

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

VOLUME 6 | ISSUE 46

ICES SCIENTIFIC REPORTS

RAPPORTS
SCIENTIFIQUES DU CIEM



International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

H.C. Andersens Boulevard 44-46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

ISSN number: 2618-1371

This document has been produced under the auspices of an ICES Expert Group or Committee. The contents therein do not necessarily represent the view of the Council.

© 2024 International Council for the Exploration of the Sea

This work is licensed under the Creative Commons Attribution 4.0 International License (CC BY 4.0). For citation of datasets or conditions for use of data to be included in other databases, please refer to ICES data policy.



ICES Scientific Reports

Volume 6 | Issue 46

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

Recommended format for purpose of citation:

ICES. 2024. Working Group on Southern Horse Mackerel, Anchovy and Sardine (WGHANSA).
ICES Scientific Reports. 6:46. 738 pp. <https://doi.org/10.17895/ices.pub.26003356>

Editors

Rosana Ourens

Authors

Leire Cidores • Jose Luis Cebrian • Itsaso Carmona • Gersom Costas • Erwan Duhamel • Susana Garrido
• Leire Ibaibarriaga • Susan Kenyon • Wendell Medeiros • Hugo Mendes • David Miller • Maxime
Olmos • Rosana Ourens • Lionel Pawlowski • Fernando Ramos • Margarita Rincón • Isabel Riveiro •
Laura Wise • Maria Jose Zuniga

Contents

i	Executive summary	1
ii	Expert group information	3
1	Introduction.....	4
1.1	Terms of reference (ToRs)	4
1.1.1	The WG work in relation to the ToRs.....	5
1.2	Report structure.....	7
1.3	Conduct of the meeting	7
1.3.1	List of participants.....	7
1.3.2	Timing of the meeting.....	8
1.3.3	Interactions with other expert groups.....	8
1.4	Quality of the fisheries data.....	8
1.4.1	Overview of sampling activities	8
1.5	Benchmarks and interbenchmarks	10
1.6	Mohn's rho.....	11
1.7	Transparent assessment framework (TAF)	11
1.8	Ecosystem and Fisheries overviews	12
1.9	Research needs	12
2	Anchovy (<i>Engraulis encrasicolus</i>) in Subarea 8 (Bay of Biscay)	13
2.1	The ACOM advice, STECF advice and political decisions.....	13
2.2	The fishery in 2023 and 2024.....	13
2.2.1	Fishing fleets	13
2.2.2	Catches.....	14
2.2.3	Catch numbers-at-age and length	17
2.2.4	Weights and lengths-at-age in the catch	22
2.2.5	Preliminary fishery data in 2024	23
2.3	Fishery independent data	23
2.3.1	BIOMAN DEPM survey 2024	23
2.3.1.1	Survey description	24
2.3.1.2	Total daily egg production estimate	24
2.3.1.3	Daily fecundity and total biomass.....	24
2.3.1.4	Population at age	24
2.3.2	PELGAS spring acoustic survey 2024.....	35
2.3.3	Autumn juvenile acoustic survey 2024 (JUVENA 2024).....	39
2.4	Biological data.....	43
2.4.1	Maturity-at-age.....	43
2.4.2	Natural mortality	43
2.4.3	Weight-at-age in the stock.....	43
2.5	Stock assessment.....	43
2.5.1	Input data.....	43
2.5.2	Model configuration	50
2.5.3	State of the stock	52
2.5.4	Model diagnostics	60
2.5.5	Retrospective pattern	64
2.6	Short-term forecast	66
2.6.1	Evidence for change in the advice	67
2.7	Reference points.....	68
2.8	Management considerations	69
2.9	References	71
3	Anchovy (<i>Engraulis encrasicolus</i>) in the western part of Division 9.a (western Iberian waters).....	73

3.1	ACOM Advice Applicable to the management period July 2024–June 2025	73
3.2	Population structure and stock identity	73
3.3	The fishery in 2023.....	75
3.3.1	Fishing fleets	75
3.3.2	Catches in Division 9.a West.....	75
3.3.2.1	Catches in Division 9.a West.....	75
3.3.3	Discards.....	76
3.3.4	Effort and landings per unit of effort.....	77
3.3.5	Catches by length and catches-at-age	77
3.3.5.1	Length distributions	77
3.3.5.2	Catch numbers-at-age	78
3.3.6	Mean length and mean weight-at-age in the catch.....	78
3.4	Fishery-independent Information.....	78
3.4.1	Spring/summer acoustic surveys	79
3.4.2	Recruitment surveys	81
3.5	Biological data.....	82
3.5.1	Weight-at-age in the stock.....	82
3.5.2	Maturity-at-Age	82
3.5.3	Natural mortality	83
3.6	Stock Assessment.....	83
3.6.1.1	Biomass survey trend as base of the advice	83
3.7	Reference points.....	84
3.8	State of the Stock.....	84
3.9	Catch advice.....	84
3.10	Short-term projections	84
3.11	Quality of the assessment.....	84
3.12	Management considerations	85
3.13	Ecosystem considerations.....	85
3.14	Deviations from stock annex caused by missing information.....	85
3.15	Stock specific Management Strategy Evaluation.....	85
3.16	References	86
3.17	Tables	88
4	Anchovy (<i>Engraulis encrasicolus</i>) in the southern part of Division 9.a (Gulf of Cadiz and southern coast of Portugal).....	118
4.1	ACOM Advice in 2024	118
4.2	Population structure and stock identity	118
4.3	The fishery in 2023 and 2024 (preliminary data).....	120
4.3.1	Fishing fleets	120
4.3.2	Catches.....	120
4.3.3	Discards.....	121
4.3.4	Effort and landings per unit of effort	121
4.3.5	Catches by length and catches-at-age	121
4.3.5.1	Length distributions	122
4.3.5.2	Catch numbers-at-age	122
4.3.6	Mean length and mean weight-at-age in the catch.....	123
4.4	Fishery-independent Information.....	123
4.4.1	DEPM-based SSB estimates	123
4.4.2	Spring/summer acoustic-trawl surveys	124
4.4.3	Recruitment acoustic-trawl surveys	127
4.5	Biological data.....	130
4.5.1	Weight-at-age in the stock.....	130
4.5.2	Maturity-at-Age	130
4.5.3	Natural mortality	130

4.6	Stock Assessment.....	130
4.6.1	Model assumptions and settings and parameter estimates.....	130
4.6.2	Reliability of the assessment	132
4.7	Reference points.....	133
4.8	Catch advice.....	134
4.9	Short-term projections	134
4.10	Management considerations	134
4.11	Ecosystem considerations.....	135
4.12	Deviations from stock annex caused by missing information.....	135
4.13	References	136
5	Horse Mackerel (<i>Trachurus trachurus</i>) in Subarea 9.a (Atlantic Iberian waters)	211
5.1	ACOM Advice applicable to 2024, 2023, STECF advice and political decisions.....	211
5.2	The fishery in 2023.....	211
5.2.1	Fishing fleets in 2023	211
5.2.2	Catches by fleet and area.....	212
5.2.3	Effort and catch per unit of effort.....	219
5.2.4	Catches by length and catches-at-age	220
5.2.5	Mean weight-at-age in the catch	228
5.3	Fishery-independent information.....	232
5.3.1	Bottom-trawl surveys	233
5.3.2	DEPM egg survey	236
5.3.3	Mean length and mean weight-at-age in the stock.....	238
5.3.4	Maturity-at-age.....	238
5.3.5	Natural mortality	238
5.4	Stock assessment.....	239
5.4.1	Model assumptions and settings and parameter estimates.....	239
5.4.2	Reliability of the assessment	244
5.5	Short-term predictions	250
5.6	Biological reference points	251
5.7	Management considerations	252
5.8	Reference	253
6	Sardine (<i>Sardina pilchardus</i>) in divisions 8.a-b and 8.d (Bay of Biscay).....	255
6.1	Population structure and stock identity	255
6.2	Input data in 8.a, b, d.....	255
6.2.1	Catch data in divisions 8.a, b, d.....	255
6.2.2	Surveys in divisions 8abd	258
6.2.2.1	DEPM surveys in Divisions 8abd	258
6.2.2.2	Acoustic spring survey (PELGAS): 8ab.....	264
6.2.3	Biological data.....	268
6.2.3.1	Catch numbers-at-length and age	268
6.2.3.2	Mean length and mean weight-at-age	268
6.2.3.3	Maturity	273
6.3	Stock assessment.....	274
6.3.1	Historical stock development	274
6.3.2	State of the stock	275
6.3.3	Diagnostics	278
6.3.4	Retrospective pattern	280
6.4	Short-term projections	282
6.4.1	Evidence for changes in advice	284
6.5	Medium-term projection	286
6.6	MSY and Biological reference points	287
6.7	Management plan.....	289
6.8	Uncertainties and bias in assessment and forecast.....	289

6.9	Management considerations	289
6.10	References	290
7	Sardine (<i>Sardina pilchardus</i>) in Subarea 7 (southern Celtic Seas and the English Channel)	291
7.1	Population structure and stock identity	291
7.2	The fishery	291
7.2.1	Analysis of the catch	291
7.3	Biological data.....	292
7.3.1	Size composition of the catch	292
7.4	Fishery-independent information.....	292
7.4.1	The PELTIC survey	292
7.5	Stock assessment.....	293
7.5.1	SPiCT	293
7.5.2	1-over-2 rule	294
7.6	Short-term projections	294
7.7	Reference points	294
7.8	Quality of the assessment.....	294
7.9	Management considerations	295
7.10	References	295
7.11	Tables	297
7.12	Figures.....	304
8	Sardina pilchardus in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters)	312
8.1	ACOM Advice Applicable to 2024, STECF advice and Political decisions	312
8.2	The fishery in 2023.....	312
8.2.1	Fishing fleets in 2023	312
8.2.2	Catches by fleet and area.....	313
8.2.3	Effort and catch per unit of effort.....	313
8.2.4	Catches by length and catches-at-age	313
8.2.5	Mean length and mean weight-at-age in the catch.....	314
8.3	Fishery-independent information.....	314
8.3.1	Iberian DEPM survey (PT-DEPM-PIL+SAREVA).....	314
8.3.2	Spring Iberian acoustic survey (PELACUS-PELAGO)	314
8.3.2.1	Portuguese spring acoustic survey	315
8.3.2.2	Spanish spring acoustic survey	315
8.3.3	Autumn acoustic survey index.....	316
8.3.4	Mean weight-at-age in the stock and in the catch	317
8.3.5	Maturity-at-age.....	317
8.3.6	Natural mortality	317
8.3.7	Catch-at-age and abundance-at-age in the spring acoustic survey	318
8.4	Assessment Data of the state of the stock	318
8.4.1	Stock assessment.....	318
8.5	Retrospective pattern	321
8.6	Short-term predictions	321
8.6.1	Evidence for change in advice	321
8.7	Reference points	322
8.8	Management considerations	322
8.9	References	323
8.10	Tables	325
9	Blue jack mackerel (<i>Trachurus picturatus</i>) in Subdivision 10.a.2 (Azores grounds)	362
9.1	Blue Jack Mackerel in ICES areas	362
9.2	The fishery in 2022 and 2023.....	363
9.2.1	Fishing Fleets.....	363
9.2.2	Catches.....	364
9.2.3	Effort	364

9.3	Basis of the advice	365
9.4	Catch scenarios for 2025 and 2026.....	365
9.5	Management considerations	365
9.6	Suggested inter-seasonal work.....	366
9.7	References	367
9.8	Tables	368
9.9	Figures.....	370
Annex 1:	List of participants.....	372
Annex 2:	Joint sessions WGACEGG-WGHANSA	374
	Joint session in May 2024.....	374
	Joint session in November 2024.....	374
Annex 3:	Stock Annexes	375
Annex 4:	Audits	376
	Review of ICES Scientific Report, WGHANSA-1 2024	376
	Review of ICES Scientific Report, WGHANSA-2 2024	380
Annex 5:	Working Documents	393
Annex 6:	Survey Sheets.....	613
Annex 7:	Report section for Anchovy 9.a, now replaced.....	640
	ACOM Advice applicable to the management period July 2023-June 2024.....	640
	Population structure and stock identity.....	640
	The fishery in 2023	641
	Fishing fleets.....	641
	Catches by stock component.....	642
	Discards	643
	Effort and landings per unit of effort	644
	Catches by length and catches-at-age by stock component	645
	Length distributions.....	645
	Catch numbers-at-age	646
	Mean length and mean weight-at-age in the catch	647
	Fishery-independent information	647
	DEPM-based SSB estimates	647
	Spring/summer acoustic surveys.....	649
	Recruitment surveys.....	653
	Biological data	655
	Weight-at-age in the stock	655
	Maturity-at-age	656
	Natural mortality	656
	Stock assessment	656
	Western component	657
	Biomass survey trend as base of the advice.....	657
	Southern component	657
	Model used as basis of the advice.....	657
	The catch advice	659
	Reference points	659
	Western component	659
	Southern component	659
	State of the stock.....	659
	Western component	659
	Southern component	660
	Catch advice	660
	Western component	660
	Southern component	660
	Short-term projections	660

Quality of the assessment	660
Western component	660
Southern component	661
Management considerations.....	661
Ecosystem considerations	661
Deviations from stock annex caused by missing information.....	661
Stock specific Management Strategy Evaluation	663
Western component	663
Southern component	663
References.....	664
Tables and figures.....	666

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 2024¹. 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	Advice to be provided in 2024	Periodicity in years	Time period for releasing the advice	Category	Assessment method	Advice basis
Anchovy (<i>Engraulis encrasiculus</i>) in the western part of Division 9.a (western Iberian waters)	ane.2 7.9a W	Susana Garrido	Yes	1	June (reopened in December 2024)	3	Survey trends based	MSY, in-year advice
Anchovy (<i>Engraulis encrasiculus</i>) in the southern part of Division 9.a (Gulf of Cadiz and the southern coast of Portugal)	ane.2 7.9aS	María José Zuñiga	Fernando Ramos	Yes	1	December (since 2024)	1	Stock Synthesis PA
Horse mackerel (<i>Trachurus trachurus</i>) in Division 9.a (Atlantic Iberian waters)	hom. 27.9a	José Luis Cebrián	Hugo Mendes	Yes	1	June	1	Stock Synthesis MSY
Anchovy (<i>Engraulis encrasiculus</i>) in Subarea 8 (Bay of Biscay)	ane.2 7.8	Leire Citores	Leire Ibaibarriaga	Yes	1	December	1	Stock synthesis Management plan
Sardine (<i>Sardina pilchardus</i>) 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 (<i>Sardina pilchardus</i>) 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 (<i>Sardina pilchardus</i>) 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 (<i>Trachurus picturatus</i>) in Subdivision 10.a.2 (Azores grounds)	jaa.2 7.10a 2	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 (<i>Engraulis encrasiculus</i>) in the western part of Division 9.a (Western Iberian waters)	ane.27.9aW	Full Benchmark 2018 Full benchmark 2024	
Anchovy (<i>Engraulis encrasiculus</i>) in the subdivision 9.a.S (Gulf of Cadiz)	ane.27.9aS	Full Benchmark 2018 Full benchmark 2024	
Horse mackerel (<i>Trachurus trachurus</i>) in Division 9.a (Atlantic Iberian waters)	hom.27.9a	Full benchmark 2011 Full benchmark 2017 Full benchmark 2024	
Anchovy (<i>Engraulis encrasiculus</i>) in Subarea 8 (Bay of Biscay)	ane.27.8	Full benchmark 2013 Full benchmark 2024	
Sardine (<i>Sardina pilchardus</i>) in Subarea 7 (Southern Celtic Seas, and the English Channel)	pil.27.7	Full benchmark 2013 Full benchmark 2017 Full benchmark 2021	
Sardine (<i>Sardina pilchardus</i>) in divisions 8.a–b and 8.d (Bay of Biscay)	pil.27.8abd	Full benchmark 2013 Full benchmark 2017 Inter-benchmark 2019	x
Sardine (<i>Sardina pilchardus</i>) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters)	pil.27.8c9a	Full benchmark 2013 Full benchmark 2017 Reference points updated in 2021 Inter-benchmark 2021	
Jack mackerel (<i>Trachurus pictoratus</i>) 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 (<i>Trachurus trachurus</i>) in Division 9a	hom.27.9a	2023	5	-0.11	No	0.05	No	-0.12
Anchovy (<i>Engraulis encrasicolus</i>) in Sub-area 8	ane.27.8	2024	5	-0.25	yes	0.43	yes	-0.30
Anchovy (<i>Engraulis encrasicolus</i>) in sub-division 9aS	ane.27.9aS	2024	5	0.33	yes	-0.13	yes	0.04
Sardine (<i>Sardinops pilchardus</i>) in divisions 8a-b and 8d	pil.27.8abd	2024	5	-0.15	yes	0.26	yes	0.33
Sardine (<i>Sardinops pilchardus</i>) 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 extend 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	VIII ^a b	VIII ^a c	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%	

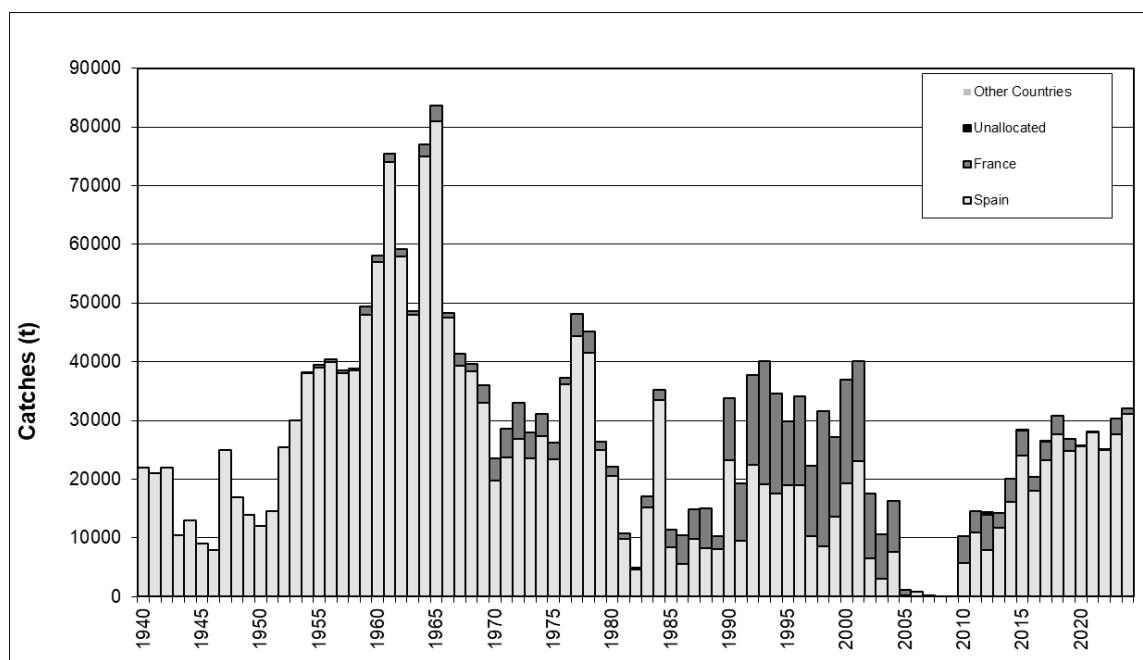


Figure 2.2.2.1: Bay of Biscay anchovy: Historical evolution of catches in Subarea 8 by countries. 2024 data are preliminary.

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	VIIIabc	VIIIabc	VIIIabc	VIIIabc	VIIIabc
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%
FRANCE	QUARTERS	1	2	3	4	Annual total
	AGE	VIIIab	VIIIab	VIIIab	VIIIab	VIIIab
	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%
TOTAL Sub-area 8	QUARTERS	1	2	3	4	Annual total
	AGE	VIIIabc	VIIIabc	VIIIabc	VIIIabc	VIIIabc
	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.

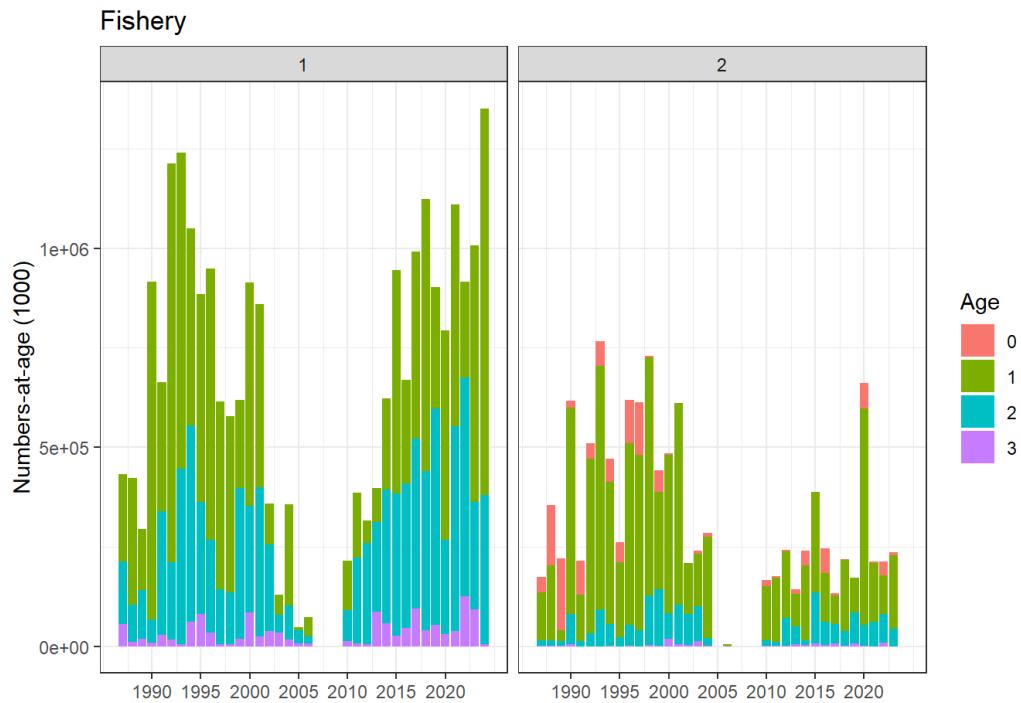


Figure 2.2.3.1: Bay of Biscay anchovy: Numbers-at-age by semester. The age classes are 0, 1, 2 and 3+.

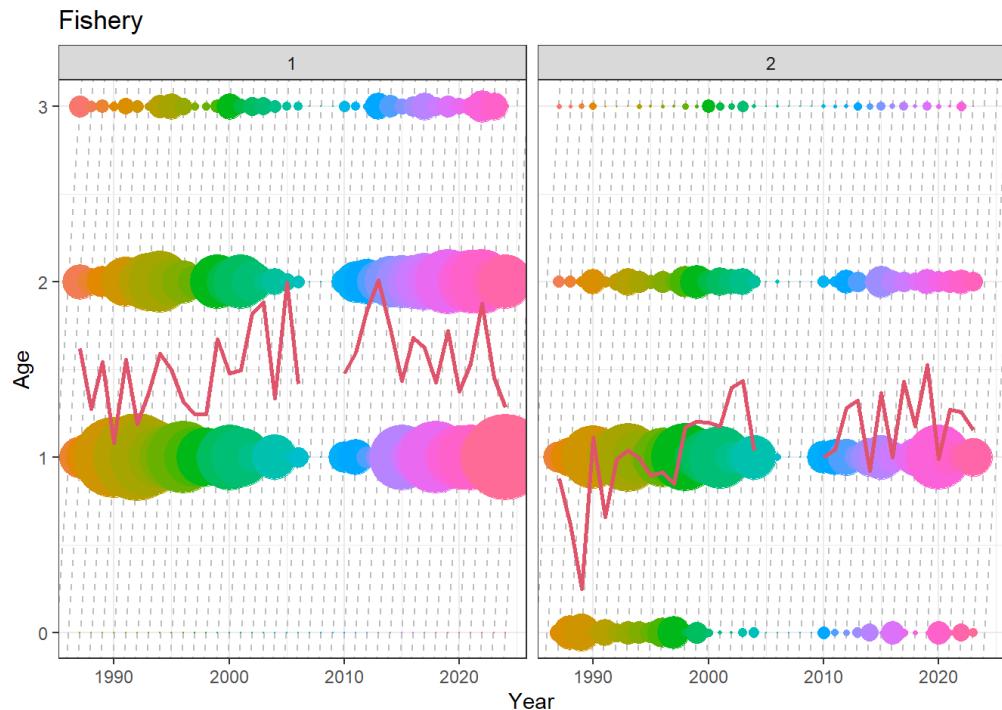


Figure 2.2.3.2: Bay of Biscay anchovy: Bubble plot of catch-at-age by semester. The red lines represent the mean age in the catches for each of the semesters.

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.

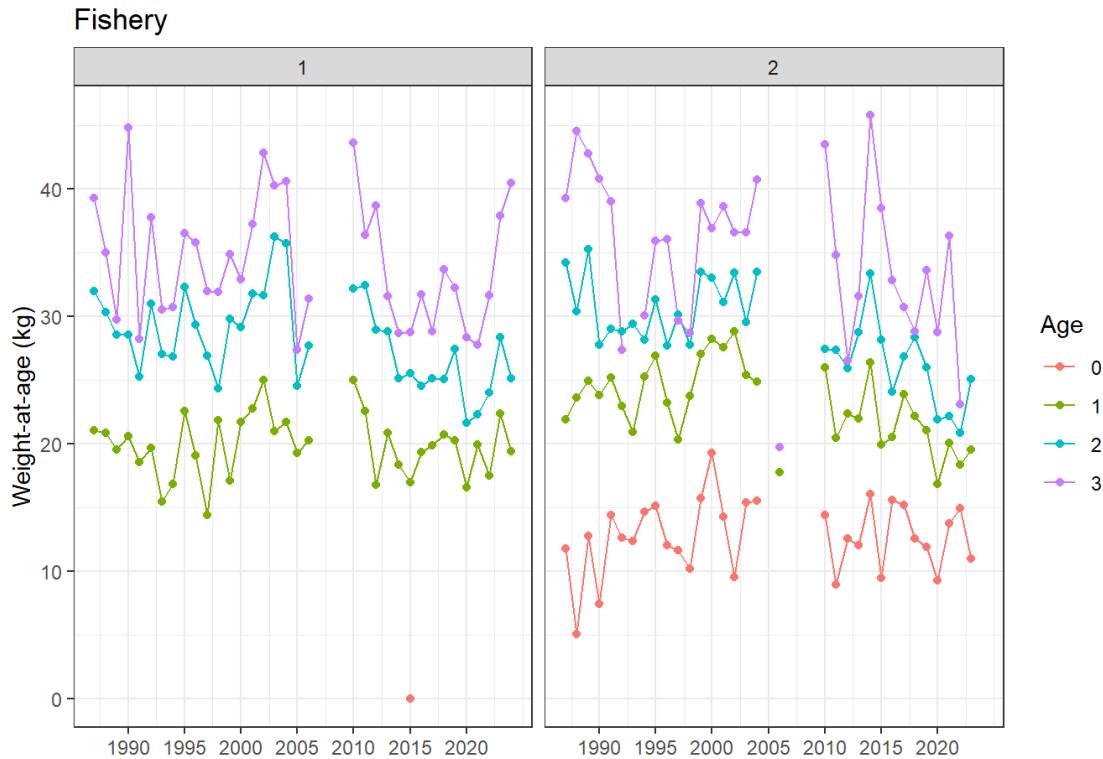


Figure 2.2.4.1: Bay of Biscay anchovy: Mean weight-at-age (grammes) in the international catches on half-year basis. Units: grammes.

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. From 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 6°20'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 (48°N) (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 were: 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(P_0), daily egg mortality rates (z) and total egg production (P_{tot}) 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 P_0 , z , spawning area and P_{tot} .

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 (E), 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	<i>Vizcon de Eza & Emma Bardán</i>
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/m ²
Max. anchovy eggs in a St	4 490 eggs/m ²
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 Km ²
Spawning area for anchovy	101 890 Km ²
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 (P_0) (egg/m²/day), daily mortality rates (z) and total daily egg production (P_{tot})(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

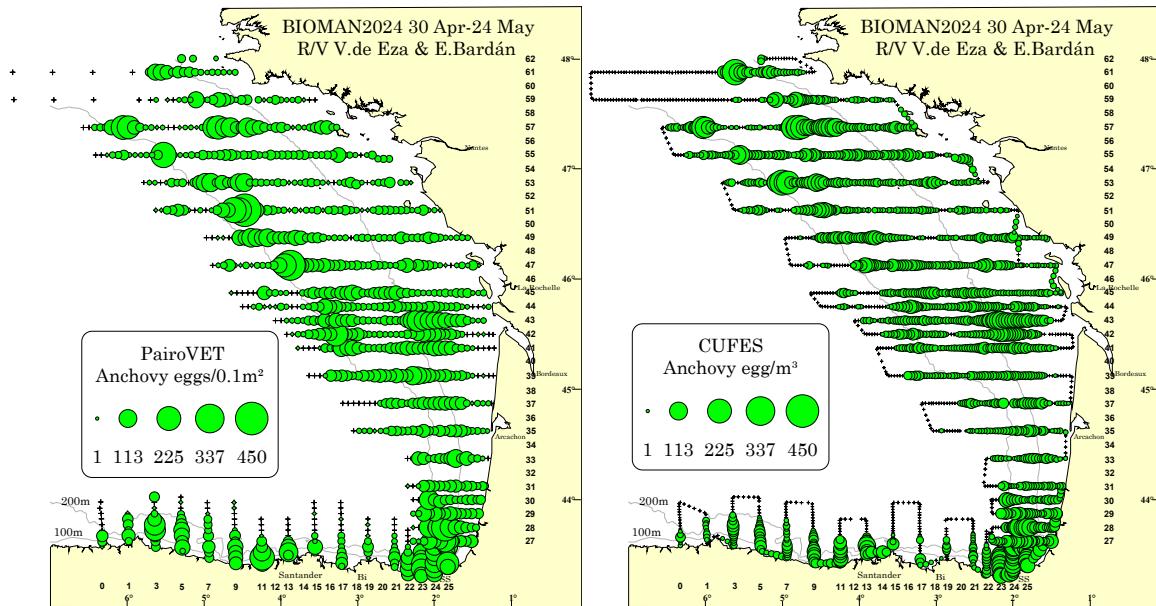


Figure 2.3.1.1: Bay of Biscay anchovy: Spatial distribution and abundance of anchovy egg obtained with PairoVET (vertical sampling net) (eggs per 0.1 m^2) (left) and CUFES (horizontal sampling net) (egg/ m^3) obtained during the DEPM survey BIOMAN2024.

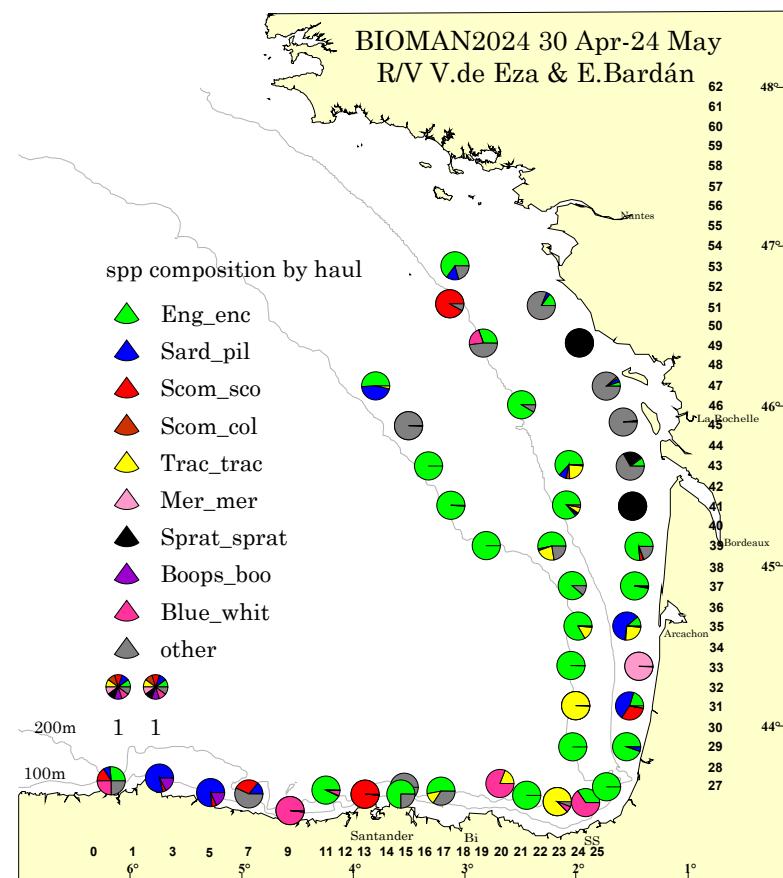


Figure 2.3.1.2: Bay of Biscay anchovy: Species composition of the 44 hauls selected for the adult parameters analysis for the application of the DEPM.

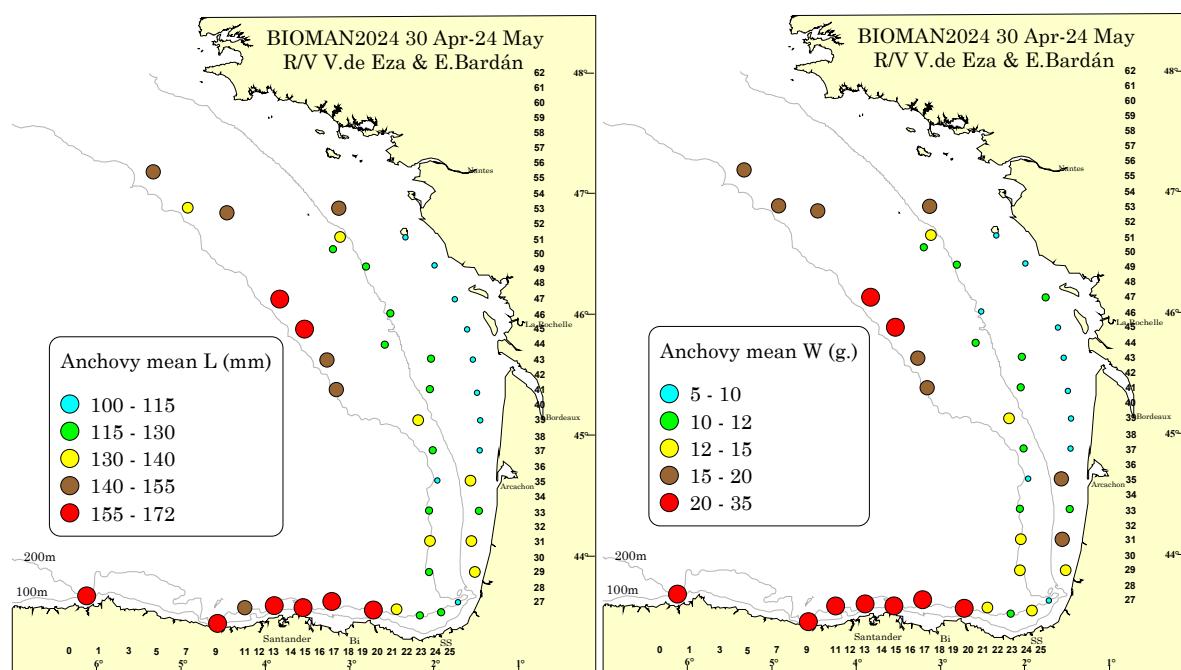


Figure 2.3.1.3: Bay of Biscay anchovy: Spatial distribution of anchovy mean length (left) and mean weight (right) (males and females) by haul during BIOMAN2024.

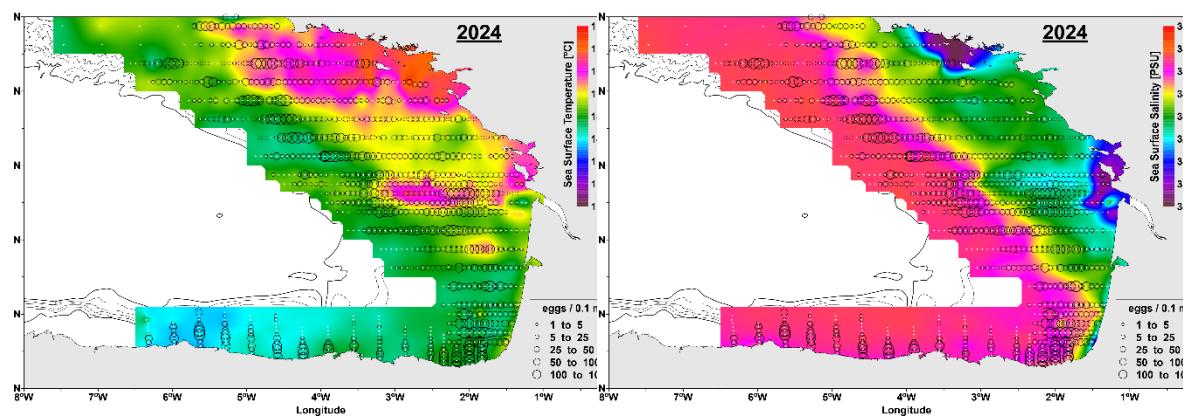


Figure 2.3.1.4: Bay of Biscay anchovy: Spatial distribution of sea surface temperature (left) and sea surface salinity (right) during BIOMAN 2024 with the anchovy egg abundances spatial distribution.

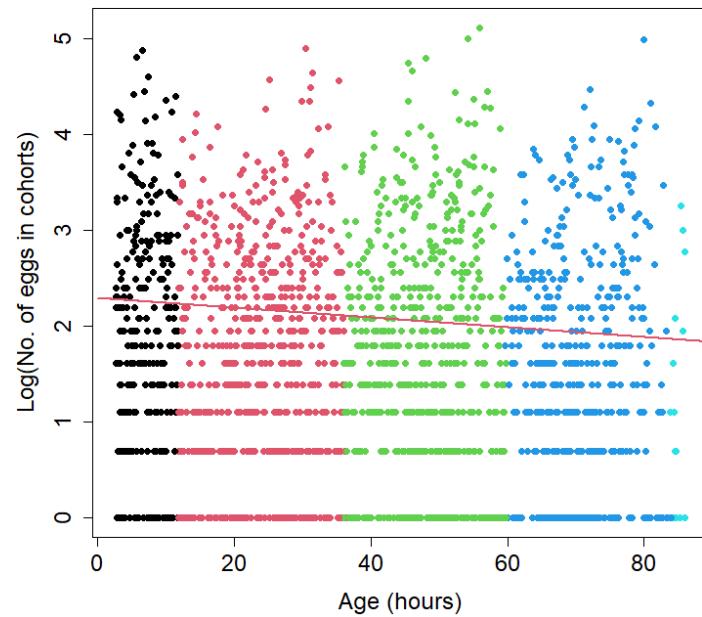


Figure 2.3.1.5: Bay of Biscay anchovy: Exponential mortality model in log scale adjusted applying a GLM to the data obtained in the Bayesian egg ageing (spawning peak at 23:00h GMT). The red line is the adjusted line. The coloured dots represent the different cohorts.

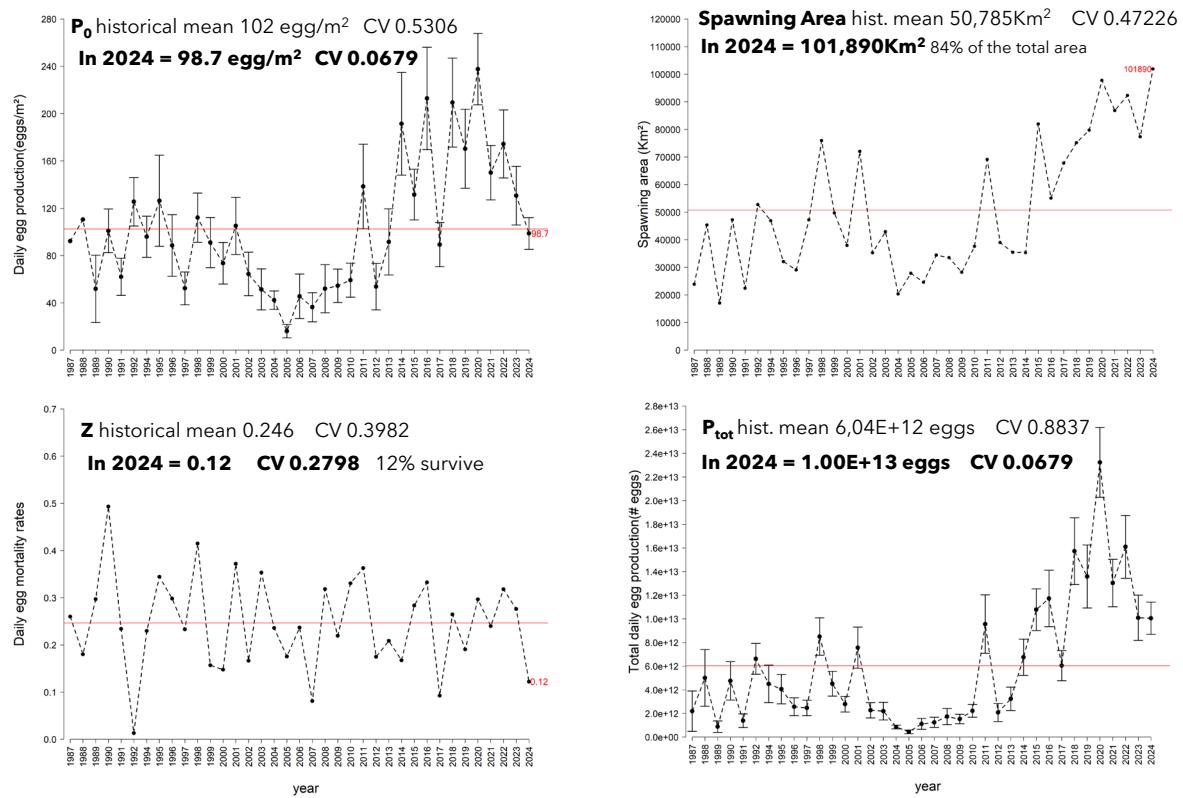


Figure 2.3.1.6: Bay of Biscay anchovy: historical series including 2024 estimates for daily egg production (P_0) (egg/m²/day), spawning area (Km²), daily mortality rates (Z) and total daily egg production (P_{tot})(eggs/day) in the Bay of Biscay (ICES 8abcd). The historical mean is also shown with a CV as the coefficient of variation over time for each parameter.

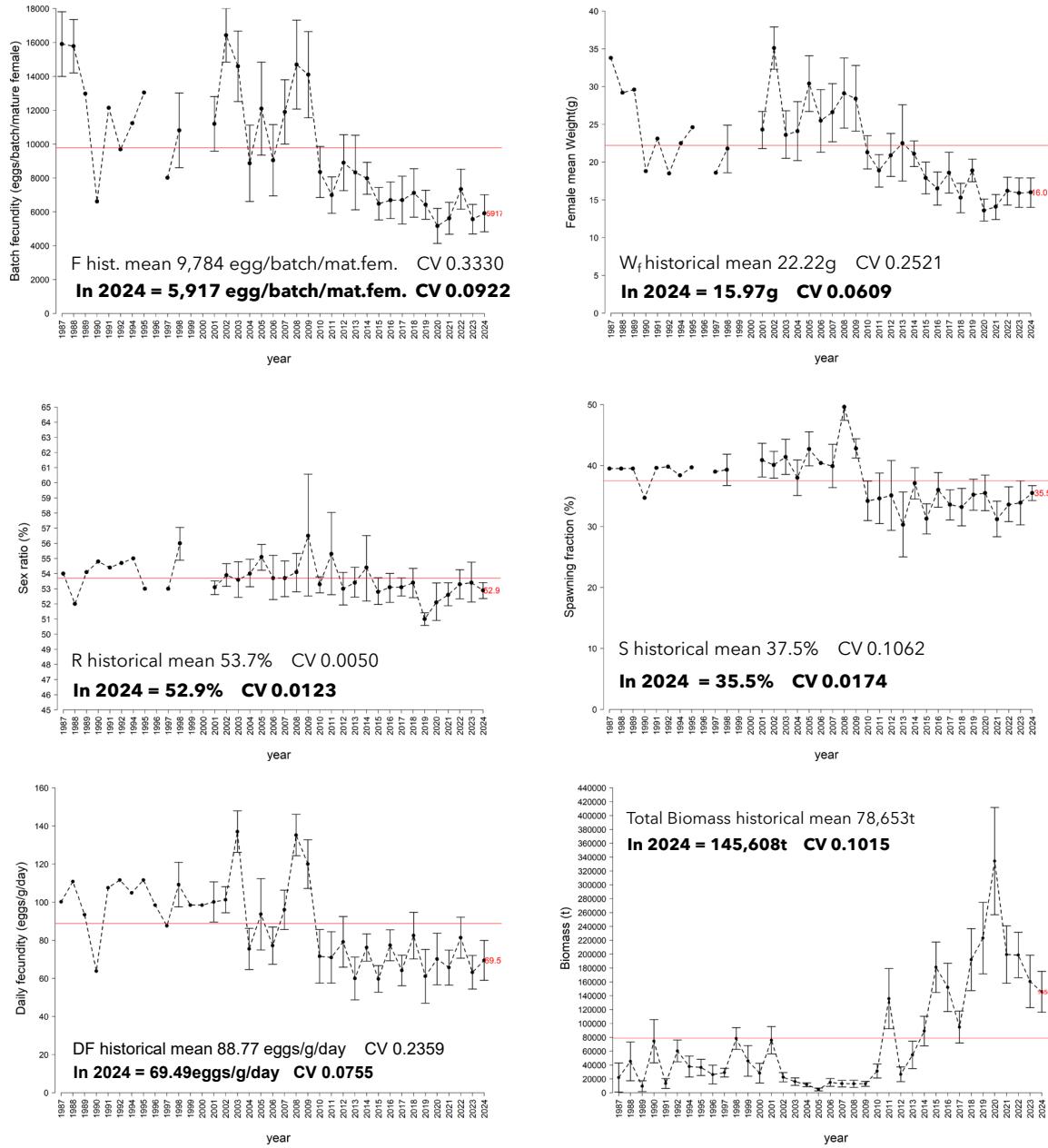


Figure 2.3.1.7: Bay of Biscay anchovy: historical series including 2024 estimates of the adult parameters in the Bay of Biscay (ICES 8abcd): batch fecundity (F) (eggs/batch/mature female), female mean weight (W_f)(g), sex ratio (R) (% of females), spawning fraction (S) (% of females spawning per day), 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.

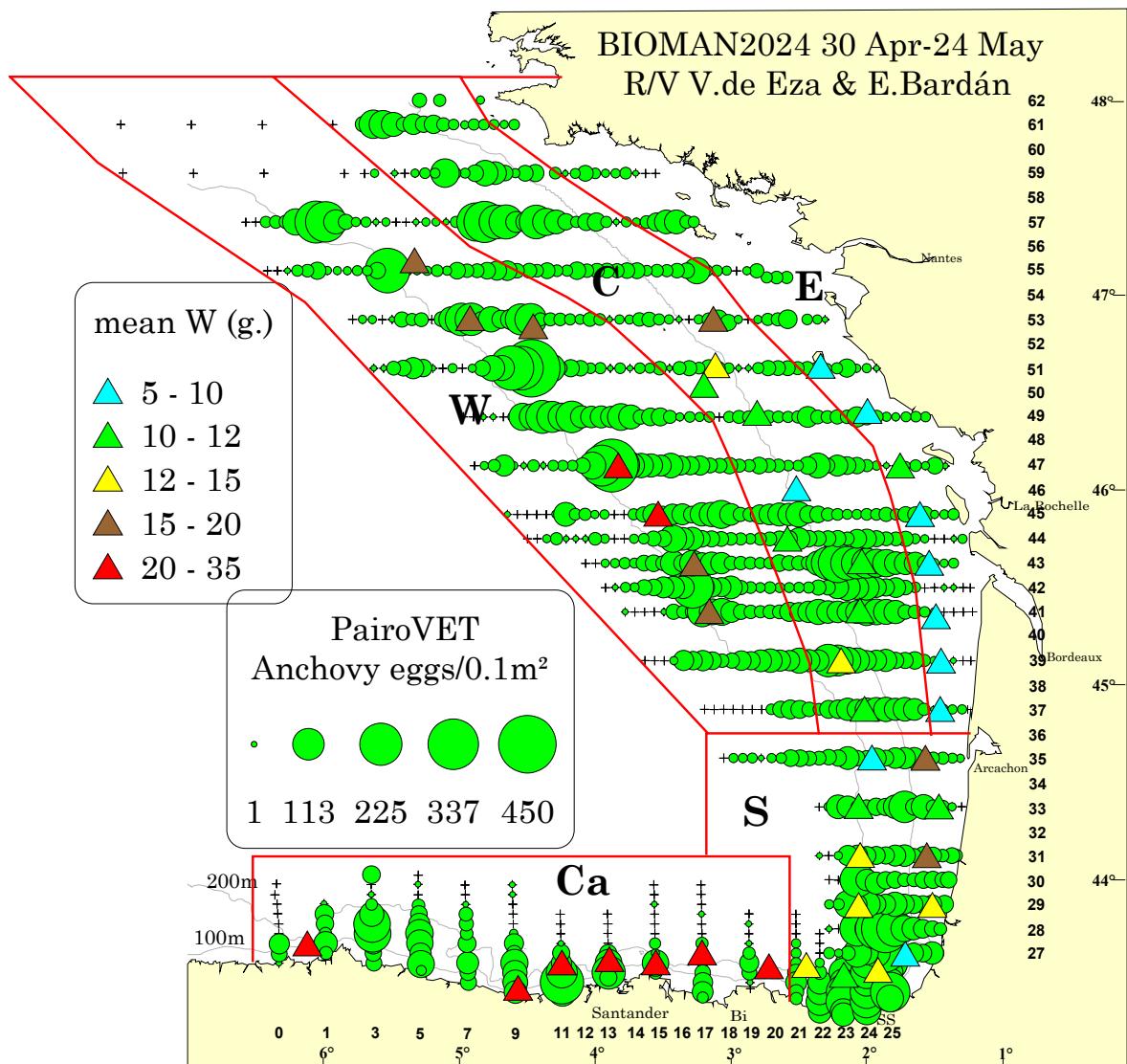


Figure 2.3.1.8: Bay of Biscay anchovy: 5 regions were defined to weight the adult samples to estimate anchovy numbers at age in 2024: Cantabrian (Ca), South (S), East €, Centre (C) and West (W). The red lines represent the border of the regions, the green bubbles the abundance of anchovy eggs (egg/0.1m²)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

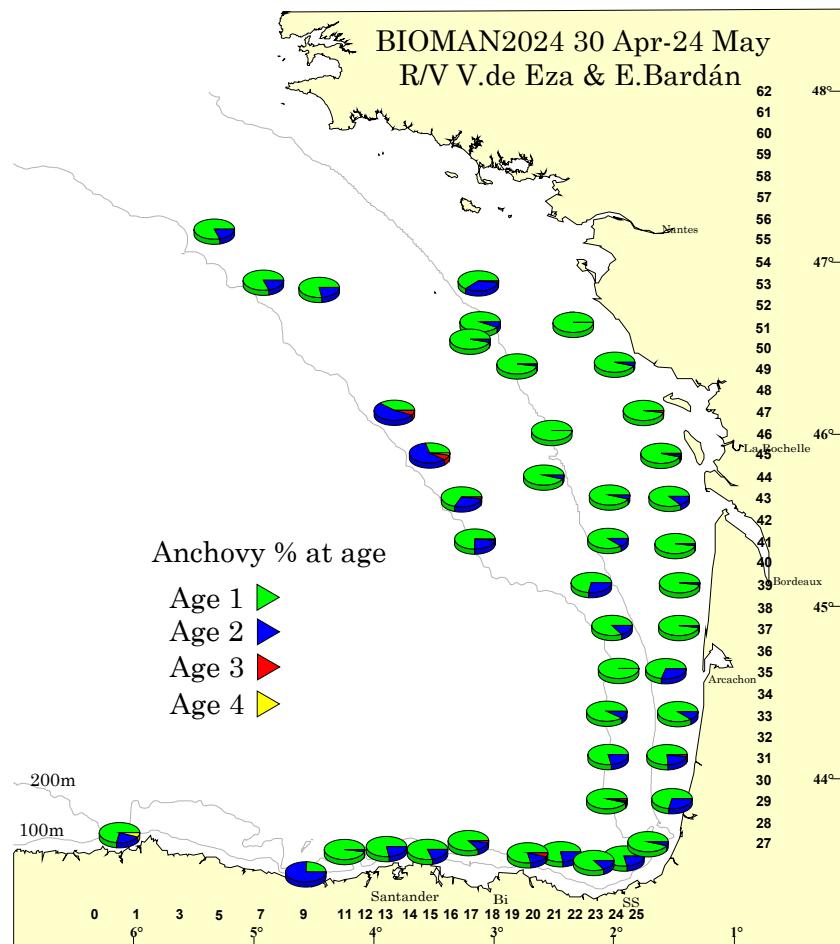


Figure 2.3.1.9: Bay of Biscay anchovy: Age composition in space by haul during BIOMAN2024

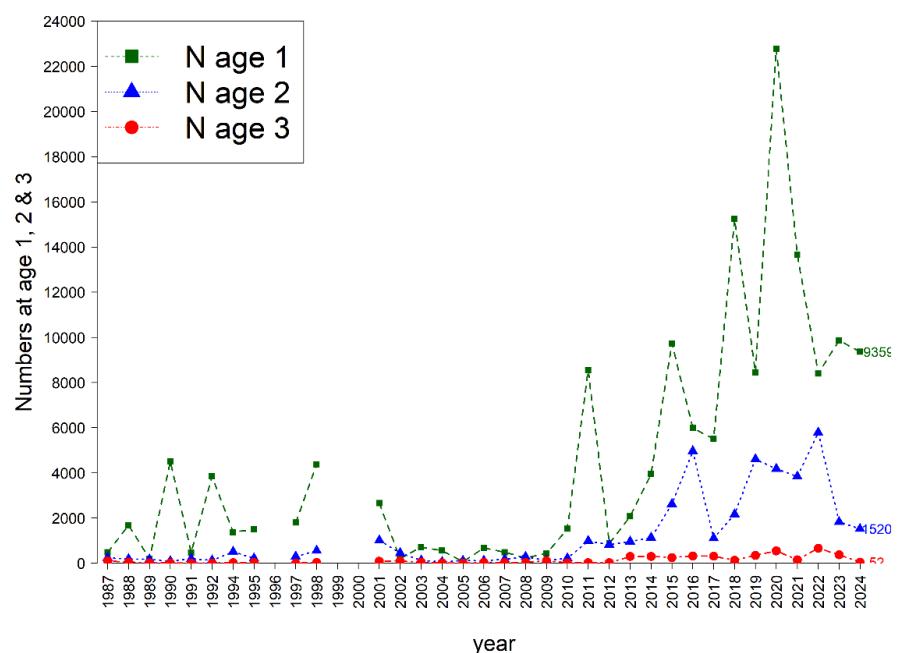


Figure 2.3.1.10: Bay of Biscay anchovy: Historical series of numbers at age. 1987 to 2024 from BIOMAN surveys.

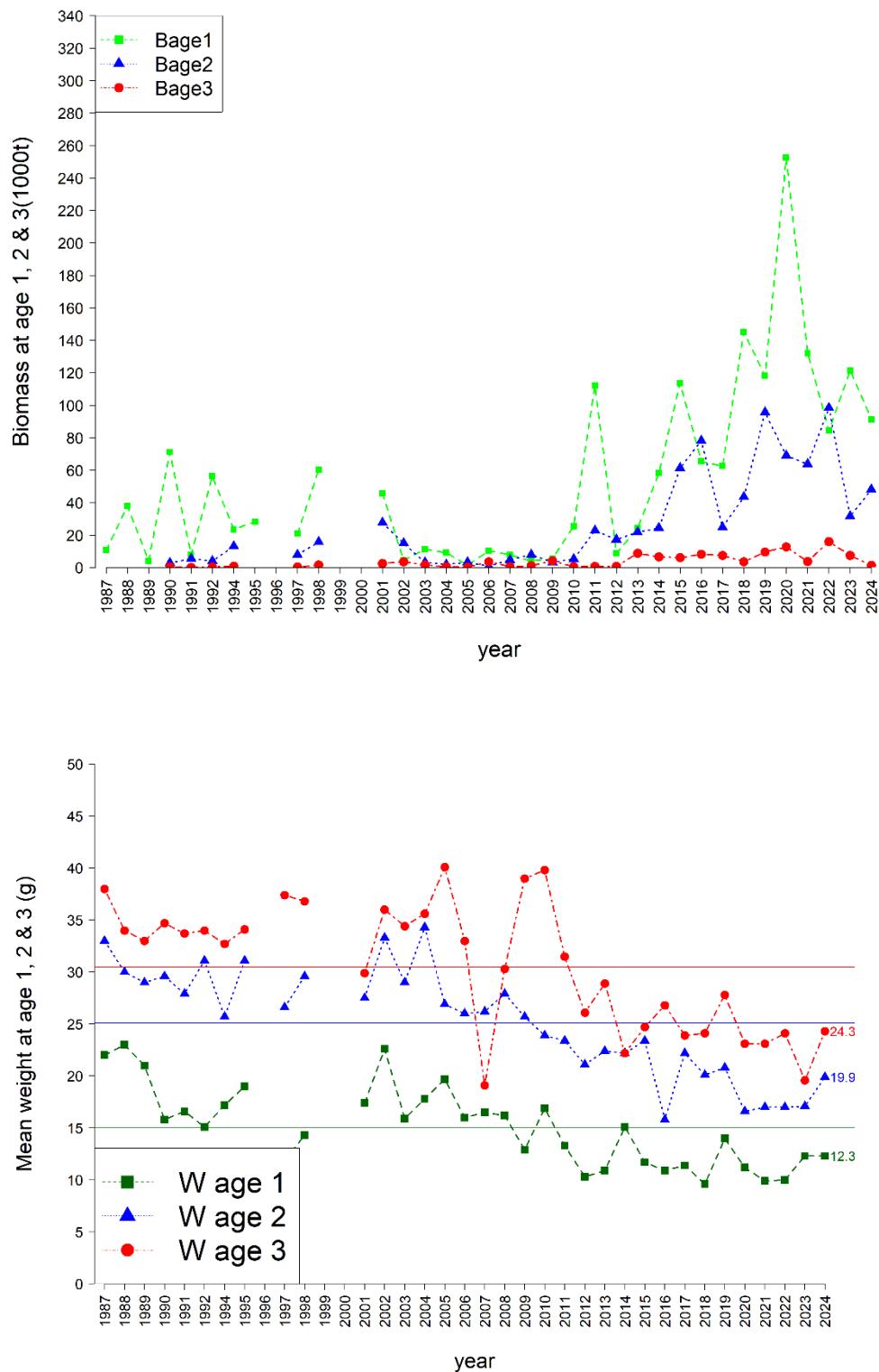


Figure 2.3.1.11: Bay of Biscay anchovy: Historical series (1987-2024) of total biomass at age and mean weight at age. The lines are the historical means

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).

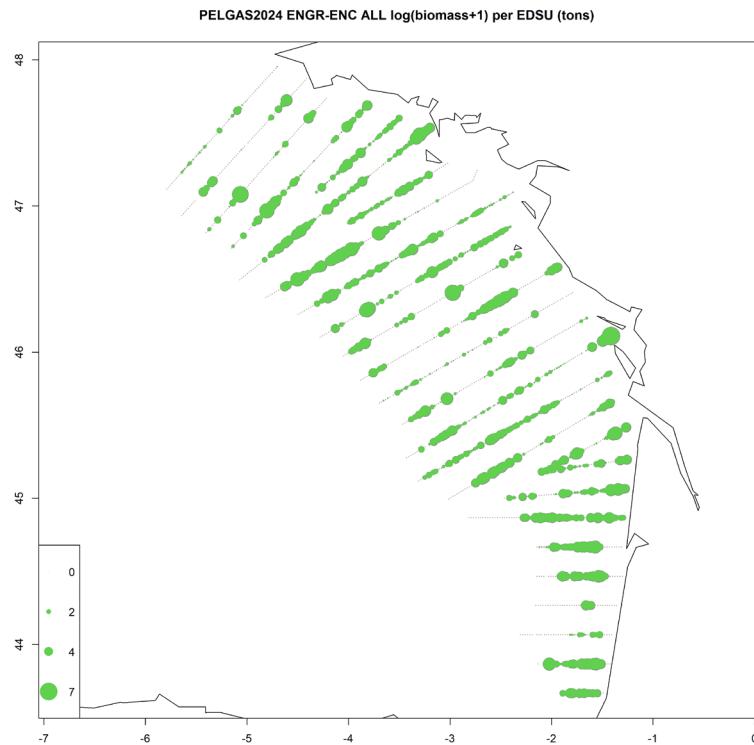


Figure 2.3.2.1: Bay of Biscay anchovy: Map of anchovy biomass observed during the PELGAS2024 survey

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).

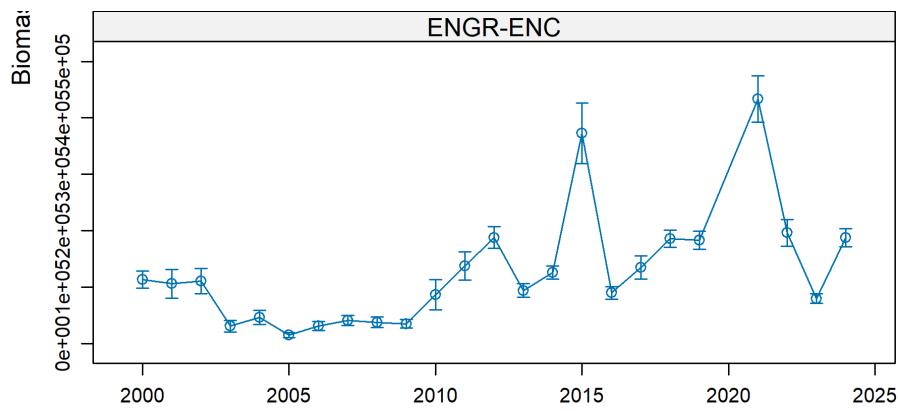


Figure 2.3.2.2: Bay of Biscay anchovy: Time series of anchovy biomass and CV derived from PELGAS survey data.

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.

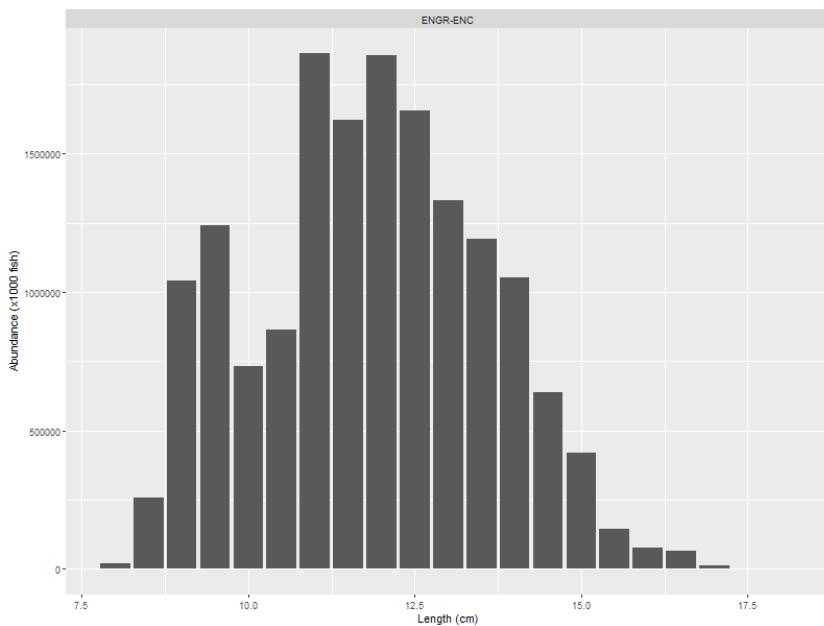


Figure 2.3.2.3: Bay of Biscay anchovy: anchovy length distribution observed during the PELGAS2024 survey.

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.

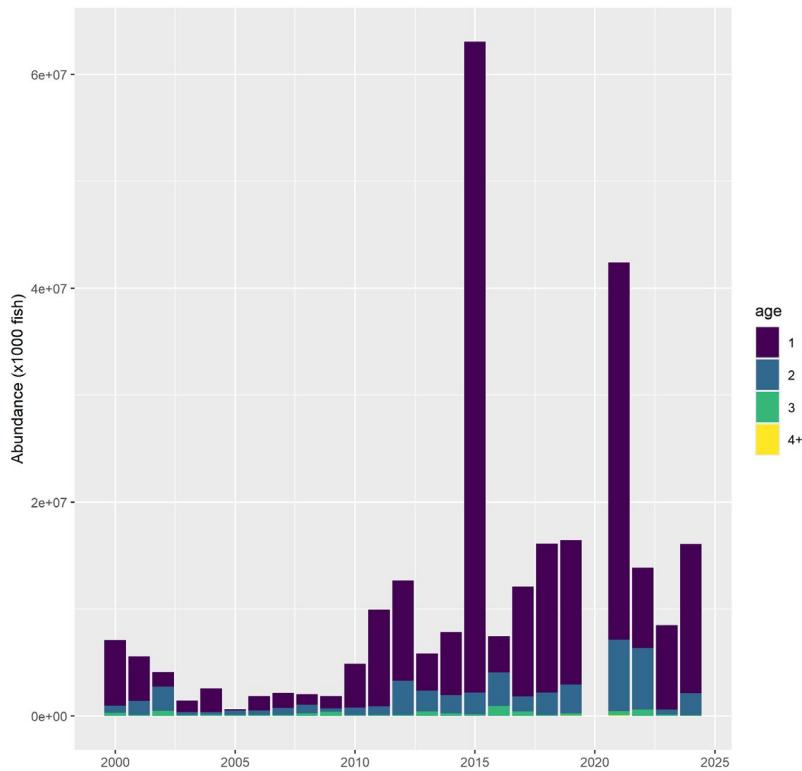


Figure 2.3.2.4: Bay of Biscay anchovy: time series of anchovy abundances at age derived from PELGAS survey data.

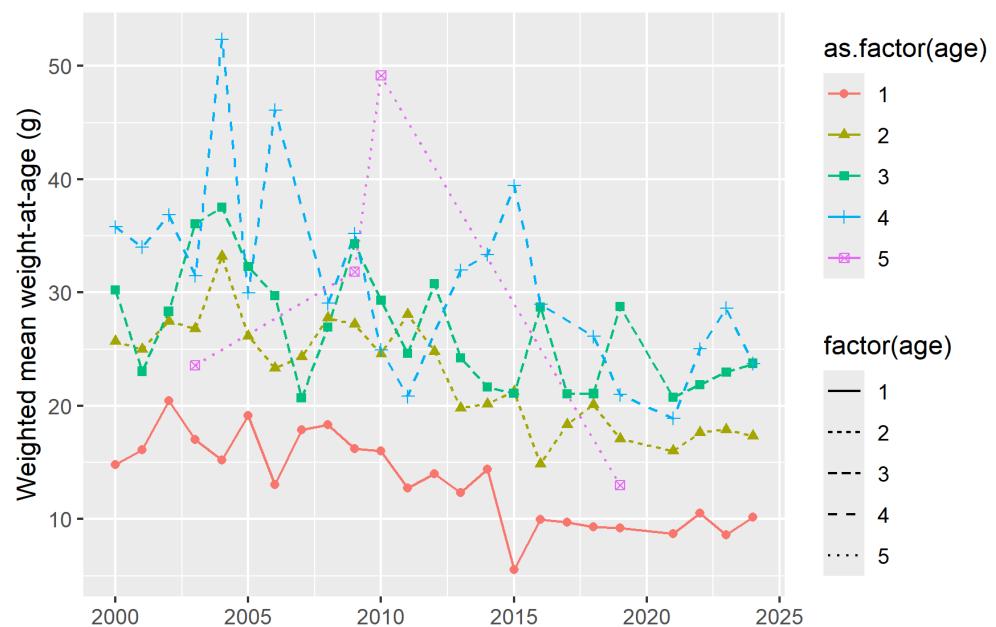


Figure 2.3.2.5: Bay of Biscay anchovy: Time series of mean weight at age (g) derived from PELGAS survey data.

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).

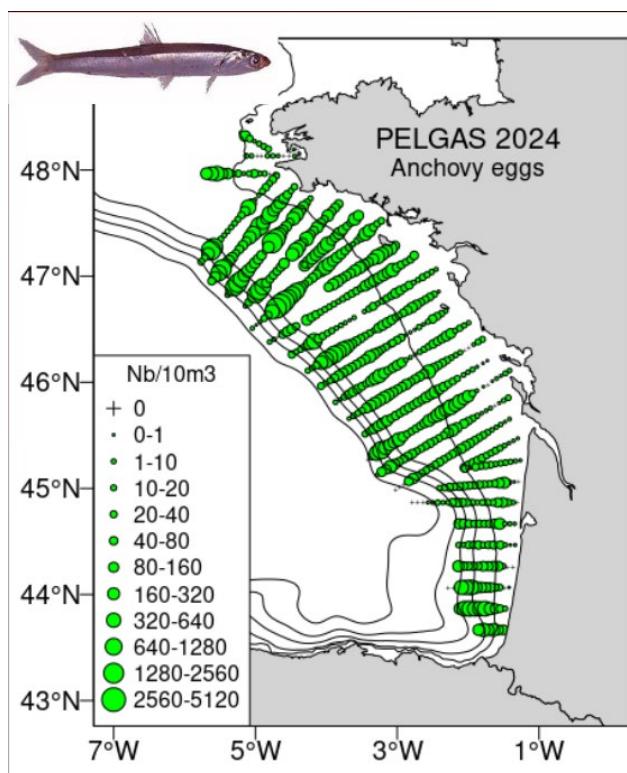


Figure 2.3.2.6: Bay of Biscay anchovy: map of anchovy eggs observed with CUFES during PELGAS2024.

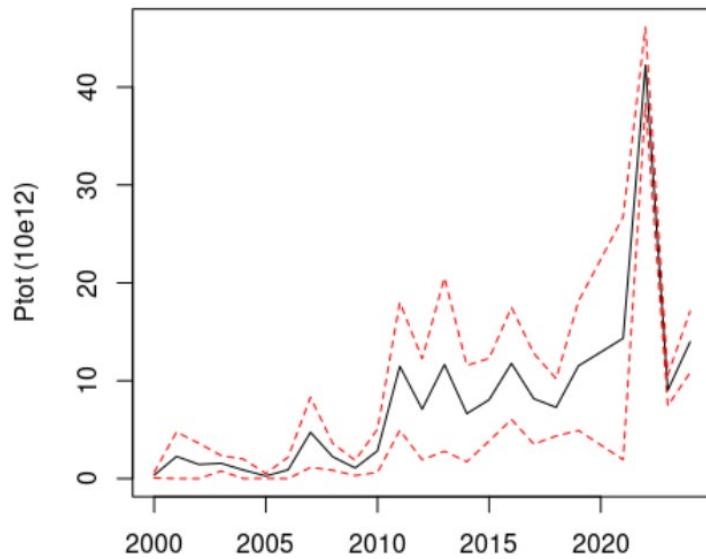


Figure 2.3.2.7: Bay of Biscay anchovy: anchovy total daily egg production estimated during PELGAS surveys from 2000 to 2024.

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 (P_{tot}) derived from PELGAS data have increased since 2010 in the Bay of Biscay. The 2024 P_{tot} 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 6°40' W in the Cantabrian area to 48° 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+ (nmi ²)
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

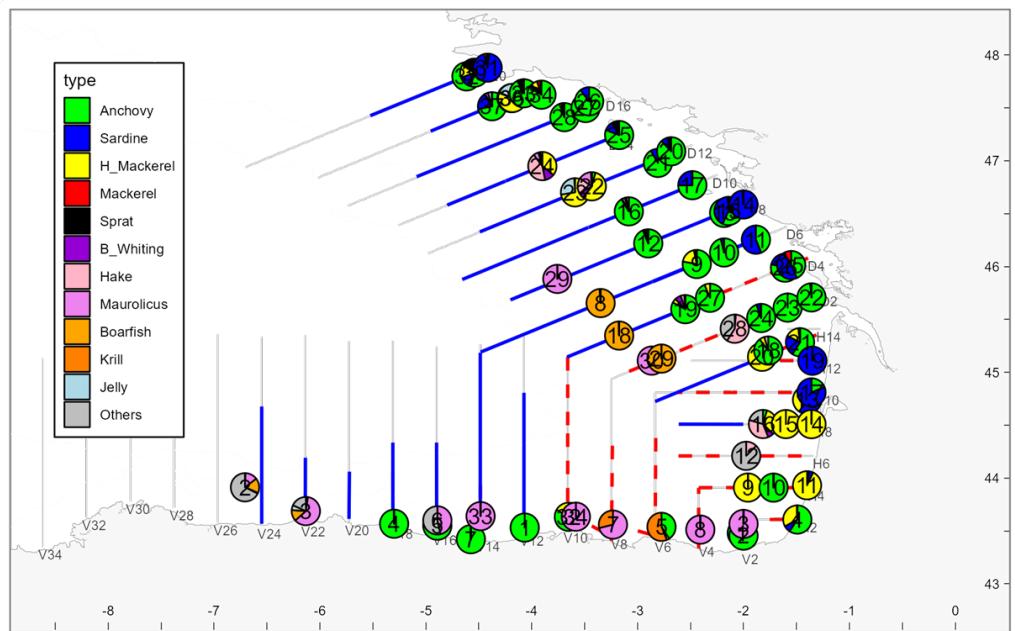


Figure 2.3.3.1: Bay of Biscay anchovy. Survey transects and species composition of the pelagic hauls in JUVENA 2024.

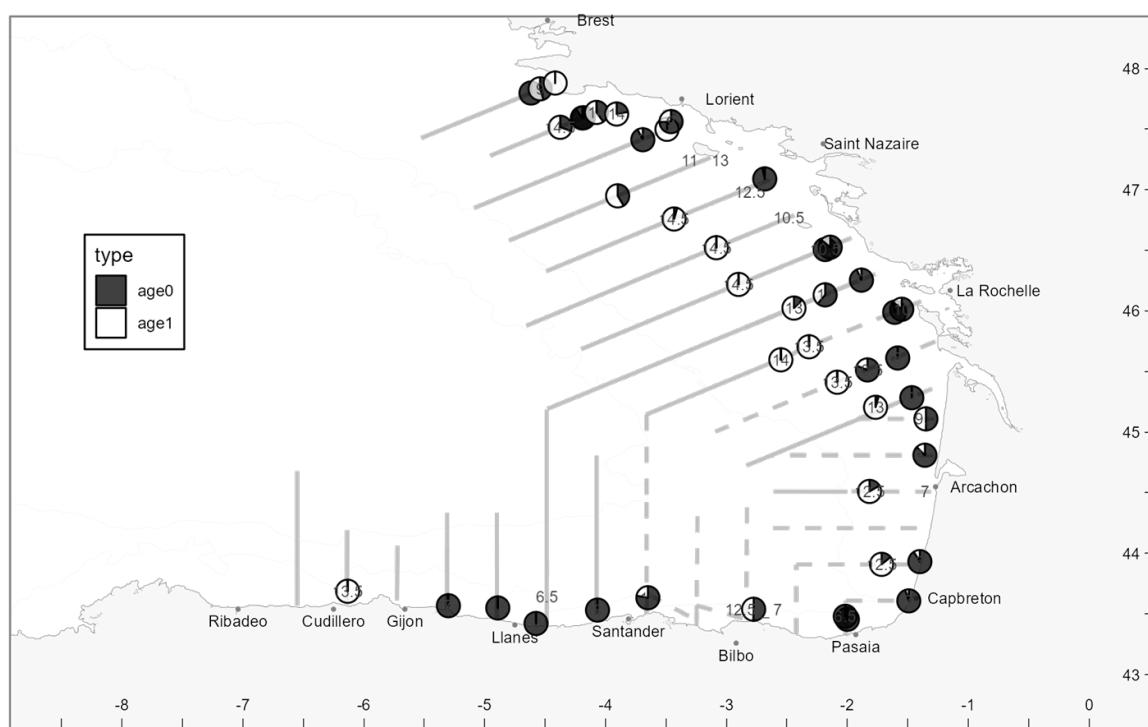


Figure 2.3.3.2: Bay of Biscay anchovy. Positive area of anchovy in JUVENA 2024. The pie charts show the percentage of juveniles (black) and adults (white) in the fishing hauls.

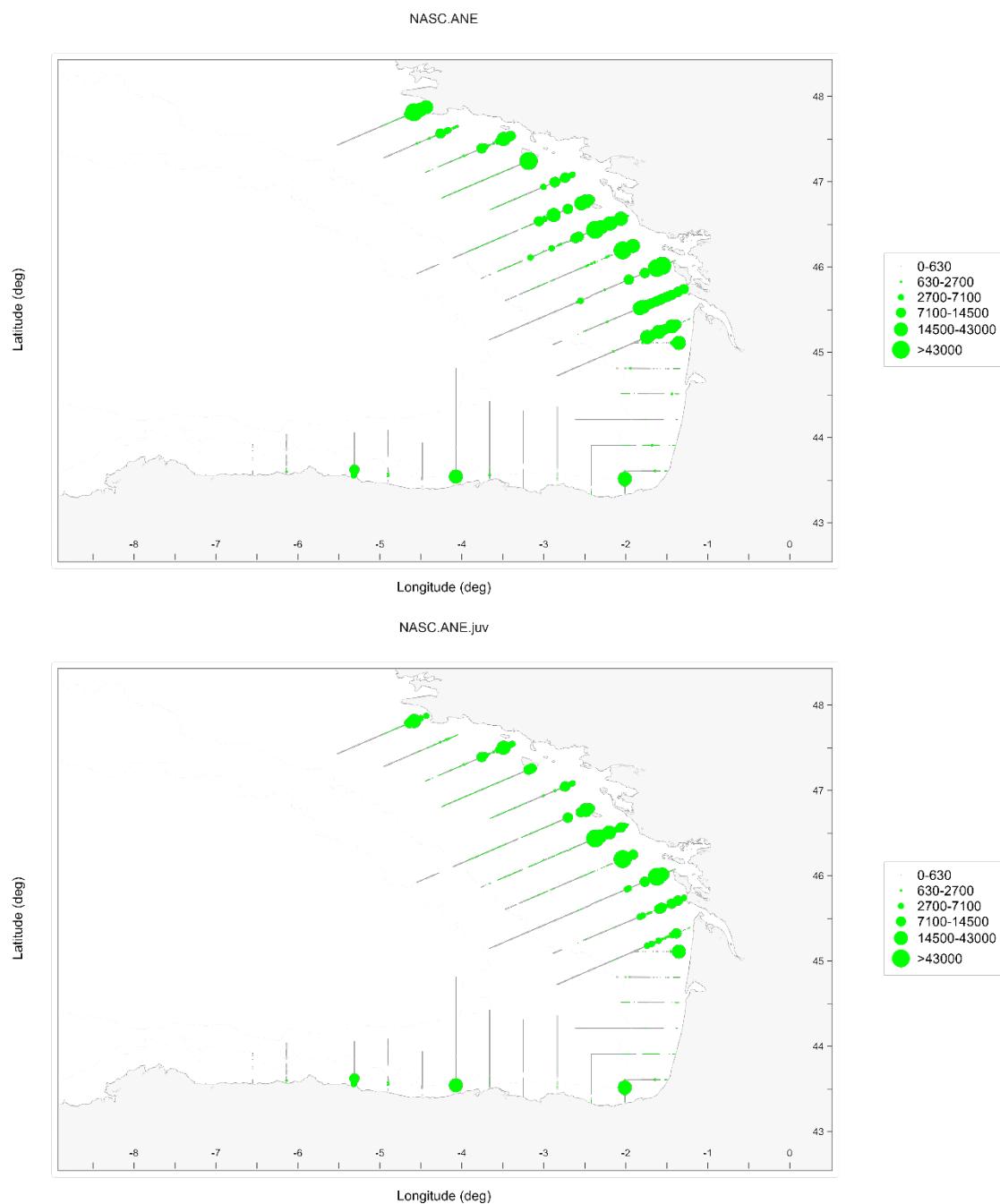


Figure 2.3.3.3: Bay of Biscay anchovy. Bubble maps representing acoustic backscattering by ESDU of 0.1 nm for total anchovy (top) and age 0 anchovy (bottom).

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 JU-VENA (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 46.6°N 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

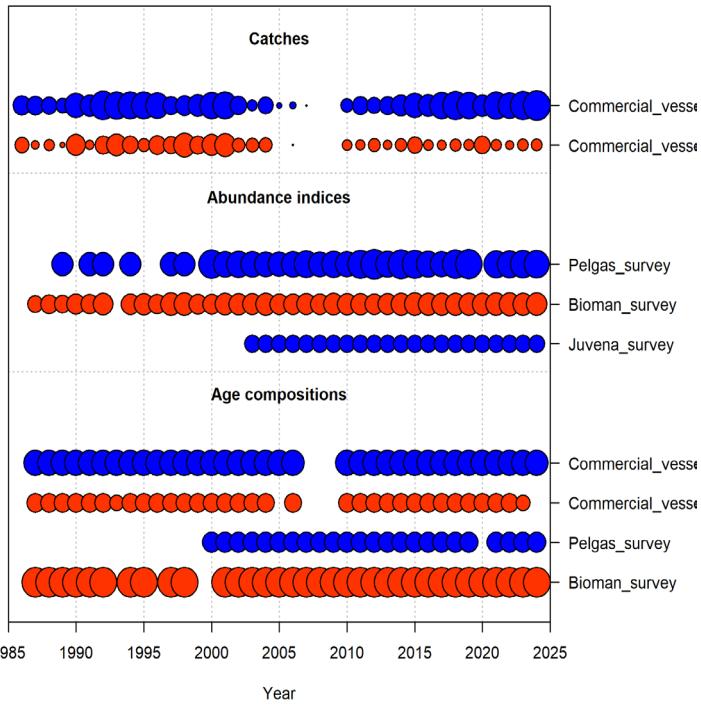


Figure 2.5.1.1: Bay of Biscay anchovy: Summary of input data for SS assessment for Bay of Biscay anchovy, where circle area is relative within a data type. Circles are proportional to total catch for catches; to precision for indices; and to total sample size for age compositions observations.

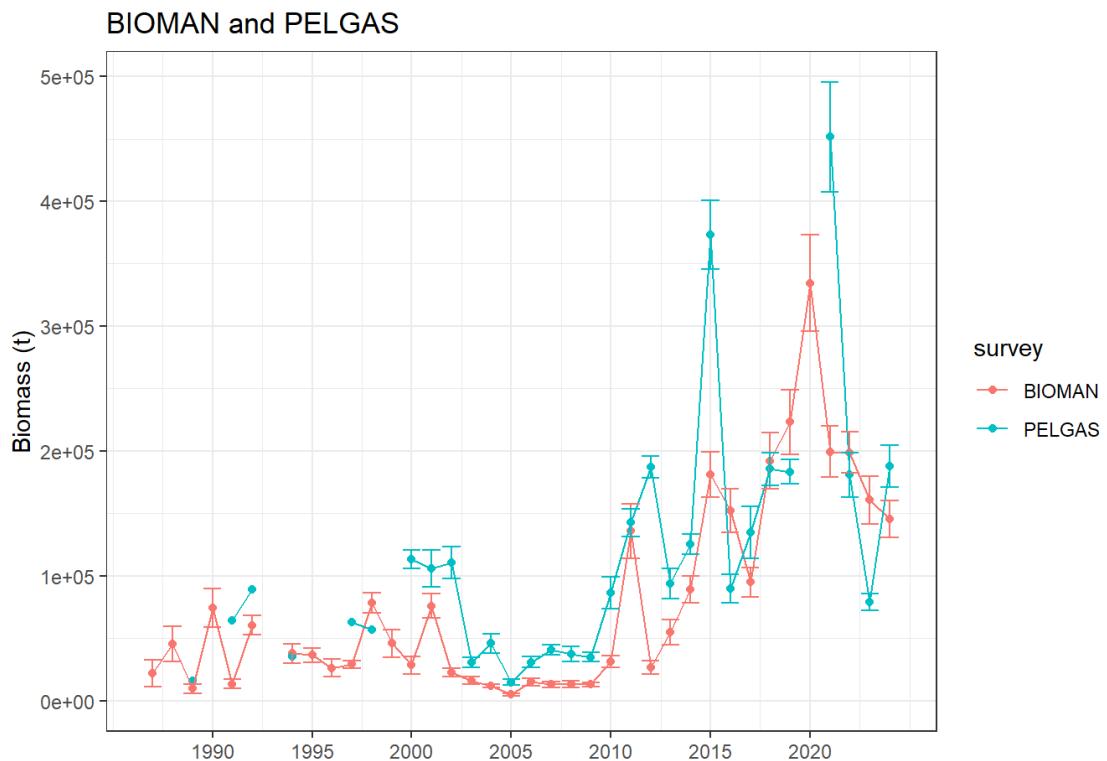


Figure 2.5.1.2: Bay of Biscay anchovy: Historical series of spawning-stock biomass estimates and the corresponding confidence intervals from DEPM (red) and acoustics (blue).

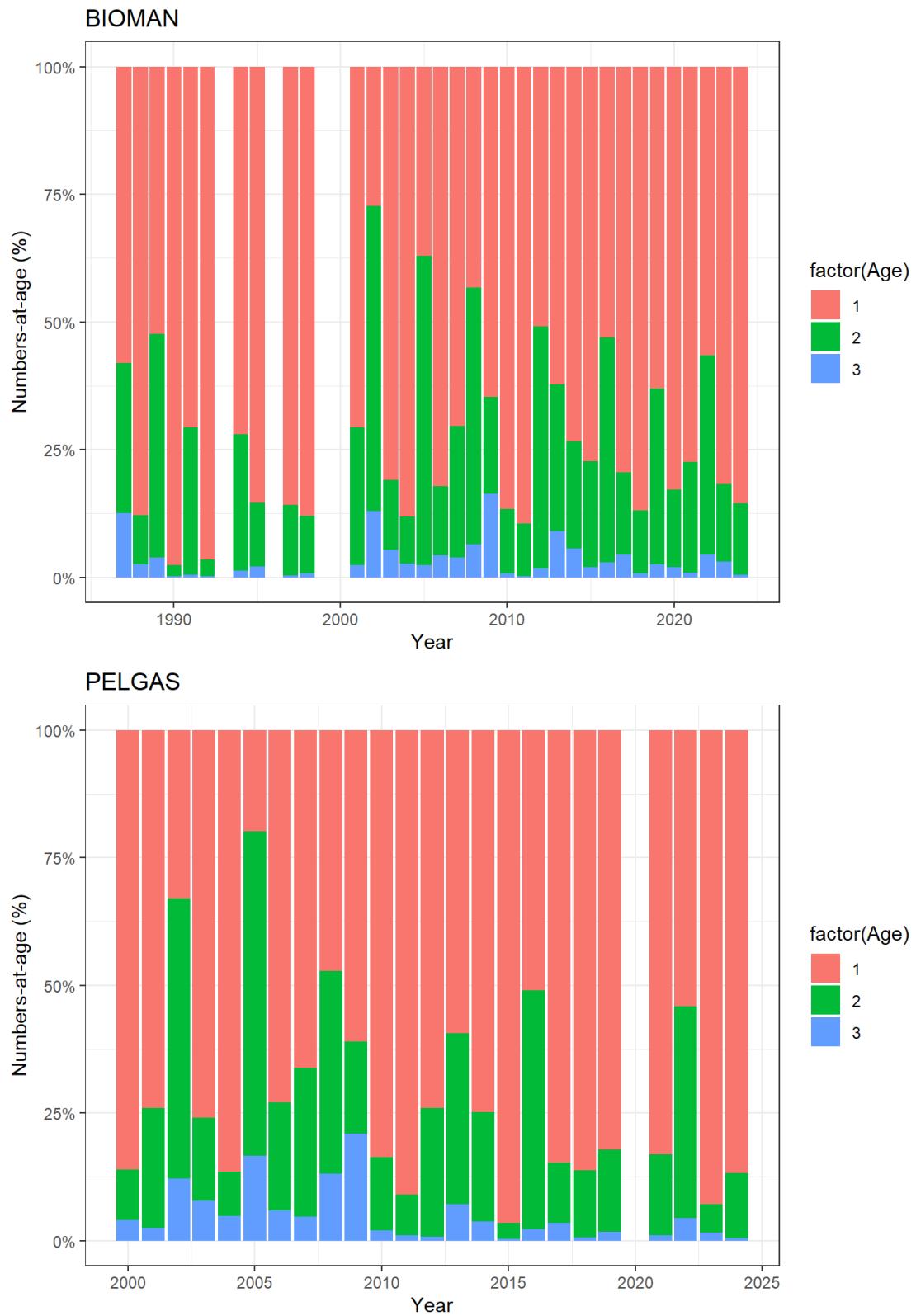


Figure 2.5.1.3: Bay of Biscay anchovy: Historical series of numbers at age proportion estimates from DEPM (top) and acoustics (bottom).

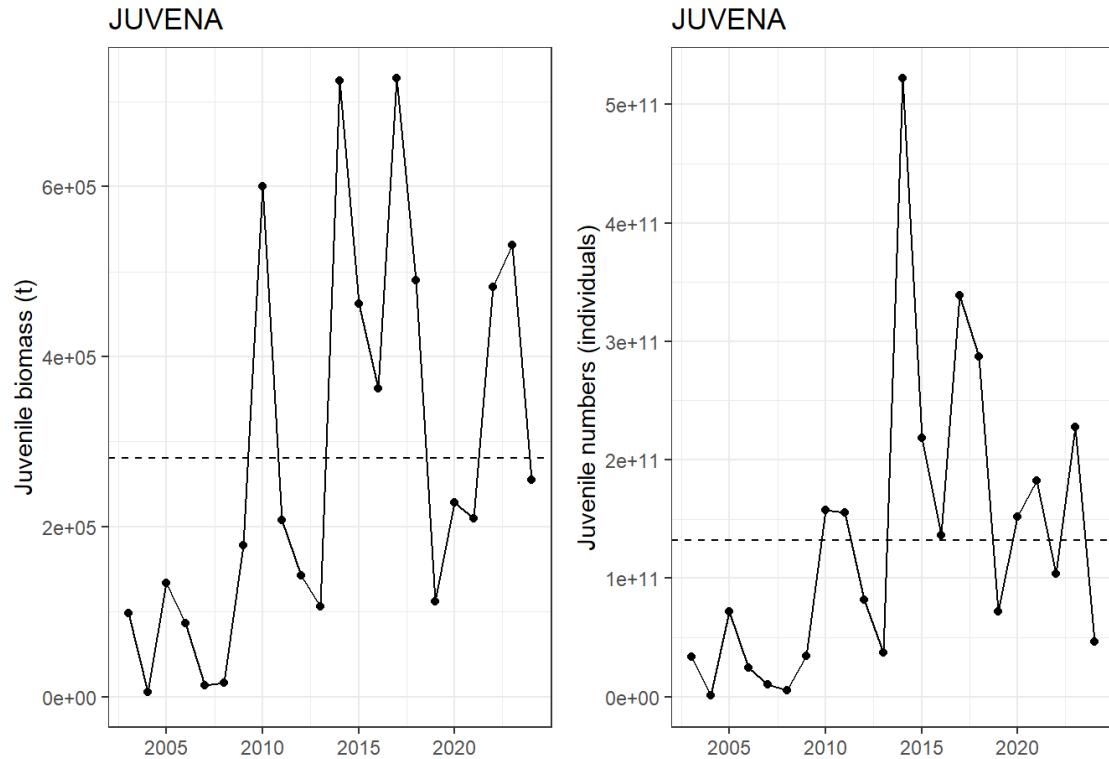


Figure 2.5.1.4: Bay of Biscay anchovy: Historical series of the juvenile abundance index from the autumn acoustic survey JUVENA that is related to recruitment (age 0) in biomass (right) and in numbers (left).

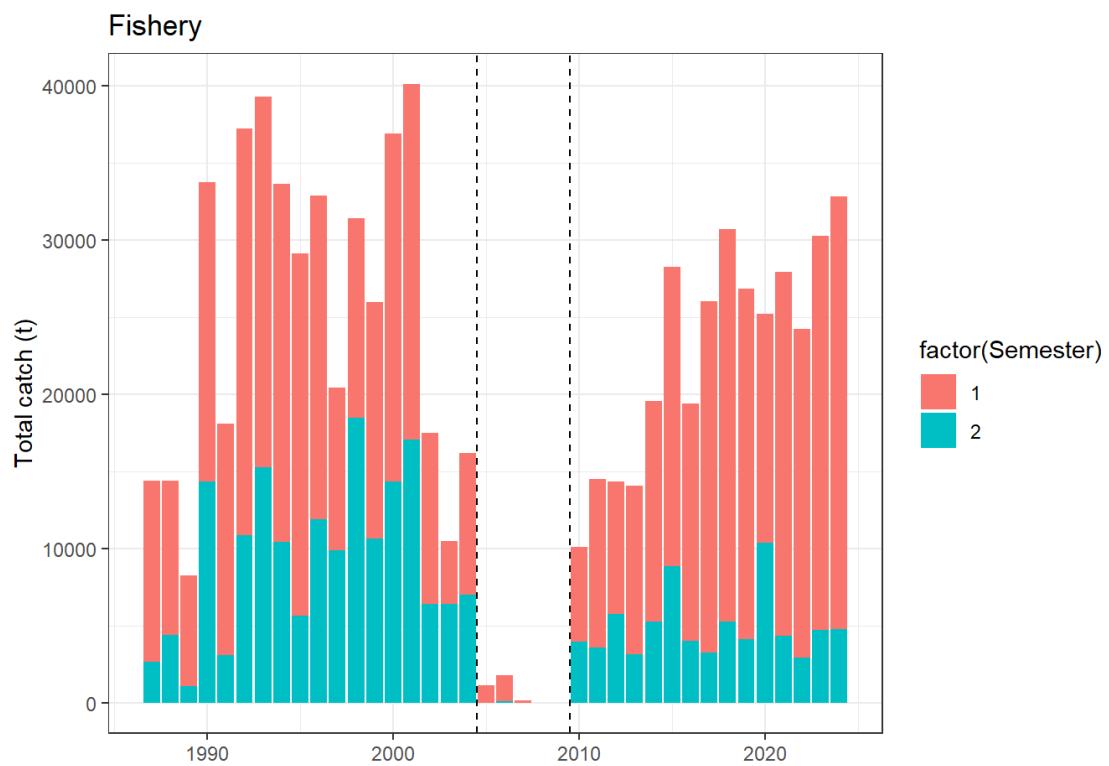


Figure 2.5.1.5: Bay of Biscay anchovy: Historical series of total catch by semesters. Note that the catch in 2024 is provisional.

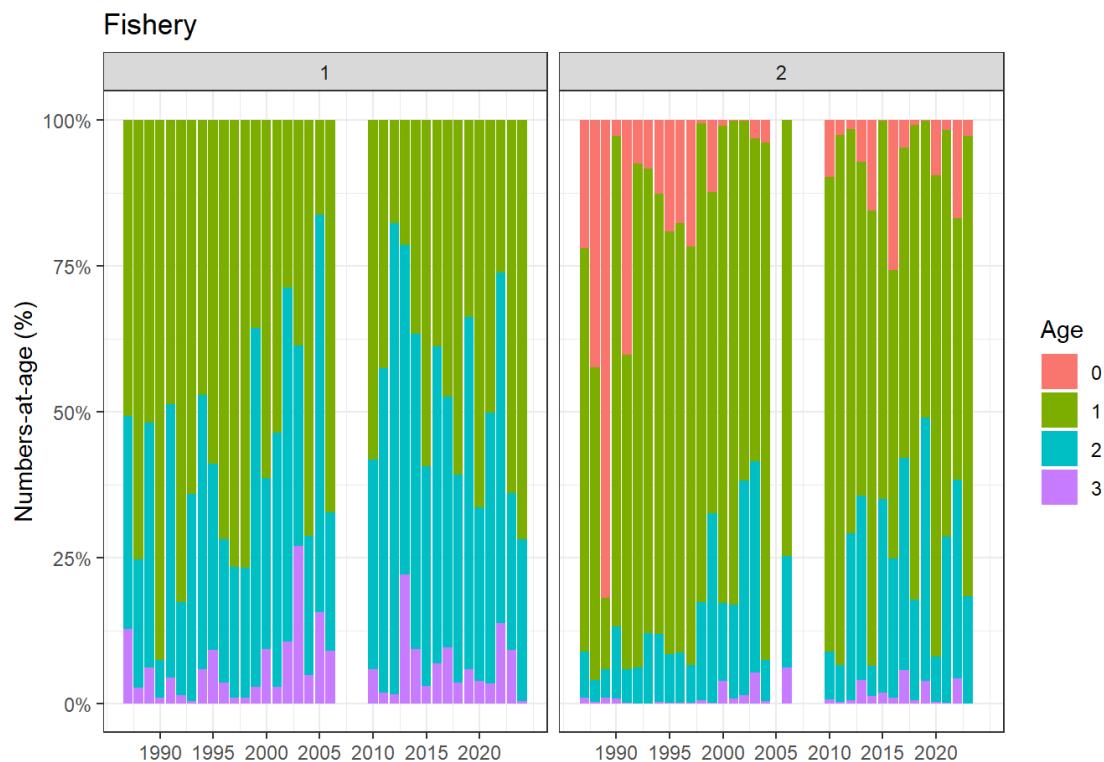


Figure 2.5.1.6: Bay of Biscay anchovy: Historical series catch at age proportions. The left panel corresponds to the first semester and the right panel to the second semester. Note that the catch in 2024 is provisional and that the catch at age 0 is not included in the assessment model.

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 1 st semester and 8164 t in 2 nd semester (average 1978-1986, 60% in 1 st half-year)
Number of areas	1
Number of seasons	2 (Jan-Jun, Jul-Dec)
Spawning time	15 th May
Recruitment settlement time	1 st 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) 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. CVs for aggregated indices: inputs from the surveys except for Juvena survey set to 0.25. 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 mortality 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 R_0 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(R_0)	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_Biomann_survey(4)	-0.05	0.14	-7	5	0.0	OK
Q_extraSD_Biomann_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	Fvaluuelower	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.

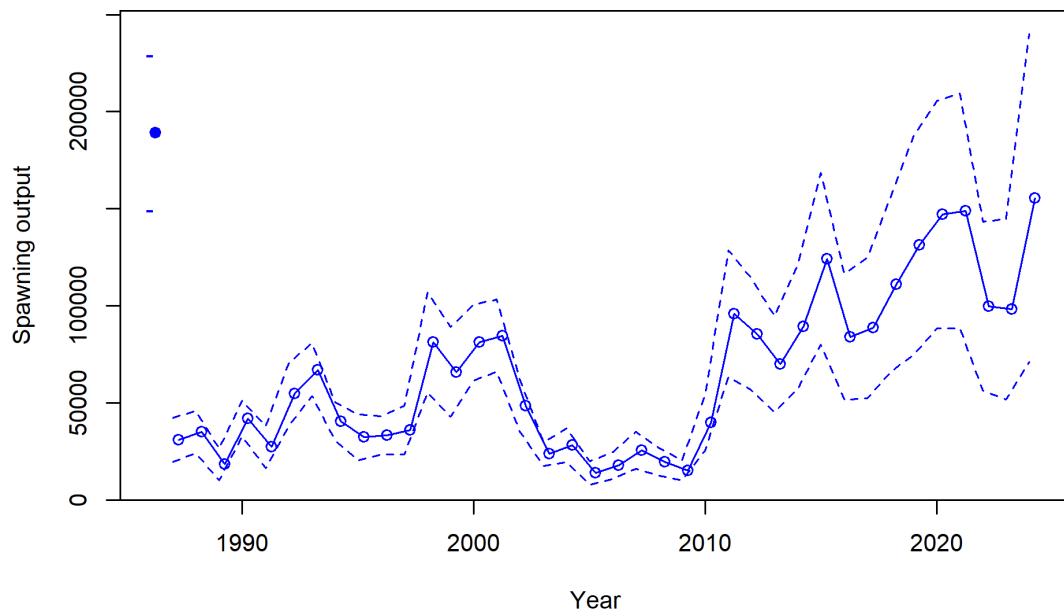
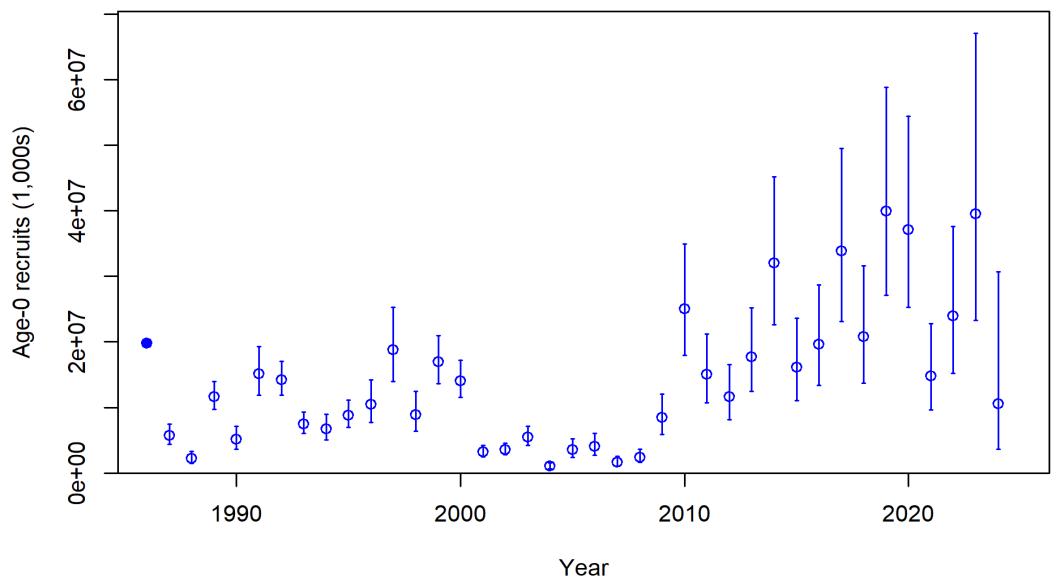
Year	0_s1	0_s2	1_s1	1_s2	2_s1	2_s2	3_s1	3_s2
1,987	0	0	0.47	0.30	0.78	0.32	0.65	0.16
1,988	0	0	0.44	0.40	0.72	0.42	0.61	0.22
1,989	0	0	0.50	0.16	0.80	0.17	0.68	0.09

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



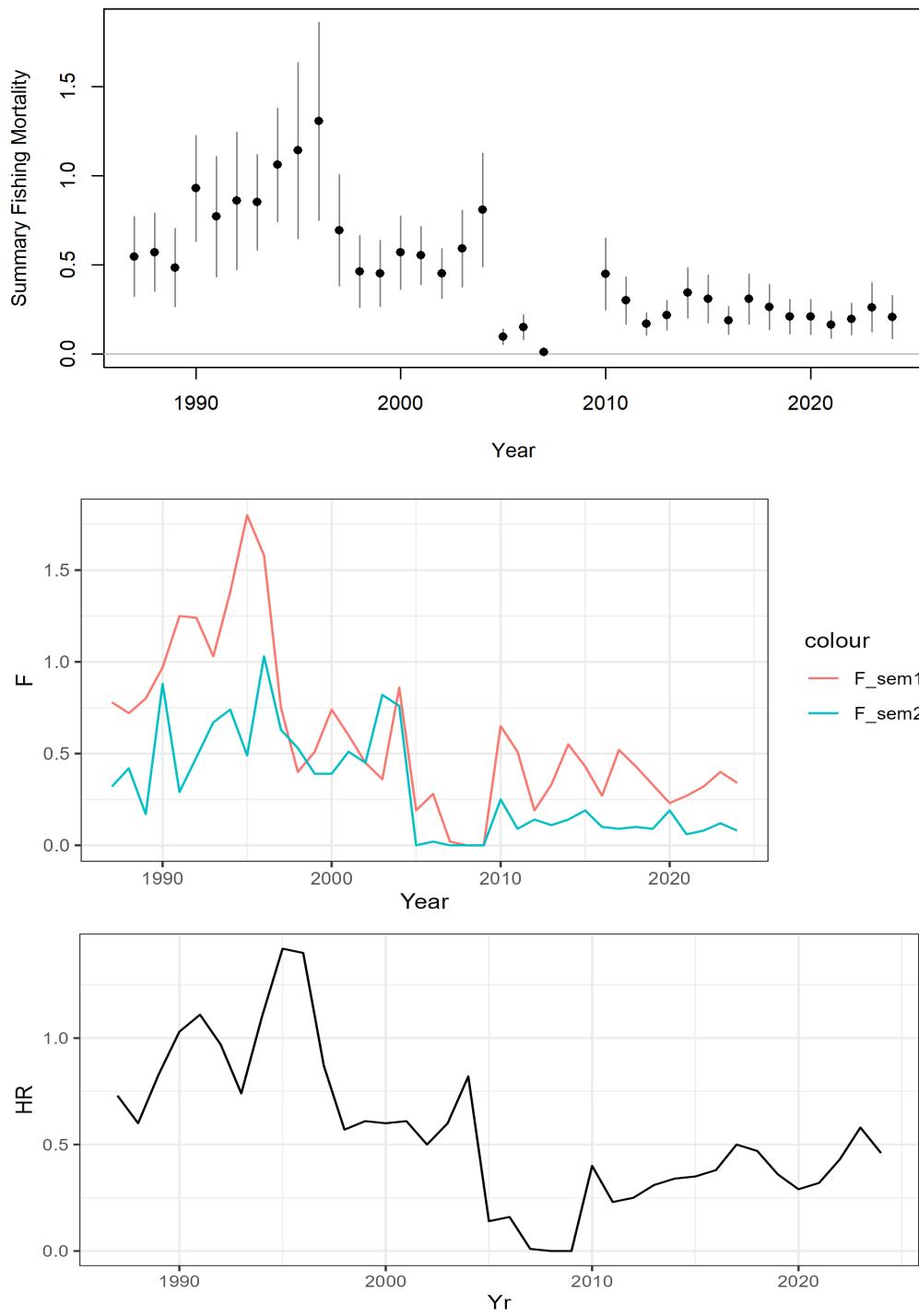


Figure 2.5.3.1:

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

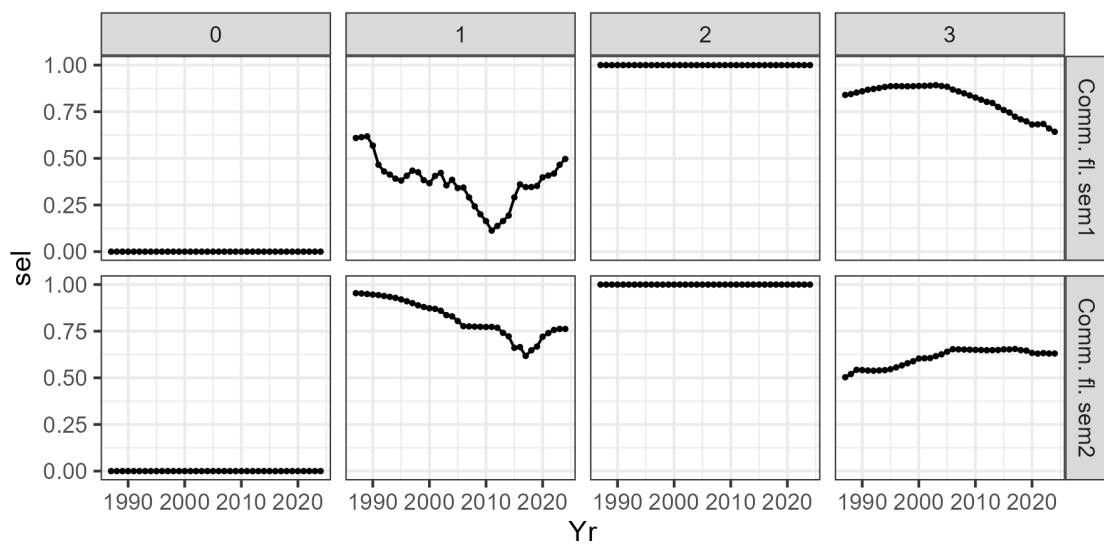


Figure 2.5.3.2: Bay of Biscay anchovy: Estimated selectivities for commercial fleets.

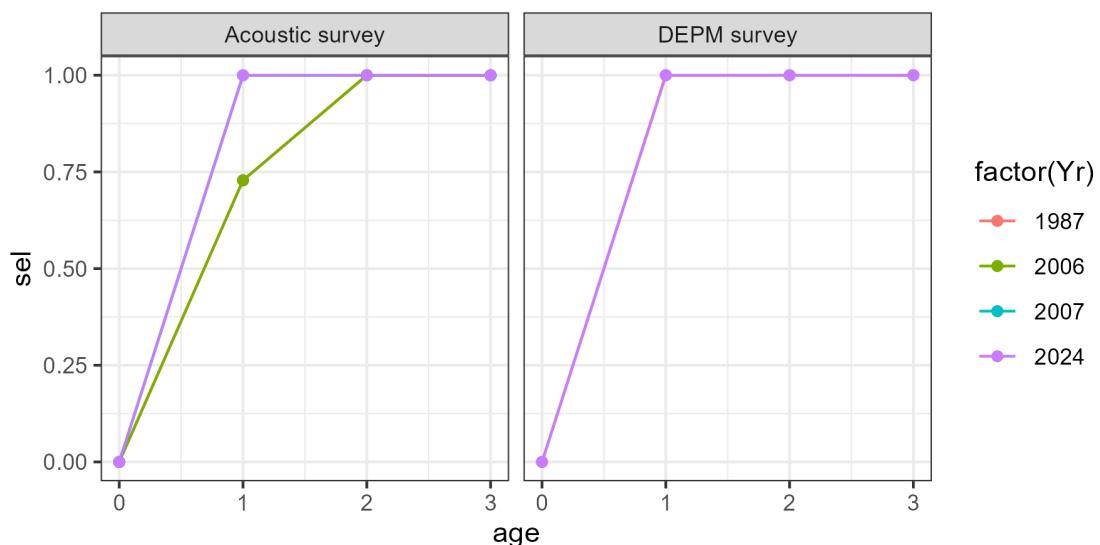


Figure 2.5.3.3: Bay of Biscay anchovy: Estimated selectivities for Acoustic and DEPM surveys.

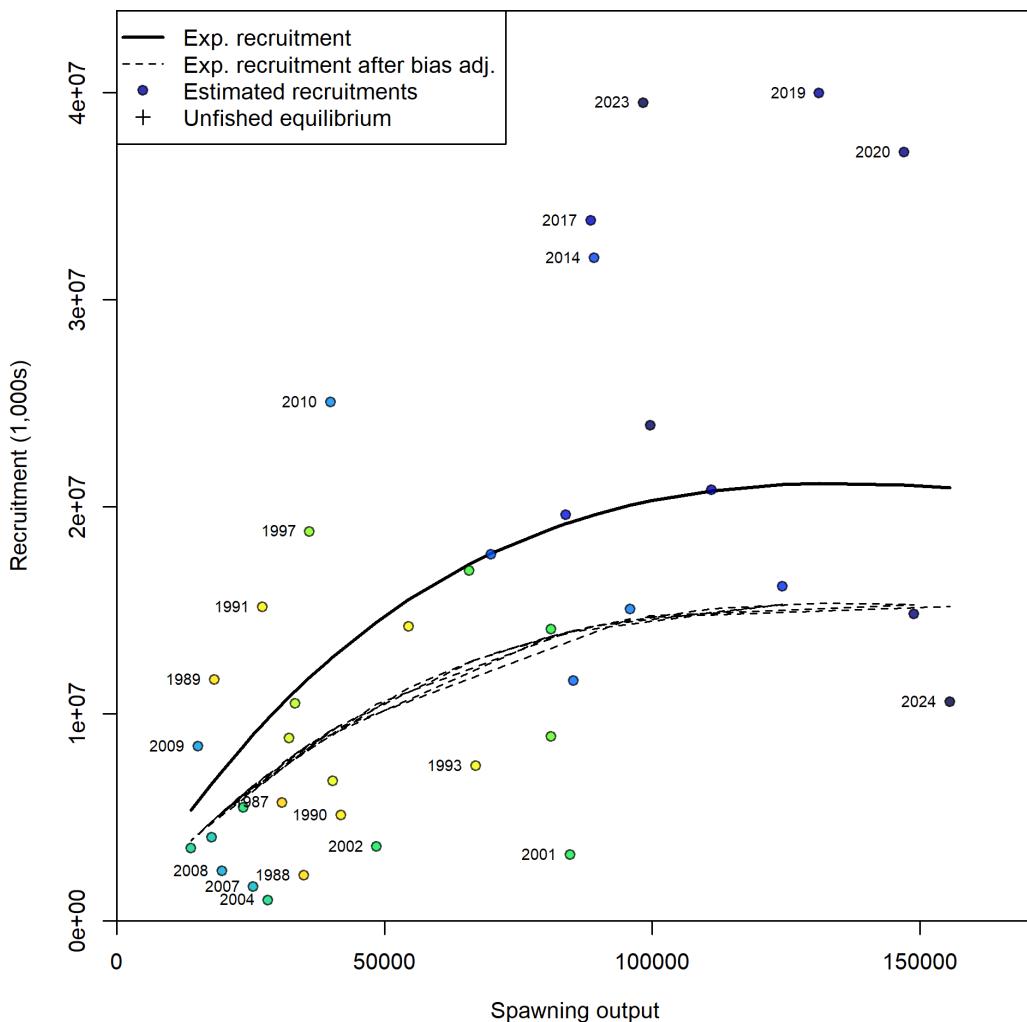


Figure 2.5.3.4: Bay of Biscay anchovy: fitted SR model within the assessment model.

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.

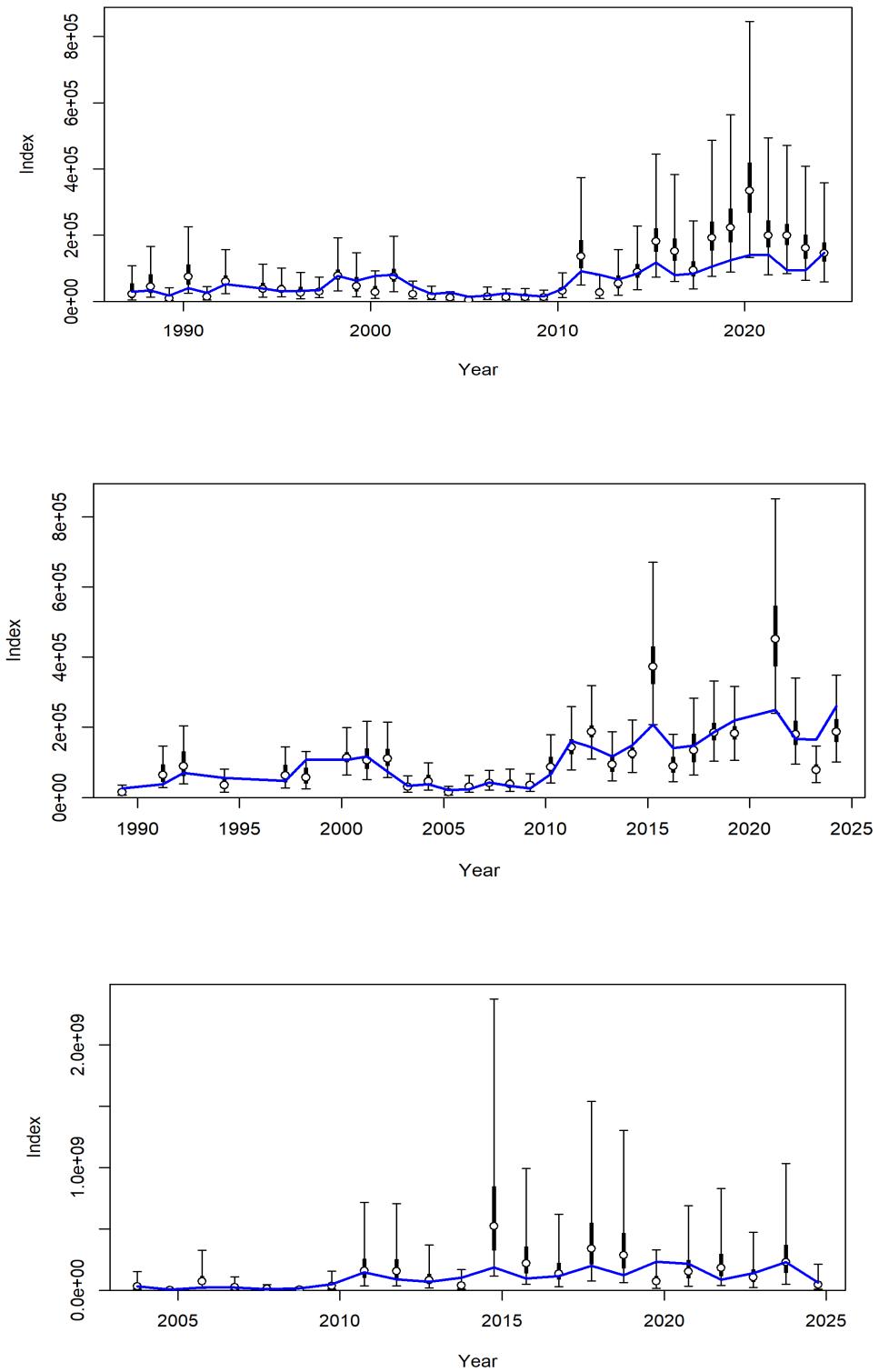


Figure 2.5.4.1: Bay of Biscay anchovy: Fit (blue line) to index data for surveys. Vertical lines indicate 95% uncertainty interval around index values based on the model assumption of lognormal error. Thicker lines (if present) indicate input uncertainty before addition of estimated additional uncertainty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

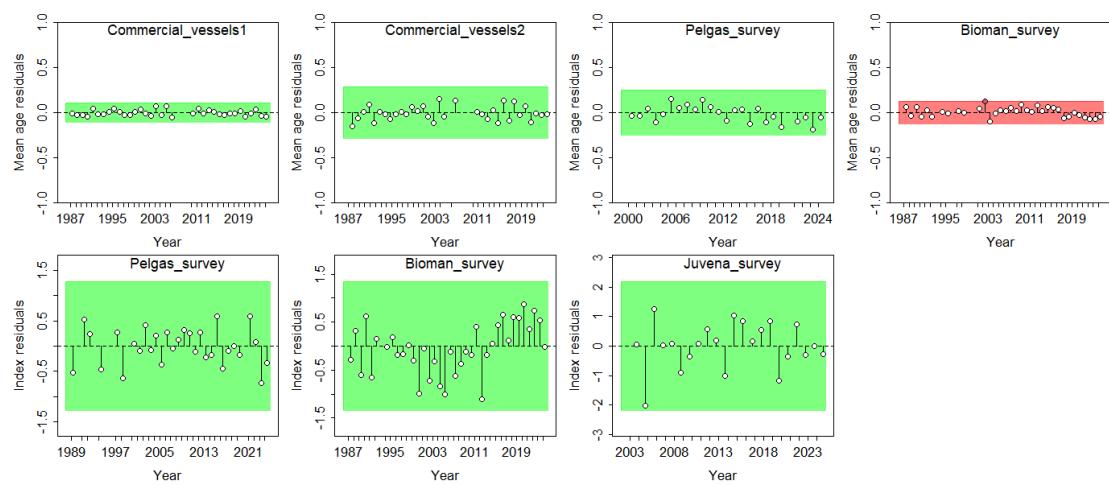


Figure 2.5.4.2: Bay of Biscay anchovy: Mean age and aggregated indices residuals for each fleet. Green shading indicates that the residual test is passed, red indicates the test is not passed.

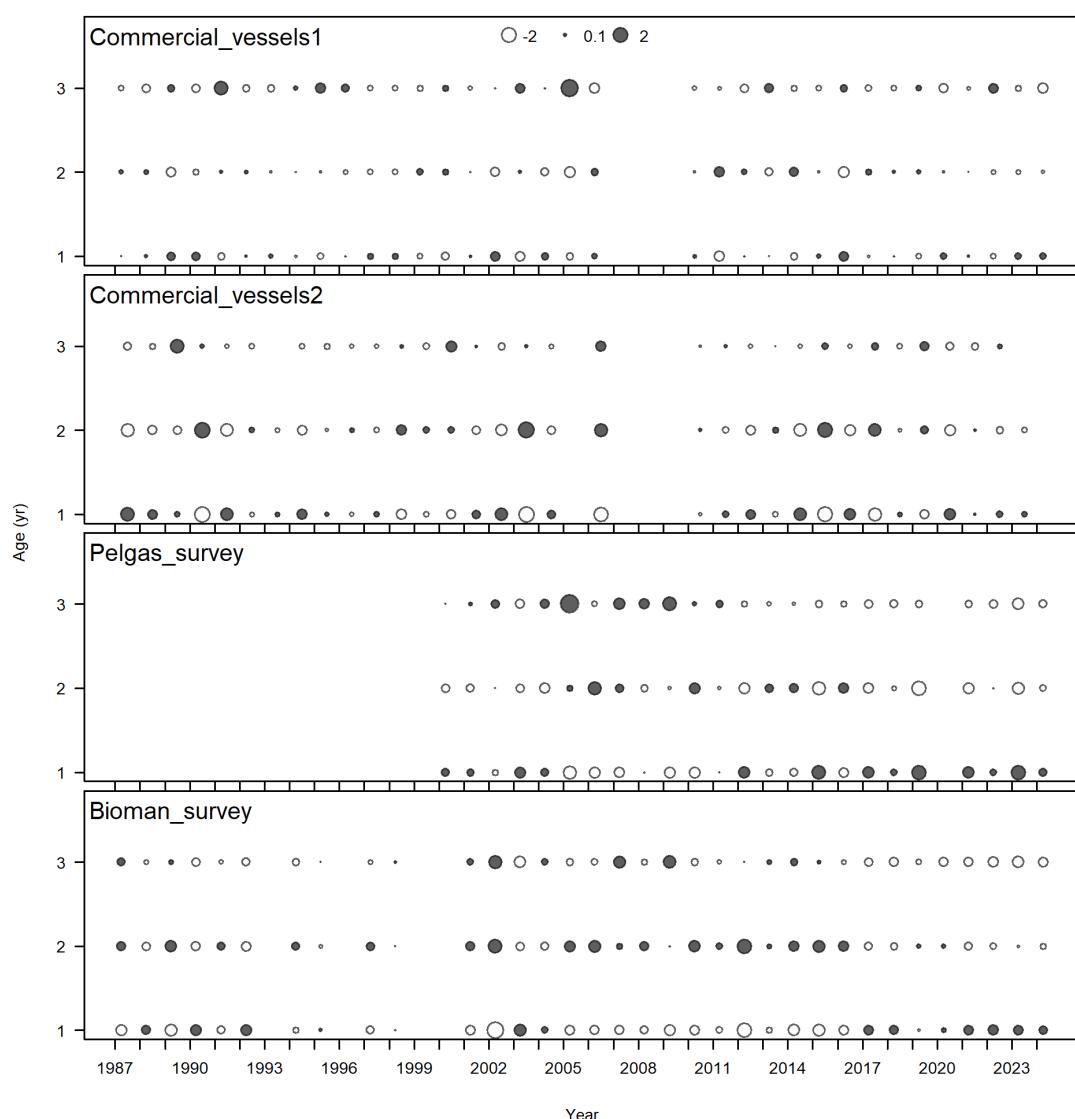


Figure 2.5.4.3: Bay of Biscay anchovy: Pearson residuals. Closed bubbles are positive residuals (observed > expected) and open bubbles are negative residuals (observed < expected).

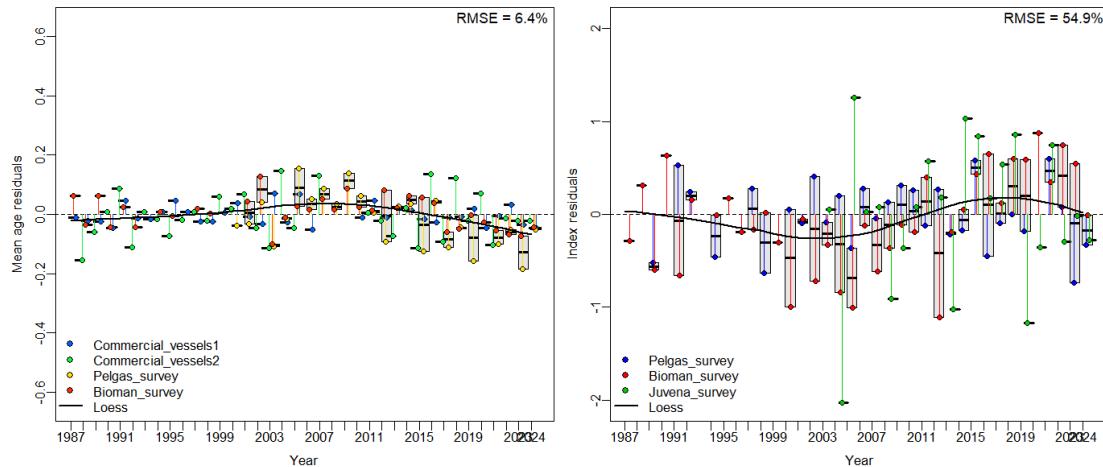


Figure 2.5.4.4: Bay of Biscay anchovy: Joint residuals for all fleets and RMSE values. Age composition residuals on the right and aggregated indices residuals on the left.

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.

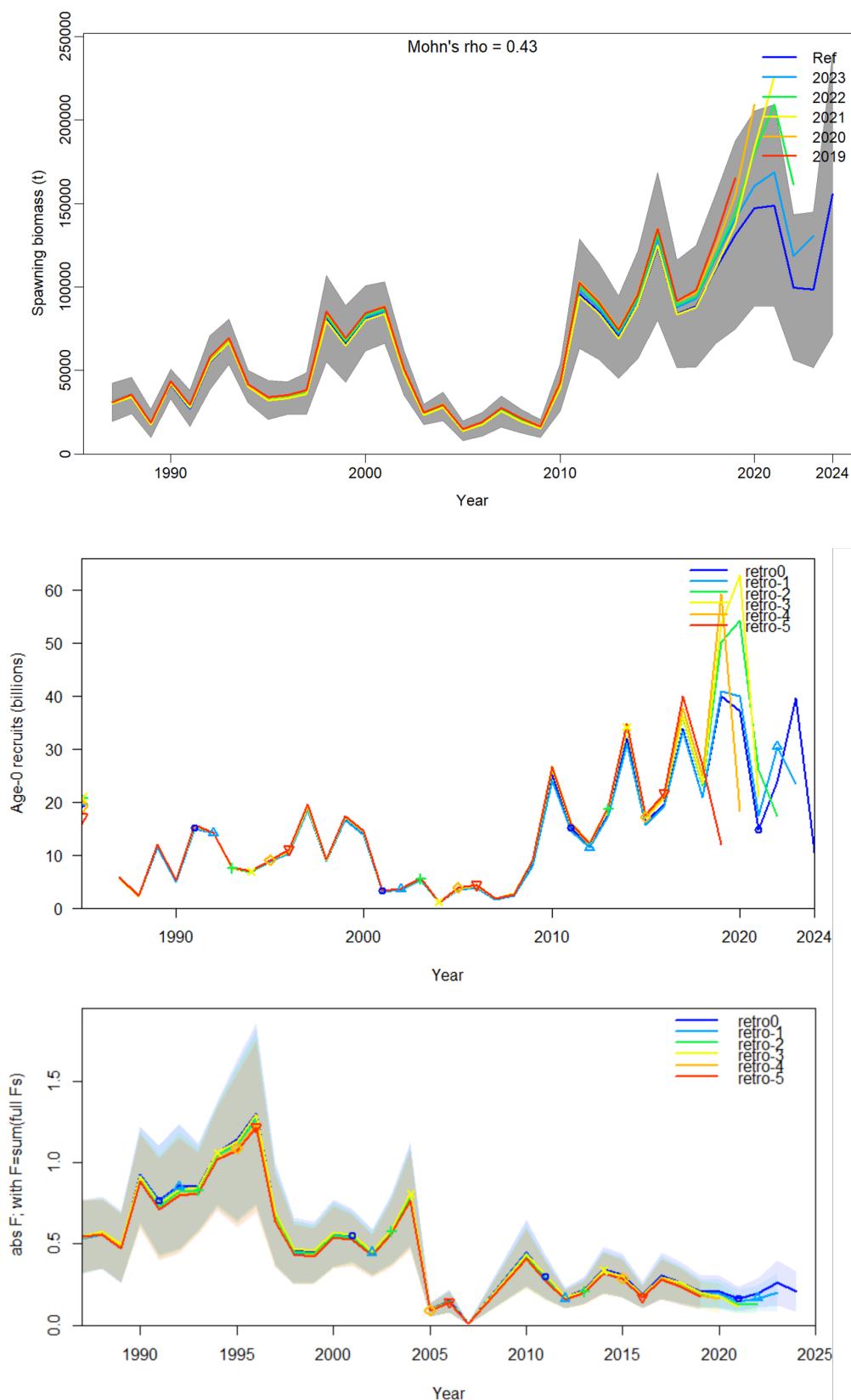


Figure 2.5.5.1: Bay of Biscay anchovy: Retrospective patterns for SSB, recruitment and F with their corresponding Mohns rho values. Grey shaded area in the SSB plot represents the 95% confidence interval for the reference run.

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 $SSB \geq Blim$, or $SSB \geq Bpa$, 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 ^AA
<hr/>							

Harvest control rule in the management plan	30663	83156	0.270	-47	-7	-7	0.0104
<hr/>							
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.

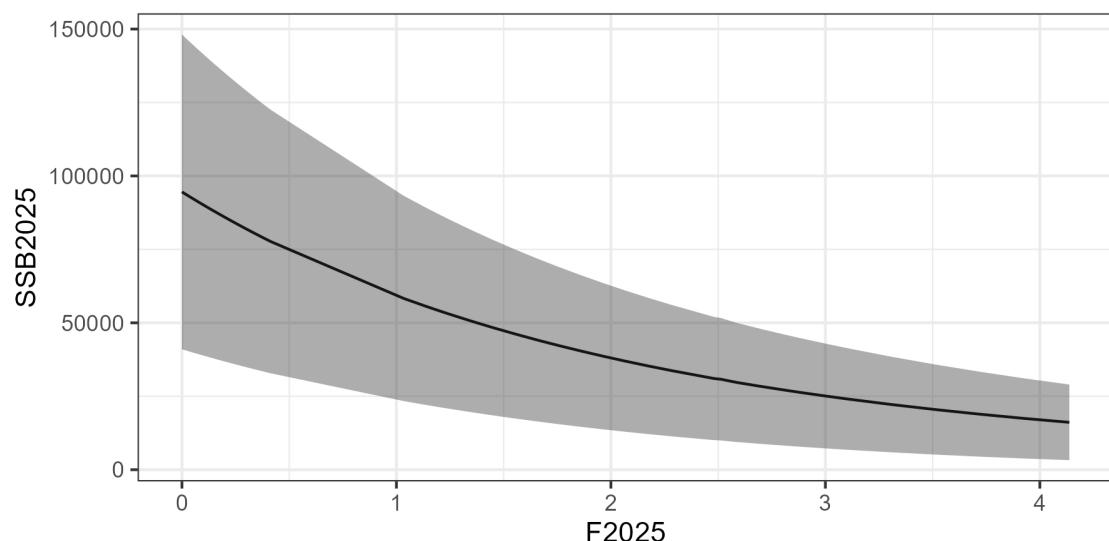


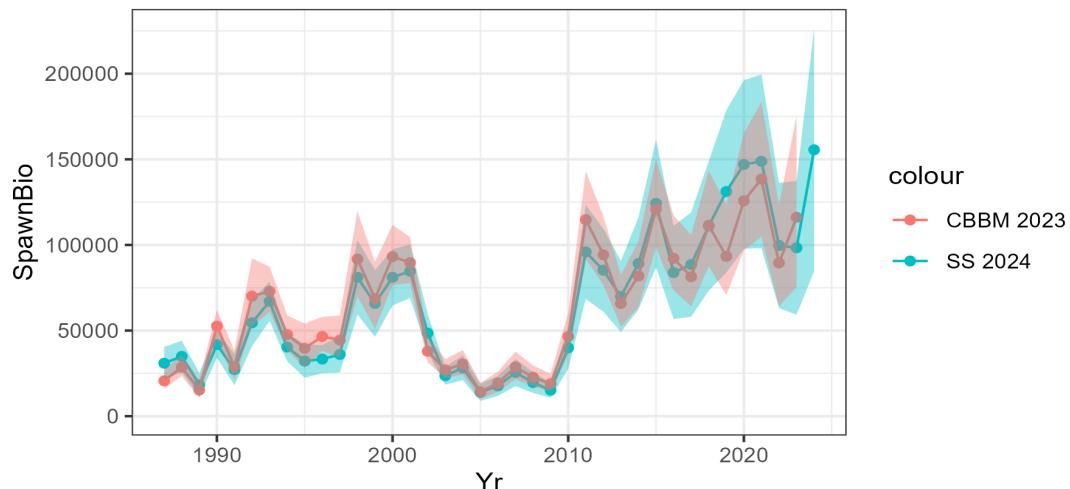
Figure 2.6.1: Bay of Biscay anchovy: Short-term projections for SSB in terms of fishing mortality levels in 2025, the shaded grey area represents the 95% confidence interval estimated by the SS forecast model.

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

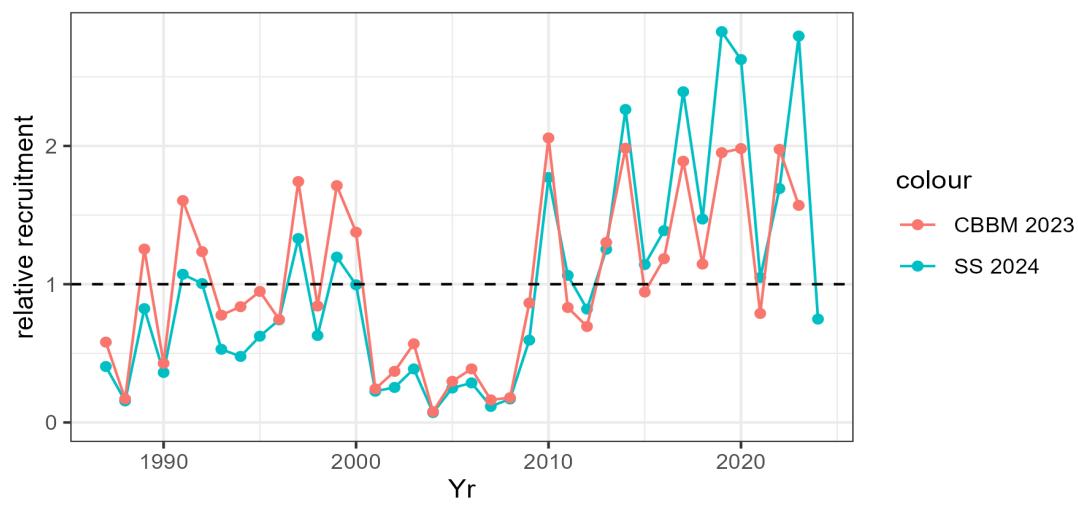
shown as an illustration of the differences in estimates between assessment models. Overall, estimated stock status are consistent.

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 Bescapement	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 * σ), σ = 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:

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

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:

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

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.

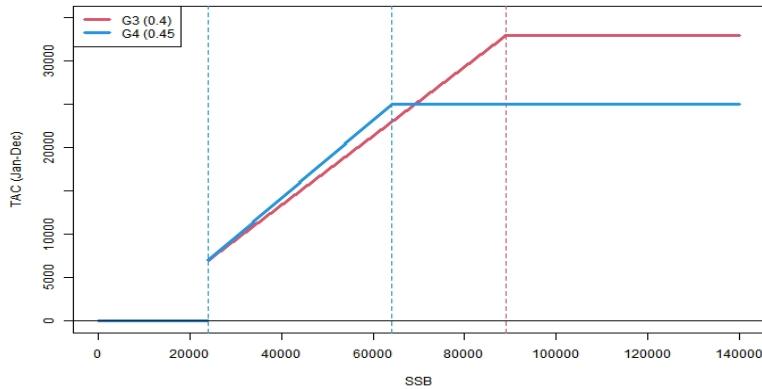


Figure 2.8.1: Bay of Biscay anchovy: Harvest control rules G4 with harvest rate of 0.45 (in red) and G3 with harvest rate of 0.4 (in blue) according to which the TAC from January to December is set as a function of the expected spawning-stock biomass (on 15th May) in the management year.

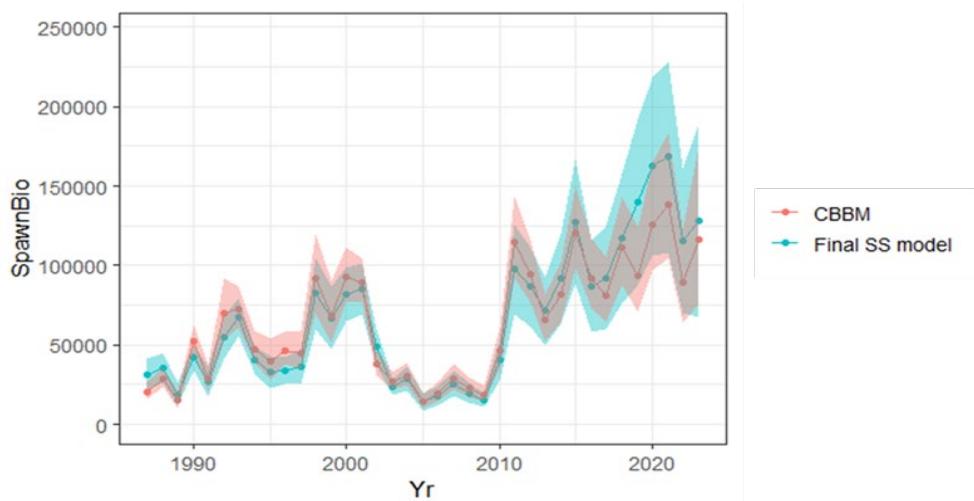


Figure 2.8.2: Bay of Biscay anchovy: Estimated SSB by the CBBM model in the last WGHANSA 2023 (red) and by the final SS model (blue). Points are medians for the CBBM and means for the SS model. Shaded areas represent the 90% probability interval for the CBBM and the 90% confidence interval for the SS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

2.9 References

- Beckensteiner, J., Villasante, S., Charles, A., Petitgas, P., Le Grand, C., and Thebaud, O. 2024. A systemic approach to analyzing post-collapse adaptations in the bay of biscay anchovy fishery. Canadian Journal of Fisheries and Aquatic Sciences, 81: 1154–1173.
- Carvalho, F., Winker, H., Courtney, D., Kapur, M., Kell, L., Cardinale, M., Schirripa, M., et al. 2021. A cookbook for using model diagnostics in integrated stock assessments. Fisheries Research, 240: 105959. <https://www.sciencedirect.com/science/article/pii/S0165783621000874>.
- Doray, M., Duhamel, E., 2024. Estimation of small pelagic fish biomass in the Bay of Biscay based on PELGAS 2024 survey acoustic-trawl data. <https://doi.org/10.13155/103492>
- Grandrémy, N., 2023. Dynamiques spatio-temporelles du zooplancton, en lien avec l'habitat et les petits poissons pélagiques, dans le Golfe de Gascogne (Biologie et écologie marine). Nantes Université.

- ICES. 2015. Report of the working group on southern horse mackerel, anchovy and sardine (WGHANSA), 24–29 june 2015, lisbon, portugal. ICES CM 2015/ACOM:16. 612 pp.
- ICES. 2023. Anchovy (*engraulis encrasicolus*) in subarea 8 (bay of biscay). In Report of the ICES Advisory Committee, 2023. ICES Advice 2023, ane.27.8. <https://doi.org/10.17895/ices.advice.2190782>.
- ICES. 2024. Benchmark Workshop on anchovy stocks (WKBANSP). ICES Scientific Reports. 6:96. 477 pp. <https://doi.org/10.17895/ices.pub.27909783>
- Menu, C., Pecquerie, L., Bacher, C., Doray, M., Hattab, T., van der Kooij, J., Huret, M., 2023. Testing the bottom-up hypothesis for the decline in size of anchovy and sardine across European waters through a bioenergetic modeling approach. *Prog. Oceanogr.* 210, 102943. <https://doi.org/10.1016/j.pocean.2022.102943>
- Methot, R. D., and Wetzel, C. R. 2013. Stock synthesis: A biological and statistical framework for fish stock assessment and fishery management. *Fisheries Research*, 142: 86–99.
- Sánchez, S., Ibaibarriaga, L., Uriarte, A., Prellezo, R., Andrés, M., Abaunza, P., Jardim, E., et al. 2019. Challenges of management strategy evaluation for small pelagic fish: The bay of biscay anchovy case study. *Marine Ecology Progress Series*, 617–618: 245–263.
- STECF. 2013. Advice on the harvest control rule and evaluation of the anchovy plan COM(2009) 399 final (EWG 13-20). Publications Office of the European Union, Luxembourg, 2013, ISBN 978-92-79-34619-4.
- STECF. 2014. Evaluation /scoping of management plans - data analysis for support of the impact assessment for the management plan of bay of biscay anchovy (COM(2009)399 final) (EWG 14-03). Publications Office of the European Union, Luxembourg, 2014, ISBN 978-92-79-37843-0.
- Taylor, I. G., Doering, K. L., Johnson, K. F., Wetzel, C. R., and Stewart, I. J. 2021. Beyond visualizing catch-at-age models: Lessons learned from the r4ss package about software to support stock assessments. *Fisheries Research*, 239: 105924.
- Uriarte, A., Ibaibarriaga, L., Pawlowski, L., Massé, J., Petitgas, P., Santos, M., and Skagen, D. 2016. Assessing natural mortality of bay of biscay anchovy from survey population and biomass estimates1. *Canadian Journal of Fisheries and Aquatic Sciences*, 73: 216–234.
- Uriarte, A., Ibaibarriaga, L., Sánchez-Maroño, S., Abaunza, P., Andrés, M., Duhamel, E., Jardim, E., et al. 2023. Lessons learnt on the management of short-lived fish from the bay of biscay anchovy case study: Satisfying fishery needs and sustainability under recruitment uncertainty. *Marine Policy*, 150: 105512.
- Winker, H., Carvalho, F., Cardinale, M., Kell, L., Oshima, M., and Fletcher, E. 2024. ss3diags: Stock synthesis model diagnostics for integrated stock assessmentsl. R package version 2.2.0 <https://github.com/PIFSCstockassessments/ss3diags>.

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 WKBANSB 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 between 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 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, 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 26th March and 16th 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 sub-division (**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 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 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 ($M_0 = 1.285$; $M_1 = 1.028$; $M_2 = 0.827$; $M_3 = 0.703$; $M_4 = 0.724$).

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

- 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>
- Garrido, S., Ramos, F., Silva, A., Angélico, M. M., Marques, V. 2018a. Population structure of the European anchovy (*Engraulis encrasicolus*) in ICES Division 9a: synopsis and updated information. Working document presented to the ICES Benchmark Workshop on Pelagic Stocks (WKPELA 2018). 12–16 February 2018. Copenhagen, Denmark. 16 pp.
- ICES. 2003. Report of the Workshop on Discard Sampling Methodology and Raising Procedures. Charlottenlund, Denmark, 2–4 September 2003.
- ICES. 2008. Report of the Workshop on Small Pelagics (*Sardina pilchardus*, *Engraulis encrasicolus*) maturity stages (WKSPMAT), 10–14 November 2008, Mazara del Vallo, Italy. ICES CM 2008/ACOM:40. 82 pp.
- ICES. 2018. Report of the Benchmark Workshop on Pelagic Stocks (WKPELA 2018), 12–16 February 2018, ICES HQ, Copenhagen, Denmark. ICES CM 2018/ACOM:32. 313 pp.
- ICES. 2020. Working Group on Southern Horse Mackerel, Anchovy and Sardine (WGHANSA). *ICES Scientific Reports*. 2:41. 655 pp. <http://doi.org/10.17895/ices.pub.5977>
- ICES. 2021. Working Group on Southern Horse Mackerel Anchovy and Sardine (WGHANSA). ICES Scientific Reports. 3:55. 689 pp. <https://doi.org/10.17895/ices.pub.8138>.
- ICES. 2022. ICES technical guidance for harvest control rules and stock assessments for stocks in categories 2 and 3. In Report of ICES Advisory Committee, 2022. ICES Advice 2022, Section 16.4.11. <https://doi.org/10.17895/ices.advice.19801564>
- ICES. 2023. Working Group on Southern Horse Mackerel, Anchovy and Sardine (WGHANSA). ICES Scientific Reports. 5:67. 573 pp. <https://doi.org/10.17895/ices.pub.23507922>
- ICES. 2024a. Benchmark Workshop on anchovy stocks (WKBANSP). ICES Scientific Reports. 6:96. 477 pp. <https://doi.org/10.17895/ices.pub.27909783>

- ICES. 2024b. Stock Identification Methods Working Group (SIMWG). ICES Scientific Reports. 6:85. 249 pp. <https://doi.org/10.17895/ices.pub.27110470Machado>
- Massé, J., Uriarte, A., Angélico, M. M., and Carrera, P. (Eds.) 2018. Pelagic survey series for sardine and anchovy in ICES subareas 8 and 9 – Towards an ecosystem approach. *ICES Cooperative Research Report* No. 332. 268 pp. <https://doi.org/10.17895/ices.pub.4599>.
- Pestana, G. 1989. Manancial Ibero Atlântico de Sardinha (*Sardina pilchardus* Walb) sua avaliação e medidas de gestão. PhD. thesis. Univ. Lisboa.
- Pestana, G. 1996. Anchovy in Portuguese waters (IXa): landings and length distribution in surveys. Working Document presented in the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES, C.M. 1996/Assess:7.
- Teles-Machado A, Plecha SM, Peliz A, Garrido S (2024) Anomalous ocean currents and European anchovy dispersal in the Iberian ecosystem. Mar Ecol Prog Ser :SPF2av13. <https://doi.org/10.3354/meps14526>
- Wise L, Susana Garrido, Alexandra A. Silva, Alfonso Pérez-Rodríguez (2023) Anchovy 9a west stock-specific management strategy evaluation conducted to determine an alternative to the current advice rule. Working Document of the ICES. 2023. Working Group on Southern Horse Mackerel, Anchovy and Sardine (WGHANSA). ICES Scientific Reports. 5:67. 573 pp. <https://doi.org/10.17895/ices.pub.23507922>

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, WGANS 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				
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				
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 are available.

