Spain** | **TOTAL** |
| **9.5** | 0 | 0 | 0 | 0 | 0 | 0 | 99.773 | 99.773 | 99.773 |
| **10** | 0 | 0 | 0 | 0 | 0 | 10.599 | 1402.222 | 1412.821 | 1412.821 |
| **10.5** | 0 | 0 | 0 | 0 | 0 | 12.479 | 2682.718 | 2695.197 | 2695.197 |
| **11** | 0 | 0 | 0 | 0 | 0 | 72.917 | 2652.804 | 2725.721 | 2725.721 |
| **11.5** | 0 | 0 | 0 | 0 | 0 | 321.624 | 930.579 | 1252.203 | 1252.203 |
| **12** | 0 | 0 | 0 | 0 | 0 | 1072.535 | 218.186 | 1290.721 | 1290.721 |
| **12.5** | 0 | 0 | 0 | 0 | 0 | 2330.124 | 120.123 | 2450.247 | 2450.247 |
| **13** | 0 | 0 | 0 | 0 | 0 | 3087.286 | 0 | 3087.286 | 3087.286 |
| **13.5** | 0 | 0 | 0 | 0 | 0 | 1215.345 | 0 | 1215.345 | 1215.345 |
| **14** | 0 | 0 | 0 | 0 | 0 | 459.096 | 0 | 459.096 | 459.096 |
| **14.5** | 0 | 0 | 0 | 0 | 0 | 589.154 | 0 | 589.154 | 589.154 |
| **15** | 0.200 | 285.848 | 9.277 | 295.325 | 0 | 206.878 | 0 | 206.878 | 502.203 |
| **15.5** | 0.615 | 878.002 | 28.495 | 907.112 | 0 | 207.106 | 0 | 207.106 | 1114.218 |
| **16** | 0.996 | 1421.508 | 46.134 | 1468.638 | 0 | 0 | 0 | 0 | 1468.638 |
| **16.5** | 0.898 | 1281.413 | 41.587 | 1323.898 | 0 | 0 | 0 | 0 | 1323.898 |
| **17** | 1.077 | 1537.857 | 49.910 | 1588.844 | 0 | 156.644 | 0 | 156.644 | 1745.488 |
| **17.5** | 2.895 | 4132.683 | 134.123 | 4269.701 | 0.001 | 0 | 0 | 0.001 | 4269.702 |
| **18** | 6.301 | 8993.682 | 291.882 | 9291.865 | 0.002 | 0 | 0 | 0.002 | 9291.867 |
| **18.5** | 9.390 | 13402.640 | 434.971 | 13847.001 | 0.004 | 625.414 | 0 | 625.418 | 14472.419 |
| **19** | 4.649 | 6636.099 | 215.369 | 6856.117 | 0.002 | 228.153 | 0 | 228.155 | 7084.272 |
| **19.5** | 0.492 | 702.680 | 22.805 | 725.977 | 0 | 0 | 0 | 0 | 725.977 |
| **20** | 1.219 | 1739.902 | 56.467 | 1797.588 | 0 | 271.406 | 0 | 271.406 | 2068.994 |
| **20.5** | 0.591 | 843.128 | 27.363 | 871.082 | 0 | 0 | 0 | 0 | 871.082 |
| **TOTAL** | **29.323** | **41855.442** | **1358.383** | **43243.148** | **0.009** | **10866.760** | **8106.405** | **18973.174** | **62216.322** |

**Table 12.** *ECOCADIZ 2023-07* survey. Sardine (*S. pilchardus*). Estimated abundance (thousands of individuals) and biomass (t) by age group (years). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 12** and ordered from west to east.

| Age class | POL 01 | POL 02 | POL 03 | POL 04 | POL 05 | POL 06 | PT | ES | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| | N | N | N | N | N | N | N | N | N |
| 0 | 37 | 53410 | 1733 | 0.01 | 553890 | 893683 | 55181 | 1447573 | 1502754 |
| I | 201 | 286705 | 9305 | 0.08 | 17208 | 0 | 296211 | 17208 | 313419 |
| II | 236 | 336513 | 10921 | 0.09 | 11114 | 0 | 347670 | 11114 | 358784 |
| III | 45 | 64400 | 2090 | 0.02 | 1931 | 0 | 66535 | 1931 | 68466 |
| IV | 20 | 28006 | 909 | 0.01 | 1804 | 0 | 28934 | 1804 | 30738 |
| V | 13 | 18035 | 585 | 0.01 | 1208 | 0 | 18633 | 1208 | 19841 |
| TOTAL | 551 | 787069 | 25544 | 0.22 | 587155 | 893683 | 813164 | 1480838 | 2294002 |

| Age class | POL 01 | POL 02 | POL 03 | POL 04 | POL 05 | POL 06 | PT | ES | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| | B | B | B | B | B | B | B | B | B |
| 0 | 1 | 2003 | 65 | 0.001 | 9286 | 8106 | 2069 | 17392 | 19462 |
| I | 10 | 13683 | 444 | 0.004 | 576 | 0 | 14137 | 576 | 14713 |
| II | 13 | 19205 | 623 | 0.005 | 673 | 0 | 19842 | 673 | 20515 |
| III | 3 | 3694 | 120 | 0.001 | 115 | 0 | 3817 | 115 | 3932 |
| IV | 1 | 1917 | 62 | 0.001 | 126 | 0 | 1980 | 126 | 2107 |
| V | 1 | 1353 | 44 | 0 | 90 | 0 | 1398 | 90 | 1488 |
| TOTAL | 29 | 41856 | 1358 | 0.01 | 10867 | 8106 | 43243 | 18973 | 62217 |

**Table 13.** *ECOCADIZ 2023-07* survey. Sardine (*S. pilchardus*). Acoustic estimates of biomass (t) from the *ECOCADIZ* summer survey series and *PELAGO* spring survey series for the whole Gulf of Cádiz anchovy population. NA refers to when no survey was performed due to several technical or financial issues.

| Estimate/Year | Total Population Biomass (t) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** |
| ***ECOCADIZ*** | NA | NA | NA | NA | NA | NA | NA | NA | NA | 26568 | NA | 123849 | 86777 | NA | 37020 |
| ***PELAGO*** | 301000 | 260000 | 203000 | 162000 | 230000 | 181000 | 112000 | 286000 | 133000 | 39000 | 102000 | 129000 | 147000 | 61000 | 98000 |

**Table 13.** *ECOCADIZ 2023-07* survey. Sardine (*S. pilchardus*). Cont`d.

| Estimate/Year | Total Population Biomass (t) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2010** | **2011** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** |
| ***ECOCADIZ*** | 66964 | NA | 9670 | 8697 | 23460 | 26919 | 11053 | 114631 | 62682 | 50721 | NA | NA | 62216 |
| ***PELAGO*** | 37000 | 22000 | 30000 | 64227 | 16663 | 80356 | 38873 | 58561 | 60088 | 155017 | 114829 | 160473 | 75121 |

**Table 14.** *ECOCADIZ 2023-07* survey. Transparent goby (*Aphia minuta*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 14**.

| ***ECOBOCADEVA0723. Aphia minuta*. ABUNDANCE (in numbers and million fish)** | | | | | | |
|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **Spain** | **TOTAL** | **Millions** | |
| | | | | | **Spain** | **TOTAL** |
| **3** | 3233 | 72356 | 75589 | 75589 | 0.075589 | 0.075589 |
| **3.5** | 16166 | 506492 | 522658 | 522658 | 0.522658 | 0.522658 |
| **4** | 15089 | 361780 | 376869 | 376869 | 0.376869 | 0.376869 |
| **4.5** | 8622 | 1302407 | 1311029 | 1311029 | 1.311029 | 1.311029 |
| **5** | 5389 | 72356 | 77745 | 77745 | 0.077745 | 0.077745 |
| **TOTAL n** | 48499 | 2315391 | 2363890 | 2363890 | **2** | **2** |
| **Millions** | **0.05** | **2** | **2** | **2** | | |

| ***ECOBOCADEVA0723. Aphia minuta*. BIOMASS (t)** | | | | |
|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **Spain** | **TOTAL** |
| **3** | 0.001 | 0.012 | 0.013 | 0.013 |
| **3.5** | 0.004 | 0.130 | 0.134 | 0.134 |
| **4** | 0.006 | 0.137 | 0.143 | 0.143 |
| **4.5** | 0.005 | 0.698 | 0.703 | 0.703 |
| **5** | 0.004 | 0.053 | 0.057 | 0.057 |
| **TOTAL** | **0.020** | **1.030** | **1.050** | **1.050** |

**Tabla 15.** *ECOCADIZ 2023-07* survey. Atlantic mackerel (*Scomber scombrus*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.,* coherent or homogeneous post-strata) numbered as in **Figure 17**.

| ***ECOBOCADEVA0723. Scomber scombrus.* ABUNDANCE (in numbers and million fish)** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **Portugal** | **POL03** | **Spain** | **TOTAL** | **Millions** | | |
| | | | | | | | **Portugal** | **Spain** | **TOTAL** |
| **17** | 0 | 0 | 0 | 34607 | 34607 | 34607 | 0 | 0.034607 | 0.034607 |
| **17.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **18** | 580272 | 321 | 580593 | 0 | 0 | 580593 | 0.580593 | 0 | 0.580593 |
| **18.5** | 580272 | 321 | 580593 | 69214 | 69214 | 649807 | 0.580593 | 0.069214 | 0.649807 |
| **19** | 1160544 | 642 | 1161186 | 34607 | 34607 | 1195793 | 1.161186 | 0.034607 | 1.195793 |
| **19.5** | 696326 | 385 | 696711 | 34607 | 34607 | 731318 | 0.696711 | 0.034607 | 0.731318 |
| **20** | 928435 | 513 | 928948 | 0 | 0 | 928948 | 0.928948 | 0 | 0.928948 |
| **20.5** | 696326 | 385 | 696711 | 0 | 0 | 696711 | 0.696711 | 0 | 0.696711 |
| **21** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **21.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **22** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **22.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **23** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **23.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **24** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **24.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **25** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **25.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **26** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **26.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **27** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **27.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **28** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **28.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **29** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **29.5** | 0 | 0 | 0 | 92285 | 92285 | 92285 | 0 | 0.092285 | 0.092285 |
| **30** | 0 | 0 | 0 | 92285 | 92285 | 92285 | 0 | 0.092285 | 0.092285 |
| **30.5** | 0 | 0 | 0 | 403747 | 403747 | 403747 | 0 | 0.403747 | 0.403747 |
| **31** | 0 | 0 | 0 | 103821 | 103821 | 103821 | 0 | 0.103821 | 0.103821 |
| **31.5** | 0 | 0 | 0 | 103821 | 103821 | 103821 | 0 | 0.103821 | 0.103821 |
| **32** | 0 | 0 | 0 | 311462 | 311462 | 311462 | 0 | 0.311462 | 0.311462 |
| **32.5** | 0 | 0 | 0 | 276855 | 276855 | 276855 | 0 | 0.276855 | 0.276855 |
| **33** | 0 | 0 | 0 | 34607 | 34607 | 34607 | 0 | 0.034607 | 0.034607 |
| **33.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **34** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **34.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **35** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **35.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **36** | 0 | 0 | 0 | 34607 | 34607 | 34607 | 0 | 0.034607 | 0.034607 |
| **36.5** | 0 | 0 | 0 | 34607 | 34607 | 34607 | 0 | 0.034607 | 0.034607 |
| **TOTAL n** | 4642175 | 2567 | 4644742 | 1661132 | 1661132 | 6305874 | **5** | **2** | **6** |
| **Millions** | **5** | **0.003** | **5** | **2** | **2** | **6** | | | |

**Table 15.** *ECOCADIZ 2023-07* survey. Atlantic mackerel (*S. scombrus*). Cont'd.

| ***ECOBOCADEVA0723. Scomber scombrus.* BIOMASS (t)** | | | | | | |
|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **Portugal** | **POL03** | **Spain** | **TOTAL** |
| **17** | 0 | 0 | 0 | 1.046 | 1.046 | 1.046 |
| **17.5** | 0 | 0 | 0 | 0 | 0 | 0 |
| **18** | 21.371 | 0.012 | 21.383 | 0 | 0 | 21.383 |
| **18.5** | 23.499 | 0.013 | 23.512 | 2.803 | 2.803 | 26.315 |
| **19** | 51.549 | 0.029 | 51.578 | 1.537 | 1.537 | 53.115 |
| **19.5** | 33.844 | 0.019 | 33.863 | 1.682 | 1.682 | 35.545 |
| **20** | 49.268 | 0.027 | 49.295 | 0 | 0 | 49.295 |
| **20.5** | 40.256 | 0.022 | 40.278 | 0 | 0 | 40.278 |
| **21** | 0 | 0 | 0 | 0 | 0 | 0 |
| **21.5** | 0 | 0 | 0 | 0 | 0 | 0 |
| **22** | 0 | 0 | 0 | 0 | 0 | 0 |
| **22.5** | 0 | 0 | 0 | 0 | 0 | 0 |
| **23** | 0 | 0 | 0 | 0 | 0 | 0 |
| **23.5** | 0 | 0 | 0 | 0 | 0 | 0 |
| **24** | 0 | 0 | 0 | 0 | 0 | 0 |
| **24.5** | 0 | 0 | 0 | 0 | 0 | 0 |
| **25** | 0 | 0 | 0 | 0 | 0 | 0 |
| **25.5** | 0 | 0 | 0 | 0 | 0 | 0 |
| **26** | 0 | 0 | 0 | 0 | 0 | 0 |
| **26.5** | 0 | 0 | 0 | 0 | 0 | 0 |
| **27** | 0 | 0 | 0 | 0 | 0 | 0 |
| **27.5** | 0 | 0 | 0 | 0 | 0 | 0 |
| **28** | 0 | 0 | 0 | 0 | 0 | 0 |
| **28.5** | 0 | 0 | 0 | 0 | 0 | 0 |
| **29** | 0 | 0 | 0 | 0 | 0 | 0 |
| **29.5** | 0 | 0 | 0 | 18.911 | 18.911 | 18.911 |
| **30** | 0 | 0 | 0 | 20.051 | 20.051 | 20.051 |
| **30.5** | 0 | 0 | 0 | 92.925 | 92.925 | 92.925 |
| **31** | 0 | 0 | 0 | 25.288 | 25.288 | 25.288 |
| **31.5** | 0 | 0 | 0 | 26.738 | 26.738 | 26.738 |
| **32** | 0 | 0 | 0 | 84.738 | 84.738 | 84.738 |
| **32.5** | 0 | 0 | 0 | 79.505 | 79.505 | 79.505 |
| **33** | 0 | 0 | 0 | 10.481 | 10.481 | 10.481 |
| **33.5** | 0 | 0 | 0 | 0 | 0 | 0 |
| **34** | 0 | 0 | 0 | 0 | 0 | 0 |
| **34.5** | 0 | 0 | 0 | 0 | 0 | 0 |
| **35** | 0 | 0 | 0 | 0 | 0 | 0 |
| **35.5** | 0 | 0 | 0 | 0 | 0 | 0 |
| **36** | 0 | 0 | 0 | 14.197 | 14.197 | 14.197 |
| **36.5** | 0 | 0 | 0 | 14.897 | 14.897 | 14.897 |
| **TOTAL** | **219.787** | **0.122** | **219.909** | **394.799** | **394.799** | **614.708** |

**Table 16.** *ECOCADIZ 2023-07* survey. Chub mackerel (*Scomber colias*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 20.**

| ***ECOBOCADEVA0723. Scomber colias.* ABUNDANCE (in numbers and million fish)** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **POL03** | **POL04** | **POL05** | **Portugal** | **POL06** | **POL07** | **Spain** | **TOTAL** | **Millions** | | |
| | | | | | | | | | | | **Portugal** | **Spain** | **TOTAL** |
| **16.5** | 13684 | 0 | 508729 | 0 | 0 | 522413 | 0 | 0 | 0 | 522413 | 0.522413 | 0 | 0.522413 |
| **17** | 30434 | 0 | 1131392 | 6709732 | 680 | 7872238 | 1524 | 1900 | 3424 | 7875662 | 7.872238 | 0.003424 | 7.875662 |
| **17.5** | 165804 | 1110713 | 6163887 | 15428978 | 0 | 22869382 | 0 | 0 | 0 | 22869382 | 22.869382 | 0 | 22.869382 |
| **18** | 254083 | 0 | 9445730 | 16098816 | 2041 | 25800670 | 4571 | 5701 | 10272 | 25810942 | 25.80067 | 0.010272 | 25.810942 |
| **18.5** | 285994 | 1110713 | 10632026 | 17442276 | 680 | 29471689 | 1524 | 1900 | 3424 | 29475113 | 29.471689 | 0.003424 | 29.475113 |
| **19** | 241952 | 1110713 | 8994742 | 8049408 | 680 | 18397495 | 1524 | 1900 | 3424 | 18400919 | 18.397495 | 0.003424 | 18.400919 |
| **19.5** | 103391 | 5476966 | 3843618 | 3352974 | 0 | 12776949 | 0 | 0 | 0 | 12776949 | 12.776949 | 0 | 12.776949 |
| **20** | 69957 | 1110713 | 2600717 | 6036110 | 680 | 9818177 | 1524 | 1900 | 3424 | 9821601 | 9.818177 | 0.003424 | 9.821601 |
| **20.5** | 85119 | 3293840 | 3164349 | 2013298 | 680 | 8557286 | 1524 | 1900 | 3424 | 8560710 | 8.557286 | 0.003424 | 8.56071 |
| **21** | 47118 | 6549379 | 1751630 | 0 | 2041 | 8350168 | 4571 | 5701 | 10272 | 8360440 | 8.350168 | 0.010272 | 8.36044 |
| **21.5** | 42565 | 16392597 | 1582380 | 2013298 | 2041 | 20032881 | 4571 | 5701 | 10272 | 20043153 | 20.032881 | 0.010272 | 20.043153 |
| **22** | 50132 | 4366252 | 1863707 | 669838 | 680 | 6950609 | 1524 | 1900 | 3424 | 6954033 | 6.950609 | 0.003424 | 6.954033 |
| **22.5** | 13684 | 6549379 | 508729 | 669838 | 3401 | 7745031 | 7618 | 9502 | 17120 | 7762151 | 7.745031 | 0.01712 | 7.762151 |
| **23** | 9105 | 3293840 | 338500 | 669838 | 4082 | 4315365 | 9141 | 11402 | 20543 | 4335908 | 4.315365 | 0.020543 | 4.335908 |
| **23.5** | 0 | 4366252 | 0 | 0 | 0 | 4366252 | 0 | 0 | 0 | 4366252 | 4.366252 | 0 | 4.366252 |
| **24** | 0 | 0 | 0 | 0 | 680 | 680 | 1524 | 1900 | 3424 | 4104 | 0.00068 | 0.003424 | 0.004104 |
| **24.5** | 0 | 0 | 0 | 0 | 680 | 680 | 1524 | 1900 | 3424 | 4104 | 0.00068 | 0.003424 | 0.004104 |
| **25** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **25.5** | 0 | 0 | 0 | 0 | 680 | 680 | 1524 | 1900 | 3424 | 4104 | 0.00068 | 0.003424 | 0.004104 |
| **26** | 0 | 0 | 0 | 0 | 1361 | 1361 | 3047 | 3801 | 6848 | 8209 | 0.001361 | 0.006848 | 0.008209 |
| **26.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **27** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **27.5** | 0 | 1110713 | 0 | 0 | 0 | 1110713 | 0 | 0 | 0 | 1110713 | 1.110713 | 0 | 1.110713 |
| **TOTAL n** | 1413022 | 55842070 | 52530136 | 79154404 | 21087 | 188960719 | 47235 | 58908 | 106143 | 189066862 | **189** | **0.1** | **189** |
| **Millions** | **1** | **56** | **53** | **79** | **0.02** | **189** | **0.05** | **0.1** | **0.1** | **189** | | | |

**Tabla 16.** *ECOCADIZ 2023-07* survey. Chub mackerel (*S. colias*). Cont'd.

| ***ECOBOCADEVA0723. Scomber colias.* BIOMASS (t)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **POL03** | **POL04** | **POL05** | **Portugal** | **POL06** | **POL07** | **Spain** | **TOTAL** |
| **16.5** | 0.465 | 0 | 17.275 | 0 | 0 | 17.740 | 0 | 0 | 0 | 17.740 |
| **17** | 1.143 | 0 | 42.490 | 251.986 | 0.026 | 295.645 | 0.057 | 0.071 | 0.128 | 295.773 |
| **17.5** | 6.867 | 46.001 | 255.283 | 639.004 | 0 | 947.155 | 0 | 0 | 0 | 947.155 |
| **18** | 11.573 | 0 | 430.246 | 733.288 | 0.093 | 1175.200 | 0.208 | 0.260 | 0.468 | 1175.668 |
| **18.5** | 14.290 | 55.498 | 531.244 | 871.528 | 0.034 | 1472.594 | 0.076 | 0.095 | 0.171 | 1472.765 |
| **19** | 13.230 | 60.732 | 491.820 | 440.131 | 0.037 | 1005.950 | 0.083 | 0.104 | 0.187 | 1006.137 |
| **19.5** | 6.172 | 326.959 | 229.453 | 200.163 | 0 | 762.747 | 0 | 0 | 0 | 762.747 |
| **20** | 4.550 | 72.233 | 169.133 | 392.548 | 0.044 | 638.508 | 0.099 | 0.124 | 0.223 | 638.731 |
| **20.5** | 6.018 | 232.870 | 223.715 | 142.338 | 0.048 | 604.989 | 0.108 | 0.134 | 0.242 | 605.231 |
| **21** | 3.614 | 502.369 | 134.359 | 0 | 0.157 | 640.499 | 0.351 | 0.437 | 0.788 | 641.287 |
| **21.5** | 3.536 | 1361.629 | 131.438 | 167.232 | 0.170 | 1664.005 | 0.380 | 0.474 | 0.854 | 1664.859 |
| **22** | 4.501 | 392.032 | 167.336 | 60.143 | 0.061 | 624.073 | 0.137 | 0.171 | 0.308 | 624.381 |
| **22.5** | 1.326 | 634.547 | 49.289 | 64.898 | 0.330 | 750.390 | 0.738 | 0.921 | 1.659 | 752.049 |
| **23** | 0.950 | 343.794 | 35.331 | 69.914 | 0.426 | 450.415 | 0.954 | 1.190 | 2.144 | 452.559 |
| **23.5** | 0 | 490.172 | 0 | 0 | 0 | 490.172 | 0 | 0 | 0 | 490.172 |
| **24** | 0 | 0 | 0 | 0 | 0.082 | 0.082 | 0.184 | 0.229 | 0.413 | 0.495 |
| **24.5** | 0 | 0 | 0 | 0 | 0.088 | 0.088 | 0.197 | 0.246 | 0.443 | 0.531 |
| **25** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **25.5** | 0 | 0 | 0 | 0 | 0.101 | 0.101 | 0.226 | 0.281 | 0.507 | 0.608 |
| **26** | 0 | 0 | 0 | 0 | 0.215 | 0.215 | 0.482 | 0.601 | 1.083 | 1.298 |
| **26.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **27** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **27.5** | 0 | 212.487 | 0 | 0 | 0 | 212.487 | 0 | 0 | 0 | 212.487 |
| **TOTAL** | **78.235** | **4731.323** | **2908.412** | **4033.173** | **1.912** | **11753.055** | **4.280** | **5.338** | **9.618** | **11762.673** |

**Table 17.** *ECOCADIZ 2023-07* survey. Chub mackerel (*S. colias*). Estimated abundance (thousands of individuals) and biomass (t) by age group (years). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 22** and ordered from west to east.

| Age class | POL 01 | POL 02 | POL 03 | POL 04 | POL 05 | POL 06 | POL 07 | PT | ES | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| | N | N | N | N | N | N | N | N | N | N |
| 0 | 1222 | 17232 | 45412 | 73091 | 7 | 15 | 18 | 136964 | 33 | 136997 |
| I | 191 | 37499 | 7118 | 6063 | 13 | 29 | 37 | 50885 | 66 | 50951 |
| II | 0 | 1111 | 0 | 0 | 1 | 3 | 4 | 1112 | 7 | 1119 |
| III | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 1413 | 55842 | 52530 | 79154 | 21 | 47 | 59 | 188961 | 106 | 189067 |

| Age class | POL 01 | POL 02 | POL 03 | POL 04 | POL 05 | POL 06 | POL 07 | PT | ES | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| | B | B | B | B | B | B | B | B | B | B |
| 0 | 63 | 1150 | 2327 | 3541 | 0 | 1 | 1 | 7081 | 2 | 7083 |
| I | 16 | 3369 | 581 | 492 | 1 | 3 | 4 | 4459 | 7 | 4465 |
| II | 0 | 212 | 0 | 0 | 0 | 0 | 1 | 213 | 1 | 214 |
| III | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 78 | 4731 | 2908 | 4033 | 2 | 4 | 5 | 11752 | 10 | 11762 |

**Table 18**. *ECOCADIZ 2023-07* survey. Chub mackerel (*S. colias*). Acoustic estimates of biomass (t) from the *ECOCADIZ* summer survey series for the whole Gulf of Cádiz anchovy population. NA refers to when no survey was performed due to several technical or financial issues.

| **Estimate/Year** | **Total Population Biomass (t)** | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** |
| ***ECOCADIZ*** | 52440 | NA | 23994 | 61530 | NA | 56276 | 2861 | NA | NA | 31267 | 22258 | 21593 | 24918 | 21918 | 31811 | 32696 | 32854 | NA | NA | 11763 |

**Table 19.** *ECOCADIZ 2023-07* survey. Horse mackerel (*Trachurus trachurus*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.,* coherent or homogeneous post-strata) numbered as in **Figure 23**.

| ***ECOBOCADEVA0723. Trachurus trachurus.* ABUNDANCE (in numbers and million fish)** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **POL03** | **POL04** | **Portugal** | **POL05** | **Spain** | **TOTAL** | **Millions** | | |
| | | | | | | | | | **Portugal** | **Spain** | **TOTAL** |
| **7** | 0 | 0 | 0 | 0 | 0 | 106827 | 106827 | 106827 | 0 | 0.106827 | 0.106827 |
| **7.5** | 0 | 0 | 0 | 0 | 0 | 45783 | 45783 | 45783 | 0 | 0.045783 | 0.045783 |
| **8** | 0 | 0 | 0 | 0 | 0 | 320482 | 320482 | 320482 | 0 | 0.320482 | 0.320482 |
| **8.5** | 0 | 0 | 0 | 0 | 0 | 686747 | 686747 | 686747 | 0 | 0.686747 | 0.686747 |
| **9** | 0 | 0 | 0 | 0 | 0 | 854618 | 854618 | 854618 | 0 | 0.854618 | 0.854618 |
| **9.5** | 0 | 0 | 0 | 450903 | 450903 | 579920 | 579920 | 1030823 | 0.450903 | 0.57992 | 1.030823 |
| **10** | 0 | 791847 | 0 | 901806 | 1693653 | 579920 | 579920 | 2273573 | 1.693653 | 0.57992 | 2.273573 |
| **10.5** | 0 | 1583695 | 0 | 4959934 | 6543629 | 686747 | 686747 | 7230376 | 6.543629 | 0.686747 | 7.230376 |
| **11** | 0 | 791847 | 0 | 9468965 | 10260812 | 1007229 | 1007229 | 11268041 | 10.260812 | 1.007229 | 11.268041 |
| **11.5** | 0 | 2375542 | 0 | 4959934 | 7335476 | 534136 | 534136 | 7869612 | 7.335476 | 0.534136 | 7.869612 |
| **12** | 0 | 791847 | 0 | 3156322 | 3948169 | 534136 | 534136 | 4482305 | 3.948169 | 0.534136 | 4.482305 |
| **12.5** | 0 | 0 | 0 | 1803612 | 1803612 | 106827 | 106827 | 1910439 | 1.803612 | 0.106827 | 1.910439 |
| **13** | 0 | 0 | 0 | 2705419 | 2705419 | 0 | 0 | 2705419 | 2.705419 | 0 | 2.705419 |
| **13.5** | 0 | 0 | 0 | 450903 | 450903 | 0 | 0 | 450903 | 0.450903 | 0 | 0.450903 |
| **14** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **14.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **15** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **15.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **16** | 392564 | 0 | 0 | 0 | 392564 | 0 | 0 | 392564 | 0.392564 | 0 | 0.392564 |
| **16.5** | 785129 | 0 | 0 | 0 | 785129 | 0 | 0 | 785129 | 0.785129 | 0 | 0.785129 |
| **17** | 392564 | 0 | 0 | 0 | 392564 | 0 | 0 | 392564 | 0.392564 | 0 | 0.392564 |
| **17.5** | 1962821 | 1583695 | 0 | 0 | 3546516 | 0 | 0 | 3546516 | 3.546516 | 0 | 3.546516 |
| **18** | 1962821 | 791847 | 0 | 0 | 2754668 | 0 | 0 | 2754668 | 2.754668 | 0 | 2.754668 |
| **18.5** | 1570257 | 7918475 | 524 | 0 | 9489256 | 0 | 0 | 9489256 | 9.489256 | 0 | 9.489256 |
| **19** | 2355386 | 7126627 | 3142 | 0 | 9485155 | 0 | 0 | 9485155 | 9.485155 | 0 | 9.485155 |
| **19.5** | 785129 | 5542932 | 2095 | 0 | 6330156 | 0 | 0 | 6330156 | 6.330156 | 0 | 6.330156 |
| **20** | 785129 | 7126627 | 1047 | 0 | 7912803 | 0 | 0 | 7912803 | 7.912803 | 0 | 7.912803 |
| **20.5** | 0 | 1583695 | 524 | 0 | 1584219 | 0 | 0 | 1584219 | 1.584219 | 0 | 1.584219 |
| **21** | 785129 | 6334780 | 1571 | 0 | 7121480 | 0 | 0 | 7121480 | 7.12148 | 0 | 7.12148 |
| **21.5** | 1570257 | 3167390 | 1571 | 0 | 4739218 | 0 | 0 | 4739218 | 4.739218 | 0 | 4.739218 |
| **22** | 0 | 1583695 | 1047 | 0 | 1584742 | 0 | 0 | 1584742 | 1.584742 | 0 | 1.584742 |
| **22.5** | 0 | 1583695 | 2619 | 0 | 1586314 | 0 | 0 | 1586314 | 1.586314 | 0 | 1.586314 |
| **23** | 0 | 0 | 1571 | 0 | 1571 | 0 | 0 | 1571 | 0.001571 | 0 | 0.001571 |
| **23.5** | 0 | 791847 | 1571 | 0 | 793418 | 0 | 0 | 793418 | 0.793418 | 0 | 0.793418 |
| **24** | 392564 | 0 | 1047 | 0 | 393611 | 0 | 0 | 393611 | 0.393611 | 0 | 0.393611 |
| **24.5** | 0 | 791847 | 3142 | 0 | 794989 | 0 | 0 | 794989 | 0.794989 | 0 | 0.794989 |
| **25** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **25.5** | 0 | 0 | 1047 | 0 | 1047 | 0 | 0 | 1047 | 0.001047 | 0 | 0.001047 |
| **26** | 0 | 791847 | 1047 | 0 | 792894 | 0 | 0 | 792894 | 0.792894 | 0 | 0.792894 |
| **26.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **27** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **27.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **28** | 0 | 791847 | 0 | 0 | 791847 | 0 | 0 | 791847 | 0.791847 | 0 | 0.791847 |
| **TOTAL n** | 13739750 | 53845624 | 23565 | 28857798 | 96466737 | 6043372 | 6043372 | 102510109 | **96** | **6** | **103** |
| **Millions** | **14** | **54** | **0.02** | **29** | **96** | **6** | **6** | **103** | | | |

**Tabla 19.** *ECOCADIZ 2023-07* survey. Horse mackerel (*T. trachurus*). Cont'd.

| ***ECOBOCADEVA0723. Trachurus trachurus.* BIOMASS (t)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **POL03** | **POL04** | **Portugal** | **POL05** | **Spain** | **TOTAL** |
| **7** | 0 | 0 | 0 | 0 | 0 | 0.345 | 0.345 | 0.345 |
| **7.5** | 0 | 0 | 0 | 0 | 0 | 0.180 | 0.180 | 0.180 |
| **8** | 0 | 0 | 0 | 0 | 0 | 1.522 | 1.522 | 1.522 |
| **8.5** | 0 | 0 | 0 | 0 | 0 | 3.888 | 3.888 | 3.888 |
| **9** | 0 | 0 | 0 | 0 | 0 | 5.712 | 5.712 | 5.712 |
| **9.5** | 0 | 0 | 0 | 3.526 | 3.526 | 4.536 | 4.536 | 8.062 |
| **10** | 0 | 7.190 | 0 | 8.189 | 15.379 | 5.266 | 5.266 | 20.645 |
| **10.5** | 0 | 16.578 | 0 | 51.920 | 68.498 | 7.189 | 7.189 | 75.687 |
| **11** | 0 | 9.494 | 0 | 113.530 | 123.024 | 12.076 | 12.076 | 135.100 |
| **11.5** | 0 | 32.431 | 0 | 67.713 | 100.144 | 7.292 | 7.292 | 107.436 |
| **12** | 0 | 12.243 | 0 | 48.799 | 61.042 | 8.258 | 8.258 | 69.300 |
| **12.5** | 0 | 0 | 0 | 31.423 | 31.423 | 1.861 | 1.861 | 33.284 |
| **13** | 0 | 0 | 0 | 52.871 | 52.871 | 0 | 0 | 52.871 |
| **13.5** | 0 | 0 | 0 | 9.842 | 9.842 | 0 | 0 | 9.842 |
| **14** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **14.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **15** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **15.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **16** | 14.110 | 0 | 0 | 0 | 14.110 | 0 | 0 | 14.110 |
| **16.5** | 30.893 | 0 | 0 | 0 | 30.893 | 0 | 0 | 30.893 |
| **17** | 16.864 | 0 | 0 | 0 | 16.864 | 0 | 0 | 16.864 |
| **17.5** | 91.830 | 74.093 | 0 | 0 | 165.923 | 0 | 0 | 165.923 |
| **18** | 99.771 | 40.250 | 0 | 0 | 140.021 | 0 | 0 | 140.021 |
| **18.5** | 86.525 | 436.328 | 0.029 | 0 | 522.882 | 0 | 0 | 522.882 |
| **19** | 140.397 | 424.795 | 0.187 | 0 | 565.379 | 0 | 0 | 565.379 |
| **19.5** | 50.523 | 356.685 | 0.135 | 0 | 407.343 | 0 | 0 | 407.343 |
| **20** | 54.438 | 494.137 | 0.073 | 0 | 548.648 | 0 | 0 | 548.648 |
| **20.5** | 0 | 118.103 | 0.039 | 0 | 118.142 | 0 | 0 | 118.142 |
| **21** | 62.864 | 507.219 | 0.126 | 0 | 570.209 | 0 | 0 | 570.209 |
| **21.5** | 134.769 | 271.845 | 0.135 | 0 | 406.749 | 0 | 0 | 406.749 |
| **22** | 0 | 145.466 | 0.096 | 0 | 145.562 | 0 | 0 | 145.562 |
| **22.5** | 0 | 155.445 | 0.257 | 0 | 155.702 | 0 | 0 | 155.702 |
| **23** | 0 | 0 | 0.165 | 0 | 0.165 | 0 | 0 | 0.165 |
| **23.5** | 0 | 88.374 | 0.175 | 0 | 88.549 | 0 | 0 | 88.549 |
| **24** | 46.624 | 0 | 0.124 | 0 | 46.748 | 0 | 0 | 46.748 |
| **24.5** | 0 | 99.955 | 0.397 | 0 | 100.352 | 0 | 0 | 100.352 |
| **25** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **25.5** | 0 | 0 | 0.149 | 0 | 0.149 | 0 | 0 | 0.149 |
| **26** | 0 | 119.151 | 0.158 | 0 | 119.309 | 0 | 0 | 119.309 |
| **26.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **27** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **27.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **28** | 0 | 148.357 | 0 | 0 | 148.357 | 0 | 0 | 148.357 |
| **TOTAL** | **829.608** | **3558.139** | **2.245** | **387.813** | **4777.805** | **58.125** | **58.125** | **4835.930** |

**Tabla 20.** *ECOCADIZ 2023-07 s*urvey. Mediterranean horse mackerel (*Trachurus mediterraneus*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 26**.

| ***ECOBOCADEVA0723. Trachurus mediterraneus.*** **ABUNDANCE (in numbers and million fish)** | | | | | |
|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **Spain** | **TOTAL** | **Millions** | |
| | | | | **Spain** | **TOTAL** |
| **29** | 8468467 | 8468467 | 8468467 | 8.468467 | 8.468467 |
| **29.5** | 13173171 | 13173171 | 13173171 | 13.173171 | 13.173171 |
| **30** | 15055052 | 15055052 | 15055052 | 15.055052 | 15.055052 |
| **30.5** | 7527526 | 7527526 | 7527526 | 7.527526 | 7.527526 |
| **31** | 15055052 | 15055052 | 15055052 | 15.055052 | 15.055052 |
| **TOTAL n** | 59279268 | 59279268 | 59279268 | **59** | **59** |
| **Millions** | **59** | **59** | **59** | | |

| ***ECOBOCADEVA0723. Trachurus mediterraneus.*** **BIOMASS (t)** | | | |
|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **Spain** | **TOTAL** |
| **29** | 1552.632 | 1552.632 | 1581.632 |
| **29.5** | 2529.748 | 2529.748 | 2559.248 |
| **30** | 3025.917 | 3025.917 | 3055.917 |
| **30.5** | 1582.306 | 1582.306 | 1612.806 |
| **31** | 3307.272 | 3307.272 | 3338.272 |
| **TOTAL** | **11997.875** | **11997.875** | **12147.875** |

**Table 21.** *ECOCADIZ 2023-07* survey. Blue Jack mackerel (*Trachurus picturatus*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 29**.

| ***ECOBOCADEVA0723. Trachurus picturatus.* ABUNDANCE (in numbers and million fish)** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **Portugal** | **POL03** | **Spain** | **TOTAL** | **Millions** | | |
| | | | | | | | **Portugal** | **Spain** | **TOTAL** |
| **13.5** | 20683 | 5294 | 25977 | 88 | 88 | 26065 | 0.025977 | 0.000088 | 0.026065 |
| **14** | 20683 | 5294 | 25977 | 88 | 88 | 26065 | 0.025977 | 0.000088 | 0.026065 |
| **14.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **15** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **15.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **16** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **16.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **17** | 41366 | 10588 | 51954 | 175 | 175 | 52129 | 0.051954 | 0.000175 | 0.052129 |
| **17.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **18** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **18.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **19** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **19.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **20** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **20.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **21** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **21.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **22** | 5909 | 1513 | 7422 | 25 | 25 | 7447 | 0.007422 | 0.000025 | 0.007447 |
| **22.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **23** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **23.5** | 5909 | 1513 | 7422 | 25 | 25 | 7447 | 0.007422 | 0.000025 | 0.007447 |
| **24** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **24.5** | 5909 | 1513 | 7422 | 25 | 25 | 7447 | 0.007422 | 0.000025 | 0.007447 |
| **25** | 47275 | 12100 | 59375 | 200 | 200 | 59575 | 0.059375 | 0.0002 | 0.059575 |
| **25.5** | 11819 | 3025 | 14844 | 50 | 50 | 14894 | 0.014844 | 0.00005 | 0.014894 |
| **26** | 5909 | 1513 | 7422 | 25 | 25 | 7447 | 0.007422 | 0.000025 | 0.007447 |
| **TOTAL n** | 165462 | 42353 | 207815 | 701 | 701 | 208516 | **0.2** | **0.001** | **0.2** |
| **Millions** | **0.2** | **0.04** | **0.2** | **0.001** | **0.001** | **0.2** | | | |

**Table 21.** *ECOCADIZ 2023-07* survey. Blue Jack mackerel (*T. picturatus*). Cont'd.

| ***ECOBOCADEVA0723. Trachurus picturatus.* BIOMASS (t)** | | | | | | |
|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **Portugal** | **POL03** | **Spain** | **TOTAL** |
| **13.5** | 0.396 | 0.101 | 0.497 | 0.002 | 0.002 | 0.499 |
| **14** | 0.443 | 0.113 | 0.556 | 0.002 | 0.002 | 0.558 |
| **14.5** | 0 | 0 | 0 | 0 | 0 | 0 |
| **15** | 0 | 0 | 0 | 0 | 0 | 0 |
| **15.5** | 0 | 0 | 0 | 0 | 0 | 0 |
| **16** | 0 | 0 | 0 | 0 | 0 | 0 |
| **16.5** | 0 | 0 | 0 | 0 | 0 | 0 |
| **17** | 1.617 | 0.414 | 2.031 | 0.007 | 0.007 | 2.038 |
| **17.5** | 0 | 0 | 0 | 0 | 0 | 0 |
| **18** | 0 | 0 | 0 | 0 | 0 | 0 |
| **18.5** | 0 | 0 | 0 | 0 | 0 | 0 |
| **19** | 0 | 0 | 0 | 0 | 0 | 0 |
| **19.5** | 0 | 0 | 0 | 0 | 0 | 0 |
| **20** | 0 | 0 | 0 | 0 | 0 | 0 |
| **20.5** | 0 | 0 | 0 | 0 | 0 | 0 |
| **21** | 0 | 0 | 0 | 0 | 0 | 0 |
| **21.5** | 0 | 0 | 0 | 0 | 0 | 0 |
| **22** | 0.515 | 0.132 | 0.647 | 0.002 | 0.002 | 0.649 |
| **22.5** | 0 | 0 | 0 | 0 | 0 | 0 |
| **23** | 0 | 0 | 0 | 0 | 0 | 0 |
| **23.5** | 0.633 | 0.162 | 0.795 | 0.003 | 0.003 | 0.798 |
| **24** | 0 | 0 | 0 | 0 | 0 | 0 |
| **24.5** | 0.721 | 0.185 | 0.906 | 0.003 | 0.003 | 0.909 |
| **25** | 6.140 | 1.572 | 7.712 | 0.026 | 0.026 | 7.738 |
| **25.5** | 1.633 | 0.418 | 2.051 | 0.007 | 0.007 | 2.058 |
| **26** | 0.867 | 0.222 | 1.089 | 0.004 | 0.004 | 1.093 |
| **TOTAL** | **12.965** | **3.319** | **16.284** | **0.056** | **0.056** | **16.340** |

**Table 22.** *ECOCADIZ 2023-07* survey. Bogue (*Boops boops*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 32.**

| ***ECOBOCADEVA0723. Boops boops.* ABUNDANCE (in numbers and million fish)** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **POL03** | **Portugal** | **TOTAL** | **Millions** | |
| | | | | | | **Portugal** | **TOTAL** |
| **19.5** | 645 | 213485 | 3703 | 217833 | 217833 | 0.217833 | 0.217833 |
| **20** | 1935 | 640455 | 11109 | 653499 | 653499 | 0.653499 | 0.653499 |
| **20.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **21** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **21.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **22** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **22.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **23** | 1290 | 426970 | 7406 | 435666 | 435666 | 0.435666 | 0.435666 |
| **23.5** | 1290 | 426970 | 7406 | 435666 | 435666 | 0.435666 | 0.435666 |
| **24** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **24.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **25** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **25.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **26** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **26.5** | 2580 | 853940 | 14812 | 871332 | 871332 | 0.871332 | 0.871332 |
| **TOTAL n** | 7740 | 2561820 | 44436 | 2613996 | 2613996 | **3** | **3** |
| **Millions** | **0.01** | **3** | **0.04** | **3** | **3** | | |

| *ECOBOCADEVA0723. Boops boops.* BIOMASS (t) | | | | | |
|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **POL02** | **POL03** | **Portugal** | **TOTAL** |
| **19.5** | 0.045 | 14.838 | 0.257 | 15.140 | 15.140 |
| **20** | 0.145 | 48.007 | 0.833 | 48.985 | 48.985 |
| **20.5** | 0 | 0 | 0 | 0 | 0 |
| **21** | 0 | 0 | 0 | 0 | 0 |
| **21.5** | 0 | 0 | 0 | 0 | 0 |
| **22** | 0 | 0 | 0 | 0 | 0 |
| **22.5** | 0 | 0 | 0 | 0 | 0 |
| **23** | 0.147 | 48.590 | 0.843 | 49.580 | 49.580 |
| **23.5** | 0.157 | 51.817 | 0.899 | 52.873 | 52.873 |
| **24** | 0 | 0 | 0 | 0 | 0 |
| **24.5** | 0 | 0 | 0 | 0 | 0 |
| **25** | 0 | 0 | 0 | 0 | 0 |
| **25.5** | 0 | 0 | 0 | 0 | 0 |
| **26** | 0 | 0 | 0 | 0 | 0 |
| **26.5** | 0.449 | 148.47 | 2.575 | 151.494 | 151.494 |
| **TOTAL** | **0.943** | **311.722** | **5.407** | **318.072** | **318.072** |

**Table 23.** *ECOCADIZ 2023-07* survey. Pearlside (*Maurolicus muelleri*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 35**.

| ***ECOBOCADEVA0723. Maurolicus muelleri*. ABUNDANCE (in numbers and million fish)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **Portugal** | **POL02** | **POL03** | **POL04** | **POL05** | **POL06** | **Spain** | **TOTAL** | **Millions** | | |
| | | | | | | | | | | **Portugal** | **Spain** | **TOTAL** |
| **0.5** | 294784 | 294784 | 248118 | 1748667 | 9569 | 868792 | 233247 | 3108393 | 3403177 | 0.294784 | 3.108393 | 3.403177 |
| **1** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **1.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **2** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **2.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **3** | 294784 | 294784 | 248118 | 1748667 | 9569 | 868792 | 233247 | 3108393 | 3403177 | 0.294784 | 3.108393 | 3.403177 |
| **3.5** | 294784 | 294784 | 248118 | 1748667 | 9569 | 868792 | 233247 | 3108393 | 3403177 | 0.294784 | 3.108393 | 3.403177 |
| **4** | 4605992 | 4605992 | 3876843 | 27322924 | 149523 | 13574868 | 3644491 | 48568649 | 53174641 | 4.605992 | 48.568649 | 53.174641 |
| **4.5** | 11938732 | 11938732 | 10048778 | 70821019 | 387564 | 35186057 | 9446520 | 125889938 | 137828670 | 11.938732 | 125.889938 | 137.82867 |
| **5** | 3353162 | 3353162 | 2822342 | 19891089 | 108853 | 9882504 | 2653189 | 35357977 | 38711139 | 3.353162 | 35.357977 | 38.711139 |
| **5.5** | 4605992 | 4605992 | 3876843 | 27322924 | 149523 | 13574868 | 3644491 | 48568649 | 53174641 | 4.605992 | 48.568649 | 53.174641 |
| **6** | 1547613 | 1547613 | 1302619 | 9180502 | 50240 | 4561156 | 1224549 | 16319066 | 17866679 | 1.547613 | 16.319066 | 17.866679 |
| **6.5** | 294784 | 294784 | 248118 | 1748667 | 9569 | 868792 | 233247 | 3108393 | 3403177 | 0.294784 | 3.108393 | 3.403177 |
| **TOTAL n** | 27230627 | 27230627 | 22919897 | 161533126 | 883979 | 80254621 | 21546228 | 287137851 | 314368478 | **27** | **287** | **314** |
| **Millions** | **27** | **27** | **23** | **162** | **1** | **80** | **22** | **287** | **314** | | | |

| ***ECOBOCADEVA0723. Maurolicus muelleri*. BIOMASS (t)** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **Portugal** | **POL02** | **POL03** | **POL04** | **POL05** | **POL06** | **Spain** | **TOTAL** |
| **0.5** | 0.002 | 0.002 | 0.001 | 0.009 | 0 | 0.005 | 0.001 | 0.016 | 0.018 |
| **1** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **1.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **2** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **2.5** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **3** | 0.100 | 0.100 | 0.084 | 0.59 | 0.003 | 0.293 | 0.079 | 1.049 | 1.149 |
| **3.5** | 0.149 | 0.149 | 0.125 | 0.883 | 0.005 | 0.439 | 0.118 | 1.570 | 1.719 |
| **4** | 3.311 | 3.311 | 2.787 | 19.64 | 0.107 | 9.758 | 2.620 | 34.912 | 38.223 |
| **4.5** | 11.739 | 11.739 | 9.881 | 69.638 | 0.381 | 34.598 | 9.289 | 123.787 | 135.526 |
| **5** | 4.371 | 4.371 | 3.679 | 25.929 | 0.142 | 12.882 | 3.459 | 46.091 | 50.462 |
| **5.5** | 7.758 | 7.758 | 6.53 | 46.021 | 0.252 | 22.865 | 6.139 | 81.807 | 89.565 |
| **6** | 3.297 | 3.297 | 2.775 | 19.557 | 0.107 | 9.717 | 2.609 | 34.765 | 38.062 |
| **6.5** | 0.780 | 0.780 | 0.657 | 4.627 | 0.025 | 2.299 | 0.617 | 8.225 | 9.005 |
| **TOTAL** | **31.507** | **31.507** | **26.519** | **186.894** | **1.022** | **92.856** | **24.931** | **332.222** | **363.729** |

**Table 24.** *ECOCADIZ 2023-07* survey. Longspine snipefish (*Macroramphosus scolopax*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 38**.

| ***ECOBOCADEVA0723. Macroramphosus scolopax.* ABUNDANCE (in numbers and million fish)** | | | | | |
|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **Portugal** | **TOTAL** | **Millions** | |
| | | | | **Portugal** | **TOTAL** |
| **7** | 259463 | 259463 | 259463 | 0.259463 | 0.259463 |
| **7.5** | 667344 | 667344 | 667344 | 0.667344 | 0.667344 |
| **8** | 444896 | 444896 | 444896 | 0.444896 | 0.444896 |
| **8.5** | 444896 | 444896 | 444896 | 0.444896 | 0.444896 |
| **9** | 222448 | 222448 | 222448 | 0.222448 | 0.222448 |
| **9.5** | 926807 | 926807 | 926807 | 0.926807 | 0.926807 |
| **10** | 259463 | 259463 | 259463 | 0.259463 | 0.259463 |
| **10.5** | 518925 | 518925 | 518925 | 0.518925 | 0.518925 |
| **11** | 2187105 | 2187105 | 2187105 | 2.187105 | 2.187105 |
| **11.5** | 4347307 | 4347307 | 4347307 | 4.347307 | 4.347307 |
| **12** | 4866233 | 4866233 | 4866233 | 4.866233 | 4.866233 |
| **12.5** | 9038579 | 9038579 | 9038579 | 9.038579 | 9.038579 |
| **13** | 10039415 | 10039415 | 10039415 | 10.039415 | 10.039415 |
| **13.5** | 7174854 | 7174854 | 7174854 | 7.174854 | 7.174854 |
| **14** | 4013816 | 4013816 | 4013816 | 4.013816 | 4.013816 |
| **14.5** | 6507509 | 6507509 | 6507509 | 6.507509 | 6.507509 |
| **15** | 3939426 | 3939426 | 3939426 | 3.939426 | 3.939426 |
| **15.5** | 1223284 | 1223284 | 1223284 | 1.223284 | 1.223284 |
| **16** | 778388 | 778388 | 778388 | 0.778388 | 0.778388 |
| **16.5** | 259463 | 259463 | 259463 | 0.259463 | 0.259463 |
| **TOTAL n** | 58119621 | 58119621 | 58119621 | **58** | **58** |
| **Millions** | **58** | **58** | **58** | | |

| ***ECOBOCADEVA0723. Macroramphosus scolopax.* BIOMASS (t)** | | | |
|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **Portugal** | **TOTAL** |
| **7** | 0.656 | 0.656 | 0.656 |
| **7.5** | 2.055 | 2.055 | 2.055 |
| **8** | 1.648 | 1.648 | 1.648 |
| **8.5** | 1.962 | 1.962 | 1.962 |
| **9** | 1.156 | 1.156 | 1.156 |
| **9.5** | 5.628 | 5.628 | 5.628 |
| **10** | 1.826 | 1.826 | 1.826 |
| **10.5** | 4.205 | 4.205 | 4.205 |
| **11** | 20.274 | 20.274 | 20.274 |
| **11.5** | 45.829 | 45.829 | 45.829 |
| **12** | 58.026 | 58.026 | 58.026 |
| **12.5** | 121.310 | 121.310 | 121.310 |
| **13** | 150.973 | 150.973 | 150.973 |
| **13.5** | 120.384 | 120.384 | 120.384 |
| **14** | 74.847 | 74.847 | 74.847 |
| **14.5** | 134.375 | 134.375 | 134.375 |
| **15** | 89.772 | 89.772 | 89.772 |
| **15.5** | 30.666 | 30.666 | 30.666 |
| **16** | 21.402 | 21.402 | 21.402 |
| **16.5** | 7.803 | 7.803 | 7.803 |
| **TOTAL** | **894.797** | **894.797** | 894.797 |

**Table 25.** *ECOCADIZ 2023-07* survey. Boarfish (*Capros aper*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 41**.

| ***ECOBOCADEVA0723. Capros aper.*** **ABUNDANCE (in numbers and million fish)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **Portugal** | **POL02** | **Spain** | **TOTAL** | **Millions** | | |
| | | | | | | **Portugal** | **Spain** | **TOTAL** |
| **5** | 760089 | 760089 | 9912 | 9912 | 770001 | 0.760089 | 0.009912 | 0.770001 |
| **5.5** | 380044 | 380044 | 4956 | 4956 | 385000 | 0.380044 | 0.004956 | 0.385 |
| **6** | 1900222 | 1900222 | 24781 | 24781 | 1925003 | 1.900222 | 0.024781 | 1.925003 |
| **6.5** | 760089 | 760089 | 9912 | 9912 | 770001 | 0.760089 | 0.009912 | 0.770001 |
| **7** | 1900222 | 1900222 | 24781 | 24781 | 1925003 | 1.900222 | 0.024781 | 1.925003 |
| **7.5** | 380044 | 380044 | 4956 | 4956 | 385000 | 0.380044 | 0.004956 | 0.385 |
| **8** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **8.5** | 2280266 | 2280266 | 29737 | 29737 | 2310003 | 2.280266 | 0.029737 | 2.310003 |
| **9** | 4180488 | 4180488 | 54517 | 54517 | 4235005 | 4.180488 | 0.054517 | 4.235005 |
| **9.5** | 8741021 | 8741021 | 113991 | 113991 | 8855012 | 8.741021 | 0.113991 | 8.855012 |
| **10** | 3800444 | 3800444 | 49561 | 49561 | 3850005 | 3.800444 | 0.049561 | 3.850005 |
| **10.5** | 760089 | 760089 | 9912 | 9912 | 770001 | 0.760089 | 0.009912 | 0.770001 |
| **TOTAL n** | 25843018 | 25843018 | 337016 | 337016 | 26180034 | **26** | **0.3** | **26** |
| **Millions** | **26** | **26** | **0.3** | **0.3** | **26** | | | |

| ***ECOBOCADEVA0723. Capros aper.*** **BIOMASS (t)** | | | | | |
|---|---|---|---|---|---|
| **SIZE CLASS (cm)** | **POL01** | **Portugal** | **POL02** | **Spain** | **TOTAL** |
| **5** | 2.254 | 2.254 | 0.029 | 0.029 | 2.283 |
| **5.5** | 1.503 | 1.503 | 0.020 | 0.020 | 1.523 |
| **6** | 9.785 | 9.785 | 0.128 | 0.128 | 9.913 |
| **6.5** | 4.993 | 4.993 | 0.065 | 0.065 | 5.058 |
| **7** | 15.650 | 15.650 | 0.204 | 0.204 | 15.854 |
| **7.5** | 3.865 | 3.865 | 0.050 | 0.050 | 3.915 |
| **8** | 0 | 0 | 0 | 0 | 0 |
| **8.5** | 34.052 | 34.052 | 0.444 | 0.444 | 34.496 |
| **9** | 74.430 | 74.430 | 0.971 | 0.971 | 75.401 |
| **9.5** | 183.837 | 183.837 | 2.397 | 2.397 | 186.234 |
| **10** | 93.634 | 93.634 | 1.221 | 1.221 | 94.855 |
| **10.5** | 21.773 | 21.773 | 0.284 | 0.284 | 22.057 |
| **TOTAL** | **445.776** | **445.776** | **5.813** | **5.813** | **451.589** |

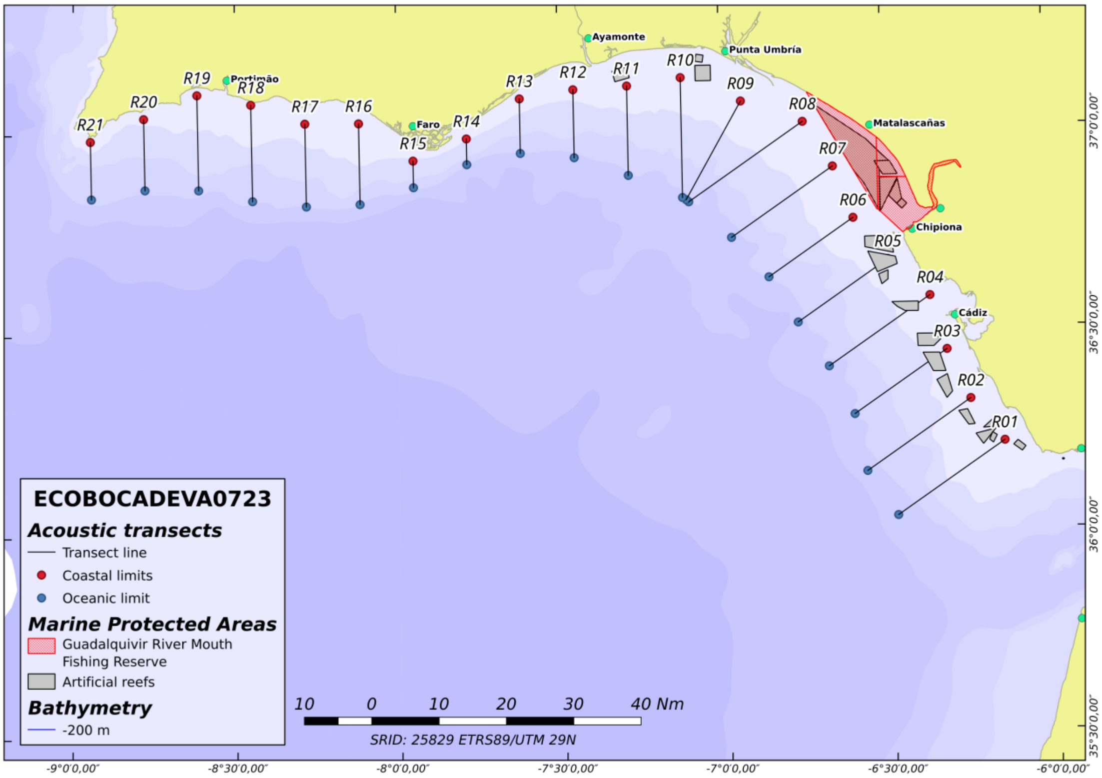



**Figure 1.** *ECOCADIZ 2023-07* survey. Location of the acoustic transects sampled during the survey. The different protected areas inside the Guadalquivir river mouth Fishing Reserve and artificial reef polygons are also shown.

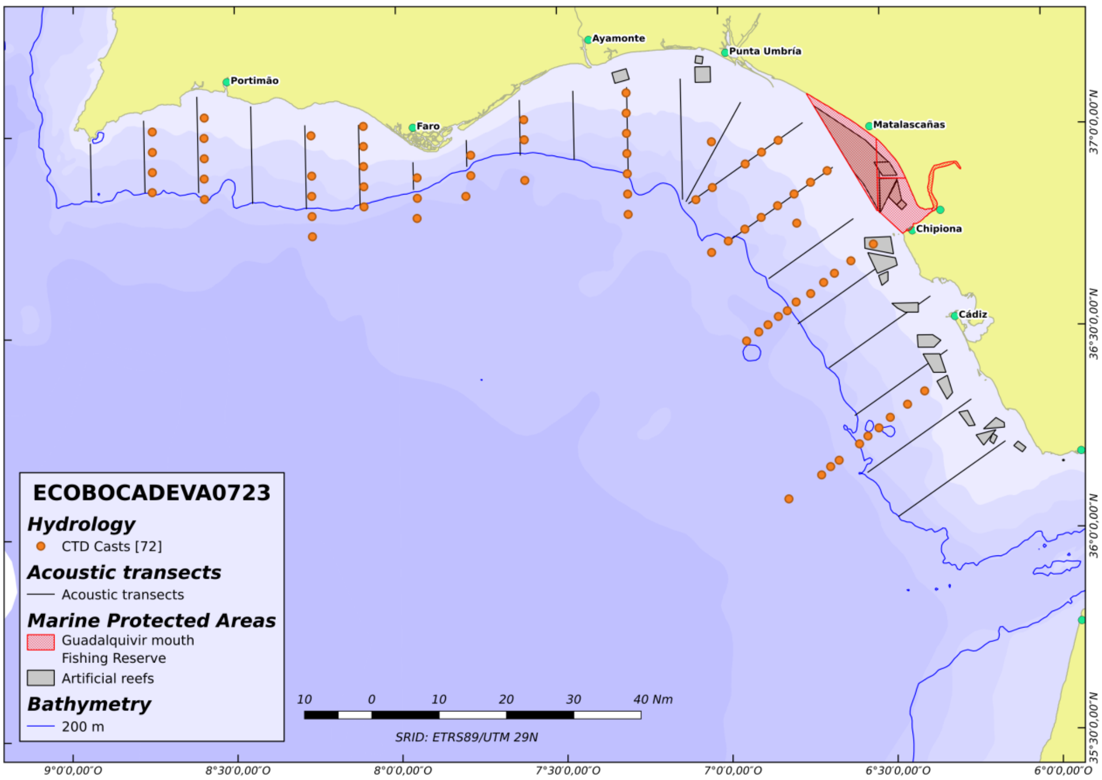



**Figure 2.** *ECOCADIZ 2023-07* survey. Location of CTD-LADCP sampling stations.

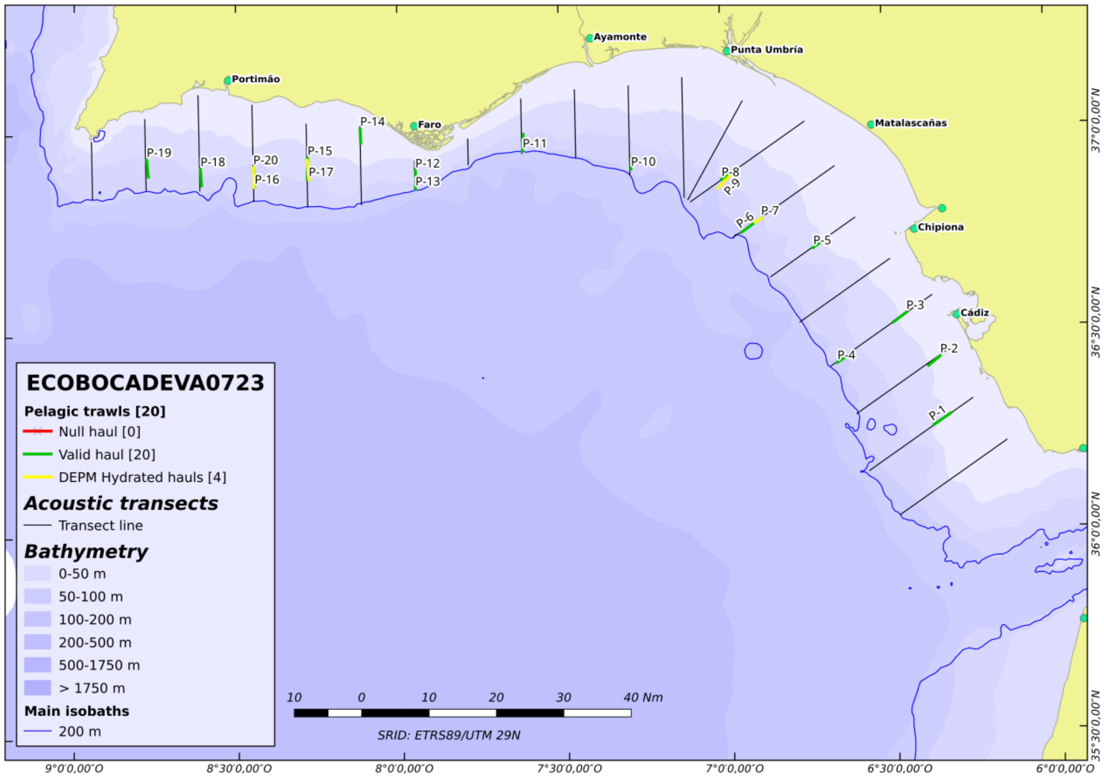



**Figure 3.** *ECOCADIZ 2023-07* survey. Location of ground-truthing fishing hauls.

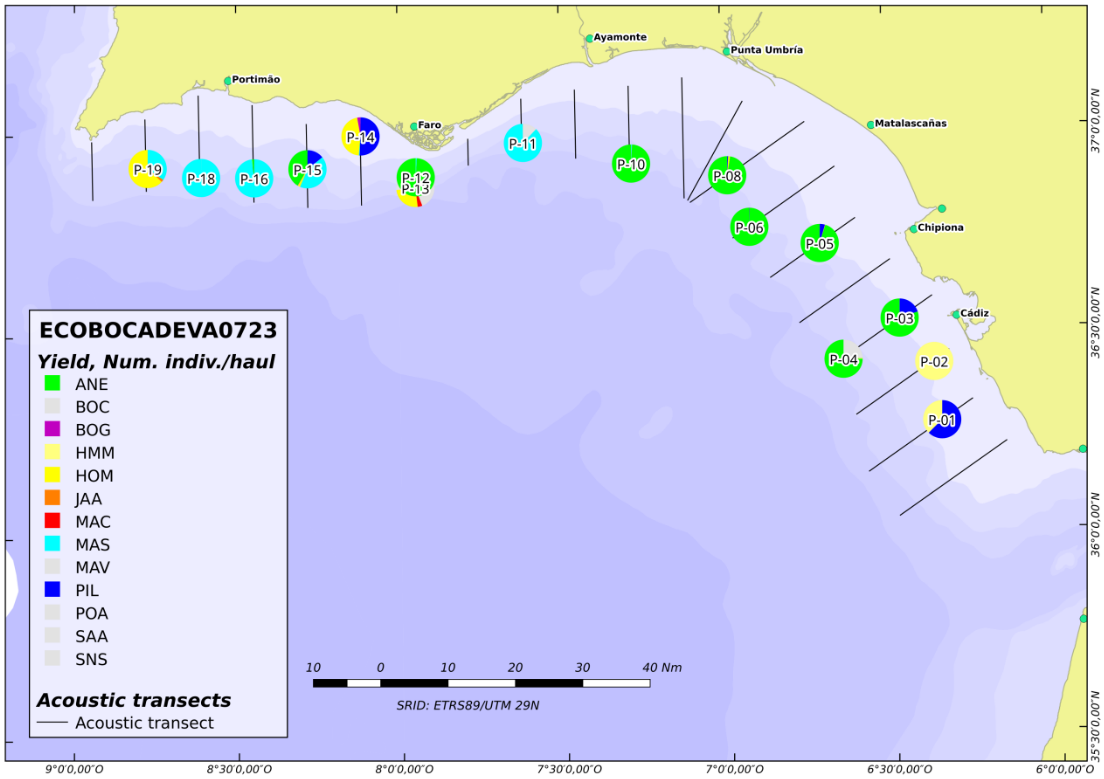



**Figure 4.** *ECOCADIZ 2023-07* survey. Species composition (percentages in number) in valid hauls.

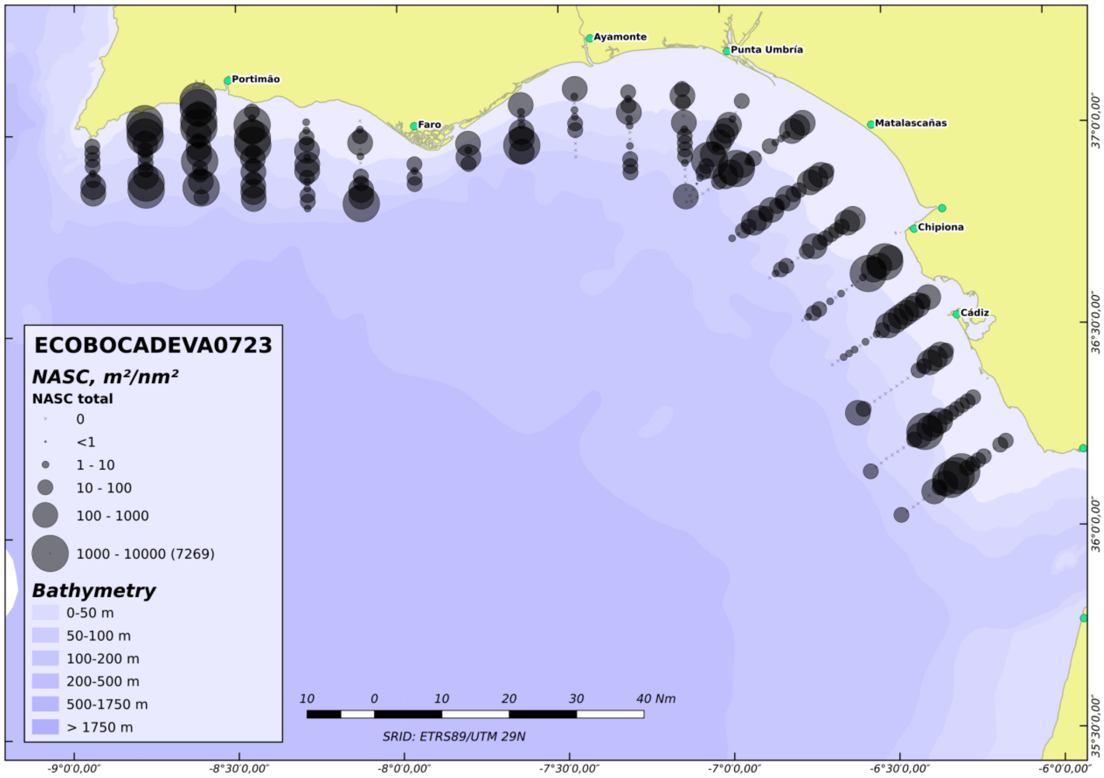



**Figure 5.** *ECOCADIZ 2023-07* survey. Distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2nmi^{-2}$) attributed to the pelagic fish species assemblage.

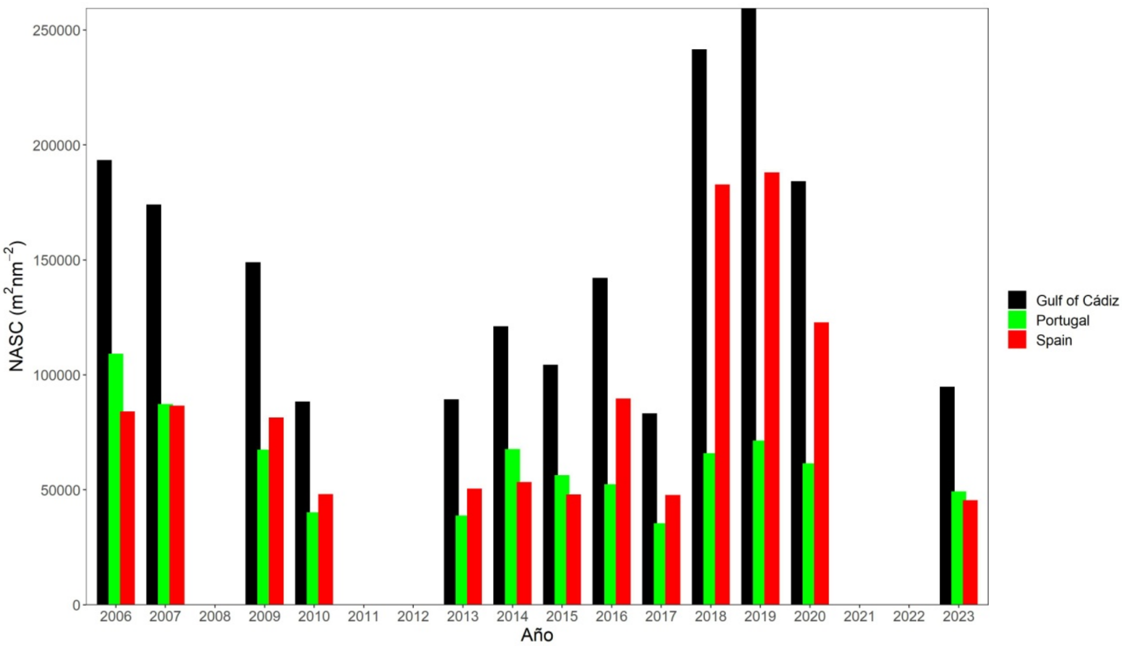
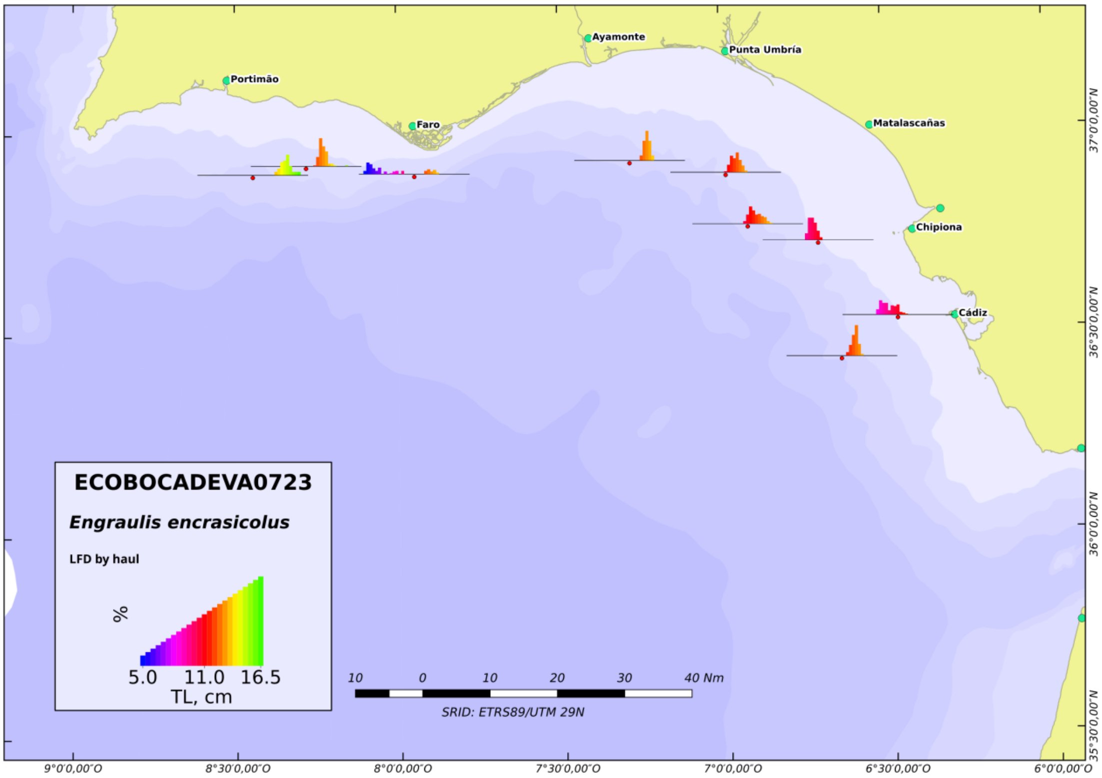



**Figure 6.** *ECOCADIZ 2023-07* survey. Time-series of NASC by total area, Spain and Portugal.



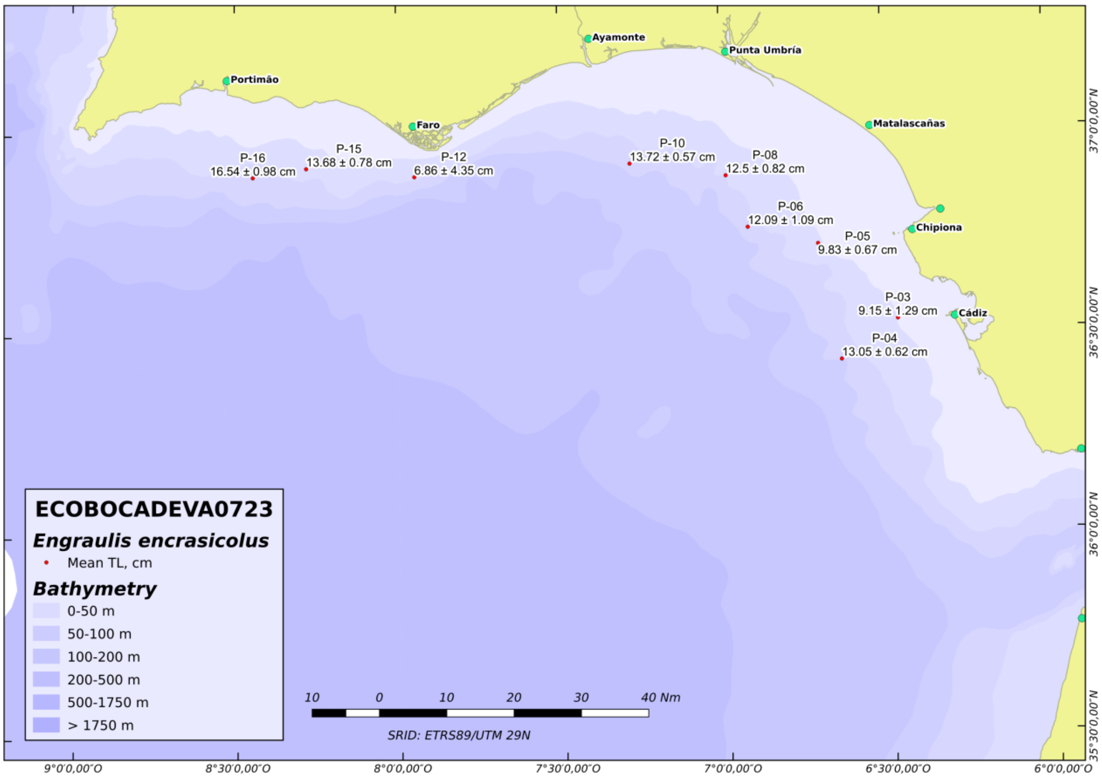




**Figure 7.** *ECOCADIZ 2023-07* survey. Anchovy (*Engraulis encrasicolus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

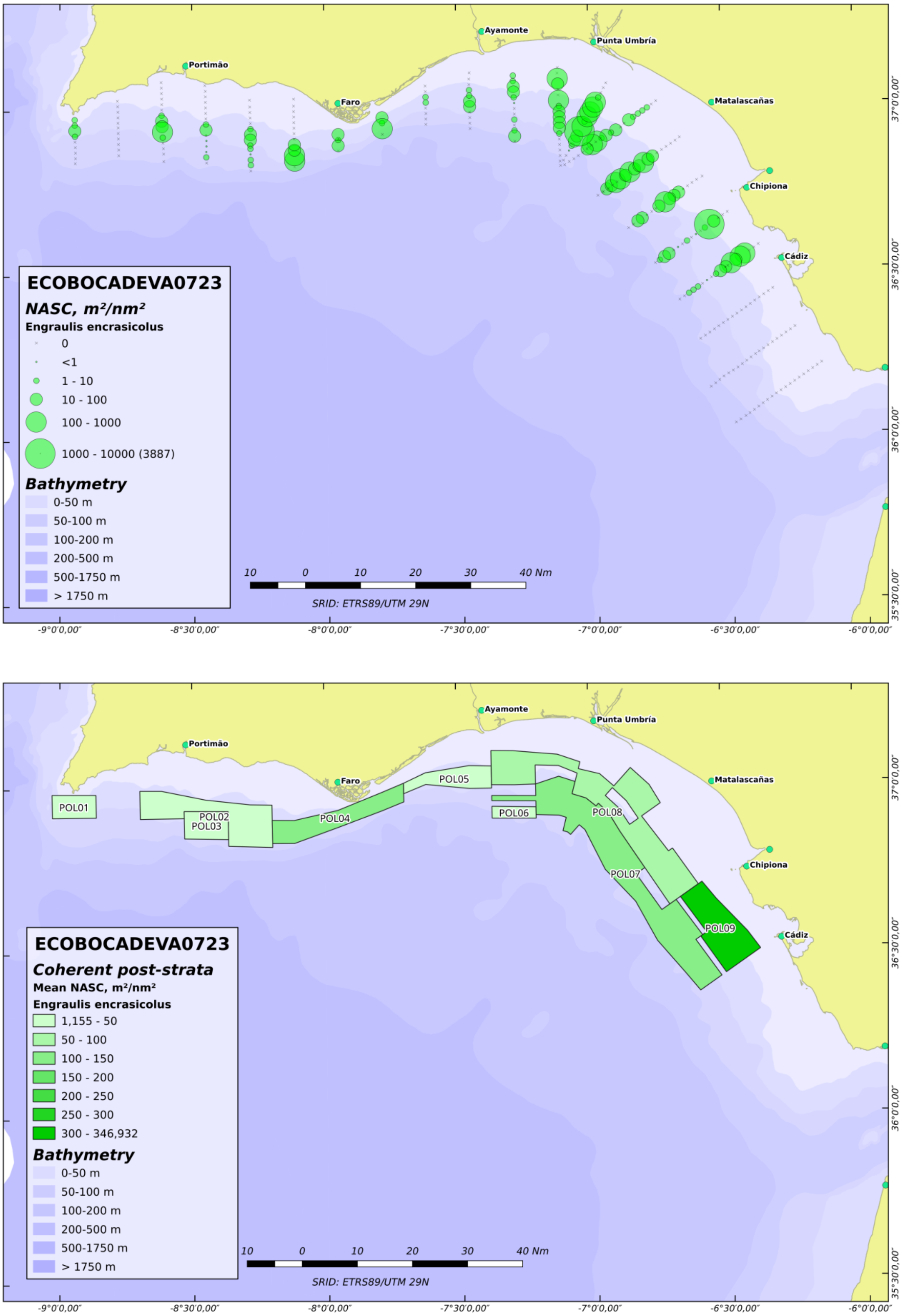



**Figure 8.** *ECOCADIZ 2023-07* survey. Anchovy (*E. encrasicolus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

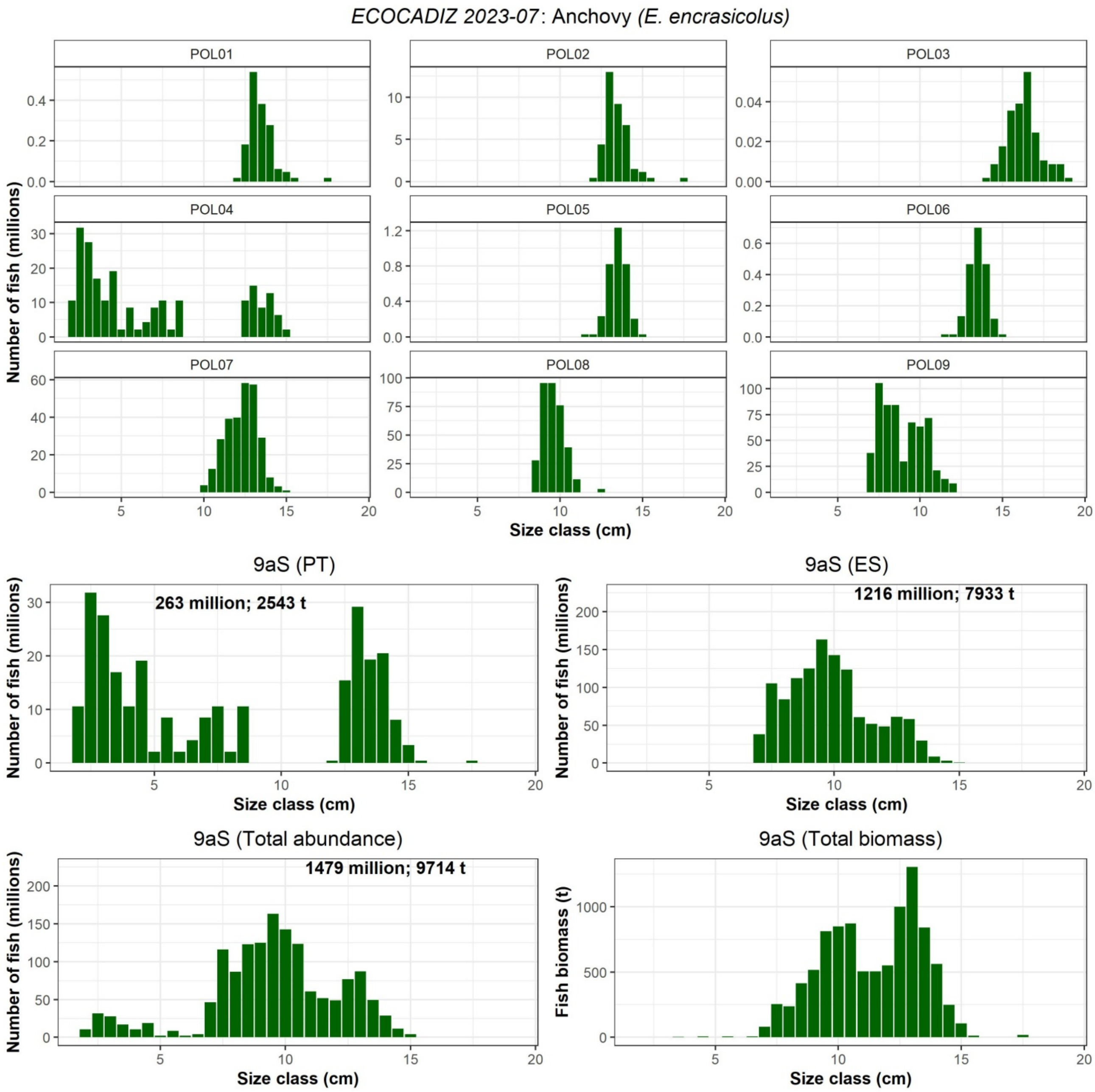



**Figure 9.** *ECOCADIZ 2023-07* survey. Anchovy *(E. encrasicolus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 8**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the *y* axis.

