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Report of the Working Group on Southern Horse Mackerel, Anchovy and Sardine (WGHANSA)

24–29 June 2017

Bilbao, Spain

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Executive Summary

The Working Group on Southern Horse Mackerel, Anchovy and Sardine (WGHANSA) met in Bilbao (Spain), 24–29 June 2017, and was chaired by Lionel Pawlowski (France). There were 15 participants from France, Portugal, Spain and UK by correspondence. The main task was to assess the status and to provide short-term predictions for the stocks of anchovy in Division 9.a, for sardine in divisions 8.c and 9.a, and in divisions 8.abd and Subarea 7, and for horse mackerel (*T. trachurus*) in Division 9.a and blue jack Mackerel (*T. picturatus*) in 10 (Azores). Assessments were updated according to the stock annexes. Four stocks have been benchmarked in 2017. Some leftover work from the benchmark was carried out prior and completed during the meeting. Some unexpected technical issues with the PELAGO survey prevented the group to provide an assessment for the Iberian sardine stock. The assessment will be carried out in October 2017 (when the delayed data PELAGO will be processed and validated and made available for the group) and subsequent advice will be drafted and released later.

As anchovy in Subarea 8 is scheduled for assessment and short-term forecast in November 2017, no preliminary or exploratory assessment was carried out in this meeting. Information from the new spring surveys 2017, provide point estimates of anchovy biomass of 85 500 t (CV=15%) and 134 500 t (CV=15%) for the DEPM and acoustic surveys respectively. Catches in 2016 were 20 670 t.

As in previous years, the WG collected the few available data on the fisheries of anchovy in northern areas (subareas 4,5,6), although no assessment is so far required for the anchovy in those regions.

Anchovy in Division 9.a is a Category 3 stock for which a trend-based assessment from surveys is provided. The current status of the stock is informed by the spring PELACUS (Subdivision 9.a North) and PELAGO surveys (subdivisions 9.a Central-North, Central-South and South). The only available 2017 survey estimates for the working group were those provided by the PELACUS survey (3566 t, a historical maximum within its series) and by the PELAGO survey, but for the Subdivision 9.a South only (13 797 t, below the average of the time-series). The abovementioned technical issues with the PELAGO survey also prevented the working group from providing stock size indicators of anchovy for the whole division and for the western component of the stock (subdivisions 9.a North, Central-North and Central-South).

In the western areas, catches are generally low (several hundred tonnes), but sometimes exceeds a thousand tones, such as in 2016 (7140 t), which was one of the highest year records of the time-series. The bulk of the population is usually concentrated in the Subdivision 9.a South, where the stock supports a fishery whose catches were 6599 t in 2016 (against 13 740 t for the whole Division 9.a). Neither the fishery nor the population indices (assessed by surveys) show any long-term trend for the anchovy in 9.a South, although the 2017 value of the biomass stock size indicator is low. Exploratory evaluations of current harvest rates (10–50%) in the context of Yield-per-recruit analysis suggest that current exploitation levels in the 9.a South (until 2016) are sustainable, since these result in 50–90% of the potential spawning biomass being allowed to spawn. The European Commission has requested to ICES to give advice on whether catches of 15 000 t in 2017 are deemed sustainable (current TAC agreed in 12 500 t). Since the working group does not have a biomass index for the whole Division 9.a, it is not possible to determine if catches of 15 000 t in 2017 in the entire Division 9.a would be sustainable. Such an increase in catches cannot be considered

sustainable if they are taken entirely in the Subdivision 9.a South because they would imply a harvest rate in this area far above the ones observed in the past and an SPR value below 50%. No catch option for this stock can be given for 2018 because there is no information on recruitment that will constitute the bulk of the biomass and catches.

The WG assessed the sardine in divisions 8.a,b,d and Subarea 7, now as separate stocks following the conclusions from the (WKPELA 2017). There are no international TACs for those two regions.

In divisions 8.a,b,d, the stock is assessed based upon trends in SSB, fishing mortality and recruitment estimates from a SS3 model relying on catch and survey data (acoustic PELGAS, eggs BIOMAN and triennial DEPM survey). The last two years have been marked by a good recruitment in 2016 leading to a high SSB in 2017. Fishing mortality estimates reflects the increase of landings in the early 2010s. Landings in 2016 in divisions 8.a.b.d were 30 181 t. Overall, the stock is in good status. There is no clear trend in biomass indices since 2000, though marked fluctuations are recorded. The last big cycle peaked in 2009–2010. Biomass estimates during the following years were lower due to an increase in the fishing mortality. Biomass estimated by PELGAS is 465 022 t in 2017 which is almost the double of the estimated biomass last year. 2017 has one of the highest age 1 group of the PELGAS survey series.

As in previous years, there is little information from Subarea 7. The survey data from Peltic are for now too short and cover only a part of the stock to be considered as an index of the biomass of this region, but the development of this survey is promising. Catches are not monitored for biological sampling, so little can be done in terms of assessing the population and the fishery in this subarea. Catch are mainly taken by France, the Netherlands and the United Kingdom in 7 with occurrences in other countries such as Germany, Denmark. Landings for the whole stock area accounted for 19 408 t in 2016, twice the amount of landings of 2015.

For the southern horse mackerel (Division 9.a) an updated analytical assessment was carried out following the stock annex. This stock has been benchmarked this year. Catches were around 40 730 tonnes in 2016. The estimated SSB in 2016 from the assessment is 487 950 t. The SSB decreased gradually from 2007 to 2011, increasing in 2012 and 2013 to around the long-term average and is since then well above it. Fishing mortality (0.077) has been increasing in the last two years. Recruitment is estimated to be well above long-term average in 2015. Catch options were provided under the assumption of historical geometric mean recruitment.

For the blue jack Mackerel (*Trachurus picturatus*) in the waters of the Azores, the biennial advice was not updated this year. The WG continued with the collation of data. The assessment is currently based on commercial abundance indices from the purse-seiners and tuna bait boat, used as an indicator of stock trends.

In addition the WG had an update about the preparation of the benchmark for anchovy in Subarea 9.a which is still recommended for 2018. The WG also had three presentations from members of WGEAWESS presenting the activity of this working group dealing with ecosystem integrated assessment. The possibility of collaborations was discussed and it was concluded that both groups could benefit from the mutual expertise of each other.

1 Introduction

1.1 Terms of reference

The **Working Group on Southern Horse Mackerel, Anchovy and Sardine** (WGHANSA), chaired by Lionel Pawlowski, France, met in Bilbao, Spain, 24–29 June 2017 and will met by correspondence 20–24 November 2017 (for Bay of Biscay anchovy) to:

a) address generic ToRs for Regional and Species Working Groups. The work on Bay of Biscay anchovy should be carried out by correspondence in November;

b) assess the progress on the benchmark preparation of anchovy in Division 9.a, horse mackerel in Division 9.a, sardine in divisions 8.a,b,d and Subarea 7, and sardine in divisions 8.c and 9.a.

c) Estimate MSY proxy reference points for the category 3 and 4 stocks in need of new advice in 2017 (see table below).

i) Collate necessary data and information for the stocks listed below prior to the Expert Group meeting. An official ICES data call was made for length and to select life-history parameters for each stock in the table below;

ii) Propose appropriate MSY proxies for each of the stocks listed below by using methods provided in the ICES Technical Guidelines (i.e. peer reviewed methods that were developed by WKLIFE V, WKLIFE VI, and WKProxy) along with available data and expert judgement.

Stock Code	Stock name description	EG	Data Category
sar-78	Sardine (*Sardina pilchardus*) in divisions 8.a–b and 8.d and in Subarea 7 (Bay of Biscay, southern Celtic Seas, and the English Channel)	WGHANSA	3.2

The assessments were carried out on the basis of the stock annexes during the meeting (not prior to it) and coordinated as indicated in the table below:

Fish Stock	Stock Name	Stock Coord.	Assess. Coord. 1	Assess. Coord. 2	Advice
ane-pore	Anchovy in Division 9.a	Spain	Spain	Spain	Update
ane-bisc	Anchovy in subareas 8.abcd (Bay of Biscay)	Spain	Spain	France	Update in nnovember
hom-soth	Horse mackerel (*Trachurus trachurus*) in Division 9.a (Southern stock)	Spain	Portugal	Spain	Update
sar-soth	Sardine in divisions 8.c and 9.a	Portugal	Portugal	Spain	Update
sar-8abd	Sardine in divisions 8.abd	France	France	Spain	Second year of multiannual advice
sar-7	Sardine in Subarea 7	France	France	Spain	
jaa-10	Blue jack mackerel (*Trachurus picturatus*) in the waters of the Azores	Portugal	Portugal	Portugal	Update

WGHANSA reported by 7 July 2017 for all stocks except Bay of Biscay anchovy and will report by 23 November for Bay of Biscay anchovy stock for the attention of ACOM.

1.2 Report structure

Ad hoc and Generic TOR relative to the stocks for which assessment is required are dealt with stock by stock in respective chapters of the report: Anchovy 8 (Chapter 3), Anchovy 9.a (Chapter 4), Sardine 8.abd (Chapter 5), Sardine 7 (Chapter 6), Sardine in 9.a (Chapter 7), Southern Horse Mackerel (Chapter 8) and Blue jack mackerel (*Trachurus picturatus*) in the waters of the Azores (Chapter 9).

1.2.1 Answer to generic ToRs are dealt as follows:

Generic ToRs a) and b). The group had a look at ecosystem and fisheries overviews without emitting comments on it as some parts were clearly still to be developed. Due to limited time during the WG, no addition was made to those documents.

Generic ToR c) was somewhat irrelevant as the northern sardine stock has been split in two stocks under category 2 for Bay of Biscay and under category 5 for Subarea 7. Reference points were estimated for the Bay of Biscay stock

Generic ToR e). The progress on the benchmark the southern anchovy stock was discussed during the meeting. No request for future benchmarks were made this year.

Generic ToR f). Prepare the data calls for the next year update assessment and for the planned data evaluation workshops.

An additional ToR was the following EU Request:

d) Address the special request from the EU regarding a potential 2017 TAC change for anchovy in 9.a, by assessing:

1) whether catches of 15 000 t in 2017 are deemed sustainable in accordance with ICES precautionary approach for data-limited (category 3) stocks.
2) the catch level in 2017 that is deemed sustainable in accordance with ICES precautionary approach for data-limited (category 3) stocks.

This request was answered by the WG and is reflected in the 2017 advice sheet.

Finally several annexes contain the remaining issues such as

- Relevant WDs (Annex 4);
- Comments to the WG structure, workload and timing of the meeting.

1.3 Comments to the WG structure, workload and timing of the meeting

1.3.1 Workload

The WG has noticed that there is a continuously increasing amount of demands to the WGs for reporting data issues, availability and transmission issues, data deficiencies, future needs, interactions with ACs, etc. (See Generic ToRs, etc.), indicators, recommendations, etc. which certainly make difficult giving due responses to all these individual requests.

Since 2012 the WGHANSA benefits from a total six working days (instead of five), as a result of the stocks added to the WG for assessment (the southern horse mackerel stock (Division 9.a), Jack mackerel in Azores Islands. However, in 2015, the change in the management calendar for the Bay of Biscay anchovy and the inclusion of the latest JUVENA index have led the assessment and advice on this stock to be done late November after WGACEGG and just before the EU Council of the Ministers of Fisheries.

This work is now carried out by correspondence and this procedure has been in place since 2014. This change may seem to have somehow eased the workload a little bit in June and allows a closer look at the preliminary data on Bay of Biscay. A preliminary assessment has been carried out but it is harder for some participants more involved into the Bay of Biscay anchovy stock to justify their attendance at the June meeting. Therefore the attendance may decrease in the future.

The amount of days available for the meeting is currently seen as a minimum for this Working Group, with the perception that the group is becoming unable to provide satisfactory replies for all the increasing “extra” demands.

The group further points out that the workload during the WG is also dependant on the availability and quality of the data ahead of the meeting. Data calls are expected to overcome this problem and data were fully available by the time of the WG, but will not solve the fact that some of the spring surveys ends only a few weeks before the meeting and in that case, any problem in the processing may be critical.

Another issue is the proper qualification of datasets. New datapoints labelled as "uncertain" or "unexplained" when provided to the working group tend to bring additional exploratory assessments or forecast assumptions to consider which requires extra times in an already tight schedule.

This year, four of the seven stocks of this working group have been benchmarked leading to some additional workload from September 2016 up to early June 2017 through data evaluation workshop, benchmark workshop and management plan evaluation workshop and intersessional work by correspondence, in addition to the routine operations needed prior to the working group including members compiling data, participating to the spring surveys. The members of the group expressed a feeling of unusually heavy workload related to the high number of stocks benchmarked.

1.3.2 Timing of the meeting

Given the usual timing of the surveys for most of the stocks of this WG, there would be benefits to postpone the meeting till mid-November as this is now the case for the Bay of Biscay anchovy stock. The participants of the WG have discussed the opportunity and pros and cons of moving the WG date from end of June to early or mid-November. The following text is a summary of the key points:

- This working group heavily relies on spring, summer and fall surveys. Having the meeting by early summer as it is currently the case means the summer and fall surveys are only taken into account at the next WG, which means a ten month gap between the situation assessed by a summer survey, and the stock assessment carried out by the WG. Autumn surveys provide indices of recruitment which are a requisite to provide advice for 9.a anchovy. Autumn surveys may also provide information to support recruitment assumptions for Iberian sardine.

  The workload pressure would also decrease for the participants having spring surveys. Currently, the data processing between the end of surveys and the beginning of the WG is short and in some years, technical issues have led to some substantial delays. By moving the date of the WG to mid-November, for all stocks, the surveys indices would be used the same year. Data on egg abundance coming from spring surveys, which are often used as complementary information for stock assessment, would also be available by November.

- The assessment of Bay of Biscay anchovy at the end of the year is now done by correspondence. A physical meeting on such a complex assessment would be preferred but the attendance of participants is likely to be lower if two physical meetings would be set.
- The WG could closely interact with WGACEGG. Given how tight the new schedule is for the assessment of Bay of Biscay anchovy in regards to the end of the Juvena survey, processing of data at WGACEGG and EU Council, it is proposed that both meetings would occur on the same place and dates. Some work, such as the presentation of survey results (already presented in the two WGs) could eventually be merged in a common session for both WGs.

- The "live" collaboration with WGACEGG may be mutual for both working group as the methodologies developed in WGACEGG may be implemented in an easier way at WGHANSA and the expectation from WGHANSA in terms of data, methods, guidance over survey estimates would be beneficial to improve methodologies such as those developed during WGACEGG.

The participants are aware that having a meeting mid-November might pose some issues regarding the short gap between the delivery of the advices and the end of the year EU Council but there are practical benefits for the assessments.

1.4 Quality of the fishery input

In 2016 (2015 catch data), the differences between the WG estimates and official data were minimal, and as is the usual procedure, estimates of the working group were used to perform the assessment in all cases.

1.5 Overview of the sampling activities on a national basis for 2016

The Working Group again carried out a brief review of the sampling data and the level of sampling on the commercial fisheries. However this was not made on the basis of InterCatch as this has not been the usual procedure for collecting the national catch data inputting the assessments. The sampling summary by stocks on national basis is the following:

a) Anchovy Other areas

Country	Official Catch 4	No measured	Official Catch 6	No measured	Official Catch 7	No measured
UK						
France						
Total						

b) Anchovy 8

Country	Official Catch	% of catch sampled	No. samples	No. measured	No. Aged
Spain	18 370	100%	436	47 202	3671
France	2300	100%	20	1658	1983
Total	20 670	100%	456	48 860	5654

c) Anchovy 9.a

Country	Official Catch	% of catch sampled	No. samples	No. measured	No. Aged
Spain	6647	100%	276	4867	3990
Portugal	6937	100%	25	2324	193
Total	13 584	100%	301	7151	4183

d) Sardine 8.abd

Country	Official Catch	% of catch sampled	No. samples	No. measured	No. Aged
France	24 280	100%	78	4083	1697
Spain	6824	100%	186	19 208	541
Total	31 104	100%	264	23 291	2238

e) Sardine 9.a and 8.c

Country	Official Catch	% of catch sampled	No. samples	No. measured	No. Aged
Spain	9006	100%	121	9788	5371
Portugal	13 697	100%	79	7570	2067
Total	22 702	100%	200	17 358	7438

f) Southern Horse Mackerel (Division 9.a)

Country	Official Catch	% of catch sampled	No. samples	No.measured	No. Aged
Portugal	20 247	100%	322	39 211	2301
Spain	16 229	100%	200	11 527	2011
Total	36 476	100%	522	50 738	4312

g) Horse Mackerel (*T. picturatus*) in the waters of Azores (blue Jack Mackerel)

Country	Official Catch	% of catch sampled	No. samples	No.measured	No. Aged
Portugal	602	100%	220	10 750	153
Total	602	100%	220	10 750	153

1.6 Date and venue for WGHANSA in 2018

In Section 1.3, the participants requested ICES to consider the possibility of having the meeting moved to mid/end-November at the same time as WGACEGG. The venue and calendar should be the same as for WGACEGG.

In the case it is not possible, in order to allow more time for the data processing from the spring surveys, the Working Group proposes the meeting to be scheduled around the same date (24 to 29th of June). The venue and precise dates are not yet decided at the time of the completion of this report but will be identified before the ICES annual conference.

2 Anchovy in northern areas

Both species, sardine and anchovy, exist outside the areas for which assessments are requested by ICES and made. In previous years, some work has been done on the sardine in other areas. Contributions on the occurrence of sardine and anchovy and historical records outside the core areas are useful to build up an understanding of the distribution dynamics of these species as well as potential effect from climate change on spatial expansion of fish stocks.

Anchovy is generally considered to be found in small amounts in other areas, typically associated with river outlets.

The WG reviewed available information on anchovy populations in ICES divisions 4, 6 and 7. Division 7 is connected to the Bay of Biscay area where local stock is assessed by this working group. Anchovy populations in ICES divisions 4 (North Sea), 6 (West of Scotland) and 7 (Celtic Sea and English Channel) are not assessed and not regulated, as those populations have not been considered so far to be locally substantial even if they sometimes represent enough biomass for a small or opportunistic fishery.

2.1 Connectivity between North Sea, Bay of Biscay and Western channel

In 2010, an ICES Workshop on Anchovy, Sardine and Climate Variability in the North Sea and Adjacent Areas (WKANSARNS) was held to investigate the phenomena of increased catches in anchovy and sardine since the mid-1990s in the North Sea and adjacent areas. The workshop attempted to increase our understanding by considering the phenomenon in terms of the processes controlling the life cycle of anchovy and sardine. It considered the historical context and synthesized across the scientific disciplines of oceanography, climatology, genetics, ecology, biophysical individual-based modelling and analysis of empirical time-series.

WKANSARNS concluded that the recent increase of anchovy in the North Sea is probably due to the development of local North Sea populations, rather than a northward movement of Bay of Biscay populations. There has always been anchovy, at a low abundance, in the North Sea (spawning along the Dutch coast, Wadden Sea and estuaries). The expansion of anchovy in the North Sea is thought to be driven by pulses of successful recruitment that are controlled by relatively high summer temperature of sufficient duration followed (or preceded) by favourable winter conditions. There is probably a balance between high enough summer temperature allowing sufficient growth and winter conditions allowing sufficient survival at length. Variability in the length of these periods or in spatial extent where such conditions can be found may have a strong influence on the recruitment success. Whilst this workshop primarily considered driving processes related to temperature, other potential mechanisms, or mechanisms that co-vary with temperature, may be important in the dynamics of North Sea anchovy. The conclusion of the workshop, although preliminary, was that climate-driven changes in water temperature appear to mediate the productivity of anchovy in the North Sea.

On stock definition, the European anchovy shows large amounts of genetic differentiation between populations. An initial analysis has been carried out on the genetic structure of anchovy populations over the whole distributional range of the species by a research group of the genetics laboratory of the University of the Basque Country and Azti-Tecnalia. This study analyses 50 nuclear neutral SNP (Single Nucleotide polymorphism) markers on 790 individuals covering an extensive regions: North Sea, English Channel, Bay of Biscay, southeast Atlantic coast, Canary Islands, South Africa, Alboran, West Mediterranean and East Mediterranean (Adriatic and Aegean seas).

Nei standard (Ds) distance-based neighbour-joining tree, pair-wise FST comparisons and the Bayesian approach clustering method suggest that North Sea and English Channel samples are genetically homogenous, exhibiting significant genetic differences with the Bay of Biscay samples. Moreover, Bay of Biscay samples appeared to be genetically more similar to the West Mediterranean samples than to the North Sea-English Channel samples. These results support that the recent increase of anchovy in the North Sea is likely due to the development of local North Sea populations, rather than a northward movement of Bay of Biscay populations.

In looking for explanations for the recent expansion of anchovy in the North Sea, two main hypothesis arise: sympatry and allopatry. Allopatry could either be due to further adult migration to the north, or increase of larval and juvenile survival into the English Channel and southern North Sea for individuals originating from Biscay spawning. The second hypothesis was tested using a particle tracking model and showed that anchovy eggs spawned in the Bay of Biscay could be transported to the Channel, but no attempt was made to quantify the strength of that potential connectivity. It was also reported that, considering the seasonal shift in the circulation from northward to southward during the anchovy spawning season, and the northward progression of spawning during the season as the temperature increase, retention of eggs in the Bay of Biscay was much more likely compared to transport to the English Channel. The fraction of eggs arriving in the English Channel was low, from ~0% for spawning grounds 1 to 3, to 10% for spawning ground 5 in the north of the Bay (2.11% when averaged over the five spawning grounds). 87% of the particles lost from the Bay are entering the Channel, the rest remaining in the Celtic Sea. Results showed that the potential connectivity fraction of the Bay of Biscay to the north of 48°N is only 2%, essentially due to northern spawning in the Bay. Considering the observed spatio-temporal spawning pattern (shift to the north as the season progress), it was concluded that connectivity may be considered as negligible.

In the context of climate change, Bay of Biscay surface temperature has already been observed to increase, which will likely continue. This could advance the spawning season with earlier spawning in the north of the Bay. Under the hypothesis of no other change than temperature increase (e.g. circulation patterns), this would increase the potential for connectivity with the English Channel. From climate change scenarios (temperature increase, wind change) run over the Bay of Biscay, Lett *et al.* (2010) have suggested modification of the circulation with further impact on the dispersal kernel for Bay of Biscay anchovy, among them further distance dispersed under increased stratification.

2.2 Data Exploration from fishery statistics

Landings and effort data are scarcely available from France and United Kingdom. Length distributions were available in 7 from the French observer program at sea (OBSMER).

2.2.1 Catch in divisions 4 and 6

In Division 4, landings are very scarce (Table 2.2.1) with data available only past 1999 and ranging from 2 kgs to 4 tons (in 2002). Landings in 2010 were 280 kgs. In Division 6, 83 kgs were reported by the French fleets in 2000 and 1875 kgs in 2011. No landings were reported in those divisions since 2012 except in 2016 when 1.7 tons were reported. 9 tons were reported by the Netherlands in 2014, none in 2015. 3326 tons were reported by Denmark in 2015.

2.2.2 Catch in Division 7

In Division 7, landings from both French and British fleets have been scarce until 1996 with up to 25 t of landed fish (Table 2.2.2). The 1997–2013 period has shown a rise of landings up to 244 tons in 2003 followed by a decrease of 5 tons over the period 2004–2006 and then strong landings especially in 2009 and 2010 where the strongest landings of the time-series were recorded (940 and 1450 tons respectively).

The proportion of France and UK landings in the total catch has been highly variable between years with the majority of the landings over the last decade made by French vessels. It is unknown if the increase of landings in 2009–2010 were a consequence of the expansion of stock of anchovy in the Bay of Biscay. In 2011, only France reported landings (77 tons) for that division. In 2012, landings were 788 t for France and 51 t for UK. In 2013, 10.3 t were reported by UK vessels only. In 2014, 767 t, 214 t and 53 t were respectively reported from UK, France and Denmark with landings mainly done in 7.e. In 2014, 38 t were reported by UK in 7.e and 7.f. France reported for 1716 t in 7.e and 7.h and 59 t in 7.k. Netherland, Germany and Ireland respectively reported 316 t, 447 t, 49 t according to ICES preliminary landing statistics but those numbers were not confirmed in the response to the ICES data call for WGHANSA therefore this information should be treated with caution.

Most of the French landings occur during the second semester (Q3–Q4) in statistical rectangles 25E4, 25E5 which are adjacent to the 8.a division (Figure 2.2.1). There have been evidence that the Bay of Biscay stock sometimes expand further north the 8.a division therefore an undefined portion of the catch of anchovy in 7 is likely to consist of individuals from the Bay of Biscay stock. A minor portion of the French catch is also made in 26E8 mainly during the summer (quarters 2–3). UK landings are located in the coastal rectangles of northwestern part of the Channel (29E4–29E7) and are mainly made during the winter months (quarter 4 and 1).

The landings by the UK fleets are made by ringnets, purse seiners and midwater trawlers (Table 2.2.3). French catches in 2015 were almost made only by midwater trawler. No information were updated in 2015 regarding the details of landings.

Data from length distribution of catch anchovy are almost non-existing. No data were available in 2015. In previous years, the level of sampling in 7 was on some occasion enough to provide comparable length distributions to other areas. All distributions had different modes. Considering the low level of sampling (few stations), it was difficult to give any meaning to those results.

Table 2.2.1. UK and French landings (kg) of anchovy in divisions 4 and 6.

	FR-IV	UK-IV	Landings in kg		FR-VI	UK-VI	Landings in kg
1983				1983			
1984				1984			
1985				1985			
1986				1986			
1987				1987			
1988				1988			
1989				1989			
1990				1990			
1991				1991			
1992				1992			
1993				1993			
1994				1994			
1995				1995			
1996				1996			
1997				1997			
1998				1998			
1999	1.6		1.6	1999			
2000	3.1		3.1	2000	82.6		82.6
2001				2001			
2002	4029	2	4031	2002			
2003	0		0	2003			
2004	12.1		12.1	2004			
2005				2005			
2006	10.8	0	10.8	2006			
2007	50	0	50	2007			
2008		2	2	2008			
2009	28	127	155	2009			
2010	280		280	2010			
2011				2011	1875		1875
2012				2012			
2013							
2014							
2015				2015			
2016		1691	1691	2016			

Table 2.2.2. UK and French landings (tons) of anchovy in Division 7.

	Landings in tons		Portion of landings in	Portion of landings in	
	FR-7	UK-7	Total	25E4-5 in FR landings	29E4-7 in UK landings
1983					
1984		25.0	25.0		?
1985					
1986	0.0		0.0	?	
1987		5.0	5.0		?
1988		3.9	3.9		?
1989	0.2	16.6	16.8	?	?
1990					
1991		12.0	12.0		?
1992			0.0		
1993	1.7		1.7	?	
1994	0.0		0.0	?	
1995					
1996	0.0			0.0%	
1997	56.0		56.0	84.7%	
1998	0.8	39.0	39.8	0.0%	?
1999	6.0		6.0	0.0%	
2000	51.1	0.0	51.1	71.6%	?
2001	141.0	0.9	141.9	92.3%	?
2002	109.8	0.3	110.1	39.8%	?
2003	220.2	23.8	244.0	50.0%	?
2004	18.2	67.6	85.8	90.9%	?
2005	7.5	7.7	15.2	99.3%	?
2006	5.2	0.2	5.4	61.7%	?
2007	0.3	763.2	763.4	0.0%	?
2008	0.7	175.8	176.5	0.0%	?
2009	585.1	353.5	938.6	85.0%	?
2010	1157.1	319.6	1449.2	84.2%	97.0%
2011	77.0		77.0	52.5%	
2012	788.3	50.9	839.2	91.2%	96.1%
2013	0	10.4	10.4	0.0%	39.5%
2014	241.2	767.2	1008.4	85%	86.6%
2015	1716.4	37.7	1754.0	100%	94.9%

Table 2.2.3. Landings (kg) of anchovy per fleets per year in ICES Division 7.

UK Fleets										
Gear	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
MIDWATER TRAWL	5814		619021	10126	98056	10840		34936	10307	355077
RING NET			92560	132294	235788	244935		12220		230862
MIDWATER PAIR TRAWL	1665	200	28103	12600	4286	1100				181064
PURSE SEINE						47056				
DRIFT NET			5241	17838	1	15613				
UNSPECIFIED OTTER TRAWL			18216	1	270	22		3622		
TRIPLE NEPHROPS OTTER					15080					
OTHER OR MIXED POTS				2688						
BOTTOM PAIR TRAWL	245									
BEAM TRAWL				199						
UNSPECIFIED GILL NET			11	27		58				
GILL NET (NOT 52 OR 53)				8		7				
WHELK POTS			1							
Total	7724	200	763153	175781	353481	319631	0	50778	10307	613773

UK Fleets										
Gear	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
PURSE SEINE					392150	517940	39692	445778		224816
MIDWATER PAIR TRAWL		1500			51460	437720	34582	208593		
MIDWATER OTTER TRAWL				0.5	78994	68294				50
SCOTISH SEINE					53400	33500	137			
BOAT DREDGES				1.7		37200		100		
NOT KNOWN					9000	26330		132283		
PURSE SEINE 1 BOAT	7415	1720					1050			
BOTTOM OTTER TRAWL	54.7	2002	270	19.7	80	4720	601	47		
OTTER TWIN TRAWL						2150	21			
GILL NETS				400		1730	936			
TRAMMEL NETS				320				1470		
Total	7470	5222	270	741.9	585084	1129584	77019	788272		224866

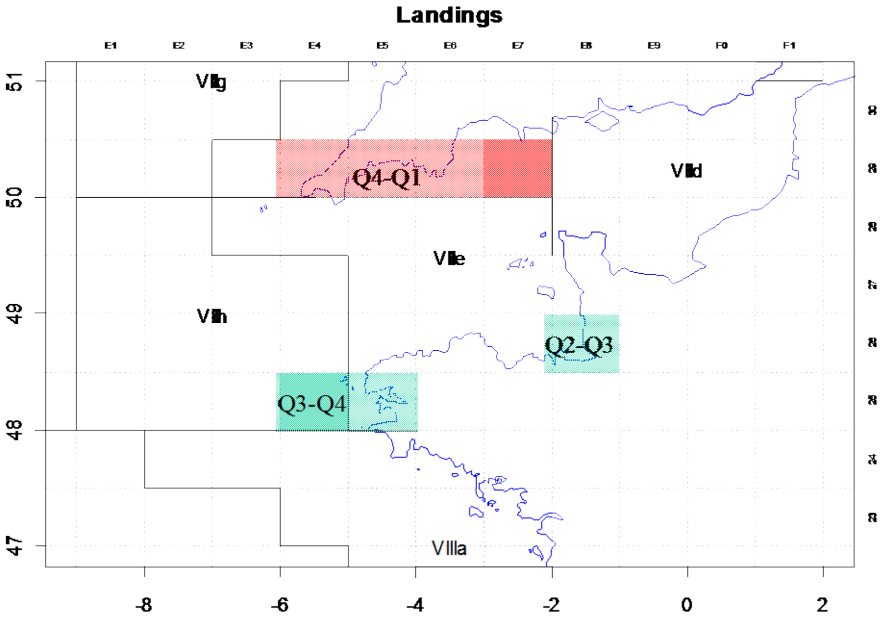


Figure 2.2.1. Map of the statistical rectangles where most of the catches of anchovy occur in ICES Division 7 for France (Green) and UK (Red).

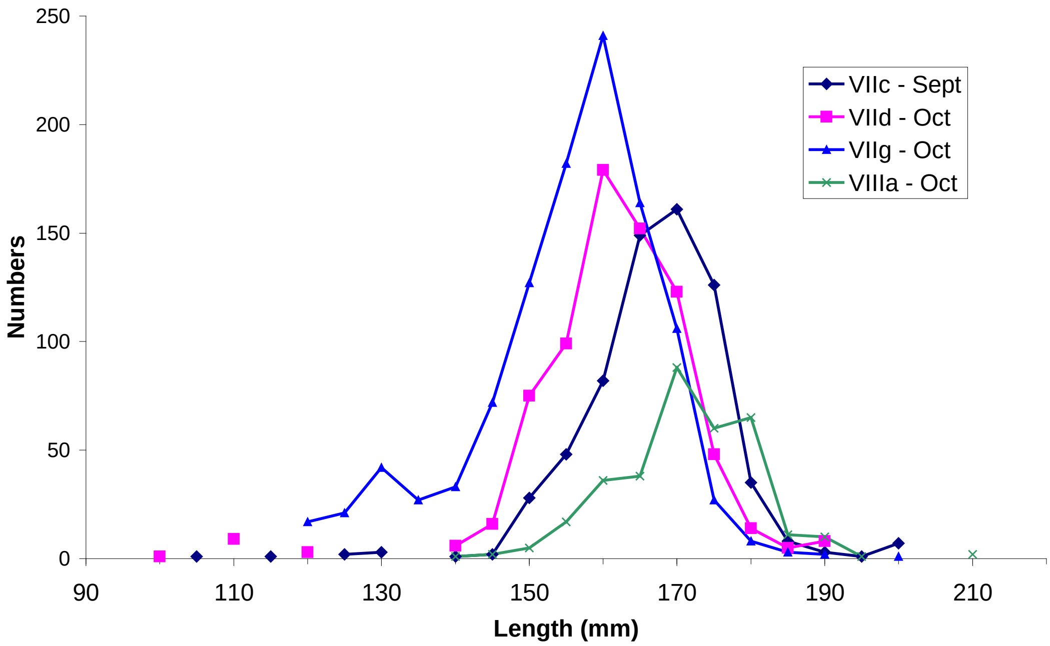


Figure 2.2.2. Length distributions of catch of anchovy in ICES divisions7.c, 7.d, 7.g and 8.a in 2010.

3 Anchovy in the Bay of Biscay (Subarea 8)

3.1 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; STECF 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, 2015b). 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 Western 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".

In December 2016 and according to the new harvest control rule, ICES advised that "when the management strategy is applied, catches in 2017 should be no more than 33 000 tonnes".

In January 2017 the Council established the TAC in 2017 for the Bay of Biscay anchovy stock at 33 000 tonnes (Council Regulation No 127/2017), from which 90% corresponded to Spain and 10% to France. However, these percentages might 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 includes an exemption from the landing obligation for anchovy caught in artisanal purse-seine fisheries based on evidence for high survivability and *de minimis* exemptions both in the pelagic trawl fishery and the purse-seine fishery from 2015 to 2017.

According to the European Commission Regulation No. 185/2013, the deductions from the anchovy fishing quota allocated to Spain on account of overfishing of mackerel quota in 2009 shall be applied from 2016 to 2023. This supposes a reduction of 3696 tonnes in the 2017 Spanish quota of Bay of Biscay anchovy.

3.2 The fishery in 2016 and 2017

3.2.1 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 (mainly during the second half of the year).

The total number of fishing licences for anchovy in Spain in 2017 was 159. Since the re-opening of the fishery in 2010 the number of fishing licences have been oscillating between 149 and 175.

For France, the number of purse seiners able to catch anchovy in 2016 was 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 decreases progressively and some of them joined the North of the Bay of Biscay in the last five years. The real target specie of these vessels is sardine, and anchovy is more opportunistic in autumn. It must be noticed that the number of French purse seiners is slowly increasing, year after year.

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 2016, as in previous years, a shift occurred on the French anchovy fishery. Pair pelagic trawlers mainly target tuna between July and October, and single pelagic trawlers caught anchovy particularly in September and October, but in lower quantity than last year. During autumn, purse seiners caught a bit of large anchovy with difficulties, so they mainly targeted sardine.

A more complete description of the fisheries is made in the stock annex.

3.2.2 Catches

Historical catches are presented in Table 3.2.2.1 and Figure 3.2.2.1. Total catches in 2016 were 20 670 tonnes, from which 18 370 corresponded to Spain and 2300 to France. From the Spanish catches 310 tonnes corresponded to anchovy used as live-bait for tuna fishing. The preliminary catches up the end of May 2017 were around 18 113 t, corresponding to the Spanish fleet.

The series of monthly catches are shown in Table 3.2.2.2. In 2016 the catches in November were larger than in the previous years, mainly due to an increase of the Spanish catches this month.

The quarterly catches by division in 2016 are given in Table 3.2.2.3. Most of the catches took place in the second quarter (68%), followed by the third, fourth and first quarter (15%, 9% and 7% respectively). The major fishing activity of the Spanish fleet occurred in the second quarter (72%), whereas the French fleet operated mainly in the second semester (57%). Regarding fishing areas, most of the Spanish catches in the first semester corresponded to ICES Division 8.c and to ICES Division 8.abd in the second semester. The French catches corresponded to ICES divisions 8.a and 8.b.

N.B.: non-negligible catches (around 800 tons) originate from divisions 7.h and 7.e, but these catches have been assigned 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. French anchovy landings declared in 25E5 and 25E4 have hence been reallocated to 8.a.

This year for the first time in the historical series, Spain reported 42 tonnes of anchovy discarded by other fleets. These discards are less than 0.2% of the total catch and they are considered negligible for this stock.

3.2.3 Catch numbers-at-age and length

Catch numbers-at-age by quarter in 2016 for Spain and France are given in Table 3.2.3.1. Age 2 individuals were predominant in the first and second quarters (50%

and 55%), whereas age 1 were the most abundant ones in the third quarter (57%). Age 0 individuals appeared in the third and fourth quarters and were the most abundant ones in the fourth quarter (59%).

Table 3.2.3.2 records the age composition of the international catches since 1987, on a half-yearly basis. One year old anchovies have dominated in the catches during both halves of most of the years. In 2016, age 2 individuals predominated in the first and second halves.

Catch-at-length data (by 0.5 cm classes) by quarter in 2016 are given in Table 3.2.3.3. The length range was between 7 and 21 cm. The mean length was between 14.5 and 16 cm, except for the Spanish catches in the third and fourth quarters that was around 13 cm.

See the stock annex for methodological issues.

3.2.4 Weights and lengths-at-age in the catch

The series of mean weight-at-age in the fishery by half year, from 1987 to 2016, is shown in Table 3.2.4.1. See the stock annex for methodological issues.

Table 3.2.2.1: Bay of Biscay anchovy: Annual catches (in tonnes) as estimated by the Working Group members.

COUNTRY	FRANCE	SPAIN	SPAIN	UNALLOCATED	OTHER COUNTRIES	INTERNATIONAL
YEAR	VIIIab	VIIIbc	Live Bait Catches			VIII
1960	1,085	57,000	n/a			58,085
1961	1,494	74,000	n/a			75,494
1962	1,123	58,000	n/a			59,123
1963	652	48,000	n/a			48,652
1964	1,973	75,000	n/a			76,973
1965	2,615	81,000	n/a			83,615
1966	839	47,519	n/a			48,358
1967	1,812	39,363	n/a			41,175
1968	1,190	38,429	n/a			39,619
1969	2,991	33,092	n/a			36,083
1970	3,665	19,820	n/a			23,485
1971	4,825	23,787	n/a			28,612
1972	6,150	26,917	n/a			33,067
1973	4,395	23,614	n/a			28,009
1974	3,835	27,282	n/a			31,117
1975	2,913	23,389	n/a			26,302
1976	1,095	36,166	n/a			37,261
1977	3,807	44,384	n/a			48,191
1978	3,683	41,536	n/a			45,219
1979	1,349	25,000	n/a			26,349
1980	1,564	20,538	n/a			22,102
1981	1,021	9,794	n/a			10,815
1982	381	4,610	n/a			4,991
1983	1,911	12,242	n/a			14,153
1984	1,711	33,468	n/a			35,179
1985	3,005	8,481	n/a			11,486
1986	2,311	5,612	n/a			7,923
1987	4,899	9,863	546			15,308
1988	6,822	8,266	493			15,581
1989	2,255	8,174	185			10,614
1990	10,598	23,258	416			34,272
1991	9,708	9,573	353			19,634
1992	15,217	22,468	200			37,885
1993	20,914	19,173	306			40,393
1994	16,934	17,554	143			34,631
1995	10,892	18,950	273			30,115
1996	15,238	18,937	198			34,373
1997	12,020	9,939	378			22,337
1998	22,987	8,455	176			31,617
1999	13,649	13,145	465			27,259
2000	17,765	19,230	n/a			36,994
2001	17,097	23,052	n/a			40,149
2002	10,988	6,519	n/a			17,507
2003	7,593	3,002	n/a			10,595
2004	8,781	7,580	n/a			16,361
2005	952	176	0			1,128
2006	913	840	0			1,753
2007	140 **	1.2 **	0			0
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 (Up 31st May)	0	18,113				
AGE (1960-2004)	6,394	26,337				32,824
AGE (2010-2016)	3,875	13,503				17,499

** : Experimental fishery

Table 3.2.2.2: Bay of Biscay anchovy : Monthly catches by country (Sub-area VIII) (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

Table 3.2.2.3: Bay of Biscay anchovy: Catches in the Bay of Biscay by country and divisions in 2016 (without live bait catches)

		QUARTERS				CATCH (t)	
COUNTRIES	DIVISIONS	1	2	3	4	ANNUAL	%
SPAIN	8abd	467	4001	915	1223	6606	36.6%
	8cE	966	8929	380	621	10895	60.3%
	8cW	0	63	489	6	559	3.1%
	TOTAL	1433	12993	1784	1850	18060	96.9%
	%	7.9%	71.9%	9.9%	10.2%	100.0%	
FRANCE	8abd	51	903	1320	27	2300	100.0%
	8cE	0	0	0	0	0	0.0%
	8cW	0	0	0	0	0	0.0%
	TOTAL	51	903	1320	27	2300	100.0%
	%	2.2%	39.2%	57.4%	1.2%	100.0%	
INTERNATIONAL	8abd	518	4903	2235	1250	8906	43.7%
	8cE	966	8929	380	621	10895	53.5%
	8cW	0	63	489	6	559	2.7%
	TOTAL	1484	13896	3103	1877	20360	100.0%
	%	7.3%	68.2%	15.2%	9.2%	100.0%	

Table 3.2.3.1: Bay of Biscay anchovy: catch at age in thousands for 2016 by country and quarter (without the catches from the live bait tuna fishing boats).

2016 units: thousands

	QUARTERS	1	2	3	4	Annual total
	AGE	VIIIabc	VIIIabc	VIIIabc	VIIIabc	VIIIabc
TOTAL Subarea 8	0	0	0	1,733	61,623	63,356
	1	28,162	231,597	80,502	41,372	381,632
	2	30,472	332,993	57,316	1,423	422,205
	3	2,698	42,514	2,239	48	47,499
	4	9	222	0	0	231
	5	0	0	0	0	0
	TOTAL(n)	61,340	607,326	141,791	104,466	914,923
	W MED.	24.19	22.88	21.87	17.95	22.25
	CATCH. (t)	1484	13896	3103	1877	20360
	SOP	1484	13893	3101	1875	20352
	VAR. %	99.97%	99.98%	99.92%	99.92%	99.96%

Table 3.2.3.2: 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 and in 2016)

Units: Thousands

INTERNATIONAL

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

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

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

YEAR	2014		2015		2016	
Age	1st half	2nd half	1st half	2nd half	1st half	2nd half
0	0	37,068	0	443	0	74,571
1	228,729	187,159	560,920	251,508	261,072	136,044
2	336,224	12,181	357,044	128,579	363,465	58,740
3	53,703	3,035	27,236	6,914	45,212	2,287
4	4,271	0	173	0	231	0
5	0	0	0	0	0	0
Total #	622,927	239,443	945,373	387,443	669,979	271,642

Table 3.2.3.3: Bay of Biscay anchovy: Catch numbers at length by country and quarters in 2016

	QUARTER 1		QUARTER 2		QUARTER 3		QUARTER 4	
Length (half cm)	**France**	**Spain**	**France**	**Spain**	**France**	**Spain**	**France**	**Spain**
3.5								
4								
4.5								
5								
5.5								
6								
6.5								
7						77		5
7.5						77		5
8						77		5
8.5						541		36
9		0		0		1,082		78
9.5						1,468		104
10		8		7		1,702		294
10.5		7	0	14		1,868		641
11		78	0	245		1,722		1,222
11.5		72	0	3,093		2,427		2,565
12		240	0	8,546		5,636		4,445
12.5		99	0	18,929	70	9,612		7,611
13		748	0	29,673	220	13,313	46	11,596
13.5	53	3,439		47,815	938	12,445	116	16,147
14	145	8,863	816	72,168	3054	11,827	162	18,707
14.5	237	9,152	1516	74,802	8266	8,273	209	13,170
15	316	7,633	2867	75,619	13051	4,496	186	9,960
15.5	355	5,768	4219	62,380	10483	2,511	139	4,596
16	303	3,686	5138	50,534	5380	1,234	116	1,568
16.5	171	2,255	5195	28,701	2734	421	70	342
17	132	1,032	4633	15,581	1244	83	46	11
17.5	92	397	2712	5,799	372	30	23	
18	39	108	1105	1,448	309	13		8
18.5		0	453	357	98	0		
19		18		197		13		13
19.5				126				
20		1		32		0		1
20.5				14				
21		1		11		0		1
21.5								
22								
22.5								
23								
23.5								
24								
24.5								
25								
25.5								
26								
Total ('000)	1842	43606	28656	496089	46219	80949	1114	93133
Catch (t)	51	1433	903	13011	1320	2071	27	1855
Mean Length(cm)	15.5	14.8	16.2	14.7	15.2	13.1	14.9	13.7

Table 3.2.4.1: Bay of Biscay anchovy: Mean weight at age (grammes) in the international catches on half year basis
Units: grams

INTERNATIONAL

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

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

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

YEAR	2014		2015		2016	
Sources:	WG data		WG data		WG data	
Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half
Age 0	na	16.1	0.0	9.4	na	14.3
1	18.3	26.3	17.0	19.9	19.3	20.0
2	25.1	33.3	25.5	28.1	24.5	24.1
3	28.9	45.8	28.7	38.5	31.7	32.8
4	26.0	na	25.5	na	32.6	na
5	na	na	na	na	na	na
Total	22.9	25.3	20.5	22.9	23.0	19.4

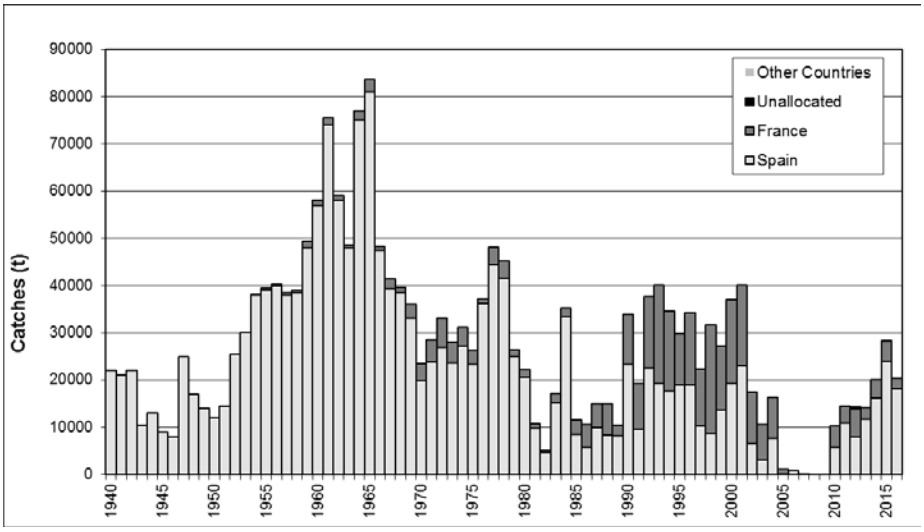


Figure 3.2.2.1. Bay of Biscay anchovy: Historical evolution of catches in Division 8 by countries.

3.3 Fishery-independent data

3.3.1 BIOMAN DEPM survey 2017

All the methodology for the survey and the estimates performance are described in detail in the stock annex, Bay of Biscay Anchovy (Subarea 8). A detailed report of the survey and results 2017 is attached as annex A3.2_ WD_DEPM_BIOMAN (Santos. M *et al.*, WD 2017).

3.3.1.1 Survey description

The 2017 anchovy DEPM survey was carried out in the Bay of Biscay from 4th to the 26th of May, covering the whole spawning area of the species, following the procedures described in the stock annex, Bay of Biscay Anchovy (Subarea 8). Two vessels were used at the same time and place: the RV Ramón Margalef to collect the plankton samples and the pelagic trawler RV Emma Bardán to collect the adult samples. Sample specifications are given in Table 3.3.1.1.1.

Total number of PairoVET samples (vertical sampling) obtained was 747. From those, 499 had anchovy eggs (67%) with an average of 210 eggs m^{-2} per station in the positive stations, and a maximum of 4270 eggs m^{-2} in a station. A total of 15 976 anchovy eggs were encountered and classified in the PairoVET stations. The number of CUFES samples (horizontal sampling) obtained was 1856. Frome those 1051 (64%) stations had anchovy eggs with an average of 13 eggs m^{-3} per station and a maximum of 1208 eggs m^{-3} in a station and 142 713 anchovy eggs in total (24 018 egg m^{-3}). This year a significant amount of anchovy eggs was found in the Cantabrico Coast finding anchovy eggs until 6ºW and offshore until 44º23’ in transect 9. Nevertheless, it was not possible to found the west limit of the spawning area in Cantabrico Coast. The northern limit was found at 48º N. The eggs in the French platform where encountered in the historical common places: Between Adour and Le Gironde passed the 200 m depth from the coast. From Le Gironde to the North the eggs were found from the coast to the 100 m depth line (Figure 3.3.1.1.1). The total area covered was 118 291 Km^2 and the spawning area was 67 756 Km^2.

In relation with the adult samples, 46 pelagic trawls were performed, from which 36 provide anchovy and all were selected for the analysis. Moreover, five hauls from the purse seines commercial fleet will be added for the final analysis. In total there will be 41 adult anchovy samples for the estimation of the adult parameters. The final estimate will be done for WGHANSA_sub in November when all the adult parameters will be estimate. The spatial distribution of the samples and their species composition is shown in Figure 3.3.1.1.2. The most abundant species in the trawls were: anchovy, mackerel, horse mackerel, sardine and hake. Spatial distribution of mean weight and mean length (males and females) for anchovy is shown in Figure 3.3.1.1.3. Less weight individuals were found in the influence of the Gironde estuary while heavier anchovies were found all alone the coast and in the French platform and the heaviest offshore and on the Cantabrian coast. Figure 3.3.1.1.4 shows the age composition by haul.

The weather conditions during the survey were good in general with a mean Sea Surface Temperature of 14.8ºC. The average salinity was 35.12; the plume due to the influence of the Gironde River was not occupying a wide area as usually. A short-term and positive SST anomaly was measured between the French coast and 3º W and around 46º N. This hot water tongue with respect to the surrounding waters was higher than 1º C and remained for approximately three days. This event was confirmed by remote data from different and independent satellites that observed an even higher SST increase with a relative maximum around 17 May. This phenomenon is currently under research.

Figure 3.3.1.1.5 shows the maps of surface salinity and temperature found during the survey with the anchovy egg distribution.

3.3.1.2 Total daily egg production estimate

The estimates of daily egg production, daily egg mortality rates and total egg production are given in Table 3.3.1.2.1 and the mortality curve model adjusted is shown in Figure 3.3.1.2.1. Total egg production in 2017 was estimated at 6.05 E+12 with a CV of 0.1047, lower than last year estimates (1.17 E+13).

3.3.1.3 Preliminary daily fecundity and preliminary index of biomass

To estimate the total Biomass following the DEPM a daily fecundity (DF) estimate is necessary. The anchovy adults from the survey to estimate DF are in process so it was obtained as the mean of the last seven years from 2010 (after the opening of the fishery) to 2016. (70.71 eggs/gramme).

The preliminary total biomass estimate resulted in 85 000 t with a coefficient of variation of 15%. Figure 3.3.1.3.1. Table 3.3.1.3.1

The definitive anchovy total biomass, to be used as input for the assessment model, will be estimated for November (WGHANSA-sub) based on the final DF estimate.

3.3.1.4 Population at age

In order to estimate the numbers-at-age, 6 strata were defined: southwest (SW), southeast (SE), centre (C), Garonne (G), north (NE) and northwest (NW). The stratification was based on the egg abundance, the adult distribution and the size and age of adult anchovy (Figure 3.3.1.4.1). 74% of the anchovy in numbers were estimate as individuals of age 1 (63% in mass), 20% of the individuals in numbers were of age 2 (28% in mass) and 6% of the individuals in numbers were of age 3 (9% in mass) (Table 3.3.1.4.1). The time-series of the age structure of the population is shown in Figure 3.3.1.4.2.

Table 3.3.1.1.1. Bay of Biscay anchovy: Details of the DEPM survey BIOMAN 2017.

Parameters	Anchovy DEPM survey
Surveyed area	(43º19' to 48º00′N & 7º 42′ to 1º13' W)
R/V	*Ramón Margalef* & *Emma Bardán*
Date	4–26/05/2017
Eggs	RV RAMON MARGALEF
Total egg stations	747
% st with anchovy eggs	67%
Anchovy egg average by st	210 eggs/m^2
Max. anchovy eggs in a St	4270 eggs/m^2
Total ANE egg collected&staged	15 976 eggs
North spawning limit	47º′53′N
West spawning limit	6ºW
Total area surveyed	118 291 Km^2
Spawning area	67 756 Km^2
CUFES stations	1856
Adults	RV EMMA BARDAN
Pelagic trawls	46
With anchovy	36
Selected for analysis	36
Hauls from purse seines	6
Total adult samples for analysis	41

Table 3.3.1.2.1. Bay of Biscay anchovy: Anchovy daily egg production (P_0), daily egg mortality rates (z) and total egg production (P_{tot}) estimates with their correspondent standard error (s.e.) and coefficient of variation (CV) for 2017.

Parameter	Value	S.e.	CV
P_0	89.23	9.34	0.1047
z	0.09	0.051	0.5461
Ptot	6.05.E+12	6.3.E+11	0.1047

Table: 3.3.1.3.1. Bay of Biscay anchovy: Parameters to estimate preliminary index of anchovy total biomass (Tons) using the Daily Egg Production Method (DEPM) for 2017: P_{tot} (total egg production; eggs) and DF (daily fecundity; egg/gramme). Considering DF as last seven years' mean (after the opening of the fishery).

Ptot (eggs)			DF (eggs/gramme)			Total biomass(Ton.)		
Model	Estimate	Var	Predic.Model	Estimate	Var.Pred.	Estimate	Var	Cv
GLM	6.05E+12	4.0E+23	210-2016 mean	70.71	63.80	85,500	1.7.E+08	0.1540

Table: 3.3.1.4.1. Bay of Biscay anchovy: Anchovy index of total biomass, percentage-at-age, numbers-at-age, mean weight-at-age, mean length-at-age, total biomass-at-age in mass and percentage-at-age in mass with the correspondent standard error (s.e.) and coefficient of variation (CV) from BIOMAN 2017. Considering DF as last seven years' mean (after the opening of the fishery).

Parameter	Estimate	S.e.	CV
Biomass (Tons)	85,500	13,169	0.1540
Tot.mean W (g)	15.64	1.37	0.0876
Population (millions)	5,466	969	0.1772
Percent age 1	0.74	0.04	0.0516
Percent age 2	0.20	0.03	0.1436
Percent age 3+	0.06	0.01	0.2132
Numbers at age 1	4,067	750	0.1845
Numbers at age 2	1,077	246	0.2281
Numbers at age 3+	307	85	0.2772
Weight at age 1	13.2	0.98	0.0900
Weight at age 2	22.4	1.00	0.0643
Weight at age 3+	23.5	1.33	0.0498
Length at age 1	119.9	3.60	0.0300
Length at age 2	133.9	2.91	0.0217
Length at age 3+	160.7	2.17	0.0135
B at age 1 in mass	54,049		
B at age 2 in mass	24,197		
B at age 3+ in mass	7,254		
Percent age 1 in mass	0.632	0.04	0.0817
Percent age 2 in mass	0.283	0.03	0.0545
Percent age 3+ in mass	0.085	0.01	0.2178

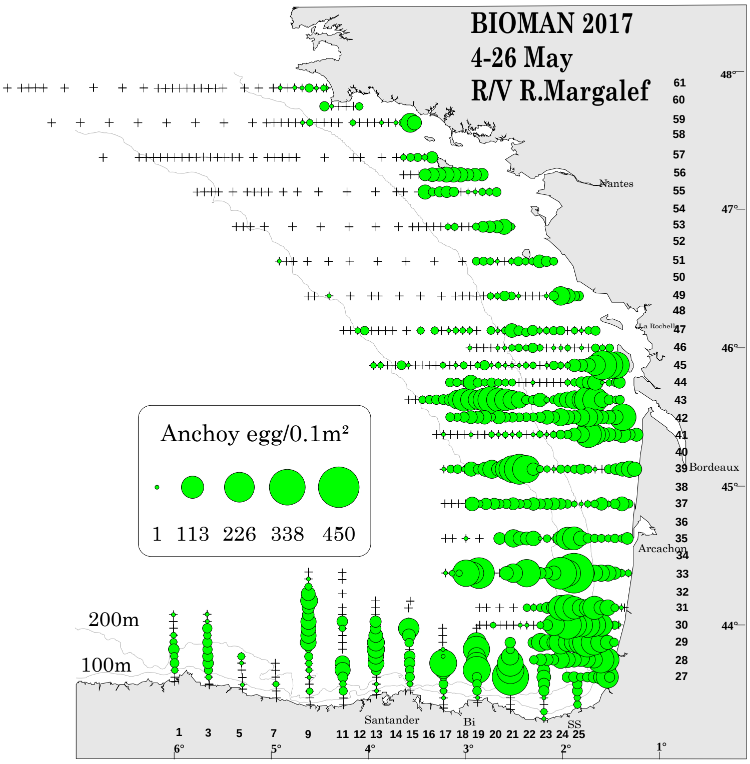


Figure 3.3.1.1.1. Bay of Biscay anchovy: Spatial distribution of anchovy egg abundance (eggs per 0.1 m²) from the DEPM survey BIOMAN2017 obtained with PairoVET (vertical sampling).

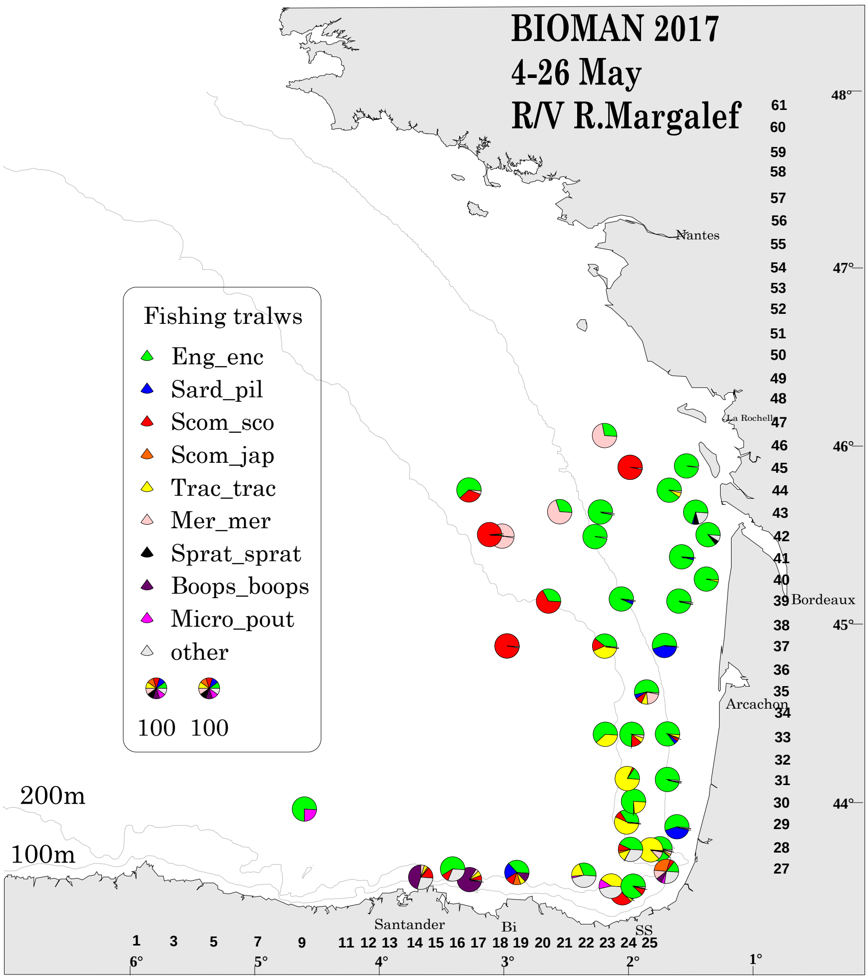


Figure 3.3.1.1.2. Bay of Biscay anchovy: Species composition of the 36 pelagic trawls from the RV Emma Bardán during BIOMAN2017.

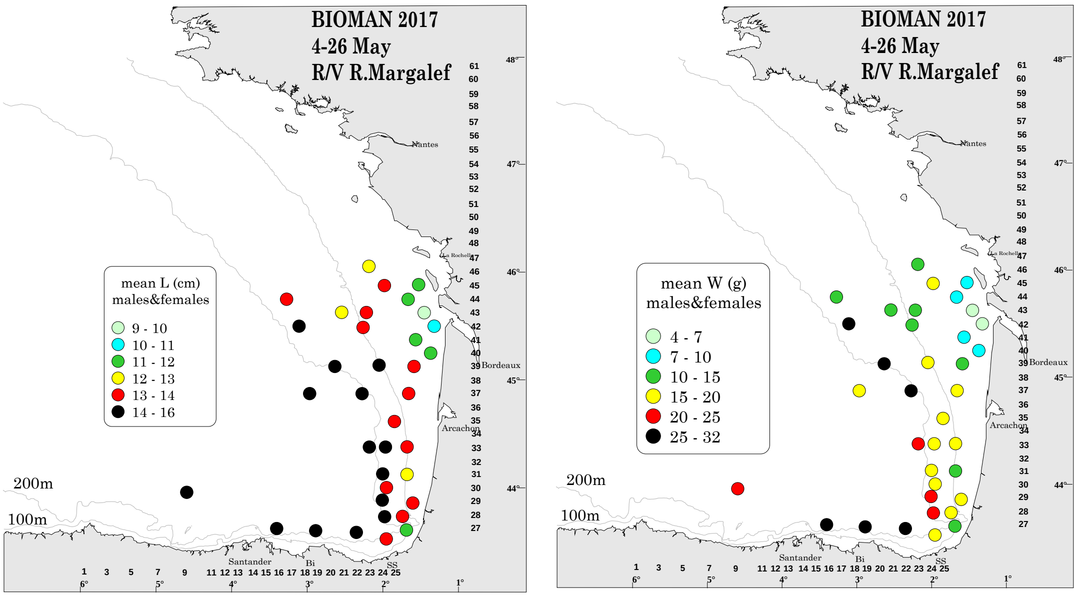


Figure 3.3.1.1.3. Bay of Biscay anchovy: Spatial distribution of anchovy mean size (left) and mean weight (right) (males and females) per haul in BIOMAN2017.

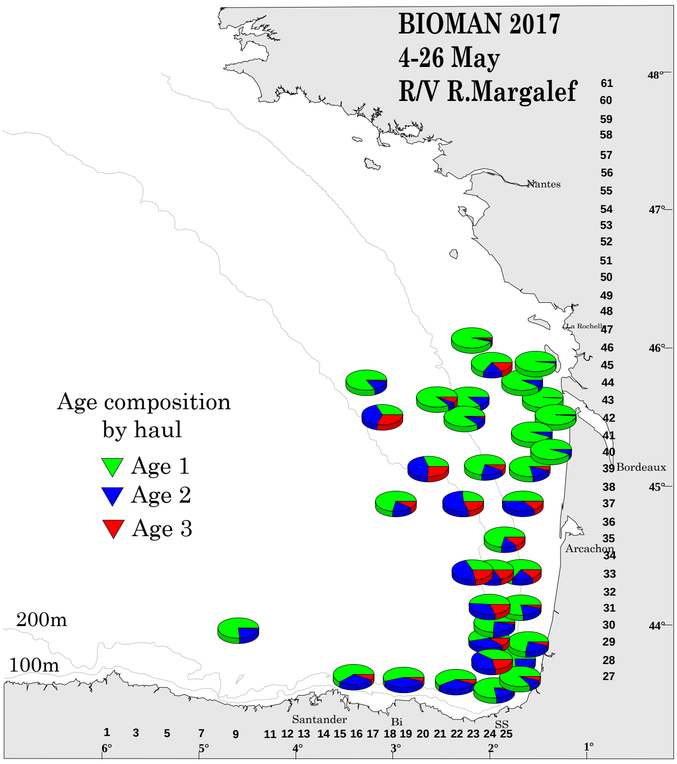


Figure 3.3.1.1.4. Bay of Biscay anchovy: Anchovy age composition by haul in BIOMAN2017.

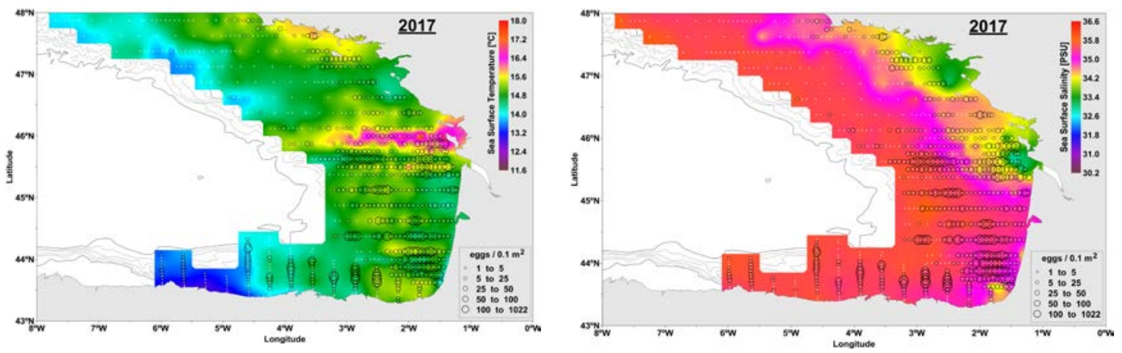


Figure 3.3.1.1.5. Bay of Biscay anchovy: From left to right spatial distribution of SST and SSS in BIOMAN 2017. The bubbles represent the anchovy egg abundance per 0.1m².

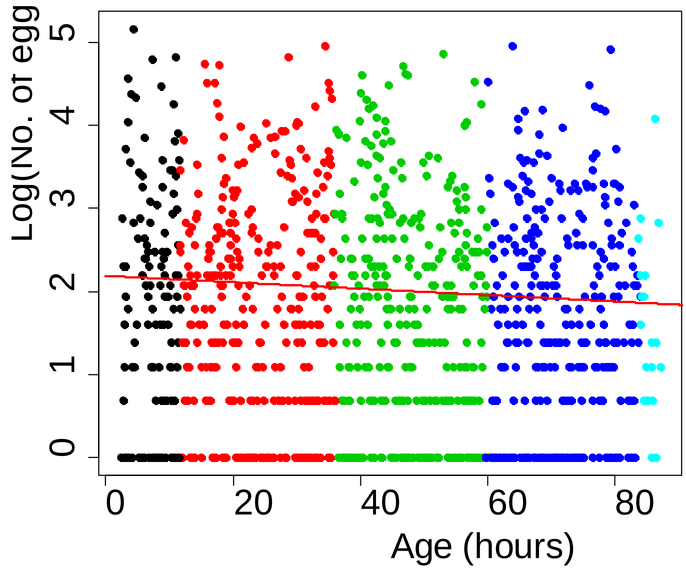


Figure 3.3.1.2.1. Bay of Biscay anchovy: Exponential mortality model adjusted applying a GLM to the data obtained in the Bayesian egg ageing (spawning peak at 23:00h GMT). The red line is the adjusted line. The coloured dots represent the different cohorts.

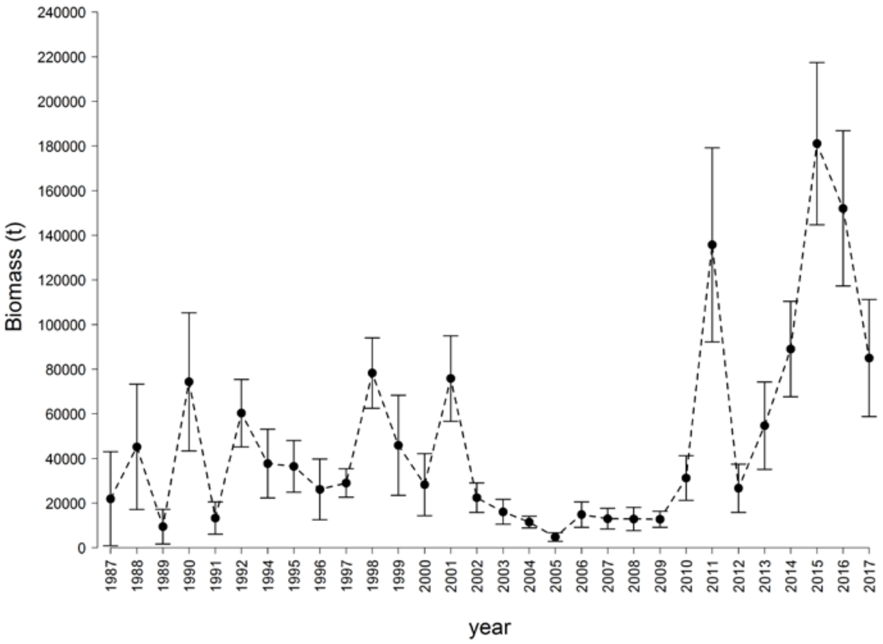


Figure 3.3.1.3.1. Bay of Biscay anchovy: Series of anchovy total biomass estimates (in tonnes) obtained from the DEPM.

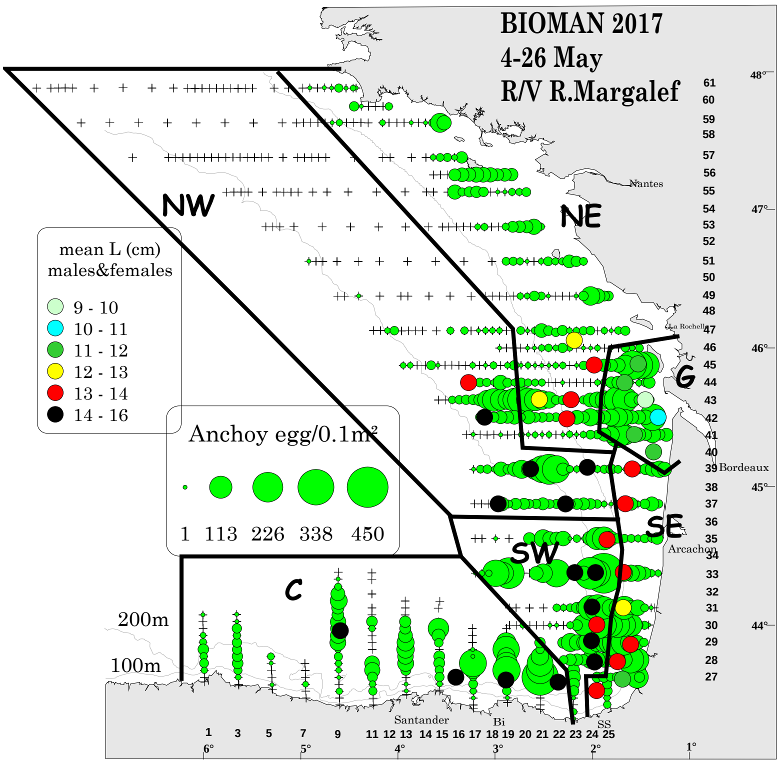


Figure 3.3.1.4.1. Bay of Biscay anchovy: Spatial 6 strata to weight the samples to estimate anchovy numbers-at-age in BIOMAN2017.

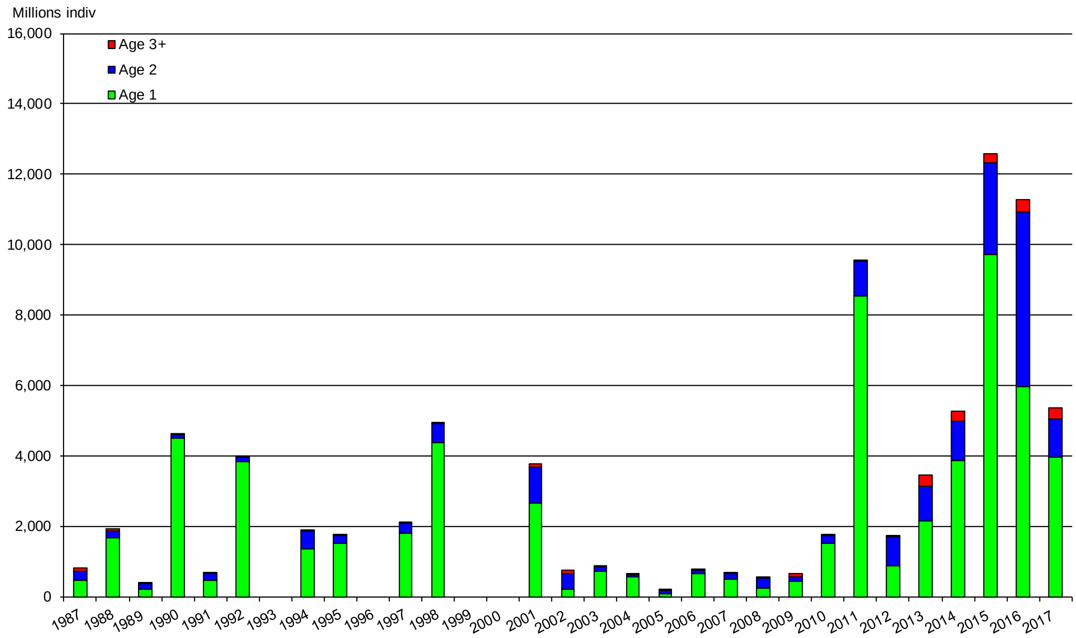


Figure 3.3.1.4.2. Bay of Biscay anchovy: Anchovy historical series of numbers-at-age from 1987 to 2017 from BIOMAN surveys.

3.3.2 The PELGAS 17 spring acoustic survey

[for more details, see WD Duhamel *et al*. (2017) presented to this group]

Acoustic surveys are carried out every year in the Bay of Biscay in spring on board the French research vessel Thalassa. The objective of PELGAS surveys is to study the abundance and distribution of pelagic fish in the Bay of Biscay. The main target species are anchovy and sardine but they are considered in a multispecific context and within an ecosystemic approach as they are located in the centre of pelagic ecosystem.

The strategy this year was the identical to previous surveys (2000 to 2016). The protocol for acoustics has been described during WGACEGG in 2009 (Doray *et al*., 2009):

- acoustic data were collected along systematic parallel transects perpendicular to the French coast (Figure 3.3.2.1.). The length of the ESDU (Elementary Sampling Distance Unit) was 1 mile and the transects were uniformly spaced by 12 nautical miles and cover the continental shelf from 20 m depth to the shelf break (or sometimes more offshore, see figure below).
- acoustic data were only collected during the day because of pelagic fishes behaviour in this area. These species are usually dispersed very close to the surface during the night and so "disappear" in the blind layer of the echosounder between the surface and 8 m depth.

Acoustic data were collected by RV Thalassa along a total amount of 5171 nautical miles from which 1896 nautical miles on one way transect were used for assessment. A total of 19 461 fishes were measured (including 5601 anchovies and 4147 sardines) and 2990 otoliths were collected for age determination (1455 of anchovy and 1535 of sardine).

A consort survey is routinely organized since 2007 with French pair trawlers during 18 days. This approach, in the continuity of last year survey, and the commercial vessels hauls were used for echo identification and biological parameters at the same level than Thalassa ones. A total of 113 hauls (including seven not valid) were carried out during the consort survey including 65 hauls by the RV Thalassa and 41 hauls by commercial vessels. (Figure 3.3.2.2).

As for previous years (except in 2003, see WD-2003), the global area has been split into several strata where coherent communities were observed (species associations) in order to minimise the variability due to the variable mixing of species. Figure 3.3.2.3 shows the strata considered to evaluate biomass of each species. For each strata, energies where converted into biomass by applying catch ratio, length distributions and weighted by abundance of fish in the haul surrounded area.

Anchovy was present this year at a relatively high level, far away the huge abundance observed in 2015 (which may be overestimated), with around 135 000 tonnes of biomass, with usual densities in the Gironde area. It must be noticed that we observed, as last year, anchovy on the first transect along the Spanish coast in relatively high densities, mainly close to the surface. (Table 3.3.2.1 and Figure 3.3.2.4).

The one year old anchovies were mostly present front of the Gironde (in terms of energy and, as well, biomass) but they were still well present on the platform, till Brittany along the bathymetric line of 100 m. The average size of one year old fish was comparable the average size in recent years (two years really differed from the average: 2012 and particularly 2015 where fishes were much smaller) but shows a clear decreasing trend, year after year.

One year old anchovies were also present, in lower quantities, mixed with older fish, even offshore.

Looking at the numbers-at-age since 2000 (Figure 3.3.2.5.), the number of 1 year old anchovies this year seems to be equivalent as 2011 or 2012, when relative good recruitments occurred.

Globally we observe that length structure shows a unimodal distribution, with a mode around 13 centimetres (constituted by age 1 and age 2 fishes). It must be noticed that even if some individuals were small (less than 10 centimetres), almost all fish were mature and in their spawning period. This observation on maturity contrasted with the 2015 observation where a large proportion of the population was not spawning at the period of the survey. (Figure 3.3.2.6).

No CUFES index, vertically integrated by the vertical model, was processed for the working group. It will be done for the next WGACEGG.

In Figure 3.3.2.7, we can see that globally the spatial distribution of eggs match with the adult's one. But on the first transect, at the east, a lot of eggs were counted despite a low abundance of adults. It could be due to the presence of fish completely closed to the surface, in the blind layer of echosounders, or due to some movements of fish to north or west.

Table 3.3.2.1. Acoustic biomass index for sardine and anchovy by strata during PELGAS17.

	Classic	surface	total
boarfish	11 247		11 247
anchovy	**110 887**	**23 613**	**134 500**
hake	22 494		22 494
blue whiting	36 961	4 507	41 468
sardine	**431 332**	**33 689**	**465 022**
chub mackerel	44 929	3 118	48 047
mackerel	1 208 675	167 186	1 375 861
sprat	15 778		15 778
horse Mackerel	46 628	15 272	61 899

Table 3.3.2.2. Acoustic biomass index for the five main pelagic species since the beginning of PELGAS surveys (2000).

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
anchovy	**113 120**	**105 801**	**110 566**	**30 632**	**45 965**	**14 643**	**30 877**	**40 876**	**37 574**	**34 855**	**86 354**	**142 601**	**186 865**	**93 854**	**125 427**	**372 916**	**89 727**	**134 500**
	14 479	29 836	24 988	8 087	15 352	5 008	8 399	8 175	12 174	7 808	25 388	22 078	17 433	24 067	15 786	54 857	23 329	41 517
CV anchovy	*0,064*	*0,141*	*0,113*	*0,132*	*0,167*	*0,171*	*0,136*	*0,100*	*0,162*	*0,112*	*0,147*	*0,0774*	*0,04665*	*0,1282*	*0,062928*	*0,0735509*	*0,13*	*0,15433929*
Sardine	**376 442**	**383 515**	**563 880**	**111 234**	**496 371**	**435 287**	**234 128**	**126 237**	**460 727**	**479 684**	**457 081**	**338 468**	**205 627**	**407 740**	**339 607**	**416 524**	**229 742**	**465 022**
	62 489	89 743	99 243	53 615	120 122	117 528	54 786	40 143	128 082	94 018	83 189	47 323	31 537	60 200	44 293	85 234	36 759	56 410
CV sardine	*0,083*	*0,117*	*0,088*	*0,241*	*0,121*	*0,135*	*0,117*	*0,159*	*0,139*	*0,098*	*0,091*	*0,0699*	*0,07668*	*0,0738*	*0,065212*	*0,1023153*	*0,08*	*0,06065334*
Sprat	**30 034**	**137 908**	**77 812**	**23 994**	**15 807**	**72 684**	**30 009**	**17 312**	**50 092**	**112 497**	**67 046**	**34 726**	**6 417**	**44 651**	**33 894**	**91 248**	**36 593**	**15 778**
	5 881	42 752	18 675	9 502	5 627	33 144	9 723	4 570	26 849	24 299	14 482	0	0	17 791	16 337	35 649	32 202	16 631
CV sprat	*0,098*	*0,155*	*0,120*	*0,198*	*0,178*	*0,228*	*0,162*	*0,132*	*0,268*	*0,108*	*0,108*	*0*	*0*	*0,1992*	*0,241009*	*0,1953397*	*0,44*	*0,52701049*
Horse mackere	**230 530**	**149 053**	**191 258**	**198 528**	**186 046**	**181 448**	**156 300**	**45 098**	**100 406**	**56 593**	**11 662**	**61 237**	**7 435**	**33 471**	**53 154**	**77 142**	**119 230**	**61 919**
	36 424	60 814	59 672	54 397	106 791	58 063	98 782	5 863	91 370	10 187	4 385	0	0	20 127	24 141	23 911	71 538	35 705
CV HM	*0,079*	*0,204*	*0,156*	*0,137*	*0,287*	*0,160*	*0,316*	*0,065*	*0,455*	*0,09*	*0,188*	*0*	*0*	*0,3007*	*0,227089*	*0,1549802*	*0,3*	*0,28831771*
Blue Whiting	-	-	**35 518**	**1 953**	**12 267**	**26 099**	**1 766**	**3 545**	**576**	**4 333**	**48 141**	**11 823**	**68 533**	**25 715**	**25 015**	**8 684**	**11 852**	**23 944**
	-	-	27 420	512	4 956	30 953	742	1 042	292	1 898	7 125	0	0	7 931	16 891	3 881	3 556	7 042
CV BW	-	-	*0,386*	*0,131*	*0,202*	*0,593*	*0,210*	*0,147*	*0,253*	*0,219*	*0,074*	*0*	*0*	*0,1542*	*0,337606*	*0,2234791*	*0,15*	*0,14706269*

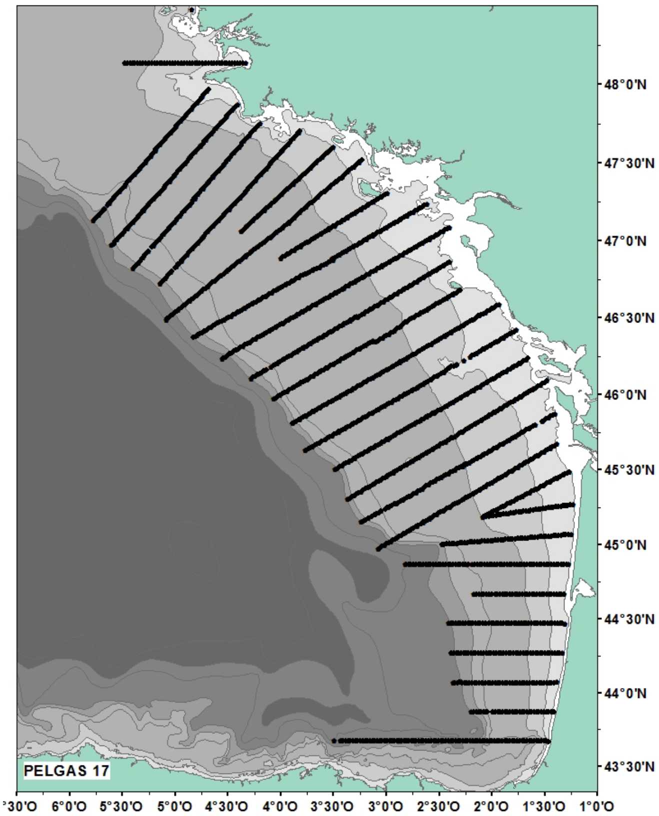
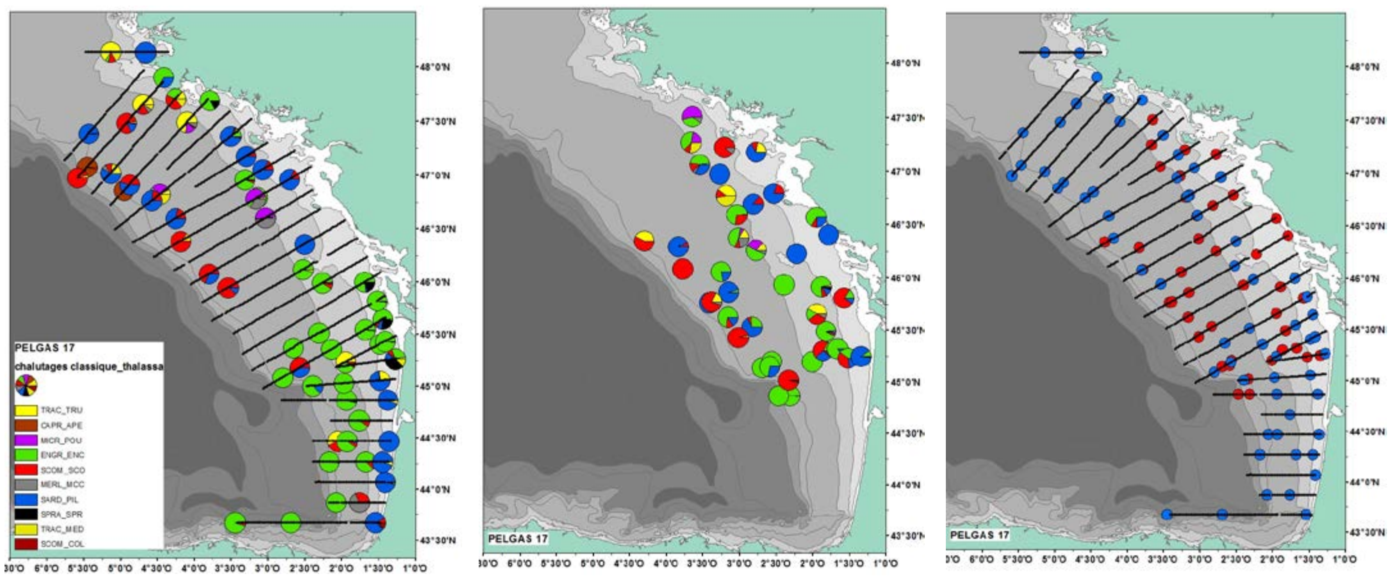


Figure 3.3.2.1. Acoustic transects network during PELGAS17 survey.

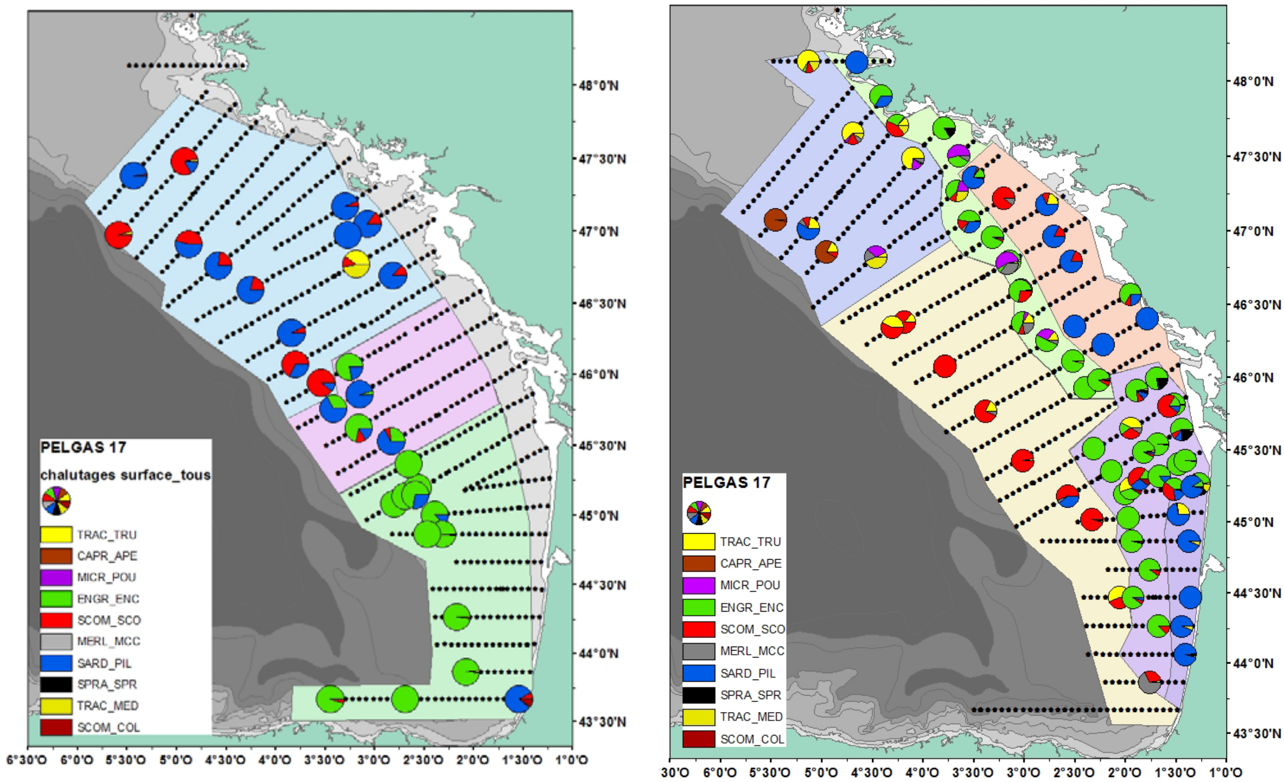


a) Thalassa (nb :65)

b) Commercial vessels (nb : 41)

c) all fishing hauls (nb :106) Thalassa in Blue and commercial in red

Figure 3.3.2.2 fishing operations carried out by Thalassa and commercial vessels during consort survey PELGAS17.



Coherent surface strata | Coherent classic strata

Figure 3.3.2.3. Coherent strata (for classic and surface echotraces) according to species distributions for abundance indices estimates.

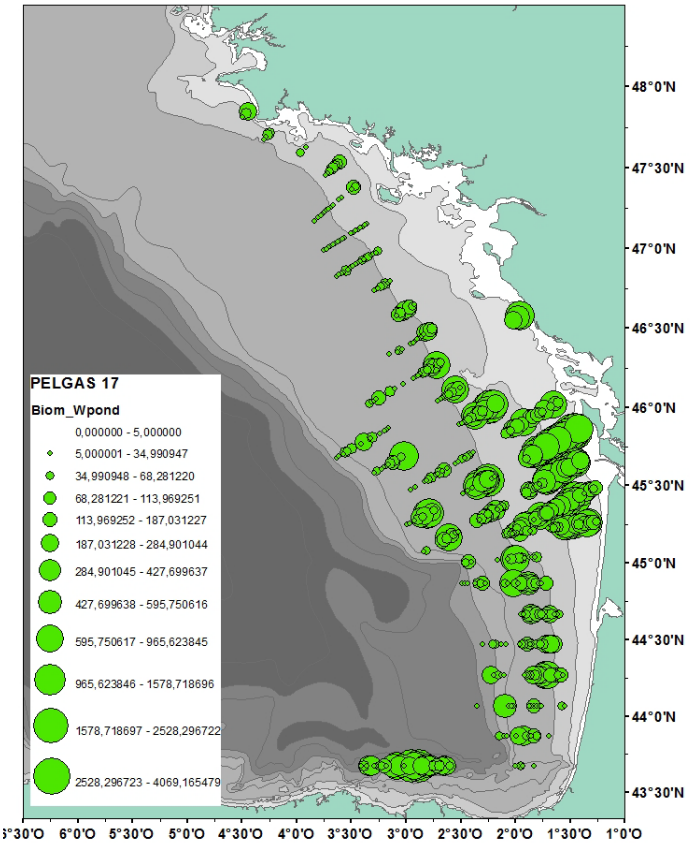


Figure 3.3.2.4. Adult anchovy distribution (density / ESDU) during PELGAS17.

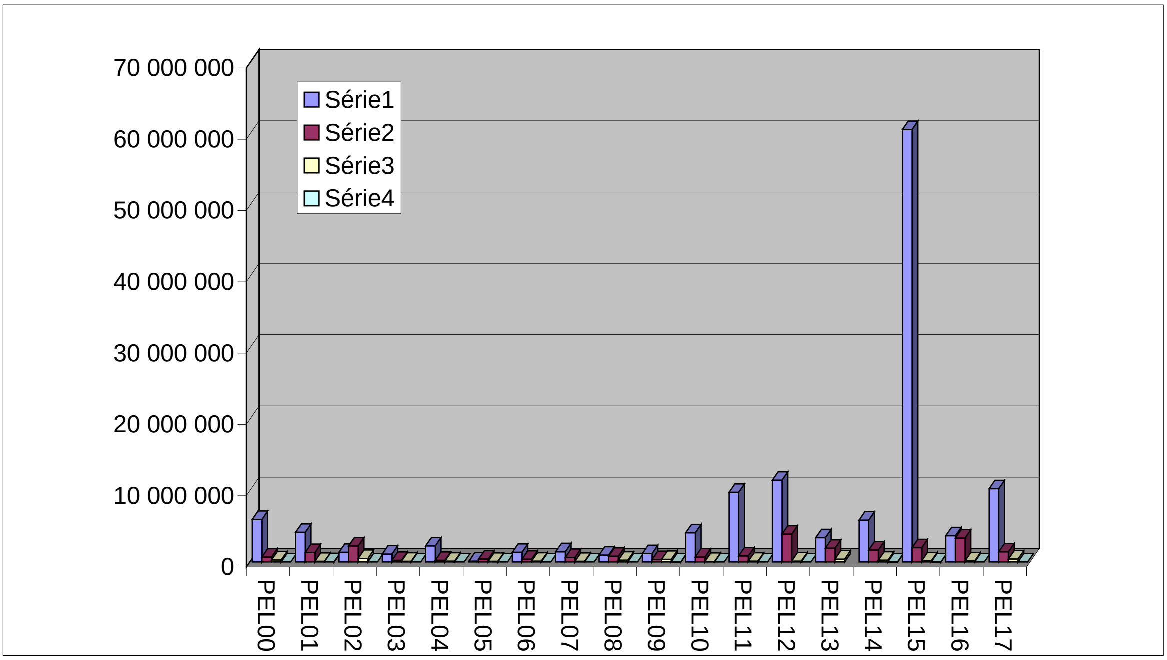


Figure 3.3.2.5. Age distribution of anchovy along PELGAS series.

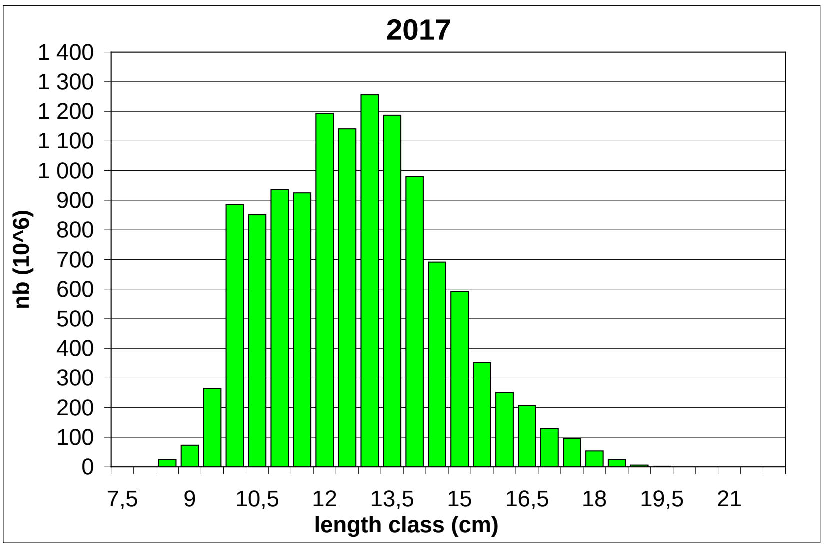


Figure 3.3.2.6. Length distribution of global anchovy as observed during PELGAS17.

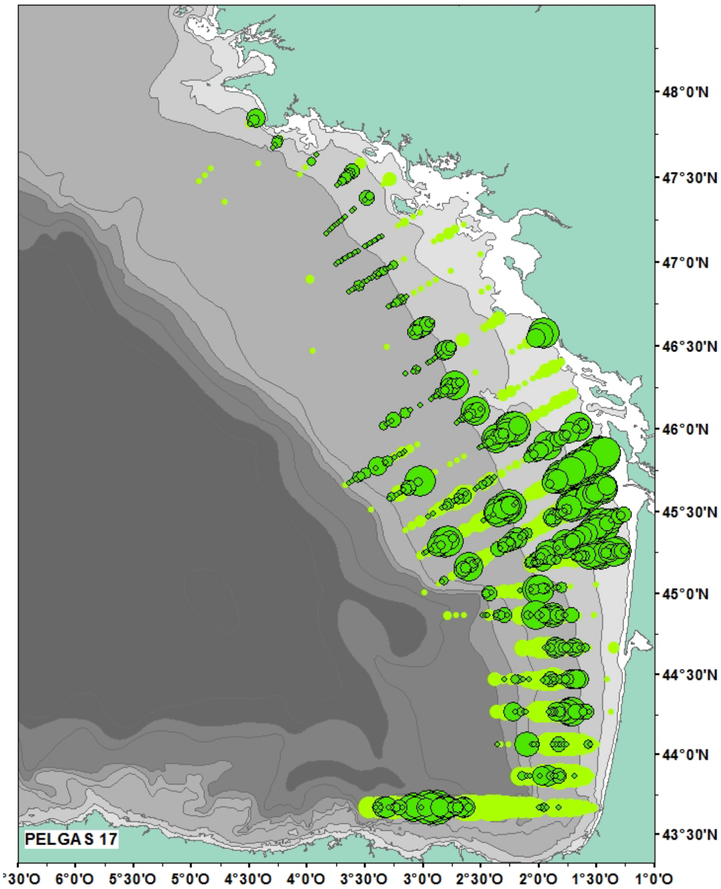


Figure 3.3.2.7. Coherence between spatial distribution of adults and eggs. Circled point = biomass of adults per ESDU, without circle = eggs.

3.3.3 Autumn juvenile acoustic survey 2016 (JUVENA 2016)

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 2016 were reported and discussed in autumn 2016 in WGACEGG meeting (Boyra *et al*., 2016, WD WGACEGG2016). The Estimate of anchovy juvenile abundance produced by this survey was already used in the assessment of the anchovy population carried out in November 2016 to produce the advice for 2017. Therefore, as the survey is already reported in WGACEGG report (ICES, 2016) here below it follows just a short summary.

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 2016, as in previous years, the survey was coordinated between AZTI and IEO. AZTI led the assessment studies whereas IEO led the ecological studies. The survey JUVENA 2016 took place between the 1st and 30th of September on board RV Ramon Margalef and the RV Emma Bardán, both equipped with scientific echosounders (Boyra *et al*., 2016; WD to WGACEGG). The sampling area covered the waters of the Bay of Biscay, being 7º32’W and 47º45’N the limits, following the standard transect design and acoustic methods as in previous years. 78 hauls were done during the survey to identify the species detected by the acoustic equipment, 54 of which were positive of anchovy (Figure 3.3.3.1). As usual, it was found anchovy distributed along two different strata: a pure juvenile anchovy stratum, offshore and along the Cantabrian coasts, and a mixed juvenile-adult stratum in the Garonne and more northern areas (Figure 3.3.3.2).

The biomass of juveniles estimated for this year was 371 563 tones (Table 3.3.3.1). This value, is the fourth maximum biomass of the JUVENA series, well above the average. The area of distribution of juvenile anchovy was also among the highest in the temporal series. The mean size of anchovy was slightly less than 7 cm. As usual, most of this biomass was located off-the-shelf or in the outer part of the shelf (Figure 3.3.3.3) in the first layers of the water column.

Table 3.3.3.1. Bay of Biscay anchovy: Summary of the estimates obtained in JUVENA autumn acoustic surveys from 2003 to 2016.

Year	Sampled area (mn2)	Posit area (mn2)	Size juv (cm)	Biom Juvenile (year y)
2003	16,829	3,476	7.9	98,601
2004	12,736	1,907	10.6	2,406
2005	25,176	7,790	6.7	134,131
2006	27,125	7,063	8.1	78,298
2007	23,116	5,677	5.4	13,121
2008	23,325	6,895	7.5	20,879
2009	34,585	12,984	9.1	178,028
2010	40,500	21,110	8.3	599,990
2011	37,500	21,063	6	207,625
2012	31,724	14,271	6.4	142,083
2013	32,500	18,189	7.4	105,271
2014	50,102	37,169	5.9	723,946
2015	32,763	21,867	6.8	462,340
2016	45,000	16,933	7.3	371,563

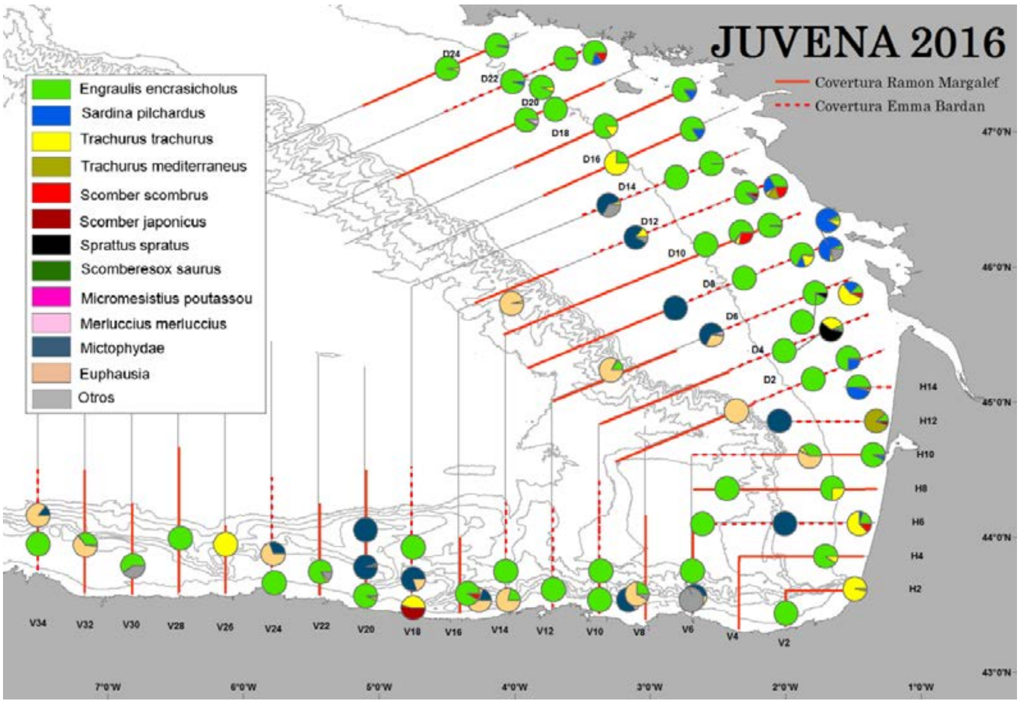


Figure 3.3.3.1. Bay of Biscay anchovy. Surveying transects and spatial distribution and species composition of the pelagic hauls in JUVENA 2016.

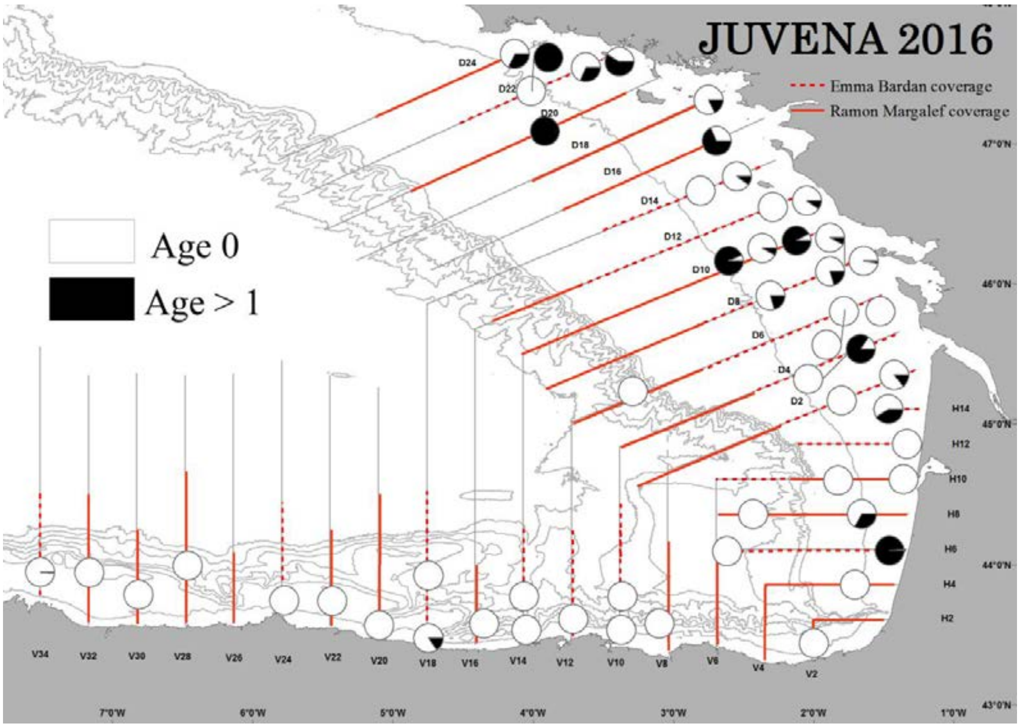


Figure 3.3.3.2. Bay of Biscay anchovy JUVENA 2016. Positive area of anchovy. The pie charts show the percentage of juveniles (white) and adults (black) in the fishing hauls.

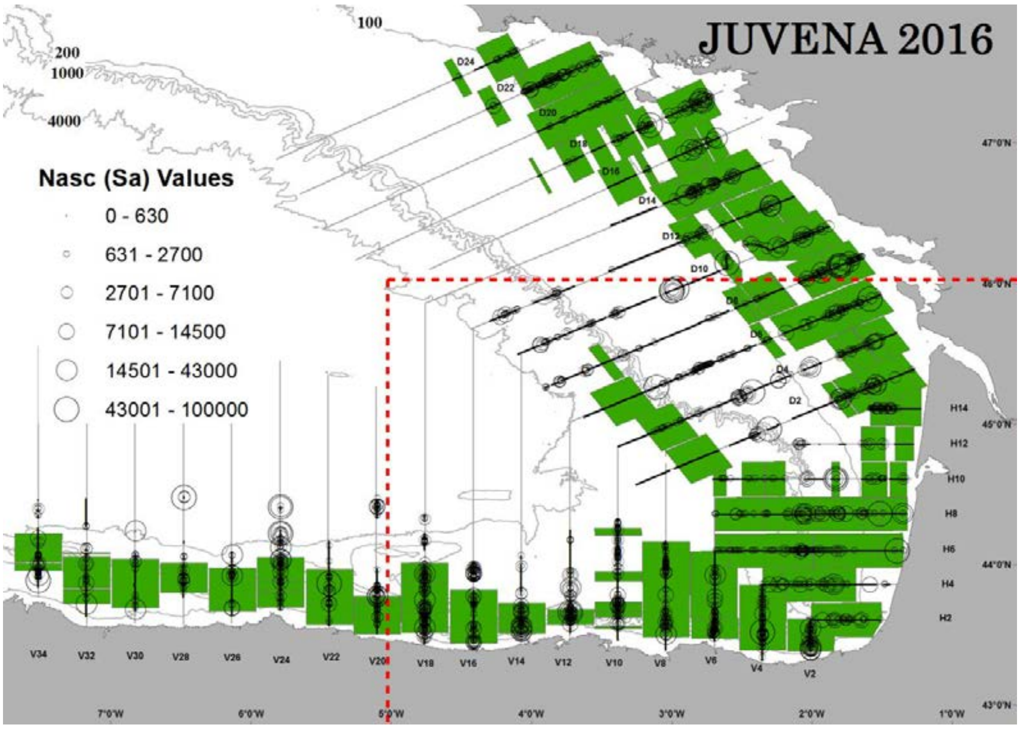


Figure 3.3.3.3. Bay of Biscay anchovy JUVENA 2016. Total acoustic energy (NASC) of anchovy.

3.4 Biological data

3.4.1 Maturity-at-age

As reported in previous year reports, anchovies are fully mature as soon as they reach their first year of life, in the spring the year after the hatch. See stock annex - Bay of Biscay Anchovy (Subarea 8) for details.

3.4.2 Natural mortality and weight-at-age in the stock

Natural mortality is fixed at 0.8 for age 1 and 1.2 for older individuals (age 2+).

In the CBBM assessment model the parameters G_1 and G_{2+} representing the annual intrinsic growth of the population by age class are assumed constant along years and are estimated based on the weight-at-age data from the surveys.

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

3.5 State of the stock

According to the stock annex approved in October 2013, the assessment of this stock can be conducted in June or December. The management plan applied in the last years is based on the December assessment. So, this year the final assessment of the stock will also be conducted in December 2017.

3.6 Short-term prediction

The short-term prediction of the population in order to explore catch options will be conducted in December, once the final assessment of the stock is conducted.

3.7 Reference points and management considerations

3.7.1 Reference points

The reference points and their definitions are found in the stock annex for this stock, which was approved in October 2013.

Bay of Biscay anchovy is a short-lived species classified in category 1. According to the guidelines, the classification of status of stock for short-lived species should be based directly on the distribution of SSB at spawning time relative to B_{lim}. B_{lim} is set at 21 000 tonnes. Given that the current assessment provides the probability distributions for SSB, the probability of SSB being below B_{lim} can be directly estimated and the definition of B_{pa} becomes irrelevant. Alternatively, F 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.

According to the recent advisory practice (ICES Advice 2016, Book1, Section 1.2 General context of ICES advice), the ICES MSY approach for short-lived stocks is aimed at achieving a target escapement (MSY $B_{escapement}$, the amount of biomass left to spawn), which is more robust against low SSB and recruitment failure than a fishing mortality approach. This applies to the Bay of Biscay anchovy. Hence, defining an F_{MSY} is irrelevant, and advice aiming at MSY is equivalent to the precautionary approach advice. MSY $B_{escapement}$ has not been defined for this stock.

3.7.2 Short-term advice

Providing a risk adverse advice according to the precautionary approach in the short-term perspective, translates into recommending a TAC which implies a low risk of leading below B_{lim}, for selected scenario(s) of recruitment.

The Bayesian assessment model provide estimates of the uncertainty which are expressed as posterior distributions of the interest parameters. The posterior distributions express the uncertainty of the results given the uncertainty of the data and the prior assumptions, and presumably represent more realistic estimates of the uncertainty than the assumptions underlying the distance between B_{lim} and B_{PA} in the common deterministic framework.

According to the current stock annex the assessment of this stock can be conducted at two points in time: in June when SSB is estimated based on the most recent spring surveys information and in December when the assessment can incorporate the most recent juvenile abundance index from JUVENA and any other updated data.

Similarly, the forecast can be given based either on the June or December assessment. In the former the assessment goes up to June, and given that there is no indication on the strength of the incoming year class, an undetermined scenario is assumed based on a mixture distribution of all the past recruitments. In the later the assessment covers the whole year up to December and the next year recruitment distribution is derived from the assessment which includes the latest juvenile abundance index.

3.7.3 Management plans

A draft management plan was proposed by the EC in 2009 in cooperation between science (STECF) and stakeholders (South Western 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 B_{lim}, and leaded to a small increase in quantity and stability of catches in comparison to 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 3.7.3.1). According to this rule, the TAC for the management period from January to December is set as:

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

where is the expected spawning–stock biomass in year. 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 recommend 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 3.7.3.1), which sets the TAC for the management period from January to December as:

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

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

3.7.4 Species interaction effects and ecosystem drivers

Anchovy is a prey species for other pelagic and demersal species, and also for cetaceans and birds. Recruitment depends strongly on environmental factors, and several recruitment predictions have been proposed in the past based on environmental variables. Approaches like the one presented in Fernandes *et al*. (2010) look promising, but its prediction capacity is still being tested.

3.7.5 Ecosystem effects of fisheries

These effects are not quantified.

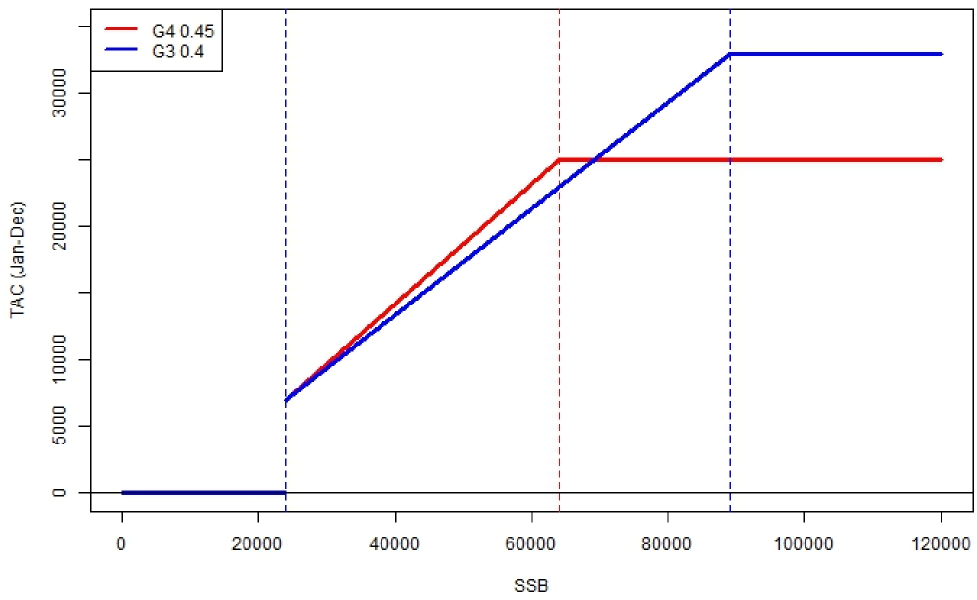


Figure 3.7.3.1. Bay of Biscay anchovy: Harvest control rules G4 with harvest rate of 0.45 (in red) and G3 with harvest rate of 0.4 (in blue) according to which the TAC from January to December is set as a function of the expected spawning–stock biomass (on 15th May) in the management year.

4 Anchovy in Division 9.a

4.1 ACOM Advice applicable to 2016 and 2017

The lack of available data on year classes that constitute the bulk of the biomass and catches (no survey indices for such year classes are available at the time of the formulation of the advice) prevents to ICES from giving catch advice in the last years, including 2017. ICES notes, however, that the historical fisheries along the division seem to have been sustainable.

The 2016 annual TAC was agreed in 10 622 t (PT: 5542 t; ES: 5080 t). A 2016 in-year assessment allowed to increase this TAC up to 15 000 t. Official anchovy landings in the division in 2016 were of 13 583 t. The agreed TAC in 2017 is 12 500 t (PT: 6522 t; ES: 5978 t).

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 on the stock and the need for a reliable index of recruitment strength.

4.2 The fishery in 2016

4.2.1 Fishing fleets

Anchovy harvesting throughout the Division 9.a was carried out in 2016 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 miscellaneous fleet in 9.a North and 9.a South (artisanal métiers accidentally fishing anchovy) (MIS_MIS_0_0_0_HC).
- Spanish artisanal trammel and gillnets in 9a North (GTR_DEF_40-59_0_0, GNS_DEF_60-79_0_0 accidental anchovy landings).
- Spanish set longline directed to demersal fish in 9.a South (LLS_DEF_0_0_0 accidental anchovy landings).
- Spanish bottom otter trawl directed to demersal fish in 9.a South (OTB_DEF_>=55_0_0 anchovy discards).

Technical characteristics of the Portuguese fleets fishing anchovy in 2016 in Division 9.a are described in the sardine section of this report.

The purse-seine fleet operated by Spain in the Subdivision 9.a North was composed in 2016 by a total of 150 vessels. From this total, 77 vessels captured anchovy in the Subdivision (**Table 4.2.1.1**).

Number and technical characteristics of the purse-seine vessels operated by Spain in their national waters off Gulf of Cadiz (Subdivision 9.a South), differentiated between total operative fleet and fleet targeting anchovy are also summarised in **Table 4.2.1.1**. In 2016, the Spanish fleet fishing in the Gulf of Cadiz with purse-seine was composed by 106 vessels. Gulf of Cadiz anchovy fishing was practised by the 78 purse seiners. Details of the dynamics of this fleet in terms of number of operative vessels over time in recent years are given in the Stock Annex and in previous WG reports.

4.2.2 Catches by fleet and area

4.2.2.1 Catches in Division 9.a

Anchovy total catches in 2016 were 13 740 t, which represented a 43% increase in relation to the catches landed in the previous year (9597 t), and well above the historical average in the recent series (at about 6000 t; **Table 4.2.2.1.1**, **Figure 4.2.2.1.1**).

The contribution by each subdivision to the total catch was characterized in 2016 by important increases in landings in the Subdivisions 9.a North and, particularly, in the Central-North, where the anchovy fishery accounted for 50% of the whole fishery in the division. Anchovy landings from the Spanish waters of the Gulf of Cadiz (Subdivision 9.a South, where the fishery usually takes place) accounted for 48% of total landings in the division (**Tables 4.2.2.1.2** and **4.2.2.2.1**).

As usual, the anchovy fishery in 2016 was almost exclusively harvested by purse seine fleets (99% of total catches; **Table 4.2.2.1.2**). However, unlike the Spanish fleet fishing in the Gulf of Cadiz, the remaining purse-seine fleets in the division (targeting sardine and fishing anchovy as a commercial bycatch) only target anchovy when its abundance is high, as occurred in 2011 and in 2014–2016.

4.2.2.2 Catches by subdivision

The updated historical series of anchovy catches by Subdivision are shown in **Table 4.2.2.1.1** (see also **Figure 4.2.2.1.1**). **Table 4.2.2.1.2** shows the contribution of each fleet in the total annual catches by subdivision. The seasonal distribution of 2016 catches by subdivision is shown in **Table 4.2.2.2.1**.

Subdivision 9.a North

Anchovy catches in 2016, 222 t, showed a 28% increase in relation to the 173 t recorded in 2015. Catches from this subdivision only accounted for about 2 % of total catches in the whole Division 9.a and occurred mainly during the third and fourth quarters in the year.

Subdivision 9.a Central-North

Anchovy catches in 2016 (6908 t) experienced a huge increase in relation to the previous year (2533 t), becoming in the highest value ever recorded within the historical. Catches from this subdivision represented 50% of the total anchovy fishery in the division. The 2016 anchovy fishery in this subdivision was concentrated in the third quarter.

Subdivision 9.a Central-South

Anchovy catches in this subdivision in 2016 were only 10 t (0.1% of total landings in the division). The fishery in this subdivision was mainly concentrated in 2016 in the third quarter as well.

Subdivision 9.a South

Catches in 2016 (6599 t; 48% of the whole fishery) experienced a 4% decrease in relation to 2015 (6880 t). As usual, the Spanish waters of the subdivision yielded the bulk of the fishery in these southernmost areas (6581 t). Spanish catches herein presented are the result of the sum of official landings (6424 t), and estimates of discarded (156 t) catches (see **Section 4.2.3**). In this subdivision the fishery in 2016 mainly developed through the three first quarters in the year, outstanding, as usual, catches in the second and third quarters.

4.2.3 Discards

See the Stock Annex for previous available information on discards.

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

Data on anchovy discarding in the Spanish fisheries operating in the Gulf of Cadiz (Subdivision 9.a South) are being gathered on a quarterly basis since the fourth quarter in 2009 on, within the Spanish National Sampling Scheme framed into the EC Data Collection Regulation (DCR). However, the sampling intensity applied until 2013 to assess the anchovy discarding was very low because it was limited to the agreed minimum sampling scheme (two trips per quarter, eight trips per year). Such a sampling scheme resulted in unreliable and not representative quarterly discard estimates which were also affected by high CVs. This low sample size made their results not conclusive and hence they were not considered. Since 2014 on a more intense sampling scheme was developed which also extends to the Spanish fishery in Subdivision 9.a North.

Zero anchovy discards were estimated for the Galician fishery in 9.a North. Quarterly and annual estimates of discarded catches by size class and gear are shown in **Tables 4.2.5.1.9** and **4.2.5.1.11** (purse-seine and bottom trawl discards in 9.a South, respectively). The overall annual discard ratio for the Spanish fishery in 9.a South, was 0.024 (2.4%). Therefore, anchovy discards for the Spanish fishery in 2016 may also be considered as negligible.

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

4.2.4 Effort and landings per unit of effort

Annual standardised lpue series for the whole Spanish purse-seine fleet fishing Gulf of Cadiz anchovy (Subdivision 9.a-South) are routinely provided to this WG. An update of the available series (1988–2016) has been provided this year to this WG. Details of data availability and the standardisation process are commented in the Stock Annex. The recent dynamics of fishing effort and lpue for this fleet has been described in previous WG reports. Fishing effort experienced a relative decrease between 2008 and 2010 which was coupled to a relative stable trend in the lpue (at around 0.7 t/fishing day). A combination of fishing closures, both in the beginning and in the end of the year, bad weather at the start and/or the end of the fishing season, and the displacement of a part of the fleet to the Moroccan fishing grounds (under the EC-Morocco Fishery Agreement) at the same time of the re-opening of the Gulf of Cadiz fishery (usually in February), may be the causes of the observed decrease in the fishing effort for the period 2008–2010. From 2011 to 2013 the EC-

Morocco Fishery Agreement was not renewed and the whole fleet was again fishing in the Gulf of Cadiz probably causing the increase in the effort observed in 2011. The premature closure of the fishery in 2012 because of the consumption of the national quota may be the responsible for the lower total annual effort levels exerted in the fishery that year. Since 2013 on the effort has exhibited a slight increase with values (ca. 6000–6400 fishing days, except in 2015, with ca. 5000 fishing days) above the historical average (ca. 5500 fishing days). Regarding lpue, 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. The available historical series of effort and lpue estimates are shown in **Table 4.2.4.1** and **Figure 4.2.4.1**.

4.2.5 Catches by length and catches-at-age by subdivision

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 Gulf of Cadiz (Subdivision 9.a South), since the anchovy fishery in the division is traditionally concentrated there. Data from the Spanish fishery in Subdivision 9.a North are 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 South (Algarve)), although in this case anchovy is also a group 3 species in its national sampling programme for DCF. Nevertheless, the local increases of anchovy abundance in Subdivisions 9.a North and Central North recorded since 2014 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.

Quarterly LFDs in 2016 has been provided for the Spanish fishery in Subdivisions 9.a North and 9.a South. LFDs from the Portuguese fishery provided to this WG are those ones from the anchovy fishery in Subdivisions 9.a Central-North and South.

Catch-at-age data in 2016 have been provided only for the Spanish fishery in the Subdivision 9.a North and South.

No age structure is available for 2016 Portuguese anchovy catches. The available age readings from the main fishery and fishing season (purse seine in 9a C-N in 3rd quarter) are restricted to the smallest fish only (<15 cm, all age-1 fish).

4.2.5.1 Length distributions

Subdivision 9.a North

Quarterly and annual size composition of anchovy catches by métier and for the whole fishery in the Subdivision 9.a North in 2016 are shown in **Tables 4.2.5.1.1** to **4.2.5.1.5**. Size range in catches from the whole fishery was comprised between 11.0 and 16.0 cm size classes (mode at 13.0 cm size class), with an annual mean size and weight in catches being estimated at 13.2 cm and 14.8 g, respectively.

Subdivision 9.a Central-North and 9.a Central-South

The available size compositions of 2016 anchovy catches from the Subdivision 9.a Central-North are shown in **Tables 4.2.5.1.6** and **4.2.5.1.7**. These length–frequency distributions (LFDs) correspond to catches landed by purse-seine and bottom-trawl fleets in some but not all the quarters with catches, hence no raising and further pooling processes were applied in order to obtain overall LFDs by quarters for the whole fishery. Anchovy size composition in purse-seine catches (i.e. the main fishery) ranged, depending on the quarter, between 10.0 and 17.5 cm size classes in the second quarter (mode at 13.50 cm size class; mean size of 13.9 cm), and between 12.0 and 18.0 cm in the third quarter (mode at 15 cm, mean size of 15.6 cm).

No size composition of anchovy catches in 2016 is available from the Subdivision 9.a Central-South.

Subdivision 9.a South

The only available LFDs from the Portuguese fishery in this subdivision correspond to a very scarce catches landed by the bottom trawl fleet in the first quarter (**Table 4.2.5.1.8**). These catches ranged between 12.5 and 15.5 cm size classes (mode and mean size at 14.0 cm).

Quarterly LFDs from the Spanish catches in 2016 by métier/fraction and for the whole fishery are shown in **Tables 4.2.5.1.9** to **4.2.5.1.16**. Size range of the exploited stock (landings plus discards) in the whole fishery was comprised between 5.5 and 20.0 cm size classes, with the modal class at 11.5 cm size class. Anchovy mean length and weight in the Spanish 2016 annual catch (12.0 cm and 11.6 g) were still amongst the highest ones ever recorded in the historical series, as it is observed since 2008, although they used to be the smallest anchovies in the division.

4.2.5.2 Catch numbers-at-age

Subdivision 9.a North

Estimates from the fishery in this subdivision in 2016 have been provided to the WG (**Table 4.2.5.2.1**). These estimates are shown together with the age composition of catches in previous years with available data in **Table 4.2.5.2.2** and **Figure 4.2.5.2.1**.

The estimated total catch in numbers in 2016 was of 14.8 million fish, composed by ages 0, 1, 2 and 3 anchovies, with age-0 and 1 olds accounting for 32% and 62% of the total catch, respectively.

Subdivision 9.a Central-North

No estimate from this subdivision in 2016 has been provided to this WG.

Subdivision 9.a Central-South

No estimate from this subdivision in 2016 has been provided to this WG.

Subdivision 9.a South

Table 4.2.5.2.3 shows the quarterly and annual anchovy catches-at-age in the Spanish fishery in 2016. Total catches in the Spanish fishery in 2016 were estimated at 551 million fish, which accounted for an 18% decrease in relation to the 671 million caught the previous year. Such a decrease was mainly caused by a 59% decrease of age 0 anchovies in catches, which was not compensated by the 2% decrease experienced by age 1 fish and by the 39% increase in age 2 anchovies. Age group 3 anchovies were absent in the fishery.

The recent historical series of annual landings-at-age in the Spanish fishery in 9.a South are shown in **Table 4.2.5.2.4** and **Figure 4.2.5.2.2**. Description of annual trends of landings-at-age data from the Spanish fishery through the available data series is given in the Stock Annex and in previous WG reports.

No data are available from the Portuguese fishery in this subdivision.

4.2.6 Mean length and mean weight-at-age in the catch

Subdivision 9.a North

The available estimates for the fishery in 2016 are shown in **Tables 4.2.6.1** and **4.2.6.2**. The available series of estimates are shown in **Figure 4.2.6.1** and indicate that anchovies by age class from this subdivision are usually larger and heavier than those harvested in the southernmost areas. In 2016, all the age groups but age 0 experienced a decrease in the mean length and weight in catches, a trend also exhibited by the overall mean estimates for the whole exploited population.

Subdivision 9.a Central-North

No estimate from this subdivision is available.

Subdivision 9.a Central-South

No estimate from this subdivision is available.

Subdivision 9.a South

The 2016 estimates of the mean length and weight-at-age of Gulf of Cadiz anchovy catches are shown in **Tables 4.2.6.3** and **4.2.6.4. Figure 4.2.6.2** shows the recent history of the evolution of such estimates. Anchovy mean length and weight in the Spanish 2016 annual catches were estimated at 12.0 cm and 11.6 g respectively.

Age 0 and age 1 anchovies have showed a noticeable increasing trend in both estimates in the most recent years, with the 2008–2016 estimates of mean size in catches being between the highest ones in the historical series. Conversely, since 2002 on age 2 anchovies experienced a remarkable decreasing trend in mean size and weight in catches, excepting the punctual relative increases observed in 2011 and 2015. Three year olds were firstly recorded in the sampled landings in 1992. New occurrences of these anchovies have been observed only from 2008 to 2010.

4.3 Fishery-independent information

Table 4.3.1 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 of interruptions through its recent history.

4.3.1 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 a,b).

The series started in 2005 and their surveys are conducted with a triennial periodicity. Since 2014 this series is financed by DCF. The last *BOCADEVA* survey was conducted in summer 2014. The next survey will be conducted in July 2017. **Figure 4.3.1.1** shows the available estimates within this survey series.

4.3.2 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 (see also ICES, 2007 b). Survey's methodologies deployed by the respective national Institutes (IPMA and IEO) are also thoroughly described in ICES (2008 c, 2009 b).

A summary list of the available acoustic and DEPM surveys providing direct estimates for anchovy in Division 9.a is given in **Table 4.3.1**. Detailed information in the present section will be provided for those surveys carried out during the elapsed time between 2016 and 2017 WGHANSA meetings.

PELACUS series

This Spanish spring acoustic survey series is the only one that samples yearly the waters off the Subdivisions 9.a North and Subarea 8.c since 1984. This series is currently funded by DCF.

PELACUS 0317

PELACUS 0316 was conducted between 15th March and 16th April 2017 on board the RV *Miguel Oliver*. **Figure 4.3.2.1** shows the distribution and species composition of the 15 valid pelagic hauls carried out during the survey in Subdivision 9.a North. A detailed description of the survey is given by Carrera and Riveiro (WD 2017).

Anchovy in Subdivision 9.a North was equally recorded both in coastal waters (and inside the rías) and offshore (**Figure 4.3.2.2**), yielding the highest estimates of abundance (124 million fish) and biomass (3566 t) ever recorded within its series. Anchovy sizes in the estimated population ranged between 11.0 and 19.0 cm size classes. The population showed a bi-modal LFD (at 14 and 17.5 cm). The first normal component corresponded to the coastal (and rías) fish and the second component to fish over the offshore area. The estimated population was structured by ages 1 (38%), 2 (46%), and 3 (16%). Mean sizes and weight-at-age were larger and heavier than in 9.a S (**Figure 4.3.2.3**).

Table 4.3.2.1 and **Figure 4.3.2.4** describe the available anchovy acoustic estimates from this survey series for the Subdivision 9.a North.

PELAGO series

The *PELAGO* survey series (spring Portuguese acoustic survey, until 2006 it was called *SAR*) is carried out every year surveying the waters of the Portuguese continental shelf and those of the Spanish Gulf of Cadiz (Subdivisions 9.a Central-North, Central-South, and South), between 20 and 200 m depth. This survey series is currently financed by DCF.

The 2012 WGHANSA concluded that the *PELAGO 11* anchovy null estimate in 9.a South resulted in a strong underestimation of the actual biomass levels in the region (as inferred by CUFES data during that survey and from the *BOCADEVA 0711* DEPM survey estimates). For this reason the estimates of *PELAGO 11* for anchovy in this area were disregarded for further analyses. There were no *PELAGO* survey in 2012 due to the RV *Noruega* was not operative for the survey season.

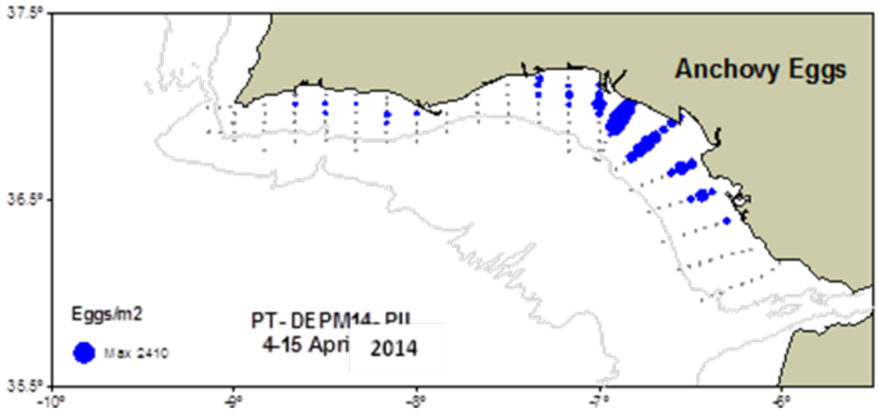
PELAGO 17

The *PELAGO 17* survey was conducted this year between 24th April and 07th June on board RV *Noruega*. Problems of different nature resulted in a greater extension of the survey period than the usual one, which have delayed both the survey ending date and the subsequent provision of estimates to this WG. At the moment of the WG meeting, only the spatial mapping of the acoustic energy allocated to anchovy and the acoustic estimates for the Subdivision 9.a South have been available. Additional details on the conduction of this survey can be consulted in the Section 8 (Sardine in 8.c and 9.a).

Regarding the mapping of acoustic energy, anchovy was only detected in subdivisions 9.a Central-North (mainly between Figueira da Foz and Porto) and South (between Tavira, in the Portuguese Algarve, and Bay of Cadiz, in Spanish waters; **Figure 4.3.2.5**).

As commented above, the only available acoustic estimates are those ones which correspond to the Subdivision 9.a South, with values of 1855 million fish and 13 797 t (**Table 4.3.2.2**). Spanish waters concentrated 93% (1718 million) and 91% (12 589 t) of the total estimated abundance and biomass in this subdivision, respectively. Portuguese waters yielded 137 million and 1208 t. The estimated population in this subdivision ranged between 7.0 and 15.0 cm size classes, with a main mode at 11.0 cm size class (**Figure 4.3.2.6**).

Table 4.3.2.2 and **Figure 4.3.2.7** track the historical series of anchovy acoustic estimates from *PELAGO* surveys in the Division 9.a. Population levels in the Subdivision 9.a South experienced in 2016 a remarkable increase (in fact, the historical maximum: 65 345 t and 9811 million anchovies) which placed them well above the historical average levels. As described below for the subsequent Spanish summer and autumn 2016 surveys, the perception of the stock derived from the sequence of these surveys contrast, however, with the abovementioned ones derived from *PELAGO 17* survey, which indicate a 79% decrease in biomass. A comparative analysis of information on the anchovy egg densities as sampled by CalVET during the last two triennial sardine DEPM surveys conducted by IPMA in 2014 and in 2017, reveals a greater extension of the anchovy spawning area in the Gulf of Cadiz the present year than in 2014, and estimated mean egg densities (5.8 eggs.m^{-3} in 2014 *vs* 4.8 eggs.m^{-3} in 2017) relatively similar in both surveys (M.M. Angélico, pers. comm. and enclosed figure). No anchovy DEPM estimates are available from these Portuguese surveys, but it should be reminded that the acoustic *PELAGO 14* survey estimated ca. 29 kt of Gulf of Cadiz anchovy against the ca. 14 kt estimated by *PELAGO 17* in this spring. Therefore, these last estimates from *PELAGO 17* should be considered with caution and as preliminary ones, awaiting the results from the summer *ECOCADIZ 2017-07* survey the next July–August.



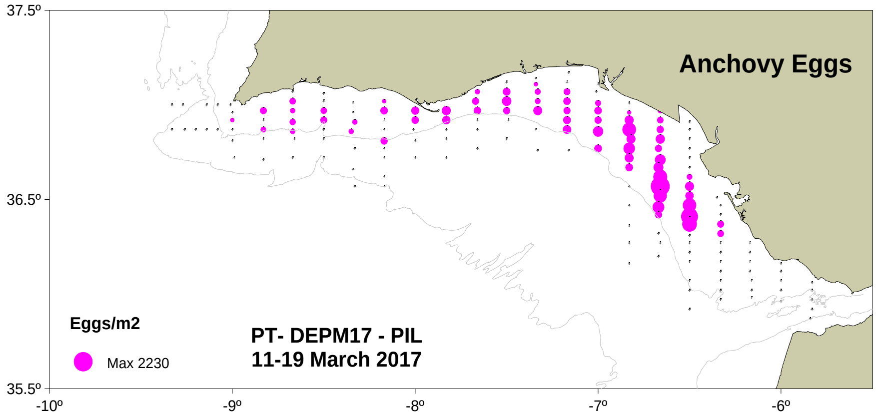


Figure. Distribution of anchovy eggs sampled by CalVET during the triennial sardine DEPM surveys conducted in 2014 and 2017.

In relative terms, anchovy also experienced an important increase in 9.a Central-North, with a population level in 2016 even higher than the previous historical peak recorded in the 2011 outburst. Unfortunately, although anchovy has been acoustically detected in this subdivision by the *PELAGO 17*, no estimate is yet available. Conversely, anchovy in 9.a Central-South is still maintaining around the usually low or even null levels recorded in the last years.

Size composition and age structure of the population estimate in 9.a South through the series was described in previous reports. In **Figure 4.3.2.8** we revisit the trends observed in the age structure of the population as estimated by the *PELAGO* and *ECOCADIZ* survey series. For *PELAGO* surveys the 2014 age-structured estimates were not available and those ones from 2013, although included in the figure, are pending of validation. As described in previous reports, Portuguese acoustic estimates for anchovy until 2013 were not provided age-structured to the WG. As an alternative, this age structure was estimated by applying the Spanish Gulf of Cadiz commercial age–length keys for the second quarter in the year. It should also be taken into consideration that such keys are based on commercial samples from purse-seine catches and therefore they may result in a biased picture of the population structure because of a different catchability.

Regarding the last years in the series, the population age structure in 2010, as estimated by the Portuguese survey, evidenced a strong decrease in 1 year old anchovies, but especially in 2 year old fish, suggesting a weak population structure sustaining a very low biomass level.

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. Reasons that led to the WG to consider the 2011 acoustic estimate with caution have been commented above. The population age structure in 2013 resembles in a great extent to the one described for 2010, whereas in the last two–three years anchovy population seems to show again clear signs of recovery, especially in 2016. The situation in 2017 is unknown since age structure from the *PELAGO* survey is not yet available.

ECOCADIZ series

The *ECOCADIZ* survey series acoustically samples the shelf waters (20–200 m depth) off the Subdivision 9.a South during mid-summer (currently between late July and early August).

No *ECOCADIZ* survey was conducted neither in 2011 (ship time invested in the *BOCADEVA 0711* DEPM survey) nor 2012 (no ship time available). The series continued in 2013. The more recent survey from this series was conducted in July 2016 (*ECOCADIZ 2016-07*), one month after the last year's WG meeting. This survey series is financed by DCF since 2014.

ECOCADIZ 2016–07

The *ECOCADIZ 2016-07* survey was conducted by IEO between 31th July and 11th August 2016 in the Portuguese and Spanish shelf waters (20–200 m isobaths) off the Gulf of Cadiz on board the Spanish RV *Miguel Oliver*. The survey design consisted in a systematic parallel grid with 21 transects equally spaced by 8 nm, normal to the shoreline. A total of 26 valid fishing hauls (between 39–194 m depth) for echotrace groundtruthing purposes were carried out (**Figure 4.3.2.9**). CUFES sampling (136 stations) was carried during the survey in order to describe the extension of the anchovy spawning area. A census of top predator species was also carried out along the sampled acoustic transects. A total of 201 CTD (with coupled altimeter, oximeter, fluorimeter and transmissometer sensors) -LADCP casts, and subsuperficial thermosalinograph-fluorimeter and VMADCP continuous sampling were carried out to oceanographically characterize the surveyed area. Results from this survey were not presented in the last ICES WGACEGG meeting (ICES, 2017). A detailed description of the *ECOCADIZ 2016-07* survey methods and results are given in Ramos *et al*. (WD 2017a).

Anchovy almost avoided the easternmost waters of the Gulf. The bulk of the population was mainly distributed all over the shelf between the Guadiana river mouth and Cadiz Bay, especially over the inner shelf waters of the central part of the Gulf, between the Guadiana river mouth and Rota. A secondary nucleus of anchovy density was recorded in the mid-/outer shelf waters off western Portuguese Algarve, between Cape San Vicente and Cape Santa Maria, with the species being quite scarce in the shallowest waters just west of the Cape of Santa Maria (**Figure 4.3.2.9**). Anchovy egg distribution in summer 2016 differed from the abovementioned distribution for adult fish, with the highest egg densities being mainly recorded in the middle-outer shelf waters located between Portimão and Cape Santa Maria.

The size class range of the assessed population varied between the 8.0 and 17.5 cm size classes, with two modal classes at 9.5 and 12.0 cm, with the latter being the most important. The size composition of anchovy by coherent post-strata confirms the usual pattern exhibited by the species in the area during the spawning season, with the largest fish being distributed both in the westernmost and easternmost waters and the smallest ones concentrated in the surroundings of the Guadalquivir river mouth and adjacent shallow waters, including those ones in front of the Cadiz Bay and even spreading to the coastal area close to the Guadiana river mouth (**Figures 4.3.2.10** and **4.3.2.11**). As it has been happening in the last years, during the 2016 survey some recruitment has also been recorded, probably as a consequence of the delayed survey dates in relation to the peak spawning.

Overall acoustic estimates in summer 2016 were of 3686 million fish and 34 301 t. By geographical strata, the Spanish waters yielded 91% (3341 million) and 85% (29 051 t) of the total estimated abundance and biomass in the Gulf, confirming the importance of these waters in the species' distribution. The estimates for the Portuguese waters were 346 million and 5250 t (**Table 4.3.2.3**, **Figures 4.3.2.10** and **4.3.2.11**).

The summer 2016 abundance estimate continues the notable increasing trend which started in 2014 and rises up the population levels well above those corresponding to the historical average (**Figure 4.3.2.12**). For this same surveyed area, the Portuguese spring survey *PELAGO 16* estimated almost four months before 9811 million fish and 65 345 t (the whole population was restricted to the Spanish waters only; see Marques *et al*., 2016). Such estimates were the highest ones within its historical series and contrast with their summer counterparts, with the *PELAGO* survey yielding almost the double in biomass and the triple in abundance that the *ECOCADIZ* survey and recording anchovy only in the Spanish waters. Marques *et al*. (2016) warned about the need of corroborating the *PELAGO* spring estimates with the *ECOCADIZ* ones because of some uncertainty in the estimation. These authors advanced the possibility of a certain overestimation of the acoustic energy attributed to anchovy in the Spanish waters of the Gulf because this energy in this area was strongly masked by a dense plankton layer. *ECOCADIZ* surveys also routinely face to this same problem, since this situation is not uncommon in the area, by acoustically surveying in a multi-frequency fashion, an approach that partially enables a more efficient discrimination of echoes.

4.3.3 Recruitment surveys

SAR/JUVESAR 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 4.3.1**). **Table 4.3.3.1** 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, acoustic surveys restricted to the Subdivision 9.a Central-North, the main sardine recruitment area for sardine in Portuguese waters, started in 2013. However, the scarce presence and abundance of anchovy in the 2013 and 2014 surveys prevented from providing any acoustic estimate for the species. A new autumn survey, *JUVESAR 16*, was conducted last year (see below). The series of point estimates is at present scattered and scarce for these autumn survey series and they are not directly used in the qualitative trend-based assessment (but see **Figure 4.3.3.6** for estimates in 9.a South).

JUVESAR 16

JUVESAR 16 was conducted by IPMA between 29th November and 10th December 2016 in the Portuguese shelf waters of the Subdivision 9.a Central-North on board the RV *Noruega*. The survey's main objective is the acoustic assessment of sardine recruitment in its main recruitment area of the Iberian Peninsula Atlantic façade. A total of 19 valid fishing hauls were carried out for echo-trace groundtruthing (**Figure 4.3.3.1**). Anchovy showed a scattered and coastal distribution, with southern isolated small spots in front of Cascais and Peniche, and with the bulk of the population being distributed between Figueira da Foz and Porto. The highest acoustic densities were recorded in the coastal fringe between Aveiro and Porto. (**Figure 4.3.3.2**).

Anchovy abundance and biomass autumn estimates in 9.a Central-North in 2016 were 2836 million fish and 14 397 t (**Table 4.3.3.1**). The size range of the estimated population was comprised between the 7.5 and 16.0 cm size classes, with a mode at 9.5 cm size class (**Figure 4.3.3.3**). Almost the whole population was composed by age-0 fish: 2835 million (99.96% in numbers) and 14 367 t (99.8% in biomass). No age-1 fish were present and two year olds were very scarce (ca. 1 million fish, 30 t).

In relation to the age-0 fish estimated in the previous year in the *JUVESAR 15* survey (1778 million, 9758 t), the 2016 autumn estimates accounted increases for 59% and 47% in terms of abundance and biomass, respectively (**Table 4.3.3.1**).

ECOCADIZ-RECLUTAS survey series

This series started in autumn 2009 as the first attempt by the IEO of acoustically assessing the abundance of anchovy and sardine juveniles in their main recruitment areas off the Gulf of Cadiz. However, the succession of a series of unforeseen problems during that survey drastically reduced the foreseen sampling area to the easternmost zone only. The continuation of this survey series was not guaranteed for next years and in fact no survey of these characteristics was carried out in 2010 and 2011. In 2012 the survey was financed by the Spanish Fisheries Secretariat and planned and conducted by the IEO but only the Spanish waters of the Gulf of Cadiz were surveyed (**Table 4.3.3.2**). The most recent surveys have been conducted since October 2014, when they also started to be financed by DCF.

ECOCADIZ-RECLUTAS 2016-10

ECOCADIZ-RECLUTAS 2016-10 was conducted by IEO between 16th October and 3rd November 2016 in the Portuguese and Spanish shelf waters (20–200 m isobaths) off the Gulf of Cadiz on board the RV *Ramón Margalef*. The survey's main objective is the acoustic assessment of anchovy and sardine juveniles (age 0 fish) in the recruitment areas of the Gulf of Cadiz. The survey is the third one within its series with a complete sampling coverage of the Subdivision 9.a South. Results from this survey have been reported to this WG by Ramos *et al.* (WD 2017b).

The acoustic transect in front of the Guadalquivir river estuary (where the species, and more specifically the recruits, typically register high abundances) was not acoustically sampled by the realization of joint Spanish-NATO naval exercises in the Spanish waters during a great part of the survey, a constraint that has resulted in an underestimation of the acoustic estimates affecting to all the assessed species.

Anchovy avoid in autumn 2016, as it also did in summer, the easternmost waters of the Gulf. The spatial pattern of distribution of the acoustic density was further characterized by a concentration of a great part of the population in an area comprising the shelf waters between Punta Umbria and the Bay of Cadiz. A secondary nucleus of anchovy density was recorded in the mid-/outer shelf waters off western Portuguese Algarve, between Cape San Vicente and Cape Santa Maria (**Figure 4.3.3.4**).

The size range recorded for the estimated population was comprised between 7.5 and 17.5 cm size classes, with a marked mode at 9 cm size class and a very residual secondary mode at 15 cm. A similar size composition is also recorded for the estimated biomass (**Figure 4.3.3.5**). The mean size and weight of the estimated population were 9.7 cm and 5.4 g respectively. The anchovy size composition by coherent post-strata in the autumn 2016 survey evidences that juveniles were mainly distributed in the coastal inner shelf waters between the Guadiana river mouth and Bay of Cadiz, with the latter area being the area where the highest densities of anchovy juveniles were recorded (**Figures 4.3.3.5** and **4.3.3.6**).

Gulf of Cadiz anchovy abundance and biomass in autumn 2016 were of 3667 million fish and 19 861 t, the second highest values within its short series. Spanish waters concentrated 95.2% (3490 million) and 84.6% (16 807 t) of the total estimated abundance and biomass respectively. Portuguese estimates amounted to 177 million and 3054 t (**Table 4.3.3.2**, **Figure 4.3.3.5**).

The age-0 population fraction was estimated at 3445 million fish and 15 969 t, 94% and 80% of the total population abundance and biomass respectively (**Table 4.3.3.2**, **Figure 4.3.3.6**). Spanish waters concentrated 99% of the juveniles in the Gulf in terms of number (3404 million) and 97% in biomass (15 506 t).

Given the shortness of the series it would be too much risky to advance that both the present estimates and the 2015 'historical' maximum might correspond to a good recruitment scenario. Notwithstanding the above, these estimates induce to optimistically perceive the present situation when they are compared with the estimates from previous years, at least when compared with the 2014 autumn estimate (**Figure 4.3.3.7**).

Figure 4.3.3.8 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 (no estimates for 2017 are still available for both surveys). Some positive relationship seems to be suggested when the most recent *ECOCADIZ-RECLUTAS* and *PELAGO* surveys estimates are compared.

4.4 Biological data

4.4.1 Weight-at-age in the stock

Weights-at-age in the stock are shown in **Table 4.4.1.1**. See the Stock Annex for comments on computation and trends.

4.4.2 Maturity-at-age

Annual maturity ogives for Gulf of Cadiz anchovy are shown in **Table 4.4.2.1**. See the Stock Annex for comments on computation and trends in the maturity ogives of Gulf of Cádiz anchovy.

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 a).

4.4.3 Natural mortality

Natural mortality is unknown for this stock. By analogy with anchovy in Subarea 8, natural mortality is probably high (a half-year M=0.6 has been used in previous years for the data exploration, see Stock Annex).

Table 4.2.1.1. Anchovy in Division 9.a. Composition of the Spanish fleets operating in Southern Galician waters (Subdivision 9.a North) and in the Gulf of Cadiz (Subdivision 9.a-South) in 2016. Fleets are differentiated into vessels targeting anchovy and total fleet. The categories include both single purpose purse-seiners 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 to one fishing day). Similar tables for yearly data since 1999 are shown for the Gulf of Cadiz Spanish fleet in the Stock Annex and previous WG reports.

SUBDIVISION 9.A NORTH													
2016	Vessels targeting anchovy						2016	Total fleet					
	Engine (HP)							Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total	Length (m)	0-50	51-100	101-200	201-500	>500	Total
≤10	6					6	≤10	22	1				23
11-15	3	17	16			36	11-15	8	23	21			52
16-20			5	10		15	16-20	1	1	10	17		29
>20				19	1	20	>20			5	40	1	46
Total	9	17	21	29	1	77	Total	31	25	36	57	1	150
Subdivision 9.a South (Spanish waters)													
2016	Vessels targeting anchovy						2016	Total fleet					
	Engine (HP)							Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total	Length (m)	0-50	51-100	101-200	201-500	>500	Total
≤10							≤10						
11-15	2	11	4	1		18	11-15	2	11	4	1		18
16-20		5	30	10		45	16-20		5	37	16		58
>20			2	12	1	15	>20			4	25	1	30
Total	2	16	36	23	1	78	Total	2	16	45	42	1	106

Table 4.2.2.1.1. Anchovy in Division 9.a. Recent historical series of annual catches (t) by Subdivision and total since 1989 on (the period with available data for all the subdivisions). Catches in Subdivision 9.a South are also differentiated between Portuguese (PT) and Spanish (ES) waters. (-) not available data; (0) less than 1 tonne (from Pestana, 1989, 1996 and WGMHSA, WGANC, WGANSA and WGHANSA members). The rest of the historical series of catches is given 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.

YEAR	9.A N	9.A C-N	9.A C-S	9.A S (PT)	9.A S (ES)	9.A S (TOTAL)	TOTAL DIVISION
1989	118	389	85	22	5330	5352	5944
1990	220	424	93	24	5726	5750	6487
1991	15	187	3	20	5697	5717	5922
1992	33	92	46	0	2995	2995	3166
1993	1	20	3	0	1960	1960	1984
1994	117	231	5	0	3035	3035	3388
1995	5329	6724	332	0	571	571	12956
1996	44	2707	13	51	1780	1831	4595
1997	63	610	8	13	4600	4613	5295
1998	371	894	153	566	8977	9543	10962
1999	413	957	96	355	5587	5942	7409
2000	10	71	61	178	2182	2360	2502
2001	27	397	19	439	8216	8655	9098
2002	21	433	90	393	7870	8262	8806
2003	23	211	67	200	4768	4968	5269
2004	4	83	139	434	5183	5617	5844
2005	4	82	6	38	4385	4423	4515
2006	15	79	15	14	4368	4381	4491
2007	4	833	7	34	5576	5610	6454
2008	5	211	87	37	3168	3204	3508
2009	19	35	5	32	2922	2954	3013
2010	179	100	2	28	2901	2929	3210
2011	541	3239	1	78	6216	6294	10076
2012	39	521	220	56	4754	4810	5589
2013	69	192	131	67	5172	5240	5632
2014	581	678	21	118	8933	9051	10332
2015	173	2533	10	2	6878	6880	9597
2016	222	6908	10	19	6581	6599	13740

Table 4.2.2.1.2. Anchovy in Division 9.a. Catches (t) by gear and Subdivision in 1989–2016. 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. Landings by gear in Subdivisions 9.a C-N to S (PT) are not available by Subdivision until 2009.

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

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

Table 4.2.2.1.2. Anchovy in Division 9.a. Cont'd.

SUBAREA	GEAR	2010	2011	2012	2013	2014	2015	2016
9.a N	Demersal trawl	-	-	-	-	-	0.2	-
	Artisanal	4	0	1	6	0	21	6
	Purse seine	175	541	37	63	581	152	217
9.a C-N	Demersal Trawl	5	4	1	0.5	2	3	2
	P. seine polyvalent	45	1116	177	17	9	150	294
	Purse seine	50	2119	342	175	668	2381	6613
9.a C-S	Demersal Trawl	1	1	0.4	1	3	2	1
	P. seine polyvalent	0	0.1	17	4	1	0.4	4
	Purse seine	1	0.4	202	127	18	8	5
9.a S (PT)	Demersal Trawl	8	13	16	2	5	1	3
	P. seine polyvalent	4	33	0.1	2	0.04	0.02	0.04
	Purse seine	17	33	41	63	113	1	16
9.a S (ES)	Demersal Trawl	0	0	2	-	99	33	118
	Artisanal	-	-	-	-	-	0.1	0.1
	Purse seine	2901	6216	4752	5172	8835	6845	6463

Table 4.2.2.2.1. Anchovy in Division 9.a. Quarterly anchovy catches (t) by Subdivision in 2016.

SUBDIVISION	QUARTER 1		QUARTER 2		QUARTER 3		QUARTER 4		ANNUAL (2016)	
	C(t)	%	C(t)	%	C(t)	%	C(t)	%	C (t)	%
9.a North	4	1.6	53	23.9	80	35.8	86	38.7	222	1.6
9.a Central North	5	0,1	344	5.0	6207	89.9	325	5.1	6908	50.3
9.a Central South	2	19.7	3	28.6	5	51.7	0.01	0.1	10	0.1
9.a South (PT)	14	73.0	1	4.5	4	22.4	-	-	19	0.1
9.a South (ES)	1266	19.2	2231	33.9	2215	33.7	868	13.2	6581	47.9
9.a South	1280	19.4	2232	33.8	2219	33.6	868	13.2	6599	48.0
TOTAL	1291	9.4	2631	19.2	8511	61.9	1307	9.5	13 740	100

Table 4.2.4.1. Anchovy in Division 9.a. Subdivision 9.a South. Standardised effort (no. of standardised fishing trips fishing anchovy) and anchovy lpue (t/fishing trip) data for the Spanish purse-seine fleet operating in the Gulf of Cadiz (1988–2016). Increasing colour intensities denote increasing problems in sampling coverage of fishing effort.

YEAR	LANDINGS	EFFORT	LPUE
1988	4263	4525	0.937
1989	5330	5685	0.927
1990	5726	6205	0.913
1991	5697	7669	0.734
1992	2995	5584	0.541
1993	1629	2983	0.480
1994	2883	3612	0.713
1995	495	1744	0.152
1996	1556	5557	0.225
1997	4376	4335	0.930
1998	7824	4957	1.474
1999	4594	5994	0.766
2000	2078	5975	0.348
2001	8180	6688	1.223
2002	7847	7532	1.042
2003	4754	6371	0.746
2004	5177	7102	0.728
2005	4386	5542	0.791
2006	4367	7085	0.616
2007	5575	6838	0.815
2008	3168	4555	0.695
2009	2922	4629	0.631
2010	2901	4338	0.669
2011	6196	6179	1.003
2012	4754	4659	1.020
2013	5172	6225	0.831
2014	6340	6366	0.996
2015	6701	5037	1.330
2016	6424	6016	1.068

Table 4.2.5.1.1. Anchovy in Division 9.a. Subdivision 9.a North. Spanish purse-seine fishery (métier PS_SPF_0_0_0). Seasonal and annual length distributions ('000) of anchovy landings in 2016. Length–frequency distribution from both Q1 and Q3 were not available but they have been estimated by raising Q1 and Q3 catches to the LFDs from Q2 and Q4 respectively. Discards are considered as negligible, hence landings correspond to catches.

2016	Q1	Q2	Q3	Q4	TOTAL
Length (cm)	**9.a N**	**9.a N**	**9.a N**	**9.a N**	**9.a N**
6	0	0	0	0	0
6.5	0	0	0	0	0
7	0	0	0	0	0
7.5	0	0	0	0	0
8	0	0	0	0	0
8.5	0	0	0	0	0
9	0	0	0	0	0
9.5	0	0	0	0	0
10	0	0	0	0	0
10.5	0	0	0	0	0
11	0	0	278	304	582
11.5	0,5	35	642	700	1377
12	2	129	712	777	1619
12.5	6	372	962	1050	2391
13	12	816	1147	1252	3226
13.5	12	816	702	767	2298
14	6	412	518	565	1502
14.5	4	243	170	185	602
15	2	116	85	93	295
15.5	0,9	59	155	169	384
16	0,2	10	85	93	187
16.5	0	0	0	0	0
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
Total N	46	3008	5455	5954	14463
Catch (T)	1	52	78	85	216
L avg (cm)	13.7	13.7	13.1	13.1	13.3
W avg (g)	14.0	15.2	15.6	13.8	14.8

Table 4.2.5.1.2. Anchovy in Division 9.a. Subdivision 9.a North. Spanish miscellaneous fleets (métier MIS_MIS_0_0_0_HC). Seasonal and annual length distributions ('000) of anchovy landings in 2016. Length–frequency distributions were not available. They have been estimated by raising catches from this métier to the respective quarterly LFDs from the métier PS_SPF_0_0_0. Discards are considered as negligible, hence landings correspond to catches.

2016	Q1	Q2	Q3	Q4	TOTAL
Length (cm)	**9.a N**	**9.a N**	**9.a N**	**9.a N**	**9.a N**
6	0	0	0	0	0
6.5	0	0	0	0	0
7	0	0	0	0	0
7.5	0	0	0	0	0
8	0	0	0	0	0
8.5	0	0	0	0	0
9	0	0	0	0	0
9.5	0	0	0	0	0
10	0	0	0	0	0
10.5	0	0	0	0	0
11	0	0	3	2	5
11.5	2	1	7	4	14
12	7	2	8	5	21
12.5	20	5	11	6	42
13	44	12	13	7	76
13.5	44	12	8	4	68
14	22	6	6	3	37
14.5	13	3	2	1	20
15	6	2	1	1	9
15.5	3	1	2	1	7
16	0.5	0.1	1	1	2
16.5	0	0	0	0	0
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
Total N	46	43	60	35	184
Catch (T)	3	1	1	0.5	5
L avg (cm)	13.7	13.7	13.1	13.1	13.4
W avg (g)	14.0	15.2	15.6	13.8	14.8

Table 4.2.5.1.3. Anchovy in Division 9.a. Subdivision 9.a North. Spanish artisanal trammelnet fishery (métier GTR_DEF_70-89_0_0). Seasonal and annual length distributions ('000) of anchovy landings in 2016. Length–frequency distributions were not available. They have been estimated by raising catches from this métier to the respective quarterly LFDs from the métier PS_SPF_0_0_0. Discards are considered as negligible, hence landings correspond to catches.

2016	Q1	Q2	Q3	Q4	TOTAL
Length (cm)	**9.a N**	**9.a N**	**9.a N**	**9.a N**	**9.a N**
6	0	0	0	0	0
6.5	0	0	0	0	0
7	0	0	0	0	0
7.5	0	0	0	0	0
8	0	0	0	0	0
8.5	0	0	0	0	0
9	0	0	0	0	0
9.5	0	0	0	0	0
10	0	0	0	0	0
10.5	0	0	0	0	0
11	0	0	0.5	0	0.5
11.5	0.01	0.03	1	0	1
12	0.03	0.1	1	0	1
12.5	0.1	0.3	2	0	2
13	0.2	1	2	0	3
13.5	0.2	1	1	0	2
14	0.1	0.3	1	0	1
14.5	0.1	0.2	0.3	0	1
15	0.03	0.1	0.1	0	0.3
15.5	0.01	0.05	0.3	0	0.3
16	0.002	0.01	0.1	0	0.2
16.5	0	0	0	0	0
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
Total N	1	2	10	0	13
Catch (T)	0.01	0.04	0.1	0	0.2
L avg (cm)	13.7	13.7	13.1	-	13.6
W avg (g)	14.0	15.2	15.6	-	15.1

Table 4.2.5.1.4. Anchovy in Division 9.a. Subdivision 9.a North. Spanish gillnet artisanal fishery (métier GNS_DEF_70-89_0_0). Seasonal and annual length distributions ('000) of anchovy landings in 2016. They have been estimated by raising catches from this métier to the respective quarterly LFDs from the métier PS_SPF_0_0_0. Discards are considered as negligible, hence landings correspond to catches.

2016	Q1	Q2	Q3	Q4	TOTAL
Length (cm)	**9.a N**	**9.a N**	**9.a N**	**9.a N**	**9.a N**
6	0	0	0	0	0
6.5	0	0	0	0	0
7	0	0	0	0	0
7.5	0	0	0	0	0
8	0	0	0	0	0
8.5	0	0	0	0	0
9	0	0	0	0	0
9.5	0	0	0	0	0
10	0	0	0	0	0
10.5	0	0	0	0	0
11	0	0	0	0	0
11.5	0	0	0	0	0
12	0	0	0	0	0
12.5	0	0	1	1	2
13	0	0.001	3	2	4
13.5	0	0.002	3	2	5
14	0	0.01	4	2	6
14.5	0	0.02	5	3	8
15	0	0.02	3	2	5
15.5	0	0.01	2	1	3
16	0	0.005	1	0.4	1
16.5	0	0.002	0.4	0.2	1
17	0	0.001	1	0.4	1
17.5	0	0	0.4	0.2	1
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
Total N	0	0.1	23	13	36
Catch (T)	0	0.001	0.3	0.2	0.4
L avg (cm)	-	13.7	13.1	13.1	13.1
W avg (g)	-	15.1	15.6	13.8	14.9

Table 4.2.5.1.5. Anchovy in Division 9.a. Subdivision 9.a North. Spanish fishery (all fleets). Seasonal and annual length distributions ('000) of anchovy landings in 2016. Discards are considered as negligible, hence landings correspond to catches.

2016	Q1	Q2	Q3	Q4	TOTAL
Length (cm)	9.a N	9.a N	9.a N	9.a N	9.a N
6	0	0	0	0	0
6.5	0	0	0	0	0
7	0	0	0	0	0
7.5	0	0	0	0	0
8	0	0	0	0	0
8.5	0	0	0	0	0
9	0	0	0	0	0
9.5	0	0	0	0	0
10	0	0	0	0	0
10.5	0	0	0	0	0
11	0	0	281	306	587
11.5	2	36	649	704	1391
12	9	131	719	781	1640
12.5	26	378	973	1056	2433
13	57	827	1159	1259	3302
13.5	57	828	710	771	2366
14	29	418	524	569	1539
14.5	17	247	171	186	621
15	8	117	86	93	304
15.5	4	60	157	170	391
16	1	10	86	93	190
16.5	0	0	0	0	0
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
Total N	209	3051	5515	5988	14765
Catch (T)	4	53	80	86	223
L avg (cm)	13.7	13.7	13.1	13.1	13.2
W avg (g)	14.0	15.2	15.6	13.8	14.8

Table 4.2.5.1.6. Anchovy in Division 9.a. Subdivision 9.a Central-North. Portuguese purse-seine fishery (métier PS_SPF_0_0_0). Seasonal and annual length distributions ('000) of anchovy landings in 2016. Discards are considered as negligible, hence landings correspond to catches.

2016	Q1	Q2	Q3	Q4	TOTAL
Length (cm)	9.a CN	9.a CN	9.a CN	9.a CN	9.a CN
6	n.a.	0	0	n.a.	n.a.
6.5	n.a.	0	0	n.a.	n.a.
7	n.a.	0	0	n.a.	n.a.
7.5	n.a.	0	0	n.a.	n.a.
8	n.a.	0	0	n.a.	n.a.
8.5	n.a.	0	0	n.a.	n.a.
9	n.a.	0	0	n.a.	n.a.
9.5	n.a.	0	0	n.a.	n.a.
10	n.a.	45	0	n.a.	n.a.
10.5	n.a.	0	0	n.a.	n.a.
11	n.a.	223	0	n.a.	n.a.
11.5	n.a.	0	0	n.a.	n.a.
12	n.a.	958	160	n.a.	n.a.
12.5	n.a.	1180	160	n.a.	n.a.
13	n.a.	3987	3526	n.a.	n.a.
13.5	n.a.	2494	4647	n.a.	n.a.
14	n.a.	1826	28686	n.a.	n.a.
14.5	n.a.	1403	21955	n.a.	n.a.
15	n.a.	1270	57531	n.a.	n.a.
15.5	n.a.	512	25160	n.a.	n.a.
16	n.a.	445	51442	n.a.	n.a.
16.5	n.a.	89	14423	n.a.	n.a.
17	n.a.	67	18429	n.a.	n.a.
17.5	n.a.	45	3205	n.a.	n.a.
18	n.a.	0	1442	n.a.	n.a.
18.5	n.a.	0	0	n.a.	n.a.
19	n.a.	0	0	n.a.	n.a.
19.5	n.a.	0	0	n.a.	n.a.
20	n.a.	0	0	n.a.	n.a.
Total N	n.a.	14544	230767	n.a.	n.a.
Catch (T)	5	271	6000	337	6613
L avg (cm)	n.a.	13,9	15,6	n.a.	n.a.
W avg (g)	n.a.	n.a.	n.a.	n.a.	n.a.

Table 4.2.5.1.7. Anchovy in Division 9.a. Subdivision 9.a Central-North. Portuguese bottom-trawl fishery (métier OTB_DEF_>=55_0_0). Seasonal and annual length distributions ('000) of anchovy landings in 2016. Discards are considered as negligible, hence landings correspond to catches.

2016	Q1	Q2	Q3	Q4	TOTAL
Length (cm)	**9.a CN**	**9.a CN**	**9.a CN**	**9.a CN**	**9.a CN**
6	0	0	n.a.	0	n.a.
6.5	0	0	n.a.	0	n.a.
7	0	0	n.a.	0	n.a.
7.5	0	0	n.a.	0	n.a.
8	0	0	n.a.	0	n.a.
8.5	0	0	n.a.	0	n.a.
9	0	0	n.a.	0	n.a.
9.5	0	0	n.a.	0	n.a.
10	0	0	n.a.	0	n.a.
10.5	0	0	n.a.	0	n.a.
11	0	0	n.a.	0	n.a.
11.5	0	0	n.a.	0	n.a.
12	0	0	n.a.	0	n.a.
12.5	0	0	n.a.	0	n.a.
13	0	0.2	n.a.	0	n.a.
13.5	0	1	n.a.	0	n.a.
14	0	4	n.a.	0	n.a.
14.5	0	3	n.a.	0	n.a.
15	0	1	n.a.	0	n.a.
15.5	0	1	n.a.	0	n.a.
16	4	1	n.a.	0	n.a.
16.5	0	0.2	n.a.	0	n.a.
17	12	0.2	n.a.	0	n.a.
17.5	0	0	n.a.	0	n.a.
18	5	0	n.a.	0	n.a.
18.5	0	0	n.a.	0	n.a.
19	0	0	n.a.	0	n.a.
19.5	0	0	n.a.	0	n.a.
20	0	0	n.a.	0	n.a.
Total N	21	11	n.a.	0	n.a.
Catch (T)	1	0.2	1	0	2
L avg (cm)	16.8	14.4	n.a.	-	n.a.
W avg (g)	n.a.	n.a.	n.a.	-	n.a.

Table 4.2.5.1.8. Anchovy in Division 9.a. Subdivisions 9.a South (PT). Portuguese bottom-trawl fishery (métier OTB_DEF_>=55_0_0). Seasonal and annual length distributions ('000) of anchovy landings in 2016. Discards are considered as negligible, hence landings correspond to catches.

2016	Q1	Q2	Q3	Q4	TOTAL
Length (cm)	9.a CN	9.a CN	9.a CN	9.a CN	9.a CN
6	0	n.a.	n.a.	0	n.a.
6.5	0	n.a.	n.a.	0	n.a.
7	0	n.a.	n.a.	0	n.a.
7.5	0	n.a.	n.a.	0	n.a.
8	0	n.a.	n.a.	0	n.a.
8.5	0	n.a.	n.a.	0	n.a.
9	0	n.a.	n.a.	0	n.a.
9.5	0	n.a.	n.a.	0	n.a.
10	0	n.a.	n.a.	0	n.a.
10.5	0	n.a.	n.a.	0	n.a.
11	0	n.a.	n.a.	0	n.a.
11.5	0	n.a.	n.a.	0	n.a.
12	0	n.a.	n.a.	0	n.a.
12.5	0.2	n.a.	n.a.	0	n.a.
13	1	n.a.	n.a.	0	n.a.
13.5	1	n.a.	n.a.	0	n.a.
14	1	n.a.	n.a.	0	n.a.
14.5	0.4	n.a.	n.a.	0	n.a.
15	0.1	n.a.	n.a.	0	n.a.
15.5	0.1	n.a.	n.a.	0	n.a.
16	0	n.a.	n.a.	0	n.a.
16.5	0	n.a.	n.a.	0	n.a.
17	0	n.a.	n.a.	0	n.a.
17.5	0	n.a.	n.a.	0	n.a.
18	0	n.a.	n.a.	0	n.a.
18.5	0	n.a.	n.a.	0	n.a.
19	0	n.a.	n.a.	0	n.a.
19.5	0	n.a.	n.a.	0	n.a.
20	0	n.a.	n.a.	0	n.a.
Total N	4	n.a.	n.a.	0	n.a.
Catch (T)	0.1	0.1	3	0	3
L avg (cm)	14.0	n.a.	n.a.	-	n.a.
W avg (g)	n.a.	n.a.	n.a.	-	n.a.

Table 4.2.5.1.9. Anchovy in Division 9.a. Subdivision 9.a South (ES). Spanish purse-seine fishery (métier PS_SPF_0_0_0). Seasonal and annual length distributions ('000) of anchovy landings and discards in 2016.

2016	Q1		Q2		Q3		Q4		TOTAL	
Length (cm)	**9.a S (ES)**		**9.a S (ES)**		**9.a S (ES)**		**9.a S (ES)**		**9.a S (ES)**	
Fraction	**Landings**	**Discards**	**Landings**	**Discards**	**Landings**	**Discards**	**Landings**	**Discards**	**Landings**	**Discards**
6	0	0	0	0	0	0	0	0	0	0
6.5	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
7.5	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
8.5	471	0	271	0	207	0	139	0	1088	0
9	2234	0	2363	12	533	0	1232	0,4	6363	13
9.5	11044	312	8682	66	1140	0	3231	1	24097	379
10	24909	744	15895	34	1787	0	3987	0,4	46578	778
10.5	28095	562	28979	104	5107	5	7849	0	70030	671
11	19360	378	22077	50	10839	15	11537	0,2	63813	443
11.5	13361	136	26279	49	18872	82	17499	0,2	76012	267
12	8659	68	18662	24	20928	110	12870	0	61118	203
12.5	7559	3	19070	311	25118	38	9212	0	60959	352
13	6171	64	15822	317	22130	19	5666	0	49789	400
13.5	4417	2	10677	22	20098	48	5817	0	41010	72
14	1818	1	6155	3	11620	19	2179	0	21773	24
14.5	1208	0	2493	0	11155	10	1077	0	15933	10
15	320	0	2113	54	2703	0	635	0	5772	54
15.5	259	0	542	0	2749	0	529	0	4079	0
16	5	0	666	54	1235	0	48	0	1953	54
16.5	24	0	160	0	765	0	10	0	958	0
17	2	0	0	0	2	0	0	0	4	0
17.5	0	0	0	0	0	0	10	0	10	0
18	0	0	0	0	2	0	0	0	2	0
18.5	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0
19.5	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0
20.5	0	0	0	0	0	0	0	0	0	0
Total N	129916	2269	180905	1101	156989	346	83526	2	551337	3717
Catch (T)	1222	18	2208	17	2128	4	866	0.01	6424	39
L avg (cm)	11.3	10.7	11.9	12.6	12.9	12.6	12.0	10.1	12.1	11.4
W avg (g)	9.4	7.8	12.2	15.0	13.6	12.3	10.4	5.8	11.7	10.3

Table 4.2.5.1.10. Anchovy in Division 9.a. Subdivision 9.a South (ES). Spanish purse-seine fishery (métier PS_SPF_0_0_0). Seasonal and annual length distributions ('000) of anchovy catches in 2016.

2016	Q1	Q2	Q3	Q4	TOTAL
Length (cm)	**9.a S (ES)**	**9.a S (ES)**	**9.a S (ES)**	**9.a S (ES)**	**9.a S (ES)**
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	471	271	207	139	1088
9	2234	2376	533	1233	6376
9.5	11356	8748	1140	3232	24476
10	25653	15930	1787	3987	47356
10.5	28657	29083	5112	7849	70701
11	19737	22127	10854	11537	64256
11.5	13498	26328	18953	17500	76279
12	8726	18686	21038	12870	61320
12.5	7561	19381	25156	9212	61311
13	6235	16138	22149	5666	50188
13.5	4419	10699	20146	5817	41081
14	1819	6159	11639	2179	21796
14.5	1208	2493	11165	1077	15942
15	320	2166	2703	635	5825
15.5	259	542	2749	529	4079
16	5	719	1235	48	2006
16.5	24	160	765	10	958
17	2	0	2	0	4
17.5	0	0	0	10	10
18	0	0	2	0	2
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
Total N	132185	182006	157335	83529	555055
Catch (T)	1240	2224	2133	866	6463
L avg (cm)	11.3	11.9	12.9	12.0	12.1
W avg (g)	9.4	12.2	13.6	10.4	11.7

Table 4.2.5.1.11. Anchovy in Division 9.a. Subdivision 9.a South (ES). Spanish bottom-trawl fishery (métier OTB_MCD_>=55_0_0). Seasonal and annual length distributions ('000) of anchovy discards in 2016.

2016	Q1	Q2	Q3	Q4	TOTAL
Length (cm)	**9.a S (ES)**	**9.a S (ES)**	**9.a S (ES)**	**9.a S (ES)**	**9.a S (ES)**
5,5	0	0	9	0	9
6	0	0	55	0	55
6.5	0	0	27	3	30
7	7	0	377	29	413
7.5	60	0	521	13	595
8	40	0	827	20	886
8.5	27	0	960	30	1016
9	7	0	1220	44	1271
9.5	0	3	1148	50	1201
10	0	22	1170	57	1249
10.5	20	25	573	20	638
11	120	67	20	43	248
11.5	162	32	146	3	342
12	412	60	279	3	755
12.5	464	36	253	3	757
13	314	13	575	9	910
13.5	163	53	843	5	1065
14	95	23	689	18	825
14.5	80	6	222	12	320
15	5	77	42	7	131
15.5	0	0	101	0	101
16	7	0	22	0	29
16.5	5	0	0	0	5
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	2	0	0	0	2
20.5	0	0	0	0	0
Total N	1989	418	10078	369	12854
Catch (T)	26	7	82	3	118
L avg (cm)	12.5	12.8	10.6	10.2	11.0
W avg (g)	13.3	15.9	8.2	6.8	9.2

Table 4.2.5.1.12. Anchovy in Division 9.a. Subdivision 9.a South (ES). Spanish artisanal fishery (métier LLS_DEF_0_0_0). Seasonal and annual length distributions ('000) of anchovy landings in 2016.

2016	Q1	Q2	Q3	Q4	TOTAL
Length (cm)	**9.a S (ES)**	**9.a S (ES)**	**9.a S (ES)**	**9.a S (ES)**	**9.a S (ES)**
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	0.005	0	0	0
9	0	0.04	0	0	0
9.5	0	0.1	0	0	0
10	0	0.3	0	0	0
10.5	0	0.5	0	0	0
11	0	0.4	0	0	0
11.5	0	0.4	0	0	0
12	0	0.3	0	0	0
12.5	0	0.3	0	0	0
13	0	0.3	0	0	0
13.5	0	0.2	0	0	0
14	0	0.1	0	0	0
14.5	0	0.04	0	0	0
15	0	0.04	0	0	0
15.5	0	0.01	0	0	0
16	0	0.01	0	0	0
16.5	0	0.003	0	0	0
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
Total N	0	3	0	0	3
Catch (T)	0	0.04	0	0	0.04
L avg (cm)	-	11.9	-	-	11.9
W avg (g)	-	12.2	-	-	12.2

Table 4.2.5.1.13. Anchovy in Division 9.a. Subdivision 9.a South (ES). Spanish miscellaneous artisanal fleets (métier MIS_MIS_0_0_0_HC). Seasonal and annual length distributions ('000) of anchovy landings in 2016.

2016	Q1	Q2	Q3	Q4	TOTAL
Length (cm)	**9.a S (ES)**	**9.a S (ES)**	**9.a S (ES)**	**9.a S (ES)**	**9.a S (ES)**
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	0.01	0	0	0	0.01
9	0.05	0	0	0	0.05
9.5	0.2	0	0	0	0.2
10	0.5	0	0	0	0.5
10.5	1	0	0	0	1
11	0.4	0	0	0	0.4
11.5	0.3	0	0	0	0.3
12	0.2	0	0	0	0.2
12.5	0.2	0	0	0	0.2
13	0.1	0	0	0	0.1
13.5	0.1	0	0	0	0.1
14	0.04	0	0	0	0.04
14.5	0.03	0	0	0	0.03
15	0.01	0	0	0	0.01
15.5	0.005	0	0	0	0.005
16	0	0	0	0	0
16.5	0	0	0	0	0
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
Total N	3	0	0	0	3
Catch (T)	0.02	0	0	0	0.02
L avg (cm)	11.3	-	-	-	11.3
W avg (g)	9.4	-	-	-	9.4

Table 4.2.5.1.14. Anchovy in Division 9.a. Subdivision 9.a South (ES). Spanish fishery (all fleets). Seasonal and annual length distributions ('000) of anchovy landings in 2016.

2016	Q1	Q2	Q3	Q4	TOTAL
Length (cm)	9.a S (ES)	9.a S (ES)	9.a S (ES)	9.a S (ES)	9.a S (ES)
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	471	271	207	139	1088
9	2234	2364	533	1232	6363
9.5	11044	8683	1140	3231	24099
10	24909	15898	1787	3987	46581
10.5	28096	28984	5107	7849	70035
11	19360	22081	10839	11537	63817
11.5	13362	26283	18872	17499	76016
12	8659	18665	20928	12870	61121
12.5	7559	19074	25118	9212	60962
13	6171	15824	22130	5666	49791
13.5	4418	10679	20098	5817	41012
14	1818	6157	11620	2179	21774
14.5	1208	2493	11155	1077	15933
15	320	2113	2703	635	5772
15.5	259	542	2749	529	4079
16	5	666	1235	48	1953
16.5	24	160	765	10	958
17	2	0	2	0	4
17.5	0	0	0	10	10
18	0	0	2	0	2
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
Total N	129919	180936	156989	83526	551371
Catch (T)	1222	2208	2128	866	6424
L avg (cm)	11.3	11.9	12.9	12.0	12.1
W avg (g)	9.4	12.2	13.6	10.4	11.7

Table 4.2.5.1.15. Anchovy in Division 9.a. Subdivision 9.a South (ES). Spanish fishery (all fleets). Seasonal and annual length distributions ('000) of anchovy discards in 2016.

2016	Q1	Q2	Q3	Q4	TOTAL
Length (cm)	**9.a S (ES)**	**9.a S (ES)**	**9.a S (ES)**	**9.a S (ES)**	**9.a S (ES)**
5,5	0	0	9	0	9
6	0	0	55	0	55
6.5	0	0	27	3	30
7	7	0	377	29	413
7.5	60	0	521	13	595
8	40	0	827	20	886
8.5	27	0	960	30	1016
9	7	12	1220	45	1284
9.5	312	69	1148	51	1580
10	744	57	1170	58	2028
10.5	582	129	578	20	1309
11	497	117	34	43	692
11.5	298	81	227	3	610
12	480	85	390	3	958
12.5	466	347	292	3	1108
13	378	329	594	9	1310
13.5	164	75	891	5	1136
14	96	26	708	18	848
14.5	80	6	231	12	330
15	5	131	42	7	185
15.5	0	0	101	0	101
16	7	54	22	0	83
16.5	5	0	0	0	5
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	2	0	0	0	2
20.5	0	0	0	0	0
Total N	4528	1518	10424	371	16571
Catch (T)	44	23	86	3	156
L avg (cm)	11.5	12.7	10.7	10.2	11.1
W avg (g)	10.4	15.2	8.3	6.8	9.5

Table 4.2.5.1.16. Anchovy in Division 9.a. Subdivision 9.a South (ES). Spanish fishery (all fleets). Seasonal and annual length distributions ('000) of anchovy catches in 2016.

2016	Q1	Q2	Q3	Q4	TOTAL
Length (cm)	**9.a S (ES)**	**9.a S (ES)**	**9.a S (ES)**	**9.a S (ES)**	**9.a S (ES)**
5,5	0	0	9	0	9
6	0	0	55	0	55
6.5	0	0	27	3	30
7	7	0	377	29	413
7.5	60	0	521	13	595
8	40	0	827	20	886
8.5	498	271	1167	169	2104
9	2241	2376	1753	1277	7647
9.5	11356	8752	2288	3283	25679
10	25653	15955	2957	4044	48609
10.5	28678	29113	5685	7868	71344
11	19857	22198	10874	11580	64509
11.5	13660	26365	19099	17502	76626
12	9139	18749	21317	12873	62079
12.5	8025	19421	25409	9215	62071
13	6549	16153	22724	5675	51101
13.5	4582	10754	20990	5823	42148
14	1914	6183	12328	2197	22622
14.5	1288	2500	11386	1089	16263
15	325	2244	2746	642	5957
15.5	259	542	2850	529	4180
16	12	719	1257	48	2035
16.5	29	160	765	10	963
17	2	0	2	0	4
17.5	0	0	0	10	10
18	0	0	2	0	2
18.5	0	0	0	0	0
19	0	0	0	0	0
19.5	0	0	0	0	0
20	2	0	0	0	2
20.5	0	0	0	0	0
Total N	134177	182454	167413	83897	567942
Catch (T)	1266	2231	2215	868	6580
L avg (cm)	11.3	11.9	12.8	12.0	12.0
W avg (g)	9.4	12.2	13.2	10.4	11.6

Table 4.2.5.2.1. Anchovy in Division 9.a. Subdivision 9.a North. Spanish catches (all fleets) in numbers- ('000) at-age of Galician anchovy in 2016 on a quarterly (Q), half-year (HY) and annual basis.

2016	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	735	3942	0	4677	4677
	1	190	2723	4247	2046	2913	6293	9206
	2	19	328	534	0	347	534	881
	3	1	0	0	0	1	0	1
	Total (n)	210	3050	5515	5988	3260	11503	14763
	Catch (t)	4	53	80	86	57	166	222
	SOP	3	46	86	82	49	168	217
	VAR.%	125	115	92	105	115	99	102

Table 4.2.5.2.2. Anchovy in Division 9.a. Subdivision 9.a North. Spanish annual catches of anchovy in numbers- ('000) at-age (only data for 2011–2012 and 2015–2016).

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

Table 4.2.5.2.3. Anchovy in Division 9.a. Subdivision 9.a South (ES). Spanish catches (all fleets) in numbers- ('000) at-age of Gulf of Cadiz anchovy in 2016 on a quarterly (Q), half-year (HY) and annual basis.

2016	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	31430	56549	0	87979	87979
	1	129063	175989	128654	26495	305052	155149	460201
	2	5113	6464	7328	853	11577	8181	19758
	3	0	0	0	0	0	0	0
	Total (n)	134176	182454	167412	83897	316630	251309	567939
	Catch (t)	1266	2231	2215	868	3497	3083	6580
	SOP	1266	2230	2215	868	3496	3083	6579
	VAR.%	100	100	100	100	100	100	100

Table 4.2.5.2.4. Anchovy in Division 9.a. Subdivision 9.a South (ES). Spanish annual catches (all fleets) in numbers- ('000) at-age of Gulf of Cadiz anchovy (1995–2016).

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

Table 4.2.6.1. Anchovy in Division 9.a. Subdivision 9.a North. Mean length- (TL, in cm) at-age in the Spanish catches of Galician anchovy (all fleets) in 2016 on a quarterly (Q), half-year (HY) and annual basis.

2016	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	-	-	11,9	12,8	-	12,7	12,7
	1	13,5	13,6	13,0	13,7	13,6	13,3	13,4
	2	14,7	14,0	15,3	-	14,1	15,26	14,8
	3	16,3	-	-	-	16,3	-	16,3
	Total	13,7	13,7	13,1	13,1	13,7	13,1	13,2

Table 4.2.6.2. Anchovy in Division 9.a. Subdivision 9.a North. Mean weight- (in kg) at-age in the Spanish catches of Galician anchovy (all fleets) in 2016 on a quarterly (Q), half-year (HY) and annual basis.

2016	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	-	-	0,013	0,013	-	0,013	0,013
	1	0,013	0,015	0,015	0,015	0,015	0,015	0,015
	2	0,017	0,017	0,022	-	0,017	0,022	0,020
	3	0,024				0,024	-	0,024
	Total	0,014	0,015	0,015	0,014	0,015	0,015	0,015

Table 4.2.6.3. Anchovy in Division 9.a. Subdivision 9.a South (ES). Mean length- (TL, in cm) at-age in the Spanish catches of Gulf of Cadiz anchovy (all fleets) in 2016 on a quarterly (Q), half-year (HY) and annual basis.

2016	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	-	-	8.7	11.4	-	11,3	11,3
	1	11.2	11.8	14.3	13.1	11,5	13,2	12,1
	2	13.8	14.6	13.2	13.8	14,3	12,8	13,6
	3	-	-	-	-	-	-	-
	Total	11,3	11,9	12,8	12,0	11,6	12,5	12,0

Table 4.2.6.4. Anchovy in Division 9.a. Subdivision 9.a South (ES). Mean weight- (in kg) at-age in the Spanish catches of Gulf of Cadiz anchovy (all fleets) in 2016 on a quarterly (Q), half-year (HY) and annual basis.

2016	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	-	-	0,011	0,009	-	0,009	0,009
	1	0.009	0,012	0,013	0,013	0,011	0,014	0,012
	2	0.018	0,024	0,013	0,016	0,021	0,013	0,018
	3	-	-	-	-	-	-	-
	Total	0,009	0,012	0,013	0,010	0,011	0,012	0,012

Table 4.3.1. Acoustic and DEPM surveys providing direct estimates for anchovy in Division 9.a. (1): surveys used until 2008 as tuning series in the exploratory analytical assessment of anchovy in Subdivision 9.a South (Algarve and Gulf of Cádiz) (see Section 4.5.1); (2): surveys analysed since 2008 in the trends-based qualitative assessment; (3): *ECOCÁDIZ-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 04**	**PELAGO**		**SAR**	**JUVESAR**	**ECOCADIZ**		**ECOCADIZ-RECLUTAS**	**BOCADEVA**	
Institute (Country)	**IEO (Spain)**	**IPMA (Portugal)**		**IPMA (Portugal)**	**IPMA (Portugal)**	**IEO (Spain)**		**IEO (Spain)**	**IEO (Spain)**	
Subareas	**9.a N**	**9.a CN-9.a S**		**9.a CN-9.a S**	**9.a CN**	**9.a S**		**9.a S**	**9.a S**	
Year/Quarter	**Q2**	**Q1**	**Q2**	**Q4**	**Q4**	**Q2**	**Q3**	**Q4**	**Q2**	**Q3**
1998				Nov						
1999		Mar (1,2)								
2000				Nov						
2001		Mar (1,2)		Nov						
2002		Mar (1,2)								
2003		Feb (1,2)		(Nov)						
2004			(Jun)			Jun(2)				
2005			Apr(1,2)	(Nov)					Jun(2)	
2006			Apr(1,2)	(Nov)		Jun(2)				
2007			Apr(1,2)	Nov			Jul (2)			
2008	Apr(2)		Apr(1,2)	(Nov)					Jun(2)	
2009	Apr(2)		Apr(2)			Jun(2)	(Jul)(3)	(Oct)		
2010	Apr(2)		Apr(2)				(Jul)(2)			
2011	Apr(2)		Apr(2)							Jul(2)
2012	Apr(2)							Nov		
2013	Mar(2)		Apr(2)		(Nov)		Aug(2)			
2014	Mar(2)		Apr(2)		(Nov)		Jul(2)	Oct		Jul(2)
2015	Mar(2)		Apr(2)		Dec		Jul(2)	Oct		
2016	Mar(2)		Apr(2)		Dec		Jul(2)	Oct		
2017	Mar(2)		Apr(2)				Jul(2)	Oct		Jul(2)

Table 4.3.2.1. 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
Apr. 08	N	10
	B	306
Apr. 09	N	0.7
	B	26
Apr. 10	N	0.03
	B	90
Apr. 11	N	73
	B	1650
Apr. 12	N	1
	B	45
Mar 13	N	-
	B	-
Mar 14	N	-
	B	-
Mar 15	N	-
	B	-
Mar 16	N	8
	B	205
Mar 17	N	124
	B	3566

Table 4.3.2.2. 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).

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

Table 4.3.2.2. Anchovy in Division 9.a. *PELAGO* survey series (spring Portuguese acoustic survey in Subdivisions 9.a Central-North to 9.a South). Cont'd.

SURVEY	ESTIMATE	PORTUGAL				SPAIN	S(TOTAL)	TOTAL
		C-N	C-S	S(A)	Total	S(C)		
Apr. 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	-	-	-	-	-	-	-
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
Apr 17	**N**			137		1718	1855	
	B			1208		12589	13797	

***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 echotraces attributable to the species were detected in this area, however, the loss of pelagic gear samplers prevented from confirming directly this.**

Table 4.3.2.3. Anchovy in Division 9.a. *ECOCADIZ* survey series (summer Spanish acoustic survey in Subdivision 9.a South). Historical series of overall and regional acoustic estimates of anchovy abundance (N, millions) and biomass (B, tonnes).

SURVEY	ESTIMATE	PORTUGAL	SPAIN	TOTAL
		S(A)	S(C)	S(Total)
Jun. 04* **	**N**	125	1109	1235
	B	2474	15703	18177
Jun. 05	**N**	-	-	-
	B	-	-	-
Jun. 06	**N**	363	2801	3163
	B	6477	30043	36521
Jul. 07	**N**	558	1232	1790
	B	11639	17243	28882
Jul. 08	**N**	-	-	-
	B	-	-	-
Jul. 09	**N**	35	1102	1137
	B	1075	20506	21580
Jul. 10	**N**	?	954+	954 +
	B	?	12339 +	12339 +
Jul. 11	**N**	-	-	-
	B	-	-	-
Jul. 12	**N**	-	-	-
	B	-	-	-
Aug. 13	**N**	50	558	609
	B	1315	7172	8487
Jul. 14	**N**	184	1778	1962
	B	4440	24779	29219
Jul. 15	**N**	168	2506	2674
	B	2137	19168	21305
Jul. 16	**N**	346	3341	3686
	B	5250	29051	34301

*****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 4.3.3.1. 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 - *JUVESAR* -). 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	S (TOTAL)	TOTAL
		C-N	C-S	S (PT)	Total	S (ES)		
Nov. 98	N	30	122	50	203	2346	2396	2549
	B	313	1951	603	2867	30092	30695	32959
Nov. 99	N	-	-	-	-	-	-	-
	B	-	-	-	-	-	-	-
Nov. 00	N	4	20	*	23	4970	4970	4994
	B	98	241	*	339	33909	33909	34248
Nov. 01	N	35	94	-	129	3322	3322	3451
	B	1028	2276	-	3304	25578	25578	28882
Nov. 02	N	-	-	-	-	-	-	-
	B	-	-	-	-	-	-	-
Nov. 03	N	-	-	-	-	-	-	-
	B	-	-	-	-	-	-	-
Nov. 04	N	-	-	-	-	-	-	-
	B	-	-	-	-	-	-	-
Nov. 05	N	-	-	-	-	-	-	-
	B	-	-	-	-	-	-	-
Nov. 06	N	-	-	-	-	-	-	-
	B	-	-	-	-	-	-	-
Nov. 07	N	0	59	475	534	1386	1862	1921
	B	0	1120	7632	8752	16091	23723	24843
Nov. 13	N	-	-	-	-	-	-	-
	B	-	-	-	-	-	-	-
Nov. 14	N	-	-	-	-	-	-	-
	B	-	-	-	-	-	-	-
Dec. 15	N	3870 (1778)	-	-	-	-	-	-
	B	29556 (9758)	-	-	-	-	-	-
Dec. 16	N	2836 (2835)	-	-	-	-	-	-
	B	14397 (14367)	-	-	-	-	-	-

*** 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 4.3.3.2. Anchovy in Division 9.a. *ECOCADIZ-RECLUTAS* survey series (autumn Spanish acoustic survey in Subdivision 9.a South). Historical series of overall and regional acoustic estimates of anchovy abundance (N, millions) and biomass (B, tonnes). Age 0 fish estimates between parentheses.

SURVEY	ESTIMATE	PORTUGAL	SPAIN	TOTAL
		S (PT)	**S (ES)**	**S (Total)**
Nov. 12*	**N**	-	2649 (2619)	-
	B	-	13680 (13354)	-
Oct. 14	**N**	111 (3)	875 (811)	986 (814)
	B	2168 (25)	5945 (5107)	8113 (5131)
Oct. 15	**N**	115 (75)	5113 (5042)	5227 (5117)
	B	1335 (430)	29491 (28789)	30827 (29219)
Oct. 16	**N**	177 (42)	3490 (3404)	3667 (3445)
	B	3054 (463)	16807 (15506)	19861 (15969)

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

Table 4.4.1.1. Anchovy in Division 9.a. 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	6.0	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	
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	

Table 4.4.2.1. Anchovy in Division 9.a. Subdivision 9.a South. Maturity ogives (ratio of mature fish at age) for Gulf of Cadiz anchovy.

Year	Age		
	0	**1**	**2+**
1988	0	0.82	1
1989	0	0.53	1
1990	0	0.65	1
1991	0	0.76	1
1992	0	0.53	1
1993	0	0.77	1
1994	0	0.60	1
1995	0	0.76	1
1996	0	0.49	1
1997	0	0.63	1
1998	0	0.55	1
1999	0	0.74	1
2000	0	0.70	1
2001	0	0.76	1
2002	0	0.72	1
2003	0	0.69	1
2004	0	0.95	1
2005	0	0.95	1
2006	0	0.77	1
2007	0	0.91	1
2008	0	0.97	1
2009	0	0.99	1
2010	0	0.97	1
2011	0	0.97	1
2012	0	0.89	1
2013	0	0.94	1
2014	0	0.91	1
2015	0	0.92	1
2016	0	0.97	0.98

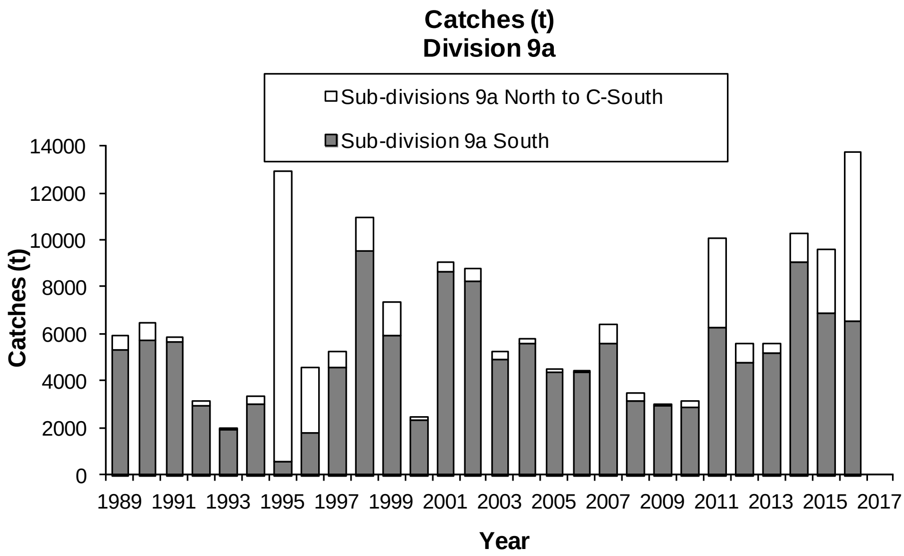


Figure 4.2.2.1.1. Anchovy in Division 9.a. Recent series of anchovy catches in Division 9.a (ICES estimates for 1989–2016, the period with data for all the subdivisions, all métiers are considered). Subareas are pooled in order to differentiate the anchovy fishery harvested throughout the Atlantic façade of the Iberian Peninsula (ICES subdivisions 9.a North, Central-North and Central-South) from the fishery in the Gulf of Cadiz (Subdivision 9.a South), where both the stock and the fishery are mainly located. Discards are considered as negligible all over the division, but since 2014 on estimates include the available discarded catches (see Section 4.2.3).

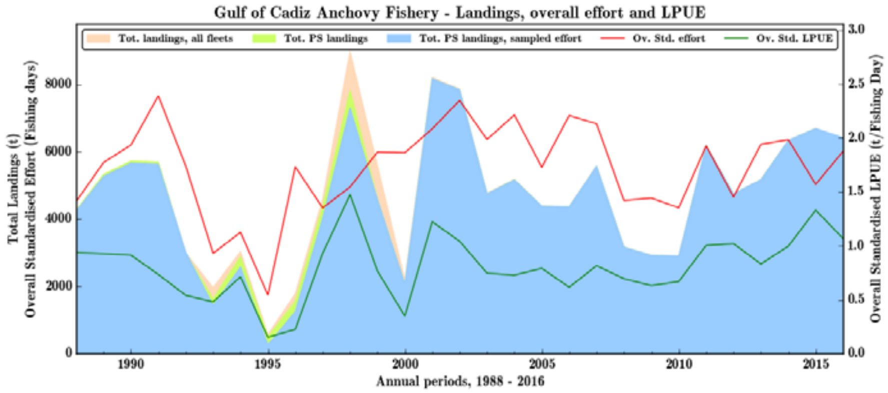


Figure 4.2.4.1. Anchovy in Division 9.a. Subdivision 9.a South. Spanish purse-seine fishery (métier PS_SPF_0_0_0). Trends in Gulf of Cadiz anchovy annual landings, and purse-seine fleets' standardised overall effort and lpue (1988–2016).

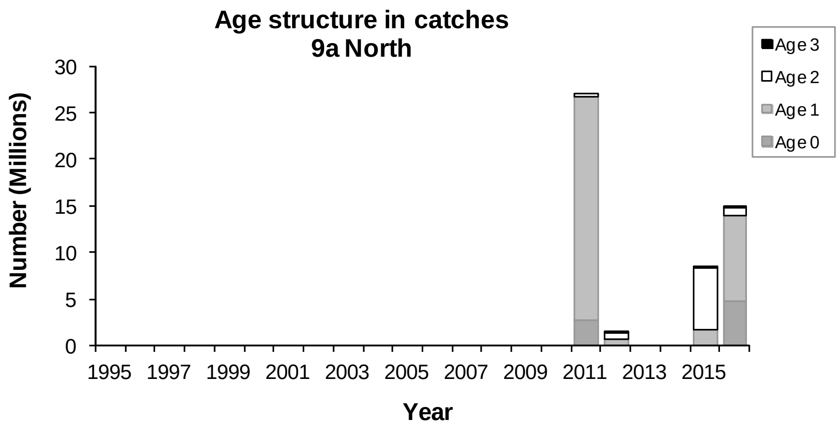


Figure 4.2.5.2.1. Anchovy in Division 9.a. Subdivision 9.a North. Spanish fishery (all métiers). Age composition in Spanish catches of SW Galician anchovy (available data provided to the WG). Although discards are still considered as negligible (hence landings are assumed as equal to catches), data for 2015 include discards estimates.

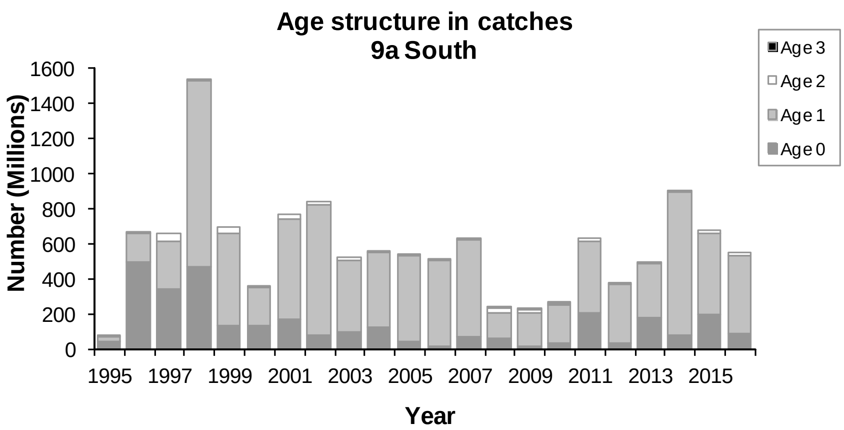
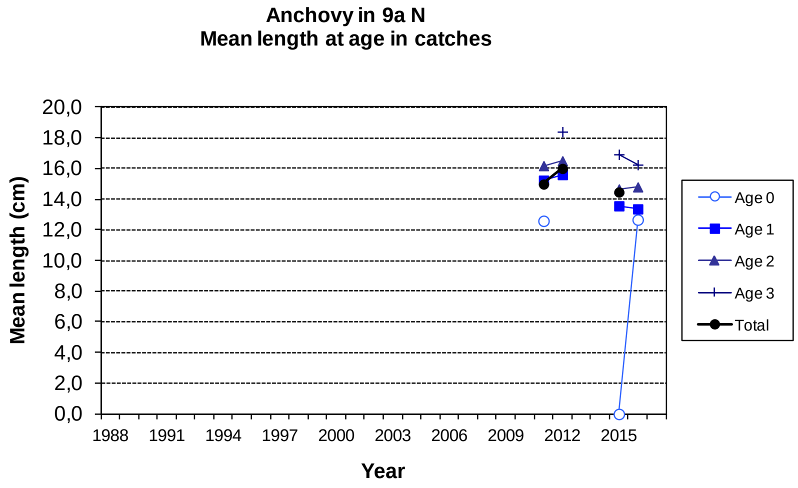


Figure 4.2.5.2.2. Anchovy in Division 9.a. Subdivision 9.a-South. Spanish fishery (all métiers). Age composition in Spanish catches of Gulf of Cadiz anchovy (1995–2016). Discards are considered as negligible in this fishery, but since 2014 on estimates include the available discarded catches (see Section 4.2.3).