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

2023	Q1	Q2	Q3	Q4	TOTAL
Length (cm)	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)
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

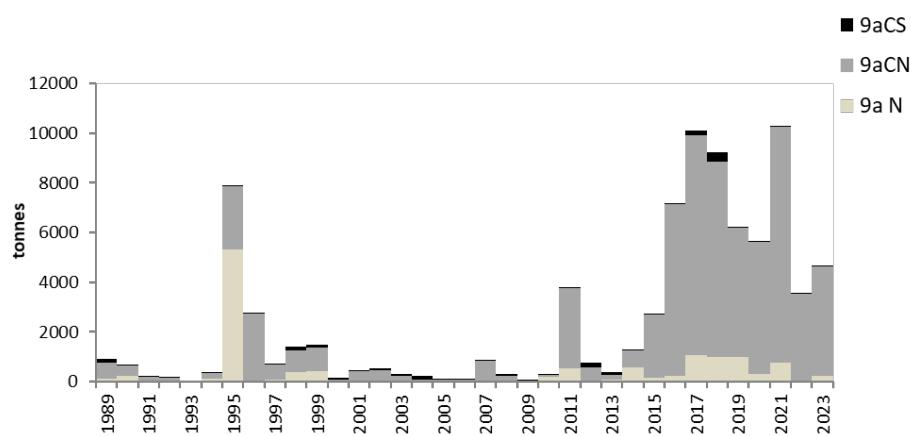


Figure 3.3.2.1.1. Anchovy in Division 9.a West. Recent series of anchovy catches in Division 9.a (ICES estimates for 1989–2023, the period with data for all the subdivisions, all metiers are considered). Catches by Subdivision (ICES subdivisions 9.a North, Central-North and Central-South). Discards are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

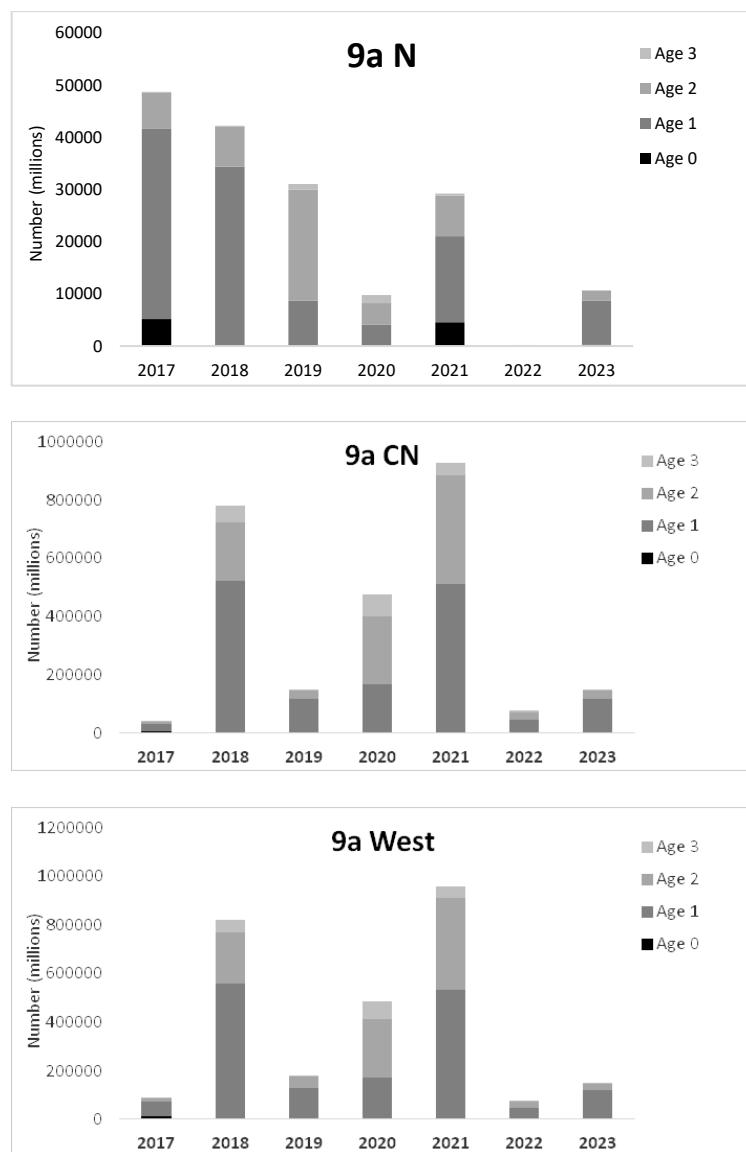


Figure 3.3.5.2.1. Anchovy in Division 9.a. West. Subdivisions 9.a North and 9.a Central North. Spanish and Portuguese fisheries (all métiers). Age composition in Spanish catches of SW Galician anchovy (9.a North) and Portuguese catches of anchovy from northern Portugal (9.a Central North) (available 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).

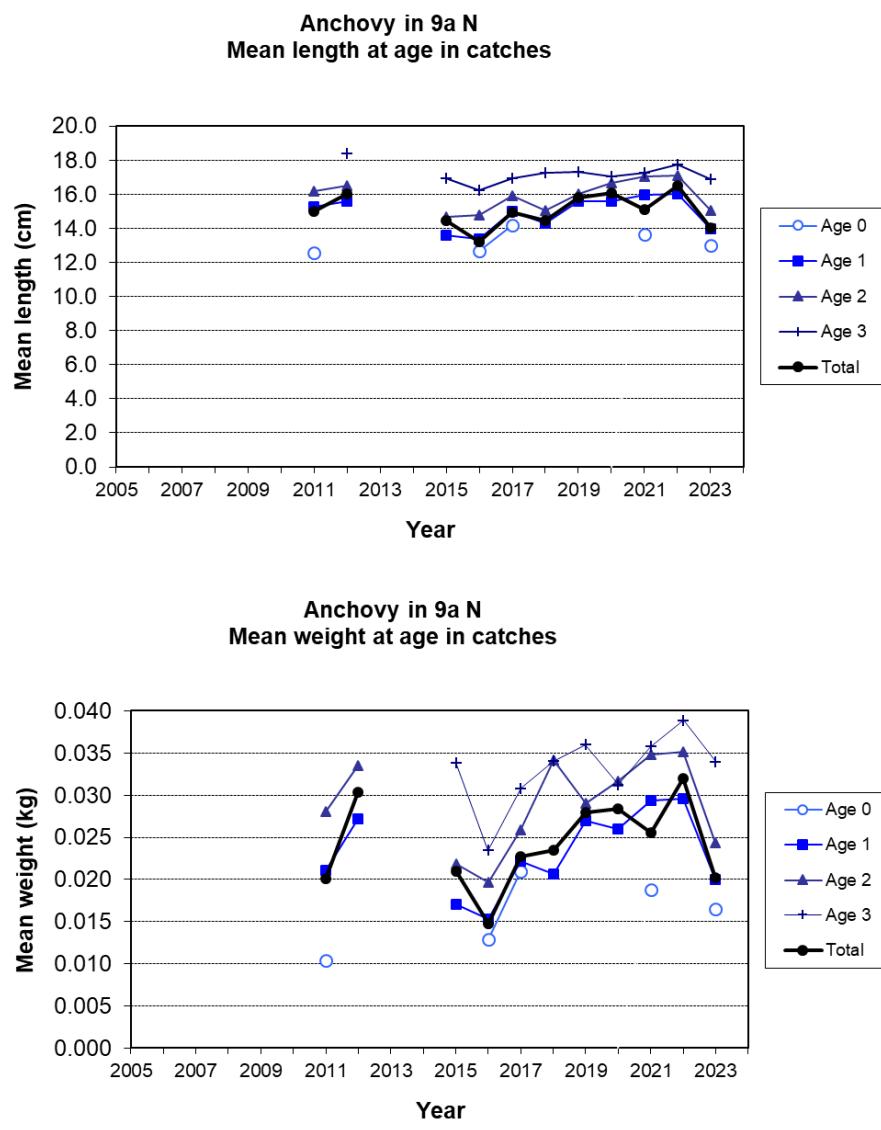


Figure 3.3.6.1. Anchovy in Division 9.a. West. Subdivision 9.a North. Spanish fishery (all métiers). Annual mean length (TL, in cm) and weight (kg) at-age in the Spanish catches of Western Galicia anchovy (2011–2023).

d

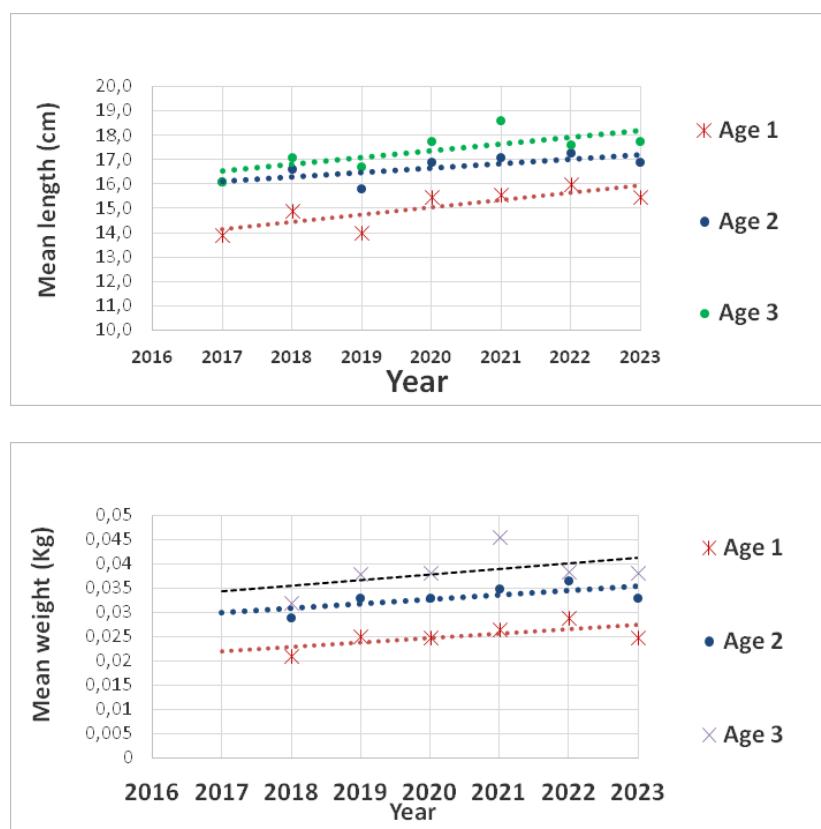


Figure 3.3.6.2. Anchovy in Division 9.a. West. Subdivision 9.a Central North. Portuguese fishery (all métiers). Annual mean length (TL, in cm) and weight (kg) at-age in the Portuguese catches of Western anchovy (2017 to 2023). Data for 2021 and 2022 are only available for the 3rd and 4th Quarters (represent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

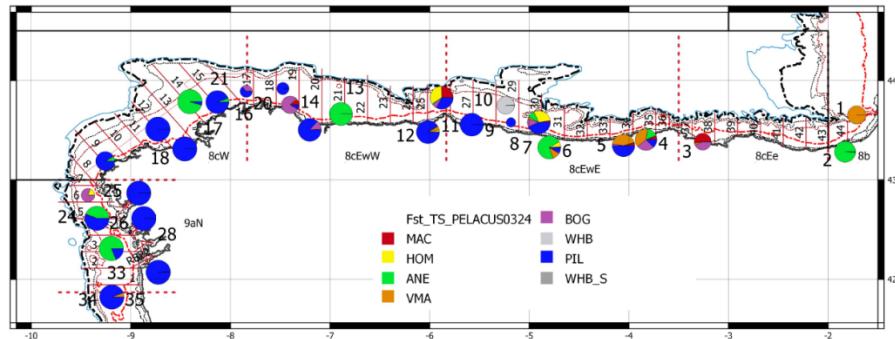


Figure 3.4.1.1. Anchovy in Division 9.a. West. Subdivision 9.a North. PELACUS 0424 survey (spring Spanish acoustic survey in Sub-division 9.a North and Sub-area 8c in 2024). Location of valid fishing stations with indication of their species composition (percentages in number).

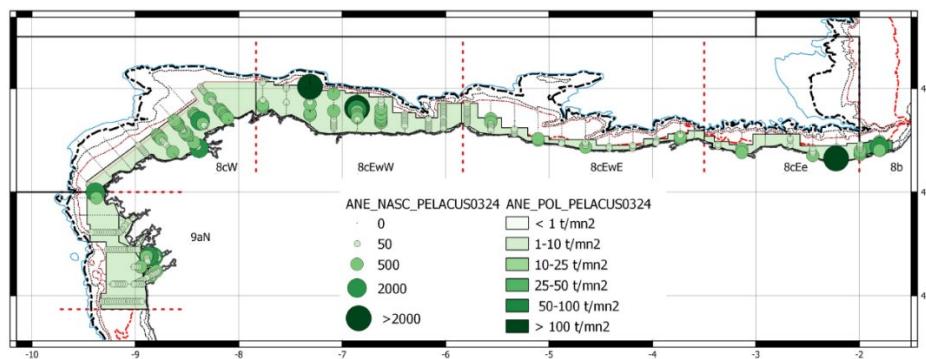


Figure 3.4.1.2. Anchovy in Division 9.a. West. Subdivision 9.a North. PELACUS 0424 survey (spring Spanish acoustic survey in Sub-division 9.a North and Sub-area 8c in 2024). Spatial distribution of energy allocated to anchovy (NASC coefficients in m²/mn²).

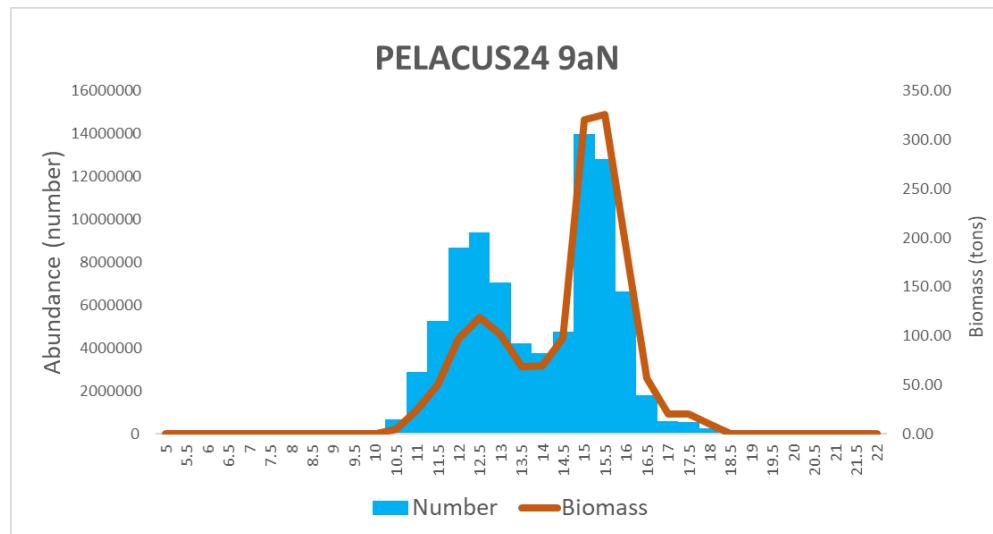


Figure 3.4.1.3. Anchovy in Division 9.a. West. Subdivision 9.a North. PELACUS 0424 survey (spring Spanish acoustic survey in Sub-division 9.a North and Sub-area 8c in 2024). Estimated abundances and biomasses (number of fish and thousand tonnes, respectively) in Sub-division 9.a North by length class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

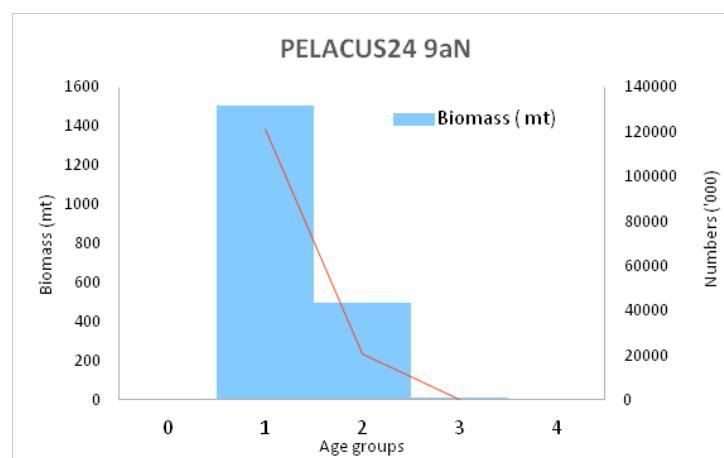


Figure 3.4.1.4. Anchovy in Division 9.a. West. Subdivision 9.a North. *PELACUS 0424* survey (spring Spanish acoustic survey in Sub-division 9.a North and Sub-area 8c in 2024). Estimated abundances and biomasses (number of fish in thousands and tonnes, respectively) in Sub-division 9.a North by age group.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

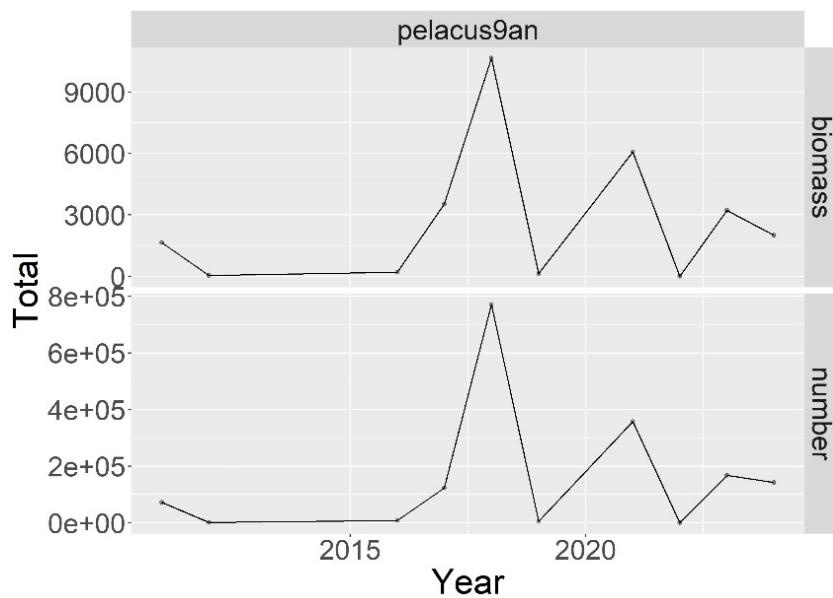


Figure 3.4.1.5. Anchovy in Division 9.a. West. Subdivision 9.a North. *PELACUS* survey series (spring Spanish acoustic survey in Subdivision 9.a North and Subarea 8c). Historical series of acoustic estimates of anchovy abundance and biomass (t) in the Subdivision 9.a North.

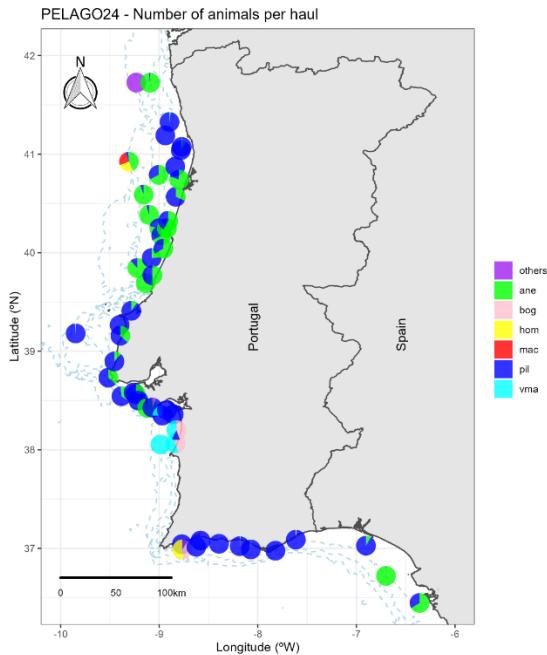


Figure 3.4.1.6. Anchovy in Division 9.a. Western and Southern stocks. Subdivisions 9.a Central-North to 9.a South. PELAGO survey series (spring Portuguese acoustic survey in Subdivisions 9.a Central-North to 9.a South). PELAGO 24 survey. Location of valid fishing stations with indication of their species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

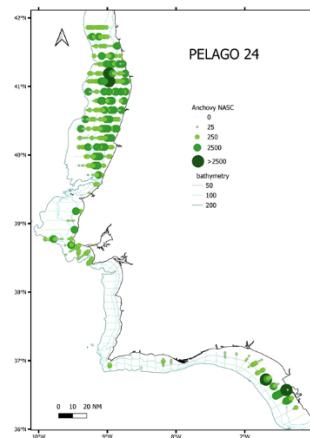


Figure 3.4.1.7. Anchovy in Division 9.a. Western and Southern stocks. Subdivisions 9.a Central-North to 9.a South. PELAGO survey series (spring Portuguese acoustic survey in Subdivisions 9.a Central-North to 9.a South). PELAGO 24 survey. Spatial distribution of energy allocated to anchovy (NASC coefficients in m^2/mn^2).

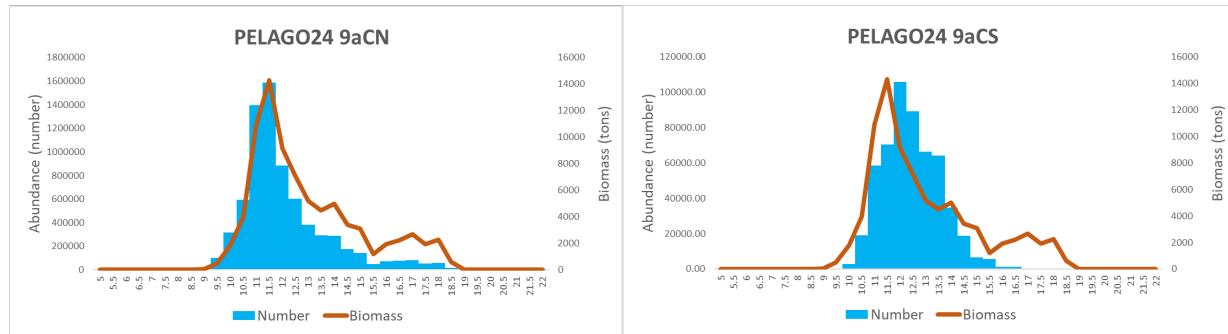


Figure 3.4.1.8. Anchovy in Division 9.a West. Sub-divisions 9.a Central-North and 9.a Central South. PELAGO survey series (spring Portuguese acoustic survey in Sub-divisions 9.a Central-North to 9.a South). PELAGO 24 survey. Estimated abundances and biomasses (number of fish in thousands and tonnes, 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.

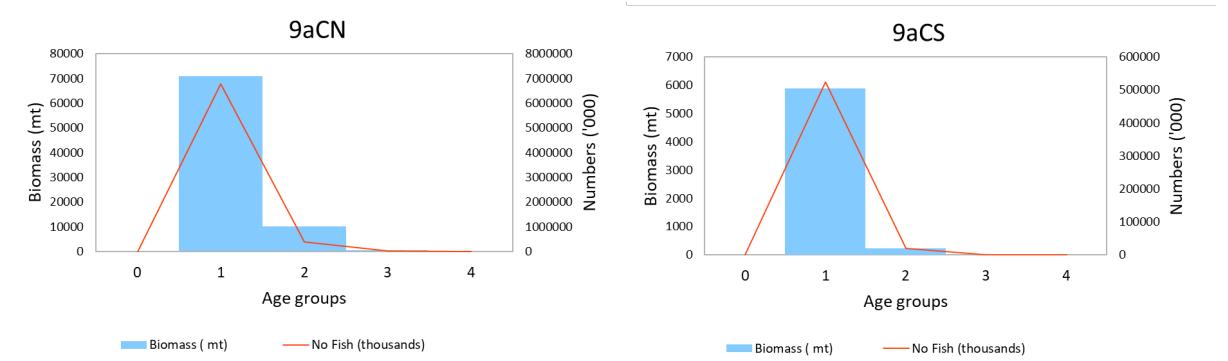


Figure 3.4.1.9. Anchovy in Division 9.a. West. Sub-divisions 9.a Central-North and 9.a Central South. PELAGO survey series (spring Portuguese acoustic survey in Sub-divisions 9.a Central-North to 9.a South). PELAGO 24 survey. Estimated abundances and biomasses (number of fish in thousands and tonnes,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

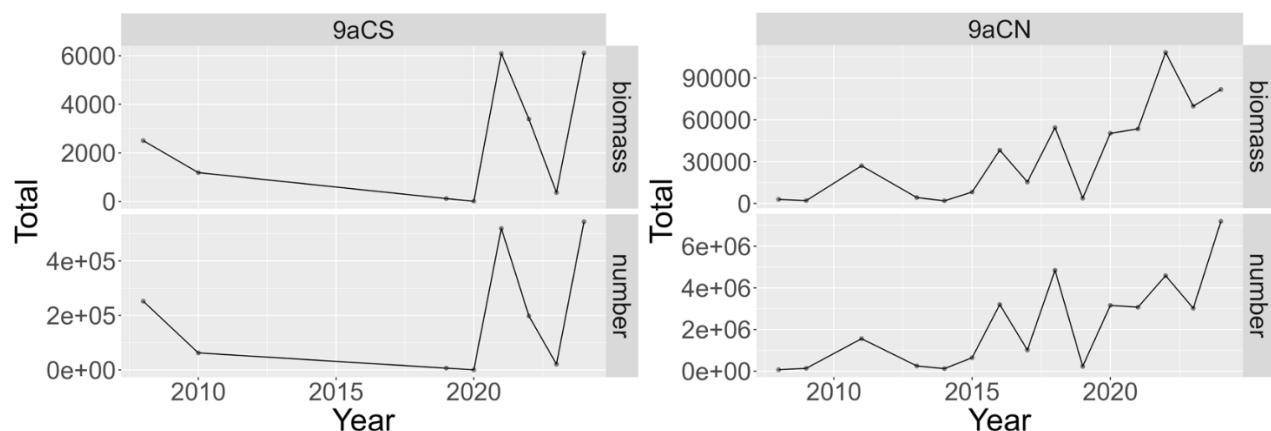


Figure 3.4.1.10. Anchovy in Division 9.a West. Sub-divisions 9.a Central-North and 9.a Central South. PELAGO survey series (spring Portuguese acoustic survey in Sub-divisions 9.a Central-North to 9.a South). Historical series of regional acoustic estimates of anchovy biomass (t). Note the different scale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

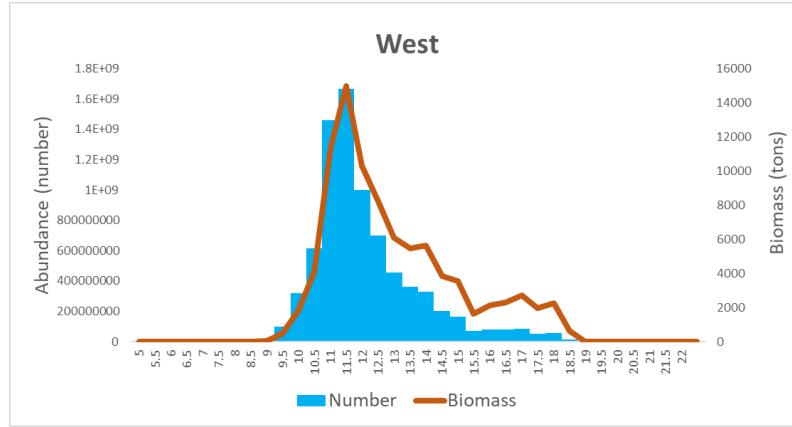


Figure 3.4.1.11. Anchovy in Division 9.a West. Subdivisions 9.a North to Central-South. Annual trends of the estimated population by length class from the PELACUS (9a North) + PELAGO (9a Central-North and Central-South). Estimated abundances and biomasses (number of fish in thousands and tonnes, respectively)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

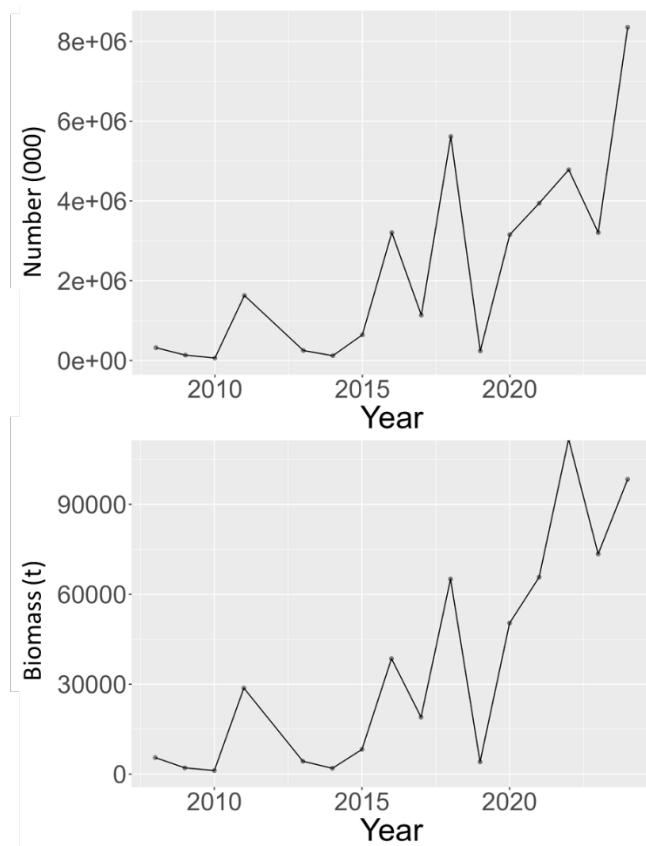


Figure 3.4.1.12. Anchovy in Division 9.a West. Subdivisions 9.a North to Central-South. Annual trends of the estimated population by length class from the PELACUS (9a North) + PELAGO (9a Central-North and Central-South). Historical series of regional acoustic estimates for anchovy in 9.a West abundance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

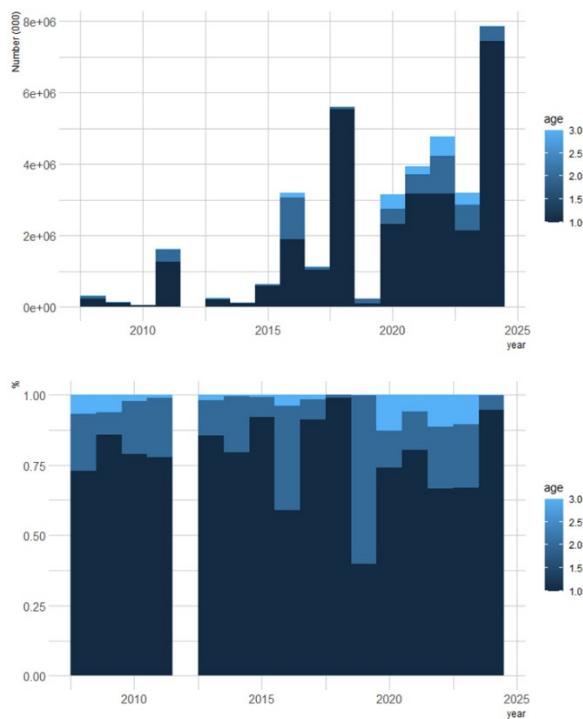


Figure 3.4.1.13. Anchovy in Division 9.a. West. Subdivisions 9.a North to Central-South. Annual trends of the estimated population by age class from the PELACUS (9a North) + PELAGO (9a Central-North and Central-South) Spring acoustic surveys, number of individuals per age (upper panel) and percentage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

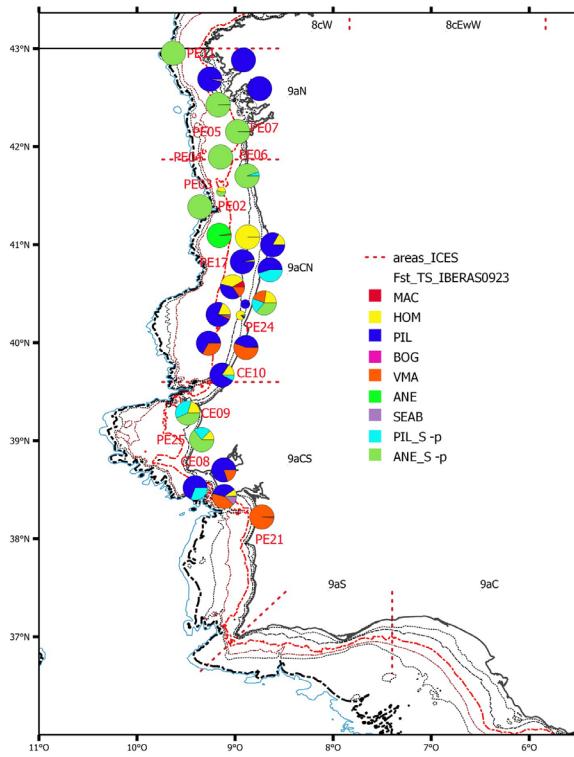


Figure 3.4.2.1. Anchovy in Division 9.a. West. Subdivisions 9.aNorth, 9.a Central-North and 9.a Central-South. *IBERAS 0923* survey (autumn Spanish-Portuguese acoustic survey in Subdivisions 9.aNorth to Central-South). Location of valid fishing stations with indication of their species composition (percentages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

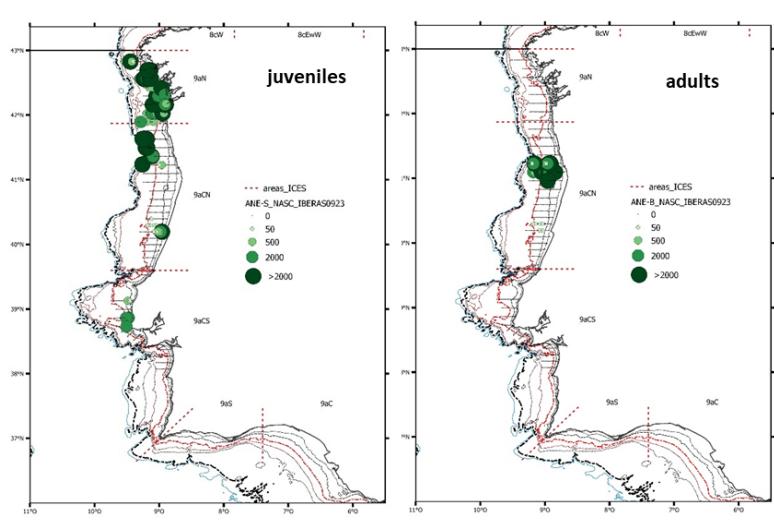


Figure 3.4.2.2. Anchovy in Division 9.a. West. Subdivisions 9.a North, 9.a Central-North and 9.a Central-South. *IBERAS 0923* survey (autumn Spanish-Portuguese acoustic survey in Subdivisions 9.a North to Central-South). Distribution of the backscattering energy (Nautical area scattering coefficient,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

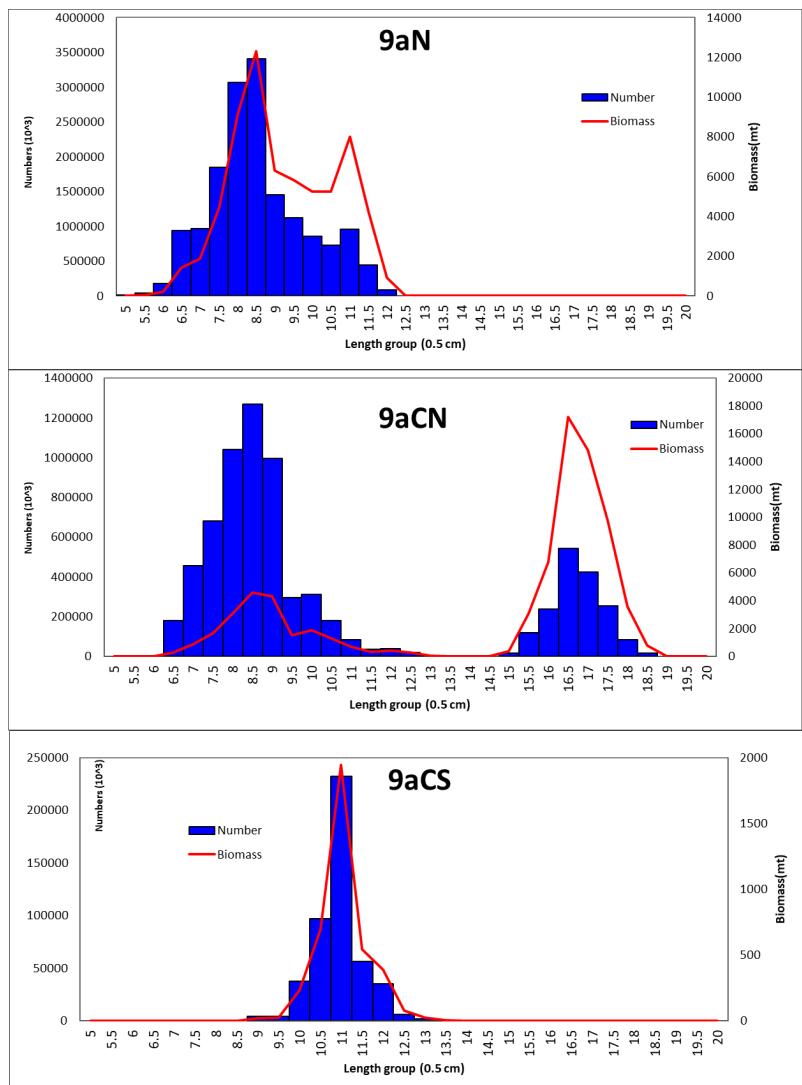


Figure 3.4.2.3. Anchovy in Division 9.a. West. Subdivisions 9.aNorth, 9.a Central-North and 9.a Central-South. IBERAS 0923 survey (autumn Spanish-Portuguese acoustic survey in Subdivisions 9.a North to Central-South). Estimated abundances and biomasses (number of fish in thousands and tonnes, respectively)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

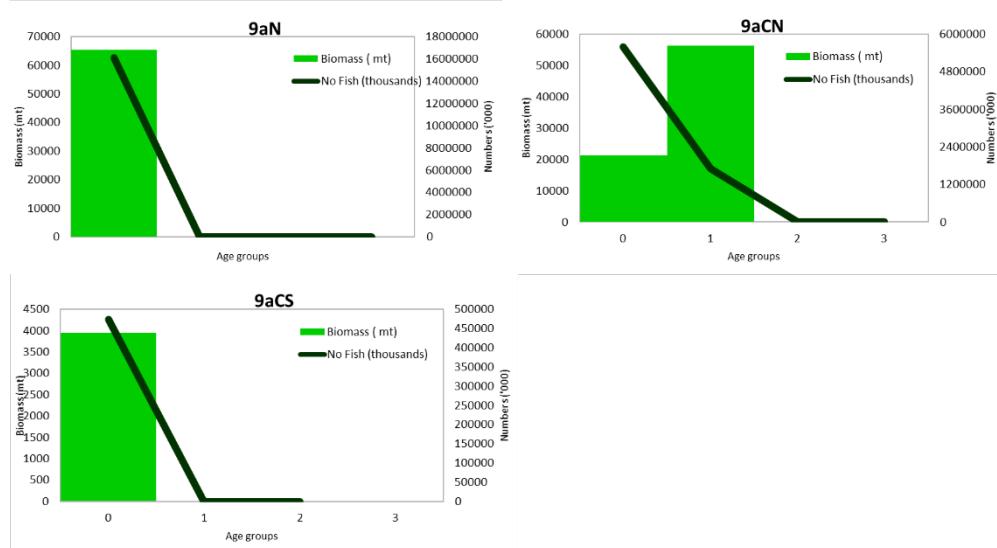


Figure 3.4.2.4. Anchovy in Division 9.a. West. Subdivisions 9.a North, 9.a Central-North and 9.a Central-South. *IBERAS 0923* survey (autumn Spanish-Portuguese acoustic survey in Subdivisions 9.a North to Central-South). Estimated abundances and biomasses (number of fish in thousands and tonnes, respectively)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

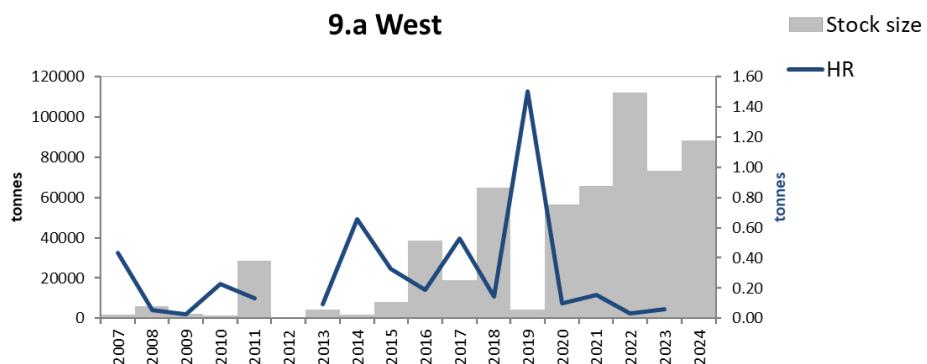


Figure 3.8.1. Anchovy in Division 9.a. West. Stock biomass survey index and harvest rates. Harvest rates were estimated with the biomass of the surveys of a given year and the catches of the management period, i.e. 2007 corresponds to the period 07/2007 to 06/2008.

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 1st 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 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/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 Guadaluquivir 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 °C - 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 $\times 10^{12}$ /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 m² nmi⁻²) has shown 63% lower than the maximum value recorded throughout the time-series, estimated in 2020 (229 241 m² nmi⁻²), and 28% below the historical mean (118 395 m² 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 PEL-AGO 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 m² nmi⁻²) was 21% lower than that recorded last year (107 026 m² nmi⁻²) and 28% below the historical mean (118 395 m² 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 18th and 30th 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 m² nmi⁻²) was 16% higher than that recorded last year (84 191 m² nmi⁻²) and 16% below the historical mean (118 395 m² 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 (R_t) 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

$B_{lim} = B_{pa} * \exp(-1.645 * \text{SigmaB}) = 4\ 721$ tonnes, with $B_{pa} = B_{loss}$ and $\text{SigmaB} = 0.2$ (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} ($F_{sq} \times \text{Mult}$) 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 ($F_{\text{mean}2020-2024}$) and the median historical apical F ($F_{\text{medianhistoric}}$), 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 $p(\text{SSB}_{2025} \leq \text{Blim}) = 0.05$ and 0.5, as well as $p(\text{SSB}_{2025} \leq \text{Bpa}) = 0.05$ 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 Blim.

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 *ECOCADIZ-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.

4.13 References

- Carvalho, F., Winker, H., Courtney, D., Kapur, M., Kell, L., Cardinale, M., Schirripa, M., et al. 2021. A cookbook for using model diagnostics in integrated stock assessments. *Fisheries Research*, 240: 105959. <https://www.sciencedirect.com/science/article/pii/S0165783621000874>.
- 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>
- Francis, R. I. C. C. 2011. Data weighting in statistical fisheries stock assessment models. *Canadian Journal of Fisheries and Aquatic Sciences*, 68: 1124–1138. <https://doi.org/10.1139/f2011-025>
- Garrido, S., Ramos, F., Silva, A., Angélico, M. M., Marques, V. 2018a. Population structure of the European anchovy (*Engraulis encrasicolus*) in ICES Division 9a: synopsis and updated information. Working document presented to the ICES Benchmark Workshop on Pelagic Stocks (WKPELA 2018). 12–16 February 2018. Copenhagen, Denmark. 16 pp.
- Garrido, S., Rodríguez-Ezpeleta, N., Ramos, F., Rincón, M.M., Feijó, D., Moreno, A., Castilho, R., Díaz, N., Fonseca, R.R., Francisco, S.M., Manuzzi, A., Silva, G., Uriarte, A., Ibaibarriaga, L. 2022. Population structure of the European anchovy (*Engraulis encrasicolus*) in ICES division 9a. Working document submitted to ICES Working Group on Southern horse mackerel, anchovy and sardine (WGHANSA 2022). 23–27 May 2022 <http://doi.org/10.17895/ices.pub.19982720>.
- Hurtado-Ferro, F., Szewalski, C. S., Valero, J. L., Anderson, S. C., Cunningham, C. J., Johnson, K. F., Licandeo, R., et al. 2014. Looking in the rear-view mirror: bias and retrospective patterns in integrated, age-structured stock assessment models. *ICES Journal of Marine Science*, 72: 99–110. <https://doi.org/10.1093/icesjms/fsu198>.

- ICES. 2003. Report of the Workshop on Discard Sampling Methodology and Raising Procedures. Charlottenlund, Denmark, 2–4 September 2003.
- ICES. 2004. Report of the Study Group on Assessment Methods Applicable to Assessment of Norwegian Spring-Spawning Herring and Blue Whiting Stocks (SGAMHBW). 19–22 February 2004, Lisbon, Portugal. ICES CM 2014/ACFM 145. 166 pp.
- ICES. 2007. Report of the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VIII and IX (WGACEGG), 26–30 November 2007, Palma de Mallorca, Spain, ICES C.M. 2007/LRC:16. 167 pp.
- ICES. 2008a. Report of the Working Group on Anchovy (WGANC), 13–16 June 2008, ICES Headquarters, Copenhagen. ICES CM 2008 ACOM:04. 226 pp.
- ICES. 2008b. Report of the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VIII and IX (WGACEGG), 24–28 November 2008, Nantes, France. ICES CM 2008/LRC:17. 183 pp.
- ICES. 2008c. Report of the Workshop on Small Pelagics (*Sardina pilchardus*, *Engraulis encrasicolus*) maturity stages (WKSPMAT), 10–14 November 2008, Mazara del Vallo, Italy. ICES CM 2008/ACOM:40. 82 pp.
- ICES. 2009a. Report of the Working Group on Anchovy and Sardine (WGANSA), 15–20 June 2009, ICES Headquarters, Copenhagen. ICES CM 2009/ACOM:13. 354 pp.
- ICES. 2009b. Report of the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VIII and IX (WGACEGG), 16–20 November 2009, Lisbon, Portugal. ICES CM 2009/LRC:20. 181 pp.
- ICES. 2012. ICES Implementation of Advice for Data-limited Stocks in 2012 in its 2012 Advice. ICES CM 2012/ACOM:68. 42 pp.)
- ICES. 2015. Interim Report of the Stock Identification Methods Working Group (SIMWG), 10–12 June 2015, Portland, Maine, USA. ICES CM 2015/SSGEPI:13. 67 pp.
- ICES. 2017a. Report of the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas 7, 8, and 9. WGACEGG Report 2016 Capo, Granitola, Sicily, Italy. 14–18 November 2016. ICES CM 2016/SSGIEOM:31. 326 pp.
- ICES. 2017b. Report of the Workshop to review the ICES advisory framework for short-lived species, including detailed exploration of the use of escapement strategies and forecast methods (WKMSYREF5), 11–15 September 2017, Capo Granitola, Sicily. ICES CM 2017/ACOM:46 A. 63 pp.
- ICES. 2018a. Report of the Benchmark Workshop on Pelagic Stocks (WKPELA 2018), 12–16 February 2018, ICES HQ, Copenhagen, Denmark. ICES CM 2018/ACOM:32. 313 pp.
- ICES. 2018b. Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas 7, 8 and 9 (WGACEGG). ICES WGACEGG REPORT 2017 3–17 November 2017. pp. 388.
- ICES. 2020b. Working Group on Southern Horse Mackerel, Anchovy and Sardine (WGHANSA). ICES Scientific Reports. 2:41. 655 pp. <http://doi.org/10.17895/ices.pub.5977>
- ICES. 2021a. Working Group on Southern Horse Mackerel Anchovy and Sardine (WGHANSA). ICES Scientific Reports. 3:55. 689 pp. <https://doi.org/10.17895/ices.pub.8138>.
- ICES. 2021b. Tenth Workshop on the Development of Quantitative Assessment Methodologies based on LIFE-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks (WKLIFE X). ICES Scientific Reports. 2:98. 72 pp. <http://doi.org/10.17895/ices.pub.5985>
- ICES. 2022. Stock Identification Methods Working Group (SIMWG). ICES Scientific Reports. 4:72. 66 pp. <http://doi.org/10.17895/ices.pub.20937001>.
- ICES. 2023. Working Group on Southern Horse Mackerel, Anchovy and Sardine (WGHANSA). ICES Scientific Reports. 5:67. <https://doi.org/10.17895/ices.pub.23507922>.
- ICES. 2024a. Benchmark Workshop on anchovy stocks (WKBANSP). ICES Scientific Reports. 6:96. 477 pp. <https://doi.org/10.17895/ices.pub.27909783>
- ICES. 2024b. Stock Identification Methods Working Group (SIMWG). ICES Scientific Reports. 6:85. 249 pp. <https://doi.org/10.17895/ices.pub.27110470>

- ICES. 2024c. ICES Guidelines - Advice rules for stocks in category 2 and 3. Version 2. ICES Guidelines and Policies - Advice Technical Guidelines. 30 pp. <https://doi.org/10.17895/ices.pub.26056306>
- Jiménez, M.P., Tornero, J., Villaverde, A., Llevot, M.J., Solla, A., Ramos, F. 2018. Anchovy spawning stock biomass of the Gulf of Cadiz in 2017. Working document presented in the ICES Working Group on Southern Horse Mackerel, Sardine and Anchovy (WGHANSA). Lisbon, Portugal, 26–30 June 2018.
- Massé, J., Uriarte, A., Angélico, M. M., and Carrera, P. (Eds.) 2018. Pelagic survey series for sardine and anchovy in ICES subareas 8 and 9 – Towards an ecosystem approach. *ICES Cooperative Research Report No. 332*. 268 pp. <https://doi.org/10.17895/ices.pub.4599>.
- Methot, R. D., and Wetzel, C. R. 2013. Stock synthesis: A biological and statistical framework for fish stock assessment and fishery management. *Fisheries Research*, 142: 86–99. <https://doi.org/10.1016/j.fishres.2012.10.012>.
- Payne, M. R., L. W. Clausen, H Mosegaard. 2009. Finding the signal in the noise: objective data-selection criteria improve the assessment of western Baltic spring-spawning herring. *ICES Journal of Marine Science*, 66: 1673–1680.
- Ramos, F., 2015. On the population structure of the European anchovy (*Engraulis encrasicolus*) in ICES Division IXa: a short review of the state of art. Working document presented in the ICES Stock Identification Methods Working Group (SIMWG). 10–12 June 2015.
- Ramos, F., Tornero, J., Oñate, D., Jiménez, M.P. 2018a. Acoustic assessment and distribution of the main pelagic fish species in ICES Subdivision 9a South during the ECOCADIZ 2017-07 Spanish survey (July–August 2017). Working document presented in the ICES Working Group on Southern Horse Mackerel, Sardine and Anchovy (WGHANSA). Lisbon, Portugal, 26–30 June 2018.
- Ramos, F., Tornero, J., Oñate, D., Córdoba, P. 2018b. Acoustic assessment and distribution of the main pelagic fish species in ICES Subdivision 9a South during the ECOCADIZ-RECLUTAS 2017-10 Spanish survey (October 2017). Working document presented in the ICES Working Group on Southern Horse Mackerel, Sardine and Anchovy (WGHANSA). Lisbon, Portugal, 26–30 June 2018.
- Ramos, F., Canseco, J.A., Tornero, J., Córdoba, P., Bruno, I., Ortíz, J.J., Aldarias, A., Sánchez-Leal, R. 2024. Acoustic assessment and distribution of the main pelagic fish species in ICES Subdivision 9a South during the ECOCADIZ-RECLUTAS 2024-10 Spanish acoustic-trawl survey (October 2024). Preliminary results. Working document presented in the ICES Working Group on Acoustic and Egg Surveys for small pelagic fish in NE Atlantic (WGACEGG), Galway, Ireland, 18-22 November 2024, and in the ICES Working Group on Southern Horse Mackerel, Anchovy and Sardine (WGHANSA-2), Madrid, Spain, 25-29 November 2024. 61 pp.
- Rincón, M M., Ramos, F., Tornero, J., Garrido, S., Elvarsson, B., Lentin, J. 2024. Gadget for anchovy 9a South: Model description and results to provide catch advice and reference points (WGHANSA 2024-1). Working Document presented in the ICES Working Group on Southern Horse Mackerel, Sardine and Anchovy (WGHANSA-1). On-line meeting. 23–27 May 2024. https://github.com/ices-taf/2024_ane.27.9a_south_assessment/blob/main/report/Assessment2024prov_May8.pdf
- Silva, G., Horne, J. B., & Castilho, R. (2014). Anchovies go north and west without losing diversity: Post-glacial range expansions in a small pelagic fish. *Journal of Biogeography*, 41(6), 1171–1182. <https://doi.org/10.1111/jbi.12275>.
- Taylor, I. G., Doering, K. L., Johnson, K. F., Wetzel, C. R., and Stewart, I. J. 2021. Beyond visualizing catch-at-age models: Lessons learned from the r4ss package about software to support stock assessments. *Fisheries Research*, 239: 105924. <https://doi.org/10.1016/j.fishres.2021.105924>.
- Zarraonaindia, I., Iriondo, M., Albaina, A., Pardo, M. A., Manzano, C., Grant, W. S., Irigoien, X., & Estonba, A. (2012). Multiple SNP Markers Reveal Fine-Scale Population and Deep Phylogeographic Structure in European Anchovy (*Engraulis encrasicolus* L.). *PLoS ONE*, 7(7), e42201. <https://doi.org/10.1371/journal.pone.0042201>.

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, WGANS 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	Total
				(PT) *	(ES) **	
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	Total
				9.a S	(PT) *	
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	Total
				9.a S	(PT) *	(ES) **
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	Total
				9.a S	(PT) *	(ES) **
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.	496	541	210	-	-	-	7056	-	-	-	-	-		
	By gear														
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	0.2	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)				
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)				
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	Q1	Q2	Q3	Q4	TOTAL
Length (cm)	9.a S (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)				
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-RE-CLUTAS	BOCADEVA	
Institute (Country)	IPMA (PT)	IPMA (PT)	IEO (ES)	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	9.a S	
Year/Quarter	Q1	Q2	Q4	Q2	Q3	Q4	Q2
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-RE-CLUTAS		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			
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			
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 Moraes, 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			
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			
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)		
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		Spain S(C)	TOTAL S(Total)
		S(A)	-		
	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	N (million)		N (million)		N (million)		N (million)
	Year	Age 0	Age 1	Age 2	Age 3	Age 4	
1999	0	2025	54	0	0	0	2079
2000	-	-	-	-	-	-	-
2001	0	2635	65	0	0	0	2700
2002	0	3774	49	0	0	0	3823
2003	0	2077	237	0	0	0	2314
2004	-	-	-	-	-	-	-
2005	0	1245	61	0	0	0	1306
2006	0	2197	48	2	0	0	2246
2007	0	3060	85	0	0	0	3144
2008	0	1540	485	7	0	0	2032
2009	0	1735	295	38	0	0	2069
2010	0	951	12	0	0	0	963
2011	-	-	-	-	-	-	-
2012	-	-	-	-	-	-	-
2013	0	157	900	201	6	0	1264
2014	0	1501	1327	63	0	0	2890

PELAGO	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 (%)					
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 (%)					
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)					
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	N (million)					
Year	Age 0	Age 1	Age 2	Age 3	Age 4	TOTAL
2020	3792	1326	35	0	0	5153
2021	-	-	-	-	-	-
2022	-	-	-	-	-	-
2023	1069	332	9	0	0	1409

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

Survey	Estimate	Portugal	Spain	TOTAL
		S (PT)	S (ES)	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)
	Catch-at-age 1989-2024 by quarters (proportion)
<i>PELAGO</i> spring acoustic survey	Total Biomass 1999-2024 (missing years: 2000, 2004, 2011, 2012) (tonnes)
	Proportion-at-age 2014-2024
<i>ECOCADIZ</i> summer acoustic survey	Total Biomass 2004-2023 (missing years: 2005, 2008, 2011, 2012, 2021, 2022) (tonnes)
	Proportion-at-age 2004-2023 (missing years: 2005, 2008, 2011, 2012, 2021, 2022)
<i>BOCADEVA</i> DEPM survey	Total SSB 2005, 2008, 2011, 2014, 2017, 2020 and 2023 (tonnes)
<i>ECOCADIZ-RECLUTAS</i> 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 (R_0) 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.
<i>PELAGO</i> spring acoustic survey selectivity-at-age	Logistic functions fixed over time.
<i>ECOCADIZ</i> summer acoustic survey selectivity-at-age	Logistic functions split into two periods: 2004-2014 and 2015-2023.
<i>BOCADEVA</i> DEPM survey selectivity-at-age	Fixed at 0 for age-0 and fixed at 1 for all ages, over time
<i>ECOCADIZ-RECLUTAS</i> autumn acoustic survey selectivity-at-age	Fixed at 1 for age-0 and fixed at 0 for all ages, over time
<i>PELAGO</i> spring acoustic survey catchability	Linear catchability parameter
<i>ECOCADIZ</i> summer acoustic survey catchability	Linear catchability parameter
<i>BOCADEVA</i> DEPM survey catchability	Linear catchability parameter
<i>ECOCADIZ-RECLUTAS</i> autumn acoustic survey catchability	Linear catchability parameter
Log-likelihood function:	
Weights of components	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 Mohn'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 × 1.2	10 450	2.14	12 370	0
F=F ₂₀₂₄ × 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}

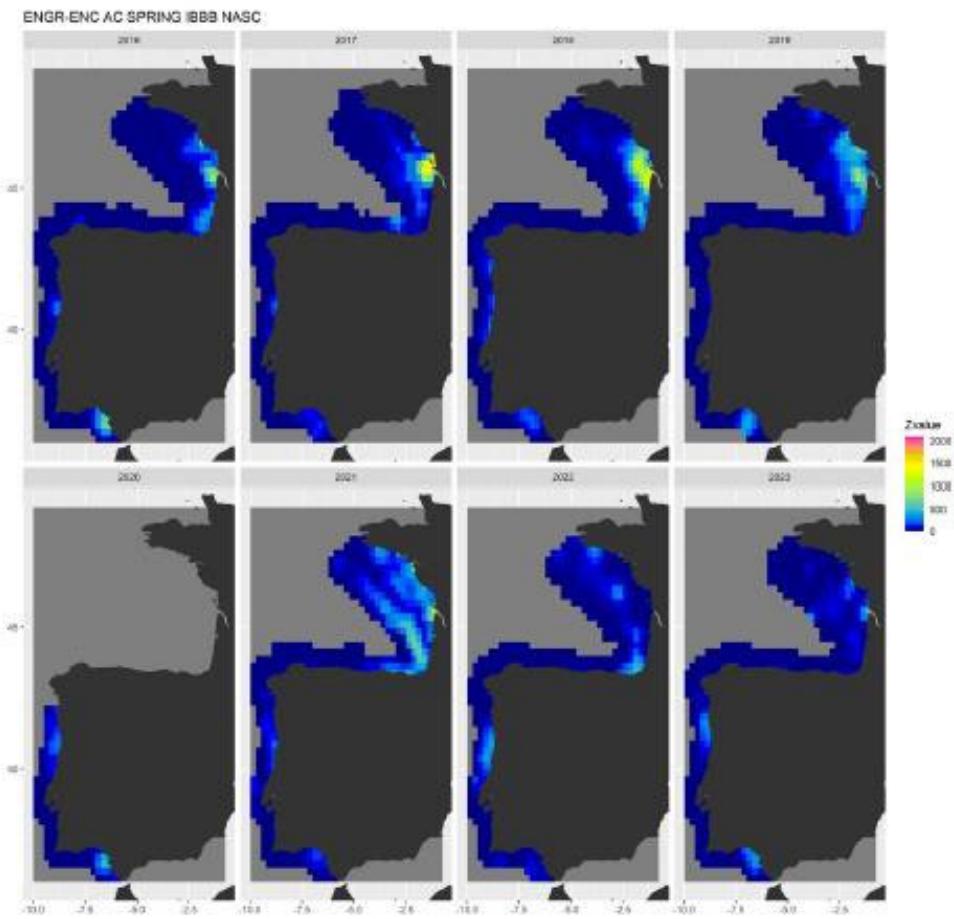


Figure 4.2.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Adult anchovy mean acoustic density (NASC, $\text{m}^2 \text{ nm}^{-3}$) maps derived from the *PELGAS*, *PELACUS* and *PELAGO* spring acoustic-trawl surveys, years 2016–2023, 0.25° map cell. Source: ICES WGACEGG 2024 report.

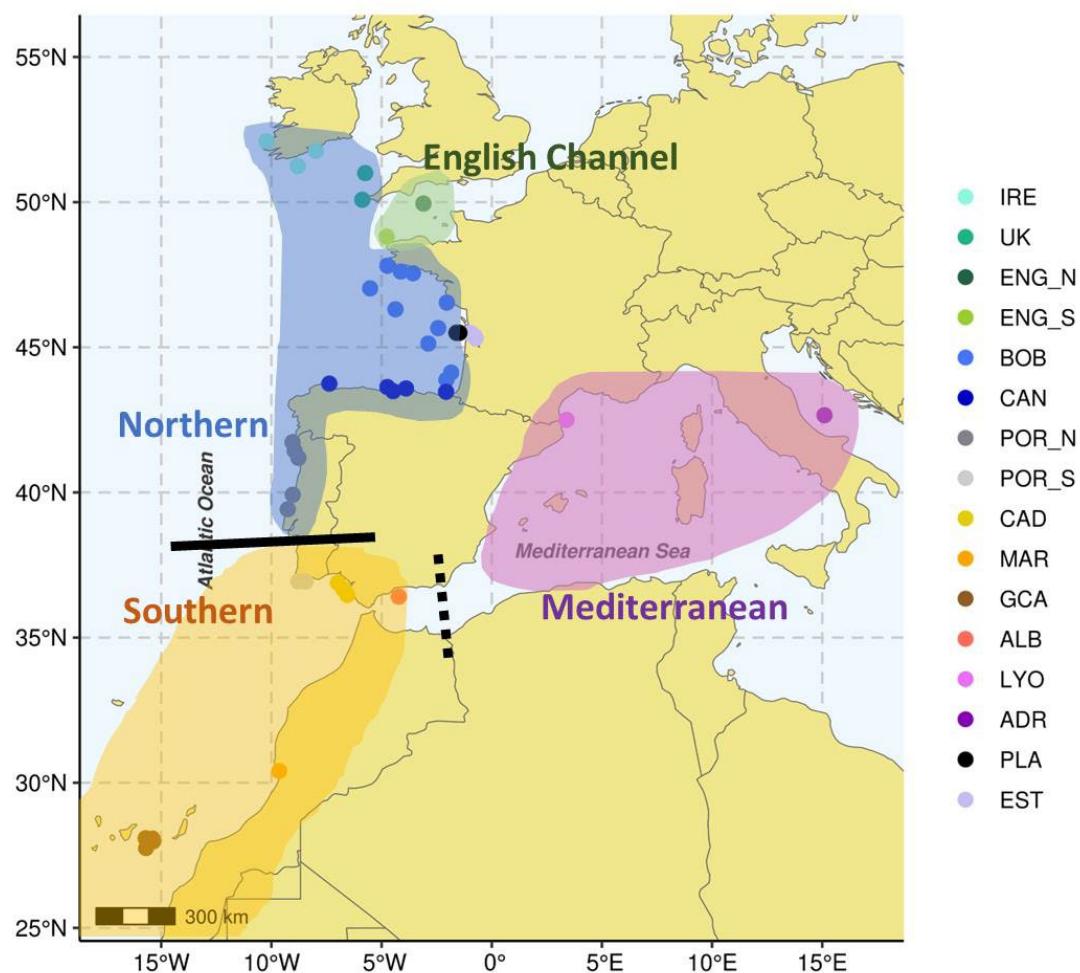


Figure 4.2.3. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Summary of the conclusions based on the genetic analyses concerning the marine ecotypes showing the main identified groups. Source: Garrido *et al.* (2024).

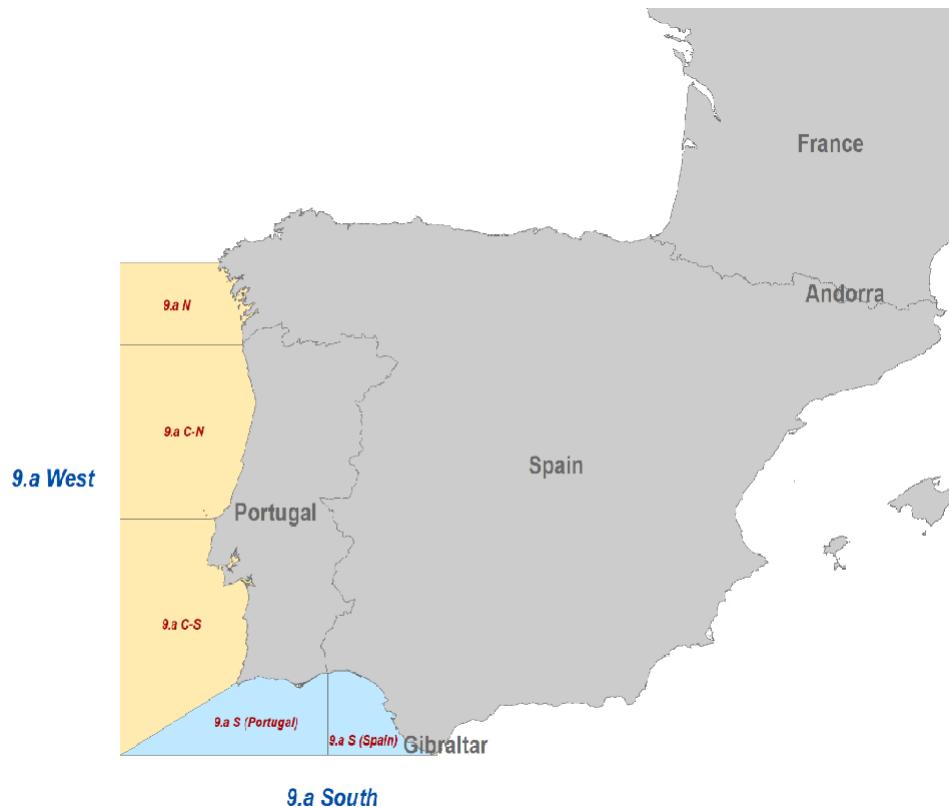


Figure 4.2.3. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Map showing the split of the former anchovy in Division 9a stock into the new stocks of anchovy in 9a West (light orange) and in 9a South (light blue). Note that, in turn, the stock 9a South is divided into Portuguese and Spanish waters,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

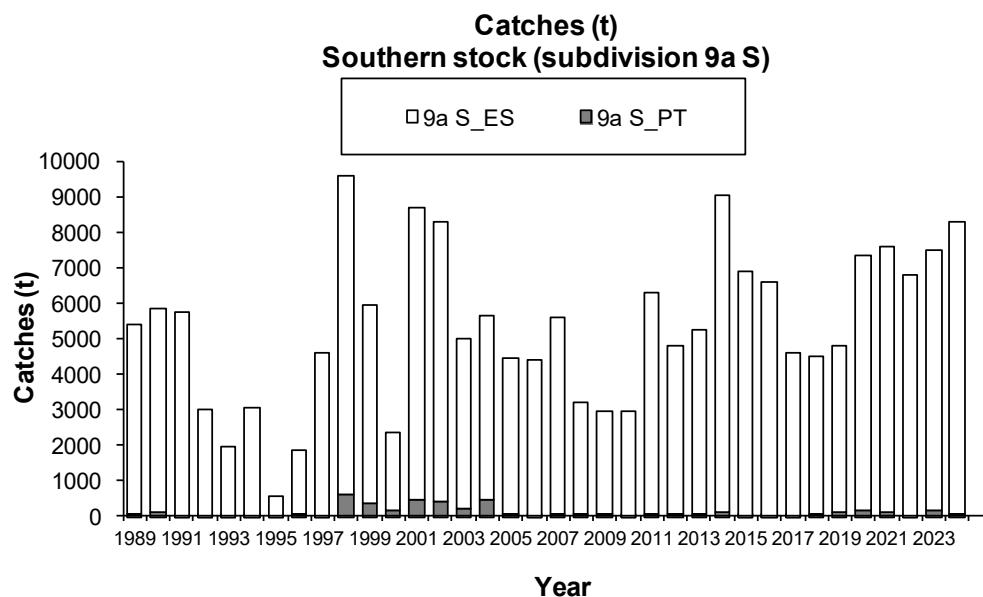


Figure 4.3.2.1.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Recent series of anchovy catches (ICES estimates for 1989–2024, the period with data for the Portuguese and Spanish fisheries, all metiers are considered). Discards are considered as negligible all over the subdivision, but since 2014 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).

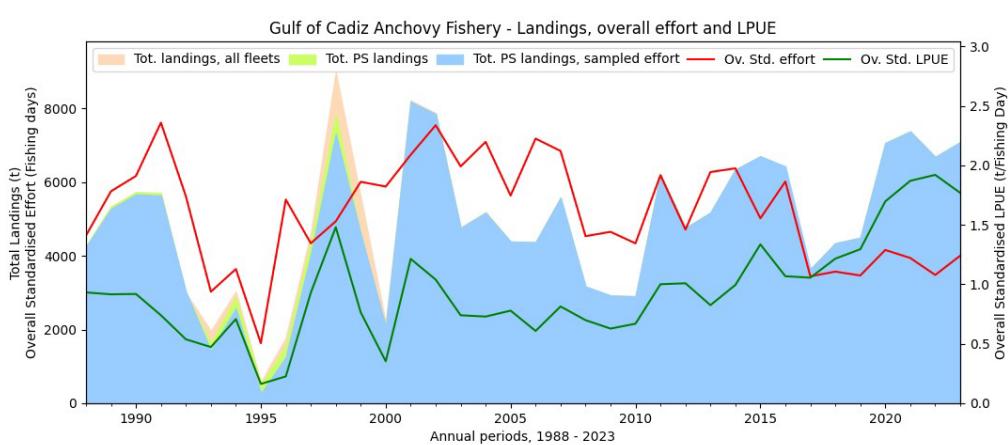


Figure 4.3.4.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Spanish purse-seine fishery (métier PS_SPF_0_0_0). Trends in Gulf of Cadiz anchovy annual landings, and purse-seine fleets' standardised overall effort and Ipue (1988–2023).

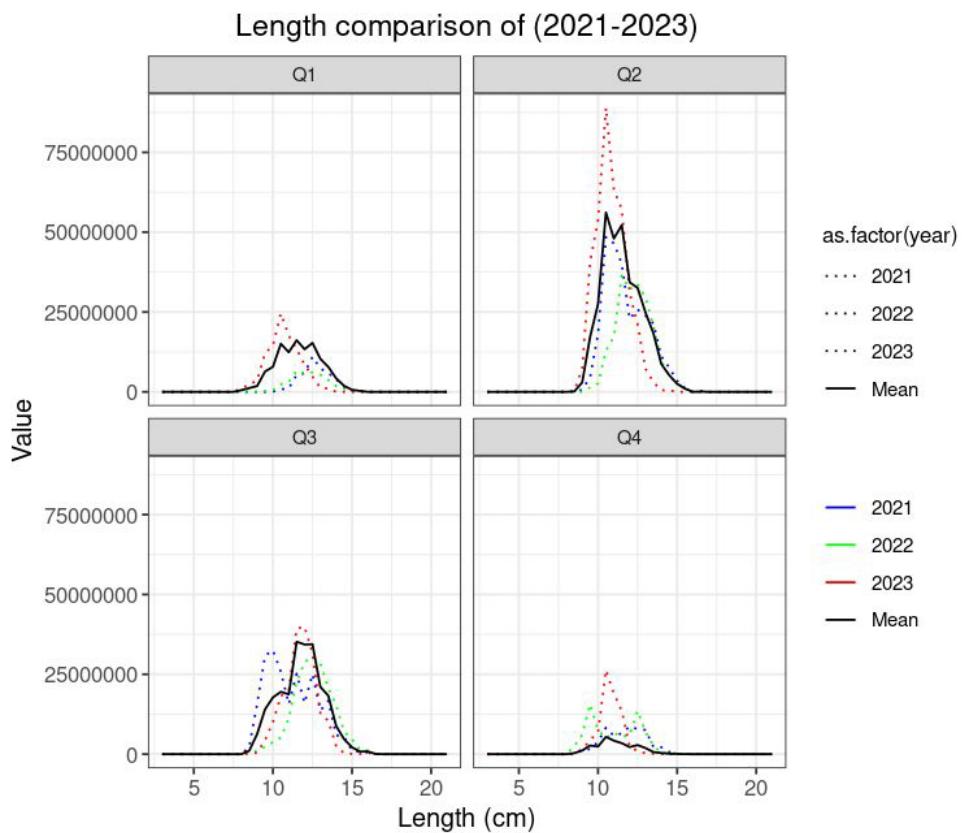


Figure 4.3.5.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Quarterly length frequency distributions of catches in the whole fishery in 2021, 2022 and 2023 and the average for the 3 years period used as a proxy to fill the data gap in 2024.

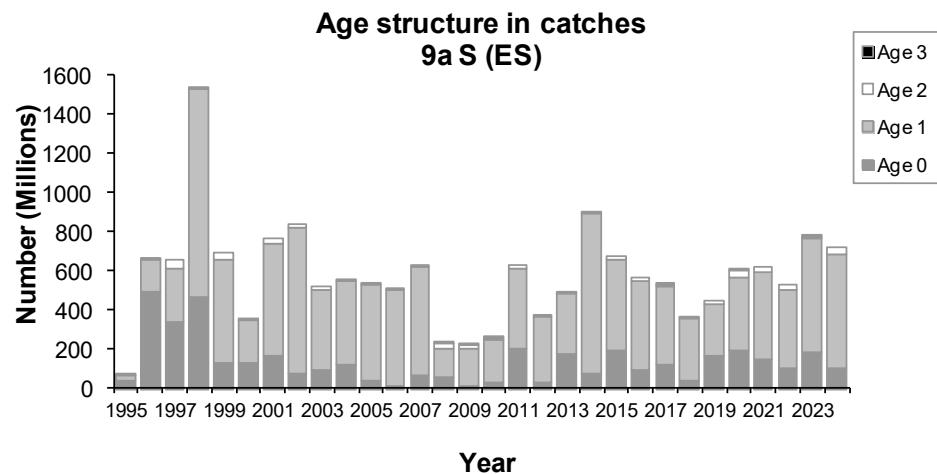


Figure 4.3.5.2.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Spanish fishery (all métiers). Age composition in Spanish catches of Gulf of Cadiz anchovy (1995–2024). Discards are considered either very low or even negligible in this fishery, but since 2014 on estimates include the available discarded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

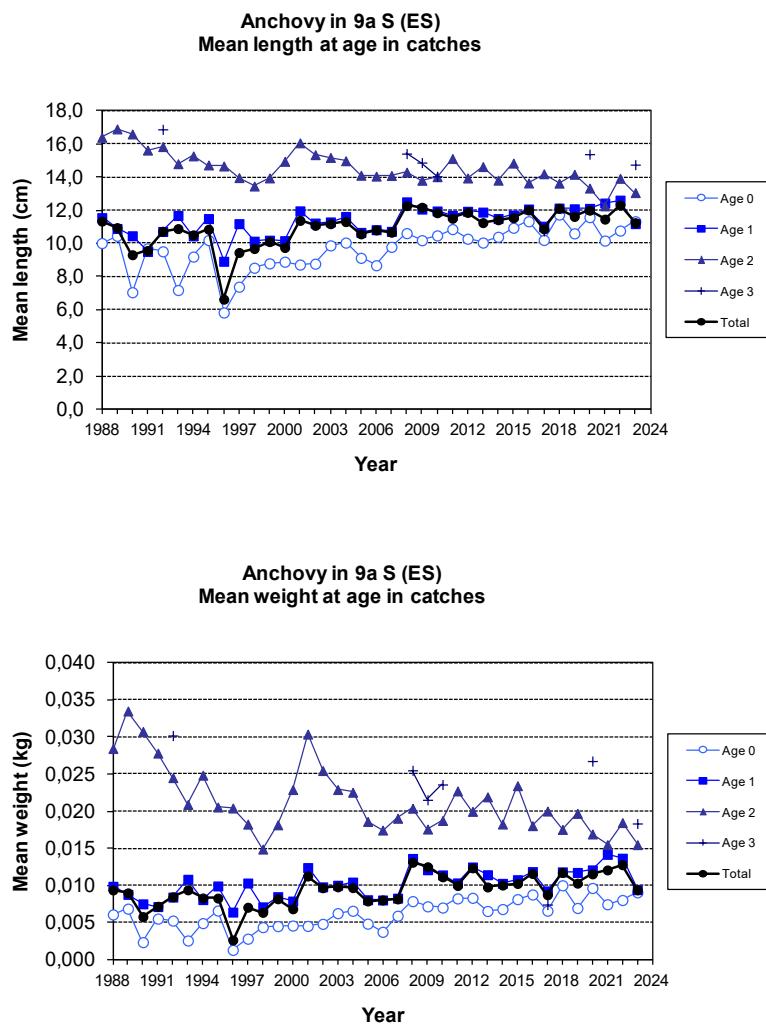


Figure 4.3.6.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Spanish fishery (all métiers). Annual mean length (TL, in cm) and weight (kg) at-age in the Spanish catches of Gulf of Cadiz anchovy (1988–2023). Data for 2024 correspond to provisional data of landings (discards not yet available).

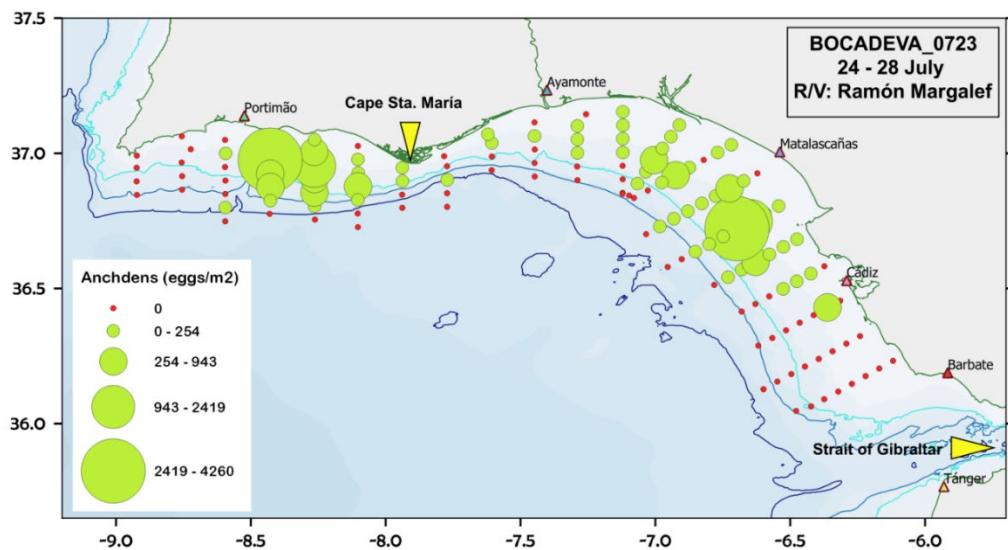


Figure 4.4.1.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). BOCADEVA 0723 survey (summer Spanish anchovy DEPM survey in Subdivision 9.a South in 2023). Mapping of anchovy eggs density (eggs/m²) sampled by PairoVET.

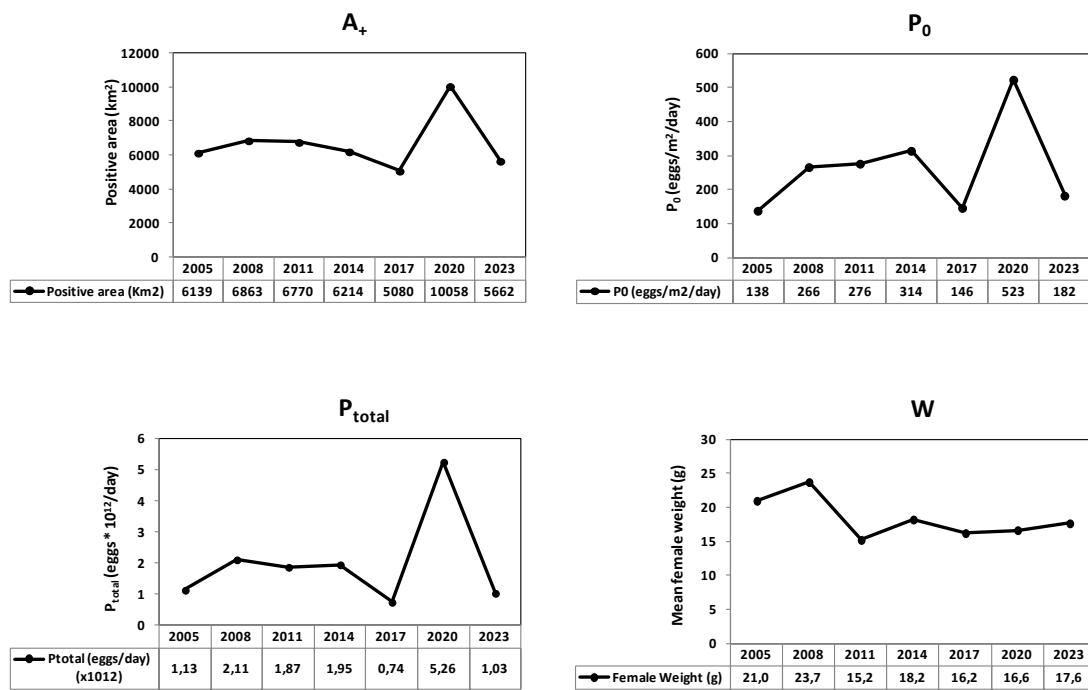


Figure 4.4.1.2. Anchovy in Subdivision 9.a South (Gulf of Cadiz). BOCADEVA survey series (summer Spanish anchovy DEPM survey in Subdivision 9.a South). Time-series of eggs and adult parameters estimates. A+ (positive area, in km²), P₀ (daily egg production, in eggs/m²/day), P_{total} (total egg production, in eggs 10¹²/day), W (mean female weight, in g).

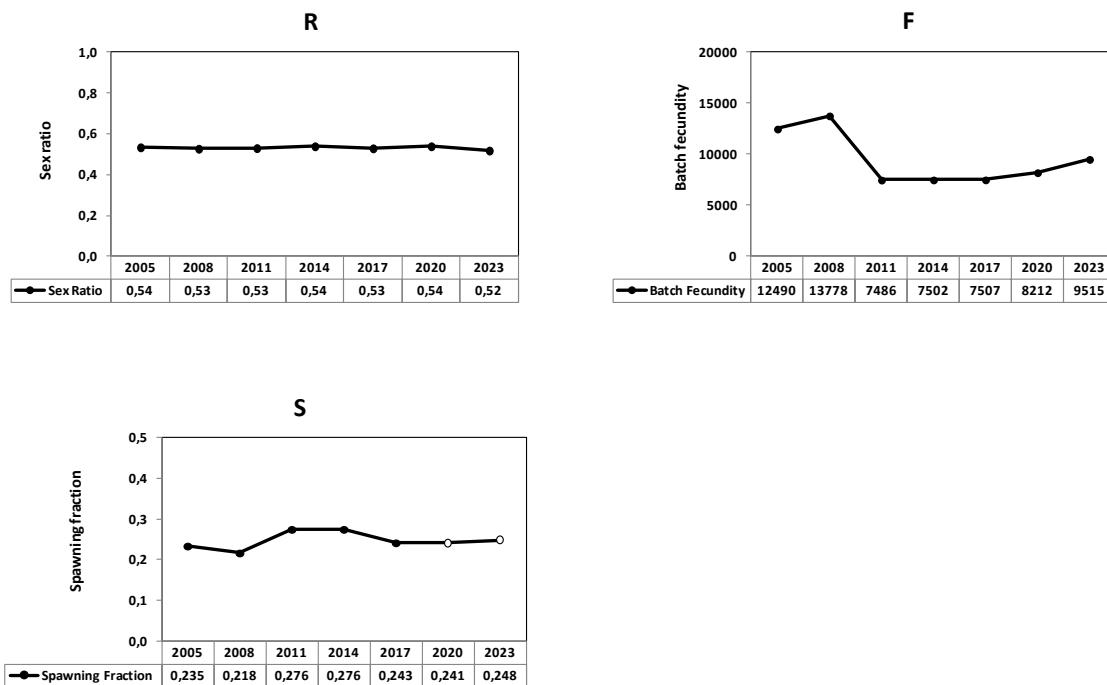


Figure 4.4.1.2. Anchovy in Subdivision 9.a South (Gulf of Cadiz). BOCADEVA survey series (summer Spanish anchovy DEPM survey in Subdivision 9.a South). Time-series of eggs and adult parameters estimates. Cont'd. R (sex ratio), F (individual batch fecundity), S (spawning fraction; the 2020 and 2023 estimates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

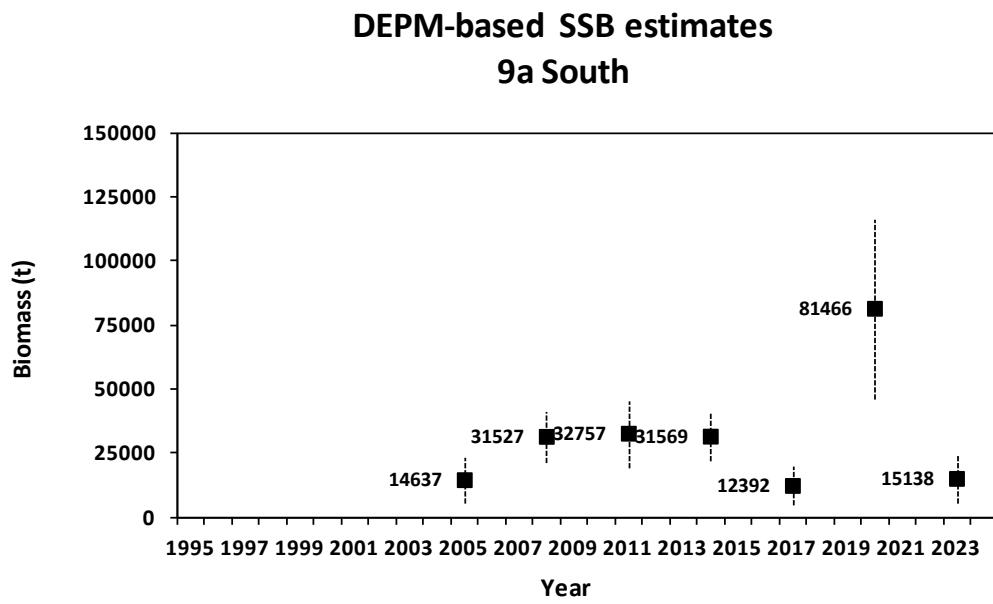


Figure 4.4.1.3. Anchovy in Subdivision 9.a South (Gulf of Cadiz). BOCADEVA survey series (summer Spanish anchovy DEPM survey in Subdivision 9.a South). Series of SSB estimates (\pm SD) obtained from the survey series.

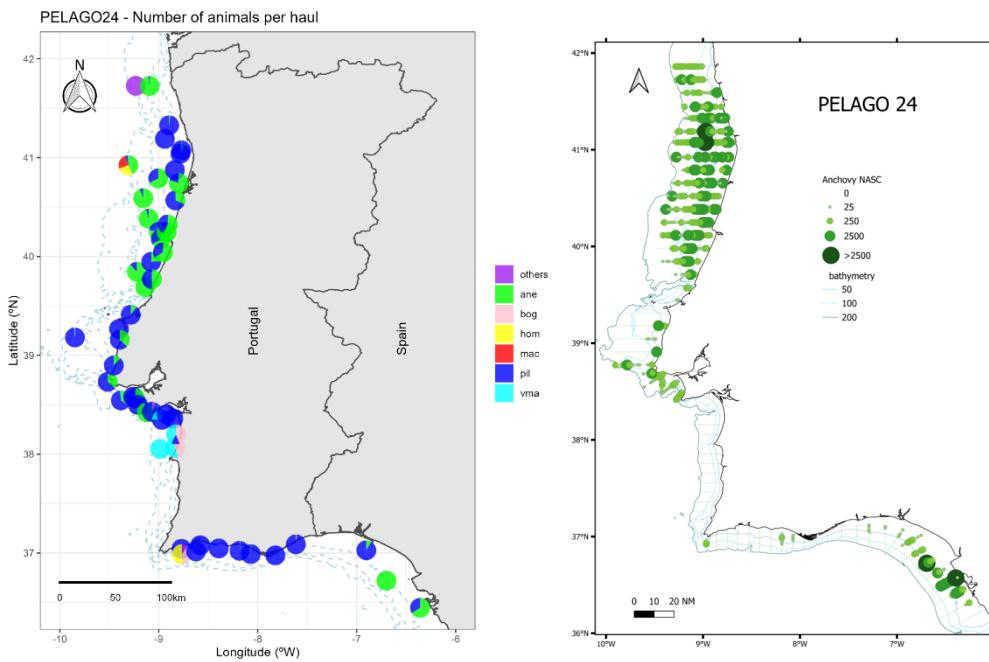


Figure 4.4.2.1. Anchovy in Division 9.a. Western and Southern stocks. Subdivisions 9.a Central-North to 9.a South. PELAGO survey series (spring Portuguese acoustic survey in Subdivisions 9.a Central-North to 9.a South). PELAGO 24 survey. Left: location of valid fishing stations with indication of their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

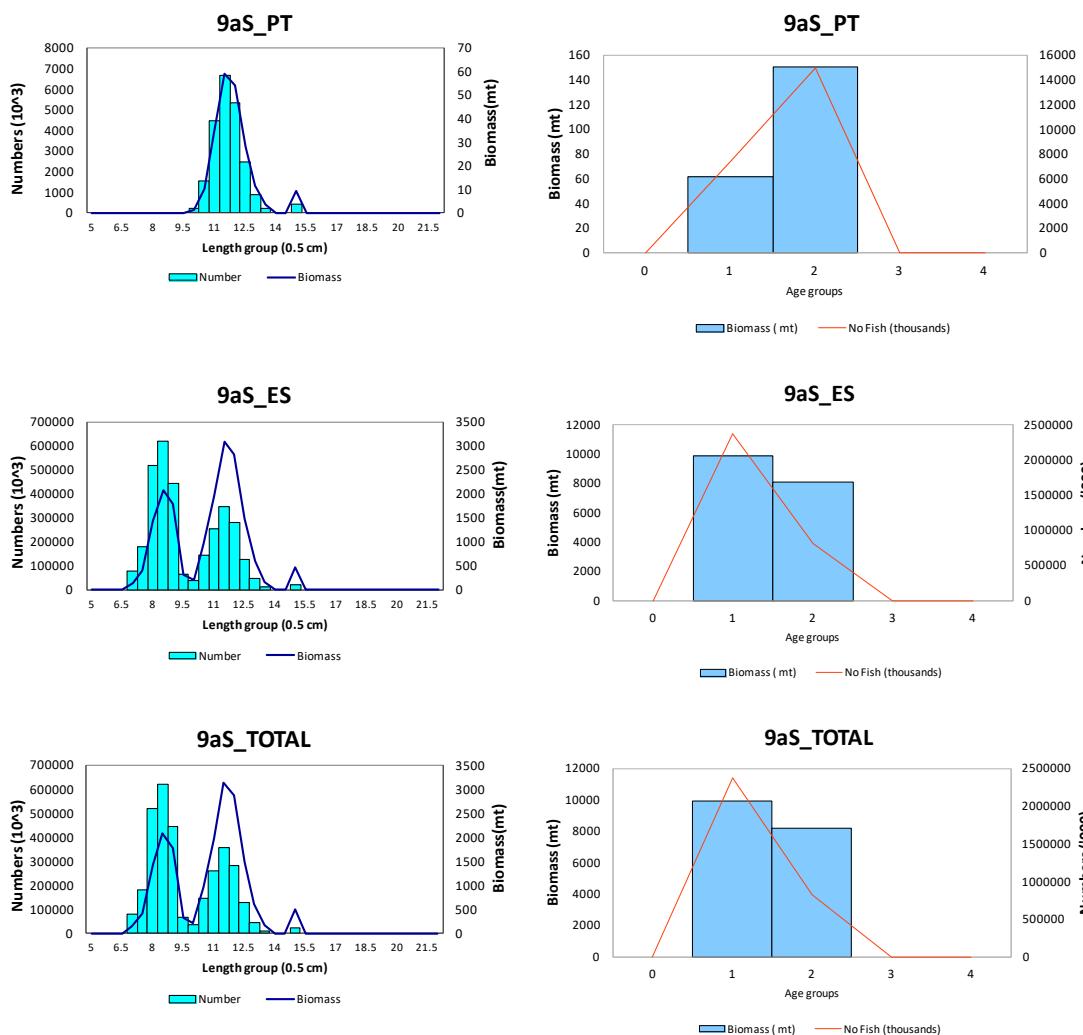


Figure 4.4.2.2. Anchovy in Subdivision 9.a South (Gulf of Cadiz). PELAGO survey series (spring Portuguese acoustic survey in Sub-divisions 9.a Central-North to 9.a South). PELAGO 24 survey. Estimated abundances and biomasses (number of fish in thousands and tonnes, respectively) for the Gulf of Cadiz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

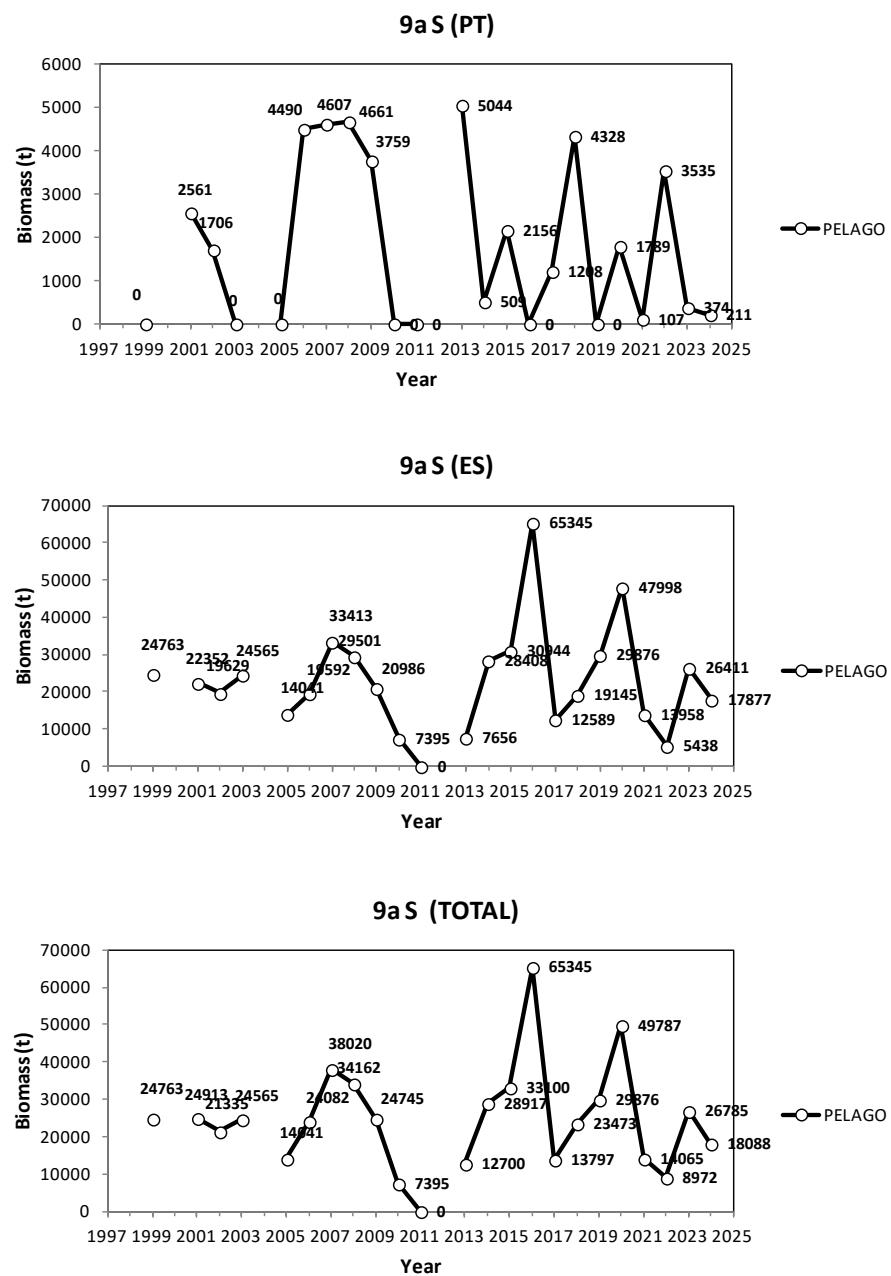


Figure 4.4.2.3. Anchovy in Subdivision 9.a South (Gulf of Cadiz). PELAGO survey series (spring Portuguese acoustic survey in Sub-divisions 9.a Central-North to 9.a South). PELAGO 24 survey. Acoustic estimates in the 9.a South differentiated by the whole Gulf of Cadiz, Portuguese (PT) and Spanish waters (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.

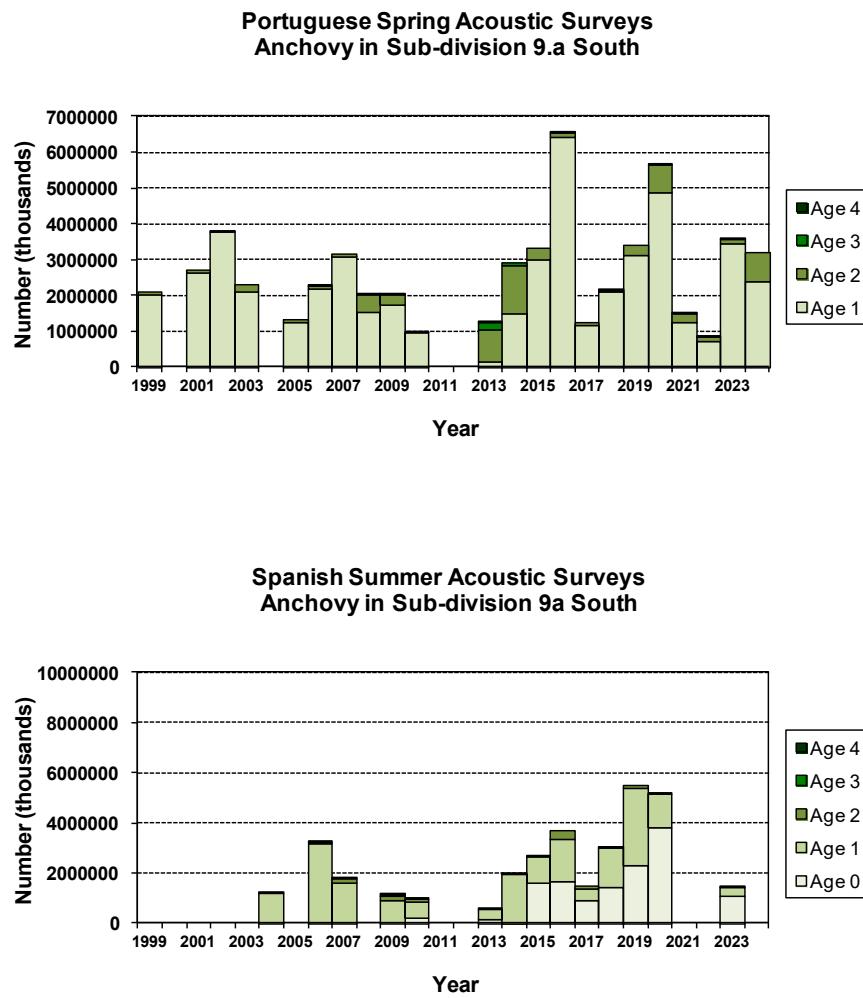


Figure 4.4.2.4. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Annual trends of the estimated population by age class from the Algarve + Gulf of Cadiz areas by the PELAGO Portuguese Spring (upper plot) and ECOCADIZ Spanish summer (lower plot) acoustic surveys (ECOCADIZ surveys in 2021 and 2022 were 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.

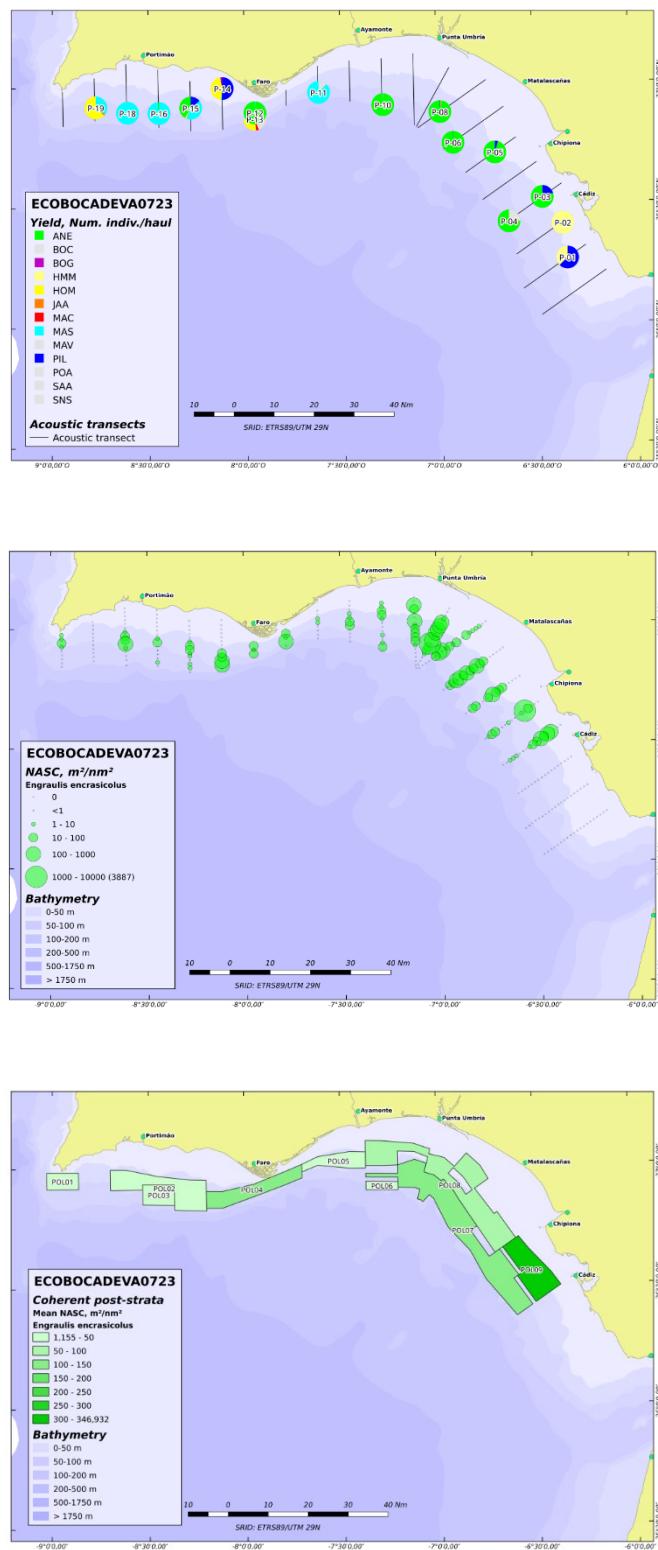


Figure 4.4.2.5. Anchovy in Subdivision 9.a South (Gulf of Cadiz). ECOCADIZ 2023-07 survey (summer Spanish acoustic survey in Subdivision 9.a South). Top: Location of valid fishing stations with indication of their species composition (percentages in number). Middle: Distribution of the backscattering 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.

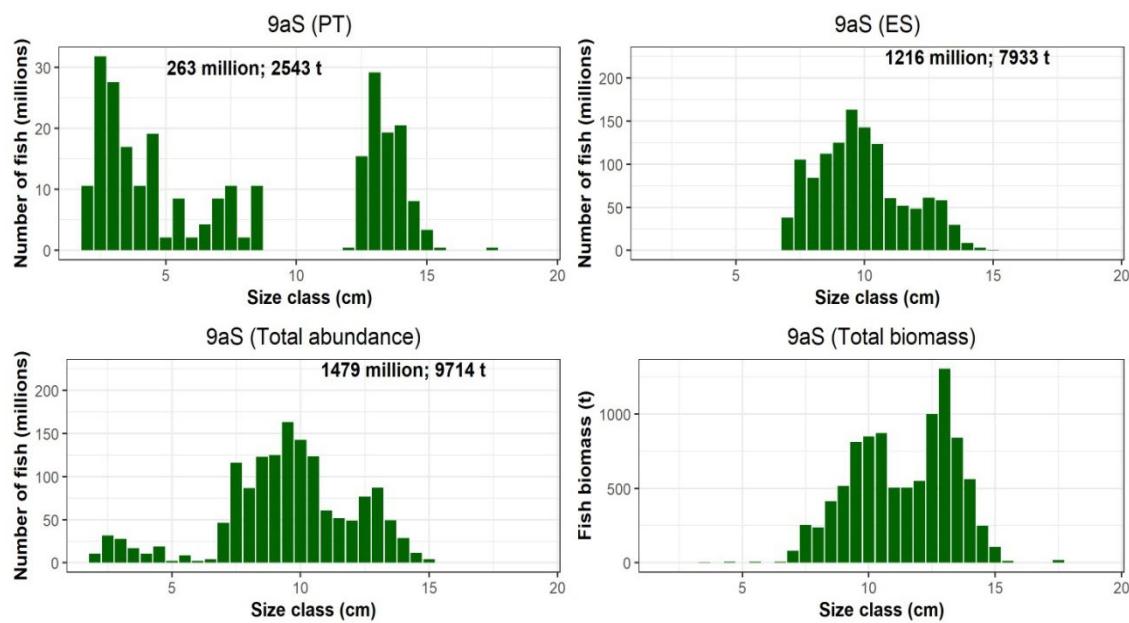


Figure 4.4.2.6. Anchovy in Subdivision 9.a South (Gulf of Cadiz). ECOCADIZ 2023-07 survey (summer Spanish acoustic survey in Subdivision 9.a South). Estimated abundances and biomasses (number of fish in millions and tonnes, respectively) for the surveyed area by length class (cm). Note the different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

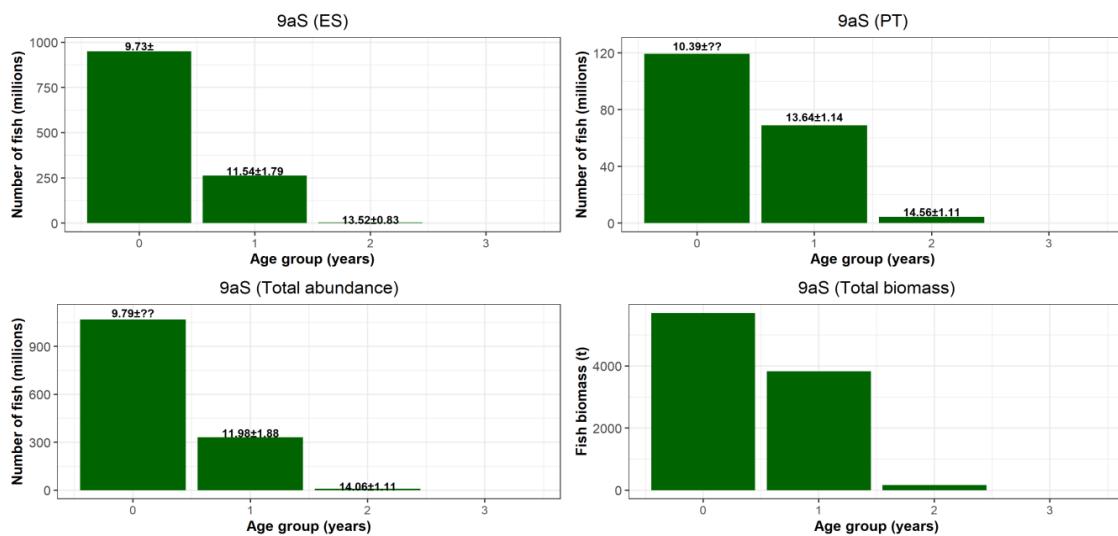


Figure 4.4.2.7. Anchovy in Subdivision 9.a South (Gulf of Cadiz). ECOCADIZ 2023-07 survey (summer Spanish acoustic survey in Subdivision 9.a South). Estimated abundances and biomasses (number of fish in millions and tonnes, respectively) for the surveyed area by age group, with indication of the mean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

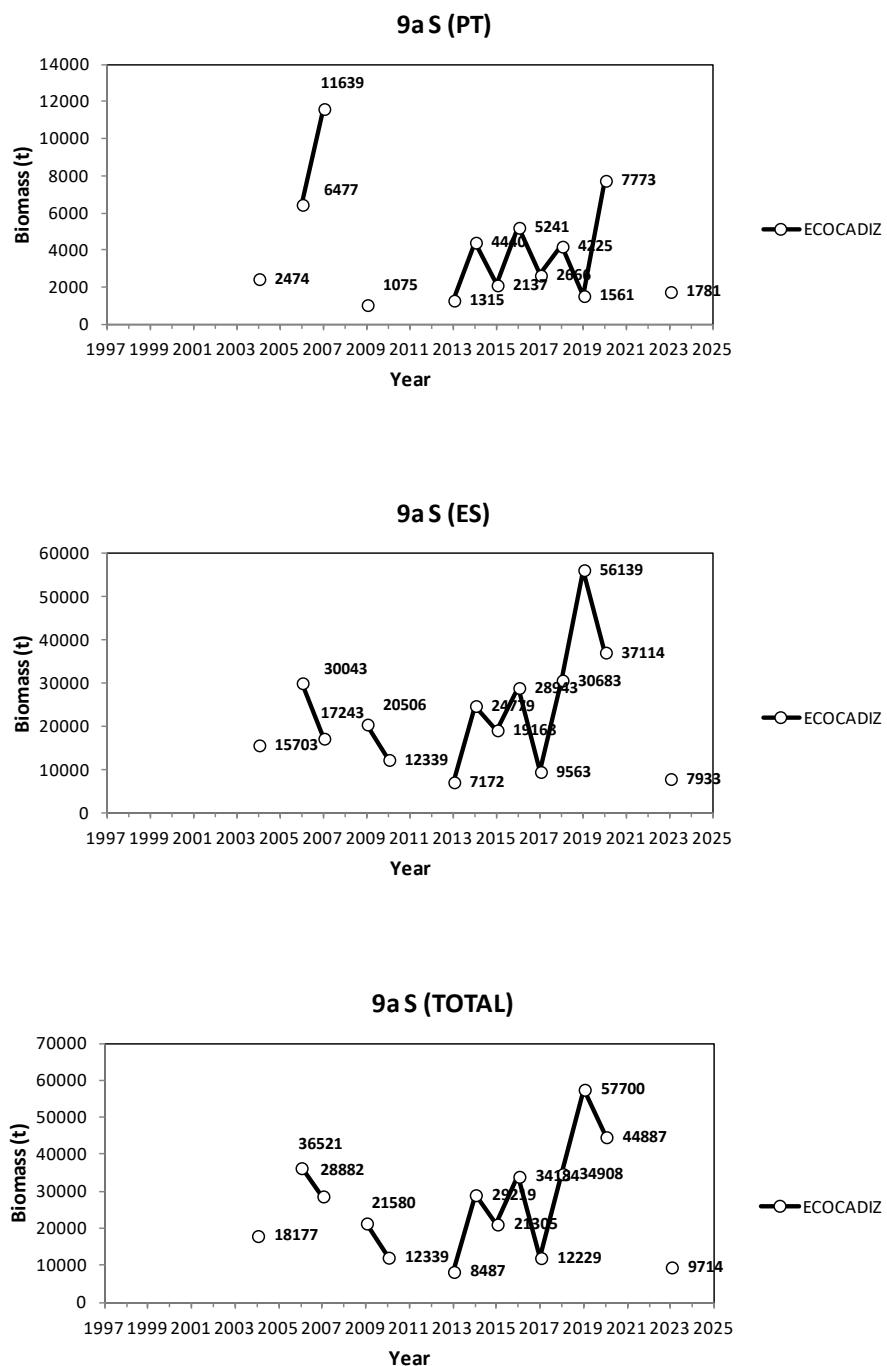


Figure 4.4.2.8. Anchovy in Subdivision 9.a South (Gulf of Cadiz). ECOCADIZ survey series (summer Spanish acoustic survey in Subdivision 9.a South). Historical series of overall and regional (Portuguese, PT, and Spanish waters of the Gulf of Cadiz, ES) acoustic estimates of anchovy biomass (t). Note the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

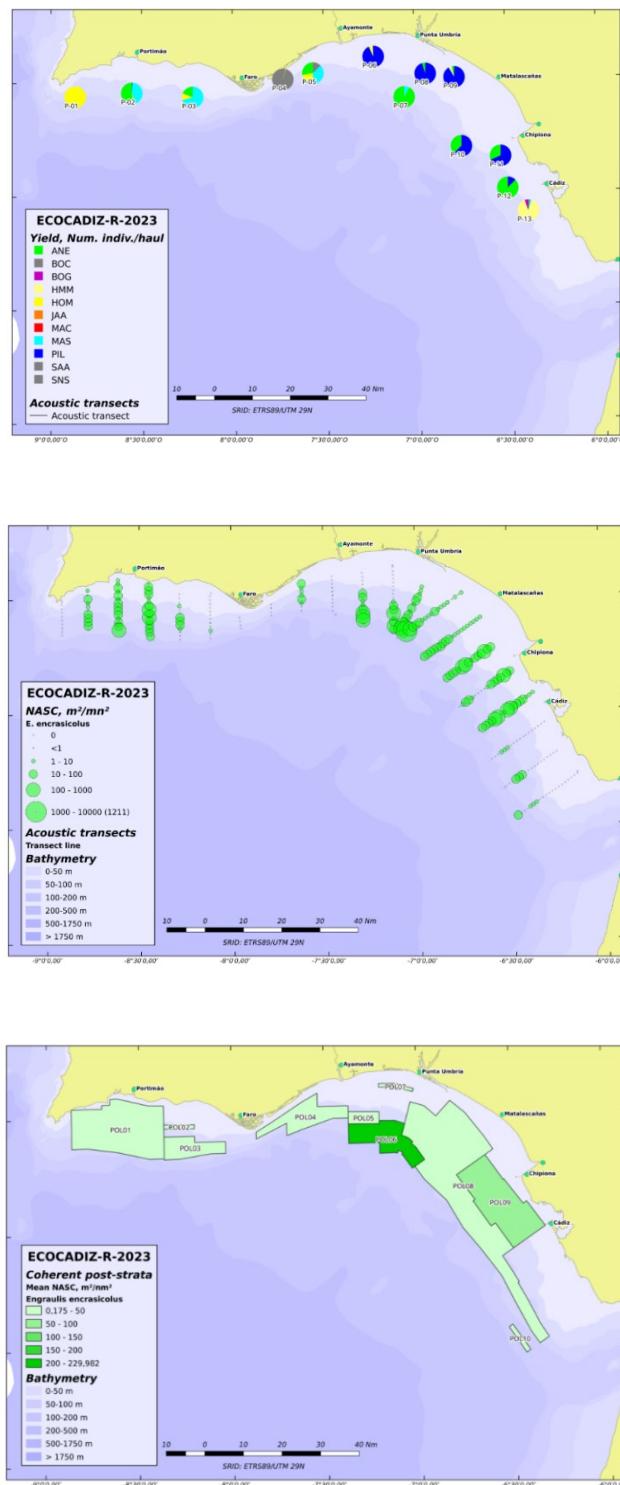


Figure 4.4.3.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). ECOCADIZ-RECLUTAS 2023-10 survey (autumn Spanish acoustic survey in Subdivision 9.a South). Top: Location of valid fishing stations with indication of their species composition (percentages in number). Middle: Distribution of the backscattering energy (Nautical area scattering coefficient, NASC, in $\text{m}^2 \text{ nmi}^{-2}$) 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.

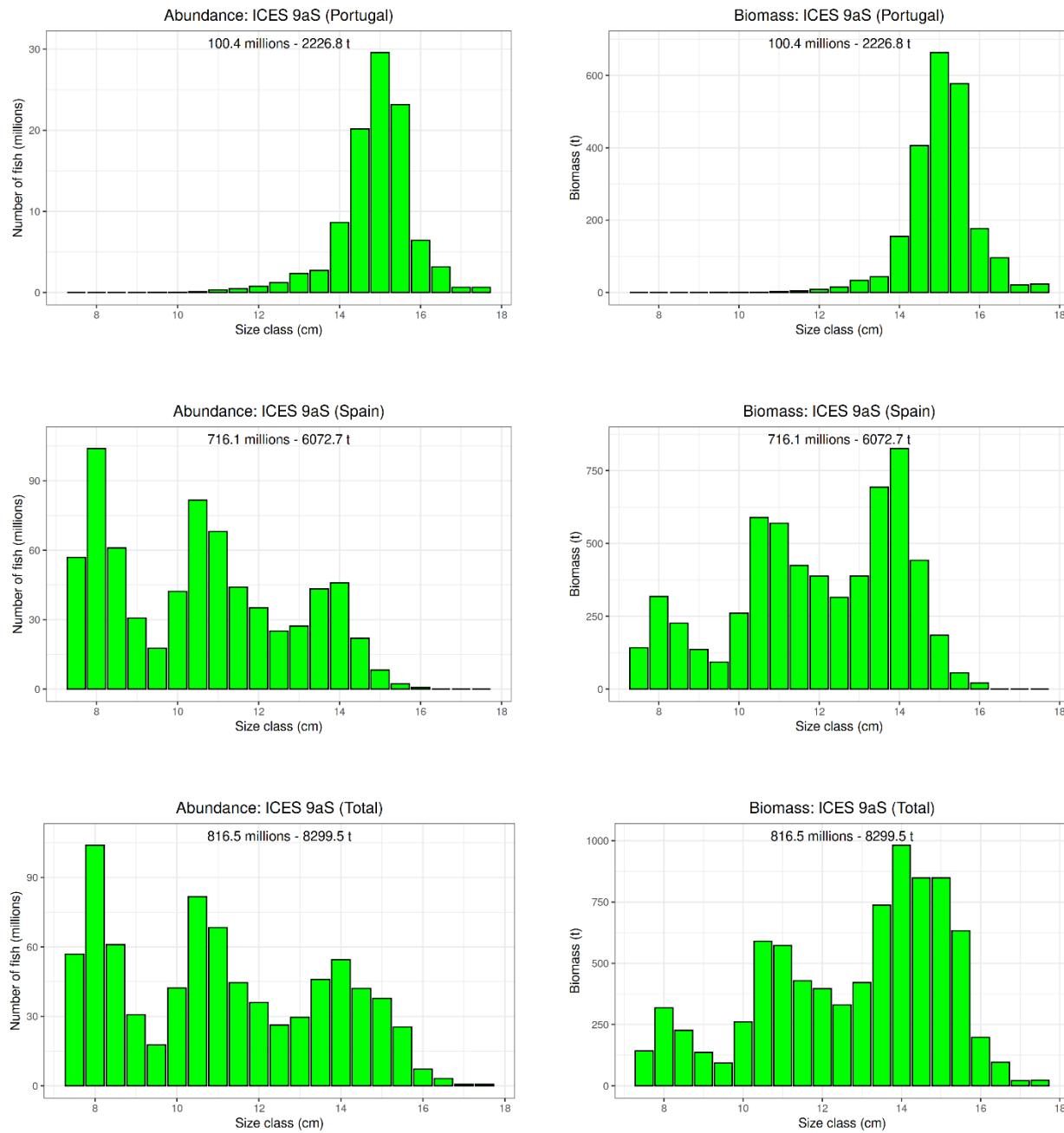


Figure 4.4.3.2. Anchovy in Subdivision 9.a South (Gulf of Cadiz). ECOCADIZ-RECLUTAS 2023-10 survey (autumn Spanish acoustic survey in Subdivision 9.a South). Estimated abundances and biomasses (number of fish in millions and tonnes, respectively) for the surveyed area by length class (cm). Note the different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

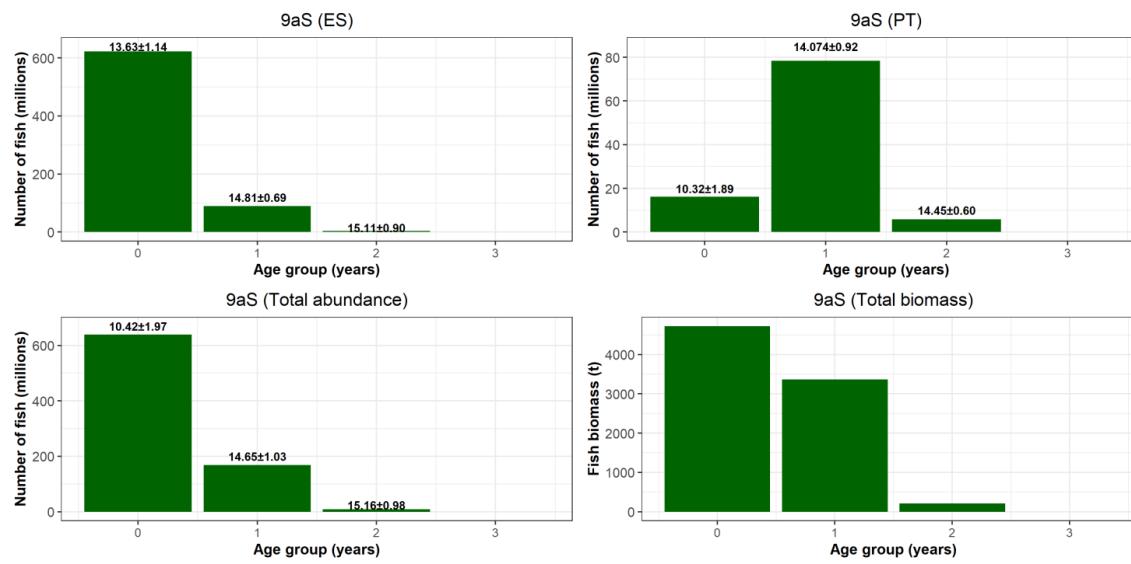


Figure 4.4.3.3. Anchovy in Subdivision 9.a South (Gulf of Cadiz). ECOCADIZ-RECLUTAS 2023-10 survey (autumn Spanish acoustic survey in Subdivision 9.a South). Estimated abundances and biomasses (number of fish in millions and tonnes, respectively) for the surveyed area by age group, with indication of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

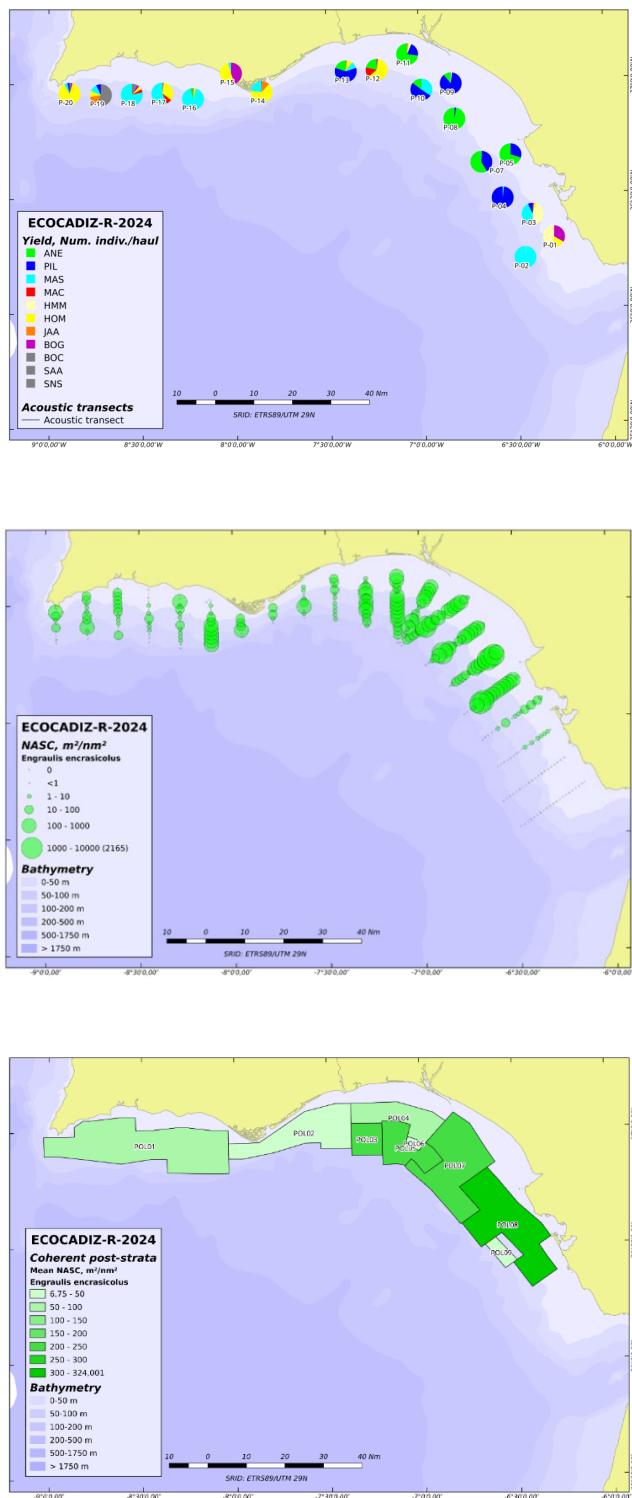


Figure 4.4.3.4. Anchovy in Subdivision 9.a South (Gulf of Cadiz). ECOCADIZ-RECLUTAS 2024-10 survey (autumn Spanish acoustic survey in Subdivision 9.a South). Top: Location of valid fishing stations with indication of their species composition (percentages in number). Middle: Distribution of the backscattering energy (Nautical area scattering coefficient, NASC, in $\text{m}^2 \text{ nmi}^{-2}$) 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.

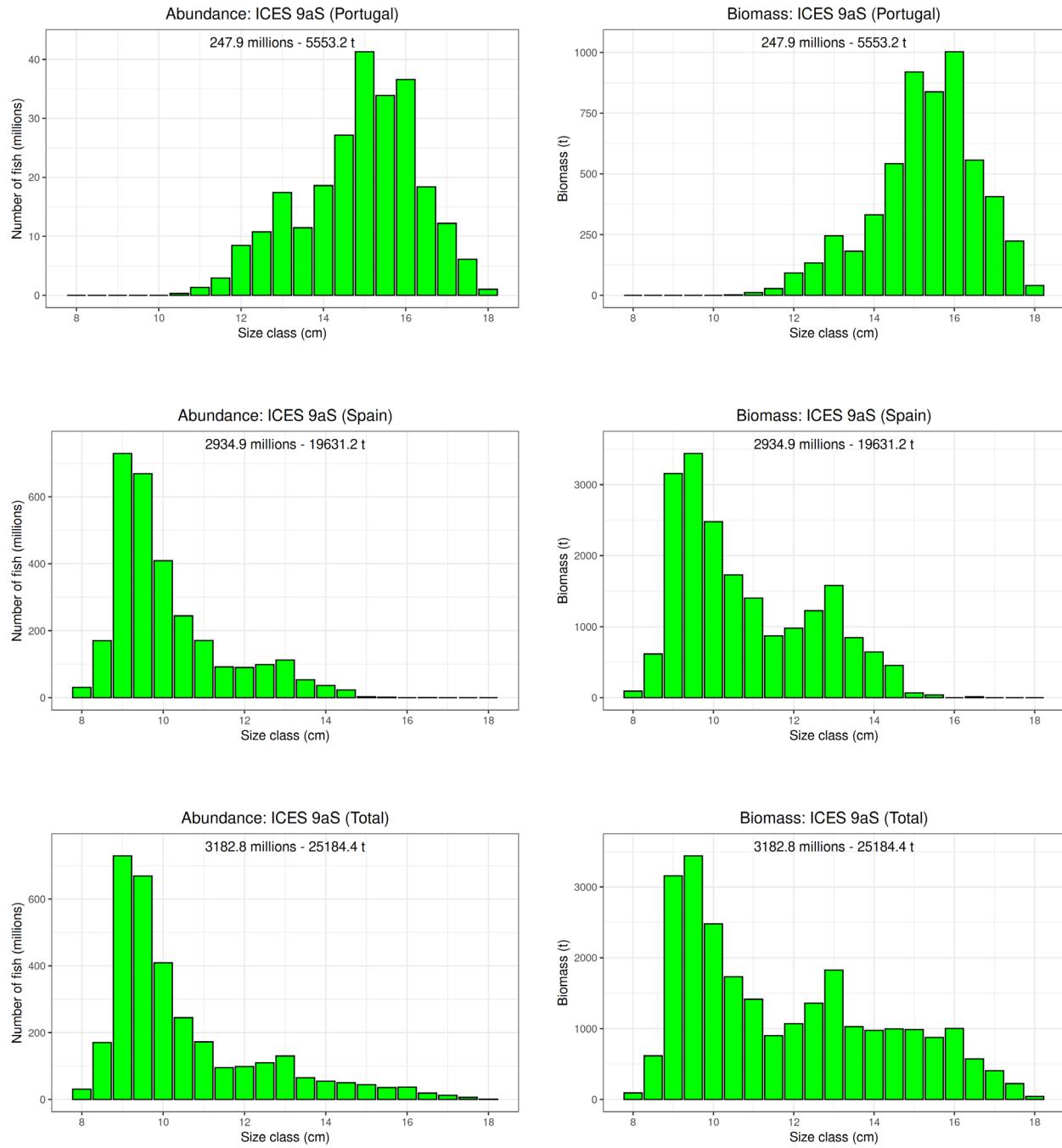


Figure 4.4.3.5. Anchovy in Subdivision 9.a South (Gulf of Cadiz). ECOCADIZ-RECLUTAS 2024-10 survey (autumn Spanish acoustic survey in Subdivision 9.a South). Estimated abundances and biomasses (number of fish in millions and tonnes, respectively) for the surveyed area by length class (cm). Note the different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

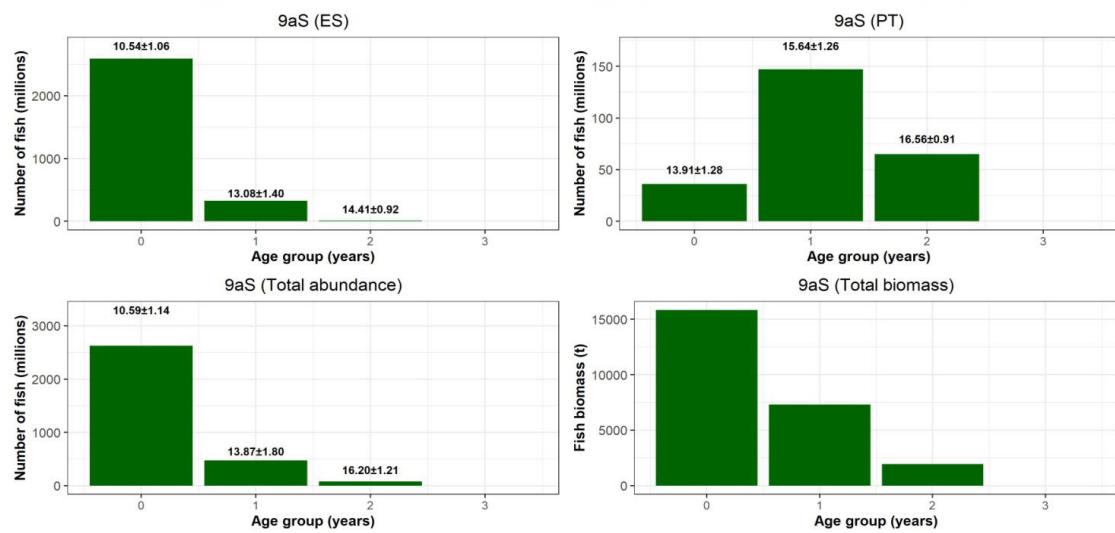


Figure 4.4.3.6. Anchovy in Subdivision 9.a South (Gulf of Cadiz). ECOCADIZ-RECLUTAS 2024-10 survey (autumn Spanish acoustic survey in Subdivision 9.a South). Estimated abundances and biomasses (number of fish in millions and tonnes, respectively) for the surveyed area by age group, with indication of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

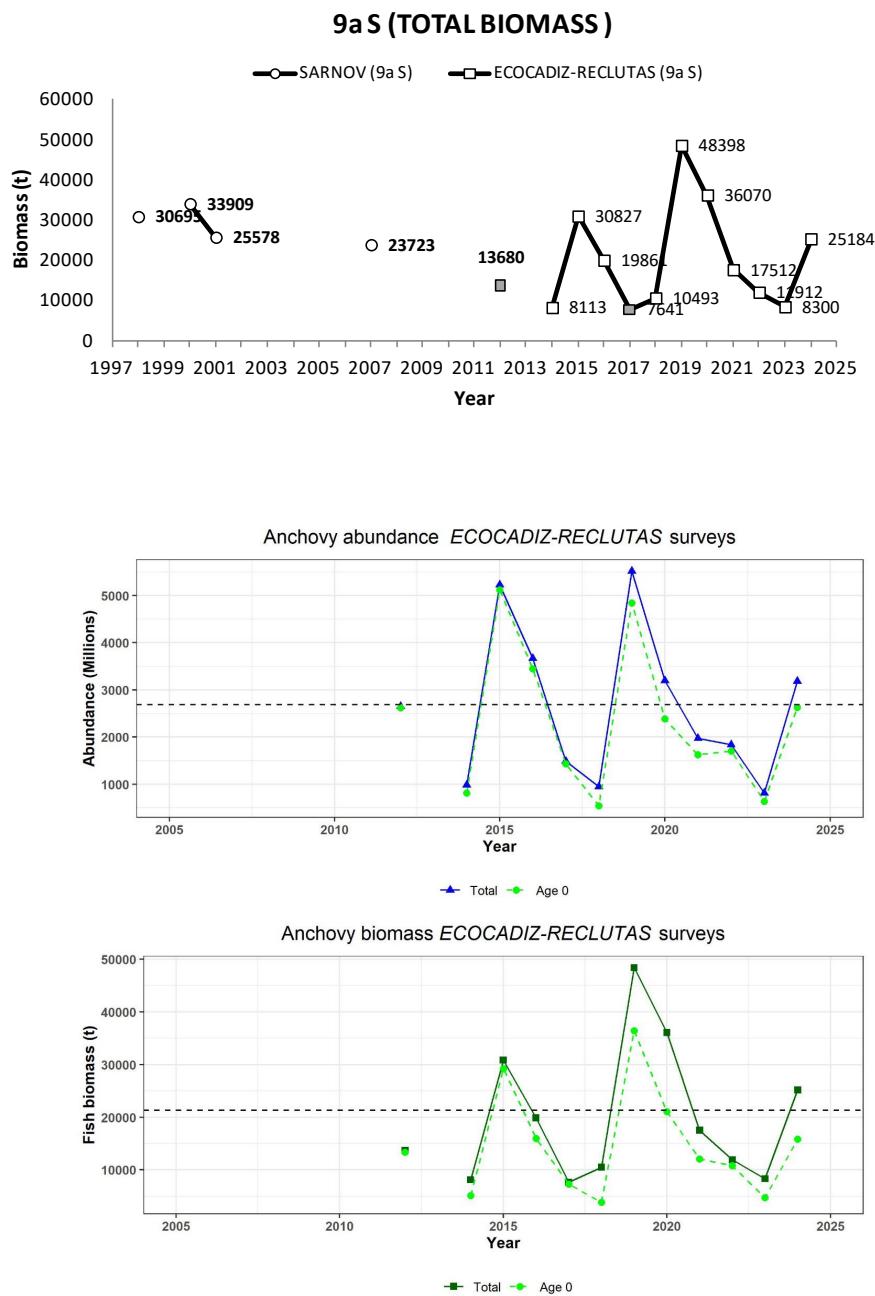


Figure 4.4.3.7. Anchovy in Subdivision 9.a South (Gulf of Cadiz). ECOCADIZ-RECLUTAS survey series (autumn Spanish acoustic survey in Subdivision 9.a South). Top: historical series of overall acoustic estimates of anchovy biomass (t), (squares). The estimates from the older Portuguese SARNOV survey series 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.

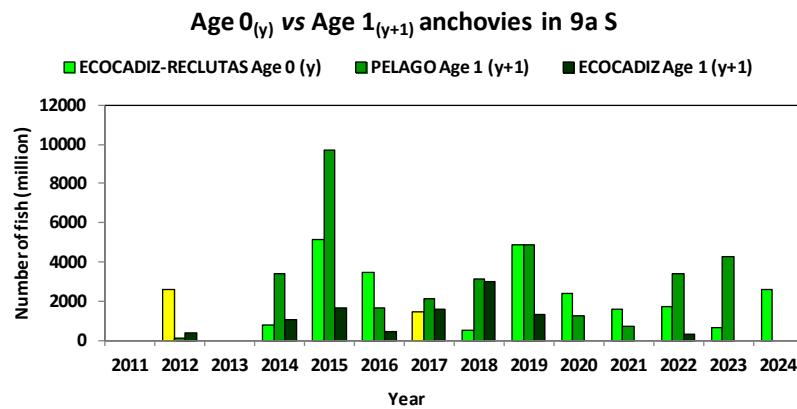


Figure 4.4.3.8. Anchovy in Subdivision 9.a South (Gulf of Cadiz). *ECOCADIZ-RECLUTAS* survey series (autumn Spanish acoustic survey in Subdivision 9.a South). Correspondence between acoustic estimates of abundance of Age 0 anchovies from *ECOCADIZ-RECLUTAS* surveys in the autumn of the year y against 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.

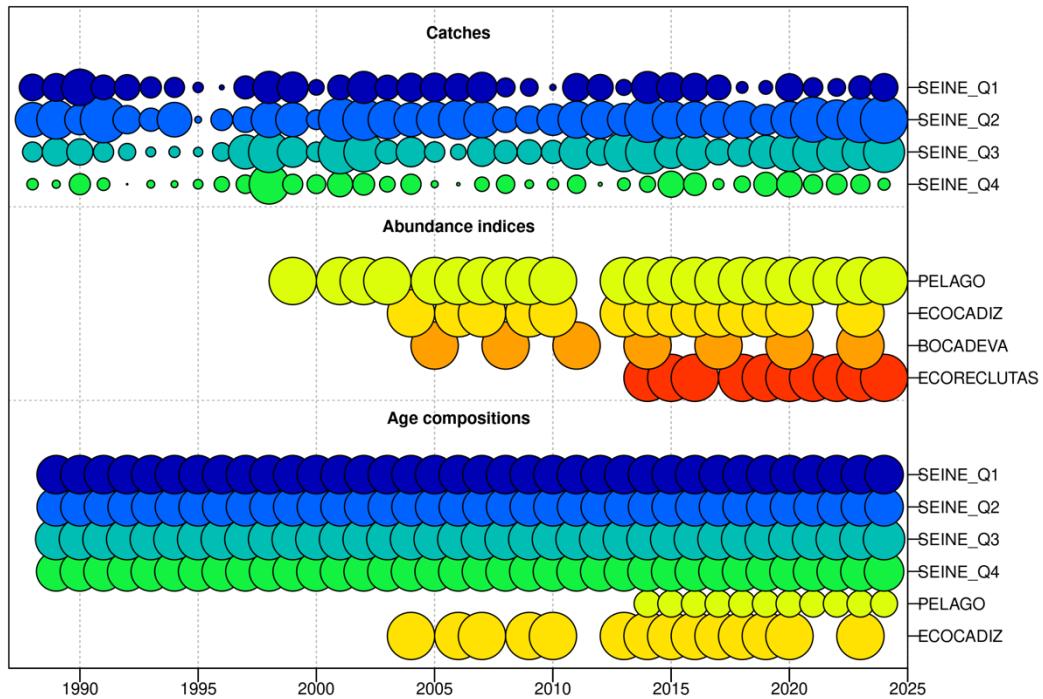


Figure 4.6.1.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Summary of model data input by year, where circle area is relative within a data type. Circles are proportional to total catch for catches, to precision for indices and to total sample size for age compositions.

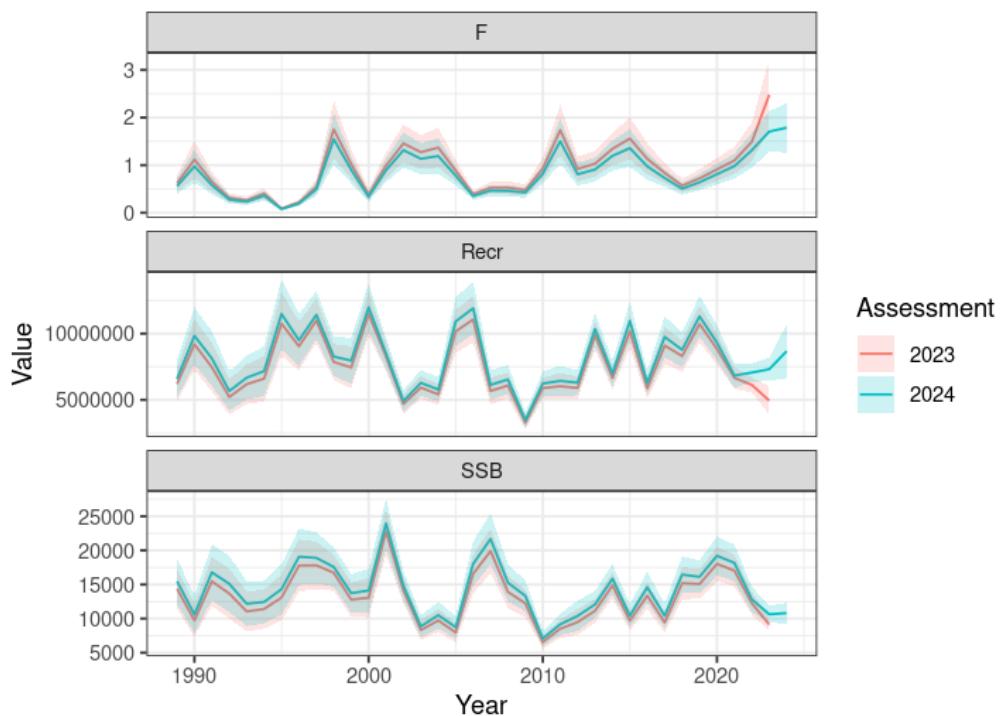


Figure 4.6.1.2. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Comparison final assessment (1989-2024) and last year assessment performed in WKBANSP 2024 (ICES, 2024b) (1989-2023). Plots of Fishing mortality (F), Recruitment (age-0) (Recr) and Spawning biomass (SSB). Grey shaded area and bars in recruitment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

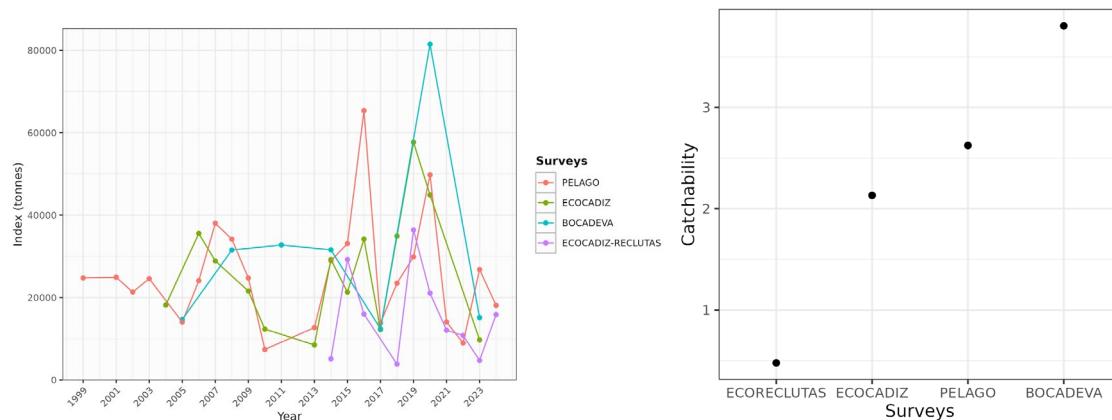


Figure 4.6.2.1. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Left panel: Biomass estimates from the PELAGO, ECOCADIZ, BOCADEVA, and ECOCADIZ-RECLUTAS surveys. Right panel: Estimated catchability parameters for the different survey indices based on the corrected final run.

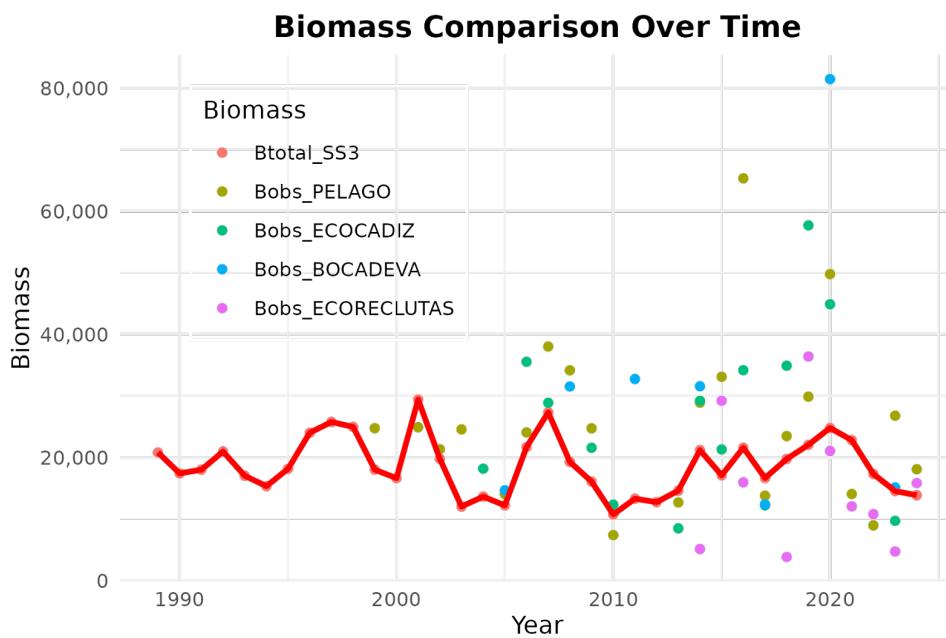


Figure 4.6.2.2. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Comparison of biomass scales: total biomass estimated by the SS3 model (red line) versus observed biomass from surveys (points) (PELAGO, ECOCADIZ, BOCADEVA, and ECOCADIZ-RECLUTAS).

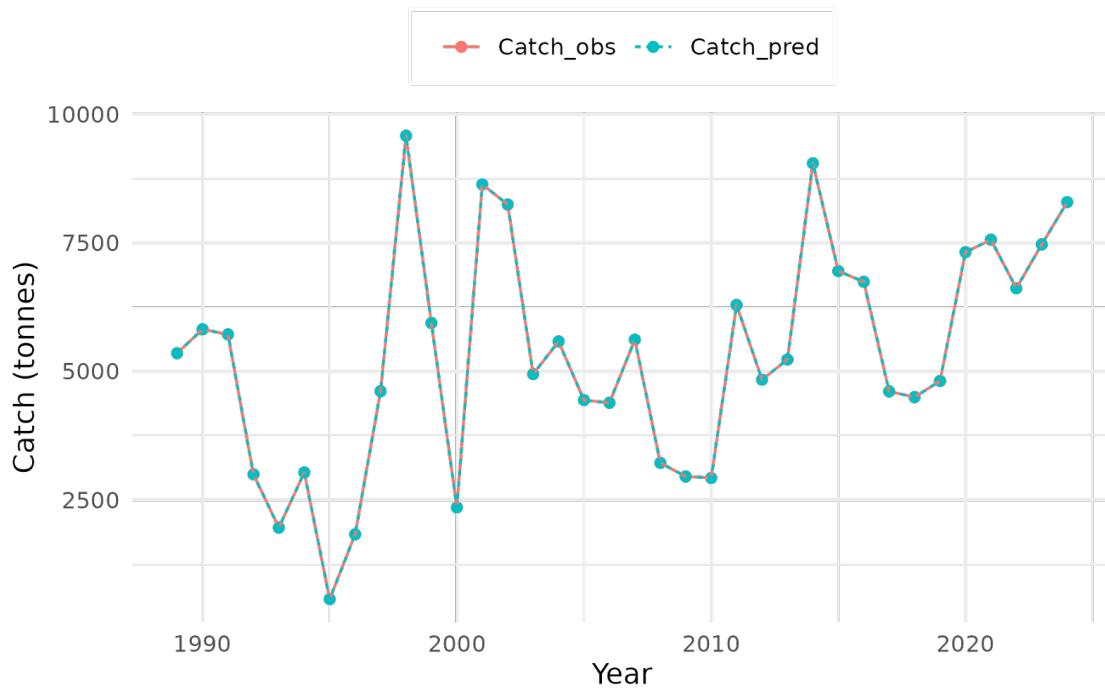


Figure 4.6.2.3. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Comparison of catches scales: catch estimated by the SS3 model (light blue line) versus observed catch (red line).