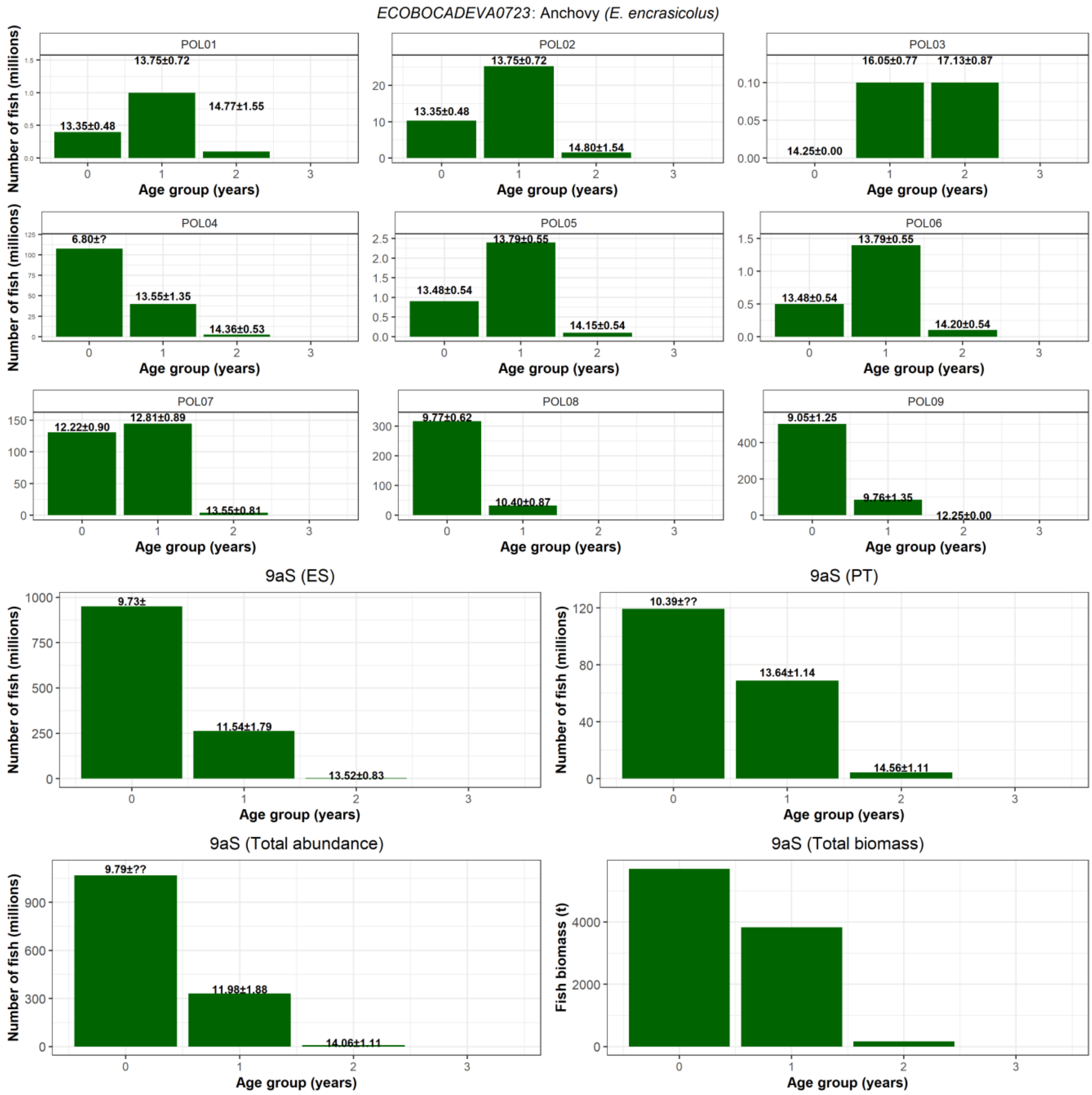
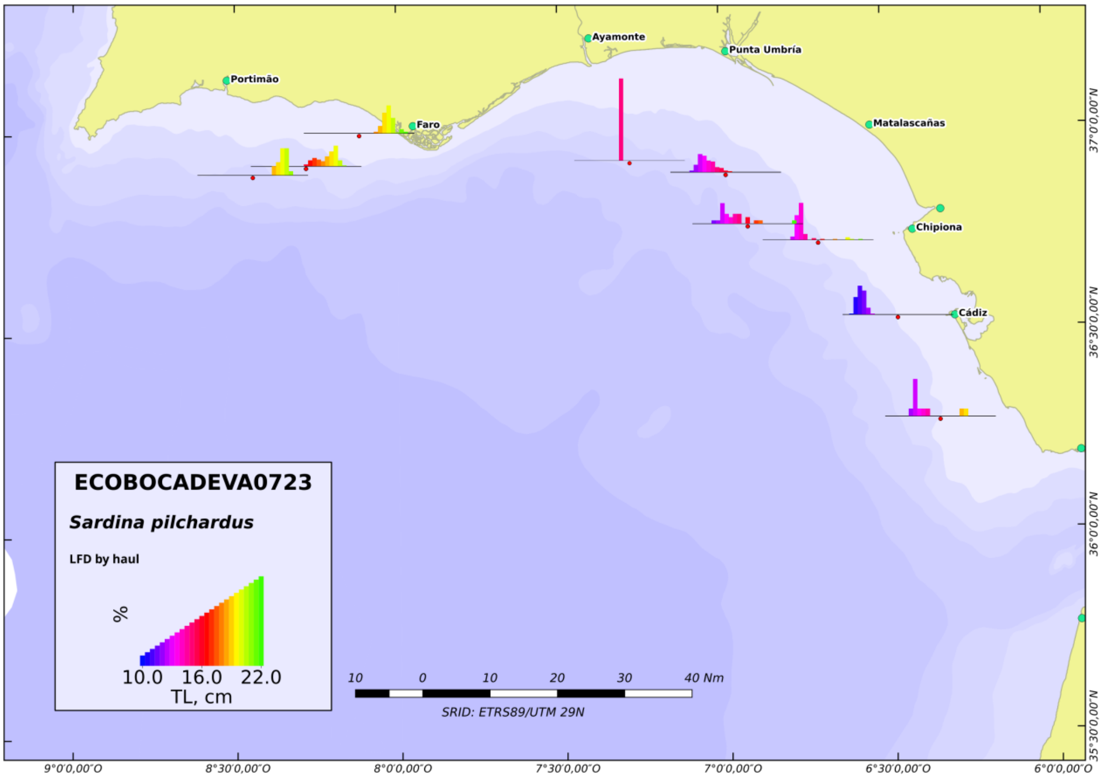



**Figure 10.** *ECOCADIZ 2023-07* survey. Anchovy *(E. encrasicolus*). Estimated abundances (number of fish in millions) by age group (years) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 8**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by age group for the whole sampled area is also shown for comparison. Note the different scale in the *y* axis.



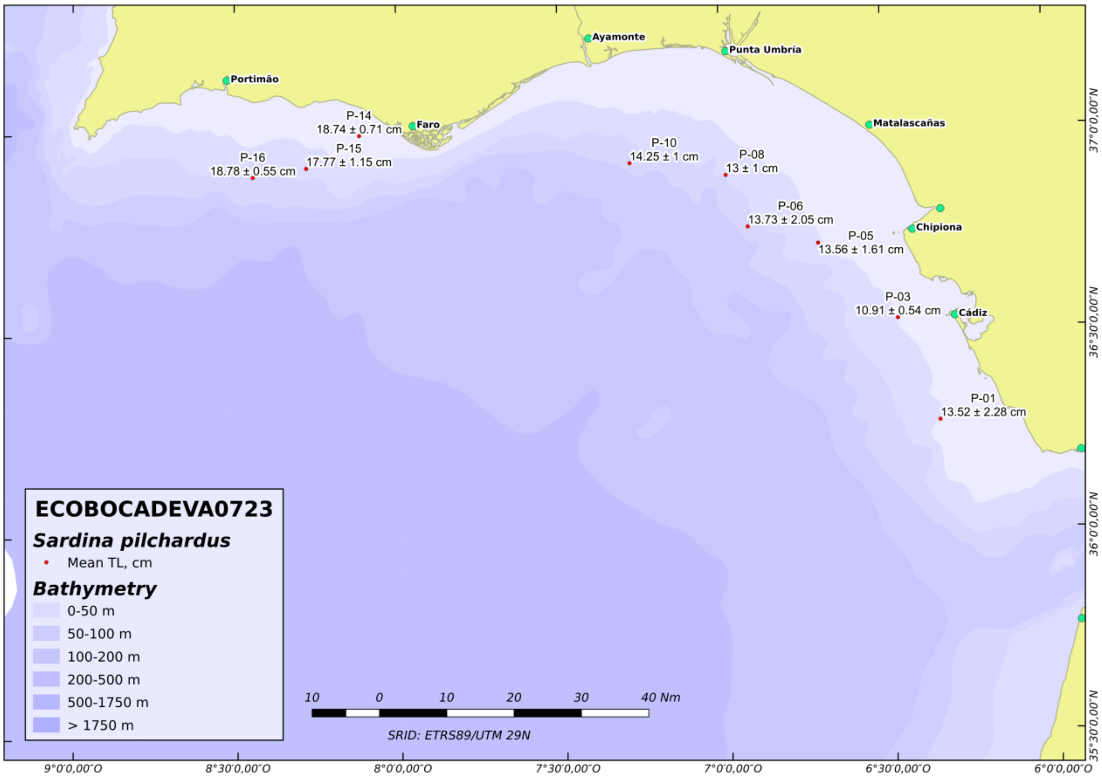
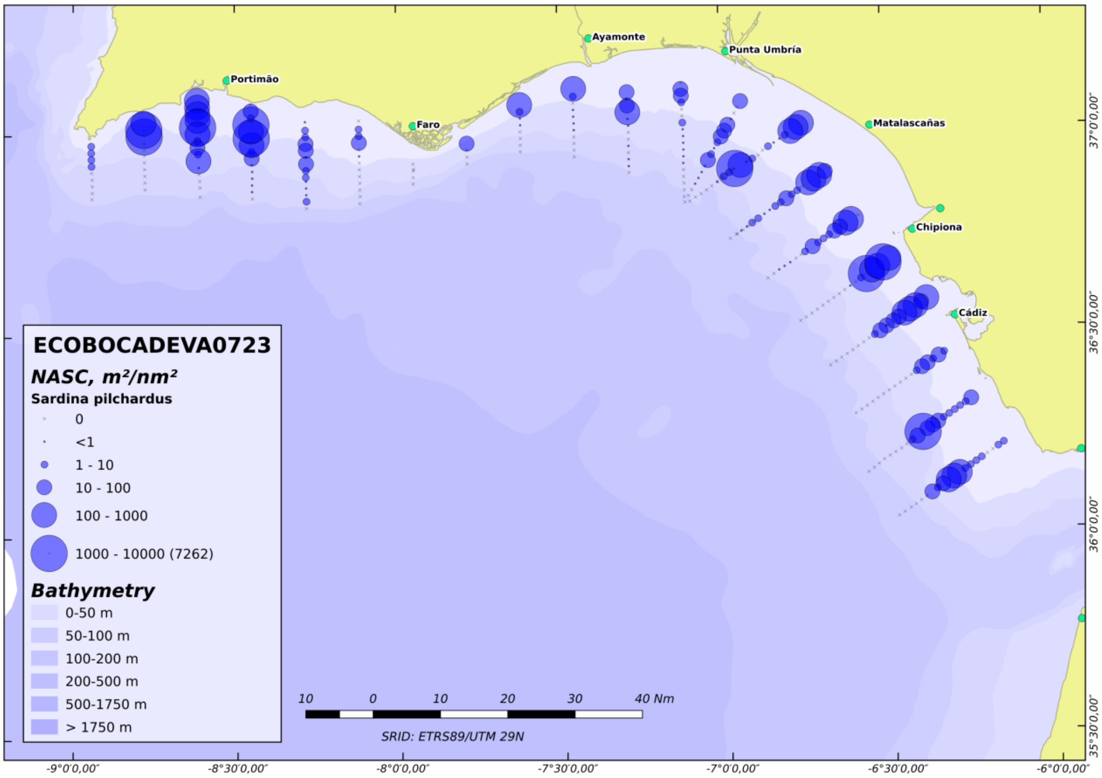




**Figure 11.** *ECOCADIZ 2023-07* survey. Sardine (*Sardina pilchardus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.



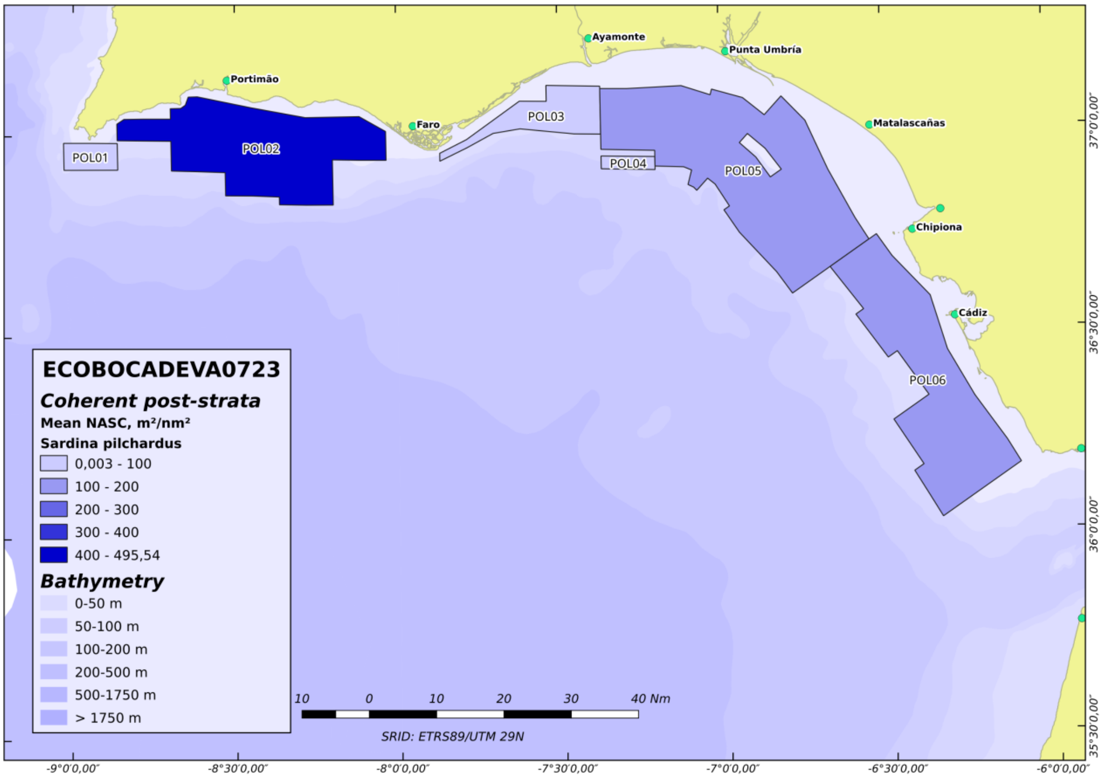




**Figure 12.** *ECOCADIZ 2023-07* survey. Sardine (*S. pilchardus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

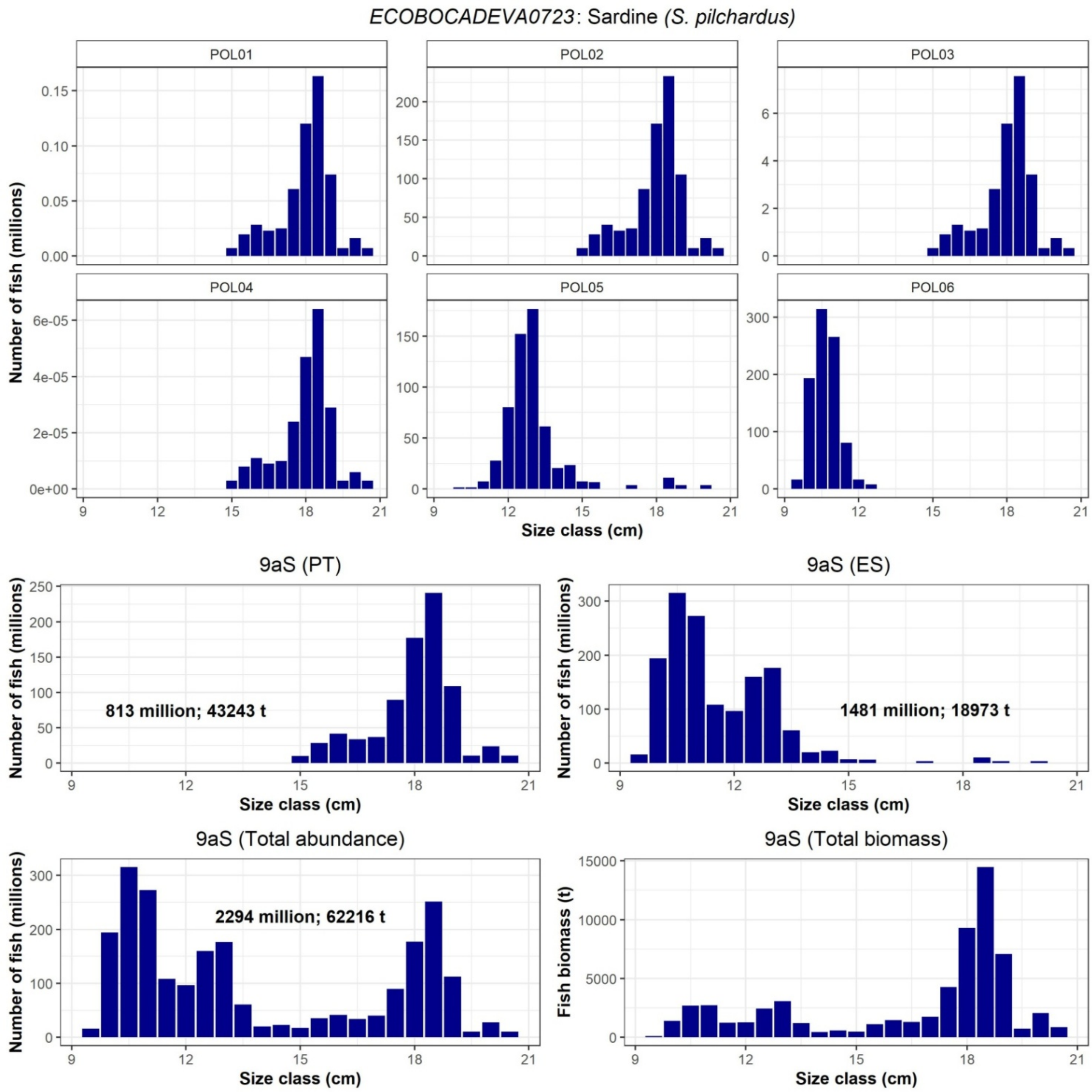



**Figure 13**. *ECOCADIZ 2023-07* survey. Sardine *(S. pilchardus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 12** and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the *y* axis.

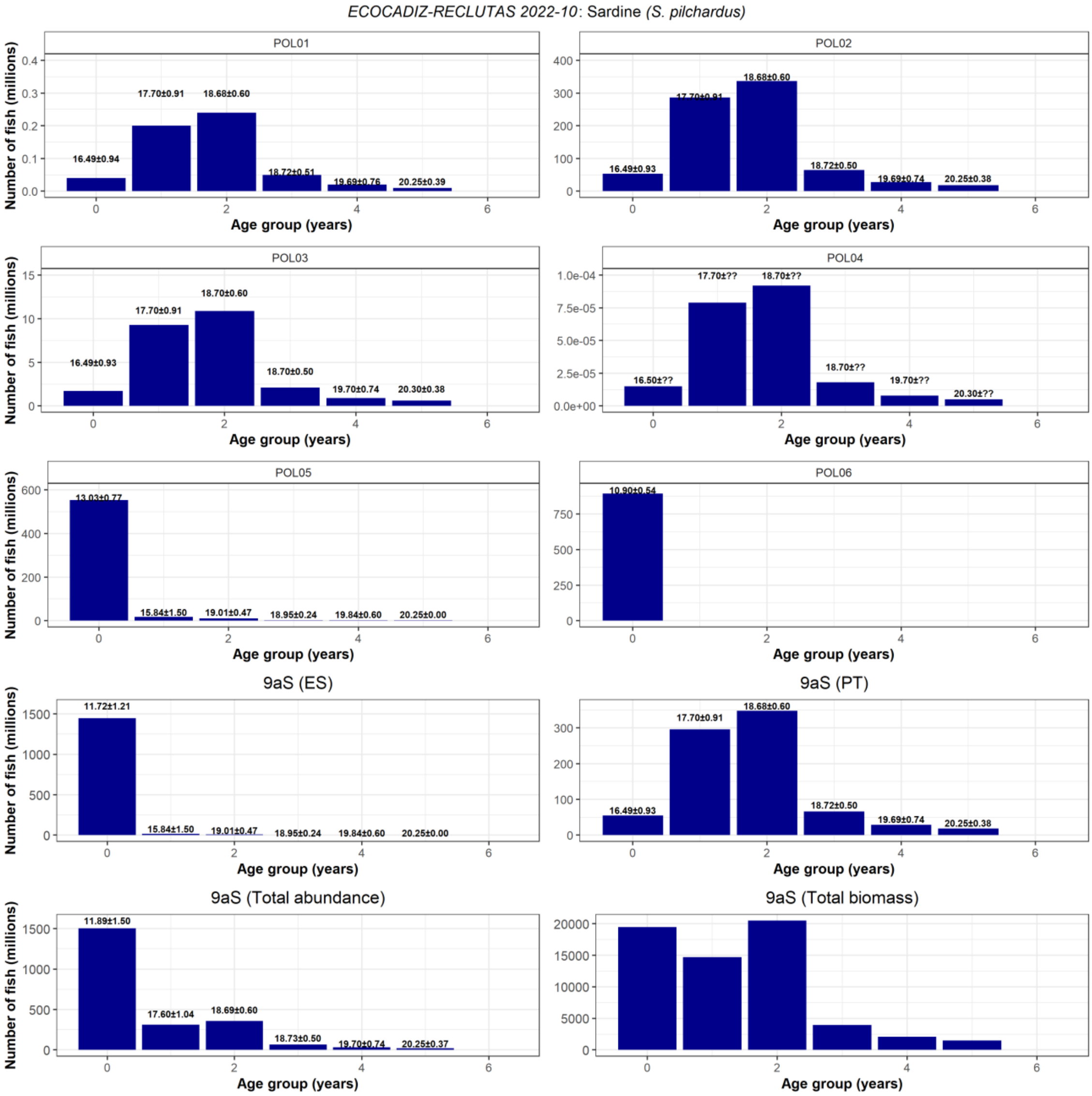
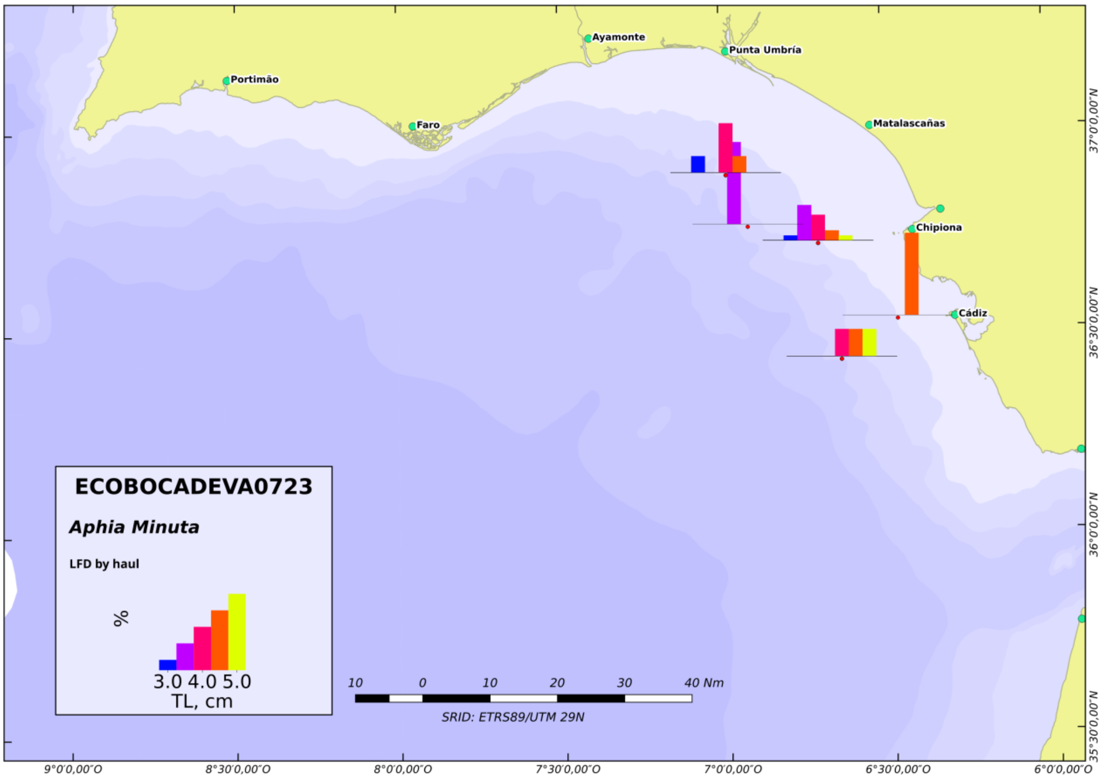



**Figure 14**. *ECOCADIZ 2023-07* survey. Sardine *(S. pilchardus*). Estimated abundances (number of fish in millions) by age group (years) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 12** and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the *y* axis.



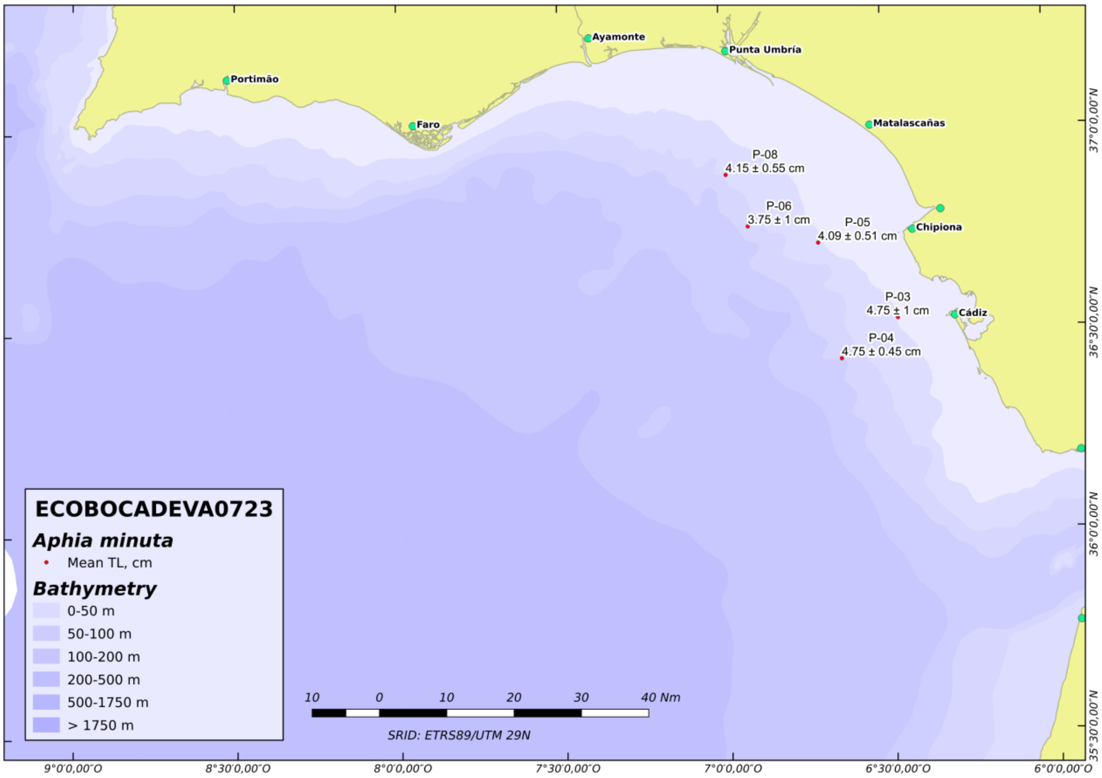
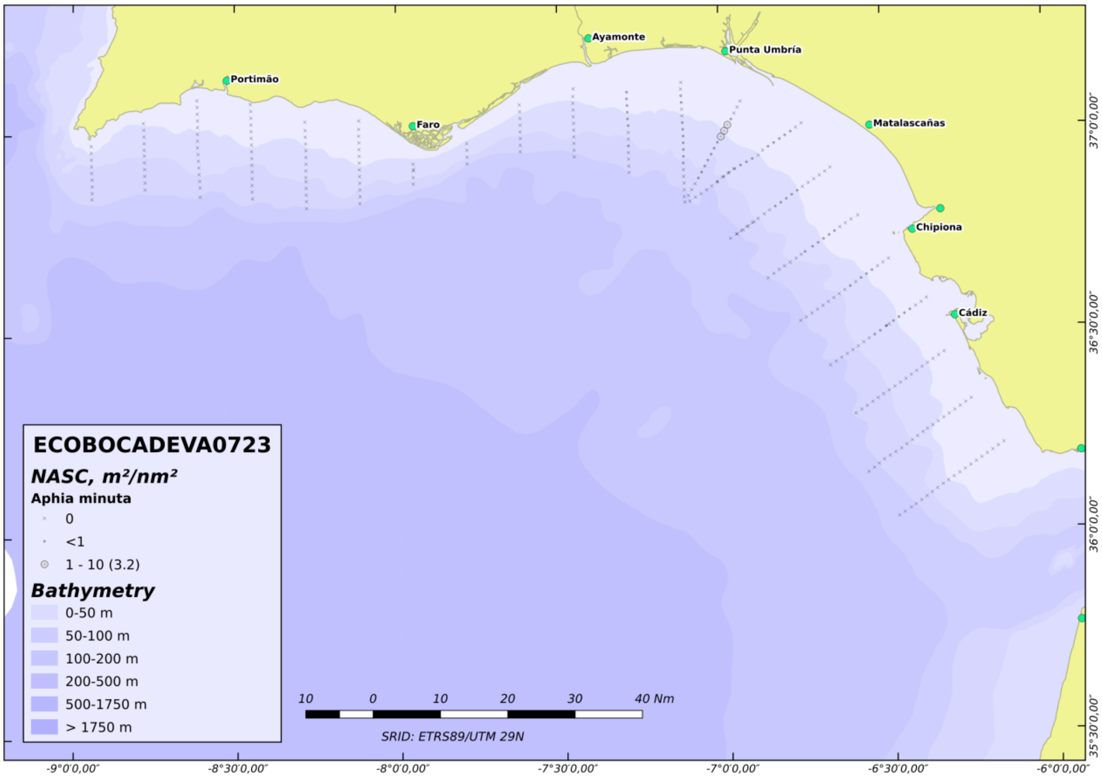




**Figure 15.** *ECOCADIZ 2023-07* survey. Transparent goby (*Aphia minuta*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.



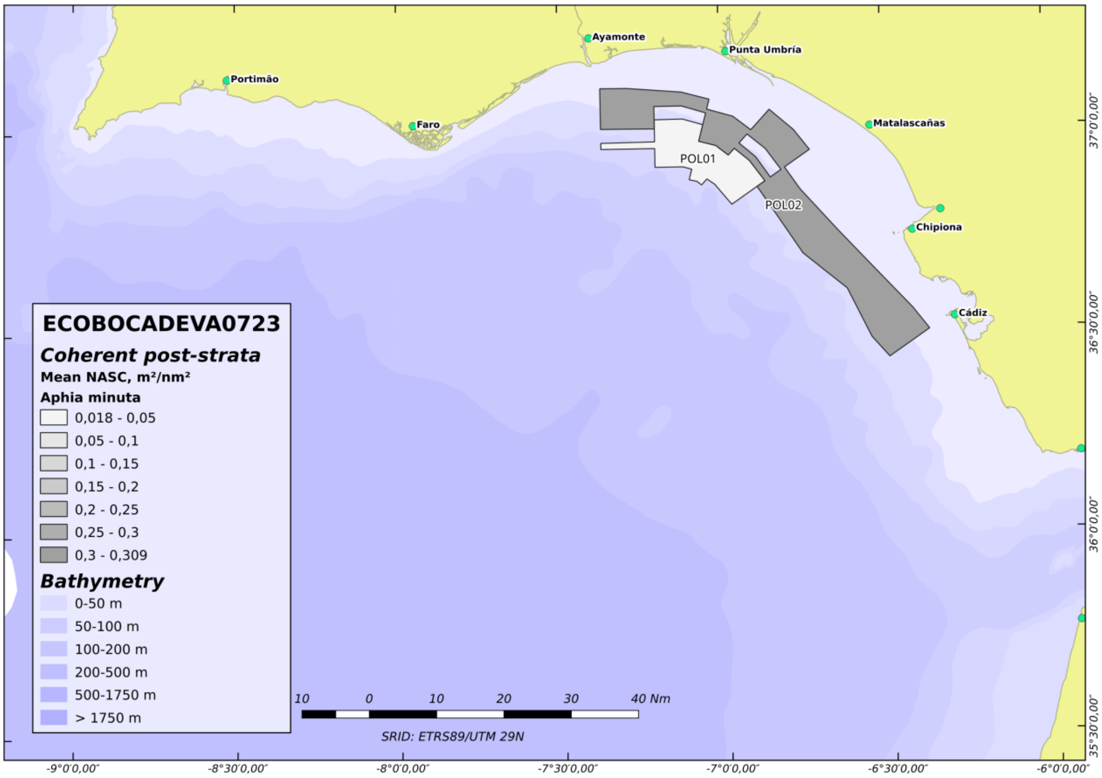




**Figure 16.** *ECOCADIZ 2023-07* survey. Transparent goby (*A. minuta*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

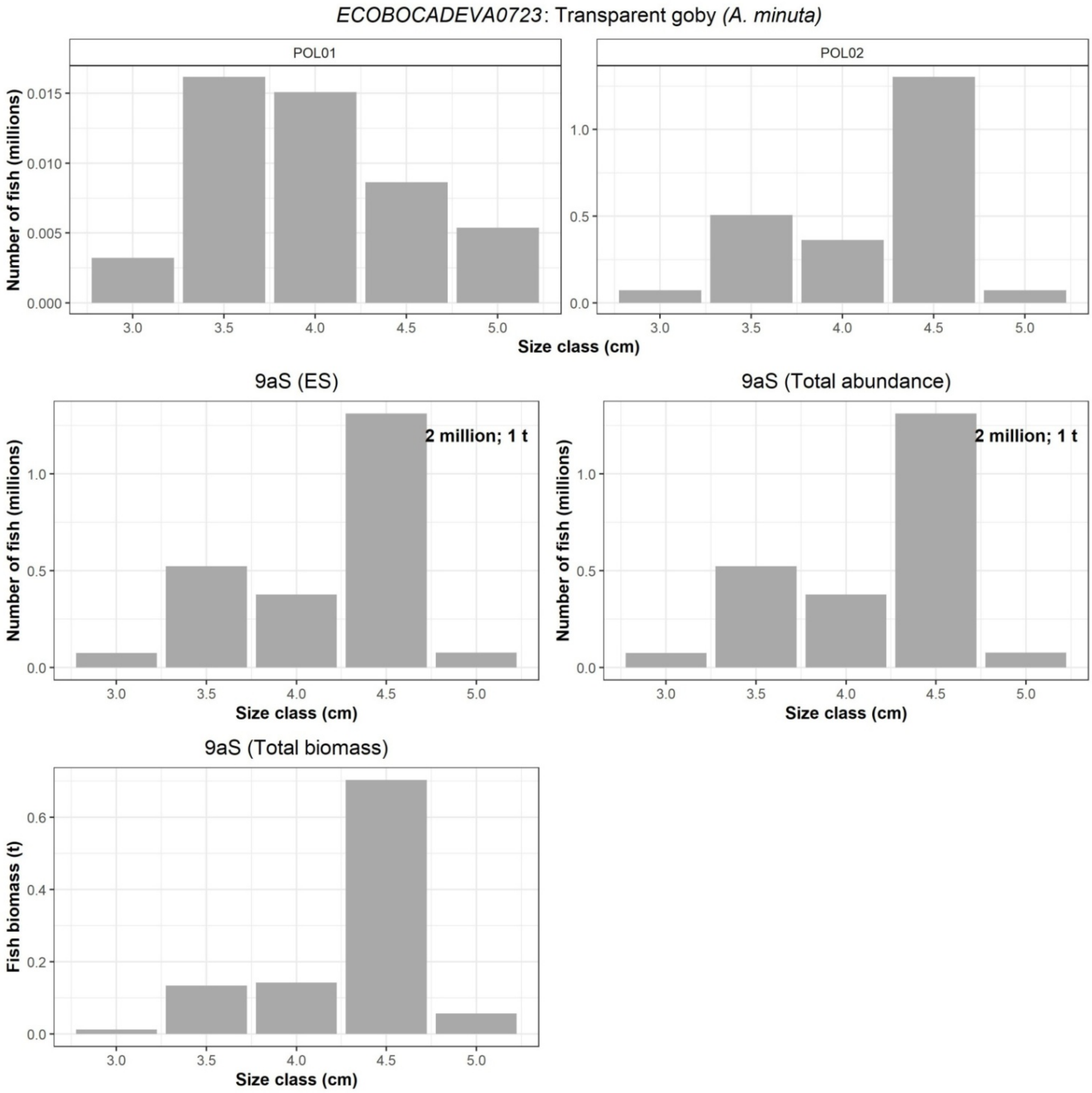
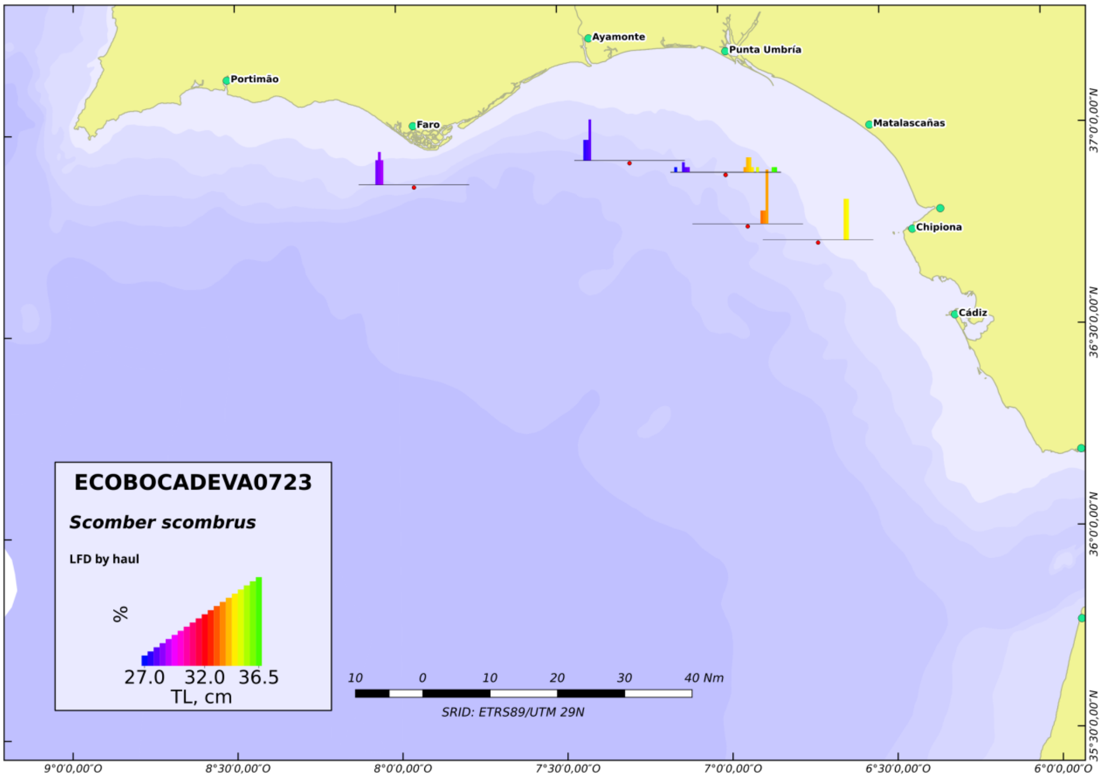



**Figure 17.** *ECOCADIZ 2023-07* survey. Transparent goby (*A. minuta*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 16**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the *y*-axis.



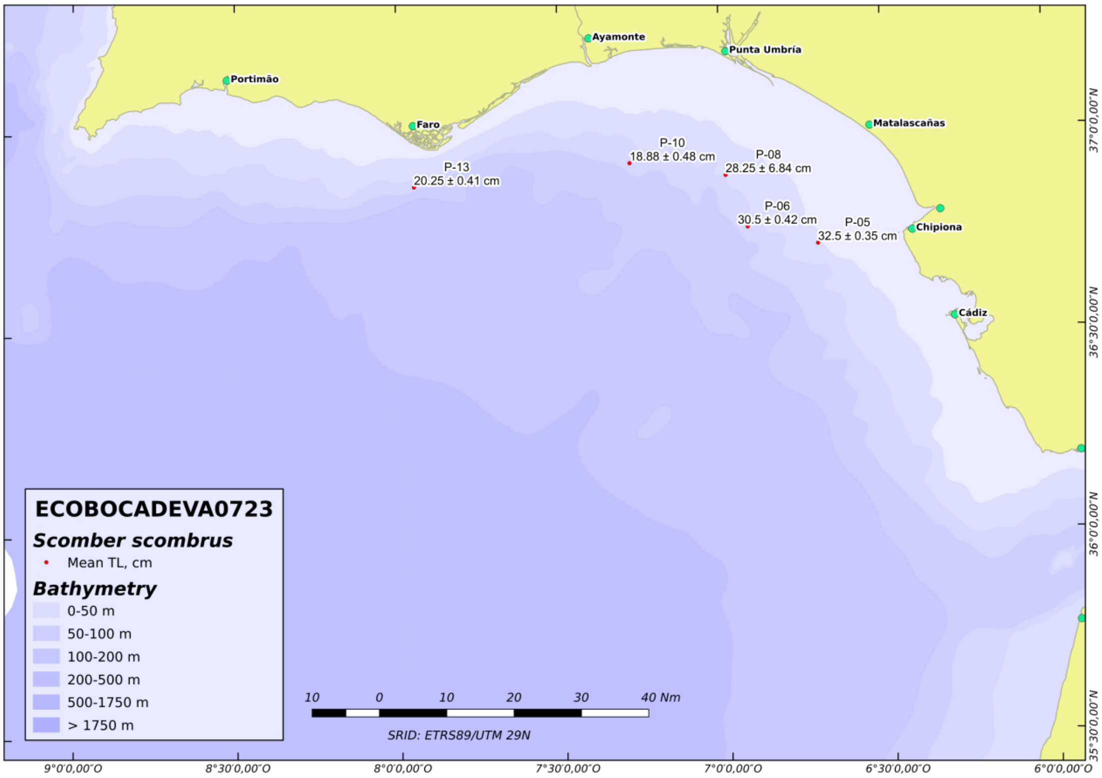
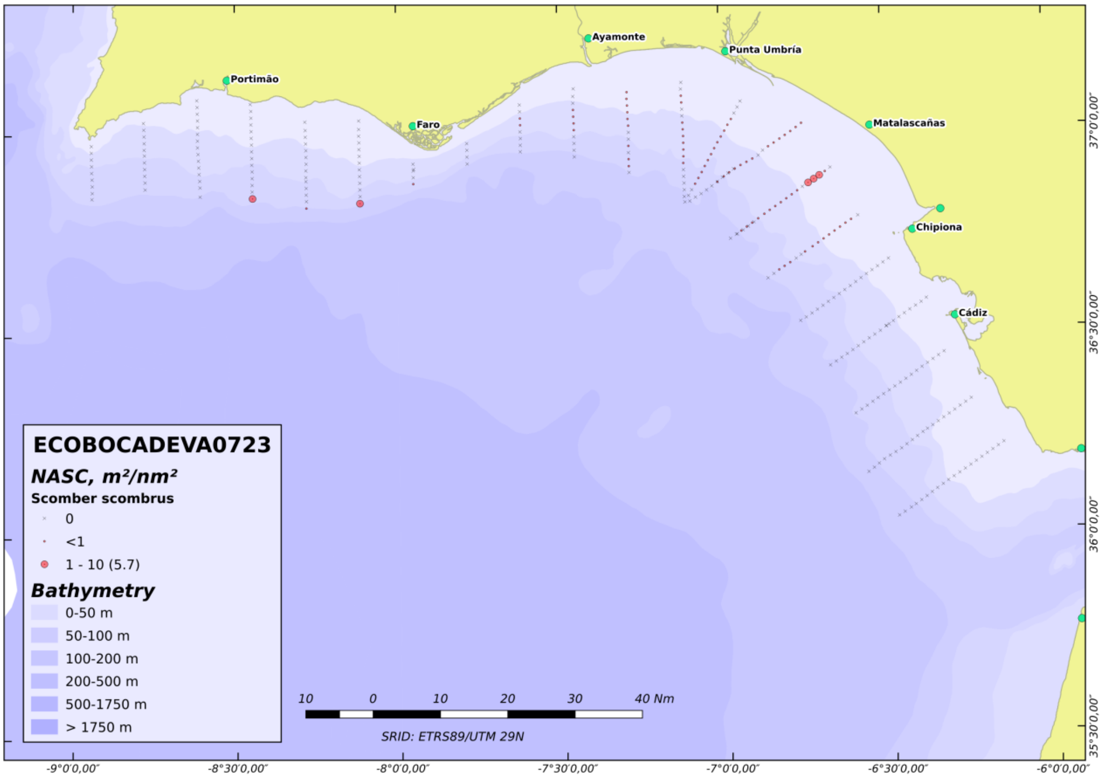




**Figure 18.** *ECOCADIZ 2023-07* survey. Atlantic mackerel (*Scomber scombrus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.



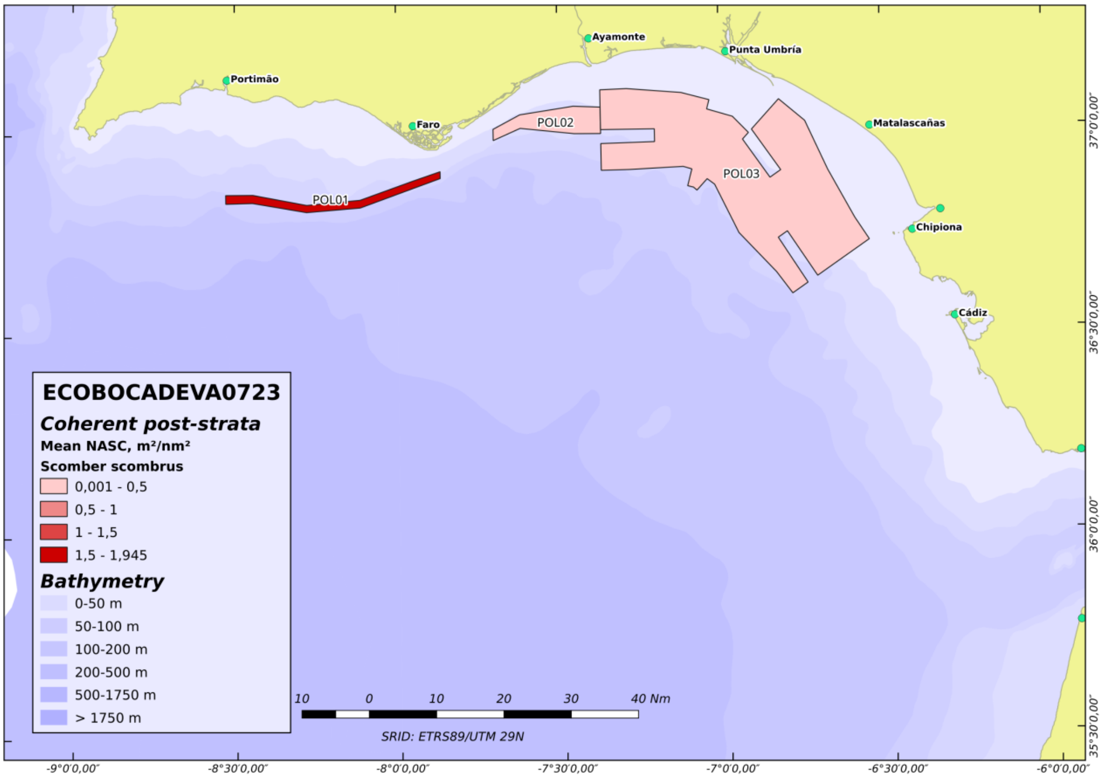




**Figure 19.** *ECOCADIZ 2023-07* survey. Atlantic mackerel (*S. scombrus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Color scale according to the mean value of the backscattering energy attributed to the species in each stratum.

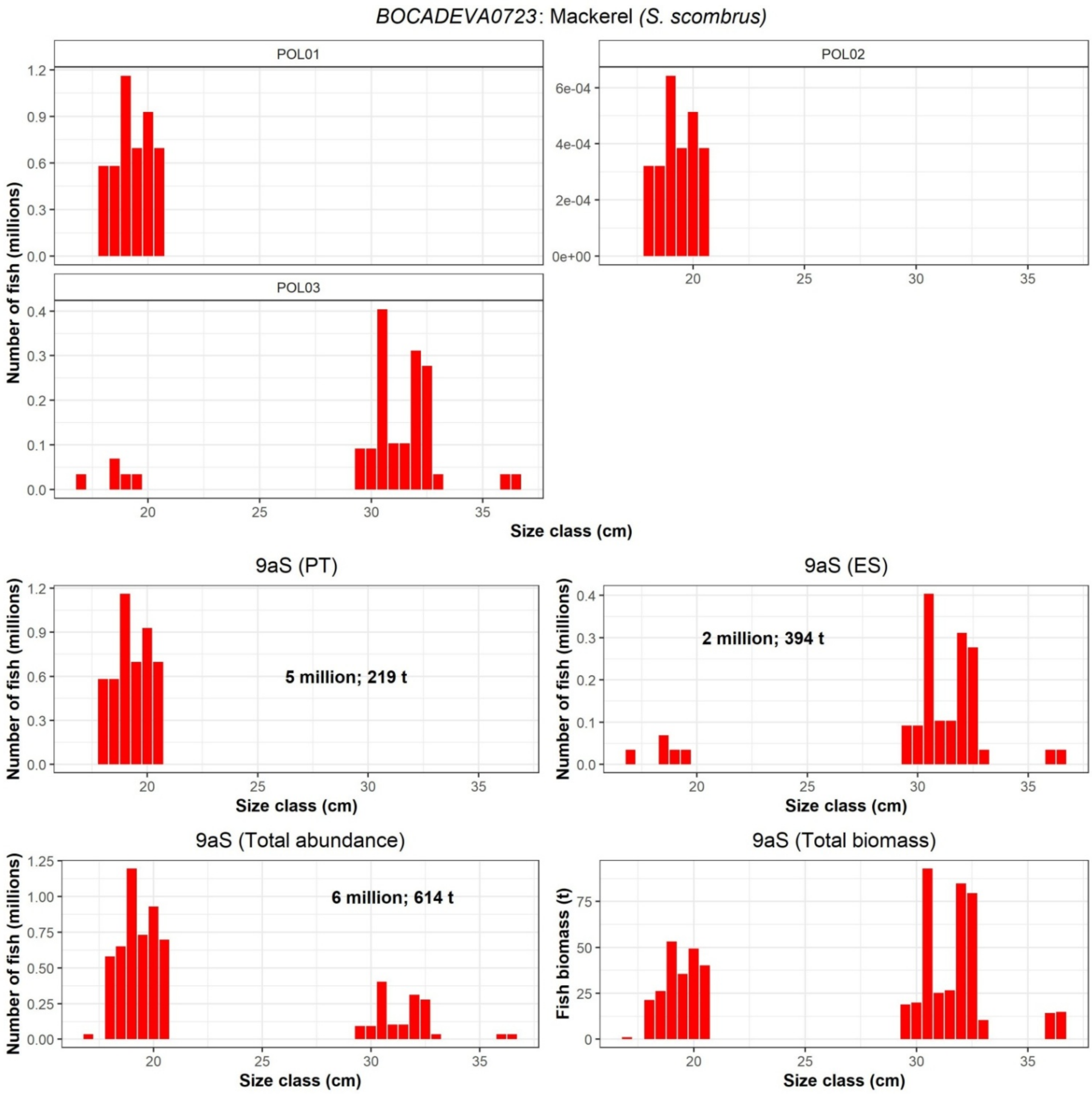



**Figure 20.** *ECOCADIZ 2023-07* survey. Atlantic mackerel (*S. scombrus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 19**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the *y* axis

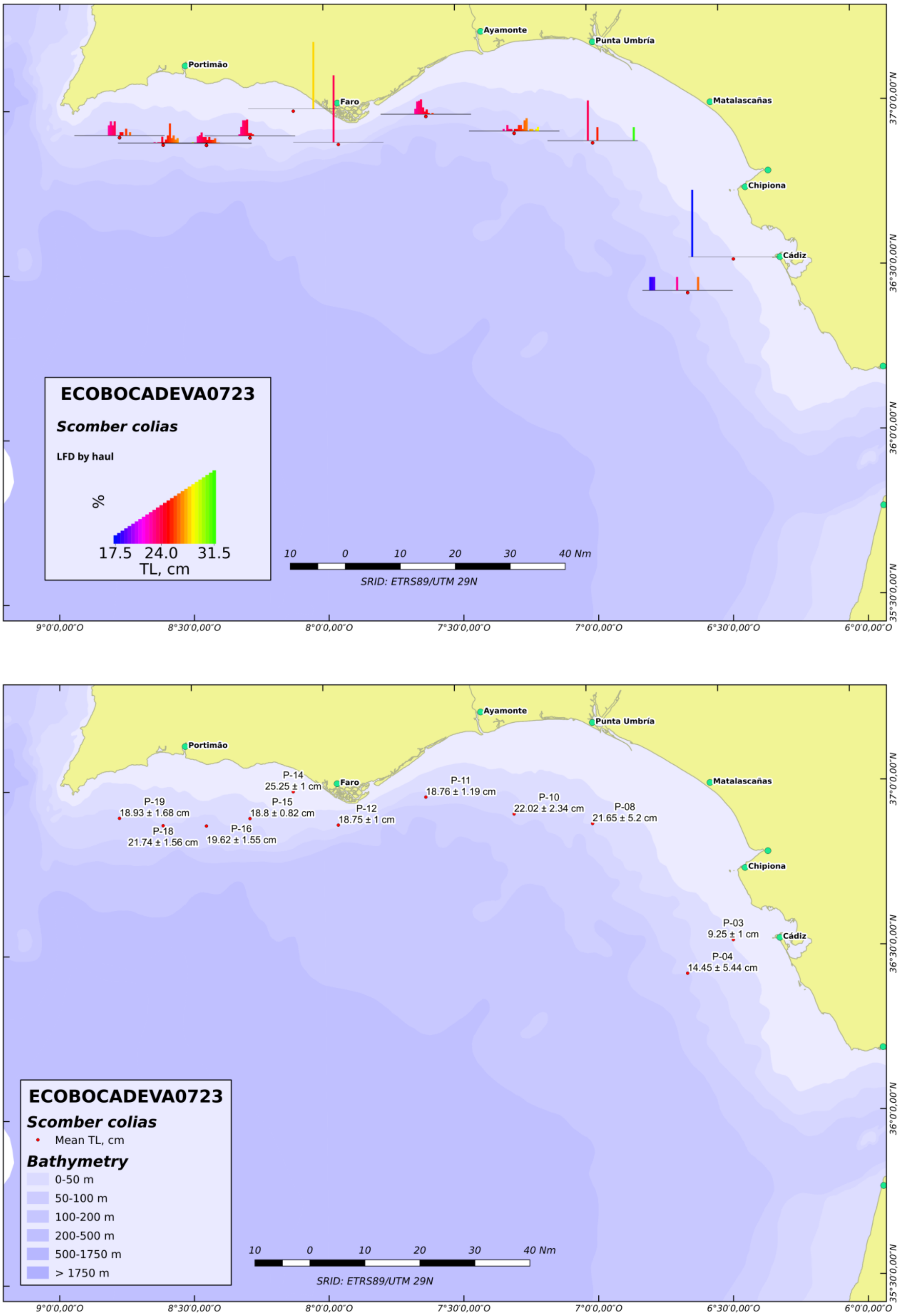



**Figure 21.** *ECOCADIZ 2023-07* survey. Chub mackerel (*Scomber colias*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

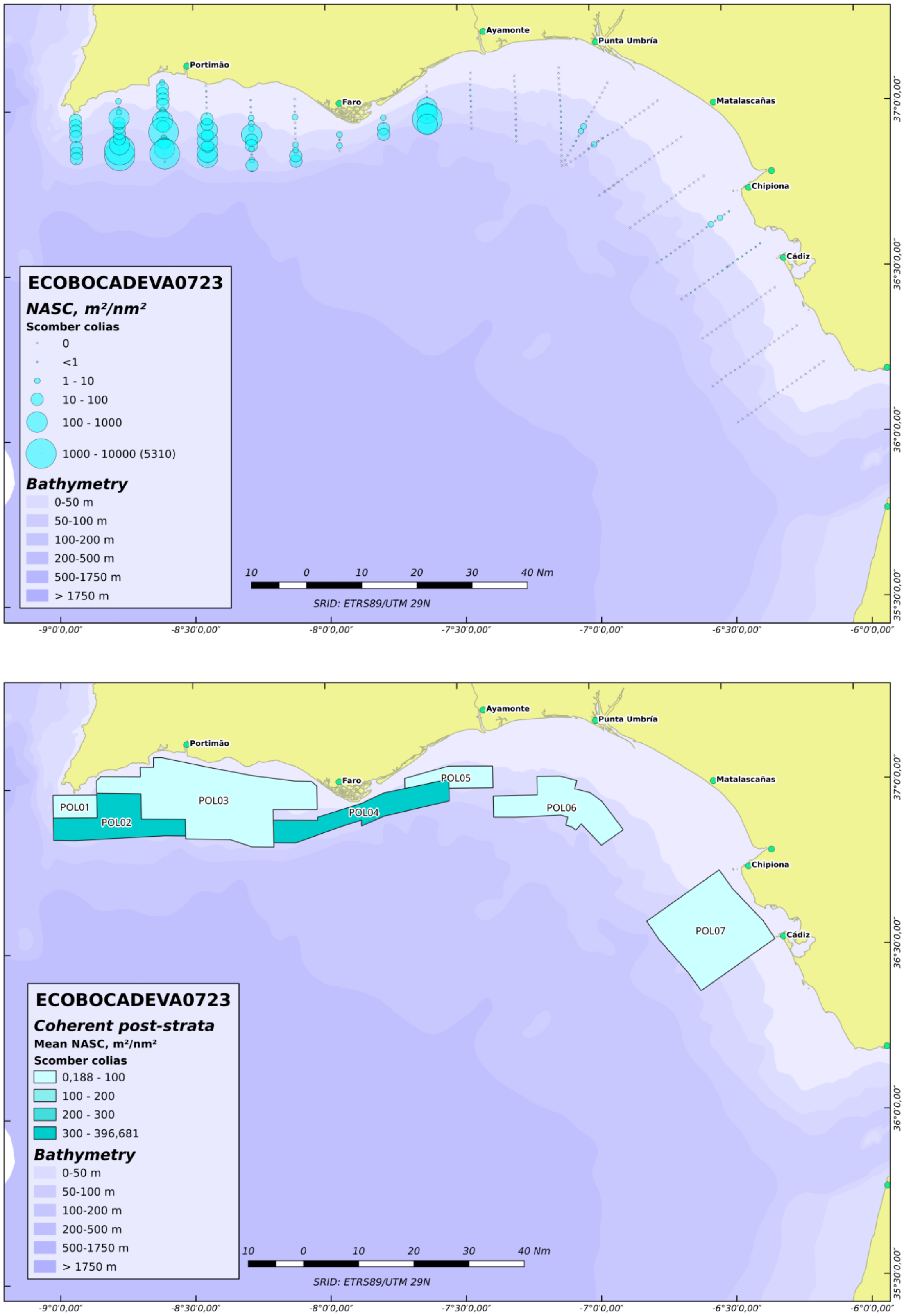



**Figure 22.** *ECOCADIZ 2023-07* survey. Chub mackerel (*S. colias*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

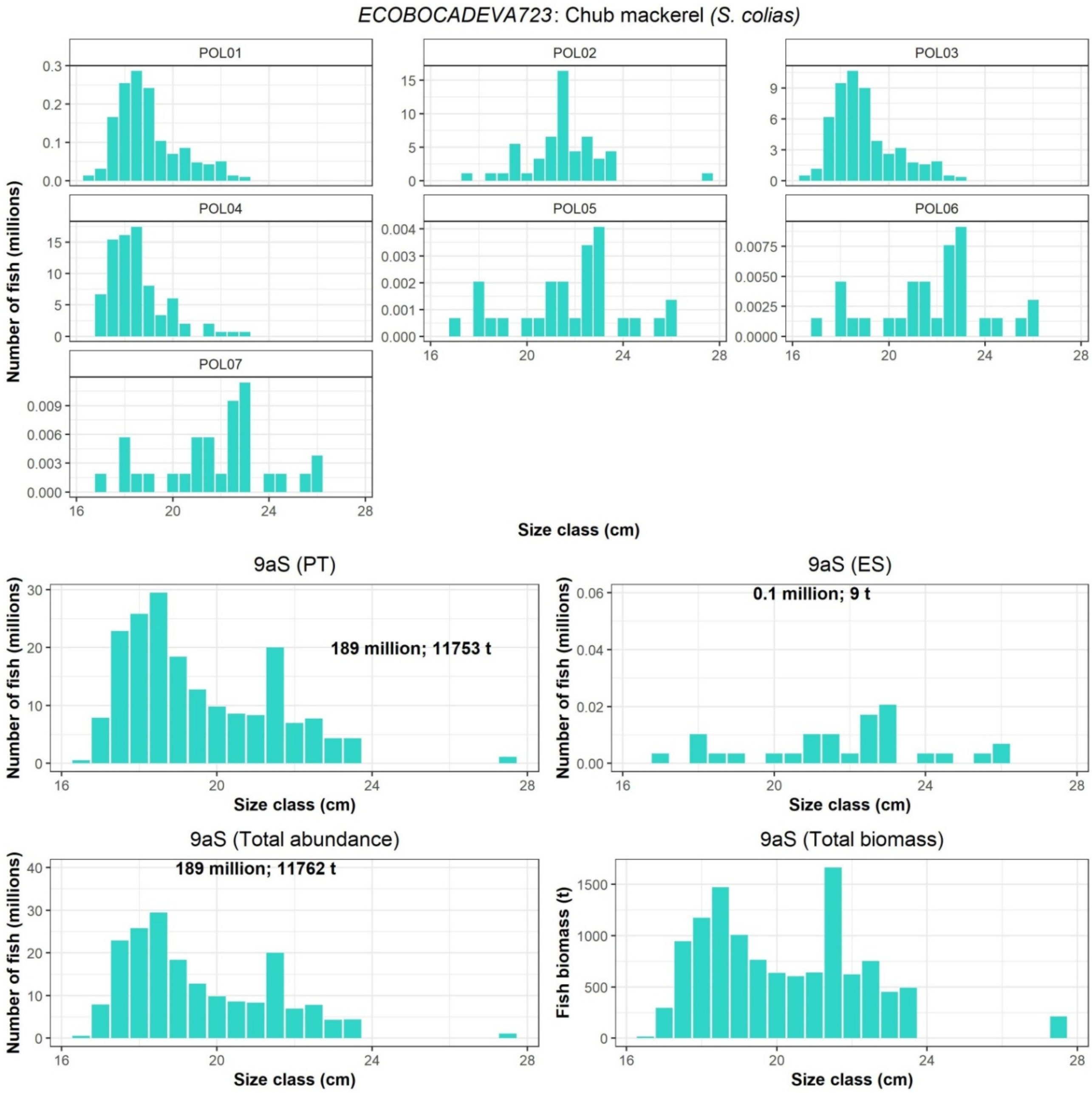



**Figure 23**. *ECOCADIZ 2023-07* survey. Chub mackerel (*S. colias*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 22**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the *y*-axis.

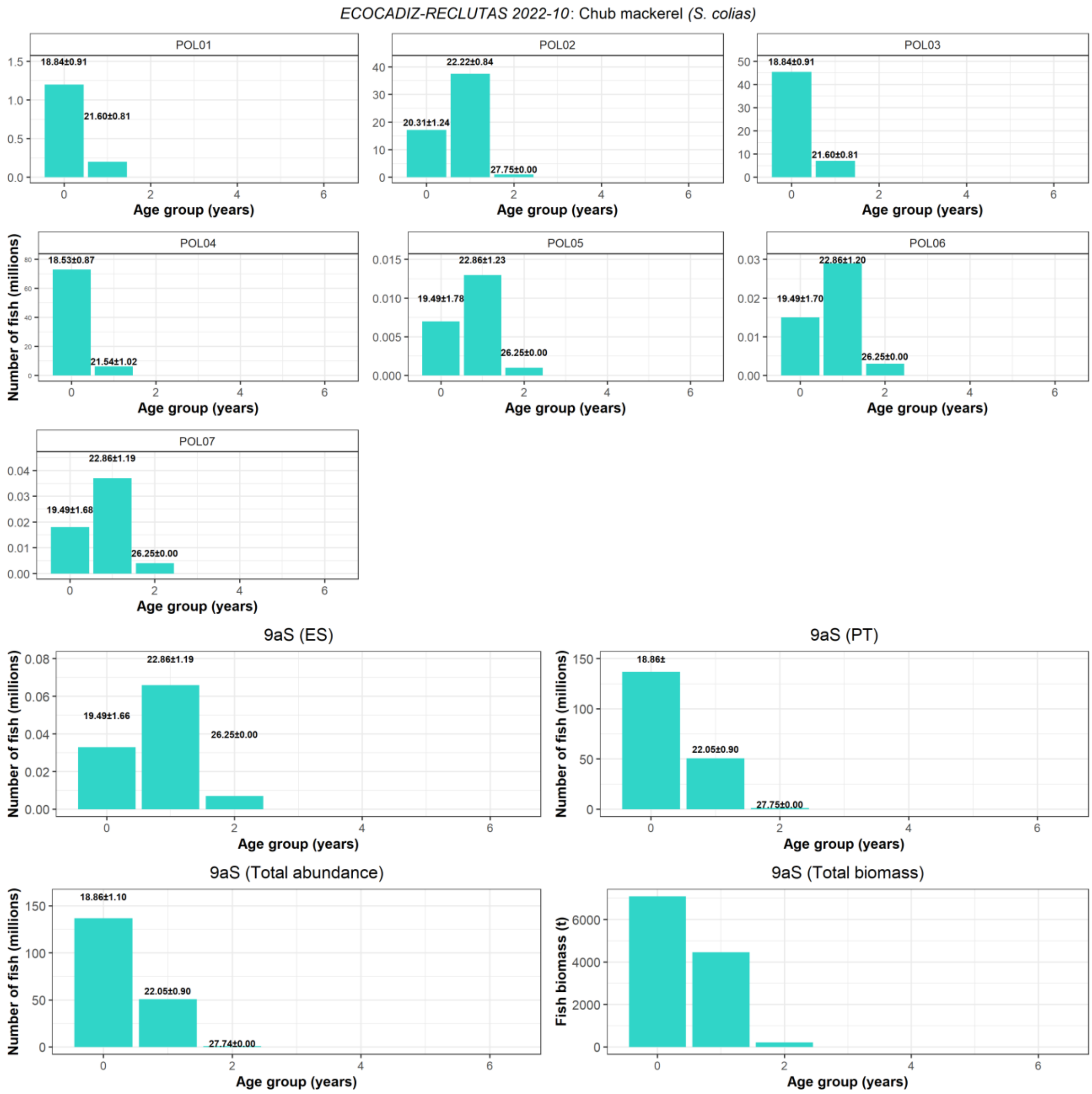
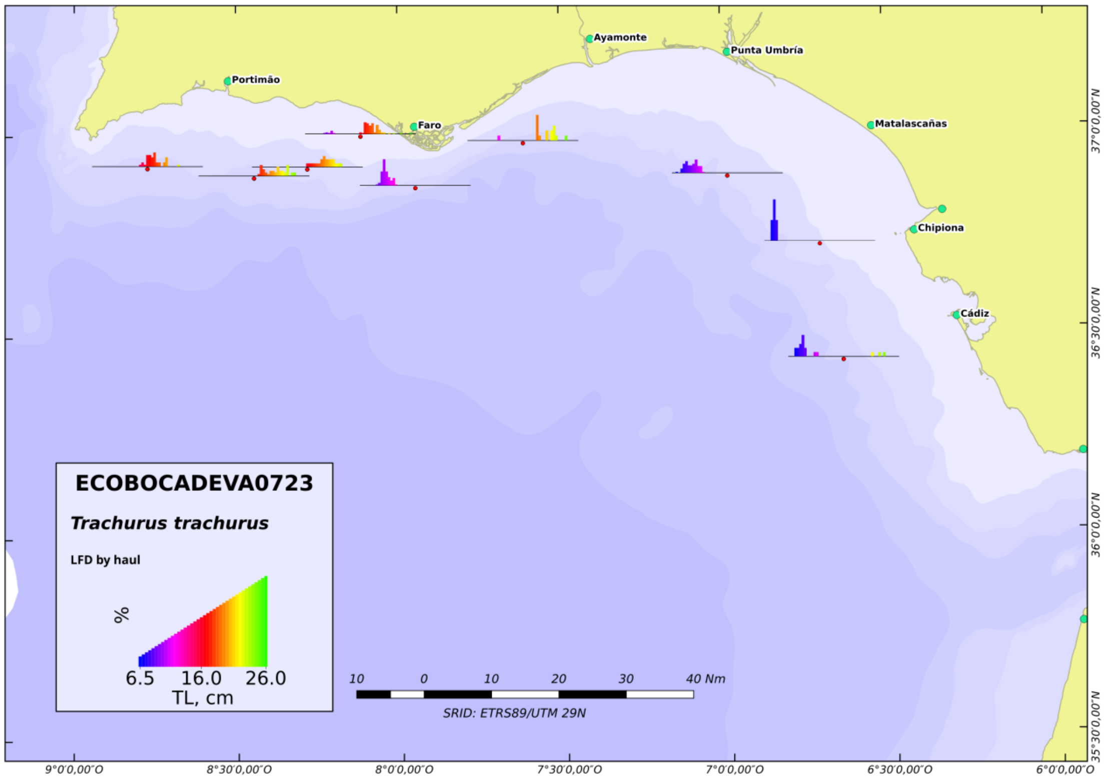



**Figure 24**. *ECOCADIZ 2023-07* survey. Chub mackerel (*S. colias*). Estimated abundances (number of fish in millions) by age group (years) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 22**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by age group for the whole sampled area is also shown for comparison. Note the different scale in the *y*-axis.



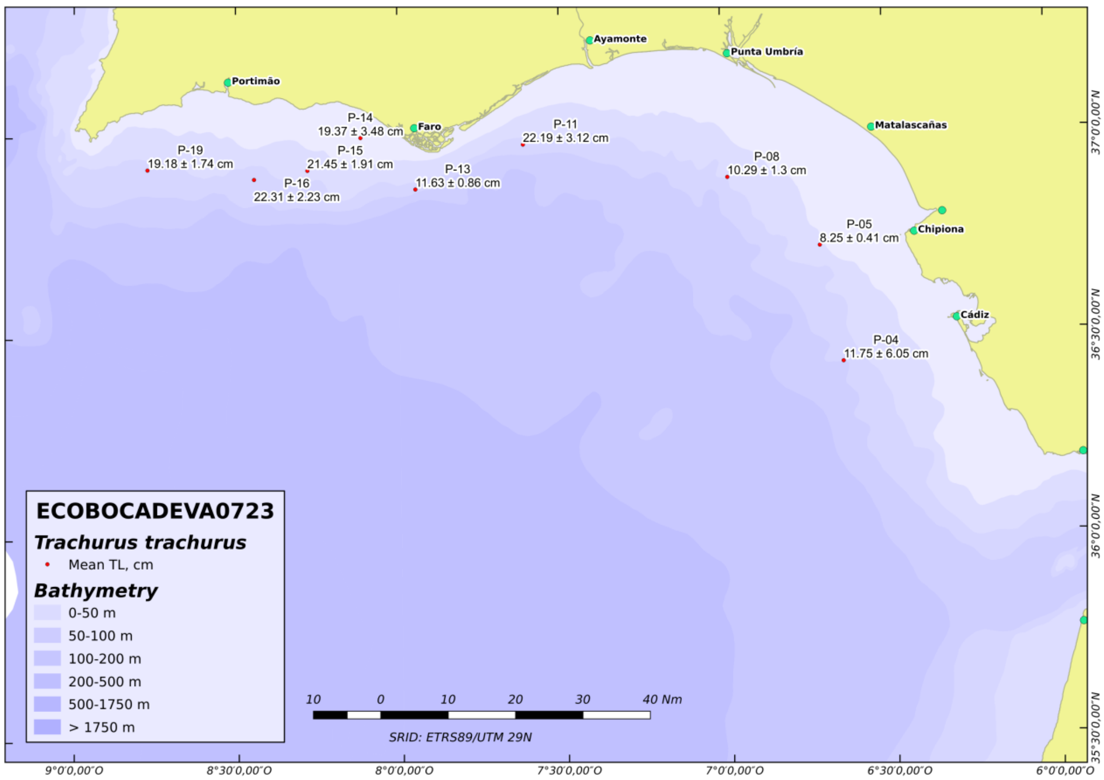
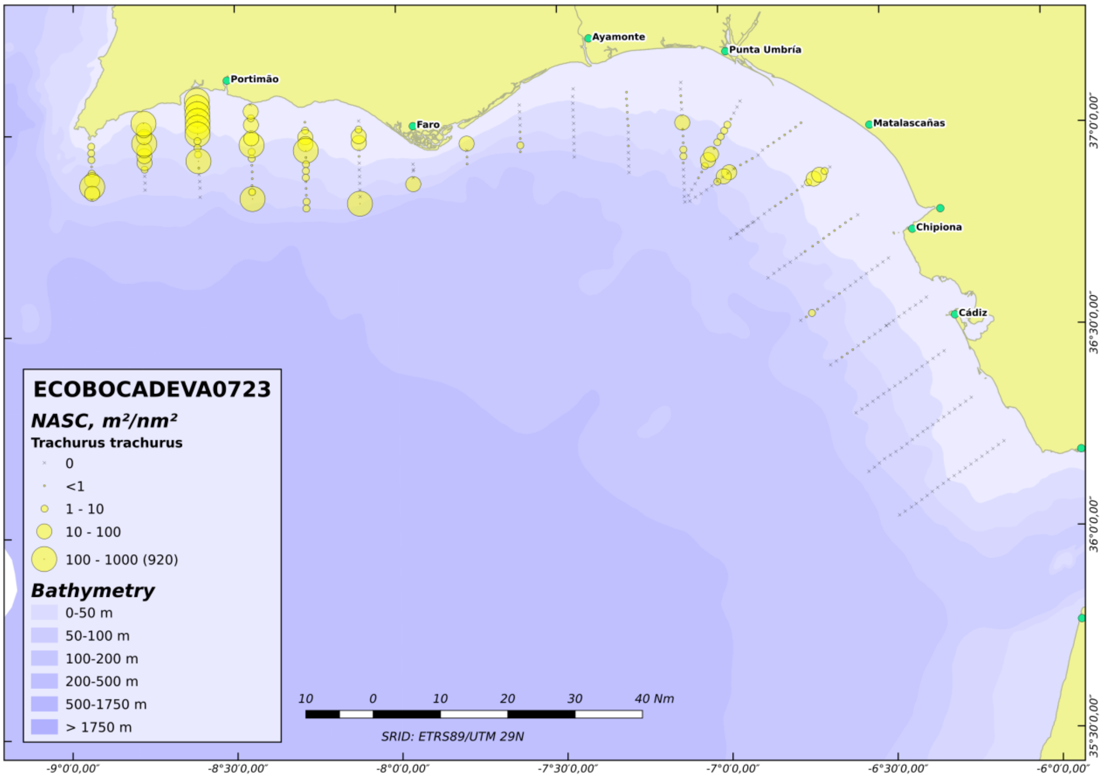




**Figure 25.** *ECOCADIZ 2023-07* survey. Horse mackerel (*Trachurus trachurus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.



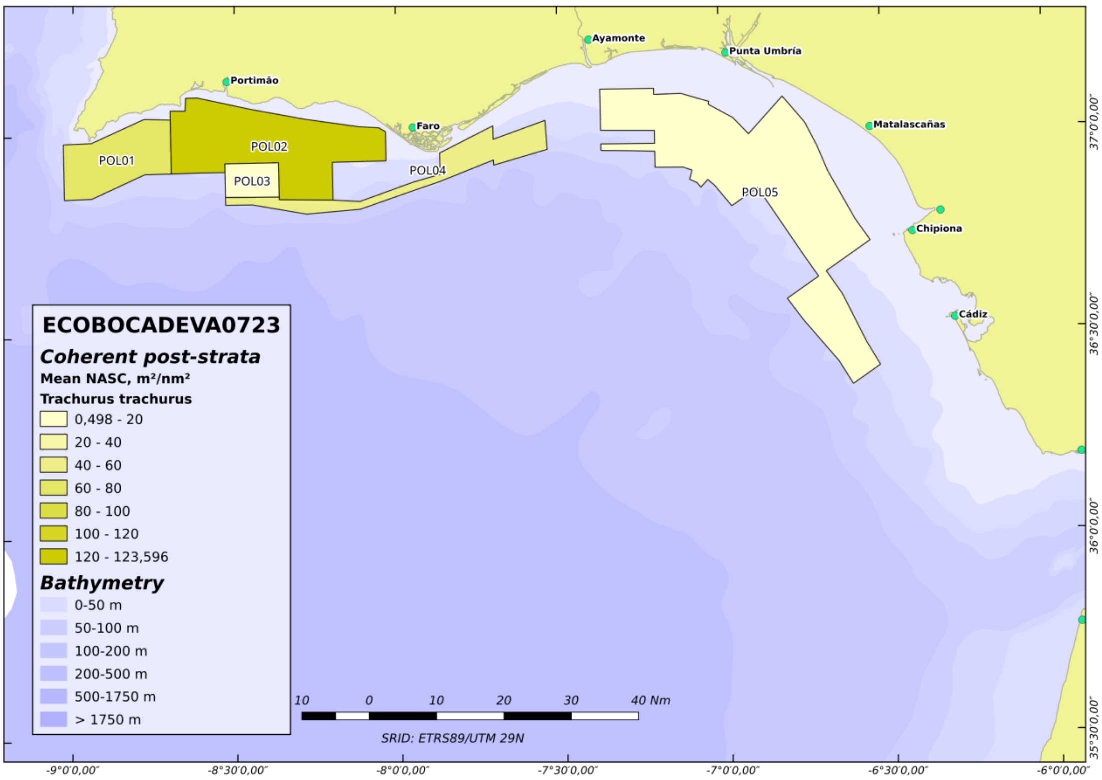




**Figure 26.** *ECOCADIZ 2023-07* survey. Horse mackerel (*T. trachurus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2 nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

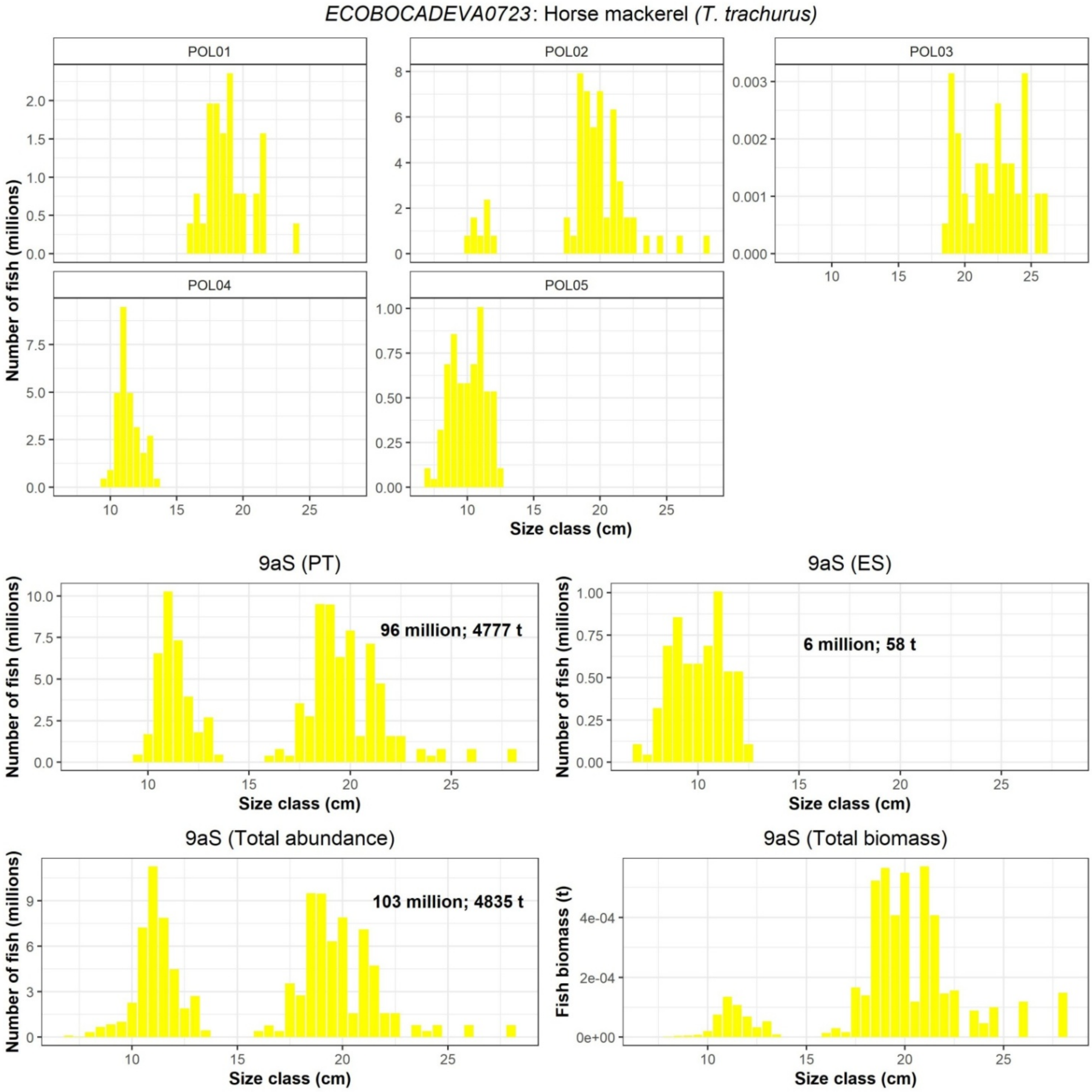



**Figure 27.** *ECOCADIZ 2023-07* survey. Horse mackerel (*T. trachurus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 26**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the *y*-axis.