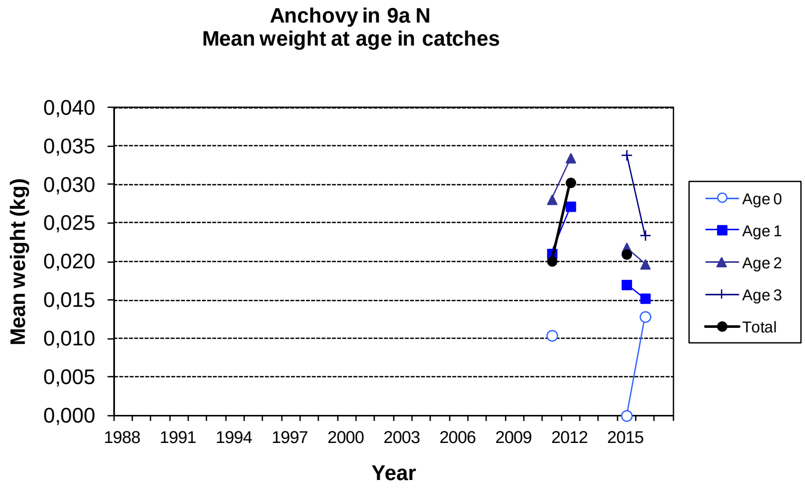
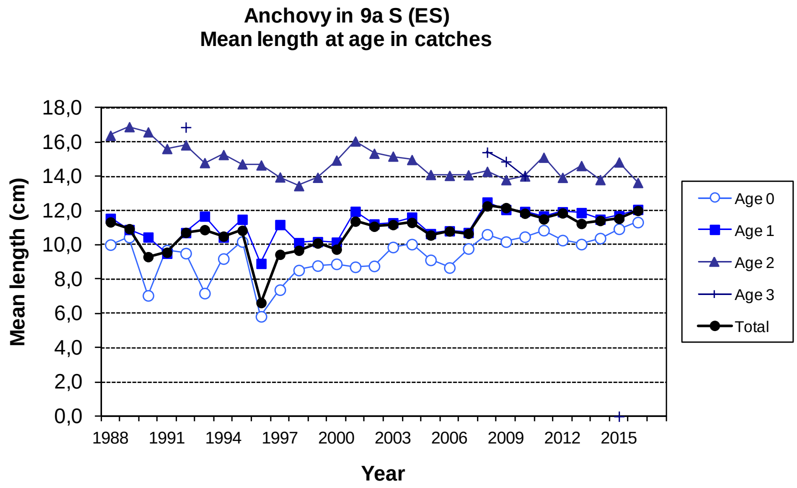


Figure 4.2.6.1. Anchovy in Division 9.a. Subdivision 9.a North. Spanish fishery (all métiers). Annual mean length (TL, in cm) and weight- (kg) at-age in the Spanish catches of Western Galicia anchovy.



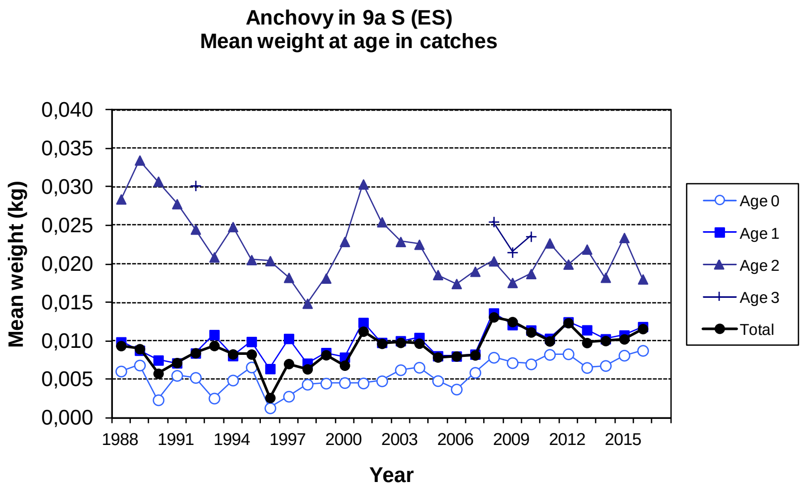


Figure 4.2.6.2. Anchovy in Division 9.a. Subdivision 9.a-South. Spanish fishery (all métiers). Annual mean length (TL, in cm) and weight- (kg) at-age in the Spanish catches of Gulf of Cadiz anchovy (1988–2016).

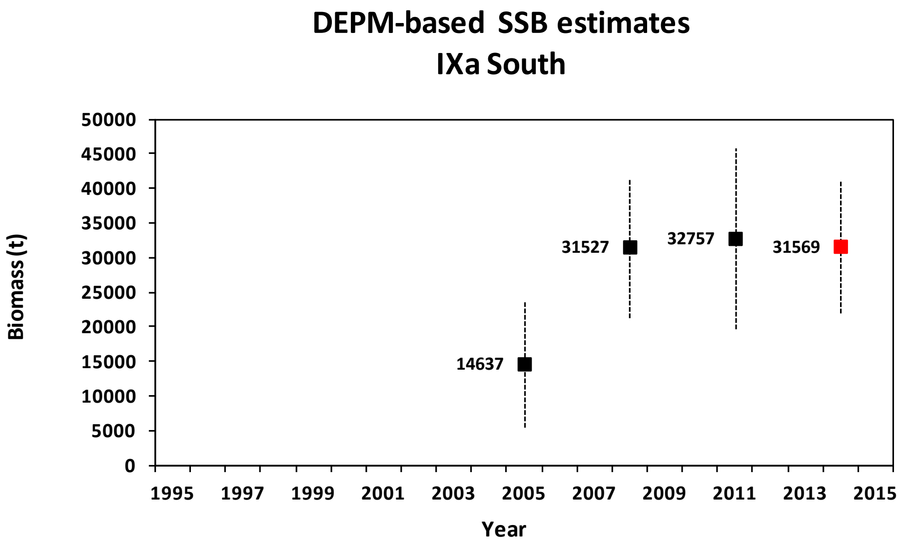


Figure 4.3.1.1. Anchovy in Division 9.a. Subdivision 9.a South. *BOCADEVA* survey series (summer Spanish DEPM survey in Subdivision 9.a South). Series of SSB estimates (±SD) obtained from the survey series. The 2014 SSB estimate (in red) is still provisional (computed with the 2011 Spawning Fraction estimate, *S*).

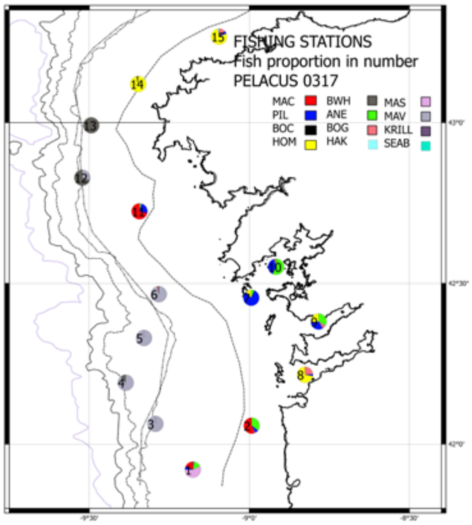


Figure 4.3.2.1. Anchovy in Division 9.a. Subdivision 9.a North. *PELACUS 0317* survey (spring Spanish acoustic survey in Subdivision 9.a North and Subarea 8c in 2017). Distribution of pelagic hauls for echo-traces identification with indication of the species composition.

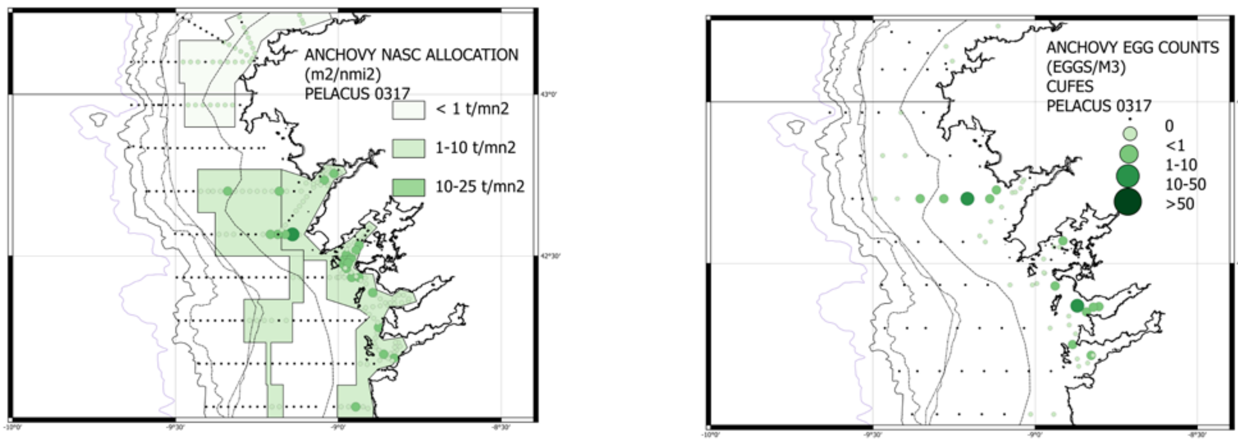


Figure 4.3.2.2. Anchovy in Division 9.a. Subdivision 9.a North. *PELACUS 0317* survey (spring Spanish acoustic survey in Subdivision 9.a North and Subarea 8c in 2017). Left: spatial distribution of energy allocated to anchovy. Polygons are drawn to encompass the observed echoes, and polygon colour indicates density in mt/ nm² within each polygon. Right: anchovy egg distribution as sampled by CUFES.

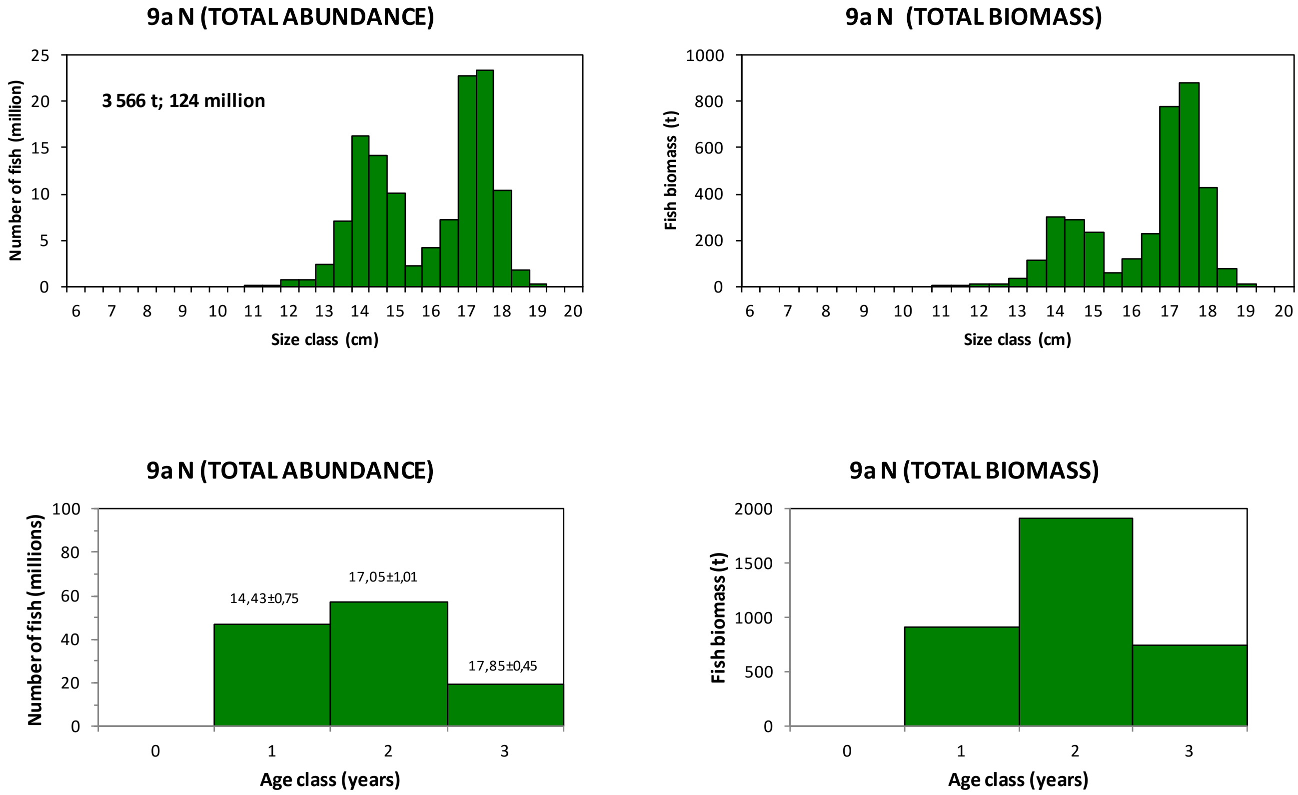


Figure 4.3.2.3. Anchovy in Division 9.a. Subdivision 9.a North. *PELACUS 0317* survey (spring Spanish acoustic survey in Subdivision 9.a North and Subarea 8.c in 2017 Estimated abundance and biomass (number of fish in millions and tonnes, respectively) in Subdivision 9.a North by age group, with indication of the mean size by age.

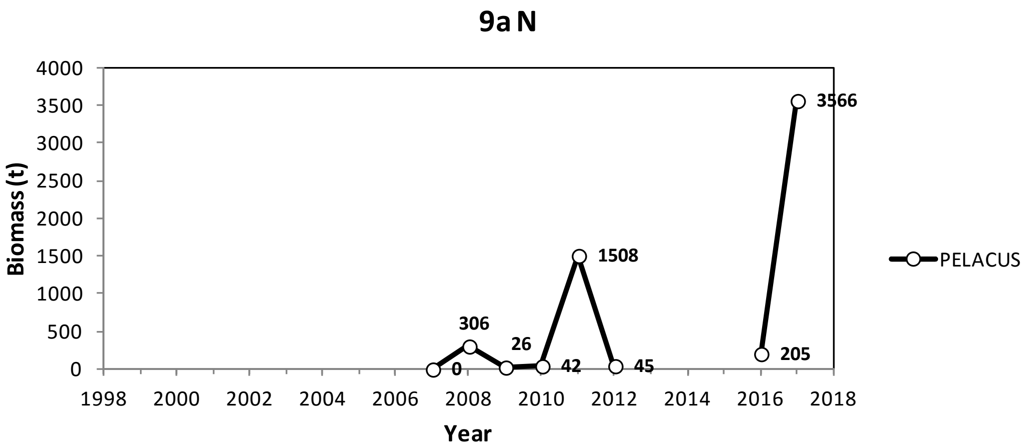


Figure 4.3.2.4. Anchovy in Division 9.a. Subdivision 9.a North. *PELACUS* survey series (spring Spanish acoustic survey in Subdivision 9.a North and Subarea 8.c). Historical series of acoustic estimates of anchovy biomass (t) for the Subdivision 9.a North.

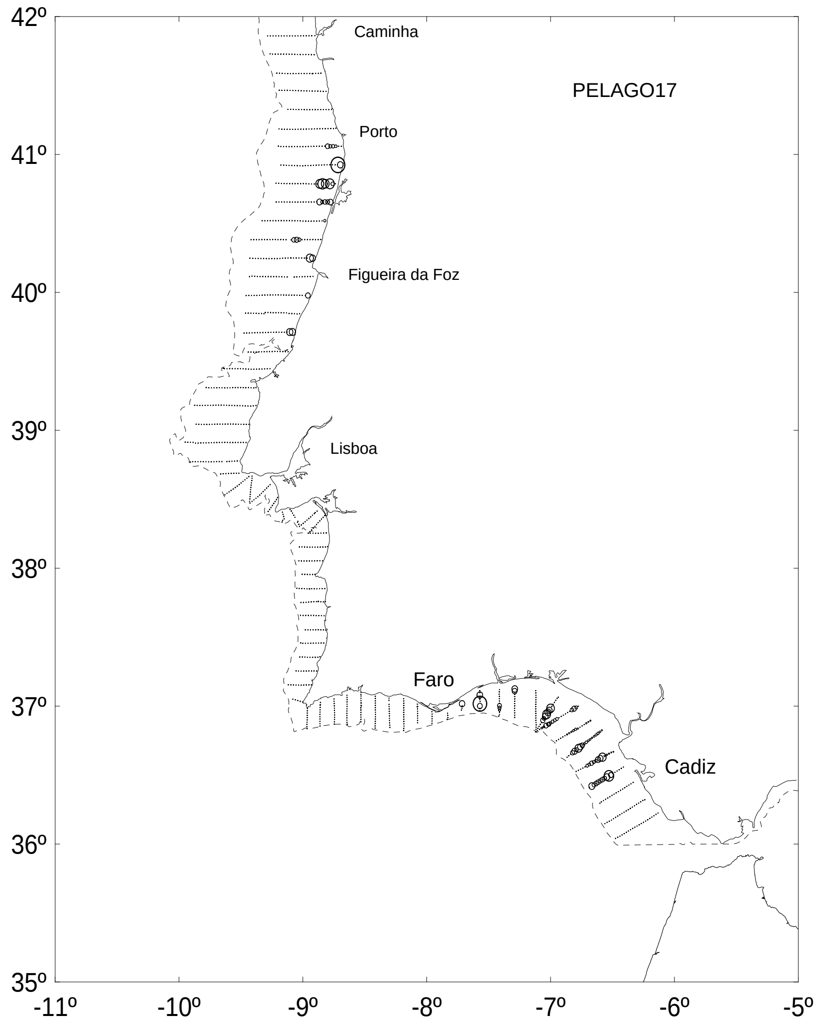


Figure 4.3.2.5. Anchovy in Division 9.a. Subdivisions 9.a Central-North to 9.a South. *PELAGO* survey series (spring Portuguese acoustic survey in Subdivisions 9.a Central-North to 9.a South). *PELAGO 17* survey. Distribution of the NASC coefficients (m²/mn²) attributed to anchovy.

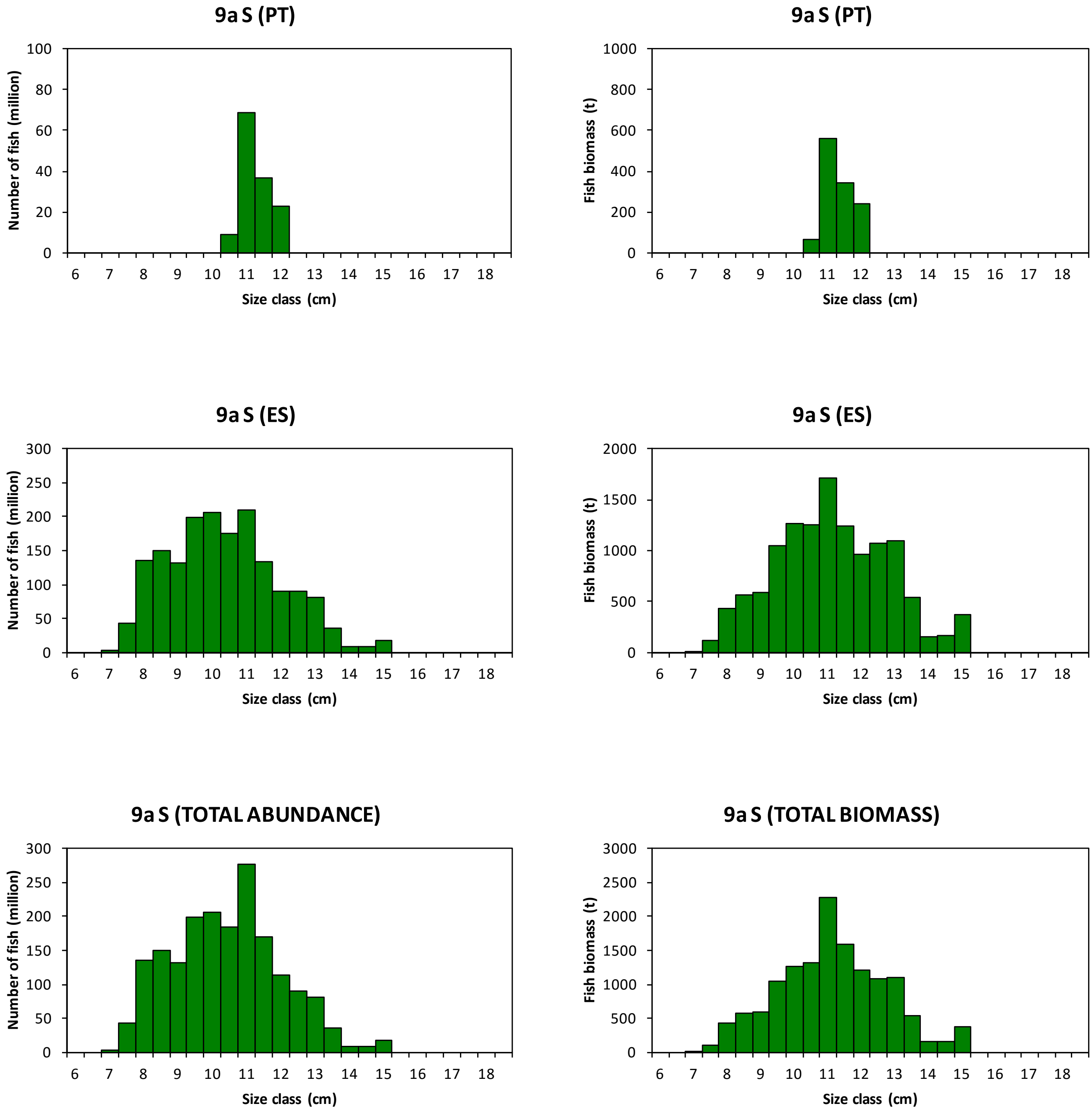


Figure 4.3.2.6. Anchovy in Division 9.a. Subdivisions 9.a Central-North to 9.a South. *PELAGO* survey series (spring Portuguese acoustic survey in Subdivisions 9.a Central-North to 9.a South). *PELAGO 17* survey. Estimated abundance (number of fish, in millions) by size class from the Subdivision 9.a South.

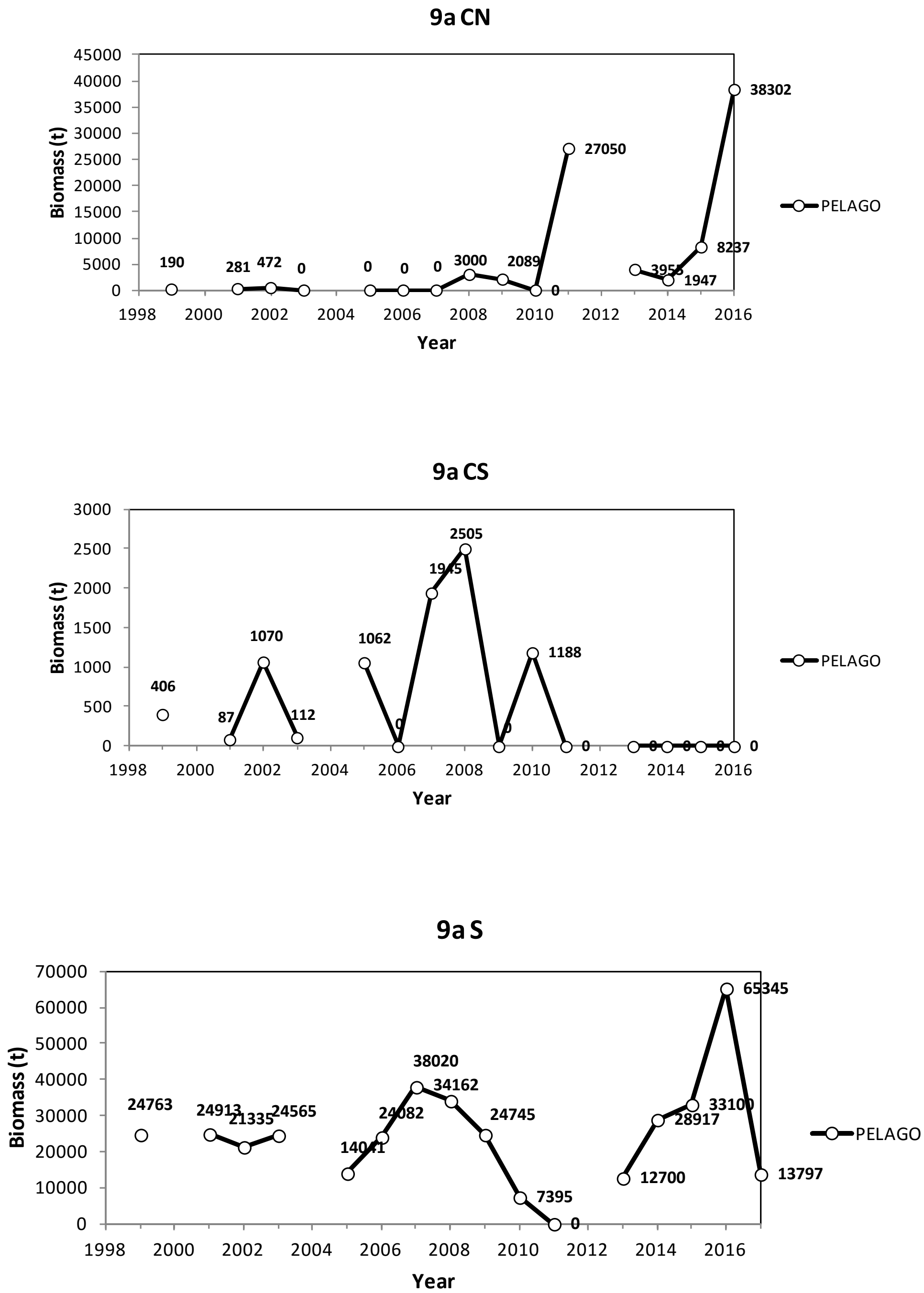
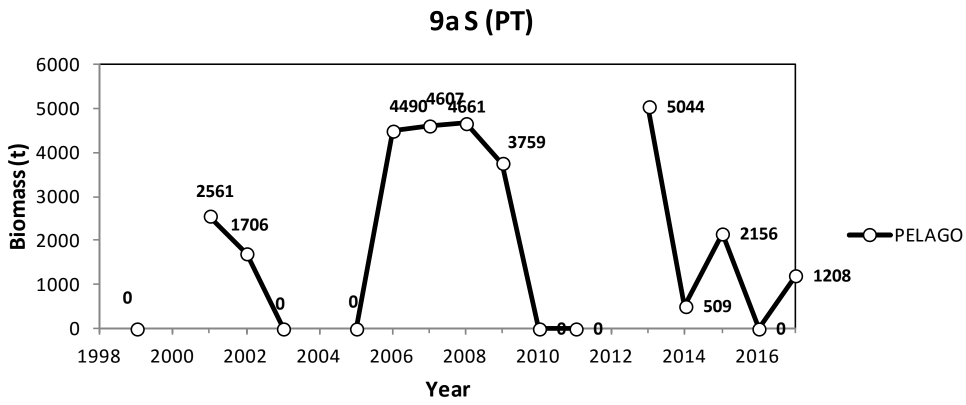


Figure 4.3.2.7. Anchovy in Division 9.a. Subdivisions 9.a Central-North to 9.a South. *PELAGO* survey series (spring Portuguese acoustic survey in Subdivisions 9.a Central-North to 9.a South). Historical series of regional acoustic estimates of anchovy biomass (t). Note the different scale of the y-axis. Acoustic estimates in 2017 only available to this WG for the Subdivision 9.a South.



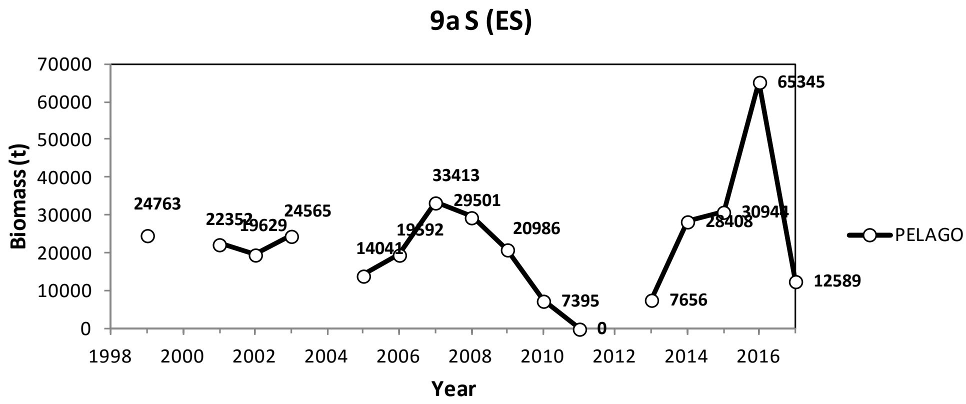
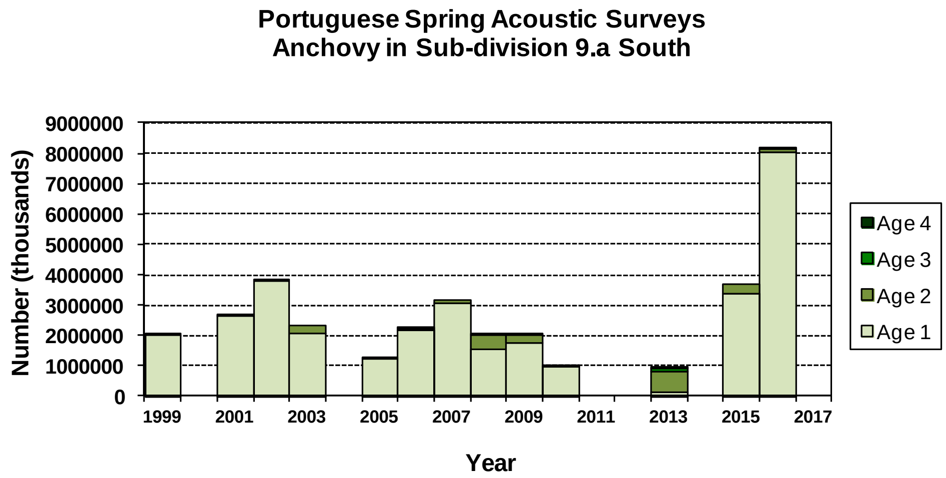


Figure 4.3.2.7 (cont'd). Acoustic estimates in the 9.a South differentiated by Portuguese (PT) and Spanish waters of the Gulf of Cádiz (ES). Note the different scale of the y-axis. Although estimates from Subdivision 9.a-South in 2010 and 2014 were not separately provided for Algarve and Cadiz to this WG, the total estimated for the Subdivision was assigned (by assuming some overestimation) to the Cadiz area according to the observed acoustic energy distribution in the area.



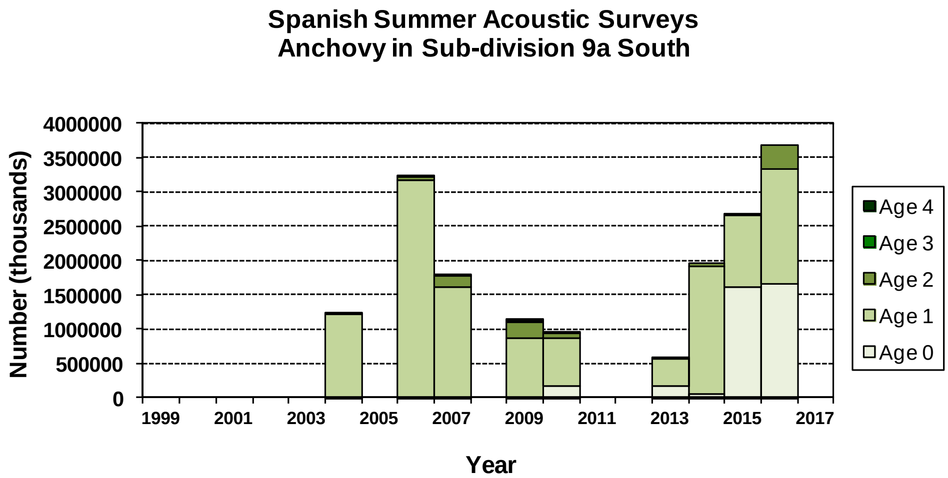


Figure 4.3.2.8. Anchovy in Division 9.a. Subdivision 9.a-South. Annual trends of the estimated population by age class from the Algarve + Gulf of Cádiz areas by the Portuguese Spring (upper plot) and Spanish summer (lower plot) acoustic surveys. Portuguese estimates until 2012 have been age structured using Spanish ALKs from the commercial fishery in the second quarter in the year. No Portuguese age-structured estimates are available for 2014 and 2017.

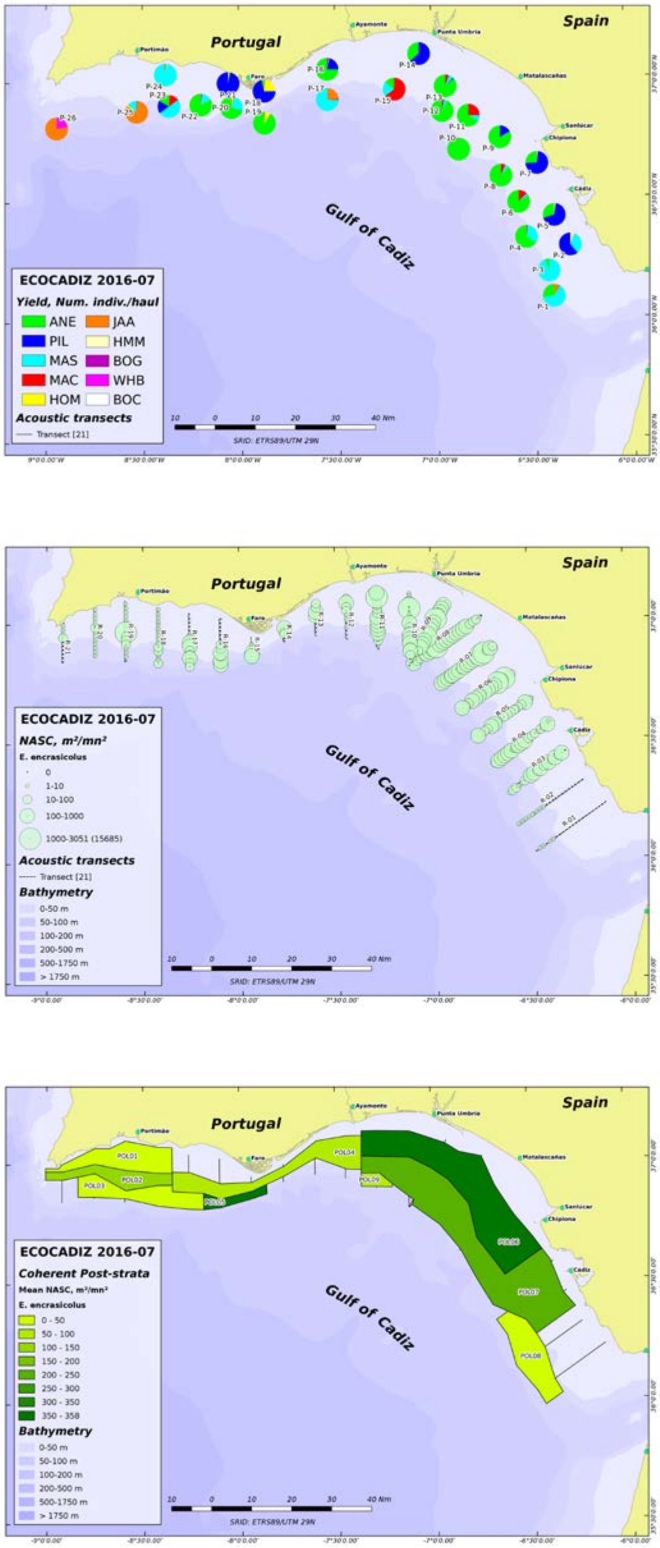


Figure 4.3.2.9. Anchovy in Division 9.a. Subdivision 9.a South. ***ECOCADIZ 2016-07*** **survey (summer Spanish acoustic survey in Subdivision 9.a South). Top: Location of valid fishing stations with indication of their species composition (percentages in number).Middle: Distribution of the backscattering 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.**

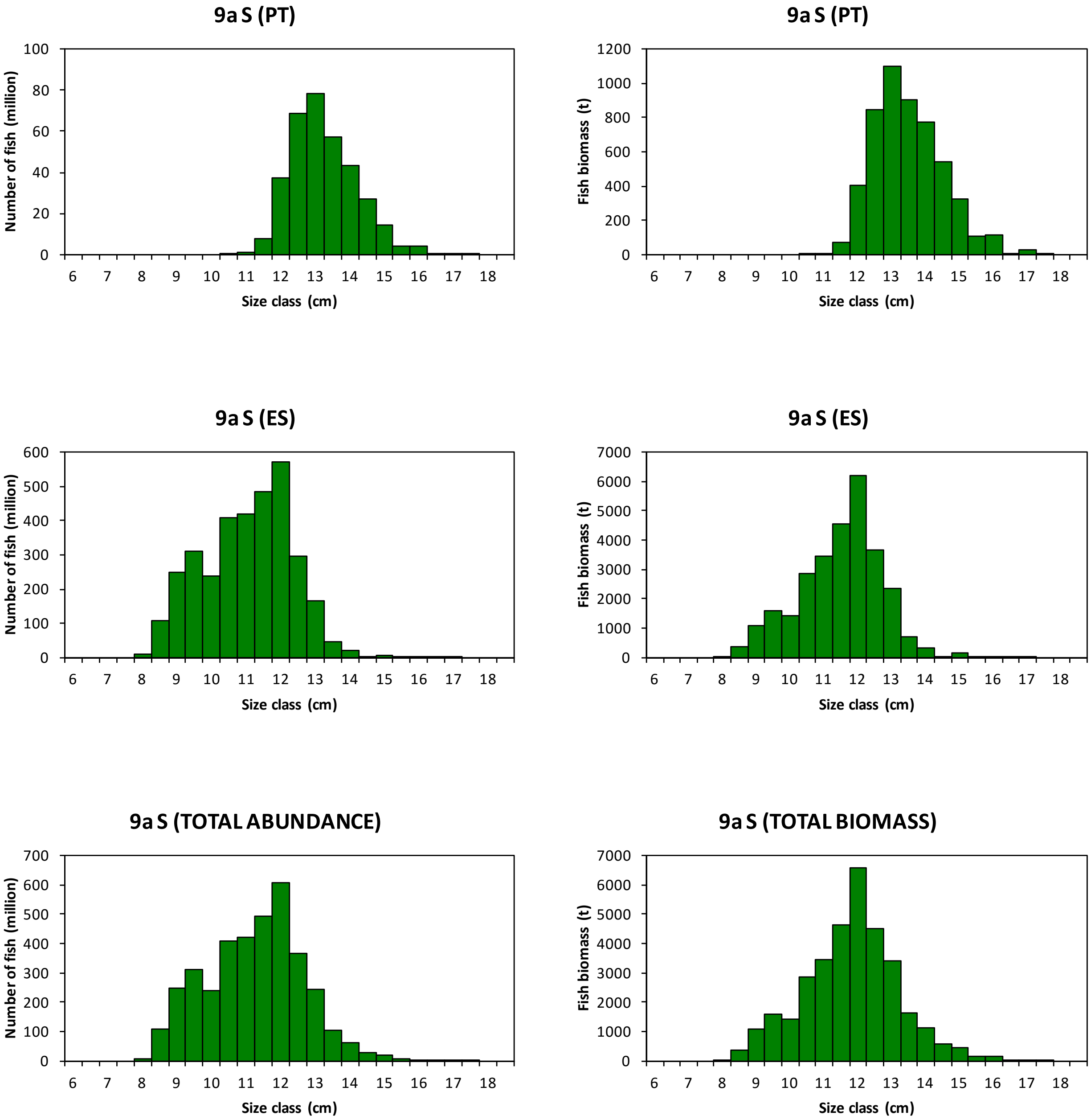


Figure 4.3.2.10. Anchovy in Division 9.a. Subdivision 9.a South. *ECOCADIZ 2016-07* survey (summer Spanish acoustic survey in Subdivision 9.a South). Estimated abundances and biomasses (number of fish in millions and tonnes, respectively) for the surveyed area by length class (cm). Note the different scales in the y axis.

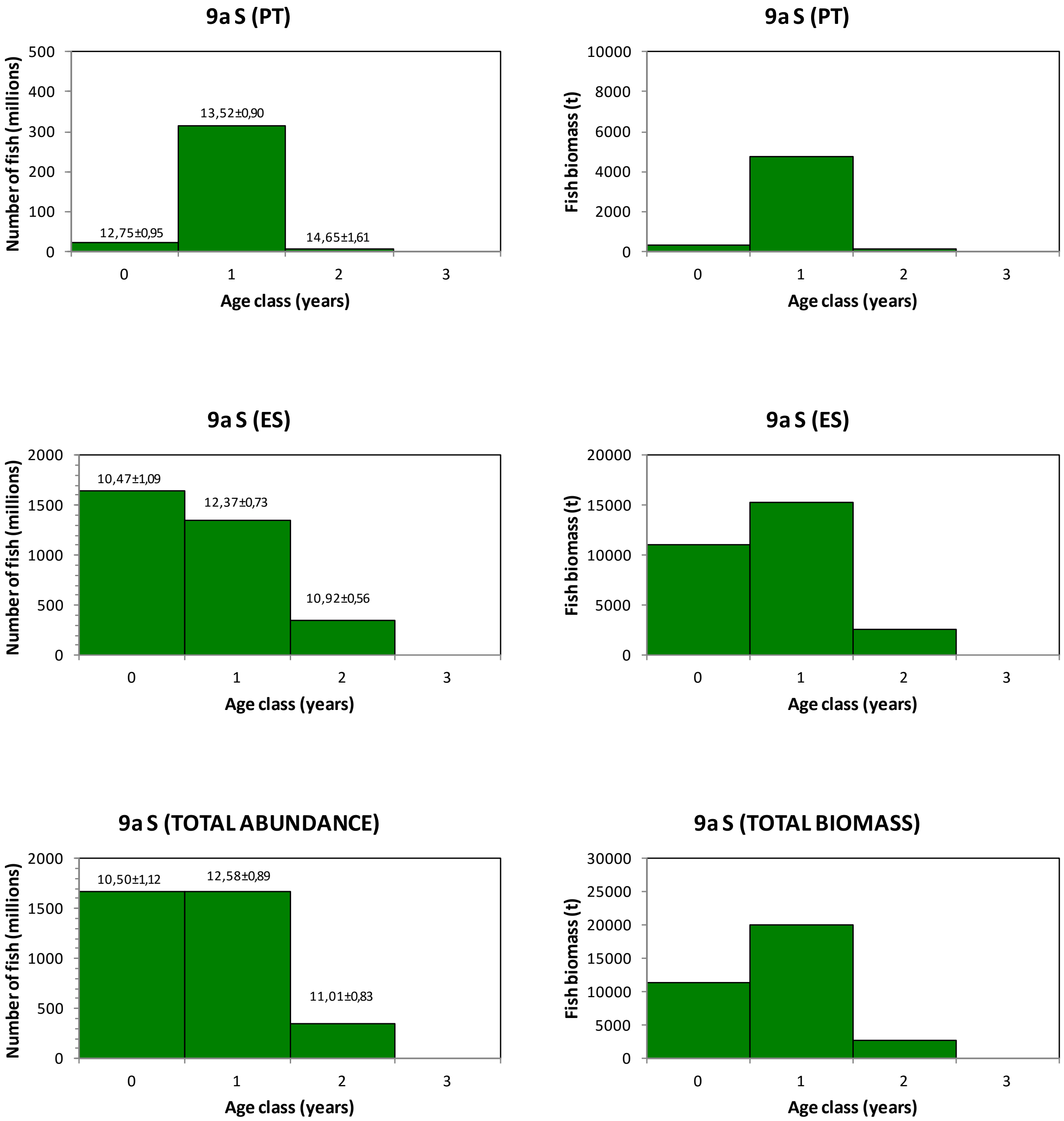


Figure 4.3.2.11. Anchovy in Division 9.a. Subdivision 9.a South. *ECOCADIZ 2016-07* survey (summer Spanish acoustic survey in Subdivision 9.a South). Estimated abundances and biomasses (number of fish in millions and tonnes, respectively) for the surveyed area by age group, with indication of the mean size by age. Note the different scales in the y axis.

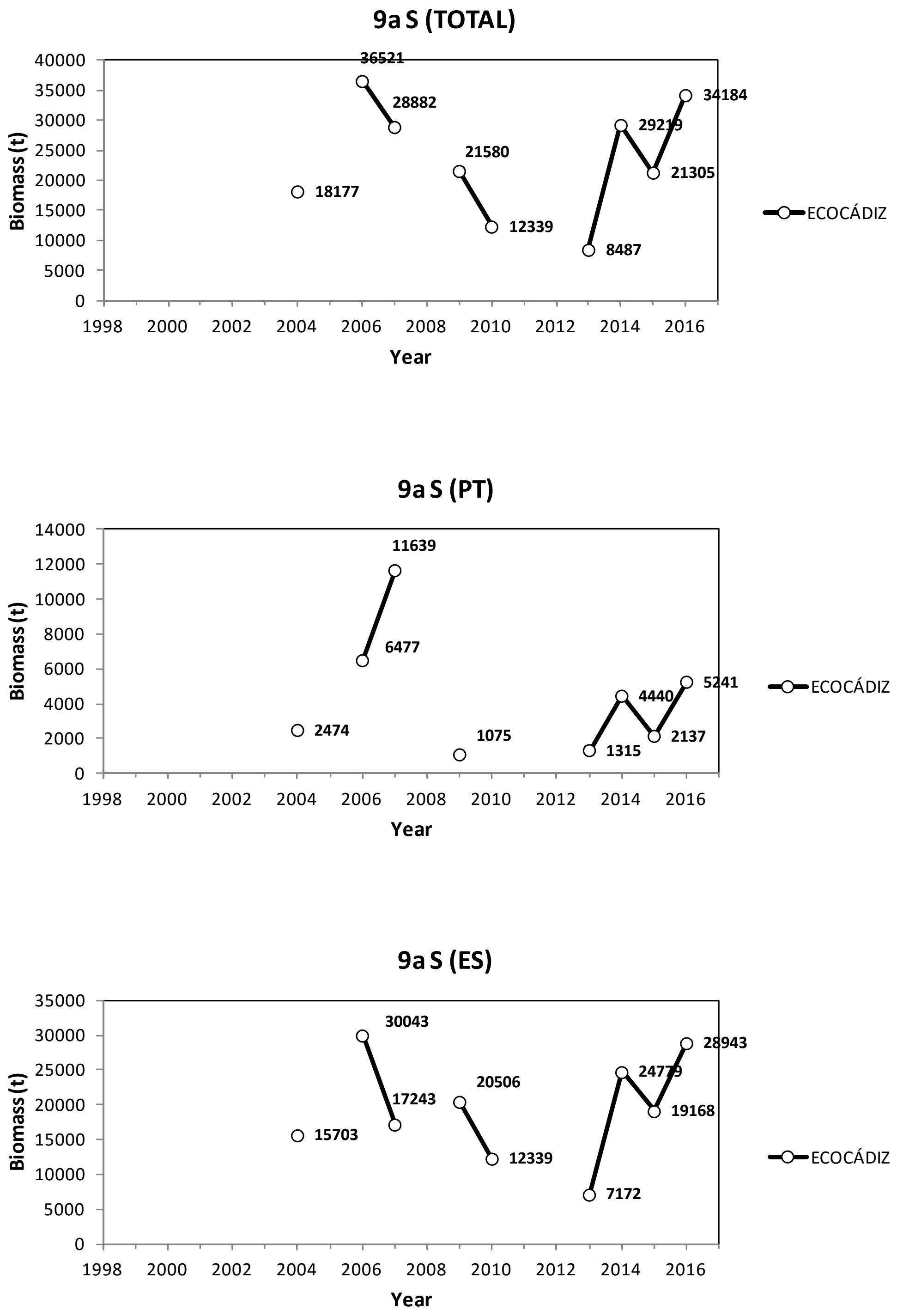


Figure 4.3.2.12. Anchovy in Division 9.a. Subdivision 9.a South. *ECOCADIZ* survey series (summer Spanish acoustic survey in Subdivision 9.a South). Historical series of overall and regional (Portuguese, PT, and Spanish waters of the Gulf of Cádiz, ES) acoustic estimates of anchovy biomass (t). Note the different scale of the y-axis.

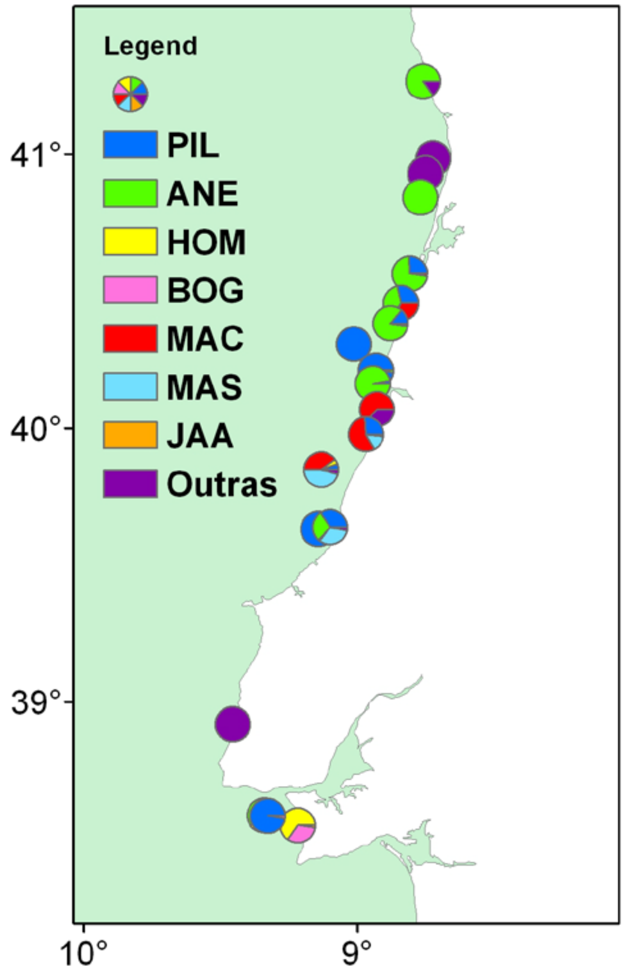


Figure 4.3.3.1. Anchovy in Division 9.a. Subdivision 9.a Central-North. ***JUVESAR 16*** **survey (autumn Portuguese acoustic survey in Subdivision 9.a Central-North). Fishing trawls location and hauls species composition (in number).**

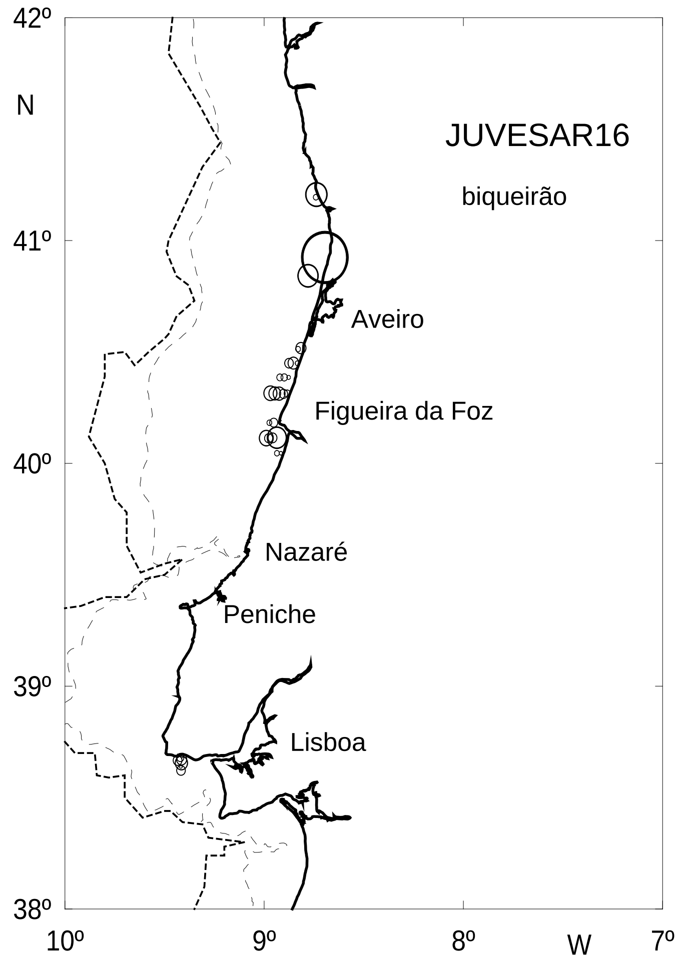


Figure 4.3.3.2. Anchovy in Division 9.a. Subdivision 9.a Central-North. *JUVESAR 16* survey (autumn Portuguese acoustic survey in Subdivision 9.a Central-North). Distribution of the NASC coefficients (m²/mn²) attributed to anchovy.

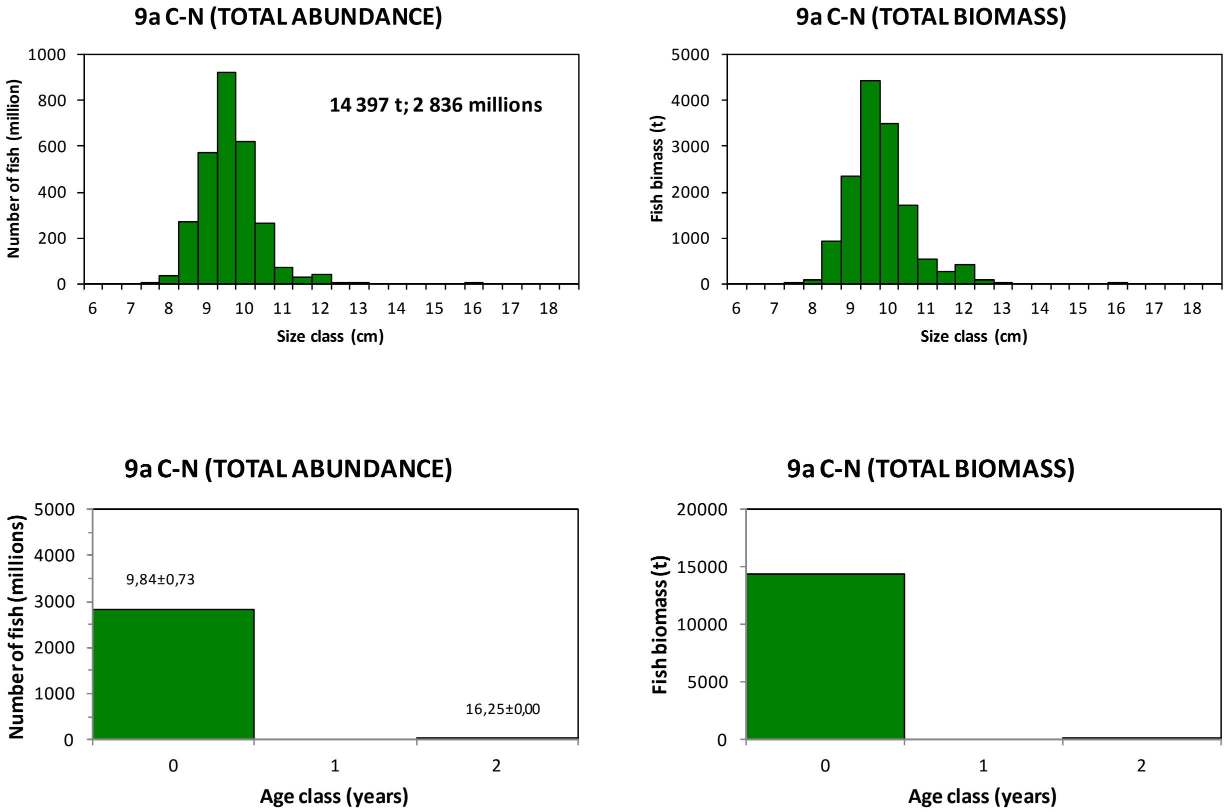


Figure 4.3.3.3. Anchovy in Division 9.a. Subdivision 9.a Central-North. *JUVESAR 16* survey (autumn Portuguese acoustic survey in Subdivision 9.a Central-North). Estimated abundance and biomass (number of fish in millions and tonnes, respectively) for the surveyed area by length class (cm) and age group, with indication of the mean size by age. Note the different scales in the y axis.

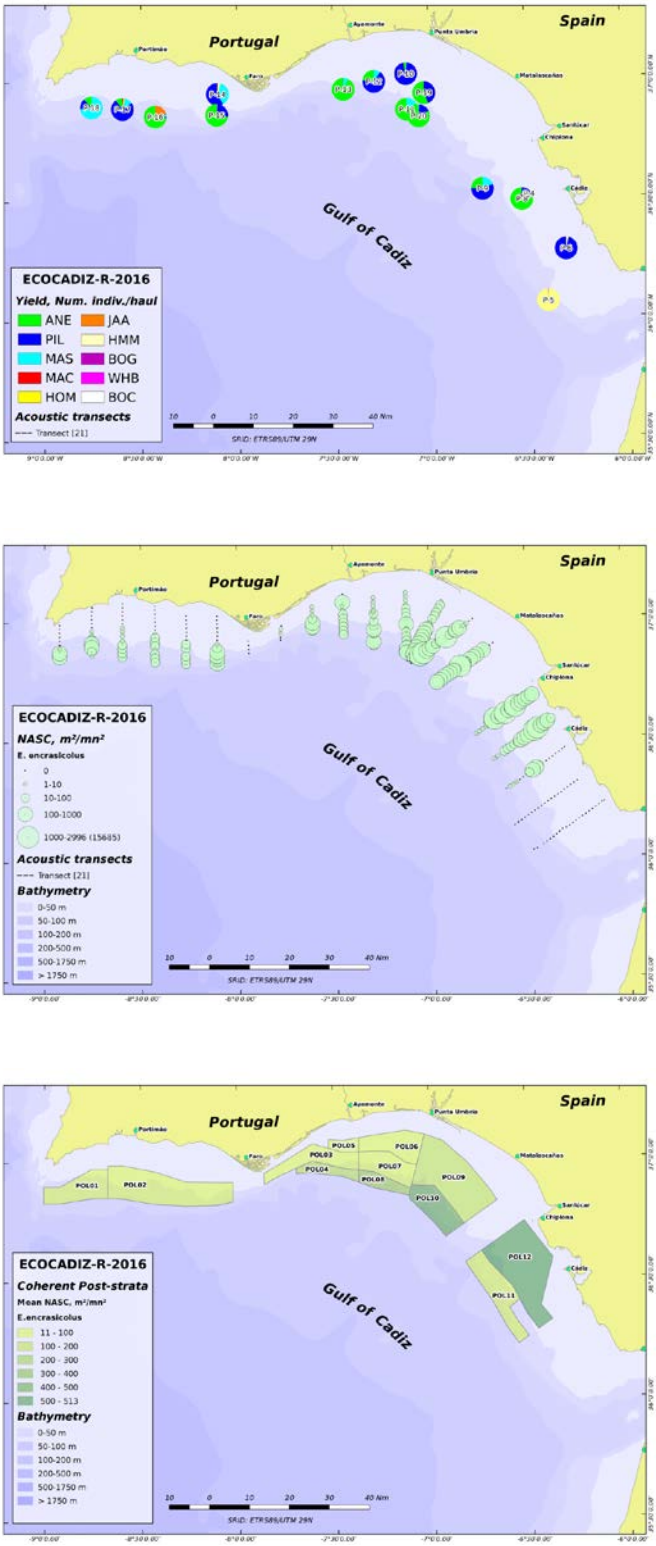


Figure 4.3.3.4. Anchovy in Division 9.a. Subdivision 9.a South. ***ECOCADIZ-RECLUTAS 2016-10*** **survey (autumn Spanish acoustic survey in Subdivision 9.a South). Top: Location of valid fishing stations with indication of their species composition (percentages in number).Middle: Distribution of the backscattering energy (Nautical area scattering coefficient, NASC, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.**

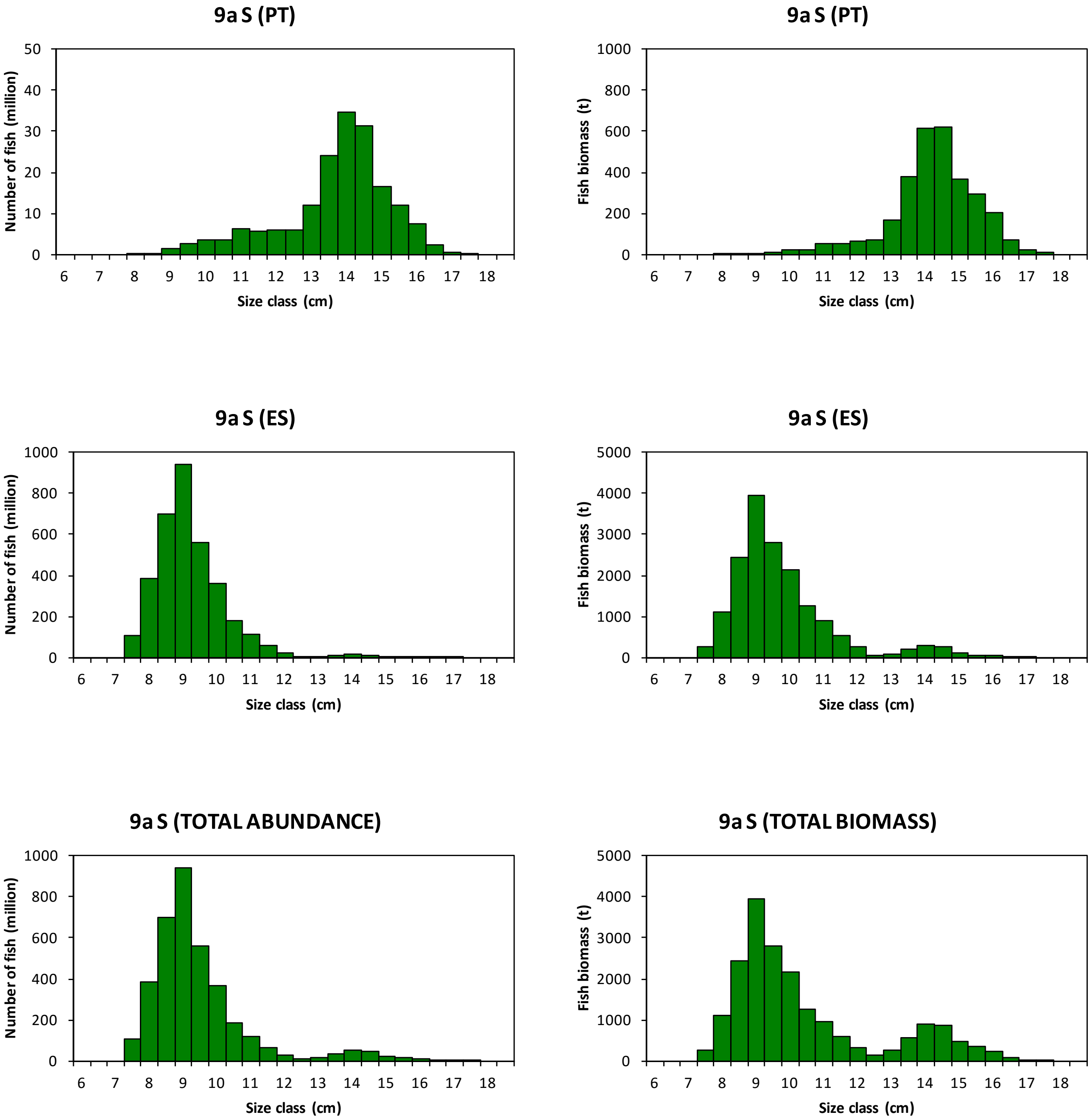


Figure 4.3.3.5. Anchovy in Division 9.a. Subdivision 9.a South. *ECOCADIZ-RECLUTAS 2016-10* survey (autumn Spanish acoustic survey in Subdivision 9.a South). Estimated abundance and biomass (number of fish in millions and tonnes, respectively) for the surveyed area and country by length class (cm). Note the different scales in the y axis.

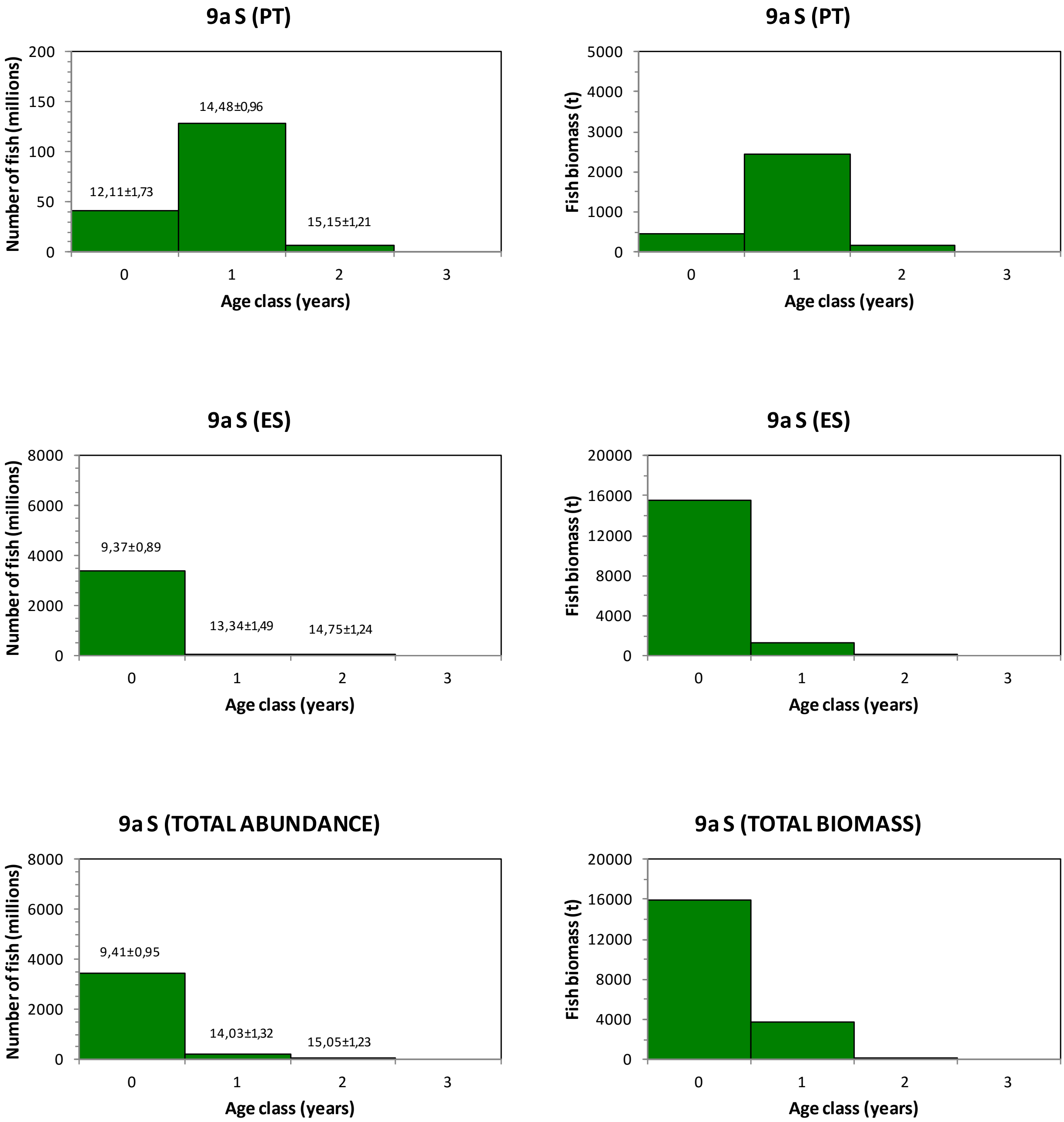


Figure 4.3.3.6. Anchovy in Division 9.a. Subdivision 9.a South. *ECOCADIZ-RECLUTAS 2016-10* survey (autumn Spanish acoustic survey in Subdivision 9.a South). Estimated abundance and biomass (number of fish in millions and tonnes, respectively) for the surveyed area and by country by age group, with indication of the mean size by age. Note the different scales in the y axis.

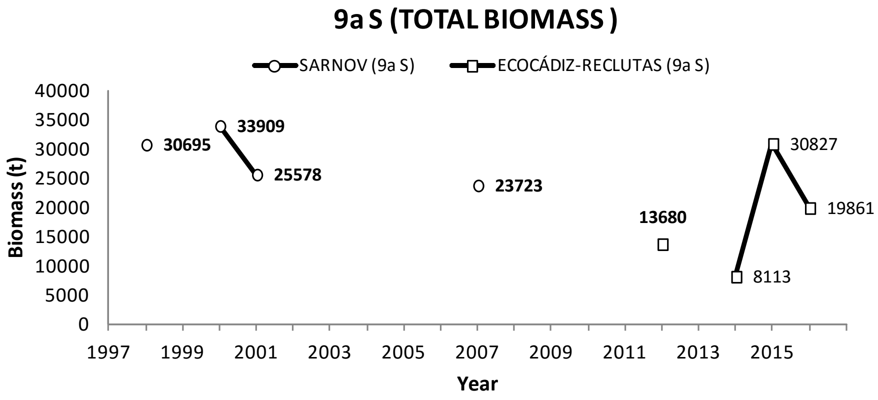


Figure 4.3.3.7. Anchovy in Division 9.a. Subdivision 9.a South. *ECOCADIZ-RECLUTAS* survey series (autumn Spanish acoustic survey in Subdivision 9.a South). Historical series of overall acoustic estimates of anchovy biomass (t), (squares). The estimates from the older Portuguese SARNOV survey series are also included for comparison of trends (circles).

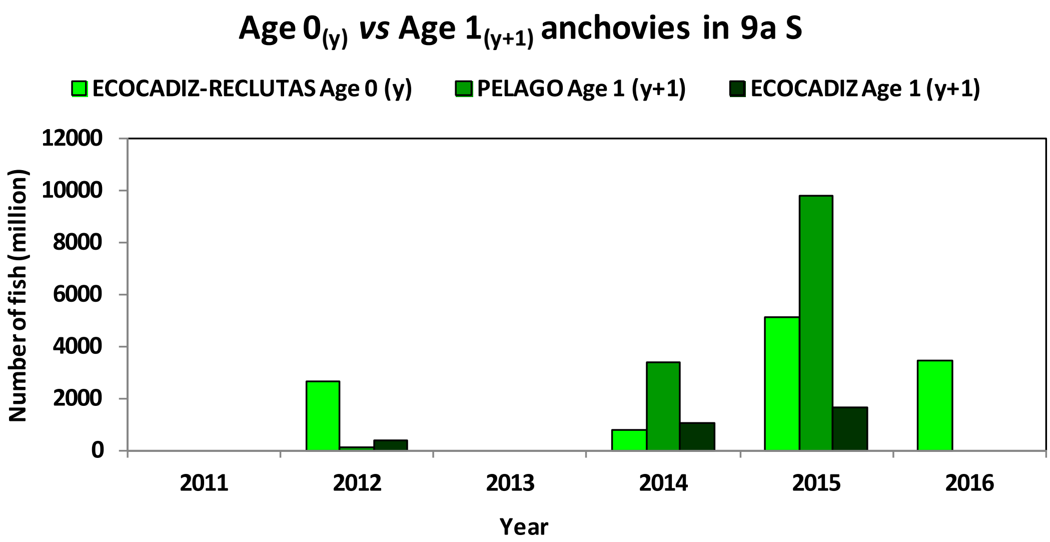


Figure 4.3.3.8. Anchovy in Division 9.a. Subdivision 9.a South. *ECOCADIZ-RECLUTAS* survey series (autumn Spanish acoustic survey in Subdivision 9.a South). Correspondence between acoustic estimates of abundance of Age 0 anchovies from *ECOCADIZ-RECLUTAS* surveys in the autumn of the year *y* against 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 (no estimates for 2017 is still available for both surveys).

4.5 Assessment of the state of the stock

4.5.1 Previous data explorations

Data availability and some fishery (recent catch trajectories) and biological evidences were the basis for a previous data exploration of anchovy catch-at-age data in Subdivision 9.a South (Algarve and Gulf of Cadiz) until 2009 by applying an *ad hoc* seasonal (half-year) separable model implemented and run on a spreadsheet (Ramos *et al*., 2001; ICES, 2002). Nevertheless, the exploratory assessments performed with this model were not recommended as a basis for predictions or advice due to they did not provide any reliable information about the true levels of the stock, F and Catch/SSB ratios since the assessment was not properly scaled. For the above reasons since 2009 it was preferred not to perform any exploratory assessment with this model. More details on the model settings and assumptions and its performance are described in the Stock Annex.

Upon request from the Workshop on the Development of Assessments based on life-history traits and exploitation characteristics (WKLIFE), a first compilation and further exploration of available data on life-history traits (LHTs) of anchovy in Division 9.a was presented in the 2013 WG (ICES, 2013). Length-based reference points considered were: length (L_{mat}) at 50% maturity, von Bertalanffy growth parameters (Linf (L_∞), K,t_0), mean length at first capture (L_c, determined as the length at half of the maximum frequency in the ascending part of the curve), length where growth rate in weight is maximum (L_{opt}, where L_{opt}= 2/3 of *Linf* (L_∞)), and the theoretical length resulting from fishing with F = M ($L_{(F=M)}$, where $L_{(F=M)}$= (3 * L_c+ *Linf*)/4). With weighted mean length in the catch (L_{mean}) as indicator (computed as the mean of fish larger than L_c), several of these population characteristics could be used as reference points to infer relative exploitation and relative stock status.

This exploratory analysis was focused in anchovy LHTs from the Subdivision 9.a South (Cadiz) because of the greater data availability. The resulting estimates seemed to suggest that the stock is supporting in its recent history a reasonable exploitation with L_{mean} above $L_{(F=M)}$ and very close to L_{opt} and L_c=L_{mat}. Nevertheless, WG members questioned the validity or appropriateness of these reference points for short-lived species like anchovy (with stocks and catches supported mainly by only age group and a fishery operating around spawning time). For the above reasons this exploratory analysis has not been updated since then.

4.5.2 Trends of biomass indices

Subdivision 9.a South

The provision of advice since 2009 has been traditionally restricted to Subdivision 9.a south as this is the only area showing a persistent population and fishery. It relies in an update of the qualitative assessment carried out in 2008 and accepted by the Review Groups of the 2008 and 2009 WGANC (2008 & 2009 RGANC). This qualitative assessment is based on the joint analysis of trends showed by the available data for the Subdivision 9.a South, both fishery-dependent and –independent information (i.e. landings, fishing effort, cpue, survey estimates). A summary of these trends for the Subdivision 9.a South is shown in **Figures 4.5.2.1** and **4.5.2.2**. They indicate a relatively stable stock status with little changes until 2009, without any evidence of serious problems: the drop of landings in 2008 and 2009 was caused by a parallel fall in the fishing effort. In fact, cpue is maintained relatively stable, and survey estimates, although variable did not show marked trends until 2009. The DEPM estimates, although uncertain, matched reasonable well with acoustic estimates. The relative levels of catches to biomass indexes (taken as absolute) suggested relatively acceptable levels of harvest rates until 2009 (of about ¼ the SSB index) (see an evaluation in **Sections 4.5.2** and **4.7**)

Since 2008 the acoustic estimates of biomass show a continuous declining trend which seems to reach an extreme situation in spring 2011, when no anchovy was detected in the *PELAGO* acoustic survey. However, anchovy eggs sampled by CUFES during that survey were found at comparable or even higher levels than in the previous year 2010 during that acoustic survey, which was not consistent with the null detection of biomass with acoustics. The fishery maintained its normal activity throughout 2010 and 2011. Up to 2010 the cpue indices of the fleet did not show any declining trend. In addition, the *BOCADEVA* DEPM survey, conducted in July 2011, provided a new indication about the state of the anchovy biomass in 2011, pointing to an SSB estimate of 32 757 t. This confirmed that the reluctance of the WG to adopt the *PELAGO* estimate as a reliable indicator in that year was correct. *BOCADEVA* indicated a recovery of the biomass in 2011 up to levels above the average. Unfortunately, there was no indication about the state of the anchovy biomass in spring/summer 2012 since no survey index was available. The *ECOCADIZ-RECLUTAS 1112* autumn survey provided a partial estimate (since only the Spanish waters were surveyed) of 13 680 t in autumn 2012, which matches well with the estimates provided later by the *PELAGO* survey in spring 2013 (12 700 t) and by *ECOCADIZ* survey in summer that same year (8487 t). Both the 2014 spring and summer acoustic biomass estimates (at about 29 kt) indicate a recovery of the population levels to values slightly higher than the average ones in their respective historical series (23 kt and 21 kt respectively), a perception which is also confirmed by the *BOCADEVA* DEPM survey and which is still maintained in 2016, as evidenced by the *PELAGO* survey. Thus, landings suggest a rather stable situation for the fishery in this area, and the most recent population estimates suggest a stock in this area slightly above the average in 2014 and 2015 and, as estimated by the *PELAGO* survey (65 kt), well above the average in 2016. Results from the *ECOCADIZ* survey in late July 2016 (34 kt) corroborated in some extent the perception about the state of the anchovy biomass in 2016. The *PELAGO 17* biomass estimate (ca. 14 kt) indicates, however, current decreased population levels below the average. However, this last estimate should be considered as a preliminary one since it may not correspond to a final estimate. **Table 4.5.2.1** and **Figure 4.5.2.3** show the evolution of the stock size indicator computed for this Subdivision and summarises the abovementioned trends. This indicator has usually been estimated as the average of the annual estimates provided by each of the spring-summer surveys conducted in the subdivision. The rationale of this approach has been advanced before (see **Section 4.3.2** and this section): uncertainties (i.e. a possible overestimation) in the anchovy acoustic assessment in the Spanish waters area and the strange situation found in 2011 by the *PELAGO* surveys and the gaps occurring in the *ECOCADIZ* series up to 2012, led to consider this averaging procedure under the assumption of equal catchabilities between surveys. Therefore, the datapoint in 2017 should be considered as provisional until it be conveniently averaged with the E*COCADIZ* counterpart. Notwithstanding the above, the ADGANE9.a in October 2016 was concerned about this way of combining survey biomass estimates to reach a total estimate of biomass for Division 9.a and recommended this WG to look at methods to combine survey indices for each stock component. ADGANE9.a recommended that the agreement on a method to combine the different survey estimates should be carefully considered and reviewed through a full benchmark process before it is used to provide advice. In any case, and keeping in mind the above, an alternative method of computation of the stock size indicator has been considered this year. Thus, this alternative indicator for the southern component is just simply the spring acoustic biomass estimate provided by the *PELAGO* surveys, for consistency with the survey season of the surveys utilized in the computation of the stock size indicator for the western component (see **Table 4.5.2.1** and **Figure 4.5.2.3**). In any case, both approaches yield quite similar trends for the most recent years.

Western Iberian shores (9.a North, Central-North and Central-South)

According to *PELAGO* survey the strongest outburst of anchovy biomass along the whole historical series has just happened in 2016 (38 kt; **Table 4.5.2.1**, **Figures 4.5.2.4, 4.5.2.5**). Previous outburst were recorded in 2008 (6 kt), 2011 (27 kt) and 2014 (8 kt). Anchovy population from 9.a Central-North was the main responsible for such outbursts. A former outburst of biomass might have happened in the mid-nineties, as a high record of catches appeared in 1995 (but acoustic surveys did only provide by then estimates of sardine and not of anchovy). The uncertainty about this phenomenon is its duration in time, as in the past these sudden outbursts have not been sustained in the following year. In 2017 the information of the state of the population biomass is incomplete for this western component, since the *PELACUS* estimate for anchovy in 9.a North (3.6 kt) is the only available estimate. Although this estimate was the historical maximum within its series, it is uncertain with the available information (only the mapping of the acoustic energy) if this perception is also applicable to the Subdivision 9.a Central-North.

Whole Division 9.a

The temporal evolution of the biomass stock size indicator is shown in **Figure 4.5.2.6**. Over the whole Division there is a noticeably recovery of the anchovy throughout the 2014–2016 period. The absence of available biomass estimates for the Subdivision 9.a Central-North prevents from the computation of the 2017 datapoint for the stock size indicator. Anyway, a perception of a fluctuating resource without a neat trend will be inferred from the figure. However, we know that such perception is erroneous as the behaviour of the population is being quite different in the different subdivisions of the region. This puts in doubt the stock unit of the anchovy populations inhabiting this area and the suitability of the unified management applied to the fisheries on anchovy in the different subdivisions of Division 9.a (however, see management considerations about the definition of stocks in this area below).

4.5.3 Assessment of potential fishery Harvest Rates (HR) on anchovy in Subdivision 9.a South

A range of a likely potential Harvest Rates (HR) applied for the fishery on the anchovy in Subdivision 9.a South was directly tried in last years through the estimation of the quotient between total Catch (tons) and Survey Biomasses for a range of potential catchabilities of the surveys. This has been updated this year for the new surveys in 2016 and 2017. Given the rather consistent levels of biomass estimates provided by the acoustic and DEPM surveys applied in this area, the HR evaluation assumed equal catchability for all surveys. In addition, the range of catchabilities explored went from 0.6 to 1.6. The results of harvest rates for the different catchabilities are shown by years in **Table 4.5.3.1**. On average, for a catchability = 1, HR = 26.2% (CV of 0.43) and a maximum individual HR happens in 2013 with a HR of 49%. The sensitivity analysis for the range of selected catchabilities is at the bottom of **Table 4.5.3.1**. If catchabilities are higher than 1, the actual biomasses at sea would be lower and hence the HR will be higher than for catchabilities = 1, by a proportion equal to the catchability raising factor. As such for a catchability= 1.6 the average HR would be around 42.0% (CV of 0.43) and the maximum individual year value would rise up to 79.1%.

In the context of the Yield per Recruit analysis for Harvest Rates shown in **Section 4.7**, all the range of HR resulting from the former sensitivity analysis on the different q values, are at maximum, but generally well below the HR corresponding to the 50% SBR per recruit (= 0.78). As such, the Expected %SBR for the range of HR for this fishery resulting from sensitivity analysis above should generate Spawning Biomass per Recruit above 50% (see summary **Table 4.5.3.2**), thus the stock seems to be explored sustainable, for any potential catchability value below or equal to 1.6.

The exercise has not been repeated for the western subdivisions (9.a North to 9.a Central South), but notice that for the years of significant fishery, in 2011 and 2016, a harvest ratio of about 13% and 18%, respectively, can be derived from the merged acoustic estimates in these subdivisions (28 558 t in 2011, 38 507 t in 2016) in relation to 3782 t and 7140 t of anchovy landings. These rates are even at a lower level than those ones estimated in the Subdivision 9.a South.

4.6 Prediction

There is no basis to predict the status of the anchovy population in 2018.

4.7 Yield per Recruit analysis and Reference Point on Harvest Rates

Although the current fishing pattern is uncertain, the matrix of catches-at-age allow to estimate the selectivities-at-age (relative fishing mortalities-at-age), which for an assumed natural mortality (M=1.2) would equal the relative catches-at-age (in percentages). For a given selectivity-at-age the Yield per Recruits can be computed straightforward. This section contains a sensitivity analysis of a Yield per Recruit analysis in terms of reference points for fishing mortality and Harvest Rates:

In 2012 we defined two vectors of relative catches-at-age, generated from the catch statistics: a first vector corresponded to the average age composition in the period 1999–2011. A second vector corresponded with the catches in the earlier period and 2011 (years 1996, 1997, 1998 and 2011) when catches-at-age 0 were more abundant. These two vectors are summarised in the text table below:

Mean catches-at-age	Age 0	Age 1	Age 2	Age 3	Total
Mean 1999–2011	87.078	414.957	15.022	0.252	517.309
Percentage-at-age	16.8	80.2	2.9	0.05	100

Mean catches-at-age	**Age 0**	**Age 1**	**Age 2**	**Age 3**	**Total**
Mean 1996, 1997, 1998 & 2011	374.929	479.572	19.244	0.000	873.745
Percentage-at-age	42.9	54.9	2.2	0.0	100

As the addition of the 2012–2016 catches would generate mean catches-at-age for the period 1999–2016 almost equal to the period 1999–2011 (see table below), and it is somewhere in the middle between the one typical of the period 1999–2011 and that of the period 1996, 1997, 1998 and 2011.

MEAN CATCHES-AT-AGE	AGE 0	AGE 1	AGE 2	AGE 3	TOTAL
Mean 1999–2016	94.197	431.875	13.850	0.182	540.104
Percentage-at-age	17.6	79.9	2.5	0.0	100

Then the WG has decided not to remake the calculations associated to the sensitivity analysis which follows (as done in 2012). And as such the two catch-at-age vectors have remained constant and correspond with the two types of catches, one for the period 1999–2011 and the other for the period 1996, 1997, 1998 and 2011 (when ages 0 were more abundant in catches).

Mean weights-at-age in the catches for the same period were used for both the catches and the population. Maturity was assumed to be knife-edge like, full maturity and reproductive capacity at age 1 (as estimated to happen here at least during the recent years and consistent with the biology of the anchovy in the Bay of Biscay as well).

As the selectivities required to reproduce the relative catches-at-age can slightly change according to the actual level of fishing mortality (unknown) ,selectivities were fitted for a vector of potential F values at age 1 (the age of reference) going from 0.2 to 1.4 in steps of 0.2. For each fitted selectivity-at-age a Yield per Recruit analysis was made in terms of % of Spawning Biomass per Recruit (%SBR) for different levels of F multipliers and corresponding Harvest Rates (HR) (the quotient between catches in tonnes and Spawning Biomass). Spawning and surveying times were set to occur at the middle of the year. For the acoustic *ECOCADIZ* and DEPM *BOCADEVA* surveys this is correct, as they are made in June–July, though acoustic *PELAGO* survey is made in April.

Sensitivity to the vector of natural mortality was not made as it has been assumed to be constant across ages at an annual rate of 1.2, which given the extremely few ages 2 or older seems to be plausible value for this population.

The Y/R assessment was made with an Excel spreadsheet. The selectivities at different F at age 1 levels were fitted with the Solver function. And the subsequent associated Y/R analysis is run with visual Basic macro in Excel.

Results for the first vector of relative catches-at-age are shown in **Table 4.7.1**. Sensitivity of the selectivity-at-age pattern to the concrete guessed level of F at age 1 for which the selectivity was fitted is minor. As such, all reference points calculated, in terms of Spawning Biomass per Recruit (at 50%, 40% and 35) as well as F_0.1, were rather similar across the potential alternative selectivities at age (**Table 4.7.1 a**). Not surprisingly F_0.1 is rather similar to assumed M, but F_35%(SBR) and F_50%(SBR) fall to 0.53 and 0.34. The value of F_0.1 at 1.23 will certainly be not sustainable as it corresponds with a %SBR of about 11%. In terms of Harvest Rates, HR_35%(SBR) and HR_50%(SBR) are around 1.44 and 0.78. The potential for HR to exceed 1 comes from the fact that part of the catches are made on age 0 or age 1 prior to the spawning and first observations of the cohort at survey time. For the potential range of HR assessed for this fishery (with a mean and a maximum at 0.26 and 0.79, see **Section 4.5.3**), according to the selected range of potential survey catchabilities, it seems very likely that HR over the last 15 years are at or below HR_50%(SBR), so at sustainable levels.

For the second vector of catches-at-age the sensitivity analysis did not differ much from the first analysis (**Table 4.7.1 b**). Results were again not much sensitive to the actual selectivity-at-age of the fleet matching the 43% of age 0. A plot with the reference points for F and HR corresponding to the selectivity-at-age fitted with a presumed F at age 1 = 1 (as an example) are shown in **Figure 4.7.1**. Again F_0.1 is rather similar to assumed M, and F_(35%SPR) and F_50%(SPR) fall to 0.49 and 0.32. The value of F_0.1 was not sustainable, as it resulted in 10% of %SBR. Results in terms of Harvest Rates were rather coincident with the former analysis on the other vector of catches-at-age: HR_35%(SBR) and HR_50%(SBR) are around 1.5 and 0.79. As before, for the potential range of HR assessed for this fishery (with a mean and a maximum at 0.25 and 0.79, see **Section 4.5.3**), according to the selected range of potential survey catchabilities (from 0.6 to 1.6), it seems very likely that HR over the last 15 years are at or below HR_50%(SBR), so at sustainable levels.

4.8 Management considerations

4.8.1 Definition of stock units

A summarised description of the distribution of the main anchovy populations in NE Atlantic European waters is given in the Stock Annex. Traditionally, the distribution of anchovy in the Division 9.a has been concentrated in the Subdivision 9.a South (**Figure 4.8.1.1.a**), where about 99% of the population is usually encountered during the acoustic surveys, mainly in the Spanish waters of the Gulf of Cadiz. Outside the main nucleus of the Gulf of Cadiz, resilient anchovy populations were usually detected in all fishery-independent surveys (ICES, 2007 b, **Figure 4.8.1.1.b**). Occasionally large catches are produced in ICES areas 9.a North and Central-North coincident with a sporadic raise up of the anchovy abundance in those areas, as for instance in 1995/1996 and in 2011. The Working Group has traditionally concentrated its exploratory analysis of the anchovy in Subdivision 9.a South, because it was the only persistent population in the area. The perception of the anchovy in other areas of 9.a is that they are marginal populations of independent dynamics from the anchovy population in 9.a South. As such the advice was based solely on the information coming from the anchovy in 9.a South (Algarve and Cadiz).

In 2014 the acoustic detection of anchovy biomass by *PELACUS* and *PELAGO* spring surveys in Subdivisions 9.a North to Central-North drop to 1947 t from 4284 t estimated in 2013. Contrary to this, the acoustic estimates in Subdivision 9.a South raised up to 28 917 t from 12 700 t estimated in the previous year (see **Figures 4.5.2.2** and **4.5.2.3**). Such data demonstrate the independent dynamics of the anchovy in the northern part of the 9.a from the dynamics of the population in 9.a south (with examples of a reversed situation in the period 1995/1996 and in 2011, see **Figure 4.8.1.1.c**).

This has a direct implication: there is no firm basis to consider the anchovy in Division 9.a as a single stock, given that the dynamics of the population (via their recruitment pulses) in the different areas are independent.

Ramos (2015) has recently reviewed the state of art of the studies on the stock identity of anchovy in 9.a. Thus, recent studies by Zarraonandía (2012) on the genetic structure of the European anchovy populations using single nucleotide polymorphisms (SNP) indicate that the Gulf of Cadiz anchovy (Subdivision 9.a South) is genetically different to the other samples in the Ibero-Atlantic coast, while is genetically similar to that of Alboran Sea (Spanish SW Mediterranean) (**Figure 4.8.1.2**). This genetic subdivision observed in Ibero-Atlantic coasts is in concordance with the morphological segregation pattern described by Caneco *et al*. (2004). That study suggests that the differences between areas could reflect slight adaptive reactions to small environmental differences.

In this context, the revision of this issue by Ramos (2015) was reviewed by the ICES Stock Identity Methods Working Group (SIMWG) just before the last year's WG meeting (ICES, 2015). SIMWG concluded that there is evidence to support a resident population in the Gulf of Cadiz (9.a South). However, SIMWG recognises there is still little information regarding the stock identity in the western and northern areas in the division and additional research to improve the understanding of the source of fish composing these local populations is needed. For these reasons, SIMWG recommends that the current stock structure stand for the time being, awaiting the results of the above requested studies, and also recommends the continued approach of employing spatially explicit management and monitoring of this stock through the division.

4.8.2 Current management situation

No EU management plan exists for the fisheries in Division 9.a.

The recent history of the regulatory measures in force for the anchovy fishery in the division (with a special reference to the Spanish fishery in the Gulf of Cadiz) is described in the Stock Annex. An updated information of such measures are given in the 2014 WG report (ICES, 2014). Since April 2013 Spain implemented a new management plan for fishing vessels operating in its national fishing grounds, so it affects the purse-seine fishing in Galician (9.a North) and Gulf of Cadiz waters (9.a South (CA)). One of the main measures in this new Plan is the introduction of an individual quota (IQ) system to allocate annual national quotas. In the case of the Gulf of Cadiz purse-seine fishery this measure involves to shift from a system of a fixed daily catch quota system for all the fleet to a new one based on the implementation of a IQ system managed quarterly by each fishery association after resolution of the National Fishery Administration on the annual allocation of the national quota by association.

By way of from Article 15(1) of Regulation (EU) No 1380/2013, which aims to progressively eliminate discards in all Union fisheries through the introduction of a landing obligation for catches of species subject to catch limits, the purse seine fishery in ICES zones 8, 9. and 10 and in CECAF areas 34.1.1, 34.1.2 and 34.2.0 targeting anchovy has a final *de minimis* exemption to the quantities that may be discarded of up to a maximum of 2% in 2015 and 2016, and 1% in 2017, of the total annual catches of this species. STECF concluded that this exemption is supported by reasoned arguments which demonstrate the difficulties of improving the selectivity in this fishery. Therefore, the exemption concerned has been included in the Commission Delegated Regulation (EU) No 1394/2014 of 20 October 2014 establishing a discard plan for certain pelagic fisheries in southwestern waters.

Finally, the joint recommendation includes a minimum conservation reference size (MCRS) of 9 cm for anchovy caught in ICES Subarea 9 and CECAF area 34.1.2 with the aim of ensuring the protection of juveniles of that species. The STECF evaluated this measure and concluded that it would not impact negatively on juvenile anchovy, that it would increase the level of catches that could be sold for human consumption without increasing fishing mortality, and that it may have benefits for control and enforcement. Therefore, the MCRS for anchovy in the fisheries concerned should be fixed at 9 cm.

Results from the qualitative assessment described in **Section 4.5** suggest that the anchovy population in the Subdivision 9.a South is a fluctuating population without any neat tendencies, even though it is assessed well above the average in 2016, but below this average in 2017. Despite the likely drop of biomass in 2010 (according to the acoustic survey *PELAGO*), the DEPM estimates in 2011 and high levels of catches in this year suggest that biomass was about normal levels in 2011. The most recent population estimates from acoustic surveys in autumn and spring since 2014, although higher than average levels in some years, don't contradict the abovementioned perception of fluctuating stock within the historical range. According to the Harvest rate analysis, exploitation seems to be sustainable. Therefore, it seems that catches can be allowed to remain at current mean levels.

In the absence of any recruitment index, neither for the anchovy in Subdivision 9.a South nor for the populations in the remaining subdivisions of 9.a there is no sufficient information as to outline what the situation in 2018 will be.

4.8.3 Scientific advice and contributions

An in-depth evaluation of the possibilities of handling the above problems on the performance and suitability of the analytical model for the Subdivision 9.a South by other kinds of assessment models was out of reach for the WGHANSA. In that context, it may be productive to consider before any benchmark process a wide range of assessment approaches in an open-minded way (see **Section 4.11**). It is noted that most of the signals in the data are found in the catches-at-age 1 in both semesters and at age 0 in the second semester, in addition to the trends in the survey biomass measurements. It might be worth exploring the time signal in these data. Production models should also be explored, but large fluctuations of the catches over time raise some doubts about the stability of the carrying capacity.

The analyses of the data should also be viewed in the context of the management strategies that might be applied. The surveys have improved greatly in recent years, both through improvements of the acoustic surveys and the initiation of a DEPM survey. In addition, recent scientific efforts have improved the understanding of the biology of the stock. As stated in previous WG, these sources of information might become the core of a knowledge base for future management, which may not necessarily need to be dependent on analytic assessments. Alternative management regimes, like harvest rate rules based on survey information, could be examined by simulations.

In order to scale the assessment, additional DEPM estimates will also be required.

4.8.4 Species interaction effects and ecosystem drivers

Anchovy is a prey species for other pelagic and demersal species, and for cetaceans and seabirds.

The anchovy population in Subdivision 9.a-South appears to be well established and relatively independent of populations in other parts of the division. These other populations seem to be abundant only when suitable environmental conditions occur, while during unfavourable conditions they seem to be restricted to the river and "rías" estuaries (Ribeiro *et al*., 1996).

The recruitment depends strongly on environmental factors. Ruiz *et al*. (2006; 2007) evidenced the clear influence that meteorological and oceanographic factors have on the distribution of anchovy early life stages in shelf waters of the northeastern sector of the Gulf of Cadiz (9.a-South). The shallowness of the water column, the influence of the Guadalquivir River, and the local topography favour the existence of warm and chlorophyll-rich waters in the area, thus offering a favourable environment for the development of eggs and larvae. However, spring and early summer easterlies bursts may cause: a) a decrease of the water temperature by several degrees, b) generate oligotrophic conditions in the area, and c) force the offshore transport of waters over this portion of the shelf, advecting early life stages away from favourable conditions. These negative influences on the development conditions of anchovy eggs and larvae can impact on the recruitment of this species in the Gulf of Cadiz and subsequently in the anchovy fishery.

In this context, Ruiz *et al*. (2009) recently implemented the Bayesian approach for a state–space model of Gulf of Cadiz anchovy life stages. The model is used to infer 17 years (1988–2004) of stock size in the Gulf of Cadiz. Its population dynamics was modelled under the influence of the physical environment and connected to available observations of sea surface temperature, river discharge, wind, catches, catch per unit of effort, and acoustic records, as available. The model diagnosed values that are consistent with independent observations of anchovy early life stages in the Gulf of Cadiz. It was also able to explain the main crises historically recorded for this fishery in the region (e.g. in 1995–1996).

As previously described, the Gulf of Cadiz anchovy population has also experienced a noticeable decreasing trend during the period 2008–2010 as a probable consequence of successive failures in the recruitment strength in those years (ICES, 2011). A man-induced alteration of the nursery function of the Guadalquivir estuary, caused by episodes of highly persistent turbidity events (HPTE; González-Ortegón *et al*., 2010), during the anchovy recruitment seasons in 2008, 2009 and 2010 could be one plausible explanation. Thus, the control of the Guadalquivir River flow, from a dam 110 km upstream, has an immediate effect on the estuarine salinity gradient, displacing it either seaward (reduction) or upstream (enlargement of the estuarine area used as nursery). This also affects the input of nutrients to the estuary and adjacent coastal areas. The abovementioned HPTEs used to start with strong and sudden freshwater discharges after relatively long periods of very low freshwater inflow and caused significant decreases in abundances of anchovy recruits and the mysid *Mesopodopsis slabberi*, its main prey.

All of these evidences confirm that the Gulf of Cadiz anchovy population relies on recruits to persist and, therefore, is highly vulnerable to ocean processes and totally controlled by environment fluctuations.

4.8.5 Ecosystem effects of fisheries

The purse-seine fishery is highly mono-specific, with a low level of reported bycatch of non-commercial species. Information gathered from observers' at sea sampling programmes and interview-based surveys indicate, at least for the western waters of the Iberian Peninsula façade, a low impact on the common dolphin population (Wise *et al*., 2007), but less data are available on seabird and turtle bycatch. Other species such as pelagic crabs are released alive and it is likely that the inflicted mortality is low.

4.9 Indicators and thresholds to trigger new advice

Anchovy, as a short lived species, requires updated assessment every year since the population is basically sustained by the recruited year class (at age 1), so no indicator to trigger advice is required for this species.

Criteria for reopening the advice in the autumn based on summer survey: The advice provided in June every year is informed by the spring acoustic surveys *PELACUS–PELAGO*. Currently advice is provided split into two regions: one for Subdivision 9.a South (Cadiz and Algarve) and the other for the remainder northern areas of Division 9.a. For the Subdivision 9.a South, a survey is carried out after the June advice; this is the summer acoustic survey *ECOCADIZ*. Since 2013 on this survey is being conducted annually. This survey could trigger revision of the split advice for this Subdivision 9.a South in case of contradicting the tendencies observed by *PELAGO* in this area (as happened in 2011). A threshold level for the changes in the relative tendencies cannot be established easily at this stage as it would depend on the DLS method being applied (which is not clear) and whether we are in the second of the two consecutive years or not. *Ad hoc* approaches should be considered according to the series available in case of perceived contradictory information.

4.10 EU special request

In 2017 the anchovy TAC in areas 9, 10 and Union waters of CECAF 34.1.1 is set at 12 500 t. ICES has received a request (here below in Italics) from the European Commission regarding a potential 2017 change for anchovy in 9.a.

Request: ICES is requested to advise on

- whether catches of 15 000 t in 2017 are deemed sustainable, in accordance with ICES precautionary approach for data-limited (category 3) stocks.
- the catch level in 2017 that is deemed sustainable, in accordance with ICES precautionary approach for data-limited (category 3) stocks.

Basis of the reply to the EU special request for 2017

The WG has assessed that past harvest rates applied to the anchovy in 9.a South were sustainable. By applying the maximum past HR observed in that area (0.49) to the current estimate of biomass in this region, catches of about 6726 t would be sustainable too for the southern region (9.a South). The TAC for the entire region contains catches allowed to be taken in the western region of which no complete estimation of biomass is available. Therefore, the total allowable level of catches would be equal to the allowable level of catches in the southern region (6726 t) plus those allowed in the western region which currently cannot be quantified. Because of this the Working Group cannot quantify the total allowable Level of Catches (TAC) which would be sustainable for the entire Division 9.a.

Available information about the western component support the perception of a higher abundance than the long-term average in this region in recent years. A relative increase in biomass was recorded in 9.a North of 3566 t (formerly estimated in 202 t in 2016). *PELAGO* survey has not yet reported the biomass estimates in the western regions, but anchovy occurred in five out of the nine fishing hauls carried out in the regions 9.a Central-North, where the major concentrations of anchovy happened in the last years. This suggests that anchovy abundance will be not be low in 2017. In addition, the information from *JUVESAR 2016* suggests a biomass of about 14 317 t of recruits, lower than the abundance recorded in 2015 (29 556 t) but still well above former estimates (where it was not reported because of a marginal occurrence).

This allowable level of catches for southern region (9.a South) is similar to the one obtained in 2016.

From this follow that Catches of 15 000 t cannot be allowed to be taken in the southern region as this would imply HRs far above the ones observed in the past and above 0.78 threshold value for SPR50%.

Concluding remarks: The basis of this advice relies on the estimate of *PELAGO* acoustic survey on anchovy in 9.a South only. Compared to the basis of the advice in 2016 for a similar request on this anchovy, other information then available is now lacking as the estimates of *PELAGO* on the anchovy over the western region and the *ECOCADIZ* summer acoustic estimate of anchovy in 9.a South. Thus, the information supporting this advice is smaller this year than in 2016. Therefore, the nature of this advice is to be taken as preliminary until the new information from *PELAGO* and *ECOCADIZ* summer survey is available.

4.11 Benchmark preparation (ToR b)

The Benchmark for anchovy in 9.a, initially foreseen for 2014 and postponed in the 2016 WGHANSA to 2017, was recommended in the last year's WG to be delayed again until 2018, basically due to limited manpower and to allow for the new progresses will be achieved in the benchmark preparation, mainly during this year, to be examined in last and this year WGACEEG (issues related with surveys) and WGHANSA meetings (e.g. advances achieved in the exploration of the stock assessment method). In this context, the issue related to the stock identity of anchovy in 9.a was reviewed by the ICES Stock Identity Methods Working Group (SIMWG) just before the last year's WG meeting by using information previously compiled by the stock coordinator (Ramos, 2015), and their conclusions and recommendations have been described in **Section 4.8.1**. Data availability from the fishery, surveys and biological parameters is at present being re-examined through the division in order to achieve a consistent database (with a suitable geographical and time coverage) which satisfies the usual requirements of any assessment model (including those applicable to data-limited stocks), as well as those ones of the next specific compilation data workshop. The data compilation/exploration is including age/length data, maturity ogives, and other biological parameters considered in the assessment. This exercise is also being applied to the information coming from the surveys. A review of discarding/slipping practices, ratios and estimates in the anchovy fishery through the division is also planned to be carried out and reported as a working document for the benchmark workshop.

As surveys are concerned, the exploration of the results from inter-calibration exercises between *PELACUS* and *PELAGO* surveys for anchovy is still pending, but is expected that some review referred to anchovy in 9.a be presented in the next WGACEGG. Methods of combination of indices for deriving stock size indicators should also be discussed within the frame of this same WG.

Approaches (empirical, etc.) available to derive the estimate of natural mortality have not been explored yet.

The understanding of what environmental issues may drive the fluctuations and intensity of the recruitment pulses in 9.a South and western subdivisions was identified as an issue in the benchmark issue list (within the "other issues" category). In the present WG, Llope (WG oral presentation 2017) presented the results of a GAM modelling of the estuarine and marine environmental effects in the Gulf of Cadiz anchovy dynamics. The potential of alternative Gulf of Cadiz anchovy survey-based recruitment indices has also been forwarded from this study.

The exploration of the assessment model is still in the very initial phase. Results from some trials with different models (generalised, DLS based, etc.) may be available to the next year WG. Somewhat more problematic could be the selection of the most suitable age-structured assessment model to this stock. Stock synthesis model is the model used at present for the Ibero-Atlantic sardine stock, and, originally, was firstly used with the northern anchovy (*Engraulis mordax*, Methot, 1986; 1989), although this anchovy species shows a rather more structured population than the European anchovy in Division 9.a and, specially, in the Gulf of Cadiz. In any case, SS3 it would be a possible candidate to be explored. Alternatively, a single-species GADGET model with the Gulf of Cadiz anchovy as a study case is being developed within the frame of the FP7 EU MAREFRAME research project. This model is making use of the information reported by the WG and the stock coordinator has initially been contacted by the project's researchers to provide advice on data characteristics, biological parameters, and fishery behaviour. During the present WG preliminary results from this Gulf of Cadiz anchovy GADGET model has been presented and the results are very promising (Rincón, WG oral presentation 2017).

Table 4.5.2.1. Anchovy in Division 9.a. Series of annual estimates of each of the biomass stock size indicators derived for the western (Subdivisions 9.a N to 9.a CS) and southern (Subdivision 9.a South) stock components and the whole division, with indication of the surveys indices used in the computation of the indicator and the method of computation. For the southern component are shown two alternative stock size indicators: one computed as usual, i.e. the average of the available estimates for the Subdivision 9.a South (both Spring and Summer surveys), and an alternative one, which only considers the *PELAGO* spring survey, for consistency with the season of the surveys used for the western component stock size indicator . These two different options are also considered in the computation of the two alternative stock size indicator for the whole division.

YEAR	WESTERN COMPONENT	SOUTHERN COMPONENT		DIVISION 9.A	
	PELACUS+PELAGO	PELAGO	PELAGO+ECOCADIZ+ BOCADEVA	PELACUS+PELAGO	Western Comp (PELACUS+PELAGO) + Southern Comp (Avgd PELAGO+ECOCADIZ+BOCADEVA)
	9.a N to 9.a CS	9.a S		9.a N to 9.a S	
	SUM OF ESTIMATES	ESTIMATE	MEAN ESTIMATE	SUM OF ESTIMATES	
1999	596	24763	24763	25359	25359
2000					
2001	368	24913	24913	25281	25281
2002	1542	21335	21335	22877	22877
2003	112	24565	24565	24677	24677
2004			18177	18177	18177
2005	1062	14041	14339	15401	15401
2006	0	24082	30301	30301	30301
2007	1945	38020	33451	35396	35396
2008	5811	34162	32845	38655	38655
2009	2115	24745	23163	25278	25278
2010	1230	7395	9867	11097	11097
2011	28558	0	16379	44937	44937
2012					
2013	4284	12700	10593	14878	14878
2014	1947	28917	29902	31849	31849
2015	8237	33100	27203	35440	35440
2016	38507	65345	49764 *	88316	103852 *
2017	n.a.	13797	13797 **	n.a.	n.a. **

*** Recalculated after averaging with ECOCADIZ 2016 estimate available in this WG. ** Provisional estimate. Needs to be averaged with ECOCADIZ (and BOCADEVA) estimate(s) derived after WG (surveys conducted in late July–early August).**

Table 4.5.3.1. Anchovy in Division 9.a. Subdivision 9.a South. Assessment of yearly harvest rates on anchovy in the Gulf of Cadiz 9.a South (with the assumption of catchability equal 1 for all surveys and averaging annual estimates).

BIOMASS (TONNES)	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	MEAN	DESVEST	CV	MAX	MIN
PELAGO (Acoustic)	24,763		24,913	21,335	24,565		14,041	24,082	38,020	34,162	24,745	7,395	failed		12,700	28,917	33,100	65,345	25,206	15077.0	59.8%	65,345	0
ECOCADIZ (Acoustic)						18,177		36,521	28,882		21,580	12,339			8,487	29,219	21,305	34,184	23,410	9566.1	40.9%	36,521	8,487
BOCADEVA (DEPM)							14,637			31,527			32,757			31,569			27,623	8675.7	31.4%	32,757	14,637
Mean Biomass (For q=1)	24,763		24,913	21,335	24,565	18,177	14,339	30,301	33,451	32,845	23,163	9,867	32,757		10,593	29,902	27,203	49,764	24,472	9956.3	40.7%	49,764	9,867
Catches	5,942	2,360	8,655	8,262	4,968	5,617	4,423	4,381	5,610	3,204	2,954	2,929	6,294	4,810	5,240	9,051	6,880	6,599	5,454	1964.1	36.0%	9,051	2,360
Harvest Rates (For Q=1)	24%		35%	39%	20%	31%	31%	14%	17%	10%	13%	30%	19%		49%	30%	25%	13%	26.2%	11.2%	42.7%	49.5%	9.8%
Harvest Rate by Q levels																							
0.6	0.144		0.208	0.232	0.121	0.185	0.185	0.087	0.101	0.059	0.077	0.178	0.115		0.297	0.182	0.152	0.080	15.7%	6.7%	42.7%	29.7%	5.9%
0.8	0.192		0.278	0.310	0.162	0.247	0.247	0.116	0.134	0.078	0.102	0.237	0.154		0.396	0.242	0.202	0.106	21.0%	9.0%	42.7%	39.6%	7.8%
1	0.240		0.347	0.387	0.202	0.309	0.308	0.145	0.168	0.098	0.128	0.297	0.192		0.495	0.303	0.253	0.133	26.2%	11.2%	42.7%	49.5%	9.8%
1.2	0.288		0.417	0.465	0.243	0.371	0.370	0.174	0.201	0.117	0.153	0.356	0.231		0.594	0.363	0.303	0.159	31.5%	13.4%	42.7%	59.4%	11.7%
1.4	0.336		0.486	0.542	0.283	0.433	0.432	0.202	0.235	0.137	0.179	0.416	0.269		0.692	0.424	0.354	0.186	36.7%	15.7%	42.7%	69.2%	13.7%
1.6	0.384		0.556	0.620	0.324	0.494	0.493	0.231	0.268	0.156	0.204	0.475	0.307		0.791	0.484	0.405	0.212	42.0%	17.9%	42.7%	79.1%	15.6%

Table 4.5.3.2. Anchovy in Division 9.a. Subdivision 9.a South. Assessment of yearly harvest rates on anchovy in the Gulf of Cadiz 9.a South (with the assumption of using PELAGO biomass estimates as stock size indicator).

BIOMASS (TONNES)	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	MEAN	DESVEST	CV	MAX	MIN
PELAGO (Acoustic)	24,763		24,913	21,335	24,565		14,041	24,082	38,020	34,162	24,745	7,395	failed		12,700	28,917	33,100	65,345	25,206	15077.0	59.8%	65,345	0
Catches	5,942	2,360	8,655	8,262	4,968	5,617	4,423	4,381	5,610	3,204	2,954	2,929	6,294	4,810	5,240	9,051	6,880	6,599	5,454	1964.1	36.0%	9,051	2,360
Harvest Rates (For Q=1)	24%		35%	39%	20%		31%	18%	15%	9%	12%	40%			41%	31%	21%	10%	24.7%	11.3%	45.8%	41.3%	9.4%
Harvest Rate by Q levels																							
0.6	0.144		0.208	0.232	0.121		0.189	0.109	0.089	0.056	0.072	0.238			0.248	0.188	0.125	0.061	14.8%	6.8%	45.8%	24.8%	5.6%
0.8	0.192		0.278	0.310	0.162		0.252	0.146	0.118	0.075	0.096	0.317			0.330	0.250	0.166	0.081	19.8%	9.1%	45.8%	33.0%	7.5%
1	0.240		0.347	0.387	0.202		0.315	0.182	0.148	0.094	0.119	0.396			0.413	0.313	0.208	0.101	24.7%	11.3%	45.8%	41.3%	9.4%
1.2	0.288		0.417	0.465	0.243		0.378	0.218	0.177	0.113	0.143	0.475			0.495	0.376	0.249	0.121	29.7%	13.6%	45.8%	49.5%	11.3%
1.4	0.336		0.486	0.542	0.283		0.441	0.255	0.207	0.131	0.167	0.554			0.578	0.438	0.291	0.141	34.6%	15.9%	45.8%	57.8%	13.1%
1.6	0.384		0.556	0.620	0.324		0.504	0.291	0.236	0.150	0.191	0.634			0.660	0.501	0.333	0.162	39.6%	18.1%	45.8%	66.0%	15.0%

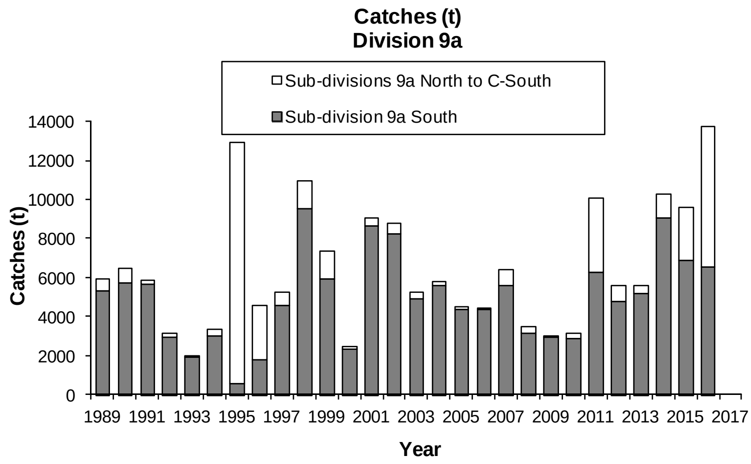
Table 4.5.3.3. Anchovy in Division 9.a. Subdivision 9.a South. Sensitivity assessment of the *status quo* exploitation of Anchovy in 9.a South to different levels of average catchability of surveys (and averaging annual estimates). For selectivity fixed at F age 1 of 1.

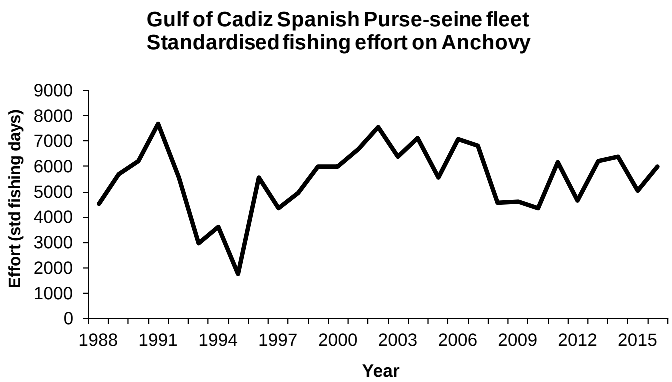
SENSITIVITY ASSESSMENT	0.6	0.8	1	1.2	1.4	1.6
Catchability of Surveys	**q = 0.6**	**q = 0.8**	**q = 1**	**q = 1.2**	**q = 1.4**	**q = 1.6**
Mean Harvest Rate (HR)	15.7%	21.0%	26.2%	31.5%	36.7%	42.0%
HR standard Deviation	6.7%	9.0%	11.2%	13.4%	15.7%	17.9%
CV	42.7%	42.7%	42.7%	42.7%	42.7%	42.7%
MIN (HR)	5.9%	7.8%	9.8%	11.7%	13.7%	15.6%
MAX (HR)	29.7%	39.6%	49.5%	59.4%	69.2%	79.1%
%SBR of Mean(HR)	83.2%	Not made	75.7%	Not made	68.5%	Not made
%SBR of Min(HR)	93.4%	Not made	89.0%	Not made	85.4%	Not made
%SBR of Max (HR)	72.8%	Not made	61.7%	Not made	53.4%	Not made

Table 4.7.1. Anchovy in Division 9.a. Subdivision 9.a South. Fishing mortality (F) and Harvest Rate (HR) reference points for a) the average age composition of the catches (1999–2011) and b) years with high presence of age 0 (1996, 1997, 1998 and 2011). Note: F reference points in terms of Fbar(ages 1–3).

A) First set of % of catches at age (Average % of age 0 in catches = 17%)							F Reference Points				HR reference points			
ANALYSIS	Fitted selectivity	S_0	S_1	S_2	S_3	S_4+	F_SBR50%	F_SBR40%	F_SBR35%	F_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1
Fitted at F (age 1)	0.02	0.0627	1.0000	0.1218	0.0074	0.0000	**0.32**	**0.44**	**0.50**	**1.19**	**0.78**	**1.18**	**1.44**	**7.09**
Fitted at F (age 1)	0.20	0.0580	1.0000	0.1372	0.0084	0.0000	**0.33**	**0.44**	**0.51**	**1.20**	**0.77**	**1.17**	**1.44**	**6.94**
Fitted at F (age 1)	0.40	0.0535	1.0000	0.1575	0.0099	0.0000	**0.33**	**0.45**	**0.52**	**1.21**	**0.77**	**1.17**	**1.43**	**6.71**
Fitted at F (age 1)	0.60	0.0494	1.0000	0.1822	0.0118	0.0000	**0.34**	**0.46**	**0.53**	**1.23**	**0.78**	**1.17**	**1.44**	**6.51**
Fitted at F (age 1)	0.80	0.0459	1.0000	0.2124	0.0143	0.0000	**0.35**	**0.47**	**0.54**	**1.24**	**0.78**	**1.17**	**1.44**	**6.25**
Fitted at F (age 1)	1.00	0.0428	1.0000	0.2502	0.0179	0.0000	**0.36**	**0.48**	**0.56**	**1.26**	**0.78**	**1.16**	**1.46**	**6.02**
Fitted at F (age 1)	1.20	0.0400	1.0000	0.2984	0.0225	0.0000	**0.37**	**0.50**	**0.58**	**1.28**	**0.78**	**1.18**	**1.44**	**5.69**
Fitted at F (age 1)	1.40	0.0374	1.0000	0.3618	0.0303	0.0000	**0.39**	**0.52**	**0.60**	**1.30**	**0.79**	**1.18**	**1.45**	**5.36**

b) Second set of Catches at age (Average % of age 0 in catches = 43%)							F Reference Points				HR reference points			
ANALYSIS	for a selectivity	S_0	S_1	S_2	S_3	S_4+	F_SBR50%	F_SBR40%	F_SBR35%	F_0.1	HR_SBR50%	HR_SBR40%	HR_SBR35%	HR_0.1
Fitted at F (age 1)	0.20	0.2121	1.0000	0.1522	0.0000	0.0000	**0.27**	**0.37**	**0.42**	**1.10**	**0.79**	**1.21**	**1.49**	**9.97**
Fitted at F (age 1)	0.60	0.1760	1.0000	0.2029	0.0000	0.0000	**0.29**	**0.39**	**0.46**	**1.14**	**0.79**	**1.19**	**1.50**	**8.67**
Fitted at F (age 1)	1.00	0.1493	1.0000	0.2805	0.0000	0.0000	**0.32**	**0.43**	**0.49**	**1.19**	**0.79**	**1.21**	**1.48**	**7.65**
Fitted at F (age 1)	1.40	0.1291	1.0000	0.4112	0.0000	0.0000	**0.34**	**0.46**	**0.54**	**1.24**	**0.79**	**1.18**	**1.49**	**6.54**





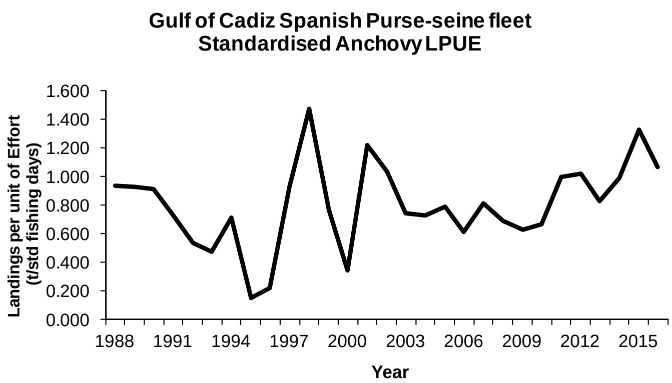
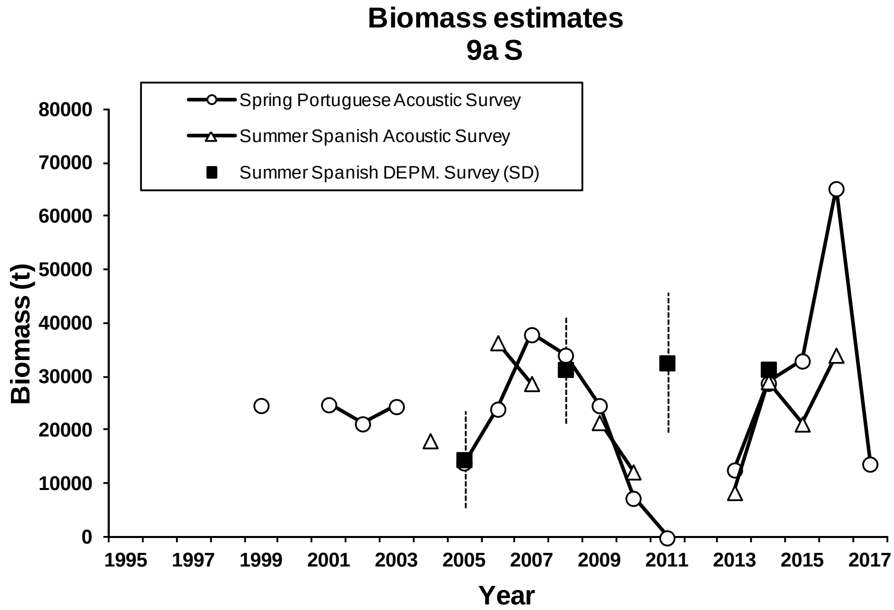


Figure 4.5.2.1. Anchovy in Division 9.a. Anchovy in Subdivision 9.a South. Information used in the Qualitative (Updated) Assessment. Top: total annual landings in Division 9.a differentiated between Subdivision 9.a South (PT + ES) and remaining subdivisions. Middle: standardised fishing effort (fishing days) exerted by the Spanish purse-seine fleet in the Sub-division. Bottom: standardised anchovy lpue (tonnes/fishing day) of the same fleet.



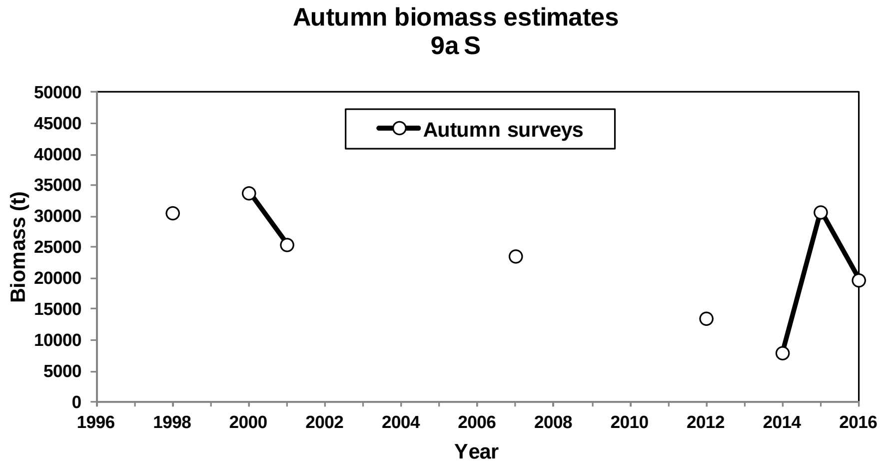
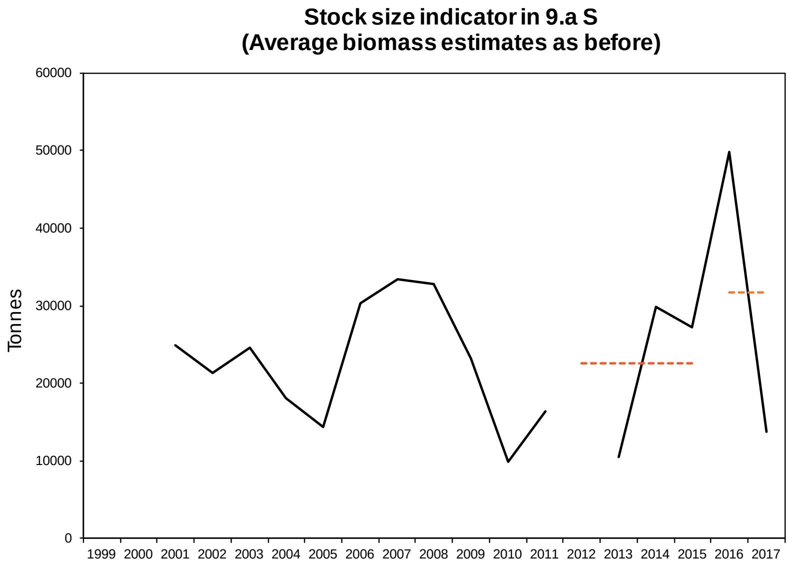


Figure 4.5.2.2. Anchovy in Division 9.a. Anchovy in Subdivision 9.a South. Information used in the Qualitative (Updated) Assessment (cont'd). Top: available biomass estimates from research surveys series sampling the subdivision in spring/summer used for comparative purposes. There are no available estimates in 2012. Bottom: available biomass estimates from research surveys series sampling the subdivision in autumn. *SARNOV* (1998, 2000, 2001, 2007) and *ECOCÁDIZ-RECLUTAS* (2012, 2014–2016) surveys have been merged in one only series.



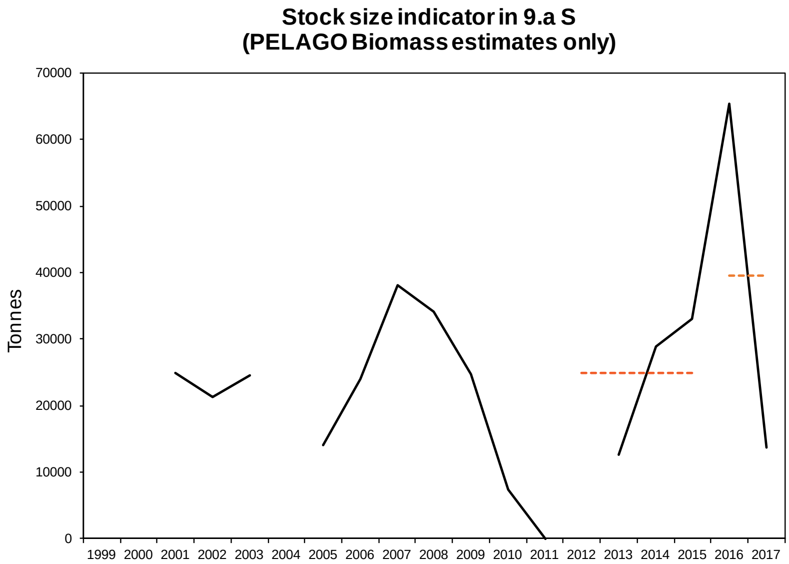


Figure 4.5.2.3. Anchovy in Division 9.a. Anchovy in Subdivision 9.a South. Information used in the Qualitative (Updated) Assessment. Annual series of the Biomass Stock Size Indicator (in tonnes). Top: this indicator is usually computed as the average of annual available survey estimates (the acoustic *PELAGO* and *ECOCADIZ* surveys and the DEPM *BOCADEVA* survey). Note that the 2016 datapoint has been re-computed after averaging with *ECOCADIZ* 2015 estimate and that 2017 datapoint is now a provisional estimate since it corresponds only to the *PELAGO* estimate and it has not been still averaged by the *ECOCADIZ* one (this survey will be conducted in late July–early August). Bottom: the indicator correspond to the *PELAGO* biomass estimate only. Note in this case the strange null estimate in 2011.

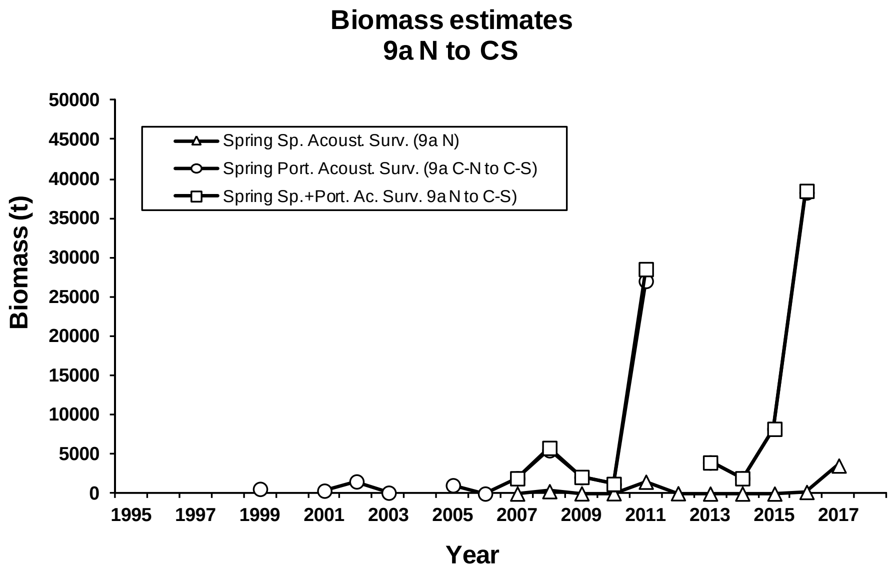


Figure 4.5.2.4. Anchovy in Division 9.a. Anchovy in Subdivisions 9.a North to Central-South (Western Iberian Atlantic façade). Information used in the Qualitative (Updated) Assessment: available biomass estimates from research surveys series sampling the subdivisions used for comparative purposes. For 2012 the only available estimates is the one from the *PELACUS 03* survey for 9.a North. This is the same situation in 2017, since *PELAGO* estimate was not available to this WG.

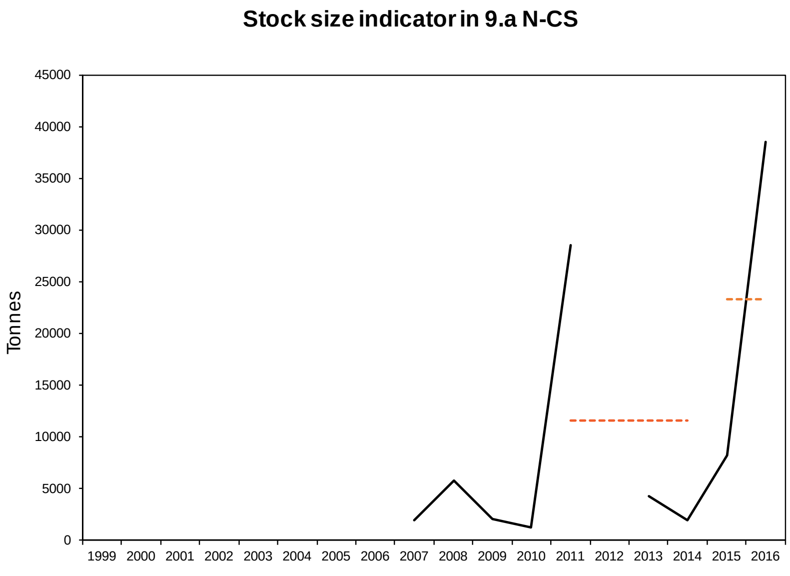
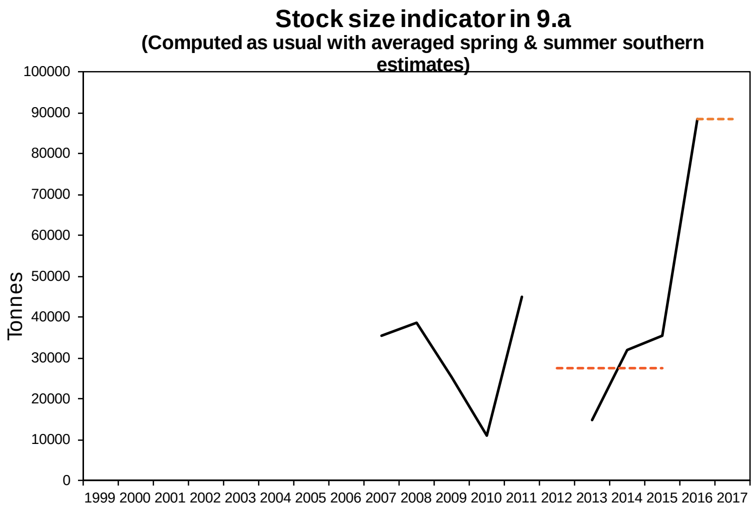


Figure 4.5.2.5. Anchovy in Division 9.a. Anchovy in Subdivision 9.a North to Central-South (Western Iberian Atlantic façade). Information used in the Qualitative (Updated) Assessment: annual series of the Biomass Stock Size Indicator (in tonnes). This indicator is computed as the sum of annual available survey estimates (the acoustic *PELACUS* and *PELAGO* surveys). The 2017 datapoint could not be computed since *PELAGO* estimate was not available to this WG. The present figure corresponds to the same one from the last year's report.



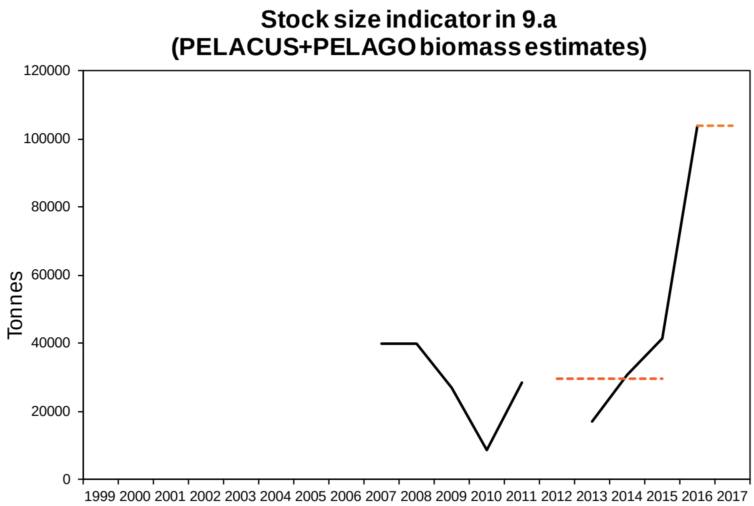
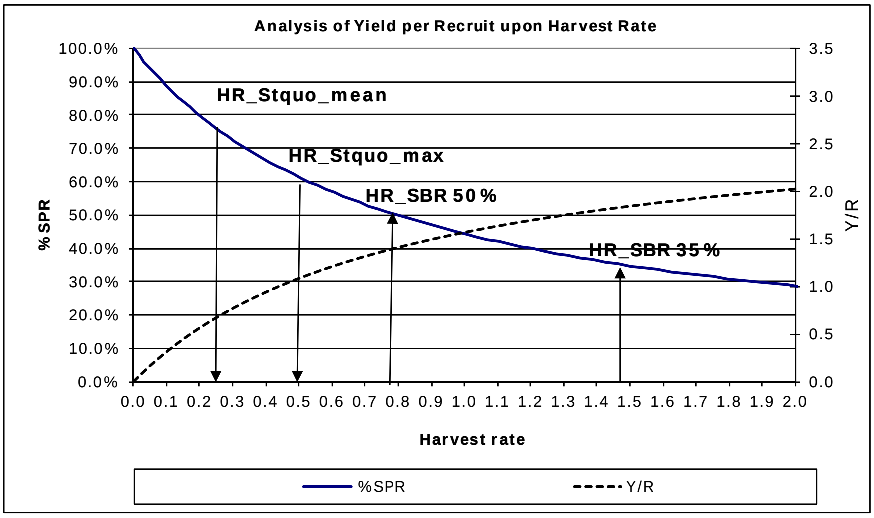


Figure 4.5.2.6. Anchovy in Division 9.a. Information used in the Qualitative (Updated) Assessment: annual series of the Biomass Stock Size Indicator (in tonnes). Top: this indicator is computed as the sum of the regional indicators for western and southern stock components. In this case, the indicator for the southern component is computed as the average of annual available survey estimates (the acoustic *PELAGO* and *ECOCADIZ* surveys and the DEPM *BOCADEVA* survey). Bottom: the indicator correspond to the sum of *PELACUS* and *PELAGO* biomass estimates only. In both cases the 2017 datapoint could not be computed since *PELAGO* estimate for the western component was not available to this WG. Therefore, the top figure corresponds to the same one from the last year's report.



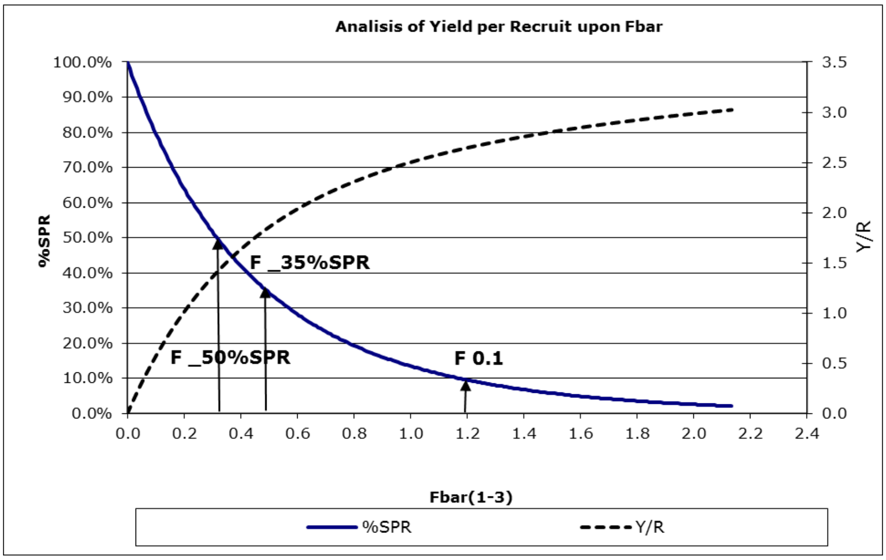


Figure 4.7.2. Anchovy in Division 9a. Subdivision 9a South. Plots with some reference points for Harvest Rate (HR) and Fishing Mortality (F) corresponding to the selectivity-at-age of the period 1996, 1997, 1998 and 2011, fitted with a presumed F at age 1 = 1.

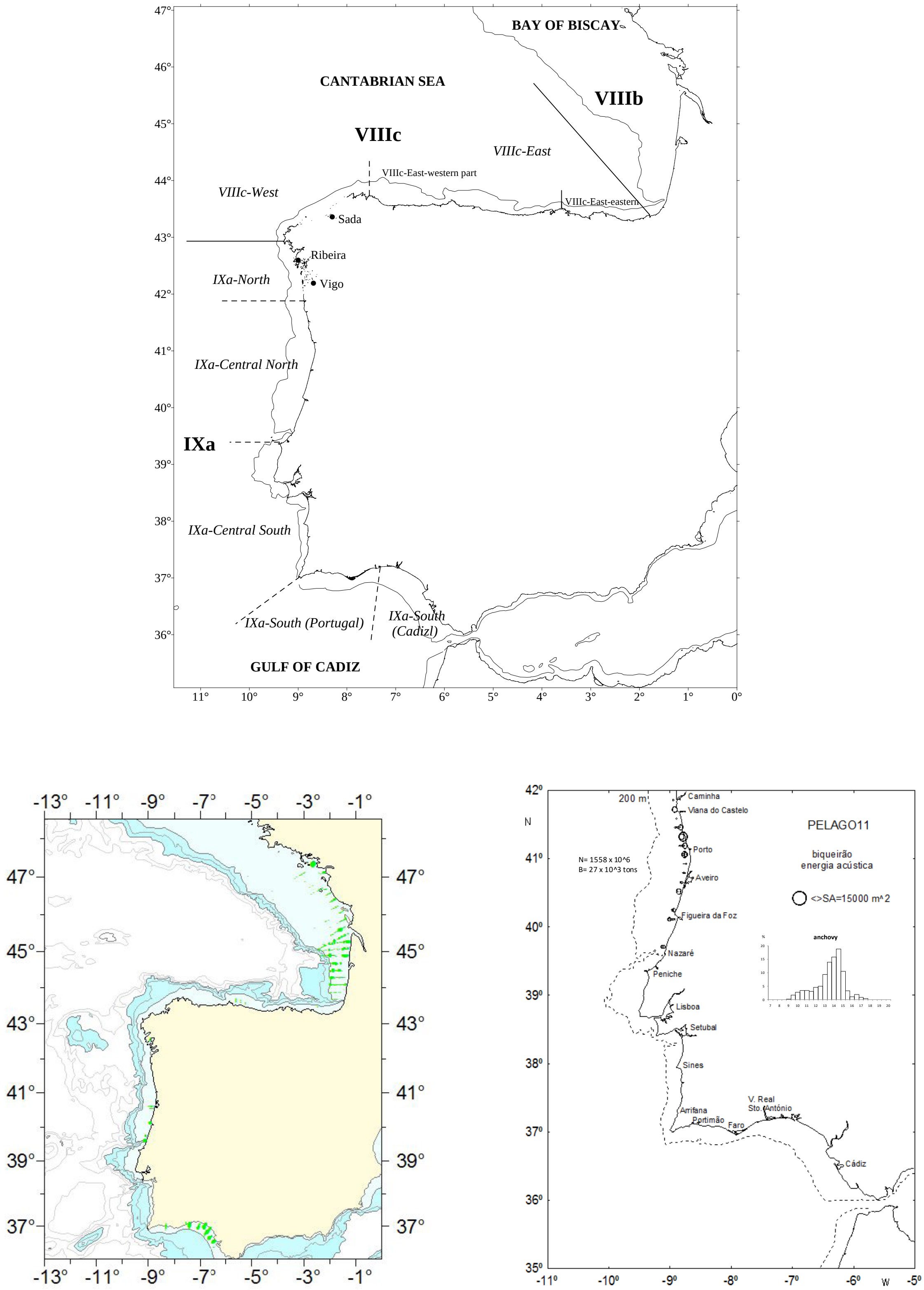


Figure 4.8.1.1. Anchovy in Division 9a. A) Geographical distribution of subdivisions. B) Usual distribution of the anchovy populations throughout the division as derived from the combined 2007 acoustic surveys off Iberia and the Armorican shelf (from ICES, 2009b). C) Spatial pattern of the anchovy abundance in the Division from the 2011 spring Portuguese acoustic survey.

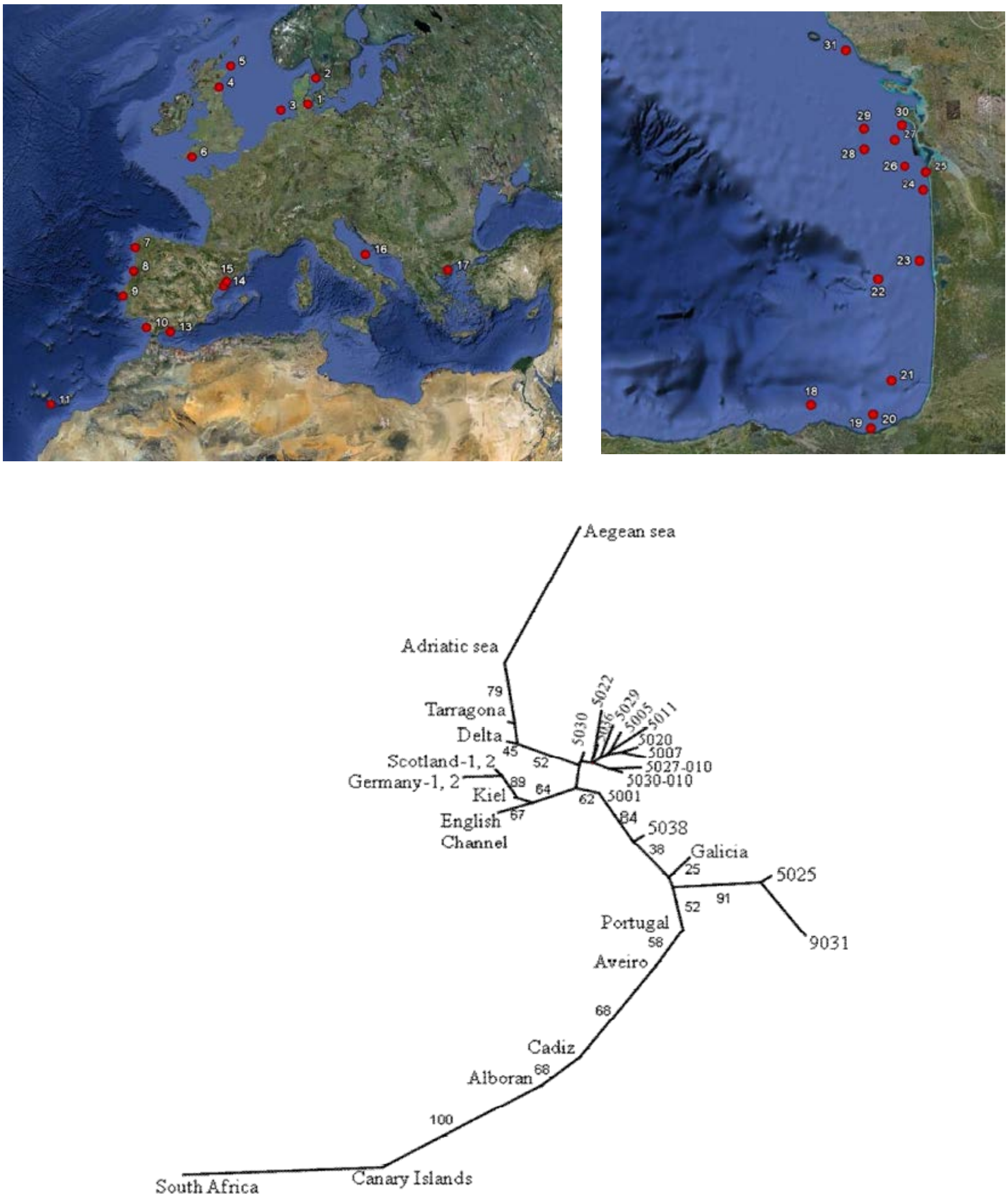


Figure 4.8.1.2. Anchovy in Division 9a. Results from Zarraonandía's (2012) studies on genetic structure of European anchovy populations using single nucleotide polymorphisms (SNP). Upper row: geographical location of the analysed samples. Lower figure: Neighbour-Joining (NJ) dendrogram based on Reynolds distances among all the analysed localities. Topological confidence obtained by 1000 bootstrap replicates.

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5 Sardine general

5.1 The fisheries for sardine in the ICES area

5.1.1 Catches for sardine in the ICES area

Commercial catch data for 2016 were provided by Portugal, Spain, France, Netherlands, Ireland, UK (England and Wales), Denmark and Germany (Table 5.1.1.1). Total reported catch was 72 183 tonnes, divided as follows: 19% of the catches by Portugal, 22% by Spain and 33.6% by France. The remaining 25% of catches are reported by Netherlands, England, and to some minor extent to Denmark, Germany and Ireland. Catches in 8.c and 9.a amount to 31% of the total sardine catches. It should be noted that fishing activities should have been limited in both Spain and Portugal because of the management plan, but total catches in these areas were more important than the TAC implemented.

In 2016, there was a 16% increase with respect to the total 2015 sardine catches reported in European waters. This increase is mainly due to the trend of catches in the Northern parts of the European waters (areas 7 and 8.ab) while Portugal and Spain showed a decrease in Iberian waters. Thus, the increase of the global catches is mainly the fact of France (+56%), United Kingdom (+118%), and Netherlands (+295%).

Table 5.1.1.1. Sardine general: 2016 commercial catch data from the ICES area, available to the Working Group.

Divisions	UK (Engl&Wal)	Germany	Ireland	Denmark	France	Spain	Portugal	Netherlands	Total
4.a									0
4.b									0
4.c					129				129
6.a									0
7.a									0
7.b									0
7.c									0
7.d	225	332			858			508	1923
7.e	6138	1439		2285	5			4016	13883
7.f	3026								3026
7.g			81						81
7.h		169						3.6	172.6
7.i									0
7.j			150						150
8.a					21981				21981
8.b					1310	6824			8134
8.c						2886			2886
8.d									0
8.e									0
9.aN						2887			2887
9.aCN							7695		7695
9.aCS							4031		4031
9.aS						3233	1972		5205
Total	9389	1940	231	2285	24283	15830	13698	4527.6	72183.6

6 Sardine in divisions 8.a, b, d

6.1 Population structure and stock identity

No genetic differentiation have been found between sardine in Celtic Seas (7.a, b, c, f, g, j, k), English Channel (7.d, 7.e, 7.h) and in Bay of Biscay (8.a, b, d). Therefore, it has been previously considered that the sardine stock in 8.a,b,d and 7.as a single stock unit. The assessment of this stock as a single unit has 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 area 7.

Information from the ICES WKSAR workshop (ICES, 2016) suggests higher growth rates for the populations of the English Channel and Celtic sea 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 evidences (Coombs *et al*., 2009) that a significant spawning takes place regularly in Subarea 7 and 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 benchmark workshop (ICES WKPELA, 2017) concluded that in the absence of evidences 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.

Table 6.2.1.1. Official landings reported to ICES (1989–2016).

Year	Divisions 8a,b,d							
	France	Spain	Netherlands	Ireland	United Kingdom	Denmark	Germany	Total
1989	8811	0	0	0	0	0	0	8811
1990	8543	0	0	0	0	0	0	8543
1991	12482	35	0	0	0	0	0	12517
1992	8847	43	0	0	0	0	0	8890
1993	8805	45	0	0	0	308	0	9158
1994	8604	0	0	0	0	0	0	8604
1995	9877	0	24	0	0	0	0	9901
1996	8604	0	0	0	0	0	0	8604
1997	10706	0	26	0	0	0	0	###
1998	9778	873	0	0	0	0	68	10719
1999	0	2384	0	0	0	124	11	2519
2000	10444	1989	34	0	0	0	38	###
2001	10121	0	333	0	0	0	135	###
2002	12316	2881	23	19	276	0	4	15519
2003	10631	2408	68	1750	68	0	0	###
2004	9971	1853	6	1401	0	0	0	13231
2005	15462	1203	1	974	0	0	54	###

Year	Divisions 8a,b,d							
	France	Spain	Netherlands	Ireland	United Kingdom	Denmark	Germany	Total
2006	16000	839	2	49	0	12	78	###
2007	16060	706	0	0	0	48	0	16814
2008	21104	1989	0	0	1	39	0	###
2009	20627	602	0	0	0	0	0	###
2010	19484	2948	0	0	0	0	0	###
2011	17927	5283	4.77	0	0	0	0	###
2012	15952	14948	0	0	0	0	0	###
2013	20066	12423	445	0	252	0	0	###
2014	17706	21295	0	0	0	0	0	###
2015	14429	13055	0	24.6	6.52	0	0	###
2016	23289	6824	66.9	0	0	0	1.11	30181

Table 6.2.1.2. Sardine landings by France (1983–2016) and Spain (1996–2016) in ICES divisions8a,b,d as estimated by the WG.

Year	France	Spain
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
1997	12088	1608
1998	10772	7749
1999	14361	7864
2000	11939	3158
2001	11285	3720
2002	13849	4428
2003	15494	1113
2004	13855	342
2005	15462	898
2006	15916	825
2007	16060	1263
2008	21104	717
2009	20627	228
2010	19485	642
2011	17925	5283
2012	15952	14948
2013	20066	12423
2014	17706	16237
2015	14229	13055
2016	23289	6824

n/a = not available.

Table 6.2.1.3. French Sardine catch at length composition (thousands) in ICES divisions 8a,b,d in 2016.

Length * (HALF CM)	Quarter 1	Quarter 2	Quarter 3	Quarter 4	All year
3.5					
4					
4.5					
5					
5.5					
6					
6.5					
7					
7.5					
8					
8.5					
9		21			21
9.5				31	31
10					
10.5	37				37
11	75	63	648		785
11.5	75	84	1 080		1 239
12		378	989	3 689	5 056
12.5		63	835	9 286	10 184
13	149	21	247	16 727	17 144
13.5			62	4 768	4 830
14	149		186	1 845	2 180
14.5	75		217	4 643	4 934
15	363	232	1 507	11 990	14 093
15.5	718	1 777	1 920	16 821	21 236
16	2 358	5 078	7 009	18 885	33 330
16.5	3 705	10 612	18 449	15 759	48 525
17	5 534	18 176	34 019	11 071	68 800
17.5	7 132	16 933	25 800	11 415	61 281
18	8 304	9 302	18 803	13 001	49 410
18.5	4 179	5 481	9 242	10 610	29 511
19	3 631	3 663	5 465	8 433	21 191
19.5	1 975	3 900	3 515	6 326	15 716
20	2 182	1 888	2 659	5 450	12 179
20.5	1 410	1 507	2 319	2 678	7 914
21	1 140	1 384	1 274	3 218	7 017
21.5	802	806	674	1 519	3 800
22	296	237	548	2 153	3 233
22.5	381	237	145	1 318	2 081
23	70	245	73	1 192	1 580

Length * (HALF CM)	Quarter 1	Quarter 2	Quarter 3	Quarter 4	All year
23.5	75	123		232	429
24	149	114			263
24.5		9			9
25					
	44 961	82 331	137 684	183 062	448 039

Table 6.2.1.4. Spanish sardine catch-at-length composition (thousands) in ICES divisions 8a,b,d in 2016.

Length *	Quarter	Quarter	Quarter	Quarter	All year
(HALF CM)	1	2	3	4	
3.5					
4					
4.5					
5					
5.5					
6					
6.5					
7					
7.5					
8					
8.5					
9					
9.5					
10					
10.5	14				14
11	23	2		5	29
11.5	20			4	24
12	9	2		6	17
12.5	7		11	106	124
13	29	7	47	546	629
13.5	42		165	1 556	1 764
14	31	22	344	3 053	3 451
14.5	16		557	3 056	3 628
15	145	70	534	2 188	2 936
15.5	440	135	897	1 216	2 688
16	916	328	1 698	1 706	4 648
16.5	1 076	800	2 028	3 023	6 928
17	1 269	550	1 240	5 339	8 398
17.5	1 949	1 428	904	8 596	12 877
18	2 648	1 298	364	11 804	16 113
18.5	2 605	1 081	284	13 256	17 226
19	2 565	797	129	12 234	15 725
19.5	2 164	396	43	10 308	12 911
20	1 909	344	15	6 348	8 617
20.5	1 392	172	5	4 207	5 776
21	1 181	138	5	2 368	3 692
21.5	889	51		1 628	2 568
22	591	50	1	950	1 593
22.5	469	2		538	1 009
23	356			201	557
23.5	147			42	189

Length *	Quarter	Quarter	Quarter	Quarter	All year
(HALF CM)	**1**	**2**	**3**	**4**	
24	69			16	85
24.5	5				5
25	5				5
25.5	5				5
26					
	22 990	7 672	9 270	94 301	134 232

Table 6.2.4.1.1. Spanish 2016 landings in ICES divisions 8abd: Catch in numbers- (thousands) at-age.

AGE	FIRST QUARTER	SECOND QUARTER	THIRD QUARTER	FOURTH QUARTER	WHOLE YEAR
0	0	0	1674.4	10175.3	11849.7
1	1856.47	815.275	2630.76	5993.03	11295.5
2	9468.74	4612.24	4149.29	36046.7	54277
3	5418.11	1449.58	720.251	26830.3	34418.3
4	4206.46	668.658	92.5316	12716.5	17684.2
5	1053.29	89.9717	0.94486	839.403	1983.61
6	355.963	12.4434	0.58429	583.362	952.353
7	477.423	22.3777	0.81113	840.392	1341
8	103.78	1.79951	0.1734	275.543	381.295
9	36.0262	0.08649	0	0	36.1127
10+	13.355	0	0	0	13.355

Table 6.2.4.1.2. French 2016 landings in ICES division 8abd: Catch in numbers- (thousands) at-age.

AGE	FIRST QUARTER	SECOND QUARTER	THIRD QUARTER	FOURTH QUARTER	WHOLE YEAR
0			7048.32	63845.6	70893.9
1	4443.75	9951.27	69861.5	75605.8	159862
2	26774.5	55418.6	46880.9	63739.6	192814
3	7784.74	10158.1	8405.15	21305.8	47653.8
4	4385.3	5098.64	4493.58	14580.1	28557.6
5	846.754	870.122	403.87	1650.62	3771.37
6	191.262	247.306	145.997	913.599	1498.16
7	396.48	449.06	352.729	2000.07	3198.34
8	86.4231	95.746	92.4455	800.355	1074.97
9	46.03	32.1142			78.1442
10+	6.21078	10.2282			16.439

Table 6.2.4.2.1. French 2016 landings in divisions 8a,b,d: Mean length- (cm) at-age.

	FIRST QUARTER	SECOND QUARTER	THIRD QUARTER	FOURTH QUARTER	WHOLE YEAR
0			13.3672	13.8032	13.7598
1	15.8078	16.0751	16.9495	16.6597	16.7263
2	17.5755	17.3322	17.8992	18.3968	17.8558
3	19.068	18.9494	19.2362	19.4436	19.2403
4	20.088	19.9083	20.191	20.2686	20.1643
5	21.1566	21.1321	21.249	21.8106	21.4471
6	21.9784	22.4004	22.1243	22.244	22.2243
7	22.1658	22.2294	21.0629	21.8011	21.825
8	23.5272	23.4442	22.089	22.7046	22.7837
9	23.3096	23.3861			23.341
10+	23.5	23.5			23.5

Table 6.2.4.2.2. French 2016 landings in divisions 8a,b,d: Mean weight- (kg) at-age.

Age	First Quarter	Second Quarter	Third quarter	Fourth Quarter	Whole Year
0			0.01905	0.02101	0.02081
1	0.03177	0.03344	0.0393	0.03729	0.03777
2	0.0439	0.04207	0.04641	0.05046	0.04615
3	0.05629	0.05523	0.05781	0.05974	0.05787
4	0.06598	0.0642	0.06702	0.06781	0.06676
5	0.07728	0.07701	0.07832	0.0848	0.08062
6	0.08681	0.092	0.08858	0.09005	0.08982
7	0.08909	0.08987	0.07625	0.08469	0.08503
8	0.10685	0.10571	0.08815	0.09586	0.09696
9	0.10387	0.10491			0.10429
10+	0.10648	0.10648			0.10648

Table 6.2.4.2.3. Spanish 2016 landings in ICES divisions 8,a,b,d: mean length- (cm) at-age.

Age	First Quarter	Second Quarter	Third quarter	Fourth Quarter	Whole Year
0			14.7008	14.4421	14.4786
1	16.0944	16.5111	16.3644	16.8802	16.6043
2	18.127	17.9293	17.1082	18.3431	18.1758
3	19.6148	19.1902	17.7276	19.2841	19.2996
4	20.6685	20.045	18.9439	20.2027	20.3009
5	21.6669	21.1503	20.8525	21.2782	21.4786
6	22.7249	20.898	20.7673	21.6174	22.0214
7	22.4962	21.6082	20.5924	21.6429	21.9455
8	23.5215	22.25	21.25	22.0734	22.468
9	23.5022	22.75			23.5004
10+	24.2107				24.2107

Table 6.2.4.2.4. Sardine general: Spanish 2016 landings in ICES Division 8b: mean weight- (kg) at-age.

	First Quarter	Second Quarter	Third quarter	Fourth Quarter	Whole Year
0			0.0239	0.02257	0.02275
1	0.03253	0.03493	0.0337	0.03759	0.03566
2	0.04704	0.04532	0.03892	0.0489	0.04751
3	0.06055	0.05637	0.04399	0.05729	0.05749
4	0.07173	0.06499	0.05409	0.0667	0.06777
5	0.08317	0.07679	0.07334	0.07845	0.08088
6	0.09718	0.07419	0.07248	0.08288	0.08811
7	0.09397	0.08218	0.07044	0.08317	0.08699
8	0.10816	0.09009	0.0777	0.08833	0.09373
9	0.10811	0.09677			0.10808
10+	0.11867				0.11867

Table 6.2.4.1.2a. Weight-at-age (in kilograms) from French and Spanish commercial fleets in 8.a,b,d.

AGE	0	1	2	3	4	5	6	7	8+
2002	0.0177	0.0454	0.0664	0.0829	0.0898	0.1013	0.1148	0.0177	0.0454
2003	0.0188	0.0540	0.0801	0.0914	0.1005	0.1109	0.1229	0.0188	0.0540
2004	0.0197	0.0398	0.0798	0.0901	0.0949	0.1013	0.1165	0.0197	0.0398
2005	0.0184	0.0469	0.0807	0.0889	0.0937	0.0974	0.1114	0.0184	0.0469
2006	0.0236	0.0390	0.0740	0.0881	0.0940	0.1012	0.1154	0.0236	0.0390
2007	0.0318	0.0525	0.0807	0.0874	0.0983	0.1035	0.1162	0.0318	0.0525
2008	0.0181	0.0437	0.0625	0.0755	0.0782	0.0909	0.1006	0.0181	0.0437
2009	0.0318	0.0379	0.0623	0.0733	0.0861	0.0869	0.0986	0.0318	0.0379
2010	0.0231	0.0378	0.0605	0.0742	0.0809	0.0898	0.0981	0.0231	0.0378
2011	0.0278	0.0426	0.0658	0.0743	0.0822	0.0890	0.1020	0.0278	0.0426
2012	0.0225	0.0393	0.0571	0.0711	0.0772	0.0837	0.0951	0.0225	0.0393
2013	0.0197	0.0369	0.0536	0.0718	0.0748	0.0821	0.0934	0.0197	0.0369
2014	0.0246	0.0352	0.0475	0.0655	0.0709	0.0777	0.0923	0.0246	0.0352
2015	0.0183	0.0331	0.0519	0.0607	0.0730	0.0869	0.0928	0.0183	0.0331
2016	0.0200	0.0384	0.0439	0.0560	0.0654	0.0774	0.0880	0.0200	0.0384

Table 6.2.4.1.2b. Weight-at-age (in grammes) from the Pelgas acoustic survey in 8.a,b,d.

	age											
Survey	1	2	3	4	5	6	7	8	9	10	11	13
PEL00	35.05	54.74	69.15	76.46	84.82	89.93	98.83	110.18	105.04	112.87		117.35
PEL01	41.28	58.85	76.83	83.84	93.68	96.92	103.41	105.35	112.71	120.97	119.92	
PEL02	40.48	60.2	74.94	81.7	92.31	99.42	106.68	118.05				
PEL03	53.35	68.04	73.15	78.11	86.04	93.33	88.74	96.09				
PEL04	35.94	64.73	76.54	84.39	95.87	98.83	104.34	109.19	106.15			
PEL05	34.44	63.45	73.29	79.62	84.88	88.96	90.04	105.42	109.45	98.35		
PEL06	39.17	58.37	70.78	81.18	86.37	82.48	91.25	97.22	107.02	112.02	110.9	
PEL07	37.55	65.96	71.77	79.05	84.02	94.45	100.37	96.93	101.27	114.86		
PEL08	33.44	60.33	71.1	75.18	83.82	92.84	90.45	95.67	99.48	101.41	109.39	
PEL09	25.97	49.90	61.08	68.05	69.92	76.44	82.73	80.54	82.25	90.94	89.28	
PEL10	30.33	50.55	64.04	73.05	78.43	87.58	93.16	105.88	106.96	116.01		
PEL11	27.37	50.13	58.69	69.84	78.35	83.00	84.28	108.17	105.38	108.33		
PEL12	22.88	44.66	57.40	65.45	78.42	87.83	95.26	92.27	99.83			
PEL13	21.16	44.33	55.82	68.30	77.42	84.27	89.28	99.10	113.27	89.17		
PEL14	23.02	44.53	55.93	62.07	69.35	76.11	78.46		86.50			
PEL15	18.75	44.73	56.98	67.22	78.86	87.07	94.81	95.23	90.01			
PEL16	22.94	43.64	56.03	63.76	75.71	88.48	95.36	102.21	102.39	105.47		
PEL17	29.50	43.02	53.06	64.99	71.84	85.37	94.93	98.72	96.88	108.27		

Table 6.2.4.1.3a. Catch-at-age (in numbers) from French and Spanish commercial fleets in 8.a,b,d (Thousands).

AGE	0	1	2	3	4	5	6	7	8+
2002	3703	162938	67783	25016	15760	11127	7444	2157	1994
2003	4382	89475	62145	27447	16545	9657	6207	3334	2384
2004	22283	88306	50184	36191	15110	9388	2796	1328	938
2005	4114	91371	41479	29105	22998	17983	9190	5115	4972
2006	8896	35588	84755	30337	21008	15204	9519	6946	6365
2007	24017	66813	25930	59416	13095	14186	12178	7468	6489
2008	3845	162408	71484	26645	42044	13223	11590	10818	10416
2009	7312	100934	119849	42949	21962	20766	10678	7952	7433
2010	1907	37905	107444	59131	18719	14837	22904	7452	13338
2011	3938	42575	62666	118526	56833	8562	15571	5400	8600
2012	4341	168344	81396	74962	114546	33118	13161	4986	2771
2013	9821	256384	136539	52648	69869	44753	13705	3312	3560
2014	20494	243108	309392	56630	30728	27472	15020	3479	683
2015	915	304443	170698	76822	20856	3893	6637	2847	500
2016	85573	177636	254519	84042	47489	5929	8886	85573	1600

Table 6.2.4.1.3b. Population-at-age estimates (in numbers) from the Pelgas acoustic survey in 8.a,b,d.

PELGAS	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
2000	1276312	1559347	1083847	721738	551465	218657	152984	132676
2001	1280080	1367856	819203	751576	353970	466190	175124	277453
2002	3458311	3585189	1115098	566798	162725	85013	38003	9120
2003	160136	528081	463812	165696	55940	2234	5426	1090
2004	2997203	2029661	1606397	706117	467766	283692	95817	61324
2005	2613794	1807043	824020	822188	610585	383260	230492	174773
2006	605847	2819592	274996	90287	42056	38918	13436	16260
2007	631471	296092	761271	131707	57856	64658	27165	35554
2008	3432039	1549493	383747	1478305	301616	223603	241521	373181
2009	6111475	3286964	707700	301305	737098	215647	148810	157875
2010	1511640	5227578	1558567	267859	125992	122739	27877	41082
2011	1435411	1504792	2516162	794842	106115	64749	23433	33899
2012	3257929	1129668	833824	1158709	340656	77427	54120	43030
2013	8334258	1934208	558270	313743	563894	211086	49522	47293
2014	3987596	3240908	863755	269980	183557	132252	39784	4771
2015	7424062	1611843	1699906	483190	193722	159709	141238	33751
2016	1412933	2501827	919725	510321	73347	32217	51729	14874
2017	8661052	1102845	1688140	725103	393362	53423	15494	20365

Table 6.2.4.4.1. Maturity ogive estimated by the PELGAS survey.

AGE	0	1	2	3	4	5	6+
2000	0.000	0.465	0.915	0.960	0.972	0.980	0.995
2001	0.000	0.430	0.816	0.942	0.971	0.971	0.993
2002	0.000	0.586	0.932	0.981	0.993	0.997	0.999
2003	0.000	0.445	0.865	0.940	0.958	0.953	0.984
2004	0.000	0.831	0.991	0.986	1.000	1.000	1.000
2005	0.000	0.816	1.000	1.000	1.000	1.000	1.000
2006	0.000	0.861	0.991	0.994	0.991	0.988	0.999
2007	0.000	0.717	0.957	0.973	1.000	0.979	0.991
2008	0.000	0.622	0.989	1.000	1.000	1.000	0.987
2009	0.000	0.485	0.990	0.989	1.000	0.979	0.988
2010	0.000	0.471	0.991	0.998	1.000	1.000	1.000
2011	0.000	0.718	0.994	0.999	0.994	1.000	1.000
2012	0.000	0.397	0.989	0.998	0.995	0.984	0.998
2013	0.000	0.499	0.992	0.984	0.978	0.997	1.000
2014	0.000	0.483	0.969	0.980	0.921	0.994	1.000
2015	0.000	0.432	0.992	0.994	0.993	1.000	1.000
2016	0.000	0.448	0.986	0.996	1.000	1.000	0.994
2017	0.000	0.683	0.993	0.996	1.000	0.990	1.000

6.2 Input data in 8.a, b, d

French sardine landings have been corrected for misallocations between 7.e,h and 8.a. A substantial part of the French catches originates from divisions 7.h and 7.e, but these catches have been assigned to Division 8.a due to their very concentrated location at the boundary between 8.a, 7.h and 7.e. French sardine landings declared in 25E5 and 25E4 have hence been reallocated to 8.a.

Official landings per country for the whole area are available in Table 6.2.1.1.

6.2.1 Catch data in Divisions 8.a, b, d

An update of the French and Spanish catch dataseries in divisions 8.abd (from 1983 and 1996 for France and Spain, respectively) including 2016 catches was presented to this year´s WG (Table 6.2.1.2).

The Spanish fishery takes place mainly during March and April and in the fourth quarter of the year. Spanish vessels are purse-seiners from the Basque Country which operate mostly in Division 8.b . Spanish landings averaged around 4000 t 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 2016 were 6824 tonnes (the half of the year before).

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 have been between 15 and 20 thousand tonnes. In 2016, landings were 23 289 tonnes, which is the maximum of the historic time-series. About 90% of French catches are taken by purse seiners while the remaining 10% 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 operate mainly in coastal areas (<10 nautical miles) while trawlers are allowed to fish within 3 nautical miles from the coast. Both pair trawlers and purse seiners operate close to their base harbour when targeting sardine. The highest catches are taken in summer. Almost all the catches are taken in southwest Brittany.

Catches were sampled and numbers by length class for divisions 8.a,b by quarter are shown in Tables 6.2.1.3 and 6.2.1.4, for France and Spain, respectively. Sardine caught in area 8.abd ranges from 9 to 25 cm. In 2016, a peak is observed in the catch-at size distributions at 17 and 18.5 cm length for the French and Spanish fleets respectively.

6.2.2 Surveys in divisions 8.a, b, d

6.2.2.1 Bioman; DEPM surveys in divisions 8.abd

The DEPM survey BIOMAN takes place annually in spring in the Bay of Biscay with the main objective of estimating the total biomass and distribution of anchovy in the Bay of Biscay and the egg abundance of sardine. Triennially the SSB of sardine is as well estimated since 2011. In 2017, the sardine spawning–stock biomass will be estimated for November for WGHANSA-sub and WGACEGG because the adult samples are in process. The survey took place from the 4th to the 26th May. All the methodology for the survey is described in detail in the stock annex - Bay of Biscay Anchovy (Subarea 8). A detailed report of the survey is attached as WD_DEPM_BIOMAN (Santos. M *et al.*, WD 2017).

Total egg abundance for sardine was estimated as the sum of the eggs in each station multiplied by the area each station represents. This year sardine egg abundance estimate was 7.20 E+12 eggs, considered the whole area surveyed. Removing the area of the Cantabrico coast and part of the North for assessment propose, as done in 2014 the total egg abundance was 5.98 E+12 eggs around the time-series average (Figure 6.2.2.1.1, Table 6.2.2.1.1). A small amount of sardine eggs was encountered in the Cantabrico, close to the coast, between 2º30' and 6W. In the French platform sardine eggs were encountered all along the coast between coast and 100 m depth until 48ºN. Moreover, there were anchovy eggs between 45ºN and 46ºN from 100 m depth to 200 m depth isoline and between 47ºN and 48ºN from 100 m depth to 200 m depth isoline. (Figure 6.2.2.1.2). In the sampling with the PairoVET net (vertical sampling) from 747 stations a total of 321 (43%) had sardine eggs with an average of 173 eggs per m^2 per station in the positive stations and a total number of eggs of 5556 eggs m^2. In the sampling with CUFES (horizontal sampling) a total of 1856 stations had sardine. From those 604 (33%) had sardine eggs. This year the DEPM for sardine will be applied. The final results will be available at November 2017 at WGACEGG. For that purpose, the survey was extended to the north until 48ºN and to the west until the west limit of the sardine spawning area was delimited. For the assessment of sardine in the 8.abd, stations from the northwest were removed to maintain the same coverage of the area of the time-series (Figure 6.2.2.1.2).

Table 6.2.2.1.1. Time-series for sardine, Total egg abundances (Σ(egg_St*area_st)) in numbers of eggs, without the north, the one adopted as an input for the assessment of sardine 8.abd.

Year	TotAb_withoutN
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

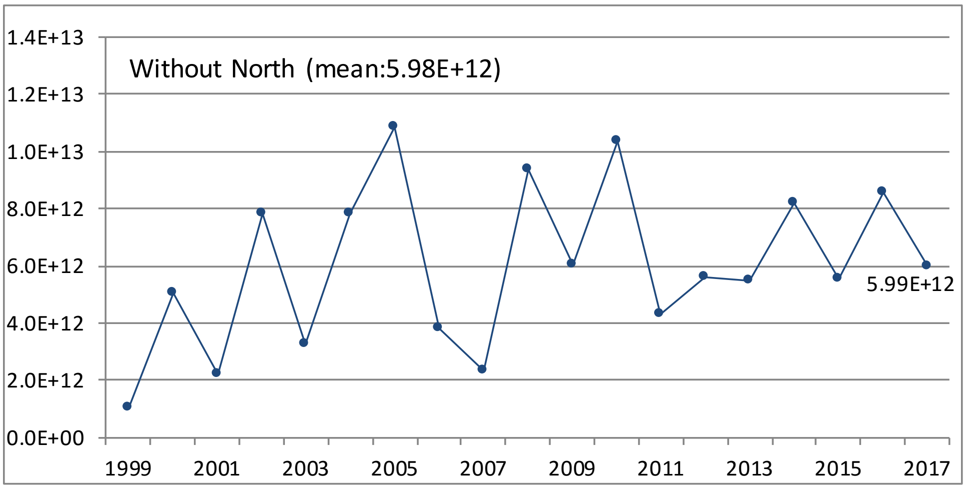

Figure 6.2.2.1.1. Historical series for sardine egg abundances (without northwest stations).

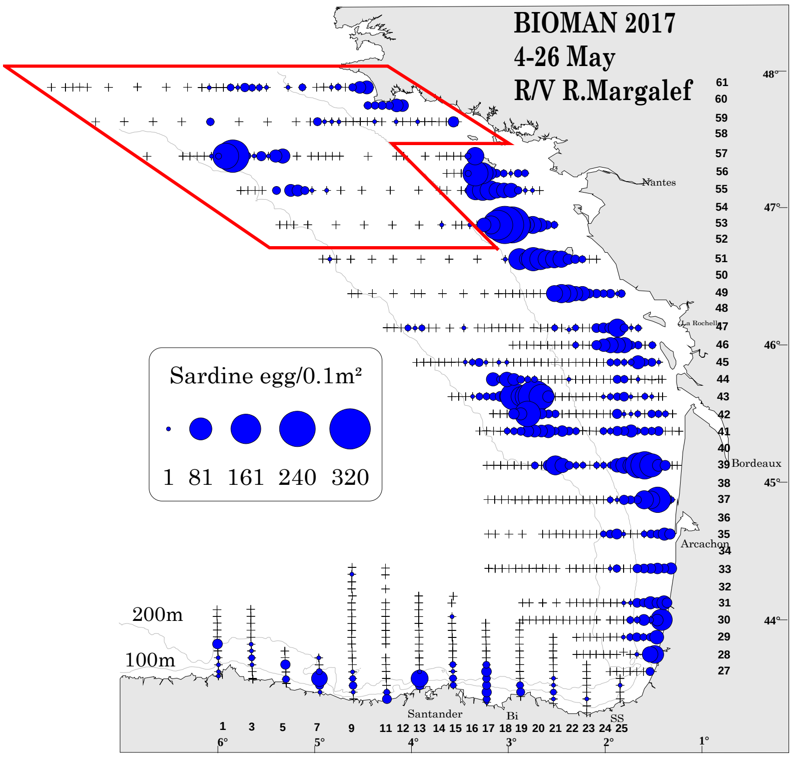

Figure 6.2.2.1.2. Distribution of sardine egg abundances (eggs per 0.1 m²) from the DEPM survey BIOMAN2017 obtained with PairoVET. The red line represents the stations removed for assessment purpose in 8.abd.

6.2.2.2 Pelgas acoustic survey in divisions 8.a, b, d

The French acoustic survey PELGAS takes place every spring in the Bay of Biscay on board the RV Thalassa with the main objective of studying the abundance and distribution of pelagic fish in the Bay of Biscay and to monitor the pelagic ecosystem. In 2017, PELGAS took place from the 21st April to 25th May and detailed objectives, methodology and sampling strategy are described in the WD- Duhamel *et al*., (2017) presented to this group.

Target species were anchovy and sardine but both species were considered in a multispecies context.

The biomass estimate of sardine observed during PELGAS17 is 465 022 tons (Table 2.3), which is at a high level of the PELGAS series, and constituting a real increase of the biomass compared to the last year. It must be enhanced that this survey doesn't cover the total area of potential presence of sardine, and it is possible that some years, this species could be present up to the North, in the Celtic sea, SW of Cornouailles or Western Channel where some fishery occurs, more or less regularly (see chapter 7 of this report). It is also possible that sometimes, a small fraction of the population could be present in very coastal waters, where the RV 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 (8.ab) sardine population.

Sardine was distributed (Figure 6.2.2.2.1) all along the French coast of the Bay of Biscay, from the south to the north. Sardine was well present this year, pure along the Lande's coast where an upwelling occurred, rarely mixed with other species along the coast. Sardine appeared also present offshore, close to the surface, along the shelf-break, contrary to previous year.

This year, sardine shows a unimodal length distribution (Figure 6.2.2.2.2). This mode, about 15 cm, corresponds to age 1 and it suggests that a (very) good recruitment occurred.

PELGAS2017 sardine length–weight and age–length keys are presented in Figure 6.2.2.2.3 and Table 6.2.2.2.1, respectively.

PELGAS2017 sardine proportions-at-age are presented in Figure 6.2.2.2.4. The age distribution is dominated by a large age 1 group (68% in numbers), denoting a good recruitment.

Series of sardine abundances-at-age (2000–2017) is shown in Figure 6.2.2.2.5. Cohorts can be visually tracked on the graph. 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. The 2017 recruitment-at-age 1 is the largest of the whole series, comparable to the 2013 one. It must be noticed that some sardine juveniles (age 0) were detected last year (see WGHANSA 2016), which eventually could be linked with the very good recruitment-at-age 1 this year.

The PELGAS sardine mean weights-at-age series (Figure 6.2.2.2.6) shows a clear decreasing trend, whose biological determinant is still poorly understood. It must be noticed that mean weight-at-age 1 seems to increase again for the second consecutive year. Further work must be conducted to explore the causes of the fluctuation of mean weights-at-ages.

Table 6.2.2.2.1. Sardine age–length key from PELGAS17 samples (based on 1535 otoliths).

Nombre de age	age										
length	1	2	3	4	5	6	7	8	9	10	Total
11	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
11.5	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
12	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
12.5	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
13	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
13.5	94.74%	5.26%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
14	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
14.5	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
15	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
15.5	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
16	94.52%	4.11%	1.37%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
16.5	80.56%	18.06%	1.39%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
17	56.45%	25.81%	17.74%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
17.5	11.29%	58.06%	29.03%	1.61%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
18	4.76%	32.14%	59.52%	3.57%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
18.5	0.00%	23.64%	67.27%	8.18%	0.91%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
19	0.00%	9.30%	68.22%	16.28%	5.43%	0.78%	0.00%	0.00%	0.00%	0.00%	100.00%
19.5	0.00%	5.84%	50.36%	33.58%	10.22%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
20	0.00%	3.01%	32.33%	44.36%	20.30%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
20.5	0.00%	2.59%	27.59%	43.10%	25.00%	0.86%	0.00%	0.00%	0.86%	0.00%	100.00%
21	0.00%	1.08%	16.13%	44.09%	33.33%	3.23%	1.08%	1.08%	0.00%	0.00%	100.00%
21.5	0.00%	1.39%	4.17%	31.94%	47.22%	12.50%	2.78%	0.00%	0.00%	0.00%	100.00%
22	0.00%	0.00%	0.00%	17.02%	53.19%	25.53%	2.13%	2.13%	0.00%	0.00%	100.00%
22.5	0.00%	0.00%	0.00%	20.51%	48.72%	15.38%	5.13%	2.56%	7.69%	0.00%	100.00%
23	0.00%	0.00%	0.00%	3.70%	44.44%	18.52%	18.52%	7.41%	3.70%	3.70%	100.00%
23.5	0.00%	0.00%	0.00%	0.00%	13.33%	40.00%	33.33%	13.33%	0.00%	0.00%	100.00%
24	0.00%	0.00%	0.00%	0.00%	0.00%	11.11%	33.33%	11.11%	33.33%	11.11%	100.00%
24.5	0.00%	0.00%	0.00%	25.00%	0.00%	25.00%	0.00%	25.00%	25.00%	0.00%	100.00%
Total	26.55%	9.97%	26.75%	17.90%	13.28%	2.97%	1.25%	0.59%	0.59%	0.13%	100.00%

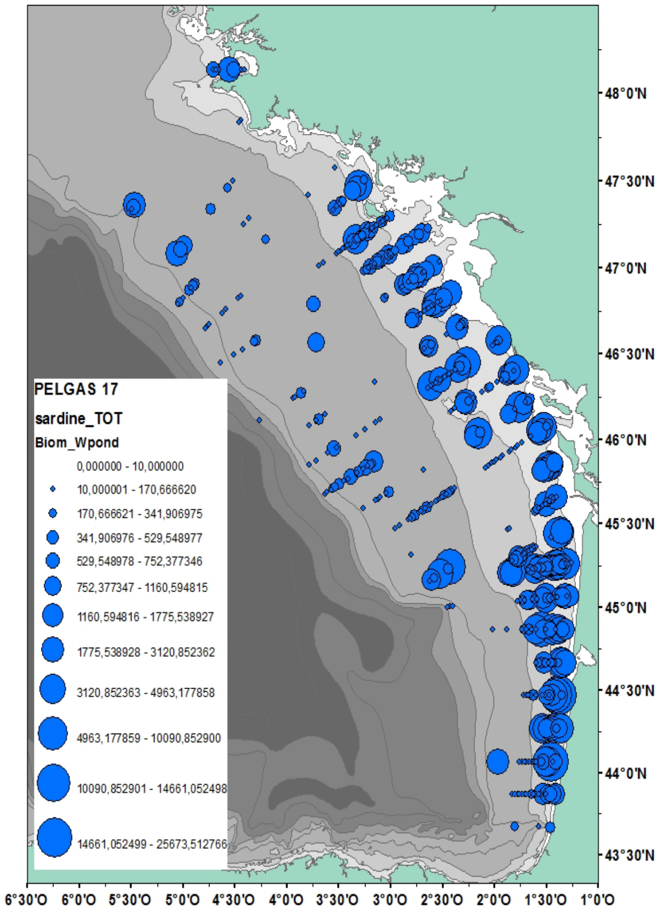

Figure 6.2.2.2.1. Sardine distribution during PELGAS17 survey.

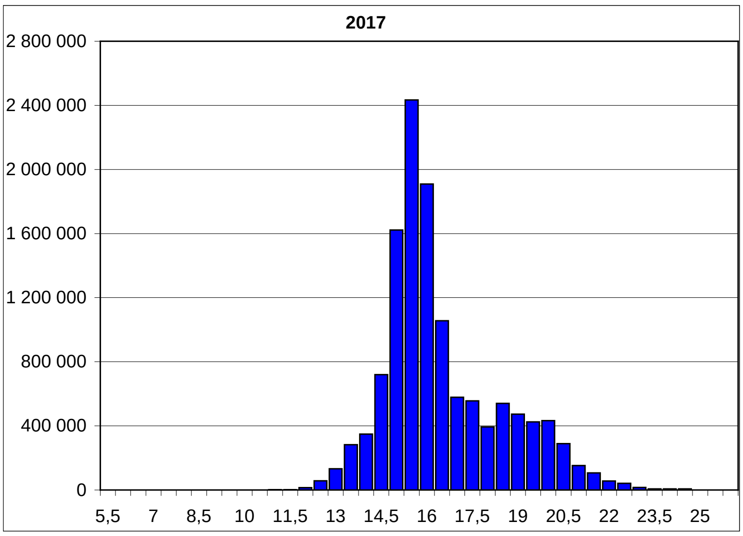

Figure 6.2.2.2.2. Length distribution of sardine as observed during PELGAS17.

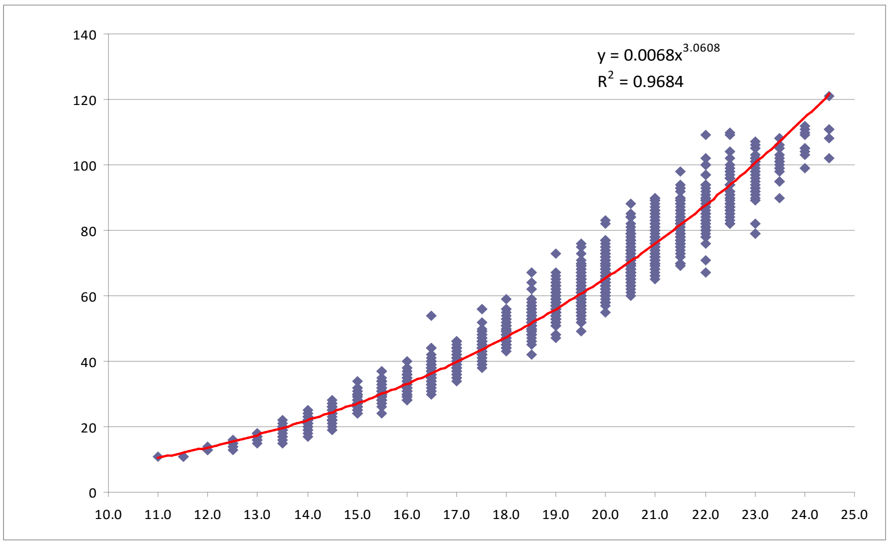

Figure 6.2.2.3. Weight–length key of sardine established during PELGAS17.

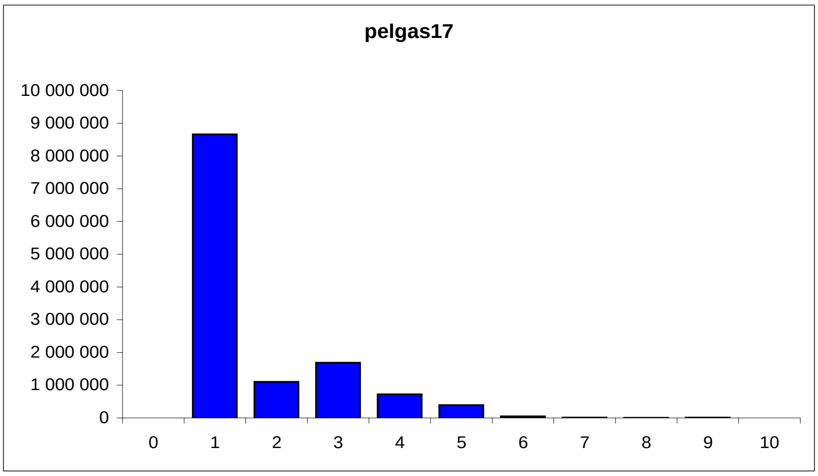

Figure 6.2.2.2.4. Global age composition (nb) of sardine as observed during PELGAS 17.

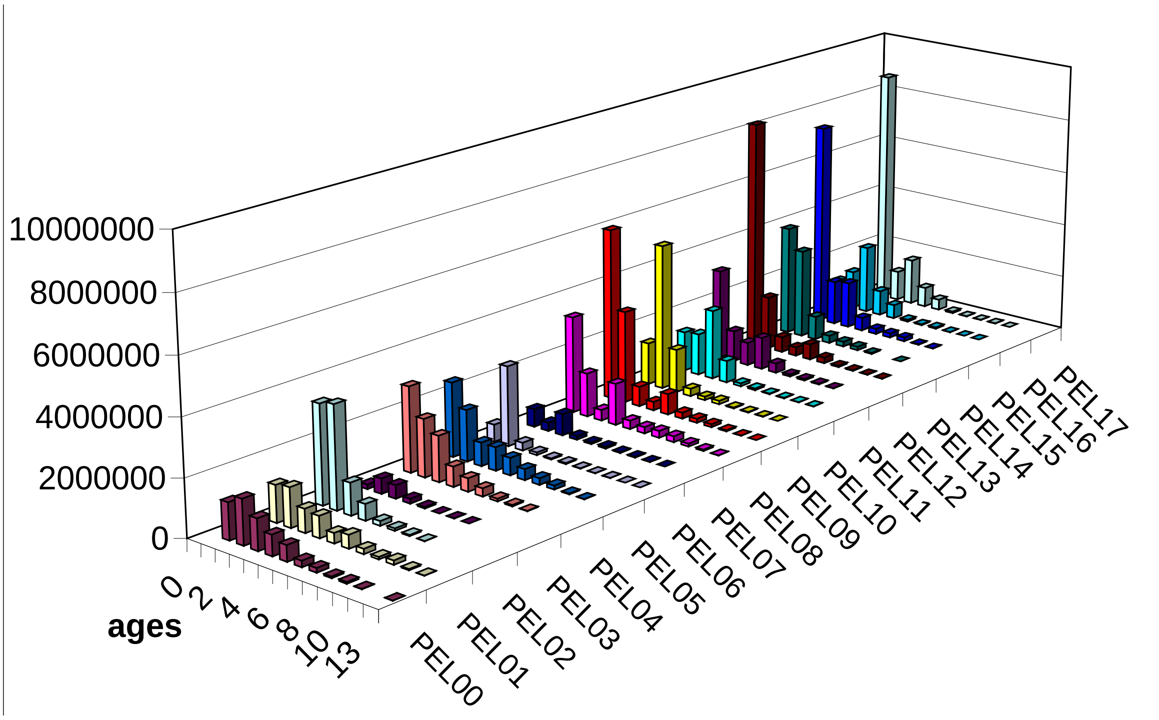

Figure 6.2.2.2.5. Age composition of sardine as estimated by acoustics since 2000.

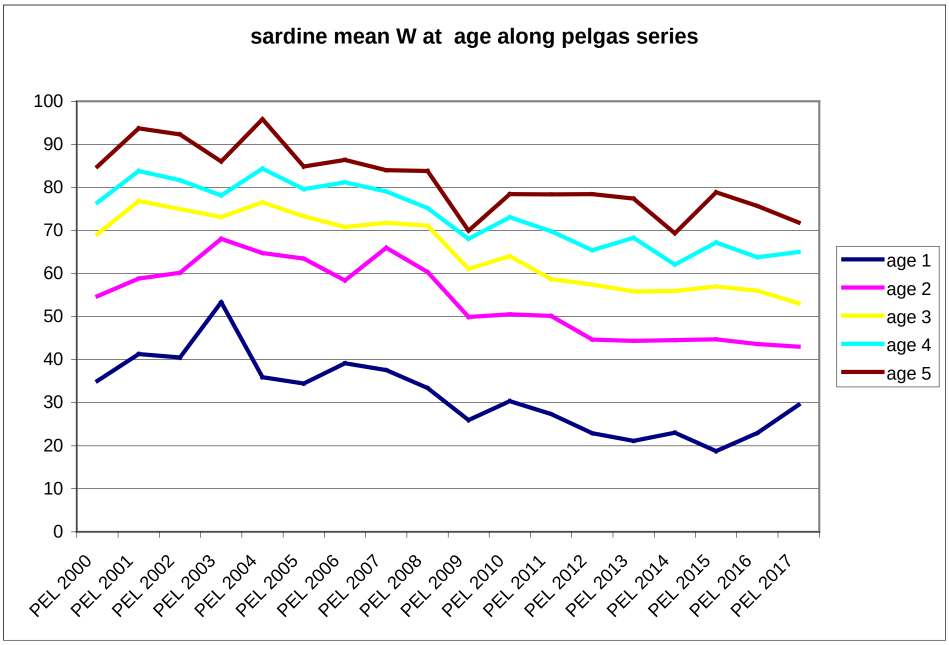

Figure 6.2.2.2.6. Sardine mean Weight-at-age along PELGAS series (since 2000).

6.2.3 DEPM survey in divisions 8.a, b, d

The DEPM triennial survey data were not available at the time of the working group. They will be added to the assessment next year.

6.2.4 Biological data

6.2.4.1 Catch numbers-at-length and age

Tables 6.2.4.1.1 and Table 6.2.4.1.2 shows the catch-at-age in numbers for each quarter of 2016 for French and Spanish landings respectively in 8.a,b,d. For France, fish of age 2 dominated the fishery in the first semester and age 1 in the second semester while for Spain, age 2 dominated the fishery in 2016 in all the quarters.

6.2.4.2 Mean length and mean weight-at-age

Mean length and mean weight-at-age by quarter in 2016 are shown in Tables 6.2.4.2.1–6.2.4.2.4 for both French and Spanish landings in 8.a, b, d.

6.2.4.3 Natural mortality

Natural mortality-at-age was unchanged from the values estimated during the ICES WKPELA benchmark (2017):

Age	0	1	2	3	4	5	6+
M (year^{-1})	1.071	0.692	0.546	0.475	0.435	0.412	0.400

6.2.4.4 Maturity

Maturity ogive is estimated every year since 2000 based on the PELGAS survey. The updated ogive is shown in Table 6.2.4.4.1–6.2.4.2.4 for both French and Spanish landings in 8.a, b, d.

6.3 Historical stock development

Model used: SS3

This is the first year this stock is assessed using SS3 (Methot and Wetzel, 2013) and the procedure described in the stock annex following the WKPELA benchmark (ICES, WKPELA 2017). No deviation were made to that procedure. DEPM triennial data for 2017 were not available by the time of WGHANSA.

6.3.1 State of the stock

Summary of the assessment is shown in Table 6.3.1 and in Figures 6.3.1–6.3.3. The spawning–stock biomass (SSB, at the beginning of the year) has been above B_{pa} all along the series. SSB decreased from 2010 to 2012 and has been since then slowly increasing until 2017 where the SSB value is the second highest of the time-series (after 2005). The decrease is related to the increase in fishing mortality as landings have gradually increased from 2011 to 2014. Landings have been above 30 kt since 2012. Fishing mortality has been around 0.35 and above F_{pa} since 2012. Recruitment has been variable over time. Recruitment in 2016 is well above the time-series average.

In the benchmark workshop (ICES, WKPELA 2017) the assessment was considered unable to provide absolute recruitment, biomass and fishing mortality estimates, so the stock was classified as category 2 (stocks with quantitative assessments and forecasts that are merely indicative of trends). **Therefore, in the ICES advice, all the estimates from the assessment are expressed in relative terms with respect to the average of the time-series**. **The values in this report cannot, in any way, be used as actual absolutes estimates of the stock biomass, recruitment and fishing mortality.** Mean SSB is calculated from 2002–2017. Mean fishing mortality (ages 2–5) and recruitment are calculated over the 2002–2016 period.

Table 6.3.1. Summary of the sardine 8abd stock assessment.

Year	Recruitment (thousand)	SSB (tonnes)	Total Catch (tonnes)	F(2–5)
2002	3783	152911	18277	0.152
2003	4123	144295	16607	0.121
2004	7712	158874	14197	0.114
2005	2331	184281	16360	0.114
2006	3735	164591	16741	0.124
2007	7490	143593	17323	0.133
2008	9117	152840	21821	0.186
2009	3566	145668	20855	0.152
2010	2633	160933	20127	0.150
2011	4538	130152	23208	0.199
2012	8217	96045	30900	0.345
2013	5891	100538	32489	0.357
2014	8765	106486	33943	0.394
2015	3660	105805	27284	0.285
2016	14650	112906	30181	0.360
2017	5281*	173611		

***Geometric mean (2002–2016).**

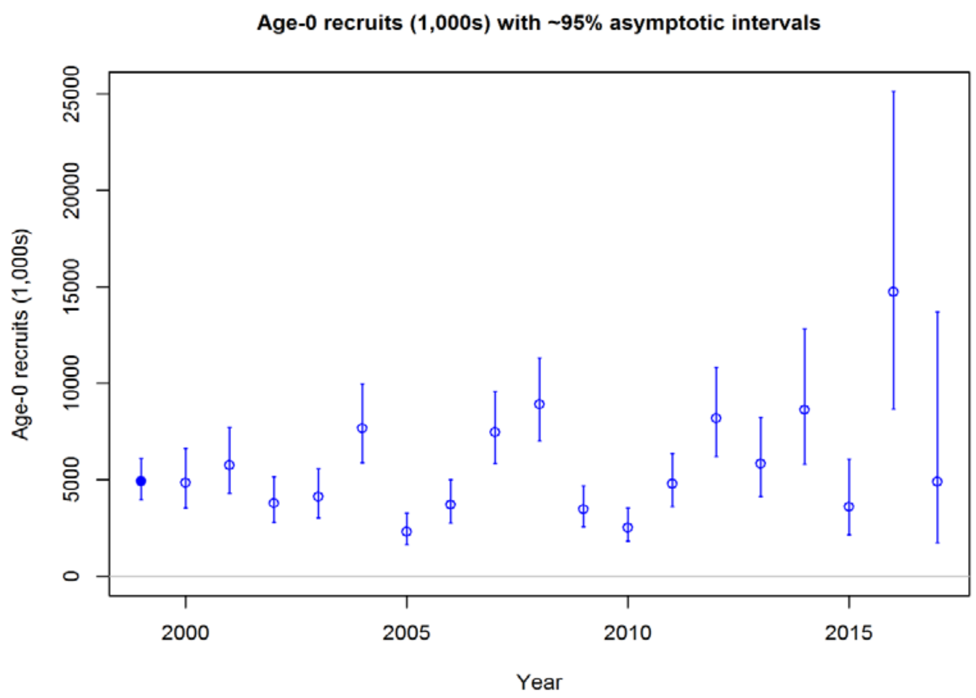

Figure 6.3.1. Recruitment estimates from SS3 outputs for sardine 8.abd with 95% confidence intervals (standard error estimates). Last year's value is estimated from the model.

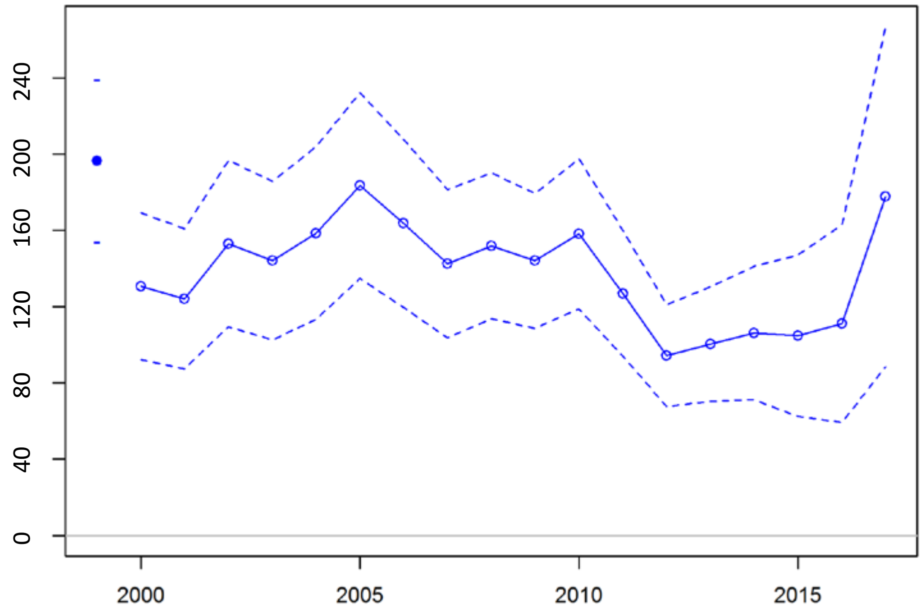

Figure 6.3.2. Spawning–stock biomass from SS3 outputs for sardine 8abd with 95% confidence intervals (standard error estimates).