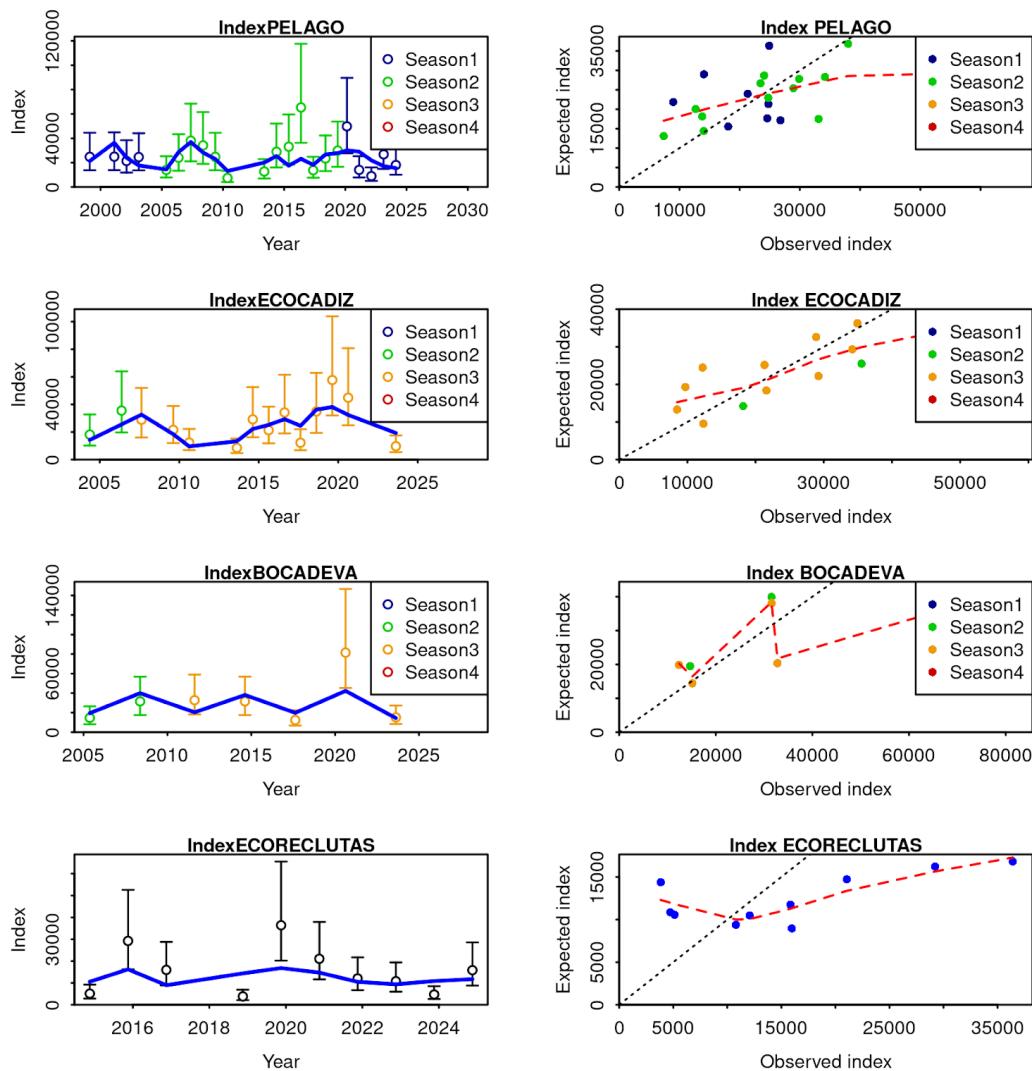


Figure 4.6.2.4. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Model fit to the data (left panel) and observed versus expected values (right panel) of the indices from the surveys PELAGO, ECOCADIZ, BOCADEVA and ECOCADIZ-RECLUTAS. The lines indicate a 95% uncertainty interval around the index values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

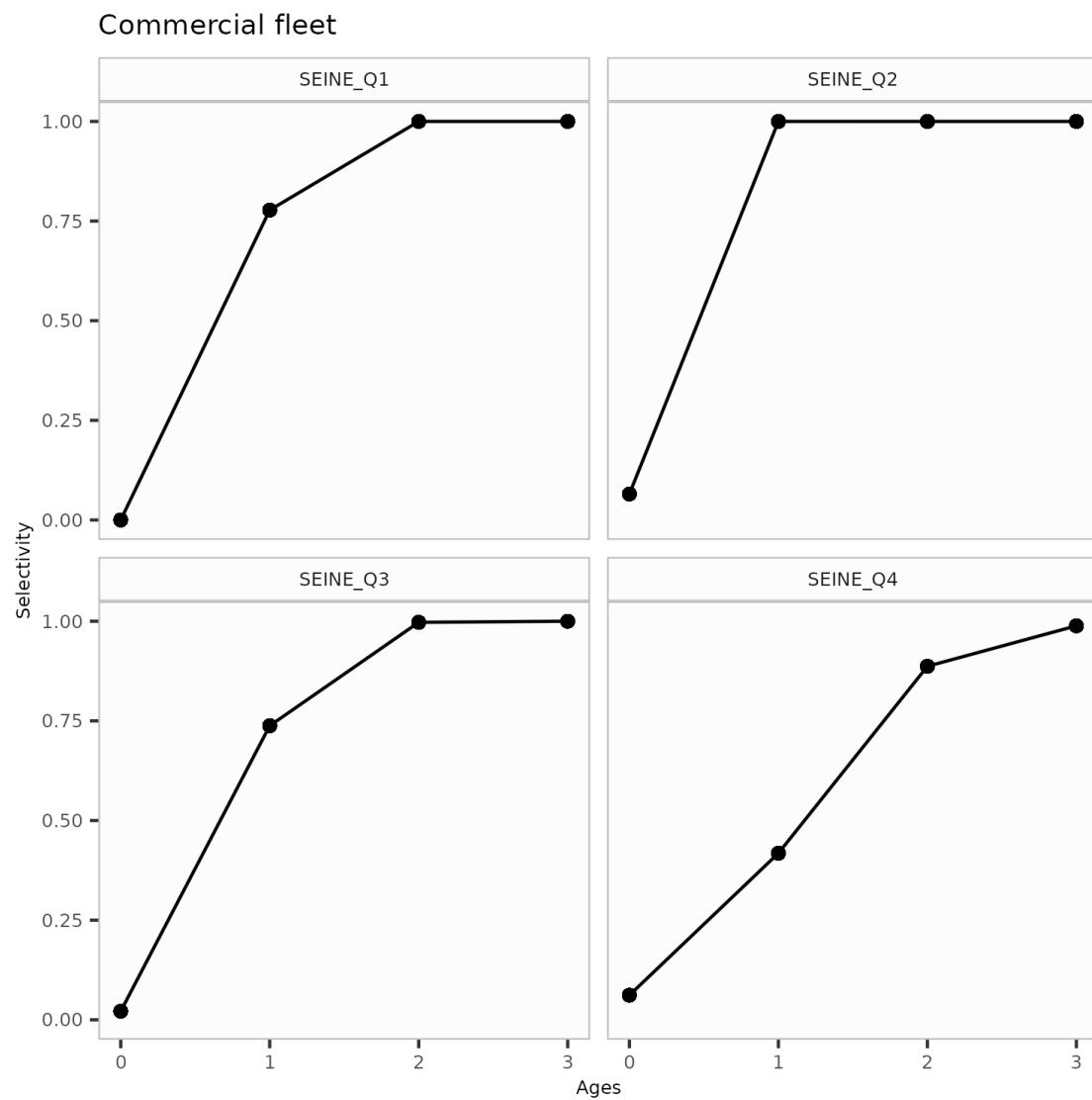


Figure 4.6.2.5. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Estimated selectivity for catch-at-age of commercial fleet (logistic shaped fixed selectivity across all years).

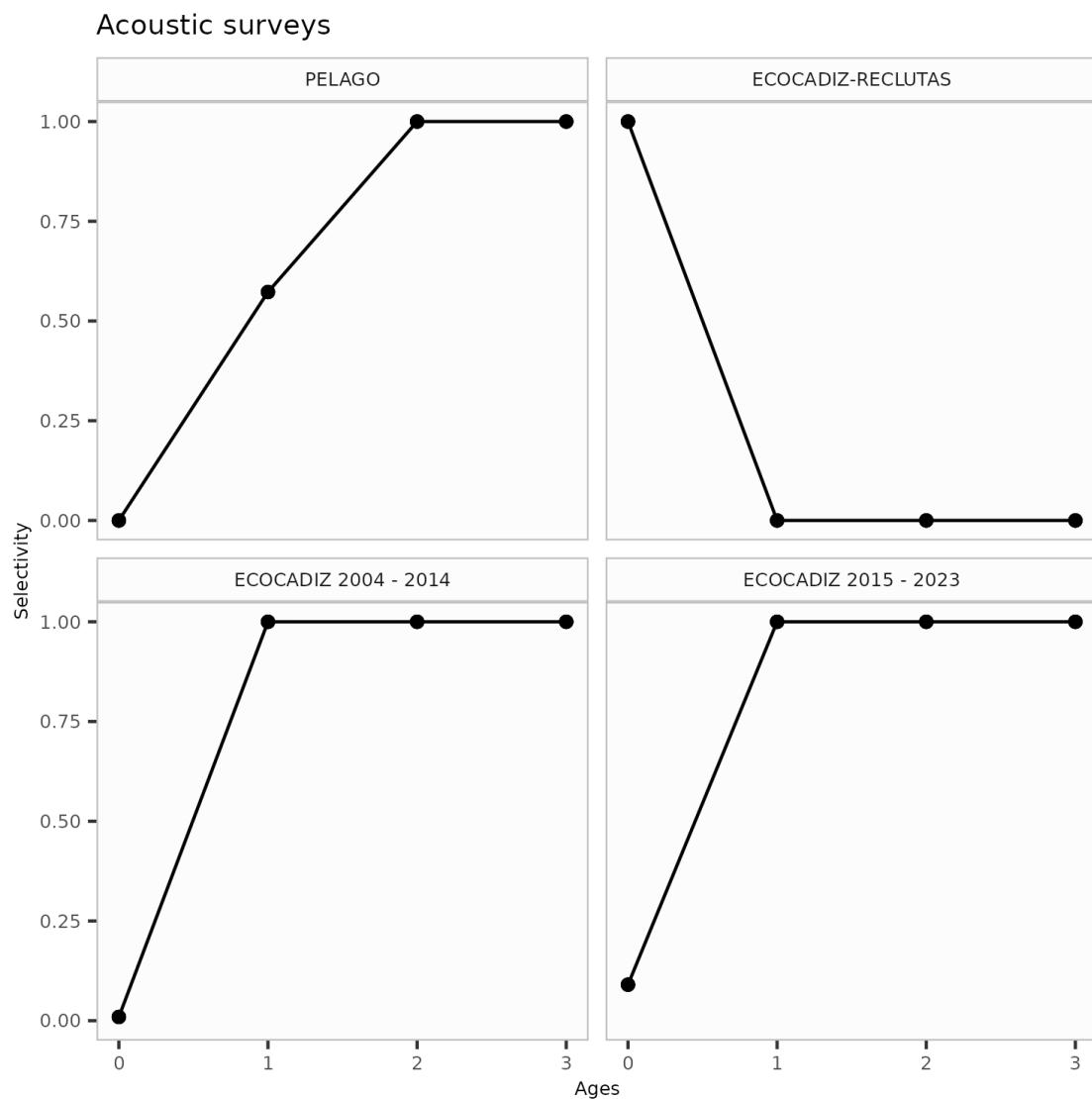


Figure 4.6.2.6. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Estimated selectivity for catch-at-age of surveys (logistic shaped fixed selectivity across all years).

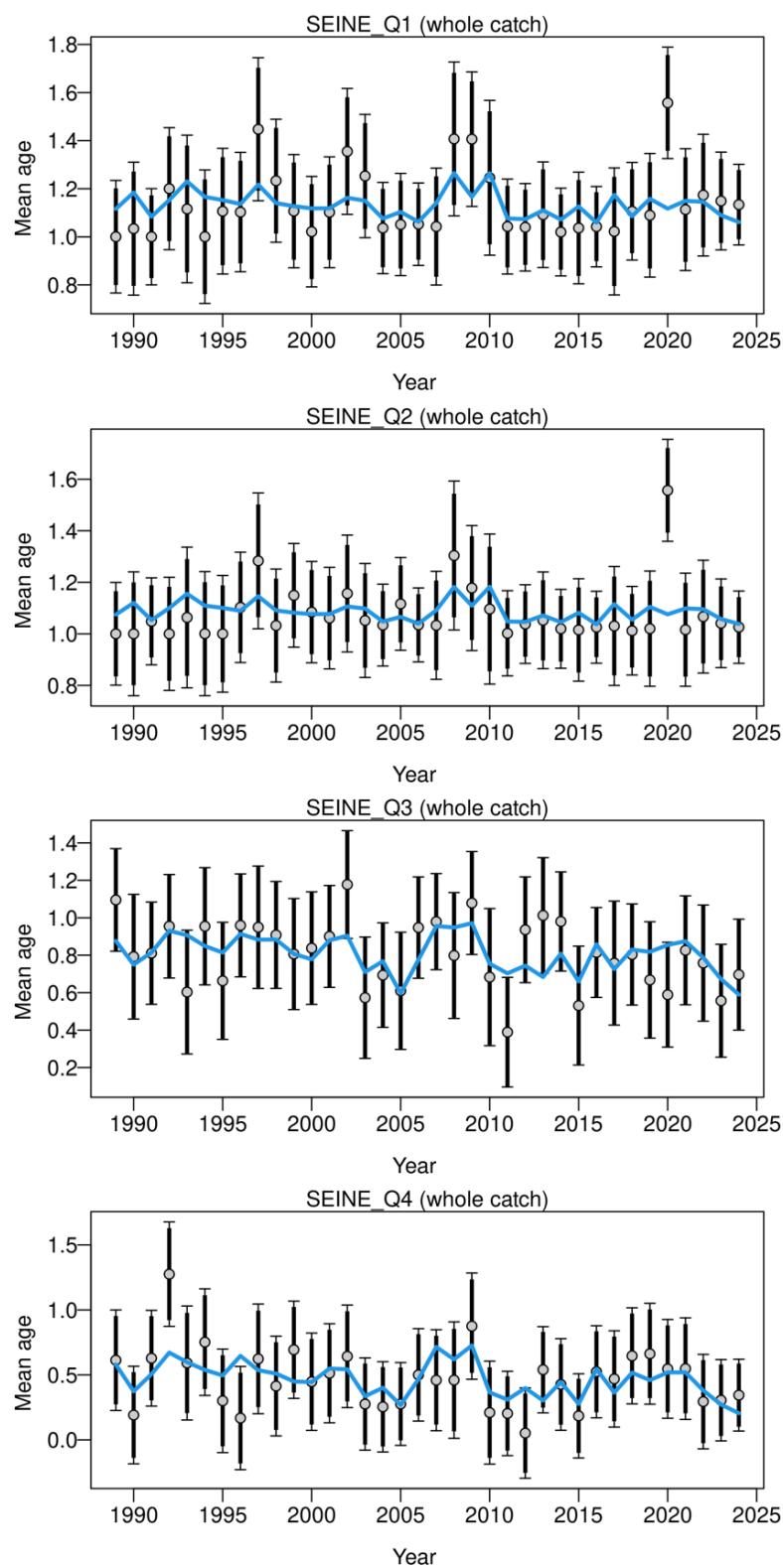


Figure 4.6.2.7. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Mean age for commercial fleet by quarters with 95% confidence intervals based on current sample sizes. Francis data weighting method TA1.8: thinner intervals (with capped ends) show the result of further adjusting sample sizes based on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

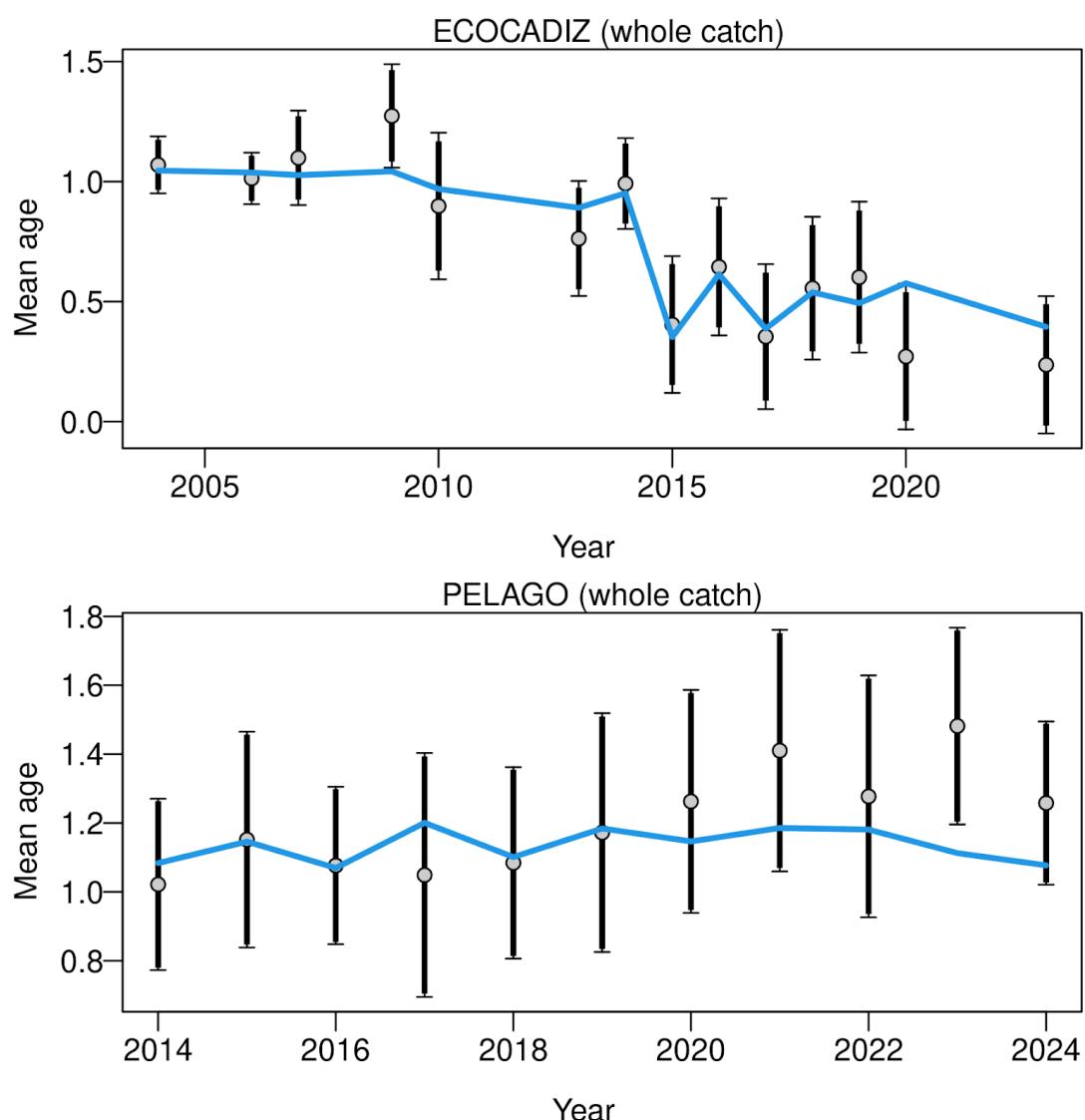


Figure 4.6.2.8. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Mean age for PELAGO, ECOCADIZ, and ECOCADIZ-RECLUTAS with 95% confidence intervals based on current sample sizes. Francis data weighting method TA1.8: thinner intervals (with capped ends) show the result of further adjusting sample sizes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

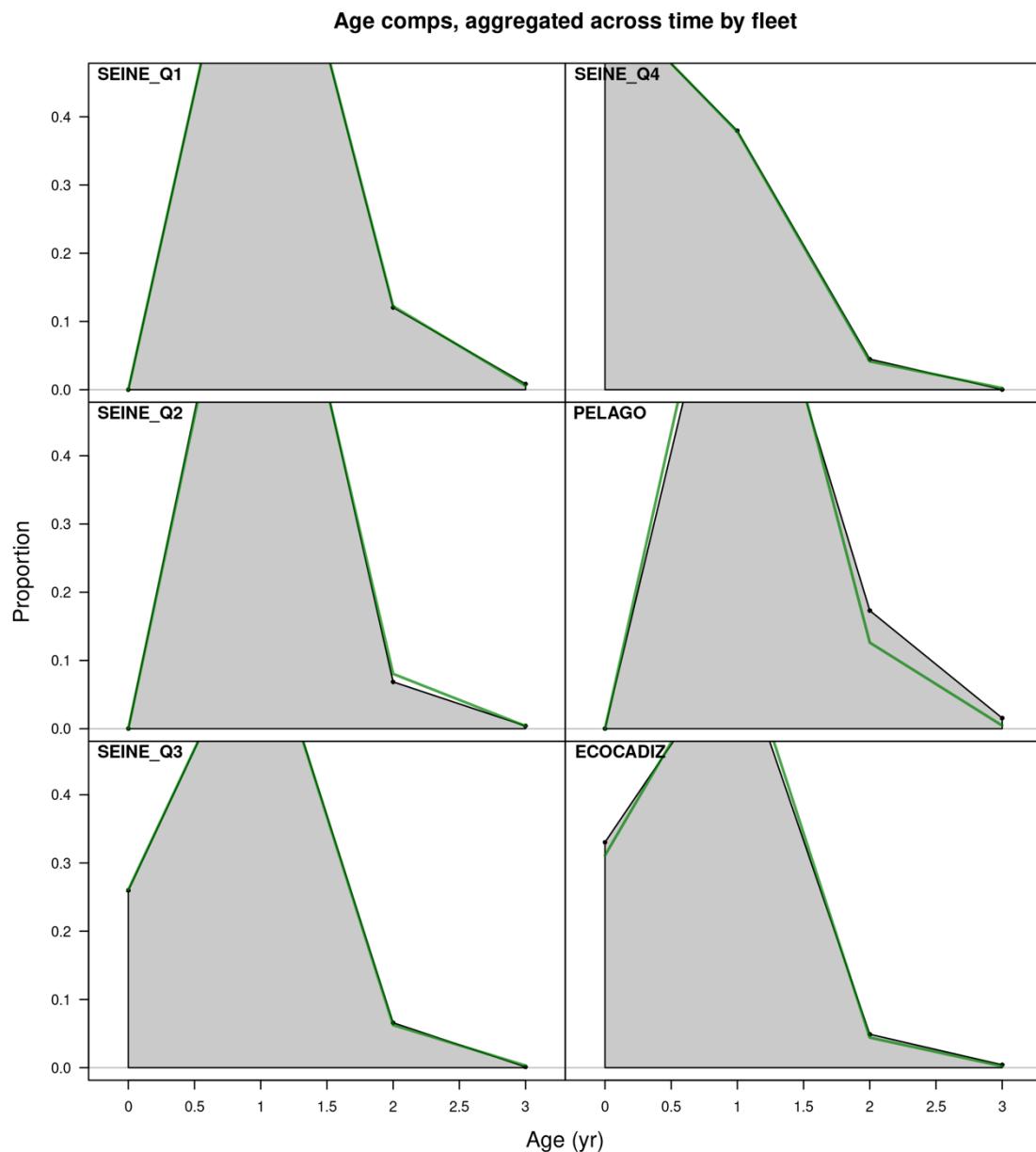


Figure 4.6.2.9. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Model fit to the aggregated age composition data from the *SEINE* fishery, and the acoustic surveys *PELAGO* and *ECOCADIZ*. The green line represents the model estimates, while the shaded grey area shows the observed data.

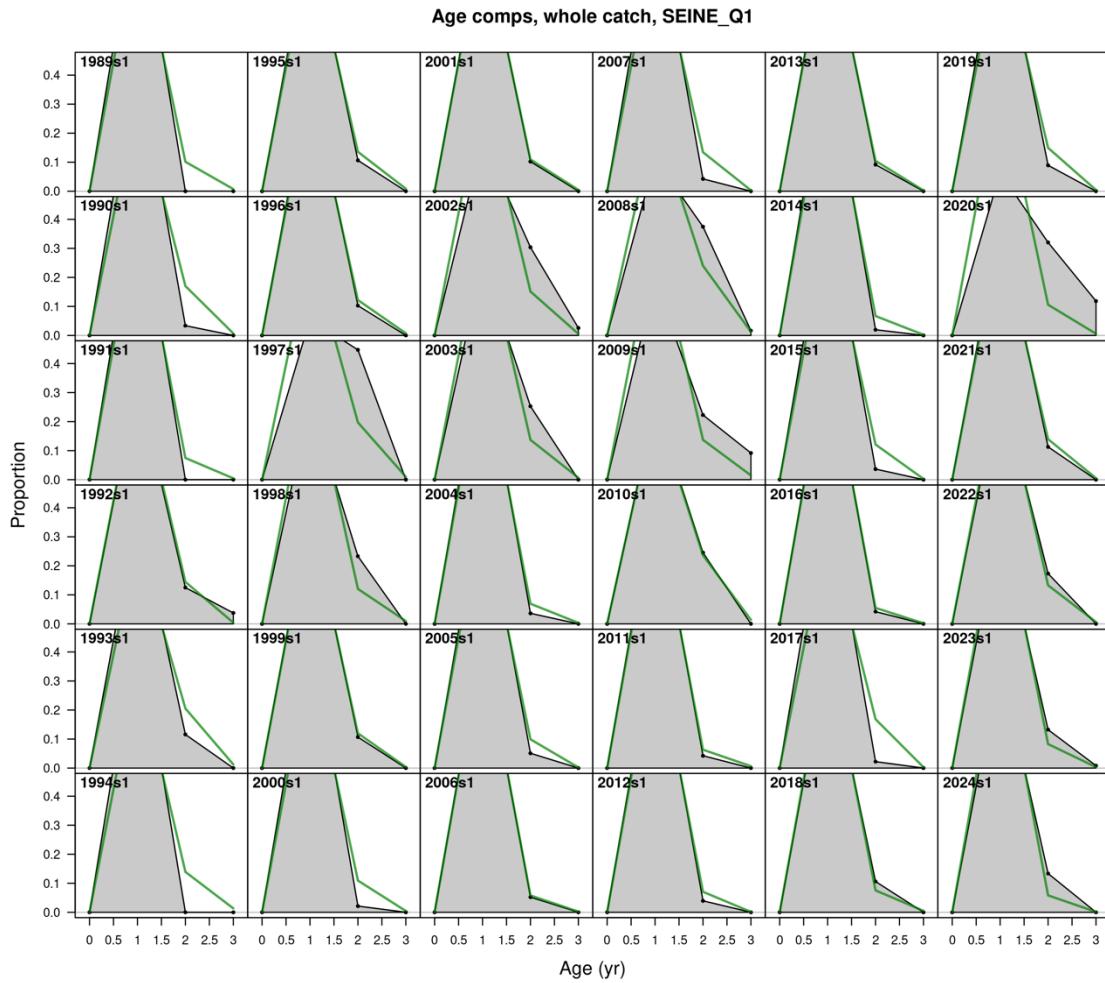


Figure 4.6.2.10. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Model fit to the age composition data from the SEINEQ1 fishery, by year and quarter. The green line represents the model estimates, while the shaded grey area shows the observed data.

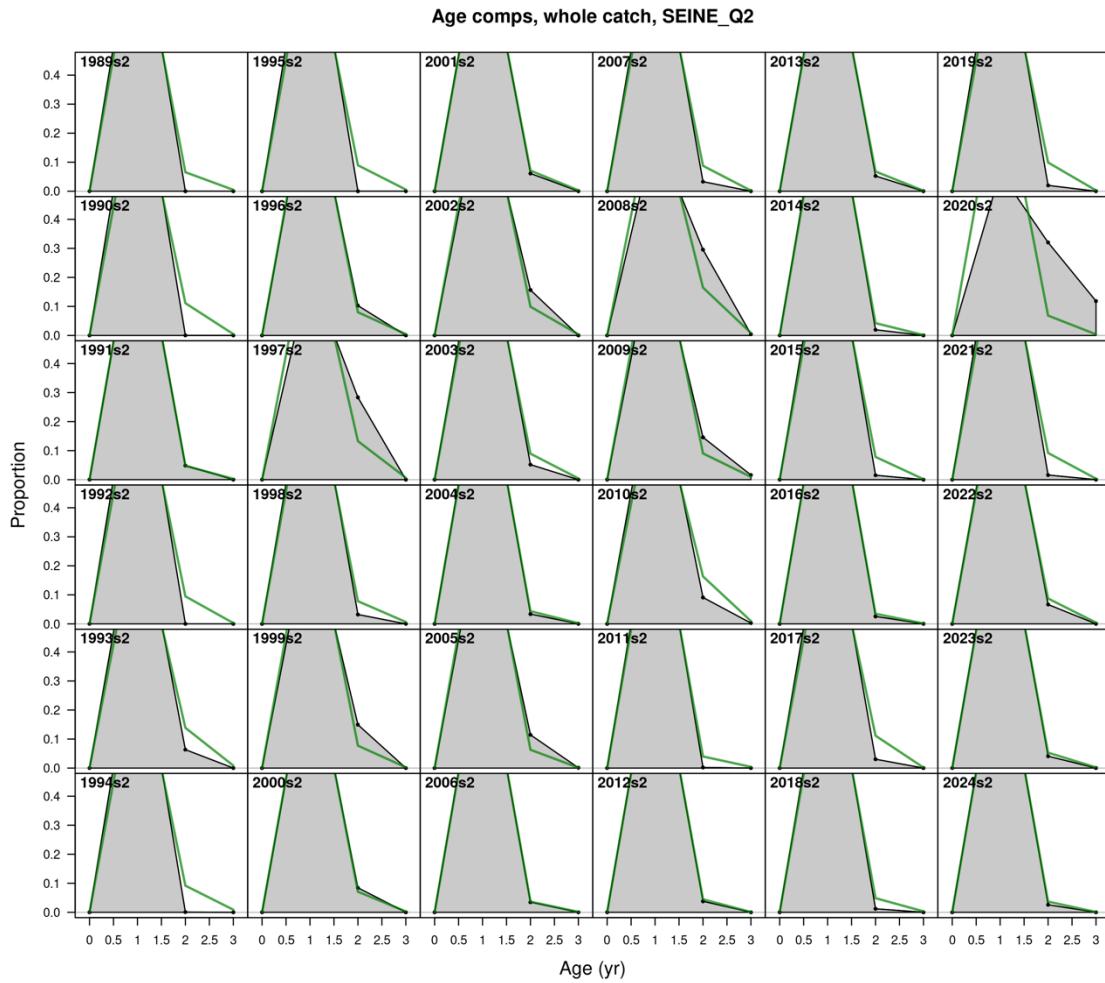


Figure 4.6.2.11. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Model fit to the age composition data from the SEINEQ2 fishery, by year and quarter. The green line represents the model estimates, while the shaded grey area shows the observed data.

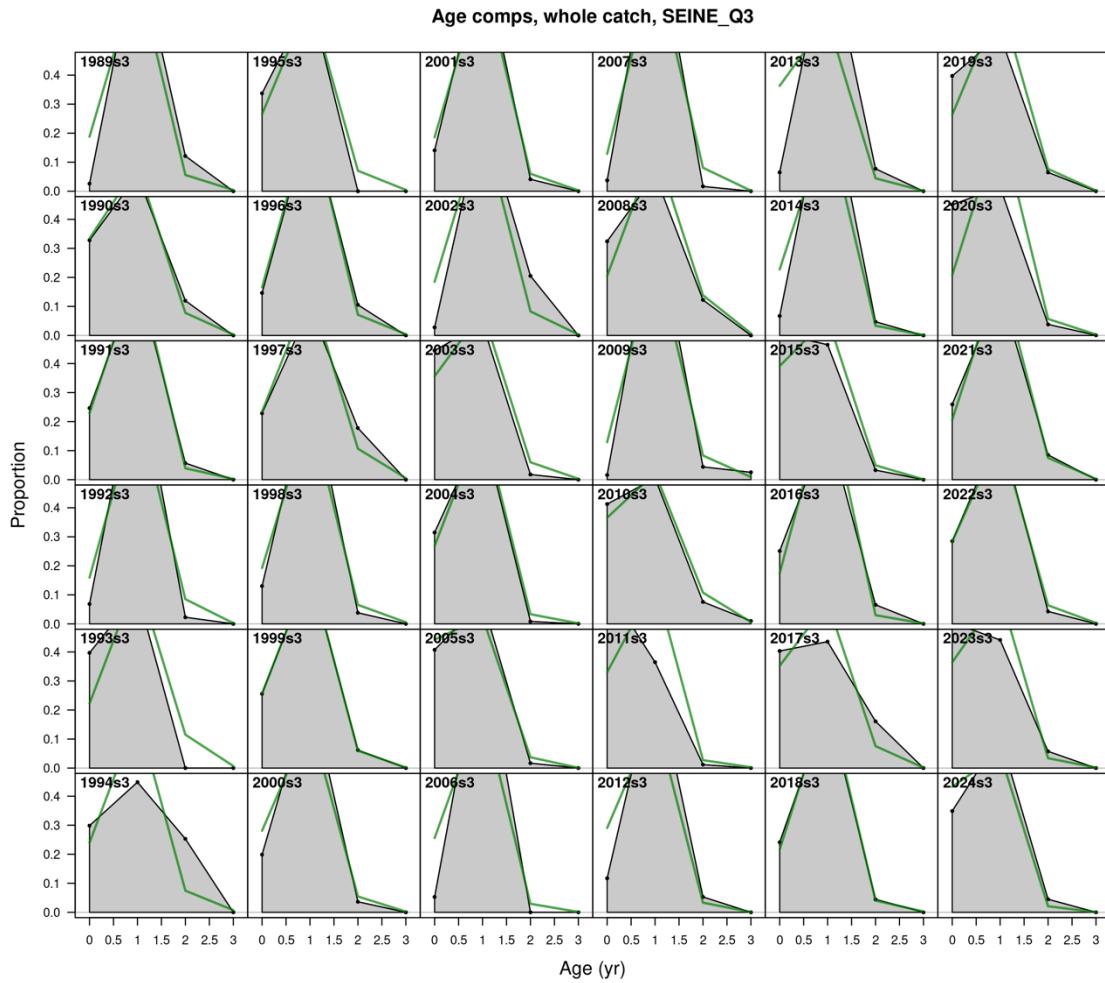


Figure 4.6.2.12. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Model fit to the age composition data from the SEINEQ3 fishery, by year and quarter. The green line represents the model estimates, while the shaded grey area shows the observed data.

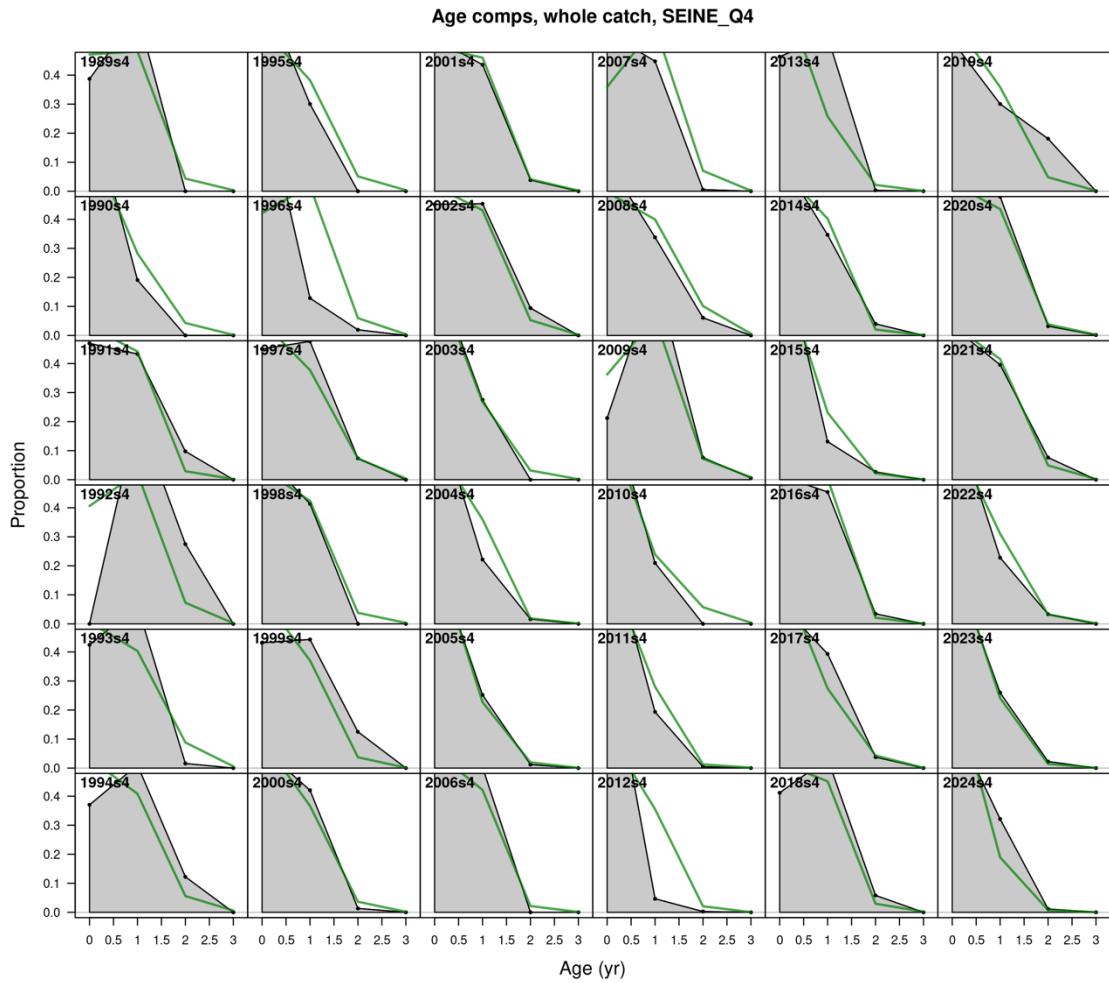


Figure 4.6.2.13. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Model fit to the age composition data from the *SEINEQ4* fishery, by year and quarter. The green line represents the model estimates, while the shaded grey area shows the observed data.

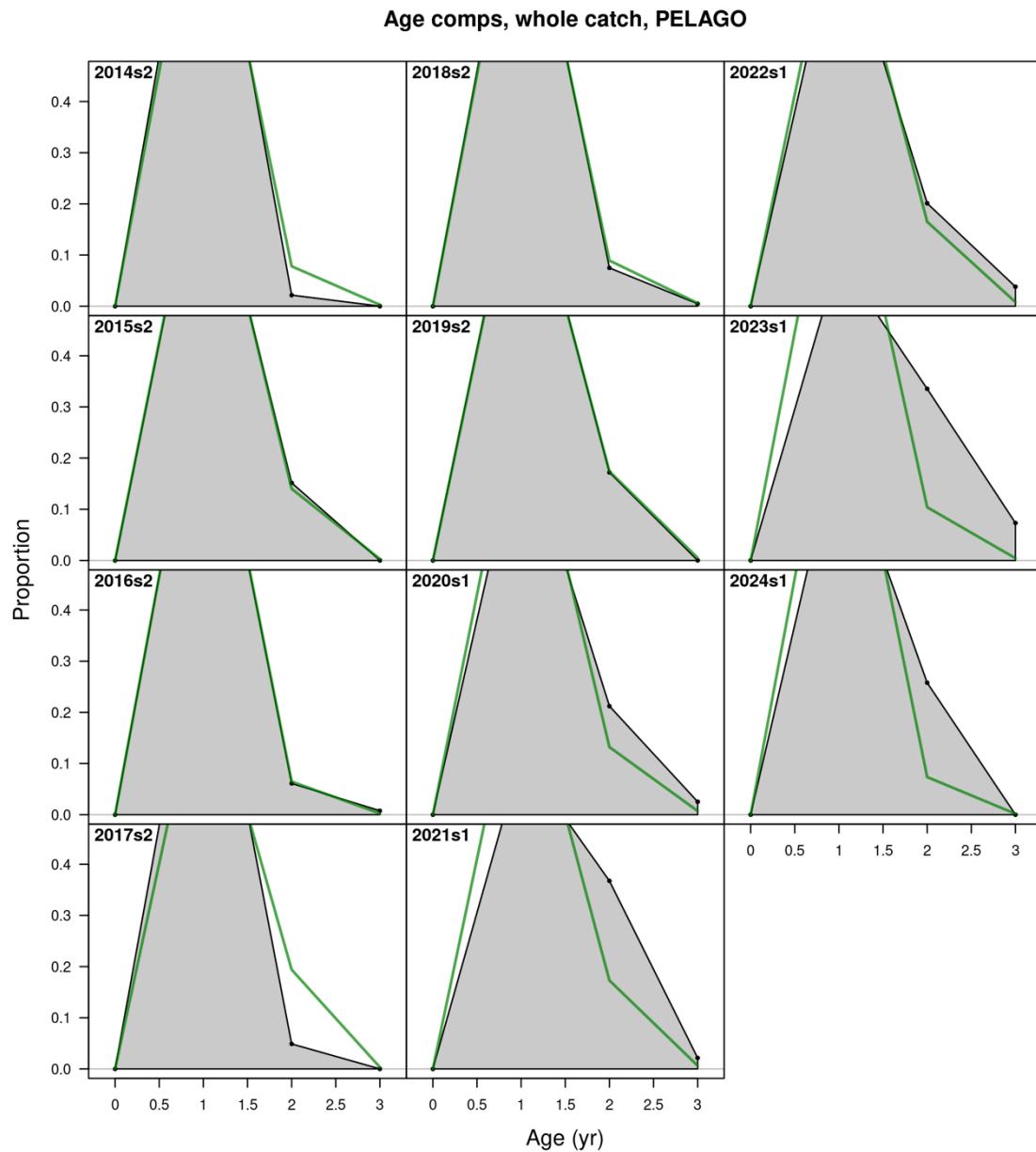


Figure 4.6.2.14. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Model fit to the age composition data from the PELAGO spring survey by year. The green line represents the model estimates, while the shaded grey area shows the observed data.

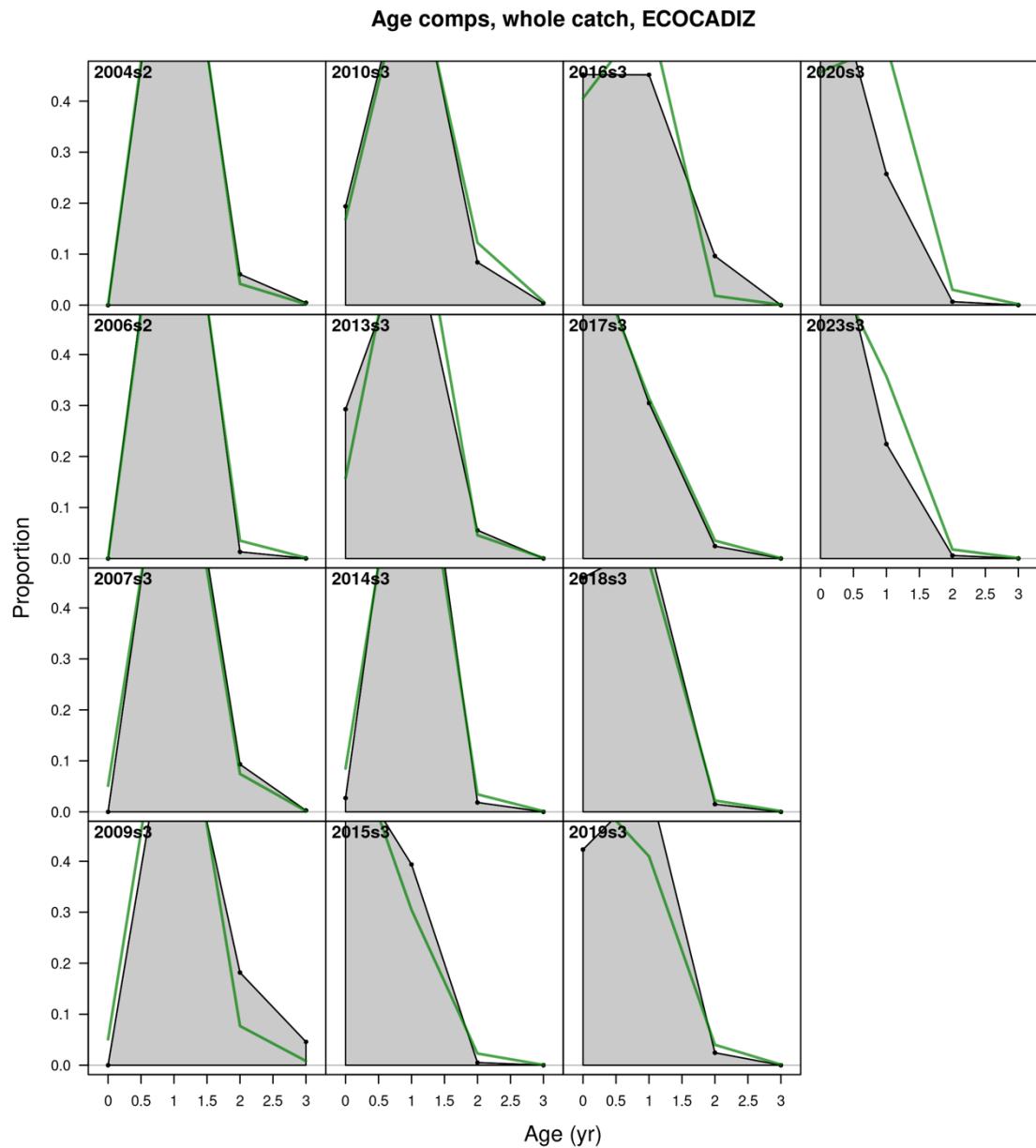


Figure 4.6.2.15. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Model fit to the age composition data from the ECOCADIZ summer survey by year. The green line represents the model estimates, while the shaded grey area shows the observed data.

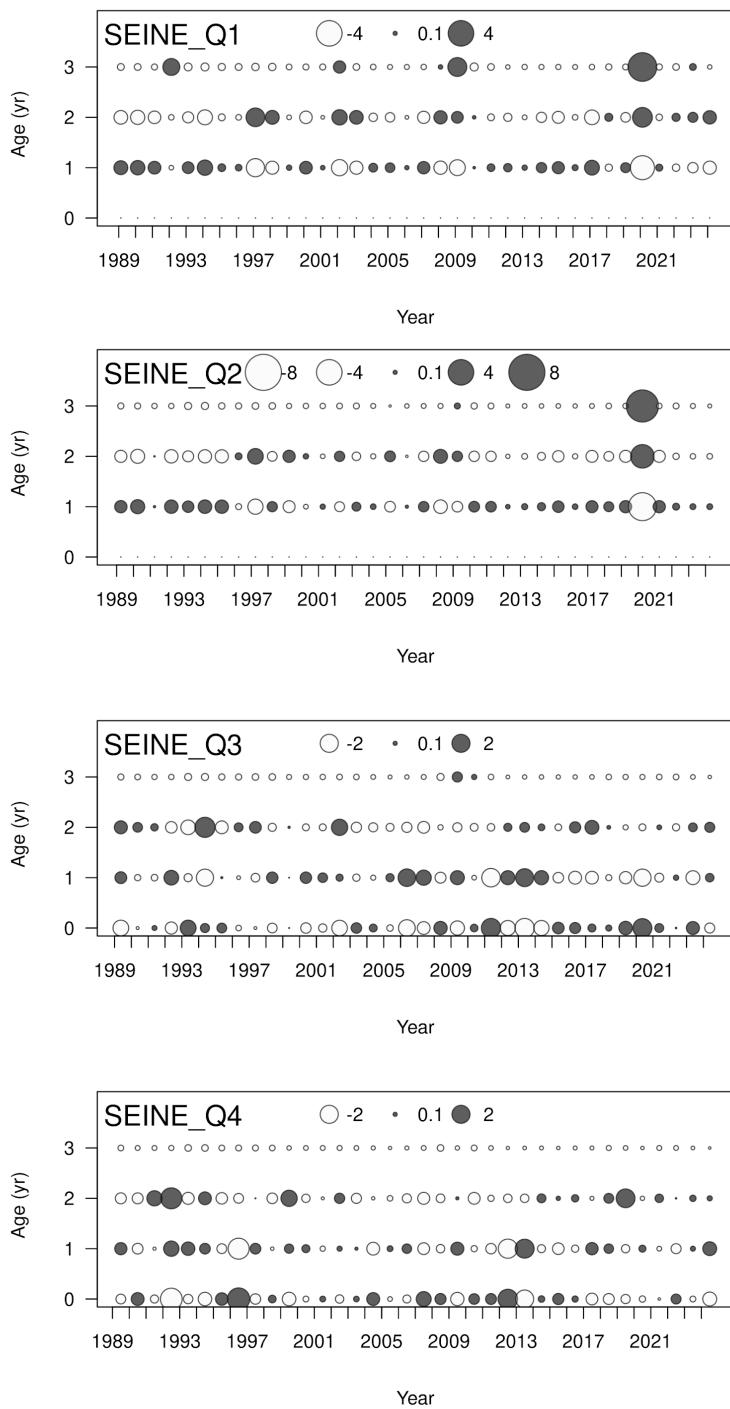


Figure 4.6.2.16. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Pearson residuals, comparing across fleets. Closed bubbles are positive residuals (observed > expected) and open negative residuals (observed < expected).

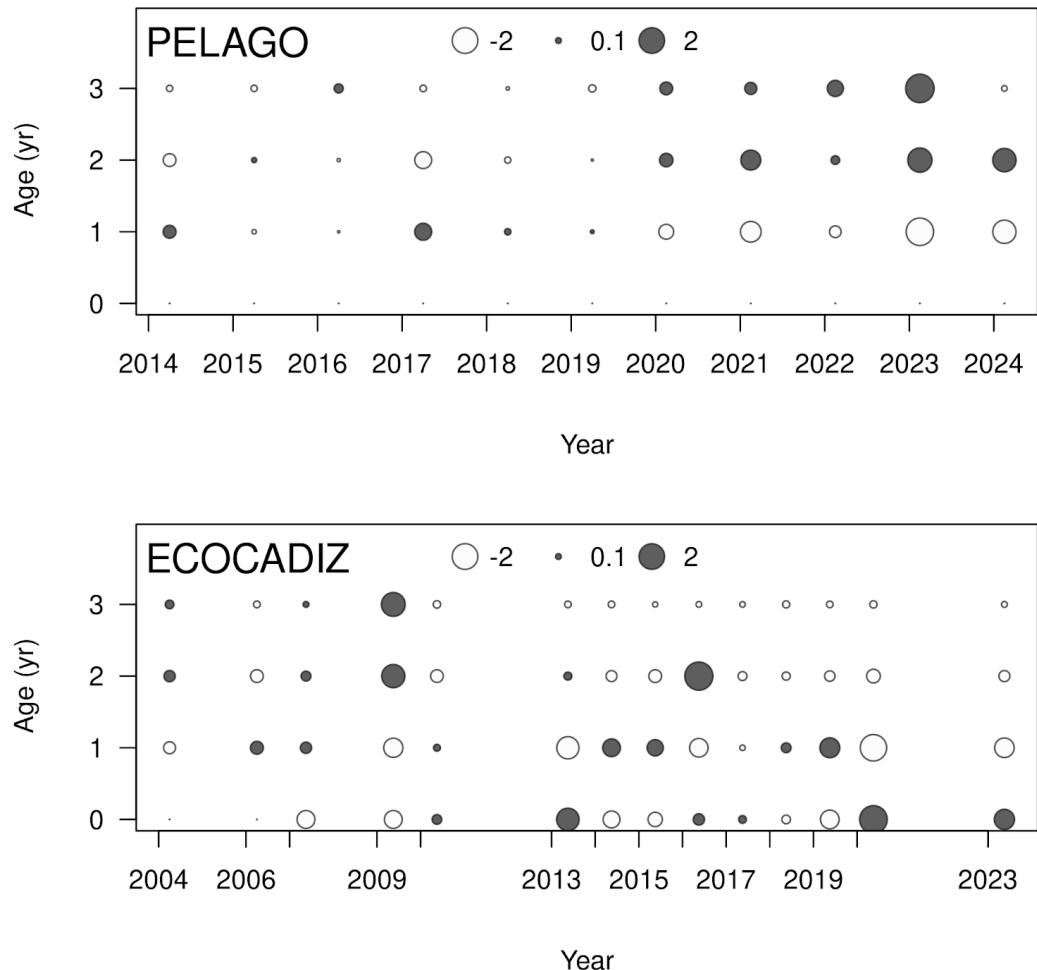


Figure 4.6.2.17. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Pearson residuals, comparing across surveys. Closed bubbles are positive residuals (observed > expected) and open negative residuals (observed < expected).

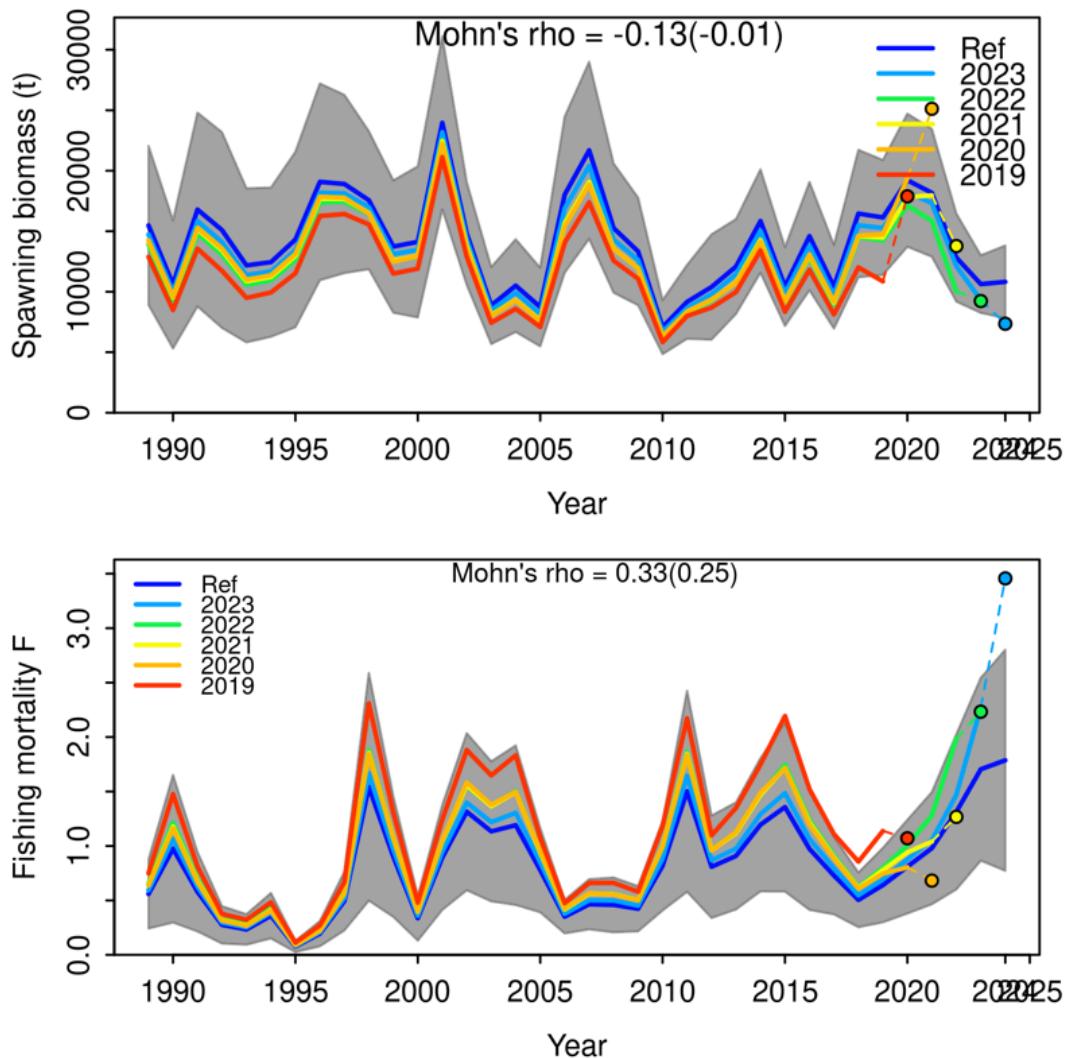


Figure 4.6.2.18. Anchovy in Subdivision 9.a South (Gulf of Cadiz). Retrospective analysis of spawning stock biomass (SSB) and fishing mortality (F). Models conducted by re-fitting the reference model (Ref) after removing five years of observations, one year at a time sequentially. The retrospective results 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_MP>=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.

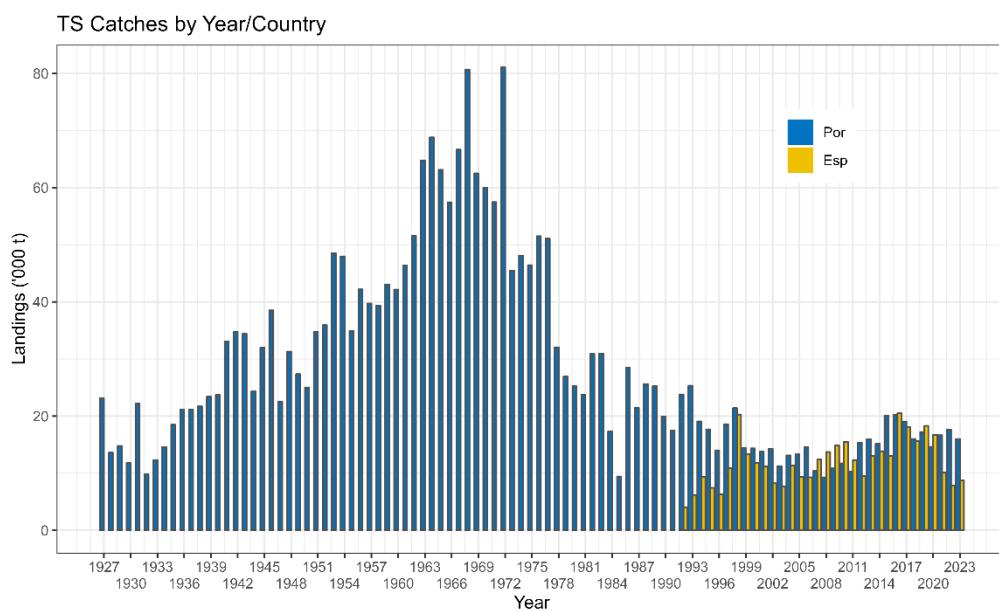


Figure 5.2.2.2. Historical time series of landings (1927-2023) for southern horse mackerel (Div. 27.9.a). Blue bars are Portuguese landings and yellow bars are Spanish landings.

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%

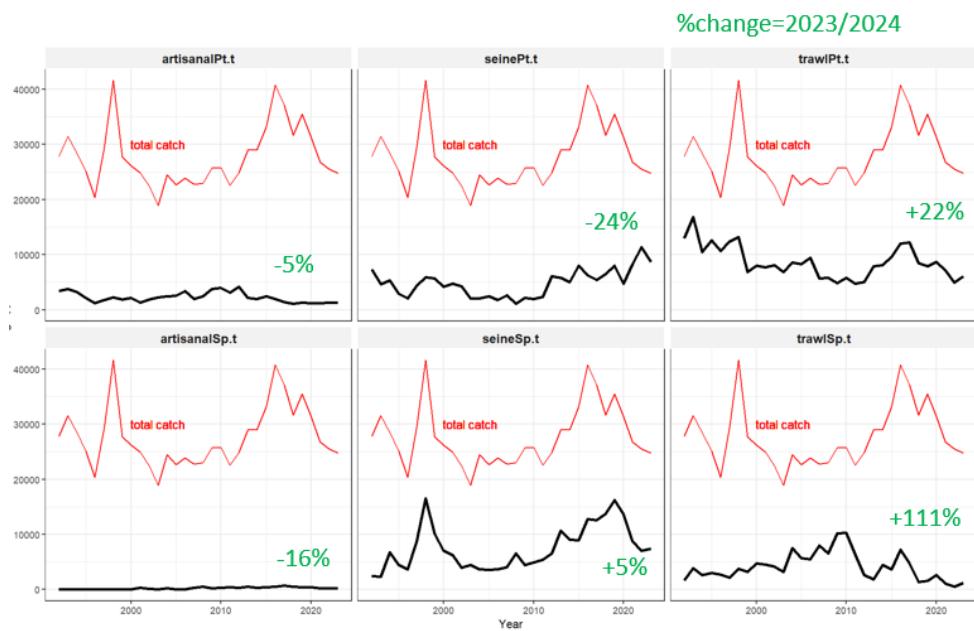


Figure 5.2.2.3. Time-series (1992-2023) of southern horse mackerel catches (in tonnes) by country (Pt – Portugal; Sp – Spain) and gear (artisanal; purse seine, trawl). The green numbers in the plots represent the % change in catch between 2023 and 2022.

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.

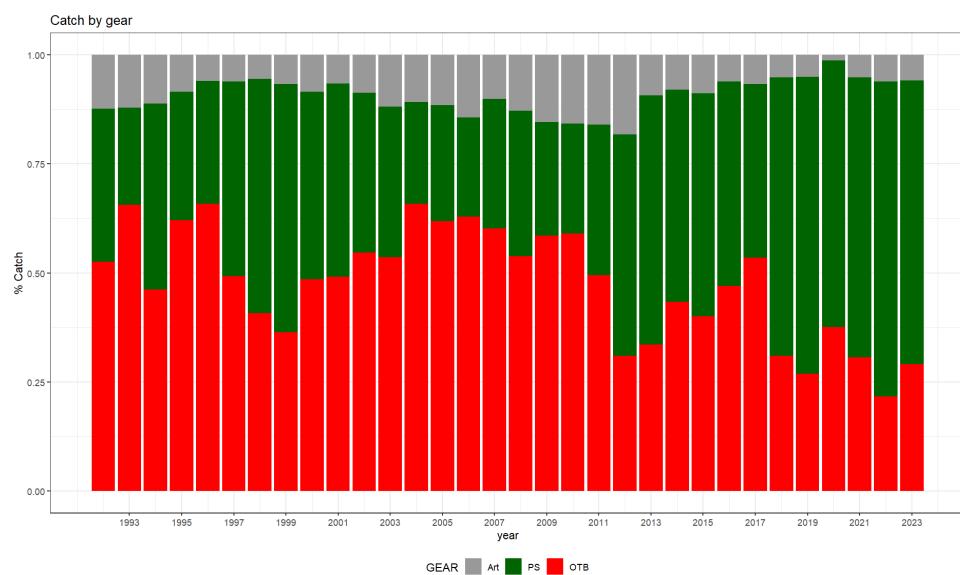


Figure 5.2.2.4. Contribution of southern horse mackerel catches by gear (PS – Purse seine, OTB – bottom trawl, Art - Artisanal) from 1992-2023.

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_MPД_>=55_0_0	27.9.a.n	0.0	2.3	0.6	0.1	3.0
SP	trawl	PTB_MPД_>=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 Maritime Services – DGRM) for the period 1988-2022 (Silva et al., 2022). A combined CPUE from multiple métiers/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

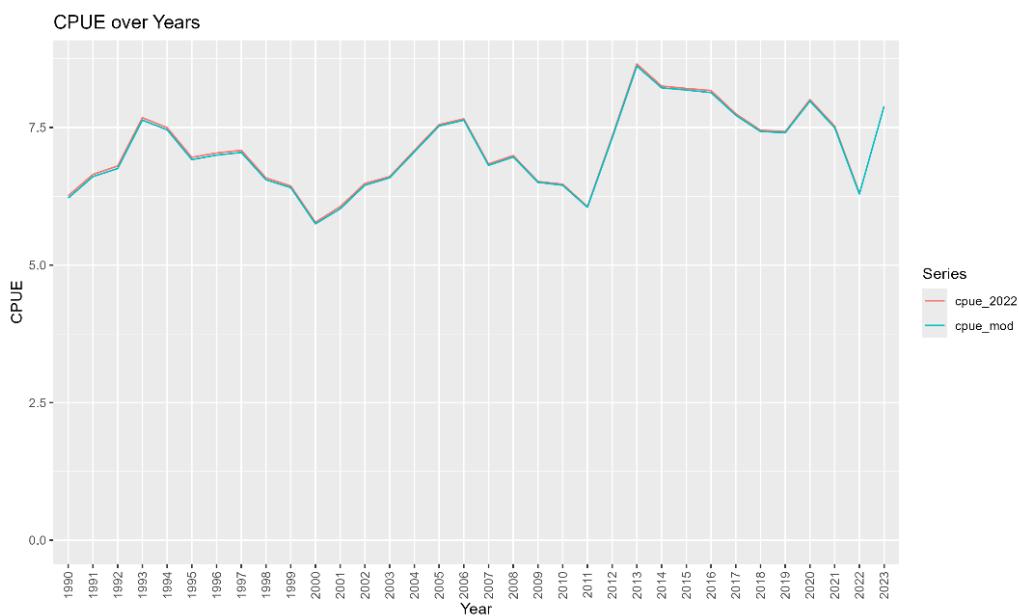


Figure 5.2.3.1. Estimated CPUE index used in assessment (cpue_mod) and comparison to last year's estimate from the benchmark (cpue_2022).

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).

Year	Ages											
	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

Year	Ages											
	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

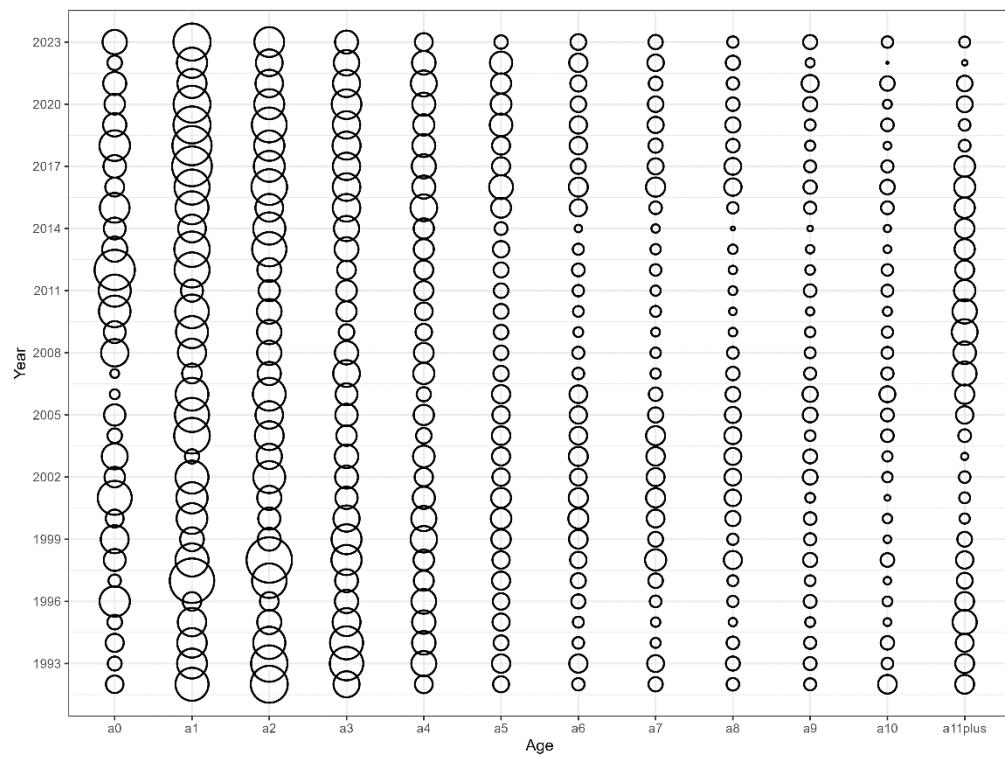


Figure 5.2.4.1. Bubble plot of proportions of southern horse mackerel catch in numbers-at-age in each year (1992–2023).

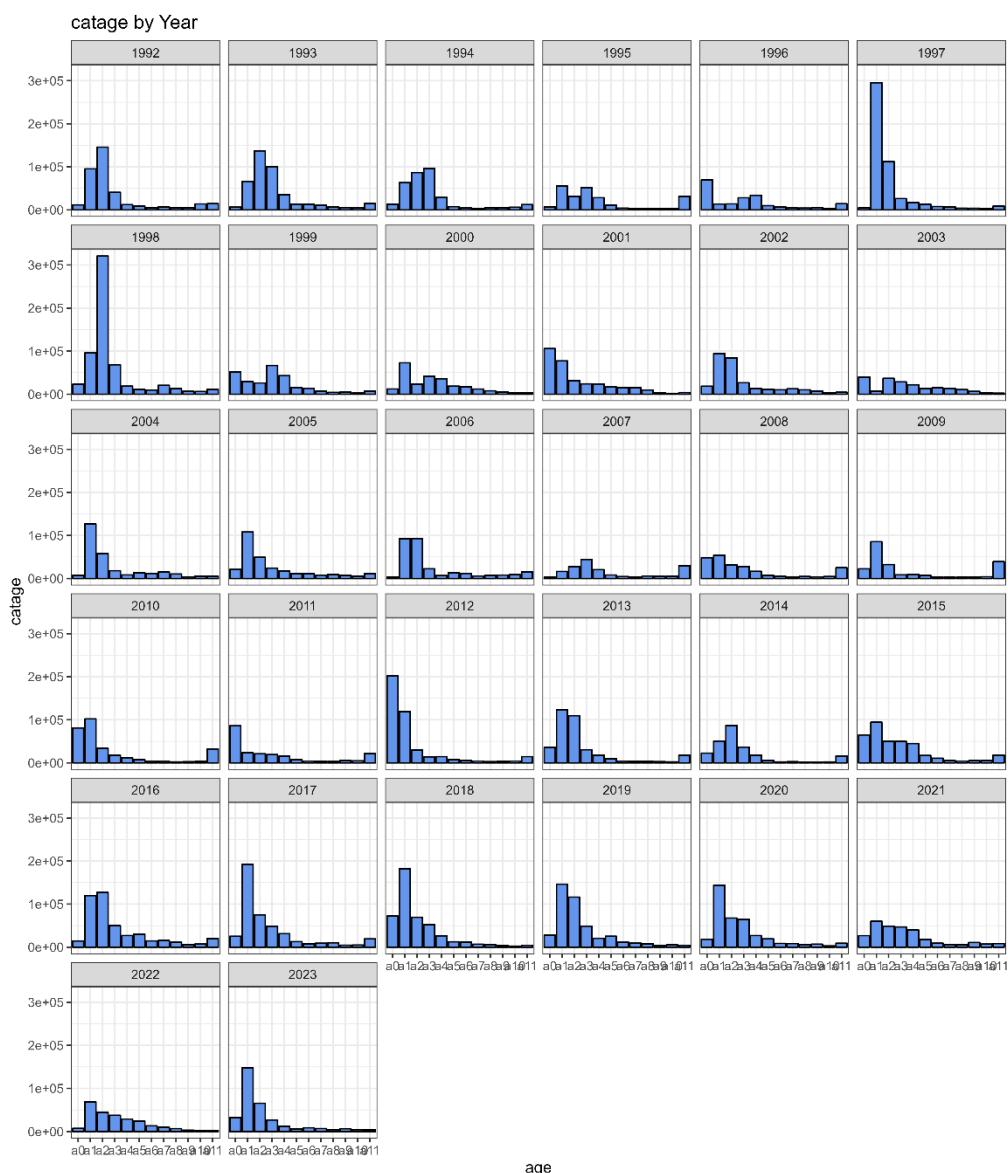


Figure 5.2.4.2. Southern horse mackerel catch in numbers-at-age in each year (1992–2023).

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												
YEAR	AGES											
	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												
YEAR	AGES											
	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

YEAR	AGES											
	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
Artisanal												
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

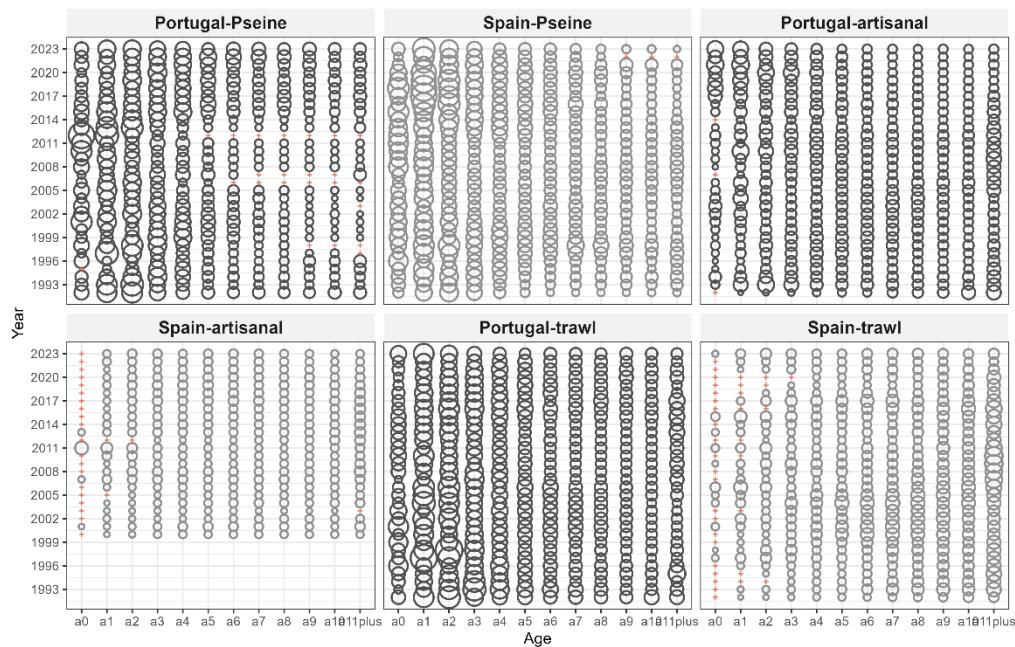


Figure 5.2.4.3. Bubble plot of proportions of southern horse mackerel catch in numbers-at-age by country and fleet in each year (1992-2023).

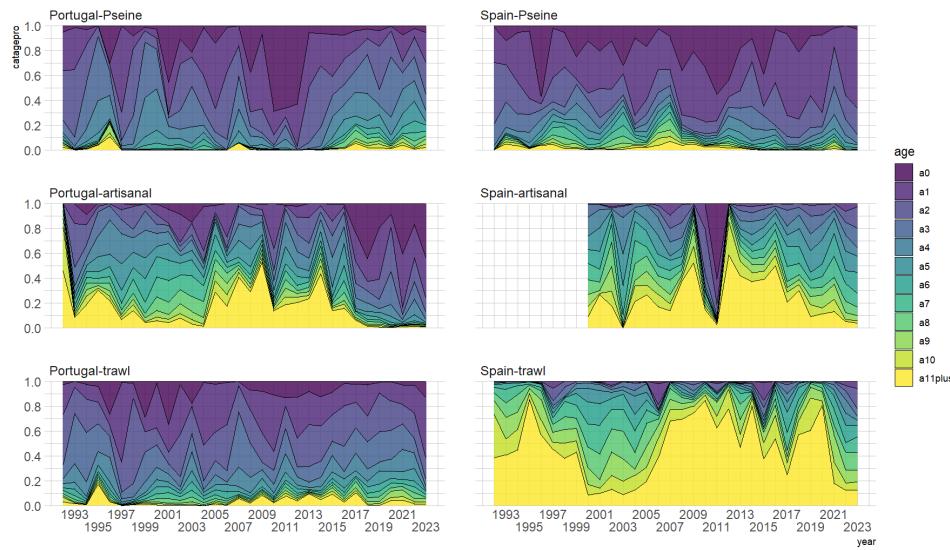


Figure 5.2.4.4. Proportion of catch for southern horse mackerel by country and fleet in each year (1992-2023).

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).

YEAR	AGES											
	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

YEAR	AGES											
	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.

— a0 — a1 — a2 — a3 — a4 — a5
— a6 — a7 — a8 — a9 — a10 — a11plus

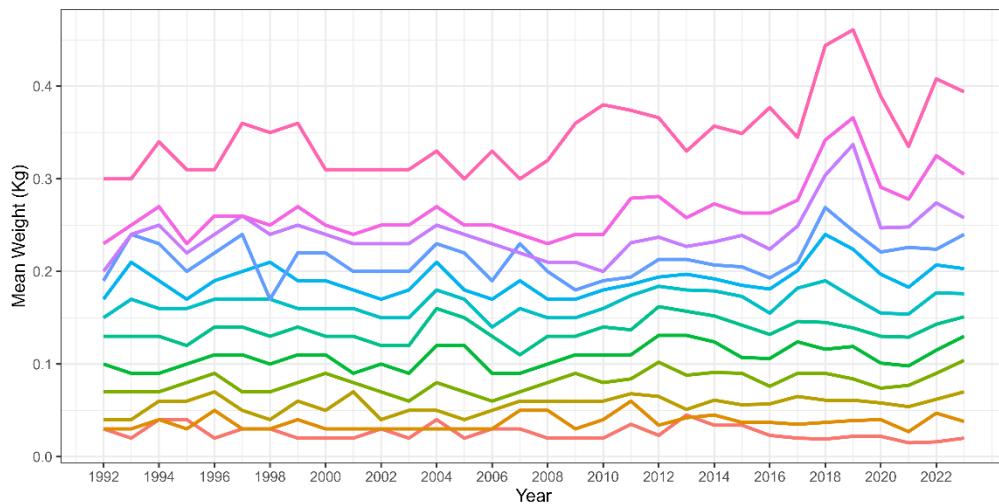


Figure 5.2.5.1. Southern horse mackerel mean weight-at-age (kg) in the catch (age range: 0 to 11+, plus group) (1992-2023).

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)

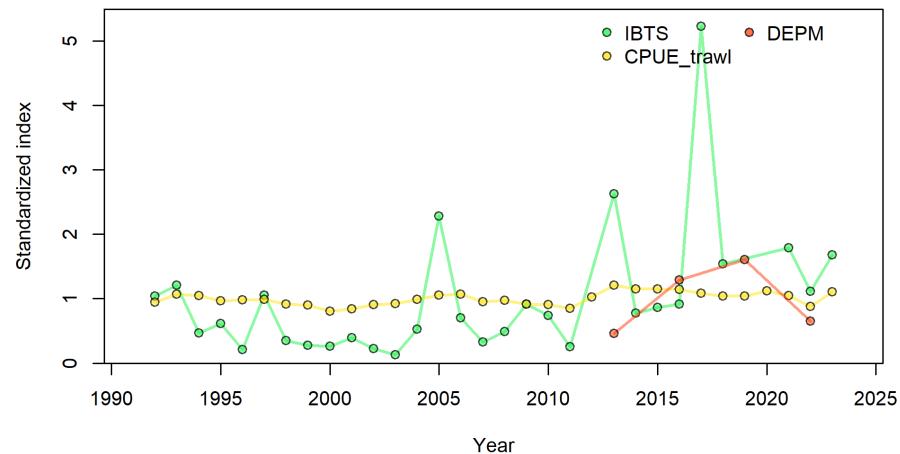


Figure 5.3.1. Southern horse mackerel standardized biomass indices used in the assessment (1992-2023).

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.

YEAR	Portuguese October Survey															
	AGES															
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	-	-	-	-

YEAR	Spanish October Survey (only Subdivision 9a North)															
	AGES															
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	0.1	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	0.1	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	0.1	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	0.1	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	0.1	0.0	0.0	0.1	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	0.0	0.5	0.2	0.2	0.0	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	0.2	0.0	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	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 the 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.

YEAR	AGES											
	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

P₀= 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).

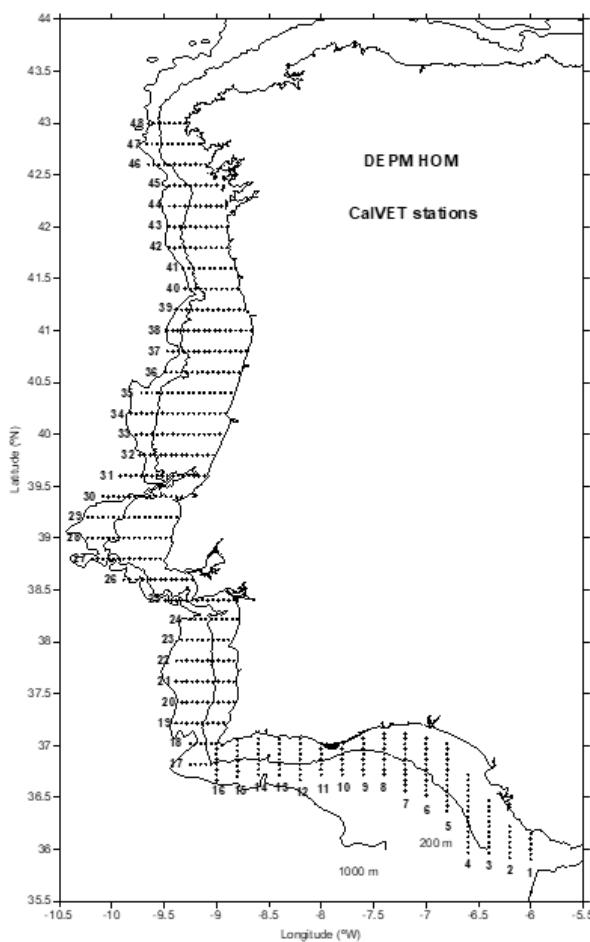


Figure 5.3.2.1. Planned plankton stations (CalVET) in the Portuguese DEPM HOM survey. On the outer shelf and beyond surveying is adaptive depending on egg presence and therefore the final number of samples in each transect may vary.

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 ontogenetic 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 $L_{\text{inf}} = 41.8$ and $k=0.11$. The adopted mortality-at-age values are presented in the text table below (11+: age 11 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 conducted 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.

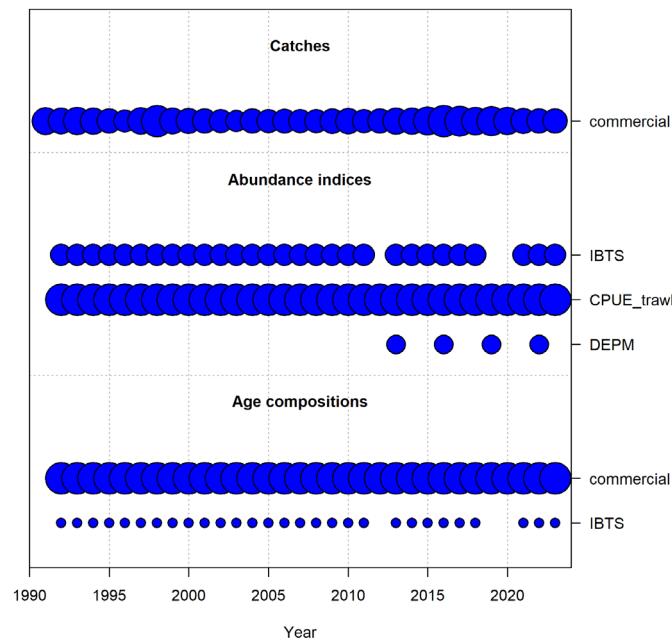


Figure 5.4.1.1. Summary of inputs and data year ranges for assessment (1992-2023).

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-age	Numbers-at-age 1992 to 2023 [1 to 11+]. Cochran stratified mean. Combined Spanish-Portuguese IBTS surveys
DEPM survey	Spawning stock biomass. Triennial 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 $F_{\bar{F}}$ 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)

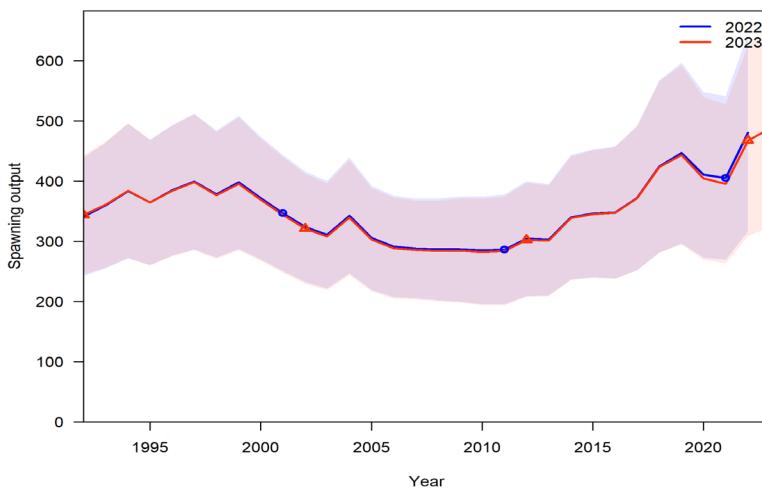


Figure 5.4.1.2. Southern horse mackerel final assessment (1992-2023) and last year assessment performed in ICES, 2024 (1992-2022). Plots of SSB (a), Fishing mortality (b), Recruitment (c). Grey shaded area and bars in recruitment shows 95% confidence bounds. SSB and are in thousand tonnes and recruitment in thousands.

b)

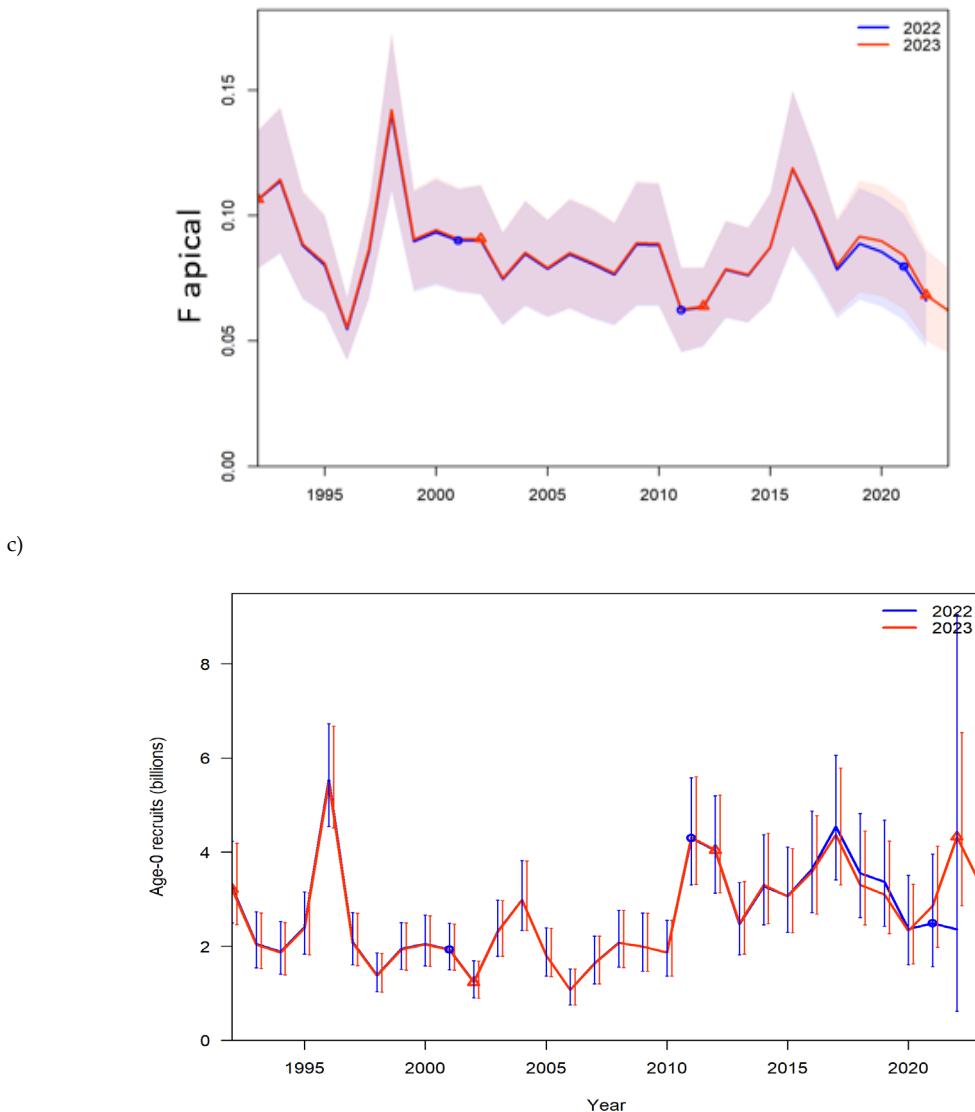


Figure 5.4.1.2. continued. Southern horse mackerel final assessment (1992-2023) and last year assessment performed in ICES, 2024 (1992-2022). Plots of SSB (a), Fishing mortality (b), Recruitment (c). Grey shaded area and bars in recruitment shows 95% confidence bounds. SSB and are in thousand tonnes 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)

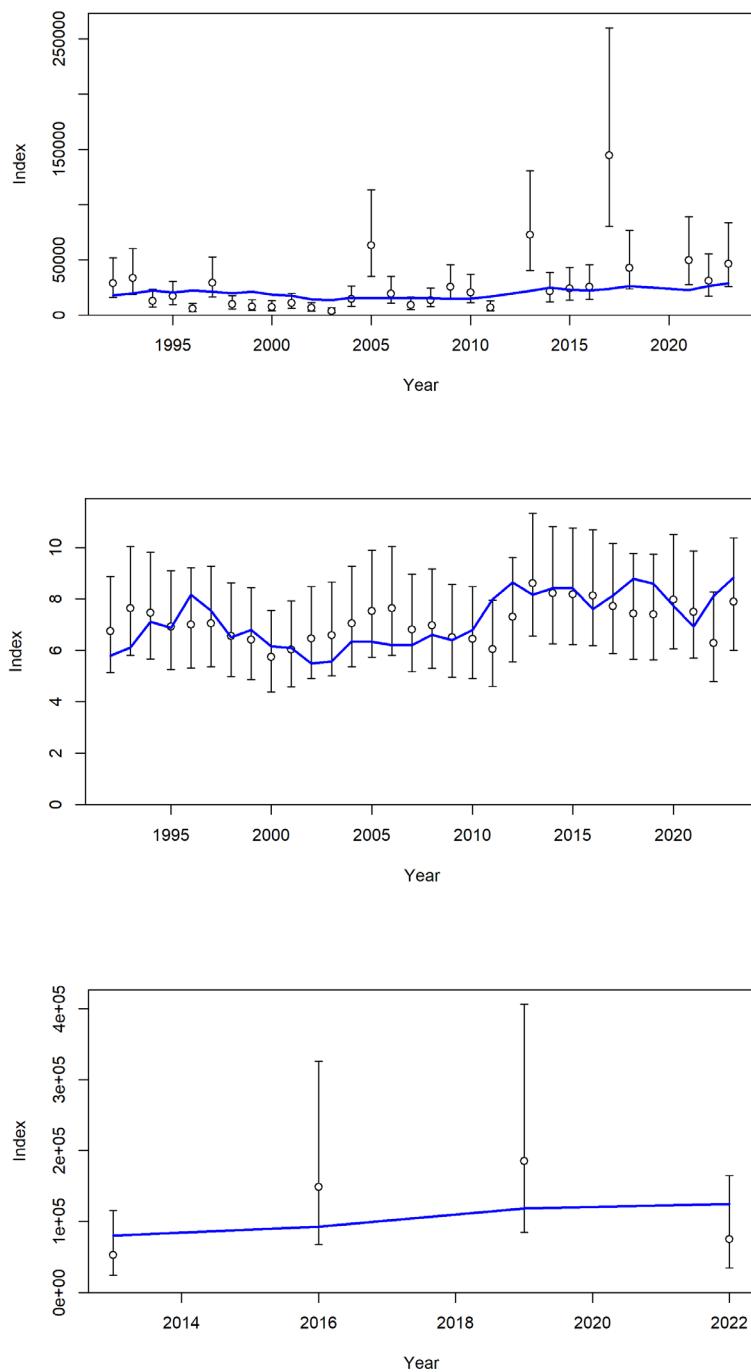


Figure 5.4.2.1. Fit to biomass abundance indices (blue line). IBTS (top), commercial CPUE (middle) and DEPM (bottom). Lines indicate 95% uncertainty interval around index values based on lognormal error.

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).

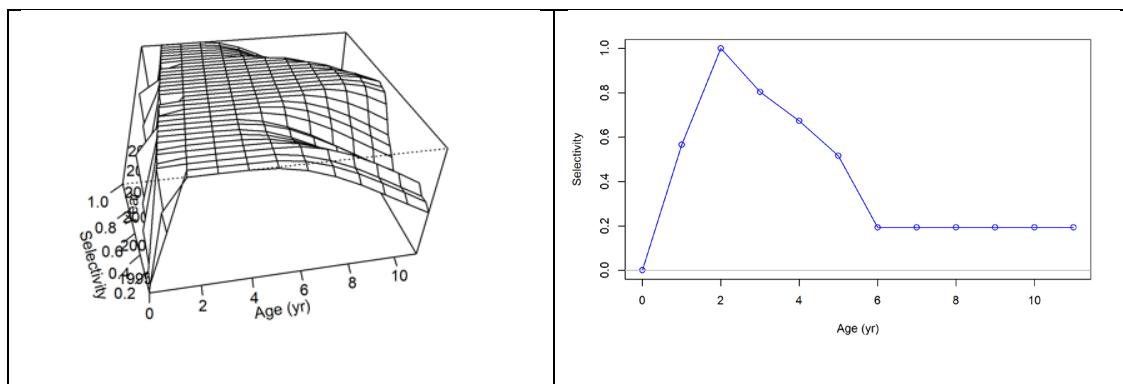


Figure 5.4.2.2. Southern horse mackerel. Estimated selectivity for the catch-at-age (dome shaped time varying selectivity) and for the IBTS combined stratified mean abundance-at-age (fixed).

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.

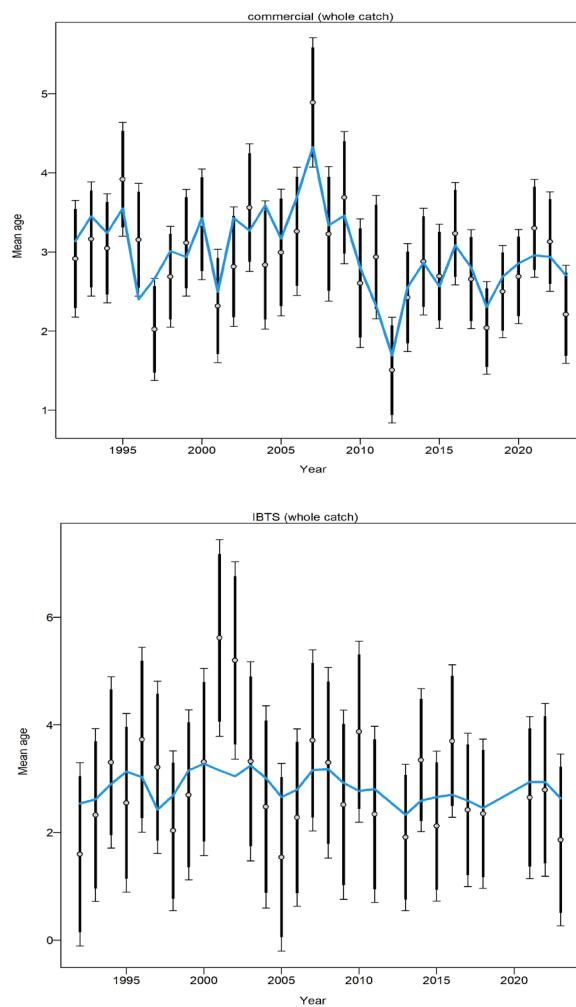


Figure 5.4.2.3. continued. Southern horse mackerel mean age in the catch (top) and IBTS survey (bottom) in the period 1992–2022 and estimated values (blue line).

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.

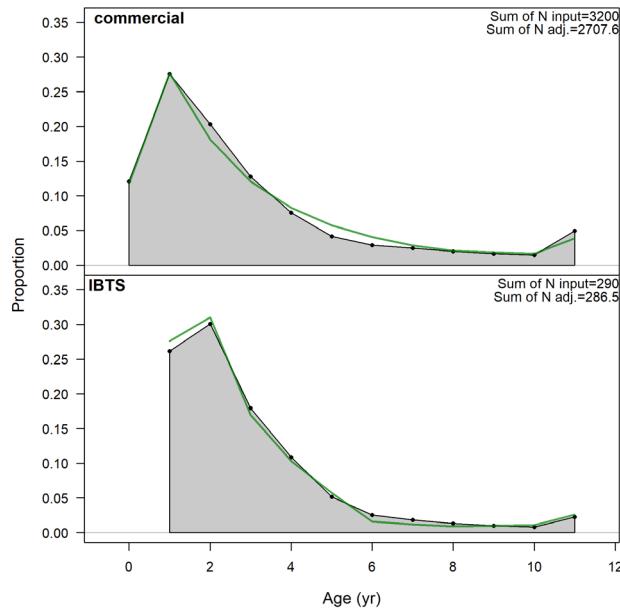


Figure 5.4.2.4. Aggregated (1992-2023) proportions-at-age for the observed and fitted (green line) catch and IBTS survey.

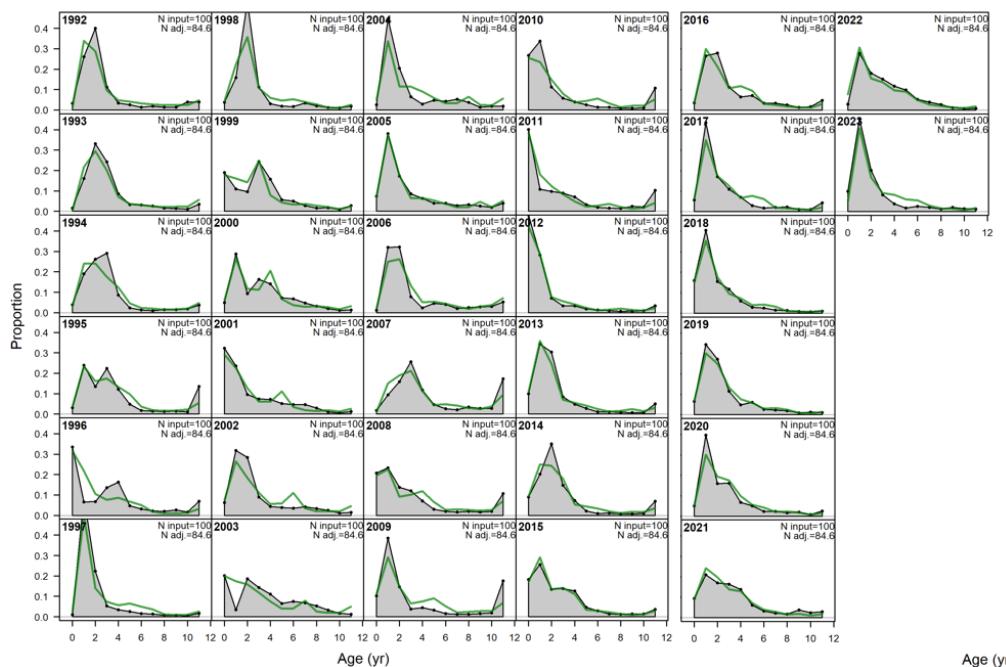


Figure 5.4.2.5. Southern horse mackerel (1992-2023). Comparison of proportions-at-age of the observed and fitted catch data (fitted values=green line).

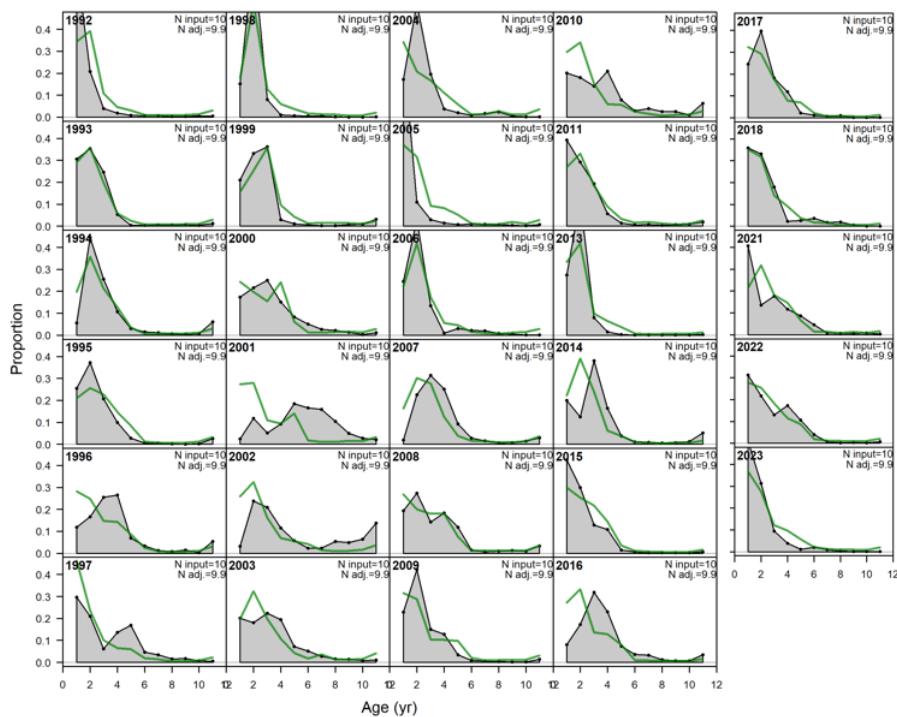


Figure 5.4.2.6. Southern horse mackerel (1992–2023). Comparison of proportions-at-age of the observed and fitted IBTS data (fitted values=green line). In 2012, 2019 and 2020 there was no survey.

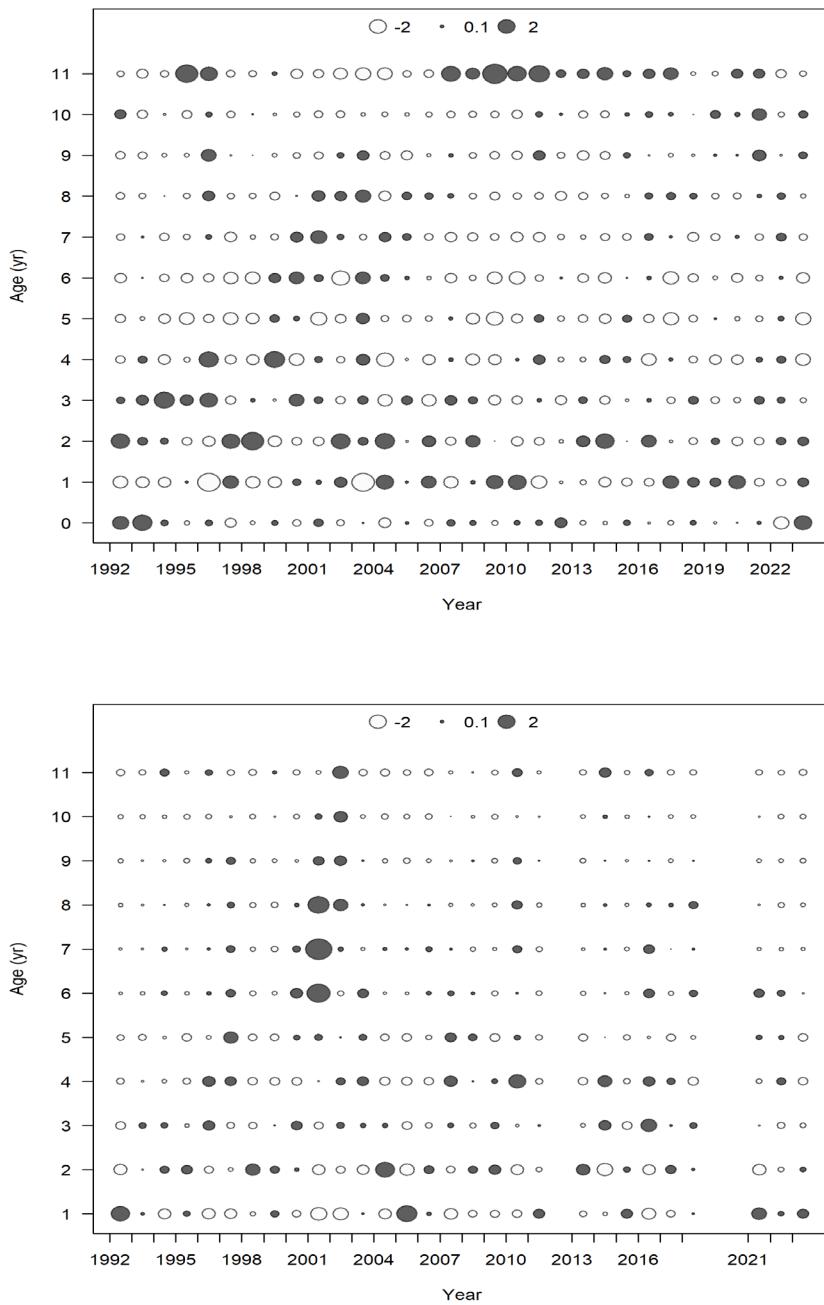


Figure 5.4.2.7. Southern horse mackerel (1992-2023). Bubble plot of catch (top, age range 0-11+) and survey (bottom, age range: 1-11+) proportion-at-age residuals (positive residual=black; negative residuals=white).

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.

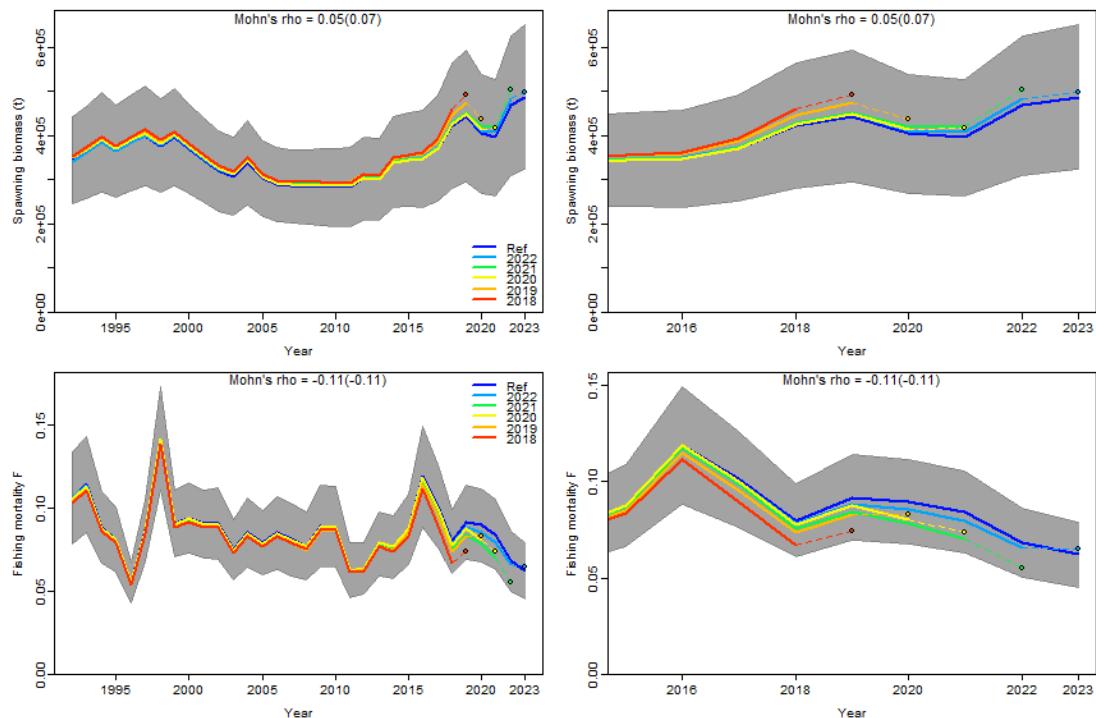


Figure 5.4.2.8. Retrospective analysis results. Trajectories of SSB, and F (grey=95% confidence intervals) for the current assessment and the retrospective assessments. The observed retrospectives for SSB and F in the available time series (1992-2023, right panels) and in more recent years (2014-2023, 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_{1-10}) 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 $F_{1-10} = 0.050$. 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 $SSB > MSY B_{trigger}$ that will result in $SSB \geq B_{lim}$ 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
$F = F_{sq} \times 1.2$	0.060	31787	533 917	547955	0.0021
$F = F_{sq} \times 1.6$	0.080	41974	533 917	538407	0.0027
$F = F_{sq} \times 2.0$	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	$B_{lim} = B_{pa} * \exp(-1.645 \sigma)$ $\sigma = 0.20$
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 ($SSB < B_{lim}$)
F_{pa}	0.146	F that leads to $SSB \geq B_{lim}$ 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.

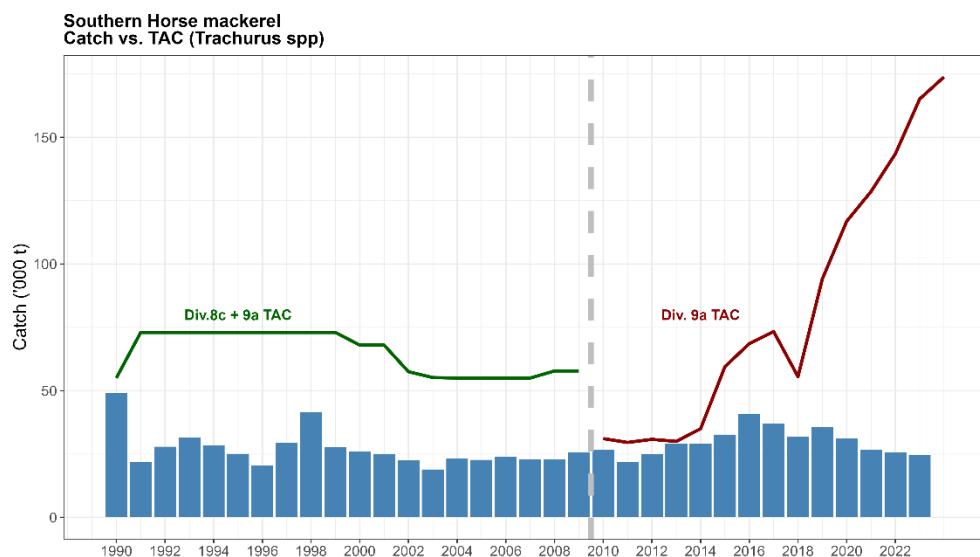


Figure 5.7.1. Catch (1990-2023) and TAC (1990-2024) for southern horse mackerel. Blue bars show catches for southern horse mackerel, green line shows combined TAC for horse mackerel in division 8c and 9a and red line shows TAC for horse mackerel in division 9a.

5.8 Reference

- Bernal, M., Somarakis, S., Witthames, P., Van Damme, C., Uriarte, A., Lo, N., and Dickey-Collas, M. 2012. Egg production methods in marine fisheries: An introduction. *Fisheries Research*, 117–118, 1–5.
- Carvalho, F., Winker, H., Courtney, D., Kapur, M., Kell, L., Cardinale, M., Schirripa, M., Kitakado, T., Yemane, D., Piner, K.R., Maunder, M.N., Taylor, I., Wetzel, C.R., Doering, K., Johnson, K.F., Methot, R.D. (2021) A cookbook for using model diagnostics in integrated stock assessments. *Fisheries Research*, 240, 105959
- Castro, J., Punzón, A., Pierce, G. J. , Marín, M., Abad, E. .2010. Identification of métiers of the Northern Spanish coastal bottom pair trawl fleet by using the partitioning method CLARA. *Fisheries Research*, 102, pp. 184-190
- Gislason, H., Daan, N., Rice, J., Pope, J. 2010 Size, growth, temperature and the natural mortality of marine fish. *Fish and Fisheries*, 11: 149–158.
- ICES. 2023. Working Group on Mackerel and Horse Mackerel Egg Surveys (WGMEGS). ICES Scientific Reports. 5:81. 118 pp.
- ICES. 2024. Benchmark workshop on horse mackerel and boarfish (WKBHMB). ICES Scientific Reports. 6:8. 296 pp. <https://doi.org/10.17895/ices.pub.25002482>
- Methot, R. D. and Wetzel, C. R. 2013. Stock synthesis: A biological and statistical framework for fish stock assessment and fishery management. *Fisheries Research*, 142, 86–99.
- Methot, R. D., Wetzel, C. R., Taylor, I. G., Doering, K. L., Gugliotti, E.F and Johnson, K. F. 2023. Stock Synthesis User Manual Version 3.30.22. Seattle, WA: NOAA Fisheries.
- Silva, A.V., Mendes, H., Silva, C. 2022. Standardization of the Portuguese trawl fleet LPUE for Iberian hake. Working Document to ICES Benchmark Workshop on anglerfish (*Lophius budegassa*, *Lophius piscatorius*) and hake (*Merluccius merluccius*).
- SISP 5. 2019. WGMEGS V12 Manual for AEPM and DEPM fecundity. https://ices-library.figshare.com/articles/report/SISP_5_Manual_for_the_AEPM_and_DEPM_estimation_of_fecundity_in_mackerel_and_horse_mackerel/19051103

SISP 6. 2019. MEGS V2.2 Sampling at Sea. https://ices-library.figshare.com/articles/report/SISP_6_-Manual_for_mackerel_and_horse_mackerel_egg_surveys_sampling_at_sea/19051136

Taylor, I.G., Doering, K.L., Johnson, K.F., Wetzel, C.R., Stewart, I.J. 2021. Beyond visualizing catch-at-age models: Lessons learned from the r4ss package about software to support stock assessments, *Fisheries Research*, 239:105924.

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).

year	8 a.,b,d										Total
	France	Spain	Netherlands	Ireland	UK	Denmark	Germany	Lithuania	Belgium		
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	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 (P₀) (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.

Parameter	ALL AREA			8abd			8abdwithoutNW		
	Value	S.e.	CV	Value	S.e.	CV	Value	S.e.	CV
P ₀	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
P _{tot}	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 ($\Sigma(\text{egg St} \times \text{area st})$) 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
P _{tot}	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
Length at age 1 (cm)	145.7	1.98	0.0136
Length at age 2 (cm)	174.8	1.08	0.0062
Length at age 3 (cm)	185.1	1.43	0.0077
Length at age 4 (cm)	190.8	1.50	0.0078
Length at age 5 (cm)	198.8	1.88	0.0094
Length 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%

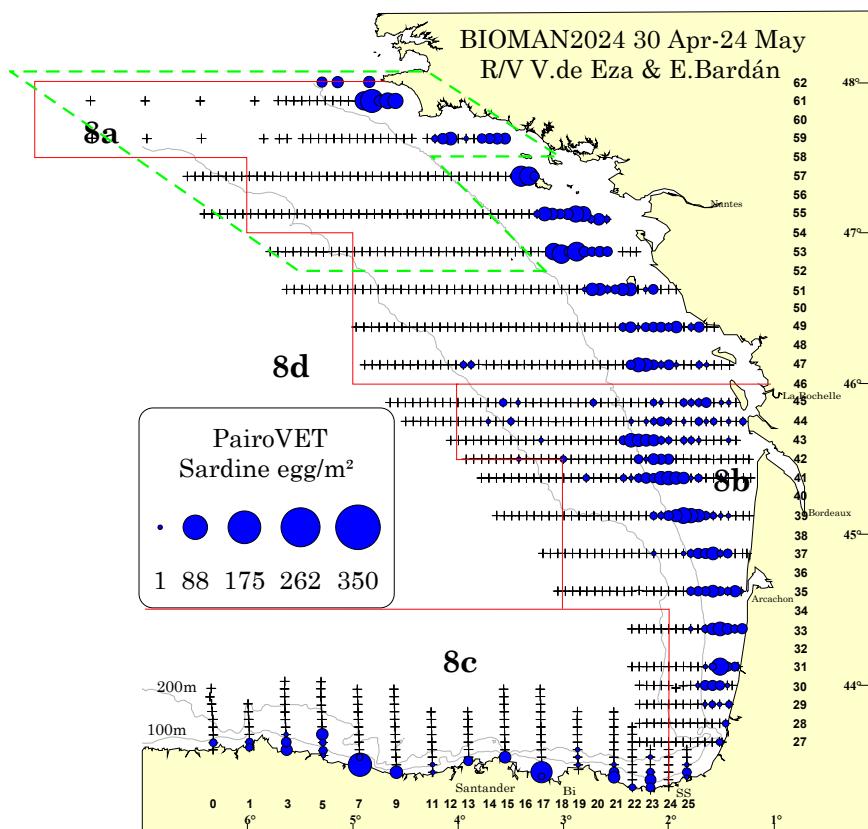


Figure 6.2.2.1.1. Sardine in 8abd. Spatial distribution and abundance of sardine eggs per 0.1m^2 from the DEPM survey BIOMAN2024 obtained with PairoVET (vertical sampling). The dash green line represents the stations removed for assessment propose in 8abd to be consistent with the historical series. Red lines represent the limits of 8abcd.

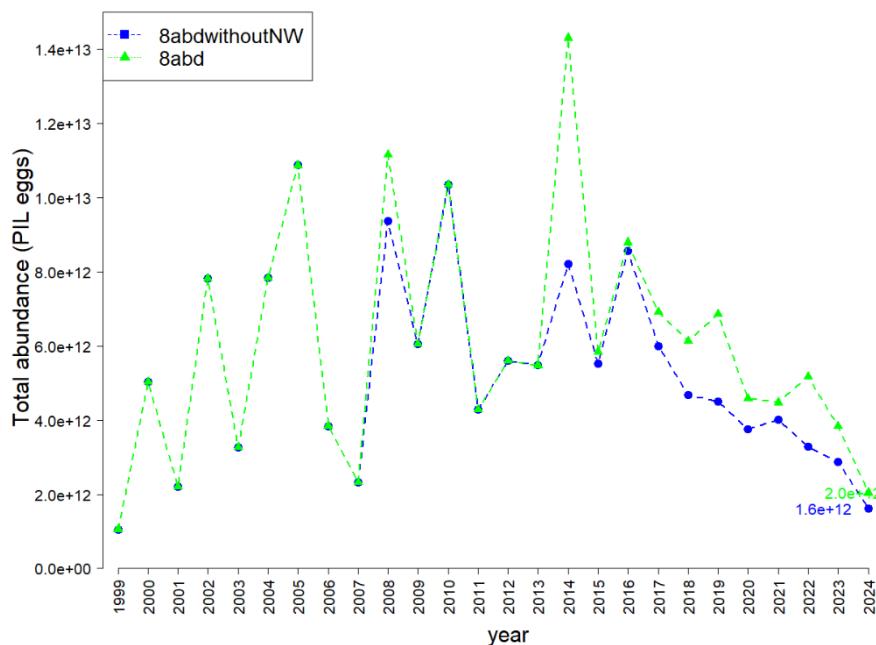


Figure 6.2.2.1.2. Sardine in 8abd. historical series for sardine egg abundances in 8abd with and without Northwest stations including 2024 values.

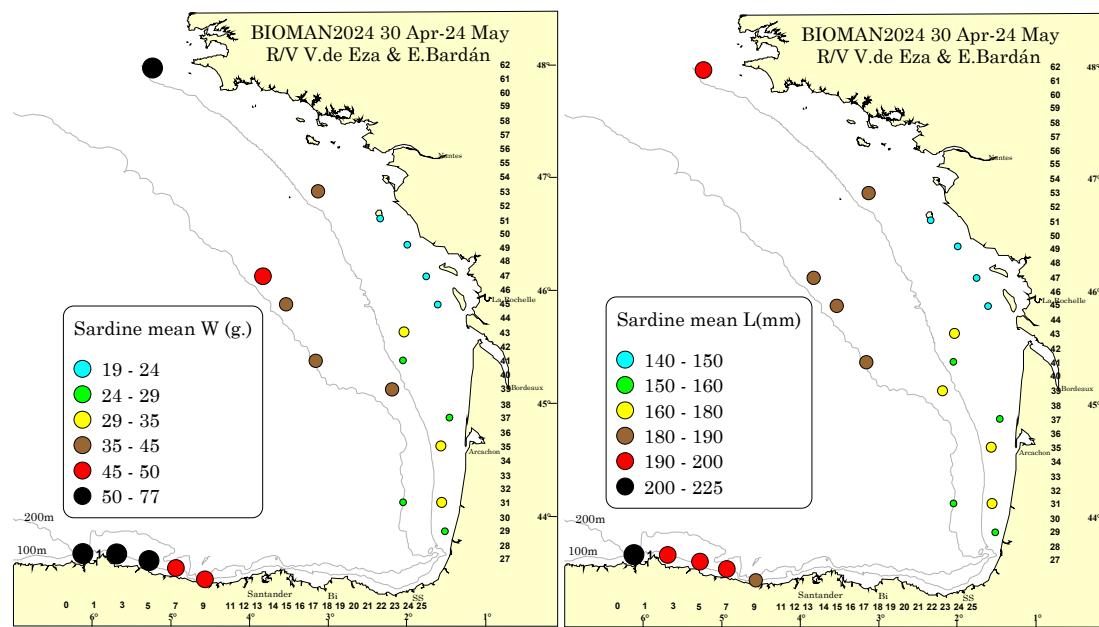


Figure 6.2.2.1.3. Sardine in 8abd. Sardine spatial distribution of mean weight (left) and mean length (right) in the Bay of Biscay from BIOMAN 2024 survey.

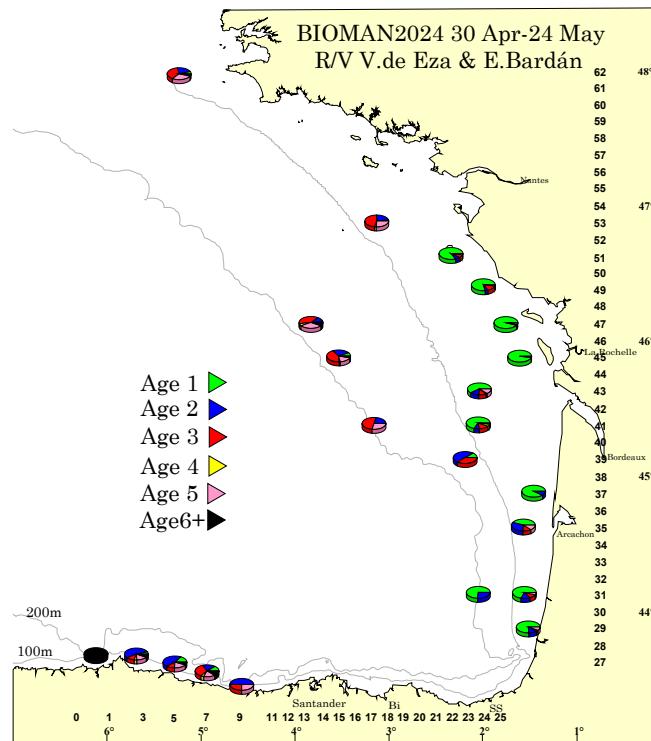


Figure 6.2.2.1.4. Sardine in 8abd. Sardine spatial distribution of percentage at age by haul in the Bay of Biscay from BIOMAN 2024 survey. The different colours are the different ages.

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.

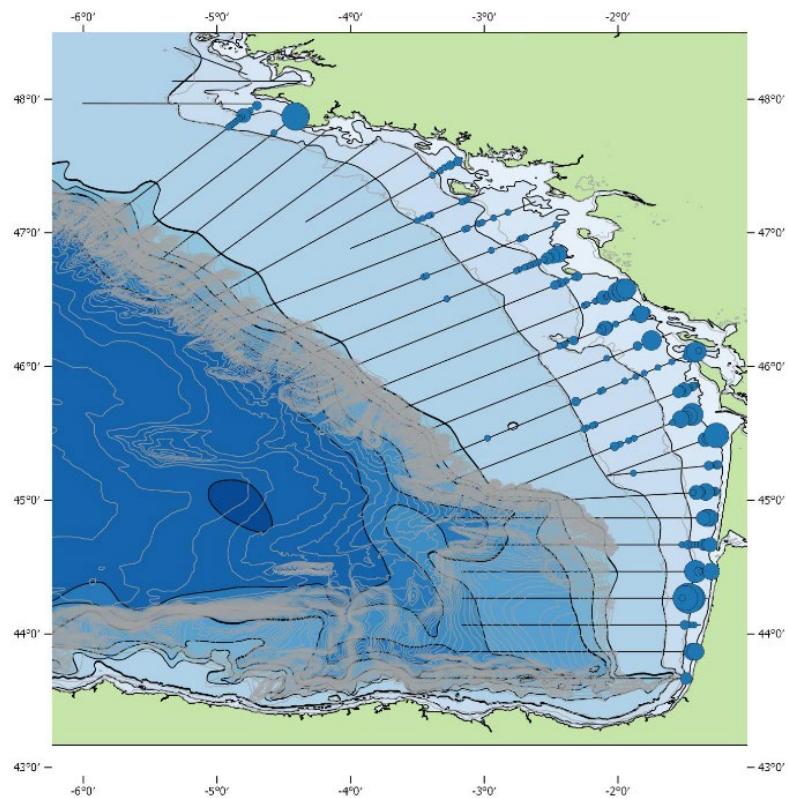


Figure 6.2.2.1. Sardine in 8abd. distribution of sardine observed by acoustics during PELGAS24.

Sardine was distributed all along the French coast of the Bay of Biscay, from the South to the Loire river (Figure 6.2.2.1). 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.

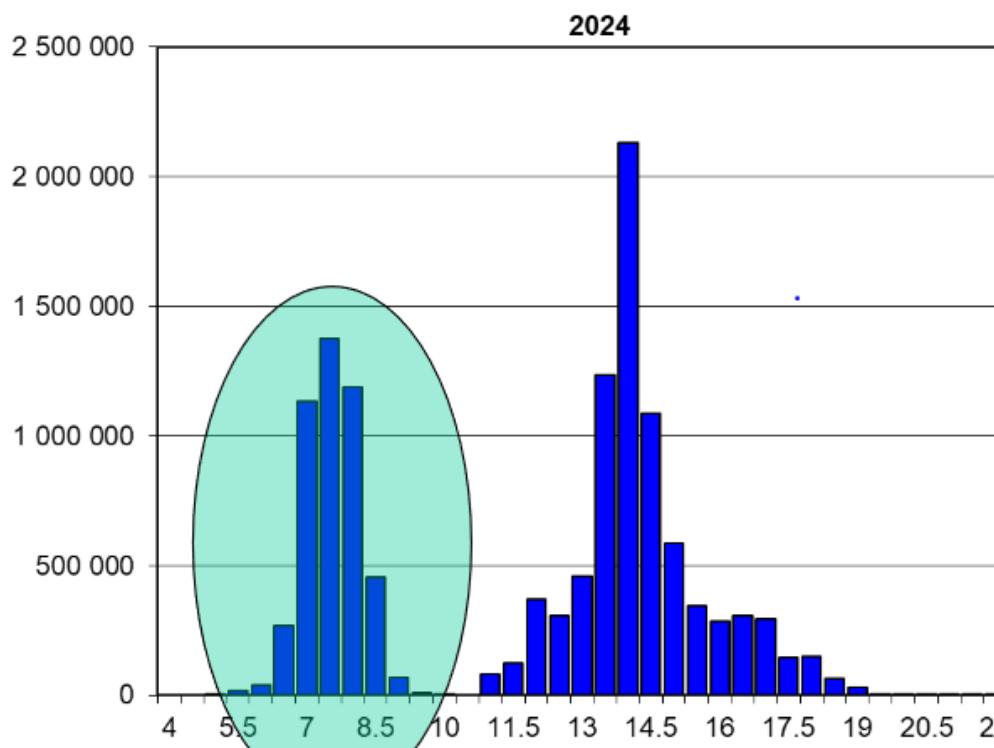


Figure 6.2.2.2.2. Sardine in 8abd. Length distribution of sardine as observed during PELGAS24. Light blue bubble represent age 0+ sardines (not included in the assessment)

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+).

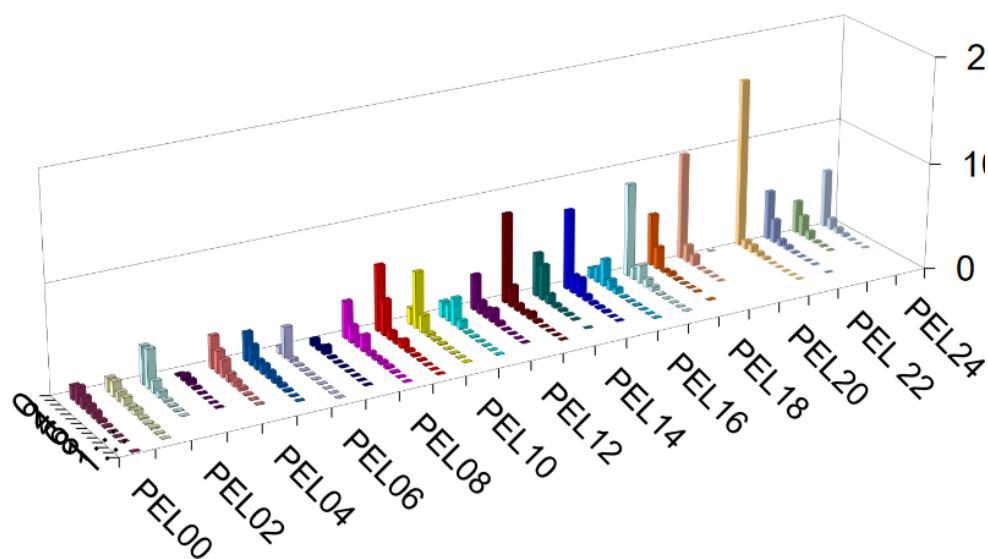


Figure 6.2.2.3. Sardine in 8abd. Age composition of sardine as estimated by acoustics since 2000

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).

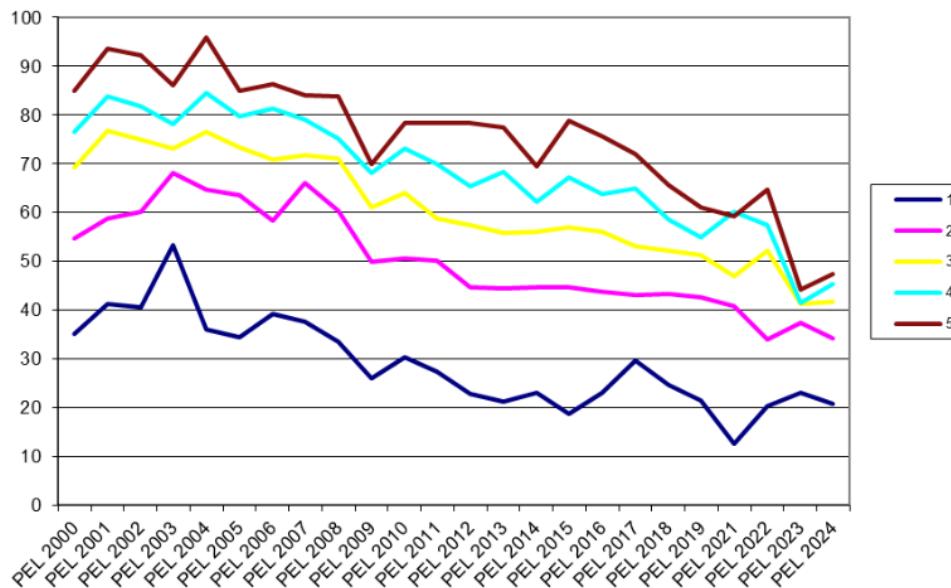


Figure 6.2.2.4. Sardine in 8abd. Evolution of mean weight at age (g) of sardine along PELGAS series.

The PELGAS sardine mean weights at age series (Figure 6.2.2.4) 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.

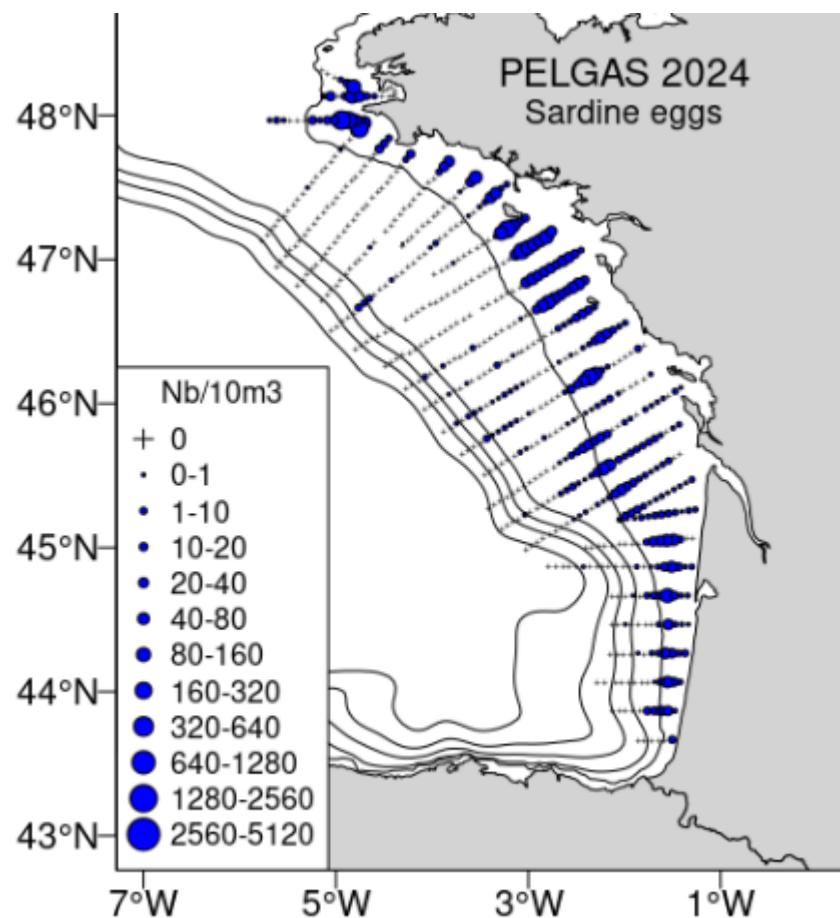


Figure 6.2.2.5. Sardine in 8abd. Distribution of sardine eggs observed with CUFES during PELGAS24.

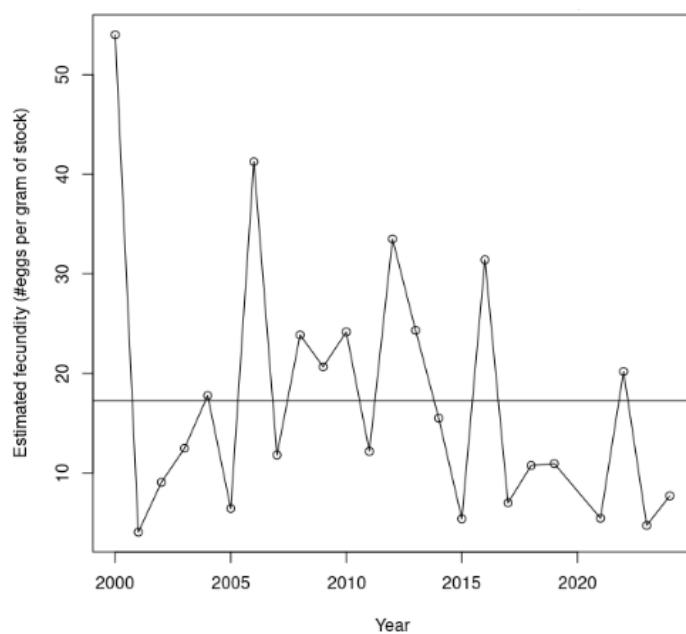


Figure 6.2.2.6. Sardine in 8abd. Eggs fecundity (number of eggs per gram of the stock) surveys from 2000 to 2024

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 *	Quarter	Quarter	Quarter	Quarter	All year
	1	2	3	4	
(half cm)					
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 *	Quarter	Quarter	Quarter	Quarter	All year
	(half cm)	1	2	3	4
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	0,04	0,03
2	0,04	0,04	0,04	0,04
3	0,05	0,05	0,05	0,05
4	0,06	0,05	0,05	0,06
5	0,06	0,05	0,05	0,06
6	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 PEL-GAS 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

Recruitment (age 0)

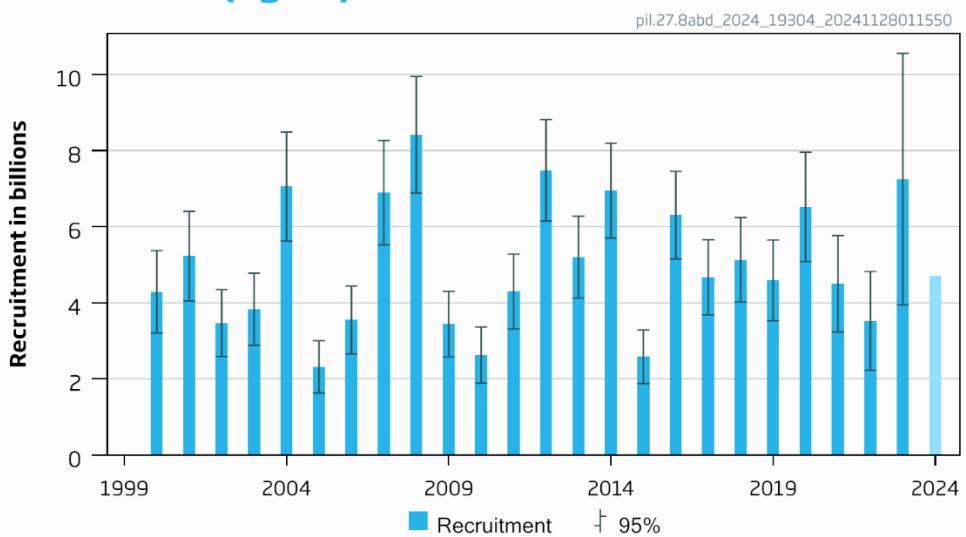


Figure 6.3.2.1. Sardine in 8abd. Recruitment estimates from SS3 outputs for sardine 8abd. Last year's value is estimated from the geometric mean (2002-2023).

SSB

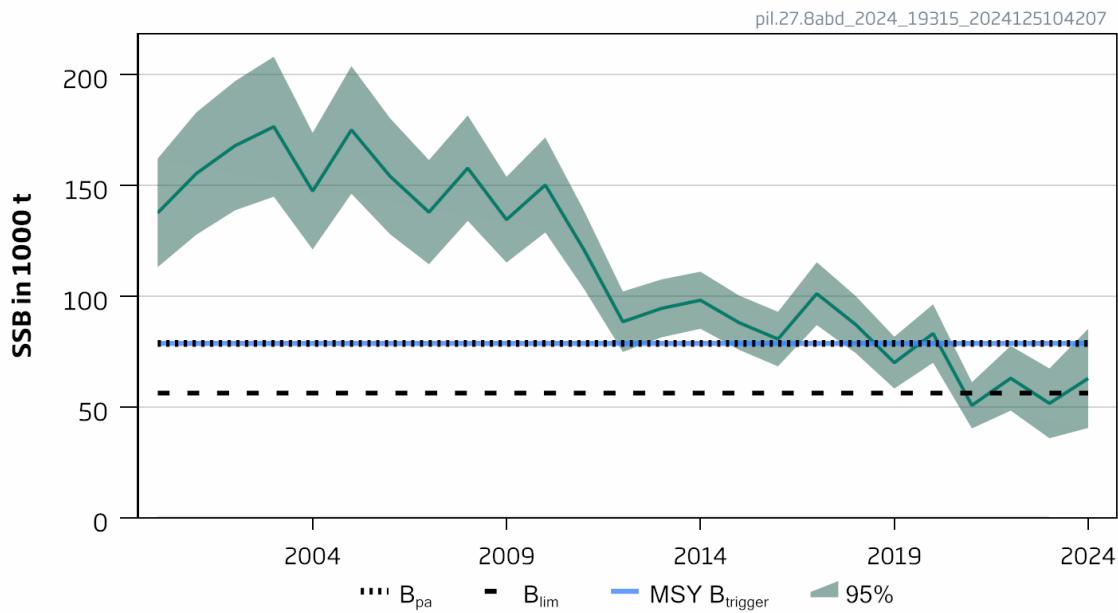


Figure 6.3.2.2. Sardine in 8abd. Spawning-stock biomass from SS3 outputs for sardine 8abd. Last year's value is estimated from the model.

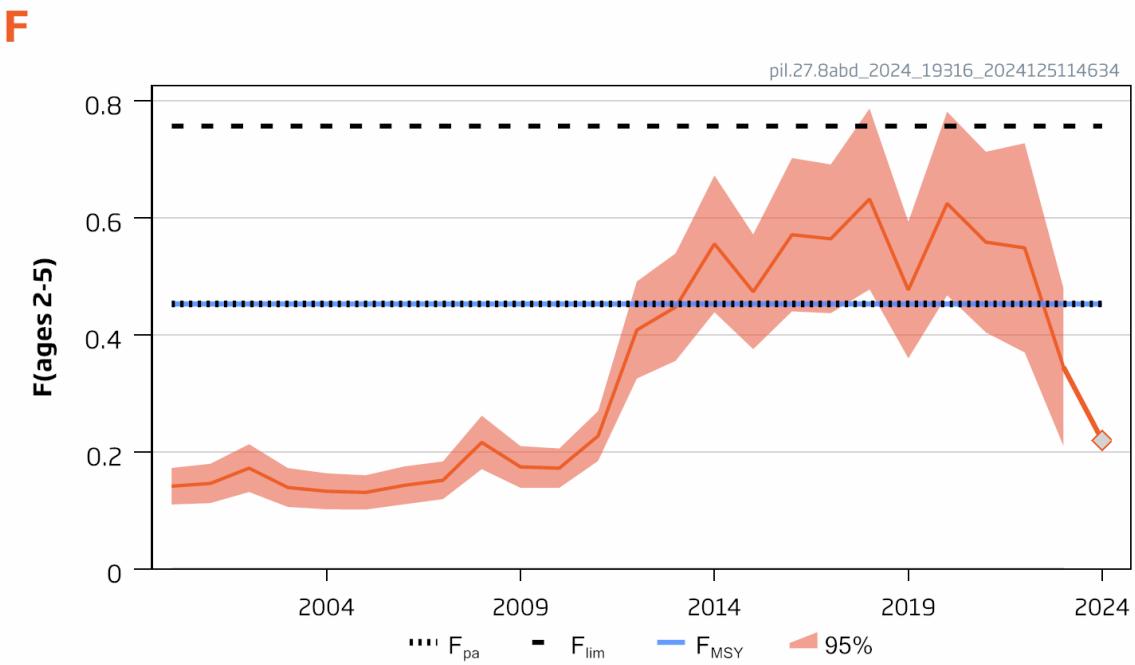


Figure 6.3.2.3. Sardine in 8abd. Fishing mortality for ages 2 to 5 derived from SS3 outputs for sardine 8abd.

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 appear to have larger residuals than others (e.g. 2009). The model fit to the survey indices is within the confidence intervals of those indices.

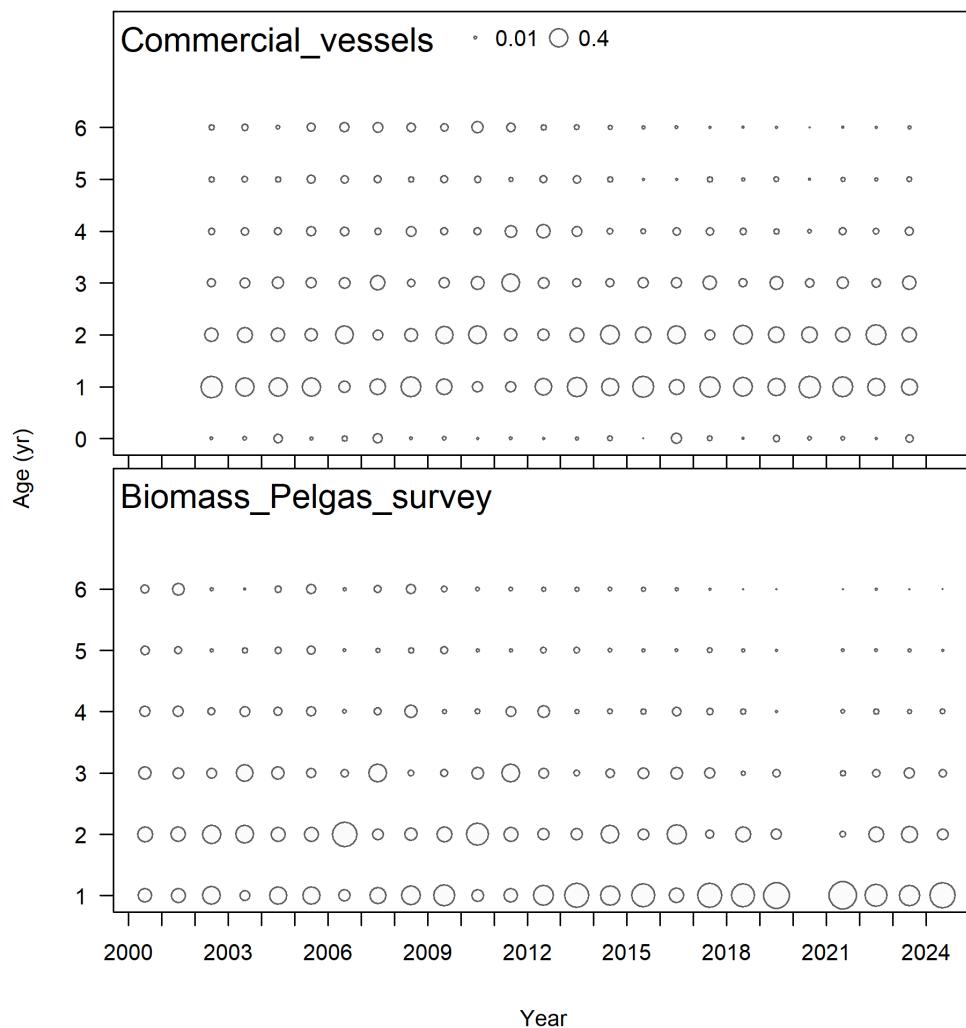


Figure 6.3.3.1. Sardine in 8abd. Fit between model and age composition from the PELGAS survey (bottom) and commercial vessels (top) up to 2023.