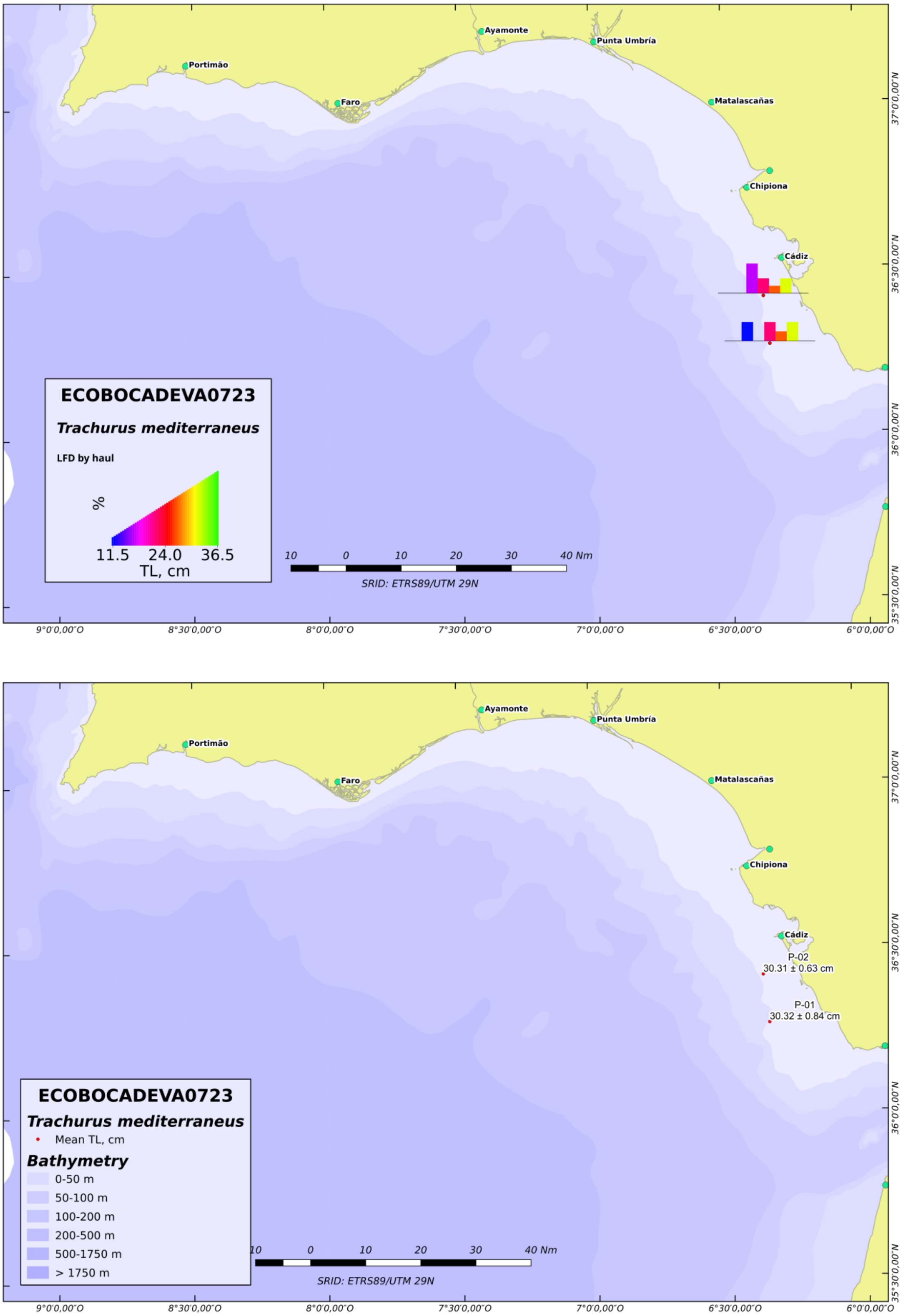
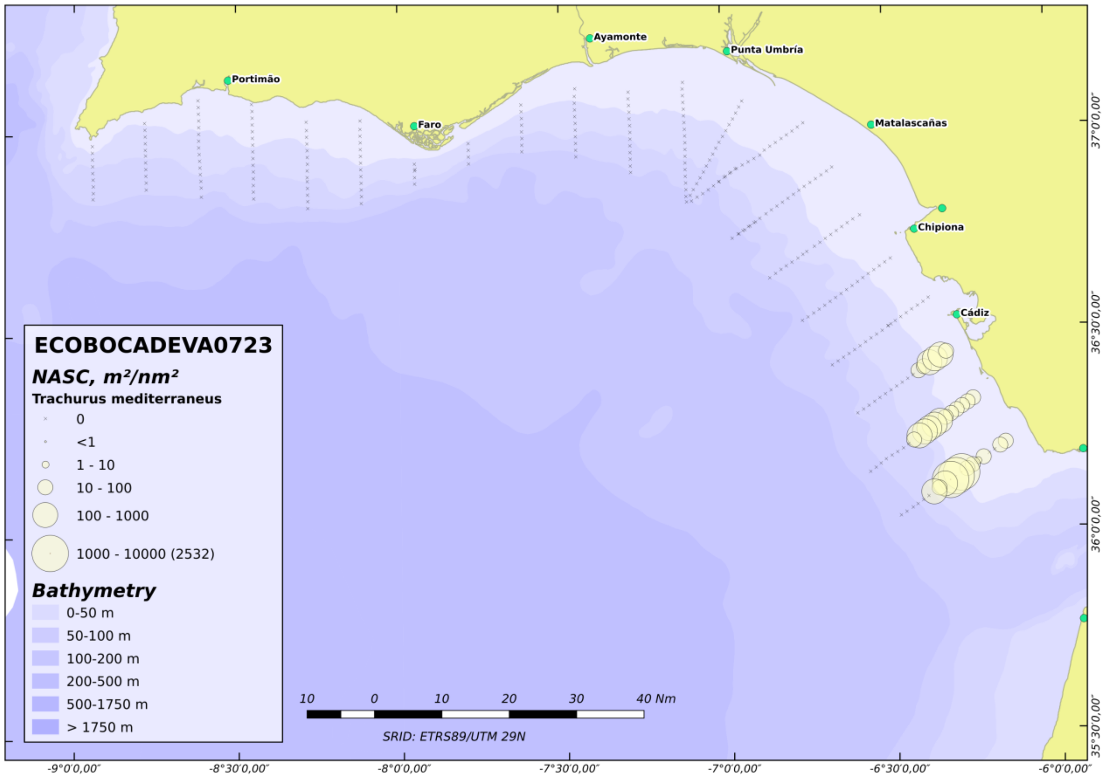



**Figure 28.** *ECOCADIZ 2023-07* survey. Mediterranean horse mackerel (*Trachurus mediterraneus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.



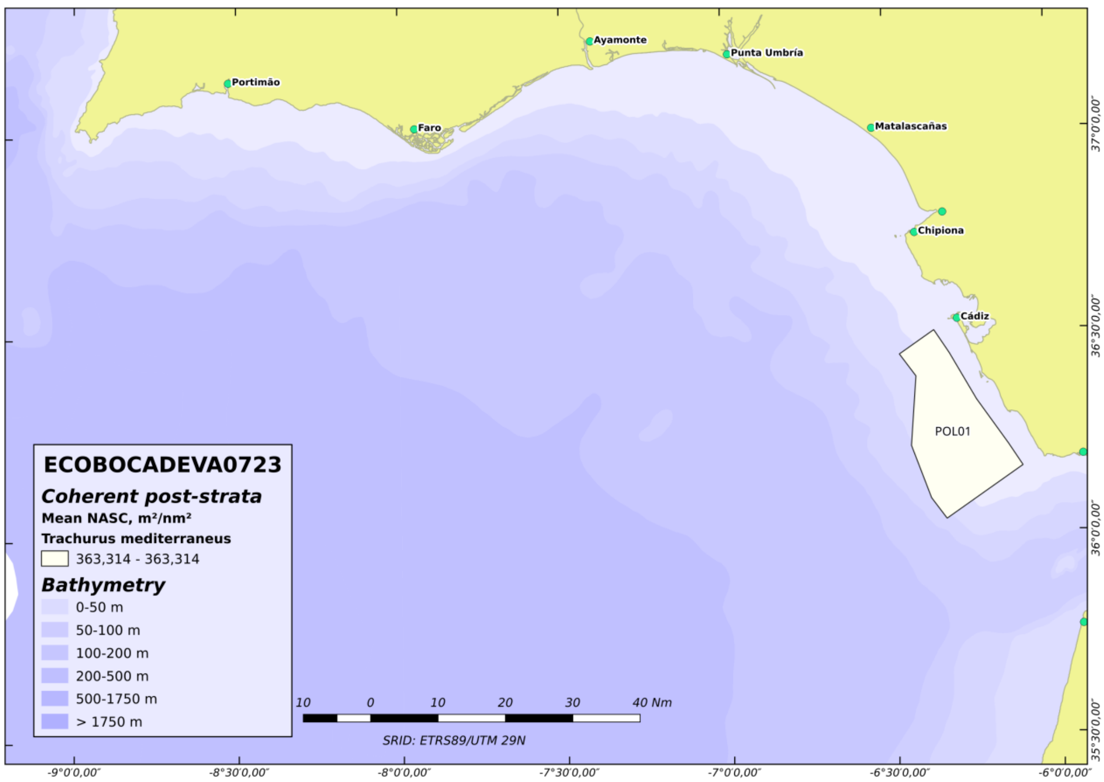




**Figure 29.** *ECOCADIZ 2023-07* survey. Mediterranean horse mackerel (*T. mediterraneus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

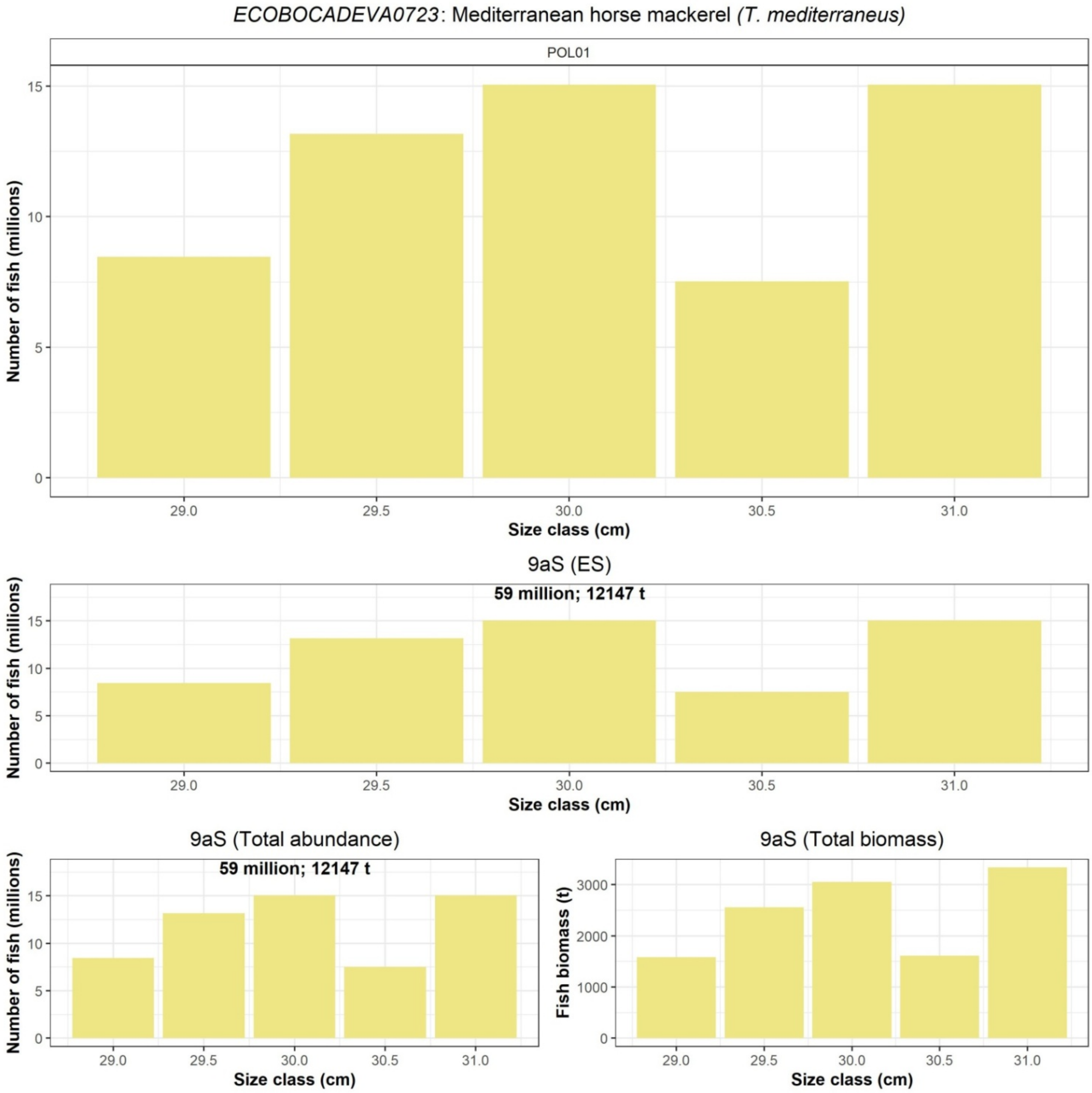
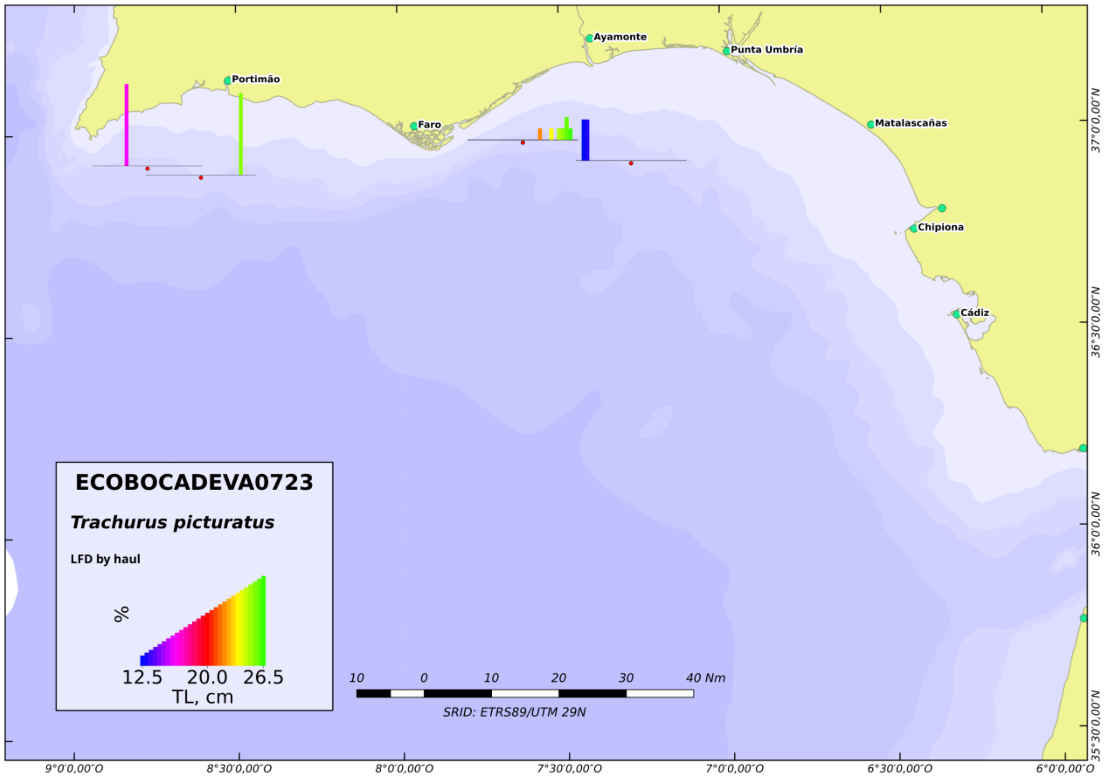



**Figure 30.** *ECOCADIZ 2023-07* survey. Mediterranean horse mackerel (*T. mediterraneus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 29**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the *y*-axis.



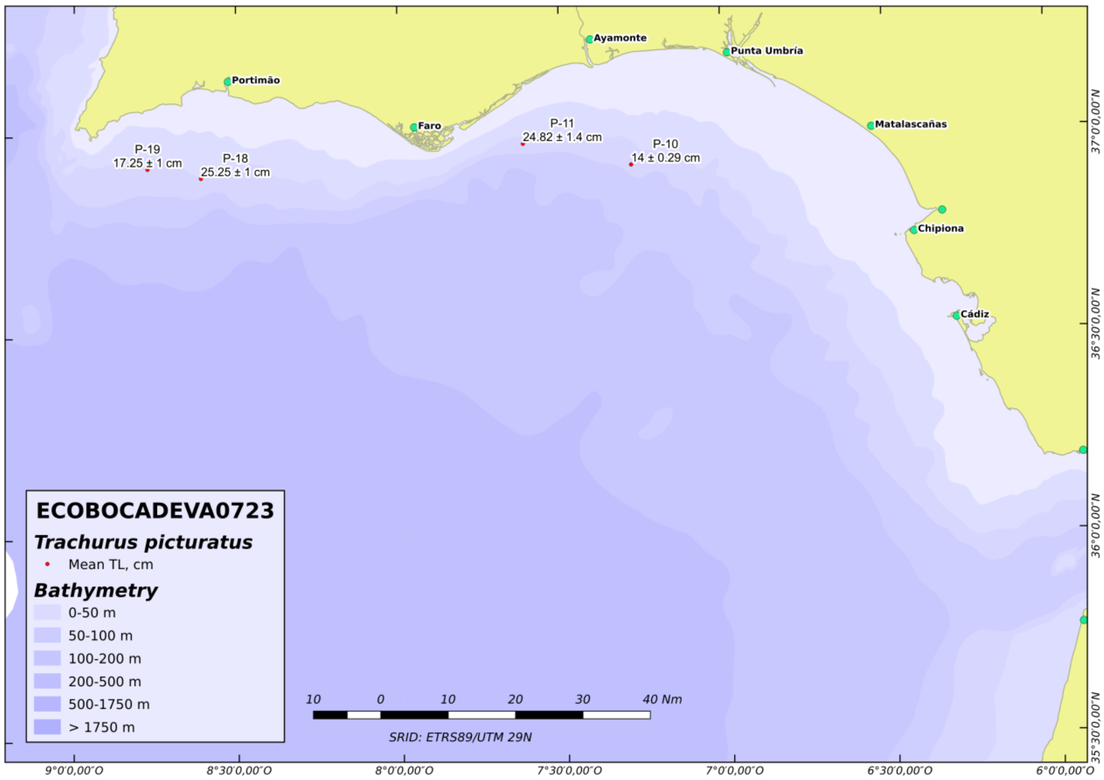




**Figure 31.** *ECOCADIZ 2023-07* survey. Blue jack mackerel (*Trachurus picturatus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

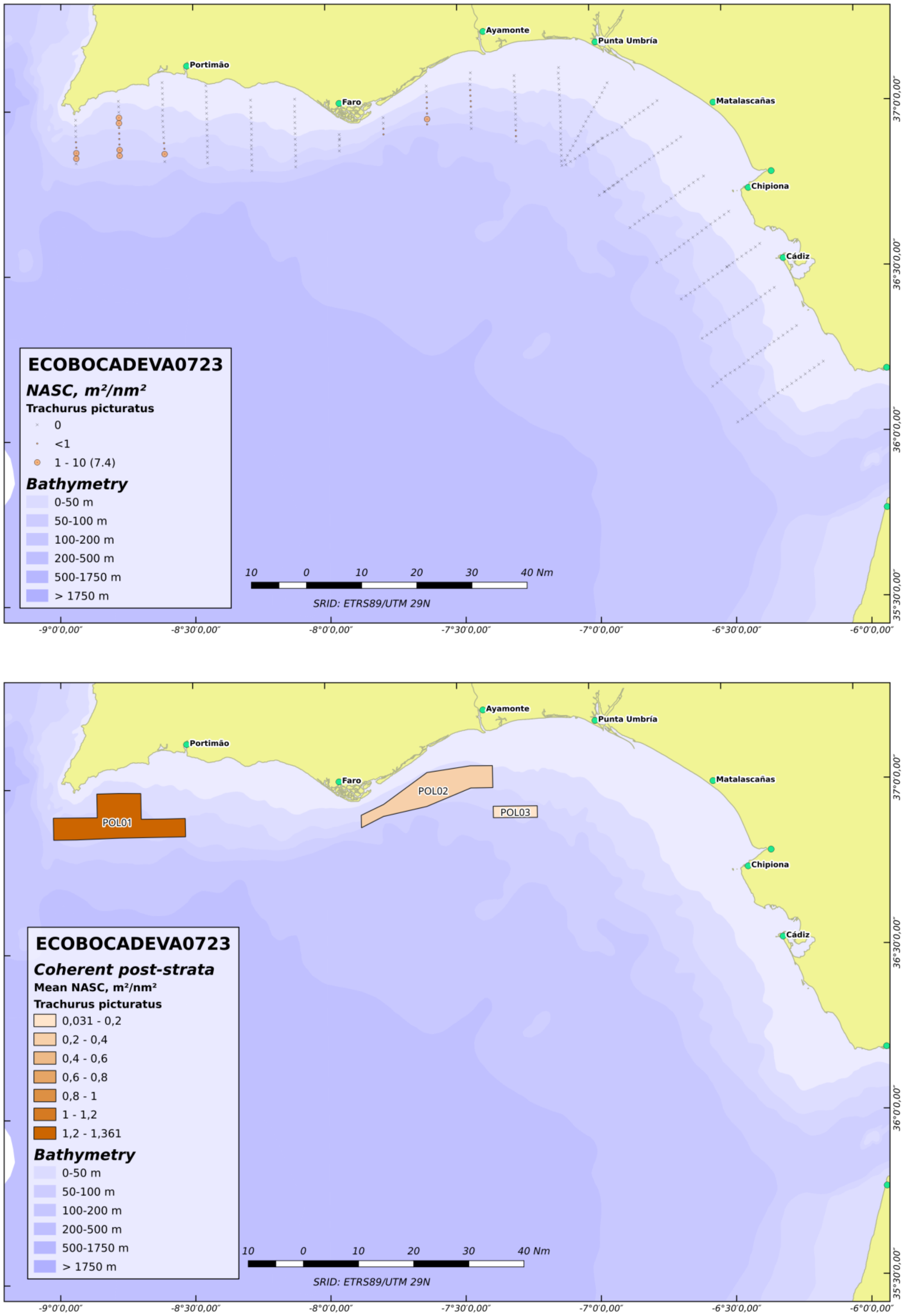



**Figure 32.** *ECOCADIZ 2023-07* survey. Blue jack mackerel (*T. picturatus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

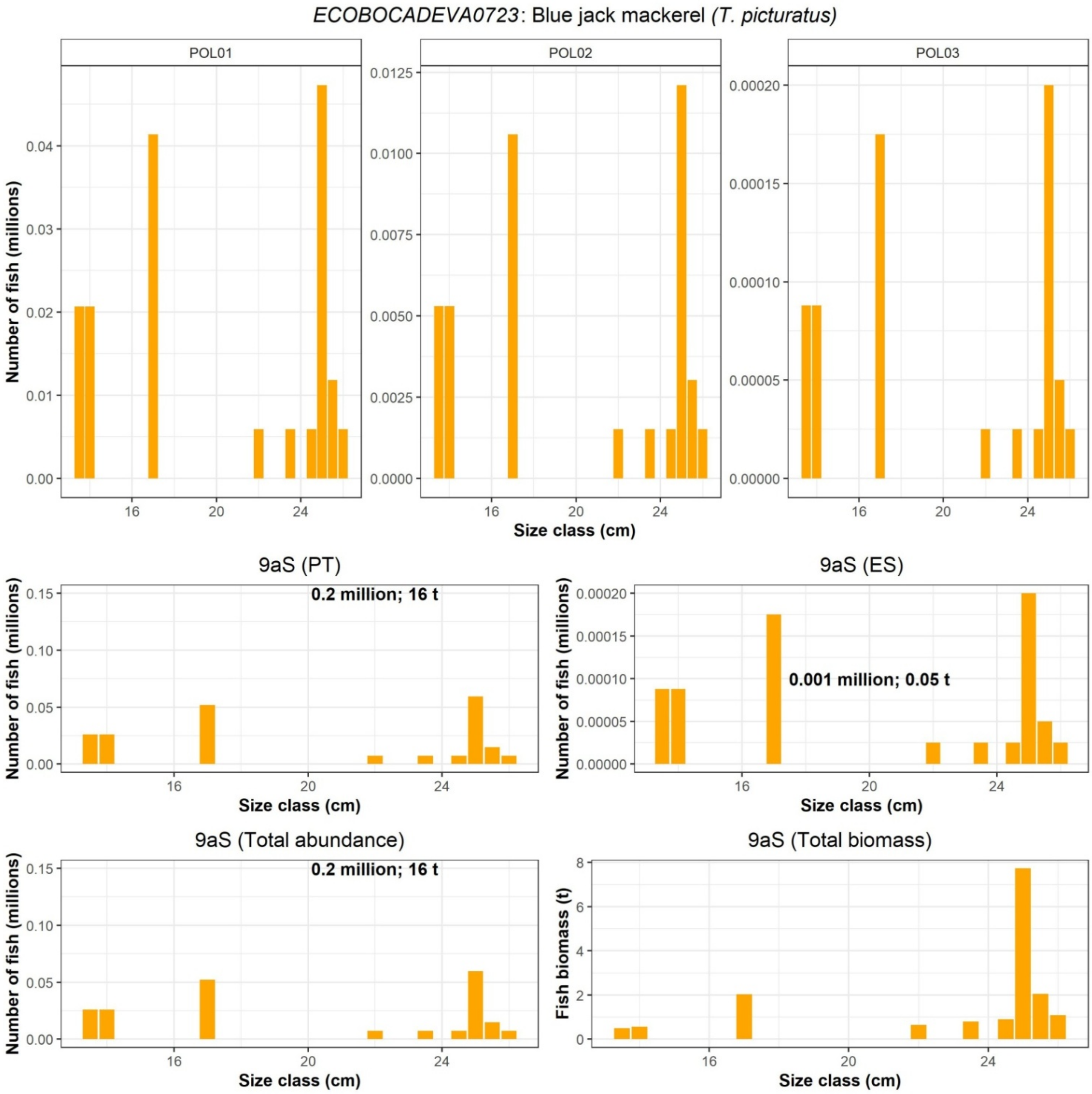



**Figure 33.** *ECOCADIZ 2023-07* survey. Blue jack mackerel (*T. picturatus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 32)** and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the *y*-axis.

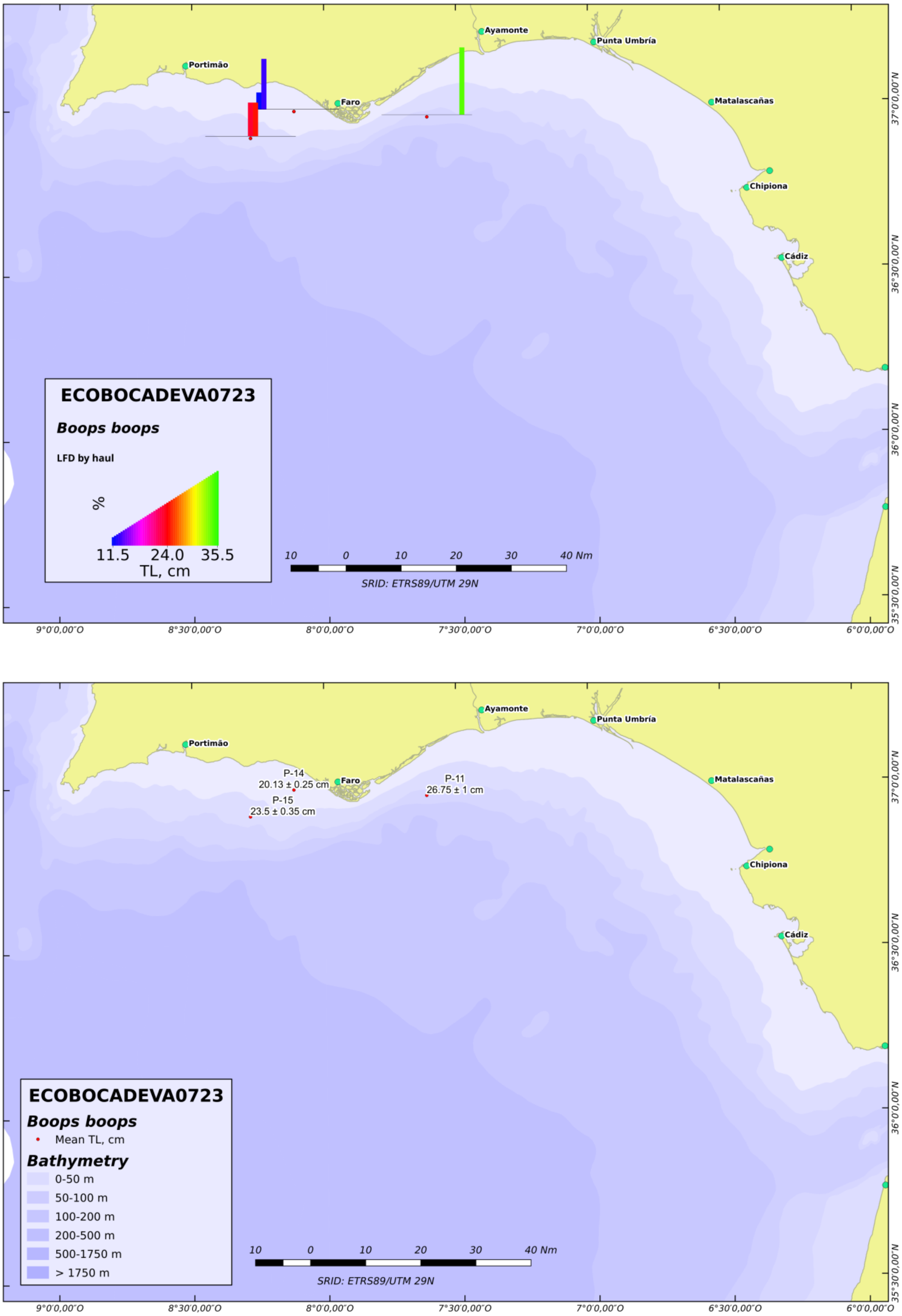
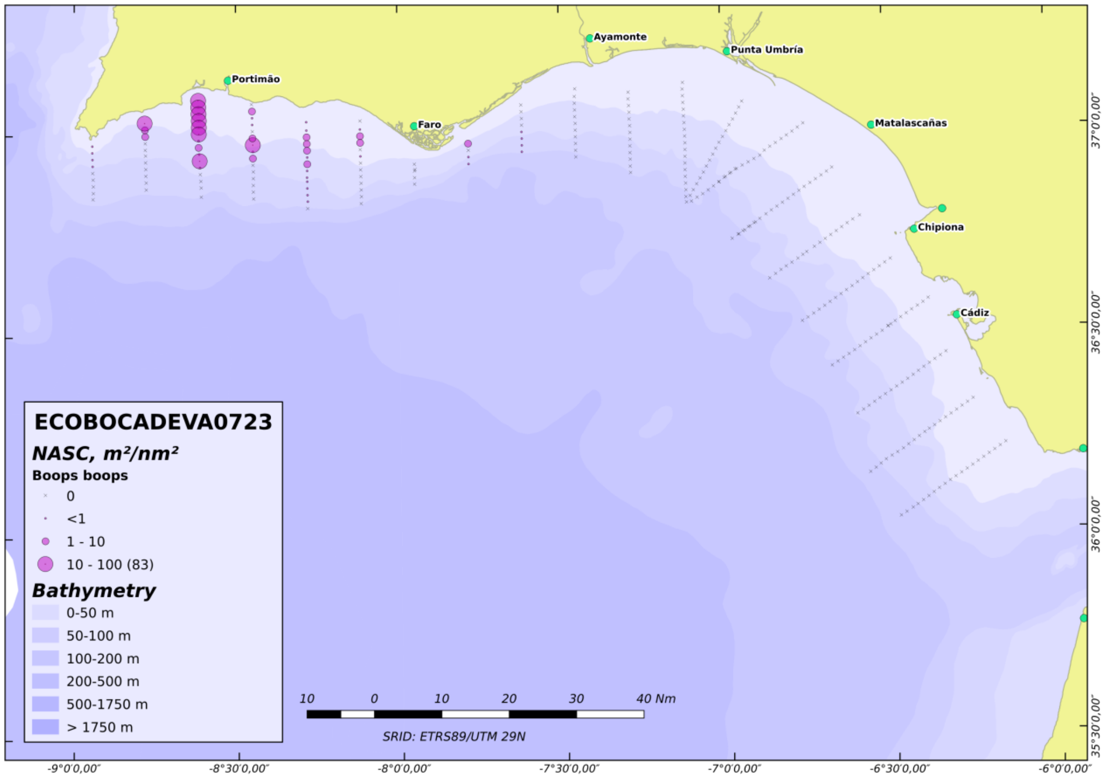



**Figure 34.** *ECOCADIZ 2023-07* survey. Bogue (*Boops boops*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.



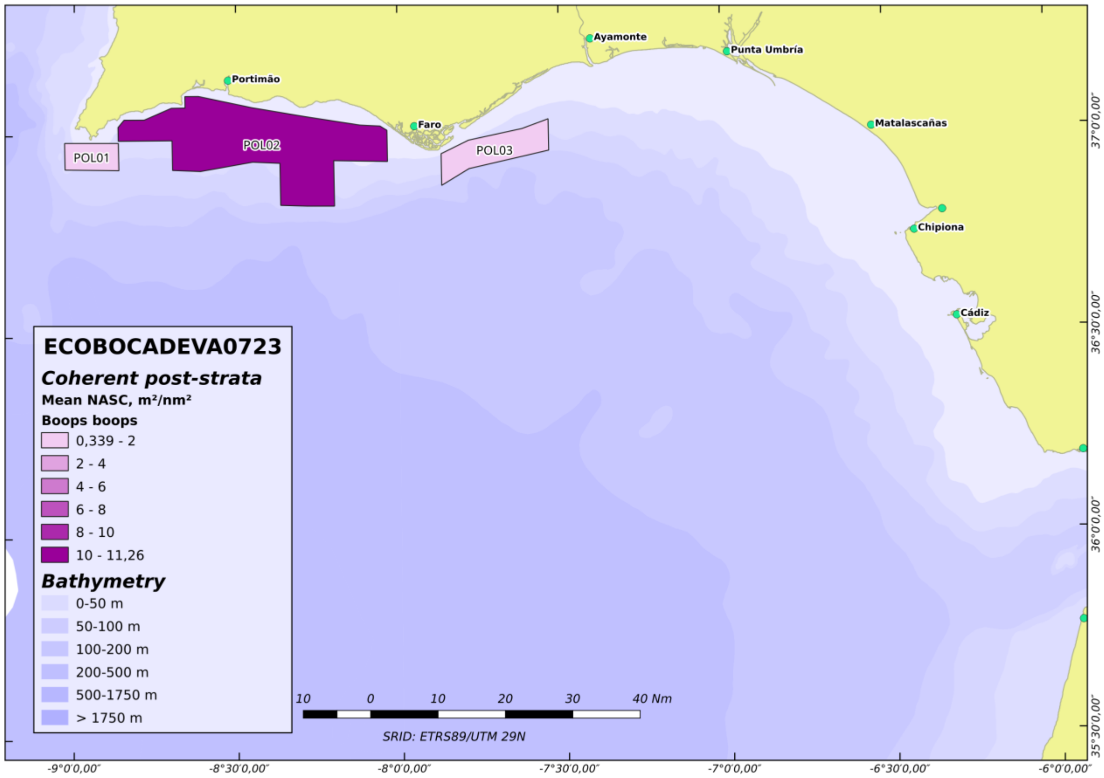




**Figure 35.** *ECOCADIZ 2023-07* survey. Bogue (*B. boops*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2 nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

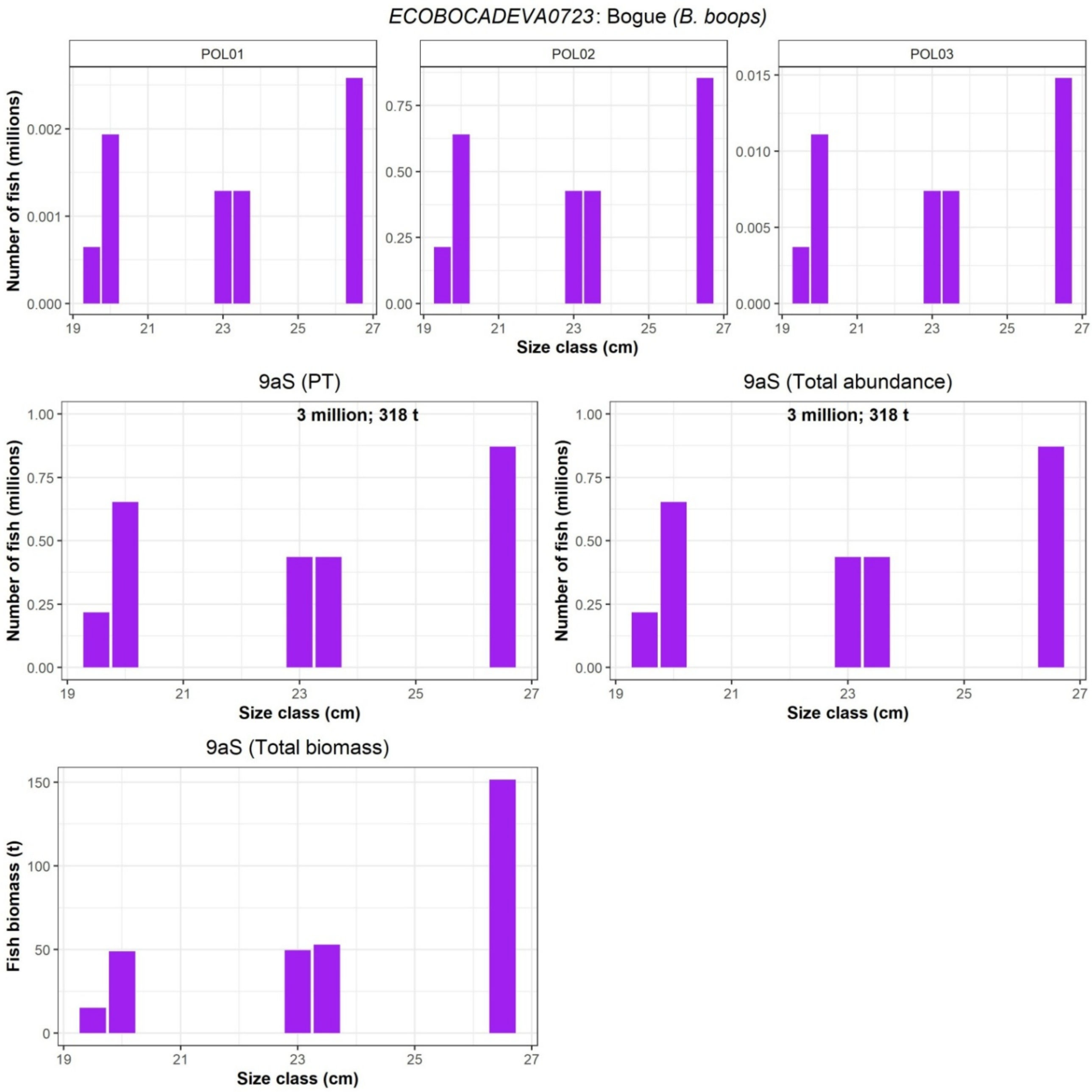
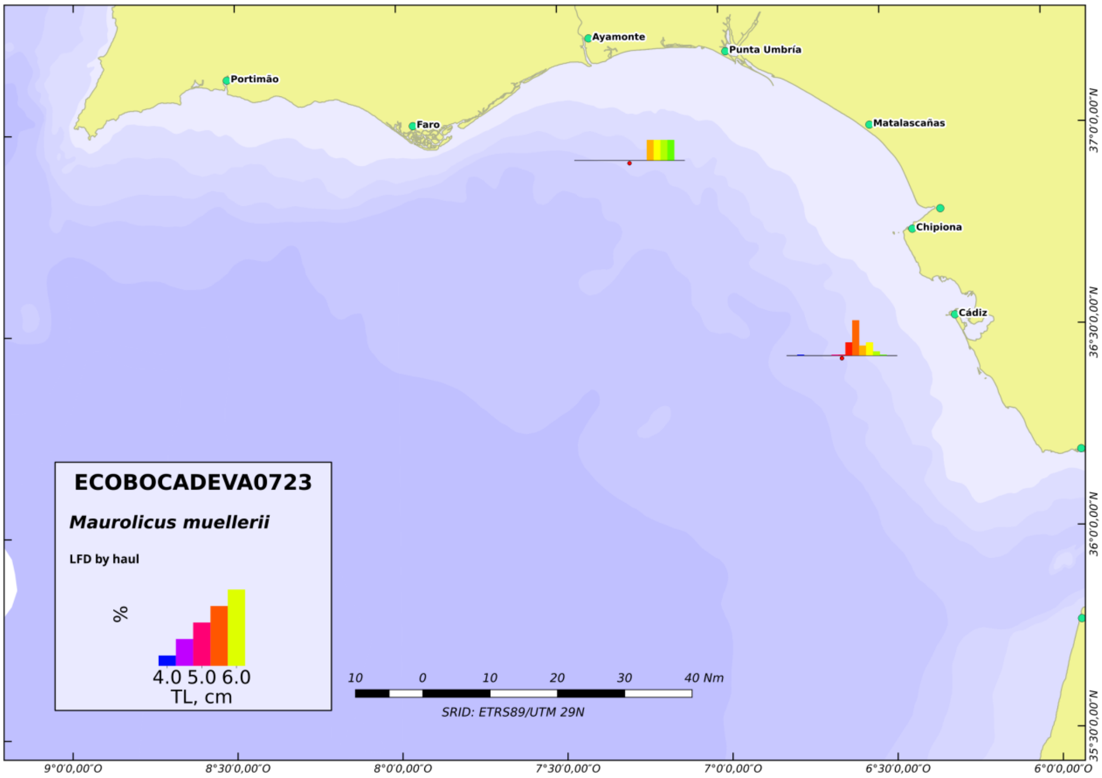



**Figure 36.** *ECOCADIZ 2023-07* survey. Bogue (*B. boops*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 35**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the *y*-axis.



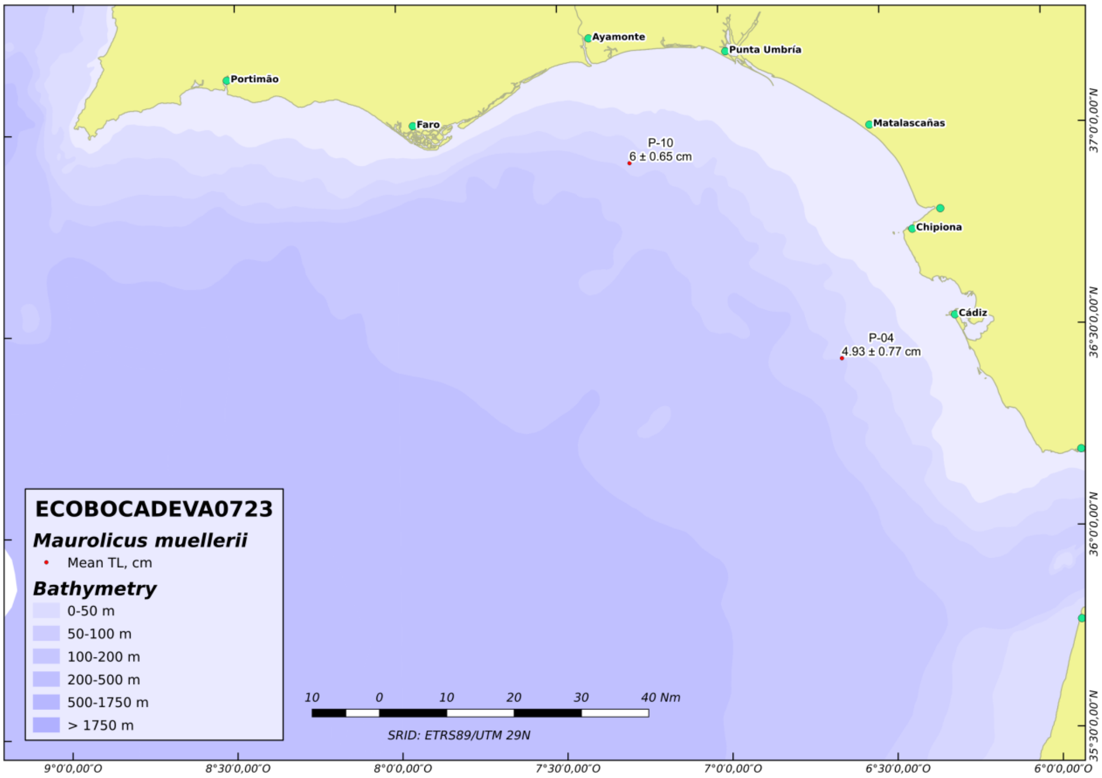




**Figure 37.** *ECOCADIZ 2023-07* survey. Pearlside (*Maurolicus muelleri*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

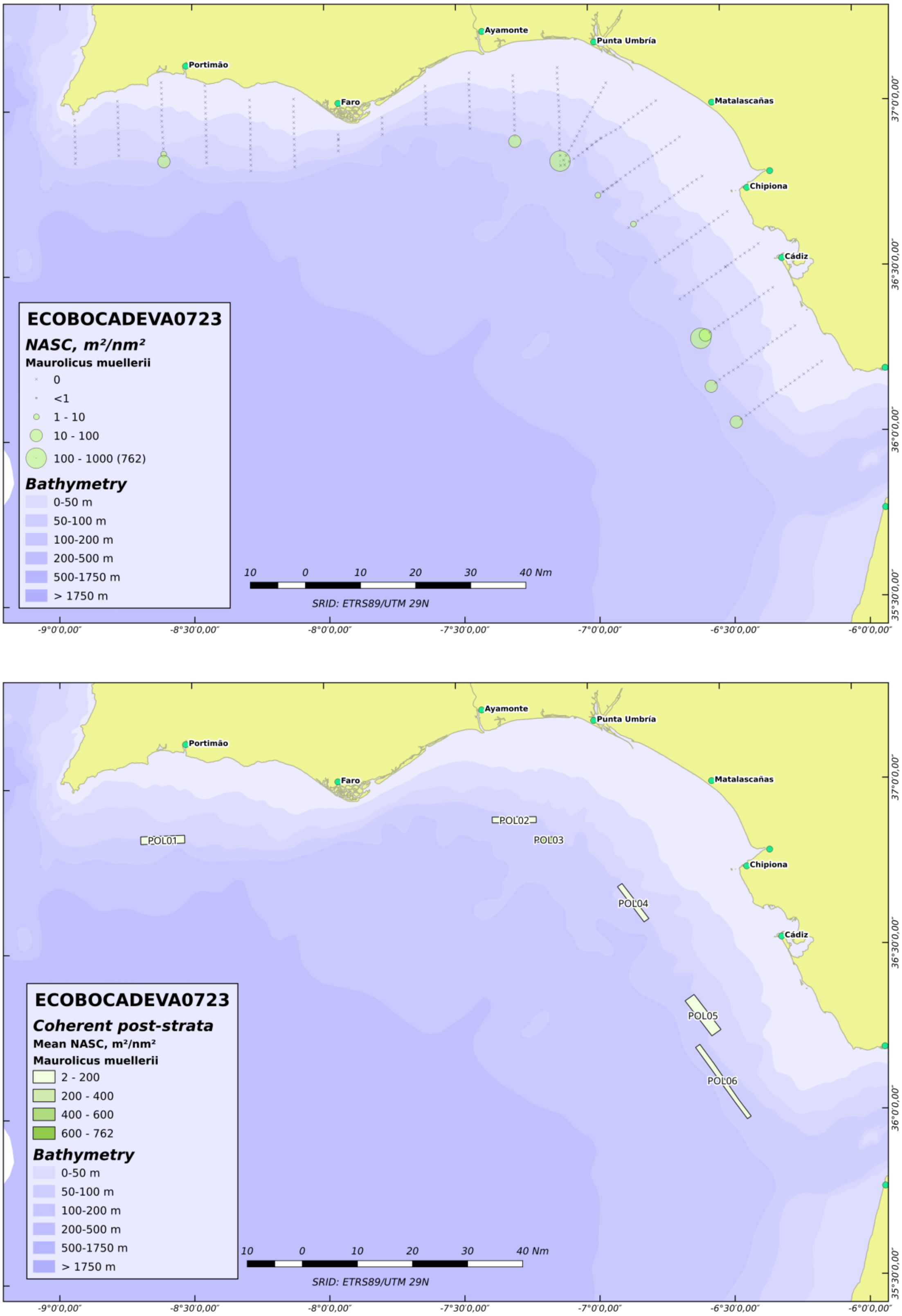



**Figure 38.** *ECOCADIZ 2023-07* survey. Pearlside (*M. muelleri*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

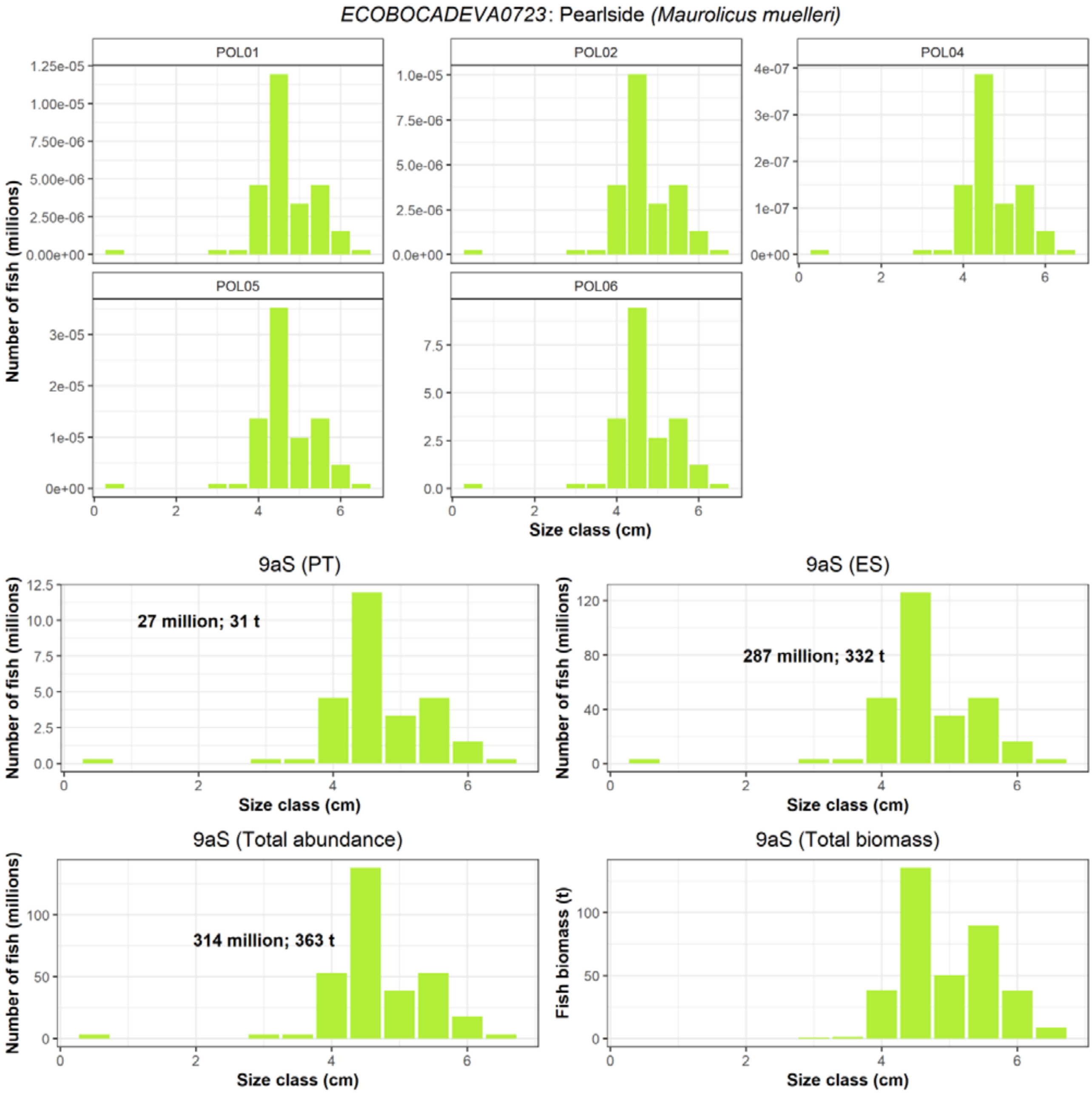
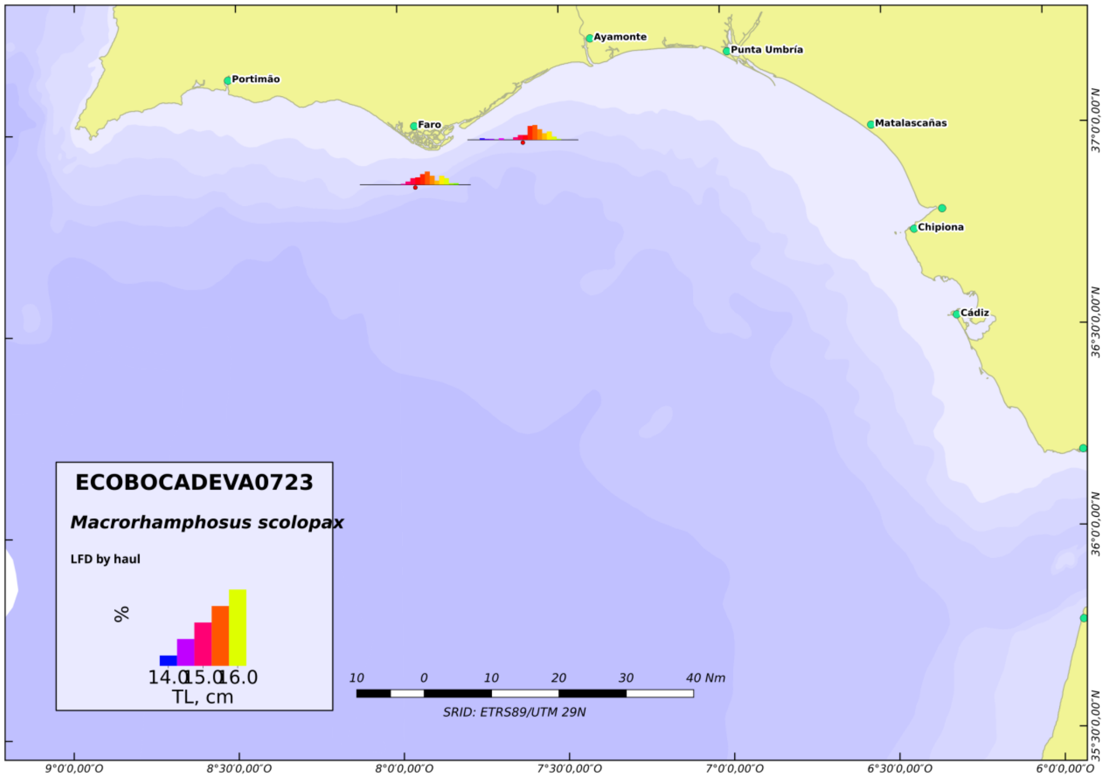



**Figure 39.** *ECOCADIZ 2023-07* survey. Pearlside (*M. muelleri*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 38**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the *y*-axis.



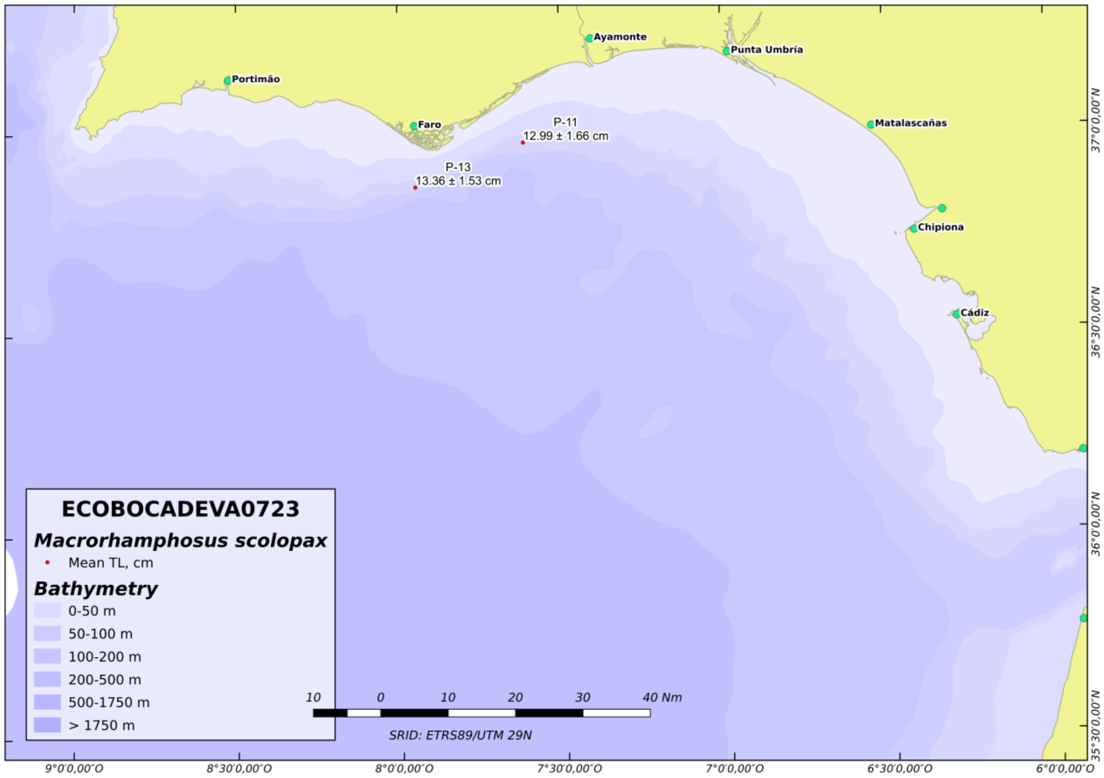
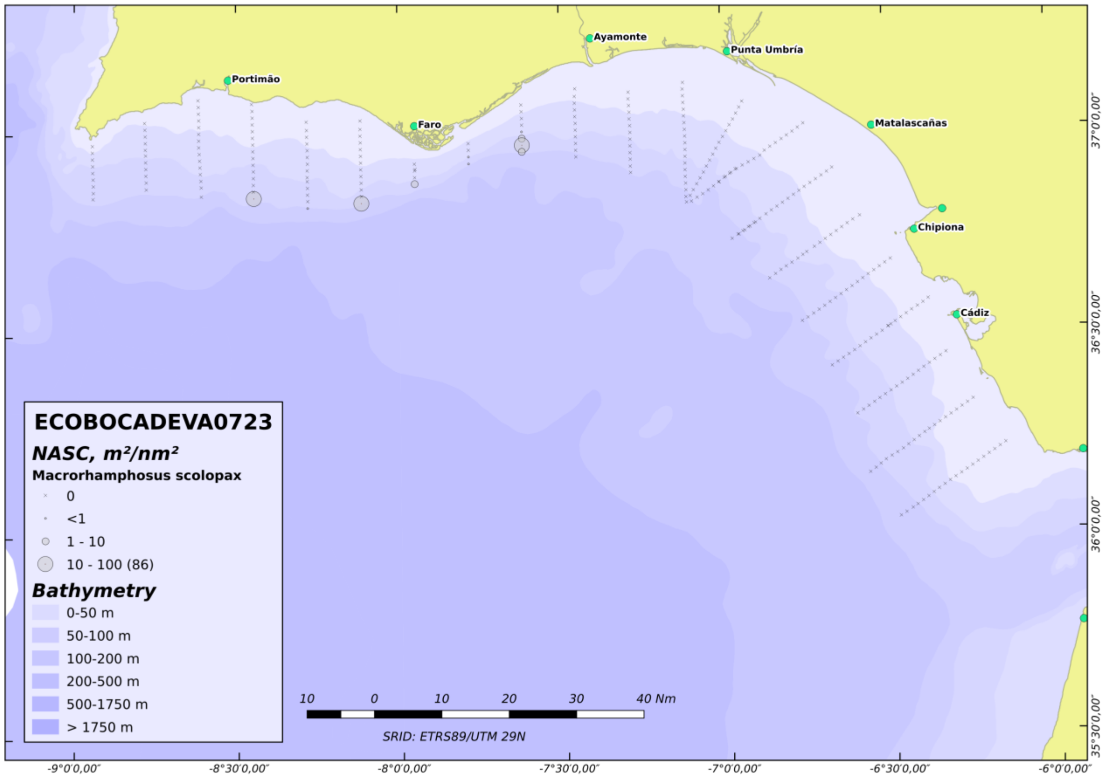




**Figure 40.** *ECOCADIZ 2023-07* survey. Longspine snipefish *(Macroramphosus scolopax)*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.



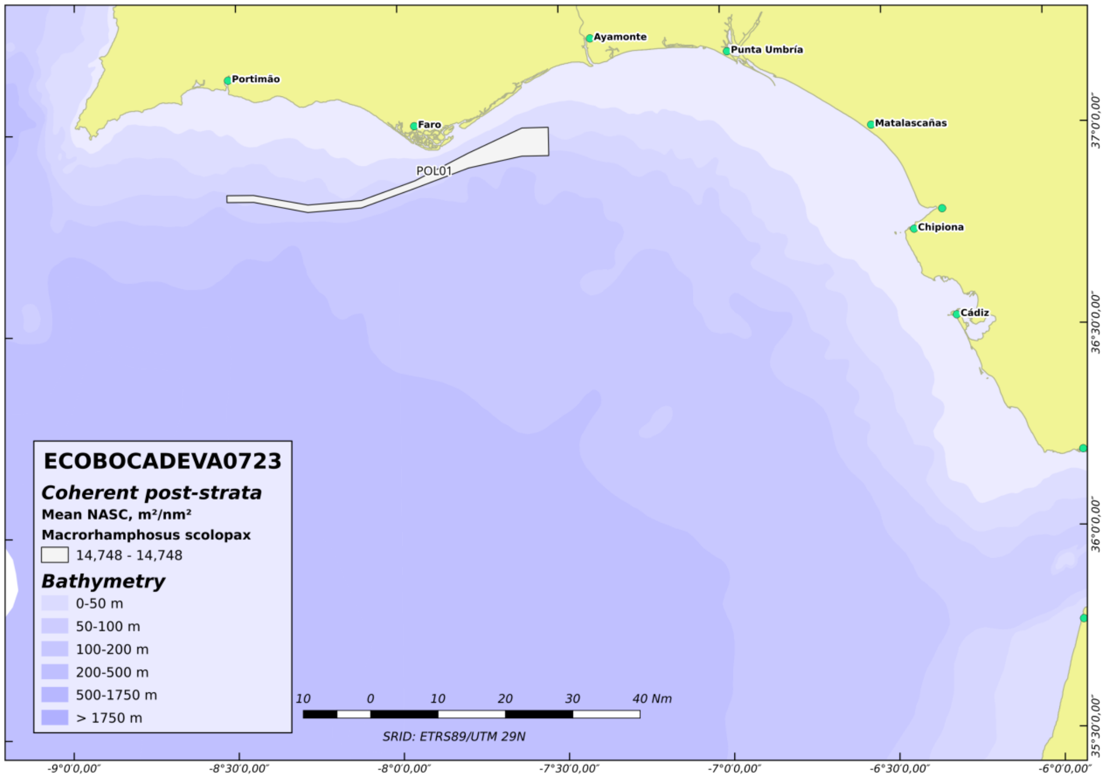




**Figure 41.** *ECOCADIZ 2023-07* survey. Longspine snipefish (*M. scolopax*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

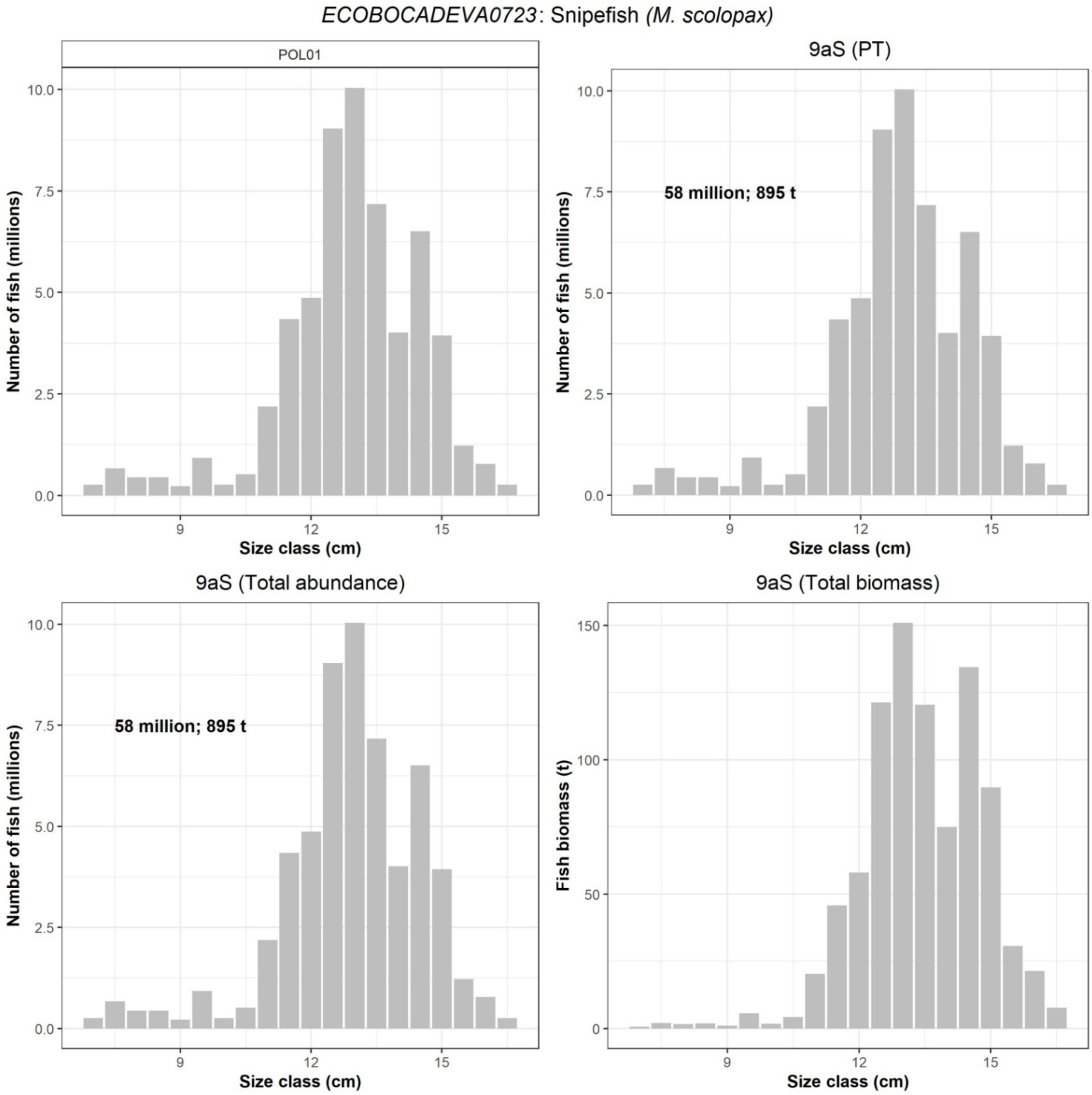



**Figure 42.** *ECOCADIZ 2023-07* survey. Longspine snipefish (*M. scolopax*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 41**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the *y*-axis.

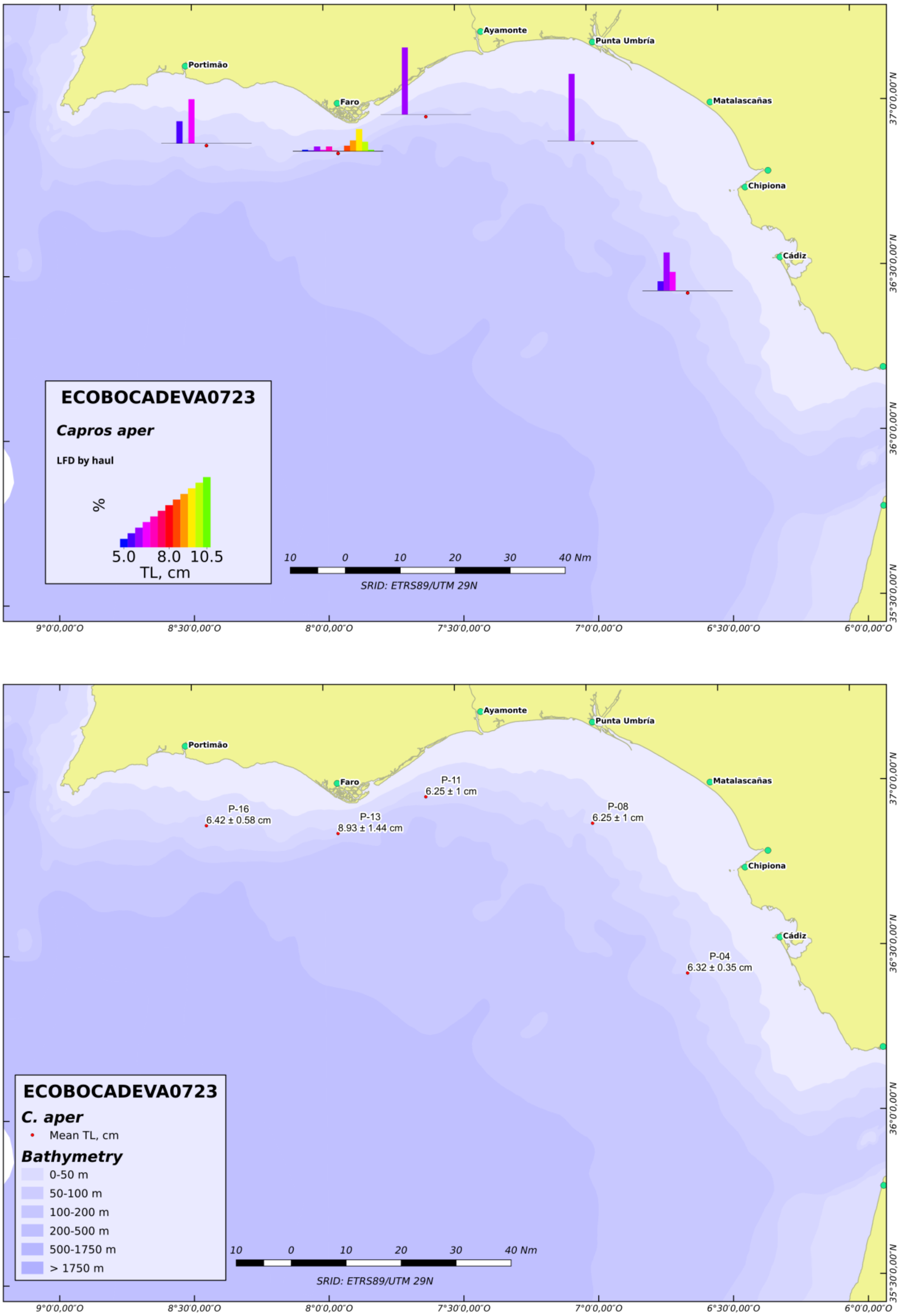



**Figure 43.** *ECOCADIZ 2023-07* survey. Boarfish *(Capros aper)*. Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

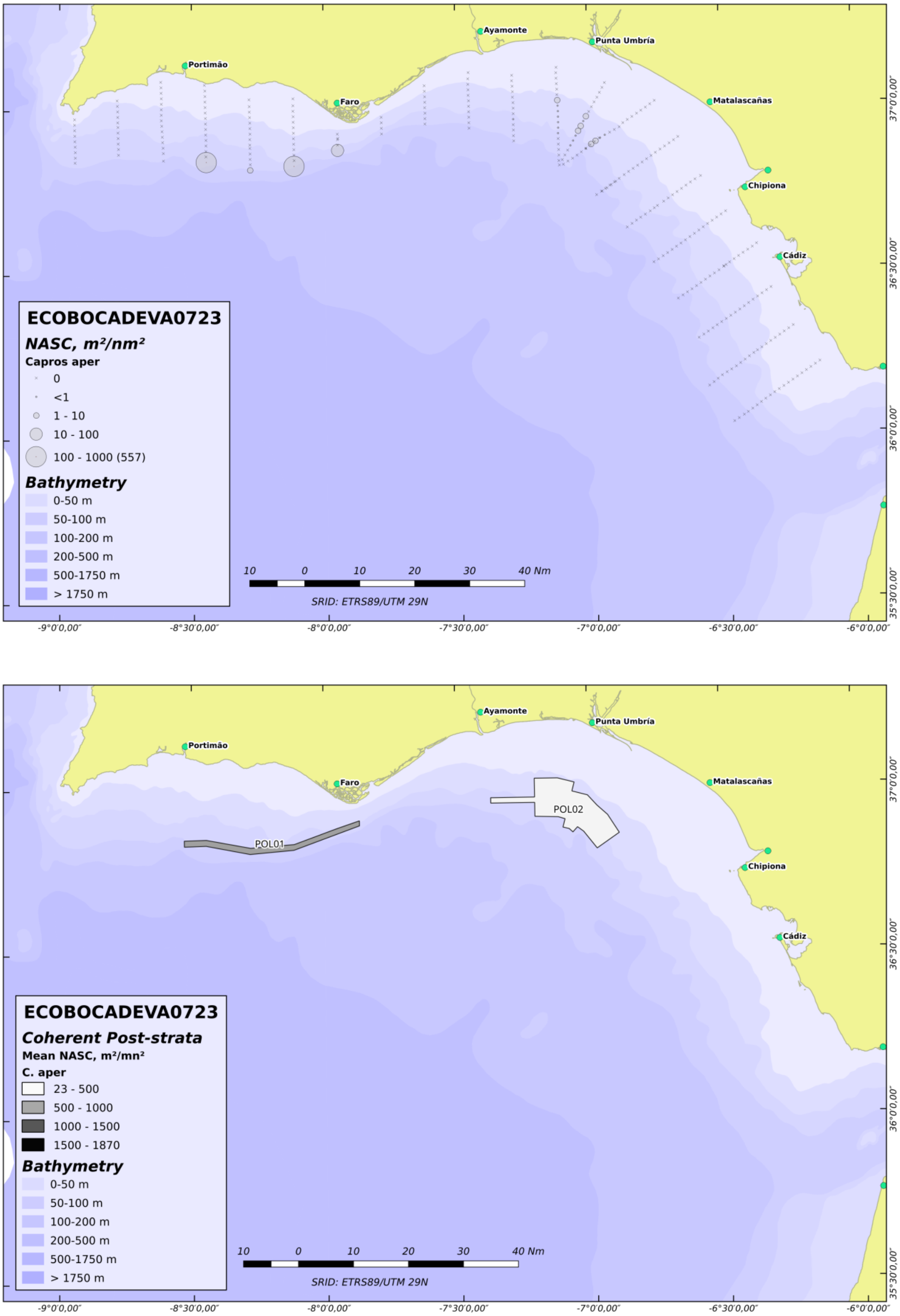



**Figure 44.** *ECOCADIZ 2023-07* survey. Boarfish (*C. aper*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

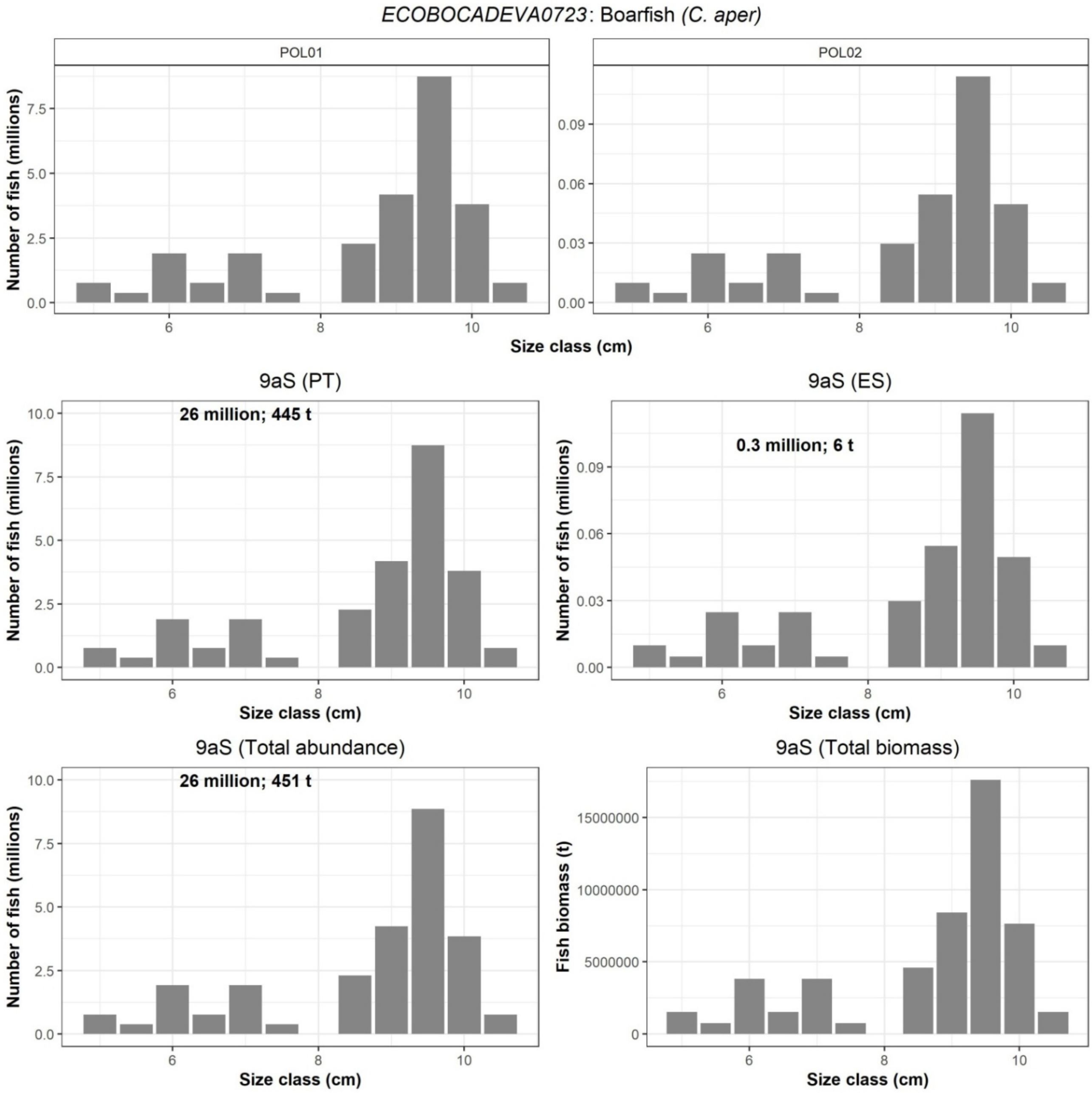



**Figure 45.** *ECOCADIZ 2023-07* survey. Boarfish (*Capros aper*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 44**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the *y*-axis.

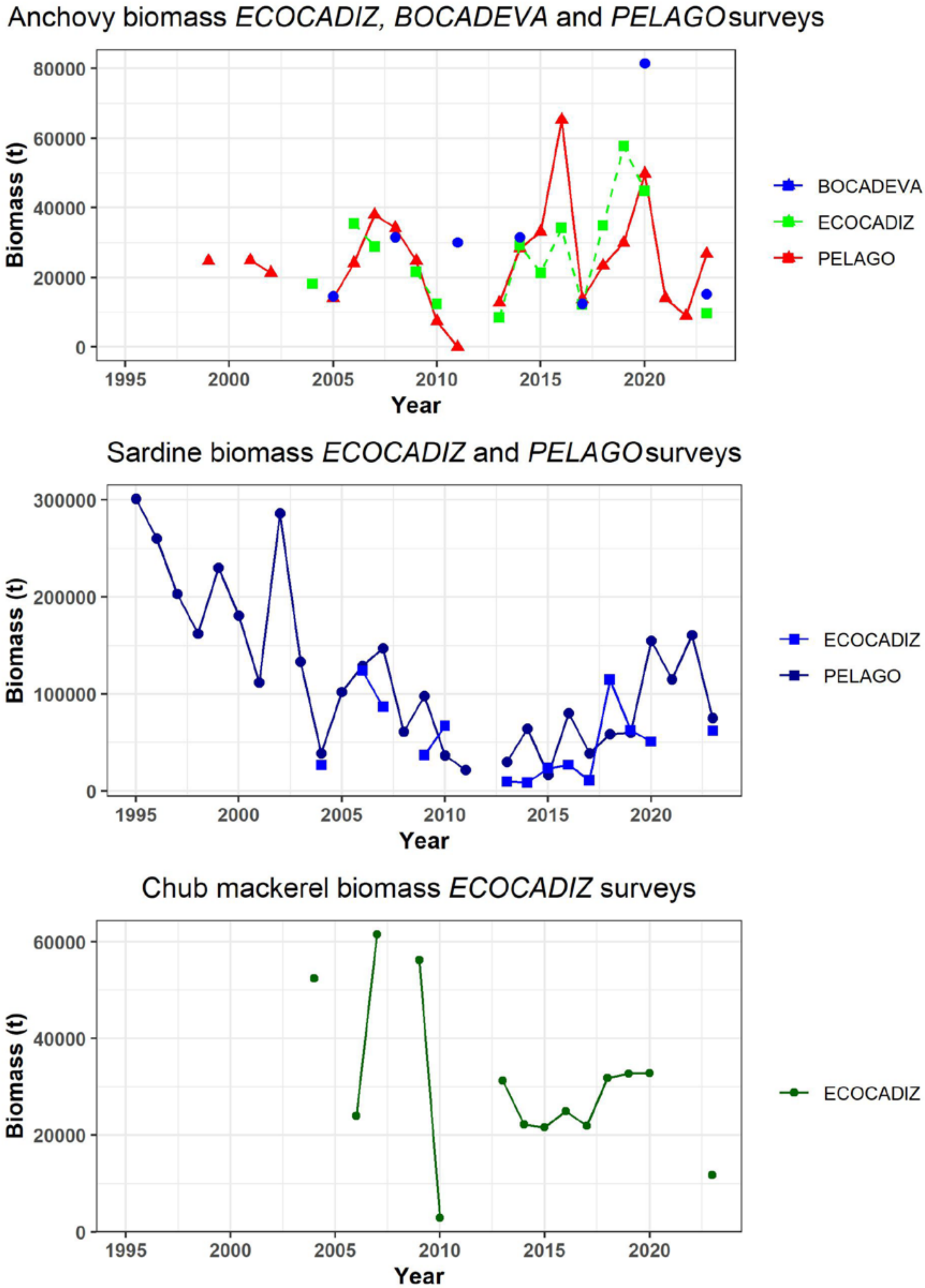



**Figure 46.** *ECOCADIZ 2023-07* survey. Historical series of acoustic estimates of anchovy, sardine and chub mackerel biomass (t) in Sub-division 9.a South from three different surveys: *BOCADEVA DEPM, ECOCADIZ* summer survey series and *PELAGO* spring survey series. The estimates correspond to the total population biomass. No chub mackerel biomass estimates are available from the *PELAGO* survey.

# Gadget for anchovy 9a South: Model description and results to provide catch advice and reference points (WGHANSA-1 2024)

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## 1. Background

The model specifications presented below correspond to those benchmarked in WKPELA 2018. The main difference is that results are presented now for the end of the second quarter of each year instead of be presented at the end of the fourth quarter. This responds to practical modifications in the definition of the assessment year, now it goes from July 1st to June 30th of the next year. Specific model assumptions for this year are presented in section 2.2 and 3, as well as estimated parameters after optimization in Table 2.