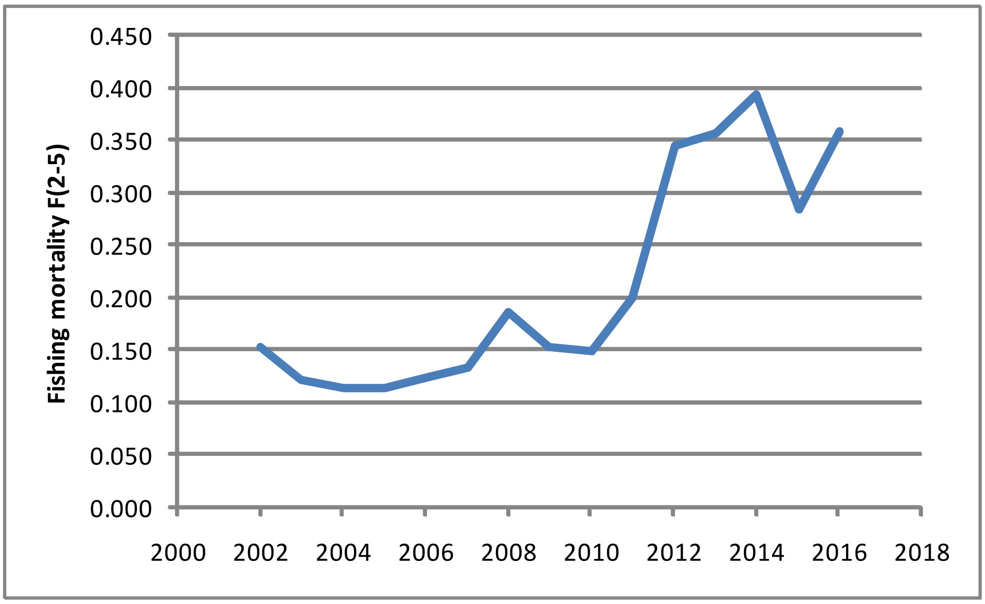

Figure 6.3.3. Average fishing mortality for ages 2 to 5 derived from SS3 outputs for sardine 8.abd.

6.3.2 Diagnostics

Residuals (Figures 6.3.4–6.3.5) and diagnostics do not highlight any problem regarding the model fit. Some cohorts lead to some model over or underestimations. This phenomena appears on some years for the Pelgas survey. For Pelgas, age 1 has positive residuals since 2011. For the commercial vessels, the cohort effect is less visible but some years appears to have more residuals than other (e.g. 2009). The model fit to the survey indices is within the confidence intervals of those indices. There is no deviation in recruitment estimates (Figure 6.3.6).

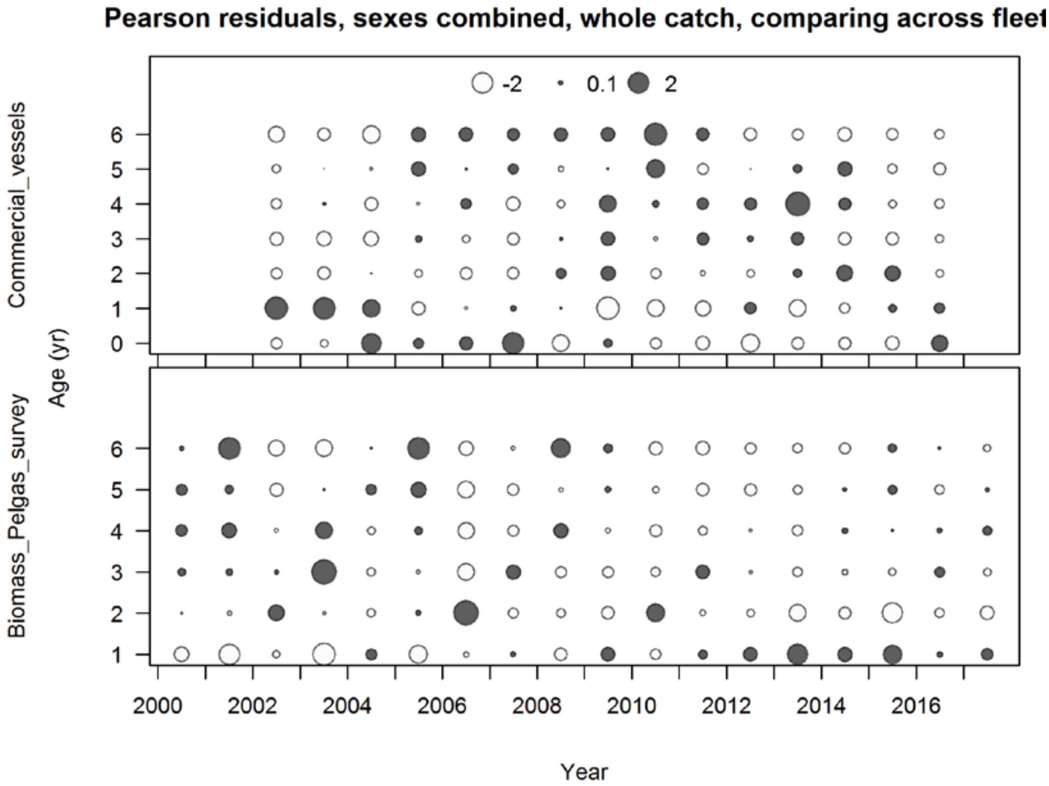

Figure 6.3.4. Pearson residuals for the age composition from the Pelgas survey (bottom panel) and commercial vessels (top panel).

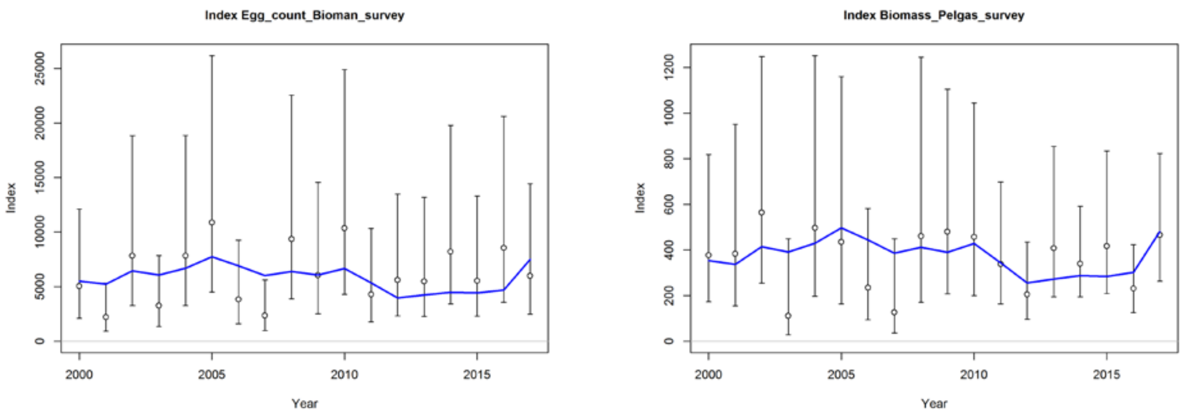

Figure 6.3.5. Observed Bioman and Pelgas survey indices (circle) and their corresponding 95% confidence bars compared to the model fit (blue line).

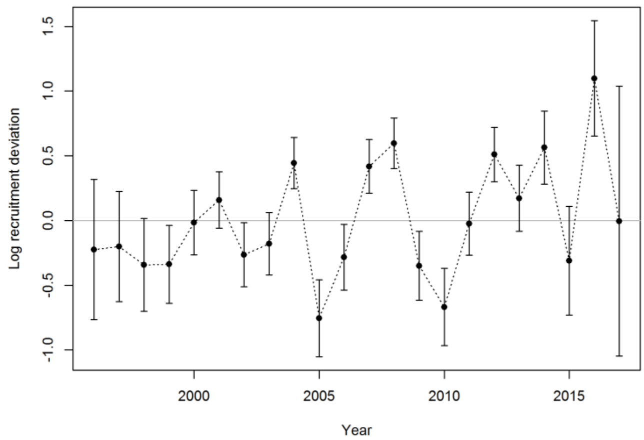

Figure 6.3.6. Log recruitment deviation from the SS3 output.

6.3.3 Retrospective patterns

Retrospective patterns for SSB, F_{bar}(2–5), apical F and recruitment were computed for years 2012–2016. 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 (2017). The model tends to overestimate SSB and underestimate F_{bar}. Given the low contrast in model output, this is not a critical issue for the assessment. (Figure 6.3.7).

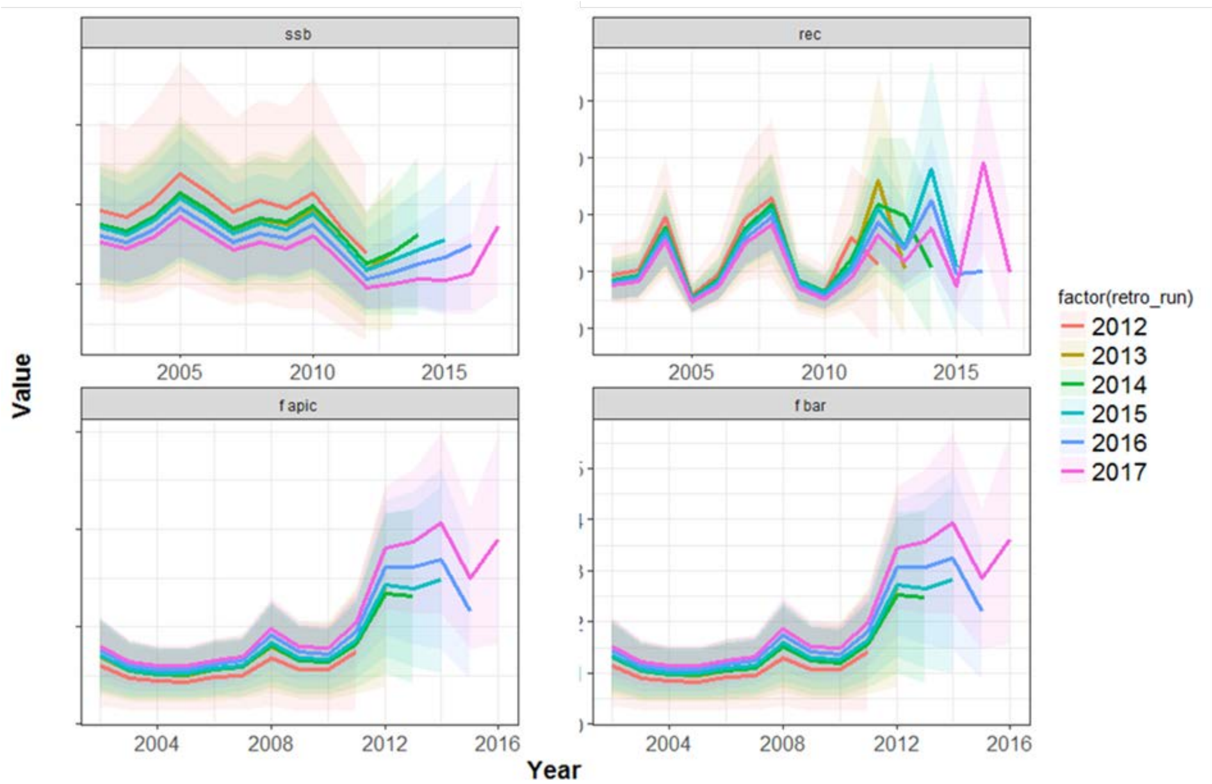

Figure 6.3.7. Retrospective patterns for sardine 8.abd runs.

6.4 Short-term projections

The short-term forecast was conducted following the stock annex agreed during the benchmark workshop (ICES, WKPELA, 2017). The recruitment of sardine for the intermediate year (2017) is assumed to be the geometric mean of the time-series of recruitment (replacing the value estimated in the assessment). The assumption on fishing mortality in 2017 is *status quo* fishing based on the average of F from the last three years (2014–2016). Biological parameters, such as maturity and weights-at-age were assumed as the average of the last three years. Natural mortality was considered the same as in the assessment. Short-term projections were performed using FLR libraries. Assumptions for the intermediate year are presented in Table 6.4.1. Recruitment for 2017 was assumed to be 5281 thousand individuals and F_{bar}(2–5) was 0.3429. Input data for the short-term forecast are provided in Table 6.4.2. Table 6.4.3 provides the short-term projections under various management options.

Table 6.4.1. Assumptions for the intermediate year.

Variable	Value	Source	Notes
F ages 2–5 (2017)	0.3429	ICES (2017a)	Fsq=$F_{average}$(2014–2016)
SSB (2018)	148 084	ICES (2017a)	conditioned to Fsq=Faverage(2014–2016)
$R_{age\ 0}$ (2017/2018)	5281	ICES (2017a)	GM(2002–2016)
Total catch (2017)	40 312	ICES (2017a)	Fishing at Fsq
Discards (2017)	0 tonnes	ICES (2017a)	Negligible

Table 6.4.2. Input data for the short-term forecast.

Year	age	stock.n	stock.wt	catch.wt	mat	M	F
2017	0	5280.913	0.0010	0.0210	0.0000	1.071	0.006
	1	4990.005	0.0215	0.0356	0.4552	0.6912	0.176
	2	519.822	0.0443	0.0478	0.9834	0.5463	0.293
	3	550.275	0.0563	0.0607	0.9899	0.4752	0.360
	4	159.004	0.0644	0.0698	0.9712	0.4356	0.360
	5	98.848	0.0746	0.0807	0.9981	0.4122	0.360
	6+	51.584	0.0874	0.0910	0.9936	0.3978	0.360

Table 6.4.3. Management option table.

Basis	Total catch (2018)	F_{total} (2018)	SSB (2019)	% SSB change **	% Catch change ***
ICES advice basis					
MSY approach: F_{MSY}	30 579	0.2670	127 504	-13.9	1.3
Other options					
F = 0	0	0	153 635	3.7	-100.0
$F = F_{pa}$	32 632	0.287	125 772	-15.1	8.1
$F = F_{lim}$	49 260	0.461	111 857	-24.5	63.2
SSB (2019) = B_{lim}	102 629	1.2382	69 100	-53.3	240.0
SSB (2019) = B_{pa}	68 571	0.6956	96 000	-35.2	127.2
$F = F_{sq}$	38 212	0.3429	121 078	-18.2	26.6

**** SSB 2019 relative to SSB 2018.**

***** Catch in 2018 relative to Catch in2016 (30 181 t).**

Based on the GM recruitment and *status quo* F in 2017, for all catch options except for the SSB target of B_{lim} in 2019, the SSB will remain well above $B_{trigger}$. In all cases except no fishing, SSB in 2019 is expected to decrease in comparison to the one of 2018. For all scenario except F_{MSY}, F is expected to be higher than F_{MSY} and between F_{pa} and F_{lim} except for when the target SSB is B_{lim}.

6.5 Medium-term projection

No medium-term projections were carried out.

6.6 MSY and Biological reference points

New values of biological and MSY reference point have been estimated using the agreed ICES guidelines (ICES, 2016, WKMSYref4) during WGHANSA 2017 as part of the WKPELA benchmark. The advice and forecasts are based on the following reference points:

Framework	Reference point	Value	Technical basis	Source
MSY approach	Relative MSY $B_{trigger}$	96 000 t	B_{pa}	ICES (2017a)
	Relative F_{MSY}	0.267	$F_{MSY} = F_{p.05}$	ICES (2017a)
Precautionary approach	Relative B_{lim}	69 100 t	$B_{lim} = B_{pa}/1.4$	ICES (2017a)
	Relative B_{pa}	96 000 t	B_{loss}, lowest observed SSB (2012)	ICES (2017a)
	Relative F_{lim}	0.461	F that results in 50% probability that SSB is above B_{lim} in the long term, using segmented regression with B_{lim}(EqSim).	ICES (2017a)
	Relative F_{pa}	0.287	$F_{pa} = F_{lim}$ x exp(-1.645 x sigma, where sigma=0.29)	ICES (2017a)
Management plan	SSB_{MGT}	Not applicable.		
	F_{MGT}	Not applicable.		

The parameter estimations is detailed below.

First, limit and precautionary reference points for spawning–stock biomass (SSB) and fishing mortality (F), namely B_{lim}, B_{pa}, F_{lim} and F_{pa}, were defined. Then, F_{MSY} and MSY $B_{trigger}$ were estimated using Eqsim (stochastic equilibrium reference point software) which provides MSY reference points based on the equilibrium distribution of stochastic projections.

In the stock–recruitment relationship, the SSB ranges from 96 to 184 thousand tonnes and recruitment seems to decrease as SSB increases (Figure 6.6.1). The stock could be considered either of type 4 (stocks with a wide dynamic range of SSB, and evidence that recruitment increases as SSB decreases) or type 6 (stocks with a narrow dynamic range of SSB and showing no evidence of past or present impaired recruitment). In any of the two cases, B_{loss} (the lowest observed biomass in the time-series) is a candidate for B_{pa}. This corresponded to 96 000 tonnes in year 2012.

Then, a proxy for B_{lim} was calculated from the inverse relationship between B_{lim} and B_{pa} as follows:

B_{lim}= B_{pa} x exp(-1.645 σ),

where σ is the standard deviation of ln(SSB) in the final assessment year. Following the ICES guidelines σ was taken as 0.2, which is lower than the true assessment uncertainty (around 0.26). Thus, B_{lim} was set at 69 100 tonnes.

The limit fishing mortality (F_{lim}) is the F that, in equilibrium from a long-term stochastic projection, gives 50% probability of SSB being above B_{lim}. This was computed using Eqsim for a projection based on stochastic recruitment around a segmented regression with breakpoint fixed at B_{lim} (Figure 6.6.2). Mean weights-at-age showed a decreasing trend along time (see Section XX), therefore biological parameters (mean weights-at-age, maturity and natural mortality) and exploitation pattern (selectivity) were sampled from the last five years of the stock assessment(2012–2016). No assessment/advice errors were considered (F_{cv}=F_{phi}=0) and no advice rule was included ($B_{trigger}$=0).The resulting limit fishing mortality F_{lim} was 0.461.

The precautionary approach fishing mortality F_{pa} is the value of the estimated F that ensures that the true F has less than 5% probability of being above F_{lim}, i.e. the 5th percentile on distribution of the estimated F if true F is at F_{lim}. Thus, F_{pa} was derived from F_{lim} as:

F_{pa}= F_{lim} x exp(-1.645 σ),

where σ is the standard deviation of ln(F) in the final assessment year. The standard deviation of the logarithm of F in 2016 was 0.29, leading to F_{pa} at 0.287.

For the stochastic projections in Eqsim to compute F_{MSY} and MSY $B_{trigger}$, recruitments are sampled from the predictive distribution of fitted parametric stock–recruitment models. Initially, Beverton–Holt, Ricker and segmented regression stock–recruitment models were considered and the fitted models were averaged using smooth AIC weights (Buckland *et al.*, 1997). However, the fit of the Beverton–Holt was unrealistic (a flat line) and no biological support was found for the Ricker model (all observed points in the impaired recruitment region). Alternatively, the breakpoint of the segmented regression model was slightly lower than the lowest observed SSB (which in this case was used to define B_{pa}).Therefore, it was decided to use a segmented regression model with the breakpoint fixed at B_{lim} (Figure 6.6.3).

Biological parameters (weights-at-age, natural mortality and maturity) and the exploitation pattern (selectivity) were resampled at random from the last five years of the assessment (2012–2016). Assessment/advice errors could not be estimated for this stock since the model was not used in the latest years to provide advice. Therefore, assessment/advice errors were set according to the default option in WKMSYREF4 (ICES, 2016). The conditional standard deviation in the log domain was FCV=0.212 and the parameter of autocorrelation in the AR(1) process for fishing mortality was Phi=0.423. The biomass trigger point ($B_{trigger}$) was fixed at 0, indicating that the ICES MSY advice rule (fishing mortality is linearly reduced if the biomass in the TAC year is predicted to be lower than MSY $B_{trigger}$) was not applied. All the settings for the base case run in Eqsim are given in Table 6.6.1.

F_{MSY} was computed as the F maximizing the median landings yield curve and was equal to 0.399. Since this value was larger than F_{pa}, F_{MSY} was reduced to F_{pa} (0.287) for consistency with the precautionary approach (Figure 6.6.4).

MSY $B_{trigger}$ in the ICES MSY advice rule is defined as the 5th percentile of the distribution of SSB when fishing at F_{MSY} and could be calculated via stochastic simulation in Eqsim. From 2002 to 2011 fishing mortalities were below 0.2, increased around 0.3 and 0.4 in 2012–2014, decreased again below 0.3 in 2015 and increased to 0.36 in 2016. In the absence of fishing at F_{MSY}, MSY $B_{trigger}$ was set at B_{pa} (96 000 tonnes).

The effect of including the ICES MSY advice rule was evaluated by running Eqsim with $B_{trigger}$ equal to MSY $B_{trigger}$ at 94 000 tonnes. $F_{p.05}$, the F that leads to SSB >B_{lim} with probability 0.95, increased from 0.216 to 0.267 when including the ICES MSY advice rule. However, this value was still below F_{MSY}, indicating that the F_{MSY} and MSY $B_{trigger}$ combination do not fulfill the precautionary criterion (Figure 6.2.6.5). Therefore, F_{MSY} was further reduced to $F_{p.05}$ at 0.267.

To test the sensitivity of the proposed reference points, the calculations were repeated by considering either the last ten or 14 years (i.e. whole time-series) for resampling the biological parameters. The larger number of years led to higher fishing mortality reference points while the biomass reference points remained unchanged (Table 6.6.2).

So far, no specific harvest control rules have been evaluated for this stock.

Table 6.6.1. Settings for the base-case run in Eqsim for sardine in 8.abd.

Data and Parameters	Setting	Comments
SSB-recruitment data	Full time-series (2002–2016)	
SR models	Segmented regression with breakpoint at B_{lim}	
Mean weights, maturity and natural mortality	2012–2016	
Exploitation pattern	2012–2016	
Assessment error in the advisory error (Fcv)	0.212	Default value
Autocorrelation in assessment in the advisory year (Phi)	0.423	Default value

Table 6.6.2. Sensitivity of reference points to number of years considered for the biological parameters.

Nb years	$B_{trigger}$	B_{pa}	B_{lim}	F_{pa}	F_{lim}	F_{p05}	F_{MSY}_unconstr	F_{MSY}
5	96	96	69.1	0.287	0.461	0.267	0.399	0.267
10	96	96	69.1	0.393	0.631	0.299	0.508	0.299
14	96	96	69.1	0.507	0.813	0.323	0.602	0.323

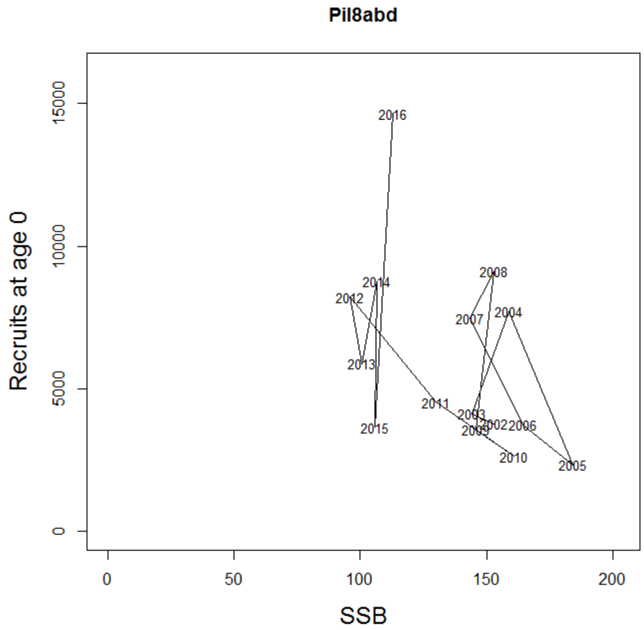

Figure 6.6.1. Stock–recruitment relationship for sardine in 8.abd.

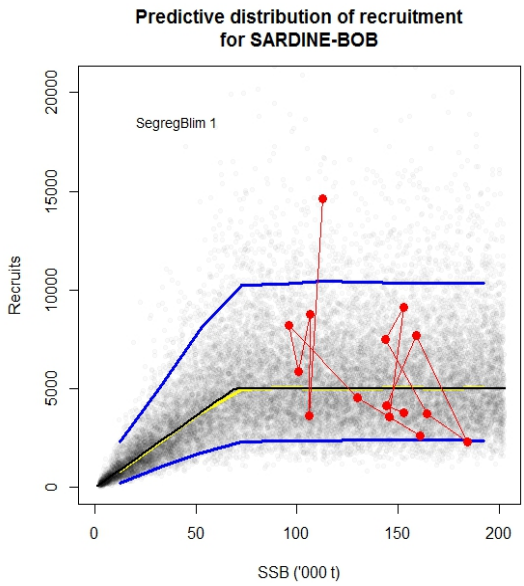

Figure 6.6.2. Segmented regression model with the breakpoint fixed at B_{lim} for sardine in 8.abd.

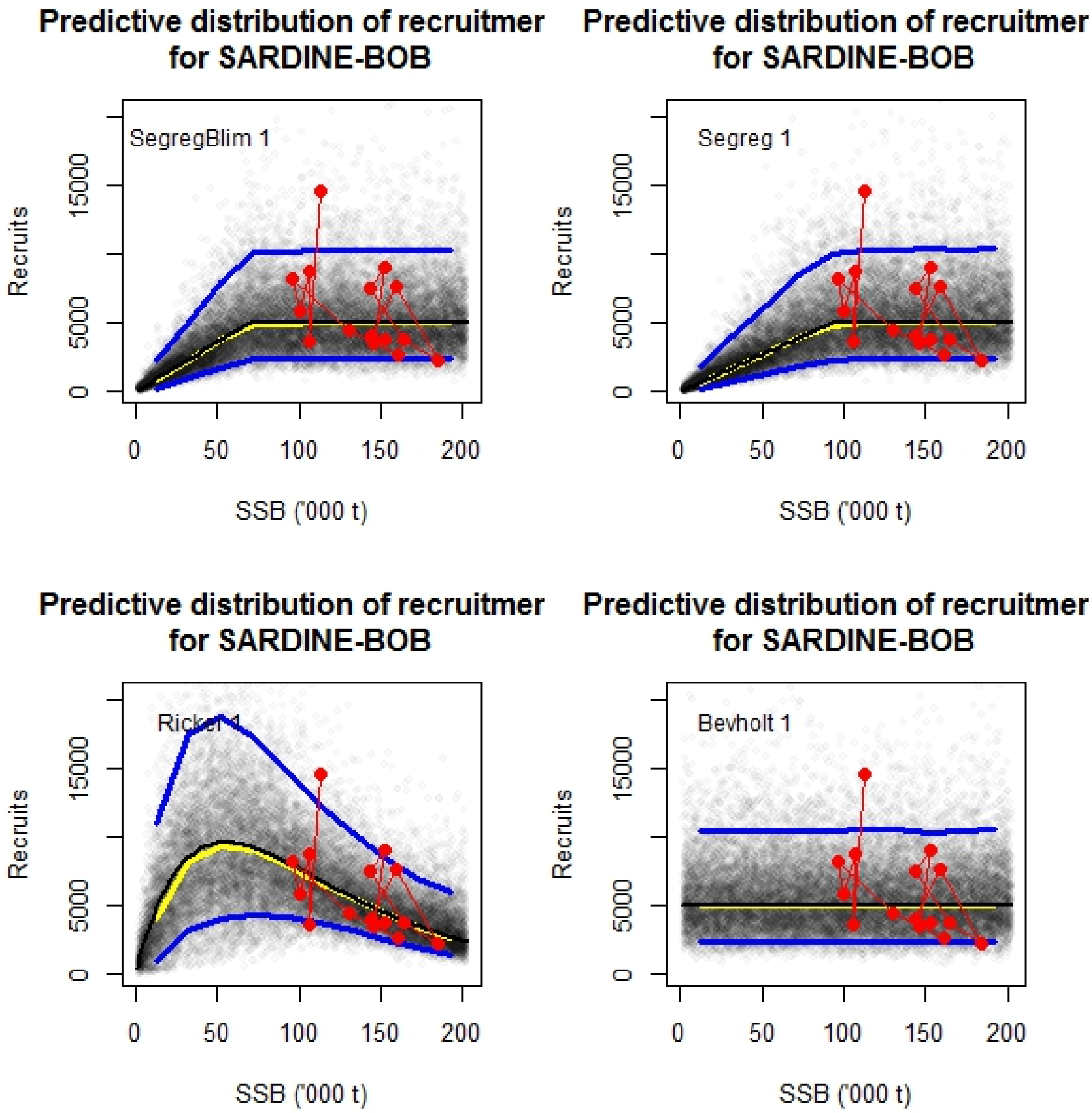

Figure 6.6.3. From top to bottom and from left to right segmented regression model with the breakpoint fixed at B_{lim}, segmented regression, Ricker and Beverton–Holt models for sardine in 8.abd.

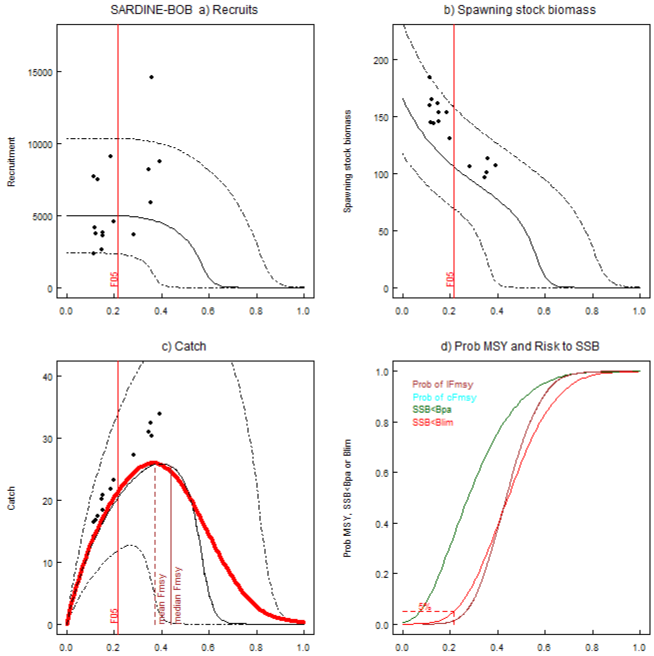

Figure 6. 6.4. Eqsim summary plots without ICES MSY AR for sardine in 8.abd.

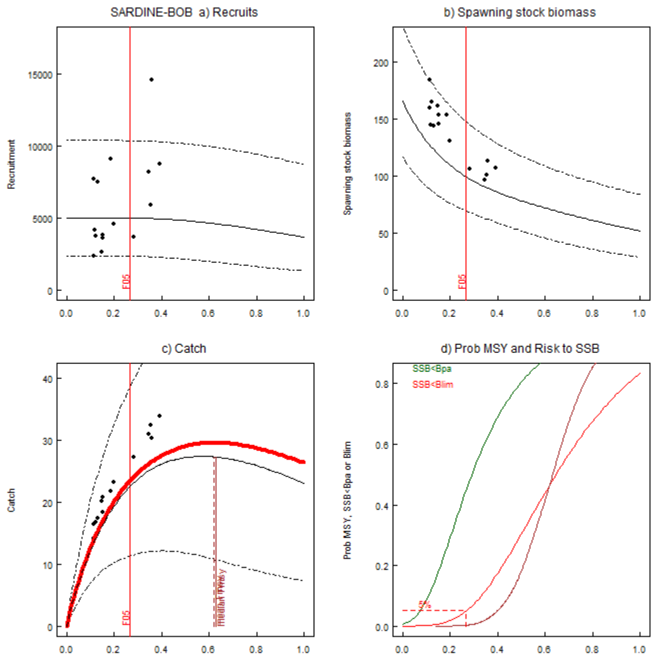

Figure 6.6.5. Eqsim summary plots with ICES MSY AR for sardine in 8.abd.

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 yet been formalised.

6.8 Uncertainties and bias in assessment and forecast

Most of the uncertainties in the forecast comes from the assumption in the intermediate year although the fishery is not expected to increase over the next years.

6.9 Management considerations

No TAC is currently set for this stock.

6.10 References

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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.

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7 Sardine in Subarea 7

7.1 Population structure and stock identity

Information is almost inexistent regarding biological sampling of sardine in the English Channel and inexistent in the Celtic Sea. From the little information available, it appears that the sardines caught in the Channel tend to be bigger than in 8.a,b,d.

From the modelling point of view, the lack of commercial sampling, dedicated survey and biological information in area 7, in contrast to the richness of the datasets available in 8.a,b,d does not allow the use of a single assessment method for the whole area.

This stock was benchmarked at WKPELA in 2017 by ICES and The workshop concluded that in the absence of evidences 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. Even in the case some connectivity would occur, dealing separately with them in a sustainable manner would be probably more robust for both stocks.

7.2 Input data

7.2.1 Catch data

French sardine landings have been corrected for notorious misallocations between 7.e,h and 8.a. A substantial part of the French catches originates from divisions 7.h and 7.e, but these catches have been assigned to Division 8.a due to their very concentrated location at the boundary between 8.a, 7.h and 7.e and the fishery operating from one side or the other of the limit between 7 and 8. French sardine landings declared in 25E5 and 25E4 have hence been reallocated to 8.a.

Official landings per country for the whole area are available in Table 7.2.1.1.

Landings seems to be very variable (Figure 7.2.1) between years, from around 2000 tons in 1984 till more than 25 000 tons in 2001. Different trends are shown: globally, catches are increasing from the 1970s to the 2000s. Then, a clear decreasing trend to 2011 happened. It must be noticed that a part of the Eastern Channel, the Seine bay, sardine catches are totally forbidden for human consumption since 2010, due to PCB contamination.

In recent years, and particularly 2016, the amount of catches is much more important for most countries compared to last years: Netherlands (4700 tons), United Kingdom (9400 tons), but also Denmark and Germany with around 2000 tons each. The last country, France, caught less than 1000 tons during the year. All these landings implicate a steep increase from 2015 to 2016 (~9000 and 19 000 tons respectively).

No additional information was available such numbers by length class due to lack of monitoring of the fisheries operating in that subarea.

7.2.2 The PELTIC survey in Divisions 7

In the Celtic Sea/English Channel, the PELTIC survey has four years of data at the time of the writing of this document, but is expected at medium terms to provide a time-series of abundance of sardine for Subarea 7.

The PELTIC survey is carried out annually over around 18 days in October on board the RV 'Cefas Endeavour'. The first of these surveys was conducted in 2012. The survey follows a systematic parallel transect design with 10 nautical miles spaced transects running perpendicular to the coastline or bathymetry (Figure 7.2.2.1). Three main areas are identified in the survey, the western English Channel, the Isles of Scilly and the Bristol Channel.

Acoustic data are collected using a Simrad EK60 scientific echosounder, at a ping rate of 0.6 s-1 and pulse duration of 0.512 μs. Split-beam transducers are mounted on the vessel's drop keel and lowered to the working depth of 3.2 m below the vessel's hull or 8.2 m subsurface. Three operating frequencies are used during the survey (38, 120 and 200 kHz) for trace recognition purposes, with 38 kHz data used to generate the abundance estimate for clupeids (and other fish with swimbladder) and 200 kHz for mackerel. All frequencies are calibrated at the start of the survey. Regular trawls are conducted to collect biological data and ground-truth acoustic marks for species and size information.

To estimate the abundance, the allocated NASC values are averaged by stratum within the survey area. For each stratum, the unit area density of fish (SA) in number per square nautical mile (N*nmi-2) is calculated using standard equations (Foote *et al.*, 1987; Toresen *et al.*, 1998). Pending further analysis to identify ecologically relevant strata, survey stratification is based on ICES statistical rectangles with a range of 0.5 degrees in latitude and 1 degree in longitude, large squares 2° lat by 1° long or other geographical bounds. Energy attributed to sardine for each Peltic surveys is shown in Figure 7.2.2.2.

This survey give some information and abundance index, but the series is still short (four years) and the spatial coverage is about one fourth of the total potential sardine habitat in Subarea 7. The abundance index estimates is about 120 000 tons on average, split between the English waters of the Western Channel and the Bristol Channel (Figure 7.2.2.3).

7.2.3 Biological data

Length distributions are scarcely available since 1994 not on an annual basis. Length distribution of discards are also available from Netherlands in the English Channel for 2011.

Biological sampling on commercial catch has been close to inexistent so far. Length distribution data are scarcely available in 1994, 1996 and then every year since 2000 from the Dutch pelagic freezer trawler operating in the English Channel. Those vessels, while capturing substantial amounts of sardine are structurally different from the fishing vessels of the other main countries (United Kingdom, France) and therefore those length structures may not reflect the actual length distribution of the population. Other countries do not provide length or age information due to the lack of national biological sampling scheme and no DCF requirement regarding that species in 7.

7.2.4 Exploratory assessments

As only catch and few efforts information are available for Subarea 7, it is impossible to use any assessment model for the time being. This stock is considered as a category 5 stock (catch only).

Overall landings in Subarea 7 have decreased since 2004, especially since 2010 (Figure 6.2.4.2.1). This is mainly due to a decrease in French landings only partly compensated by an increase in landings from the UK. It is worth noting that since 2004 this subarea almost evolve in opposite to the neighbouring landings in the Bay of Biscay. The opportunistic nature of the fisheries and the mixing between 7 and 8 makes the interpretation of this decrease difficult.

It must be noticed that the catches strongly increased in 2016.

7.2.5 Short-term predictions

Due to the lack of assessment, no predictions have been carried out.

7.2.6 Reference points and harvest control rules for management purposes

No reference points, TACs and no harvest control rules are currently implemented for this stock.

7.2.7 Management considerations

There are no management objectives for these fisheries and there is no international TAC.

Catches are mainly taken by France, the Netherlands and the United Kingdom in area 7. The absence of a sampling programme makes any attempt to analytically assess this stock useless. If a sampling programme were started, several years of data collection would be necessary before the time-series of data is long enough. It is therefore recommended that a proper sampling programme should be implemented to monitor the sardine fishery in Subarea 7.

Table 7.2.1.1. Official landings reported to ICES (1989–2016) in ICES Division 7 (tonnes).

	France	United Kingdom	Netherlands	Ireland	Germany	Denmark	Lithuania	Belgium	Spain
1970	1014	890	38	0	2112	0	0	0	0
1971	1350	1242	108	0	3362	0	0	0	0
1972	1297	2190	54	0	1553	0	0	0	0
1973	1603	2375	17	0	2577	0	0	0	0
1974	833	1280	15	0	1826	0	0	0	0
1975	678	6	561	0	4043	0	0	0	0
1976	1284	3	127	0	2346	0	0	0	0
1977	3544	10778	623	0	183	0	0	0	0
1978	2773	549	1523	0	1463	0	0	0	0
1979	3247	46	1321	0	1188	0	0	0	0
1980	3573	753	1131	0	79	0	0	0	0
1981	1125	35	553	0	0	4471	0	0	0
1982	908	141	928	0	0	1311	0	0	0
1983	802	6	795	0	19	4743	0	0	0
1984	817	1	0	0	0	1210	0	0	0
1985	2089	20	0	0	0	3111	0	0	0
1986	2570	30	0	0	0	3602	0	0	0
1987	965	124	0	0	0	1573	0	0	0
1988	2586	0	0	0	0	3234	0	0	0
1989	1219	1660	11	0	0	4667	0	0	0
1990	1128	2078	6	0	107	6113	0	0	0
1991	1963	2952	0	0	8	4462	0	0	0
1992	1777	4493	41	0	4	17843	0	0	0
1993	1135	4917	109	0	0	13395	0	0	0
1994	1285	2081	20	0	2	20804	0	0	0
1995	1282	7133	107	0	66	9603	0	0	0
1996	1563	7304	48	0	0	1396	0	0	0
1997	3346	7280	411	0	13	1124	0	0	0
1998	1974	6873	1647	192	100	14316	0	0	0
1999	119	4815	5166	2375	146	3490	0	0	8
2000	4073.5	4353	6586	354	436	1682	0	0	0
2001	8589	10375	6609	1060	454	0	0	0	0
2002	5323.6	7858	1905	2652	224	0	0	0	10
2003	6593.8	4358	6897	2580	25	0	0	0	0
2004	6680.7	2681	2187	6195	109	742	0	0	0
2005	11113.1	3631	2231	2083	274	0	0	0	5
2006	12964.9	1925	2287	698	481	0	17	0	2
2007	8864.6	2654	1106	14	0	4	0	0	0
2008	8664.6	3470	2073	875	42	54	0	0	0
2009	4135.2	2541	3406	33	0	0	0	0	0
2010	850	2521	6645	25	106	13	0	0	0
2011	507.5	3604	513	983	22	3	0	0	0

	France	United Kingdom	Netherlands	Ireland	Germany	Denmark	Lithuania	Belgium	Spain
2012	444	4423	1439	8	0	0	0	0	0
2013	1768	3722	1804	236	214	40	0	0	0
2014	1202	3889	249	0	18	953	0	0	0
2015	1040	4293	1137	380	1551	1011	1	0	0
2016	863	9389	4697	232	1941	2286	0	1	0

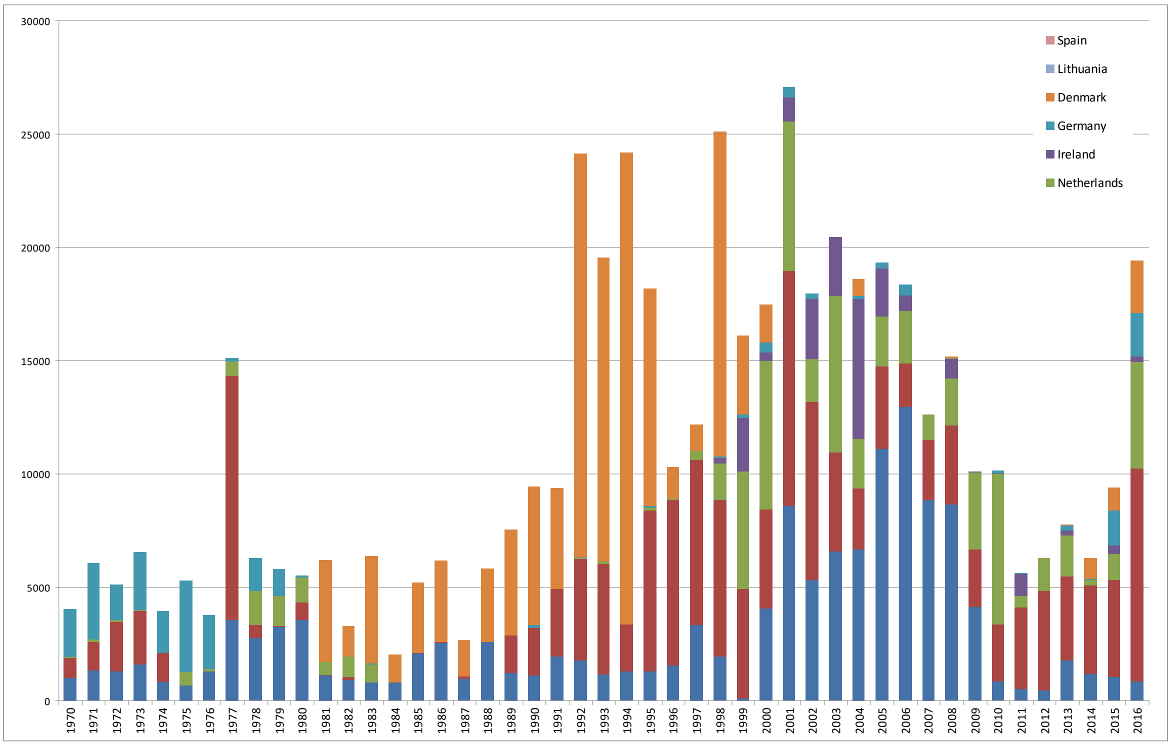

Figure 7.2.1.1. Official landings reported (1970–2016) in Subarea 7 (tonnes).

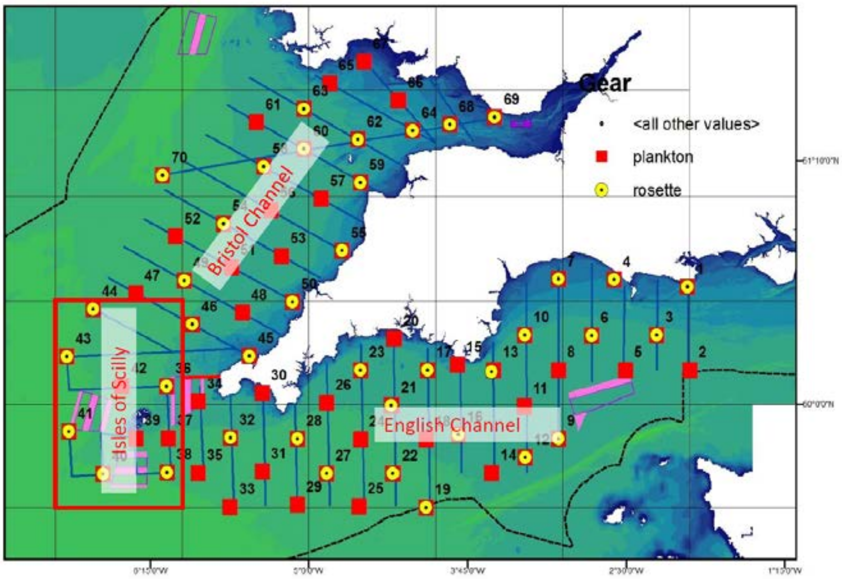

Figure 7.2.2.1. Overview of the survey area (PELTIC), with the acoustic transect (blue lines), plankton stations (red squares) and hydrographic stations (Yellow circles). Emboldened red lines delineate the three "ecoregions."

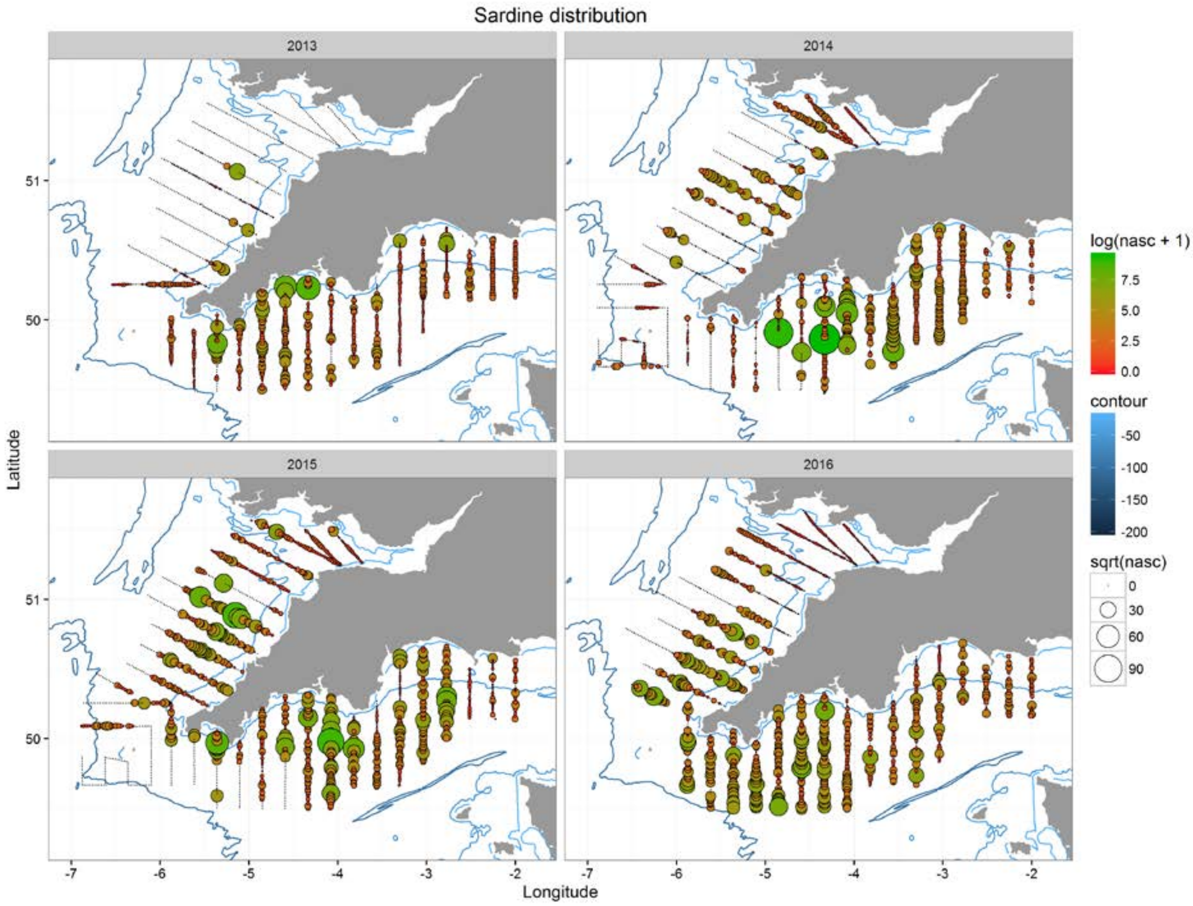

Figure 7.2.2.2. Sardine NASC along PELTIC series.

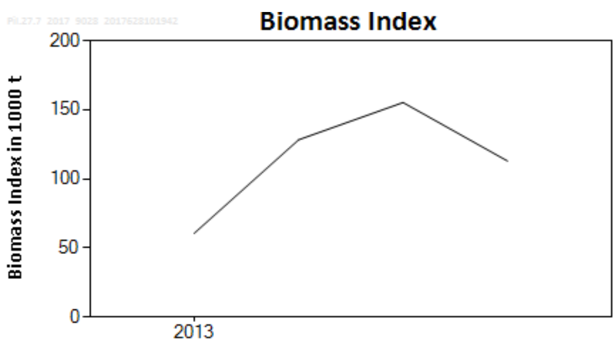

Figure 7.2.2.3. Sardine biomass index during PELTIC surveys.

8 Sardine in 8.c and 9.a

8.1 ACOM Advice Applicable to 2017, STECF advice and Political decisions

ICES advises on the basis of the Management Plan that catches in 2017 should be no more than 23 000 tonnes.

8.2 The fishery in 2016

8.2.1 Fishing Fleets in 2016

Details about the vessels operated by both Spain and Portugal targeting sardine are given in Table 8.2.1.1.

Sardine is taken in purse seine throughout the stock area and the fleet has remained constant in recent years.

In Spain (Gulf of Cadiz and northern waters), data from 2016 indicate that the number of purse seiners taking sardine were 323, with mean power of 209 Kw. In Portuguese waters, fleet data indicate that, in 2016, 181 vessels were licensed for purse seining, with mean vessel length of 39 GT tonnage and 2016 Fishing Fleets engine power category of 202 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 2016 have suffered an increment in comparison with those of 2015 (Tables 8.2.2.1 and 8.2.2.2, Figure 8.2.2.1). Total 2016 landings in divisions 8.c and 9.a were 22 702 t, i.e. an increase by 10% with respect to the 2015 values (20 595 tonnes). The bulk of the landings (99%) were made by purse seiners.

In Spain, landings of sardine, 9006 tonnes, have shown a 32% increase in relation to values from 2015 (6818 tonnes). All ICES subdivisions, and specially Subdivision 8.c east (with an increase by 79%), showed a substantial increase in catches (by 48% in 9.aN, 13% in 8.c and 9% in 9.aS (Cadiz)).

In Portugal, landings in 2016 (13 697 tonnes) remain stable with reference to 2015 (13 777 tonnes). By subdivisions, both 9.acN and 9.aS (Algarve) showed an increase by 8%, while 9.acS showed a decrease by 16% in catches.

Table 8.2.2.1 summarises the quarterly landings and their relative distribution by ICES subdivision. Sixty-eight percent of the catches were landed in the second semester and 34% of the landings took place off the northern Portuguese coast (9.aCN), representing a relative contribution similar to that of recent years (i.e. last year the contribution of 9.aCN was 35% of the total catches).

Northern areas (9.aN and 8.c) input to total catches has increased in the last year and represents in 2016 a fourth of catches. Figure 8.2.2.2 shows the historical relative contribution of the different subareas to the total catches.

Data from Portugal and Spanish regular DCF monitoring in 2016, show that discards are negligible and do not constitute a major issue for this fishery.

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 8.2.4.1a,b,c,d show the quarterly length distributions of landings from each subdivision. Annual length distributions (Table 8.2.4.1.) were unimodal in Spain in all subdivisions. Smaller individuals were caught in 9.aS-Cádiz subdivision, with a mode at 12.5 cm. In Cantabrian Sea and Galicia, modes were at 18 cm in 8.cEast, at 19 in 8.cWest and at 18.5 cm in 9.aNorth subdivision.

For Portugal, sardine showed bimodal length distributions. Mode in 9.aS-Algarve was at 16 cm and a small mode at 13 cm; at 21 and 17 cm in 9.aCS and at 18.5 and 14 cm in 9.aCN subdivisions.

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, the relative contribution of each age group in each subdivision is shown as well as their relative contribution to the catches. Age-1 had the higher contribution, with a 41% to the total biomass in catches, followed by age 0, with the 31% of the catches. By areas, age 0 was mainly caught in 9S-Cadiz (81%) and age 1 in 9.aCN with the 51% of age 1 in that subdivision. Age 2 and older were landed in all subdivisions without a clear pattern.

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 and 8.3.2 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 (IPIMAR) and Spain (IEO). The DEPM survey is planned and discussed within WGACEG (e.g. WGACEGG, 2016), where final results were presented and fully discussed.

As described in the Stock Annex, the total spawning biomass from the two surveys is used in the assessment.

8.3.1.1 Spanish DEPM survey

In 2017, the Spanish survey, SAREVA0317, was carried out from 23rd March to 15th April on board Vizconde de Eza, with a total of 21 operative days of work, covering 9.aNorth and 8.c subdivisions (Riveiro *et al*., 2017) (Figure 8.3.1.1.1). During this survey, 537 CTD cast were carried out for the hydrographical characterization of the area and egg mortality estimation. For plankton and fish eggs sampling, 421 samples from CUFES and 473 CALVET were analysed.

For adult parameter estimation, sardine samples were collected onboard RV Miguel Oliver during PELACUS0317 acoustic survey (15th March–16th April) (Figure 8.3.1.1.2) (Pérez *et al*., 2017).

110 of the 473 plankton stations performed were positive for sardine, representing the 23%. The total number of eggs was 669, with an average density of 30 eggs/m^2. Highest egg densities from CUFES sampler and PAIROVET net (Figure 8.3.1.1.3) were observed in South Galicia (Rias Baixas) and in the French area sampled (until 45ºN,

outside the area of this stock). In the Cantabrian Sea, sardine eggs were scarce and showed a more coastal distribution.

In 2014, previous sardine DEPM survey, 28% of CALVET stations were positive for sardine and egg density was higher in average (59 eggs/m^2). Egg distribution was not continuous in the sampled area, with some gaps in Galicia and in the Cantabrian Sea.

For the P0 preliminary estimation, positive area in 8.c and 9.aN subdivisions were estimated to be 7642 km^2. Egg mortality computation was done considering two separate strata (8.c–9.a and 8.b) and one single mortality. Figure 8.3.1.1.4 shows the P0 time-series for north stratum. Preliminary value of 2017 is not very different from those observed in the last DEPM survey carried out in 2014.

The four adults parameters needed to estimate Spawning–Stock Biomass in the 2017 Sardine DEPM survey are summarised in Table 8.3.1.1. All laboratory tasks for histological processing and microscopical analysis are still in progress. For the moment, the expected individual batch fecundity (Fexp) for all mature females (hydrated and non-hydrated) was estimated by modelling 52 selected individual batch fecundity observed (Fobs) in the sampled hydrated females. Preliminary spawning fraction estimated as the quotient between the total number of random hydrated females in the haul and the total random mature females, without histological correction. The decrease on mean females weight and batch fecundity estimates in 9.a N and 8.c area in 2014 sardine DEPM survey is also maintained in 2017.

8.3.1.2 Portuguese DEPM survey

The 2017 IPMA, DEPM survey (PT-DEPM17-PIL), took place during approximately 30 effective working days, during the period from 11 March to 26 May and much later than scheduled due to logistics constraints and adverse weather conditions. In fact, the survey covered the southern stratum (Algarve-Cadiz Bay) during mid-March (11–19 March) but the western shores were only surveyed in April–May (24 April–26 May) and, once again, as it had happened in 2014, concurrently to the acoustics surveys, which was also delayed, and covered the period 24 April–2 June.

Given that the survey was much delayed, the laboratorial work for egg processing is still underway and, at the present, the only egg results available are those corresponding to the southern coast. In addition, as the CUFES samples are also sorted back in the laboratory, the egg data collected by this sampler, both from the DEPM and the acoustics surveys, are not yet available. All egg results will be submitted to WGACEGG during the coming November meeting.

The DEPM survey was conducted in the south under mild weather conditions (~14–18ºC), in mid-March, when the onset of spring was already noticeable (Figure 8.3.1.2.1). An area of approximately 20 429 km^2, of which around 43% were considered the spawning ground, was covered (8695 km^2) and a total of 162 CalVET samples were collected along 22 transects. Sardine eggs (2900 in total) were observed in about half of the samples gathered (79) and anchovy eggs (1642 in total) were counted for a slightly smaller number of stations (66). The sardine and anchovy eggs distributions were, quite similar, and spread from Cape S. Vicente to just off Cadiz, with maximums for sardine on both ends of the region sampled and anchovy in higher numbers towards the east in the area under the influence of the Guadalquivir-Tinto/Odiel rivers (Figure 8.3.1.2.2). The sardine egg observations in 2017, number of eggs collected and spawning ground range, were slightly higher than during the last DEPM survey, in 2014. The egg production estimate (Eggs/day: 1.5 x 10^{12}) obtained for 2017 using the traditional DEPM methodology was also higher than the calculation for 2014 and within the range of the values for other years of the series (Figure 8.3.1.2.3).

8.3.2 Iberian acoustic survey (PELACUS04+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 9.a and 8.c. The Iberian acoustic survey is planned and discussed within WGACEGG (e.g. WGACEGG, 2016). As described in the Stock Annex, the total 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 9.a and 8.c using acoustic methods. The Portuguese survey (PELAGOS17) took place on board the RV "Noruega" while the Spanish survey (PELACUS0317) took place in March–April on board the RV "Miguel Oliver".

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 2017 survey was carried out on board RV Noruega from 24th April to 7th June. Figure 8.3.2.1.1 shows the acoustic transect along the surveyed area.

The survey was delayed about one month due to logistic problems related to the installation of transducers and upgrade of the echosounder. The survey ended up only 15 days before WGHANSA. Despite all efforts to speed up the data logging and the processing of acoustic data, preliminary estimations of sardine biomass were only achieved during the WG meeting and only for three of the four surveyed areas, because difficulties were encountered in the biomass estimation in the Occidental North area (OCN).

The OCN area includes the main recruitment area for sardine on the west Portuguese coast and is considered an important area for the distribution of this species and in recent years also for anchovy. Due to bad weather and technical problems in vessel engine and during the fishing operations, few valid fishing hauls were achieved in a significant part of the OCN area (Figure 8.3.2.1.2). This posed extra difficulties to the assignment of the acoustic energy to species and in particular to sardine in this important area. Moreover, due to bad weather fish schools were dispersed and therefore not with their typical shape. Additionally, due to time limitations, a complete verification of the database could not be done in time.

IPMA considered that, before solving the above technical issues and review of the database, it is impossible to deliver reliable estimations of the total sardine biomass and length distribution for the PELAGO17 to the present WGHANSA meeting. Moreover, it was decided that further discussions are needed within the WGACEGG before deliver this survey estimations to be used in the assessment given its contribution to the stock estimates.

Final results are expected to be available at the WGACEGG in November after reanalysis of the echograms for the OCN area, use of additional information, namely fishery samples, fishing fleet activity during the period of the survey and the distribution of eggs collected along the survey.

8.3.2.2 Spanish spring acoustic survey

The Spanish survey PELACUS 0317 survey was carried out from 13th March to 16th April in the RV Miguel Oliver. Sampling design and methodology was similar to that of the previous surveys. Figure 8.3.2.2.1 shows the acoustic tracks carried out along the sampling area.

In the area surveyed, a total of 69 fishing stations were performed, a higher sampling coverage than last year (Figure 8.3.2.2.2.). On the other hand, 494 CUFES stations, comprising 3 nautical miles each were taken. This number is considerably higher than last year because in 2016 alternate transects were sampled. In addition, PELACUS0317 area sampled was higher than previous years, because the need of covering the area of SAREVA0317 (that includes also part of 8.b subdivision up to 45ºN) for adult sardine samples.

Sardine distribution was very scarce in density, although area occupied by this species was higher during PELACUS0317 than in previous surveys. Higher densities were observed in 9.aNorth subdivision (Rías Baixas) and particularly in French waters (8.b subdivision).

As it has been already observed in previous years, no clear echotrace of sardine schools have been detected, with sardine occurring in very small echotraces, thus the energy attributed to this species was in general very low (Figure 8.3.2.2.3.). In such circumstances, with sardine observed in a mixed layer with other fish species (mainly mackerel, horse mackerel or bogue) no direct allocation from scrutinisation is feasible, being the backscattering energy attributed to sardine derived from the results obtained at the groundtruth fishing stations (length distribution and catch in number).

Sardine ranged in length from 14 to 24.5 cm, with a mode at 16 cm (Figure 8.3.2.2.4). Most fish in the entire surveyed area were assigned as belonging to the age 1 (52% of the abundance and 40% of the biomass), and age 2 (34% of the abundance and 40% of the biomass).

This year, unlike previous years, age 3 had a low contribution to the total abundance (10%) and biomass (13%) (Table 8.3.2.2, Figure 8.3.2.2.5).

By subdivisions, the signal of 2016 recruitment (age 1) was detected in the Cantabrian area (8.cE subdivision), but not in Galicia (9.aN and 8.cW). Age group 1 was dominant in 8.b, 8.cE–W and 8.cE–E, while age 2 was the most abundant in 9.aN and 8.cW. 8.cE–W subdivision represented 38%, 9.aNorth 37%, 8.cE–E 22% and 8.cW only the 3% of the total abundance (Figure 8.3.2.2.5).

The distribution of sardine eggs (obtained from the analysis of 494 CUFES stations) indicates a coastal distribution, agreeing with that observed in previous years (Figure 8.3.2.2.6).

8.3.3 Other regional indices

Despite it not being included as an input of the sardine assessment, ECOCADIZ survey (fully described in the Section 4), provides sardine abundance and biomass estimates in the Gulf of Cadiz and Algarve (9.aS subdivision) in summer, which can be compared with the results obtained by the spring Portuguese acoustic survey in the same area. For both surveys, trends in abundance (and biomass) are broadly similar, although they have interannual differences (Figure 8.3.3.1).

In the past (from 1997) some juvenile sardine surveys were carried out in the north-western Portuguese coast in autumn. In the recent period (2013–2015) three acoustic surveys (JUVESAR) were carried out from Lisbon to the Portuguese-Spanish border, a major recruitment area of the stock, to assess the abundance of recruits in that particular area. Figure 8.3.3.4 shows the estimation of age 0 in the autumn surveys and age 1 in the next spring survey, with similar trends.

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 8.4.1a.

According to the stock annex (WKPELA 2017), mean weights-at-age in the stock comes from DEPM surveys (ICES, 2017a) (Table 8.4.1b).

- For years with no DEPM survey, a linear interpolation of the data from two consecutive surveys was carried out to obtain the estimates of mean weight-at-age.
- For the period 1978–1998 (before 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 (WKPELA 2017), maturity ogive from the stock comes from DEPM surveys (ICES, 2017).

- For years with no DEPM survey a linear interpolation of the data between two consecutive surveys was carried out to obtain the estimates of maturity-at-age.
- For the period 1978–1998 (years before starting 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, as is the case of 2016, the estimates of the last DEPM survey are assumed.

8.3.6 Natural mortality

Following the Stock Annex (WKPELA 2017), 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 Figures 84.4.1 and 8.4.4.2.

8.4 Assessment Data of the state of the stock

8.4.1 Stock assessment

The assessment deviates from the Stock Annex (WKPELA 2017) because it does not include the acoustic surveys ' data for 2017 (Section 8.3.2.1). This assessment is considered to be provisional since the 2017 spring acoustic survey was not used in the model due to technical issues related to the assignment of the acoustic energy to species, in particular to the sardine (Section 8.3.2). The group considered necessary to check the estimates which should be carried out by the experts during WGACEGG meeting in November 2017.

The table below presents an overview of the model settings. Additional details can be found in the Stock Annex.

Input data	WGHANSA 2017
Catch	Catch biomass 1978–2016 (tons)
	Catch-at-age 1978–2016 (thousands of individuals)
Acoustic survey (Joint SP+PT)	Total numbers 1996–2016 (thousands of individuals)
	Numbers-at-age 1996–2016 (thousands of individuals)
DEPM survey (Joint SP+PT)	SSB 1997, 1999, 2002, 2005, 2008, 2011, 2014 (tons)
Weight-at-age in the catch	Yearly averages 1978–2016 (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, 2015–2017), Kg
Maturity-at-age	From DEPM surveys in DEPM years, linear interpolation for years in-between (constant 1978–1998, 2015–2017), 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
Recruitment	Density-dependent R model; annual recruitments are parameters, defined as lognormal deviations from Beverton–Holt stock–recruitment model, penalized by a sigma of 0.70, and na input steepness of 0.71.

Input data	WGHANSA 2017
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 2006–2016. Selectivity-at-age is estimated for each period and within each period assumed to be fixed over time.
Survey selectivity-at-age	Selectivity assumed to be equal at all ages.
Fishery catchability	Scaling factor, median unbiased
Acoustic survey catchability	Parameter, mean unbiased
DEPM catchability	Parameter, mean unbiased
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 and 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 8.5.1.1 shows the parameters estimated by the assessment model. The parameter estimates and the fit of the model are similar to those of the benchmark assesment model (ICES, 2017_WKPELA2017). Fishing mortality-at-age and numbers-at-age are presented in Tables 8.5.1.2 and 8.5.1.3. The parameters estimated in the provisional 2017 assessment are also comparable to those from the 2016 assessment, apart from virgin recruitment (R0= 15 608 200, CV=3%) and the initial F (0.68 year-1, CV= 11.0%) which are 46.0% and 23.5% higher, respectively. The catchability parameters are closer to 1 for both the acoustic (Q=1.35, CV=8%) and the DEPM (Q=1.13, CV=11%) surveys. The coefficients of variation of parameters indicate that the initial F is estimated with higher precision in the present assessment than in the 2016 assessment model. The correlations between the assessment parameters range from -0.98 to 0.76 although the majority are very close to zero. Negative correlations below -0.5 are observed between R0 and Q_acoustic survey and between selectivity parameters from the first period (five cases).

The assumed CVs for both surveys, all years=0.25, are consistent with the residual mean square errors estimated by the model, 0.21 for the acoustic index and 0.31 for the DEPM index. The harmonic mean of the fishery age composition sample size, 72.9, suggests that the data are slightly more precise than assumed (mean initial sample size=66.7 for the whole period). In the case of the 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 21.4).

Figures 8.5.1.1 and 8.5.1.2 show the fit of the model to the acoustic survey and DEPM indices of abundance. Compared to the 2016 assessment model, the present model shows an overall better fit to both survey indices, especially in the case of the DEPM. On the other hand, the present model fits poorly to the highest acoustic observations in 2002 and 2005.

Figure 8.5.1.3 shows the model residuals from the fit to the catch-at-age composition (a) and the acoustic survey age composition (b). In both cases the residuals from the present assessment are lower than those from the 2016 assessment model, suggesting the current assumptions about survey and catch selectivity are more consistent with the age composition data. In particular, catch-at-age residuals show a more random distribution in recent years.

The fishery selectivity patterns estimated in the present assessment show less abrupt changes over time and through ages (particularly at the 6+ group) and therefore seem to be more realistic than the patterns estimated in the 2016 assessment model (Figure 8.5.1.4). The patterns over age are dome-shaped in the three periods with the early (1978–1987) and recent periods (2006–2016) 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 2017 provisional assessment results is shown in Table 8.5.1.4 and Figure 8.5.1.5 (in the figure compared also to the 2016 WGHANSA results). The estimate of B1+ in 2017 assumes stock weights are equal to those in 2016. The model estimates standard errors of SSB, recruitment and ApicalF (maximum F over age within years). We assume the CVs of SSB and ApicalF apply to B1+ and F(2–5).

B1+ in 2016 = 165 337 t (CV = 17%) is 70% below the historical mean 1978–2015 and 51% below the proposed Blim=337 448 t. B1+ shows an increase of 28% from 2015 to 2016. Nevertheless it is still around the historical low as observed in the past five years. F in 2016 is estimated to be 0.16 year (CV = 17%), 51% below the historical mean. F has decreased continuously since 2011 and F2016 is 72% below F2011. F was stable from 2015 to 2016.

B1+ in 2017 is predicted to be 194 283 t, assuming that the stock weights and maturity-at-age are equal to those in 2016.

The series of historical recruitments 1978–2016 shows a marked downward trend until 2006 and since then, fluctuates around historically low values (geometric mean 2011–2015 = 4 705 812 thousand individuals). The R2016 estimate, 9 996 550 thousand is provisional (CV = 30%) and more uncertain that in previous assessments because the assessment did not include the 2017 acoustic survey index.

8.4.2 Reliability of the assessment

This assessment is considered to be provisional since the 2017 spring acoustic survey was not used in the model due to technical issues related to the assignment of the acoustic energy to species, in particular to the sardine (Section 8.3.2). The group considered necessary to check the estimates which should be carried out by the experts during WGACEGG meeting in November 2017.

8.4.3 Short-term predictions (divisions 8.c and 9.a)

Short-term predictions were not carried out because this assessment is provisional.

8.5 Reference points

An estimation of biological reference points (BRP) for this stock was proposed based on data from the latest benchmark assessment (ICES, 2017a). The methodology used followed the framework proposed in ICES (2017c) guidelines for fisheries management reference points. Simulations analyses were conducted with the package "msy" using the EqSim routines (https://github.com/ices-tools-prod/msy; ICES, 2016c), a stochastic equilibrium reference point software that provides MSY reference points based on the equilibrium distribution of stochastic projections.

The Hockey-stick Stock–recruitment relationship was adopted for the calculation of reference points. Following ICES (2017) guidelines, the S–R data of this stock is consistent with a Type 2 pattern given the wide dynamic range of SSB and evidence that recruitment is impaired. In this case, Blim is equal to the change point of a Hockey-stick model fitted to S–R data. Table 8.6.1 shows BRPs and technical basis for the estimation.

BRP	1993–2015	Technical basis
B_{lim}	337 448 t	B_{lim} = Hockey-stick change point
B_{pa}	446 331 t	$B_{pa} = B_{lim} * \exp(1.645 * \sigma)$, $\sigma = 0.17$ (ICES, in press)
F_{lim}	0.25	Stochastic long-term simulations (50% probability SSB < B_{lim})
F_{pa}	0.19	$F_{pa} = F_{lim} * \exp(-1.645 * \sigma)$, $\sigma = 0.17$ (ICES, in press) If $F_{pa} < F_{MSY}$ then $F_{MSY} = F_{pa}$
$B_{trigger}$	446 331 t.	$B_{trigger} = B_{pa}$
$F_{p0.5}$	0.12	Stochastic long-term simulations with ICES MSY AR (≤ 5% probability SSB < B_{lim}); Constraint to F_{msy} if $F_{p0.5} < F_{msy}$
F_{MSY}	0.20	Median F_{target} which maximizes yield without $B_{trigger}$
Adopted F_{MSY}	0.12	If $F_{p0.5} < F_{MSY}$ then $F_{MSY} = F_{p0.5}$

8.6 Management considerations

Management considerations are not provided given this is a provisional stock assessment.

The current management plan of Iberian sardine was re-evaluated in a workshop within the WKPELA benchmark process (WKEMPIS, Lisbon, Portugal, on 29–31 May 2017). The report, together with the current report and the proposed reference points will be re-viewed by ADGHANSA and ACOM in July.

8.7 Reply to reviewers comments

Most general and technical comments from the reviewers were taken into account.

8.8 References

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Table 8.2.1.1. Sardine in 8.c and 9.a: Spanish fleet that operates in the purse seine fishery in 2016 and Portuguese composition of the fleet licensed to catch sardine in 2016. Engine power average in Kw.

Country	Engine power (Kw)	Gear	Storage	Discard estimates	No vessels
Spain	209	Purse seine	Dry hold with ice	No	323
Portugal	202	Purse seine	Dry hold with ice	No	181

Table 8.2.2.1. Sardine in 8.c and 9.a: Quarterly distribution of sardine landings (t) in 2016 by ICES subdivision. Above absolute values; below, relative numbers.

Sub-Div	1st	2nd	3rd	4th	Total
VIIIc-E	227	399	131	597	**1355**
VIIIc-W	60	457	938	76	**1531**
IXa-N	139	864	1732	153	**2887**
IXa-CN	7	2000	4644	1044	**7695**
IXa-CS	4	1616	2074	337	**4031**
IXa-S (A)	5	1110	740	117	**1972**
IXa-S (C)	190	170	1135	1738	**3233**
Total	**632**	**6616**	**11393**	**4062**	**22702**

Sub-Div	1st	2nd	3rd	4th	Total
VIIIc-E	1.00	1.76	0.58	2.63	**5.97**
VIIIc-W	0.27	2.01	4.13	0.33	**6.74**
IXa-N	0.61	3.80	7.63	0.67	**12.72**
IXa-CN	0.03	8.81	20.45	4.60	**33.89**
IXa-CS	0.02	7.12	9.14	1.48	**17.75**
IXa-S (A)	0.02	4.89	3.26	0.52	**8.68**
IXa-S (C)	0.84	0.75	5.00	7.65	**14.24**
Total	**2.78**	**29.14**	**50.18**	**17.89**	

Table 8.2.2.2. Sardine in 8.c and 9.a: Iberian Sardine Landings (tonnes) by subarea and total for the period 1940–2016.

	Subarea							
Year	8.c	9.a North	9.a Central North	9.a Central South	9.a South Algarve	9.a South Cadiz	All sub-areas	Div. 9.a
1940	66816		42132	33275	23724		165947	99131
1941	27801		26599	34423	9391		98214	70413
1942	47208		40969	31957	8739		128873	81665
1943	46348		85692	31362	15871		179273	132925
1944	76147		88643	31135	8450		204375	128228
1945	67998		64313	37289	7426		177026	109028
1946	32280		68787	26430	12237		139734	107454
1947	43459	21855	55407	25003	15667		161391	117932
1948	10945	17320	50288	17060	10674		106287	95342
1949	11519	19504	37868	12077	8952		89920	78401
1950	13201	27121	47388	17025	17963		122698	109497
1951	12713	27959	43906	15056	19269		118903	106190
1952	7765	30485	40938	22687	25331		127206	119441
1953	4969	27569	68145	16969	12051		129703	124734
1954	8836	28816	62467	25736	24084		149939	141103
1955	6851	30804	55618	15191	21150		129614	122763
1956	12074	29614	58128	24069	14475		138360	126286
1957	15624	37170	75896	20231	15010		163931	148307
1958	29743	41143	92790	33937	12554		210167	180424
1959	42005	36055	87845	23754	11680		201339	159334
1960	38244	60713	83331	24384	24062		230734	192490
1961	51212	59570	96105	22872	16528		246287	195075
1962	28891	46381	77701	29643	23528		206144	177253
1963	33796	51979	86859	17595	12397		202626	168830
1964	36390	40897	108065	27636	22035		235023	198633
1965	31732	47036	82354	35003	18797		214922	183190
1966	32196	44154	66929	34153	20855		198287	166091
1967	23480	45595	64210	31576	16635		181496	158016
1968	24690	51828	46215	16671	14993		154397	129707
1969	38254	40732	37782	13852	9350		139970	101716
1970	28934	32306	37608	12989	14257		126094	97160
1971	41691	48637	36728	16917	16534		160507	118816
1972	33800	45275	34889	18007	19200		151171	117371
1973	44768	18523	46984	27688	19570		157533	112765
1974	34536	13894	36339	18717	14244		117730	83194
1975	50260	12236	54819	19295	16714		153324	103064
1976	51901	10140	43435	16548	12538		134562	82661
1977	36149	9782	37064	17496	20745		121236	85087
1978	43522	12915	34246	25974	23333	5619	145609	102087
1979	18271	43876	39651	27532	24111	3800	157241	138970
1980	35787	49593	59290	29433	17579	3120	194802	159015

	Subarea							
Year	8.c	9.a North	9.a Central North	9.a Central South	9.a South Algarve	9.a South Cadiz	All sub-areas	Div. 9.a
1981	35550	65330	61150	37054	15048	2384	216517	180967
1982	31756	71889	45865	38082	16912	2442	206946	175190
1983	32374	62843	33163	31163	21607	2688	183837	151463
1984	27970	79606	42798	35032	17280	3319	206005	178035
1985	25907	66491	61755	31535	18418	4333	208439	182532
1986	39195	37960	57360	31737	14354	6757	187363	148168
1987	36377	42234	44806	27795	17613	8870	177696	141319
1988	40944	24005	52779	27420	13393	2990	161531	120587
1989	29856	16179	52585	26783	11723	3835	140961	111105
1990	27500	19253	52212	24723	19238	6503	149429	121929
1991	20735	14383	44379	26150	22106	4834	132587	111852
1992	26160	16579	41681	29968	11666	4196	130250	104090
1993	24486	23905	47284	29995	13160	3664	142495	118009
1994	22181	16151	49136	30390	14942	3782	136582	114401
1995	19538	13928	41444	27270	19104	3996	125280	105742

Table 8.2.2.2 (cont.). Sardine in 8.c and 9.a: Iberian Sardine Landings (tonnes) by subarea and total for the period 1940–2016.

	Subarea							
Year	8.c	9.a North	9.a Central North	9.a Central South	9.a South Algarve	9.a South Cadiz	All sub-areas	Div. 9.a
1996	14423	11251	34761	31117	19880	5304	**116736**	**102313**
1997	15587	12291	34156	25863	21137	6780	**115814**	**100227**
1998	16177	3263	32584	29564	20743	6594	**108924**	**92747**
1999	11862	2563	31574	21747	18499	7846	**94091**	**82229**
2000	11697	2866	23311	23701	19129	5081	**85786**	**74089**
2001	16798	8398	32726	25619	13350	5066	**101957**	**85159**
2002	15885	4562	33585	22969	10982	11689	**99673**	**83787**
2003	16436	6383	33293	24635	8600	8484	**97831**	**81395**
2004	18306	8573	29488	24370	8107	9176	**98020**	**79714**
2005	19800	11663	25696	24619	7175	8391	**97345**	**77545**
2006	15377	10856	30152	19061	5798	5779	**87023**	**71646**
2007	13380	12402	41090	19142	4266	6188	**96469**	**83088**
2008	13636	9409	45210	20858	4928	7423	**101464**	**87828**
2009	11963	7226	36212	20838	4785	6716	**87740**	**75777**
2010	13772	7409	40923	17623	5181	4662	**89571**	**75798**
2011	8536	5621	37152	13685	6387	9023	**80403**	**71867**
2012	13090	4154	19647	9045	2891	6031	**54857**	**41768**
2013	5272	2128	15065	9084	4112	10157	**45818**	**40546**
2014	4344	1924	6889	6747	2398	5635	**27937**	**23593**
2015	1916	1946	7111	4848	1812	2956	**20595**	**18679**
2016	2886	2887	7695	4031	1972	3233	**22702**	**19817**

Table 8.2.4.1. Sardine in 8.c and 9.a: Sardine length composition (thousands), mean length (cm) and catch (t) by ICES subdivision in 2016.

				Total				
Length	**8c E**	**8c W**	**9a N**	**9a CN**	**9a CS**	**9a S**	**9a S (Ca)**	**Total**
6.5								
7								
7.5								
8								
8.5								
9								
9.5								
10							709	709
10.5						37	5 272	5 309
11			13				14 723	14 736
11.5	3		67			8	23 098	23 177
12	14		202			258	34 093	34 567
12.5	40		269	718		418	37 069	38 514
13	61		161	6 235		783	19 228	26 470
13.5	278	12	81	13 904		700	14 796	29 770
14	394	20	126	14 455	28	600	8 589	24 212
14.5	207	12	231	5 630	39	296	8 608	15 022
15	197	78	587	2 088	114	2 517	5 776	11 357
15.5	328	60	1 231	2 148	129	3 943	2 106	9 946
16	829	764	2 119	3 305	181	6 542	2 800	16 539
16.5	1 736	288	2 450	5 930	399	3 177	694	14 674
17	2 379	1 149	2 485	9 683	884	5 107	804	22 491
17.5	3 193	1 369	3 477	12 737	758	3 162	331	25 026
18	3 864	1 814	5 603	16 349	686	3 383	209	31 910
18.5	3 241	2 134	6 942	19 471	333	2 764	260	35 144
19	3 496	3 182	5 141	16 487	1 167	1 829	816	32 118
19.5	2 083	2 777	3 397	10 759	2 481	1 951	1 136	24 585
20	1 495	2 399	1 416	5 808	4 622	1 995	861	18 596
20.5	991	1 888	1 496	2 995	7 465	1 191	683	16 710
21	620	859	1 461	1 943	10 017	755	281	15 936
21.5	322	1 308	1 792	1 339	6 736	485	201	12 183
22	182	1 038	1 280	987	4 990	158	26	8 661
22.5	155	394	802	491	3 895		26	5 763
23	43	308	666	60	1 860	13		2 950
23.5	82	229	472	12	307			1 103
24	27	66	756	30	85			965
24.5	20	4	471		19			513
25			212					212
25.5	7		47					54
26			1					1
26.5								
27								
27.5								
28								
28.5								
29								
Total	26 290	22 155	45 455	153 563	47 195	42 071	183 196	519 925
Mean L	18.5	19.6	19.0	17.3	21.1	17.3	13.0	16.5
sd	1.67	1.69	2.25	2.36	1.43	1.95	1.67	3.37
Catch	**1355**	**1531**	**2887**	**7695**	**4031**	**1972**	**3233**	**22702**

Table 8.2.4.1a. Sardine in 8.c and 9.a: Sardine length composition (thousands), mean length (cm) and catch (t) by ICES subdivision in the first quarter 2016.

	First Quarter							
Length	**8c E**	**8c W**	**9a N**	**9a CN**	**9a CS**	**9a S**	**9a S (Ca)**	**Total**
6.5								
7								
7.5								
8								
8.5								
9								
9.5								
10							3	3
10.5							5	5
11							28	28
11.5							156	156
12							649	649
12.5							939	939
13							873	873
13.5	1					11	364	376
14						12	173	185
14.5	2	3				12	108	125
15	32	15				21	79	147
15.5	102	6				23	45	176
16	341	20	16			20	66	464
16.5	508	24				17	24	574
17	443	52	50			9	9	563
17.5	502	51	117			4	111	785
18	611	95	421				65	1 192
18.5	367	113	401			4	106	991
19	318	104	674			4	419	1 519
19.5	208	68	491			5	566	1 338
20	171	105	177			3	489	944
20.5	192	114	102				344	752
21	251	117	64			1	120	554
21.5	155	80	81				34	349
22	52	53	48				1	154
22.5	100	21	16					137
23	42	11						53
23.5	77	5						82
24	20	6						27
24.5	20	4						24
25								
25.5	7							7
26								
26.5								
27								
27.5								
28								
28.5								
29								
Total	4 521	1 067	2 658			146	5 776	14 169
Mean L	18.7	19.8	19.3			16.1	15.8	17.7
sd	2.01	1.82	1.07			1.64	3.39	3.02
Catch	**227**	**60**	**139**	**7**	**4**	**5**	**190**	**632**

Table 8.2.4.1b. Sardine in 8.c and 9.a: Sardine length composition (thousands), mean length (cm) and catch (t) by ICES subdivision in the second quarter 2016.

	Second Quarter							
Length	**8c E**	**8c W**	**9a N**	**9a CN**	**9a CS**	**9a S**	**9a S-C**	**Total**
7								
7.5								
8								
8.5								
9								
9.5								
10								
10.5								
11			13					13
11.5			67				8	76
12			202				119	321
12.5			269	718			219	1 206
13			161	5 442			218	5 822
13.5			81	9 778		20	81	9 960
14			126	8 383	28	31	41	8 608
14.5			185	3 326	28	136	36	3 710
15	3	49	294	1 925	83	2 010	4	4 368
15.5	89	48	442	1 842	55	3 666	35	6 177
16	157	688	986	1 700	166	6 090	34	9 821
16.5	409	148	1 726	2 695	305	2 719	87	8 090
17	894	743	1 504	3 765	736	4 021	64	11 726
17.5	960	905	1 500	5 263	681	2 423	84	11 816
18	1 160	680	1 730	5 272	599	2 023	120	11 585
18.5	829	612	2 831	3 677	206	1 588	138	9 880
19	1 490	559	1 512	1 659	343	677	350	6 590
19.5	696	645	740	1 147	488	339	519	4 574
20	452	380	274	922	795	174	366	3 364
20.5	234	538	99	734	1 482	130	336	3 553
21	98	320	337	586	2 921		148	4 410
21.5	75	507	535	292	3 249		144	4 802
22	53	360	449	215	3 341		25	4 443
22.5	46	166	275	42	3 206		26	3 761
23	2	156	279		1 615			2 053
23.5	2	93	154		191			440
24	7	21	70		51			149
24.5			18		19			37
25			5					5
25.5								
26								
26.5								
27								
27.5								
28								
28.5								
29								
Total	7 655	7 618	16 864	59 382	20 589	26 047	3 203	141 359
Mean L	18.6	19.2	18.2	16.0	21.2	16.9	18.2	17.6
sd	1.28	2.01	2.27	2.29	1.81	1.17	3.02	2.71
Catch	**399**	**457**	**864**	**2 000**	**1 616**	**1 110**	**170**	**6 616**

Table 8.2.4.1c. Sardine in 8.c and 9.a: Sardine length composition (thousands), mean length (cm) and catch (t) by ICES subdivision in the third quarter 2016.

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								
8.5								
9								
9.5								
10								
10.5								
11							1 141	1 141
11.5	3						4 576	4 579
12	13						20 588	20 601
12.5	40						29 774	29 814
13	61			793			9 221	10 074
13.5	92			4 126			4 747	8 965
14	93			6 072			57	6 221
14.5	57		46	2 304	11		114	2 532
15	70		293	163		5	68	600
15.5	82	3	788	268	11	34	45	1 232
16	136	43	1 117	1 604	14	26	11	2 952
16.5	201	80	724	3 197	63	293	34	4 592
17	381	285	931	5 404	148	961	45	8 155
17.5	340	314	1 836	6 308	77	730	34	9 640
18	238	918	3 348	9 661	87	1 319	23	15 594
18.5	234	1 272	3 510	13 047	127	1 163	11	19 365
19	237	2 336	2 395	11 340	746	1 139		18 194
19.5	161	1 866	1 771	6 973	1 867	1 570		14 207
20	124	1 739	684	3 471	3 401	1 818		11 237
20.5	55	1 165	1 175	1 763	5 495	1 062		10 715
21	34	392	860	1 039	6 423	751	11	9 510
21.5	7	706	1 110	980	2 595	485	23	5 905
22		610	756	733	1 223	158		3 480
22.5		201	506	377	576			1 660
23		138	386	60	197			781
23.5		129	315	12	85			541
24		37	679		34			750
24.5			432					432
25			182					182
25.5			37.2515					37
26								
26.5								
27								
27.5								
28								
28.5								
29								
Total	2 658	12 235	23 883	79 692	23 183	11 515	70 524	223 688
Mean L	17.5	19.9	19.4	18.0	20.9	19.4	12.7	16.9
sd	1.97	1.38	2.24	2.08	0.95	1.37	0.61	3.42
Catch	**131**	**938**	**1 732**	**4 644**	**2 074**	**740**	**1 135**	**11 393**

Table 8.2.4.1d. Sardine in 8.c and 9.a: Sardine length composition (thousands) by ICES subdivision in the fourth quarter 2016.

				Fourth Quarter				
Length	**8c E**	**8c W**	**9a N**	**9a CN**	**9a CS**	**9a S**	**9a S-C**	**Total**
7								
7.5								
8								
8.5								
9								
9.5								
10							706	706
10.5						37	5 267	5 303
11							13 554	13 554
11.5	1					8	18 358	18 367
12	1					258	12 738	12 997
12.5	1					418	6 136	6 555
13	1					783	8 917	9 701
13.5	185	12				669	9 604	10 469
14	301	20				558	8 318	9 197
14.5	148	10				148	8 350	8 656
15	92	14				480	5 625	6 211
15.5	55	3		38		222	1 981	2 298
16	195	13				406	2 689	3 303
16.5	617	35		38		148	548	1 387
17	662	70		514		115	687	2 047
17.5	1 392	99	24	1 166		4	101	2 785
18	1 855	121	104	1 417		41	1	3 540
18.5	1 811	137	200	2 748		8	5	4 909
19	1 451	182	560	3 489	78	8	47	5 816
19.5	1 019	199	396	2 639	126	37	51	4 466
20	748	175	281	1 414	425		6	3 050
20.5	510	71	119	499	488		3	1 690
21	238	31	200	318	673	3	1	1 463
21.5	85	16	66	67	893			1 127
22	77	16	27	39	425			584
22.5	9	7	5	73	112			206
23		3			47			51
23.5	3	2	3		31			39
24		2	8					
24.5			20					
25			25					
25.5			10					
26			1					
26.5								
27								
27.5								
28								
28.5								
29								
Total	11 456	1 235	2 049	14 458	3 298	4 350	103 694	140 476
Mean L	18.5	19.	20.	19.2	21.3	14.4	13.	14.4
sd	1.6	1.61	1.32	.97	.86	1.54	1.56	3.03
Catch	**597**	**76**	**153**	**1 044**	**337**	**117**	**1 738**	**4 062**

Table 8.2.4.2. Sardine in 8.c and 9.a: Catch in numbers- (thousands) at-age by quarter and by sub-division in 2016.

							First Quarter	
Age	8c-E	8c-W	9a-N	9a-CN	9a-CS	9a-S	9a-C	Total
0								
1	3	282	973				3 543	4 801
2	1 985	369	1 351				667	4 371
3	1 366	230	240				960	2 796
4	717	123	71				455	1 366
5	318	26	15				84	443
6	126	19	5				54	204
7	7	13	4				12	36
8		6						6
9								
10								
11								
12								
Total	4 521	1 067	2 658				5 776	14 022
Catch (Tons)	227	60	139	7	4	5	190	632

							Second Quarter	
Age	8c-E	8c-W	9a-N	9a-CN	9a-CS	9a-S	9a-C	Total
0								
1		3 178	10 901	47 547	2 404	12 664	965	77 658
2	3 037	2 210	3 786	10 122	2 088	8 165	642	30 050
3	3 019	1 147	1 184	1 498	3 527	4 569	873	15 816
4	1 265	647	568	88	3 693	320	445	7 025
5	263	188	225	157	4 086	204	122	5 245
6	72	123	122		3 154	117	93	3 681
7		83	79		825	4	62	1 054
8		42			800	4		846
9					13			13
10								
11								
12								
Total	7 655	7 618	16 864	59 412	20 589	26 047	3 203	141 389
Catch (Tons)	399	457	864	2 000	1 616	1 110	170	6 616

							Third Quarter	
Age	8c-E	8c-W	9a-N	9a-CN	9a-CS	9a-S	9a-C	Total
0	836	174	3 573	21 225	79		61 816	87 704
1	611	7 299	14 499	53 266	5 781	3 698	8 488	93 642
2	671	2 518	2 477	2 200	7 629	1 490	183	17 168
3	433	2 042	1 515	1 974	5 764	3 104	16	14 847
4	100	202	744	452	1 606	1 675	9	4 788
5	7		482	331	1 346	879	8	3 054
6			291	195	602	180	2	1 270
7			291	50	278	233	1	853
8			9		98	268		375
9								
10								
11								
12								
Total	2 658	12 235	23 883	79 692	23 183	11 528	70 524	223 702
Catch (Tons)	131	938	1 732	4 644	2 074	740	1 135	11 393

							Fourth Quarter	
Age	8c-E	8c-W	9a-N	9a-CN	9a-CS	9a-S	9a-C	Total
0	1 818	92	14	1 056	124	3 987	77 407	84 498
1	2 176	839	1 508	8 252	326	214	25 536	38 849
2	3 764	201	308	598	994	140	675	6 680
3	2 941	98	136	3 230	767	6	68	7 246
4	703	5	27	624	868	5	8	2 239
5	46		19	698	305	1	1	1 071
6	3		18		10			31
7	3		18		22			43
8	3		3		5			11
9								
10								
11								
12								
Total	11 456	1 235	2 049	14 458	3 423	4 352	103 694	140 667
Catch (Tons)	597	76	153	1 044	337	117	1 738	4 062

							Whole Year	
Age	8c-E	8c-W	9a-N	9a-CN	9a-CS	9a-S	9a-C	Total
0	2 653	266	3 588	22 281	203	3 987	139 223	172 202
1	2 790	11 598	27 881	109 065	8 510	16 576	38 532	214 950
2	9 457	5 298	7 922	12 920	10 711	9 795	2 167	58 269
3	7 759	3 517	3 075	6 702	10 058	7 678	1 917	40 705
4	2 786	977	1 409	1 164	6 166	2 000	917	15 419
5	634	214	742	1 187	5 738	1 084	215	9 813
6	200	142	435	195	3 766	297	150	5 186
7	9	96	391	50	1 126	237	76	1 986
8	3	48	12		902	272		1 237
9					13			13
10								
11								
12								
Total	26 290	22 155	45 455	153 563	47 195	41 926	183 196	519 780
Catch (Tons)	1 355	1 531	2 887	7 695	4 031	1 972	3 233	22 702

Table 8.2.4.3. Sardine 8.c and 9.a: 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

Table 8.2.4.4. Sardine 8.c and 9.a: Relative distribution of sardine catches. Upper panel relative contribution of each 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	10%	1%	8%	15%	0%	10%	76%	33%
1	11%	52%	61%	71%	18%	40%	21%	41%
2	36%	24%	17%	8%	23%	23%	1%	11%
3	30%	16%	7%	4%	21%	18%	1%	8%
4	11%	4%	3%	1%	13%	5%	1%	3%
5	2%	1%	2%	1%	12%	3%	0%	2%
6+	1%	1%	2%	0%	12%	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	2%	0%	2%	13%	0%	2%	81%	100%
1	1%	5%	13%	51%	4%	8%	18%	100%
2	16%	9%	14%	22%	18%	17%	4%	100%
3	19%	9%	8%	16%	25%	19%	5%	100%
4	18%	6%	9%	8%	40%	13%	6%	100%
5	6%	2%	8%	12%	58%	11%	2%	100%
6+	3%	3%	10%	3%	69%	10%	3%	100%

Table 8.2.5.1. Sardine 8.c and 9.a: Sardine Mean length- (cm) at-age by quarter and by subdivision in 2016.

						First Quarter	
Age	8c-E	8c-W	9a-N	9a-CN	9a-CS	9a-S	9a-S-C
0							
1	14.4	17.7	18.5				13.3
2	17.3	19.6	19.5				18.8
3	18.6	20.9	20.9				19.9
4	20.5	21.4	21.4				20.3
5	21.8	22.3	21.5				20.7
6	22.7	22.0	21.9				20.7
7	25.0	23.1	21.9				21.4
8		24.0					
9							
10							
11							
12							

						Second Quarter	
Age	8c-E	8c-W	9a-N	9a-CN	9a-CS	9a-S	9a-S-C
0							
1		17.5	17.1	15.4	17.3	16.0	14.2
2	17.8	19.4	19.2	18.2	19.8	17.7	18.8
3	18.8	21.0	21.7	20.8	21.5	17.6	19.9
4	19.6	21.6	22.3	21.4	21.8	19.5	20.4
5	20.8	22.6	23.0	22.4	22.1	19.7	21.1
6	21.5	22.4	23.2		22.3	20.0	21.3
7		22.8	23.2		22.8	20.8	22.2
8		23.5			22.7	20.8	
9					24.3		
10							
11							
12							

						Third Quarter	
Age	8c-E	8c-W	9a-N	9a-CN	9a-CS	9a-S	9a-S-C
0		17.9	16.5	15.2	16.2		12.6
1	15.5	19.2	18.9	18.8	20.0	17.9	13.1
2	17.3	20.6	21.3	20.4	20.9	19.2	14.1
3	18.4	21.4	21.9	21.5	21.3	20.0	20.4
4	19.4	23.4	23.4	22.1	21.6	20.6	21.5
5	19.8		24.4	21.7	21.8	20.1	21.6
6	19.7		24.7	22.2	21.7	20.3	21.7
7			24.7	23.0	22.3	21.0	21.6
8			25.8		22.3	21.8	
9							
10							
11							
12							

						Fourth Quarter	
Age	8c-E	8c-W	9a-N	9a-CN	9a-CS	9a-S	9a-S-C
0	16.2	15.7	18.1	17.4	15.9	14.1	12.4
1	17.8	18.8	19.5	19.3	20.0	17.2	14.5
2	18.8	20.3	20.6	19.9	21.0	17.9	15.1
3	19.5	20.9	21.1	18.8	21.8	20.0	18.2
4	20.0	23.3	22.3	19.0	21.5	19.8	19.9
5	19.8		25.0	21.2	21.9	19.3	20.5
6	23.2		25.1		23.8		20.9
7	23.2		25.1		22.8		21.3
8	23.2		25.8		23.8		
9							
10							
11							
12							

						Whole Year	
Age	8c-E	8c-W	9a-N	9a-CN	9a-CS	9a-S	9a-S-C
0	16.0	17.1	16.5	15.3	16.0	14.1	12.5
1	17.7	18.6	18.2	17.4	19.2	16.5	14.1
2	18.2	20.0	20.0	18.6	20.7	17.9	17.2
3	19.1	21.3	21.7	20.0	21.4	18.6	19.9
4	19.9	22.0	22.8	20.4	21.7	20.4	20.4
5	21.2	22.6	23.9	21.5	22.1	20.0	20.9
6	22.3	22.4	24.3	22.2	22.3	20.2	21.1
7	24.5	22.8	24.4	23.0	22.7	21.0	22.0
8	23.2	23.6	25.8		22.7	21.7	
9					24.3		
10							
11							
12							

Table 8.2.5.2. Sardine 8.c and 9.a: Sardine Mean weight- (kg) at-age by quarter and by subdivision in 2016.

						First Quarter	
Age	8c-E	8c-W	9a-N	9a-CN	9a-CS	9a-S	9a-S-C
0							
1	0.022	0.040	0.045				0.017
2	0.040	0.054	0.053				0.050
3	0.049	0.066	0.065				0.059
4	0.064	0.070	0.070				0.063
5	0.075	0.079	0.071				0.066
6	0.084	0.077	0.075				0.066
7	0.111	0.088	0.075				0.073
8		0.098					
9							
10							
11							
12							

						Second Quarter	
Age	8c-E	8c-W	9a-N	9a-CN	9a-CS	9a-S	9a-S-C
0							
1		0.043	0.040	0.029	0.043	0.036	0.024
2	0.045	0.060	0.058	0.048	0.063	0.048	0.055
3	0.053	0.078	0.087	0.072	0.080	0.048	0.065
4	0.061	0.086	0.096	0.078	0.083	0.063	0.071
5	0.074	0.099	0.105	0.091	0.087	0.065	0.078
6	0.083	0.097	0.108		0.090	0.068	0.080
7		0.102	0.109		0.095	0.075	0.091
8		0.113			0.094	0.075	
9					0.113		
10							
11							
12							

						Third Quarter	
Age	8c-E	8c-W	9a-N	9a-CN	9a-CS	9a-S	9a-S-C
0	0.033	0.053	0.040	0.032	0.039	0.051	0.016
1	0.047	0.067	0.064	0.065	0.078	0.062	0.018
2	0.057	0.085	0.097	0.087	0.089	0.070	0.024
3	0.067	0.098	0.105	0.103	0.095	0.075	0.083
4	0.071	0.130	0.131	0.113	0.099	0.070	0.097
5	0.069		0.150	0.106	0.103	0.072	0.099
6			0.157	0.116	0.102	0.079	0.099
7			0.157	0.129	0.110	0.087	0.099
8			0.180		0.110		
9							
10							
11							
12							

						Fourth Quarter	
Age	8c-E	8c-W	9a-N	9a-CN	9a-CS	9a-S	9a-S-C
0	0.034	0.036	0.054	0.051	0.047	0.025	0.014
1	0.045	0.062	0.069	0.074	0.085	0.047	0.023
2	0.055	0.077	0.081	0.082	0.096	0.054	0.027
3	0.062	0.086	0.088	0.068	0.106	0.077	0.049
4	0.067	0.120	0.106	0.070	0.103	0.075	0.063
5	0.066		0.150	0.102	0.108	0.068	0.070
6	0.108		0.151		0.133		0.074
7	0.108		0.151		0.119		0.078
8	0.108		0.164		0.133		
9							
10							
11							
12							

						Whole Year	
Age	8c-E	8c-W	9a-N	9a-CN	9a-CS	9a-S	9a-S-C
0	0.034	0.047	0.040	0.033	0.044	0.025	0.015
1	0.045	0.059	0.054	0.050	0.068	0.040	0.022
2	0.049	0.072	0.070	0.056	0.084	0.050	0.042
3	0.056	0.089	0.094	0.079	0.090	0.057	0.062
4	0.064	0.093	0.113	0.087	0.090	0.073	0.067
5	0.074	0.097	0.135	0.102	0.092	0.069	0.074
6	0.084	0.094	0.142	0.116	0.092	0.071	0.075
7	0.110	0.100	0.146	0.129	0.099	0.079	0.089
8	0.108	0.111	0.177		0.096	0.087	
9					0.113		
10							
11							
12							

Table 8.3.1.1.1. Sardine adults' parameters in Spanish DEPM survey for the total surveyed area and by ICES divisions. In brackets coefficient of variation in percentage.

2017	IEO	IEO	IEO
Sardine DEPM	9.a N + 8.c	8.b (up to 45ºN)	Total area
Female Weight (g)	51.06 (5.6)	40.06 (8.1)	47.55 (5.1)
Batch Fecundity (eggs/female)	19010 (7.5)	16305 (10.3)	18090 (6.6)
Sex Ratio	0.505 (6.3)	0.434 (13.2)	0.48 (6.0)
Spawning Fraction	0.170 (32)	0.082 (47.2)	0.142 (27.3)

Table 8.3.2.2.1. Sardine in 8.c and 9.a: sardine abundance in number (millions of fish) and biomass (tons) by age groups and ICES subdivision in PELACUS0317. MW (mean weight) in grams and ML (mean length) in cm.

AREA VIIIcE								
AGE	1	2	3	4	5	6	7	TOTAL
Biomass (Tonnes)	7192	2157	1885	614	120	26	8	12001
% Biomass	59.9	18.0	15.7	5.1	1.0	0.2	0.1	100
Abundance (N $*10^6$)	218	51	37	11	2	0.3	0.1	318
% Abundance	68.4	16.0	11.5	3.3	0.6	0.1	0.03	100
Medium Weight (gr)	33.1	42.4	51.5	57.7	62.6	76.5	81.3	57.9
Medium Length (cm)	16.37	17.77	19.02	19.74	20.33	21.79	22.25	19.61
AREA VIIIcW								
AGE	1	2	3	4	5	6	7	TOTAL
Biomass (Tonnes)	70	520	115	68	45	21		839
% Biomass	8.3	62.0	13.8	8.1	5.3	2.5		100
Abundance (N $*10^6$)	1.69	9	1	1	0.4	0.2		13
% Abundance	12.8	65.9	10.9	5.6	3.3	1.5		100
Medium Weight (gr)	41.1	59.6	80.0	91.8	100.3	106.4		79.9
Medium Length (cm)	17.5	20.0	22.1	23.1	23.9	24.4		21.8
AREA IXaN								
AGE	1	2	3	4	5	6	7	TOTAL
Biomass (Tonnes)	2391	6870	1211	427	215	42		11156
% Biomass	21.4	61.6	10.9	3.8	1.9	0.4		100
Abundance (N $*10^6$)	54	122	15	5	2	0.4		198
% Abundance	27.0	61.4	7.7	2.6	1.1	0.2		100
Medium Weight (gr)	44.7	56.4	78.9	83.8	95.8	103.1		77.1
Medium Length (cm)	18.1	19.6	22.0	22.4	23.5	24.1		21.6
TOTAL SPAIN								
AGE	1	2	3	4	5	6	7	TOTAL
Biomass (Tonnes)	9652	9548	3211	1109	379	89	8	23996
% Biomass	40.23	39.79	13.38	4.62	1.58	0.37	0.03	100
Abundance (N $*10^6$)	273	181	53	16	5	1	0.1	530
% Abundance	51.51	34.24	10.07	3.11	0.87	0.18	0.02	100
Medium Weight (gr)	35.4	52.7	60.2	67.3	82.5	94.2	81.3	67.6
Medium Length (cm)	16.72	19.12	19.96	20.72	22.23	23.33	22.25	20.62

Table 8.4.1a. Sardine in 8.c and 9.a: Mean weights-at-age (kg) in the catch. Weights-at-age in 1978–1990 and are fixed.

Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6+
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

Table 8.4.1b. Mean weights-at-age (Kg) in the stock. Weights-at-age in 1978–1998 are fixed. Weights-at-age in 2015–2016 are assumed to be equal to weigths-at-age in 2014, the last DEPM survey (see Stock Annex).

Year	Age1	Age2	Age3	Age4	Age5	Age6+
1998	0.027	0.041	0.050	0.059	0.060	0.063
1999	0.030	0.043	0.050	0.054	0.059	0.062
2000	0.027	0.041	0.050	0.059	0.060	0.063
2001	0.024	0.039	0.051	0.064	0.061	0.064
2002	0.022	0.037	0.052	0.069	0.062	0.066
2003	0.021	0.041	0.054	0.068	0.065	0.072
2004	0.020	0.045	0.056	0.067	0.068	0.079
2005	0.019	0.049	0.058	0.066	0.072	0.086
2006	0.024	0.052	0.060	0.067	0.072	0.084
2007	0.029	0.054	0.062	0.069	0.072	0.081
2008	0.033	0.057	0.064	0.070	0.072	0.079
2009	0.030	0.054	0.063	0.070	0.069	0.075
2010	0.027	0.051	0.062	0.070	0.067	0.072
2011	0.024	0.048	0.061	0.070	0.064	0.068
2012	0.027	0.048	0.062	0.068	0.068	0.073
2013	0.030	0.049	0.063	0.067	0.073	0.077
2014	0.032	0.049	0.065	0.066	0.077	0.081
2015	0.032	0.049	0.065	0.066	0.077	0.081
2016	0.032	0.049	0.065	0.066	0.077	0.081

Table 8.5.1.1. Sardine in 8.c and 9.a: Parameters and asymptotic standard deviations estimated in the provisional 2017 assessment model.

Number	Label	Param_value	Parm_StDev	Phase	Min	Max	Init
1	SR_LN(R0)	16.56	0.03	1	0.1	2	1.6
2	Early_InitAge_4	0.44	0.57				
3	Early_InitAge_3	0.43	0.46				
4	Early_InitAge_2	0.44	0.28				
5	Early_InitAge_1	0.74	0.19				
6	Main_RecrDev_1978	0.89	0.16				
7	Main_RecrDev_1979	1.01	0.15				
8	Main_RecrDev_1980	1.12	0.14				
9	Main_RecrDev_1981	0.62	0.17				
10	Main_RecrDev_1982	0.00	0.23				
11	Main_RecrDev_1983	1.51	0.11				
12	Main_RecrDev_1984	0.26	0.18				
13	Main_RecrDev_1985	0.14	0.18				
14	Main_RecrDev_1986	-0.01	0.19				
15	Main_RecrDev_1987	0.79	0.12				
16	Main_RecrDev_1988	0.17	0.16				
17	Main_RecrDev_1989	0.14	0.16				
18	Main_RecrDev_1990	0.20	0.15				
19	Main_RecrDev_1991	1.28	0.09				
20	Main_RecrDev_1992	0.85	0.10				
21	Main_RecrDev_1993	0.01	0.14				
22	Main_RecrDev_1994	-0.12	0.13				
23	Main_RecrDev_1995	-0.35	0.14				
24	Main_RecrDev_1996	0.04	0.11				
25	Main_RecrDev_1997	-0.34	0.13				
26	Main_RecrDev_1998	-0.07	0.11				
27	Main_RecrDev_1999	-0.33	0.14				
28	Main_RecrDev_2000	0.84	0.09				
29	Main_RecrDev_2001	0.30	0.11				
30	Main_RecrDev_2002	-0.28	0.14				
31	Main_RecrDev_2003	-0.52	0.17				
32	Main_RecrDev_2004	0.95	0.08				
33	Main_RecrDev_2005	-0.12	0.11				
34	Main_RecrDev_2006	-1.30	0.18				
35	Main_RecrDev_2007	-0.96	0.14				
36	Main_RecrDev_2008	-0.67	0.11				
37	Main_RecrDev_2009	-0.48	0.10				
38	Main_RecrDev_2010	-1.00	0.12				
39	Main_RecrDev_2011	-1.10	0.13				
40	Main_RecrDev_2012	-0.91	0.12				
41	Main_RecrDev_2013	-0.75	0.12				
42	Main_RecrDev_2014	-1.07	0.15				
43	Main_RecrDev_2015	-0.54	0.17				
44	Main_RecrDev_2016	-0.19	0.26				
45	InitF_1purse_seine	0.68	0.12	1	-1	2	0.3
46	Q_base_2_Acoustic_survey	0.30	0.08	1	-3	3	0
47	Q_base_3_DEPM_survey	0.12	0.11	1	-3	3	0
48	AgeSel_1P_2_purse_seine	1.65	0.15	2	-3	3	0.9
49	AgeSel_1P_3_purse_seine	0.76	0.14	2	-4	4	0.4
50	AgeSel_1P_4_purse_seine	-0.18	0.17	2	-4	4	0.1
51	AgeSel_1P_7_purse_seine	-0.25	0.51	2	-4	4	-0.5
52	AgeSel_1P_2_purse_seine_BLK1delta_1988	-0.35	0.18	2	-4	4	0.9
53	AgeSel_1P_2_purse_seine_BLK1delta_2006	-0.12	0.15	2	-4	4	0.9
54	AgeSel_1P_3_purse_seine_BLK1delta_1988	-0.03	0.17	2	-4	4	0.4
55	AgeSel_1P_3_purse_seine_BLK1delta_2006	-0.24	0.15	2	-4	4	0.4
56	AgeSel_1P_4_purse_seine_BLK1delta_1988	0.82	0.19	2	-4	4	0.1
57	AgeSel_1P_4_purse_seine_BLK1delta_2006	-0.48	0.15	2	-4	4	0.1
58	AgeSel_1P_7_purse_seine_BLK1delta_1988	-0.48	0.52	2	-4	4	-0.5
59	AgeSel_1P_7_purse_seine_BLK1delta_2006	0.55	0.39	2	-4	4	-1

Table 8.5.1.2. Sardine in 8.c and 9.a: Fishing mortality-at-age estimated in the assessment. RefF is equal to F(2–5) is the reference fishing mortality, corresponding to the average F of ages 2 to 5 years.

Year	age0	age1	age2	age3	age4	age5	age6	refF
1978	0.04	0.18	0.39	0.33	0.33	0.33	0.26	0.34
1979	0.03	0.15	0.32	0.26	0.26	0.26	0.21	0.28
1980	0.03	0.15	0.31	0.26	0.26	0.26	0.20	0.27
1981	0.03	0.14	0.30	0.25	0.25	0.25	0.20	0.26
1982	0.03	0.14	0.29	0.24	0.24	0.24	0.19	0.26
1983	0.03	0.14	0.29	0.24	0.24	0.24	0.19	0.25
1984	0.03	0.13	0.29	0.24	0.24	0.24	0.19	0.25
1985	0.02	0.12	0.26	0.22	0.22	0.22	0.17	0.23
1986	0.03	0.15	0.32	0.27	0.27	0.27	0.21	0.28
1987	0.03	0.17	0.37	0.31	0.31	0.31	0.24	0.33
1988	0.03	0.12	0.24	0.46	0.46	0.46	0.22	0.40
1989	0.03	0.11	0.23	0.44	0.44	0.44	0.21	0.38
1990	0.03	0.12	0.25	0.48	0.48	0.48	0.23	0.42
1991	0.03	0.11	0.23	0.44	0.44	0.44	0.21	0.39
1992	0.02	0.08	0.17	0.32	0.32	0.32	0.16	0.29
1993	0.02	0.08	0.17	0.31	0.31	0.31	0.15	0.28
1994	0.02	0.07	0.14	0.26	0.26	0.26	0.13	0.23
1995	0.02	0.07	0.14	0.26	0.26	0.26	0.13	0.23
1996	0.02	0.09	0.19	0.36	0.36	0.36	0.17	0.31
1997	0.03	0.12	0.25	0.48	0.48	0.48	0.23	0.42
1998	0.04	0.13	0.28	0.53	0.53	0.53	0.26	0.47
1999	0.03	0.12	0.26	0.48	0.48	0.48	0.23	0.43
2000	0.03	0.11	0.23	0.43	0.43	0.43	0.21	0.38
2001	0.03	0.10	0.21	0.41	0.41	0.41	0.20	0.36
2002	0.02	0.09	0.18	0.34	0.34	0.34	0.16	0.30
2003	0.02	0.08	0.16	0.30	0.30	0.30	0.15	0.27
2004	0.02	0.08	0.18	0.33	0.33	0.33	0.16	0.30
2005	0.02	0.08	0.18	0.33	0.33	0.33	0.16	0.29
2006	0.03	0.10	0.16	0.19	0.19	0.19	0.16	0.18
2007	0.04	0.11	0.19	0.22	0.22	0.22	0.18	0.21
2008	0.06	0.18	0.29	0.34	0.34	0.34	0.29	0.33
2009	0.06	0.21	0.34	0.39	0.39	0.39	0.33	0.38
2010	0.08	0.26	0.43	0.50	0.50	0.50	0.41	0.48
2011	0.10	0.31	0.51	0.60	0.60	0.60	0.50	0.58
2012	0.08	0.25	0.40	0.47	0.47	0.47	0.39	0.45
2013	0.07	0.23	0.38	0.44	0.44	0.44	0.37	0.42
2014	0.05	0.15	0.24	0.28	0.28	0.28	0.23	0.27
2015	0.03	0.09	0.15	0.17	0.17	0.17	0.14	0.16
2016	0.03	0.09	0.14	0.17	0.17	0.17	0.14	0.16

Table 8.5.1.3. Sardine in 8.c and 9.a: Numbers-at-age, in thousands at the beginning of the year, estimated in the assessment. Estimates of survivors in 2017 are also shown. Age 0 in 2017 is the estimated of recruitment using the S–R model fitted within the assessment.

Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6+
1978	36649000	11556600	3390440	1057600	404463	102816	76651.5
1979	42650600	13280500	5228540	1430210	510581	203232	95277.6
1980	48603800	15564000	6232310	2385750	737242	273935	166509
1981	29964700	17740600	7312900	2851290	1232520	396416	247470
1982	16000600	10948700	8381260	3385130	1487520	669246	365219
1983	71258900	5850790	5192750	3912290	1778410	813373	588946
1984	21132900	26061200	2777540	2428850	2058840	974081	804132
1985	18475700	7731490	12393900	1304110	1282240	1131260	1025340
1986	15699300	6774250	3719420	5964750	702815	719233	1269030
1987	34295800	5724450	3166010	1682260	3052160	374306	1133500
1988	18597000	12450100	2614240	1362630	825876	1559560	838858
1989	17753400	6765420	6030280	1285760	579594	365622	1186590
1990	18583100	6466900	3292550	2995510	557321	261482	864955
1991	54469900	6751040	3116390	1602280	1248740	241813	614166
1992	37069000	19838400	3283770	1546300	693033	562160	471037
1993	16230800	13607100	9932570	1730560	749866	349796	579221
1994	14123400	5962410	6831560	5264720	848441	382641	542027
1995	11044400	5205700	3030780	3715770	2710810	454692	553727
1996	15807300	4070920	2646370	1648780	1913920	1453270	600356
1997	10603200	5789870	2021910	1371500	774567	935819	1085030
1998	13529300	3852030	2790150	983950	571751	336079	1036810
1999	10395400	4896080	1829990	1317990	387656	234451	721946
2000	32202500	3774420	2354560	886726	544970	166832	517251
2001	19938500	11735800	1840180	1173970	387076	247600	382015
2002	11214800	7277250	5753410	928133	523792	179751	344121
2003	8815260	4112130	3628770	3006510	442918	260162	302313
2004	37486000	3240460	2069630	1933330	1488460	228228	325097
2005	13122500	13750300	1618130	1084710	927805	743464	316093
2006	4211660	4814170	6869860	849003	521631	464385	571438
2007	5817800	1533970	2372130	3658610	472000	301834	626535
2008	7483730	2108310	743536	1229790	1971070	264667	550264
2009	8579570	2658680	957848	346701	585335	976444	432931
2010	4920900	3023530	1176580	427836	156930	275757	691376
2011	4091930	1705430	1267090	480687	174480	66611.1	450230
2012	4468740	1395280	677845	474683	177147	66925.3	224530
2013	5124930	1555750	593424	283704	199132	77346.9	139901
2014	3804490	1792400	671638	254524	122469	89468.6	105537
2015	6472550	1365490	841942	330751	129128	64667.7	108495
2016	9996550	2363910	678878	454999	187055	76007.9	106840
2017	12310000	3653020	1177430	367986	258232	110495	112897

Table 8.5.1.4. Sardine in 8.c and 9.a: Summary table of the provisional WGHANSA 2017 assessment. CVs, in %, are presented for SSB, recruitment and Apical F (maximum F-at-age by year); biomass and landings in t, recruits in thousand of individuals, F in year^{-1}.

Year	Biomass 1+	SSB	CV SSB	Recruits	CV R	F (2–5)	Apical F	CV apicalF	Landings
1978	538777	489161	0.16	36649000	0.17	0.34	0.39	0.20	145609
1979	692775	634424	0.16	42650600	0.16	0.28	0.31	0.19	157241
1980	865463	796974	0.15	48603800	0.15	0.27	0.31	0.18	194802
1981	1033480	955208	0.14	29964700	0.18	0.26	0.30	0.17	216517
1982	959430	907254	0.15	16000600	0.24	0.26	0.29	0.16	206946
1983	757320	728724	0.15	71258900	0.11	0.25	0.29	0.15	183837
1984	1169550	1062530	0.11	21132900	0.18	0.25	0.29	0.14	206005
1985	990231	946911	0.10	18475700	0.18	0.23	0.26	0.11	208439
1986	798208	767391	0.10	15699300	0.19	0.28	0.32	0.14	187363
1987	642426	616362	0.11	34295800	0.12	0.33	0.37	0.15	177696
1988	706615	654201	0.09	18597000	0.16	0.40	0.45	0.12	161531
1989	625084	591992	0.09	17753400	0.16	0.38	0.44	0.12	140961
1990	562439	533279	0.10	18583100	0.16	0.42	0.47	0.12	149429
1991	517042	486921	0.10	54469900	0.09	0.39	0.44	0.12	132587
1992	851881	769244	0.08	37069000	0.10	0.29	0.32	0.11	130250
1993	962876	898515	0.07	16230800	0.14	0.28	0.31	0.11	142495
1994	811479	780798	0.07	14123400	0.13	0.23	0.26	0.09	136582
1995	672708	648855	0.07	11044400	0.14	0.23	0.26	0.08	125280
1996	538795	519865	0.07	15807300	0.11	0.31	0.36	0.09	116736
1997	478005	452824	0.07	10603200	0.13	0.42	0.47	0.09	115814
1998	386815	368617	0.08	13529300	0.12	0.47	0.53	0.10	108924
1999	370998	359376	0.08	10395400	0.14	0.43	0.48	0.10	94091
2000	317533	300080	0.09	32202500	0.09	0.38	0.43	0.11	85786
2001	477625	405370	0.08	19938500	0.11	0.36	0.41	0.11	101957
2002	491237	427265	0.08	11214800	0.14	0.30	0.34	0.11	99673
2003	466281	429755	0.08	8815260	0.17	0.27	0.30	0.10	97831
2004	407137	379144	0.09	37486000	0.07	0.29	0.33	0.10	98020
2005	545407	433786	0.07	13122500	0.11	0.29	0.33	0.09	97345
2006	640099	587846	0.06	4211660	0.18	0.18	0.19	0.11	87023
2007	504463	492887	0.06	5817800	0.14	0.21	0.22	0.08	96469
2008	391164	384095	0.07	7483730	0.11	0.33	0.34	0.08	101464
2009	294144	287869	0.07	8579570	0.09	0.38	0.39	0.09	87740
2010	247407	244383	0.07	4920900	0.12	0.48	0.50	0.11	89571
2011	178165	176459	0.08	4091930	0.13	0.58	0.60	0.12	80403
2012	132627	131232	0.10	4468740	0.13	0.45	0.47	0.13	54857
2013	123384	121828	0.11	5124930	0.14	0.42	0.44	0.15	45818
2014	130332	130332	0.13	3804490	0.18	0.27	0.28	0.16	27937
2015	128740	128740	0.15	6472550	0.21	0.16	0.17	0.17	20595
2016	165337	165337	0.17	9996550	0.30	0.16	0.17	0.19	22704
2017	194283								

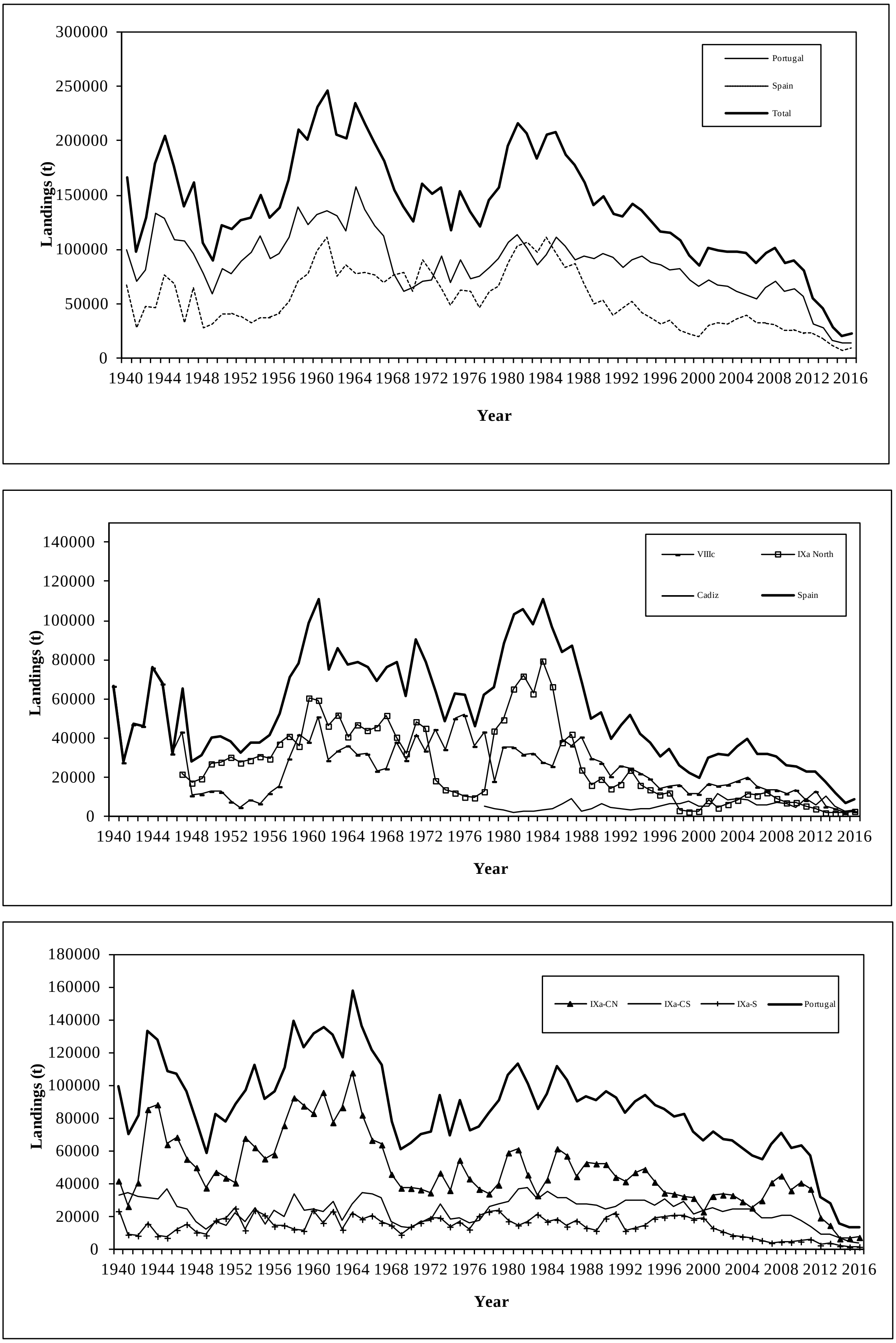


Figure 8.2.2.1. Sardine in 8.c and 9.a: WG estimates of annual landings of sardine, by country (upper panel) and by ICES subdivision and country.

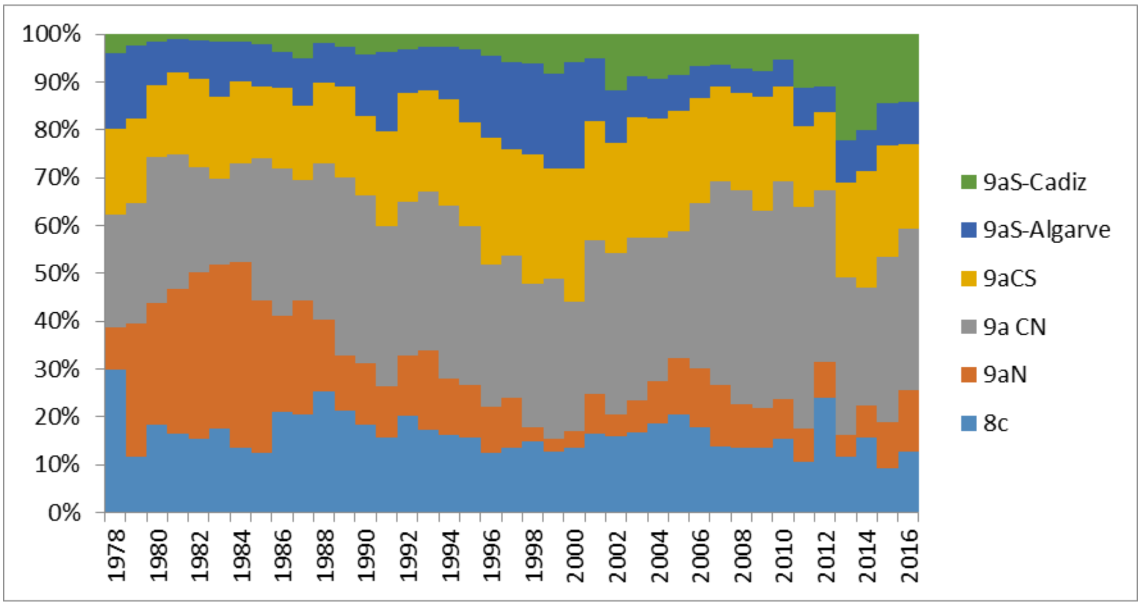
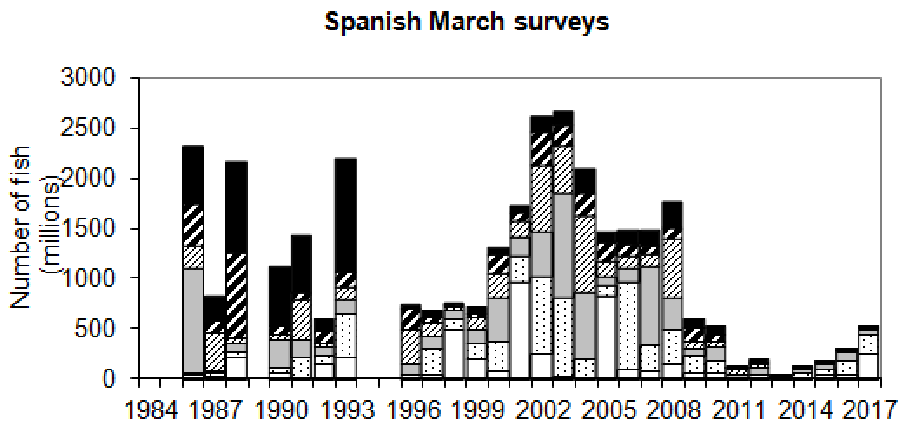


Figure 8.2.2.2. Sardine in 8.c and 9.a: Historical relative contribution of the different subareas to the total catches (1978–2016).



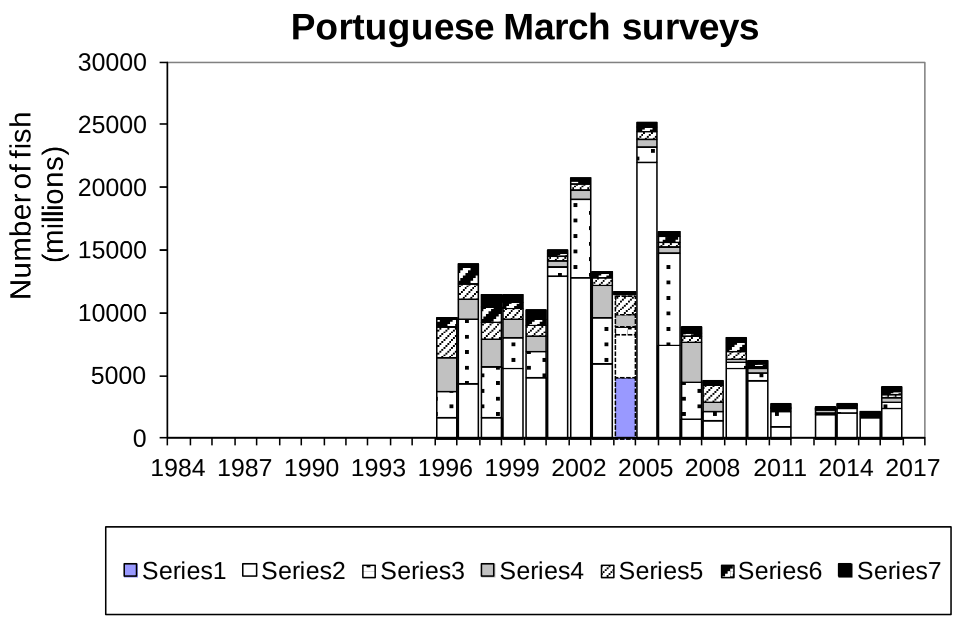


Figure 8.3.1. Sardine in 8.c and 9.a: Total abundance and age structure (numbers) of sardine estimated in the acoustic surveys. The Spanish March survey series covers area 8.c and 9.a-N (Galicia) and the Portuguese March surveys covers the Portuguese area and the Gulf of Cadiz (Subdivisions 9-CN, 9.a-CS, 9.a-S-Algarve and 9.a-S-Cadiz). Portuguese acoustic survey in June 2004 was considered as indications of the population abundance and is not included in assessment. Estimates from Portuguese acoustic surveys are not available for 2012 (year without survey) and 2017 (not reported for the moment).

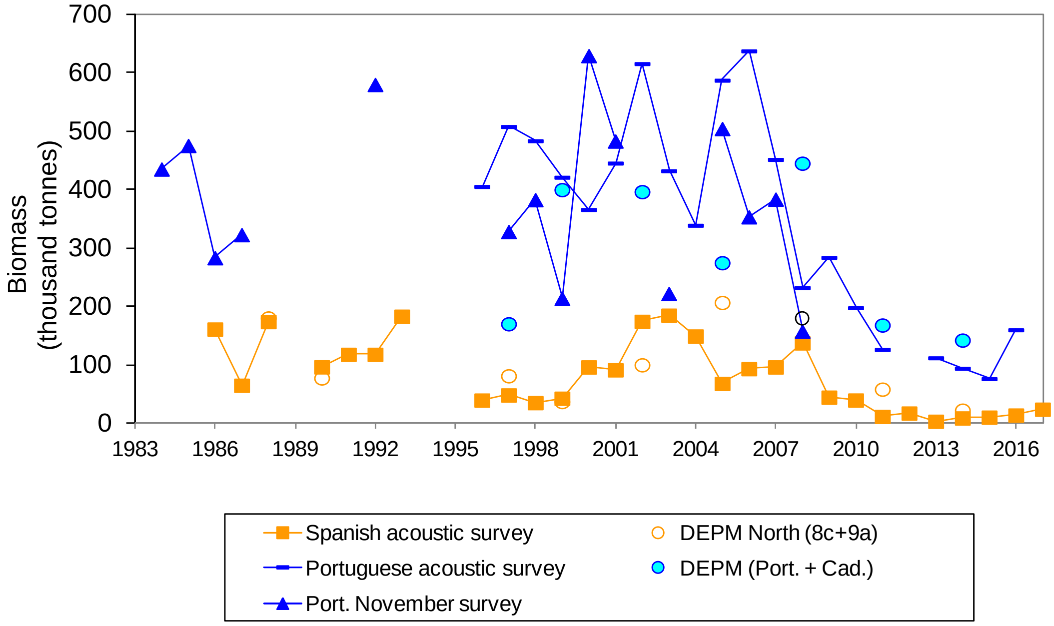


Figure 8.3.2. Sardine in 8.c and 9.a: Total sardine biomass (thousand tonnes) estimated in the different series of acoustic surveys and SSB estimates from the DEPM series covering the northern area and the west and southern area of the stock. For 2017, values for DEMP surveys and Portuguese acoustic survey are not available for the moment.

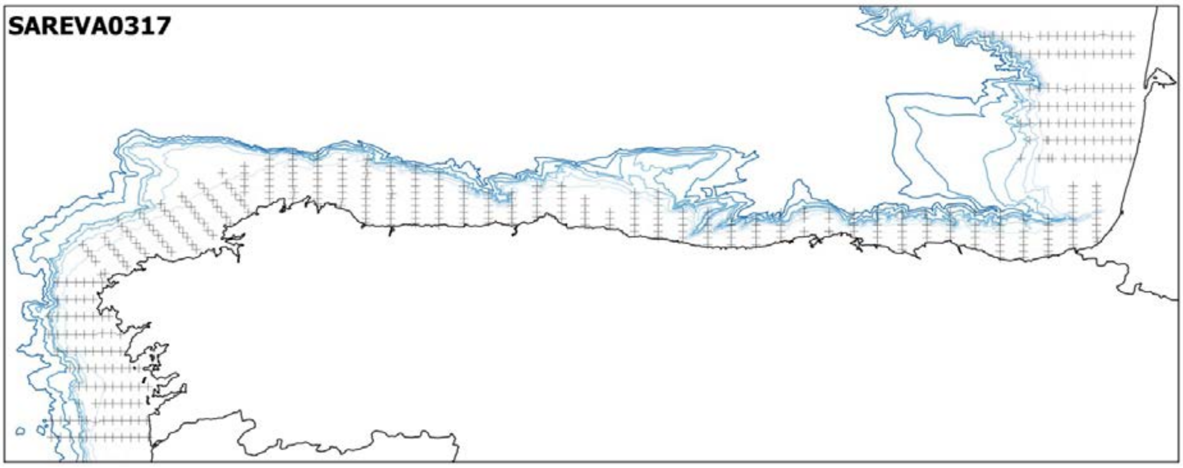


Figure 8.3.1.1.1. Sardine in 8.c and 9.a: area sampled by SAREVA0317 Spanish DEPM survey.

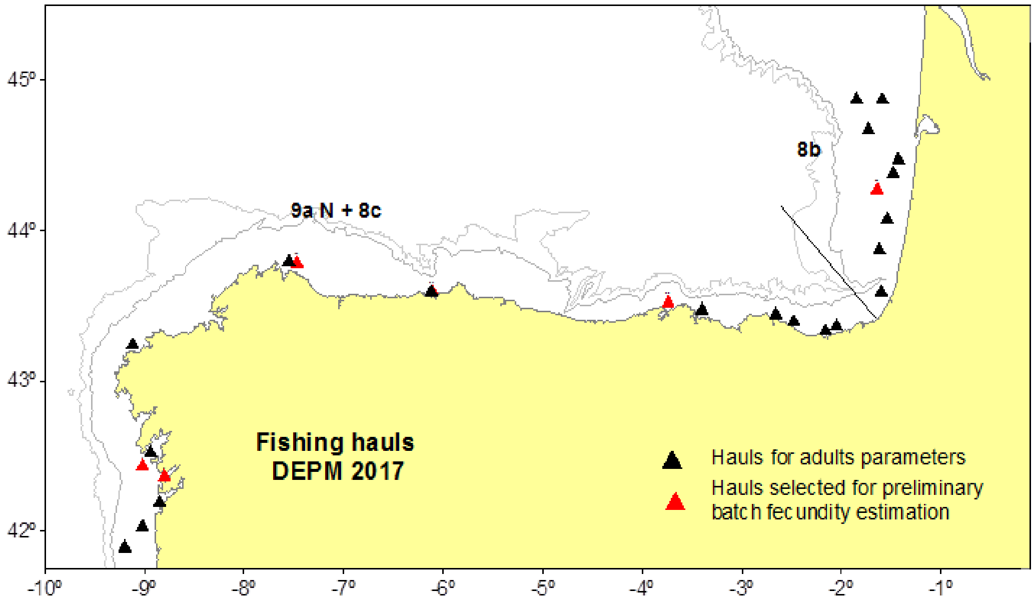
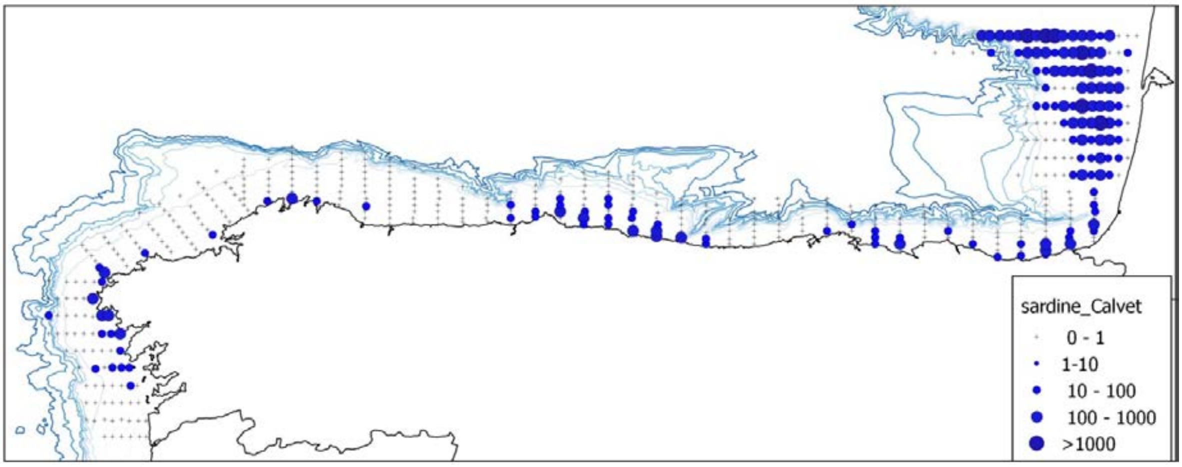


Figure 8.3.1.1.2. Sardine in 8.c and 9.a: Spatial distribution of fishing hauls for adult DEPM parameters estimation. Hauls selected for preliminary batch fecundity estimation (triangle in red).



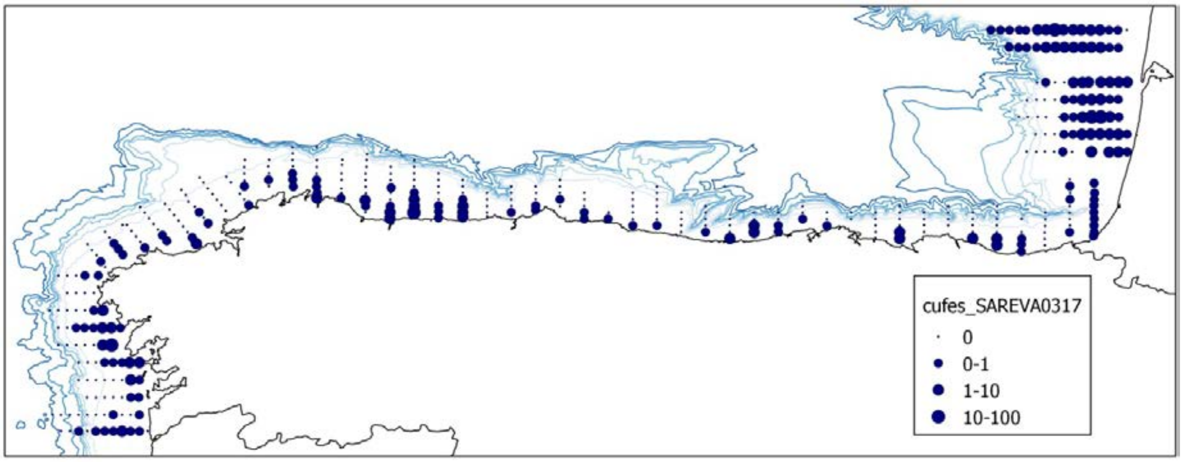


Figure 8.3.1.1.3. Sardine in 8.c and 9.a: Sardine egg density in CUFES (top) and CALVET (bottom) samples from Spanish 2017 DEPM survey.

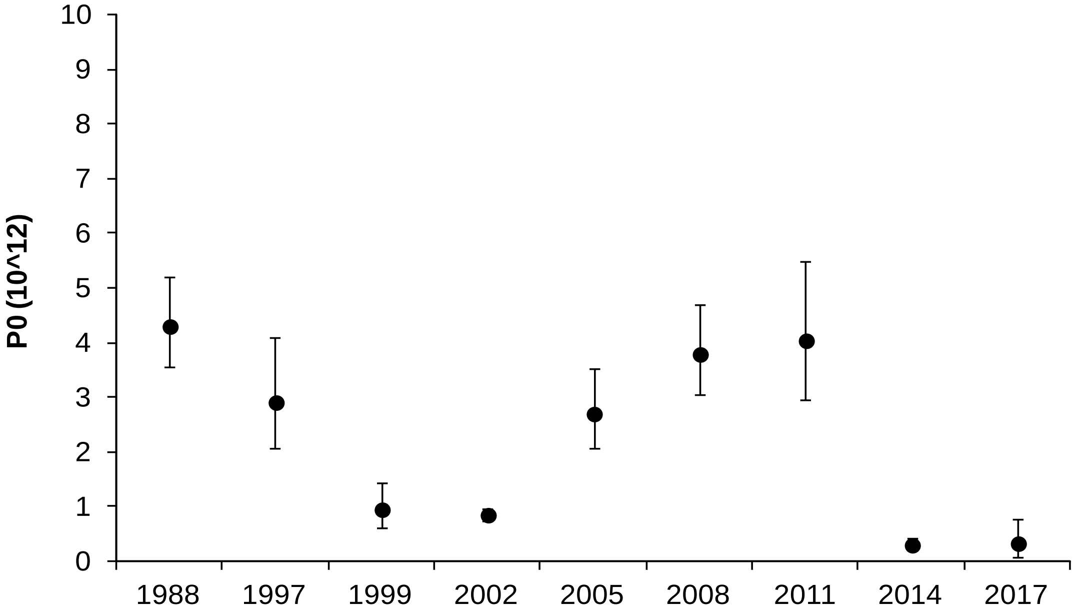


Figure 8.3.1.1.4. Sardine in 8.c and 9.a: Total egg production (eggs/day*10^{12}) in north stratum along the time-series (1988–2017). Dots and lines indicate egg production estimates and confidence intervals.

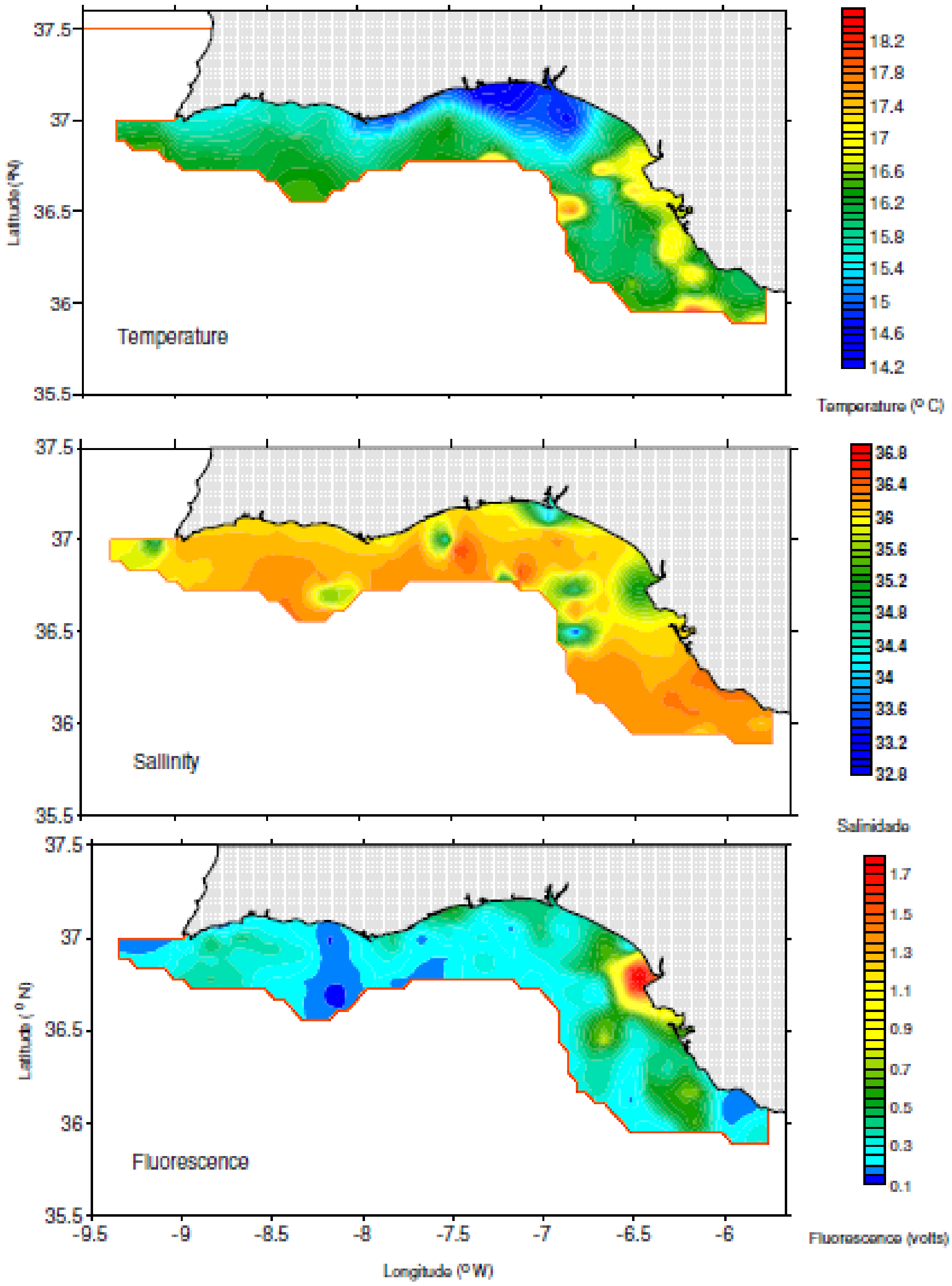


Figure 8.3.1.2.1. Surface temperature (top panel), salinity (mid panel) and fluorescence (bottom panel) distributions obtained by the sensors associated to the CUFES pump.

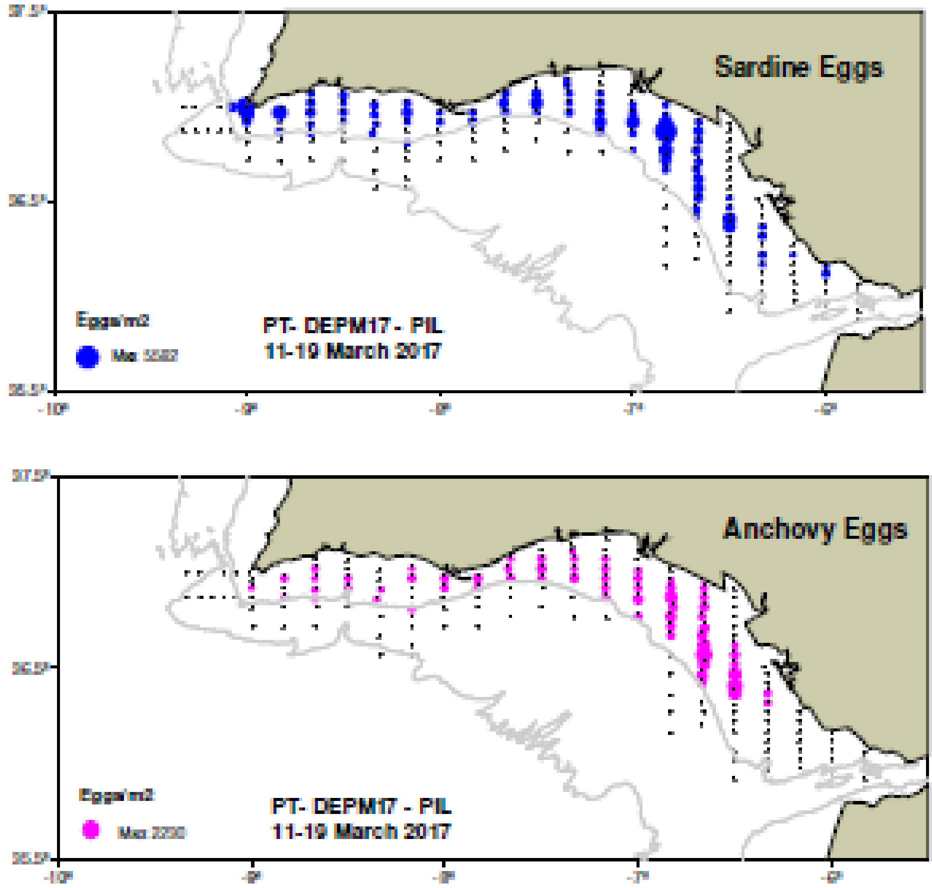


Figure 8.3.1.2.2. Egg distribution (eggs/m²) derived from CalVET surveying, top panel: sardine, bottom panel: anchovy.

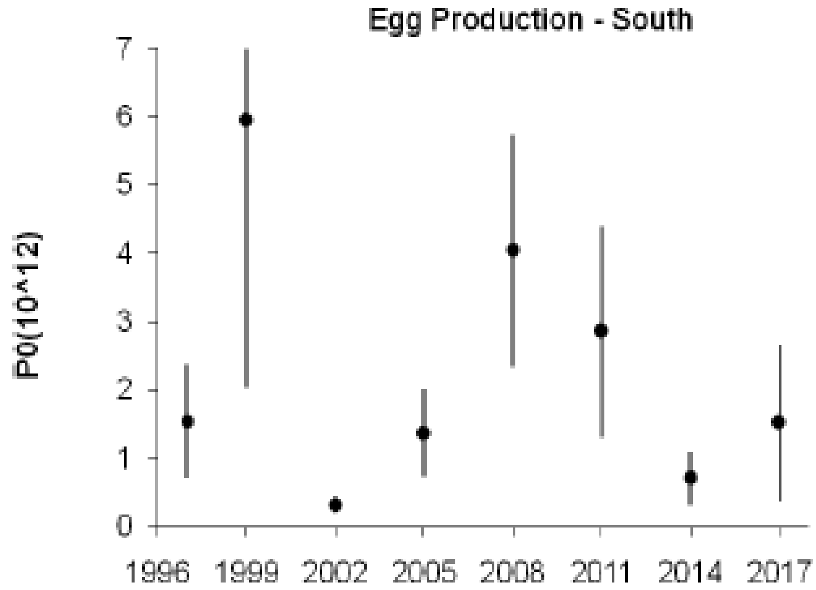


Figure 8.3.1.2.3. Sardine egg production (eggs/day) estimates for the southern stratum (ICES 9.a south) during the DEPM series (1997–2017).

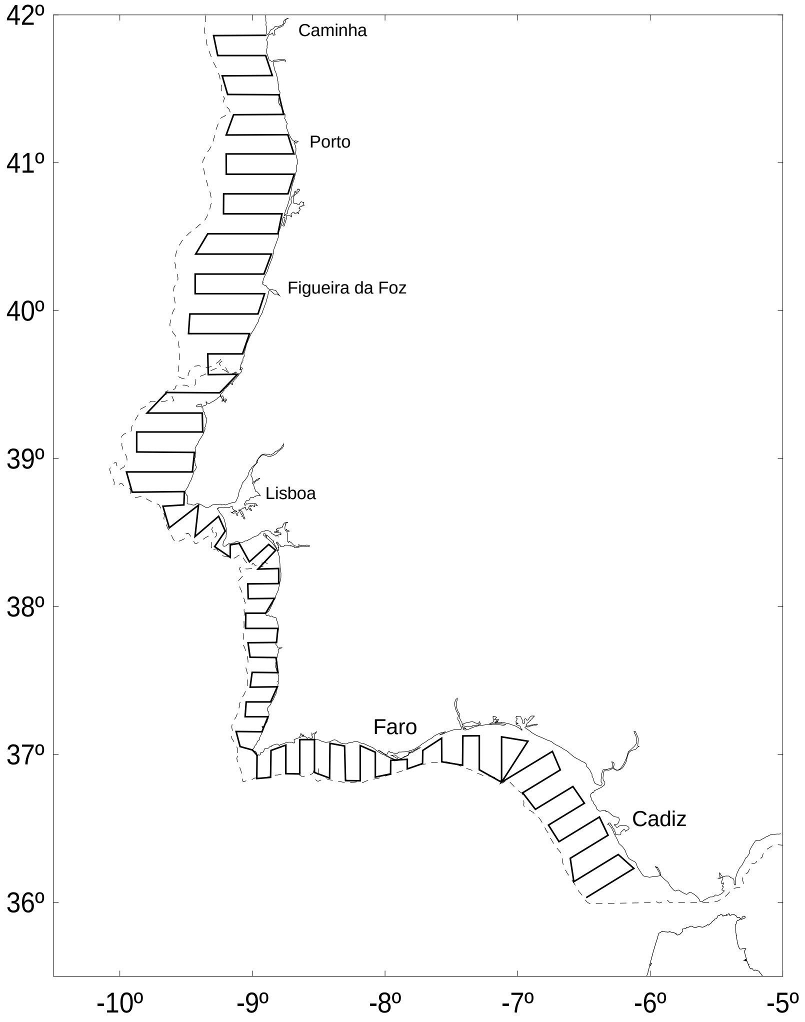


Figure 8.3.2.1.1. Sardine in 8.c and 9.a: acoustic transect during PELAGO 2017 survey.

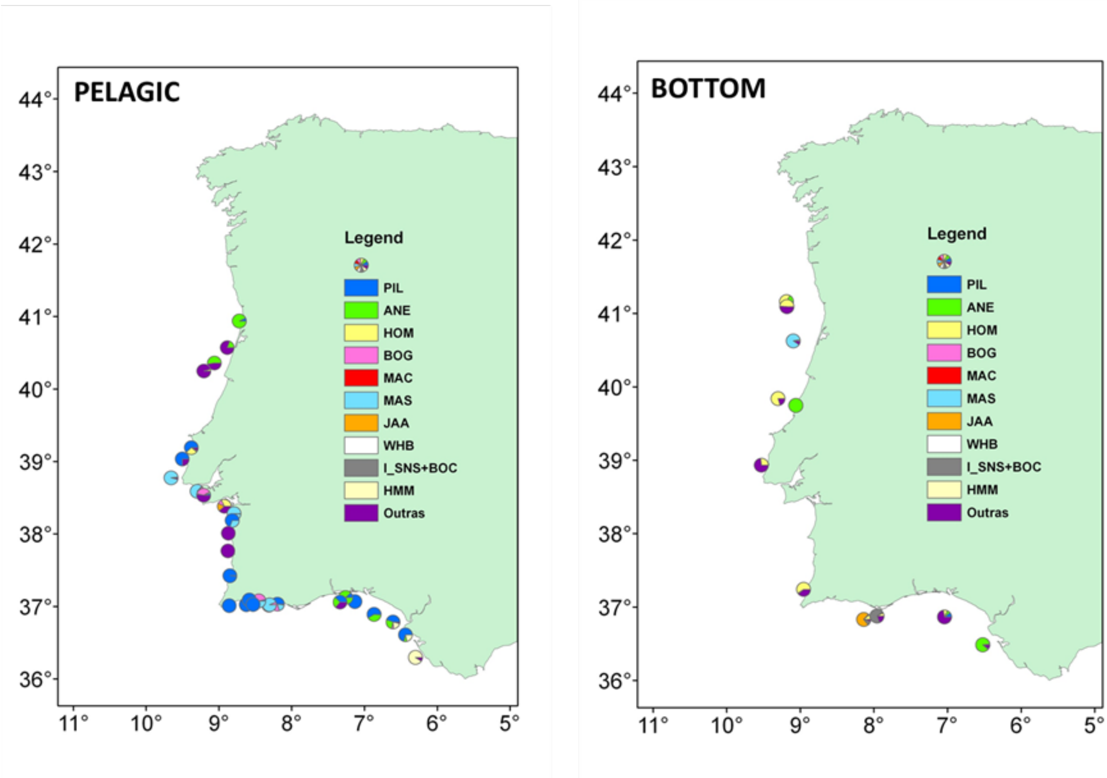


Figure 8.3.2.1.2. Sardine in 8.c and 9.a: Fishing haul operations during PELAGO 2017 survey. Left: pelagic trawl operations, right: bottom trawl operations.

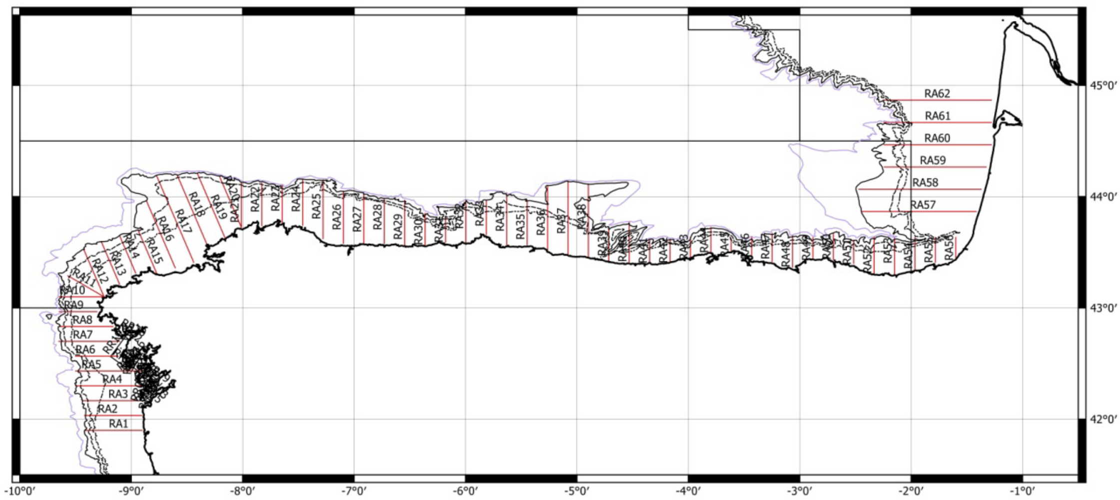


Figure 8.3.2.2.1. 2017 PELACUS survey track.

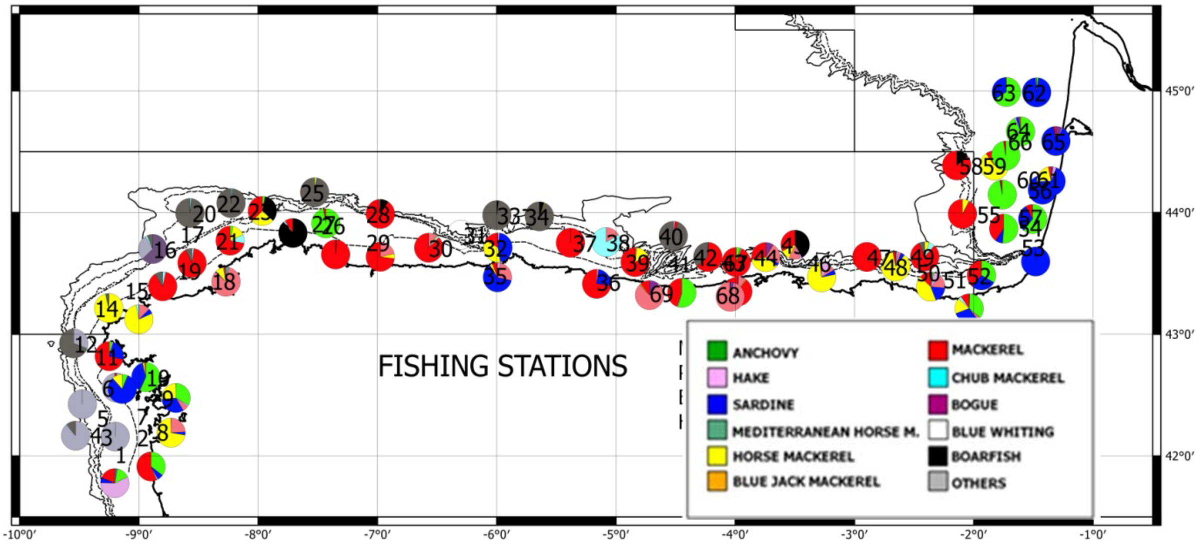


Figure 8.3.2.2.2. Sardine in 8.c and 9.a: Spanish spring acoustic survey PELACUS0317. Fishing hauls.

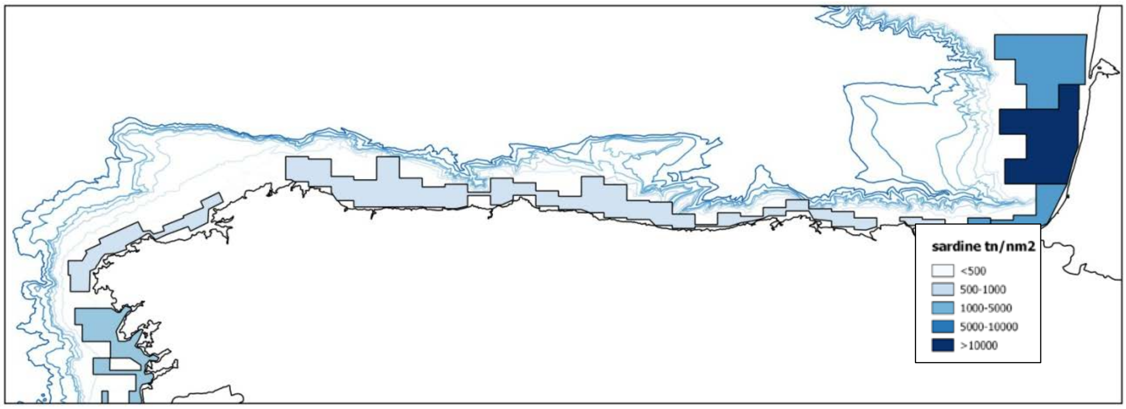


Figure 8.3.2.2.3. Sardine in 8.c and 9.a: Spanish spring acoustic survey PELACUS0317. Spatial distribution of energy allocated to sardine during the PELACUS0317 survey. Polygons are drawn to encompass the observed echoes, and polygon colour indicates integrated energy in m² within each polygon.

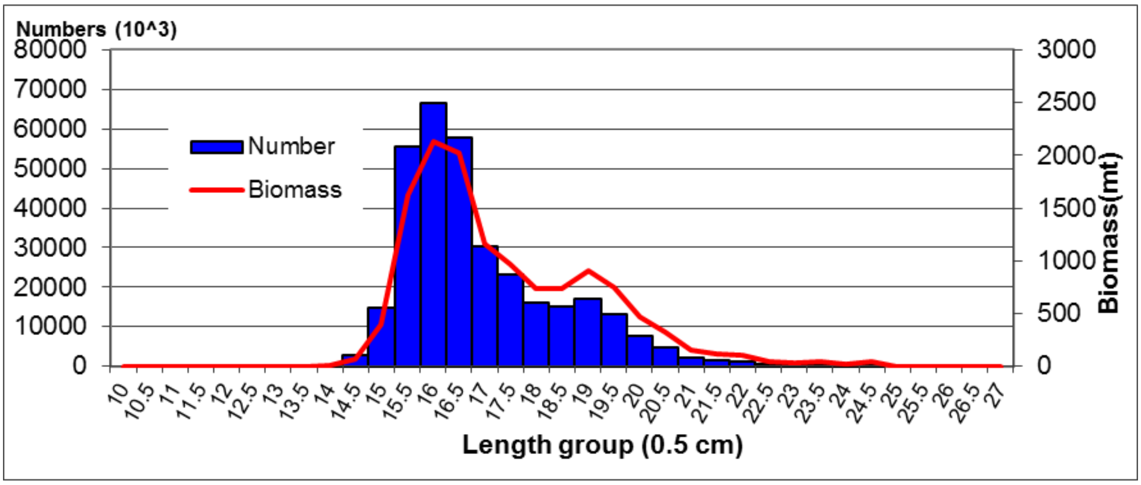


Figure 8.3.2.2.4. Sardine in 8.c and 9.a: Spanish spring acoustic survey PELACUS0317.Sardine length distribution (cm) in numbers and biomass (tonnes). In the small chart, the estimates when excluded the school accounted as probably sardine.

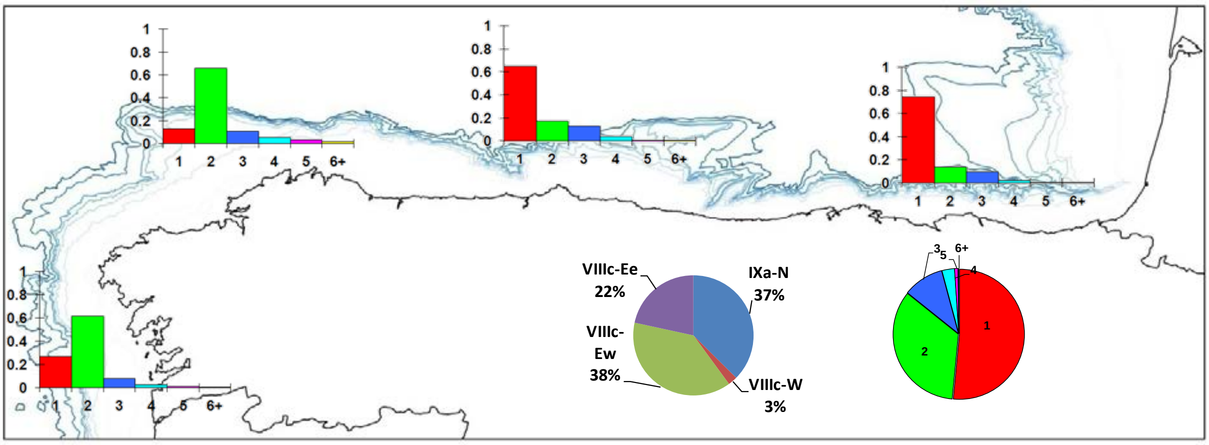


Figure 8.3.2.2.5. Sardine in 8.c and 9.a: Spanish spring acoustic survey in 2017. Sardine age frequency by area and age and area contribution to the total abundance (charts) in PELACUS0317.

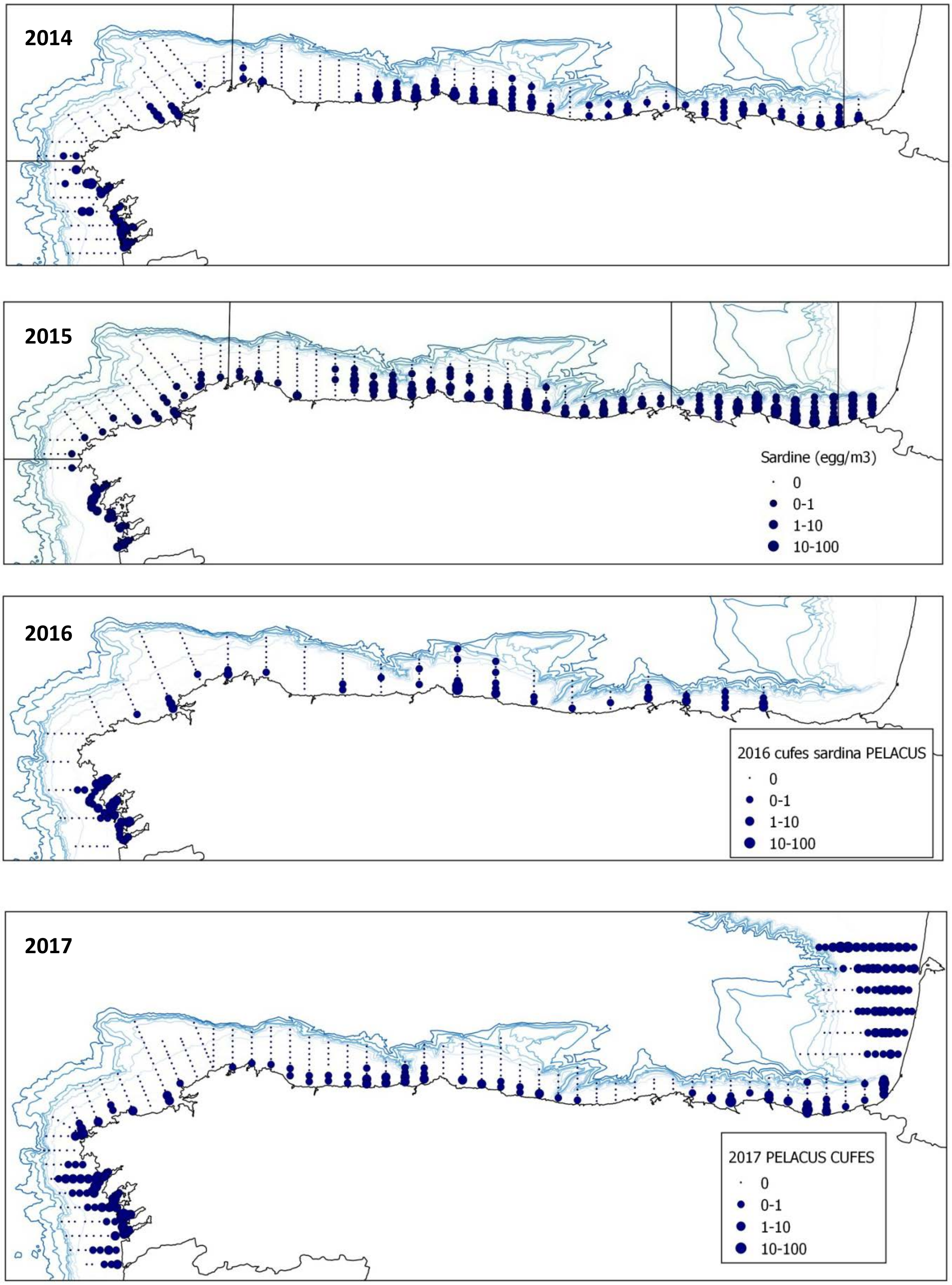


Figure 8.3.2.2.6. Sardine in 8.c and 9.a: Spanish spring acoustic survey in 2017. PELACUS0317. Total number of sardine eggs obtained during the PELACUS (2014–2017) surveys. Diameter of circles is proportional to egg density.

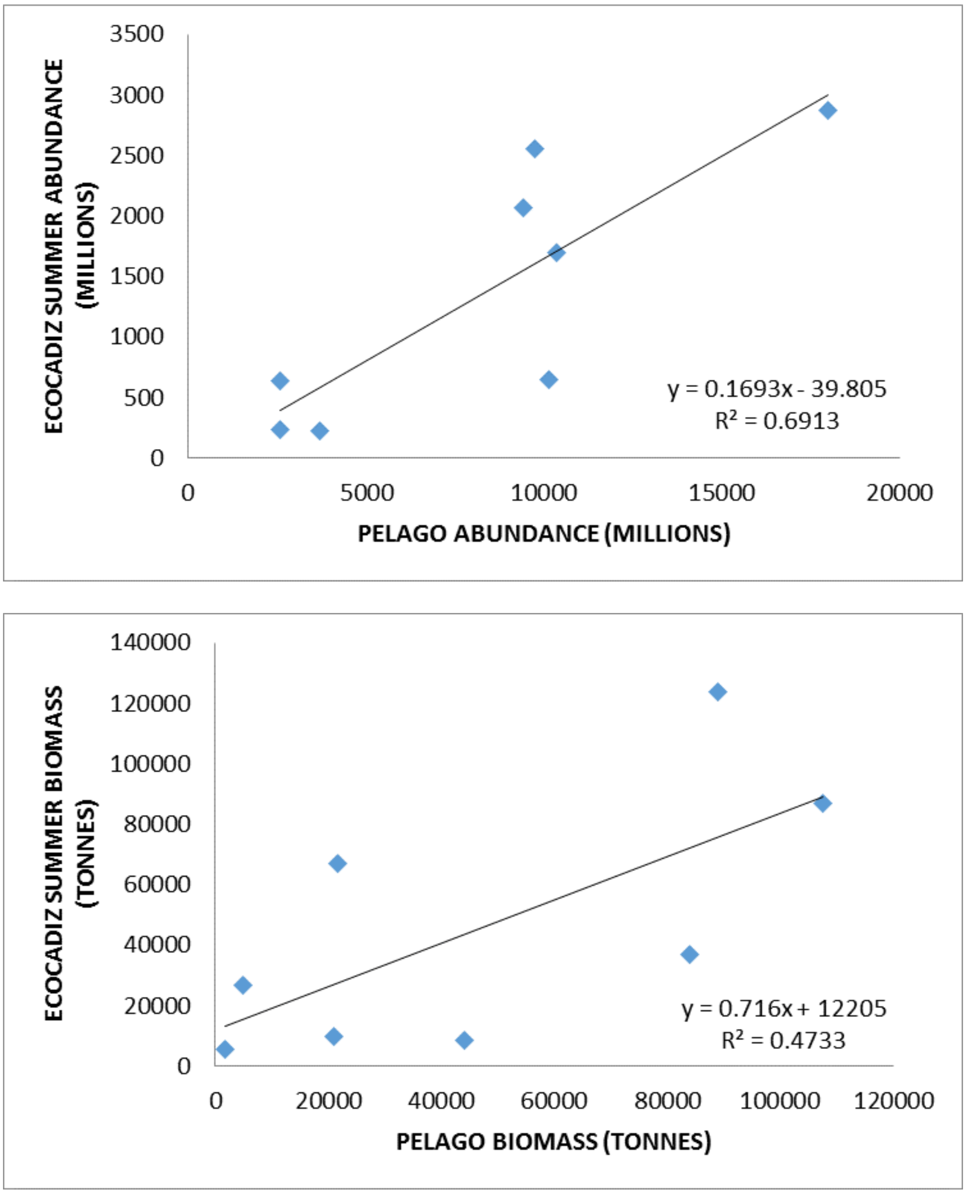


Figure 8.3.3.1. Sardine in 8.c and 9.a: relationship between abundance (top) and biomass (bottom) between PELAGO and ECOCADIZ-summer surveys.

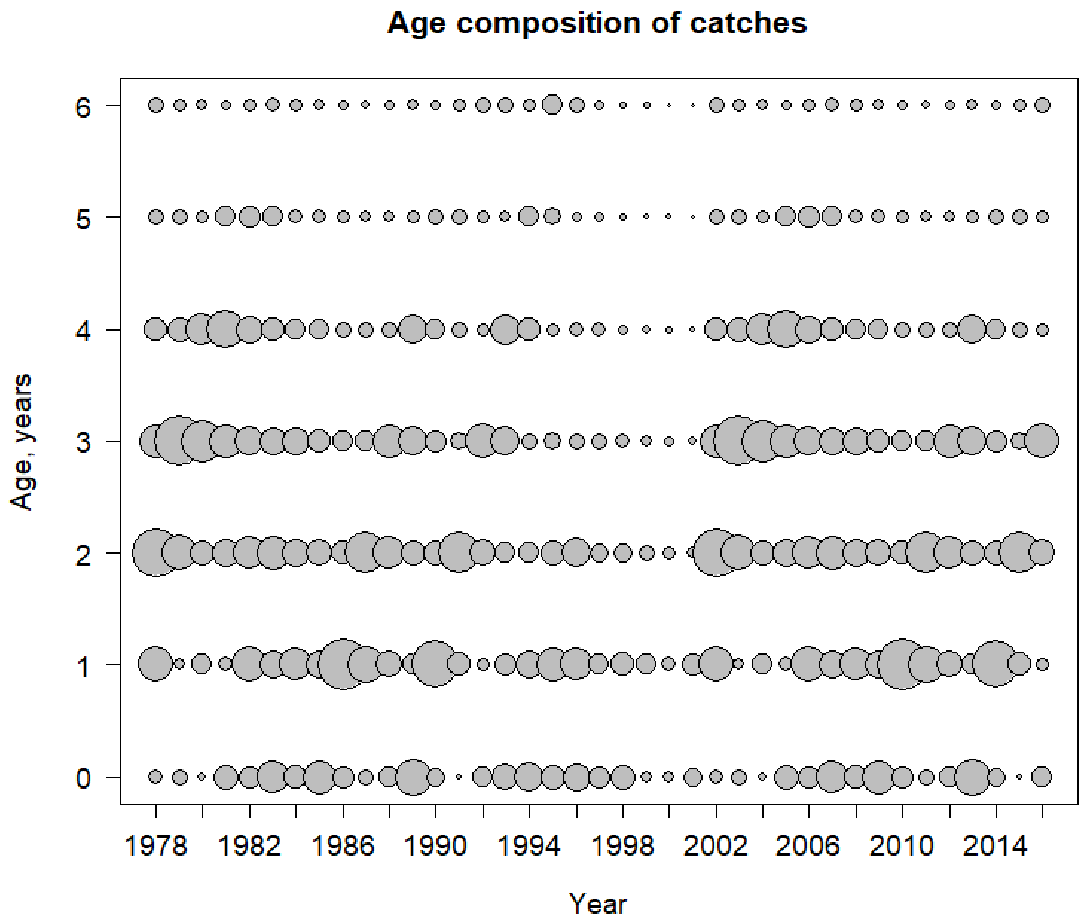


Figure 8.4.4.1. Sardine in 8.c and 9.a: Catches-at-age for 1978–2016.

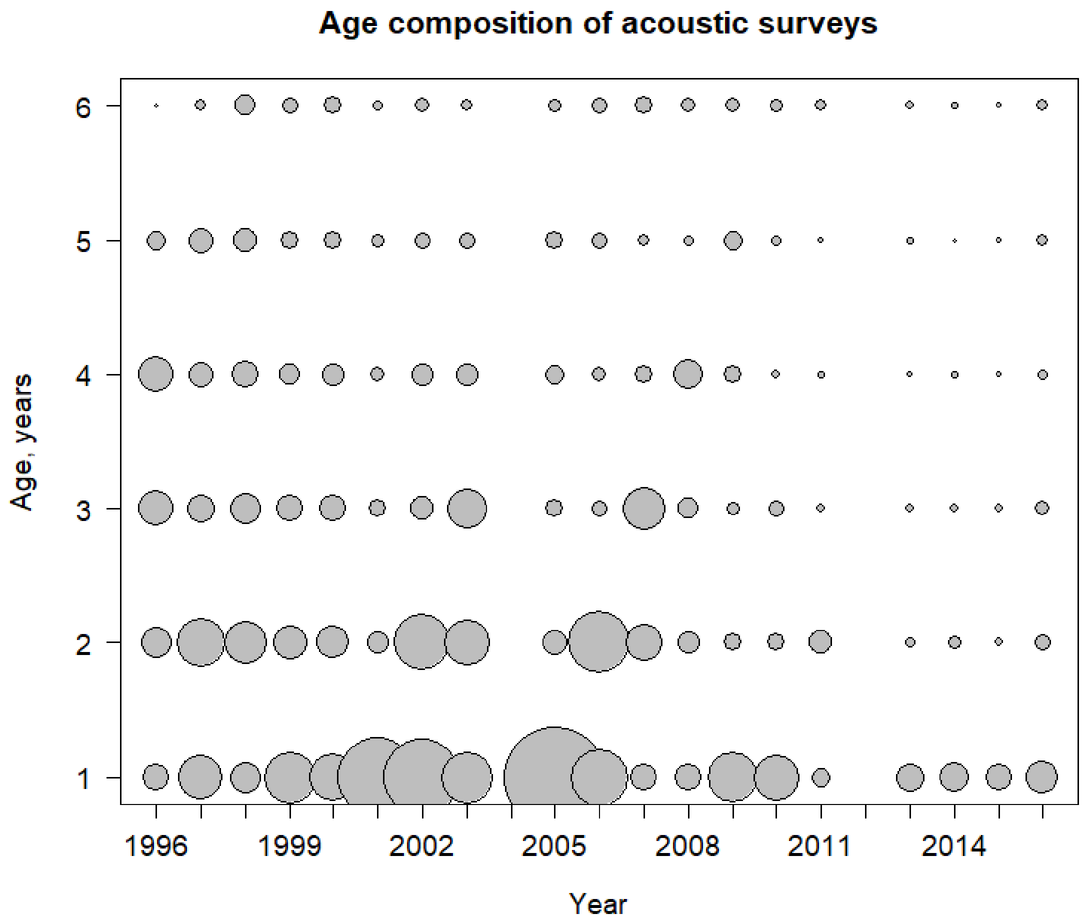


Figure 8.4.4.2. Sardine in 8.c and 9.a: Abundance-at-age in the joint Spanish-Portuguese spring acoustic survey 1996–2016.

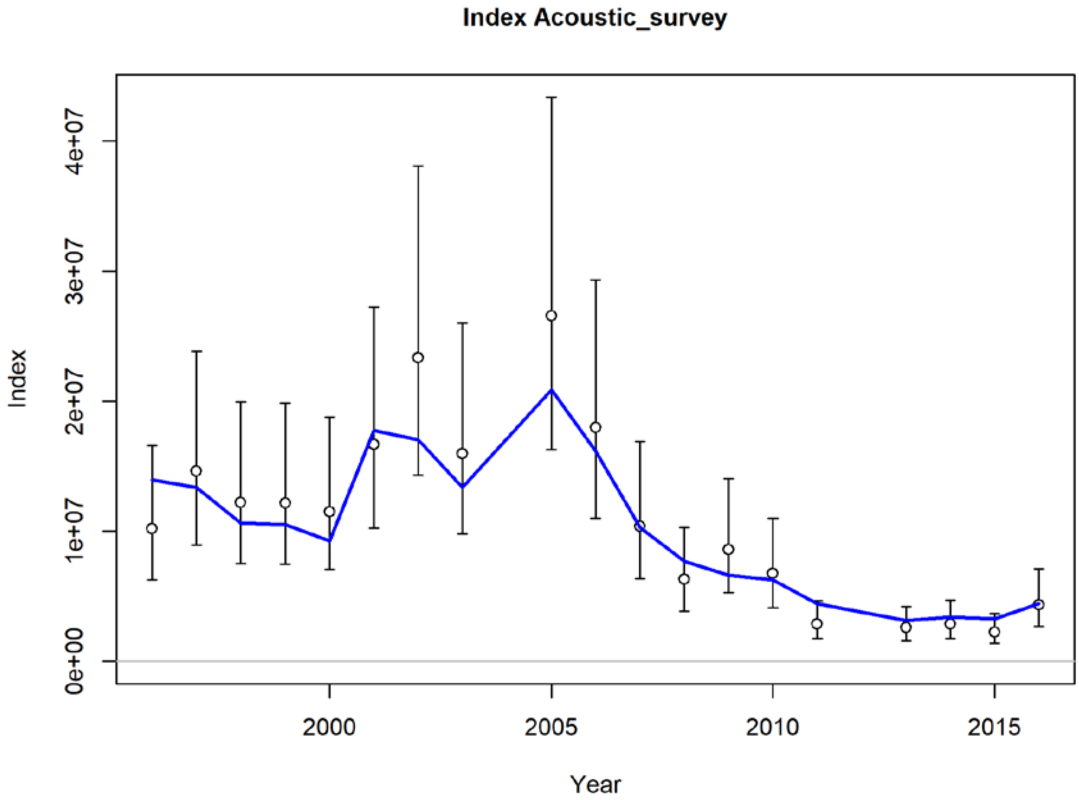


Figure 8.5.1.1. Sardine in 8.c and 9.a: Model fit to the acoustic survey series. The index is total abundance (in thousands of individuals). Bars are standard errors re-transformed from the log scale.

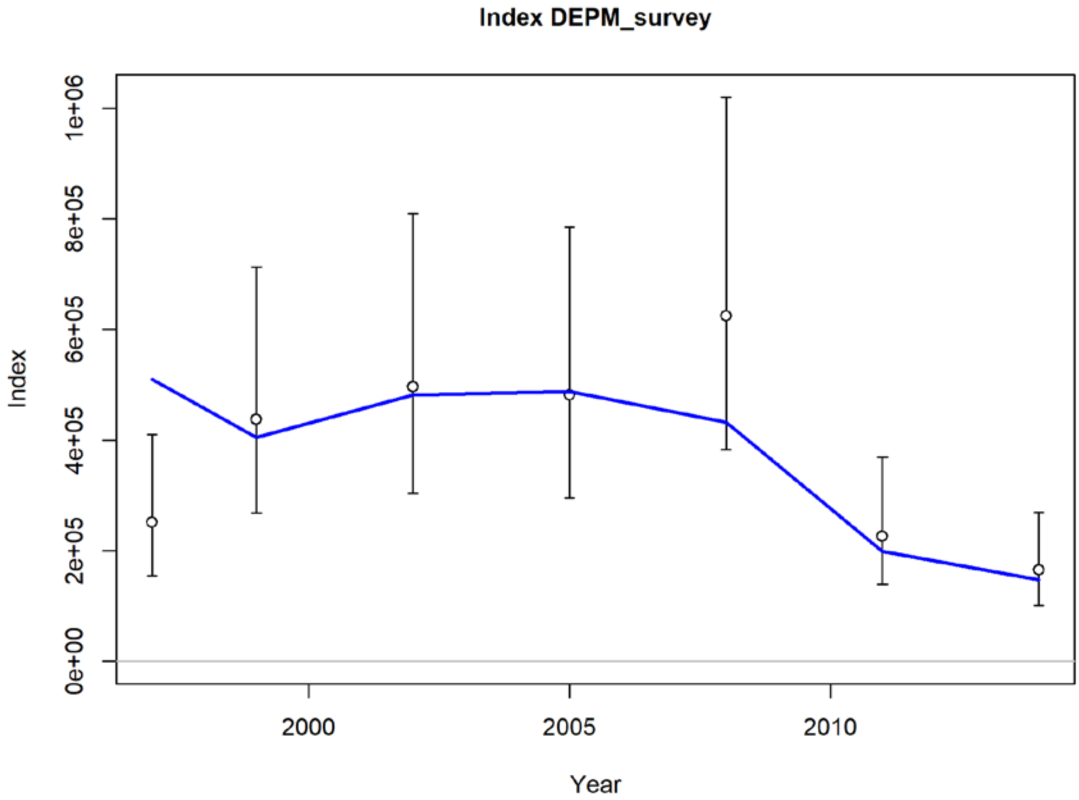


Figure 8.5.1.2. Sardine in 8.c and 9.a: Model fit to the DEPM survey series. The index is SSB (in thousand tons). Bars are standard errors re-transformed from the log scale.

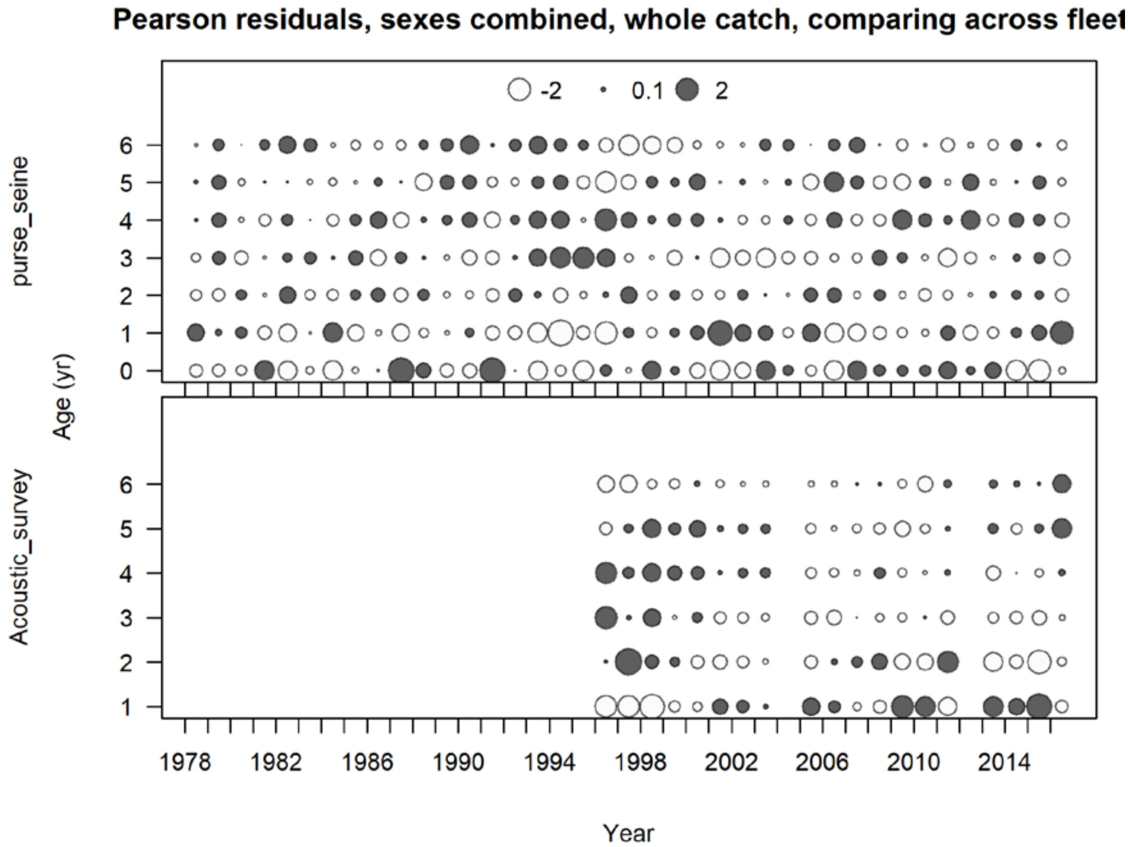


Figure 8.5.1.3. Sardine in 8.c and 9.a: Model residuals from the fit to the catch-at-age composition (top) and the acoustic survey age composition (bottom).

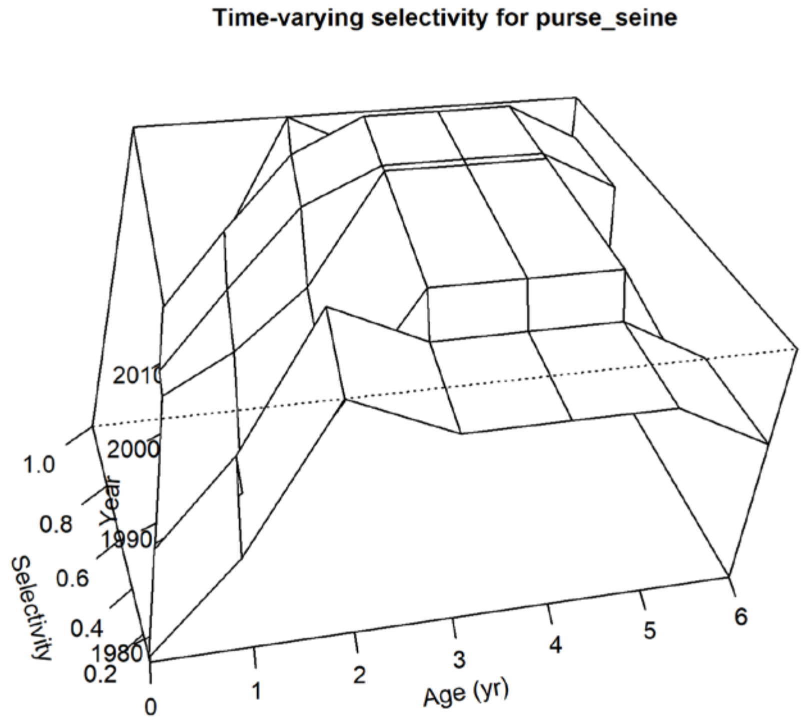


Figure 8.5.1.4. Sardine in 8.c and 9.a: Selectivity-at-age in the fishery showing the three blocks of fixed selectivity, 1978–1987, 1988–2005 and 2006–2016.

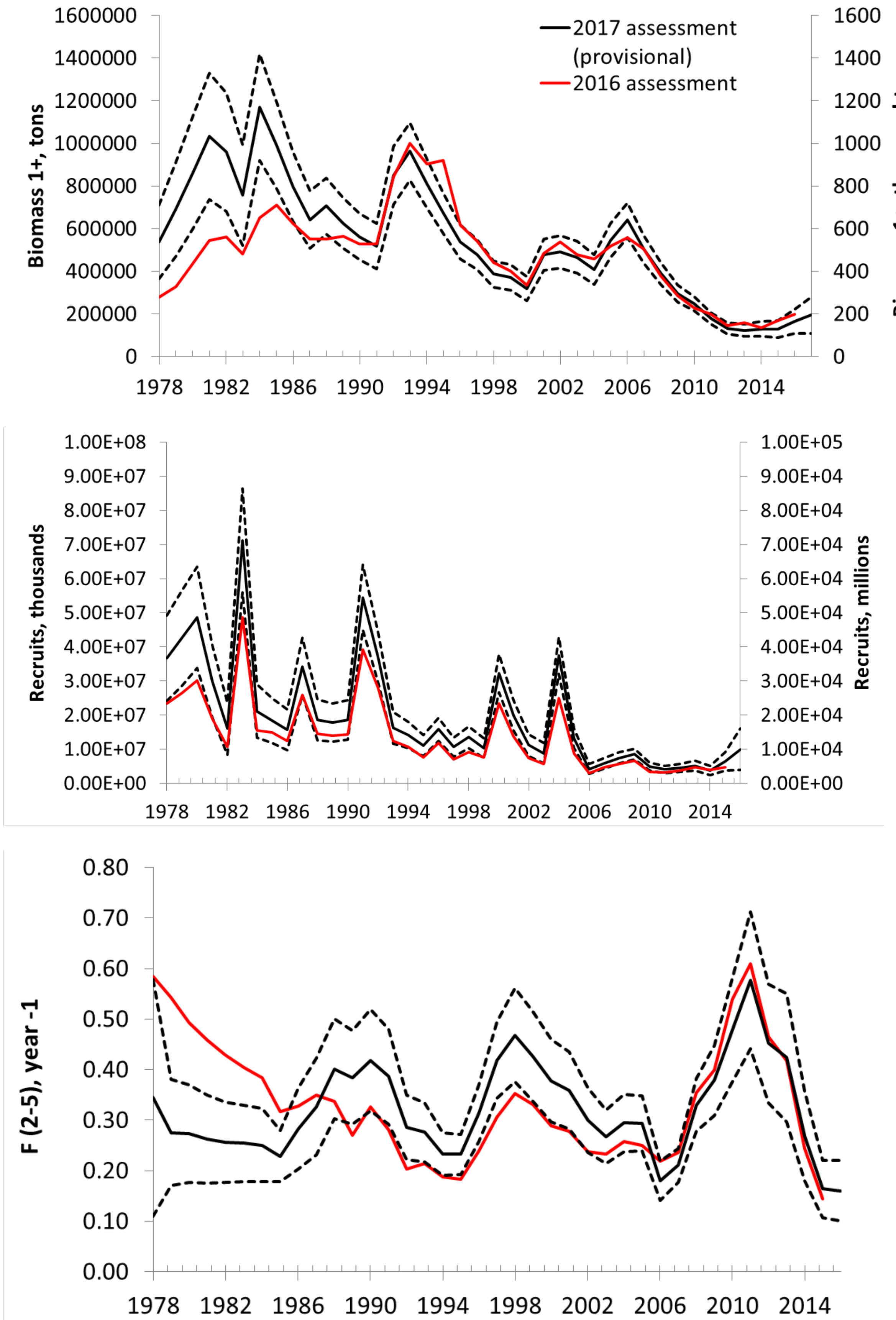


Figure 8.5.1.5. Sardine in 8.c and 9.a: Historical B1+ (top), F (middle) and recruitment (bottom) trajectories in the period 1978–2016 (B1+ is estimated up to 2017). The WG2016 assessment is shown for comparison (red line).

9 Southern Horse Mackerel (hom.27.9a)

9.1 ACOM Advice Applicable to 2017, 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) has been relatively stable over the time-series and above MSY $B_{trigger}$. SSB has increased in the last two years resulting from the strong recruitments in 2011 and 2012. The ICES advice was based on the MSY approach. ICES therefore recommended that catches in 2017 should not exceed 73 349 t. ICES also recommended that the TAC for this stock should only apply to *Trachurus trachurus*. STECF agreed with the ICES assessment of the state of the stock and the advice for 2017. A TAC of 73 349 t in 2017 has been set for *Trachurus* spp.

9.2 The fishery in 2016

9.2.1 Fishing fleets in 2016

Six fleets used to target on southern horse mackerel in Division 9.a. These fleets are defined by the gear type (bottom trawl, purse-seine and artisanal) and country (Portugal and Spain). Portuguese bottom-trawl fleet, Portuguese purse-seine fleet and Spanish purse-seine fleet show a similar exploitation pattern with a great presence of juveniles and lower abundance of adults. The Portuguese artisanal fleet is mainly composed by small size vessels licensed to operate with several gears (gill and trammelnets, purse-seine and lines). Catches of horse mackerel from the Portuguese artisanal fleet are mainly from trips operating with nets showing the presence of larger/adult fish while the catches from trips operating with purse-seine show the presence of small/juveniles. The Spanish bottom trawl fleet catches mainly adults. Horse mackerel is the main target species in the Portuguese bottom trawl demersal fish fleet, which accounts for more than 50% of the Portuguese annual catches, while in Spain main catches are from the Purse-seine fleet (70%). Spanish artisanal fishery is negligible (<5%). In recent years, and due to the lower catch opportunities for the Iberian sardine stock (sar27.8c9a), the relative importance in the annual catches of the purse-seine fleets has increased. Description of the Portuguese and Spanish fleets is available in Stock Annex.

9.2.2 Catches by fleet and area

The catches of horse mackerel in Division 9.a comprise the following four subdivisions: 9.aNorth (9.a.n: Spain - Galicia), 9.aCentral-North (9.a.c.n: Portugal – Caminha to Figueira da Foz), 9.aCentral-South (9.a.c.s: Portugal – Nazaré to Sines) and 9.aSouth (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. However, the definition of the Subdivisions was set quite recently (ICES, 1992) and some of the previous catch statistics came from an area that comprised more than one subdivision. This is the case of the Galician coasts where the Subdivision 8.c West and Subdivision 9.a North are located. That is the reason why the time-series of catch statistics used in the assessment of southern stock is from 1992 onwards. Spanish catches from the Gulf of Cádiz (Subdivision 9.a.s) are available since

2002 but they are scarce, representing less than the 5% of the total catch and, therefore, are not included in the assessment to avoid a possible bias in the assessment results. 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.

The catch time-series used in the assessment (1992–2016) shows a peak in 1998, of 41 564 t, a steady increase from 2011 to 2015, peaking again in 2016 with 40 741 t (Table 9.2.2.1, Figure 9.2.2.1). The minimum catch, of 18 887 t, was observed in 2003. The relative contribution of each gear to the total catch is given in Table 8.2.2.2. Until 2011 the highest contribution to the total catches was, in general, from the trawl fleets. Since 2012 there has been a significant increase in the catches from the purse seine, in particular from the Spanish purse seine, of 42% from 2015 to 2016. The catches from the Portuguese purseseine decreased 21% from 2015 to 2016. The contribution of the artisanal fleet from both Portugal and Spain is very small, less than 10% in recent years.

Table 9.2.2.1. Time-series of southern horse mackerel historical catches (in tonnes).

YEAR	TOTAL CATCH
1991	34,992
1992	27,858
1993	31,521
1994	28,441[1]
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)*
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)*

(*) 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 data until the rest of the time-series is completed.

(1) These figures have been revised in 2008.