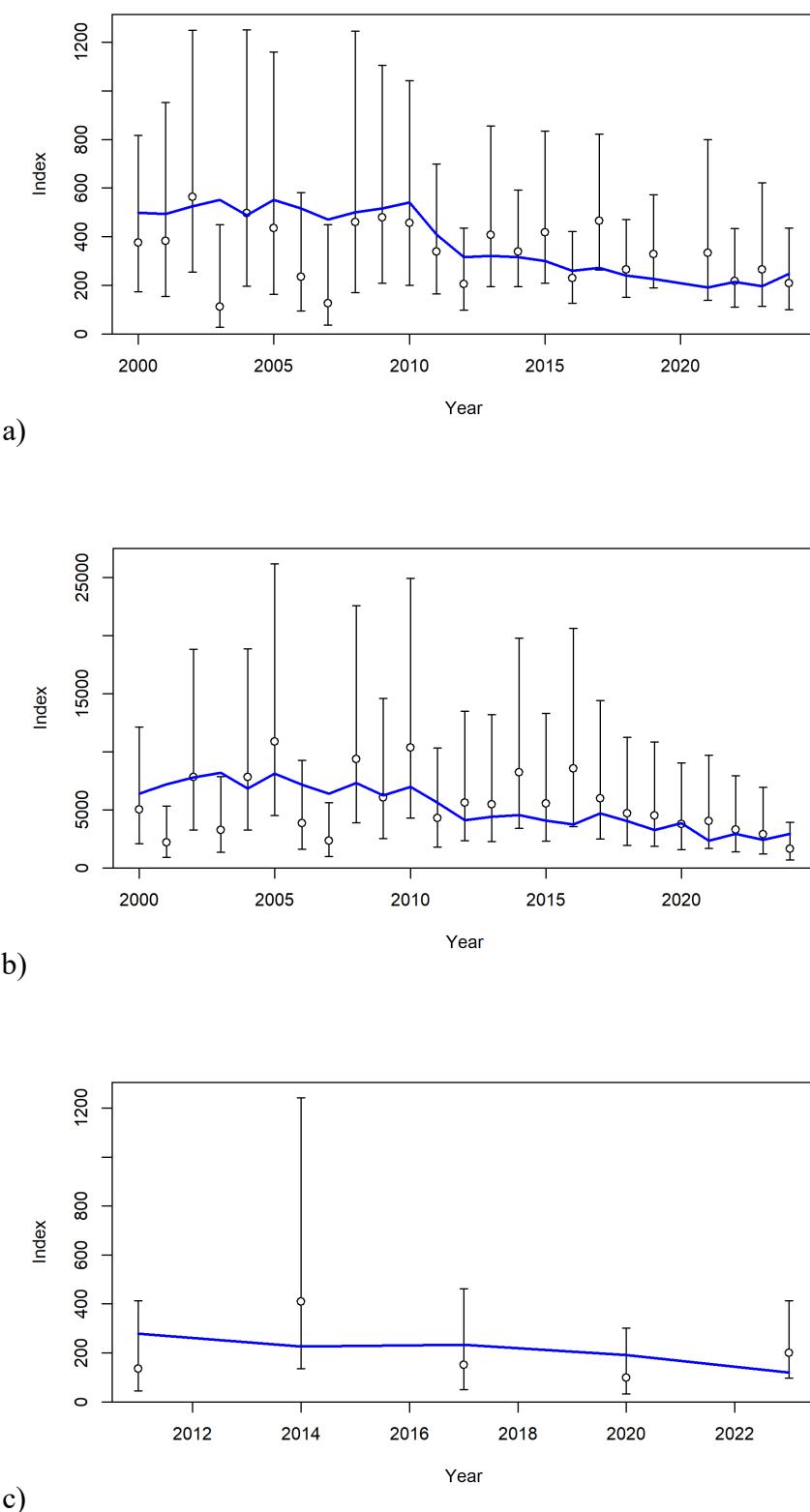


Figure 6.3.3.2. Sardine in 8abd. Fit between model and survey indices: a - Acoustic (PELGAS), b - egg count (BIOMAN), c - DEPM.

6.3.4 Retrospective pattern

Retrospective patterns for SSB, $F_{\bar{F}}(2-5)$, 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).

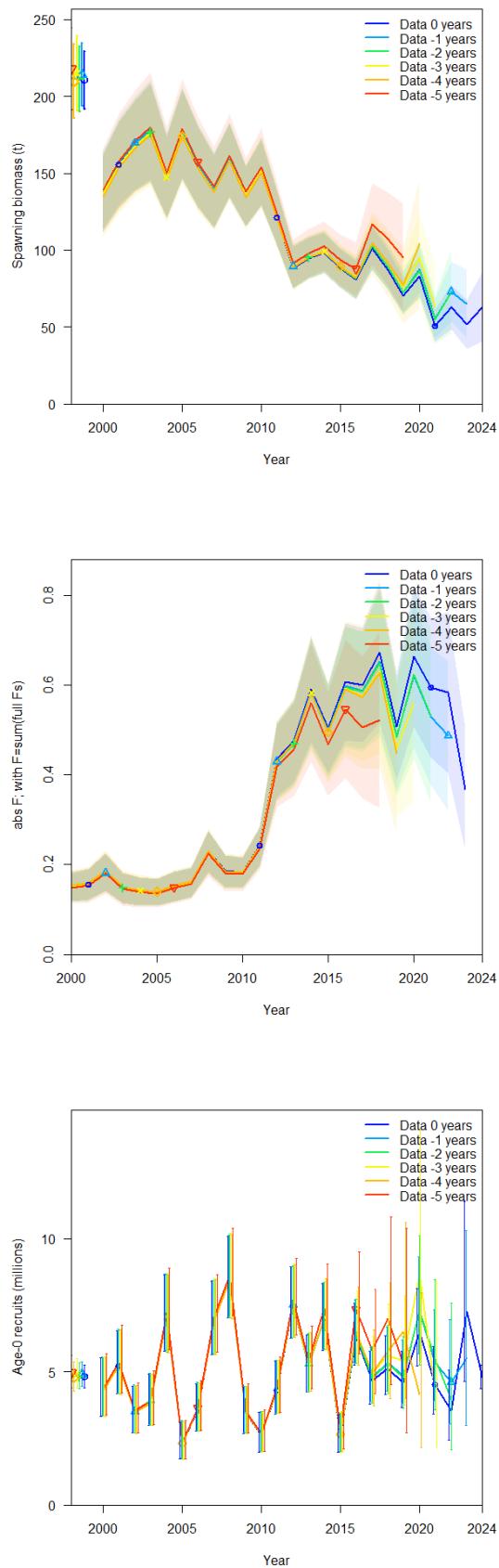


Figure 6.3.4.1. Sardine in 8abd. Summary of retrospective plots.

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
$F_{\text{ages } 2-5} \text{ (2024)}$	0.48	Based on assumed catches for 2024
SSB (2025)	72 870	Short term forecast; tonnes
$R_{\text{age } 0} \text{ (2024)}$	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
2024	6+	20.12	0.07	0.07	1.00	0.40	0.50
	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
2025	5		0.06	0.06	0.99	0.41	0.51
	6+		0.07	0.06	1.00	0.40	0.51
	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:	23667	0.42	67869	-6.9	1.78	19.5
$F = F_{MSY} * SSB(2024) / MSY B_{trigger}$						
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.

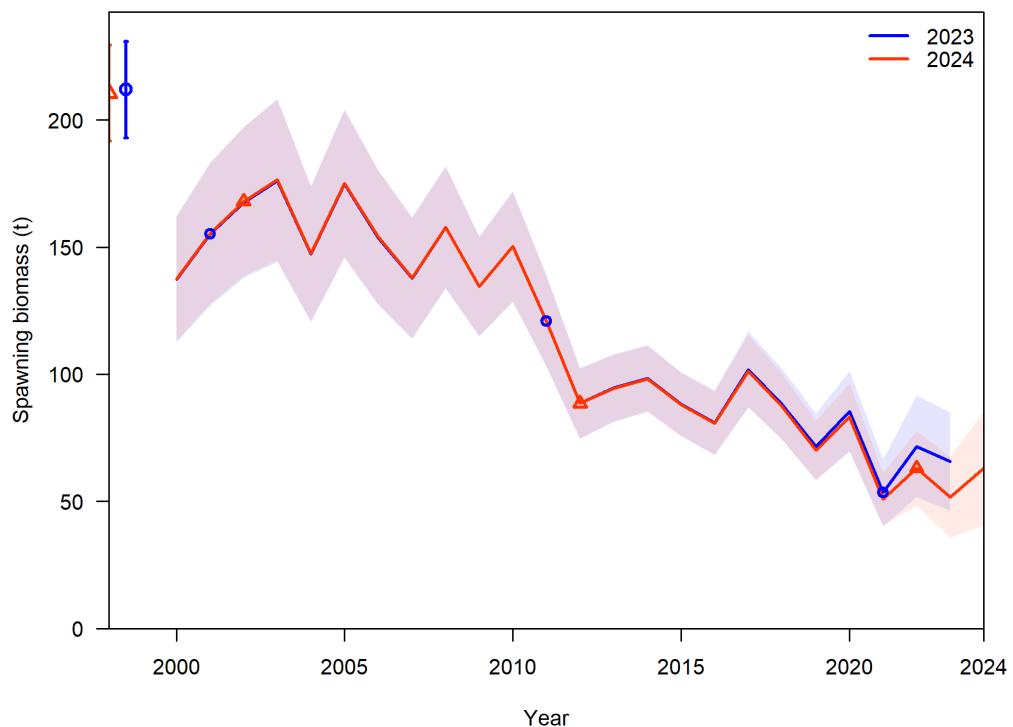


Figure 6.4.1.1. Sardine in 8abd. Comparison of SSB estimates between this year and the 2023 run.

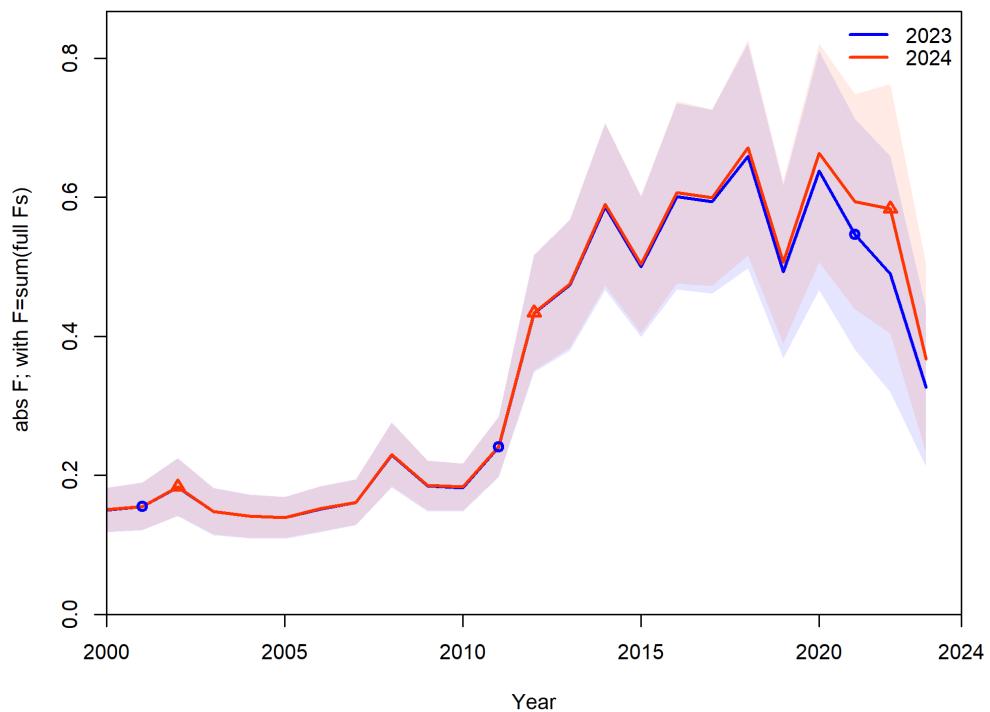


Figure 6.4.1.2. Sardine in 8abd. Comparison of fishing mortality estimates between this year and the 2023 run.

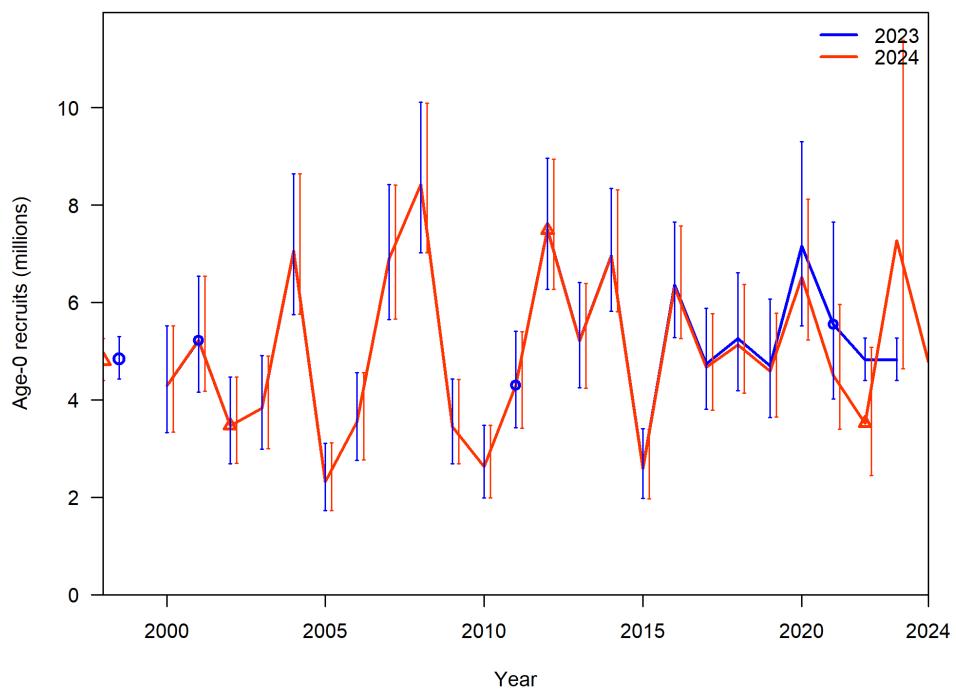


Figure 6.4.1.3. Sardine in 8abd. Comparison of Recruitment estimates between this year and the 2023 run.

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% B_0 . 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 Sissenwine. 1993). This led the IBP group to set B_{lim} at 35% B_0 , 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). B_{pa} was derived as $B_{pa} = B_{lim} \times \exp(1.645 \sigma B)$, where σB 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).

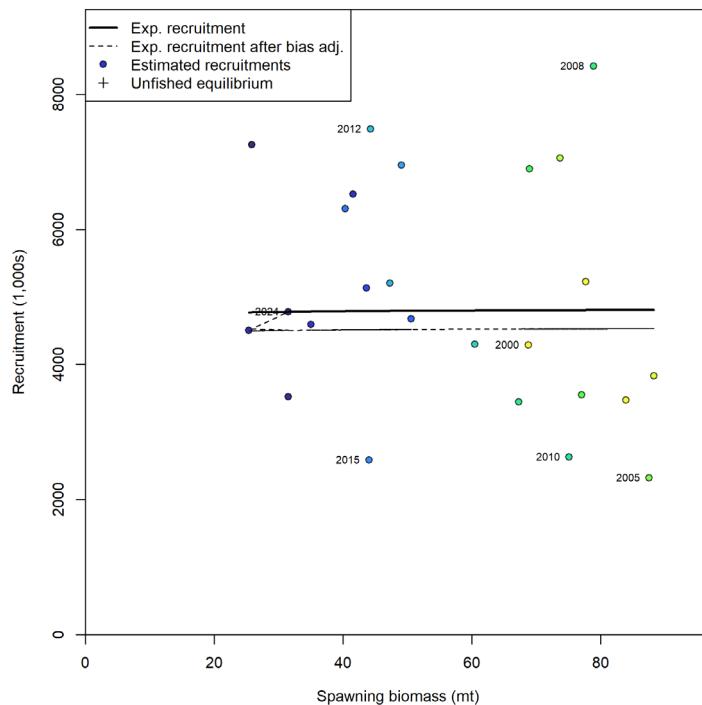
In 2021, ICES has been revising the definition of reference points. F_{pa} is now equal to $F_{p0.05}$. Therefore, that value has been updated and used in the short-term forecast this year.

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	$F_{MSY} = F_{p,0.95}$. 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	$F_{p,0.95}$. The F that leads to $SSB \geq B_{lim}$ 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**

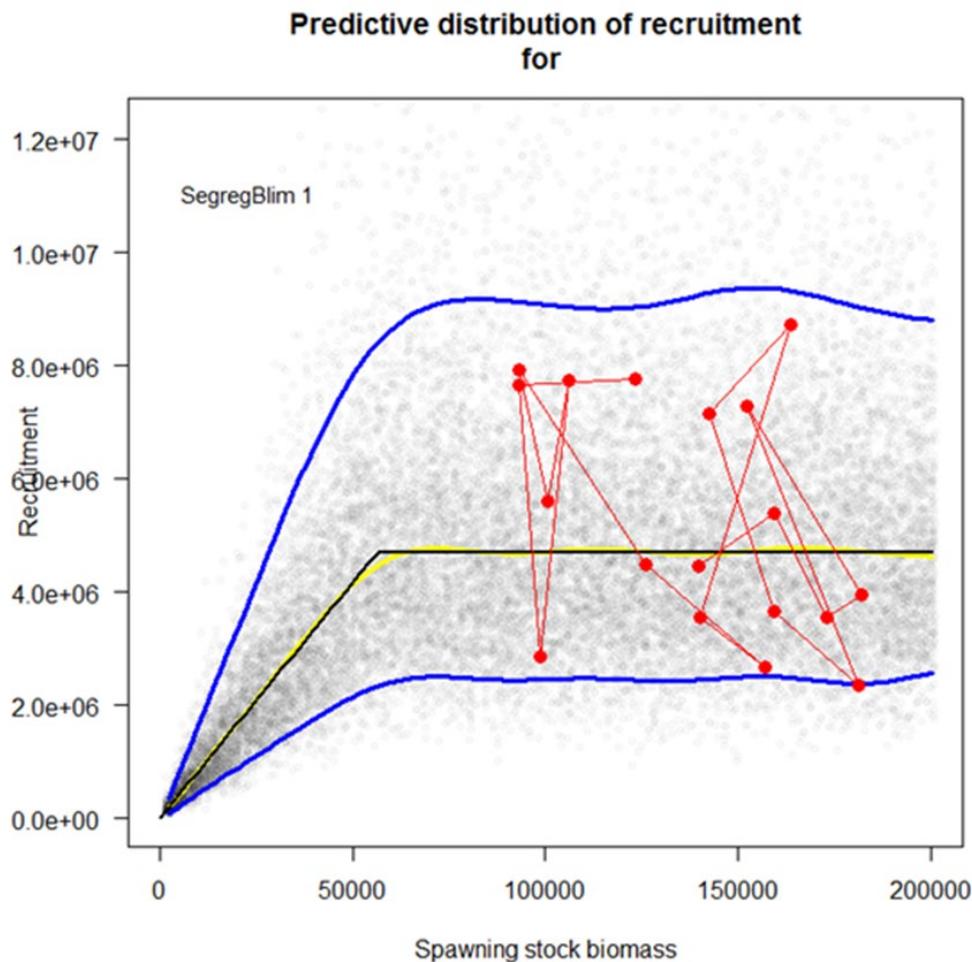


Figure 6.6.2. Sardine in 8abd. Segmented regression model with the breakpoint fixed at B_{lim} for sardine in 8abd as estimated during the interbenchmark.

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

- Beddington, J.R. and Cooke, J. 1983. The potential yield of previously unexploited stocks. FAO Fisheries Technical Paper No. 242. 63 pp.
- Buckland S.T., Burnham K.P., Augustin N.H. 1997. Model selection: an integral part of inference. *Biometrics* 53:603–618.
- Horbowy, J.. and Luzeńczyk, A. 2012. The estimation and robustness of FMSY and alternative fishing mortality reference points associated with high long-term yield. *Canadian Journal of Fisheries and Aquatic Sciences*. 69: 1468–1480.
- ICES. 2017. ICES Advice technical guidelines. ICES Advice. Book 12.
- ICES. 2016. Report of the Workshop to consider FMSY ranges for stocks in ICES categories 1 and 2 in western waters (WKMSYREF4). 13–16 October 2015. Brest. France. ICES CM 1025/ACOM:58.187 pp.
- ICES. 2019. Inter-benchmark process on sardine (*Sardina pilchardus*) in the Bay of Biscay (IBPSardine). ICES Scientific Reports. 1:80. 34 pp. <http://doi.org/10.17895/ices.pub.5552>.
- ICES. 2018. Report of the Working Group on Southern Horse Mackerel, Anchovy and Sardine (WGHANSA). 26–30 June 2018. Lisbon. Portugal. ICES CM 2018/ACOM:17. 639 pp.
- ICES. 2019. Inter-benchmark process on sardine (*Sardina pilchardus*) in the Bay of Biscay (IBPSardine). ICES Scientific Reports. 1:80. 34 pp. <http://doi.org/10.17895/ices.pub.5552>
- ICES. 2021. Working Group on Southern Horse Mackerel Anchovy and Sardine (WGHANSA). ICES Scientific Reports. 3:55. 679 pp. <https://doi.org/10.17895/ices.pub.8138>
- Mace, P.M. 1994. Relationships between common biological reference points used as thresholds and targets of fisheries management strategies. *Can. J. Fish. Aquat. Sci.* 51(1): 110–122. doi:10.1139/f94-013.
- Mace, P.M. and Sissenwine, M.P. 1993. How much spawning per recruit is enough? Risk Evaluation and Biological Reference Points for Fisheries Management (eds S.J. Smith, J.J. Hunt and D. Rivard). Canadian Special Publication in Fisheries and Aquatic Sciences No. 120. National Research Council of Canada. Ottawa. 101–118.
- Myers, R.A., Bowen, K.G., and Barrowman, N.J. 1999. Maximum reproductive rate of fish at low population sizes. *Can. J. Fish. Aquat. Sci.* 56: 2404–2419. doi:10.1139/f99-201.
- Zhou, S., Yin, S., Thorson, James T., Smith, Anthony D. M., Fuller, M., and Walters, C. J. 2012. Linking fishing mortality reference points to life history traits: an empirical study. *Canadian Journal of Fisheries and Aquatic Sciences*. 69: 1292–1301.

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 been 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, by-catch, 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:

$$C_y = \left\{ \begin{array}{ll} 0.2C_{y-1} & \text{if } \frac{I_y}{(I_{y-1} + I_{y-2})/2} < 0.2 \\ C_{y-1} \frac{I_y}{(I_{y-1} + I_{y-2})/2} & \text{if } 0.2 \leq \frac{I_y}{(I_{y-1} + I_{y-2})/2} \leq 1.8 \\ 1.8C_{y-1} & \text{if } \frac{I_y}{(I_{y-1} + I_{y-2})/2} > 1.8 \end{array} \right\} \cdot \left[\min \left(1, \frac{I_{current}}{I_{stat}} \right) \right]$$

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

- ICES. 2016. Report of the Workshop on Atlantic Sardine (WKSAR), 26–30 September 2016, Lisbon, Portugal. ICES CM 2016/ACOM:41. 351 pp.
- ICES. 2017. Report of the Benchmark Workshop on Pelagic Stocks (WKPELA), 6–10 February 2017, Lisbon, Portugal. ICES CM 2017/ACOM:35. 278 pp.
- ICES. 2020a. Tenth Workshop on the Development of Quantitative Assessment Methodologies based on LIFE-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks (WKLIFE X). ICES Scientific Reports. 2:98. 72 pp. <http://doi.org/10.17895/ices.pub.5985>
- ICES. 2020b. Workshop on Data-limited Stocks of Short-Lived Species (WKDLSSLS2). ICES Scientific Reports. 2:99. 119 pp. <http://doi.org/10.17895/ices.pub.5984>

- ICES. 2021. Benchmark Workshop on selected stocks in the Western Waters in 2021 (WKWEST). ICES Scientific Reports. 3:31. 504 pp. <https://doi.org/10.17895/ices.pub.8137>
- ICES. 2022. Working Group on Southern Horse Mackerel, Anchovy and Sardine (WGHANSA). ICES Scientific Reports. 4:51. 518 pp. <http://doi.org/10.17895/ices.pub.19982720>
- ICES. 2024. ICES Guidelines - Advice rules for stocks in category 2 and 3. Version 2. ICES Guidelines and Policies - Advice Technical Guidelines. 30 pp. <https://doi.org/10.17895/ices.pub.26056306>
- Mildenberger, T.K., Kokkalis, A., Berg, C.W. 2021. Guidelines for the stochastic production model in continuous time (SPiCT). [DTUAqua/spict: Surplus Production model in Continuous Time \(github.com\)](https://github.com/DTUAqua/spict)
- Pedersen, M. W., and Berg, C. W. 2017. A stochastic surplus production model in continuous time. Fish and Fisheries, 18: 226–243.
- Shaw P., McKeown, N., Van der Kooij, J. 2012. Analysis of genetic population structuring of Sardine (*Sardina pilchardus*) in Eastern Atlantic waters using nuclear microsatellite DNA markers Working Document for WKPELA, 13-17/02/2012 Copenhagen

7.11 Tables

Table 7.2.1.1. Sardine in Subarea 7. Landings reported by country (tonnes)*

	France** UK		Nether- lands		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
2018	123003	0.14	3317972	0.14	145514	0.12	4300528
2019	273708	0.21	11256581	0.18	374617	0.19	15409434
2020	178781	0.31	3713016	0.29	332098	0.20	6476230
2021	174375	0.28	5977676	0.28	227117	0.19	8714354
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 re- stricted area	Multiplier (av- erage 2020- 2021) for re- stricted 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	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	B_{trigger}	Not defined		
	F_{MSY}	Not defined		
Precautionary approach	I_{stat}	120 751 tonnes	Geomean(Ihist) \times exp(-1.645 \times sd(log(Ihist)); Ihist is the available historical series of the abundance index (2017–2021)	(ICES, 2022)
	$B_{\text{lim}}, B_{\text{pa}}$	Not defined		
	F_{lim}	Not defined		
	F_{pa}	Not defined		
Management plan	SSB_{MGT}	Not defined		
	F_{MGT}	Not defined		

7.12 Figures

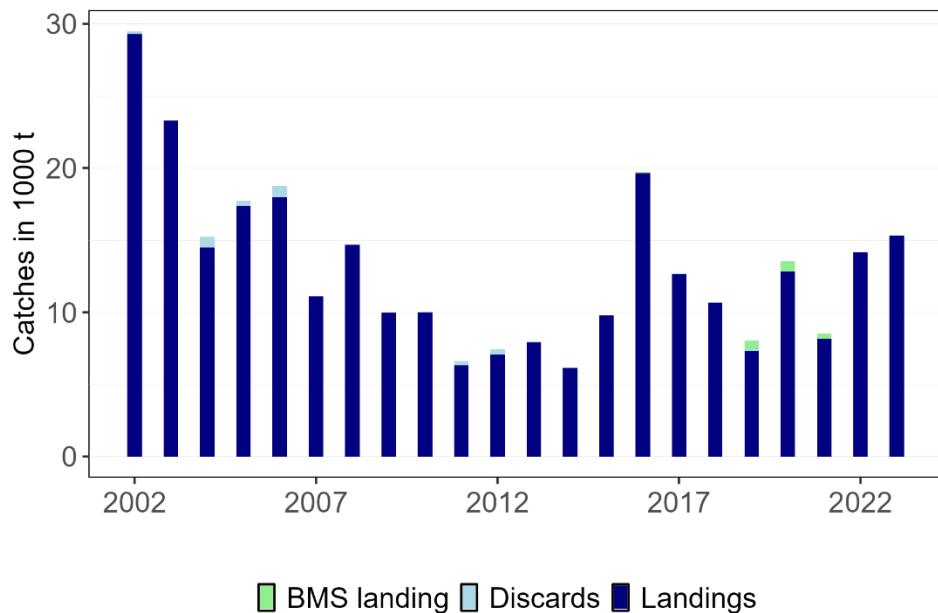


Figure 7.2.1.1. Sardine in Subarea 7. Catches by category (tonnes).

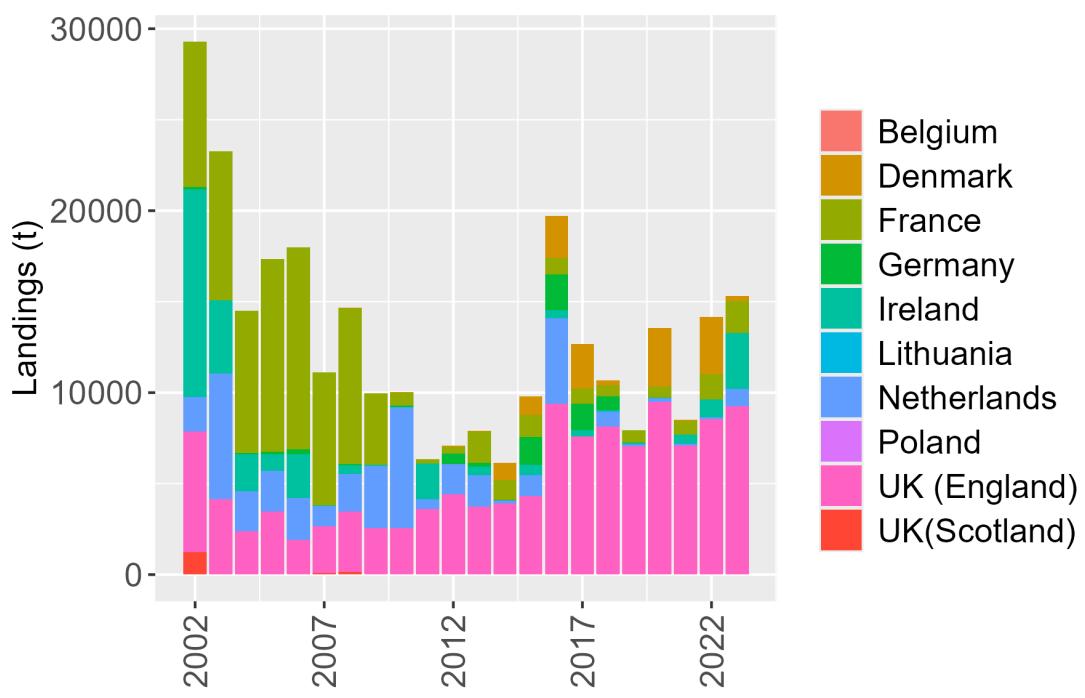


Figure 7.2.1.2. Sardine in Subarea 7. Landings reported by country (tonnes).

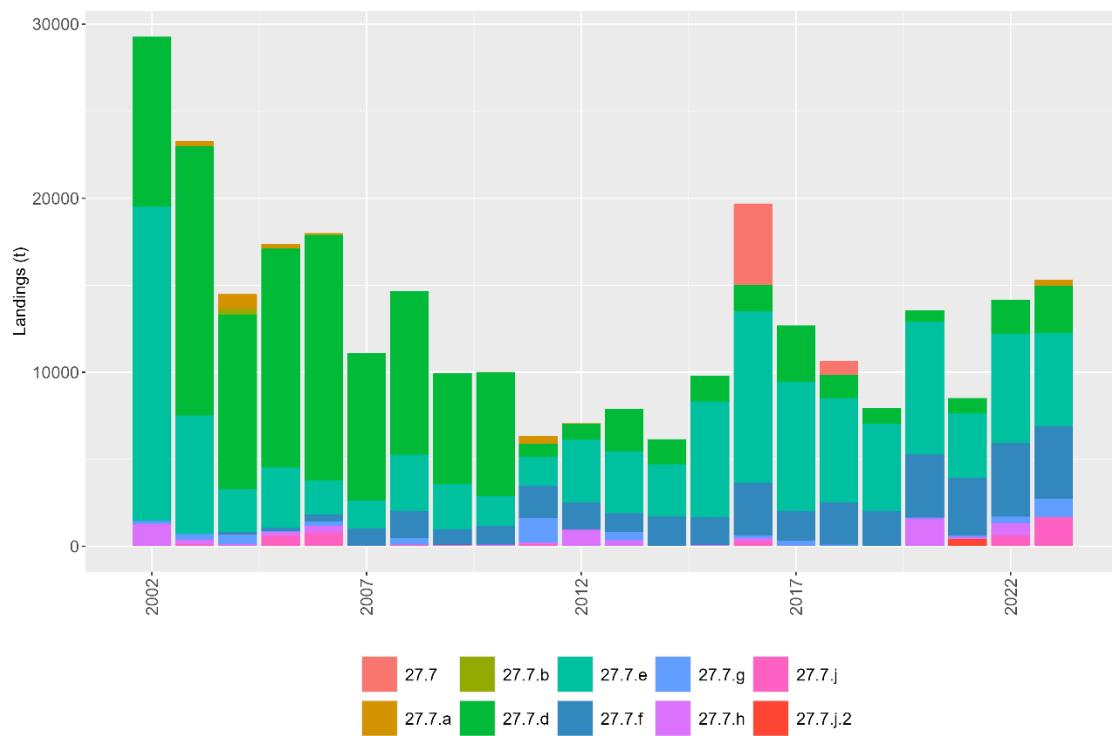


Figure 7.2.1.3. Sardine in Subarea 7. Landings by ICES division (tonnes).

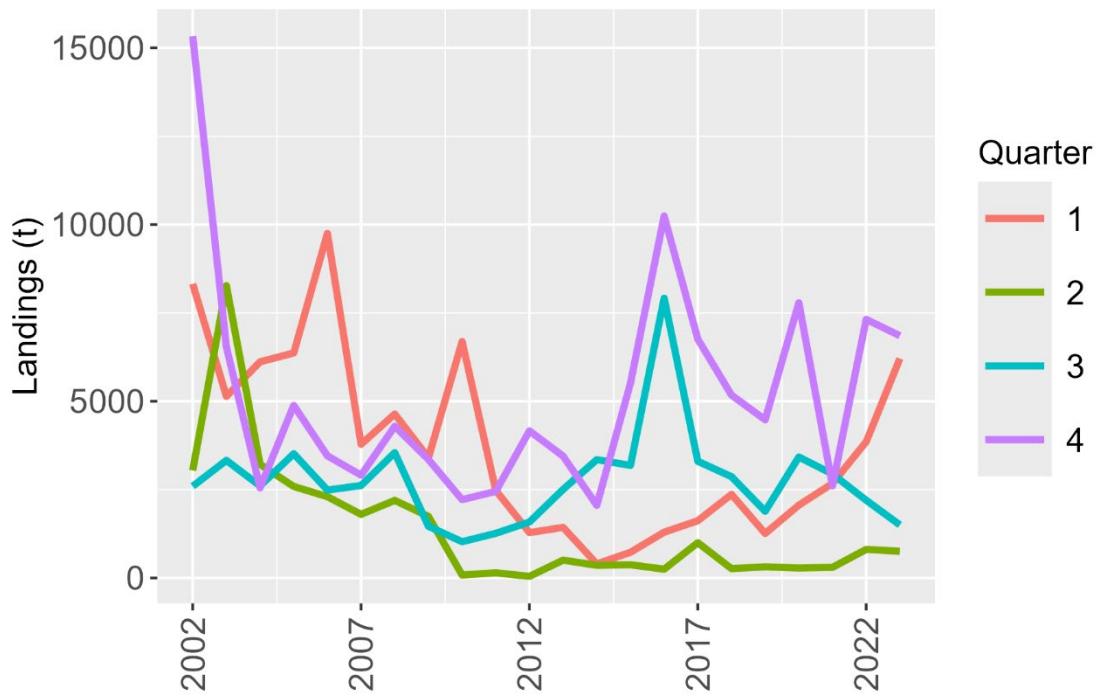


Figure 7.2.1.4. Sardine in Subarea 7. Landings by quarter (tonnes).

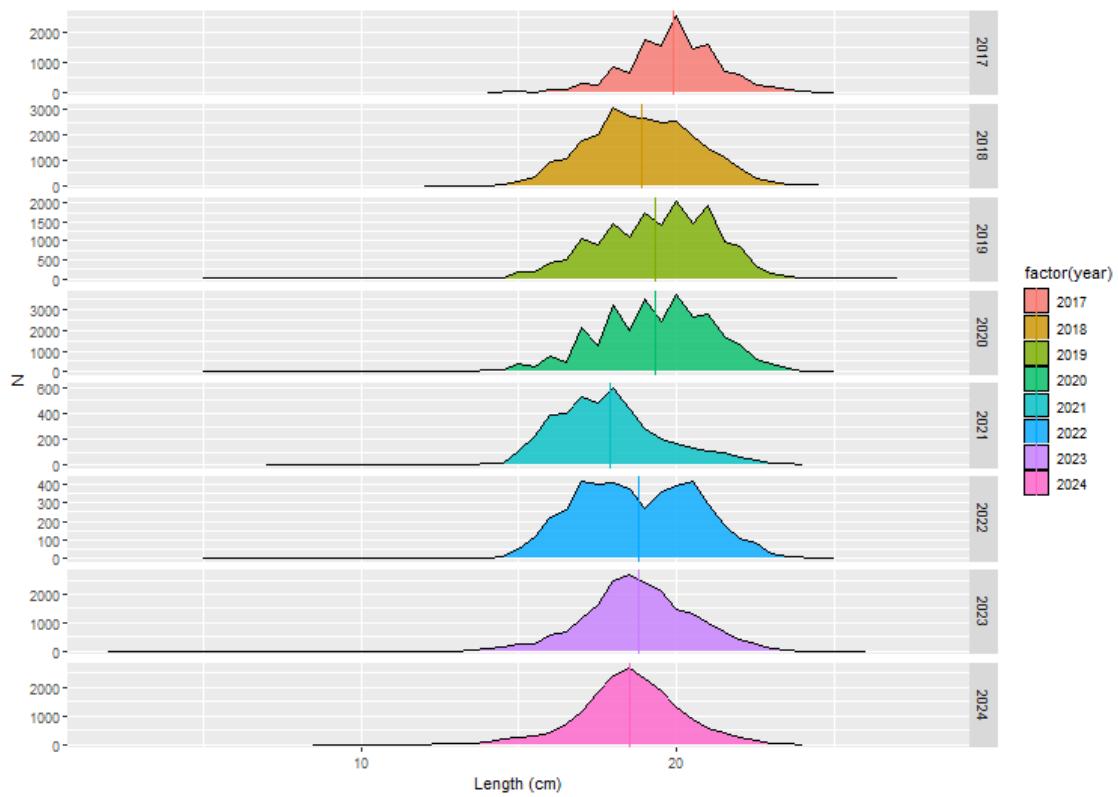


Figure 7.3.1.1. Sardine in Subarea 7. Length distribution of landings provided by the English fishing industry.

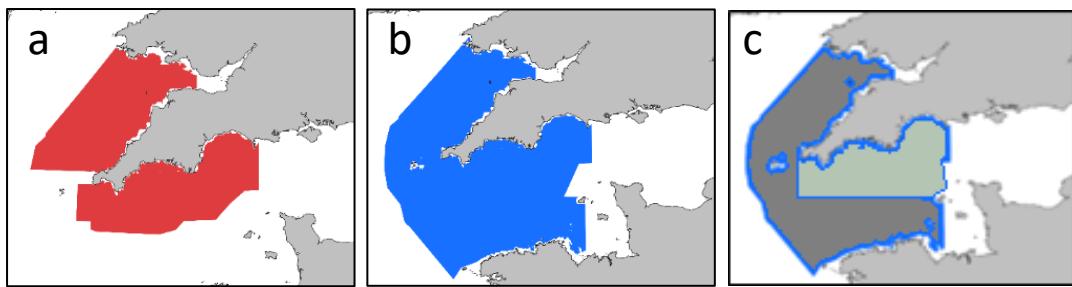


Figure 7.4.1.1. Sardine in Subarea 7. a) PELTIC coverage of core area 2013-2023; b) PELTIC coverage of total area 2017-2023 and; c) PELTIC coverage of reduced survey extent in 2022.

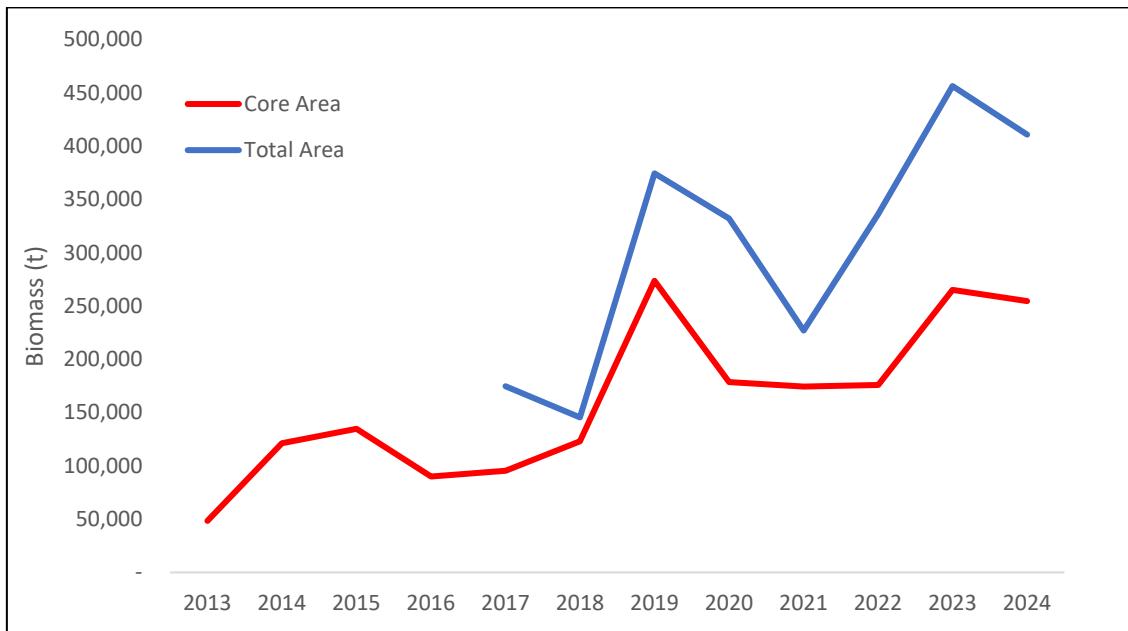


Figure 7.4.1.2. Sardine in Subarea 7. Sardine biomass in tonnes estimated from PELTIC survey in the core area (red line), covering division 7.f and English waters of 7.e and in the total area (blue line), covering division 7.f and 7.e (also French side). Biomass for both the core and total areas in 2022 are raised estimates using the biomass index for the restricted area sampled in 2022.

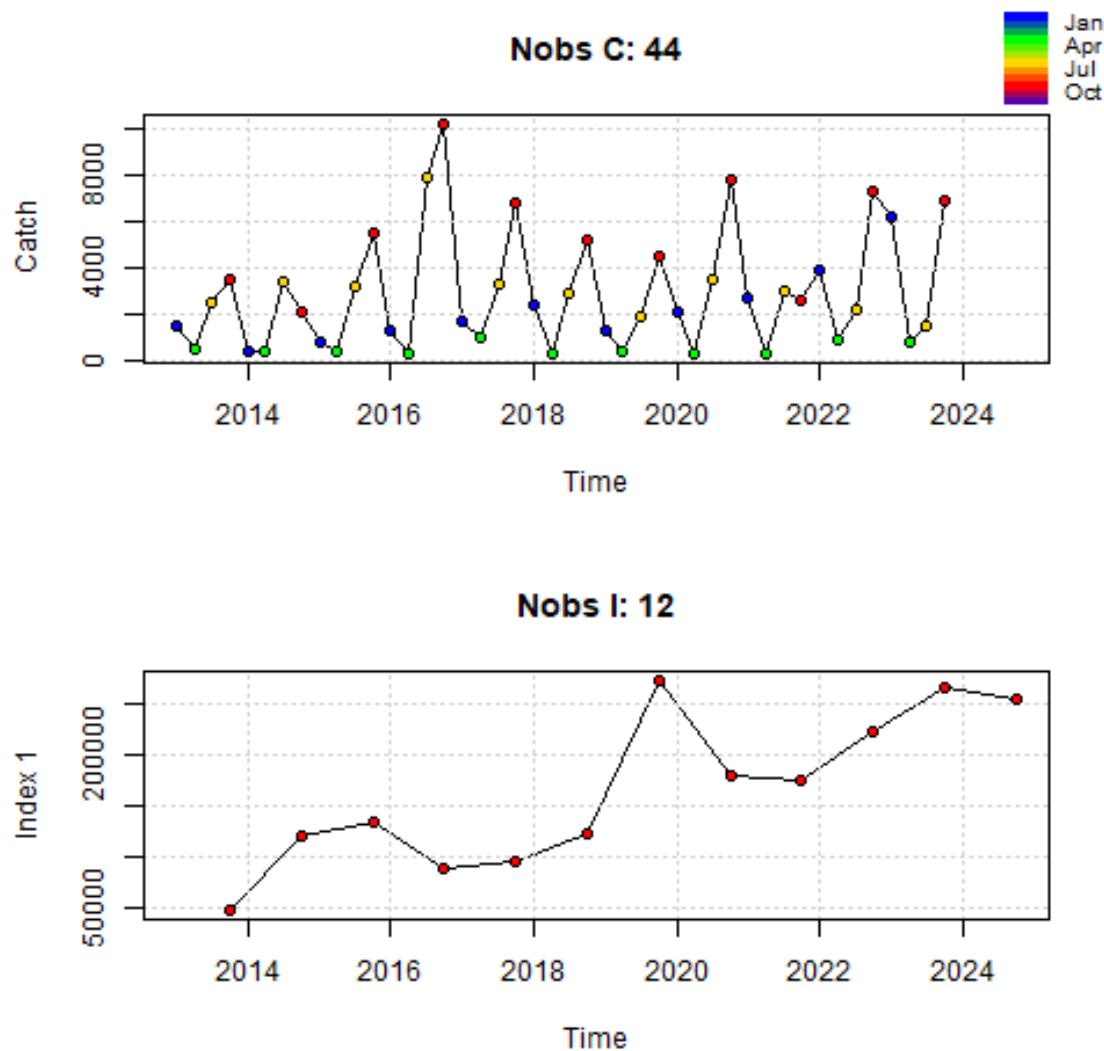


Figure 7.5.1.1. Sardine in Subarea 7. Input data of the SPiCT model. Top: landings by quarter (2013-2023). Bottom: biomass estimates in the core area (2013-2024). Blue represents quarter 1, green represents quarter 2, yellow represents quarter 3, and red represents quarter 4.

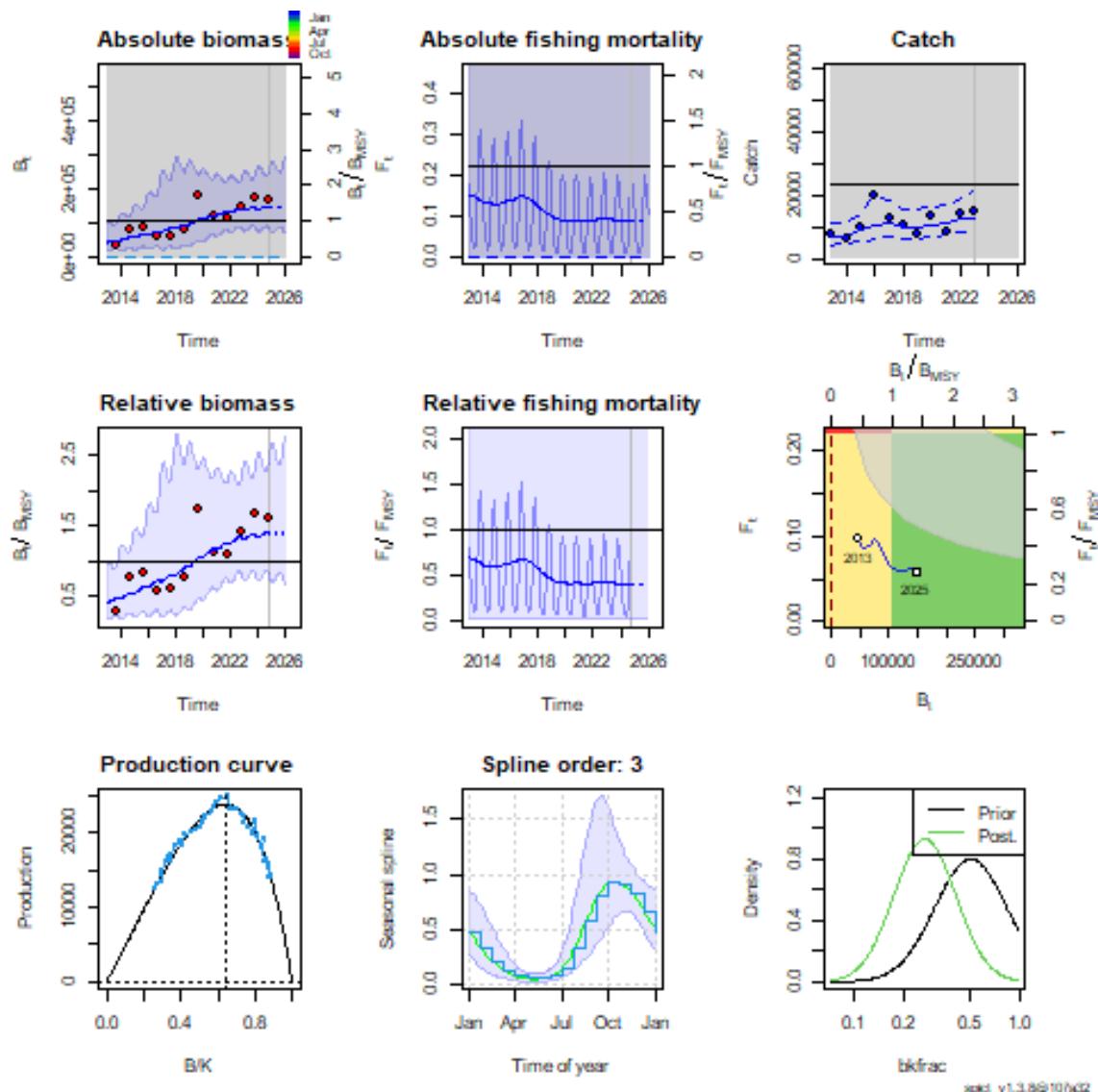


Figure 7.5.1.2. Sardine in Subarea 7. SPICT model results. Top row: absolute biomass, absolute F estimates, and fitted catch. Middle row: relative biomass, relative F, and a Kobe plot comparing biomass and F. The grey area in the Kobe plot represents the uncertainty in the relative biomass and F estimates. 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).

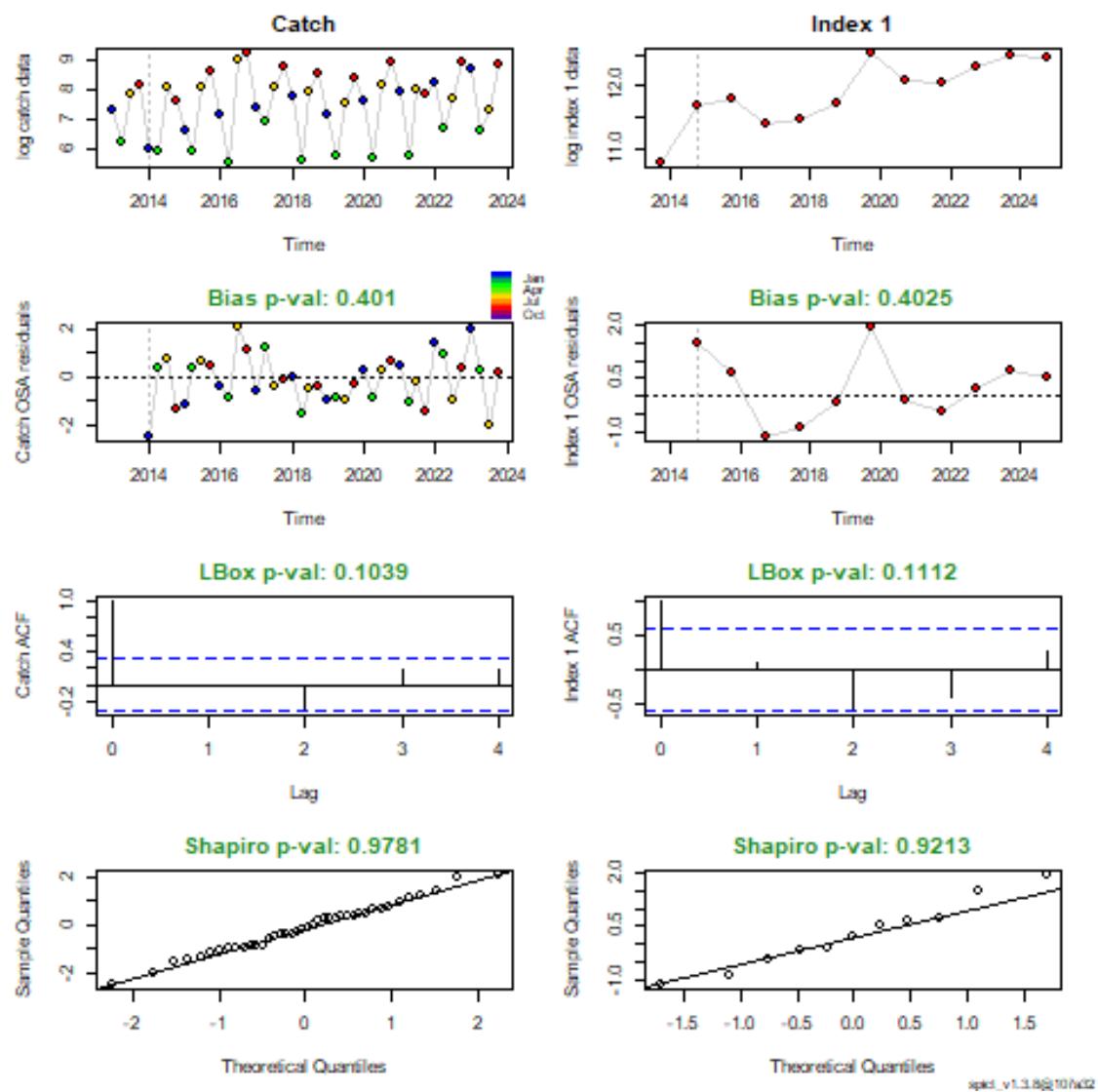


Figure 7.5.1.3. Sardine in Subarea 7. SPICT model diagnosis.

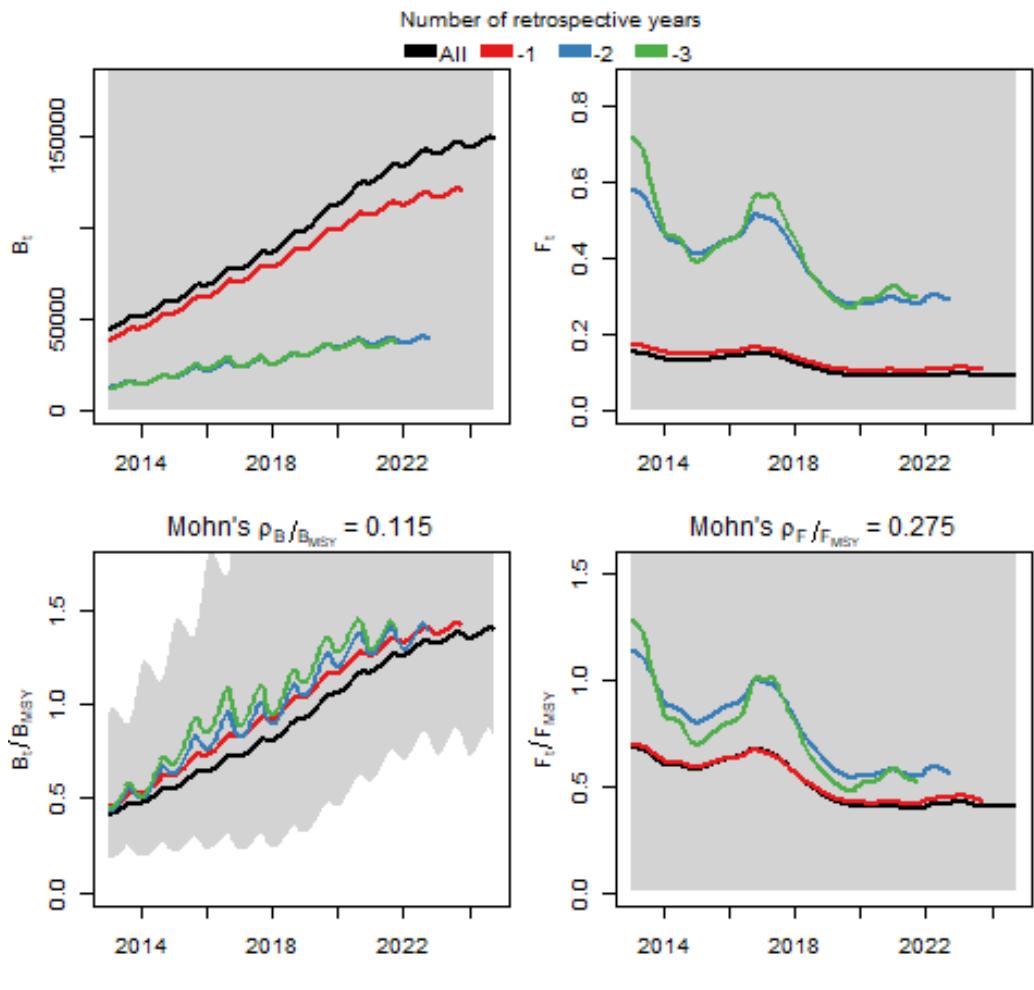


Figure 7.5.1.4. Sardine in Subarea 7. Retrospective analysis of the SPiCT model. Top row: absolute biomass and absolute F; bottom row: relative biomass and relative F.

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 Co-operative 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 41°30' in 9aCN together with the area comprehended between Figueira da Foz and north Aveiro (between 40°15'N and 41° 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 6.5×10^9 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 (6.7×10^9 fish as mean value for those recruitment above average of the time series, estimated at 4.4×10^9 fish) and low values (1.4×10^9 fish as mean value for those recruitment below average of the time series). In this context, 2024 recruitment index estimate is 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 $\text{init}F_{2024} = 0.41\ \text{year}^{-1}$. 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 $Q_{\text{recruitment index}}$ (-0.99), R_0 and $Q_{\text{acoustic survey}}$ (-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 $B_{\text{lim}} = 196\ 334$ t, $B_{\text{pa}} = 252\ 523$ t and MSY $B_{\text{trigger}} = 252\ 523$ t of the current low productivity regime of the stock (see Section 8.7).

$F_{\text{bar}\ 2-5}$ in 2023 is estimated to be $0.114\ \text{year}^{-1}$ ($CV = 15\%$) which represents an increase of 33% when compared to $F_{\text{bar}\ 2-5}$ in 2022. $F_{\text{bar}\ 2-5}$ 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+, $F_{\text{ages}2-5}$ 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 (Mohr, 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 $F_{\text{ages}2-5}$ (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 $F_{\text{ages}2-5}$, 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	$F_{p0.05}$; the F that leads to SSB $\geq B_{lim}$ 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 B_{1+} , $B_{low} = 112\,943$ t, defined as the lowest observed time series B_{1+} 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 $B_{1+} \leq 112\,943$ t, then $F = 0$
- ii) If $112\,943$ t $< B_{1+} \leq 252\,523$ t, then F increases linearly from 0 to 0.064
- iii) If $252\,523$ t $< B_{1+} \leq 446\,331$ t, then F increases linearly from 0.064 to 0.12
- iv) If $B_{1+} > 446\,331$ 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.

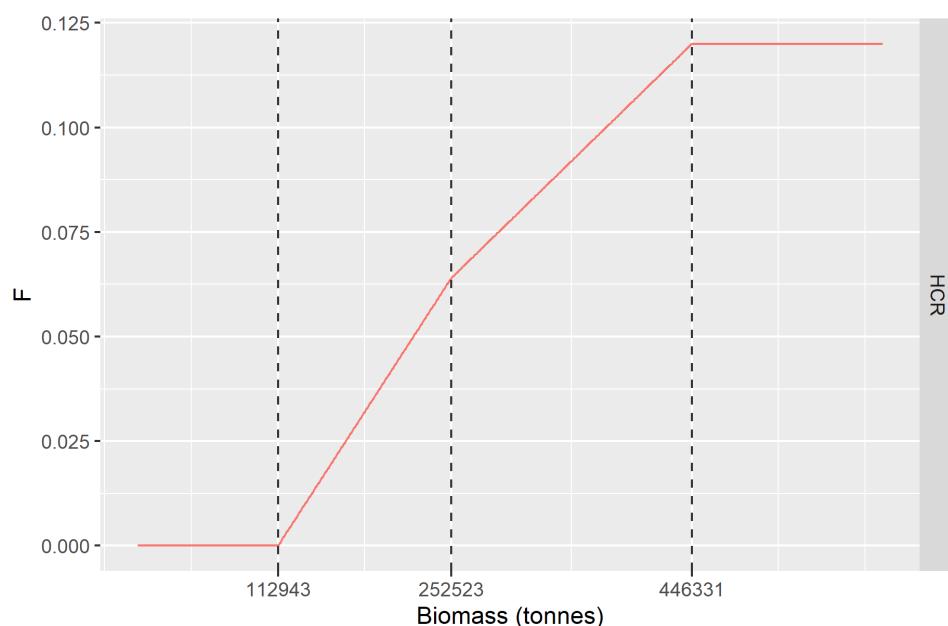


Figure 8.8.1. Proposed HCR. The biomass reference levels of biomass (B1+) reported correspond to $B_{loss(2018)} = 112\,943$ t, MSY $B_{trigger_low} = B_{pa_low} = 252\,523$ t and MSY $B_{trigger_medium} = B_{pa_medium} = 446\,331$ t.

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

- Direcção Geral de Recursos Naturais, Segurança e Serviços Marítimos. 2023. Despacho n.º 43/DG/2023. Determina o fecho da pesca dirigida à sardinha exceto, a título acessório, até 10% do total desembarcado em cada maré.
- Direcção Geral de Recursos Naturais, Segurança e Serviços Marítimos. 2024. Despacho n.º 15/DG/2024. Alarga o período em que se não se permite capturar sardinha exceto, a título acessório, até 10% do total desembarcado em cada maré.
- ICES. 2021a. Request from Portugal and Spain to evaluate a new Harvest Control Rule for the management of the Iberian sardine stock (divisions 8.c and 9.a). In Report of the ICES Advisory Committee, 2021. ICES Advice 2021, sr.2021.05. <https://doi.org/10.17895/ices.advice.816>
- ICES. 2021b. Inter-Benchmark Protocol for Iberian sardine (IBPIS). ICES Scientific Reports. 3:108. 57 pp. <https://doi.org/10.17895/ices.pub.8144>
- ICES. 2021c. The Workshop for the evaluation of the Iberian sardine HCR (WKSARHCR). ICES Scientific Reports. 3:49. 115 pp. <https://doi.org/10.17895/ices.pub.7926>
- ICES. 2023. Sardine (*Sardina pilchardus*) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters). In Report of the ICES Advisory Committee, 2023. ICES Advice 2023, pil.27.8c9a. <https://doi.org/10.17895/ices.advice.21975209>

ICES. 2024. Working Group on Acoustic and Egg Surveys for small pelagic fish in Northeast Atlantic (WGACEGG; outputs from 2023 meeting). ICES Scientific Reports. 6:21. 227 pp. <https://doi.org/10.17895/ices.pub.25296220>

Massé, J., Uriarte, A., Angélico, M. M., and Carrera, P. (Eds.) 2018. Pelagic survey series for sardine and anchovy in ICES subareas 8 and 9 – Towards an ecosystem approach. ICES Cooperative Research Report No. 332. 268 pp. <https://doi.org/10.17895/ices.pub.4599>

Ministerio de Agricultura, Pesca y Alimentación BOE-A-2024-3919 Resolución de 27 de febrero de 2024, de la Secretaría General de Pesca, por la que se establecen disposiciones de ordenación de la pesquería de la sardina ibérica («*Sardina pilchardus*») que se pesca en aguas ibéricas de la zona CIEM 8C y 9A para 2024. 29 de febrero de 2024.

Ministerio de Agricultura, Pesca y Alimentación BOE-A-2024-3920 Resolución de 27 de febrero de 2024, de la Secretaría General de Pesca, por la que se publican el inicio de la pesquería de sardina ibérica («*Sardina pilchardus*») en aguas ibéricas de la zona CIEM 8C y 9A y las cuotas de esta especie para los buques del censo de cerco del Golfo de Cádiz durante 2024. 29 de febrero de 2024.

Ministerio de Agricultura, Pesca y Alimentación BOE-A-2024-5468 Resolución de 16 de marzo de 2024, de la Secretaría General de Pesca, por la que se declara el inicio de la pesquería de sardina ibérica («*Sardina pilchardus*») en aguas ibéricas de la zona CIEM 8c y 9a para los buques de cerco, racú y piobardeira en el caladero nacional Cantábrico y Noroeste en 2024, 19 de marzo de 2024.

Ministério da Agricultura e Alimentação. 2024. Despacho n.º 4702-A/2024, de 30 de abril de 2024 Deter-mina a reabertura, a partir das 00:00 horas do dia 2 de maio de 2024, da pesca da sardinha (*Sardina pilchardus*). Diário da República, 2.ª série <https://diariodarepublica.pt/dr/detalhe/despacho/4702-a-2024-863368978>

Mohn, 1999. The retrospective problem in sequential population analysis; An investigation using cod fishery and simulated data. ICES Journal of Marine Science, 56: 473–488.

Nogueira A, Castro J (2024) Number of vessels by LOA (length overall) ranges for Spanish purse-seiners fishing the Sardine stock in ICES Divisions 8c and 9a. Working document of the WGHANSA meeting in Madrid, 25-29 November 2024, 6 pp.

Rodríguez-Climent, S., Angélico, M. M., Marques, V., Oliveira, P., Wise, L., and Silva, A. 2017. Essential habitat for sardine juveniles in Iberian waters. Scientia Marina, 81: 351.

Silva, A., Garrido, S., Ibaibarriaga, L., Pawłowski, L., Riveiro, I., Marques, V., Ramos, F., et al. 2019. Adult-mediated connectivity and spatial population structure of sardine in the Bay of Biscay and Iberian coast. Deep Sea Research Part II: Topical Studies in Oceanography, 159: 62-74.

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	9a North	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
24			22					22
24.5								
25								
25.5								
26								
26.5								
27								
27.5								
<hr/>								
Total	10 843	2 523	5 233			14 212		32 811
<hr/>								
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
14		134	213	4 812				5 160
14.5	5	382	447	9 565	76			
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		
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		
21	44	5 123	4 382					
21.5	50	888	2 812					
22	10	1 582	1 596					
22.5		254	570					
23		494	374					
23.5		80	53					
24		131	29					
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.

Age	First Quarter							
	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	

Age	Second Quarter							
	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

Age	Third Quarter							
	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

Age	Fourth Quarter							
	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

Age	Whole Year							
	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.

Age	First Quarter						
	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							

Age	Second Quarter						
	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							

Age	Third Quarter						
	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							

Age	Fourth Quarter						
	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.

Age	First Quarter						
	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							

Age	Second Quarter						
	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							

Age	Third Quarter						
	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							

Age	Fourth Quarter						
	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			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			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 Length (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 Length (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 Length (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	8	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 Length (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)	Catch 2026	% 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 gill-nets. 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.

9.7 References

- Garcia A., Pereira J., Canha Â, Reis D. and Diogo H. (2015). Life history parameters of blue jack mackerel *Trachurus picturatus* (Teleostei: Carangidae) from north-east Atlantic. Journal of the Marine Biological Association of the United Kingdom, 95(2), 401-410.
- Gouveia M.E.P. 1993. Aspectos da biologia do chicharro, *Trachurus picturatus* (Bowdich, 1825) da Madeira. Dipl. thesis, Univ. Lisboa, Lisboa, 153 pp.
- Isidro H. A. 1990. Age and growth of *Trachurus picturatus* (Bowdich, 1825) (Teleostei: Carangidae) from the Azores. Arquipel. Cienc. Biol. Mar. 8, 45–54.
- Jesus G. T. 1992. Study of the growth and reproduction of *Trachurus picturatus* (Bowdich, 1825) in Madeira. Doc. No XIV/C/1-1991/03 (DG XIV/CE). 66, p.
- Jurado-Ruzafa A. and Santamaria M. T. 2013. Reproductive biology of the blue jack mackerel, *Trachurus picturatus* (Bowdich, 1825), off the Canary Islands. J. Appl. Ichthyol. 29: 526–531.
- Mendes B, Fonseca P, Campos A. 2004. Weight/length relationship for 46 species of the Portuguese west coast. J Appl Ichthyol 20: 355–361.
- Menezes G. M., Sigler M. F., Silva H. M. and Pinho, M. R. 2006. Structure and zonation of demersal fish assemblages off the Azores Archipelago (mid-Atlantic). Mar. Ecol. Prog. Ser. 324, 241–260.
- Shaboneyev I. Y. and Kotlyar A. N. 1979. A comparative morphoeco-logical analysis of the Eastern Pacific forms of *Trachurus symmetricus* and the Atlantic Oceanic horse mackerel, *Trachurus picturatus*. J. Ichthyol. 19, 24–29.
- Smith-Vaniz W.F. 1986. Carangidae. p. 815-844. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) Fishes of the north-eastern Atlantic and the Mediterranean. UNESCO, Paris. vol. 2.
- Vasconcelos J., Alves A., Gouveia E., Faria G. 2006: Age and growth of the blue jack mackerel, *Trachurus picturatus* Bowdich, 1825 (Pisces: Teleostei) off Madeira archipelago. Arquipel. Cienc. Biol. Mar. 23, 47–57.

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.

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)*	
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 con- sump- tion)	Purse seine (with- drawn at the port and used for bait)*	Longline + handline	Recrea- tional**	Longline (dis- cards and used for bait)	Tuna bait	Purse seine (withdrawn at the port and used for bait)*	
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

Number of Vessels (purse seine)



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.

Catches

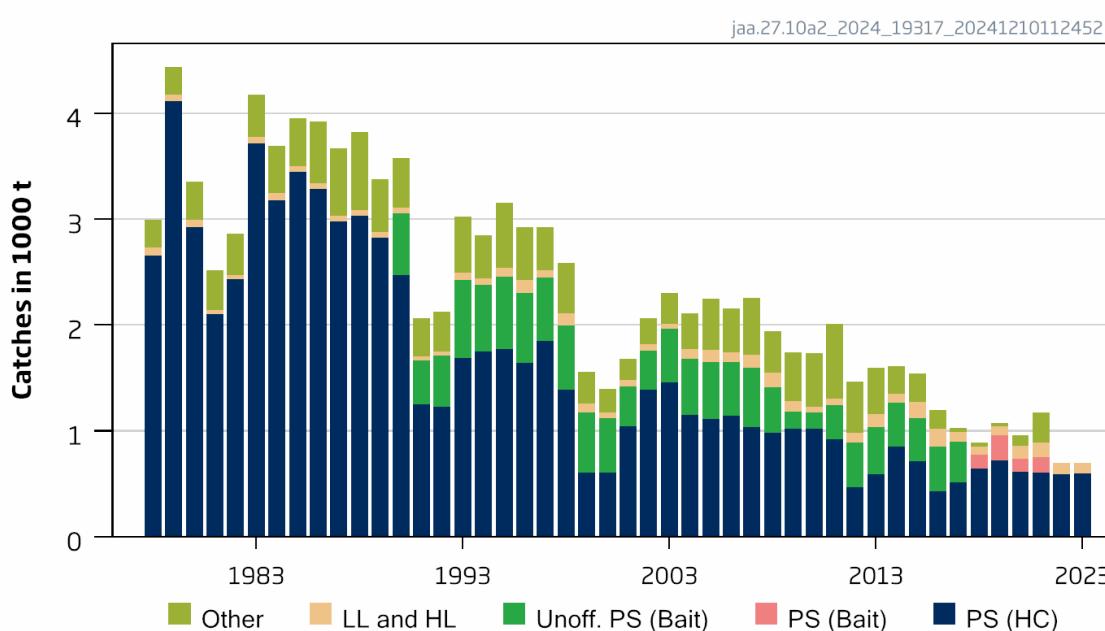


Figure 9.2.2.1. Blue jack mackerel in Azores grounds. Landings and other catches. Landings include purse seine catches for human consumption – PS (HC) – purse seine catches for bait – PS (Bait) – and have unsold purse seine landings withdrawn at the port as well as longline and handline landings (LL & HL). Other catches include recreational catches, discards/longline bait, and tuna live bait (incomplete in 2017-2020) and not available for 2022-2023.

Fishing Days (São Miguel and Terceira mackerel PS)



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.

LPUE (purse seine)

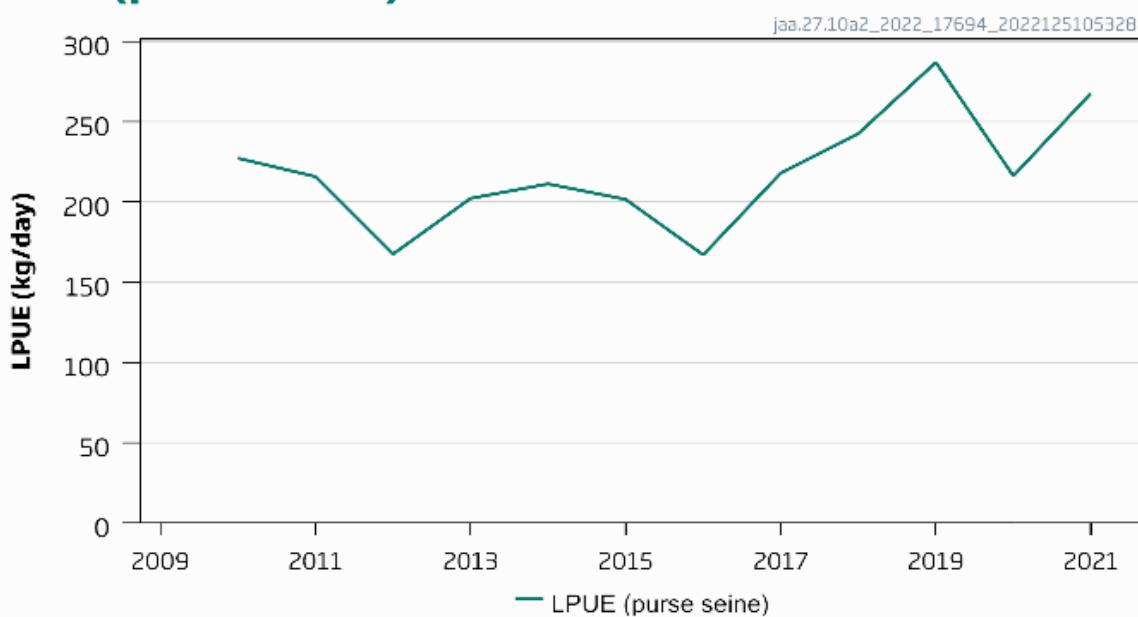


Figure 9.2.3.2. Blue jack mackerel in Azores grounds. Nominal LPUE (kg/day) of the "Mackerel fleet" for 2010 – 2021. No new information is available for 2022-2023.

Annex 1: List of participants

WGHNNSA-1 (Online): 27 – 31 May 2024

Name	Institution	Country
Leire Cidores	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 Cidores	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 (<i>Engraulis encrasicolus</i>) in Subarea 8 (Bay of Biscay)	December 2024*	https://doi.org/10.17895/ices.pub.28053440
ane.27.9a	Anchovy (<i>Engraulis encrasicolus</i>) in Division 9.a (Atlantic Iberian waters) [‡]	June 2024	https://doi.org/10.17895/ices.pub.26004166
ane.27.9aS	Anchovy (<i>Engraulis encrasicolus</i>) 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 (<i>Engraulis encrasicolus</i>) 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 (<i>Trachurus trachurus</i>) in Division 9.a (Atlantic Iberian waters)	June 2024	https://doi.org/10.17895/ices.pub.26004166
jaa.27.10a2	Blue jack mackerel (<i>Trachurus picturatus</i>) in Subdivision 10.a.2 (Azores grounds)	June 2015	https://doi.org/10.17895/ices.pub.18622022
pil.27.7	Sardine (<i>Sardina pilchardus</i>) 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 (<i>Sardina pilchardus</i>) 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 (<i>Sardina pilchardus</i>) 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.27.9aW

*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

Audit of Anchovy in Division 9.a. Western component

Date: 05/06/2024

Auditor: Jose Luis Cebrian

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 ($Q_{IDX} = 1.5$). 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 (which 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).

Audit of Anchovy in Division 9.a. Southern component

Date: 05/06/2024

Auditor: Leire Ibaibarriaga

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} ($B_{lim} \cdot e^{1.645 \cdot \sigma}$ 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 $\exp(\text{mean}(\log(I_y)) - 1.645 * \text{sd}(\log(I_y)))$ 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 B_{lim} , 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.

Audit of Southern Horse Mackerel (hom.27.9a)

Date: 06/06/2023

Auditor: Laura Wise

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 $MSYB_{trigger}$

Review of ICES Scientific Report, WGHANSA-2 2024

Expert group Chair: Rosana Ouréns

Secretariat representative: David Miller

Audit of Anchovy in Subarea 8 (Bay of Biscay), Ane.27.8.

Date: 29/11/2024

Auditor: Fernando Ramos

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 benchmark 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 B_{lim} and B_{pa} ; 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.

Audit of Anchovy in Subarea 8 (Bay of Biscay), Ane.27.8.

Date: 29/11/2024

Auditor: Susan Garrido

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+ (PEL-GAS).

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 Blim and Bpa. 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 is nowadays conducted 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 from 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 conducted 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 underestimation of 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.

Audit of Sardine in subdivisions 8.ab and d (western Iberian waters), pil.27.8abd.

Date: 02/12/2024

Reviewers: Isabel Riveiro

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 fourth 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 Triennial 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 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.

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

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).

Rincón M.M, Ramos F., Tornero J., Garrido S., Elvarsson B., Lentin J. Gadget for anchovy 9.a South: Model description and results to provide catch advice and reference points (WGHANSA-1 2024).

The following working document was presented to WGHANSA-2 2024 and is included in Annex 4:

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.

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

Fernando Ramos^(1, *), José A. Canseco⁽¹⁾, Jorge Tornero⁽¹⁾, Pilar Córdoba⁽²⁾, Miguel Cojan⁽¹⁾, Isabel Bruno⁽³⁾, Carmen González⁽¹⁾, José A. Martínez Cedeira⁽³⁾, Venicio Pita⁽⁴⁾, Ricardo Sánchez-Leal⁽¹⁾, María J. Sánchez⁽³⁾, Rosario Navarro⁽⁵⁾

(1) Instituto Español de Oceanografía (IEO-CSIC), Centro Oceanográfico de Cádiz.

(2) IEO-CSIC, Centro Oceanográfico de las Islas Baleares.

(3) IEO-CSIC, Centro Oceanográfico de Vigo.

(4) IEO-CSIC Centro Oceanográfico de Gijón.

(5) IEO-CSIC Centro Oceanográfico de Santander.

(*) Cruise leader and corresponding author: e-mail: fernando.ramos@ieo.csic.es

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).

TABLE OF CONTENTS

ABSTRACT.....	1
INTRODUCTION	3
MATERIAL AND METHODS.....	4
RESULTS	5
Acoustic sampling	5
Groundtruthoring hauls.....	5
Spatial distribution and abundance/biomass estimates	7
(SHORT) DISCUSSION	13
REFERENCES.....	14

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 manoeuvres, 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 Dommases, 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 CTDO₂-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 Sentinel 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 29th of September and 12th 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 5th 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 pilchardus* (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 *Micromesistius 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 $84\ 191\ \text{m}^2\ \text{nmi}^{-2}$, 63% lower than the maximum value recorded throughout the time-series, estimated in 2020 ($229\ 241\ \text{m}^2\ \text{nmi}^{-2}$), and 28% below the historical mean ($118\ 395\ \text{m}^2\ \text{nmi}^{-2}$). The highest NASC value ($5357\ \text{m}^2\ \text{nmi}^{-2}$) 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 $\text{m}^2\text{nmi}^{-2}$) 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 María (**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 (\pm SD) are shown in **Figure 10**. The mapping of the backscattering energy (NASC, in $m^2 nmi^{-2}$) 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 ($\pm SD$) size in the fishing hauls are spatially explicit represented in **Figure 15**. The NASC mapping (in $m^2 nmi^{-2}$) 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 $m^2 nmi^{-2}$) 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 ($\pm SD$) size in the fishing hauls are spatially explicit represented in **Figure 21**. The NASC mapping (in $m^2 nmi^{-2}$) 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 María 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 ($\pm SD$) size in the fishing hauls are mapped in **Figure 25**. The NASC mapping (in $m^2 nmi^{-2}$) 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 $m^2 nmi^{-2}$) 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 $m^2 nmi^{-2}$) 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 ($\pm SD$) 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 $m^2 nmi^{-2}$) 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 ($\pm SD$) 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 $m^2 nmi^{-2}$) 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 ($\pm SD$) 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 $m^2 nmi^{-2}$) 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.

ACKNOWLEDGEMENTS

We are very grateful to the crew of the *R/V Ramon Margalef* and to all the scientific and technical staff participating in the present survey. *ECOCADIZ-RECLUTAS 2023-10* has been funded by the EU through the European Maritime and Fisheries Fund (EMFF) within the National Program of collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy. The survey has been conducted onboard the *R/V Ramon Margalef*, which was built within the frame of the Program FEDER, FICTS-2011-03-01.

REFERENCES

- Buckland, S.T., Anderson, D.R., Burnham, K.P., Laake, J.L. 1993. *Distance sampling: Estimating abundance of biological populations*. Chapman and Hall, London.
- 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.
- 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 (WGACCEGG). 1st Edition. *ICES Techniques in Marine Environmental Sciences* Vol. 64. 100 pp. <https://doi.org/10.17895/ices.pub.7462>.
- Fässler, S. M.M., O'Donnell, C., Jech, J.M. 2013. Boarfish (*Capros aper*) target strength modelled from magnetic resonance imaging (MRI) scans of its swimbladder. *ICES Journal of Marine Science*, 70: 1451–1459.
- Foote, K.G., Knudsen, H.P., Vestnes, G., MacLennan, D.N., Simmonds, E.J. 1987. Calibration of acoustic instruments for fish density estimation: a practical guide. *ICES Coop. Res. Rep.*, 144, 57 pp.
- ICES, 1998. Report of the Planning Group for Acoustic Surveys in ICES Sub-Areas VIII and IX. A Coruña, 30- 31 January 1998. ICES CM 1998/G:2.
- ICES, 2006a. Report of the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES areas VIII and IX (WGACCEGG), 24-28 October 2005, Vigo, Spain. ICES, C.M. 2006/LRC: 01. 126 pp.
- ICES, 2006b. Report of the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VIII and IX (WGACCEGG), 27 November-1 December 2006, Lisbon, Portugal. ICES C.M. 2006/LRC:18. 169 pp.

Leaper, R., Gordon, J. 2001. Application of photogrammetric methods for locating and tracking cetacean movements at sea. *Journal of Cetacean Research and Management* 3: 131-141.

Leaper, R., Burt, L., Gillespie, D., Macleod, K. 2010. Comparisons of measured and estimated distances and angles from sighting surveys. *Journal of Cetacean Research and Management* 11: 229-237.

Nakken, O., Dommasnes, A. 1975. The application for an echo integration system in investigations on the stock strength of the Barents Sea capelin (*Mallotus villosus*, Müller) 1971-74. ICES CM 1975/B:25.

Ramos, F., Iglesias, M., Miquel, J., Oñate, D., Tornero, J., Ventero, A., Peña, M.A. 2010. Acoustic assessment and distribution of anchovy and sardine juveniles in the ICES Subdivision IXa South during the *ECOCADIZ-RECLUTAS 1009* Spanish survey (October-November 2009). Working document presented in the ICES Working Group on Southern Horse Mackerel, Anchovy and Sardine in ICES Area VIII and IX (WGACEGG), Palma de Mallorca, Spain, 22-26 November 2010. 31 pp.

Ramos, F., Iglesias, M., Miquel, J., Oñate, D., Tornero, J., Ventero, A., Díaz, N. 2013. Acoustic assessment and distribution of the main pelagic fish species in the ICES Subdivision IXa South during the *ECOCADIZ-RECLUTAS 1112* Spanish survey (November 2012). Working document presented in the ICES Working Group on Southern Horse Mackerel, Anchovy and Sardine (WGHANSA), Bilbao (Basque Country), Spain, 21-26 June 2013 and in the ICES Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VIII and IX (WGACEGG). Lisbon, Portugal, 25-29 November 2013

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
<i>Merluccius merluccius</i>	12	92.31 %	21.760	177
<i>Trachurus trachurus</i>	11	84.62 %	39.454	827
<i>Sardina pilchardus</i>	10	76.92 %	1342.307	82985
<i>Engraulis encrasiculus</i>	10	76.92 %	873.072	100124
<i>Scomber colias</i>	9	69.23 %	357.588	4119
<i>Pagellus erythrinus</i>	5	38.46 %	13.312	92
<i>Trachurus mediterraneus</i>	4	30.77 %	176.870	895
<i>Boops boops</i>	4	30.77 %	24.265	149
<i>Sardinella aurita</i>	4	30.77 %	5.615	24
<i>Scomber scombrus</i>	4	30.77 %	2.780	19
<i>Spondyliosoma cantharus</i>	4	30.77 %	2.665	22
<i>Trachinus draco</i>	4	30.77 %	0.395	6
<i>Spicara flexuosa</i>	3	23.08 %	63.035	1205
<i>Mola mola</i>	3	23.08 %	26.905	11
<i>Caranx rhonchus</i>	3	23.08 %	8.545	27
<i>Alosa fallax</i>	3	23.08 %	1.495	7
<i>Diplodus bellottii</i>	3	23.08 %	1.045	15
<i>Pagellus bellottii bellottii</i>	2	15.38 %	2.305	20
<i>Pomatomus saltatrix</i>	2	15.38 %	1.990	6
<i>Pagellus acarne</i>	2	15.38 %	1.905	16
<i>Diplodus annularis</i>	2	15.38 %	0.335	6
<i>Diplodus vulgaris</i>	2	15.38 %	0.305	3
<i>Remora brachyptera</i>	2	15.38 %	0.133	2
<i>Lepidopus caudatus</i>	2	15.38 %	0.046	4
<i>Capros aper</i>	1	7.69 %	85.095	8596
<i>Macroramphosus scolopax</i>	1	7.69 %	3.830	390
<i>Sarda sarda</i>	1	7.69 %	2.755	4
<i>Stromateus fiatola</i>	1	7.69 %	2.285	3
<i>Zeus faber</i>	1	7.69 %	1.290	1
<i>Trachinotus ovatus</i>	1	7.69 %	0.975	3
<i>Microchirus boscanion</i>	1	7.69 %	0.002	1
<i>Maurolicus muelleri</i>	1	7.69 %	0.001	1

Table 2. ECOCADIZ-RECLUTAS 2023-10 survey. TS/length relationships used for acoustic estimation of assessed species. Boarfish b₂₀ estimate following to Fässler *et al.* (2013). Between parentheses the usual IEO value considered in previous surveys.

Species	b20
Sardine (<i>Sardina pilchardus</i>)	-72.6
Round sardinella (<i>Sardinella aurita</i>)	-72.6
Anchovy (<i>Engraulis encrasiculus</i>)	-72.6
Chub mackerel (<i>Scomber japonicus</i>)	-68.7
Mackerel (<i>S. scombrus</i>)	-84.9
Horse mackerel (<i>Trachurus trachurus</i>)	-68.7
Mediterranean horse-mackerel (<i>T. mediterraneus</i>)	-68.7
Blue jack mackerel (<i>T. picturatus</i>)	-68.7
Bogue (<i>Boops boops</i>)	-67.0
Transparent goby (<i>Aphia minuta</i>)	-67.5
Atlantic pomfret (<i>Brama brama</i>)	-67.5
Blue whiting (<i>Micromesistius poutassou</i>)	-67.5
Silvery lightfish/pearlside (<i>Maurolicus muelleri</i>)	-72.2
Longspine snipefish (<i>Macroramphosus scolopax</i>)	-80.0
Boarfish (<i>Capros aper</i>)	-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 encrasiculus*; 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(m² 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°54.4658' 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 MANOEUVRE						
1	01-10-2023	36° 52.2681 N	8° 55.3469 W	129.02	36° 54.9726 N	8° 55.7670 W	111.5	08:34	09:16	00:42	01:35	2.722	R21	Ponta de Sagres			
2	02-10-2023	36° 53.6703 N	8° 36.9126 W	106.04	36° 55.5153 N	8° 36.9532 W	93.96	08:57	09:24	00:27	01:07	1.843	R19	Portimao			
3	04-10-2023	36° 52.5392 N	8° 16.8997 W	106.76	36° 54.4144 N	8° 16.8482 W	94.8	09:02	09:29	00:27	01:00	1.873	R17	Albufeira			
4	06-10-2023	36° 57.2295 N	7° 47.0825 W	84.18	36° 58.7072 N	7° 47.0956 W	65.36	07:47	08:09	00:21	01:01	1.476	R14	Fuzeta			
5	06-10-2023	37° 00.6922 N	7° 37.1160 W	93.52	36° 58.3702 N	7° 37.1851 W	114.39	11:14	11:48	00:33	01:18	2.32	R13	Tavira			
6	07-10-2023	37° 02.4748 N	7° 17.1570 W	52.69	37° 04.8475 N	7° 17.2000 W	30.55	07:56	08:30	00:33	01:08	2.37	R11	Isla Cristina			
7	07-10-2023	36° 54.1292 N	7° 07.1995 W	108.63	36° 51.5834 N	7° 07.2050 W	138.07	12:00	12:36	00:36	01:19	2.543	R10	El Rompido			
8	08-10-2023	36° 58.0414 N	7° 00.6698 W	62.19	36° 59.8272 N	6° 59.5925 W	49.27	07:42	08:10	00:27	00:59	1.981	R09	Punta Umbría			
9	08-10-2023	36° 58.4927 N	6° 49.4822 W	35.31	36° 57.2235 N	6° 51.8280 W	43.61	12:32	13:05	00:33	01:34	2.267	R08	Mazagón			
10	09-10-2023	36° 40.4077 N	6° 47.3398 W	100.69	36° 38.8489 N	6° 50.1336 W	129.19	07:41	08:19	00:38	01:04	2.734	R06	Doñana			
11	09-10-2023	36° 36.0679 N	6° 37.4007 W	64.47	36° 37.6258 N	6° 34.5139 W	44.33	12:17	12:57	00:39	01:09	2.797	R05	Chipiona			
12	11-10-2023	36° 27.5170 N	6° 35.3525 W	90.65	36° 29.2198 N	6° 32.3368 W	68.33	08:35	09:16	00:41	01:21	2.968	R04	Rota			
13	11-10-2023	36° 22.9702 N	6° 25.7832 W	57.68	36° 21.4102 N	6° 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
r²	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; r²=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**.

SIZE CLASS (cm)	ECOCADIZ-RECLUTAS 2023-10. <i>Engraulis encrasicolus</i> . ABUNDANCE (in numbers and million fish)													Millions		
	POL01	POL02	POL03	POL04	Portugal	POL05	POL06	POL07	POL08	POL09	POL10	Spain	TOTAL	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. encrasiculus*). Cont'd

ECOCADIZ-RECLUTAS 2023-10. <i>Engraulis encrasiculus</i> . 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. encrasiculus*). 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**.

SIZE CLASS (cm)	ECOCADIZ-RECLUTAS 2023-10. <i>Sardina pilchardus</i> . ABUNDANCE (in numbers and million fish)																
	POL01	POL02	Portugal	POL03	POL04	POL05	POL06	POL07	POL08	POL09	POL10	POL11	Spain	TOTAL	Millions	Portugal	Spain
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	
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. <i>Sardina pilchardus</i> . 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	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**.

SIZE CLASS (cm)	POL01	ECOCADIZ-RECLUTAS 2023-10. <i>Sardinella aurita</i> . ABUNDANCE (in numbers and million fish)							Millions		
		Portugal	POL02	POL03	POL04	Spain	TOTAL	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	0
26	0	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	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	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	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	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. <i>Sardinella aurita</i> . 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. <i>Scomber scombrus</i> . 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				

Tabla 13. ECOCADIZ-RECLUTAS 2023-10 survey. Atlantic mackerel (*Scomber scombrus*). Cont'd.

ECOCADIZ-RECLUTAS 2023-10. <i>Scomber scombrus</i> . 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**.

SIZE CLASS (cm)	ECOCADIZ-RECLUTAS 2023-10. <i>Scomber colias</i> . ABUNDANCE (in numbers and million fish)												TOTAL	Millions		
	POL01	POL02	POL03	Portugal	POL04	POL05	POL06	POL07	POL08	POL09	POL10	Spain		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	0.1023808	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	37130	37130	0.03713	0	0.03713
28	0	111391	0	111391	0	0	0	0	0	0	0	111391	111391	0	0.111391	0
28.5	0	185651	0	185651	0	0	0	0	0	0	0	185651	185651	0	0.185651	0
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	185651	185651	0	0.185651	0
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	
35.5	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. <i>Scomber colias</i> . 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**.

SIZE CLASS (cm)	ECOCADIZ-RECLUTAS 2023-10. <i>Trachurus trachurus</i> . ABUNDANCE (in numbers and million fish)											Millions		
	POL01	POL02	POL03	POL04	Portugal	POL05	POL06	POL07	POL08	Spain	TOTAL	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	8506	0	0	8506	8506	0	0.008506	0.008506	0.008506
8.5	0	614610	0	0	614610	0	0	0	0	614610	0.61461	0	0.61461	0.61461
9	0	614610	0	0	614610	0	0	0	0	614610	0.61461	0	0.61461	0.61461
9.5	0	3073050	0	0	3073050	0	0	0	0	3073050	3.07305	0	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	32574326	32.574326	0	0	32.574326
11	0	30730496	0	0	30730496	0	0	0	0	30730496	30.730496	0	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	3073050	3.07305	0	0	3.07305
12.5	0	1229220	0	0	1229220	0	0	0	0	1229220	1.22922	0	0	1.22922
13	0	0	0	0	0	0	2651	58	2709	2709	0	0.002709	0.002709	0.002709
13.5	0	0	0	0	0	0	3977	87	4064	4064	0	0.004064	0.004064	0.004064
14	0	0	0	0	0	0	3977	87	4064	4064	0	0.004064	0.004064	0.004064
14.5	0	0	0	0	0	0	1326	29	1355	1355	0	0.001355	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	3977	87	4064	4064	0	0.004064	0.004064	0.004064
16.5	0	0	0	0	0	0	1326	29	1355	1355	0	0.001355	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. <i>Trachurus trachurus</i> . 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	0.054	0.001	0.055	0.055	
13.5	0	0	0	0	0	0	0.090	0.002	0.092	0.092	
14	0	0	0	0	0	0	0.100	0.002	0.102	0.102	
14.5	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	
15.5	0	0	0	0	0	0	0	0	0	0	
16	0	0	0	0	0	0	0.146	0.003	0.149	0.149	
16.5	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**.

SIZE CLASS (cm)	POL01	ECOCADIZ-RECLUTAS 2023-10. <i>Trachurus mediterraneus</i> . ABUNDANCE (in numbers and million fish)							Millions		
		Portugal	POL02	POL04	POL05	POL06	Spain	TOTAL			
								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. <i>Trachurus mediterraneus</i> . 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**.

SIZE CLASS (cm)	ECOCADIZ-RECLUTAS 2023-10, <i>Boops boops</i> , ABUNDANCE (in numbers and million fish)								Millions		
	POL01	POL02	Portugal	POL03	POL04	POL05	Spain	TOTAL	Portugal	Spain	Total
	1549	1338	2887	14418	1378	17605	33401	36288	0.002887	0.033401	0.036288
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. <i>Boops boops</i> . 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**.

SIZE CLASS (cm)	ECOCADIZ-RECLUTAS 2023-10. <i>Maurolicus muelleri</i> . ABUNDANCE (in numbers and million fish)									Millions			
	POL01	POL02	POL03	POL04	Portugal	POL05	POL06	POL07	Spain	TOTAL	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	77.313220	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			

SIZE CLASS (cm)	ECOCADIZ-RECLUTAS 2023-10. <i>Maurolicus muelleri</i> . BIOMASS (t)												
	POL01	POL02	POL03	POL04	Portugal	POL05	POL06	POL07	Spain	TOTAL	Portugal	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. <i>Macroramphosus scolopax</i> . 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. <i>Macroramphosus scolopax</i> . 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. <i>Capros aper</i> . 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. <i>Capros aper</i> . 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

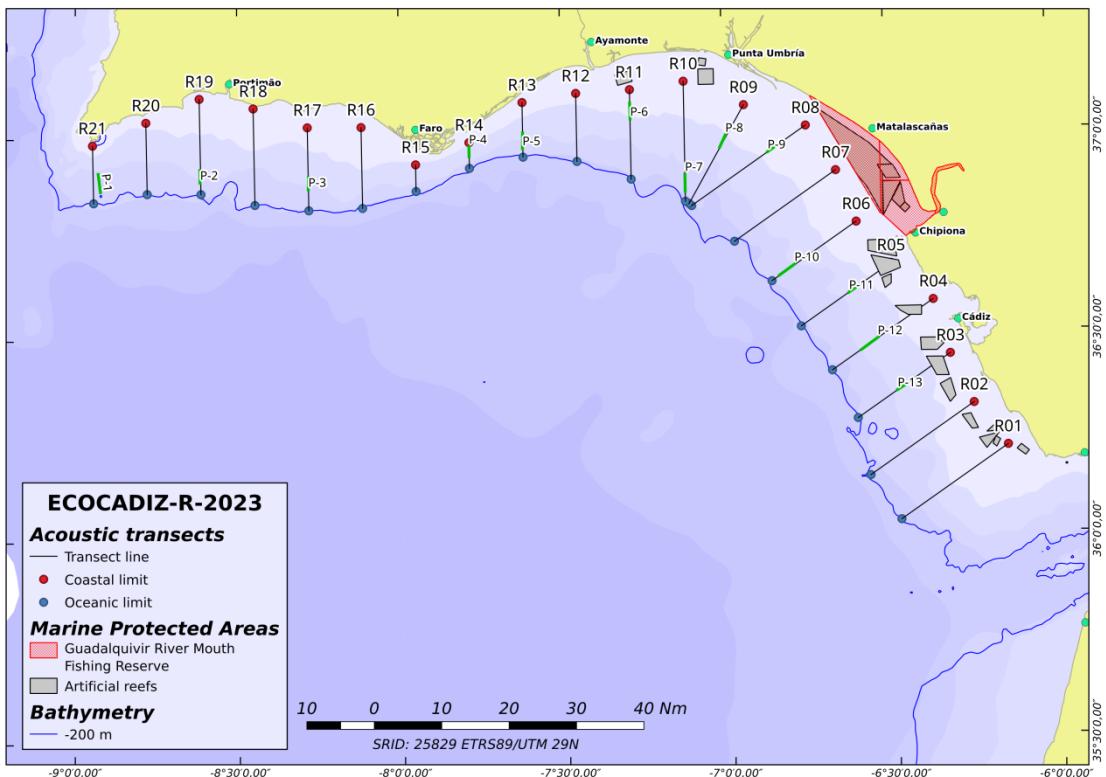


Figure 1. ECOCADIZ-RECLUTAS 2023-10 survey. Location of the acoustic transects sampled during the survey. The different protected areas inside the Guadalquivir river mouth Fishing Reserve and artificial reef polygons are also shown.

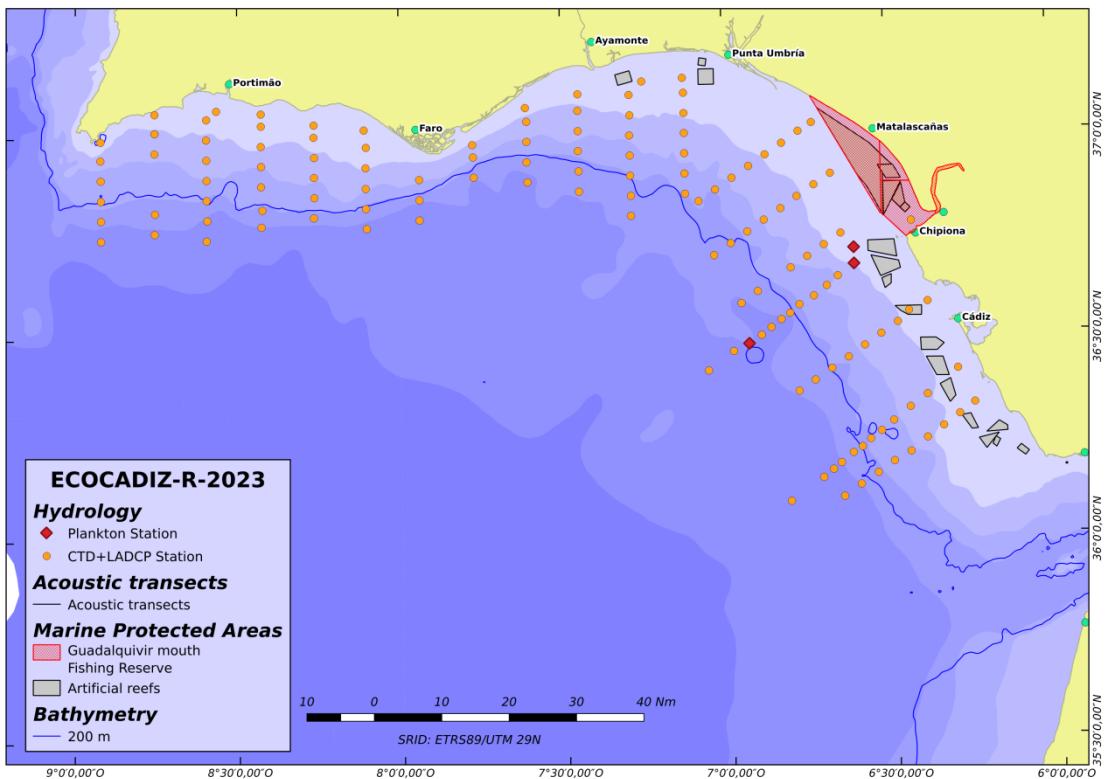


Figure 2. ECOCADIZ-RECLUTAS 2023-10 survey. Location of CTD-LADCP, Bongo 40, Neuston sledge and water sampling stations.

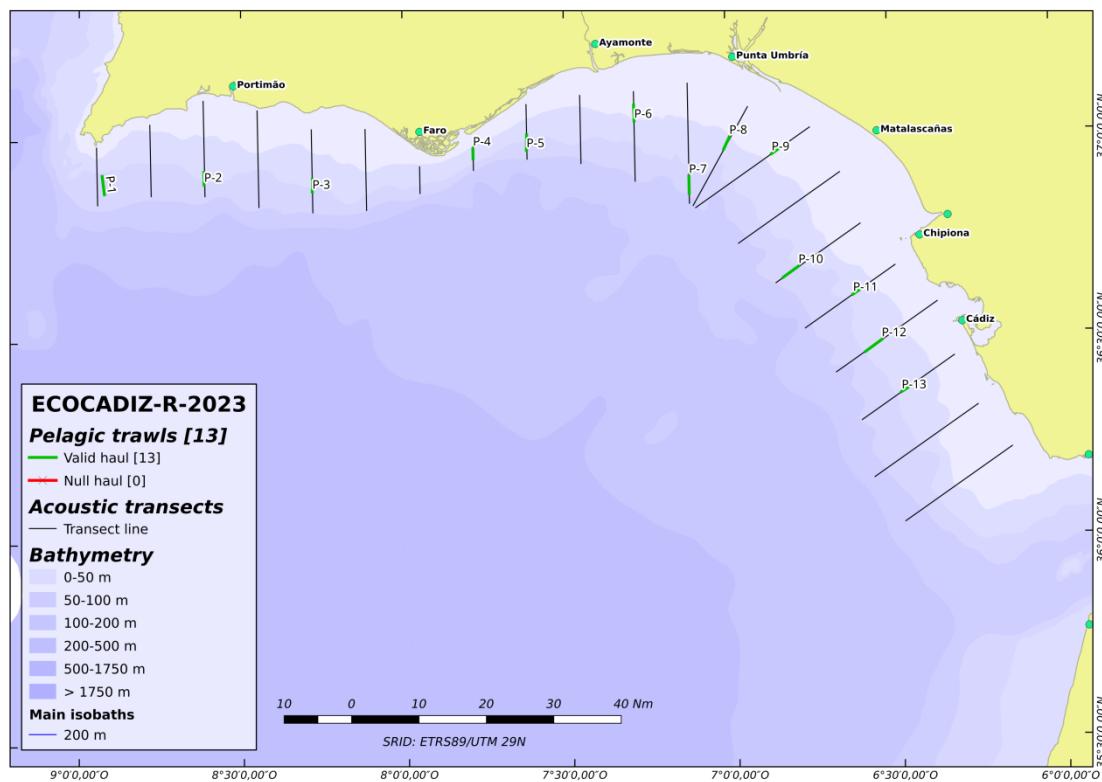


Figure 3. ECOCADIZ-RECLUTAS 2023-10 survey. Location of ground-truthing fishing hauls.

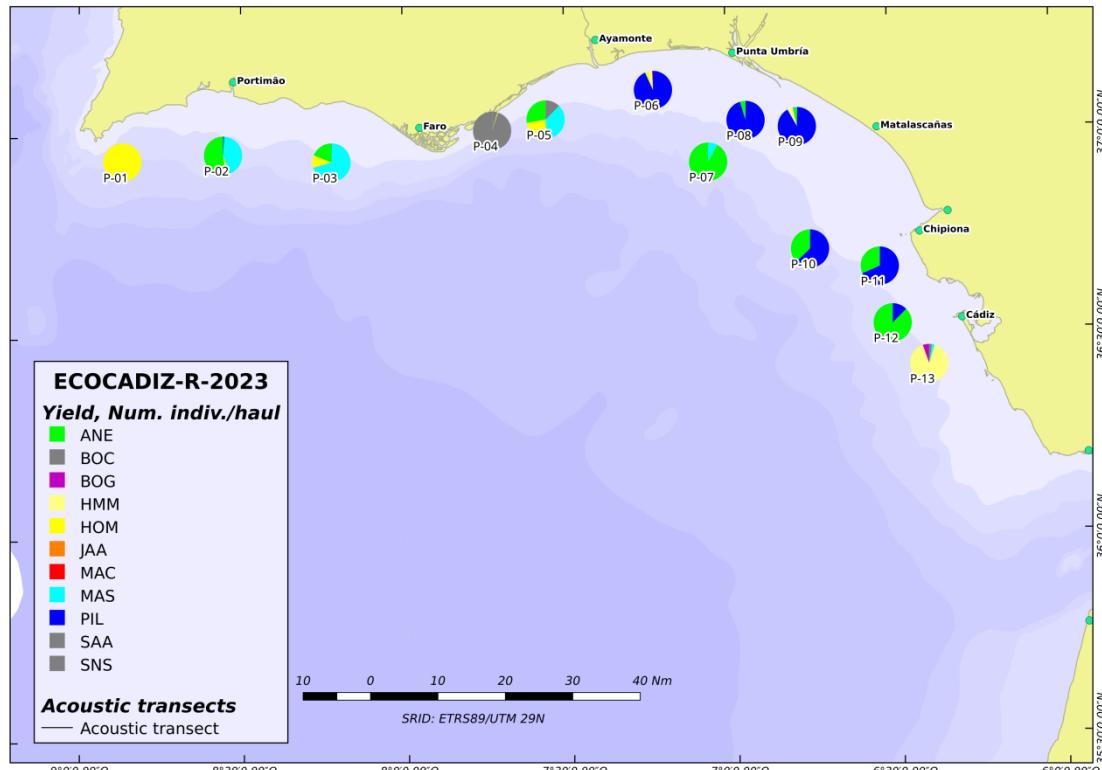


Figure 4. ECOCADIZ-RECLUTAS 2023-10 survey. Species composition (percentages in number) in valid hauls.

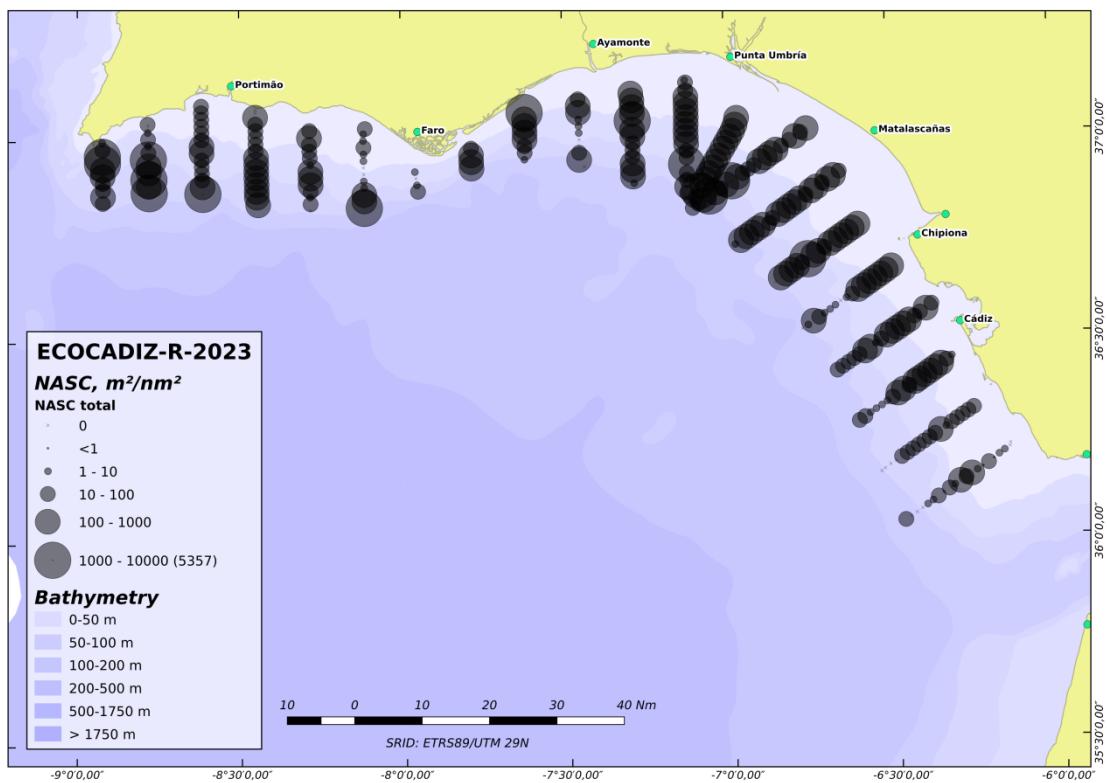


Figure 5. ECOCADIZ-RECLUTAS 2023-10 survey. Distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2 nm^{-2}$) attributed to the pelagic fish species assemblage.

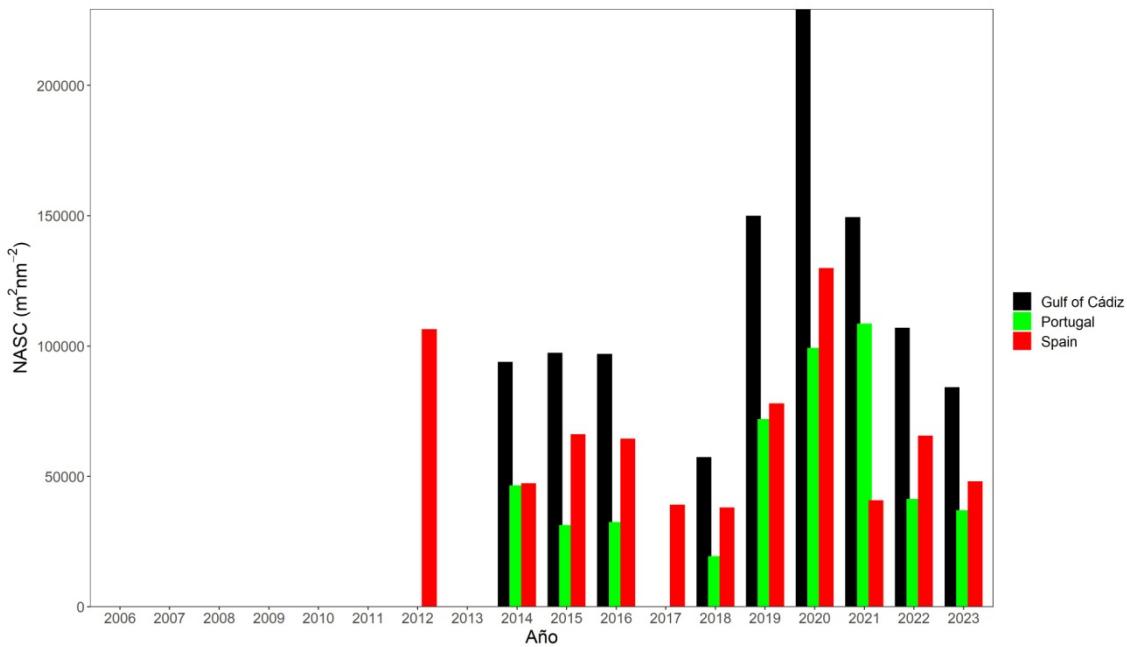


Figure 6. ECOCADIZ-RECLUTAS 2023-10 survey. Time-series of NASC by total area, Spain and Portugal.

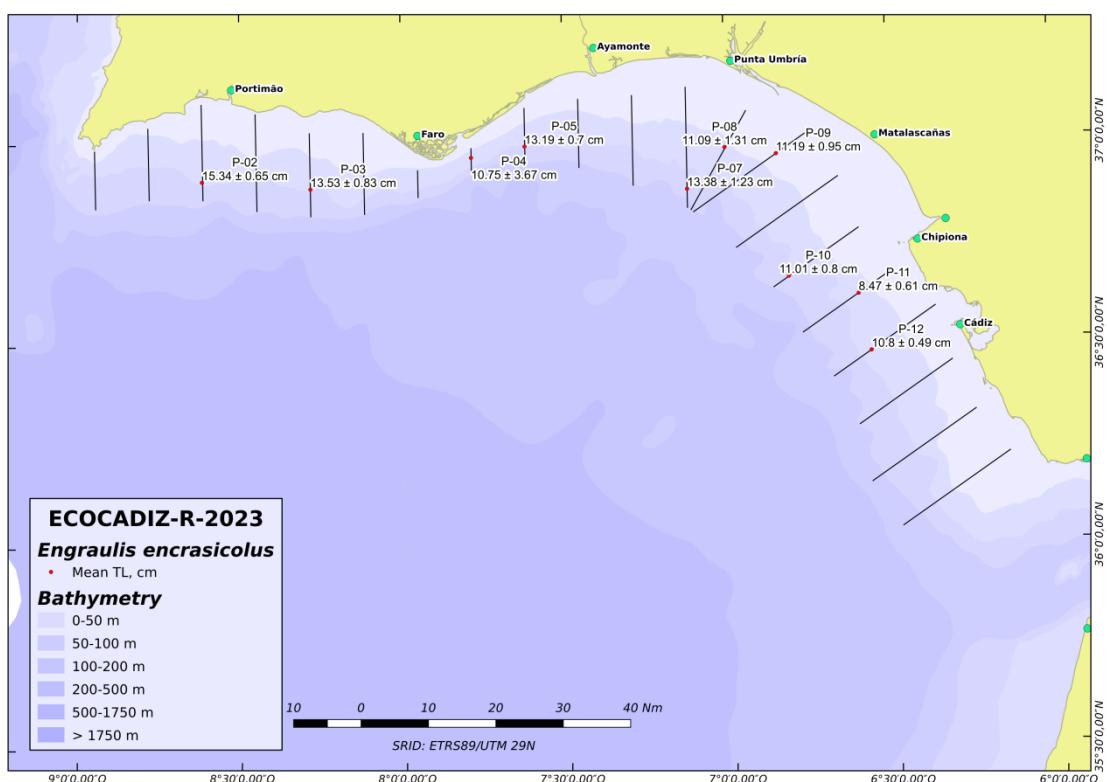
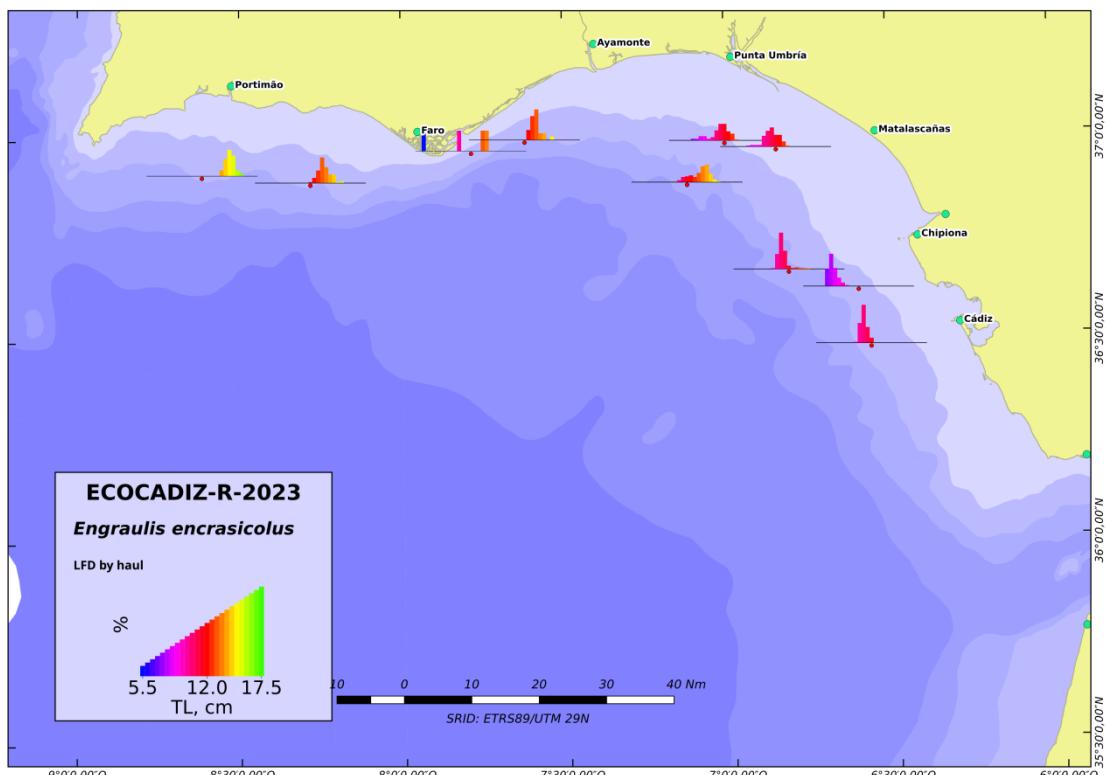


Figure 7. ECOCADIZ-RECLUTAS 2023-10 survey. Anchovy (*Engraulis encrasicolus*). Top: length frequency distributions in fishing hauls. Bottom: mean \pm sd length by haul.

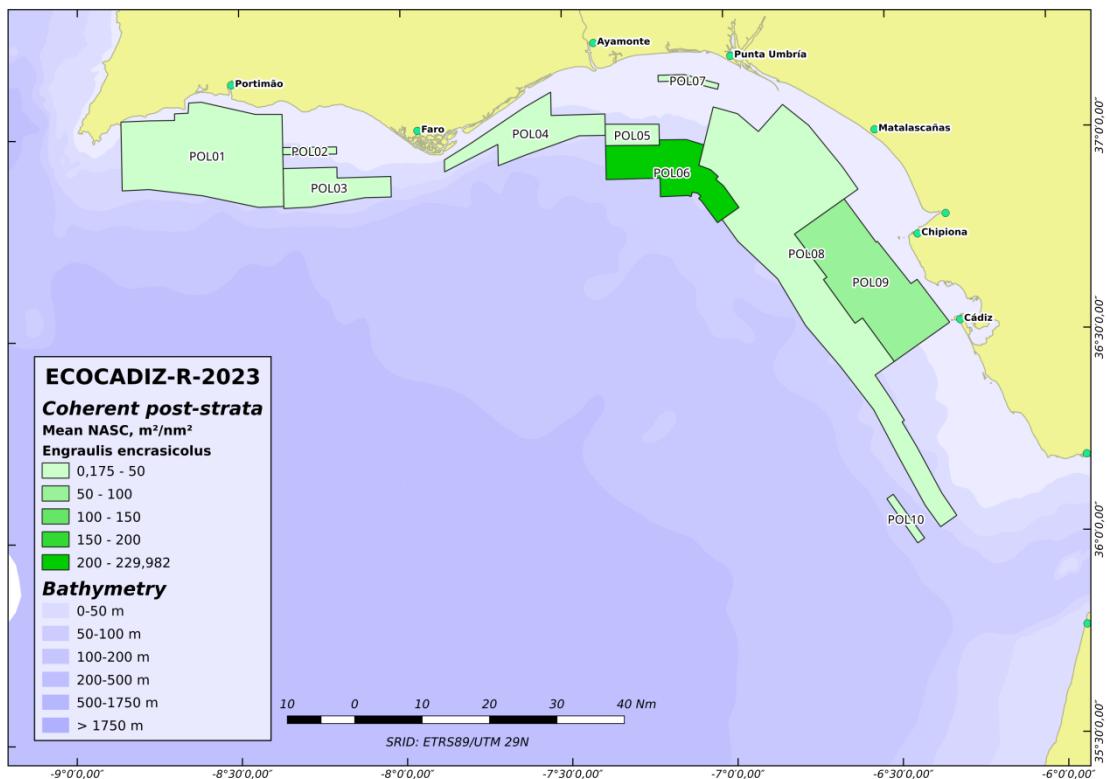
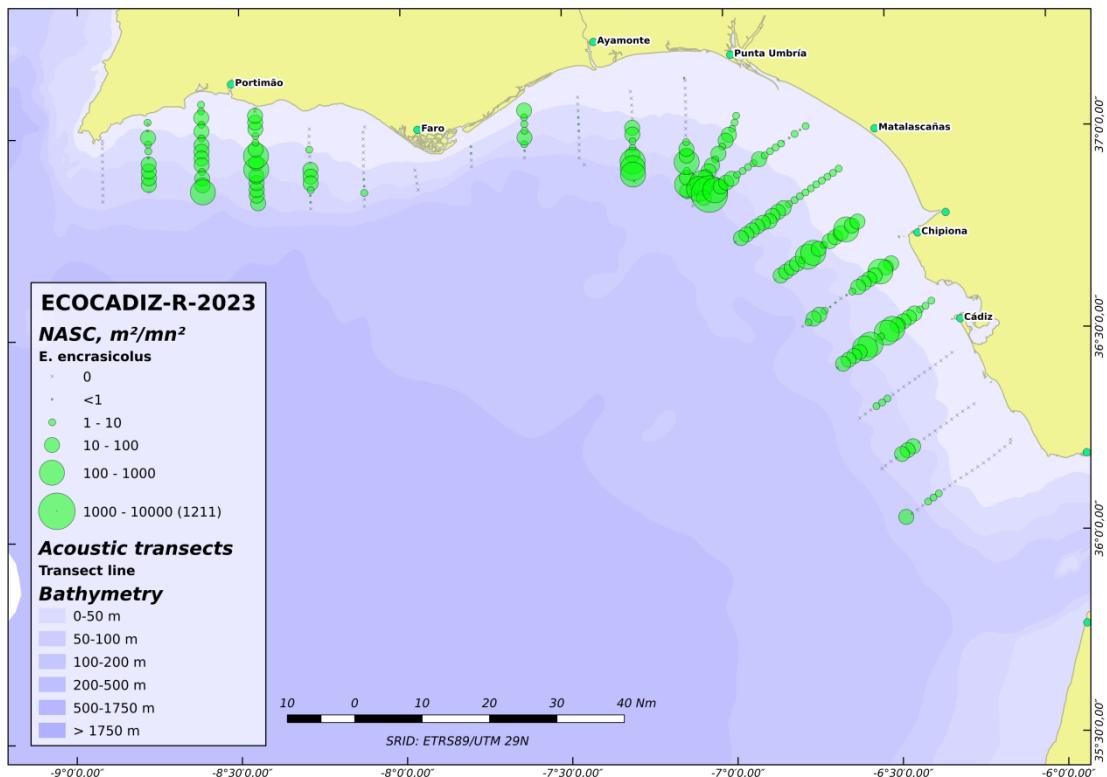


Figure 8. ECOCADIZ-RECLUTAS 2023-10 survey. Anchovy (*Engraulis encrasicolus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in m^2/nm^2) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

ECOCADIZ-RECLUTAS 2023-10: Anchovy (*E. encrasiculus*)

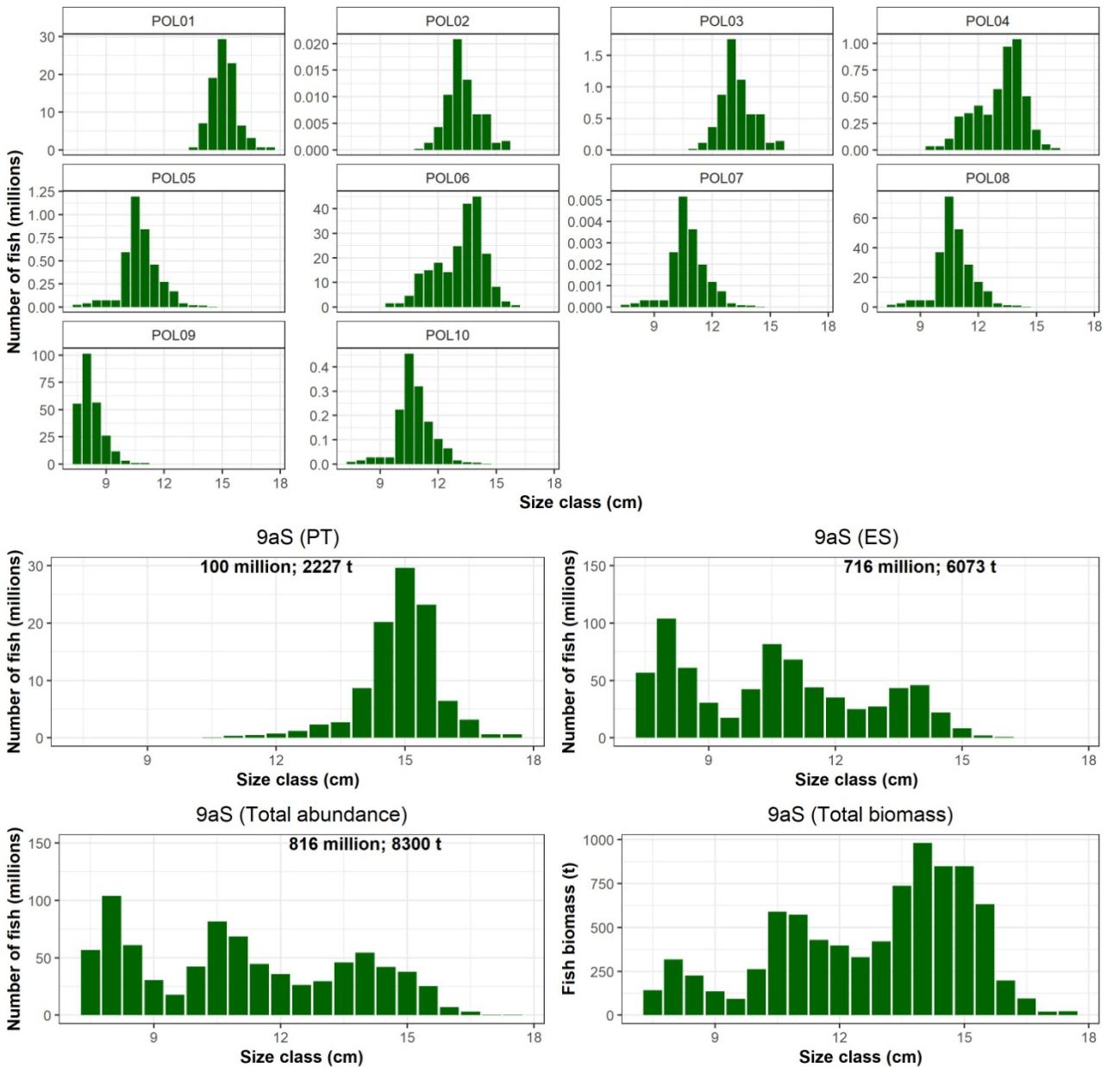


Figure 9. ECOCADIZ-RECLUTAS 2023-10 survey. Anchovy (*Engraulis encrasiculus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 8**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the y axis.

ECOCADIZ-RECLUTAS 2023-10: Anchovy (*E. encrasicolus*)

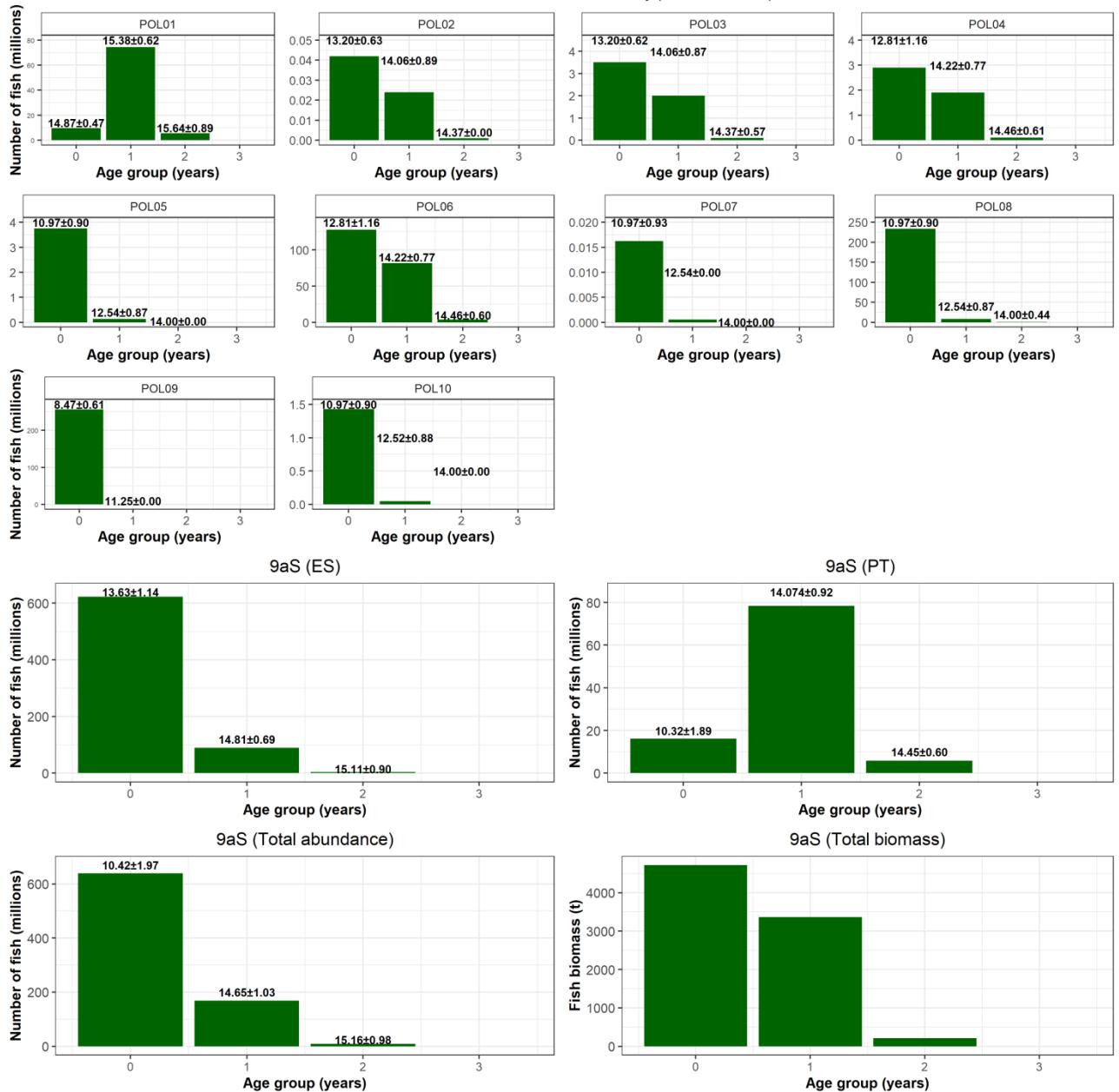


Figure 10. ECOCADIZ-RECLUTAS 2023-10 survey. Anchovy (*Engraulis encrasicolus*). Estimated abundances (number of fish in millions) by age group (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 8**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by age group for the whole sampled area is also shown for comparison. Note the different scale in the y axis.

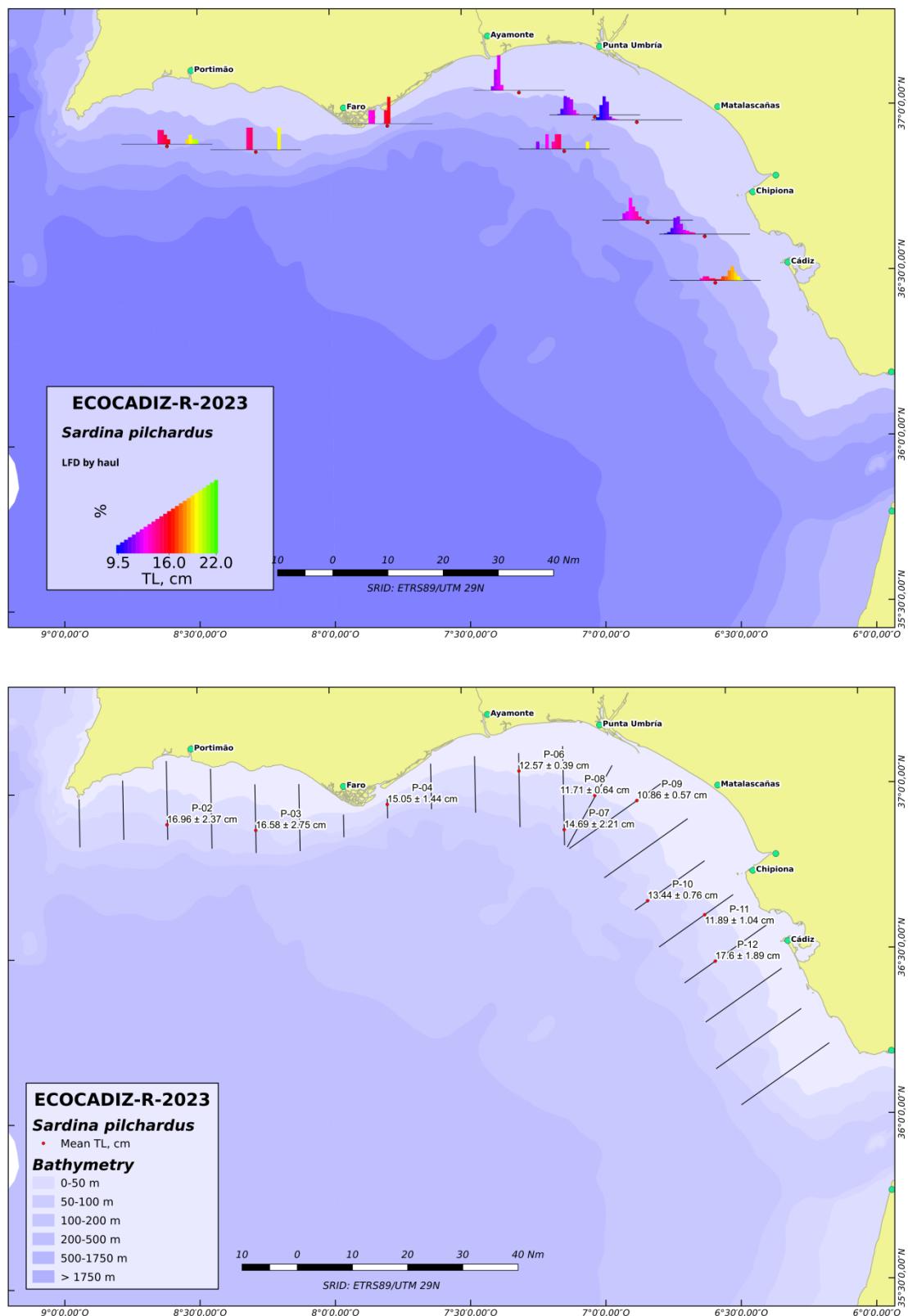


Figure 11. ECOCADIZ-RECLUTAS 2023-10 survey. Sardine (*Sardinops sagax*). Top: length frequency distributions in fishing hauls. Bottom: mean \pm sd length by haul.

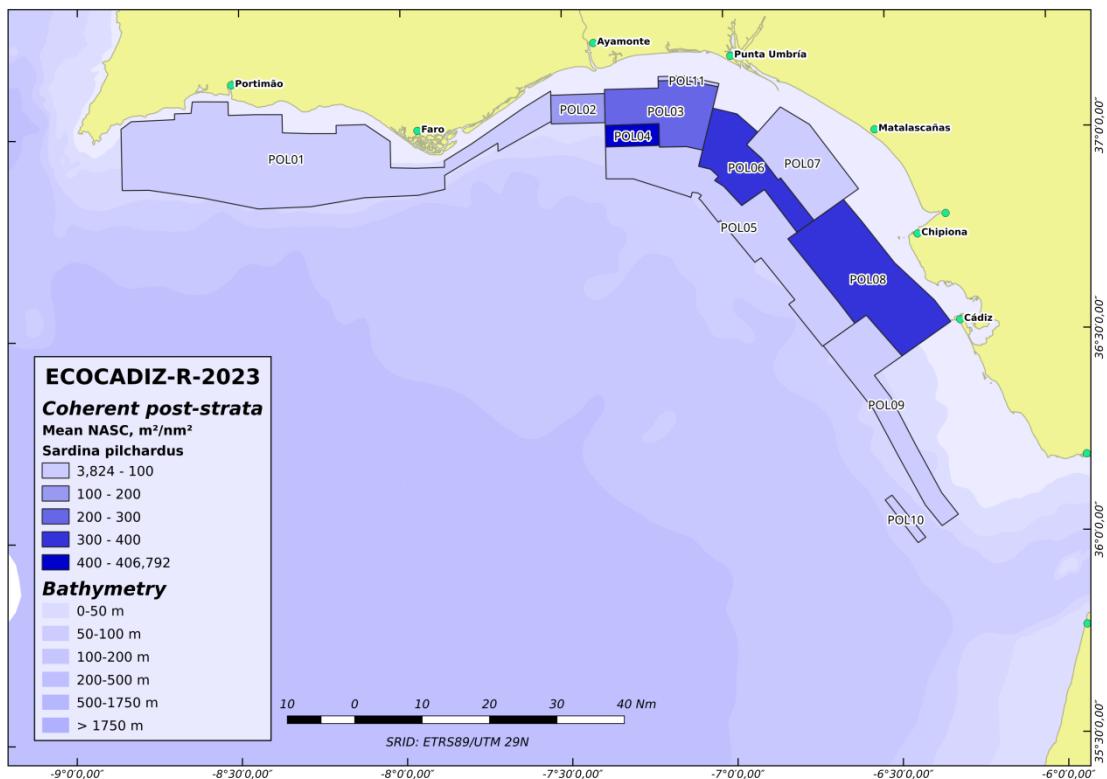
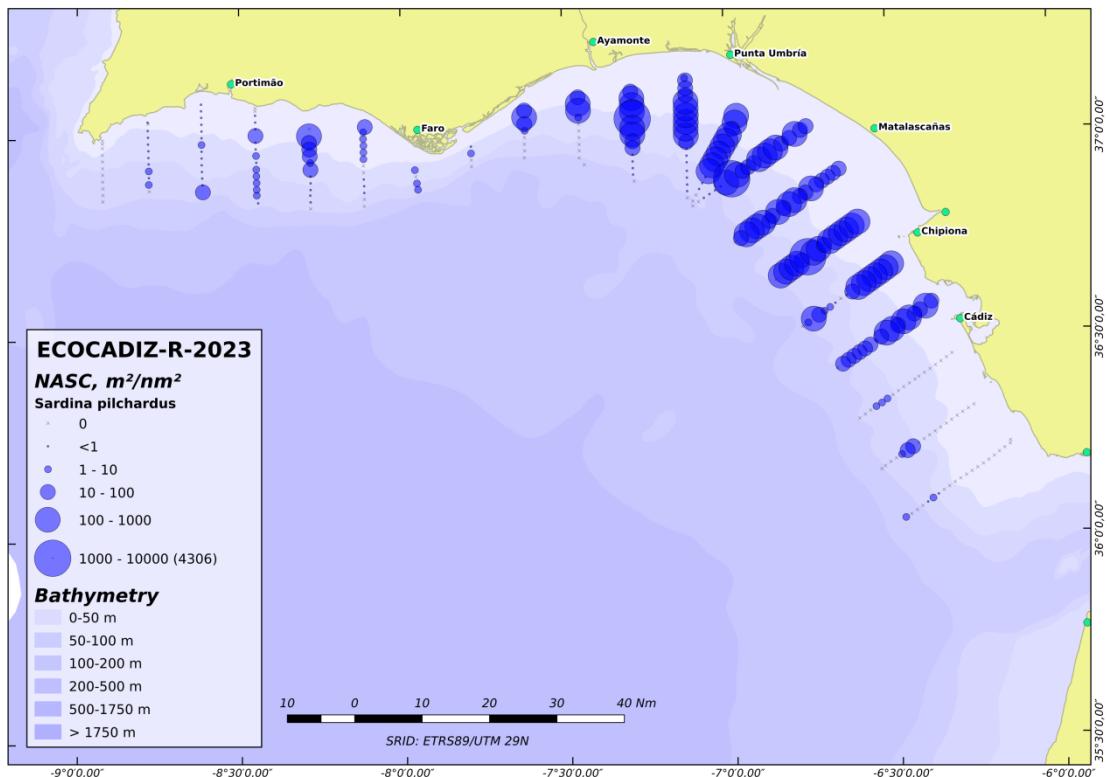


Figure 12. ECOCADIZ-RECLUTAS 2023-10 survey. Sardine (*Sardina pilchardus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in m^2/nm^2) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

ECOCADIZ-RECLUTAS 2023-10: Sardine (*S. pilchardus*)

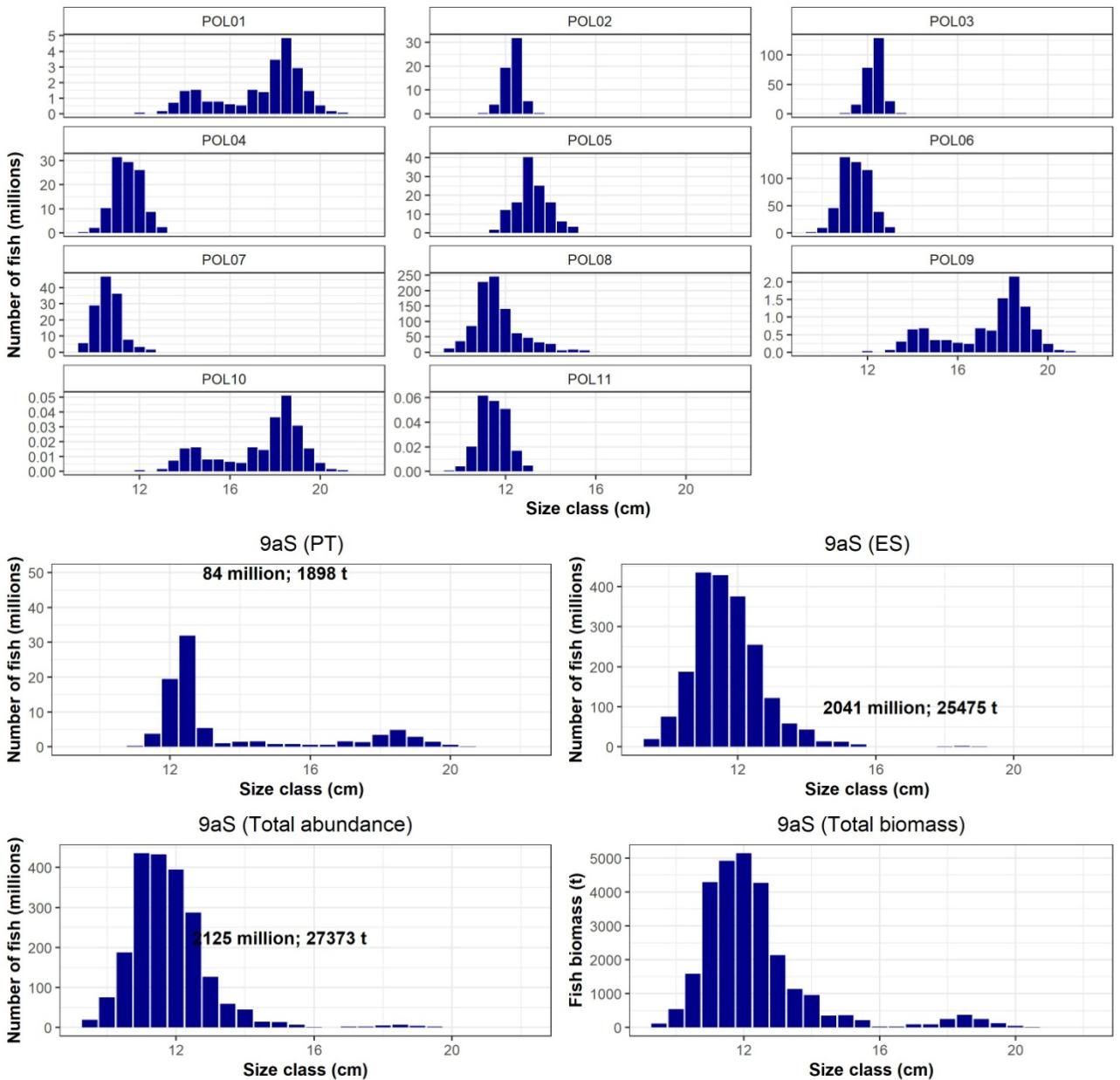


Figure 13. ECOCADIZ-RECLUTAS 2023-10 survey. Sardine (*Sardina pilchardus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 12**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the y axis.

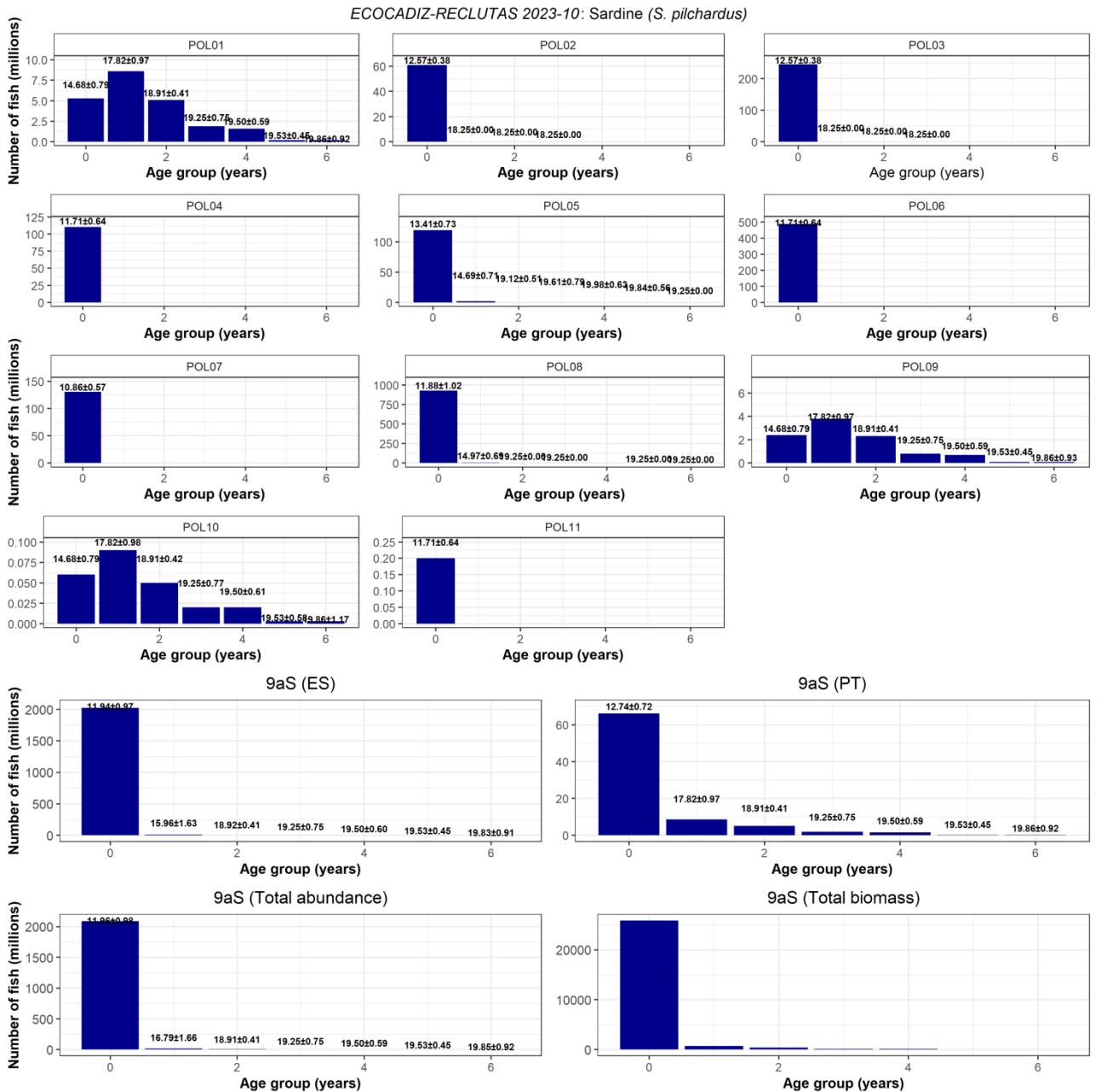


Figure 14. ECOCADIZ-RECLUTAS 2023-10 survey. Sardine (*Sardina pilchardus*). Estimated abundances (number of fish in millions) by age group (years) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 12**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by age group for the whole sampled area is also shown for comparison. Note the different scale in the y axis.