## 2. Model Description

Gadget is an age-length-structured model that integrates different sources of information in order to produce a diagnose of the stock dynamics. It works making forward simulations and minimizing an objective (negative log-likelihood) function that measures the difference between the model and data, the discrepancy is presented as a likelihood score for each time period and model component.

The general Gadget model description and all the options available can be found in Gadget manual (Begley, 2004) and some specific examples can be found in Taylor et al. (2007), Elvarsson et al. (2014) and WKICEMSE assessment for Ling (Elvarsson, 2017). The latest was used as a guide for this document.

The Gadget model implementation consists in three parts, a simulation of biological dynamics of the population (simulation model), a fitting of the model to observed data using a weighted log-likelihood function (observation model) and the optimization of the parameters using different iterative algorithms.

A list of the symbols used and estimated parameters is presented in Table 2 and a graph with the Gadget model structure presented in the last benchmark (WKPELA 2018) is available at Gadget structure graph.

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### 2.1. Simulation model

The model consists of one stock component of anchovy (*Engraulis encrasicolus*) in the ICES subdivision, 9.a South-Atlantic Iberian waters, Gulf of Cádiz. Gadget works by keeping track of the number of individuals, $N_{a,l,y,t}$, at age $a = 0, \ldots, 3$, at length $l = 3, 3.5, 4, 4.5, \ldots, 22$, at year $y = 1989, \ldots, 2024$, and each year divided into quarters $t = 1, \ldots, 4$.. The last time step of a year involves increasing the age by one year, except for the last age group, which its age remains unchanged and the age group next to is added to it, like a 'plus group' including all ages from the oldest age onwards (Taylor et al., 2007).

*Growth*

The growth function is a simplified version of the Von Bertalanffy growth equation, defined in Begley (2004) as the LengthVBSimple Growth Function (*lengthvbsimple*). Length increase for each length group of the stock is given by the equation below:

$$\Delta l = (l_\infty - l)(1 - e^{k\Delta t}), \tag{1}$$

where $\Delta t$ is the length of the timestep, $l_\infty = 19\ cm$ (fixed) is the terminal length and $k$ is the growth rate parameter.

The corresponding increase in weight (in $Kg$) of the stock is given by:

$$\Delta w = a((l + \Delta l)^b - l^b), \tag{2}$$

with $a = 3.128958e^{-6}$ and $b = 3.277667619$ set as fixed and extracted from all the samples available in third and fourth quarters from 2003 to 2017. The growth functions described above calculate the mean growth for the stock within the model. In a second step the growth is translated into a beta-binomial distribution of actual growths around that mean with parameters $\beta$ and $n$. The first is fitted by the model as described in Taylor et al. (2007) and the second represents the number of length classes that an individual is allowed to grow in a quarter and it is fixed and equal to 5.

*Initial abundance and recruitment*

Stock population in numbers at the starting point of the simulation is defined as:

$$N_{a,l,1,1} = 10000\nu_a q_{a,l}, \quad a = 0, \ldots, 3, l = 3, \ldots, 20$$

Where $\nu_a$ is an age factor to be calculated by the model and $q_{a,l}$ is the proportion at lengthgroup $l$ that is determined by a normal density with a specified mean length and standard deviation for each age group. Mean length at age ($\mu_a$) and its standard deviation ($\sigma_a$) were extracted from all the data available from 1989 to 2018 including three surveys that are not included in the model: ARSA, ECOCADIZ-RECLUTAS and SAR survey (See table 2). The mean weight at age for this initial population is calculated by multiplying a reference weight corresponding to the length by a relative condition factor assumed as 1. This reference weight at length was calculated using the formula $w = al^b$, with $a$ and $b$ as defined before. In Gadget files this was specified as a normal condition distribution (*Normalcondfile*).

@

Similarly to the process of calculate the initial abundance described above, the recruitment specifies how the stock will be renewed. Recruits enter to the age 0 population at quarters 2, 3, 4 (because of the Gadget order of calculations for each time step this is equivalent to have recruitment one quarter later, i.e. in quarters 3,4 and 1 of the next year) of all years, respectively, as follows:

$$N_{0,l,y,t} = p_{l,t} R_{y,t}, \quad t = 2, 3, 4, l = 3, \ldots, 15,$$

where $R_{y,t}$ represents recruitment at year $y$ and quarter $t$, and $p_{l,t}$ the proportion in lengthgroup $l$ that is recruited at quarter $t$ which is sampled from a normal density with mean ($\mu$) and standard deviation ($\sigma_t$) calculated by the model. The mean weight for these recruits is calculated by multiplying the reference weight corresponding to the length by a relative condition factor assumed as 1. Reference weight at age was the same used to calculate the initial population mean weight at age explained above. In Gadget files this was specified also as a normal condition distribution (*Normalcondfile*).

*Fleet operations*

In the model the fleets act as predators. There are three fleets inside the model: two for surveys (ECOCADIZ acoustic survey and PELAGO acoustic survey) and one for commercial landings including all fleets: Spanish purse-seine, trawlers, Portuguese purse-seine, and others. The main fleet is Spanish purse-seine representing more than a 90 % of all the catches from 2001 to 2016 and more than a 80 % from 1989 to 2000. It is also the only fleet with a lenght distribution available, then we decide to include all commercial reported data in the same fleet which is mostly the Spanish purse-seine.

Surveys fleets are assumed to remove 1 $Kg$ in each of the quarters when the surveys take place while the commercial fleet is assumed to remove the reported number of individuals each quarter. This total amount of biomass (for the surveys) or numbers (for the commercial fleet) landed is then split between the length groups according to the equations 3 and 4 respectively, as follows:

$$C_{l,y,t} = \frac{E_{y,t} S_{l,T} N_{l,y,t} W_l}{\sum_l S_{l,T} N_{l,y,t} W_l}, \tag{3}$$

and

$$C_{l,y,t} = \frac{E_{y,t} S_{l,T} N_{l,y,t}}{\sum_l S_{l,T} N_{l,y,t}}, \tag{4}$$

where $E_{y,t}$ represents biomass landed (in $Kg$) at year $y$ and quarter $t$ in equation 3 and numbers landed in equation 4, $W_l$ corresponds to weight at length and $S_{l,T}$ represents the suitability function that determines the proportion of prey of length $l$ that the fleet is willing to consume during period $T, T = 1, 2, 3$ where $T = 1$ corresponds to the period 1989-2000, $T = 2$ to 2001-**2023** and $T = 3$ to 1989-**2023**.

For this model the suitability function chosen for the fleet and surveys is specified in Gadget manual as an ExponentialL50 function (*expsuitfuncl50*), and it is defined as follows:

$$S_{l,T} = \frac{1}{1 + e^{\alpha_T (l - l_{50,T})}} \tag{5}$$

where $l_{50,T}$ is the length of the prey with a 50% probability of predation during period T and $\alpha_T$ a parameter related to the shape of the function, both parameters are estimated from the data within the Gadget model. The whole model time period (1989-**2023**) has been splited into two different periods for suitability parameters of the commercial fleet because of changes in size regulation for the fishery around 1995 that become effective around 2001.

### *2.2. Observation model*

Data are assimilated by Gadget using a weighted log-likelihood function. The model uses as likelihood components two biomass survey indices: ECOCADIZ acoustic survey and PELAGO acoustic survey; age - length keys from the commercial fleet (Spanish purse-seine), PELAGO survey and the ECOCADIZ survey; and length distributions for the commercial fleet, PELAGO and ECOCADIZ surveys (see Table 2.2 for a detailed description of the likelihood data used in the model).

#### *Biomass Survey indices*

The survey indices are defined as the total biomass of fish caught in a survey. The survey index is compared to the modelled abundance using a log linear regression with slope equal to 1 (*fixedslopeloglinearfit*), as follows:

$$\ell = \sum_t (\log(I_{y,t}) - (\alpha + \log(N_{y,t}))^2 \tag{6}$$

where $I_{y,t}$ is the observed survey index at year $y$ and quarter $t$ and $N_{y,t}$ is the corresponding population biomass calculated within the model. Note that the intercept of the log-linear regression, $\alpha = \log(q)$, with $q$ as the catchability of the fleet (i.e $I_{y,t} = qN_{y,t}$).

#### *Catch distribution*

Age-length distributions are compared using $l$ lengthgroup at age $a$ and time-step $y, t$ for both, commercial and survey fleets with a sum of squares likelihood function (*sumofsquares*):

$$\ell = \sum_y \sum_t \sum_l (P_{a,l,y,t} - \pi_{a,l,y,t})^2 \tag{7}$$

where $P_{a,l,t,y}$ is the proportion of the data sample for that time/age/length combination, while $\pi_{a,l,t,y}$ is the proportion of the model sample for the same combination, as follows:

$$P_{a,l,t,y} = \frac{O_{a,l,y,t}}{\sum_a \sum_l O_{a,l,y,t}} \tag{8}$$

and

$$\pi_{a,l,t,y} = \frac{N_{a,l,y,t}}{\sum_a \sum_l N_{a,l,y,t}}, \tag{9}$$

where $O_{a,l,y,t}$ corresponds to observed data.

When only length or age distribution is available. It is compared using equation 7 described above but considering all ages or all lengths, respectively.

*Understocking*

If the total consumption of fish by all the predators (fleets in this case) amounts to more than the biomass of prey available, then the model runs into "understocking". In this case, the consumption by the predators is adjusted so that no more than 95% of the available prey biomass is consumed, and a penalty, given by the equation 10 below, is applied to the likelihood score obtained from the simulation (Stefansson 2005, sec 4.1.)

$$\ell = \sum_t U_t^2 \tag{10}$$

where $U_t$ is the understocking that has occurred in the model for that timestep.

*Penalties*

The BoundLikelihood likelihood component is used to give a penalty weight to parameters that have moved beyond the bounds in the optimisation process. This component does specify the penalty that is to be applied when these bounds are exceeded.

$$\ell_i = \begin{cases} lw_i(val_i - lb_i)^2 & \text{if } val_i < lb_i \\ uw_i(val_i - ub_i)^2 & \text{if } val_i > ub_i \\ 0 & otherwise \end{cases}$$

Where $lw_i = 10000$ and $uw_i = 10000$ are the weights applied when the parameter exceeds the lower and upper bounds, respectively, $val_i$ is the value of the parameter and, $lb_i$ and $ub_i$ are the lower and upper bounds defined for the parameter.

*2.3. Order of calculations*

The order of calculations is as follows:

1. **Printing**: model output at the beginning of the time-step
2. **Consumption**: by the fleets
3. **Natural mortality**
4. **Growth**
5. **Recruitment**: new individuals enter to the population
6. **Likelihood comparison**: Comparison of estimated and observed data, a likelihood score is calculated

7. **Printing**: model output at the end of the time-step
8. **Ageing**: if this is the end of year the age is increased

Because of this order of calculations the time step of indexes, age-length keys and length distributions of the surveys are defined in Gadget a quarter before.

### *2.4. Implementation, weighting procedure*

Input data (Likelihood files) were prepared for Gadget format using the *mfdb* R package (Lentin, 2014), running and weighting procedures were implemented in R with the gadget.iterative function from *Rgadget* package. This function follows the approach presented in Taylor et al. (2007) and in the appendix of Elvarsson et al. (2014) based on the iterative reweighting scheme of Stefánsson (1998) and Stefansson (2003), which is summarized as follows:

Let $\mathbf{w_r}$ be a vector of length $L$ with the weights of the likelihood components (excluding understocking and penalties) for the run $r$, and $SS_{i,r}, i = 1, \ldots, L$, the likelihood score of component $i$ after run $r$. First, a Gadget optimization run is performed to get a likelihood score ($SS_{i,1}$) for each likelihood component assuming that all components have a weight equal to one, i.e., $\mathbf{w_1} = (1, 1, \ldots, 1)$. Then, a separated optimization run for each of the components ($L$ optimization runs) is performed using the following weight vectors:

$$\mathbf{w_{i+1}} = (1/SS_{1,1}, \ldots, (1/SS_{i,1}) * 10000, 1/SS_{i+1,1}, \ldots, 1/SS_{L,1}), i = 1, \ldots, L.$$

Resulting likelihood scores $SS_{i,i+1}$ are then used to calculate the residual variance, $\hat{\sigma}_i^2 = SS_{i,i+1}/df^*$ for each component, that is used to define the final weight vector as

$$\mathbf{w} = (1/\hat{\sigma}_1^2, \ldots, 1/\hat{\sigma}_L^2).$$

Where degrees of freedom $df^*$ are approximated by the number of non-zero data points in the observed data for each component. Finally, the total objective function is the sum of all likelihoods components multiplied by their respective weights according to the vector $\mathbf{w}$ .

In order to assign weights to the individual likelihood components (See table 2.2) in the procedure described above, all the survey indices were grouped together.

### *2.5. Initial parameters and optimization*

Initial parameter values with their boundaries and settings for the optimising algorithms can be found in initial values for parameters file and optimization file. The optimization algorithms converged in individual and weighted runs.

## 3. Remarkable Model Assumptions (in bold the terms associated to the more recent assumptions)

- Due to lack of information of length distributions and Age-length keys for commercial catches in the first and second quarter of 2020, for this year assessment, the length distribution of those quarters in year 2020 was approximated using the joint distribution of 2018 and 2019. For the Age-length key the one for the PELAGO 2020 survey was used.

- Due to discrepancies on mean lenght and weight at age in PELAGO survey for 2023 a crossvalidation for age composition was required. This crossvalidation reveals some missestimations in the otolith reading suggesting that more analysis was needed to agreed on the definitive age composition. For this reason age distribution of PELAGO survey has been updated since 2020 after the crossvalidation exercise. This update started at 2020 because the age reader in Portugal was replaced in that year.

- Due to technical problems there are no data available for ECOCADIZ survey in 2021 and 2022.

- The model was implemented quarterly from 1989 to the second quarter of **2024**.

- All commercial fleets where grouped into only one from 1989 to **2024** second quarter: The Spanish purse-seine. The Spanish purse-seine which represents more than a 90 % of all the catches from 2001 to 2016 and more than a 80 % from 1989 to 2000. It is also the only fleet with a lenght distribution available. For the first two quarters of year **2024**, provisional catches estimations of Spanish (until May 18th) purse-seine fleet were used and catches for June were estimated as the **39%** of January to May catches based on historical records from 2009 to **2023**. There were not any catches for Portuguese purse-seine in these two quarters.

- It was decided to include also discards (available from 2014 onwards) in WGHANSA-1-2020. This decision was taken because they were already accounted for some years in the previous assessments to 2020 but we did not notice about that. Since then we include discards in catches data.

- The parameters for weight-length relationship equation ($w = al^b$,) were assumed fixed and defined as $a = 3.128958e^{-6}$ and $b = 3.277667619$. Those values were calculated from all the samples available in third and fourth quarters from 2003 to 2017.

- Natural mortality at age was also considered fixed with $M_0 = 2.21$ and $M_1, M_2, M_3 = 1.3$,.

- There was a minimum landing size restriction from 1995, that were only effective until 2001. As a consequence it was neccesary to define different suitability parameters for two different periods. One from 1989 to 2000, and the other from 2001 to **2023**.

- Age 0 individuals were removed for **all** the data input corresponding to ECOCADIZ survey. It was noticed that age 0 was not removed from the length distribution in the assessments prior to 2021.

- It was noticed that the length distribution for year 2020 in ECOCADIZ survey was not included in the model used for 2021 assessment. We include that missing information in the model described in this document.

- Recruits enter to the age 0 population at quarters 2, 3 and 4 (because of the Gadget order of calculations for each time step this is equivalent to have recruitment one quarter later, i.e. in quarters 3,4 and 1 of the next year) of all years except the last year, because at the end of June there are no recruits (zero age individuals). Then, biomass and abundance estimates at the end of the second quarter need to be corrected removing age 0 individuals.

## 4. Natural mortality selection

Natural mortality selection is justified by the following arguments:

- Natural mortality was preferred to be selected from classical indirect formulations based on life history parameters. For it we used the R package *FSA* to obtain empirical estimates of natural mortality.

- For the estimation of the natural mortality rate, the Von Bertalanffy growth parameters and the maximum age that the species can live were used. Growth parameters of the Von Bertalanffy function were taken from Bellido et al. (2000) ($l_\infty = 18.95, k = 0.89, t_0 = -0.02$), and for the maximum observed age, we explored a range from age 3 to 5, but finally age 4 was considered adequate. A total of 13 estimators were produced using the R package *FSA* and the a value of $M = 1.3$ was undertaken (midway between the median and the mean of the available estimates for Agemax=4).

- Currently is generally accepted that Natural mortality may decrease with age, as far as it presumed to be particularly greater at the juvenile phase. It was agreed to adopt for the adult ages of anchovy (ages 1 to 4) the constant natural mortality estimated before (1.3), but for the juveniles (age 0) a greater one in proportion to the ratio of natural mortality at ages 0 and 1 ($M_0/M_1$) resulting from the application of the Gislason et al. (2010) method for modelling natural mortality as a function of the growth parameters. For it we used four vectors of length-at-age: derived from the Von Bertalanffy growth function in Bellido et al. (2000) for ages 1-5, from the ECOCADIZ-RECLUTAS survey for ages 0-3, the average of the length-at-age in the catches from 1987 to 2016 and the average of the length-at-age in the catches from 2007 to 2016. There was no major basis to select one or the other, we directly choosed the pattern shown by the ECOCADIZ-RECLUTAS data just because it seemed to be smoothest one (particularly for age 1 onwards as presumed here). The ratio $M_0/M_1$ is 2.722670/ 1.595922 = 1.7. Therefore $M_0 = 1.3 * 1.7 = 2.21$.

- In summary for anchovy 9a South, the adopted natural mortality by ages are $M_0 = 2.21, M_1 = 1.3$ and $M_2^+ = 1.3$ (similar at any older age).

## 5. Fit to data

A summary of likelihood scores is presented in Figure 1 while a comparison of estimated versus observed data is summarized in the following Figures:

*Length distributions*

- Figure 2: Length distribution of the commercial fleet.
- Figure 3: Length distribution of the ECOCADIZ acoustic survey.
- Figure 4: Length distribution of the PELAGO acoustic survey.
- Figure 5: Summary of residuals for length distributions.

*Age distributions*

- Figure 6: Age distribution of the commercial fleet.
- Figure 7: Age distribution of the ECOCADIZ acoustic survey.
- Figure 8: Age distribution of the PELAGO acoustic survey.
- Figure 9: Summary of residuals for age distributions.

*Biomass survey indices fit*

- Figure 10: Summary of biomass survey indices fit.

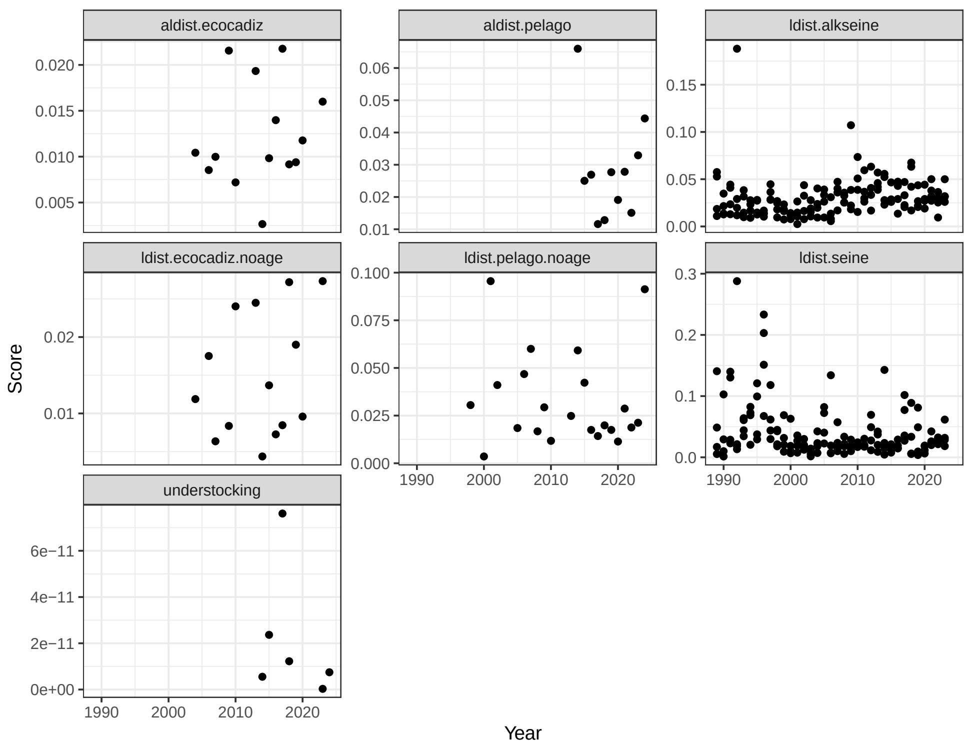


Figure 1: Likelihood scores for age-length key of ECOCADIZ survey, PELAGO survey and commercial landings (Upper panel) and length distribution of ECOCADIZ survey, PELAGO survey and landings. Dots represent the score for each quarter.

| | |
|---|---|
| **Index** | |
| $a$ | Age, $a = 0,\ldots,3$ |
| $l$ | Length, $l = 3,3.5,4,4.5,\ldots,22$ |
| $y$ | Years, $y = 1989,\ldots,2024$ |
| $t$ | Quartely timestep, $t = 1,\ldots,4$ |
| $T$ | $T = 1$ for period 1989-2000, $T = 2$ for period 2001-2023 |
| **Parameters** | |
| *Fixed* | |
| $a$ | Parameter of weight-length relationship $w = al^b$, $a = 3.128958 \times 10^{-6}$ |
| $b$ | Parameter of weight-length relationship $w = al^b$, $b = 3.277667619$ |
| $\mu_a$ | Initial population mean length at age |
| | $\mu_0 = 9.99, \mu_1 = 12.1, \mu_2 = 15.2, \mu_3 = 16.1$ |
| $\sigma_a$ | Initial population standard deviation for length at age |
| | $\sigma_0 = 0.836, \sigma_1 = 0.5, \sigma_2 = 1, \sigma_3 = 1.2$ |
| $M_a$ | Natural mortality, $M_0 = 2.21, M_1 = 1.3, M_2 = 1.3, M_3 = 1.3$ |
| $n$ | Maximum number of length classes that an individual is supposed to grow $n = 5$ |
| *Estimated* | |
| $l_\infty$ | Asympthotic length, $l_\infty$=30 |
| $k$ | Annual growth rate, $k = 0.0781331$ |
| $\beta$ | Beta-binomial parameter, $\beta = 5000$ |
| $\nu_a$ | Age factor, $\nu_0 = 120000, \nu_1 = 84400,$ |
| | $\nu_2 = 0.0601, \nu_3 = 4.48e-07$ |
| $\mu$ | Recruitment mean length, $\mu = 9.84532$ |
| $\sigma_t$ | Recruitment length standard deviation by quarter, $\sigma_2 = 3.06345$, $\sigma_3 = 1.68705$, $\sigma_4 = 3.6848$ |
| $l_{50,T}$ | Length with a 50% probability of predation during period T, |
| | $l_{50,1}^{seine} = 11.1$, $l_{50,2}^{seine} = 10.9$, $l_{50,3}^{ECO} = 12.9$, $l_{50,3}^{PEL} = 14.6$ |
| $\alpha_T$ | Shape of function, $\alpha_1^{seine} = 0.366$, $\alpha_2^{seine} = 0.875$, $\alpha_3^{ECO} = 1.39$, $\alpha_3^{PEL} = 0.404$ |
| **Observed Data** | |
| $E_{y,t}$ | Number or biomass landed at year $y$ and quarter $t$ |
| $W_l$ | Weight at length |
| $I_{y,t}$ | Observed survey index at year $y$ and quarter $t$ |
| $P_{a,l,y,t}$ | Proportion of the data sample over all ages and lengths for timestep/age/length combination |
| $O_{a,l,y,t}$ | Observed data sample for time/age/length combination |
| $x_{a,y,t}$ | Sample mean weight from the data for the timestep/age combination |
| **Others** | |
| $\Delta l$ | Length increase |
| $\Delta w$ | Weight increase |
| $\Delta t$ | Length of timestep |
| $N_{a,l,y,t}$ | Number of individuals of age $a$, length $l$ in the stock at year and quarter $y$ and $t$, respectively. |
| $q_{a,l}$ | Proportion in lengthgroup $l$ for each age group |
| $R_{y,t}$ | Recruitment at year $y$ and quarter $t$ |
| $p_{l,t}$ | Proportion in lengthgroup $l$ that is recruited at quarter $t$ |
| $C_{l,y,t}$ | Total amount in biomass landed by surveys and in number caught by commercial fleet (discards 2014-2019) |
| $S_{l,T}$ | Proportion of prey of length $l$ that the fleet/predator is willing to consume during period $T$ |
| $\pi_{a,l,y,t}$ | Proportion of the model sample over all ages and lengths for that timestep/age/length combination |
| $\mu_{a,y,t}$ | Mean length at age for the timestep/age combination |
| $U_t$ | Understocking for timestep $t$ |
| $lw_i$ and $uw_i$ | Weights applied when the parameter exceeds the lower or upper bound |
| $lb_i$ and $ub_i$ | Lower and upper bound defined for the parameter |
| $val_i$ | Value of the parameter |

Table 1: List of Symbols used in model specification and parameter estimates after optimization

| Data source | type | Timespan | Likelihood function |
|---|---|---|---|
| Commercial catches | Length distribution | All quarters, 1989-**2023** | See eq. 7 |
| (discards from 2014 onwards) | Age-length key | All quarters, 1989-**2023** | See eq. 7 |
| ECOCADIZ acoustic survey | Biomass survey indexes | Second quarter 2004, 2006 | see eq. 6 |
| | | third quarter 2007, 2009, 2010, 2013-**2023** | |
| | Length distribution | Second quarter 2004, 2006 | see eq. 7 |
| | | third quarter 2007, 2009, 2010, 2013-**2023** | |
| | Age-length key | Second quarter 2004, 2006 | see eq. 7 |
| | | third quarter 2007, 2009, 2010, 2013-**2023** | |
| PELAGO acoustic survey | Biomass survey indexes | First quarter 1999, 2001-2003 | see eq. 6 |
| | | second quarter 2005-2010 and 2013-2024 | |
| | length distribution | First quarter 1999, 2001-2003 | see eq. 7 |
| | | second quarter 2005-2010, 2013-2024 | |
| | Age-length key | second quarter 2014-2024 | see eq. 7 |

Table 2: Overview of the likelihood data used in the model. Important remark: Due to lack of information of length distributions and Age-length keys for commercial catches in the first and second quarter of 2020, the length distribution was approximated using the joint distribution of 2018 and 2019 and the Age-length key used was the one for the PELAGO 2020 survey.


Figure 2: Comparison between observed and estimated catches length distribution. Black lines represent estimated data while gray lines represent observed data

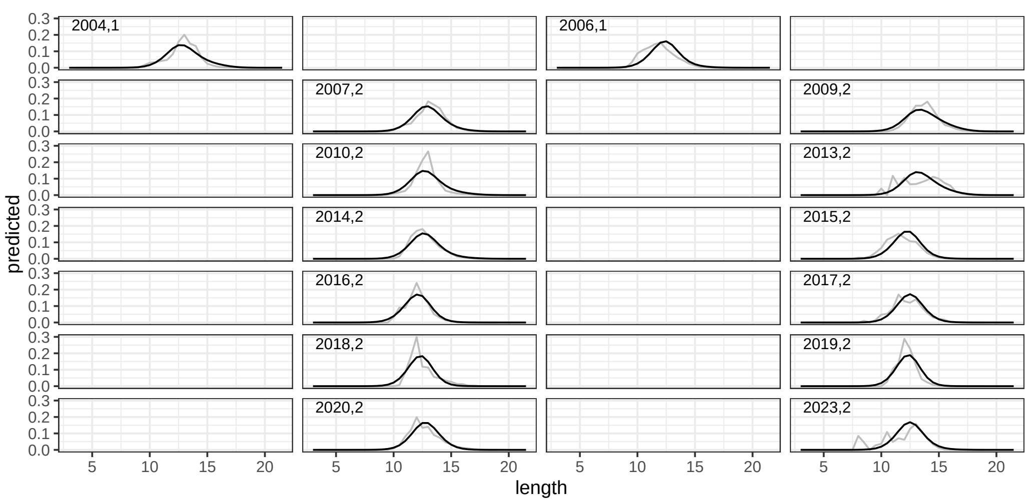


Figure 3: Comparison between observed and estimated catches length distribution for ECOCADIZ survey. Black lines represent estimated data while gray lines represent observed data

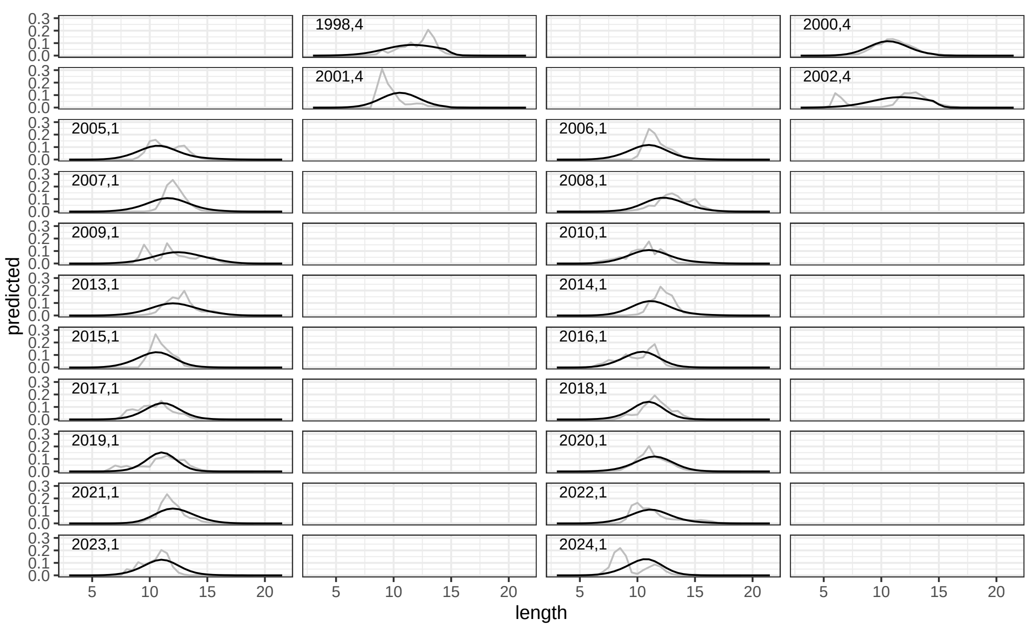


Figure 4: Comparison between observed and estimated catches length distribution for PELAGO survey. Black lines represent estimated data while gray lines represent observed data

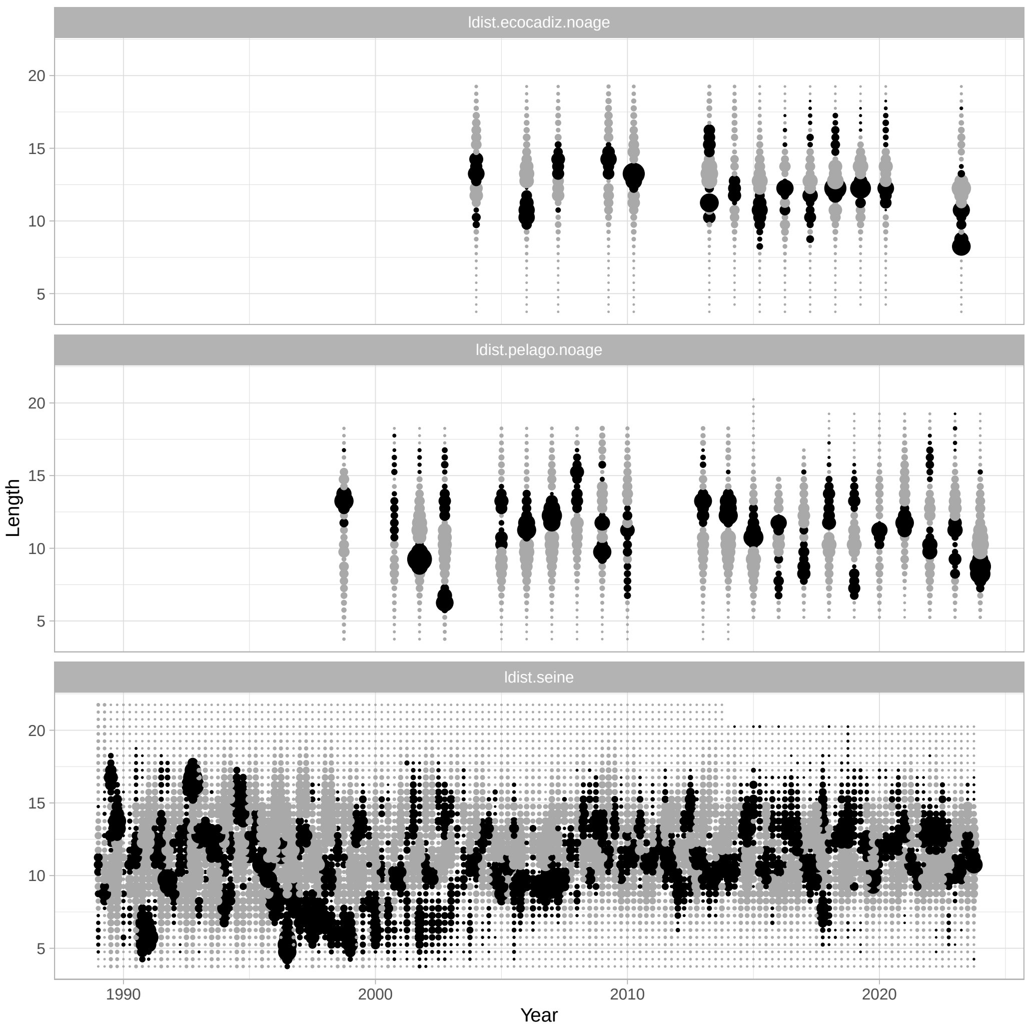


Figure 5: Standardised residual plots for the fitted length distribution from the ECOCADIZ survey, PELAGO survey and commercial landings. Black points denote a model underestimate and gray points an overestimated. The size of the points denote the scale of the standardised residual.

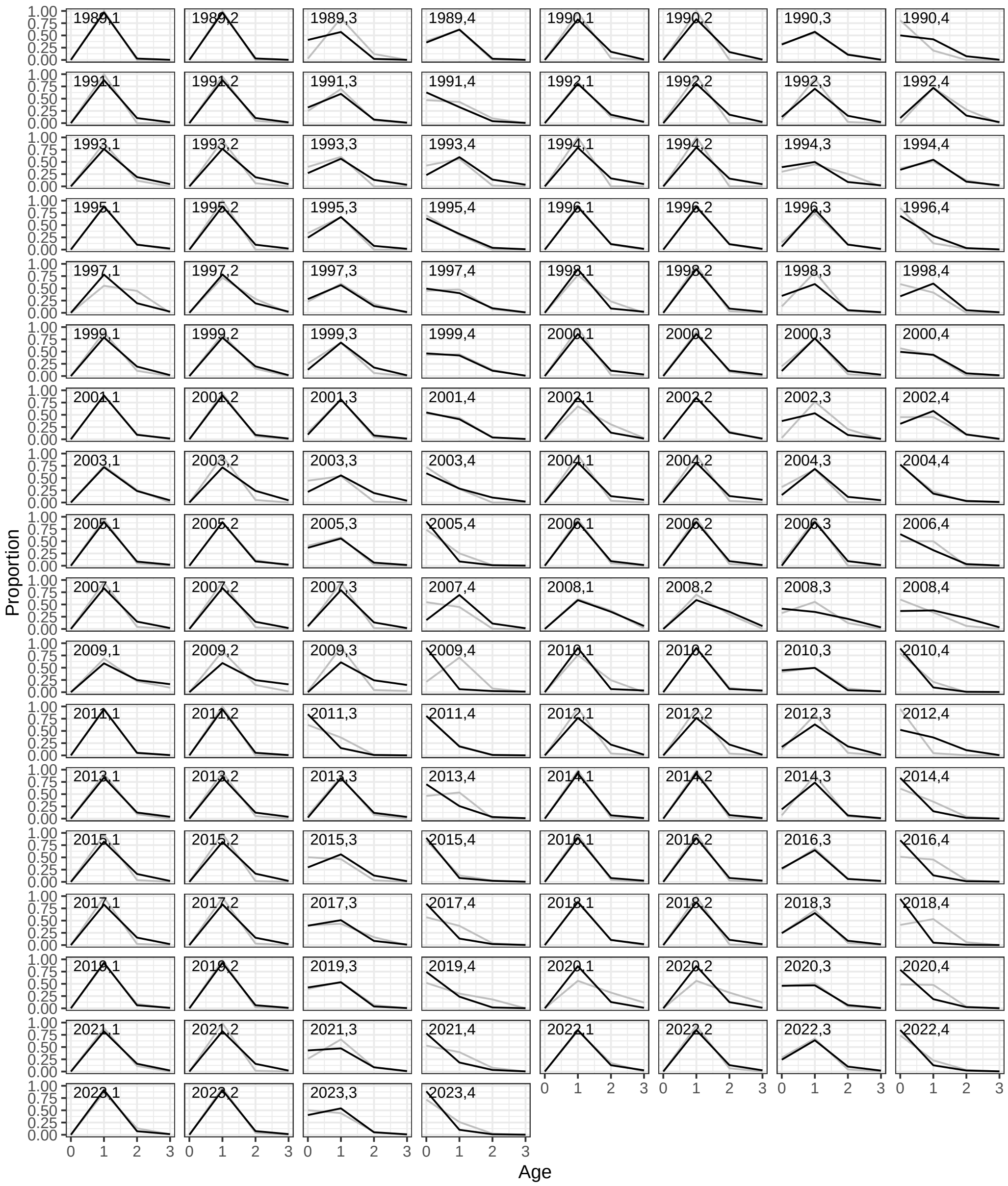

Figure 6: Comparison between observed and estimated catches age distribution. Black lines represent estimated data while gray lines represent observed data.

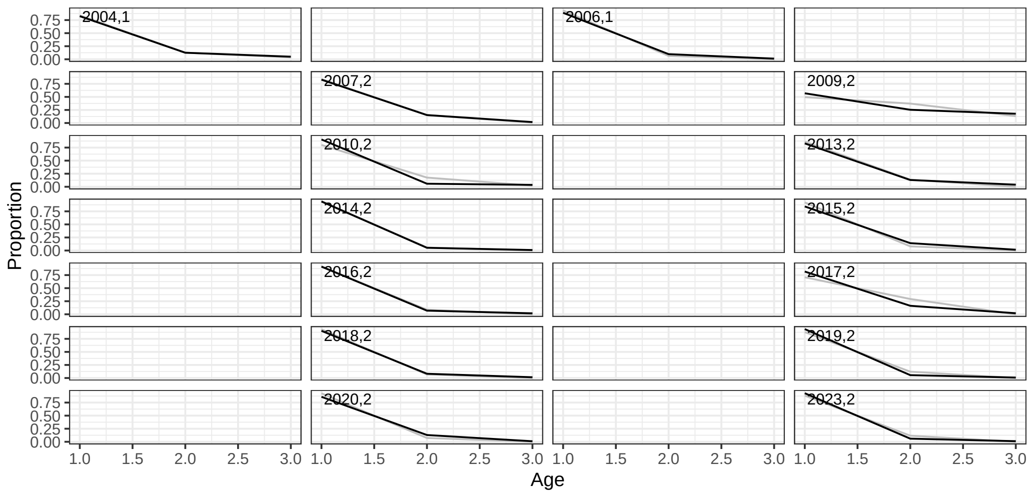


Figure 7: Comparison between observed and estimated ECOCADIZ survey age distribution. Black lines represent estimated data while gray lines represent observed data.

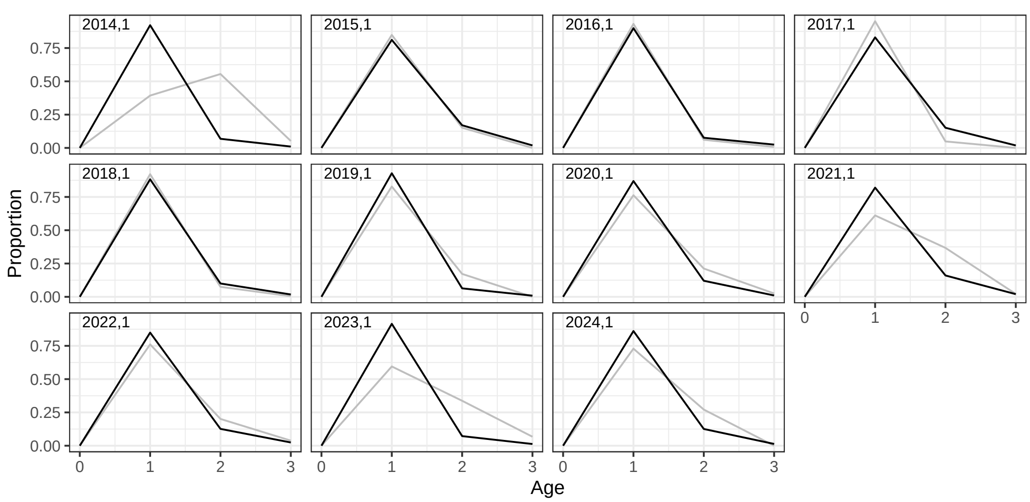


Figure 8: Comparison between observed and estimated PELAGO survey age distribution. Black lines represent estimated data while gray lines represent observed data.

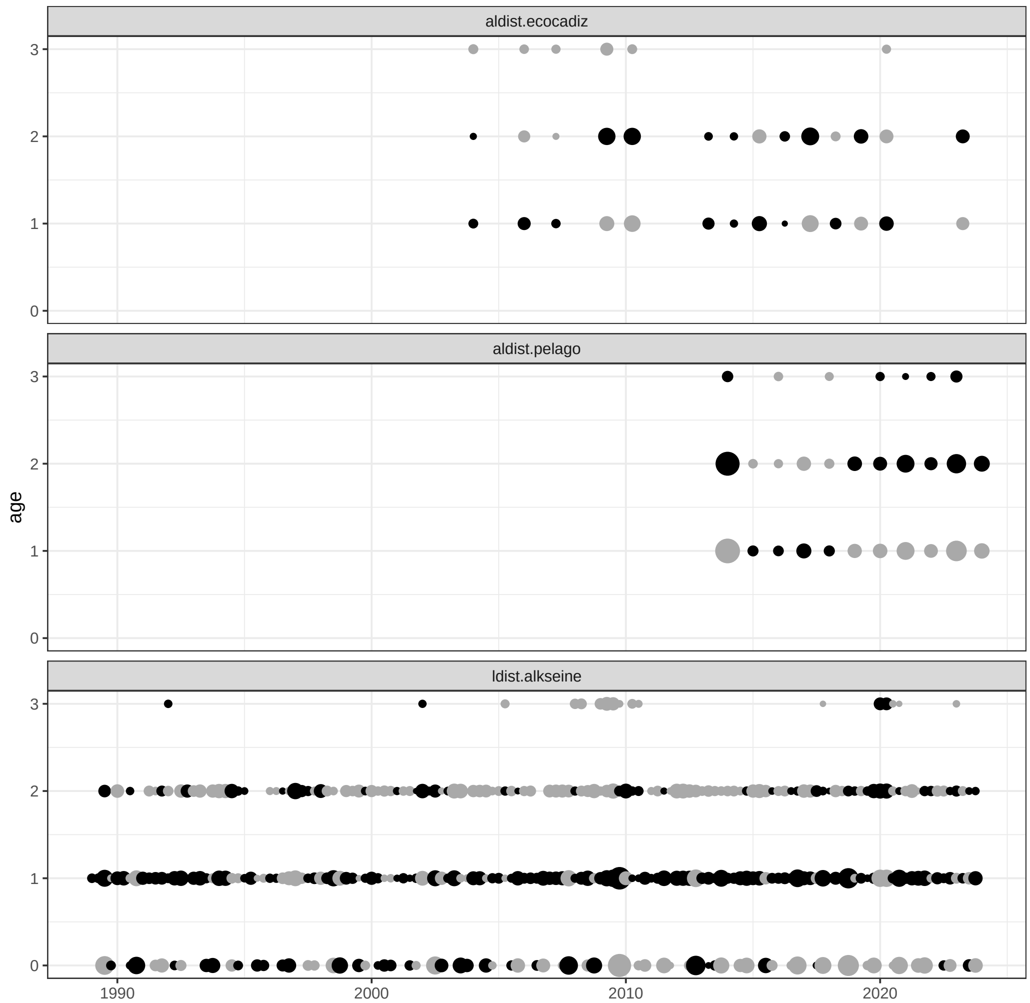


Figure 9: Standardised residual plots for the fitted age distribution from the ECOCADIZ survey, PELAGO survey and commercial fleet. Black points denote a model underestimate and gray points an overestimated. The size of the points denote the scale of the standardised residual.

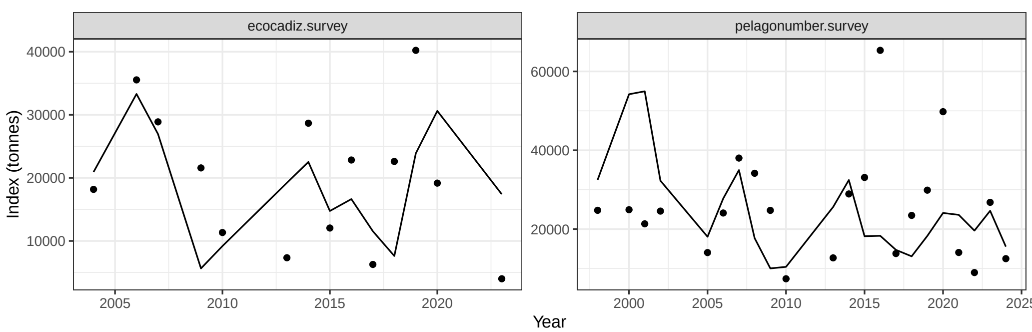


Figure 10: Comparison between observed and estimated survey indices. Black points represent observed data while black line represent estimated data

## 6. Model estimates

Parameter estimates after optimization are presented in Table 2. Detailed model outputs are available in Results folder on TAF repository, where each file corresponds to the following description:

- sidat: Model fit to the surveyindices
- suitability: Model estimated fleet suitability
- stock.recruitment: Model estimated recruitment
- res.by.year: Results by year
- catchdist.fleets: Data compared with model output for the length and age-length distributions
- stock.full: Modeled abundance and mean weight by year,step, length and stock
- stock.std: Modeled abundance, mean weight, number by age consumed by the fleet, stock and year
- stock.prey: Consumption of the fleet by length, year and step
- fleet.info: Information on catches, harvest rate and harvestable biomass by fleet, year and step
- params: parameter values used for the fit

### *6.1. Catchability*

Figure 11 shows the catchability estimated by the model for the different surveys indices

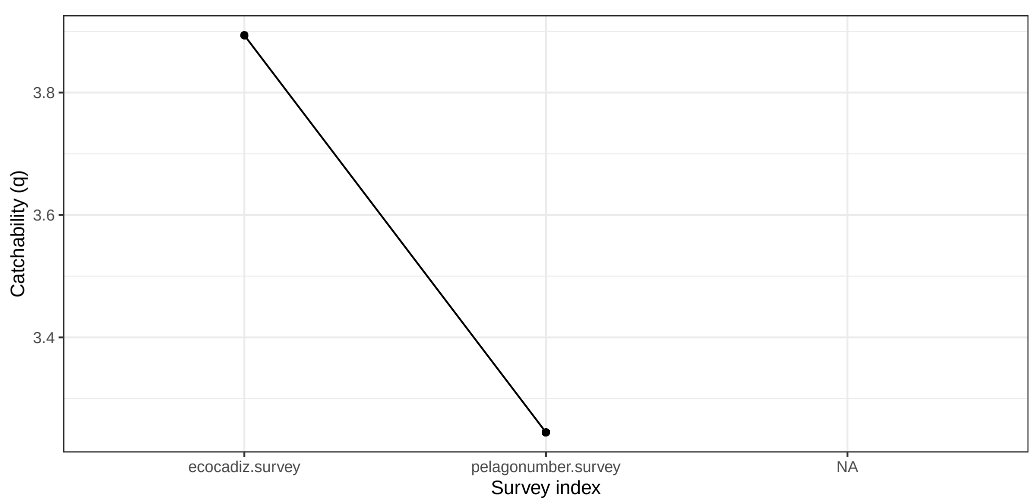


Figure 11: Estimated catchability parameters for the different survey indices

### *6.2. Estimated age composition*

Figure 12 shows the estimated age composition of the population.

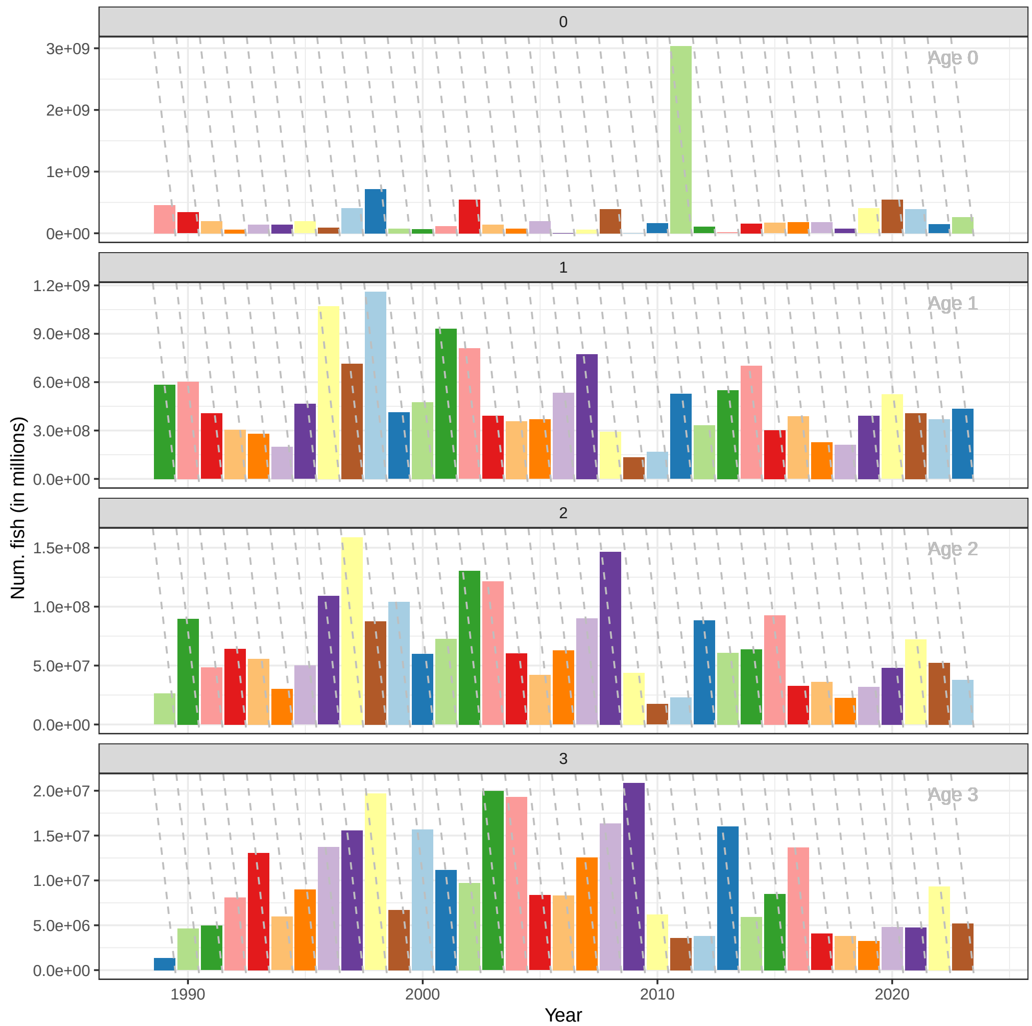


Figure 12: Estimated age composition of the estimated population at the end of the second quarter for each year

*6.3. Suitability*

Figure 13 shows the fleet suitability functions estimated by the model for the commercial fleet and different surveys

*6.4. Abundance, recruitment and Fishing mortality*

Figure 14 presents model annual estimates for biomass, abundance (removing age 0 individuals to be accurate with the time of the assessment, see section 3 above for a detailed explanation), recruitment, fishing mortality and catches **at the end of the second quarter of each year**. Figure 15 shows annual estimates for biomass of individuals of age 1+ at the end of the second quarter of each year. Due to some inconsistencies in the maturity ogives not noticed during WKPELA 2018, we assume that all individuals with age 1 or higher ($B_1$+), are mature i.e. these abundance estimates result equivalent to spawning stock biomass estimates.

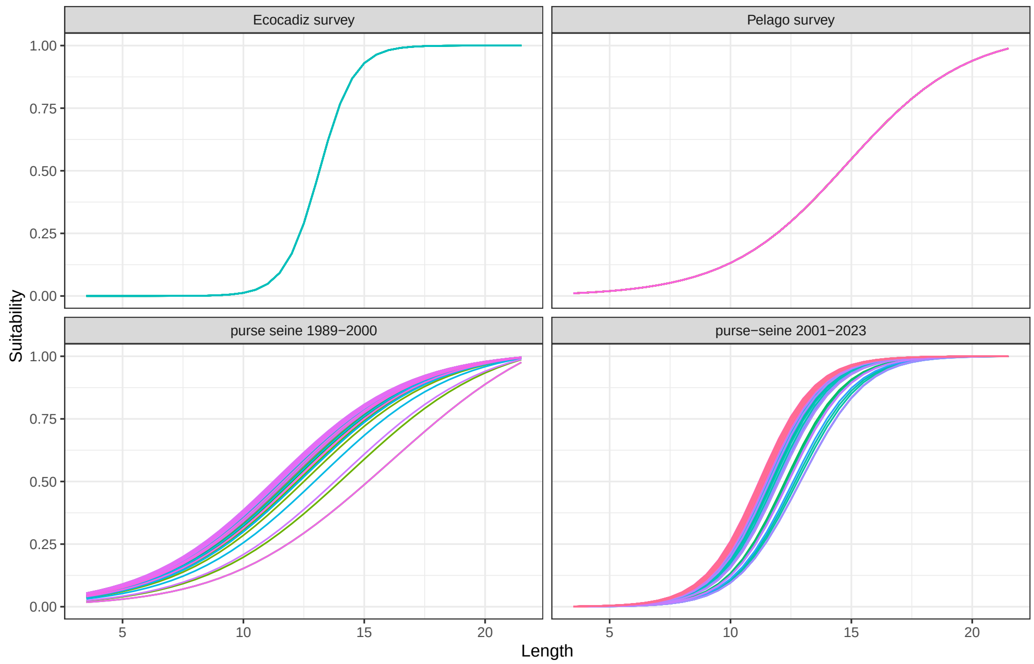


Figure 13: Estimated fleet suitability functions for the commercial fleet and different surveys.

### *6.5. Comparison with the last two years estimated time series*

A comparison with the last two years estimated time series is presented in Figure 16. The pink line represents the current year estimated time series (the one estimated by the model described in this document), the green line, the estimated in 2023 and the blue line, the estimated in 2022. Trends are consistent even considering that each year the model updates the last values with the new information available.

## 7. Reference points

The methodology applied was the same decided in WKPELA 2018 (page 286 of WKPELA 2018 report (ICES, 2018)) following ICES guidelines for calculation of reference points for category 1 and 2 stocks and the report of the workshop to review the ICES advisory framework for short lived species ICES WKMSYREF5 2017 (ICES, 2017).

According to the above ICES guidelines and the S-R plot characteristics (Figure 17), this stock component can be classified as a "stock type 5" (i.e. stocks showing no evidence of impaired recruitment or with no clear relation between stock and recruitment (no apparent $S - R$ signal)). According to this classification, $B_{lim}$ estimation is possible according to the standard method and it is assumed to be equal to $Bloss$ ($B_{lim} = B_{loss}$). For **2024** the value of $B_{loss}$ for the 9a South anchovy corresponds to the estimated $SSB$ in **2010** (1288.75 t), hence $B_{lim}$ is set at 1288.75 t and the relative $B_{lim}$ (divided by the mean value of $B_1+$) results equal to 0.323. Note that due to some inconsistencies in the maturity ogives used in WKPELA2018, age 1+ individuals ($B_1+$) are assumed as mature i.e. $B_1+$ class is equivalent to Stock Spawning Biomass (SSB) (see subsection 6.4 above).

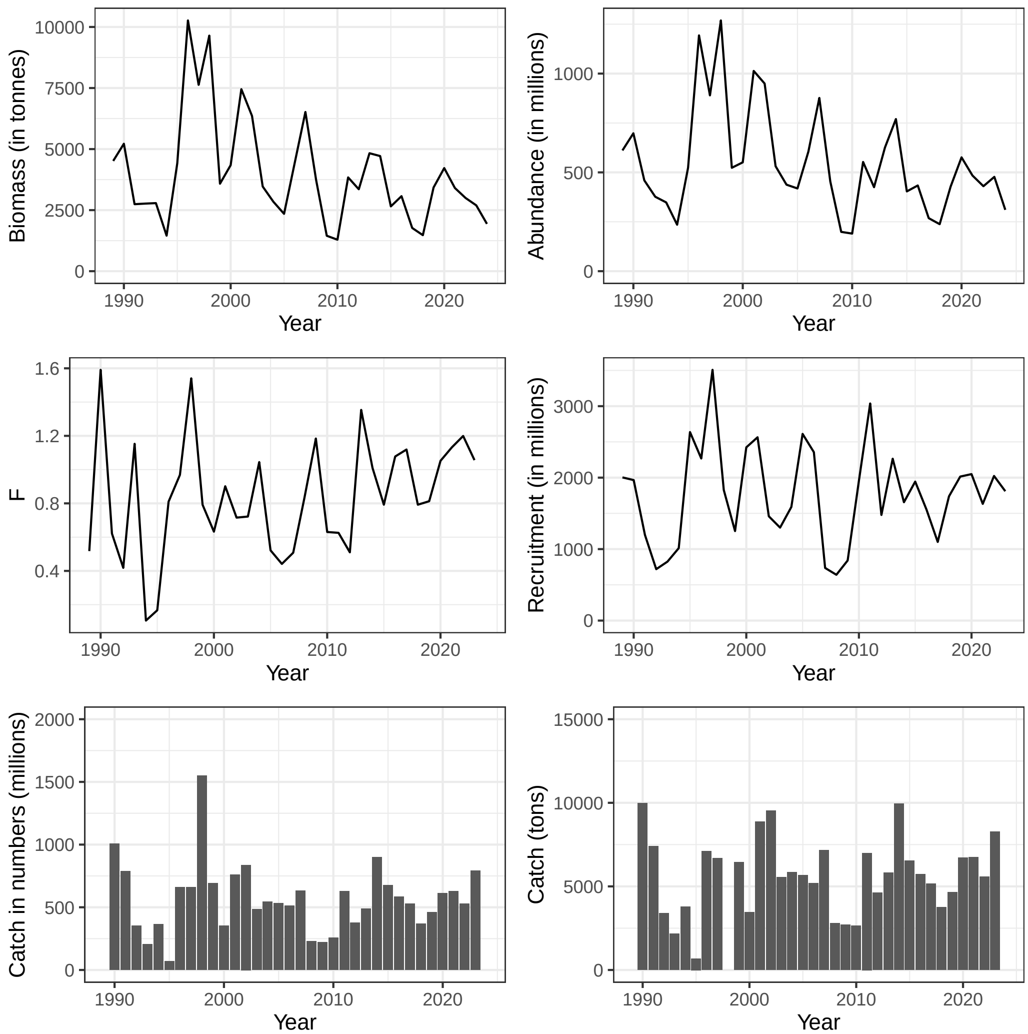


Figure 14: Annual catches time series (in numbers and biomass) compared with annual model estimates for abundance of individuals with more than one year of age(in numbers and biomass) recruitment and fishing mortality. Measures were summarized at the end of June each year, assuming that a year starts in July and ends in June of the next year. Recruitment was calculated including all the recruits of the previous year according to calendar year

ICES recommends to calculate $B_{pa}$ as follows:

$$B_{pa} = e^{(1.645\sigma)} B_{lim},$$

where $\sigma$ is the estimated standard deviation of $ln(SSB)$ in the last year of the assessment, accounting for the uncertainty in $SSB$ for the terminal year. If $\sigma$ is unknown and for short living species, as it is in our case, it can be assumed that $\sigma = 0.30$ (see page 34 of ICES WKMSYREF5 2017 report (ICES, 2017)), then $B_{pa} = e^{(1.645\sigma)} B_{lim} = 1.64 B_{lim}$. According to this $B_{pa}$ is set at 2113.55 t.

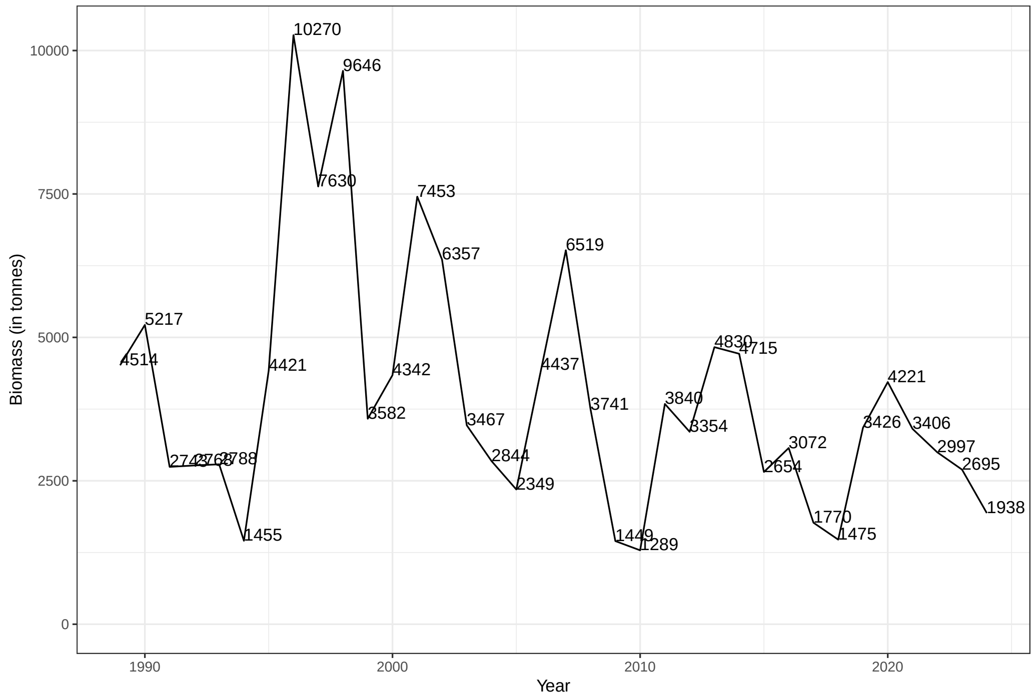


Figure 15: Estimated biomass time series at the end of quarter two (Age 0 removed to be consistent with recruitment at the end of the second quarter of the year). Note that under the assumption that all individuals in $B1+$ class are mature, this biomass is equivalent to SSB

## 8. Catch advice for July 2024 to June 2025

### *8.1. Constant harvest rate rule*

According to this rule, adviced catches (in tonnes) for the next year (July 2024 to June 2024) would be the product of the last year biomass estimate and a constant harvest rate. In this case a rate of 0.5 was considered like the most suitable rate for this stock, as follows:

$$C_{y+1} = B_y * 0.5 = 1938 * 0.5 = 969.$$

This procedure modification has been implemented since 2023 and it is not specified in the Stock annex.

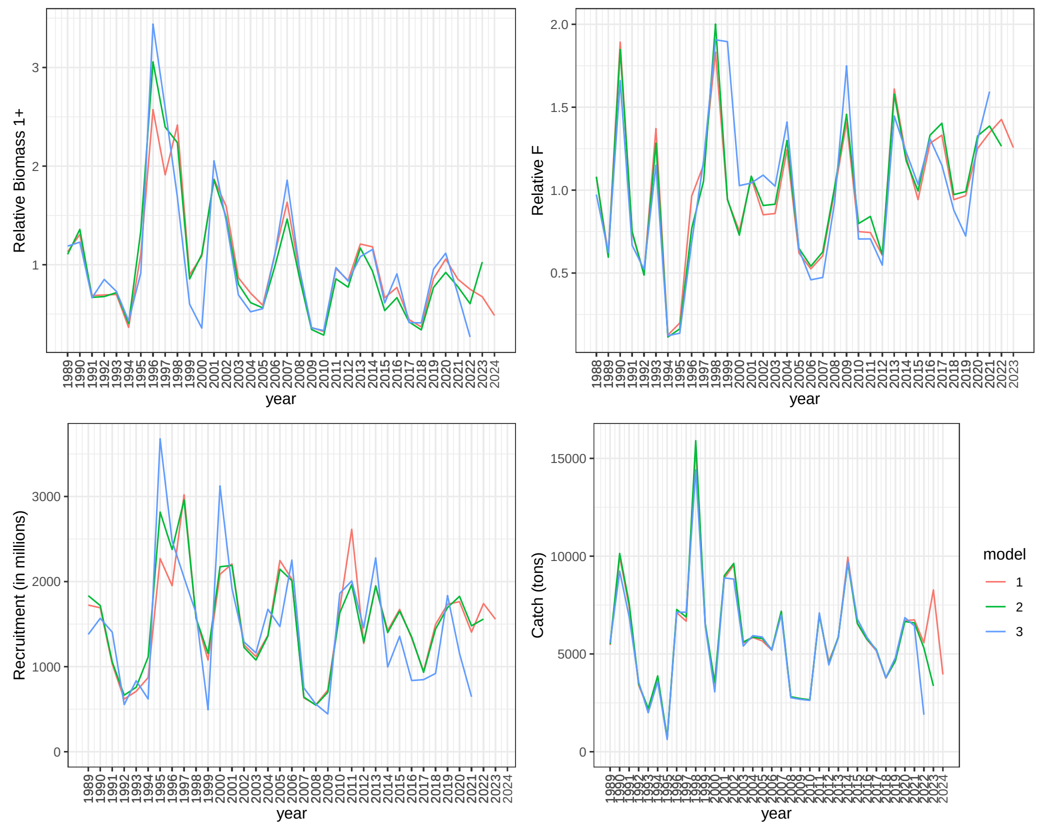


Figure 16: Comparison of estimates from different model implementations. Pink line corresponds to the current year estimated time series (the one estimated by the model described in this document), the green line, to the estimated in 2023 and the blue line, to the estimated in 2022. Measures were summarized at the end of June each year, assuming that a year starts in July and ends in June of the next year.

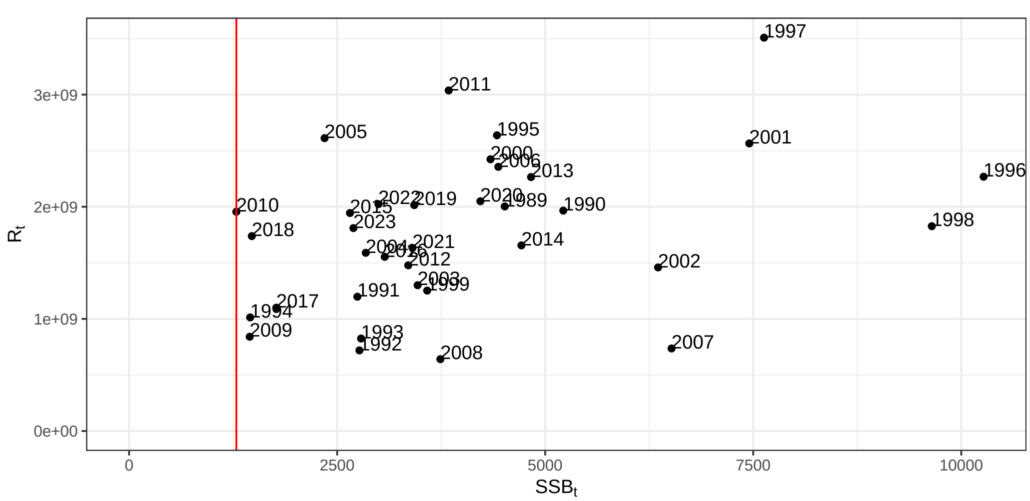


Figure 17: Estimated Stock Spawning biomass ($SSB_t$) vs. Recruitment ($R_t$), $SSB_t$ corresponds to the Stock Spawning Biomass at the end of quarter 2 of year $t$, while $R_t$ corresponds to the sum of the recruitment at the beginning of quarters 3,4 and 1 of years $t$ and $t + 1$, respectively.

## 9. Acknowledgements

We thank Jamie Lentin from Shuttlethread for the automatization of data input, Bjarki Elvarsson for having an open repository with very useful Gadget data processing routines and his valuable help, and to the members of WGHANSA group for their guidance and support.

We gratefully thank CESGA (Galician Supercomputing Center) for computational time at the FTII Supercomputer and technical assistance.

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# Number of vessels by LOA (length overall) ranges for Spanish purse-seiners fishing the Sardine stock in ICES Divisions 8c and 9a

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## Introduction:

Two tables for the sardine fishery in ICES Divisions 8 and 9 are requested annually to IEO (Spanish Institute of Oceanography):

1) A table showing the total catches for each year, broken down per quarter, month, Division, and ICES Rectangle.
2) A table showing the total number of vessels by LOA (Length overall[1]) range, along with the corresponding mean vessel power for each LOA range, as well as the maximum and minimum vessel power.

The total number of purse-seine vessels is used in the annual WGHANSA report for the description of the purse-seine Spanish sardine fishery (ICES, 2024).

In 2024, IEO decided to change the method used to calculate the outputs for the second table, aiming to improve the information.

## Material and methods:

*Data source:*

We used official fisheries data (logbooks and sales notes) provided by the Spanish Ministry of Fisheries in 2022 and 2023. Data compilation and identification of metiers were carried out by the IEO-CSIC for the trips conducted by Spanish non-Basque vessels and by AZTI for the Spanish Basque vessel trips.

The regulation of fishing in Spanish waters falls under the responsibility of the Spanish Ministry of Fisheries, which distinguishes between national fishing grounds geographically and fishing fleet modalities, a term referred as "*modalidades*" in Spanish) technically. The Iberian sardine stock fishery involves two national fishing grounds and two fishing fleet modalities:

[1] Maximum length of a vessel's hull measured parallel to the waterline.

- National fishing grounds: the Cantabrian-Northwestern national fishing ground (ICES Divisions 27.8c and 27.9a-North) and the Gulf of Cadiz national fishing ground (ICES Division 27.9a-South), both separated by Portuguese waters, which extend from the River Miño to the River Guadiana.
- Fishing fleet modalities: the Purse Seine modality and the Small Scale modality. The latter includes a very high number of vessels (up to 4000 vessels) with multipurpose license, among which a small number of vessels use small purse seine fishing gears for fishing sardine.

*Data analysis:*

Prior to 2023, the total number of vessels per LOA was calculated separately for each ICES Division in French waters and then in Iberian subdivision in Spanish waters, within the Bay of Biscay and the Iberian Coast ecoregion, and then summed up (Table 1 and 2). It should be noted that, although the sardine stocks of this Ecoregion host two separate stocks of sardine (Sardine in Divisions 8abd and Sardine in 8c9a), they are exploited by the same Spanish purse seine fleet. These are the Iberian subdivisions, used by WGHANSA, that we will reference here to describe the Spanish sardine fleet:

- 27.8.c.e: Bay of Biscay - South east
- 27.8.c.w: Bay of Biscay - South west
- 27.9.a.n: Spanish Waters – Division 9 North
- 27.9.a.s.c: Spanish Waters - South – Cadiz

This procedure results in the same vessel being counted multiple times across the different geographical areas where it operates, which often occurs due to the mobility of this type of fleet. Therefore in 2023, we revised the data extraction process and decided to provide the real total number of vessels, to present a more realistic picture of the sardine fishery. We also recalculated the number of vessels per LOA range for 2022.

To facilitate comparison, we produced the 2023 tables calculated using both methods.

**Results and discussion:**

*2022 Tables*

The method used prior to 2023 resulted in duplication of vessels that fished in more than one subdivision. In 2022, 176 out of 446 purse-seine vessels and 14 out of 188 small-scale vessels listed in the table were fishing in more than one subdivision.

The total number of vessels for the sardine fleet for purse-seine and small-scale fisheries in 2022, by subdivision, is given in Table 3. The final total number of vessels is the same as the total in Table 1. There is only a 1-vessel difference, for which we could not identify the reason after reproducing the tables made last year (188 vs 187 vessels).

When comparing the results from both methods, the number of purse-seine vessels has decreased 40% (from 446 to 269 vessels). This difference is mainly due to vessels in the LOA ranges VL 1824 followed by VL2240 and VL1218.

*2023 Tables*

We presented the tables for 2023 using both the old and new methods, as well as the total number of vessels per division.

Using the method prior to 2024, the number of vessels is similar to the table presented last year (489 purse-seine vessels in 2023 and 446 vessels in 2022) (Table 4). We found the same numbers in Table 5, when we split by subdivision.

When using the new method to extract the data, the number is reduced by 55 % for the purse-seine fishery (489 to 271 purse-seine vessels) (Table 6).

**<u>Conclusion:</u>**

Prior to 2023, the total number of vessels per LOA was calculated separately for each ICES Division, and then summed up. To provide a more realistic picture of the Spanish sardine fishery, the IEO decided in 2023 to revise the method and report the real total number of vessels fishing for sardine per LOA range.

Therefore, we recommend updating the tables.

**<u>References:</u>**

ICES. 2024. Working group on southern horse mackerel, anchovy and sardine (WGHANSA). ICES Scientific Reports. 5:67. 621 pp. https://doi.org/10.17895/ices.pub.23507922

## Tables

**Table 1:** Total number of vessels per LOA. Table produced in 2022 (the number of vessels was calculated by subdivision and then summed up).

| 2022 | TRAWL | | PURSE SEINE | | SMALL SCALE | |
|---|---|---|---|---|---|---|
| LOA | Nº | KW | Nº | KW | Nº | KW |
| VL0010 | 0 | 0.0 | 1 | 33.8 | 156 | 21.3 |
| | | | | (33.8-33.8) | | (2.9-73.6) |
| VL1012 | 0 | 0.0 | 11 | 60.6 | 27 | 36.9 |
| | | | | (20.6-106.7) | | (17.7-72.1) |
| VL1218 | 0 | 0 | 114 | 104.9 | 5 | 83.4 |
| | | | | (22.1-219.9) | | (36.8-123.6) |
| VL1824 | 0 | 0.0 | 184 | 209.5 | 0 | |
| | | | | (48.5-397.2) | | |
| VL2440 | 0 | 0.0 | 136 | 374.1 | 0 | |
| | | | | 147.1-809.1) | | |
| VL40XX | 0 | 0.0 | 0 | 0.0 | 0 | |
| | | | | | | |
| **Targeting PIL89** | **0** | **0.0** | **446** | **228.9** | **188** | **25.2** |

**Table 2:** Number of vessels by subdivision, in 2022:

| DIVICES | Purse-seine | Small-scale |
|---|---|---|
| 8A | 1 | - |
| 8B | 54 | - |
| 8cE | 137 | 8 |
| 8cW | 96 | 28 |
| 9aN | 101 | 151 |
| 9aS | 57 | - |
| TOTAL | 446 | 187 |

**Table 3:** Total number of vessels by LOA range, in 2022, based on the new method.

| 2022 | TRAWL | | PURSE SEINE | | SMALL SCALE | |
|---|---|---|---|---|---|---|
| LOA | Nº | KW | Nº | KW | Nº | KW |
| VL0010 | 0 | 0,0 | 1 | 33,8<br>(33.8-33.8) | 144 | 21,3<br>(2.9-73.6) |
| VL1012 | 0 | 0,0 | 10 | 59,6<br>(20.6-106.7) | 24 | 33,2<br>(17.7-72.1) |
| VL1218 | 0 | 0 | 88 | 101,5<br>(22.1-219.9) | 5 | 83,4<br>(36.8-123.6) |
| VL1824 | 0 | 0,0 | 93 | 199,5<br>(48.5-397.2) | 0 | |
| VL2440 | 0 | 0,0 | 77 | 324,8<br>147.1-809.1) | 0 | |
| VL40XX | 0 | 0,0 | 0 | 0,0 | 0 | |
| **Targeting PIL89** | **0** | **0,0** | **269** | **197,5** | **173** | **24,7** |

**Table 4:** Total number of vessels, in 2023, calculated by subdivision and then summed up (based on the old method).

| 2023 | TRAWL | | PURSE SEINE | | SMALL SCALE | |
|---|---|---|---|---|---|---|
| LOA | Nº | KW | Nº | KW | Nº | KW |
| VL0010 | 0 | 0,0 | 1 | 33,8<br>(33.82-33.82) | 113 | 19,9<br>(4.19-73.55) |
| VL1012 | 0 | 0,0 | 13 | 59,9<br>(20.59-106.65) | 32 | 33,3<br>(17.65-94.14) |
| VL1218 | 0 | 0 | 107 | 95,8<br>(22.06-169.16) | 8 | 83,5<br>(20.59-147.1) |
| VL1824 | 0 | 0,0 | 186 | 200,3<br>(48.54-397.17) | 0 | |
| VL2440 | 0 | 0,0 | 182 | 309,4<br>(147.1-809.05) | 0 | |
| VL40XX | 0 | 0,0 | 0 | 0,0 | 0 | |
| **Targeting PIL89** | **0** | **0,0** | **489** | **214,0** | **153** | **26,0** |

**Table 5:** Total number of vessels per subdivision for purse-seine and small-scale, in 2023:

| DIVICES | Purse-seine | Small-scale |
|---|---|---|
| 8B | 77 | - |
| 8cE | 148 | 8 |
| 8cW | 94 | 17 |
| 9aN | 115 | 127 |
| 9aS | 55 | 1 |
| | 489 | 153 |

**Table 6:** Total number of vessels by LOA range in 2023 (new method):

<table>
<tr><th>2023</th><th colspan="2">TRAWL</th><th colspan="2">PURSE SEINE</th><th colspan="2">SMALL SCALE</th></tr>
<tr><th>LOA</th><th>Nº</th><th>KW</th><th>Nº</th><th>KW</th><th>Nº</th><th>KW</th></tr>
<tr><td rowspan="2">VL0010</td><td rowspan="2">0</td><td>0,0</td><td rowspan="2">1</td><td>33,8</td><td rowspan="2">113</td><td>19,9</td></tr>
<tr><td></td><td>(33.82-33.82)</td><td>(4.19-73.55)</td></tr>
<tr><td rowspan="2">VL1012</td><td rowspan="2">0</td><td>0,0</td><td rowspan="2">11</td><td>59,9</td><td rowspan="2">26</td><td>33,3</td></tr>
<tr><td></td><td>(20.59-106.65)</td><td>(17.65-94.14)</td></tr>
<tr><td rowspan="2">VL1218</td><td rowspan="2">0</td><td>0</td><td rowspan="2">79</td><td>95,8</td><td rowspan="2">8</td><td>83,5</td></tr>
<tr><td></td><td>(22.06-169.16)</td><td>(20.59-147.1)</td></tr>
<tr><td rowspan="2">VL1824</td><td rowspan="2">0</td><td>0,0</td><td rowspan="2">89</td><td>200,3</td><td rowspan="2">0</td><td></td></tr>
<tr><td></td><td>(48.54-397.17)</td><td></td></tr>
<tr><td rowspan="2">VL2440</td><td rowspan="2">0</td><td>0,0</td><td rowspan="2">91</td><td>309,4</td><td rowspan="2">0</td><td></td></tr>
<tr><td></td><td>(147.1-809.05)</td><td></td></tr>
<tr><td rowspan="2">VL40XX</td><td rowspan="2">0</td><td>0,0</td><td rowspan="2">0</td><td>0,0</td><td rowspan="2">0</td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Targeting PIL89</td><td>0</td><td>0,0</td><td>271</td><td>200,2</td><td>147</td><td>25,7</td></tr>
</table>

# Annex 6: Survey Sheets

The survey summary sheets provide an overview of the acoustic and egg surveys carried out in 2024 and used in the assessments performed by WGHANSA. The summary sheets were created by the corresponding expert surveys, and they were discussed during WGACEGG 2024. WGACEGG made them available to WGHANSA to be included in this report.