Table 9.2.2.2. Southern horse mackerel landings by gear in the period 1992–2016 (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%
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
	30.97%	50.95%	18.09%
2013	9,221	16,774	2,687
	33.77%	57.09%	9.14%

Year	Bottom trawl	Purse seine	Artisanal
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%

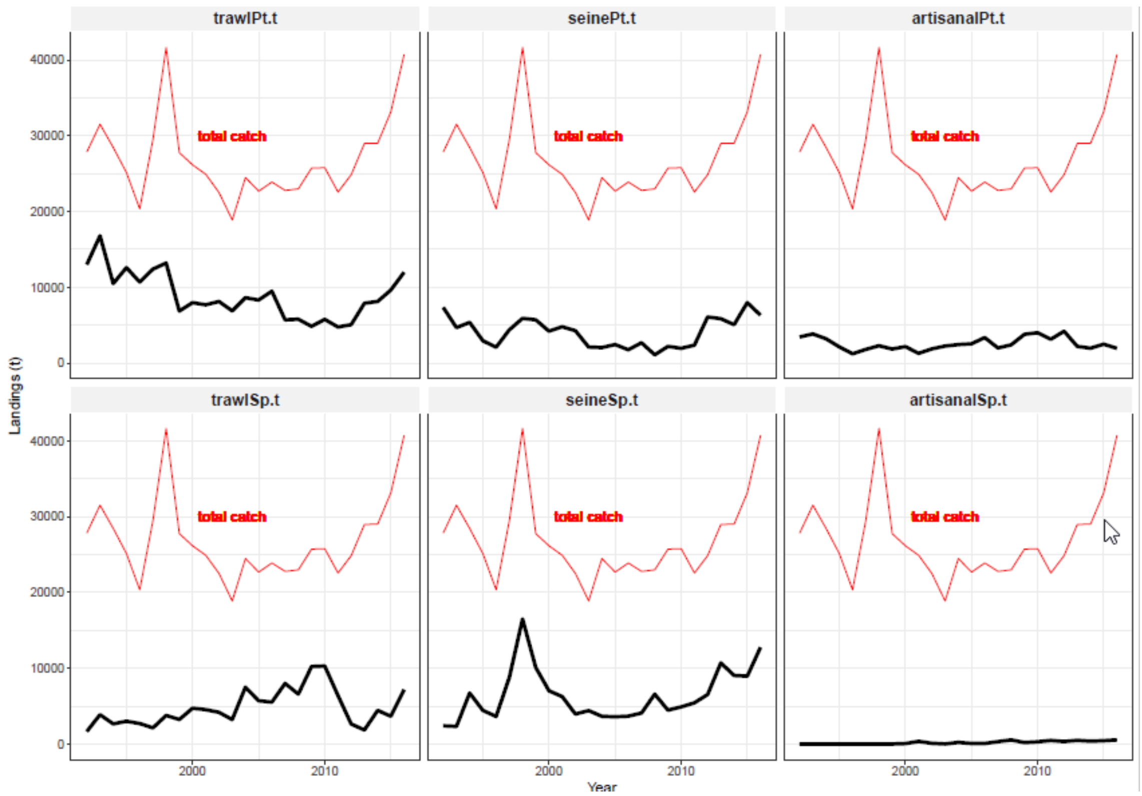


Figure 9.2.2.1. Time-series of southern horse mackerel catches (in tonnes) by country (Pt – Portugal; Sp – Spain) and gear.

Discards are estimated by both countries (Portugal since 2014, Spain since 2003) from national at-sea sampling (DCF) on board commercial vessels operating in ICES Division 9a. Discards are usually very low and not frequent thus being considered negligible. The horse mackerel Spanish Discards come mainly from the bottom trawl fleet. Spanish discards in 2016 at Subdivision 9a were estimated to be around 486 tonnes, mainly from the trawl fleet (Table 9.2.2.3). The frequency of occurrence of horse mackerel discards from the Portuguese fleets in 2016 were either too low (considered zero discards because such low frequency of occurrence bias will result in highly biased estimates) or inexistent (Table 9.2.2.3).

Table 9.2.2.3. Discard estimates (tonnes) of southern horse mackerel in 2016 by country (SP – Spain, PT - Portugal), fleet/metier and quarter.

Country	Fleet	Metier	FishingArea	Quarter				Total
				1	2	3	4	
SP	artisanal	GNS_DEF_60-79_0_0	27.9.a	0.0	0.0	0.0	0.9	0.9
SP	artisanal	GNS_DEF_80-99_0_0	27.9.a	0.0	0.6	0.4	0.0	0.9
SP	trawl	OTB_DEF_BIG=55_0_0	27.9.a	7.7	43.5	2.8	3.3	57.3
SP	trawl	OTB_MCD_BIG=55_0_0	27.9.a	26.9	82.9	25.7	231.1	366.5
SP	trawl	OTB_MPD_BIG=55_0_0	27.9.a	0.5	0.0	0.0	24.2	24.7
SP	trawl	PTB_MPD_BIG=55_0_0	27.9.a	1.3	0.0	0.0	0.0	1.3
SP	purse-seine	PS_SPF_0_0_0	27.9.a	0.6	26.1	7.0	1.0	34.8
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

9.2.3 Effort and catch per unit of effort

No series of catch perunit of effort (cpue) is currently available to be used for stock assessment.

9.2.4 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 quarterly ALK (Portuguese data) and a semester ALK (Spanish data) 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 total international catch-at-age from 1992–2016 with age range 0–11+.

In general, catches are dominated by juveniles and young adults (Table 9.2.4.1, Figure 9.2.4.1).

Table 9.2.4.1. Southern horse mackerel catch-at-age data in the period 1992–2016 (thousands).

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

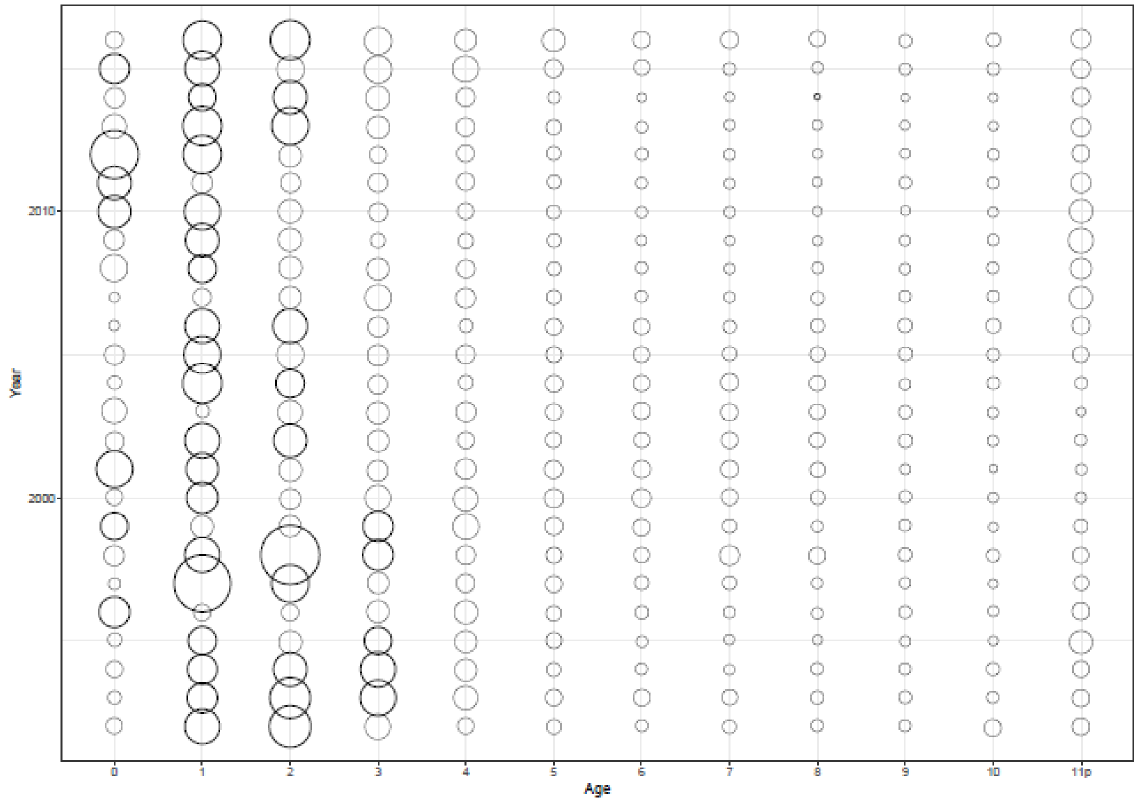


Figure 9.2.4.1. Bubble plot of proportions of southern horse mackerel catch in numbers-at-age**, by year (1992–2016).**

Table 9.2.4.2 presents the southern horse mackerel catch in numbers-at-age by fishing fleet and Figure 9.2.4.2 shows the proportion of catch-at-age by fleet and country in the period 1992–2016. The Portuguese and Spanish purse-seine fleet and the Portuguese trawl fleet catch mainly juveniles and young adults, while the Spanish trawl and artisanal fleets catch larger, adult horse mackerel.

Table 9.2.4.2. Southern horse mackerel catch in numbers-at-age (thousands) by fleet (bottom trawl, purse-seine and artisanal) in the period 1992–2016.

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

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

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

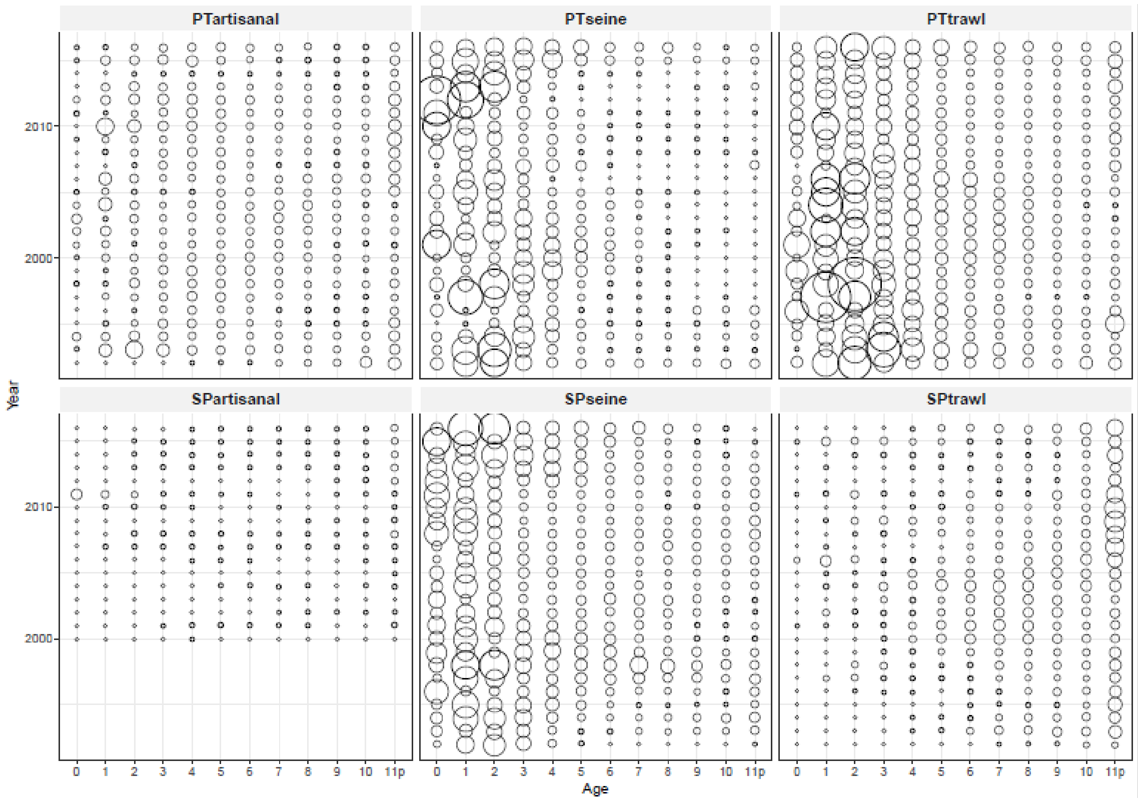


Figure 9.2.4.2. Bubble plot of proportions of southern horse mackerel catch in numbers-at-age by country, fleet and year.

9.2.5 Mean weight-at-age in the catch

Detailed information on the way to calculate mean weight-at-age and mean length-at-age is provided in the Stock Annex. Tables 9.2.5.1 and 9.2.5.2 show the mean weight-at-age in the catch and the mean length-at-age in catch, respectively, from 1992 to 2016.

The mean weight-at-age is of a similar magnitude to previous years in all ages (Figure 9.2.5.1) and the variations of mean length-at-age are of a similar scale along temporal series (Table 9.2.5.2).

Table 9.2.5.1. Southern horse mackerel mean weight-at-age (kg) in the catch.

	AGES											
YEAR	0	1	2	3	4	5	6	7	8	9	10	11+
1992	0.03	0.03	0.04	0.07	0.1	0.13	0.15	0.17	0.19	0.2	0.23	0.3
1993	0.02	0.03	0.04	0.07	0.09	0.13	0.17	0.21	0.24	0.24	0.25	0.3
1994	0.04	0.04	0.06	0.07	0.09	0.13	0.16	0.19	0.23	0.25	0.27	0.34
1995	0.04	0.03	0.06	0.08	0.1	0.12	0.16	0.17	0.2	0.22	0.23	0.31
1996	0.02	0.05	0.07	0.09	0.11	0.14	0.17	0.19	0.22	0.24	0.26	0.31
1997	0.03	0.03	0.05	0.07	0.11	0.14	0.17	0.2	0.24	0.26	0.26	0.36
1998	0.03	0.03	0.04	0.07	0.1	0.13	0.17	0.21	0.17	0.24	0.25	0.35
1999	0.02	0.04	0.06	0.08	0.11	0.14	0.16	0.19	0.22	0.25	0.27	0.36
2000	0.02	0.03	0.05	0.09	0.11	0.13	0.16	0.19	0.22	0.24	0.25	0.31
2001	0.02	0.03	0.07	0.08	0.09	0.13	0.16	0.18	0.2	0.23	0.24	0.31
2002	0.03	0.03	0.04	0.07	0.1	0.12	0.15	0.17	0.2	0.23	0.25	0.31
2003	0.02	0.03	0.05	0.06	0.09	0.12	0.15	0.18	0.2	0.23	0.25	0.31
2004	0.04	0.03	0.05	0.08	0.12	0.16	0.18	0.21	0.23	0.25	0.27	0.33
2005	0.02	0.03	0.04	0.07	0.12	0.15	0.17	0.18	0.22	0.24	0.25	0.3
2006	0.03	0.03	0.05	0.06	0.09	0.13	0.14	0.17	0.19	0.23	0.25	0.33
2007	0.03	0.05	0.06	0.07	0.09	0.11	0.16	0.19	0.23	0.22	0.24	0.3
2008	0.02	0.05	0.06	0.08	0.11	0.13	0.15	0.17	0.20	0.21	0.23	0.32
2009	0.02	0.03	0.06	0.09	0.11	0.13	0.15	0.17	0.18	0.21	0.24	0.36
2010	0.02	0.04	0.06	0.08	0.11	0.14	0.16	0.18	0.19	0.2	0.24	0.38
2011	0.03	0.06	0.07	0.08	0.11	0.13	0.17	0.18	0.19	0.22	0.26	0.35
2012	0.02	0.03	0.07	0.10	0.13	0.16	0.18	0.19	0.21	0.24	0.28	0.37
2013	0.05	0.04	0.05	0.09	0.13	0.16	0.18	0.20	0.21	0.23	0.26	0.33
2014	0.03	0.05	0.06	0.09	0.12	0.15	0.18	0.19	0.21	0.23	0.27	0.36
2015	0.03	0.04	0.06	0.09	0.11	0.14	0.17	0.19	0.21	0.24	0.26	0.35
2016	0.02	0.04	0.06	0.08	0.11	0.13	0.16	0.18	0.19	0.22	0.26	0.38

Table 9.2.5.2. Southern horse mackerel mean length-at-age (cm) in the catch (age range: 0–15 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

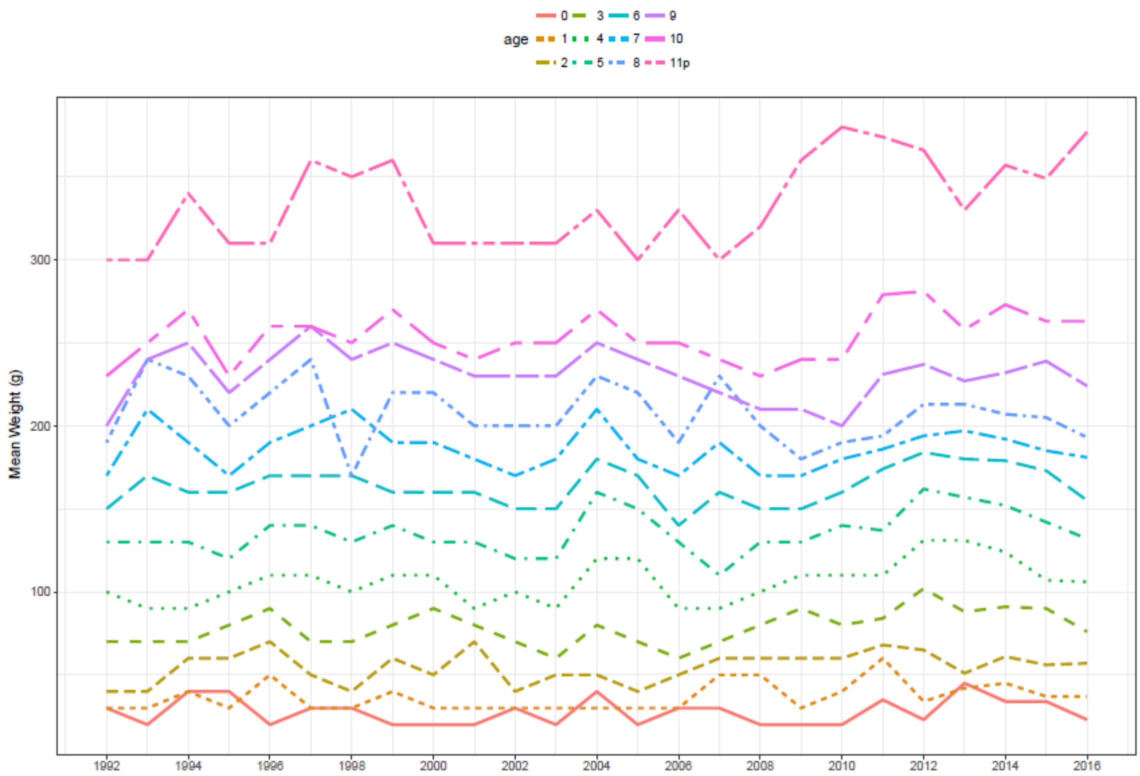


Figure 9.2.5.1. Southern horse mackerel mean weight-at-age (g) in the catch (age range: 0 to 11+, plus group).

9.3 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) and Spain (Sp-GFS-WIBTS-Q4) in ICES Division 9.a. Both IBTS surveys covers 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), usually in November. As explained in the Stock Annex, the survey series is shorter in time (only since 1998) and the raw data were unavailable in time for the WKPELA benchmark (ICES, 2017) to investigate the effect of merging it with the datasets from the other areas.

During the benchmark horse mackerel estimations from spring acoustic surveys were also analysed to investigate the spatial distribution of juveniles and as a possible indicator of the recruitment strength for this species, which could prove to be useful for short-term forecasts (ICES, 2017). However, the analysis did not reveal any relationship between the estimates of recruitment from the acoustic survey and the stock assessment.

SSB estimates from DEPM surveys require further analysis (WGMEGGS 2017) to be used as external auxiliary information according to the Stock Annex.

9.3.1 Bottom-trawl surveys

Historical horse mackerel bottom trawl survey data from the Portuguese and Spanish IBTS was analysed from 1983–2015 as preparation for the stock benchmark (ICES, 2017). The IBTS data provided 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 (Mendes *et al*., 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 keyparameters 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 following the methodology by Cochran (1960) 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.

The abundance indices from both surveys are shown in Table 9.3.1.1. 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 combined survey abundance-at-age for tuning the assessment excluding age 0 is presented in Table 9.3.1.2.

Table 9.3.1.1.Southern horse mackerel. Cpue-at-age (number/hour) by survey, in the period 1992–2016. The Portuguese IBTS (October) survey was not conducted in 2012.

Portuguese October Survey

YEAR	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 [1]	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

Spanish October Survey (only Subdivision IXa North)

YEAR	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	0.0	0.1	0.1	0.1	1.0	0.4	0.5	0.3	0.1	0.6
1993	33.1	0.4	1.2	0.9	0.1	0.0	0.6	2.5	2.6	3.6	2.2	4.2	0.8	0.5	0.1	0.2
1994	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.6	0.0	3.7	3.0	0.3	1.5
1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.6	1.0	2.2	0.6	0.5
1996	8.4	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.7	0.2	0.1	0.5	0.7	0.3	1.1
1997**	0.5	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.3	0.5	0.2	0.1	0.1	0.2	0.3	0.7
1998	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
1999	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.6	0.9	0.7	1.3	0.5	0.4	0.1
2000	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.8	1.0	0.9	0.2	0.2	0.1	0.1	0.1	0.2
2001	3.4	0.8	0.0	0.0	0.0	0.1	0.1	0.7	1.2	1.1	0.9	0.5	0.3	0.3	0.0	0.1
2002	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.4	2.1	2.0	2.5	2.9	1.0	1.2	0.4	0.6
2003	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.2	0.1	0.1	0.0	0.0	0.2
2004	24.1	0.3	0.7	4.3	1.4	1.2	0.5	0.4	0.2	0.1	0.2	0.0	0.1	0.0	0.0	0.0
2005	938.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.2	0.1	0.1	0.0	0.0
2006	7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.1
2007	0.4	0.0	0.0	0.0	0.0	0.1	0.3	0.3	0.4	0.2	0.2	0.2	0.0	0.1	0.1	0.0
2008	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1
2009	23.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.1
2010	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.1	0.2	0.3	0.3
2011	0.4	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.1	0.3	0.3	0.0	0.0	0.0	0.1	0.2
2012	12.9	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.2
2013	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2014	0.3	7.5	1.2	8.5	8.0	2.6	0.4	0.2	0.2	0.2	0.2	0.1	0.9	0.0	0.0	0.0
2015	6.6	0.0	0.1	1.9	2.8	1.0	0.1	0.2	0.0	0.1	0.2	0.0	0.1	0.0	0.1	0.2
2016	11.9	2.8	20.0	3.2	4.0	11.0	4.6	2.2	0.5	0.3	0.1	0.0	0.0	0.0	0.1	0.1

* The surveys were carried out with a different vessel

** Since 1997 another stratification design was applied in the Spanish surveys

1 In 2002 started a new series in which the duration of the trawling per haul has changed from one hour to thirty minutes

Table 9.3.1.2.Southern horse mackerel. Stratified mean abundance-at-age (number/hour) in the period 1992–2016. There was no Portuguese survey in 2012 and the combined survey index for 2012 is not estimated. Age 0 is not used in the stock assessment.

	AGES											
YEAR	0	1	2	3	4	5	6	7	8	9	10	11+
1992	454.5	488.2	145.8	26.8	13.2	5.9	4.0	4.4	2.4	2.3	4.0	3.4
1993	1678.9	184.2	213.3	148.8	32.6	2.0	2.1	3.2	3.1	4.3	2.6	7.3
1994	3.8	8.0	63.0	36.1	15.2	4.2	2.0	1.7	0.9	0.8	0.9	8.7
1995	15.8	61.2	89.7	49.7	23.9	6.5	1.4	1.2	0.6	0.3	0.4	6.2
1996	1222.5	6.3	8.7	13.5	14.0	3.6	1.7	0.6	0.4	0.8	0.2	2.8
1997	2095.3	97.4	69.0	20.4	45.0	55.4	15.0	11.2	4.8	5.8	2.1	1.7
1998	86.6	33.2	161.7	17.4	2.2	1.4	1.0	1.2	0.3	0.1	0.0	0.1
1999	159.5	20.2	31.8	34.8	2.8	1.0	0.6	0.2	0.2	0.7	0.9	3.0
2000	2.5	13.7	17.1	19.8	11.9	6.6	4.1	2.1	1.7	1.0	0.3	0.9
2001	1296.1	1.8	8.8	3.9	6.9	13.8	12.3	11.9	7.8	3.7	2.1	1.6
2002	21.2	1.5	11.4	10.0	5.5	2.8	1.2	1.1	2.6	2.3	3.1	6.6
2003	58.9	9.1	8.2	10.2	8.8	3.3	2.4	1.3	0.7	0.6	0.4	0.5
2004	82.7	37.4	112.4	42.4	8.1	4.2	1.9	3.8	5.1	1.0	0.4	0.2
2005	1290.0	1188.6	162.2	45.2	21.8	10.5	13.8	14.5	11.8	6.7	4.1	11.3
2006	72.6	84.6	181.8	46.6	3.4	10.4	7.4	6.7	2.7	1.4	0.5	0.3
2007	36.6	2.0	22.6	31.5	25.1	9.2	2.7	1.6	0.6	0.6	1.4	2.9
2008	52.6	28.2	39.7	20.6	26.8	17.3	2.2	0.8	1.3	1.9	1.4	5.0
2009	1268.3	79.5	147.0	52.4	44.7	11.6	2.8	1.7	1.4	0.9	0.7	4.6
2010	83.4	36.8	32.8	25.6	38.3	14.1	5.2	7.0	4.7	4.6	1.8	11.6
2011	133.2	33.1	24.5	16.2	4.7	1.2	0.4	0.6	0.4	0.7	0.8	1.6
2012	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2013	12.6	363.8	820.0	105.4	18.9	3.0	2.5	2.7	2.2	2.2	1.5	2.9
2014	53.9	40.8	25.4	77.7	33.6	7.8	2.1	1.7	1.2	1.4	2.4	10.5
2015	906.8	160.3	112.6	48.5	40.9	5.5	2.4	1.2	0.9	1.0	0.9	2.6
2016	13.6	19.9	43.1	80.0	57.6	18.6	8.8	8.1	3.0	1.6	1.7	8.6

9.3.2 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.

9.3.3 Maturity-at-age

The maturity ogive corresponds to females. Horse mackerel is a multiple spawner (ICES, 2008) and hence maturity ogives should be based on histological analysis of the gonads which provide a correct and precise means to follow the development of both ovaries and testes (Costa, 2009). Maturity ogive estimation procedures are detailed in Stock Annex. The predicted proportion-at-age is given in the text table below (7+: age 7 and older fish) and was adopted by WKPELA for the assessment period (1992–2015).

Age	0	1	2	3	4	5	6	7+
Proportion mature	0.0	0.0	0.36	0.82	0.95	0.97	0.99	1.0

During the benchmark it was also agreed to estimate a maturity ogive every three years with the data collected during the triennial DEPM surveys. New information from the triennial 2016 DEPM is still in ongoing analysis.The maturity ogive will be updated only in the case there is strong evidence that the proportion of fish mature at age has changed.

9.3.4 Natural mortality

The natural mortality (M) used in the assessment is presented in the text table below (5+: age 5 and older fish).

Age	0	1	2	3	4	5+
M	0.9	0.6	0.4	0.3	0.2	0.15

The procedure in the estimation of natural mortality rate and considerations for adopting the current values are detailed in Stock Annex.

9.4 Stock assessment

9.4.1 Model assumptions and settings and parameter estimates

The stock assessment has been performed for the period 1992–2016 with the method and settings agreed during the benchmark (ICES, WKPELA 2017) and described in the Stock Annex. Table 9.4.1.1 presents the input data type, model assumptions and settings adopted by the benchmark.

The assessment was tuned with the stratified mean abundance-at-age estimated for the combined Portuguese and Spanish IBTS survey for the age range 1–11+. The survey series was updated to 2016. In 2012 the Portuguese survey was not carried and, hence, the combined survey index for 2012 could not be estimated. Benchmark discussions also concluded that it was appropriate to adopt only one time-block for the survey selectivity given that the survey characteristics (e.g. survey design, surveyed area, Research vessels and fishing gear) were relatively unchanged along the assessment period.

The three time-blocks for the catch selectivity accommodates the recent changes in the fishery due to the strong year classes of 2011 and 2012, and the increase of horse mackerel catches by purse-seiners. Moreover, this pattern is likely to persist in the incoming years since the condition of the sardine stock does not show signs of improvement (see Section 8, pil.8c9a).

Table 9.4.1.1. Input data type, model assumptions and settings for the assessment of southern horse mackerel.

Name	Year range	Age range	Assumptions/settings
Catch in weight	1992–2016		Variable in time
Catch-at-age	1992–2016	0–11+	Variable by age and time
IBTS (Spanish-Portuguese) mean stratified abundance-at-age	1992–2016	1–11+	Variable by age and time
Mean weight-at-age (catch & stock)	1992–2016	0–11+	Variable by age and time
Proportion of F and M before spawning	1992–2016	0–11+	Fixed at 0.04 (mid-January)
Natural Mortality	1992–2016	0–11+	Age-dependent; time invariant
Catch-at-age selectivity	1992–2016	0–11+	Dome-shaped; constant at age 7+ Three blocks 1992–1997; 1998–2011; 2012–2016
Initial parameter vector		0–11+	0.2,0.7,1,1,0.8,0.5,0.5,0.2,0.2,0.2,0.2,0.2
Survey abundance-at-age selectivity	1992–2011; 2013–2016	1–11+	Dome-shaped; constant at age 7+ One time-block 1992–2016 (no survey index in 2012)
Initial parameter vector		1–11+	1,1,0.7,0.5,0.4,0.3,0.2,0.2,0.2,0.2,0.2
Proportion-at-age in the catch	1992–2016	0–11+	Multinomial distribution; log-normal with a constant CV of 5%
Proportion-at-age in the survey	1992–2016	1–11+	Multinomial distribution; log-normal with a constant CV of 30%

Name	Year range	Age range	Assumptions/settings
Effective sample size catch			100
Effective sample size survey			10

Figure 9.4.1.1 presents the estimated selectivity in the survey (age range 1–11+) and in the catch-at-age (age range 0–11+) for the period 1992–2016.

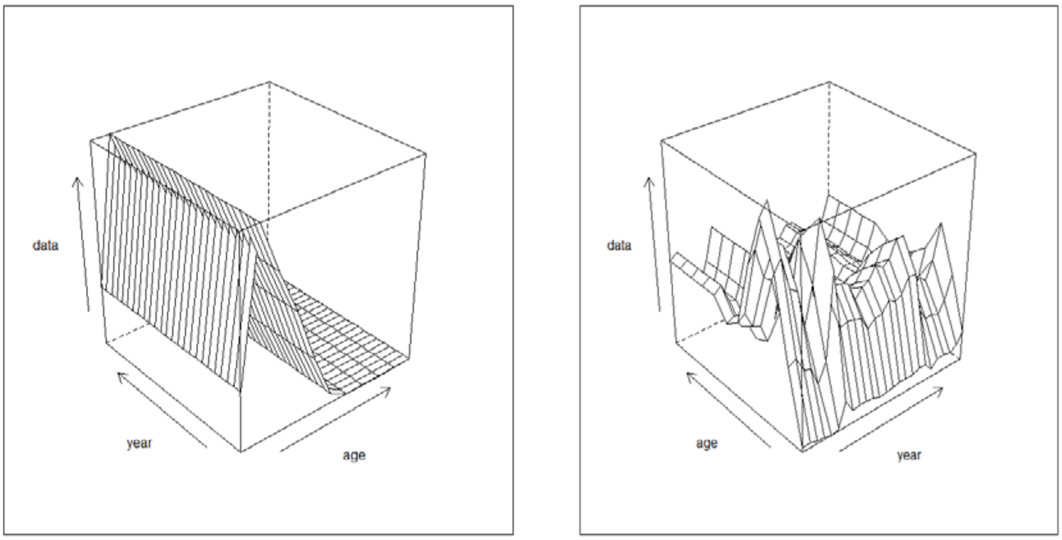


Figure 9.4.1.1 Southern horse mackerel. Estimated selectivity for the IBTS combined stratified mean abundance-at-age (left) and the catch-at-age (right).

The summarised results of the stock assessment are shown in Table 9.4.1.2 and Figure 9.4.1.2.

Table 9.4.1.2 Southern horse mackerel final assessment. Stock summary table (SSB at spawning time).

Year	Recruits (10*3)	SD	CV	SSB (t)	SD	CV	mean F_{2-10}	SD	CV	Catch (t)
1992	4172520	761592	0.18	266327	59342	0.22	0.094	0.021	0.22	27858
1993	2917790	565709	0.19	286326	66026	0.23	0.100	0.023	0.23	31521
1994	2882430	565518	0.20	305193	73519	0.24	0.082	0.020	0.24	28441
1995	3946050	748561	0.19	292190	73071	0.25	0.079	0.019	0.24	25147
1996	10612700	1794490	0.17	311547	80457	0.26	0.057	0.014	0.24	20400
1997	3482100	657370	0.19	327387	84763	0.26	0.079	0.019	0.24	29491
1998	2218680	451549	0.20	331904	84515	0.25	0.105	0.025	0.24	41564
1999	3364200	645576	0.19	378377	99587	0.26	0.065	0.016	0.25	27733
2000	3054550	604847	0.20	366081	98514	0.27	0.067	0.017	0.25	26160
2001	3599120	708528	0.20	350598	96939	0.28	0.066	0.017	0.26	24910
2002	2027470	440785	0.22	338296	95477	0.28	0.064	0.017	0.26	22506
2003	4014710	807172	0.20	337973	96818	0.29	0.054	0.014	0.25	18887
2004	4415630	889713	0.20	383351	111063	0.29	0.059	0.015	0.26	23252
2005	2767540	592928	0.21	349969	102322	0.29	0.060	0.016	0.26	22695
2006	1436960	346297	0.24	337895	99227	0.29	0.067	0.018	0.27	23902
2007	2107830	490293	0.23	340241	101806	0.30	0.064	0.017	0.27	22790
2008	3355690	770808	0.23	333415	102245	0.31	0.067	0.019	0.28	22993
2009	3058930	745019	0.24	331806	104679	0.32	0.076	0.022	0.29	25737
2010	3850700	961685	0.25	330860	107449	0.32	0.076	0.023	0.30	26556
2011	10217400	2445200	0.24	330976	110334	0.33	0.048	0.014	0.30	21875
2012	10268300	2493860	0.24	350252	116526	0.33	0.048	0.015	0.31	24868
2013	4582150	1254860	0.27	358670	115900	0.32	0.050	0.015	0.31	28993
2014	5357860	1577510	0.29	450786	140771	0.31	0.047	0.014	0.31	29017
2015	4875990	1659140	0.34	481538	148977	0.31	0.057	0.018	0.31	32723
2016	3757649*			487950	153193	0.31	0.077	0.025	0.32	40730
Average	4274471	957459	0.22	350396	100941	0.28	0.068	0.018	0.27	26830
(*)Geometric mean (1992-2015)										

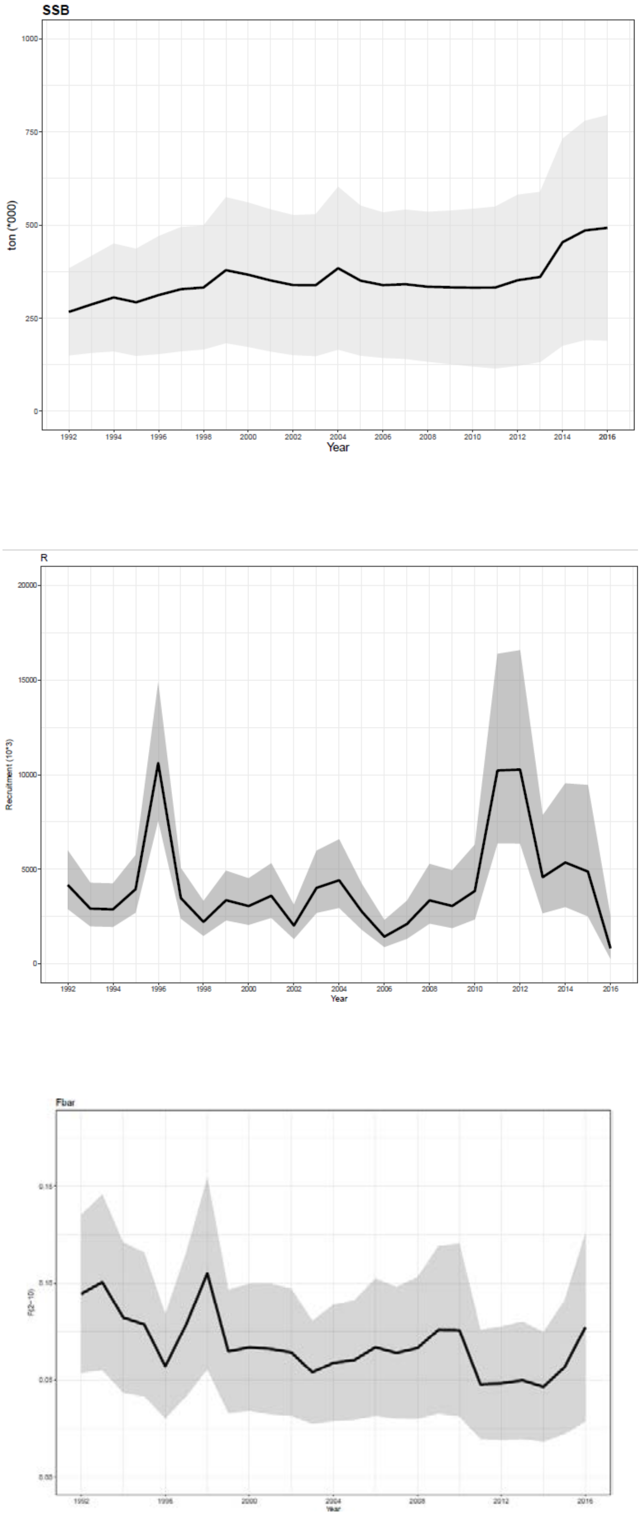


Figure 9.4.1.2 Southern horse mackerel final assessment. Plots of SSB, Recruitment and Fishing mortality (F mean 2–10) with 95% confidence intervals (grey). SSB are in thousand tonnes and recruitment in thousands. (average CV is 22% for SSB and 27% for mean F).

The estimated SSB shows a significant increase from 2012 to 2015 from 350 thousand tonnes to 482 thousand tonnes. SSB in 2016 is estimated to have slightly increased to around 488 thousand tonnes. Confidence intervals of SSB are in the range 22–33%. The fishing mortality has been below F_{MSY} over the whole time-series but it shows a significant increase from 2014 to 2016, of around 64%. The stock shows sporadic events of strong recruitments (1996, 2011 and 2012). Recruitment in 2016 (802 million) is estimated to be the lowest in the time-series but it is estimated with high uncertainty (coefficient of variance of 60%).

Figure 9.4.1.3 shows the scatterplot of the estimated spawning–stock biomass and recruitment in the period 1992–2015. The underlying S–R relationship is similar to that used to estimate the Biological Reference Points.

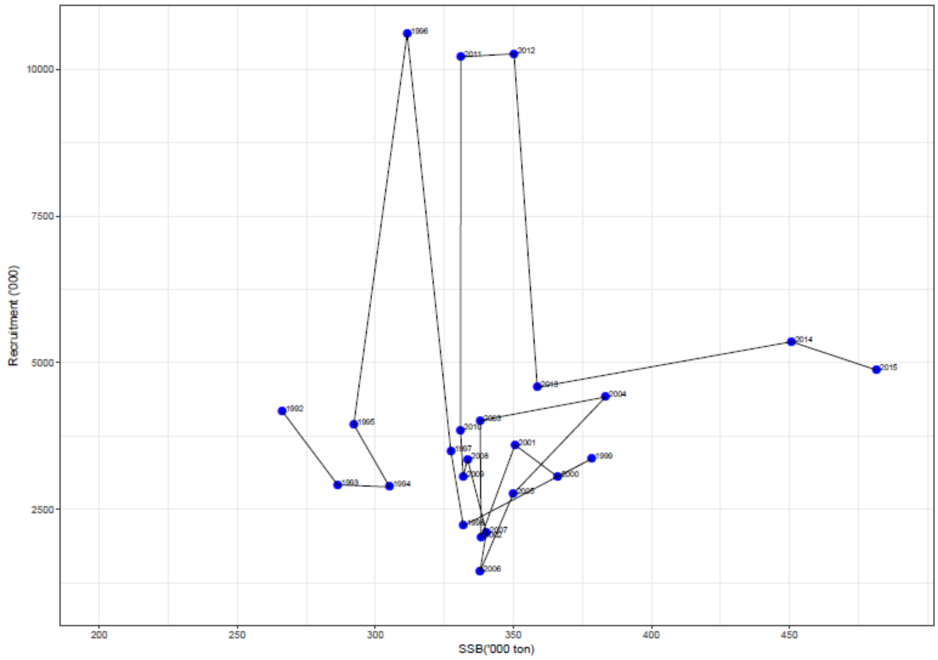


Figure 9.4.1.3. Stock–recruitment relationship for southern horse mackerel.

9.4.2 Reliability of the assessment

The landings of this stock are believed to be fairly accurate, given the good samplingcoverage, few discards (according to on-board observers) and the existence of well-defined ageing criteria. Therefore, a higher weight was given to the data series of landings in weight, which was very well fitted by the model (Figure 9.4.2.1). There was also a good fit to the survey biomass index. The model down-weighted the high biomasses observed in 2005 and 2013 which are, however, highly uncertain (Figure 9.4.2.1).

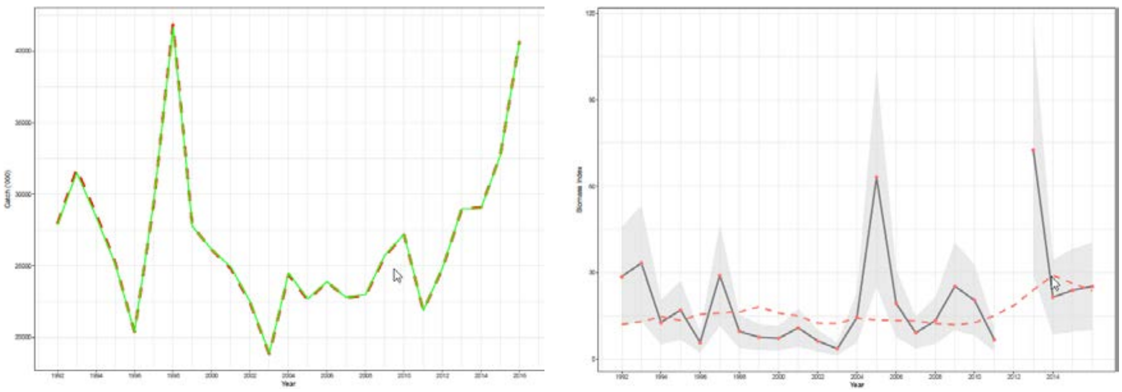


Figure 9.4.2.1. Southern horse mackerel. Catch biomass (left) and survey biomass index (right): observed (solid black line) and estimated values (dashed red line). (grey shaded area shows 95% confidence bounds of survey biomass index).

A good fit was obtained for the proportions-at-age of the catch in numbers (Figure9.4.2.2) as well as for the abundance indices in number/hour from the IBTS combined survey (Figure 9.4.2.3). The bubble plots of the residuals corresponding to the fittingof those data are shown in Figure 9.4.2.4.

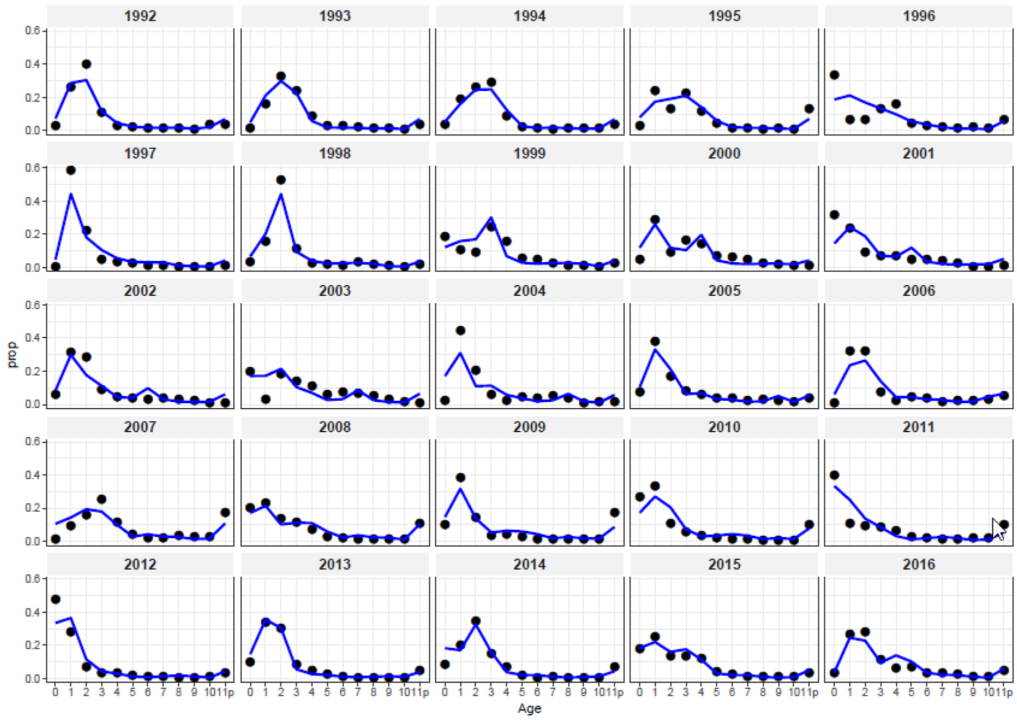


Figure 9.4.2.2.Southern horse mackerel. Comparison of proportions-at-age of the observed and fitted catch data (observed values=dots; fitted values=solid lines).

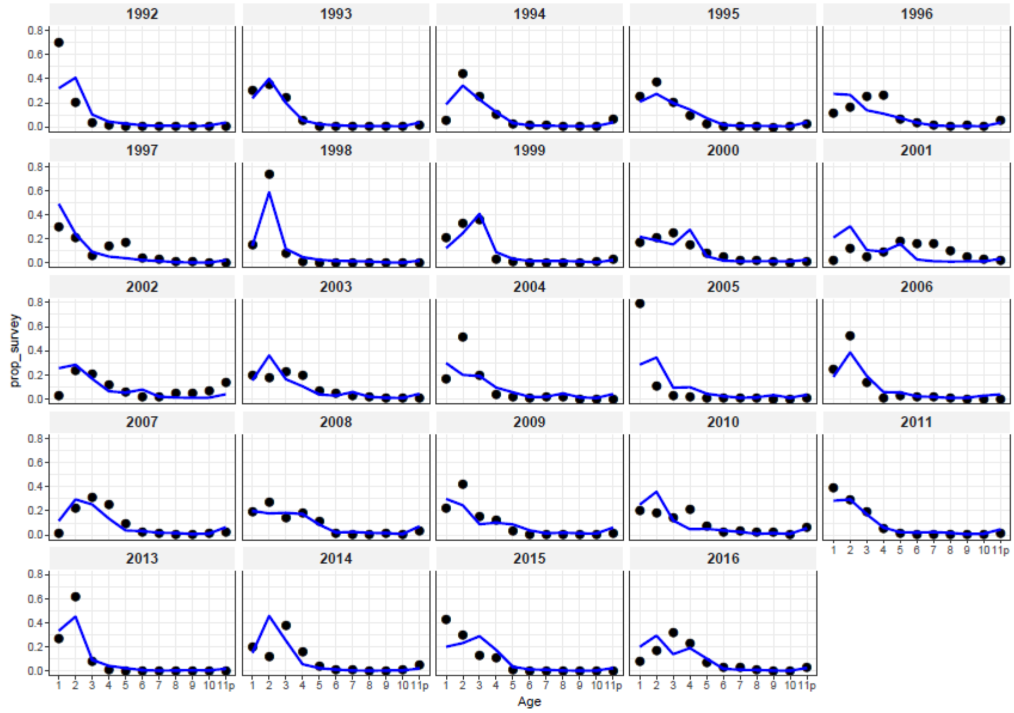


Figure 9.4.2.3. Southern horse mackerel. Comparison of proportions-at-age of the observed and fitted survey data (observed values=dots; fitted values=solid lines).

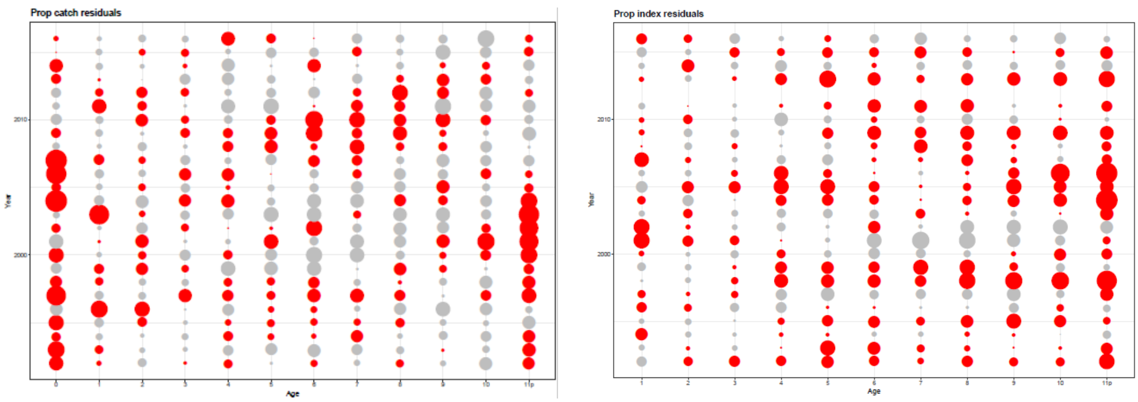


Figure 9.4.2.4. Southern horse mackerel. Bubble plot of catch (left, age range 0–11+) and survey (right, age range: 1–11+) proportion-at-age residuals (negative residuals=red bubbles).

The significant increase in SSB in 2014–2015 is reflecting the contribution of the survivors of the good year classes of 2011 and 2012 (proportion mature between 82% and 95%). The uncertainty in SSB in most recent years is around 31% (coefficient of variance). Recruitment in 2016 was estimated to be very low (around 820 million). There are no survey data at-age 0 in 2016 and recruitment estimate is highly uncertain (coefficient of variation of 60%). The estimate was replaced by the geometric mean recruitment of the period 1992–2015 (3758 million). There is an increase in F since the low in 2011–2014 and uncertainty of the estimated F_{bar} is of similar magnitude (coefficient of variance around 31%).

The retrospective analysis on SSB, recruitment and F_{bar} (mean F ages 2–10) was performed for a seven year period, from 1992–2009 to 1992–2015 time-series. Results are shown in Figure 9.4.2.5, which indicate an overestimation of SSB in years 2013 to 2015 and an underestimation in the years 2009 to 2012. No retrospective pattern occurs for F_{bar} in the years 2013 to 2015 while in the years 2009 to 2012 F_{bar} is slightly underestimated. The observed pattern in SSB and F_{bar}, showing major deviations from the assessments with time-series 1992–2012 and 1992–2013, is due to the fact that the most recent block for the selectivity in the catch starts in 2012, there is no survey in 2012 to tune the assessment and there are two strong recruitments in 2011 and 2012. All of these factors impact the estimates of the selectivity blocks and are likely to result in the observed retro. More important, however, is that the observed retro is inside confidence bounds of the assessment estimates of SSB and F_{bar}time-series (Figure 9.4.2.5).

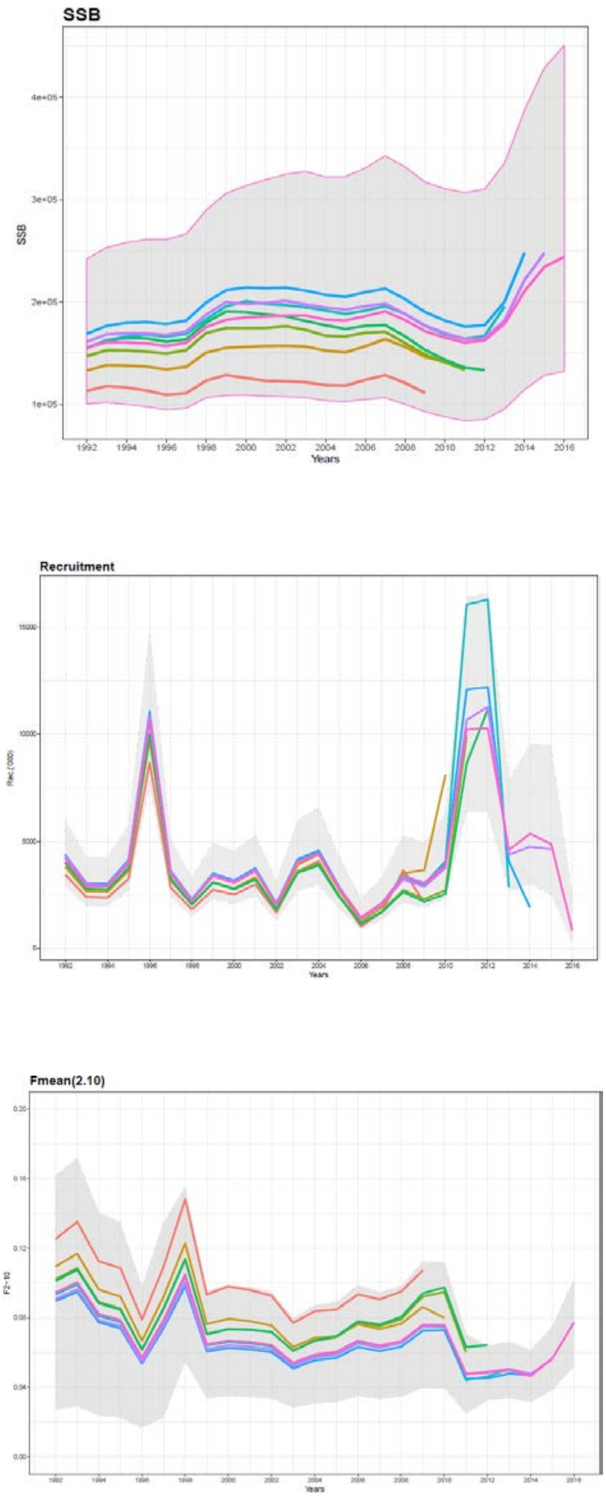


Figure 9.4.2.5. Retrospective analysis results. Trajectories of SSB, Recruitment and F_{bar} (grey=95% confidence intervals for the current assessment).

9.5 Short-term predictions

Deterministic short-term forecasts were carried out with R using the Fisheries Library in R (FLR) "FLAssess" and "Flash" (FLCore Version 2.6.0.20170123), following assumptions and settings agreed during the benchmark (ICES, 2017) and described in the Stock Annex. In short, it is assumed a constant recruitment corresponding to the geometric mean recruitment of the period 1992–2015 (3.758 million fish), weight-at-age in the catch and in the stock and fishing mortality of the last assessment year. The abundance-at-age-1 in 2017 are the survivors of the geometric mean recruitment assumed for 2016. The input data used for the forecasts are presented in Table 9.5.1.

Table 9.5.2 shows the management options table from the deterministic short-term forecasts. At current fishing mortality (F_{bar} of 0.0774), SSB in 2017 is estimated to be 490 476 tonnes. Predicted SSB levels for 2019 are 477 475 tonnes.

The forecasts are deterministic and, therefore, no estimate of uncertainty is calculated. Sources of uncertainty in the outcomes is the recruitment assumed for 2016 and 2017, the assumptions on mean fishing mortality with a significant increase from 2015 to 2016 and the likely changes in the fishery selection pattern in most recent years.

Table 9.5.1. Southern horse mackerel. Input for the short-term forecast (2017–2019).

2017								
Age	**N**	**M**	**Mat**	**PF**	**PM**	**SWt**	**Sel**	**CWt**
0	3757649	0.90	0	0.04	0.04	0.023	0.0298	0.023
1	1494769	0.60	0	0.04	0.04	0.037	0.0722	0.037
2	1113790	0.40	0.36	0.04	0.04	0.057	0.1085	0.057
3	594593	0.30	0.82	0.04	0.04	0.076	0.0804	0.076
4	941522	0.20	0.95	0.04	0.04	0.106	0.0702	0.106
5	738500	0.15	0.97	0.04	0.04	0.132	0.0636	0.132
6	226470	0.15	0.99	0.04	0.04	0.155	0.0684	0.155
7	143218	0.15	1	0.04	0.04	0.181	0.0763	0.181
8	122377	0.15	1	0.04	0.04	0.193	0.0763	0.193
9	60899	0.15	1	0.04	0.04	0.224	0.0763	0.224
10	33523	0.15	1	0.04	0.04	0.263	0.0763	0.263
11+	363815	0.15	1	0.04	0.04	0.377	0.0763	0.377
2018								
Age	**N**	**M**	**Mat**	**PF**	**PM**	**SWt**	**Sel**	**CWt**
0	3757649	0.90	0	0.04	0.04	0.023	0.0298	0.023
1	.	0.60	0	0.04	0.04	0.037	0.0722	0.037
2	.	0.40	0.36	0.04	0.04	0.057	0.1085	0.057
3	.	0.30	0.82	0.04	0.04	0.076	0.0804	0.076
4	.	0.20	0.95	0.04	0.04	0.106	0.0702	0.106
5	.	0.15	0.97	0.04	0.04	0.132	0.0636	0.132
6	.	0.15	0.99	0.04	0.04	0.155	0.0684	0.155
7	.	0.15	1	0.04	0.04	0.181	0.0763	0.181
8	.	0.15	1	0.04	0.04	0.193	0.0763	0.193
9	.	0.15	1	0.04	0.04	0.224	0.0763	0.224
10	.	0.15	1	0.04	0.04	0.263	0.0763	0.263
11+	.	0.15	1	0.04	0.04	0.377	0.0763	0.377
2019								
Age	**N**	**M**	**Mat**	**PF**	**PM**	**SWt**	**Sel**	**CWt**
0	3757649	0.90	0	0.04	0.04	0.023	0.0298	0.023
1	.	0.60	0	0.04	0.04	0.037	0.0722	0.037
2	.	0.40	0.36	0.04	0.04	0.057	0.1085	0.057
3	.	0.30	0.82	0.04	0.04	0.076	0.0804	0.076
4	.	0.20	0.95	0.04	0.04	0.106	0.0702	0.106
5	.	0.15	0.97	0.04	0.04	0.132	0.0636	0.132
6	.	0.15	0.99	0.04	0.04	0.155	0.0684	0.155
7	.	0.15	1	0.04	0.04	0.181	0.0763	0.181
8	.	0.15	1	0.04	0.04	0.193	0.0763	0.193
9	.	0.15	1	0.04	0.04	0.224	0.0763	0.224
10	.	0.15	1	0.04	0.04	0.263	0.0763	0.263
11+	.	0.15	1	0.04	0.04	0.377	0.0763	0.377

N – number of fish; SWt and CWt – mean weight in the stock and in the catch (in kg).

Table 9.5.2. Short-term forecast (2017–2019) for southern horse mackerel. Catch and SSB (at spawning time) in tonnes.

			2017		2018		2019
	Fmult	Fbar	SSB	Catch	SSB	Catch	SSB
	0	0.000			489532	0	516525
	0.1	0.008			489380	4157	512478
	0.2	0.015			489228	8283	508464
	0.3	0.023			489076	12380	504481
	0.4	0.031			488924	16448	500530
	0.5	0.039			488772	20486	496611
	0.6	0.046			488620	24496	492722
	0.7	0.054			488468	28477	488865
	0.8	0.062			488316	32429	485038
	0.9	0.070			488165	36353	481241
F_{2017}	1	0.077	490476	40805	488013	40249	477475
	1.1	0.085			487861	44117	473739
	1.2	0.093			487710	47957	470032
	1.3	0.101			487558	51770	466355
$F_{MSY;}$ F_{pa}	1.4	0.11			487407	55555	462707
	1.5	0.116			487255	59314	459087
	1.6	0.124			487104	63046	455497
	1.7	0.132			486952	66751	451935
	1.8	0.139			486801	70430	448401
	1.9	0.147			486650	74082	444896
	2	0.155			486499	77708	441418
	2.1	0.162			486348	81309	437967
	2.2	0.170			486196	84884	434544
	2.3	0.178			486045	88434	431148
	2.4	0.186			485894	91958	427780
F_{lim}	2.5	0.19			485743	95457	424437
SSB_{2019}=$B_{pa=}$MSY $B_{trigger}$	13.4	1.037			469570	360990	181000
SSB_{2019}=B_{lim}	20.7	1.601			459043	455403	103000

9.6 Biological reference points

Biological Reference Points for southern horse mackerel (B_{lim}, B_{pa}, MSY $B_{trigger}$, F_{lim}, F_{pa} and F_{MSY}) estimated in the 2016 Assessment Working Group (ICES, WGHANSA 2016a), were approved by ICES and adopted for the development of the management plan for this stock in the PELAC October 2016 meeting (Table 9.6.1). The biological reference points were re-evaluated during the 2017 benchmark (WKPELA). However, the new estimates resulted in very similar values and it was agreed not to revise the previously accepted BRP´s from both ICES and PELAC (ICES, 2017).

Table 9.6.1 Biological Reference points for southern horse mackerel. Values and the technical basis (weights in thousand tonnes).

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	181	Lower bound (average) of 90% confidence intervals of the SSB time-series in a stock being exploited well below F_{MSY}.	ICES, 2016a
	F_{MSY}	0.11	Constrained by F_{pa} (F_{MSY}=F_{pa}). Stochastic long-term simulations using a segmented regression with breakpoint at MSY $B_{trigger}$.	ICES, 2016a
Precautionary approach	B_{lim}	103	Derived from B_{pa} and assessment uncertainty (B_{lim}= B_{pa} × $e^{-1.645\sigma}$; σ = 0.34)	ICES, 2016a
	B_{pa}	181	MSY $B_{trigger}$	ICES, 2016a
	F_{lim}	0.19	Equilibrium scenarios with stochastic recruitment: F value corresponding to 50% probability of (SSB < B_{lim}).	ICES, 2016a
	F_{pa}	0.11	Derived from F_{lim} and assessment uncertainty (F_{pa}= F_{lim} × $e^{-1.645\sigma}$; σ = 0.32)	ICES, 2016a

9.7 Management considerations

The traditional fishery across several fleets has for a long time targeted juvenile age classes. This exploitation pattern combined with a fishing mortality well below F_{MSY} over the whole time-series does not seem to have been detrimental to the dynamics of the stock. The basis for the advice is the same as last year: the MSY approach, which implies increasing current fishing mortality to 0.11 (a factor of 1.4) and gives estimated catches in 2018 of 55 555 tonnes.

Sporadic events of strong recruitment have been observed in this species, such as in 1996 and 2011/2012 for this stock, which resulted in rapid increases in SSB. However, recruitment in the last three years is around average. The analysis carried out with the stochastic long-term simulations estimate an equilibrium catch at F_{MSY} of 44 thousand tonnes. Keeping the fishing mortality in 2018 at the level of 2017 (0.077) would imply catches of 40 249 t which is around recent levels.

A management plan for southern horse mackerel, aiming to be consistent with MSY and precautionary, is being developed by the Pelagic Advisory Council (PELAC). A HCR and preferred TAC options have been indicated by stakeholders. The stock assessment outputs and the Biological Reference points were used to evaluate the MP, within a full MSE framework. The framework and preliminary results for several catch options indicated by stakeholders were presented and discussed during WGHANSA. The Group agreed that the implemented MSE framework follows good practice for the evaluation of MP. The analysis will be finalized to be presented and discussed at the PELAC meeting the 11th of July 2017.

10 Blue Jack Mackerel (*Trachurus picturatus*) in the waters of Azores

The *T. picturatus* 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 sea mounts up to 300 m depth. However, a different size structure was observed between islands shelf and offshore areas. The island shelf areas seems to function as nursery or growth zones, while the seamount/bank offshore areas as feeding zones where adults predominate (Menezes *et al*., 2006).

In the Azores, the *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 the purse seines, and bottom longline. Purse seines are also used by the tuna bait boat fleet, which targets the *T. picturatus* to be used as live bait for tuna. The blue jack mackerel is also a very popular species among the recreational fisherman that fish along the coast of all islands.

The *T. picturatus* landings were considerably high during the 1980s, however changes in the local markets lead to a strong reduction in the catches afterwards. This reduction was also accompanied by a sharp decrease in the fleet targeting small pelagic fish. Since this period, the catches maintained at a low level due to a voluntary auto regulation adopted by the fishermen associations. Despite this reduction in the landings, this fishery still has a strong impact on some fishermen communities, which directly depends on the income of this fishery.

10.1 General Blue Jack Mackerel in ICES areas

The blue jack mackerel, *Trachurus picturatus* Bowdich, 1825 (*Carangidae*) has a broad geographical distribution within the Eastern Atlantic waters and can be found from the southern Bay of Biscay to southern Morocco, including the Macaronesian 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 which characteristic habitat includes the neritic zones of islands shelves, banks and seamounts (Smith-Vaniz, 1986). It has a shoal behaviour and prey mainly on crustaceans, being common in the islands of Madeira, Azores, and Canaries and Portuguese continental waters.

No studies specifically addressing the existence of distinct populations in the distribution range of this species have been attempted so far. Some studies on growth and biological characteristics from Madeira, Azores and Canary islands (Garcia *et al*., 2015; Isidro, 1990; Jesus, 1992; Gouveia, 1993; Vasconcelos *et al*., 2006; Jurado-Ruzafa and Santamaría, 2013) indicated similar growth rates and reproductive season. However, biological differences on age at first maturity seem to exist between individuals from the Azores compared with those from the Madeira and Canary islands (Jesus, 1992; Jurado-Ruzafa and Santamaría, 2013). The morphometric studies carried out on *T. picturatus* from Azores archipelago (Isidro, 1990), western coast of Portugal (Mendes *et al*., 2004) and 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 and 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*, are usually considered of reduced utility for the identification of stock units.

A number of studies have successfully used parasites as biological markers. Gaevskaya and Kovaleva (1985) conducted a survey of the parasites of *T. picturatus* from the Azores and Western Sahara. Their study identified a number of protozoan and helminth parasites showing differences in prevalence. The myxosporean Kudoa nova was found in samples from the Western Sahara, but not from banks of the Azores archipelago. Similarly, some species of digeneans (Platyhelminths: *Digenea*) found in the banks of the Azores, were not observed in the samples from the Western Sahara and *vice versa*. The apicomplexan, *Goussia cruciata* which is common in *T. picturatus* from the Mediterranean (Kalfa-Papaioannou and Athanassopoulou-Raptopoulou, 1984) and more recently from Madeira waters (Gonçalves, 1996), was not found in the Azores or from the Western Sahara. These variations in the occurrence of parasites could be indicative of the existence of different populations of *T. picturatus*. Further studies concentrating the occurrence of helminth parasites indicate some differences in both species diversity and parasitic infections levels (Costa *et al*., 2000; 2003).

The blue jack mackerel is an economically important resource, especially in the Micronesian islands of Azores and Madeira, where is the main pelagic fish species being caught in the local fisheries. The landings of this species in the Portuguese mainland have suffered strong fluctuations, which may be related, at least partially to fluctuations in abundance or availability. From 2005 to 2007 the landings have tripled, being 2007 the year with the highest landings recorded. In the Azores archipelago the landings have also fluctuated, while in Madeira the average of the landings from 1986 to 1991 was three times higher than the average landings from 1992 to 2007. 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 the observation of fluctuations in the abundance indices obtained from research surveys.

10.2 ACOM Advice applicable to 2017

The advice for this stock is biennial and so the 2016 advice is valid for 2017 and 2018 (see ICES, 2014): ICES advises on the basis of the approach for data-limited stocks that catches should be no more than 1318 tonnes.

10.3 The fishery in 2016

Commercial catches for 2016 include landings, landings not commercialised (withdrawn and other uses), discards, tuna bait catches, and recreational catches. In 2016, length frequencies and ages from landings sampling were collected and commercial abundance indices from the main fleet catching juveniles was updated (LPUE_PurseSeiners). A new cpue series from the purse-seine fleet logbooks was analysed for the first time, corresponding to the 2004–2016 period.

2006 was an anomalous year for the tuna fishery in Azores, with a general lack a fish in the region. Due to the low abundance of tuna, the fleet moved to Madeira and only a limited number of records of blue jack mackerel caught by this fleet is available. Consequently the JAA CPUE for the BaitBoats was not updated.

10.3.1 Fishing Fleets in 2016

The blue jack mackerel is mostly landed by the artisanal fleet, using purse seines. These fleet landings represent around 82% of the total landings and the catches about 63% of the total catches of blue jack mackerel, in Azores.

The artisanal purse-seines fleet is composed by small open deck vessels, mostly with less than 12 meters of overall length. The composition of this fleet presents a regular decrease in the recent years, with a reduction of 213 vessels in 2010 to 43 active vessels in 2016 in the small pelagic fishery. The number of vessels of each size category, for the last 15 years is shown in Figure 9.3.1.1.

10.3.2 Catches

Commercial catches including landings, discards, and tuna bait catches and recreational catches, for the period 1978 to 2016, are presented in Table 9.3.2.1.

Total estimated catches of blue jack mackerel in the Azores, for the considered period in Figure 9.3.2.1 (2002–2016), are around 1600 tonnes; while landings, in same period, are in average 1100 tonnes. In the last three years, the average catches and landings decreased to about 1040 and 806 tonnes, respectively.

An important reduction was observed in the catches in 2016, particularly for the fleets targeting the juveniles, such as the artisanal purse seine fleet and the tuna baitboats fleet. A low recruitment in 2006 is apparently the cause of this reduction. Preliminary information for the first semester of 2017 shows increasing catches of age 0 fish, suggesting a strong recruitment. This situation has been observed in the past. In the case of the tuna fleet, the reductions in the catches of blue jack mackerel (used as live bait) are related to the lack of tuna. Concerning the longliners, the increase in the catches observed in 2016 is mostly related to the practice of using the blue jack mackerel for bait, since their market price is too low. These values increased since 2013, although are still below the average of the preceding ten years.

10.3.3 Effort and catch per unit of effort

The fishing effort in number of days at sea is presented by year and by vessel size category in Figure 10.3.3.1. The majority of the effort is conducted by the small segment of the fleet (VL0010 – vessel with less than 10 m), followed by the fleet segment VL1012 (vessels between 10 and 12 meters).

For the last twelve years, and with the reduction of this fleet in the 1990s, the threshold of 5000 fishing days has never been exceeded.

The standardized lpue series were updated for the small purse-seine fleet up to 2016 (Figure 10.3.3.2) and a new cpue series (from logbooks) is presented for the same fleet (Figure 10.3.3.3). The cpue for the purse-seine catches of blue jack mackerel by tuna baitboat fleet (Figure 10.3.3.4) is available until 2015. Scaled standardized lpue from small purse seiners and cpue from the baitboat tuna fishery are presented in Figure 10.3.35.

Landings of blue jack mackerel from the longliners are less representative and a considerable part of the catch is not landed, being used as bait and discarded. The lpue for the adult stock, based on the landed fraction of blue jack mackerel caught as bycatch by the bottom longliners was not updated.

10.3.4 Catches by length

Size frequencies for the blue jack mackerel caught in the Azores are available since 1980. In Figure 10.3.4.1 is presented the size distribution of the landings (catch at size) for the years 2010 to 2015. The two main fisheries target on different size categories, Size frequencies for the blue jack mackerel caught in the Azores are available since 1980. In Figure 10.3.4.1 is presented the size distribution of the landings (catch at size) for the years 2011 to 2016. The two main fisheries target on different size categories, the surface fleets catches the juvenile fraction of the population while the longliners target the adult stock.

10.3.5 Assessment of the state of the stock

The assessment method is described in the stock annex.

10.4 Management considerations

The Azores Administration, put in place in October 2014 a specific management measure for the purse-seine fleet with the aim of regulate markets. This measure allows only 200 kg per vessel, per day. Also states that fishing and consequent landings shall also be forbidden on weekends (Portaria n.º 66/2014 de 8 de Outubro de 2014).

Table 10.3.2.1. Estimated catches of blue jack mackerel (*T. picturatus*) by fishery, in the Azores from 1978 to 2016.

Year	Tuna bait	Recreational	Discards/Bait (LL)	Withdrawn (PS)	PS	LL+Hand	Total
1978	115	129	15	0	2657	78	2995
1979	118	130	15	0	4114	61	4439
1980	210	132	22	0	2920	70	3354
1981	229	135	9	0	2104	39	2516
1982	239	142	10	0	2429	43	2862
1983	231	142	21	0	3711	67	4172
1984	295	135	17	0	3180	62	3689
1985	303	136	11	0	3442	60	3952
1986	433	135	9	0	3282	58	3918
1987	491	139	8	0	2974	53	3666
1988	586	143	8	0	3032	55	3824
1989	352	138	9	0	2824	50	3373
1990	345	117	11	27	2472	48	3021
1991	242	115	6	127	1247	33	1770
1992	249	121	6	126	1226	35	1762
1993	375	130	22	173	1684	70	2454
1994	264	125	18	179	1745	59	2390
1995	474	119	24	182	1769	79	2648
1996	351	110	38	173	1642	123	2437
1997	259	110	31	192	1849	72	2513
1998	308	111	52	151	1387	120	2129
1999	141	119	37	35	609	84	1024
2000	83	117	23	32	602	53	910
2001	59	121	24	110	1046	55	1415
2002	82	132	28	145	1387	63	1837
2003	140	128	21	150	1455	47	1941
2004	208	111	19	125	1148	98	1709
2005	124	120	236	123	1111	120	1834
2006	264	111	40	124	1145	96	1781
2007	370	115	58	115	1032	122	1812
2008	205	110	75	111	980	139	1620
2009	230	119	115	112	1023	98	1697
2010	313	114	75	116	1021	57	1696
2011	510	118	79	105	920	62	1794
2012	399	42	41	Not available	467	94	1043
2013	237	147	54	Not available	592	123	1153
2014	96	112	49	52	852	91	1252
2015	92	103	67	Not available	714	160	1136
2016	34	32	61	Not available	428	174	729

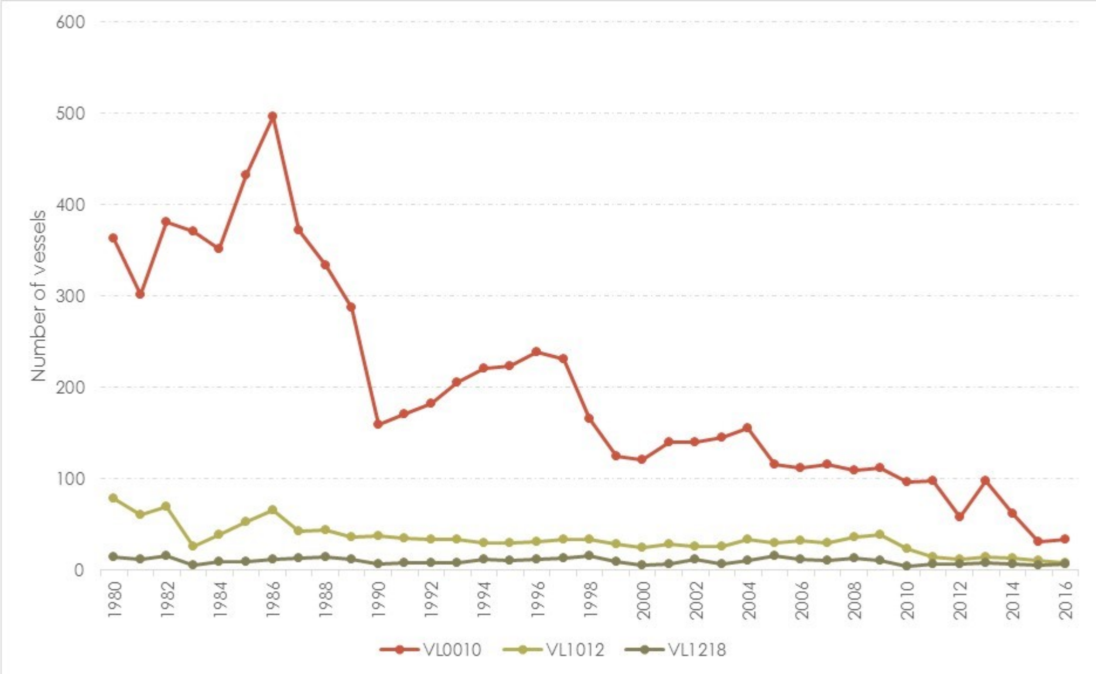


Figure 10.3.1.1. Number of small purse-seine vessels, by length category, of the blue jack mackerel (*T. picturatus*) fishery in the Azores (ICES Subdivision 10.a2) from 1980 to 2016.

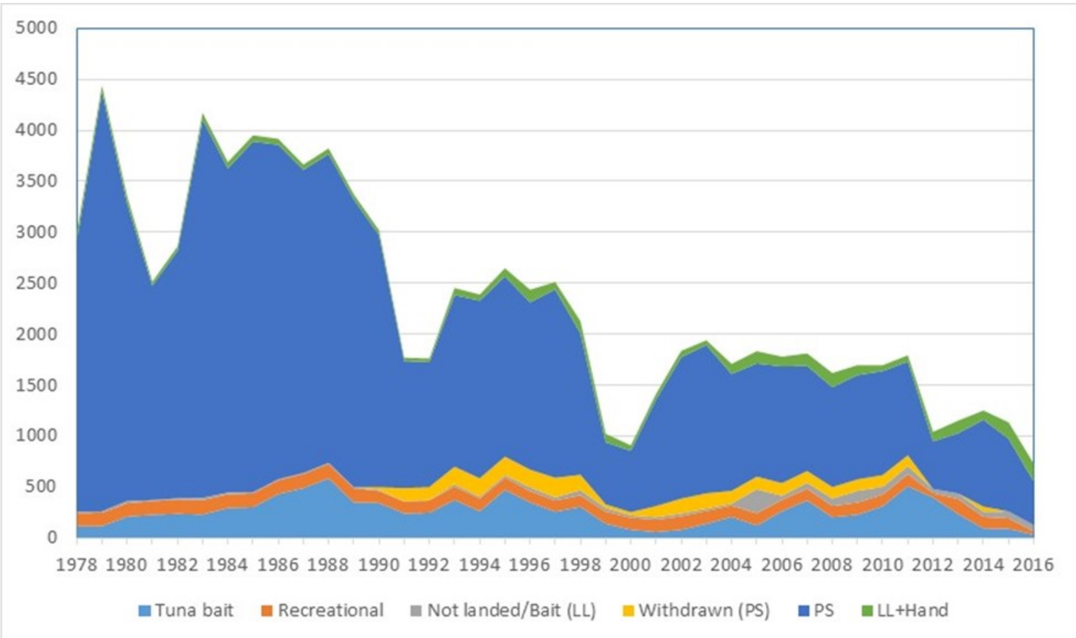


Figure 10.3.2.1. Estimated catches of blue jack mackerel (*T. picturatus*) in the Azores (ICES Subdivision 10.a2) from 1978 to 2016.

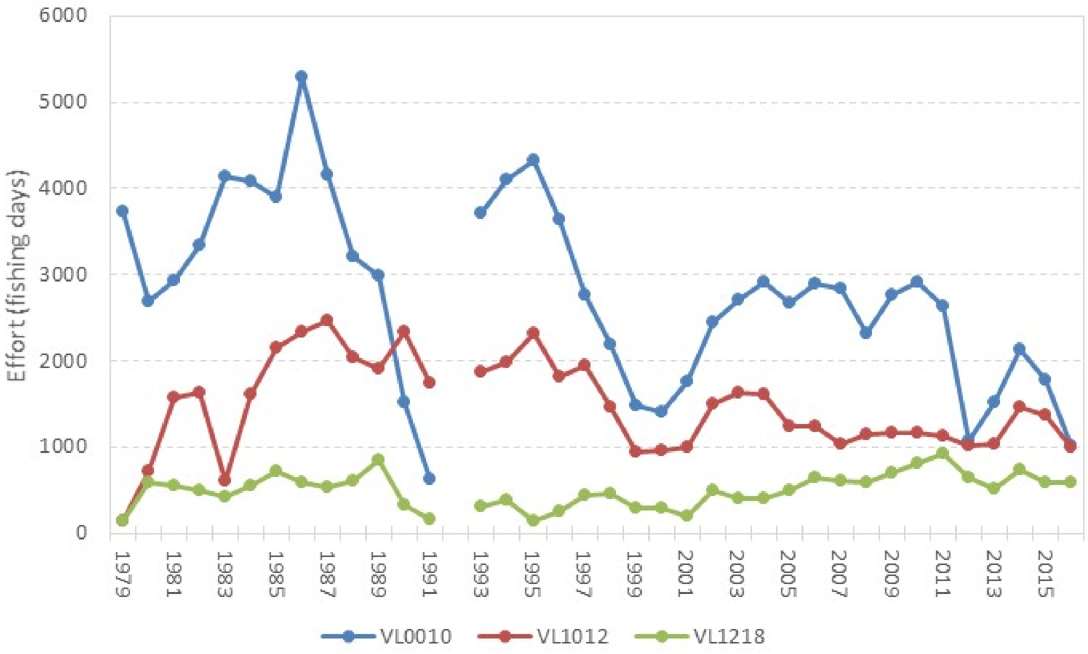


Figure 10.3.3.1. Nominal effort (number of days) of the purse-seine fleet, total and by vessel size category for the period 1978–2016.

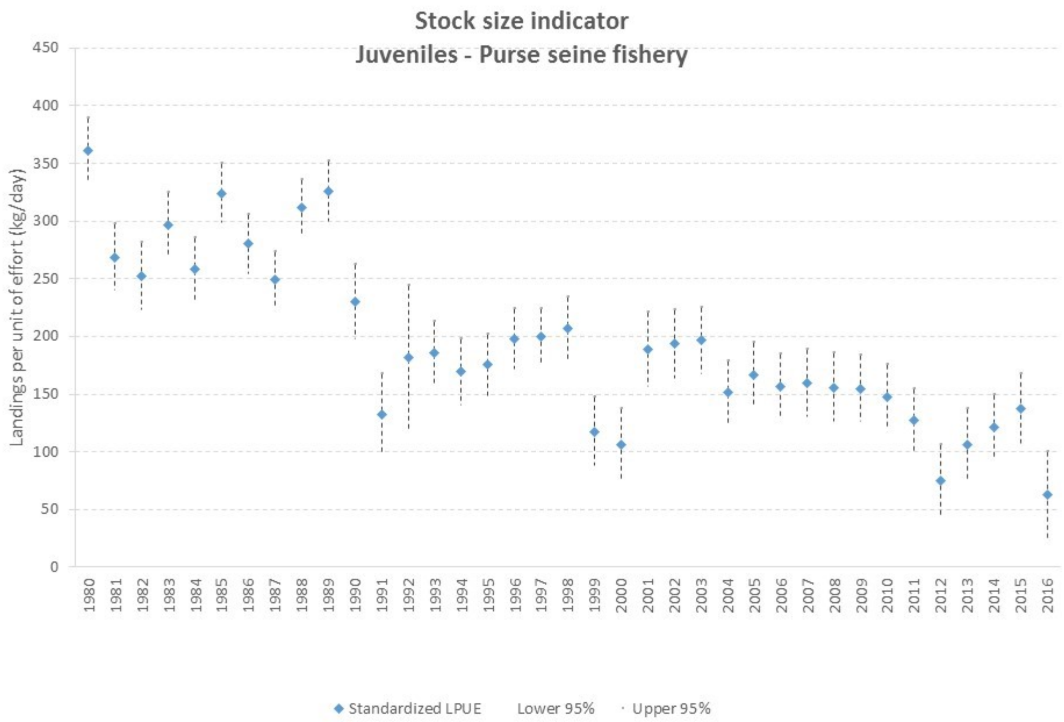


Figure 10.3.3.2. Standardized lpue for blue jack mackerel from the Azores small purse-seine fishery, for the years 1980–2015. Broken lines indicate 95% confidence intervals.

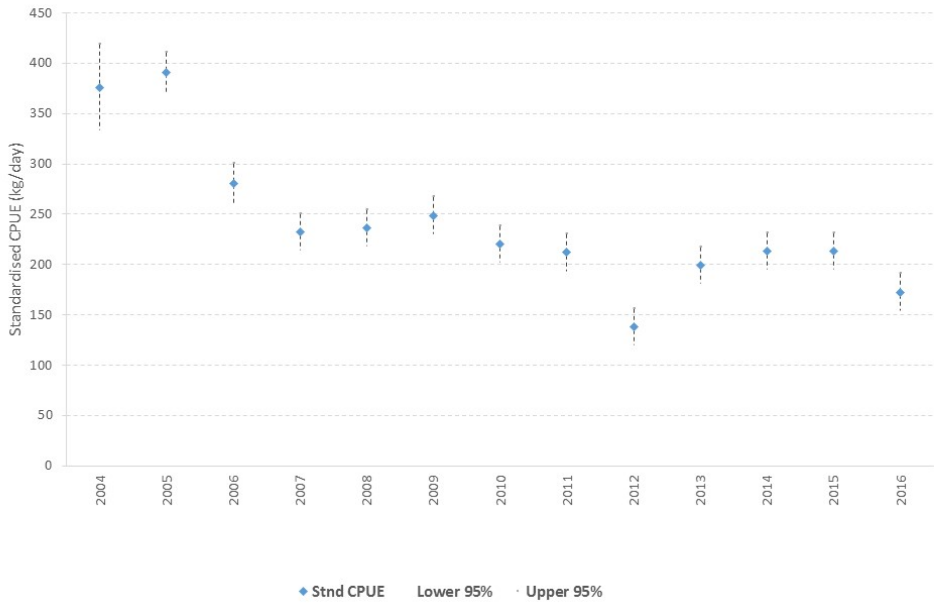


Figure 10.3.3.3. Standardized cpue for blue jack mackerel for the Azores small purse-seine fishery (logbook data), for the years 2004–2016. Broken lines indicate 95% confidence intervals.

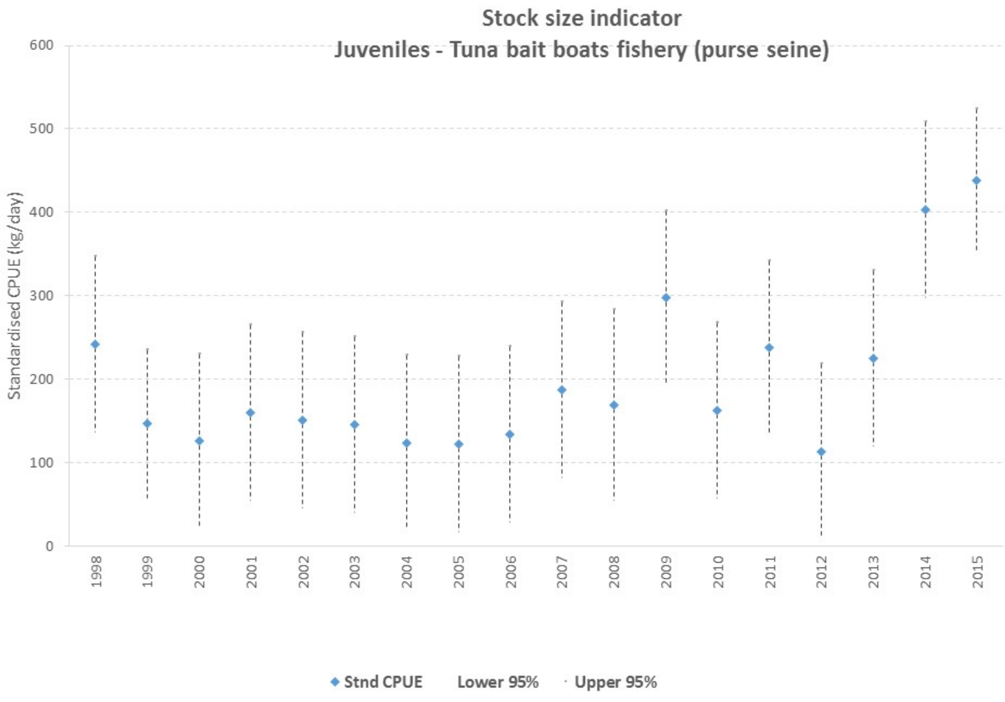


Figure 10.3.3.4. Standardized cpue for blue jack mackerel from the Azorean baitboat tuna fishery, for the years 1998–2015. Broken lines indicate 95% confidence intervals.

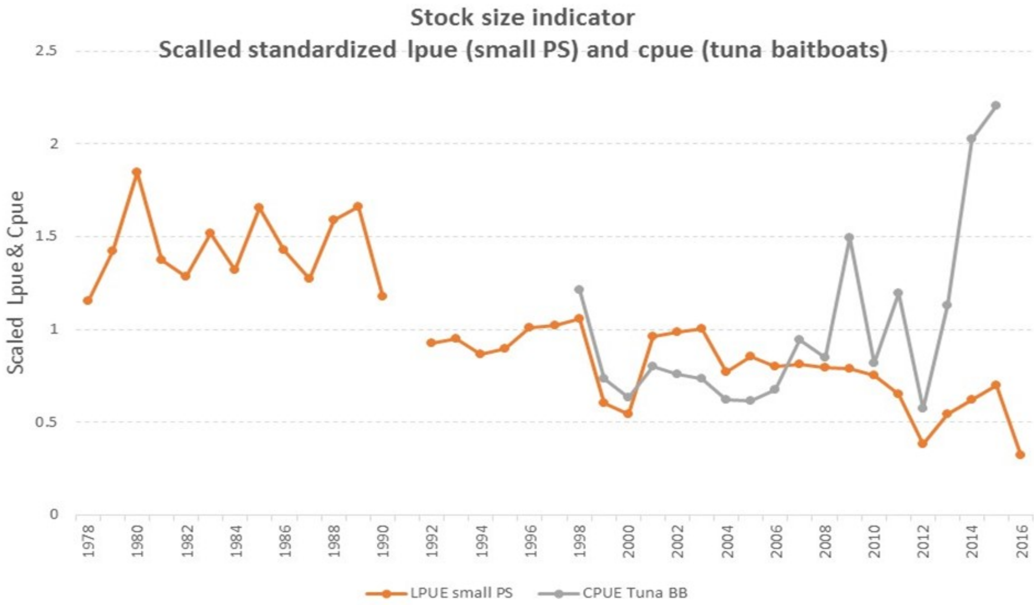


Figure 10.3.3.5. Scaled standardized lpue from small purse seiners and cpue from the baitboat tuna fishery, for blue jack mackerel in Azores.

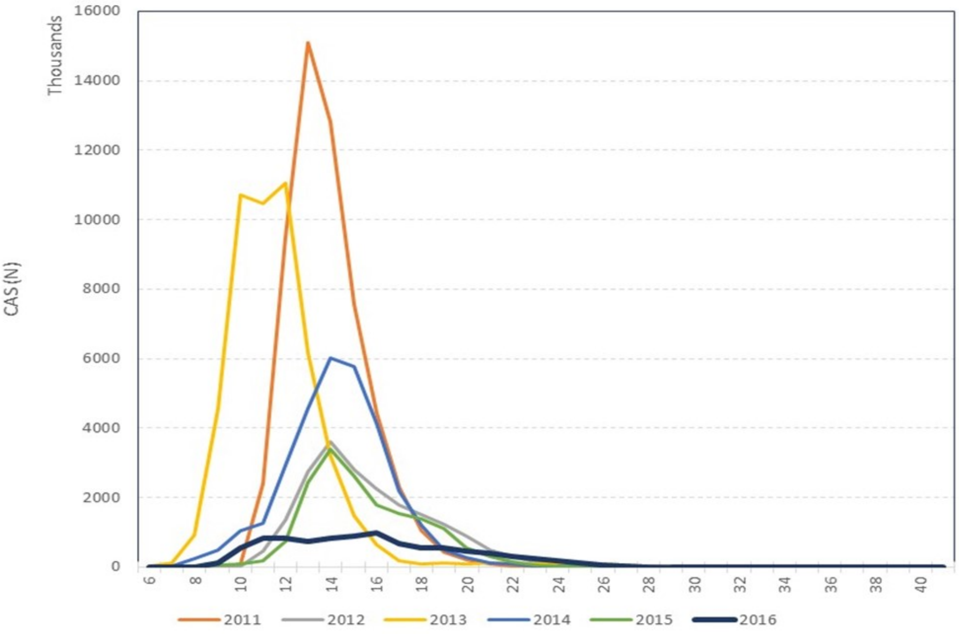


Figure 10.3.4.1. Annual size frequencies of the catches of blue jack mackerel (*T. picturatus*) in the Azores, from 2011 to 2016, from the surface fisheries.

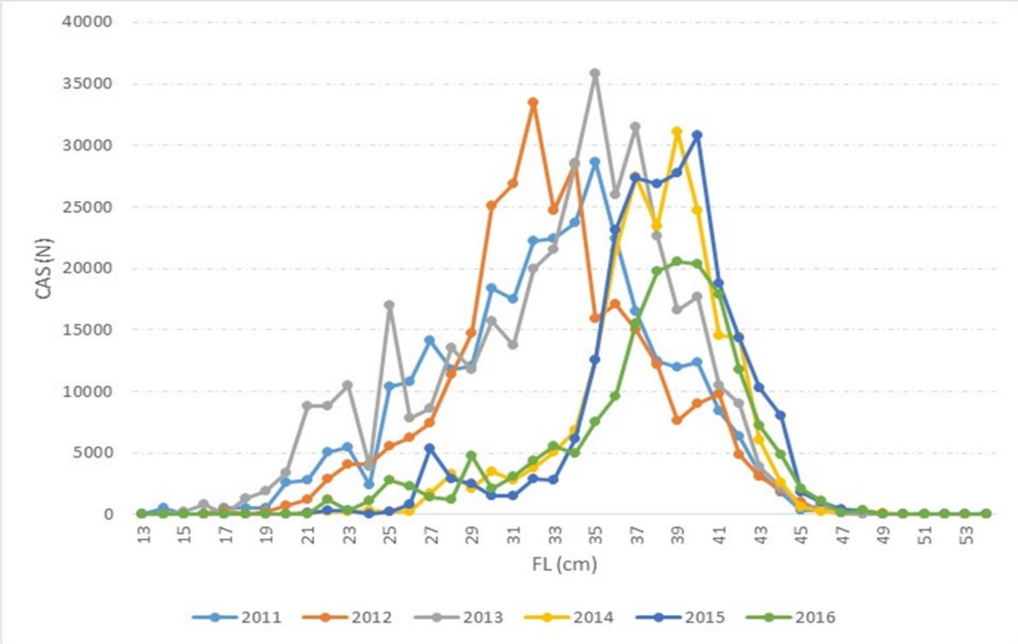


Figure 10.3.4.2. Annual size frequencies of the catches of blue jack mackerel (*T. picturatus*) in the Azores, from 2011 to 2016, from the longline and handline fisheries.

11 General Recommendations

WGHANSA 2016 General Recommendations	to
The WGHANSA considers each of the survey series directly assessing anchovy in Division 9.a 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 of interruptions through its recent history. The WGHANSA recommends the extension of the BIOMAN survey to the north to cover the potential area of sardine spawners in 8.a. This extension should be funded by DCMAP. The WGHANSA recommends a pelagic survey to be carried out on an annual basis in Autumn in the western Portuguese coast to provide information on the recruitment of small pelagics (particularly sardine and anchovy) in that region. The WGHANSA recommends a pelagic survey to be carried out on an annual basis in Spring in the English Channel (7.d, 7.e, 7.h) to provide information on the status of small pelagics (particularly sardine and anchovy) in that region. The WGHANSA recommends that length distributions and biological parameters of catches are collected for sardine in area 7 by countries operating in those waters.	PGDATA, WGCATCH, RCM's
The consort PELGAS survey (18 days of joint survey with fishing vessels) should be renewed and funded on a long-term basis.	DCMAP, French national administration
In Section 1.3, the participants requested ICES to consider the possibility of having the meeting moved to mid/end of November at the same time and place as WGACEGG. Once a benchmark has been scheduled, an early involvement of the external experts is recommended in the preparatory process (leading to data evaluation workshop) so that the selection of tools and modelling approach could be narrowed as early as possble. Stock coordinators could, that way, 1) get early guidance on the approach to try/follow and/or 2) have more time to prepare the second (modelling) meeting. WGHANSA is seeking additional participation in the working group from countries fishing sardine in area 7, especially experts from Denmark, Germany and the Netherlands. Following the presentations by WGEAWESS members on the first day of WGHANSA, it appears it would be beneficial to establishing interactions between the groups (workshops, requests, etc.) and to explore the real options of binging all these ideas into practice, due mainly to the lack of funding. Nevertheless, both groups recognize that establishing links and collaborations between assessment groups and more ecosystem focused groups should happen especially when current fisheries management approaches do not solve existing problems.	ICES secretariat, ACOM

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13 Additional presentation on ecosystem/environmental modelling related to the work of WGHANSA

During the WGHANSA 2017, on the first day, three members of the ICES Working Group on Ecosystem Assessment of Western European Shelf Seas (WGEAWESS) presented some of their ongoing works, followed by some exchange on how both groups could increase their interactions. One challenge for WGHANSA (and other ICES WG) is to include environmental drivers into stock assessment and therefore could benefit in the long term from exchanges with WGEAWESS while providing to the latter additional information on fisheries and species dynamics.

Eider Andonegi (AZTI, Spain, co-chair of WGEAWESS) presented the work being developed by WGEAWESS. First, a brief overview of the ICES regional groups in general and WGEAWESS particularly was provided, aiming at answering to the following questions: why do these group exist? How do these groups integrate within the ICES structure? Secondly, practical examples were presented. Different concepts of the Ecosystem Approach were explained in a first step, following the approach given by Link (2010) and Link and Browman (2014). Then, examples of different studies under each of the Term of Reference (ToR) of WGEAWESS were presented but higher emphasis was given to ToRs that could be more valuable for improving current stock assessments. More information can be found in the WGEAWESS 2016 report (ICES, 2016).

Margarita Maria Rincon (ICMAN-CSIC, Spain) presented "Modelling anchovy dynamics in the Gulf of Cadiz: an ecosystem and socio-economic approach". The presentation showed different modelling approaches to assess the sock of European anchovy (*Engraulis encrasicous*) and its dynamics in the Gulf of Cadiz. This works builds on fifteen years of research in the Gulf of Cadiz conducted at the ICMAN-CSIC Ecosystems Oceanography group. This research trajectory is also presented since it conforms most of the existing knowledge on the natural and human forcings on this stock that is included in the models, including also the main social and economic aspects to be considered in the fishery as identified in consensus with the main stakeholders (fisheries and environmental departments at the state and regional ministries, fishery sector, Doñana National Park, WWF and other environmental NGOs,. . .).

Marcos Llope (IEO, Spain) presented "Estuarine and marine environmental effects on GoC anchovy dynamics". The Gulf of Cadiz socio-ecosystem is characterized by a focal ecosystem component, the estuary of the Guadalquivir River that has an influence on the marine ecosystem (serves as a nursery area), and at the same time concentrates a great number of sectoral human activities. This nursery role particularly affects the anchovy fishery, which is the most economically and culturally important fishery in the region. As a transition zone between terrestrial and marine environments, estuaries are particularly sensitive to human activities, either developed directly at the aquatic environment or its surroundings. A dam 110 km upstream from the river mouth regulates freshwater input (mainly for agriculture purposes) into the estuary with consequences on turbidity and salinity. Using time-series analysis we (1) quantify the effects that natural (nekton, temperature, winds) and anthropogenic-influenced variables (freshwater discharges, turbidity, salinity) have on the abundance of anchovy larvae and juveniles, and (2) relate the abundance of these estuarine-resident early stages to the abundance of adult anchovy in the sea. Water management stands out as a key node where potentially conflicting interests (agriculture, power generation, aquaculture, fisheries) converge. Linking land-based activities to its impact on stock biomass represents the main challenge to ecosystem-based management in this particular regional sea. By focusing on the effects that these activities ultimately have on the anchovy fishery, via recruitment, our study aims to provide alternative management scenarios by quantifying trade-offs between sectors.

Finally, interesting discussions were opened, both about the proper official way of establishing interactions between the groups (workshops, requests, etc.) and the real options of binging all these ideas into practice, due mainly to the lack of funding. Nevertheless, both groups recognize that establishing links and collaborations between assessment groups and more ecosystem focused groups should happen especially when current fisheries management approaches do not solve existing problems.

Annex 1: Participants list

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Annex 2: External Reviewers' Comments

A.2.1 External Expert Review for Bay of Biscay sardine reference points

I, Martin Dorn (US), conducted a desk review of the portion of the WGHANSA 2017 report that deals with the estimation of precautionary and MSY reference points for Bay of Biscay sardine. This review was done under a compressed time frame (June 30–July 3), but there was sufficient time to read and review the material provided. A stock assessment for Bay of Biscay sardine was done in stock synthesis and reviewed during WKPELA 2017 earlier this year. Since this is the first analytical assessment that has been done for the stock, an attempt was made to derive reference points for the stock based on the recently completed assessment.

The reference point analysis very carefully followed the ICES guidance document *ICES fisheries management reference points for category 1 and 2 stocks*. I agree with the conclusion that the stock has either type 4 or type 6 stock–recruit relationship. Although examination of the stock–recruit relationship shows an apparent increase in recruitment with spawning biomass, that impression pretty much vanishes when putting your thumb over the 2016 datapoint, which is recruitment in the final year of the assessment, and would be highly uncertain. So I would argue that a stronger case could be made for a type 6 stock–recruit relationship. The ICES guidance is the same for either type of stock–recruit relationship, so it is not a critical issue. Overall, I support the reference point analysis. Various approaches were considered, defensible choices were made, and ICES guidance document was followed. The fishing mortality reference points are relatively low for sardine stock (0.25–0.3), but not completely implausible, and are likely to be sustainable.

The general impression from the recently completed stock assessment was that stock was relatively stable, and that stock had been relatively lightly exploited. The entire reference point analysis is driven by B_{loss}, since B_{pa} is set equal to B_{loss}, and B_{lim} set to 71% of B_{pa}, and the inflection point of segmented regression used to estimate F_{MSY} is set equal to B_{lim}. While this is all according to ICES guidance, from an outsider's perspective I wonder how defensible this approach is. B_{loss} is just not that meaningful for a lightly exploited stock. One particular concern is allowing $F_{p.05}$ to override both F_{pa} and F_{MSY} when B_{lim} is not based on an analysis, but is simply a convenient buffer below B_{pa}. One alternative that advisory group might consider is using F_{pa} and F_{MSY} as estimated rather allowing $F_{p.05}$ to override them.

A.2.2 Review of Reference points calculations for Sardine in 8abd

by Dankert Skagen

PA reference points: According to the assessment, the stock–recruit set has two periods, before and after 2011. The first has SSB around 140–180, the last has SSB around 100. This shift is associated with an increase in fishing mortality, but not with impaired recruitment. Although this stock has been exploited, probably lightly, for decades, the situation has some similarity to a developing fishery on a virgin stock. Then, we cannot know how much exploitation it will tolerate before we have exceeded the limit. By using the B_{loss} as a B_{pa}, and deriving B_{lim} from that assuming some assessment uncertainty effectively says that exploitation should not be allowed to increase further. That may be a sound conclusion, although the justification is artificial. The procedure has some support in the ICES standards, and should be acceptable.

The other PA reference points then follow automatically from the B_{lim}. They have been derived with the recommended software and proceedings.

MSY reference points were derived by stochastic simulation using standard ICES approved software. The justification for choosing the hockey-stick model over the available alternatives looks fine. The 2016 recruitment should probably have been left out. That would reduce the geometric mean by some 7–8%, which will have some, probably small, effect on risks to B_{lim}. The further derivation of F_{MSY} and $MSYB_{trigger}$ has been done according to the guidelines, and the presented arguments and reasoning are fine.

The check of sensitivity of the F-reference points to the reference period for biological parameters (mean weights-at-age, maturity and natural mortality) and exploitation pattern (selectivity) is timely and the result is impressive. This should be taken as a strong warning that these F- values are not stable. It would have been helpful to trace further which parameters are most important here.

A.2.2.1 Minor points

- Which assessment was used?- apparently the 2017 by WGHANSA.
- Parameters in the S–R function should be stated, in particular the distribution and its parameters (lognormal with the geometric mean and some CV?)
- Parameters for the assessment error are just stated as the default values in the software, which probably is right but hard to evaluate and hard to trace. The reference to WKMSYREF4 was only partly helpful. The default values are in Section 4.1.1 in WKMSYREF4 (2015, not 2016), and seems to be the average of values for some stocks developed by WKMSYREF3 in 2014. How adequate these values are for the Northern sardine stock in particular and for stocks in general is not clear, but this is probably the best that could be done under the circumstances. The ICES guidance document (12.4.3.1.....) is not very informative at this point.

A.2.2.2 Conclusion

The reference points have been derived correctly according to the ICES guidelines.

Annex 3: Working Documents

The following working documents were presented to WGHANSA 2017 and are presented in full in Annex 3:

WD1: Preliminary Results of the PELACUS0317: Estimates of sardine, anchovy and horse mackerel abundance and biomass in Galicia and Cantabrian waters: Pablo Carrera and Isabel Riveiro.

WD2: Preliminary adults results for the IEO Sardine DEPM survey 2017, ICES 9a North, 8c and 8b: José Ramón Pérez, Paz Díaz, Rosario Domínguez, Dolores Garabana and Pablo Carrera.

WD3: Direct assessment of small pelagic fish by the PELGAS17 acoustic survey: Erwan Duhamel, Mathieu Doray, Martin Huret, Florence Sanchez, Patrick Lespagnol, Ghislain Doremus and Pierre Le Bourdonnec.

WD4: Acoustic assessment and distribution of the main pelagic fish species in ICES Subdivision 9.a South during the *ECOCADIZ 2016-07* Spanish survey (July–August 2016): Fernando Ramos, Jorge Tornero, Dolors Oñate and Paz Jiménez.

WD5: Acoustic assessment and distribution of the main pelagic fish species in ICES Subdivision 9.a South during the *ECOCADIZ 2016-07* Spanish survey (October–November 2016): Fernando Ramos, Jorge Tornero, Dolors Oñate and Pilar Córdoba.

WD6: Preliminary indez of biomass of Bay of Biscay anchovy (*Engraulis encrasicolus*, L.) in 2017 applying the DEPM and sardine total egg abundance: M. Santos, L. Ibaibarriaga and A. Uriarte.

WD7: Preliminary results of the triennial DEPM survey SAREVA0317: I. Riveiro, P. Carrera, D. Garabana, P. Diaz and L. Iglesias.

Working document for the WGHANSA 24-29/06/2017,Bilbao, Spain

PRELIMINARY RESULTS OF THE PELACUS0317 SURVEY: ESTIMATES OF SARDINE, ANCHOVY AND HORSE MACKEREL ABUNDANCE AND BIOMASS IN GALICIA AND CANTABRIAN WATERS

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Introduction

PELACUS 0317 is the latest of the long-time series (started in 1984) of spring acoustic surveys carried out by the Instituto Español de Oceanografía to monitor pelagic fishery resources in the north and northwest shelf of the Iberian Peninsula (ICES divisions IXa – South Galicia and VIIIc – Cantabrian Sea). Since 2013, the survey is carried out in the R/V Miguel Oliver.

We present the results obtained on spatial distribution and abundance estimates of sardine anchovy and horse mackerel and also the egg spatial distribution of sardine and anchovy obtained from CUFES. We also compare the new values with those obtained in previous years.

Material and methods

The methodology was similar to that of the previous surveys. Although this year the surveyed area was extended further north (up to 45ºN) in order to accomplished de ichthyoplankton survey SAREVA17 aiming at to estimate the Spawning Stock Biomass of sardine by means of the Daily Egg Production Method.

Survey was carried out from 13th March to 16th April in the R/V Miguel Oliver and sampling design consisted in a grid with systematic parallel transects equally separated by 8 nm and perpendicular to the coastline (Figure 1) with random start, covering the continental shelf from 30 to 1000 m depth and from Portuguese-Spanish border to the Bay of Biscay, until 45ºN in the French platform. Acoustic records were obtained during day time together with egg samples from a Continuous Underwater Fish Egg Sampler (CUFES), with an internal water intake located at 5 m depth. CTD casts and plankton and water samples were taken during night time over the same grid in alternating transects. Besides, pelagic trawl hauls were performed in an opportunistic way to provide ground-truthing for acoustic data.

Acoustic equipment consisted in a Simrad EK-60 scientific echosounder (18, 38, 120 and 200 KHz). The elementary distance sampling unit (EDSU) was fixed at 1 nm. Acoustic data were obtained only during daytime at a survey speed of 10 knots. Data were stored in raw format and post-processed using SonarData Echoview software (Myriax Ltd.). The integration values, obtained each nautical mile (ESDU= 1nmi) are expressed as nautical area scattering coefficient (NASC) units or s_A values (m^2 nm^{-2}) (MacLennan *et al.*, 2002).

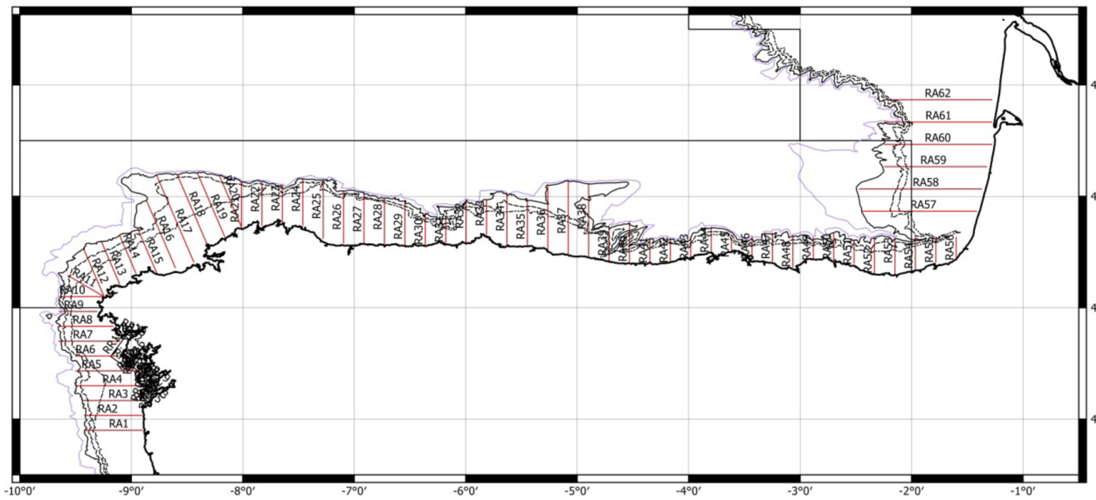

Figure 1. 2017 Survey track

A pelagic gear with vertical opening of 20 m has been used together with a smaller one, with vertical opening of about 12-14 m, for shallower waters. Hauls were mainly performed in depths between 35 and 330.5 m (mean depth 125 m), with an average duration of 26 minutes (maximum 50 minutes, minimum 8 minutes, in this case due to very dense mackerel layers).

A two steps method was used to assess the pelagic fish community. First, hauls were classified on account the following criteria: weather condition, gear performance and fish behaviour in front of the trawl derived from the analysis of the net sonar (Simrad FS20/25), catch composition in number and length distribution. Each haul was categorised and ranked as follows:

	0	**1**	**2**	**3**
Gear performance Fish behaviour	Crash	Bad geometry Fish escaping	Bad geometry No escaping	God geometry No escaping
Weather conditions	Swell >4 m height Wind >30 knots	Swell: 2 -4 m Wind: 30-20 knots	Swell: 1-2m Wind 20-10 knots	Swell <1 m Wind < 10 knots
Fish number	total fish caught <100	Main species >100 Second species <25	Main species > 100 Second species< 50	Main species > 100 Second species > 50
Fish length distribution	No bell shape	Main species bell shape	Main species bell shape Seconds: almost bell shape	Main species bell shape Seconds: bell shape

These criteria were used as a proxy for ground-truthing. Hauls considered as the best representation of the fish community (i.e. those with higher overall rank on account the four criteria) were used to allocate the backscattering energy got on similar echotraces located in the same area.

Once backscattering energy was allocated, spatial distribution for each species was analysed on account both the NASC values and the length frequency distributions (LFD). These were obtained for all the fish species in the trawl (either from the total catch or from a representative random sample of 100-200 fish). For the purpose of acoustic assessment, only those size distributions which were based on a minimum of 30 individuals and which presented a continuous distribution (either bell shape –normal- or bimodal) were considered. Random subsamples were taken when the total fish caught was higher than 100 specimens. Differences in probability density functions (PDF) were tested using Kolmogorov-Smirnoff (K-S) test. PDF distributions without significant differences were joined, giving a homogenous PDF stratum. Spatial structure and surface (square nautical miles) for each stratum were calculated using QGIS. Fish abundance was calculated with the 38 kHz frequency as recommended at the PGAAM (ICES 2002). Nevertheless, echograms from 18, 70, 120 and 200 kHz frequencies were used to better scrutinize and discriminate among the different backscattering targets. The threshold used to scrutinize the echograms was –70 dB. Backscattered energy (s_A) was allocated to fish species either by direct assignation of echotrace to a specific fish species or according to the proportions found at the fishing stations (Nakken and Dommasnes, 1975). For this purpose, the following TS values were used: sardine and anchovy, -72.6 dB (b_{20}); horse mackerels (*Trachurus trachurus, T. picturatus* and *T. mediterraneus*), –68.7 dB, bogue (*Boops boops*), –67 dB, chub mackerel (*Scomber colias*), -68.7, mackerel (*Scomber scombrus*), –84.9 dB and blue whiting (*Micromesistius poutassou*), -67.5 dB. Biomass estimation was done on each strata (polygon) using the arithmetic mean of the backscattering energy (NASC, s_A) attributed to each fish species and the surface expressed in square nautical miles.

Besides each fish was measured and weighed to obtain a length-weight relationship. Otoliths were also extracted from anchovy, sardine, horse mackerel, blue whiting, chub mackerel, Mediterranean horse mackerel and mackerel in order to estimate age and to obtain the age-length key (ALK) for each species for each area.

Results

A total of 4676 nautical miles were steamed, 1513 corresponding to the survey track.

In the area surveyed, a total of 69 fishing stations were performed, with only a null station (number 31, Figure 2).

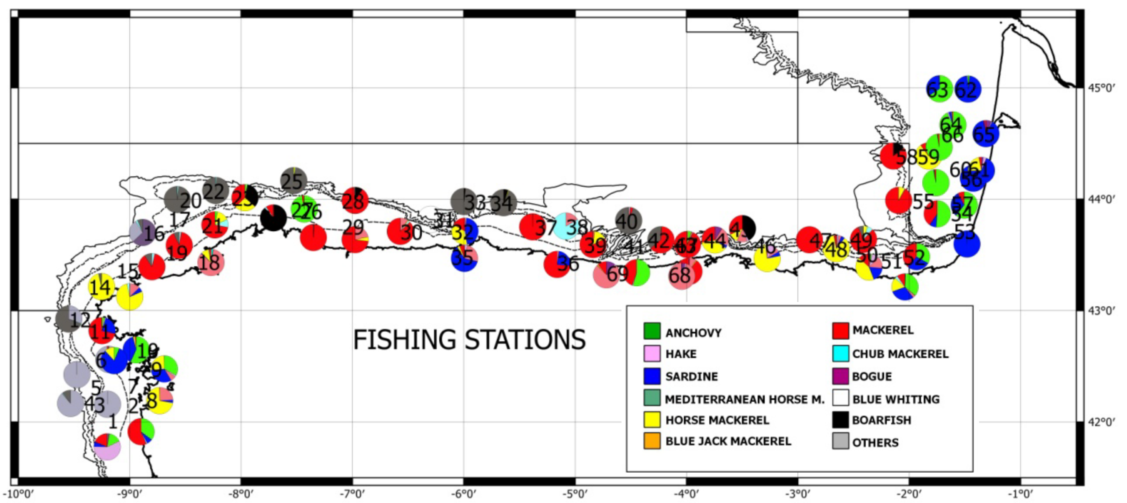

Figure 2: PELACUS0316 Fish proportion (abundance) at each fishing station

Of 69 tows performed, 68 were considered valid. Comparing with the previous year, the number of hauls has increased either by the increase of the surveyed area but also due to the presence of much more fish schools.

Table 1 summarises the main results of the fishing station for the principal pelagic species. A total of 75 tonnes were caught, corresponding to 911 thousand fish. Although 60% of the total biomass caught belonged to mackerel, a 30% of fish caught in number was anchovy, with similar percentages for sardine, mackerel and horse mackerel (round 15 % each). Besides, as in previous years, mackerel and hake were present in most of the fishing station (>80% of the valid hauls).

Table 1. PELACUS0317 Catch composition.

	TOTAL CAP (Kg)	No ind.	No Fishing st	Sample weight (kg	Measured fish	Mean length	%PRES	% Catch_W	% Catch_No
WHB	5683	98686	23	115	1931	21.96	33.82	7.55	10.83
MAC	45085	163901	57	1720	6070	33.91	83.82	59.89	17.99
HKE	371	3162	58	220	1816	24.97	85.29	0.49	0.35
HOM	5520	140275	46	369	4238	20.16	67.65	7.33	15.40
PIL	5180	151189	36	180	3980	18.03	52.94	6.88	16.60
BOG	5259	41671	30	398	2684	24.58	44.12	6.99	4.57
VMA	1483	23640	37	239	1992	23.83	54.41	1.97	2.60
BOC	360	6235	10	54	965	14.08	14.71	0.48	0.68
SEAB	305	557	13	131	258	29.57	19.12	0.40	0.06
ANE	5638	277070	30	64	2860	14.98	44.12	7.49	30.42
HMM	393	4459	11	98	867	22.43	16.18	0.52	0.49
Total	**75275**	**910845**	**68**	**3589**	**27661**				

On the other hand, 494 CUFES stations, comprising 3 nautical miles each. were taken, as shown in Figure 3. This number is considerably higher than last year because in 2016, due to lack of staff, alternate transects were sampled. In addition, PELACUS0317 area sampled was higher than previous years, because the need of covering the area of SAREVA0317 (that includes also part of 8b subdivision up to 45ºN) for adult sardine samples.

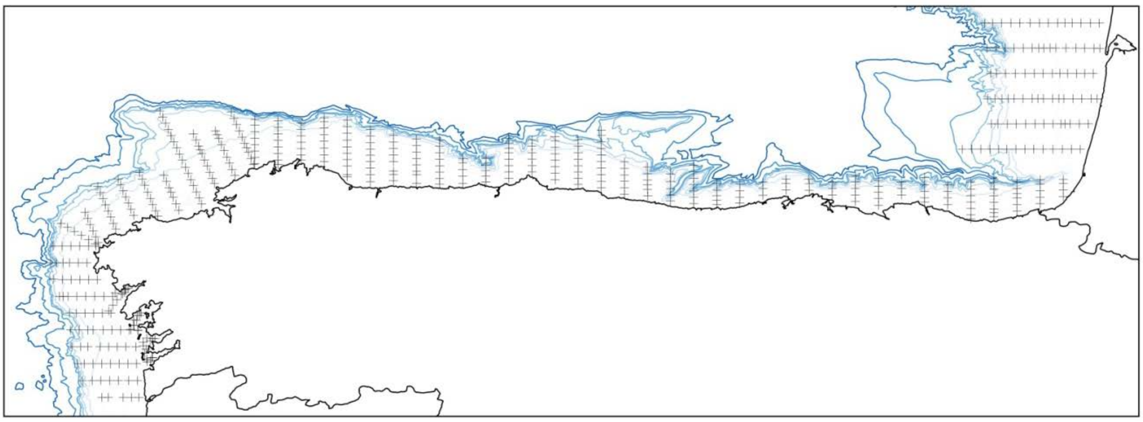

Figure 3. PELACUS0317 CUFES stations.

Results

Acoustic

Sardine distribution and assessment

Sardine distribution was very scarce in density, although area occupied by this species was higher during PELACUS0317 than in previous surveys. Higher densities were observed in 9aNorth subdivision (Rías Baixas) and particularly in French waters (8b subdivision).

As it has been already observed in previous years, no clear echotrace of sardine schools have been detected, with sardine occurring in very small echotraces, thus the energy attributed to this species was in general very low (Figure 4). In such circumstances, with sardine observed in a mixed layer with other fish species (mainly mackerel, horse mackerel or bogue) no direct allocation from scrutinization is feasible, being the backscattering energy attributed to sardine derived from the results obtained at the ground-truth fishing stations (length distribution and catch in number).

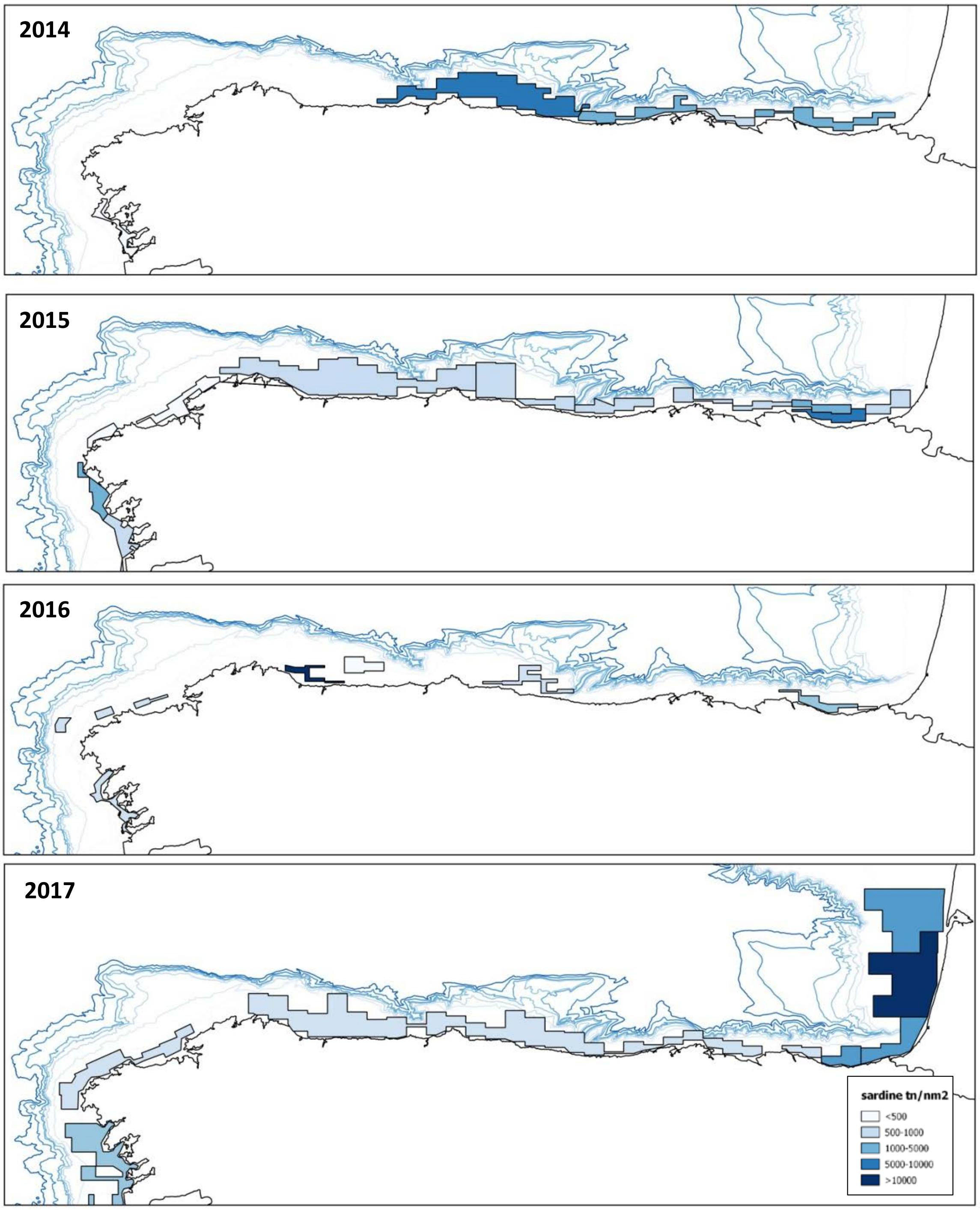

Figure 4. Sardine: spatial distribution of energy allocated to sardine during 2014-2017 PELACUS

surveys. Polygons are drawn to encompass the observed echoes, and polygon colour indicates sardine density in nm^2 within each polygon.

Table 2. Sardine acoustic assessment

		SURVEY:	PELACUS 0317 SARDINE						
Zone	**Area**	**No**	**Mean**	**Area**	**Fishing st.**	**PDF**	**No (million fish)**	**Biomass (tonnes)**	**Density (Tn/nmi-2)**
9a	Rias Baixas	166	77.93	674	P01-P02-P07-P08-P09-P10-P11	S01	198	11156	17
	Total	***166***	***78***	***674***			***198***	***11156***	17
8cW	Artabro	64	8.53	444	P15-P18-P27	S02	13	839	2
	Total	***64***	***8.53***	***444***			***13***	***839***	2
8cEW	Cantabrico	250	21.91	1911	P32-P35-P44-P46	S03	204	7901	4
	Total	**250**	***21.91***	**1911**			***204***	***7901***	4
8cEE	Machichaco	11	14.40	68	P48-P50	S04	4	200	3
	Gipuzkoa	18	170.04	126	P51-P52-P53	S05	110	3900	31
	Total	**29**	***111.00***	**194**			**114**	**4100**	21
8b	Euskadi_8b	26	162.68	266	P51-P52-P53	S05	223	7894	30
	Francia sur	80	619.59	900	P23-P54-P56-P57-P60-P61-P65	S06	3018	99768	111
	Francia Norte	72	186.83	801	P62-P63-P64-P66	S07	623	30214	38
	Total	**178**	***377.80***	**1966**			**3864**	**137877**	70
	Total IXa	***166***	***78***	***674***			***198***	***11156***	17
	Total VIIIc	***343***	***27***	***2550***			***331***	***12839***	5
	Total VIIIb	***178***	***378***	***1966***			***3864***	***137877***	70
	TOTAL	**687**	***130.17***	**5190**			**4394**	**161872**	31
	Total Spain	***535***	***49***	***3489***			***753***	***31890***	9
	Total France	**152**	**415**	**1700**			**3641**	**129983**	76
	total	**687**	***130.17***	**5190**			**4394**	**161872**	31

Sardine ranged in length from 14 to 24.5 cm, with a mode at 16 cm (Figure 5). Most fish in the entire surveyed area were assigned as belonging to the age 1 (52% of the abundance and 40% of the biomass), and age 2 (34% of the abundance and 40% of the biomass).

This year, unlike previous years, age 3 had a low contribution to the total abundance (10%) and biomass (13%) (Table 4, Figure 5).

By subdivisions, the signal of 2016 recruitment (age 1) was detected in the Cantabrian area, but not in Galicia. Age group 1 was dominant in 8b, 8cE-W and 8cE-E, while age 2 was the most abundant in 9aN and 8cW. 8cE-W subdivision represented 38%, 9aNorth 37%, 8cE-E 22% and 8cW only the 3% of the total abundance (Figure 7).

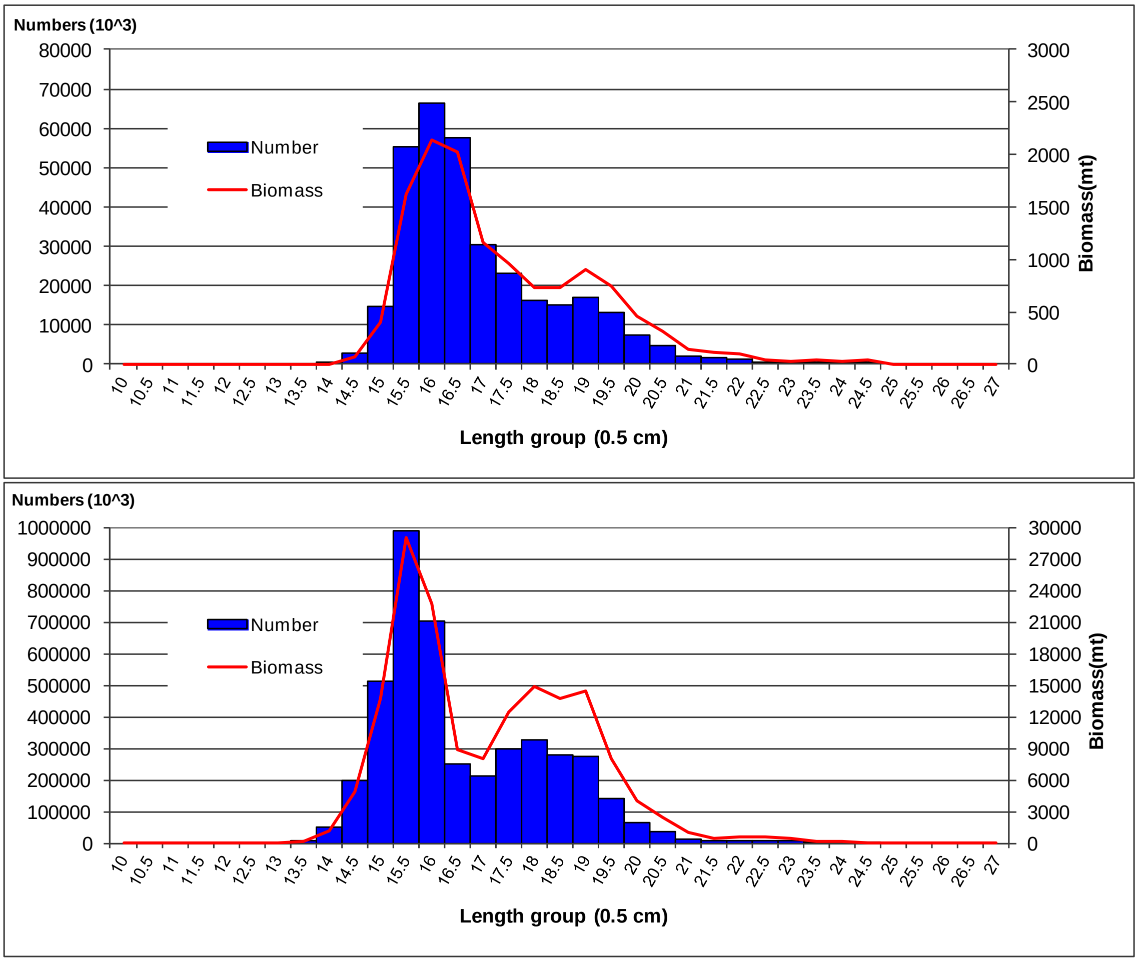

Figure 5. Sardine: fish length distribution in biomass and abundance during PELACUS0317 survey (top: sardine in 8c and 9a, bottom including 8b subdivision).

Table 4. Sardine abundance in number (thousand fish) and biomass (tons) by age group and ICES sub-area in PELACUS0317.

AREA VIIIcE								
AGE	1	2	3	4	5	6	7	TOTAL
Biomass (Tonnes)	7192	2157	1885	614	120	26	8	12001
% Biomass	59.9	18.0	15.7	5.1	1.0	0.2	0.1	100
Abundance ($N*10^6$)	218	51	37	11	2	0.3	0.1	318
% Abundance	68.4	16.0	11.5	3.3	0.6	0.1	0.03	100
Medium Weight (gr)	33.1	42.4	51.5	57.7	62.6	76.5	81.3	57.9
Medium Length (cm)	16.37	17.77	19.02	19.74	20.33	21.79	22.25	19.61
AREA VIIIcW								
AGE	1	2	3	4	5	6	7	TOTAL
Biomass (Tonnes)	70	520	115	68	45	21		839
% Biomass	8.3	62.0	13.8	8.1	5.3	2.5		100
Abundance ($N*10^6$)	1.69	9	1	1	0.4	0.2		13
% Abundance	12.8	65.9	10.9	5.6	3.3	1.5		100
Medium Weight (gr)	41.1	59.6	80.0	91.8	100.3	106.4		79.9
Medium Length (cm)	17.5	20.0	22.1	23.1	23.9	24.4		21.8
AREA IXaN								
AGE	1	2	3	4	5	6	7	TOTAL
Biomass (Tonnes)	2391	6870	1211	427	215	42		11156
% Biomass	21.4	61.6	10.9	3.8	1.9	0.4		100
Abundance ($N*10^6$)	54	122	15	5	2	0.4		198
% Abundance	27.0	61.4	7.7	2.6	1.1	0.2		100
Medium Weight (gr)	44.7	56.4	78.9	83.8	95.8	103.1		77.1
Medium Length (cm)	18.1	19.6	22.0	22.4	23.5	24.1		21.6
TOTALSPAIN								
AGE	1	2	3	4	5	6	7	TOTAL
Biomass (Tonnes)	9652	9548	3211	1109	379	89	8	23996
% Biomass	40.23	39.79	13.38	4.62	1.58	0.37	0.03	100
Abundance ($N*10^6$)	273	181	53	16	5	1	0.1	530
% Abundance	51.51	34.24	10.07	3.11	0.87	0.18	0.02	100
Medium Weight (gr)	35.4	52.7	60.2	67.3	82.5	94.2	81.3	67.6
Medium Length (cm)	16.72	19.12	19.96	20.72	22.23	23.33	22.25	20.62

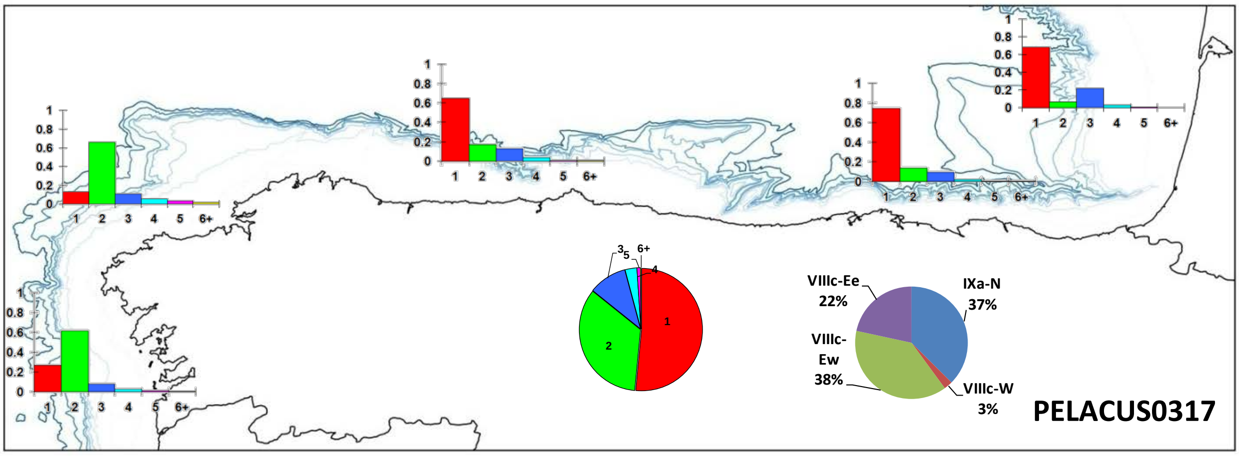

Figure 7. Sardine: relative abundance at age in each sub-area estimated in the PELACUS0317. The pie chart shows the contribution of each sub-area and each age group to the total numbers only for 8c and 9a subdivisions.

Sardine egg abundance

The distribution of sardine eggs (obtained from the analysis of 494 CUFES stations) indicates a coastal distribution, agreeing with that observed in previous years (Figure 8).

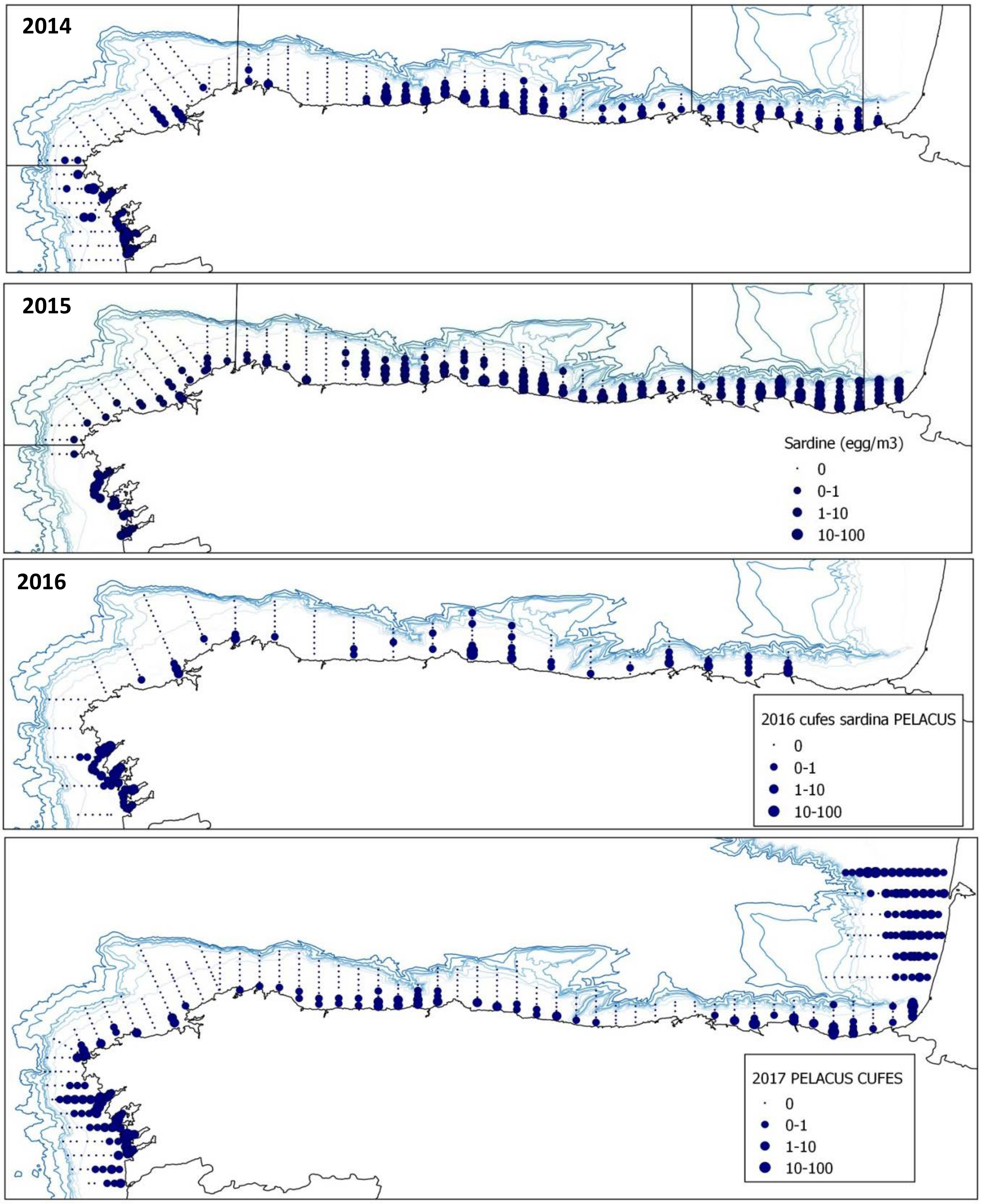

Figure 8. Sardine: distribution of sardine eggs (CUFES samples) in 2014-2017 PELACUS surveys. Blue circles indicate positive stations with diameter proportional to egg density.

Working Document presented to WGHANSA, Bilbao, 24-29 June 2017

Preliminary adults results for the IEO Sardine DEPM survey 2017
ICES 9a North, 8c and 8b

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1. Background

The IEO (Insituto Español de Oceanografía) carries out DEPM surveys every three years to estimate the sardine spawning stock biomass within the Atlanto-Iberian stock area. DEPM surveys consisted of ichthyoplankton, adults and hydrographic sampling and are internationally coordinated and planned under the framework of ICES WGACEGG. Fishing hauls are undertaken for estimation of adult daily fecundity parameters (sex ratio, female weight, batch fecundity and spawning fraction) within the mature component of the population.

In 2017, the Spanish survey took place in March/April covering the northern stock area from the river Minho to the south of the Armorican shelf in French waters (ICES areas 9a North and 8c). Division 8b in the Bay of Biscay, beyond the boundaries of Atlanto-Iberian sardine stock, has also been covered by the IEO in the inner part of the Bay of Biscay (8b up to a maximum of 45°N)

The Spanish DEPM survey (SAREVA0417) was undertaken using two vessels; RV Vizconde de Eza (from 24 March to 14 April), for ichthyoplankton sampling mainly and RV Miguel Oliver for adult samples which were collected during the acoustics survey (PELACUS0317) from 14 March to 16 April.

This document provides a description of the survey, laboratory analyses and estimation procedures used to obtain preliminary adults parameters (mean female weight, sex ratio, batch fecundity and spawning fraction) for the 2017 DEPM applied to the Atlanto-Iberian sardine stock. The laboratory tasks for processing samples are still underway, and therefore estimates presented for the batch fecundity and spawning fraction are preliminary at this meeting.

2. Methodology

2.1 Surveying

Fishing hauls for estimation of adult parameters were undertaken from PELACUS acoustic survey which was carried out concurrently with RV Vizconde de Eza. Fishing hauls were conducted by pelagic trawling following sardine schools detection by the echo-sounder. The number of samples and its spatial distribution was scheduled to ensure a good and homogeneous coverage of the survey area (Figure 1).

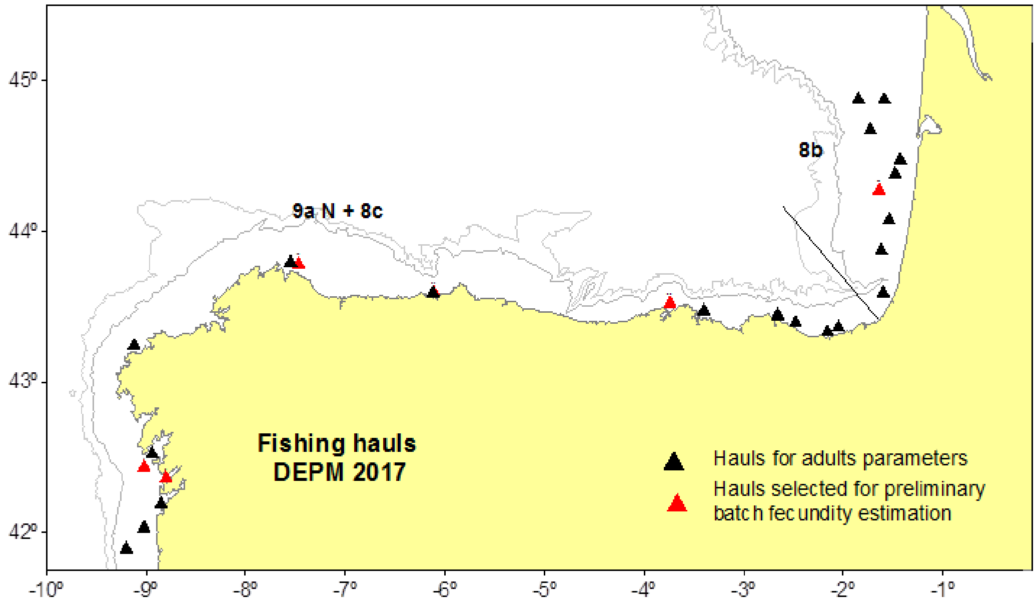


Figure 1. Spatial distribution of fishing hauls. Hauls selected for preliminary batch fecundity estimation (triangle in red).

Onboard the RV, and for each haul with sardine catches, a minimum of 60 sardines (males and females) were randomly selected and biologically sampled. For reproductive parameters, a minimum of 30 females per haul was required, thus, in some occasions, the random sampling was complemented with additional directed sampling in order to get females enough for histological analysis, and/or fecundity estimations. Individual biological information (length, total weight, sex, maturity state, gonad weight) was recorded for all fish, the ovaries were preserved for histology (with a 4% buffered formaldehyde) and the otoliths removed for age determination. The biological sampling and ovaries fixation were always carried out in fresh material. Details on the methodologies used on board, during laboratory work and data analyses are summarized in Table 1.

Table 1. Sampling, processing and analyses carried out in sardine adults samples.

SURVEY ADULTS	Divisions 9a N + 8c + 8b
Biological sampling:	On fresh material, on board of the R/V
Sample size	60 indiv randomly (30 mature female); extra if needed and if hydrated found
Sampling for age	Otoliths from random males and females
Fixation	4% buffered formaldehyde
Preservation	4% buffered formaldehyde
Sex ratio (R) estimation	The observed weight fraction of females
Mean female weight (W)	Individual total weight of hydrated females corrected by a linear regression between total weight of non-hydrated females and their corresponding gonad-free weight
Spawning fraction (S) : preliminary estimation	Quotient between the total number of random hydrated females (macroscopically classified) and the total random mature females in the haul.
Batch fecundity (F): preliminary estimation	On hydrated females (without checking histologically POFs absence), according to Pérez et al. 1992b

2.2 Laboratorial analyses

In order to report a preliminary batch fecundity estimate, a total of 52 hydrated females with total length between 157 and 245 mm were selected from six hauls over a total for 26 positive sardine hauls from 65 performed during Pelacus0317 survey (Table 2 and Figure 1).

At the laboratory, the individual batch fecundity (number of hydrated oocytes in the gonad) was estimated by the gravimetric method, on 1-3 whole mount sub-samples per ovary of 50-150 mg (Hunter et al. 1985).

Table 2. Description of selected hauls and samples used to estimate preliminary batch fecundity.

ICES area	Lat	Long	Date	Depth (m)	Time	Females No.
9a N+ 8c	42.43	-9.02	2017/03/17	82	12:29	12
9a N+ 8c	42.36	-8.8	2017/03/18	35	13:14	3
9a N+ 8c	43.78	-7.47	2017/03/27	126	11:05	1
9a N+ 8c	43.59	-6.11	2017/03/29	58.5	16:10	12
9a N+ 8c	43.52	-3.74	2017/04/05	46	16:40	12
8b	44.27	-1.64	2017/04/12	106.5	13:08	12

2.3 Data analysis

Adult parameters (W, R, F, and S) are estimated independently for each fishing haul, using only the mature fraction of the population (macroscopic maturity stages 2-6).

Before the estimation of the mean female weight per haul (W), the individual total weight (Wt) of the hydrated females was corrected by a linear regression between the total weight of non-hydrated females and their corresponding gonad-free weight (Wnov).

The sex ratio (R) in weight per haul was obtained as the quotient between the total weight of females on the total weight of males and females based on random samples.

The expected individual batch fecundity (Fexp) for all mature females (hydrated and non-hydrated) was estimated by modelling the 52 observed individual batch fecundity (Fobs) with their gonad-free weight (Wnov) by a GLM.

The preliminary daily spawning fraction of females (S) was determined, for each haul, as the ratio between hydrated females (macroscopically determined) and the total number of mature females from random samples. No histological correction (presence of recent POFs) was taking into account to estimate the preliminary spawning fraction.

$$S=\frac{\sum_0^i H}{\sum_0^i Mat}$$

where H is the number of hydrated females in the haul (i), and Mat the number of mature females in the haul (i).

The mean and variance of the adult parameters was obtained according to Picquelle and Stauffer 1985 (weighed means and variances).

Those hauls containing less than 30 fish sampled were excluded from the mean and variance calculations.

All estimations and statistical analysis were performed using the R software. Final adult parameters include individual estimates for the 9a N+ 8c, and 8b areas, with two independent estimates.

3. Results

In total, 26 fishing hauls positive for sardine were performed during the survey (Figure 1). A total of 2358 sardines were sampled (Table 3), 818 ovaries were collected and preserved for histological analysis and otoliths were removed for age determination. A total of 229 hydrated females were caught for batch fecundity estimation and 52 hydrated females selected from them to obtain a preliminary estimate. Mean female weight (W) and sex ratio (R) were based on samples collected in the total area (26 hauls), therefore, preliminary spawning fraction (S) has been estimated from 17 hauls in which hydrated females were found.

Table 3. General sardine adult sampling DEPM 2017.

ADULTS	9a N + 8c	8b (up to 45ºN)	Total area
Number (+) trawls	18	8	26
Date	15.03 - 10.04	10.04 - 14.04	15.03 – 14.04
Depth range (m)	35-127	55-111	35-127
Time range	07:00 – 17:00		07:00-17:00
Total sardine sampled	1534	824	2358
Length range (mm)	145-245	137-226	137-245
Weight range (g)	23.3-117.7	18.4-85.6	18.4-117.7
Hydrated females	190	39	229

The same linear regression (Table 4 and figure 2) between the non-hydrated females Wt and their corresponding Wnov was used for the whole surveyed area (Wt = - 1.39 + 1.09 * Wnov, R^2 = 0.993).

Table 4. Coefficients from the linear regression model between gonad-free-weight and total weight fitted to non-hydrated females.

Parameter	Estimate	Standard error	Pr(>|t|)
Intercept	-1.388696	0.183165	1.4e-13***
Slope	1.096860	0.003855	<2e-16***

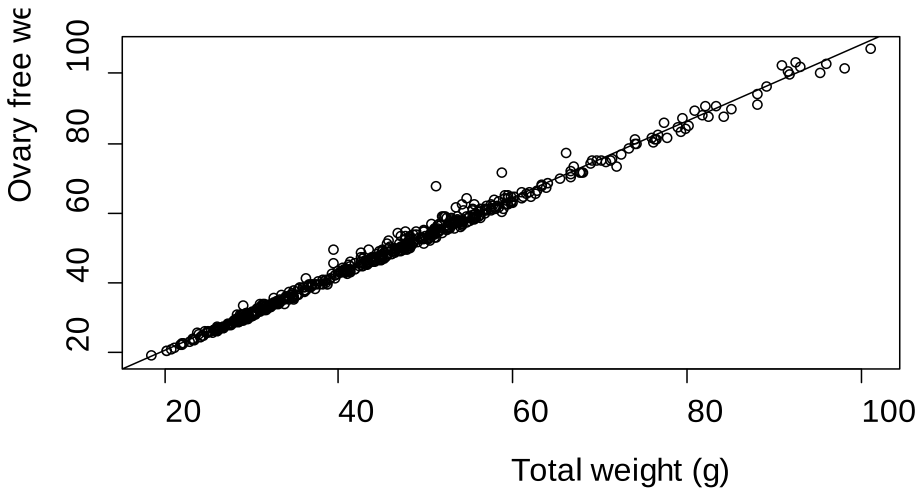


Figure 2. Linear regression model between gonad-free-weight and total weight fitted to non-hydrated females.

Minimum mean female weight (Figure 3) by haul was observed in the French coast (27 g) and maximum in Galicia (87 g). Mean female weight (W) was 51.06 g in the 9a N + 8c area and 40.06 in 8b area. Female mean weight observed in 2017 in 8b area is the minimum of the serie. Regarding 9a-8c area, female mean weight is slightly higher than in 2014 but significantly lower than those observed between 1996 and 2011 (Figure 4).

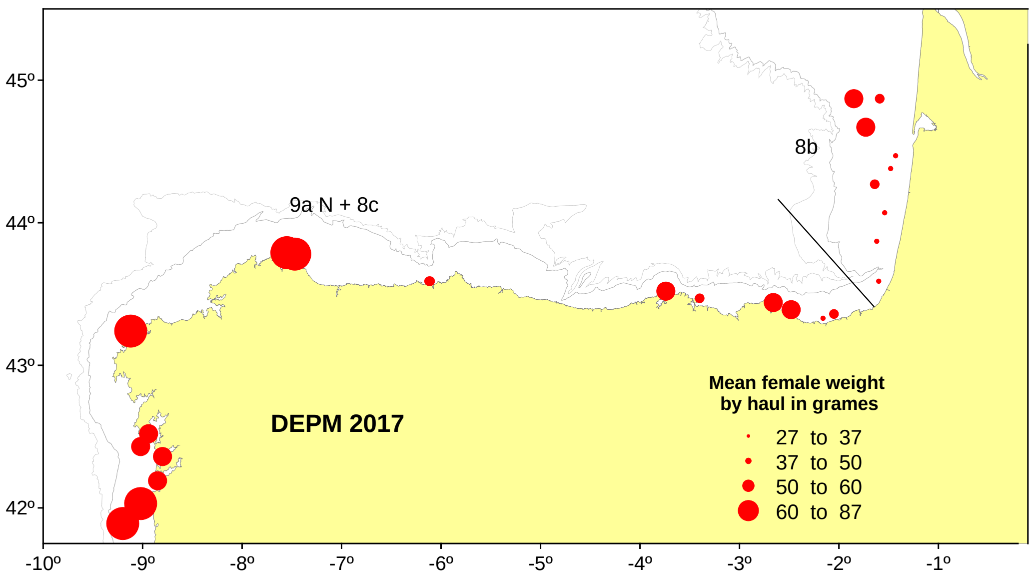


Figure 3. Spatial distribution of mean female weight (g) by haul.

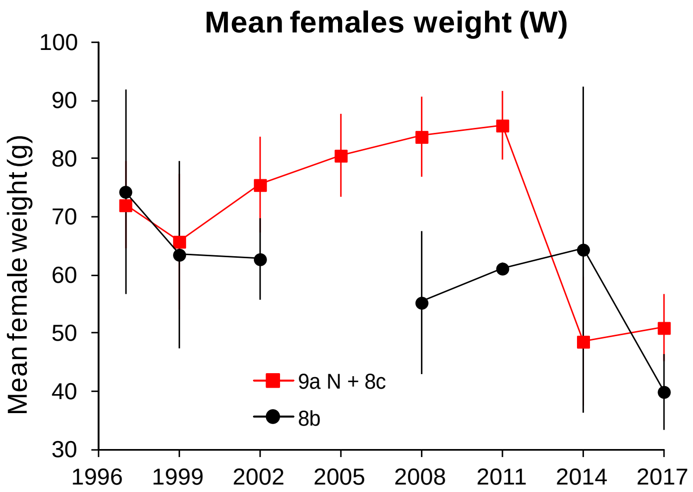
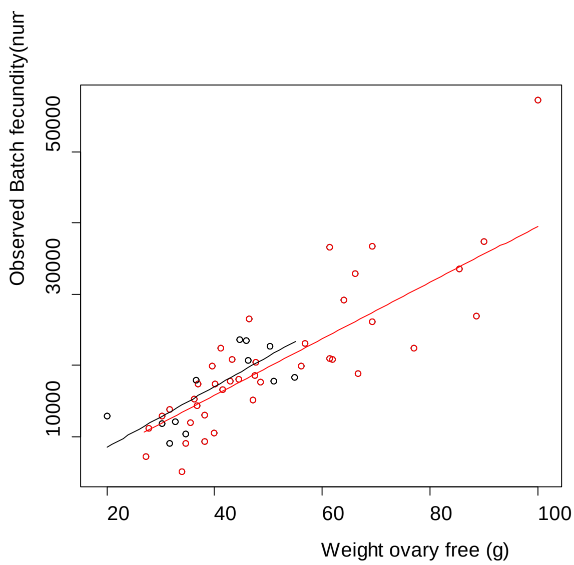


Figure 4. Mean females weight (W) in grams for 9a N+8c area in red and 8b area in black. Vertical lines correspond to 95% confidence intervals (i.e., ± 2 standard-deviations)

The geographical distribution of female weight (Figure 3) and mean observed batch fecundity (Fobs = 19010 and 16305 eggs/female, respectively, for 9a N + 8c and 8b strata) suggest the need for a spatial stratification in view of the parameters estimation. Fobs data were thus modelled against the Wnov and the Stratum (GLM: Fobs ~ -1 + Wnov:Stratum, negative binomial distribution and identity link) with two different strata, and the model obtained was statistically significant (Figure 5).

Though the model obtained with the two strata was statistically significant, in 2017, the relationship between the Fobs and the female Wnov was very similar for the two areas considered, i.e., that the batch fecundity estimated for a fish of the same weight would be similar off the North, West and South coasts (Figure 5). Similarly to the mean weight, mean batch fecundity estimate (F) was lowest off the French coast (8b).




```
> batch_S_0_3.glm <- glm.nb(Fobs ~ -1 + Wnov:Stratum, link=identity,
data=adults.dat, na.action="na.omit")

Deviance Residuals:
   Min       1Q   Median       3Q      Max
-3.2824  -0.6478   0.0541   0.5740   1.7489

Coefficients:
              Estimate Std. Error z value Pr(>|z|)
Wnov:9aN + 8c   395.62      15.86   24.95   <2e-16 ***
Wnov:8b         425.85      31.16   13.66   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for Negative Binomial(15.5768) family taken to be 1)

    Null deviance:    Inf  on 52  degrees of freedom
Residual deviance: 52.564  on 50  degrees of freedom
  (2306 observations deleted due to missingness)
AIC: 1030.3
Number of Fisher Scoring iterations: 1
          Theta:  15.58
      Std. Err.:  3.03
 2 x log-likelihood:  -1024.274
```

Figure 5. Preliminary observed batch fecundity vs. gonad free weight of the 52 hydrated females, the regression line of the corresponding model for the two geographical areas (black: 8b stratum, red: 9a N + 8c) (left panel) and results of the GLM obtained (right panel).

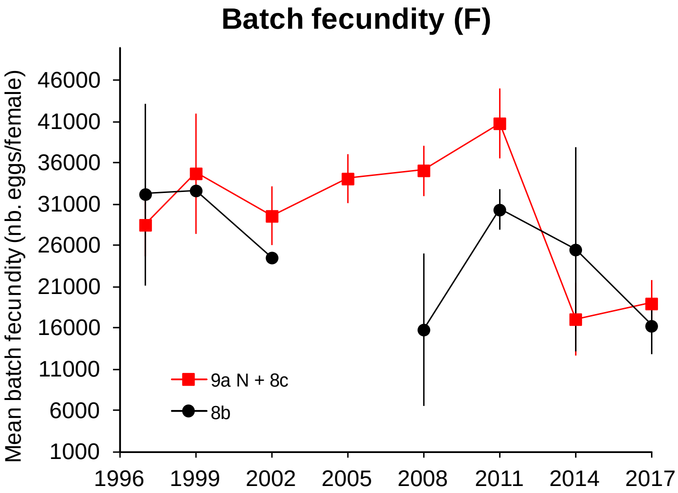


Figure 4. Batch fecundity (F) in number of eggs by female for 9a N+8c area in red and 8b area in black. Vertical lines correspond to 95% confidence intervals (i.e., ± 2 standard-deviations)

Preliminary S for the Northern Spanish coast (9a N + 8c) was 0.170, the highest in the historical series (Figure 5) and similar to those estimated in 1996; nevertheless the preliminary S estimated in the French coast (8b), 0.082, was similar to those obtained during the 2014 survey. In any case, as preliminary S has been estimated without considering females with other evidence of recent spawning (POFs), present results could over or underestimate S values. Thus, results have to be interpreted with caution until final estimates based on histological analysis be available.

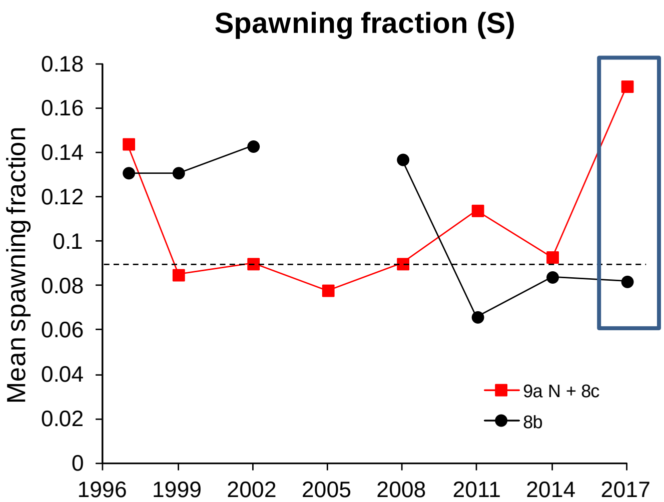


Figure 5. Spawning fraction (S) for 9a N+8c area in red and 8b area in black. The blue rectangle shows the preliminary spawning fraction estimated in 2017 using hydrated females without histological correction.

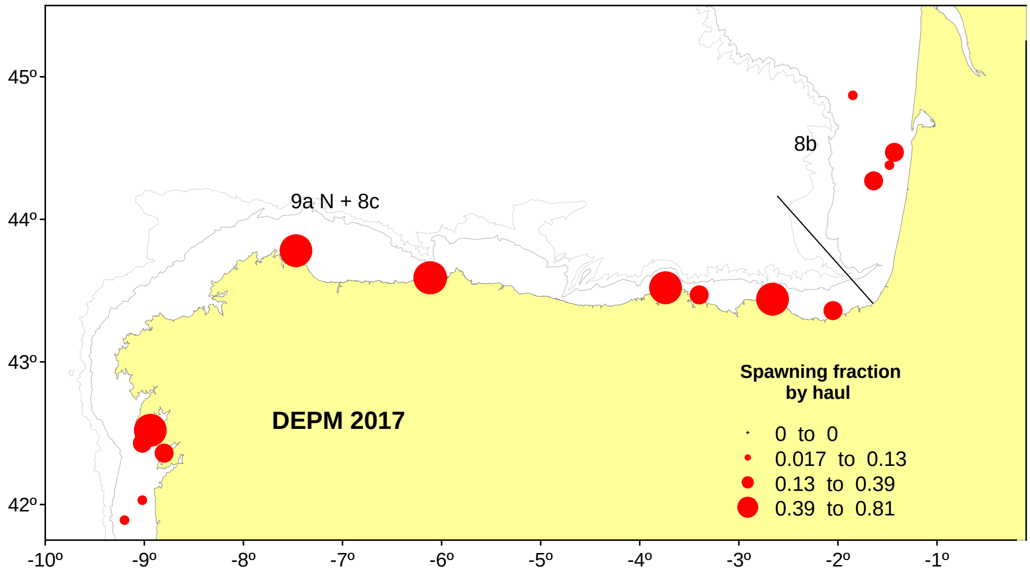


Figure 6. Spatial distribution of mean spawning fraction by haul.

The four adults parameters needed to estimate Spawning Stock Biomass in the 2017 Sardine DEPM survey are summarised in table 5.

Table 5. Sardine adults parameters for the total surveyed area and by ICES divisions. In brackets coefficient of variation in percentage.

2017	IEO	IEO	IEO
Sardine DEPM	9a N + 8c	8b (up to 45ºN)	Total area
Female Weight (g)	51.06 (5.6)	40.06 (8.1)	47.55 (5.1)
Batch Fecundity (eggs/female)	19010 (7.5)	16305 (10.3)	18090 (6.6)
Sex Ratio	0.505 (6.3)	0.434 (13.2)	0.48 (6.0)
Spawning Fraction	0.170 (32)	0.082 (47.2)	0.142 (27.3)

Final remarks

- All laboratory tasks for histological processing and microscopical analysis are still in progress.
- The expected individual batch fecundity (Fexp) for all mature females (hydrated and non-hydrated) was estimated by modelling 52 selected individual batch fecundity observed (Fobs) in the sampled hydrated females.
- Preliminary spawning fraction estimated as the quotient between the total number of random hydrated females in the haul and the total random mature females. No histological correction was taking into account to estimate the preliminary spawning fraction.
- Observed decrease on mean females weight and batch fecundity estimates in 9a N + 8c area in 2014 sardine DEPM survey are also maintained in 2017**.**
- For the first time in the historical series, the minimum mean female weight (W) was obtained for the 8b area.

Working Document for ***WGHANSA***
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Direct assessment of small pelagic fish by the PELGAS17 acoustic survey

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1. MATERIAL AND METHOD

1.1. PELGAS survey on board Thalassa

An acoustic survey (PELGAS) is carried out every year in the Bay of Biscay in spring onboard the French research vessel Thalassa. The objective of PELGAS survey is to study the abundance and distribution of pelagic fish in the Bay of Biscay. The main target species are anchovy and sardine but they are considered in a multi-specific context and within an ecosystemic approach as they are located in the centre of pelagic ecosystem.

This survey is connected with IFREMER programs on data collection for monitoring and management of fisheries and ecosystemic approach for fisheries. This task is formally included in the first priorities defined by the Commission regulation EU N° 199/2008 of 06 November 2008 establishing the minimum and extended Community programmes for the collection of data in the fisheries sector and laying down detailed rules for the application of Council Regulation (EC) No 1543/2000. This survey must be considered in the frame of the Ifremer fisheries ecology action "resources variability" which is the French contribution to the international Globec programme. It is planned with Spain and Portugal in order to have most of the potential area covered from Gibraltar to Brest with the same protocol regarding sampling strategy. Data are available for the ICES working groups WGHANSA, WGWIDE and WGACEGG.

In the spirit of the ecosystemic approach, the pelagic ecosystem is characterised at each trophic level. To achieve this and to assess an optimum horizontal and vertical description of the area, two types of actions are combined:

- Continuous acquisition of acoustic data with two different echosounders, pumping sea-water under the surface in order to evaluate the number of fish eggs using a CUFES system (Continuous Under-water Fish Eggs Sampler) and a visual counting and identification of cetaceans and birds (from board) carried out in order to characterise the higher level predators of the pelagic ecosystem.
- Discrete sampling at stations (by pelagic trawls, plankton nets, CTD).

Satellite imagery (temperature and sea colour) and modelling have been also used before and during the survey to recognise the main physical and biological structures and to improve the sampling strategy.

The strategy this year was the identical to previous surveys (2000 to 2016). The survey protocols are described *in Doray M, Badts V, Masse J, Duhamel E, Huret M, Doremus G, Petitgas P (2014).* ***Manual of fisheries survey protocols. PELGAS surveys (PELagiques GAScogne)***. http://dx.doi.org/10.13155/30259:

- acoustic data were collected along systematic parallel transects perpendicular to the French coast (figure 1.1.1). The length of the ESDU (Elementary Sampling Distance Unit) was 1 mile and the transects were uniformly spaced by 12 nautical miles and cover the continental shelf from 20 m depth to the shelf break (or sometimes more offshore – see figure below).
- acoustic data were only collected during the day because of pelagic fishes behaviour in this area. These species are usually dispersed very close to the surface during the night and so "disappear" in the blind layer of the echo-sounders between the surface and 8 m depth.

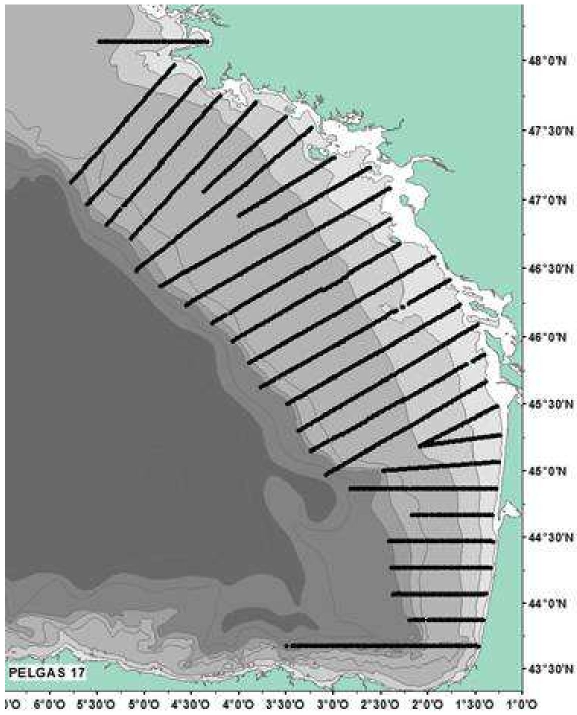


Fig. 1.1.1 - Transects prospected during PELGAS17 by Thalassa.

In 2017, as in previous surveys (since 2009), three modes of acoustic observations were used:

- 1 SIMRAD ME70 multi-beam echo-sounder (21 2 to 7°beams, from 70 to 120 kHz) used essentially for visualisation and observing the behaviour and shapes of fish schools during the whole survey. Nevertheless, only echoes stored on the vertical echo-sounder were used for abundance index calculation.
- 1 horizontal echo-sounder on the starboard side for surface echo-traces
- this year, the broadband echosounder EK80 was installed and used, instead of the ER60 (single beam, multi frequency)

Energies and samples provided by all sounders were simultaneously visualised and stored using the MOVIES3D software and stored at the same standard HAC format.

The calibration method was the same that the one described for the previous years (see WD 2001) and was performed at anchorage near Brest, in the West of Brittany, in optimal meteorological conditions at the beginning of the survey.

Acoustic data were collected by R/V Thalassa along a total amount of 5171 nautical miles from which 1896 nautical miles on one way transect were used for assessment. A total of 19 461 fishes were measured (including 5 601 anchovies and 4 147 sardines) and 2 990 otoliths were collected for age determination (1 455 of anchovy and 1 535 of sardine).

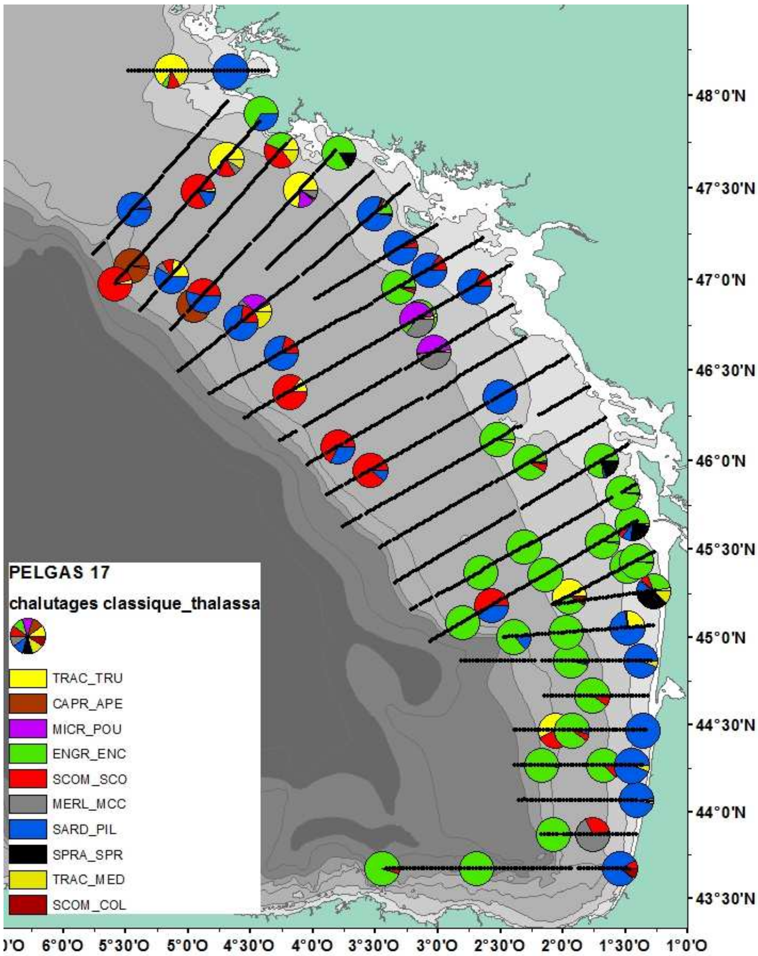


Fig. 1.1.2: Species distribution according to Thalassa identification hauls.

1.2. The consort survey

A consort survey is routinely organised since 2007 with French commercial vessels during 17 days. This approach is in identical to last year's surveys, using the commercial vessel's hauls were for echoes identification and biological parameters to complement hauls made by the R/V Thalassa.

Four commercial vessels (two pairs of pelagic trawlers) participated to PELGAS17 survey:

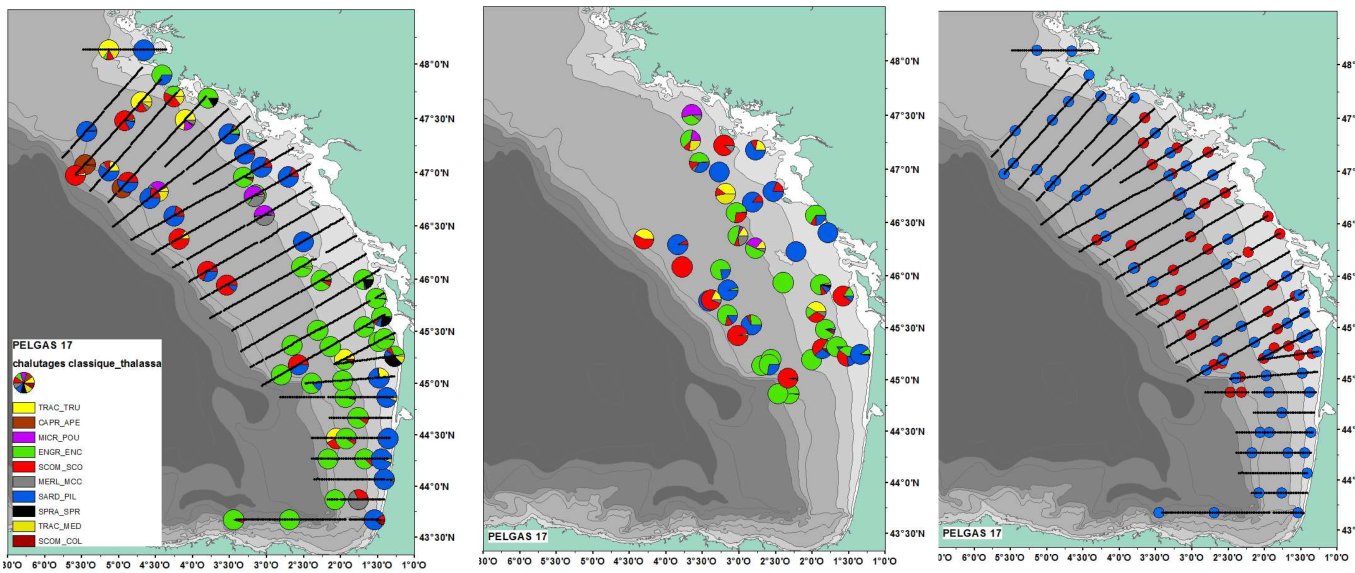
Vessel	Gear	Period	Days at sea
Cintharth / Marilude	Pelagic pair trawl	28/04 to 04/05/2017	7
Les Menhirs / Le Dolmen	Pelagic pair trawl	05/05 to 14/05/2017	9

The regular transects network agreed for several years for Thalassa is 12 miles separated in parallel transects. Commercial vessels worked between standard transects and 2 NM northern. Sometimes, they carried out fishing operations on request (complementary to Thalassa, particularly for surface hauls or in very coastal areas) Their pelagic trawl was up to 25 m vertical opening and the mesh of their codend was similar to the on uses by the R/V Thalassa (12 mm).

A scientific observer was on board the commercial vessel to control every fishing operation, and to collect biological data. The fishing operations were systematically agreed after a radio contact with Thalassa in order to confirm their usefulness. In some occasions, these fishing operation were used to check the spatial extension of species already observed and identified by Thalassa (and therefore the spatial distribution); in others the objective was to enlarge the vertical distribution description by stratified catches. Globally, a great attention was given on a good distribution of samples to avoid over-sampling on some situations. Regularly a biological sample was provided by the commercial vessels to Thalassa to improve otoliths collection and sexual maturity (220 otoliths of anchovy, 338 of sardine). A total of 5255 fishes were measured onboard commercial vessels, including 1783 anchovies and 1074 sardines.

Catches and biological data were used to complement the sampling made on boar the R/V Thalassa.

A total of 113 hauls (including 7 not valid) were carried out during the consort survey including 65 hauls by the R/V Thalassa and 41 hauls by commercial vessels.



a) Thalassa (nb :65)

b) Commercial vessels (nb : 41)

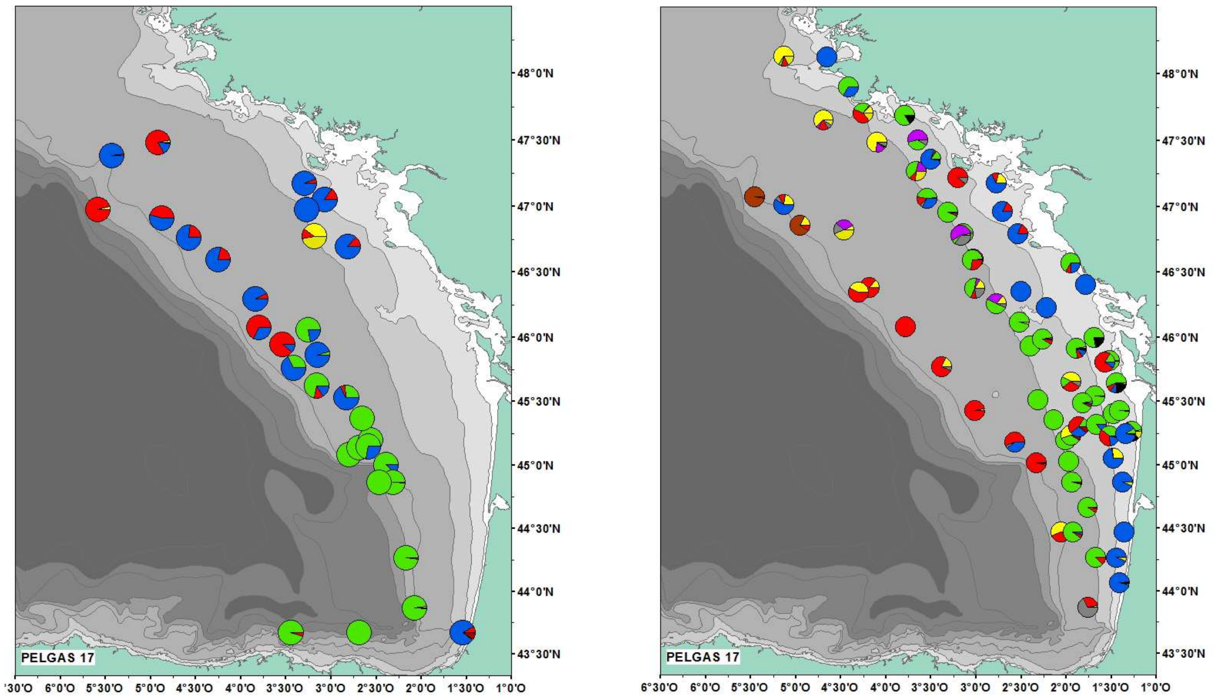
c) all fishing hauls (nb :106) Thalassa in Blue and commercial in red

Figure 1.2.2 : fishing operations carried out by Thalassa and commercial vessels during consort survey PELGAS17

The collaboration between Thalassa and commercial vessels was excellent. It was once more a very good opportunity to 1)explain our methodology to the fishermen and 2) check consistency between scientists and fishermen echo-trace's observation and interpretations. Some fishing operations were done in parallel by Thalassa and commercial vessel in order to check catches' similarity (in proportion of species and, most of the time, in quantity as well - taking the vertical and horizontal opening into account). As last year, commercial vessels' fishing operations were only carried out at day time (as for Thalassa) each time it was necessary and preferentially at the surface or in mid-water, since the pair trawlers are more efficient at surface than single back trawlers.

Table 1.2.3. : Number of fishing operations carried out by Thalassa and commercial vessels during consort survey PELGAS17

	thalassa	commercial	total
classic	46	27	73
surface	19	14	33
null	6	1	7
total	71	42	113



a) Hauls carried out at surface or in mid-water levels (Thalassa & commercial vessels)

b) classic Hauls carried out near the bottom and 50m upper (Thalassa + commercial vessels)

Figure 1.2.4 : Vertical localisation of fishing operations carried out by Thalassa and commercial vessels and species composition during survey PELGAS17

2. ACOUSTICS DATA PROCESSING

2.1. Echo-traces classification

All the acoustic data along the transects were processed and scrutinised by the date of the meeting. Acoustic energies (Sa) have been cleaned by sorting only fish energies (excluding bottom echoes, parasites, plankton, etc.) and classified into 5 categories of echo-traces this year:

D1 – energies attributed to mackerel, chub mackerel, horse mackerel, blue whiting, hake, and whiting, corresponding to cloudy schools or layers (sometimes small dispersed points) close to the bottom or of small drops in a 10m height layer close to the bottom.

D2 –energies attributed to anchovy, sardine, and sprat corresponding to the usual echo-traces observed in this area since more than 15 years, constituted by schools well defined, mainly situated between the bottom and 50 meters above. These echoes are typical of clupeids in coastal and sometimes more offshore areas.

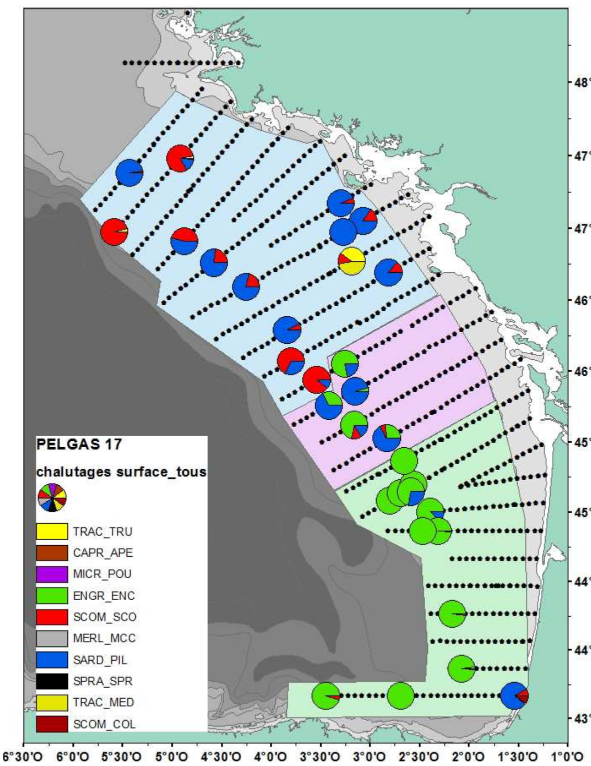
D3 – energies attributed to scattered detection corresponding to blue whiting, myctophids, boarfish, mackerel and horse mackerel.

D4 – energies attributed to sardine, mackerel and anchovy corresponding to echoes very close to the surface. This year, horse mackerel was also allocated in this category

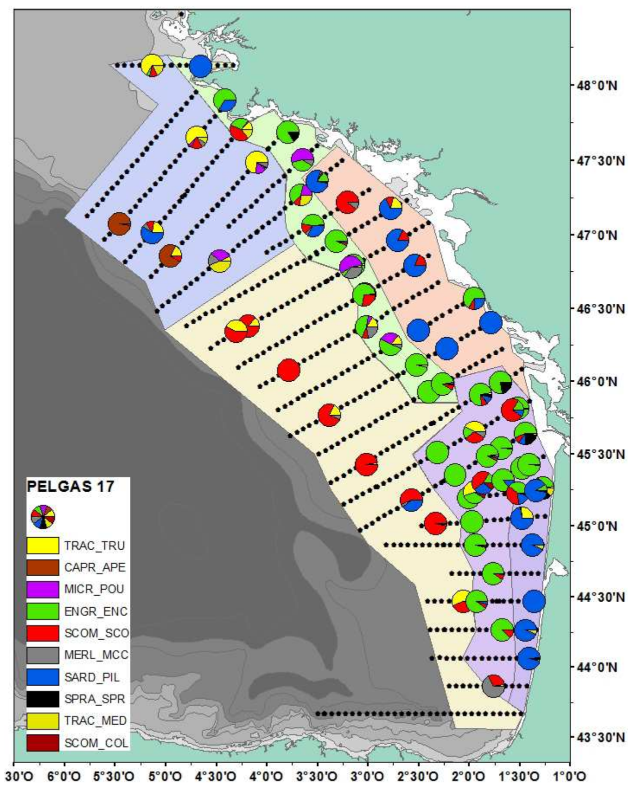
D8 – energies attributed exclusively to sardine (big and very dense schools).

2.2. Splitting of energies into species

As for previous years (except in 2003, see WD-2003), the global area has been split into several strata where coherent communities were observed (species associations) in order to minimise the variability due to different species assemblages. Figure 2.2 shows the strata considered to evaluate biomass of each species. For each stratum, energies where converted into biomass by applying catch ratio, length distributions and weighted by abundance of fish in the haul surrounded area.



Coherent surface strata



Coherent classic strata

Fig. 2.2 – Coherent strata (classic and surface), in terms of echoes and species distribution, taken into consideration for multi-species biomass estimate from acoustic and catches data during PELGAS17 survey.

2.3. Biomass estimates

The fishing strategy has been followed all along the survey in order to benefit of each vessel's efficiency and maximise the number of samples (in term of identification and biological parameters). Therefore, the commercial vessels carried out mostly surface hauls when Thalassa fished preferably in the bottom layer. According to previous strata (Figure 2.2), using both Thalassa and consort fishing operations, biomass estimates were calculated for each main pelagic species in the surveyed area.

Biomass indices are presented in tables 2.3.1 and 2.3.2 and in figure 2.3.1. No estimate is provided for mackerel according to the low level of TS and particular behaviour in the Bay of Biscay where it is scattered and mixed with plankton echoes.

Anchovy was more abundant than last year and their abundance was estimated this year at a high level compared to the historical time series (around 135 000 tonnes). Strong densities were observed in the Gironde area. It must be noticed that we observed anchovy on the first transect along the Spanish coast in also high densities, exclusively close to the surface.

Sardine was also more present this year compared to 2016, mainly in coastal waters from the South until the Brittany, and it was also present in variable densities in surface along the shelfbreak.

About other species, another characteristic of this year was that horse mackerel showed a decline of the biomass again, after 3 years of increasing. The biomass reached again a low level compared to the abundance calculated in te first years of the serie.

Mackerel appeared well abundant this year, particularly offshore, close to the bottom, and sometimes near the surface.

Table 2.3.1. Acoustic biomass index for the main species by strata during PELGAS17

	Classic	**surface**	**total**
boarfish	11 247		11 247
anchovy	**110 887**	**23 613**	**134 500**
hake	22 494		22 494
blue whiting	36 961	4 507	41 468
sardine	**431 332**	**33 689**	**465 022**
chub mackerel	44 929	3 118	48 047
mackerel	1 208 675	167 186	1 375 861
sprat	15 778		15 778
horse Mackerel	46 628	15 272	61 899

Table 2.3.2. Acoustic biomass index for the five main pelagic species since the beginning of PELGAS surveys (2000)

	2000	2001	2002	2003	2004	2005	2006	2007	2008
anchovy	**113 120**	**105 801**	**110 566**	**30 632**	**45 965**	**14 643**	**30 877**	**40 876**	**37 574**
	14 479	29 836	24 988	8 087	15 352	5 008	8 399	8 175	12 174
CV anchovy	*0,064*	*0,141*	*0,113*	*0,132*	*0,167*	*0,171*	*0,136*	*0,100*	*0,162*
Sardine	**376 442**	**383 515**	**563 880**	**111 234**	**496 371**	**435 287**	**234 128**	**126 237**	**460 727**
	62 489	89 743	99 243	53 615	120 122	117 528	54 786	40 143	128 082
CV sardine	*0,083*	*0,117*	*0,088*	*0,241*	*0,121*	*0,135*	*0,117*	*0,159*	*0,139*
Sprat	**30 034**	**137 908**	**77 812**	**23 994**	**15 807**	**72 684**	**30 009**	**17 312**	**50 092**
	5 881	42 752	18 675	9 502	5 627	33 144	9 723	4 570	26 849
CV sprat	*0,098*	*0,155*	*0,120*	*0,198*	*0,178*	*0,228*	*0,162*	*0,132*	*0,268*
Horse mackere	**230 530**	**149 053**	**191 258**	**198 528**	**186 046**	**181 448**	**156 300**	**45 098**	**100 406**
	36 424	60 814	59 672	54 397	106 791	58 063	98 782	5 863	91 370
CV HM	*0,079*	*0,204*	*0,156*	*0,137*	*0,287*	*0,160*	*0,316*	*0,065*	*0,455*
Blue Whiting	-	-	**35 518**	**1 953**	**12 267**	**26 099**	**1 766**	**3 545**	**576**
	-	-	27 420	512	4 956	30 953	742	1 042	292
CV BW	-	-	*0,386*	*0,131*	*0,202*	*0,593*	*0,210*	*0,147*	*0,253*

	2009	2010	2011	2012	2013	2014	2015	2016	2017
anchovy	**34 855**	**86 354**	**142 601**	**186 865**	**93 854**	**125 427**	**372 916**	**89 727**	**134 500**
	7 808	25 388	22 078	17 433	24 067	15 786	54 857	23 329	41 517
CV anchovy	*0,112*	*0,147*	*0,0774*	*0,04665*	*0,1282*	*0,062928*	*0,0735509*	*0,13*	*0,15433929*
Sardine	**479 684**	**457 081**	**338 468**	**205 627**	**407 740**	**339 607**	**416 524**	**229 742**	**465 022**
	94 018	83 189	47 323	31 537	60 200	44 293	85 234	36 759	56 410
CV sardine	*0,098*	*0,091*	*0,0699*	*0,07668*	*0,0738*	*0,065212*	*0,1023153*	*0,08*	*0,06065334*
Sprat	**112 497**	**67 046**	**34 726**	**6 417**	**44 651**	**33 894**	**91 248**	**36 593**	**15 778**
	24 299	14 482	0	0	17 791	16 337	35 649	32 202	16 631
CV sprat	*0,108*	*0,108*	*0*	*0*	*0,1992*	*0,241009*	*0,1953397*	*0,44*	*0,52701049*
Horse mackere	**56 593**	**11 662**	**61 237**	**7 435**	**33 471**	**53 154**	**77 142**	**119 230**	**61 919**
	10 187	4 385	0	0	20 127	24 141	23 911	71 538	35 705
CV HM	*0,09*	*0,188*	*0*	*0*	*0,3007*	*0,227089*	*0,1549802*	*0,3*	*0,28831771*
Blue Whiting	**4 333**	**48 141**	**11 823**	**68 533**	**25 715**	**25 015**	**8 684**	**11 852**	**23 944**
	1 898	7 125	0	0	7 931	16 891	3 881	3 556	7 042
CV BW	*0,219*	*0,074*	*0*	*0*	*0,1542*	*0,337606*	*0,2234791*	*0,15*	*0,14706269*

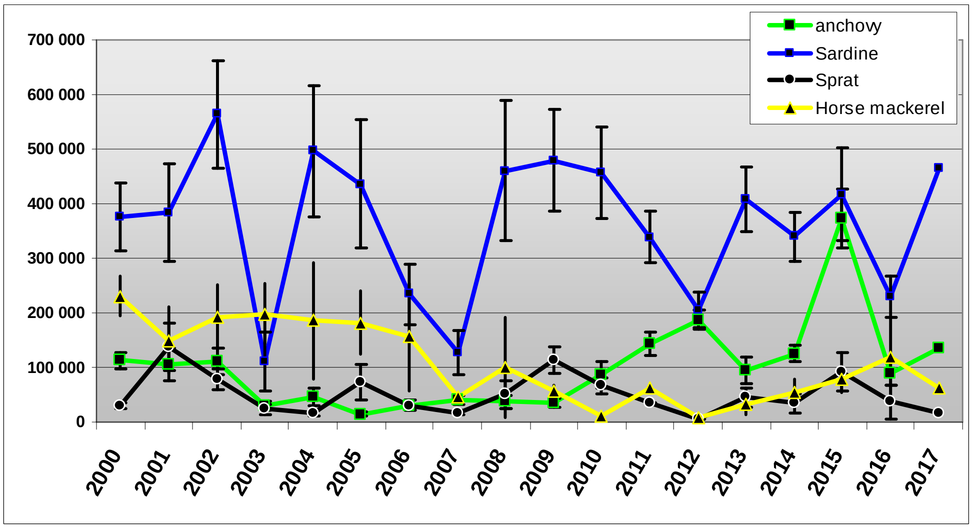


figure 2.3.3. – biomass estimate using Thalassa acoustic data along transects and all the consort identification fishing operations (Thalassa + commercial vessels) and associated coefficients of variation.

3. Anchovy data

3.1. anchovy biomass

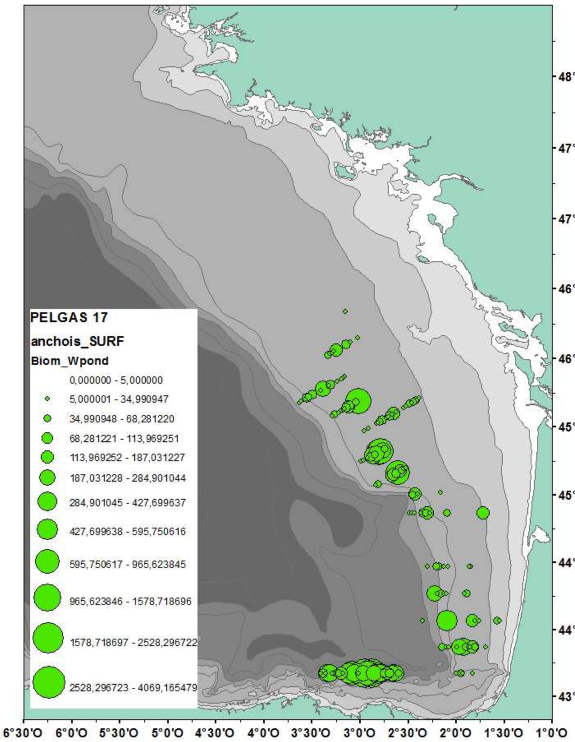
The biomass estimate of anchovy observed during PELGAS2016 is **134 500** tons. (table 2.3.2.), which seems to be a relatively high biomass compared to previous year's, comparable to 2014.

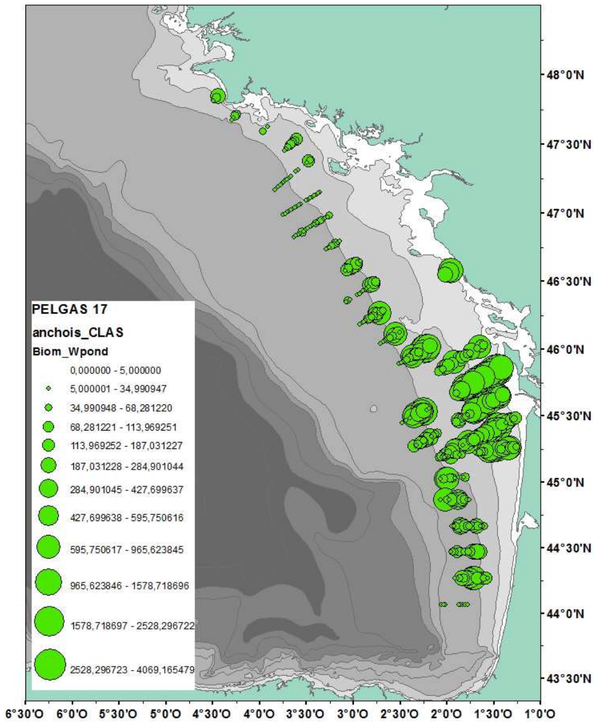
In the Gironde area, the configuration was usual in terms of energy compared to what was observed last years, with a high energy attributed to anchovy.

The one year old anchovies were mostly present front of the Gironde (in terms of energy and, as well, biomass) but they were still well present on the platform, till Brittany along the bathymetric line of 100m. The average size of one year old fish was comparable the average size in recent years (two years really differed from the average: 2012 and particularly 2015 where fishes were much smaller) but shows a clear decreasing trend, year after year.

One years old anchovies were also present, in lower quantities, mixed with older fish, even offshore.

Figure 3.1 shows the vertical distribution of anchovy.





Surface distribution

Near-seabed distribution, between the bottom and 40m above

Figure 3.1. – Anchovy distribution according to PELGAS17 survey.

3.2. Anchovy length structure and maturity

Length distribution in the trawl hauls were estimated from random samples. The population length distributions (figures 3.2) were estimated by a weighted average of the length distribution in the hauls. Weights used are acoustic coefficients (Dev*Xe Moule in thousands of individuals per n.m.^{2}) which correspond to the abundance in the area sampled by each trawl haul.

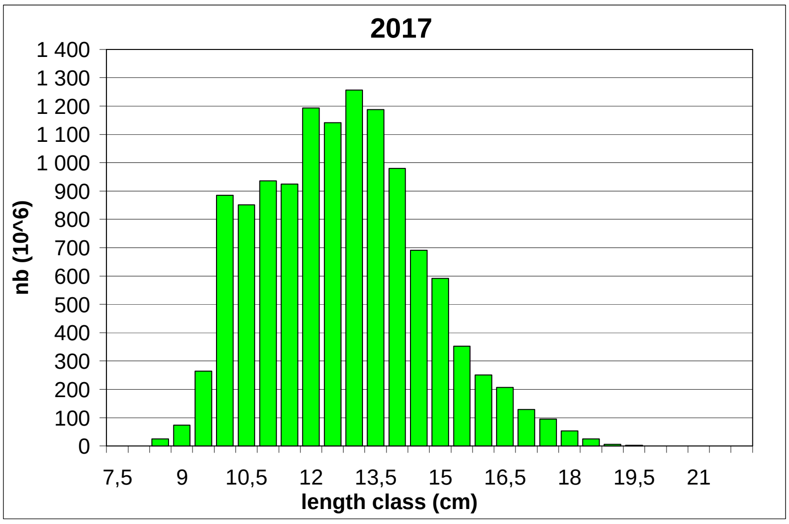


Figure 3.2: length distribution of global anchovy as observed during PELGAS17 survey

Globally we observe that length structure shows an unimodal distribution, with a mode around 13 centimetres (constituted by age 1 and Age 2 fishes). It must be noticed that even if some individuals were small (less than 10centimeters), almost all fishes were mature and in their spawning period. This observation on maturity contrasted with the 2015 observation where a large proportion of the population was not spawning at the period of the survey.

3.3. Demographic structure

An age length key was built for anchovy from the trawl catches (Thalassa hauls) and samples from commercial vessels. We took the otoliths from a given number of fishes per length class (4 to 6 / half-cm), for a total amount of around 50 fishes per haul. As there was a lot of fishing operations where anchovy was present (as previous surveys), the number of otoliths taken during the survey was still important (1455 otoliths of anchovy taken and read on board), The population length distributions were estimated by a weighted use of length distributions in the hauls, weighted as described in section 3.2.

Table 3.3.1. PELGAS2017 anchovy Age/Length key.

Nombre de Age	Age				
Taille	1	2	3	4	Total
7,5	100,00%	0,00%	0,00%	0,00%	100,00%
8	100,00%	0,00%	0,00%	0,00%	100,00%
8,5	100,00%	0,00%	0,00%	0,00%	100,00%
9	100,00%	0,00%	0,00%	0,00%	100,00%
9,5	96,97%	3,03%	0,00%	0,00%	100,00%
10	100,00%	0,00%	0,00%	0,00%	100,00%
10,5	96,00%	2,00%	2,00%	0,00%	100,00%
11	97,22%	2,78%	0,00%	0,00%	100,00%
11,5	94,25%	5,75%	0,00%	0,00%	100,00%
12	91,53%	7,63%	0,85%	0,00%	100,00%
12,5	87,30%	11,90%	0,79%	0,00%	100,00%
13	82,68%	15,75%	1,57%	0,00%	100,00%
13,5	77,10%	20,61%	2,29%	0,00%	100,00%
14	59,83%	30,77%	9,40%	0,00%	100,00%
14,5	44,23%	41,35%	14,42%	0,00%	100,00%
15	16,84%	64,21%	18,95%	0,00%	100,00%
15,5	19,10%	52,81%	26,97%	1,12%	100,00%
16	6,33%	53,16%	40,51%	0,00%	100,00%
16,5	6,78%	50,85%	42,37%	0,00%	100,00%
17	5,00%	40,00%	52,50%	2,50%	100,00%
17,5	5,56%	50,00%	38,89%	5,56%	100,00%
18	0,00%	55,56%	33,33%	11,11%	100,00%
Total	62,55%	25,73%	11,44%	0,28%	100,00%

Applying the age distribution to the abundance in biomass and numbers, the distribution in age of the biomass has been calculated. The total biomass used here has been updated with the value obtained from the previous method based on strata.

Age distribution is shown in figures 3.3.2. The age distributions compared from 2000 to 2017 are shown in figure 3.3.3.

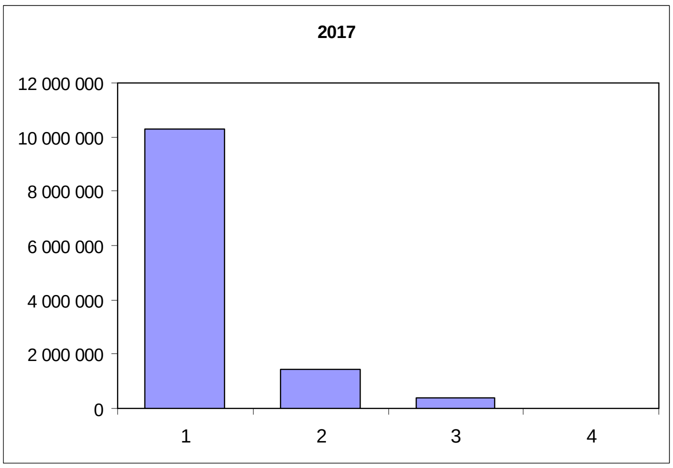


Figure 3.3.2– global age composition (numbers) of anchovy as observed during PELGAS17.

Looking at the numbers at age since 2000 (fig 3.3.3.), the number of 1 year old anchovies this year seems to be equivalent to 2011 or 2012, far away from the very best recruitment observed in 2015.

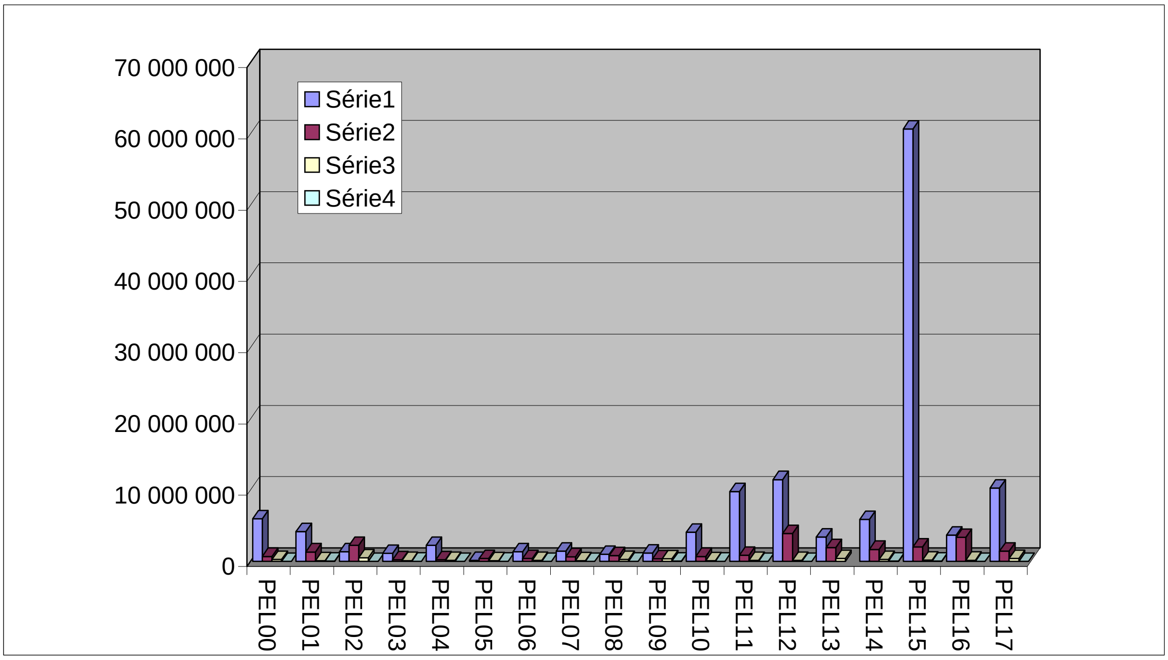


Figure 3.3.3 Anchovy numbers at age as observed during PELGAS surveys since 2000

The huge 2015 age class last year is not fully followed in 2016 in a high abundance of age 2 this year, and this year as well as age 3. Once again, it could indicate that an overestimation occurred on the recruitment in 2015. Several investigation have been done to explain, without results for the time being.