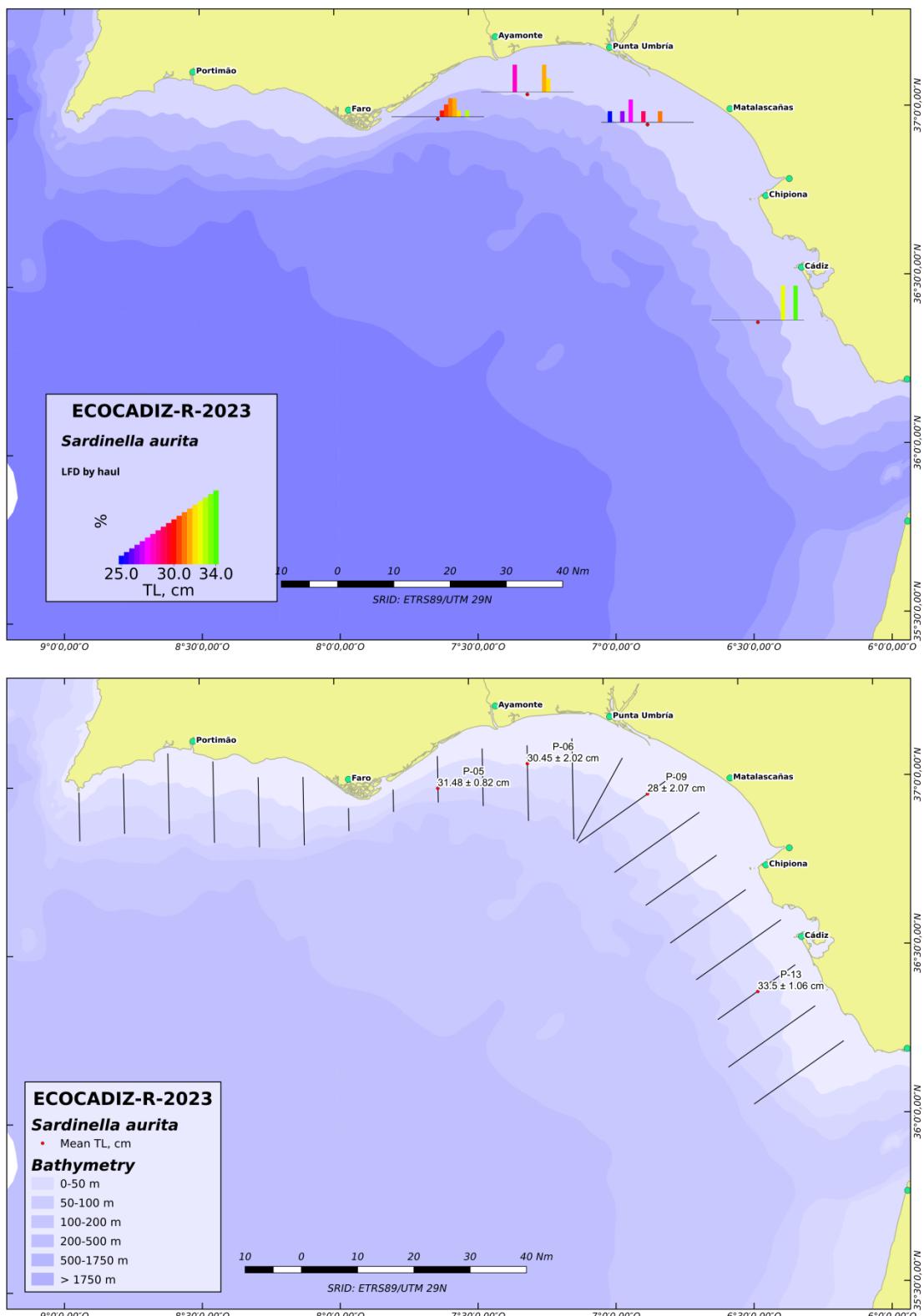


Figure 15. ECOCADIZ-RECLUTAS 2023-10 survey. Round sardinella (*Sardinella aurita*). Top: length frequency distributions in fishing hauls. Bottom: mean \pm sd length by haul.

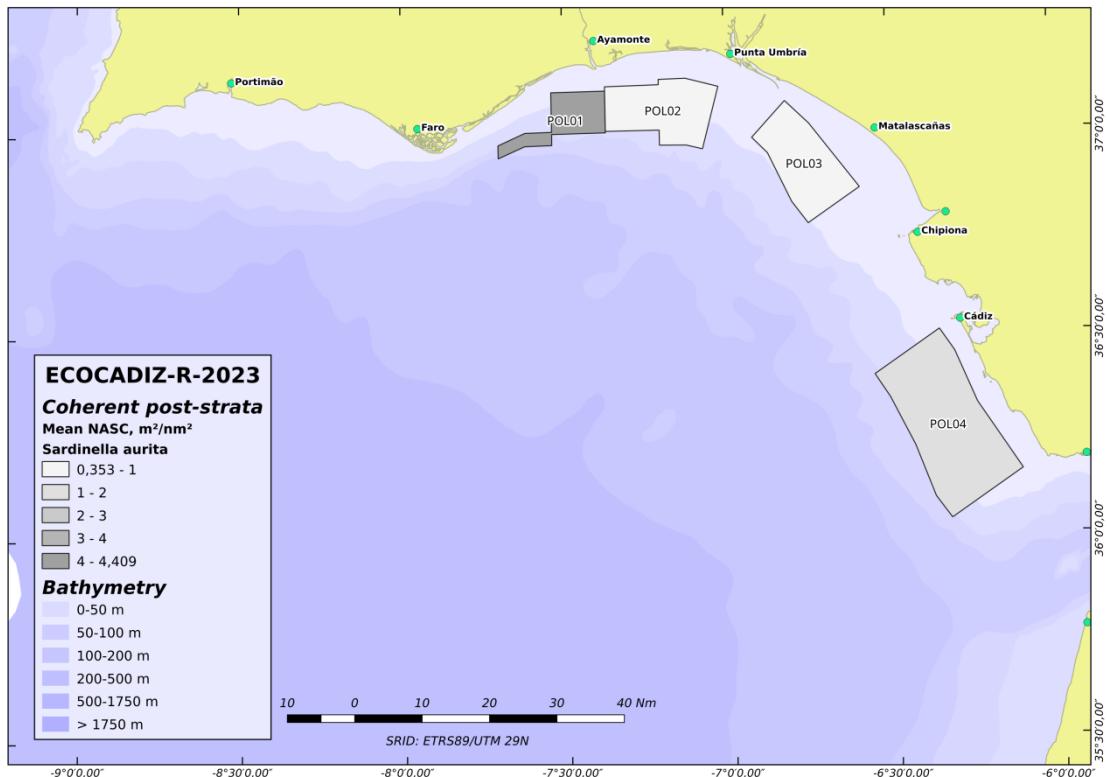
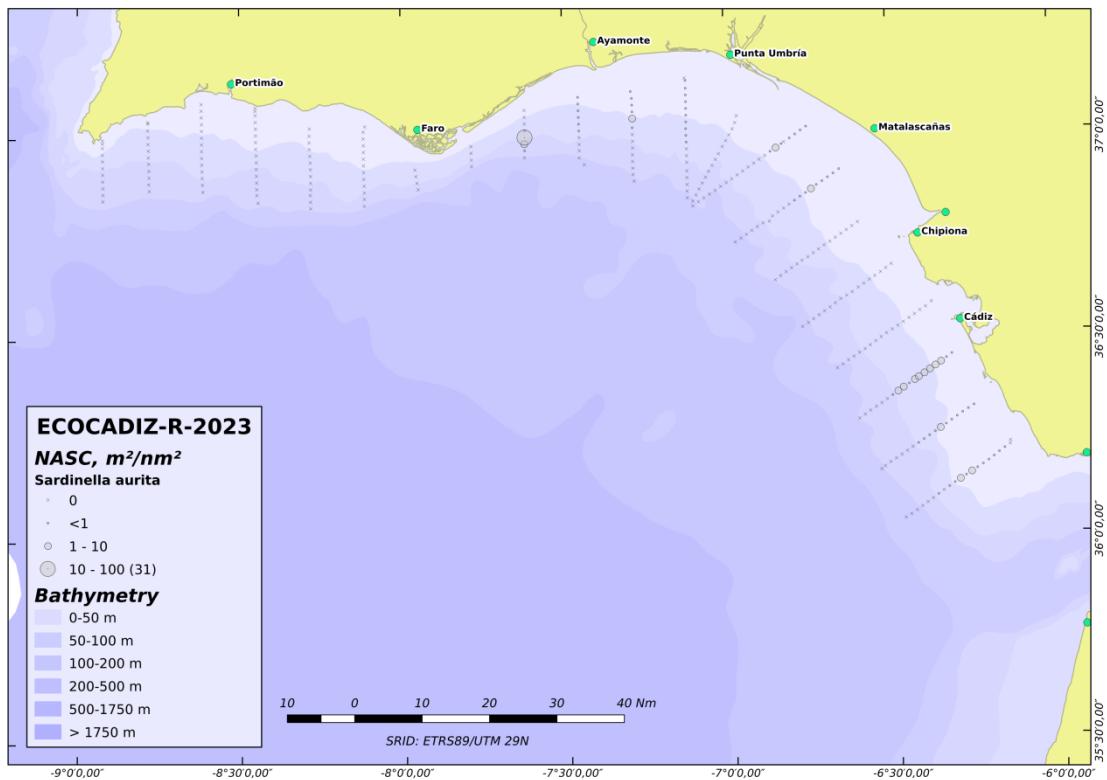


Figure 16. ECOCADIZ-RECLUTAS 2023-10 survey. Round sardinella (*Sardinella aurita*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2 nm^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Color scale according to the mean value of the backscattering energy attributed to the species in each stratum.

ECOCADIZ-RECLUTAS 2023-10: Round sardinella (*S. aurita*)

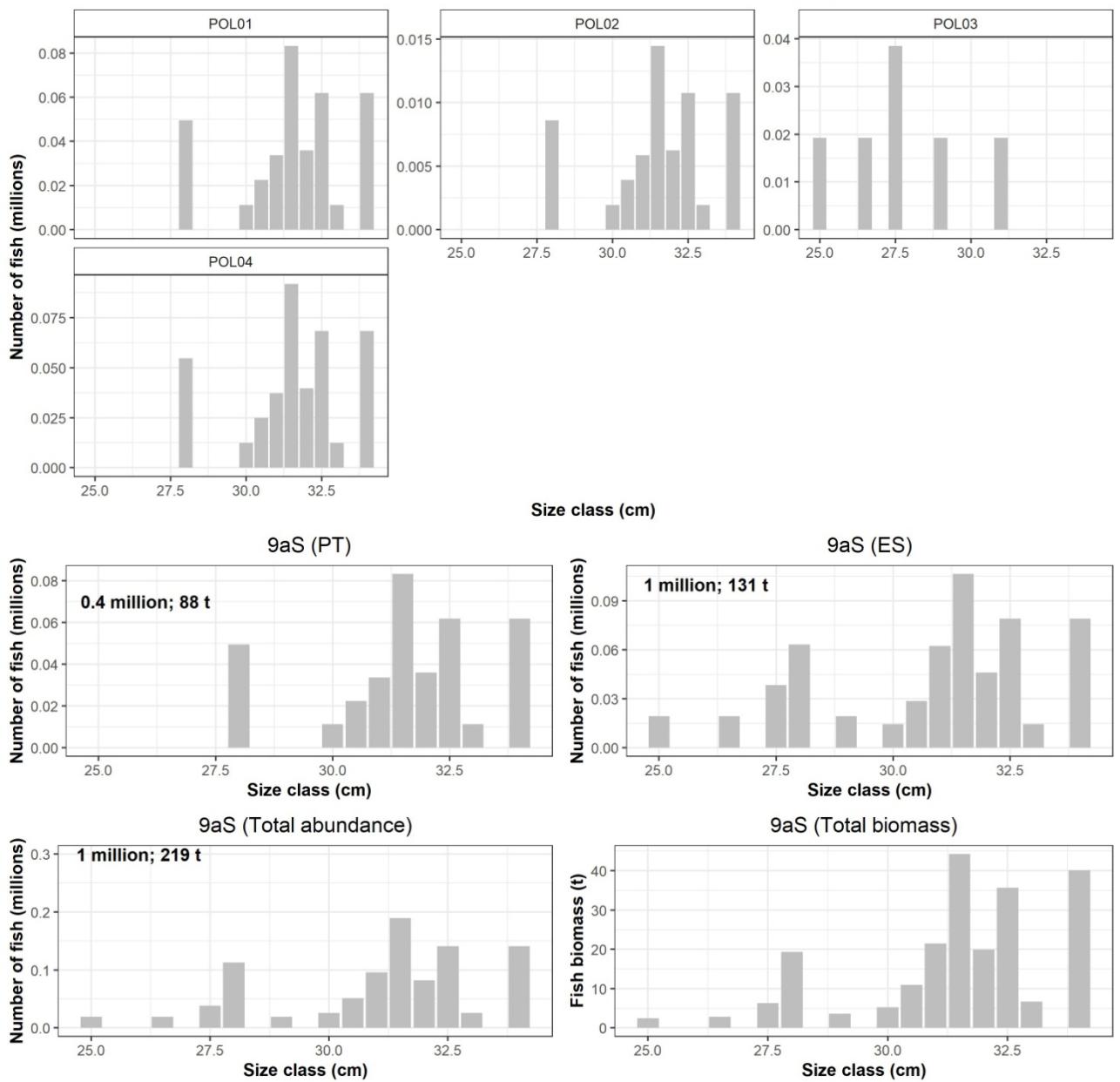


Figure 17. ECOCADIZ-RECLUTAS 2023-10 survey. Round sardinella (*Sardinella aurita*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 16**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the y axis

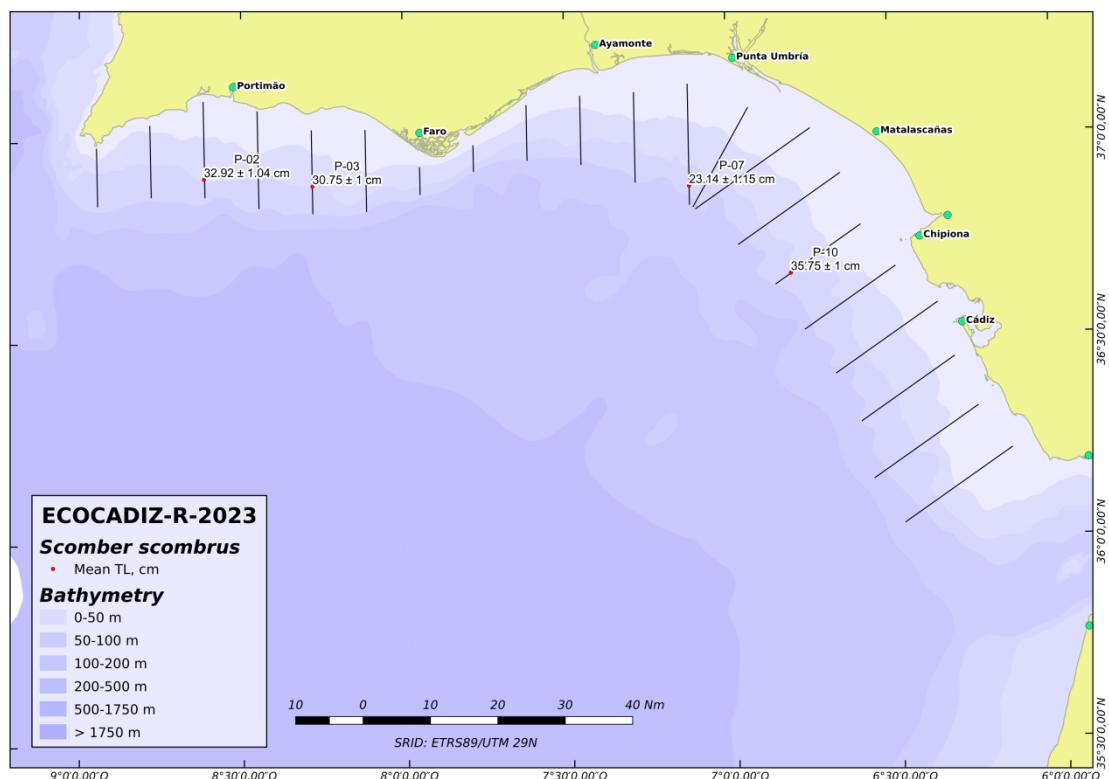
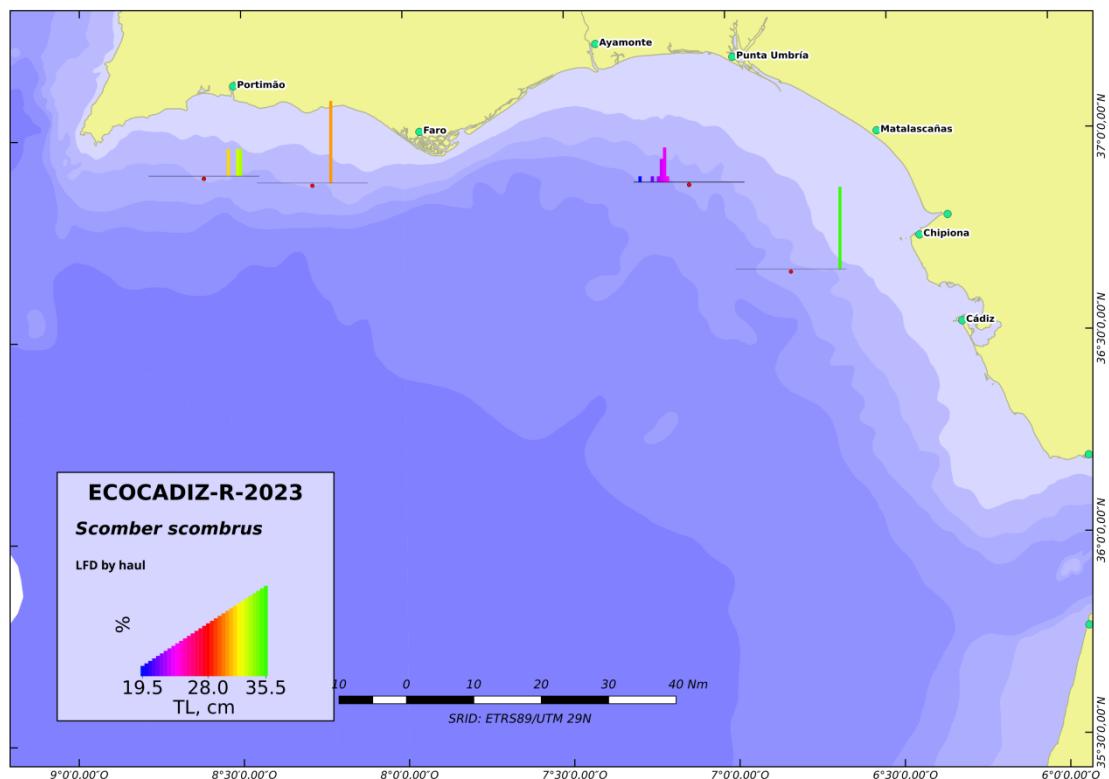


Figure 18. ECOCADIZ-RECLUTAS 2023-10 survey. Atlantic mackerel (*Scomber scombrus*). Top: length frequency distributions in fishing hauls. Bottom: mean \pm sd length by haul.

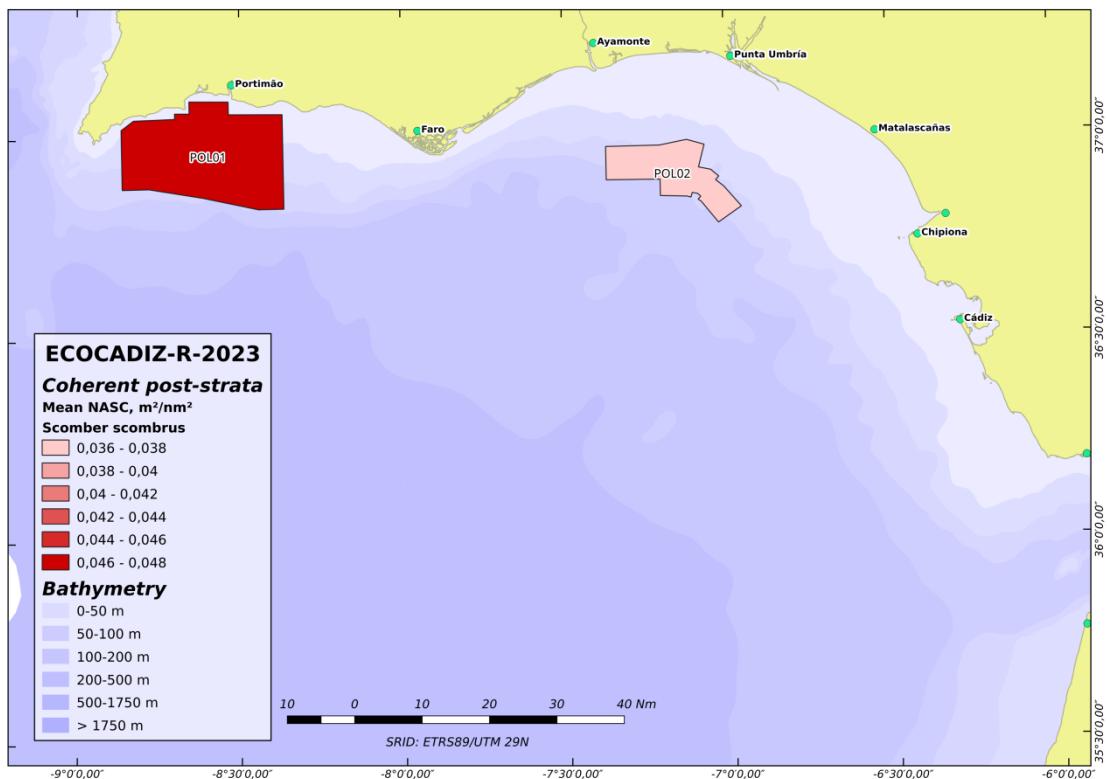
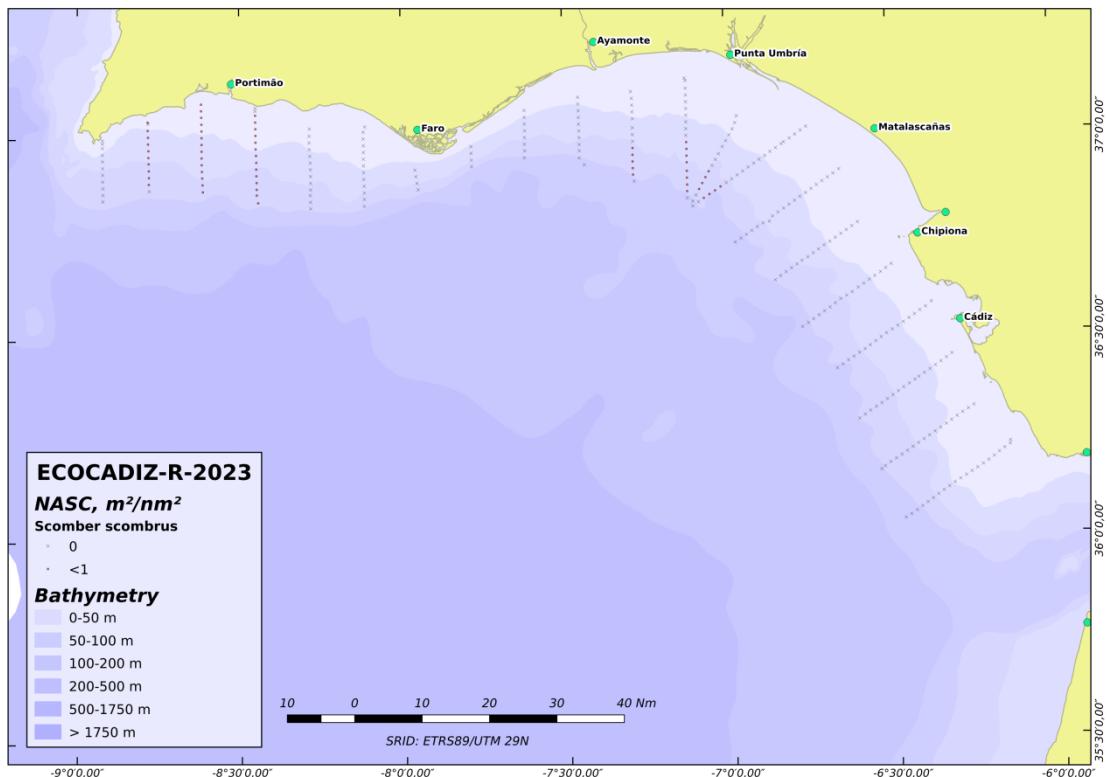


Figure 19. ECOCADIZ-RECLUTAS 2023-10 survey. Atlantic mackerel (*Scomber scombrus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2 nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

ECOCADIZ-RECLUTAS 2023-10: Mackerel (*S. scombrus*)

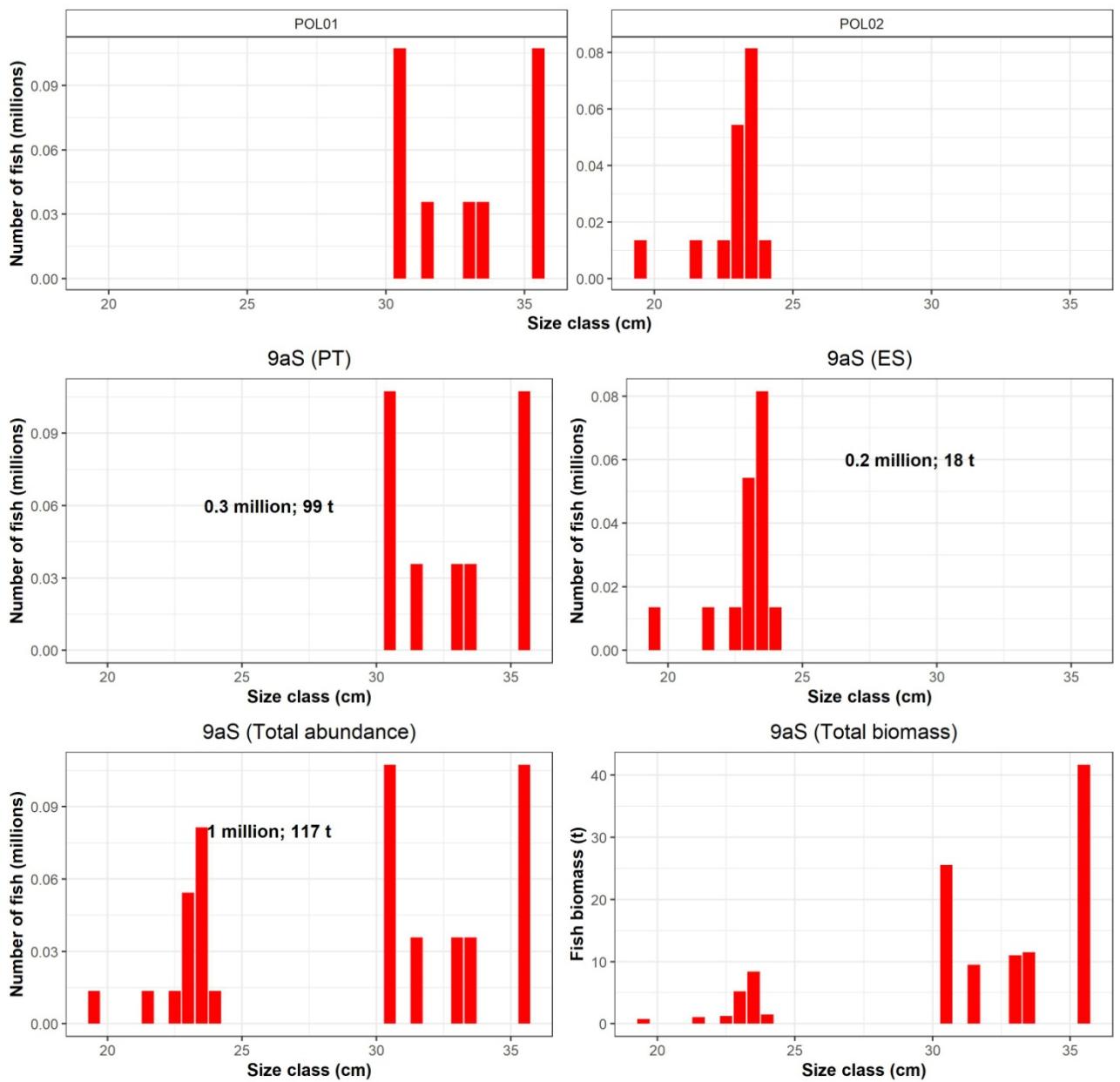


Figure 20. ECOCADIZ-RECLUTAS 2023-10 survey. Atlantic mackerel (*Scomber scombrus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 19**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the y-axis.

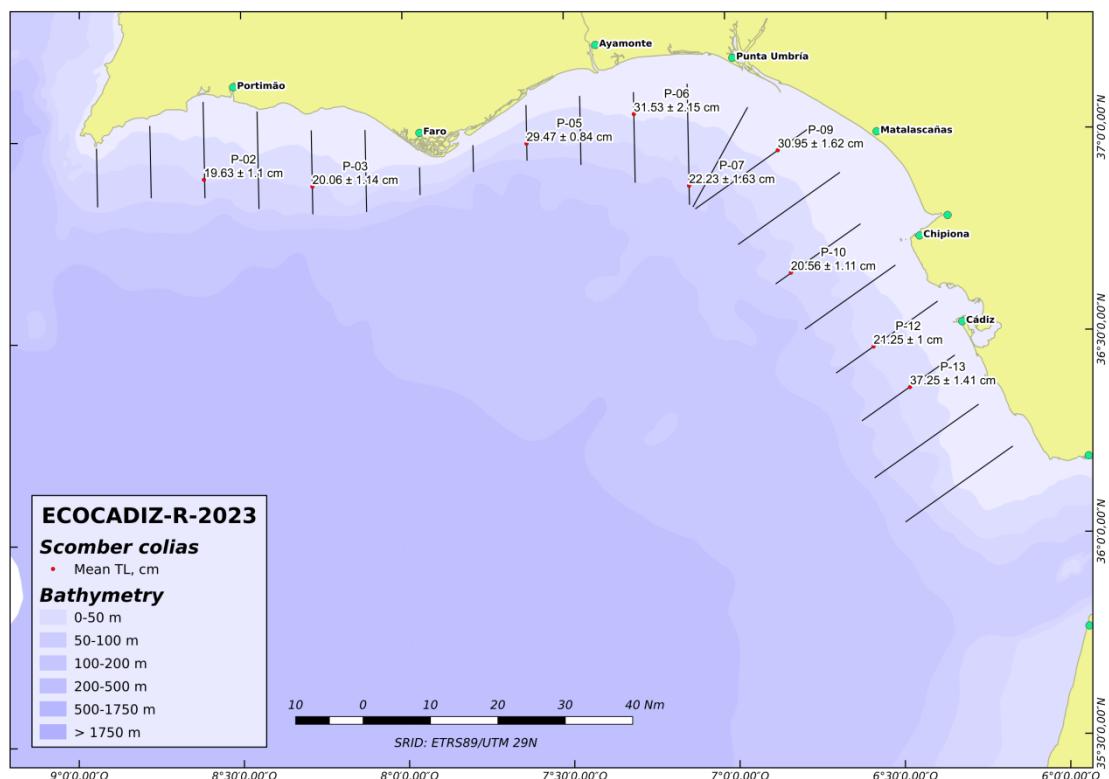
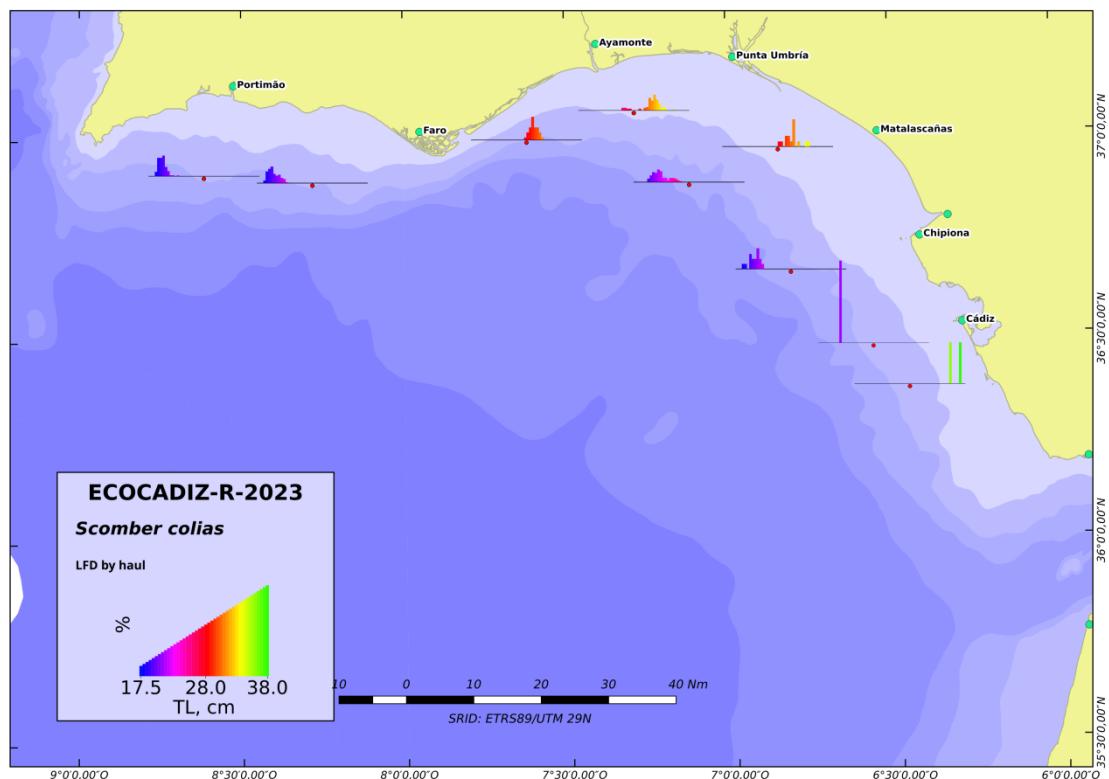


Figure 21. ECOCADIZ-RECLUTAS 2023-10 survey. Chub mackerel (*Scomber colias*). Top: length frequency distributions in fishing hauls. Bottom: mean \pm sd length by haul.

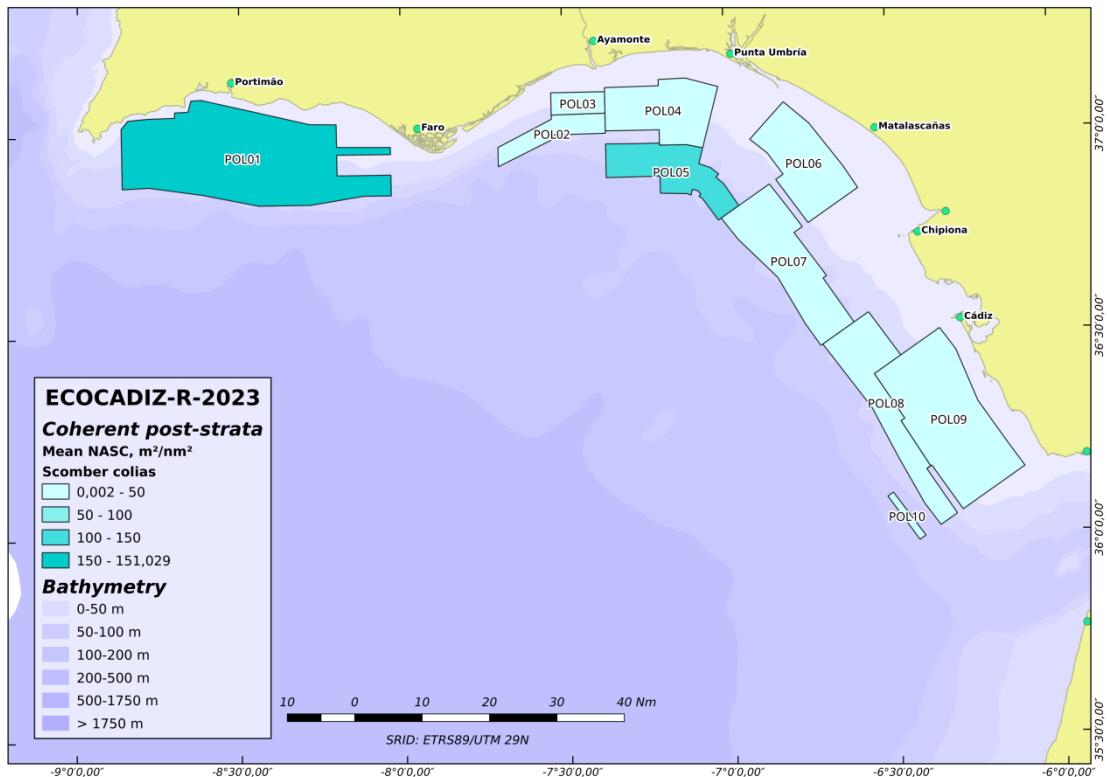
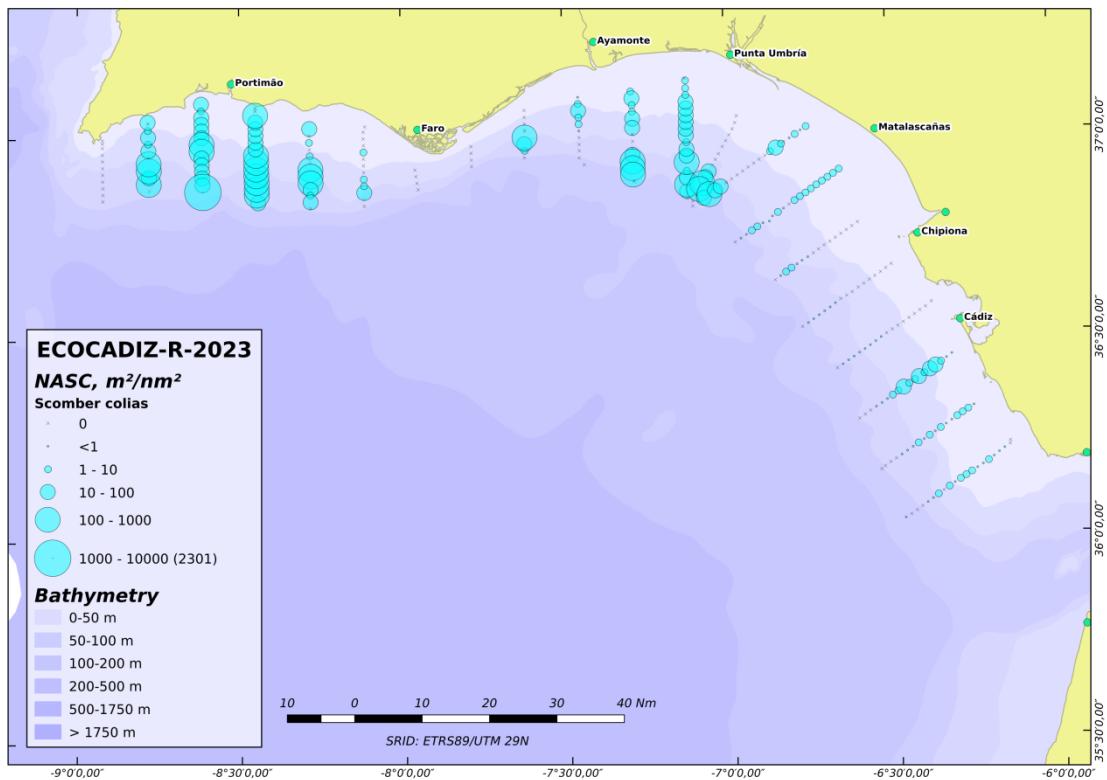


Figure 22. ECOCADIZ-RECLUTAS 2023-10 survey. Chub mackerel (*Scomber colias*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2 nm^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

ECOCADIZ-RECLUTAS 2023-10: Chub mackerel (*S. colias*)

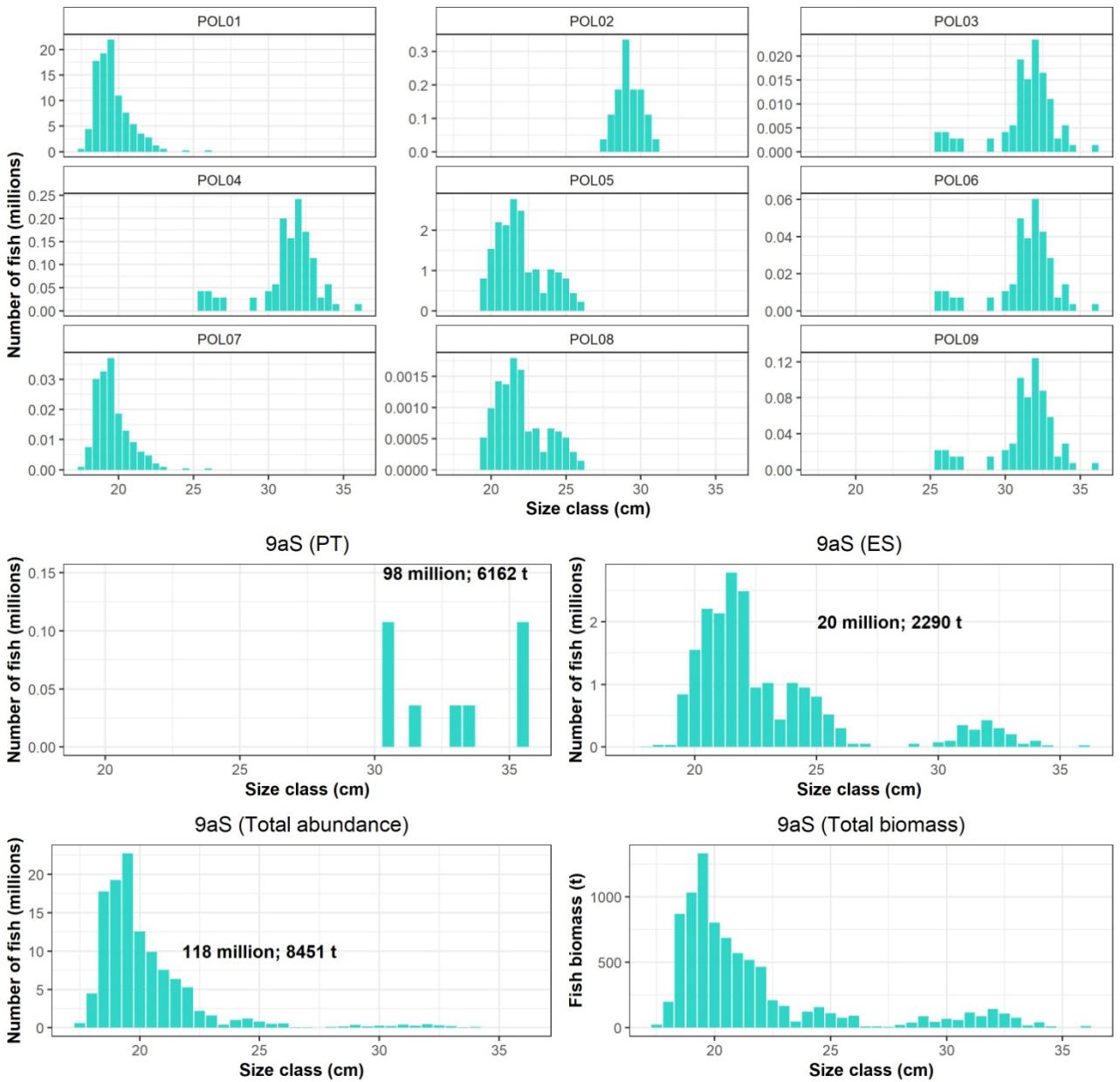


Figure 23. ECOCADIZ-RECLUTAS 2023-10 survey. Chub mackerel (*Scomber colias*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 22**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the y-axis.

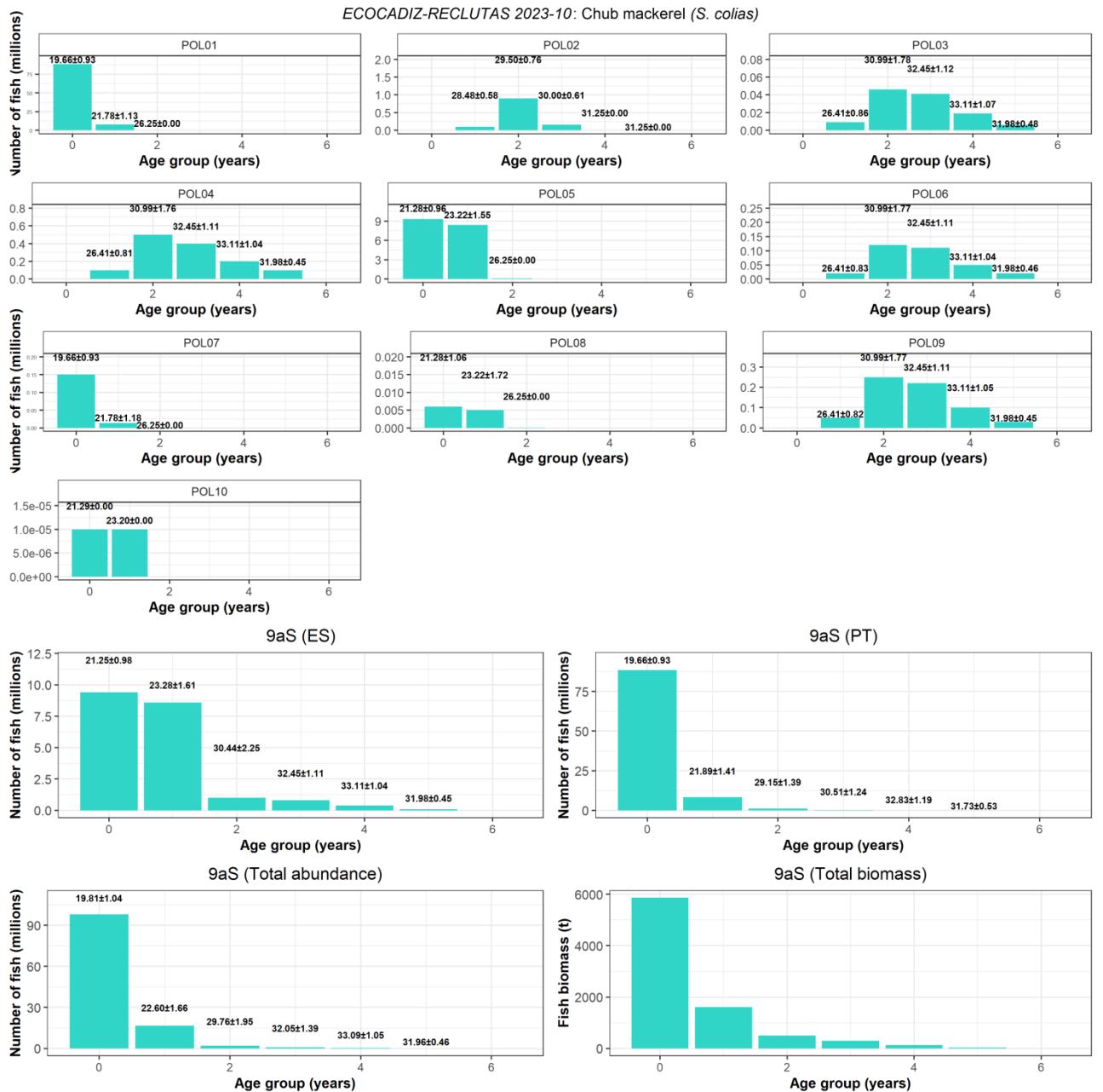


Figure 24. ECOCADIZ-RECLUTAS 2023-10 survey. Chub mackerel (*Scomber colias*). Estimated abundances (number of fish in millions) by age group (years) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 22**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by age group for the whole sampled area is also shown for comparison. Note the different scale in the y-axis.

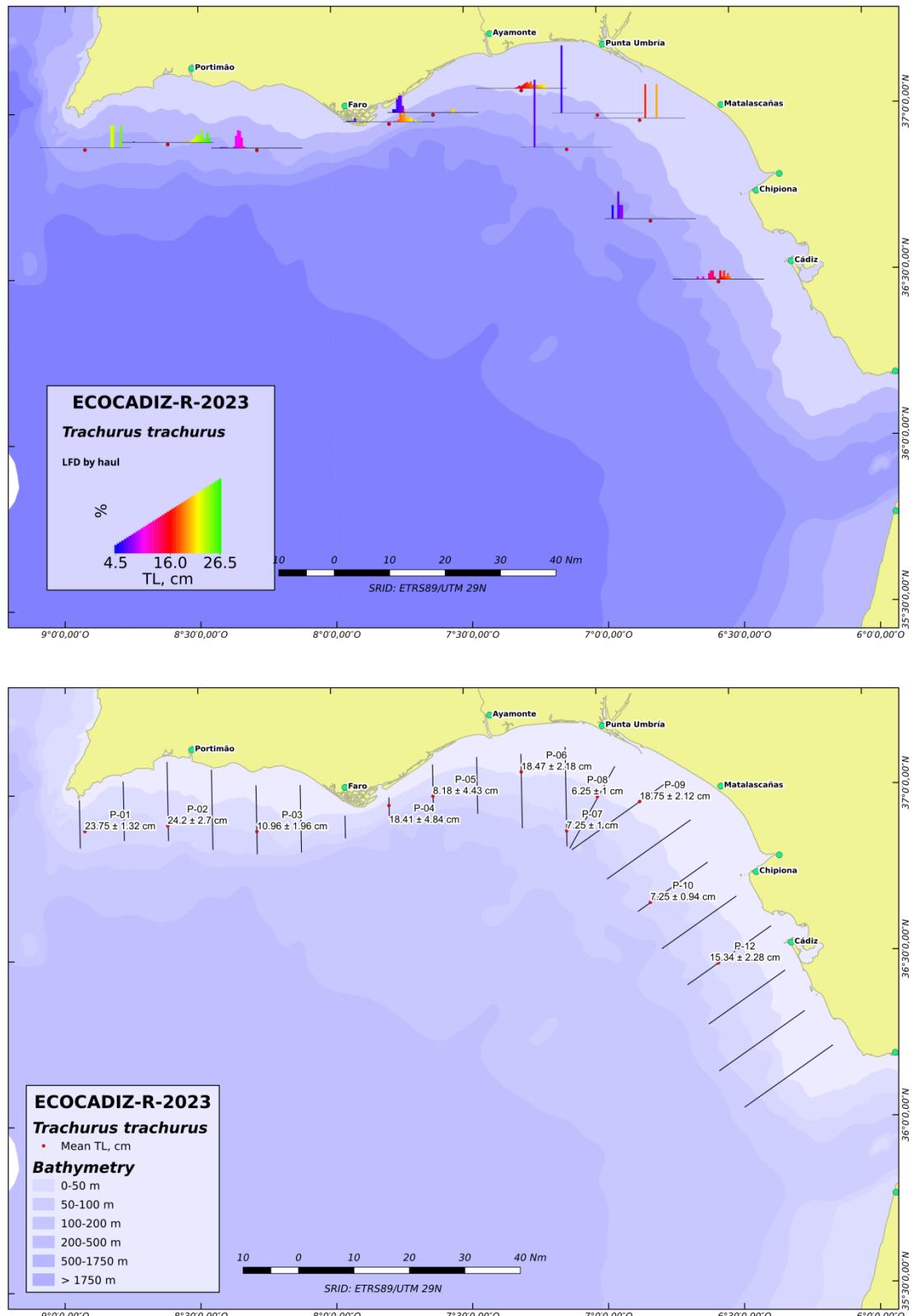


Figure 25. ECOCADIZ-RECLUTAS 2023-10 survey. Horse mackerel (*Trachurus trachurus*). Top: length frequency distributions in fishing hauls. Bottom: mean \pm sd length by haul.

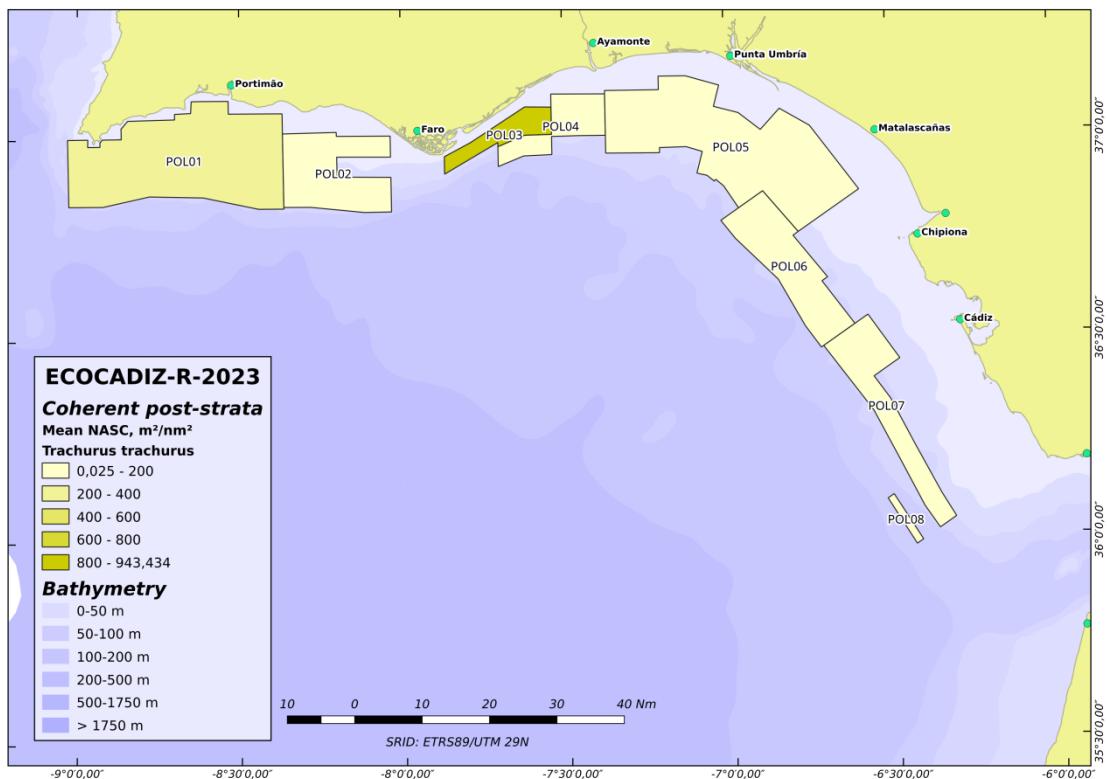
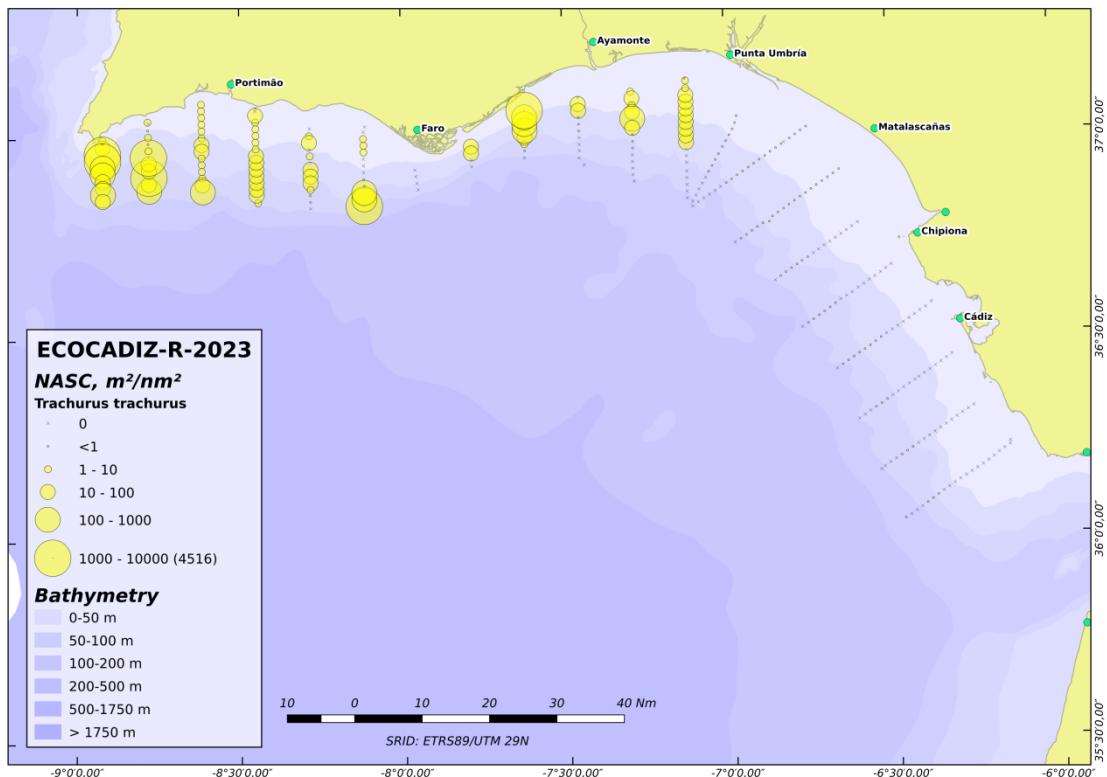


Figure 26. ECOCADIZ-RECLUTAS 2023-10 survey. Horse mackerel (*Trachurus trachurus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in m^2/nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

ECOCADIZ-RECLUTAS 2023-10: Horse mackerel (*T. trachurus*)

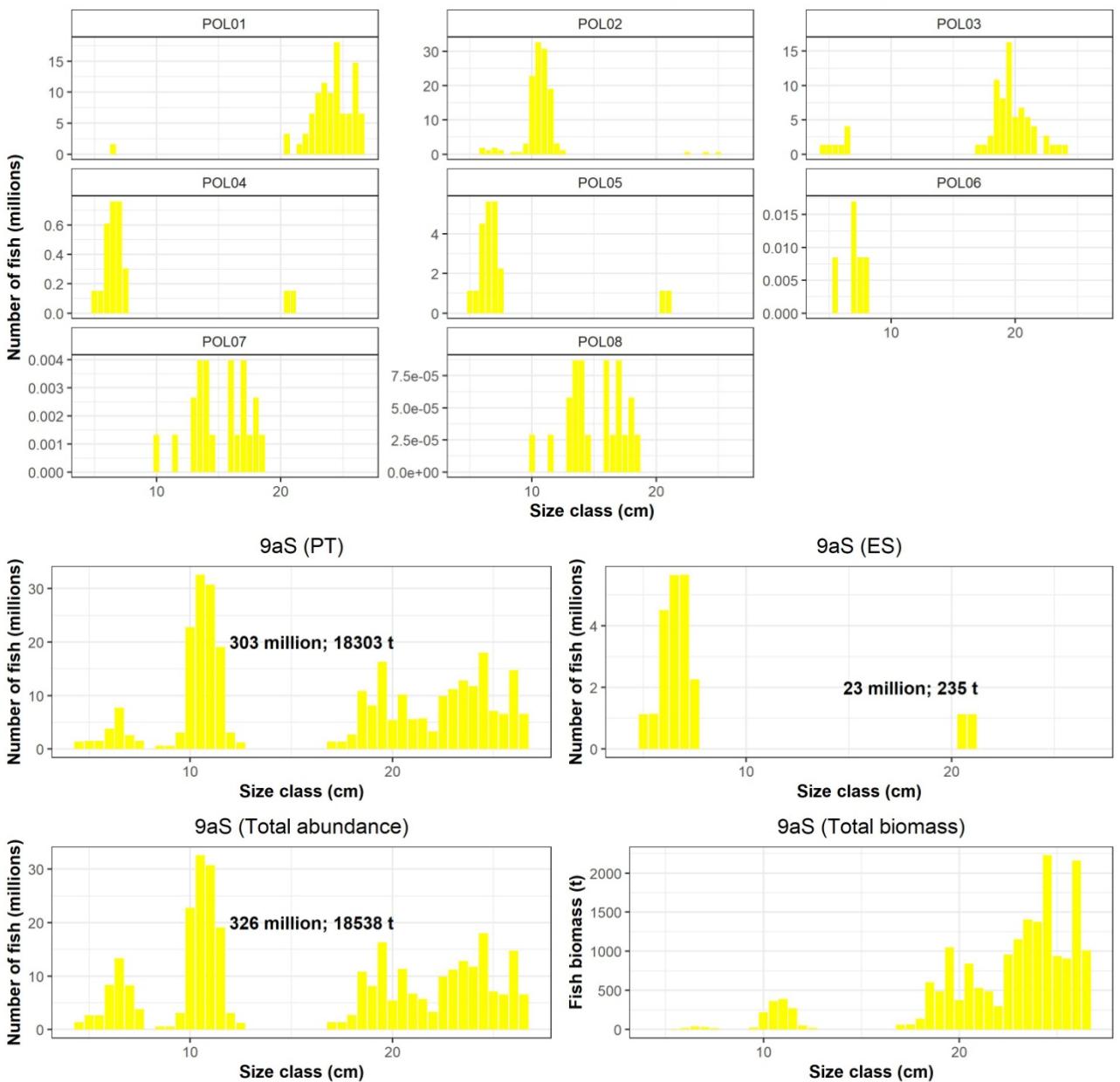


Figure 27. ECOCADIZ-RECLUTAS 2023-10 survey. Horse mackerel (*Trachurus trachurus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POLn, numeration as in **Figure 26**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the y-axis.

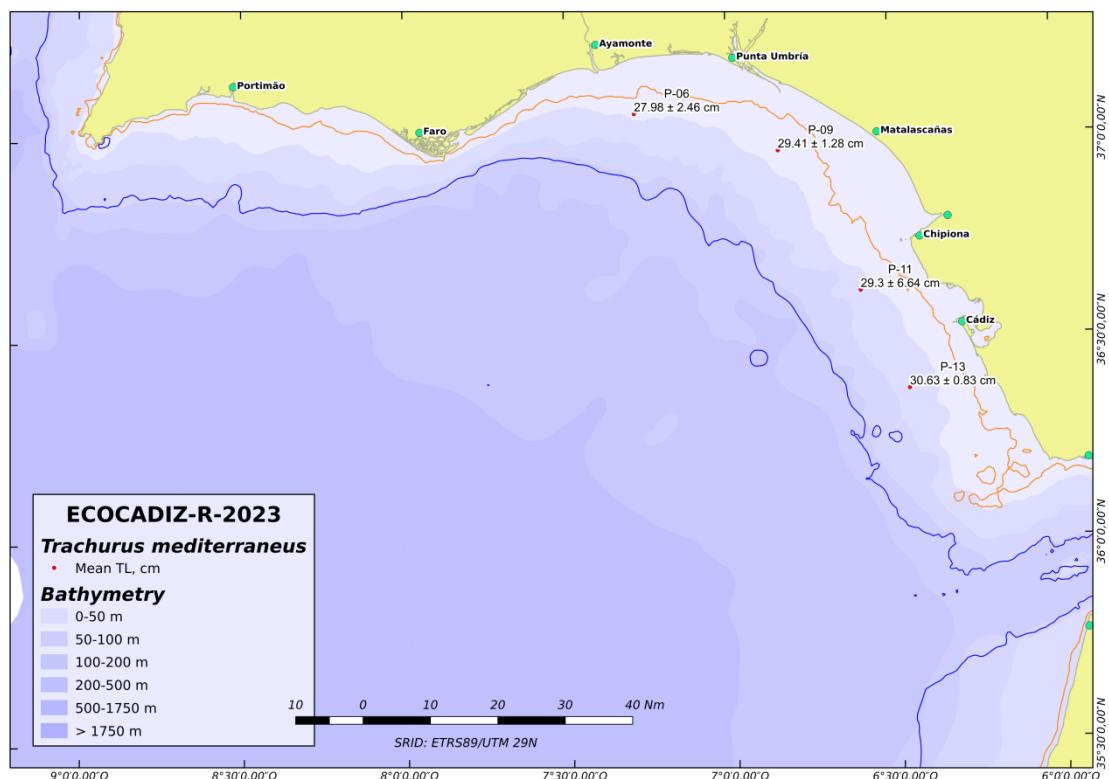
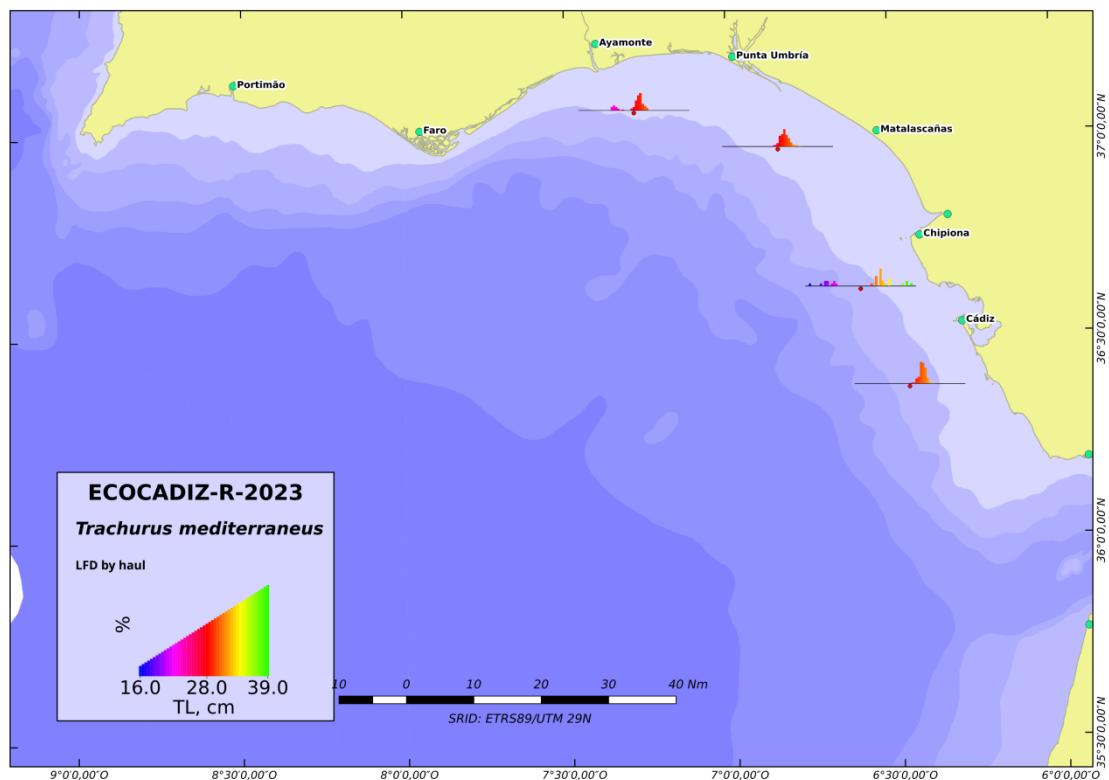


Figure 28. ECOCADIZ-RECLUTAS 2023-10 survey. Mediterranean horse mackerel (*Trachurus mediterraneus*). Top: length frequency distributions in fishing hauls. Bottom: mean \pm sd length by haul.

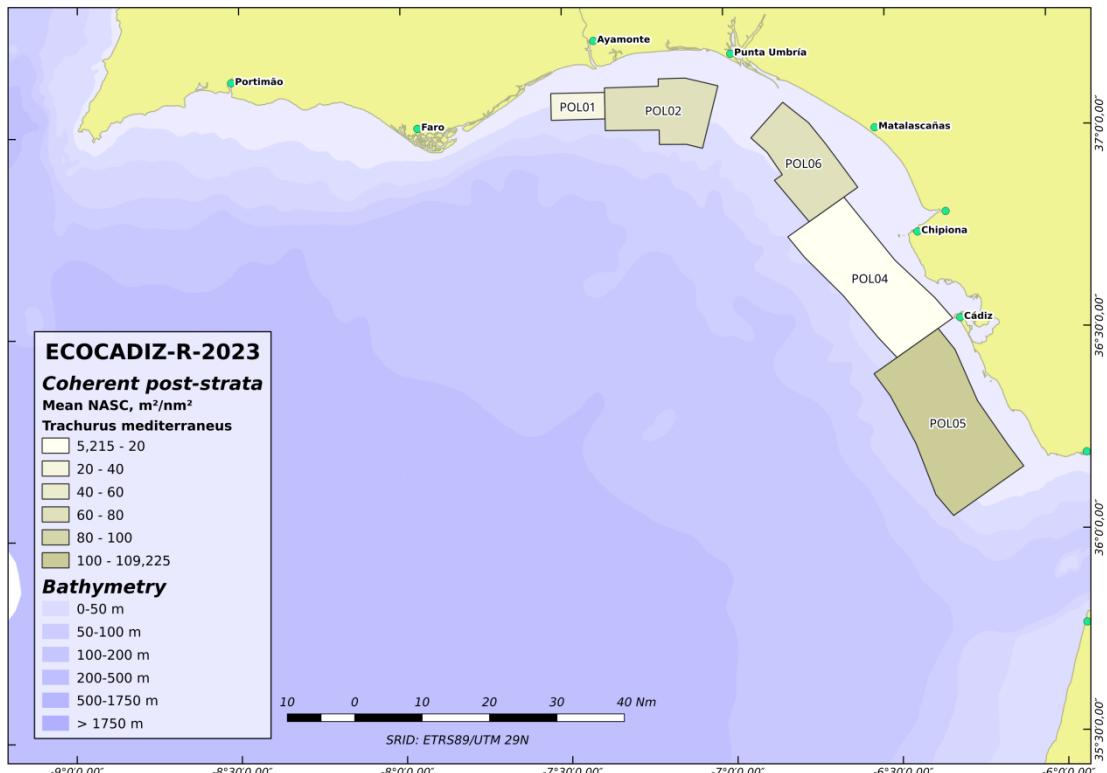
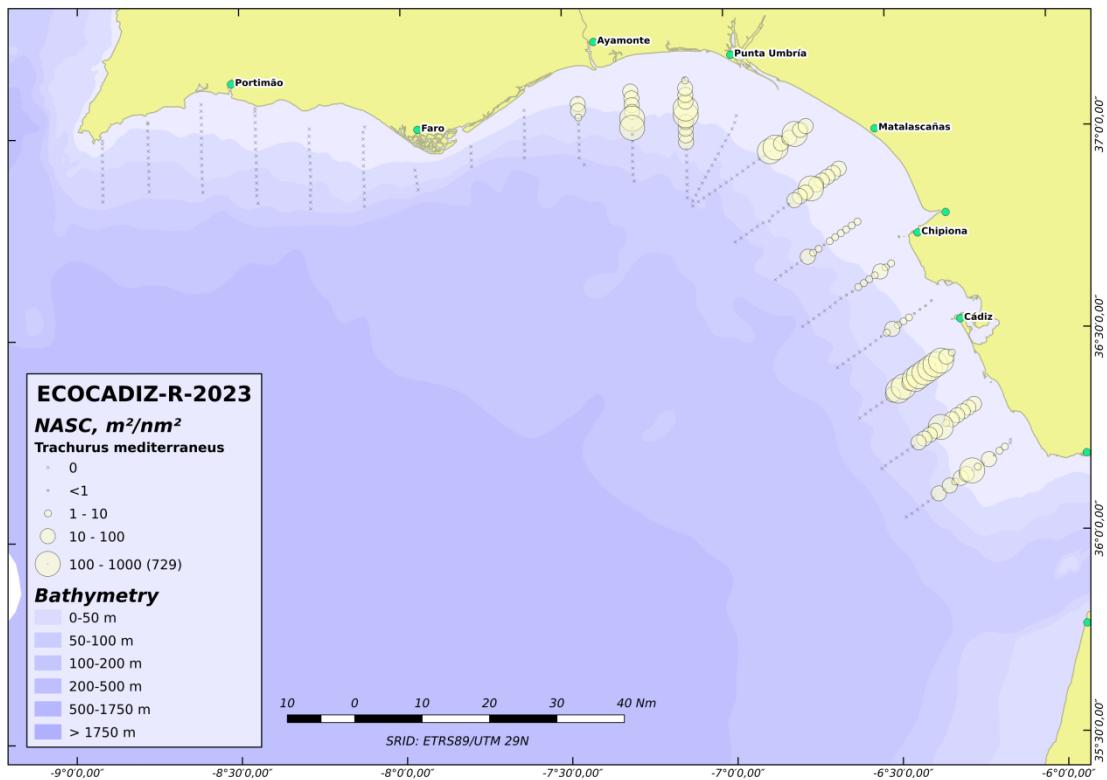


Figure 29. ECOCADIZ-RECLUTAS 2023-10 survey. Mediterranean horse mackerel (*Trachurus mediterraneus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2 nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

ECOCADIZ-RECLUTAS 2023-10: Mediterranean horse mackerel (*T. mediterraneus*)

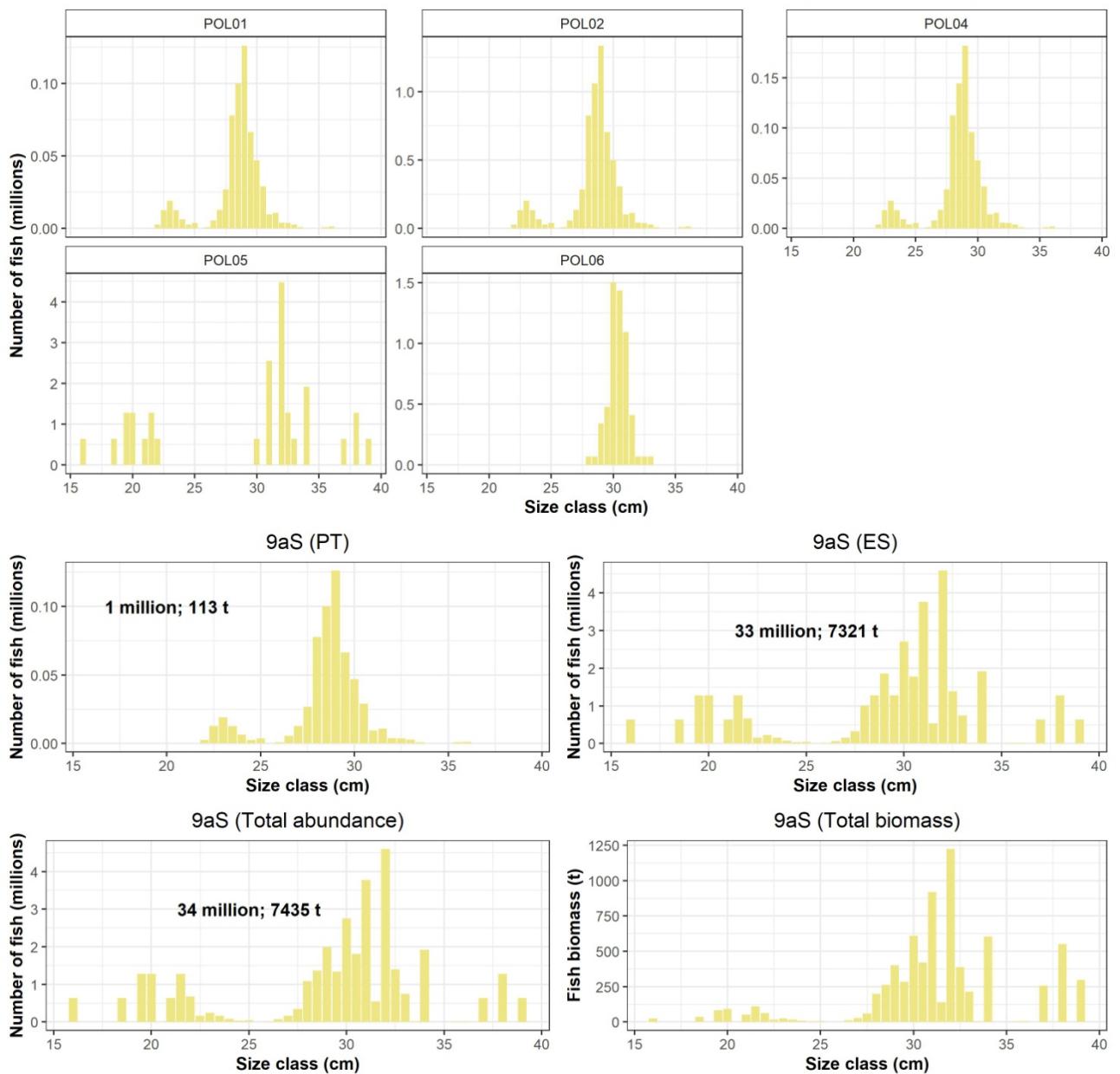


Figure 30. ECOCADIZ-RECLUTAS 2023-10 survey. Mediterranean horse mackerel (*Trachurus mediterraneus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 29**) and total sampled area. Post-strata ordered in the W-E 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.

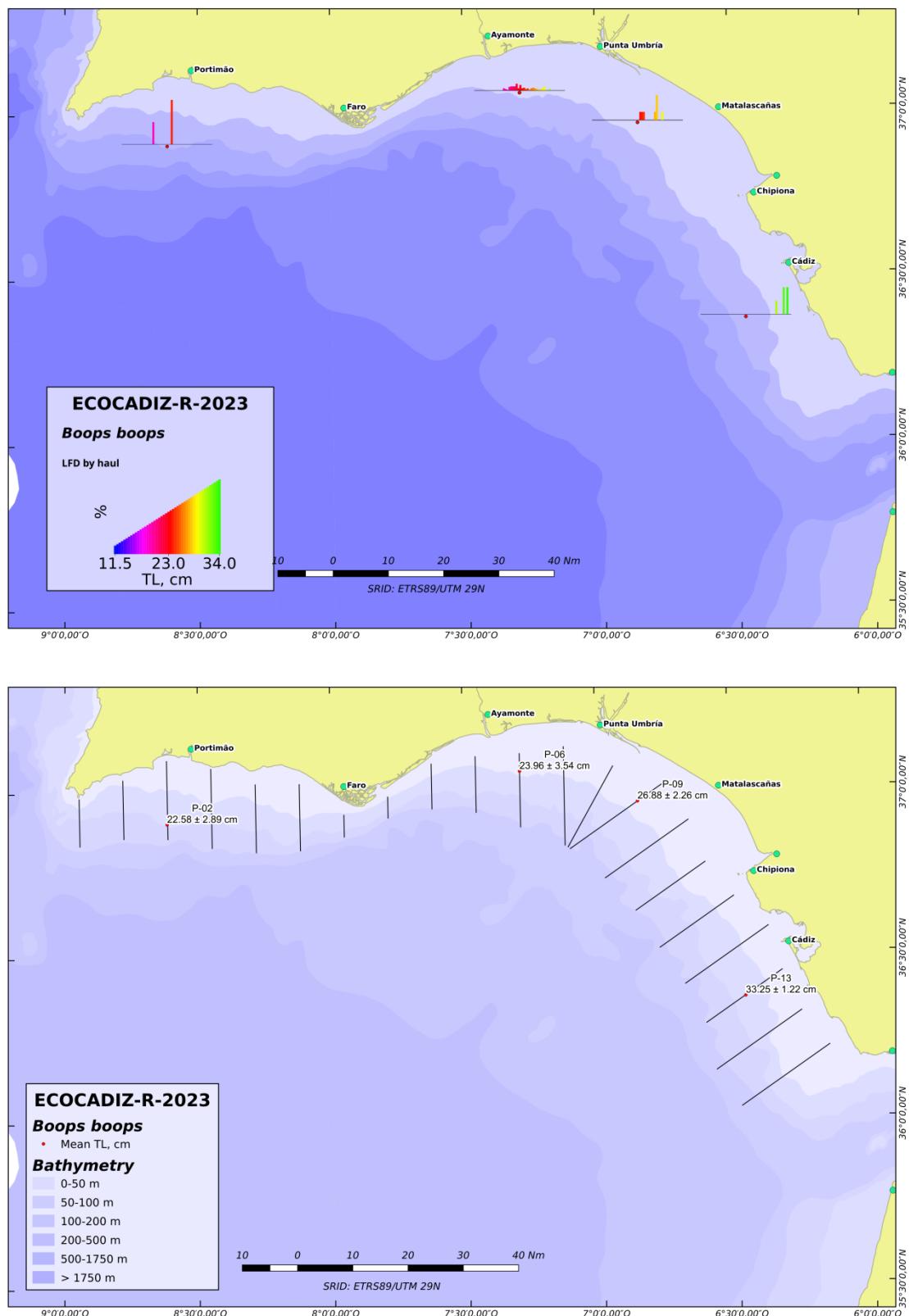


Figure 31. ECOCADIZ-RECLUTAS 2023-10 survey. Bogue (*Boops boops*). Top: length frequency distributions in fishing hauls. Bottom: mean \pm sd length by haul.

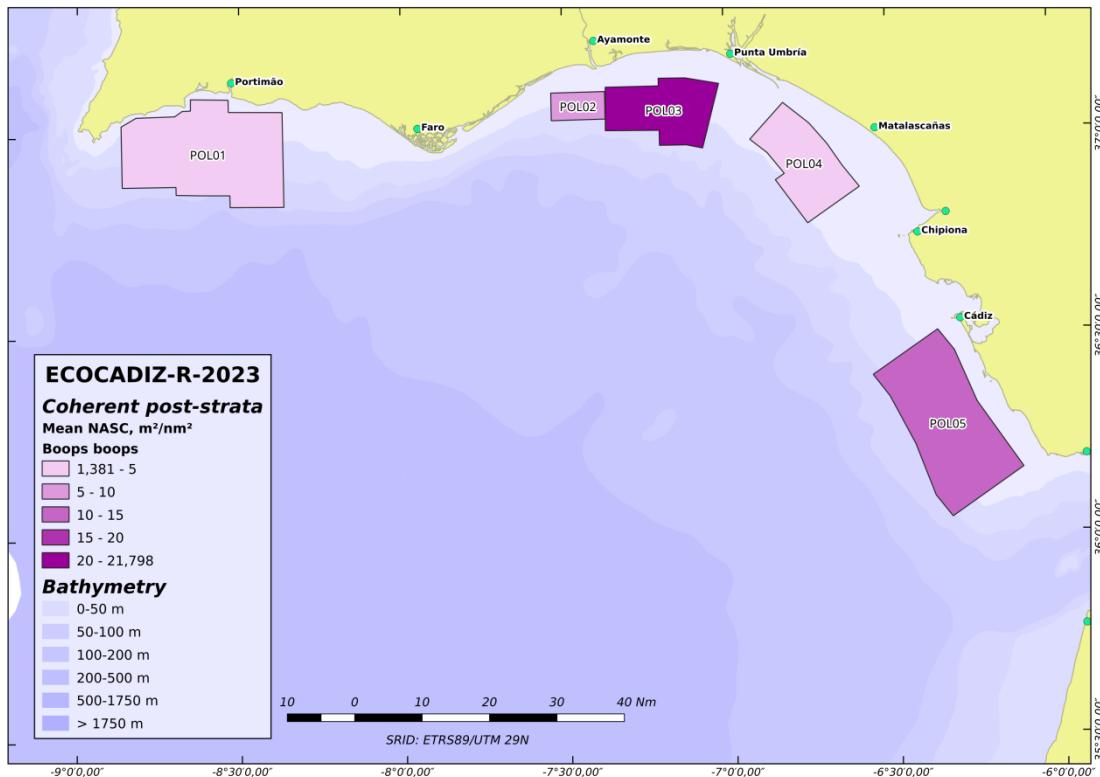
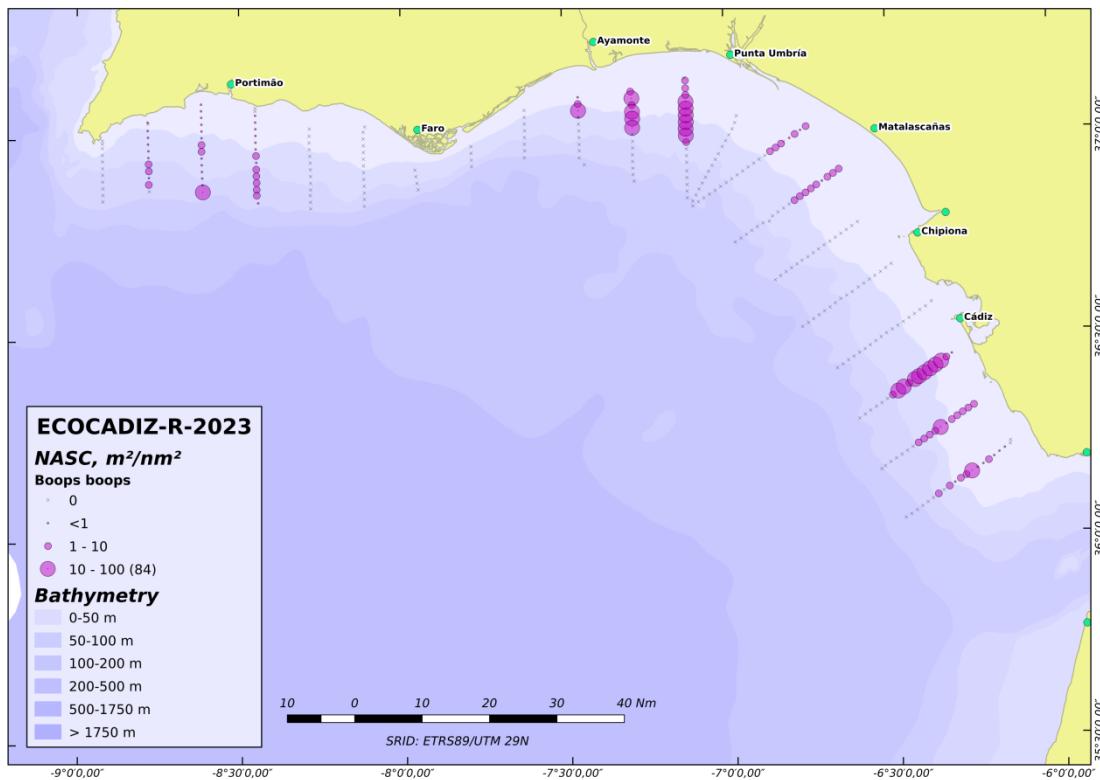


Figure 32. ECOCADIZ-RECLUTAS 2023-10 survey. Bogue (*Boops boops*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $\text{m}^2 \text{nm}^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

ECOCADIZ-RECLUTAS 2023-10: Bogue (*B. boops*)

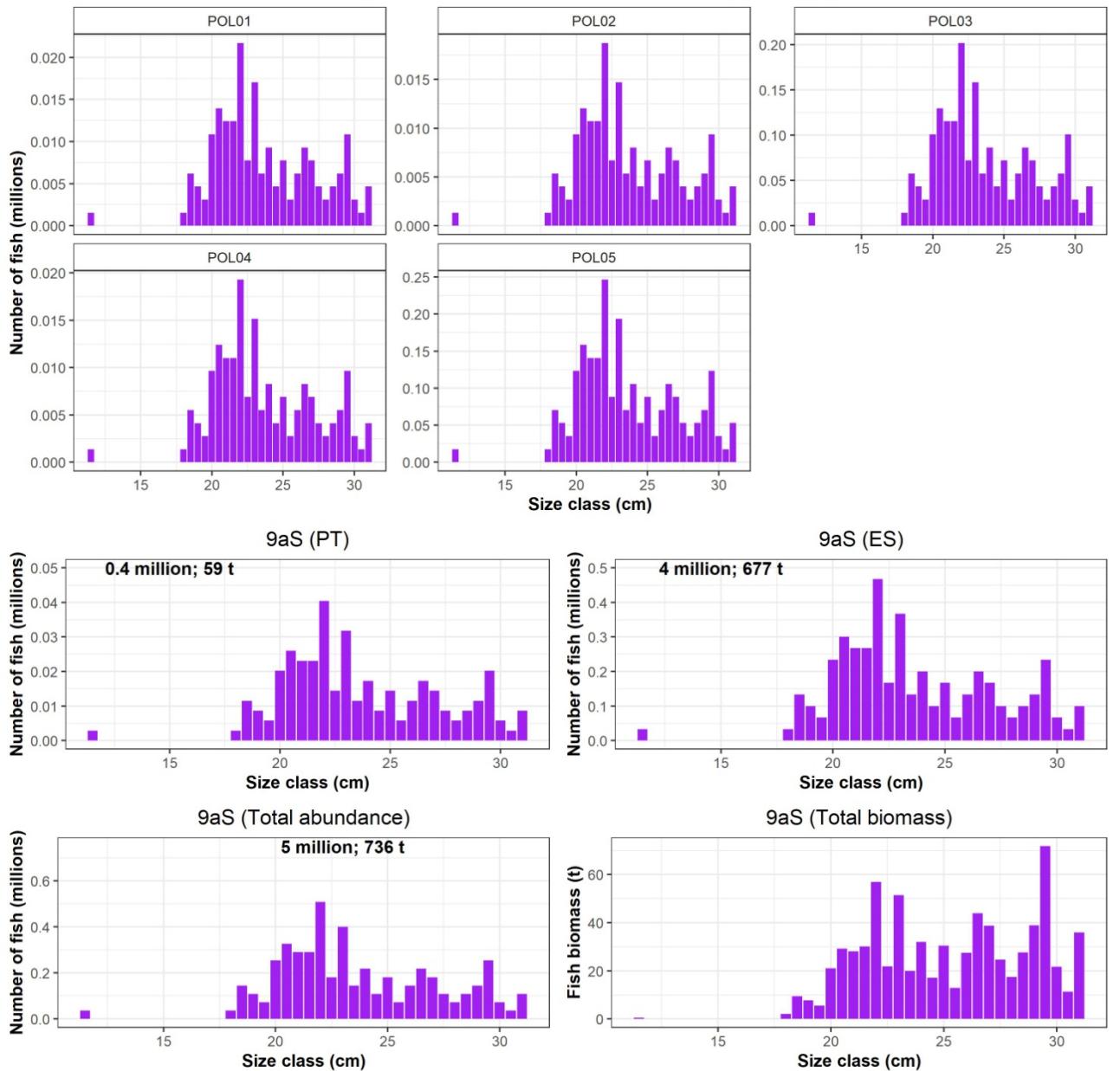


Figure 33. ECOCADIZ-RECLUTAS 2023-10 survey. Bogue (*Boops boops*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 32**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the y-axis.

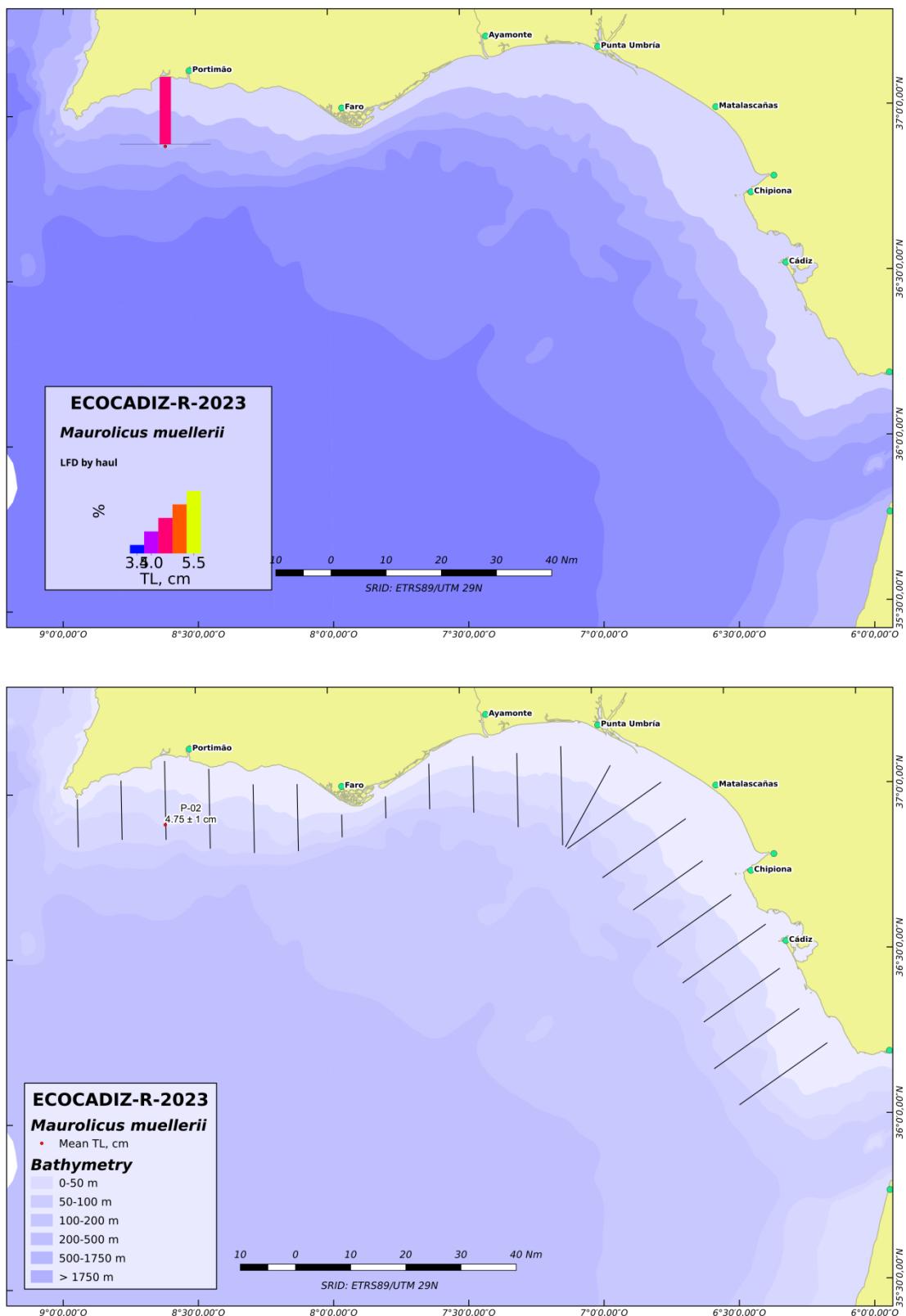


Figure 34. ECOCADIZ-RECLUTAS 2023-10 survey. Pearlside (*Maurolicus muellerii*). Top: length frequency distributions in fishing hauls. Bottom: mean \pm sd length by haul.

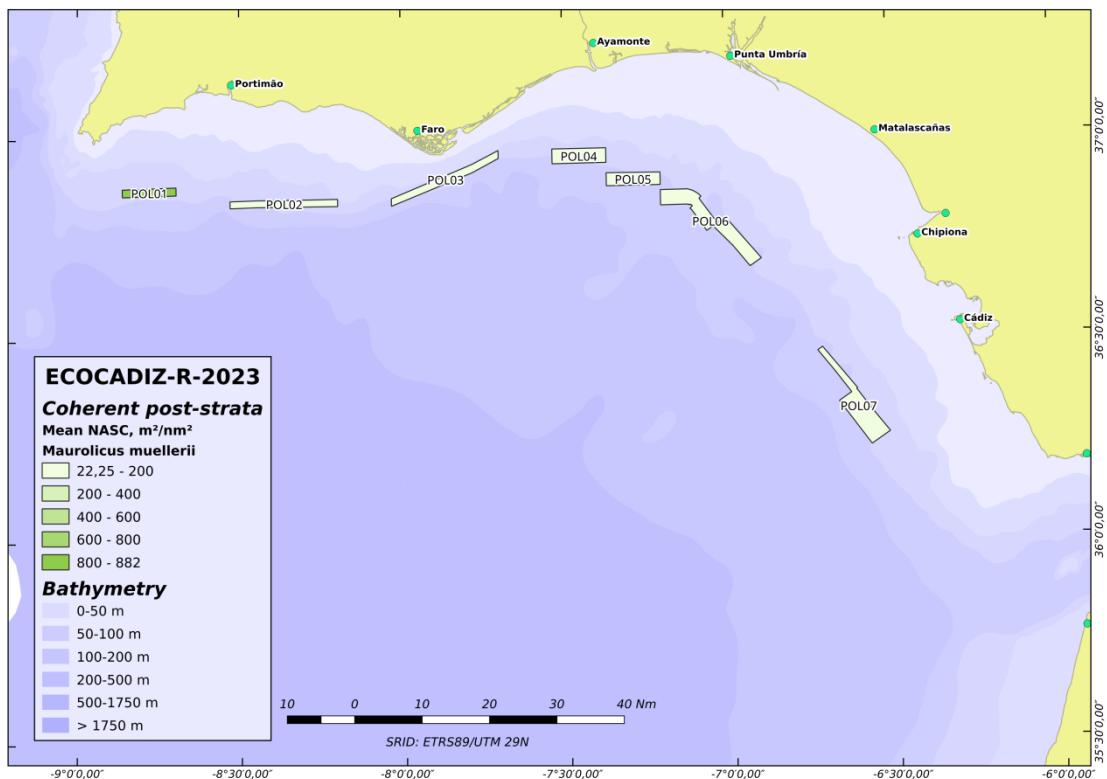
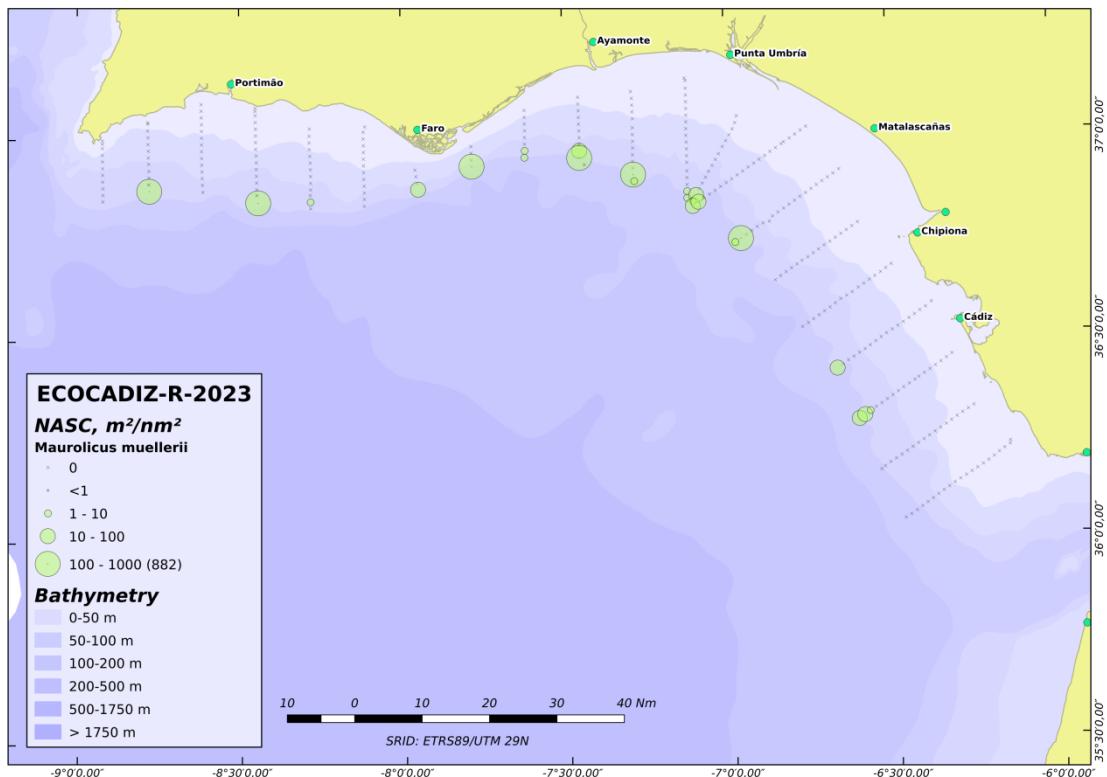


Figure 35. ECOCADIZ-RECLUTAS 2023-10 survey. Pearlside (*Maurolicus muelleri*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in m^2/nm^2) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

ECOCADIZ-RECLUTAS 2023-10: Pearlside (*Maurolicus muelleri*)

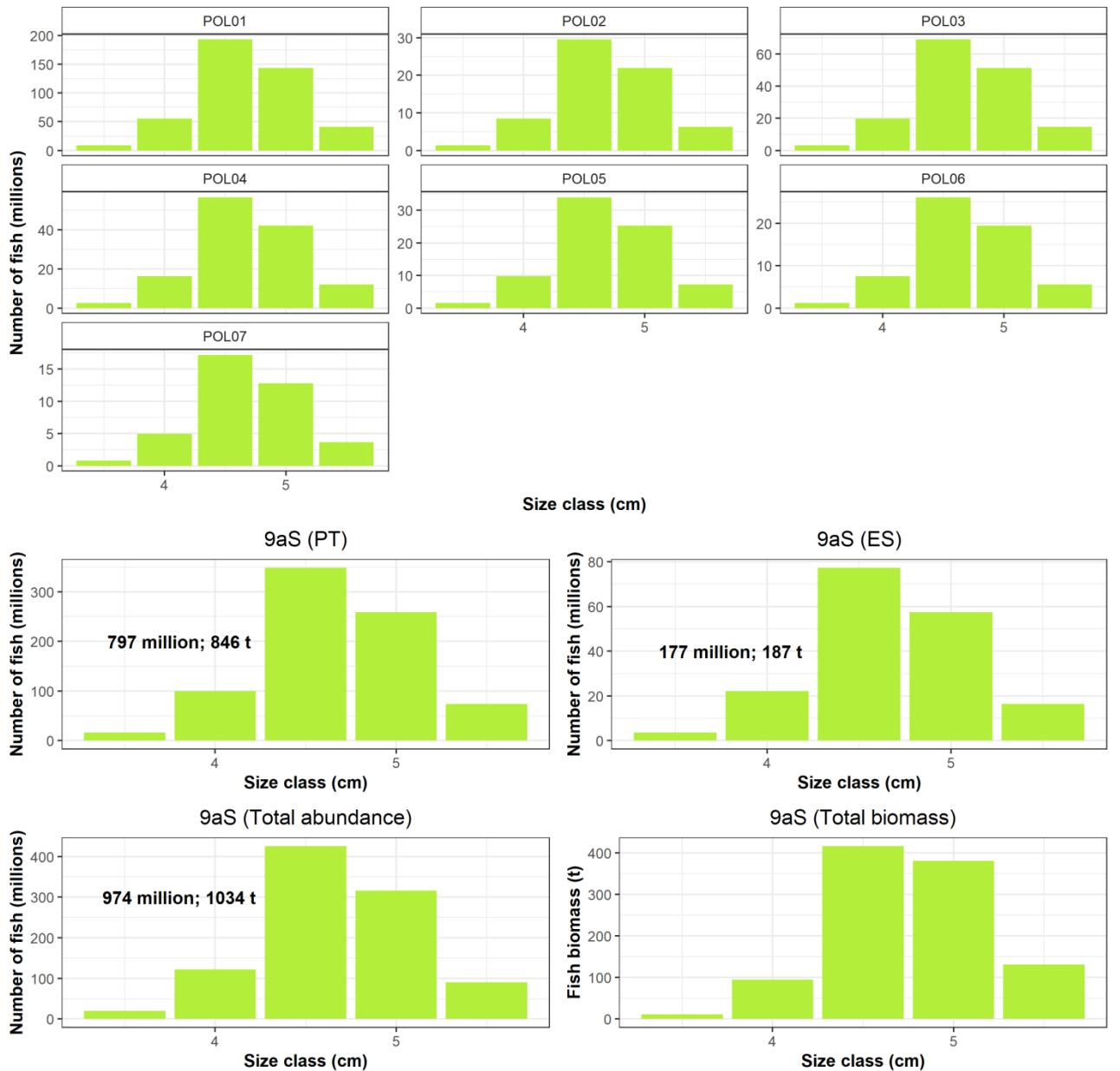


Figure 36. ECOCADIZ-RECLUTAS 2023-10 survey. Pearlside (*Maurolicus muelleri*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 35**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the y-axis.

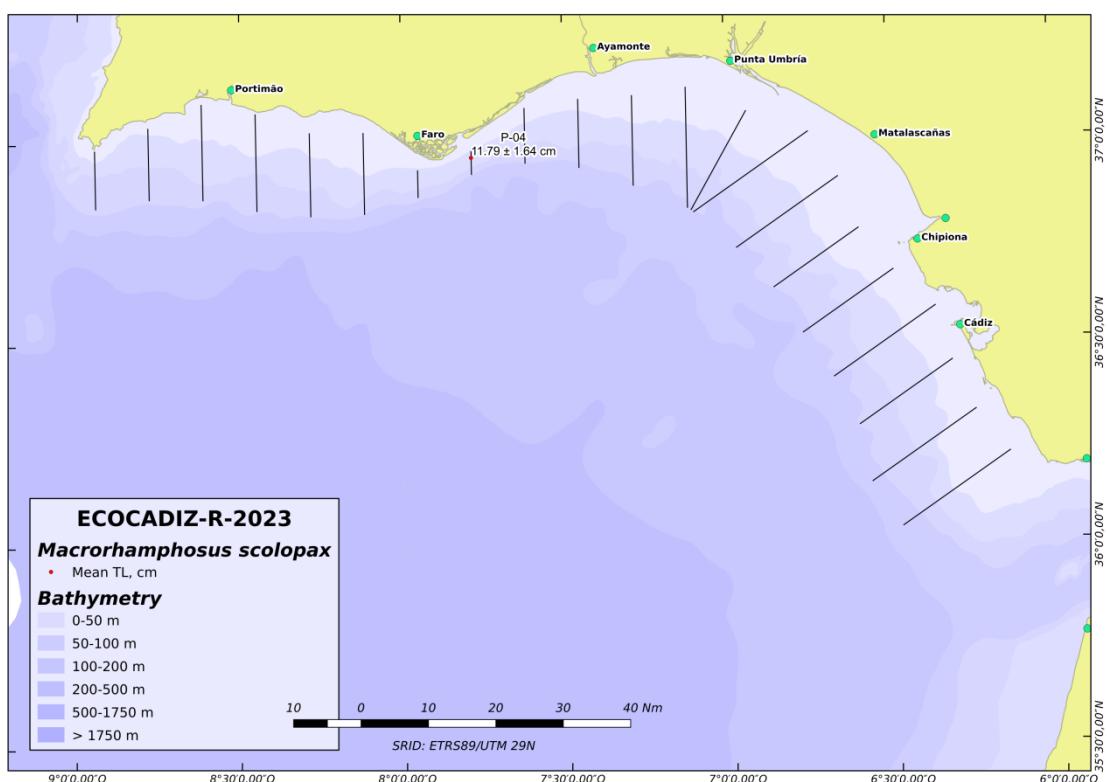
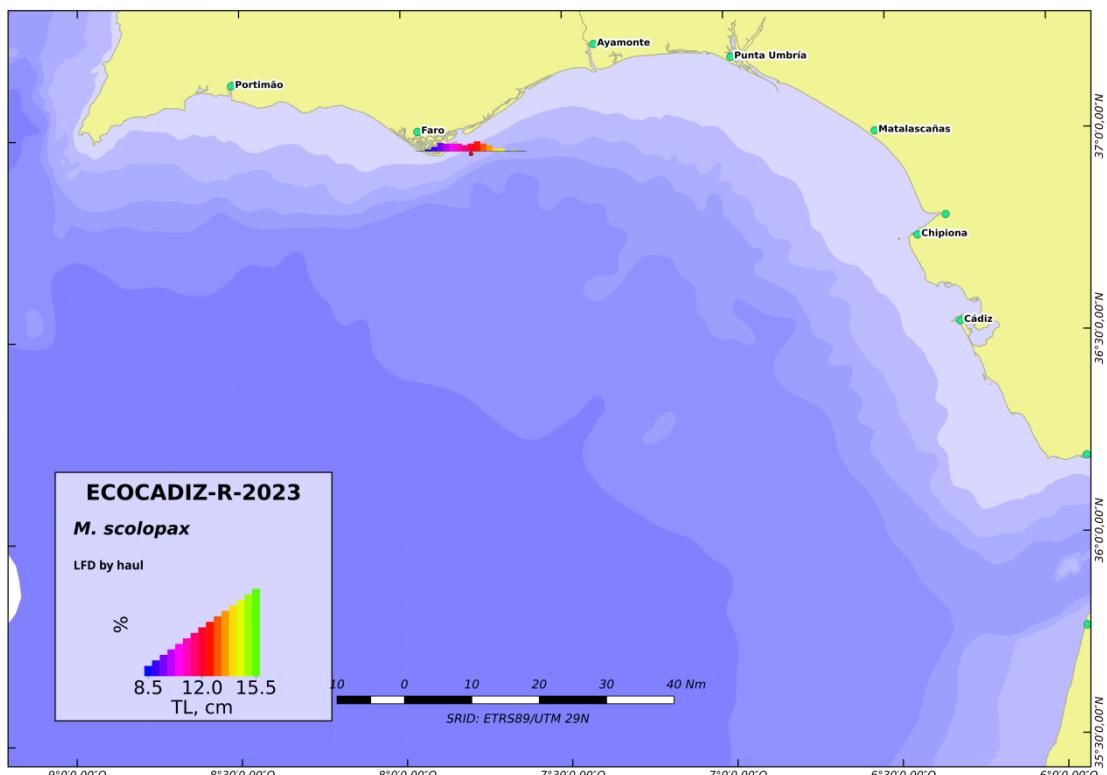


Figure 37. ECOCADIZ-RECLUTAS 2023-10 survey. Longspine snipefish (*Macrourhamphosus scolopax*). Top: length frequency distributions in fishing hauls. Bottom: mean \pm sd length by haul.

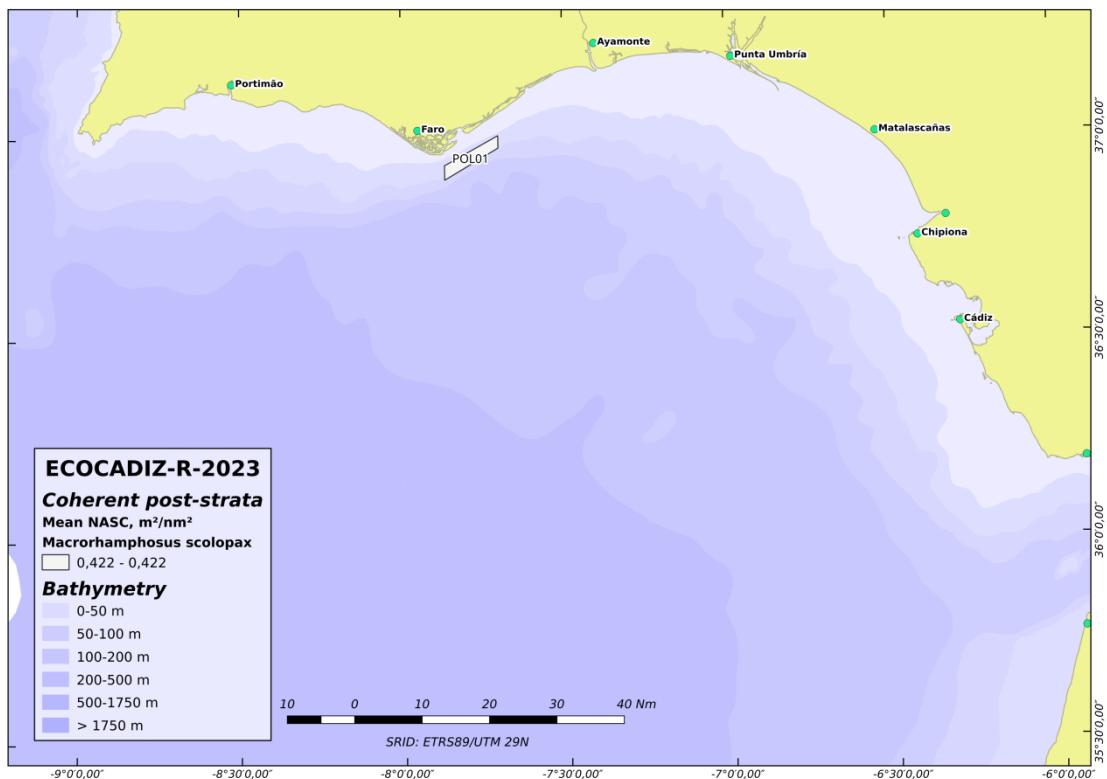
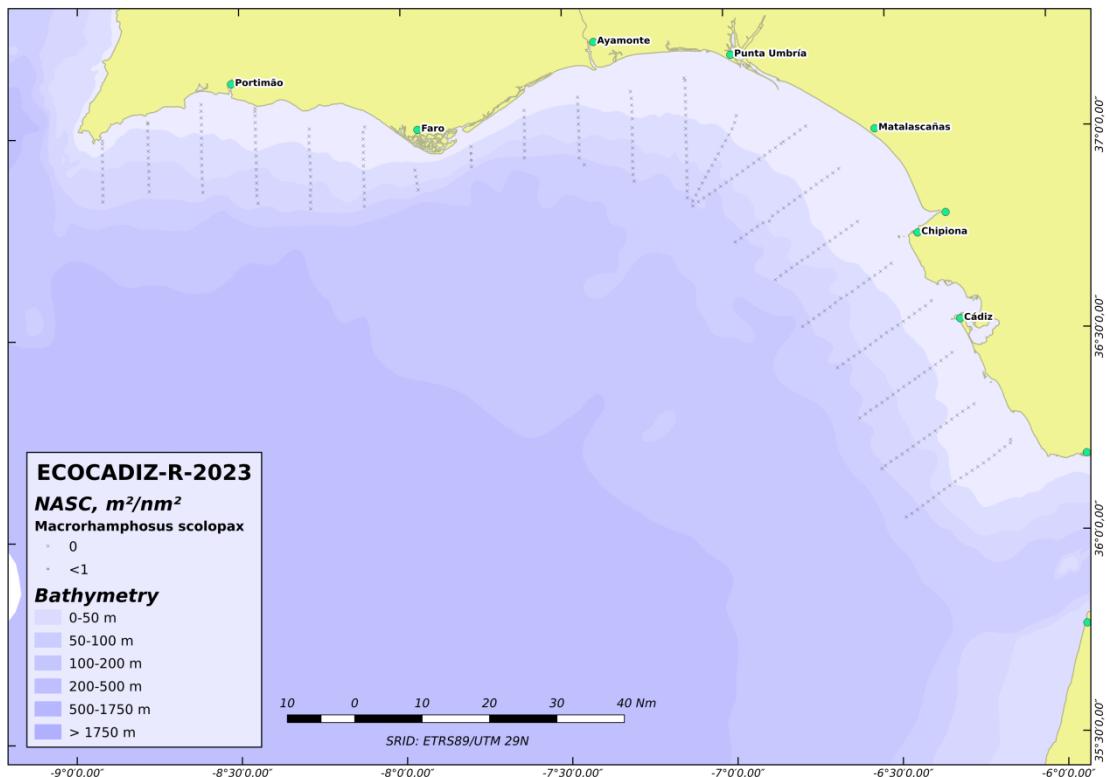


Figure 38. ECOCADIZ-RECLUTAS 2023-10 survey. Longspine snipefish (*Macrorhamphosus scolopax*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2 nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

ECOCADIZ-RECLUTAS 2023-10: Snipefish (*M. scolopax*)

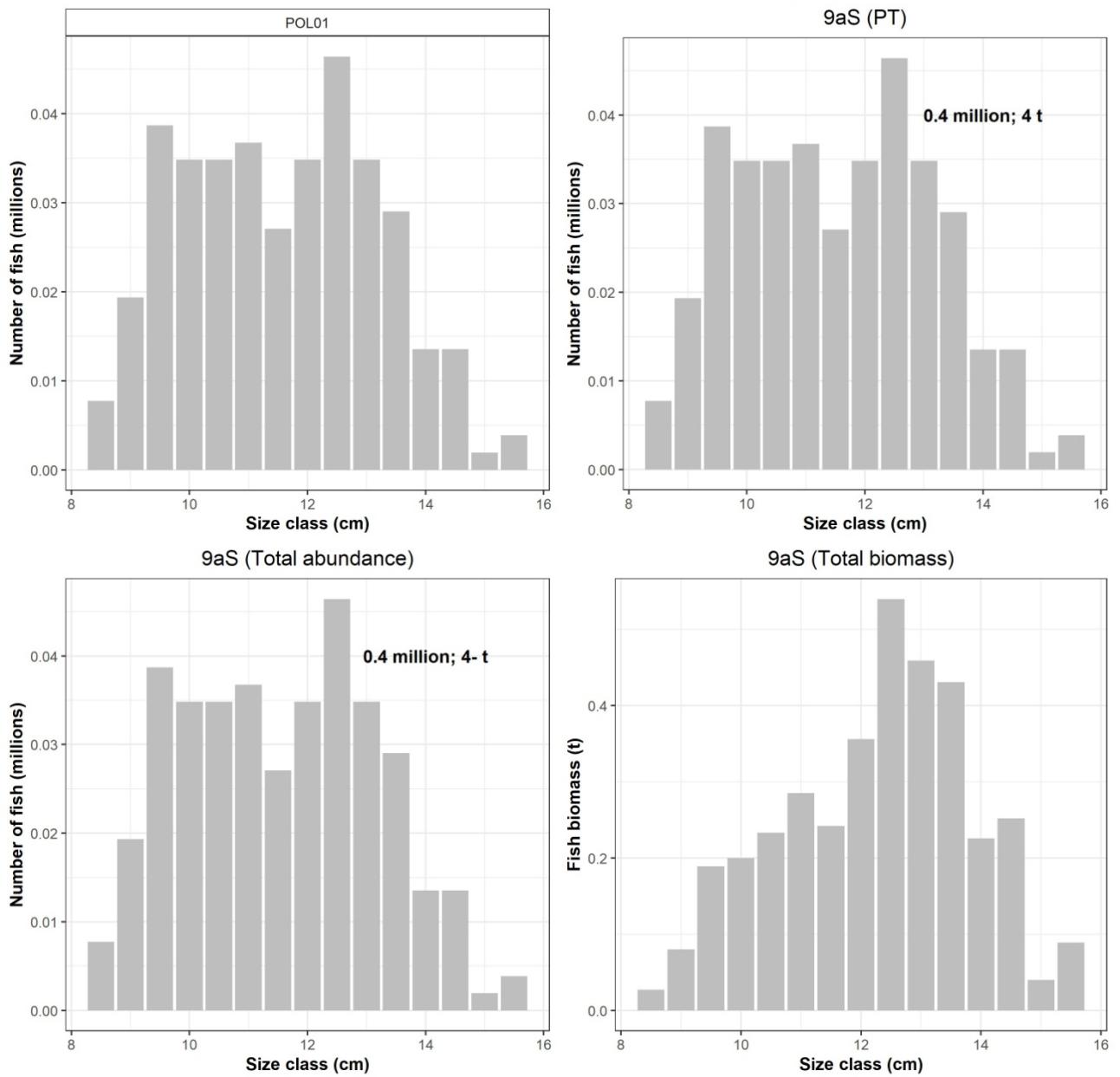


Figure 39. ECOCADIZ-RECLUTAS 2023-10 survey. Longspine snipefish (*Macroramphosus scolopax*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 38**) and total sampled area. Post-strata ordered in the W-E direction. 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.

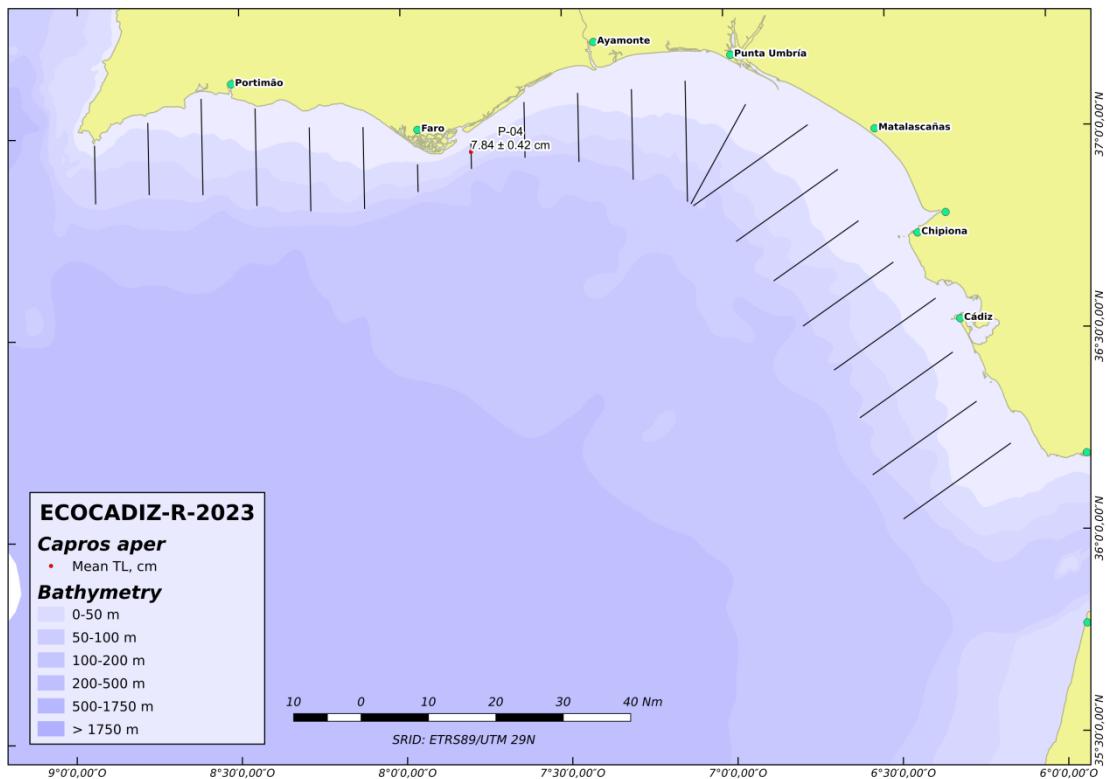
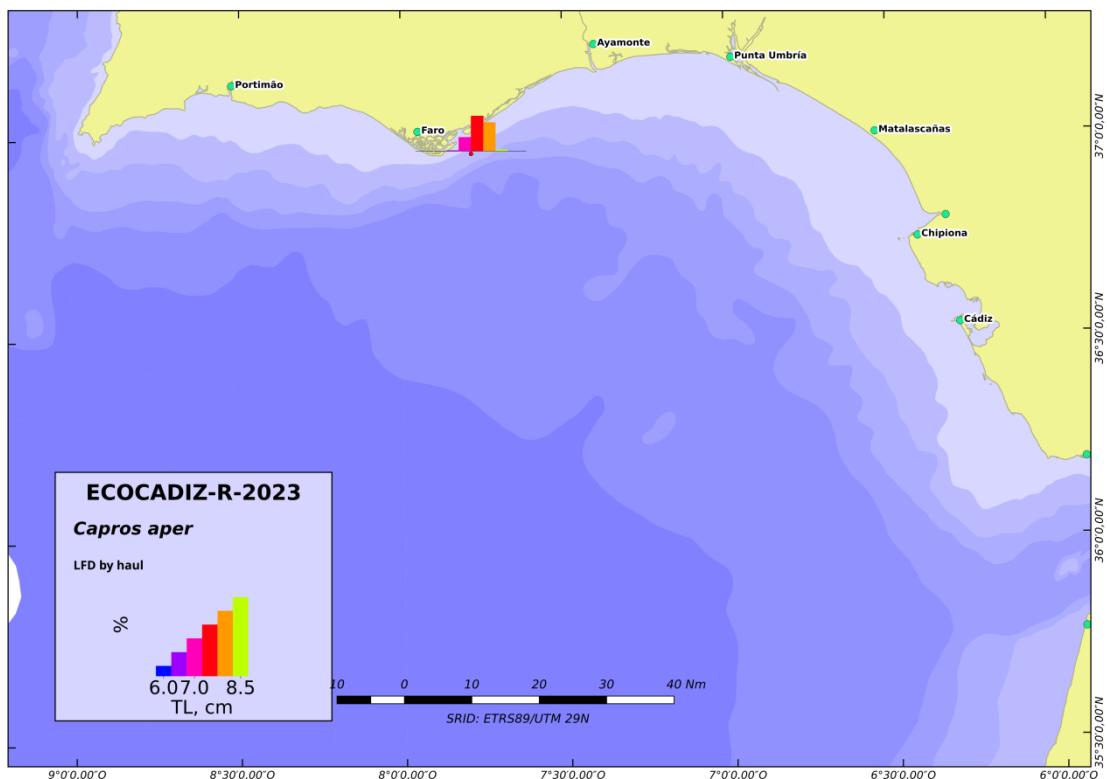


Figure 40. ECOCADIZ-RECLUTAS 2023-10 survey. Boarfish (*Capros aper*). Top: length frequency distributions in fishing hauls. Bottom: mean \pm sd length by haul.

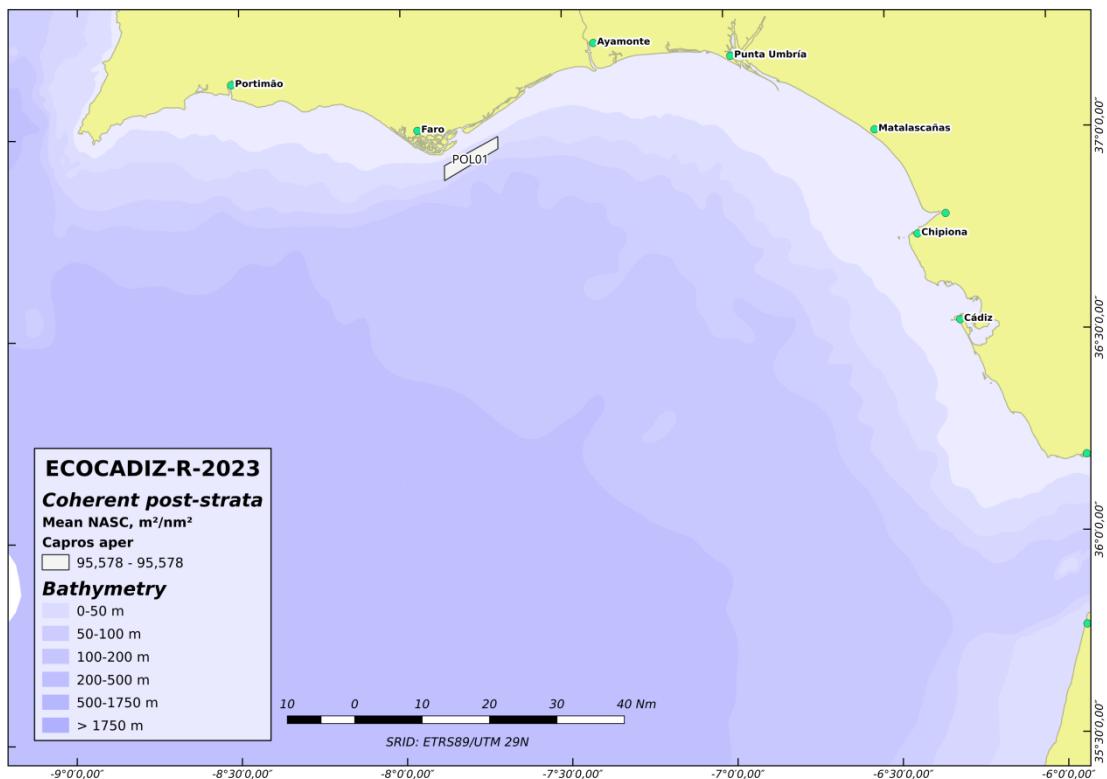
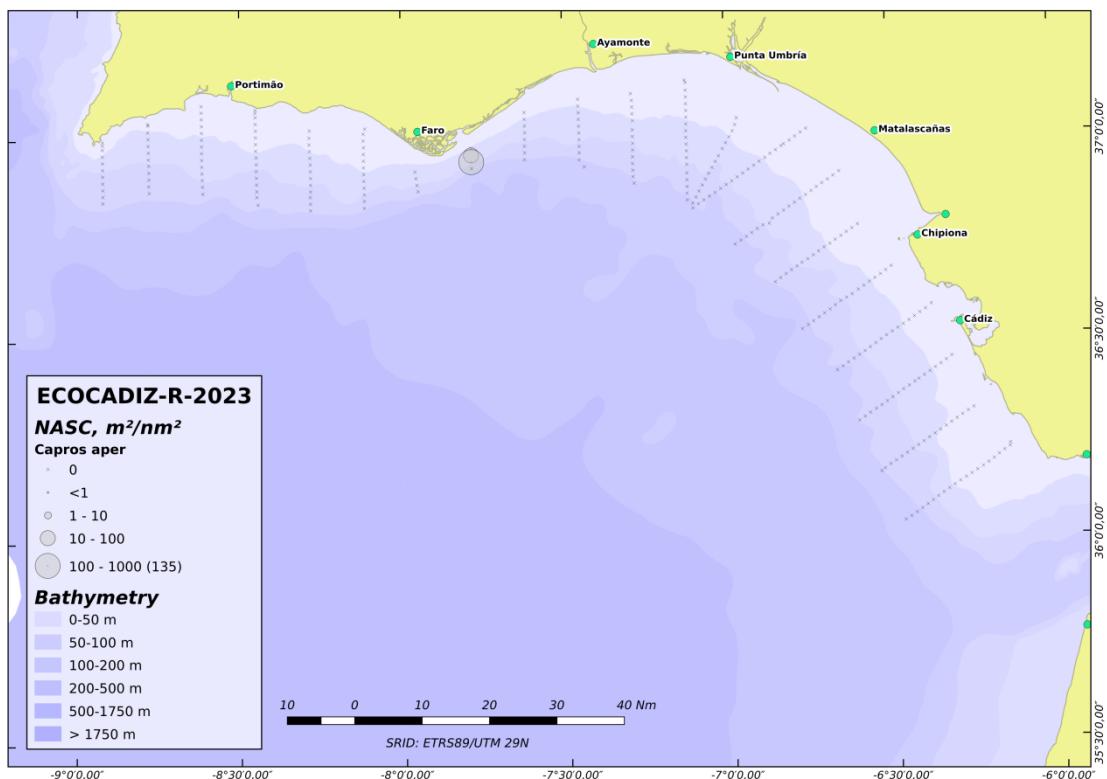


Figure 41. ECOCADIZ-RECLUTAS 2023-10 survey. Boarfish (*Capros aper*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in m^2/nm^2) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

ECOCADIZ-RECLUTAS 2023-10: Boarfish (*C. aper*)

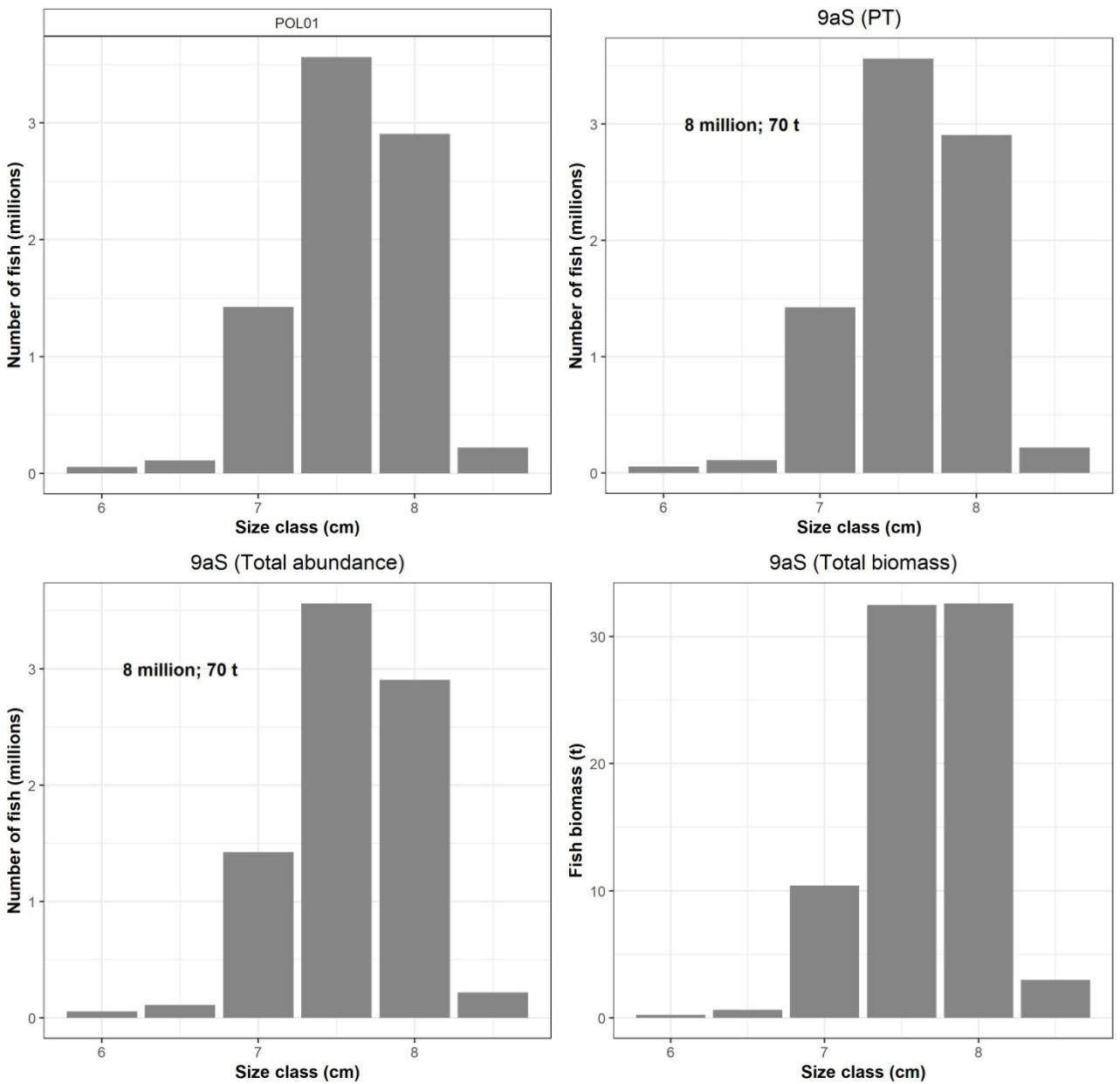
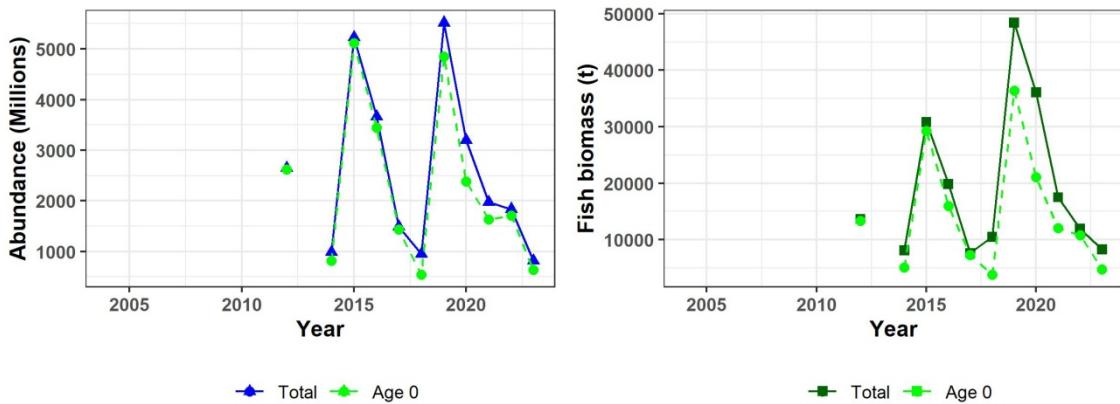
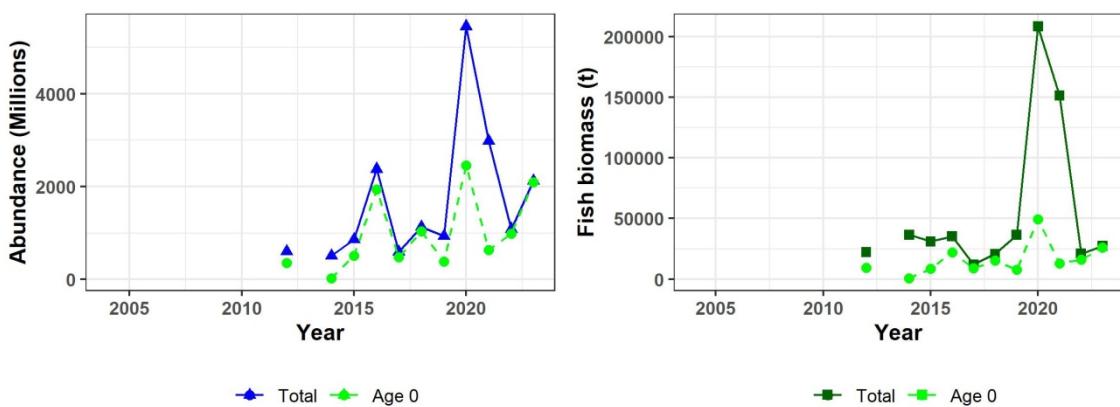


Figure 42. ECOCADIZ-RECLUTAS 2023-10 survey. Boarfish (*Capros aper*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 41**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the y-axis.

Anchovy abundance and biomass ECOCADIZ-RECLUTAS surveys



Sardine abundance and biomass ECOCADIZ-RECLUTAS surveys



Chub mackerel abundance and biomass ECOCADIZ-RECLUTAS surveys

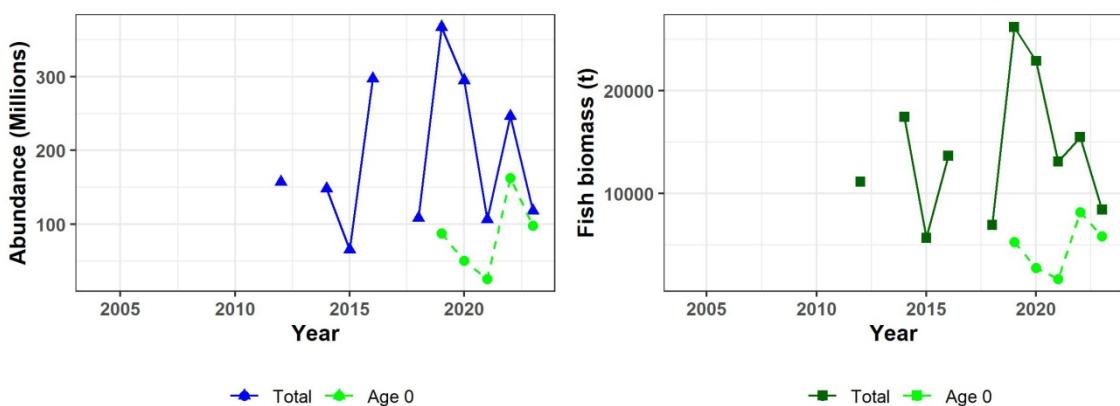


Figure 43. ECOCADIZ-RECLUTAS surveys series. Historical series of autumn acoustic estimates of anchovy, sardine and chub mackerel abundance (million) and biomass (t) in Sub-division 9.a South. The estimates correspond to the total population and age 0 fish. The 2012 survey only surveyed the Spanish waters. 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.

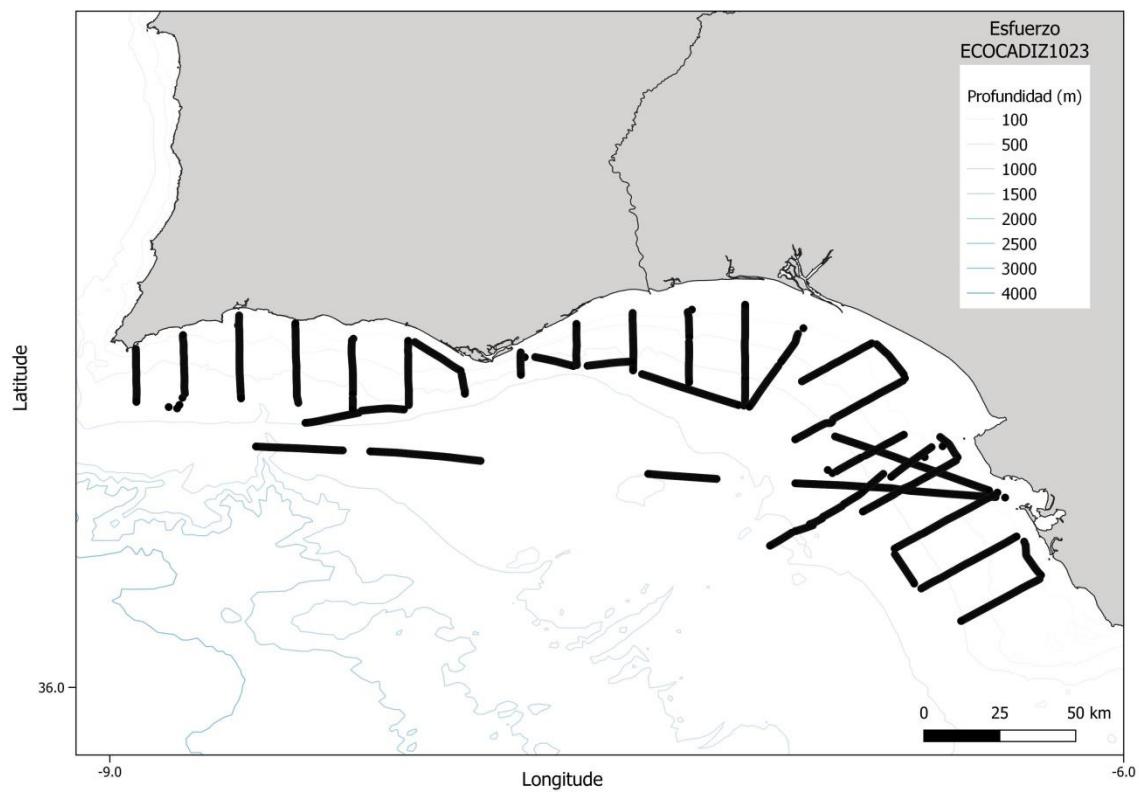


Figure 44. ECOCADIZ-RECLUTAS 2023-10 survey. Spatial distribution of the sampling effort (black lines) performed by the observer of top predator during the ECOCADIZ-RECLUTAS 2023-10 survey

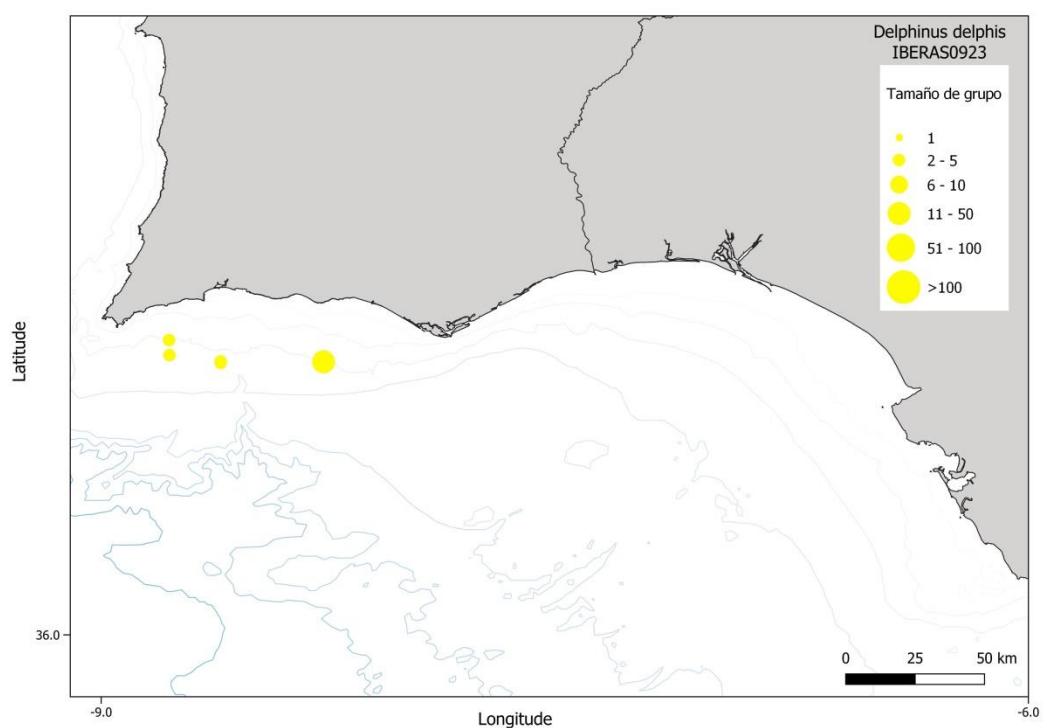
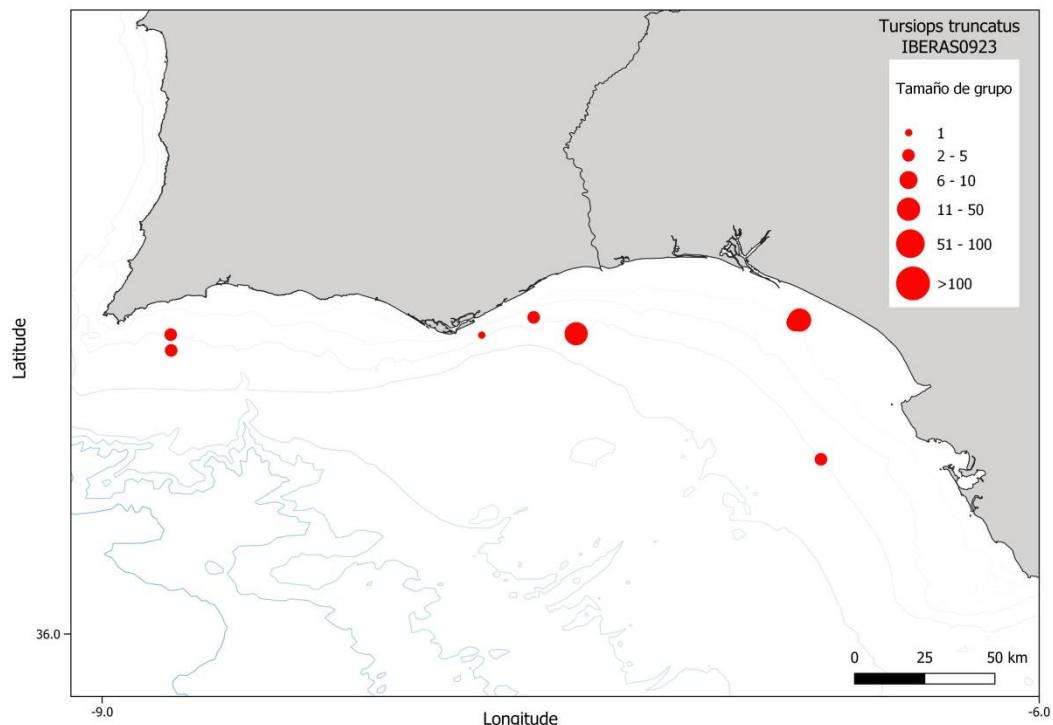


Figure 45. ECOCADIZ-RECLUTAS 2023-10 survey. Sightings of marine mammals. Top: Bottlenose dolphin (*Tursiops truncatus*); bottom: Common dolphin (*Delphinus delphis*).