## Survey DEPM summary table: BIOMAN 2024

| | | | |
|---|---|---|---|
| Nation: | *SPAIN* | Institute | *AZTI- . CENTER OF PASAIA* |
| Survey: | *BIOMAN 2024* | Dates: | *30/04/2024-24/05/2024* |
| Vessel: | *R/V VIZCONDE DE EZA*<br>*R/V EMMA BARDAN* | Survey area | *ICES 8abcd* |
| Target species and stock | *Engraulis encrasicolus &*<br>*Sardina Pilchardus*<br>*Anc & Pil.27.8* | Results to join with other survey (code) | |
| Survey coordination Group | *ICES WGACEGG* | Data submitted for assessment HANSA | *Anc.27.8 → Total biomass & % B age 1,W*<br>*Pil.27.8abd → SSB and egg Abundance* |
| Survey responsible | *Maria Santos Mocoroa: msantos@azti.es* | | |

| | |
|---|---|
| Survey description: | **Link to the working document:**<br>**http://dx.doi.org/ 10.13140/RG.2.2.10327.24485**<br><br>**Objectives:**<br>o Contribute to the assessment:<br>- estimation of Biomass for anchovy annually by the DEPM; as well as numbers at age, % at age, biomass at age, weight at age and length at age; Total biomass and B at age 1 submitted to WGHANSA as inputs for assessment of anchovy 8abcd.<br>- Estimation of SSB for sardine 2011,2014,2017 and since 2020 annually by the DEPM in 8abcd and 8abd. Egg abundance annually and SSB triennially submitted to WGHANSA as inputs for assessment of sardine in 8abd.<br>o Ecosystem approach: Characterization of the Hydrography, Zooplankton and ichthyoplankton analysis, eDNA analysis, Top predators, Fishing activities, marine debris and microplastics distribution and abundance<br>**Methodology:**<br>The DEPM is applied to both spp to estimate the biomass since 1987<br>In 1987 a study was done on egg sampling design. Since then, the strategy of egg sampling is identical: a systematic central sampling scheme with random origin and sampling intensity depending on the egg abundance found. Stations are located at intervals of 3 nm along 15 nm apart transects; A research vessel performs this sampling.<br>The adult samples are obtained on board another research vessel (pelagic trawler) coinciding in space and time with the plankton sampling. |
| Gear used: | PairoVET 150 µm mesh size net; CUFES 335 µm mesh size; CTD RBR (temp, salinity) |
| Notes from survey | See Survey Summary Table |
| Number of working days | 25 working days |
| Any unusual observation | Non |
| Survey outputs (main and extra info) | - Main outputs see **Survey results summary table.**<br>- Extra info: *Maurolicus muelleri* egg abundance obtained as well |
| survey&data quality (green, yellow, red) | Green |

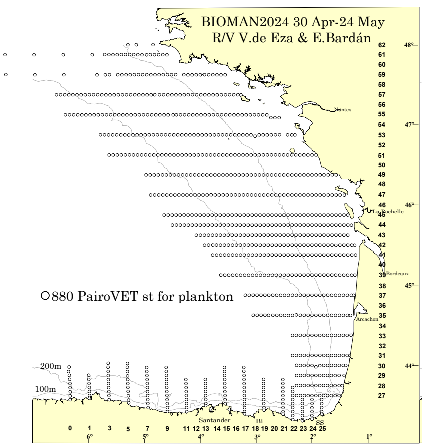
## Survey summary table

| | | |
|---|---|---|
| **Study area** | **ICES 8abcd** | |
| **Survey dates** | 30/04 – 24/5 2024 | |
| **EGGS SAMPLING** | | |
| Transects | 40 | |
| PairoVET stations | 880 | |
| CUFES stations | 1969 | |
| ***Specie*** | ***anchovy*** | ***sardine*** |
| Positive PairoVET stations | 759 (86%) | 208 (24%) |
| PairoVET total egg: number counted and staged | 24177 | 1742 |
| PairoVET maximum eggs/m² in a station | 4490 | 780 |
| Positive CUFES stations | 1588 (81%) | 555 (28%) |

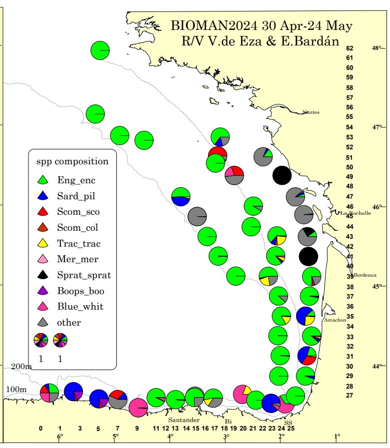
| | | |
|---|---|---|
| CUFES total Egg nº counted | 148177 | 7233 |
| CUFES maximum eggs/m³ in a station | 258 | 61 |
| **ADULTS SAMPLING** | | |
| Time range (hh:mm) | 24h | |
| Fishing depth range (m) | 8 – 76 | |
| Number Hauls from research vessels | 50 | |
| ***Specie*** | ***anchovy*** | ***sardine*** |
| Number Hauls purse seines | 1 | 0 |
| Number of hauls from research vessels for the analysis | 44 | 22 |
| Total individuals sampled | 3119 | 1068 |
| Length range (mm) | 86 - 196 | 90 - 232 |
| Weight range (g) | 3.10 – 46.60 | 4.6 – 86.6 |
| Females for histology | 1323 | 345 |
| Hydrated females for batch fecundity regression | 93 | 35 |
| Otoliths | 2786 | 1008 |
| **HYDROLOGY** | | |
| CTD stations | 880 | |
| SST (°C) min/mean/max | 13.8 / 15.2 / 17.8 | |
| SSS min/mean/max | 28.05 / 34.41 / 35.66 | |

## Survey results summary table

| **Study area** | **ICES 8abcd** | ICES 8abd |
|---|---|---|
| Total area (Km²) | 121647 | |
| Specie | anchovy | sardine |
| Spawning area (Km²) | 101890 | 22881 |
| Z (daily rate) (CV%) | 0.12 (27.89) | 0.21 (50.78) |
| $P_0$ (eggs/m²) (CV%) | 98.76 (6.79) | 47.18 (16.04) |
| $P_{tot}$ (eggs/day) (CV%) | 1.00E13 (6.79) | 1.08E12 (16.04) |
| Female Weight (g) (CV%) | 15.98 (6.09) | 38.56 (8.50) |
| Batch Fecundity egg/batch/mat.fem (CV%) | 5917(9.22) | 15778 (11.25) |
| Sex Ratio (%) (CV%) | 52.89 (0.05) | 52.13 (0.84) |
| Spawning Fraction (%) (CV%) | 35.48 (10.62) | 11.32 (9.34) |
| Daily Fecundity (egg/day/g mat. female) | 69.49 (7.55) | 12.13 (11.48) |
| Total biomass (tons) (CV%) | **145,608 (10.15)** | **48567 (19.93)** |




**plankton stations**




**Fishing stations: spp composition by haul**

## Survey Summary Table WGACEGG 2024

| | |
|---|---|
| **Name of the survey (abbreviation):** | Spanish autumn acoustic-trawl survey in the Gulf of Cadiz (*ECOCADIZ-RECLUTAS*). *ECOCADIZ-RECLUTAS 2024-10*. |
| **Target Species:** | Anchovy (*Engraulis encrasicolus*), sardine (*Sardina pilchardus*) and chub mackerel (*Scomber colias*), with special reference to their Age-0 population fractions. Acoustic estimates are also regularly provided for Atlantic mackerel (*S. scombrus*), horse mackerel species (*Trachurus trachurus*, *T. mediterraneus*, *T. picturatus*) and bogue (*Boops boops*). Estimates for round sardinella (*Sardinella aurita*), blue whiting (*Micromesistius poutassou*), boarfish (*Capros aper*), longspine snipefish (*Macrorhamphosus scolopax*) and pearlside (*Maurolicus muelleri*),when present. |
| **Survey dates:** | 18$^{th}$-30$^{th}$ October 2024. |

**Summary:**

The *ECOCADIZ-RECLUTAS 2024-10* Spanish (pelagic ecosystem-) acoustic-trawl survey was conducted by IEO between 18$^{th}$ and 30$^{th}$ October 2024 in the Portuguese and Spanish shelf waters (20-200 m isobaths) off the Gulf of Cadiz (GoC) onboard the R/V *Ramón Margalef*. The survey's main objective is the acoustic assessment of anchovy, sardine and chub mackerel juveniles (age 0 fish) in the GoC recruitment areas. The survey was shortened ca. 3-4 days regarding the usual duration of the survey. The start and direction of the acoustic sampling was the usual E to W direction. The 21 foreseen acoustic transects were sampled. 17 transects (132 CTD-LADCP casts) from the 23-transect sampling grid of oceanographic variables could be finally performed because time constraints. A total of 19 valid fishing hauls were carried out for echo-trace ground-truthing purposes (in accordance with the historical mean of about 20 hauls per survey). No information on age structure of the resulting estmates is still available for sardine and chub mackerel.

Sardine, anchovy, horse mackerel, bogue and chub mackerel were the most frequent captured species in the fishing hauls, followed by Mediterranean horse mackerel, Atlantic mackerel and round sardinella were less frequent. Boarfish, longspine snipefish and pearlside showed an incidental occurrence in the hauls performed in the surveyed area, whereas blue-jack mackerel was observed exclusively in Algarve waters. Hauls' yields were especially high this year, with sardine, chub mackerel, and anchovy being the most abundant. Total NASC estimate allocated to the "pelagic fish species assemblage" in this survey was 16% higher than that recorded in 2023.

GoC anchovy was widely distributed in the GoC, but absent in the easternmost area. Densities found in the westernmost Algarve waters were higher than last year in the same area. Anchovy acoustic estimates in autumn 2024 were of 3183 million fish and 25 184 tonnes, accounting for 290% and 203% increases in abundance and biomass, comported to 2023 estimates and they are above their time-series averages. The population was composed by fishes not older than 2 years. Age 0 fish accounted for 82% (2 629 million) and 64% (15 842 t) of the total estimated abundance and biomass, respectively. Spanish waters concentrated the bulk (99%) of this juvenile fraction whereas 69% (328 million) of age-1 group was also observed in Spanish waters. GoC sardine showed low acoustic detections in central and eastern Algarve and the easternmost Spanish waters, lower than those observed in the remaining Spanish waters where medium to high integrations were observed. Sardine abundance (1870 million fish) and biomass (25 108 t) estimates decreased (11% in abundance and 8% in biomass), when compared to 2023 estimates and Portuguese waters recorded an increase in the presence of large adult sardines (>16 cm) although they were almost absent in Spanish waters. Chub mackerel population was distributed all over the GoC with three areas of high density 1) in Algarve waters, 2) between Ayamonte and Punta Umbria and 3) in front of the Bay of Cadiz. Low or none integration was recorded in Cape Trafalgar. Chub mackerel estimated biomass and abundance were 201 million fish and 17 349 t, which were 70% and 112% higher than 2023 estimates. This year's abundance and biomass were above their time series averages.

| | *Description* |
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| **Survey design** | Systematic design of a grid of 21 8-nm inter-spaced parallel transects normal to the shoreline, between 20 and 200 m depth, including both GoC Portuguese and Spanish waters. Acoustic sampling is carried out during day-light, starting in the easternmost transect. Acoustic Elementary Distance Sampling Unit (EDSU)= 1 nm. Average survey duration= 20 days (includes days for echo-sounder calibration). EK 80 echo-sounder working at 18, 38, 70, 120, 200 kHz. 38 kHz as reference frequency for biomass |

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| | estimation. |
| **Index Calculation method** | Biomass and abundance per species are calculated at the post-stratification region level only. A mean NASC value (arithmetic mean) is calculated in post-stratification regions with homogeneous species composition. Post-stratification regions are defined as areas where trawl hauls display non significantly different averages in their Length Frequency Distributions (LFD), according to Kolgomorov Smirnov test. Hauls LFDs and scrutinized NASC of the target species are averaged within post-stratification regions. The products of TS by size class and NASC values per species per regions are multiplied by the region area to calculate fish biomass estimates. Estimates of abundance and biomass at length (all the fish species) and age (anchovy, sardine and chub mackerel) are then derived for each species and region. Numbers are converted into biomass through a length–weight relationship. Methodology described in Doray, M., Van Der Kooij, J., Boyra, G. (Eds.), 2021. ICES Survey Protocols - Manual for acoustic surveys coordinated under the ICES Working Group on Acoustic and Egg Surveys for Small Pelagic Fish (WGACEGG). https://doi.org/10.17895/ICES.PUB.7462 |
| **Random/systematic error issues** | Echo-sounder properly calibrated during the previous survey (*IBERAS-2024*). Background-noise levels were not recorded during the survey due to lack of survey time. Target strength values are not specific for each of the assessed species. Acoustic backscattering is allocated to different fish species by taking into account the species composition of trawl samples (subjective method and not testable for bias). Spatial coverage of identification trawls used to be very high (0.06 haul/nm) and this survey was in accordance to the historical spatial coverage of identification hauls (20 hauls; 0.06 haul/nm). Fish avoidance not tested, but R/V assumed as a relatively “silent” vessel following ICES recommendations (Mitson, 1995; Mitson & Knudsen, 2003). Post-stratification regions, where species/size compositions and echo-integrals are supposed homogeneous, are defined to estimate total fish biomass. Homogeneity in species-specific length frequency distributions is tested with KS test. For the time being, acoustic estimates (i.e. indices) are provided without any measure of uncertainty.<br><br>Mitson RB. 1995. Underwater noise of research vessels: review and recommendations. *ICES Cooperative Research Report*, 209, 61 pp.<br>Mitson RB, Knudsen H.P. 2003. Causes and effects of underwater noise on fish abundance estimation. *Aquatic Living Resources*, 16 (3): 255-263 . |
| **Specific survey error issues (acoustic)** | *There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:* |
| **Bubble sweep down** | *Time-series:* Drop-keel mounted transducers at 6.5 m depth, downward facing. Upper integration limit set at 10 m depth. Background-noise levels are recorded during the survey with transmitters disabled during an exercise of passive echosounder operations at different increasing propeller blade regimes (i.e. different speeds; 0-10 knots) and two contrasting depths. Background noise was removed from echograms according to De Robertis and Higginbottom (2007), using the EchoView’s Background Noise Removal (BNR) filter.<br>*Survey Year specific*: No specific survey error related with this issue.<br><br>De Robertis, A., Higginbottom, I. 2007. A post-processing technique to estimate the signal-to-noise ratio and remove echosounder background noise. *ICES Journal of Marine Science*, 64: 1282–1291. |
| **Extinction (shadowing)** | *Time-series:* Shadowing effect has not been properly assessed in dense schools of the assessed species, but no clear attenuation of echoes from deeper cells of these schools seems to have clearly been detected. In any case, the most recent echosounders (EK 500, EK60, EK 80), which have a wide dynamic range, do not saturate — even at very high densities (Bodholt *et al*., 1989; de Moor *et al*., 2008; Coetzee *et al*., 2008 ).<br>*Survey Year specific*: No specific survey error related with this issue.<br><br>Bodholt H, Nes H, Solli H. 1989. A new echo sounder system. *Proceedings of the Institute of Acoustics* (UK) 11: 123–130.<br>de Moor CL, Butterworth DS, Coetzee JC. 2008. Revised estimates of abundance of South African |

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| | sardine and anchovy from acoustic surveys adjusting for echosounder saturation in earlier surveys and attenuation effects for sardine. *African Journal of Marine Science* 30(2): 219–232.<br>Coetzee JC, Merkle D, de Moor CL, Twatwa NW, Barange M, Butterworth DS.2008. Refined estimates of South African pelagic fish biomass from hydro-acoustic surveys: quantifying the effects of target strength, signal attenuation and receiver saturation. *African Journal of Marine Science* 30(2): 205–217. |
| **Blind zone** | *Time-series:* Drop-keel mounted transducers at 6.5 m depth, downward facing. Upper integration limit set at 10 m depth.<br>*Survey Year specific*: No specific survey error related with thi issue. |
| **Dead zone** | A 0.5 m offset is added to the bottom line detected by the transducers. |
| **Allocation of backscatter to species** | Expert echogram scrutiny is performed at the EDSU scale using Echoview software package. Virtual echograms are generated from multifrequency algorithms (templates) to extract fish echotraces. Allocation mainly based in the species composition of close trawl catches considered representative of the real species composition. Spatial coverage of identification trawls used to be very high (0.06 haul/nm), and this survey had similar spatial coverage of identification hauls (20 hauls; 0.06 haul/nm) This year there was a higher number of individual schools that were directly allocated to the species, based on the species-specific multi-frequency response. |
| **Target strength** | Species-specific b20 values are listed in Table A2.2 in Massé *et al*. (2018) and Table 3.12 in Doray *et al*. (2021). TS values are not species-specific. Anchovy and sardine: -72.6; chub mackerel and *Trachurus* spp.: -68.7; mackerel: -84.9.<br><br>Massé, J., Uriarte, A., Angelico, M. M., and Carrera, P. 2018. Pelagic survey series for sardine and anchovy in ICES subareas 8 and 9 (WGACEGG) – Towards an ecosystem approach. *ICES Coop. Res. Rep.*, 332, 268 pp.<br>Doray, M., Boyra, G., and van der Kooij, J. (Eds.). 2021. ICES Survey Protocols – Manual for acoustic surveys coordinated under the ICES Working Group on Acoustic and Egg Surveys for Small Pelagic Fish (WGACEGG). 1st Edition. ICES Techniques in Marine Environmental Sciences Vol. 64. 100 pp. https://doi. org/10.17895/ices.pub.7462 |
| **Calibration** | Acoustic equipment was formerly calibrated before the beginning of the survey in the Bay of Algeciras following the ICES standard procedures (Demer *et al*., 2015; see also Foote *et al*., 1987). Since 2023 on, calibration was scheduled to be performed during the survey in front of Portimão (R18). However, this year no calibration was performed during the survey because time constraints and the calibration settings were those ones recorded during the previous survey (*IBERAS-2024*).<br><br>Demer, D.A., Berger, L., Bernasconi, M., Bethke, E., Boswell, K., Chu, D., Domokos, R., *et al*. 2015. Calibration of acoustic instruments. *ICES Coop. Res. Rep*, 326, 133 pp.<br>Foote, K.G., H.P. Knudsen, G. Vestnes, D.N. MacLennan, E.J. Simmonds, 1987. Calibration of acoustic instruments for fish density estimation: a practical guide. *ICES Coop. Res. Rep.*, 144, 57 pp. |
| **Specific survey error issues (biological)** | *There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:* |
| **Stock containment** | *Time-series:* The timing and spatial coverage of the *ECOCADIZ-RECLUTAS* surveys have been defined to achieve stock containment of target species whose survey indices are used in analytical stock assessment (anchovy, sardine) at the mesoscale of the survey (and stocks). Containment is consistently achieved at the survey mesoscale for anchovy adults (southern component of ane.27.9.a), and for anchovy and sardine recruits. Spanish coastal waters of GoC are the main (anchovy) or very important (sardine) recruitment areas within its respective stocks. For sardine adults (pil.27.8c9a), the survey only provides a regional index for the sub-division 9a South. These surveys do not capture the actual autumn extension of blue whiting, mackerel, horse mackerel, blue jack mackerel, boarfish, snipefish and pearlside because the whole population of these species or a fraction of it (larger fish) are distributed in upper continental slope waters not sampled by the survey. The 2012 survey only sampled the Spanish waters. The 2017 survey only sampled the 7 easternmost transects from the Spanish waters because R/V breakdown. No survey in 2013.<br>*Survey Year specific*: NA. |

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| **Stock ID and mixing issues** | *Time-series:* Affinities of the GoC anchovy and sardine (especially fishes inhabiting the Spanish waters) with populations further south (NW Moroccan waters) and east (Alboran Sea) probable but not yet confirmed. Adult sardine displacements between 9a S-Algarve and 9a C-S also probable.<br>*Survey Year specific*: NA. |
| **Measures of uncertainty (CV)** | Quality Control checks of size and biological samplings incorporated in the IEO's OSB-PELAKAMP open source-open hardware paperless sampling system. Homogeneity in species-specific length frequency distributions is tested with KS test. Only considered those LFDs containing ≥30 individuals. |
| **Biological sampling** | *Time-series:* random sample of 50 fish/haul of anchovy, sardine, *Scomber* spp., *Trachurus* spp. and bogue (since 2014). Individual length, weight, sex, maturity stage, stomach fullness, and mesenteric fat content. Otolith dissection in all the sampled anchovy and sardine specimens (chub mackerel since 2019 on). Anchovy, sardine and chub mackerel own survey's ALKs.<br>*Survey Year specific*: No specific survey error related with this issue. Anchovy age structure of the acoustic estimates from the current survey will be available to WGACEGG 2024. The age structure of the acoustic estimates from the remaining species (i.e. sardine and chub mackerel) are expected to be presented in WGHANSA-1 2025. |
| **Were any concerns raised during the meeting regarding the fitness of the survey for use in the assessment either for the whole times series or for individual years? (please specify)** | *To be answered by Assessment Working Group* |
| **Did the Survey Summary Table contain adequate information to allow for evaluation of the quality of the survey for use in assessment? Please identify shortfalls** | *To be answered by Assessment Working Group* |

| Survey Summary table WGACEGG 2024 | |
|---|---|
| **Name of the survey (abbreviation):** | IBERAS (ES & PT) |
| **Target Species:** | Recruitment of the Iberoatlantic stock of Sardine and Anchovy |
| **Survey dates:** | 1-15 October 2024 |

**Summary:** **Cruise Report Link:**

IBERAS1024 was carried out on board R/V Ramón Margalef from 1st to 14th October 2024 aiming to estimate the strength of recruitment of both the Iberoatlantic stock of sardine (*Sardina pilchardus*) and the western spawning fraction of the 9a anchovy stock (*Engraulis enchrasicholus*). Prior the survey the acoustic equipment (EK-80 with 18-38-70-120 and 200 kHz) was calibrated. The survey plan was deeply changed due to a series of deep storms that hit the survey area for 5 days. Therefore, the area was finally covered in 9 days only. Moreover, the Rias Baixas were not covered due to the lack of time and also due to the bad weather conditions, focussing the survey effort mainly in 9aCN.

Given the lack of time, only 17 pelagic trawl hauls were carried out together with 9 purse seiner shots, all of them for ground truthing both sardine ad anchovy echotraces. Total NASC was lower than those on previous years (332*$10^3$ $s_A$ this year comparing with 810*$10^3$ $s_A$ in the previous year). 12% of this NASC was unallocated due to the lack of time to perform specific fishing stations to verify those echotraces. This low figure in NASC could be explained by both the unsurveyed area inside the Rias Baixas (155*$10^3$ $s_A$ recorded in this area last year) and the one south of the Espichel Cape (Sado Area) together with the shortened in the outer part of some tracks. Of that 66% (219*$10^3$ $s_A$) was allocated to sardine (only one category), and 12% (37*$10^3$ $s_A$) to big anchovy category and 6% (20*$10^3$ $s_A$) to small anchovy category.

Sardine recruitment was estimated to be at 6.5*$10^9$ fish, corresponding to 131*$10^3$ metric tonnes, of them 6.0*$10^9$ fish, corresponding to 121*$10^3$ metric tonnes, located in 9aCN, with 13.72 cm as mean length. Anchovy recruitment was preliminary estimated to be at 3.3*$10^9$ fish, corresponding to 20*$10^3$ metric tonnes, with 8.3 cm as mean length (21.9*$10^9$ fish, corresponding to 88*$10^3$ in 2023).

On the other hand, it should be highlighted the thickness of some sardine schools, with very high density achieving at to -14/-12 dB as maximum $s_v$ within those schools, never recorded for sardine until now.

| | *Description* |
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| **Survey design** | The survey area over the shelf until the 200 m isobath, was covered following a parallel grid with fixed starting point. Tracks in 9aN and north 9aCN were extended to the shelf edge similar to the previous year to cover the offshore distribution of juvenile anchovy. Acoustic screening was performed from sunrise to sunset with the scientific eco-sound Simrad EK80 (18-38–70-120-200 kHz). |
| **Index Calculation method** | Methodology described in Doray, M., Van Der Kooij, J., Boyra, G. (Eds.), 2021. ICES Survey Protocols - Manual for acoustic surveys coordinated under the ICES Working Group on Acoustic and Egg Surveys for Small Pelagic Fish (WGACEGG). https://doi.org/10.17895/ICES.PUB.7462 |
| **Random/systematic error issues** | NA, outside of those already described in literature for standardised acoustic surveys |
| **Specific survey error issues (acoustic)** | *There are some bias considerations that apply to acoustic-trawl surveys only, and the respective TIMES should outline how these are evaluated:* |
| **Bubble sweep down** | The survey had to be interrupted for 5 days due to a storm, but because the vessel has a drop-keel no significant bubble sweep down occurred. |

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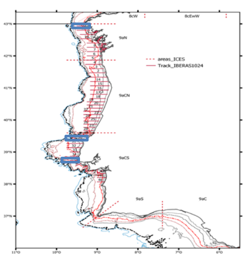
| **Extinction (shadowing)** | Not observed during the survey. |
| **Blind zone** | Drop-keel mounted transducers at 6.5 m depth, downward facing. Upper integration limit set at 10 m depth. |
| **Dead zone** | A 0.5 m offset is added to the bottom line detected by the transducers. Target species were generally distributed above this deadzone. |
| **Allocation of backscatter to species** | Direct allocation to the species, based on the expert judgment, was applied in cases of clearly identifiable individual schools. The remaining allocation was based in the species composition of the closer trawl hauls which were considered a good approximation of the real species composition. |
| **Target strength** | Species-specific $b_{20}$ values are listed in Table 2.12 in Doray *et al*. (2021). Anchovy and Sardine: -72.6; Chub mackerel: -68.7.<br>Doray, M., Boyra, G., and van der Kooij, J. (Eds.). 2021. ICES Survey Protocols – Manual for acoustic surveys coordinated under the ICES Working Group on Acoustic and Egg Surveys for Small Pelagic Fish (WGACEGG). 1st Edition. ICES Techniques in Marine Environmental Sciences Vol. 64. 100 pp. https://doi. org/10.17895/ices.pub.7462 |
| **Calibration** | All frequencies were calibrated according to the standard procedures (ICES-CRR326) by the IEO-CSIC team before the start of the survey, following the ICES standard procedures (Demer *et al*., 2015; see also Foote *et al*., 1987).<br>Demer, D.A., Berger, L., Bernasconi, M., Bethke, E., Boswell, K., Chu, D., Domokos, R., *et al*. 2015. Calibration of acoustic instruments. *ICES Coop. Res. Rep*, 326, 133 pp.<br>Foote, K.G., H.P. Knudsen, G. Vestnes, D.N. MacLennan, E.J. Simmonds, 1987. Calibration of acoustic instruments for fish density estimation: a practical guide. *ICES Coop. Res. Rep*., 144, 57 pp. |
| **Specific survey error issues (biological)** | *There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:* |
| **Acoustic sampling scheme completion (incl. map)** | The acoustic sampling scheme has not been entirely completed due to the bad weather conditions (982 nmi covered). Blue squares indicate the uncovered areas (transects 13, 30 and 35).<br>The survey only focussed on the two main target species (juvenile sardine and anchovy).<br> |
| **Biological sampling** | Good sampling carried out for all species: 17 trawl hauls together with 9 purse seiner shots have been used for identification purposes.<br>No. of identification haul per surveyed distance: 0.02 haul/n.m. |
| **Stock containment** | Juvenile anchovy (9a): Yes<br>Juvenile sardine (9a): Yes<br>The survey is only targeting juvenile sardine and anchovy. Recruitment index for sardine is done with data recorded only in 9aCN while for anchovy, the bulk is located north 9aCN and in the whole 9aN. For sardine, the survey is achieving the |

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| | whole potential distribution area while for anchovy part of the juvenile stock would be located at the outer part of the survey area. The number of schools outside the surveyed area, offshore, is unknown. |
| **Stock ID and mixing issues** | Since the survey is only focusing on juveniles, no major issues are found. |
| **Measures of uncertainty (CV)** | Acoustic data are checked using taylor-made routines before biomass estimation. Biomass per echotype and species, internal consistency checks. For the time being, acoustic estimates (i.e. indices) are provided without a measure of uncertainty. |
| **Spawning** | Spawning activity at the survey time seems to be low. |
| **Hydrology** | CTD data are still under revision. |
| **Were any concerns raised during the meeting regarding the fitness of the survey for use in the assessment either for the whole times series or for individual years? (please specify)** | *To be answered by Assessment Working Group* |
| **Did the Survey Summary Table contain adequate information to allow for evaluation of the quality of the survey for use in assessment? Please identify shortfalls** | *To be answered by Assessment Working Group* |

| Survey Summary table WGACEGG 2024 | |
|---|---|
| **Name of the survey (abbreviation):** | JUVENA (ES) |
| **Target Species:** | Anchovy (Engraulis encrasicolus), sardine (Sardina pilchardus), spratt (Sprattus sprattus), horse mackerel (Trachurus trachurus), mackerel (Scomber scombrus), chub mackerel (Scomber colias) pearlside (Maurolicus muelleri), krill (Euphasiacea), boarfish (Capros aper) and blue whiting (Micromesistius poutassou). |
| **Survey dates:** | 01/09/2024 – 14/10/2024 |

**Summary:** **Cruise Report Link:**

The objectives of the survey were carried out successfully and as planned. The survey is delayed by 15 days due to ship availability. Particularly bad weather conditions limited part of the surveyed area in the outer Northernmost area. Main objective species assessment not affected (explained below). Fewer number of pelagic trawls were carried out (N=71) mainly because of the scarce small pelagic fish presence beyond the shelf break in the Cantabric zone, reducing the ground-truth need in that area. Acoustic sampling effort (2162 nautical miles, n.m. linear transect) and geographical survey coverage were comparable to 2023.
Survey effort and area coverage were globally comparable to previous years and the same vessel and sampling equipment (transducers and trawl) were used. Time frame was delayed 15 days but still comparable with the series.
Juvenile anchovy: distribution shift northwards, decrease of biomass, medium-low recruitment, increase of size and weight
Sardine: expected distribution in French coast, absent from Cantabric area. Increase of biomass but decrease of mean weight and length values.

| | *Description* |
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| **Survey design** | Systematic parallel design with adaptive degree of extension of the transects based on anchovy presence. Fixed starting point. The acoustic sampling was performed during the daytime, when the juveniles are supposed to aggregate in schools (Uriarte 2002 FAIR CT 97-3374) and can be distinguished from plankton structures. The survey is performed by two vessels.<br>Details of the sampling design and data analysis can be found in Boyra et al., 2013 and Boyra, 2016. |
| **Index Calculation method** | No changes with respect to last year, details in Boyra et al., 2013; Doray et al., 2021. https://doi.org/10.17895/ICES.PUB.7462<br>Data uploaded to the ICES Trawl acoustic portal. https://www.ices.dk/data/data-portals/Pages/acoustic.aspx |
| **Random/systematic error issues** | NA, outside of those already described in literature for standardised acoustic surveys |
| **Specific survey error issues (acoustic)** | *There are some bias considerations that apply to acoustic-trawl surveys only, and the respective TIMES should outline how these are evaluated:* |
| **Bubble sweep down** | NA. Under bad weather conditions we pause the survey. |
| **Extinction (shadowing)** | None |

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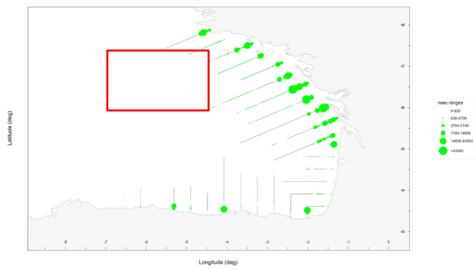
| **Blind zone** | Transducers are located at the drop keel, looking downwards at 6.5 m from the surface. Since juvenile anchovy is often observed at shallower layers, scrutinization of the shallower layers is done with the aid of a 333 kHz transducer (reduced blind zone) installed in a lateral perch at 2 m depth vertically oriented, and a multibeam lateral sonar MS70. These measurements are used to calculate a correction factor to account for the individuals in the blind zone of the transducers located in the keel. |
| **Dead zone** | A 0.5 m offset is added to the bottom line detected by the transducers. |
| **Allocation of backscatter to species** | Directed trawling has been performed for verification purposes |
| **Target strength** | Species-specific b20 values are listed in Table A2.2 in Massé et al. (2018). TS values are not species-specific. Anchovy and sardine: -72.6 dB; chub mackerel and Trachurus spp.: -68.7 dB; mackerel: -84.9 dB; pearlside: -71.4 dB |
| **Calibration** | All survey frequencies calibrated and results within recommended tolerances |
| **Specific survey error issues (biological)** | *There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:* |
| **Acoustic sampling scheme completion (incl. map)** | The acoustic sampling scheme has been entirely completed (2162 nautical miles, n.m. linear transect), except for the Northwestern part of the area (red square in Figure below), because of inclement weather.  The negative bias in biomass estimates caused by the non-coverage of the Northwestern area was deemed negligible for main objective species (anchovy <1% of presence in that area for temporal series). Boarfish might have been undersampled. |
| **Biological sampling** | Good sampling carried out for all species: 71 identification hauls performed, comparable to previous years.<br>No. of identification haul per surveyed distance: 0.04 haul/n.m. |
| **Stock containment** | Anchovy (8abcd): Yes<br>Sardine (8abcd): Yes<br>Sprat (8abcd): Yes<br>Horse mackerel (8abcd): Yes<br>Atlantic mackerel (8abcd): Yes<br>Blue whiting (8abcd): Yes<br>Chub mackerel (8abcd): Yes<br>Boarfish (8abcd): Yes<br>Where possible, JUVENA survey timings are coordinated with CSHAS, PELTIC, |

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| | IBERAS and ECOCADIZ-RECLUTAS within WGACEGG to ensure a quasi-synoptic sampling of the European continental shelf from Portugal to the Celtic Sea, although logistics, such as vessel availability affect this. The combination of semi-adaptive strategy and coordination with other autumn surveys assure containment for anchovy and sardine. |
| **Stock ID and mixing issues** | None |
| **Measures of uncertainty (CV)** | CV estimates of 22-24 have been calculated according to TIMES (Doray et al., 2021) and are currently being validated. An exhaustive revision of the formulation is being carried out to definitively establish the common methodology for obtaining CV in all campaigns. |
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| **Were any concerns raised during the meeting regarding the fitness of the survey for use in the assessment either for the whole times series or for individual years? (please specify)** | *To be answered by Assessment Working Group* |
| **Did the Survey Summary Table contain adequate information to allow for evaluation of the quality of the survey for use in assessment? Please identify shortfalls** | *To be answered by Assessment Working Group* |

| Survey Summary table WGACEGG 2024 | |
|---|---|
| **Name of the survey (abbreviation):** | PELACUS (ES) |
| **Target Species:** | Sardine, anchovy and horse mackerel |
| **Survey dates:** | 26/03/2024 –17/04/2024 |

**Summary:** **Cruise Report Link:**

PELACUS0324 was carried out onboard the R/V Miguel Oliver one month later than usual due to an extended dry dock period. The first leg of the survey was carried out from the 26th -31st March, and the second leg from the 5th-17th April. The acoustic equipment was calibrated in las Rias Baixas (Galicia) on 1st April.

The objectives of the survey were successfully achieved as planned, although the first leg of the survey was adversely affected by bad weather conditions with Storm Nelson. During the survey, 35 pelagic trawls were performed with the research vessel, which is comparable to previous years. The main species present at most of the fishing stations was sardine (85% of the total NASC allocated), followed by anchovy (57%) and Atlantic mackerel (57%).

As a main result, biomass estimates for sardine achieved in area 9aN and 8c were 189 thousand metric tonnes, corresponding to 4.37 *$10^9$ fish. Sardine were mainly found in 9aN this year, similar to last year´s results. Biomass estimates for anchovy achieved in area 9aN and 8c were 26719 metric tonnes, corresponding to 1665 *$10^9$ fish.

| | *Description* |
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| **Survey design** | Stratified systematic parallel design (8nmi apart) with randomised starting point. |
| **Index Calculation method** | Methodology described in Doray, M., Van Der Kooij, J., Boyra, G. (Eds.), 2021. ICES Survey Protocols - Manual for acoustic surveys coordinated under the ICES Working Group on Acoustic and Egg Surveys for Small Pelagic Fish (WGACEGG). https://doi.org/10.17895/ICES.PUB.7462 |
| **Random/systematic error issues** | NA, outside of those already described in literature for standardised acoustic surveys |
| **Specific survey error issues (acoustic)** | *There are some bias considerations that apply to acoustic-trawl surveys only, and the respective TIMES should outline how these are evaluated:* |
| **Bubble sweep down** | NA. Under bad weather conditions the survey was paused. |
| **Extinction (shadowing)** | None |
| **Blind zone** | Drop-keel mounted transducers at 6.5 m depth, downward facing. Upper integration limit set at 10 m depth. |
| **Dead zone** | A 0.5 m offset is added to the bottom line detected by the transducers. |

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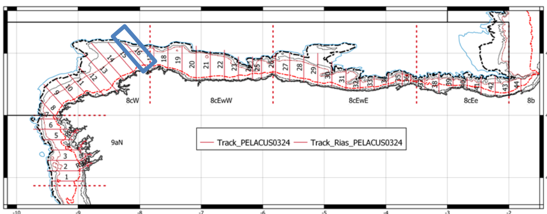
| **Allocation of backscatter to species** | When possible, direct allocation was done, accounting for the shape of the schools and also the relative frequency response (Korneliussen and Ona, 2003, De Robertis et al, 2010).<br>For all school candidates, several of variables were extracted, among them the NASC ($s_A$, m[2] /nmi[2]) together with the proportioned region to cell (ESDU, 1 nmi) NASC and the $s_V$ mean and $s_V$ max and geographic position and time.<br>PRC_NASC values were summed for each ESDU and distances were referenced to a single starting point for each transect. Results for 38 and 120 kHz were compared. Besides, the frequency response for each valid school (i.e. those with length and $s_V$ which allows them be properly measured) was calculated as the ratio $s_A$(fi)/$s_A$(38), being fi the $s_A$ values for 18, 70, 120 and 200 kHz. |
| **Target strength** | Species-specific $b_{20}$ values are listed in Table 2.12 in Doray *et al*. (2021). Anchovy and Sardine: -72.6<br>Doray, M., Boyra, G., and van der Kooij, J. (Eds.). 2021. ICES Survey Protocols – Manual for acoustic surveys coordinated under the ICES Working Group on Acoustic and Egg Surveys for Small Pelagic Fish (WGACEGG). 1st Edition. ICES Techniques in Marine Environmental Sciences Vol. 64. 100 pp. https://doi. org/10.17895/ices.pub.7462 |
| **Calibration** | All frequencies were calibrated according to the standard procedures (ICES-CRR326) during the first two days, following the ICES standard procedures (Demer *et al*., 2015; see also Foote *et al*., 1987).<br>Demer, D.A., Berger, L., Bernasconi, M., Bethke, E., Boswell, K., Chu, D., Domokos, R., *et al*. 2015. Calibration of acoustic instruments. *ICES Coop. Res. Rep*, 326, 133 pp.<br>Foote, K.G., H.P. Knudsen, G. Vestnes, D.N. MacLennan, E.J. Simmonds, 1987. Calibration of acoustic instruments for fish density estimation: a practical guide. *ICES Coop. Res. Rep*., 144, 57 pp. |
| **Specific survey error issues (biological)** | *There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:* |
| **Acoustic sampling scheme completion (incl. map)** | The acoustic sampling scheme has been entirely completed (2923 nautical miles), except transect number 16 (blue square, figure below)which was covered with bad weather and could not be used for the acoustic estimations.<br><br><br>The negative bias in biomass estimates caused by the non-coverage of the Northwestern area was deemed negligible for main objective species. |
| **Biological sampling** | Good sampling carried out for all species: 35 identification hauls performed, comparable to previous years.<br>No. of identification haul per surveyed distance: 0.012 haul/n.m. |
| **Stock containment** | Anchovy (9a8c): Yes<br>Sardine (9a8c): Yes<br>Sprat (9a8c): No<br>Horse mackerel (9a8c): Yes<br>Blue whiting (9a8c): Yes<br>Atlantic mackerel (9a8c): Yes<br>Chub mackerel (9a8c): Yes<br>Anchovy and sardine: good geographical alignment on the northern (FR: |

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| | PELGAS, not this year due to the impossibility of the French vessel to cover Spanish waters as clearance to use echosounders in this small area was refused by Spanish authorities) and southern (PT: PELAGO) boundaries. |
| **Stock ID and mixing issues** | None |
| **Measures of uncertainty (CV)** | CV estimates of 22-24 have been calculated according to TIMES (Doray et al., 2021) and are currently being validated. An exhaustive revision of the formulation is being carried out to definitively establish the common methodology for obtaining CV in all campaigns. |
| **Spawning** | During the acoustics surveying 288 CUFES samples were collected in the whole study area. Eggs of sardine were observed in 41% of the samples (mainly the Galician coast and the central and eastern parts of the Cantabrian Sea) whereas anchovy eggs were collected in 59% of the stations (mainly in the Galician coast and in the central and western parts of the Cantabrian sea). The sardine and anchovy egg density declined sharply comparing to the previous survey. Horse mackerel eggs were observed in 78% of the samples. The same pattern observed with others species was repeated, numbers and densities decreased. On the contrary, Mackerel eggs gathered and densities increased with regards to 2023. |
| **Hydrology** | Sea temperature conditions and surface salinity were close to the average situation. |
| **Were any concerns raised during the meeting regarding the fitness of the survey for use in the assessment either for the whole times series or for individual years? (please specify)** | *To be answered by Assessment Working Group* |
| **Did the Survey Summary Table contain adequate information to allow for evaluation of the quality of the survey for use in assessment? Please identify shortfalls** | *To be answered by Assessment Working Group* |

## Survey Summary Table WGACEGG 2024

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| **Name of the survey (abbreviation):** | PELAGO |
| **Target Species:** | Anchovy, sardine, chub mackerel, small pelagic fish |
| **Survey dates:** | 1 – 24 March, 2024 |

**Summary:** **Cruise Report Link:**

PELAGO survey was carried out by IPMA on board R/V Miguel Oliver, between the 1th of March 2024 and the 24th of March 2024, for a total of 21 days at sea, without major issues. A total of 1134 nautical miles were tracked over the foreseen 71 sampling tracks and 51 fishing hauls were carried out for echo-trace ground-truthing purposes.

Survey effort, timing and area coverage were comparable to previous years and the same vessel and sampling equipment (transducers and trawl) were used.

The post processing scrutiny and integration was done by IEO and IPMA during a workshop in Vigo. The assessment of anchovy from pelago24 was delivered to WGHANSA in May as an input in the stock assessment models of the west and south components of the stock. Data processing for the others pelagic species proceeded later only after the anchovy advice was given. This analysis revealed a possible general underestimation in May of the NASC from the school's detection in the software Echoview (219 916 $m^2/nmi^2$). This underestimation was mainly due to the misuse of a virtual echogram with a too high threshold (-60 dB) that left part of the schools out of the scrutiny process. Even more, the use of an appropriate threshold also led to an update of the scrutiny processes, which, in turn, revealed the need to perform small changes in the NASC allocation criteria to fish species using the fishing stations undertook in the surveyed area to those schools and aggregations recorded with the new threshold fixed at -70dB. Facing this, the echogram analysis was deeply revised, producing new integration files for the whole survey (total NASC 359 582 $m^2/nmi^2$). A new assessment for anchovy was produced with the revised data yielding a significant increase in abundance and biomass estimations. All other species were also assessed using the revised NASC.

| | *Description* |
|---|---|
| **Survey design** | The survey area, over the shelf until the 200 m isobath, was covered following a parallel grid with fixed starting point. The northern 11 tracks were extended to the shelf edge similar to the previous year to cover the offshore distribution of anchovy and sardine. Acoustic screening was performed from sunrise to sunset with the scientific eco-sound Simrad EK80 (18-38–70-120-200 kHz), covering the continental shelf of Portugal and the Bay of Cadiz, in Spain. |
| **Index Calculation method** | The echo-integration of the acoustic signal was performed with a frequency of 38 kHz, while the remaining frequencies were used to assist in the echogram scrutiny process. The acoustic data was recorded in Echoview, which was also used to integrate the fish acoustic energy. The echogram bottom was manually corrected prior to the acoustic energy extraction. Fishing operations were used to split the acoustic energy by species and by length within each species, to collect weight-at-length, age, and other biological data. Biological sampling of sardine, anchovy, horse mackerel, mackerel and chub-mackerel was performed in each fishing station, whenever the species was captured. Age data was used to produce Age Length Keys (ALK) for sardine, anchovy and chub mackerel. The abundance by age group and area was estimated from the combination of the ALK and the estimates of abundance at length from the echo-integration in each area. Fishing was carried out according to the echogram information. Methodology partly described in Doray, M., Van Der Kooij, J., Boyra, G. (Eds.), 2021. |
| **Random/systematic error issues** | NA, outside of those already described in literature for standardised acoustic surveys. |
| **Specific survey error issues (acoustic)** | *There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:* |
| **Bubble sweep down** | The survey had to be interrupted for 3 days due to a storm, but in the 21 days at sea no significant bubble sweep down occurred. |

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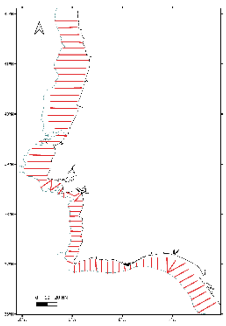
| **Extinction (shadowing)** | Not observed during the survey. |
| **Blind zone** | Hull mounted transducers at 5.7 m depth, downward facing. Upper integration limit set at 10 m depth. In this survey aggregations of sardine and/or anchovy were not observed near the surface. |
| **Dead zone** | A 0.5 m offset is added to the bottom line detected by the transducers. Target species were generally distributed above this deadzone. |
| **Allocation of backscatter to species** | Direct allocation to the species, based on the expert judgment, was applied in cases of clearly identifiable individual schools. The remaining allocation was based in the species composition of the closer trawl hauls which were considered a good approximation of the real species composition. |
| **Target strength** | Species-specific b20 values are listed in Table 2.12 in Doray *et al*. (2021). Anchovy and sardine: -72.6; chub mackerel: -68.7. |
| **Calibration** | Acoustic equipment was calibrated by the IEO team before the PELAGO survey–, following the ICES standard procedures (Demer *et al*., 2015; see also Foote *et al*., 1987). |
| **Specific survey error issues (biological)** | *There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:* |
| **Acoustic sampling scheme completion** | The acoustic sampling scheme has been entirely completed. The northern 11 tracks were extended to the shelf edge similar to the previous year to cover the offshore distribution of anchovy and sardine.  |
| **Biological sampling** | Good sampling carried out for all species: 51 identification hauls performed, comparable to previous years. Note that small number of fishing hauls in 9aSC (N=3) was only related to the distribution of fishable schools. |
| **Stock containment** | The timing of the survey is well coordinated with the PELACUS survey to enlarge the sampling northwards and to the Cantabric, pursuing a comprehensive containment of PIL and ANE stocks.<br>Chub mackerel: No |
| **Stock ID and mixing issues** | Potential mixing of the sardine stock with the north-western stock on the African coast. The existence of genetically unrelated stocks of anchovy in southern and western parts of the surveyed area was analysed recently in the WKBANSP confirming the separation into 2 stocks. |
| **Measures of uncertainty (CV)** | Acoustic data are checked using taylor-made routines before biomass estimation. Biomass per echotype and species, internal consistency checks. For the time being, acoustic estimates (i.e. indices) are provided without a measure of uncertainty. |
| **Spawning** | During the acoustics surveying 449 CUFES samples were collected in the whole study area. Eggs of sardine were observed in 57% of the samples (mainly the NW and S coasts) whereas anchovy eggs were collected in 35% of the stations (mainly in the NW and S shores. The sardine egg density dropped slightly comparing to the previous survey while the abundances of anchovy declined sharply. The timing of the survey, in |

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| | early spring, is more in line with the sardine reproductive season than for anchovy. |
| **Hydrology** | The hydrographic conditions found were the usual for a late winter-early spring period. However, water temperatures observed in the whole study area were lower than in previous years. March 2024 was quite rainy and that was apparent in the signatures of the major river plumes in particular in the NW coast but also off Lisbon. Apart from the SST and SSS data recorded continuously underway, profiles of temperature and salinity, 62 CTD profiles were obtained in the area monitored. |
| **Were any concerns raised during the meeting regarding the fitness of the survey for use in the assessment either for the whole times series or for individual years? (please specify)** | *To be answered by Assessment Working Group* |
| **Did the Survey Summary Table contain adequate information to allow for evaluation of the quality of the survey for use in assessment? Please identify shortfalls** | *To be answered by Assessment Working Group* |

| Survey Summary table WGACEGG 2024 | |
|---|---|
| **Name of the survey (abbreviation):** | PELGAS (FR) |
| **Target Species:** | Anchovy, sardine, small pelagic fish |
| **Survey dates:** | 28 April – 28 May, 2024 |

**Summary:** **Cruise Report Link:** https://doi.org/10.17600/18003027

The objectives of the survey were carried out successfully and as planned. Good weather conditions dominated during the survey. Comprehensive pelagic trawling was carried out (N=97), comparable to previous years. Acoustic sampling effort (1779 nautical miles, n.m. linear transect) and geographical survey coverage were comparable to 2023, except for the Southernmost part. Spanish waters were not covered for the first time, as clearance to use echosounders in this small area was refused by Spanish authorities (cf. sampling scheme completion section).

Survey effort, timing and area coverage were globally comparable to previous years and the same vessel and sampling equipment (transducers and trawl) were used.
Egg sampling was performed with the CUFES and fish abiotic and biotic environment were characterised.

| | *Description* |
|---|---|
| **Survey design** | Stratified systematic parallel design with fixed starting point. |
| **Index Calculation method** | Methodology described in Doray, M., Van Der Kooij, J., Boyra, G. (Eds.), 2021. ICES Survey Protocols - Manual for acoustic surveys coordinated under the ICES Working Group on Acoustic and Egg Surveys for Small Pelagic Fish (WGACEGG). https://doi.org/10.17895/ICES.PUB.7462<br>Implemented with EchoR R package V1.4.7 |
| **Random/systematic error issues** | NA, outside of those already described in literature for standardised acoustic surveys |
| **Specific survey error issues (acoustic)** | *There are some bias considerations that apply to acoustic-trawl surveys only, and the respective TIMES should outline how these are evaluated:* |
| **Bubble sweep down** | The weather has been clement during the survey, no significant bubble sweep down occurred. |
| **Extinction (shadowing)** | None |
| **Blind zone** | The lateral-beaming echosounder used to sample the 0-15m depth layer allowed to visually control for the presence of small pelagic fish (SPF) schools in the vertical echosounders blind zone. A technical issue did not allow to derive a quantitative estimate of SPF biomass in the vertical echosounders blind zone, as in previous years.<br>However, the lateral echosounder allowed to visually check that SPF distribution was not as shallow as last year.<br>Based on these observations, the fish acoustic biomass in the vertical |

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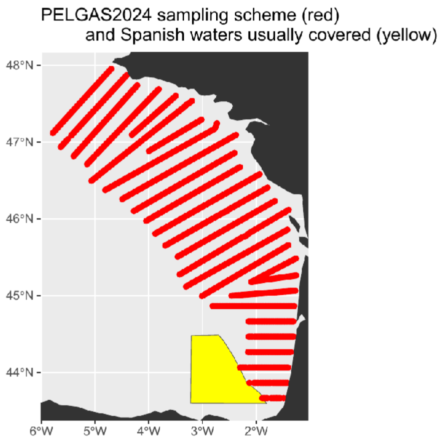
| | echosounders blind zone was assumed to be of the same order of magnitude as in 2019 (~5% and 0% of total acoustic biomass for anchovy and sardine, respectively). |
| **Dead zone** | A 70 cm offset was applied above seabed to avoid integrating seafloor backscatter in the water column. Target species were generally distributed above this deadzone. |
| **Allocation of backscatter to species** | Directed trawling has been performed for verification purposes |
| **Target strength** | Cf. [https://doi.org/10.17895/ICES.PUB.7462](https://doi.org/10.17895/ICES.PUB.7462) |
| **Calibration** | All survey frequencies calibrated and results within recommended tolerances |
| **Specific survey error issues (biological)** | *There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:* |
| **Acoustic sampling scheme completion (incl. map)** | The acoustic sampling scheme has been entirely completed (1779 nautical miles, n.m. linear transect), except Spanish waters (yellow polygon in Figure below), whose access was not allowed by Spanish authorities.<br><br><br>The negative bias in biomass estimates caused by the non-coverage of Spanish waters was deemed negligible for all assessed species, based on the analysis of fish biomass estimated in this area over the series (Doray et al. 2024). |
| **Biological sampling** | Good sampling carried out for all species: 97 identification hauls performed, comparable to previous years.<br>No. of identification haul per surveyed distance: 0.05 haul/n.m. |
| **Stock containment** | Anchovy (8ab): Yes<br>Sardine (8ab): Yes<br>Sprat (8ab): Yes<br>Blue whiting: No<br>Atlantic mackerel: No<br>Chub mackerel: No<br>Boarfish and horse mackerel: good geographical alignment on the northern (IRL: WESPAS) and southern (SP: PELACUS) boundaries but temporal mis-match (~1 month). |

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| **Stock ID and mixing issues** | None |
| **Measures of uncertainty (CV)** | *CV on abundance*<br><br>Boarfish: 0.21<br>Anchovy 0.09<br>Hake 0.22<br>Blue whiting 0.12<br>Sardine 0.15<br>Atlantic mackerel 1.49<br>Chub mackerel 0.34<br>Sprat 0.26<br>Med. horse mackerel: 0.69<br>Horse mackerel: 0.28<br><br>*Calculation carried out using EchoR package version 1.4.7 |
| **Spawning** | Large amount of anchovy eggs were found with an unusual maximum abondance in the northwest of the Bay as compared the classic situation.<br>The abundance of sardine eggs was quite low and the presence only along the coast. |
| **Hydrology** | Sea temperature conditions were close to the average situation, while sea surface salinity was above the average due to the large precipitations at the beginning of the year. |
| **Were any concerns raised during the meeting regarding the fitness of the survey for use in the assessment either for the whole times series or for individual years? (please specify)** | *To be answered by Assessment Working Group* |
| **Did the Survey Summary Table contain adequate information to allow for evaluation of the quality of the survey for use in assessment? Please identify shortfalls** | *To be answered by Assessment Working Group* |

| Survey Summary table WGACEGG 2024 | |
|---|---|
| **Name of the survey (abbreviation):** | PELTIC (UK) |
| **Target Species:** | Sardine , Sprat, Anchovy |
| **Survey dates:** | 3 Octcober, 2024- 2 November 2024 |
| **Summary:** | **Cruise Report Link:** |

All survey objectives were successfully met. Survey timing, coverage (area), acoustic sampling (1917 nautical miles) and number of trawls (n=36) were comparable to the most successful previous years. In contrast to 2020, 2021 and 2023, PELTIC was not extended into Cardigan Bay. The survey started in the north (Swansea) and worked down, around the Isles of Scilly and into the western English Channel eastwards. Oceanographic conditions (SST and location of Ushant and Celtic Sea fronts) were comparable to long-term average.

Sardine total biomass was the second highest of the time series series at 410,861 t (CV 0.13). Sardine was widely distributed but the highest aggregations were around the Isles of Scilly and the south of the southwestern point of Cornwall. The large numbers of eggs found in plankton samples were found at the same location. Sardine size in French waters were larger than typically found in this area.

The preliminary 2024 sprat biomass in the western Channel of 67,314 t (CV 0.52) was similar to that in 2023 and the second highest in the time series since 2016. As has been observed in last few years, the total biomass was primarily made up of 0-group sprat, with no fish older age 2 reported.

Anchovy biomass in the survey area in 2024 had crashed to 13,112t following the exceptionally high biomass in 2023. It represented some of the lowest biomass in the time series. There was an absence of post-larval anchovy in French waters, which had been seen there in some years since 2019 and were confirmed to have originated form the Bay of Biscay. However, this year small numbers of anchovy larvae were found in the mesh of the trawl at two stations along the south coast of England, one off Cornwall and one in Lyme Bay.

| | *Description* |
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| **Survey design** | Stratified systematic parallel design with 10 and 15 nmi inter-transect distance. |
| **Index Calculation method** | StoX (V3.6.2) and RStoX (V1.9.0)<br>Data uploaded to the ICES Trawl acoustic portal |
| **Random/systematic error issues** | NA, outside of those already described in literature for standardised acoustic surveys |
| **Specific survey error issues (acoustic)** | *There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:* |
| **Bubble sweep down** | Excellent weather conditions meant that data was of very high quality with no concerns raised about bubbles. |
| **Extinction (shadowing)** | Not an issue (school backscatter explored in situ for high values >20,000 NASC ) |

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| **Blind zone** | Time-series: survey conducted daylight only to avoid effects of diurnal vertical migration. High pingrate (0.5 s-1) also ensures that surface fish schools just below nearfield are captured acoustically at 10 knots.<br><br>2024. No significant presence of sub-surface schools. |
| **Dead zone** | 1m; presence of some dense sardine schools tight to seabed meant that bottom line was extended to incorporate more of the deadzone |
| **Allocation of backscatter to species** | Directed trawling for verification purposes |
| **Target strength** | Recommended (-71.2 clupeids, -66.2 boarfish; -68.7 horse mackerel; -67.5 gadoids); Mackerel processed at 200 kHz using b20 of 84.03 |
| **Calibration** | On drift at 0.512 µs for 38, 70, 120 and 200 kHz (333 kHz not done). Results comfortably within recommended parameters (RMS <0.3), apart from 200 kHz for which two calibrations were conducted and both exceeded the recommended RMS. |
| **Specific survey error issues (biological)** | *There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:* |
| **Stock containment** | Sardine (Celtic Sea); Yes to West and North although no coverage in eastern Channel and possible links with Biscay fish.<br>Sprat (Lyme Bay); questions remain about the link of Lyme Bay sprat to other populations in Channel and beyond although seemingly isolated in autumn.<br>Sprat in Celtic Sea not captured as extending further west (covered by MI, Ireland during CSHAS)<br>. |
| **Stock ID and mixing issues** | Time series:Sprat is genetically linked to wider NE Atlantic but population is likely to be split (geographic separation); Sardine is thought to be single stock although likely to be interacting with sardine in Bay of Biscay and southern North Sea; northern anchovy is separate stock.<br><br>2024 survey: Absence of juvenile anchovy schools suggest that issue of Bay of Biscay post-larval mixing with northern anchovy in the Channel during the survey was not a major issue. |
| **Measures of uncertainty (CV)** | *CV on abundance*<br>Sardine: 0.13<br>Sprat (7de): 0.52<br>Anchovy: not known as issues with bootstrap<br>*Calculation carried out using StoX (V3.6.2) and R-StoX (V1.9.0) |
| **Biological sampling** | Good sampling carried out across the key species with details provided in survey report. |
| **Were any concerns raised during the meeting regarding the fitness of the survey for use in the assessment either for the** | *To be answered by Assessment Working Group* |

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| **whole times series or for individual years? (please specify)** | |
| **Did the Survey Summary Table contain adequate information to allow for evaluation of the quality of the survey for use in assessment? Please identify shortfalls** | *To be answered by Assessment Working Group* |

| Survey Summary table WGACEGG 2024 | |
|---|---|
| **Name of the survey (abbreviation):** | WESPAS / MSHAS (IRL) |
| **Target Species:** | Herring, boarfish, horse mackerel |
| **Survey dates:** | 08 June – 19 July, 2024 |

**Summary:** **Cruise Report Link:** http://hdl.handle.net/10793/1984

The objectives of the survey were carried out as planned and timing was consistent with previous years. Survey coverage (area) and acoustic sampling (transect miles) and biological sampling were comparable to 2024.

Boarfish distribution was similar to previous years in terms of latitudinal range. Total biomass (TSB) decreased by 17% and total abundance (TSN) decreased by 26% compared to observations in 2023. The Porcupine Bank stratum was not surveyed in 2024 as effort was reallocated to the Celtic Sea core area. The decrease in biomass as compared to 2023 is likely due to inter-annual variability of acoustically derived abundance estimates more so than not covering the Porcupine Bank (annual contribution of <1.5% over last three years).

Boarfish TSB (total stock biomass) and abundance (TSN) estimates were 438,611 t and 11,858,064,000 individuals (CV 0.09) respectively. The highest density of biomass was observed in the Celtic Sea stratum (57.5 % of TSB and 56% of TSN), followed by the Irish west coast (32% TSB & 33.4% TSN), the western Hebrides (7.2 % of TSB and 7.3% of TSN) and the southern Hebrides stratum (3.3 % of TSB and 3.3% of TSN).

The 4-year age class dominated the 2024 estimate contributing 22% of TSB and 28% of TSN. Ranked second and third were the 5-year-old (20% TSB & 18% TSN) and 7-year-old fish (18% TSB & 16% TSN) respectively. Ranked fourth are the 6-year-old fish (11% TSB & 12% TSN). Combined, these four age classes represented 67% of TSB and 77% of TSN. The 15+ age class represented 10.4% of TSB and 4.3% of TSN.

The contribution of immature fish to the total biomass of boarfish was 0.02% of TSB and 0.06% of TSN, the lowest in the recent time series. Indicating the strong pulse of recent recruitment is likely at an end.

Horse mackerel TSB (total stock biomass) and abundance (TSN) estimates were 74,855 t and 259,561,500 individuals (CV 0.24) respectively. As compared to 2023, this is a reduction of TSB of 21% and TSN of 24% for comparable effort and coverage.

Horse mackerel were observed predominantly in the Celtic Sea (92% TSB), followed by the western Hebrides stratum (2.9%), southern Hebrides (2%) and west of Ireland with 2.7% of TSB. The Porcupine Bank area was not surveyed in 2024. Medium density and high density, monospecific and mixed species aggregations containing horse mackerel were encountered in the Celtic Sea. The estimates of abundance from the west coast, western Hebrides and southern Hebrides strata were composed of a small number of echotraces (2, 2 and 10 respectively).

The 11-year-old fish dominated this year's survey estimate representing 34% of TSB and 30% of TSN (Table 9). Seven-year-old fish ranked second representing 17% of TSB and 17% of TSN and 6-year-old fish ranked third (8% to TSB & 9% TSN). Com-bined these three age classes represented 60% of TSB and 56% of TSN.
Analysis of horse mackerel samples indicated 98% of TSB and 91% of TSB was mature.

The same vessel and sampling equipment (transducers and trawl) were used.

| | *Description* |
|---|---|
| **Survey design** | Stratified systematic parallel design with randomised starting point within each stratum. Zig-zag transects in the Minch strata. |
| **Index Calculation method** | StoX (V3.6.2) and RStoX (V3.6.2)<br>Data uploaded to the ICES Trawl acoustic portal |
| **Random/systematic error issues** | NA, outside of those already described in literature for standardised acoustic surveys |
| **Specific survey error issues (acoustic)** | *There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:* |
| **Bubble sweep down** | Poor weather was an issue during the survey. Transducer placement is 8.8m below the sea surface (drop keel), combined with the near-field exclusion, data integration takes place below 12m |
| **Extinction (shadowing)** | Yes, in some areas in the southwest Celtic Sea and northwest IRL/SCO |
| **Blind zone** | Aggregations of immature boarfish tend to be located above the thermocline in near surface waters and so it is likely that an unknown proportion was unaccounted for in the estimate |
| **Dead zone** | Some shelf slope areas |
| **Allocation of backscatter to species** | Directed trawling for verification purposes |
| **Target strength** | Herring TS = 20log10(L) – 71.2 (38 kHz)<br>Boarfish TS = 20log10(L) – 66.2 (38 kHz)<br>Horse Mackerel TS = 20log10(L) – 67.5 (38 kHz) |
| **Calibration** | All survey frequencies calibrated and results within recommended tolerances (RMS <0.4) |
| **Specific survey error issues (biological)** | *There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:* |
| **Stock containment** | Herring (Celtic Sea); Yes<br>Boarfish and horse mackerel; Good geographical alignment on the southern boundary (Fra: PELGAS) No survey coverage in the western Channel area. |
| **Stock ID and mixing issues** | Herring (Celtic Sea); Potential mixing with unidientified stocks on the feeding grounds. Genetic sampling underway. |
| **Measures of uncertainty (CV)** | *CV on abundance*<br>Boarfish: 0.09<br>Horse mackerel: 0.24<br>*Calculation carried out using StoX (V3.6.2) and R-StoX (V3.6.2) |

| | |
|---|---|
| **Biological sampling** | Good sampling carried out for boarfish and herring and hore mackerel (Celtic Sea & Malin Shelf). Horse mackerel estimate utilised otolith aged fish from the survey. No horse mackerel biological samples north of 52°N but some acoustic allocations, samples from neighbouring strata used in the analysis. |
| **Were any concerns raised during the meeting regarding the fitness of the survey for use in the assessment either for the whole times series or for individual years? (please specify)** | *To be answered by Assessment Working Group* |
| **Did the Survey Summary Table contain adequate information to allow for evaluation of the quality of the survey for use in assessment? Please identify shortfalls** | *To be answered by Assessment Working Group* |

# Annex 7: Report section for Anchovy 9.a, now replaced

## ACOM Advice applicable to the management period July 2023-June 2024

The stock was benchmarked in February 2018 (WKPELA 2018 ICES, 2018a). WKPELA 2018 supported the proposal of considering two different components of the stock (western and southern component) due to the different dynamics of their fisheries and populations. However, until the stock structure along the division is properly identified, the provision of advice will still be given for the whole stock, but with separate catch advice for each stock component. Given the high natural mortality experienced by this stock, its high dependence upon recruitment (the fishery depends largely on the incoming year class, the abundance of which cannot be properly estimated before it has entered the fishery), and the large inter-annual fluctuations observed in the spawning stock, ICES is aware that the state of this resource can change quickly. Therefore, an in-year monitoring and management, or alternative management measures should be considered. However, such measures should take into account the data limitation of the stock and the need for a reliable index of recruitment strength.

From the above reasons, the management calendar for the application of the advice has been agreed to be the one from 1st July of year *y* to 30th June of year *y+1* since 2018 onwards.

ICES advised for the period 1st July 2023 to 30th June 2024 that when the precautionary approach is applied, catches from the western component should be no more than 18 354 t and catches from the southern component should be no more than 2201 t (no more than 20 555 t for the whole stock). The TAC for this same management period was initially agreed in 20 555 t (Portugal: 10 724 t; Spain: 9831 t). After the application of inter-annual flexibility criteria and swaps the national quotas were finally adjusted to 10 724 t for Portugal and 10 206 t for Spain (western component: 125 t; southern component: 10 081 t).

Official anchovy landings in the division in 2023 were 11 867 t. Estimated total catches were 12 101 t. Provisional estimated catches for the current management calendar are 10 491 t (western component: 3923 t; southern component: 6568 t).

## Population structure and stock identity

A review of the anchovy sub-stock structure in the Iberian Atlantic waters (Ramos, 2015) was submitted in 2015 to the ICES Stock Identification Methods Working Group SIMWG; ICES, 2015). At that time, SIMWG considered that there was evidence to support a self-sustained population of anchovy located in the Gulf of Cadiz (GoC, ICES Subdivision 9a South), but there was a lack of information regarding the origin of European anchovy in the western subdivisions (comprising subdivisions 9a North, 9a Central-North and 9a Central-South; Figure A7.2.1).

This stock was benchmarked at WKPELA in 2018 by ICES (ICES, 2018a) and an updated review of this issue was provided to this workshop, which included new available information of the potential connectivity of anchovy population of the 9a West subdivisions with the south Iberian population (Garrido *et al.*, 2018a). Evidence shown at that time led to the decision of considering the anchovy populations inhabiting the southern and western Iberian regions as separate stock components for management purposes. The western component comprises the subdivisions 9a North, 9a Central-

North and 9a Central-South. The southern component includes the Portuguese and Spanish waters of the Subdivision 9a South.

A Working Document was submitted and presented during WGHANSA-1 2022 with updated information on anchovy stock structure in the 9a area (Garrido *et al*. 2022). Anchovy spatial distribution in Division 9a provided by surveys shows a persistent discontinuity between the western and southern components of the stock for several life stages (eggs, juveniles and adults) and during different seasons of the year. Landings also show this discontinuity, with more than 90% of Portuguese landings occurring in Subdivision 9a C-N since 2017. No correlation was found between anchovy catches between the two areas, suggesting independent dynamics. The hypothesis that the western stock might come from migration from the southern component was not supported by the current data, since there was no correlation between anchovy abundance and landings in the western Iberia with anchovy abundance in the southern Iberia in the following year. The spatial discontinuity and the independent dynamics between the western and southern anchovy populations point to the presence of a self-sustained anchovy population in the western Iberia, independent of the southern component. A review of studies conducted in Portuguese estuaries have also shown the persistent presence of recruits in numerous estuaries, mainly in the Subdivision 9a C-N, which, agreeing with the concentration of eggs in this subdivision, points to the presence of a self-sustained population in this area. Morphometric and genetic studies seem to indicate a differentiation of the western and Cantabrian populations, as well as a separation with those from the Gulf of Cadiz, but additional analyses are needed as these conclusions might be affected by the presence of two ecotypes (marine and coastal), which are often not considered in these studies. From the evidence presented in that working document, WGHANSA supported the separation of the western and southern components of the anchovy 27.9.a into two stock units: the population in Subdivision 9a South and the populations from sub-divisions in the western coast (9a North, Central-North and Central-South). Such a proposal was then submitted to the ICES Stock Identification Methods Working Group (SIMWG) for consideration (ICES, 2022). SIMWG stated that the results of those studies detect differentiation between both stock components (e.g. Silva *et al*., 2014; Zarraonaindia *et al*., 2012) but may be biased by different (and unknown) proportions of each ecotype in the samples used. SIMWG advocates for the need for future monitoring programs to include sampling that considers the ecotypes presence and to further use genomic markers that display an appropriate level of resolution both geographic and genetic.

A Working Document was submitted and presented during WGHANSA-1 2024 with updated information on anchovy stock structure in the 9a area, that includes new information of genetics, stable isotopic composition and connectivity in the larval stage (Garrido *et al*. 2024). The same WD was also presented to the SIMWG to be reviewed in June 2024.

# The fishery in 2023

## Fishing fleets

Anchovy harvesting throughout the Division 9.a was carried out in 2023 by the following fleets in each stock component:

#### Western component

- Portuguese purse-seine fleet (PS_SPF_0_0_0).
- Portuguese multipurpose fleet (although fishing with artisanal purse-seines) (MIS_MIS_0_0_0_HC).
- Portuguese trawl fleet for demersal fish species (OTB_DEF_>=55_0_0).
- Spanish purse-seine fleet (PS_SPF_0_0_0).
- Spanish trammel net directed to demersal fish (60-79 mm mesh size) (GTR_DEF_60-79_0_0).

- Spanish miscellaneous fleet (artisanal métiers accidentally fishing anchovy) (MIS_MIS_0_0_0_HC).
- Spanish trawl fleet for demersal fish species (OTB_DEF_>=55_0_0 anchovy discards).

#### Southern component

- Portuguese purse-seine fleet (PS_SPF_0_0_0).
- Spanish purse-seine fleet (PS_SPF_0_0_0).
- Spanish bottom otter trawl directed to demersal fish in 9.a South (OTB_MCD_>=55_0_0 anchovy discards).

The Spanish fleet fishing anchovy in the Western component was composed in 2023 by a total of 77 vessels. From this total, 71 vessels (92%) were purse-seiners (Table A7.3.1.1). No information on the number of Portuguese vessels fishing anchovy in 2023 was available to the working group, but it may be assumed that the fleet operating in 2023 should not be very different from the one in 2020. The Portuguese fleet targeting anchovy and operating in the Western component in 2020 was composed by a total of 113 vessels in the Subdivision 9.a Central North and 52 vessels in the Subdivision 9.a Central South (ICES, 2021a).

Number and technical characteristics of the purse-seine vessels operated by Spain targeting anchovy in their national waters off GoC (Southern component) are also summarised in Table A7.3.1.1. In 2023, GoC anchovy fishing was practised by 51 purse-seiners, 3 vessels less targeting anchovy than in 2022, and still lower than in previous years (74-78 vessels for the period 2016-2018). Details of the dynamics of this fleet in terms of number of operative vessels over time in recent years are given in ICES (2008a; WGANC 2008 report) and subsequent WGHANSA reports. The Portuguese fleet targeting anchovy and operating in the Southern component in 2020 was composed of a total of 22 vessels (ICES, 2021a).

## Catches by stock component

The updated historical series of anchovy catches by subdivision are shown in Table A7.3.2.1.1 (see also Figure A7.3.2.1.1). Table A7.3.2.2.1 shows the contribution of each fleet in the total annual catches by subdivision. The seasonal distribution of 2023 catches by subdivision is shown in Table A7.3.2.2.2.

#### Western component

The total catch in 2023 for this stock component was estimated at 4631 t, which accounted for 31% increase with respect to the 2022 catch (3548 t), and is above the time-series average (2381 t). Catches from this component in 2023 accounted for 38% of the total catch in the division. The fractions composing this total catch in 2023 were: 4631 t of official landings and 0.031 t of discards.

Provisional official landings during the first semester in 2024 amounted to 48 t.

Provisional catches during the current management period (July 2023–June 2024) amounted to 3923 t.

The distribution of these catches by subdivision is as follows:

##### *Subdivision 9a North*

In this Spanish subdivision a total of 218 t was caught in 2023, which accounted for 1353% increase in relation to the 2022 catches (15 t), 5% of the total catch estimated for the Western component and 2% for the whole division. These catches are below the time-series average (376 t). Purse seiners were the main responsible for the fishery (98.3% of the total catch in the subdivision). The fishery was concentrated in the fourth quarter.

Provisional official landings during the first semester in 2024 amounted to 0.9 t (up to 16th May 2023). Those ones corresponding to the current management calendar amounted to 137 t.

#### *Subdivision 9a Central-North*

This subdivision concentrated the greatest part of the anchovy fishery in 2023 in the Western component (95%), and represented 37% of fisheries of the whole division: a total catch of 4411 t was estimated (with all of these catches corresponding to official landings; no unallocated nor discarded catches were reported). These catches represented a 26% increase regarding the catches estimated the previous year (3509 t), and they are still well above the time-series average (1948 t). Purse-seiners practically harvested the whole fishery (96%), mainly during the third and fourth quarters in the year.

Provisional official landings during the first semester in 2024 amounted to 46 t (up to end of April). Official landings for the current management calendar were 3782 t.

#### *Subdivision 9a Central-South*

Anchovy catches from this subdivision were only 2 t (all of them official landings), accounting for a 91% decrease in relation to the catches in 2022 (24 t), being below the time-series average (56 t). Such catches accounted only for 0.05% of the total catch in the Western component and 0.02% of the total catch in the division. The fishery was mainly harvested by purse-seiners, mostly during the third quarter.

Provisional official landings during the first semester in 2024 (up to end of April) in this subdivision amounted to only 1 t. Official landings for the current management calendar were 3 t.

#### Southern component

#### *Subdivision 9a South*

Total catch in 2023 of this stock component was estimated at 7470 t, which accounted for a 10% increase with respect to the 2022 catch (6795 t), staying above the time-series average (5156 t), and represented 62% of the total catch in the division. The fractions composing this total catch in 2023 were: 7236 t of official landings (Portugal: 155 t, Spain: 7082 t) and 233 t of (Spanish) discards.

Almost the whole of the total catch (97%) was captured by the purse-seine fleet.

The fishery was concentrated during the second and third quarters in the year.

As mentioned above, provisional official landings during the first semester in 2024 amounted to 3657 t (Portugal: 4 t, Spain: 3653 t). Preliminary; 1025 t, corresponding to 39% of the Spanish official landings in January–May (mean 2009–2023), were added to the Spanish data to account for landings in June 2024 not yet reported. Official landings and total catches during 2023 in the subdivision for the current management calendar (i.e. second semester 2023) were 2850 t and 2911 t, respectively. Preliminary estimates for catches for the current management calendar (July 2023–June 2024) amounted to 6568 t (landings: 6507 t; discards: 61 t).

## Discards

See the stock annex (see annex 3) for previous available information on discards in the division.

General guidelines on appropriate discard sampling strategies and methodologies were established during the ICES Workshop on Discard Sampling Methodology and Raising Procedures (ICES, 2003).

Covid-19 disruption and the interruption of the IEO's on-shore and at-sea sampling programs during the first semester in 2020 because administrative and budgetary reasons prevented from estimating discards during that semester in the Spanish fisheries in subdivision 9a N and 9a S. Sampling programs performed as planned in 2021.

Average discards estimates (in t) in subdivision 9a N for the available time-series (2014-2023) show that quarterly discards could be considered, for the time being, as negligible, almost null. The same considerations have also been applied to the discards in the Spanish fishery in 9a S.

**Western component**

***Subdivision 9a North***

A total of only 0.03 t of discards fished by the trawl fleet have been recorded during 2023, accounting for an overall annual discard ratio for the Spanish fishery of 0.0001 (0.01%) in the subdivision 9a N in this stock component.

***Subdivisions 9a Central-North and Central-south***

Regarding the Portuguese anchovy fishery in this stock component, the official information provided to the WG states that there are no anchovy discards in the fishery.

**Southern component**

***Subdivision 9a South***

No anchovy discards have been reported from the Portuguese fishery.

Discards in the Spanish fishery were recorded in the bottom-trawl fishery (233 t) mainly during the first semester. The estimated discards represented an annual discard ratio of 0.03 (3.3%) and may be considered as a very low ratio.

## Effort and landings per unit of effort

**Western component**

CPUE indices are not considered for this stock component.

**Southern component**

Annual standardised landings per unit of effort, lpue, series for the whole Spanish purse-seine fleet fishing GoC anchovy (Subdivision 9.a-South) are routinely provided to this WG. An update of the available series (1988–2023) has been provided this year to this WG (**Figure A7.3.4.1**). Details of data availability and the standardisation process are commented in the stock annex. At present, the series of commercial lpue indices is only used for interpreting the Spanish purse-seine fleets' dynamics in Subdivision 9a S. The recent dynamics of fishing effort and lpue for this fleet has been described in previous WG reports. Fishing effort experienced a strong decrease since 2017, which was coupled to a parallel decrease in catches. A relatively stable trend in effort (with some increase in 2020, 2021 and 2023) has been recorded during the 2017-2023 period, which was coupled with steeply increasing catches resulting in an increasing trend in lpue in the very recent years (from less than 1 t until 2014 to at around 1.2-1.9 t/fishing day in the most recent years). However, a probable overestimation of the annual estimates computed so far was suggested in previous WG reports because of a probable underestimation of the true exerted fishing effort on anchovy, since fishing trips targeting anchovy with zero anchovy catches are not considered in the effort measure.

## Catches by length and catches-at-age by stock component

Length–frequency distribution (LFD) of catches and catch-at-age data from the whole Division 9.a are routinely provided to this WG from the Spanish fishery operating in the GoC (Subdivision 9.a S), since the anchovy fishery in the division is traditionally concentrated there. Data from the Spanish fishery in Subdivision 9.a N were usually not available since commercial landings used to be almost negligible. The same reason is also valid for the Portuguese subdivisions (included the Portuguese part of the 9.a S (Algarve), although in this case anchovy was also a group 3 species in its national sampling program for DCF. Nevertheless, the local increases of anchovy abundance in subdivisions 9.a N and C-N recorded since 2014 have led to a circumstantial exploitation of the species by the fleets operating in those areas. The respective national sampling programmes accounted for this event those years but in an accidental way. A higher sampling effort has been made in the port of Matosinhos (9.a C-N) since 2017 to have monthly biological data of anchovy in that area that represents the bulk of catches in the western component.

Quarterly LFDs in 2023 have been provided for the Spanish fishery in subdivision 9.a N for all quarters but the third quarter because the low landings. Landings of that quarter were raised to the LFD in the second quarter in that year. Quarterly ALKs were based either on monthly commercial samples only (first and fourth quarters) or by combining *PELACUS* (April) survey samples and April and May commercial ones (for the second quarter ALK), and DEMERSALES (September) survey samples and September commercial ones (third quarter ALK).

Quarterly LFDs and ALKs from the Spanish fishery in subdivision 9.a S were also available and showed a relatively good coverage. Quarterly ALKs were based on commercial samples only (first and second quarters), survey samples only (ECOCADIZ-RECLUTAS survey for the fourth quarter) or by combining commercial and survey samples (ECOCADIZ survey for the third quarter). LFDs from bottom-trawl discards were available in all of the quarters when they were estimated.

LFDs from the Portuguese fishery provided to this WG are the ones from the anchovy purse-seine fishery in Subdivision 9.a Central-North, given that only 0.5% and 3% of the Portuguese catches occurred in the 9.a Central-South and 9.a South (Algarve) subdivisions, respectively. Data was only available for the 3rd and 4th quarters.

Catch-at-age data in 2023 have only been provided for the Portuguese fishery from subdivision 9.a C-N for the 3rd and 4th Quarters. No age structure is available for 2023 Portuguese anchovy catches in subdivisions 9.a C-S and 9 a. S (Algarve), related to the low catches observed in those areas.

## Length distributions

#### Western component

##### *Subdivision 9.a North*

Quarterly and annual size composition of anchovy catches for the whole fishery in the Subdivision 9.a North in 2023 are shown in Table A7.3.5.1.1. Size range in catches from the whole fishery varied between 12.0 and 17.5 cm size classes (a single mode at 13.5 cm size class), with the annual mean size and weight in catches being estimated at 14.0 cm and 20.2 g, respectively.

##### *Subdivision 9.a Central-North*

The size composition of 2023 anchovy catches from the Subdivision 9.a Central-North is shown in Table A7.3.5.1.2. These length–frequency distributions (LFDs) correspond to catches landed by purse-seiners throughout the year to obtain overall LFDs by quarters for purse-seiners, which account for 96% of all catches. Anchovy size composition in catches from the whole fishery in 2023 ranged between 10.5 and 19.0 cm size classes (main mode at 15.0 cm size class and a secondary mode at 17.5

cm size class), with a mean size and weight in catches being estimated at 15.3 cm and 25.6 g, respectively.

***Subdivision 9.a Central-South***

No length composition is available from the Portuguese fishery in this subdivision since the catches were very scarce.

**Southern component**

***Subdivision 9.a South***

Quarterly LFDs from the Spanish catches in 2023 for the whole fishery is shown in Table A7.3.5.1.3. Size range of the exploited stock (landings plus discards) in the whole fishery varied between 3.5 and 17.0 cm size classes, with the main modal class located at the 10.5 cm size class and very secondary modes at the 4.0 cm and 16.0 cm size classes. Anchovy mean length and weight in the Spanish 2023 annual catch (11.2 cm and 9.4 g) were lower than in previous years as a consequence of the increase of age 0 fish in the catches. In any case, they used to be the smallest anchovies in the division.

No length composition is available from the Portuguese fishery in this subdivision since the catches were very scarce.

## Catch numbers-at-age

**Western component**

***Subdivision 9.a North***

Estimates from the fishery in this subdivision in 2023 are shown in Table A7.3.5.2.1. These estimates are shown together with the age structure of catches in previous years with available data in Table A7.3.5.2.2 and Figure A7.3.5.2.1. The estimated total catch in numbers in 2023 was of 11 million fish, composed by ages 0 (8% of the total catch in numbers), 1 (81%), 2 (10%) and 3 (0.3%) anchovies.

***Subdivision 9.a Central-North***

Estimates from the fishery in this subdivision in 2023 have been provided to the WG only for the third and fourth quarters (Table A7.3.5.2.3, Figure A7.3.5.2.2). During the second semester of the year 81% and 79% of fish were age 1 for 9aN and 9aCN, respectively. Age 2 individuals represented 15% and 20% for 9aN and 9aCN, respectively.

***Subdivision 9.a Central-South***

No estimate from this subdivision in 2023 has been provided to this WG since the catches were very scarce.

**Southern component**

***Subdivision 9.a South***

Table A7.3.5.2.4 shows the quarterly and annual anchovy catches-at-age in the Spanish fishery in 2023. Total catches in the Spanish fishery in 2023 were estimated at 779 million fish, which accounted for 47% increase in relation to the 530 million caught during the previous year. Such an increase resulted from 78% and 46% increases of ages 0 (the dominant age group) and 1 and 64% decrease of age 2, respectively. Age 1 group is the dominant age group (75% of the total catch in numbers). The occurrence of age group 3 anchovies in the fishery was incidental.

The recent historical series of annual landings-at-age in the Spanish fishery in 9.a South is shown in Table A7.3.5.2.5 and Figure A7.3.5.2.3. Description of annual trends of landings-at-age data from the Spanish fishery through the available data series is given in previous WG reports.

No data are available from the Portuguese fishery in this subdivision since the catches were very low.

## Mean length and mean weight-at-age in the catch

#### Western component

##### *Subdivision 9.a North*

The resulting estimates for the fishery in 2023 are shown in Tables A7.3.6.1 and A7.3.6.2. Anchovy mean length and weight in the catches were estimated at 14.0 cm and 20.2 g. The available series of estimates are shown in Figure 3.3.6.1 and indicate that anchovies by age group from this subdivision are usually larger and heavier than those harvested in the southernmost areas. In 2023, all the age groups experienced a strong decrease in the mean length and weight in catches.

##### *Subdivision 9.a Central-North*

The available estimates for the fishery in 2023 are shown in Tables A7.3.6.3 and A7.3.6.4. A series of regular estimates is only available since 2017 in this subdivision. Anchovy mean length and weight in the catches from north-western Portugal in 2023 were estimated at 15.2 cm and 24.5 g (Figure A7.3.6.2).

##### *Subdivision 9.a Central-South*

No estimate from this subdivision is available.

#### Southern component

##### *Subdivision 9.a South*

The 2023 estimates of the mean length and weight-at-age of Gulf of Cadiz anchovy Spanish catches are shown in Tables A7.3.6.5 and A7.3.6.6. Figure A7.3.6.3 shows the recent history of the evolution of such estimates. Anchovy mean length and weight in the Spanish 2023 annual catches were estimated at 11.2 cm and 9.4 g, respectively. Such estimates were lower, especially the mean weight, than those ones recorded in the previous year. In 2023, all the age groups but age 0 experienced decreases in the mean length and weight in catches.

# Fishery-independent information

Table A7.4.1 shows the list of acoustic and DEPM surveys providing direct estimates for anchovy in Division 9.a. The WG considers each of these survey series as an essential tool for the direct assessment of the population in their respective survey areas (subdivisions) and recommends their continuity in time, mainly in those series that are suffering from interruptions through its recent history.

## DEPM-based SSB estimates

#### *BOCADEVA* series

Anchovy DEPM surveys in the division are only conducted by IEO for the SSB estimation of Gulf of Cadiz anchovy (Subdivision 9.a-South, *BOCADEVA* survey series). The methods adopted for both the conduction of these surveys and the estimation of parameters are described in the stock annex and in ICES (2009) and Massé *et al*. (2018).

The series started in 2005 and their surveys are conducted with a triennial periodicity. Since 2014, this series has been financed by DCF. The last *BOCADEVA* survey has been conducted in summer 2023. The time-series of mean estimates and their associated variances for the egg and adult parameters, and the SSB are shown in Table A7.4.1.1 and Figures A7.4.1.2 and A7.4.1.3.

***BOCADEVA 0723***

*BOCADEVA 0723* DEPM survey was carried out on board R/V *Ramón Margalef* (IEO) between 24th and 28th July 2023 surveying the Spanish and Portuguese waters of the Gulf of Cadiz between the 20 and 200 m isobaths. The survey was the DEPM component of a combined anchovy egg (*BOCADEVA*) and acoustic-trawl (*ECOCADIZ*) *ad hoc* survey (*ECO/BOCADEVA_0723* survey), which were performed one after the other, the egg survey first. PairoVET plankton samples, which were obtained from a grid of 21 parallel and 8 nm inter-spaced transects perpendicular to the coast, were utilised for the delimitation of the spawning area and the estimation of egg densities required for the estimate of the daily egg production. The fishing hauls providing samples for the estimation of adult parameters (sex ratio, female mean weight, batch fecundity and spawning fraction) were carried out during the *ECOCADIZ 2023-07* acoustic-trawl survey, a survey which was conducted just after the egg survey finished. A summary of the survey's results is given by Ramos *et al.* (Presentation 2024).

A total of 139 PairoVET stations were carried out, with 65 stations (47%) showing presence of anchovy eggs (positive stations), which yielded a total of 1736 anchovy eggs, with total and maximum egg densities estimated at 22 588 and 4260 eggs/m$^2$, respectively. Anchovy eggs presented a patched distribution along the area (Figure A7.4.1.1). In two stations were found more than 4000 eggs/m$^2$; two stations with 1700-2500 eggs/m$^2$, and the rest of stations with less than 1000 eggs/m$^2$ (ranging between 0.8 and 943 egg/m$^2$). The highest abundances were found in two stations located close to the Guadalquivir river mouth area (4260 eggs/m$^2$), in Spanish waters, and in front of Portimão, in Portuguese waters (4023 eggs/m$^2$). The 54.6% and the 45.4% of the eggs were caught to the East and West of Cape Sta. Maria, respectively. The station where the maximum abundance was registered was at 50 m depth, to west to Cape Sta. Maria, with the temperature and salinity being recorded at 21.15 ºC - 36.41 psu, respectively.