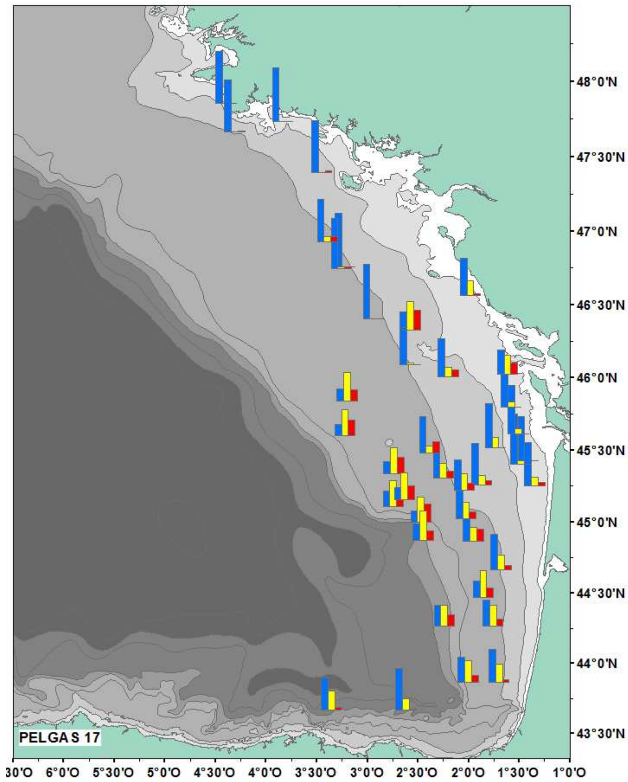


Figure 3.3.4 Anchovy proportion at age in each haul as observed during PELGAS17 survey (blue = age 1, yellow = age 2).

During previous surveys, anchovy was well geographically stratified depending on the age (*see WD 2010, Direct assessment of small pelagic fish by the PELGAS10 acoustic survey, Masse J and Duhamel E*.). It is less true this year, as in 2014, as age 1 were present all over the area where anchovy was present. This one year old anchovy is almost pure front of the Gironde and in the South of Brittany, and mixed with older individuals offshore and closed to the surface.

	PEL17 - N - %
1	84,8%
2	11,8%
3	3,4%
4	0,05%

	PEL17 - W - %
1	62,24%
2	28,13%
3	9,46%
4	0,17%

Figure 3.3.5 percentage by age of the Anchovy population observed during PELGAS17 in numbers (left) and biomass (right).

3.4. Weight/Length key

Based on 1781 weights of individual fishes, the following weight/length key was established (figure 4.5.):

$W= 0.0029L^{3.314}$ with $R2 = 0.9757$ *(with W in grams and L in cm)*

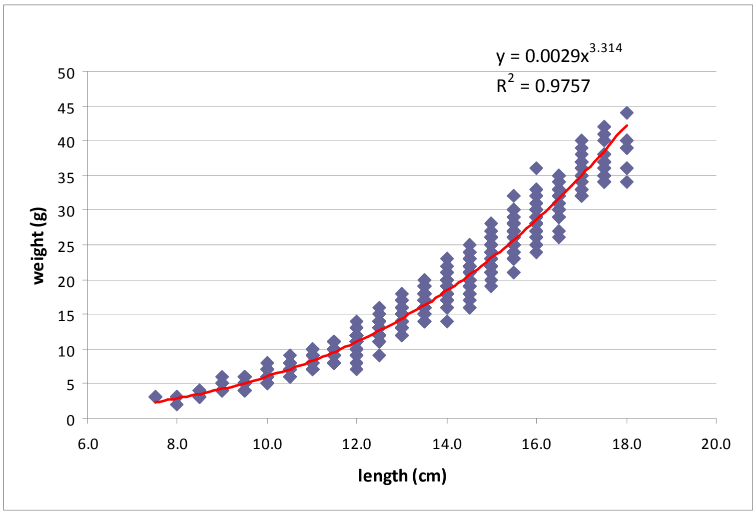


Fig. 3.4 – Weight/length key of anchovy established during PELGAS17

3.5. Mean Weight at age

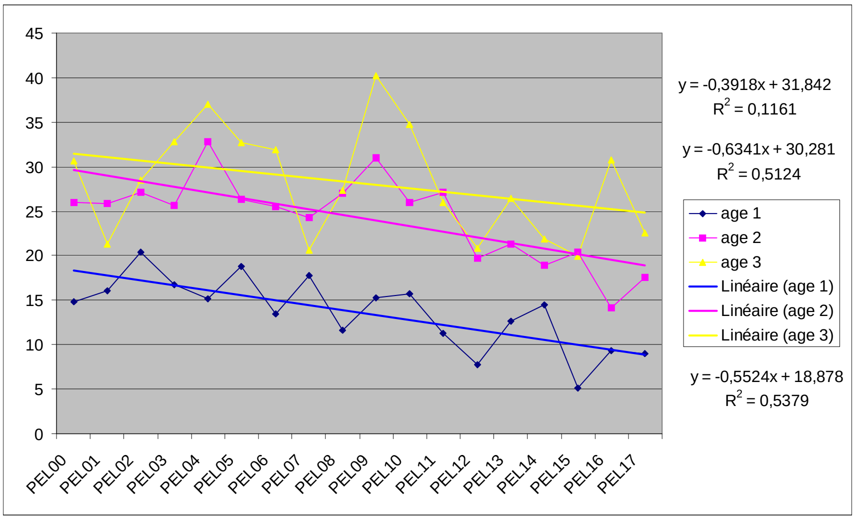


Fig. 3.5. – evolution of mean weight at age (g) of anchovy along pelgas series

As previous years, we observe that globally the trend of the mean weight at age is a decrease. This trend is almost the same for sardine in the bay of Biscay. Further investigates should be done and, if we have some hypothesis (maybe an effect of density-dependance), we do not have real explanation for the time being.

3.6. Eggs

During this survey, in addition of acoustic transects and pelagic trawl hauls, 783 CUFES samples were collected and counted, 65 vertical plankton hauls and 111 vertical profiles with CTD were carried out. Eggs were sorted and counted automatically with the zoocam system, and staged during the survey.

2017, as from 2011, was marked by a large quantity of collected and counted anchovy eggs (Fig 3.6.2).Their spatial pattern of distribution was quite usual, with major part of the abundance South of 46°N. However, eggs are also abundant on 3 more transects than usual North of the Gironde estuary, with a connection all over the shelf between the classical inshore and slope distributions. This may be related to the large extension of the Gironde plume to the North-West, as well as the large adult abundance spreading larger than usual. South of the Gironde eggs are almost everywhere. Small amount of eggs are again found in front of the Loire mouth and along the southern coast of Brittany.

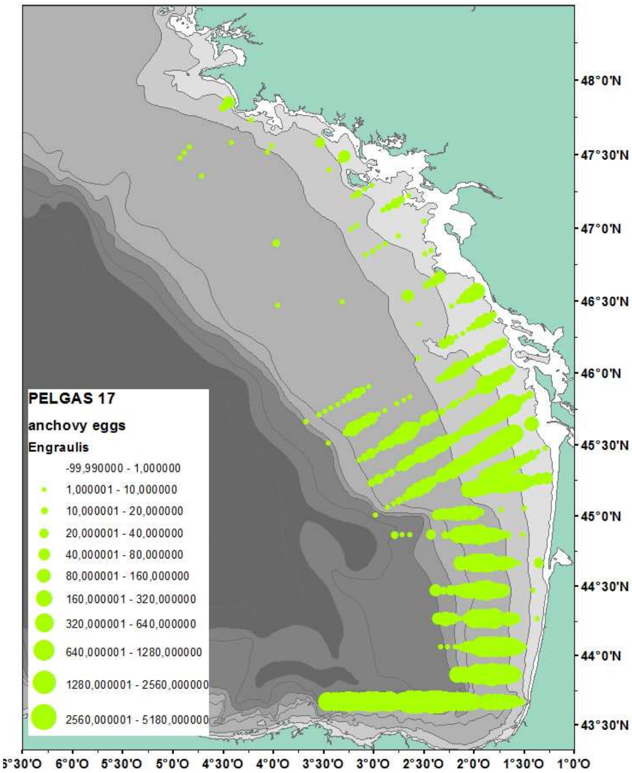


Figure 3.6.1 – Distribution of anchovy eggs observed with CUFES during PELGAS17.

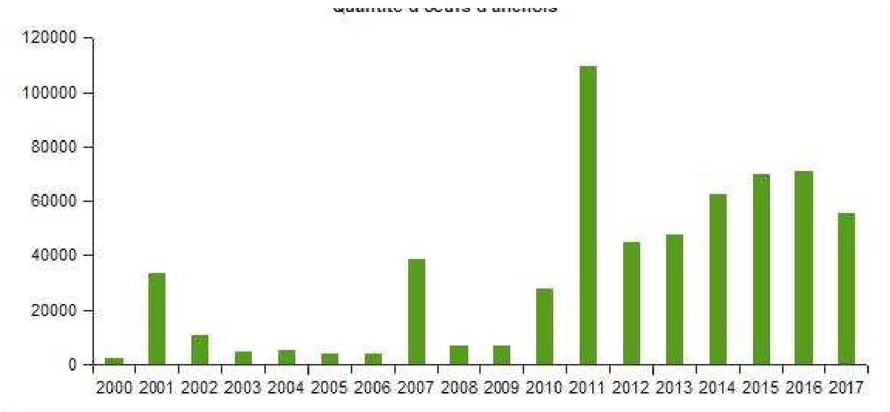


Figure 3.6.2 – Number of eggs observed during PELGAS surveys from 2000 to 2017

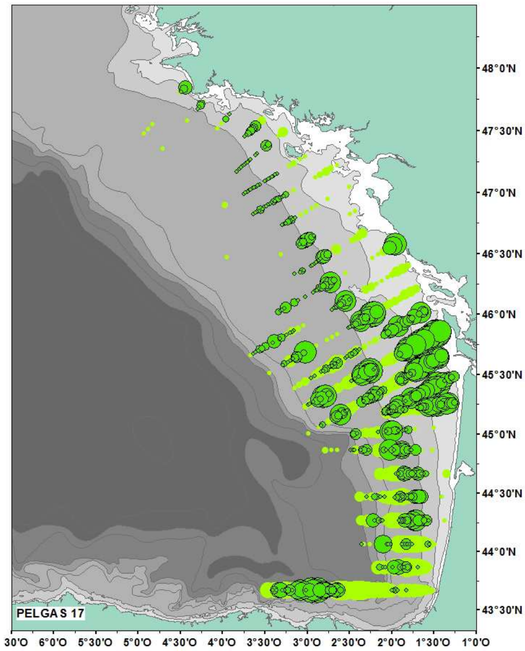


Figure 3.6.3 – Coherence between spatial distribution of adults and eggs. circled point = biomass of adults per ESDU, without circle and light green = eggs

We can see that globally the spatial distribution of eggs match with the adult's one. But on the first transect, at the East, a lot of eggs were counted despite a low abundance of adults. it could be due to the presence of fish completely closed to the surface, in the blind layer of echosounders, or due to some movements of fish to North or West.

4. SARDINE DATA

4.1. Adults

The biomass estimate of sardine observed during PELGAS15 is **465 022** tons (table 2.3.), which constitutes an increase from last year, the biomass reaching a high level of the PELGAS series. It must be enhance that this survey doesn't cover the total area of potential presence of sardine, and it is possible that some years, this specie could be present up to the North, in the Celtic sea, SW of Cornouailles or Western Channel where some fishery occurs, more or less regularly. It is also possible that sometimes, a small fraction 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 (VIIIab) sardine population.

Sardine was distributed all along the French coast of the bay of Biscay, from the South to the North. Sardine was well present this year, pure along the Lande's coast where an upwelling occurred, rarely mixed with other species along the coast. Sardine appeared also present offshore, close to the surface, along the shelfbreak, contrary to previous year.

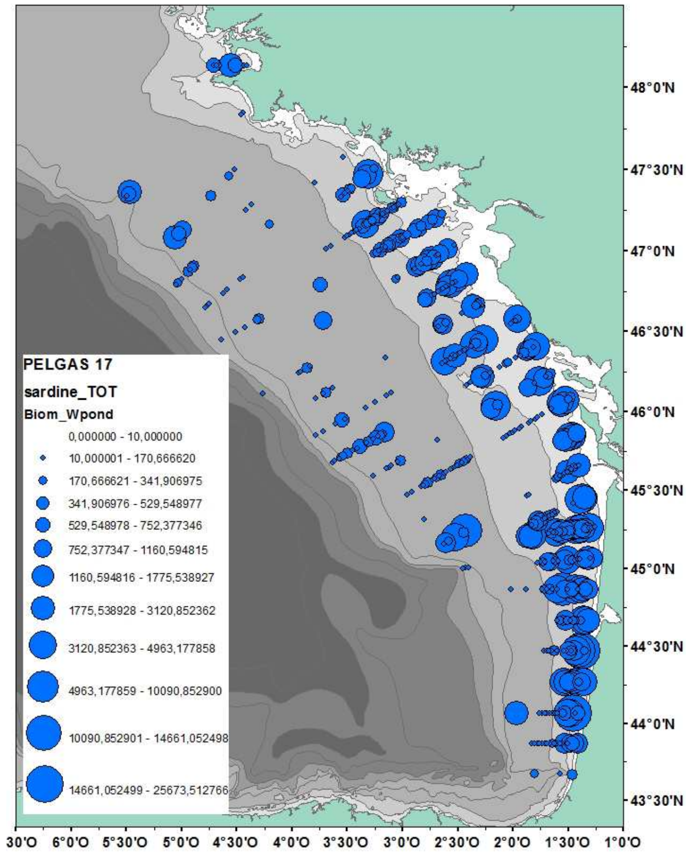


Figure 4.1.1 – distribution of sardine observed by acoustics during PELGAS17

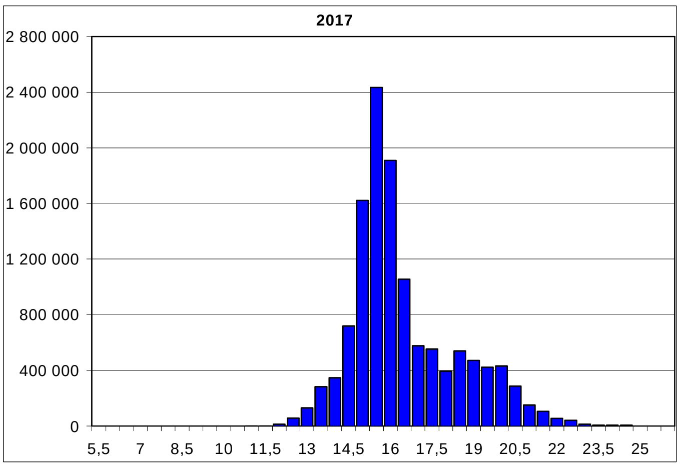


Figure 4.1.2. – length distribution of sardine as observed during PELGAS17

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 on figure 4.1.2.

This year, sardine shows an unimodal length distribution. This mode, about 15cm, corresponds to age 1 and it suggests that a (very) good recruitment occured.

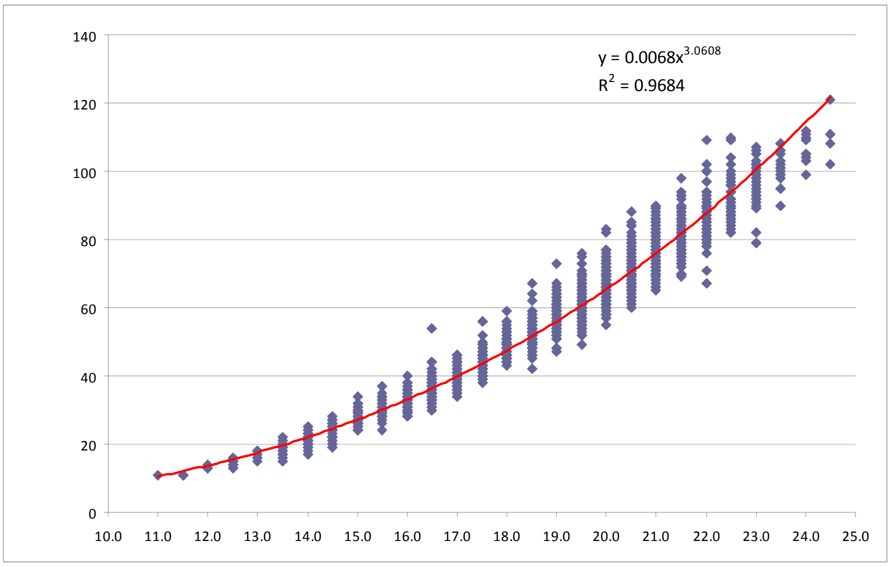


Figure 4.1.3 – Weight/length key of sardine established during PELGAS17

Nombre de age	age										
length	1	2	3	4	5	6	7	8	9	10	Total
11	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
11.5	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
12	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
12.5	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
13	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
13.5	94.74%	5.26%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
14	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
14.5	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
15	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
15.5	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
16	94.52%	4.11%	1.37%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
16.5	80.56%	18.06%	1.39%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
17	56.45%	25.81%	17.74%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
17.5	11.29%	58.06%	29.03%	1.61%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
18	4.76%	32.14%	59.52%	3.57%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
18.5	0.00%	23.64%	67.27%	8.18%	0.91%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
19	0.00%	9.30%	68.22%	16.28%	5.43%	0.78%	0.00%	0.00%	0.00%	0.00%	100.00%
19.5	0.00%	5.84%	50.36%	33.58%	10.22%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
20	0.00%	3.01%	32.33%	44.36%	20.30%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
20.5	0.00%	2.59%	27.59%	43.10%	25.00%	0.86%	0.00%	0.00%	0.86%	0.00%	100.00%
21	0.00%	1.08%	16.13%	44.09%	33.33%	3.23%	1.08%	1.08%	0.00%	0.00%	100.00%
21.5	0.00%	1.39%	4.17%	31.94%	47.22%	12.50%	2.78%	0.00%	0.00%	0.00%	100.00%
22	0.00%	0.00%	0.00%	17.02%	53.19%	25.53%	2.13%	2.13%	0.00%	0.00%	100.00%
22.5	0.00%	0.00%	0.00%	20.51%	48.72%	15.38%	5.13%	2.56%	7.69%	0.00%	100.00%
23	0.00%	0.00%	0.00%	3.70%	44.44%	18.52%	18.52%	7.41%	3.70%	3.70%	100.00%
23.5	0.00%	0.00%	0.00%	0.00%	13.33%	40.00%	33.33%	13.33%	0.00%	0.00%	100.00%
24	0.00%	0.00%	0.00%	0.00%	0.00%	11.11%	33.33%	11.11%	33.33%	11.11%	100.00%
24.5	0.00%	0.00%	0.00%	25.00%	0.00%	25.00%	0.00%	25.00%	25.00%	0.00%	100.00%
Total	26.55%	9.97%	26.75%	17.90%	13.28%	2.97%	1.25%	0.59%	0.59%	0.13%	100.00%

Table 4.1.4 : sardine age/length key from PELGAS17 samples (based on 1535 otoliths from Thalassa and commercial vessels)

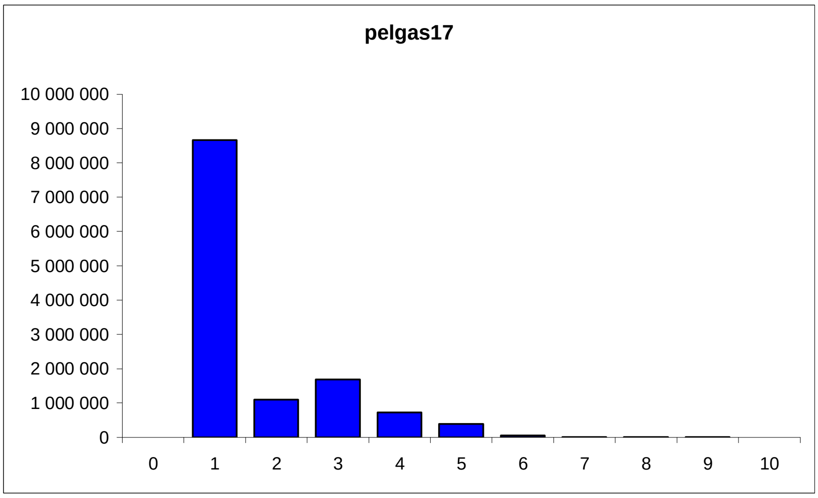


Figure 4.1.5.- Global age composition (nb) of sardine as observed during PELGAS 17

	PEL 17 - N - %
1	68,41%
2	8,71%
3	13,33%
4	5,73%
5	3,11%
6	0,42%
7	0,12%
8	0,07%
9	0,08%
10	0,01%

	PEL17 - W - %
1	43,57%
2	11,63%
3	21,92%
4	12,86%
5	7,82%
6	1,28%
7	0,39%
8	0,23%
9	0,28%
10	0,04%

Figure 4.1.6 percentage by age of the sardine population observed during PELGAS17 in numbers (left) and biomass (right).

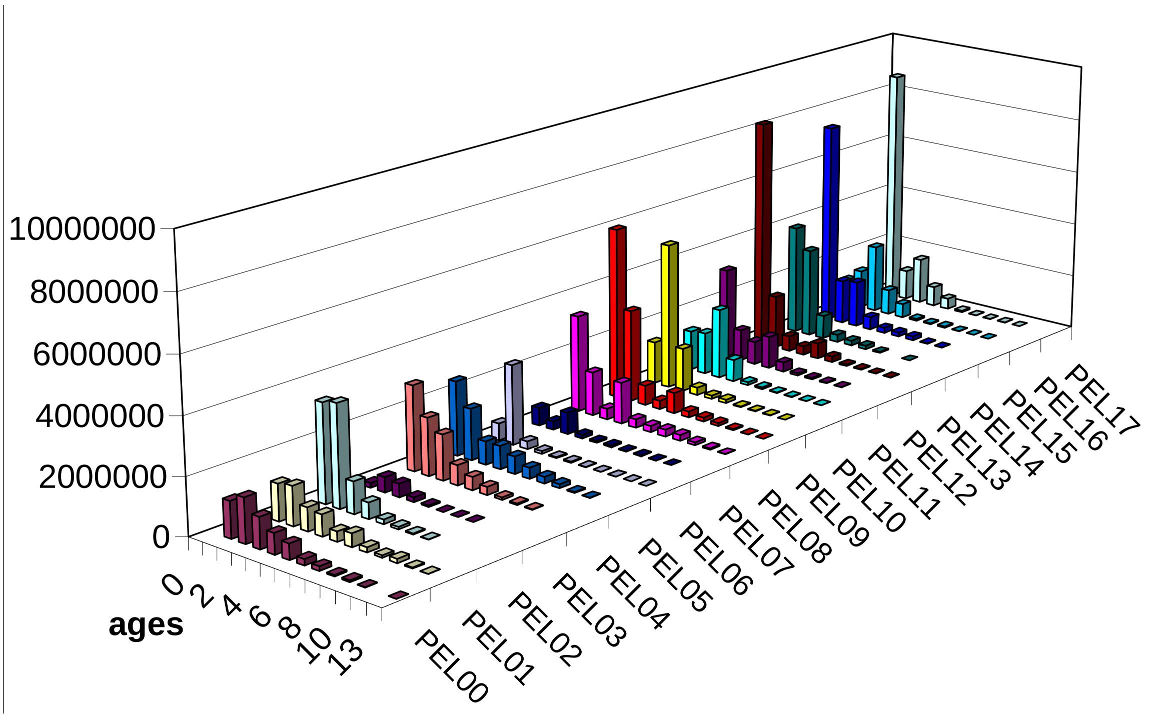


Figure 4.1.7- Age composition of sardine as estimated by acoustics since 2000

PELGAS serie of sardine abundances at age (2000-2017) 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 less true in recent years, with the good recruitment in 2013 which doesn't profit to incoming years.

The 2017 recruitment at age 1 seems to be high, maybe the best one for the whole serie, comparable to the 2013 one. It must be noticed that some sardine juveniles (age 0) were detected last year (*see WGHANSA report 2016*), which eventually could be linked with the very good recruitment at age 1 this year.

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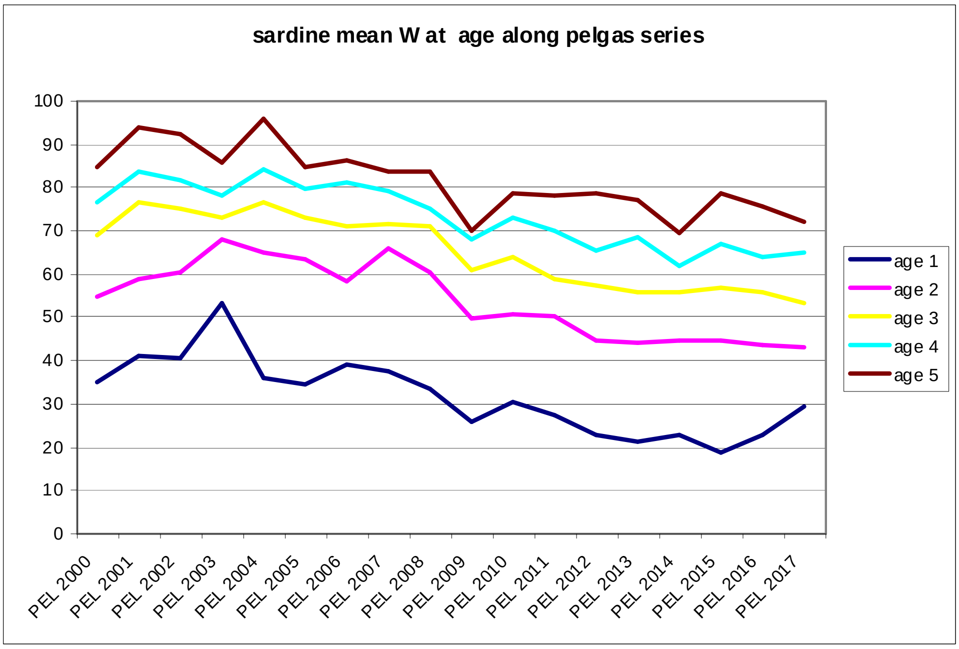

Figure 4.1.8- evolution of mean weight at age (g) of sardine along pelgas series

The PELGAS sardine mean weights at age series (Figure 4.1.8) shows a clear decreasing trend, whose biological determinant is still poorly understood. It must be noticed that mean weight at age 1 seems to increase again for the second consecutive year. Further work must be conducted to explore the causes of the fluctuation of mean weights at ages.

4.2. Eggs

The spatial pattern of sardine eggs overlaps with the one of anchovy, with a further north distribution along the coast, and also along the shelfbreak.

For sardine, egg abundances are at a mean level with regards to the whole Pelgas time-series.

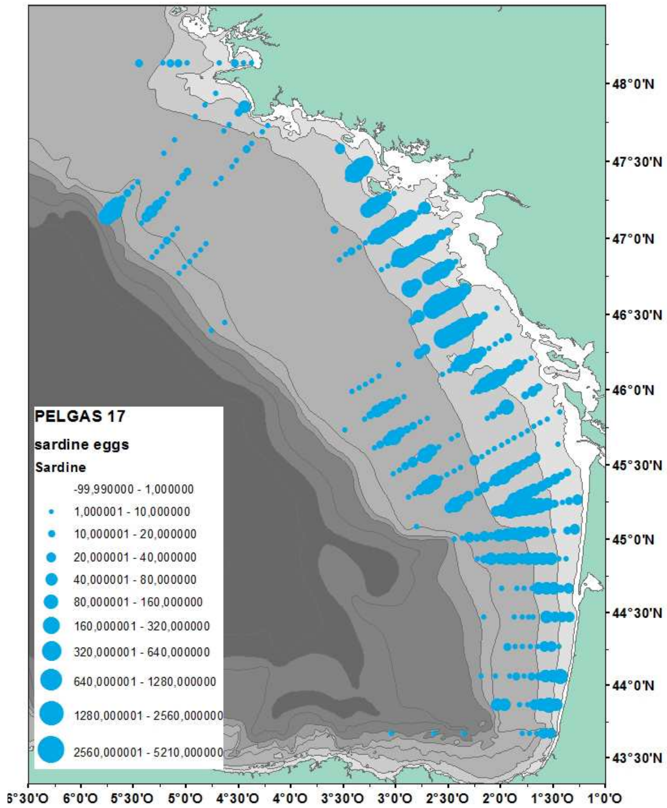

Figure 4.2.1. Distribution of sardine eggs observed with CUFES during PELGAS17.

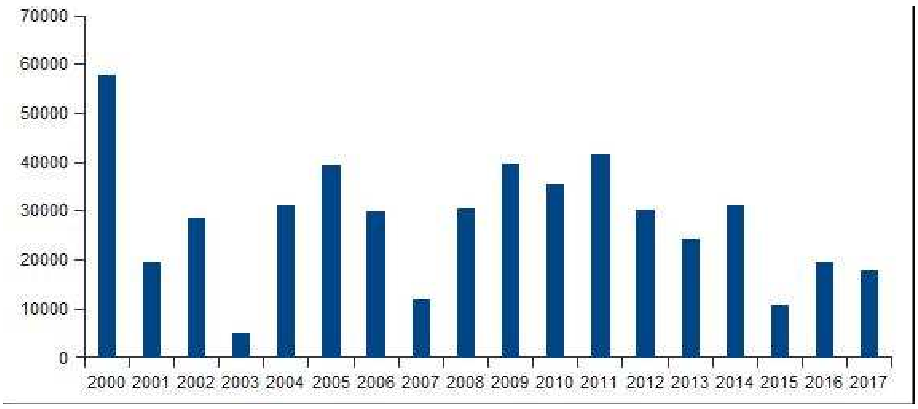

Figure 4.2.2. Number of eggs observed during PELGAS surveys from 2000 to 2017

2017 was marked by a medium abundance of sardine eggs as compared to the PELGAS time-series. It must be noticed that this year almost all sardines were mature and in spawning period, except in the South along the coast where 1 year old sardine was well present in a zone where an upwelling occured. This fish was just starting his maturation.

5. Top predators

For the fourteenth consecutive year, monitoring program to record marine top predator sightings (marine birds and cetaceans) has been carried out , during the whole coverage of the transects network (from the 22nd of April to the 24th of may 2017).

A total of 272 hours of sighting effort were performed for 32 days (Figure 5.1.), with an average of 8.5 hours of sighting effort per day. Weather conditions were generally medium : 60% of the time with good conditions, 40 % of medium or bad conditions.

During the survey, 4243 sightings of animals or objects were recorded. Seabirds constitute the majority of sightings (83%). Most of the surveys, other most frequent sightings concern either litter drifting at sea, but they were strangely less detected this year, with only 4.2 % of the sightings (mabye because of the regular wind). Other sightings are constituted by fishing ships (6.5%) and buoys (3.55%). Cetaceans only account for less than 2% of sightings.

5.1 – Sighting effort and conditions

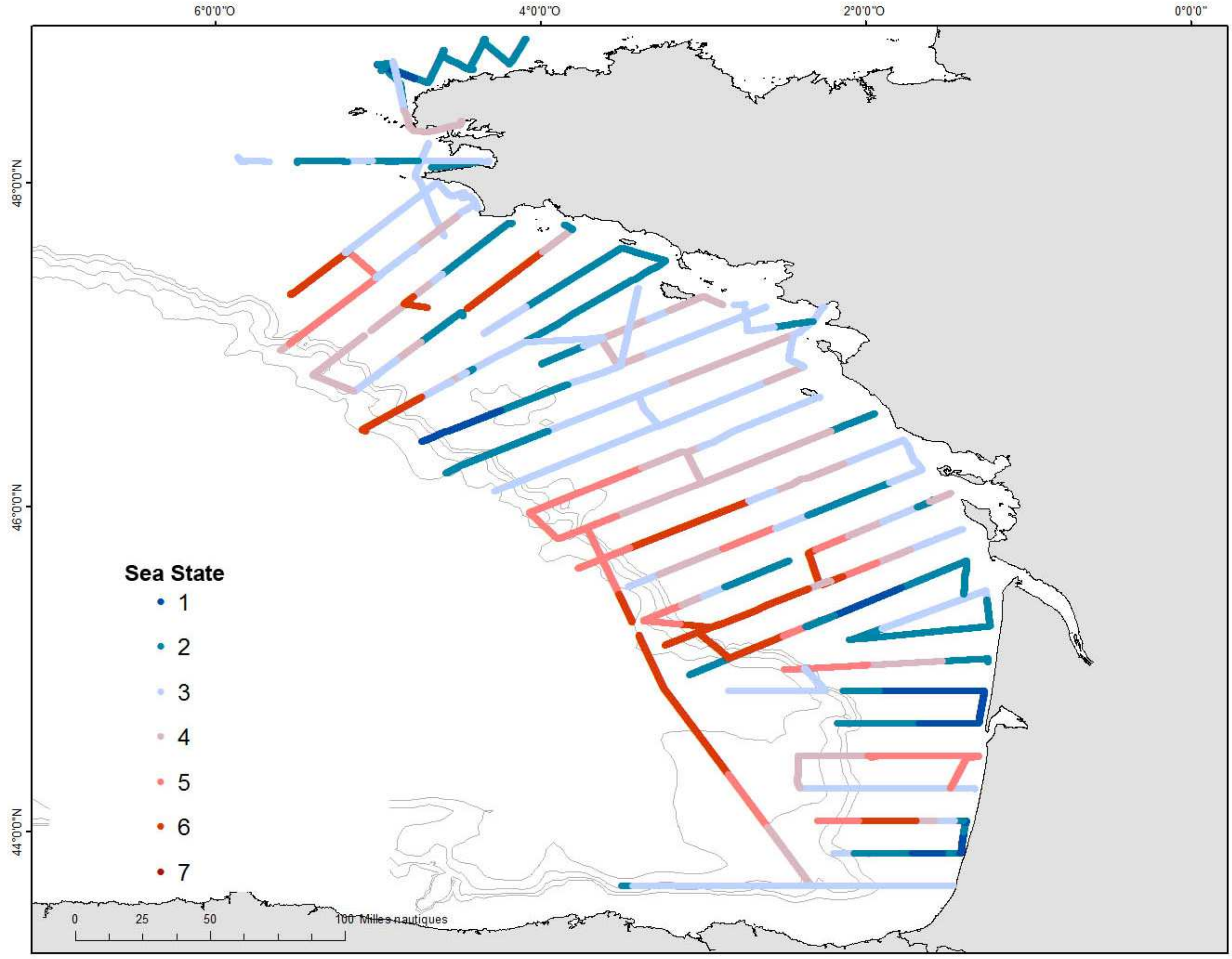

Figure 5.1. Sighting effort and conditions

The worst conditions were met in the central part of the bay of Biscay, offshore and the best along the coast. Globally conditions of sightings (including rain, fog and wind) were considered as "variable" : 45% as good, 18% as medium and 37 % as bad.

5.2 – Birds

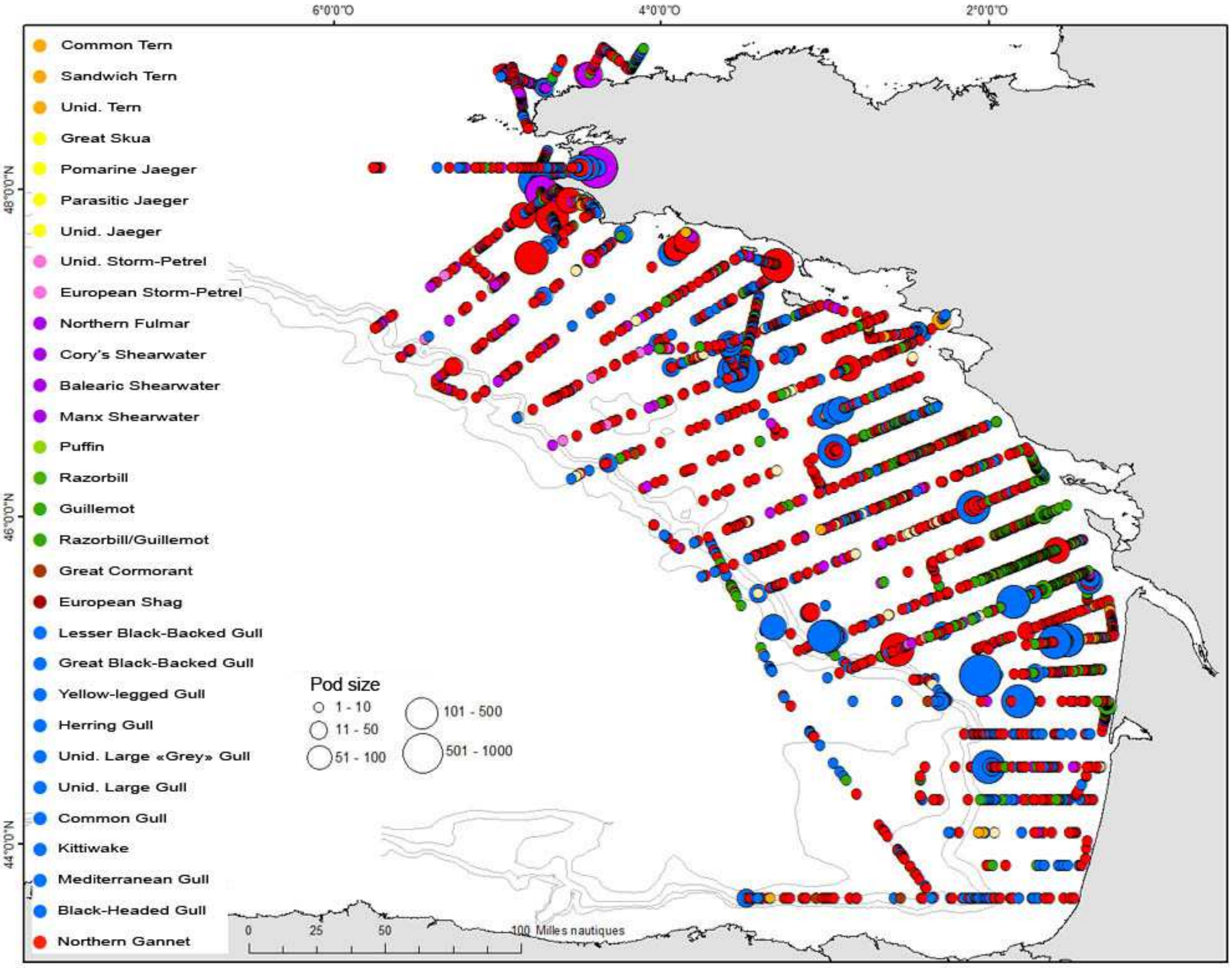

Figure 5.2. Distribution of birds observed during the PELGAS17 survey

Birds constitute the vast majority of sightings. Shorebirds and passerines accounted for less than 4% of bird sightings. 3304 sightings of seabirds were found all over the Bay of Biscay (Figure 5.2), divided into 26 identified species and a raw estimate of 14 697 individuals.

Northern gannets accounted for 52% of all seabird sightings: its distribution is homogeneous across the Bay of Biscay. It must be noticed that this year they were particularly numerous, with more than two times more individuals than last year (3975 ind.).

An other group of species was also well met : the larids, including the sea gulls and Black-legged Kittiwake (4 species observed this year in this family). They represent the first most important number of individuals observed during the survey, with a total of 7399 birds. Some groups are really huge in terms of numbers of birds.

Alcids (guillemot, razorbill) are well present this year, representing 16.5 % of the total sightings observations.

5.2 – Mammals

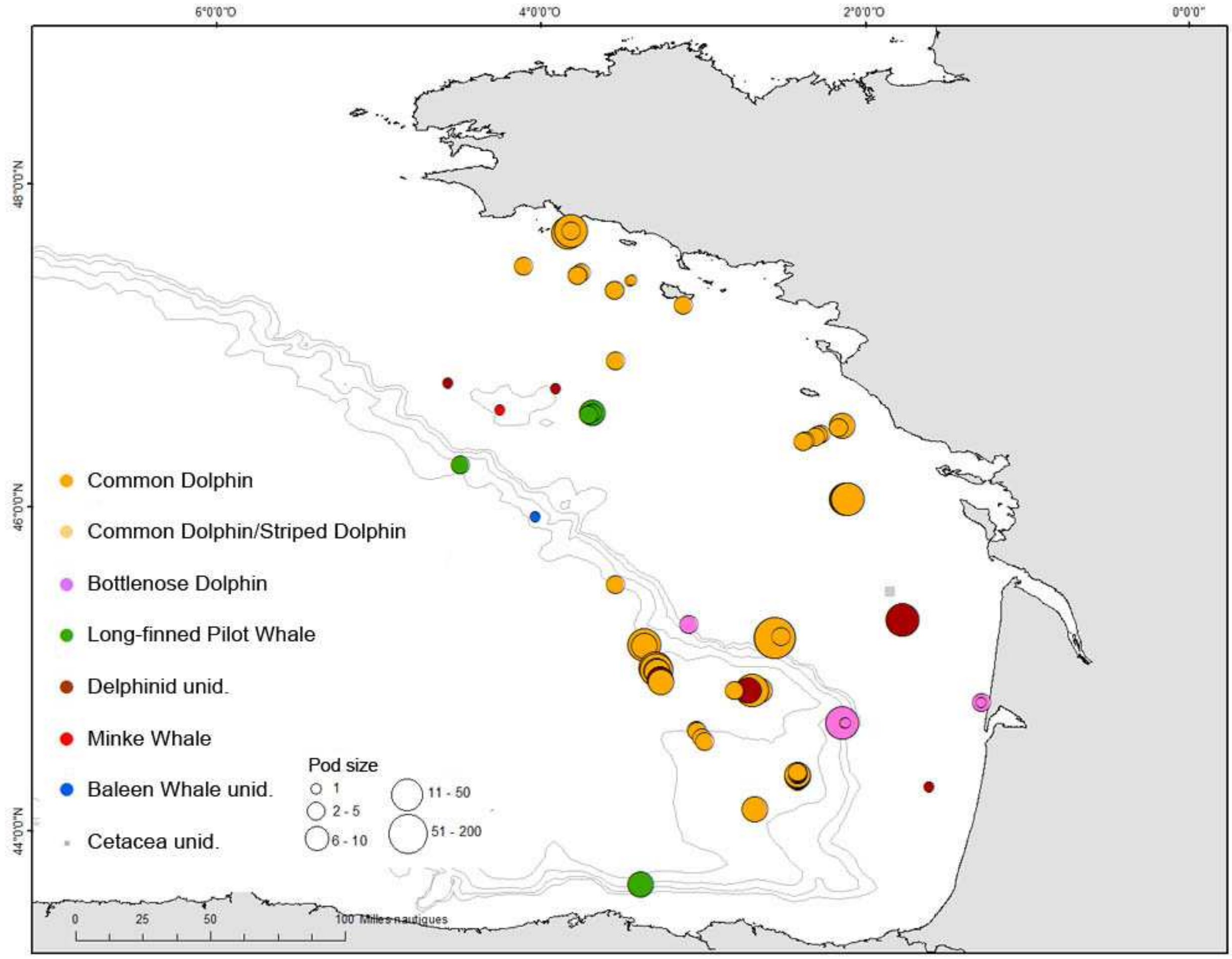

Figure 5.2. Distribution of mammals during the PELGAS17 survey.

A total of 88 sightings were recorded corresponding to a raw estimate of 746 individuals and 4 species of cetaceans clearly identified (Figure 5.2). The greatest diversity of marine mammals was observed in the central part of the Bay of Biscay. The overall distribution pattern is similar to that of previous PELGAS spring surveys.

The raw number of cetacean observed this years is three times lower than in 2016, and the number of species detected is the half (4 against 8 in 2016).

Common dolphin is the most recorded species (74% of total observations, 629 individuals). Common dolphins were present on the continental shelf, particularly in the northern part of the Bay of Biscay. Offshore, there were located around the "fer à cheval" area.

no Striped or Risso's dolphins were sighted this year, but as usual in lower quantities than Bottlenose dolphins. However, few long-finned pilot whales were sighted on the continental slope in the central part of the Bay of Biscay and at the shelfbreak.

very few bottlenose dolphins were detected this year (5 sightings), all located front of the Gironde, in small groups (3 to 15 individuals).

6. Hydrological conditions

Early spring weather was mild and calm. It was also dry, in the continuity with a fresh and dry winter. Warming and stratification (thermal mostly with lack of significant river runoff) set up during this early spring, with blooms occuring from late February in the south of the bay of Biscay.

Change in weather conditions in mid-April, with an atmospheric flux from the North, significantly slowed down the warming. Associated with an earlier timing of survey as compared to previous years, this resulted in fresh conditions during the survey, with surface temperatures most often below 14°C.

An upwelling was generated along the coast of 'Les Landes', with a very low surface temperature signature (below 13°C). The 'cold pool' has also a strong signature north of the Gironde, with bottom temperatures around 11°C.

Thermal stratification is however established, with a chlorophyll maximum in sub-surface over most of the shelf. Though it does not prevent mixing over the slope (internal waves ?), with in that area chlorophyll concentrations more homogeneous throughout the mixed-layer.

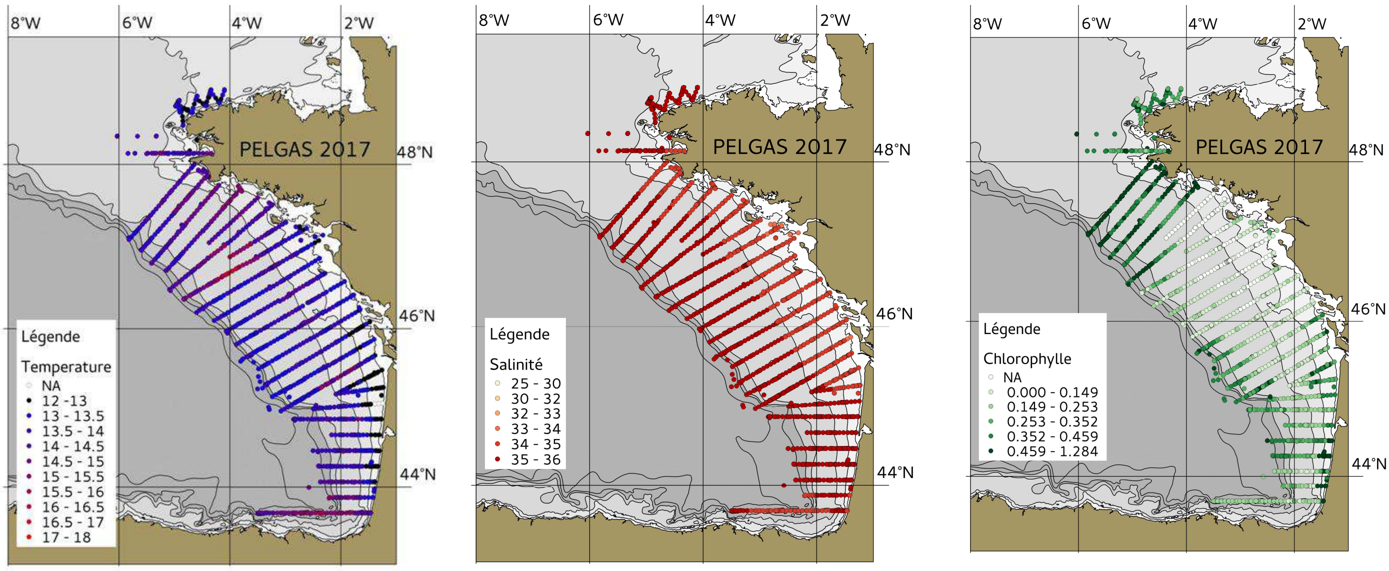

Figure 6.1. – Surface temperature, salinity and fluorescence observed during PELGAS17.

7. CONCLUSION

The Pelgas17 acoustic survey has been carried out with medium weather conditions (regular wind, low atmospheric temperatures) for the whole area, from the South of the bay of Biscay to the west of Brittany. The help of commercial vessels (two pairs of pelagic trawlers and a single one) during 18 days provided about 110 valid identification hauls instead of about 60 before 2007 when Thalassa was alone to identify echotraces. Their participation increased the precision of identification of echoes and some double hauls permitted to confirm that results provided by the two types of vessels (R/V and Fishing boats) were comparable and usable for biomass estimate purposes. These commercial vessels participated to the PELGAS survey in a very good spirit of collaboration. Vessels (and the scientific observer onboard) are founded by EMFF (European Maritime and Ficheries Found) for the period 2017- 2019, with the financial help of "France Filière Pêche" which is a groupment of French fishing organisations.

Temperature and salinity recorded during PELGAS17 were close to the average of the serie, with a surface temperature still relatively cold (just above 14°C) maintained by low atmospheric temperature and a regular wind from North during the survey and some time before.

The PELGAS17 survey observed a relatively high level of anchovy biomass (**134 500 tons**), which seems to be higher to previous year, comparable to 2011 and far away from the 2015 biomass (which was probably overestimated but it is not explained for the time being). Offshore, anchovies were present closed to the surface in the South. As previous years, we observe that globally the trend of the mean weight at age is a decrease. This trend is globally the same for sardine in the bay of Biscay except for age 1 since last year. Further investigates should be done and, if we have some hypothesis (maybe an effect of density-dependance), we do not have real explanation for the time being.

The biomass estimate of sardine observed during PELGAS17 is **465 022 tons**, which constitutes a strong increase from the last survey. It confirms that this specie shows a variable abundance in the bay of Biscay at this period.

The proportion of age 1 (68% in number, and 43 % in mass) seems to be very high compared to last year. 2017 should be the best recruitment at age 1 for the whole PELGAS serie. The global age structure of the population and his evolution trough years confirms the validity of age readings and the fact that we can follow sardine cohorts in the sardine population of the bay of Biscay. But it must be noticed that global weights and lengths at age are regularly decreasing in the bay of Biscay, maybe due to an effect of density-dependence or other reasons not well known at this time. Old individuals (>5 years old) seems to be less an less present in the bay of Biscay, year after year.

Concerning the other species, mackerel was relatively well present this year compared to recent surveys, while horse mackerel seems to decline, after 3 years of increasing biomass. Sprat, according to very low river discharges, was not present in the surveyed area.

Working document presented in the ICES Working Group on Southern Horse Mackerel, Sardine and Anchovy (WGHANSA). Bilbao, Spain, 24-29 June 2017.

Acoustic assessment and distribution of the main pelagic fish species in ICES Subdivision 9a South during the *ECOCADIZ 2016-07* Spanish survey (July-August 2016).

By

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ABSTRACT

The present working document summarises the main results obtained from the Spanish (pelagic ecosystem-) acoustic survey conducted by IEO between 31th July and 11th August 2016 in the Portuguese and Spanish shelf waters (20-200 m isobaths) off the Gulf of Cadiz onboard the R/V *Miguel Oliver*. The 21 foreseen acoustic transects were sampled. A total of 26 valid fishing hauls were carried out for echo-trace ground-truthing purposes. CUFES sampling (136 stations) was carried during the survey in order to describe the extension of the anchovy spawning area. A census of top predator species was also carried out along the sampled acoustic transects. The distribution of all the mid-sized and small pelagic fish species susceptible of being acoustically assessed is shown from the mapping of their back-scattering energies. Chub mackerel was the most frequent species in the fishing hauls, followed in order of importance by anchovy, mackerel, horse mackerel, bogue, sardine, blue jack mackerel and Mediterranean horse mackerel. However, the most abundant species in these hauls was anchovy, followed at quite a distance by sardine, chub mackerel and mackerel. As usual, the bulk of the anchovy population was concentrated in the central part of the surveyed area. A secondary nucleus of anchovy density was recorded in the mid-/outer shelf waters off western Portuguese Algarve, between Cape San Vicente and Cape Santa Maria. The smallest anchovies mainly occurred in the inner shelf waters surrounding the Guadiana and Guadalquivir river mouths and Bay of Cadiz, and larger/older anchovies occurring in the mid-/outer shelf waters located in both extremes of the surveyed area. The total biomass estimated for anchovy, 34.3 kt (3 686 million fish), was well above the historical average, and in the range of recent population levels featuring to a recovered population. Some anchovy recruitment has also been recorded in this survey, probably as a consequence of the delayed survey dates in relation to the peak spawning. In fact, the population is basically composed by equal contributions of age-0 and age-1 fish. The spring *PELAGO* survey estimates (9 811 millions, 65.3 kt) were the highest in its historical series, with the whole estimated population being restricted to the Spanish waters. Reasons other than an added total mortality suffered during the 4-month inter-survey period might be the responsible for such differences. Possible problems in the allocation of the acoustic energy to anchovy in the Spanish waters of the Gulf by the *PELAGO* survey have been advanced. Such problems are related to the difficulties in the discrimination of anchovy echoes in this area from a dense plankton layer where the species is usually embedded. Sardine was widely distributed all over the surveyed area, although preferably over the inner shelf between Bay of Cadiz and Guadiana river mouth. A secondary density nucleus was observed just to the west of Cape Santa Maria, in the Portuguese Algarve. Although the population was composed by sardines up to 4 years old, age-0 fish constituted the bulk of the population. The total estimated biomass of 26.9 kt (2 553 million fish), indicates a light increase in relation to the biomass estimated the previous year (23.5 kt). An increasing trend was also recorded by the PELAGO survey, although of quite higher magnitude (16.7 kt in 2015 *vs* 80.4 kt in 2016).

INTRODUCTION

ECOCADIZ surveys constitute a series of yearly acoustic surveys conducted by IEO in the Subdivision 9a South (Algarve and Gulf of Cadiz, between 20 – 200 m depth) under the "pelagic ecosystem survey" approach onboard R/V *Miguel Oliver* (until 2013 on onboard R/V *Cornide de Saavedra*). This series started in 2004 with the *BOCADEVA 0604* pilot acoustic - anchovy DEPM survey. The following surveys within this new series (named *ECOCADIZ* since 2006 onwards) are planned to be routinely performed on a yearly basis, although the series, because of the available ship time, has shown some gaps in those years coinciding with the conduction of the triennial anchovy DEPM survey (the true *BOCADEVA* series, which first survey started in 2005).

Results from the *ECOCADIZ* series are routinely reported to ICES Expert Groups on both stock assessment (formerly in WGMHSA, WGANC, WGANSA, at present in WGHANSA) and acoustic and egg surveys on anchovy and sardine (WGACEGG).

The present Working Document reports the main results from the *ECOCADIZ 2016-07* survey. These results will refer to the acoustic estimates (age-structured for anchovy and sardine) and spatial distribution of the assessed species.

MATERIAL AND METHODS

The *ECOCADIZ 2016-07* survey was carried out between 31th July and 11th August 2016 onboard the Spanish R/V *Miguel Oliver* covering a survey area comprising the waters of the Gulf of Cadiz, both Spanish and Portuguese, between the 20 m and 200 m isobaths. The survey design consisted in a systematic parallel grid with tracks equally spaced by 8 nm, normal to the shoreline (**Figure 1**).

Echo-integration was carried out with a *Simrad™ EK60* echo sounder working in the multi-frequency fashion (18, 38, 70, 120, 200 kHz). Average survey speed was about 10 knots and the acoustic signals were integrated over 1-nm intervals (ESDU). Raw acoustic data were stored for further post-processing using *Myriax Software Echoview™* software package (by *Myriax Software Pty. Ltd.,* ex *SonarData Pty. Ltd.*). Acoustic equipment was previously calibrated during the *MEDIAS 07 2015* acoustic survey, a survey conducted in the Spanish Mediterranean waters just before the *ECOCADIZ* one, following the standard procedures (Demer *et al*., 2015).

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 more recently by the *Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES areas VIII and IX* (WGACEGG; ICES, 2006a,b).

Fishing stations for echo-trace ground-truthing were opportunistic, according to the echogram information, and they were carried out using a ca. 16 m-mean vertical opening pelagic trawl (*Tuneado* gear) at an average speed of 4 knots. Gear performance and geometry during the effective fishing was monitored with *Simrad™ Mesotech FS20/25* trawl sonar. Trawl sonar data from each haul were recorded and stored for further analyses.

Ground-truthing haul samples provided biological data on species and they were also used to identify fish species and to allocate the back-scattering values into fish species according to the proportions found at the fishing stations (Nakken and Dommasnes, 1975).

Length frequency distributions (LFD) by 0.5-cm class were obtained for all the fish species in trawl samples (either from the total catch or from a representative random sample of 100-200 fish). Only those LFDs based on a minimum of 30 individuals and showing a normal distribution were considered for the purpose of the acoustic assessment.

Individual biological sampling (length, weight, sex, maturity stage, stomach fullness, and mesenteric fat content) was performed in each haul for anchovy, sardine (in both species with otolith extraction and with additional preservation of gonads in anchovy mature females), mackerel and horse-mackerel species, and bogue.

The following TS/length relationship table was used for acoustic estimation of assessed species (recent IEO standards after ICES, 1998; and recommendations by ICES, 2006a,b):

Species	**b_{20}**
Sardine (*Sardina pilchardus*)	-72.6
Round sardinella (*Sardinella aurita*)	-72.6
Anchovy (*Engraulis encrasicolus*)	-72.6
Chub mackerel (*Scomber japonicus*)	-68.7
Mackerel (*S. scombrus*)	-84.9
Horse mackerel (*Trachurus trachurus*)	-68.7
Mediterranean horse-mackerel (*T. mediterraneus*)	-68.7
Blue jack mackerel (*T. picturatus*)	-68.7
Bogue (*Boops boops*)	-67.0
Blue whiting (*Micromesistius poutassou*)	-67.5
Boarfish (*Capros aper*)	-66.2* (-72.6)

*Boarfish b_{20} estimate following to Fässler *et al*. (2013). Between parentheses the usual IEO value considered in previous surveys.

The *PESMA 2010* software (J. Miquel, unpublished) has got implemented the needed procedures and routines for the acoustic assessment following the above approach.

A *Continuous Underway Fish Egg Sampler* (CUFES, 136 stations), 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 monitor the anchovy egg abundance and to collect some hydrographical variables (sub-surface sea temperature, salinity, and *in vivo* fluorescence; **Figure 2**). Vertical profiles of hydrographical variables were also recorded by night from 201 CTD casts by using *Sea-bird Electronics™ SBE 911+ SEACAT* (with coupled *Teledyne Benthos* altimeter, *SBE 43* oximeter, *WetLabs ECO-FL-NTU* fluorimeter and *WetLabs C-Star 25 cm* transmissometer sensors) and *LADCP T-RDI WHS* 300 kHz profilers (**Figure 3**). *VMADCP RDI 150 kHz* records were also continuously recorded by night between CTD stations. Information on presence and abundance of sea birds, turtles and mammals was also recorded during the acoustic sampling by one onboard observer.

Twenty three (23) *Manta trawl* hauls were also carried out to characterize the distribution pattern of micro-plastics over the shelf (**Figure 2**). These hauls did not follow a pre-established sampling scheme although the main goal was to have samples well distributed both in the coastal and oceanic areas of the shelf. Consequently, the hauls were opportunistically carried out taking the advantage of the conduction of fishing hauls, the start or end of an acoustic transect or whatever discrete station devoted to the sampling of either hydrographical or biological variables which were close to the preferred depths.

ECOCADIZ 2016-07 was also utilized this year as an observational platform for the IFAPA (Instituto de Investigación y Formación Agraria y Pesquera)/IEO research project entitled *Ecology of the early stages of the anchovy life-cycle: the role of the coupled Guadalquivir estuary-coastal zone of influence in the species' recruitment process (ECOBOGUE)*. Thus, 3 *Bongo 90* coastal stations were carried out at sunset in the surroundings of the Guadiana (2 stations) and Guadalquivir (1 stations) river mouths to collect anchovy larvae for genetics studies (**Figure 2**).

RESULTS

Acoustic sampling

The acoustic sampling started on 31th July in the coastal end of the transect RA01 and finalized on 11th August in the oceanic end of the transect RA21 (**Table 1, Figure 1**). Transects were acoustically sampled in the E-W direction. The whole 21-transect sampling grid was sampled. The acoustic sampling usually started at 06:00 UTC although this time might vary depending on the duration of the works related with the hydrographic sampling. The foreseen coastal starting points of transects RA14 and RA15 had to be displaced to deeper waters in order to avoid the occurrence of open-sea fish farming/fattening cages.

Groundtruthing hauls

Twenty six (26) fishing operations, with all of them being considered as valid ones according to a correct gear performance and resulting catches, were carried out (**Table 2**, **Figure 4**).

As usual in previous surveys, some fishing hauls were attempted by fishing over an isobath crossing the acoustic transect as close as possible to the depths where the fishing situation of interest was detected over that transect. In this way the mixing of different size compositions (*i.e.*, bi-, multi-modality of length frequency distributions) was avoided as well as a direct interaction with fixed gears. The mixing of sizes is more probable close to nursery-recruitment areas and in regions with a very narrow continental shelf. Given that all of these situations were not very uncommon in the sampled area, 42% of valid hauls (11 hauls) were conducted over isobath.

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. According to the above, the sampled depth range in the valid hauls oscillated between 39-194 m.

During the survey were captured 1 Chondrichthyan, 48 Osteichthyes, 7 Cephalopod, 1 polyplacophoran mollusc, 3 Crustacean, 4 Echinoderm, 1 Polychaeta, 1 Sipunculidea, 1 Porifera and 1 Cnidarian species. The percentage of occurrence of the more frequent species in the trawl hauls is shown in the enclosed text table below (see also **Figure 5**). The pelagic ichthyofauna was 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 was the most frequent captured species in the valid hauls (26 hauls, 100% presence index) followed by anchovy and mackerel (with relative occurrences of 85%), horse mackerel, bogue and sardine (between 60 and 65%), blue jack mackerel (46%), whereas Mediterranean horse mackerel showed a low occurrence in the whole surveyed area (21%), with blue whiting and boarfish occurring in an incidental way.

For the purposes of the acoustic assessment, anchovy, sardine, mackerel species, horse & jack mackerel species, bogue, blue whithing and boarfish were initially considered as the survey target species. All of the invertebrates, and both bentho-pelagic (*e.g.*, manta rays) and benthic fish species (*e.g.*, skates and rays, flatfish, gurnards, etc.) 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 species were included in an operational category termed as "*Others*".

According to the above premises, during the survey were captured a total of 11.6 tonnes and 467 thousand fish (**Table 3**). 39% of this fished biomass corresponded to chub mackerel, 26% to anchovy, 11% to sardine, between 6 and 7% to mackerel and blue jack mackerel, 4% to horse mackerel, 2% to Mediterranean horse mackerel, and contributions lower than 1% to the remaining species. However, the most abundant species in ground-truthing trawl hauls was anchovy (58%) followed by a long distance by sardine (25%), chub mackerel (10%), and mackerel (5%).

Species	# of fishing stations	Occurrence (%)	Total weight (kg)	Total number
Scomber colias	26	100	4479,004	68094
Merluccius merluccius	22	85	126,583	983
Loligo media	22	85	7,767	856
Engraulis encrasicolus	22	85	2972,308	270738
Scomber scombrus	22	85	839,369	25217
Trachurus trachurus	17	65	518,198	4269
Boops boops	16	62	70,846	554
Sardina pilchardus	15	58	1282,094	116193
Trachurus picturatus	12	46	714,365	9892
Spondyliosoma cantharus	9	35	49,641	358
Diplodus vulgaris	7	27	122,202	628
Trachurus mediterraneus	7	27	260,885	1217
Pagellus erythrinus	7	27	37,411	189
Diplodus annularis	6	23	2,648	46
Diplodus bellottii	6	23	2,638	40
Illex coindetii	4	15	0,486	4
Alosa fallax	4	15	1,319	7
Chelidonichthys lucerna	4	15	2,284	9
Pagellus acarne	4	15	21,32	77
Spicara flexuosa	4	15	2,461	43
Macroramphosus scolopax	3	12	0,254	7
Micromesistius poutassou	3	12	0,476	5
Loligo vulgaris	3	12	1,837	19
Pagellus bellottii bellottii	3	12	5,521	39
Scorpaena notata	3	12	0,278	3
Parastichopus regalis	2	8	5,433	22
Sardinella aurita	2	8	0,435	2
Capros aper	2	8	14,092	805

The species composition, in terms of percentages in number, in each valid fish station is shown in **Figure 5**. A first impression of the distribution pattern of the main species may be derived from the above figure. Thus, anchovy and sardine showed a relatively wide distribution over the surveyed area, although the highest anchovy yields were recorded in the Spanish waters and those from sardine in the Portuguese waters. Mackerel yields not showed any spatial preference, whereas chub mackerel, horse mackerel, blue jack mackerel and bogue, although they occurred in a great part of the study area, only showed relatively high yields in the Portuguese waters. Blue whiting and boarfish were restricted to the Portuguese waters whereas Mediterranean horse mackerel was restricted to the easternmost Spanish waters.

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

A total of 326 nmi (ESDU) from 21 transects has been acoustically sampled by echo-integration for assessment purposes. From this total, 213 nmi (11 transects) were sampled in Spanish waters, and 113 nmi (10 transects) in the Portuguese waters. The enclosed text table below provides the nautical area-scattering coefficients attributed to each of the selected target species and for the whole "pelagic fish assemblage".

$S_{A\,(m^2\,nmi^{-2})}$	Total spp.	Anchovy	Sardine	Mackerel	Chub mack.	Horse mack.	Medit. h-mack.	Blue jack-mack.	Bogue	Blue whiting	Boarfish	Silvery lightfish
Total Area	142169	48336	30979	377	39506	2332	5091	10218	1569	4	32	3724
%	100	34,00	21,79	0,27	27,79	1,64	3,58	7,19	1,10	0,003	0,02	2,62
Portugal	52445	5529	4035	130	28998	2303	0	10199	927	4	32	287
%	36,89	11,44	13,02	34,46	73,40	98,77	0	99,81	59,11	100,00	100,00	7,71
Spain	89724	42808	26944	247	10508	29	5091	19	641	0	0	3437
%	63,11	88,56	86,98	65,54	26,60	1,23	100,00	0,19	40,89	0	0	92,29

For this "pelagic fish assemblage" has been estimated a total of 142 169 m^2 nmi^{-2}. Portuguese waters accounted for 37% of this total back-scattering energy and the Spanish waters the remaining 63%. However, given that the Portuguese sampled ESDUs were almost the half of the Spanish ones, the (weighted-) relative importance of the Portuguese area (*i.e.*, its density of "pelagic fish") is actually much higher. The mapping of the total back-scattering energy is shown in **Figure 6**. By species, anchovy (34%), chub mackerel (28%) and sardine (22%) were the most important species in terms of their contributions to the total back-scattering energy. Blue jack mackerel (7%) and Mediterranean horse mackerel (4%) were the following species in importance. Horse mackerel and silvery lightfish (*Maurolicus muelleri*) only contributed with 2-3%, followed by negligible energetic contributions by mackerel, bogue, boarfish (*Capros aper*) and blue whiting (*Micromesistius poutassou*). Acoustic energy was not allocated to round sardinella since the species was incidentally captured in fishing hauls.

Some inferences on the species' distribution may be carried out from regional contributions to the total energy attributed to each species: Mediterranean horse mackerel, slivery lightfish, anchovy and sardine seemed to show greater densities in the Spanish waters, whereas horse mackerel, chub mackerel, blue jack mackerel, blue whiting and boarfish could be considered as typically "Portuguese species" in this survey.

According to the resulting values of integrated acoustic energy, the species acoustically assessed in the present survey finally were anchovy, sardine, mackerel, chub mackerel, blue jack mackerel, horse mackerel, Mediterranean horse mackerel, bogue, blue whithing and boarfish.

Spatial distribution and abundance/biomass estimates

Anchovy

Parameters of the survey's length-weight relationship for anchovy are given in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 7**. The back-scattering energy attributed to this species and the coherent strata considered for the acoustic estimation are shown in **Figure 8**. The estimated abundance and biomass by size and age class are given in **Tables 5** and **6** and **Figures 9** and **10**.

Anchovy almost avoided the easternmost waters of the Gulf. The bulk of the population was mainly distributed all over the shelf between the Guadiana river mouth and Cadiz Bay, especially over the inner shelf waters of the central part of the Gulf, between the Guadiana river mouth and Rota. A secondary nucleus of anchovy density was recorded in the mid-/outer shelf waters off western Portuguese Algarve, between Cape San Vicente and Cape Santa Maria, with the species being quite scarce in the shallowest waters just west of the Cape of Santa Maria (**Figure 8**).

The size class range of the assessed population varied between the 8.0 and 17.5 cm size classes, with two modal classes at 9.5 and 12.0 cm, with the latter being the most important. The size composition of anchovy by coherent post-strata confirms the usual pattern exhibited by the species in the area during the spawning season, with the largest fish being distributed both in the westernmost and easternmost waters and the smallest ones concentrated in the surroundings of the Guadalquivir river mouth and adjacent shallow waters, including those ones in front of the Cadiz Bay and even spreading to the coastal area close to the Guadiana river mouth (**Table 5**, **Figures 8** and **9**, see also **Figure 6**). As it has been happening in the last years, during the 2016 survey some recruitment has also been recorded, probably as a consequence of the delayed survey dates in relation to the peak spawning.

Nine (9) coherent post-strata have been differentiated according to the S_A value distribution and the size composition in the fishing stations. The acoustic estimates by homogeneous post-stratum and total area are shown in **Table 5** and **Figure 9**. Overall acoustic estimates in summer 2016 were of 3 686 million fish and 34 301 tonnes. By geographical strata, the Spanish waters yielded 91% (3 341 million) and 85% (29 051 t) of the total estimated abundance and biomass in the Gulf, confirming the importance of these waters in the species' distribution. The estimates for the Portuguese waters were 346 million and 5 250 t.

The Gulf of Cadiz anchovy egg distribution from CUFES sampling is shown in **Figure 11**. Anchovy egg distribution in summer 2016 differed from the abovementioned distribution for adult fish, with the highest egg densities being mainly recorded in the middle-outer shelf waters located between Portimão and Cape Santa Maria.

Sardine

Parameters of the survey's size-weight relationship for sardine are shown in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 12**. The back-scattering energy attributed to this species and the coherent strata considered for the acoustic estimation are shown in **Figure 13**. The estimated abundance and biomass by size and age class are given in **Tables 5** and **6** and **Figures 14** and **15**.

Sardine was widely distributed all over the surveyed area, although preferably over the inner shelf between Bay of Cadiz and Guadiana river mouth. A secondary density nucleus was observed just to the west of Cape Santa Maria, in the Portuguese Algarve (**Figure 13**).

The size class range of the assessed population ranged between 8 and 22 cm size classes, with a modal size at 10.5 cm size class. The size composition of sardine both by fishing haul and coherent post-strata indicate that the largest sardines occurred in the westernmost shelf waters, whereas the smallest ones were observed in the coastal fringe comprised between Tinto/Odiel river mouth and Cadiz Bay (**Figures 12** and **14**). Although the population was composed by sardines up to 4 years old, age-0 fish constituted the bulk of the population (**Table 6**, **Figure 15**).

Overall acoustic estimates in summer 2016 were of 2 553 million fish and 26 919 tonnes. By geographical strata, the Spanish waters yielded 89% (2 270 million) and 85% (22 911 t) of the total estimated abundance and biomass in the Gulf, confirming the importance of these waters in the species' distribution. The estimates for the Portuguese waters were 283 million and 4 009 t.

Mackerel

Parameters of the survey's length-weight relationship are shown in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 16**.The distribution of the back-scattering energy attributed to this species and the coherent strata considered for the acoustic estimation are shown in **Figure 17**. The estimated abundance and biomass by size class are given in **Table 7** and **Figure 18**.

Mackerel showed a wide distribution although avoided the easternmost waters of the surveyed area. Highest densities were recorded in the central part of the Gulf (**Figure 17**). The size class range of the assessed population ranged between 14 and 39 cm size classes, with a main modal size at 17 cm size class and a secondary one at 31 cm. The size composition in fishing hauls and coherent post-strata indicated that largest mackerels were located between Cape San Vicente and Cape Santa Maria, in Portuguese Algarve waters, whereas smaller fish were recorded in the Spanish waters (**Table 7**, **Figures 16** and **18**).

Mackerel acoustic estimates in summer 2016 were of 198 million fish and 9 277 tonnes. By geographical strata, the Spanish waters yielded 67% (133 million) and 60% (5 573 t) of the total estimated abundance and biomass in the Gulf. The estimates for the Portuguese waters were 65 million and 3 704 t.

Chub mackerel

Parameters of the survey's length-weight relationship are shown in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 19**. The distribution of the back-scattering energy attributed to this species and the coherent strata considered for the acoustic estimation are shown in **Figure 20**. The estimated abundance and biomass by size class are given in **Table 8** and **Figure 21**.

Although practically occurring all over the surveyed area, chub mackerel showed the highest densities westward the Guadiana river mouth, all over the Portuguese shelf, mainly between Tavira and Cape San Vicente (**Figure 20**). The smallest fish were recorded in the Spanish waters (**Figure 19**). The size class range of the assessed population ranged between 10.5 and 36 cm size classes, with a main modal size at 15 cm size class and a secondary one at 26 cm (**Table 8**, **Figure 21**).

Overall acoustic estimates of abundance and biomass were of 499 million and 24 918 t. Portuguese waters concentrated 72% of the total abundance (357 million) and 79% of biomass (19 762 t). A total of 142 million fish and 5 156 t were estimated in Spanish waters.

Blue jack-mackerel

The survey's length-weight relationship for this species is given in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 22**. The back-scattering energy attributed to this species and the coherent strata considered for the acoustic estimation are illustrated in **Figure 23**. The estimated abundance and biomass by size class are given in **Table 9** and **Figure 24**.

Blue jack mackerel was almost exclusively distributed throughout the Portuguese waters, showing an incidental occurrence in the easternmost waters and being absent in the entire central part of the Gulf (**Figure 23**). No clear spatial pattern in size can be evidenced from the length frequency distributions observed in fishing hauls (**Figure 22**). The size class range of the assessed population ranged between 12.5 and 28 cm size classes, with a modal size at 19-19.5 cm size classes (**Table 9**, **Figure 24**).

Blue jack mackerel estimates in summer 2016 were of 119 million fish and 7 973 t. Almost 100% of the population, both in terms of abundance (118 million) and biomass (7 961 t) were recorded in Portuguese waters, whereas in the Spanish ones were estimated 0.2 million and 12 t only.

Horse mackerel

The survey's length-weight relationship for horse mackerel is shown in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 25**. The back-scattering energy attributed to this species and the coherent strata considered for the acoustic estimation are shown in **Figure 26**. The estimated abundance and biomass by size class are given in **Table 10** and **Figure 27**.

Although relatively wide distributed in the surveyed area, horse mackerel showed the highest densities in the Portuguese shelf between Cape San Vicente and Cape Santa Maria (**Figure 26**). A modal size belonging to juvenile/sub-adult fish is detected in many of the sampled fishing hauls (**Figure 25**). The size class range of the assessed population ranged between 10.5 and 29.5 cm size classes, with a main modal size at 23 cm size class and a secondary one at 12.5 cm (**Table 10**, **Figure 27**).

Overall acoustic estimates for the surveyed area were of 22 million fish and 1 979 t. Again, Portuguese waters contributed with almost the whole population, both in terms of abundance (22 million, 98%) and biomass (1 962 t, 99%). Estimates for the Spanish waters were of 0.4 million fish and 18 t only.

Mediterranean horse-mackerel

The survey's length-weight relationship for this species is shown in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 28**. The back-scattering energy attributed to this species and the coherent strata considered for the acoustic estimation are represented in **Figure 29**. The estimated abundance and biomass by size class are given in **Table 11** and **Figure 30**.

Mediterranean horse-mackerel was only present over the Spanish inner shelf waters, with the densest concentrations being recorded in the inner shelf waters between Chipiona and Cape Trafalgar (**Figure 29**). The smallest fish were recorded in the inner shelf waters in front of the Tinto/Odiel river mouth (**Table 11**, **Figures 28** and **30**). The size class range of the assessed population ranged between 21 and 45.5 cm size classes, with a modal size at 29 cm size class (**Table 11**, **Figure 30**).

Overall acoustic estimates of abundance and biomass were of 24 million and 5 284 t, with the whole population, as above mentioned, concentrated in the Spanish waters.

Bogue

Parameters of the survey's length-weight relationship for bogue are shown in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 31**. The back-scattering energy attributed to this species and the coherent strata considered for the acoustic estimation are shown in **Figure 32**. The estimated abundance and biomass by size class are given in **Table 12** and **Figure 33**.

Bogue avoided the easternmost waters in the Gulf. In the remaining surveyed area the species showed higher acoustic densities between Cape San Vicente and the central part of the Gulf (**Figure 32**). The largest fish were recorded in the surroundings of the Cadiz Bay, whereas the smallest bogues were observed in the westernmost waters of the Gulf (**Figure 31**). The size class range of the assessed population ranged between 18.5 and 29 cm size classes, with a modal size at 25 cm size class (**Table 12**, **Figure 33**).

Bogue acoustic estimates in summer 2016 were of 8 million fish and 1 010 t. Portuguese waters yielded 65% of abundance (5 million) and 61% of biomass (618 t). Estimates from Spanish waters were of 3 million and 391 t.

Blue whiting

Parameters of the survey's length-weight relationship for blue whiting are shown in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 34**. The back-scattering energy attributed to this species and the coherent strata considered for the acoustic estimation are shown in **Figure 35**. The estimated abundance and biomass by size class are given in **Table 13** and **Figure 36**.

Blue whiting showed an incidental occurrence in the surveyed area, just in the outer shelf waters between Alfanzinha and Cape Santa Maria (**Figure 35**). Length frequency distributions were not representative enough to provide information on its spatial pattern in size (**Figure 34**). The size class range of the assessed population ranged between 19 and 23.5 cm size classes, with a (non-representative) modal size at 23 cm size class (**Table 13**, **Figure 36**).

Overall acoustic estimates in summer 2016 were of 0.03 million and 2 t, with the whole estimated population being restricted to the Portuguese waters.

Boarfish

Parameters of the survey's length-weight relationship for boarfish are shown in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 37**. The back-scattering energy attributed to this species and the coherent strata considered for the acoustic estimation are shown in **Figure 38**. The estimated abundance and biomass by size class are given in **Table 14** and **Figure 39**.

Boarfish occurrence in the surveyed area was very incidental and exclusively restricted to two small density spots in the outer shelf waters of Cape San Vicente and Alfanzinha-Albufeira, in the Portuguese Algarve, with the smallest fish being recorded in the later zone (**Table 14**, **Figures 37, 39**).

Overall acoustic estimates in summer 2016 were of 3 million and 78 t, with the whole estimated population being restricted to the Portuguese waters.

(SHORT) DISCUSSION

The historical series of anchovy, sardine and chub mackerel biomass estimates is shown in **Figure 29**.

For anchovy, the summer 2016 abundance estimate continues the notable increasing trend which started in 2014 and rises up the population levels well above those corresponding to the historical average. For this same surveyed area, the Portuguese spring survey *PELAGO 16* estimated almost four months before 9 811 million fish and 65 345 t (the whole population was restricted to the Spanish waters only; see Marques *et al*., 2016). Such estimates were the highest ones within its historical series and contrast with their summer counterparts, with the *PELAGO* survey yielding almost the double in biomass and the triple in abundance that the *ECOCADIZ* survey and recording anchovy only in the Spanish waters. Marques *et al*. (2016) warned about the need of corroborating the *PELAGO* spring estimates with the *ECOCADIZ* ones because of some uncertainty in the estimation. These authors advanced the possibility of a certain overestimation of the acoustic energy attributed to anchovy in the Spanish waters of the Gulf because this energy in this area was strongly masked by a dense plankton layer. *ECOCADIZ* surveys also routinely face to this same problem, since this situation is not uncommon in the area, by acoustically surveying in a multi-frequency fashion, an approach that partially enables a more efficient discrimination of echoes.

Regarding sardine, trends in biomass exhibited by *PELAGO* and *ECOCADIZ* surveys series are quite different in the most recent years. *PELAGO* estimated a decreased population in 2015 whereas *ECOCADIZ* recorded the opposite trend. In 2016 both surveys showed increased population levels but with a very different magnitude (80 kt by *PELAGO* versus 27 kt by *ECOCADIZ*). In fact, the *PELAGO* 2016 estimate is the highest one since 2010 on.

As evidenced by the *ECOCADIZ* survey series estimates, since 2013 on, chub mackerel shows relatively stable population biomass levels, at around 20-30 kt. In 2016, the population seems to have experienced only a light and not significant increase (24.9 kt) in relation to the two previous years (at around 22 kt). In any case, the current levels are well below the peaks recorded in 2007 (61.5 kt) and 2009 (56.3 kt).

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Table 1. *ECOCADIZ 2016-07 s*urvey. 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)
R01	Trafalgar	31/07/16	36º 13.758' N	6º 07.520 W	09:41	26	36º 02.140' N	6º 28.756' W	11:42	175
R02	Sancti-Petri	01/08/16	36º 19.445' N	6º 14.400' W	06:11	26	36º 08.870' N	6º 34.266' W	10:36	213
R03	Cádiz	01/08/16	36º 16.925' N	6º 36.517' W	11:35	195	36º 27.168' N	6º 19.148' W	16:33	24
R04	Rota	02/08/16	36º 24.497' N	6º 40.733' W	06:14	195	36º 34.145' N	6º 24.268' W	09:23	26
R05	Chipiona	02/08/16	36º 40.138' N	6º 29.900' W	10:04	23	36º 31.140' N	6º 46.325' W	13:32	175
R06	Doñana	03/08/16	36º 46.422' N	6º 35.847' W	06:09	21	36º 37.893' N	6º 51.495' W	08:55	202
R07	Matalascañas	30/08/16	36º 44.034' N	6º 58.133' W	11:37		36º 53.526' N	6º 40.944' W	16:52	22
R08	Mazagón	04/08/16	36º 49.469' N	7º 06.111' W	06:14	155	37º 11.786' N	6º 44.368' W	10:18	21
R09	Punta Umbría	04/08/16	37º 04.029' N	6º 56.233' W	11:51	29	36º 49.667' N	7º 06.408' W	15:11	204
R10	El Rompido	05/08/16	37º 06.982' N	7º 06.792' W	06:14	21	36º 49.780' N	7º 6.689' W	09:35	229
R11	Isla Cristina	05/08/16	36º 53.481' N	7º 16.698' W	11:30	147	37º 07.433' N	7º 17.011' W	15:00	21
R12	V.R. do Sto. Antonio	06/08/16	37º 06.433' N	7º 26.576' W	06:13	29	36º 56.205' N	7º 26.502' W	07:14	266
R13	Tavira	06/08/16	36º 57.077' N	7º 36.104' W	09:15	156	37º 04.913' N	7º 36.028' W	10:01	22
R14	Fuzeta	06/08/16	36º 59.218' N	7º 45.911' W	14:35	78	36º 55.839' N	7º 45.998' W	15:24	199
R15	Cabo Sta. María	08/08/16	36º 55.066' N	7º 56.089' W	06:07	72	36º 52.144' N	7º 56.000' W	08:24	229
R16	Cuarteira	08/08/16	36º 50.145' N	8º 05.894' W	11:36	131	37º 01.336' N	8º 05.842' W	14:07	22
R17	Albufeira	09/08/16	37º 02.540' N	8º 15.578' W	06:08	29	36º 49.363' N	8º 15.500' W	07:29	218
R18	Alfanzinha	09/08/16	36º 50,369' N	8º 25.296' W	11:29	133	37º 04.145' N	8º 25.248' W	15:59	19
R19	Portimao	10/08/16	37º 05.101' N	8º 35.394' W	06:01	32	36º 51.322' N	8º 35.401' W	07:35	215
R20	Burgau	10/08/16	36º 52.462' N	8º 45.000' W	12:09	111	37º 4.039' N	8º 44.971' W	14:09	28
R21	Punta de Sagres	11/08/16	37º 00.411' N	8º 54.961' W	06:08	26	36º 50.667' N	8º 55.005' W	07:09	150

Table 2. *ECOCADIZ 2016-07* survey. Descriptive characteristics of the fishing stations.

Fishing station	**Date**	**Start**		**End**		**UTC Time**		**Depth (m)**		**Duration (min.)**		**Trawled Distance (nm)**	**Acoustic transect**	**Zone (landmark)**
		Latitude	**Longitude**	**Latitude**	**Longitude**	**Start**	**End**	**Start**	**End**	**Effective trawling**	**Total manoeuvre**			
01	31-07-2016	36º 03.4439 N	6º 28.3299 W	36º 02.0029 N	6º 26.2570 W	12:47	13:18	122,00	122,00	00:31	00:56	2,21	R01	Trafalgar
02	01-08-2016	36º 15.0037 N	6º 22.7191 W	36º 15.8912 N	6º 21.1686 W	07:13	07:36	49,87	46,79	00:22	00:38	1,54	R02	Sancti-Petri
03	01-08-2016	36º 11.3529 N	6º 29.6919 W	36º 12.5224 N	6º 27.4778 W	09:06	09:36	109,15	46,79	00:29	00:55	2,14	R02	Sancti-Petri
04	01-08-2016	36º 18.1858 N	6º 34.4266 W	36º 16.9732 N	6º 36.3409 W	12:23	12:51	134,51	194,23	00:28	00:58	1,97	R03	Cádiz
05	01-08-2016	36º 23.4336 N	6º 25.5753 W	36º 22.3195 N	6º 27.7524 W	14:53	15:23	56,77	66,34	00:29	00:50	2,08	R03	Cádiz
06	02-08-2016	36º 26.9173 N	6º 36.5721 W	36º 25.8502 N	6º 38.5211 W	07:00	07:31	95,35	117,38	00:31	n.a..	1,90	R04	Rota
07	02-08-2016	36º 35.4271 N	6º 30.5366 W	36º 36.5970 N	6º 32.7218 W	11:27	11:58	44,41	44,85	00:31	00:41	2,11	R05	Chipiona
08	02-08-2016	36º 32.4356 N	6º 43.8117 W	36º 33.6612 N	6º 41.7732 W	13:58	14:28	44,41	101,76	00:30	n.a..	2,05	R05	Chipiona
09	03-08-2016	36º 42.2476 N	6º 43.5951 W	36º 43.0292 N	6º 42.2360 W	07:13	07:33	64,00	47,92	00:20	n.a..	1,34	R06	Doñana
10	03-08-2016	36º 45.9131 N	6º 54.5770 W	36º 44.9519 N	6º 56.5166 W	12:26	12:57	113,76	137,00	00:30	00:57	1,83	R07	Matalascañas
11	03-08-2016	36º 49.0724 N	6º 52.9665 W	36º 47.2947 N	6º 51.9304 W	15:02	15:21	89,9	92,30	00:18	00:40	1,96	R07	Matalascañas
12	04-08-2016	36º 52.8596 N	6º 59.4325 W	36º 51.7602 N	7º 01.6120 W	07:45	08:16	95,95	108,93	00:30	01:03	2,07	R08	Mazagón
13	04-08-2016	36º 55.0148 N	6º 58.4340 W	36º 56.2261 N	7º 00.4854 W	13:18	13:48	78,39	77,71	00:30	00:51	2,04	R09	Punta Umbría
14	05-08-2016	37º 04.1518 N	7º 08.7414 W	37º 03.5658 N	7º 06.3079 W	07:15	07:45	40,1	39,93	00:30	00:48	2,03	R10	El Rompido
15	05-08-2016	36º 54.7260 N	7º 14.1426 W	36º 55.3591 N	7º 16.5682 W	13:00	13:30	123,39	122,86	00:30	00:58	2,05	R11	Isla Cristina
16	05-08-2016	37º 02.6293 N	7º 37.8260 W	37º 03.6178 N	7º 34.2997 W	11:04	11:48	45,82	46,76	00:44	01:02	2,99	R13	Tavira
17	06-08-2016	36º 59.5399 N	7º 36.0859 W	36º 57.2794 N	7º 35.9906 W	12:47	13:19	103,72	177,34	00:32	00:54	2,26	R13	Tavira
18	08-08-2016	36º 55.1970 N	7º 54.6666 W	36º 54.7830 N	7º 56.8230 W	07:15	07:40	76,38	74,14	00:24	00:43	1,78	R15	Cabo de Santa María
19	08-08-2016	36º 52.8929 N	7º 54.8187 W	36º 52.5047 N	7º 56.5115 W	09:15	09:36	109,14	108,92	00:20	00:44	1,41	R15	Cabo de Santa María
20	08-08-2016	36º 54.7881 N	8º 05.9701 W	36º 52.9373 N	8º 05.7654 W	12:29	12:56	72,86	99,75	00:27	00:45	1,86	R16	Cuarteira
21	08-08-2016	36º 57.0340 N	8º 02.4631 W	36º 56.9696 N	8º 04.3759 W	15:44	16:06	45,47	45,33	00:21	00:41	1,54	R16	Cuarteira
22	09-08-2016	36º 50.6291 N	8º 15.5104 W	36º 52.7824 N	8º 15.4209 W	07:50	08:20	117,58	108,56	00:30	00:55	2,15	R17	Albufeira
23	09-08-2016	36º 57.9953 N	8º 25.3151 W	36º 56.1906 N	8º 25.2787 W	12:49	13:15	72,28	97,05	00:26	00:47	1,80	R18	Alfanzina
24	09-08-2016	36º 59.2836 N	8º 27.1439 W	36º 59.2521 N	8º 25.6416 W	14:57	15:15	49,69	46,04	00:18	05:27	1,20	R18	Alfanzina
25	10-08-2016	36º 54.0996 N	8º 35.4574 W	36º 51.5721 N	8º 35.3492 W	08:12	08:48	108,45	192,72	00:36	00:59	2,53	R19	Portimao
26	11-08-2016	36º 51.3950 N	8º 52.5116 W	36º 51.6656 N	8º 53.8606 W	08:05	08:21	132,24	134,40	00:16	00:43	1,12	R21	Ponta de Sagres

Table 3. *ECOCADIZ 2016-07* survey. Catches by species in number (upper panel) and weight (in kg, lower panel) from valid fishing stations.

ABUNDANCE (nº)												
Fishing station	***Anchovy***	***Sardine***	***Chub mack.***	***Mackerel***	***Horse-mack.***	***Blue Jack-mack.***	***Medit. Horse-mack.***	***Bogue***	***Blue whiting***	***Boarfish***	**Other spp.**	**TOTAL**
01	764	0	1778	20	2	185	1	0	0	0	3	**2753**
02	0	2316	1272	0	0	0	217	0	0	0	170	**3975**
03	991	0	16220	24	5	14	23	0	0	0	3	**17280**
04	2052	0	1014	45	0	0	0	0	0	0	173	**3284**
05	7694	17317	67	0	4	0	485	13	0	0	149	**25729**
06	22753	0	1055	3373	0	0	0	0	0	0	65	**27246**
07	7827	21809	4	0	0	0	475	3	0	0	28	**30146**
08	23733	0	1382	1695	0	0	0	0	0	0	45	**26855**
09	42206	8384	191	15	2	0	9	5	0	0	31	**50843**
10	14404	0	121	53	0	0	0	0	0	0	34	**14612**
11	29999	23	3780	11275	0	0	0	0	0	0	13	**45090**
12	38403	2	2108	1080	1	0	0	1	0	0	38	**41633**
13	9602	147	759	536	1	0	0	44	0	0	50	**11139**
14	20543	35447	32	9	7	0	7	7	0	0	34	**56086**
15	1384	0	2013	6157	0	0	0	0	0	0	60	**9614**
16	5030	1414	67	50	1	2	0	128	0	0	153	**6845**
17	0	0	7785	135	0	2510	0	0	0	0	10	**10440**
18	266	5207	37	10	1698	31	0	41	0	0	494	**7784**
19	14716	0	51	62	1353	42	0	55	1	0	95	**16375**
20	4502	21	1626	47	177	2	0	18	2	0	66	**6461**
21	0	23575	116	0	526	1	0	23	0	0	423	**24664**
22	23276	0	4178	218	17	3	0	5	2	221	84	**28004**
23	459	490	1374	390	9	0	0	1	0	0	93	**2816**
24	126	40	20277	2	328	75	0	155	0	0	186	**21189**
25	8	1	780	18	137	4963	0	49	0	0	59	**6015**
26	0	0	7	3	1	2064	0	6	0	584	7	**2672**
TOTAL	**270145**	**115662**	**45656**	**24804**	**3794**	**2790**	**1217**	**343**	**5**	**221**	**2221**	**466858**

BIOMASS (kg)												
Fishing station	***Anchovy***	***Sardine***	***Chub mack.***	***Mackerel***	***Horse-mack.***	***Blue Jack-mack.***	***Medit. Horse-mack.***	***Bogue***	***Blue whiting***	***Boarfish***	**Other spp.**	**TOTAL**
01	16,600	0,000	85,700	1,297	0,055	14,550	0,043	0,000	0,000	0,000	3,631	**121,876**
02	0,000	42,300	37,701	0,000	0,000	0,000	46,000	0,000	0,000	0,000	20,440	**146,441**
03	21,750	0,000	1597,910	0,693	0,240	1,336	10,350	0,000	0,000	0,000	0,395	**1632,674**
04	38,500	0,000	19,850	1,330	0,000	0,000	0,000	0,000	0,000	0,000	8,215	**67,895**
05	82,735	212,330	10,367	0,000	0,086	0,000	98,290	2,151	0,000	0,000	14,322	**420,281**
06	250,500	0,000	32,750	113,000	0,000	0,000	0,000	0,000	0,000	0,000	10,350	**406,600**
07	38,700	159,495	1,049	0,000	0,000	0,000	103,400	0,795	0,000	0,000	4,617	**308,056**
08	255,400	0,000	35,700	53,211	0,000	0,000	0,000	0,000	0,000	0,000	6,800	**351,111**
09	289,800	71,600	3,586	0,610	0,047	0,000	1,993	0,939	0,000	0,000	15,118	**383,693**
10	158,300	0,000	5,186	3,132	0,000	0,000	0,000	0,000	0,000	0,000	4,834	**171,452**
11	293,948	0,384	86,056	332,299	0,000	0,000	0,000	0,000	0,000	0,000	5,415	**718,102**
12	439,600	0,035	54,890	32,017	0,028	0,000	0,000	0,142	0,000	0,000	4,770	**531,482**
13	93,350	1,545	23,400	16,300	0,015	0,000	0,000	6,500	0,000	0,000	6,987	**148,097**
14	168,200	357,921	0,820	0,766	0,114	0,000	0,809	1,182	0,000	0,000	3,527	**533,339**
15	20,550	0,000	73,900	214,200	0,000	0,000	0,000	0,000	0,000	0,000	7,950	**316,600**
16	63,850	18,362	9,560	2,629	0,130	0,238	0,000	19,000	0,000	0,000	33,210	**146,979**
17	0,000	0,000	441,200	5,800	0,000	251,800	0,000	0,000	0,000	0,000	5,218	**704,018**
18	3,254	68,800	3,823	2,096	233,700	3,326	0,000	6,150	0,000	0,000	95,060	**416,209**
19	209,200	0,000	2,134	12,600	205,900	4,943	0,000	8,700	0,180	0,000	14,040	**457,697**
20	61,500	0,855	173,951	3,216	19,250	0,191	0,000	2,246	0,137	0,000	5,928	**267,274**
21	0,000	339,750	5,866	0,000	20,480	0,113	0,000	2,903	0,000	0,000	76,172	**445,284**
22	454,410	0,000	145,200	14,650	1,408	0,118	0,000	0,632	0,159	1,142	12,210	**629,929**
23	8,900	6,850	58,650	22,609	0,266	0,000	0,000	0,128	0,000	0,000	9,507	**106,910**
24	3,108	1,828	1456,180	0,431	27,250	6,800	0,000	13,650	0,000	0,000	27,565	**1536,812**
25	0,153	0,039	112,436	5,818	9,150	291,650	0,000	5,004	0,000	0,000	7,185	**431,435**
26	0,000	0,000	1,139	0,665	0,079	139,300	0,000	0,724	0,000	12,950	0,875	**155,732**
TOTAL	**2972,308**	**1282,094**	**4479,004**	**839,369**	**518,198**	**714,365**	**260,885**	**70,846**	**0,476**	**14,092**	**404,341**	**11555,978**

Table 4. *ECOCADIZ 2016-07* survey. Parameters of the size-weight relationships for survey's target species. FAO codes for the species: PIL: *Sardina pilchardus*; ANE: *Engraulis encrasicolus*; MAS: *Scomber colias*; MAC: *Scomber scombrus*; JAA: *Trachurus picturatus;* HOM: *Trachurus trachurus*; HMM: *Trachurus mediterraneus*; BOG: *Boops boops*; WHB: *Micromesistius poutassou* (Estimates from Torres *et al*., 2012; BOC: *Capros aper*.

Parameter	PIL	ANE	MAS	MAC	JAA	HOM	HMM	BOG	WHB	BOC
Size range (mm)	80-220	82-176	106-364	150-398	145-282	107-294	102-457	194-290	131-402	56-115
n	596	1097	1219	779	341	346	190	292	566	109
a	0,0051066	0,0028743	0,0024452	0,0014168	0,0168675	0,0069983	0,0151100	0,0085527	0,0020000	0,0176035
b	3,1456107	3,2865386	3,3576196	3,4940716	2,7601535	3,0580742	2,8016909	3,0194273	3,3660000	3,0782399
r^2	0,9628780	0,9711498	0,9597170	0,9479620	0,8606646	0,9622208	0,9609760	0,9095278	0,9900000	0,9911688

Table 5. *ECOCADIZ 2016-07* survey. Anchovy (*E. encrasicolus*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e*., coherent or homogeneous post-strata) numbered as in **Figure 8**.

***ECOCADIZ 2016-07*. *Engraulis encrasicolus*. ABUNDANCE (in numbers and million fish)**															
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**POL08**	**POL09**	***n***			**millions**		
										PORTUGAL	**SPAIN**	**TOTAL**	**PORTUGAL**	**SPAIN**	**TOTAL**
6	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
6,5	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
7	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
7,5	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
8	0	0	0	0	0	9550672	0	0	0	0	9550672	9550672	**0**	**10**	**10**
8,5	0	0	0	0	0	107953489	0	0	0	0	107953489	107953489	**0**	**108**	**108**
9	0	0	0	0	0	249463339	0	0	0	0	249463339	249463339	**0**	**249**	**249**
9,5	0	0	0	0	0	312045186	0	0	0	0	312045186	312045186	**0**	**312**	**312**
10	0	0	0	0	0	235756315	3232092	0	0	0	238988407	238988407	**0**	**239**	**239**
10,5	0	0	0	333395	0	389433123	17825772	0	0	333395	407258895	407592290	**0**	**407**	**408**
11	0	0	0	1081666	0	347077391	72967454	0	0	1081666	420044845	421126511	**1**	**420**	**421**
11,5	0	378798	0	6995897	493089	216320523	267437545	0	66424	7867784	483824492	491692276	**8**	**484**	**492**
12	0	2366036	0	32027594	3079914	103693667	466831236	19654	273077	37473544	570817634	608291178	**37**	**571**	**608**
12,5	1266	6412829	69810	53561386	8347701	65668823	229364995	37096	1439189	68392992	296510103	364903095	**68**	**297**	**365**
13	5071	19663700	279706	32673606	25596610	20462521	143464503	117727	2745529	78218693	166790280	245008973	**78**	**167**	**245**
13,5	40053	19795888	2209338	9260205	25768681	0	42114405	357150	3225259	57074165	45696814	102770979	**57**	**46**	**103**
14	66562	15540587	3671608	4073592	20229475	0	17001716	798430	1712266	43581824	19512412	63094236	**44**	**20**	**63**
14,5	99681	8147357	5498442	2759396	10605569	0	0	1520571	413305	27110445	1933876	29044321	**27**	**2**	**29**
15	98119	3505900	5412276	1010940	4563697	0	4056148	2153349	206653	14590932	6416150	21007082	**15**	**6**	**21**
15,5	50467	338065	2783799	737516	440066	0	0	2127928	66424	4349913	2194352	6544265	**4**	**2**	**7**
16	15982	1267744	881548	404121	1650246	0	0	1119565	0	4219641	1119565	5339206	**4**	**1**	**5**
16,5	4676	0	257932	0	0	0	0	371919	66424	262608	438343	700951	**0,3**	**0,4**	**1**
17	7793	0	429887	333395	0	0	0	18853	0	771075	18853	789928	**1**	**0**	**1**
17,5	3117	0	171955	0	0	0	0	0	0	175072	0	175072	**0,2**	**0**	**0,2**
18	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
18,5	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL *n*	392787	77416904	21666301	145252709	100775048	2057425049	1264295866	8642242	10214550	345503749	3340577707	3686081456	**346**	**3341**	**3686**
Millions	**0,4**	**77**	**22**	**145**	**101**	**2057**	**1264**	**9**	**10**						

Table 5. *ECOCADIZ 2016-07* survey. Anchovy (*E. encrasicolus*). Cont'd.

ECOCADIZ 2016-07 . Engraulis encrasicolus . BIOMASS (t)												
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**POL08**	**POL09**	**PORTUGAL**	**SPAIN**	**TOTAL**
6	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
6,5	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
7	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
7,5	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
8	0	0	0	0	0	28,216	0	0	0	**0**	**28,216**	**28,216**
8,5	0	0	0	0	0	386,972	0	0	0	**0**	**386,972**	**386,972**
9	0	0	0	0	0	1073,415	0	0	0	**0**	**1073,415**	**1073,415**
9,5	0	0	0	0	0	1596,321	0	0	0	**0**	**1596,321**	**1596,321**
10	0	0	0	0	0	1421,507	19,488	0	0	**0**	**1440,995**	**1440,995**
10,5	0	0	0	2,351	0	2746,004	125,695	0	0	**2,351**	**2871,699**	**2874,050**
11	0	0	0	8,856	0	2841,750	597,432	0	0	**8,856**	**3439,182**	**3448,038**
11,5	0	3,578	0	66,080	4,658	2043,273	2526,103	0	0,627	**74,316**	**4570,003**	**4644,319**
12	0	25,629	0	346,925	33,362	1123,215	5056,740	0,213	2,958	**405,916**	**6183,126**	**6589,042**
12,5	0,016	79,225	0,862	661,705	103,129	811,282	2833,609	0,458	17,780	**844,937**	**3663,129**	**4508,066**
13	0,071	275,666	3,921	458,052	358,84	286,865	2011,234	1,650	38,490	**1096,550**	**2338,239**	**3434,789**
13,5	0,634	313,447	34,983	146,626	408,02	0	666,838	5,655	51,069	**903,710**	**723,562**	**1627,272**
14	1,185	276,719	65,378	72,535	360,211	0	302,737	14,217	30,489	**776,028**	**347,443**	**1123,471**
14,5	1,988	162,485	109,657	55,031	211,510	0	0	30,325	8,243	**540,671**	**38,568**	**579,239**
15	2,183	78,015	120,437	22,496	101,554	0	90,260	47,917	4,599	**324,685**	**142,776**	**467,461**
15,5	1,249	8,364	68,876	18,247	10,888	0	0	52,648	1,643	**107,624**	**54,291**	**161,915**
16	0,438	34,759	24,17	11,08	45,247	0	0	30,696	0	**115,694**	**30,696**	**146,390**
16,5	0,142	0	7,813	0	0	0	0	11,265	2,012	**7,955**	**13,277**	**21,232**
17	0,260	0	14,343	11,123	0	0	0	0,629	0	**25,726**	**0,629**	**26,355**
17,5	0,114	0	6,302	0	0	0	0	0	0	**6,416**	**0**	**6,416**
18	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
18,5	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL	**8,280**	**1257,887**	**456,742**	**1881,107**	**1637,419**	**14358,820**	**14230,136**	**195,673**	**157,910**	**5241,435**	**28942,539**	**34183,974**

Table 6. *ECOCADIZ 2016-07* survey. Anchovy (*E. encrasicolus*). Estimated abundance (thousands of individuals) and biomass (tonnes) by age group. Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 8** and ordered from west to east.

Age class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**POL08**	**POL09**	**PT**	**ES**	**TOTAL**
	N	**N**	**N**	**N**	**N**	**N**	**Nr**	**N**	**N**	**N**	**N**	**N**
0	14	2905	767	16831	3781	1369202	272192	369	402	24298	1642166	1666463
I	343	72789	18909	126131	94751	387485	947624	7458	9673	312924	1352239	1665163
II	36	1723	1990	2291	2243	300738	44480	815	140	8282	346173	354455
III	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	393	77417	21666	145253	100775	2057425	1264296	8642	10215	345504	3340578	3686081

Age class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**POL08**	**POL09**	**PT**	**ES**	**TOTAL**
	B	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**
0	0,3	42	17	192	55	8309	2718	8	5	307	11041	11348
I	7	1181	389	1653	1537	3876	11115	167	150	4767	15307	20074
II	1	35	51	36	45	2176	400	20	3	169	2599	2768
III	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	8	1258	457	1881	1638	14361	14232	196	158	5242	28947	34190

Table 7. *ECOCADIZ 2016-07* survey. Sardine (*S. 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 13**.

***ECOCADIZ 2016-07*. *Sardina pilchardus*. ABUNDANCE (in numbers and million fish)**																	
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**POL08**	**POL09**	**POL10**	***n***			**millions**		
											PORTUGAL	**SPAIN**	**TOTAL**	**PORTUGAL**	**SPAIN**	**TOTAL**
6	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
6,5	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
7	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
7,5	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
8	2637217	0	0	0	0	0	0	0	0	0	2637217	0	2637217	**3**	**0**	**3**
8,5	527443	0	0	0	11191756	0	0	0	0	0	527443	11191756	11719199	**1**	**11**	**12**
9	3164661	0	0	0	9762599	0	0	0	0	0	3164661	9762599	12927260	**3**	**10**	**13**
9,5	2637217	0	0	0	120643619	1017159	0	0	0	0	2637217	121660778	124297995	**3**	**122**	**124**
10	2637217	0	0	0	468734483	0	0	0	0	0	2637217	468734483	471371700	**3**	**469**	**471**
10,5	7560023	2946	5196	223170	597939749	4068634	0	0	0	0	7791335	602008383	609799718	**8**	**602**	**610**
11	3932431	0	0	2696638	403617807	41696098	0	0	0	0	6629069	445313905	451942974	**7**	**445**	**452**
11,5	22539145	0	0	11214296	208568323	92242950	75	408	698438	35570	33753441	301545764	335299205	**34**	**302**	**335**
12	82157439	5893	10393	9187168	51013992	102161494	150	815	1396875	71141	91360893	154644467	246005360	**91**	**155**	**246**
12,5	88558058	0	0	2008531	13399123	35986924	1342	7300	12505358	636881	90566589	62536928	153103517	**91**	**63**	**153**
13	27029216	14731	25982	223170	17771	14084682	3797	20658	35387502	1802237	27293099	51316647	78609746	**27**	**51**	**79**
13,5	9792812	8839	15589	446340	99966	4068634	2159	11746	20121653	1024768	10263580	25328926	35592506	**10**	**25**	**36**
14	2637217	2946	5196	223170	88854	2657699	746	4058	6951116	354011	2868529	10056484	12925013	**3**	**10**	**13**
14,5	527443	8839	15589	0	46654	1017159	0	0	0	0	551871	1063813	1615684	**1**	**1**	**2**
15	527443	2946	5196	0	4478222	0	0	0	0	0	535585	4478222	5013807	**1**	**4**	**5**
15,5	0	5893	10393	0	17771	0	0	0	0	0	16286	17771	34057	**0,02**	**0,02**	**0,03**
16	0	5893	10393	0	0	17269	0	0	0	0	16286	17269	33555	**0,02**	**0,02**	**0,03**
16,5	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
17	0	0	0	0	17771	0	0	0	0	0	0	17771	17771	**0**	**0,02**	**0,02**
17,5	0	2946	5196	0	0	8634	0	0	0	0	8142	8634	16776	**0,01**	**0,01**	**0,02**
18	0	2946	5196	0	17771	8634	0	0	0	0	8142	26405	34547	**0,01**	**0,03**	**0,03**
18,5	0	8839	15589	37195	17771	0	0	0	0	0	61623	17771	79394	**0,06**	**0,02**	**0,08**
19	0	8839	15589	0	46654	0	0	0	0	0	24428	46654	71082	**0,02**	**0,05**	**0,07**
19,5	0	8839	15589	0	0	0	0	0	0	0	24428	0	24428	**0,02**	**0**	**0,02**
20	0	8839	15589	0	0	0	0	0	0	0	24428	0	24428	**0,02**	**0**	**0,02**
20,5	0	2946	5196	37195	35541	8634	0	0	0	0	45337	44175	89512	**0,05**	**0,04**	**0,09**
21	0	5893	10393	0	0	0	0	0	0	0	16286	0	16286	**0,02**	**0**	**0,02**
21,5	0	5893	10393	0	0	0	0	0	0	0	16286	0	16286	**0,02**	**0**	**0,02**
22	0	2946	5196	0	0	0	0	0	0	0	8142	0	8142	**0,01**	**0**	**0,01**
22,5	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
23	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL *n*	256864982	117852	207853	26296873	1889756197	299044604	8269	44985	77060942	3924608	283487560	2269839605	2553327165	**283**	**2270**	**2553**
Millions	**257**	**0,1**	**0,2**	**26**	**1890**	**299**	**0,01**	**0,04**	**77**	**4**						

***ECOCADIZ 2016-07*. *Sardina pilchardus*. BIOMASS (t)**													
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**POL08**	**POL09**	**POL10**	**PORTUGAL**	**SPAIN**	**TOTAL**
6	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
6,5	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
7	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
7,5	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
8	10,282	0	0	0	0	0	0	0	0	0	**10,282**	**0**	**10,282**
8,5	2,474	0	0	0	52,504	0	0	0	0	0	**2,474**	**52,504**	**54,978**
9	17,682	0	0	0	54,548	0	0	0	0	0	**17,682**	**54,548**	**72,230**
9,5	17,389	0	0	0	795,502	6,707	0	0	0	0	**17,389**	**802,209**	**819,598**
10	20,352	0	0	0	3617,319	0	0	0	0	0	**20,352**	**3617,319**	**3637,671**
10,5	67,772	0,026	0,047	2,001	5360,26	36,473	0	0	0	0	**69,846**	**5396,733**	**5466,579**
11	40,672	0	0	27,891	4174,539	431,254	0	0	0	0	**68,563**	**4605,793**	**4674,356**
11,5	267,291	0	0	132,99	2473,404	1093,906	0,001	0,005	8,283	0,422	**400,281**	**3576,021**	**3976,302**
12	1110,775	0,080	0,141	124,211	689,713	1381,231	0,002	0,011	18,886	0,962	**1235,207**	**2090,805**	**3326,012**
12,5	1357,881	0	0	30,797	205,452	551,796	0,021	0,112	191,747	9,765	**1388,678**	**958,893**	**2347,571**
13	467,755	0,255	0,450	3,862	0,308	243,743	0,066	0,357	612,400	31,189	**472,322**	**888,063**	**1360,385**
13,5	190,414	0,172	0,303	8,679	1,944	79,111	0,042	0,228	391,250	19,926	**199,568**	**492,501**	**692,069**
14	57,376	0,064	0,113	4,855	1,933	57,822	0,016	0,088	151,231	7,702	**62,408**	**218,792**	**281,200**
14,5	12,790	0,214	0,378	0	1,131	24,666	0	0	0	0	**13,382**	**25,797**	**39,179**
15	14,204	0,079	0,140	0	120,601	0	0	0	0	0	**14,423**	**120,601**	**135,024**
15,5	0	0,176	0,310	0	0,530	0	0	0	0	0	**0,486**	**0,530**	**1,016**
16	0	0,194	0,342	0	0	0,568	0	0	0	0	**0,536**	**0,568**	**1,104**
16,5	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
17	0	0	0	0	0,705	0	0	0	0	0	**0**	**0,705**	**0,705**
17,5	0	0,128	0,226	0	0	0,375	0	0	0	0	**0,354**	**0,375**	**0,729**
18	0	0,140	0,246	0	0,842	0,409	0	0	0	0	**0,386**	**1,251**	**1,637**
18,5	0	0,456	0,804	1,919	0,917	0	0	0	0	0	**3,179**	**0,917**	**4,096**
19	0	0,495	0,874	0	2,614	0	0	0	0	0	**1,369**	**2,614**	**3,983**
19,5	0	0,537	0,947	0	0	0	0	0	0	0	**1,484**	**0**	**1,484**
20	0	0,581	1,024	0	0	0	0	0	0	0	**1,605**	**0**	**1,605**
20,5	0	0,209	0,369	2,639	2,522	0,613	0	0	0	0	**3,217**	**3,135**	**6,352**
21	0	0,451	0,795	0	0	0	0	0	0	0	**1,246**	**0**	**1,246**
21,5	0	0,485	0,855	0	0	0	0	0	0	0	**1,340**	**0**	**1,340**
22	0	0,260	0,459	0	0	0	0	0	0	0	**0,719**	**0**	**0,719**
22,5	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
23	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL	**3655,109**	**5,002**	**8,823**	**339,844**	**17557,288**	**3908,674**	**0,148**	**0,801**	**1373,797**	**69,966**	**4008,778**	**22910,674**	**26919,452**

Table 8. *ECOCADIZ 2016-07* survey. Sardine (*S. pilchardus*). Estimated abundance (thousands of individuals) and biomass (tonnes) by age group. Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 13** and ordered from west to east.

Age class	POL01	POL02	POL03	POL04	POL05	POL06	POL07	POL08	POL09	POL10	PT	ES	TOTAL
	N	N	N	N	N	N	Nr	N	N	N	N	N	N
0	247648	40	71	25906	1887343	293887	7	38	64581	3289	273665	2249145	2522810
I	8292	25	44	331	1412	4709	1	7	11407	581	8692	18117	26809
II	925	27	48	33	966	442	0,1	1	1072	55	1033	2536	3569
III	0	25	44	16	25	5	0	0	0	0	84	30	114
IV	0	1	1	11	10	2	0	0	0	0	13	13	26
V	0	0	0	0	0	0	0	0	0	0	0	0	0
VI	0	0	0	0	0	0	0	0	0	0	0	0	0
VII	0	0	0	0	0	0	0	0	0	0	0	0	0
VIII	0	0	0	0	0	0	0	0	0	0	0	0	0
IX	0	0	0	0	0	0	0	0	0	0	0	0	0
X	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	256865	118	208	26297	1889756	299045	8	46	77060	3925	283487	2269841	2553328

Age class	POL01	POL02	POL03	POL04	POL05	POL06	POL07	POL08	POL09	POL 10	PT	ES	TOTAL
	B	B	B	B	B	B	B	B	B	B	B	B	B
0	3486	1	1	329	17494	3809	0,1	1	1130	58	3817	22492	26309
I	152	1	2	7	34	91	0,02	0,1	225	11	162	362	524
II	17	1	3	2	28	8	0,002	0,02	19	1	23	56	79
III	0	2	3	1	2	0,3	0	0	0	0	6	2	8
IV	0	0,1	0	1	1	0,1	0	0	0	0	1	1	2
V	0	0	0	0	0	0	0	0	0	0	0	0	0
VI	0	0	0	0	0	0	0	0	0	0	0	0	0
VII	0	0	0	0	0	0	0	0	0	0	0	0	0
VIII	0	0	0	0	0	0	0	0	0	0	0	0	0
IX	0	0	0	0	0	0	0	0	0	0	0	0	0
X	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	3655	5	8	340	17558	3909	0,1	1	1374	70	4009	22912	26920

Table 9. *ECOCADIZ 2016-07* survey. Atlantic mackerel (*S. 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**.

***ECOCADIZ 2016-07*. *Scomber scombrus*. ABUNDANCE (in numbers and million fish)**														
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**POL08**	***n***			**millions**		
									PORTUGAL	**SPAIN**	**TOTAL**	**PORTUGAL**	**SPAIN**	**TOTAL**
12	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
12,5	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
13	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
13,5	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
14	0	0	845	0	1369	125329	0	0	2214	125329	127543	**0,002**	**0,1**	**0,1**
14,5	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
15	0	240408	0	0	0	0	3512	766	240408	4278	244686	**0,2**	**0,004**	**0,2**
15,5	0	948884	0	0	0	0	0	0	948884	0	948884	**1**	**0**	**1**
16	0	0	9994	0	16188	1481541	10537	2298	26182	1494376	1520558	**0,03**	**1**	**2**
16,5	5192	948884	85964	14509	139239	12743492	49175	10724	1193788	12803391	13997179	**1**	**13**	**14**
17	12114	6710668	358383	33853	580487	53127607	63225	13788	7695505	53204620	60900125	**8**	**53**	**61**
17,5	3461	9736169	296751	9672	480660	43991208	28100	6128	10526713	44025436	54552149	**11**	**44**	**55**
18	3461	20794947	92277	9672	149464	13679361	3512	766	21049821	13683639	34733460	**21**	**14**	**35**
18,5	0	14450356	6702	0	10855	993518	0	0	14467913	993518	15461431	**14**	**1**	**15**
19	0	1990653	1509	0	2444	223707	0	0	1994606	223707	2218313	**2**	**0,2**	**2**
19,5	0	560953	0	0	0	0	0	0	560953	0	560953	**1**	**0**	**1**
20	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
20,5	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
21	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
21,5	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
22	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
22,5	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
23	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
23,5	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
24	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
24,5	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
25	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
25,5	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
26	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
26,5	0	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**	**0**
27,5	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
28	1731	0	668	4836	1082	99024	0	0	8317	99024	107341	**0,01**	**0,1**	**0,1**
28,5	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
29	0	141695	3378	0	5471	500725	0	0	150544	500725	651269	**0,2**	**1**	**1**
29,5	3461	425085	3431	9672	5557	508558	0	0	447206	508558	955764	**0,4**	**1**	**1**
30	17306	425085	7855	48362	12723	1164395	0	0	511331	1164395	1675726	**1**	**1**	**2**
30,5	8653	1072002	0	24181	0	0	0	0	1104836	0	1104836	**1**	**0**	**1**
31	15575	1010443	9327	43526	15107	1382636	0	0	1093978	1382636	2476614	**1**	**1**	**2**
31,5	8653	850171	5483	24181	8881	812818	0	0	897369	812818	1710187	**1**	**1**	**2**
32	13845	283390	4363	38690	7066	646731	0	0	347354	646731	994085	**0,3**	**1**	**1**
32,5	1731	646917	668	4836	1082	99024	0	0	655234	99024	754258	**1**	**0,1**	**1**
33	6922	807189	1904	19345	3085	282323	0	0	838445	282323	1120768	**1**	**0,3**	**1**
33,5	1731	0	0	4836	0	0	0	0	6567	0	6567	**0,01**	**0**	**0,01**
34	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
34,5	3461	80136	1790	9672	2900	265384	0	0	97959	265384	363343	**0,1**	**0,3**	**0,4**
35	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**
36	0	80136	1904	0	3085	282323	0	0	85125	282323	367448	**0,1**	**0,3**	**0,4**
36,5	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
37	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
37,5	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
38	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
38,5	0	141695	0	0	0	0	0	0	141695	0	141695	**0,1**	**0**	**0,1**
39	0	0	1904	0	3085	282323	0	0	4989	282323	287312	**0,005**	**0,3**	**0,3**
39,5	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
40	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL *n*	107297	62345866	895100	299843	1449830	132692027	158061	34470	65097936	132884558	197982494	**65**	**133**	**198**
Millions	**0,1**	**62**	**1**	**0,3**	**1**	**133**	**0,2**	**0,03**						

Table 9. *ECOCADIZ 2016-07* survey. Atlantic mackerel (*S. scombrus*). Cont'd.

ECOCADIZ 2016-07 . Scomber scombrus . BIOMASS (t)											
Size class	POL01	POL02	POL03	POL04	POL05	POL06	POL07	POL08	PORTUGAL	SPAIN	TOTAL
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	0,013	0	0,021	1,909	0	0	0,034	1,909	1,943
14,5	0	0	0	0	0	0	0	0	0	0	0
15	0	4,642	0	0	0	0	0,068	0,015	4,642	0,083	4,725
15,5	0	20,508	0	0	0	0	0	0	20,508	0	20,508
16	0	0	0,241	0	0,390	35,714	0,254	0,055	0,631	36,023	36,654
16,5	0,139	25,429	2,304	0,389	3,731	341,510	1,318	0,287	31,992	343,115	375,107
17	0,360	199,303	10,644	1,005	17,240	1577,863	1,878	0,409	228,552	1580,150	1808,702
17,5	0,114	319,518	9,739	0,317	15,774	1443,689	0,922	0,201	345,462	1444,812	1790,274
18	0,125	752,004	3,337	0,350	5,405	494,684	0,127	0,028	761,221	494,839	1256,060
18,5	0	574,322	0,266	0	0,431	39,487	0	0	575,019	39,487	614,506
19	0	86,738	0,066	0	0,106	9,747	0	0	86,910	9,747	96,657
19,5	0	26,733	0	0	0	0	0	0	26,733	0,000	26,733
20	0	0	0	0	0	0	0	0	0	0	0
20,5	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0
21,5	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0
22,5	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0
23,5	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0
24,5	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0
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	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	0,288	0	0,111	1	0,180	16,482	0	0	1,384	16,482	17,866
28,5	0	0	0	0	0	0	0	0	0	0	0
29	0	26,633	0,635	0	1,028	94,117	0	0	28,296	94,117	122,413
29,5	0,690	84,774	0,684	1,929	1,108	101,421	0	0	89,185	101,421	190,606
30	3,658	89,858	1,660	10,223	2,689	246,139	0	0	108,088	246,139	354,227
30,5	1,937	239,967	0	5,413	0	0	0	0	247,317	0	247,317
31	3,689	239,301	2,209	10,308	3,578	327,446	0	0	259,085	327,446	586,531
31,5	2,166	212,827	1,373	6,053	2,223	203,476	0	0	224,642	203,476	428,118
32	3,660	74,923	1,153	10,229	1,868	170,983	0	0	91,833	170,983	262,816
32,5	0,483	180,478	0,186	1,349	0,302	27,626	0	0	182,798	27,626	210,424
33	2,036	237,434	0,560	5,690	0,907	83,045	0	0	246,627	83,045	329,672
33,5	0,536	0	0	1,499	0	0	0	0	2,035	0	2,035
34	0	0	0	0	0	0	0	0	0	0	0
34,5	1,188	27,501	0,614	3,319	0,995	91,075	0	0	33,617	91,075	124,692
35	0	0	0	0	0	0	0	0	0	0	0
35,5	0	0	0	0	0	0	0	0	0	0	0
36	0	31,877	0,757	0	1,227	112,305	0	0	33,861	112,305	146,166
36,5	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0
37,5	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0
38,5	0	71,156	0	0	0	0	0	0	71,156	0	71,156
39	0	0	1,000	0	1,620	148,271	0	0	2,620	148,271	150,891
39,5	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0
TOTAL	21,069	3525,926	37,552	58,878	60,823	5566,989	4,567	0,995	3704,248	5572,551	9276,799

Table 10. *ECOCADIZ 2016-07* survey. Chub mackerel (*S. 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**.

***ECOCADIZ 2016-07*. *Scomber colias*. ABUNDANCE (in numbers and million fish)**

Size class	POL01	POL02	POL03	POL04	POL05	POL06	POL07	POL08	POL09	POL10	POL11	POL12	POL13	POL14	POL15	POL16	*n*			millions		
																	PORTUGAL	SPAIN	TOTAL	PORTUGAL	SPAIN	TOTAL
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
9,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
10,5	0	0	0	0	0	0	0	0	0	0	40321	0	0	11007	0	0	0	51328	51328	**0**	**0,1**	**0,1**
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
11,5	0	0	0	0	0	0	0	29413	0	225871	442437	27171	0	120779	0	0	0	845671	845671	**0**	**1**	**1**
12	0	0	0	0	0	13210	0	77920	0	598372	802261	54342	16238	219007	0	165823	13210	1933963	1947173	**0,01**	**2**	**2**
12,5	0	0	0	0	11804	13210	0	285859	0	2195200	1344004	163027	62693	366896	0	640234	25014	5057913	5082927	**0,03**	**5**	**5**
13	0	0	0	24741	15739	6605	77447	209819	333034	1611263	1657468	163027	91314	452467	0	932507	124532	5450899	5575431	**0,1**	**5**	**6**
13,5	742033	6779266	43155	122755	7869	19815	230190	350585	450575	2692253	1131818	135856	102667	308971	0	1048445	7945083	6221170	14166253	**8**	**6**	**14**
14	9525345	15212011	0	196978	200246	39630	385085	455741	1144687	3499773	972244	108685	86259	265410	0	880886	25559295	7413685	32972980	**26**	**7**	**33**
14,5	5531100	8432745	0	245509	376884	66050	690571	475758	568662	3653495	1168161	27171	221163	318893	0	2258544	15342859	8691847	24034706	**15**	**9**	**24**
15	8552021	59359912	0	270251	47217	19815	998208	484122	2028883	3717721	813457	0	418649	222063	0	4275292	69247424	11960187	81207611	**69**	**12**	**81**
15,5	4410294	50927167	0	294992	1278331	39630	537828	364949	2678542	2802555	742831	27171	520834	202783	0	5318822	57488242	12658487	70146729	**57**	**13**	**70**
16	4423491	32242849	0	663256	473702	13210	1766226	216696	3303290	1664073	511051	0	555847	139510	0	5676378	39582734	12066845	51649579	**40**	**12**	**52**
16,5	2468274	17030838	0	810752	671273	6605	1613483	148787	4301847	1142581	402065	0	437666	109759	135420	4469500	22601225	11147625	33748850	**23**	**11**	**34**
17	2144604	0	0	589984	120427	13210	922912	175375	4512564	1346757	599957	27171	237577	163780	812521	2426161	3791137	10301863	14093000	**4**	**10**	**14**
17,5	1693248	1653479	0	294992	108622	19815	1228398	69417	3753320	533076	163560	27171	278886	44650	1625043	2848013	4998554	9343136	14341690	**5**	**9**	**14**
18	742033	1653479	0	49482	0	0	922912	21858	2418003	167851	176327	0	232565	48135	4740886	2374984	3367906	10180609	13548515	**3**	**10**	**14**
18,5	107890	0	0	0	0	0	152743	46141	1046735	354331	106356	0	95906	29034	4605466	979407	260633	7263376	7524009	**0,3**	**7**	**8**
19	849923	0	0	53289	3935	0	690571	48198	973647	370130	106356	0	92403	29034	2438742	943627	1597718	5002137	6599855	**2**	**5**	**7**
19,5	0	0	0	49482	0	0	152743	24283	831788	186479	106356	0	16340	29034	2845003	166861	202225	4206144	4408369	**0,2**	**4**	**4**
20	1585358	3472307	0	4758	0	0	307637	18930	80997	145373	55453	0	32883	15138	812521	335802	5370060	1497097	6867157	**5**	**1**	**7**
20,5	258936	0	215777	0	0	0	77447	0	377487	0	0	0	11362	0	270840	116027	552160	775716	1327876	**1**	**1**	**1**
21	979391	0	323666	0	39347	0	230190	0	198538	0	69971	0	15479	19101	270840	158073	1572594	732002	2304596	**2**	**1**	**2**
21,5	1152015	0	323666	13322	0	0	460380	0	0	0	36385	0	28747	9933	270840	293565	1949383	639470	2588853	**2**	**1**	**3**
22	2274056	0	323666	13322	279366	0	385085	0	215493	0	0	0	60442	0	135420	617239	3275495	1028594	4304089	**3**	**1**	**4**
22,5	2185962	496044	215777	13322	794816	6605	615275	15498	0	119011	38136	0	81080	10411	0	828004	4327801	1092140	5419941	**4**	**1**	**5**
23	1465506	661392	215777	34257	834163	6605	1613483	15557	80997	119469	0	0	95819	0	0	978519	4831183	1290361	6121544	**5**	**1**	**6**
23,5	3598696	165348	0	56144	834163	0	845465	38893	0	298673	106356	0	42014	29034	0	429057	5499816	944027	6443843	**5**	**1**	**6**
24	4201082	2976263	668910	25693	1284666	6605	922912	76085	279535	584279	19068	27171	31695	5205	0	323674	10086131	1346712	11432843	**10**	**1**	**11**
24,5	2185962	2314871	431555	25693	1158055	6605	460380	7779	80997	59735	0	0	26535	0	0	270983	6583121	446029	7029150	**7**	**0,4**	**7**
25	3394314	3141611	1316243	34257	1169724	6605	307637	15557	0	119469	0	0	13268	0	0	135492	9370391	283786	9654177	**9**	**0,3**	**10**
25,5	1840713	3141611	1100465	34257	1405228	0	152743	31115	0	238938	0	27171	5160	0	0	52691	7675017	355075	8030092	**8**	**0,4**	**8**
26	3480626	5291134	2093042	13322	1881469	6605	0	23336	0	179204	0	27171	5160	0	0	52691	12766198	287562	13053760	**13**	**0,3**	**13**
26,5	1033946	3306959	1553598	13322	2210691	13210	0	7779	0	59735	0	54342	15602	0	135420	159334	8131726	432212	8563938	**8**	**0,4**	**9**
27	1236529	4464394	3538751	17129	1195837	0	0	0	0	0	0	108685	2948	0	0	30109	10452640	141742	10594382	**10**	**0,1**	**11**
27,5	345248	1984175	1769375	8564	735489	0	0	0	0	0	0	81514	0	0	0	0	4842851	81514	4924365	**5**	**0,1**	**5**
28	345248	2149523	1553598	0	717365	0	0	29413	0	225871	0	81514	0	0	0	0	4765734	336798	5102532	**5**	**0,3**	**5**
28,5	0	0	431555	4758	829497	0	0	0	0	0	0	81514	1034	0	0	10556	1265810	93104	1358914	**1**	**0**	**1**
29	0	165348	323666	0	290455	0	0	0	0	0	0	108685	0	0	0	0	779469	108685	888154	**1**	**0**	**1**
29,5	86312	165348	215777	0	96818	0	0	0	0	0	0	0	0	0	0	0	564255	0	564255	**1**	**0**	**1**
30	0	0	107889	0	96818	0	0	0	0	0	0	0	0	0	0	0	204707	0	204707	**0,2**	**0**	**0,2**
30,5	0	0	0	0	0	0	0	0	0	0	0	81514	0	0	0	0	0	81514	81514	**0**	**0,1**	**0,1**
31	0	0	0	0	0	0	0	0	0	0	0	27171	0	0	0	0	0	27171	27171	**0**	**0,03**	**0,03**
31,5	0	0	0	0	0	6605	0	0	0	0	0	27171	0	0	0	0	6605	27171	33776	**0,01**	**0,03**	**0,03**
32	0	0	0	0	0	0	0	0	0	0	0	81514	0	0	0	0	0	81514	81514	**0**	**0,1**	**0,1**
32,5	0	0	0	0	0	0	0	0	0	0	0	54342	0	0	0	0	0	54342	54342	**0**	**0,1**	**0,1**
33	0	0	0	0	0	0	0	0	0	0	0	27171	0	0	0	0	0	27171	27171	**0**	**0,03**	**0,03**
33,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
34	86312	0	0	0	0	0	0	0	0	0	0	27171	0	0	0	0	86312	27171	113483	**0,1**	**0**	**0**
34,5	0	0	0	0	0	0	0	0	0	0	0	27171	0	0	0	0	0	27171	27171	**0**	**0,03**	**0,03**
35	0	0	0	0	0	0	0	0	0	0	0	54342	2067	0	0	21112	0	77521	77521	**0**	**0**	**0**
35,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
36	0	0	0	0	0	0	0	0	0	0	0	54342	0	0	0	0	0	54342	54342	**0**	**0,1**	**0,1**
36,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
37,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
38,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
39,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL *n*	72926468	227188074	16765908	3978583	19170016	330250	16747951	3764863	29659621	28911538	11612399	1820468	3938302	3170034	19098962	40218412	357107250	142194599	499301849	**357**	**142**	**499**
Millions	**73**	**227**	**17**	**4**	**19**	**0,3**	**17**	**4**	**30**	**29**	**12**	**2**	**4**	**3**	**19**	**40**						

Table 10. *ECOCADIZ 2016-07* survey. Chub mackerel (*S. colias*). Cont'd.

ECOCADIZ 2016-07. *Scomber colias*. BIOMASS (t)																			
Size class	POL01	POL02	POL03	POL04	POL05	POL06	POL07	POL08	POL09	POL10	POL11	POL12	POL13	POL14	POL15	POL16	PORTUGAL	SPAIN	TOTAL
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10,5	0	0	0	0	0	0	0	0	0	0	0,286	0	0	0,078	0	0	0	0,364	0,364
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11,5	0	0	0	0	0	0	0	0,282	0	2,162	4,236	0,260	0	1,156	0	0	0	8,096	8,096
12	0	0	0	0	0	0,145	0	0,858	0	6,589	8,834	0,598	0,179	2,412	0	1,826	0,145	21,296	21,441
12,5	0	0	0	0	0,149	0,166	0	3,600	0	27,648	16,927	2,053	0,790	4,621	0	8,064	0,315	63,703	64,018
13	0	0	0	0,355	0,226	0,095	1,110	3,007	4,773	23,091	23,753	2,336	1,309	6,484	0	13,364	1,786	78,117	79,903
13,5	12,043	110,021	0,700	1,992	0,128	0,322	3,736	5,690	7,312	43,693	18,368	2,205	1,666	5,014	0	17,015	128,942	100,963	229,905
14	174,285	278,333	0	3,604	3,664	0,725	7,046	8,339	20,944	64,035	17,789	1,989	1,578	4,856	0	16,118	467,657	135,648	603,305
14,5	113,626	173,235	0	5,044	7,742	1,357	14,186	9,774	11,682	75,054	23,998	0,558	4,543	6,551	0	46,397	315,190	178,557	493,747
15	196,492	1363,861	0	6,209	1,085	0,455	22,935	11,123	46,616	85,419	18,690	0	9,619	5,102	0	98,230	1591,037	274,799	1865,836
15,5	112,924	1303,974	0	7,553	32,731	1,015	13,771	9,344	68,583	71,759	19,020	0,696	13,336	5,192	0	136,187	1471,968	324,117	1796,085
16	125,793	916,907	0	18,861	13,471	0,376	50,227	6,162	93,937	47,322	14,533	0	15,807	3,967	0	161,422	1125,635	343,150	1468,785
16,5	77,710	536,190	0	25,525	21,134	0,208	50,798	4,684	135,437	35,972	12,658	0	13,779	3,456	4,263	140,715	711,565	350,964	1062,529
17	74,528	0	0	20,503	4,185	0,459	32,073	6,095	156,819	46,802	20,849	0,944	8,256	5,692	28,236	84,313	131,748	358,006	489,754
17,5	64,768	63,247	0	11,284	4,155	0,758	46,987	2,655	143,567	20,391	6,256	1,039	10,668	1,708	62,159	108,939	191,199	357,382	548,581
18	31,158	69,430	0	2,078	0	0	38,753	0,918	101,532	7,048	7,404	0	9,765	2,021	199,071	99,726	141,419	427,485	568,904
18,5	4,961	0	0	0	0	0	7,023	2,122	48,128	16,292	4,890	0	4,410	1,335	211,755	45,032	11,984	333,964	345,948
19	42,689	0	0	2,677	0,198	0	34,685	2,421	48,903	18,590	5,342	0	4,641	1,458	122,491	47,395	80,249	251,241	331,490
19,5	0	0	0	2,709	0	0	8,362	1,329	45,535	10,208	5,822	0	0,894	1,589	155,744	9,134	11,071	230,255	241,326
20	94,387	206,730	0	0,283	0	0	18,316	1,127	4,822	8,655	3,301	0	1,958	0,901	48,375	19,993	319,716	89,132	408,848
20,5	16,732	0	13,943	0	0	0	5,004	0	24,392	0	0	0	0,734	0	17,501	7,497	35,679	50,124	85,803
21	68,553	0	22,655	0	2,754	0	16,112	0	13,897	0	4,898	0	1,083	1,337	18,958	11,064	110,074	51,237	161,311
21,5	87,186	0	24,495	1,008	0	0	34,842	0	0	0	2,754	0	2,176	0,752	20,497	22,217	147,531	48,396	195,927
22	185,750	0	26,438	1,088	22,819	0	31,455	0	17,602	0	0	0	4,937	0	11,061	50,418	267,550	84,018	351,568
22,5	192,387	43,657	18,991	1,172	69,952	0,581	54,151	1,364	0	10,474	3,356	0	7,136	0,916	0	72,873	380,891	96,119	477,010
23	138,747	62,617	20,429	3,243	78,974	0,625	152,756	1,473	7,668	11,311	0	0	9,072	0	0	92,641	457,391	122,165	579,556
23,5	365,938	16,814	0	5,709	84,823	0	85,972	3,955	0	30,371	10,815	0	4,272	2,952	0	43,629	559,256	95,994	655,250
24	458,145	324,574	72,947	2,802	140,098	0,720	100,647	8,297	30,484	63,718	2,079	2,963	3,456	0,568	0	35,298	1099,933	146,863	1246,796
24,5	255,296	270,352	50,401	3,001	135,248	0,771	53,767	0,909	9,460	6,976	0	0	3,099	0	0	31,648	768,836	52,092	820,928
25	423,954	392,391	164,401	4,279	146,100	0,825	38,424	1,943	0	14,922	0	0	1,657	0	0	16,923	1170,374	35,445	1205,819
25,5	245,554	419,095	146,803	4,570	187,459	0	20,376	4,151	0	31,875	0	3,625	0,688	0	0	7,029	1023,857	47,368	1071,225
26	495,291	752,925	297,839	1,896	267,732	0,940	0	3,321	0	25,501	0	3,866	0,734	0	0	7,498	1816,623	40,920	1857,543
26,5	156,753	501,356	235,535	2,020	335,155	2,003	0	1,179	0	9,056	0	8,239	2,365	0	20,531	24,156	1232,822	65,526	1298,348
27	199,492	720,251	570,915	2,763	192,927	0	0	0	0	0	0	17,534	0,476	0	0	4,858	1686,348	22,868	1709,216
27,5	59,206	340,263	303,427	1,469	126,128	0	0	0	0	0	0	13,979	0	0	0	0	830,493	13,979	844,472
28	62,865	391,396	282,887	0	130,622	0	0	5,356	0	41,128	0	14,842	0	0	0	0	867,770	61,326	929,096
28,5	0	0	83,348	0,919	160,204	0	0	0	0	0	0	15,743	0	0	0	2,039	244,471	17,982	262,453
29	0	33,838	66,236	0	59,440	0	0	0	0	0	0	22,242	0	0	0	0	159,514	22,242	181,756
29,5	18,698	35,819	46,743	0	20,974	0	0	0	0	0	0	0	0	0	0	0	122,234	0	122,234
30	0	0	24,717	0	22,181	0	0	0	0	0	0	0	0	0	0	0	46,898	0	46,898
30,5	0	0	0	0	0	0	0	0	0	0	0	19,731	0	0	0	0	0	19,731	19,731
31	0	0	0	0	0	0	0	0	0	0	0	6,943	0	0	0	0	0	6,943	6,943
31,5	0	0	0	0	0	1,780	0	0	0	0	0	7,323	0	0	0	0	1,780	7,323	9,103
32	0	0	0	0	0	0	0	0	0	0	0	23,153	0	0	0	0	0	23,153	23,153
32,5	0	0	0	0	0	0	0	0	0	0	0	16,253	0	0	0	0	0	16,253	16,253
33	0	0	0	0	0	0	0	0	0	0	0	8,551	0	0	0	0	0	8,551	8,551
33,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	30,004	0	0	0	0	0	0	0	0	0	0	9,445	0	0	0	0	30,004	9,445	39,449
34,5	0	0	0	0	0	0	0	0	0	0	0	9,916	0	0	0	0	0	9,916	9,916
35	0	0	0	0	0	0	0	0	0	0	0	20,807	0,791	0	0	8,084	0	29,682	29,682
35,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	22,856	0	0	0	0	0	22,856	22,856
36,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	4585,915	9327,276	2473,850	144,616	2272,458	14,326	943,514	111,478	1042,093	856,062	256,858	260,689	146,074	70,118	920,642	1491,742	19761,955	5155,756	24917,711

Table 11. *ECOCADIZ 2016-07* survey. Blue jack mackerel (*T. 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 23**.

***ECOCADIZ 2016-07*. *Trachurus picturatus*. ABUNDANCE (in numbers and million fish)**									
Size class	**POL01**	**POL02**	**POL03**	***n***			**millions**		
				PORTUGAL	**SPAIN**	**TOTAL**	**PORTUGAL**	**SPAIN**	**TOTAL**
10	0	0	0	0	0	0	**0**	**0**	**0**
10,5	0	0	0	0	0	0	**0**	**0**	**0**
11	0	0	0	0	0	0	**0**	**0**	**0**
11,5	0	0	0	0	0	0	**0**	**0**	**0**
12	0	0	0	0	0	0	**0**	**0**	**0**
12,5	35803	0	0	35803	0	35803	**0,04**	**0**	**0,04**
13	0	0	0	0	0	0	**0**	**0**	**0**
13,5	0	0	0	0	0	0	**0**	**0**	**0**
14	0	0	0	0	0	0	**0**	**0**	**0**
14,5	0	0	0	0	0	0	**0**	**0**	**0**
15	0	0	829	0	829	829	**0**	**0,001**	**0,001**
15,5	0	577173	829	577173	829	578002	**1**	**0,001**	**1**
16	35803	577173	0	612976	0	612976	**1**	**0**	**1**
16,5	35803	577173	0	612976	0	612976	**1**	**0**	**1**
17	0	4051528	0	4051528	0	4051528	**4**	**0**	**4**
17,5	0	4699437	0	4699437	0	4699437	**5**	**0**	**5**
18	20050	8276742	5801	8296792	5801	8302593	**8**	**0,01**	**8**
18,5	20050	12635400	6630	12655450	6630	12662080	**13**	**0,01**	**13**
19	20050	15778572	8288	15798622	8288	15806910	**16**	**0,01**	**16**
19,5	39213	15958550	19891	15997763	19891	16017654	**16**	**0,02**	**16**
20	127509	14865344	25692	14992853	25692	15018545	**15**	**0,03**	**15**
20,5	177190	12675490	20720	12852680	20720	12873400	**13**	**0,02**	**13**
21	400077	8257413	17404	8657490	17404	8674894	**9**	**0,02**	**9**
21,5	679456	4255708	3315	4935164	3315	4938479	**5**	**0,003**	**5**
22	807947	4196289	5801	5004236	5801	5010037	**5**	**0,01**	**5**
22,5	772750	680123	4973	1452873	4973	1457846	**1**	**0,005**	**1**
23	791528	2258869	14089	3050397	14089	3064486	**3**	**0,01**	**3**
23,5	387188	647909	9117	1035097	9117	1044214	**1**	**0,01**	**1**
24	600020	0	6630	600020	6630	606650	**1**	**0,01**	**1**
24,5	182426	680123	829	862549	829	863378	**1**	**0,001**	**1**
25	442777	353664	0	796441	0	796441	**1**	**0,0**	**1**
25,5	199066	0	0	199066	0	199066	**0,2**	**0,0**	**0,2**
26	84311	0	829	84311	829	85140	**0,1**	**0,001**	**0,1**
26,5	71606	0	0	71606	0	71606	**0,1**	**0**	**0,1**
27	35803	0	0	35803	0	35803	**0,04**	**0**	**0,04**
27,5	0	0	0	0	0	0	**0**	**0**	**0**
28	48508	353664	0	402172	0	402172	**0,4**	**0**	**0,4**
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	0	0	0	**0**	**0**	**0**
30	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL *n*	6014934	112356344	151667	118371278	151667	118522945	**118**	**0,2**	**119**
Millions	**6**	**112**	**0,2**						

Table 11. *ECOCADIZ 2016-07* survey. Blue jack mackerel (*T. picturatus*). Cont'd.

***ECOCADIZ 2016-07* . *Trachurus picturatus* . BIOMASS (t)**						
Size class	**POL01**	**POL02**	**POL03**	**PORTUGAL**	**SPAIN**	**TOTAL**
10	0	0	0	**0**	**0**	**0**
10,5	0	0	0	**0**	**0**	**0**
11	0	0	0	**0**	**0**	**0**
11,5	0	0	0	**0**	**0**	**0**
12	0	0	0	**0**	**0**	**0**
12,5	0,680	0	0	**0,680**	**0**	**0,680**
13	0	0	0	**0**	**0**	**0**
13,5	0	0	0	**0**	**0**	**0**
14	0	0	0	**0**	**0**	**0**
14,5	0	0	0	**0**	**0**	**0**
15	0	0	0,026	**0**	**0,026**	**0,026**
15,5	0	19,641	0,028	**19,641**	**0,028**	**19,669**
16	1,328	21,409	0	**22,737**	**0**	**22,737**
16,5	1,444	23,276	0	**24,720**	**0**	**24,720**
17	0	177,199	0	**177,199**	**0**	**177,199**
17,5	0	222,394	0	**222,394**	**0**	**222,394**
18	1,024	422,882	0,296	**423,906**	**0,296**	**424,202**
18,5	1,104	695,555	0,365	**696,659**	**0,365**	**697,024**
19	1,187	933,986	0,491	**935,173**	**0,491**	**935,664**
19,5	2,491	1013,884	1,264	**1016,375**	**1,264**	**1017,639**
20	8,679	1011,867	1,749	**1020,546**	**1,749**	**1022,295**
20,5	12,901	922,862	1,509	**935,763**	**1,509**	**937,272**
21	31,106	642,012	1,353	**673,118**	**1,353**	**674,471**
21,5	56,328	352,805	0,275	**409,133**	**0,275**	**409,408**
22	71,314	370,390	0,512	**441,704**	**0,512**	**442,216**
22,5	72,520	63,827	0,467	**136,347**	**0,467**	**136,814**
23	78,874	225,090	1,404	**303,964**	**1,404**	**305,368**
23,5	40,915	68,465	0,963	**109,380**	**0,963**	**110,343**
24	67,156	0	0,742	**67,156**	**0,742**	**67,898**
24,5	21,600	80,530	0,098	**102,130**	**0,098**	**102,228**
25	55,401	44,251	0	**99,652**	**0**	**99,652**
25,5	26,292	0	0	**26,292**	**0**	**26,292**
26	11,742	0	0,115	**11,742**	**0,115**	**11,857**
26,5	10,506	0	0	**10,506**	**0**	**10,506**
27	5,528	0	0	**5,528**	**0**	**5,528**
27,5	0	0	0	**0**	**0**	**0**
28	8,273	60,316	0	**68,589**	**0**	**68,589**
28,5	0	0	0	**0**	**0**	**0**
29	0	0	0	**0**	**0**	**0**
29,5	0	0	0	**0**	**0**	**0**
30	0	0	0	**0**	**0**	**0**
TOTAL	**588,393**	**7372,641**	**11,657**	**7961,034**	**11,657**	**7972,691**

Table 12. *ECOCADIZ 2016-07* survey. Horse mackerel (*T. 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 26**.

ECOCADIZ 2016-07.Trachurus trachurus. ABUNDANCE (in numbers and million fish)													
Size class	POL01	POL02	POL03	POL04	POL05	POL06	POL07	*n*			millions		
								PORTUGAL	SPAIN	TOTAL	PORTUGAL	SPAIN	TOTAL
10	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
10,5	0	8801	7042	0	0	85	1705	15928	1705	17633	**0,02**	**0,002**	**0,02**
11	0	136412	109146	0	0	1321	26426	246879	26426	273305	**0,2**	**0,03**	**0,3**
11,5	0	371818	297498	0	0	3111	62229	672427	62229	734656	**1**	**0,1**	**1**
12	0	389387	311555	0	0	2301	46033	703243	46033	749276	**1**	**0,05**	**1**
12,5	0	591709	473437	0	0	1321	26426	1066467	26426	1092893	**1**	**0,03**	**1**
13	0	479547	383694	0	0	1704	34098	864945	34098	899043	**1**	**0,03**	**1**
13,5	0	388648	310964	0	0	2131	42623	701743	42623	744366	**1**	**0,04**	**1**
14	0	118811	95063	0	0	1151	23016	215025	23016	238041	**0,2**	**0,02**	**0,2**
14,5	0	91670	73346	0	0	724	14492	165740	14492	180232	**0,2**	**0,01**	**0,2**
15	0	57205	45771	0	0	554	11082	103530	11082	114612	**0,1**	**0,01**	**0,1**
15,5	0	26402	21125	0	0	256	5115	47783	5115	52898	**0**	**0,01**	**0,1**
16	0	13201	10563	0	0	128	2557	23892	2557	26449	**0,02**	**0,003**	**0,03**
16,5	0	13201	10563	0	0	128	2557	23892	2557	26449	**0,02**	**0,003**	**0,03**
17	0	4400	3521	0	0	43	852	7964	852	8816	**0,01**	**0,001**	**0,01**
17,5	0	46927	37547	0	0	128	2557	84602	2557	87159	**0,1**	**0,003**	**0,1**
18	0	38865	31096	0	0	213	4262	70174	4262	74436	**0,1**	**0,004**	**0,1**
18,5	6525	115856	92698	0	0	469	9377	215548	9377	224925	**0,2**	**0,01**	**0,2**
19	32627	64528	51630	0	0	298	5967	149083	5967	155050	**0,1**	**0,01**	**0,2**
19,5	19576	129796	103852	0	0	767	15344	253991	15344	269335	**0,3**	**0,02**	**0,3**
20	172923	100470	80388	53498	0	810	16197	408089	16197	424286	**0,4**	**0,02**	**0,4**
20,5	153347	105610	84500	160493	15955	1023	20459	520928	20459	541387	**1**	**0,02**	**0,5**
21	261016	88008	70417	320985	0	852	17049	741278	17049	758327	**1**	**0,02**	**1**
21,5	94618	74068	59263	213990	0	554	11082	442493	11082	453575	**0,4**	**0,01**	**0,5**
22	127245	82869	66305	1016454	0	639	12787	1293512	12787	1306299	**1**	**0,01**	**1**
22,5	88093	161305	129063	909459	78003	256	5115	1366179	5115	1371294	**1**	**0,01**	**1**
23	75042	237557	190074	1765420	31024	341	6820	2299458	6820	2306278	**2**	**0,01**	**2**
23,5	19576	262482	210016	1872415	62048	256	5115	2426793	5115	2431908	**2**	**0,01**	**2**
24	19576	238296	190665	1551429	109027	511	10229	2109504	10229	2119733	**2**	**0,01**	**2**
24,5	0	131241	105008	909459	591069	128	2557	1736905	2557	1739462	**2**	**0,003**	**2**
25	0	8801	7042	320985	542383	85	1705	879296	1705	881001	**1**	**0,002**	**1**
25,5	0	33726	26984	213990	604378	0	0	879078	0	879078	**1**	**0**	**1**
26	0	0	0	53498	426238	0	0	479736	0	479736	**0,5**	**0**	**0,5**
26,5	0	8801	7042	0	256922	85	1705	272850	1705	274555	**0,3**	**0,002**	**0,3**
27	0	0	0	0	122336	0	0	122336	0	122336	**0,1**	**0**	**0,1**
27,5	0	0	0	0	80542	0	0	80542	0	80542	**0,1**	**0**	**0,1**
28	0	0	0	0	38975	0	0	38975	0	38975	**0,04**	**0**	**0,04**
28,5	0	0	0	0	25612	0	0	25612	0	25612	**0,03**	**0**	**0,03**
29	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
29,5	0	0	0	0	31024	0	0	31024	0	31024	**0,03**	**0**	**0,03**
30	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL *n*	1070164	4620418	3696878	9362075	3015536	22373	447538	21787444	447538	22234982	**22**	**0,4**	**22**
Millions	**1**	**5**	**4**	**9**	**3**	**0,02**	**0,4**						

Table 12. *ECOCADIZ 2016-07* survey. Horse mackerel (*T. trachurus*). Cont'd.

***ECOCADIZ 2016-07*. Trachurus trachurus. BIOMASS (t)**										
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**PORTUGAL**	**SPAIN**	**TOTAL**
10	0	0	0	0	0	0	0	**0**	**0**	**0**
10,5	0	0,088	0,070	0	0	0,001	0,017	**0,159**	**0,017**	**0,176**
11	0	1,564	1,252	0	0	0,015	0,303	**2,831**	**0,303**	**3,134**
11,5	0	4,871	3,897	0	0	0,041	0,815	**8,809**	**0,815**	**9,624**
12	0	5,794	4,636	0	0	0,034	0,685	**10,464**	**0,685**	**11,149**
12,5	0	9,950	7,961	0	0	0,022	0,444	**17,933**	**0,444**	**18,377**
13	0	9,071	7,258	0	0	0,032	0,645	**16,361**	**0,645**	**17,006**
13,5	0	8,233	6,588	0	0	0,045	0,903	**14,866**	**0,903**	**15,769**
14	0	2,807	2,246	0	0	0,027	0,544	**5,080**	**0,544**	**5,624**
14,5	0	2,407	1,926	0	0	0,019	0,381	**4,352**	**0,381**	**4,733**
15	0	1,663	1,331	0	0	0,016	0,322	**3,010**	**0,322**	**3,332**
15,5	0	0,847	0,678	0	0	0,008	0,164	**1,533**	**0,164**	**1,697**
16	0	0,466	0,373	0	0	0,005	0,090	**0,844**	**0,090**	**0,934**
16,5	0	0,511	0,409	0	0	0,005	0,099	**0,925**	**0,099**	**1,024**
17	0	0,186	0,149	0	0	0,002	0,036	**0,337**	**0,036**	**0,373**
17,5	0	2,171	1,737	0	0	0,006	0,118	**3,914**	**0,118**	**4,032**
18	0	1,957	1,566	0	0	0,011	0,215	**3,534**	**0,215**	**3,749**
18,5	0,357	6,337	5,070	0	0	0,026	0,513	**11,790**	**0,513**	**12,303**
19	1,934	3,825	3,061	0	0	0,018	0,354	**8,838**	**0,354**	**9,192**
19,5	1,255	8,322	6,658	0	0	0,049	0,984	**16,284**	**0,984**	**17,268**
20	11,968	6,953	5,563	3,702	0	0,056	1,121	**28,242**	**1,121**	**29,363**
20,5	11,435	7,875	6,301	11,968	1,190	0,076	1,526	**38,845**	**1,526**	**40,371**
21	20,933	7,058	5,647	25,743	0	0,068	1,367	**59,449**	**1,367**	**60,816**
21,5	8,148	6,378	5,103	18,427	0	0,048	0,954	**38,104**	**0,954**	**39,058**
22	11,746	7,650	6,121	93,828	0	0,059	1,180	**119,404**	**1,180**	**120,584**
22,5	8,704	15,937	12,752	89,855	7,707	0,025	0,505	**134,980**	**0,505**	**135,485**
23	7,924	25,084	20,070	186,416	3,276	0,036	0,720	**242,806**	**0,720**	**243,526**
23,5	2,206	29,580	23,667	211,007	6,992	0,029	0,576	**273,481**	**0,576**	**274,057**
24	2,351	28,621	22,900	186,336	13,095	0,061	1,229	**253,364**	**1,229**	**254,593**
24,5	0	16,778	13,424	116,266	75,563	0,016	0,327	**222,047**	**0,327**	**222,374**
25	0	1,196	0,957	43,623	73,712	0,012	0,232	**119,500**	**0,232**	**119,732**
25,5	0	4,867	3,894	30,879	87,214	0	0	**126,854**	**0**	**126,854**
26	0	0	0,000	8,188	65,233	0	0	**73,421**	**0**	**73,421**
26,5	0	1,427	1,142	0	41,656	0,014	0,276	**44,239**	**0,276**	**44,515**
27	0	0	0	0	20,991	0	0	**20,991**	**0**	**20,991**
27,5	0	0	0	0	14,610	0	0	**14,610**	**0**	**14,610**
28	0	0	0	0	7,467	0	0	**7,467**	**0**	**7,467**
28,5	0	0	0	0	5,177	0	0	**5,177**	**0**	**5,177**
29	0	0	0	0	0	0	0	**0**	**0**	**0**
29,5	0	0	0	0	6,962	0	0	**6,962**	**0**	**6,962**
30	0	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL	**88,961**	**230,474**	**184,407**	**1026,238**	**430,845**	**0,882**	**17,645**	**1961,807**	**17,645**	**1979,452**

Table 13. *ECOCADIZ 2016-07* survey. Mediterranean horse mackerel (*T. 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 29**.

***ECOCADIZ 2016-07*.*Trachurus mediterraneus*. ABUNDANCE (in numbers and million fish)**									
Size class	**POL01**	**POL02**	**POL03**	***n***			**millions**		
				PORTUGAL	**SPAIN**	**TOTAL**	**PORTUGAL**	**SPAIN**	**TOTAL**
20	0	0	0	0	0	0	**0**	**0**	**0**
20,5	0	0	0	0	0	0	**0**	**0**	**0**
21	50786	0	767	0	51553	51553	**0**	**0,1**	**0,1**
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	50786	0	767	0	51553	51553	**0**	**0,1**	**0,1**
26,5	50786	0	767	0	51553	51553	**0**	**0,1**	**0,1**
27	50786	0	767	0	51553	51553	**0**	**0,1**	**0,1**
27,5	828885	0	12519	0	841404	841404	**0**	**1**	**1**
28	1482538	0	22392	0	1504930	1504930	**0**	**2**	**2**
28,5	3156670	0	47677	0	3204347	3204347	**0**	**3**	**3**
29	5833110	0	88101	0	5921211	5921211	**0**	**6**	**6**
29,5	2928558	0	44232	0	2972790	2972790	**0**	**3**	**3**
30	2563221	0	38714	0	2601935	2601935	**0**	**3**	**3**
30,5	1794956	0	27110	0	1822066	1822066	**0**	**2**	**2**
31	1283953	0	19392	0	1303345	1303345	**0**	**1**	**1**
31,5	1017424	0	15367	0	1032791	1032791	**0**	**1**	**1**
32	740534	0	11185	0	751719	751719	**0**	**1**	**1**
32,5	502350	0	7587	0	509937	509937	**0**	**1**	**1**
33	281009	0	4244	0	285253	285253	**0**	**0,3**	**0,3**
33,5	328858	0	4967	0	333825	333825	**0**	**0,3**	**0,3**
34	0	0	0	0	0	0	**0**	**0**	**0**
34,5	200696	0	3031	0	203727	203727	**0**	**0,2**	**0,2**
35	50786	0	767	0	51553	51553	**0**	**0,1**	**0,1**
35,5	237002	0	3580	0	240582	240582	**0**	**0,2**	**0,2**
36	0	11555	0	0	11555	11555	**0**	**0,01**	**0,01**
36,5	0	23111	0	0	23111	23111	**0**	**0,02**	**0,02**
37	0	11555	0	0	11555	11555	**0**	**0,01**	**0,01**
37,5	118501	11555	1790	0	131846	131846	**0**	**0,1**	**0,1**
38	0	57777	0	0	57777	57777	**0**	**0,1**	**0,1**
38,5	148028	11555	2236	0	161819	161819	**0**	**0,2**	**0,2**
39	0	23111	0	0	23111	23111	**0**	**0,02**	**0,02**
39,5	0	11555	0	0	11555	11555	**0**	**0,01**	**0,01**
40	118501	34666	1790	0	154957	154957	**0**	**0,2**	**0,2**
40,5	0	11555	0	0	11555	11555	**0**	**0,01**	**0,01**
41	50786	0	767	0	51553	51553	**0**	**0,1**	**0,1**
41,5	0	23111	0	0	23111	23111	**0**	**0,02**	**0,02**
42	0	0	0	0	0	0	**0**	**0**	**0**
42,5	0	11555	0	0	11555	11555	**0**	**0,01**	**0,01**
43	0	0	0	0	0	0	**0**	**0**	**0**
43,5	0	0	0	0	0	0	**0**	**0**	**0**
44	0	0	0	0	0	0	**0**	**0**	**0**
44,5	0	11555	0	0	11555	11555	**0**	**0,01**	**0,01**
45	0	0	0	0	0	0	**0**	**0**	**0**
45,5	0	11555	0	0	11555	11555	**0**	**0,01**	**0,01**
46	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL *n*	23869510	265771	360516	0	24495797	24495797	**0**	**24**	**24**
Millions	**24**	**0,3**	**0,4**						

Table 13. *ECOCADIZ 2016-07* survey. Mediterranean horse mackerel (*T. mediterraneus*). Cont'd.

***ECOCADIZ 2016-07*. *Trachurus mediterraneus*. BIOMASS (t)**						
Size class	**POL01**	**POL02**	**POL03**	**PORTUGAL**	**SPAIN**	**TOTAL**
20	0	0	0	**0**	**0**	**0**
20,5	0	0	0	**0**	**0**	**0**
21	4,007	0	0,061	**0**	**4,068**	**4,068**
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	7,265	0	0,110	**0**	**7,375**	**7,375**
26,5	7,662	0	0,116	**0**	**7,778**	**7,778**
27	8,072	0	0,122	**0**	**8,194**	**8,194**
27,5	138,667	0	2,094	**0**	**140,761**	**140,761**
28	260,810	0	3,939	**0**	**264,749**	**264,749**
28,5	583,451	0	8,812	**0**	**592,263**	**592,263**
29	1131,781	0	17,094	**0**	**1148,875**	**1148,875**
29,5	595,999	0	9,002	**0**	**605,001**	**605,001**
30	546,716	0	8,257	**0**	**554,973**	**554,973**
30,5	400,940	0	6,056	**0**	**406,996**	**406,996**
31	300,125	0	4,533	**0**	**304,658**	**304,658**
31,5	248,695	0	3,756	**0**	**252,451**	**252,451**
32	189,156	0	2,857	**0**	**192,013**	**192,013**
32,5	133,998	0	2,024	**0**	**136,022**	**136,022**
33	78,225	0	1,181	**0**	**79,406**	**79,406**
33,5	95,474	0	1,442	**0**	**96,916**	**96,916**
34	0	0	0	**0**	**0**	**0**
34,5	63,260	0	0,955	**0**	**64,215**	**64,215**
35	16,665	0	0,252	**0**	**16,917**	**16,917**
35,5	80,917	0	1,222	**0**	**82,139**	**82,139**
36	0	4,102	0	**0**	**4,102**	**4,102**
36,5	0	8,528	0	**0**	**8,528**	**8,528**
37	0	4,429	0	**0**	**4,429**	**4,429**
37,5	47,161	4,599	0,712	**0**	**52,472**	**52,472**
38	0	23,862	0	**0**	**23,862**	**23,862**
38,5	63,413	4,950	0,958	**0**	**69,321**	**69,321**
39	0	10,264	0	**0**	**10,264**	**10,264**
39,5	0	5,318	0	**0**	**5,318**	**5,318**
40	56,495	16,527	0,853	**0**	**73,875**	**73,875**
40,5	0	5,704	0	**0**	**5,704**	**5,704**
41	25,944	0	0,392	**0**	**26,336**	**26,336**
41,5	0	12,214	0	**0**	**12,214**	**12,214**
42	0	0	0	**0**	**0**	**0**
42,5	0	6,528	0	**0**	**6,528**	**6,528**
43	0	0	0	**0**	**0**	**0**
43,5	0	0	0	**0**	**0**	**0**
44	0	0	0	**0**	**0**	**0**
44,5	0	7,425	0	**0**	**7,425**	**7,425**
45	0	0	0	**0**	**0**	**0**
45,5	0	7,901	0	**0**	**7,901**	**7,901**
46	0	0	0	**0**	**0**	**0**
TOTAL	**5084,898**	**122,351**	**76,800**	**0**	**5284,049**	**5284,049**

Table 14. *ECOCADIZ 2016-07* survey. Bogue (*B. boops*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 32**.

***ECOCADIZ 2016-07*.Boops boops. ABUNDANCE (in numbers and million fish)**													
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	***n***			**millions**		
								PORTUGAL	**SPAIN**	**TOTAL**	**PORTUGAL**	**SPAIN**	**TOTAL**
16	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
16,5	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
17	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
17,5	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
18	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
18,5	14957	0	0	0	0	0	0	14957	0	14957	**0,01**	**0**	**0,01**
19	37394	0	0	0	0	0	0	37394	0	37394	**0,04**	**0**	**0,04**
19,5	59830	22189	0	0	0	0	0	82019	0	82019	**0,1**	**0**	**0,1**
20	157053	0	0	0	0	0	0	157053	0	157053	**0,2**	**0**	**0,2**
20,5	201925	22189	0	0	0	0	50582	224114	50582	274696	**0,2**	**0,05**	**0,3**
21	329063	44377	498	0	13032	3421	0	386970	3421	390391	**0,4**	**0,003**	**0,4**
21,5	149574	155321	498	0	13032	3421	0	318425	3421	321846	**0,3**	**0,003**	**0,3**
22	149574	199698	2489	0	65158	17104	0	416919	17104	434023	**0,4**	**0,02**	**0,4**
22,5	37394	199698	4979	12454	130317	34209	0	384842	34209	419051	**0,4**	**0,03**	**0,4**
23	14957	133132	7966	55928	208507	54734	151746	420490	206480	626970	**0,4**	**0,2**	**1**
23,5	0	177510	7468	68382	195475	51313	202328	448835	253641	702476	**0,4**	**0,3**	**1**
24	0	44377	11451	77665	299729	78680	101164	433222	179844	613066	**0,4**	**0,2**	**1**
24,5	14957	88755	3485	124310	91222	23946	354074	322729	378020	700749	**0,3**	**0,4**	**1**
25	0	0	6970	145821	182444	47892	354074	335235	401966	737201	**0,3**	**0,4**	**1**
25,5	0	0	4481	136537	117285	30788	404656	258303	435444	693747	**0,3**	**0,4**	**1**
26	0	0	4481	136537	117285	30788	252910	258303	283698	542001	**0,3**	**0,3**	**1**
26,5	14957	0	3485	71325	91222	23946	101164	180989	125110	306099	**0,2**	**0,1**	**0,3**
27	0	0	2987	92836	78190	20525	151746	174013	172271	346284	**0,2**	**0,2**	**0,3**
27,5	0	0	1494	77665	39095	10263	0	118254	10263	128517	**0,1**	**0,01**	**0,1**
28	0	0	498	0	13032	3421	101164	13530	104585	118115	**0,01**	**0,1**	**0,1**
28,5	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
29	0	0	498	21737	13032	3421	0	35267	3421	38688	**0,04**	**0,003**	**0,04**
29,5	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
30	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL *n*	1181635	1087246	63728	1021197	1668057	437872	2225608	5021863	2663480	7685343	**5**	**3**	**8**
Millions	**1**	**1**	**0,1**	**1**	**2**	**0,4**	**2**						

***ECOCADIZ 2016-07*. Boops boops. BIOMASS (t)**										
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**PORTUGAL**	**SPAIN**	**TOTAL**
16	0	0	0	0	0	0	0	**0**	**0**	**0**
16,5	0	0	0	0	0	0	0	**0**	**0**	**0**
17	0	0	0	0	0	0	0	**0**	**0**	**0**
17,5	0	0	0	0	0	0	0	**0**	**0**	**0**
18	0	0	0	0	0	0	0	**0**	**0**	**0**
18,5	0,893	0	0	0	0	0	0	**0,893**	**0**	**0,893**
19	2,416	0	0	0	0	0	0	**2,416**	**0**	**2,416**
19,5	4,177	1,549	0	0	0	0	0	**5,726**	**0**	**5,726**
20	11,825	0	0	0	0	0	0	**11,825**	**0**	**11,825**
20,5	16,366	1,798	0	0	0	0	4,100	**18,164**	**4,100**	**22,264**
21	28,658	3,865	0,043	0	1,135	0,298	0	**33,701**	**0,298**	**33,999**
21,5	13,974	14,511	0,047	0	1,218	0,320	0	**29,750**	**0,320**	**30,070**
22	14,967	19,982	0,249	0	6,520	1,711	0	**41,718**	**1,711**	**43,429**
22,5	4,001	21,369	0,533	1,333	13,945	3,661	0	**41,181**	**3,661**	**44,842**
23	1,709	15,212	0,910	6,391	23,825	6,254	17,339	**48,047**	**23,593**	**71,640**
23,5	0	21,629	0,910	8,332	23,818	6,252	24,653	**54,689**	**30,905**	**85,594**
24	0	5,758	1,486	10,078	38,893	10,209	13,127	**56,215**	**23,336**	**79,551**
24,5	2,064	12,249	0,481	17,156	12,589	3,305	48,865	**44,539**	**52,170**	**96,709**
25	0	0	1,022	21,377	26,746	7,021	51,906	**49,145**	**58,927**	**108,072**
25,5	0	0	0,697	21,237	18,242	4,789	62,940	**40,176**	**67,729**	**107,905**
26	0	0	0,739	22,507	19,333	5,075	41,689	**42,579**	**46,764**	**89,343**
26,5	2,610	0	0,608	12,446	15,918	4,179	17,653	**31,582**	**21,832**	**53,414**
27	0	0	0,551	17,132	14,429	3,788	28,003	**32,112**	**31,791**	**63,903**
27,5	0	0	0,291	15,141	7,622	2,001	0	**23,054**	**2,001**	**25,055**
28	0	0	0,102	0	2,681	0,704	20,815	**2,783**	**21,519**	**24,302**
28,5	0	0	0	0	0	0	0	**0**	**0**	**0**
29	0	0	0,114	4,968	2,978	0,782	0	**8,060**	**0,782**	**8,842**
29,5	0	0	0	0	0	0	0	**0**	**0**	**0**
30	0	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL	**103,660**	**117,922**	**8,783**	**158,098**	**229,892**	**60,349**	**331,090**	**618,355**	**391,439**	**1009,794**

Table 15. *ECOCADIZ 2016-07* survey. Blue whiting (*M. poutassou*). 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 34**.

ECOCADIZ 2016-07. *Micromesistius poutassou*. ABUNDANCE (in numbers and million fish)							
Size class	POL01	*n*			millions		
		PORTUGAL	SPAIN	TOTAL	PORTUGAL	SPAIN	TOTAL
18	0	0	0	0	0	0	0
18,5	0	0	0	0	0	0	0
19	5270	5270	0	5270	0,01	0	0,01
19,5	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
20,5	5270	5270	0	5270	0,01	0	0,01
21	0	0	0	0	0	0	0
21,5	0	0	0	0	0	0	0
22	5270	5270	0	5270	0,01	0	0,01
22,5	0	0	0	0	0	0	0
23	10540	10540	0	10540	0,01	0	0,01
23,5	5270	5270	0	5270	0,01	0	0,01
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
TOTAL *n*	31620	31620	0	31620	0,03	0	0,03
Millions	0,03						

ECOCADIZ 2016-07. *Micromesistius poutassou*. BIOMASS (t)				
Size class	POL01	PORTUGAL	SPAIN	TOTAL
18	0	0	0	0
18,5	0	0	0	0
19	0,222	0,222	0	0,222
19,5	0	0	0	0
20	0	0	0	0
20,5	0,286	0,286	0	0,286
21	0	0	0	0
21,5	0	0	0	0
22	0,361	0,361	0	0,361
22,5	0	0	0	0
23	0,838	0,838	0	0,838
23,5	0,450	0,450	0	0,450
24	0	0	0	0
24,5	0	0	0	0
25	0	0	0	0
TOTAL	2,157	2,157	0	2,157

Table 16. *ECOCADIZ 2016-07* survey. Boarfish (*C. 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 38**.

***ECOCADIZ 2016-07*. *Capros aper*. ABUNDANCE (in numbers and million fish)**								
Size class	**POL01**	**POL02**	***n***			**millions**		
			PORTUGAL	**SPAIN**	**TOTAL**	**PORTUGAL**	**SPAIN**	**TOTAL**
3	0	0	0	0	0	**0**	**0**	**0**
3,5	0	0	0	0	0	**0**	**0**	**0**
4	0	0	0	0	0	**0**	**0**	**0**
4,5	0	0	0	0	0	**0**	**0**	**0**
5	0	0	0	0	0	**0**	**0**	**0**
5,5	0	19856	19856	0	19856	**0,02**	**0**	**0,02**
6	0	151123	151123	0	151123	**0,2**	**0**	**0,2**
6,5	0	58464	58464	0	58464	**0,1**	**0**	**0,1**
7	0	14340	14340	0	14340	**0,01**	**0**	**0,01**
7,5	0	0	0	0	0	**0**	**0**	**0**
8	0	0	0	0	0	**0**	**0**	**0**
8,5	119138	0	119138	0	119138	**0,1**	**0**	**0,1**
9	438645	0	438645	0	438645	**0,4**	**0**	**0,4**
9,5	471137	0	471137	0	471137	**0,5**	**0**	**0,5**
10	379076	0	379076	0	379076	**0,4**	**0**	**0,4**
10,5	936859	0	936859	0	936859	**1**	**0**	**1**
11	617352	0	617352	0	617352	**1**	**0**	**1**
11,5	173292	0	173292	0	173292	**0,2**	**0**	**0,2**
12	27077	0	27077	0	27077	**0,03**	**0**	**0,03**
12,5	0	0	0	0	0	**0**	**0**	**0**
13	0	0	0	0	0	**0**	**0**	**0**
TOTAL *n*	3162576	243783	3406359	0	3406359	**3**	**0**	**3**
Millions	**3**	**0,2**						

***ECOCADIZ 2016-07*. *Capros aper*. BIOMASS (t)**					
Size class	**POL01**	**POL02**	**PORTUGAL**	**SPAIN**	**TOTAL**
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	0,076	**0,076**	**0**	**0,076**
6	0	0,750	**0,750**	**0**	**0,750**
6,5	0	0,368	**0,368**	**0**	**0,368**
7	0	0,112	**0,112**	**0**	**0,112**
7,5	0	0	**0**	**0**	**0**
8	0	0	**0**	**0**	**0**
8,5	1,665	0	**1,665**	**0**	**1,665**
9	7,273	0	**7,273**	**0**	**7,273**
9,5	9,186	0	**9,186**	**0**	**9,186**
10	8,621	0	**8,621**	**0**	**8,621**
10,5	24,672	0	**24,672**	**0**	**24,672**
11	18,700	0	**18,700**	**0**	**18,700**
11,5	6,001	0	**6,001**	**0**	**6,001**
12	1,066	0	**1,066**	**0**	**1,066**
12,5	0	0	**0**	**0**	**0**
13	0	0	**0**	**0**	**0**
TOTAL	**77,184**	**1,306**	**78,490**	**0**	**78,490**

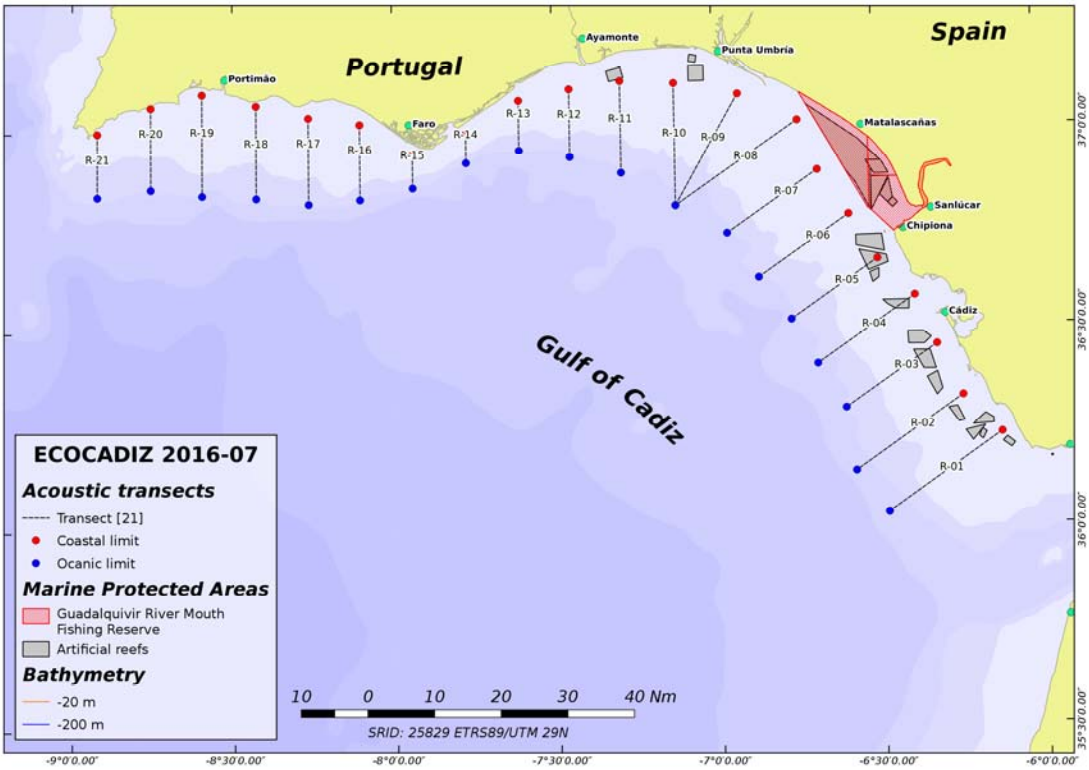


Figure 1. *ECOCADIZ 2016-07* survey. Location of the acoustic transects sampled during the survey. The different protected areas inside the Guadalquivir river mouth Fishing Reserve and artificial reef polygons are also shown.

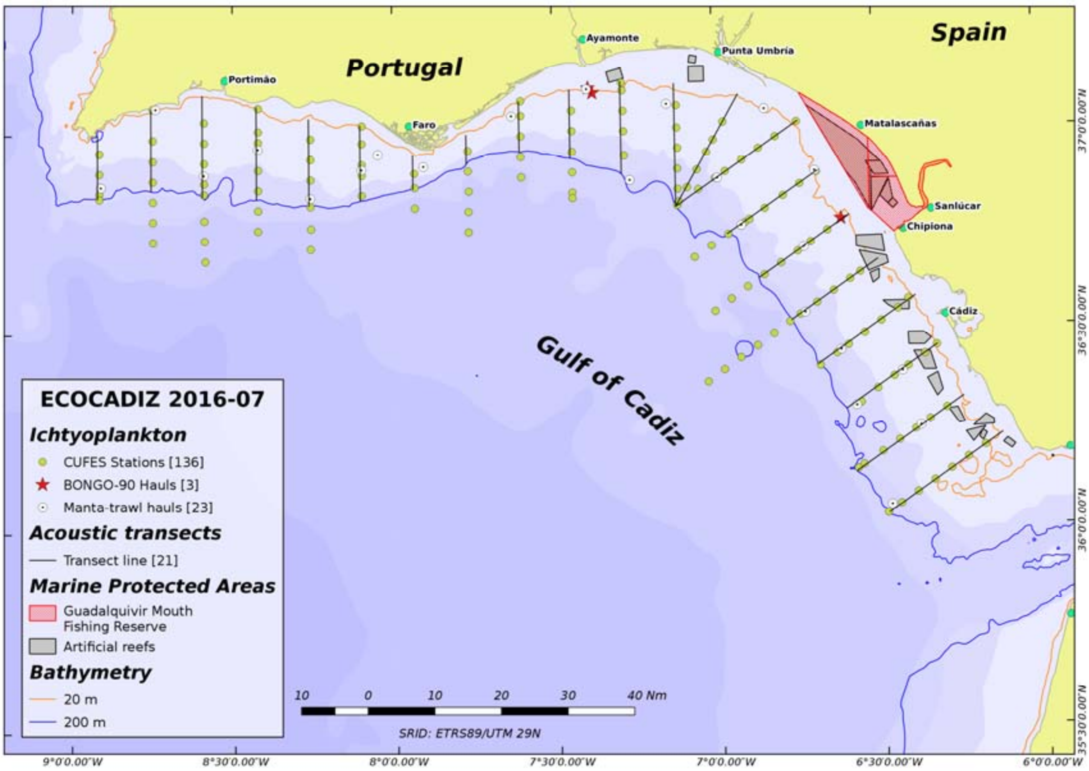


Figure 2. *ECOCADIZ 2016-07* survey. Location of CUFES, Bongo-90 and *Manta trawl* sampling stations.

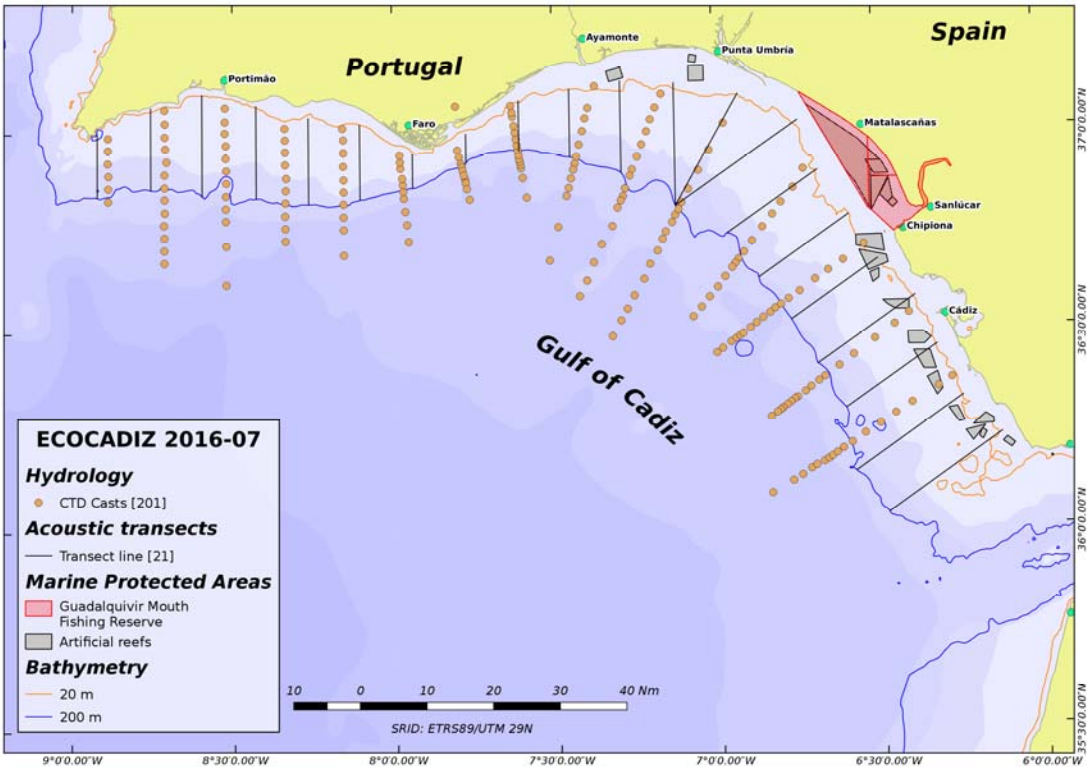


Figure 3. *ECOCADIZ 2016-07* survey. Location of CTD-LADCP stations.

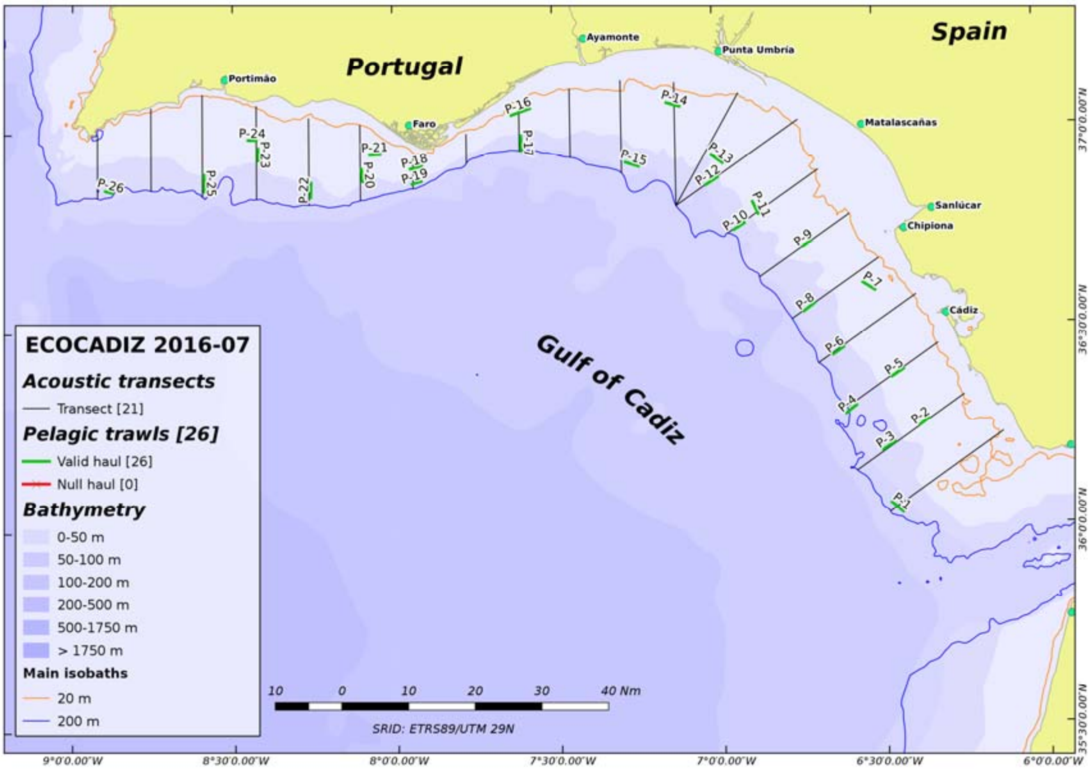


Figure 4. *ECOCADIZ 2016-07* survey. Location of ground-truthing fishing hauls.

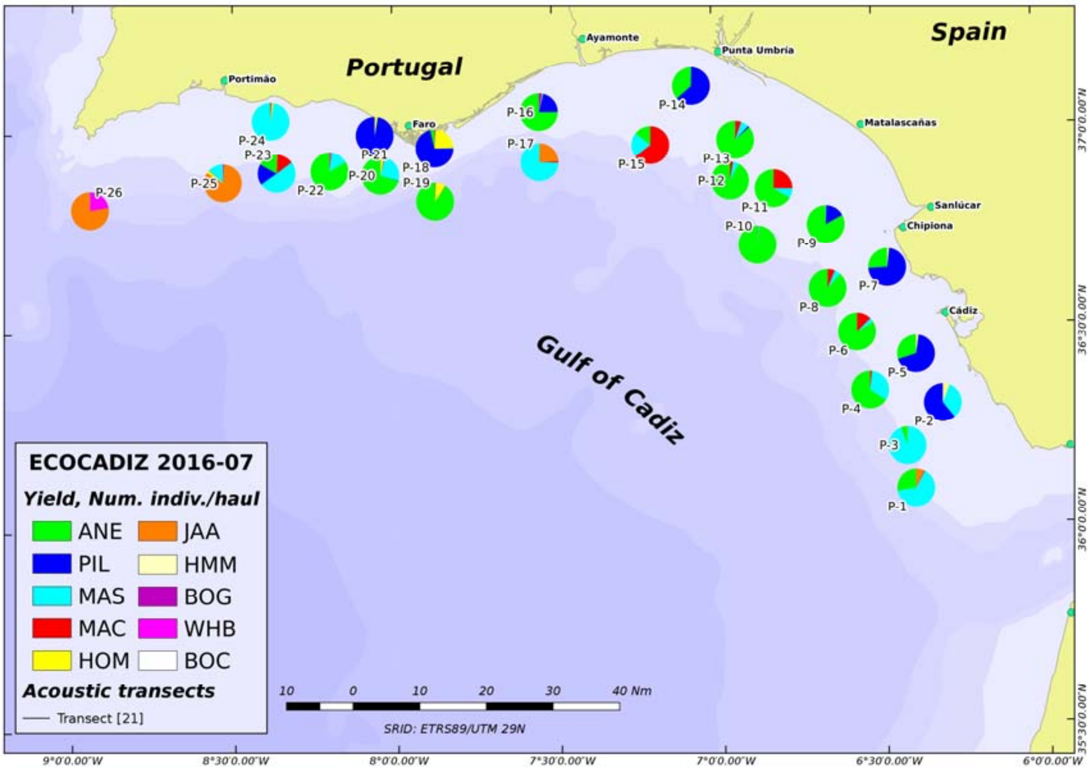


Figure 5. *ECOCADIZ 2016-07* survey. Species composition (percentages in number) in fishing hauls.

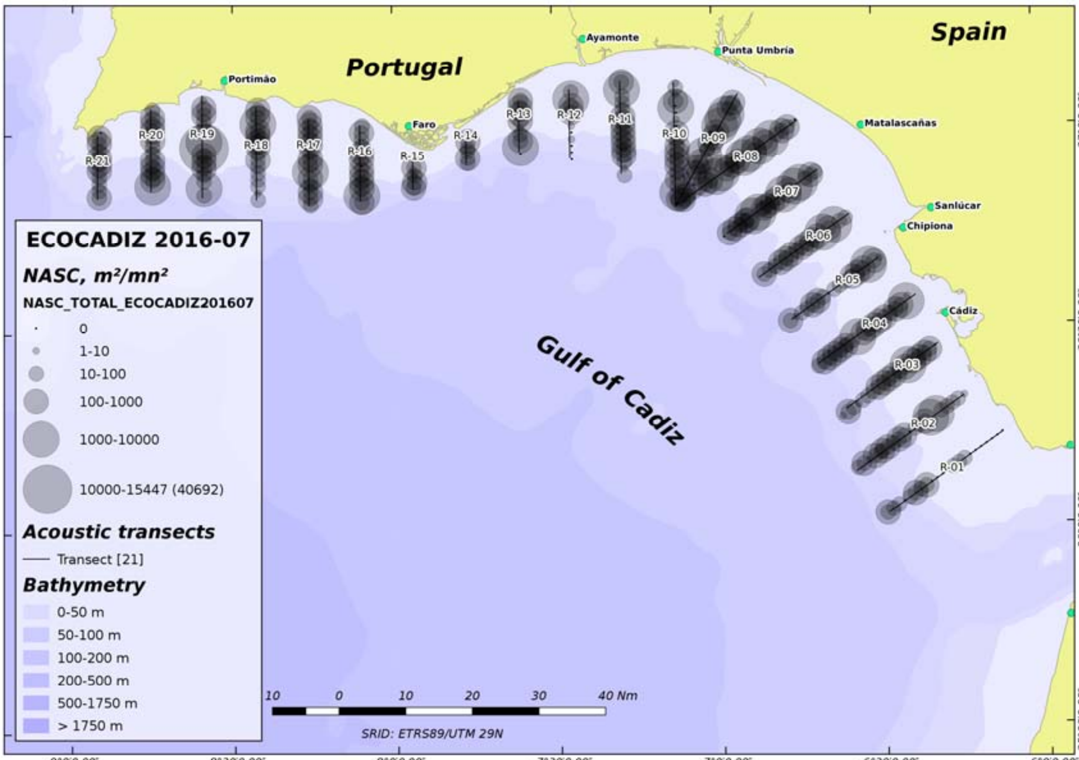
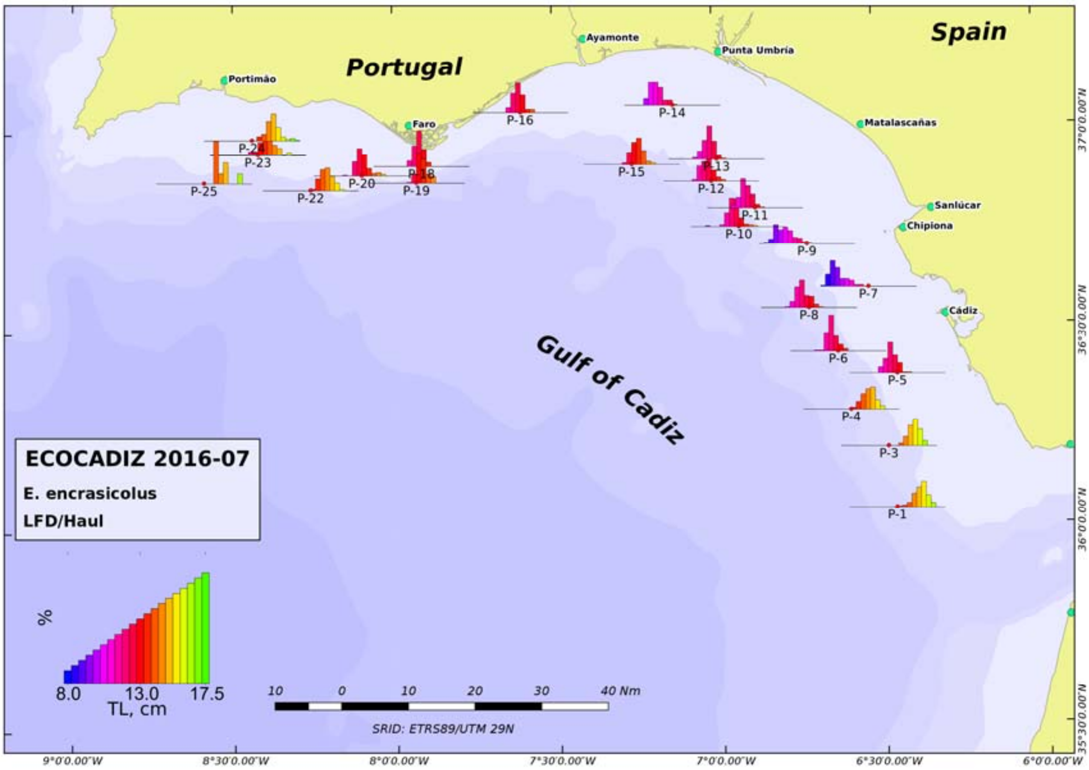


Figure 6. *ECOCADIZ 2016-07* survey. Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the pelagic fish species assemblage.



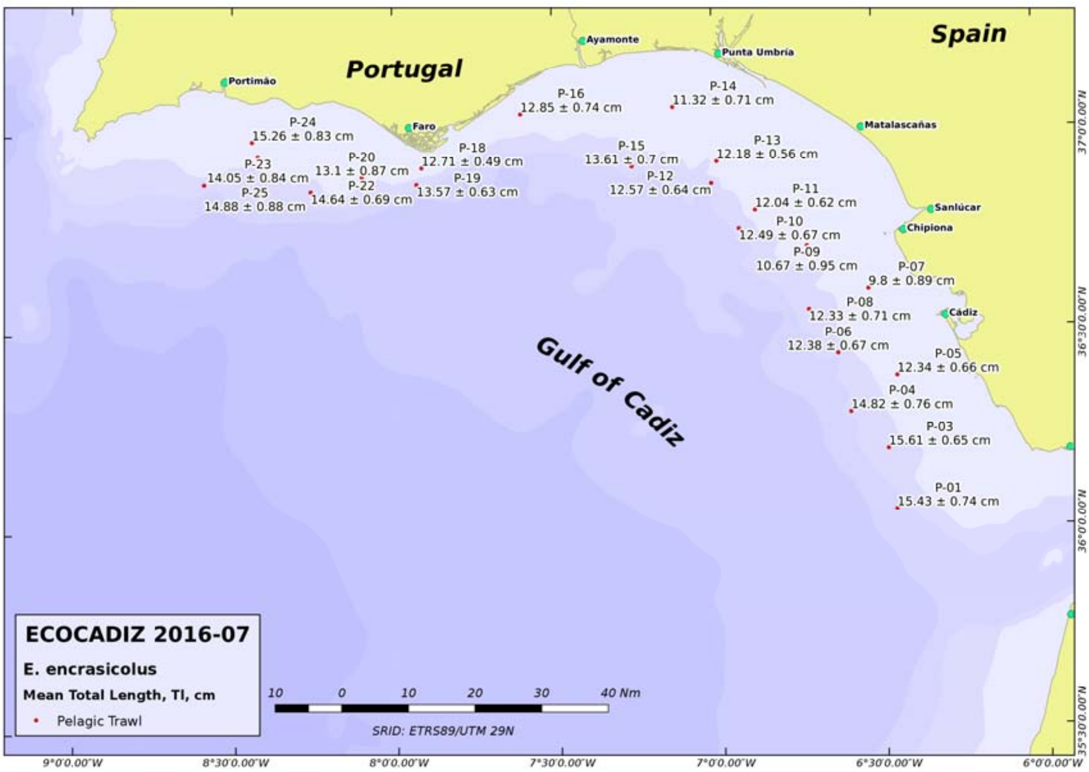


Figure 7. *ECOCADIZ 2016-07* survey. Anchovy (*Engraulis encrasicolus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

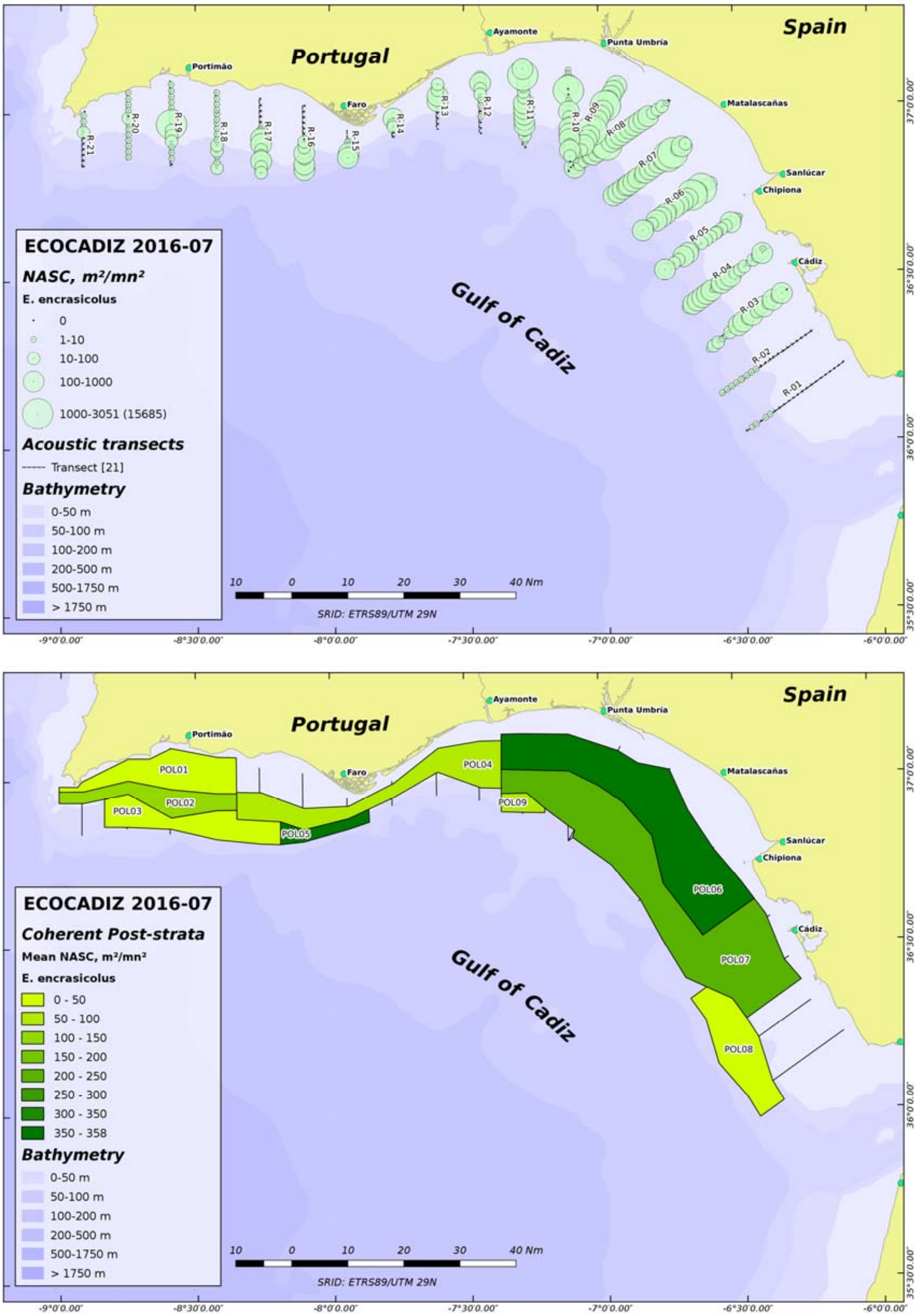


Figure 8. *ECOCADIZ 2016-07* survey. Anchovy (*Engraulis encrasicolus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

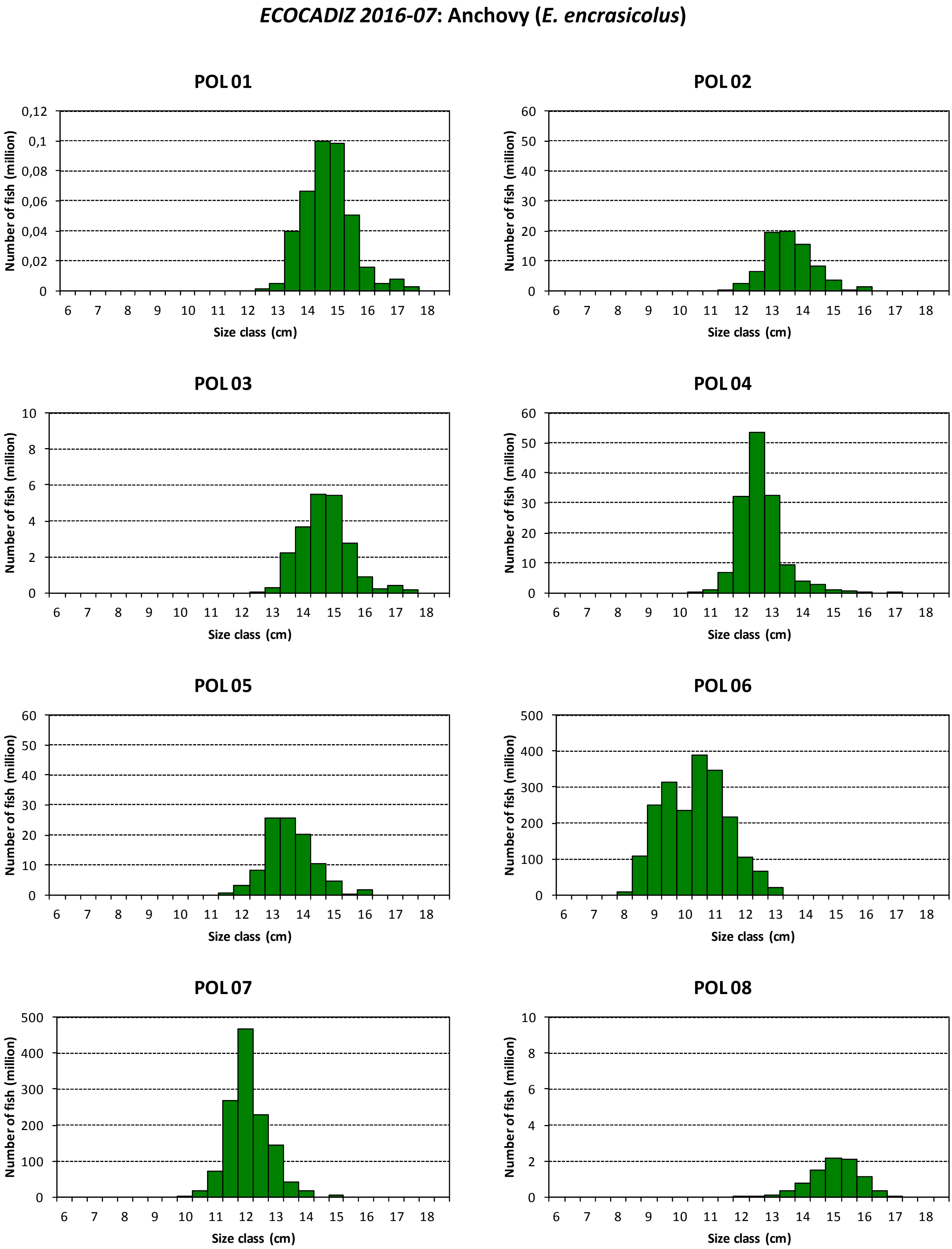


Figure 9. *ECOCADIZ 2016-07* survey. Anchovy (*E. encrasicolus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 8**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

***ECOCADIZ 2016-07*: Anchovy (*E. encrasicolus*)**

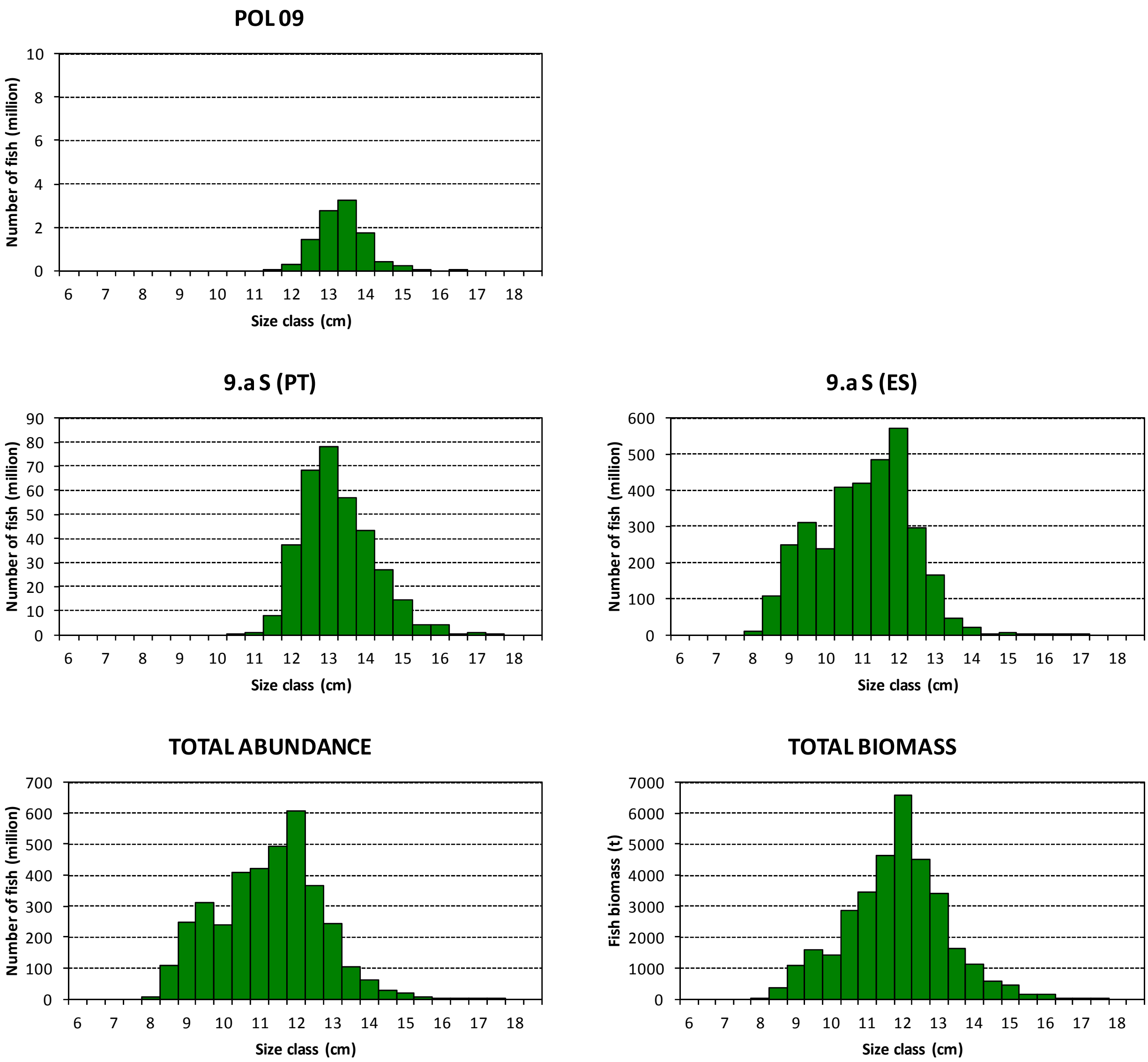


Figure 9. *ECOCADIZ 2016-07* survey. Anchovy (*E. encrasicolus*). Cont'd.