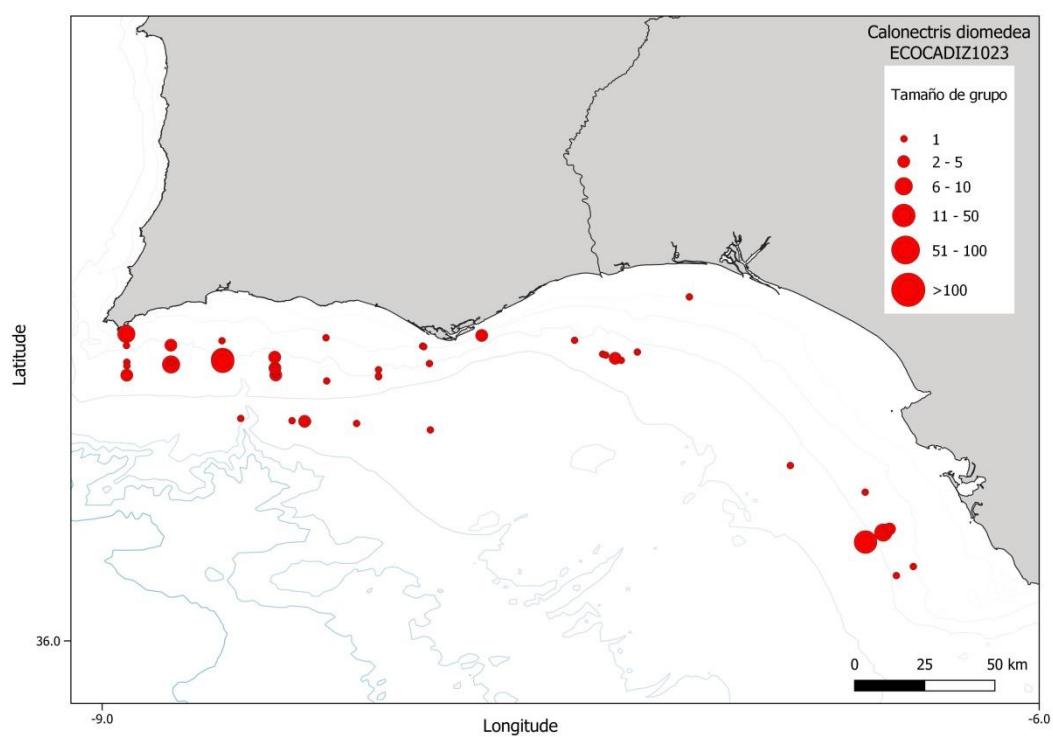
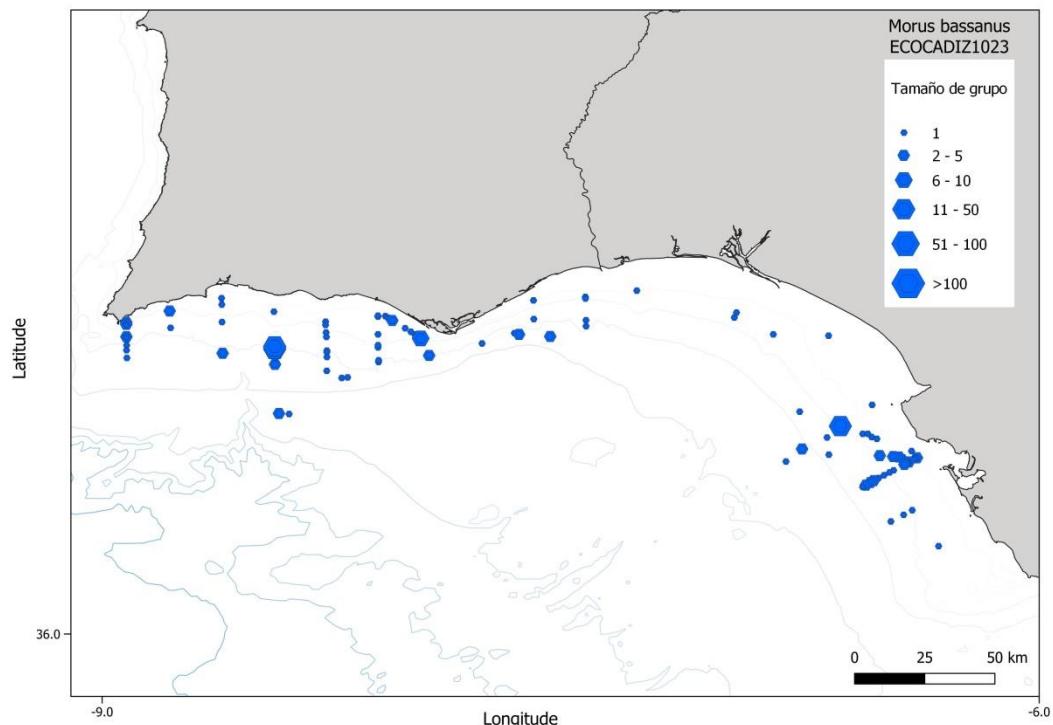


Figure 46. ECOCADIZ-RECLUTAS 2023-10 survey. Sightings of sea bird species. Top: northern gannet (*Morus bassanus*); bottom: Scopoli's shearwater (*Calonectris diomedea*).

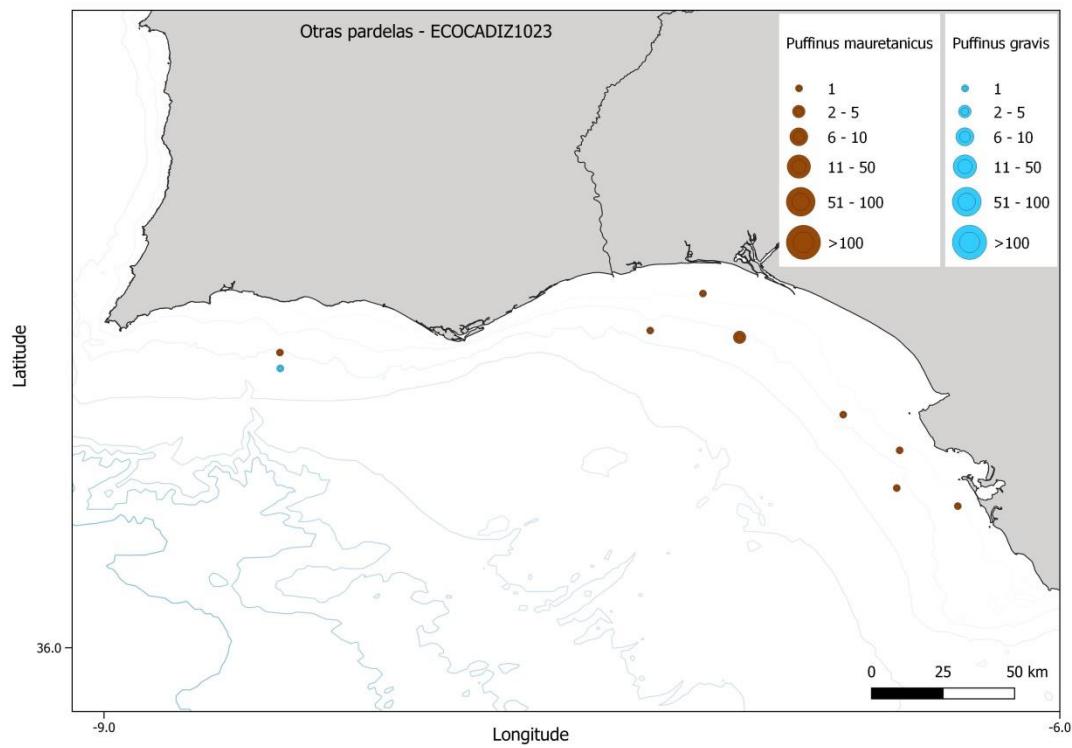


Figure 47. ECOCADIZ-RECLUTAS 2023-10 survey. Sightings of great shearwater (*Puffinus gravis*) and shadowy shearwater (*Puffinus mauretanicus*).

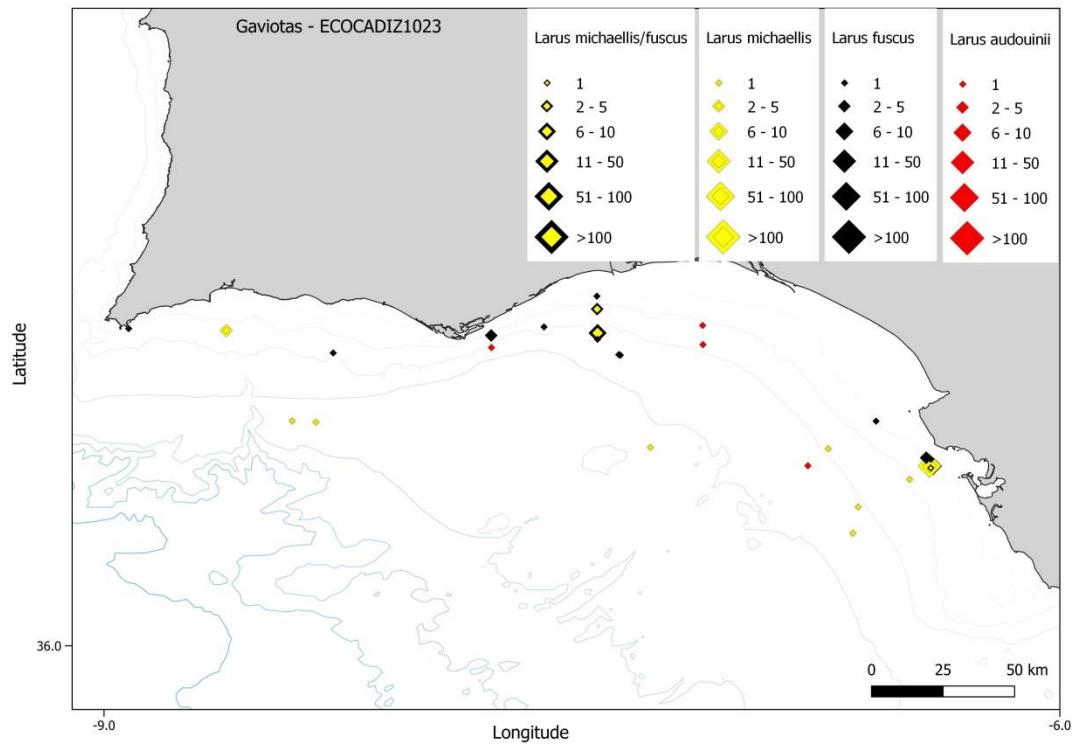


Figure 48. ECOCADIZ-RECLUTAS 2023-10 survey. Sightings of seagull species registered during the survey.

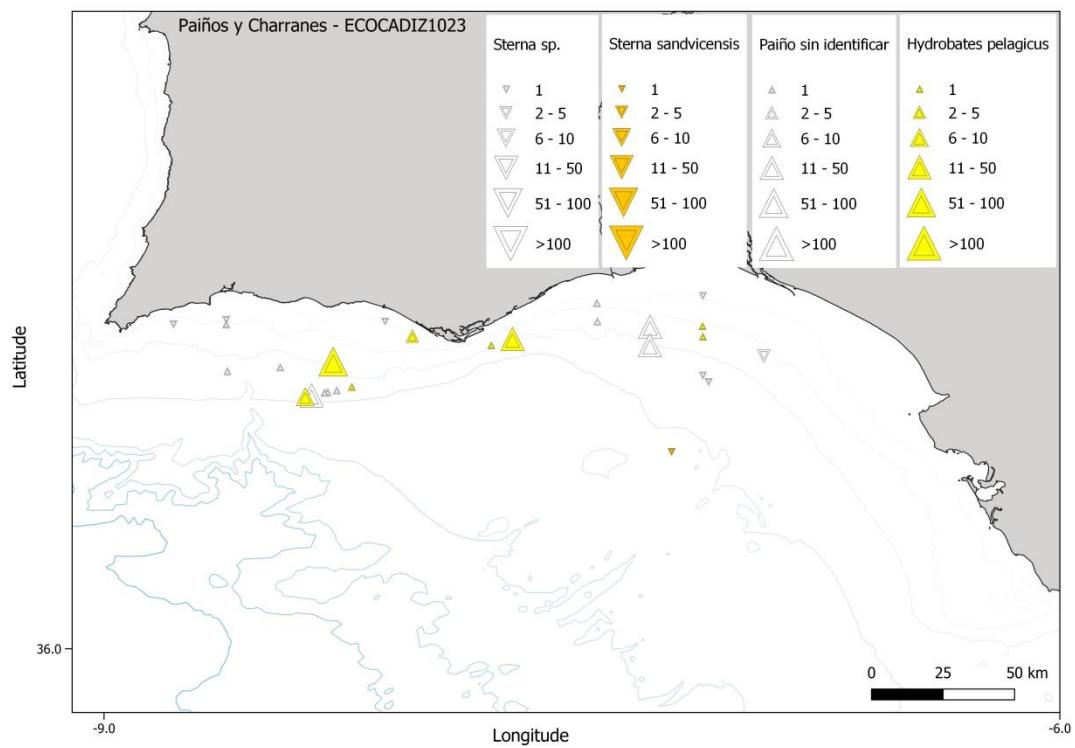
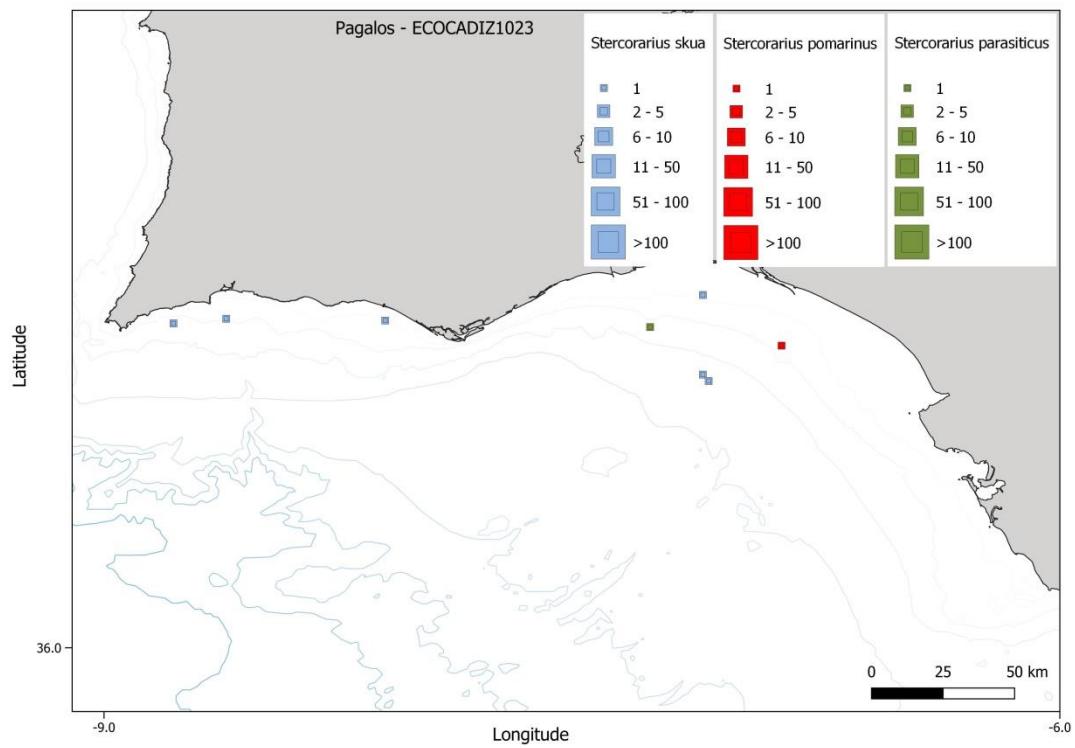


Figure 49. ECOCADIZ-RECLUTAS 2023-10 survey. Sightings of tern species registered during the survey.

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

Fernando Ramos^(1, *), Jorge Tornero⁽¹⁾, José A. Canseco⁽¹⁾, A. Juárez⁽¹⁾, I. Franco⁽²⁾, R. Sánchez-Leal⁽¹⁾

(1) Instituto Español de Oceanografía (IEO-CSIC), Centro Oceanográfico Costero de Cádiz.

(2) IEO-CSIC, Centro Oceanográfico de Murcia.

(*) Cruise leader and corresponding author: e-mail: fernando.ramos@ieo.csic.es

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 series in 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).

TABLE OF CONTENTS

ABSTRACT.....	1
INTRODUCTION	3
MATERIAL AND METHODS.....	4
RESULTS	5
Acoustic sampling	5
Groundtruthoring hauls.....	5
Spatial distribution and abundance/biomass estimates	6
(SHORT) DISCUSSION	13
REFERENCES.....	14

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, WGANS, 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 CTDO₂-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 Sentinel* 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

Acoustic sampling

The acoustic sampling was accomplished during the period comprised between the 29th of July and the 7th 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.

Groundtruthing hauls

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*), 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**.

Back-scattering energy attributed to the "pelagic assemblage" and individual species

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 m² 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 m²nmi⁻²), and 21% below the historical mean (153 181 m²nmi⁻²). The highest NASC value (7269 m²nmi⁻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 $\text{m}^2\text{nmi}^{-2}$) 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 ($\pm SD$) are shown in **Figure 11**. The mapping of the backscattering energy (NASC, in $m^2 nmi^{-2}$) 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, with showing 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 María, 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 $\text{m}^2\text{nmi}^{-2}$) 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 $\text{m}^2\text{nmi}^{-2}$) 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 ($\pm\text{SD}$) size in the fishing hauls are spatially explicit represented in **Figure 21**. The

NASC mapping (in $\text{m}^2\text{nmi}^{-2}$) 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 ($\pm \text{SD}$) size in the fishing hauls are mapped in **Figure 25**. The NASC mapping (in $\text{m}^2\text{nmi}^{-2}$) 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 $m^2 nmi^{-2}$) 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 $m^2 nmi^{-2}$) 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 $m^2 nmi^{-2}$) 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 $m^2 nmi^{-2}$) 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 $\text{m}^2\text{nmi}^{-2}$) 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 $\text{m}^2\text{nmi}^{-2}$) 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).

ACKNOWLEDGEMENTS

We are very grateful to the crew of the *R/V Ramon Margalef* and to all the scientific and technical staff participating in the present survey. *ECOCADIZ 2023-07* has been funded by the EU through the European Maritime and Fisheries Fund (EMFF) within the National Program of collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy. The survey has been conducted onboard the *R/V Ramon Margalef*, which was built within the frame of the Program FEDER, FICTS-2011-03-01.

REFERENCES

- Buckland, S.T., Anderson, D.R., Burnham, K.P., Laake, J.L. 1993. *Distance sampling: Estimating abundance of biological populations*. Chapman and Hall, London.
- 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.
- 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>.
- Fässler, S. M.M., O'Donnell, C., Jech, J.M. 2013. Boarfish (*Capros aper*) target strength modelled from magnetic resonance imaging (MRI) scans of its swimbladder. *ICES Journal of Marine Science*, 70: 1451–1459.
- Foote, K.G., Knudsen, H.P., Vestnes, G., MacLennan, D.N., Simmonds, E.J. 1987. Calibration of acoustic instruments for fish density estimation: a practical guide. *ICES Coop. Res. Rep.*, 144, 57 pp.
- ICES, 1998. Report of the Planning Group for Acoustic Surveys in ICES Sub-Areas VIII and IX. A Coruña, 30- 31 January 1998. ICES CM 1998/G:2.
- ICES, 2006a. Report of the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES areas VIII and IX (WGACEGG), 24-28 October 2005, Vigo, Spain. ICES, C.M. 2006/LRC: 01. 126 pp.
- ICES, 2006b. Report of the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VIII and IX (WGACEGG), 27 November-1 December 2006, Lisbon, Portugal. ICES C.M. 2006/LRC:18. 169 pp.
- Nakken, O., Dommases, A. 1975. The application for an echo integration system in investigations on the stock strength of the Barents Sea capelin (*Mallotus villosus*, Müller) 1971-74. ICES CM 1975/B:25.
- Ramos, F., Iglesias, M., Miquel, J., Oñate, D., Tornero, J., Ventero, A., Peña, M.A. 2010. Acoustic assessment and distribution of anchovy and sardine juveniles in the ICES Subdivision IXa South during the *ECOCADIZ-RECLUTAS 1009* Spanish survey (October-November 2009). Working document presented in the ICES Working Group on Southern Horse Mackerel,

Anchovy and Sardine in ICES Area VIII and IX (WGACEGG), Palma de Mallorca, Spain, 22-26 November 2010. 31 pp.

Ramos, F., Iglesias, M., Miquel, J., Oñate, D., Tornero, J., Ventero, A., Díaz, N. 2013. Acoustic assessment and distribution of the main pelagic fish species in the ICES Subdivision IXa South during the *ECOCADIZ-RECLUTAS 1112* Spanish survey (November 2012). Working document presented in the ICES Working Group on Southern Horse Mackerel, Anchovy and Sardine (WGHANSA), Bilbao (Basque Country), Spain, 21-26 June 2013 and in the ICES Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VIII and IX (WGACEGG). Lisbon, Portugal, 25-29 November 2013

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
<i>Merluccius merluccius</i>	12	75.00 %	8.030	122
<i>Scomber colias</i>	11	68.75 %	2965.435	49748
<i>Engraulis encrasiculus</i>	9	56.25 %	602.080	51185
<i>Sardina pilchardus</i>	9	56.25 %	31.585	1937
<i>Trachurus trachurus</i>	9	56.25 %	19.355	669
<i>Spondyliosoma cantharus</i>	5	31.25 %	11.269	112
<i>Scomber scombrus</i>	5	31.25 %	6.175	38
<i>Capros aper</i>	5	31.25 %	1.295	81
<i>Aphia minuta</i>	5	31.25 %	0.011	29
<i>Pagellus erythrinus</i>	4	25.00 %	14.050	62
<i>Trachurus picturatus</i>	4	25.00 %	1.255	13
<i>Trachinus draco</i>	4	25.00 %	0.760	7
<i>Diplodus vulgaris</i>	3	18.75 %	16.480	136
<i>Alosa fallax</i>	3	18.75 %	5.110	11
<i>Diplodus bellottii</i>	3	18.75 %	1.975	26
<i>Mullus barbatus</i>	3	18.75 %	1.940	15
<i>Boops boops</i>	3	18.75 %	0.715	7
<i>Pagellus bellottii bellottii</i>	3	18.75 %	0.500	4
<i>Serranus cabrilla</i>	3	18.75 %	0.415	5
<i>Lepidotrigla cavillone</i>	3	18.75 %	0.305	10
<i>Zeus faber</i>	3	18.75 %	0.280	4
<i>Serranus hepatus</i>	3	18.75 %	0.240	11
<i>Macroramphosus scolopax</i>	2	12.50 %	41.770	2986
<i>Trachurus mediterraneus</i>	2	12.50 %	3.370	16
<i>Maurolicus muelleri</i>	2	12.50 %	0.840	743
<i>Pagellus acarne</i>	2	12.50 %	0.795	8
<i>Spicara smaris</i>	1	6.25 %	4.190	68
<i>Lepidotrigla dieuzeidei</i>	1	6.25 %	0.460	10
<i>Chelidonichthys lastoviza</i>	1	6.25 %	0.450	6
<i>Alosa alosa</i>	1	6.25 %	0.220	1
<i>Mullus surmuletus</i>	1	6.25 %	0.125	1
<i>Lepidopus caudatus</i>	1	6.25 %	0.080	15
<i>Diplodus annularis</i>	1	6.25 %	0.060	1
<i>Cepola macrophthalma</i>	1	6.25 %	0.050	1
<i>Syphurus nigrescens</i>	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	b_{20}
Sardine (<i>Sardina pilchardus</i>)	-72.6
Round sardinella (<i>Sardinella aurita</i>)	-72.6
Anchovy (<i>Engraulis encrasiculus</i>)	-72.6
Chub mackerel (<i>Scomber japonicus</i>)	-68.7
Mackerel (<i>S. scombrus</i>)	-84.9
Horse mackerel (<i>Trachurus trachurus</i>)	-68.7
Mediterranean horse-mackerel (<i>T. mediterraneus</i>)	-68.7
Blue jack mackerel (<i>T. picturatus</i>)	-68.7
Bogue (<i>Boops boops</i>)	-67.0
Transparent goby (<i>Aphia minuta</i>)	-67.5
Atlantic pomfret (<i>Brama brama</i>)	-67.5
Blue whiting (<i>Micromesistius poutassou</i>)	-67.5
Silvery lightfish/pearlside (<i>Maurolicus muelleri</i>)	-72.2
Longspine snipefish (<i>Macroramphosus scolopax</i>)	-80.0
Boarfish (<i>Capros aper</i>)	-66.2* (-72.6)

Table 3. ECOCADIZ 2023-07 survey. Total and regional NASC values by species. FAO codes for the species: ANE: *Engraulis encrasiculus*; 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 ($m^2 nmi^{-2}$)	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	36° 13,840' N	06° 07,220' W	17:34	23	36° 20,020' N	06° 28,900' W	19:40	243
2	Sancti-Petri	30/07/23	36° 19,550' N	06° 14,490' W	06:10	22	36° 08,740' N	06° 34,000' W	10:47	201
3	Cádiz	30/07/23	36° 17,230' N	06° 36,600' W	11:43	196	36° 27,040' N	06° 18,430' W	13:30	20
4	Rota	31/07/23	36° 34,440' N	06° 22,600' W	06:11	20	36° 24,560' N	06° 40,840' W	10:28	202
5	Chipiona	31/07/23	36° 31,210' N	06° 46,320' W	13:27	200	36° 40,930' N	06° 28,400' W	15:12	20
6	Doñana	01/08/23	36° 46,720' N	06° 35,410' W	06:19	20	36° 37,950' N	06° 51,600' W	10:24	203
7	Matalascañas	01/08/23	36° 44,010' N	06° 58,260' W	11:20	198	36° 54,090' N	06° 39,840' W	15:12	21
8	Mazagón	02/08/23	37° 01,040' N	06° 44,630' W	06:11	21	36° 52,410' N	07° 00,570' W	10:42	101
9	Punta Umbría	02/08/23	36° 49,730' N	07° 06,580' W	11:22	200	37° 05,990' N	06° 54,980' W	13:12	20
10	El Rompido	02/08/23	37° 07,150' N	07° 07,140' W	14:14	23	36° 49,920' N	07° 06,890' W	15:55	201
11	Isla Cristina	03/08/23	37° 07,010' N	07° 17,150' W	06:28	23	36° 53,430' N	07° 17,010' W	17:48	205
12	Vila Real do Santo Antonio	03/08/23	36° 56,300' N	07° 27,110' W	10:12	199	37° 06,480' N	07° 27,090' W	11:13	19
13	Tavira	03/08/23	37° 04,730' N	07° 37,170' W	12:29	20	36° 56,950' N	07° 37,090' W	13:17	208
14	Fuzeta	04/08/23	36° 59,640' N	07° 47,040' W	06:12	20	36° 55,450' N	07° 46,980' W	06:37	202
15	Cabo de Santa María	04/08/23	36° 52,140' W	07° 56,980' W	07:34	199	36° 57,060' N	07° 57,010' W	08:03	20
16	Cuarreira	04/08/23	36° 49,730' N	08° 06,900' W	12:33	199	37° 02,060' N	08° 07,040' W	13:47	20
17	Albufeira	05/08/23	37° 02,220' N	08° 16,980' W	06:21	22	37° 49,350' N	08° 16,800' W	10:23	201
18	Alfanzina	05/08/23	36° 50,180' N	08° 26,770' W	11:15	199	37° 04,660' N	08° 27,030' W	12:42	20
19	Portimao	06/08/23	37° 06,210' N	08° 37,030' W	06:13	20	36° 51,260' N	08° 36,500' W	07:43	200
20	Burgau	06/08/23	36° 51,960' N	08° 46,680' W	10:48	200	37° 03,530' N	08° 46,940' W	14:22	20
21	Ponta de Sagres	07/08/23	36° 59,430' N	08° 56,580' W	05:35	24	36° 50,680' N	08° 56,500' W	06:28	200

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 MANOEUVRE						
1	30-07-2023	36° 15.4753 N	6° 22.1575 W	50.05	36° 17.1270 N	6° 19.0440 W	42.46	07:26	08:11	00:45	01:26	3.01	R02	Sancti-Petri			
2	30-07-2023	36° 25.6725 N	6° 20.6973 W	39.31	36° 24.3085 N	6° 22.8510 W	48.43	14:12	14:45	00:33	01:02	2.208	R03	Cádiz			
3	30-07-2023	36° 30.8809 N	6° 29.1510 W	49.81	36° 32.2710 N	6° 26.7060 W	40.22	07:14	07:50	00:36	01:13	2.41	R04	Rota			
4	31-07-2023	36° 25.0872 N	6° 39.6126 W	162	36° 26.2549 N	6° 37.2568 W	106.5	11:00	11:33	00:33	00:38	2.23	R04	Rota			
5	01-08-2023	36° 42.2560 N	6° 43.5637 W	64.13	36° 43.6608 N	6° 41.0725 W	41.85	07:32	08:08	00:36	01:13	2.445	R06	Doñana			
6	01-08-2023	36° 46.4337 N	6° 53.7858 W	104.7	36° 44.7760 N	6° 56.7010 W	128.6	12:17	12:59	00:42	01:27	2.868	R07	Matalascañas			
7	01-08-2023	36° 46.8075 N	6° 53.0623 W	97.75	36° 46.2031 N	6° 54.1873 W	103.1	18:08	18:24	00:16	00:58	1.087	R07	Matalascañas			
8	02-08-2023	36° 52.6923 N	7° 00.2223 W	98.86	36° 53.9827 N	6° 58.0471 W	82.5	08:14	08:46	00:32	01:19	2.169	R08	Mazagón			
9	02-08-2023	36° 53.5641 N	6° 58.2627 W	86.45	36° 51.4311 N	7° 00.8433 W	106.1	19:00	19:42	00:42	01:25	2.971	R08	Mazagón			
10	03-08-2023	36° 54.4915 N	7° 16.9393 W	134.9	36° 56.2156 N	7° 16.8357 W	111.6	08:16	08:42	00:26	01:12	1.724	R11	Isla Cristina			
11	03-08-2023	36° 57.4609 N	7° 36.9436 W	164.4	36° 59.9091 N	7° 36.7837 W	99.89	14:55	15:29	00:34	02:04	2.448	R13	Tavira			
12	03-08-2023	36° 54.6973 N	7° 56.8729 W	73.46	36° 52.8627 N	7° 56.7249 W	104.1	08:31	08:57	00:26	01:08	1.836	R15	Cabo de Santa María			
13	04-08-2023	36° 52.3915 N	7° 56.8845 W	110	36° 52.0092 N	7° 56.8779 W	20.5	11:03	11:09	00:06	00:52	0.382	R15	Cabo de Santa María			
14	04-08-2023	37° 01.0012 N	8° 07.0014 W	28.38	36° 58.8751 N	8° 06.9075 W	43.25	14:21	14:53	00:32	01:21	2.125	R16	Cuarteira			
15	05-08-2023	36° 53.5420 N	8° 16.8766 W	104.4	36° 56.7001 N	8° 16.7917 W	70.99	07:48	08:34	00:46	01:42	3.155	R17	Albufeira			
16	05-08-2023	36° 55.1500 N	8° 26.8006 W	109.1	36° 52.4971 N	8° 26.6340 W	130.6	14:49	15:26	00:37	01:29	2.653	R18	Alfanzina			
17	05-08-2023	36° 56.4024 N	8° 16.8568 W	75.12	36° 53.5534 N	8° 16.6024 W	101.3	19:02	19:39	00:37	01:20	2.853	R17	Albufeira			
18	06-08-2023	36° 52.6908 N	8° 36.4438 W	113.3	36° 55.1329 N	8° 36.6369 W	98.83	08:13	08:48	00:35	01:26	2.444	R19	Portimao			
19	06-08-2023	36° 56.5425 N	8° 46.5877 W	110.2	36° 54.0225 N	8° 46.2861 W	108.5	12:14	12:49	00:35	01:36	2.528	R20	Burgau			
20	06-08-2023	36° 55.3900 N	8° 26.8531 W	108	36° 52.4050 N	8° 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													TOTAL
	<i>Anchovy</i>	<i>Boarfish</i>	<i>Bogue</i>	<i>Transp. Goby</i>	<i>Medit. Horse-mack.</i>	<i>Horse-mack.</i>	<i>Blue jack mack.</i>	<i>Mackerel</i>	<i>Chub mackerel</i>	<i>Pearlside</i>	<i>Sardine</i>	<i>Snipefish</i>	<i>OTHERS</i>	
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 WEIGHT													TOTAL
	<i>Anchovy</i>	<i>Boarfish</i>	<i>Bogue</i>	<i>Transp. Goby</i>	<i>Medit. Horse- mack.</i>	<i>Horse- mack.</i>	<i>Blue jack mack.</i>	<i>Mackerel</i>	<i>Chub mackerel</i>	<i>Pearlside</i>	<i>Sardine</i>	<i>Snipefish</i>	<i>OTHERS</i>	
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
r²	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**.

SIZE CLASS (cm)	ECOBODADEVA0723. <i>Engraulis encrasicolus</i> . ABUNDANCE (in numbers and million fish)											Millions						
	POL01	POL02	POL03	POL04	POL05	Portugal	POL06	POL07	POL08	POL09	Spain	TOTAL	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	0	0	37909775	37909775	46385650	8.475875	37.909775	46.38565	
7.5	0	0	0	10594844	0	10594844	0	0	0	0	0	105492661	105492661	116087505	10.594844	105.492661	116.087505	
8	0	0	0	2118969	0	2118969	0	0	0	0	0	84373009	84373009	86491978	2.118969	84.373009	86.491978	
8.5	0	0	0	10594844	0	10594844	0	0	0	0	0	27979899	84373009	112352908	122947752	10.594844	112.352908	122.947752
9	0	0	0	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	0	0	0	95449159	67477287	162926446	162926446	0	162.926446	162.926446
10	0	0	0	0	0	0	0	0	0	0	0	3647128	75803698	63253357	142704183	0	142.704183	142.704183
10.5	0	0	0	0	0	0	0	0	0	0	0	12496216	39290922	71701218	123488356	0	123.488356	123.488356
11	0	0	0	0	0	0	0	0	0	0	0	28251534	11311023	21119652	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. encrasiculus*). Cont'd.

ECOBODADEV0723. <i>Engraulis encrasiculus</i> . 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. encrasiculus*). 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. encrasiculus*). 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**.

SIZE CLASS (cm)	ECOBOCADEVA0723. <i>Sardina pilchardus</i> . ABUNDANCE (in numbers and million fish)										Millions			
	POL01	POL02	POL03	Portugal	POL04	POL05	POL06	Spain	TOTAL	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					
Millions	1	787	26	813	0.0002	587	894	1481	2294	8132	1481	2294		

Table 11. ECOCADIZ 2023-07 survey. Sardine (*S. pilchardus*). Cont'd.

ECOBODADEV0723. <i>Sardina pilchardus</i> . 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**.

SIZE CLASS (cm)	ECOBODADEVA0723. <i>Aphia minuta</i> . ABUNDANCE (in numbers and million fish)					Millions	
	POL01	POL02	Spain	TOTAL	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			

ECOBODADEVA0723. <i>Aphia minuta</i> . 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.**

SIZE CLASS (cm)	POL01	POL02	Portugal	POL03	Spain	TOTAL	ECOBOCADEVA0723. <i>Scomber scombrus</i> . ABUNDANCE (in numbers and million fish)		
							Portugal	Spain	Millions 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. <i>Scomber scombrus</i> . 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**.

SIZE CLASS (cm)	ECOBOCADEVA0723. <i>Scomber colias</i> . ABUNDANCE (in numbers and million fish)										Millions		
	POL01	POL02	POL03	POL04	POL05	Portugal	POL06	POL07	Spain	TOTAL			
	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. <i>Scomber colias</i> . 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	
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.

SIZE CLASS (cm)	ECOBOCADEVA0723. <i>Trachurus trachurus</i> . ABUNDANCE (in numbers and million fish)								Millions		
	POL01	POL02	POL03	POL04	Portugal	POL05	Spain	TOTAL	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	1030823	0.450903	0.57992	1.030823	0.57992
10	0	791847	0	901806	1693653	579920	2273573	1.693653	0.57992	2.273573	0.57992
10.5	0	1583695	0	4959934	6543629	686747	7230376	6.543629	0.686747	7.230376	0.686747
11	0	791847	0	9468965	10260812	1007229	11268041	10.260812	1.007229	11.268041	1.007229
11.5	0	2375542	0	4959934	7335476	534136	7869612	7.335476	0.534136	7.869612	0.534136
12	0	791847	0	3156322	3948169	534136	4482305	3.948169	0.534136	4.482305	0.534136
12.5	0	0	0	1803612	1803612	106827	1910439	1.803612	0.106827	1.910439	0.106827
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. <i>Trachurus trachurus</i> . 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 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**.

ECOBODADEVA0723. <i>Trachurus mediterraneus</i> . 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		

ECOBODADEVA0723. <i>Trachurus mediterraneus</i> . 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**.

SIZE CLASS (cm)	ECOBOCADEVA0723. <i>Trachurus picturatus</i> . ABUNDANCE (in numbers and million fish)						Millions		
	POL01	POL02	Portugal	POL03	Spain	TOTAL	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. <i>Trachurus picturatus</i> . 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**.

SIZE CLASS (cm)	ECOBODADEVA0723. <i>Boops boops</i> . ABUNDANCE (in numbers and million fish)					Millions	
	POL01	POL02	POL03	Portugal	TOTAL	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		

<i>ECOBOCADEVA0723. <i>Boops boops</i>. BIOMASS (t)</i>					
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**.

ECOBODADEVA0723. <i>Maurolicus muelleri</i> . 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			

ECOBODADEVA0723. <i>Maurolicus muelleri</i> . 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**.

ECOBODEVA0723. <i>Macroramphosus scolopax</i> . 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		

ECOBODEVA0723. <i>Macroramphosus scolopax</i> . 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**.

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. <i>Capros aper</i> . 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

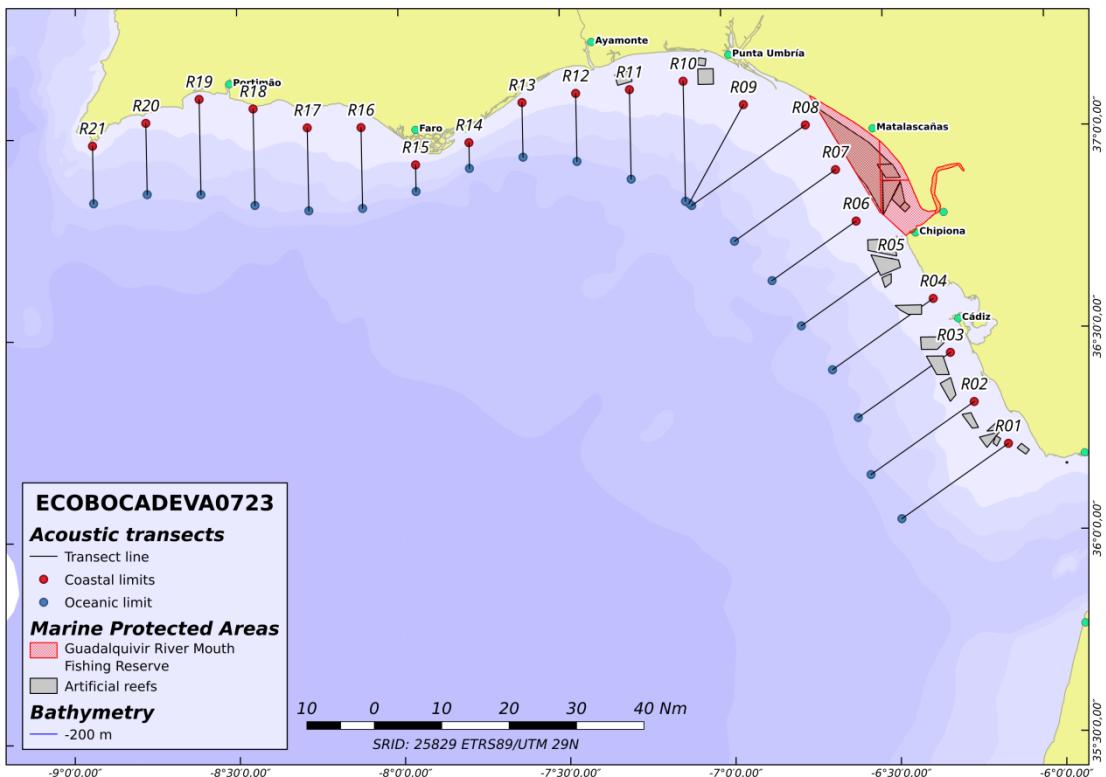


Figure 1. ECOCADIZ 2023-07 survey. Location of the acoustic transects sampled during the survey. The different protected areas inside the Guadalquivir river mouth Fishing Reserve and artificial reef polygons are also shown.

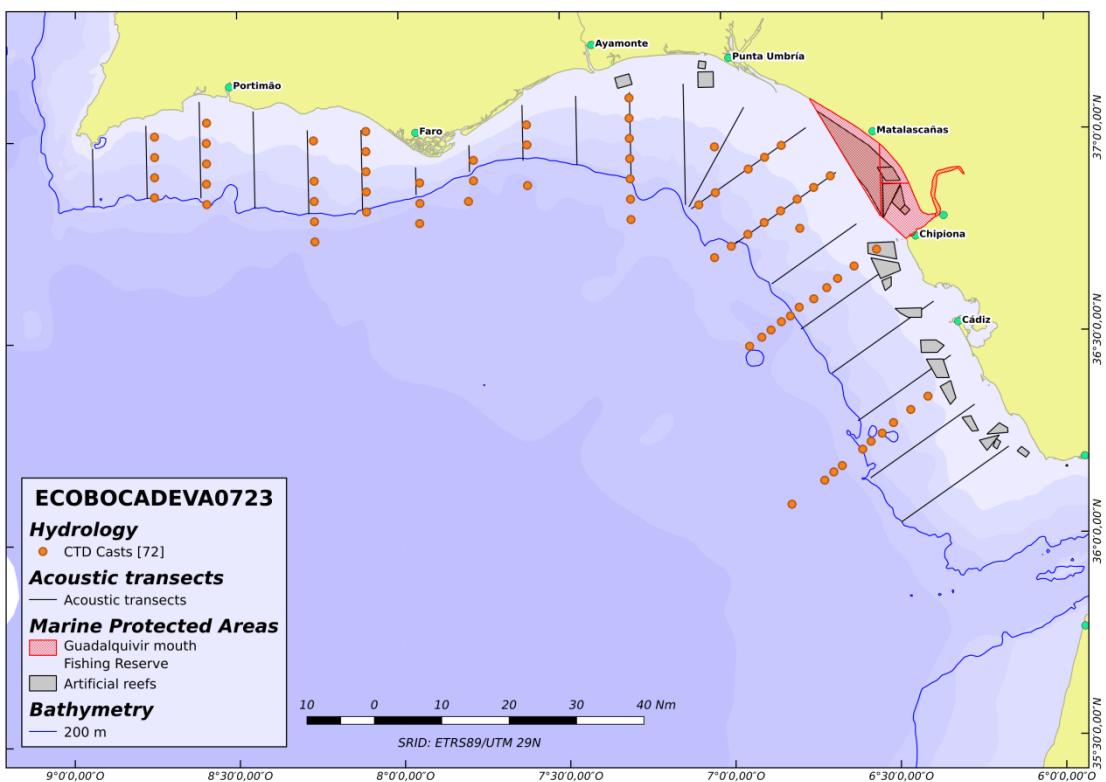


Figure 2. ECOCADIZ 2023-07 survey. Location of CTD-LADCP sampling stations.

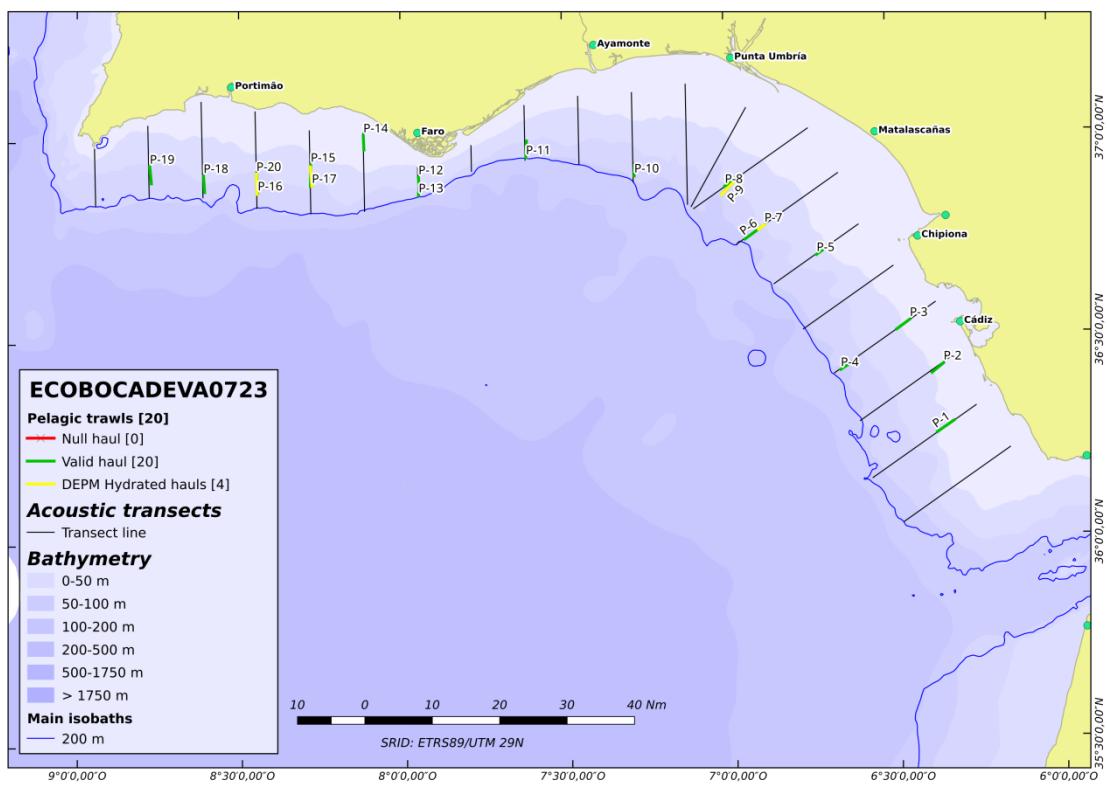


Figure 3. ECOCADIZ 2023-07 survey. Location of ground-truthing fishing hauls.

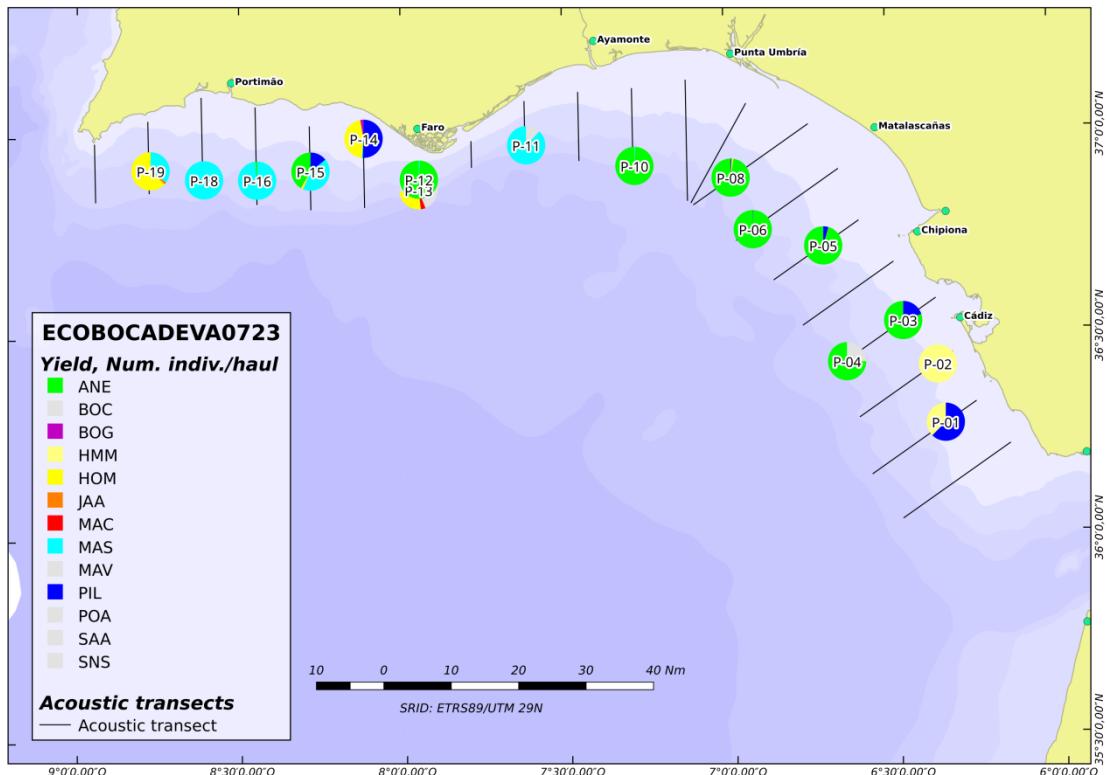


Figure 4. ECOCADIZ 2023-07 survey. Species composition (percentages in number) in valid hauls.

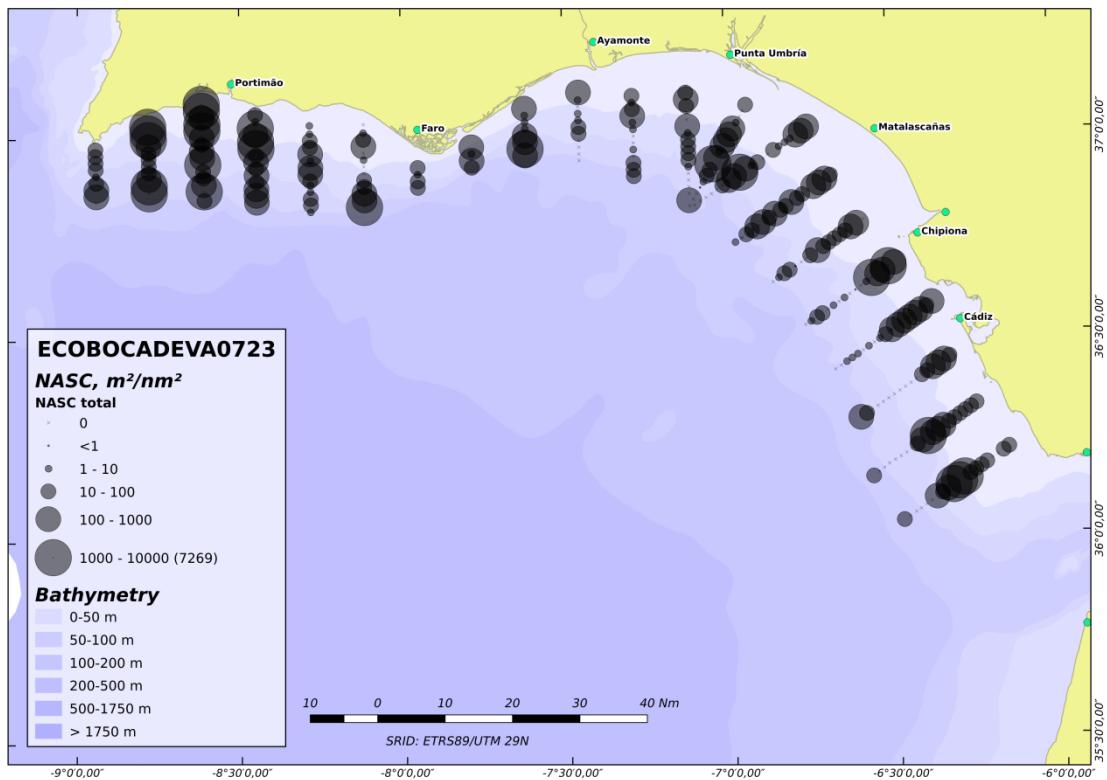


Figure 5. ECOCADIZ 2023-07 survey. Distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2 nmi^{-2}$) attributed to the pelagic fish species assemblage.

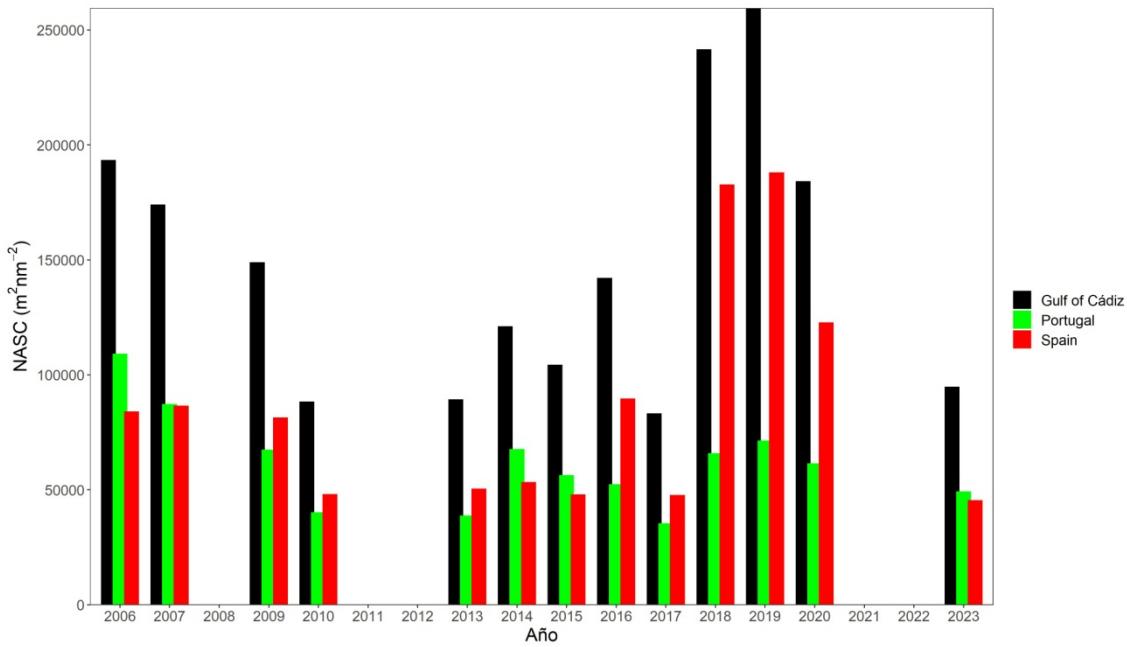


Figure 6. ECOCADIZ 2023-07 survey. Time-series of NASC by total area, Spain and Portugal.

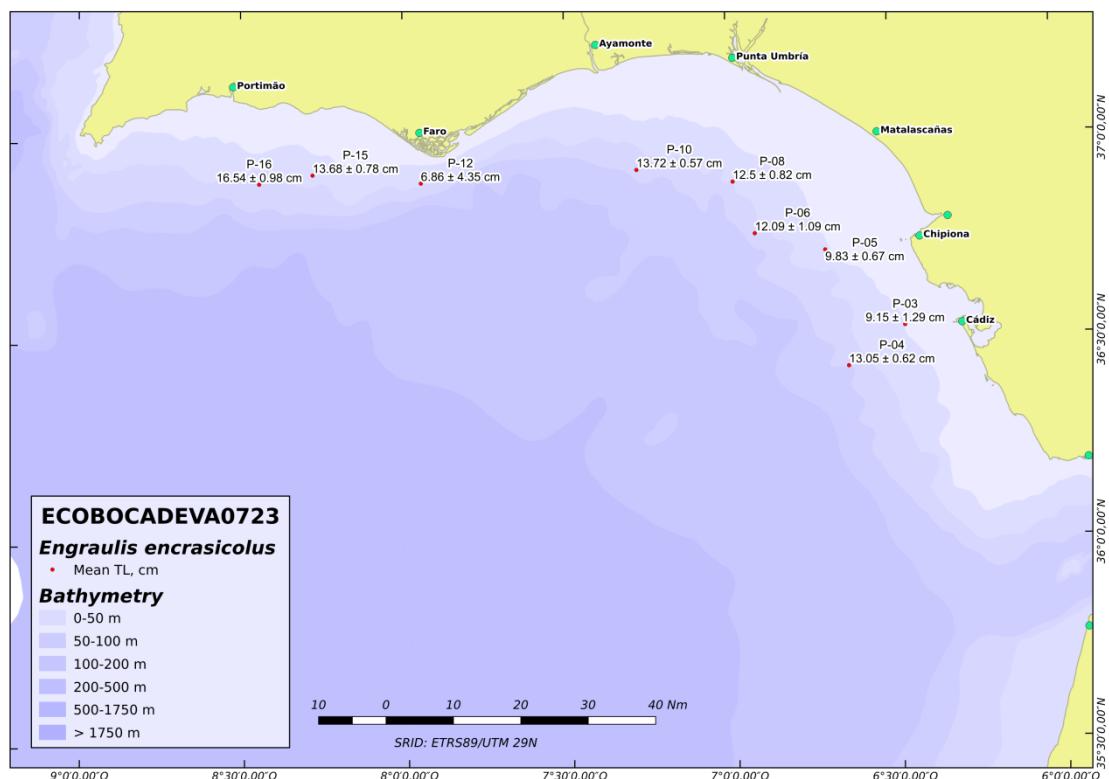
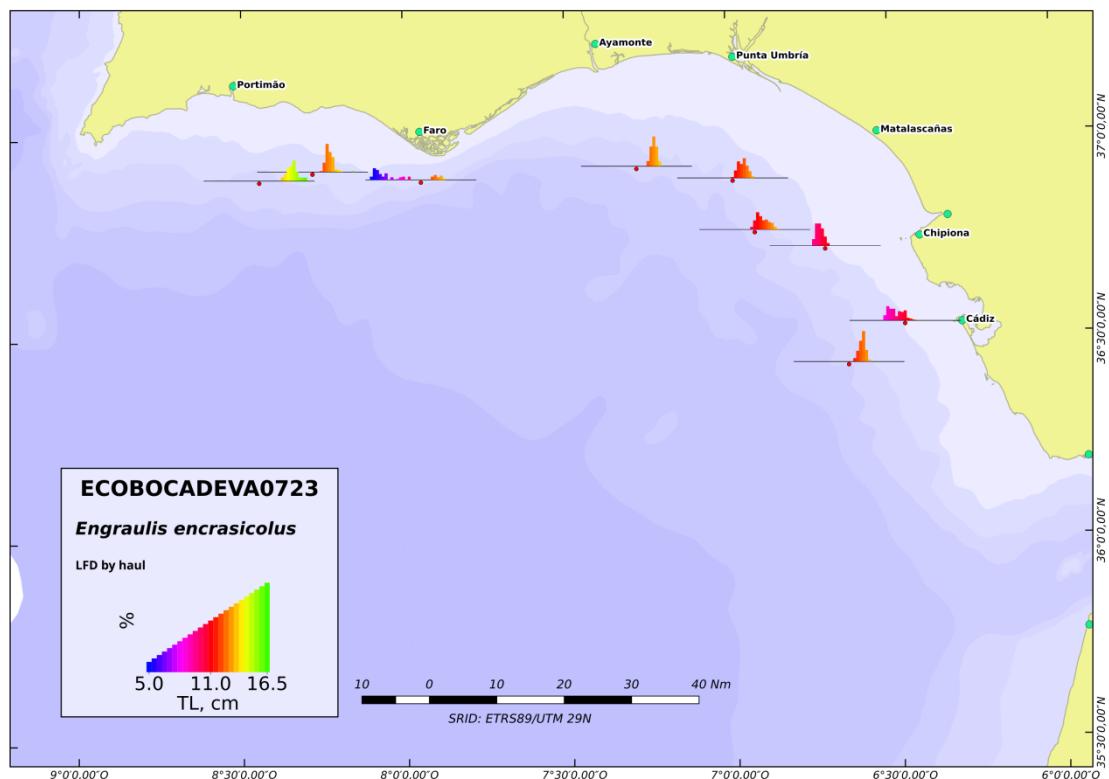


Figure 7. ECOCADIZ 2023-07 survey. Anchovy (*Engraulis encrasicolus*). Top: length frequency distributions in fishing hauls. Bottom: mean \pm sd length by haul.

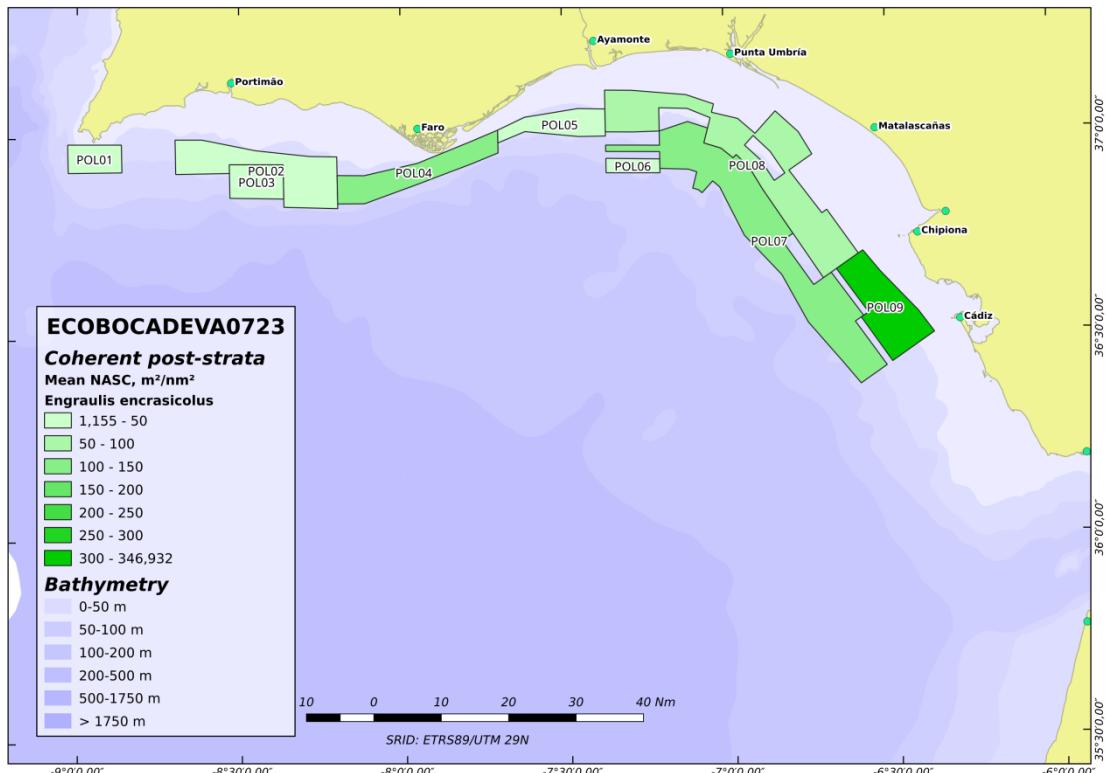
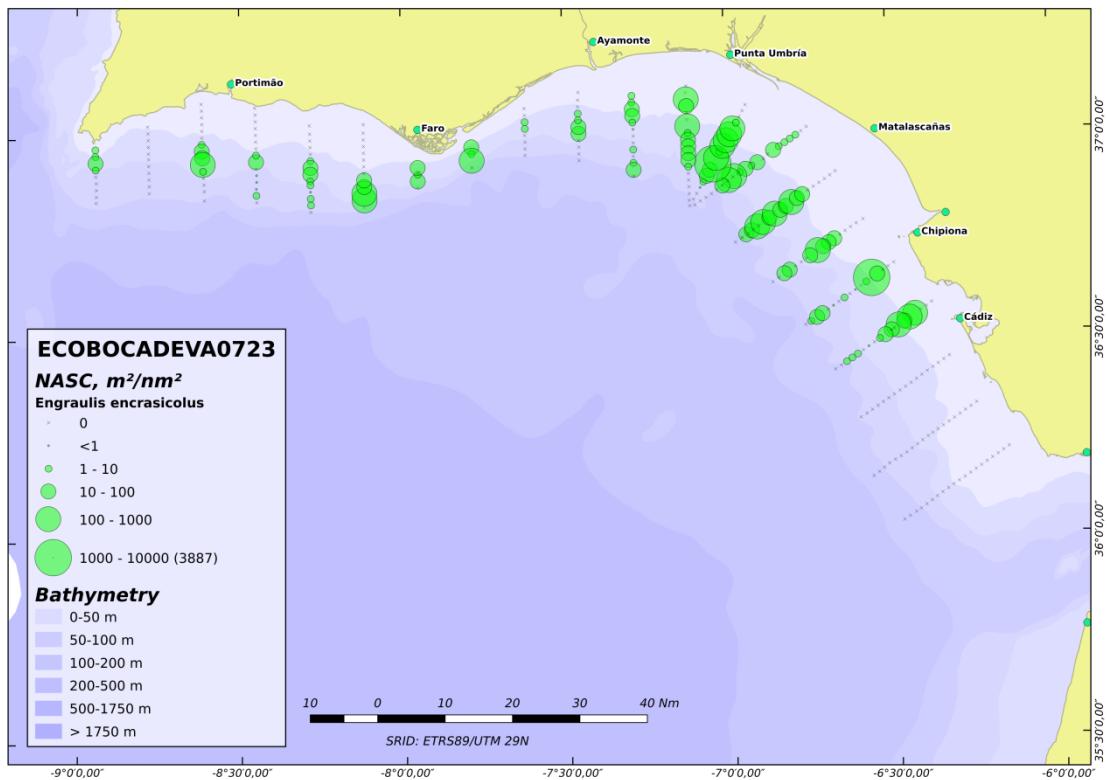


Figure 8. ECOCADIZ 2023-07 survey. Anchovy (*E. encrasicolus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2 nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

ECOCADIZ 2023-07: Anchovy (*E. encrasiculus*)

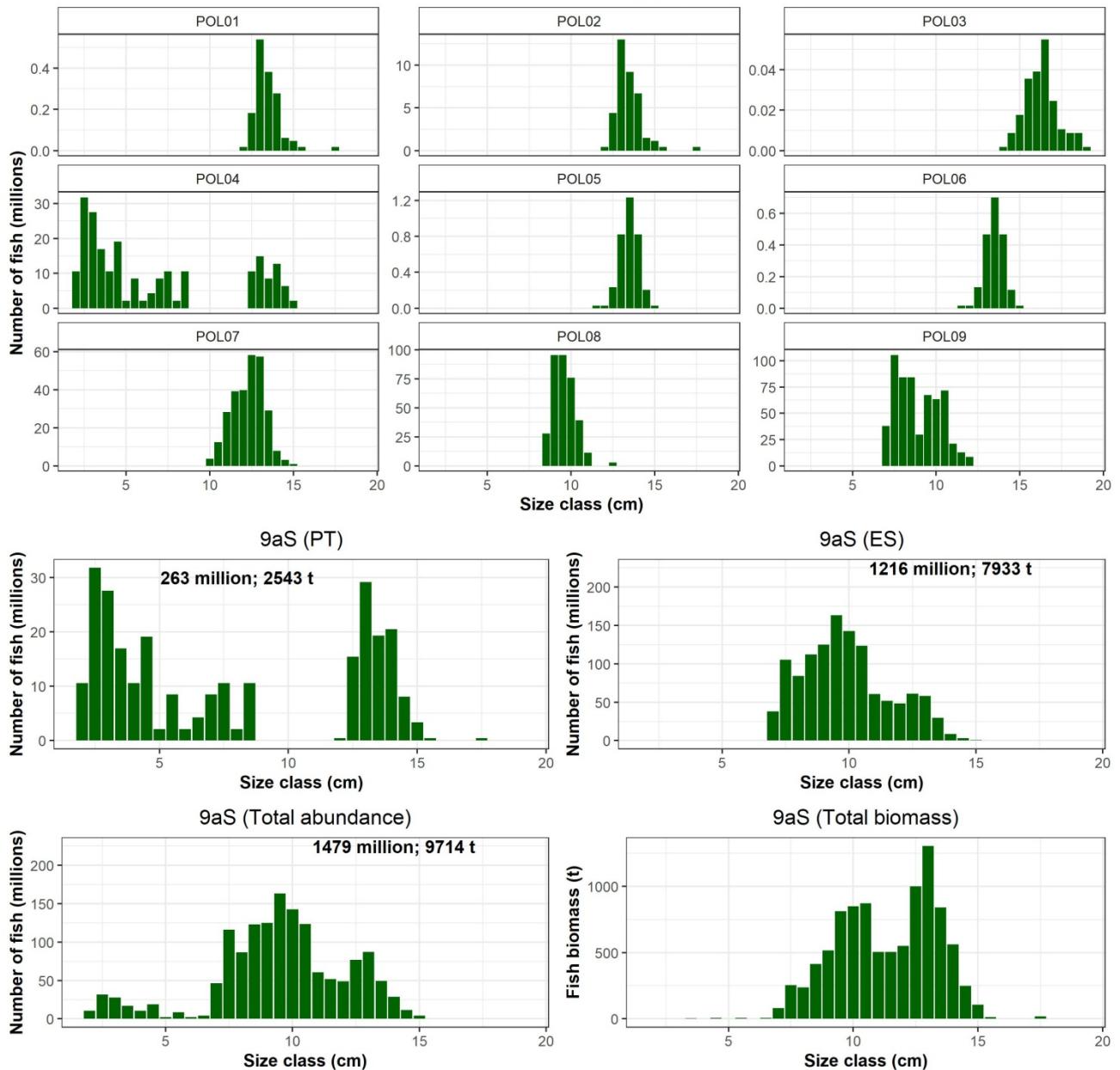


Figure 9. ECOCADIZ 2023-07 survey. Anchovy (*E. encrasiculus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 8**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the y axis.

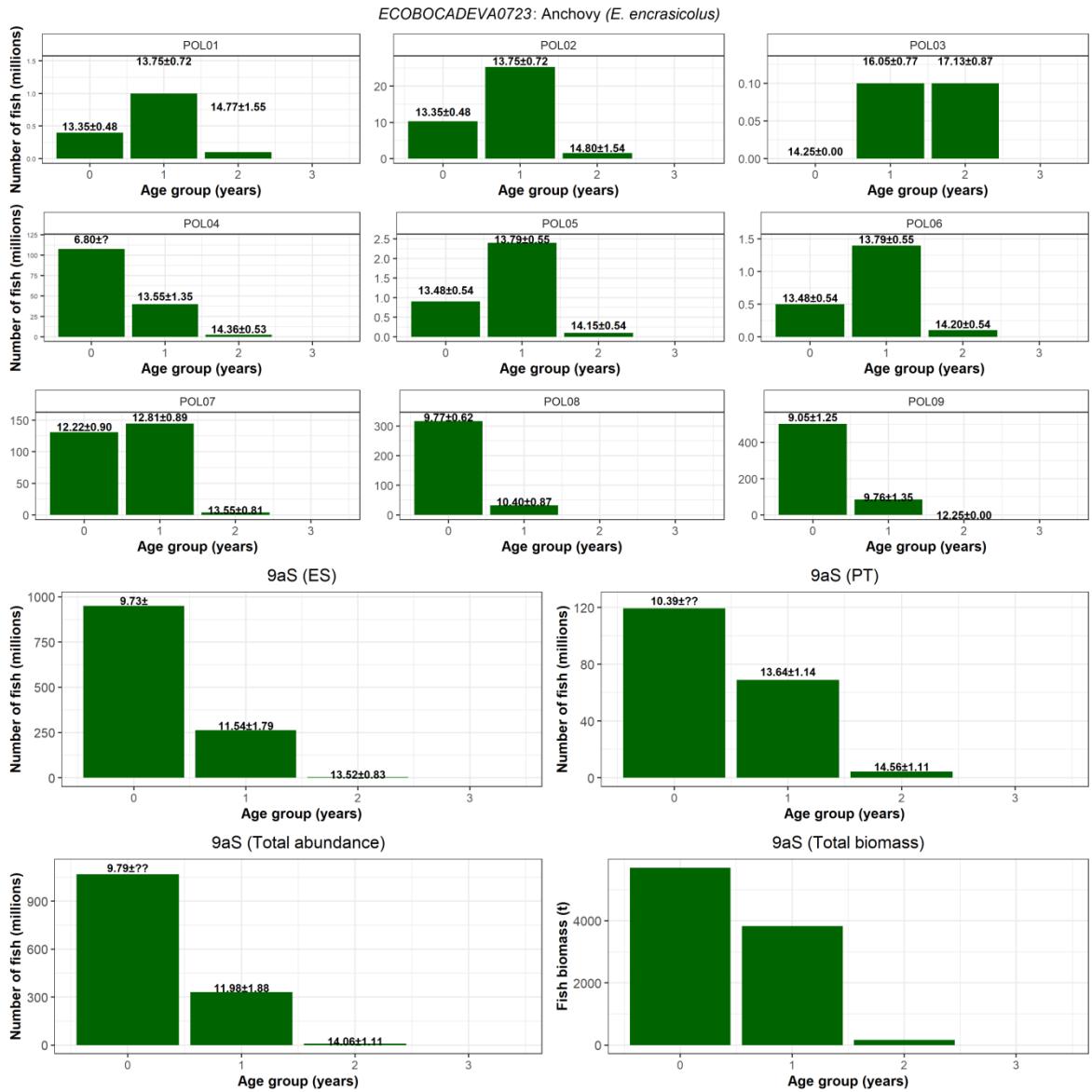


Figure 10. ECOCADIZ 2023-07 survey. Anchovy (*E. encrasiculus*). Estimated abundances (number of fish in millions) by age group (years) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 8**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by age group for the whole sampled area is also shown for comparison. Note the different scale in the y axis.

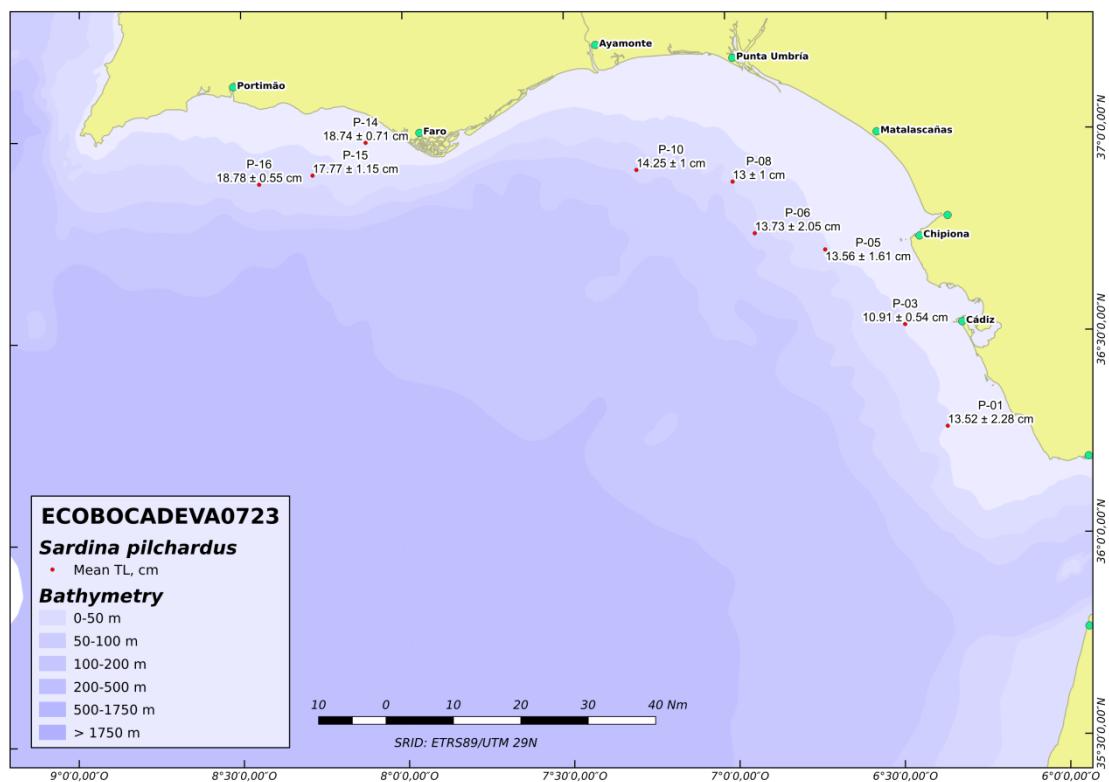
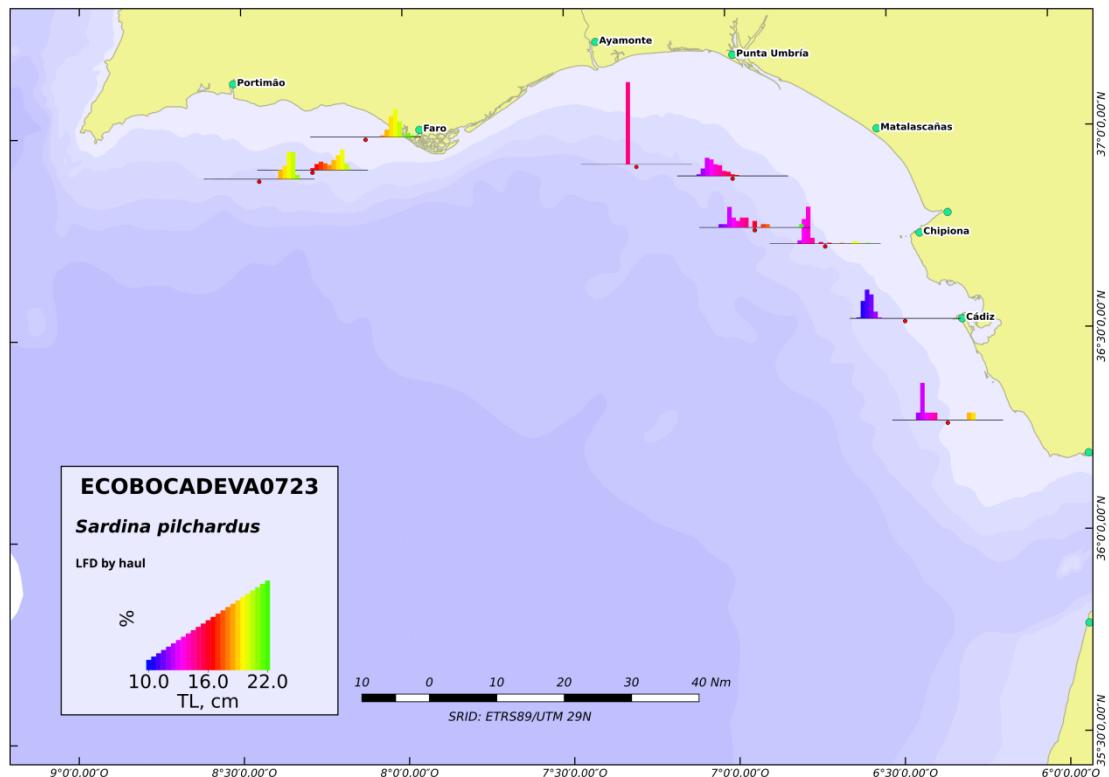


Figure 11. ECOCADIZ 2023-07 survey. Sardine (*Sardina pilchardus*). Top: length frequency distributions in fishing hauls. Bottom: mean \pm sd length by haul.

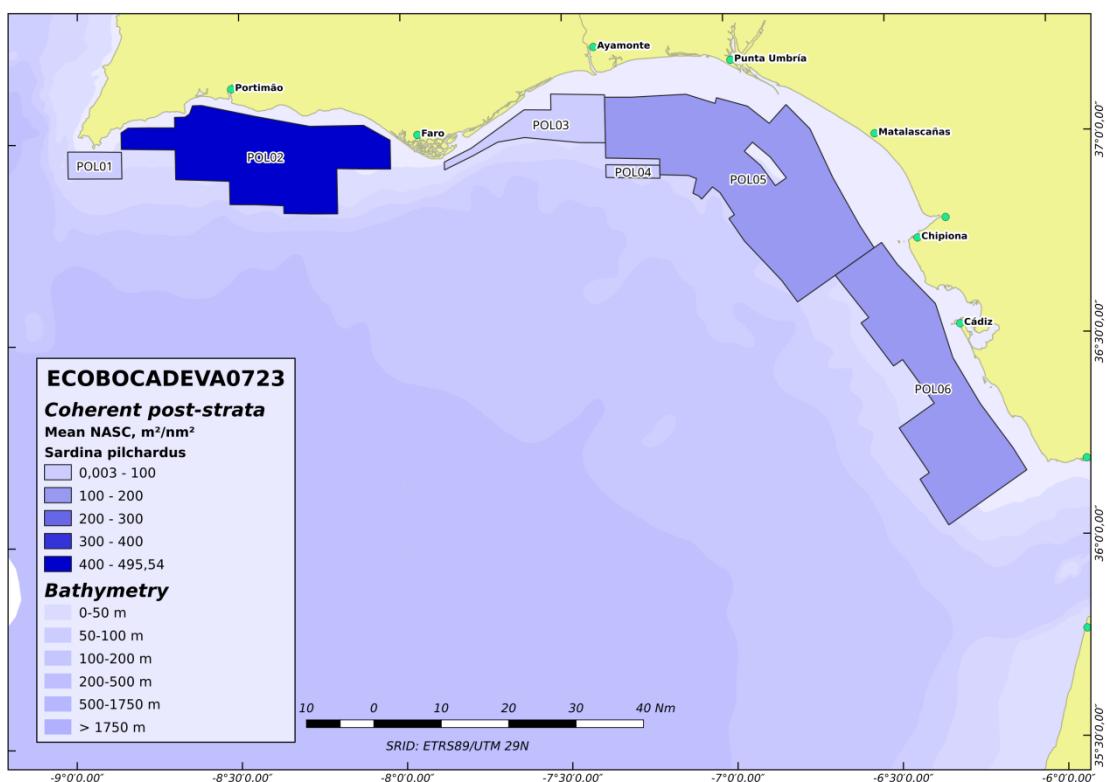
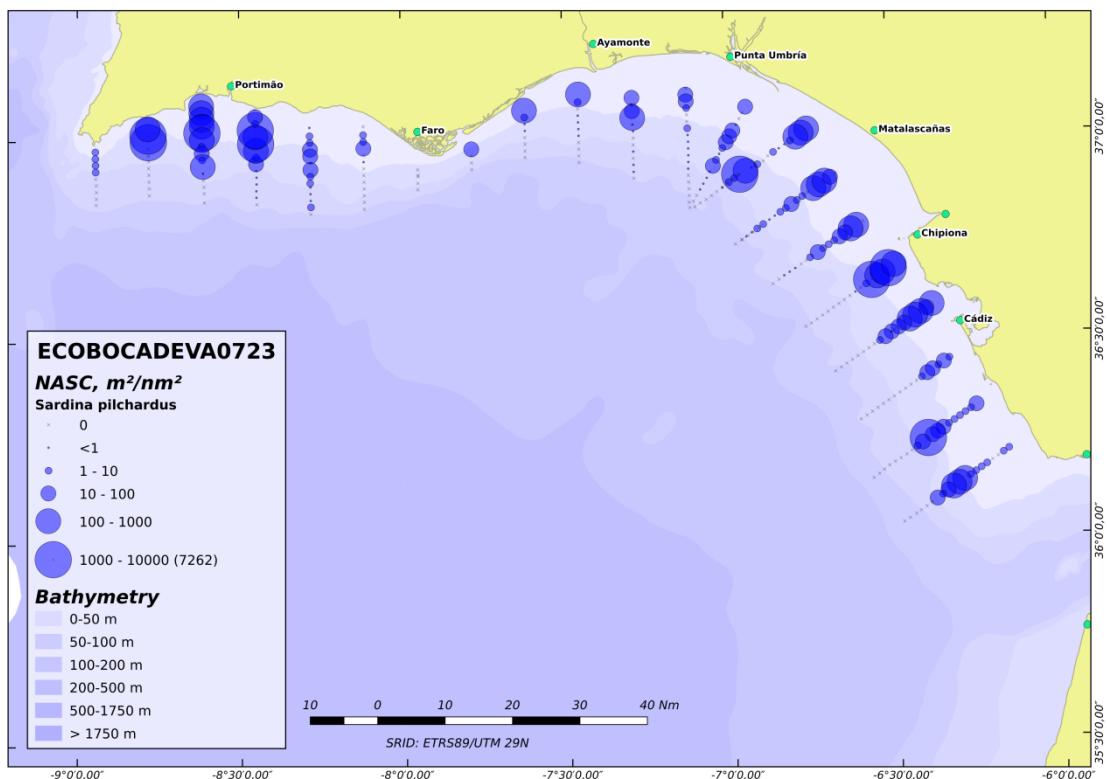


Figure 12. ECOCADIZ 2023-07 survey. Sardine (*S. pilchardus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2\text{m}^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

*ECOBOCADEVA0723: Sardine (*S. pilchardus*)*

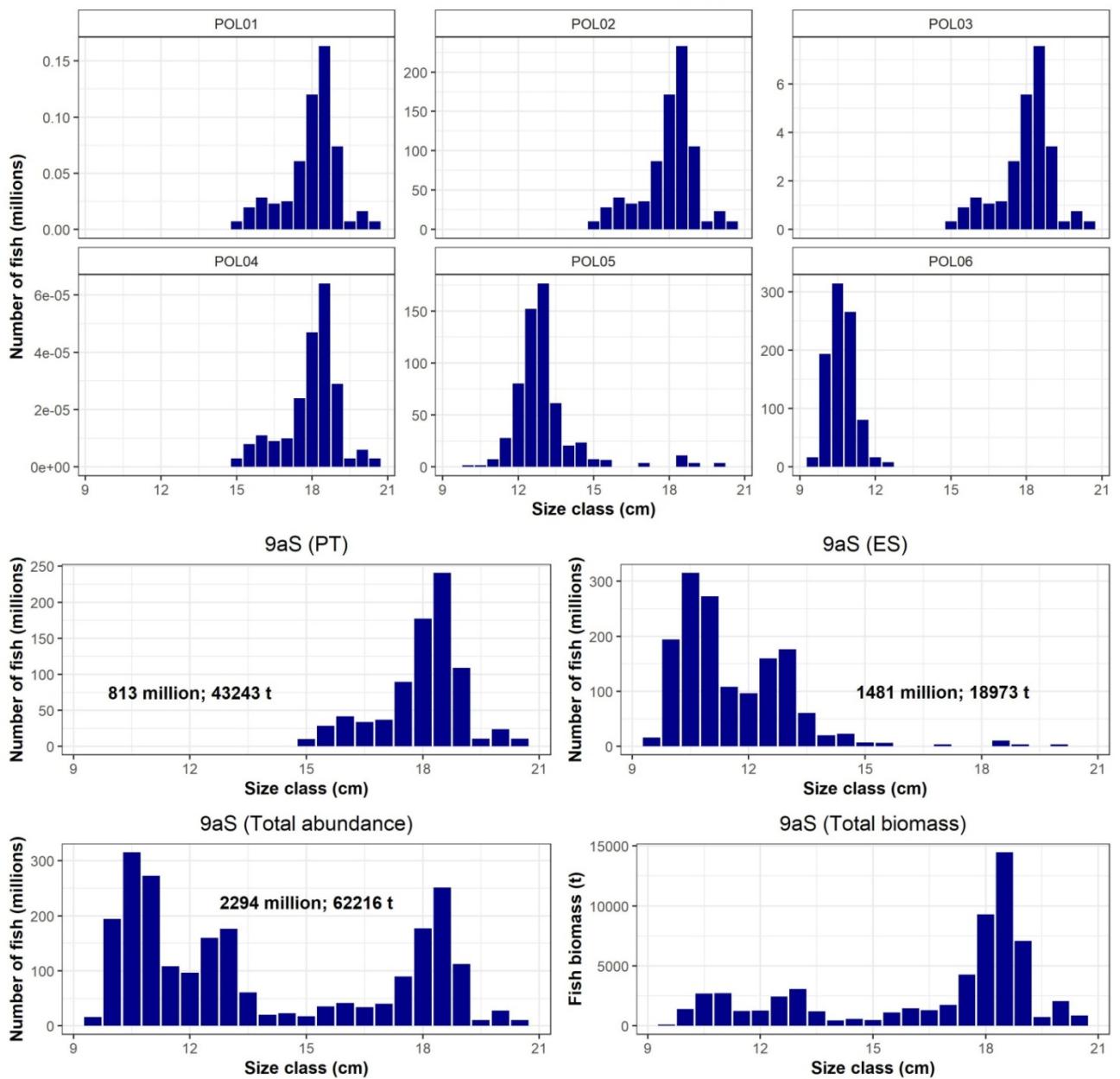


Figure 13. ECOCADIZ 2023-07 survey. Sardine (*S. pilchardus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 12** and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the y axis.

ECOCADIZ-RECLUTAS 2022-10: Sardine (*S. pilchardus*)

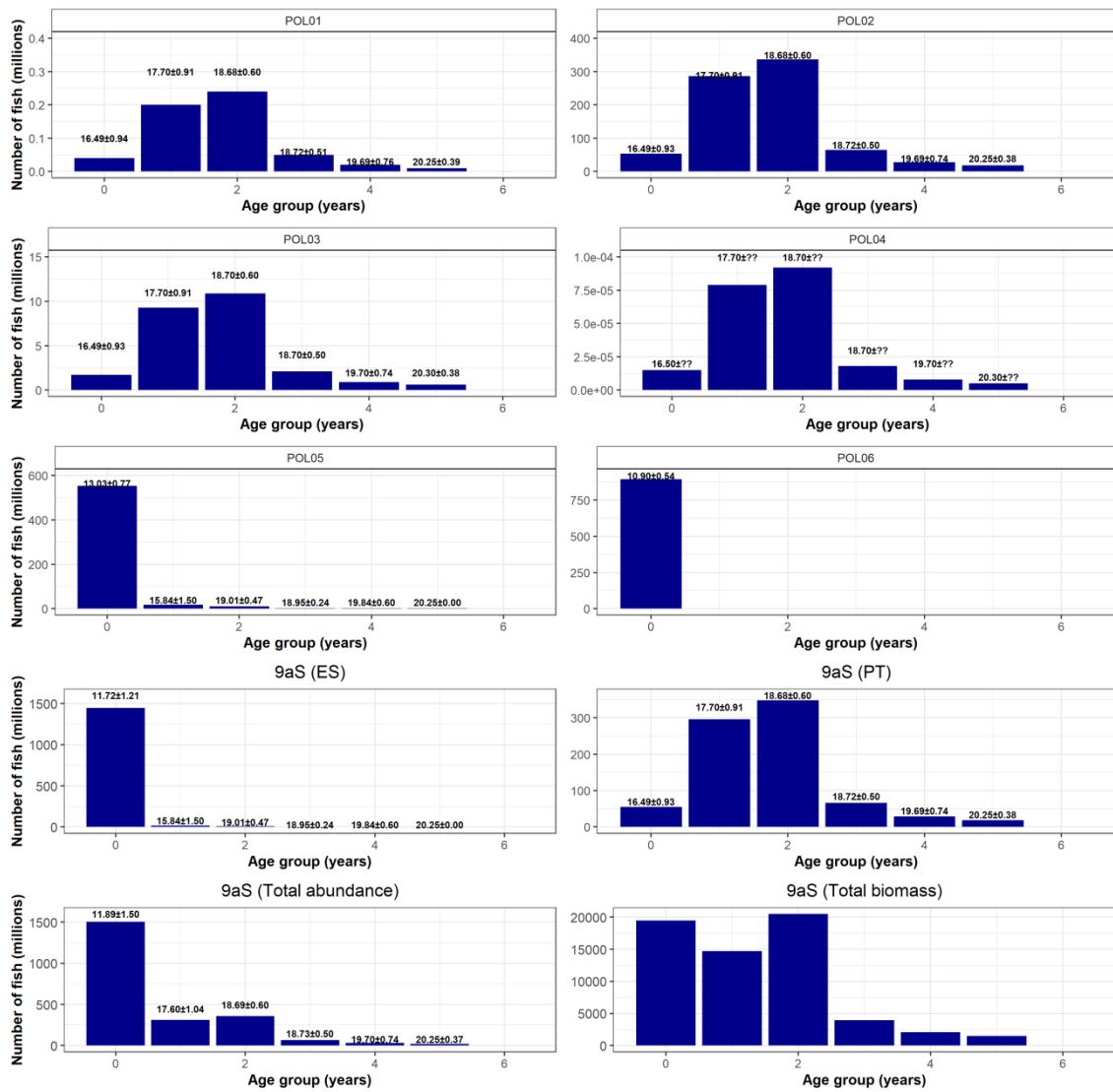


Figure 14. ECOCADIZ 2023-07 survey. Sardine (*S. pilchardus*). Estimated abundances (number of fish in millions) by age group (years) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 12** and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the y axis.

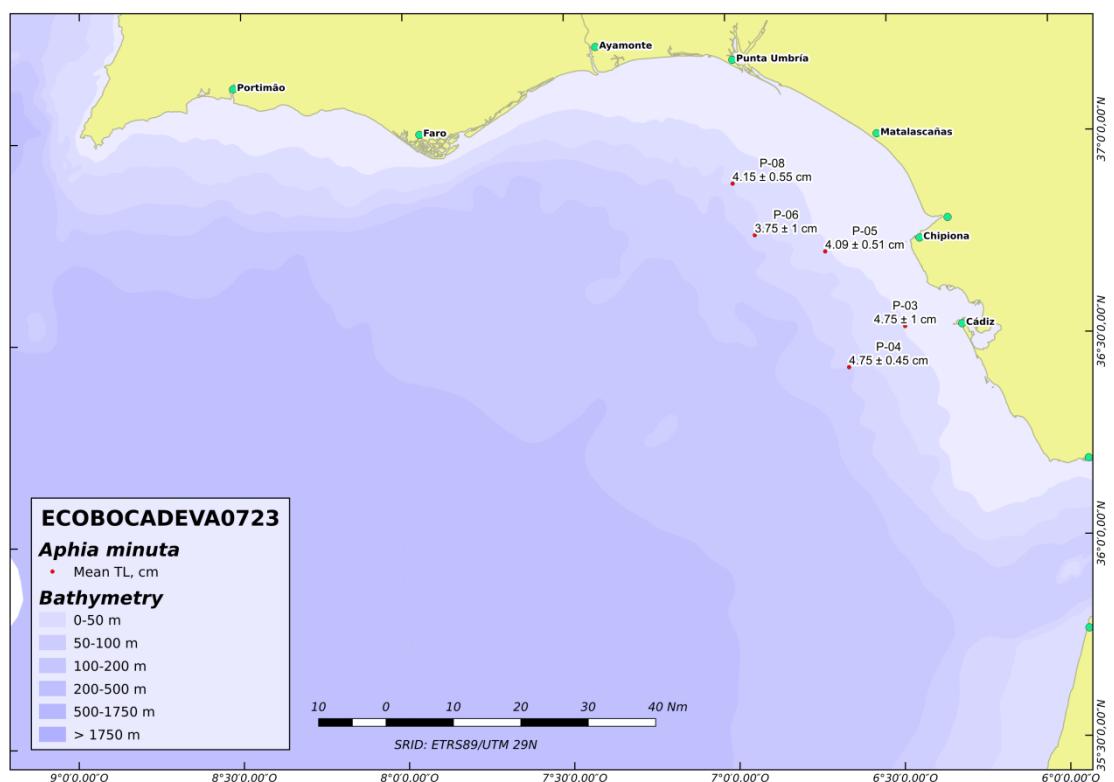
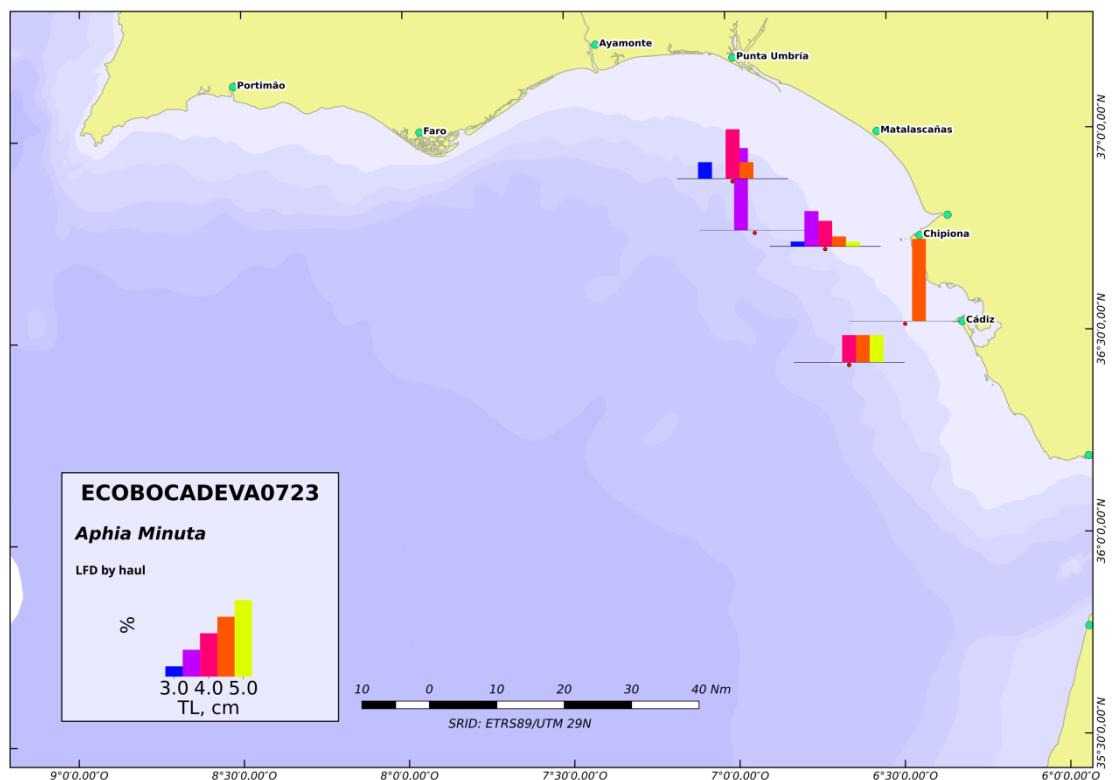


Figure 15. ECOCADIZ 2023-07 survey. Transparent goby (*Aphia minuta*). Top: length frequency distributions in fishing hauls. Bottom: mean \pm sd length by haul.

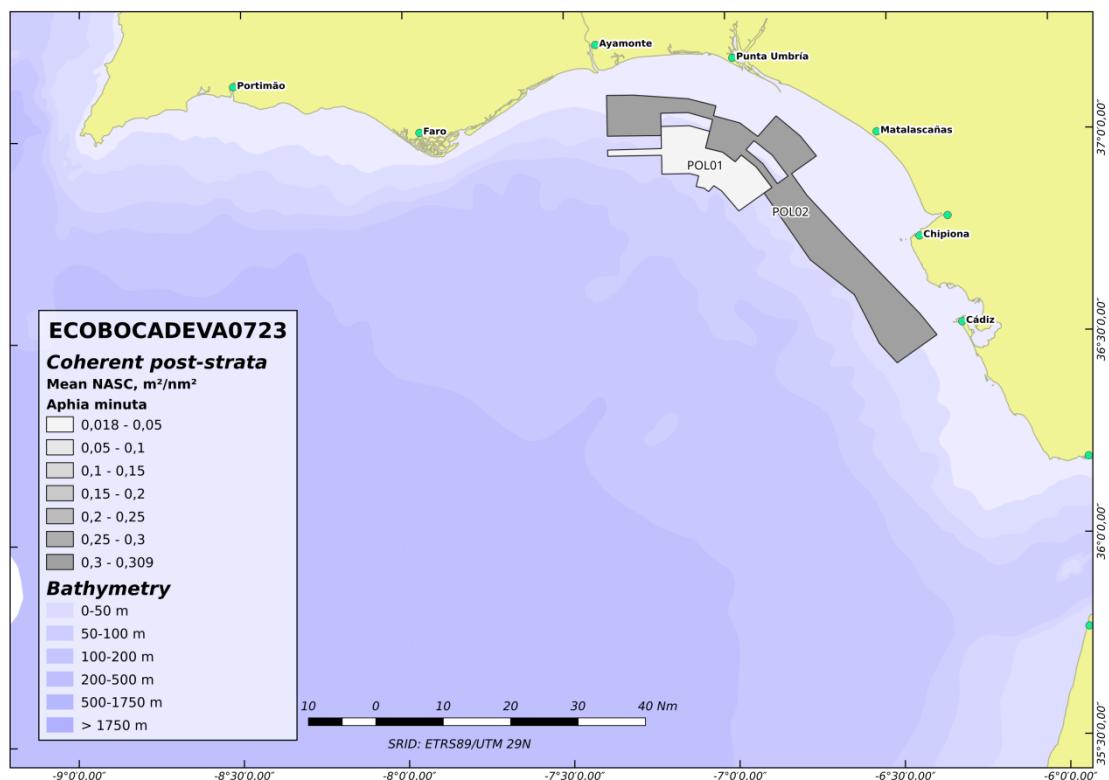
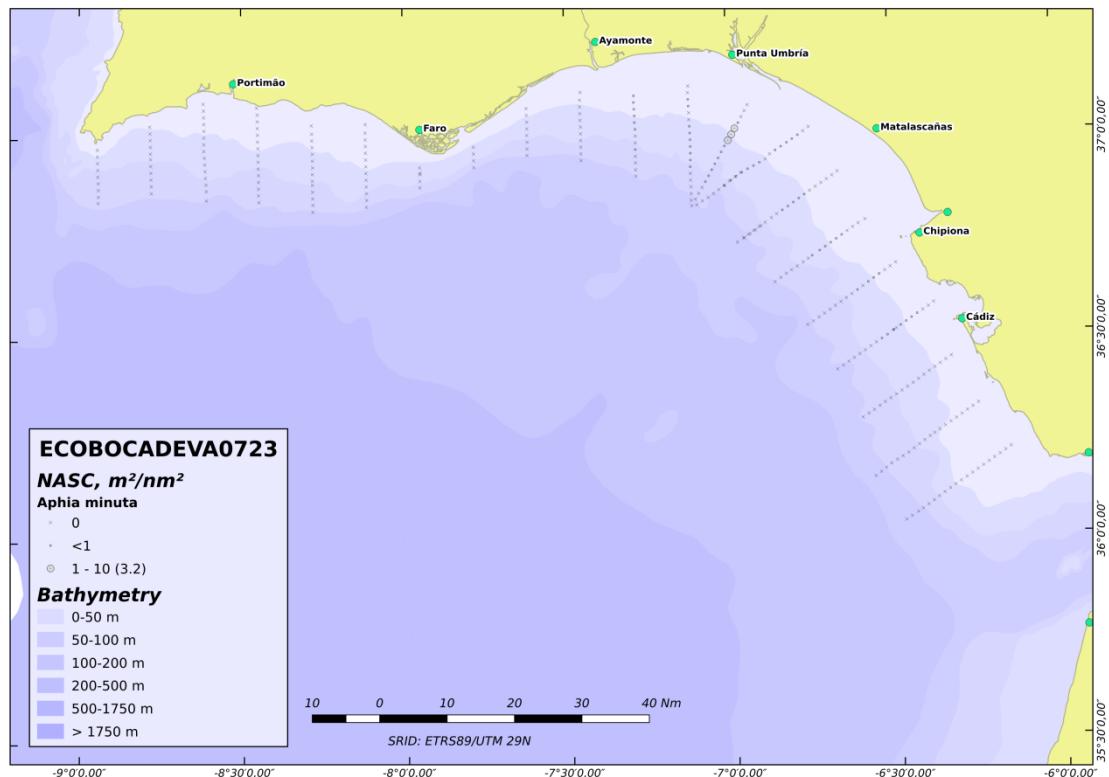


Figure 16. ECOCADIZ 2023-07 survey. Transparent goby (*A. minuta*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in m^2/nm^2) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

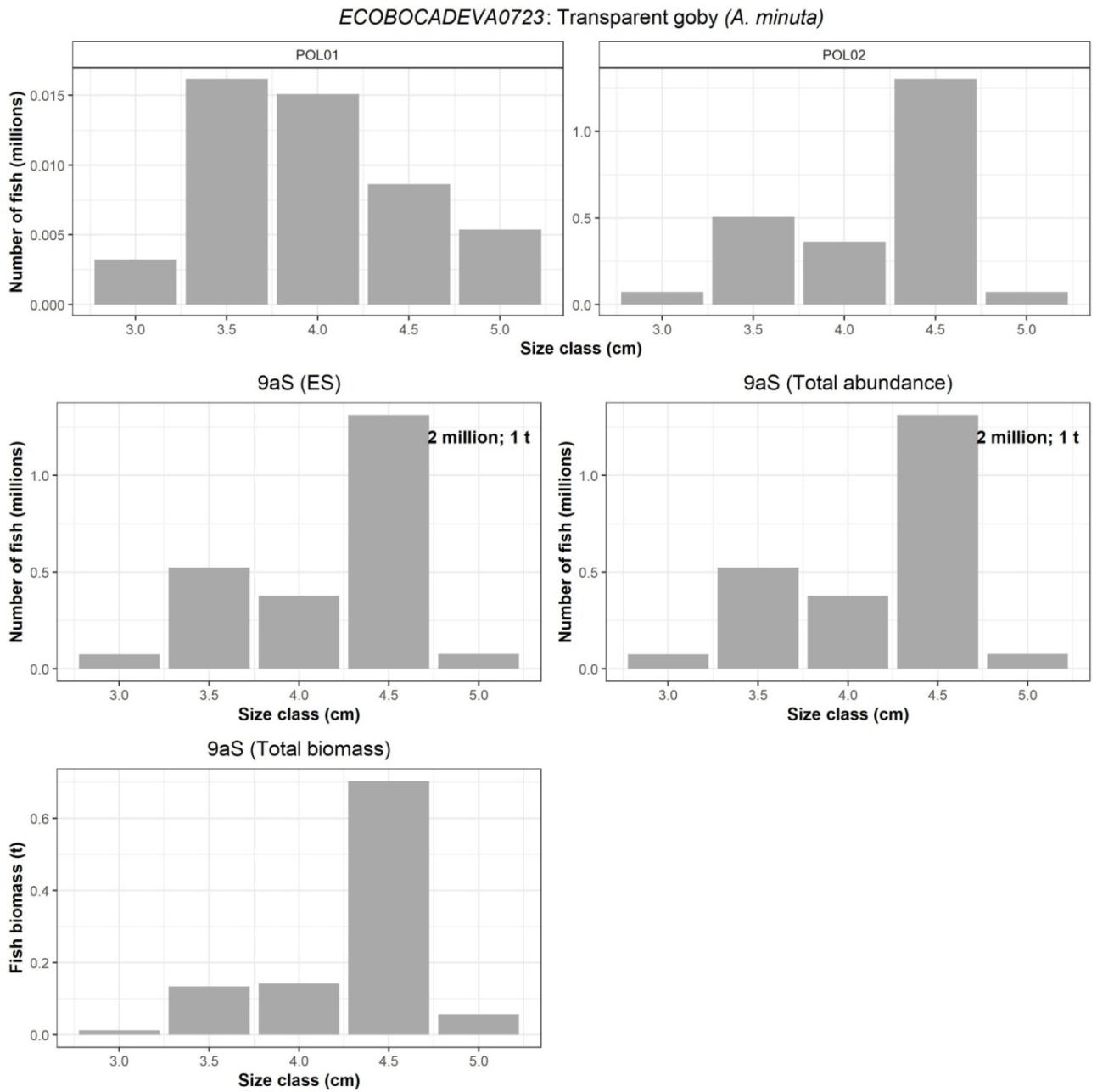


Figure 17. ECOCADIZ 2023-07 survey. Transparent goby (*A. minuta*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 16**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the y-axis.

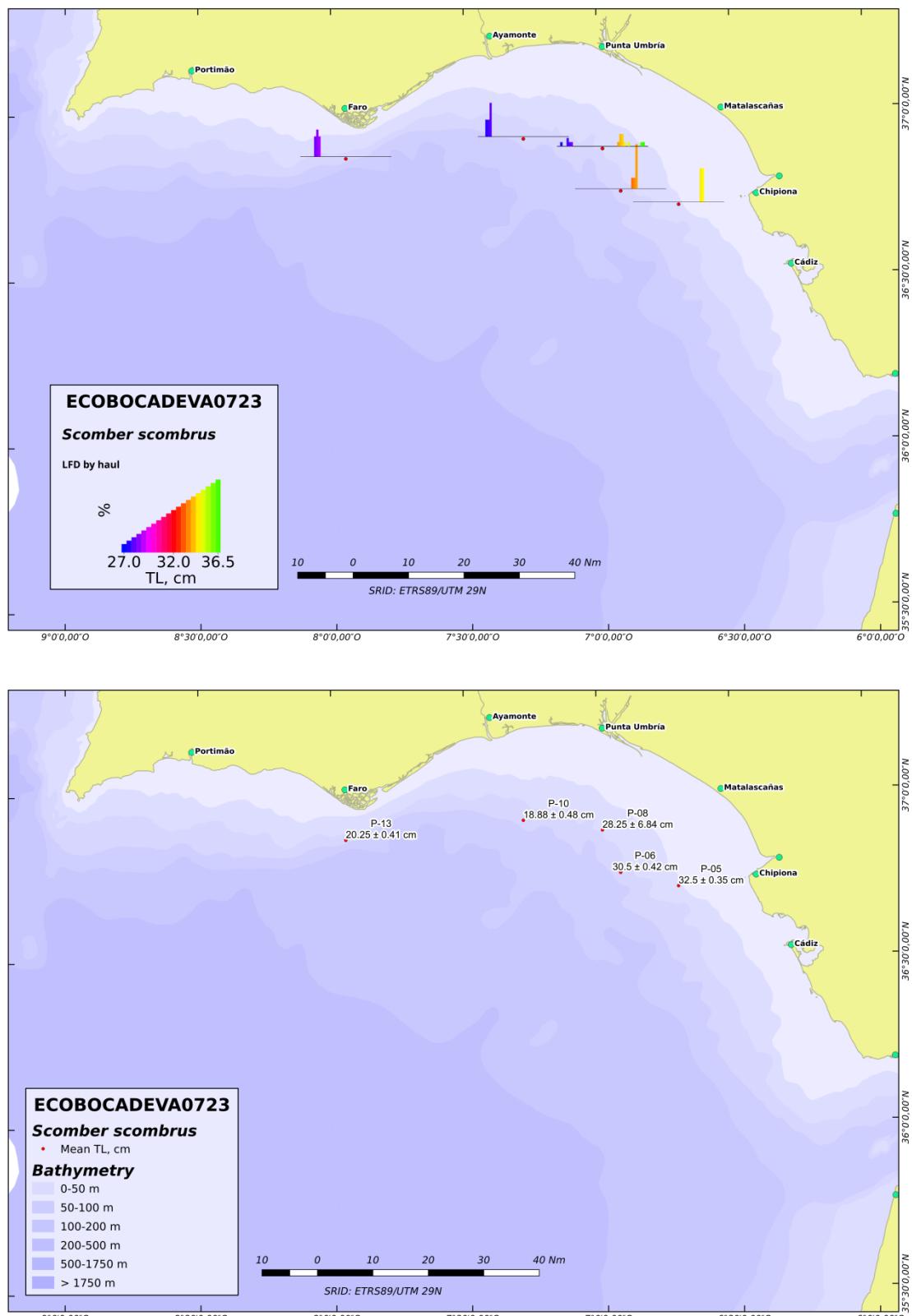


Figure 18. ECOCADIZ 2023-07 survey. Atlantic mackerel (*Scomber scombrus*). Top: length frequency distributions in fishing hauls. Bottom: mean \pm sd length by haul.

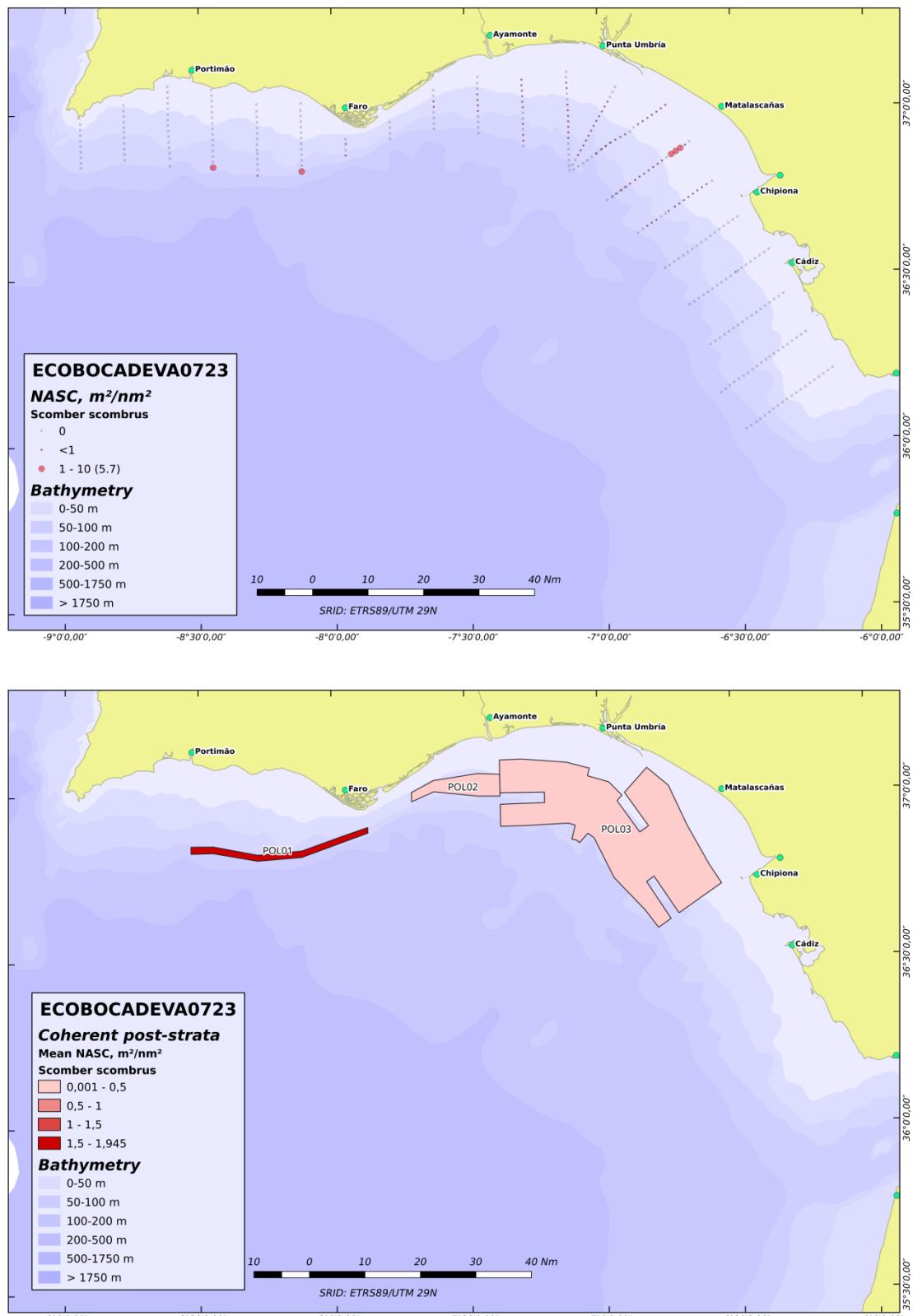


Figure 19. ECOCADIZ 2023-07 survey. Atlantic mackerel (*S. scombrus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in m^2/nmi^2) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Color scale according to the mean value of the backscattering energy attributed to the species in each stratum.

BOCADEVA0723: Mackerel (*S. scombrus*)

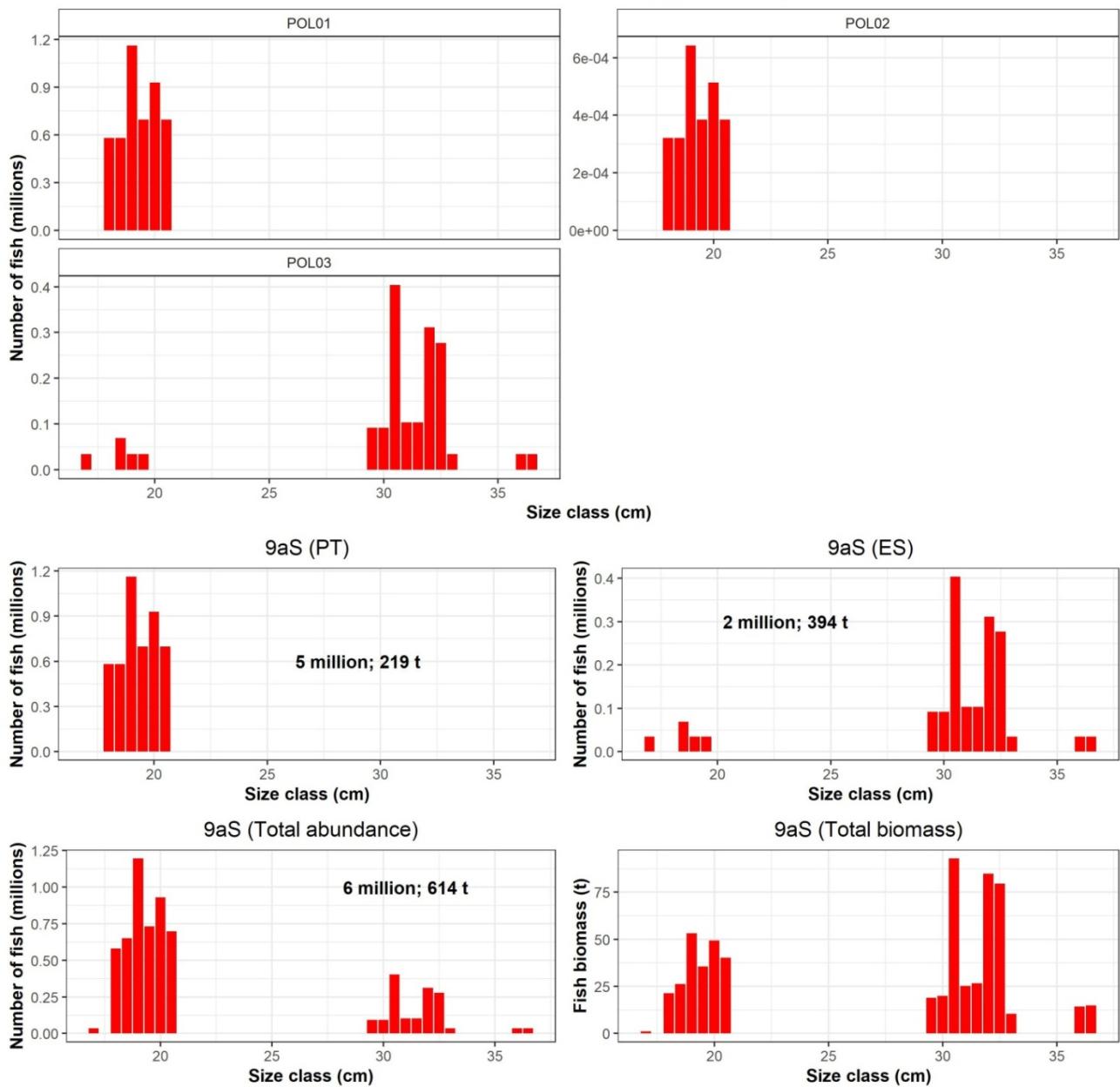


Figure 20. ECOCADIZ 2023-07 survey. Atlantic mackerel (*S. scombrus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 19**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the y axis

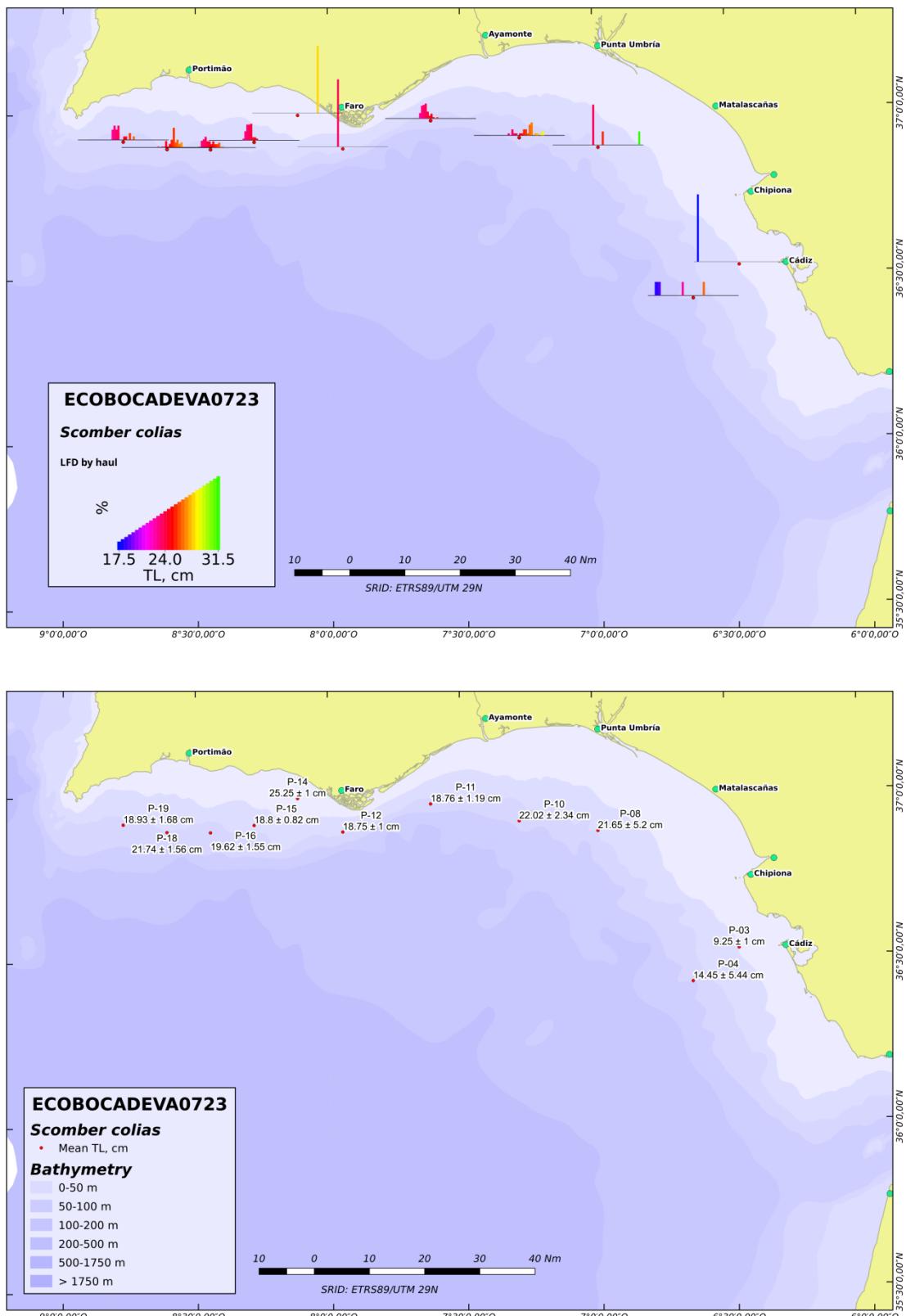


Figure 21. ECOCADIZ 2023-07 survey. Chub mackerel (*Scomber colias*). Top: length frequency distributions in fishing hauls. Bottom: mean \pm sd length by haul.

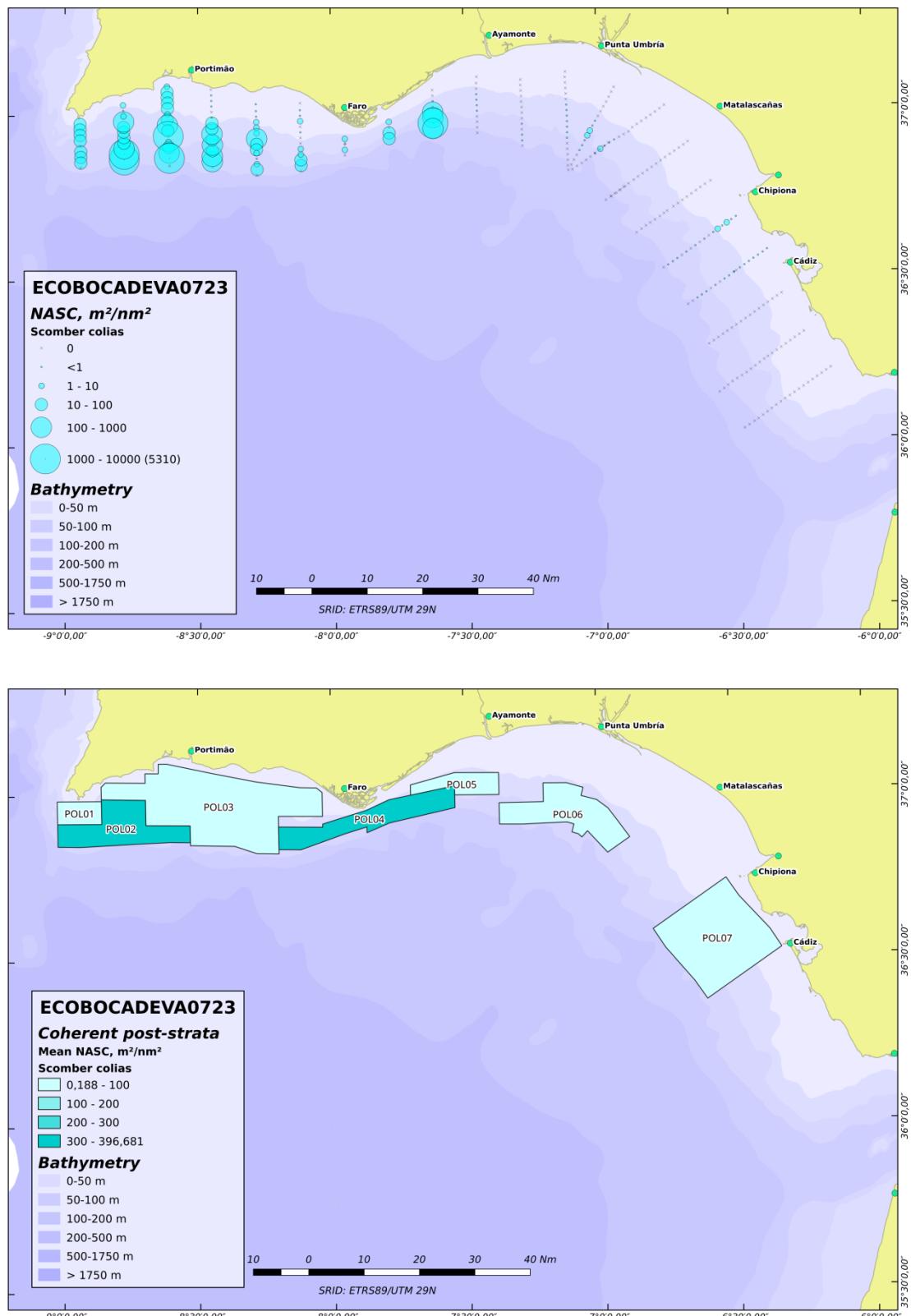


Figure 22. ECOCADIZ 2023-07 survey. Chub mackerel (*S. colias*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in m^2/nmi^2) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

ECOBOCADEVA723: Chub mackerel (*S. colias*)

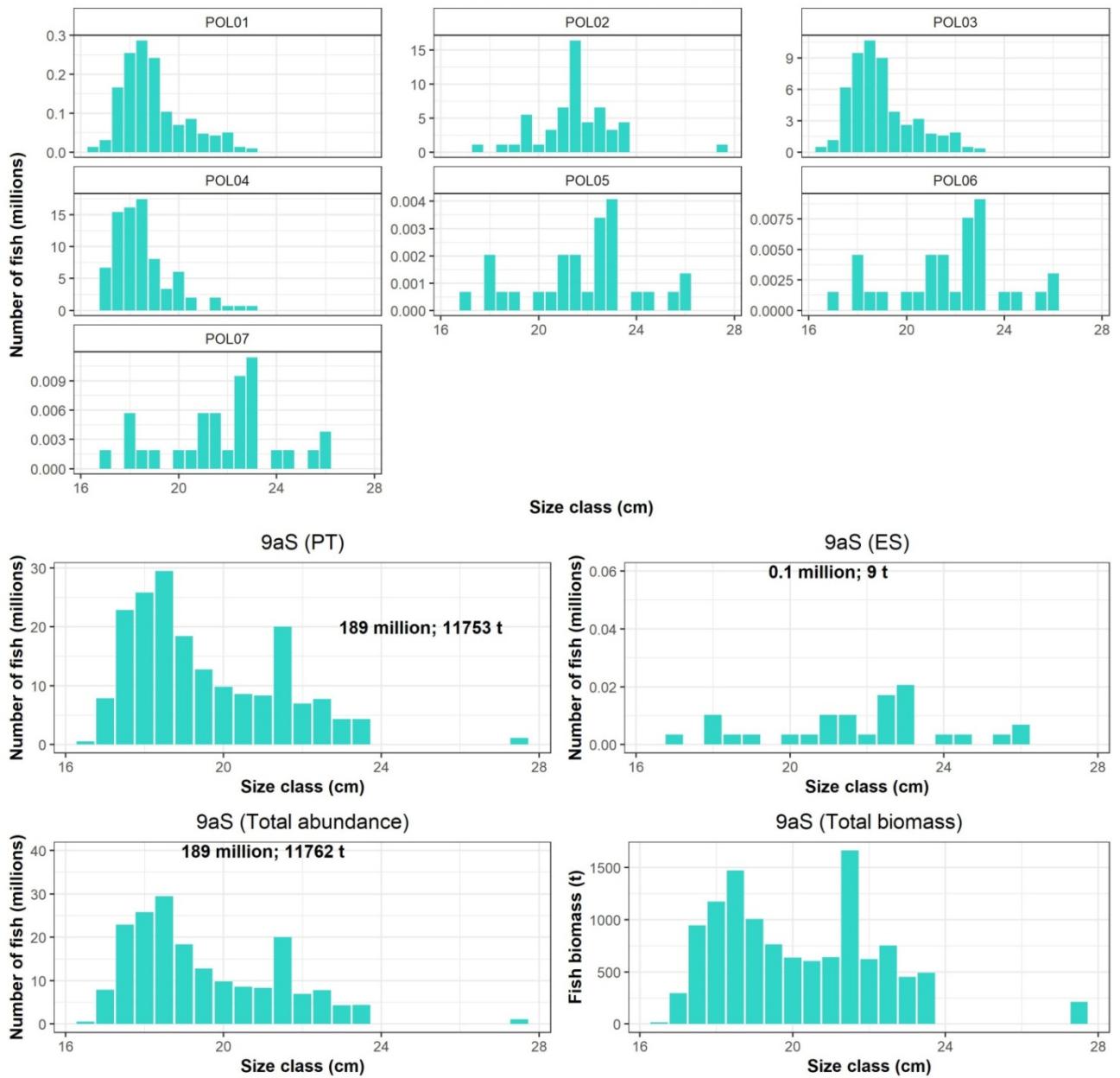


Figure 23. ECOCADIZ 2023-07 survey. Chub mackerel (*S. colias*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 22**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the y-axis.

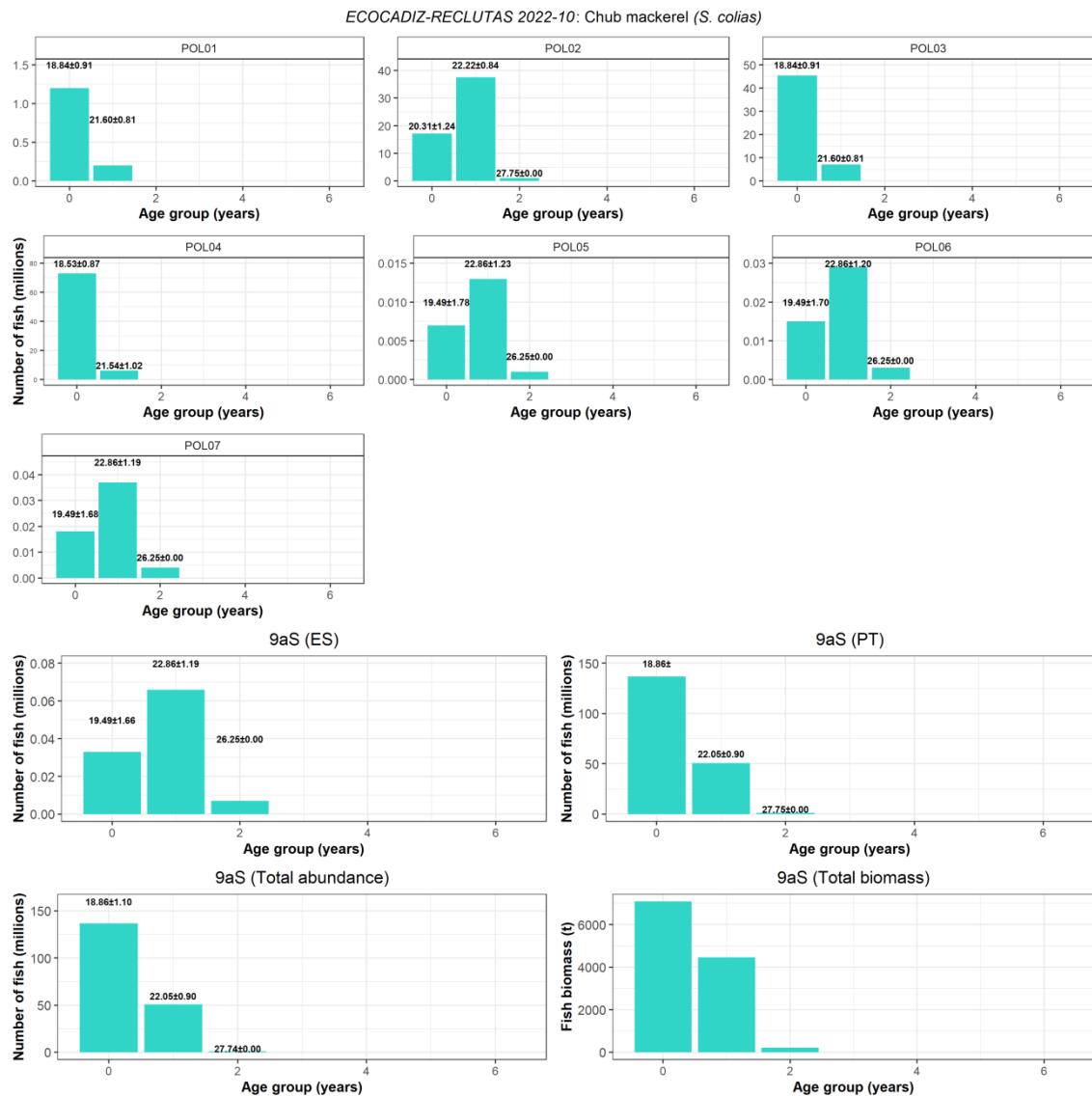


Figure 24. ECOCADIZ 2023-07 survey. Chub mackerel (*S. colias*). Estimated abundances (number of fish in millions) by age group (years) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 22**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by age group for the whole sampled area is also shown for comparison. Note the different scale in the y-axis.

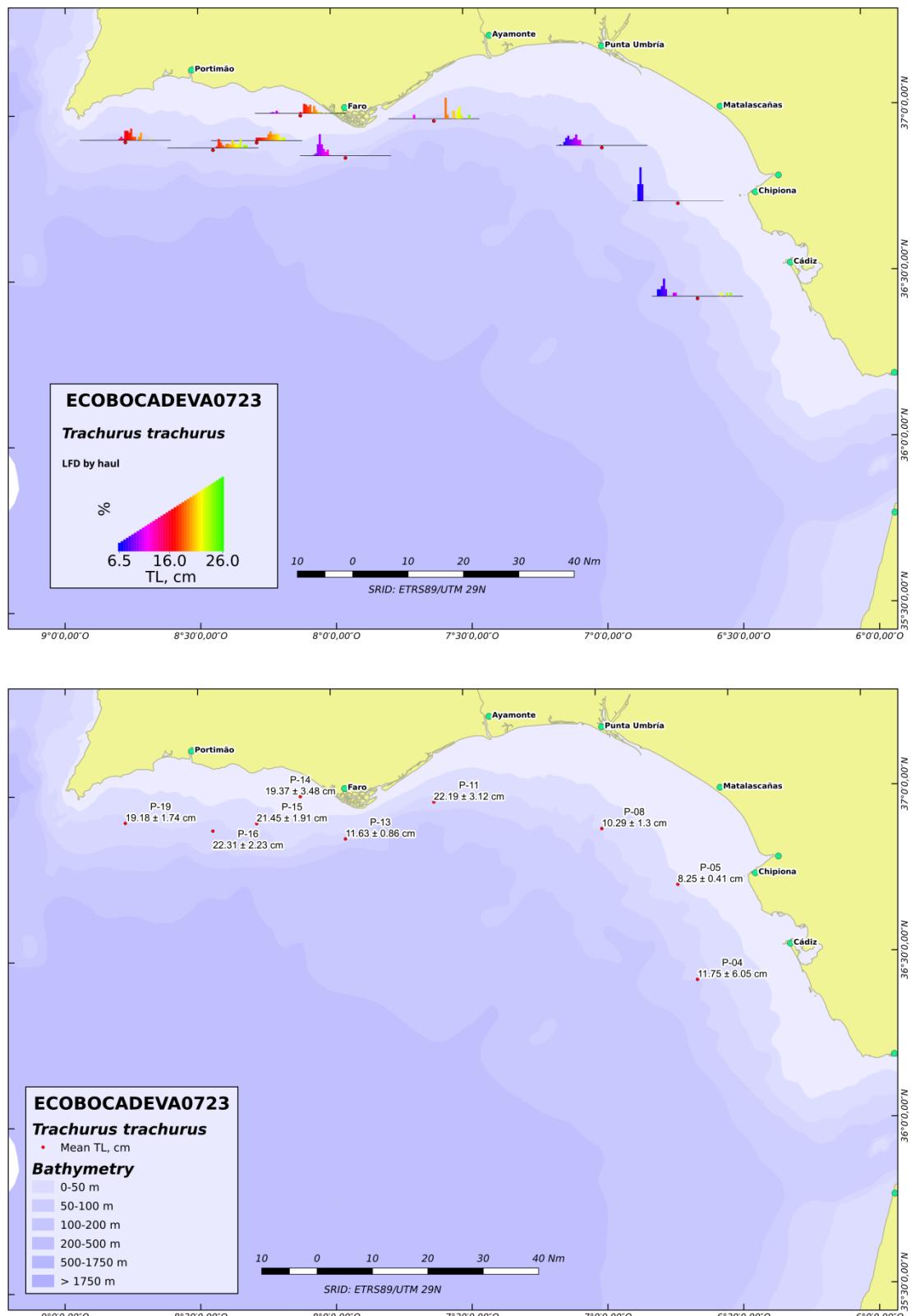


Figure 25. ECOCADIZ 2023-07 survey. Horse mackerel (*Trachurus trachurus*). Top: length frequency distributions in fishing hauls. Bottom: mean \pm sd length by haul.

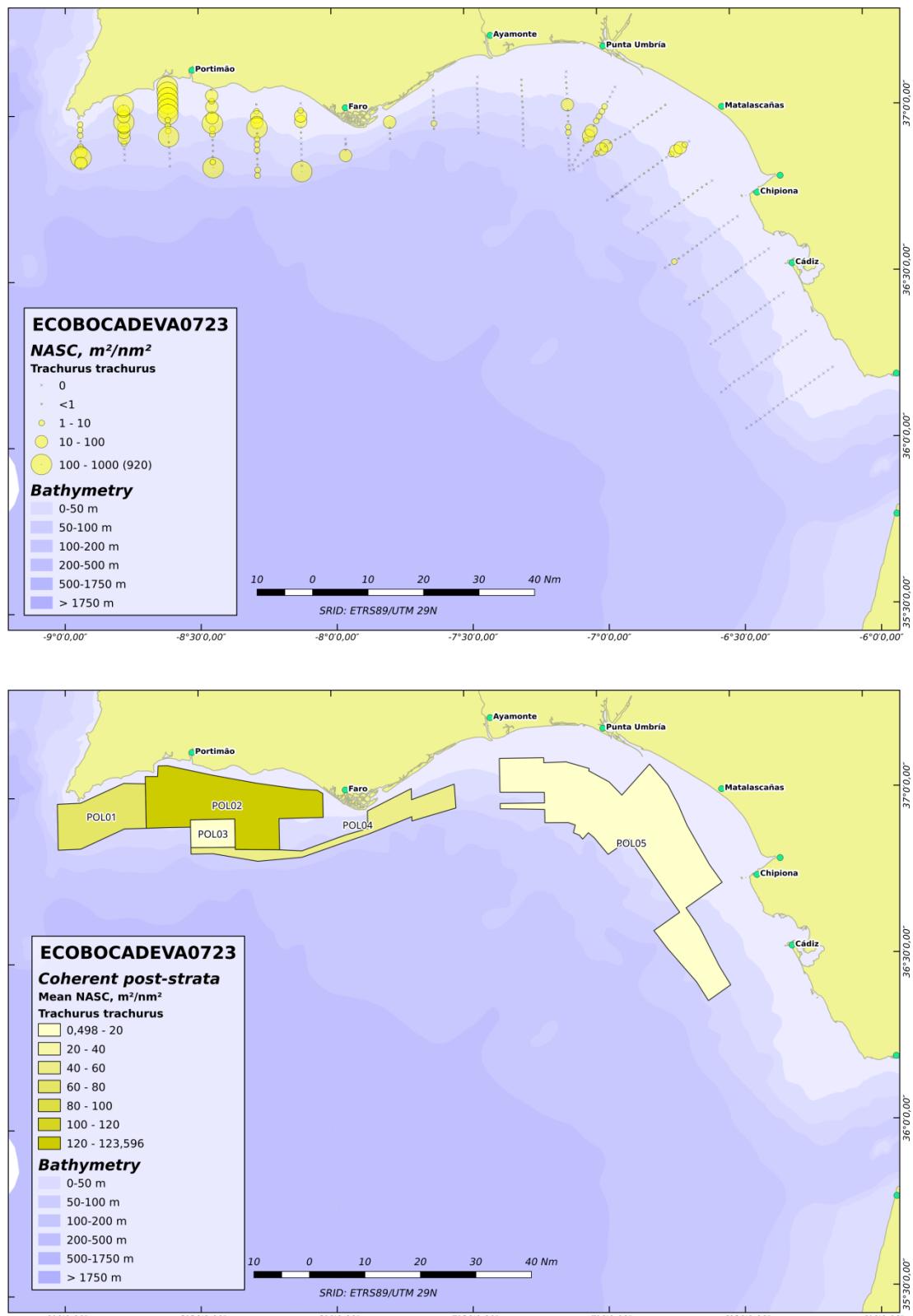


Figure 26. ECOCADIZ 2023-07 survey. Horse mackerel (*T. trachurus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in m^2/nmi^2) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

ECOBODADEVA0723: Horse mackerel (*T. trachurus*)

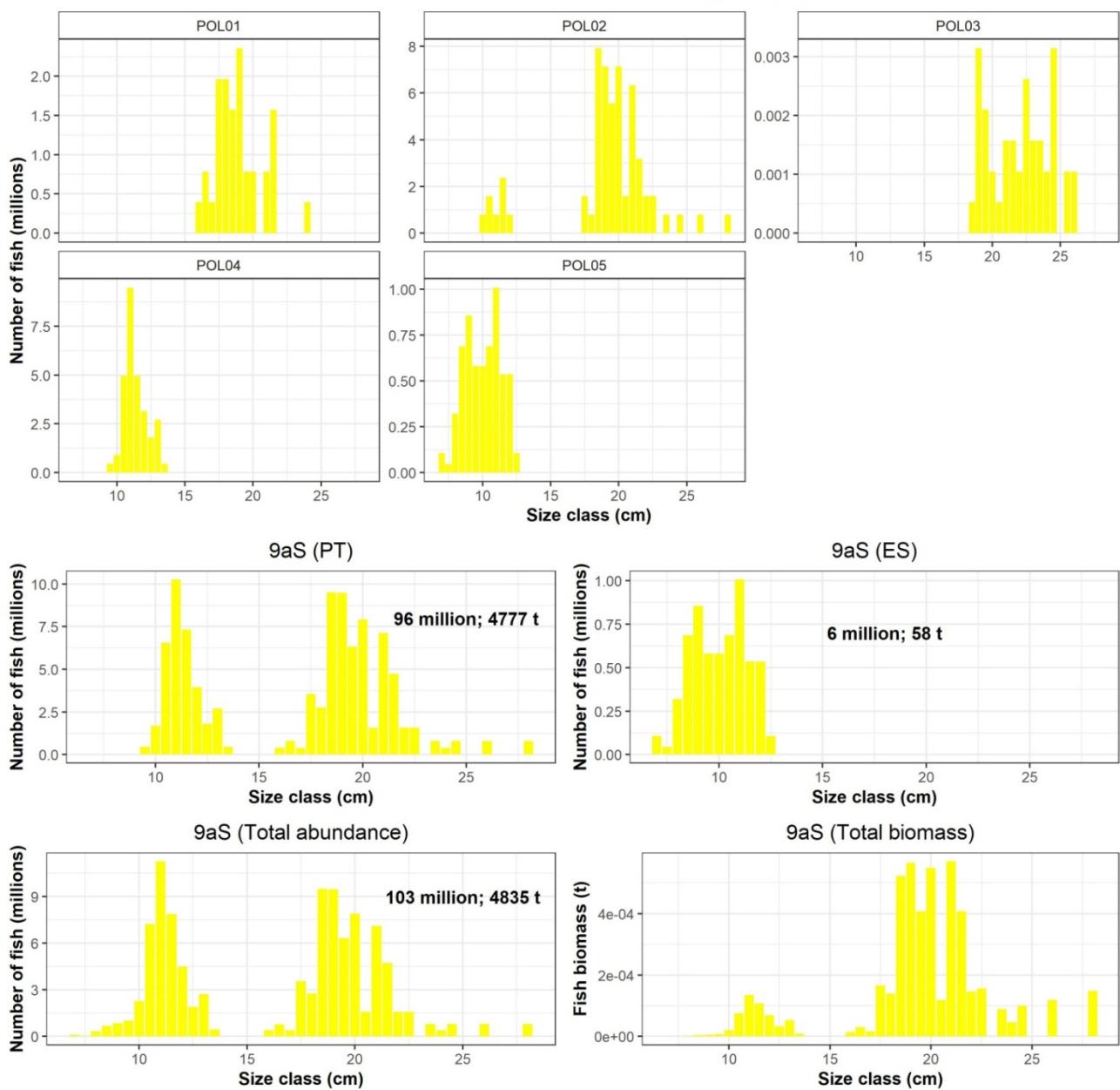


Figure 27. ECOCADIZ 2023-07 survey. Horse mackerel (*T. trachurus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in Figure 26) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the y-axis.