The total spawning area (*A*+) was estimated at 5662 km$^2$, experiencing a strong reduction in relation to the highest estimate in the time-series estimated in the previous survey in 2020 (10 058 km$^2$), but only somewhat lower than the time-series average. Daily ($P_0$, 182 eggs/m$^2$/day) and total egg production ($P_{total}$, 1.03 eggs x10$^{12}$/day) estimates also drop in relation to their respective historical maxima also achieved in the 2020 survey (Figure A7.4.1.2). Adult parameters estimated so far did not show significant differences with the more recent estimates. The values of the mean estimates and their associated variances for the egg and adult parameters, and the SSB estimates are summarized in Table A7.4.1.1. Given that the spawning fraction estimate (*S*) is not yet available (the histological analysis is still in progress) and the constancy of the point estimates throughout the time-series, a provisional SSB estimate has been derived by using the time-series average of *S*. The resulting provisional SSB estimate, 15 138 t (CV=0.62), is the second time-series historical minimum (Figure A7.4.1.3) and shows very close to those estimates provided by the acoustic surveys conducted in spring and summer 2023.

The time-series of mean estimates and their associated variances for the egg and adult parameters, and the SSB are shown in Table A7.4.1.1 and Figures A7.4.1.2 and A7.4.1.3.

## Spring/summer acoustic surveys

#### General

A description of the available acoustic surveys providing estimates for anchovy in Division 9.a is given in the stock annex. Survey's methodologies deployed by the respective national Institutes (IPMA and IEO) are also thoroughly described in Massé *et al*. (2018) and Doray *et al.* (2021).

A summary list of the available acoustic and DEPM surveys providing direct estimates for anchovy in Division 9.a is given in Table A7.4.1. Detailed information in the present section will be provided for those surveys carried out during the elapsed time between 2022 and 2023 WGHANSA meetings.

#### *PELACUS* series

#### *PELACUS 0424*

The Spanish *PELACUS* acoustic-trawl time-series started in 1984. Since 1998, survey strategies and methodologies, together with the Portuguese *PELAGO*, are standardized with the French one *PELGAS*. Moreover, since 2000 the three time-series are using CUFES to collect sub-surface sardine and anchovy eggs. *PELACUS* was carried out on board R/V *Thalassa* from 1997 to 2012 and since then is routinely conducted on board the Spanish R/V *Miguel Oliver*. An inter-calibration survey was done in April 2014 off Garonne mouth (*i.e.* at the spawning season and area of both sardine and anchovy). No significant changes in both fish availability (acoustic) or in fish accessibility, catchability or selectivity (trawl) were detected, and therefore similar performance for both vessels was assumed.

*PELACUS 0424* was conducted between 26$^{st}$ March and 16$^{th}$ April 2024 on board the R/V *Miguel Oliver*. The survey was conducted under rough weather conditions (storm Nelson and other storms). The bad weather is known to affect the distribution and behaviour of the fish. Sampling grid this year was based on acoustic transects separated 10 nm, between 20 and 1000 m depth, and with random start in each of the geographical strata, which correspond to the ICES subareas. Two different fishing gears were used: a HOD 352 -50 m wings was used for shallower waters (<40 m), sometimes with fences for trawling near surface, and a 63.5/51-100 m wings (>40 m), was used, sometimes with fences, for trawling in shallower waters. In total 35 pelagic fishing hauls were done.

Total NASC suffered an important drop since last year (from 705 $*10^3$ to 437 $*10^3$ sA). NASC allocated to sardine was 85% of the total NASC while only 6 % was allocated to anchovy. Anchovy schools occurred throughout the Cantabrian Sea with higher densities in the inner part of the Bay of Biscay (subarea 8cEe) and in western Cantabrian (8cEwW). The occurrence of the species in the subdivision 9a N decreased 15% in number and 37% in biomass since last year. Figure 3.4.2.1 shows the species contribution (% in number) in each of the valid hauls performed during the survey. A total of 0.3 t anchovies were caught in the whole surveyed area, corresponding to 205 317 specimens. Sardine, with a presence in 85.7% of the fishing hauls accounted for the 55% of the total catch in number (Table A7.4.2.1). Anchovy was caught in 57% of the trawl hauls and represented 15.4% of total catch number. On overall, anchovy mean length in the catch was 18.64 cm. Figure 3.4.2.2 shows the distribution area and density derived from the NASC values attributed to this fish species in the surveyed area.

A total of 2015 t of anchovies, corresponding to 142 million fish were estimated in the subdivision 9.a N (Table A7.4.2.2). The population was structured by the Age-groups 1, 2 and 3, with the bulk of the biomass belonging to age group 1 (85% in biomass, 75% in number). Figure 3.4.2.3 shows the estimated abundance and biomass by length class, while in Figure A7.4.2.4 the estimates are shown by age group. Figure A7.4.2.5 shows the time series (1996-2024) of anchovy biomass estimates from *PELACUS* in area 9.a N.

***PELAGO series***

***PELAGO 24***

The *PELAGO 24* survey was conducted from 1st to 24th March on board R/V *Miguel Oliver*. Seventy-one (71) transects were acoustically sampled between Caminha and Cape Trafalgar (30-200 m depth). A total of 26 pelagic trawl hauls were carried out by the research vessel; 29 additional hauls were done by 1 purse-seiner. The distribution and species composition of all of these hauls are shown in Figure 3.4.2.3.

Regarding the mapping of acoustic energy, anchovy was distributed throughout the 9.a CN and the northern part of 9.a CS around Lisbon and was also concentrated in the 9.a S (CAD). The distribution along the 9.a CN extending further south, in the northern 9.a CS area, is similar to the previous year (Figure A7.4.2.1).

Anchovy acoustic estimates for the whole surveyed area was 4914 million fish and 44 401 t (Table A7.4.2.2).

In 9.a Central-North a total of 1783 million fish and 19 422 t were estimated, which represents the lowest number and biomass of fish in this sub-division of the last 5 years (72% and 41% decrease in abundance and biomass in relation to the 2023 estimates; Table A7.4.2.2, Figure A7.4.2.5). The estimated population in this subdivision ranged between 9 and 18.5 cm size classes, with a mode at 11.5 cm size class (Figure A7.4.2.4). Age 1 fish accounted for 95% (1697 million) and 88% (17206 t) of the total estimated abundance and biomass in this subdivision, respectively (Table A7.5.1.1; Figure A7.4.2.6). Age 2 fish represented 4.6% and 0.6% of the total abundance and biomass, while Age 3 fish accounted for <1% of the total abundance and biomass (Table A7.5.1.1; Figure A7.4.2.6).

Anchovy population in 9a Central-South was supported by 1163 million fish and 12481 t, entailing 97% and 98% increase of abundance and biomass in relation to the 2023 estimates (Table A7.4.2.2, Figure A7.4.2.5). The population showed a size range between 10 and 16.5 size classes, with a 11.0 cm modal size class and a secondary one at 12.5 cm (Figures A7.4.2.4). Age 1 fish accounted for 97% (1128 million) and 97% (12106 t) of the total estimated abundance and biomass in this subdivision, respectively (Table A7.5.1.1; Figure A7.4.2.6). Age 2 fish represented 3% and 3% of the total abundance and biomass, while Age 3 fish was absent (Table A7.5.1.1; Figure A7.4.2.6).

In the Subdivision 9.a South, with values of 1968 million fish and 12 497 t (Table A7.4.2.2, Figure A7.4.2.5). The Spanish waters concentrated most of the population (99.97% and 99.97% of abundance and biomass, respectively). The above 2024 estimates accounted for 76% and 72% decrease in relation to those estimated in the 2023 survey (Figure A7.4.2.5). In 9a South-Algarve were estimated a total of 1 million fish and 4 t representing a 99 and 93% decrease of population levels in number and biomass, respectively, in relation to the last years (Table A7.4.2.2, Figure A7.4.2.5). The estimated population in subdivision 9.a South-Algarve ranged between 7.0 and 15.0 cm size classes, with a mode at 8.5 cm size class (Figure A7.4.2.4). In 9a South-Cadiz were estimated a total of 1 967 million fish and 12 493 t, entailing a decrease of 43% and 54% in abundance and biomass, respectively, in relation to the previous year's estimates, respectively (Table A7.4.2.2, Figure A7.4.2.5). The estimated population in this subdivision 9.a South-Cadiz ranged between 7.0 and 15.0 cm size classes, with a main mode at 8.0 cm size class (Figure A7.4.2.4). Age 1 fish accounted for 79.5% (1565 million) and 62.6% (7827 t) of the total estimated abundance and biomass in this subdivision, respectively (Table A7.4.2.5; Figure A7.4.2.7). Age 2 fish represented 20.0% and 37.4% of the total abundance and biomass, while Age 3 fish were absent from 9aS (Table A7.4.2.5; Figure A7.4.2.7).

Table A7.4.2.2 and Figure A7.4.2.5 track the historical series of anchovy acoustic estimates from *PELAGO* surveys in the Division 9.a. Anchovy experienced a huge outburst in 9.a Central-North in 2018, after the decreased biomass recorded in 2017, and reaching population levels even higher than the previous historical peaks recorded in the 2011 and 2016 outbursts. After a strong drop in 2019 the population has experienced consecutive increases in abundance and biomass which culminate in the historical maximum recorded in 2022, decreasing in 2023 and 2024. Anchovy in 9.a Central-South had low abundances in the past and had a 3 order of magnitude increased in number and biomass. Biomass levels in the subdivision 9.a South, after experiencing an increasing trend started in 2018 which peaked in 2020 have shown consecutive drops in 2021 and 2022 down to levels well below the historical average and an increase in 2023 and 2024 (Figure A7.4.2.5).

Figure A7.4.2.6 shows the age structure of the population estimates in the western component. Age 2 anchovies constitute the bulk of the population in spring 2024 (68.8%), followed by age 1 (26.0%) and 3 (5.3%). Strong incoming recruitments seem to be inferred in in the period 2019-2022, in most noticeable in 2020 and 2024.

Size composition and age structure of the population estimated in the southern component through the time-series was described in previous reports. In Table A7.4.2.4 and Figure A7.4.2.7 we revisit the trends observed in the age structure of the population as estimated by the *PELAGO* and *ECOCADIZ* survey series. As described in previous reports, Portuguese acoustic estimates for anchovy until 2013 were not provided age-structured to the WG. The age readings of PELAGO since 2020 were revised this year and presented to the ongoing Benchmark (WKBANSP) datacall, following the detection of some inconsistencies last year in the reading that led to a intercalibration exercise between Spanish and Portuguese readers.

The population age structure in previous years suggests strong 2000, (exceptionally) 2001, and 2006-year classes, with the last one still being present in 2009 (as age 3 anchovies). The strength of the 2007, 2008- and 2009-year classes decreased in relation to that observed for the 2006 year-class: population numbers of age 1 anchovies in 2008, 2009 and 2010 showed 49.7%, 43.3% and 68.9% decreases in relation those ones estimated in 2007. Notwithstanding the above, the extreme situation that the population reached in spring 2011, when no anchovy was detected in the *PELAGO* acoustic survey, seems uncertain because the observation of high egg densities during the survey is not consistent with the null detection of biomass with acoustics and with the estimates provided by the *BOCADEVA* DEPM survey (32.7 kt) some months later. These reasons led to the WG to consider the 2011 acoustic estimate with caution. The population age structure in 2013 suggests a failed recruitment, which, however, seems to show clear signs of progressive recovery in the three following years, especially in 2016. The decreased population levels in 2017 pointed again to a failed incoming recruitment. The situation in 2018 and 2019 seems to be quite similar to the one occurring in 2015–2016. Conversely, the 2020, 2021- and 2022-year classes show again a low strength.

#### *ECOCADIZ series*

#### *ECOCADIZ 2023-07*

The *ECOCADIZ 2023-07* Spanish (pelagic ecosystem-) acoustic-trawl survey was conducted by IEO between July 29th and August 8th 2023 in the Portuguese and Spanish shelf waters (20-200 m isobaths) off the Gulf of Cádiz (GoC) onboard the R/V *Ramón Margalef*. The survey was the acoustic component of a combined anchovy egg (*BOCADEVA*) and acoustic-trawl (*ECOCADIZ*) *ad hoc* survey (*ECO/BOCADEVA_0723* survey), which were performed one after the other, the egg survey first. This year's acoustic survey was marked by a reduction of 3-4 days to the usual survey length (ca. 14 days at sea), due to the R/V tight schedule.

The survey design consisted in a systematic parallel grid with 21 transects equally spaced by 8 nm, normal to the shoreline. A total of 16 valid fishing hauls (between 28-164 m depth) were carried out for echo-trace ground-truthing purposes. Four additional night trawls were conducted to collect anchovy females with hydrated ovaries (DEPM-adult *ad hoc* sampling) (Figure 3.4.2.8). CUFES sampling was not used in the survey because logistical problems. The census of top predators was not recorded during the survey because of the accommodation for at least one onboard observer was not available.

A total of 74 CTD (with coupled altimeter, oximeter, fluorometer and transmissometer sensors) - LADCP casts, and sub-superficial thermosalinograph-fluorometer and VMADCP continuous sampling were carried out to oceanographically characterize the surveyed area. A detailed description of the *ECOCADIZ 2023-07* survey methods and results are given in Ramos *et al*. (WD 2024a).

Chub mackerel (69%) was the most frequent small pelagic species in the valid hauls, followed by anchovy, sardine and horse mackerel *Trachurus trachurus* (the three with 56% occurrences each). Mediterranean horse mackerel *T. mediterraneus*, longspine snipefish *Macroramphosus scolopax* and pearlside *Maurolicus muelleri* (13% each) showed an incidental occurrence in the hauls performed in the surveyed area. Chub mackerel, anchovy and longspine snipefish showed the highest yields in these hauls (Figure A7.4.2.8).

The estimate of total NASC allocated to the "pelagic fish species assemblage" (95 940 $m^2$ $nmi^{-2}$) has shown 63% lower than the maximum value recorded throughout the time-series, estimated in 2020 (229 241 $m^2$ $nmi^{-2}$), and 28% below the historical mean (118 395 $m^2$ $nmi^{-2}$). Sardine (46%), chub mackerel (17%), anchovy (16%) and Mediterranean horse-mackerel (12%) were the main contributors to the total NASC.

Gulf of Cádiz anchovy was widely distributed in the surveyed area, although it showed very low acoustic densities in the easternmost and westernmost waters. High densities were mainly recorded between Ayamonte and the Bay of Cadiz. Anchovy showed lower densities in Algarve waters than in previous years, and somewhat similar to what was recorded in the *PELAGO* 2023 spring survey (Figure A7.4.2.8).

Overall anchovy acoustic estimates in summer 2023 were of 1479 million fish and 9714 t (Table A7.4.2.4; Figure A7.4.2.9), accounting for 71% and 78% decreases in abundance and biomass, respectively, as compared to 2020 estimates (5153 million, 44 886 t). Current overall estimates are also well below the time-series average (i.e. 2424 million, 26 368 t; see Table A7.4.2.4 and Figure A7.4.2.4). By geographical strata, the Spanish waters yielded 82% (1216 million) and 81% (7933 t) of the total estimated abundance and biomass in the Gulf, highlighting the importance of these waters in the species' distribution, but also the noticeable regional decrease experienced by the species in the Spanish waters. The estimates for the Portuguese waters were 263 million and 1781 t (Table A7.4.2.4; Figure A7.4.2.9).

The size class range of the assessed anchovy population in summer 2023 ranged between the 2.0 and 19.0 cm size classes. The size distribution showed a mixed composition, with one main mode at 13.0 cm, and with a small proportion of individuals being observed at 2.0 cm. It is noticeable the occurrence of this last modal size during summer, as it is a consequence of the record of very tiny juveniles in the coastal waters located in front of Faro, Portugal. The size composition of anchovy throughout the surveyed area confirms the usual pattern exhibited by the species during the survey season, with the largest (and oldest) fish being distributed in the westernmost waters, although individuals belonging to the smallest size classes were also observed in the Algarve (Figure 3.4.2.9).

The population was composed by fishes not older than 2 years. Age 0 fish accounted for 75% (1069 million) and 58% (5710 t) of the total estimated abundance and biomass, respectively (Table A7.4.2.5; Figure A7.4.2.10). Spanish waters not only concentrated the bulk (88%) of this juvenile fraction, but also 79% (263 million) of age-1 group. The estimates of age-0 fish experienced a similar trend than the one showed by the whole population in relation to the historical peak recorded in 2019 and the values recorded in 2020. The recent strong decreasing trends for the whole population seem to have increased in 2023, with the 2023 estimates being well below their time-series averages (Tables A7.4.2.4 and A7.4.2.5; Figure A7.4.2.11). Age 1 fish represented 23% and 39% of the total abundance and biomass, while Age 2 fish accounted for <1% of the total abundance and biomass (Table A7.4.2.5; Figure A7.4.2.10).

The 2023 summer estimates of mean size and weight of the whole population (9.4 cm, 11.3 g) were somewhat lower than their respective time-series averages (12 cm, 12.2 g).

Time-series of available estimates so far are shown in Table A7.4.2.4 and Figure A7.4.2.11. Table A7.4.2.5 shows the time-series of population estimates at age in the southern component estimated by *PELAGO* and *ECOCADIZ* surveys (see also Figure A7.4.2.7).

The 2023 survey will be the last one in its series. No more ECOCADIZ surveys are planned to be conducted in the next years.

## Recruitment surveys

#### *SAR, JUVESAR* and *IBERAS* autumn survey series

The last survey in the *SAR* series (aimed to cover the sardine early spawning and recruitment season in the Division 9.a, but also covering the anchovy recruitment season) which provided anchovy estimates was carried out in 2007 (see Table A7.4.1). Table A7.4.3.1 shows the historical series of anchovy acoustic estimates derived from this survey series in the Division 9.a available so far. The *JUVESAR* autumn survey series, an acoustic survey restricted to the Subdivision 9.a Central-North, the main recruitment area of sardine in Portuguese waters, started in 2013. The scarce presence and abundance of anchovy in the 2013 and 2014 surveys prevented the provision of acoustic estimates for the species. The last survey in this series was conducted in 2017 (*JUVESAR 17*), because in 2018 the *JUVESAR* acoustic sampling area was incorporated into the new *IBERAS* survey series, described below. Point estimates of anchovy abundance of the *JUVESAR*/*IBERAS* series are at present scarce but the trend is so far not consistent with spring survey series.

*IBERAS* is a new acoustic-trawl time-series aiming to get a synoptic coverage of the Atlantic waters of the Iberian Peninsula and the Bay of Biscay targeting on Young of the Year (YoY) of sardine and anchovy. Since 2017, both the Bay of Biscay (*JUVENA*) and the Gulf of Cadiz (*ECOCADIZ-RECLUTAS*) were routinely prospected by R/V *Ramón Margalef* and the Northwest coast of Portugal (*JUVESAR*) by R/V *Noruega* since 2013. The idea is to fill the gap between both *JUVENA* and *ECOCADIZ-RECLUTAS* surveys and incorporate the *JUVESAR* series, following the same radials in Subdivision 9.a Central-North. This new time-series is being conducted either in the vessel R/V *Ángeles Alvariño* or in R/V *Ramón Margalef*, twin of the former. Both vessels have similar shape, with slight changes in the main engine but using the same equipment (acoustic and trawling devices). Together with this synoptic coverage, using similar vessel equipment will limit both the vessel and trawling effects on the overall precision and accuracy of the estimates. In 2018, due to the lack of available vessel time in September, the survey was delayed until November, but in 2019 the survey was planned in September, at the same time of *JUVENA* and previous to *ECOCADIZ-RECLUTAS* one (see Table A7.4.3.2).

The rationale of this new time-series is to track and assess early juveniles for predicting the strength of the recruitment previously to the incoming fishing season (e.g. next year) as this will heavily depend on the incoming year class. This strategy is of special interest to manage the fisheries for short-lived species because of the short time between spawning and the exploitation of subsequent emerging recruits.

#### *IBERAS 0923*

The *IBERAS 0923* survey was carried out on board R/V *Ramón Margalef* from 12$^{th}$ to 25$^{th}$ September 2023. The survey covered the areas 9aN, 9aCN and 9aCs (*i.e.* western coast of the Iberian Peninsula) on a survey design consisting in parallel transects 6 nmi apart, with a random start, and covering from 20-15 m depth up to 100 m. This zone coincides with the main potential distribution area for sardine recruitment of the Ibero-Atlantic stock. Moreover, in the main recruitment area (*i.e.* middle part of 9aCN, observed historically) sampling intensity has been increased up to 4 nmi among transects to increment the sampling resolution (Figure 3.4.3.1). The vessel's acoustic equipment consisted of a *Simrad™ EK-80* scientific echosounder, operating at 18, 38, 70, 120 and 200 kHz, working in CW mode. All frequencies were calibrated according to the standard procedures (Demer *et al*., 2015) at the start of the survey. The backscattering acoustic energy from marine organisms was measured continuously during daylight.

A total of 25 pelagic hauls and 12 purse-seine shots were done as shown in Figure A7.4.3.1. In 2023, anchovy assessment was divided between adult anchovy (length>12.0cm) and juvenile anchovy (length≤12.0cm). Anchovy occurred in 41% of the hauls, with adult anchovy accounting for 5% total NASC and juvenile anchovy accounting for 20% total NASC..

Anchovy was found in rather dense epi-pelagic schools, mainly outside the coastal area, and sometimes mixed with krill. Adult anchovy was found exclusively in 9aCN area, between 25 and 100 m, although some schools were found a little bit deeper (Figure A7.4.3.2).

Juveniles were mainly concentrated in the North, especially in the Rias Baixas, whereas adults were found in the northern part of the 9aCN, near Aveiro. The estimated biomass for adult anchovy increased significantly in 2023 when compared to the previous years, being 56 414 tonnes and 1696 million of fish, which is the historical maximum. Juvenile anchovy was majorly present in the North, in the Spanish side (9aN), with 16 090 million fish and 65 270 tonnes, representing 93% of the total number of fish (Table A7.4.3.2; Figures A7.4.3.3 and A7.4.3.4).

#### ***ECOCADIZ-RECLUTAS* survey series**

##### ***ECOCADIZ-RECLUTAS 2023-10***

*ECOCADIZ-RECLUTAS 2023-10* Spanish (pelagic ecosystem-) acoustic-trawl survey was conducted by IEO between 29th September and 13th October 2023 in the Portuguese and Spanish shelf waters (20-200 m isobaths) off the Gulf of Cádiz (GoC) onboard the R/V *Ramón Margalef.* The survey’s main objective is the acoustic assessment of anchovy, sardine and chub mackerel juveniles (age 0 fish) in the GoC recruitment areas. The surveys in this series have experienced a successive reduction in ship-time up to the 15-16 days in 2022-2023. Additionally, the 2023 survey invested half working day in picking up a spare pelagic trawl gear to the nearest port and it finished one day before the schedule due to logistic reasons. Furthermore, the start and direction of the acoustic sampling had to be shifted to a W to E direction because NATO naval maneuvers which entailed a shortening of the available time to sample Spanish waters. Results from this survey have been reported to this WG by Ramos *et al*. (WD 2024b).

The 21 foreseen acoustic transects were sampled. A total of 13 valid fishing hauls were carried out for echo-trace ground-truthing purposes. Horse mackerel, sardine and anchovy, were the most frequent captured species in the fishing hauls, followed by chub mackerel, Mediterranean horse mackerel, bogue, round sardinella and Atlantic mackerel. Longspine snipefish, boarfish and pearlside showed an incidental occurrence in the hauls performed in the surveyed area. Anchovy, sardine and chub mackerel showed the highest yields in these hauls, followed by Mediterranean horse mackerel and horse mackerel (Figure 3.4.3.5).

The estimate of total NASC allocated to the “pelagic fish species assemblage” in this survey (84 191 $m^2$ $nmi^{-2}$) was 21% lower than that recorded last year (107 026 $m^2$ $nmi^{-2}$) and 28% below the historical mean (118 395 $m^2$ $nmi^{-2}$). Such a decrease was more noticeable in Portuguese waters. By species, sardine accounted for 34% of this total back-scattered energy, followed by horse mackerel (26%), chub mackerel (14%) and anchovy (13%), with the remaining species showing relative contributions of acoustic energies lower than 10%.

GoC anchovy was widely distributed in the surveyed area in autumn 2023, although it showed low acoustic detections in the easternmost waters. Higher densities were mainly recorded in two areas:

between Ayamonte and the Bay of Cadiz and between Cape San Vicente and Cape Santa Maria (Figure A7.4.3.5). Overall anchovy acoustic estimates in autumn 2023 were of 816 million fish and 8300 t (Table A7.4.3.3; Figure A7.4.3.6), accounting for 55% and 30% decreases in abundance and biomass, respectively, as compared to last year's estimates (1836 million, 11 912 t). Current overall estimates are also lower than the time-series average (*i.e.* 2686 million; 21 276 t), and this year's abundance estimate is the lowest of the time series (see Table A7.4.3.3 and Figure A7.4.3.8). By geographical strata, the Spanish waters yielded 88% (716 million) and 73% (6073 t) of the total estimated abundance and biomass in the Gulf, highlighting the importance of these waters in the species' distribution. The estimates for the Portuguese waters were 100 million and 2227 t (Table A7.4.3.3; Figure A7.4.3.8).

The size class range of the assessed anchovy population in autumn 2023 ranged between the 5.5 and 17.5 cm size classes. The size distribution showed a mixed composition, with one main mode at 9.5 cm, a secondary mode at 13.0 cm, and with a small proportion of individuals being observed at 7.5 cm. The size composition of anchovy throughout the surveyed area confirms the usual pattern exhibited by the species during the survey season, with the largest (and oldest) fish being distributed in the westernmost waters and the smallest (and youngest) ones concentrated in the surroundings of the Guadalquivir river mouth and adjacent shallow waters (Figure A7.4.3.6).

The population was composed by fishes not older than 2 years. Age 0 fish accounted for 78% (639 million) and 57% (4723 t) of the total estimated abundance and biomass, respectively (Table A7.4.3.3; Figure A7.4.3.7). Spanish waters concentrated the bulk (97%, 623 million fish) of this juvenile fraction and 53% (90 million) of age-1 group. The estimates of age-0 fish experienced a similar trend than the one showed by the whole population in relation to the historical peak recorded in 2019 and the values recorded in 2020. The recent strong decreasing trends for the whole population and juveniles seem to have increased in 2023, with the 2023 estimates being well below their time-series averages (Table A7.4.3.3; Figure A7.4.3.8). Age 1 fish represented 20% and 40% of the total abundance and biomass, while age 2 fish accounted for <1% of the total abundance and biomass (Figure A7.4.3.7).

The 2023 autumn estimates of mean size and mean weight of the whole population were higher (11.0 cm, 12.7 g) than their respective time-series averages (11.1 cm, 9.5 g).

The time-series of survey estimates is shown in Figure A7.4.3.8. Figure A7.4.3.9 shows the correspondence between acoustic estimates of abundance of age-0 anchovies from *ECOCADIZ-RECLUTAS* surveys in the autumn of the year *y* against the abundance of age-1 anchovies estimated in spring of the following year (*y+1*) by the *PELAGO* survey and in summer by the *ECOCADIZ* survey. Some positive relationship seems to be suggested when the most recent *ECOCADIZ-RECLUTAS* and *PELAGO* surveys estimates are compared.

# Biological data

## Weight-at-age in the stock

#### Western component

Weight-at-age in the stock estimated from the combined *PELACUS* and *PELAGO* surveys are shown in Table A7.5.1.1

#### Southern component

Weight-at-age in the stock is shown in Table A7.5.1.2. See the stock annex for comments on their computation.

## Maturity-at-age

Maturity stage assignment criteria were agreed between national institutes involved in the biological study of the species during the Workshop on Small Pelagics (*Sardina pilchardus*, *Engraulis encrasicolus*) maturity stages (WKSPMAT; ICES, 2008 c).

See the stock annex for comments on computation of the maturity ogives in both stock components.

Due to some inconsistencies in the maturity ogives of anchovy in the southern component, not noticed during WKPELA 2018, we assume that all individuals with age 1 or higher (B1+), are mature for assessment purposes.

The macroscopic maturity scale used by IPMA (Soares *et al*., 2009) has been validated with histology (microscopic identification of macroscopic maturity stages). Results show that only histology allows the correct identification of mature and immature individuals macroscopically identified as stage 1 (Immature or Resting); therefore, the maturity ogive of this species must be obtained during the spawning season with histology.

## Natural mortality

#### Western component

Natural mortality, M, is unknown for this stock component. It has been suggested in WKPELA 2018 to follow the M pattern at-age used for the anchovy in the Bay of Biscay, which is 1.2 for age 0, 0.8 for age 1 and 1.2 for older ages, for further modelling exercises. Recent work on growth estimates (Wise *et al*., 2022) estimated other values for the natural mortality (M0= 1.285; M1= 1.028; M2= 0.827; M3= 0.703; M4= 0.724).

#### Southern component

M is also unknown for this stock component. The following estimates for M at-age were finally adopted in WKPELA 2018: M0=2.21; M1=1.30; M2+=1.30 (similar at any older age; see ICES, 2018a). A description of the rationale and whole process for deriving the above estimates is shown in the stock annex.

# Stock assessment

Both components of the stock are assessed following the ICES framework for category 3 stocks.

A stock-specific management strategy evaluation (MSE) process was conducted in 2023 to update the assessment method (see Pérez-Rodríguez *et al*., WD 2023a,b and Wise *et al*., WD 2023a,b). A constant harvest rate rule (*chr*, Method 3.2, ICES, 2022) was determined for each component. The *chr* rule was tested alongside the *1over2* with 80% uncertainty cap rule.

The *chr* rule is based on the stock biomass indicator of the current year, $I_{current}$, multiplied by a sustainable harvest rate, $HR_{MSYproxy}$, as follows:

$$C_y = HR_{MSYproxy} * I_{current}$$

where $C_y$ and $I_{current}$, represent the catch advice for July to June of the following year, and the stock biomass indicator of the current (*y*) year, respectively. For the Western component the stock biomass indicator input has been taken from the results of the acoustic spring surveys covering this area (by adding *PELAGO* and *PELACUS* estimates for areas 9a N, 9a C-N and 9a C-S), while for the Southern component the biomass indicator input has been obtained from the results of SSB estimates from the Gadget assessment model.

In addition, for the Southern component $C_y$ should be multiplied by a biomass safeguard defined as the minimum between 1 and the ratio of $I_{current}$ and $B_{trigger}$ with $B_{trigger}$ = 1194.132 t.

The *chr* rule was found to be more precautionary for both components than the current *1over2* rule. The *chr* rule of 25% ($HR_{MSYproxy}$ =0.25) was the maximum value estimated for the western component while a *chr* rule of 50% ($HR_{MSYproxy}$ =0.5) was the maximum value estimated for the southern component.

The basis of this procedure for both components was approved by WGHANSA-1 2023 and the methodology followed for its approval is described in Pérez-Rodríguez *et al.* (WD 2023a,b) and Wise *et al.* (WD 2023a,b).

## Western component

The stock assessment procedure for this component is described in the stock annex.

### Biomass survey trend as base of the advice

The anchovy biomass indicator for the Western component is computed as the sum of *PELACUS* (9a N) and *PELAGO* (9a C-N and 9a C-S) acoustic estimates of biomass.

During the WGHANSA-1 2023 meeting (ICES, 2023), after the Workshop on the Management Strategy Evaluation of constant harvest rates strategies for anchovy in Division 9a (WKANEMSE) on May 5th 2023 (see annex 6 in ICES, 2023), it was agreed for the Western component of the 27.9.a anchovy to switch from the current *1over2* advice rule to a Constant Harvest Rate, *chr*, advice rule, with a $HR_{MSYproxy}$ = 0.25. The catch advice, $C_y$, is defined as follows:

$$C_y = 0.25\ I_{current}$$

where $C_y$ and $I_{current}$, represent the catch advice for July to June of the following year and the stock biomass indicator of the current ($y$) year, respectively.

The adopted Constant Harvest Rate (*chr*) advice rule with HR=0.25 was shown to outperform the former *1over2* advice rule when uncertainty was included in the operating models, reducing the risk of falling below $B_{lim}$ in the short and medium terms, with higher relative yields in the medium and long term. The *chr* advice rule was tested under different operating models with uncertainty. Reference points are consistent with the dynamics of the different operating models. Values for $B_{lim}$ were adopted according to the re-estimation of the reference points. For the base case productivity (h = 0.75) a $B_{lim}$ = 16 279 t was assumed.

Although under the base case scenario, a harvest rate of 0.4 was considered to be precautionary by ICES standards in the medium and long terms, it was acknowledged that the *chr* advice rule is highly sensitive to the assumed value of catchability of the survey index (QIDX = 1.5). Therefore, to account for possible shifts in productivity, a harvest rate HR = 0.25 was adopted as the basis of advice for the *chr* advice rule to be applied to the Anchovy 9a western component.

## Southern component

### Model used as basis of the advice

The model used to provide the estimates of the SSB indicator is a Gadget model. Gadget is an age–length-structured model that integrates different sources of information in order to produce a diagnosis of the stock dynamics. It works making forward simulations and minimizing an objective (negative log-likelihood) function that measures the difference between the model and data. General model specifications are described in the Stock Annex, while details on data input, implementation and results up to 2024 are described in Rincón *et al*. (WD 2024).

## Data input

Data input for optimization routines is summarized in Table A7.6.2.1.1.1. It corresponds to all the information of the fishery available until the end of June of 2024, together with data from *ECOCADIZ* and *PELAGO* survey series up to 2023 and 2024, respectively (no *ECOCADIZ* survey in 2021 and 2022).

Due to discrepancies on mean length and weight at age in PELAGO survey for 2023 it was decided to conduct an IPMA-IEO workshop for the inter-calibration of anchovy age reading before agreeing on the definitive age composition. An inter-calibration exercise was held in early 2024, aiming at cross-validating age attribution of experienced and new age readers for the stock. The cross-validation exercise revealed some misestimation in the otolith reading that affected the most recent PELAGO surveys. Following the cross-validation exercise, the anchovy age structure of the PELAGO surveys was revised and updated since 2020, when age readers changed for the stock in Portugal.

Catches (landings +discards, discards from 2014 onwards) from Spain and Portugal are assumed to be removed from the population by only one fleet from 1989 to the second quarter of 2024. For the first two quarters of year 2024, provisional catches estimations of Spanish (until May 17$^{th}$) purse-seine fleet were used and catches for June were estimated as the 39% of January to May catches based on historical records from 2009 to 2023.

## Model fit

A summary of the goodness of fit of model estimations compared with data is shown in Figures A7.6.2.1.2.1, A7.6.2.1.2.2, A7.6.2.1.2.3 (length distributions), A7.6.2.1.2.5, A7.6.2.1.2.6 and A7.6.2.1.2.7 (age distributions). These figures show that length and age frequency distributions of catches and surveys match reasonably well with available data. Goodness of fit for length distribution of catches (Figure A7.6.2.1.2.1) is better in the last 20 years compared to the first years, in coherence with the assumption of two different selectivity periods. The model seems to not capture well enough the fluctuating or sharp patterns of year 2013 and 2023 for the *ECOCADIZ* survey (Figure A7.6.2.1.2.2) and for most of the years for *PELAGO* survey; in this survey series the length distribution fit is better for years 2000, 2005, 2008, 2017-2020 and 2023 (Figure A7.6.2.1.2.3). Age distributions present a very good fit in almost all the cases (Figures A7.6.2.1.2.5, A7.6.2.1.2.6 and A7.6.2.1.2.7), except for some mismatch in years 2014, 2021 and 2023 for *PELAGO* survey (Figure A7.6.2.1.2.7). There are no remarkable differences compared with the fit of the 2018 model implementation.

Figure A7.6.2.1.2.4 shows the model residuals from the fit to the catch-at-length composition and the acoustic survey length composition, while Figure A7.6.2.1.2.8 shows the model residuals from the fit to the catch-at-age composition and the acoustic survey age composition. In both cases the residuals from the present assessment are similar to those in the benchmark model implementation.

Figure A7.6.2.1.2.9 presents the comparison between observed and estimated survey indices. It can be observed that in general the model assimilates the trend of survey indices.

## Model estimates

Parameter estimates after optimization are presented in Table A7.6.2.1.3.1, while Figure A7.6.2.1.3.1 presents model annual estimates for abundance (removing Age-0 individuals to be accurate with the time of the assessment), recruitment, fishing mortality and catches at the end of the second quarter of each year. Figure A7.6.2.1.3.2 shows annual estimates for biomass of individuals of Age-1+ at the end of the second quarter of each year. Due to some inconsistencies in the maturity ogives not noticed during WKPELA 2018, we assume that all individuals with Age 1 or older ($B_{1+}$) are mature, *i.e.* these biomass estimates result equivalent to spawning stock biomass estimates. The SSB estimate used for the advice was the estimate for year 2024 corresponding to 1938 t (Figure A7.6.2.1.3.2). Detailed model outputs are available at https://github.com/ices-taf/2024_ane.27.9a_south_assessment/tree/main/results, where each file corresponds to the following description:

- sidat: model fit to the survey indices.
- suitability: model estimated fleet suitability.
- stock.recruitment: model estimated recruitment.
- res.by.year: results by year.
- catchdist.fleets: data compared with model output for the length and age-length distributions.
- stock.full: modelled abundance and mean weight by year, step, length and stock.
- stock.std: modelled abundance, mean weight, number by age consumed by the fleet, stock and year.
- stock.prey: consumption of the fleet by length, year and step.
- fleet.info: information on catches, harvest rate and harvestable biomass by fleet, year and step.
- params: parameter values used for the fit.

### The catch advice

As mentioned before, anchovy biomass indicator for the Southern component is obtained from the results of SSB estimates from the Gadget assessment model.

During the WGHANSA-1 2023 meeting (ICES, 2023), and after the Workshop on the Management Strategy Evaluation of constant harvest rates strategies for anchovy in Division 9a (WKANEMSE) on May 5th 2023 (see annex 6 in ICES, 2023), it was agreed to support the proposal for the Southern component of the 27.9.a anchovy of a switch from the current *1over2* advice rule to a Constant Harvest Rate advice rule (*chr*), with a $HR_{MSYproxy}$ = 0.5 with a biomass safeguard defined as the minimum between 1 and the ratio of $I_{current}$ and $B_{trigger}$,with $B_{trigger}$ = 1194.132 t, as follows:

$$C_y = 0.5\, I_{current} * min\left\{\frac{I_{current}}{B_{\text{trigger}}}, 1\right\}$$

where $C_y$ and $I_{current}$, represent the catch advice for July to June of the following year and the stock biomass indicator of the current ($y$) year, respectively.

# Reference points

## Western component

For the western component, a reference point for fishing pressure on the stock was defined as $HR_{MSYproxy}$ = 0.25. No reference points for stock size have been defined for this component.

## Southern component

Reference points for stock size are $B_{trigger}$ = 1194.132 t, $B_{lim}$=1186.34 t and $B_{pa}$=1945.598 t, which are the values used for the MSE simulations presented at the WKANEMSE in 2023. Those values also correspond to those calculated in 2022 following the procedure agreed at the most recent benchmark (Figure A7.7.2.1). A reference point for fishing pressure on the stock was defined as $HR_{MSYproxy}$ = 0.5.

# State of the stock

## Western component

The stock size indicator (a combined index from *PELAGO* and *PELACUS* estimates for the 9.a N, 9.a CN and 9.a CS) was obtained this year. Anchovy biomass estimated for the 9.a N area was 2015 t and the biomass estimated during the PELAGO survey for the 9.a CN and CS sub-divisions was 31 904 t. The combined index was 33 919 t, which represents a decrease of 54% with respect to the combined index of the previous year. As a result, the catch advice for the western component for the period from 1 July 2024 to 30 June 2025 is 8480 t, representing a decrease of 54% in relation to the advice of the previous management year.

### Southern component

The SSB has been fluctuating without a trend over the time-series showing a decrease in the last year, which is consistent with the trend of *PELAGO* and *ECOCADIZ* survey biomass estimates. Time series for recruitment and F are fluctuating with no clear trend (Figures A7.6.2.1.3.1 and A7.6.2.1.3.2).

## Catch advice

### Western component

The ICES framework for category 3 stocks was applied (Method 2.2: Constant harvest rate, *chr*, rule; ICES, 2022). The combination of anchovy biomass estimated in the *PELACUS* and *PELAGO* acoustic surveys is used as the index of stock development. The advice is based on the product of the last index value (33 919 t) and the MSY proxy harvest rate (0.25).

### Southern component

The ICES framework for category 3 stocks was applied (Method 2.2: Constant harvest rate, *chr*, rule; ICES, 2022). The SSB estimated by the assessment model was used as the index of stock size development. The advice is based on the product of the last index value (1938 t) and the MSY proxy harvest rate (0.5). No biomass safeguard was applied because the last index value was higher than $B_{trigger}$ =1194.132 t. As follows:

$$C_y = 0.5\ I_{current} * min\left\{\frac{I_{current}}{B_{\text{trigger}}}, 1\right\} = 0.5 * 1938 * min\left\{\frac{1938}{1194.132}, 1\right\} = 0.5 * 1938$$

The index ratio is estimated to have decreased a 56%.

## Short-term projections

No short-term projections are presented for this stock.

## Quality of the assessment

A MSE has been developed on 2023 for each component resulting in a new assessment method that provides advice based on the application of constant harvest rate over the stock size indicators, as detailed in Pérez-Rodríguez *et al.* (WD 2023) and Wise *et al.* (WD 2023).

### Western component

This stock component is assessed based on survey trends. The acoustic spring surveys that cover the distribution area of this component (*PELAGO* and *PELACUS*) were normally carried out and it was possible to have estimates for this year.

## Southern component

The biomass estimates provided by the Gadget model are assumed as absolute. Even with some instability (as shown by the occurrence of a certain retrospective pattern) and also with a high estimated catchability for both surveys, the MSE simulations in Pérez-Rodríguez *et al*. (WD 2023) showed that the estimates are precautionary. In addition, a harvest rate of 0.5 over that biomass, with a biomass safeguard $B_{trigger}$ = 1194.132 tons, has proved to be sustainable and optimum in the short, medium and long term.

A comparison with last year's estimated time-series is presented in Figure 3.11.2.1. This figure shows the annual model estimates for relative SSB of individuals with more than one year of age, relative fishing mortality, recruitment and catches (in tons). Pink line corresponds to the current year's estimated time-series (the one estimated by the model described here), the green line, to the estimated in 2023 and the blue line, to the estimated in 2022.

# Management considerations

ICES has agreed with the clients that the catch advice will be framed in a management calendar set from 1st July (*y*) to the following 30th June (*y+1*), instead of calendar years.

Other management considerations and the current management situation are described in the stock annex (see annex 3).

# Ecosystem considerations

Ecosystem considerations are described in the stock annex (see annex 3) and there have not been remarkable changes in the last year.

# Deviations from stock annex caused by missing information

For this year assessment, there were some deviations for the southern component of the stock, but they were not related to the Covid-19 disruption. For the western component there were only deviations that were previously considered in the 2020 assessment. Those deviations in 2020 were related to missing survey data associated to *PELACUS* survey, details which were provided at ICES (2020b; WGHANSA 2020 report).

1. Stock: ane.27.9a. Anchovy 9.a southern and western components.

2. Missing or deteriorated survey data: For the western component surveys took place as planned, although the weather conditions were particularly rough during the PELACUS survey. For the southern component: *ECO/BOCADEVA 0723* survey was planned and conducted in summer 2023 as a combined anchovy egg (*BOCADEVA*, first leg) and acoustic-trawl (*ECOCADIZ*, second leg) *ad hoc* survey. The acoustic part (also providing DEPM adult samples) was given less days (11) than usual (14) and in a different RV (*Ramón Margalef* instead of *Miguel Oliver*). Notwithstanding the above, the resulting estimates are considered as valid ones and used in the assessment model since sampling methods and acoustic-trawl equipment are considered as standard. In fact, the *ECOCADIZ-RECLUTAS* survey series is conducted onboard the *Ramón Margalef*. The number of ground-truthing fishing hauls, although lower than in previous surveys, was still considered adequate for the purpose of the acoustic estimation. *ECOCADIZ* series has finished

in 2023: given that there are two other acoustic-trawl series covering the Gulf of Cadiz on an annual basis (*PELAGO* in spring time and *EOCADIZ-RECLUTAS* in autumn) and the lack of available ship time, this series has been suspended by IEO, as long as the surveyed area doesn`t cover the entire stock distribution of the Iberian-Atlantic sardine nor both stock components of the anchovy stock in 9a but southern stock component. Although not considered so far in the assessment model, the DEPM-based SSB estimates in the last two triennial *BOCADEVA* surveys are preliminary because of a shortage of personnel involved in the histological sampling, especially in the estimation of spawning fraction, *S*. As an alternative, the corresponding time-series average values of this parameter has been used in these last two surveys to estimate the SSB. The potential use of the SSB estimates from this survey series in the stock assessment modeling of anchovy in the southern component is being explored during the current benchmark process.

3. Missing or deteriorated catch data: NO.

4. Missing or deteriorated commercial *LPUE/CPUE* data: NO.

5. Missing or deteriorated biological data: For the western component: missing length frequency distribution (LFD) for Spanish commercial catches in the third quarter (Q3) in 2023 in 9a N. Missing LFD and ALK in Q1 and Q2 in 2022 for the Portuguese fishery in 9a CN. No data from the Portuguese fishery in 9a CS in 2023, but catches were very scarce in that subdivision. For the southern component: Missing LFDs and ALKs for commercial catches from the Portuguese fishery, but landings were very low (2% of total catches from this component in 2023). Discrepancies on the age structure in *PELAGO 2023* were found during the last year meeting, mainly some inconsistencies on mean length- and weight-at-age compared to previous years as a consequence of an unusual high relative proportion of age-2 fish in the estimated population. Such discrepancies have also been found in those *PELAGO* surveys conducted in 2020, 2021, 2022.

   Brief description of methods explored to remedy the challenge: For the western component: Q2 LFD for the Spanish commercial catches in 9a N was propagated to the Q3 catches. Quarterly ALKs for Spanish commercial catches in 9a N were based either on commercial samples only (Q1 and Q4) or in a combination of samples from commercial and research *PELACUS 0423* (Q2) and DEMERSALES 2023 (Q3) samples. Methods to remedy gaps of biological information in the Portuguese fishery have not been explored because the very low catches recorded in those quarters without biological data. For the southern component: quarterly LFDs and ALKs from the Spanish fishery were propagated to the very low quarterly catches from the Portuguese fishery. A cross validation exercise of the age-readings from a sub-set of otoliths (images) used for the *PELAGO 2023* ALK was performed by IPMA and IEO assessment age-readers during the WG meeting. This exercise revealed certain disagreement between readers suggesting that a more detailed analysis is needed to agree a consistent ALK and the resulting age structure of the estimated population. An IPMA-IEO anchovy age reading inter-calibration exercise was held in the IEO's Cadiz lab in mid January 2024, which resulted in a revision of the ages attributed to anchovy in survey *PELAGO* 2020, 2021, 2022 and 2023 with respect to what was presented at the respective WGHANSA meetings. The resulting new ALKs and age-structures from these surveys have been incorporated in the Gadget assessment model.

6. Suggested solution to the challenge, including reason for this selecting this solution: For the western component: Q2 LFD for the Spanish commercial catches in 9a N was propagated to the Q3 catches from that subdivision. Quarterly ALKs for Spanish commercial catches in 9a N were

based either on commercial samples only (Q1 and Q4) or in a combination of samples from commercial and research *PELACUS 0423* (Q2) and DEMERSALES 2023 (Q3) samples. Methods to remedy gaps of biological information in the Portuguese fishery have not been explored because the very low catches recorded in those quarters without biological data. For the southern component: quarterly LFDs and ALKs from the Spanish fishery were propagated to the very low quarterly catches from the Portuguese fishery. The assessment model for this year did not include the missing data corresponding to 2021 and 2022 in the *ECOCADIZ* time series. No further analysis was performed to understand the effect of this missing data, but considering that *PELAGO* survey estimates were available and that estimated biomass was consistent with the last year estimates, it was assumed that *PELAGO* and fishery information was enough to provide an accurate biomass index for this year. The new ALKs from the *PELAGO* surveys in 2020, 2021, 2022 and 2023 has been used as data input to the model.

7. Was there an evaluation of the loss of certainty caused by the solution that was carried out? For the southern component: A comparison with last year model implementation was performed where it can be observed that estimated biomass without this survey was consistent with the previous estimated biomass time series.

# Stock specific Management Strategy Evaluation

During WGHANSA meeting on May 2022, the working group agreed on proposing to conduct a dedicated workshop in 2023 to evaluate by Management Strategy Evaluation the performance of a constant harvest rate advice rule that could be used as an alternative to the current applied *1over2* advice rule.

The proposed draft Terms of Reference for such workshop were:

> The Workshop on the Management Strategy Evaluation of constant harvest rates strategies for anchovy in Division 9a (WKANEMSE), will meet to:
>
> c) develop a Management Strategy Evaluation framework to test alternative advice rules for anchovy in Division 9a (Iberian Atlantic waters);
>
> d) identify constant harvest rate rules that could be appropriate to provide advice for this stock and compare them with respect to the current basis for advice (*1over2* rule with 80% uncertainty cap and biomass safeguard)

On the 5$^{th}$ of May 2023, the results and conclusions of a first group of simulations conducted with FLBEIA MSE framework separately to the anchovy 27.9a south and west components were presented by members of WGHANSA to the ICES designated external reviewers.

## Western component

During the WGHANSA meeting from May 29$^{th}$ to June 2$^{nd}$ 2023 it was agreed to support the proposal, for the western component of the 27.9.a anchovy, of a switch from the current *1over2* advice rule to a *chr* advice rule with a $HR_{MSYproxy}$=0.25.

## Southern component

During the WGHANSA meeting from May 29$^{th}$ to June 2$^{nd}$ 2023 it was agreed to support the proposal, for the southern component of the 27.9.a anchovy, of a switch from the current *1over2* advice rule to a *chr* advice rule with a $HR_{MSYproxy}$=0.5 and a biomass safeguard with $B_{trigger}$ = 1194.132 tons.

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# Tables and figures

**Table A7.3.1.1. Anchovy in Division 9.a. Composition of the Spanish fleets operating in Southern Galician waters (Western component, subdivision 9.a North) and in the Gulf of Cadiz (Southern component, Subdivision 9.a-South) targeting anchovy in 2023. The categories include both single purpose purse-seiners, artisanal and trawl and artisanal vessels fishing with purse-seine in some periods through the year (multi-purpose vessels). Storage: catches are dry hold with ice (one fishing trip equals one fishing day). Similar tables for yearly data since 1999 are shown for the Gulf of Cadiz Spanish fleet in previous WG reports.**

| Subdivision 9.a North | | | | | | |
|---|---|---|---|---|---|---|
| 2023 | Vessels targeting anchovy | | | | | |
| | Engine (HP) | | | | | |
| Length (m) | 0–50 | 51–100 | 101–200 | 201-500 | >500 | Total |
| <10 | 4 | | | | | 4 |
| 10–<15 | 6 | 12 | 11 | | | 29 |
| 15–<20 | | 1 | 5 | 7 | | 13 |
| ≥20 | | | 4 | 26 | 1 | 31 |
| Total | 10 | 13 | 20 | 33 | 1 | 77 |
| Subdivision 9.a South | | | | | | |
| 2023 | Vessels targeting anchovy | | | | | |
| | Engine (HP) | | | | | |
| Length (m) | 0–50 | 51–100 | 101–200 | 201-500 | >500 | Total |
| <10 | | | | | | |
| 10–<15 | 1 | 1 | 1 | 1 | | 4 |
| 15–<20 | | 5 | 19 | 9 | | 33 |
| ≥20 | | | 3 | 10 | 1 | 14 |
| Total | 1 | 6 | 23 | 20 | 1 | 51 |

**Table A7.3.2.1.1. Anchovy in Division 9.a. Recent historical series of annual catches (t) by subdivision, stock component and total division since 1989 on (the period with available data for all the subdivisions). Catches in Subdivision 9.a South are also differentiated between Portuguese (PT) and Spanish (ES) waters. (-) not available data; (0) less than 1 tonne (from Pestana, 1989, 1996 and WGMHSA, WGANC, WGANSA and WGHANSA members). The rest of the historical series of catches is shown in the stock annex. Discards are considered negligible in both the Portuguese (9.a C-N to 9.a S (PT)) and Spanish (9.a N, 9.a S (ES)) fisheries. Notwithstanding the above, the estimates for the Spanish fishery include estimates of discarded (and unallocated) catches since 2014 on. Discards estimates for the Spanish fishery are not available for the first semester 2020 because Covid-19 disruption and interruption of the IEO's observers at-sea sampling program. (*) Provisional official landings data for the 2024 first semester updated until 30th April (9a.CN, 9a.CS, 9a.S-ALG) –16th May (9a.N, 9a.S-CAD).**

| Year | 9.a N | 9.a C-N | 9.a C-S | West. Comp. | 9.a S (PT) | 9.a S (ES) | South. Comp. | Total Division |
|---|---|---|---|---|---|---|---|---|
| 1989 | 118 | 646 | 141 | 905 | 36 | 5330 | 5365 | 6270 |
| 1990 | 220 | 431 | 4 | 655 | 110 | 5726 | 5836 | 6491 |
| 1991 | 15 | 187 | 3 | 205 | 22 | 5697 | 5718 | 5924 |
| 1992 | 33 | 136 | 1 | 170 | 2 | 2995 | 2997 | 3167 |
| 1993 | 1 | 22 | 1 | 24 | 0 | 1960 | 1960 | 1984 |
| 1994 | 117 | 236 | 8 | 361 | 0 | 3035 | 3035 | 3397 |
| 1995 | 5329 | 2521 | 9 | 7859 | 0 | 571 | 571 | 8430 |
| 1996 | 44 | 2711 | 13 | 2768 | 51 | 1780 | 1831 | 4599 |
| 1997 | 63 | 610 | 8 | 682 | 14 | 4600 | 4614 | 5296 |
| 1998 | 371 | 894 | 153 | 1419 | 610 | 8977 | 9587 | 11006 |
| 1999 | 413 | 957 | 96 | 1466 | 355 | 5587 | 5942 | 7409 |
| 2000 | 10 | 71 | 61 | 142 | 178 | 2182 | 2360 | 2502 |
| 2001 | 27 | 397 | 19 | 444 | 439 | 8216 | 8655 | 9098 |
| 2002 | 21 | 433 | 90 | 543 | 393 | 7870 | 8262 | 8806 |
| 2003 | 23 | 211 | 67 | 301 | 200 | 4768 | 4968 | 5269 |
| 2004 | 4 | 83 | 139 | 226 | 434 | 5183 | 5617 | 5844 |
| 2005 | 4 | 82 | 6 | 92 | 38 | 4385 | 4423 | 4515 |
| 2006 | 15 | 79 | 15 | 110 | 14 | 4368 | 4381 | 4491 |
| 2007 | 4 | 833 | 7 | 844 | 34 | 5576 | 5610 | 6454 |
| 2008 | 5 | 211 | 87 | 303 | 37 | 3168 | 3204 | 3508 |
| 2009 | 19 | 35 | 5 | 59 | 32 | 2922 | 2954 | 3013 |
| 2010 | 179 | 100 | 2 | 281 | 28 | 2901 | 2929 | 3210 |
| 2011 | 541 | 3239 | 1 | 3782 | 78 | 6216 | 6294 | 10076 |
| 2012 | 39 | 521 | 220 | 779 | 56 | 4754 | 4810 | 5589 |

| Year | 9.a N | 9.a C-N | 9.a C-S | West. Comp. | 9.a S (PT) | 9.a S (ES) | South. Comp. | Total Division |
|---|---|---|---|---|---|---|---|---|
| 2013 | 69 | 192 | 131 | 392 | 67 | 5172 | 5240 | 5632 |
| 2014 | 581 | 678 | 21 | 1281 | 118 | 8933 | 9051 | 10332 |
| 2015 | 173 | 2533 | 10 | 2717 | 2 | 6878 | 6880 | 9597 |
| 2016 | 222 | 6908 | 10 | 7140 | 19 | 6581 | 6599 | 13740 |
| 2017 | 1069 | 8854 | 170 | 10094 | 26 | 4585 | 4611 | 14705 |
| 2018 | 992 | 7871 | 370 | 9233 | 65 | 4433 | 4499 | 13732 |
| 2019 | 991 | 5205 | 4 | 6200 | 113 | 4701 | 4814 | 11014 |
| 2020 | 309 | 5327 | 2 | 5639 | 155 | 7163 | 7317 | 12956 |
| 2021 | 747 | 9521 | 8 | 10276 | 109 | 7452 | 7562 | 17837 |
| 2022 | 15 | 3509 | 24 | 3548 | 0 | 6795 | 6795 | 10343 |
| 2023 | 218 | 4411 | 2 | 4631 | 155 | 7315 | 7470 | 12101 |
| 2024* | 0.9 | 46 | 1 | 48 | 4 | 3653 | 3657 | 3705 |

**Table A7.3.2.2.1. Anchovy in Division 9.a. Catches (t) by gear and subdivision in 1989–2023. Discards are considered negligible in both the Portuguese (9.a C-N to 9.a S (PT)) and Spanish (9.a N, 9.a S (ES)) fisheries. Notwithstanding the above, the estimates for the Spanish fishery include estimates of discarded catches by gear since 2014 on. Discards estimates for the Spanish fishery are not available for the first semester 2020 because Covid-19 disruption and interruption of the IEO's observers at-sea sampling program. Landings by gear in subdivisions 9.a C-N to S (PT) are not available by subdivision until 2009.**

| Subarea | Gear | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995* | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.a N | Artisanal | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Purse-seine | 118 | 220 | 15 | 33 | 1 | 117 | 5329 | 44 | 63 | 371 | 413 | 10 |
| 9.a C-N to 9.a S (PT) | Demersal Trawl | - | - | - | 4 | 9 | 1 | - | 56 | 46 | 37 | 43 | 6 |
| | P. seine polyvalent | - | - | - | 1 | 1 | 3 | - | 94 | 7 | 35 | 20 | 7 |
| | Purse-seine | - | - | - | 270 | 14 | 233 | - | 2621 | 579 | 1541 | 1346 | 297 |
| | Not different. By gear | 496 | 541 | 210 | - | - | - | 7056 | - | - | - | - | - |
| 9.a S (ES) | Demersal Trawl | 0 | 0 | 0 | 0 | 330 | 152 | 75 | 224 | 190 | 1148 | 993 | 104 |
| | Purse-seine | 5336 | 5911 | 5696 | 2995 | 1630 | 2884 | 496 | 1556 | 4410 | 7830 | 4594 | 2078 |

| Subarea | Gear | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|
| 9.a N | Artisanal | 0 | 0 | 4 | 1 | 0 | 0 | 0 | 1 | 0.1 |
| | Purse-seine | 27 | 21 | 19 | 2 | 4 | 15 | 4 | 4 | 18 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 9.a C-N to 9.a S (PT) | Demersal Trawl | 16 | 13 | 7 | 5 | 7 | 27 | 14 | 9 | 4 |
| | P. seine polyvalent | 32 | 13 | 184 | 197 | 57 | 24 | 376 | 141 | 38 |
| | Purse-seine | 806 | 888 | 287 | 455 | 62 | 57 | 484 | 185 | 30 |
| | Not different. By gear | - | - | - | - | - | - | - | - | - |
| 9.a S (ES) | Demersal Trawl | 36 | 23 | 14 | 6 | 0.2 | 0.4 | 0.3 | 0.1 | 0.02 |
| | Purse-seine | 8180 | 7847 | 4754 | 5177 | 4385 | 4367 | 5575 | 3168 | 2922 |

| Sub-area | Gear | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.a N | Demersal trawl | 0 | 0 | 0 | 0 | 0 | 0.2 | 0 | 7 | 0.6 | 0.6 | 0 | 0 | 0 | 0.03 |
| | Artisanal | 4 | 0 | 1 | 6 | 0 | 21 | 6 | 6 | 0.4 | 0.1 | 0.1 | 0.1 | 0.01 | 4 |
| | Purse-seine | 175 | 541 | 37 | 63 | 581 | 152 | 217 | 1057 | 991 | 990 | 309 | 747 | 15 | 215 |
| 9.a C-N | Demersal Trawl | 5 | 4 | 1 | 0.5 | 2 | 3 | 2 | 2 | 0,3 | 0.2 | 2 | 2 | 5 | 48 |
| | P. seine polyva-lent | 45 | 1116 | 177 | 17 | 9 | 150 | 294 | 332 | 403 | 34 | 122 | 400 | 126 | 113 |
| | Purse-seine | 50 | 2119 | 342 | 175 | 668 | 2381 | 6613 | 8521 | 7468 | 5170 | 5203 | 9119 | 3379 | 4250 |
| 9.a C-S | Demersal Trawl | 1 | 1 | 0.4 | 1 | 3 | 2 | 1 | 0.2 | 1 | 0.02 | 0.02 | 0.01 | 0 | 0.3 |
| | P. seine polyva-lent | 0 | 0.1 | 17 | 4 | 1 | 0.4 | 4 | 13 | 14 | 1 | 2 | 2 | 0.1 | 0.002 |
| | Purse-seine | 1 | 0.4 | 202 | 127 | 18 | 8 | 5 | 157 | 355 | 4 | 0 | 5 | 24 | 2 |
| 9.a S (PT) | Demersal Trawl | 8 | 13 | 16 | 2 | 5 | 1 | 3 | 6 | 1 | 0 | 0.1 | 0.1 | 0.04 | 0 |
| | P. seine polyva-lent | 4 | 33 | 0.1 | 2 | 0.04 | 0.02 | 0.04 | 0 | 0 | 0 | 1 | 2 | 0 | 0 |
| | Purse-seine | 17 | 33 | 41 | 63 | 113 | 1 | 16 | 20 | 65 | 113 | 153 | 107 | 0.1 | 155 |
| 9.a S (ES) | Demersal Trawl | 0 | 0 | 2 | 0 | 99 | 33 | 118 | 204 | 90 | 209 | 105 | 66 | 110 | 233 |
| | Artisanal | 0 | 0 | 0 | 0 | 0 | 0.1 | 0.1 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Purse-seine | 2901 | 6216 | 4752 | 5172 | 8835 | 6845 | 6463 | 4381 | 4343 | 4492 | 7058 | 7387 | 6686 | 7082 |

**Table 4.3.2.2.2. Anchovy in Division 9.a. Quarterly anchovy catches (t) by subdivision in 2023.**

| SUBDIVISION/ COMPONENT | QUARTER 1 | | QUARTER 2 | | QUARTER 3 | | QUARTER 4 | | ANNUAL (2023) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | C(t) | % | C(t) | % | C(t) | % | C(t) | % | C (t) | % |
| 9.a North | 64 | 29,5 | 18 | 8,0 | 10 | 4,4 | 127 | 58,1 | 218 | 1,8 |
| 9.a Central North | 669 | 15,2 | 5,6 | 0,13 | 2655 | 60,2 | 1081 | 24,5 | 4411 | 36,4 |
| 9.a Central South | 0 | 13,4 | 0,0 | 1,4 | 2 | 85,2 | 0 | 0,0 | 2 | 0,0 |
| Western Comp. | 734 | 15,8 | 23 | 0,50 | 2667 | 57,6 | 1208 | 26,1 | 4631 | 38,3 |
| 9.a South (PT) | 0 | 0,0 | 17 | 11,2 | 137 | 88,5 | 0,4 | 0,3 | 155 | 1,3 |
| 9.a South (ES) | 933 | 12,8 | 3609 | 49,3 | 2151 | 29,4 | 622 | 8,5 | 7315 | 60,5 |
| Southern Comp. | 933 | 12,5 | 3626 | 48,5 | 2288 | 30,6 | 623 | 8,3 | 7470 | 61,7 |
| TOTAL | 1666 | 13,8 | 3649 | 30,2 | 2679 | 22,1 | 722 | 6,0 | 12101 | 100,0 |

**Table A7.3.5.1.1. Anchovy in Division 9.a. Western Component. Subdivision 9.a North. Spanish fishery (all fleets). Seasonal and annual length distributions ('000) of anchovy catches in 2023. Discards were sampled but they were null, hence landings equals to catches.**

| **2023** | **Q1** | **Q2** | **Q3** | **Q4** | **TOTAL** |
|---|---|---|---|---|---|
| Length (cm) | 9.a N | 9.a N | 9.a N | 9.a N | 9.a N |
| 6 | 0 | 0 | 0 | 0 | 0 |
| 6.5 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 |
| 7.5 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 |
| 8.5 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 |
| 9.5 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 |
| 10.5 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 0 | 0 | 0 | 0 |
| 11.5 | 0 | 0 | 0 | 0 | 0 |
| 12 | 0 | 0 | 0 | 235 | 235 |
| 12.5 | 10 | 0 | 0 | 860 | 870 |
| 13 | 162 | 0 | 0 | 1876 | 2038 |
| 13.5 | 516 | 45 | 25 | 2189 | 2774 |
| 14 | 702 | 248 | 136 | 938 | 2024 |
| 14.5 | 484 | 327 | 179 | 469 | 1459 |
| 15 | 345 | 124 | 68 | 156 | 693 |
| 15.5 | 236 | 34 | 19 | 0 | 289 |
| 16 | 172 | 0 | 0 | 0 | 172 |
| 16.5 | 78 | 0 | 0 | 0 | 78 |
| 17 | 15 | 0 | 0 | 0 | 15 |
| 17.5 | 10 | 0 | 0 | 0 | 10 |
| 18 | 0 | 0 | 0 | 0 | 0 |
| 18.5 | 0 | 0 | 0 | 0 | 0 |

| 2023<br>Length (cm) | Q1<br>9.a N | Q2<br>9.a N | Q3<br>9.a N | Q4<br>9.a N | TOTAL<br>9.a N |
|---|---|---|---|---|---|
| 19 | 0 | 0 | 0 | 0 | 0 |
| 19.5 | 0 | 0 | 0 | 0 | 0 |
| 20 | 0 | 0 | 0 | 0 | 0 |
| 20.5 | 0 | 0 | 0 | 0 | 0 |
| 21 | 0 | 0 | 0 | 0 | 0 |
| 21.5 | 0 | 0 | 0 | 0 | 0 |
| Total N | 2730 | 779 | 426 | 6723 | 10657 |
| Catch (T) | 64 | 18 | 10 | 127 | 218 |
| L avg (cm) | 14.7 | 14.7 | 14.7 | 13.6 | 14.0 |
| W avg (g) | 22.6 | 22.4 | 22,9 | 18.7 | 20.2 |

**Table A7.3.5.1.2. Anchovy in Division 9.a. Western Component. Subdivision 9.a Central North. Portuguese fishery (purse-seine fleet). Seasonal and annual length distributions ('000) of anchovy catches in 2023. Discards are null, hence landings correspond to catches. Length frequency distributions were not available for other métiers. Only data for the 3rd and 4th Quarter LFDs from the métier PS_SPF_0_0_0 are available.**

| 2023<br>Length (cm) | Q1<br>9.a CN | Q2<br>9.a CN | Q3<br>9.a CN | Q4<br>9.a CN | TOTAL<br>9.a CN |
|---|---|---|---|---|---|
| 6 | | | | | |
| 6.5 | | | | | |
| 7 | | | | | |
| 7.5 | | | | | |
| 8 | | | | | |
| 8.5 | | | | | |
| 9 | | | | | |
| 9.5 | | | | | |
| 10 | | | | | |
| 10.5 | | | | 50 | |
| 11 | | | | 302 | |
| 11.5 | | | | 201 | |
| 12 | | | | 352 | |

| 2023 | Q1 | Q2 | Q3 | Q4 | TOTAL |
|---|---|---|---|---|---|
| Length (cm) | 9.a CN | 9.a CN | 9.a CN | 9.a CN | 9.a CN |
| 12.5 | | | | 101 | |
| 13 | | | | 221 | |
| 13.5 | | | 1106 | 563 | |
| 14 | | | 4184 | 392 | |
| 14.5 | | | 14325 | 3171 | |
| 15 | | | 18404 | 3271 | |
| 15.5 | | | 14370 | 6029 | |
| 16 | | | 12029 | 7510 | |
| 16.5 | | | 6532 | 6412 | |
| 17 | | | 5914 | 2365 | |
| 17.5 | | | 6219 | 3876 | |
| 18 | | | 4574 | 171 | |
| 18.5 | | | 1217 | 926 | |
| 19 | | | 292 | | |
| 19.5 | | | | | |
| 20 | | | | | |
| 20.5 | | | | | |
| 21 | | | | | |
| 21.5 | | | | | |
| Total N | | | | | |
| Catch (T) | | | | | |
| L avg (cm) | | | | | |
| W avg (g) | | | | | |

**Table A7.3.5.1.3. Anchovy in Division 9.a. Southern component. Subdivision 9.a South (ES). Spanish fishery (all fleets). Seasonal and annual length distributions ('000) of anchovy catches in 2023. Discards were sampled and estimated.**

| **2023** | **Q1** | **Q2** | **Q3** | **Q4** | **TOTAL** |
|---|---|---|---|---|---|
| Length (cm) | 9.a S (ES) | 9.a S (ES) | 9.a S (ES) | 9.a S (ES) | 9.a S (ES) |
| 3 | 0 | 0 | 0 | 0 | 0 |
| 3.5 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 3 | 8 | 10 |
| 4.5 | 0 | 0 | 1 | 2 | 3 |
| 5 | 4 | 0 | 3 | 4 | 11 |
| 5,5 | 11 | 0 | 0 | 0 | 11 |
| 6 | 29 | 111 | 7 | 28 | 175 |
| 6.5 | 52 | 88 | 21 | 66 | 227 |
| 7 | 175 | 224 | 47 | 158 | 604 |
| 7.5 | 306 | 458 | 62 | 244 | 1070 |
| 8 | 1798 | 664 | 90 | 855 | 3408 |
| 8.5 | 3267 | 1192 | 289 | 712 | 5460 |
| 9 | 4743 | 8920 | 821 | 2345 | 16828 |
| 9.5 | 13214 | 42632 | 4695 | 5145 | 65685 |
| 10 | 15498 | 56114 | 10603 | 7264 | 89479 |
| 10.5 | 25709 | 91528 | 18667 | 26637 | 162542 |
| 11 | 18808 | 64853 | 20480 | 19121 | 123261 |
| 11.5 | 14190 | 58154 | 39594 | 13625 | 125564 |
| 12 | 9150 | 31334 | 40305 | 2325 | 83114 |
| 12.5 | 4957 | 21270 | 31803 | 1093 | 59123 |
| 13 | 1512 | 7424 | 13114 | 322 | 22371 |
| 13.5 | 1113 | 3146 | 10565 | 151 | 14975 |
| 14 | 91 | 509 | 2530 | 99 | 3229 |
| 14.5 | 67 | 471 | 348 | 21 | 906 |
| 15 | 26 | 0 | 87 | 46 | 158 |
| 15.5 | 5 | 0 | 83 | 14 | 102 |

| 2023 Length (cm) | Q1 9.a S (ES) | Q2 9.a S (ES) | Q3 9.a S (ES) | Q4 9.a S (ES) | TOTAL 9.a S (ES) |
|---|---|---|---|---|---|
| 16 | 14 | 0 | 467 | 12 | 494 |
| 16.5 | 4 | 0 | 0 | 2 | 6 |
| 17 | 4 | 0 | 0 | 0 | 4 |
| 17.5 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 0 | 0 | 0 | 0 |
| 18.5 | 0 | 0 | 0 | 0 | 0 |
| 19 | 0 | 0 | 0 | 0 | 0 |
| 19.5 | 0 | 0 | 0 | 0 | 0 |
| 20 | 0 | 0 | 0 | 0 | 0 |
| 20.5 | 0 | 0 | 0 | 0 | 0 |
| 21 | 0 | 0 | 0 | 0 | 0 |
| 21.5 | 0 | 0 | 0 | 0 | 0 |
| Total N | 114745 | 389092 | 194687 | 80298 | 778822 |
| Catch (T) | 933 | 3609 | 2151 | 622 | 7315 |
| L avg (cm) | 10.9 | 11.1 | 12.0 | 10.9 | 11.2 |
| W avg (g) | 8.1 | 9.3 | 11.0 | 7.8 | 9.4 |

**Table A7.3.5.2.1. Anchovy in Division 9.a. Western component. Subdivision 9.a North. Spanish catches (all fleets) in numbers-('000) at-age of Galician anchovy in 2023 on a quarterly (Q), half-year (HY) and annual basis.**

| 2023 | AGE | Q1 | Q2 | Q3 | Q4 | HY1 | HY2 | ANNUAL |
|---|---|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 0 | 866 | 0 | 866 | 866 |
| | 1 | 1972 | 521 | 321 | 5857 | 2492 | 6178 | 8670 |
| | 2 | 734 | 250 | 104 | 0 | 983 | 104 | 1087 |
| | 3 | 25 | 9 | 0 | 0 | 33 | 0 | 33 |
| | Total (n) | 2730 | 779 | 426 | 6723 | 3508 | 7149 | 10657 |
| | Catch (t) | 64 | 18 | 10 | 127 | 82 | 136 | 218 |
| | SOP | 62 | 17 | 10 | 126 | 79 | 136 | 215 |
| | VAR.% | 104 | 100 | 98 | 101 | 103 | 101 | 102 |

**Table A7.3.5.2.2. Anchovy in Division 9.a. Western component. Subdivision 9.a North. Spanish annual catches of anchovy in numbers ('000) at-age (only data for 2011–2012 and 2015–2023).**

| Year | Age 0 | Age 1 | Age 2 | Age 3 |
|---|---|---|---|---|
| 2011 | 2725 | 23903 | 380 | 0 |
| 2012 | 0 | 668 | 599 | 7 |
| 2013 | n.a | n.a | n.a | n.a |
| 2014 | n.a | n.a | n.a | n.a |
| 2015 | 0 | 1667 | 6667 | 66 |
| 2016 | 4677 | 9206 | 881 | 1 |
| 2017 | 14116 | 21150 | 10310 | 184 |
| 2018 | 0 | 33336 | 8551 | 354 |
| 2019 | 0 | 3274 | 5942 | 196 |
| 2020 | 0 | 4091 | 4170 | 1526 |
| 2021 | 12697 | 12148 | 4331 | 30 |
| 2022 | 0 | 279 | 152 | 30 |
| 2023 | 866 | 8670 | 1087 | 33 |

**Table A7.3.5.2.3. Anchovy in Division 9.a. Western component. Subdivision 9.a Central-North. Portuguese catches (all fleets) of anchovy in numbers ('000) at-age in 2023 on a quarterly (Q), half-year (HY) and annual basis.**

| 2023 | AGE | Q1 | Q2 | Q3 | Q4 | HY1 | HY2 | ANNUAL |
|---|---|---|---|---|---|---|---|---|
| | 0 | | | 0 | 0 | | 0 | |
| | 1 | | | 75494 | 24349 | | 99841 | |
| | 2 | | | 12683 | 11467 | | 24151 | |
| | 3 | | | 990 | 97 | | 1087 | |
| | Total (n) | | | 89167 | 35913 | | 125079 | |
| | Catch (t) | | | 2597 | 1043 | | 3640 | |
| | SOP | | | 2597 | 1043 | | 3640 | |
| | VAR.% | | | 100 | 100 | | 100 | |

**Table A7.3.5.2.4. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. Spanish catches (all fleets) in numbers ('000) at-age of Gulf of Cadiz anchovy in 2023 on a quarterly (Q), half-year (HY) and annual basis.**

| 2023 | AGE | Q1 | Q2 | Q3 | Q4 | HY1 | HY2 | ANNUAL |
|---|---|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 106055 | 78661 | 0 | 184715 | 184715 |
| | 1 | 114153 | 383564 | 85776 | 1626 | 497716 | 87402 | 585118 |
| | 2 | 570 | 5528 | 2856 | 12 | 6098 | 2867 | 8966 |
| | 3 | 22 | 0 | 0 | 0 | 22 | 0 | 22 |
| | Total (n) | 114745 | 389092 | 194687 | 80298 | 503837 | 274985 | 778822 |
| | Catch (t) | 933 | 3609 | 2151 | 622 | 4551 | 2774 | 7315 |
| | SOP | 933 | 3609 | 2151 | 622 | 4543 | 2773 | 7316 |
| | VAR.% | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

**Table A7.3.5.2.5. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. Spanish annual catches (all fleets) in numbers ('000) at-age of Gulf of Cadiz anchovy (1995–2023).**

| Year | Age 0 | Age 1 | Age 2 | Age 3 |
|---|---|---|---|---|
| 1995 | 34497 | 33961 | 189 | 0 |
| 1996 | 484540 | 162483 | 2053 | 0 |
| 1997 | 333758 | 279641 | 44823 | 0 |
| 1998 | 436307 | 1015535 | 13260 | 0 |
| 1999 | 124784 | 472348 | 32279 | 0 |
| 2000 | 118808 | 197497 | 3844 | 0 |
| 2001 | 158126 | 541331 | 23342 | 0 |
| 2002 | 74399 | 708070 | 17515 | 0 |
| 2003 | 71847 | 381407 | 13109 | 0 |
| 2004 | 105958 | 398862 | 2590 | 0 |
| 2005 | 37906 | 482256 | 3495 | 0 |
| 2006 | 11303 | 491307 | 5261 | 0 |
| 2007 | 61692 | 559217 | 7342 | 0 |
| 2008 | 57477 | 138295 | 30970 | 394 |
| 2009 | 9695 | 184941 | 20051 | 2673 |
| 2010 | 34462 | 210384 | 11118 | 257 |
| 2011 | 199191 | 406217 | 16117 | 0 |

| Year | Age 0 | Age 1 | Age 2 | Age 3 |
|---|---|---|---|---|
| 2012 | 25265 | 335487 | 8348 | 0 |
| 2013 | 176169 | 300781 | 5950 | 0 |
| 2014 | 73210 | 808350 | 6155 | 0 |
| 2015 | 196337 | 460887 | 13667 | 0 |
| 2016 | 87979 | 460201 | 19758 | 0 |
| 2017 | 118554 | 402410 | 4339 | 8 |
| 2018 | 39467 | 316336 | 6450 | 0 |
| 2019 | 163216 | 265091 | 17311 | 0 |
| 2020 | 196225 | 373573 | 28237 | 1357 |
| 2021 | 144927 | 444421 | 28745 | 0 |
| 2022 | 103884 | 401337 | 24877 | 0 |
| 2023 | 184715 | 585118 | 8966 | 22 |

**Table A7.3.6.1. Anchovy in Division 9.a. Western component. Subdivision 9.a North. Mean length (TL, in cm) at-age in the Spanish catches of Galician anchovy (all fleets) in 2023 on a quarterly (Q), half-year (HY) and annual basis.**

| 2023 | AGE | Q1 | Q2 | Q3 | Q4 | HY1 | HY2 | ANNUAL |
|---|---|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 0 | 13.0 | 14.5 | 13.0 | 13.0 |
| | 1 | 14.4 | 14.6 | 14.6 | 13.7 | 15.1 | 13.7 | 13.9 |
| | 2 | 15.2 | 14.8 | 14.8 | 0 | 16.9 | 14.8 | 15.0 |
| | 3 | 17.5 | 15.2 | 0 | 0 | 14.7 | 0 | 16.9 |
| | Total | 14.7 | 14.7 | 14.7 | 13.6 | 14.5 | 13.7 | 14.0 |

**Table A7.3.6.2. Anchovy in Division 9.a. Western component. Subdivision 9.a North. Mean weight (in kg) at-age in the Spanish catches of Galician anchovy (all fleets) in 2023 on a quarterly (Q), half-year (HY) and annual basis.**

| 2023 | AGE | Q1 | Q2 | Q3 | Q4 | HY1 | HY2 | ANNUAL |
|---|---|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 0 | 16.5 | 0 | 16.5 | 16.5 |
| | 1 | 21.6 | 22.1 | 22.8 | 19.0 | 21.7 | 19.2 | 19.9 |
| | 2 | 25.0 | 23.0 | 23.3 | 0 | 24.5 | 23.3 | 24.4 |
| | 3 | 37.0 | 25.1 | 0 | 0 | 34.0 | 0 | 34.0 |
| | Total | 22.6 | 22.4 | 22.9 | 18.7 | 22.6 | 19.0 | 20.2 |

**Table A7.3.6.3. Anchovy in Division 9.a. Western component. Subdivision 9.a Central-North. Mean length (TL, in cm) at-age in the Portuguese catches of Northwestern anchovy (all fleets) in 2023 on a quarterly (Q), half-year (HY) and annual basis.**

| 2023 | AGE | Q1 | Q2 | Q3 | Q4 | HY1 | HY2 | ANNUAL |
|---|---|---|---|---|---|---|---|---|
| | 0 | | | | | | | |
| | 1 | | | 15.7 | 16.0 | | 15.8 | |
| | 2 | | | 17.3 | 16.5 | | 16.9 | |
| | 3 | | | 17.7 | 17.8 | | 17.7 | |
| | Total | | | 16.0 | 16.1 | | 16.0 | |

**Table A7.3.6.4. Anchovy in Division 9.a. Western component. Subdivision 9.a Central-North. Mean weight (in kg) at-age in the Portuguese catches of Northwestern anchovy (all fleets) in 2023 on a quarterly (Q), half-year (HY) and annual basis.**

| 2023 | AGE | Q1 | Q2 | Q3 | Q4 | HY1 | HY2 | ANNUAL |
|---|---|---|---|---|---|---|---|---|
| | 0 | | | | | | | |
| | 1 | | | 27.6 | 28.1 | | 26.9 | |
| | 2 | | | 37.7 | 30.8 | | 33.6 | |
| | 3 | | | 40.4 | 38.4 | | 38.6 | |
| | Total | | | 29.2 | 29.0 | | 28.3 | |

**Table A7.3.6.5. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. Mean length (TL, in cm) at-age in the Spanish catches of Gulf of Cadiz anchovy (all fleets) in 2023 on a quarterly (Q), half-year (HY) and annual basis.**

| 2023 | AGE | Q1 | Q2 | Q3 | Q4 | HY1 | HY2 | ANNUAL |
|---|---|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 11.7 | 10.9 | 0 | 11.3 | 11.3 |
| | 1 | 10.9 | 11.0 | 12.4 | 12.3 | 11.0 | 12.4 | 11.2 |
| | 2 | 13.8 | 13.5 | 12.0 | 14.7 | 13.5 | 12.1 | 13.1 |
| | 3 | 14.8 | 0 | 0 | 0 | 14.8 | 0 | 14.8 |
| | Total | 10.9 | 11.1 | 12.0 | 10.9 | 11.0 | 11.7 | 11.2 |

**Table A7.3.6.6. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. Mean weight (in kg) at-age in the Spanish catches of Gulf of Cadiz anchovy (all fleets) in 2023 on a quarterly (Q), half-year (HY) and annual basis.**

| 2023 | AGE | Q1 | Q2 | Q3 | Q4 | HY1 | HY2 | ANNUAL |
|---|---|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 10.1 | 7.7 | 0 | 9.1 | 9.1 |
| | 1 | 8.1 | 9.2 | 12.2 | 11.4 | 8.9 | 12.2 | 9.4 |
| | 2 | 15.4 | 17.4 | 11.8 | 20.2 | 17.2 | 11.8 | 15.5 |
| | 3 | 18.3 | 0 | 0 | 0 | 18.3 | 0 | 18.3 |
| | Total | 8.1 | 9.3 | 11.0 | 7.7 | 9.0 | 10.1 | 9.4 |