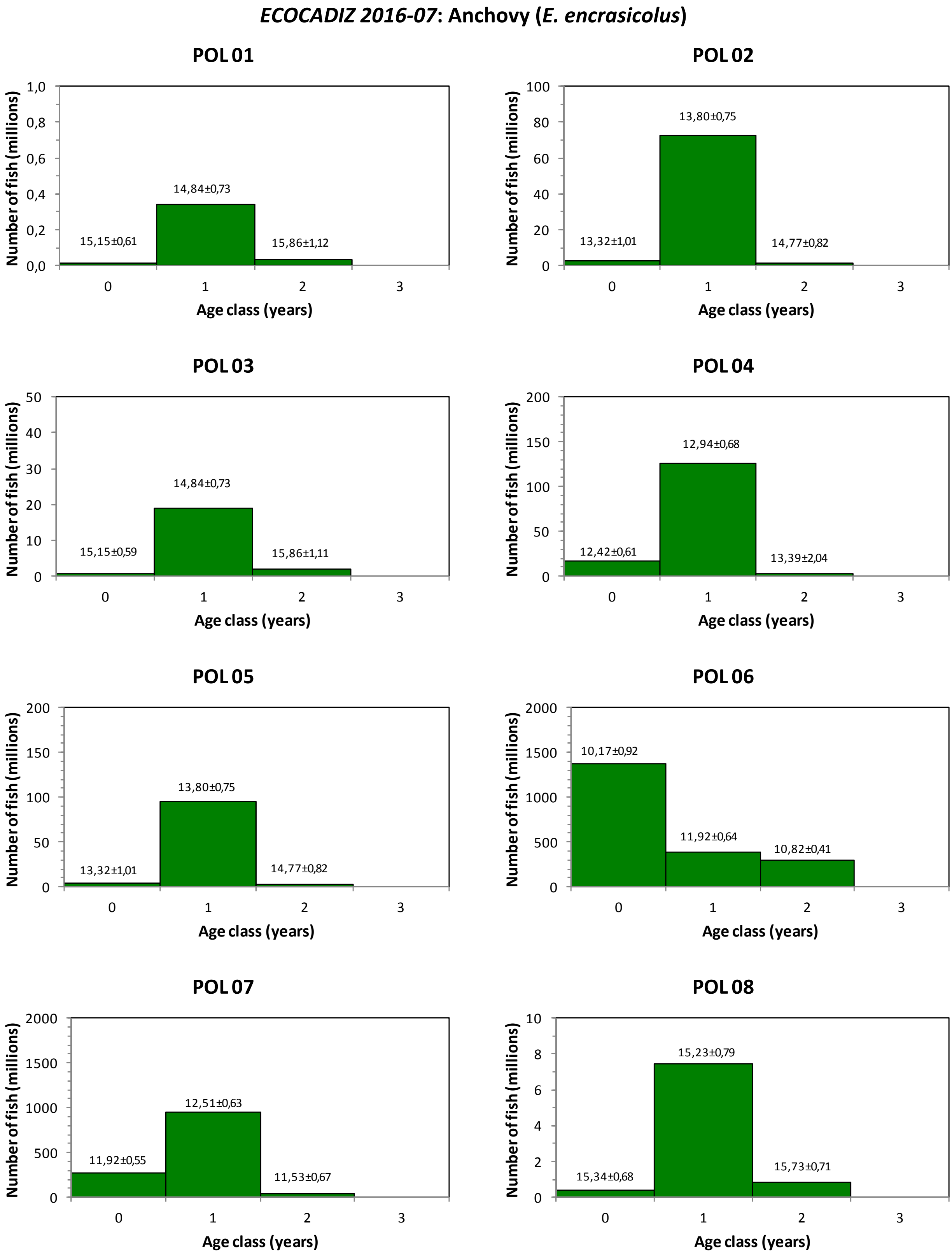


Figure 10. *ECOCADIZ 2016-07* survey. Anchovy (*E. encrasicolus*). Estimated abundances (number of fish in millions) by age class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 8**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

***ECOCADIZ 2016-07*: Anchovy (*E. encrasicolus*)**

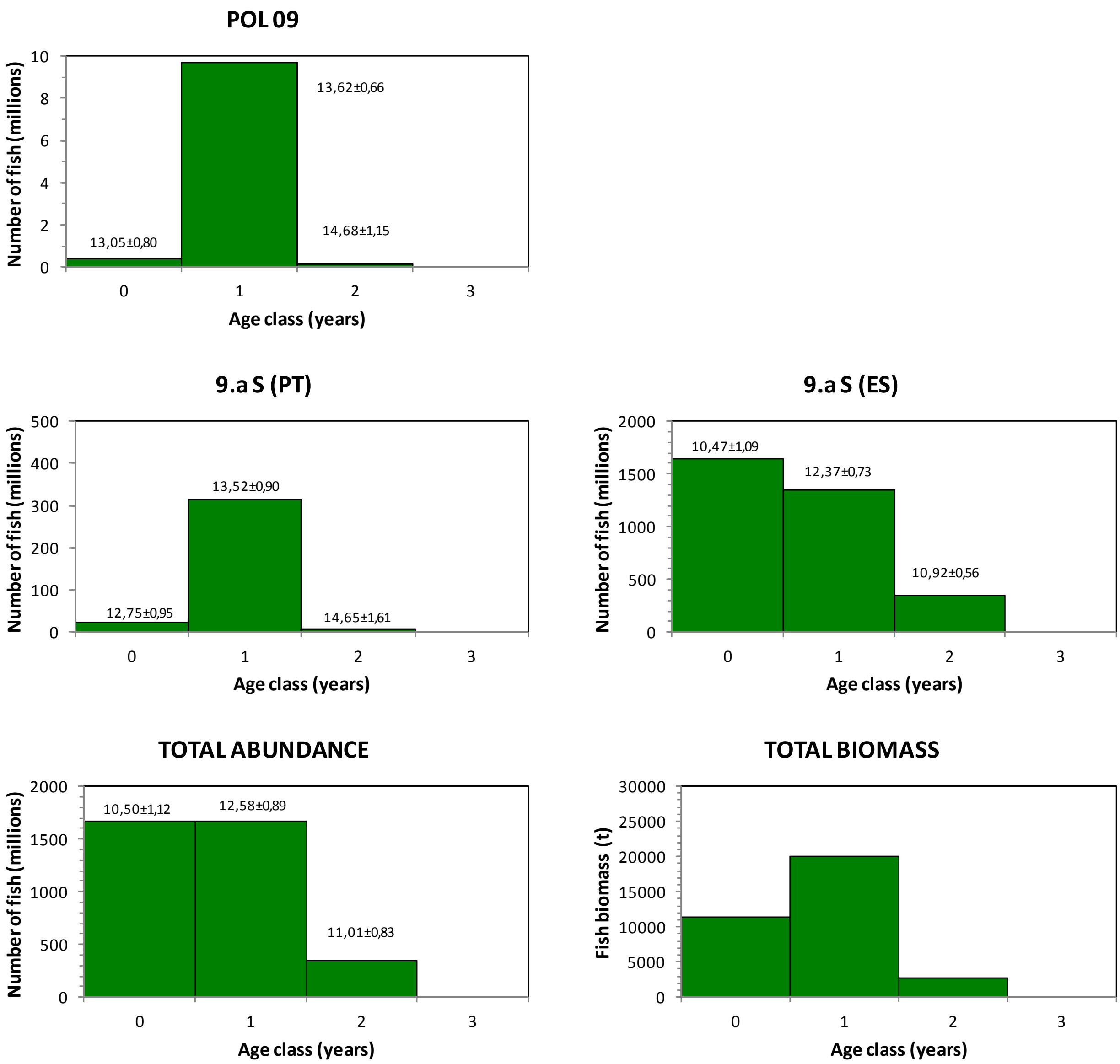


Figure 10. *ECOCADIZ 2016-07* survey. Anchovy (*E. encrasicolus*). Cont'd.

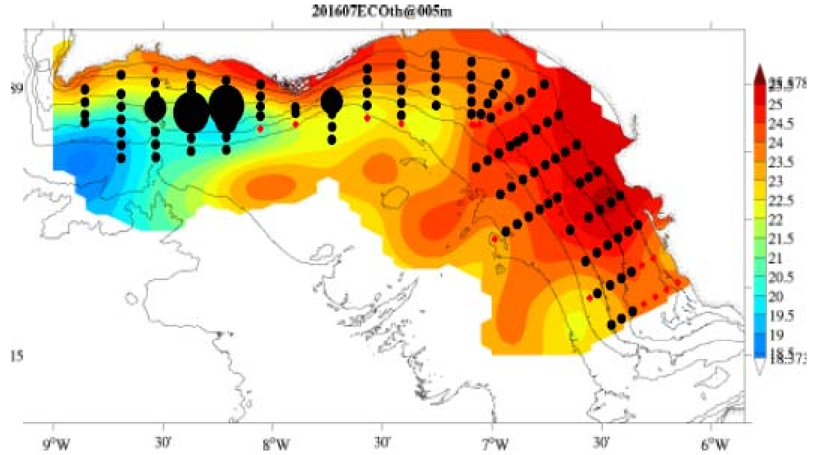


Figure 11. *ECOCADIZ 2016-07* survey. Anchovy (*E. encrasicolus*). Distribution of anchovy egg densities as sampled by CUFES (eggs m^{-3}).

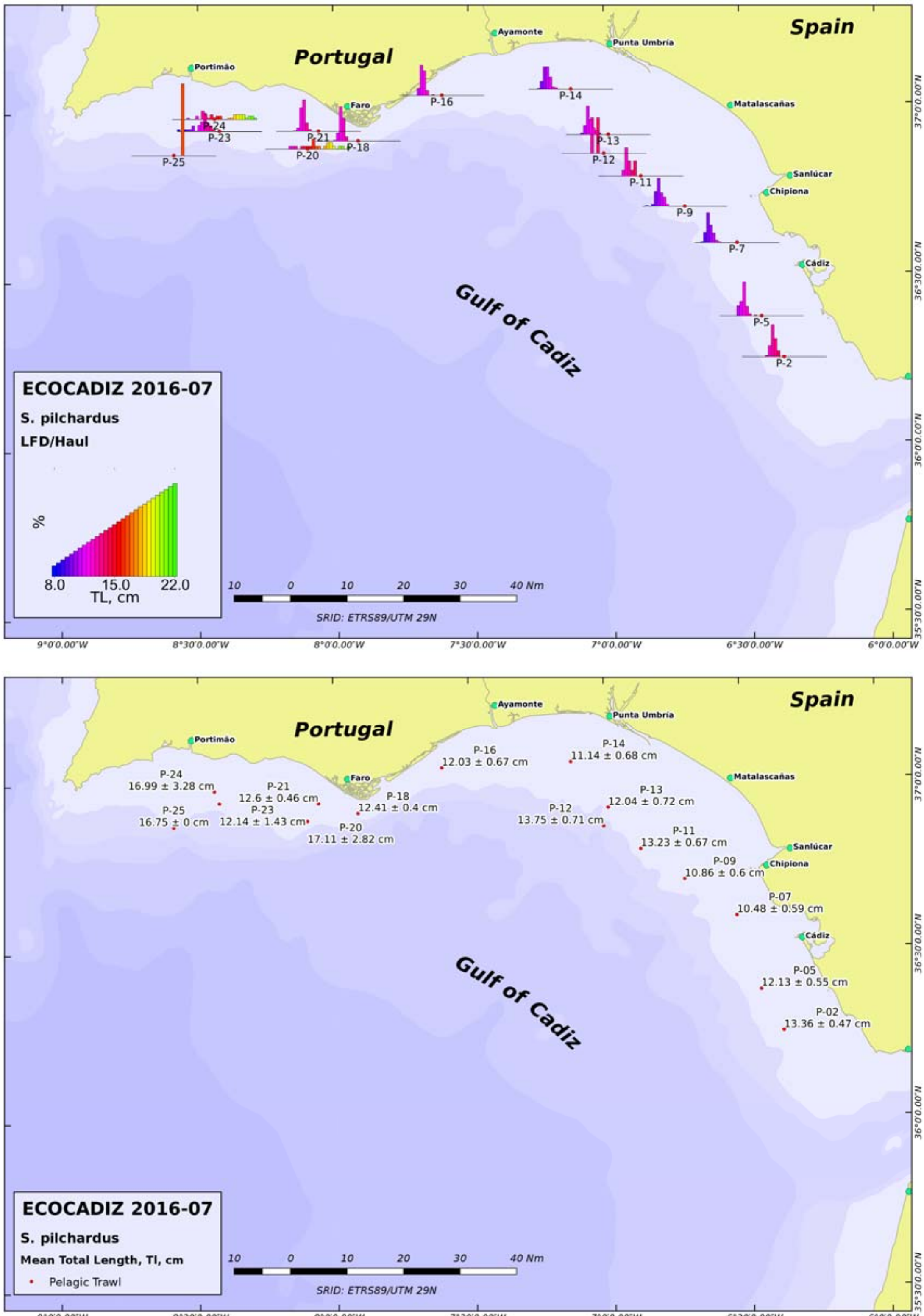
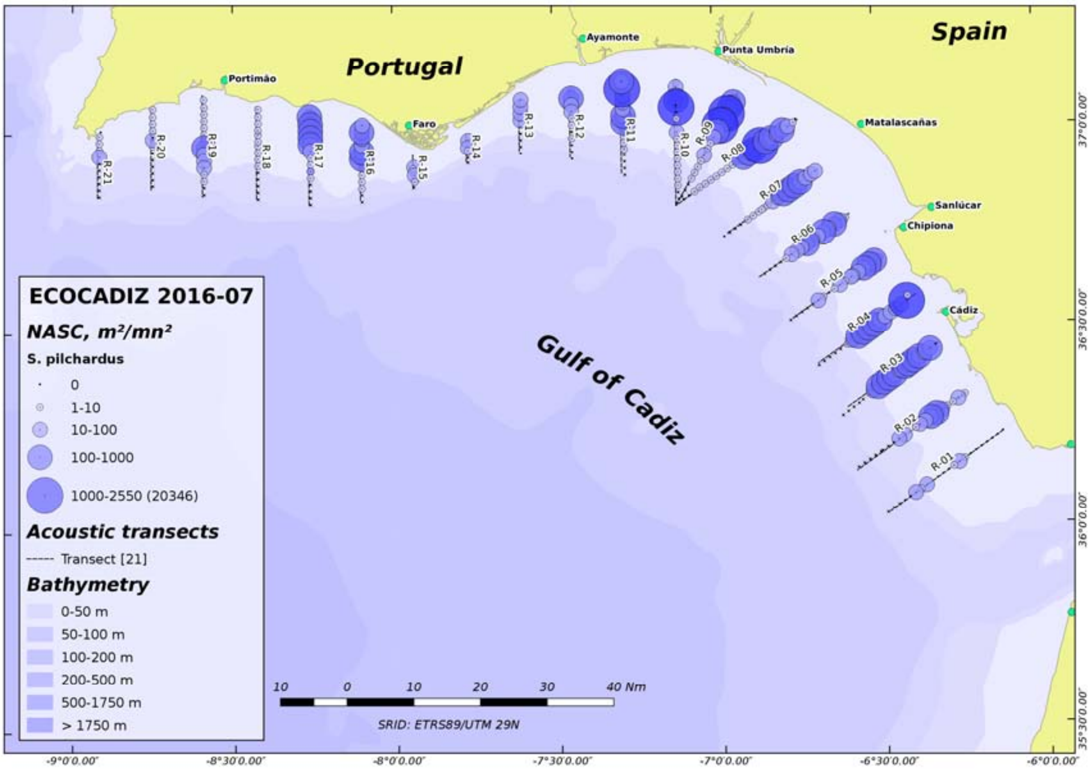


Figure 12. *ECOCADIZ 2016-07* survey. Sardine (*Sardina pilchardus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.



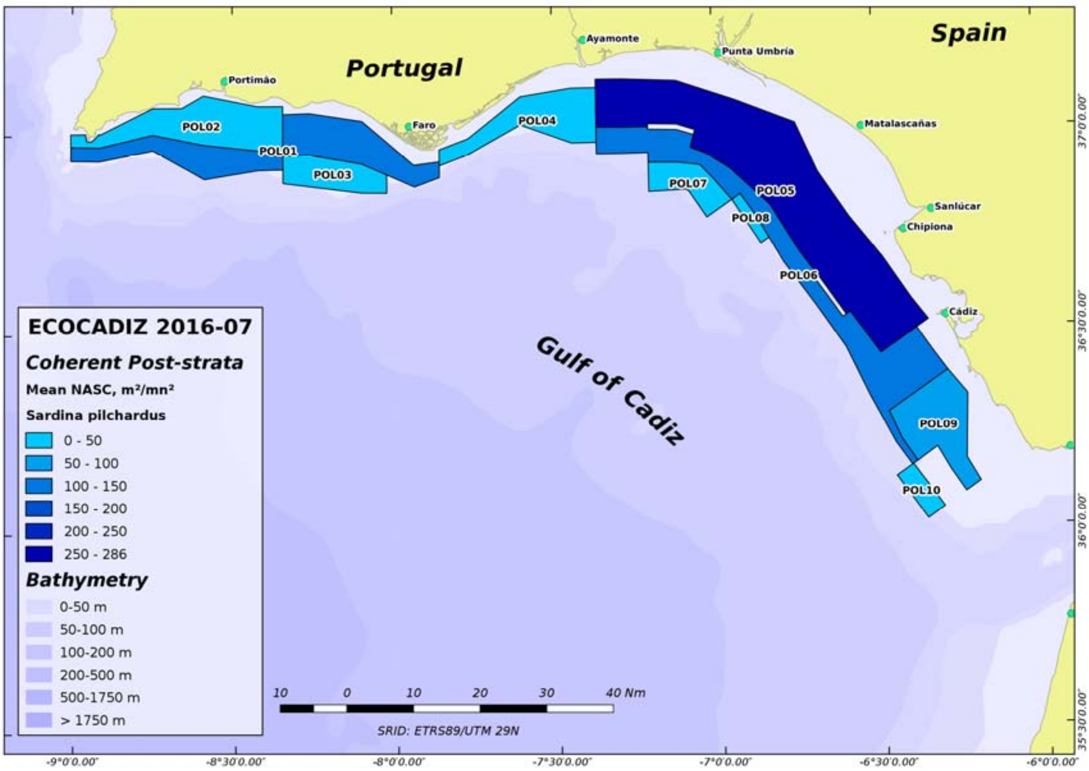


Figure 13. *ECOCADIZ 2016-07* survey. Sardine (*Sardina pilchardus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

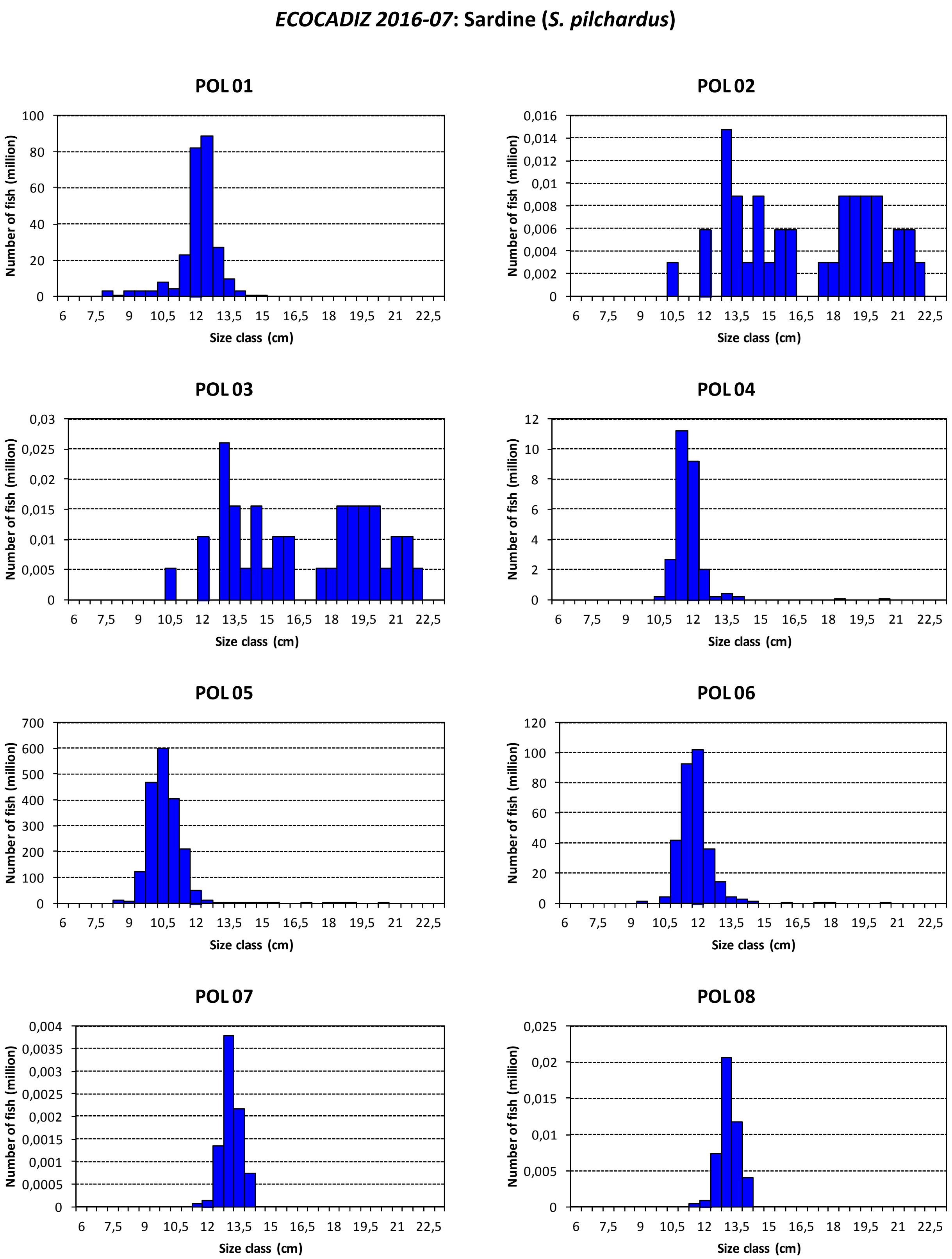


Figure 14. *ECOCADIZ 2016-07* survey. Sardine (*Sardina pilchardus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 13**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

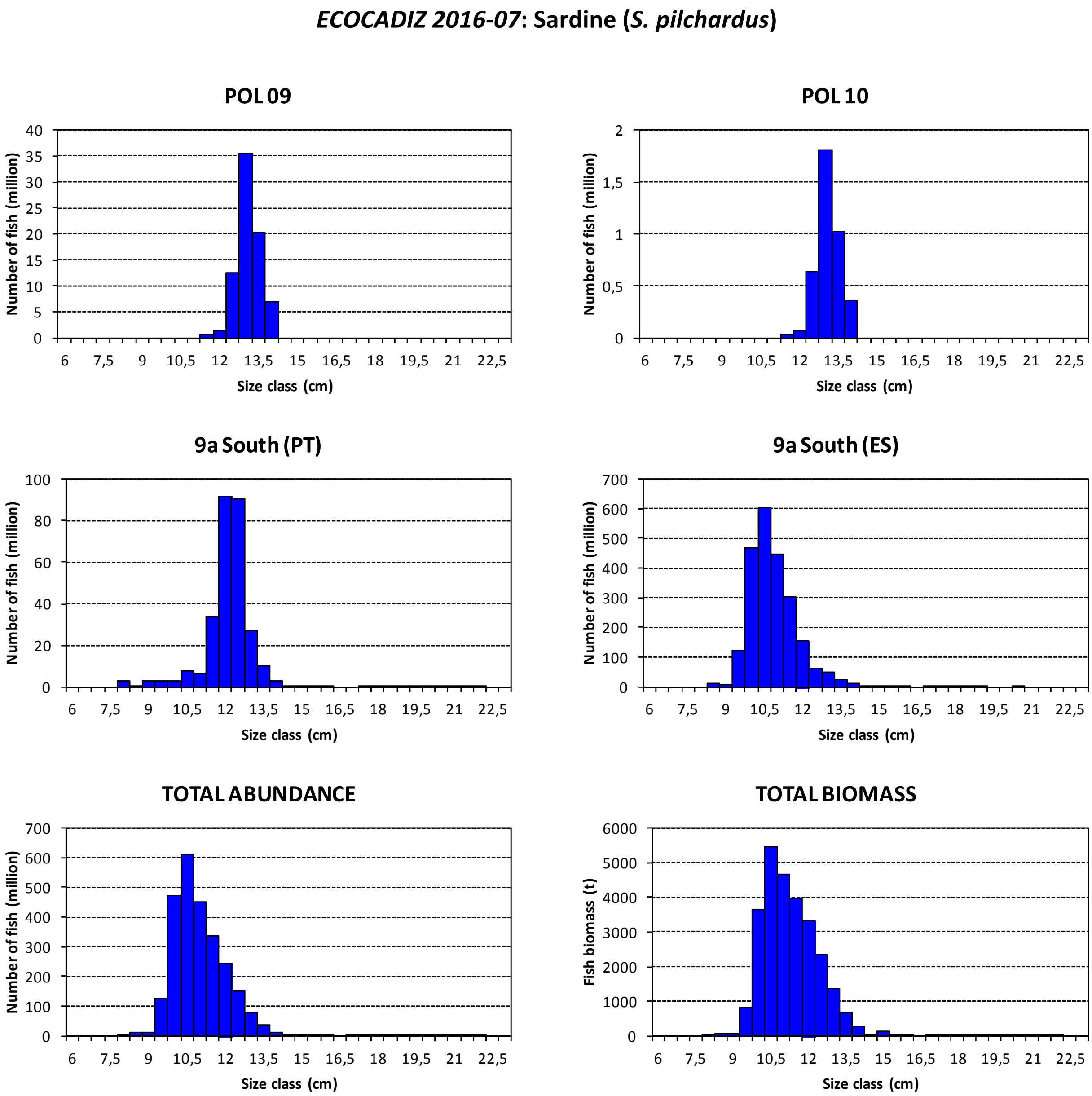


Figure 14. *ECOCADIZ 2016-07* survey. Sardine (*Sardina pilchardus*). Cont'd.

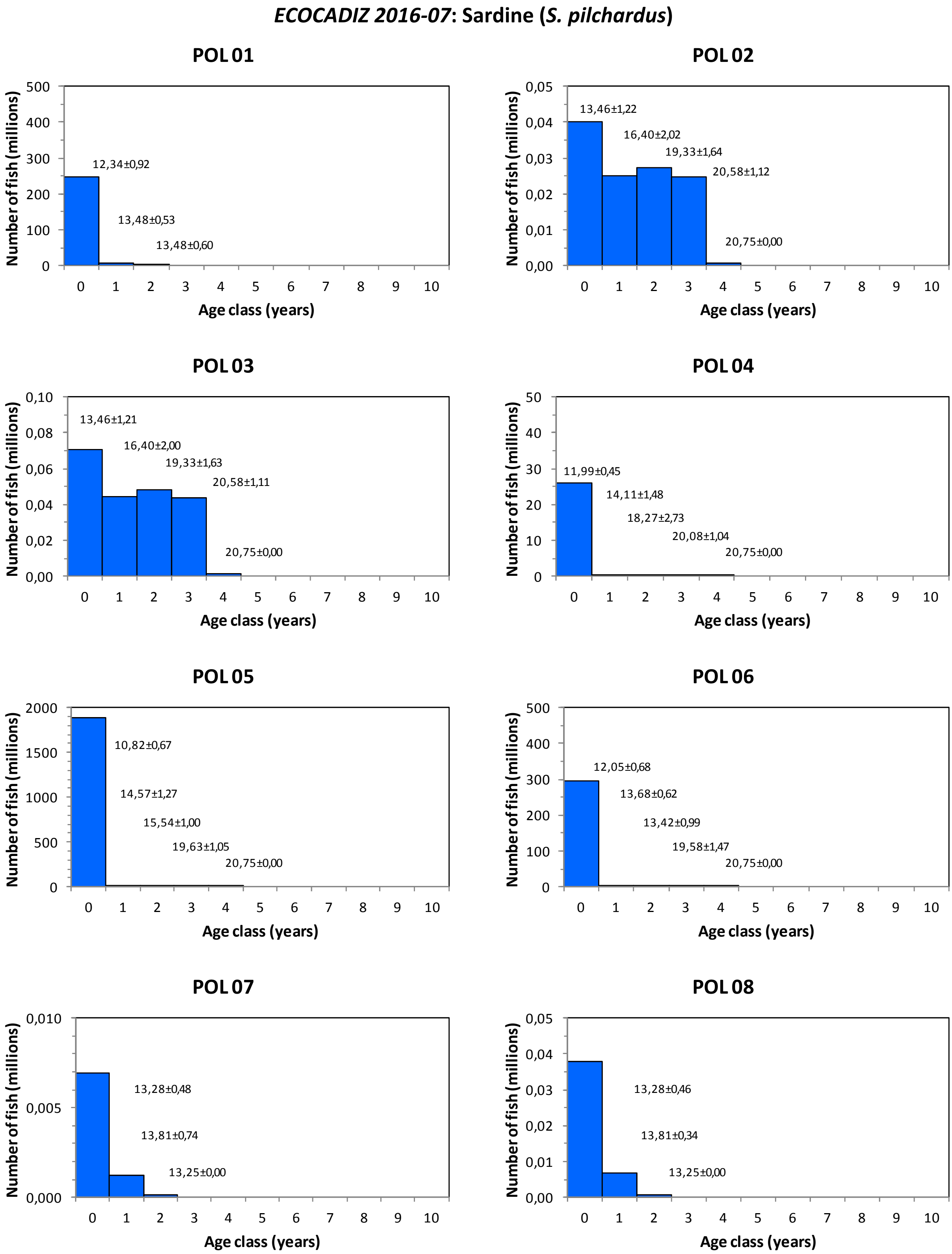


Figure 15. *ECOCADIZ 2016-07* survey. Sardine (*Sardina pilchardus*). Estimated abundances (number of fish in millions) by age class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 13**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

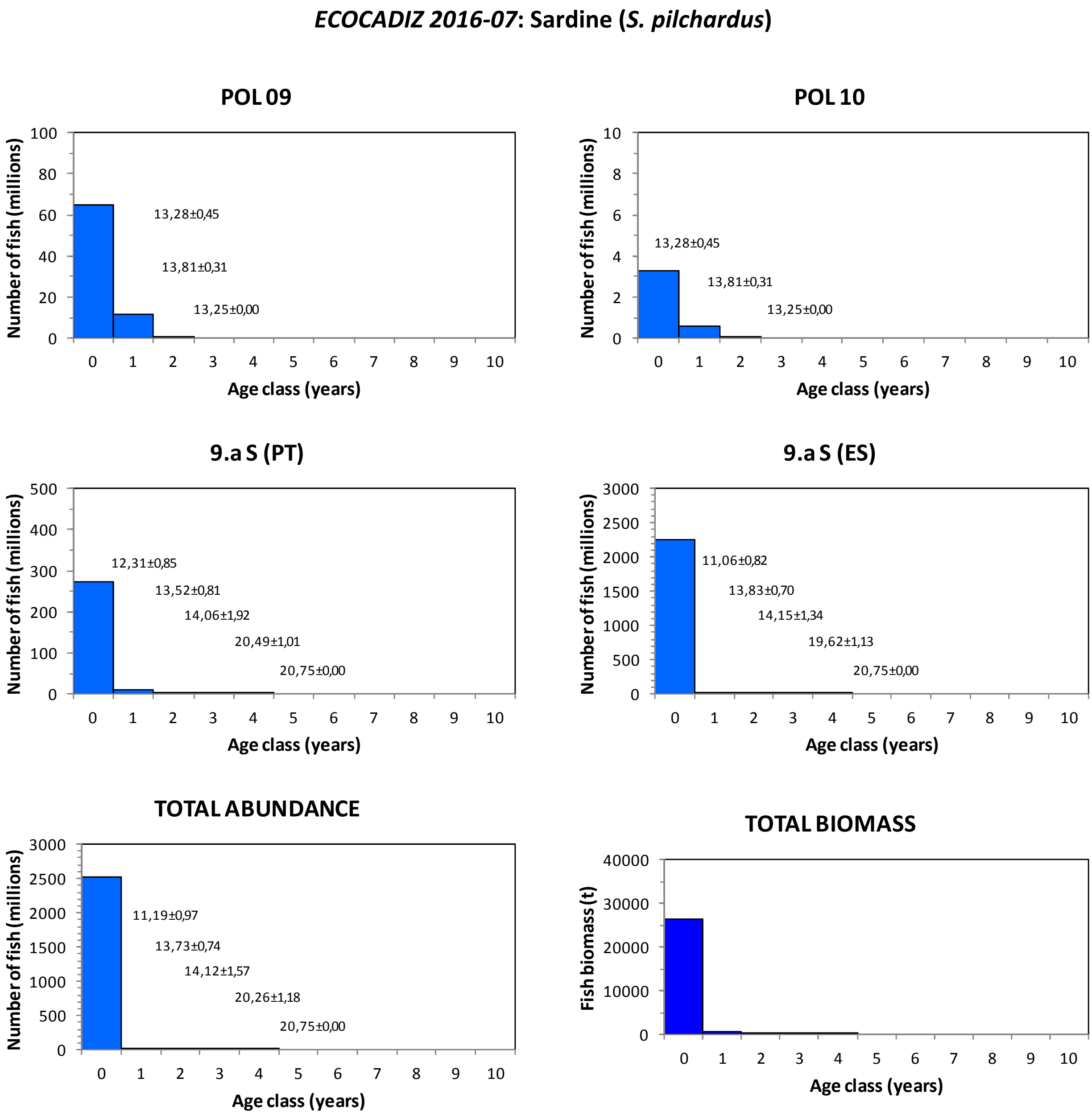
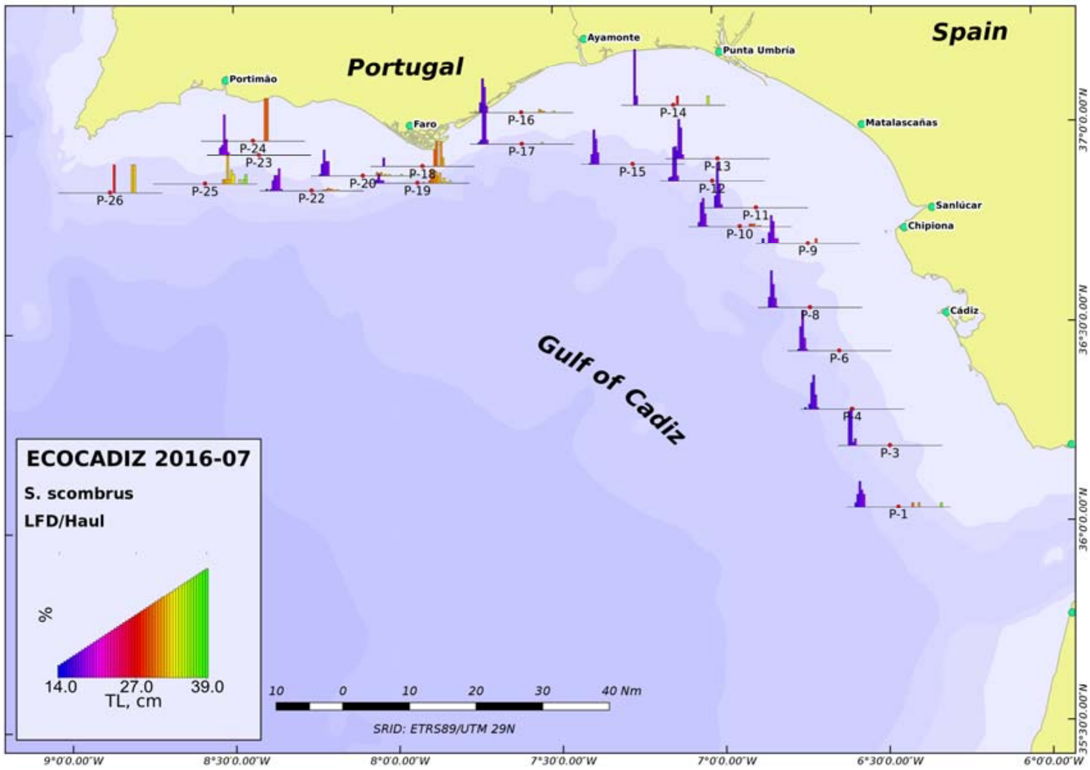


Figure 15. *ECOCADIZ 2016-07* survey. Sardine (*Sardina pilchardus*). Cont'd.



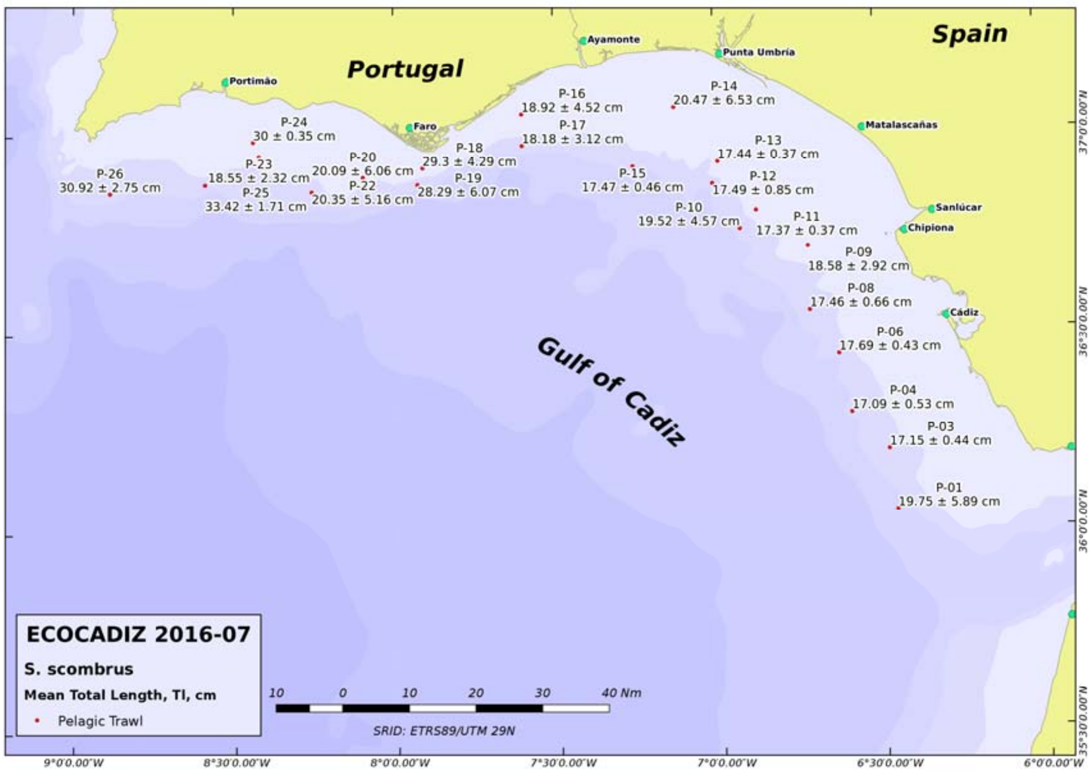


Figure 16. *ECOCADIZ 2016-07* survey. Atlantic mackerel (*Scomber scombrus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

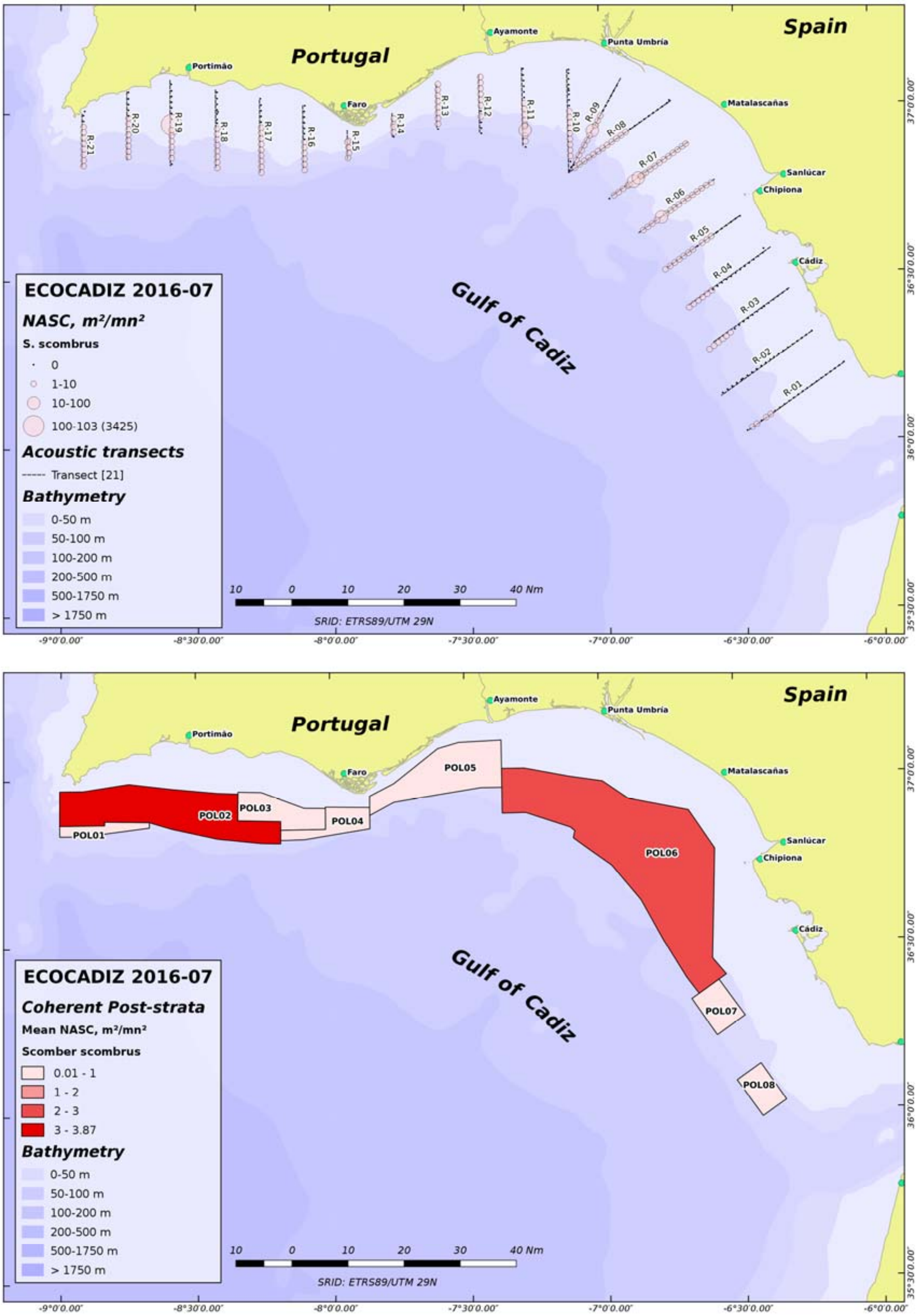


Figure 17. *ECOCADIZ 2016-07* survey. Atlantic mackerel (*Scomber scombrus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

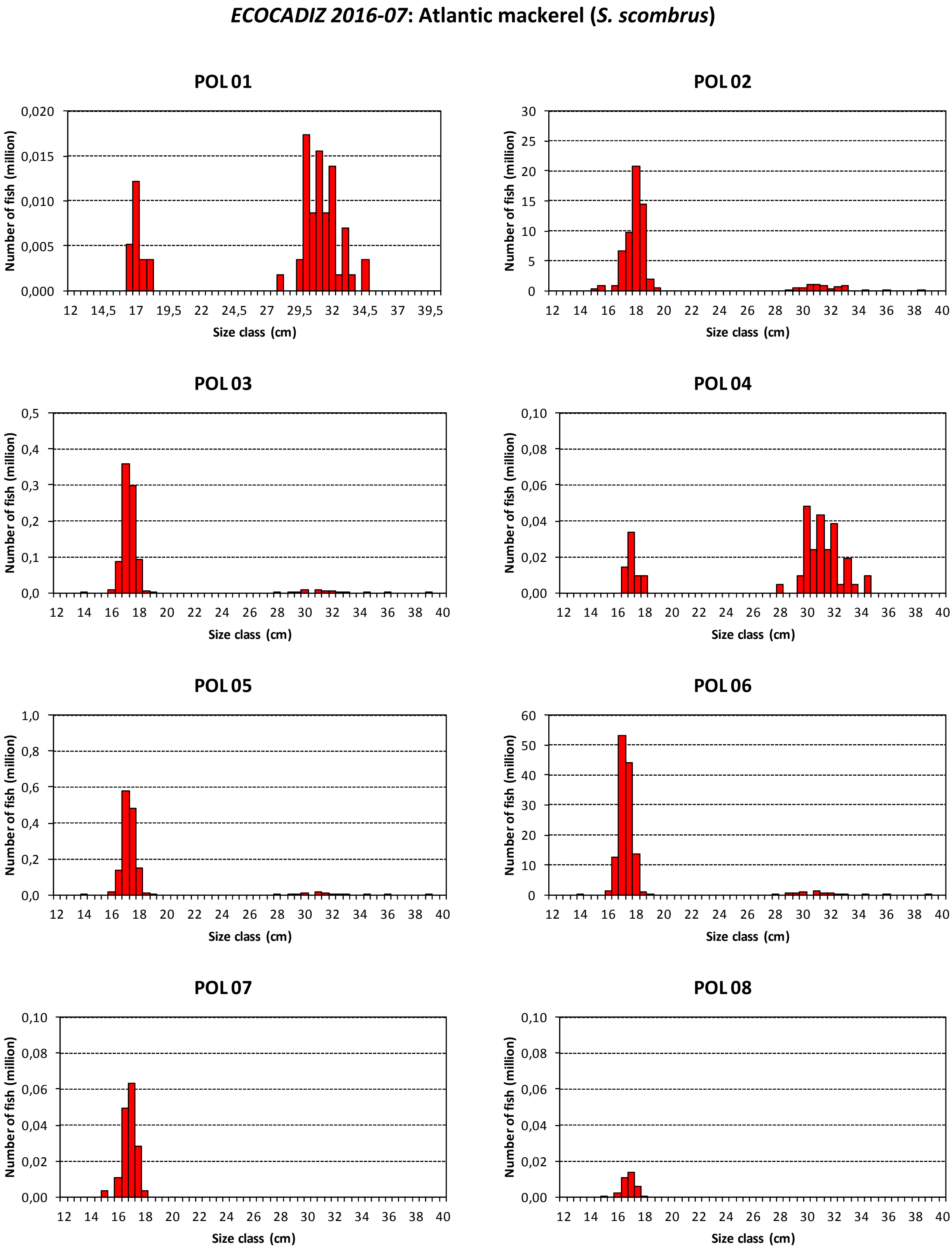


Figure 18. *ECOCADIZ 2016-07* survey. Atlantic mackerel (*Scomber scombrus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 17**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

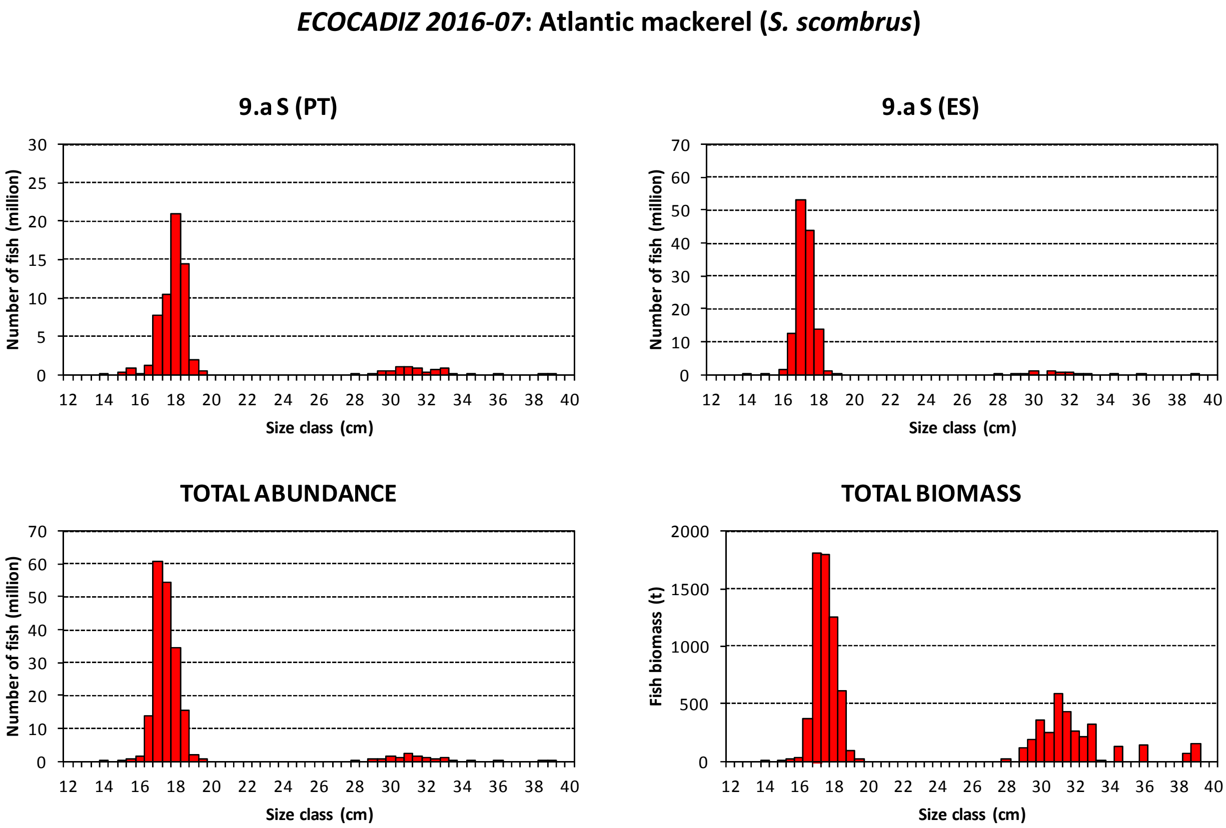
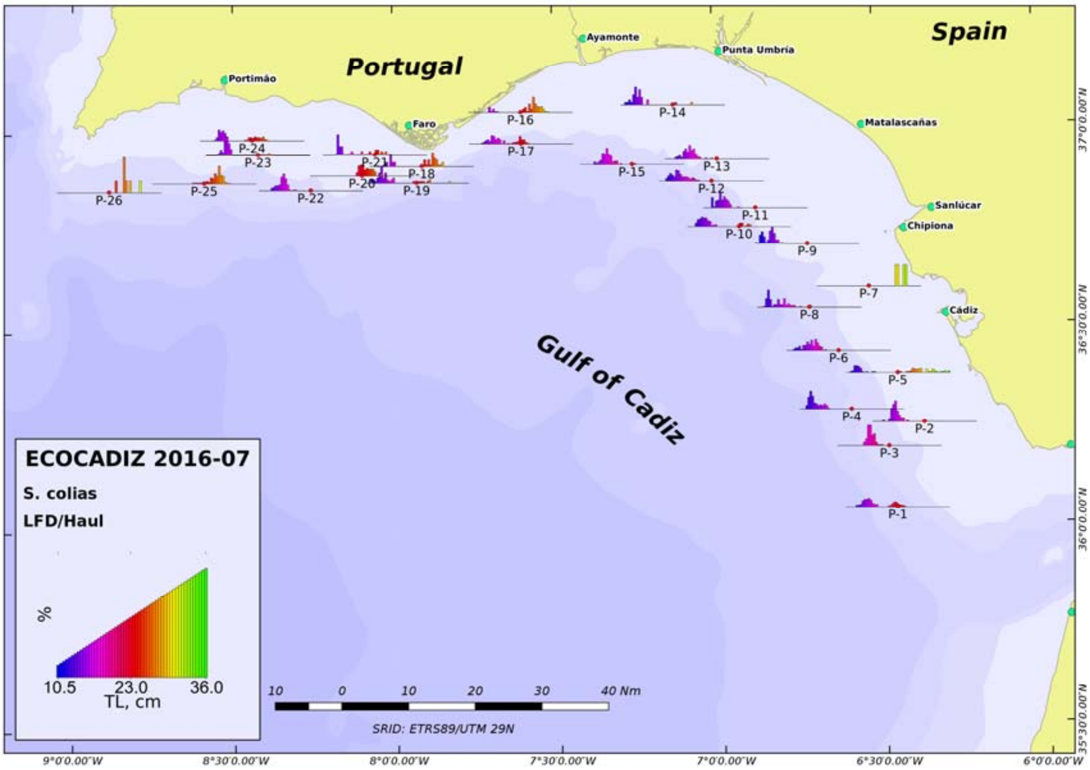


Figure 18. *ECOCADIZ 2016-07* survey. Atlantic mackerel (*Scomber scombrus*). Cont'd.



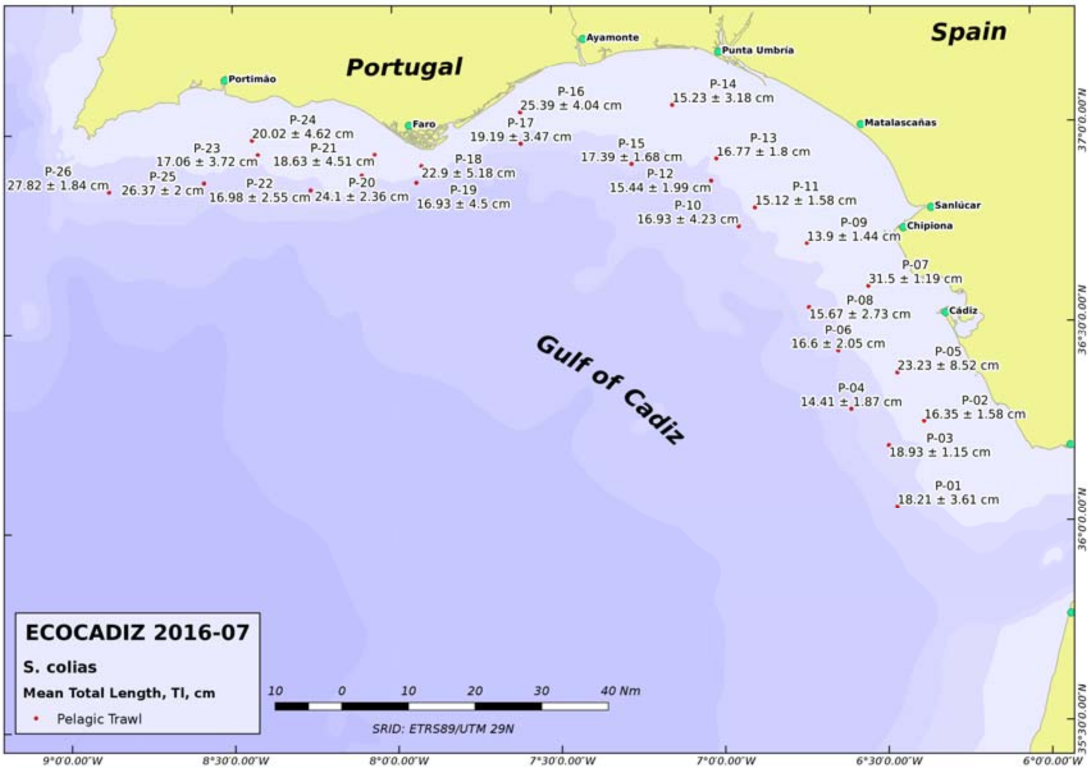


Figure 19. *ECOCADIZ 2016-07* survey. Chub mackerel (*Scomber colias*).Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

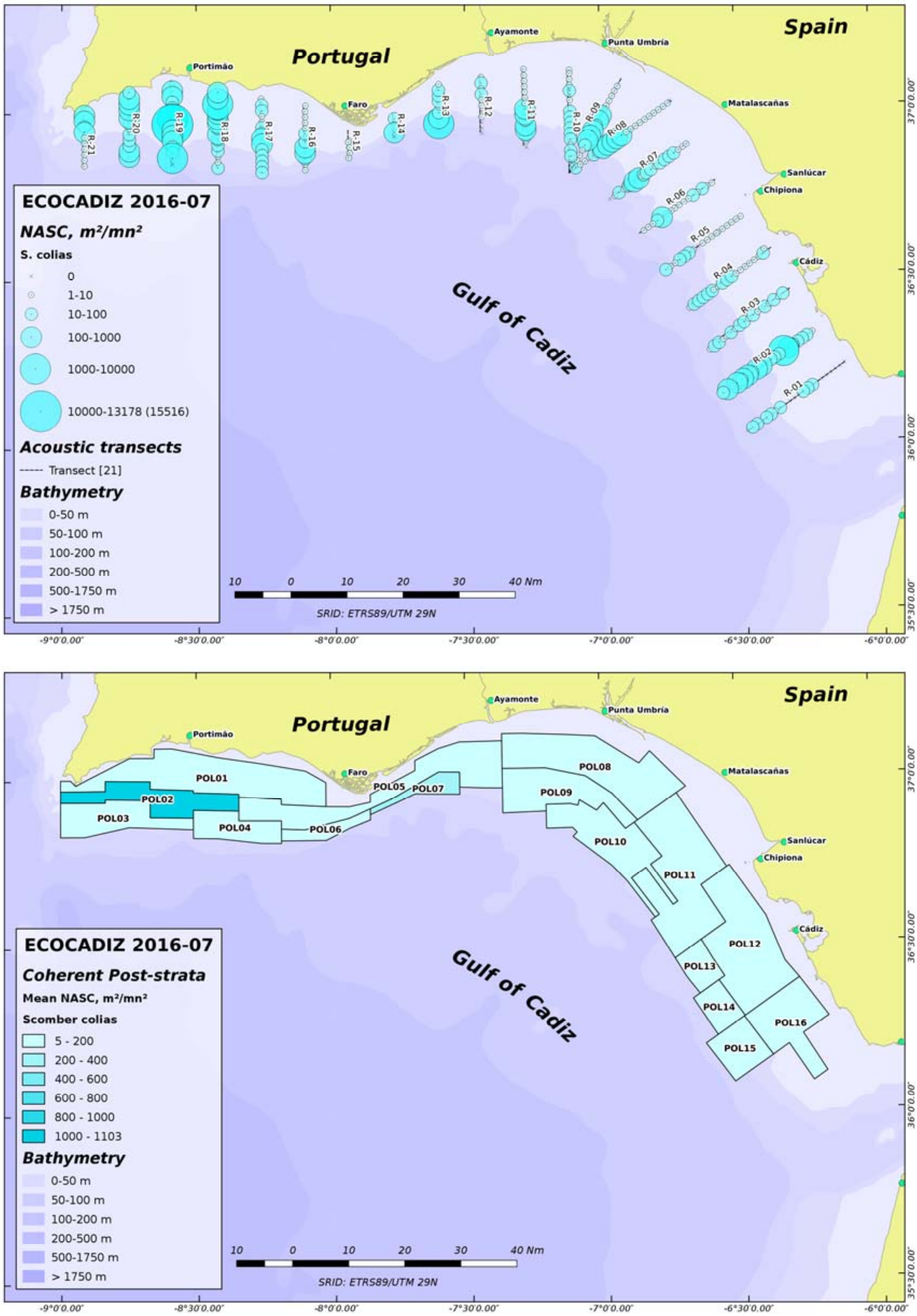


Figure 20. *ECOCADIZ 2016-07* survey. Chub mackerel (*Scomber colias*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

***ECOCADIZ 2016-07*: Chub mackerel (*S. colias*)**

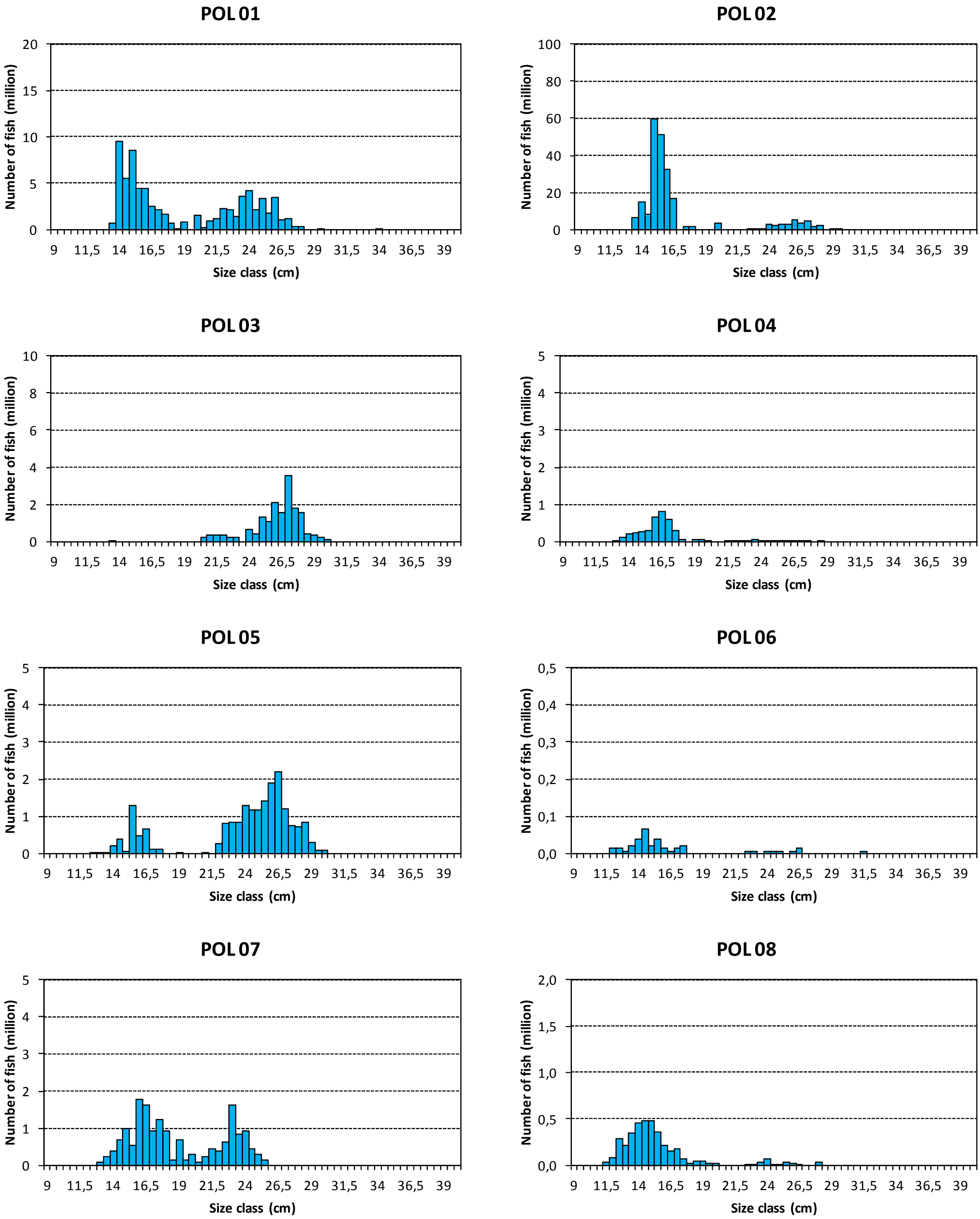


Figure 21. *ECOCADIZ 2016-07* survey. Chub mackerel (*Scomber colias*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 20**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

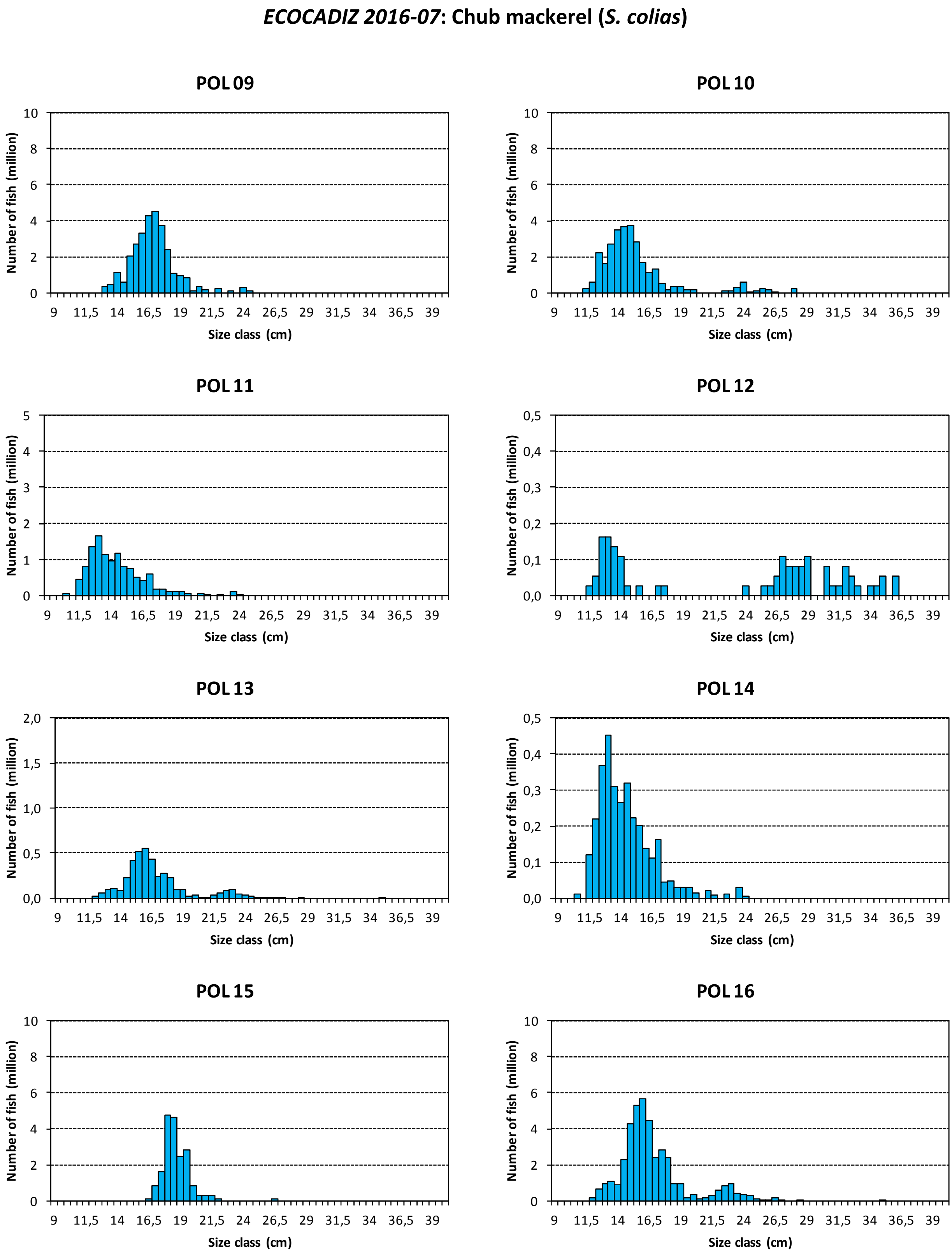


Figure 21. *ECOCADIZ 2016-07* survey. Chub mackerel (*Scomber colias*). Cont'd.

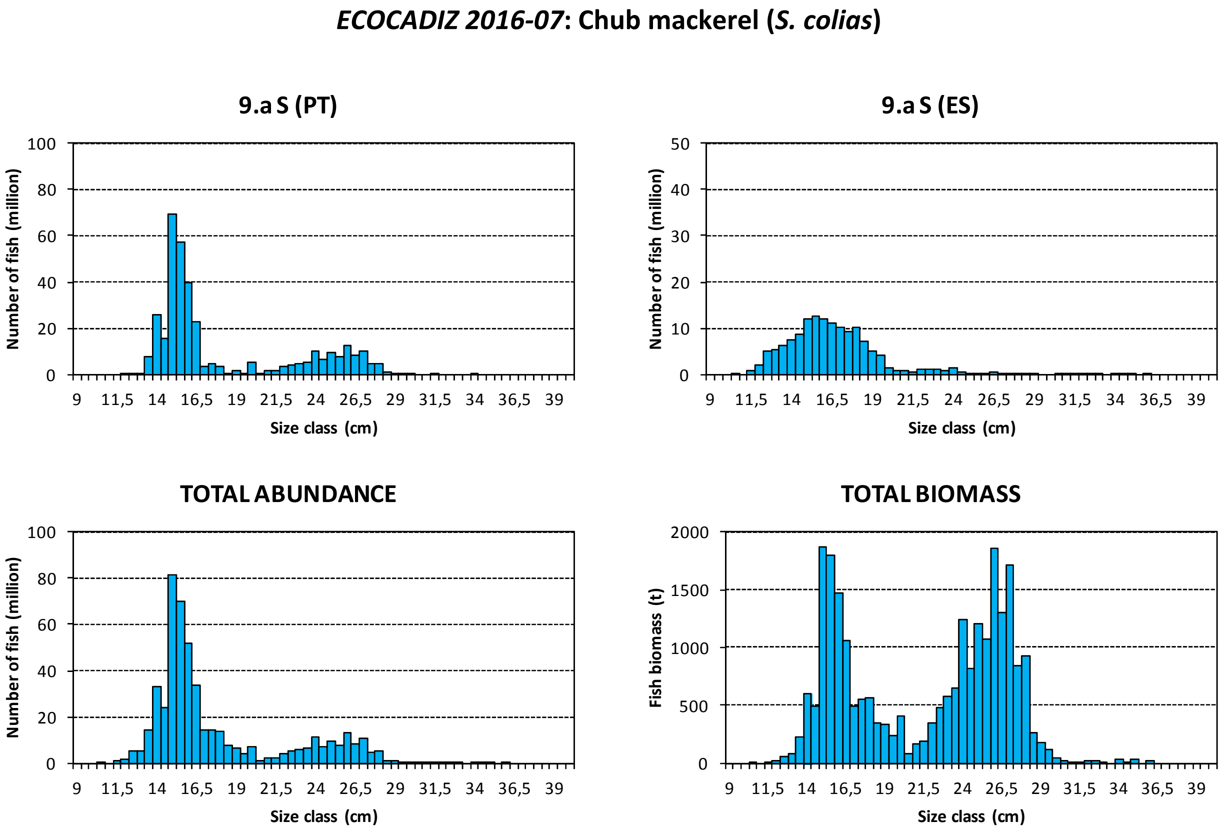
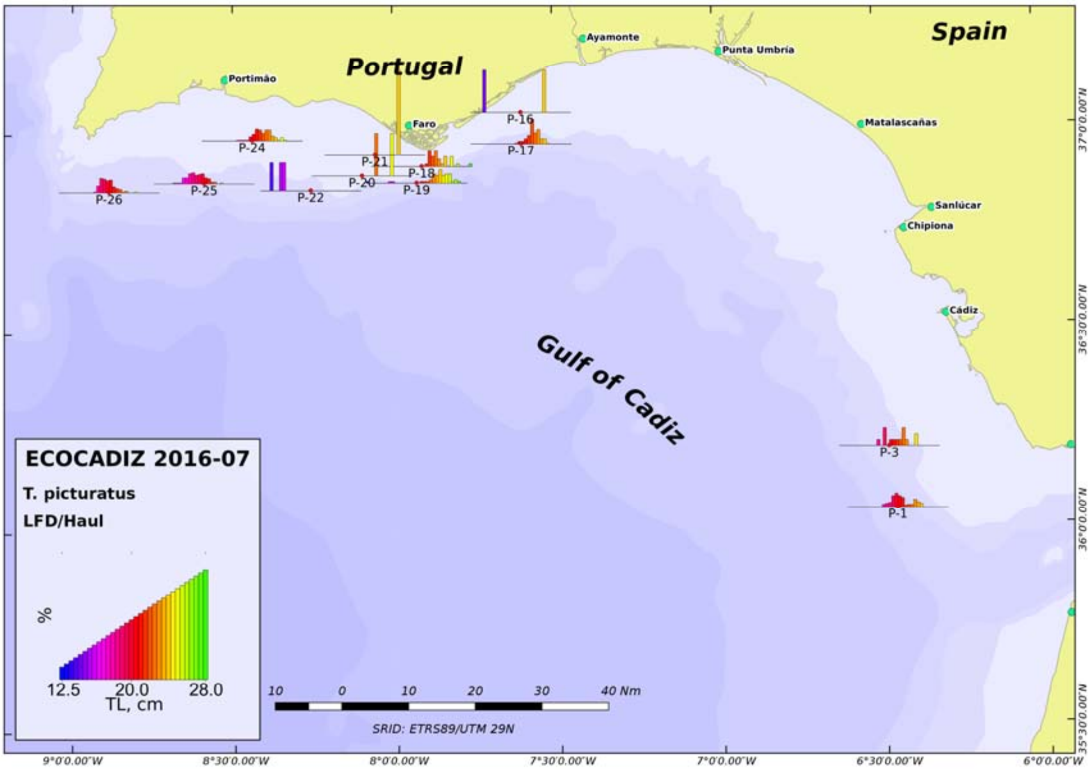


Figure 21. *ECOCADIZ 2016-07* survey. Chub mackerel (*Scomber colias*). Cont'd.



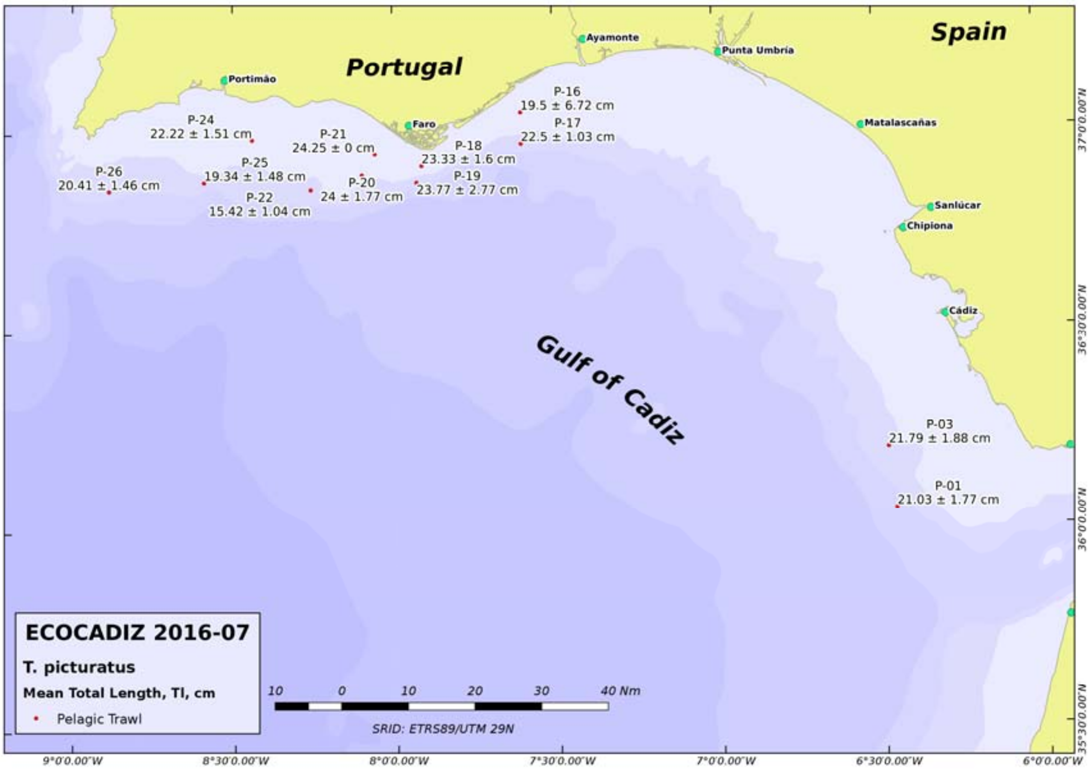


Figure 22. *ECOCADIZ 2016-07* survey. Blue jack mackerel (*Trachurus picturatus*).Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

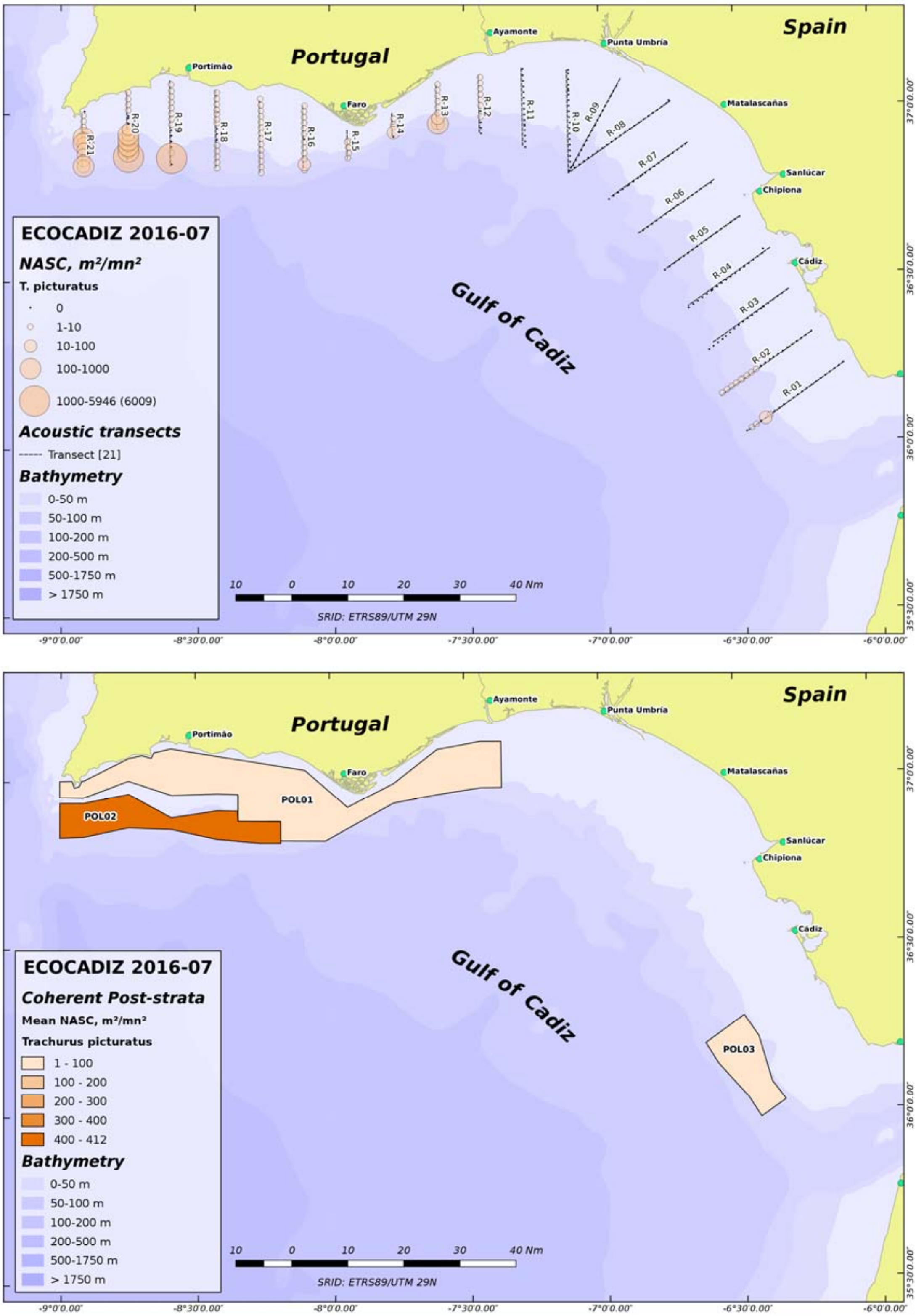


Figure 23. *ECOCADIZ 2016-07* survey. Blue jack mackerel (*Trachurus picturatus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

ECOCADIZ 2016-07: Blue Jack mackerel (*T. picturatus*)

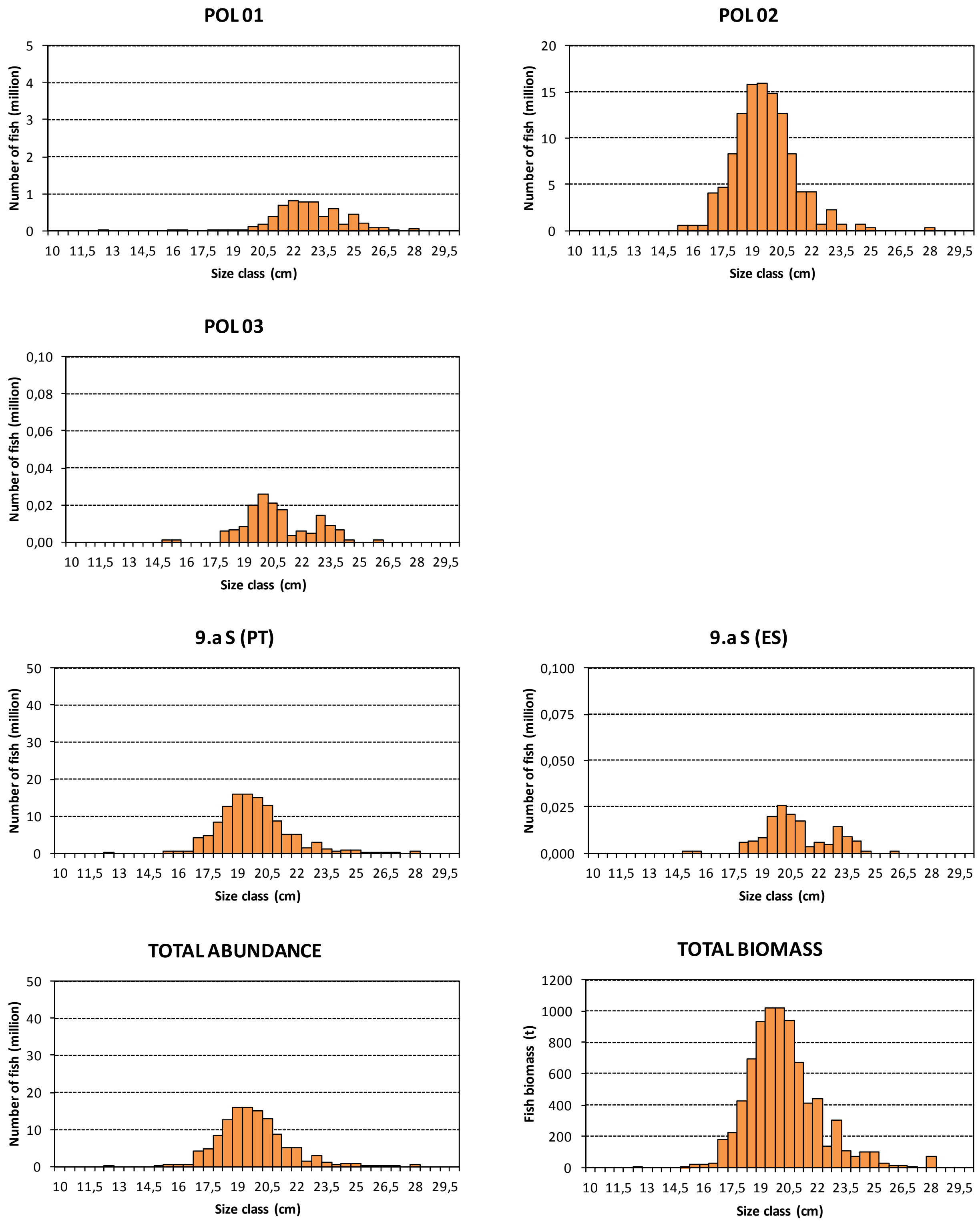
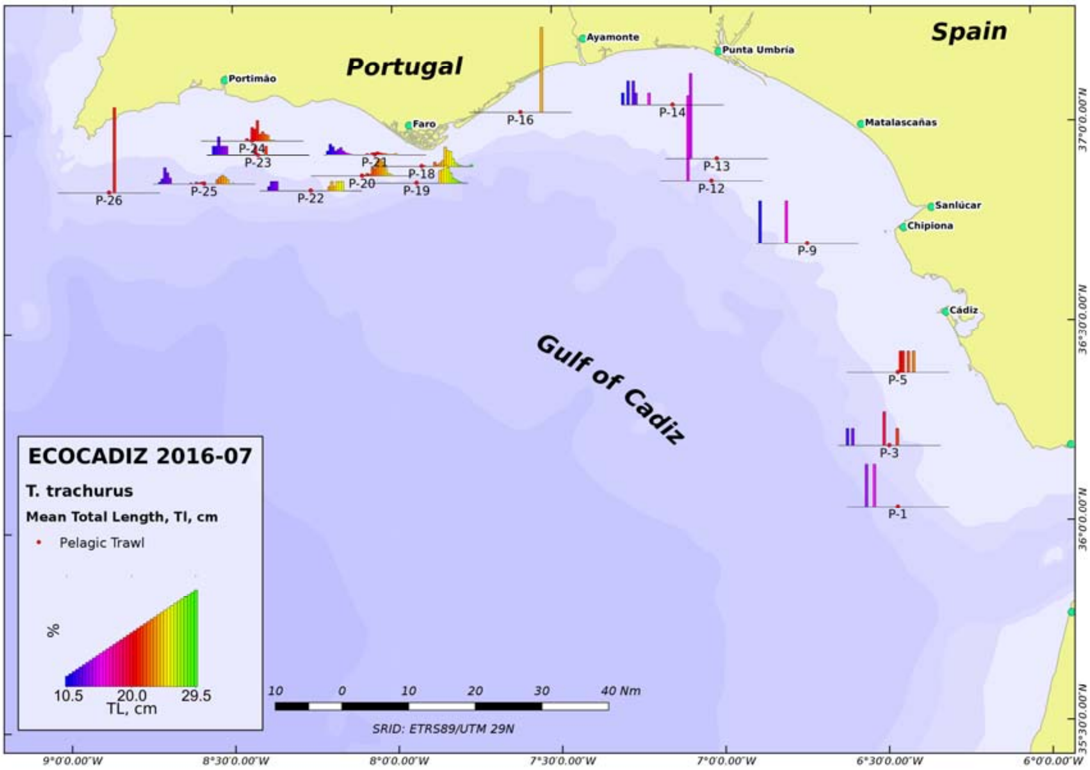


Figure 24. *ECOCADIZ 2016-07* survey. Blue Jack mackerel (*Trachurus picturatus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 23**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.



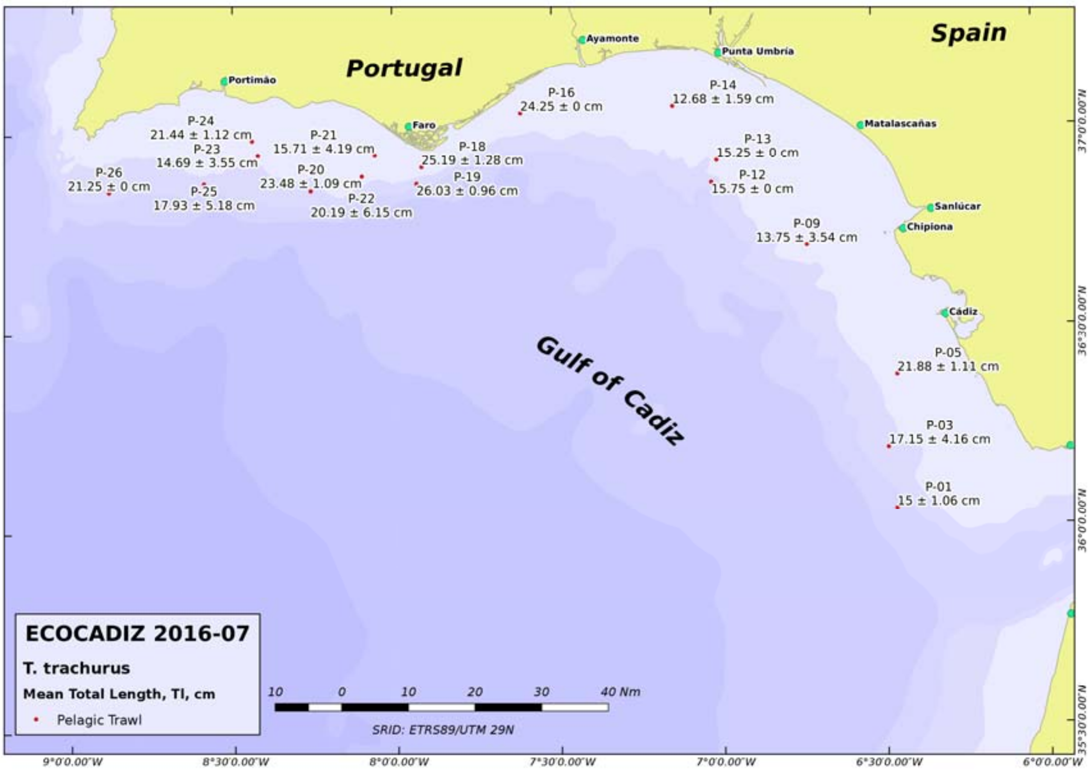


Figure 25. *ECOCADIZ 2016-07* survey. Horse mackerel (*Trachurus trachurus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

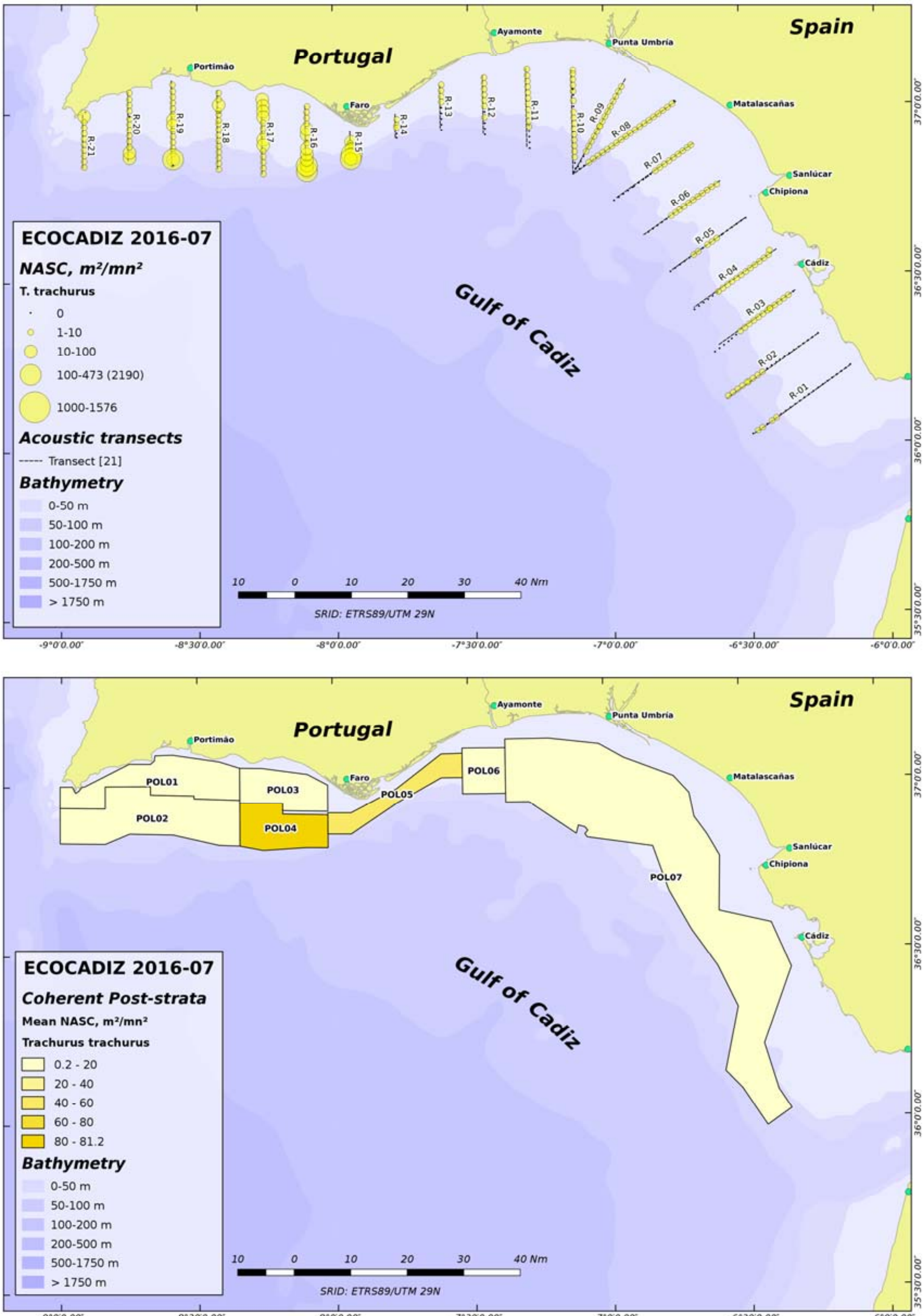


Figure 26. *ECOCADIZ 2016-07* survey. Horse mackerel (*Trachurus trachurus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

***ECOCADIZ 2016-07*: Horse mackerel (*T. trachurus*)**

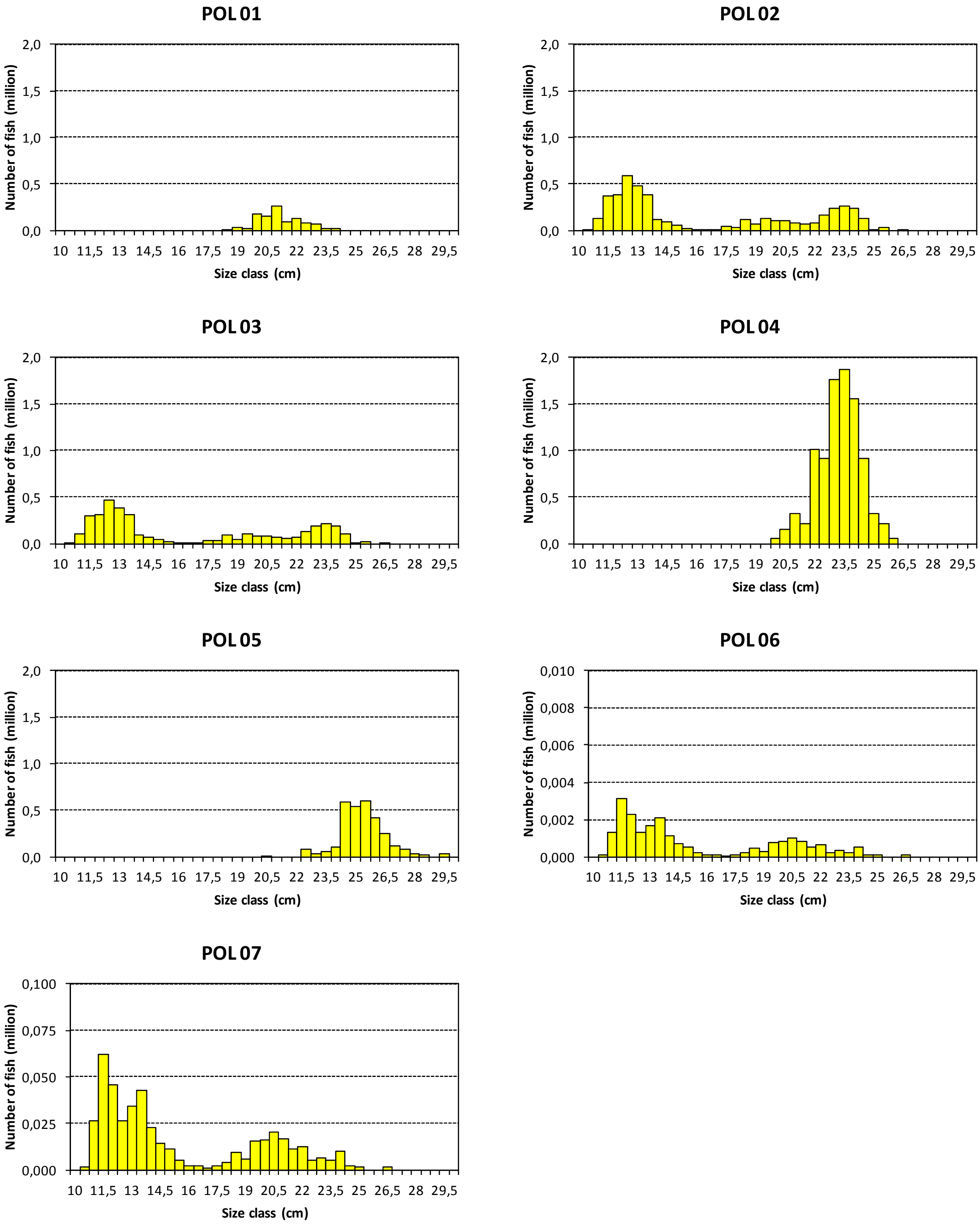


Figure 27. *ECOCADIZ 2016-07* survey. Horse mackerel (*Trachurus trachurus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 26**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

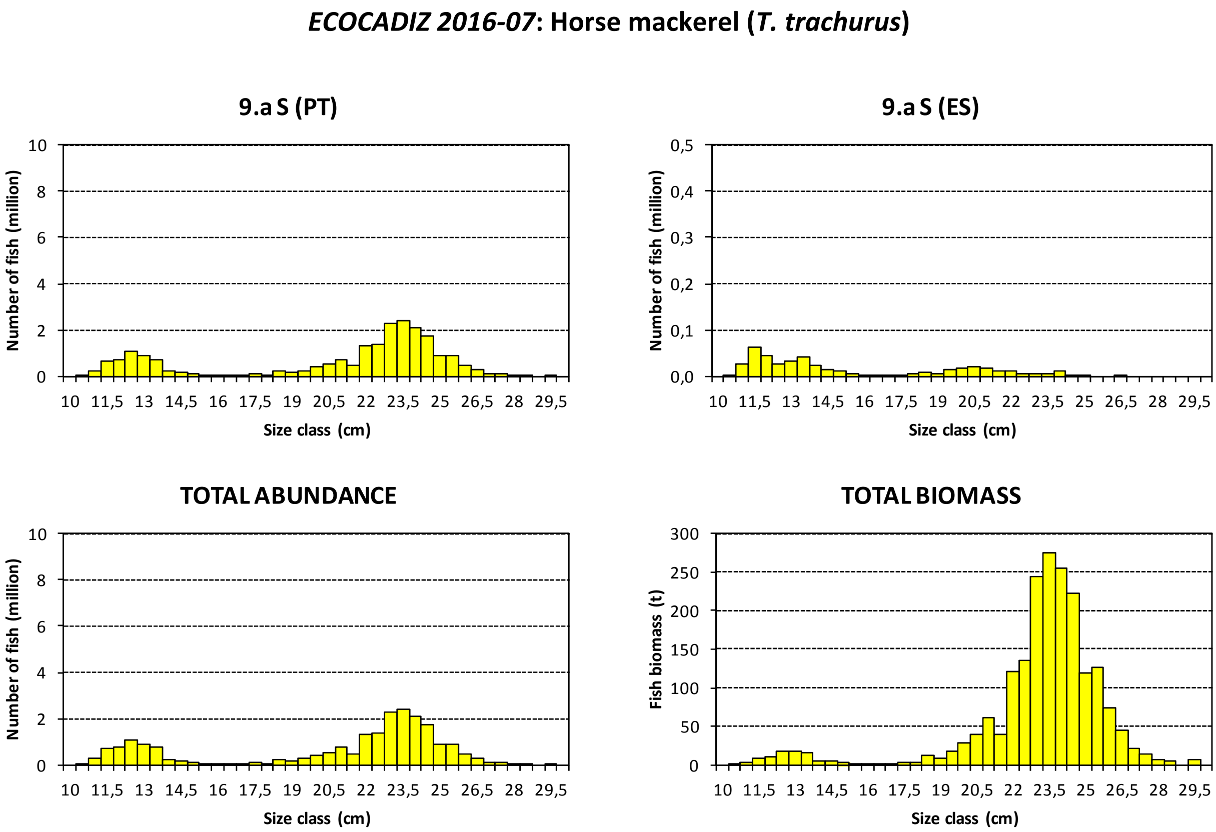


Figure 27. *ECOCADIZ 2016-07* survey. Horse mackerel (*Trachurus trachurus*). Cont'd.

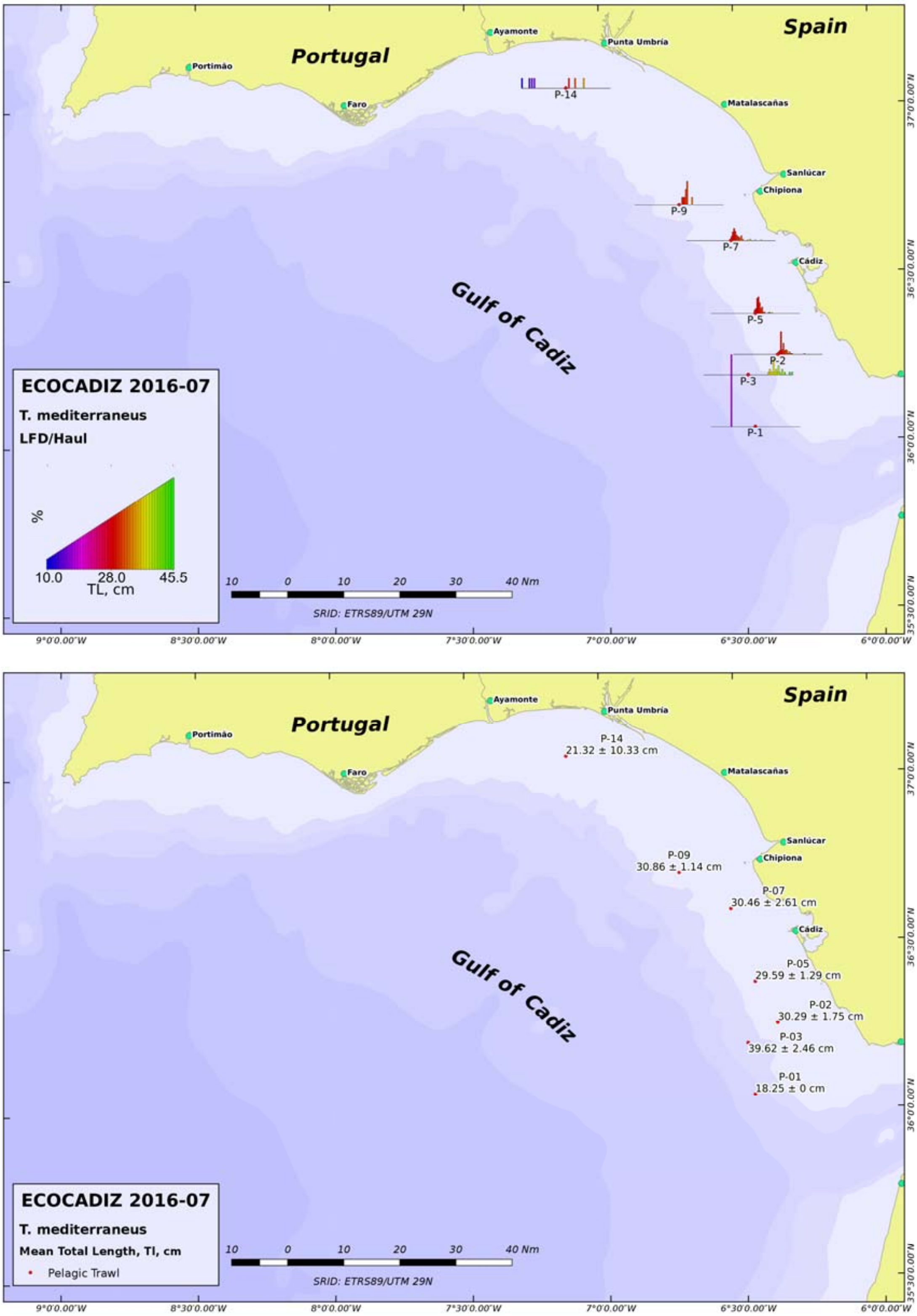
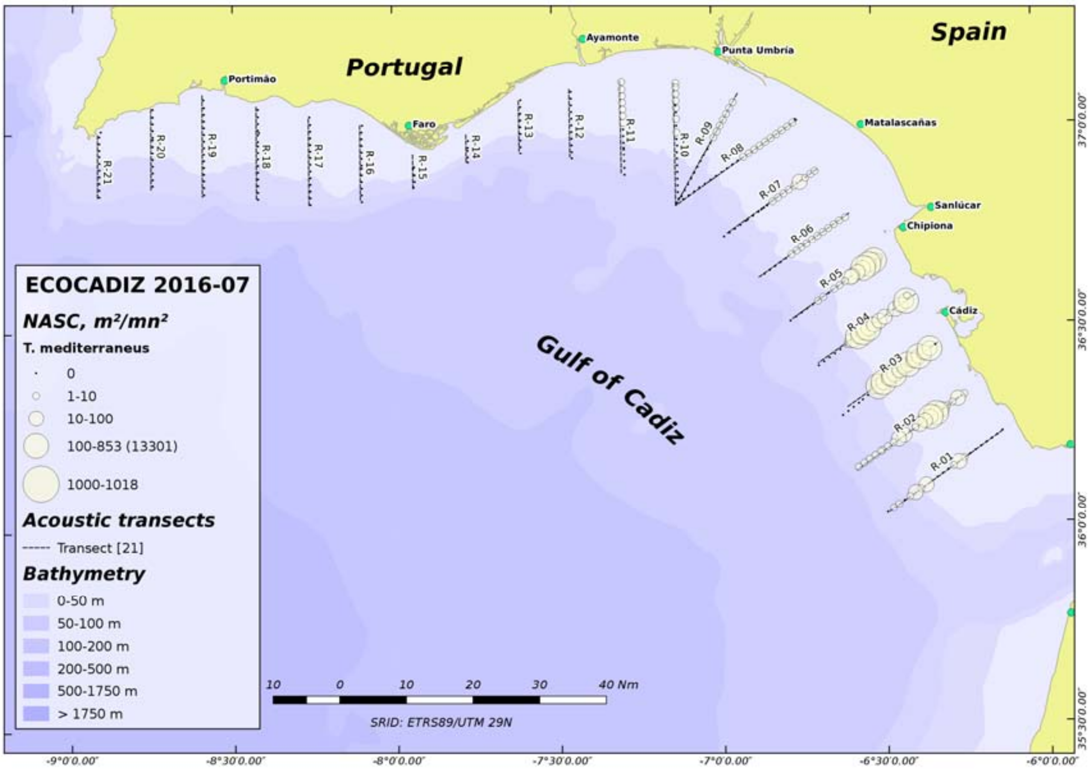


Figure 28. *ECOCADIZ 2016-07* survey. Mediterranean horse mackerel (*Trachurus mediterraneus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.



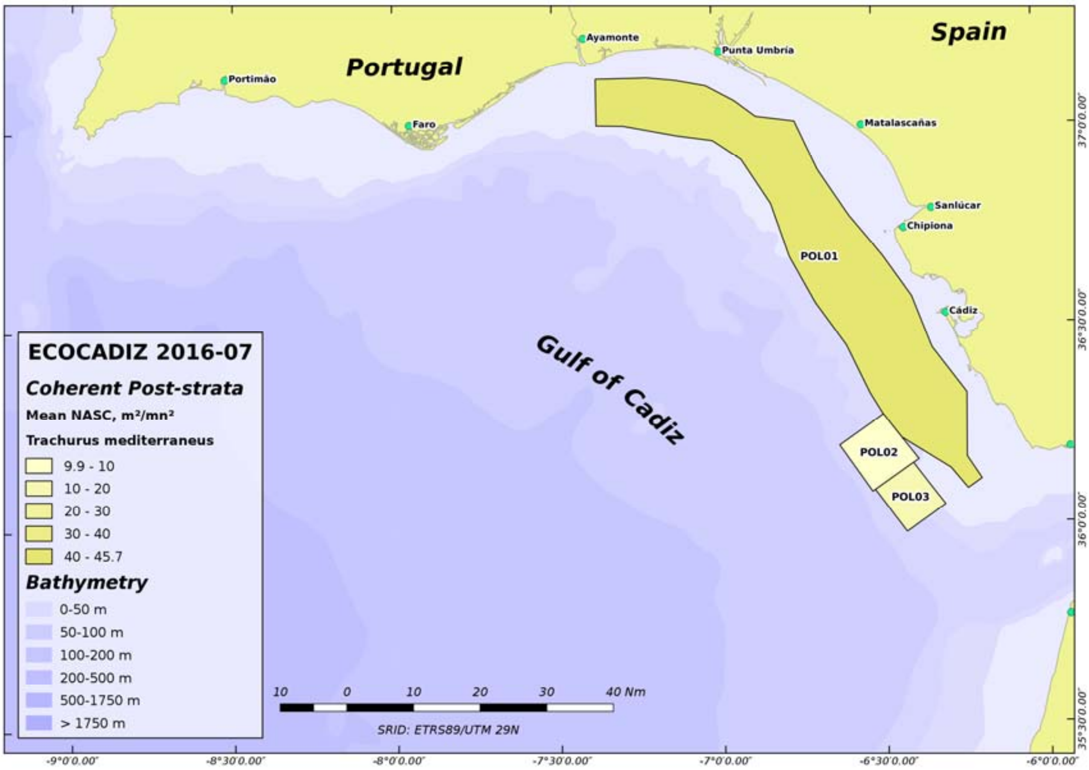


Figure 29. *ECOCADIZ 2016-07* survey. Mediterranean horse mackerel (*Trachurus mediterraneus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

***ECOCADIZ 2016-07*: Mediterranean horse mackerel (*T. mediterraneus*)**

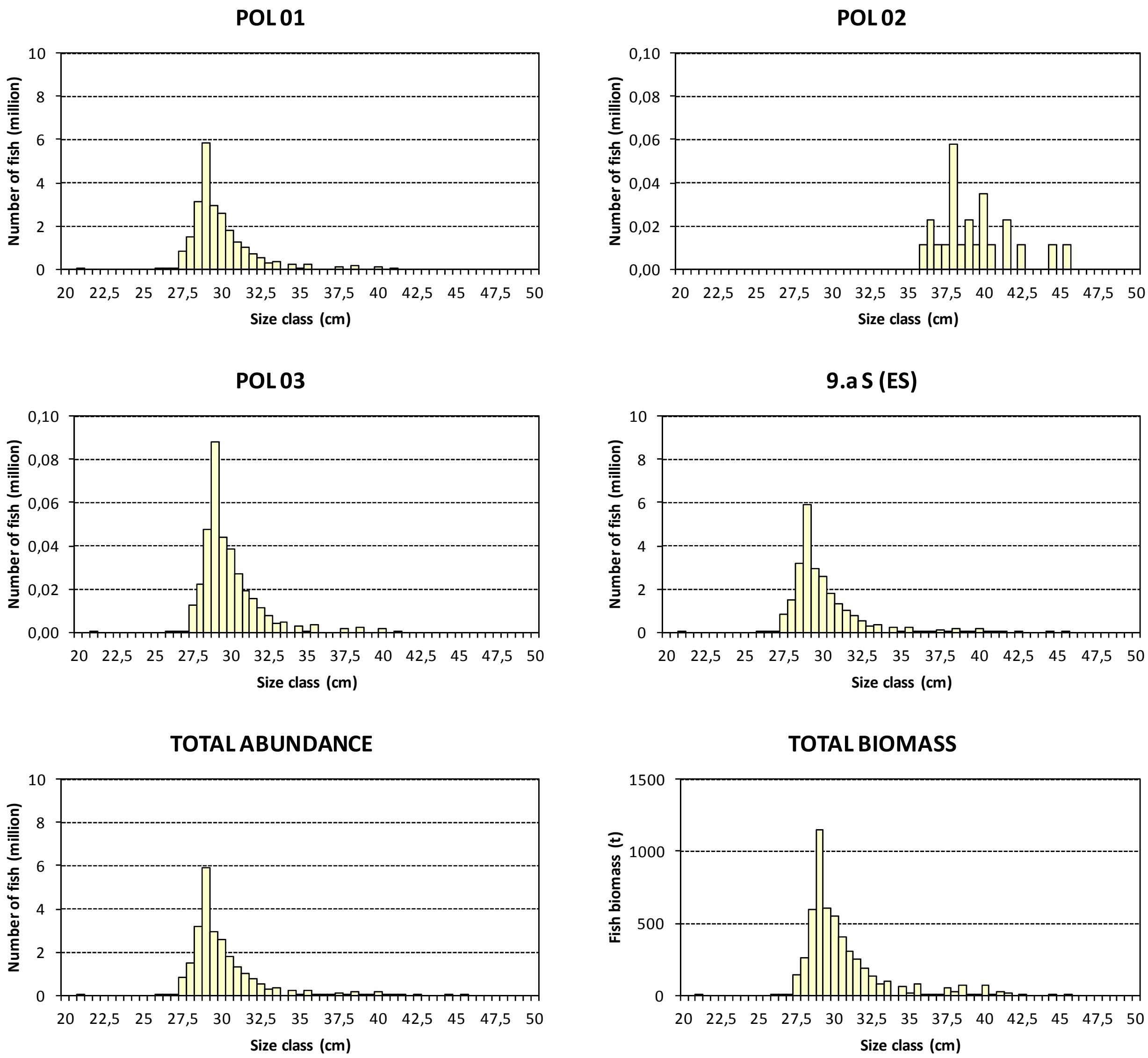


Figure 30. *ECOCADIZ 2016-07* survey. Mediterranean horse mackerel (*Trachurus mediterraneus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 29**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

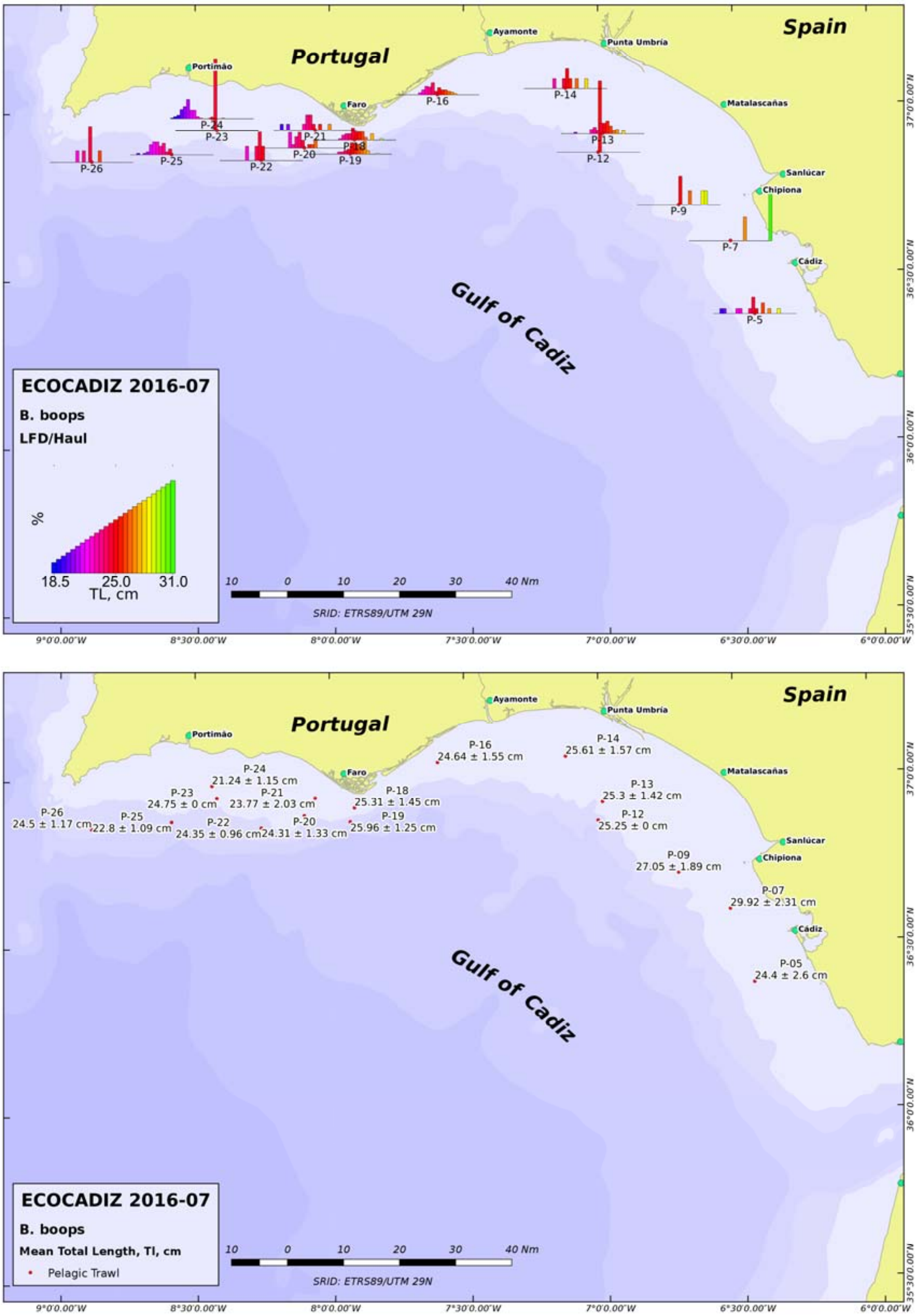


Figure 31. *ECOCADIZ 2016-07* survey. Bogue (*Boops boops*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

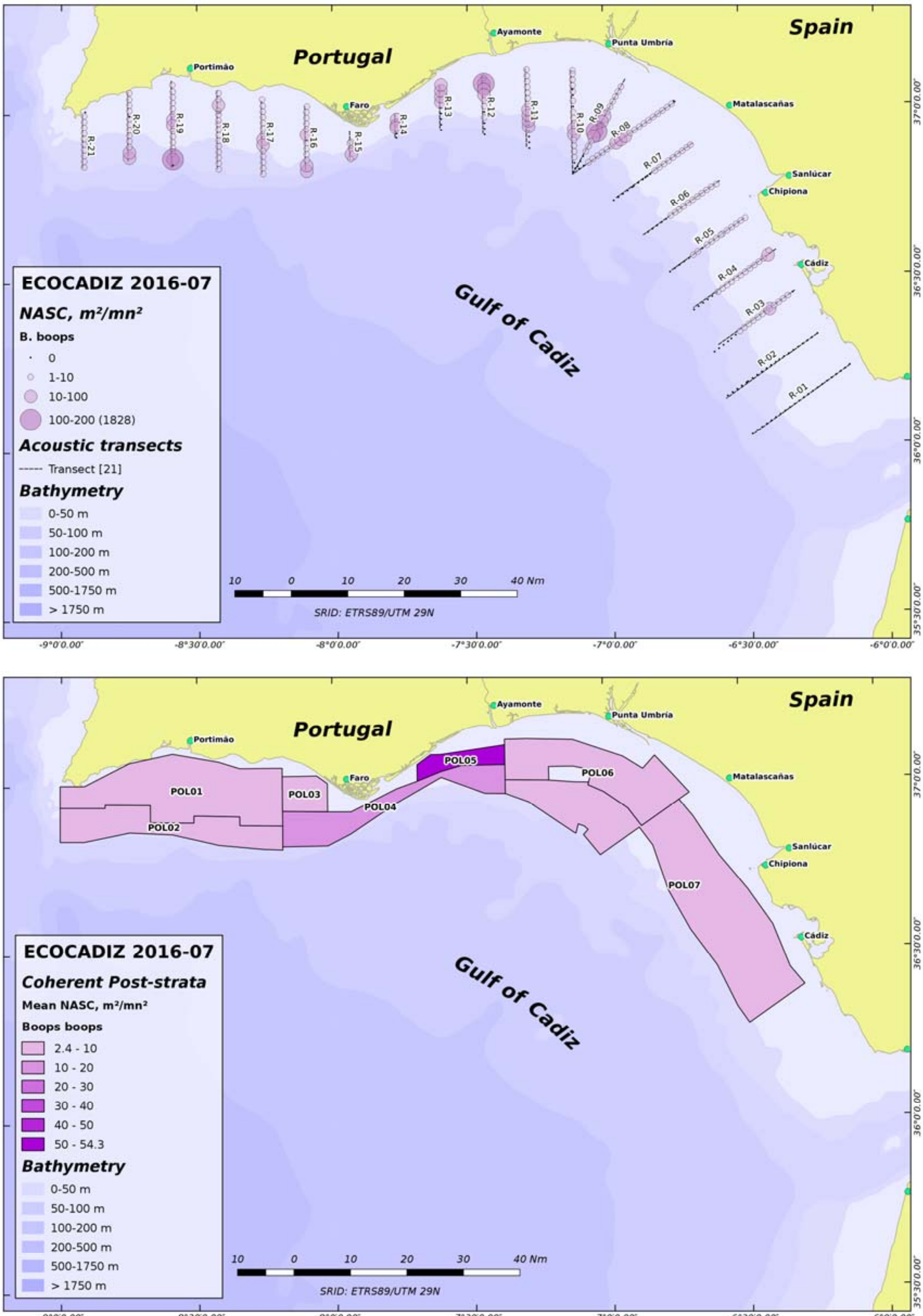


Figure 32. *ECOCADIZ 2016-07* survey. Bogue (*Boops boops*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

ECOCADIZ 2016-07: Bogue (*B. boops*)

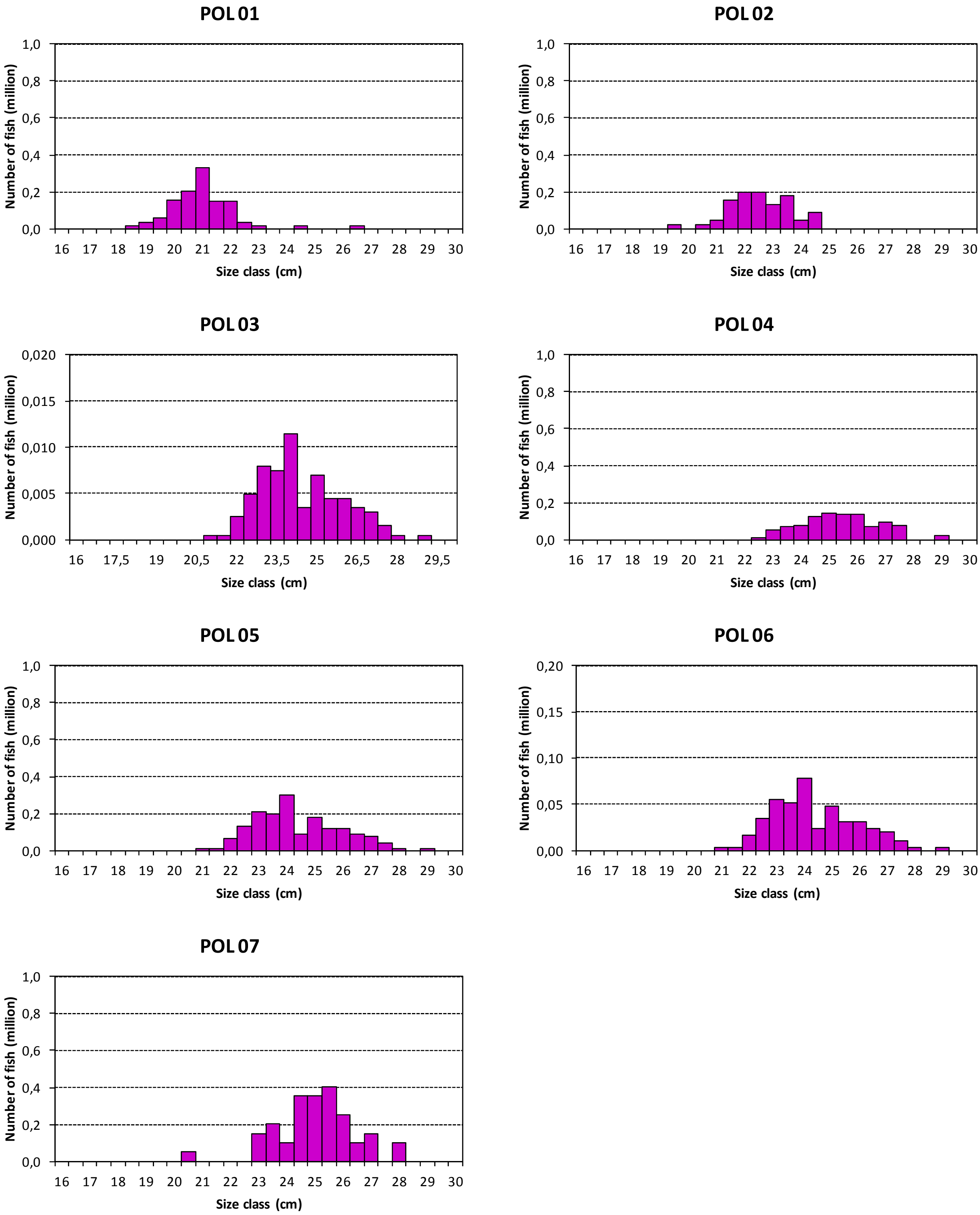


Figure 33. *ECOCADIZ 2016-07* survey. Bogue (*Boops boops*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 32**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

***ECOCADIZ 2016-07*: Bogue (*B. boops*)**

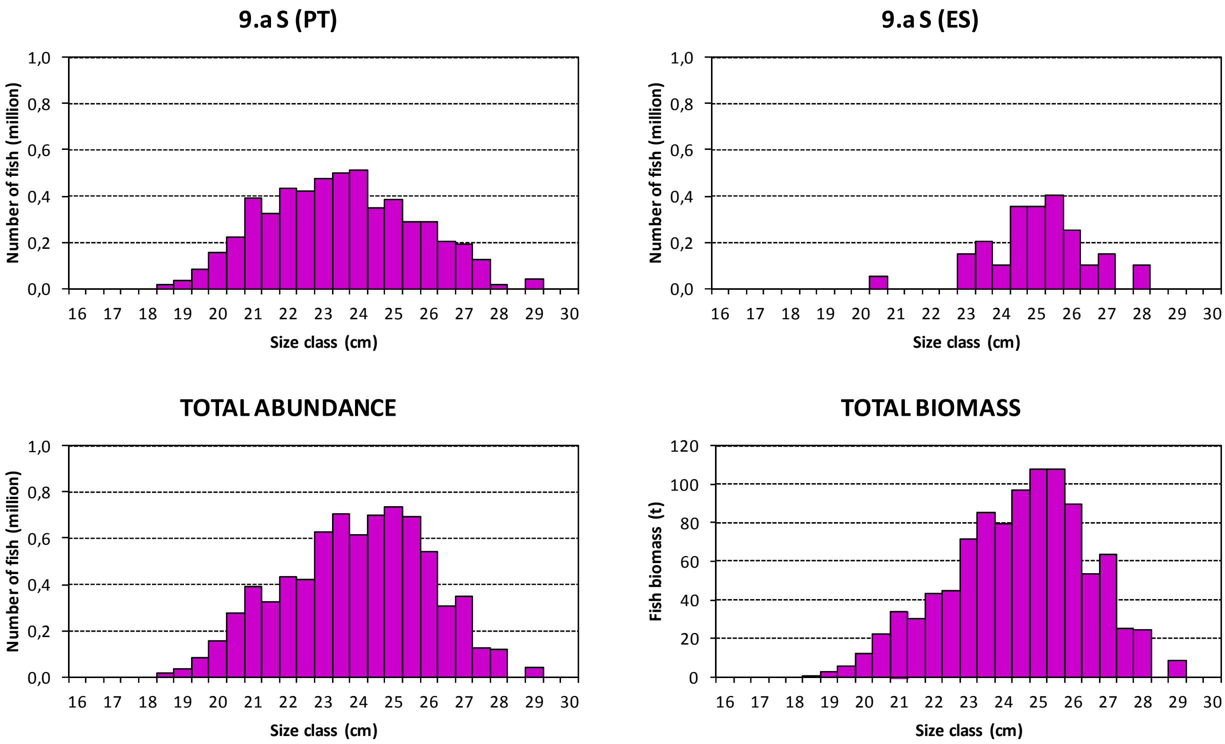


Figure 33. *ECOCADIZ 2016-07* survey. Bogue (*Boops boops*). Cont'd.

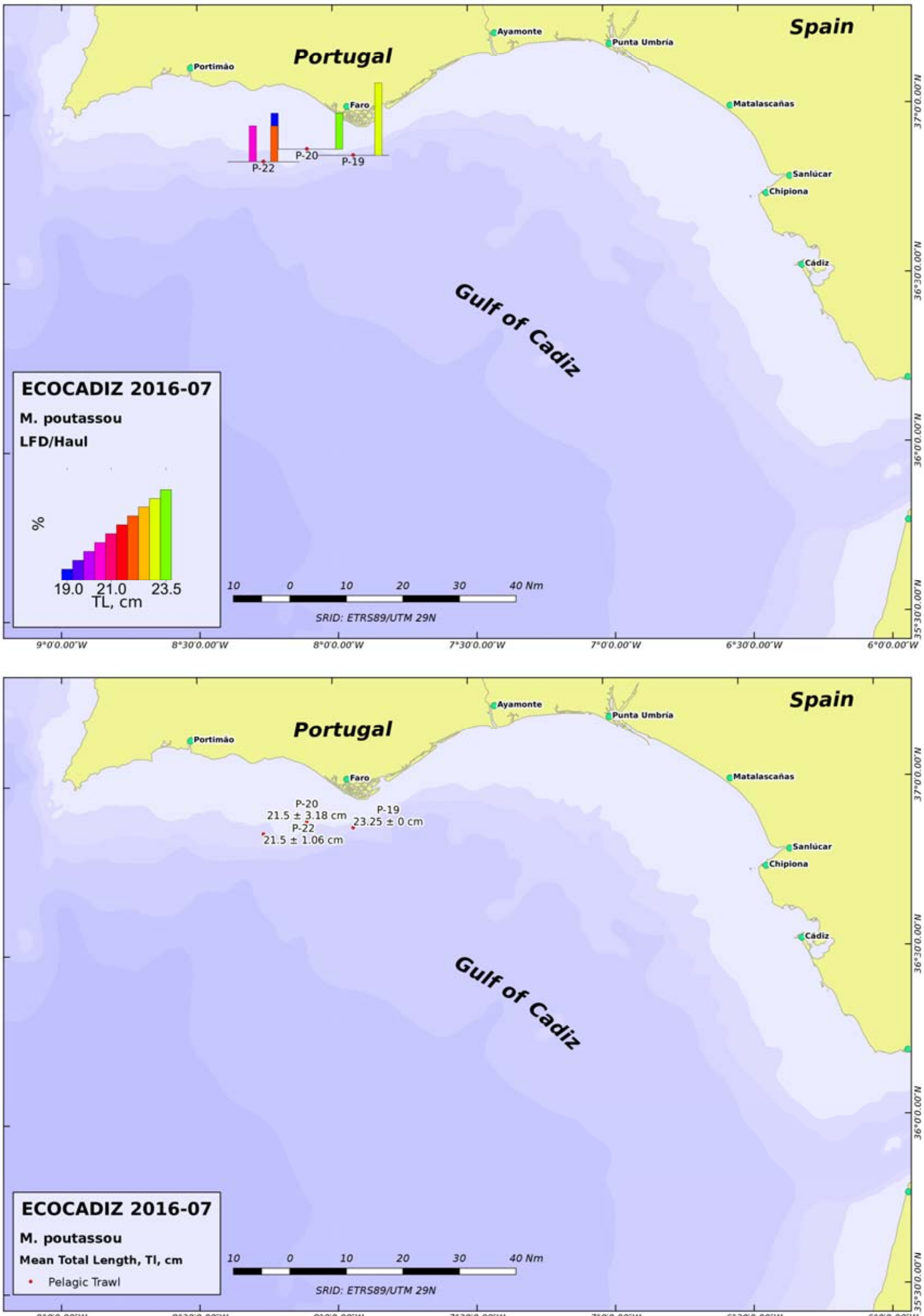


Figure 34. *ECOCADIZ 2016-07* survey. Blue whiting (*Micromesistius poutassou*).Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

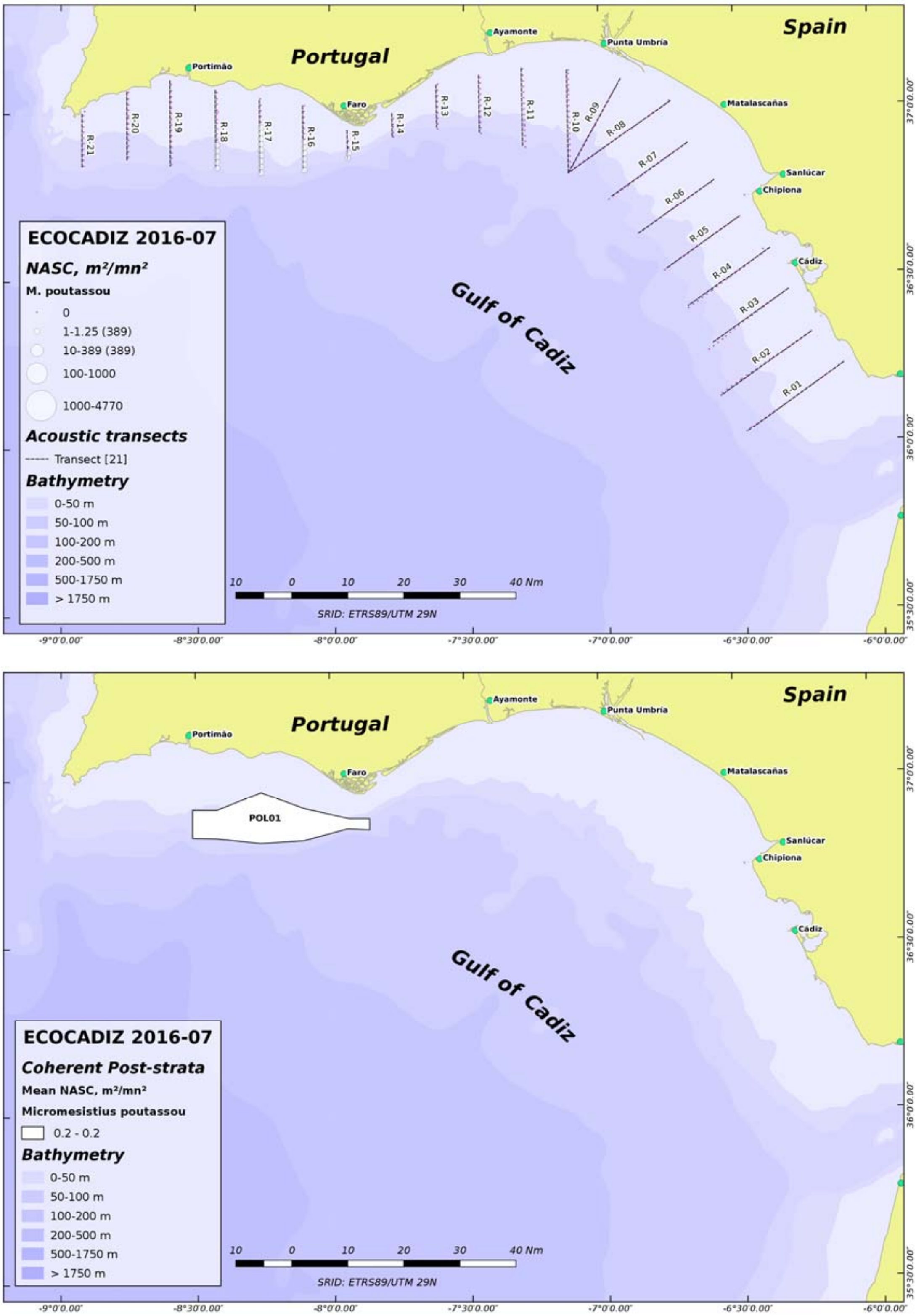


Figure 35. *ECOCADIZ 2016-07* survey. Blue whiting (*Micromesistius poutassou*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

***ECOCADIZ 2016-07*: Blue whiting (*M. poutassou*)**

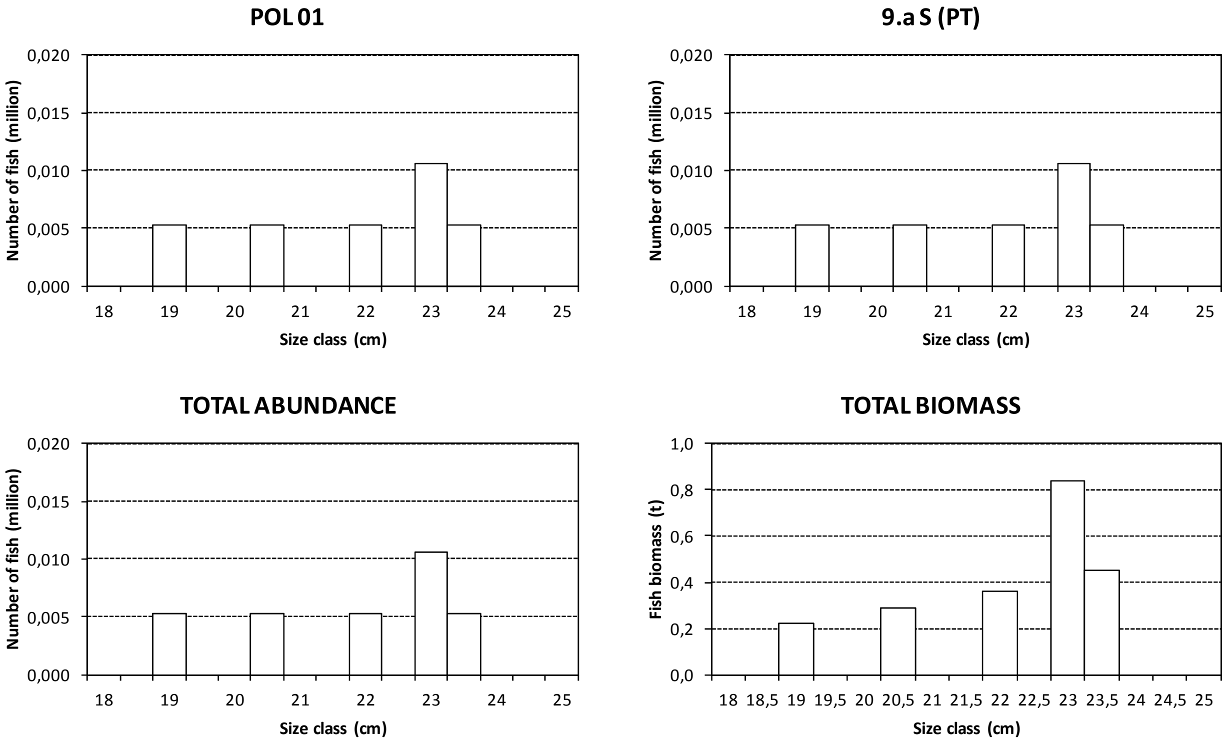


Figure 36. *ECOCADIZ 2016-07* survey. Blue whiting (*Micromesistius poutassou*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 35**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

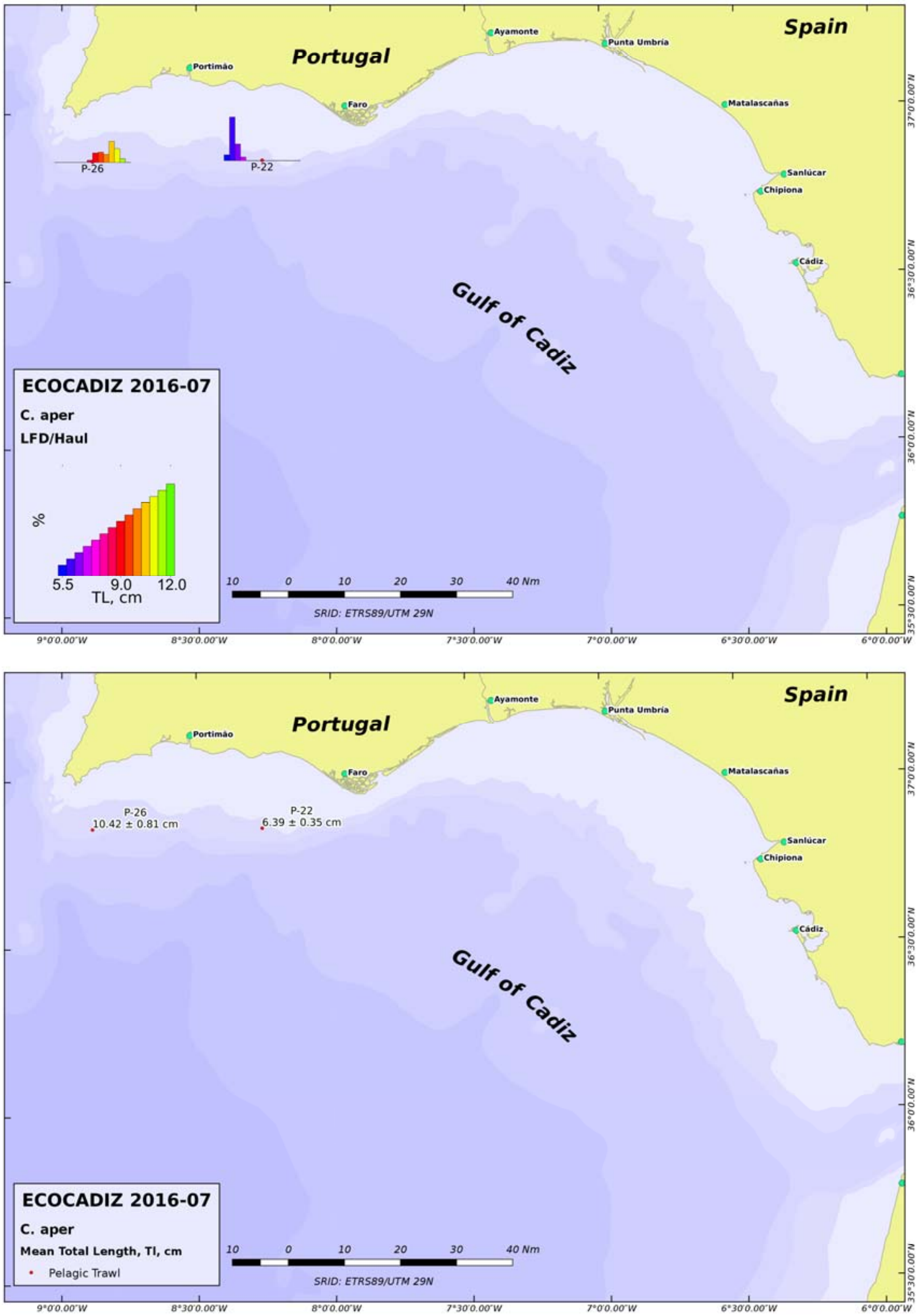
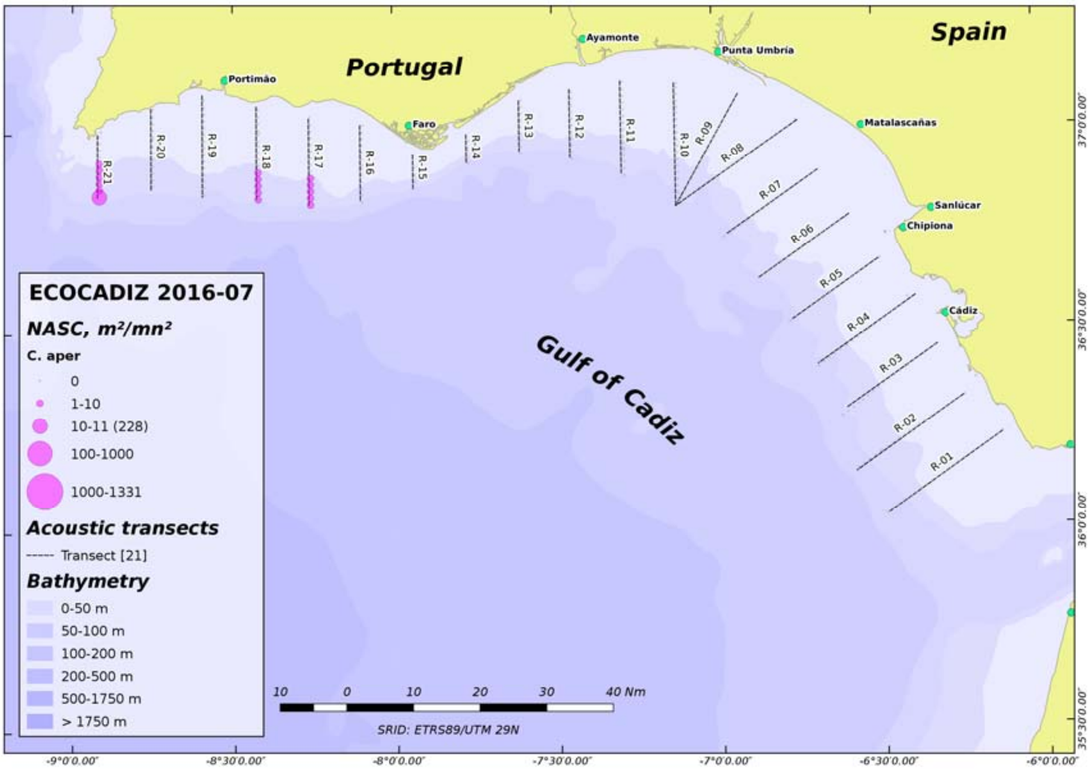


Figure 37. *ECOCADIZ 2016-07* survey. Boarfish (*Capros aper*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.



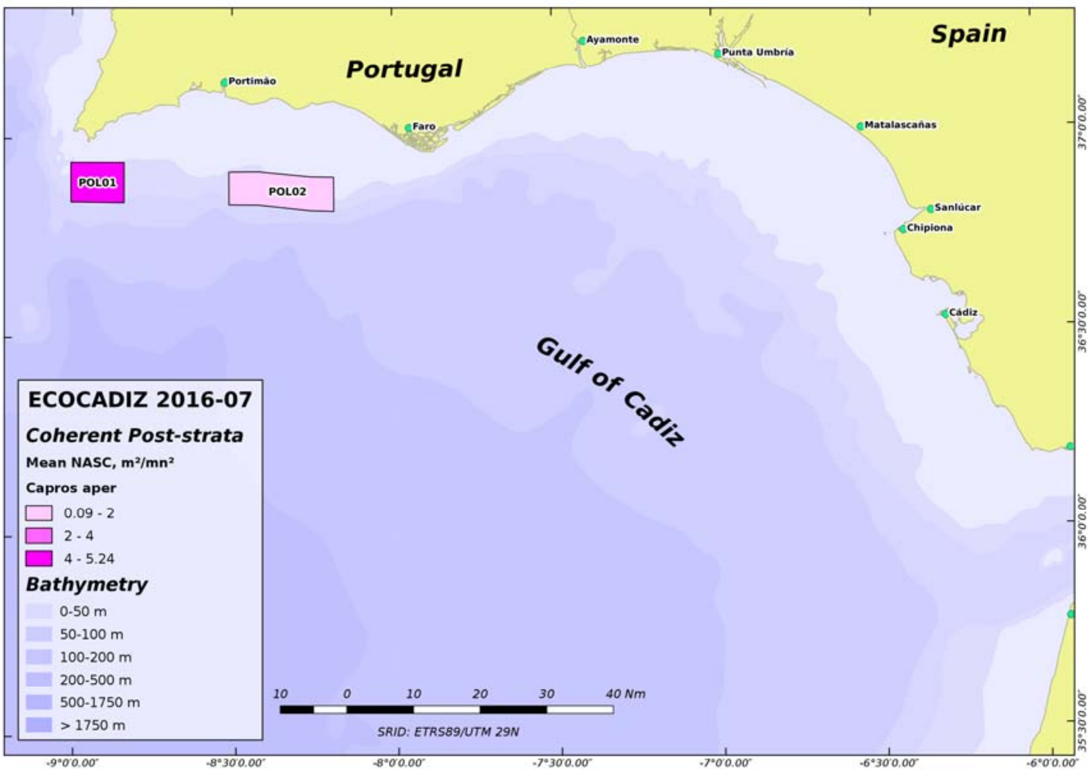


Figure 38. *ECOCADIZ 2016-07* survey. Boarfish (*Capros aper*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

***ECOCADIZ 2016-07*: Boarfish (*C. aper*)**

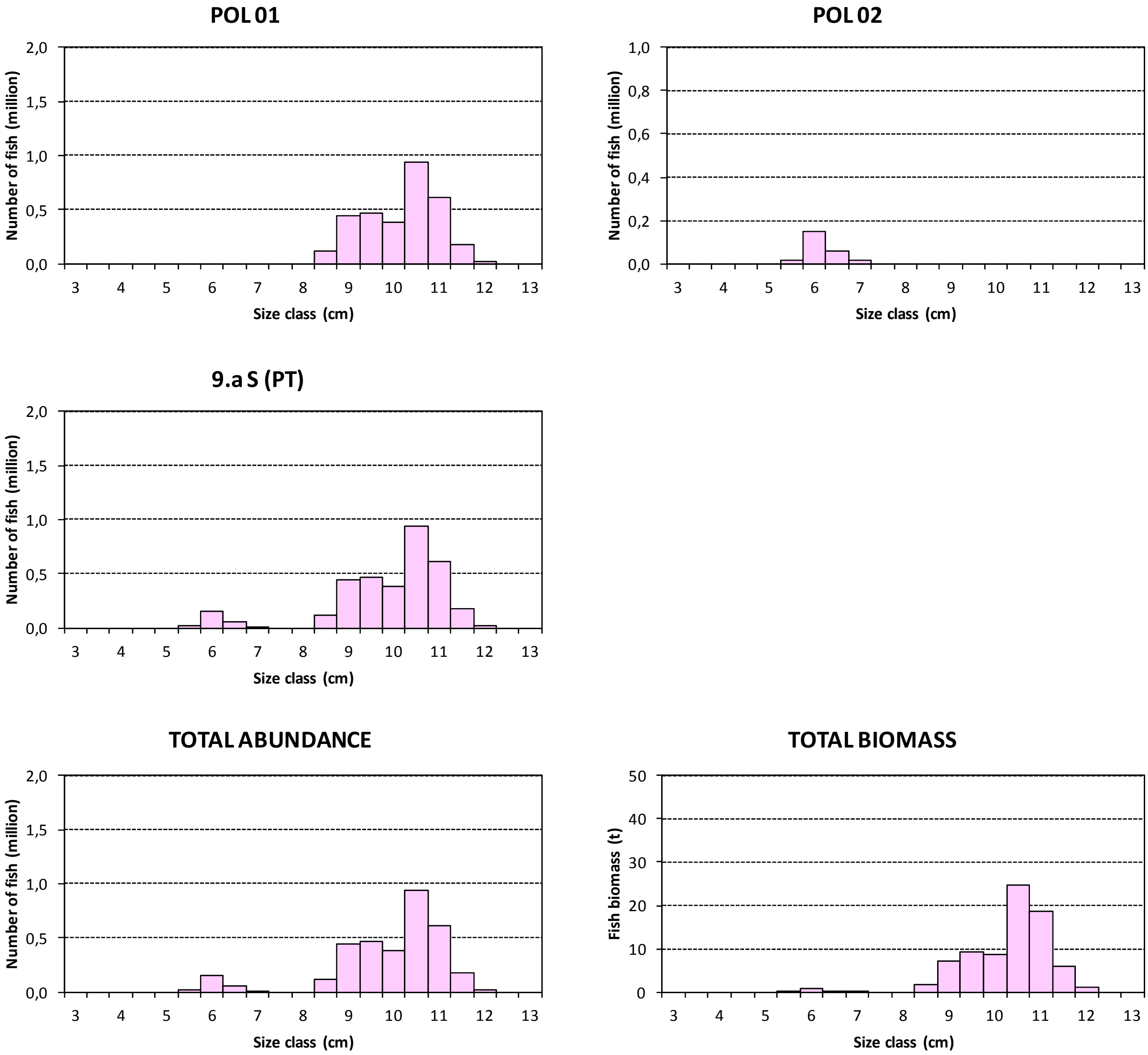
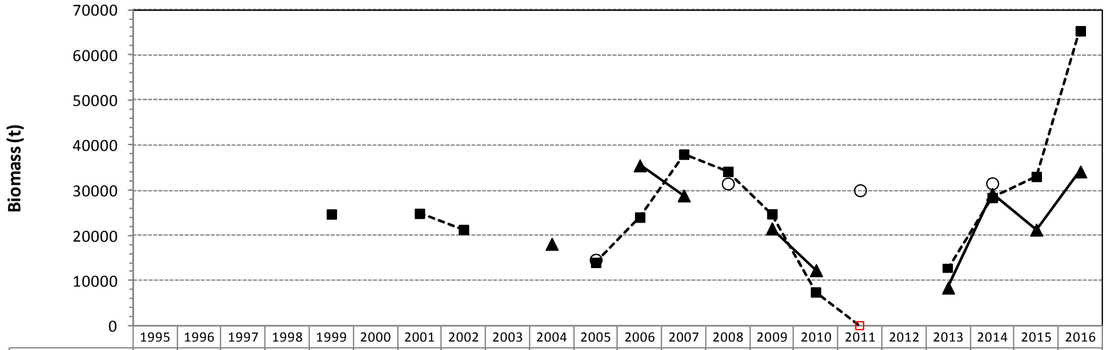


Figure 39. *ECOCADIZ 2016-07* survey. Boarfish (*Capros aper*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 38**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

Biomass trends (in tons)

Anchovy biomass estimates

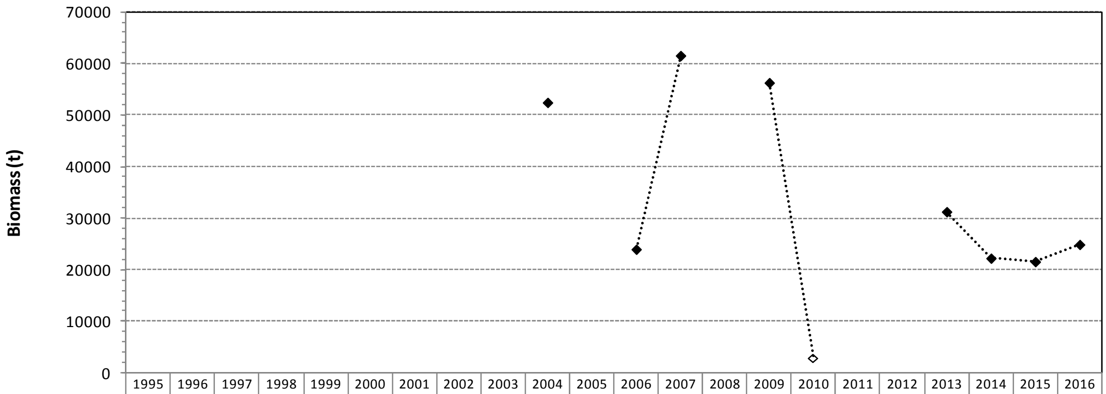


	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
PELAGO					24763		24913	21335			14041	24082	38020	34200	24800	7395	0		12700	28408	33100	65345
ECOCADIZ										18177		35539	28882		21580	12339			8487	29219	21305	34184
BOCADEVA											14637			31527			30037			31569		

Sardine biomass estimates

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
PELAGO	301000	260000	203000	162000	230000	181000	112000	286000	133000	39000	102000	129000	147000	61000	98000	37000	22000		30000	64227	16663	80356
ECOCADIZ										26568		123849	86777		37020	66964			9670	8697	23460	26919

Chub mackerel biomass estimates



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
ECOCADIZ										52440		23994	61530		56276	2861			31267	22258	21593	24918

Figure 40. Trends in Gulf of Cadiz anchovy, sardine and chub mackerel biomass estimates (in tons) in Portuguese (*PELAGO*, without available estimates for chub mackerel) and Spanish (*ECOCADIZ*) survey series. Gaps for the 2005, 2008 and 2011 anchovy acoustic estimates in the *ECOCADIZ* series are filled for anchovy with the *BOCADEVA* Spanish egg survey estimates. Note that the *PELAGO* survey in 2004 only covered Portuguese waters, and the *ECOCADIZ* survey in 2010 only covered the Spanish waters. The anchovy null estimate in 2011 from the *PELAGO* survey should be considered with caution.

Working document presented in the ICES Working Group on Southern Horse Mackerel, Sardine and Anchovy (WGHANSA). Bilbao, Spain, 24-29 June 2017.

Acoustic assessment and distribution of the main pelagic fish species in ICES Subdivision 9a South during the *ECOCADIZ-RECLUTAS 2016-07* Spanish survey (October-November 2016).

By

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ABSTRACT

The present working document summarises the main results obtained during the *ECOCADIZ-RECLUTAS 2016-10* Spanish (pelagic ecosystem-) acoustic survey. The survey was conducted by IEO between 16th October and 03rd November 2016 in the Portuguese and Spanish shelf waters (20-200 m isobaths) off the Gulf of Cadiz onboard the R/V *Ramón Margalef*. The survey's main objective is the acoustic assessment of anchovy and sardine juveniles (age 0 fish) in the recruitment areas of the Gulf of Cadiz. The acoustic transect in front of the Guadalquivir river estuary was not acoustically sampled by the realization of joint Spanish-NATO naval exercises in the Spanish waters during a great part of the survey, a constraint that has resulted in an underestimation of the acoustic estimates affecting to all the assessed species. Gulf of Cadiz anchovy abundance and biomass in autumn 2016 were 3 667 million fish and 19 861 t, the second highest values within its short series. The abundance and biomass of age-0 anchovies in the surveyed area were estimated at 3 445 million fish and 15 969 t. This juvenile fraction accounted for 94% and 80% of the total estimated population abundance and biomass, respectively. Spanish waters concentrated 99 % of the juveniles in the Gulf in terms of abundance (3 404 million) and 97% in biomass (15 506 t). As compared with the previous last years, these estimates and observations suggest the persistence of the scenario of good recruitments started the last year. Even a better perception is obtained from the autumn 2016 estimates for Gulf of Cadiz sardine: 2 379 million fish and 35 173 t, values which represent with respect to previous years a notable increase in abundance and biomass. Such a trend is caused by a noticeable increase of the juvenile fraction in the population in the autumn 2016 survey in terms both absolute and relative. Estimates of age-0 sardine are the highest ones within its series (1 940 millions and 21 899 t, 82% and 74% of the total population, respectively). These juveniles were mainly distributed in the Spanish coastal waters as well.

INTRODUCTION

During the 2007 and 2008 meetings of the ICES *Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES areas VIII and IX* (WGACEGG) was advanced the possibility of carrying out, since 2009 on, internationally coordinated yearly surveys aimed at the direct estimation of the anchovy and sardine recruitment in the Division 9a (ICES, 2007, 2008). The conduction of such surveys would require, at least in the Gulf of Cadiz, of an appropriate acoustic sampling of the shallowest waters of its central part, an area which the conventional surveys (either Spanish or Portuguese) do not sample but, however, used to form a great part of the recruitment areas of these species.

The general objective of these surveys should initially be focused in the acoustic assessment by vertical echo-integration and mapping of the abundance and biomass of recruits of small pelagic species (especially anchovy and secondarily sardine), as well as the mapping of both the oceanographic and biological conditions featuring the recruitment areas of these species in the Division 9a. The long term objective of the surveys would be to be able to assess the strength of the incoming recruitment to the fishery the next year.

The first attempt by the IEO of acoustically assessing the abundance of anchovy and sardine juveniles in their main recruitment areas off the Gulf of Cadiz dates back to 2009 (*ECOCADIZ-RECLUTAS 1009* survey). However, that survey was unsuccessful as to the achievement of their objectives because of the succession of a series of unforeseen problems which led to drastically reduce the foreseen sampling area to only the 6 easternmost transects. The continuation of this survey series was not guaranteed for next years and in fact no survey of these characteristics was carried out in 2010 and 2011. In 2012, the *ECOCADIZ-RECLUTAS 1112* survey was financed by the Spanish Fisheries Secretariat and planned and conducted by the IEO with the aim of obtaining an autumn estimate of Gulf of Cadiz anchovy biomass and abundance. The survey was conducted with the R/V *Emma Bardán*. Although the survey was restricted to the Spanish waters only it has been considered as the first survey within its series (Ramos *et al*., 2013. *ECOCADIZ-RECLUTAS 2014-10* survey was the next one and it was conducted with the R/V *Ramón Margalef*.

Given the closeness between the dates of the survey and the WG, the present Working Document advances some results from the *ECOCADIZ-RECLUTAS 2016-10* survey, the fourth in the series. These results will only refer to the acoustic estimates (not age-structured) and spatial distribution of anchovy as well as to inferences on the spatial distribution of other pelagic species from the distribution of the acoustic energy attributed to each of them.

MATERIAL AND METHODS

The *ECOCADIZ-RECLUTAS 2016-10* survey was carried out between 16th October and 3rd November 2016 onboard the Spanish R/V *Ramón Margalef* covering a survey area which comprised the waters of the Gulf of Cadiz, both Spanish and Portuguese, between the 20 m and 200 m isobaths. The survey design consisted in a systematic parallel grid with tracks equally spaced by 8 nm, normal to the shoreline (**Figure 1**).

Echo-integration was carried out with a *Simrad™ EK60* echo sounder working in the multi-frequency fashion (18, 38, 70, 120, 200, 333 kHz). Average survey speed was about 10 knots and the acoustic signals were integrated over 1-nm intervals (ESDU). Raw acoustic data were stored for further post-processing using *Myriax Software Echoview™* software package (by *Myriax Software Pty. Ltd.,* ex *SonarData Pty. Ltd.*). Acoustic equipment was calibrated during 17th and 18th October in the Bay of Algeciras following the new ICES standard procedures (Demer *et al*., 2015).

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 more recently by the *Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES areas VIII and IX* (WGACEGG; ICES, 2006a,b).

Fishing stations 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 monitored with *Simrad™ Mesotech FS20/25* trawl sonar. Trawl sonar data from each haul were recorded and stored for further analyses.

Ground-truthing haul samples provided biological data on species and they were also used to identify fish species and to allocate the back-scattering values into fish species according to the proportions found at the fishing stations (Nakken and Dommasnes, 1975).

Length frequency distributions (LFD) by 0.5-cm class were obtained for all the fish species in trawl samples (either from the total catch or from a representative random sample of 100-200 fish). Only those LFDs based on a minimum of 30 individuals and showing a normal distribution were considered for the purpose of the acoustic assessment.

Individual biological sampling (length, weight, sex, maturity stage, stomach fullness, and mesenteric fat content) was performed in each haul for anchovy, sardine (in both species with otolith extraction), mackerel (2 spp.) and horse-mackerel species (3 spp.), and bogue.

The following TS/length relationship table was used for acoustic estimation of assessed species (recent IEO standards after ICES, 1998; and recommendations by ICES, 2006a,b):

Species	b_{20}
Sardine (*Sardina pilchardus*)	-72.6
Round sardinella (*Sardinella aurita*)	-72.6
Anchovy (*Engraulis encrasicolus*)	-72.6
Chub mackerel (*Scomber japonicus*)	-68.7
Mackerel (*S. scombrus*)	-84.9
Horse mackerel (*Trachurus trachurus*)	-68.7
Mediterranean horse-mackerel (*T. mediterraneus*)	-68.7
Blue jack mackerel (*T. picturatus*)	-68.7
Bogue (*Boops boops*)	-67.0
Blue whiting (*Micromesistius poutassou*)	-67.5
Boarfish (*Capros aper*)	-66.2* (-72.6)

*Boarfish b_{20} estimate following to Fässler *et al*. (2013). Between parentheses the usual IEO value considered in previous surveys.

The *PESMA* software (J. Miquel, 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.

Egg sampling by CUFES was not carried out during the survey. 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 141 $CTDO_2$ casts by using *Sea-bird Electronics™ SBE 911+ SEACAT* (with coupled *Datasonics* altimeter, *SBE 43* oximeter, *WetLabs ECO-FL-NTU* fluorimeter and *WetLabs C-Star 25 cm* transmissometer sensors) profiler (**Figure 2**). *VMADCP RDI 150 kHz* records were also continuously recorded by night between CTD stations. Census of top predators was not recorded during the survey.

RESULTS

Acoustic sampling

The acoustic sampling was carried out between 22th October and 1st November. The complete grid was not possible to be sampled. Transect RA06 was not acoustically sampled for the reasons exposed below. Thus, the sampling scheme followed to accomplish this grid was highly conditioned by the realization of joint NATO naval exercises in the Spanish waters during a great part of the survey. The consecutive implementation of different naval exercises' polygons conditioned the order of realization of the acoustic transects during the survey's first and second legs. Thus, the acoustic sampling started by the coastal end of the transect R01 on 22nd October and proceeded westward up to the R05 on 24th. The acoustic sampling stopped on 24th-25th October in order to satisfy the R/V's refueling and provisioning needs. The second leg proceeded between 26th and 30th October by acoustically sampling the R10 to R21 transects in the usual E-W direction. On 1st November the acoustic sampling came back again to the Spanish waters to sample the remaining transects R09 to R06. These transects were sampled in the W-E direction but, again, the execution of new naval exercises finally prevented from sampling the R06 transect (**Table 1**; **Figure 1**).

In order to perform the acoustic sampling with daylight, this sampling started at 06:30-06:45 UTC until 25th October and at 07:30 UTC since 30th October on, 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 (15 of them valid according to a correct gear performance and resulting catches), were carried out during the survey (**Table 2**, **Figure 3**). Four additional trial fishing hauls were carried out during two previous days to the acoustic sampling in order to test different configurations of towing warp lengths, angles of attack of the doors (by adjusting the backstraps) and weights. 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. According to the above, the sampled depth range in the valid hauls oscillated between 41-154 m.

During the survey were captured 1 Chondrichthyan, 27 Osteichthyes, 2 Cephalopod, 1 Cnidarian and 1 Salpid species. The percentage of occurrence of the more frequent species in the hauls is shown in the enclosed Text Table below (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, sardine, anchovy and chub mackerel were the most frequent species in the valid hauls (70-80% presence index), followed by mackerel and horse mackerel (40-50%), and Mediterranean horse mackerel, bogue and blue-jack mackerel (with relative occurrences between 30-35%) (see text table below).

For the purposes of the acoustic assessment, anchovy, sardine, mackerel species, horse & jack mackerel species, and bogue were initially considered as the survey target species. All of the invertebrates, and both bentho-pelagic (*e.g.*, manta rays) and benthic fish species (e.g., flatfish, gurnards, etc.) 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 species were included in an operational category termed as “Others”.

According to the above premises, during the survey were captured a total of 5 086 kg and 207 thousand fish (**Table 3**). 40% of this “total” fished biomass corresponded to chub mackerel, 30% to sardine, 20% to anchovy, 2% to blue jack-mackerel and Mediterranean horse mackerel, 1% to horse mackerel and contributions lower than 1% for the remaining species. The most abundant species in ground-truthing trawl hauls were anchovy and chub mackerel (40% and 30% respectively), followed by sardine (29%), with each of the remaining species accounting for less than 1%.

Species	# of fishing stations	Occurrence (%)	Total weight (kg)	Total number
Sardina pilchardus	14	82	1500,935	59169
Scomber colias	12	71	2011,670	61749
Engraulis encrasicolus	12	71	1035,366	82072
Merluccius merluccius	11	65	6,055	48
Mola mola	10	59	170,944	60
Scomber scombrus	9	53	22,931	105
Trachurus trachurus	7	41	57,848	573
Trachurus mediterraneus	6	35	101,157	593
Boops boops	5	29	29,275	270
Trachurus picturatus	5	29	123,889	1770
Spondyliosoma cantharus	4	24	9,797	62
Spicara flexuosa	3	18	0,318	4
Pagellus erythrinus	3	18	2,739	16
Loligo media	3	18	0,883	172
Loligo vulgaris	3	18	1,027	13
Diplodus annularis	2	12	0,148	2
Sarda sarda	2	12	4,060	7
Lepidopus caudatus	2	12	0,022	2
Pomatomus saltatrix	2	12	7,973	23
Pagellus bellottii bellottii	1	6	0,330	2
Diplodus vulgaris	1	6	0,091	1
Pteromylaeus bovinus	1	6	41,32	1
Zeus faber	1	6	0,853	1
Diplodus bellottii	1	6	0,112	2
Maurolicus muelleri	1	6	0,001	1
Rhizostoma pulmo	1	6	5,610	2
Capros aper	1	6	0,007	1
Stromateus fiatola	1	6	0,630	1

The species composition of these fishing hauls (as expressed in terms of percentages in number) is shown in **Figure 4**. First impressions on the species' distribution patterns could be inferred from the relative contribution of the species in the fishing hauls. Thus, anchovy, sardine and chub mackerel were widely distributed all over the surveyed area, although the two later species showed higher yields in those hauls carried out in Portuguese waters. Yields of the remaining species were very low. Nevertheless, horse mackerel, blue-jack mackerel and bogue seemed to show higher yields in Portuguese waters. Surprisingly, Mediterranean horse mackerel occurred in hauls conducted as far west as just to the west of Cape Santa Maria.

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

A total of 295 nmi (ESDU) from 20 transects has been acoustically sampled by echo-integration for assessment purposes. The enclosed text table below provides the nautical area-scattering coefficients attributed to each of the selected target species and for the whole "pelagic fish assemblage".

S_A (m^2 nmi^{-2})	Total spp.	Anchovy	Sardine	Mackerel	Chub mack.	Horse mack.	Medit. h-mack.	Blue jack-mack.	Bogue
Total Area	96973	35121	35278	15	22479	217	2153	1229	481
%	100	36,2	36,4	0,02	23,2	0,2	2,2	1,3	0,5
Portugal	32470	3104	10298	7	16693	201	537	1229	400
%	33,5	8,8	29,2	47,1	74,3	92,5	25,0	100	83,1
Spain	64503	32017	24980	8	5786	16	1615	0	81
%	66,5	91,2	70,8	52,9	25,7	7,5	75,0	0,0	16,9

For this “pelagic fish assemblage” has been estimated a total of 96 973 m^2 nmi^{-2}. The highest NASC value was recorded in the coastal waters close to the Guadiana river mouth (R12), although the Spanish waters recorded the bulk of the acoustic energy (**Figure 7**). By species, anchovy and sardine accounted each one for 36% of this total back-scattered energy, followed by chub mackerel (23%) and Mediterranean horse mackerel (2%), and the remaining species with relative contributions of acoustic energies lower than 2%.

From the regional contributions to the total energy attributed to each species it could be inferred that chub mackerel, horse mackerel, blue-jack mackerel and bogue have been typically Portuguese species. The incidental occurrence of mackerel prevented from inferring any spatial pattern from their acoustic energy. Conversely, anchovy, Mediterranean horse mackerel and sardine showed a greater preference for the Spanish waters.

According to the resulting values of integrated acoustic energy, the species acoustically assessed in the present survey finally were anchovy, sardine, mackerel, chub mackerel, blue jack mackerel, horse mackerel, Mediterranean horse mackerel and bogue. For the time being the only available acoustic estimates of abundance and biomass are the ones for anchovy. Furthermore, these estimates are not still presented with age-structure. For the remaining species only the spatial distribution of NASCs will be shown in the present WD

Spatial distribution and abundance/biomass estimates

Anchovy

Parameters of the survey’s length-weight relationship for anchovy are given in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 8**. The mapping of the backscattering energy (nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species and the coherent strata considered for the acoustic estimation are shown in **Figure 9**. The estimated abundance and biomass by size and age class are given in **Tables 5** and **6** and **Figures 10** and **11**.

Anchovy avoid in autumn 2016, as it also did in summer, the easternmost waters of the Gulf. The spatial pattern of distribution of the acoustic density was further characterized by a concentration of a great part of the population in an area comprising the shelf waters between Punta Umbria and the Bay of Cadiz. A secondary nucleus of anchovy density was recorded in the mid-/outer shelf waters off western Portuguese Algarve, between Cape San Vicente and Cape Santa Maria (**Figure 9**).

The size composition of anchovy catches indicates that smallest recruits showed this year high occurrences in the coastal waters off the eastern Algarve, surroundings of the Guadiana and Guadalquivir river mouths and Bay of Cadiz (**Figure 8**).

The size range recorded for the estimated population was comprised between 7.5 and 17.5 cm size classes, with a marked mode at 9 cm size class and a very residual secondary mode at 15 cm. A similar size composition is also recorded for the estimated biomass (**Table 5**, **Figure 10**). The mean size and weight of the estimated population were 9.7 cm and 5.4 g respectively. The anchovy size composition by coherent post-strata in the autumn 2016 survey evidences that juveniles were mainly distributed in the coastal-inner shelf waters between the Guadiana river mouth and Bay of Cadiz, with the latter area being the area where the highest densities of anchovy juveniles were recorded (**Table 5**, **Figure 10**).

Gulf of Cadiz anchovy abundance and biomass in autumn 2016 were of 3 667 million fish and 19 861 t. Spanish waters concentrated 95.2% (3 490 million) and 84.6% (16 807 t) of the total estimated abundance and biomass respectively. Portuguese estimates amounted to 177 million and 3 054 t.

The age-0 population fraction was estimated at 3 445 million fish and 15 969 t, 94% and 80% of the total population abundance and biomass respectively (**Table 6**, **Figure 11**). Spanish waters concentrated 99% of the juveniles in the Gulf in terms of number (3 404 million) and 97% in biomass (15 506 t).

Sardine

Parameters of the survey's size-weight relationship for sardine are shown in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 12**. The mapping of the backscattering energy (nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species and the coherent strata considered for the acoustic estimation are shown in **Figure 13**. Estimated abundance and biomass by size and age class are given in **Tables 8** and **9**, and **Figures 14** and **15**.

Sardine was widely distributed all over the surveyed area, although showed two main nuclei of acoustic density: the most important one, comprising the inner-mid shelf waters between the Guadiana river mouth and Bay of Cadiz, and a secondary zone, which included the shelf waters between San Vicente and Santa Maria capes (**Figure 13**).

The sardine size composition in the positive hauls indicates that juveniles were mainly distributed over the coastal waters comprised between the Guadiana river mouth and Bay of Cadiz, whereas the largest sardines were captured in the Portuguese waters (**Figure 12**).

The size range recorded for the estimated population was comprised between 9 and 23 cm size classes, with a dominant mode at 11 cm size class, and a secondary mode at 19.5 cm size class. A similar size composition is also recorded for the estimated biomass (**Table 8**, **Figure 14**). The mean size and weight of the estimated population were 12.2 cm and 14.8 g respectively. The sardine size and age composition by coherent post-strata in the autumn 2016 survey evidence that juveniles were mainly distributed in the coastal-inner shelf waters between the Guadiana river mouth and Bay of Cadiz, with the area comprised between Guadiana mouth and Punta Umbria being the area where the highest densities of sardine juveniles were recorded (**Tables 8** and **9**, **Figures 14** and **15**).

Gulf of Cadiz sardine abundance and biomass in autumn 2016 were of 2 379 million fish and 35 173 t. Spanish waters concentrated 74.4% (1 770 million) and 62.8% (22 083 t) of the total estimated abundance and biomass respectively. Portuguese estimates amounted to 609 million and 13 091 t.

The age-0 population fraction was estimated at 1 940 million fish and 21 899 t, 82% and 62% of the total population abundance and biomass respectively (**Table 9**, **Figure 15**). Spanish waters concentrated 77% of the juveniles in the Gulf in terms of number (1 494 million) and 74% in biomass (16 220 t).

Mackerel

Parameters of the survey's length-weight relationship are shown in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 16**. The mapping of the backscattering energy (nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species and the coherent strata considered for the acoustic estimation are shown in **Figure 17**. Estimated abundance and biomass by size class are given in **Table 10** and **Figure 18**.

The species was mainly confined to the shelf waters between Cape Santa Maria and Matalascañas, showing a secondary zone of occurrence in the outer shelf waters between Portimão and Cape Santa Maria (**Figure 17**).

The mackerel size composition in the positive hauls indicates the occurrence of sub-adult fish restricted to the mid-shelf waters in front of the Guadiana river mouth. Larger specimens were recorded but scattered all over the species' distribution area (**Figure 16**).

The size range recorded for the estimated population was comprised between 19 and 36 cm size classes, with a dominant mode at 32 cm size class, and secondary modes at 21 and 35.5 cm size classes. A similar size composition is also recorded for the estimated biomass (**Table 10**, **Figure 18**).

Gulf of Cadiz mackerel abundance and biomass in autumn 2016 were of 3 million fish and 673 t. Portuguese waters concentrated 55.6% (ca. 1 million) and 41.7% (347 t) of the total estimated abundance and biomass respectively. Spanish waters yielded quite similar estimates amounting to ca. 1 million and 325 t (**Table 10**, **Figure 18**).

Chub mackerel

Parameters of the survey's length-weight relationship are shown in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 19**. The mapping of the backscattering energy (nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species and the coherent strata considered for the acoustic estimation are shown in **Figure 20**. Estimated abundance and biomass by size class are given in **Table 11** and **Figure 21**.

Chub mackerel, although widely distributed, showed, however, wide voids, especially in the inner-middle shelf waters in front of Doñana National Park and in the easternmost waters of the surveyed area. The highest integration values were recorded Tinto-Odiel river mouth and Cape San Vicente, outstanding the Algarve westernmost waters (**Figure 20**).

Size composition in the species' positive hauls indicates that juvenile/sub-adult fish mainly occurred in the central and western outer-shelf waters of the surveyed area whereas larger fish were distributed in shallower waters, mainly in the eastern sector (**Figure 19**).

The size range recorded for the estimated population was comprised between 12.5 and 28 cm size classes, with a dominant mode at 15.5 cm size class, and a secondary mode at 22 cm size class. In terms of biomass by size class, the main mode was at 22.5 cm size class and the secondary one at 16 cm size class (**Table 11**, **Figure 21**).

Gulf of Cadiz chub mackerel abundance and biomass in autumn 2016 were of 297 million fish and 13 689 t. Portuguese waters concentrated 77.6% (231 million) and 75% (10 269 t) of the total estimated abundance and biomass respectively. Spanish waters yielded 67 million and 3 429 t (**Table 10**, **Figure 18**).

Blue jack mackerel

Parameters of the survey's length-weight relationship are shown in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 22**. The mapping of the backscattering energy (nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species and the coherent strata considered for the acoustic estimation are shown in **Figure 23**. Estimated abundance and biomass by size class are given in **Table 12** and **Figure 24**.

The species only occurred in the Portuguese waters comprised between San Vicente and Santa Maria capes (**Figure 23**).

Size composition in the species' positive hauls indicates that the population is mainly composed by sub-adult fish, with larger specimens being recorded in the closeness of the Cape Santa Maria (**Figure 22**). Regarding the estimated population, the size range was comprised between 17.5 and 27 cm size classes, with a main mode at 25 cm and a secondary one at 19.5 cm. A similar size composition is also recorded for the estimated biomass (**Table 12**, **Figure 24**).

Blue jack mackerel abundance and biomass in autumn 2016 were of 9 million fish and 1 087 t, respectively. The whole estimated population was restricted to the Portuguese waters (**Table 12**, **Figure 24**).

Horse-mackerel

The survey's length-weight relationship for this species is shown in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 25**. The mapping of the backscattering energy (nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species and the coherent strata considered for the acoustic estimation are represented in **Figure 26**. Estimated abundance and biomass by size class are given in **Table 13** and **Figure 27**.

Horse mackerel was absent in the easternmost waters of the Gulf. The occurrence of the species was somewhat more constant in the Algarve westernmost outer shelf waters, where the species' highest acoustic densities were recorded (**Figure 26**).

Size composition in the species' positive hauls shows that larger specimens are located in the westernmost waters of the surveyed area (**Figure 25**).

The size range recorded for the estimated population was comprised between 13.5 and 29 cm size classes, with a dominant mode at 23 cm size class. A similar size composition is also recorded for the estimated biomass (**Table 13**, **Figure 27**).

Gulf of Cadiz horse mackerel abundance and biomass in autumn 2016 were of 2 million fish and 182 t. Portuguese waters concentrated 92.8% (2 million) and 93.3% (170 t) of the total estimated abundance and biomass respectively. Spanish waters yielded 0.1 million and 12 t (**Table 13**, **Figure 27**).

Mediterranean horse-mackerel

The survey's length-weight relationship for this species is shown in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 28**. The mapping of the backscattering energy (nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species and the coherent strata considered for the acoustic estimation are shown in **Figure 29**. Estimated abundance and biomass by size class are given in **Table 14** and **Figure 30**.

The species showed a relatively wide distribution all over the surveyed area, although rather scattered (**Figure 29**).

Size composition in the species' positive hauls shows that larger specimens are located in the easternmost waters of the surveyed area, whereas the rest of the surveyed area is frequented by juvenile fish (**Figure 28**).

The size range recorded for the estimated population was comprised between 17 and 41.5 cm size classes, with a main mode at 19.5 cm and a secondary one at 37.5 cm. The same modal classes were also recorded in the distribution of the estimated biomass by size class, although with a reversed importance of both modes (**Table 14**, **Figure 30**).

Mediterranean horse mackerel abundance and biomass in autumn 2016 were of 15 million fish and 2 222 t. Spanish waters concentrated 57.2% (8 million) and 83.4% (1 852 t) of the total estimated abundance and biomass respectively. Portuguese waters yielded 6 million and 370 t (**Table 14**, **Figure 30**).

Bogue

Parameters of the survey's length-weight relationship are shown in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 31**. The mapping of the backscattering energy (nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species and the coherent strata considered for the acoustic estimation are shown in **Figure 32**. Estimated abundance and biomass by size class are given in **Table 15** and **Figure 33**.

The species was absent to the east of Matalascañas, showing a somewhat scattered distribution in the remaining surveyed area (**Figure 32**).

The size range recorded for the estimated population was comprised between 15 and 28 cm size classes, with a mode at 21.5 cm, which also coincides with its counterpart in biomass (**Table 15**, **Figures 32** and **33**).

The total estimated abundance and biomass were of 3 million fish and 307 t. Portuguese waters yielded 83.6% of both the abundance (ca. 3 million) and biomass (257 t). Spanish waters estimates were of ca. 1 million fish and 50 t (**Table 15**, **Figure 33**).

(SHORT) DISCUSSION

Gulf of Cadiz anchovy abundance and biomass in autumn 2016 were of 3 667 million fish and 19 861 t, the second highest values within its short series (**Table 7**, **Figure 34**). Such population levels are, however, underestimated because of the incompleteness of the acoustic sampling in the surroundings of the Guadalquivir river estuary, just the zone where the species, and more specifically the recruits, typically register the highest abundances. Therefore, the same abovementioned considerations are also applicable to the estimates of the abundance and biomass of the age-0 recruits (3 445 million, 15 969 t). In any case, the available estimates seem to suggest a relatively good anchovy recruitment scenario during the last two years in the Gulf of Cadiz.

For sardine are also valid the same considerations on the acoustic sampling constraints and their implications in the final estimates but, the present situation seems to be even better in terms of recruitment strength than the scenario described for anchovy, with the 2016 autumn estimate for age-0 sardines being the highest one within its series (1 940 millions and 21 899 t; **Table 10**, **Figure 34**). The total population yielded estimates of 2 379 million fish and 35 173 t.

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Table 1. *ECOCADIZ-RECLUTAS 2016-10* 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)
R01	Trafalgar	22/10/16	36º 13.960' N	6º 07.201' W	06:34	25	36º 01.938' N	6º 28.852' W	11:16	226
R02	Sancti-Petri	22/10/16	36º 08.726' N	6º 08.745' W	12:05	201	36º 19.326' N	6º 14.680' W	16:07	26
R03	Cádiz	23/10/16	36º 27.370' N	6º 18.811' W	06:32	25	36º 17.490' N	6º 36.849' W	08:34	200
R04	Rota	23/10/16	36º 24.811' N	6º 40.886' W	09:29	168	36º 34.700' N	6º 22.873' W	12:20	21
R05	Chipiona	24/10/16	36º 31.220' N	6º 46.220' W	06:50	161	36º 40.482' N	6º 28.490' W	11:27	21
R06	Doñana	NOT SAMPLED								
R07	Matalascañas	01/11/16	36º 53.890' N	6º 40.431' W	16:25	23	36º 44.031' N	6º 58.643' W	18:04	206
R08	Mazagón	01/11/16	36º 49.254' N	7º 05.742' W	11:37	171	37º 00.020' N	6º 96.530' W	15:37	27
R09	Punta Umbría	01/11/16	37º 04.220' N	6º 56.130' W	07:30	27	36º 49.585' N	7º 06.556' W	11:26	226
R10	El Rompido	26/10/16	37º 07.350' N	7º 07.330' W	06:50	20	36º 49.924' N	7º 07.144' W	10:37	230
R11	Isla Cristina	26/10/16	36º 53.659' N	7º 17.401' W	13:31	143	37º 05.901' N	7º 17.355 W	16:44	26
R12	V.R. Do Sto. Antonio	27/10/16	37º 06.380' N	7º 26.970' W	06:48	22	36º 56.170' N	7º 26.760' W	07:49	200
R13	Tavira	27/10/16	36º 57.161' N	7º 36.494' W	10:39	178	37º 04.209' N	7º 36.667' W	11:22	26
R14	Fuzeta	27/10/16	36º 58.952' N	7º 46.260' W	13:17	74	36º 55.594' N	7º 46.417' W	13:38	203
R15	Cabo Sta. María	28/10/16	36º 55.180' N	7º 56.440' W	06:51	73	36º 52.030' N	7º 56.347' W	07:09	200
R16	Cuarteira	28/10/16	36º 50.050' N	8º 06.237' W	08:01	118	37º 01.580' N	8º 06.308' W	09:44	25
R17	Albufeira	28/10/16	36º 49.430' N	8º 15.940' W	15:38	133	37º 02.104' N	8º 15.953' W	16:50	23
R18	Alfanzinha	29/10/16	37º 04.118' N	8º 25.704' W	06:47	31	36º 50.350' N	8º 25.614' W	08:15	200
R19	Portimao	29/10/16	36º 51.188' N	8º 35.764' W	10:50	115	37º 05.140' N	8º 35.742' W	15:01	34
R20	Burgau	30/10/16	37º 03.641' N	8º 45.293' W	07:32	37	36º 52.090' N	8º 45.293' W	08:32	37
R21	Ponta de Sagres	30/10/16	36º 50.930' N	8º 55.351' W	11:30	173	36º 59.599' N	8º 55.398' W	12:22	27

Table 2. *ECOCADIZ-RECLUTAS 2016-10* survey. Descriptive characteristics of the fishing stations. Null hauls in light grey.

Fishing Station	Date	Start		End		UTC Time		Depth (m)		Duration (min)		Trawled Distance (nm)	Acoustic Transect	Zone (landmark)
		Latitude	Longitude	Latitude	Longitude	Start	End	Start	End	Effective Trawling	Total Manoeuvre			
01	19-10-2016	36º 19.3042 N	6º 36.3165 W	36º 18.5871 N	6º 35.9658 W	14:16	14:30	165,75	166,16	00:13	01:22	0,77	--	TEST HAUL
02	19-10-2016	36º 17.0321 N	6º 35.4577 W	36º 17.5861 N	6º 35.7734 W	15:45	15:55	168,08	171,90	00:09	01:02	0,61	--	TEST HAUL
03	20-10-2016	36º 31.2917 N	6º 28.8378 W	36º 30.3946 N	6º 30.7102 W	07:18	07:46	50,16	59,01	00:28	01:07	1,76	--	TEST HAUL
04	20-10-2016	36º 31.3734 N	6º 28.6767 W	36º 30.4852 N	6º 30.5007 W	11:50	12:17	65,63	65,63	00:26	01:03	1,72	--	TEST HAUL
05	22-10-2016	36º 03.5381 N	6º 25.5979 W	36º 04.7208 N	6º 23.2962 W	09:02	09:35	106,13	88,42	00:33	01:32	2,21	R01	Trafalgar
06	22-10-2016	36º 17.8889 N	6º 19.0515 W	36º 16.0818 N	6º 18.0873 W	14:22	14:53	41,32	40,81	00:30	00:58	1,97	R02	Sancti-Petri
07	23-10-2016	36º 30.0321 N	6º 31.1014 W	36º 30.0292 N	6º 31.1063 W	11:00	11:00	60,99	61,24	00:00	00:36	0,005	R04	Rota
08	23-10-2016	36º 30.2491 N	6º 30.7472 W	36º 29.0117 N	6º 33.0607 W	14:45	15:20	57,50	71,90	00:35	01:15	2,24	R04	Rota
09	24-10-2016	36º 33.2007 N	6º 42.6913 W	36º 31.7231 N	6º 45.3827 W	07:53	08:33	109,65	153,83	00:40	01:41	2,62	R05	Chipiona
10	26-10-2016	37º 00.1753 N	7º 07.2210 W	37º 02.9554 N	7º 07.2177 W	08:04	08:47	60,82	44,51	00:42	01:21	2,78	R10	El Rompido
11	26-10-2016	36º 51.3930 N	7º 07.1261 W	36º 53.9805 N	7º 07.1128 W	11:17	11:57	143,13	110,85	00:39	01:41	2,58	R10	El Rompido
12	26-10-2016	37º 00.9008 N	7º 17.3054 W	36º 58.6725 N	7º 17.1228 W	14:46	15:20	66,06	94,42	00:33	01:17	2,23	R11	Isla Cristina
13	27-10-2016	36º 56.7498 N	7º 26.7638 W	36º 59.0922 N	7º 26.7889 W	08:26	09:01	137,6	103,68	00:34	01:30	2,34	R12	Vila Real do Santo Antonio
14	28-10-2016	36º 57.9599 N	8º 06.2151 W	36º 56.1512 N	8º 06.0749 W	10:35	11:02	44,32	50,43	00:26	01:06	1,81	R16	Cuarteira
15	28-10-2016	36º 53.4483 N	8º 06.4037 W	36º 50.1979 N	8º 06.5357 W	13:19	14:07	94,22	115,22	00:47	01:43	3,25	R16	Cuarteira
16	29-10-2016	36º 51.4760 N	8º 24.2617 W	36º 51.5065 N	8º 26.9819 W	08:56	09:29	n.a.	133,81	00:32	01:32	2,18	R18	Alfanzina
17	29-10-2016	36º 54.8948 N	8º 35.8385 W	36º 52.0046 N	8º 35.8688 W	11:52	12:36	101.00	118,23	00:43	01:43	2,89	R19	Portimao
18	30-10-2016	36º 53.1732 N	8º 45.4499 W	36º 54.5536 N	8º 45.5273 W	09:09	09:29	104,82	109,60	00:20	01:22	1,38	R20	Burgau
19	01-11-2016	36º 55.5391 N	7º 02.5424 W	36º 57.8970 N	7º 00.7500 W	08:56	09:37	88,41	62,43	00:40	01:28	2,76	R09	Punta Umbría
20	01-11-2016	36º 51.4378 N	7º 02.5934 W	36º 50.4359 N	7º 04.2132 W	12:28	12:52	111,92	130,18	00:24	01:24	1,64	R08	Mazagón

Table 3. *ECOCADIZ-RECLUTAS 2016-10* survey. Catches by species in number (upper panel) and weight (in kg, lower panel) from valid fishing stations.

ABUNDANCE (nº)												
Fishing station	***Anchovy***	***Sardine***	***Chub mack.***	***Mackerel***	***Horse-mack.***	***Blue Jack-mack.***	***Medit. Horse-mack.***	***Bogue***	***Blue whiting***	***Boarfish***	**Other spp.**	**TOTAL**
05	0	1	0	0	0	0	201	0	0	0	15	**217**
06	0	434	0	0	0	0	17	0	0	0	24	**475**
08	5407	1026	1	0	0	0	7	0	0	0	9	**6450**
09	1409	3225	1045	0	0	0	0	0	0	0	22	**5701**
10	260	7143	85	14	0	0	11	6	0	0	25	**7544**
11	14974	20	2958	5	0	0	0	0	0	0	15	**17972**
12	845	2413	346	2	0	0	0	0	0	0	7	**3613**
13	4661	0	324	25	1	0	0	0	0	0	6	**5017**
14	0	4781	3008	0	1	2	352	45	0	0	46	**8235**
15	7469	2648	9	6	95	34	0	0	0	0	10	**10271**
16	5744	88	263	36	2	1610	0	0	0	0	8	**7751**
17	1878	14188	2128	1	413	107	0	214	0	1	5	**18935**
18	8175	10609	51352	8	57	17	0	4	0	0	2	**70224**
19	11159	8587	0	0	4	0	5	1	0	0	28	**19784**
20	20091	4006	230	8	0	0	0	0	0	0	10	**24345**
TOTAL	**82072**	**59169**	**61749**	**105**	**573**	**1770**	**593**	**270**	**0**	**1**	**232**	**206534**

BIOMASS (kg)												
Fishing station	***Anchovy***	***Sardine***	***Chub mack.***	***Mackerel***	***Horse-mack.***	***Blue Jack-mack.***	***Medit. Horse-mack.***	***Bogue***	***Blue whiting***	***Boarfish***	**Other spp.**	**TOTAL**
05	0,000	0,024	0,000	0,000	0,000	0,000	73,815	0,000	0,000	0,000	39,605	113,444
06	0,000	6,980	0,000	0,000	0,000	0,000	3,720	0,000	0,000	0,000	12,060	22,760
08	39,960	9,956	0,239	0,000	0,000	0,000	0,587	0,000	0,000	0,000	5,388	56,130
09	10,038	60,862	106,430	0,000	0,000	0,000	0,000	0,000	0,000	0,000	43,134	220,464
10	1,465	87,218	10,180	3,992	0,000	0,000	0,402	0,640	0,000	0,000	4,007	107,904
11	257,240	0,454	93,756	1,232	0,000	0,000	0,000	0,000	0,000	0,000	20,764	373,446
12	7,322	67,275	24,918	0,542	0,000	0,000	0,000	0,000	0,000	0,000	10,398	110,455
13	85,520	0,000	8,600	1,786	0,024	0,000	0,000	0,000	0,000	0,000	0,266	96,196
14	0,000	321,980	262,480	0,000	0,103	0,240	22,466	9,200	0,000	0,000	10,418	626,887
15	150,040	69,580	0,300	1,267	13,533	4,549	0,000	0,000	0,000	0,000	0,800	240,069
16	104,130	1,516	9,005	9,900	0,186	109,650	0,000	0,000	0,000	0,000	19,592	253,979
17	33,115	478,569	79,498	0,258	37,738	8,215	0,000	18,840	0,000	0,007	0,923	657,163
18	190,104	259,722	1404,224	1,905	6,145	1,235	0,000	0,360	0,000	0,000	2,142	1865,837
19	37,172	69,057	0,000	0,000	0,119	0,000	0,167	0,235	0,000	0,000	10,775	117,525
20	119,260	67,742	12,040	2,049	0,000	0,000	0,000	0,000	0,000	0,000	23,184	224,275
TOTAL	**1035,366**	**1500,935**	**2011,670**	**22,931**	**57,848**	**123,889**	**101,157**	**29,275**	**0,000**	**0,007**	**203,456**	**5086,534**

Table 4. *ECOCADIZ-RECLUTAS 2016-10* survey. Parameters of the size-weight relationships for survey's target species. FAO codes for the species: PIL: *Sardina pilchardus*; ANE: *Engraulis encrasicolus*; MAS: *Scomber colias*; MAC: *Scomber scombrus*; JAA: *Trachurus picturatus;* HOM: *Trachurus trachurus*; HMM: *Trachurus mediterraneus*; BOG: *Boops boops*.