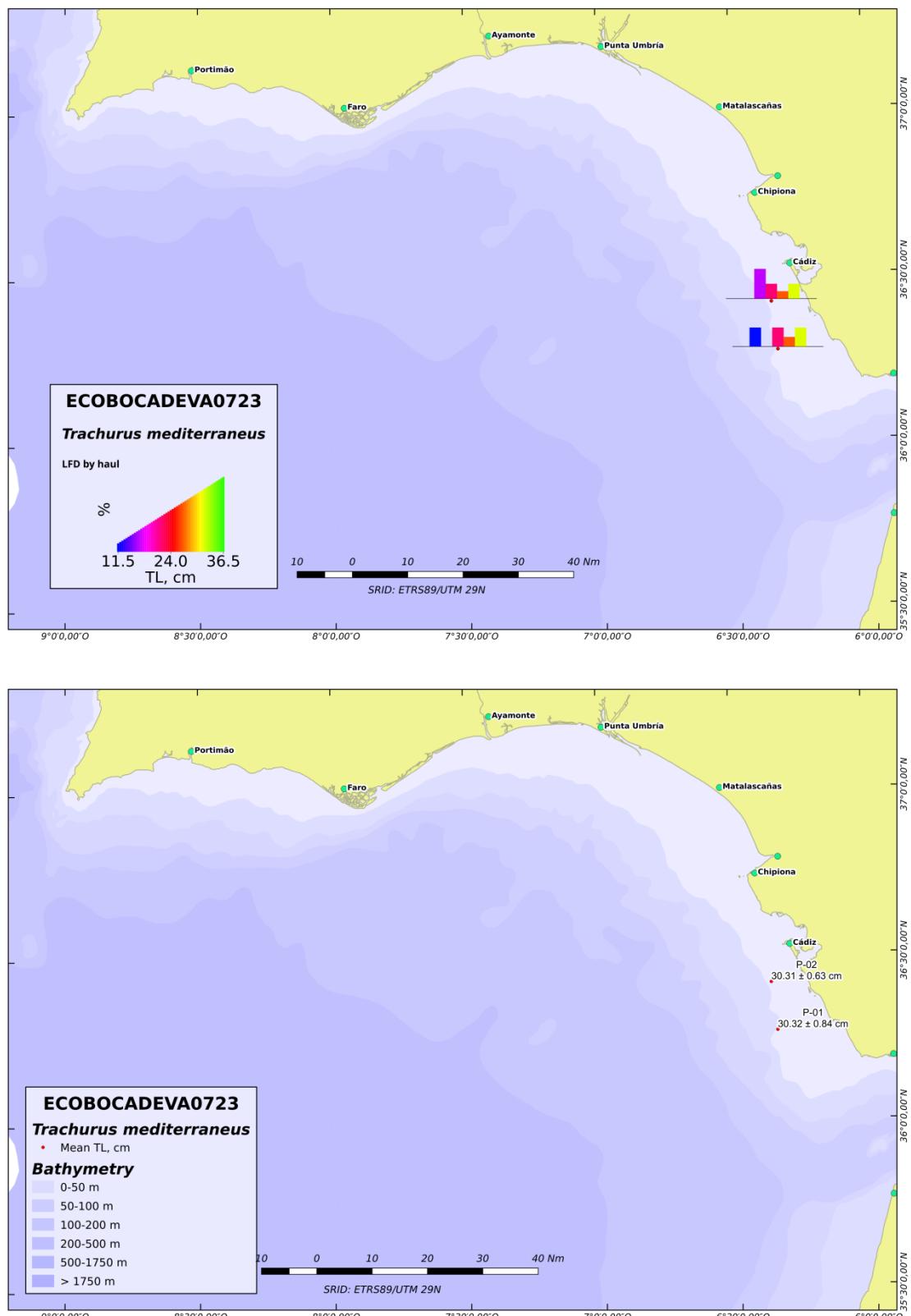


Figure 28. ECOCADIZ 2023-07 survey. Mediterranean horse mackerel (*Trachurus mediterraneus*). Top: length frequency distributions in fishing hauls. Bottom: mean \pm sd length by haul.

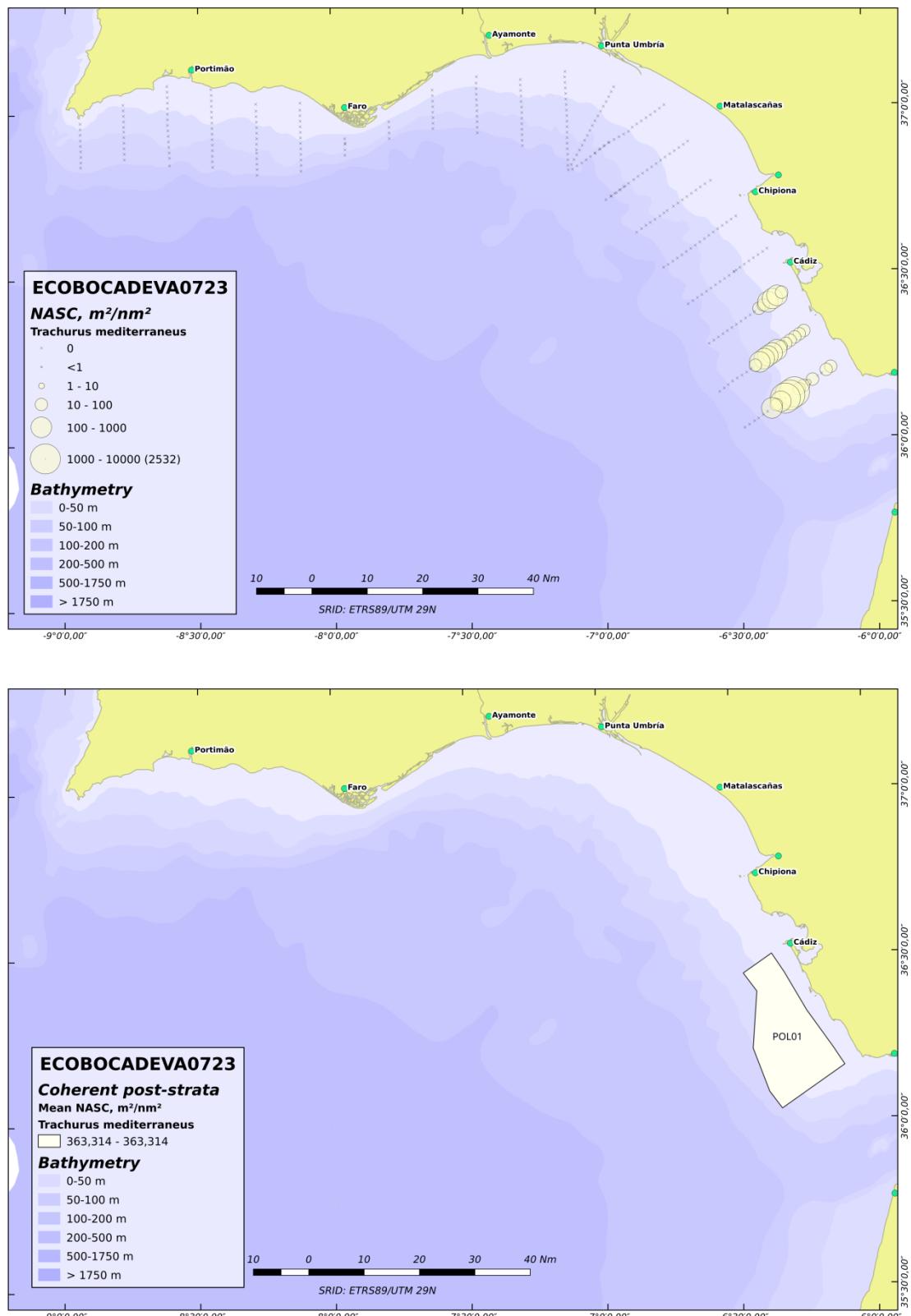


Figure 29. ECOCADIZ 2023-07 survey. Mediterranean horse mackerel (*T. mediterraneus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2 nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

ECOBOCADEVA0723: Mediterranean horse mackerel (*T. mediterraneus*)

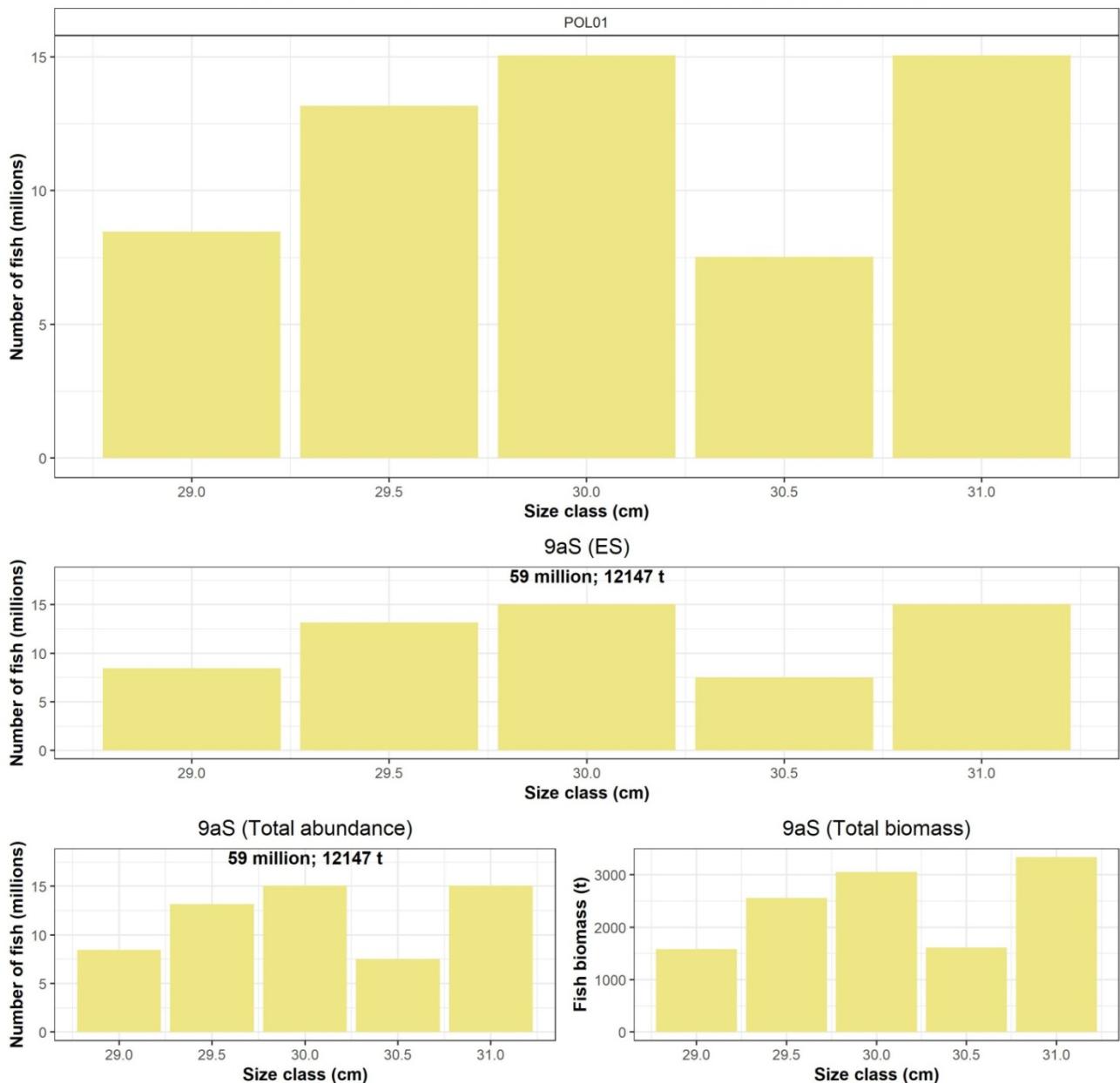


Figure 30. ECOCADIZ 2023-07 survey. Mediterranean horse mackerel (*T. mediterraneus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 29**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the y-axis.

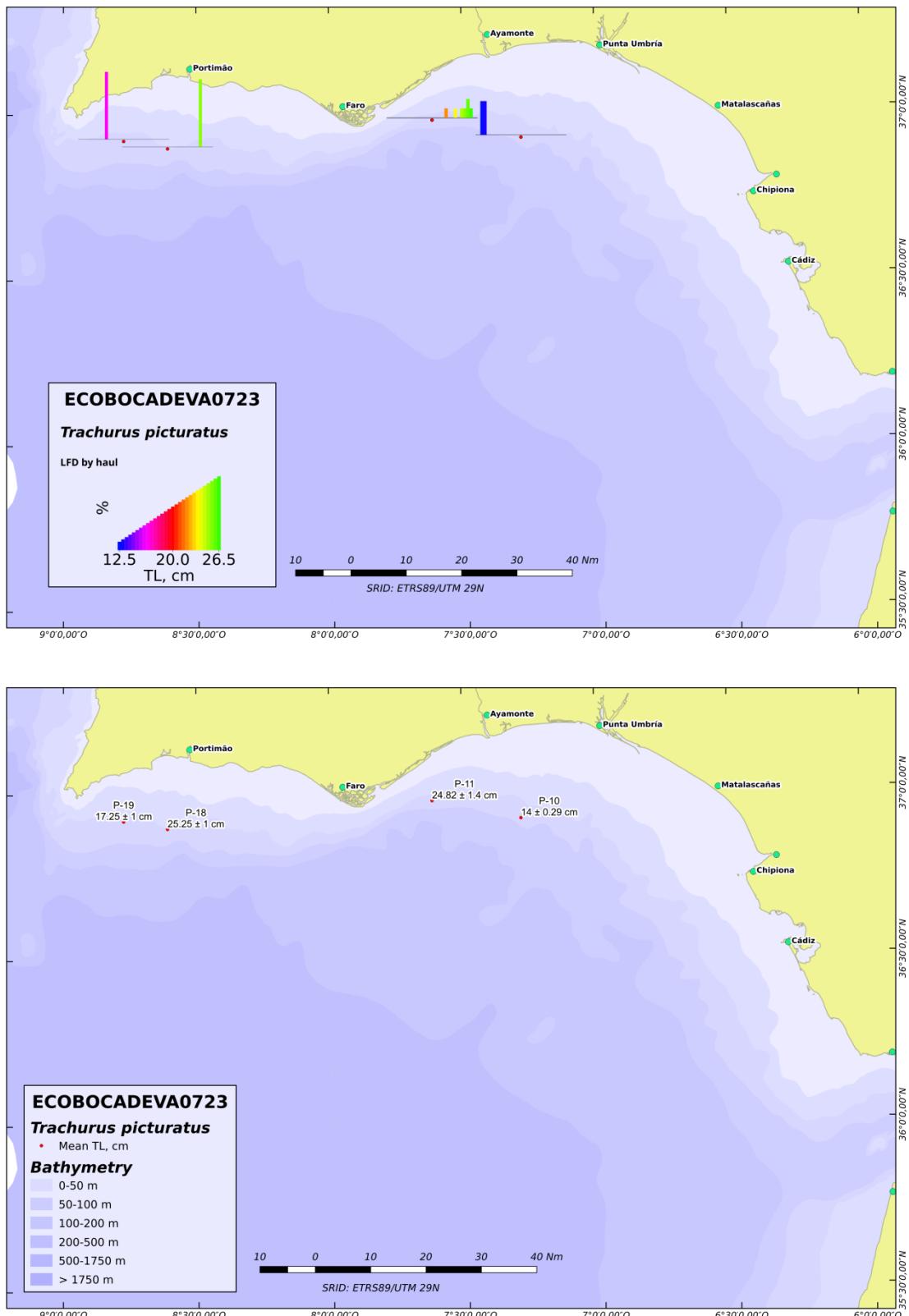


Figure 31. ECOCADIZ 2023-07 survey. Blue jack mackerel (*Trachurus picturatus*). Top: length frequency distributions in fishing hauls. Bottom: mean \pm sd length by haul.

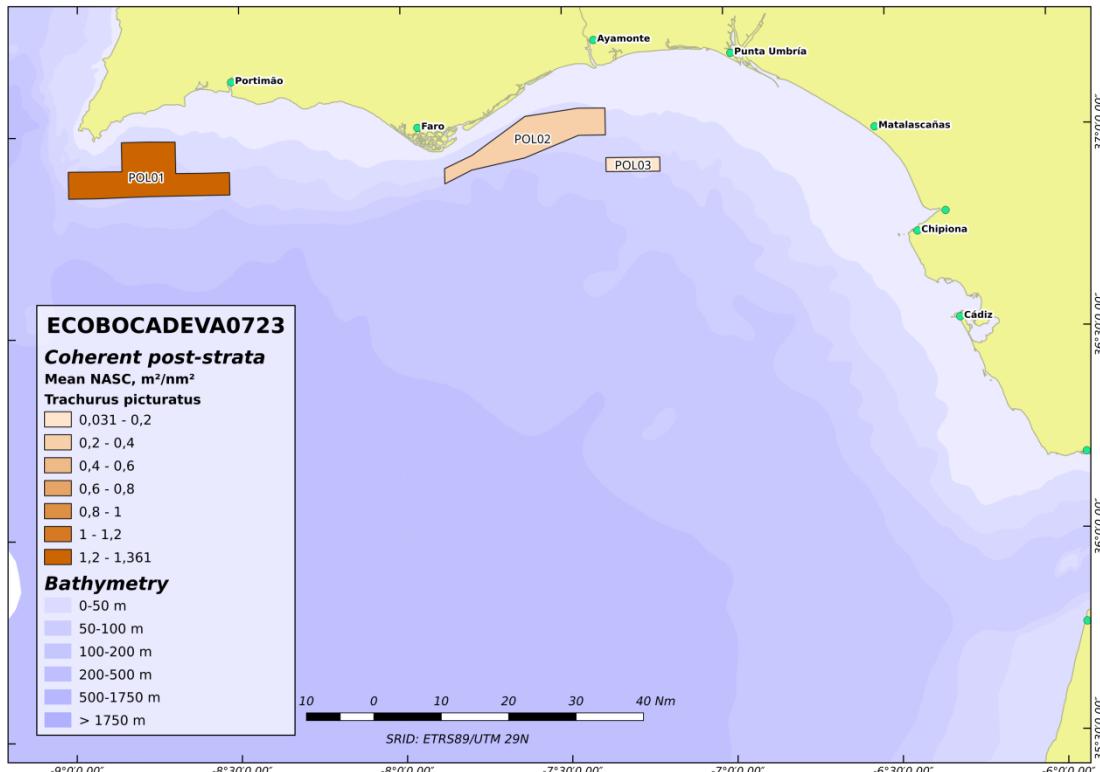
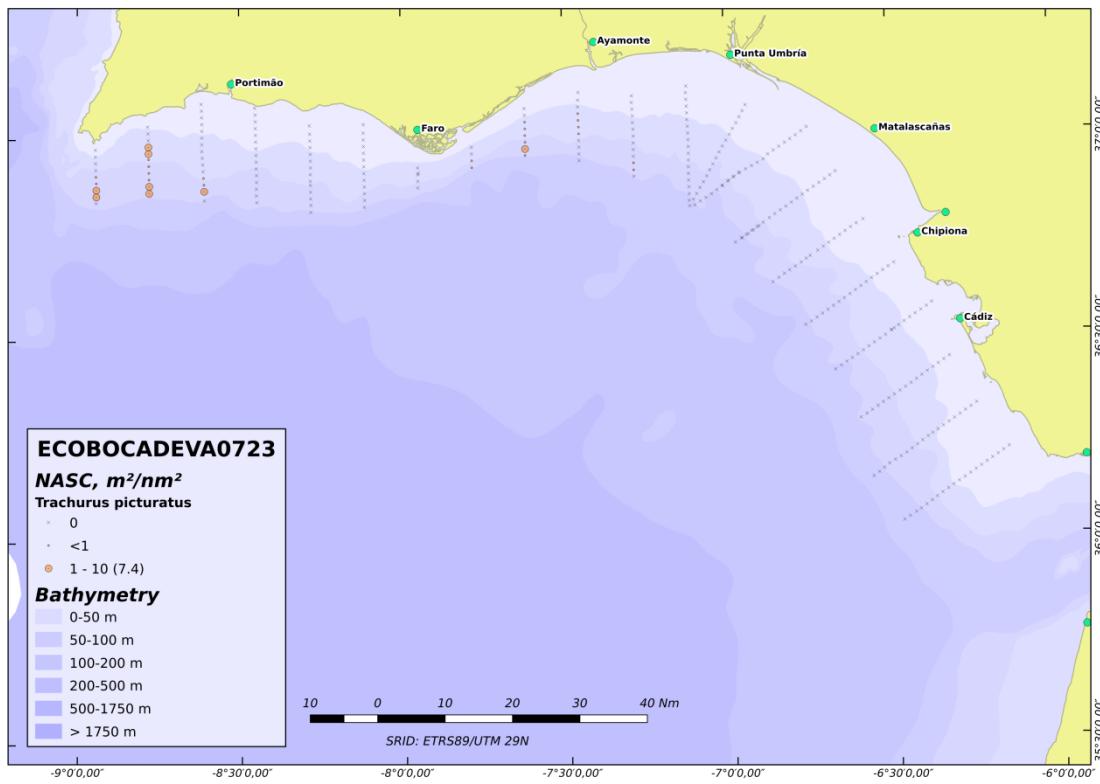


Figure 32. ECOCADIZ 2023-07 survey. Blue jack mackerel (*T. picturatus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2 nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

ECOBOCADEVA0723: Blue jack mackerel (*T. picturatus*)

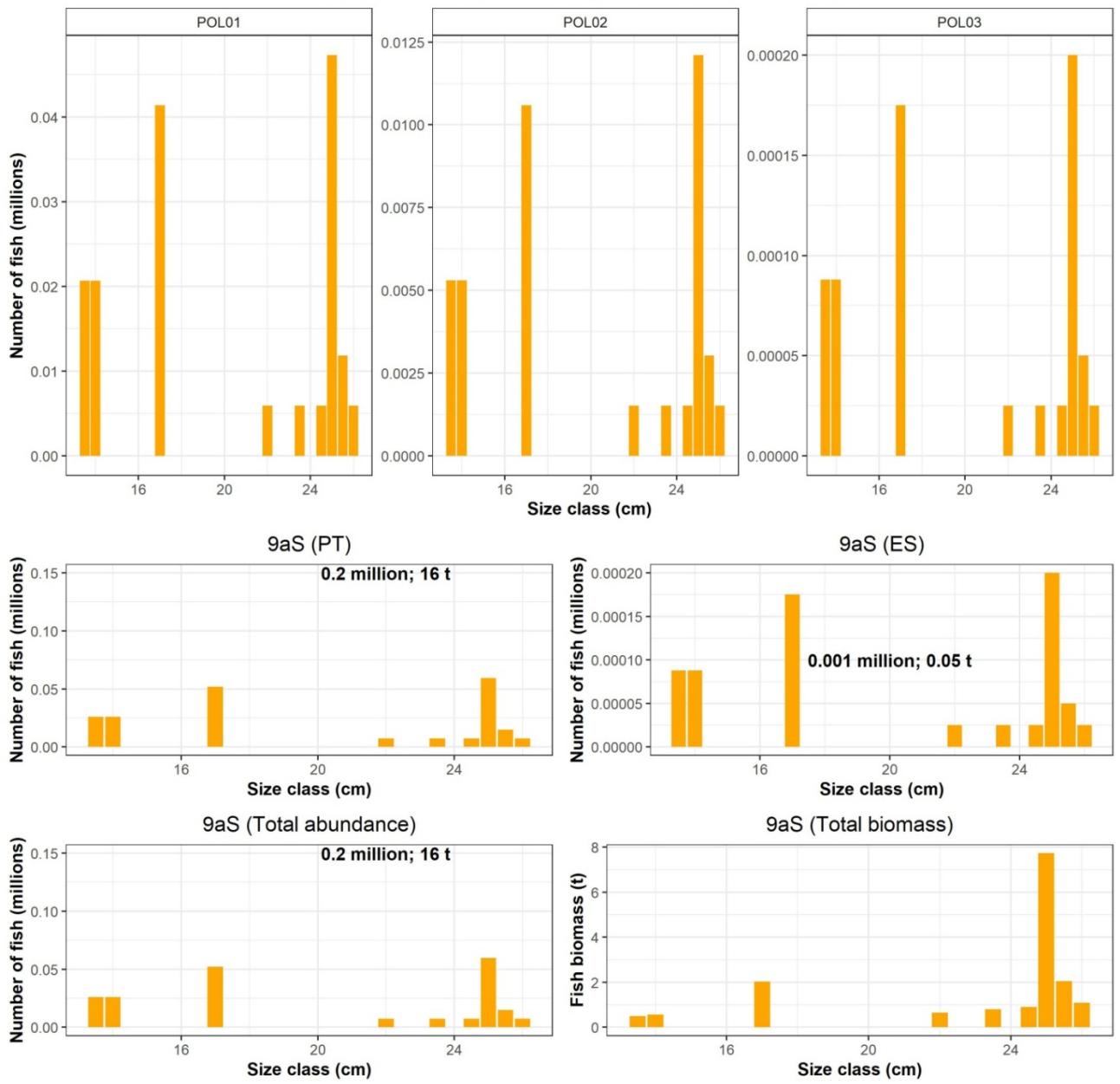


Figure 33. ECOCADIZ 2023-07 survey. Blue jack mackerel (*T. picturatus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 32**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the y-axis.

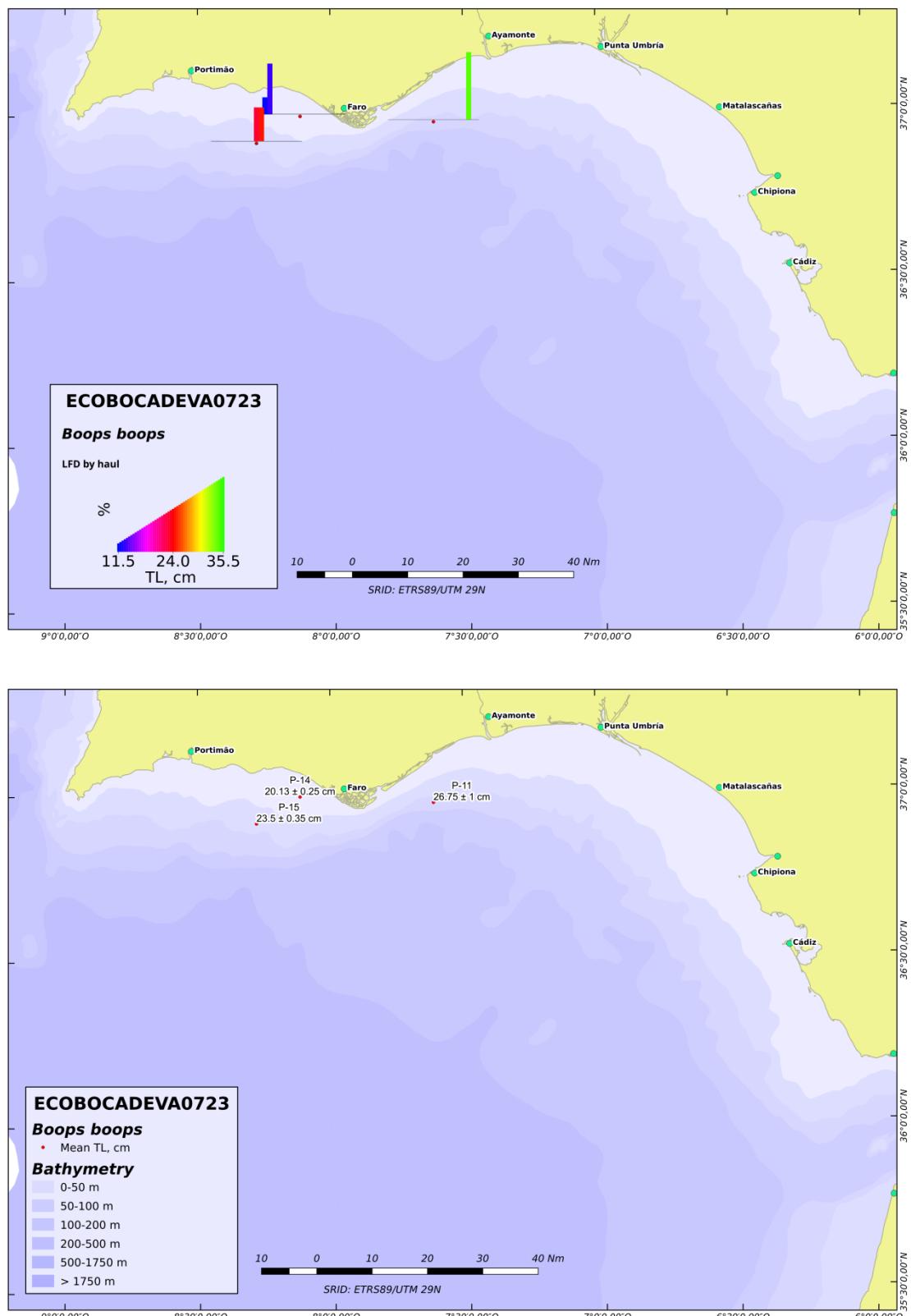


Figure 34. ECOCADIZ 2023-07 survey. Bogue (*Boops boops*). Top: length frequency distributions in fishing hauls. Bottom: mean \pm sd length by haul.

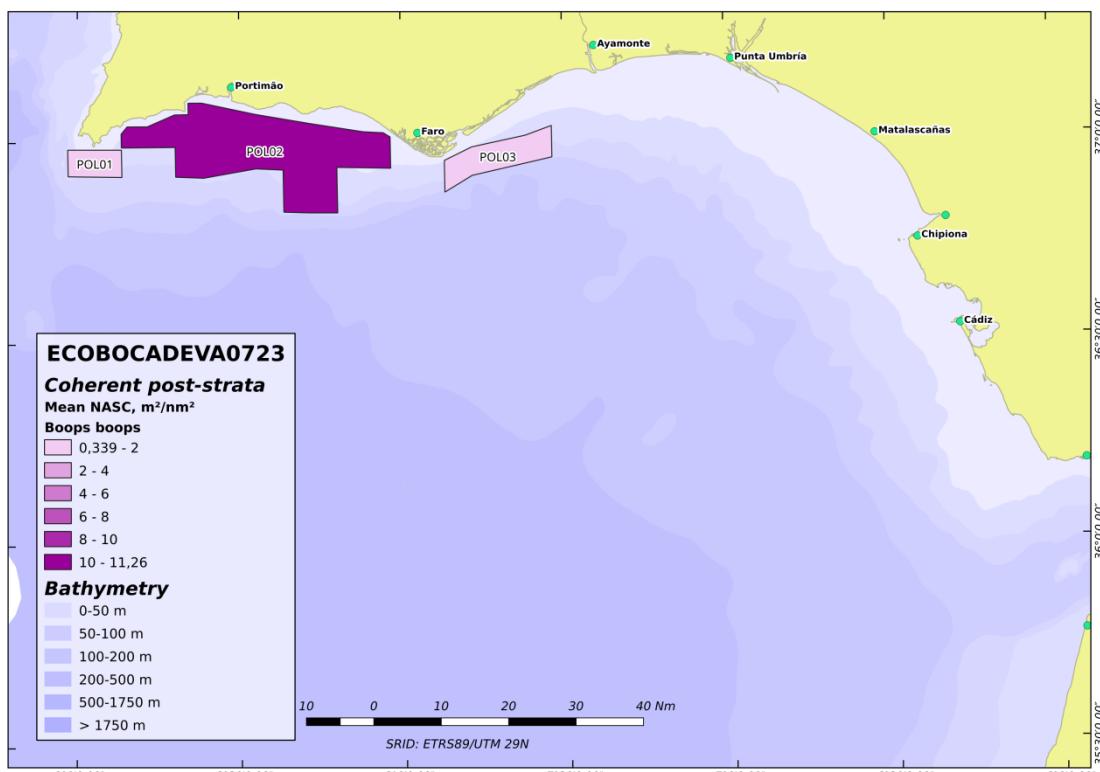
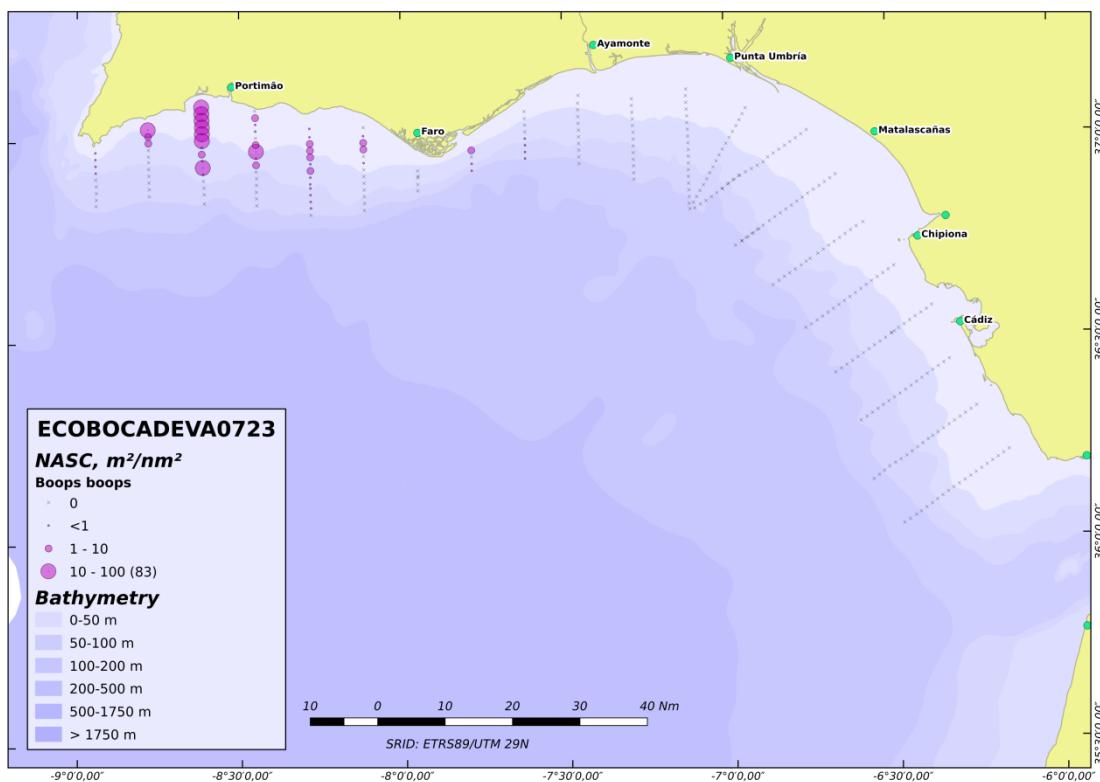


Figure 35. ECOCADIZ 2023-07 survey. Bogue (*B. boops*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in m^2/nmi^2) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

ECOBOCADEVA0723: Bogue (*B. boops*)

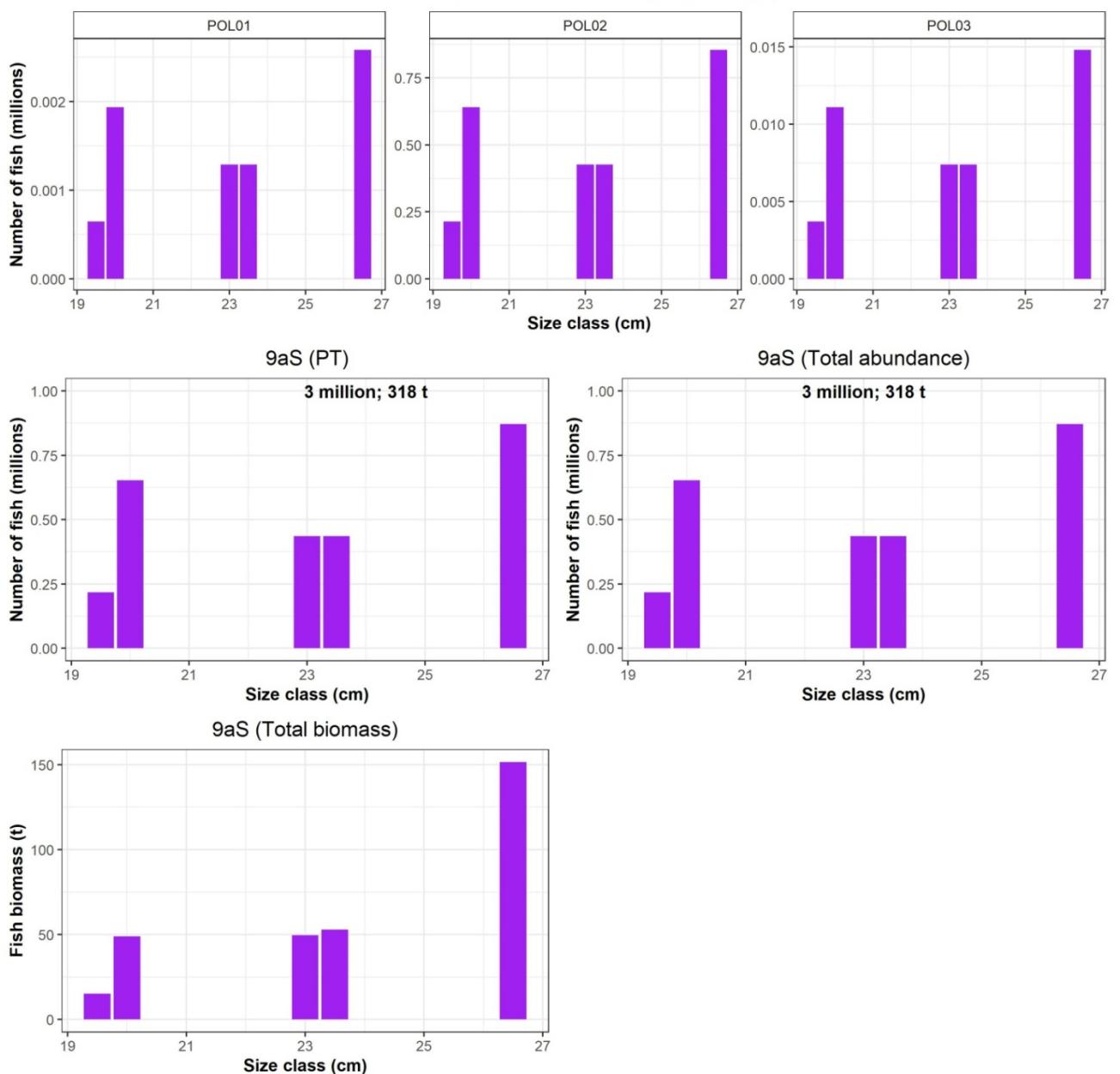


Figure 36. ECOCADIZ 2023-07 survey. Bogue (*B. boops*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 35**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the y-axis.

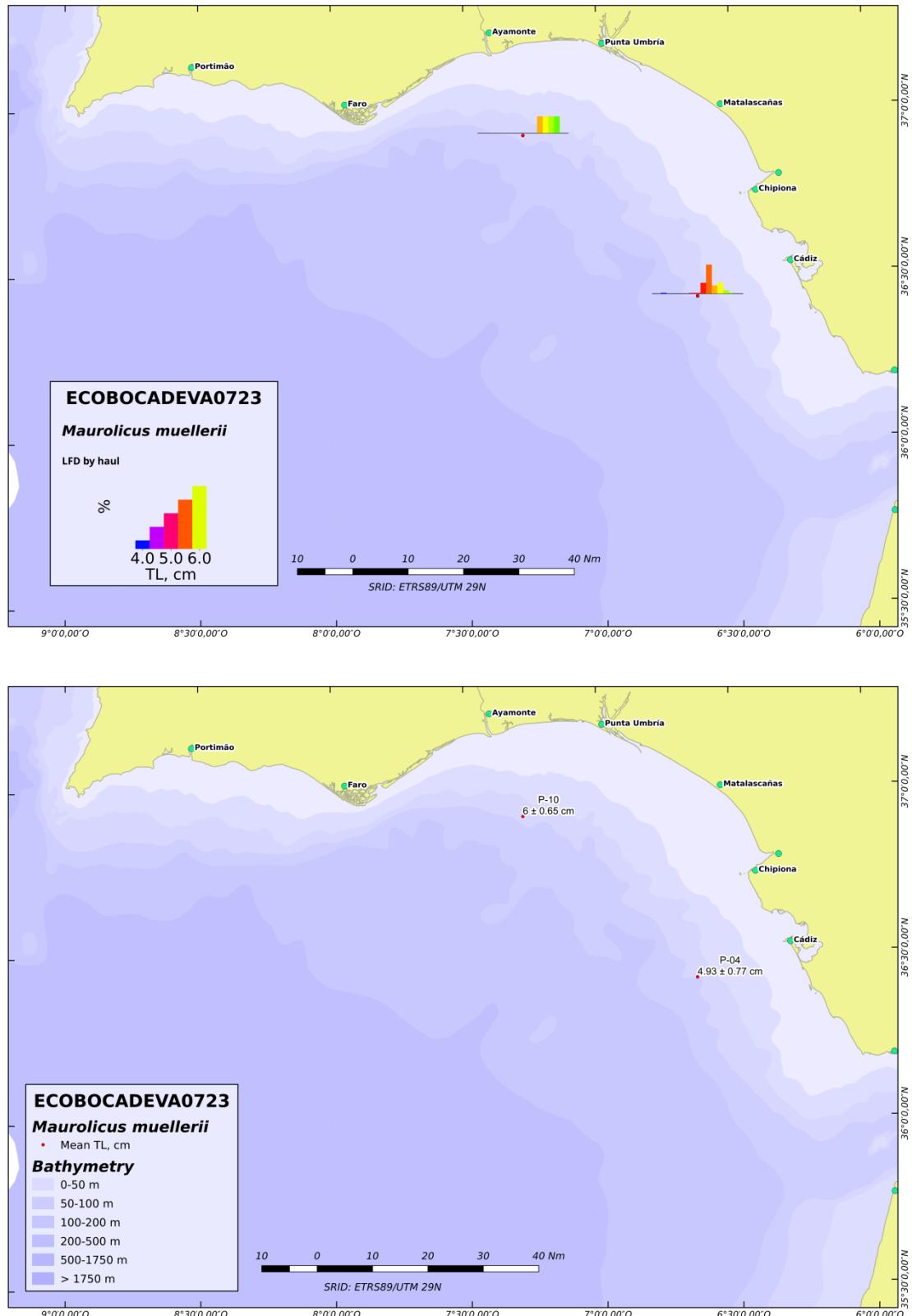


Figure 37. ECOCADIZ 2023-07 survey. Pearlside (*Maurolicus muelleri*). Top: length frequency distributions in fishing hauls. Bottom: mean \pm sd length by haul.

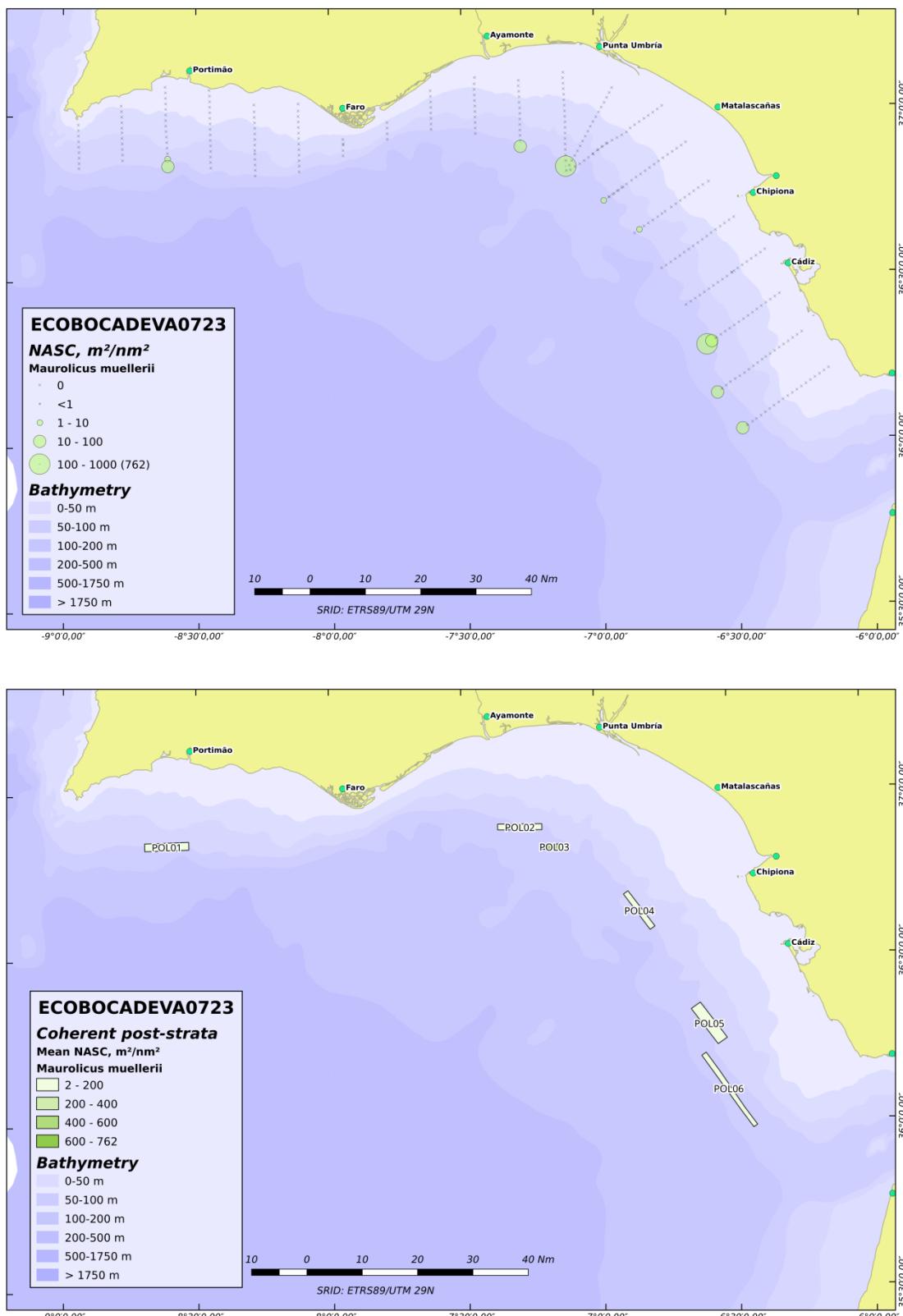


Figure 38. ECOCADIZ 2023-07 survey. Pearlside (*M. muellerii*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2 nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

ECOBOCADEVA0723: Pearlside (*Maurolicus muelleri*)

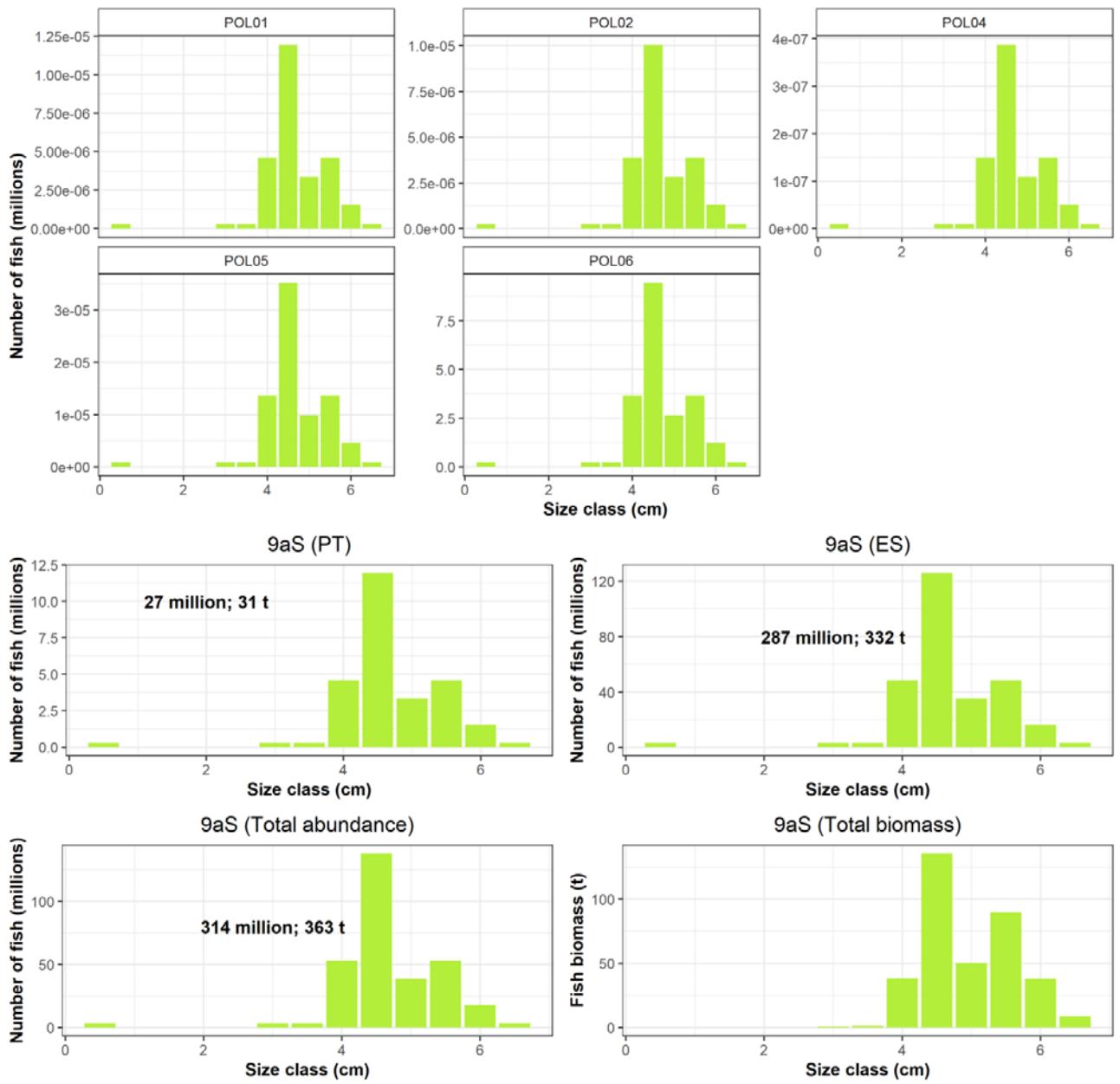


Figure 39. ECOCADIZ 2023-07 survey. Pearlside (*M. muelleri*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 38**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the y-axis.

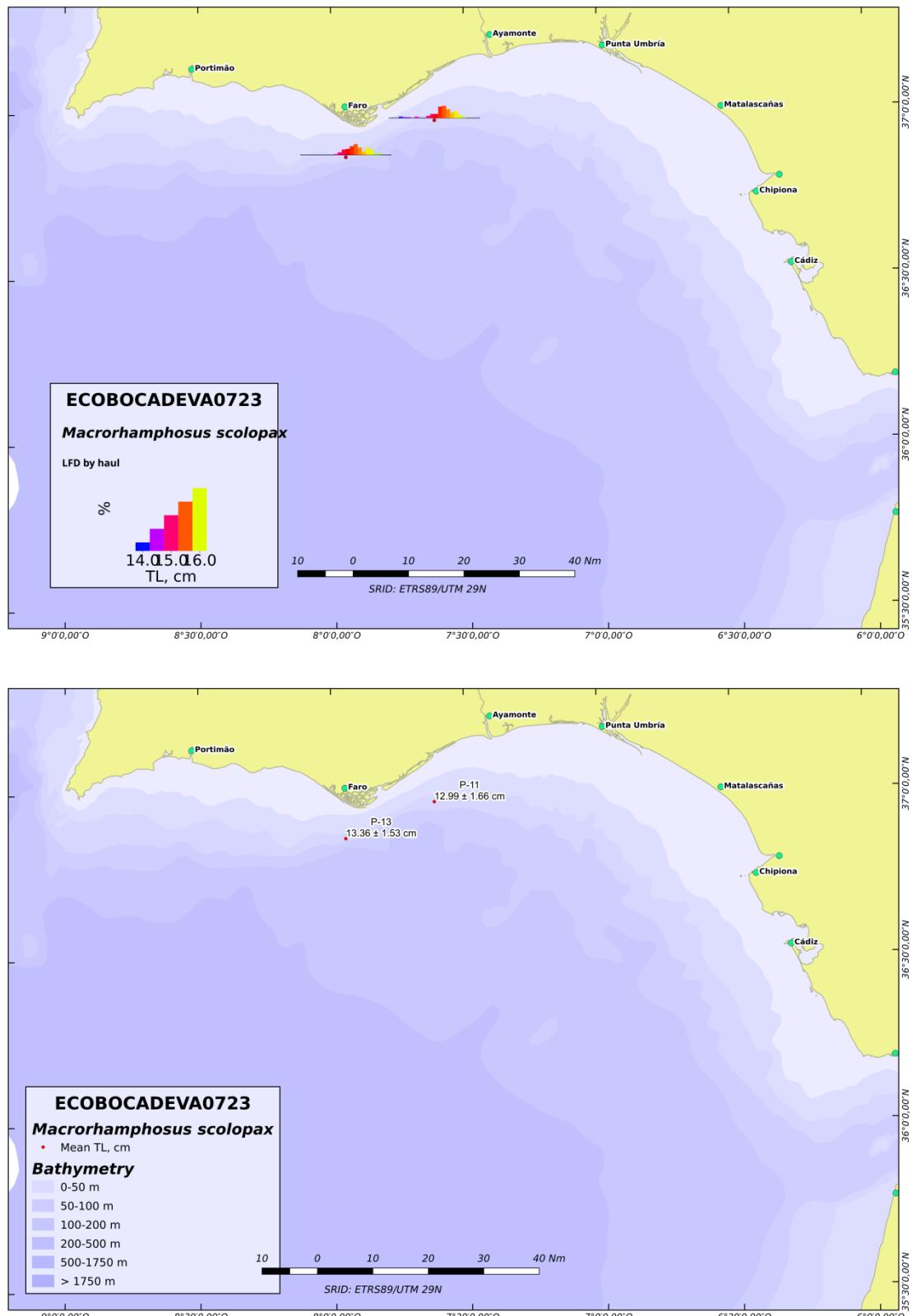


Figure 40. ECOCADIZ 2023-07 survey. Longspine snipefish (*Macroramphosus scolopax*). Top: length frequency distributions in fishing hauls. Bottom: mean \pm sd length by haul.

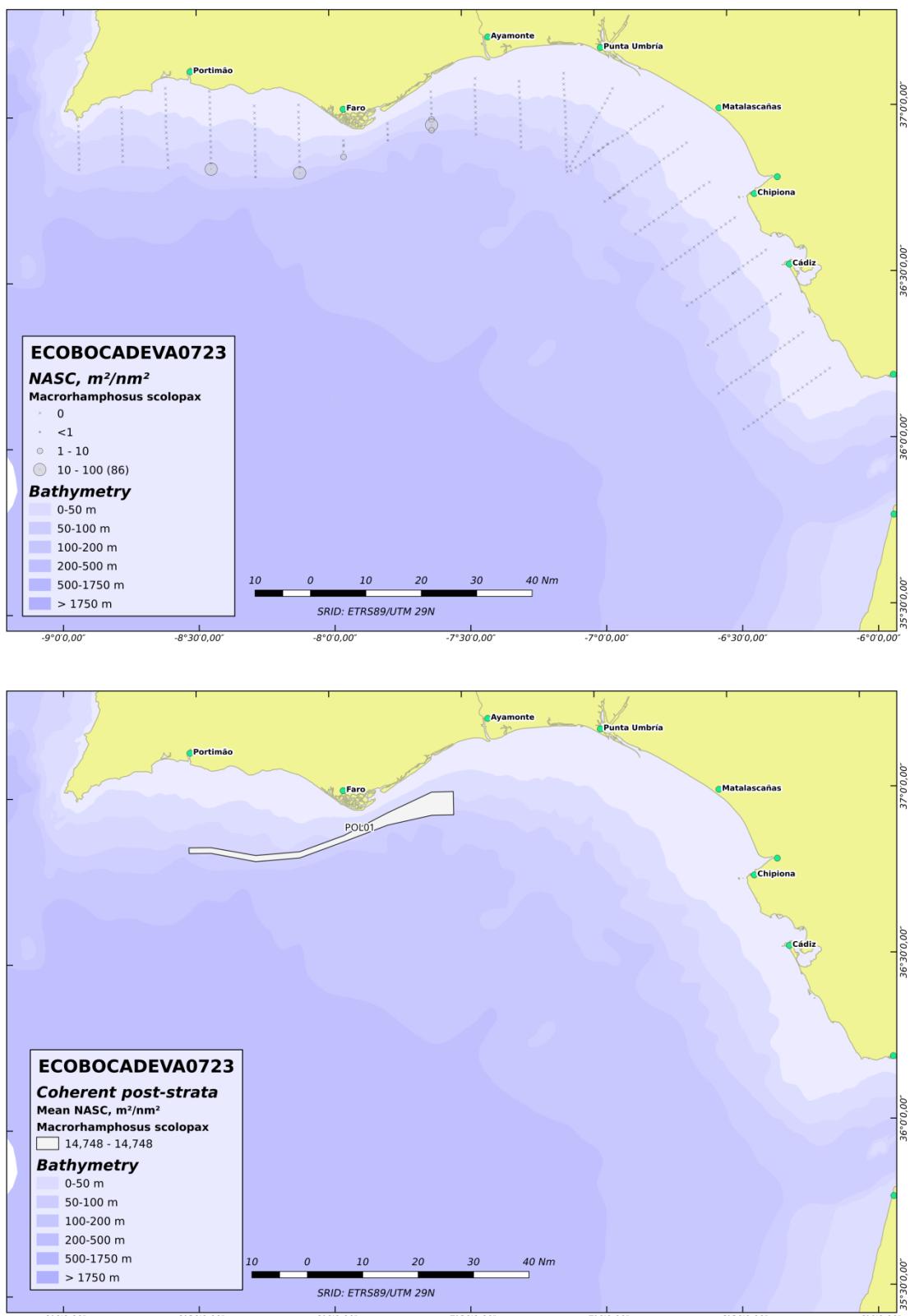


Figure 41. ECOCADIZ 2023-07 survey. Longspine snipefish (*M. scolopax*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2 nmi^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

*ECOBOCADEVA0723: Snipefish (*M. scolopax*)*

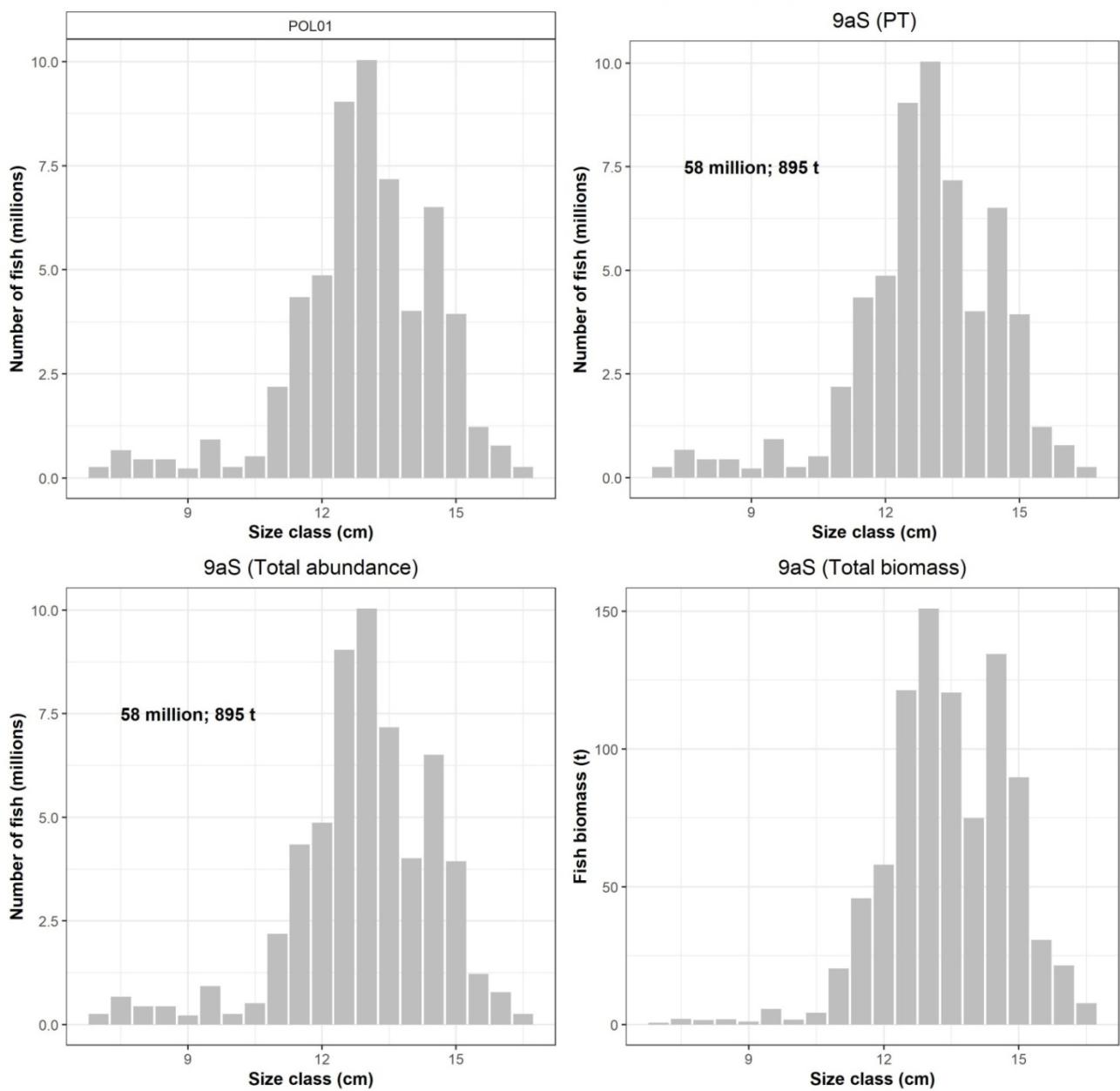


Figure 42. ECOCADIZ 2023-07 survey. Longspine snipefish (*M. scolopax*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 41**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the y-axis.

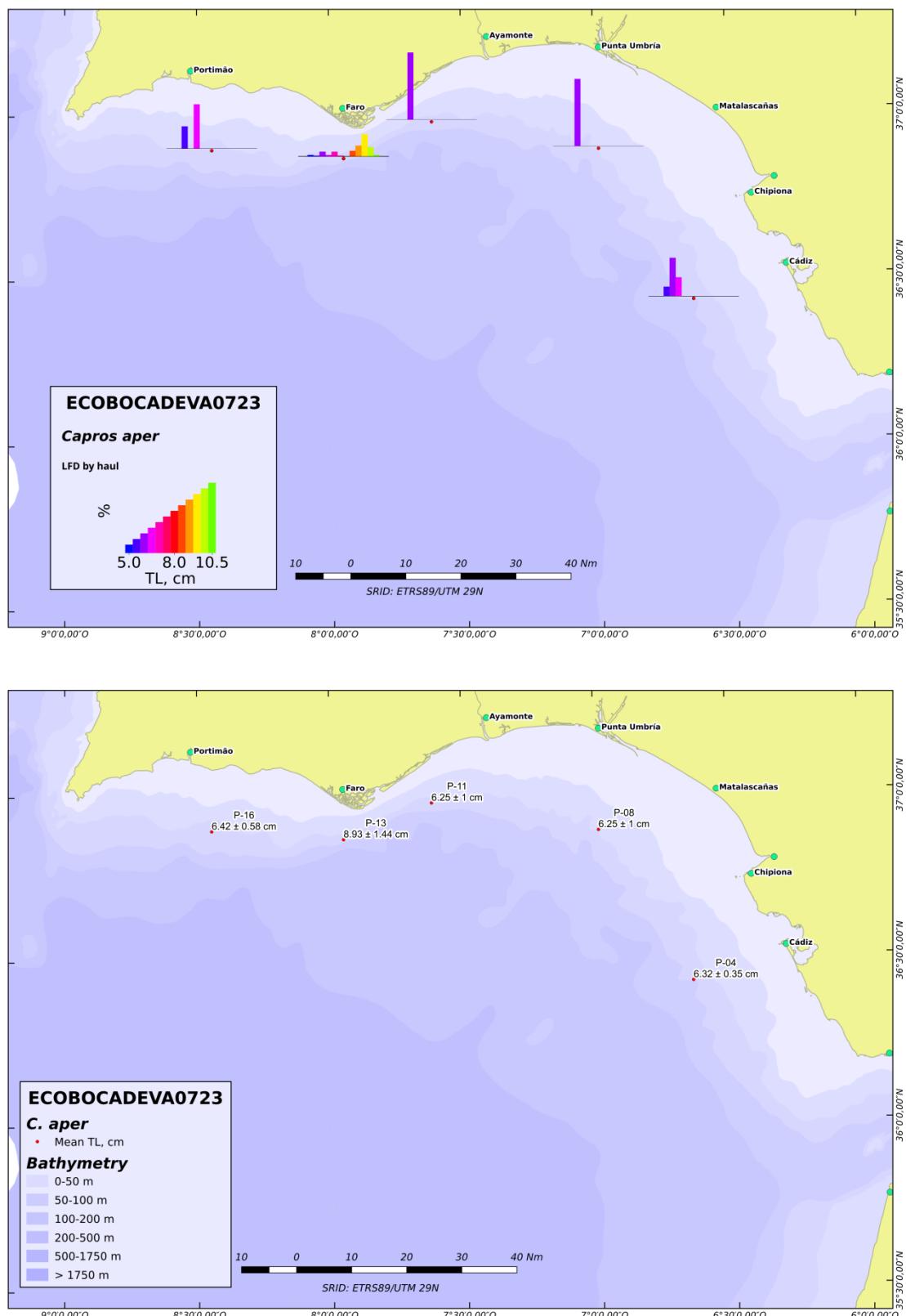


Figure 43. ECOCADIZ 2023-07 survey. Boarfish (*Capros aper*). Top: length frequency distributions in fishing hauls. Bottom: mean \pm sd length by haul.

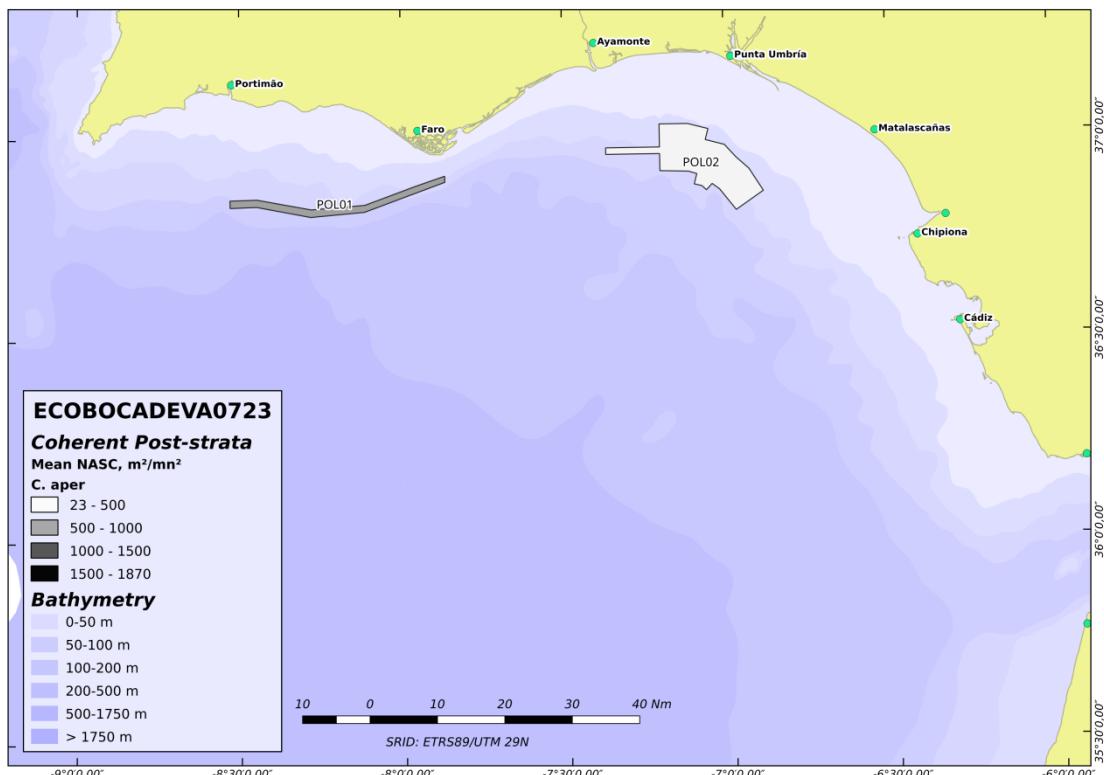
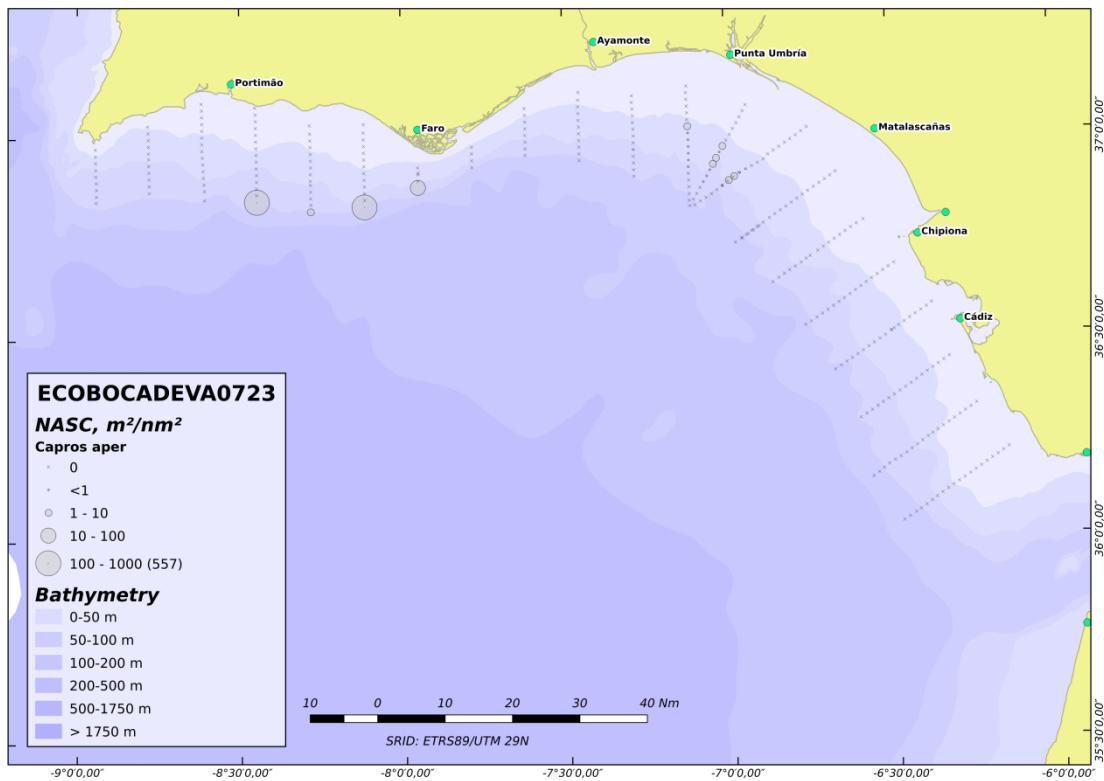


Figure 44. ECOCADIZ 2023-07 survey. Boarfish (*C. aper*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, NASC, in $m^2 nm^{-2}$) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

*ECOBOCADEVA0723: Boarfish (*C. aper*)*

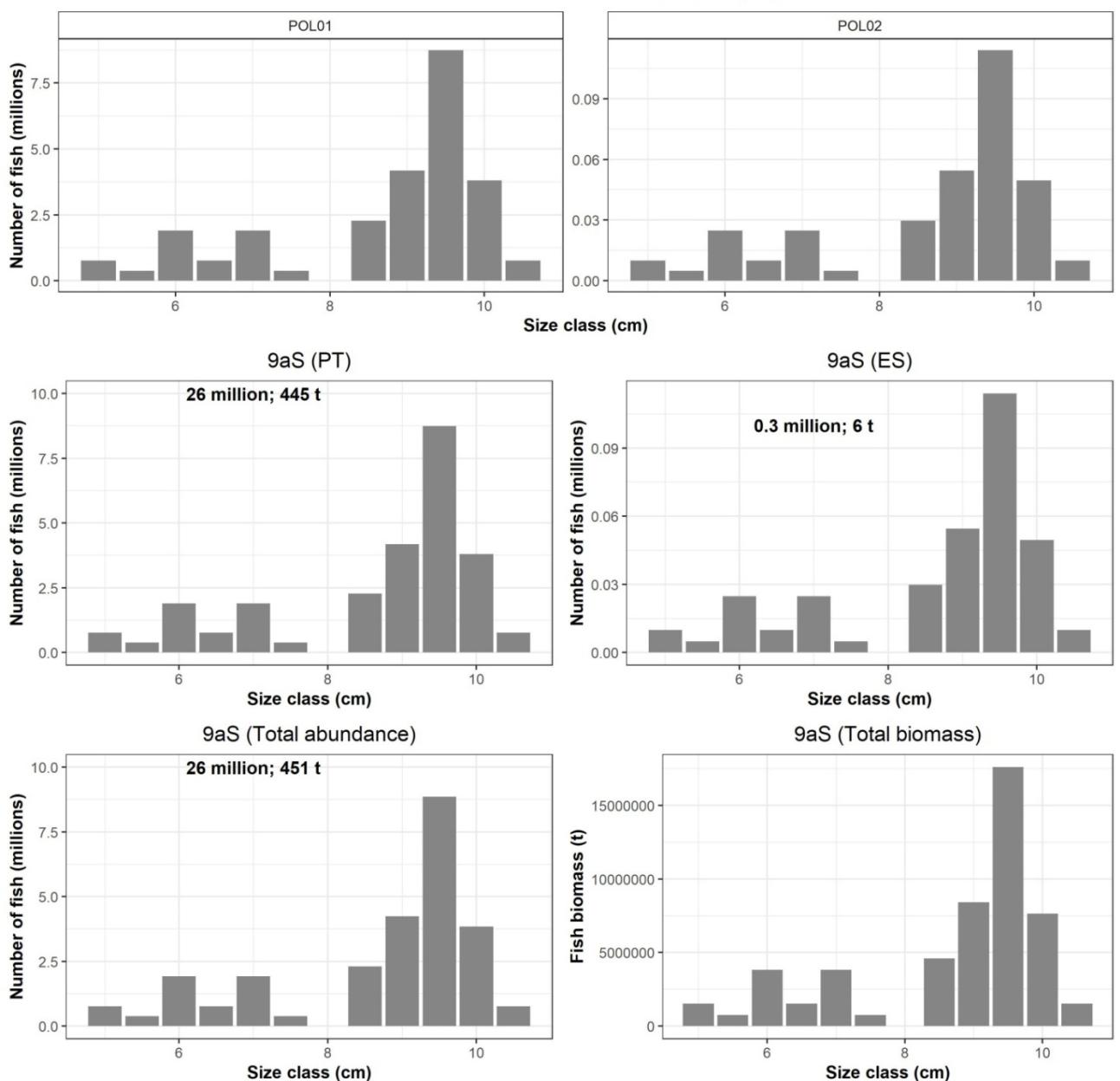
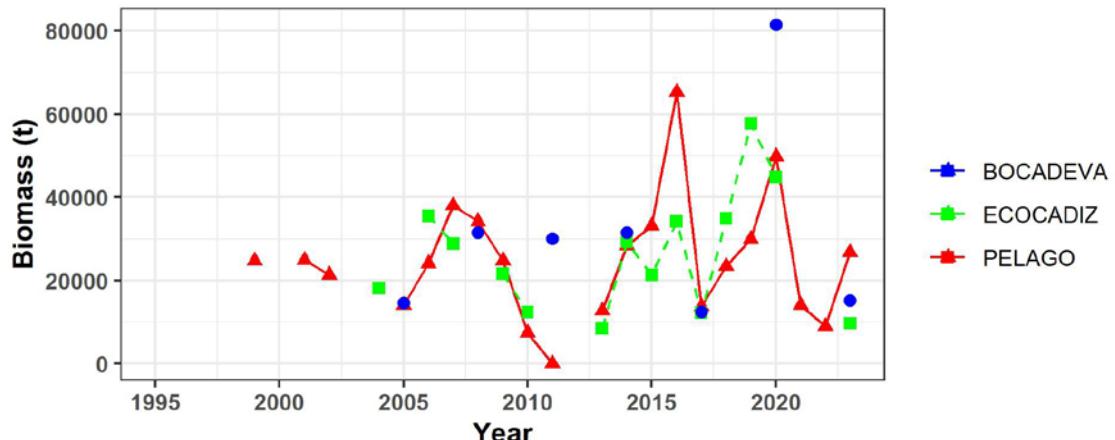
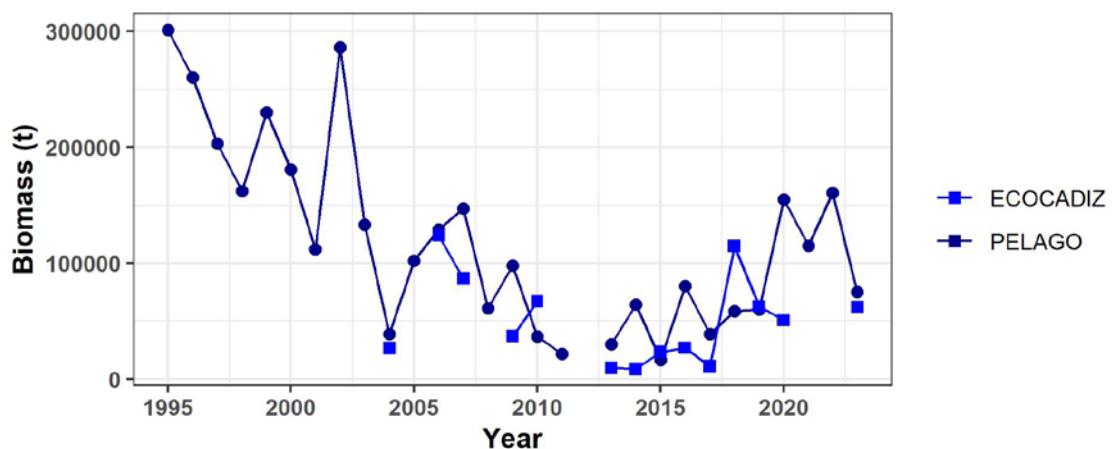


Figure 45. ECOCADIZ 2023-07 survey. Boarfish (*Capros aper*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous post-stratum (POL01-POLn, numeration as in **Figure 44**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scale in the y-axis.

Anchovy biomass *ECOCADIZ*, *BOCADEVA* and *PELAGO* surveys



Sardine biomass *ECOCADIZ* and *PELAGO* surveys



Chub mackerel biomass *ECOCADIZ* surveys

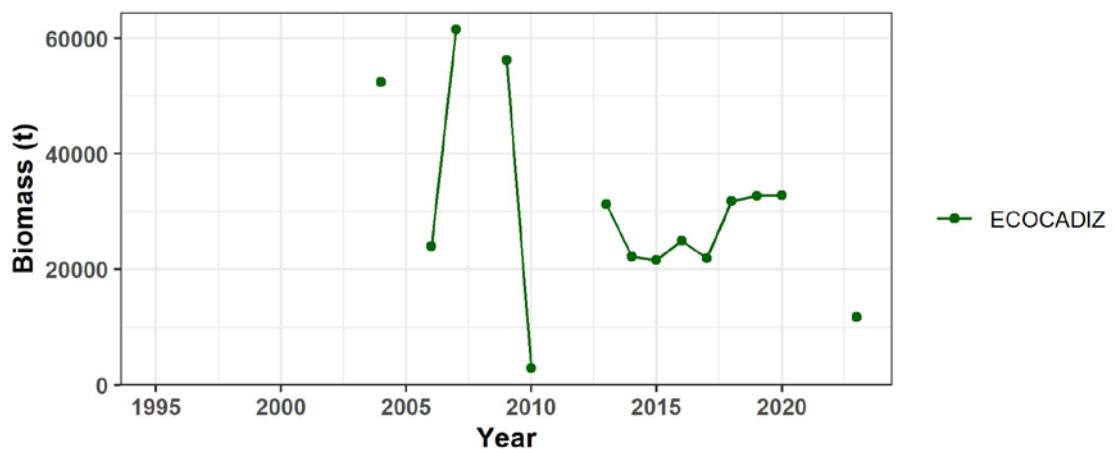


Figure 46. ECOCADIZ 2023-07 survey. Historical series of acoustic estimates of anchovy, sardine and chub mackerel biomass (t) in Sub-division 9.a South from three different surveys: *BOCADEVA DEPM*, *ECOCADIZ* summer survey series and *PELAGO* spring survey series. The estimates correspond to the total 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)

Margarita María Rincón^{a,*}, Fernando Ramos^a, Jorge Tornero^a, Susana Garrido^b, Bjarki Elvarsson^c, Jamie Lentini^c

^a*Instituto Español de Oceanografía (IEO-CSIC), Centro Oceanográfico de Cádiz, Puerto pesquero, Muelle de Levante s/n, Apdo. 2609, 11006 Cádiz, Spain*

^b*Instituto Português do Mar e da Atmosfera-IPMA, Av. Brasília, 6, 1449-006 Lisboa, Portugal*

^c*Marine and Freshwater Research Institute, Fornubúðum 5 220 Hafnarfjörður, Iceland*

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 being 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 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, 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.

*Corresponding author

Email address: margarita.rincon@ieo.csic.es (Margarita María Rincón)

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 $a = 0, \dots, 3$, at length $l = 3, 3.5, 4, 4.5, \dots, 22$, at year $y = 1989, \dots, 2024$, and each year divided into quarters $t = 1, \dots, 4$. 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 it 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:

$$\Delta l = (l_\infty - l)(1 - e^{k\Delta t}), \quad (1)$$

where Δt 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:

$$\Delta w = a((l + \Delta l)^b - l^b), \quad (2)$$

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 β 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:

$$N_{a,l,1,1} = 10000\nu_a q_{a,l}, \quad a = 0, \dots, 3, l = 3, \dots, 20$$

Where ν_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 (μ_a) and its standard deviation (σ_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:

$$N_{0,l,y,t} = p_{l,t} R_{y,t}, \quad t = 2, 3, 4, l = 3, \dots, 15,$$

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 (μ) and standard deviation (σ_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:

$$C_{l,y,t} = \frac{E_{y,t} S_{l,T} N_{l,y,t} W_l}{\sum_l S_{l,T} N_{l,y,t} W_l}, \quad (3)$$

and

$$C_{l,y,t} = \frac{E_{y,t} S_{l,T} N_{l,y,t}}{\sum_l S_{l,T} N_{l,y,t}}, \quad (4)$$

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:

$$S_{l,T} = \frac{1}{1 + e^{\alpha_T(l - l_{50,T})}} \quad (5)$$

where $l_{50,T}$ is the length of the prey with a 50% probability of predation during period T and α_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 split into two different periods for suitability parameters of the commercial fleet because of changes in size regulation for the fishery around 1995 that became 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:

$$\ell = \sum_t (\log(I_{y,t}) - (\alpha + \log(N_{y,t}))^2 \quad (6)$$

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*):

$$\ell = \sum_y \sum_t \sum_l (P_{a,l,y,t} - \pi_{a,l,y,t})^2 \quad (7)$$

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:

$$P_{a,l,t,y} = \frac{O_{a,l,y,t}}{\sum_a \sum_l O_{a,l,y,t}} \quad (8)$$

and

$$\pi_{a,l,t,y} = \frac{N_{a,l,y,t}}{\sum_a \sum_l N_{a,l,y,t}}, \quad (9)$$

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.)

$$\ell = \sum_t U_t^2 \quad (10)$$

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.

$$\ell_i = \begin{cases} lw_i(val_i - lb_i)^2 & \text{if } val_i < lb_i \\ uw_i(val_i - ub_i)^2 & \text{if } val_i > ub_i \\ 0 & \text{otherwise} \end{cases}$$

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 $SS_{i,r}, i = 1, \dots, L$, 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., $\mathbf{w}_1 = (1, 1, \dots, 1)$. Then, a separated optimization run for each of the components (L optimization runs) is performed using the following weight vectors:

$$\mathbf{w}_{i+1} = (1/SS_{1,1}, \dots, 1/SS_{i,1}) * 10000, 1/SS_{i+1,1}, \dots, 1/SS_{L,1}), i = 1, \dots, L.$$

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

$$\mathbf{w} = (1/\hat{\sigma}_1^2, \dots, 1/\hat{\sigma}_L^2).$$

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.

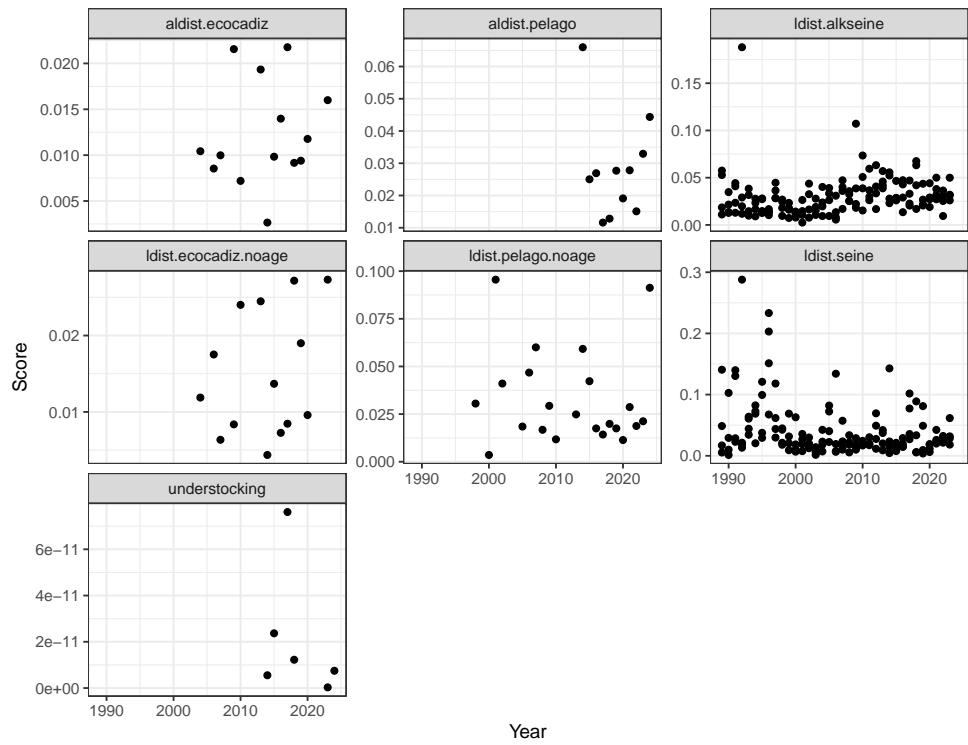


Figure 1: Likelihood scores for age-length key of ECOCADIZ survey, PELAGO survey and commercial landings (Upper panel) and length distribution of ECOCADIZ survey, PELAGO survey and landings. Dots represent the score for each quarter.

Index	
a	Age, $a = 0, \dots, 3$
l	Length, $l = 3, 3.5, 4, 4.5, \dots, 22$
y	Years, $y = 1989, \dots, 2024$
t	Quartely timestep, $t = 1, \dots, 4$
T	$T = 1$ for period 1989-2000, $T = 2$ for period 2001-2023
Parameters	
<i>Fixed</i>	
a	Parameter of weight-length relationship $w = al^b$, $a = 3.128958 \times 10^{-6}$
b	Parameter of weight-length relationship $w = al^b$, $b = 3.277667619$
μ_a	Initial population mean length at age
	$\mu_0 = 9.99, \mu_1 = 12.1, \mu_2 = 15.2, \mu_3 = 16.1$
σ_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 $n = 5$
<i>Estimated</i>	
l_∞	Asymptotic length, $l_\infty = 30$
k	Annual growth rate, $k = 0.0781331$
β	Beta-binomial parameter, $\beta = 5000$
ν_a	Age factor, $\nu_0 = 120000, \nu_1 = 84400,$ $\nu_2 = 0.0601, \nu_3 = 4.48e - 07$
μ	Recruitment mean length, $\mu = 9.84532$
σ_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, $l_{50,1}^{seine} = 11.1, l_{50,2}^{seine} = 10.9, l_{50,3}^{ECO} = 12.9, l_{50,3}^{PEL} = 14.6$
α_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	
Δl	Length increase
Δw	Weight increase
Δt	Length of timestep
$N_{a,l,y,t}$	Number of individuals of age a , length l in the stock at year y and quarter 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 (discards from 2014 onwards)	Length distribution	All quarters, 1989- 2023	See eq. 7
	Age-length key	All quarters, 1989- 2023	See eq. 7
	Biomass survey indexes	Second quarter 2004, 2006	see eq. 6
		third quarter 2007, 2009, 2010, 2013- 2023	
		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	
ECOCADIZ 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
PELAGO acoustic survey	Biomass survey indexes	First quarter 1999, 2001-2003	see eq. 6
		second quarter 2005-2010 and 2013-2024	

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.

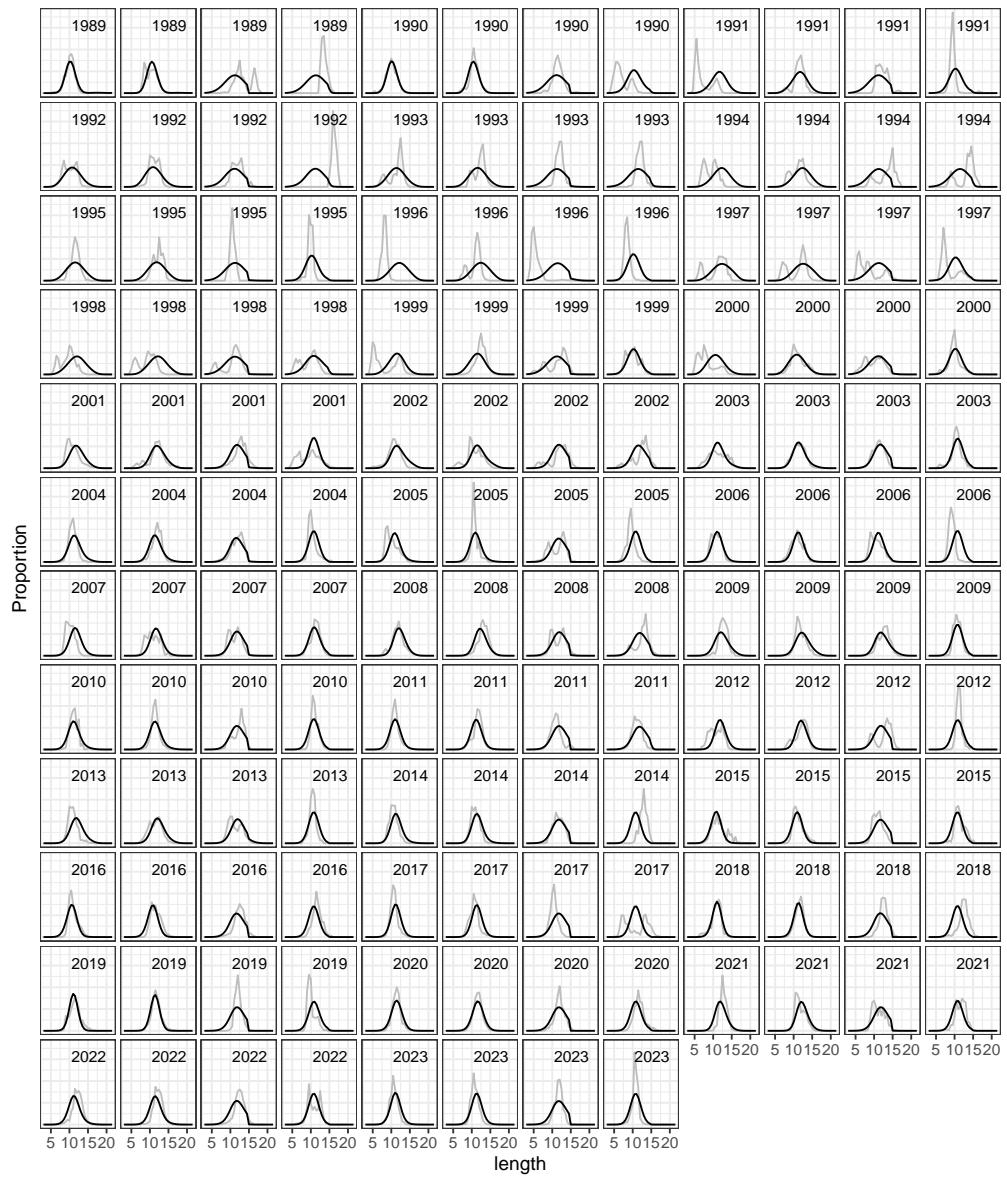


Figure 2: Comparison between observed and estimated catches length distribution. Black lines represent estimated data while gray lines represent observed data

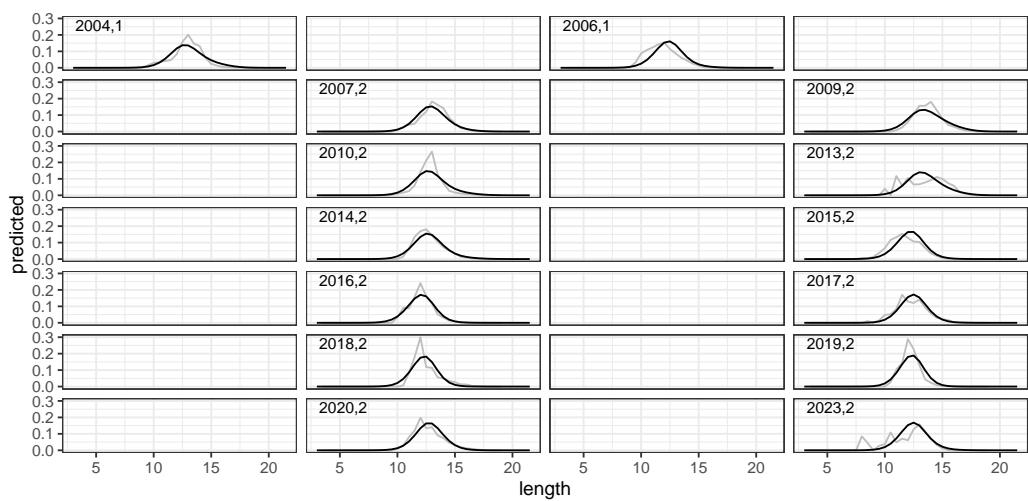


Figure 3: Comparison between observed and estimated catches length distribution for ECOCADIZ survey. Black lines represent estimated data while gray lines represent observed data

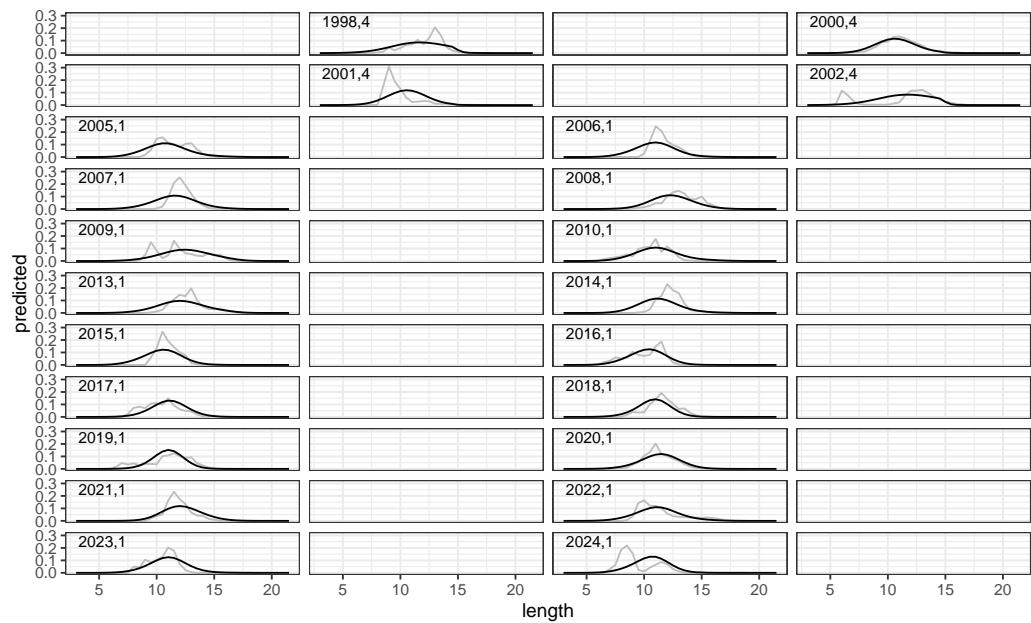


Figure 4: Comparison between observed and estimated catches length distribution for PELAGO survey. Black lines represent estimated data while gray lines represent observed data

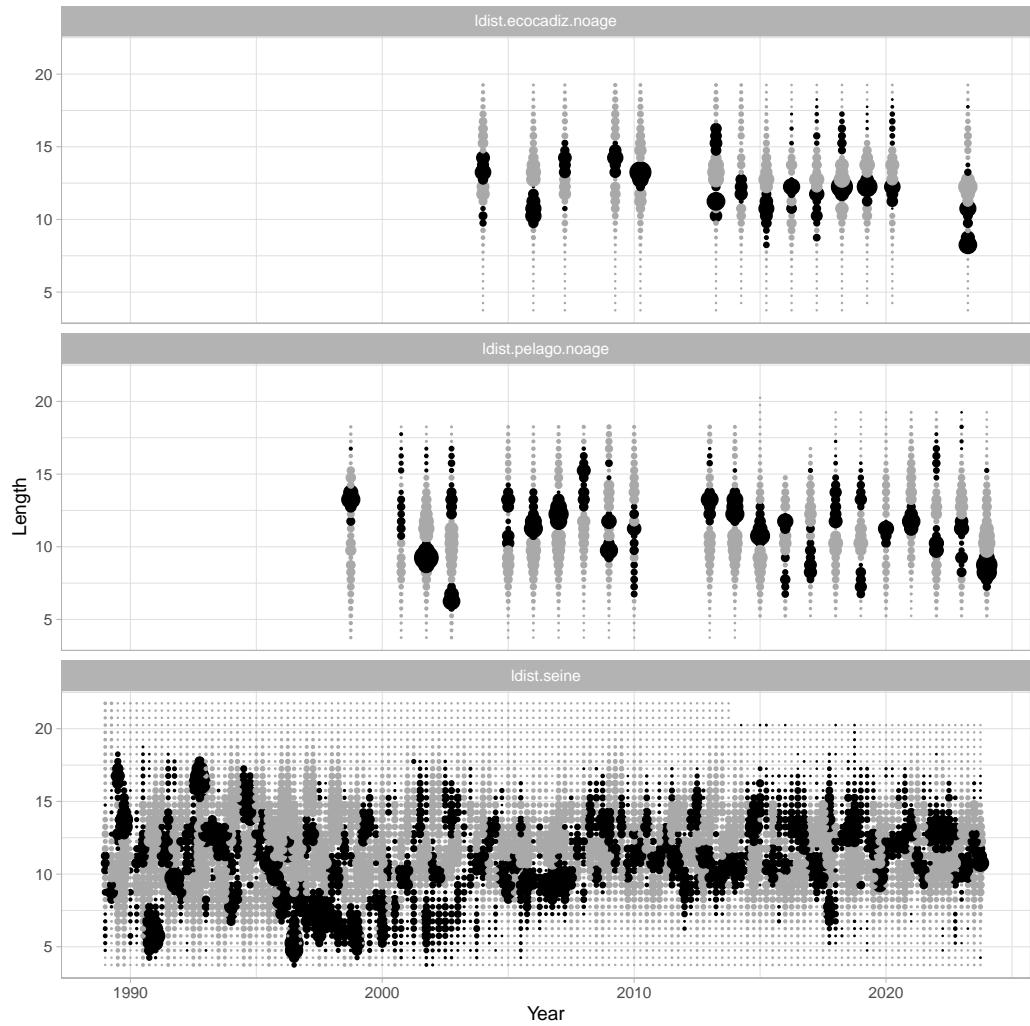


Figure 5: Standardised residual plots for the fitted length distribution from the ECOCADIZ survey, PELAGO survey and commercial landings. Black points denote a model underestimate and gray points an overestimated. The size of the points denote the scale of the standardised residual.

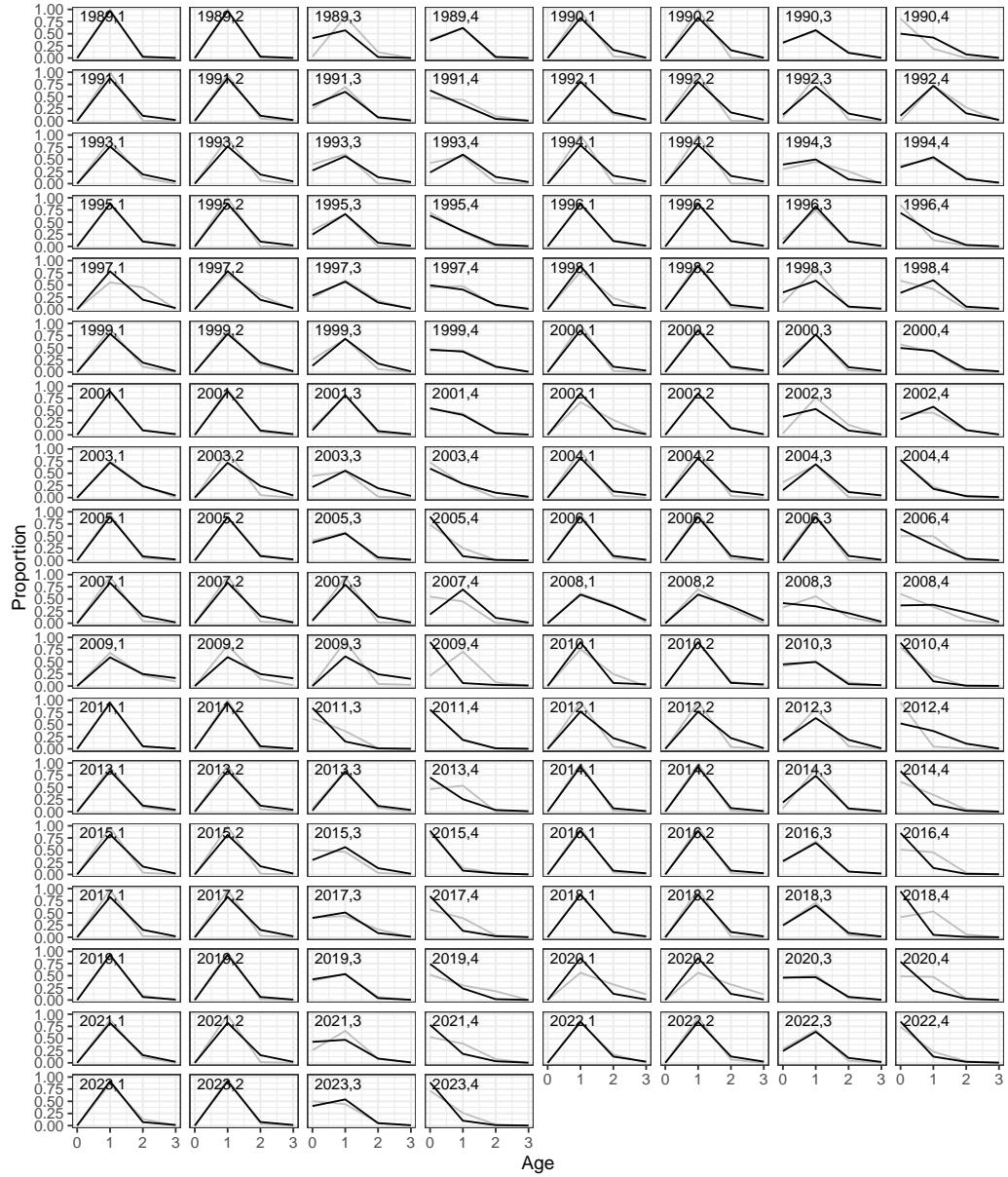


Figure 6: Comparison between observed and estimated catches age distribution. Black lines represent estimated data while gray lines represent observed data.

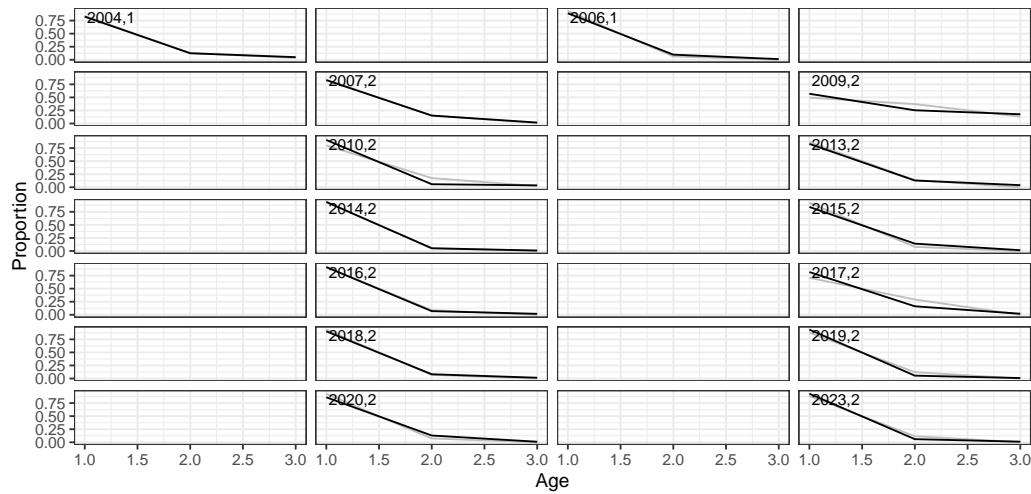


Figure 7: Comparison between observed and estimated ECOCADIZ survey age distribution. Black lines represent estimated data while gray lines represent observed data.

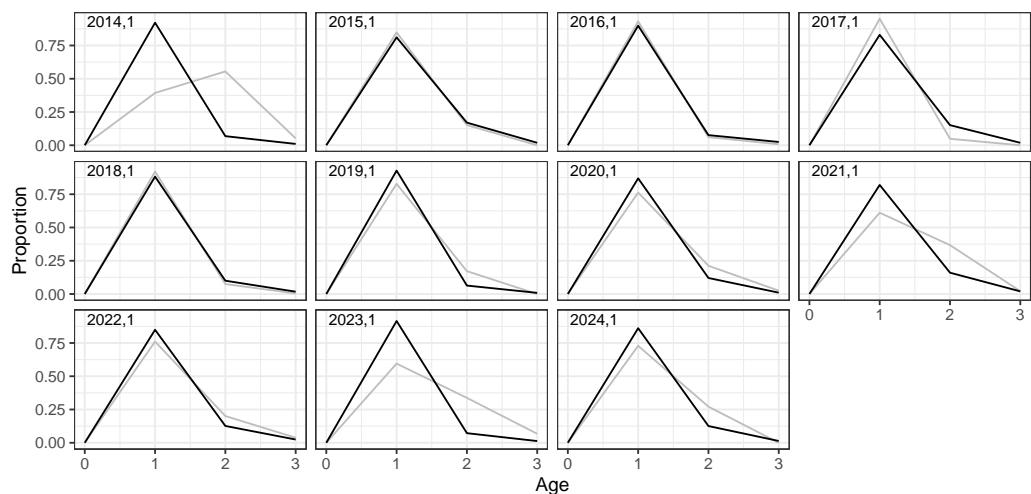


Figure 8: Comparison between observed and estimated PELAGO survey age distribution. Black lines represent estimated data while gray lines represent observed data.

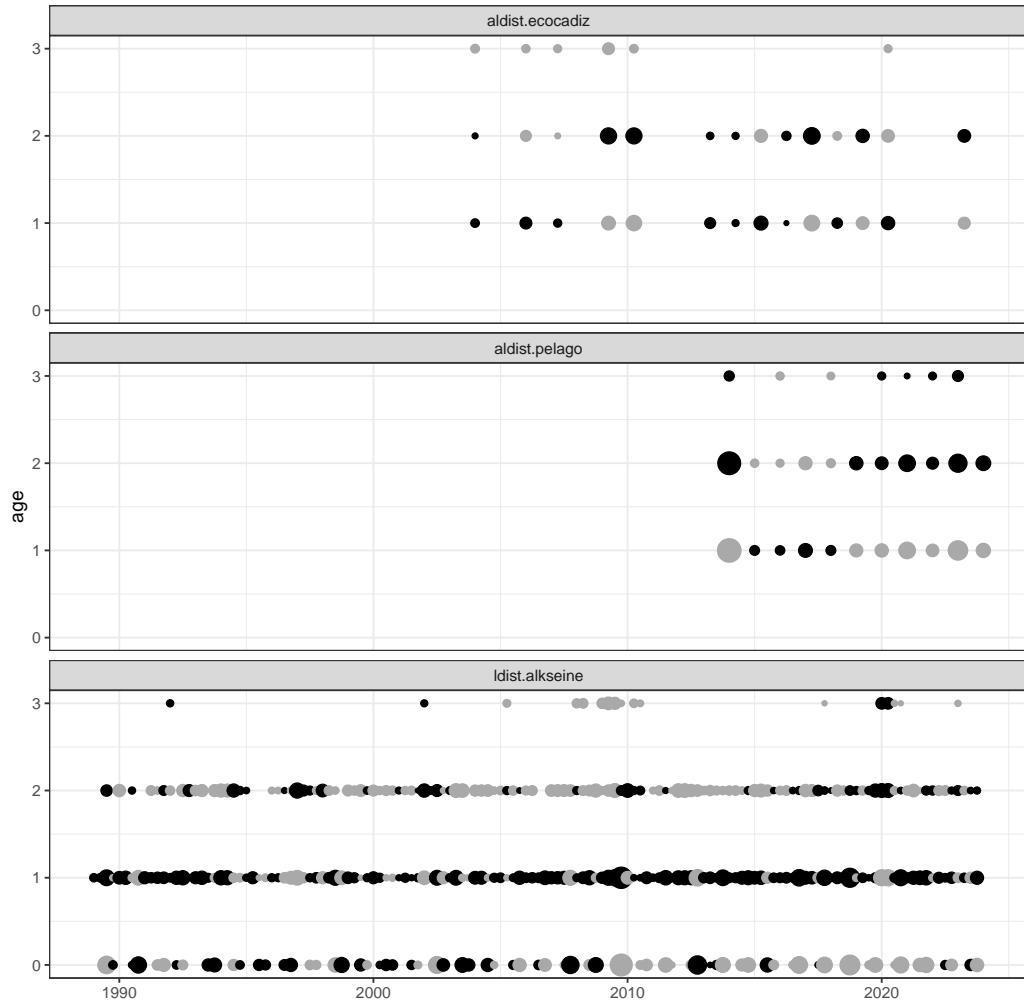


Figure 9: Standardised residual plots for the fitted age distribution from the ECOCADIZ survey, PELAGO survey and commercial fleet. Black points denote a model underestimate and gray points an overestimated. The size of the points denote the scale of the standardised residual.

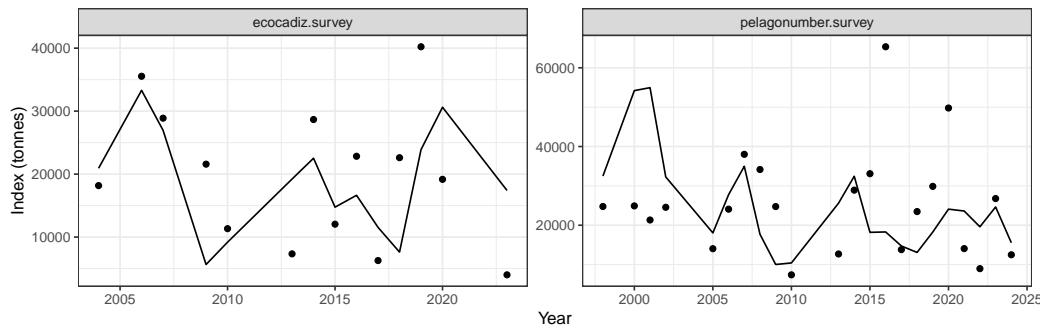


Figure 10: Comparison between observed and estimated survey indices. Black points represent observed data while black line represent estimated data

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

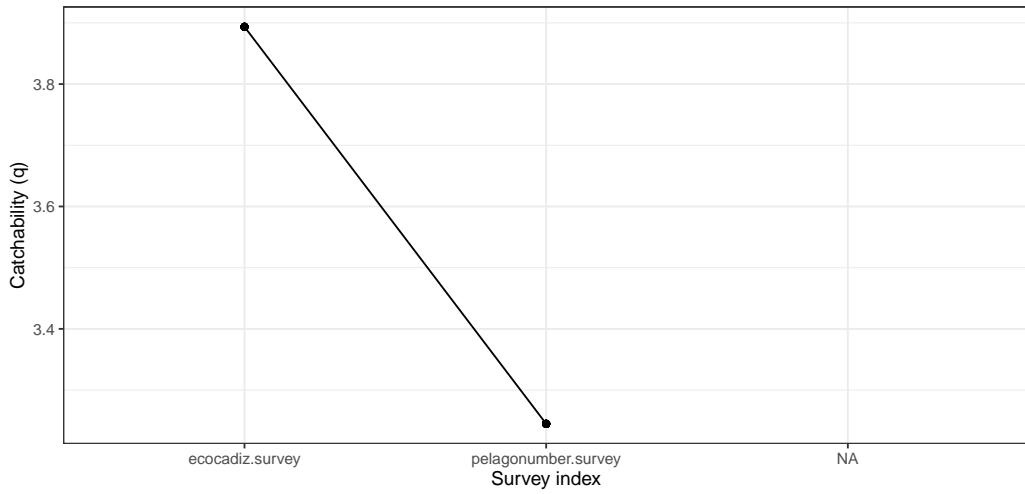


Figure 11: Estimated catchability parameters for the different survey indices

6.2. Estimated age composition

Figure 12 shows the estimated age composition of the population.

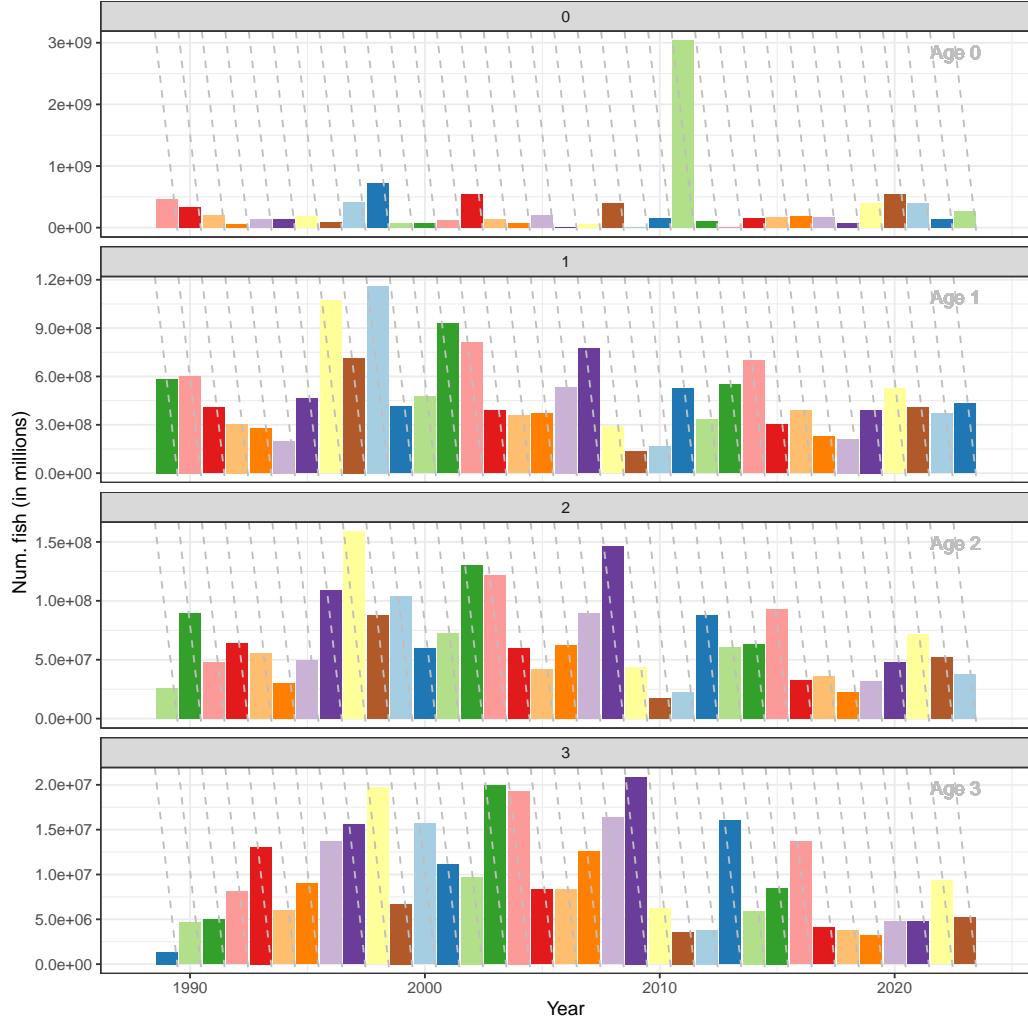


Figure 12: Estimated age composition of the estimated population at the end of the second quarter for each year

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.

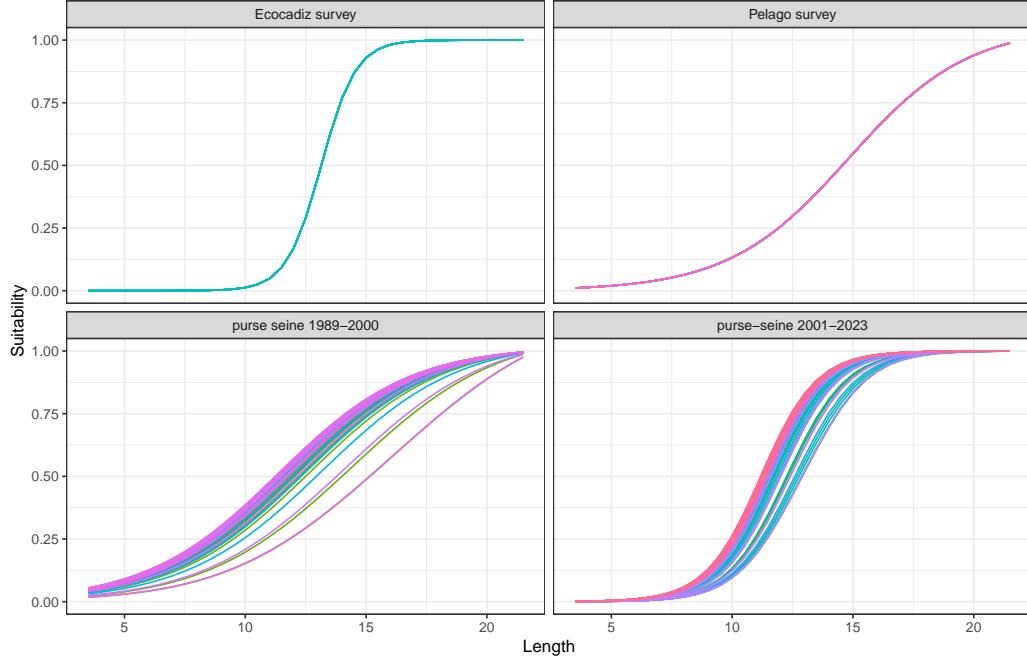


Figure 13: Estimated fleet suitability functions for the commercial fleet and different surveys.

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 B_{loss} ($B_{lim} = B_{loss}$). 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).

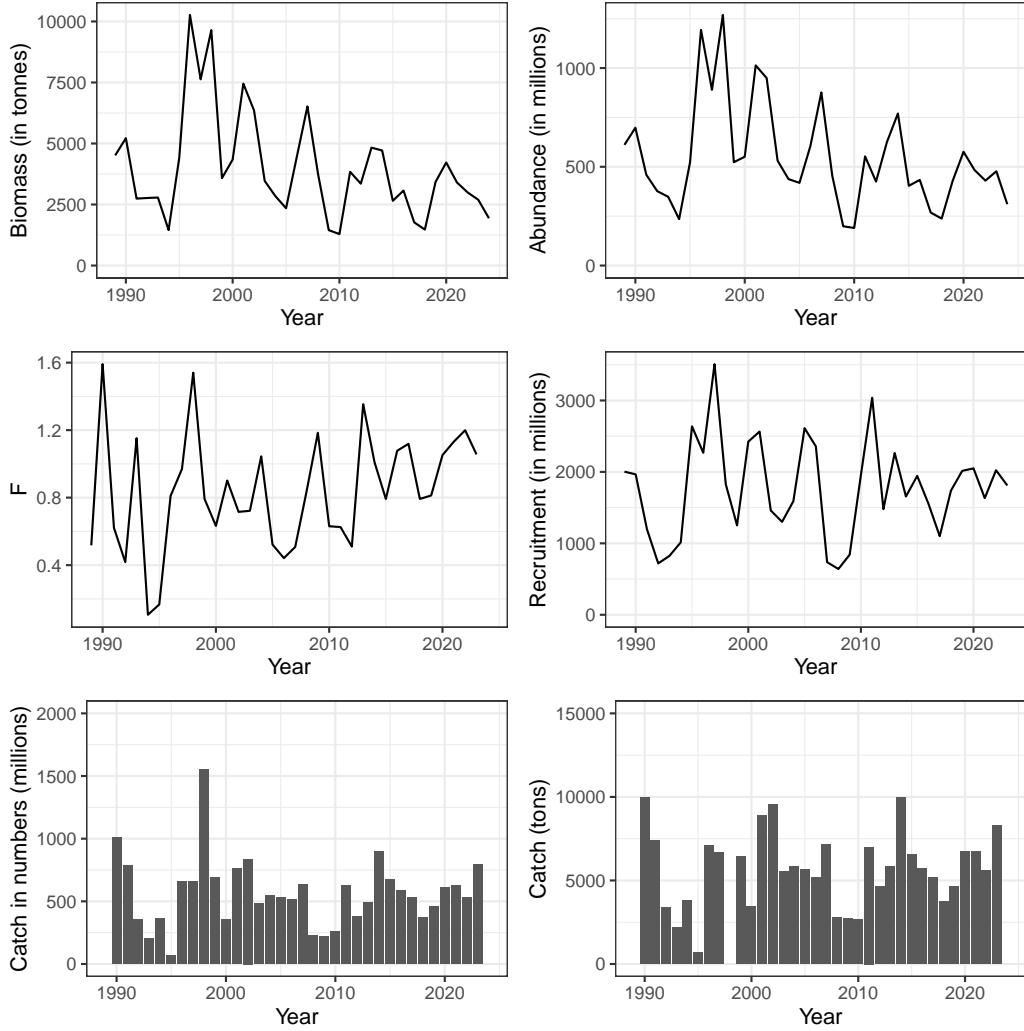


Figure 14: Annual catches time series (in numbers and biomass) compared with annual model estimates for abundance of individuals with more than one year of age (in numbers and biomass), recruitment and fishing mortality. Measures were summarized at the end of June each year, assuming that a year starts 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 σ 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 σ 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.

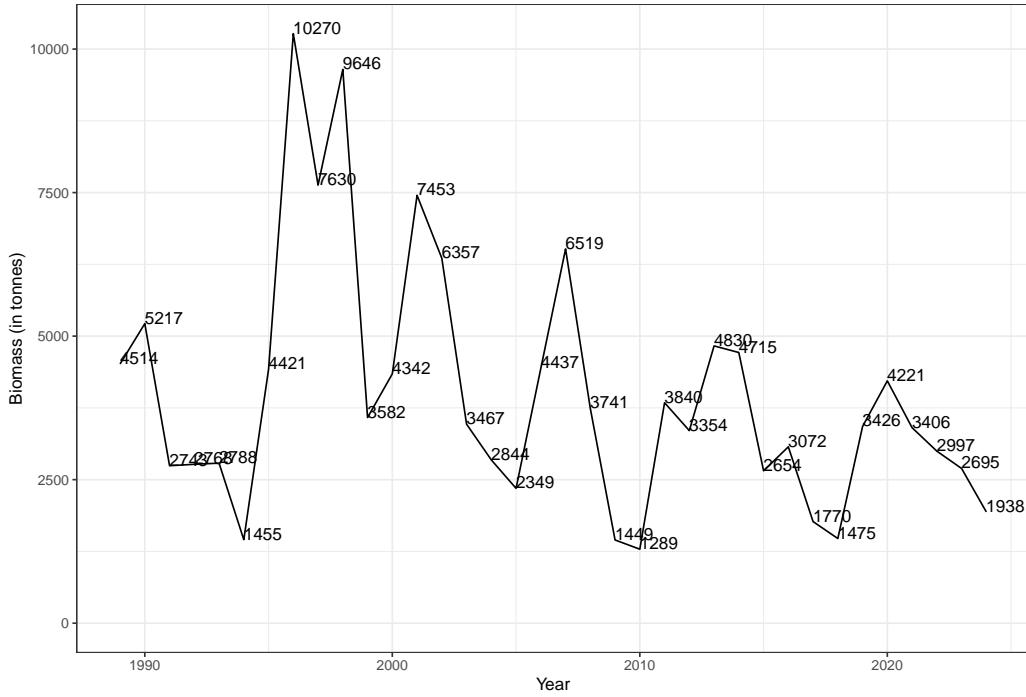


Figure 15: Estimated biomass time series at the end of quarter two (Age 0 removed to be consistent with recruitment at the end of the second quarter of the year). Note that under the assumption that all individuals in *B1+* class are mature, this biomass is equivalent to SSB

8. Catch advice for July 2024 to June 2025

8.1. Constant harvest rate rule

According to this rule, advised 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.

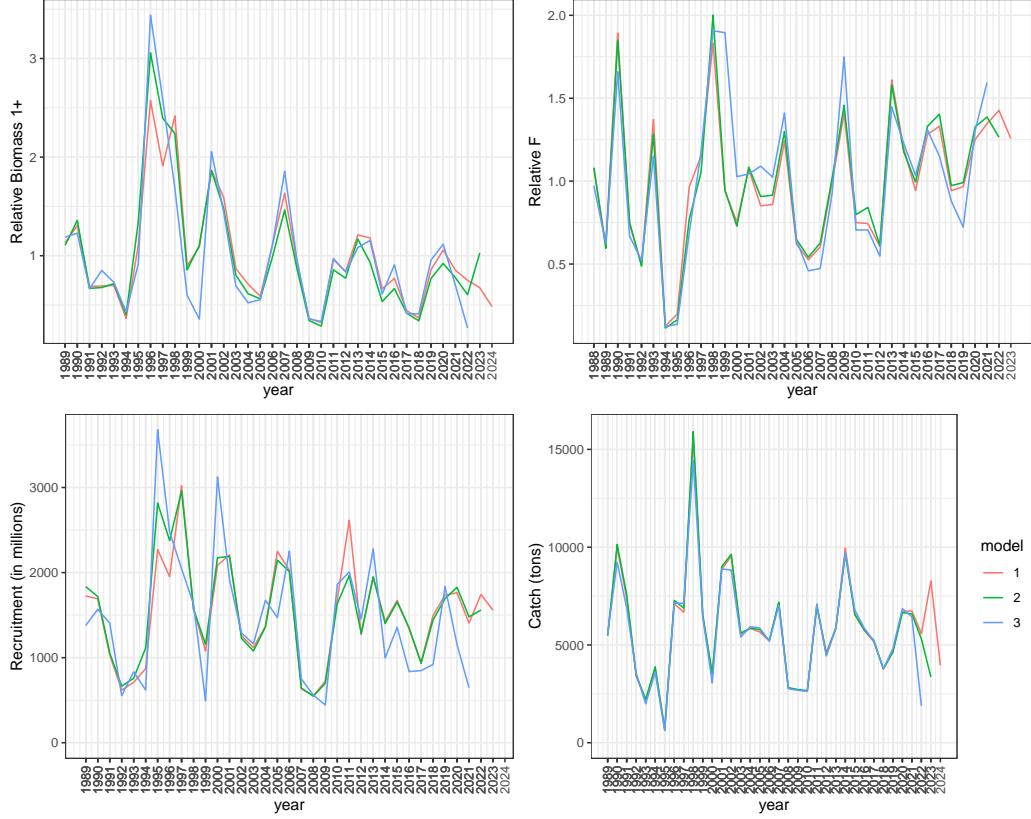


Figure 16: Comparison of estimates from different model implementations. Pink line corresponds to the current year estimated time series (the one estimated by the model described in this document), the green line, to the estimated in 2023 and the blue line, to the estimated in 2022. Measures were summarized at the end of June each year, assuming that a year starts in July and ends in June of the next year.

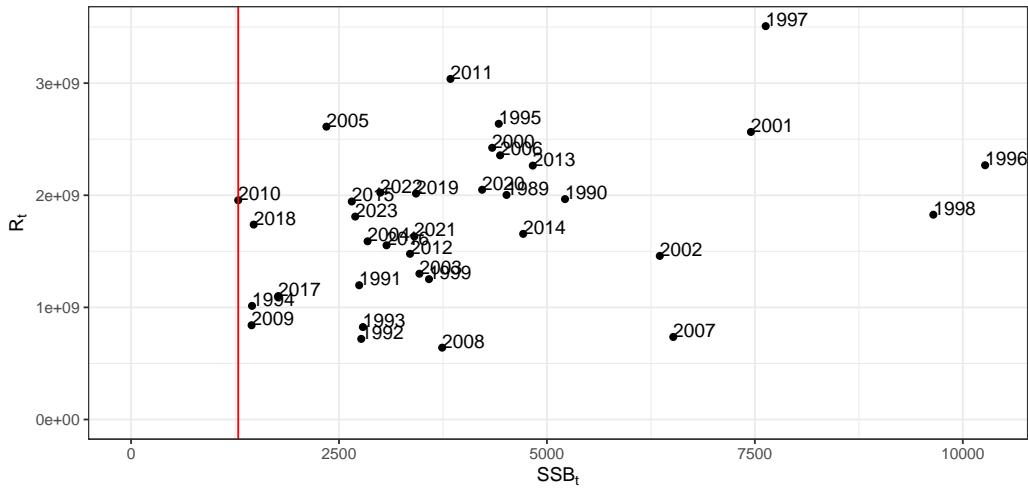


Figure 17: Estimated Stock Spawning biomass (SSB_t) vs. Recruitment (R_t), SSB_t corresponds to the Stock Spawning Biomass at the end of quarter 2 of year t , while R_t corresponds to the sum of the recruitment at the beginning of quarters 3,4 and 1 of years t and $t + 1$, respectively.

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.

10. References

- Begley, J., 2004. Gadget User Guide. URL: <http://www.hafro.is/gadget/files/userguide.pdf>.
- Bellido, J.M., Pierce, G.J., Romero, J.L., Millan, M., 2000. Use of frequency analysis methods to estimate growth of anchovy (*Engraulis encrasicolus* L. 1758) in the gulf of Cádiz (SW Spain). *Fisheries Research* 48, 107–115.
- Elvarsson, B., Taylor, L., Trenkel, V., Kupca, V., Stefansson, G., 2014. A bootstrap method for estimating bias and variance in statistical fisheries modelling frameworks using highly disparate datasets. *African Journal of Marine Science* 36, 99–110. URL: <http://www.tandfonline.com/doi/abs/10.2989/1814232X.2014.897253>, doi:10.2989/1814232X.2014.897253.
- Gislason, H., Daan, N., Rice, J.C., Pope, J.G., 2010. Size, growth, temperature and the natural mortality of marine fish. *Fish and Fisheries* 11, 149–158.
- Lentin, J., 2014. mfdb: MareFrame DB Querying Library. R package version 3.2-0.
- Stefansson, G., 2003. Issues in Multispecies Models. *Natural Resource Modeling* 16, 415–437. URL: <http://onlinelibrary.wiley.com/doi/10.1111/j.1939-7445.2003.tb00121.x/abstract>, doi:10.1111/j.1939-7445.2003.tb00121.x.
- Stefánsson, G., 1998. Comparing different information sources in a multispecies context. Fishery stock assessment models. Alaska Sea Grant College Program. AK-SG-98-01 , 741–758URL: <http://mdgs.un.org/unsd/envaccounting/ceea/archive/Fish/Iceland.PDF>.
- Taylor, L., Begley, J., Kupca, V., Stefansson, G., 2007. A simple implementation of the statistical modelling framework Gadget for cod in Icelandic waters. *African Journal of Marine Science* 29, 223–245. URL: <http://www.tandfonline.com/doi/abs/10.2989/AJMS.2007.29.2.7.190>, doi:10.2989/AJMS.2007.29.2.7.190.

Number of vessels by LOA (length overall) ranges for Spanish purse-seiners fishing the Sardine stock in ICES Divisions 8c and 9a

Adriana Nogueira and José Castro

by

CSIC-Instituto Español de Oceanografía

Subida Radio Faro, 50-52, 36390 Vigo, Spain

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 overall¹) 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).

Conclusion:

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.

References:

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 (33.8-33.8)	156	21.3 (2.9-73.6)	
VL1012	0	0.0	11	60.6 (20.6-106.7)	27	36.9 (17.7-72.1)	
VL1218	0	0	114	104.9 (22.1-219.9)	5	83.4 (36.8-123.6)	
VL1824	0	0.0	184	209.5 (48.5-397.2)	0		
VL2440	0	0.0	136	374.1 147.1-809.1)	0		
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 (33.8-33.8)	144	21,3 (2.9-73.6)	
VL1012	0	0,0	10	59,6 (20.6-106.7)	24	33,2 (17.7-72.1)	
VL1218	0	0	88	101,5 (22.1-219.9)	5	83,4 (36.8-123.6)	
VL1824	0	0,0	93	199,5 (48.5-397.2)	0		
VL2440	0	0,0	77	324,8 147.1-809.1)	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 (33.82-33.82)	113	19,9 (4.19-73.55)	
VL1012	0	0,0	13	59,9 (20.59-106.65)	32	33,3 (17.65-94.14)	
VL1218	0	0	107	95,8 (22.06-169.16)	8	83,5 (20.59-147.1)	
VL1824	0	0,0	186	200,3 (48.54-397.17)	0		
VL2440	0	0,0	182	309,4 (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):

2023	TRAWL		PURSE SEINE		SMALL SCALE		
	LOA	Nº	KW	Nº	KW	Nº	KW
VL0010	0	0,0		1	33,8	113	19,9
					(33.82-33.82)		(4.19-73.55)
VL1012	0	0,0		11	59,9	26	33,3
					(20.59-106.65)		(17.65-94.14)
VL1218	0	0		79	95,8	8	83,5
					(22.06-169.16)		(20.59-147.1)
VL1824	0	0,0		89	200,3	0	
					(48.54-397.17)		
VL2440	0	0,0		91	309,4	0	
					(147.1-809.05)		
VL40XX	0	0,0		0	0,0	0	
Targeting PIL89	0	0,0	271	200,2	147	25,7	

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 R/V EMMA BARDAN	Survey area	ICES 8abcd
Target species and stock	<i>Engraulis encrasiculus & Sardina Pilchardus</i> <i>Anc & Pil.27.8</i>	Results to join with other survey (code)	
Survey coordination Group	ICES WGACEGG	Data submitted for assessment HANSA	<i>Anc.27.8</i> → Total biomass & % B age 1, W <i>Pil.27.8abd</i> → SSB and egg Abundance
Survey responsible	<i>Maria Santos Mocoroa: msantos@azti.es</i>		

Survey description:	<p>Link to the working document: http://dx.doi.org/10.13140/RG.2.2.10327.24485</p> <p>Objectives:</p> <ul style="list-style-type: none"> ○ Contribute to the assessment: <ul style="list-style-type: none"> - 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. - 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. ○ Ecosystem approach: Characterization of the Hydrography, Zooplankton and ichthyoplankton analysis, eDNA analysis, Top predators, Fishing activities, marine debris and microplastics distribution and abundance <p>Methodology:</p> <p>The DEPM is applied to both spp to estimate the biomass since 1987</p> <p>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.</p> <p>The adult samples are obtained on board another research vessel (pelagic trawler) coinciding in space and time with the plankton sampling.</p>
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)	<ul style="list-style-type: none"> - Main outputs see Survey results summary table. - Extra info: <i>Maurolicus muelleri</i> egg abundance obtained as well
survey&data quality (green, yellow, red)	Green

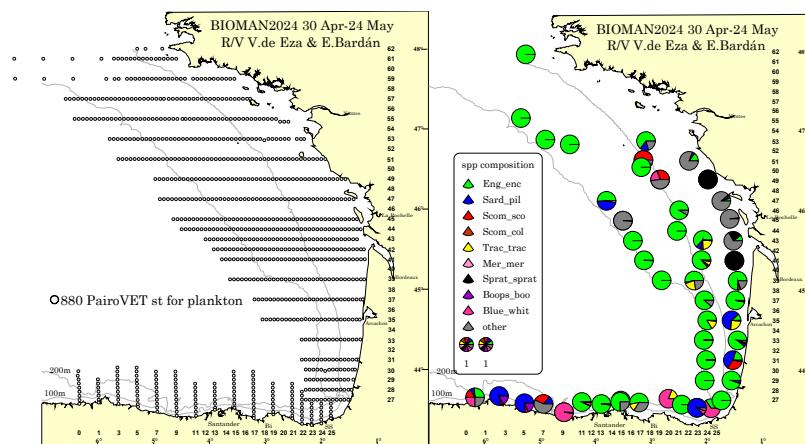
Survey summary table

Study area	ICES 8abcd	
Survey dates	30/04 – 24/5 2024	
EGGS SAMPLING		
Transects	40	
PairoVET stations	880	
CUFES stations	1969	
Specie	<i>anchovy</i>	<i>sardine</i>
Positive PairoVET stations	759 (86%)	208 (24%)
PairoVET total egg: number counted and staged	24177	1742
PairoVET maximum eggs/m ² in a station	4490	780
Positive CUFES stations	1588 (81%)	555 (28%)

CUFES total Egg n° counted	148177	7233
CUFES maximum eggs/m ³ in a station	258	61
ADULTS SAMPLING		
Time range (hh:mm)		
Fishing depth range (m)		
Number Hauls from research vessels		
<i>Specie</i>	<i>anchovy</i>	<i>sardine</i>
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 (Km ²)	121647	
Species	anchovy	sardine
Spawning area (Km ²)	101890	22881
Z (daily rate) (CV%)	0.12 (27.89)	0.21 (50.78)
P ₀ (eggs/m ²) (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)



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 (<i>Engraulis encrasicolus</i>), sardine (<i>Sardina pilchardus</i>) and chub mackerel (<i>Scomber colias</i>), with special reference to their Age-0 population fractions. Acoustic estimates are also regularly provided for Atlantic mackerel (<i>S. scombrus</i>), horse mackerel species (<i>Trachurus trachurus</i> , <i>T. mediterraneus</i> , <i>T. picturatus</i>) and bogue (<i>Boops boops</i>). Estimates for round sardinella (<i>Sardinella aurita</i>), blue whiting (<i>Micromesistius poutassou</i>), boarfish (<i>Capros aper</i>), longspine snipefish (<i>Macrorhamphosus scolopax</i>) and pearlside (<i>Maurolicus muelleri</i>), when present.				
Survey dates:	18 th -30 th October 2024.				
Summary:					
<p>The ECOCADIZ-RECLUTAS 2024-10 Spanish (pelagic ecosystem-) acoustic-trawl survey was conducted by IEO between 18th and 30th October 2024 in the Portuguese and Spanish shelf waters (20-200 m isobaths) off the Gulf of Cadiz (GoC) onboard the R/V <i>Ramón Margalef</i>. 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 estimates is still available for sardine and chub mackerel.</p> <p>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.</p> <p>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, compared 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.</p>					
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center; background-color: #cccccc;"></th> <th style="text-align: center; background-color: #cccccc;"><i>Description</i></th> </tr> </thead> <tbody> <tr> <td>Survey design</td> <td>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</td> </tr> </tbody> </table>			<i>Description</i>	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
	<i>Description</i>				
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				

	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 (<i>IBERAS-2024</i>). 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. Mitson RB. 1995. Underwater noise of research vessels: review and recommendations. <i>ICES Cooperative Research Report</i> , 209, 61 pp. Mitson RB, Knudsen H.P. 2003. Causes and effects of underwater noise on fish abundance estimation. <i>Aquatic Living Resources</i> , 16 (3): 255-263 .
Specific survey error issues (acoustic)	<i>There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:</i>
Bubble sweep down	<i>Time-series:</i> 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. <i>Survey Year specific:</i> No specific survey error related with this issue. De Robertis, A., Higginbottom, I. 2007. A post-processing technique to estimate the signal-to-noise ratio and remove echosounder background noise. <i>ICES Journal of Marine Science</i> , 64: 1282-1291.
Extinction (shadowing)	<i>Time-series:</i> 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 <i>et al.</i> , 1989; de Moor <i>et al.</i> , 2008; Coetzee <i>et al.</i> , 2008). <i>Survey Year specific:</i> No specific survey error related with this issue. Bodholt H, Nes H, Solli H. 1989. A new echo sounder system. <i>Proceedings of the Institute of Acoustics (UK)</i> 11: 123-130. de Moor CL, Butterworth DS, Coetzee JC. 2008. Revised estimates of abundance of South African

	sardine and anchovy from acoustic surveys adjusting for echosounder saturation in earlier surveys and attenuation effects for sardine. <i>African Journal of Marine Science</i> 30(2): 219–232. 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. <i>African Journal of Marine Science</i> 30(2): 205–217.
Blind zone	<i>Time-series:</i> Drop-keel mounted transducers at 6.5 m depth, downward facing. Upper integration limit set at 10 m depth. <i>Survey Year specific:</i> 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 <i>et al.</i> (2018) and Table 3.12 in Doray <i>et al.</i> (2021). TS values are not species-specific. Anchovy and sardine: -72.6; chub mackerel and <i>Trachurus</i> spp.: -68.7; mackerel: -84.9. Massé, J., Uriarte, A., Angelico, M. M., and Carrera, P. 2018. Pelagic survey series for sardine and anchovy in ICES subareas 8 and 9 (WGACCEGG) – Towards an ecosystem approach. <i>ICES Coop. Res. Rep.</i> , 332, 268 pp. 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 (WGACCEGG). 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 <i>et al.</i> , 2015; see also Foote <i>et al.</i> , 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). Demer, D.A., Berger, L., Bernasconi, M., Bethke, E., Boswell, K., Chu, D., Domokos, R., <i>et al.</i> 2015. Calibration of acoustic instruments. <i>ICES Coop. Res. Rep.</i> , 326, 133 pp. 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. <i>ICES Coop. Res. Rep.</i> , 144, 57 pp.
Specific survey error issues	<i>There are some bias considerations that apply to acoustic-trawl surveys only, and the (biological) respective SISP should outline how these are evaluated:</i>
Stock containment	<i>Time-series:</i> 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. <i>Survey Year specific:</i> NA.

Stock ID and mixing issues	<i>Time-series:</i> 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. <i>Survey Year specific:</i> 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	<i>Time-series:</i> random sample of 50 fish/haul of anchovy, sardine, <i>Scomber</i> spp., <i>Trachurus</i> 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. <i>Survey Year specific:</i> 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)	<i>To be answered by Assessment Working Group</i>
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	<i>To be answered by Assessment Working Group</i>

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:

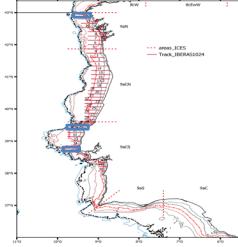
IBERAS1024 was carried out on board R/V Ramón Margalef from 1st to 14th October 2024 aiming to estimate the strength of recruitment of both the Iberoatlantic stock of sardine (*Sardina pilchardus*) and the western spawning fraction of the 9a anchovy stock (*Engraulis encrasicholus*). Prior the survey 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 SA this year comparing with 810×10^3 SA 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 SA 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 SA) was allocated to sardine (only one category), and 12% (37×10^3 SA) to big anchovy category and 6% (20×10^3 SA) 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 sv within those schools, never recorded for sardine until now.

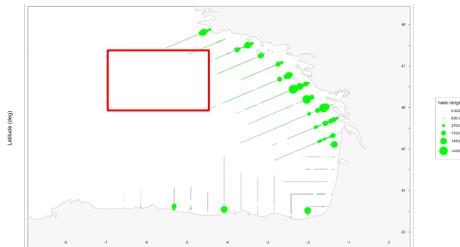
	<i>Description</i>
Survey design	The survey area over the shelf until the 200 m isobath, was covered following a parallel grid with fixed starting point. Tracks in 9aN and north 9aCN were extended to the shelf edge similar to the previous year to cover the offshore distribution of juvenile anchovy. Acoustic 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)	<i>There are some bias considerations that apply to acoustic-trawl surveys only, and the respective TIMES should outline how these are evaluated:</i>
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.

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 <i>et al.</i> (2021). Anchovy and Sardine: -72.6; Chub mackerel: -68.7. 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 <i>et al.</i> , 2015; see also Foote <i>et al.</i> , 1987). Demer, D.A., Berger, L., Bernasconi, M., Bethke, E., Boswell, K., Chu, D., Domokos, R., <i>et al.</i> 2015. Calibration of acoustic instruments. <i>ICES Coop. Res. Rep.</i> , 326, 133 pp. 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. <i>ICES Coop. Res. Rep.</i> , 144, 57 pp.
Specific survey error issues <i>There are some bias considerations that apply to acoustic-trawl surveys only, and (biological) the respective SISP should outline how these are evaluated:</i>	
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). The survey only focussed on the two main target species (juvenile sardine and anchovy). 
Biological sampling	Good sampling carried out for all species: 17 trawl hauls together with 9 purse seiner shots have been used for identification purposes. No. of identification haul per surveyed distance: 0.02 haul/n.m.
Stock containment	Juvenile anchovy (9a): Yes Juvenile sardine (9a): Yes 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

	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)	<i>To be answered by Assessment Working Group</i>
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	<i>To be answered by Assessment Working Group</i>

Survey Summary table WGACEGG 2024

Name of the survey (abbreviation):	JUVENA (ES)
Target Species:	Anchovy (<i>Engraulis encrasiculus</i>), sardine (<i>Sardina pilchardus</i>), spratt (<i>Sprattus sprattus</i>), horse mackerel (<i>Trachurus trachurus</i>), mackerel (<i>Scomber scombrus</i>), chub mackerel (<i>Scomber colias</i>) pearlside (<i>Maurolicus muelleri</i>), krill (<i>Euphasiacea</i>), boarfish (<i>Capros aper</i>) and blue whiting (<i>Micromesistius poutassou</i>).
Survey dates:	01/09/2024 – 14/10/2024
Summary:	Cruise Report Link:
	<p>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 Cantabrian 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.</p> <p>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.</p> <p><u>Juvenile anchovy</u>: distribution shift northwards, decrease of biomass, medium-low recruitment, increase of size and weight</p> <p><u>Sardine</u>: expected distribution in French coast, absent from Cantabrian area. Increase of biomass but decrease of mean weight and length values.</p>
	Description
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. 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 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)	<i>There are some bias considerations that apply to acoustic-trawl surveys only, and the respective TIMES should outline how these are evaluated:</i>
Bubble sweep down	NA. Under bad weather conditions we pause the survey.
Extinction (shadowing)	None

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)	<i>There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:</i>
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. No. of identification haul per surveyed distance: 0.04 haul/n.m.
Stock containment	Anchovy (8abcd): Yes Sardine (8abcd): Yes Sprat (8abcd): Yes Horse mackerel (8abcd): Yes Atlantic mackerel (8abcd): Yes Blue whiting (8abcd): Yes Chub mackerel (8abcd): Yes Boarfish (8abcd): Yes Where possible, JUVENA survey timings are coordinated with CSHAS, PELTIC,

	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.
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)	<i>To be answered by Assessment Working Group</i>
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	<i>To be answered by Assessment Working Group</i>

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

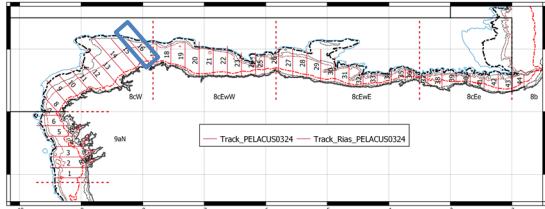
Summary: Cruise Report Link:

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.