**Table A7.4.1. Acoustic and DEPM surveys providing direct estimates for anchovy in Division 9.a. (1): *ECOCADIZ-COSTA 0709*, (pilot) Spanish survey surveying shallow waters <20 m depth and complementary to the standard survey; ((Month)): surveys that were carried out but did not provide any anchovy acoustic estimate because of its very low presence and/or for an incomplete geographical coverage (some areas were not covered: either the Spanish or the Portuguese part of the Gulf of Cadiz).**

| Method | Acoustics | | | | | | | | | | | DEPM | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey | PELACUS | | PELAGO | | SAR | JUVESAR | IBERAS | | ECOCADIZ | | ECO-CADIZ-RE-CLU-TAS | BOCADEVA | |
| Institute (Country) | IEO (ES) | | IPMA (PT) | | IPMA (PT) | IPMA (PT) | IPMA-IEO (PT-ES) | | IEO (ES) | | IEO (ES) | IEO (ES) | |
| Subareas | 9.a N | | 9.a CN-9.a S | | 9.a CN-9.a S | 9.a CN | 9.a N-9.a CS | | 9.a S | | 9.a S | 9.a S | |
| Year/Quarter | Q1 | Q2 | Q1 | Q2 | Q4 | Q4 | Q3 | Q4 | Q2 | Q3 | Q4 | Q2 | Q3 |
| 1998 | | | | | Nov | | | | | | | | |
| 1999 | | | Mar | | | | | | | | | | |
| 2000 | | | | | Nov | | | | | | | | |
| 2001 | | | Mar | | Nov | | | | | | | | |
| 2002 | | | Mar | | | | | | | | | | |
| 2003 | | | Feb | | (Nov) | | | | | | | | |
| 2004 | | | | (Jun) | | | | | Jun | | | | |

| **Method** | **Acoustics** | | | | | | | | | | | **DEPM** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey | PELACUS | | PELAGO | | SAR | JUVESAR | IBERAS | | ECOCADIZ | | ECOCADIZ-RECLUTAS | BOCADEVA | |
| Institute (Country) | IEO (ES) | | IPMA (PT) | | IPMA (PT) | IPMA (PT) | IPMA-IEO (PT-ES) | | IEO (ES) | | IEO (ES) | IEO (ES) | |
| Subareas | 9.a N | | 9.a CN-9.a S | | 9.a CN-9.a S | 9.a CN | 9.a N-9.a CS | | 9.a S | | 9.a S | 9.a S | |
| Year/Quarter | Q1 | Q2 | Q1 | Q2 | Q4 | Q4 | Q3 | Q4 | Q2 | Q3 | Q4 | Q2 | Q3 |
| 2005 | | | | Apr | (Nov) | | | | | | | Jun | |
| 2006 | | | | Apr | (Nov) | | | | Jun | | | | |
| 2007 | | | | Apr | Nov | | | | | Jul | | | |
| 2008 | | Apr | | Apr | (Nov) | | | | | | | Jun | |
| 2009 | | Apr | | Apr | | | | | Jun | (Jul)(1) | (Oct) | | |
| 2010 | | Apr | | Apr | | | | | | (Jul) | | | |
| 2011 | | Apr | | Apr | | | | | | | | | Jul |
| 2012 | | Apr | | | | | | | | | Nov | | |
| 2013 | Mar | | | Apr | | (Nov) | | | | Aug | | | |
| 2014 | Mar | | | Apr | | (Nov) | | | | Jul | Oct | | Jul |
| 2015 | Mar | | | Apr | | Dec | | | | Jul | Oct | | |
| 2016 | Mar | | | Apr | | Dec | | | | Jul | Oct | | |
| 2017 | Mar | | | Apr | | Dec | | | | Jul | Oct | | Jul |
| 2018 | Mar | | | Apr | | | | Nov | | Jul | Oct | | |
| 2019 | Mar | | | Apr | | | Sep | | | Jul | Oct | | |
| 2020 | | No survey (Covid-19 disruption) | Mar | | | | Sep | | | Aug | Oct | | Jul |
| 2021 | | Apr | Mar | | | | Sep | | | No survey | Oct | | |

| **Method** | **Acoustics** | | | | | | | | | | | **DEPM** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey | PELACUS | | PELAGO | | SAR | JUVESAR | IBERAS | | ECOCADIZ | | ECO-CADIZ-RE-CLU-TAS | BOCADEVA | |
| Institute (Country) | IEO (ES) | | IPMA (PT) | | IPMA (PT) | IPMA (PT) | IPMA-IEO (PT-ES) | | IEO (ES) | | IEO (ES) | IEO (ES) | |
| Subareas | 9.a N | | 9.a CN-9.a S | | 9.a CN-9.a S | 9.a CN | 9.a N-9.a CS | | 9.a S | | 9.a S | 9.a S | |
| Year/Quarter | Q1 | Q2 | Q1 | Q2 | Q4 | Q4 | Q3 | Q4 | Q2 | Q3 | Q4 | Q2 | Q3 |
| 2022 | | Apr | Mar | | | | Sep | | | No survey | Oct | | |
| 2023 | | Apr | Mar | | | | Sep | | | Jul | Oct | | Jul |
| 2024 | Mar | Apr | Mar | | | | | | | | | | |

**Table A7.4.1.1. Anchovy in Division 9.a. *BOCADEVA* survey series (summer Spanish anchovy DEPM survey in Subdivision 9.a South). Historical series of eggs, adult and SSB estimates in Subdivision 9.a South. (1): time-series average**

| Year | 2005 | 2008 | 2011 | 2014 | 2017 | 2020 | 2023 |
|---|---|---|---|---|---|---|---|
| P0 (eggs/m$^2$/day) | 50.8 / 224.5 | 184 / 348 | 276 | 314 | 146 | 523 | 182 |
| Z (day$^{-1}$) | -0.039 | -1,43 | -0.29 | -0.33 | -0,16 | -1.11 | -0.12 |
| Ptotal (eggs/day) (x10$^{12}$) | 1,13 | 2,11 | 1,87 | 1,95 | 0,74 | 5,26 | 1.03 |
| Surveyed area (km$^2$) | 11982 | 13029 | 13107 | 14595 | 15556 | 16223 | 13261 |
| Positive area (km$^2$) | 6139 | 6863 | 6770 | 6214 | 5080 | 10058 | 5662 |
| Female Weight (g) | 25.2 / 16.7 | 23,7 | 15,2 | 18,2 | 16,2 | 16,6 | 17.64 |
| Batch Fecundity | 13820/ 11160 | 13778 | 7486 | 7502 | 7507 | 8212 | 9515 |
| Sex Ratio | 0.53 / 0.54 | 0,53 | 0,53 | 0,54 | 0,53 | 0,54 | 0.52 |
| Spawning Fraction | 0.26 / 0.21 | 0,218 | 0,276 | 0,276 | 0,243 | 0,241 (1) | 0.248 (1) |
| Spawning Biomass (tons) | 14673 | 31527 | 32757 | 31569 | 12392 | 81466 | 15138 |

**Table A7.4.2.1. Anchovy in Division 9.a. *PELACUS* survey series (spring Spanish acoustic survey in Subdivision 9.a North and Subarea 8.c). Main descriptors of the results from the fishing hauls.**

| | TOTAL CAP (Kg) | No ind. | No Fishing st | Sample weight (kg) | Measured fish | Mean length | %PRES | % Catch_W | % Catch_No |
|---|---|---|---|---|---|---|---|---|---|
| ANE | 3441 | 205317 | 20 | 54 | 3206 | 13.88 | 57.14 | 15.44 | 40.46 |
| BOC | 0 | 1 | 1 | 0 | 1 | 15.50 | 2.86 | 0.00 | 0.00 |
| BOG | 192 | 1908 | 20 | 126 | 1024 | 23.22 | 57.14 | 0.86 | 0.38 |
| HMM | 21 | 1012 | 5 | 11 | 458 | 14.30 | 14.29 | 0.10 | 0.20 |
| HKE | 11 | 86 | 16 | 11 | 86 | 25.06 | 45.71 | 0.05 | 0.02 |
| HOM | 159 | 3614 | 16 | 42 | 676 | 18.60 | 45.71 | 0.72 | 0.71 |
| MAC | 6037 | 16244 | 20 | 713 | 2166 | 35.48 | 57.14 | 27.09 | 3.20 |
| PIL_B | 12327 | 278092 | 30 | 275 | 5938 | 18.64 | 85.71 | 55.32 | 54.80 |
| WHB | 95 | 1207 | 2 | 17 | 213 | 24.05 | 0.00 | 0.43 | 0.24 |
| WHB_S- | 0 | 7 | 1 | 0 | 7 | 8.07 | 2.86 | 0.00 | 0.00 |
| ***Total*** | **22285** | **507488** | **35** | **1250** | **13775** | | | | |

**Table A7.4.2.2. Anchovy in Division 9.a. *PELACUS* survey series (spring Spanish acoustic survey in Subdivision 9.a North and Subarea 8.c). Historical series of acoustic estimates of anchovy abundance (N, millions) and biomass (B, tonnes) in Subdivision 9.a North.**

| Survey | Estimate | 9.a North |
|---|---|---|
| April 2008 | N | 10 |
| | B | 306 |
| April 2009 | N | 0.7 |
| | B | 26 |
| April 2010 | N | 0.03 |
| | B | 90 |
| April 2011 | N | 73 |
| | B | 1650 |
| April 2012 | N | 1 |
| | B | 45 |
| March 2013 | N | - |
| | B | - |
| March 2014 | N | - |
| | B | - |
| March 2015 | N | - |
| | B | - |
| March 2016 | N | 8 |
| | B | 205 |
| | N | 124 |

| Survey | Esti-mate | 9.a North |
|---|---|---|
| March 2017 | B | 3566 |
| March 2018 | N | 771 |
| | B | 10660 |
| March 2019 | N | 7 |
| | B | 192 |
| March 2020 | N | No survey (Covid-19 disrup-tion) |
| | B | |
| April 2021 | N | 358 |
| | B | 6075 |
| April 2022 | N | 0.1 |
| | B | 2 |
| April 2023 | N | 168 |
| | B | 3223 |
| March/April 2024 | N | 142 |
| | B | 2015 |

**Table A7.4.2.3. Anchovy in Division 9.a. *PELAGO* survey series (spring Portuguese acoustic survey in Subdivisions 9.a Central-North to 9.a South). Historical series of overall and regional acoustic estimates of anchovy abundance (N, millions) and biomass (B, tonnes).**

| Survey | Estimate | Portugal | | | | Spain | S(Total) | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | | C-N | C-S | S(A) | Total | S(C) | | |
| Mar. 99 | N | 22 | 15 | * | 37 | 2079 | 2079 | 2116 |
| | B | 190 | 406 | * | 596 | 24763 | 24763 | 25359 |
| Mar. 00 | N | - | - | - | - | - | - | - |
| | B | - | - | - | - | - | - | - |
| Mar. 01 | N | 25 | 13 | 285 | 324 | 2415 | 2700 | 2738 |
| | B | 281 | 87 | 2561 | 2929 | 22352 | 24913 | 25281 |
| Mar. 02 | N | 22 | 156 | 92 | 270 | 3731 ** | 3823 ** | 4001 ** |
| | B | 472 | 1070 | 1706 | 3248 | 19629 ** | 21335 ** | 22877 ** |
| Feb. 03 | N | 0 | 14 | * | 14 | 2314 | 2314 | 2328 |
| | B | 0 | 112 | * | 112 | 24565 | 24565 | 24677 |
| Mar. 04 | N | - | - | - | - | - | - | - |
| | B | - | - | - | - | - | - | - |
| Apr. 05 | N | - | 59 | - | 59 | 1306 | 1306 | 1364 |
| | B | - | 1062 | - | 1062 | 14041 | 14041 | 15103 |
| Apr. 06 | N | - | - | 319 | 319 | 1928 | 2246 | 2246 |
| | B | - | - | 4490 | 4490 | 19592 | 24082 | 24082 |
| Apr. 07 | N | 0 | 103 | 284 | 387 | 2860 | 3144 | 3247 |
| | B | 0 | 1945 | 4607 | 6552 | 33413 | 38020 | 39965 |
| Apr.08 | N | 69 | 252 | 213 | 534 | 1819 | 2032 | 2353 |
| | B | 3000 | 2505 | 4661 | 10166 | 29501 | 34162 | 39667 |
| Apr.09 | N | 127 | 0**** | 159 | 286 | 1910 | 2069 | 2196 |
| | B | 2089 | 0**** | 3759 | 5848 | 20986 | 24745 | 26834 |
| Apr. 10 | N | 0 | 62 | 0 | 62 | 963 | 963 | 1026 |
| | B | 0 | 1188 | 0 | 1188 | 7395 | 7395 | 8583 |
| Apr. 11 | N | 1558 | 0 | 0 | 1558 | 0 | 0 | 1558 |
| | B | 27050 | 0 | 0 | 27050 | 0 | 0 | 27050 |

| Survey | Estimate | Portugal | | | | Spain | S(Total) | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | | C-N | C-S | S(A) | Total | S(C) | | |
| Apr. 12 | N | - | - | - | - | - | - | - |
| | B | - | - | - | - | - | - | - |

***Due to the distribution observed during the survey, the last transect (near the border with Spain) that normally belongs to the Algarve subarea was included in Cadiz.**

****Corrected estimates after detection of errors in the sA values attributed to the Cadiz area (Marques and Morais, 2003).**

******Possible underestimation: although no echo-traces attributable to the species were detected in this area, however, the loss of pelagic gear samplers prevented from confirming directly this.**

**Table A7.4.2.3. Anchovy in Division 9.a. *PELAGO* survey series (spring Portuguese acoustic survey in Subdivisions 9.a Central-North to 9.a South). Cont'd.**

| Survey | Estimate | Portugal | | | | Spain | S(Total) | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | | C-N | C-S | S(A) | Total | S(C) | | |
| Apr. 13 | N | 251 | 0 | 263 | 514 | 634 | 897 | 1148 |
| | B | 3955 | 0 | 5044 | 8999 | 7656 | 12700 | 16655 |
| Apr. 14 | N | 130 | 0 | 26 | 156 | 2216 | 2241 | 2371 |
| | B | 1947 | 0 | 509 | 2456 | 28408 | 28917 | 30864 |
| Apr. 15 | N | 645 | 0 | 158 | 802 | 3531 | 3689 | 4334 |
| | B | 8237 | 0 | 2156 | 10393 | 30944 | 33100 | 41337 |
| Apr. 16 | N | 3198 | 0 | 0 | 3198 | 9811 | 9811 | 13009 |
| | B | 38302 | 0 | 0 | 38302 | 65345 | 65345 | 103647 |
| May 17 | N | 1015 | 0 | 137 | 1152 | 1718 | 1855 | 2870 |
| | B | 15481 | 0 | 1208 | 16689 | 12589 | 13797 | 29278 |
| Apr. 18 | N | 4845 | 0 | 300 | 5145 | 1857 | 2157 | 7001 |
| | B | 54437 | 0 | 4328 | 58765 | 19145 | 23473 | 77910 |
| Apr. 19 | N | 229 | 7 | 0 | 236 | 3398 | 3398 | 3634 |
| | B | 3814 | 123 | 0 | 3937 | 29876 | 29876 | 33813 |
| Apr. 20 | N | 3152 | 0.3 | 89 | 3242 | 5550 | 5639 | 8791 |
| | B | 50282 | 9 | 1789 | 52080 | 47998 | 49787 | 100078 |
| Mar. 21 | N | 3069 | 519 | 9 | 3597 | 1485 | 1485 | 5082 |
| | B | 53513 | 6095 | 107 | 59715 | 13958 | 13958 | 73673 |

| Survey | Estimate | Portugal | | | | Spain | S(Total) | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | | C-N | C-S | S(A) | Total | S(C) | | |
| Apr. 22 | N | 4589 | 198 | 196 | 4983 | 654 | 849 | 5637 |
| | B | 108571 | 3391 | 3535 | 115496 | 5438 | 8972 | 120934 |
| Apr. 23 | N | 3018 | 21 | 14 | 3053 | 3537 | 3551 | 6590 |
| | B | 69825 | 366 | 374 | 70565 | 26411 | 26785 | 96977 |
| Mar. 24 | N | 1783 | 1163 | 0.6 | 2947 | 1967 | 1968 | 4914 |
| | B | 19422 | 12481 | 4 | 31908 | 12493 | 12497 | 44401 |

**Table A7.4.2.4. Anchovy in Division 9.a. *ECOCADIZ* survey series (summer Spanish acoustic survey in Subdivision 9.a South). Historical series of overall and regional acoustic estimates of anchovy abundance (N, millions) and biomass (B, tonnes).**

| Survey | Estimate | Portugal | Spain | TOTAL |
|---|---|---|---|---|
| | | S(A) | S(C) | S(Total) |
| Jun. 04*** | N | 125 | 1109 | 1235 |
| | B | 2474 | 15703 | 18177 |
| Jun. 05 | N | - | - | - |
| | B | - | - | - |
| Jun. 06 | N | 363 | 2801 | 3163 |
| | B | 6477 | 30043 | 36521 |
| Jul. 07 | N | 558 | 1232 | 1790 |
| | B | 11639 | 17243 | 28882 |
| Jul. 08 | N | - | - | - |
| | B | - | - | - |
| Jul. 09 | N | 35 | 1102 | 1137 |
| | B | 1075 | 20506 | 21580 |
| Jul. 10 | N | ? | 954+ | 954 + |
| | B | ? | 12339 + | 12339 + |
| Jul. 11 | N | - | - | - |
| | B | - | - | - |
| Jul. 12 | N | - | - | - |
| | B | - | - | - |
| Aug. 13 | N | 50 | 558 | 609 |
| | B | 1315 | 7172 | 8487 |
| Jul. 14 | N | 184 | 1778 | 1962 |
| | B | 4440 | 24779 | 29219 |
| Jul. 15 | N | 168 | 2506 | 2674 |
| | B | 2137 | 19168 | 21305 |
| Jul. 16 | N | 346 | 3341 | 3686 |
| | B | 5250 | 29051 | 34301 |

| Survey | Estimate | Portugal<br>S(A) | Spain<br>S(C) | TOTAL<br>S(Total) |
|---|---|---|---|---|
| Jul. 17 | N | 151 | 1354 | 1504 |
| | B | 2666 | 9563 | 12229 |
| Jul. 18 | N | 224 | 2839 | 3063 |
| | B | 4224 | 30683 | 34908 |
| Jul. 19 | N | 80 | 5405 | 5485 |
| | B | 1561 | 56139 | 57670 |
| Aug. 20 | N | 439 | 4714 | 5153 |
| | B | 7773 | 37114 | 44887 |
| Jul. 21 | N | - | - | - |
| | B | - | - | - |
| Jul. 22 | N | - | - | - |
| | B | - | - | - |
| Jul. 23 | N | 263 | 1216 | 1479 |
| | B | 1781 | 7933 | 9714 |

*****Possible underestimation: shallow waters between 20 and 30 m depth were not acoustically sampled. + Partial estimate due to an incomplete coverage of the subdivision (only the Spanish part).**

**Table A7.4.2.5. Anchovy in Division 9.a. Southern component. Historical series of overall acoustic estimates of anchovy abundance (N, millions) by age group estimated by *PELAGO* and *ECOCADIZ* acoustic surveys. The age structure estimated for the *PELAGO* surveys in 2020, 2021, 2022 and 2023 has been revised after an IPMA-IEO inter-calibration age reading exercise carried out in January 2024 because the previous detection of some inconsistencies in the age readings. N.a.: not available.**

| **PELAGO**<br>Year | **N (million)**<br>Age 0 | **N (million)**<br>Age 1 | **N (million)**<br>Age 2 | **N (million)**<br>Age 3 | **N (million)**<br>Age 4 | **N (million)**<br>TOTAL |
|---|---|---|---|---|---|---|
| 1999 | 0 | 2025 | 54 | 0 | 0 | 2079 |
| 2000 | - | - | - | - | - | - |
| 2001 | 0 | 2635 | 65 | 0 | 0 | 2700 |
| 2002 | 0 | 3774 | 49 | 0 | 0 | 3823 |
| 2003 | 0 | 2077 | 237 | 0 | 0 | 2314 |

| PELAGO | N (million) | N (million) | N (million) | N (million) | N (million) | N (million) |
|---|---|---|---|---|---|---|
| Year | Age 0 | Age 1 | Age 2 | Age 3 | Age 4 | TOTAL |
| 2004 | - | - | - | - | - | - |
| 2005 | 0 | 1245 | 61 | 0 | 0 | 1306 |
| 2006 | 0 | 2197 | 48 | 2 | 0 | 2246 |
| 2007 | 0 | 3060 | 85 | 0 | 0 | 3144 |
| 2008 | 0 | 1540 | 485 | 7 | 0 | 2032 |
| 2009 | 0 | 1735 | 295 | 38 | 0 | 2069 |
| 2010 | 0 | 951 | 12 | 0 | 0 | 963 |
| 2011 | - | - | - | - | - | - |
| 2012 | - | - | - | - | - | - |
| 2013 | 0 | 157 | 900 | 201 | 6 | 1264 |
| 2014 | 0 | 1501 | 1327 | 63 | 0 | 2890 |
| 2015 | 0 | 2999 | 311 | 0 | 0 | 3310 |
| 2016 | 0 | 6403 | 127 | 4 | 0 | 6535 |
| 2017 | 0 | 1142 | 117 | 0 | 0 | 1259 |
| 2018 | 0 | 2115 | 39 | 3 | 0 | 2157 |
| 2019 | 0 | 3105 | 289 | 0 | 0 | 3393 |
| 2020 | 0 | 4857 | 777 | 4 | 0 | 5639 |
| 2021 | 0 | 1241 | 246 | 7 | 0 | 1494 |
| 2022 | 0 | 727 | 104 | 18 | 0 | 849 |
| 2023 | 0 | 3433 | 111 | 7 | 0 | 3551 |
| 2024 | 0 | 1565 | 403 | 0 | 0 | 1968 |

| PELAGO | N (%) | N (%) | N (%) | N (%) | N (%) | N (%) |
|---|---|---|---|---|---|---|
| Year | Age 0 | Age 1 | Age 2 | Age 3 | Age 4 | TOTAL |
| 1999 | 0 | 97.4 | 2.6 | 0 | 0 | 100 |
| 2000 | - | - | - | - | - | - |
| 2001 | 0 | 97.6 | 2.4 | 0 | 0 | 100 |
| 2002 | 0 | 98.7 | 1.3 | 0 | 0 | 100 |
| 2003 | 0 | 89.7 | 10.3 | 0 | 0 | 100 |

| **PELAGO** | **N (%)** | **N (%)** | **N (%)** | **N (%)** | **N (%)** | **N (%)** |
|---|---|---|---|---|---|---|
| Year | Age 0 | Age 1 | Age 2 | Age 3 | Age 4 | TOTAL |
| 2004 | - | - | - | - | - | - |
| 2005 | 0 | 95.3 | 4.7 | 0 | 0 | 100 |
| 2006 | 0 | 97.8 | 2.1 | 0.1 | 0 | 100 |
| 2007 | 0 | 97.3 | 2.7 | 0 | 0 | 100 |
| 2008 | 0 | 75.8 | 23.9 | 0.3 | 0 | 100 |
| 2009 | 0 | 83.9 | 14.3 | 1.9 | 0 | 100 |
| 2010 | 0 | 98.7 | 1.3 | 0 | 0 | 100 |
| 2011 | - | - | - | - | - | - |
| 2012 | - | - | - | - | - | - |
| 2013 | 0 | 12.4 | 71.2 | 15.9 | 0.5 | 100 |
| 2014 | 0 | 51.9 | 45.9 | 2.2 | 0 | 100 |
| 2015 | 0 | 90.6 | 9.4 | 0 | 0 | 100 |
| 2016 | 0 | 98.0 | 1.9 | 0.1 | 0 | 100 |
| 2017 | 0 | 90.7 | 9.3 | 0 | 0 | 100 |
| 2018 | 0 | 98.1 | 1.8 | 0.1 | 0 | 100 |
| 2019 | 0 | 91.5 | 8.5 | 0 | 0 | 100 |
| 2020 | 0 | 86,1 | 13,8 | 0,1 | 0 | 100 |
| 2021 | 0 | 83,1 | 16,5 | 0,5 | 0 | 100 |
| 2022 | 0 | 85,6 | 12,3 | 2,1 | 0 | 100 |
| 2023 | 0 | 96,7 | 3,1 | 0,2 | 0 | 100 |
| 2024 | 0 | 79,5 | 20,5 | 0 | 0 | 100 |

**Table A7.4.2.5. Anchovy in Division 9.a. Southern component. Cont'd.**

| **ECOCADIZ** | **N (million)** | **N (million)** | **N (million)** | **N (million)** | **N (million)** | **N (million)** |
|---|---|---|---|---|---|---|
| Year | Age 0 | Age 1 | Age 2 | Age 3 | Age 4 | TOTAL |
| 2004 | 0 | 1215 | 19 | 0 | 0 | 1235 |
| 2005 | - | - | - | - | - | - |
| 2006 | 0 | 3170 | 42 | 0.1 | 0 | 3211 |

| ECOCADIZ | N (million) | N (million) | N (million) | N (million) | N (million) | N (million) |
|---|---|---|---|---|---|---|
| Year | Age 0 | Age 1 | Age 2 | Age 3 | Age 4 | TOTAL |
| 2007 | 0 | 1619 | 167 | 5 | 0 | 1790 |
| 2008 | - | - | - | - | - | - |
| 2009 | 0 | 879 | 218 | 39 | 0 | 1137 |
| 2010 | 185 | 686 | 80 | 4 | 0 | 954 |
| 2011 | - | - | - | - | - | - |
| 2012 | - | - | - | - | - | - |
| 2013 | 169 | 394 | 33 | 0 | 0 | 596 |
| 2014 | 51 | 1873 | 36 | 0 | 0 | 1960 |
| 2015 | 1607 | 1053 | 13 | 0 | 0 | 2673 |
| 2016 | 1666 | 1665 | 354 | 0 | 0 | 3686 |
| 2017 | 892 | 447 | 149 | 0 | 0 | 1488 |
| 2018 | 1408 | 1609 | 46 | 0 | 0 | 3063 |
| 2019 | 2320 | 3031 | 134 | 0 | 0 | 5485 |
| 2020 | 3792 | 1326 | 35 | 0 | 0 | 5153 |
| 2021 | - | - | - | - | - | - |
| 2022 | - | - | - | - | - | - |
| 2023 | 1069 | 332 | 9 | 0 | 0 | 1409 |

| ECOCADIZ | N (%) | N (%) | N (%) | N (%) | N (%) | N (%) |
|---|---|---|---|---|---|---|
| Year | Age 0 | Age 1 | Age 2 | Age 3 | Age 4 | TOTAL |
| 2004 | 0 | 98.5 | 1.5 | 0 | 0 | 100 |
| 2005 | - | - | - | - | - | - |
| 2006 | 0 | 98.7 | 1.3 | 0.004 | 0 | 100 |
| 2007 | 0 | 90.4 | 9.3 | 0.3 | 0 | 100 |
| 2008 | - | - | - | - | - | - |
| 2009 | 0 | 77.3 | 19.2 | 3.4 | 0.02 | 100 |
| 2010 | 19.4 | 71.8 | 8.4 | 0.4 | 0 | 100 |
| 2011 | - | - | - | - | - | - |

| **ECOCADIZ** | **N (%)** | **N (%)** | **N (%)** | **N (%)** | **N (%)** | **N (%)** |
|---|---|---|---|---|---|---|
| Year | Age 0 | Age 1 | Age 2 | Age 3 | Age 4 | TOTAL |
| 2012 | - | - | - | - | - | - |
| 2013 | 28.4 | 66.1 | 5.5 | 0 | 0 | 100 |
| 2014 | 2.6 | 95.6 | 1.8 | 0 | 0 | 100 |
| 2015 | 60.1 | 39.4 | 0.5 | 0 | 0 | 100 |
| 2016 | 45.2 | 45.2 | 9.6 | 0 | 0 | 100 |
| 2017 | 60.0 | 30.0 | 10.0 | 0 | 0 | 100 |
| 2018 | 46.0 | 52.5 | 1.5 | 0 | 0 | 100 |
| 2019 | 42.3 | 55.3 | 2.4 | 0 | 0 | 100 |
| 2020 | 73.6 | 25.7 | 0.7 | 0 | 0 | 100 |
| 2021 | - | - | - | - | - | - |
| 2022 | - | - | - | - | - | - |
| 2023 | 75.8 | 23.6 | 0.6 | 0 | 0 | 100 |

**Table A7.4.3.1. Anchovy in Division 9.a. *SAR/JUVESAR* autumn survey series (autumn Portuguese acoustic survey in subdivisions 9.a Central–North to 9.a South - SAR - or Subdivision 9.a Central-North and Central-South - *JUVESAR* -). Historical series of overall and regional acoustic estimates of anchovy abundance (N, millions) and biomass (B, tonnes). Juvenile fish (< 10.0 cm) estimates between parentheses.**

| Survey | Estimate | Portugal | | | | Spain | S (Total) | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | | C-N | C-S | S (PT) | Total | S (ES) | | |
| Nov. 98 | N | 30 | 122 | 50 | 203 | 2346 | 2396 | 2549 |
| | B | 313 | 1951 | 603 | 2867 | 30092 | 30695 | 32959 |
| Nov. 99 | N | - | - | - | - | - | - | - |
| | B | - | - | - | - | - | - | - |
| Nov. 00 | N | 4 | 20 | * | 23 | 4970 | 4970 | 4994 |
| | B | 98 | 241 | * | 339 | 33909 | 33909 | 34248 |
| Nov. 01 | N | 35 | 94 | - | 129 | 3322 | 3322 | 3451 |
| | B | 1028 | 2276 | - | 3304 | 25578 | 25578 | 28882 |
| Nov. 02 | N | - | - | - | - | - | - | - |
| | B | - | - | - | - | - | - | - |
| Nov. 03 | N | - | - | - | - | - | - | - |

| Survey | Estimate | Portugal | | | | Spain | S (Total) | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | | C-N | C-S | S (PT) | Total | S (ES) | | |
| | B | - | - | - | - | - | - | - |
| Nov. 04 | N | - | - | - | - | - | - | - |
| | B | - | - | - | - | - | - | - |
| Nov. 05 | N | - | - | - | - | - | - | - |
| | B | - | - | - | - | - | - | - |
| Nov. 06 | N | - | - | - | - | - | - | - |
| | B | - | - | - | - | - | - | - |
| Nov. 07 | N | 0 | 59 | 475 | 534 | 1386 | 1862 | 1921 |
| | B | 0 | 1120 | 7632 | 8752 | 16091 | 23723 | 24843 |
| Nov. 13 | N | - | - | - | - | - | - | - |
| | B | - | - | - | - | - | - | - |
| Nov. 14 | N | - | - | - | - | - | - | - |
| | B | - | - | - | - | - | - | - |
| Dec. 15 | N | 3870 (3835) | - | - | - | - | - | - |
| | B | 30000 (29000) | - | - | - | - | - | - |
| Dec. 16 | N | 2836 (2835) | - | - | - | - | - | - |
| | B | 14397 (14367) | - | - | - | - | - | - |
| Dec 17 | N | 2145 (570) | | - | - | - | - | - |
| | B | 38000 (4700) | | - | - | - | - | - |

*** Due to the distribution observed during the survey, the last transect (near the border with Spain) that normally belongs to the Algarve subarea was included in Cadiz.**

**Table A7.4.3.2. Anchovy in Division 9.a. *IBERAS* survey series (autumn Spanish-Portuguese acoustic survey in subdivisions 9.a North to Central-South). Historical series of overall and regional acoustic estimates of anchovy abundance (N, millions) and biomass (B, tonnes). Age 0 fish estimates between parentheses.**

| Survey | Estimate | Spain | Portugal | | | TOTAL |
|---|---|---|---|---|---|---|
| | | N | C-N | C-S | Total | |
| Nov. 18 | N | 0.04 (0.03) | 8836 (592) | 0.02 (0.001) | 8836 (592) | 8836 (592) |
| | B | 0.4 (0) | 181576 (5894) | 0.4 (0) | 181577 (5894) | 181577 (5894) |
| Sep. 19 | N | 0 (0) | 122 (0.3) | 42 (0) | 164 (0.3) | 164 (0.3) |
| | B | 0 (0) | 2981 (3) | 1232 (0) | 4212 (3) | 4212 (3) |
| Sep. 20 | N | 0 (570) | 12 (1) | 0 (0.7) | 583 (560) | 583 (572) |
| | B | 0 (4879) | 289 (20) | 0 (8) | 5176 (4669) | 5176 (4907) |
| Sep. 21 | N | 0 (0) | 1429 (664) | 2 (2) | 1431 (666) | 1431 (666) |
| | B | 0 (0) | 31206 (10591) | 29 (26) | 31236 (10617) | 31236 (10617) |
| Sep. 22 | N | 168 (159) | 244 (209) | 70 (0.1) | 314 (209) | 482 (368) |
| | B | 1925 (1718) | 3471 (2520) | 2243 (4) | 5714 (2524) | 7639 (4242) |
| Sep. 23 | N | 16090 (16090) | 7288 (5592) | 474 (474) | 7762 (6066) | 23852 (22156) |
| | B | 65270 (65270) | 77761 (21348) | 3948 (3948) | 81709 (25295) | 146979 (90566) |

**Table A7.4.3.3. Anchovy in Division 9.a. *ECOCADIZ-RECLUTAS* survey series (autumn Spanish acoustic survey in Subdivision 9.a South). Historical series of overall and regional acoustic estimates of anchovy abundance (N, millions) and biomass (B, tonnes). Age 0 fish estimates between parentheses.**

| Survey | Estimate | Portugal | Spain | TOTAL |
|---|---|---|---|---|
| | | S (PT) | S (ES) | S (Total) |
| Nov. 12* | N | - | 2649 (2619) | - |
| | B | - | 13680 (13354) | - |
| Oct. 14 | N | 111 (3) | 875 (811) | 986 (814) |
| | B | 2168 (25) | 5945 (5107) | 8113 (5131) |
| Oct. 15 | N | 115 (75) | 5113 (5042) | 5227 (5117) |
| | B | 1335 (430) | 29491 (28789) | 30827 (29219) |
| Oct. 16 | N | 177 (42) | 3490 (3404) | 3667 (3445) |
| | B | 3054 (463) | 16807 (15506) | 19861 (15969) |
| Oct. 17** | N | - | 1492 (1433) | - |
| | B | - | 7641 (7290) | - |

| Survey | Estimate | Portugal<br>S (PT) | Spain<br>S (ES) | TOTAL<br>S (Total) |
|---|---|---|---|---|
| Oct. 18 | N | 405 (96) | 548 (447) | 952 (543) |
| | B | 6259 (1005) | 4234 (2830) | 10493 (3834) |
| Oct. 19 | N | 1217 (763) | 4301 (4082) | 5518 (4845) |
| | B | 16089 (6613) | 32309 (29792) | 48398 (36405) |
| Oct. 20 | N | 145 (30) | 3051 (2355) | 3197 (2385) |
| | B | 3290 (512) | 32779 (20547) | 36070 (21060) |
| Oct. 21 | N | 211 (53) | 1763 (1575) | 1973 (1629) |
| | B | 4143 (923) | 13370 (11140) | 17512 (12063) |
| Oct. 22 | N | 11 (3) | 1825 (1703) | 1837 (1705) |
| | B | 193 (35) | 11719 (10761) | 11912 (10797) |
| Oct. 23 | N | 100 (16) | 716 (623) | 816 (639) |
| | B | 2227 (230) | 6073 (4432) | 8300 (4723) |

*** Partial estimate: only the Spanish waters were acoustically surveyed. ** Partial estimate only 70% of the Spanish waters was acoustically surveyed.**

**Table A7.5.1.1. Anchovy in Division 9.a. Western component. Subdivision 9.a North, 9.a Central North and 9.a Central South. Mean weight-at-age in the stock (in g).**

| Year | Age 0 | Age 1 | Age 2 | Age 3 |
|---|---|---|---|---|
| 2008 | | 14.6 | 37.2 | |
| 2009 | | 14.9 | 31.6 | 36.4 |
| 2010 | | 19.5 | 17.2 | 19.6 |
| 2011 | | 16.2 | 21.2 | 28.1 |
| 2012 | | | | |
| 2013 | | 14.3 | 22.7 | 34.1 |
| 2014 | | 13.6 | 23.4 | 27.7 |
| 2015 | | 12.0 | 25.6 | 29.9 |
| 2016 | | 11.5 | 12.5 | 16.2 |
| 2017 | | 15.4 | 30.0 | 34.3 |
| 2018 | | 11.3 | 24.0 | 36.6 |
| 2019 | | 13.8 | 19.0 | 30.0 |
| 2020 | | 13.0 | 22.0 | 25.0 |
| 2021 | | 15.2 | 22.6 | 28.8 |
| 2022 | | 20.9 | 28.7 | 30.7 |
| 2023 | | 19.8 | 27.7 | 30.1 |
| 2024 | | 9.88 | 18.87 | 29.35 |

**Table A7.5.1.2. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. Mean weight-at-age in the stock (in g).**

| Year | Age 0 | Age 1 | Age 2 | Age 3 |
|---|---|---|---|---|
| 1995 | 7,0 | 10,7 | 22,6 | |
| 1996 | 1,1 | 6,3 | 20,0 | |
| 1997 | 2,6 | 11,1 | 20,9 | |
| 1998 | 2,6 | 7,4 | 20,4 | |
| 1999 | 3,2 | 12,8 | 20,0 | |
| 2000 | 3,1 | 10,0 | 23,8 | |
| 2001 | 6,2 | 13,3 | 31,8 | |
| 2002 | 3,3 | 10,5 | 26,3 | |
| 2003 | | 10,6 | 26,8 | |
| 2004 | 6,6 | 12,0 | 21,9 | |
| 2005 | 4,9 | 9,2 | 22,6 | |
| 2006 | 3,6 | 8,2 | 21,0 | |
| 2007 | 5,4 | 9,4 | 20,4 | |
| 2008 | 7,2 | 14,9 | 21,8 | 23,1 |
| 2009 | 4,1 | 12,2 | 20,3 | 24,2 |
| 2010 | 6,9 | 11,3 | 19,1 | 23,0 |
| 2011 | 8,2 | 10,3 | 22,7 | |
| 2012 | 8,3 | 14,3 | 22,5 | |

| Year | Age 0 | Age 1 | Age 2 | Age 3 |
|---|---|---|---|---|
| 2013 | 6,4 | 11,9 | 21,8 | |
| 2014 | 6,6 | 10,9 | 19,0 | |
| 2015 | 7,7 | 10,5 | 20,7 | |
| 2016 | 8,7 | 12,9 | 18,2 | |
| 2017 | 6,7 | 9,1 | 19,9 | |
| 2018 | 10,2 | 12,4 | 18,6 | |
| 2019 | 10.0 | 11.9 | 20.0 | |
| 2020 | 9.6 | 12.3 | 17.4 | 26.6 |
| 2021 | 7.4 | 12.9 | 21.8 | |
| 2022 | 9,5 | 14,0 | 19,3 | |
| 2023 | 10,1 | 9,7 | 15,5 | |

**Table A7.6.2.1.1.1. Anchovy in Division 9.a. Southern component. Overview of the data used in the assessment model for optimization routines (maximization of likelihood function). Due to lack of information of length distributions and Age-length keys for commercial catches in the first and second quarter of 2020, the length distribution was approximated using the joint distribution of 2018 and 2019 and the Age-length key used was the one for the *PELAGO* 2020 survey.**

| Data source | Type | Time span |
|---|---|---|
| Commercial landings | Length distribution | All quarters, 1989–2023 |
| | Age–length key | All quarters, 1989–2023 |
| *ECOCADIZ* acoustic survey | Biomass survey indexes | Second quarter 2004, 2006<br>third quarter 2007, 2009, 2010, 2013–2020,2023 |
| | Length distribution | Second quarter 2004, 2006<br>third quarter 2007, 2009, 2010, 2013–2020, 2023 |
| | Age–length key | Second quarter 2004, 2006<br>third quarter 2007, 2009, 2010, 2013–2020, 2023 |
| *PELAGO* acoustic survey | Biomass survey indexes | First quarter 1999, 2001–2003<br>second quarter 2005–2010 and 2013–2024 |
| | Length distribution | First quarter 1999, 2001–2003<br>second quarter 2005–2010, 2013–2024 |
| | Age–length key | second quarter 2014–2024 |

**Table A7.6.2.1.3.1. Anchovy in Division 9.a. Southern component. Summary of parameters estimated by the assessment model.**

| Symbol | Meaning and estimated value |
|---|---|
| $l_\infty$ | Asymptotic length, $l_\infty$= 30 cm |
| k | Annual growth rate, k = 0.078 0.00831751 |
| β | Beta-binomial parameter, β = 5000 |
| $\nu_a$ | Age factor, $\nu_{0=}$ 120000, $\nu_{1=}$ 84400, $\nu_{2=}$ 0.06, $\nu_{3=}$ 4.48e-7.0601, $\nu_3$ = 1.25e − 07 |
| μ | Recruitment mean length, μ = 9.84 cm |
| $\sigma_t$ | Recruitment length standard deviation by quarter, 2:3.063; 3:1.687; 4:3.68485, $\sigma_3$ = 1.67904, $\sigma_4$ = 4 |
| $l_{50,T}$ | Length with a 50% probability of predation during period T, seine_1: 11.1, seine_2:10.9, ECO_3:12.9,PEL_3:14.6 |
| $\alpha_T$ | Shape of selectivity function, seine_1: 0.366, seine_2:0.875, ECO_3:1.39,PEL_3:0.404 |

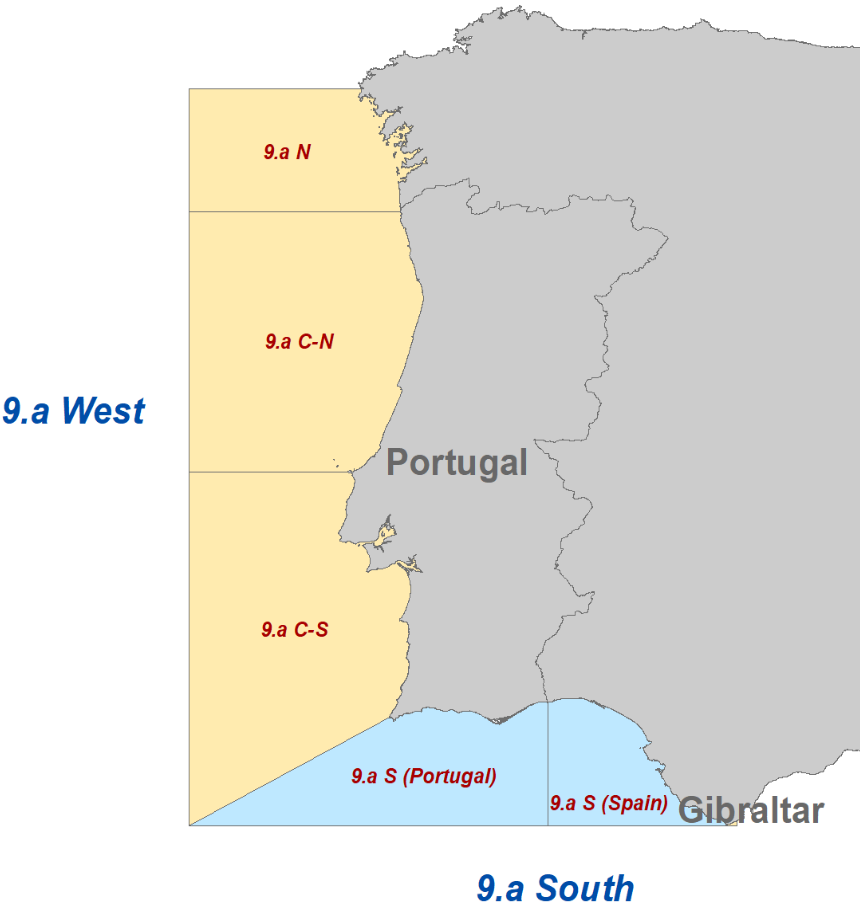



**Figure A7.2.1. Anchovy in Division 9.a. Map showing the split of Division 9a into the stock components 9a South and 9a West. Note that, in turn, the stock component 9a South is divided into Portuguese and Spanish waters, whereas stock component 9a West is divided into the subdivisions 9a North, 9a Central–North, and 9a Central–South.**

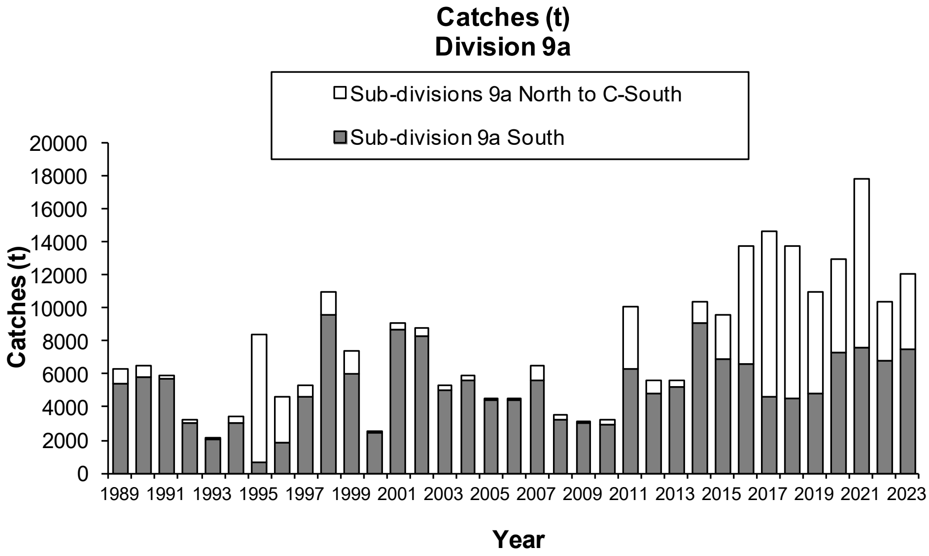



**Figure A7.3.2.1.1. Anchovy in Division 9.a. Recent series of anchovy catches in Division 9.a (ICES estimates for 1989–2023, the period with data for all the subdivisions, all metiers are considered). Subdivisions are pooled in order to differentiate the anchovy fishery harvested throughout the Atlantic façade of the Iberian Peninsula (Western component: ICES subdivisions 9.a North, Central-North and Central-South) from the fishery in the Gulf of Cadiz (Southern component: Subdivision 9.a South), where both the stock and the fishery were mainly located during a great part of the time-series. Discards are considered as negligible all over the division, but since 2014 on estimates include the available discarded catches (see Section 4.3.3).**

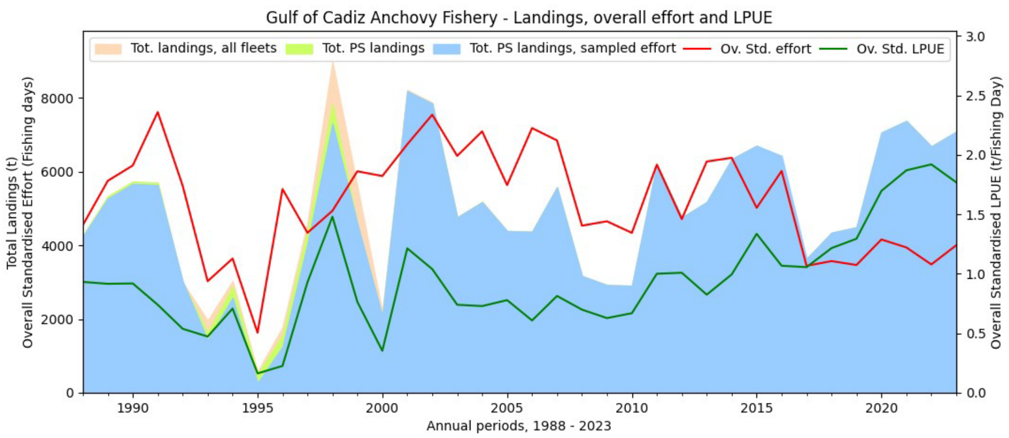



**Figure A7.3.4.1. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. Spanish purse-seine fishery (métier PS_SPF_0_0_0). Trends in Gulf of Cadiz anchovy annual landings, and purse-seine fleets' standardised overall effort and lpue (1988–2023).**

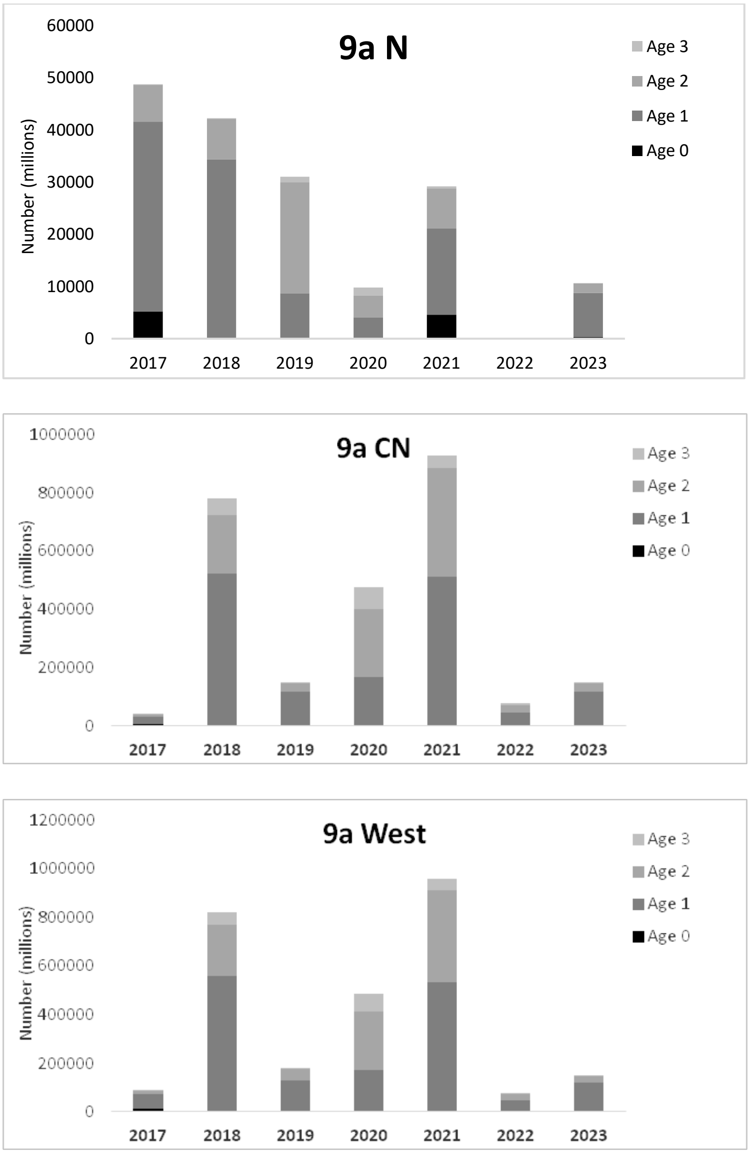



**Figure A7.3.5.2.1. Anchovy in Division 9.a. Western component. Subdivisions 9.a North and 9.a Central North. Spanish and Portuguese fisheries (all métiers). Age composition in Spanish catches of SW Galician anchovy (9.a North) and Portuguese catches of anchovy from northern Portugal (9.a Central North) (available data provided to the WG). Although discards are still considered as negligible (hence landings are assumed as equal to catches), data since 2014 include discards estimates for the Spanish fisheries (see Section 4.3.3). Data for 2021 and 2022 from the Portuguese fisheries are only available for the 3rd and 4th Quarters (represent 95% catches in 2021 and 70% catches in 2022).**

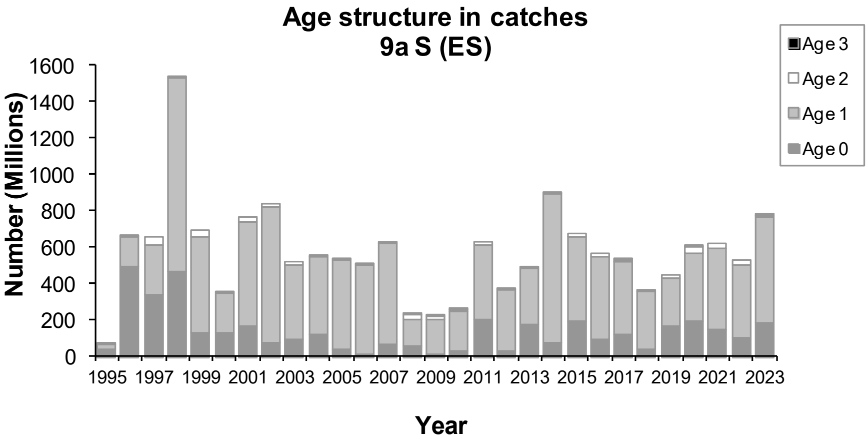
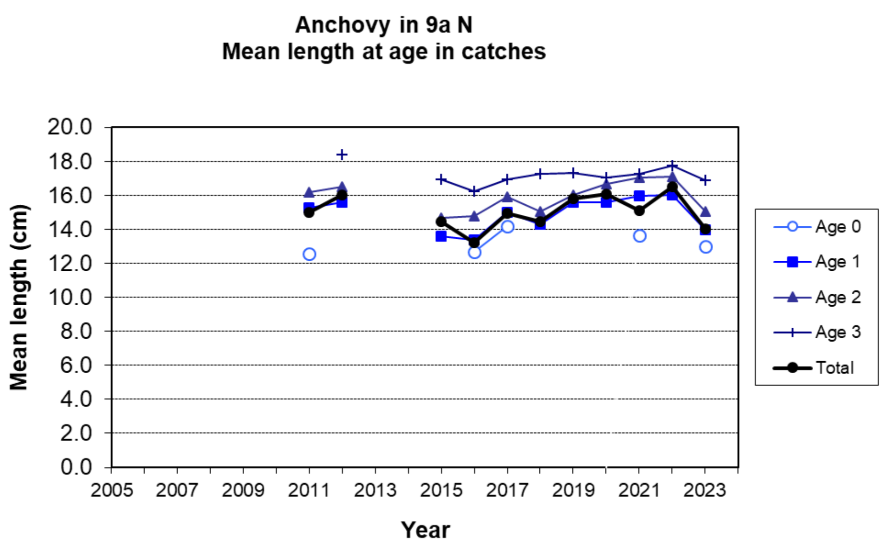



**Figure A7.3.5.2.3. Anchovy in Division 9.a. Southern component. Subdivision 9.a-South. Spanish fishery (all métiers). Age composition in Spanish catches of Gulf of Cadiz anchovy (1995–2023). Discards are considered either very low or even negligible in this fishery, but since 2014 on estimates include the available discarded catches (see Section 4.3.3).**



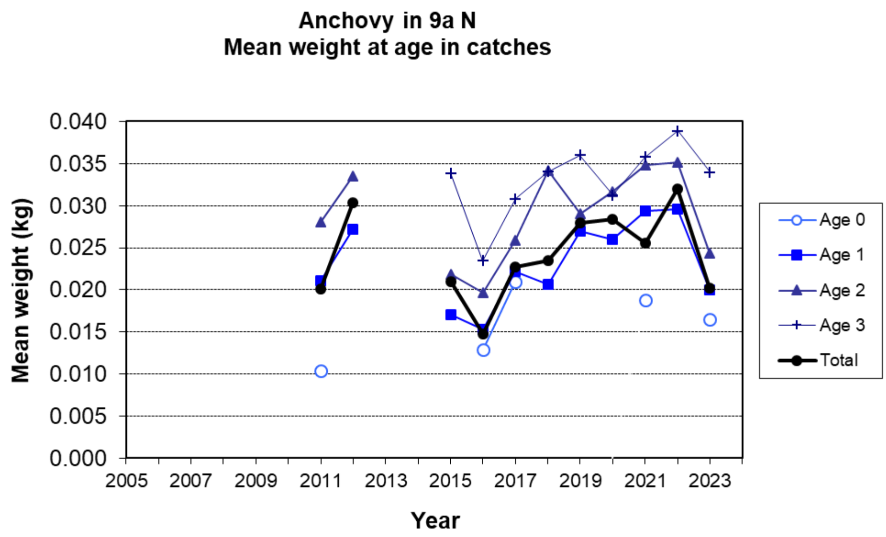




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**Figure A7.3.6.1. Anchovy in Division 9.a. Western component. Subdivision 9.a North. Spanish fishery (all métiers). Annual mean length (TL, in cm) and weight (kg) at-age in the Spanish catches of Western Galicia anchovy (2011–2023).**

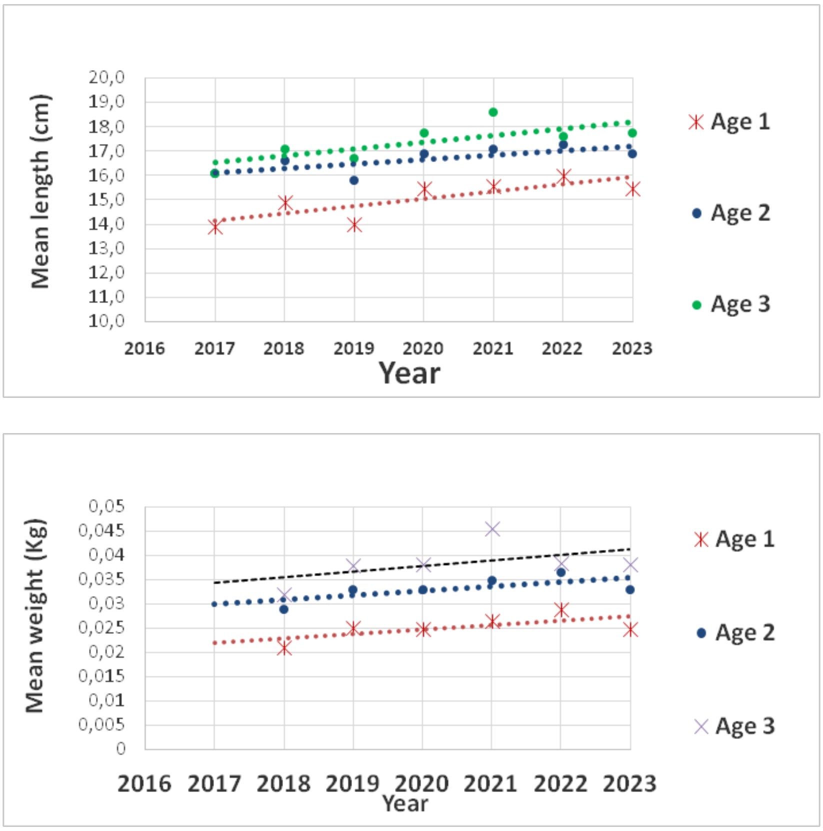
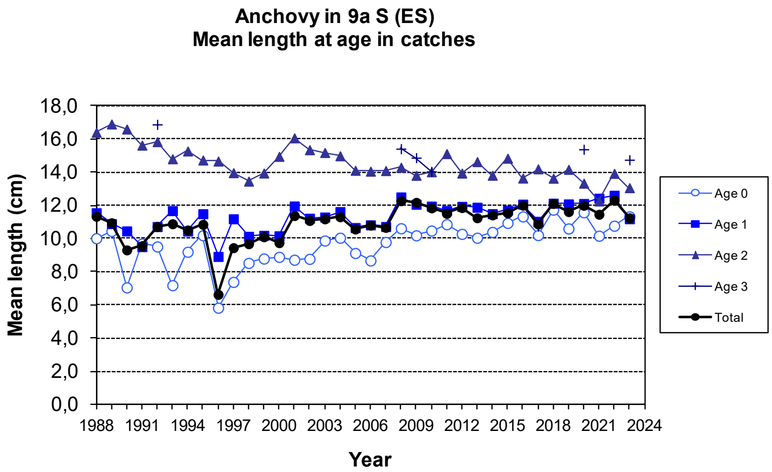



**Figure A7.3.6.2. Anchovy in Division 9.a. Western component. Subdivision 9.a Central North. Portuguese fishery (all métiers). Annual mean length (TL, in cm) and weight (kg) at-age in the Portuguese catches of Western anchovy (2017 to 2023). Data for 2021 and 2022 are only available for the 3rd and 4th Quarters (represent 95% catches in 2021 and 70% catches in 2022).**



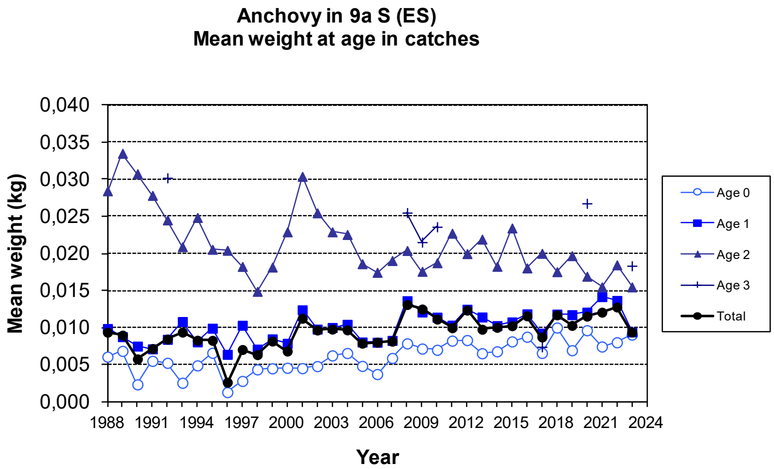




**Figure A7.3.6.3. Anchovy in Division 9.a. Southern component. Subdivision 9.a-South. Spanish fishery (all métiers). Annual mean length (TL, in cm) and weight (kg) at-age in the Spanish catches of Gulf of Cadiz anchovy (1988–2023).**

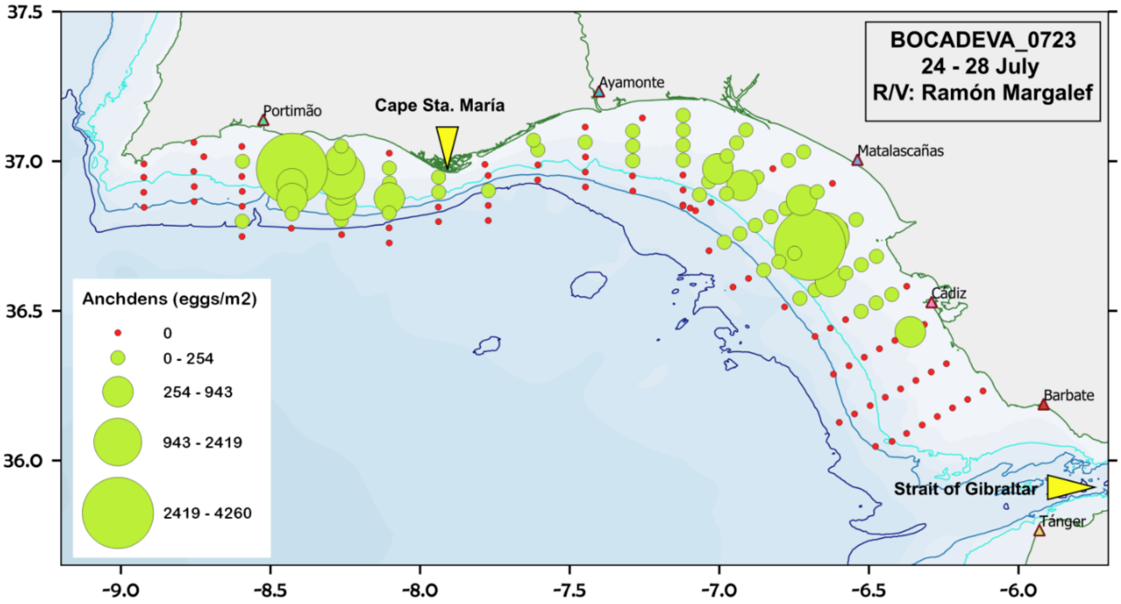



Figure A7.4.1.1. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. *BOCADEVA 0723* survey (summer Spanish anchovy DEPM survey in Subdivision 9.a South in 2023). Mapping of anchovy eggs density (eggs/m²) sampled by PairoVET..

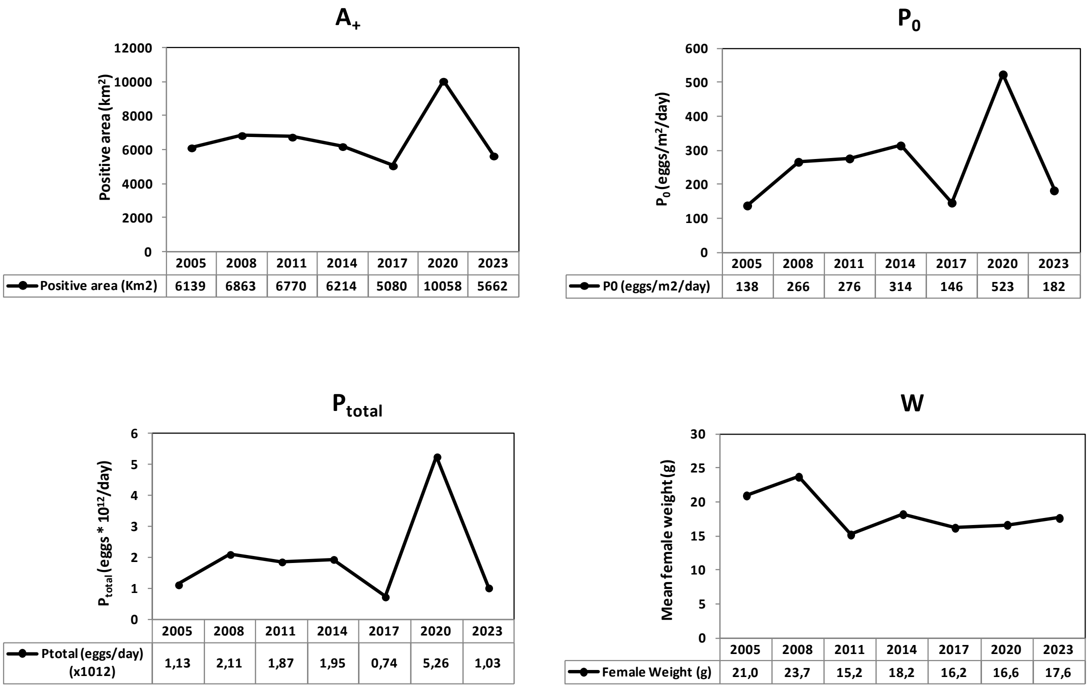



Figure A7.4.1.2. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. *BOCADEVA* survey series (summer Spanish anchovy DEPM survey in Subdivision 9.a South). Time-series of eggs and adult parameters estimates. A+ (positive area, in km²), $P_0$ (daily egg production, in eggs/m²/day), $P_{total}$ (total egg production, in eggs $10^{12}$/day), W (mean female weight, in g).

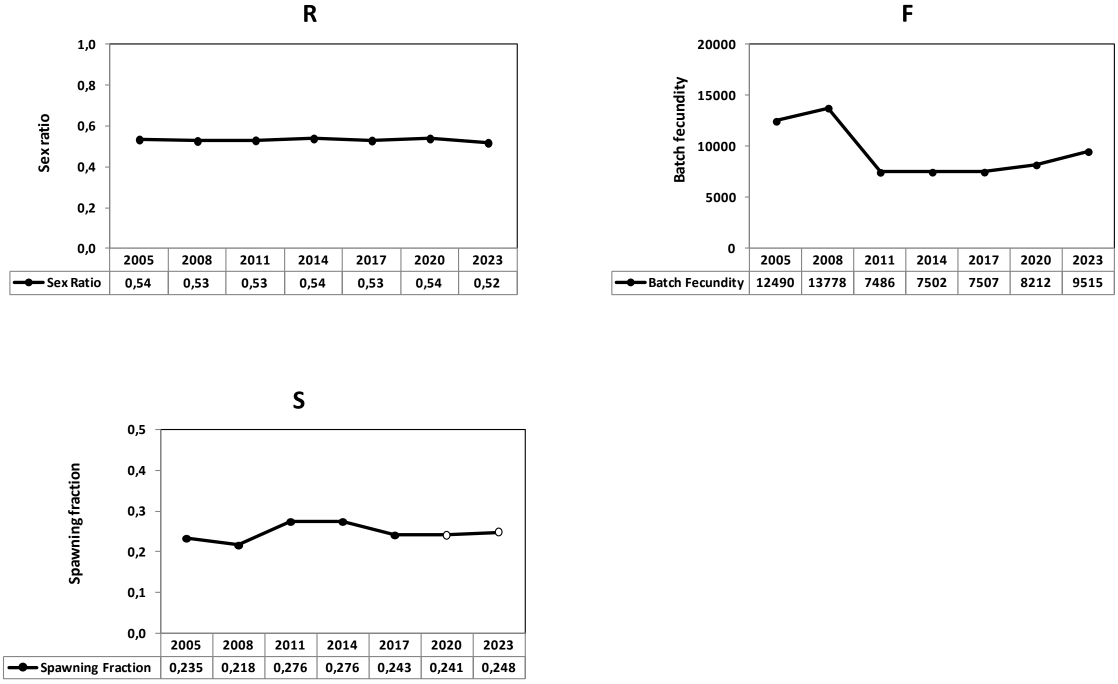



**Figure A7.4.1.2. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. *BOCADEVA* survey series (summer Spanish anchovy DEPM survey in Subdivision 9.a South). Time-series of eggs and adult parameters estimates. Cont'd. R (sex ratio), F (individual batch fecundity), S (spawning fraction; the 2020 and 2023 estimates are provisionally computed as the time-series average value).**

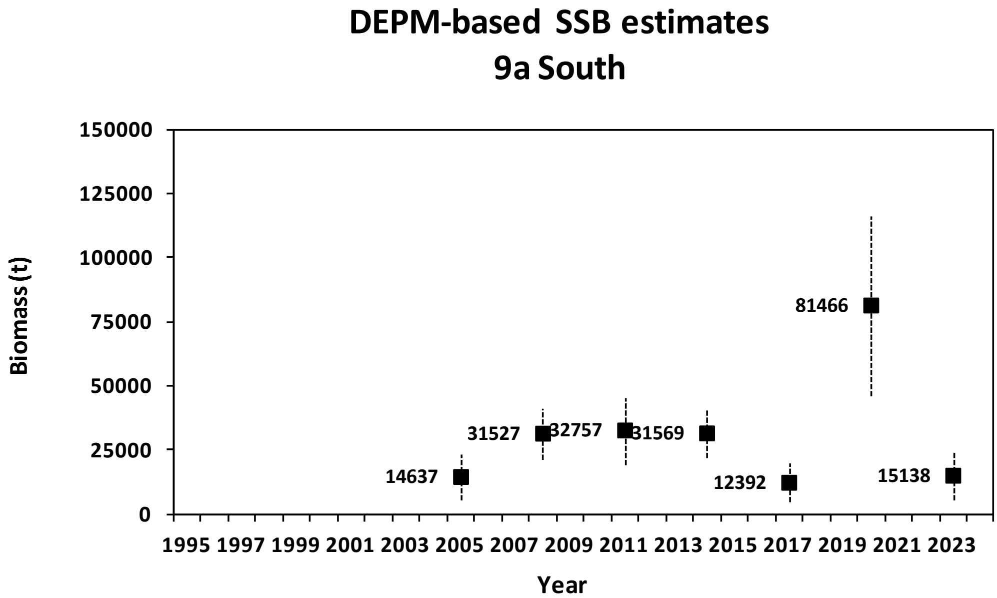



**Figure A7.4.1.3. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. *BOCADEVA* survey series (summer Spanish anchovy DEPM survey in Subdivision 9.a South). Series of SSB estimates (±SD) obtained from the survey series.**

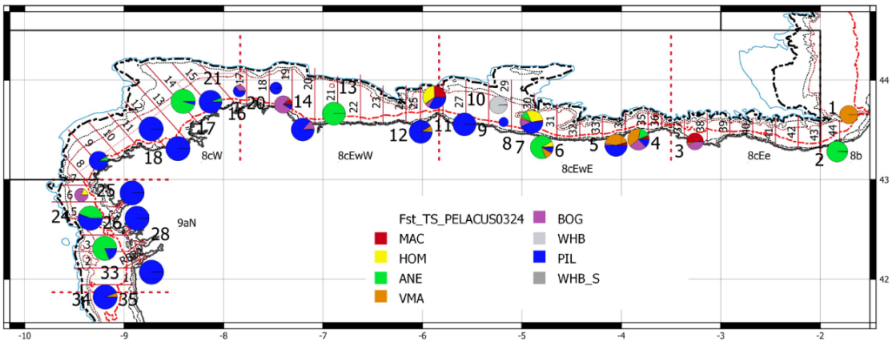



**Figure A7.4.2.1. Anchovy in Division 9.a. Western component. Subdivision 9.a North. *PELACUS 0424* survey (spring Spanish acoustic survey in Sub-division 9.a North and Sub-area 8c in 2024). Location of valid fishing stations with indication of their species composition (percentages in number).**

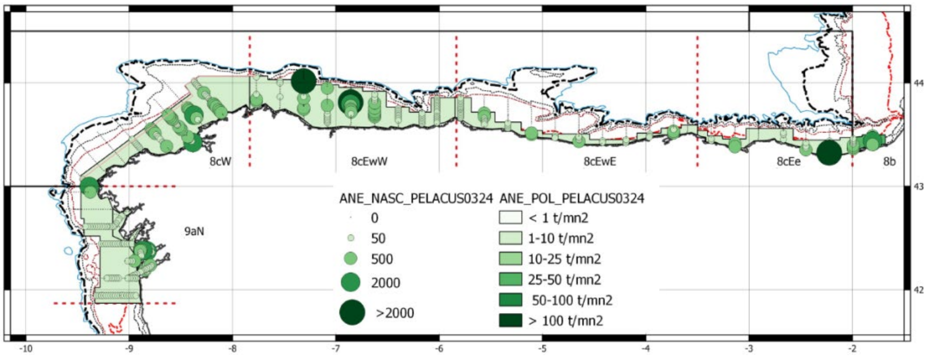



**Figure A7.4.2.2. Anchovy in Division 9.a. Western component. Subdivision 9.a North. *PELACUS 0424* survey (spring Spanish acoustic survey in Sub-division 9.a North and Sub-area 8c in 2024). Spatial distribution of energy allocated to anchovy (NASC coefficients in $m^2/mn^2$).**

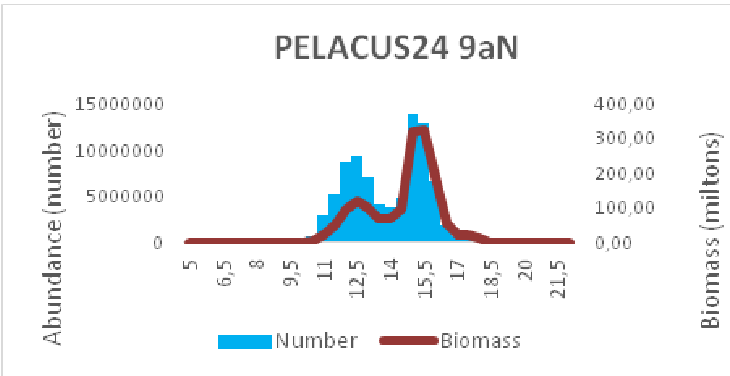



**Figure A7.4.2.3. Anchovy in Division 9.a. Western component. Subdivision 9.a North. *PELACUS 0424* survey (spring Spanish acoustic survey in Sub-division 9.a North and Sub-area 8c in 2024). Estimated abundances and biomasses (number of fish and thousand tonnes, respectively) in Sub-division 9.a North by length class (cm). Note the different scales in the y axis.**

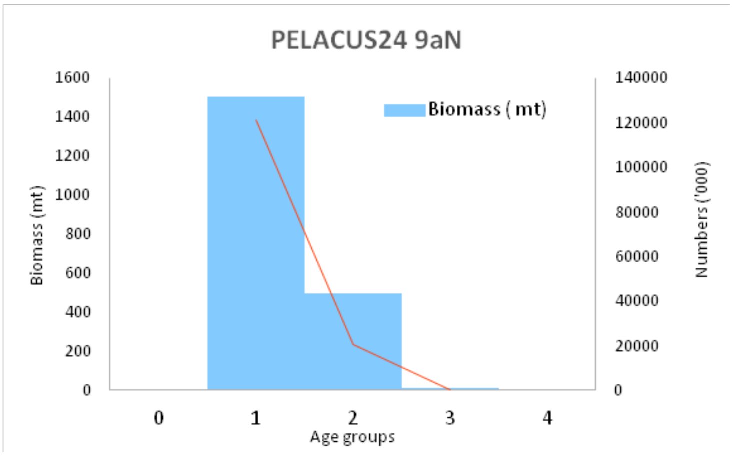



**Figure A7.4.2.4. Anchovy in Division 9.a. Western component. Subdivision 9.a North. *PELACUS 0424* survey (spring Spanish acoustic survey in Sub-division 9.a North and Sub-area 8c in 2024). Estimated abundances and biomasses (number of fish in thousands and tonnes, respectively) in Sub-division 9.a North by age group. Note the different scales in the y axis.**

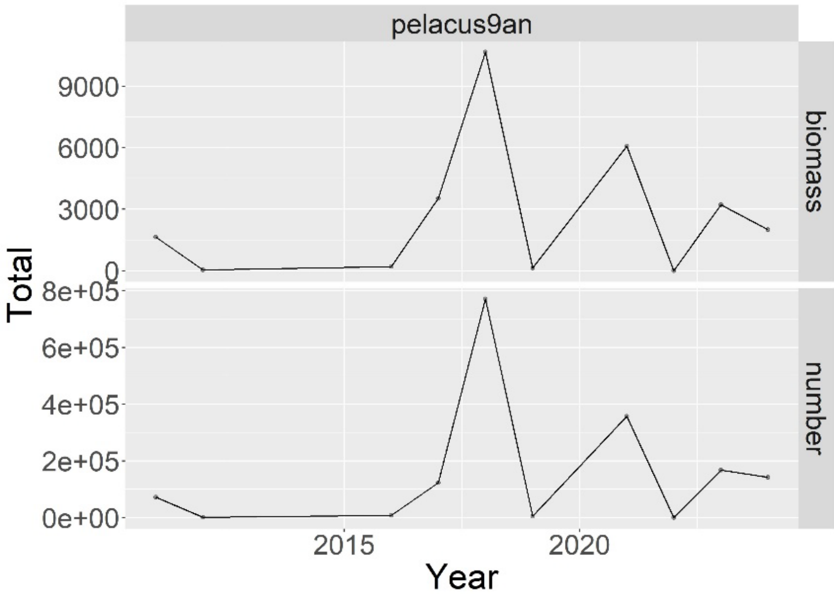



**Figure A7.4.2.5. Anchovy in Division 9.a. Western component. Subdivision 9.a North. *PELACUS* survey series (spring Spanish acoustic survey in Subdivision 9.a North and Subarea 8c). Historical series of acoustic estimates of anchovy abundance and biomass (t) in the Subdivision 9.a North.**

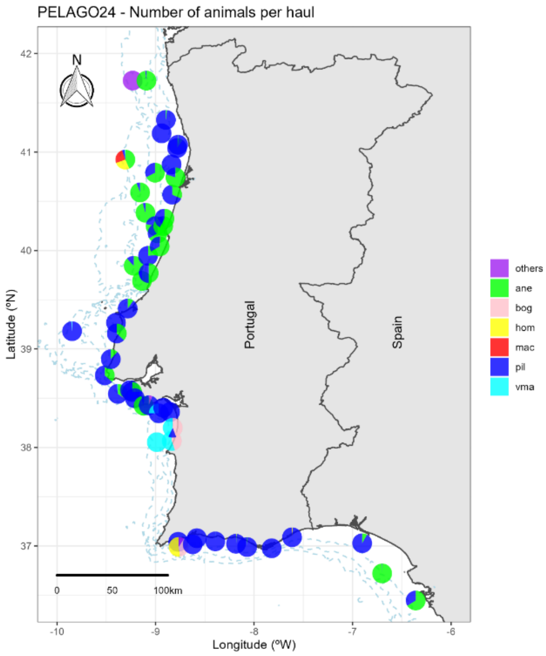



**Figure A7.4.2.3. Anchovy in Division 9.a. Western and Southern components. Subdivisions 9.a Central-North to 9.a South. *PELAGO* survey series (spring Portuguese acoustic survey in Subdivisions 9.a Central-North to 9.a South). *PELAGO 24* survey. Location of valid fishing stations with indication of their species composition (percentages in number).**

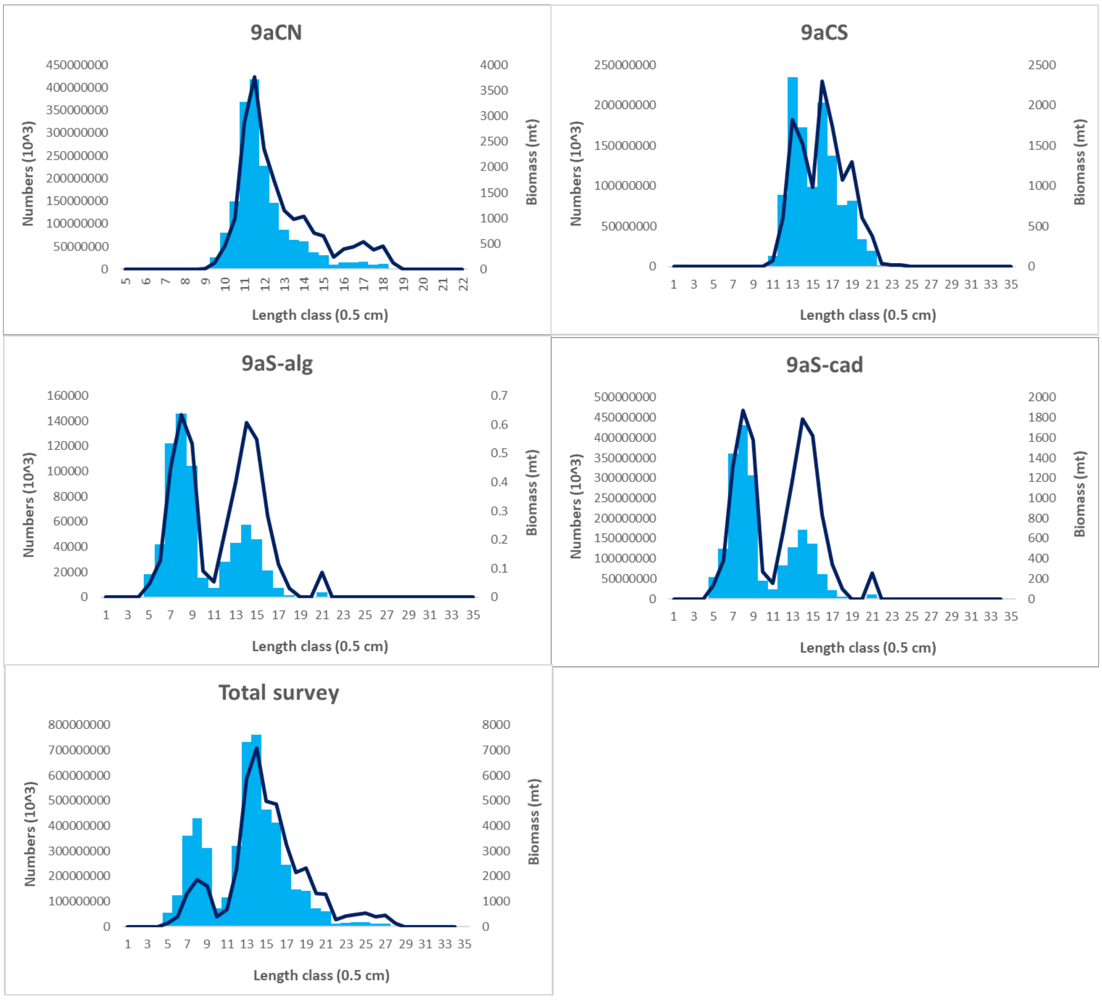



**Figure A7.4.2.4. Anchovy in Division 9.a. Western and Southern components. Sub-divisions 9.a Central-North to 9.a South. *PELAGO* survey series (spring Portuguese acoustic survey in Sub-divisions 9.a Central-North to 9.a South). *PELAGO 24* survey. Estimated abundances and biomasses (number of fish in thousands and tonnes, respectively) for the surveyed area by length class (cm). Note the different scales in the y axis.**

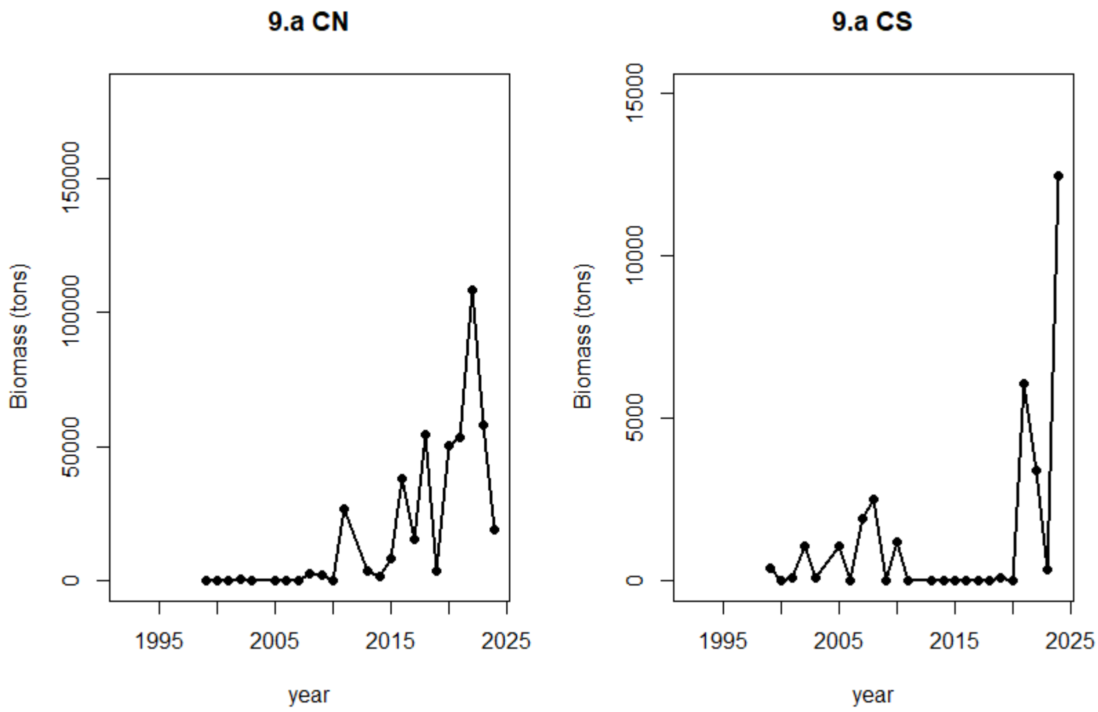
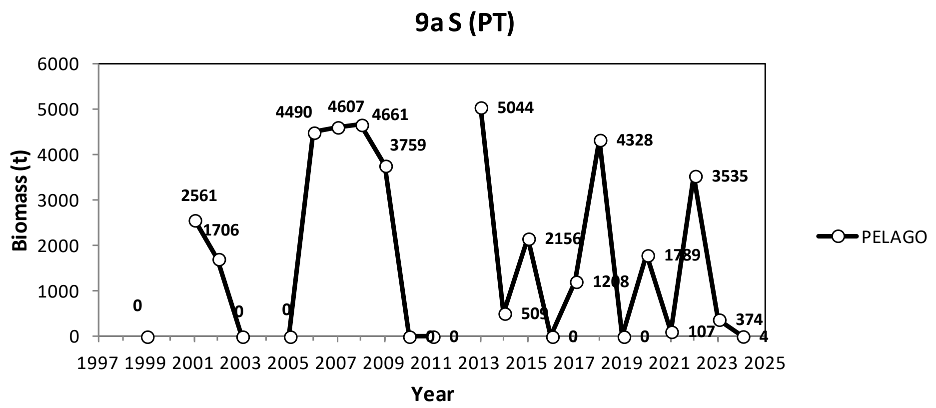



**Figure A7.4.2.5. Anchovy in Division 9.a. Western and Southern components. Subdivisions 9.a Central-North to 9.a South. *PELAGO* survey series (spring Portuguese acoustic survey in Subdivisions 9.a Central-North to 9.a South). Historical series of regional acoustic estimates of anchovy biomass (t). Note the different scale of the y-axis.**



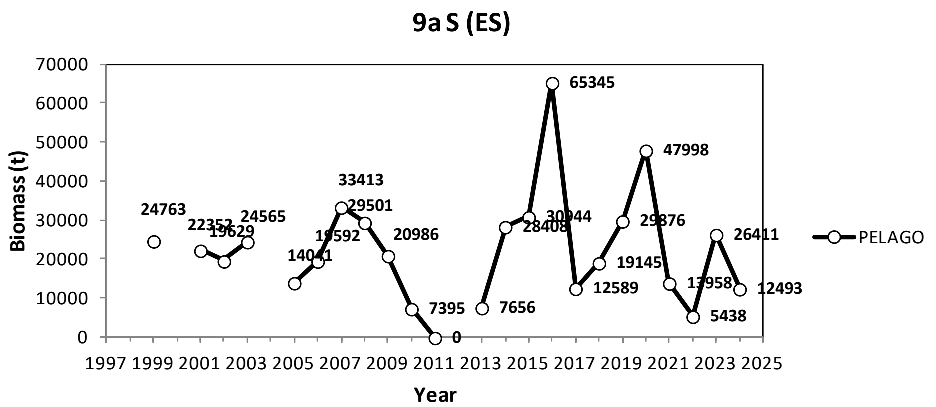




Figure A7.4.2.5. Continued. Acoustic estimates in the 9.a South differentiated by Portuguese (PT) and Spanish waters of the Gulf of Cadiz (ES). Note the different scale of the y-axis. Although estimates from Subdivision 9.a South in 2010 and 2014 were not separately provided for Algarve and Cadiz to this WG, the total estimated for the subdivision was assigned to the Cadiz area (by assuming some overestimation) according to the observed acoustic energy distribution in the area.