Parameter	PIL	ANE	MAS	MAC	JAA	HOM	HMM	BOG
Size range (mm)	95-229	74-179	136-307	192-361	178-271	133-290	143-415	173-283
n	704	635	471	105	150	158	142	105
a	0,002927381	0,002553664	0,00170471	0,001671031	0,00390559	0,004891172	0,011185539	0,012752233
b	3,346989755	3,329386573	3,473183972	3,444663104	3,225878937	3,169580434	2,870514722	2,878886839
r^2	0,985828503	0,987975559	0,990370594	0,981904596	0,964055779	0,98184743	0,994915773	0,867747068

Table 5. *ECOCADIZ-RECLUTAS 2016-10* 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 9**.

***ECOCADIZ-RECLUTAS 2016-07*. *Engraulis encrasicolus*. ABUNDANCE (in numbers and million fish)**																		
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**POL08**	**POL09**	**POL10**	**POL11**	**POL12**	***n***			**millions**		
													PORTUGAL	**SPAIN**	**TOTAL**	**PORTUGAL**	**SPAIN**	**TOTAL**
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
6,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
7,5	0	0	0	0	0	0	0	0	109915487	0	0	0	0	109915487	109915487	**0**	**110**	**110**
8	0	0	0	0	35498	37119	0	0	274826646	1343558	44541	109245593	35498	385497457	385532955	**0,04**	**385**	**386**
8,5	0	0	0	0	240736	251731	0	0	214369335	9111633	302064	473274130	240736	697308893	697549629	**0,2**	**697**	**698**
9	0	0	0	0	1581579	1653819	0	0	164911159	59861405	1984493	709911195	1581579	938322071	939903650	**2**	**938**	**940**
9,5	0	0	87379	0	2643603	2764351	316801	0	32997403	100058104	3317073	418466172	2730982	557919904	560650886	**3**	**558**	**561**
10	0	0	87379	0	3345332	3498132	316801	0	27459908	126617944	4197570	200345309	3432711	362435664	365868375	**3**	**362**	**366**
10,5	0	104485	990293	70047	2443148	2554740	3590407	90132	5461639	92471046	3065551	72953837	3607973	180187352	183795325	**4**	**180**	**184**
11	0	308410	4106803	206759	1658862	1734632	14889631	266046	10999134	62786507	2081465	18145878	6280834	110903293	117184127	**6**	**111**	**117**
11,5	0	486960	3859230	326460	981359	1026183	13992029	420070	5461639	37143593	1231365	0	5654009	59274879	64928888	**6**	**59**	**65**
12	0	2163911	2053401	1450698	359033	375432	7444815	1866671	0	13589078	450498	0	6027043	23726494	29753537	**6**	**24**	**30**
12,5	0	3141919	815535	2106359	0	0	2956806	2710336	0	0	0	0	6063813	5667142	11730955	**6**	**6**	**12**
13	492574	6749825	247573	4525118	0	0	897602	5822651	0	0	0	0	12015090	6720253	18735343	**12**	**7**	**19**
13,5	981604	13827131	87379	9269782	0	0	316801	11927801	0	0	0	0	24165896	12244602	36410498	**24**	**12**	**36**
14	2944811	18937942	0	12696096	0	0	0	16336577	0	0	0	0	34578849	16336577	50915426	**35**	**16**	**51**
14,5	5645106	15315795	0	10267789	0	0	0	13211978	0	0	0	0	31228690	13211978	44440668	**31**	**13**	**44**
15	5893165	6374708	0	4273638	0	0	0	5499062	0	0	0	0	16541511	5499062	22040573	**17**	**5**	**22**
15,5	7119283	2882367	0	1932354	0	0	0	2486438	0	0	0	0	11934004	2486438	14420442	**12**	**2**	**14**
16	4418988	1810899	0	1214036	0	0	0	1562149	0	0	0	0	7443923	1562149	9006072	**7**	**2**	**9**
16,5	981604	767957	0	514843	0	0	0	662469	0	0	0	0	2264404	662469	2926873	**2**	**1**	**3**
17	244515	242584	0	162630	0	0	0	209262	0	0	0	0	649729	209262	858991	**1**	**0,2**	**1**
17,5	244515	0	0	0	0	0	0	0	0	0	0	0	244515	0	244515	**0,2**	**0**	**0,2**
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
18,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL *n*	28966165	73114893	12334972	49016609	13289150	13896139	44721693	63071642	846402350	502982868	16674620	2002342114	176721789	3490091426	3666813215	**177**	**3490**	**3667**
Millions	**29**	**73**	**12**	**49**	**13**	**14**	**45**	**63**	**846**	**503**	**17**	**2002**						

Table 5. *ECOCADIZ-RECLUTAS 2016-10* survey. Anchovy (*E. encrasicolus*). Cont'd.

***ECOCADIZ-RECLUTAS 2016-07 . Engraulis encrasicolus* . BIOMASS (t)**															
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**POL08**	**POL09**	**POL10**	**POL11**	**POL12**	**PORTUGAL**	**SPAIN**	**TOTAL**
6	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
6,5	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
7	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
7,5	0	0	0	0	0	0	0	0	256,747	0	0	0	**0**	**256,747**	**256,747**
8	0	0	0	0	0,102	0,107	0	0	790,349	3,864	0,128	314,170	**0,102**	**1108,618**	**1108,720**
8,5	0	0	0	0	0,842	0,880	0	0	749,758	31,868	1,056	1655,280	**0,842**	**2438,842**	**2439,684**
9	0	0	0	0	6,655	6,959	0	0	693,877	251,872	8,350	2987,009	**6,655**	**3948,067**	**3954,722**
9,5	0	0	0,438	0	13,252	13,857	1,588	0	165,409	501,570	16,628	2097,683	**13,69**	**2796,735**	**2810,425**
10	0	0	0,517	0	19,804	20,709	1,875	0	162,563	749,579	24,850	1186,046	**20,321**	**2145,622**	**2165,943**
10,5	0	0,725	6,869	0,486	16,946	17,720	24,904	0,625	37,883	641,401	21,263	506,025	**25,026**	**1249,821**	**1274,847**
11	0	2,488	33,136	1,668	13,385	13,996	120,138	2,147	88,747	506,598	16,794	146,411	**50,677**	**894,831**	**945,508**
11,5	0	4,541	35,984	3,044	9,150	9,568	130,465	3,917	50,926	346,336	11,482	0	**52,719**	**552,694**	**605,413**
12	0	23,177	21,993	15,538	3,845	4,021	79,738	19,993	0	145,547	4,825	0	**64,553**	**254,124**	**318,677**
12,5	0	38,441	9,978	25,771	0	0	36,176	33,161	0	0	0	0	**74,190**	**69,337**	**143,527**
13	6,849	93,856	3,442	62,921	0	0	12,481	80,964	0	0	0	0	**167,068**	**93,445**	**260,513**
13,5	15,439	217,475	1,374	145,796	0	0	4,983	187,602	0	0	0	0	**380,084**	**192,585**	**572,669**
14	52,159	335,434	0	224,877	0	0	0	289,358	0	0	0	0	**612,47**	**289,358**	**901,828**
14,5	112,141	304,250	0	203,971	0	0	0	262,458	0	0	0	0	**620,362**	**262,458**	**882,82**
15	130,797	141,484	0	94,852	0	0	0	122,05	0	0	0	0	**367,133**	**122,05**	**489,183**
15,5	175,909	71,220	0	47,746	0	0	0	61,437	0	0	0	0	**294,875**	**61,437**	**356,312**
16	121,149	49,647	0	33,283	0	0	0	42,827	0	0	0	0	**204,079**	**42,827**	**246,906**
16,5	29,765	23,287	0	15,612	0	0	0	20,088	0	0	0	0	**68,664**	**20,088**	**88,752**
17	8,177	8,112	0	5,438	0	0	0	6,998	0	0	0	0	**21,727**	**6,998**	**28,725**
17,5	8,992	0	0	0	0	0	0	0	0	0	0	0	**8,992**	**0**	**8,992**
18	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
18,5	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL	**661,377**	**1314,137**	**113,731**	**881,003**	**83,981**	**87,817**	**412,348**	**1133,625**	**2996,259**	**3178,635**	**105,376**	**8892,624**	**3054,229**	**16806,684**	**19860,913**

Table 6. *ECOCADIZ-RECLUTAS 2016-07* survey. Anchovy (E. encrasicolus). Estimated abundance (thousands of individuals) and biomass (tonnes) by age group. Polygons (i.e., coherent or homogeneous post-strata) numbered as in **Figure 9** and ordered from west to east.

Age class	POL01	POL02	POL03	POL04	POL05	POL06	POL07	POL08	POL09	POL10	POL11	POL12	PT	ES	TOTAL
	N	N	N	N	N	N	Nr	N	N	N	N	N	N	N	N
0	1864	10103	9975	6773	12828	13414	36167	8715	844846	485538	16096	1998929	41544	3403706	3445250
I	24647	60157	2336	40330	461	482	8470	51894	1557	17445	578	3413	127932	83839	211770
II	2455	2855	23	1914	0	0	84	2463	0	0	0	0	7246	2547	9793
III	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	28966	73115	12335	49017	13289	13896	44722	63072	846402	502983	16675	2002342	176722	3490091	3666813

Age class	POL01	POL02	POL03	POL04	POL05	POL06	POL07	POL08	POL09	POL10	POL11	POL12	PT	ES	TOTAL
	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
0	40	153	88	102	80	83	320	132	2983	3020	100	8868	463	15506	15969
I	559	1103	25	739	4	4	91	951	13	159	5	25	2430	1249	3678
II	63	59	0	39	0	0	1	51	0	0	0	0	161	52	213
III	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	661	1314	114	881	84	88	412	1134	2996	3179	105	8893	3054	16807	19861

Table 7. *ECOCADIZ-RECLUTAS* surveys series. Anchovy (*E. encrasicolus*). Acoustic estimates of biomass (t) and abundance (million fish) for the whole Gulf of Cadiz anchovy population and for the juvenile fraction (*i.e*. age 0 fish, between parentheses).

Estimate/Year	Total Population (Recruits at age 0)			
	2012	2014	2015	2016
Biomass (t)	13680 (13354)	8113 (5131)	30827 (29219)	19861 (15969)
Abundance (millions)	2469 (2619)	986 (814)	5227 (5117)	3667 (3445)

Table 8. *ECOCADIZ-RECLUTAS 2016-10* 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 13**.

***ECOCADIZ-RECLUTAS 2016-10*. *Sardina pilchardus*. ABUNDANCE (in number and million fish)**																				
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**POL08**	**POL09**	**POL10**	**POL11**	**POL12**	**POL13**	**POL14**	***n***			**millions**		
															PORTUGAL	**SPAIN**	**TOTAL**	**PORTUGAL**	**SPAIN**	**TOTAL**
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
6,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
7,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
8,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
9	0	0	0	0	0	0	0	0	0	0	0	10913328	0	0	0	10913328	10913328	**0**	**11**	**11**
9,5	0	0	0	0	0	0	0	0	0	0	0	76349110	0	0	0	76349110	76349110	**0**	**76**	**76**
10	0	0	0	0	0	0	22433482	23471535	0	527220	12357412	120002420	18211799	871441	22433482	175441827	197875309	**22**	**175**	**198**
10,5	0	0	0	0	0	0	79475279	83152796	0	790830	43778701	87262437	64519088	1307161	79475279	280811013	360286292	**79**	**281**	**360**
11	0	0	0	0	0	963173	152258660	159304044	3004068	790830	83871193	51827260	123605604	1307161	153221833	423710160	576931993	**153**	**424**	**577**
11,5	0	0	0	0	0	1351317	84452739	88360576	4214662	2688770	46520520	10913328	68559856	4444259	85804056	225701971	311506027	**86**	**226**	**312**
12	0	85289	292470	0	16056	2314490	51334494	53709868	7218729	12276139	28277441	19087277	41674025	20291195	54042799	182534674	236577473	**54**	**183**	**237**
12,5	0	518843	0	11615	97673	2889519	6658727	6966843	9012203	24672534	3667939	2739378	5405643	40781160	10176377	93245700	103422077	**10**	**93**	**103**
13	0	1947000	1172960	27102	366525	3665808	3329364	3483422	11433391	24118954	1833969	0	2702822	39866149	10508759	83438707	93947466	**11**	**83**	**94**
13,5	0	4735347	1465430	41298	891436	1351317	0	0	4214662	17892320	0	0	0	29574164	8484828	51681146	60165974	**8**	**52**	**60**
14	0	7465307	292470	21940	1405354	2515750	1540213	1611482	7846445	14764865	848421	0	1250365	24404802	13241034	50726380	63967414	**13**	**51**	**64**
14,5	0	6872055	880490	9034	1293674	4830240	0	0	15065174	8617378	0	0	0	14243639	13885493	37926191	51811684	**14**	**38**	**52**
15	0	5078750	4688761	2581	956082	5089003	0	0	15872237	3206608	0	0	0	5300193	15815177	24379038	40194215	**16**	**24**	**40**
15,5	0	4742701	10846032	0	892820	2630756	114090	119369	8205140	1150953	62846	0	92620	1902407	19226399	11533335	30759734	**19**	**12**	**31**
16	0	3083542	11138502	0	580481	1164433	1568735	1641324	3631783	334064	864133	0	1273520	552173	17535693	8296997	25832690	**18**	**8**	**26**
16,5	0	1015925	6449741	0	191249	43127	199657	208896	134510	140908	109981	44184	162084	232906	7899699	1033469	8933168	**8**	**1**	**9**
17	0	955731	4396291	0	179918	345017	142612	149211	1076084	122078	78558	0	115775	201783	6019569	1743489	7763058	**6**	**2**	**8**
17,5	1035546	671434	1172960	0	126398	71879	256702	268580	224184	114939	141404	44184	208394	189983	3334919	1191668	4526587	**3**	**1**	**5**
18	2087529	106612	0	0	20070	848167	399314	417792	2645373	86695	219961	44184	324169	143298	3461692	3881472	7343164	**3**	**4**	**7**
18,5	10437644	170579	0	0	32112	704410	342269	358107	2197005	67866	188538	0	277859	112175	11687014	3201550	14888564	**12**	**3**	**15**
19	15648248	63967	292470	0	12042	862543	713061	746057	2690210	114627	392788	0	578873	189467	17592331	4712022	22304353	**18**	**5**	**22**
19,5	13905901	63967	0	0	12042	704410	598972	626687	2197005	187044	329942	44184	486253	309165	15285292	4180280	19465572	**15**	**4**	**19**
20	15648248	0	292470	0	0	891294	627494	656530	2779883	182493	345653	44184	509408	301642	17459506	4819793	22279299	**17**	**5**	**22**
20,5	10782826	49752	0	0	9366	589404	342269	358107	1838310	91247	188538	88367	277859	150821	11773617	2993249	14766866	**12**	**3**	**15**
21	6607768	14215	292470	0	2676	589404	369929	387047	1838310	124042	203774	44184	300314	205028	7876462	3102699	10979161	**8**	**3**	**11**
21,5	1742347	0	0	0	0	158133	228180	238738	493205	77281	125692	0	185239	127737	2128660	1247892	3376552	**2**	**1**	**3**
22	690364	0	0	0	0	71879	114090	119369	224184	32795	62846	0	92620	54207	876333	586021	1462354	**1**	**1**	**1**
22,5	0	0	0	0	0	0	28522	29842	0	0	15712	0	23155	0	28522	68709	97231	**0,03**	**0,1**	**0,1**
23	0	0	0	0	0	43127	0	0	134510	0	0	0	0	0	43127	134510	177637	**0,04**	**0,1**	**0,2**
23,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL *n*	78586421	37641016	43673517	113570	7085974	34688600	407528854	426386222	108191267	113173480	224485962	379448009	330837344	187064116	609317952	1769586400	2378904352	**609**	**1770**	**2379**
Millions	**79**	**38**	**44**	**0,1**	**7**	**35**	**408**	**426**	**108**	**113**	**224**	**379**	**331**	**187**						

Table 8. *ECOCADIZ-RECLUTAS 2016-10* survey. Sardine (*Sardina pilchardus*). Cont'd.

***ECOCADIZ-RECLUTAS 2016-10 . Sardina pilchardus* . BIOMASS (t)**																	
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**POL08**	**POL09**	**POL10**	**POL11**	**POL12**	**POL13**	**POL14**	**PORTUGAL**	**SPAIN**	**TOTAL**
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
6,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
7,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
8,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
9	0	0	0	0	0	0	0	0	0	0	0	54,734	0	0	**0**	**54,734**	**54,734**
9,5	0	0	0	0	0	0	0	0	0	0	0	456,670	0	0	**0**	**456,670**	**456,670**
10	0	0	0	0	0	0	158,622	165,962	0	3,728	87,377	848,512	128,772	6,162	**158,622**	**1240,513**	**1399,135**
10,5	0	0	0	0	0	0	659,033	689,529	0	6,558	363,026	723,607	535,012	10,839	**659,033**	**2328,571**	**2987,604**
11	0	0	0	0	0	9,299	1470,002	1538,023	29,003	7,635	809,746	500,373	1193,367	12,620	**1479,301**	**4090,767**	**5570,068**
11,5	0	0	0	0	0	15,090	943,056	986,693	47,064	30,025	519,479	121,865	765,585	49,628	**958,146**	**2520,339**	**3478,485**
12	0	1,095	3,755	0	0,206	29,712	659,002	689,496	92,670	157,594	363,009	245,031	534,987	260,486	**693,770**	**2343,273**	**3037,043**
12,5	0	7,615	0	0,170	1,433	42,407	97,724	102,246	132,263	362,095	53,831	40,203	79,333	598,505	**149,349**	**1368,476**	**1517,825**
13	0	32,499	19,579	0,452	6,118	61,189	55,573	58,145	190,844	402,589	30,612	0	45,115	665,438	**175,410**	**1392,743**	**1568,153**
13,5	0	89,470	27,688	0,780	16,843	25,532	0	0	79,632	338,06	0	0	0	558,779	**160,313**	**976,471**	**1136,784**
14	0	158,956	6,227	0,467	29,924	53,567	32,795	34,313	167,071	314,382	18,065	0	26,624	519,642	**281,936**	**1080,097**	**1362,033**
14,5	0	164,22	21,041	0,216	30,915	115,427	0	0	360,010	205,928	0	0	0	340,378	**331,819**	**906,316**	**1238,135**
15	0	135,687	125,268	0,069	25,543	135,961	0	0	424,052	85,67	0	0	0	141,603	**422,528**	**651,325**	**1073,853**
15,5	0	141,151	322,797	0	26,572	78,296	3,396	3,553	244,199	34,254	1,87	0	2,757	56,619	**572,212**	**343,252**	**915,464**
16	0	101,887	368,042	0	19,180	38,476	51,835	54,233	120,003	11,038	28,553	0	42,080	18,245	**579,420**	**274,152**	**853,572**
16,5	0	37,151	235,857	0	6,994	1,577	7,301	7,639	4,919	5,153	4,022	1,616	5,927	8,517	**288,880**	**37,793**	**326,673**
17	0	38,564	177,392	0	7,260	13,922	5,754	6,021	43,420	4,926	3,17	0	4,672	8,142	**242,892**	**70,351**	**313,243**
17,5	45,977	29,811	52,078	0	5,612	3,191	11,397	11,925	9,953	5,103	6,278	1,962	9,252	8,435	**148,066**	**52,908**	**200,974**
18	101,711	5,194	0	0	0,978	41,325	19,456	20,356	128,890	4,224	10,717	2,153	15,794	6,982	**168,664**	**189,116**	**357,780**
18,5	556,687	9,098	0	0	1,713	37,569	18,255	19,099	117,176	3,62	10,056	0	14,819	5,983	**623,322**	**170,753**	**794,075**
19	911,413	3,726	17,035	0	0,701	50,238	41,531	43,453	156,688	6,676	22,877	0	33,716	11,035	**1024,644**	**274,445**	**1299,089**
19,5	882,489	4,059	0	0	0,764	44,703	38,012	39,770	139,425	11,87	20,939	2,804	30,858	19,620	**970,027**	**265,286**	**1235,313**
20	1079,704	0	20,180	0	0	61,498	43,296	45,300	191,807	12,592	23,85	3,049	35,148	20,813	**1204,678**	**332,559**	**1537,237**
20,5	807,262	3,725	0	0	0,701	44,126	25,624	26,810	137,626	6,831	14,115	6,616	20,802	11,291	**881,438**	**224,091**	**1105,529**
21	535,717	1,152	23,712	0	0,217	47,785	29,992	31,379	149,039	10,057	16,521	3,582	24,348	16,622	**638,575**	**251,548**	**890,123**
21,5	152,690	0	0	0	0	13,858	19,996	20,922	43,222	6,772	11,015	0	16,233	11,194	**186,544**	**109,358**	**295,902**
22	65,280	0	0	0	0	6,797	10,788	11,287	21,199	3,101	5,943	0	8,758	5,126	**82,865**	**55,414**	**138,279**
22,5	0	0	0	0	0	0	2,905	3,040	0	0	1,6	0	2,359	0	**2,905**	**6,999**	**9,904**
23	0	0	0	0	0	4,724	0	0	14,735	0	0	0	0	0	**4,724**	**14,735**	**19,459**
23,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL	5138,930	965,060	1420,651	2,154	181,674	976,269	4405,345	4609,194	3044,91	2040,481	2426,671	3012,777	3576,318	3372,704	**13090,083**	**22083,055**	**35173,138**

Table 9. *ECOCADIZ-RECLUTAS 2016-07* survey. Sardine (*Sardina pilchardus*). Estimated abundance (thousands of individuals) and biomass (tonnes) by age group. Polygons (i.e., coherent or homogeneous post-strata) numbered as in **Figure 13** and ordered from west to east.

Age class	POL01	POL02	POL03	POL04	POL05	POL06	POL07	POL08	POL09	POL10	POL11	POL12	POL13	POL14
	N	N	N	N	N	N	Nr	N	N	N	N	N	N	N
0	580	23174	26626	65	4362	19352	372066	389283	60357	67762	204951	357807	302048	112003
I	12607	14080	16000	49	2651	11161	32433	33934	34810	44594	17866	10502	26330	73710
II	28138	248	314	0	47	1777	1217	1273	5542	296	670	63	988	489
III	21121	98	502	0	18	1275	940	983	3975	264	518	84	763	436
IV	8176	30	91	0	6	518	369	386	1617	110	203	44	300	183
V	7048	11	119	0	2	478	384	402	1490	118	211	32	312	196
VI	721	1	21	0	0,2	65	59	62	202	20	33	3	48	33
VII	197	0	0	0	0	21	33	34	64	9	18	0	26	15
VIII	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IX	0	0	0	0	0	0	0	0	0	0	0	0	0	0
X	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	78588	37642	43673	114	7086	34647	407501	426357	108057	113173	224470	368535	330815	187065

Age class	PT	ES	TOTAL
	N	N	N
0	446225	1494211	1940435
I	88980	241746	330725
II	31740	9320	41060
III	23954	7022	30976
IV	9190	2844	12034
V	8041	2760	10802
VI	867	400	1267
VII	250	167	418
VIII	0	0	0
IX	0	0	0
X	0	0	0
TOTAL	609247	1758470	2367717

Table 9. *ECOCADIZ-RECLUTAS 2016-07* survey. Sardine (*Sardina pilchardus*). Cont'd.

Age class	POL01	POL02	POL03	POL04	POL05	POL06	POL07	POL08	POL09	POL10	POL11	POL12	POL13	POL14
	B	B	B	B	B	B	B	B	B	B	B	B	B	B
0	34	582	809	1	109	412	3721	3893	1286	1179	2050	2827	3020	1949
I	711	363	547	1	68	280	461	482	874	803	254	132	374	1327
II	1728	13	19	0	3	107	74	78	334	18	41	4	60	30
III	1459	6	29	0	1	90	66	69	279	19	36	6	53	31
IV	598	2	7	0	0,4	39	28	29	120	8	15	3	23	14
V	532	1	9	0	0,2	37	30	32	115	9	17	2	25	16
VI	60	0	2	0	0,02	5	5	5	17	2	3	0,2	4	3
VII	19	0	0	0	0	2	3	3	6	1	2	2827	2	1
VIII	0	0	0	0	0	0	0	0	0	0	0	132	0	0
IX	0	0	0	0	0	0	0	0	0	0	0	4	0	0
X	0	0	0	0	0	0	0	0	0	0	0	6	0	0
TOTAL	5141	967	1422	2	182	972	4388	4591	3030	2039	2417	3	3562	3371

Age class	PT	ES	TOTAL
	B	B	B
0	5679	16220	21899
I	2433	4252	6684
II	1943	565	2508
III	1649	494	2143
IV	674	213	887
V	609	215	825
VI	72	34	106
VII	24	16	40
VIII	0	0	0
IX	0	0	0
X	0	0	0
TOTAL	13084	22008	35092

Table 10. *ECOCADIZ-RECLUTAS* surveys series. Sardine (*Sardina pilchardus*). Acoustic estimates of biomass (t) and abundance (million fish) for the whole Gulf of Cadiz anchovy population and for the juvenile fraction (*i.e*. age 0 fish, between parentheses). Note that the 2012 survey only surveyed the Spanish waters.

Estimate/Year	Total Population (Recruits at age 0)			
	2012	**2014**	**2015**	**2016**
Biomass (t)	22119 (9182)	36571 (705)	30992 (8645)	35173 (21899)
Abundance (millions)	603 (359)	507 (26)	861 (509)	2379 (1940)

Table 10. *ECOCADIZ-RECLUTAS 2016-10* 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 17**.

***ECOCADIZ-RECLUTAS 2016-10* . *Scomber scombrus* . ABUNDANCE (in number and million fish)**										
Size class	**POL01**	**POL02**	**POL03**	**POL04**	***n***			**millions**		
					PORTUGAL	**SPAIN**	**TOTAL**	**PORTUGAL**	**SPAIN**	**TOTAL**
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	**0**	**0**	**0**
16,5	0	0	0	0	0	0	0	**0**	**0**	**0**
17	0	0	0	0	0	0	0	**0**	**0**	**0**
17,5	0	0	0	0	0	0	0	**0**	**0**	**0**
18	0	0	0	0	0	0	0	**0**	**0**	**0**
18,5	0	0	0	0	0	0	0	**0**	**0**	**0**
19	0	0	11320	0	11320	0	11320	**0,01**	**0**	**0,01**
19,5	0	0	45278	0	45278	0	45278	**0,05**	**0**	**0,0**
20	0	0	56598	0	56598	0	56598	**0,1**	**0**	**0,1**
20,5	0	0	67917	0	67917	0	67917	**0,1**	**0**	**0,1**
21	0	0	67917	0	67917	0	67917	**0,1**	**0**	**0,1**
21,5	0	0	11320	0	11320	0	11320	**0,01**	**0**	**0,01**
22	0	0	0	0	0	0	0	**0**	**0**	**0**
22,5	0	0	0	0	0	0	0	**0**	**0**	**0**
23	0	0	0	0	0	0	0	**0**	**0**	**0**
23,5	0	0	0	0	0	0	0	**0**	**0**	**0**
24	0	0	0	0	0	0	0	**0**	**0**	**0**
24,5	0	0	0	0	0	0	0	**0**	**0**	**0**
25	0	0	0	0	0	0	0	**0**	**0**	**0**
25,5	0	0	0	0	0	0	0	**0**	**0**	**0**
26	0	0	0	0	0	0	0	**0**	**0**	**0**
26,5	0	0	0	0	0	0	0	**0**	**0**	**0**
27	0	0	0	0	0	0	0	**0**	**0**	**0**
27,5	8455	23678	0	31925	32133	31925	64058	**0,03**	**0,03**	**0,1**
28	0	0	0	0	0	0	0	**0**	**0**	**0**
28,5	0	0	0	0	0	0	0	**0**	**0**	**0**
29	0	0	0	0	0	0	0	**0**	**0**	**0**
29,5	0	0	0	0	0	0	0	**0**	**0**	**0**
30	0	0	0	0	0	0	0	**0**	**0**	**0**
30,5	8455	23678	0	31925	32133	31925	64058	**0,03**	**0,03**	**0,1**
31	42274	118391	11320	159623	171985	159623	331608	**0,2**	**0,2**	**0,3**
31,5	25364	71035	11320	95774	107719	95774	203493	**0,1**	**0,1**	**0,2**
32	67638	189426	0	255397	257064	255397	512461	**0,3**	**0,3**	**0,5**
32,5	33819	94713	0	127699	128532	127699	256231	**0,1**	**0,1**	**0,3**
33	33819	94713	0	127699	128532	127699	256231	**0,1**	**0,1**	**0,3**
33,5	8455	23678	0	31925	32133	31925	64058	**0,03**	**0,03**	**0,1**
34	16909	47357	0	63849	64266	63849	128115	**0,1**	**0,1**	**0,1**
34,5	16909	47357	0	63849	64266	63849	128115	**0,1**	**0,1**	**0,1**
35	8455	23678	0	31925	32133	31925	64058	**0,03**	**0,03**	**0,1**
35,5	25364	71035	0	95774	96399	95774	192173	**0,1**	**0,1**	**0,2**
36	8455	23678	0	31925	32133	31925	64058	**0,03**	**0,03**	**0,1**
36,5	0	0	0	0	0	0	0	**0**	**0**	**0**
37	0	0	0	0	0	0	0	**0**	**0**	**0**
37,5	0	0	0	0	0	0	0	**0**	**0**	**0**
38	0	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL *n*	304371	852417	282990	1149289	1439778	1149289	2589067	**1**	**1**	**3**
Millions	**0,3**	**1**	**0,3**	**1**	**1**	**1**	**3**			

Table 10. *ECOCADIZ-RECLUTAS 2016-10* survey. Atlantic mackerel (*Scomber scombrus*). Cont'd.

***ECOCADIZ-RECLUTAS 2016-10. Scomber scombrus*. BIOMASS (t)**							
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**PORTUGAL**	**SPAIN**	**TOTAL**
15	0	0	0	0	**0**	**0**	**0**
15,5	0	0	0	0	**0**	**0**	**0**
16	0	0	0	0	**0**	**0**	**0**
16,5	0	0	0	0	**0**	**0**	**0**
17	0	0	0	0	**0**	**0**	**0**
17,5	0	0	0	0	**0**	**0**	**0**
18	0	0	0	0	**0**	**0**	**0**
18,5	0	0	0	0	**0**	**0**	**0**
19	0	0	0,503	0	**0,503**	**0**	**0,503**
19,5	0	0	2,196	0	**2,196**	**0**	**2,196**
20	0	0	2,992	0	**2,992**	**0**	**2,992**
20,5	0	0	3,905	0	**3,905**	**0**	**3,905**
21	0	0	4,239	0	**4,239**	**0**	**4,239**
21,5	0	0	0,765	0	**0,765**	**0**	**0,765**
22	0	0	0	0	**0**	**0**	**0**
22,5	0	0	0	0	**0**	**0**	**0**
23	0	0	0	0	**0**	**0**	**0**
23,5	0	0	0	0	**0**	**0**	**0**
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	0	0	0	0	**0**	**0**	**0**
27	0	0	0	0	**0**	**0**	**0**
27,5	1,323	3,706	0	4,997	**5,029**	**4,997**	**10,026**
28	0	0	0	0	**0**	**0**	**0**
28,5	0	0	0	0	**0**	**0**	**0**
29	0	0	0	0	**0**	**0**	**0**
29,5	0	0	0	0	**0**	**0**	**0**
30	0	0	0	0	**0**	**0**	**0**
30,5	1,885	5,278	0	7,116	**7,163**	**7,116**	**14,279**
31	9,961	27,897	2,667	37,613	**40,525**	**37,613**	**78,138**
31,5	6,313	17,679	2,817	23,836	**26,809**	**23,836**	**50,645**
32	17,764	49,751	0	67,077	**67,515**	**67,077**	**134,592**
32,5	9,366	26,229	0	35,364	**35,595**	**35,364**	**70,959**
33	9,867	27,635	0	37,259	**37,502**	**37,259**	**74,761**
33,5	2,597	7,273	0	9,806	**9,870**	**9,806**	**19,676**
34	5,464	15,302	0	20,631	**20,766**	**20,631**	**41,397**
34,5	5,743	16,086	0	21,687	**21,829**	**21,687**	**43,516**
35	3,017	8,448	0	11,391	**11,465**	**11,391**	**22,856**
35,5	9,500	26,605	0	35,871	**36,105**	**35,871**	**71,976**
36	3,322	9,303	0	12,543	**12,625**	**12,543**	**25,168**
36,5	0	0	0	0	**0**	**0**	**0**
37	0	0	0	0	**0**	**0**	**0**
37,5	0	0	0	0	**0**	**0**	**0**
38	0	0	0	0	**0**	**0**	**0**
TOTAL	86,122	241,192	20,084	325,191	**347,398**	**325,191**	**672,589**

Table 11. *ECOCADIZ-RECLUTAS 2016-10* 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 20**.

ECOCADIZ-RECLUTAS 2016-10. *Scomber colias*. ABUNDANCE (in number and million fish)															
Size class	POL01	POL02	POL03	POL04	POL05	POL06	POL07	POL08	POL09	*n*			millions		
										PORTUGAL	SPAIN	TOTAL	PORTUGAL	SPAIN	TOTAL
10	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
10,5	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
11	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
11,5	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
12	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
12,5	0	0	0	0	0	0	0	27400	0	0	27400	27400	**0**	**0,03**	**0,03**
13	0	836526	0	0	117362	0	451119	27400	0	953888	478519	1432407	**1**	**0,5**	**1**
13,5	0	1155339	0	0	217814	0	837241	27400	0	1373153	864641	2237794	**1**	**1**	**2**
14	0	6514850	0	62508	353091	68535	1357223	27400	0	6930449	1453158	8383607	**7**	**1**	**8**
14,5	0	11377106	0	0	959825	0	3689411	109600	0	12336931	3799011	16135942	**12**	**4**	**16**
15	0	27062401	0	62508	2416039	68535	9286856	27400	0	29540948	9382791	38923739	**30**	**9**	**39**
15,5	0	32285469	0	0	2159378	0	8300296	27400	0	34444847	8327696	42772543	**34**	**8**	**43**
16	0	30691407	0	0	1596357	0	6136136	219199	118254	32287764	6473589	38761353	**32**	**6**	**39**
16,5	0	15565384	0	0	1009389	0	3879924	219199	0	16574773	4099123	20673896	**17**	**4**	**21**
17	0	11659564	0	0	796968	0	3063413	301399	0	12456532	3364812	15821344	**12**	**3**	**16**
17,5	0	13013805	0	0	384648	0	1478522	657598	0	13398453	2136120	15534573	**13**	**2**	**16**
18	0	6393859	0	62508	409966	68535	1575843	739797	0	6866333	2384175	9250508	**7**	**2**	**9**
18,5	0	836526	0	0	252981	0	972419	712398	0	1089507	1684817	2774324	**1**	**2**	**3**
19	0	3246655	0	0	67136	0	258058	767197	0	3313791	1025255	4339046	**3**	**1**	**4**
19,5	0	0	0	125015	63434	137069	243829	931597	118254	188449	1430749	1619198	**0,2**	**1**	**2**
20	931090	0	13507	187523	20360	205604	78261	356199	0	1152480	640064	1792544	**1**	**1**	**2**
20,5	931090	0	13507	187523	108610	205604	417479	191799	0	1240730	814882	2055612	**1**	**1**	**2**
21	1862179	0	27013	187523	12956	205604	49802	27400	224682	2089671	507488	2597159	**2**	**1**	**3**
21,5	6975281	0	101185	62508	5553	68535	21344	109600	685871	7144527	885350	8029877	**7**	**1**	**8**
22	12104164	418263	175586	62508	1851	68535	7115	109600	342936	12762372	528186	13290558	**13**	**1**	**13**
22,5	11630728	418263	168718	0	1851	0	7115	137000	685871	12219560	829986	13049546	**12**	**1**	**13**
23	6517627	0	94546	62508	1851	68535	7115	137000	1596425	6676532	1809075	8485607	**7**	**2**	**8**
23,5	3724358	0	54027	187523	0	205604	0	246599	2294122	3965908	2746325	6712233	**4**	**3**	**7**
24	1388744	418263	20145	437553	0	479743	0	0	3204675	2264705	3684418	5949123	**2**	**4**	**6**
24,5	931090	418263	13507	937614	0	1028021	0	27400	1489997	2300474	2545418	4845892	**2**	**3**	**5**
25	0	418263	0	687584	0	753882	0	0	567618	1105847	1321500	2427347	**1**	**1**	**2**
25,5	457654	1254790	6639	1000122	0	1096555	0	27400	804125	2719205	1928080	4647285	**3**	**2**	**5**
26	0	836526	0	562569	0	616812	0	0	118254	1399095	735066	2134161	**1**	**1**	**2**
26,5	0	836526	0	312538	0	342674	0	0	118254	1149064	460928	1609992	**1**	**0**	**2**
27	0	0	0	62508	0	68535	0	0	0	62508	68535	131043	**0,1**	**0,1**	**0,1**
27,5	0	0	0	62508	0	68535	0	0	0	62508	68535	131043	**0,1**	**0,1**	**0,1**
28	0	836526	0	0	0	0	0	0	0	836526	0	836526	**1**	**0**	**1**
28,5	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
29	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
29,5	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
30	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL *n*	47454005	166494574	688380	5313151	10957420	5825452	42118521	6192381	12369338	230907530	66505692	297413222	**231**	**67**	**297**
Millions	**47**	**166**	**1**	**5**	**11**	**6**	**42**	**6**	**12**						

Table 11. *ECOCADIZ-RECLUTAS 2016-10* survey. Chub mackerel (*Scomber colias*). Cont'd.

***ECOCADIZ-RECLUTAS 2016-10*. *Scomber colias*. BIOMASS (t)**												
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**POL08**	**POL09**	**PORTUGAL**	**SPAIN**	**TOTAL**
10	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
10,5	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
11	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
11,5	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
12	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
12,5	0	0	0	0	0	0	0	0,323	0	**0**	**0,323**	**0,323**
13	0	11,267	0	0	1,581	0	6,076	0,369	0	**12,848**	**6,445**	**19,293**
13,5	0	17,697	0	0	3,336	0	12,824	0,420	0	**21,033**	**13,244**	**34,277**
14	0	112,971	0	1,084	6,123	1,188	23,535	0,475	0	**120,178**	**25,198**	**145,376**
14,5	0	222,388	0	0	18,762	0	72,117	2,142	0	**241,150**	**74,259**	**315,409**
15	0	593,924	0	1,372	53,023	1,504	203,814	0,601	0	**648,319**	**205,919**	**854,238**
15,5	0	792,562	0	0	53,010	0	203,76	0,673	0	**845,572**	**204,433**	**1050,005**
16	0	839,815	0	0	43,681	0	167,904	5,998	3,236	**883,496**	**177,138**	**1060,634**
16,5	0	473,194	0	0	30,686	0	117,951	6,664	0	**503,880**	**124,615**	**628,495**
17	0	392,581	0	0	26,834	0	103,146	10,148	0	**419,415**	**113,294**	**532,709**
17,5	0	483,894	0	0	14,302	0	54,976	24,452	0	**498,196**	**79,428**	**577,624**
18	0	261,825	0	2,560	16,788	2,806	64,530	30,294	0	**281,173**	**97,630**	**378,803**
18,5	0	37,627	0	0	11,379	0	43,739	32,044	0	**49,006**	**75,783**	**124,789**
19	0	160,011	0	0	3,309	0	12,718	37,811	0	**163,320**	**50,529**	**213,849**
19,5	0	0	0	6,735	3,418	7,385	13,136	50,190	6,371	**10,153**	**77,082**	**87,235**
20	54,714	0	0,794	11,019	1,196	12,082	4,599	20,931	0	**67,723**	**37,612**	**105,335**
20,5	59,551	0	0,864	11,994	6,947	13,15	26,701	12,267	0	**79,356**	**52,118**	**131,474**
21	129,37	0	1,877	13,028	0,900	14,284	3,460	1,904	15,609	**145,175**	**35,257**	**180,432**
21,5	525,357	0	7,621	4,708	0,418	5,162	1,608	8,255	51,658	**538,104**	**66,683**	**604,787**
22	986,530	34,090	14,311	5,095	0,151	5,586	0,580	8,933	27,950	**1040,177**	**43,049**	**1083,226**
22,5	1024,008	36,825	14,854	0	0,163	0	0,626	12,062	60,386	**1075,850**	**73,074**	**1148,924**
23	618,84	0	8,977	5,935	0,176	6,507	0,676	13,008	151,578	**633,928**	**171,769**	**805,697**
23,5	380,745	0	5,523	19,171	0	21,019	0	25,210	234,531	**405,439**	**280,760**	**686,199**
24	152,627	45,968	2,214	48,088	0	52,725	0	0	352,203	**248,897**	**404,928**	**653,825**
24,5	109,846	49,345	1,594	110,616	0	121,282	0	3,233	175,784	**271,401**	**300,299**	**571,700**
25	0	52,895	0	86,954	0	95,338	0	0	71,782	**139,849**	**167,120**	**306,969**
25,5	61,955	169,868	0,899	135,392	0	148,446	0	3,709	108,859	**368,114**	**261,014**	**629,128**
26	0	121,067	0	81,419	0	89,269	0	0	17,114	**202,486**	**106,383**	**308,869**
26,5	0	129,267	0	48,296	0	52,953	0	0	18,274	**177,563**	**71,227**	**248,790**
27	0	0	0	10,301	0	11,294	0	0	0	**10,301**	**11,294**	**21,595**
27,5	0	0	0	10,972	0	12,030	0	0	0	**10,972**	**12,030**	**23,002**
28	0	156,237	0	0	0	0	0	0	0	**156,237**	**0**	**156,237**
28,5	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
29	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
29,5	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
30	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL	4103,543	5195,318	59,528	614,739	296,183	674,010	1138,476	312,116	1295,335	**10269,311**	**3419,937**	**13689,248**

Table 12. *ECOCADIZ-RECLUTAS 2016-10* 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 23**.

***ECOCADIZ-RECLUTAS 2016-10*. *Trachurus picturatus*. ABUNDANCE (in number and million fish)**									
Size class	**POL01**	**POL02**	**POL03**	***n***			**millions**		
				PORTUGAL	**SPAIN**	**TOTAL**	**PORTUGAL**	**SPAIN**	**TOTAL**
10	0	0	0	0	0	0	**0**	**0**	**0**
10,5	0	0	0	0	0	0	**0**	**0**	**0**
11	0	0	0	0	0	0	**0**	**0**	**0**
11,5	0	0	0	0	0	0	**0**	**0**	**0**
12	0	0	0	0	0	0	**0**	**0**	**0**
12,5	0	0	0	0	0	0	**0**	**0**	**0**
13	0	0	0	0	0	0	**0**	**0**	**0**
13,5	0	0	0	0	0	0	**0**	**0**	**0**
14	0	0	0	0	0	0	**0**	**0**	**0**
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	0	0	0	0	0	0	**0**	**0**	**0**
17,5	0	0	20664	20664	0	20664	**0,02**	**0**	**0,02**
18	0	0	82654	82654	0	82654	**0,1**	**0**	**0,1**
18,5	0	7488	166600	174088	0	174088	**0,2**	**0**	**0,2**
19	0	26208	125273	151481	0	151481	**0,2**	**0**	**0,2**
19,5	0	33696	561789	595485	0	595485	**0,6**	**0**	**1**
20	0	63648	353863	417511	0	417511	**0,4**	**0**	**0,4**
20,5	0	67392	269917	337309	0	337309	**0,3**	**0**	**0,3**
21	0	56160	166600	222760	0	222760	**0,2**	**0**	**0,2**
21,5	204853	26208	207927	438988	0	438988	**0,4**	**0**	**0,4**
22	0	26208	61991	88199	0	88199	**0,1**	**0**	**0,1**
22,5	204853	33696	20664	259213	0	259213	**0,3**	**0**	**0,3**
23	409707	29952	0	439659	0	439659	**0,4**	**0**	**0,4**
23,5	409707	14976	41327	466010	0	466010	**0,5**	**0**	**0,5**
24	204853	3744	0	208597	0	208597	**0,2**	**0**	**0,2**
24,5	614560	7488	0	622048	0	622048	**1**	**0**	**1**
25	1843680	3744	0	1847424	0	1847424	**2**	**0**	**2**
25,5	819413	0	0	819413	0	819413	**1**	**0**	**1**
26	1024267	0	0	1024267	0	1024267	**1**	**0**	**1**
26,5	819413	0	0	819413	0	819413	**1**	**0**	**1**
27	409707	0	0	409707	0	409707	**0,4**	**0**	**0,4**
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	0	0	0	**0**	**0**	**0**
30	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL *n*	6965013	400608	2079269	9444890	0	9444890	**9**	**0**	**9**
Millions	**7**	**0,4**	**2**	**9**	**0**	**9**			

Table 12. *ECOCADIZ-RECLUTAS 2016-10* survey. Blue jack mackerel (*Trachurus picturatus*). Cont'd.

ECOCADIZ-RECLUTAS 2016-10 . Trachurus picturatus . **BIOMASS (t)**						
Size class	**POL01**	**POL02**	**POL03**	**PORTUGAL**	**SPAIN**	**TOTAL**
10	0	0	0	**0**	**0**	**0**
10,5	0	0	0	**0**	**0**	**0**
11	0	0	0	**0**	**0**	**0**
11,5	0	0	0	**0**	**0**	**0**
12	0	0	0	**0**	**0**	**0**
12,5	0	0	0	**0**	**0**	**0**
13	0	0	0	**0**	**0**	**0**
13,5	0	0	0	**0**	**0**	**0**
14	0	0	0	**0**	**0**	**0**
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	0	0	0	**0**	**0**	**0**
17,5	0	0	0,864	**0,864**	**0**	**0,864**
18	0	0	3,781	**3,781**	**0**	**3,781**
18,5	0	0,374	8,316	**8,690**	**0**	**8,690**
19	0	1,424	6,807	**8,231**	**0**	**8,231**
19,5	0	1,989	33,159	**35,148**	**0**	**35,148**
20	0	4,072	22,641	**26,713**	**0**	**26,713**
20,5	0	4,665	18,683	**23,348**	**0**	**23,348**
21	0	4,198	12,453	**16,651**	**0**	**16,651**
21,5	16,505	2,112	16,752	**35,369**	**0**	**35,369**
22	0	2,272	5,375	**7,647**	**0**	**7,647**
22,5	19,08	3,139	1,925	**24,144**	**0**	**24,144**
23	40,933	2,992	0	**43,925**	**0**	**43,925**
23,5	43,841	1,603	4,422	**49,866**	**0**	**49,866**
24	23,445	0,428	0	**23,873**	**0**	**23,873**
24,5	75,120	0,915	0	**76,035**	**0**	**76,035**
25	240,380	0,488	0	**240,868**	**0**	**240,868**
25,5	113,811	0	0	**113,811**	**0**	**113,811**
26	151,370	0	0	**151,370**	**0**	**151,370**
26,5	128,695	0	0	**128,695**	**0**	**128,695**
27	68,309	0	0	**68,309**	**0**	**68,309**
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	**0**	**0**	**0**
30	0	0	0	**0**	**0**	**0**
TOTAL	921,489	30,671	135,178	**1087,338**	**0**	**1087,338**

Table 13. *ECOCADIZ-RECLUTAS 2016-10* 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 26**.

***ECOCADIZ-RECLUTAS 2016-10. Trachurus trachurus*. ABUNDANCE (in number and million fish)**											
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	***n***			**millions**		
						PORTUGAL	**SPAIN**	**TOTAL**	**PORTUGAL**	**SPAIN**	**TOTAL**
10	0	0	0	0	0	0	0	0	**0**	**0**	**0**
10,5	0	0	0	0	0	0	0	0	**0**	**0**	**0**
11	0	0	0	0	0	0	0	0	**0**	**0**	**0**
11,5	0	0	0	0	0	0	0	0	**0**	**0**	**0**
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	2525	0	0	0	0	2525	0	2525	**0,003**	**0**	**0,003**
14	0	9909	0	32	968	9941	968	10909	**0,01**	**0,001**	**0,01**
14,5	0	0	0	0	0	0	0	0	**0**	**0**	**0**
15	0	26425	0	86	2581	26511	2581	29092	**0,03**	**0,003**	**0,03**
15,5	0	26425	0	86	2581	26511	2581	29092	**0,03**	**0,003**	**0,03**
16	0	9909	0	32	968	9941	968	10909	**0,01**	**0,001**	**0,01**
16,5	0	16515	0	53	1613	16568	1613	18181	**0,02**	**0,002**	**0,02**
17	0	26425	0	86	2581	26511	2581	29092	**0,03**	**0,003**	**0,03**
17,5	0	42940	0	139	4194	43079	4194	47273	**0,04**	**0,004**	**0,05**
18	0	26425	0	86	2581	26511	2581	29092	**0,03**	**0,003**	**0,03**
18,5	0	66062	0	214	6452	66276	6452	72728	**0,1**	**0,01**	**0,1**
19	2525	49546	0	160	4839	52231	4839	57070	**0,1**	**0,005**	**0,1**
19,5	0	16515	0	53	1613	16568	1613	18181	**0,02**	**0,002**	**0,02**
20	0	42940	0	139	4194	43079	4194	47273	**0,04**	**0,004**	**0,05**
20,5	0	26425	0	86	2581	26511	2581	29092	**0,03**	**0,003**	**0,03**
21	2525	66062	0	214	6452	68801	6452	75253	**0,1**	**0,01**	**0,1**
21,5	5049	99092	0	321	9678	104462	9678	114140	**0,1**	**0,01**	**0,1**
22	0	75971	0	246	7420	76217	7420	83637	**0,1**	**0,01**	**0,1**
22,5	17672	115608	4152	374	11292	137806	11292	149098	**0,1**	**0,01**	**0,1**
23	25245	224609	10379	727	21938	260960	21938	282898	**0,3**	**0,02**	**0,3**
23,5	47966	158548	10379	513	15486	217406	15486	232892	**0,2**	**0,02**	**0,2**
24	25245	132123	16606	428	12905	174402	12905	187307	**0,2**	**0,01**	**0,2**
24,5	12623	33031	18682	107	3226	64443	3226	67669	**0,1**	**0,003**	**0,1**
25	2525	42940	31137	139	4194	76741	4194	80935	**0,1**	**0,004**	**0,1**
25,5	0	16515	31137	53	1613	47705	1613	49318	**0,05**	**0,002**	**0,05**
26	0	9909	33212	32	968	43153	968	44121	**0,04**	**0,001**	**0,04**
26,5	0	9909	18682	32	968	28623	968	29591	**0,03**	**0,001**	**0,03**
27	0	0	18682	0	0	18682	0	18682	**0,02**	**0**	**0,02**
27,5	0	0	0	0	0	0	0	0	**0**	**0**	**0**
28	0	0	0	0	0	0	0	0	**0**	**0**	**0**
28,5	0	9909	2076	32	968	12017	968	12985	**0,01**	**0,001**	**0,01**
29	0	0	2076	0	0	2076	0	2076	**0,002**	**0**	**0,002**
29,5	0	0	0	0	0	0	0	0	**0**	**0**	**0**
30	0	0	0	0	0	0	0	0	**0**	**0**	**0**
30,5	0	0	0	0	0	0	0	0	**0**	**0**	**0**
31	0	0	0	0	0	0	0	0	**0**	**0**	**0**
31,5	0	0	0	0	0	0	0	0	**0**	**0**	**0**
32	0	0	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL *n*	143900	1380687	197200	4470	134854	1726257	134854	1861111	**2**	**0,1**	**2**
Millions	**0,1**	**1**	**0,2**	**0,004**	**0,1**	**2**	**0,1**	**2**			

Table 13. *ECOCADIZ-RECLUTAS 2016-10* survey. Horse mackerel (*Trachurus trachurus*). Cont'd.

***ECOCADIZ-RECLUTAS 2016-10*. *Trachurus trachurus*. BIOMASS (t)**								
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**PORTUGAL**	**SPAIN**	**TOTAL**
10	0	0	0	0	0	**0**	**0**	**0**
10,5	0	0	0	0	0	**0**	**0**	**0**
11	0	0	0	0	0	**0**	**0**	**0**
11,5	0	0	0	0	0	**0**	**0**	**0**
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	0,050	0	0	0	0	**0,050**	**0**	**0,050**
14	0	0,220	0	0,001	0,021	**0,221**	**0,021**	**0,242**
14,5	0	0	0	0	0	**0**	**0**	**0**
15	0	0,728	0	0,002	0,071	**0,730**	**0,071**	**0,801**
15,5	0	0,806	0	0,003	0,079	**0,809**	**0,079**	**0,888**
16	0	0,334	0	0,001	0,033	**0,335**	**0,033**	**0,368**
16,5	0	0,612	0	0,002	0,060	**0,614**	**0,060**	**0,674**
17	0	1,075	0	0,003	0,105	**1,078**	**0,105**	**1,183**
17,5	0	1,913	0	0,006	0,187	**1,919**	**0,187**	**2,106**
18	0	1,286	0	0,004	0,126	**1,290**	**0,126**	**1,416**
18,5	0	3,501	0	0,011	0,342	**3,512**	**0,342**	**3,854**
19	0,145	2,854	0	0,009	0,279	**3,008**	**0,279**	**3,287**
19,5	0	1,032	0	0,003	0,101	**1,035**	**0,101**	**1,136**
20	0	2,905	0	0,009	0,284	**2,914**	**0,284**	**3,198**
20,5	0	1,931	0	0,006	0,189	**1,937**	**0,189**	**2,126**
21	0,199	5,206	0	0,017	0,508	**5,422**	**0,508**	**5,930**
21,5	0,428	8,407	0	0,027	0,821	**8,862**	**0,821**	**9,683**
22	0	6,927	0	0,022	0,677	**6,949**	**0,677**	**7,626**
22,5	1,729	11,31	0,406	0,037	1,105	**13,482**	**1,105**	**14,587**
23	2,646	23,541	1,088	0,076	2,299	**27,351**	**2,299**	**29,650**
23,5	5,378	17,777	1,164	0,058	1,736	**24,377**	**1,736**	**26,113**
24	3,024	15,825	1,989	0,051	1,546	**20,889**	**1,546**	**22,435**
24,5	1,613	4,221	2,387	0,014	0,412	**8,235**	**0,412**	**8,647**
25	0,344	5,846	4,239	0,019	0,571	**10,448**	**0,571**	**11,019**
25,5	0	2,393	4,511	0,008	0,234	**6,912**	**0,234**	**7,146**
26	0	1,526	5,114	0,005	0,149	**6,645**	**0,149**	**6,794**
26,5	0	1,620	3,054	0,005	0,158	**4,679**	**0,158**	**4,837**
27	0	0	3,239	0	0	**3,239**	**0**	**3,239**
27,5	0	0	0	0	0	**0**	**0**	**0**
28	0	0	0	0	0	**0**	**0**	**0**
28,5	0	2,036	0,426	0,007	0,199	**2,469**	**0,199**	**2,668**
29	0	0	0,450	0	0	**0,450**	**0**	**0,450**
29,5	0	0	0	0	0	**0**	**0**	**0**
30	0	0	0	0	0	**0**	**0**	**0**
30,5	0	0	0	0	0	**0**	**0**	**0**
31	0	0	0	0	0	**0**	**0**	**0**
31,5	0	0	0	0	0	**0**	**0**	**0**
32	0	0	0	0	0	**0**	**0**	**0**
TOTAL	15,556	125,832	28,067	0,406	12,292	**169,861**	**12,292**	**182,153**

Table 13. *ECOCADIZ-RECLUTAS 2016-10* 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 29**.

***ECOCADIZ-RECLUTAS 2016-10*. *Trachurus mediterraneus*. ABUNDANCE (in number and million fish)**												
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	***n***			**millions**		
							PORTUGAL	**SPAIN**	**TOTAL**	**PORTUGAL**	**SPAIN**	**TOTAL**
15	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**
16	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
16,5	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
17	129766	1751	10835	22577	70685	0	142352	93262	235614	**0,1**	**0,1**	**0,2**
17,5	227090	3064	18962	39510	123699	0	249116	163209	412325	**0,2**	**0,2**	**0,4**
18	600168	8097	50114	104419	326920	0	658379	431339	1089718	**1**	**0,4**	**1**
18,5	405519	5471	33861	70553	220892	0	444851	291445	736296	**0,4**	**0,3**	**1**
19	794817	10723	66367	138284	432948	0	871907	571232	1443139	**1**	**1**	**1**
19,5	1200335	16194	100227	208837	653839	0	1316756	862676	2179432	**1**	**1**	**2**
20	843479	11380	70430	146751	459455	0	925289	606206	1531495	**1**	**1**	**2**
20,5	908362	12255	75848	158039	494797	0	996465	652836	1649301	**1**	**1**	**2**
21	405519	5471	33861	70553	220892	0	444851	291445	736296	**0,4**	**0,3**	**1**
21,5	97324	1313	8127	16933	53014	0	106764	69947	176711	**0,1**	**0,1**	**0,2**
22	64883	875	5418	11289	35343	0	71176	46632	117808	**0,1**	**0,05**	**0,1**
22,5	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
23	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
23,5	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
24	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
24,5	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
25	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
25,5	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
26	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
26,5	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**
27,5	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
28	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
28,5	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
29	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
29,5	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
30	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
30,5	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
31	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
31,5	16221	219	1354	2822	8836	0	17794	11658	29452	**0,02**	**0,01**	**0,03**
32	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
32,5	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
33	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
33,5	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
34	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
34,5	0	0	0	0	0	21176	0	21176	21176	**0**	**0,02**	**0,02**
35	0	0	0	0	0	42353	0	42353	42353	**0**	**0,04**	**0,04**
35,5	0	0	0	0	0	105882	0	105882	105882	**0**	**0,1**	**0,1**
36	0	0	0	0	0	169410	0	169410	169410	**0**	**0,2**	**0,2**
36,5	0	0	0	0	0	550584	0	550584	550584	**0**	**1**	**1**
37	0	0	0	0	0	762347	0	762347	762347	**0**	**1**	**1**
37,5	0	0	0	0	0	995286	0	995286	995286	**0**	**1**	**1**
38	0	0	0	0	0	698818	0	698818	698818	**0**	**1**	**1**
38,5	0	0	0	0	0	444702	0	444702	444702	**0**	**0,4**	**0,4**
39	0	0	0	0	0	232939	0	232939	232939	**0**	**0,2**	**0,2**
39,5	0	0	0	0	0	127058	0	127058	127058	**0**	**0,1**	**0,1**
40	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
40,5	0	0	0	0	0	42353	0	42353	42353	**0**	**0,04**	**0,04**
41	0	0	0	0	0	42353	0	42353	42353	**0**	**0,04**	**0,04**
41,5	0	0	0	0	0	21176	0	21176	21176	**0**	**0,02**	**0,02**
42	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
42,5	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
43	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
43,5	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
44	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
44,5	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
45	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL *n*	5693483	76813	475404	990567	3101320	4256437	6245700	8348324	14594024	**6**	**8**	**15**
Millions	**6**	**0,1**	**0,5**	**1**	**3**	**4**	**6**	**8**	**15**			

Table 13. *ECOCADIZ-RECLUTAS 2016-10* survey. Mediterranean horse mackerel (*Trachurus mediterraneus*). Cont'd.

***ECOCADIZ-RECLUTAS 2016-10*. *Trachurus mediterraneus*. BIOMASS (t)**									
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**PORTUGAL**	**SPAIN**	**TOTAL**
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	5,153	0,070	0,430	0,896	2,807	0	**5,653**	**3,703**	**9,356**
17,5	9,788	0,132	0,817	1,703	5,332	0	**10,737**	**7,035**	**17,772**
18	28,016	0,378	2,339	4,874	15,261	0	**30,733**	**20,135**	**50,868**
18,5	20,457	0,276	1,708	3,559	11,143	0	**22,441**	**14,702**	**37,143**
19	43,242	0,583	3,611	7,523	23,554	0	**47,436**	**31,077**	**78,513**
19,5	70,292	0,948	5,869	12,230	38,289	0	**77,109**	**50,519**	**127,628**
20	53,069	0,716	4,431	9,233	28,908	0	**58,216**	**38,141**	**96,357**
20,5	61,297	0,827	5,118	10,665	33,389	0	**67,242**	**44,054**	**111,296**
21	29,30	0,395	2,447	5,098	15,960	0	**32,142**	**21,058**	**53,200**
21,5	7,517	0,101	0,628	1,308	4,095	0	**8,246**	**5,403**	**13,649**
22	5,350	0,072	0,447	0,931	2,914	0	**5,869**	**3,845**	**9,714**
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	0	0	0	**0**	**0**	**0**
30	0	0	0	0	0	0	**0**	**0**	**0**
30,5	0	0	0	0	0	0	**0**	**0**	**0**
31	0	0	0	0	0	0	**0**	**0**	**0**
31,5	3,711	0,050	0,310	0,646	2,022	0	**4,071**	**2,668**	**6,739**
32	0	0	0	0	0	0	**0**	**0**	**0**
32,5	0	0	0	0	0	0	**0**	**0**	**0**
33	0	0	0	0	0	0	**0**	**0**	**0**
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	6,278	**0**	**6,278**	**6,278**
35	0	0	0	0	0	13,082	**0**	**13,082**	**13,082**
35,5	0	0	0	0	0	34,055	**0**	**34,055**	**34,055**
36	0	0	0	0	0	56,704	**0**	**56,704**	**56,704**
36,5	0	0	0	0	0	191,679	**0**	**191,679**	**191,679**
37	0	0	0	0	0	275,899	**0**	**275,899**	**275,899**
37,5	0	0	0	0	0	374,255	**0**	**374,255**	**374,255**
38	0	0	0	0	0	272,89	**0**	**272,890**	**272,890**
38,5	0	0	0	0	0	180,253	**0**	**180,253**	**180,253**
39	0	0	0	0	0	97,958	**0**	**97,958**	**97,958**
39,5	0	0	0	0	0	55,409	**0**	**55,409**	**55,409**
40	0	0	0	0	0	0	**0**	**0**	**0**
40,5	0	0	0	0	0	19,835	**0**	**19,835**	**19,835**
41	0	0	0	0	0	20,542	**0**	**20,542**	**20,542**
41,5	0	0	0	0	0	10,632	**0**	**10,632**	**10,632**
42	0	0	0	0	0	0	**0**	**0**	**0**
42,5	0	0	0	0	0	0	**0**	**0**	**0**
43	0	0	0	0	0	0	**0**	**0**	**0**
43,5	0	0	0	0	0	0	**0**	**0**	**0**
44	0	0	0	0	0	0	**0**	**0**	**0**
44,5	0	0	0	0	0	0	**0**	**0**	**0**
45	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL	337,192	4,548	28,155	58,666	183,674	1609,471	**369,895**	**1851,811**	**2221,706**

Table 14. *ECOCADIZ-RECLUTAS 2016-10* survey. Bogue (*Boops boops*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 32**.

ECOCADIZ-RECLUTAS 2016-10. *Boops boops*. ABUNDANCE (in number and million fish)										
Size class	POL01	POL02	POL03	POL04	*n*			millions		
					PORTUGAL	SPAIN	TOTAL	PORTUGAL	SPAIN	TOTAL
10	0	0	0	0	0	0	0	0	0	0
10,5	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0
11,5	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0
12,5	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0
13,5	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0
14,5	0	0	0	0	0	0	0	0	0	0
15	12786	69	1942	2909	14797	2909	17706	0,01	0,003	0,02
15,5	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0
16,5	0	0	0	0	0	0	0	0	0	0
17	12786	69	1942	2909	14797	2909	17706	0,01	0,003	0,02
17,5	0	0	0	0	0	0	0	0	0	0
18	12786	69	1942	2909	14797	2909	17706	0,01	0,003	0,02
18,5	25571	137	3885	5818	29593	5818	35411	0,03	0,01	0,04
19	43999	236	6685	10010	50920	10010	60930	0,1	0,01	0,1
19,5	52283	281	7943	11895	60507	11895	72402	0,1	0,01	0,1
20	178278	957	27085	40559	206320	40559	246879	0,2	0,04	0,2
20,5	274560	1474	41713	62464	317747	62464	380211	0,3	0,1	0,4
21	335126	1799	50914	76243	387839	76243	464082	0,4	0,1	0,5
21,5	481049	2583	73084	109442	556716	109442	666158	0,6	0,1	0,7
22	346771	1862	52683	78893	401316	78893	480209	0,4	0,1	0,5
22,5	215134	1155	32684	48944	248973	48944	297917	0,2	0,05	0,3
23	145924	783	22170	33199	168877	33199	202076	0,2	0,03	0,2
23,5	84997	456	12913	19337	98366	19337	117703	0,1	0,02	0,1
24	117711	632	17883	26780	136226	26780	163006	0,1	0,03	0,2
24,5	38357	206	5827	8726	44390	8726	53116	0,04	0,01	0,1
25	0	0	0	0	0	0	0	0	0	0
25,5	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0
26,5	0	0	0	0	0	0	0	0	0	0
27	12786	69	1942	2909	14797	2909	17706	0,01	0,003	0,02
27,5	0	0	0	0	0	0	0	0	0	0
28	12786	69	1942	2909	14797	2909	17706	0,01	0,003	0,02
28,5	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0
29,5	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0
30,5	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0
31,5	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0
TOTAL *n*	2403690	12906	365179	546855	2781775	546855	3328630	3	1	3
Millions	2	0,01	0,4	1	3	1	3			

Table 14. *ECOCADIZ-RECLUTAS 2016-10* survey. Bogue (*Boops boops*). Cont'd.

***ECOCADIZ-RECLUTAS 2016-10*. *Boops boops*. BIOMASS (t)**							
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**PORTUGAL**	**SPAIN**	**TOTAL**
10	0	0	0	0	**0**	**0**	**0**
10,5	0	0	0	0	**0**	**0**	**0**
11	0	0	0	0	**0**	**0**	**0**
11,5	0	0	0	0	**0**	**0**	**0**
12	0	0	0	0	**0**	**0**	**0**
12,5	0	0	0	0	**0**	**0**	**0**
13	0	0	0	0	**0**	**0**	**0**
13,5	0	0	0	0	**0**	**0**	**0**
14	0	0	0	0	**0**	**0**	**0**
14,5	0	0	0	0	**0**	**0**	**0**
15	0,416	0,002	0,063	0,095	**0,481**	**0,095**	**0,576**
15,5	0	0	0	0	**0**	**0**	**0**
16	0	0	0	0	**0**	**0**	**0**
16,5	0	0	0	0	**0**	**0**	**0**
17	0,593	0,003	0,090	0,135	**0,686**	**0,135**	**0,821**
17,5	0	0	0	0	**0**	**0**	**0**
18	0,697	0,004	0,106	0,159	**0,807**	**0,159**	**0,966**
18,5	1,507	0,008	0,229	0,343	**1,744**	**0,343**	**2,087**
19	2,797	0,015	0,425	0,636	**3,237**	**0,636**	**3,873**
19,5	3,579	0,019	0,544	0,814	**4,142**	**0,814**	**4,956**
20	13,114	0,070	1,992	2,983	**15,176**	**2,983**	**18,159**
20,5	21,666	0,116	3,292	4,929	**25,074**	**4,929**	**30,003**
21	28,321	0,152	4,303	6,443	**32,776**	**6,443**	**39,219**
21,5	43,468	0,233	6,604	9,889	**50,305**	**9,889**	**60,194**
22	33,453	0,180	5,082	7,611	**38,715**	**7,611**	**46,326**
22,5	22,125	0,119	3,361	5,034	**25,605**	**5,034**	**30,639**
23	15,977	0,086	2,427	3,635	**18,490**	**3,635**	**22,125**
23,5	9,894	0,053	1,503	2,251	**11,450**	**2,251**	**13,701**
24	14,549	0,078	2,210	3,310	**16,837**	**3,310**	**20,147**
24,5	5,028	0,027	0,764	1,144	**5,819**	**1,144**	**6,963**
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	0	0	0	0	**0**	**0**	**0**
27	2,211	0,012	0,336	0,503	**2,559**	**0,503**	**3,062**
27,5	0	0	0	0	**0**	**0**	**0**
28	2,453	0,013	0,373	0,558	**2,839**	**0,558**	**3,397**
28,5	0	0	0	0	**0**	**0**	**0**
29	0	0	0	0	**0**	**0**	**0**
29,5	0	0	0	0	**0**	**0**	**0**
30	0	0	0	0	**0**	**0**	**0**
30,5	0	0	0	0	**0**	**0**	**0**
31	0	0	0	0	**0**	**0**	**0**
31,5	0	0	0	0	**0**	**0**	**0**
32	0	0	0	0	**0**	**0**	**0**
TOTAL	221,848	1,190	33,704	50,472	**256,742**	**50,472**	**307,214**

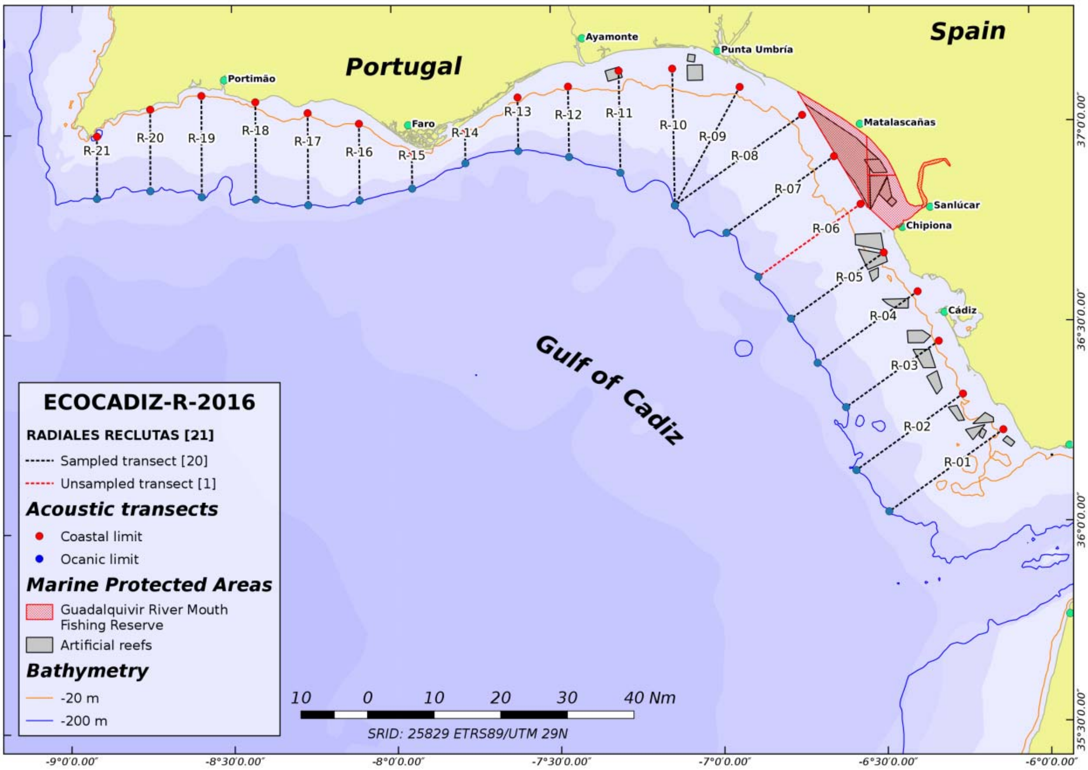


Figure 1. *ECOCADIZ-RECLUTAS 2016-10* survey. Location of the acoustic transects sampled during the survey. Transect R06 was not sampled. The different protected areas inside the Guadalquivir river mouth Fishing Reserve and artificial reef polygons are also shown.

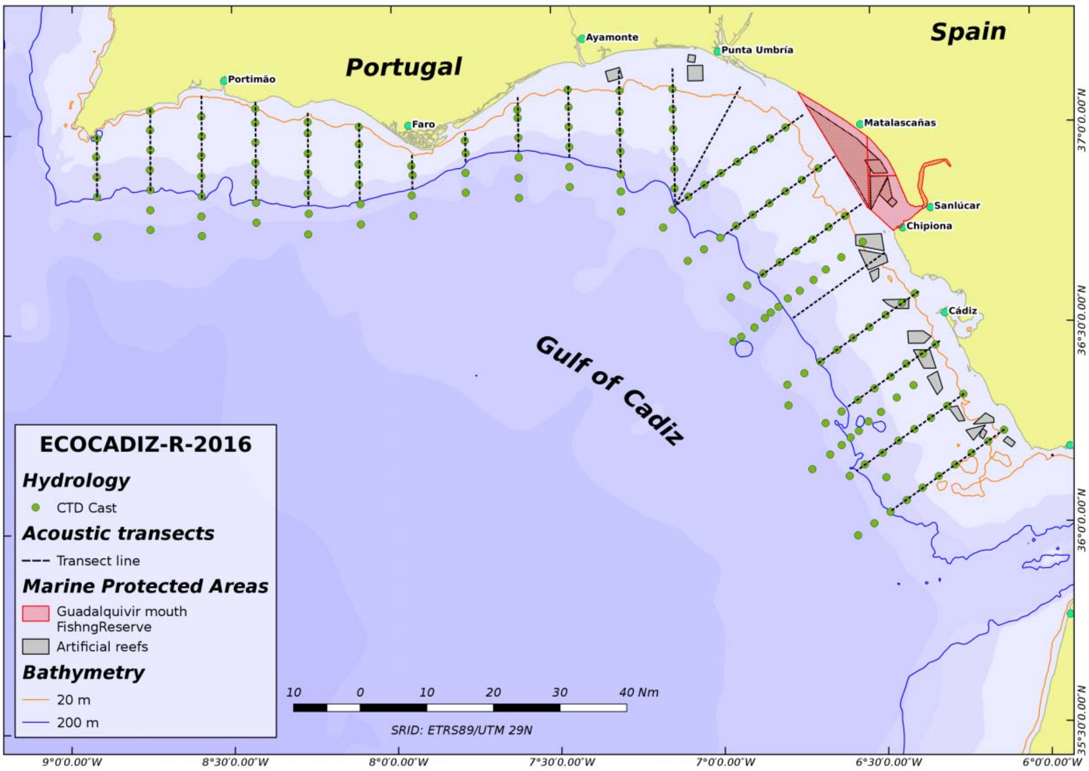


Figure 2. *ECOCADIZ-RECLUTAS 2016-10* survey. Location of CTD stations.

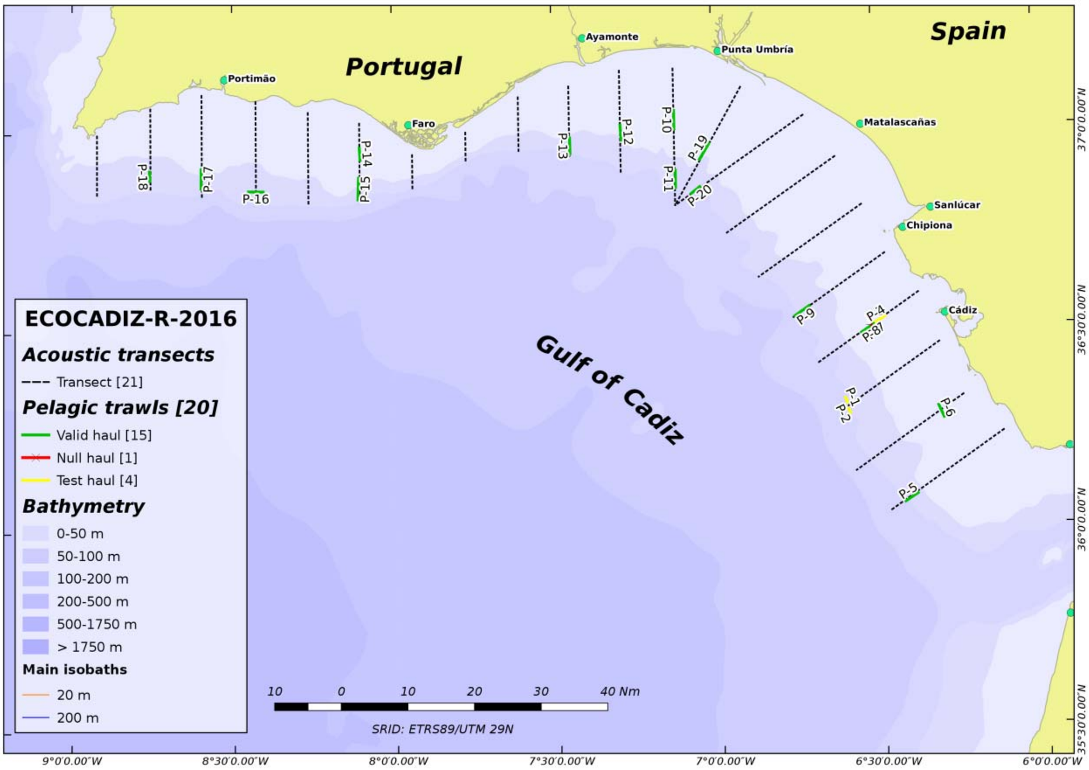


Figure 3. *ECOCADIZ-RECLUTAS 2016-10* survey. Location of ground-truthing fishing hauls. Null hauls in red.

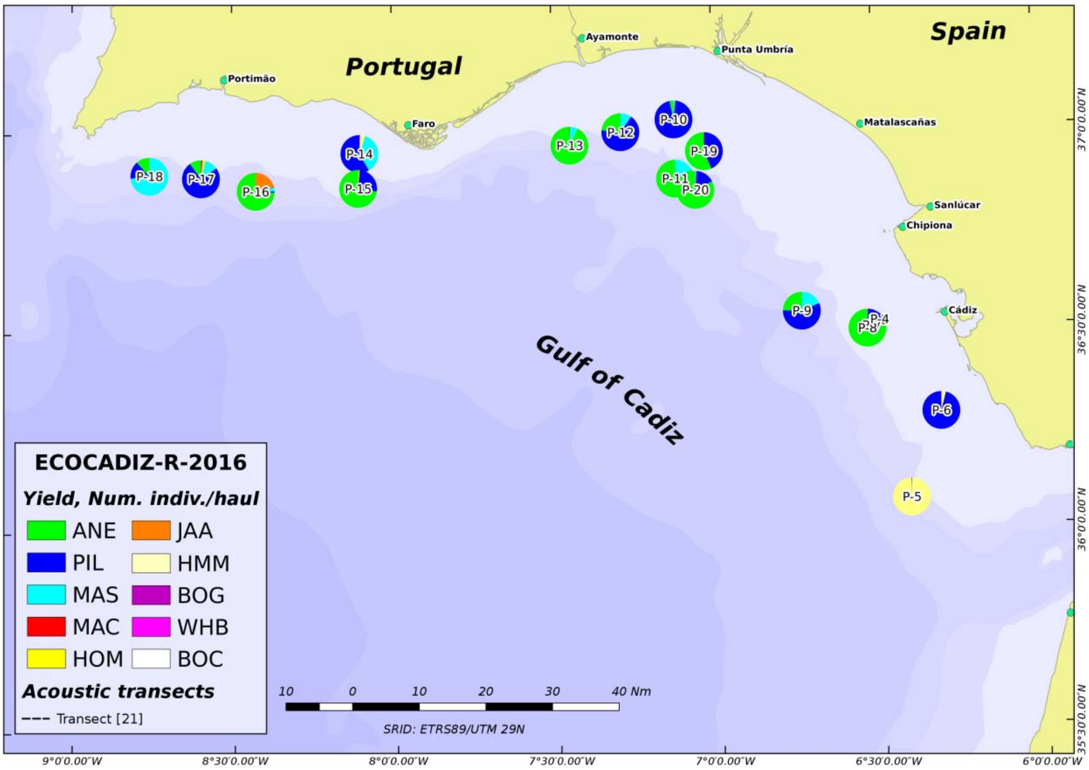


Figure 4. *ECOCADIZ-RECLUTAS 2016-10* survey. Species composition (percentages in number) in valid fishing hauls.

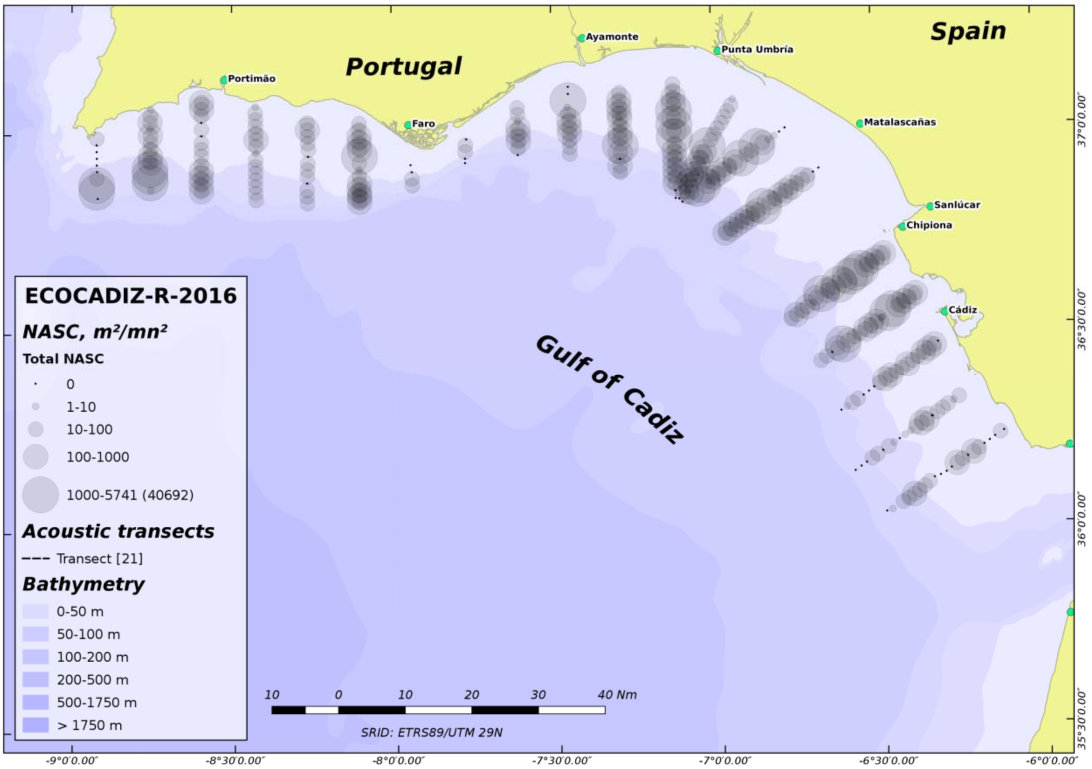


Figure 7. *ECOCADIZ-RECLUTAS 2016-10* survey. Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the pelagic fish species assemblage. Note that transect RA06 was impossible to be sampled due to NATO/Spanish navy military exercises.

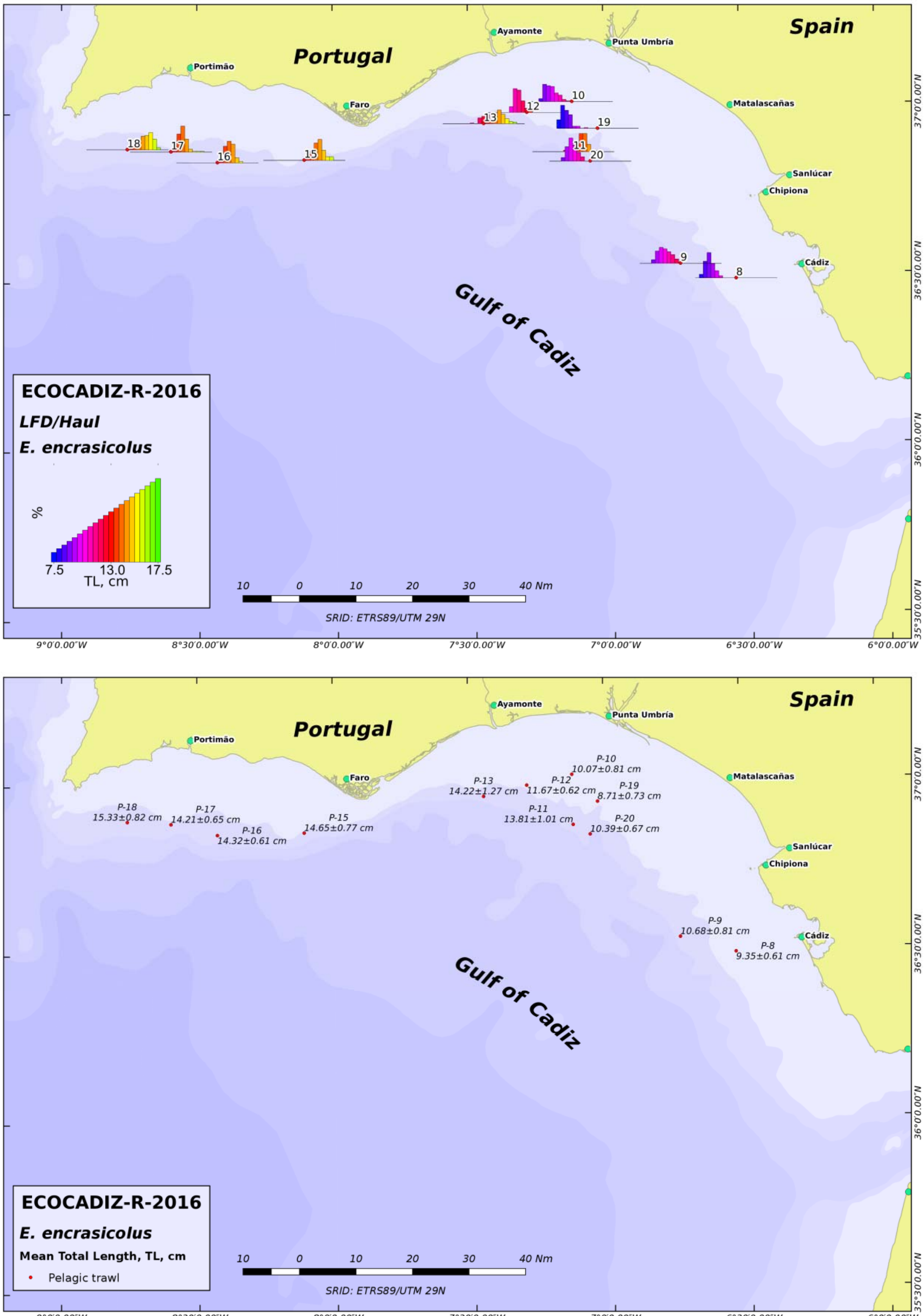
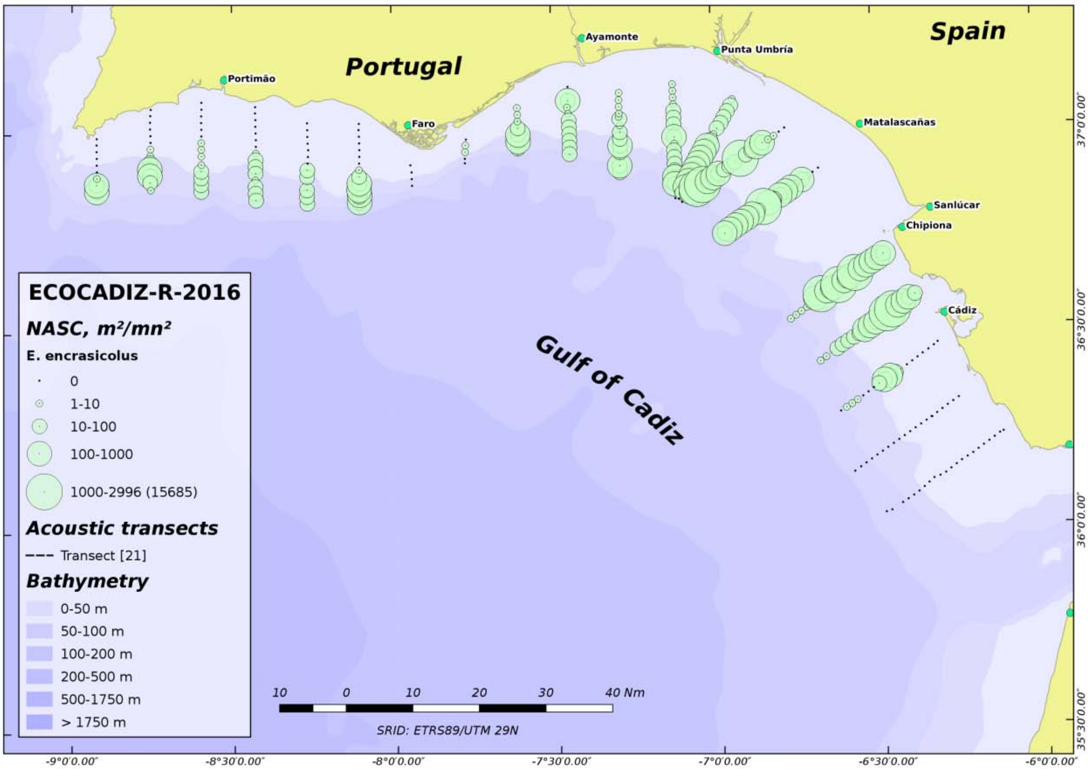


Figure 8. *ECOCADIZ-RECLUTAS 2016-10* survey. Anchovy (*Engraulis encrasicolus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul. Note that transect RA06 was impossible to be sampled due to NATO/Spanish navy military exercises.



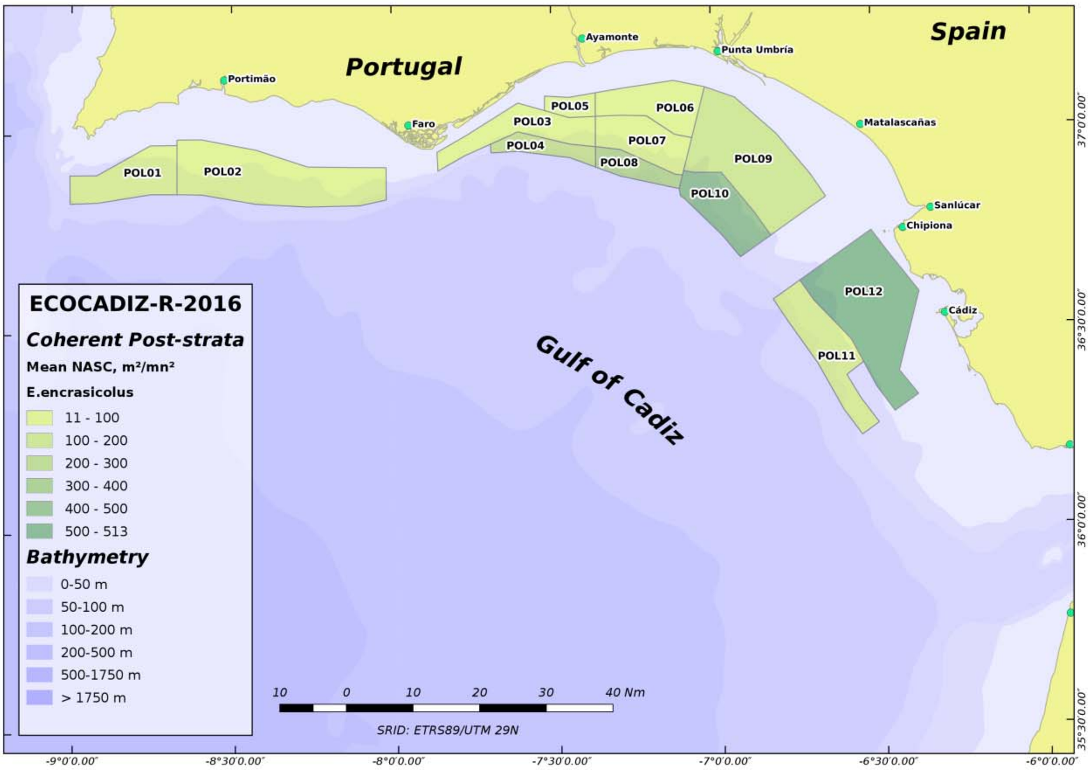


Figure 9. *ECOCADIZ-RECLUTAS 2016-10* survey. Anchovy (*Engraulis encrasicolus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum. Note that transect RA06 was impossible to be sampled due to NATO/Spanish navy military exercises.

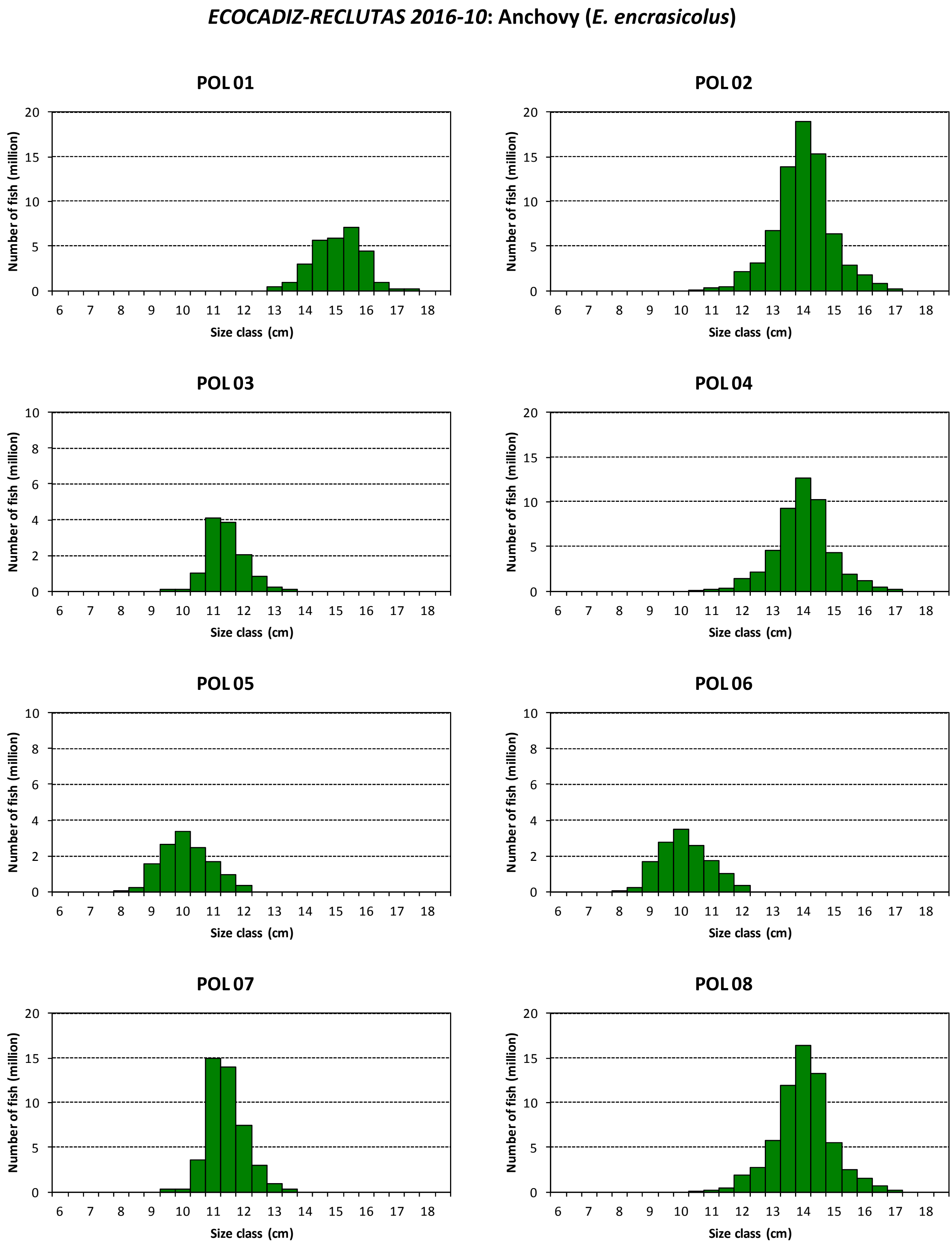


Figure 10. *ECOCADIZ-RECLUTAS 2016-10* survey. Anchovy (*Engraulis encrasicolus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 9**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

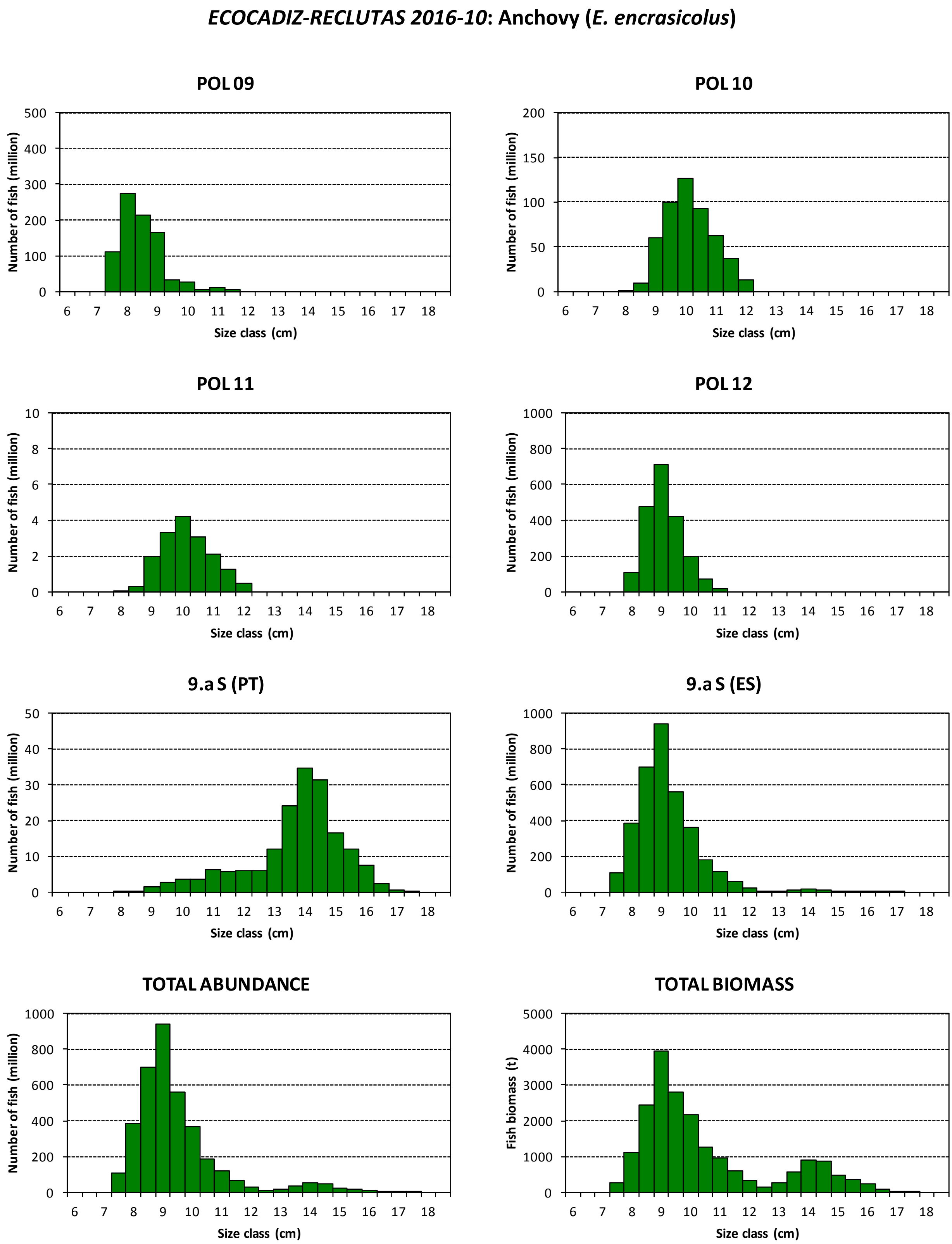


Figure 10. *ECOCADIZ-RECLUTAS 2016-10* survey. Anchovy (*Engraulis encrasicolus*). Cont'd.

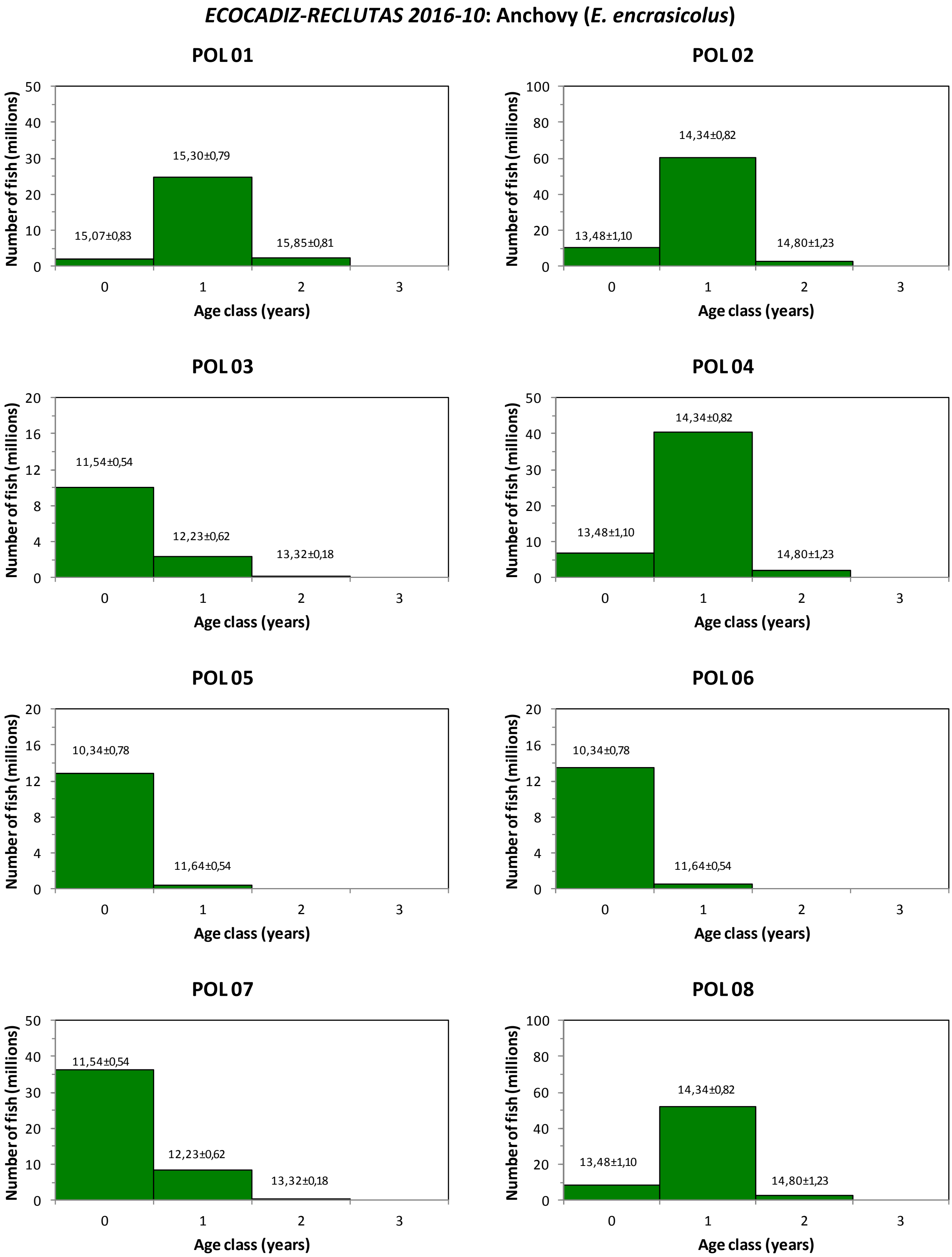


Figure 11. *ECOCADIZ-RECLUTAS 2016-10* survey. Anchovy (*Engraulis encrasicolus*). Estimated abundances (number of fish in millions) by age class (years) by homogeneous stratum (POL01-POLn, numeration as in **Figure 9**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

***ECOCADIZ-RECLUTAS 2016-10*: Anchovy (*E. encrasicolus*)**

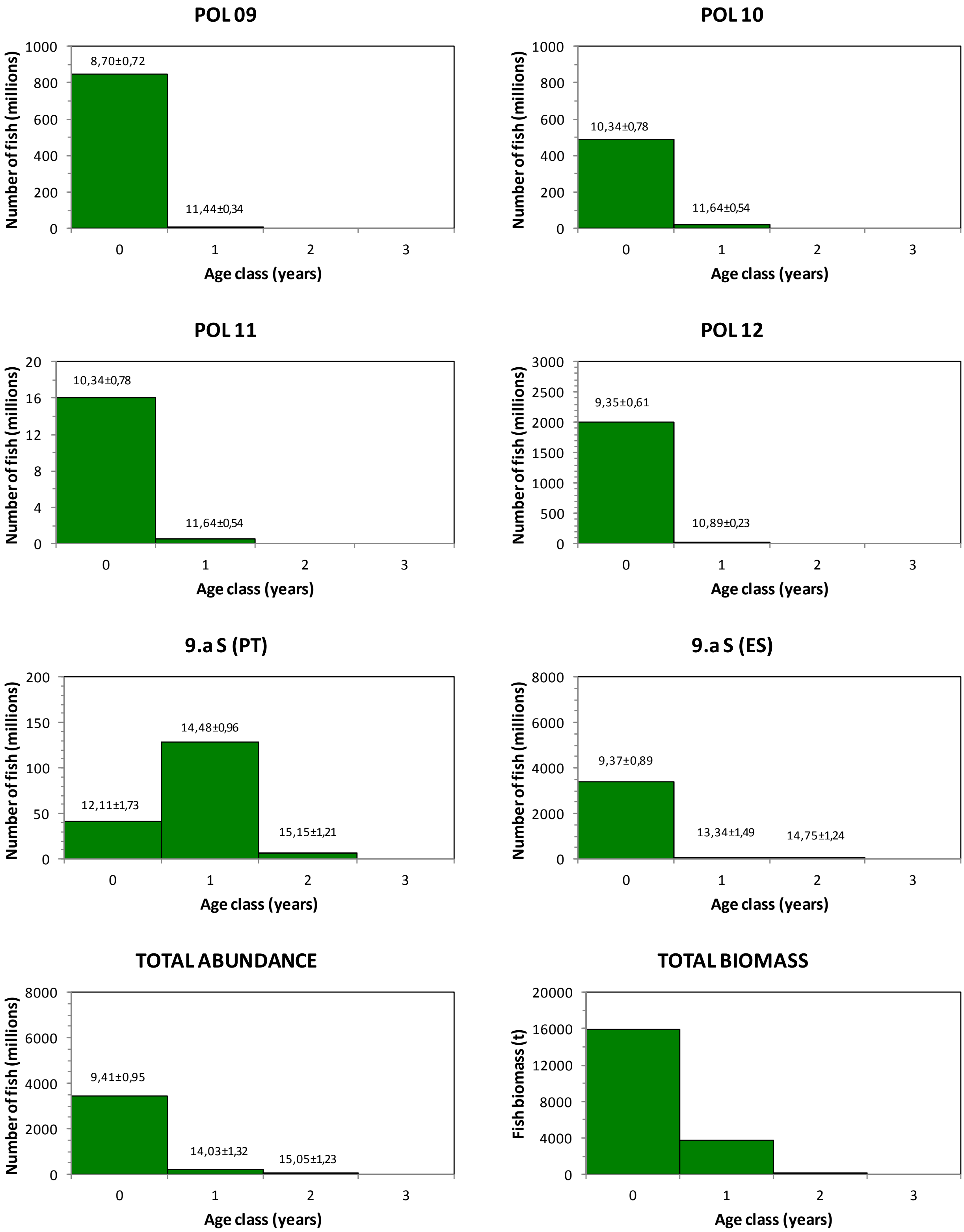


Figure 11. *ECOCADIZ-RECLUTAS 2016-10* survey. Anchovy (*Engraulis encrasicolus*). Cont'd.

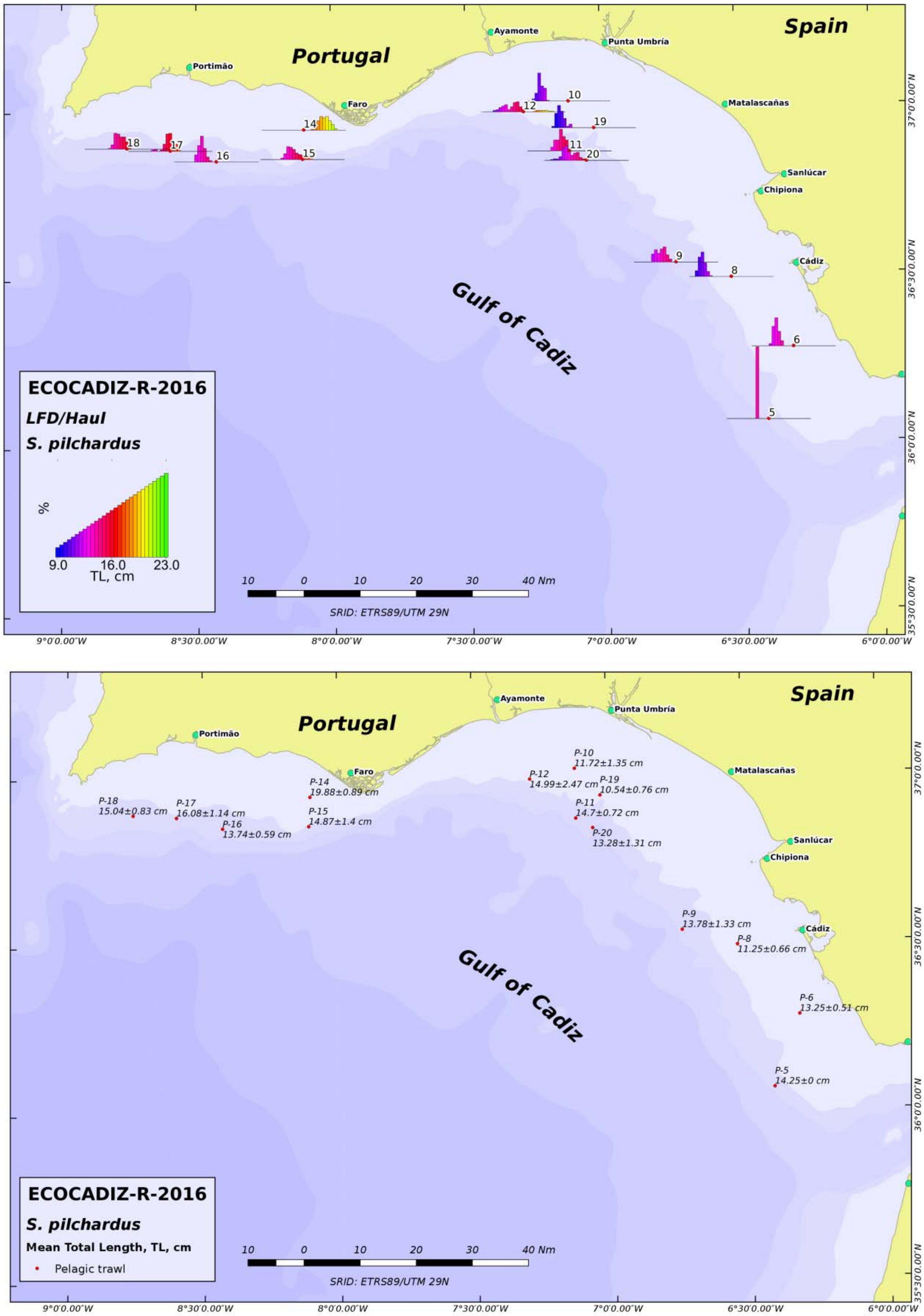


Figure 12. *ECOCADIZ-RECLUTAS 2016-10* survey. Sardine (*Sardina pilchardus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul. Note that transect RA06 was impossible to be sampled due to NATO/Spanish navy military exercises.

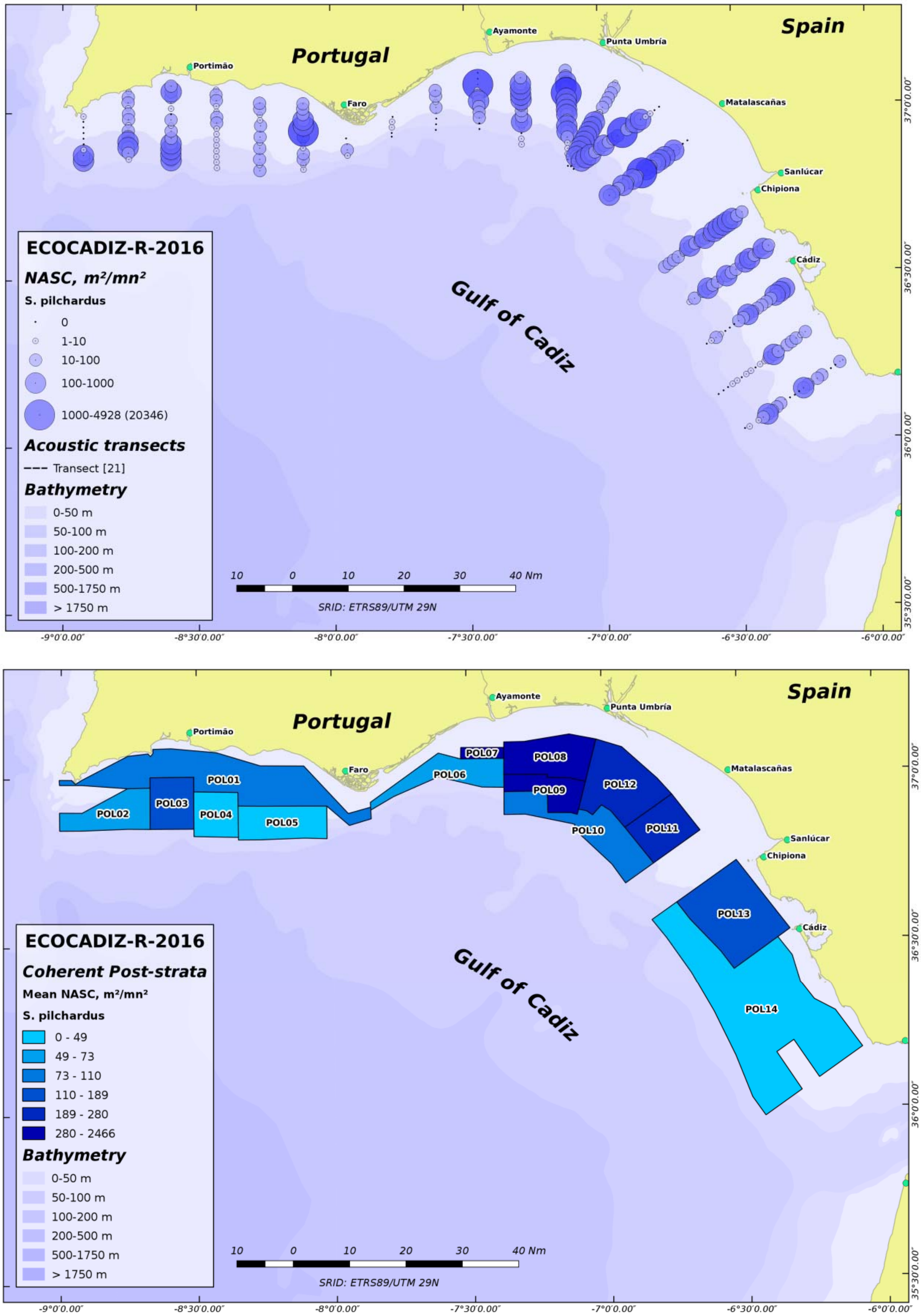


Figure 13. *ECOCADIZ-RECLUTAS 2016-10* survey. Sardine (*Sardina pilchardus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum. Note that transect RA06 was impossible to be sampled due to NATO/Spanish navy military exercises.

***ECOCADIZ-RECLUTAS 2016-10*: Sardine (*S. pilchardus*)**

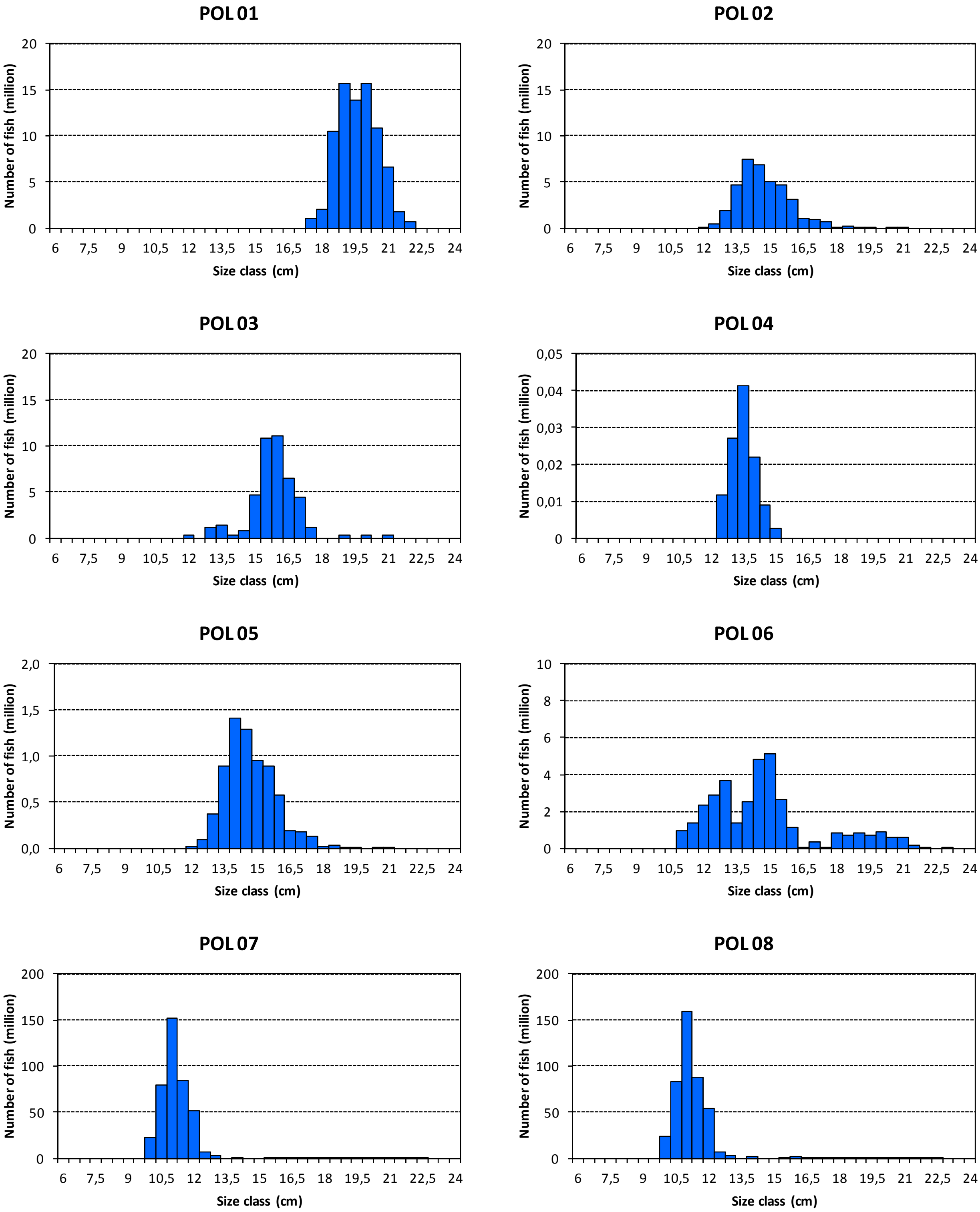


Figure 14. *ECOCADIZ-RECLUTAS 2016-10* survey. Sardine (*Sardina pilchardus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 13**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

***ECOCADIZ-RECLUTAS 2016-10*: Sardine (*S. pilchardus*)**

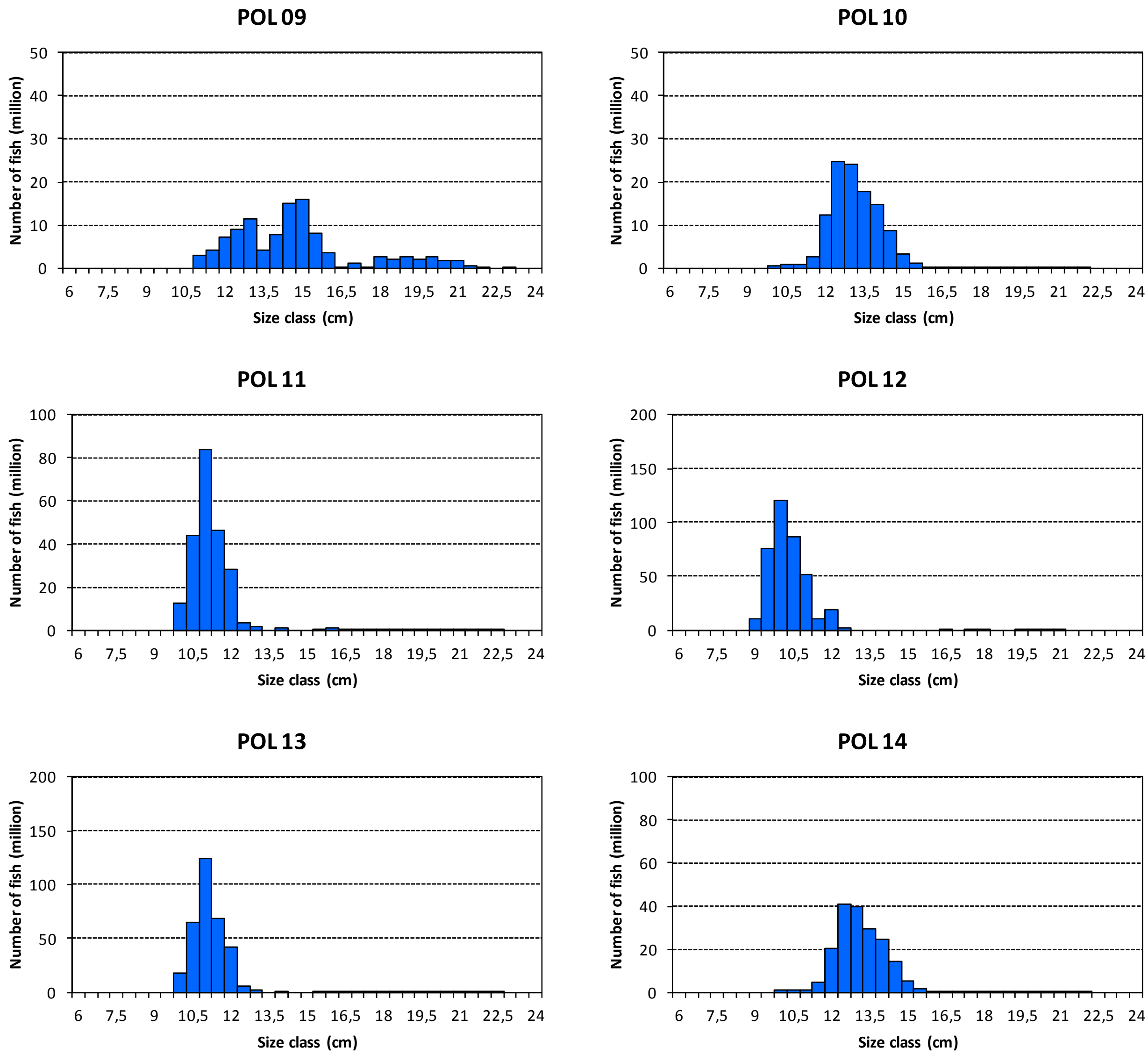


Figure 14. *ECOCADIZ-RECLUTAS 2016-10* survey. Sardine (*Sardina pilchardus*). Cont'd.

***ECOCADIZ-RECLUTAS 2016-10*: Sardine (*S. pilchardus*)**

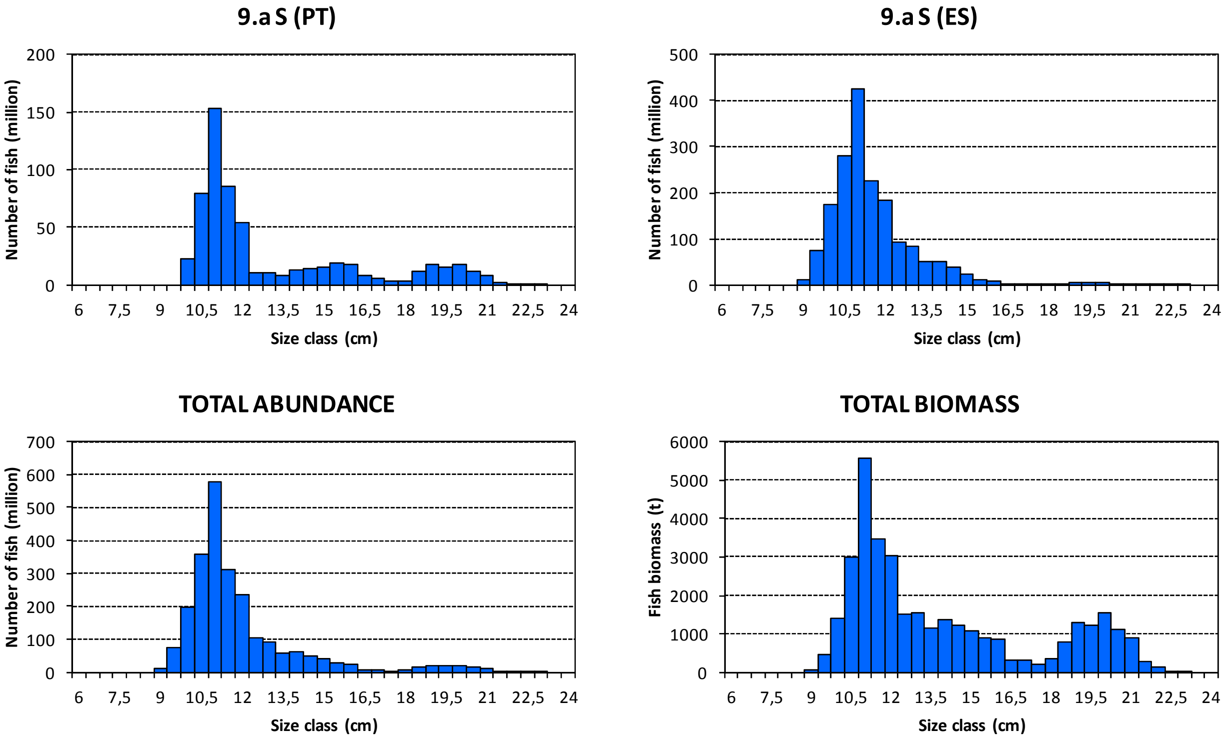


Figure 14. *ECOCADIZ-RECLUTAS 2016-10* survey. Sardine (*Sardina pilchardus*). Cont'd.

***ECOCADIZ-RECLUTAS 2016-10*: Sardine (*S. pilchardus*)**

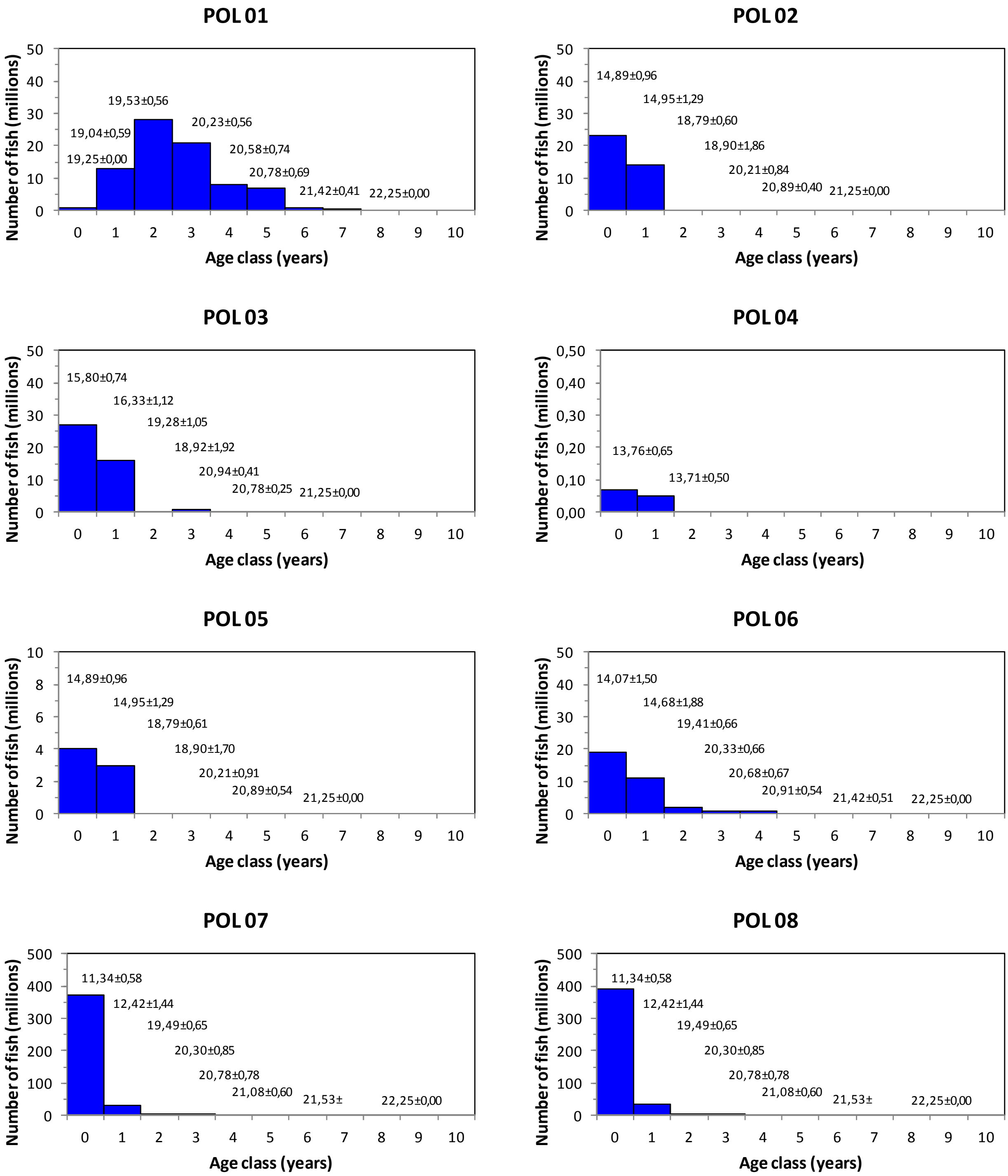


Figure 15. *ECOCADIZ-RECLUTAS 2016-10* survey. Sardine (*Sardina pilchardus*). Estimated abundances (number of fish in millions) by age class (years) by homogeneous stratum (POL01-POLn, numeration as in **Figure 13**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

***ECOCADIZ-RECLUTAS 2016-10*: Sardine (*S. pilchardus*)**

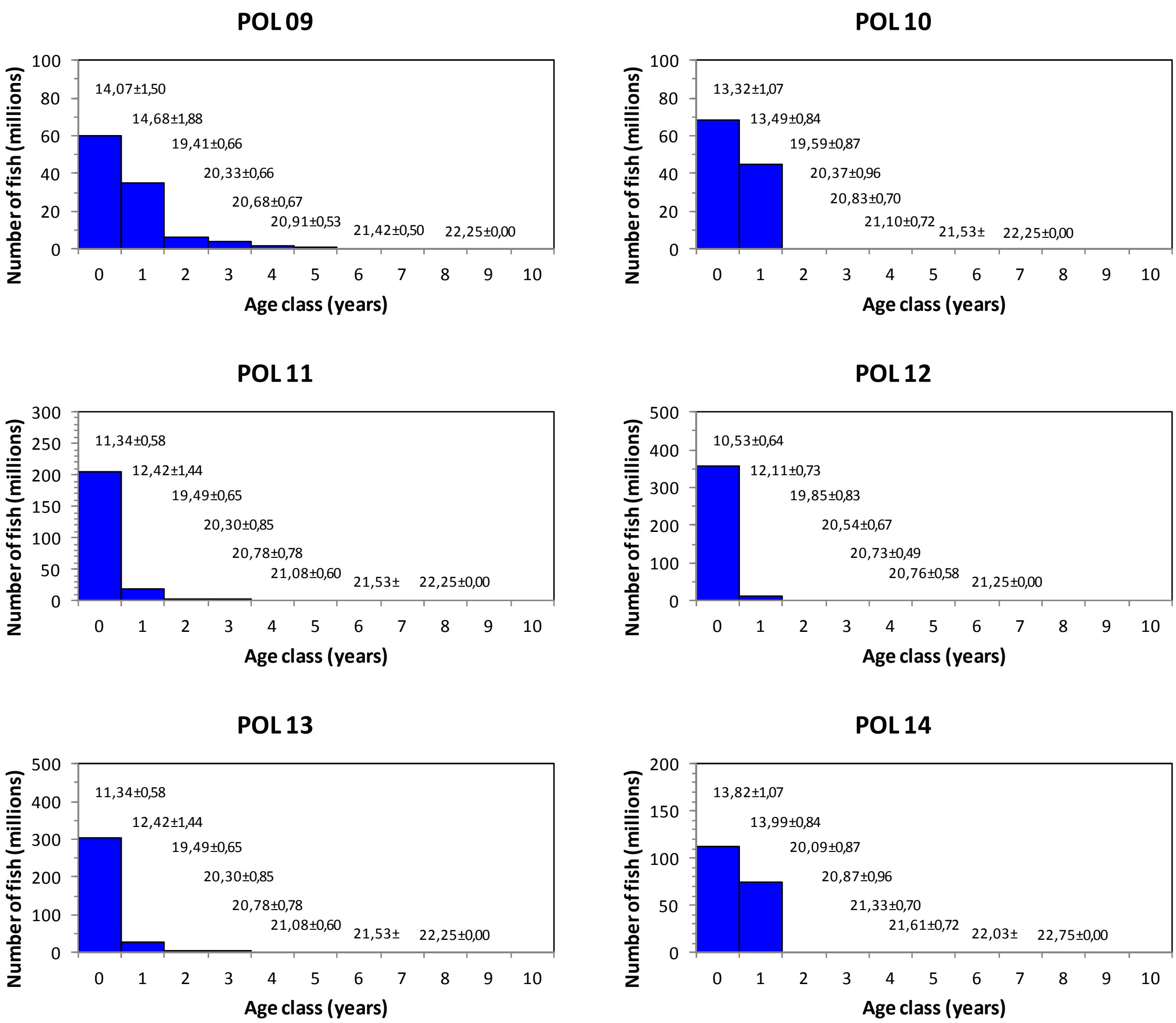


Figure 15. *ECOCADIZ-RECLUTAS 2016-10* survey. Sardine (*Sardina pilchardus*). Cont'd.

***ECOCADIZ-RECLUTAS 2016-10*: Sardine (*S. pilchardus*)**

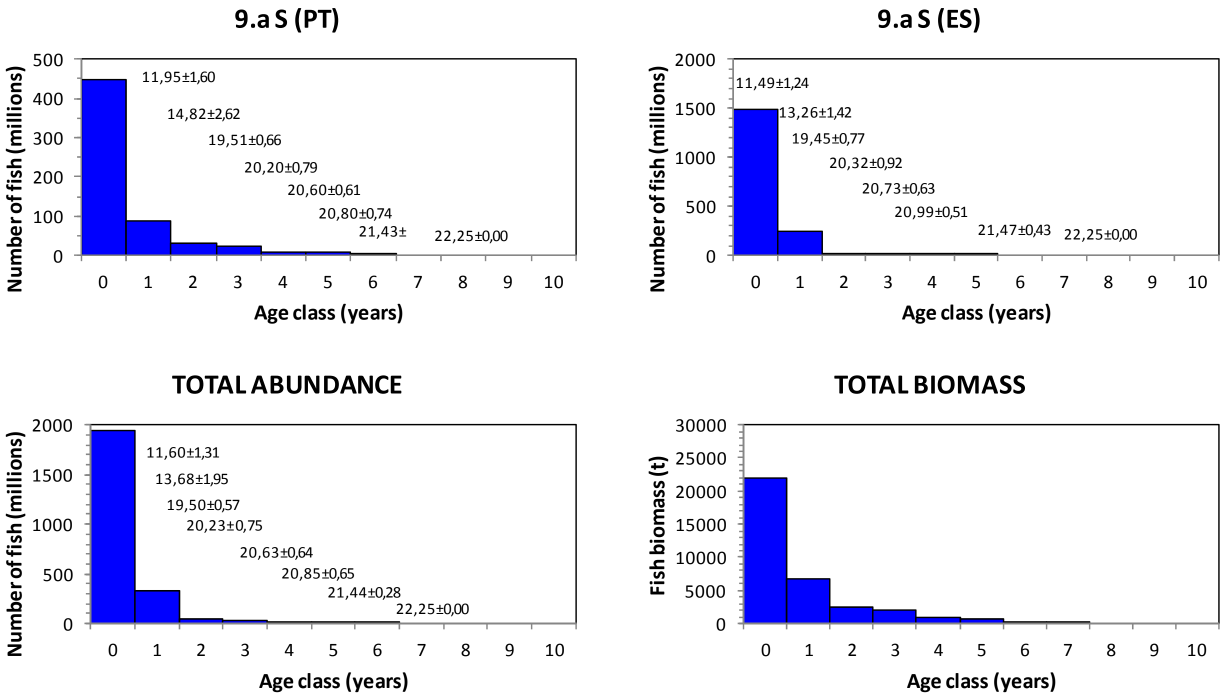


Figure 15. *ECOCADIZ-RECLUTAS 2016-10* survey. Sardine (*Sardina pilchardus*). Cont'd.

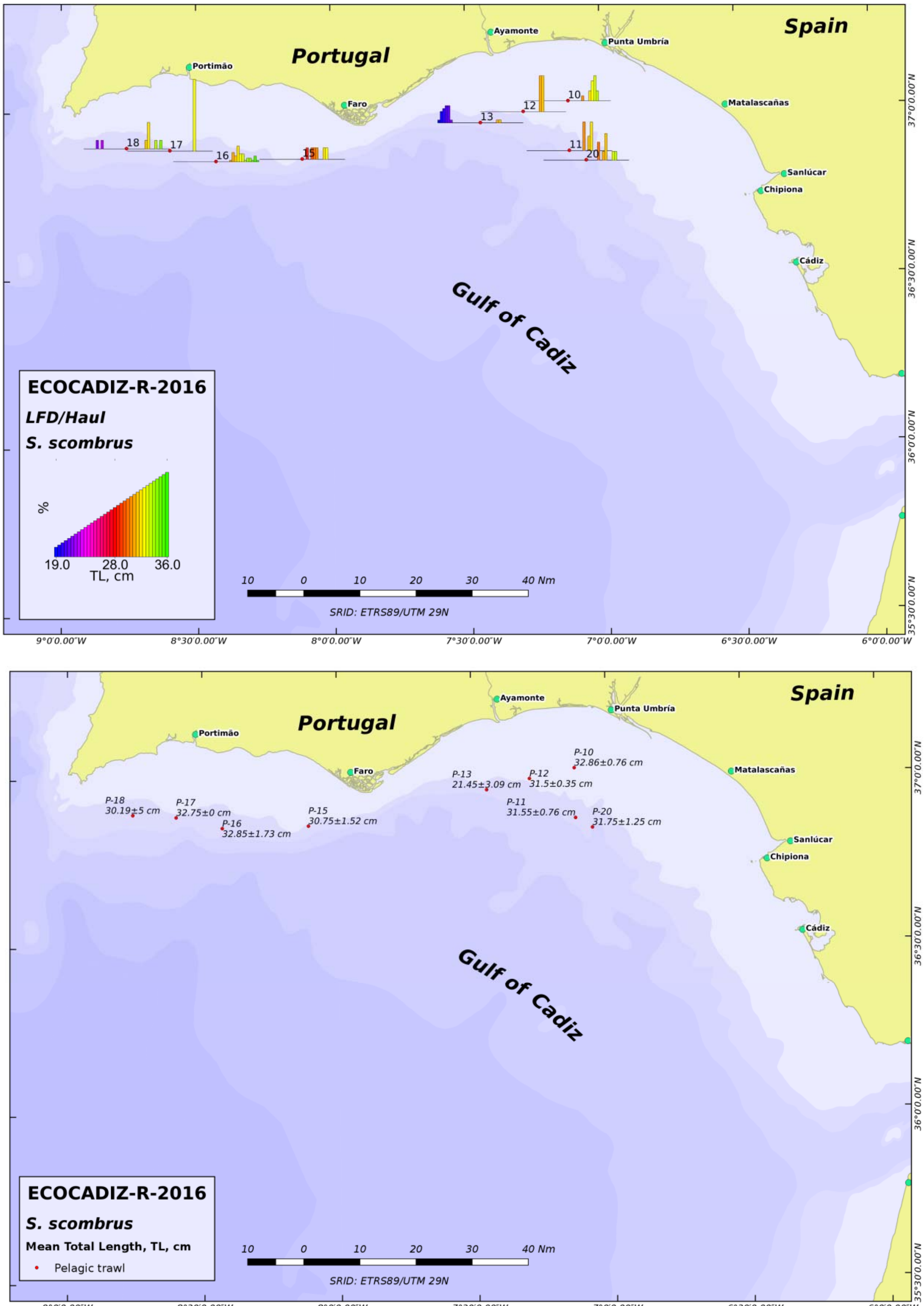
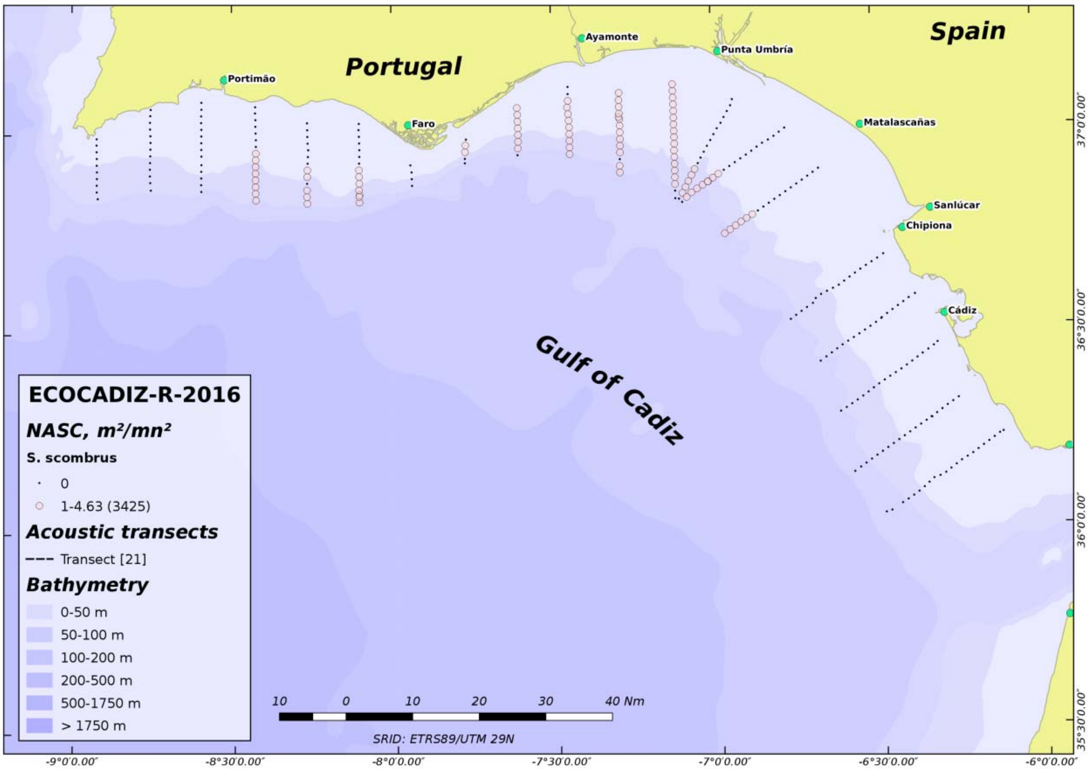


Figure 16. *ECOCADIZ-RECLUTAS 2016-10* survey. Atlantic mackerel (*Scomber scombrus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul. Note that transect RA06 was impossible to be sampled due to NATO/Spanish navy military exercises.



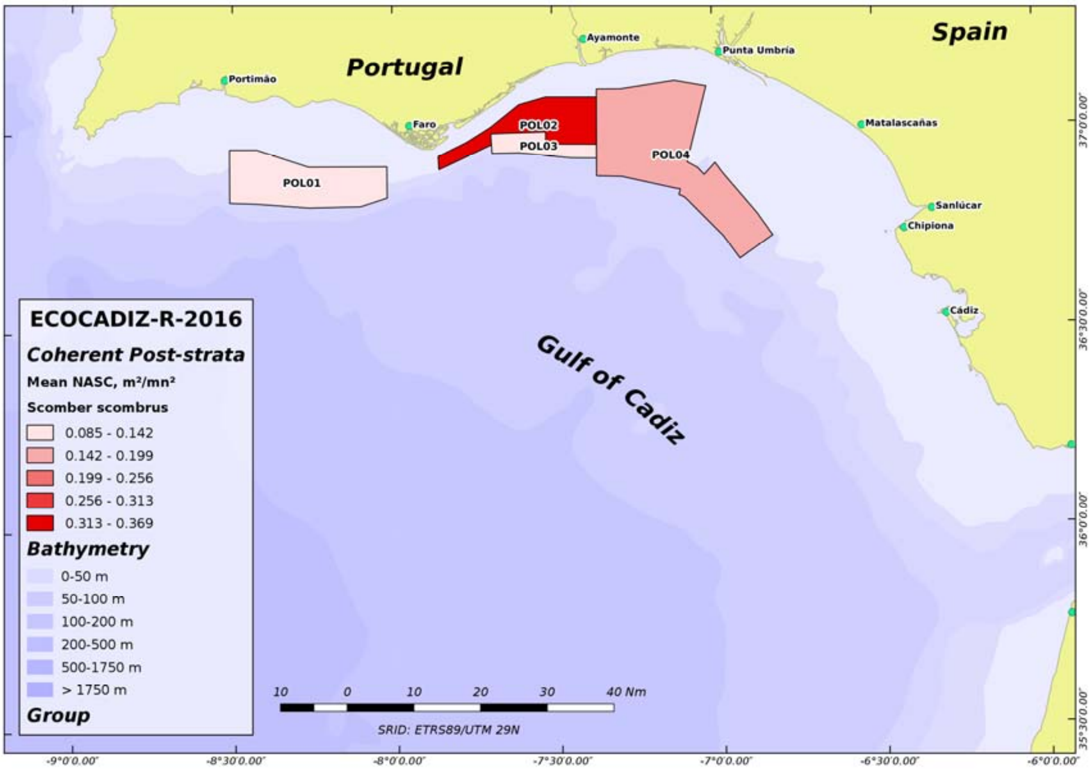


Figure 17. *ECOCADIZ-RECLUTAS 2016-10* survey. Atlantic mackerel (*Scomber scombrus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum. Note that transect RA06 was impossible to be sampled due to NATO/Spanish navy military exercises.

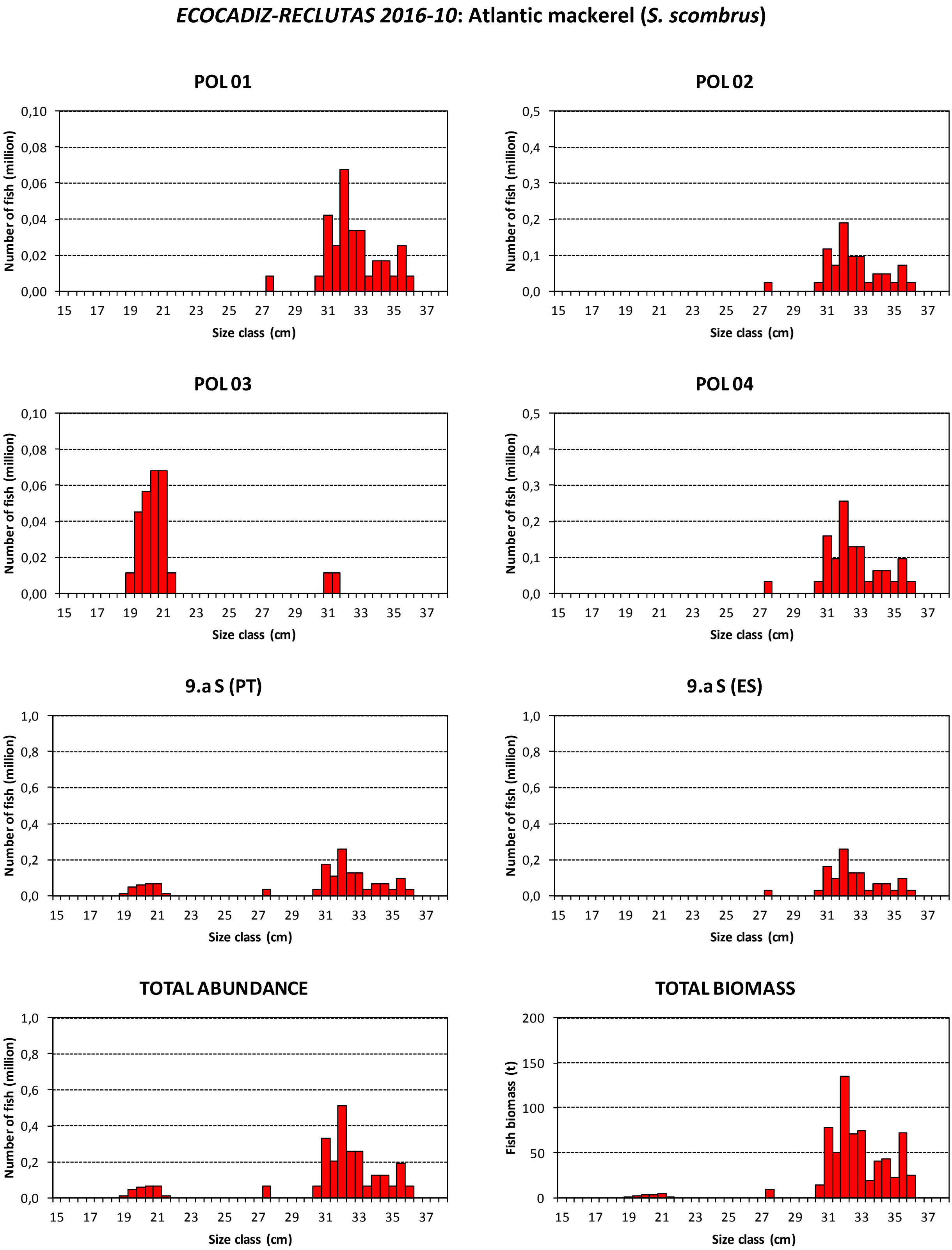


Figure 18. *ECOCADIZ-RECLUTAS 2016-10* survey. Atlantic mackerel (*Scomber scombrus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 17**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

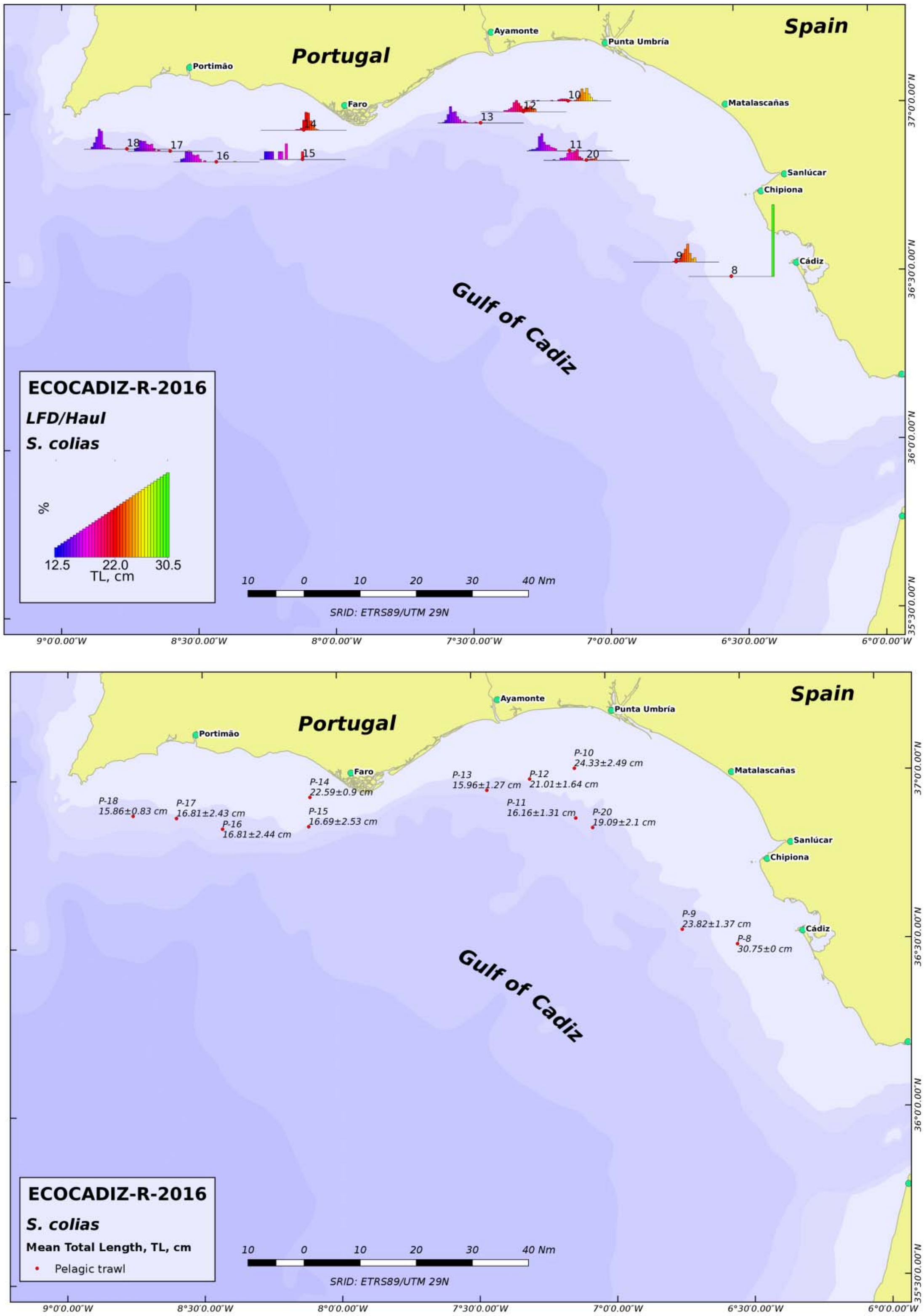
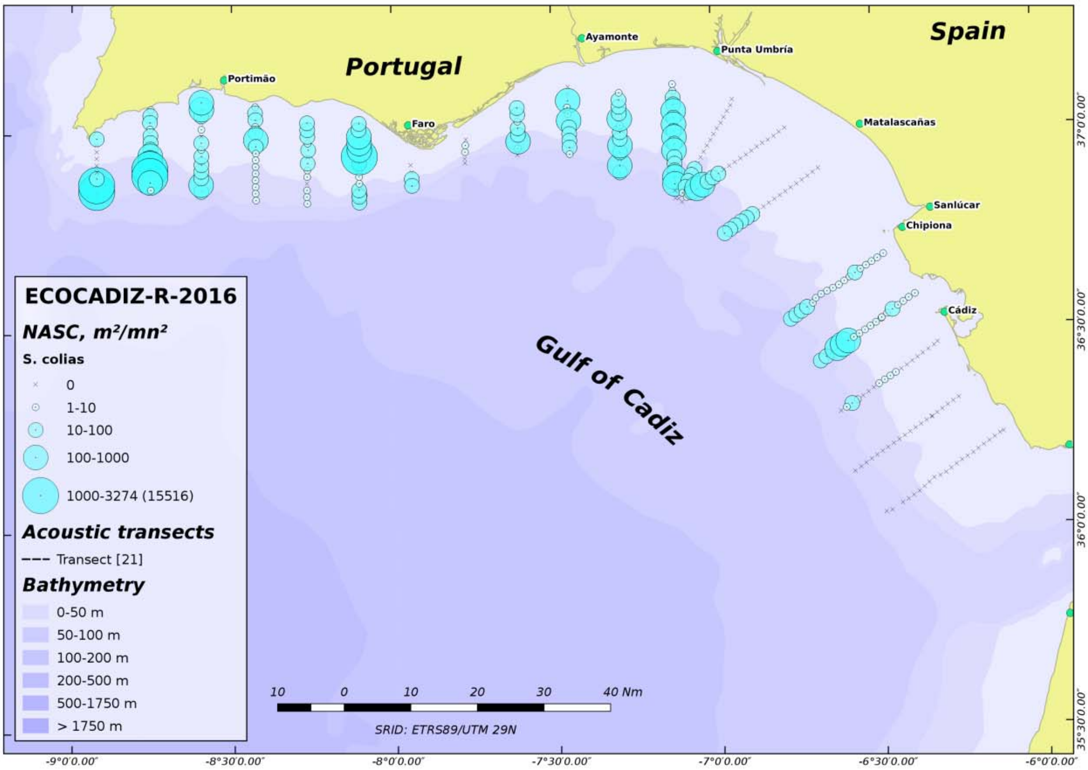


Figure 19. *ECOCADIZ-RECLUTAS 2016-10* survey. Chub mackerel (*Scomber colias*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul. Note that transect RA06 was impossible to be sampled due to NATO/Spanish navy military exercises.



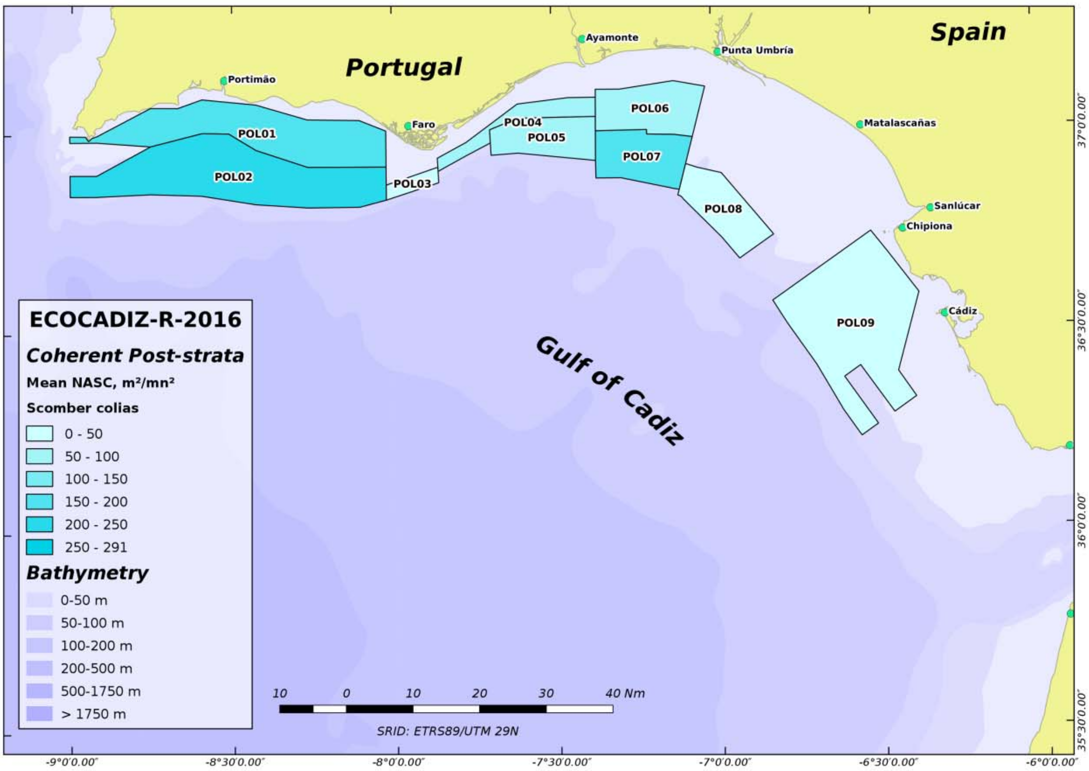


Figure 20. *ECOCADIZ-RECLUTAS 2016-10* survey. Chub mackerel (*Scomber colias*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum. Note that transect RA06 was impossible to be sampled due to NATO/Spanish navy military exercises.

***ECOCADIZ-RECLUTAS 2016-10*: Chub mackerel (*S. colias*)**

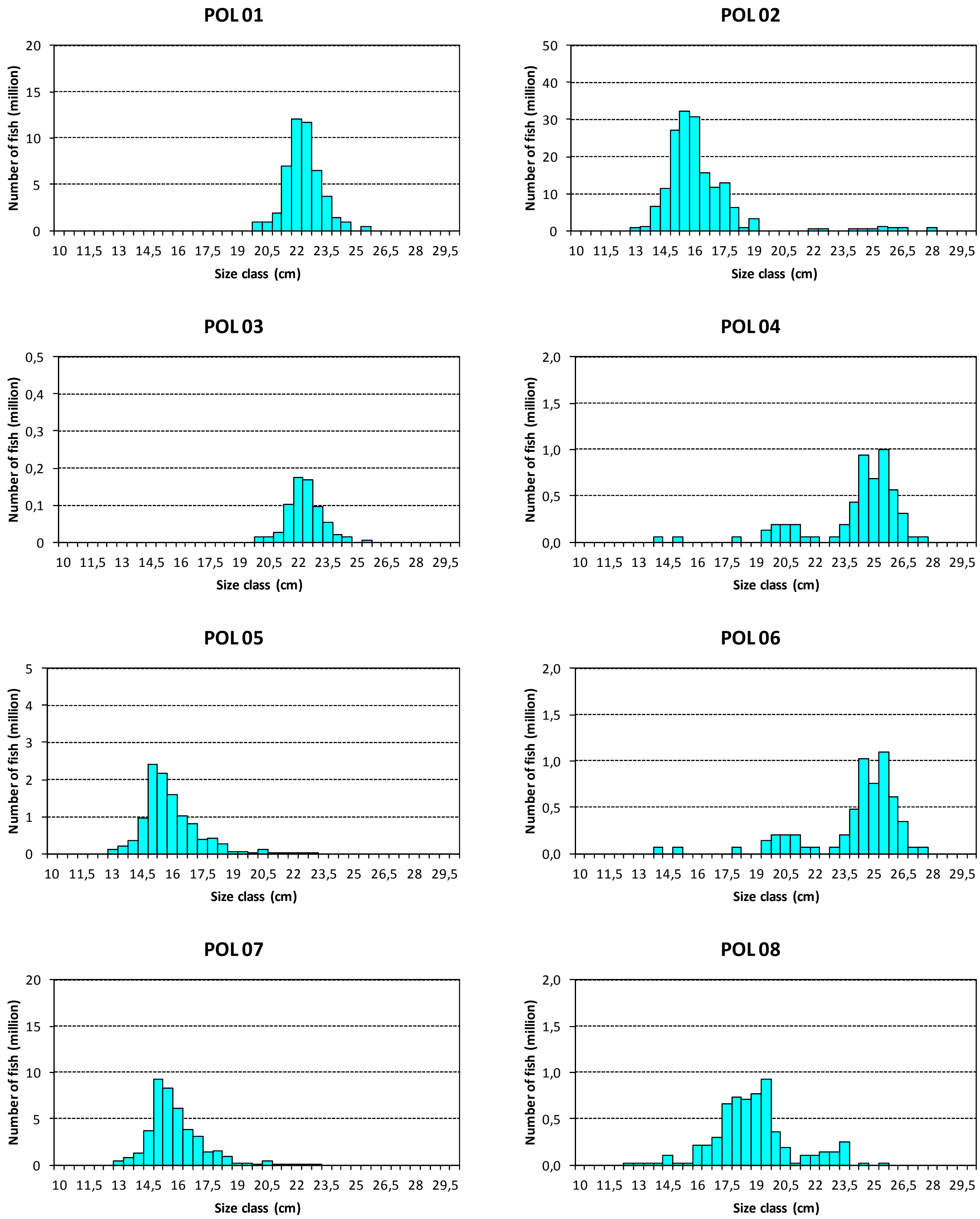


Figure 21. *ECOCADIZ-RECLUTAS 2016-10* survey. Chub mackerel (*Scomber colias*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 20**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

***ECOCADIZ-RECLUTAS 2016-10*: Chub mackerel (*S. colias*)**

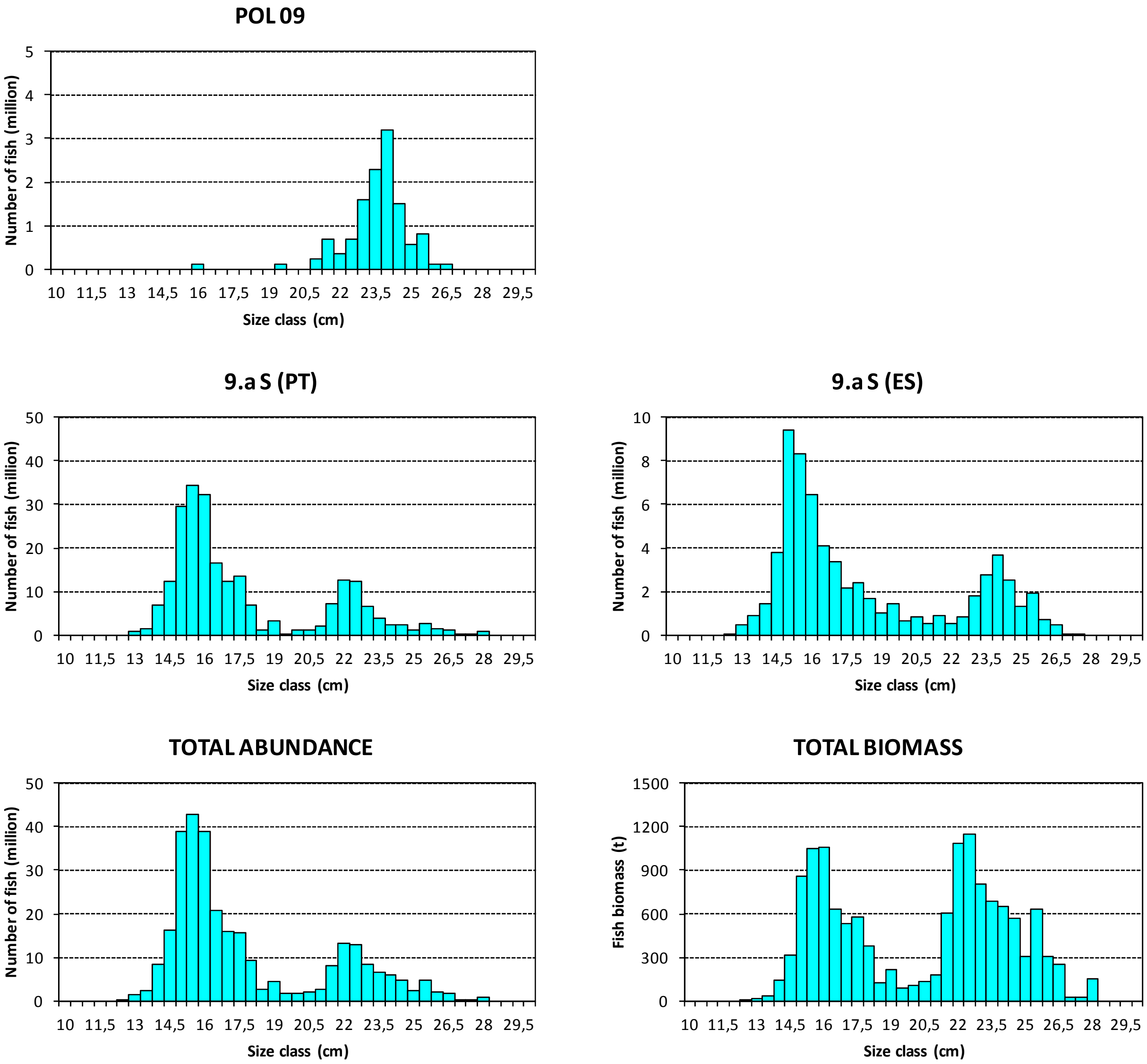


Figure 21. *ECOCADIZ-RECLUTAS 2016-10* survey. Chub mackerel (*Scomber colias*). Cont'd.

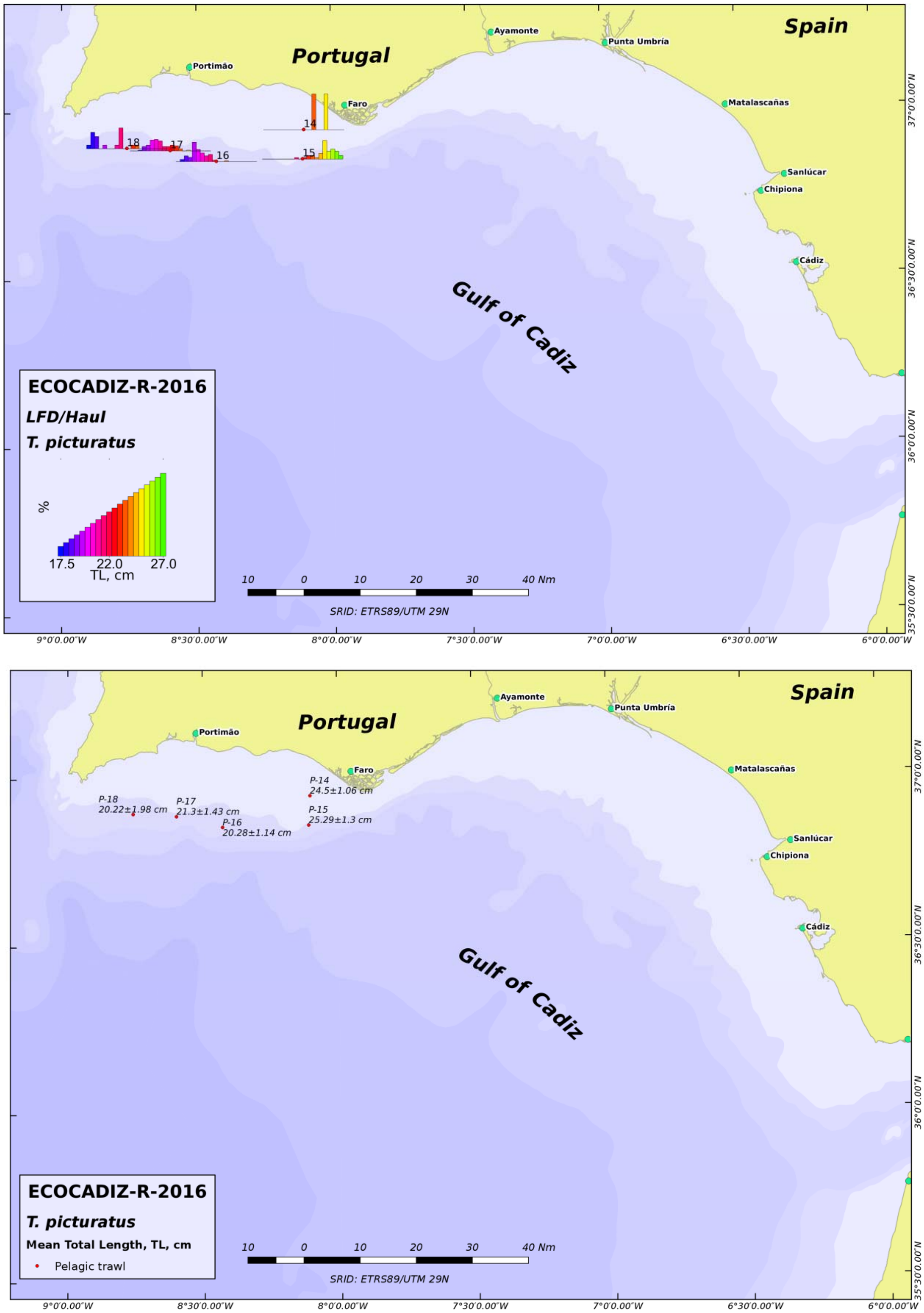
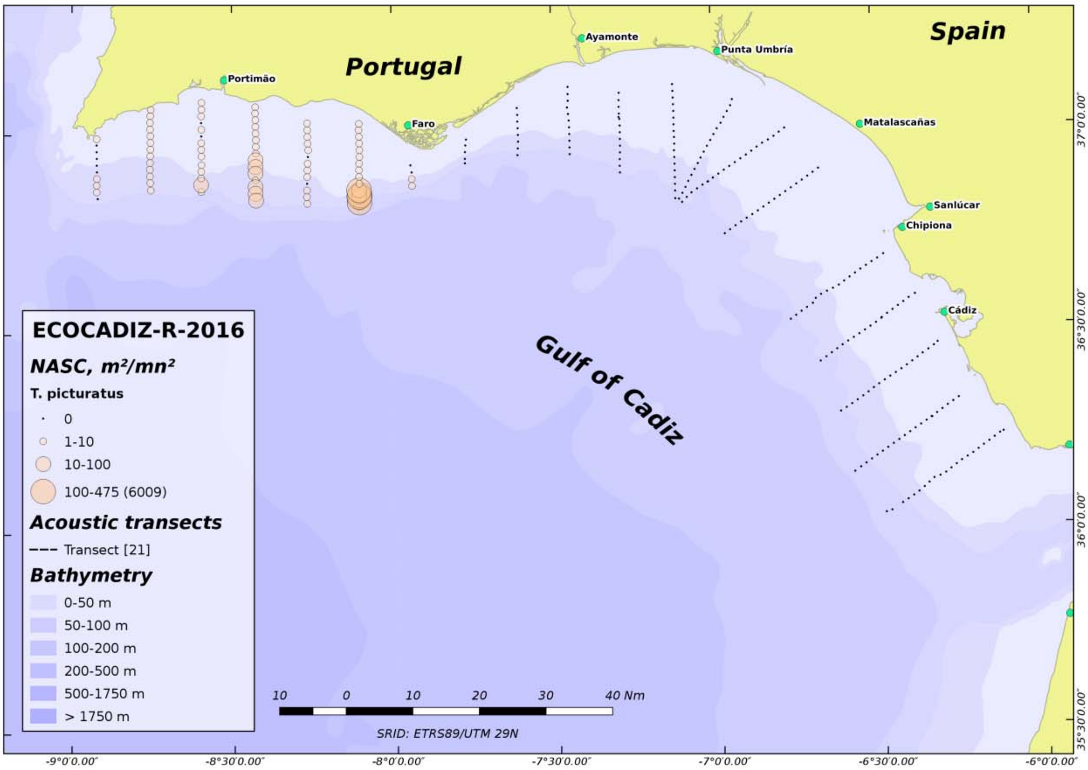


Figure 22. *ECOCADIZ-RECLUTAS 2016-10* survey. Blue jack mackerel (*Trachurus picturatus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul. Note that transect RA06 was impossible to be sampled due to NATO/Spanish navy military exercises.



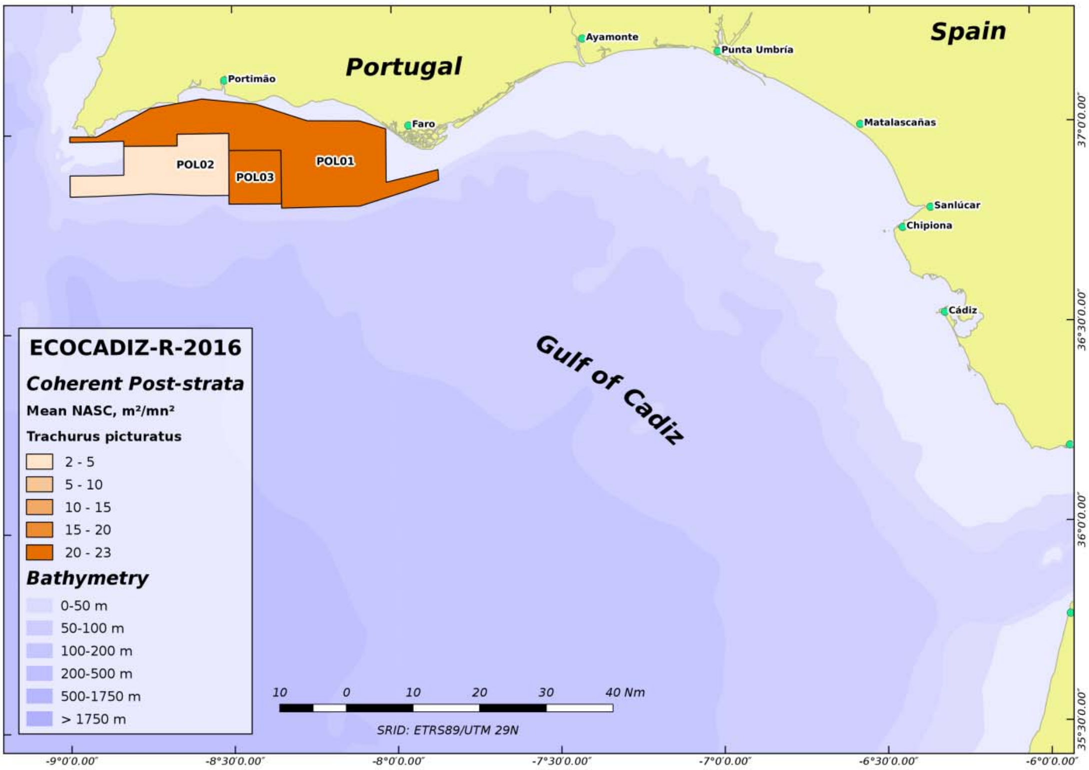


Figure 23. *ECOCADIZ-RECLUTAS 2016-10* survey. Blue jack mackerel (*Trachurus picturatus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum. Note that transect RA06 was impossible to be sampled due to NATO/Spanish navy military exercises.

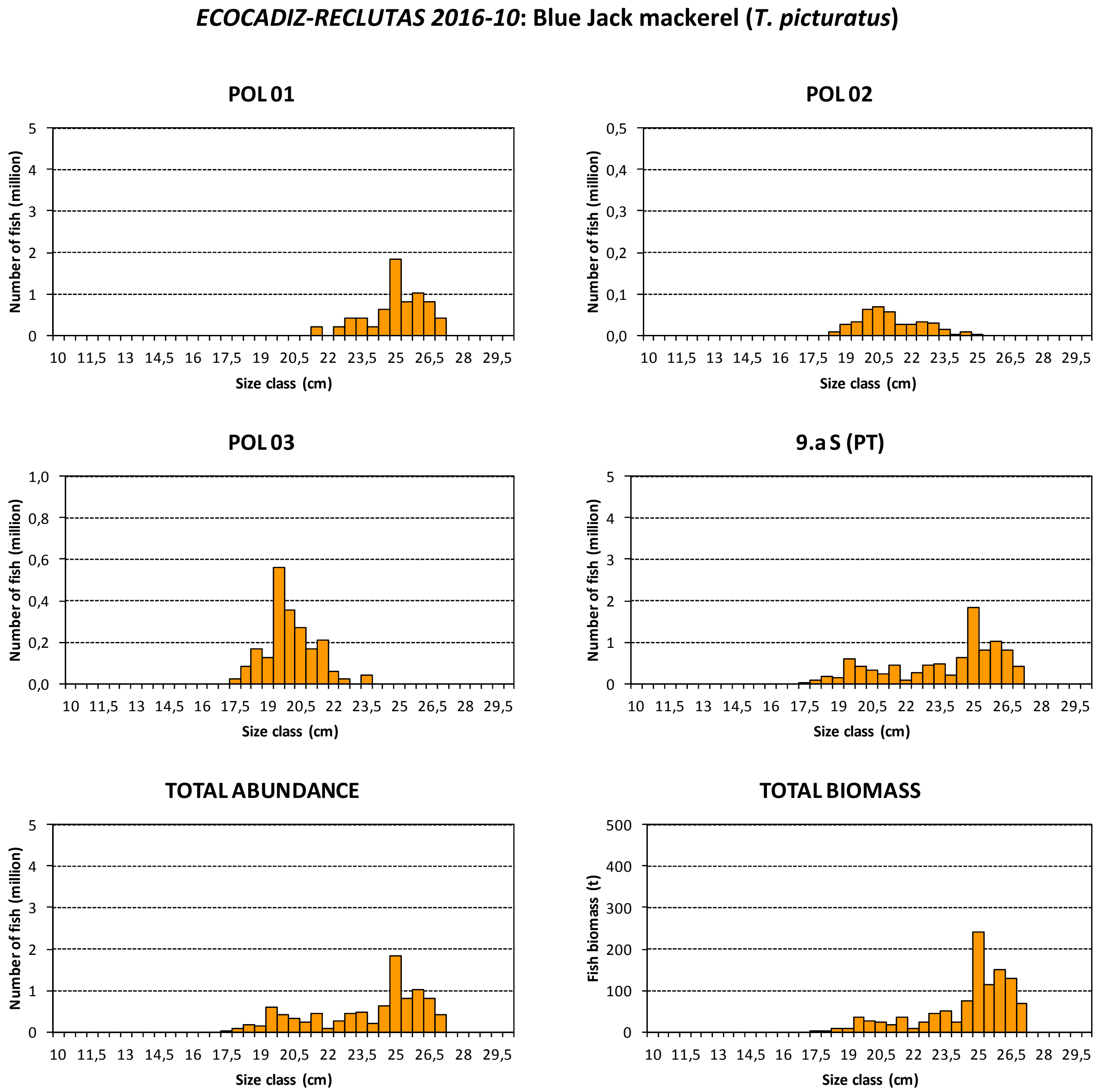


Figure 24. *ECOCADIZ-RECLUTAS 2016-10* survey. Blue jack mackerel (*Trachurus picturatus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 23**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

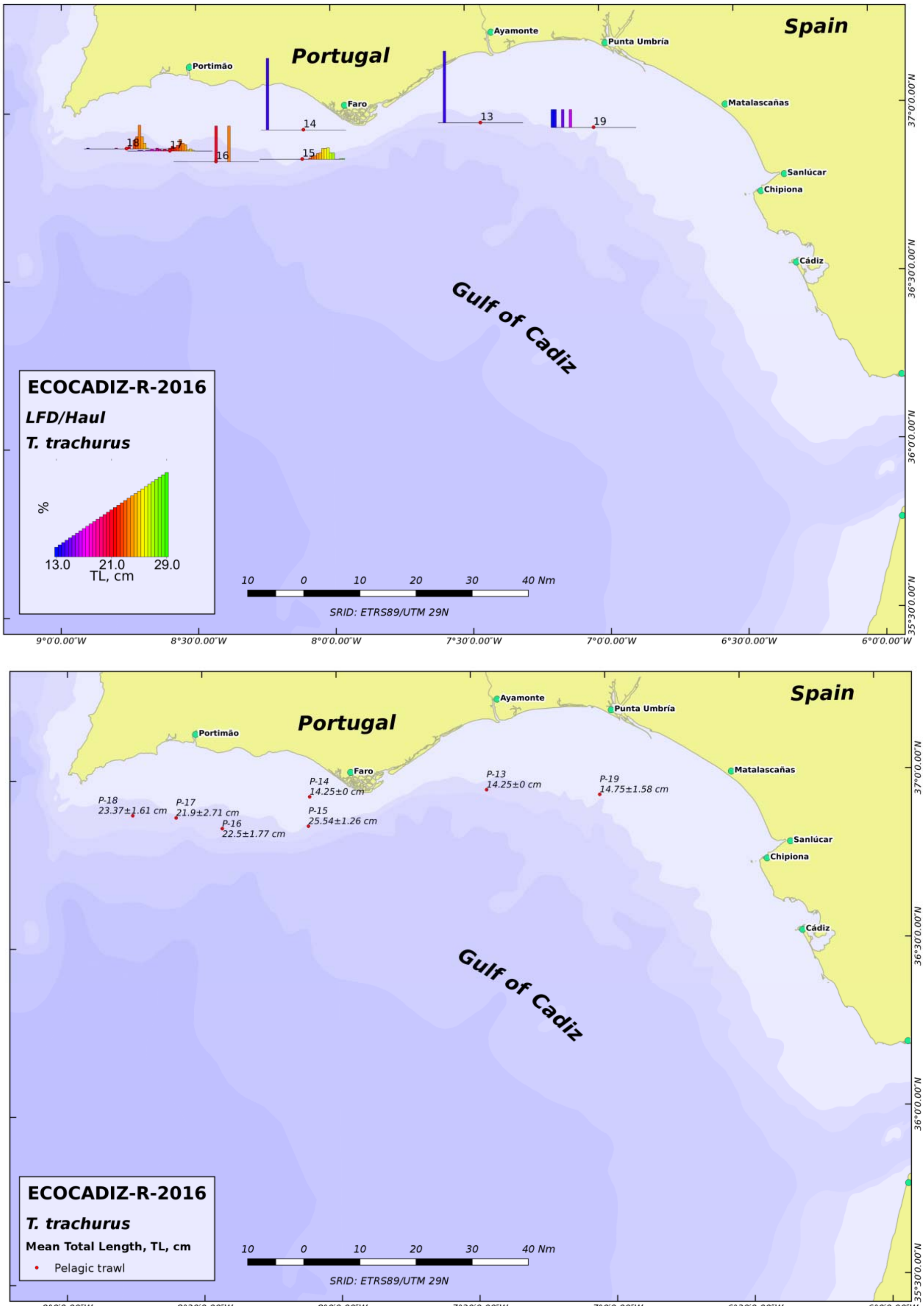
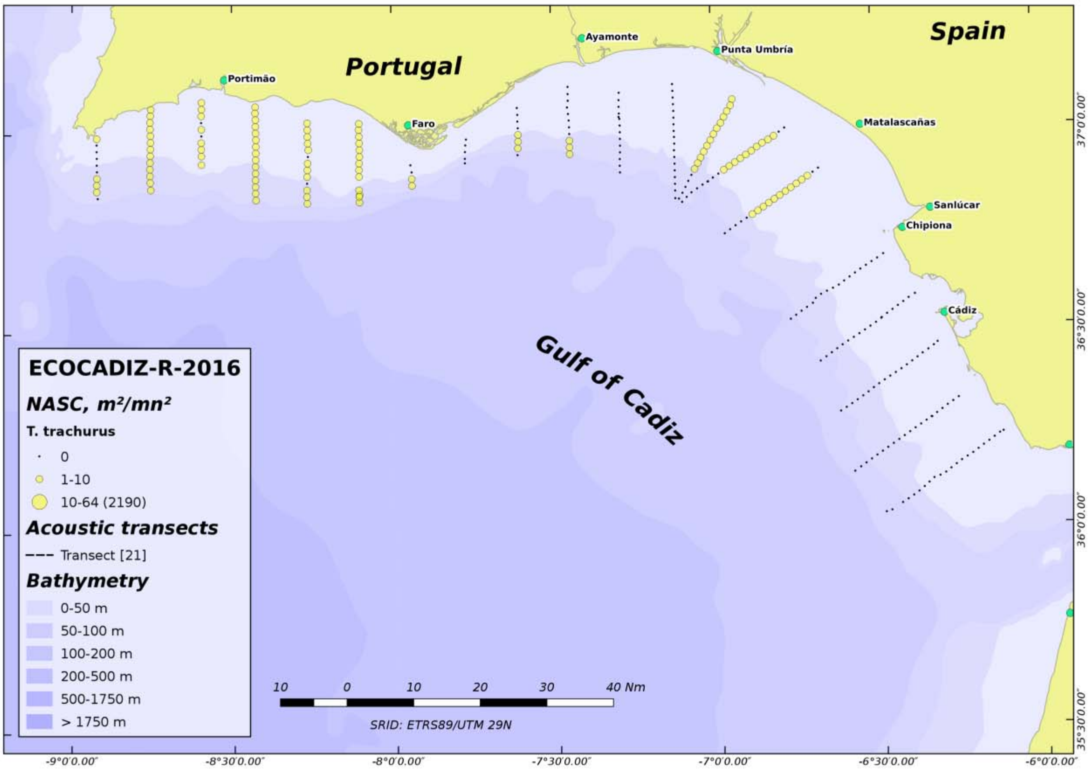


Figure 25. *ECOCADIZ-RECLUTAS 2016-10* survey. Horse mackerel (*Trachurus trachurus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul. Note that transect RA06 was impossible to be sampled due to NATO/Spanish navy military exercises.



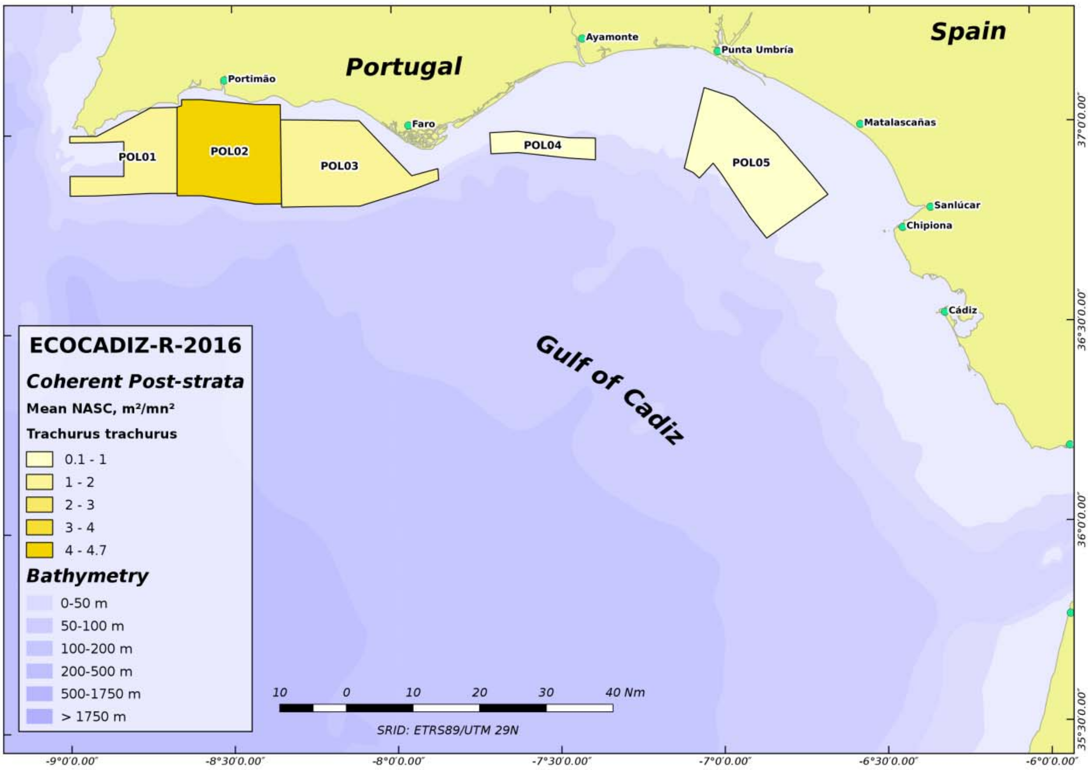


Figure 26. *ECOCADIZ-RECLUTAS 2016-10* survey. Horse mackerel (*Trachurus trachurus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum. Note that transect RA06 was impossible to be sampled due to NATO/Spanish navy military exercises.

***ECOCADIZ-RECLUTAS 2016-10*: Horse mackerel (*T. trachurus*)**

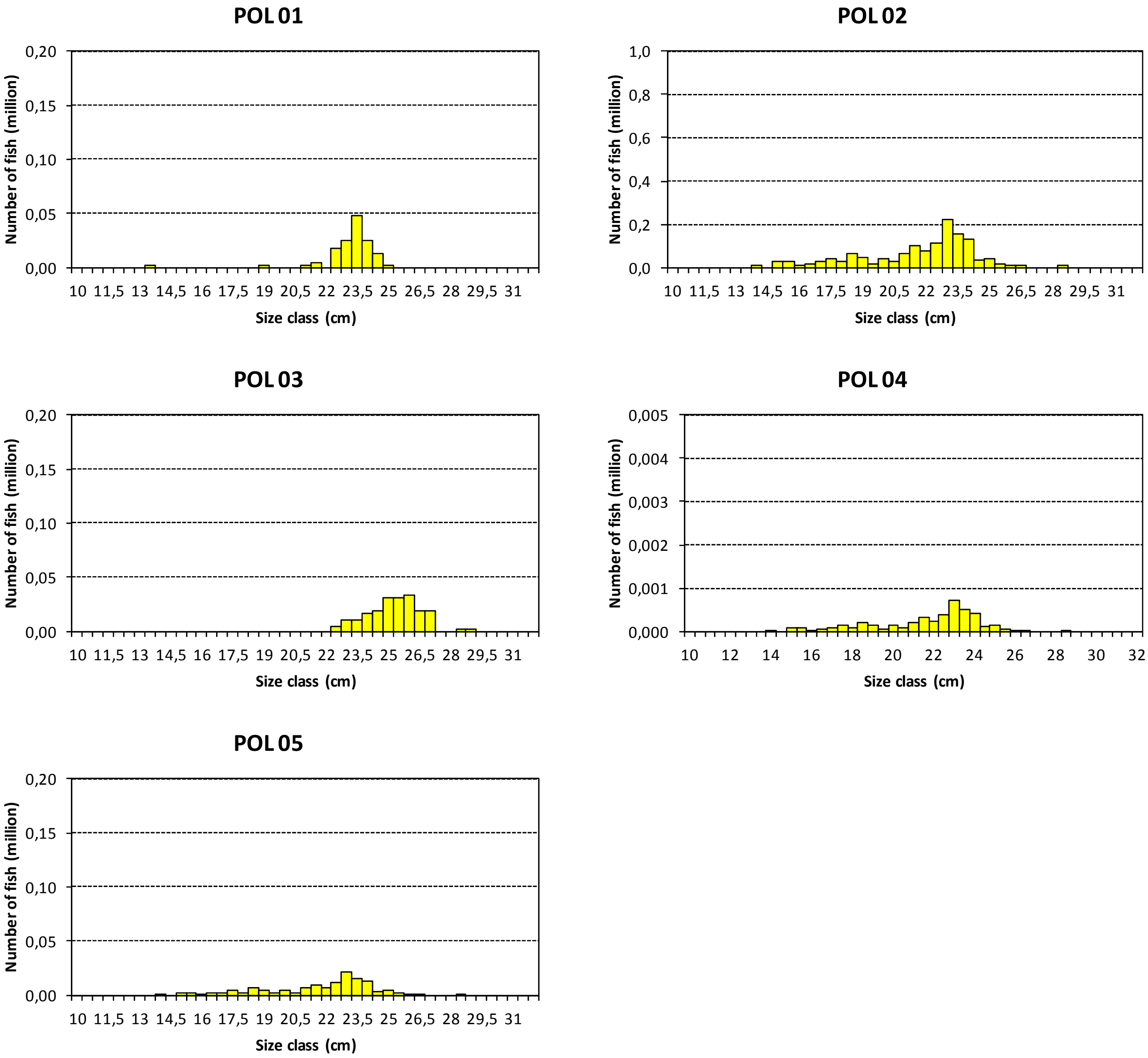


Figure 27. *ECOCADIZ-RECLUTAS 2016-10* survey. Horse mackerel (*Trachurus trachurus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 26**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

ECOCADIZ-RECLUTAS 2016-10: Horse mackerel (*T. trachurus*)

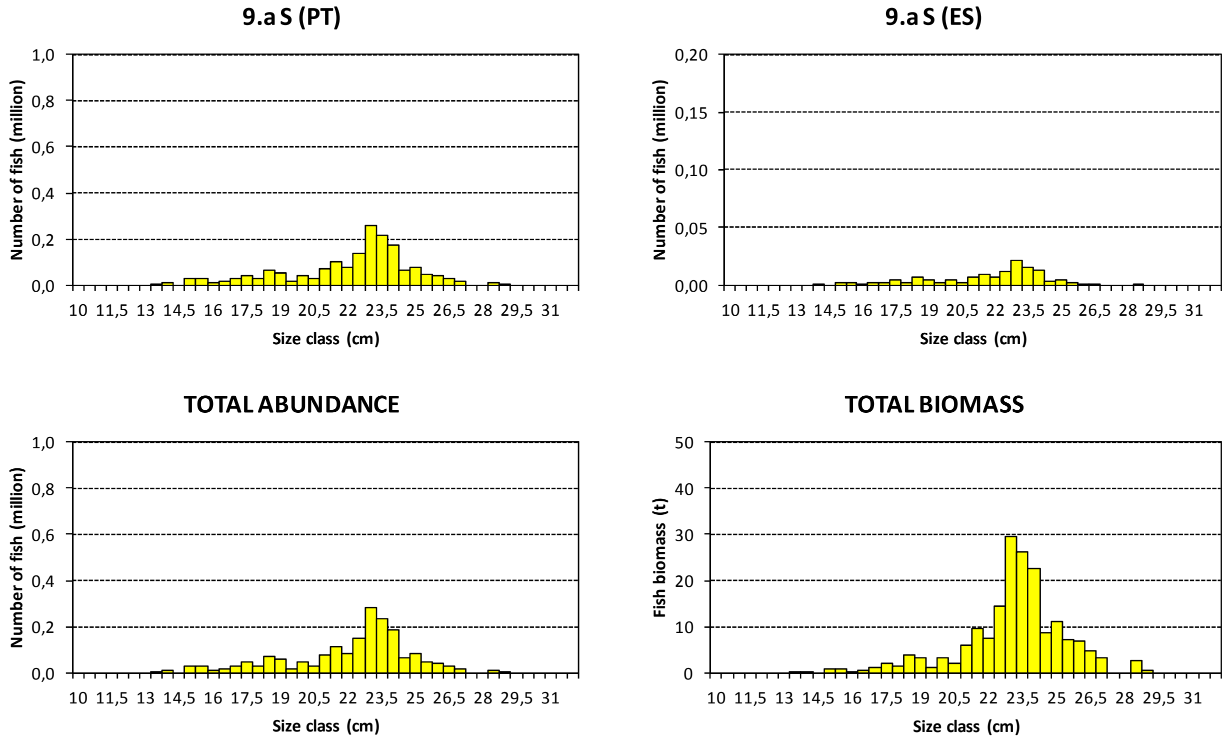
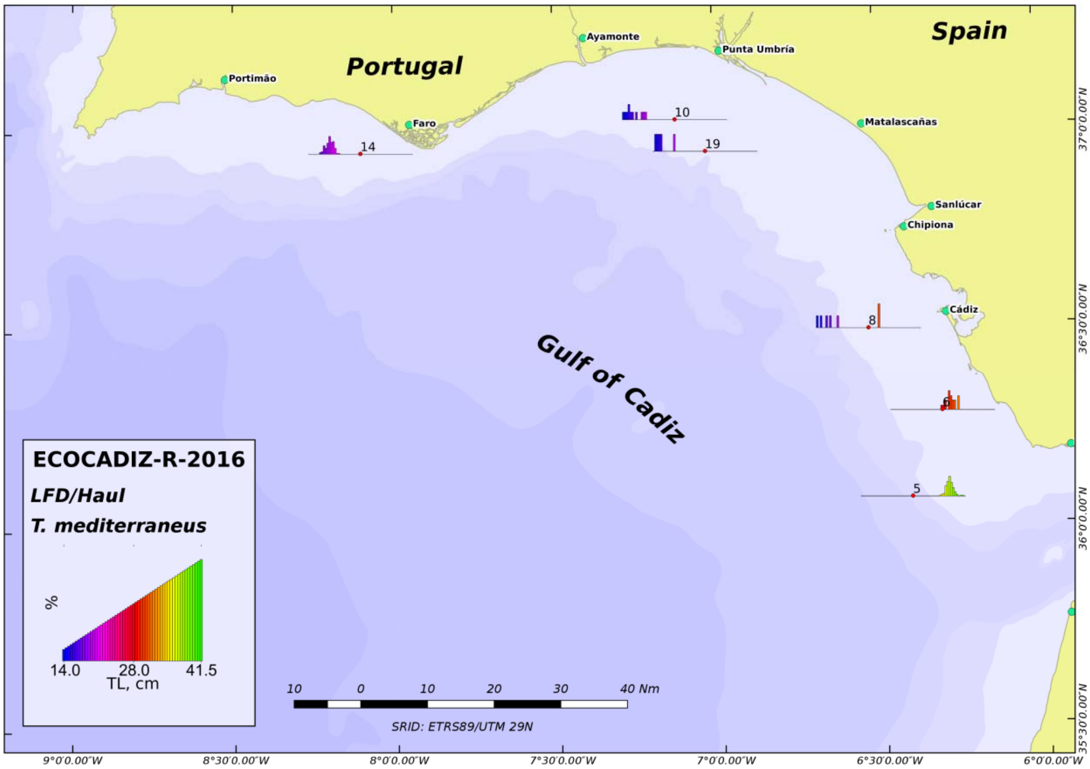


Figure 27. *ECOCADIZ-RECLUTAS 2016-10* survey. Horse mackerel (*Trachurus trachurus*). Cont'd.