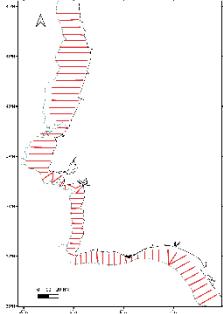
	<i>Description</i>
Survey design	Stratified systematic parallel design (8nmi apart) with randomised starting point.
Index Calculation method	Methodology described in Doray, M., Van Der Kooij, J., Boyra, G. (Eds.), 2021. ICES Survey Protocols - Manual for acoustic surveys coordinated under the ICES Working 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)	<i>There are some bias considerations that apply to acoustic-trawl surveys only, and the respective TIMES should outline how these are evaluated:</i>
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.

Allocation of backscatter to species	<p>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).</p> <p>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 sv mean and sv max and geographic position and time.</p> <p>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 sv which allows them be properly measured) was calculated as the ratio $s_A(f_i)/s_A(38)$, being f_i the s_A values for 18, 70, 120 and 200 kHz.</p>
Target strength	<p>Species-specific b_{20} values are listed in Table 2.12 in Doray <i>et al.</i> (2021). Anchovy and Sardine: -72.6</p> <p>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</p>
Calibration	<p>All frequencies were calibrated according to the standard procedures (ICES-CRR326) during the first two days, following the ICES standard procedures (Demer <i>et al.</i>, 2015; see also Foote <i>et al.</i>, 1987).</p> <p>Demer, D.A., Berger, L., Bernasconi, M., Bethke, E., Boswell, K., Chu, D., Domokos, R., <i>et al.</i> 2015. Calibration of acoustic instruments. <i>ICES Coop. Res. Rep.</i>, 326, 133 pp.</p> <p>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. <i>ICES Coop. Res. Rep.</i>, 144, 57 pp.</p>
Specific survey error issues	<p>(biological) <i>There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:</i></p>
Acoustic sampling scheme completion (incl. map)	<p>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.</p>  <p>The negative bias in biomass estimates caused by the non-coverage of the Northwestern area was deemed negligible for main objective species.</p>
Biological sampling	<p>Good sampling carried out for all species: 35 identification hauls performed, comparable to previous years.</p> <p>No. of identification haul per surveyed distance: 0.012 haul/n.m.</p>
Stock containment	<p>Anchovy (9a8c): Yes Sardine (9a8c): Yes Sprat (9a8c): No Horse mackerel (9a8c): Yes Blue whiting (9a8c): Yes Atlantic mackerel (9a8c): Yes Chub mackerel (9a8c): Yes Anchovy and sardine: good geographical alignment on the northern (FR:</p>

	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)	<i>To be answered by Assessment Working Group</i>
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	<i>To be answered by Assessment Working Group</i>

Survey Summary Table WGACEGG 2024

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:
<p>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.</p> <p>Survey effort, timing and area coverage were comparable to previous years and the same vessel and sampling equipment (transducers and trawl) were used.</p> <p>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 m²/nmi²). 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 m²/nmi²). 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.</p>	
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)	<i>There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:</i>
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.

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 <i>et al.</i> (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 <i>et al.</i> , 2015; see also Foote <i>et al.</i> , 1987).
Specific survey error issues (biological)	<i>There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:</i>
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. 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

	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)	<i>To be answered by Assessment Working Group</i>
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	<i>To be answered by Assessment Working Group</i>

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
<p>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).</p> <p>Survey effort, timing and area coverage were globally comparable to previous years and the same vessel and sampling equipment (transducers and trawl) were used.</p> <p>Egg sampling was performed with the CUFES and fish abiotic and biotic environment were characterised.</p>	
	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 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 <i>There are some bias considerations that apply to acoustic-trawl surveys only, and (acoustic) the respective TIMES should outline how these are evaluated:</i>	
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. However, the lateral echosounder allowed to visually check that SPF distribution was not as shallow as last year. Based on these observations, the fish acoustic biomass in the vertical

	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
Calibration	All survey frequencies calibrated and results within recommended tolerances
Specific survey error issues (biological)	<i>There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:</i>
Acoustic sampling scheme completion (incl. map)	<p>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.</p> <p>PELGAS2024 sampling scheme (red) and Spanish waters usually covered (yellow)</p> <p>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).</p>
Biological sampling	<p>Good sampling carried out for all species: 97 identification hauls performed, comparable to previous years.</p> <p>No. of identification haul per surveyed distance: 0.05 haul/n.m.</p>
Stock containment	<p>Anchovy (8ab): Yes Sardine (8ab): Yes Sprat (8ab): Yes Blue whiting: No Atlantic mackerel: No Chub mackerel: No Boarfish and horse mackerel: good geographical alignment on the northern (IRL: WESPAS) and southern (SP: PELACUS) boundaries but temporal mis-match (~1 month).</p>

Stock ID and mixing issues	None																				
Measures of uncertainty (CV)	<p><i>CV on abundance</i></p> <table> <tbody> <tr><td>Boarfish:</td><td>0.21</td></tr> <tr><td>Anchovy</td><td>0.09</td></tr> <tr><td>Hake</td><td>0.22</td></tr> <tr><td>Blue whiting</td><td>0.12</td></tr> <tr><td>Sardine</td><td>0.15</td></tr> <tr><td>Atlantic mackerel</td><td>1.49</td></tr> <tr><td>Chub mackerel</td><td>0.34</td></tr> <tr><td>Sprat</td><td>0.26</td></tr> <tr><td>Med. horse mackerel:</td><td>0.69</td></tr> <tr><td>Horse mackerel:</td><td>0.28</td></tr> </tbody> </table> <p>*Calculation carried out using EchoR package version 1.4.7</p>	Boarfish:	0.21	Anchovy	0.09	Hake	0.22	Blue whiting	0.12	Sardine	0.15	Atlantic mackerel	1.49	Chub mackerel	0.34	Sprat	0.26	Med. horse mackerel:	0.69	Horse mackerel:	0.28
Boarfish:	0.21																				
Anchovy	0.09																				
Hake	0.22																				
Blue whiting	0.12																				
Sardine	0.15																				
Atlantic mackerel	1.49																				
Chub mackerel	0.34																				
Sprat	0.26																				
Med. horse mackerel:	0.69																				
Horse mackerel:	0.28																				
Spawning	Large amount of anchovy eggs were found with an unusual maximum abundance in the northwest of the Bay as compared the classic situation. 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)	<i>To be answered by Assessment Working Group</i>																				
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	<i>To be answered by Assessment Working Group</i>																				

Survey Summary table WGACEGG 2024

Name of the survey (abbreviation):	PELTIC (UK)
Target Species:	Sardine , Sprat, Anchovy
Survey dates:	3 October, 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 from 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
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) 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)	<i>There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:</i>
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)

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. 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 <i>There are some bias considerations that apply to acoustic-trawl surveys only, and (biological) the respective SISP should outline how these are evaluated:</i>	
Stock containment	Sardine (Celtic Sea); Yes to West and North although no coverage in eastern Channel and possible links with Biscay fish. Sprat (Lyme Bay); questions remain about the link of Lyme Bay sprat to other populations in Channel and beyond although seemingly isolated in autumn. Sprat in Celtic Sea not captured as extending further west (covered by MI, Ireland during CSHAS) .
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. 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)	<i>CV on abundance</i> Sardine: 0.13 Sprat (7de): 0.52 Anchovy: not known as issues with bootstrap *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	<i>To be answered by Assessment Working Group</i>

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	<i>To be answered by Assessment Working Group</i>

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
<p>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.</p> <p>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).</p> <p>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).</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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).</p> <p>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). Combined these three age classes represented 60% of TSB and 56% of TSN.</p> <p>Analysis of horse mackerel samples indicated 98% of TSB and 91% of TSB was mature.</p> <p>The same vessel and sampling equipment (transducers and trawl) were used.</p>	

	<i>Description</i>
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) 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)	<i>There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:</i>
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) Boarfish TS = 20log10(L) – 66.2 (38 kHz) 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)	<i>There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:</i>
Stock containment	Herring (Celtic Sea); Yes 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 unidentified stocks on the feeding grounds. Genetic sampling underway.
Measures of uncertainty (CV)	<i>CV on abundance</i> Boarfish: 0.09 Horse mackerel: 0.24 *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 horse 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)	<i>To be answered by Assessment Working Group</i>
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	<i>To be answered by Assessment Working Group</i>

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/m², respectively. Anchovy eggs presented a patched distribution along the area (Figure A7.4.1.1). 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 °C - 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 $\times 10^{12}$ /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 PEL-GAS. 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 26th March and 16th 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” ($95\ 940\ \text{m}^2\ \text{nmi}^{-2}$) has shown 63% lower than the maximum value recorded throughout the time-series, estimated in 2020 ($229\ 241\ \text{m}^2\ \text{nmi}^{-2}$), and 28% below the historical mean ($118\ 395\ \text{m}^2\ \text{nmi}^{-2}$). 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 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 3.4.3.1). 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 m² nmi⁻²) was 21% lower than that recorded last year (107 026 m² nmi⁻²) and 28% below the historical mean (118 395 m² 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 ($M_0= 1.285$; $M_1= 1.028$; $M_2= 0.827$; $M_3= 0.703$; $M_4= 0.724$).

Southern component

M is also unknown for this stock component. The following estimates for M at-age were finally adopted in WKPELA 2018: $M_0=2.21$; $M_1=1.30$; $M_2+=1.30$ (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 17th) 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:

$$C_y = 0.5 I_{current} * \min\left\{\frac{I_{current}}{B_{trigger}}, 1\right\}$$

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:

$$C_y = 0.5 I_{current} * \min\left\{\frac{I_{current}}{B_{trigger}}, 1\right\} = 0.5 * 1938 * \min\left\{\frac{1938}{1194.132}, 1\right\} = 0.5 * 1938$$

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 5th of May 2023, the results and conclusions of a first group of simulations conducted with FLBEIA MSE framework separately to the anchovy 27.9.a south and west components were presented by members of WGHANSA to the ICES designated external reviewers.

Western component

During the WGHANSA meeting from May 29th to June 2nd 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 29th to June 2nd 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.

References

- 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>
- Garrido, S., Ramos, F., Silva, A., Angélico, M. M., Marques, V. 2018a. Population structure of the European anchovy (*Engraulis encrasicolus*) in ICES Division 9a: synopsis and updated information. Working document presented to the ICES Benchmark Workshop on Pelagic Stocks (WKPELA 2018). 12–16 February 2018. Copenhagen, Denmark. 16 pp.
- ICES. 2003. Report of the Workshop on Discard Sampling Methodology and Raising Procedures. Charlottenlund, Denmark, 2–4 September 2003.
- ICES. 2004. Report of the Study Group on Assessment Methods Applicable to Assessment of Norwegian Spring-Spawning Herring and Blue Whiting Stocks (SGAMHBW). 19–22 February 2004, Lisbon, Portugal. ICES CM 2014/ACFM 145. 166 pp.
- ICES. 2007. Report of the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VIII and IX (WGACEGG), 26–30 November 2007, Palma de Mallorca, Spain, ICES C.M. 2007/LRC:16. 167 pp.
- ICES. 2008a. Report of the Working Group on Anchovy (WGANC), 13–16 June 2008, ICES Headquarters, Copenhagen. ICES CM 2008 ACOM:04. 226 pp.
- ICES. 2008b. Report of the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VIII and IX (WGACEGG), 24–28 November 2008, Nantes, France. ICES CM 2008/LRC:17. 183 pp.
- ICES. 2008c. Report of the Workshop on Small Pelagics (*Sardina pilchardus*, *Engraulis encrasicolus*) maturity stages (WKSPMAT), 10–14 November 2008, Mazara del Vallo, Italy. ICES CM 2008/ACOM:40. 82 pp.
- ICES. 2009a. Report of the Working Group on Anchovy and Sardine (WGANS), 15–20 June 2009, ICES Headquarters, Copenhagen. ICES CM 2009/ACOM:13. 354 pp.
- ICES. 2009b. Report of the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VIII and IX (WGACEGG), 16–20 November 2009, Lisbon, Portugal. ICES CM 2009/LRC:20. 181 pp.
- ICES. 2012. ICES Implementation of Advice for Data-limited Stocks in 2012 in its 2012 Advice. ICES CM 2012/ACOM:68. 42 pp.)
- ICES. 2015. Interim Report of the Stock Identification Methods Working Group (SIMWG), 10–12 June 2015, Portland, Maine, USA. ICES CM 2015/SSGEPI:13. 67 pp.
- ICES. 2017a. Report of the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas 7, 8, and 9. WGACEGG Report 2016 Capo Granitola, Sicily, Italy. 14–18 November 2016. ICES CM 2016/SSGIEOM:31. 326 pp.
- ICES. 2017b. Report of the Workshop to review the ICES advisory framework for short-lived species, including detailed exploration of the use of escapement strategies and forecast methods (WKMSYREF5), 11–15 September 2017, Capo Granitola, Sicily. ICES CM 2017/ACOM:46 A. 63 pp.
- ICES. 2018a. Report of the Benchmark Workshop on Pelagic Stocks (WKPELA 2018), 12–16 February 2018, ICES HQ, Copenhagen, Denmark. ICES CM 2018/ACOM:32. 313 pp.
- ICES. 2018b. Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas 7, 8 and 9 (WGACEGG). ICES WGACEGG REPORT 2017 3–17 November 2017. pp. 388.
- ICES. 2020b. Working Group on Southern Horse Mackerel, Anchovy and Sardine (WGHANSA). *ICES Scientific Reports*. 2:41. 655 pp. <http://doi.org/10.17895/ices.pub.5977>
- ICES. 2021a. Working Group on Southern Horse Mackerel Anchovy and Sardine (WGHANSA). *ICES Scientific Reports*. 3:55. 689 pp. <https://doi.org/10.17895/ices.pub.8138>.

- ICES. 2021b. Tenth Workshop on the Development of Quantitative Assessment Methodologies based on LIFE-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks (WKLIFE X). *ICES Scientific Reports*. 2:98. 72 pp. <http://doi.org/10.17895/ices.pub.5985>
- ICES. 2022. Stock Identification Methods Working Group (SIMWG). *ICES Scientific Reports*. 4:72. 66 pp. <http://doi.org/10.17895/ices.pub.20937001>.
- Jiménez, M.P., Tornero, J., Villaverde, A., Llevot, M.J., Solla, A., Ramos, F. 2018. Anchovy spawning stock biomass of the Gulf of Cadiz in 2017. Working document presented in the ICES Working Group on Southern Horse Mackerel, Sardine and Anchovy (WGHANSA). Lisbon, Portugal, 26–30 June 2018.
- Massé, J., Uriarte, A., Angélico, M. M., and Carrera, P. (Eds.) 2018. Pelagic survey series for sardine and anchovy in ICES subareas 8 and 9 – Towards an ecosystem approach. *ICES Cooperative Research Report* No. 332. 268 pp. <https://doi.org/10.17895/ices.pub.4599>.
- Payne, M. R., L. W. Clausen, H Mosegaard. 2009. Finding the signal in the noise: objective data-selection criteria improve the assessment of western Baltic spring-spawning herring. *ICES Journal of Marine Science*, 66: 1673–1680.
- Ramos, F., 2015. On the population structure of the European anchovy (*Engraulis encrasicolus*) in ICES Division IXa: a short review of the state of art. Working document presented in the ICES Stock Identification Methods Working Group (SIMWG). 10–12 June 2015.
- Ramos, F., Tornero, J., Oñate, D., Jiménez, M.P. 2018a. Acoustic assessment and distribution of the main pelagic fish species in ICES Subdivision 9a South during the ECOCADIZ 2017-07 Spanish survey (July–August 2017). Working document presented in the ICES Working Group on Southern Horse Mackerel, Sardine and Anchovy (WGHANSA). Lisbon, Portugal, 26–30 June 2018.
- Ramos, F., Tornero, J., Oñate, D., Córdoba, P. 2018b. Acoustic assessment and distribution of the main pelagic fish species in ICES Subdivision 9a South during the ECOCADIZ-RECLUTAS 2017-10 Spanish survey (October 2017). Working document presented in the ICES Working Group on Southern Horse Mackerel, Sardine and Anchovy (WGHANSA). Lisbon, Portugal, 26–30 June 2018.
- Rincón, M M., Ramos, F., Tornero, J., Garrido, S., Elvarsson, B., Lentin, J. 2024. Gadget for anchovy 9a South: Model description and results to provide catch advice and reference points (WGHANSA 2024-1). Working Document presented in the ICES Working Group on Southern Horse Mackerel, Sardine and Anchovy (WGHANSA-1). On-line meeting. 23–27 May 2024. https://github.com/ices-taf/2024_ane.27.9a_south_assessment/blob/main/report/Assessment2024prov_May8.pdf
- Silva, G., Horne, J. B., & Castilho, R. (2014). Anchovies go north and west without losing diversity: Post-glacial range expansions in a small pelagic fish. *Journal of Biogeography*, 41(6), 1171–1182. <https://doi.org/10.1111/jbi.12275>.
- Zarraonaindia, I., Iriondo, M., Albaina, A., Pardo, M. A., Manzano, C., Grant, W. S., Irigoien, X., & Estonba, A. (2012). Multiple SNP Markers Reveal Fine-Scale Population and Deep Phylogeographic Structure in European Anchovy (*Engraulis encrasicolus* L.). *PLoS ONE*, 7(7), e42201. <https://doi.org/10.1371/journal.pone.0042201>.

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, WGANS 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 polyva- lent	-	-	-	1	1	3	-	94	7	35	20	7
9.a S (ES)	Purse-seine	-	-	-	270	14	233	-	2621	579	1541	1346	297
	Not different. By gear	496	541	210	-	-	-	7056	-	-	-	-	-
Subarea	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 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
	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 4.3.2.2. 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				
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	Q1	Q2	Q3	Q4	TOTAL
Length (cm)	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	Q1	Q2	Q3	Q4	TOTAL
Length (cm)	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				
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)				
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	Q1	Q2	Q3	Q4	TOTAL
Length (cm)	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	IEO (ES)		IPMA (PT)	IPMA (PT)	IPMA (PT)	IPMA-IEO (PT-ES)	IEO (ES)	IEO (ES)	IEO (ES)		
(Country)											
Subareas	9.a N		9.a CN-9.a S	9.a CN-	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
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		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		
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 disrup-tion)	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
Institute (Country)	IEO (ES)		IPMA (PT)		IPMA (PT)	IPMA (PT)	IPMA-IEO (PT-ES)	IEO (ES)		IEO (ES)
Subareas	9.a N		9.a CN-9.a S		9.a CN-	9.a CN	9.a N-9.a CS	9.a S		9.a S
Year/Quarter	Q1	Q2	Q1	Q2	Q4	Q4	Q3	Q4	Q2	Q3
2022	Apr		Mar		Sep			No survey	Oct	
2023	Apr		Mar		Sep			Jul	Oct	
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 Fecun- dity	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 Bio- mass (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
BOC	0	1	1	0	1	15.50	2.86	0.00
BOG	192	1908	20	126	1024	23.22	57.14	0.86
HMM	21	1012	5	11	458	14.30	14.29	0.10
HKE	11	86	16	11	86	25.06	45.71	0.05
HOM	159	3614	16	42	676	18.60	45.71	0.72
MAC	6037	16244	20	713	2166	35.48	57.14	27.09
PIL_B	12327	278092	30	275	5938	18.64	85.71	55.32
WHB	95	1207	2	17	213	24.05	0.00	0.43
WHB_S-	0	7	1	0	7	8.07	2.86	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	Esti- mate	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 disruption)
	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			
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			
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			
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			
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 Sub-division 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	Spain	TOTAL
		S(A)	S(C)	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	N (million)					
Year	Age 0	Age 1	Age 2	Age 3	Age 4	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)					
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 (%)					
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 (%)					
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)					
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)					
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 (%)					
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 (%)					
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			
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)			
	B	-	-	-	-	-	-
Nov. 04	N	-	-	-	-	-	-
	B	-	-	-	-	-	-
Nov. 05	N	-	-	-	-	-	-
	B	-	-	-	-	-	-
Nov. 06	N	-	-	-	-	-	-
	B	-	-	-	-	-	-
Nov. 07	N	0	59	475	534	1386	1862
	B	0	1120	7632	8752	16091	23723
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				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)		
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	Spain	TOTAL
		S (PT)	S (ES)	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).

Ye ar	Age 0	Age 1	Age 2	Age 3
20 08		14. 6	37. 2	
20 09		14. 9	31. 6	36. 4
20 10		19. 5	17. 2	19. 6
20 11		16. 2	21. 2	28. 1
20 12				
20 13		14. 3	22. 7	34. 1
20 14		13. 6	23. 4	27. 7
20 15		12. 0	25. 6	29. 9
20 16		11. 5	12. 5	16. 2
20 17		15. 4	30. 0	34. 3
20 18		11. 3	24. 0	36. 6
20 19		13. 8	19. 0	30. 0
20 20		13. 0	22. 0	25. 0
20 21		15. 2	22. 6	28. 8
20 22		20. 9	28. 7	30. 7
20 23		19. 8	27. 7	30. 1
20 24		9.8 8	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 third quarter 2007, 2009, 2010, 2013–2020, 2023
	Length distribution	Second quarter 2004, 2006 third quarter 2007, 2009, 2010, 2013–2020, 2023
	Age-length key	Second quarter 2004, 2006 third quarter 2007, 2009, 2010, 2013–2020, 2023
	Biomass survey indexes	First quarter 1999, 2001–2003 second quarter 2005–2010 and 2013–2024
PELAGO acoustic survey	Length distribution	First quarter 1999, 2001–2003 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_∞	Asymptotic length, $l_\infty = 30$ cm
k	Annual growth rate, $k = 0.078$ 0.00831751
β	Beta-binomial parameter, $\beta = 5000$
v_a	Age factor, $v_0 = 120000$, $v_1 = 84400$, $v_2 = 0.06$, $v_3 = 4.48e-7$.0601, $v_4 = 1.25e - 07$
μ	Recruitment mean length, $\mu = 9.84$ cm
σ_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
α_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.

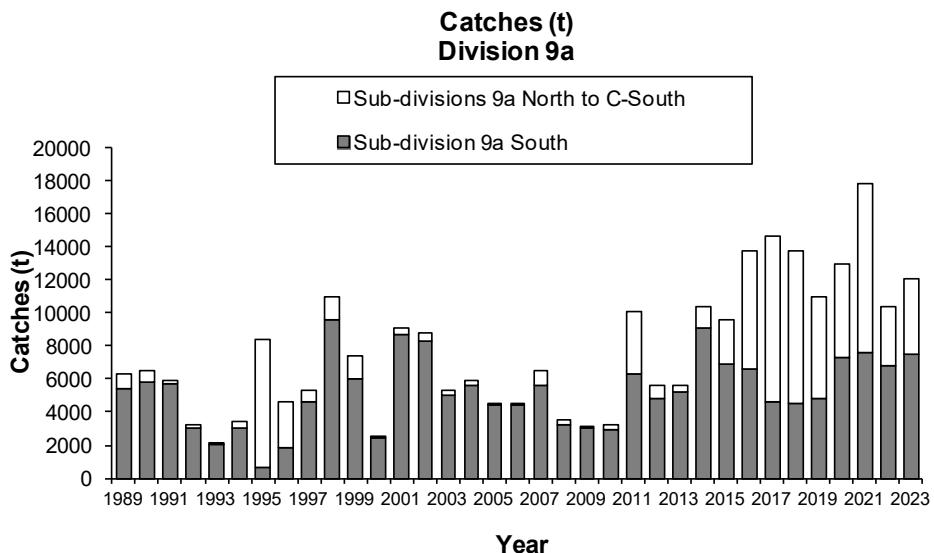


Figure A7.3.2.1.1. Anchovy in Division 9.a. Recent series of anchovy catches in Division 9.a (ICES estimates for 1989–2023, the period with data for all the subdivisions, all metiers are considered). Subdivisions are pooled in order to differentiate the anchovy fishery harvested throughout the Atlantic 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).

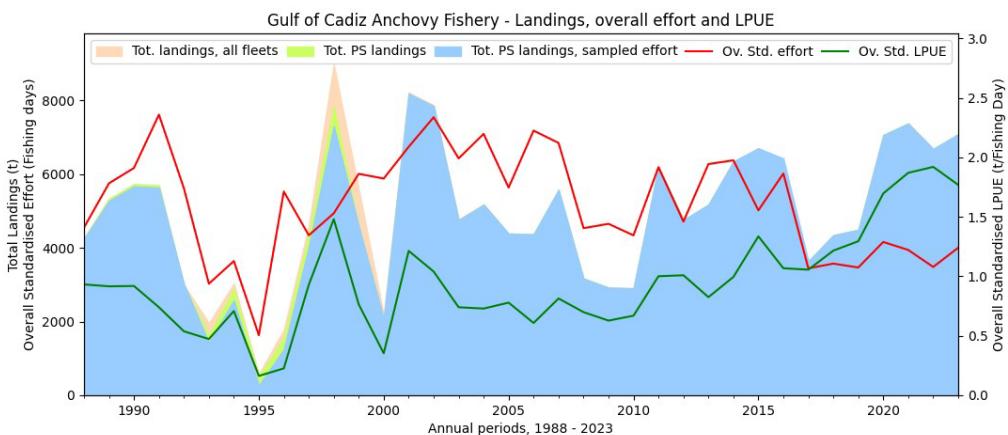


Figure A7.3.4.1. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. Spanish purse-seine fishery (métier PS_SPF_0_0_0). Trends in Gulf of Cadiz anchovy annual landings, and purse-seine fleets' standardised overall effort and lpue (1988–2023).

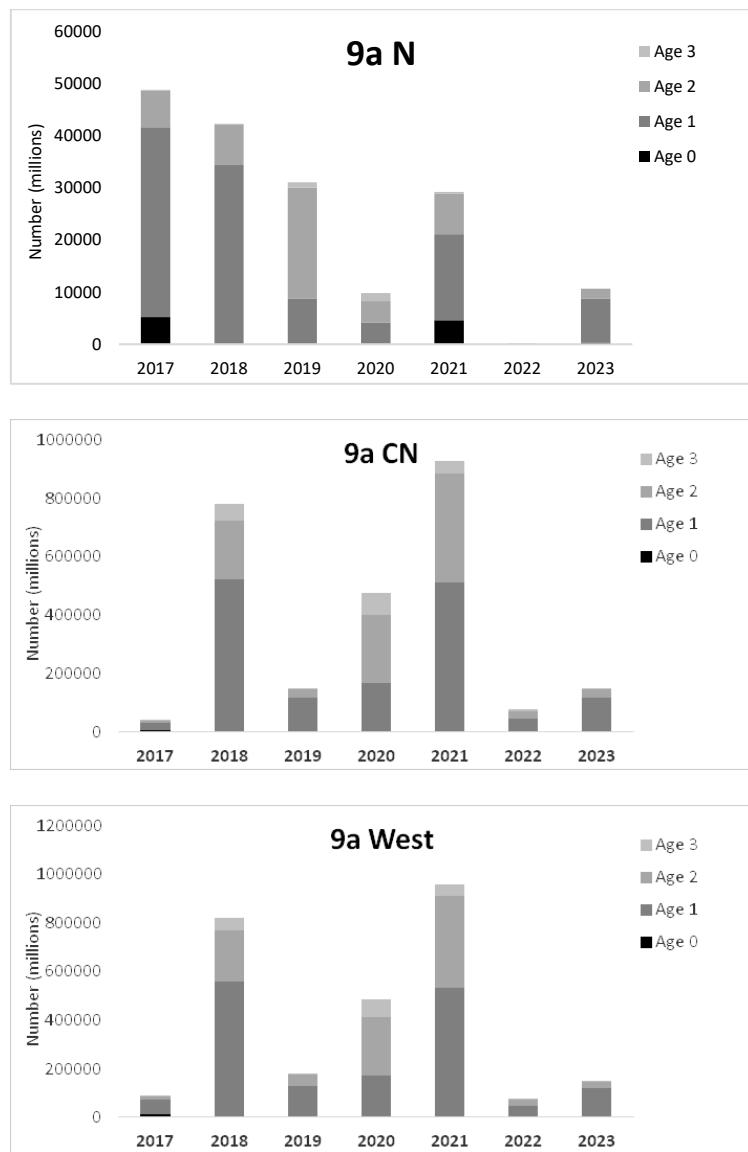


Figure A7.3.5.2.1. Anchovy in Division 9.a. Western component. Subdivisions 9.a North and 9.a Central North. Spanish and Portuguese fisheries (all métiers). Age composition in Spanish catches of SW Galician anchovy (9.a North) and Portuguese catches of anchovy from northern Portugal (9.a Central North) (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).

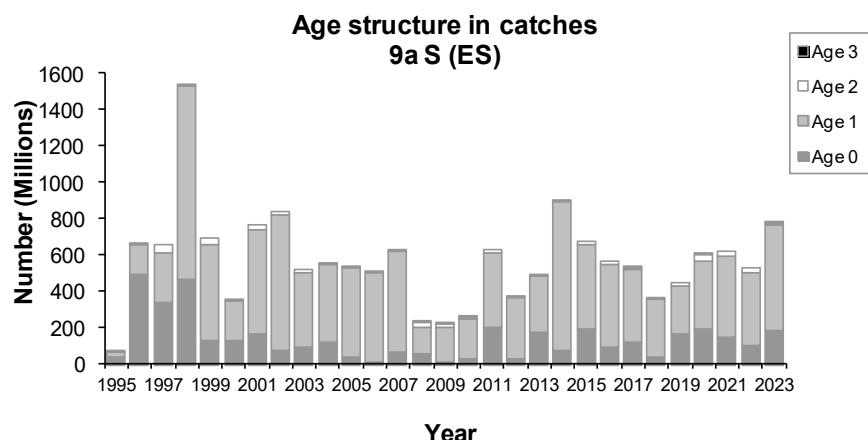
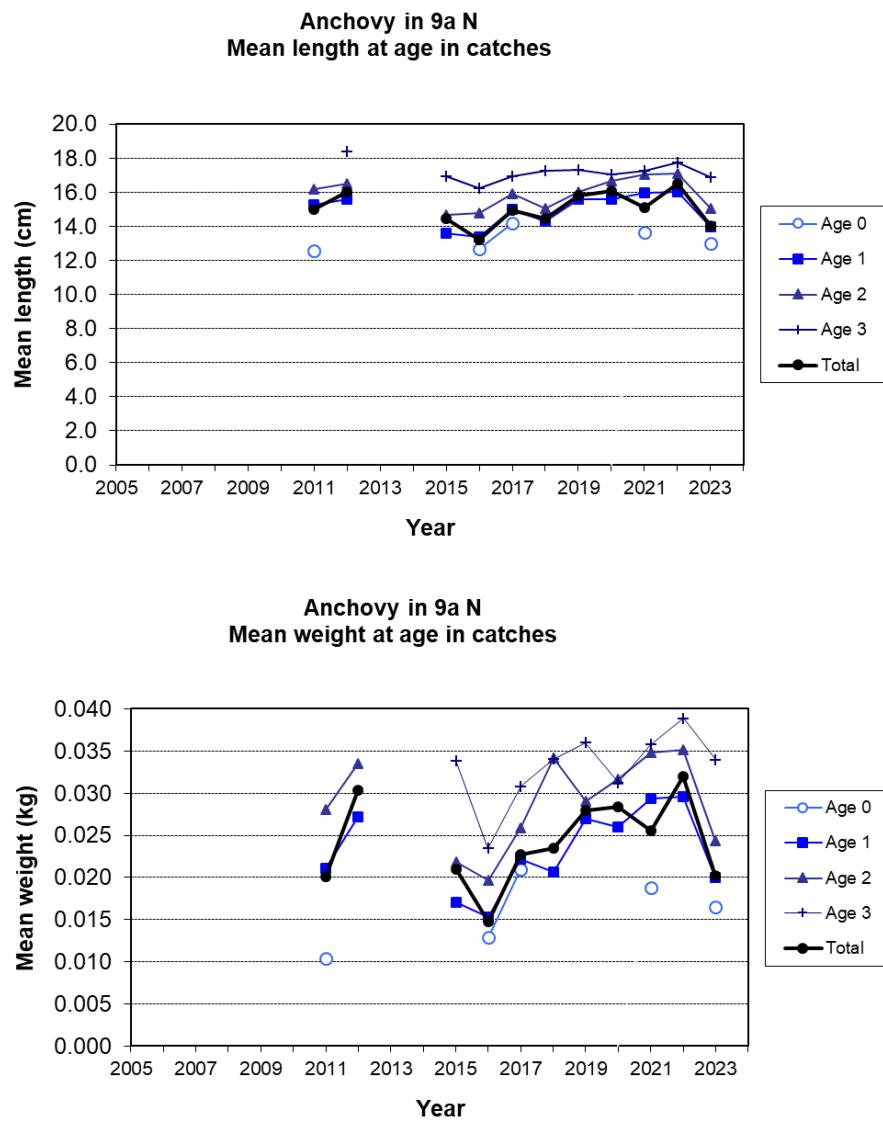


Figure A7.3.5.2.3. Anchovy in Division 9.a. Southern component. Subdivision 9.a-South. Spanish fishery (all métiers). Age composition in Spanish catches of Gulf of Cadiz anchovy (1995–2023). Discards are considered either very low or even negligible in this fishery, but since 2014 on estimates include the available discarded catches (see Section 4.3.3).



d

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).

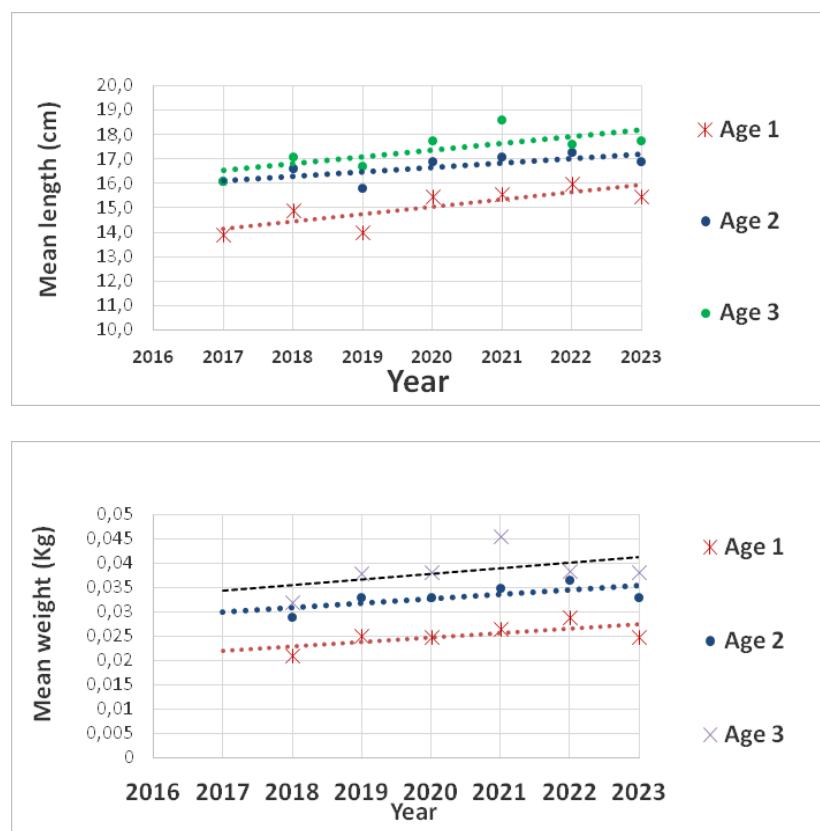


Figure A7.3.6.2. Anchovy in Division 9.a. Western component. Subdivision 9.a Central North. Portuguese fishery (all métiers). Annual mean length (TL, in cm) and weight (kg) at-age in the Portuguese catches of Western anchovy (2017 to 2023). Data for 2021 and 2022 are only available for the 3rd and 4th Quarters (represent 95% catches in 2021 and 70% catches in 2022).

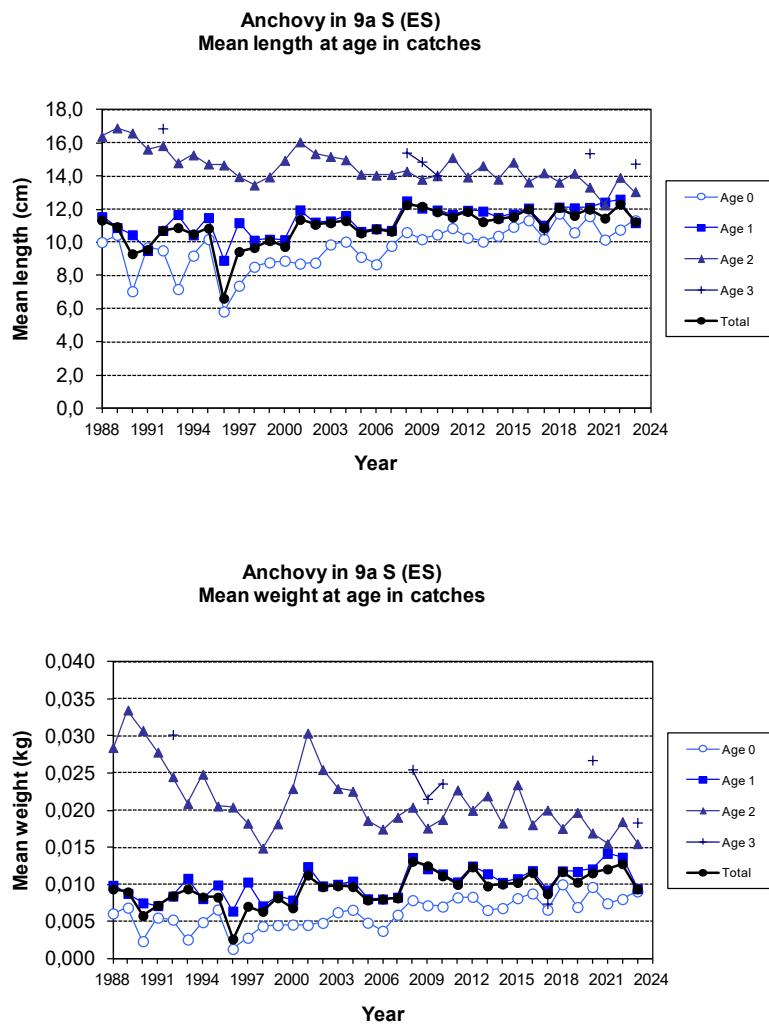


Figure A7.3.6.3. Anchovy in Division 9.a. Southern component. Subdivision 9.a-South. Spanish fishery (all métiers). Annual mean length (TL, in cm) and weight (kg) at-age in the Spanish catches of Gulf of Cadiz anchovy (1988–2023).

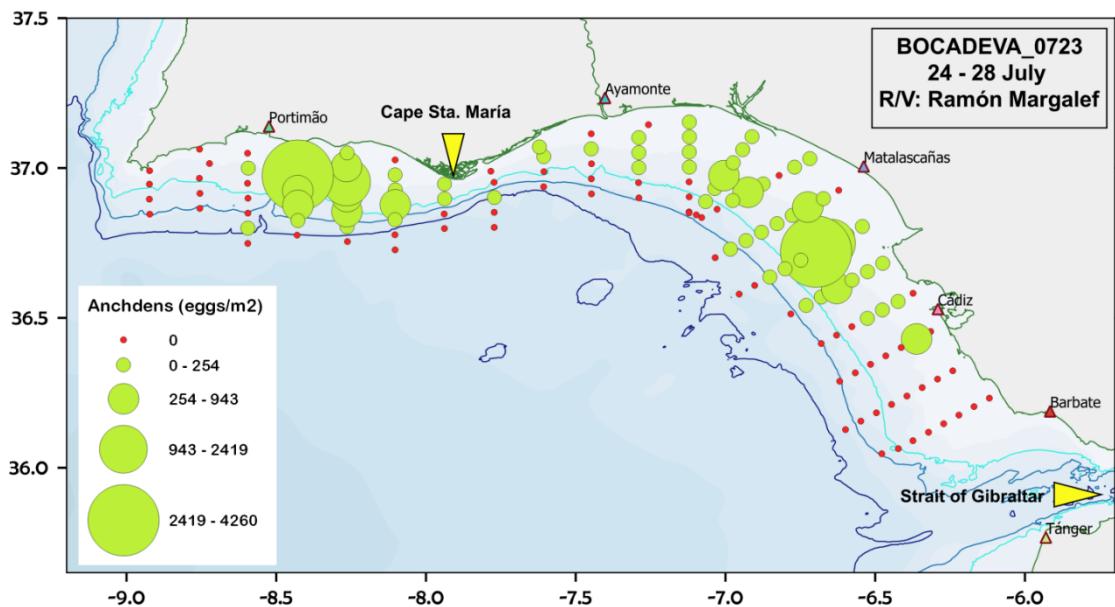


Figure A7.4.1.1. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. BOCADEVA 0723 survey (summer Spanish anchovy DEPM survey in Subdivision 9.a South in 2023). Mapping of anchovy eggs density (eggs/m²) sampled by PairoVET..

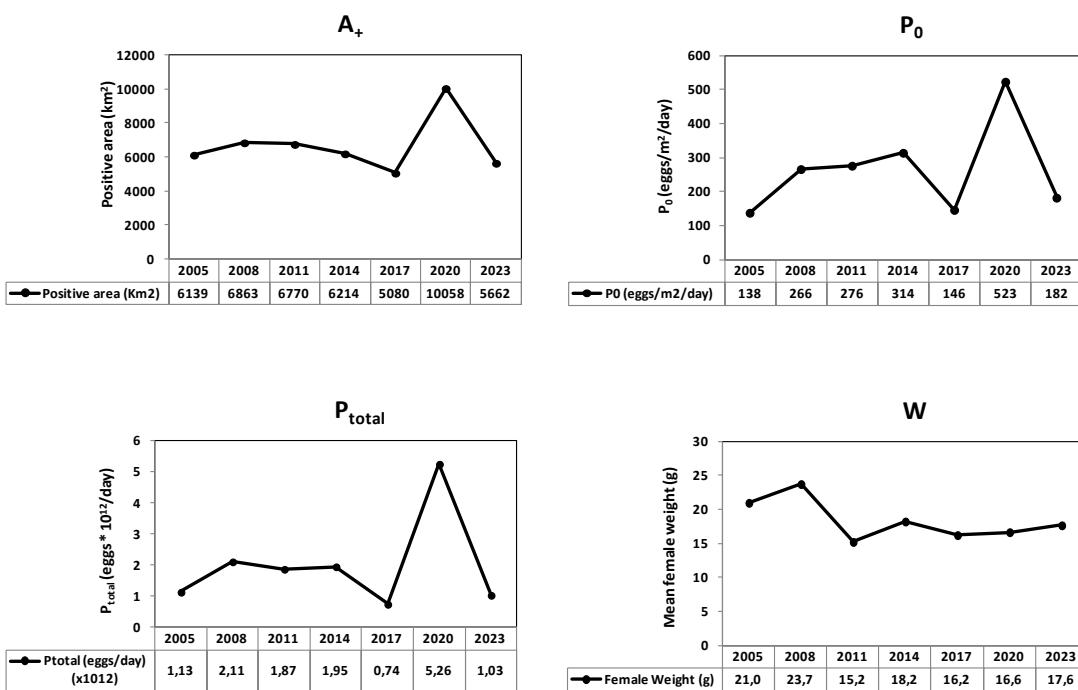


Figure A7.4.1.2. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. BOCADEVA survey series (summer Spanish anchovy DEPM survey in Subdivision 9.a South). Time-series of eggs and adult parameters estimates. A+ (positive area, in km²), P₀ (daily egg production, in eggs/m²/day), P_{total} (total egg production, in eggs 10¹²/day), W (mean female weight, in g).

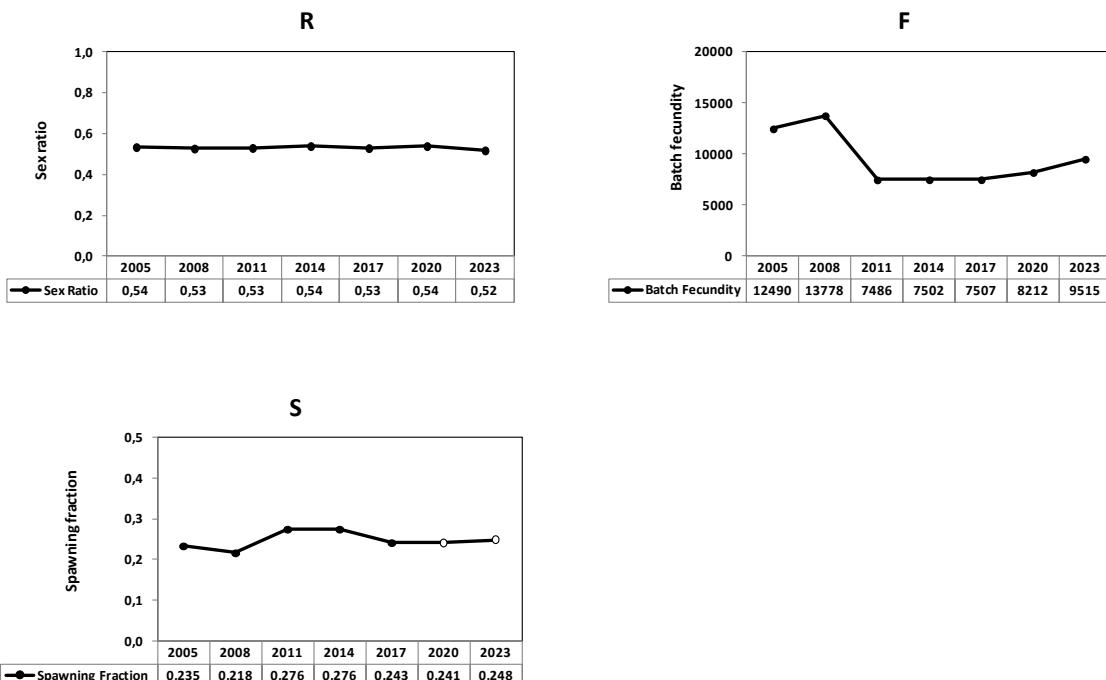


Figure A7.4.1.2. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. BOCADEVA survey series (summer Spanish anchovy DEPM survey in Subdivision 9.a South). Time-series of eggs and adult parameters estimates. Cont'd. R (sex ratio), F (individual batch fecundity), S (spawning fraction; the 2020 and 2023 estimates are provisionally computed as the time-series average value).

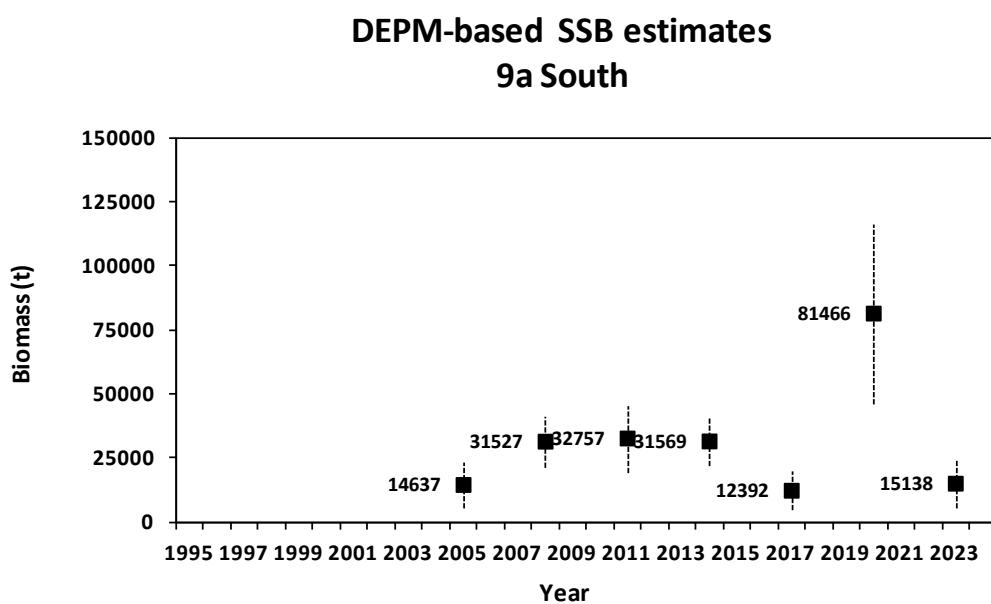


Figure A7.4.1.3. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. BOCADEVA survey series (summer Spanish anchovy DEPM survey in Subdivision 9.a South). Series of SSB estimates (\pm SD) obtained from the survey series.

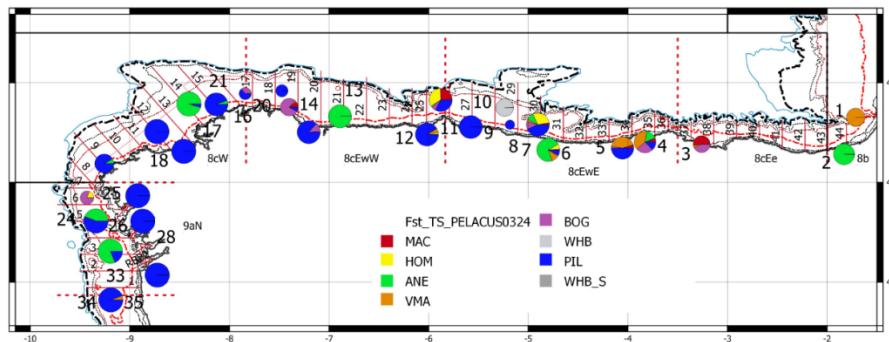


Figure A7.4.2.1. Anchovy in Division 9.a. Western component. Subdivision 9.a North. PELACUS 0424 survey (spring Spanish acoustic survey in Sub-division 9.a North and Sub-area 8c in 2024). Location of valid fishing stations with indication of their species composition (percentages in number).

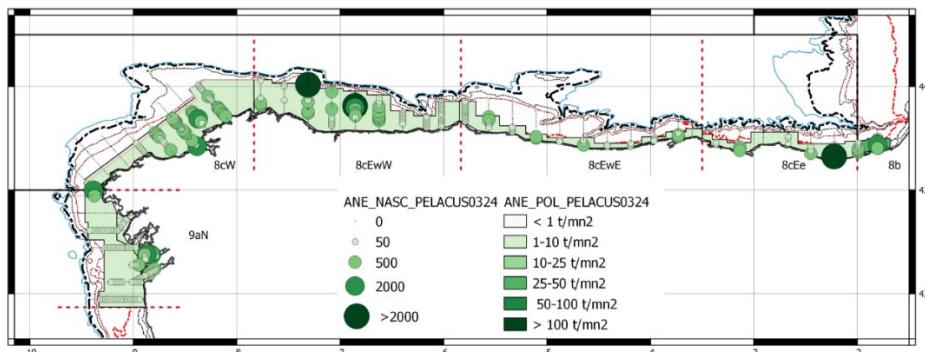


Figure A7.4.2.2. Anchovy in Division 9.a. Western component. Subdivision 9.a North. PELACUS 0424 survey (spring Spanish acoustic survey in Sub-division 9.a North and Sub-area 8c in 2024). Spatial distribution of energy allocated to anchovy (NASC coefficients in m^2/mn^2).

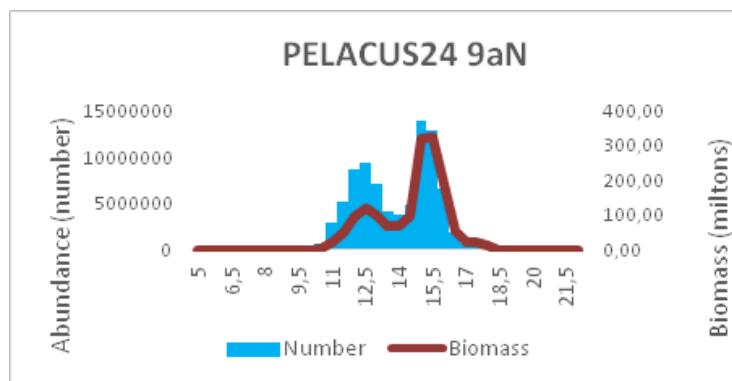


Figure A7.4.2.3. Anchovy in Division 9.a. Western component. Subdivision 9.a North. PELACUS 0424 survey (spring Spanish acoustic survey in Sub-division 9.a North and Sub-area 8c in 2024). Estimated abundances and biomasses (number of fish and thousand tonnes, respectively) in Sub-division 9.a North by length class (cm). Note the different scales in the y axis.

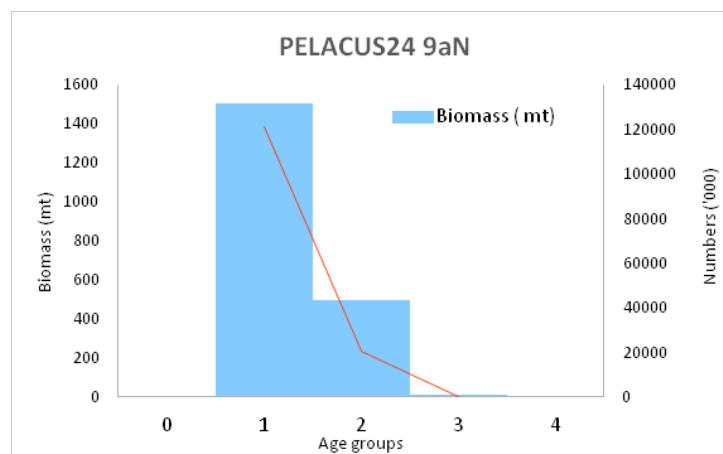


Figure A7.4.2.4. Anchovy in Division 9.a. Western component. Subdivision 9.a North. PELACUS 0424 survey (spring Spanish acoustic survey in Sub-division 9.a North and Sub-area 8c in 2024). Estimated abundances and biomasses (number of fish in thousands and tonnes, respectively) in Sub-division 9.a North by age group. Note the different scales in the y axis.

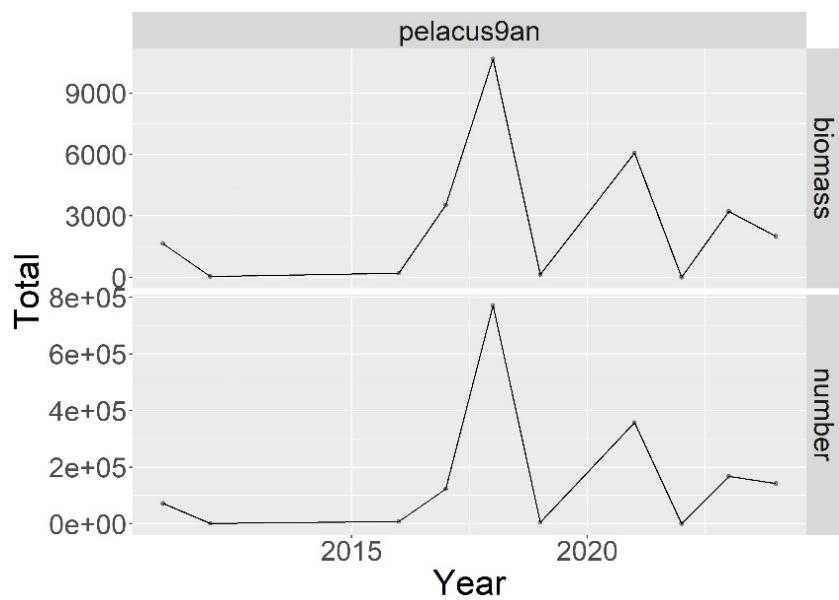


Figure A7.4.2.5. Anchovy in Division 9.a. Western component. Subdivision 9.a North. PELACUS survey series (spring Spanish acoustic survey in Subdivision 9.a North and Subarea 8c). Historical series of acoustic estimates of anchovy abundance and biomass (t) in the Subdivision 9.a North.

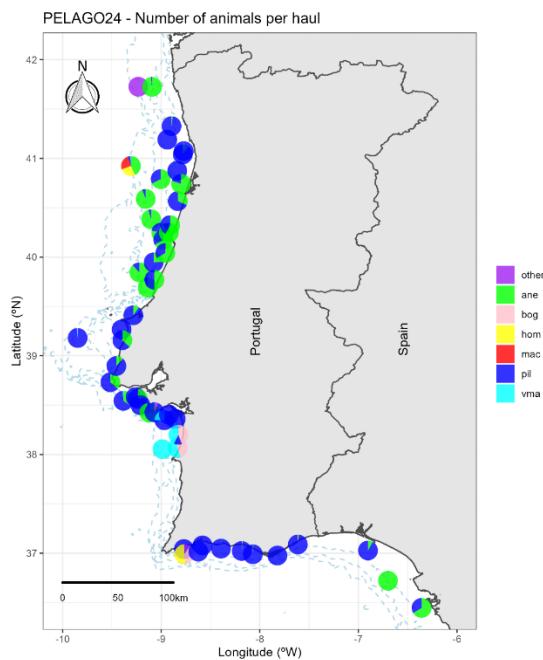


Figure A7.4.2.3. Anchovy in Division 9.a. Western and Southern components. Subdivisions 9.a Central-North to 9.a South. PELAGO survey series (spring Portuguese acoustic survey in Subdivisions 9.a Central-North to 9.a South). PELAGO 24 survey. Location of valid fishing stations with indication of their species composition (percentages in number).

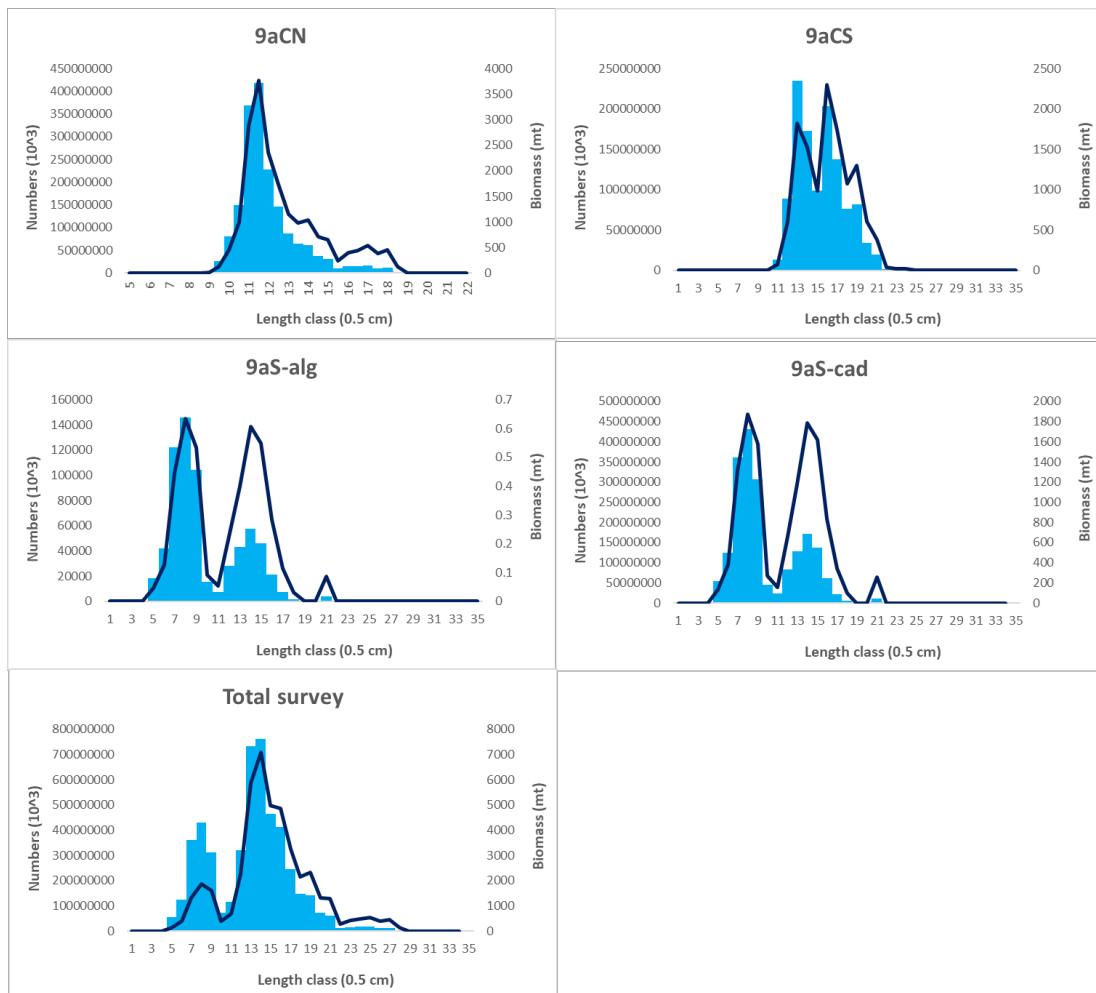


Figure A7.4.2.4. Anchovy in Division 9.a. Western and Southern components. Sub-divisions 9.a Central-North to 9.a South. PELAGO survey series (spring Portuguese acoustic survey in Sub-divisions 9.a Central-North to 9.a South). PELAGO 24 survey. Estimated abundances and biomasses (number of fish in thousands and tonnes, respectively) for the surveyed area by length class (cm). Note the different scales in the y axis.

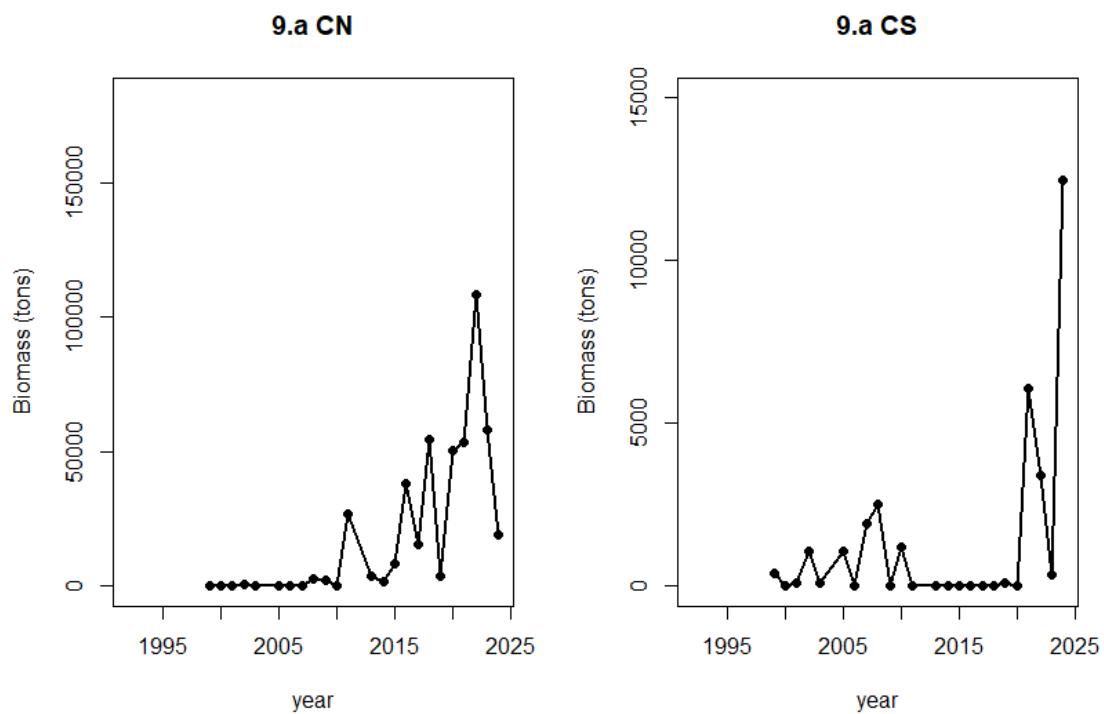


Figure A7.4.2.5. Anchovy in Division 9.a. Western and Southern components. Subdivisions 9.a Central-North to 9.a South. PELAGO survey series (spring Portuguese acoustic survey in Subdivisions 9.a Central-North to 9.a South). Historical series of regional acoustic estimates of anchovy biomass (t). Note the different scale of the y-axis.

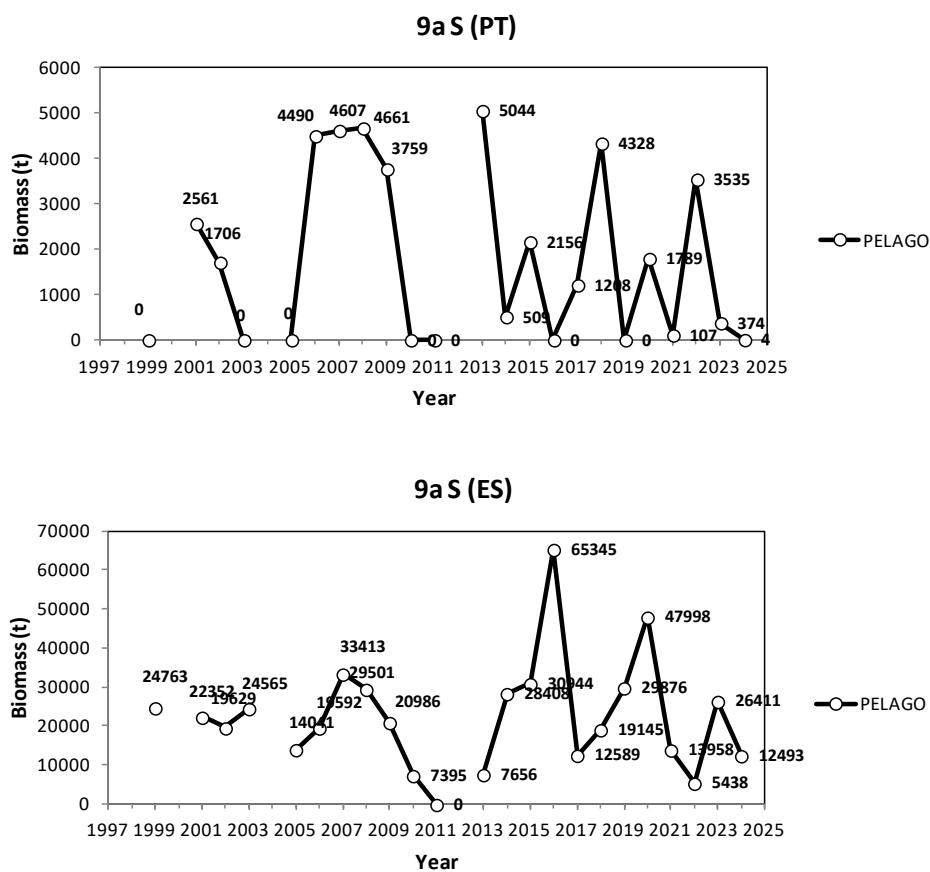


Figure A7.4.2.5. Continued. Acoustic estimates in the 9.a South differentiated by Portuguese (PT) and Spanish waters of the Gulf of Cadiz (ES). Note the different scale of the y-axis. Although estimates from Subdivision 9.a South in 2010 and 2014 were not separately provided for Algarve and Cadiz to 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.

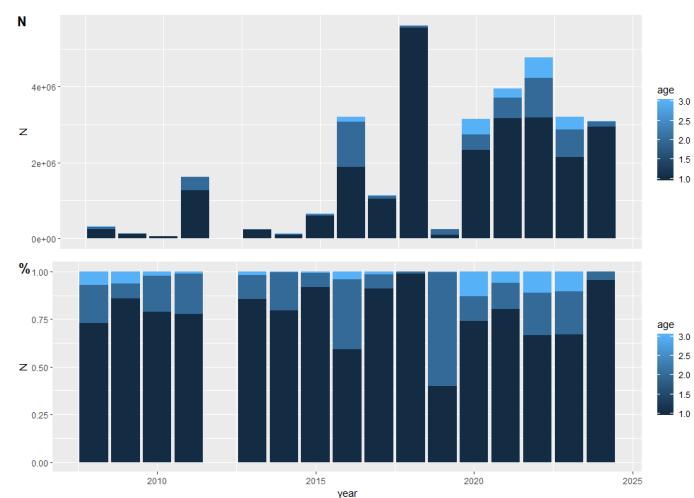


Figure A7.4.2.6. Anchovy in Division 9.a. Western component. Subdivisions 9.a North to Central-South. Annual trends of the estimated population by age class from the *PELACUS* (9a North) + *PELAGO* (9a Central-North and Central-South) Spring acoustic surveys, number of individuals per age (upper panel) and percentage by number (lower panel). Age composition for 2020 only derived from the *PELAGO* survey given the *PELACUS* was not carried out.

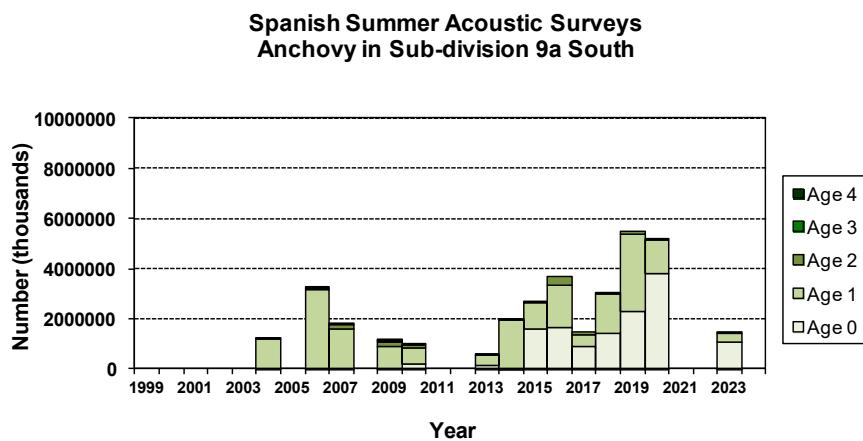
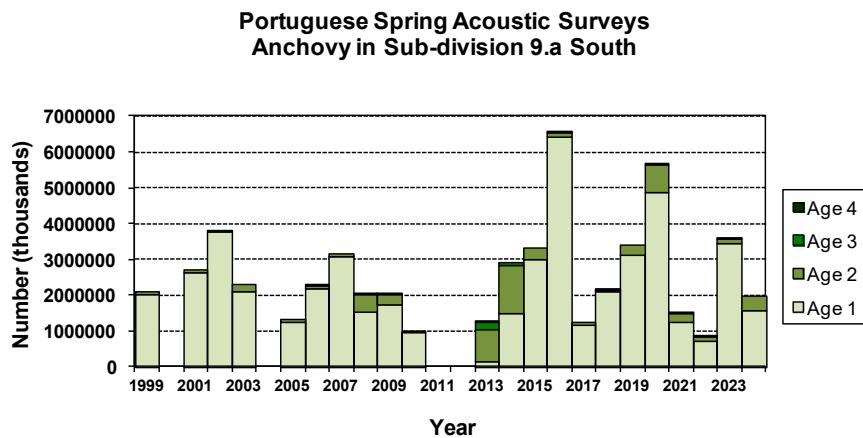


Figure A7.4.2.7. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. Annual trends of the estimated population by age class from the Algarve + Gulf of Cadiz areas by the *PELAGO* Portuguese Spring (upper plot) and *ECOCADIZ* Spanish summer (lower plot) acoustic surveys (*ECOCADIZ* surveys 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.

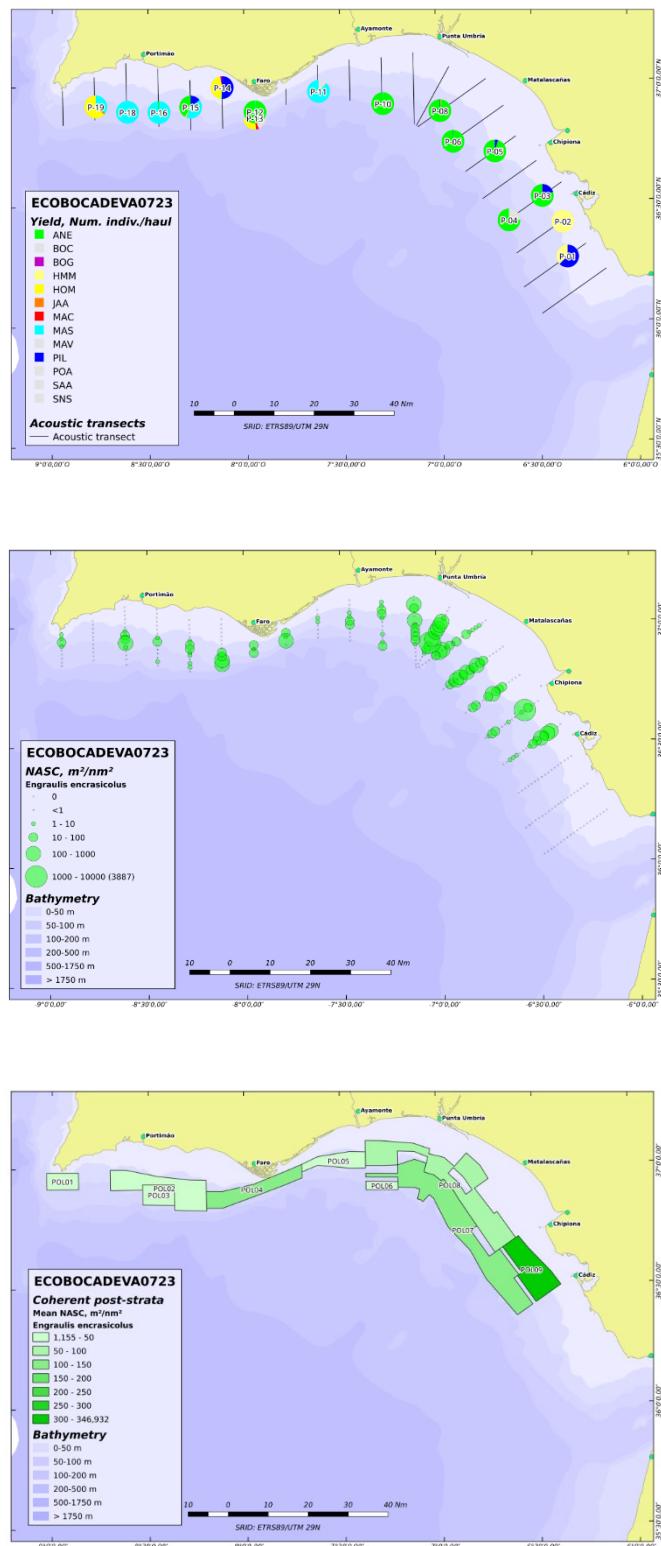


Figure A7.4.2.8. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. ECOCADIZ 2023-07 survey (summer Spanish acoustic survey in Subdivision 9.a South). Top: Location of valid fishing stations with indication of their species composition (percentages in number). Middle: Distribution of the backscattering energy (Nautical area scattering coefficient, NASC, in $m^2 nmi^{-2}$) 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.

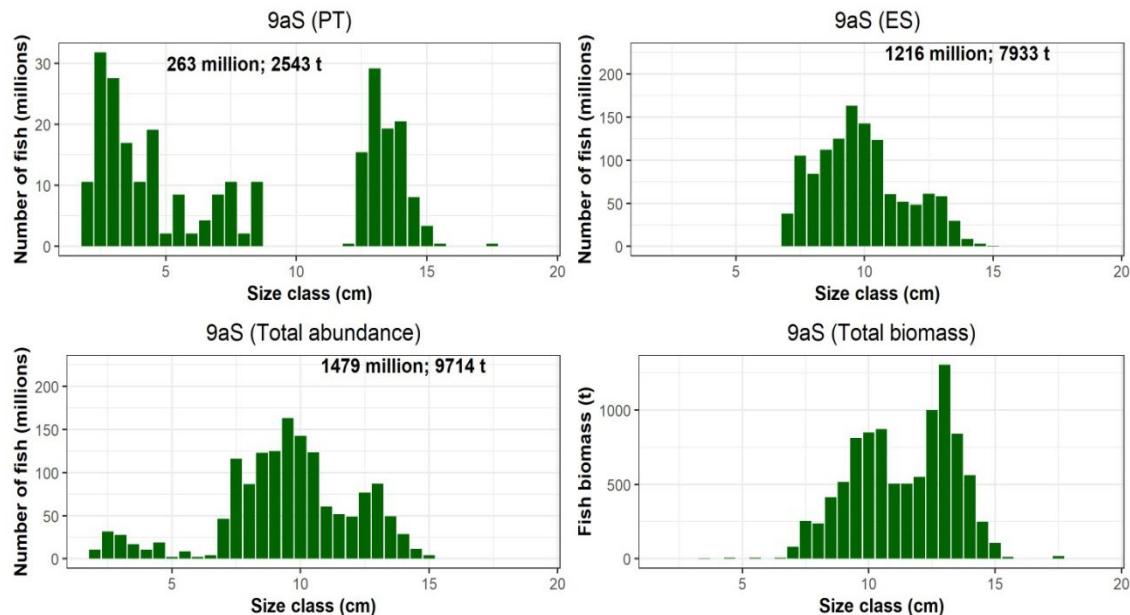


Figure A7.4.2.9. Anchovy in Division 9.a. Southern component. Sub-division 9.a South. ECOCADIZ 2023-07 survey (summer Spanish acoustic survey in Subdivision 9.a South). Estimated abundances and biomasses (number of fish in millions and tonnes, respectively) for the surveyed area by length class (cm). Note the different scales in the y-axis.

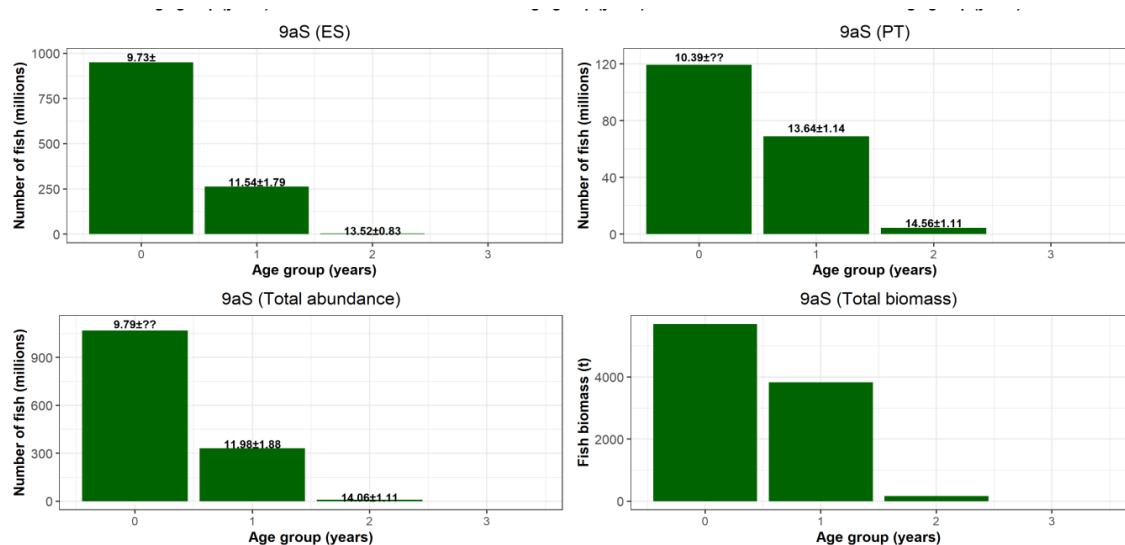


Figure A7.4.2.10. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. ECOCADIZ 2023-07 survey (summer Spanish acoustic survey in Subdivision 9.a South). Estimated abundances and biomasses (number of fish in millions and tonnes, respectively) for the surveyed area by age group, with indication of the mean size by age. Note the different scales in the y-axis.

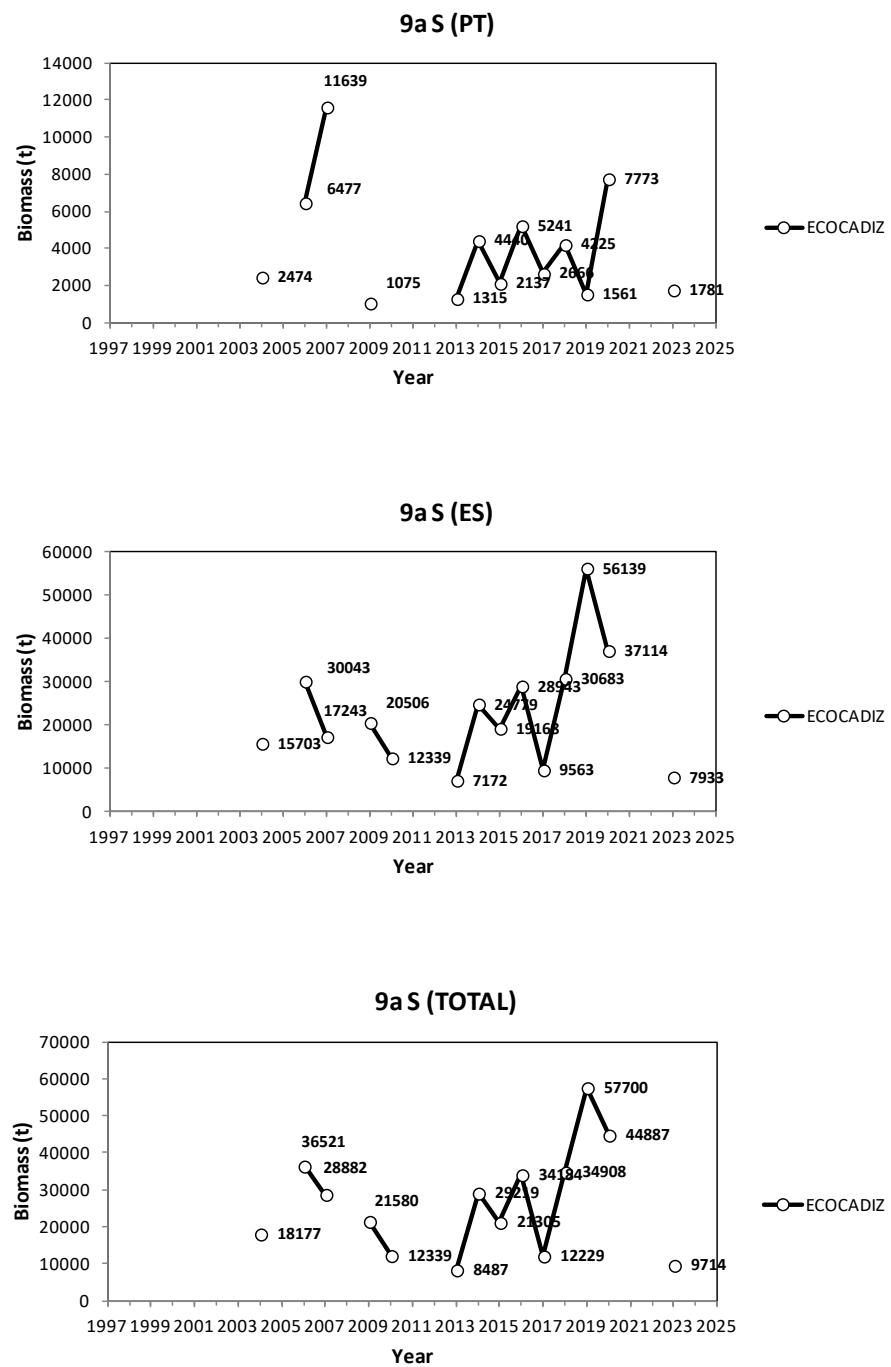


Figure A7.4.2.11. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. ECOCADIZ survey series (summer Spanish acoustic survey in Subdivision 9.a South). Historical series of overall and regional (Portuguese, PT, and Spanish waters of the Gulf of Cadiz, ES) acoustic estimates of anchovy biomass (t). Note the different scale of the y-axis. ECOCADIZ 2021 and 2022 were not finally conducted.

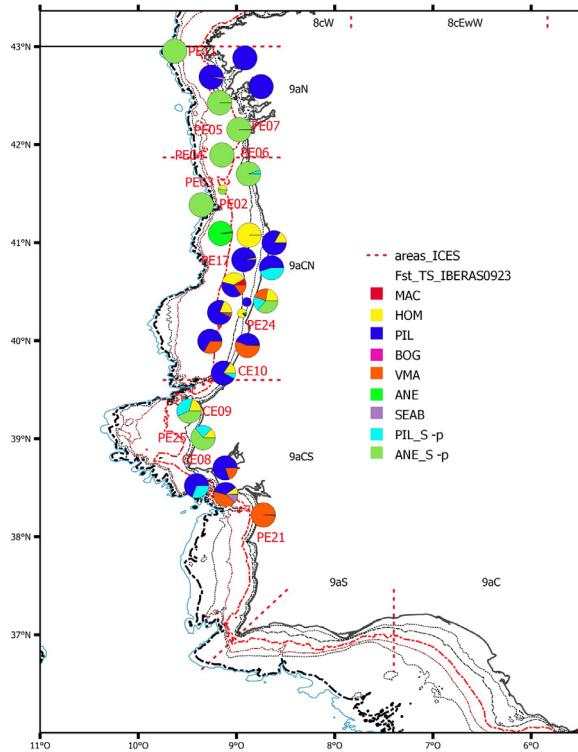


Figure A7.4.3.1. Anchovy in Division 9.a. Western component. Subdivisions 9.aNorth, 9.a Central-North and 9.a Central-South. IBERAS 0923 survey (autumn Spanish-Portuguese acoustic survey in Subdivisions 9.aNorth to Central-South). Location of valid fishing stations with indication of their species composition (percentages in number).

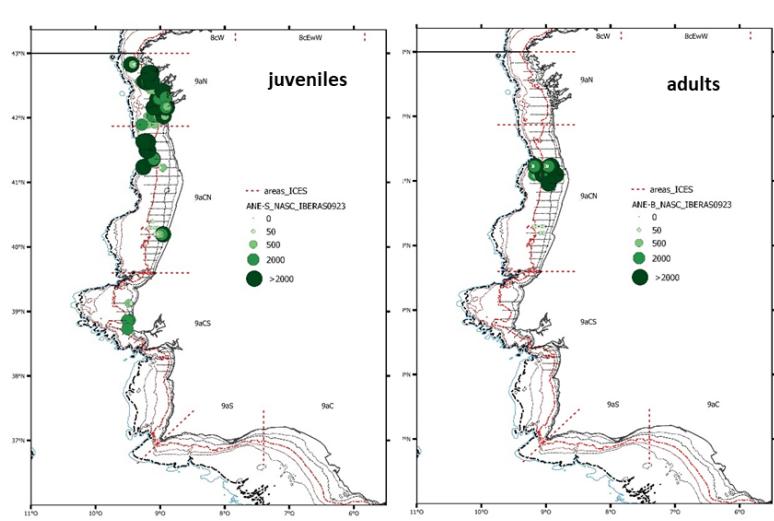


Figure A7.4.3.2. Anchovy in Division 9.a. Western component. Subdivisions 9.a North, 9.a Central-North and 9.a Central-South. IBERAS 0923 survey (autumn Spanish-Portuguese acoustic survey in Subdivisions 9.a North to Central-South). Distribution of the backscattering energy (Nautical area scattering coefficient, NASC, in $\text{m}^2 \text{nmi}^{-2}$) attributed to the species. Left: juveniles ($\leq 12.0\text{cm}$); right: adults ($>12.0\text{cm}$).

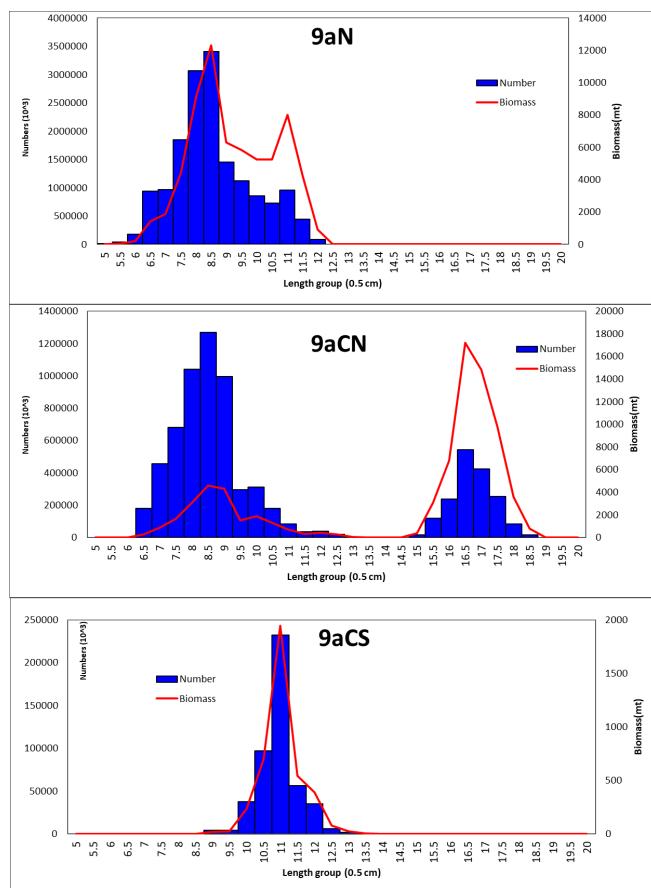


Figure A7.4.3.3. Anchovy in Division 9.a. Western component. Subdivisions 9.aNorth, 9.a Central-North and 9.a Central-South. IBERAS 0923 survey (autumn Spanish-Portuguese acoustic survey in Subdivisions 9.a North to Central-South). Estimated abundances and biomasses (number of fish in thousands and tonnes, respectively) for the surveyed area by length class (cm). Note the different scales in the y-axis.

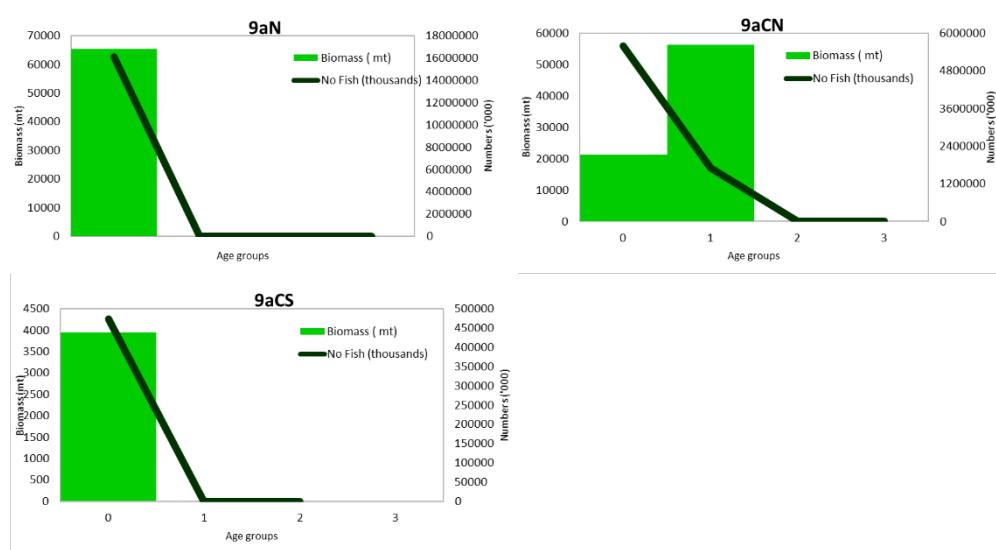


Figure A7.4.3.4. Anchovy in Division 9.a. Western component. Subdivisions 9.a North, 9.a Central-North and 9.a Central-South. IBERAS 0923 survey (autumn Spanish-Portuguese acoustic survey in Subdivisions 9.a North to Central-South). Estimated abundances and biomasses (number of fish in thousands and 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.

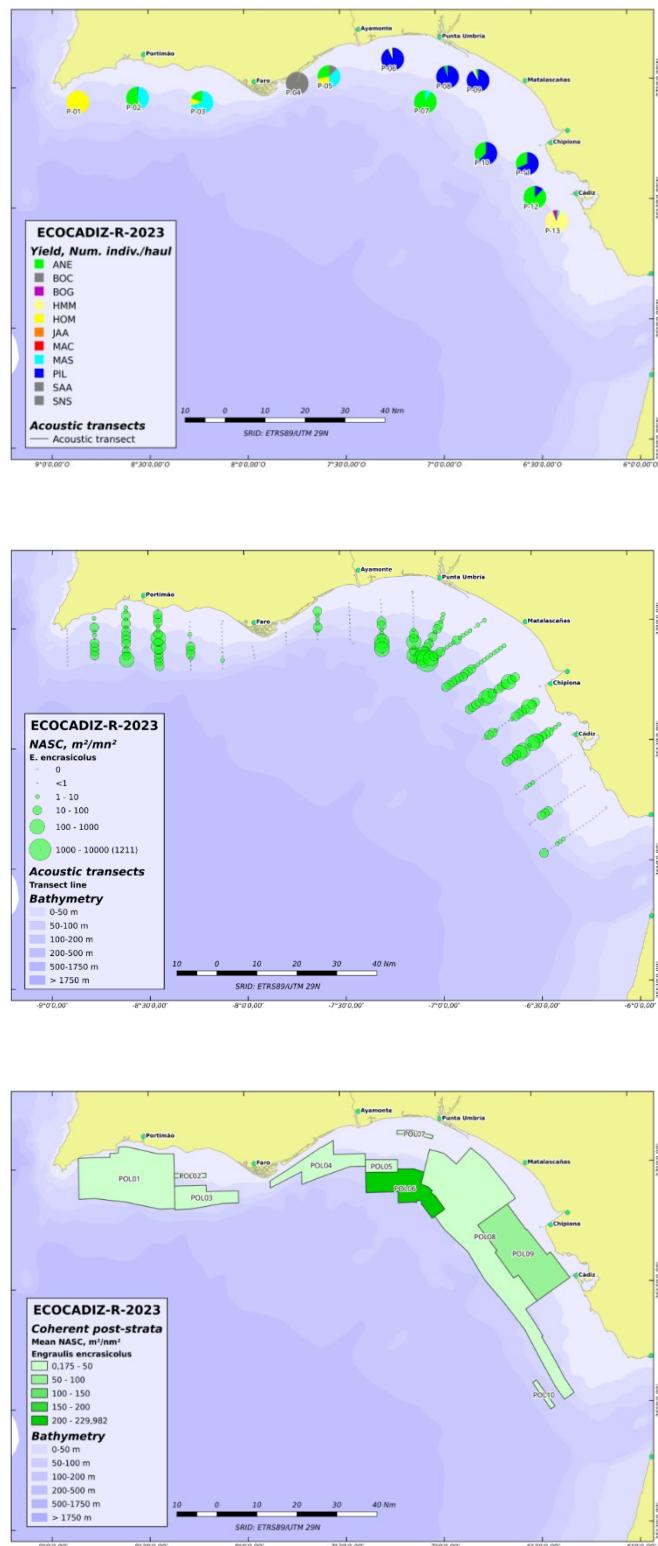


Figure A7.4.3.5. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. ECOCADIZ-RECLUTAS 2023-10 survey (autumn Spanish acoustic survey in Subdivision 9.a South). Top: Location of valid fishing stations with indication of their species composition (percentages in number). Middle: Distribution of the backscattering energy (Nautical area scattering coefficient, NASC, in $\text{m}^2 \text{nmi}^{-2}$) 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.

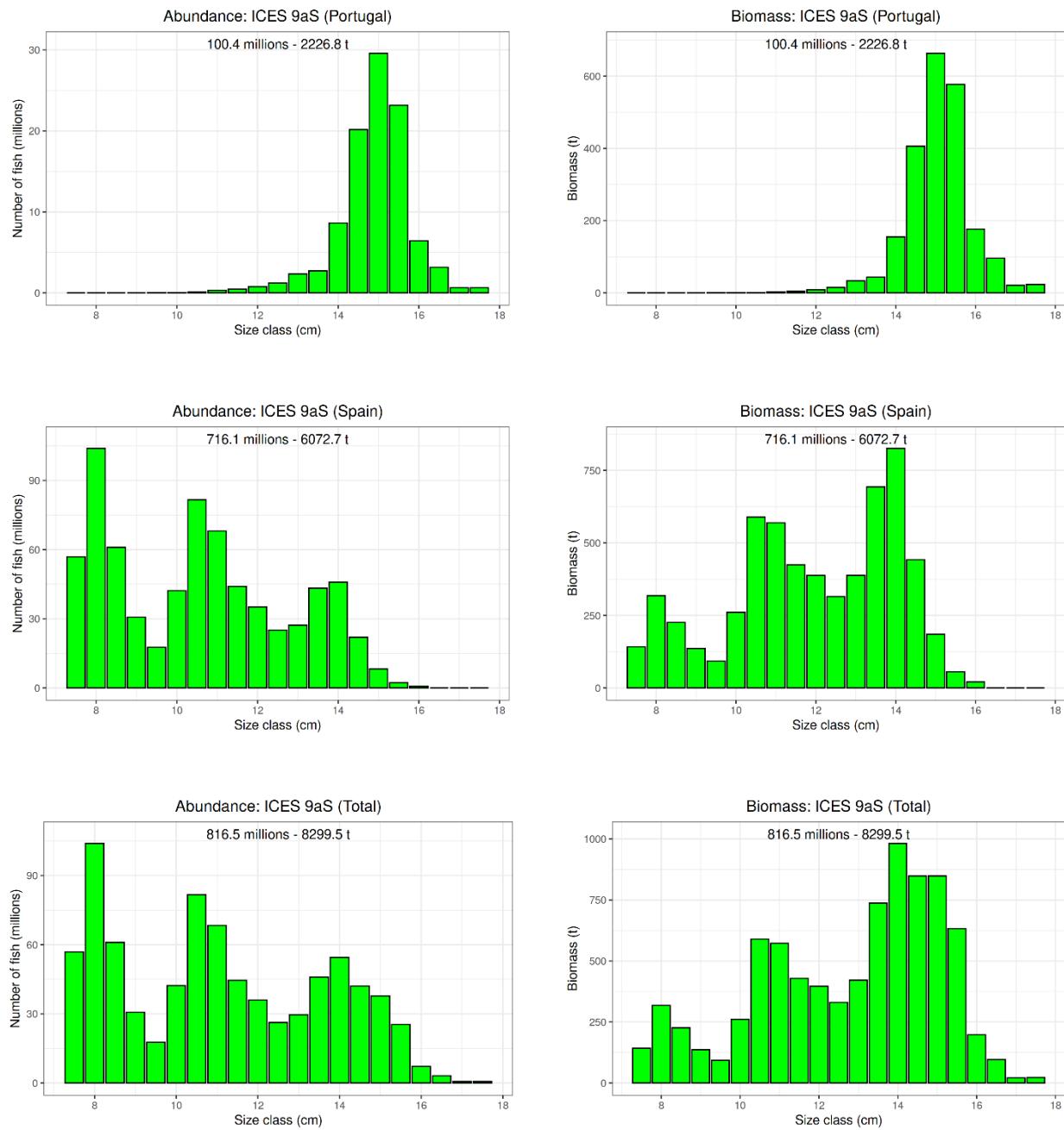


Figure A7.4.3.6. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. ECOCADIZ-RECLUTAS 2023-10 survey (autumn Spanish acoustic survey in Subdivision 9.a South). Estimated abundances and biomasses (number of fish in millions and tonnes, respectively) for the surveyed area by length class (cm). Note the different scales in the y-axis.

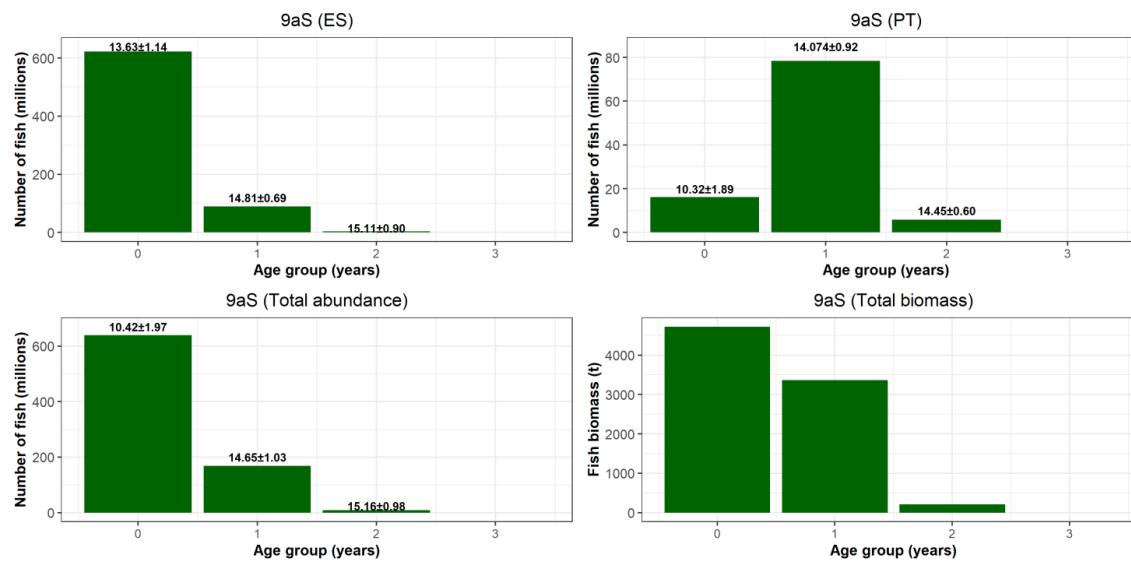


Figure A7.4.3.7. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. ECOCADIZ-RECLUTAS 2023-10 survey (autumn Spanish acoustic survey in Subdivision 9.a South). Estimated abundances and biomasses (number of fish in millions and tonnes, respectively) for the surveyed area by age group, with indication of the mean size by age. Note the different scales in the y-axis.

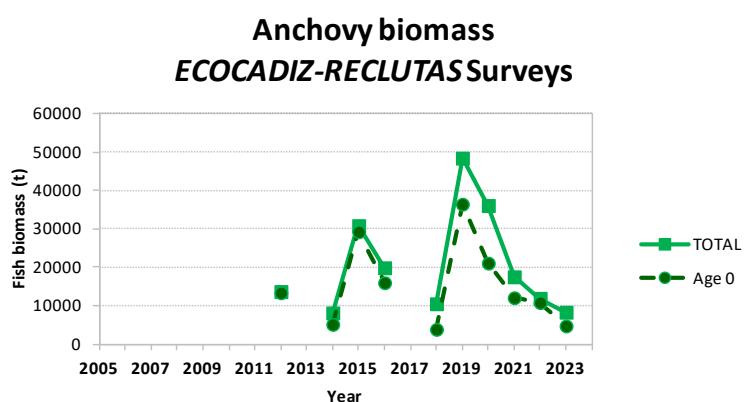
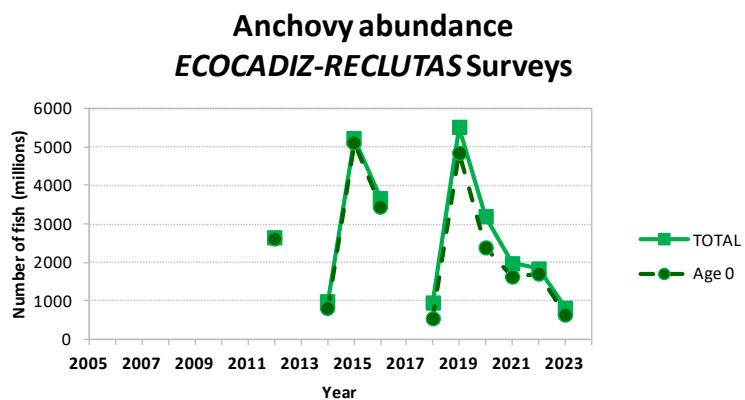
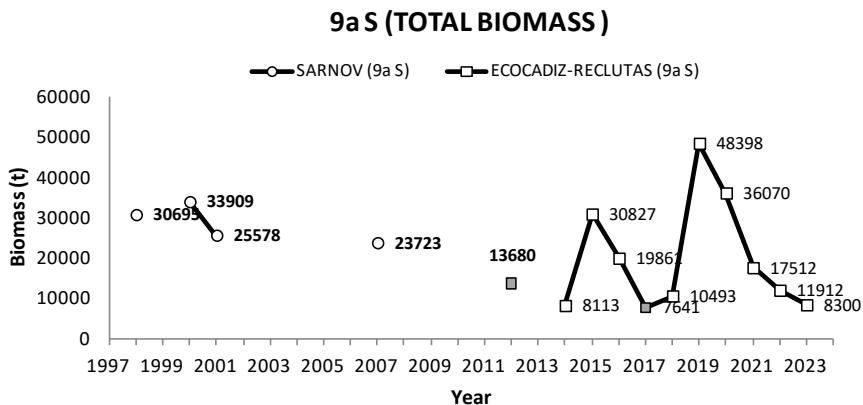


Figure A7.4.3.8. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. ECOCADIZ-RECLUTAS survey series (autumn Spanish acoustic survey in Subdivision 9.a South). Top: historical series of overall acoustic estimates of anchovy biomass (t), (squares). The estimates from the older Portuguese 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.

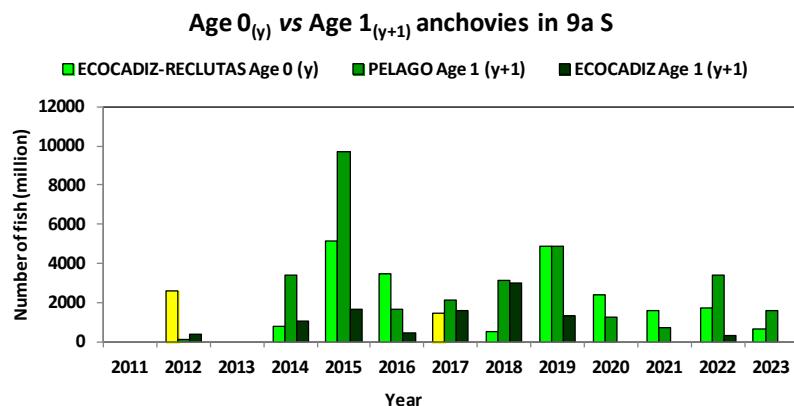


Figure A7.4.3.9. Anchovy in Division 9.a. Southern component. Subdivision 9.a South. ECOCADIZ-RECLUTAS survey series (autumn Spanish acoustic survey in Subdivision 9.a South). Correspondence between acoustic estimates of abundance of Age 0 anchovies from ECOCADIZ-RECLUTAS surveys in the autumn of the 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.

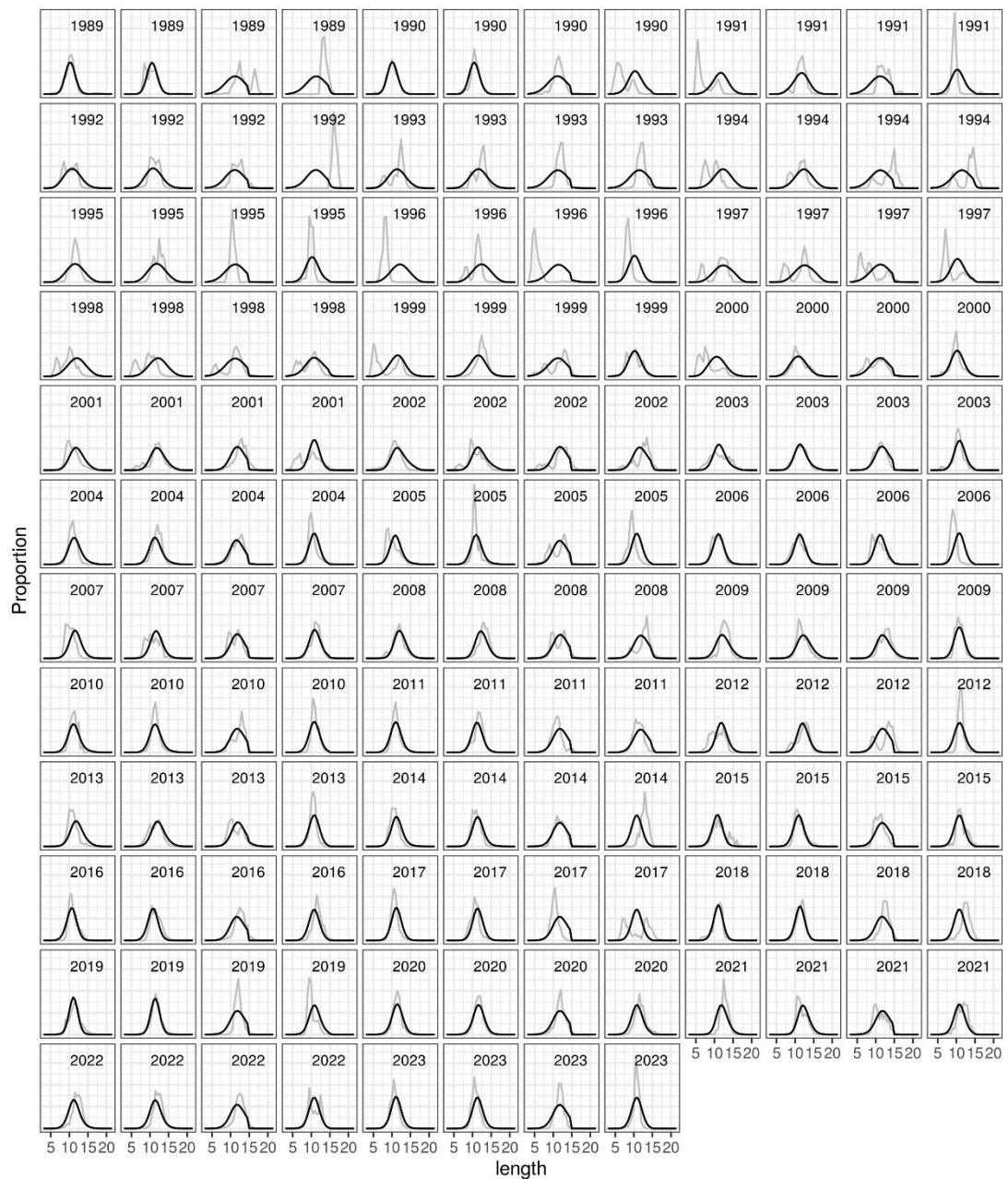


Figure A7.6.2.1.2.1. Anchovy in Division 9.a. Southern component. Comparison between observed and estimated catches length distribution by quarters from 1989 to 2023. Black lines represent estimated data while gray lines represent observed data.

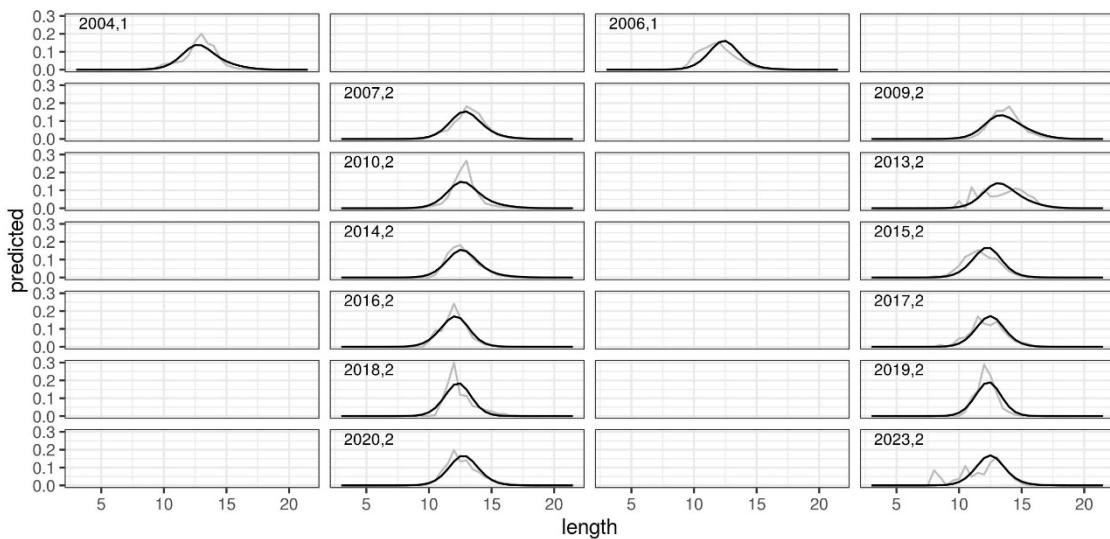


Figure A7.6.2.1.2.2. Anchovy in Division 9.a. Southern component. Comparison between observed and estimated catches length distribution for ECOCADIZ survey from 2004 to 2023. Black lines represent estimated data while gray lines represent observed data. The number next to the year indicates the quarter. 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.

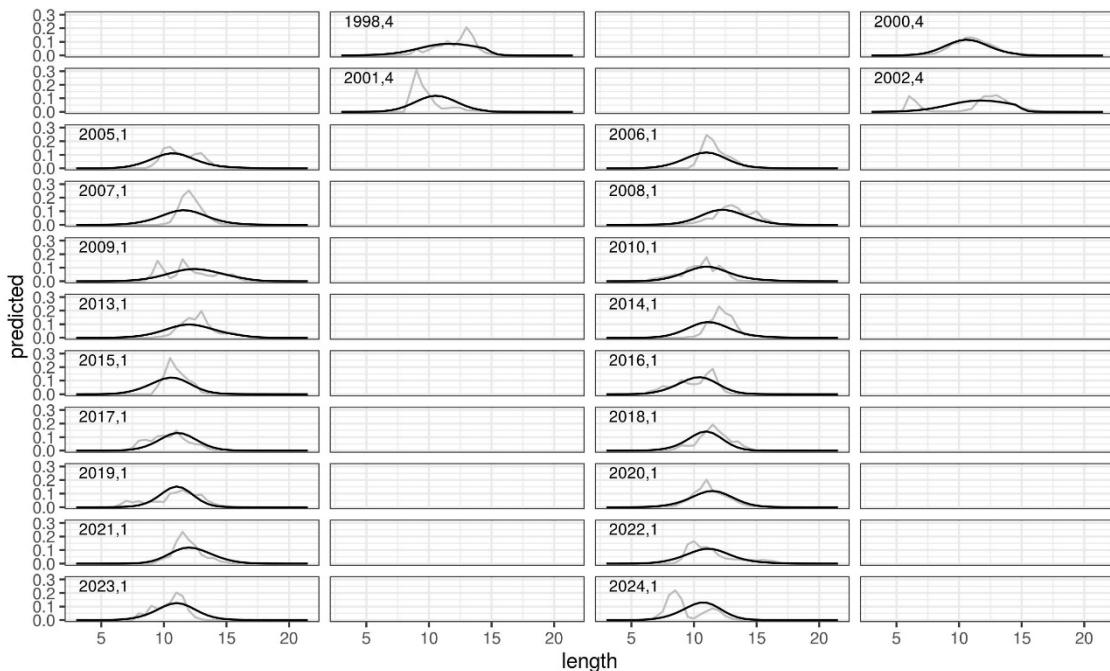


Figure A7.6.2.1.2.3. Anchovy in Division 9.a. Southern component. Comparison between observed and estimated catches length distribution for PELAGO survey from 1998 to 2024. Black lines represent estimated data while gray lines represent observed data. The number next to the year indicates the quarter. 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.

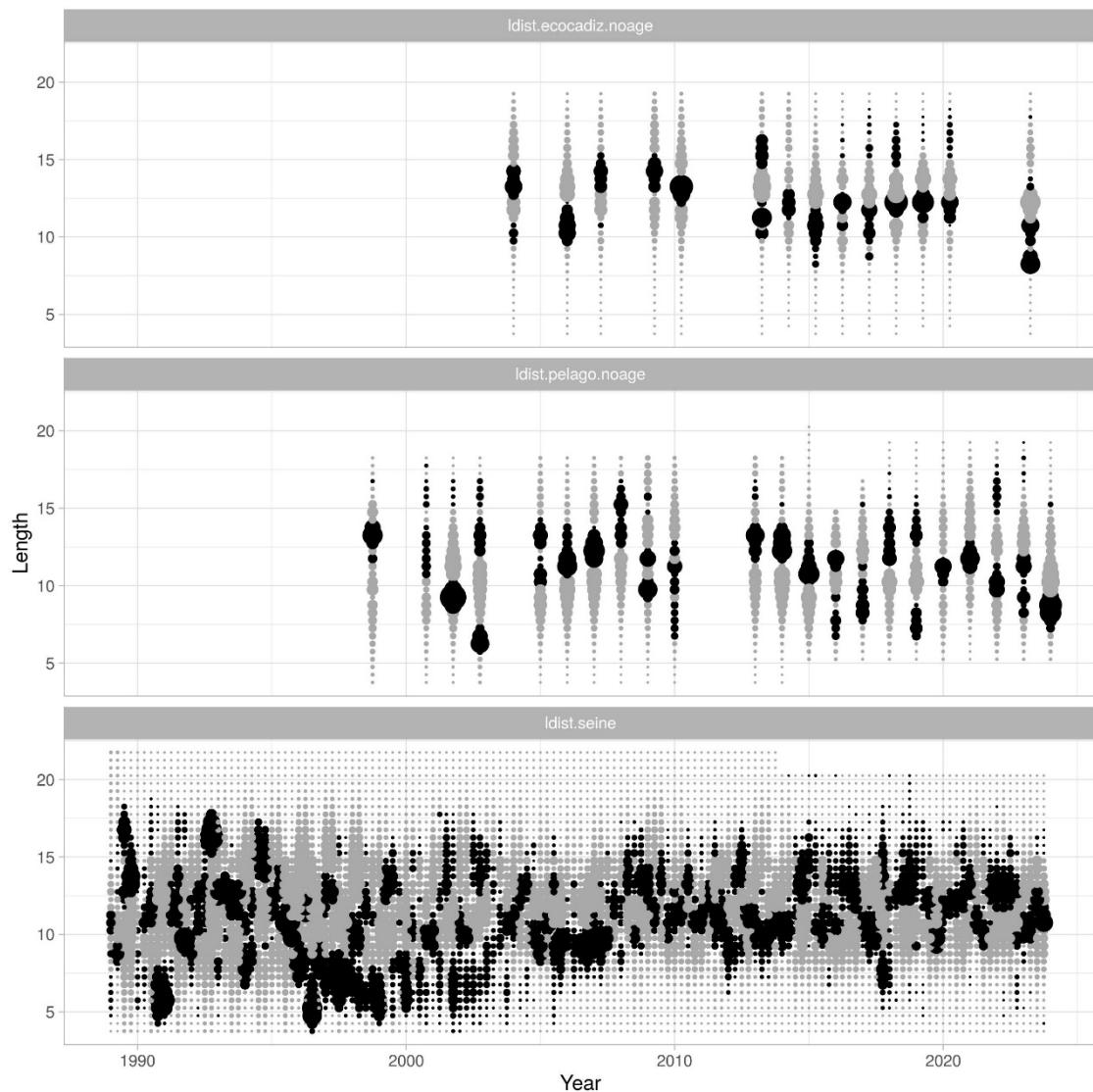


Figure A7.6.2.1.2.4. Anchovy in Division 9.a. Southern component. Standardised residual plots for the fitted length distribution from the ECOCADIZ survey, PELAGO survey and commercial fleet. Black points denote a model underestimate and grey points an overestimate. The size of the points denotes the scale of the standardised residual.

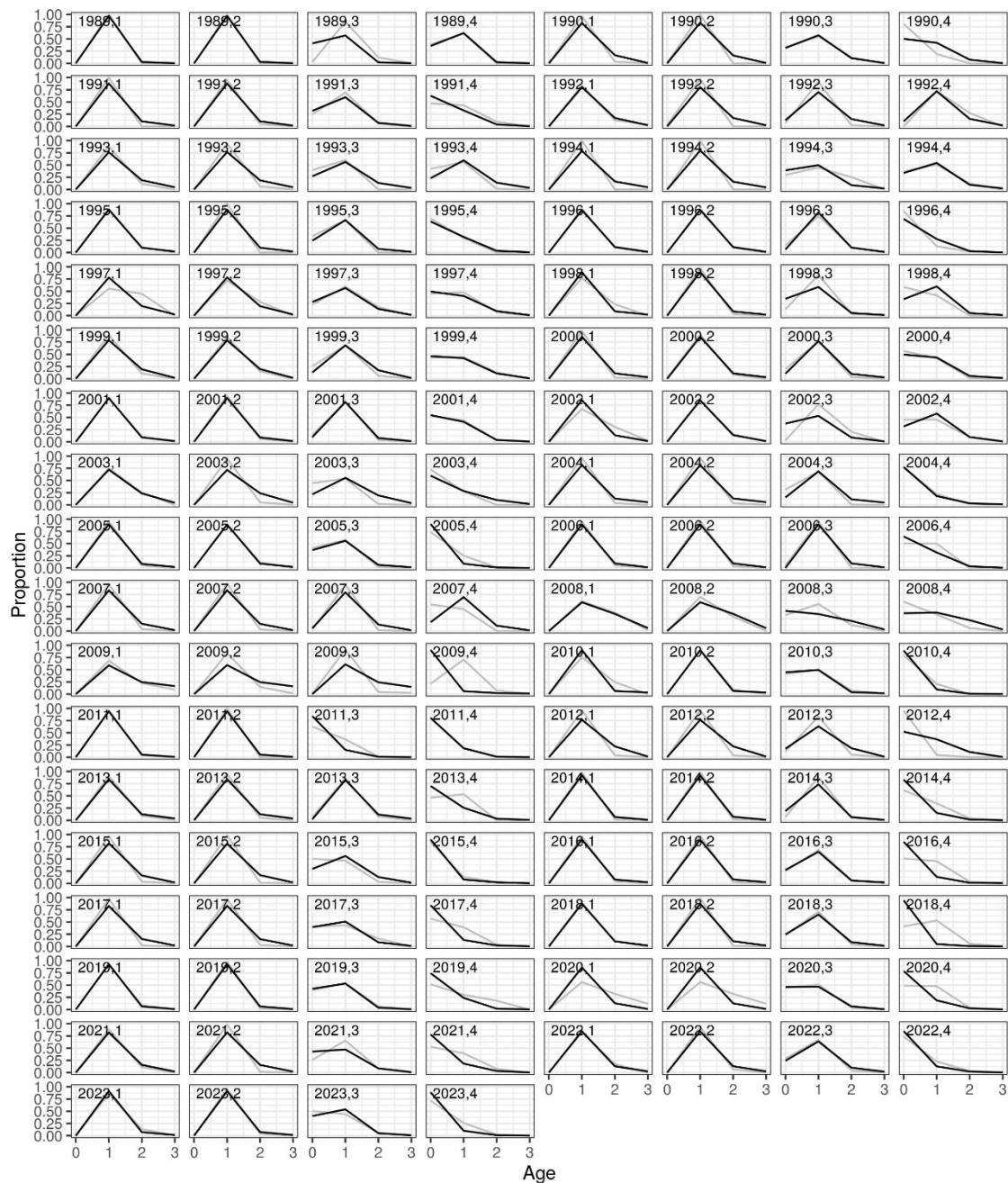


Figure A7.6.2.1.2.5. Anchovy in Division 9.a. Southern component. Comparison between observed and estimated quarterly catches age distribution from 1989 to 2023. Black lines represent estimated data while gray lines represent observed data. The number next to the year indicates the quarter.

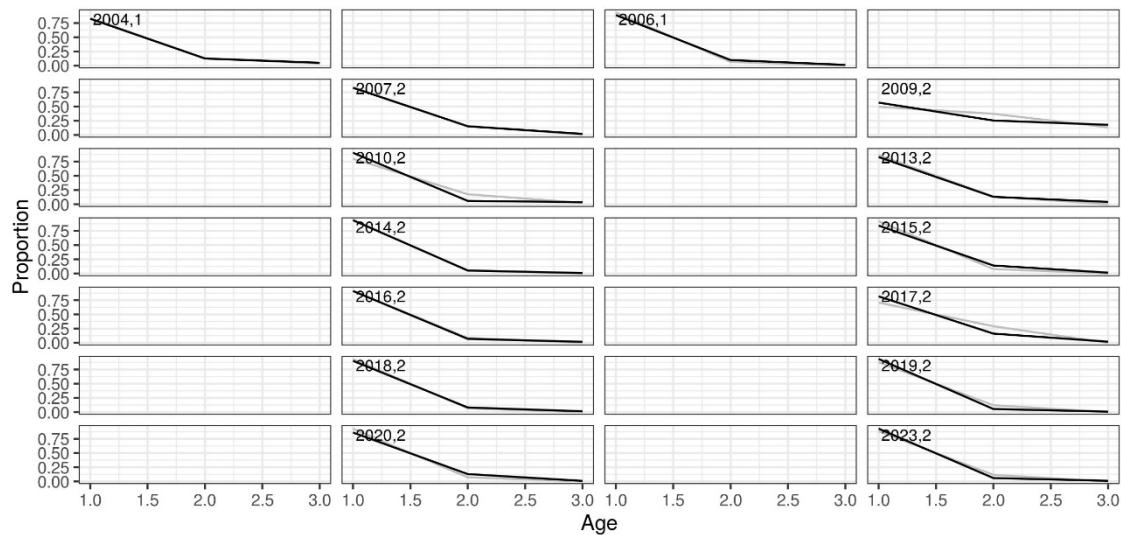


Figure A7.6.2.1.2.6. Anchovy in Division 9.a. Southern component. Comparison between observed and estimated ECOCADIZ survey age distribution from 2004 to 2023. Black lines represent estimated data while gray lines represent observed data. The number next to the year indicates the quarter. Note that the 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.

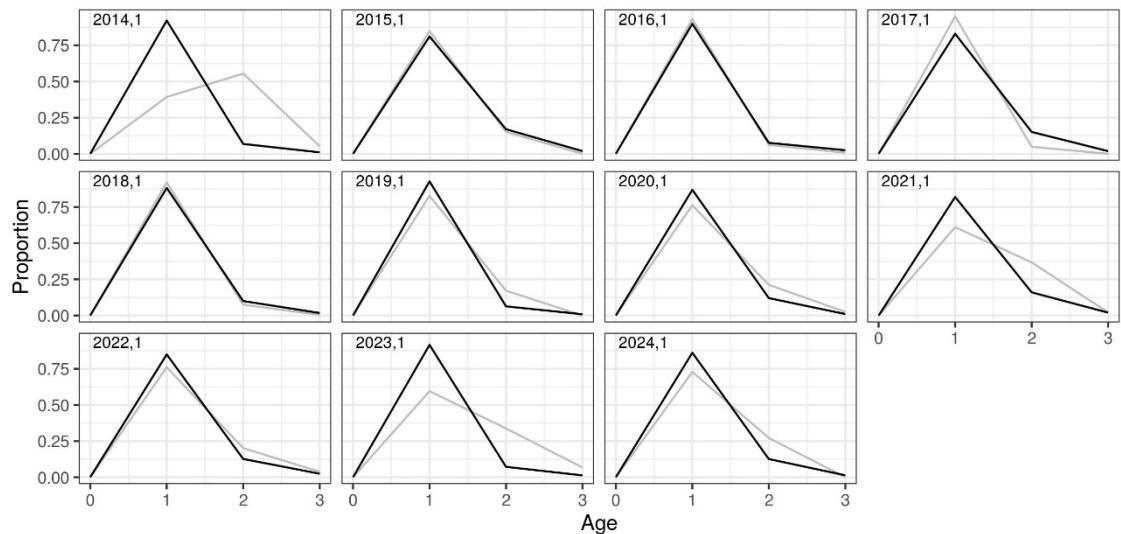


Figure A7.6.2.1.2.7. Anchovy in Division 9.a. Southern component. Comparison between observed and estimated PELAGO survey age distribution from 2014 to 2024. Black lines represent estimated data while gray lines represent observed data. The number next to the year indicates the quarter. Note that the 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.

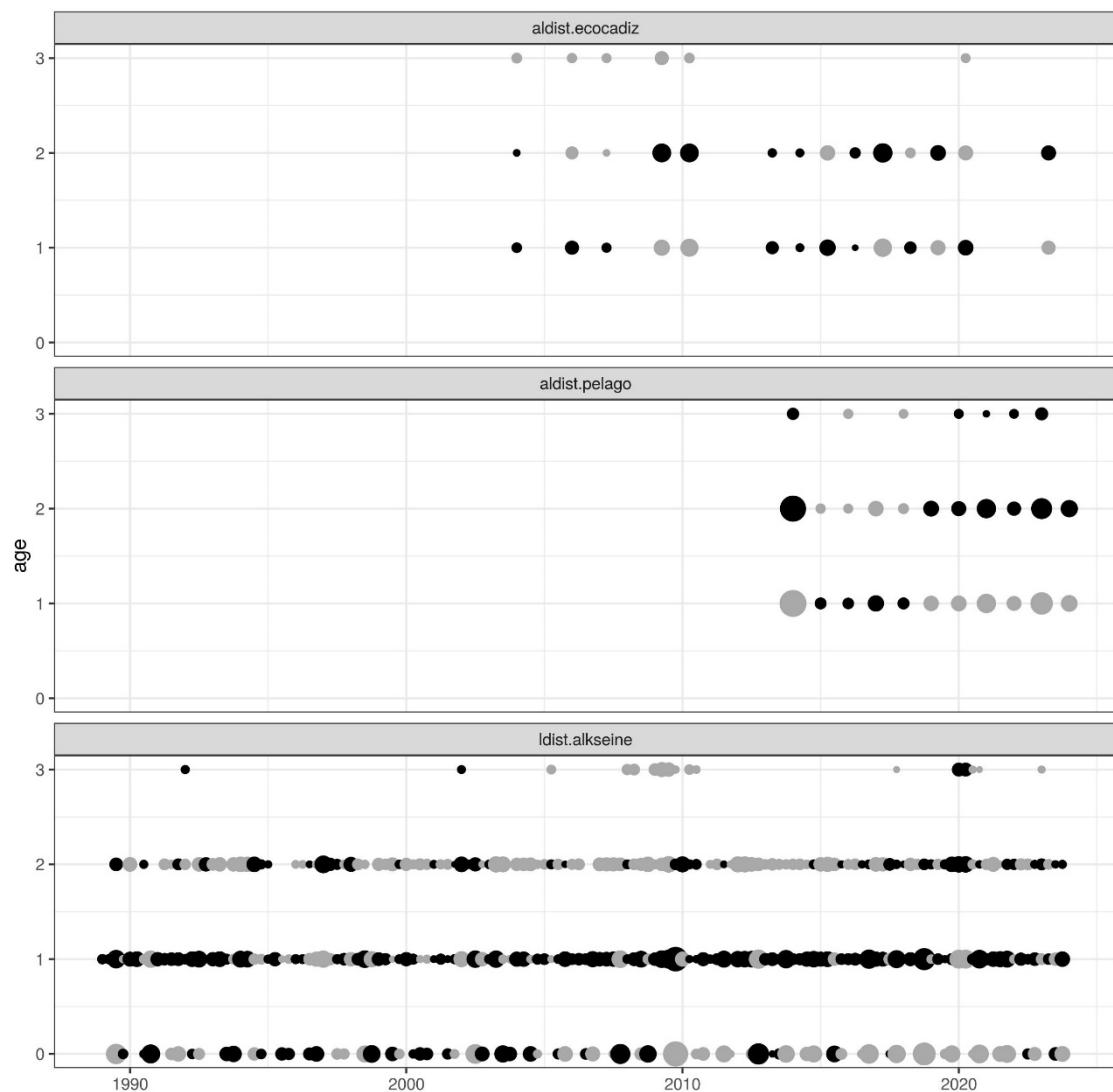


Figure A7.6.2.1.2.8. Anchovy in Division 9.a. Southern component. Standardised residual plots for the fitted age distribution from the ECOCADIZ survey, PELAGO survey and commercial fleet. Black points denote a model underestimate and grey points an overestimate. The size of the points denotes the scale of the standardised residual.

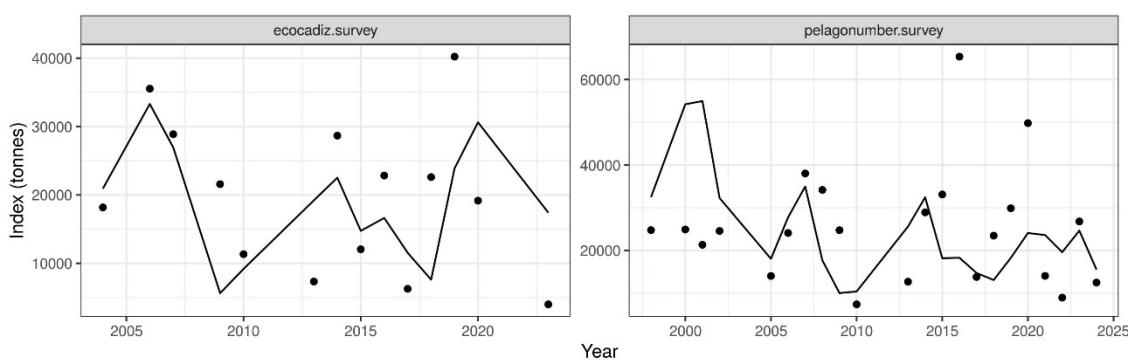


Figure A7.6.2.1.2.9. Anchovy in Division 9.a. Southern component. Comparison between observed and estimated survey biomass indices. Black points represent observed data while black line represents estimated data.

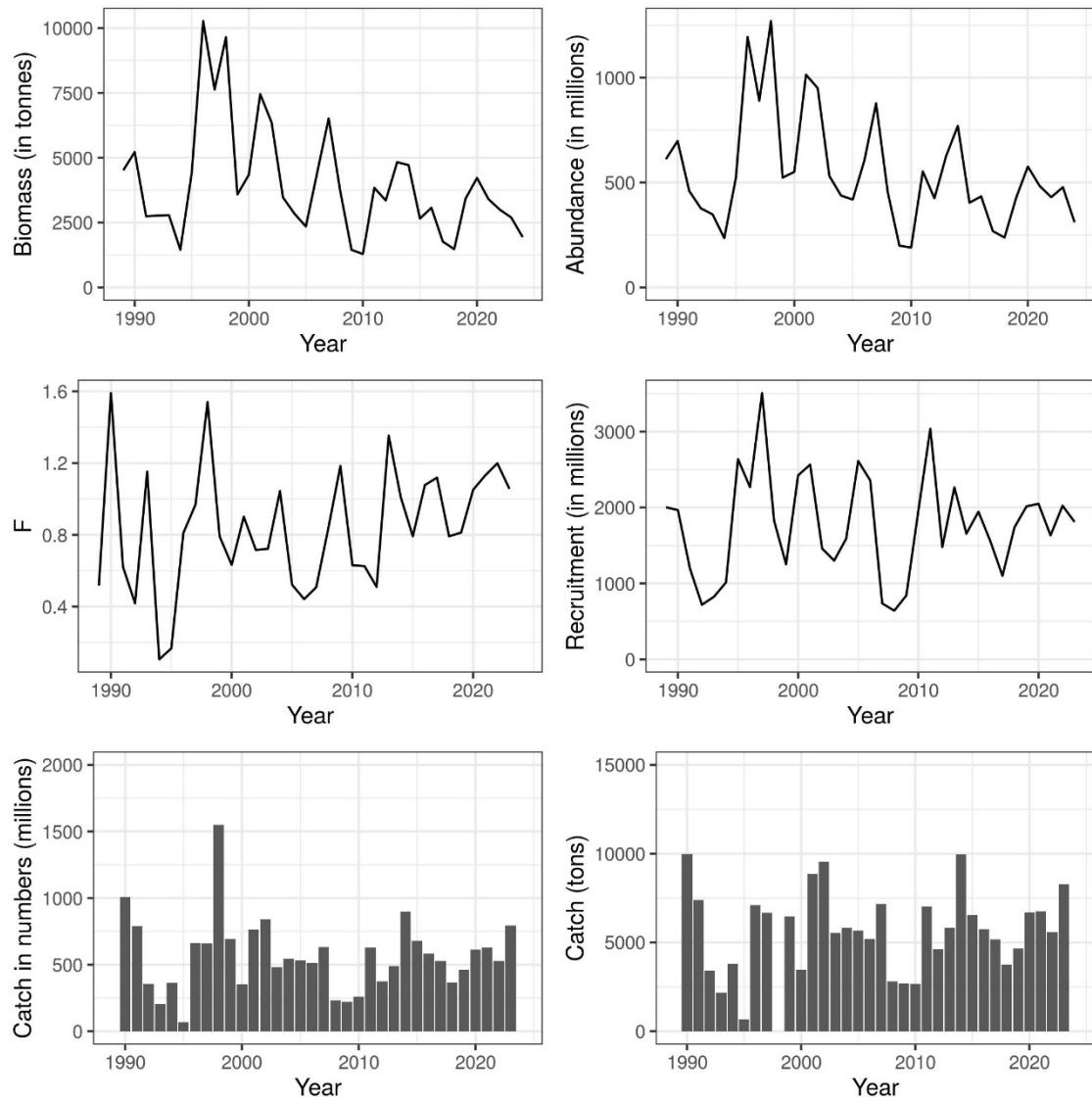


Figure A7.6.2.1.3.1. Anchovy in Division 9.a. Southern component. Annual model estimates for abundance with more than one year of age (in numbers and biomass), recruitment and fishing mortality compared with annual catch time-series (in numbers and biomass). Measures were summarised at the end of June each year, assuming that a year starts in July and ends in June of the next year.

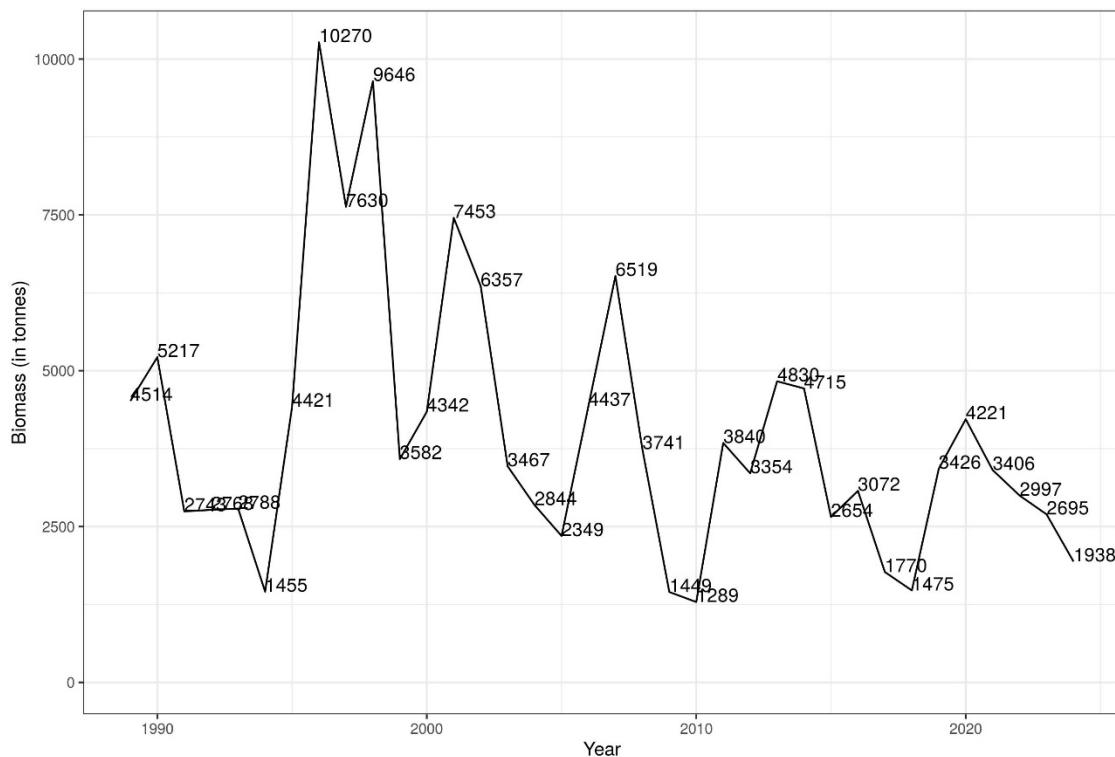


Figure A7.6.2.1.3.2. Anchovy in Division 9.a. Southern component. Time-series of estimated biomass at the end of June each year, assuming that a year starts in July and ends in June of the next year. For this stock, it is assumed that there are no individuals of age 0 at that time of the year, then this 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.

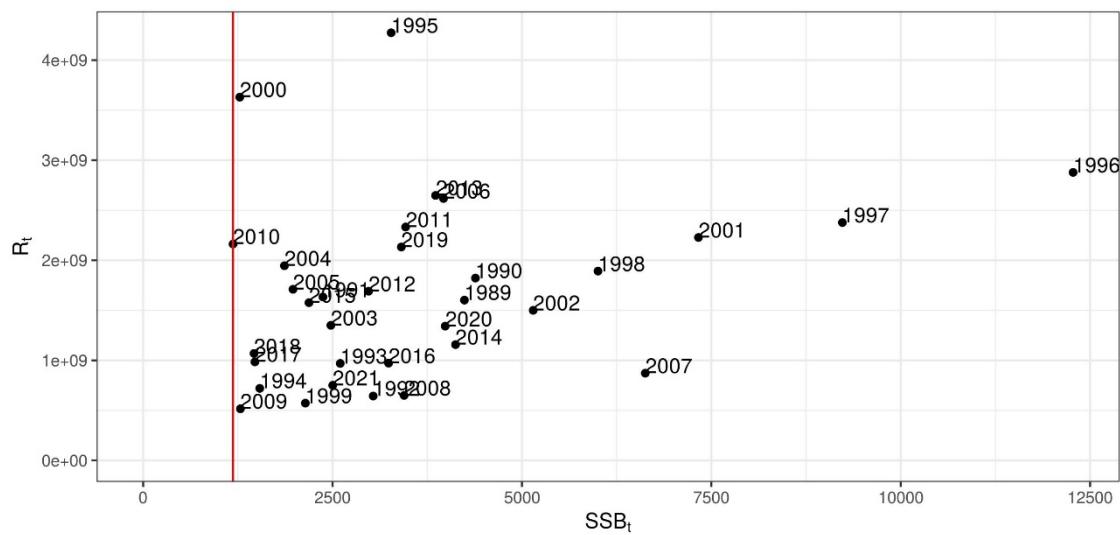


Figure A7.7.2.1. Anchovy in Division 9.a. Southern component. Estimated Stock Spawning biomass vs. Recruitment plot for 2022. Red line indicates the B_{lim} value ($B_{lim}=B_{loss}=SSB_{2010}= 1186.340$ t).

9.a West

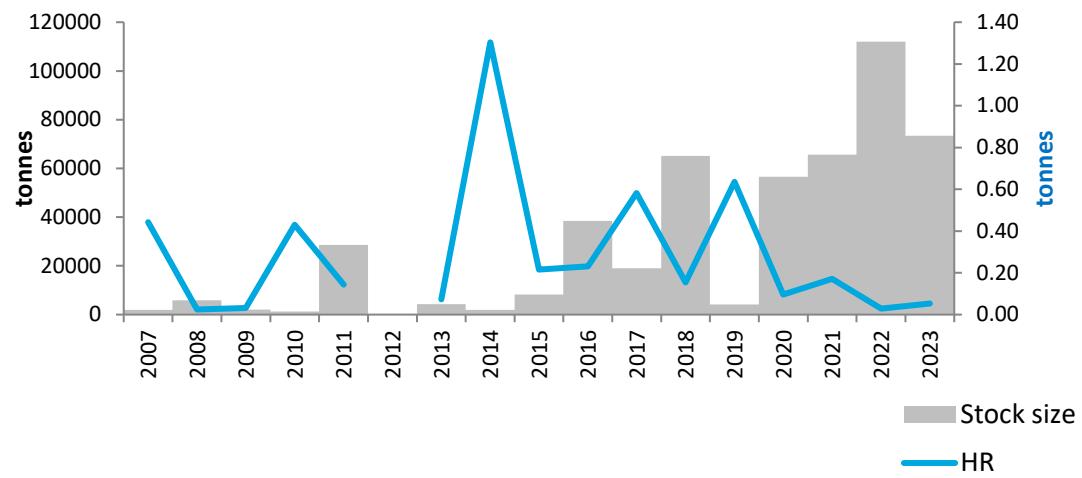


Figure A7.8.1.1. Anchovy in Division 9.a. Western Component. Stock biomass survey index and harvest rates. Harvest rates were estimated with the biomass of the surveys of a given year and the catches of the management period, i.e. 2007 corresponds to the period 07/2007 to 06/2008.

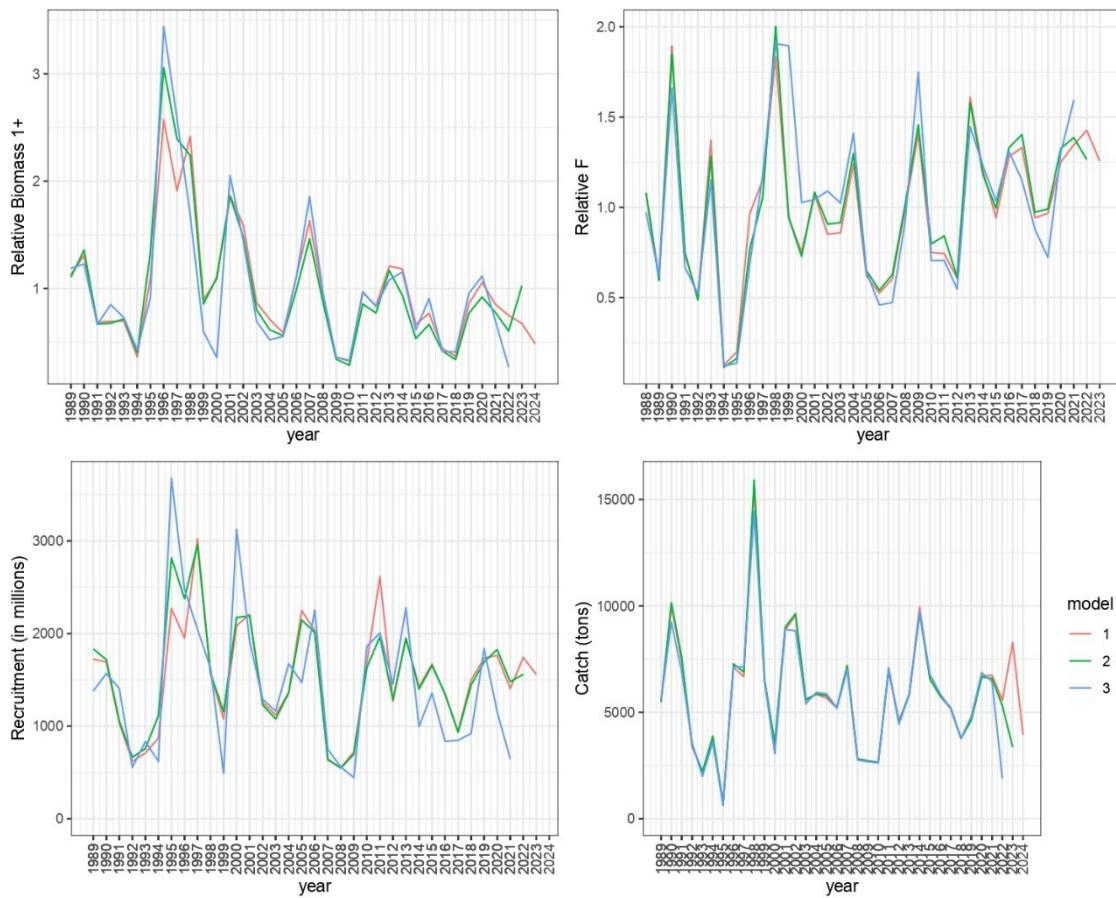


Figure A7.11.2.1: Anchovy in Division 9.a. Southern component. Comparison of estimates from different model implementations. 1: model used this year (pink); 2: model used last year (green); 3: model used in 2022 (blue). Annual model estimates for: relative abundance of individuals with more than one 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.