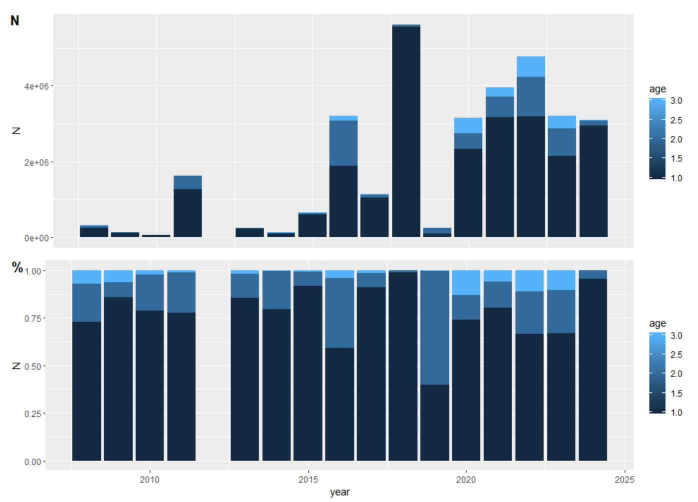
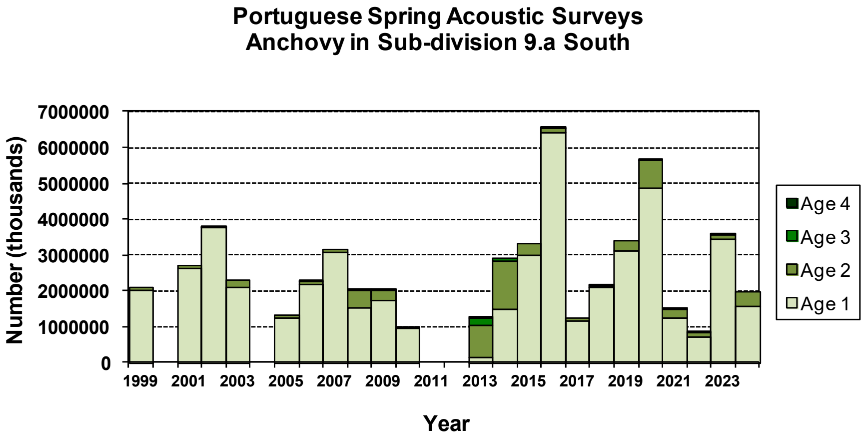


**Figure A7.4.2.6. Anchovy in Division 9.a. Western component. Subdivisions 9.a North to Central-South. Annual trends of the estimated population by age class from the *PELACUS* (9a North) + *PELAGO* (9a Central-North and Central-South) Spring acoustic surveys, number of individuals per age (upper panel) and percentage by number (lower panel). Age composition for 2020 only derived from the *PELAGO* survey given the *PELACUS* was not carried out.**



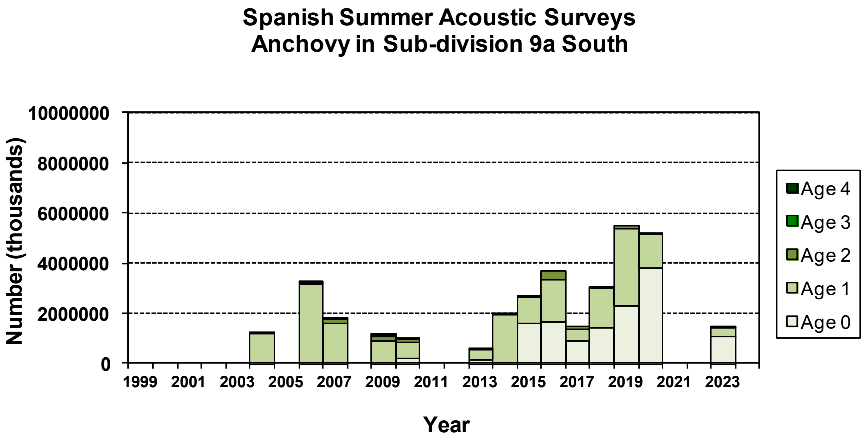




**Figure A7.4.2.7. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. Annual trends of the estimated population by age class from the Algarve + Gulf of Cadiz areas by the *PELAGO* Portuguese Spring (upper plot) and *ECOCADIZ* Spanish summer (lower plot) acoustic surveys (*ECOCADIZ* surveys in 2021 and 2022 were not finally conducted). Portuguese estimates until 2012 have been age-structured using Spanish ALKs from the commercial fishery in the second quarter in the year. The age structure estimated for the *PELAGO* surveys in 2020, 2021, 2022 and 2023 has been revised and re-estimated after detecting some inconsistencies in the age readings.**

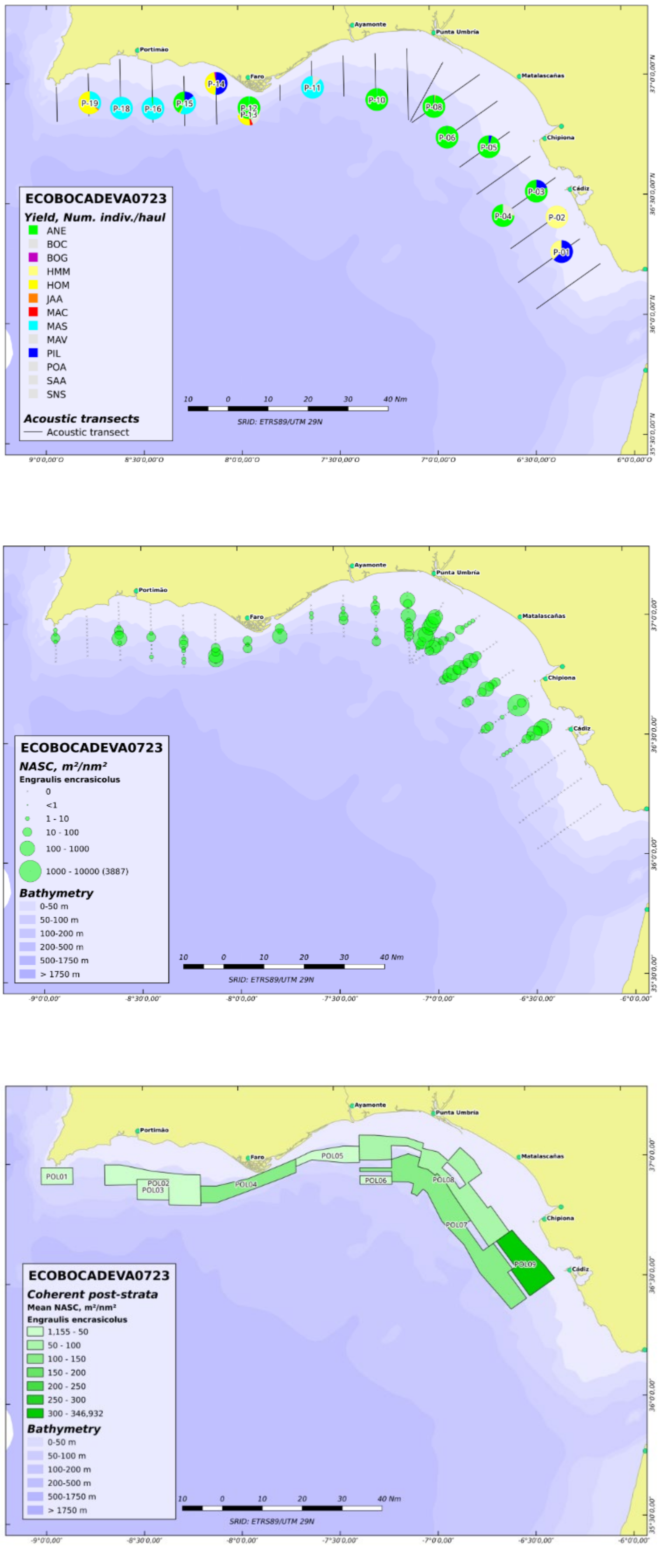



**Figure A7.4.2.8. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. *ECOCADIZ 2023-07* survey (summer Spanish acoustic survey in Subdivision 9.a South). Top: Location of valid fishing stations with indication of their species composition (percentages in number). Middle: Distribution of the backscattering energy (Nautical area scattering coefficient, NASC, in m² nmi⁻²) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.**

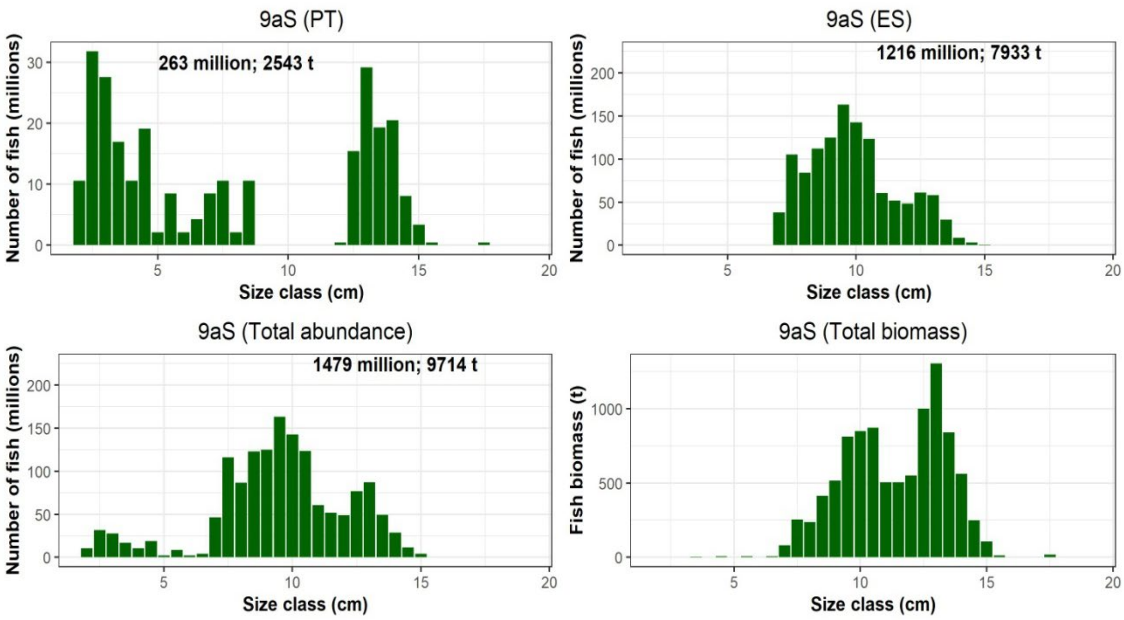



**Figure A7.4.2.9. Anchovy in Division 9.a. Southern component. Sub-division 9.a South. *ECOCADIZ 2023-07* survey (summer Spanish acoustic survey in Subdivision 9.a South). Estimated abundances and biomasses (number of fish in millions and tonnes, respectively) for the surveyed area by length class (cm).Note the different scales in the y-axis.**

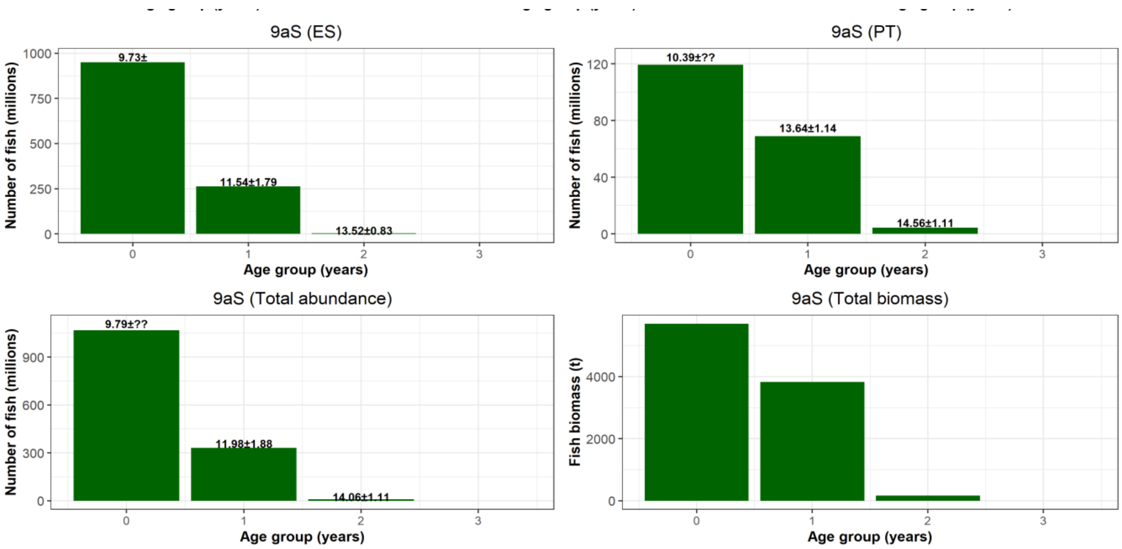



**Figure A7.4.2.10. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. *ECOCADIZ 2023-07* survey (summer Spanish acoustic survey in Subdivision 9.a South). Estimated abundances and biomasses (number of fish in millions and tonnes, respectively) for the surveyed area by age group, with indication of the mean size by age. Note the different scales in the y-axis.**

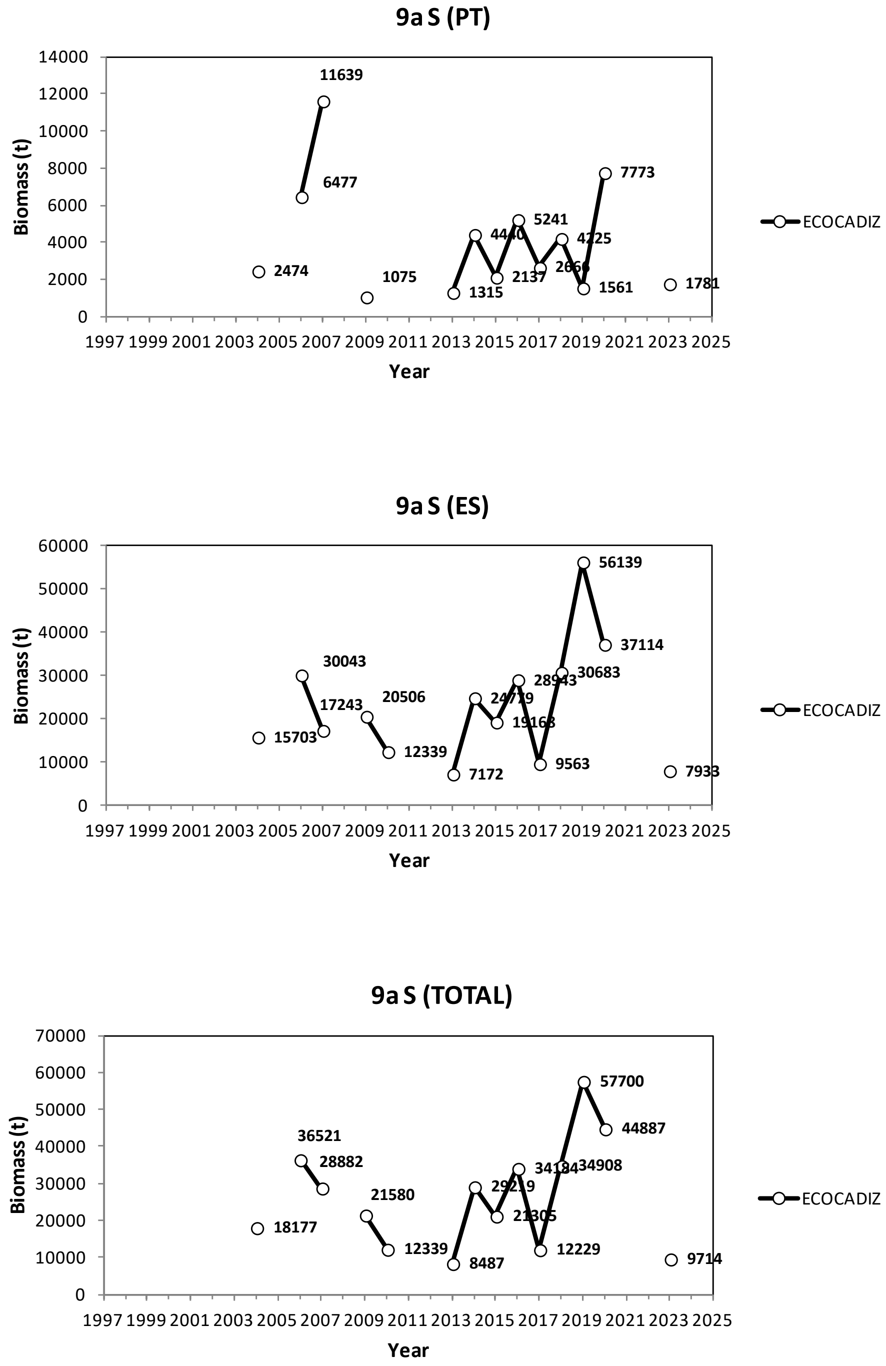



**Figure A7.4.2.11. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. *ECOCADIZ* survey series (summer Spanish acoustic survey in Subdivision 9.a South). Historical series of overall and regional (Portuguese, PT, and Spanish waters of the Gulf of Cadiz, ES) acoustic estimates of anchovy biomass (t). Note the different scale of the y-axis. *ECOCADIZ* 2021 and 2022 were not finally conducted.**

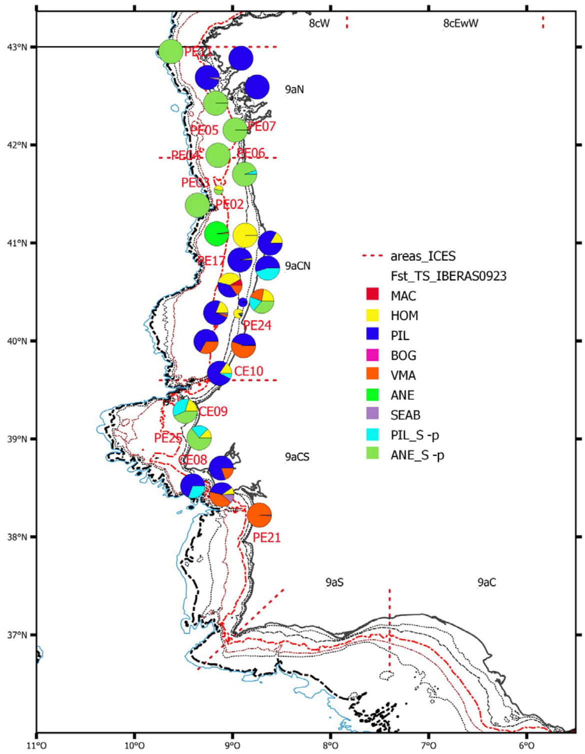



**Figure A7.4.3.1. Anchovy in Division 9.a. Western component. Subdivisions 9.aNorth, 9.a Central-North and 9.a Central-South. *IBERAS 0923* survey (autumn Spanish-Portuguese acoustic survey in Subdivisions 9.aNorth to Central-South). Location of valid fishing stations with indication of their species composition (percentages in number).**

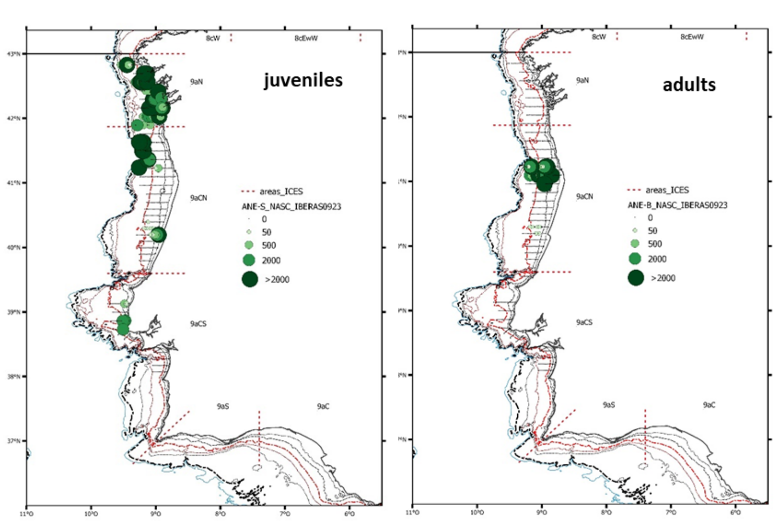



**Figure A7.4.3.2. Anchovy in Division 9.a. Western component. Subdivisions 9.a North, 9.a Central-North and 9.a Central-South. *IBERAS 0923* survey (autumn Spanish-Portuguese acoustic survey in Subdivisions 9.a North to Central-South). Distribution of the backscattering energy (Nautical area scattering coefficient, NASC, in $m^2$ $nmi^{-2}$) attributed to the species. Left: juveniles (≤12.0cm); right: adults (>12.0cm).**

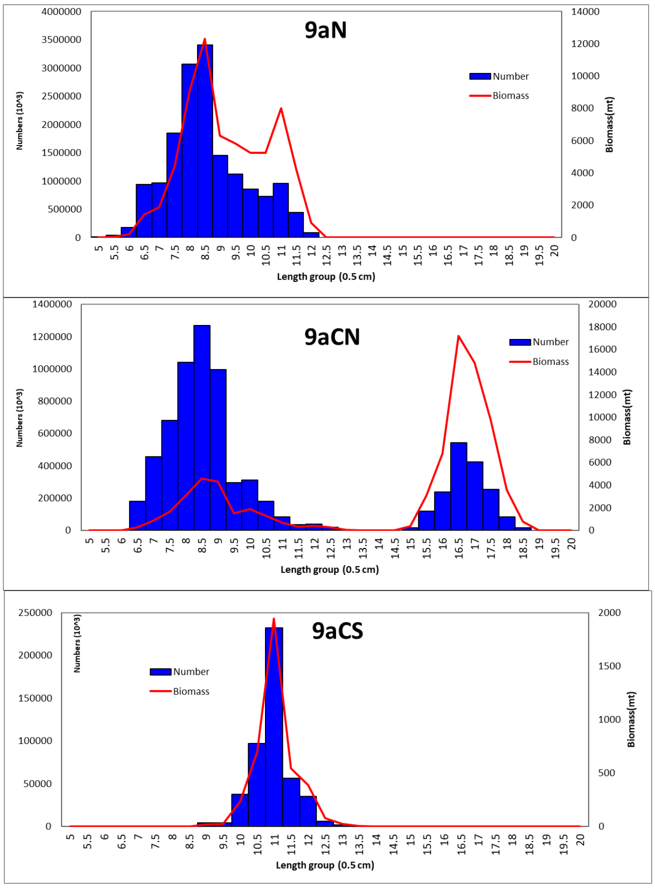



**Figure A7.4.3.3. Anchovy in Division 9.a. Western component. Subdivisions 9.aNorth, 9.a Central-North and 9.a Central-South. *IBERAS 0923* survey (autumn Spanish-Portuguese acoustic survey in Subdivisions 9.a North to Central-South). Estimated abundances and biomasses (number of fish in thousands and tonnes, respectively) for the surveyed area by length class (cm). Note the different scales in the y-axis.**

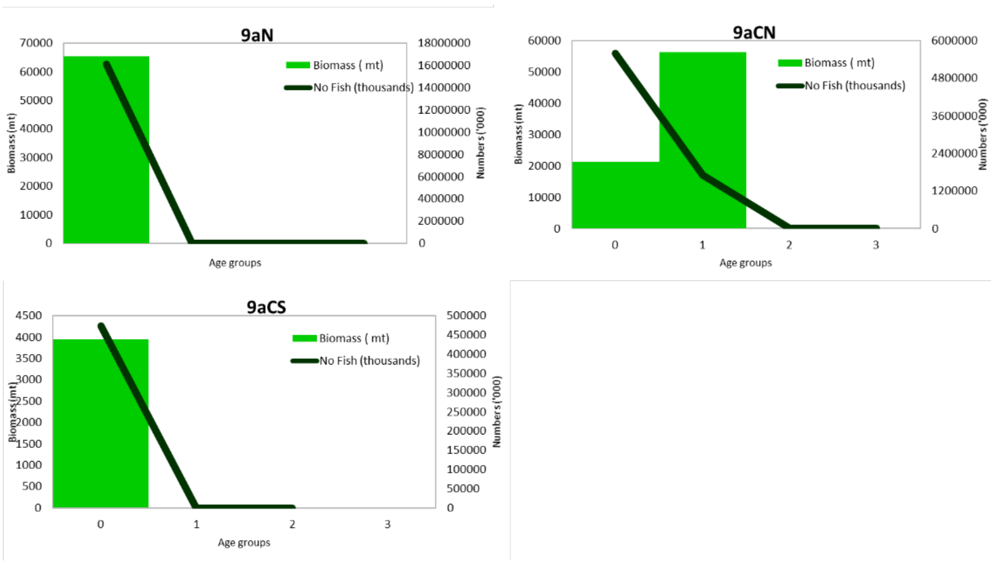



**Figure A7.4.3.4. Anchovy in Division 9.a. Western component. Subdivisions 9.a North, 9.a Central-North and 9.a Central-South. *IBERAS 0923* survey (autumn Spanish-Portuguese acoustic survey in Subdivisions 9.a North to Central-South). Estimated abundances and biomasses (number of fish in thousands and tonnes, respectively) for the surveyed area by age group, with indication of the mean size by age. Note the different scales in the y-axis.**

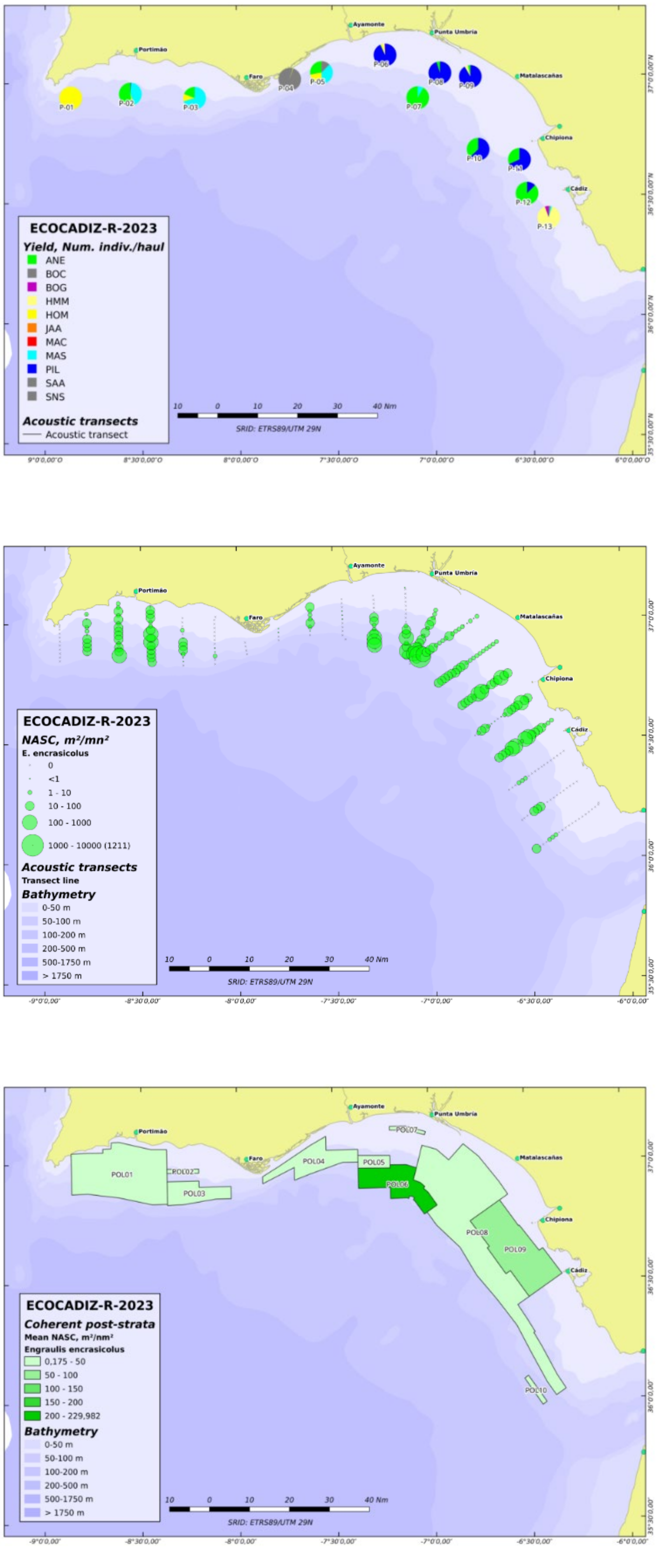



**Figure A7.4.3.5. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. *ECOCADIZ-RECLUTAS 2023-10* survey (autumn Spanish acoustic survey in Subdivision 9.a South). Top: Location of valid fishing stations with indication of their species composition (percentages in number).Middle: Distribution of the backscattering energy (Nautical area scattering coefficient, NASC, in m² nmi⁻²) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.**

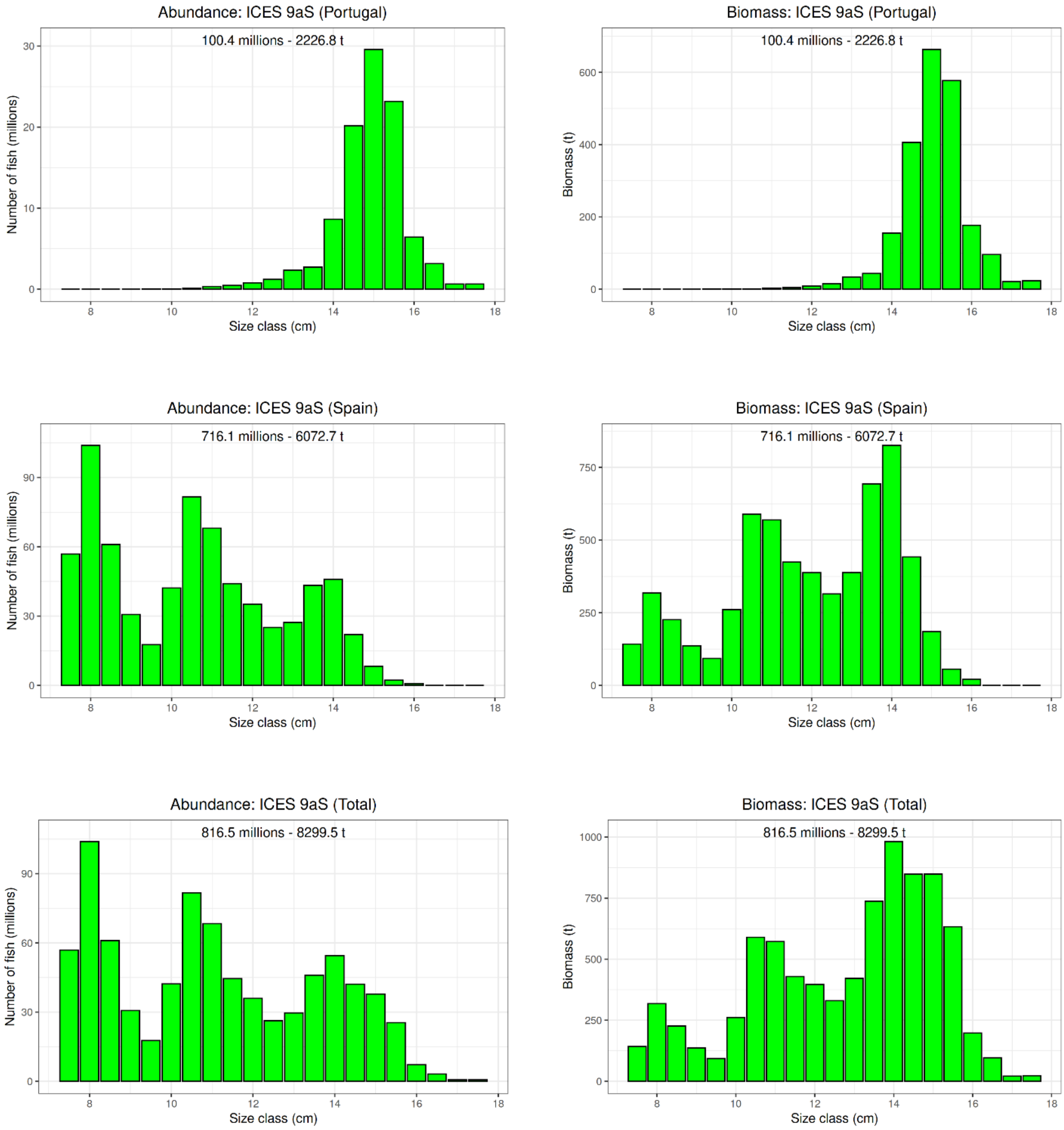



**Figure A7.4.3.6. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. *ECOCADIZ-RECLUTAS 2023-10* survey (autumn Spanish acoustic survey in Subdivision 9.a South). Estimated abundances and biomasses (number of fish in millions and tonnes, respectively) for the surveyed area by length class (cm). Note the different scales in the y-axis.**

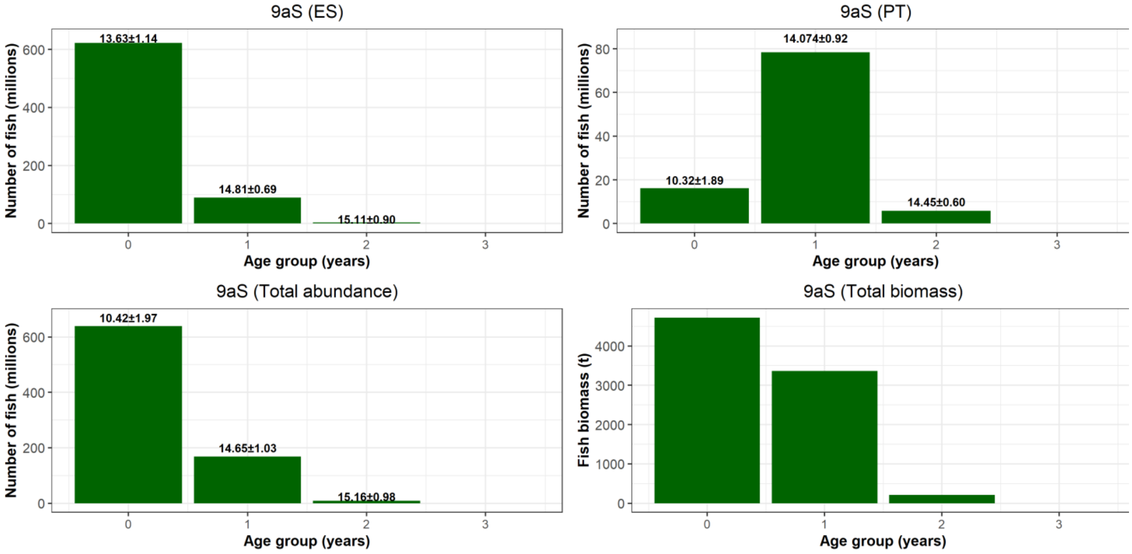



**Figure A7.4.3.7. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. *ECOCADIZ-RECLUTAS 2023-10* survey (autumn Spanish acoustic survey in Subdivision 9.a South). Estimated abundances and biomasses (number of fish in millions and tonnes, respectively) for the surveyed area by age group, with indication of the mean size by age. Note the different scales in the y-axis.**

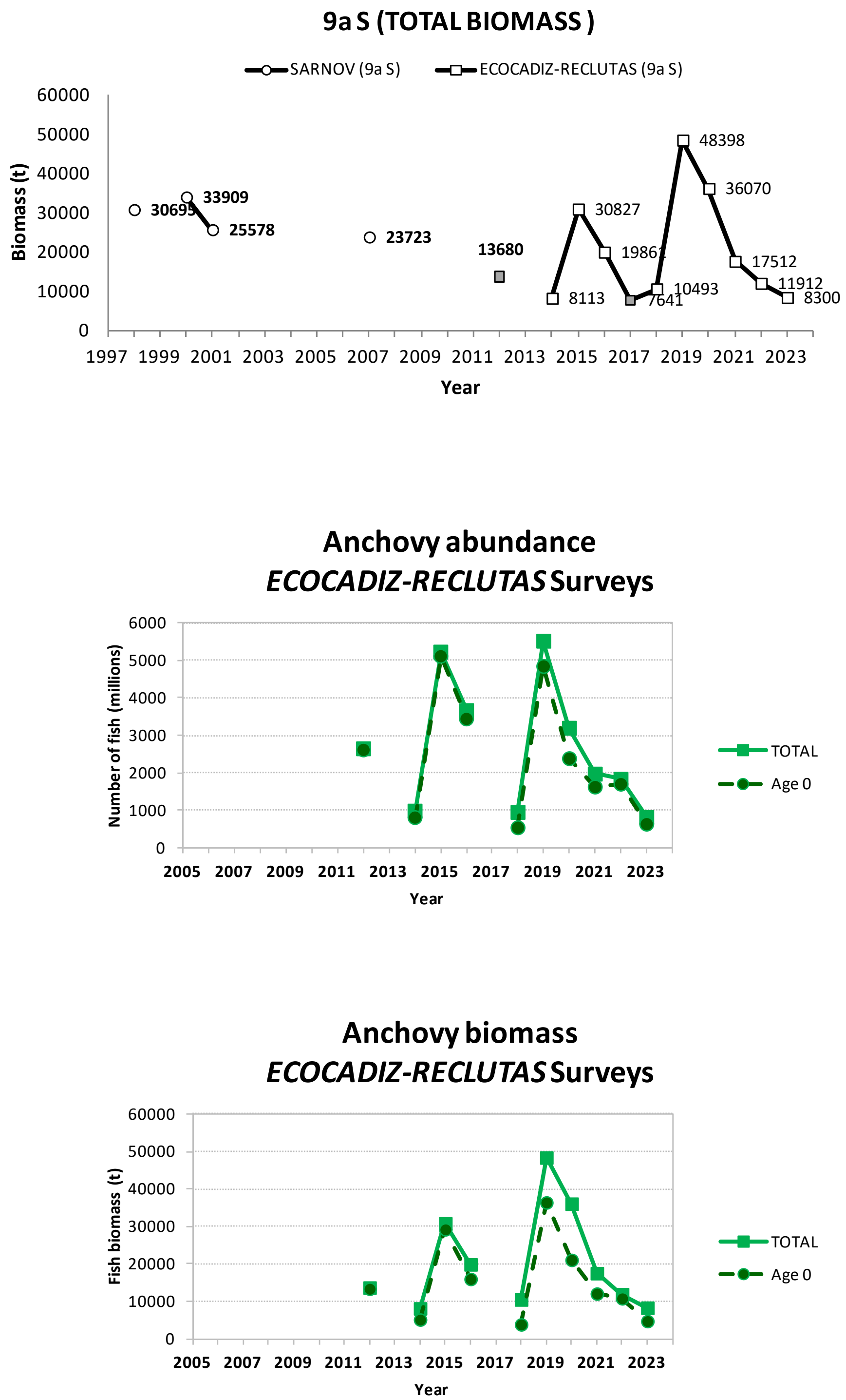



**Figure A7.4.3.8. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. *ECOCADIZ-RECLUTAS* survey series (autumn Spanish acoustic survey in Subdivision 9.a South). Top: historical series of overall acoustic estimates of anchovy biomass (t), (squares). The estimates from the older Portuguese *SARNOV* survey series are also included for comparison of trends (circles). The 2012 and 2017 estimates (in dark grey) are partial ones, since the surveys either covered the Spanish waters (2012) or the seven easternmost transects (2017). Middle and bottom: time-series estimates of abundance and biomass of the total population and Age 0 fish. In this case, the 2017 has not been included. The 2012 estimate is retained because the recruitment area was almost covered.**

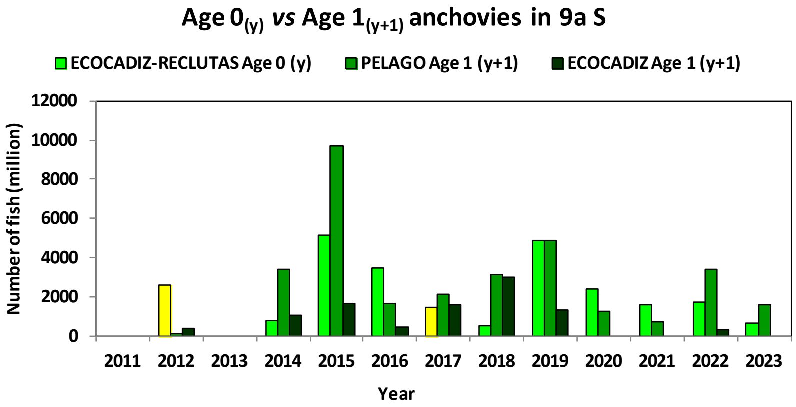



**Figure A7.4.3.9. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. *ECOCADIZ-RECLUTAS* survey series (autumn Spanish acoustic survey in Subdivision 9.a South). Correspondence between acoustic estimates of abundance of Age 0 anchovies from *ECOCADIZ-RECLUTAS* surveys in the autumn of the year *y* against the abundance of Age 1 anchovies estimated in spring of the following year (*y+1*) by the *PELAGO* survey and in summer by the *ECOCADIZ* survey. The *ECOCADIZ-RECLUTAS* 2012 and 2017 estimates (in yellow) are partial ones since the 2012 survey only covered the Spanish waters and the 2017 survey the seven easternmost transects. *ECOCADIZ* 2021 and 2022 surveys were not finally conducted.**

**Figure A7.6.2.1.2.1. Anchovy in Division 9.a. Southern component. Comparison between observed and estimated catches length distribution by quarters from 1989 to 2023. Black lines represent estimated data while gray lines represent observed data.**

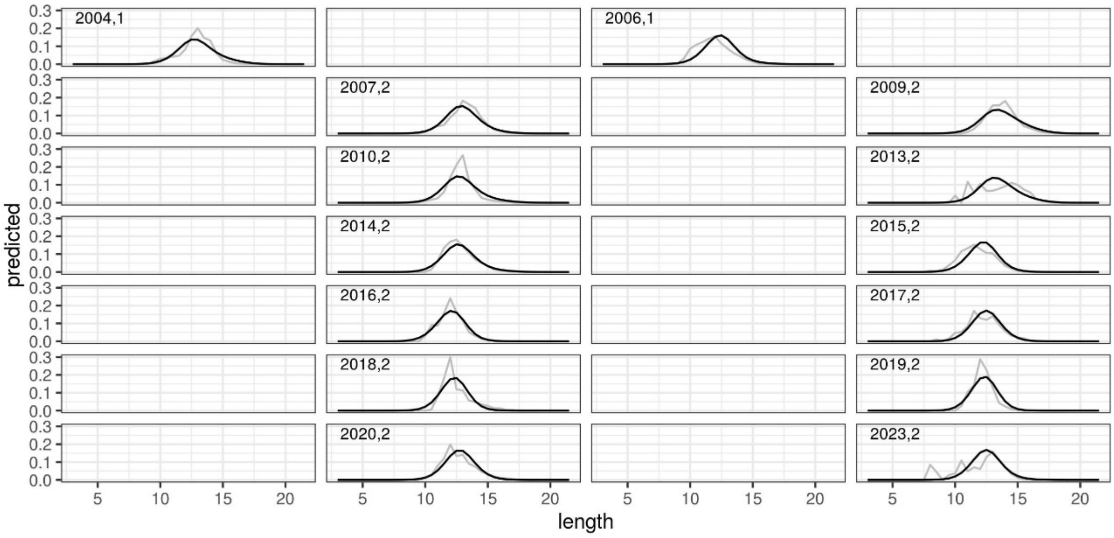



**Figure A7.6.2.1.2.2. Anchovy in Division 9.a. Southern component. Comparison between observed and estimated catches length distribution for *ECOCADIZ* survey from 2004 to 2023. Black lines represent estimated data while gray lines represent observed data. The number next to the year indicates the quarter. Note that the time of the survey in the model is assumed to be one quarter before it really happens; this assumption follows from the order of calculations in the model.**

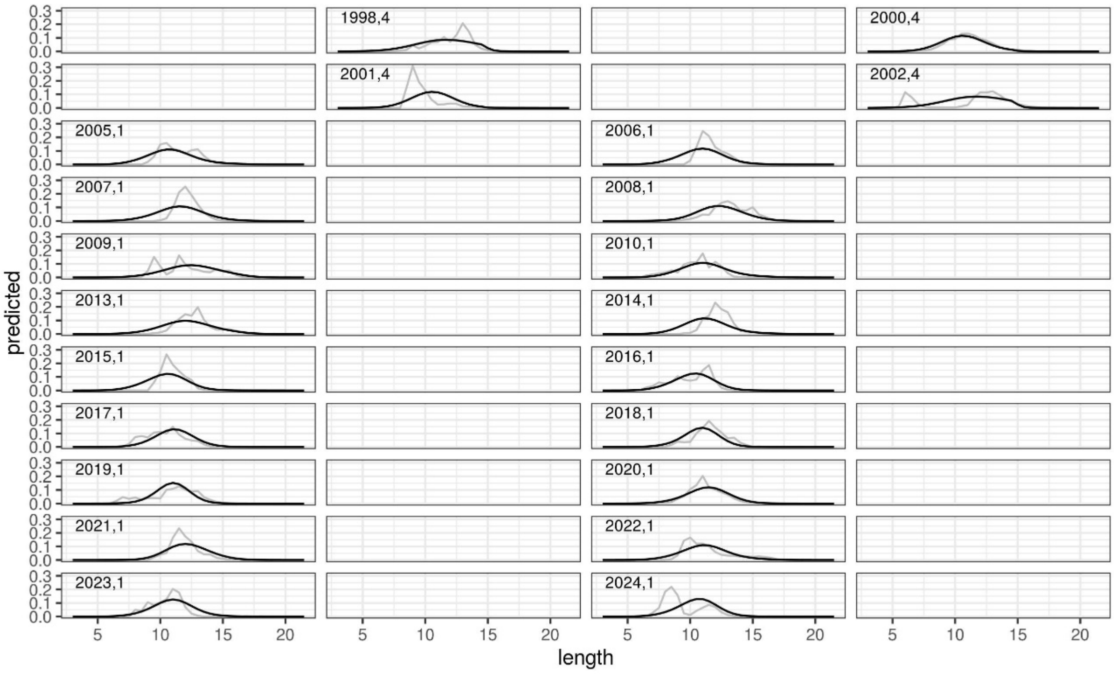



**Figure A7.6.2.1.2.3. Anchovy in Division 9.a. Southern component. Comparison between observed and estimated catches length distribution for *PELAGO* survey from 1998 to 2024. Black lines represent estimated data while gray lines represent observed data. The number next to the year indicates the quarter. Note that the time of the survey in the model is assumed to be one quarter before it really happens; this assumption follows from the order of calculations in the model.**

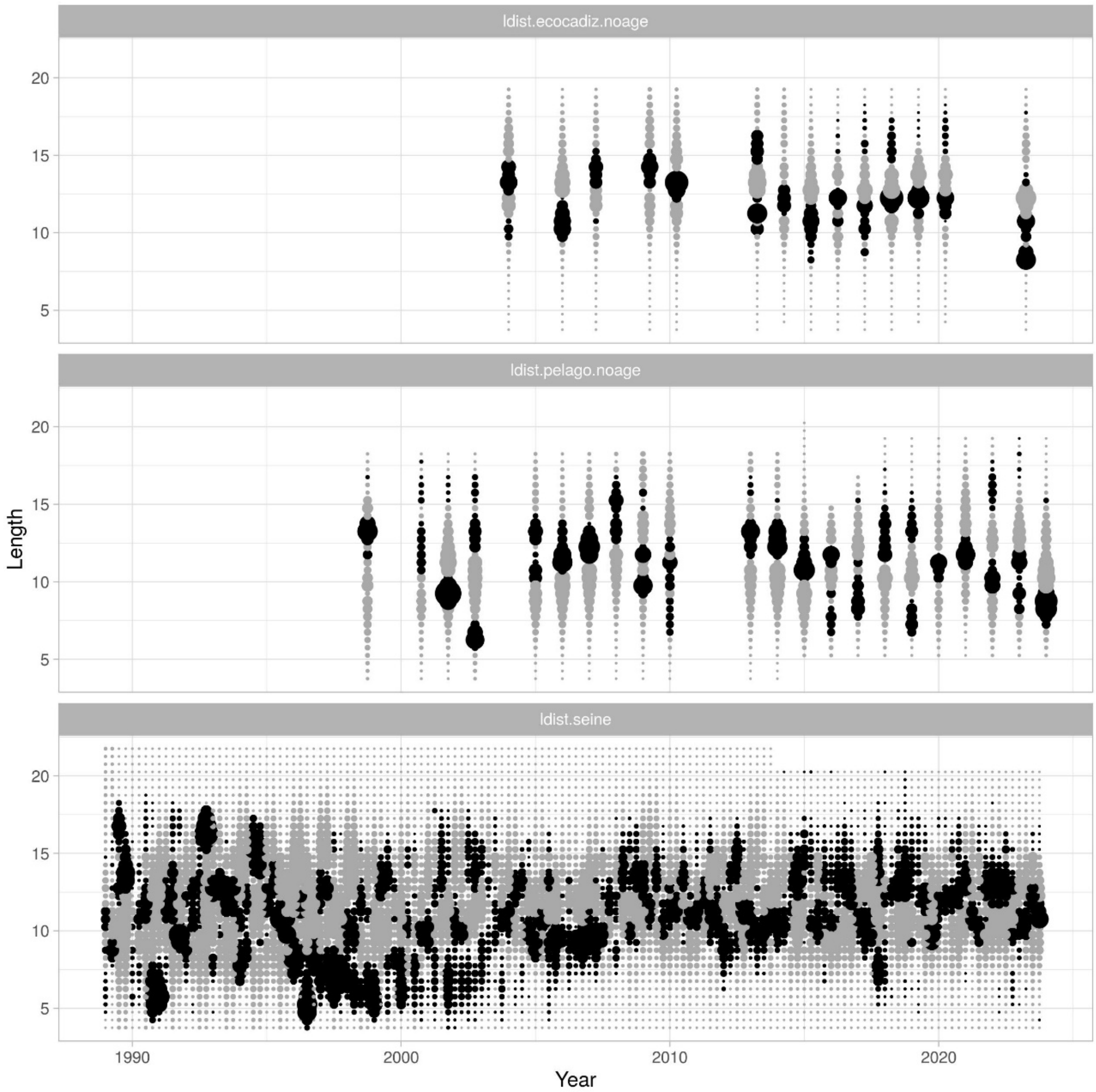



**Figure A7.6.2.1.2.4. Anchovy in Division 9.a. Southern component. Standardised residual plots for the fitted length distribution from the *ECOCADIZ* survey, *PELAGO* survey and commercial fleet. Black points denote a model underestimate and grey points an overestimate. The size of the points denotes the scale of the standardised residual.**

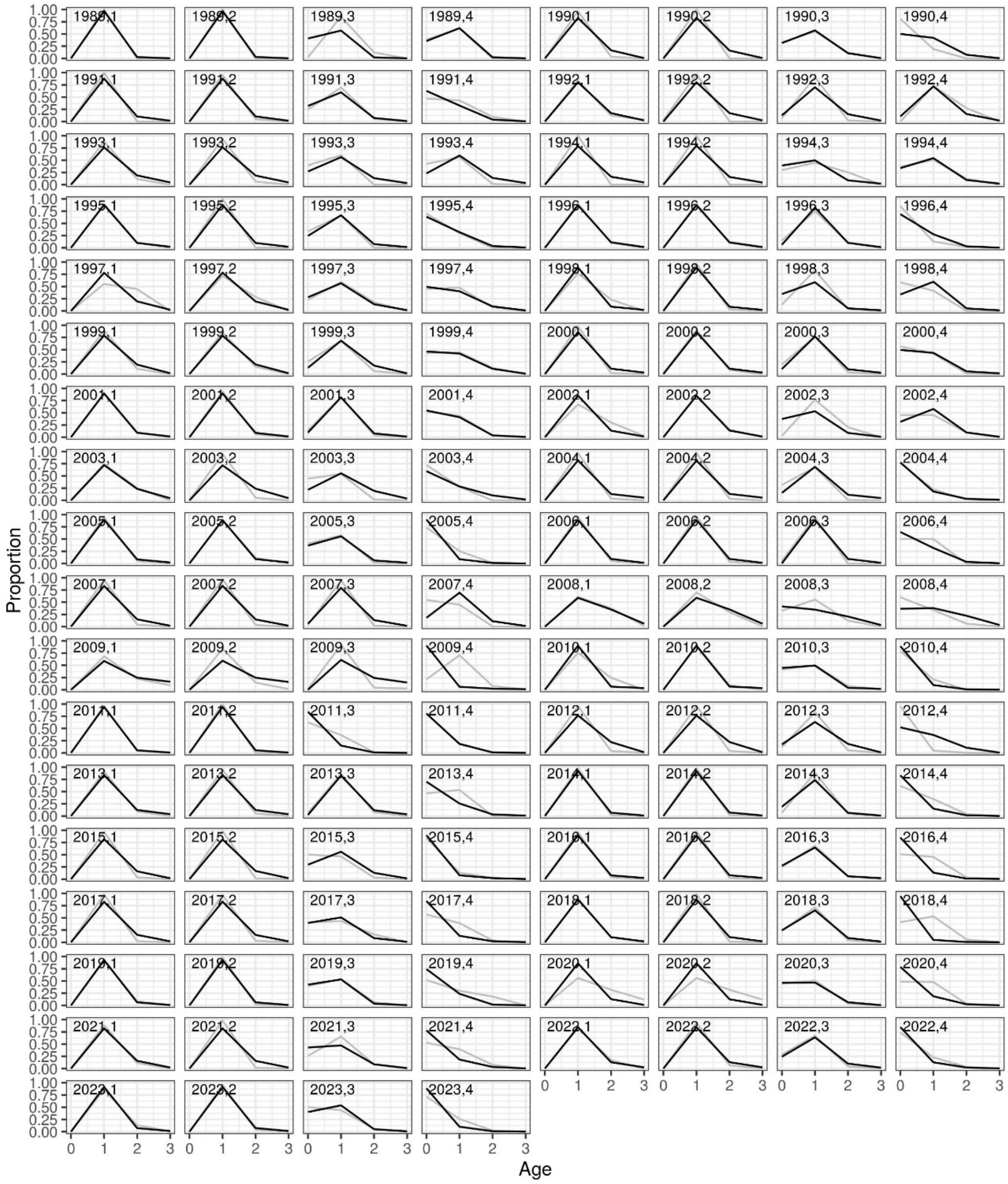



**Figure A7.6.2.1.2.5. Anchovy in Division 9.a. Southern component. Comparison between observed and estimated quarterly catches age distribution from 1989 to 2023. Black lines represent estimated data while gray lines represent observed data. The number next to the year indicates the quarter.**

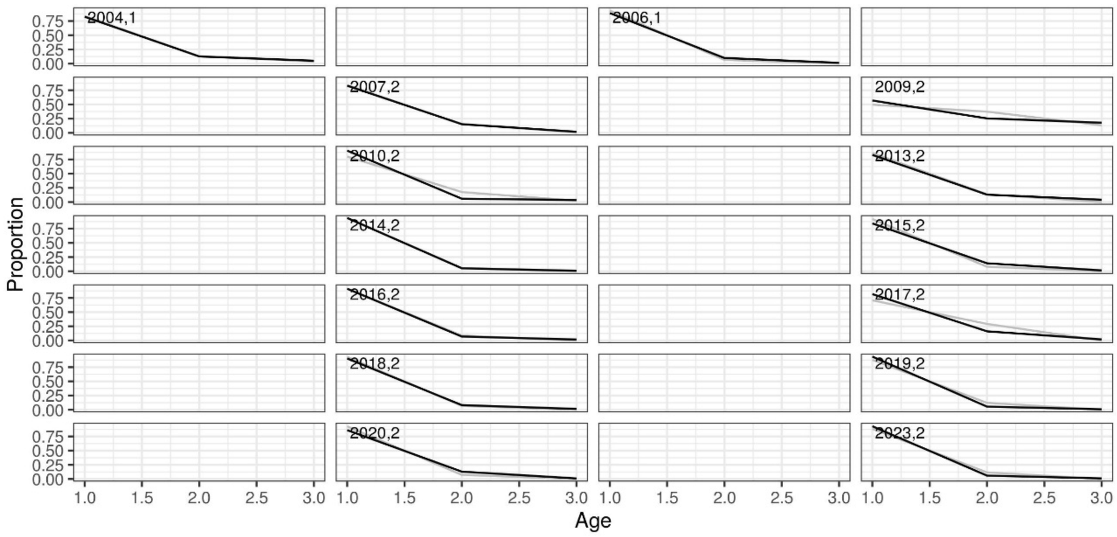



**Figure A7.6.2.1.2.6. Anchovy in Division 9.a. Southern component. Comparison between observed and estimated *ECOCADIZ* survey age distribution from 2004 to 2023. Black lines represent estimated data while gray lines represent observed data. The number next to the year indicates the quarter. Note that the time of the survey in the model is assumed to be one quarter before it really happens; this assumption follows from the order of calculations in the model.**

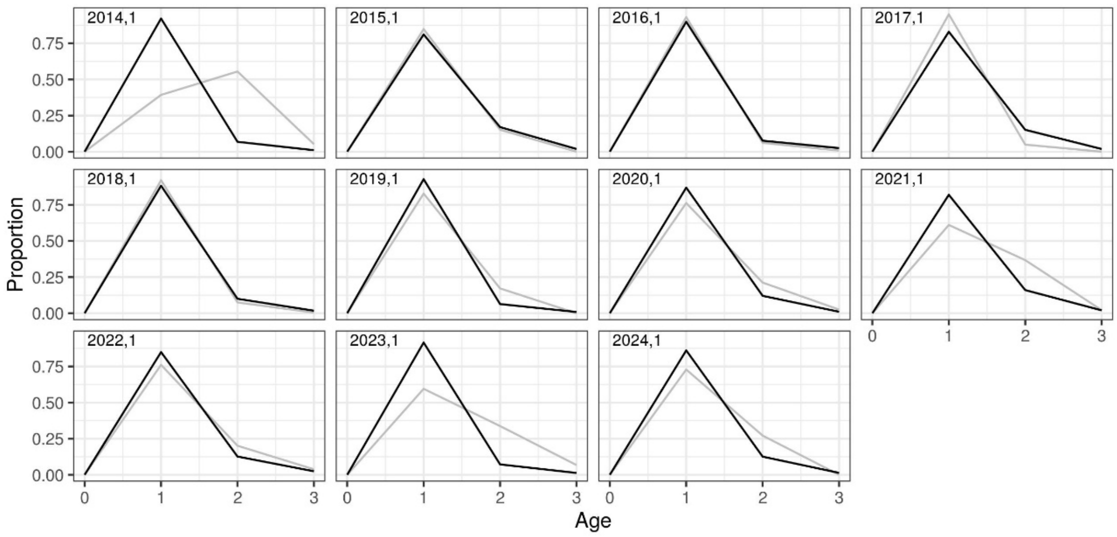



**Figure A7.6.2.1.2.7. Anchovy in Division 9.a. Southern component. Comparison between observed and estimated *PELAGO* survey age distribution from 2014 to 2024. Black lines represent estimated data while gray lines represent observed data. The number next to the year indicates the quarter. Note that the time of the survey in the model is assumed to be one quarter before it really happens; this assumption follows from the order of calculations in the model.**

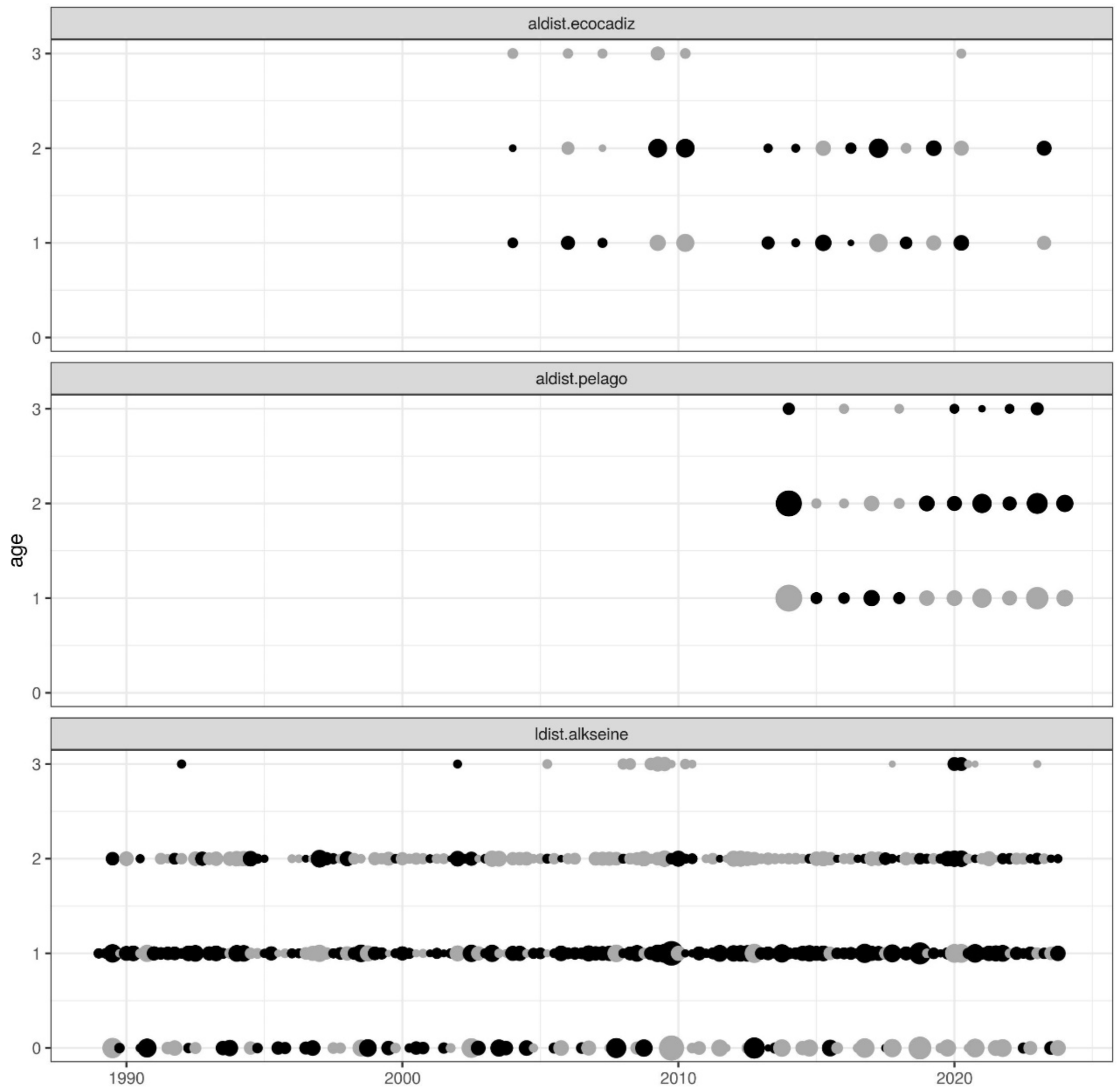



**Figure A7.6.2.1.2.8. Anchovy in Division 9.a. Southern component. Standardised residual plots for the fitted age distribution from the *ECOCADIZ* survey, *PELAGO* survey and commercial fleet. Black points denote a model underestimate and grey points an overestimate. The size of the points denotes the scale of the standardised residual.**

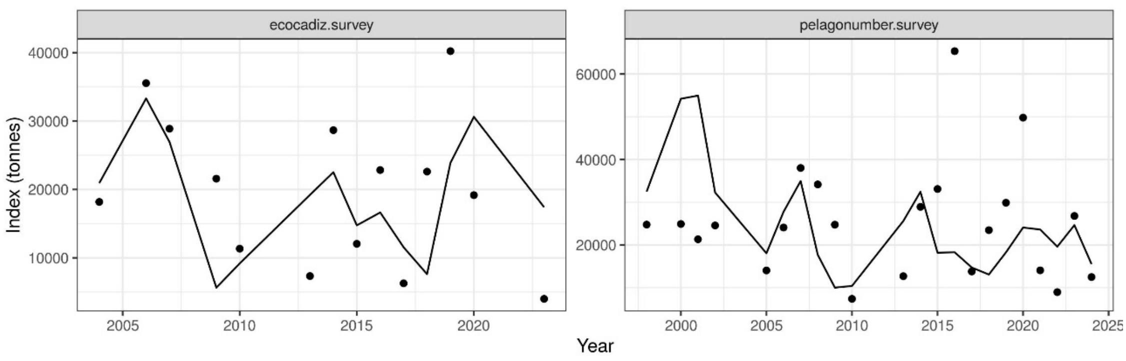



**Figure A7.6.2.1.2.9. Anchovy in Division 9.a. Southern component. Comparison between observed and estimated survey biomass indices. Black points represent observed data while black line represents estimated data.**

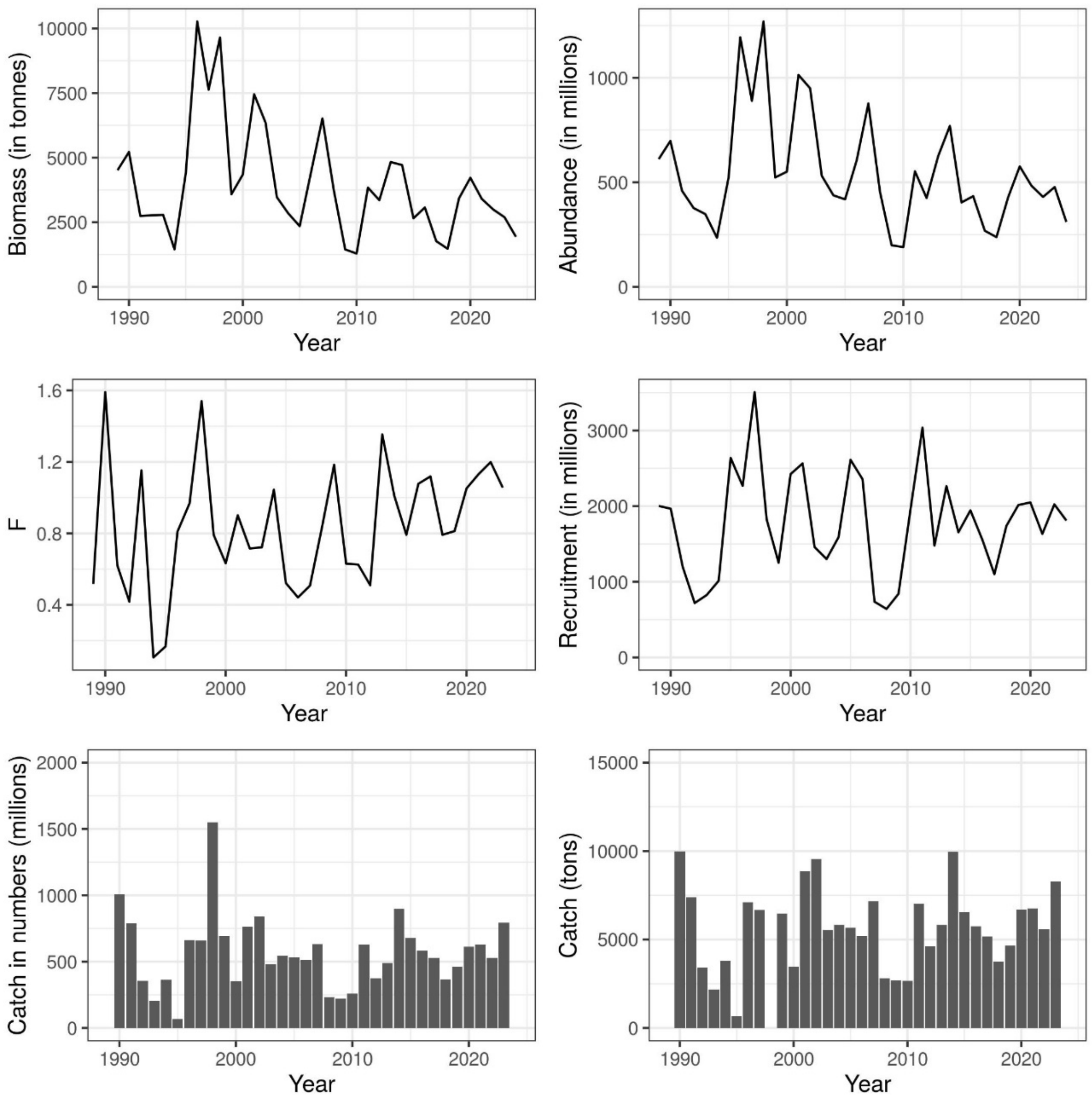



**Figure A7.6.2.1.3.1. Anchovy in Division 9.a. Southern component. Annual model estimates for abundance with more than one year of age (in numbers and biomass), recruitment and fishing mortality compared with annual catch time-series (in numbers and biomass). Measures were summarised at the end of June each year, assuming that a year starts in July and ends in June of the next year.**

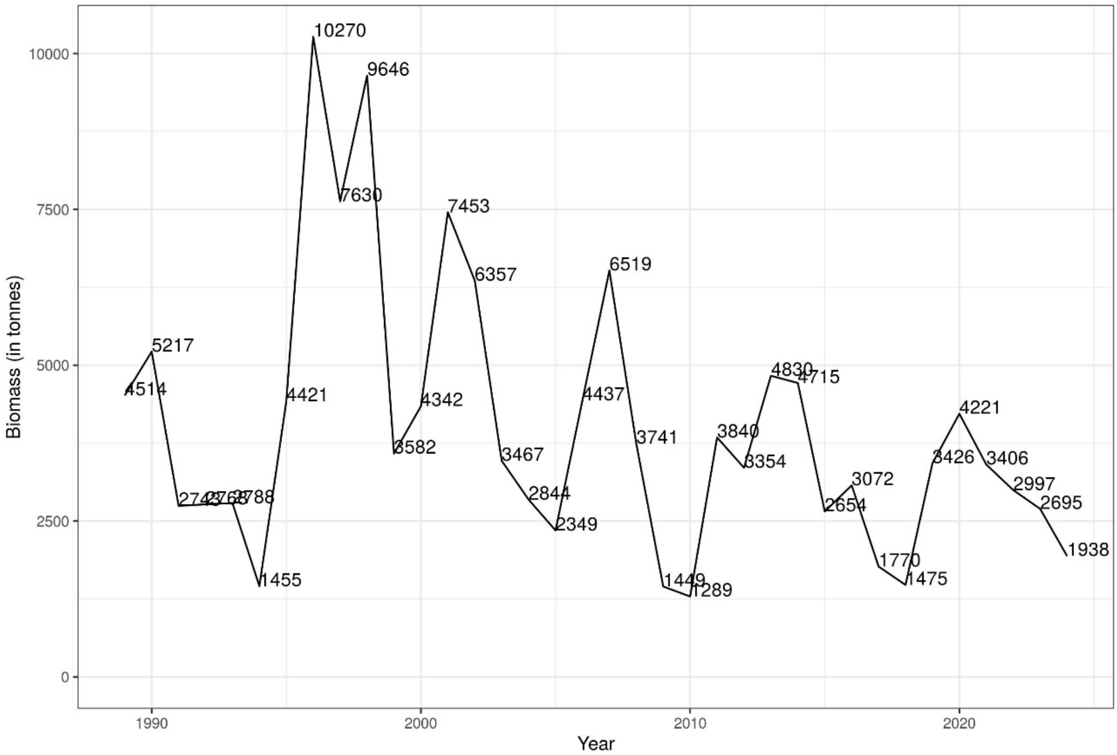



**Figure A7.6.2.1.3.2. Anchovy in Division 9.a. Southern component. Time-series of estimated biomass at the end of June each year, assuming that a year starts in July and ends in June of the next year. For this stock, it is assumed that there are no individuals of age 0 at that time of the year, then this abundance estimates corresponds to individuals of age 1+. These biomass estimates are equivalent to spawning–stock biomass estimates since it is assumed that all individuals with age 1 or higher are mature.**

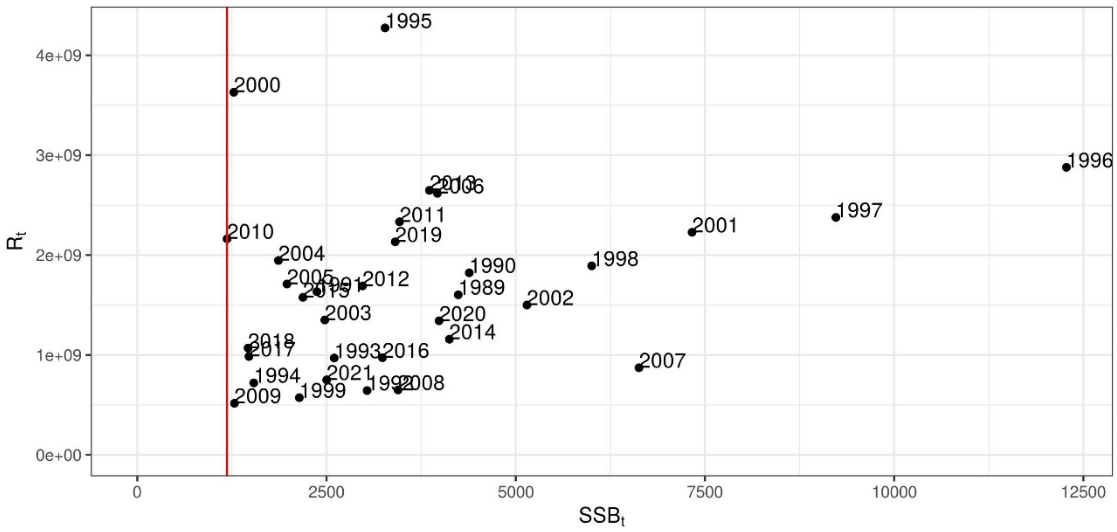



**Figure A7.7.2.1. Anchovy in Division 9.a. Southern component. Estimated Stock Spawning biomass vs. Recruitment plot for 2022. Red line indicates the $B_{lim}$ value ($B_{lim}$=$B_{loss}$=$SSB_{2010}$= 1186.340 t).**

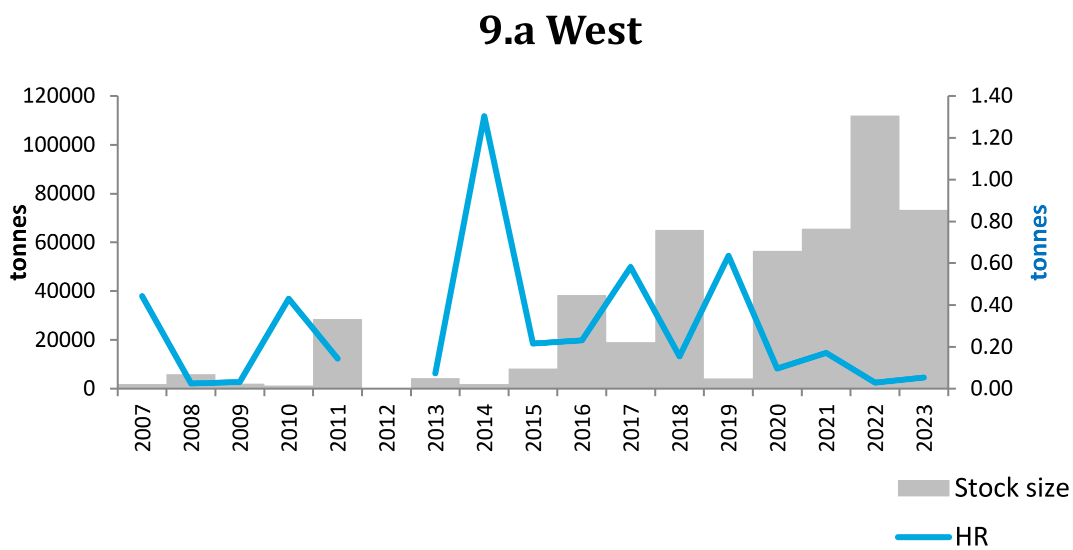



**Figure A7.8.1.1. Anchovy in Division 9.a. Western Component. Stock biomass survey index and harvest rates. Harvest rates were estimated with the biomass of the surveys of a given year and the catches of the management period, i.e. 2007 corresponds to the period 07/2007 to 06/2008.**

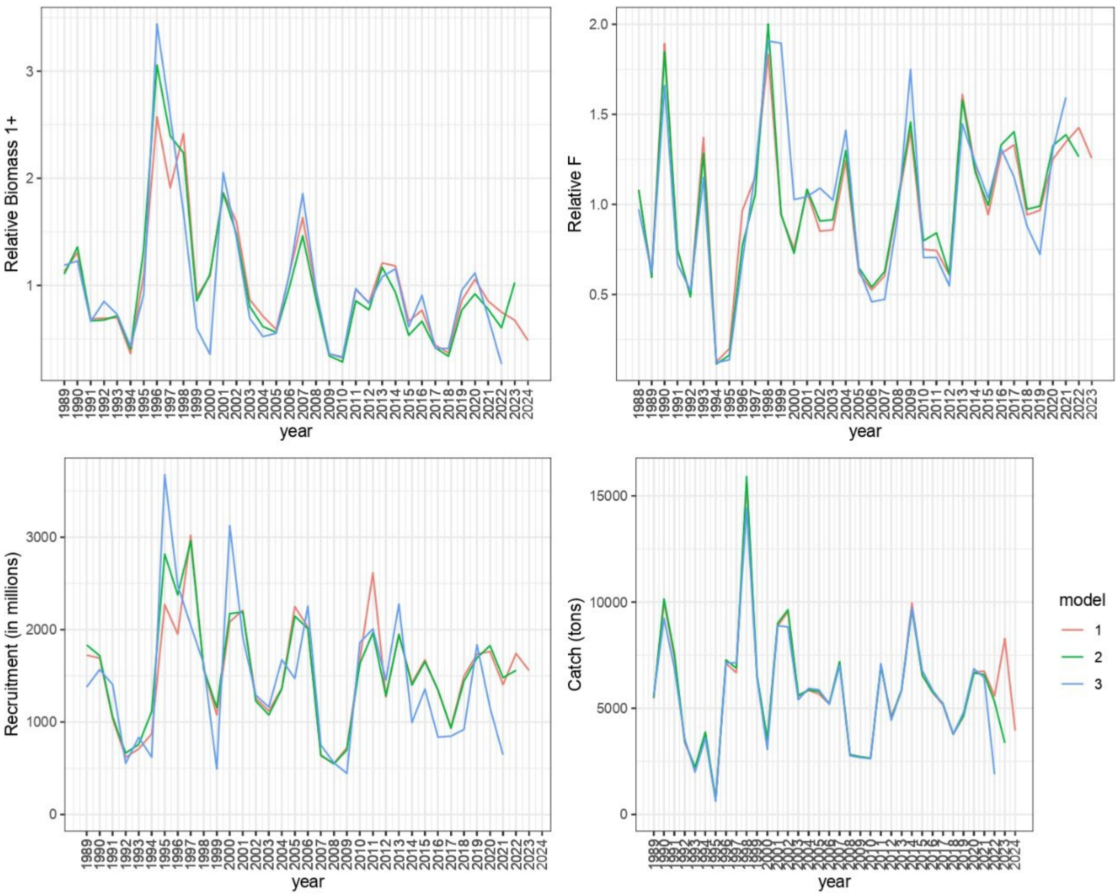



**Figure A7.11.2.1: Anchovy in Division 9.a. Southern component. Comparison of estimates from different model implementations. 1: model used this year (pink); 2: model used last year (green); 3: model used in 2022 (blue). Annual model estimates for: relative abundance of individuals with more than one year of age (upper left), relative fishing mortality (upper right), recruitment (in million fish, bottom left) and catches (in numbers). Measures were summarized at the end of June each year, assuming that a year starts in July and ends in June of the next year.**