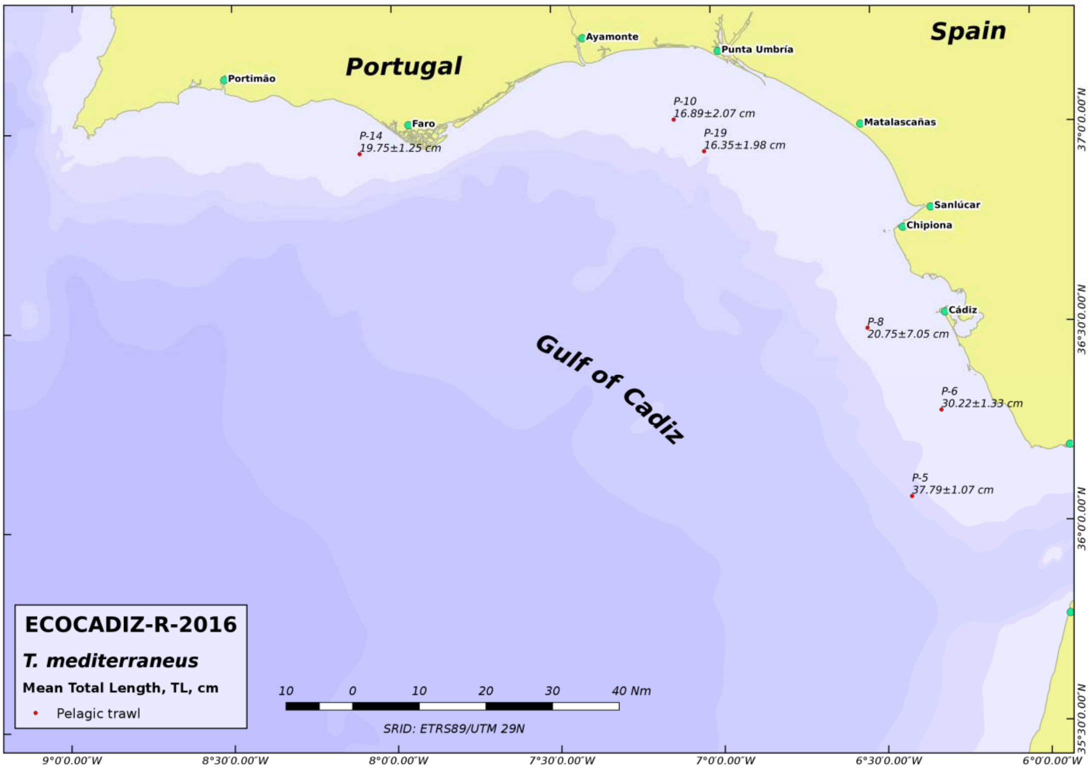


Figure 28. *ECOCADIZ-RECLUTAS 2016-10* survey. Mediterranean horse mackerel (*Trachurus mediterraneus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul. Note that transect RA06 was impossible to be sampled due to NATO/Spanish navy military exercises.

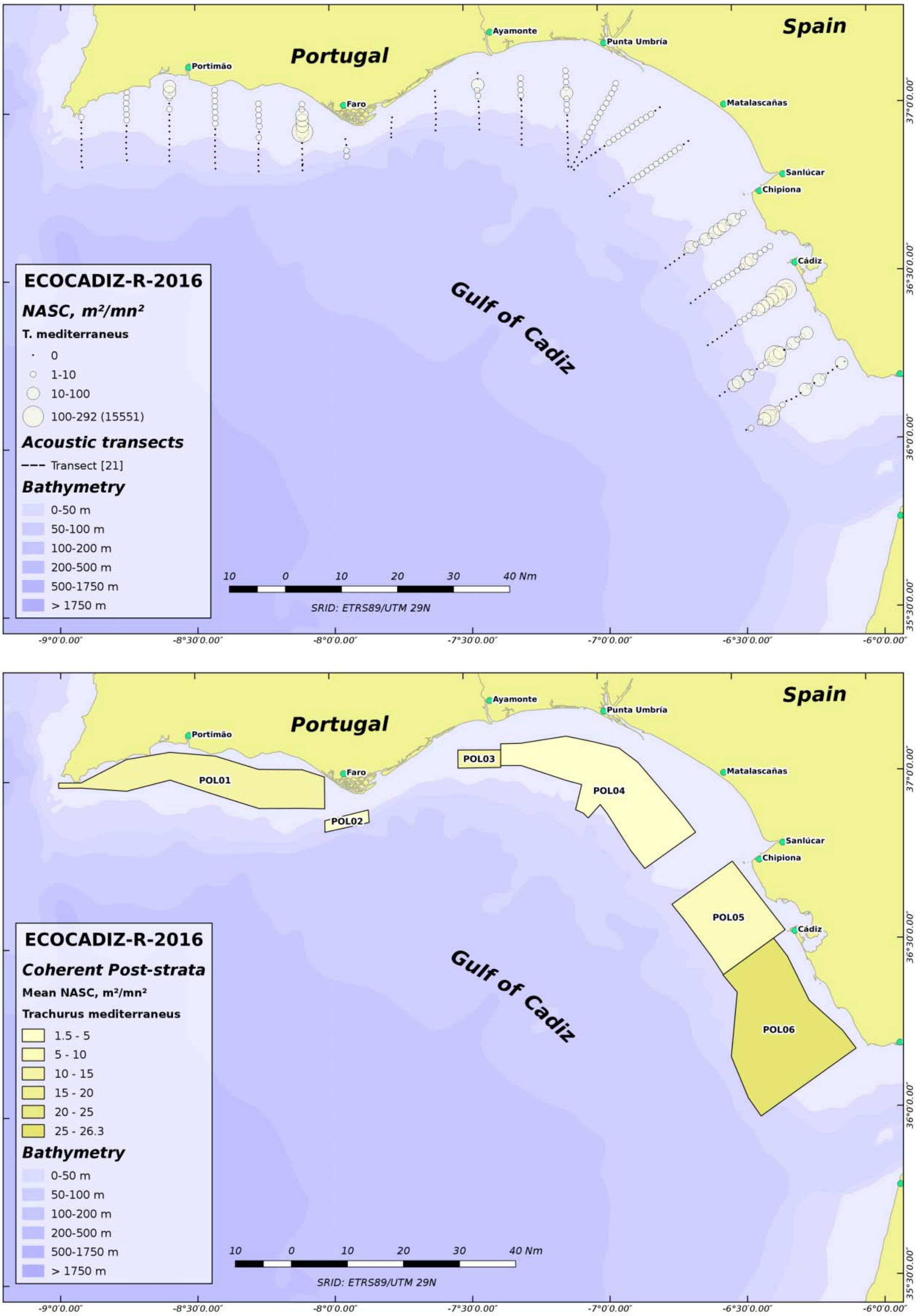


Figure 29. *ECOCADIZ-RECLUTAS 2016-10* survey. Mediterranean horse mackerel (*Trachurus mediterraneus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum. Note that transect RA06 was impossible to be sampled due to NATO/Spanish navy military exercises.

***ECOCADIZ-RECLUTAS 2016-10*: Mediterranean horse mackerel (*T. mediterraneus*)**

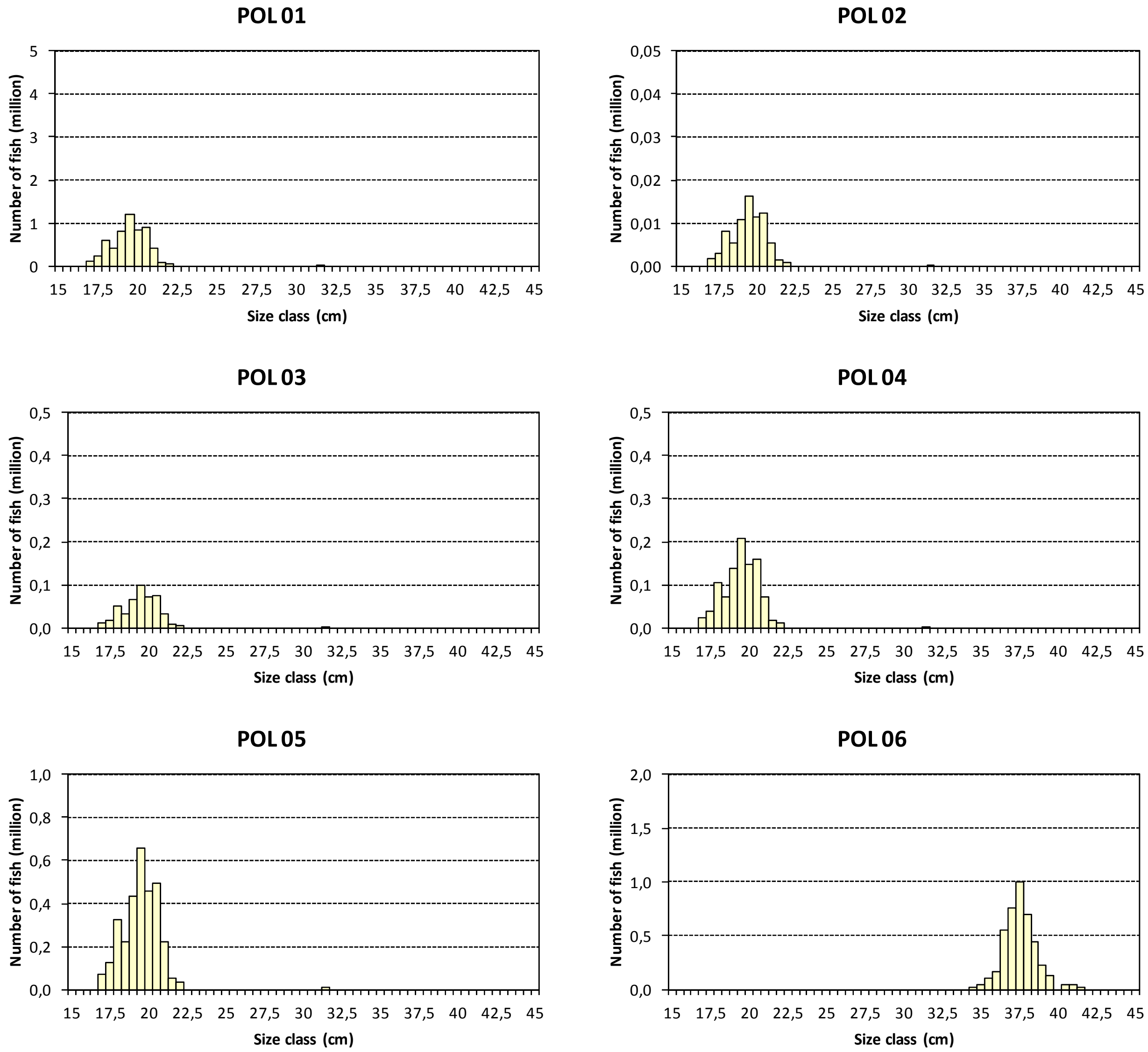


Figure 30. *ECOCADIZ-RECLUTAS 2016-10* survey. Mediterranean horse mackerel (*Trachurus mediterraneus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 29**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

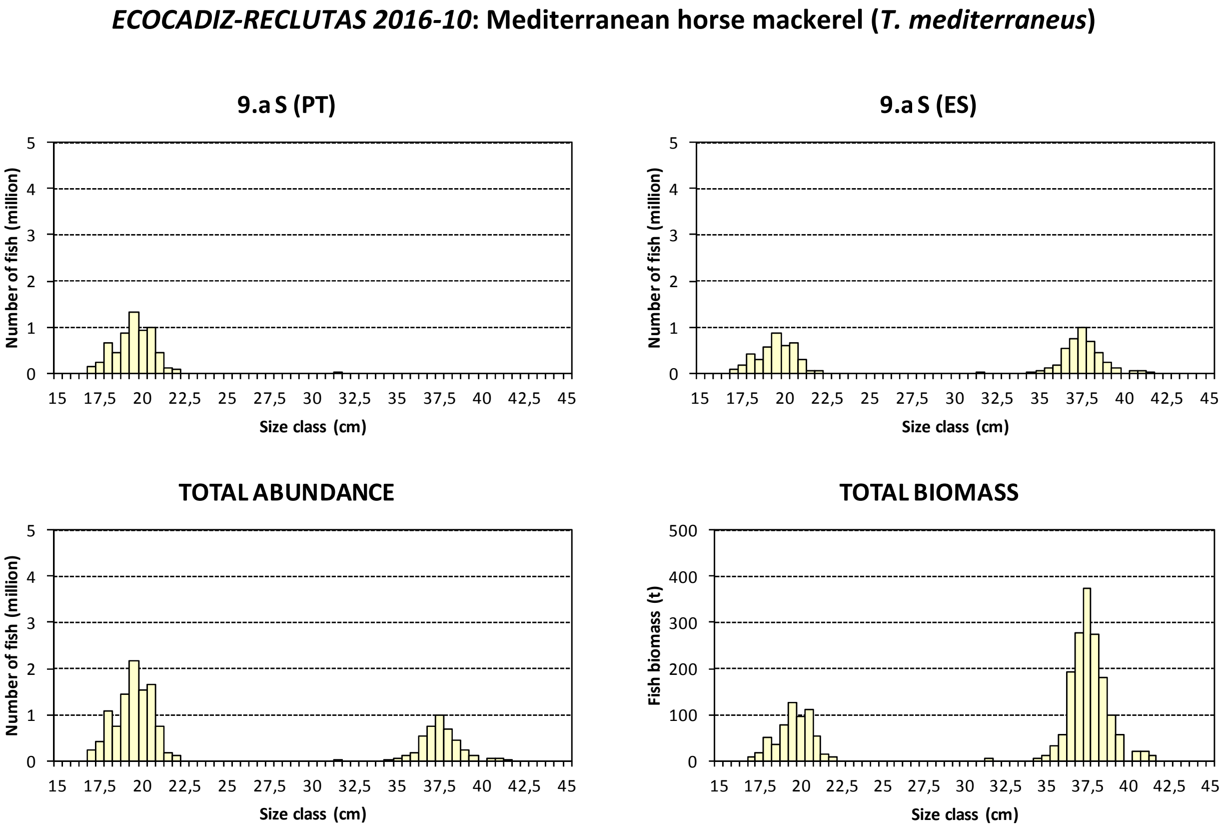


Figure 30. *ECOCADIZ-RECLUTAS 2016-10* survey. Mediterranean horse mackerel (*Trachurus mediterraneus*). Cont'd.

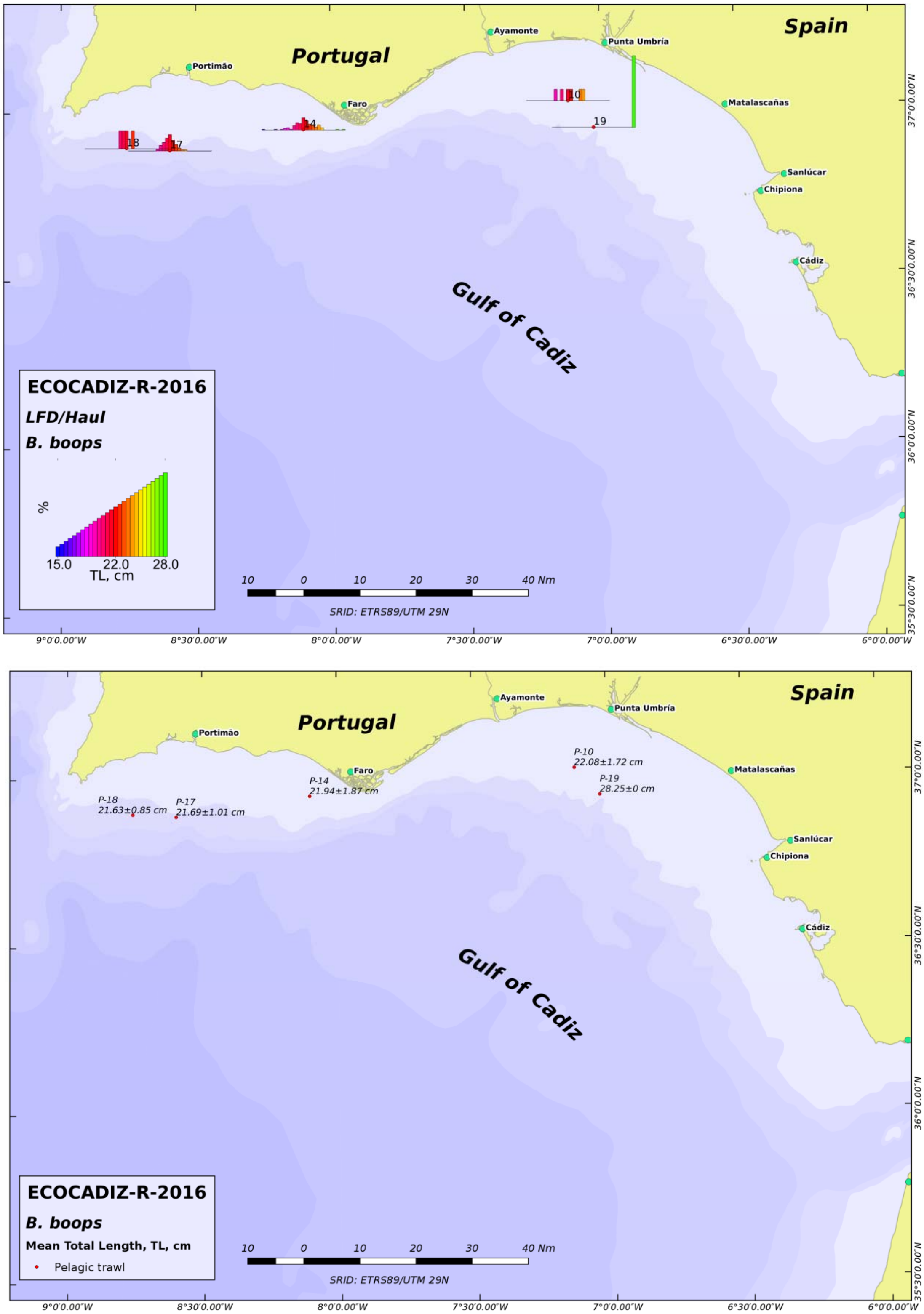


Figure 31. *ECOCADIZ-RECLUTAS 2016-10* survey. Bogue (*Boops boops*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul. Note that transect RA06 was impossible to be sampled due to NATO/Spanish navy military exercises.

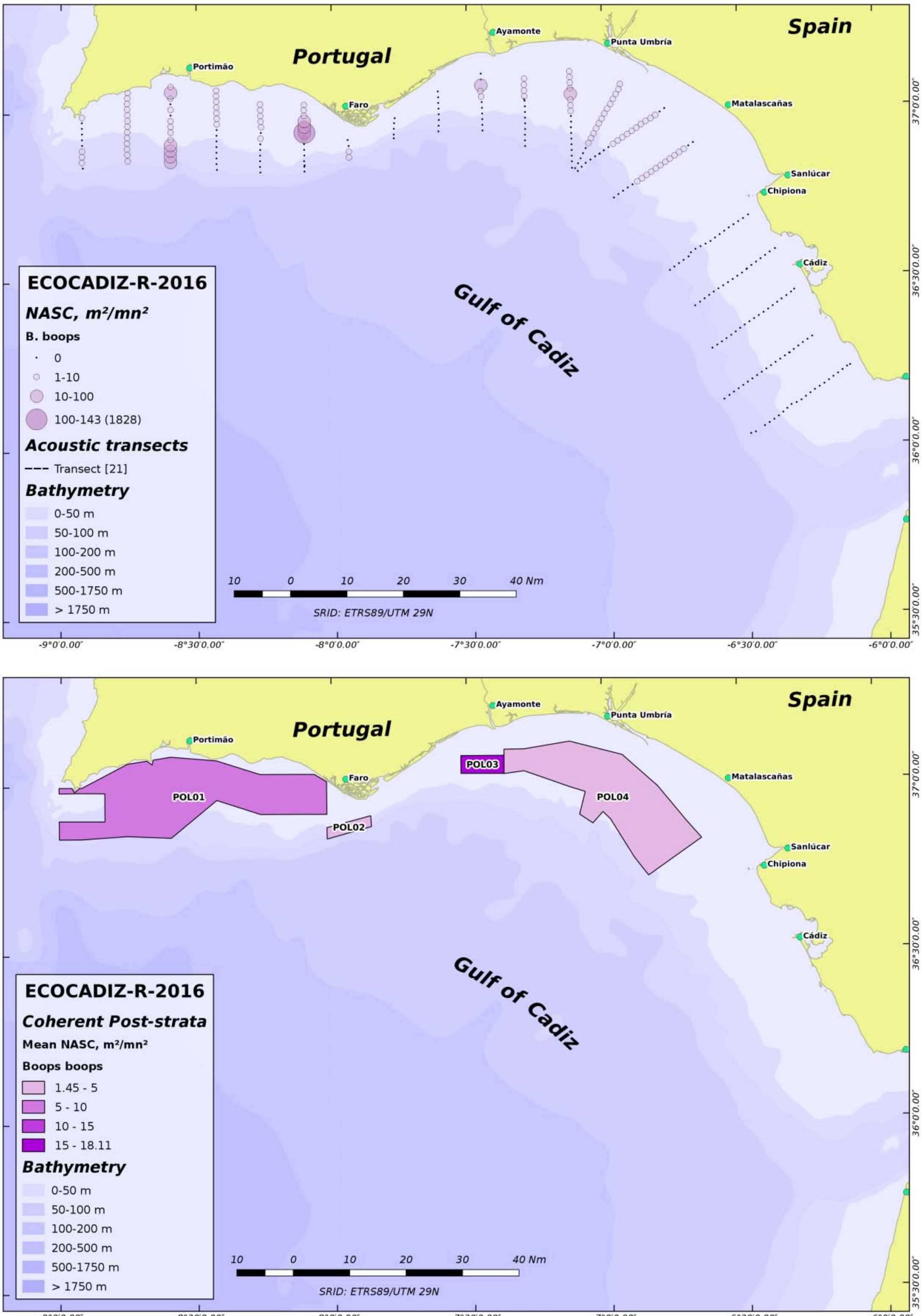


Figure 32. *ECOCADIZ-RECLUTAS 2016-10* survey. Bogue (*Boops boops*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum. Note that transect RA06 was impossible to be sampled due to NATO/Spanish navy military exercises.

***ECOCADIZ-RECLUTAS 2016-10*: Bogue (*B. boops*)**

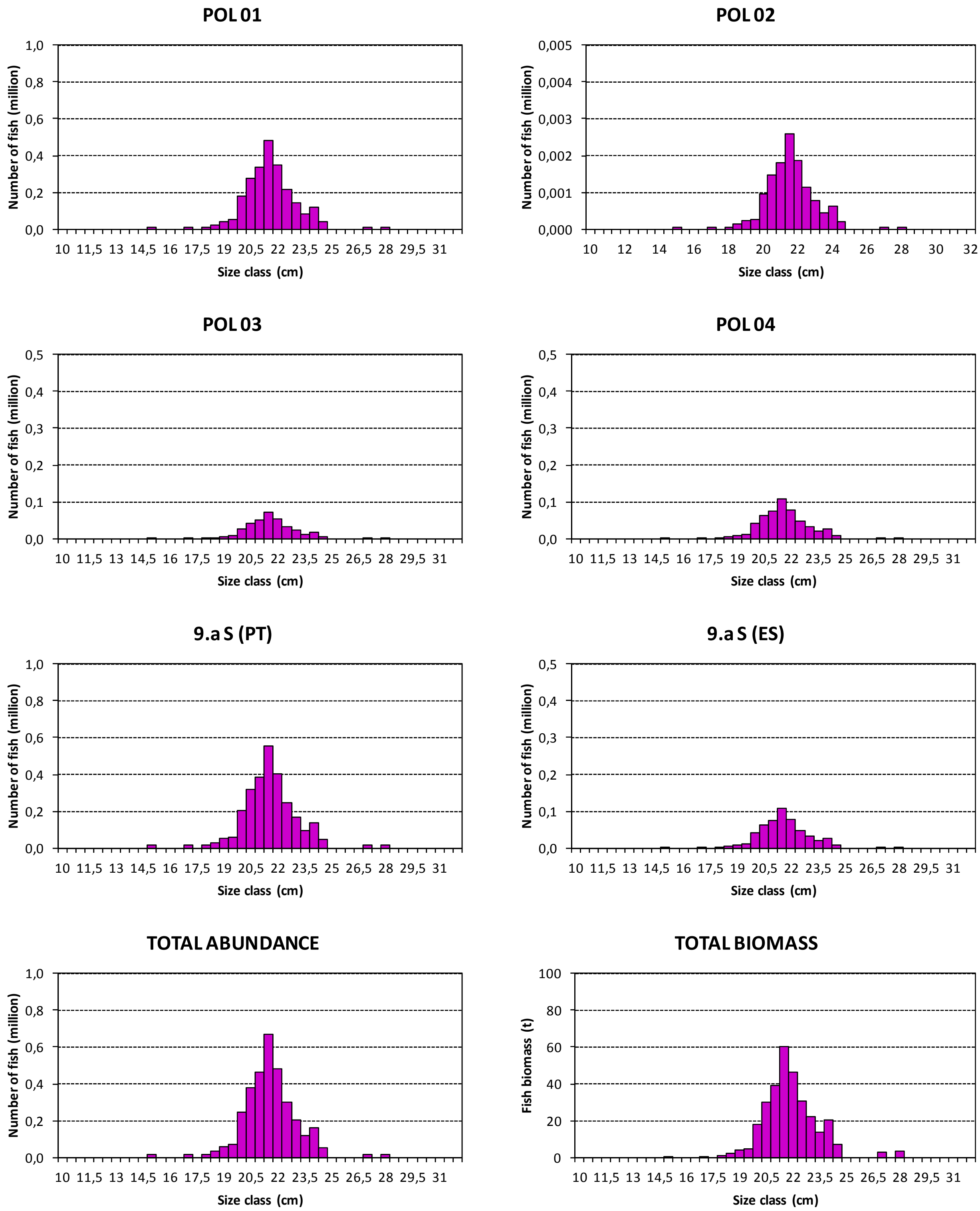


Figure 33. *ECOCADIZ-RECLUTAS 2016-10* survey. Bogue (*Boops boops*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 32**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

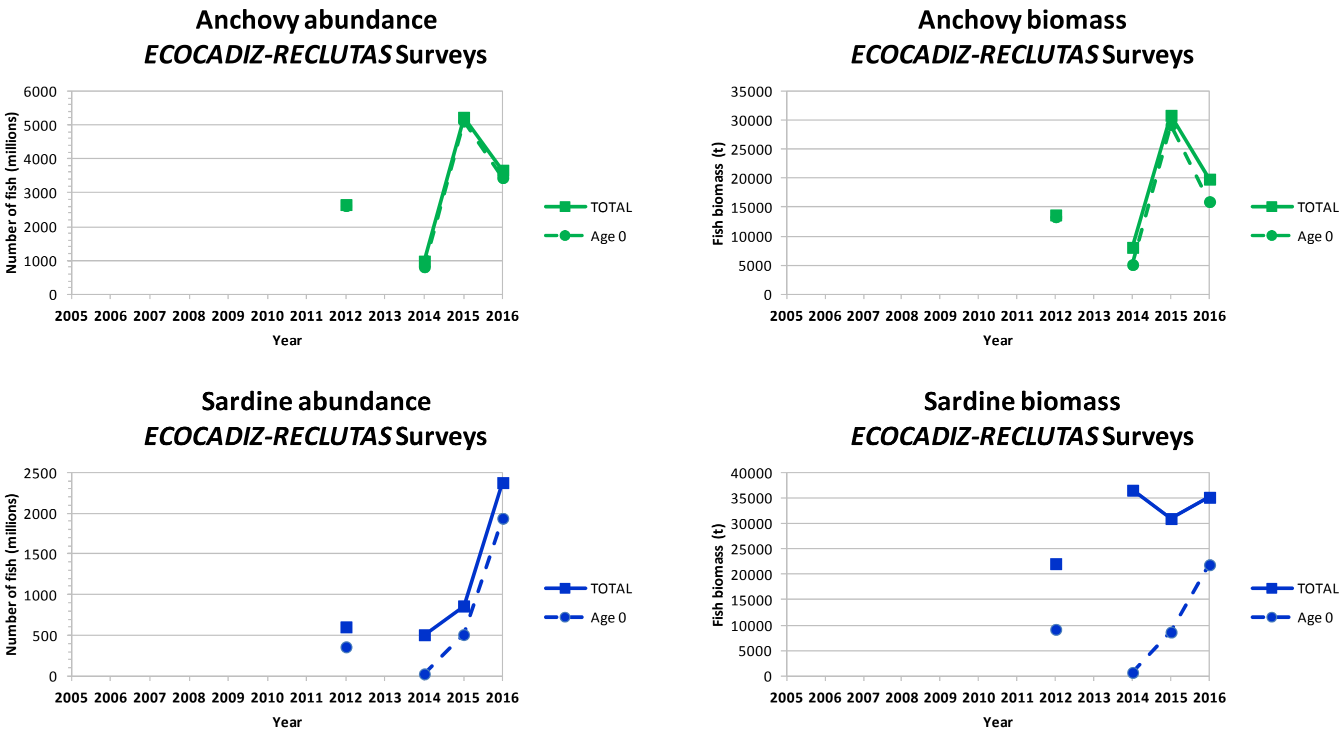


Figure 34. *ECOCADIZ-RECLUTAS* surveys series. Historical series of autumn acoustic estimates of anchovy and sardine abundance (million) and biomass (t) in Sub-division 9.a South. The estimates correspond to the total population and age 0 fish.

Working Document to WGHANSA, 24-29 June 2017, Bilbao, Spain

Preliminary index of biomass of Bay of Biscay anchovy (*Engraulis encrasicolus*, L.) in 2017 applying the DEPM and sardine total egg abundance

by

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Abstract

The research survey BIOMAN 2017 for the application of the Daily Egg Production Method (DEPM) in the Bay of Biscay anchovy and sardine was conducted in May 2017 from the 4th to the 26th covering the whole spawning area of the species. Two vessels were used: The R/V Ramón Margalef to collect the plankton samples and the pelagic trawler Emma Bardán to collect the adult samples. The total area covered was 118,291Km^2 and the spawning area was 67,756Km^2. During the survey 747 vertical plankton samples were obtained (PairoVET), 1,856 horizontal plankton samples (CUFES) and 46 pelagic trawls were performed, from which 36 contained anchovy and all of them were selected for the analysis. Moreover, 6 extra samples were obtained from the commercial fleet, one of these redundant. In total, there were 41 samples for the adult parameters estimates. In this analysis at June just the samples from the pelagic trawl were included. The 5 from the purse seines will be add for WGACEGG in November, when the final estimates applying the DEPM will be present for sardine and anchovy.
Anchovy eggs were found significantly in the Cantabrian Coast but it was not possible to find the west limit of the spawning, the survey arrived until 6ºW. The eggs in the French platform where encountered in the historical common places: Between Adour and Le Gironde passed the 200m isoline from the coast, and from Le Gironde to the North the eggs were found from the coast to the 100m depth line. The northern limit was found at 48ºN. The weather conditions during the survey were good in general with a mean Sea Surface Temperature (SST) of 14.8ºC and a mean sea surface salinity of 35.12.

Total egg production (P_{tot}) was calculated as the product of the spawning area and the daily egg production rate (P_0), which was obtained from the exponential decay mortality model fitted as a Generalized Linear Model (GLM) to the egg daily cohorts. The daily fecundity used was obtained as the mean of the las 7 years from 2010 (after the open of the fishery) to 2016. The index of biomass estimate resulted in 85,500 t with a coefficient of variation of 15%, the fourth higher of the series since 1987, the highest was the one estimate in 2015. Total abundance of sardine in the total area was 7.2 E12 eggs, on the levels of the mean series (6.64E+12) since 1990.

Introduction

Anchovy (*Engraulis encrasicolus*) is one of the commercial species of high economic importance in the Bay of Biscay. The economy of the Spanish purse seine fleets (primarily from the Basque Country, Cantabria and Galicia) and the French fleet rely greatly on this resource (Uriarte *et al*., 1996 and Arregi *et al*., 2004). To provide proper advice on the fishery management, it is necessary to conduct annually a monitoring of the population. Thanks to that monitoring, ICES (International Council for the Exploration of the Sea) recommended a limited TAC of 33,000 t for 2016.

Anchovy is a short-lived species, for which the evaluation of its biomass should be conducted by direct assessment methods as the daily egg production method (DEPM) (Barange *et al*, 2009). This method consists of estimating the spawning stock biomass (*SSB*) as the ratio between the total daily egg production (P_{tot}) and the daily fecundity (*DF*) estimates. In consequence, this method requires a survey to collect anchovy eggs (plankton sampling) for estimating the P_{tot} and to collect anchovy adults (adult sampling) for estimating the *DF*. Since 1987, AZTI-Tecnalia (Marine and Food Technological Centre, Basque country, Spain), either alone or in collaboration with other institutes, has conducted annually specific surveys to obtain anchovy biomass indices (Somarakis *et al*., 2004; Motos *et al*., 2005, Santos *et al,* 2010). In addition, the Basque fishery on anchovy has been continuously monitored. This information has been submitted annually to ICES, to advice on the exploitation of the fishery.

The survey for the application of the DEPM to estimate the Bay of Biscay anchovy biomass is one of the two surveys which give information about the anchovy population in spring. The other one carried out at the same time in May is the acoustic French survey. The biomass indices provided by the acoustic and DEPM surveys together with the information supplied by JUVENA (survey to estimate in autumn the juvenile biomass) and the fleet are used as input variables for a two-stage biomass model used to assess the Bay of Biscay anchovy population (Ibaibarriaga *et al*., 2008). Apart from the anchovy SSB estimates the DEPM survey in the Bay of Biscay gives information on the distribution and abundance of sardine eggs and environmental conditions due to the recollection of different parameters in the area surveyed such as sea surface temperature, sea surface salinity, temperature and salinity in the water column, currents and winds.

This working document describes the BIOMAN2017 survey for the application of the DEPM for the Bay of Biscay anchovy in 2017. First, the data collection, the estimation of the total egg production and the reproductive parameters are described in detail. Then, the biomass index and the age structure of the population are given, those will be used for the assessment and posterior management of this stock. Finally, the historical trajectory of the population is reviewed.

Material and Methods

Survey description

The BIOMAN2017 survey was carried out in May from the 4th to the 26th, at the spawning peak, covering the whole spawning area of anchovy in the Bay of Biscay. During the survey, icthyoplankton and adult samples were obtained for the estimation of total daily egg production and total daily fecundity respectively for anchovy. The age structure of the population was also estimated. In addition, 43 Neuston net were collected spread all over the area to obtain plastic debris distribution in the area. Moreover, 48 water samples from the surface were filtered for eDNA analysis to obtain map distribution of marine mammals, seabirds, sharks, turtles and anisakis. Besides, an observer sighted marine mammals, seabirds, marine litters and human activities.

The collection of plankton samples was carried out on board R/V Ramón Margalef from the 4th to the 26th of May. The area covered was the southeast of the Bay of Biscay (**Fig. 1**), which corresponds to the main spawning area and spawning season of anchovy. The sampling strategy was adaptive. The survey started from the West (transect 7, at 5ºW), as there were eggs the survey continued to the west looking for the west limit until 6ºW but the west limit was not found at the Cantabrico. Then the survey continuous covering the Cantabrico Coast eastwards up to Pasajes (transect 25, approx. 1º50’W) (**Fig. 1**). Then, the survey continued to the north, to find the Northern limit of the spawning area up to 48ºN. When the egg abundances found were relatively high, additional transects separated by 7.5 nm were completed. This occurred from the Adour until Arcachon inside the 100m depth and the area of influence of Gironde. The survey was stopped for 12h the 16th of May, after 13 days of survey to do gas oleo and change the crew.

The strategy of egg sampling was identical to that used in previous years, i.e. a systematic central sampling scheme with random origin and sampling intensity depending on the egg abundance found (Motos, 1994). Stations were situated at intervals of 3 nmi along 15 nmi apart transects perpendicular to the coast.

At each station, a vertical plankton haul was performed using a PairoVET net (Pair of Vertical Egg Tow, Smith *et al*., 1985 in Lasker, 1985) with a net mesh size of 150 µm for a total retention of the anchovy and sardine eggs under all likely conditions. The net was lowered to a maximum depth of 100 m or 5 m above the bottom in shallower waters. After allowing 10 seconds at the maximum depth for stabilisation, the net was retrieved to the surface at a speed of 1 m s^{-1}. A 45kg depressor was used to allow for correctly deploying the net. "G.O. 2030" flowmeters were used to detect sequential clogging of the net during a series of tows.

Immediately after the haul, the net was washed and the samples obtained were fixed in formaldehyde 4% buffered with sodium tetra borate in sea water. After six hours of fixing, anchovy, sardine and other eggs species were identified, sorted out and counted on board. Afterwards, in the laboratory, the sorting of the samples was finished and a percentage of the samples were checked to assess the quality of the sorting made at sea. According to that, a portion of the samples were sorted again to ensure no eggs were left in the sample. In the laboratory, anchovy and sardine eggs were classified into morphological stages (Moser and Alshtrom, 1985).

Sample depth, temperature, salinity and fluorescence profiles were obtained at each sampling station using a CTD RBR-XR420 coupled to the PairoVET. At some points determinate before the survey, water was filtered from the surface to obtain chlorophyll samples to calibrate the chlorophyll data.

The Continuous Underway Fish Egg Sampler (CUFES, Checkley *et al*., 1997) was used to record the eggs found at 3m depth with a net mesh size of 350µm. The samples obtained were immediately checked under the microscope so that the presence/absence of anchovy eggs was detected in real time. When anchovy eggs were not found in six consecutive CUFES samples in the oceanic area transect was abandoned. The CUFES system had a CT to record simultaneously temperature and salinity at 3 m depth, a flowmeter to measure the volume of the filtered water, a fluorimeter and a GPS (Geographical Position System) to provide sampling position and time. All these data were registered at real time using the integrated EDAS (Environmental Data Acquisition System) with custom software.

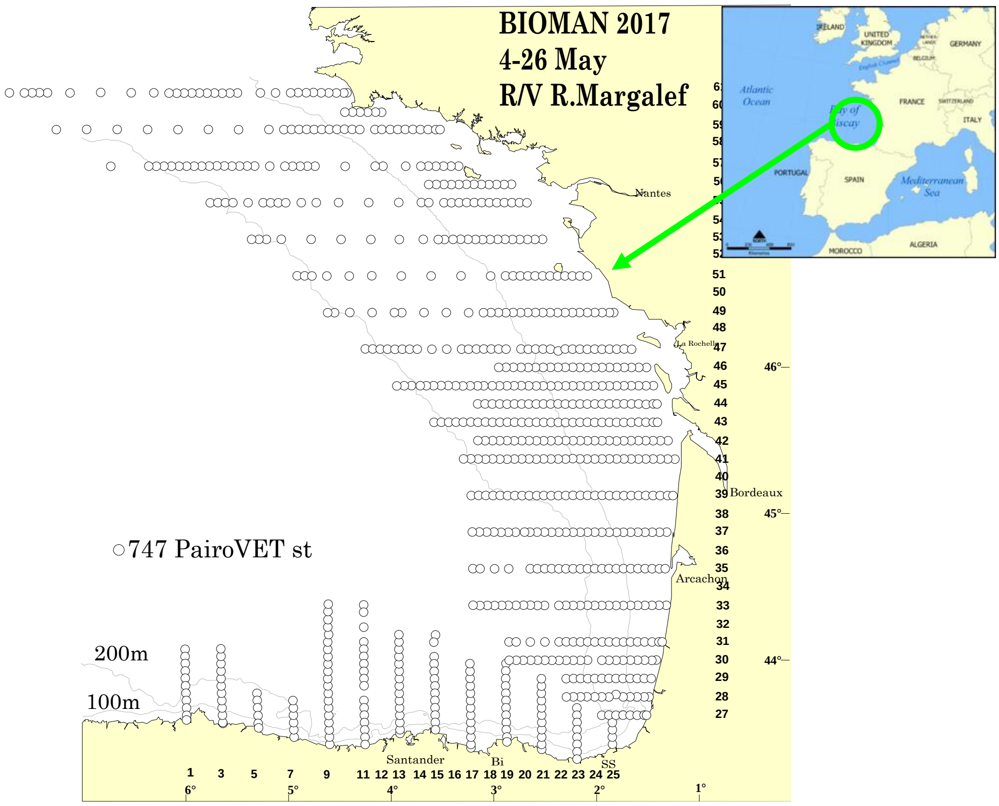

Figure 1: Vertical Plankton stations (PairoVET) during BIOMAN 2017.

The adult samples were obtained on board R/V Emma Bardán (pelagic trawler) from the 4th to the 30th of May coinciding in space and time with the plankton sampling. When the plankton vessel encountered areas with anchovy or sardine eggs, the R/V Emma Bardán was directed to those areas to fish. In each haul, immediately after fishing, anchovies were sorted from the bulk of the catch and a sample of two kg was selected at random. A minimum of one kg or 60 anchovies were weighted, measured and sexed in each haul and from the mature females, the gonads of 25 non-hydrated females (NHF) were preserved. If the target of 25 NHF was not completed 10 more anchovies were taken at random and processed in the same manner. Sampling was stopped when 120 anchovies had to be sexed to achieve the target of 25 NHF. Otoliths were extracted onboard and read in the laboratory to obtain the age composition per sample. The sardine samples were kept in formalin to be analysed afterwards in the laboratory on land. In each haul, 100 individuals (apart from anchovy and sardine) of each species were measured.

This year 6 additional anchovy adult samples were obtained from the commercial Basque purse seine fleet. One of these is redundant so just 5 will be add to the 36 from pelagic trawler having in total 41 adult samples for the analysis. For the present analysis, these 5 samples will not be added because they are in process. The spatial distribution of the pelagic hauls with anchovy is shown in **Figure 2**.

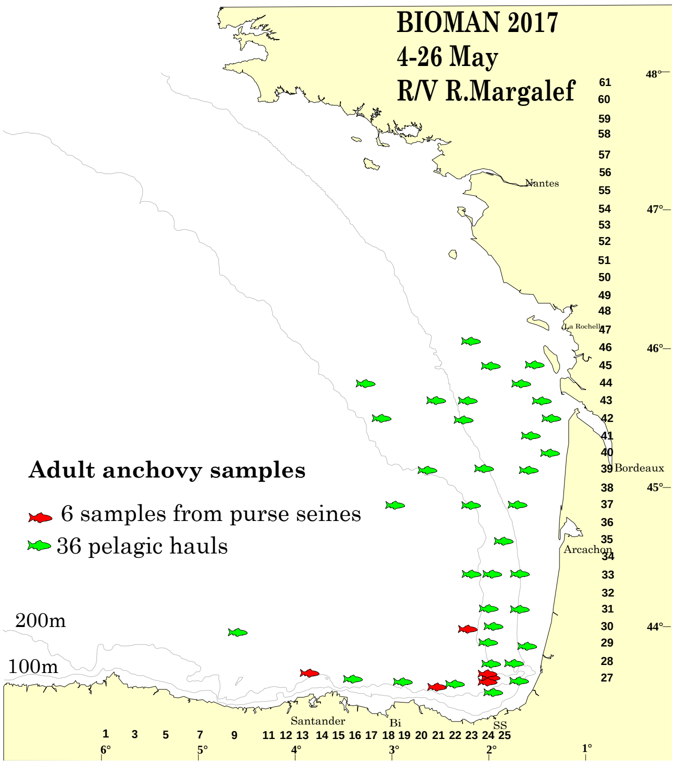

Figure 2: Spatial distribution of fishing hauls from pelagic trawler R/V Emma Bardán (green) and purse seines (red) in 2017

Total egg production

Total daily egg production (P_{tot}) was calculated as the product between the spawning area (SA) and the daily egg production (P_0) estimates:

(1) $$P_{tot} = P_0 \; SA .$$

A standard PairoVET sampling station represented a surface of 45 Nm^2 (i.e. 154 km^2). Since the sampling was adaptive, the area represented by each station was corrected according to the sampling intensity and the cut of the coast. The total area was calculated as the sum of the area represented by each station. The spawning area (*SA*) was delimited with the outer zero anchovy egg stations although it could contain some inner zero anchovy egg stations embedded. The spawning area was computed as the sum of the area represented by the stations within the spawning area.
The daily egg production per area unit (P_0) was estimated together with the daily mortality rate (Z) from a general exponential decay mortality model of the form:

$$(2) \qquad P_{i,j} = P_0 \exp\left(-Z\, a_{i,j}\right),$$

where $P_{i,j}$ and $a_{i,j}$ denote respectively the number of eggs per unit area in cohort *j* in station *i* and their corresponding mean age. Let the density of eggs in cohort *j* in station *i*, $P_{i,j}$, be the ratio between the number of eggs $N_{i,j}$ and the effective sea area sampled R_i (*i.e.* $P_{i,j} = N_{i,j} / R_i$). The model was written as a generalised linear model (GLM, McCullagh and Nelder, 1989; ICES, 2004) with logarithmic link function:

$$(3) \qquad \log\left(E[N_{i,j}]\right) = \log(R_i) + \log\left(P_0\right) - Z\, a_{i,j} \ ,$$

where the number of eggs of daily cohort *j* in station *i* (N_{ij}) was assumed to follow a negative binomial distribution. The logarithm of the effective sea surface area sampled ($\log(R_i)$) was an offset accounting for differences in the sea surface area sampled and the logarithm of the daily egg production $\log(P_0)$ and the daily mortality *Z* rates were the parameters to be estimated.
The eggs collected at sea and sorted into morphological stages had to be transformed into daily cohort frequencies and their mean age calculated to fit the above model. For that purpose, the Bayesian ageing method described in ICES (2004), Stratoudakis *et al*., (2006) and Bernal *et al.*, (2011) was used. This ageing method is based on the probability density function (pdf) of the age of an egg *f (age | stage, temp),* which is constructed as:

$$(4) \qquad f\,(age\,|\,stage, temp) \propto f\,(stage\,|\,age, temp)\, f\,(age)\,.$$

The first term *f(stage | age, temp)* is the pdf of stages given age and temperature. It represents the temperature dependent egg development, which is obtained by fitting a multinomial model like extended continuation ratio models (Agresti, 1990) to data from temperature dependent incubation experiments (Ibaibarriaga *et al.,* 2007, Bernal *et al.,* 2008). The second term is the prior distribution of age. A priori the probability of an egg that was sampled at time τ of having an age *age* is the product of the probability of an egg being spawned at time τ - *age* and the probability of that egg surviving since then (*Expo (-Z age)*):

(5) $$f(age) \propto f(spawn = \tau - age)\exp(-Z\ age)\ .$$

The pdf of spawning time *f (spawn=*τ *- age)* allows refining the ageing process for species with spawning synchronicity that spawn at approximately certain times of the day (Lo, 1985a; Bernal *et al*., 2001). Anchovy spawning time was assumed to be normally distributed with mean at 23:00h GMT and standard deviation of 1.25 (ICES, 2004). The peak of the spawning time was also used to define the age limits for each daily cohort (spawning time peak plus and minus 12 hours). Details on how the number of eggs in each cohort and the corresponding mean age are computed from the pdf of age are given in Bernal *et al* (2011). The incubation temperature considered was the one obtained from the CTD at 10m in the way down.

Given that this ageing process depends on the daily mortality rate which is unknown, an iterative algorithm in which the ageing and the model fitting are repeated until convergence of the *Z* estimates was used (Bernal *et al.*, 2001; ICES, 2004; Stratoudakis *et al.*, 2006). The procedure is as follows:

Step 1. Assume an initial mortality rate value

Step 2. Using the current estimates of mortality calculate the daily cohort frequencies and their mean age.

Step 3. Fit the GLM and estimate the daily egg production and mortality rates. Update the mortality rate estimate.

Step 4. Repeat steps (1) - (3) until the estimate of mortality converged (i.e. the difference between the old and updated mortality estimates was smaller than 0.0001).

Incomplete cohorts, either because the bulk of spawning for the day was not over at the time of sampling, or because the cohort was so old that its constituent eggs had started to hatch in substantial numbers, were removed to avoid any possible bias. At each station, younger cohorts were dropped if they were sampled before twice the spawning peak width after the spawning peak and older cohorts were dropped if their mean age plus twice the spawning peak width was over the critical age at which less than 99% eggs were expected to be still unhatched. In addition, eggs younger than 4 hours and older than 90% of the survey incubation time (Motos, 1994) were removed.

Once the final model estimates were obtained the coefficient of variation of P_0 was given by the standard error of the model intercept (log *(P_0)*) (Seber, 1982) and the coefficient of variation of Z was obtained directly from the model estimates.

The analysis was conducted in R (www.r-project.org). The ”MASS” library was used for fitting the GLM with negative binomial distribution and the ”egg” library (http://sourceforge.net/projects/ichthyoanalysis/) for the ageing and the iterative algorithm.

Daily fecundity

The daily fecundity (DF) is usually estimated as follows:

(6) $$DF = \frac{R \cdot F \cdot S}{W_f}$$

where *R* is the sex ratio in weight, *F* is the batch fecundity (eggs per batch per female weight), *S* is the spawning frequency (percentage of females spawning per day) and W_f is the female mean weight.

At the moment of this working group, the anchovy adults from the survey to estimate F and S were in process so the DF was obtained as a mean of the last 7 years, just after the open of the fishery in 2010. The final DF estimate will be provided in November for WGHANSA-sub when all the anchovy adults samples will be processed and the adult parameters estimated.

A linear regression model between total weight (*W*) and gonad free weight (W_{gf}) was fitted to data from non-hydrated females:

(7) $$E[W] = a + b * W_{gf} \;.$$

This model was used to correct the weight increase due to hydration in anchovy females. **The female mean weight (W_f)** per sample was calculated as the average of the individual female weights.

SSB and numbers at age

The Spawning Stock Biomass (*SSB*) was estimated as the ratio between the total egg production (P_{tot}) and daily fecundity (*DF*) estimates and its variance was computed using the Delta method (Seber, *1982*).

To deduce the numbers at age 6 regions: South West (SW), South East (SE), Centre (C), Garonne (G), North(NE) and North West (NW) were defined depending on the distribution of the adult samples (size, weight and age) and the distribution of anchovy eggs (**Figure 3**). Mean and variance of anchovy mean weights and proportions at age in the adult population were computed as a weighted average of the mean weight and age composition per samples (**equations 9 and 10**) where the weights were proportional to the population in numbers, in each region. In particular, the weighting factors were proportional to the egg abundance divided by the numbers of adult samples in the region and the mean weight of anchovy per sample.

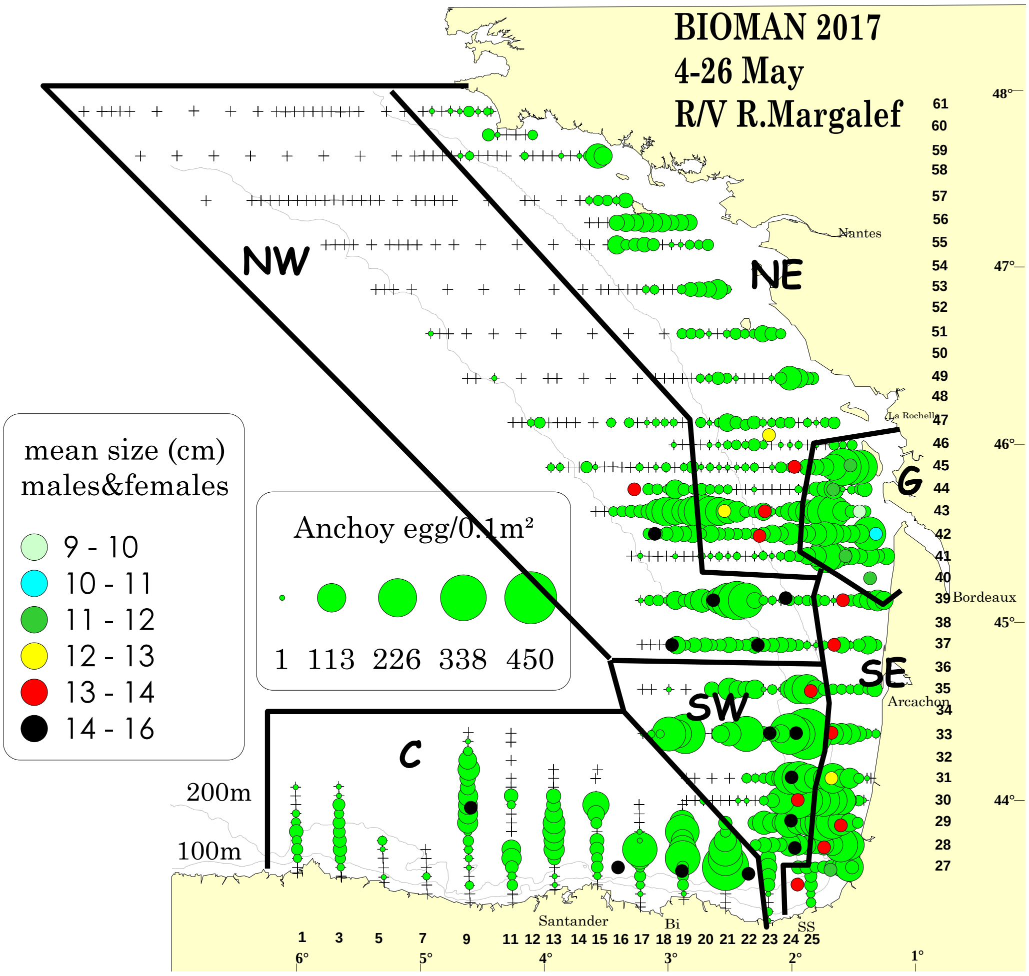

Figure 3: 6 regions defined to estimate the numbers at age. The black lines represent the border of the regions, the green bubbles the abundance of anchovy eggs(egg/0.1m^2) in each station and the small colour bubbles represent the mean size (cm) of individuals within each haul.

Results

This year a significant amount of anchovy eggs was found in the Cantabrico Coast founding anchovy eggs until 6ºW and offshore until 44º23' in transect 9 (**Figure 4**). Nevertheless, it was not possible to found the west limit of the spawning area in Cantabrico Coast. The northern limit was found at 48º N. The eggs in the French platform where encountered in the historical common places: Between Adour and Le Gironde passed the 200m depth from the coast and from Le Gironde to the North the eggs were found from the coast to the 100m depth line (**Figure 4**). The weather conditions during the survey were good in general with a mean sea surface temperature (SST) of 14.8ºC and a mean sea surface salinity of 35.12. The total area surveyed was 118,291 km^2 and the spawning area was 67,756 km^2. Total number of PairoVET samples obtained was 747. From those, 499 had anchovy eggs (67%) with an average of 210 eggs m^{-2} per station and a maximum of 4270 eggsm^{-2} in a station. A total of 15,973 anchovy eggs were encountered and classified. The number of CUFES samples obtained was 1,856 From those 1,051(64%) stations had anchovy eggs with an average of 13 eggs m^{-3} per station in the positive stations with 142,713 anchovy eggs in total (24,018eggm^{-3}).

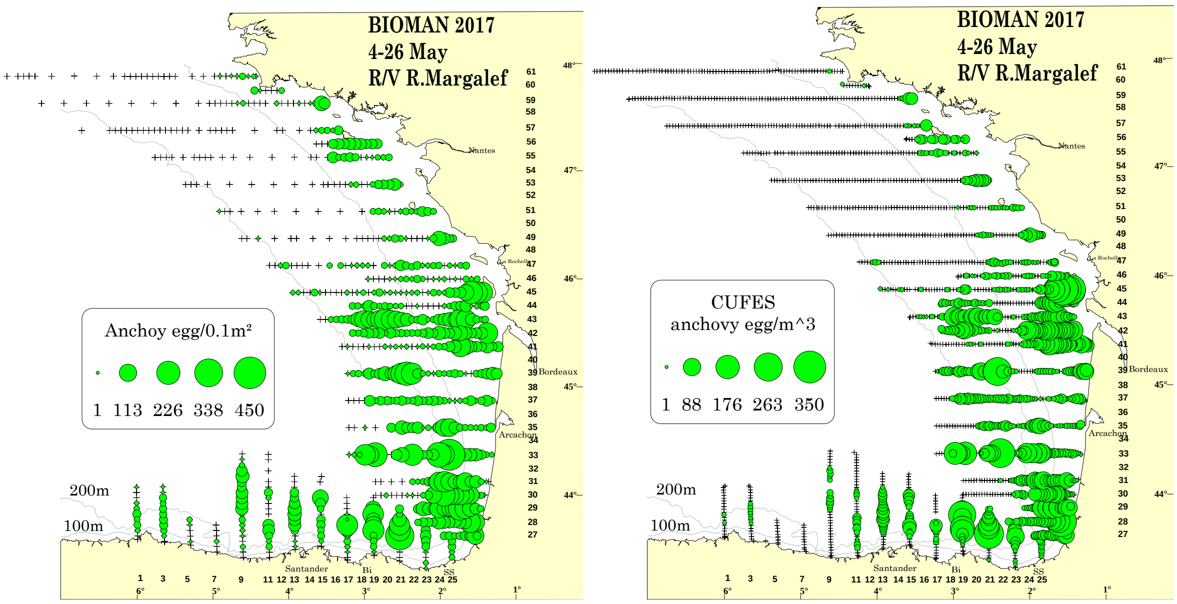

Figure 4: Distribution of anchovy egg abundances obtained with PairoVET (left) (eggs per 0.1m^2) and CUFES (right) (eggs per m^3) from the DEPM survey BIOMAN2017.

Figure 5 shows the sea surface temperature and sea surface salinity maps overlapped with the abundance of anchovy eggs as observed during the BIOMAN2017 survey.

This year the mean SST of the survey (14.8ºC) was the same as last year. The mean SSS (35.12) was lower than last year (35.12). The plume derived from the influence of the Garona river was not wide spread as previous years (**Fig.6**). A short-term and positive SST anomaly was measured between the French coast and 3º W and around 46º N. This hot water tongue with respect to the surrounding waters was higher than 1º C and remained for approximately three days. This event was con-firmed by remote data from different and independent satellites that observed an even higher SST increase with a relative maximum around 17 May. This phenomenon is currently under research.

The adult samples covered adequately the positive spawning area as shown in **Figure 3** except for the North coast from 46ºN to 48ºN were no adult samples were achieved due to problems with the engine of the vessel and a net crash that did to lose more than one week of the survey. Overall 46 pelagic trawls were performed of these, 36 provide anchovy and all of them were selected for the analysis. More over 6 hauls from the commercial fleet, purse seines, were added for the analysis. Frome these 5 will be added to the 36 samples for the final analysis that will be done for WGHANSA-sub and

WGACEGG in November. In total, there will be 41 adult anchovy samples for the analysis. The spatial distribution of the 36 samples and their species composition is shown in **Figure 7.** The most abundant species in the trawls ware: anchovy, mackerel, horse mackerel, hake, sardine.

Spatial distribution of mean weight and mean Length (males and females) is shown in **Figure 8**. Less weight individuals were found all along the coast inside the 100m depth isoline and in the influence of the Gironde estuary while heavier anchovies were found offshore, once passed the isoline of 100m depth.

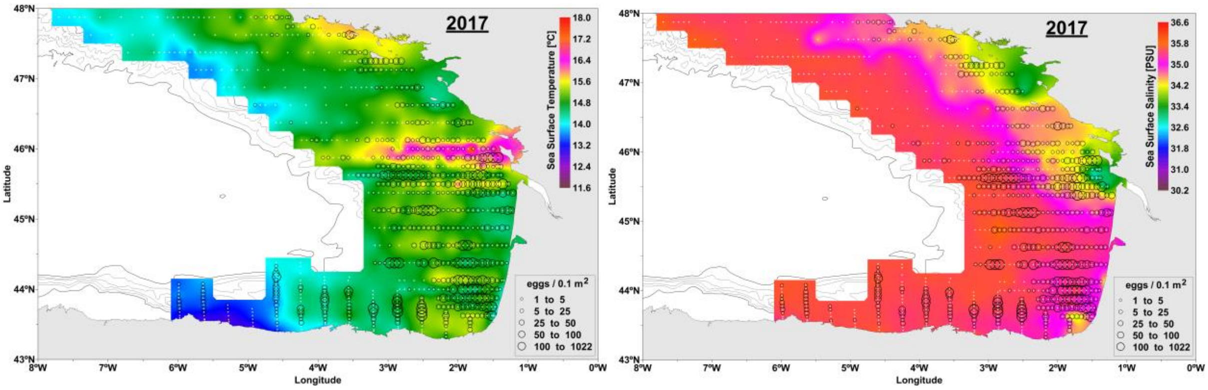

Figure 5: SST and SSS maps (left and right respectively) overlapped with anchovy egg distribution 2017.

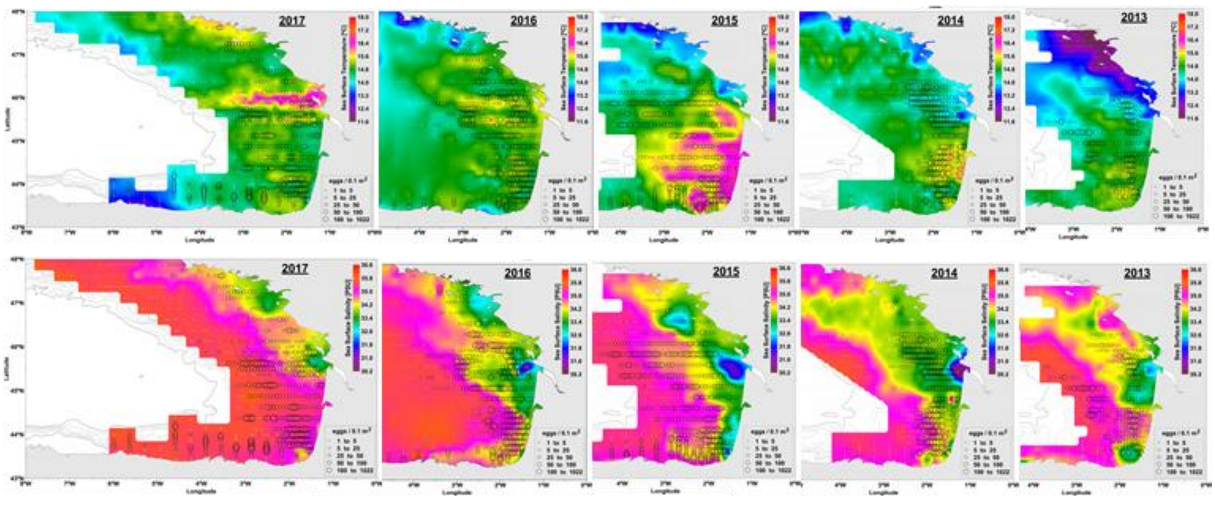

Figure 6: SST (top) and SSS (below) maps overlapped with anchovy egg distribution from 20013 to 2017.

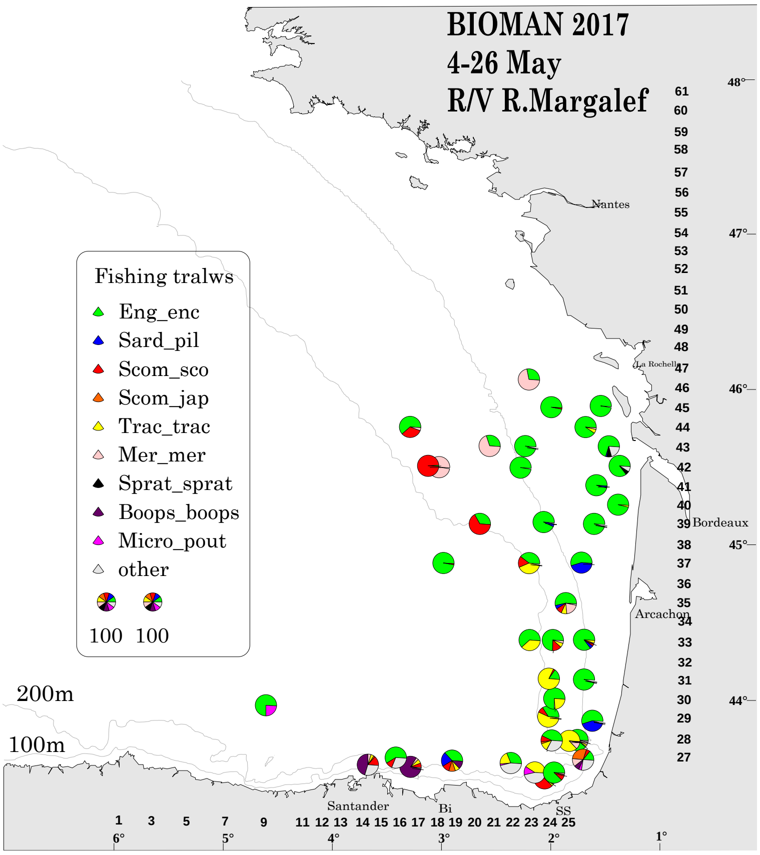

Figure 7: Species composition of the 36 pelagic trawls from the R/V Emma Bardán during BIOMAN17.

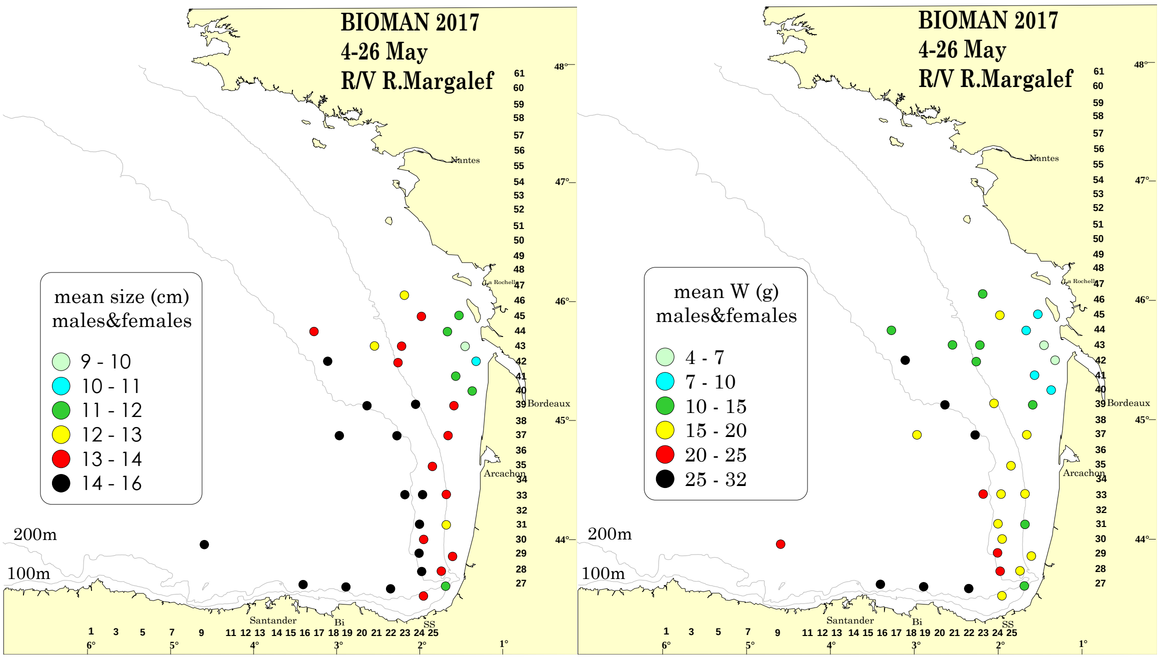

Figure 8: Anchovy (male and female) mean size (left) and weight (right) per haul 2017

Sardine total egg abundance estimates

Total egg abundance for sardine was estimate as the sum of the numbers of eggs in each station multiply by the area each station represents. This year sardine egg abundance estimate was 7.20 E+12 eggs, taken into account the whole area surveyed. Removing the area of the Cantabrico coast and part of the North for assessment propose, as done in 2014, the total egg abundance was 5.98 E+12 eggs as the time series average (**Fig.9, Tab.1**). A small amount of sardine eggs was encountered in the Cantabrico, close to the coast, between 2º30' and 6W. In the French platform sardine eggs were encountered all along the coast between coast and 100m depth until 48ºN. Moreover, there were anchovy eggs between 45ºN and 46ºN from 100m depth to 200m depth isoline and between 47ºN and 48ºN from 100m depth to 200m depth isoline. (**Fig. 10**). In the sampling with the PairoVET net (vertical sampling) from 747 stations a total of 321 (43%) had sardine eggs with an average of 173 eggs per m² per station in the positive stations and a total number of eggs of 5,556 eggs m². In the sampling with CUFES (horizontal sampling) a total of 1,856 stations had sardine. From those 604 (33%) had sardine eggs. This year the DEPM for sardine will be applied. The final results will be available at November 2017 at WGACEGG. For that propose, the survey was extended to the North until 48ºN and to the West until the West limit of the sardine spawning area was delimited. But for propose to be an input for the assessment of sardine in the VIIIabd, stations from the Northwest were removed to maintain the same coverage of the area of the time series (**Fig.10**).

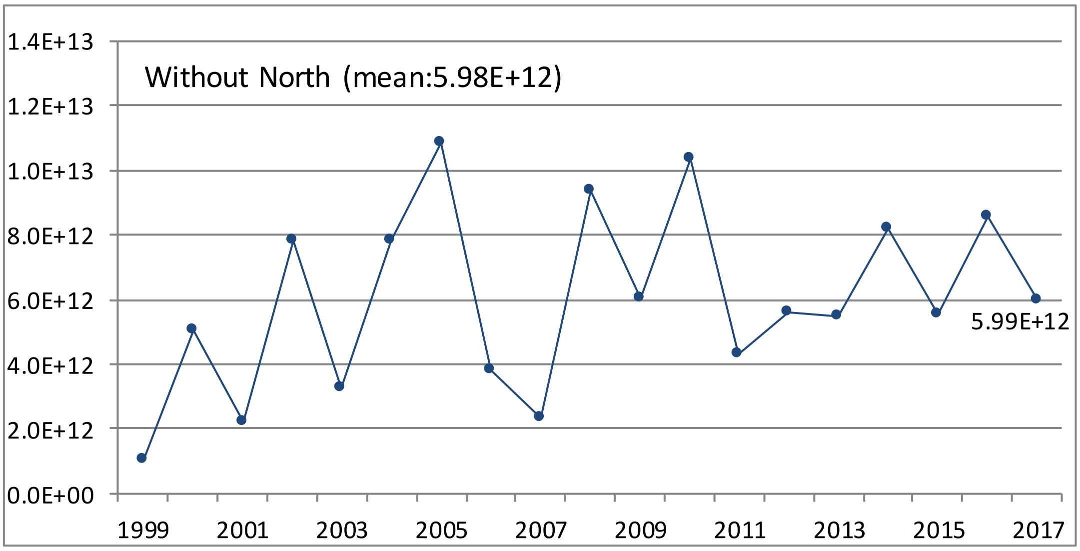

Figure 9: historical series for sardine egg abundances with and without Northwest stations.

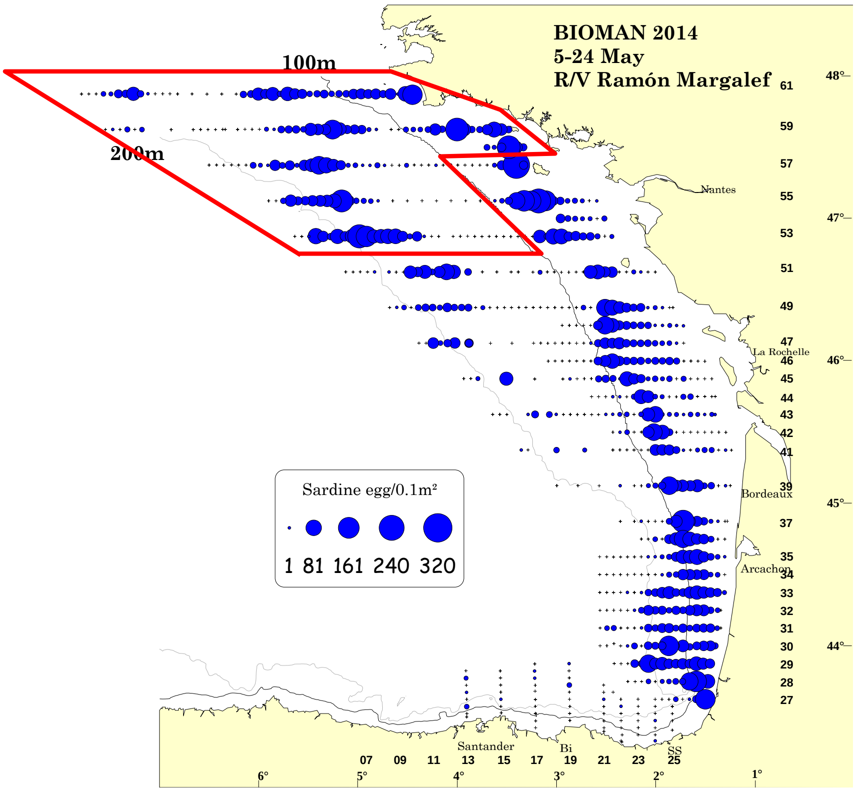

Figure 10: Distribution sardine egg abundances (eggs per 0.1m^2) from the DEPM survey BIOMAN2014 obtained with PairoVET. The red line represents the stations removed for assessment propose.

Table 1: Time series for sardine, Total egg abundances (Σ(egg_St*area_st)) in numbers of eggs, without the North, the one adopted as an input for the assessment of sardine VIIIabd.

Year	TotAb_withoutN
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

Anchovy total daily egg production estimates

As a result of the adjusted GLM (**Fig. 11**) the daily egg production (P_0) was 191.37 egg m^{-2} day^{-1} with a standard error of 21.7 and a CV of 0.11. The daily mortality z was 0.17 with a standard error of 0.056 and a CV of 0.34. Then, the total daily egg production as the product of spawning area and daily egg production was 6.76 E+12 3.24 E+12 with a standard error of 7.7 E+11 and a CV of 0.11, two times last year estimate.

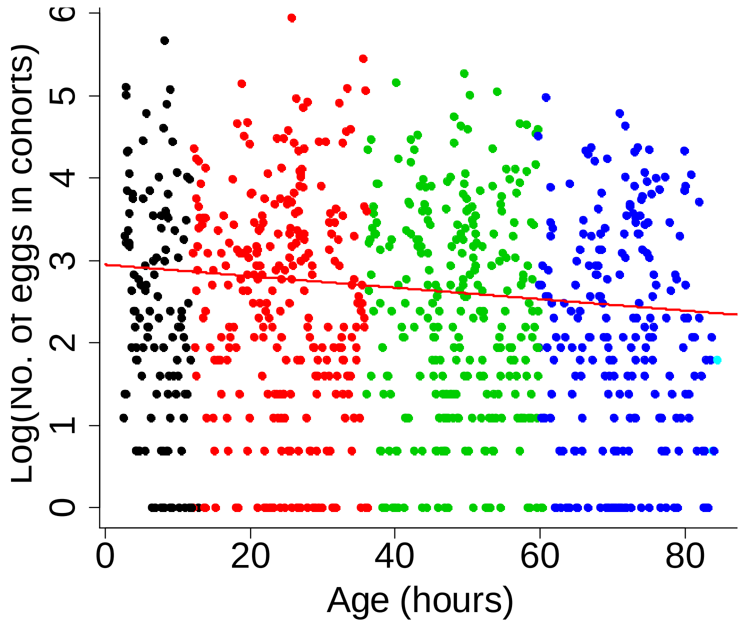

Figure 11: Exponential decay mortality model adjusted applying a GLM to the data obtained in the ageing of anchovy eggs following the Bayesian method (spawning peak 23:00h). The red line is the adjusted line. Data in Log scale.

Daily fecundity, total biomass and numbers at age

To correct the weight of the females due to the hydration, a linear regression model between gonad-free-weight and total weight fitted to non-hydrated females (hydrated females identified *a visu* following the mature scale adopted at ICES workshop WKSPMAT) was performed (**Table 2)**. The extra females taken not in random, for batch fecundity, were not considered. The model fitted the data adequately (**Figure 12**, R^2=99.8%, n= 824). The **female mean weight** was obtained as the weighted mean of the average female weights per sample (Lasker, 1985).

Table 2: Coefficients resulted from the linear regression model between gonad-free-weight and total weight fitted to non-hydrated females with their standard error and the P-Value.

Parameter	Estimate	Standard error	P-Value
Intercept	-0.3057	0.0331	0
Slope	1.0998	0.0018	0

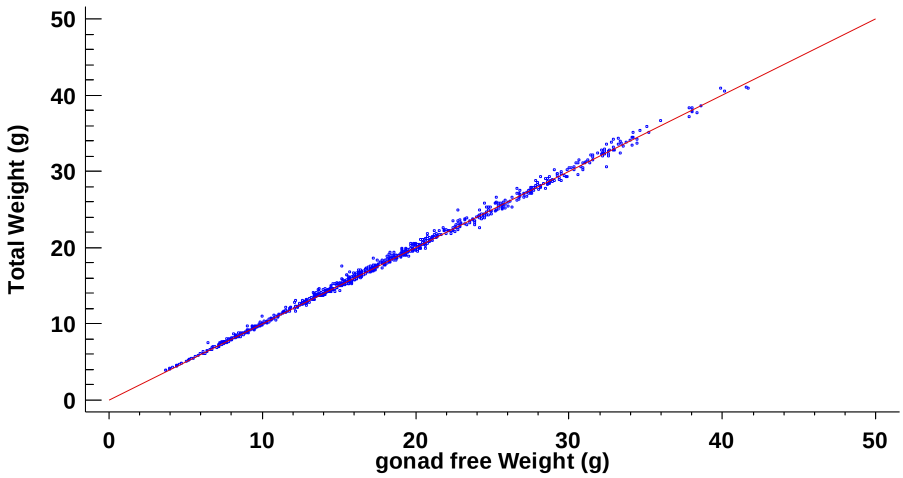

Figure 12: linear regression model between gonad-free-weight and total weight fitted to non-hydrated females for 2017.

To estimate the total Biomass following the DEPM a daily fecundity (DF) estimate is necessary. The anchovy adults from the survey to estimate DF are in process so it was obtained as the mean of the las 7 years, from 2010 (after the open of the fishery) to 2016. (70.71 eggs/gramme).
The preliminary total biomass estimate resulted in 85,000t with a coefficient of variation of 15%. **Table 3.**
The definitive anchovy total biomass, to be used as input for the assessment model, will be estimated for November (WGHANSA-sub) based on the final DF estimate.

Table 3. Total egg production, daily fecundity considering last 6 years mean and total biomass estimates.

Ptot (eggs)			DF (eggs/gramme)			Total biomass(Ton.)		
Model	**Estimate**	**Var**	**Predic.Model**	**Estimate**	**Var.Pred.**	**Estimate**	**Var**	**Cv**
GLM	6.05E+12	4.0E+23	210-2016 mean	70.71	63.80	85,500	1.7.E+08	0.1540

For the purposes of producing population at age estimates, the age readings based on 2,739 otoliths from 36 samples were available at the WGHANSA. For WGHANSA-sub another 5 samples will be add for this purpose. Estimates of anchovy mean weights and proportions at age in the population were the average of proportions at age in the samples, weighted by the population each sample represents.

Given that mean weights of anchovies change between different regions (**Figure 3**) proportionality between the number of samples and approximate biomass, indices by regions was checked. The approximate index of biomass by regions was set equal to egg abundance divided by the daily fecundity assigned to each region (**Table 4**). According to that table, the 36 samples selected cannot be considered to be balanced between these regions and differential weighting factors were applied to each sample coming from one or the other region for the purposes of the number at age estimates and biomass estimates. The proportion by age, numbers by age, weight at age and biomass by age estimates are given in **table 5**. 74% of the population in numbers and 63% in mass correspond to age 1. **Figure 13** shows the distribution of anchovy age composition in space.

Table 4: Balance of adult sampling to egg abundance by 6 regions South West (SW), South East (SE), Centre (C), Garonne (G), Northeast (NE) and North West (NW). (see **Figure 3**). The 6th row of the table corresponds to the weighting factor for each sample by region to obtain the population structure. Mean weight by regions arise from the 36 adult samples selected for the analysis.

Region	SW	SE	C	G	NE	NW	Addition
Total egg abundance	5.7.E+12	2.5.E+12	4.2.E+12	2.2.E+12	2.3.E+12	2.6.E+12	1.95.E+13
% egg abundance	29%	13%	22%	11%	12%	13%	100%
Nº of adult samples	7	8	4	6	5	6	36
% Egg/sample	0.042	0.016	0.054	0.019	0.024	0.022	
% of Biomass relative to C region	0.78	0.30	1.00	0.35	0.44	0.41	
W. factor proportional to the population	0.78/wi	0.3/wi	1/wi	0.35/wi	0.44/wi	0.41/wi	
Mean weight of anchovies by region	19.1	14.8	27.9	7.1	14.1	22.4	
Standard Deviation	2.62	2.63	4.01	1.43	2.43	5.57	
CV	0.13702	0.17808	0.143416	0.19966	0.17266	0.248376	

Table 5: 2017 estimates and correspondent standard error (S.e.) and coefficient of variation (CV) of biomass, the percentage, numbers, weight, biomass at age estimates and percentage at age in mass.

Parameter	Estimate	S.e.	CV
Biomass (Tons)	85,500	13,169	0.1540
Tot.mean W (g)	15.64	1.37	0.0876
Population (millions)	5,466	969	0.1772
Percent age 1	0.74	0.04	0.0516
Percent age 2	0.20	0.03	0.1436
Percent age 3+	0.06	0.01	0.2132
Numbers at age 1	4,067	750	0.1845
Numbers at age 2	1,077	246	0.2281
Numbers at age 3+	307	85	0.2772
Weight at age 1	13.2	0.98	0.0900
Weight at age 2	22.4	1.00	0.0643
Weight at age 3+	23.5	1.33	0.0498
Length at age 1	119.9	3.60	0.0300
Length at age 2	133.9	2.91	0.0217
Length at age 3+	160.7	2.17	0.0135
B at age 1 in mass	54,049		
B at age 2 in mass	24,197		
B at age 3+ in mass	7,254		
Percent age 1 in mass	0.632	0.04	0.0817
Percent age 2 in mass	0.283	0.03	0.0545
Percent age 3+ in mass	0.085	0.01	0.2178

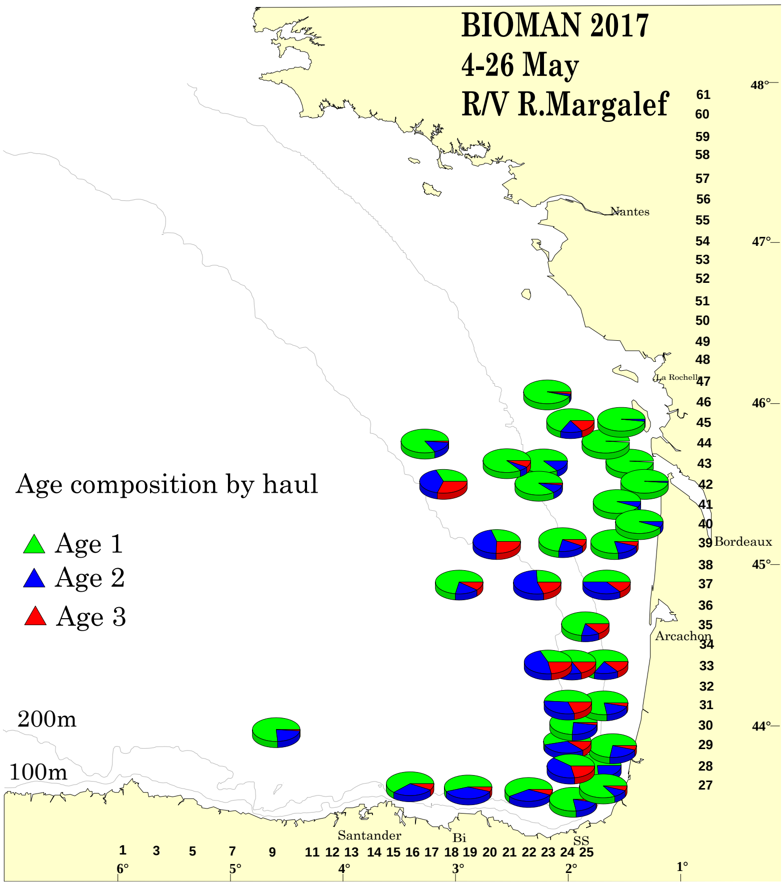

Figure 13: Anchovy age composition per haul in 2017

Historical perspective

The whole series of biomass index estimated with the DEPM, including the current preliminary estimate for 2017, is presented in **figure 14**. The historical series of numbers at age in numbers is shown in **figure 15.** To provide a broader point of view for the interpretation of current survey results, distribution maps of the anchovy egg abundances in the last 30 DEPM surveys were compiled for anchovy and sardine. (**Fig 16 & 17** respectively).

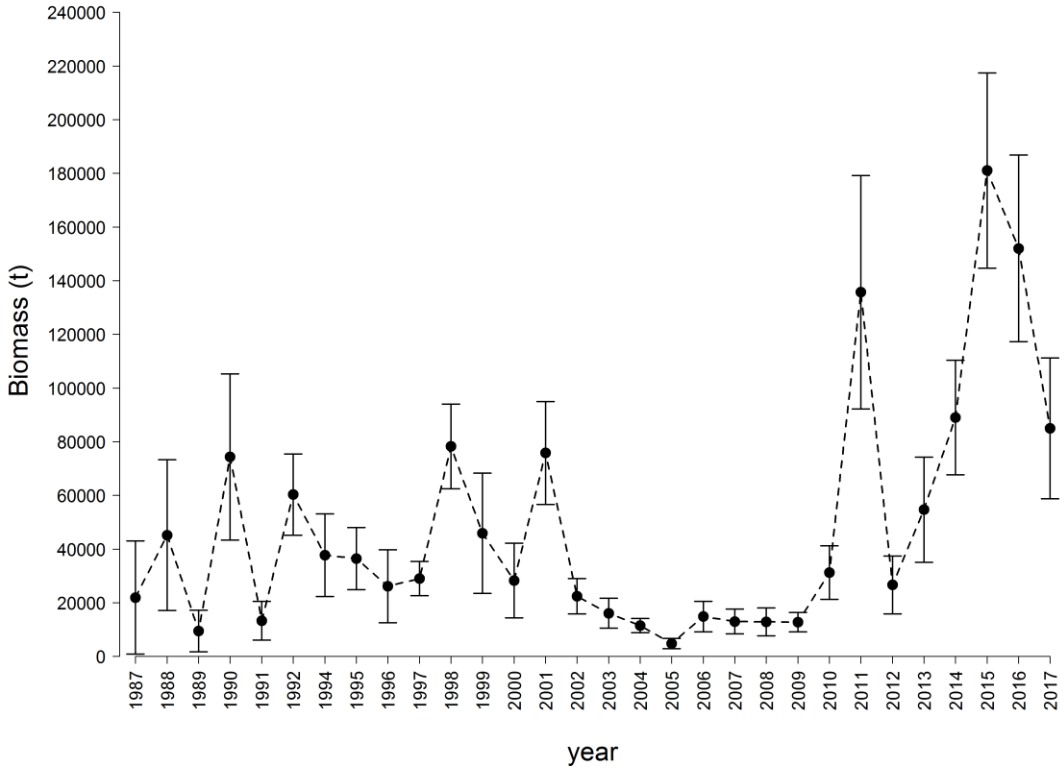

Figure 14: Series of Biomass estimates (tonnes) obtained from the DEPM since 1987.

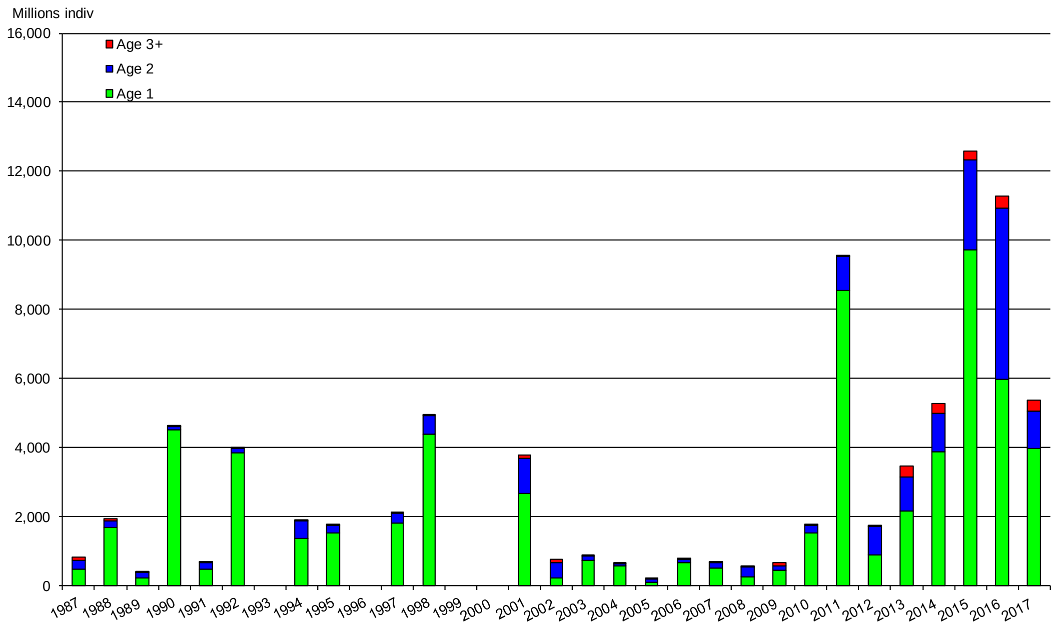

Figure 16: Historical series of numbers at age from 1987 to 2017. This year 74% of the biomass in numbers and 63% in mass was year one.

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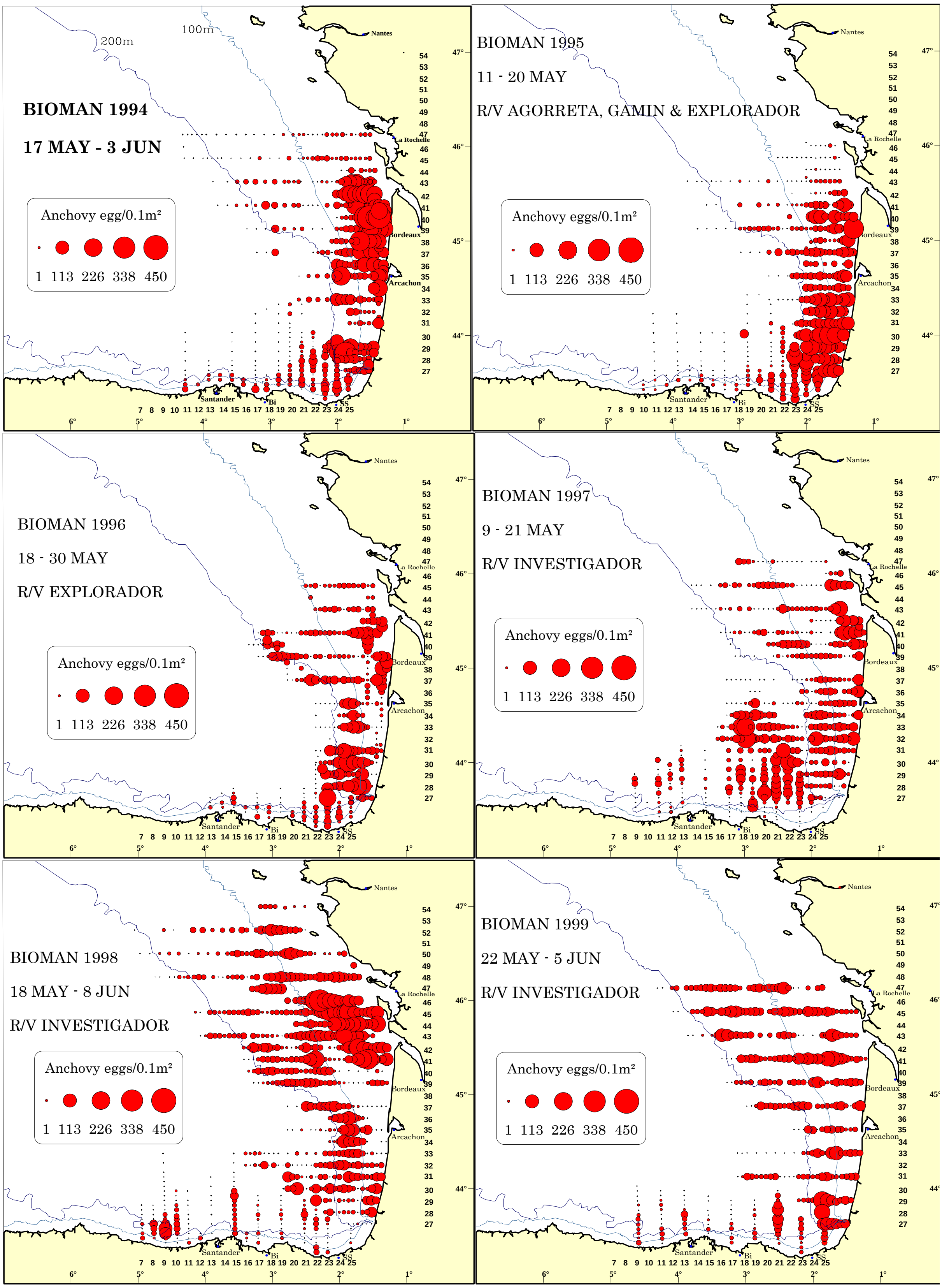
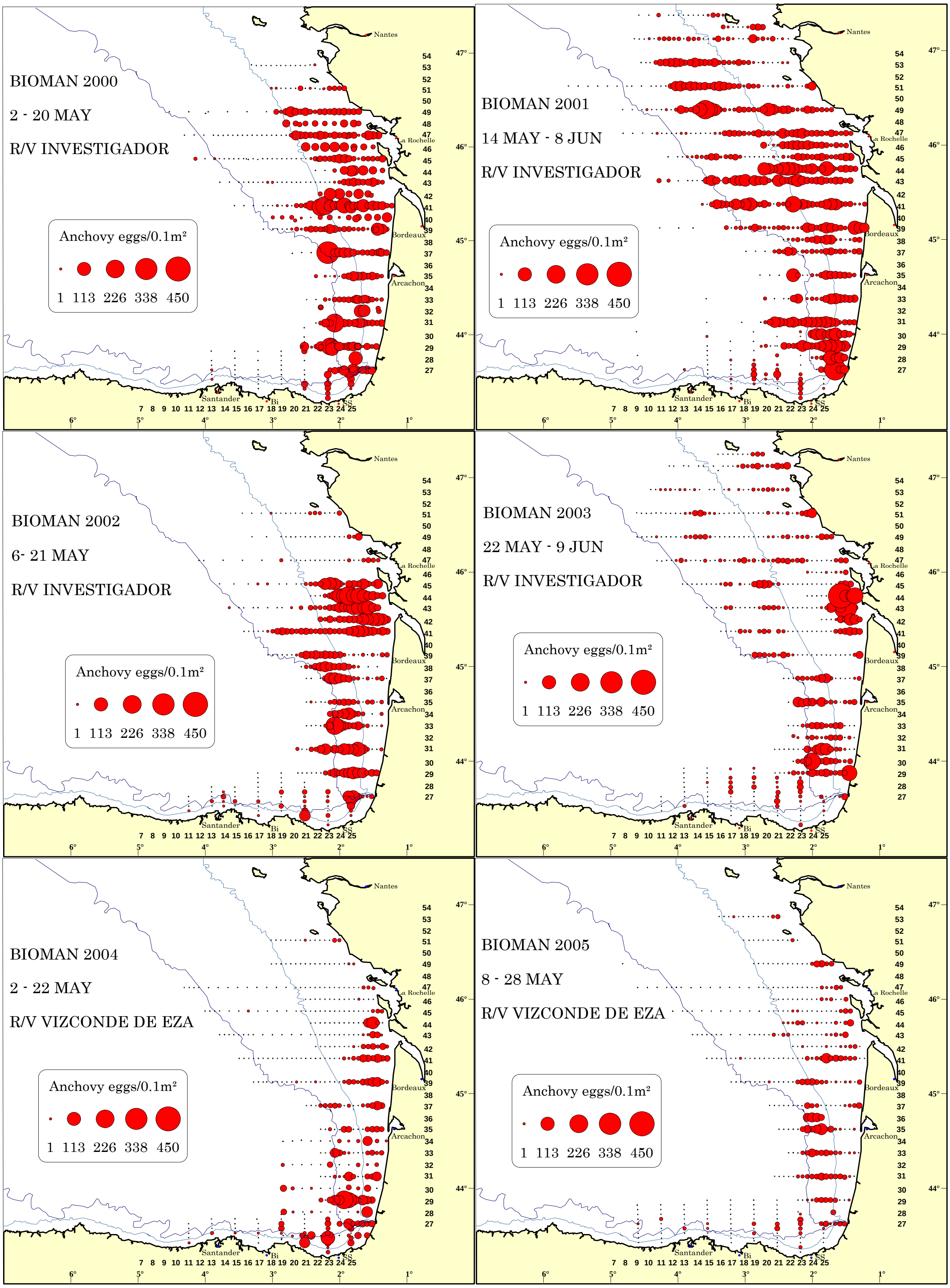
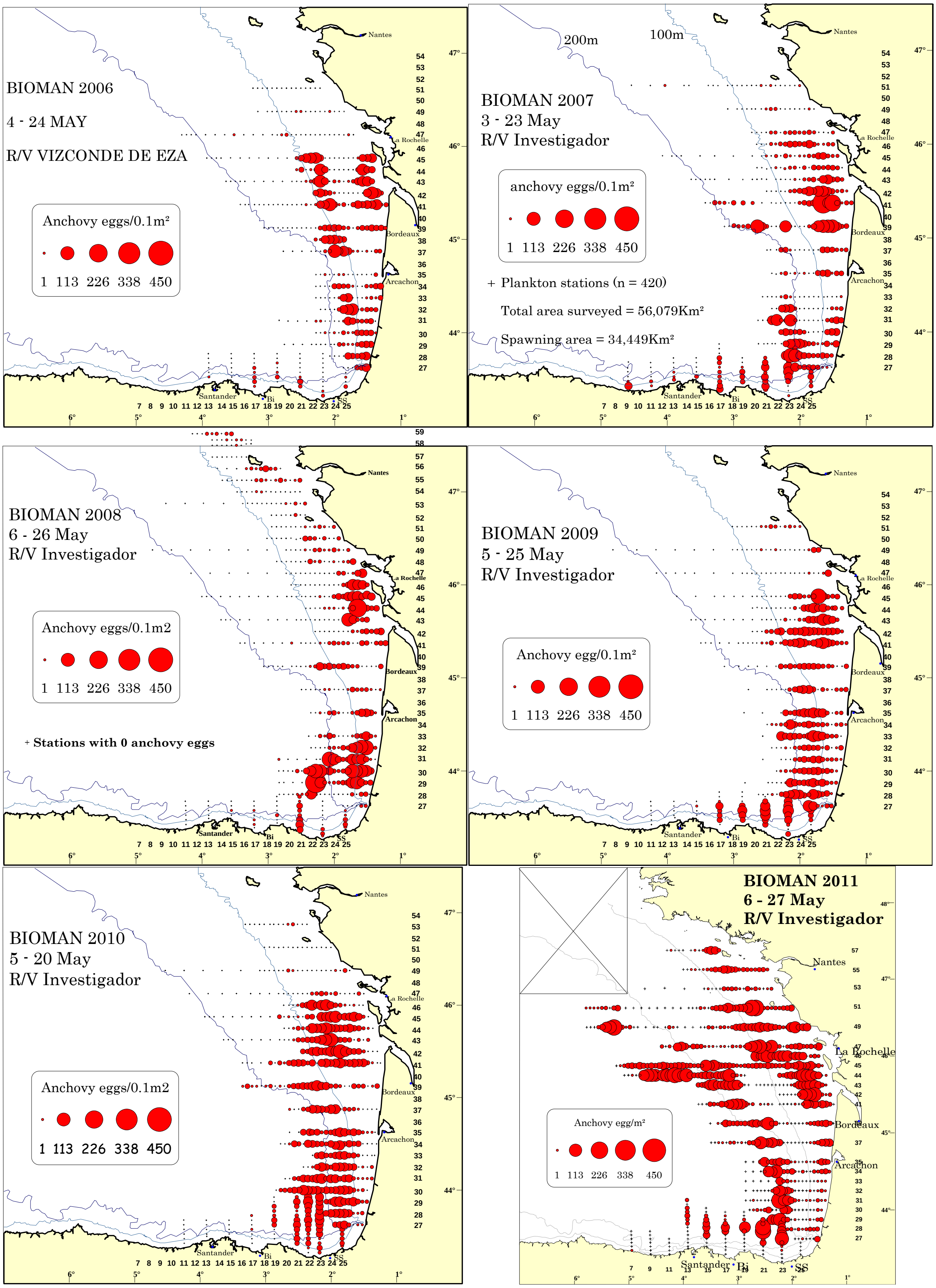

BIOMAN 1994
17 MAY - 3 JUN
Anchovy egg/0.1m²
1 113 226 338 450
BIOMAN 1995
11 - 20 MAY
R/V AGORRETA, GAMIN & EXPLORADOR
Anchovy eggs/0.1m²
1 113 226 338 450
BIOMAN 1996
18 - 30 MAY
R/V EXPLORADOR
Anchovy eggs/0.1m²
1 113 226 338 450
BIOMAN 1997
9 - 21 MAY
R/V INVESTIGADOR
Anchovy eggs/0.1m²
1 113 226 338 450
BIOMAN 1998
18 MAY - 8 JUN
R/V INVESTIGADOR
Anchovy eggs/0.1m²
1 113 226 338 450
BIOMAN 1999
22 MAY - 5 JUN
R/V INVESTIGADOR
Anchovy eggs/0.1m²
1 113 226 338 450
200m
100m
Nantes
La Rochelle
Bordeaux
Arcachon
Santander
47°
46°
45°
44°
6°
5°
4°
3°
2°
1°


BIOMAN 2000
2 - 20 MAY
R/V INVESTIGADOR
Anchovy eggs/0.1m²
1 113 226 338 450
BIOMAN 2001
14 MAY - 8 JUN
R/V INVESTIGADOR
Anchovy eggs/0.1m²
1 113 226 338 450
BIOMAN 2002
6- 21 MAY
R/V INVESTIGADOR
Anchovy eggs/0.1m²
1 113 226 338 450
BIOMAN 2003
22 MAY - 9 JUN
R/V INVESTIGADOR
Anchovy eggs/0.1m²
1 113 226 338 450
BIOMAN 2004
2 - 22 MAY
R/V VIZCONDE DE EZA
Anchovy eggs/0.1m²
1 113 226 338 450
BIOMAN 2005
8 - 28 MAY
R/V VIZCONDE DE EZA
Anchovy eggs/0.1m²
1 113 226 338 450
Nantes
La Rochelle
Bordeaux
Arcachon
Santander
Bi
SS
47°
46°
45°
44°
6°
5°
4°
3°
2°
1°


BIOMAN 2006
4 - 24 MAY
R/V VIZCONDE DE EZA
Anchovy eggs/0.1m²
1 113 226 338 450
Nantes
La Rochelle
Bordeaux
Arcachon
Santander
BIOMAN 2007
3 - 23 May
R/V Investigador
200m
100m
anchovy eggs/0.1m²
1 113 226 338 450
+ Plankton stations (n = 420)
Total area surveyed = 56,079Km²
Spawning area = 34,449Km²
BIOMAN 2008
6 - 26 May
R/V Investigador
Anchovy eggs/0.1m2
1 113 226 338 450
+ Stations with 0 anchovy eggs
BIOMAN 2009
5 - 25 May
R/V Investigador
Anchovy egg/0.1m²
1 113 226 338 450
BIOMAN 2010
5 - 20 May
R/V Investigador
Anchovy eggs/0.1m2
1 113 226 338 450
BIOMAN 2011
6 - 27 May
R/V Investigador
Anchovy egg/m²
1 113 226 338 450

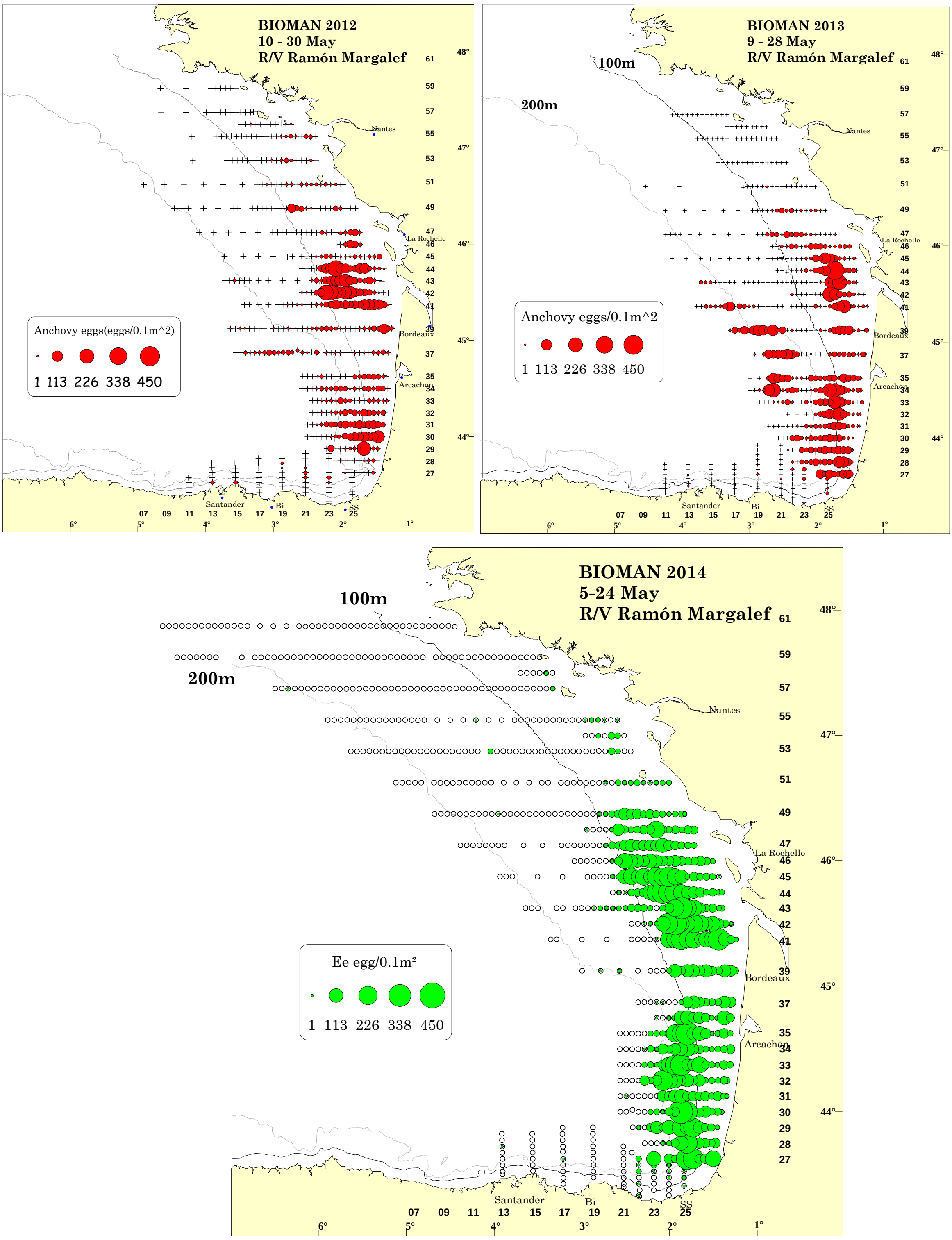
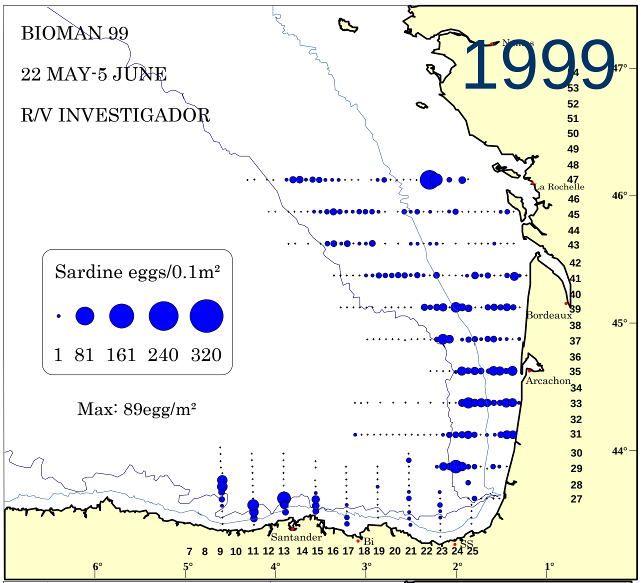
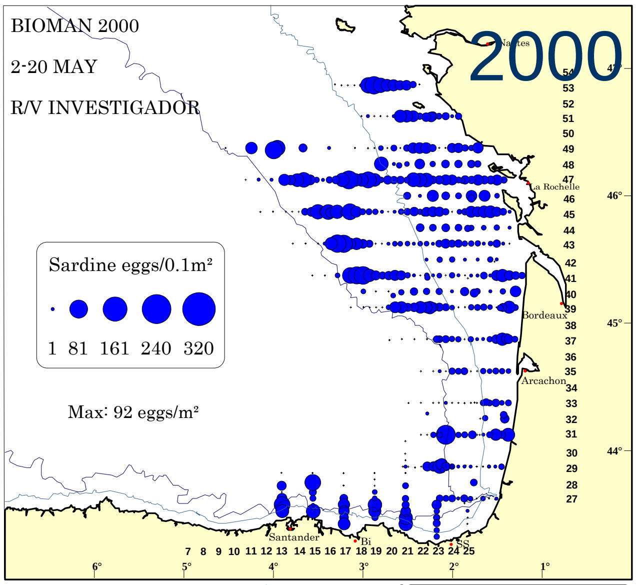
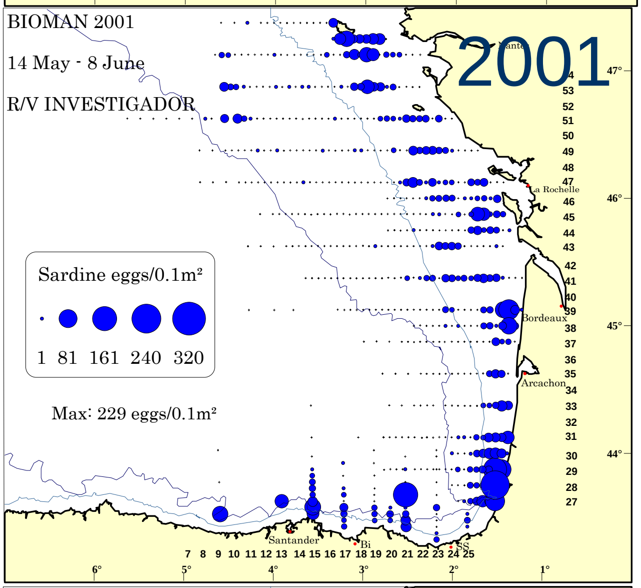
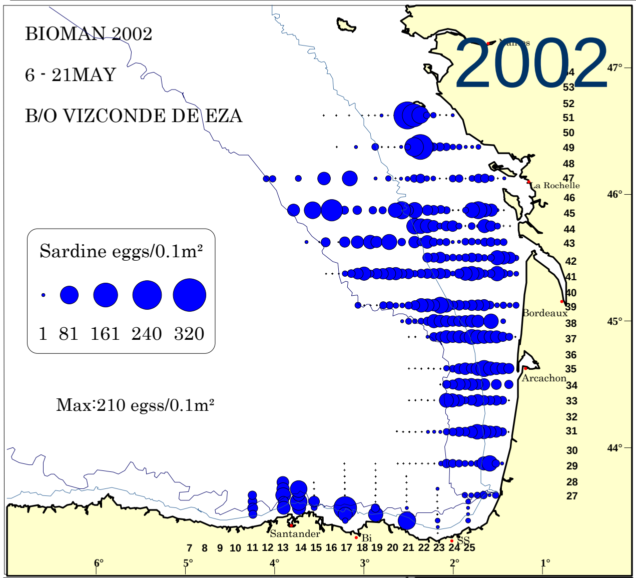


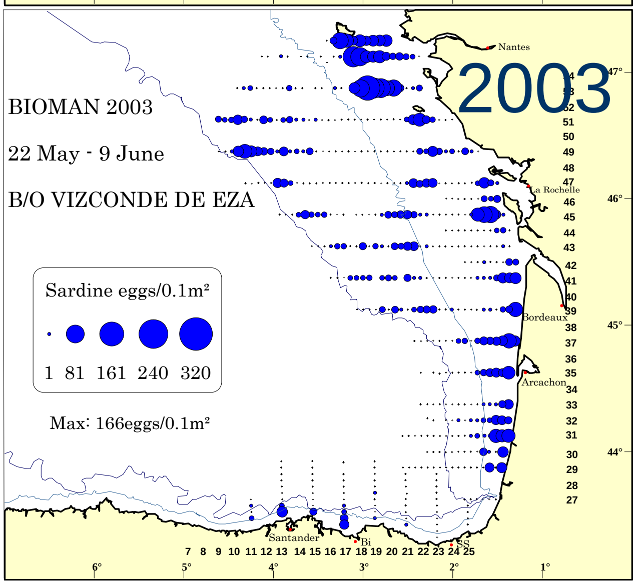
Figure 16: Anchovy egg distribution and abundance from 1994 to 2017.

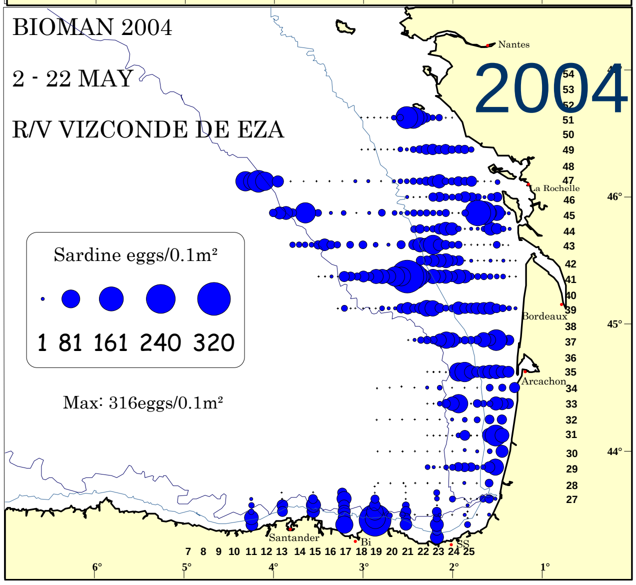

BIOMAN 99
22 MAY-5 JUNE
R/V INVESTIGADOR
1999
Sardine eggs/0.1m²
1 81 161 240 320
Max: 89egg/m²
Nantes
La Rochelle
Bordeaux
Arcachon
Santander
Bi
SS
47°
46°
45°
44°
6° 5° 4° 3° 2° 1°

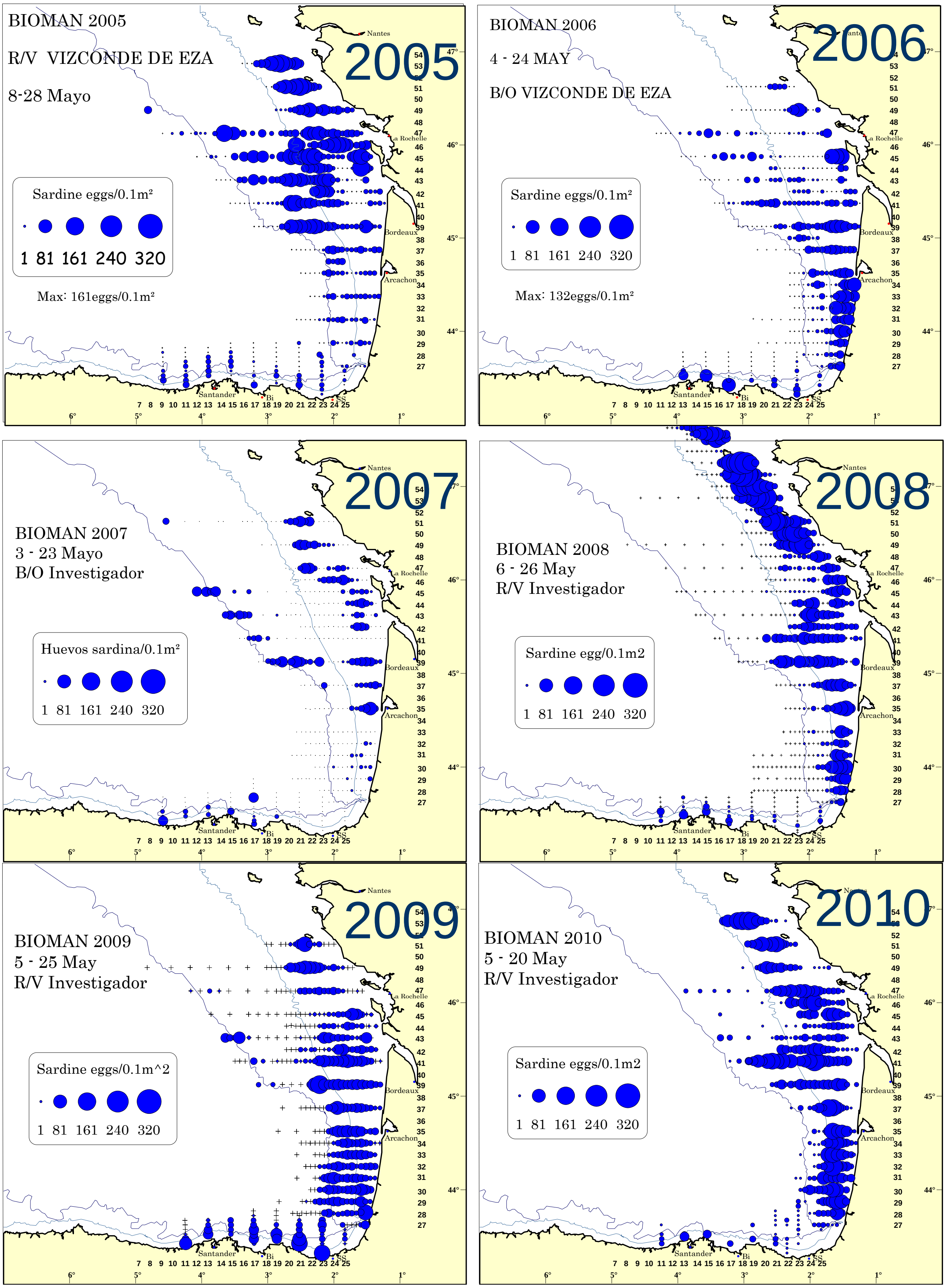

BIOMAN 2000
2-20 MAY
R/V INVESTIGADOR
2000
Sardine eggs/0.1m²
1 81 161 240 320
Max: 92 eggs/m²
La Rochelle
Bordeaux
Arcachon
Santander
Bi
SS
46°
45°
44°
6° 5° 4° 3° 2° 1°


BIOMAN 2001
14 May - 8 June
R/V INVESTIGADOR
2001
Sardine eggs/0.1m²
1 81 161 240 320
Max: 229 eggs/0.1m²
La Rochelle
Bordeaux
Arcachon
Santander
Bi
SS
47°
46°
45°
44°
6° 5° 4° 3° 2° 1°


BIOMAN 2002
6 - 21MAY
B/O VIZCONDE DE EZA
2002
Sardine eggs/0.1m²
1 81 161 240 320
Max:210 egss/0.1m²
La Rochelle
Bordeaux
Arcachon
Santander
Bi
SS
47°
46°
45°
44°
6° 5° 4° 3° 2° 1°


BIOMAN 2003
22 May - 9 June
B/O VIZCONDE DE EZA
2003
Sardine eggs/0.1m²
1 81 161 240 320
Max: 166eggs/0.1m²
Nantes
La Rochelle
Bordeaux
Arcachon
Santander
Bi
SS
47°
46°
45°
44°
6° 5° 4° 3° 2° 1°


BIOMAN 2004
2 - 22 MAY
R/V VIZCONDE DE EZA
2004
Sardine eggs/0.1m²
1 81 161 240 320
Max: 316eggs/0.1m²
Nantes
La Rochelle
Bordeaux
Arcachon
Santander
Bi
SS
46°
45°
44°
6° 5° 4° 3° 2° 1°


BIOMAN 2005
R/V VIZCONDE DE EZA
8-28 Mayo
2005
Sardine eggs/0.1m²
1 81 161 240 320
Max: 161eggs/0.1m²
BIOMAN 2006
4 - 24 MAY
B/O VIZCONDE DE EZA
2006
Sardine eggs/0.1m²
1 81 161 240 320
Max: 132eggs/0.1m²
BIOMAN 2007
3 - 23 Mayo
B/O Investigador
2007
Huevos sardina/0.1m²
1 81 161 240 320
BIOMAN 2008
6 - 26 May
R/V Investigador
2008
Sardine egg/0.1m2
1 81 161 240 320
BIOMAN 2009
5 - 25 May
R/V Investigador
2009
Sardine eggs/0.1m^2
1 81 161 240 320
BIOMAN 2010
5 - 20 May
R/V Investigador
2010
Sardine eggs/0.1m2
1 81 161 240 320
Nantes
La Rochelle
Bordeaux
Arcachon
Santander
Bi
SS
46°
45°
44°
6°
5°
4°
3°
2°
1°

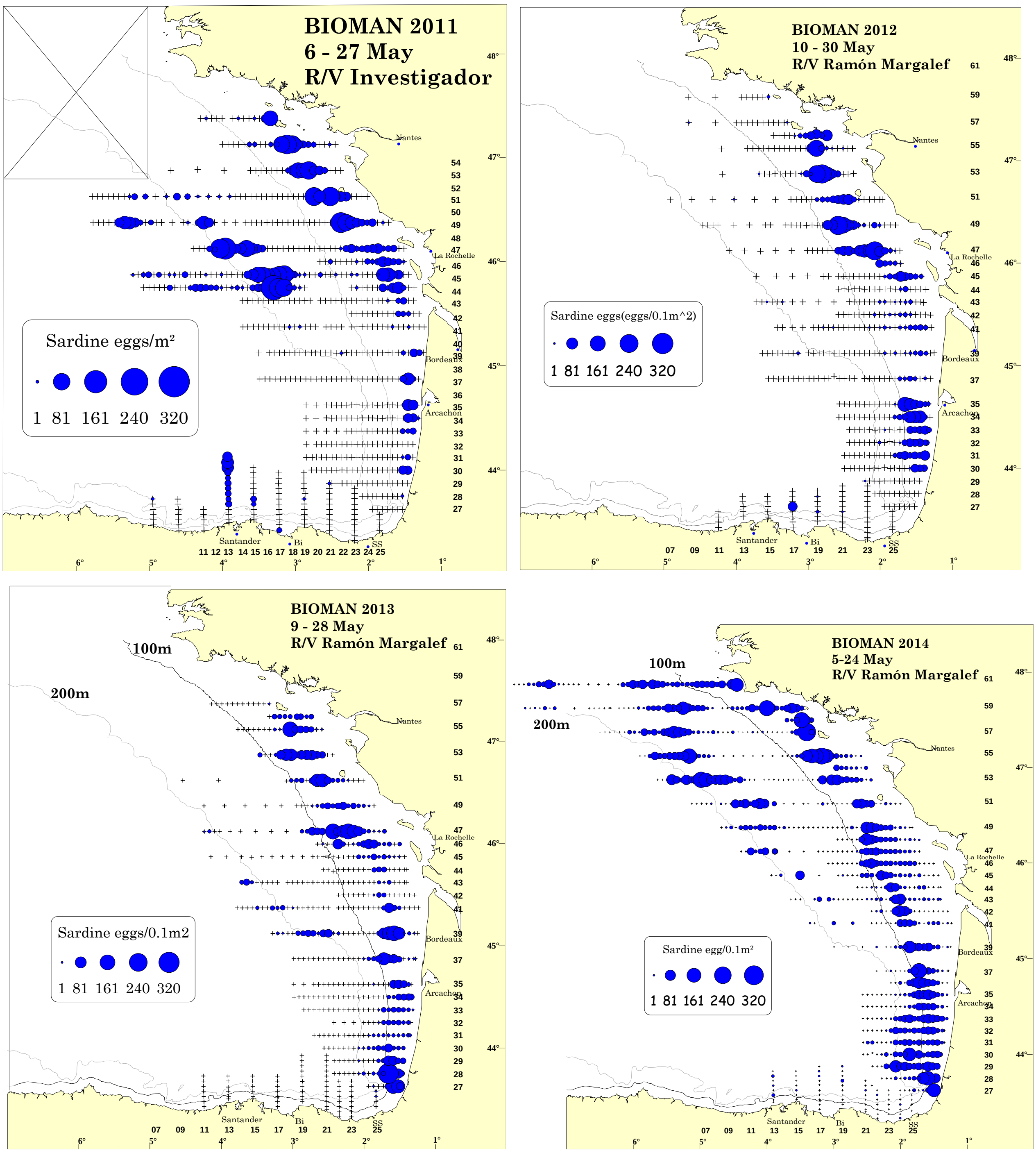


Figure 17: Sardine egg distribution and abundance from 1999 to 2017.

WD to the WGHANSA17 meeting, Bilbao, 24-29 June 2017

Preliminary results of the triennial DEPM survey SAREVA0317.

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Background

SAREVA0317 is the last in the triennial survey series carried out by IEO since 1988 for the estimation of spawning stock biomass of sardine in the Iberian Peninsula (9a-8c and part of 8b subdivisions).
This survey is carried out in coordination with IPMA and AZTI in the framework of WGACEGG with standardized methodologies for surveying and laboratorial and data analyses (see ICES2017 for details on survey methodology and data analysis).

Results

SAREVA0317 survey was performed onboard R/V Vizconde de Eza from 23rd March to 15th April, with a total of 21 operative days of work (Figure 1).

Due to operational reasons, two of the planned transects in 8b subdivision could not be performed on time.

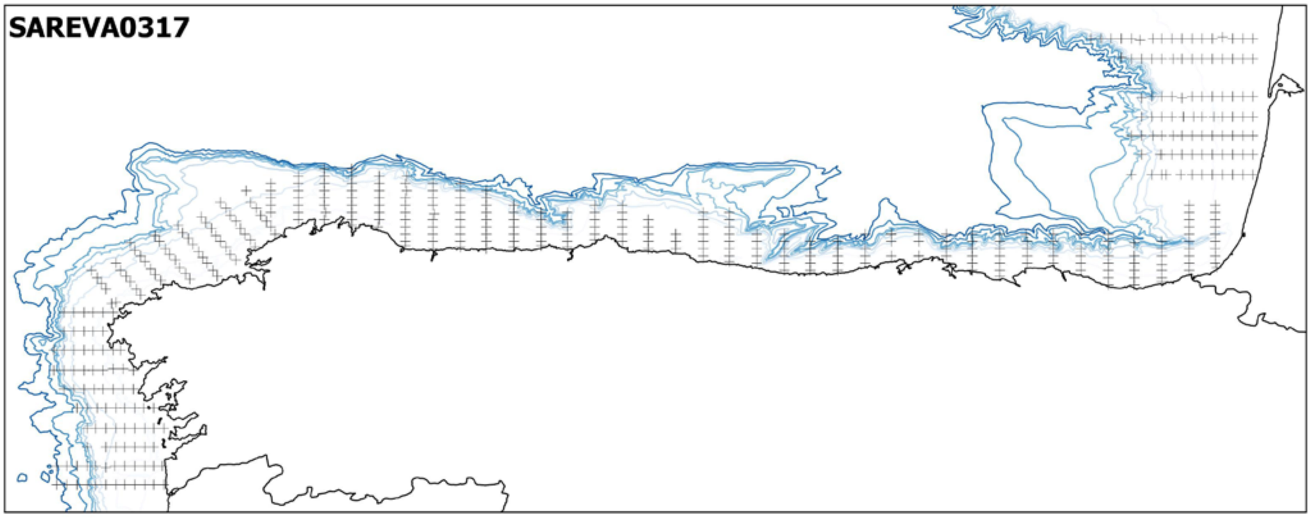


Figure 1. Sampled area during SAREVA0317 survey.

For adult parameter estimation, sardine samples were collected onboard R/V Miguel Oliver during PELACUS0317 survey (15th March-16th April).

Temperature and salinity at 10m

Along the sampling area, in every plankton station, in order to characterise hydrographical conditions, seabird 37 (coupled to the PAIROVET net, 100) or seabird25 CTD casts (437), were made (Figure 2, preliminary data at 10m depth). Physical data are still been processed and results will be presented in WGACEGG17.

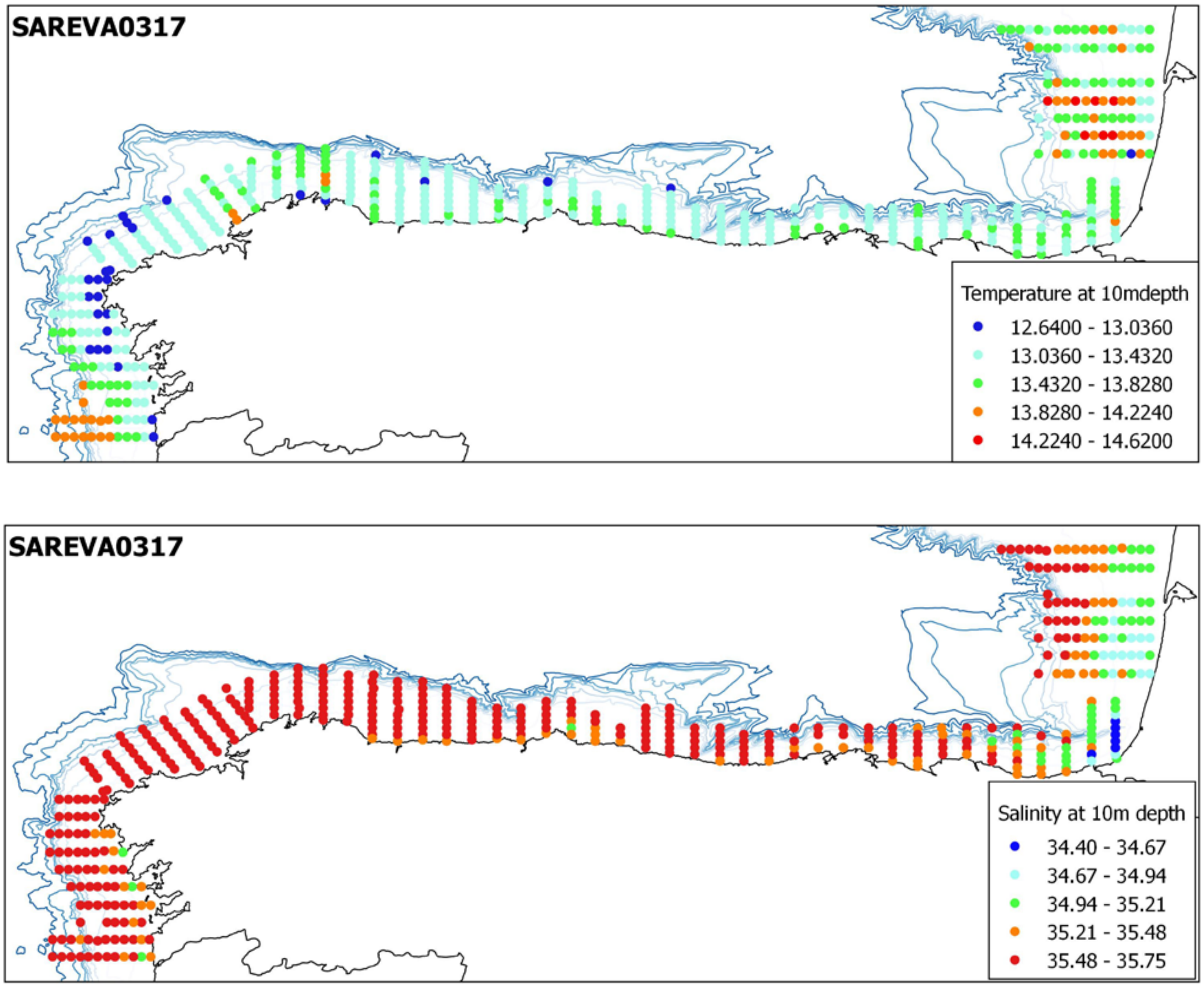


Figure 2. Preliminary data of temperature(TOP) and salinity(BOTTOM) at 10m depth from CTDs during SAREVA0317

Egg density in CUFES samples.

Spawning area was delimited with a total of 421 CUFES stations.

- ***Sardine (FIGURE3)***

  A total of 3414 sardine eggs were collected, with a 41% of positive stations. Highest densities were observed in South Galicia (Rias Baixas) and in the French area sampled. In the Cantabrian Sea, sardine eggs were scarce and showed a more coastal distribution.

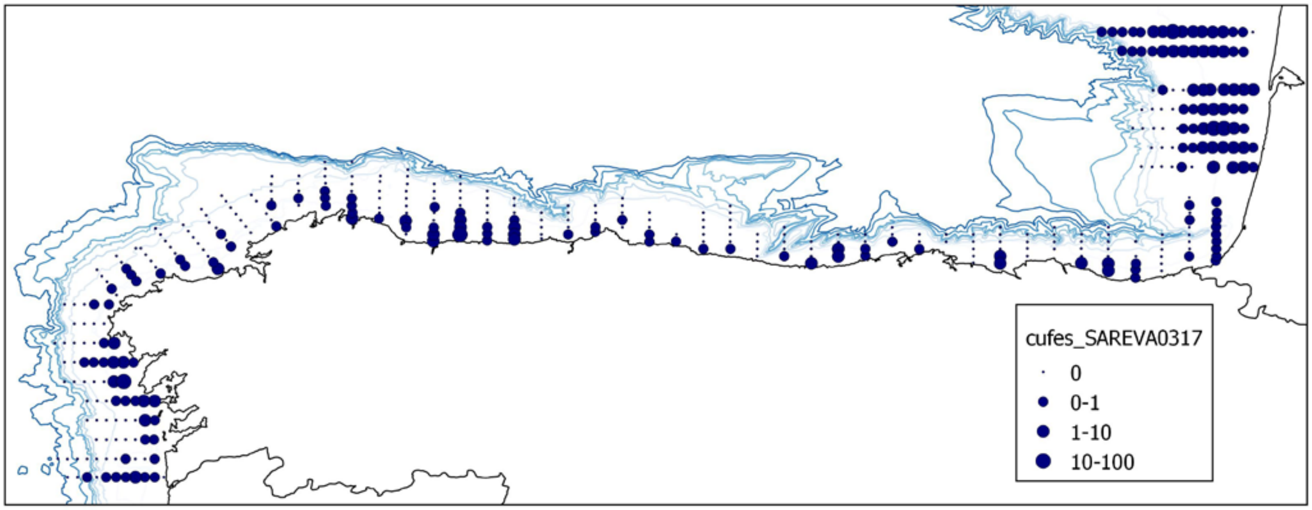


Figure 3. Sardine egg density in CUFES samples from SAREVA0317 survey.

- ***Anchovy (FIGURE 4)***

  A total of 47644 anchovy eggs were collected, with a 45% of positive stations. Highest densities were observed in South Galicia (Rias Baixas) and especially in the French area sampled. Anchovy eggs were practically absent between Cudillero (Asturias) and the inner part of the Bay of Biscay (8b subdivision). This fact can be due to the dates of the survey, very early for the anchovy spawning season.

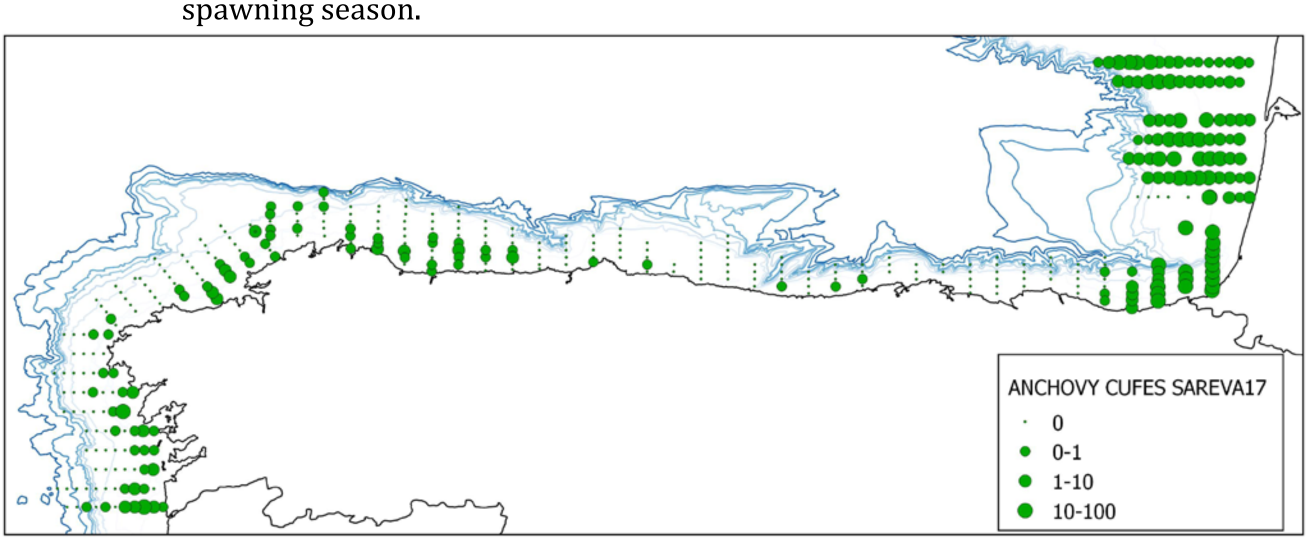


Figure 4. Anchovy egg density in CUFES samples from SAREVA0317 survey.

Egg density in CALVET sampling.

Vertical plankton samples were collected in 473 CALVET stations.

- ***Sardine (FIGURE 5)***

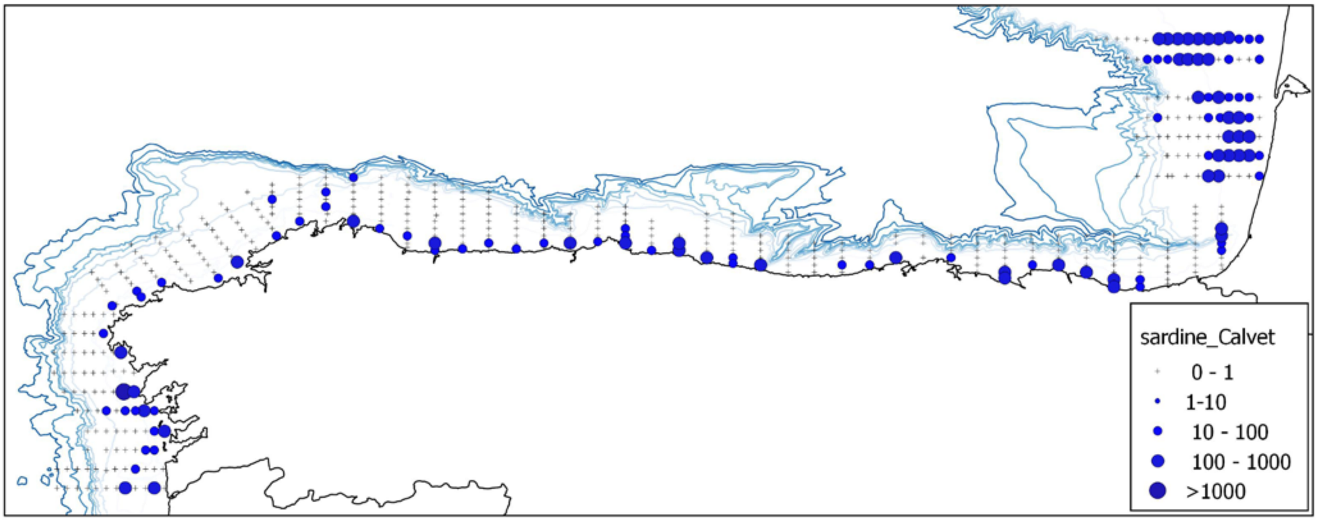


Figure 5. Sardine egg density in CALVET samples from SAREVA0317 survey.

110 of the 473 stations performed were positive for sardine, representing the 23%. The total number of eggs was 669, with an average density of 30 eggs/m^2 (FIGURE 5). Sardine eggs were found in the whole area, with a low density and very coastal area distribution, except for the French platform, where were more abundant and widespread distributed.

In 2014 (FIGURE 6), previous sardine DEPM survey, total CALVET stations were 522, with 28% of them positive for sardine (144). Total sardine eggs collected were 1763, with a higher density in average (59 eggs/m^2). Egg distribution was not continuous in the sampled area, with some gaps in Galicia and in the Cantabrian Sea.

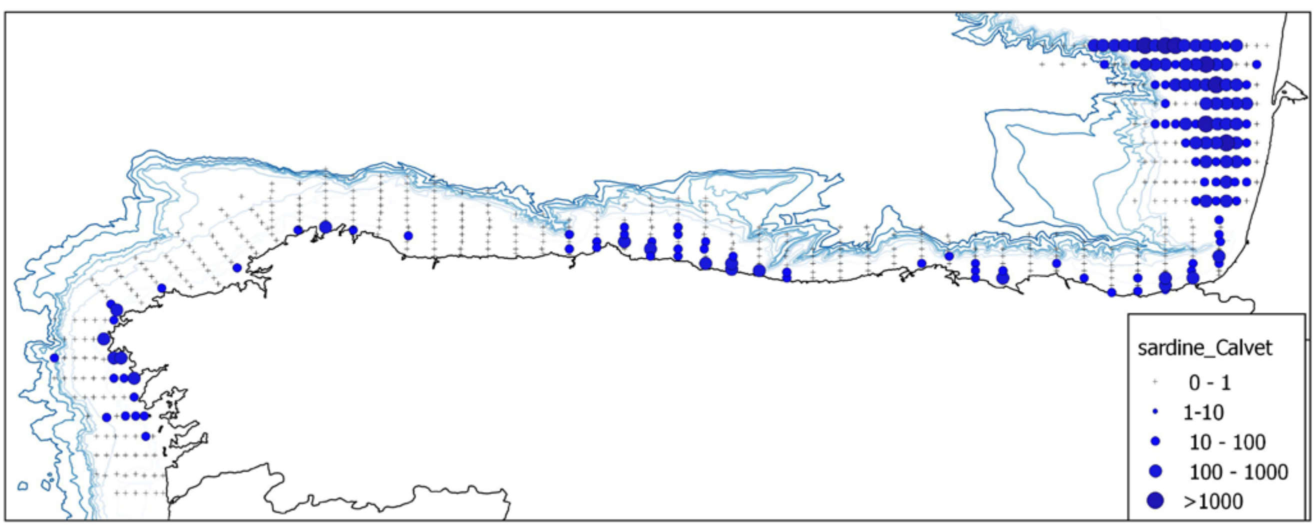


Figure 6. Sardine egg density in CALVET samples from SAREVA0314 survey.

- ***Anchovy (FIGURE 7)***

109 of the 473 stations carried out were positive for anchovy eggs, representing the 23%. The total number of eggs was 1388, with an average density of 74 eggs/m^2 (FIGURE 5). Anchovy eggs were only present in Galicia and in the French coast, where adults of anchovy were also abundant during PELACUS0317 survey (Carrera&Riveiro, 2017, WD to this WG) .

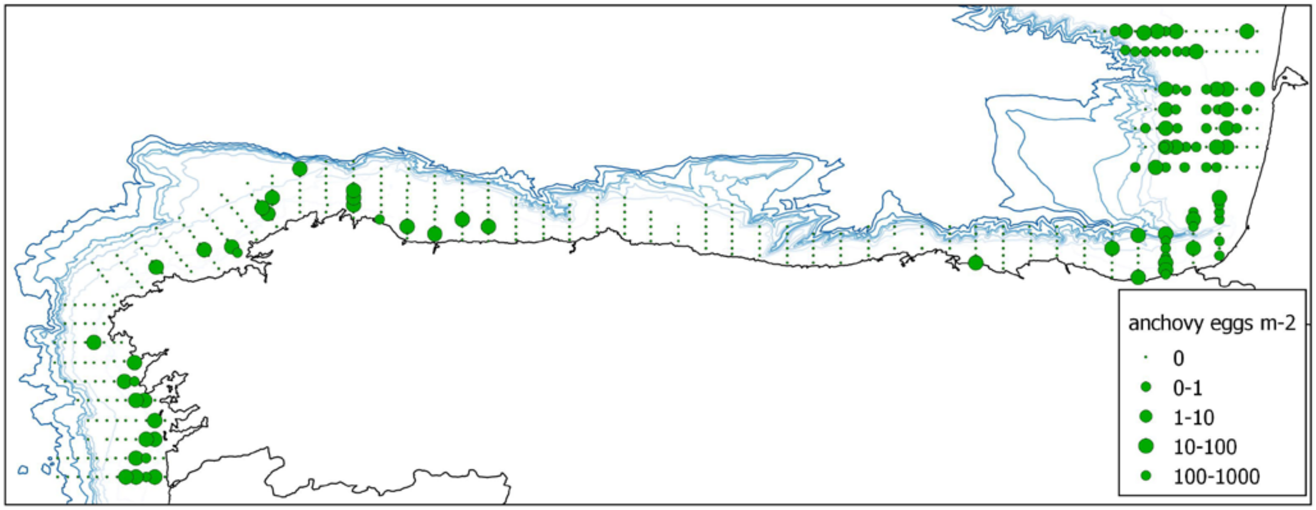


Figure 7. Anchovy egg density in CALVET samples from SAREVA0317survey

- ***Mackerel (FIGURE 8)***

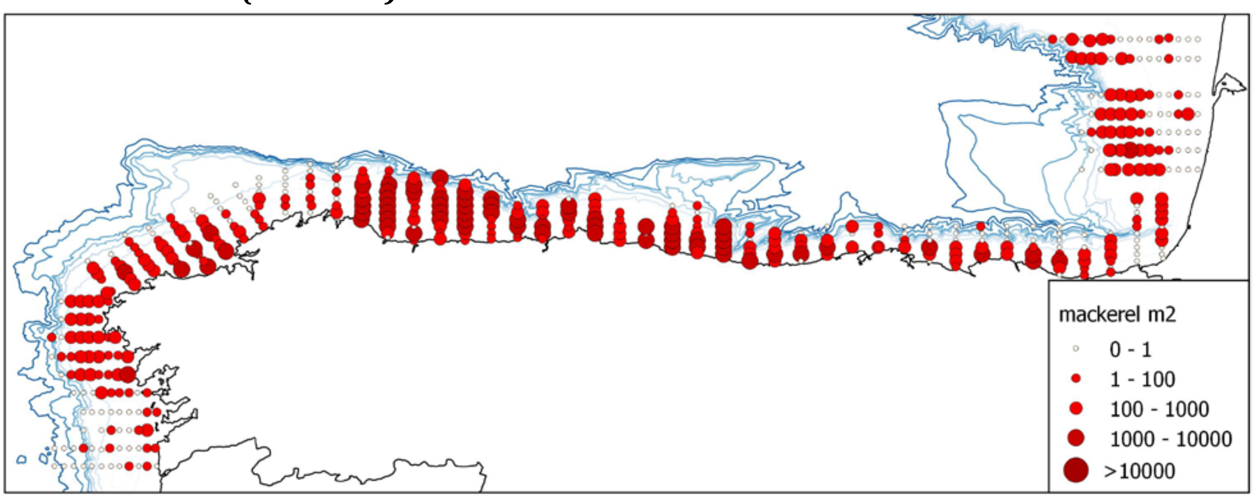


Figure 8. Mackerel egg density in CALVET samples from SAREVA0317survey

Mackerel was the more abundant and widely distributed fish species sampled along the area, with 12160 eggs counted in 310 positive stations (66%), and an average density of 519 egg/m^2

- ***Horse mackerel (FIGURE 9)***

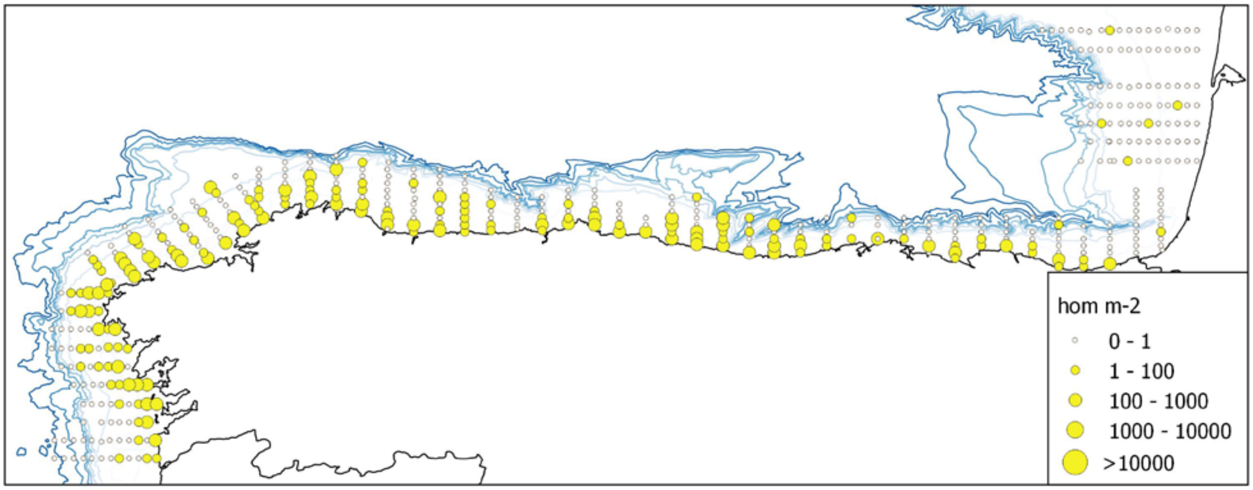


Figure 9. Horse mackerel egg density in CALVET samples from SAREVA0317survey

Horse mackerel egg distribution was restricted to Cantabrian and Galician coast, and almost disappears in the French platform. The total number of egg identified were 1072, with a 36% of positive stations and an average density of 48 egg/m^2.

- ***Others (FIGURE 10)***

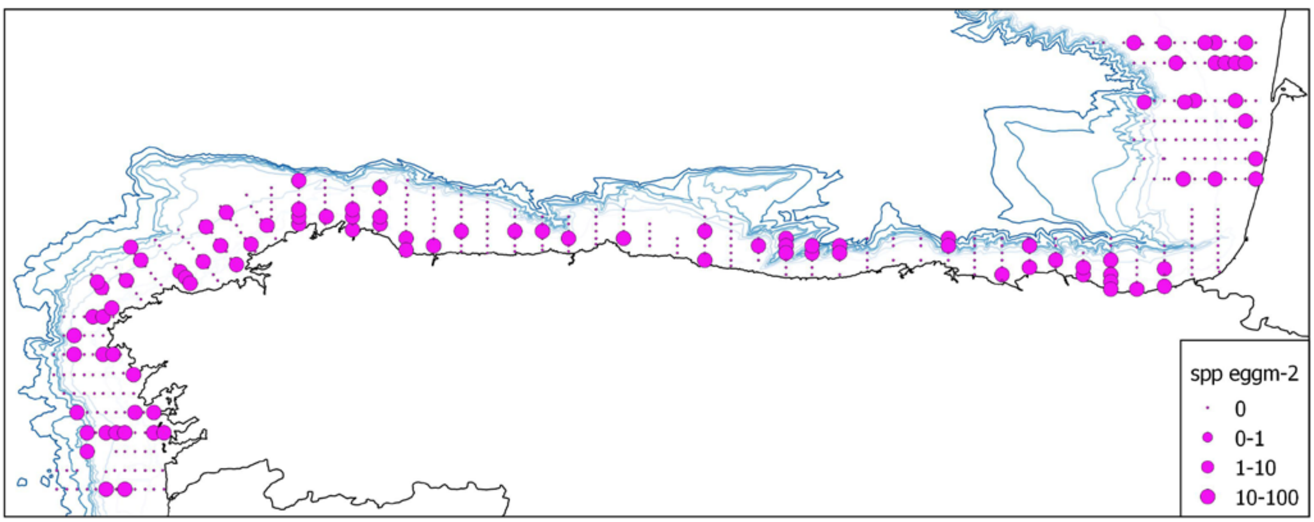


Figure 10. Spp. egg density in CALVET samples from SAREVA0317survey

Many other species share spawning area and spawning season with sardine, some of them were found during SAREVA0317 in 111 stations (23%) and with a total abundance of 456 eggs (average density of 30 eggs/m2).

<u>P0 preliminary estimation</u>

- **Positive area**

Sampled area was 37685 for 9a-8c and 10980 for 8b. Figure 11 shows positive sardine egg area for both strata.

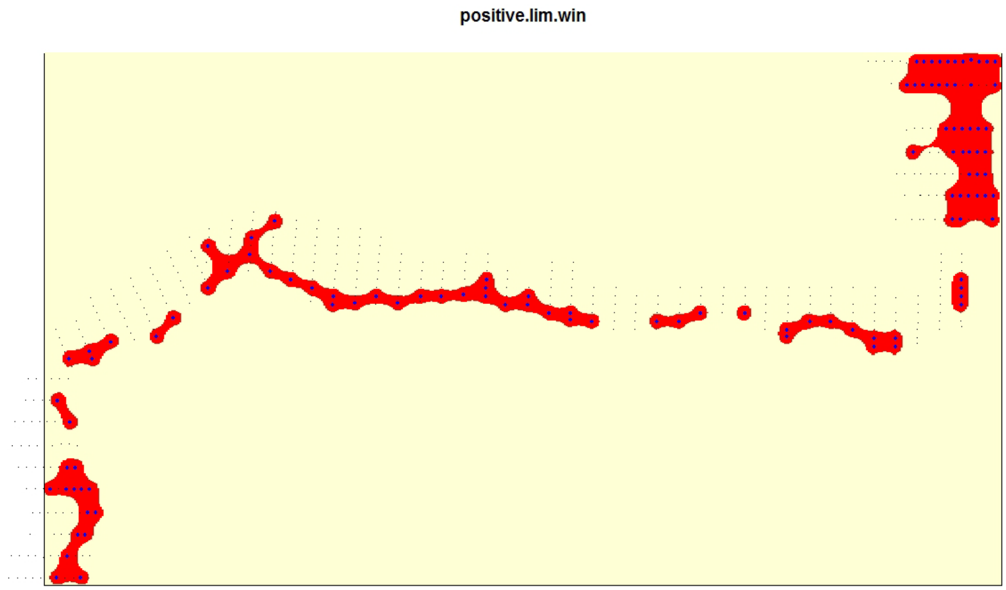


Figure 11. Positive sardine egg area in SAREVA0317 survey.

- ***Temperature by strata***

Figure 12 shows temperature by strata, for 8c-9ac (stratum 3) mean temperature was 13.35ºC and for 8b (stratum 4) 13.68ºC.

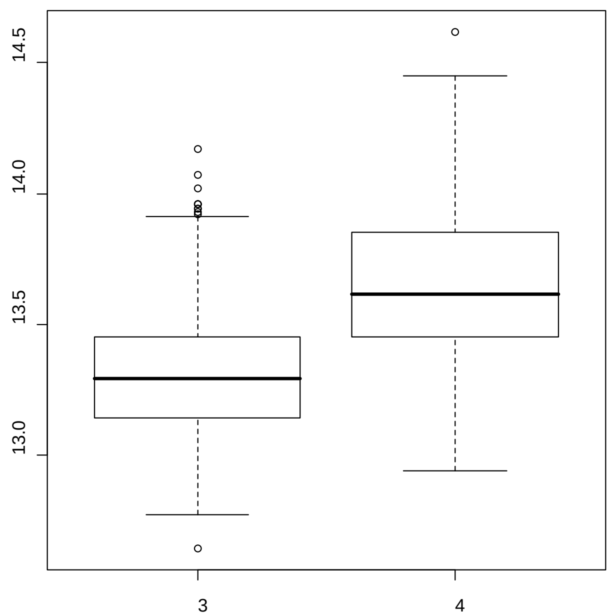


Figure 12. Temperature by strata. 3=subdivision 9aN+8c, 4=subdivision 8b sampled.

- ***Mortality by strata***

We have explored 3 different scenarios of mortality.

1. One area, one mortality

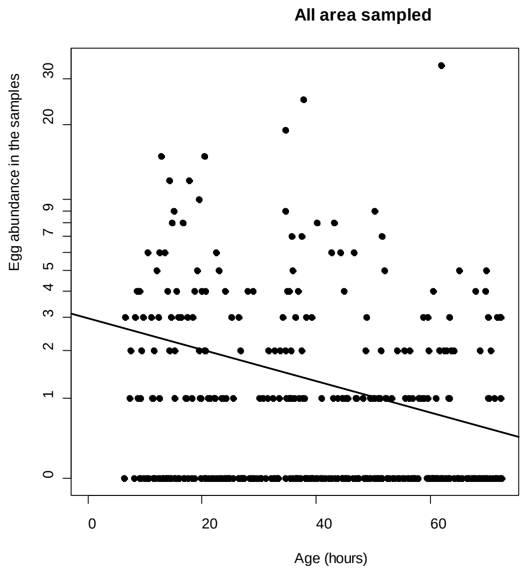


Figure 13. Observations and fit of the model for scenario 1

2. Two areas, two mortalities

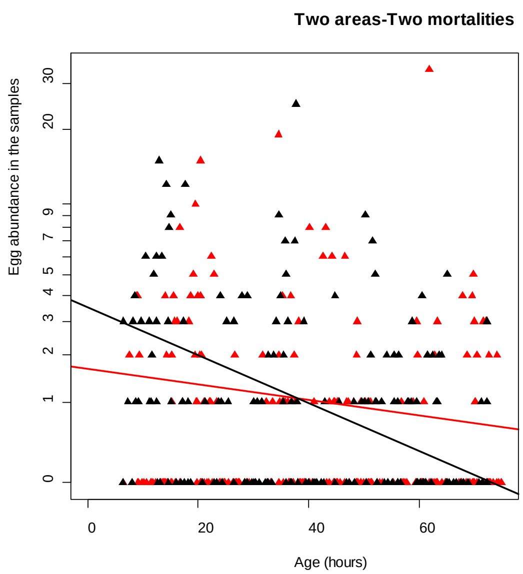


Figure 14. Observations and fit of the model for scenario 2

3. Two areas one mortality (3)

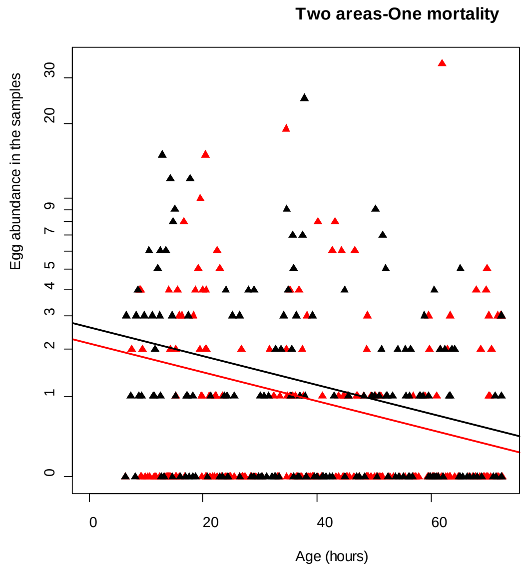


Figure 15. Observations and fit of the model for scenario 3

Table 1. ***Results of the different scenarios for mortality estimation***

Scenario			z	zcv	Pr(>|z|)	p0	cv	p0Tot	area.pos	area.tot
1	Model no strata	All area	-0.014	-35.5	0.0089 **	51.6	20.6	7.2302E+11	14021.43	48665.79
2	Model: 2 strata, 2 z	9a N+8c	-0.007	-94.4	0.28931	33.8	28.3	2.5825E+11	7641.546	37685.41
		8b	-0.021	-33.6	0.00295 **	75.8	29.0	4.8337E+11	6379.887	10980.38
3	Model: 2 strata, 1 z	9a N+8c	-0.012	-38.2	0.0089 **	43.5	22.5	3.3278E+11	7641.546	37685.41
		8b	-0.012	-38.2	0.0089 **	56.3	22.4	3.5932E+11	6379.887	10980.38

Given than the model with two strata and two mortalities doesn't give significant mortality estimates for 8c-9a strata, the scenario of -two strata and one single mortality- was selected for the P0 estimation (Table 1,yellow, 3).
Preliminary 2017 value of total sardine egg production in north strata (8c+9a) 43.5eggs/m2/day, represents an increase by 13% regarding 2014 value, but still at very low levels (Figure 16).

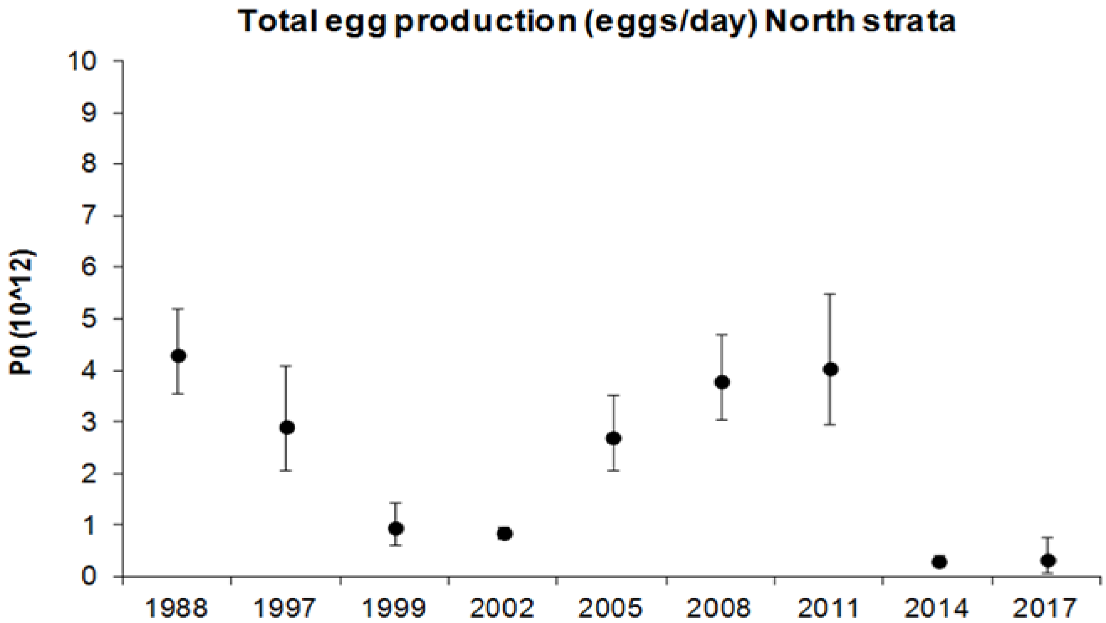


Figure 16. Sardine total egg production (eggs/m2/day) estimates for ICES 9aN+8c during the DEPM series (1988-2017).

References

ICES. 2017. 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.

Carrera P, Riveiro I (2017) Preliminary results of the PELACUS0317 survey: estimates of sardine abundance and biomass in Galicia and Cantabria waters. Working document for the WGHANSA 24-29/06/2017,Bilbao, Spain. 9pp.

Annex 4: Stock Annexes

The table below provides an overview of the WGHANSA Stock Annexes. Stock Annexes for other stocks are available on the ICES website library under the publication type "Stock Annexes". Use the search facility to find a particular Stock Annex, refining your search in the left-hand column to include the *year*, *ecoregion*, *species*, and *acronym* of the relevant ICES expert group.

STOCK ID	STOCK NAME	LAST UPDATED	LINK
ane.27.8	Anchovy (*Engraulis encrasicolus*) in Subarea 8 (Bay of Biscay)	October 2013	Anchovy 8
ane.27.9a	Anchovy (*Engraulis encrasicolus*) in Division 9.a (Atlantic Iberian waters)	June 2011	Anchovy 9a
hom.27.9a	Horse mackerel (*Trachurus trachurus*) in Division 9.a (Atlantic Iberian waters)	February 2017	Southern horse mackerel 9a
jaa.27.10a2	Blue jack mackerel (*Trachurus picturatus*) in Subdivision 10.a.2 (Azores grounds)	June 2015	Blue jack mackerel 10a2
pil.27.78abd	Sardine (*Sardina pilchardus*) in divisions 8.a–b and 8.d and in Subarea 7 (Bay of Biscay, southern Celtic Seas, and the English Channel)	February 2017	Sardine 7 and 8abd
pil.27.8c9a	Sardine (*Sardina pilchardus*) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters)	February 2017	Sardine 8c and 9a

Annex 5: Sardine (*Sardina pilchardus*) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters) assessment October 2017

1. Introduction

In WGHANSA 2017 (24–29 June 2017), a provisional assessment was carried out for the sardine 8c9a stock. This assessment included fishery data updated to 2016 but did not include the 2017 acoustic survey, as indicated in the Stock Annex, because the results of the Portuguese PELAGO17 survey were not available at the time of the meeting. ICES did not provide advice for the stock because the assessment was provisional. A calendar was set for WGHANSA to deliver (a) a WD with the PELAGO17 data (11 September), (b) report on the PELAGO17 results, the assessment of the stock and the draft advice (6 October).

This annex presents the assessment of the stock and the final estimates of the PELAGO17 survey. Preliminary estimates of the survey indicated a historically low biomass in the northern Portuguese coast. To substantiate the results of the survey, the echograms for the OCN area were re-analysed with the use of data on the distribution and abundance of eggs collected along the survey. An additional acoustic survey covering the OCN zone (PEL17AGO) was carried out in August 2017 by IPMA to further validate PELAGO17 estimates. The results of the PELAGO17 and PEL17AGO as well as updated results on the egg distribution from the Portuguese DEPM17 survey are summarised in this annex; detailed results are presented in WD Marques *et al*. (2017) appended to this annex.

2. Data on egg distribution from the Portuguese DEPM17 and PELAGO17 surveys

The 2017 IPMA, DEPM survey (PT-DEPM17-PIL), took place during approximately 30 effective working days, during the period from 11 March to 26 May and much later than scheduled due to logistics constraints and adverse weather conditions (Marques *et al*. WD2017). In fact, the survey covered the southern stratum (Algarve-Cadiz Bay) during mid March (11–19 March) but the western shores were only surveyed in April–May (24 April–26 May) and, once again, as it had happened in 2014, concurrently to the acoustics survey, which was also delayed, and covered the period 24 April–2 June. In 2017, the plankton sampling for DEPM was reduced, during the period of the joint sampling for acoustics and DEPM, to avoid further delay in the PELAGO survey, consequently the CalVET results available for spawning area definition and egg production estimation are limited.

Given that the survey was much delayed, the laboratorial work for egg processing is still underway and, the data available at present include the egg abundances obtained from the CUFES samples associated to the acoustics transects in the NW region (OCN) and egg abundances and staging for sardine from the CalVET paired samples.

A total of 350 CalVET samples were collected along 50 of the regular 59 transects of the sardine DEPM survey grid. The gaps in the sampling grid, in particular from Cabo Mondego to Cabo Carvoeiro and in the SW shore, limit an accurate definition of the spawning area.

The egg abundance distributions for sardine available at present are depicted in Figures 2.1 and 2.2. Sardine egg abundance in the western stratum was lower than in the other years of the historic series with the exception of 2011. Despite the low egg densities, the percentage of positive stations (38%) was not among the lowest indicating a scattered egg distribution, which is noticeable in the map of Figure 3.3. It can be observed that for many CalVET samples the number of eggs collected was quite low (resulting possibly from low and spread fish and egg abundances and egg dispersal). Nonetheless, a small area of higher abundances was observed to the north of Douro (also observed in the densities from the CUFES samples) and some patches were also detected in the southern coast, in Cadiz Bay and Algarve. The low egg abundances during this year´s survey on the west coast may be attributable to low sardine abundance and/or low reproductive activity during the survey period which was conducted late in the usual spawning season. In the southern stratum, sampled for DEPM in mid-March, the egg densities and spawning area size (46% of positive stations) were within the range observed for other years of the DEPM historic series and slightly higher than during the last DEPM survey, in 2014. Final egg production estimates will only be available when the spawning area definition can be completed using the CUFES results and the calculations attained using the three strata information (south, west and north) and the methodology considering the mortality estimation using the external model which considers the values for the whole dataseries and the water temperature as covariate. The final estimates will be presented at the 2017 WGACEGG meeting in November.

3. Portuguese spring acoustic survey

In 2017, the Portuguese survey (PELAGOS17) was delayed by about one month to enable the installation of transducers and upgrade of the echosounder. The survey ended up only 15 days before WGHANSA in June. Despite all efforts to speed up the data logging and the acoustic data processing, preliminary estimations of sardine and anchovy biomass were only achieved during the WG meeting and only for three of the four surveyed areas, because difficulties were encountered in the biomass estimation in the Occidental North area (OCN).

The PELAGO 2017 survey was carried out on board RV Noruega from 24th April to 7th June. Figure 3.1 shows the acoustic transect along the surveyed area. Some schools were assigned directly to sardine, due to morphologic and density characteristics of the schools, typical for adult sardine in this region. Additionally, an important school, in the north (transect 3) was also attributed to sardine, due to a great amounted of sardine eggs (CUFES), in the vicinity (Figure 2.2) which may have drifted from the school location.

The distribution of sardine acoustic energy presented a patchy pattern (Figure 3.1). In particular, sardine energy in the Occidental North (OCN) area was very scarce, restricted to only a few transects. Main sardine acoustic energy was located between Peniche and Lisboa, South of Sines, and in the Western part of the Algarve.

The biomass of sardine age 1 and older, 80 thousand tonnes for the whole area (Table 3.1) is a significant reduction in relation to the 2016 PELAGO survey (172 thousand tonnes). This biomass reduction is mainly due to a strong reduction in the Occidental zones, 11.9 thousand tonnes comparing with 30 thousand tonnes in 2016 survey (Figures 3.2 and 3.3). The present biomass for this zone is similar to the one obtained on the PELAGO13 survey (9 thousand tonnes). In the total area, the biomass estimate compares with the total biomass estimated for the PELAGO15 survey (78 thousand tonnes).

Small sardines (<16 cm) were almost only observed in the Cadiz Spanish waters and in Algarve areas, and thus almost completely absent from the West coast (Table 3.1). In the Occidental North (OCN) and Cadiz (CAD) areas, as observed in the latest surveys, most sardines were young, aged up to 2–3 years old, with a modal age of 2 and 1, respectively. In the Occidental South (OCS) and Algarve areas, sardine presented a wider age distribution (up to age group 8), modal age being of one and two years old, respectively.

The additional acoustic survey, PEL17AGO, was carried out on board RV "Noruega" from 21th to 31th August 2017 (sampling between 22 and 30 August)(Marques *et al.* WD2017). The survey covered the Portuguese shelf from Caminha to Nazaré, which corresponds to the Occidental Central North zone (OCN). The acoustic transects were similar to those performed in the PELAGO17 survey (17 for the OCN zone) and the same methodology was followed. 23 fishing hauls were undertaken, of which twelve pelagic and eleven bottom trawls.

Only three fishing trawls caught a significant number of sardines (more than 30 individuals), and low numbers occurred in seven other hauls. Besides the pelagic crab *Polybius henslowi*, samples were dominated, either by horse mackerel or chub mackerel, in the more coastal hauls, and blue whiting in the off-shore hauls. The frequency of anchovy was low.

Sardine acoustic energy showed a very localized distribution in the vicinity of Ria de Aveiro, and some acoustic energy south of Figueira da Foz (Figure 3.4). The distribution of sardine shoals in the northern limit of Ria de Aveiro shows a geographical consistency when compared to PELAGO17. The size distribution in August shows the presence of recruits (14–16 cm) not detected in late April–early May during the PELAGO17. The sizes within the second mode (16.5–20.5 cm) are consistent with the length distribution observed in the PELAGO17 plus the expected growth.

The sardine abundance estimated at the OCN zone during the PEL17AGO was 162 935 thousand individuals, corresponding to a biomass of 9642 tonnes. These new estimates are of the same order of magnitude as the PELAGO17 estimate for the same area (232 547 thousand and 11 878 tonnes), and confirm the strong biomass reduction in the Occidental North zone in 2017 compared with 2016.

4. Stock assessment

The assessment follows the Stock Annex (ICES, 2017).

The table below presents an overview of the input data and model settings (see also Figures 4.1 and 4.2). Additional details can be found in the Stock Annex. The mean weights-at-age in the stock and the maturity-at-age for 2017, used to estimate the biomass in 2017, were assumed to be the average of the last six years of the assessment period (2011–2016) (Tables 4.1a,b). These are the assumptions of the short-term forecast (Section 5).

Input data:	WGHANSA 2017
Catch	Catch biomass 1978–2016 (tons)
	Catch-at-age 1978–2016 (thousands of individuals)
Acoustic survey (Joint SP+PT)	Total numbers 1996–2017 (thousands of individuals)
	Numbers-at-age 1996–2017 (thousands of individuals)
DEPM survey (Joint SP+PT)	SSB 1997, 1999, 2002, 2005, 2008, 2011, 2014 (tons)
Weight-at-age in the catch	Yearly averages 1978–2016 (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, 2015–2016); weight-at-age in 2017 assumed to be equal to the mean of the last six years, 2011–2016; Kg
Maturity-at-age	From DEPM surveys in DEPM years, linear interpolation for years in-between (constant 1978–1998, 2015–2017); maturity-at-age in 2017 assumed to be equal to the mean of the last six years, 2011–2016; proportions

Model structure and assumptions:	WGHANSA 2017
M	0.98, 0.61, 0.47, 0.40, 0.36, 0.35, 0.32
Recruitment	Beverton–Holt stock–recruitment model, sigma= 0.70, input steepness = 0.71.
Initial population	N-at-age in the first year derived from an initial equilibrium catch of 135 000 tons assumed to take place in 1972.
Fishery selectivity-at-age	Estimated, flat from age 3 to age 5.
Fishery selectivity over time	Three periods: 1978–1987, 1988–2005 and 2006–2016, estimated for each period, fixed over time within each period.
Survey selectivity-at-age	Estimated, flat all ages.
Fishery catchability	Scaling factor, median unbiased
Acoustic survey catchability	Parameter, mean unbiased
DEPM catchability	Parameter, mean unbiased

Log-likelihood function:	WGHANSA 2017
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.

Table 4.2 shows the parameters estimated by the assessment model. The parameter estimates and the fit of the model are similar to those of the benchmark assessment model (ICES, 2017). Fishing mortality-at-age and numbers-at-age are presented in Tables 4.3 and 4.4. The parameters estimated in the 2017 assessment are also comparable to those from the 2016 assessment, apart from virgin recruitment (R0= 15 072 765, CV=3%) and the initial F (0.73 year-1, CV= 12.0%) which are 41.0% and 29.0% higher, respectively. The catchability parameters are closer to 1 in the 2017 assessment than in the 2016 assessment, for both the acoustic (Q=1.35, CV=8.2%) and the DEPM (Q=1.15, CV=11.2%) surveys. The coefficients of variation of parameters indicate that the initial F is estimated with higher precision in the present assessment than in the 2016 assessment model. The correlations between the assessment parameters range from -0.98 to 0.76 although the majority are very close to zero. Negative correlations below -0.5 are observed between R0 and Q_acoustic survey and between selectivity parameters from the first period (five cases).

The assumed CVs for both surveys, all years=0.25, are consistent with the residual mean square error estimated by the model for the acoustic index (0.23) and below that for the DEPM index (0.32). The harmonic mean of the fishery age composition sample size, 72.5, suggests that the data are slightly more precise than assumed (mean initial sample size=66.9 for the whole period). In the case of the 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 20.9).

Figures 4.3 and 4.4 show the fit of the model to the acoustic survey and DEPM indices of abundance. Compared to the 2016 assessment model, the present model shows an overall better fit to both survey indices, especially in the case of the DEPM. On the other hand, the present model fits poorly to the highest acoustic observations in 2002 and 2005. The last acoustic estimate, 2017, has some influence on the assessment in recent years, and lead to a downward scaling of the biomass and upward scaling of fishing mortality compared to the WGHANSA 2016 assessment.

Figure 4.5 shows the model residuals from the fit to the catch-at-age composition (a) and the acoustic survey age composition (b). In both cases, the residuals from the present assessment are lower than those from the 2016 assessment model, suggesting the current assumptions about survey and catch selectivity are more consistent with the age composition data. In particular, catch-at-age residuals show a more random distribution in recent years. The acoustic survey residuals show some clustering with positive residuals in the 1990s at ages 2–5 and negative residuals thereafter.

Recruitment deviations shifted from positive in the 1980s to negative in the second half of the 2000s. Deviations have similar magnitude since 2006.

The fishery selectivity patterns estimated in the present assessment show less abrupt changes over time and through ages (particularly at the 6+ group) and therefore seem to be more realistic than the patterns estimated in the 2016 assessment model (Figure 4.6). The patterns over age are dome-shaped in the three periods with the early (1978–1987) and recent periods (2006–2016) 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 2017 assessment results is shown in Table 4.5 and Figure 4.7(in the figure compared also with the 2016 WGHANSA assessment and with the benchmark 2017 assessment). The estimate of B1+ in 2017 assumes that the stock weights-at-age and maturity-at-age in 2017 are equal to mean values of the last six years of the assessment, 2011–2016. This is the same assumption taken in the short-term forecast. The model estimates standard errors of SSB, recruitment and ApicalF (maximum F over age within years). We assume the CVs of SSB and ApicalF apply to B1+ and F(2–5), respectively.

B1+ in 2016 = 136 611 t (CV = 16%) is 76% below the historical mean 1978–2015 and 60% below the B_{lim}=337448 t. B1+ shows an increase of 22% from 2015 to 2016. Nevertheless, it is still around the historical low as observed in the previous five years. F in 2016 is estimated to be 0.20 year-1 (CV = 18%), 37% below the historical mean. F decreased 68% from 2011 to 2015 and increased 8% from 2015 to 2016.

B1+ in 2017 is predicted to be 146 831 t, assuming that the stock weights and maturity-at-age are the mean values of 2011–2016.

The series of historical recruitments 1978–2016 shows a marked downward trend until 2006 and since then, fluctuates around historically low values (geometric mean 2012–2016 = 4 391 480 thousand individuals). The R2016 estimate, 5 097 110 thousand individuals (CV = 23%) is supported by the 2017 acoustic survey index.

5. Reliability of the assessment

This year, a provisional assessment was presented at the 2017 WGHANSA. The reason that it was provisional is that it did not include the 2017 spring acoustic survey. The spring acoustic index is a joint index from the Spanish and Portuguese PELACUS and PELAGO survey and can therefore only be used when data are available from both surveys. Due to technical issues related to the assignment of the acoustic energy to species in the PELAGO 2017 survey (Section 8.3.2) data from this survey were not available to the working group in June. These issues affected only the estimates for the northern Portuguese area (Occidental North-OCN). IPMA carried out a revision of the acoustic estimates in this area taking into account the egg distribution/abundance observed concurrently (Marques *et al*. WD2017). The revised estimates were corroborated by the results of an acoustic survey carried out by IPMA in the OCN area in August 2017.

DEPM surveys carried out in 2017 were not included in the assessment, as they will not be available until the end of this year.

The current assessment is comparable to the benchmark assessment. It revised the biomass downwards and fishing mortality upwards in the period since 1990, in comparison with last years' assessment. These scaling effects result from the revision of data and assumptions carried out in the benchmark, in particular, the options regarding the fishery selectivity-at-age. The 2017 acoustic survey provided a perception of lower abundance in comparison with the 2016 survey. Scaling effects have an impact back in time. The upward scaling of recruitment in the current assessment in comparison with last years' assessment results from the increase of the assumed natural mortality.

The model used in the current assessment, as the one used in the benchmark assessment, shows a better fit to the data available and provides more precise estimates of biomass, recruitment and fishing mortality in comparison with last years' assessment. The assumptions of survey selectivity and fishery selectivity in the current model are parsimonious. Finally, the retrospective plots of B1+ and fishing mortality indicate that the model is robust (Figure 5.1).

The current low abundance and patchy spatial distribution of sardine is likely to decrease the accuracy and precision of acoustic estimates in comparison with past periods of higher abundance.

6. Short-term predictions (divisions 8.c and 9.a)

Catch predictions were carried out following the Stock Annex, apart from the assumption of fishing mortality in the interim year.

In the Stock Annex fishing mortality in the interim year is the fishing mortality corresponding to a catch constraint based on regulations operative in the interim year fishery. According to that assumption F2017 =0.096 , corresponding to a catch limit of 17 000 tonnes, based on the Spanish and Portuguese regulations for the sardine fishery in 2017 (Spanish: Boletín Oficial del estado, nº 174, 22/07/2017, sec. III, pág. 64914; Boletín Oficial del estado, nº 207, 21/08/2017, sec. III, pág. 85955, Portuguese: Despacho n.º 1847-A/2017, Diário da República, 2.ª série — N.º 44 — 2 de março de 2017; Despacho n.º 6649-A/2017, Diário da República, 2.ª série — N.º 147 — 1 de agosto de 2017).

Fishing mortality assumed in the interim year was F = 0.130, corresponding to the ICES catch advice for 2017, 23 000 tonnes. The WG considers 23 000 tonnes to be the more realistic prediction of 2017 catches which can be made at this time. The basis for this assumption is the following; catch data available to the WG in 2/10/2017 were 16 870 tonnes, corresponding to Spanish catches of 3458 tonnes in the first semester (communicated to the WG by the Spanish Secretaria de Pescas) and Portuguese catches of 13 412 tonnes from January to September 2017 (communicated to the WG by the Portuguese Direção Geral dos Recursos Marinhos); Spanish catches are usually higher in the second semester than in the first semester. The Portuguese catches until the end of September are higher than the quota agreed between the two countries, 11 560 t, according to the regulations above.

For 2018, predictions were carried out with an $F_{multiplier}$ assuming an F_{sq} = 0.23, the average estimate of the last three years in the assessment (i.e. F mean 2014–2016), as indicated in the Stock Annex.

Tables 6.1 shows input data of the short-term forecast.

Table 6.2 shows the results of the short-term forecast. The complete set of results for fine steps of $F_{multiplier}$ scenarios is stored in file pil8c9a_STF2017_scenarios.xls on the WGHANSA SharePoint site.

7. Management considerations

The benchmark assessment and reference points for the stock lead to a more pessimistic perception of the state of the stock than that provided by previous assessments.

The harvest control rule (HCR) included in the management plan for the stock was considered to be non-precautionary because it would result in a zero probability of rebuilding the spawning biomass above B_{lim} from the current low biomass level in the short term. In the long term, the probability that the stock exceeds B_{lim} would be about 50%. However, this HCR would prevent further stock decline at the recent level of productivity.

No other management plan is known to ICES.

The recruitment of the stock has been around the lowest historical level for approximately a decade. The biomass of the stock is also around the lowest historical level and below the limit biomass (B_{lim}) since 2009. In 2012–2017 the biomass estimates were 48–67% below B_{lim}. The current stock productivity seems to be insufficient to support a sustainable fishery.

The spatial distribution of the productivity of the stock appears to have changed; the southern area seems to be currently less depleted than the north and northwestern areas that include the main recruitment area of the stock.

Measures to protect spawners and recruits should be maintained and possibly reinforced.

A recovery plan could be considered. Some variants of the HCR of the old management plan for the stock could be considered. The exploratory analyses carried out at WKEMPIS 2017 suggested that options such as a decrease of the catch target and an increase of $B_{trigger}$ (or a combination of both) could be explored to develop an alternative harvest rule to cope with the present poor state of the stock and low productivity regime.

8. References

Marques V, Angélico MM, Nunes C, Moreno A, Silva AV, Henriques E, Seoane EG, Soares E, Pastor J, Oliveira P, Amorim P, Silva A. 2017. IPMA Pelagic Surveys in the Atlantic Iberian Waters of ICES area 9a (River Minho - Cabo Trafalgar): PELAGO17 acoustic estimations for sardine and anchovy and PT-DEPM17-PIL summary. Working Document presented to WGHANSA (by correspondence), 12 September 2017.

Table 3.1. Sardine in 8.c and 9.a: Sardine assessment from 2017 Portuguese spring acoustic survey (PELAGO17). Number in thousand fish and biomass in tonnes.

AREA		1	2	3	4	5	6	7	8	9	10	TOTAL
9aCN	Biomass	2356	8393	1129								11878
	%	19.8	70.7	9.5								100
	No fish	55211	159043	18294								232547
	%	23.7	68.4	7.9								100
9aCS	Biomass	10403	8460	3897	2323	1184	1793	954	1220			30233
	%	34.4	28.0	12.9	7.7	3.9	5.9	3.2	4.0			100
	No fish	263717	176745	66685	31293	15853	24532	11265	14522			604613
	%	43.6	29.2	11.0	5.2	2.6	4.1	1.9	2.4			100
9aS	Biomass	5908	12509	2965	3654	4904	1985	1051	1064			34039
Algarve	%	17.4	36.8	8.7	10.7	14.4	5.8	3.1	3.1			100
	No fish	206235	356014	54138	61465	79488	29294	16209	12064			814907
	%	25.3	43.7	6.6	7.5	9.8	3.6	2.0	1.5			100
9aS	Biomass	3194	510									3704
Cadiz	%	86.2	13.8									100
	No fish	192627	18620									211247
	%	86.2	13.8									100
Portugal	Biomass	18667	29362	7991	5977	6087	3777	2005	2283			76150
	%	24.5	38.6	10.5	7.8	8.0	5.0	2.6	3.0			100
	No fish	525162	691802	139117	92758	95341	53827	27474	26586			1652067
	%	24.5	38.6	10.5	7.8	8.0	5.0	2.6	3.0			100
TOTAL	Biomass	21861	29873	7991	5977	6087	3777	2005	2283			79854
	%	27.4	37.4	10.0	7.5	7.6	4.7	2.5	2.9			100
	No fish	717789	710421	139117	92758	95341	53827	27474	26586			1863314
	%	38.5	38.1	7.5	5.0	5.1	2.9	1.5	1.4			100

Table 4.1a. Sardine in 8.c and 9.a: Mean weights-at-age (Kg) in the stock. Weights-at-age in 1978–1998 are fixed, equal to those in 1998. Weights-at-age in 2015–2016 are assumed to be equal to weigths-at-age in 2014, the last DEPM survey; weight-at-age in 2017 assumed to be equal to the mean of the last six years of the assessment, 2011–2016 (see Stock Annex).

Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6+
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
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	0.032	0.049	0.065	0.066	0.077	0.081
2016	0	0.032	0.049	0.065	0.066	0.077	0.081
2017	0	0.030	0.049	0.063	0.067	0.073	0.077

Table 4.1b. Sardine in 8.c and 9.a: Maturity ogive. Proportion-at-age mature in 1978–1997 are fixed, equal to those in 1998. Proportion-at-age mature in 2015–2016 are assumed to be equal to proportion-at-age mature in 2014, the last DEPM survey; proportion-at-age mature in 2017 assumed to be equal to the mean of the last six years of the assessment, 2011–2016 (see Stock Annex).

Year	age0	age1	age2	age3	age4	age5	age6+
1998	0	0.85	0.98	1	1	1	1
1999	0	0.93	0.98	1	1	1	1
2000	0	0.85	0.98	1	1	1	1
2001	0	0.75	0.97	1	1	1	1
2002	0	0.64	0.97	1	1	1	1
2003	0	0.62	0.98	1	1	1	1
2004	0	0.6	0.98	1	1	1	1
2005	0	0.58	0.98	1	1	1	1
2006	0	0.67	0.96	1	1	1	1
2007	0	0.79	0.98	1	1	1	1
2008	0	0.91	0.98	1	1	1	1
2009	0	0.93	0.98	1	1	1	1
2010	0	0.96	1	1	1	1	1
2011	0	0.96	1	1	1	1	1
2012	0	0.96	1	1	1	1	1
2013	0	0.97	1	1	1	1	1
2014	0	1	1	1	1	1	1
2015	0	1	1	1	1	1	1
2016	0	1	1	1	1	1	1
2017	0	0.97	1	1	1	1	1

Table 4.2. Sardine in 8.c and 9.a: Parameters and asymptotic standard deviations estimated in the 2017 assessment.

Label	Value	Parm_StDev	Phase	Min	Max	Init
SR_LN(R0)	16.528	0.030	1	1	20	16
Early_InitAge_4	0.510	0.585				
Early_InitAge_3	0.503	0.463				
Early_InitAge_2	0.492	0.282				
Early_InitAge_1	0.770	0.188				
Main_RecrDev_1978	0.912	0.158				
Main_RecrDev_1979	1.034	0.154				
Main_RecrDev_1980	1.145	0.144				
Main_RecrDev_1981	0.649	0.170				
Main_RecrDev_1982	0.030	0.231				
Main_RecrDev_1983	1.539	0.108				
Main_RecrDev_1984	0.298	0.182				
Main_RecrDev_1985	0.171	0.176				
Main_RecrDev_1986	0.025	0.187				
Main_RecrDev_1987	0.824	0.123				
Main_RecrDev_1988	0.206	0.157				
Main_RecrDev_1989	0.169	0.155				
Main_RecrDev_1990	0.227	0.152				
Main_RecrDev_1991	1.312	0.086				
Main_RecrDev_1992	0.879	0.098				
Main_RecrDev_1993	0.042	0.140				
Main_RecrDev_1994	-0.087	0.133				
Main_RecrDev_1995	-0.316	0.135				
Main_RecrDev_1996	0.066	0.108				
Main_RecrDev_1997	-0.314	0.130				
Main_RecrDev_1998	-0.041	0.115				
Main_RecrDev_1999	-0.298	0.135				
Main_RecrDev_2000	0.864	0.086				
Main_RecrDev_2001	0.335	0.108				
Main_RecrDev_2002	-0.247	0.141				
Main_RecrDev_2003	-0.487	0.166				
Main_RecrDev_2004	0.977	0.075				
Main_RecrDev_2005	-0.092	0.112				
Main_RecrDev_2006	-1.274	0.175				
Main_RecrDev_2007	-0.932	0.136				
Main_RecrDev_2008	-0.648	0.114				
Main_RecrDev_2009	-0.465	0.098				
Main_RecrDev_2010	-0.993	0.120				
Main_RecrDev_2011	-1.111	0.128				
Main_RecrDev_2012	-0.945	0.115				
Main_RecrDev_2013	-0.819	0.117				
Main_RecrDev_2014	-1.187	0.147				
Main_RecrDev_2015	-0.674	0.150				
Main_RecrDev_2016	-0.773	0.197				
InitF_1purse_seine	0.732	0.123	1	-1	2	0.3
Q_base_2_Acoustic_survey	0.301	0.082	1	-3	3	0
Q_base_3_DEPM_survey	0.135	0.112	1	-3	3	0
AgeSel_1P_2_purse_seine	1.654	0.152	2	-3	3	0.9
AgeSel_1P_3_purse_seine	0.766	0.136	2	-4	4	0.4
AgeSel_1P_4_purse_seine	-0.174	0.167	2	-4	4	0.1
AgeSel_1P_7_purse_seine	-0.206	0.513	2	-4	4	-0.5
AgeSel_1P_2_purse_seine_BLK1delta_1988	-0.349	0.183	2	-4	4	0.9
AgeSel_1P_2_purse_seine_BLK1delta_2006	-0.202	0.151	2	-4	4	0.9
AgeSel_1P_3_purse_seine_BLK1delta_1988	-0.031	0.167	2	-4	4	0.4
AgeSel_1P_3_purse_seine_BLK1delta_2006	-0.246	0.151	2	-4	4	0.4
AgeSel_1P_4_purse_seine_BLK1delta_1988	0.815	0.190	2	-4	4	0.1
AgeSel_1P_4_purse_seine_BLK1delta_2006	-0.494	0.152	2	-4	4	0.1
AgeSel_1P_7_purse_seine_BLK1delta_1988	-0.516	0.524	2	-4	4	-0.5
AgeSel_1P_7_purse_seine_BLK1delta_2006	0.522	0.394	2	-4	4	-0.5

Table 4.3. Sardine in 8.c and 9.a: Fishing mortality-at-age estimated in the assessment. RefF is equal to F(2–5) is the reference fishing mortality, corresponding to the average F of ages 2 to 5 years.

Year	age0	age1	age2	age3	age4	age5	age6	refF
1978	0.036	0.187	0.402	0.338	0.338	0.338	0.275	0.354
1979	0.028	0.149	0.32	0.269	0.269	0.269	0.219	0.282
1980	0.028	0.147	0.316	0.266	0.266	0.266	0.216	0.278
1981	0.027	0.141	0.303	0.255	0.255	0.255	0.208	0.267
1982	0.026	0.137	0.294	0.247	0.247	0.247	0.201	0.259
1983	0.026	0.135	0.291	0.245	0.245	0.245	0.199	0.256
1984	0.025	0.133	0.287	0.241	0.241	0.241	0.196	0.252
1985	0.023	0.122	0.261	0.22	0.22	0.22	0.179	0.23
1986	0.029	0.15	0.322	0.27	0.27	0.27	0.22	0.283
1987	0.033	0.172	0.371	0.312	0.312	0.312	0.254	0.326
1988	0.031	0.115	0.24	0.455	0.455	0.455	0.221	0.401
1989	0.03	0.11	0.229	0.435	0.435	0.435	0.212	0.384
1990	0.033	0.12	0.25	0.475	0.475	0.475	0.23	0.418
1991	0.03	0.111	0.231	0.438	0.438	0.438	0.213	0.386
1992	0.022	0.082	0.171	0.324	0.324	0.324	0.157	0.286
1993	0.021	0.079	0.165	0.313	0.313	0.313	0.152	0.276
1994	0.018	0.067	0.139	0.264	0.264	0.264	0.128	0.233
1995	0.018	0.067	0.139	0.264	0.264	0.264	0.128	0.233
1996	0.024	0.09	0.188	0.356	0.356	0.356	0.173	0.314
1997	0.033	0.12	0.251	0.476	0.476	0.476	0.231	0.419
1998	0.036	0.134	0.28	0.532	0.532	0.532	0.259	0.469
1999	0.033	0.122	0.255	0.484	0.484	0.484	0.235	0.427
2000	0.029	0.109	0.226	0.43	0.43	0.43	0.209	0.379
2001	0.028	0.103	0.215	0.407	0.407	0.407	0.198	0.359
2002	0.023	0.086	0.179	0.34	0.34	0.34	0.165	0.3
2003	0.021	0.077	0.16	0.303	0.303	0.303	0.147	0.267
2004	0.023	0.084	0.176	0.334	0.334	0.334	0.162	0.294
2005	0.023	0.084	0.175	0.331	0.331	0.331	0.161	0.292
2006	0.033	0.098	0.16	0.185	0.185	0.185	0.151	0.179
2007	0.038	0.115	0.187	0.217	0.217	0.217	0.177	0.209
2008	0.06	0.18	0.293	0.34	0.34	0.34	0.278	0.328
2009	0.068	0.206	0.336	0.39	0.39	0.39	0.319	0.376
2010	0.087	0.263	0.429	0.497	0.497	0.497	0.407	0.48
2011	0.106	0.32	0.522	0.605	0.605	0.605	0.496	0.585
2012	0.085	0.255	0.416	0.482	0.482	0.482	0.394	0.465
2013	0.082	0.246	0.402	0.466	0.466	0.466	0.381	0.45
2014	0.054	0.163	0.265	0.307	0.307	0.307	0.252	0.297
2015	0.034	0.104	0.169	0.196	0.196	0.196	0.16	0.189
2016	0.037	0.112	0.183	0.212	0.212	0.212	0.173	0.204

Table 4.4. Sardine in 8.c and 9.a: Numbers-at-age, in thousands at the beginning of the year, estimated in the assessment. Estimates of survivors in 2017 are also shown. Age 0 in 2017 is the estimated recruitment using the SR model fitted within the assessment.

Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6+
1978	36397500	11445000	3351880	1018340	371378	84140	57242
1979	42401000	13180500	5157800	1401100	486831	184788	73857
1980	48364900	15466900	6170860	2340300	717612	259520	142581
1981	29882200	17648700	7254890	2811250	1202710	383840	223611
1982	16027500	10916600	8327500	3347510	1460300	650240	341555
1983	71216200	5859960	5172940	3877770	1752280	795602	560633
1984	21183900	26044800	2780640	2415970	2034920	957064	772478
1985	18525200	7750470	12385300	1304710	1272770	1115770	991119
1986	15748900	6793050	3729420	5960800	702163	712927	1233200
1987	34315800	5744000	3177990	1689440	3048830	373799	1101930
1988	18605100	12461300	2626650	1370770	829244	1557560	813805
1989	17756400	6768450	6035920	1291980	583097	367140	1170330
1990	18582200	6468250	3294470	2999260	560296	263193	855189
1991	54386600	6751020	3117460	1603720	1250900	243219	608554
1992	37011900	19808500	3283940	1547060	693771	563226	467832
1993	16215800	13586100	9917250	1730570	750110	350111	577348
1994	14106600	5956770	6820500	5255920	848175	382643	540479
1995	11029800	5199380	3027650	3709150	2705280	454382	552254
1996	15777200	4065440	2642910	1646780	1909740	1449720	598723
1997	10595000	5778610	2018890	1369320	773150	933197	1081230
1998	13509300	3848920	2784270	982182	570449	335233	1031850
1999	10398000	4888580	1828140	1314700	386625	233715	717278
2000	32198800	3775180	2350430	885445	543102	166233	513209
2001	19957800	11734000	1840240	1171520	386237	246573	378698
2002	11244200	7284140	5751900	927987	522466	179281	341209
2003	8848150	4122930	3632120	3005660	442793	259471	299987
2004	37572100	3252580	2075120	1935270	1488160	228183	323081
2005	13159400	13782400	1624380	1087890	929148	743642	314665
2006	4191320	4828010	6887320	852672	523572	465423	570770
2007	5777120	1522730	2378570	3669210	475013	303579	628780
2008	7411240	2087190	737687	1232910	1980170	266813	554568
2009	8451030	2620450	947538	343936	588513	983778	438862
2010	4808120	2961940	1158530	423098	156158	278109	701222
2011	3923130	1653630	1237060	471461	172517	66272	458164
2012	4185820	1323850	652205	458536	172524	65706	228186
2013	4577090	1443480	557413	268947	189853	74347	140291
2014	3198270	1582910	613010	233090	113172	83150	102473
2015	5229320	1137230	730920	293837	114892	58060	100940
2016	5097110	1896310	557139	385852	161968	65915	96095
2017	11267100	1843230	921245	290111	209339	91460	96280

Table 4.5. Sardine in 8.c and 9.a: Summary table of the WGHANSA 2017 assessment. CVs, in %, are presented for SSB, recruitment and Apical F (maximum F-at-age by year); biomass and landings in t, recruits in thousands of individuals, F in year⁻¹.

Year	Biomass 1+	SSB	CV $_{SSB}$	Recruits	CV $_{R}$	F (2–5)	Apical F	CV $_{apicalF}$	Landings
1978	527924	478793	0.16	36397500	0.03	0.35	0.40	0.10	145609
1979	681861	623981	0.16	42401000	0.17	0.28	0.32	0.03	157241
1980	854519	786481	0.15	48364900	0.16	0.28	0.32	0.03	194802
1981	1022610	944756	0.14	29882200	0.15	0.27	0.30	0.04	216517
1982	950240	898246	0.14	16027500	0.18	0.26	0.29	0.05	206946
1983	750638	722026	0.15	71216200	0.24	0.26	0.29	0.07	183837
1984	1164160	1057200	0.11	21183900	0.11	0.25	0.29	0.10	206005
1985	986777	943390	0.10	18525200	0.18	0.23	0.26	0.10	208439
1986	796254	765352	0.10	15748900	0.18	0.28	0.32	0.11	187363
1987	641588	615434	0.11	34315800	0.19	0.33	0.37	0.20	177696
1988	706336	653864	0.09	18605100	0.12	0.40	0.45	0.19	161531
1989	624982	591872	0.09	17756400	0.16	0.38	0.44	0.18	140961
1990	562405	533238	0.10	18582200	0.16	0.42	0.47	0.16	149429
1991	517014	486893	0.10	54386600	0.15	0.39	0.44	0.15	132587
1992	851022	768505	0.08	37011900	0.09	0.29	0.32	0.15	130250
1993	961595	897334	0.07	16215800	0.10	0.28	0.31	0.14	142495
1994	810320	779672	0.07	14106600	0.14	0.23	0.26	0.11	136582
1995	671641	647816	0.07	11029800	0.13	0.23	0.26	0.14	125280
1996	537842	518937	0.07	15777200	0.14	0.31	0.36	0.15	116736
1997	476988	451855	0.07	10595000	0.11	0.42	0.48	0.12	115814
1998	385962	367782	0.08	13509300	0.13	0.47	0.53	0.12	108924
1999	370140	358535	0.08	10398000	0.12	0.43	0.48	0.12	94091
2000	316919	299468	0.09	32198800	0.14	0.38	0.43	0.12	85786
2001	477129	404885	0.08	19957800	0.09	0.36	0.41	0.11	101957
2002	491012	426987	0.08	11244200	0.11	0.30	0.34	0.11	99673
2003	466378	429763	0.08	8848150	0.14	0.27	0.30	0.09	97831
2004	407553	379458	0.08	37572100	0.17	0.29	0.33	0.08	98020
2005	546486	434602	0.07	13159400	0.07	0.29	0.33	0.09	97345
2006	641708	589309	0.06	4191320	0.11	0.18	0.19	0.09	87023
2007	505658	494143	0.06	5777120	0.18	0.21	0.22	0.10	96469
2008	391465	384466	0.06	7411240	0.14	0.33	0.34	0.10	101464
2009	293440	287251	0.07	8451030	0.11	0.38	0.39	0.11	87740
2010	245342	242380	0.06	4808120	0.09	0.48	0.50	0.11	89571
2011	175298	173644	0.07	3923130	0.12	0.58	0.61	0.11	80403
2012	128336	127013	0.09	4185820	0.13	0.47	0.48	0.10	54857
2013	116511	115068	0.11	4577090	0.12	0.45	0.47	0.10	45818
2014	118014	118014	0.12	3198270	0.13	0.30	0.31	0.09	27937
2015	111536	111536	0.14	5229320	0.17	0.19	0.20	0.11	20595
2016	136611	136611	0.16	5097110	0.18	0.20	0.21	0.08	22704
2017	146831	144987	0.18						

Table 6.1. Sardine in 8.c and 9.a: Input data for short-term catch predictions. Number (N-at-age) for 2017. Input values of natural mortality (M) and Fishing mortality (F). Input units are thousands and kg.

2017						
Age	Number	Stock_weights	Catch_weights	Maturity	M	F
0	4391480	0.000	0.024	0	0.98	0.024
1	1843230	0.030	0.047	0.97	0.61	0.071
2	921245	0.049	0.065	1	0.47	0.116
3	290111	0.063	0.076	1	0.40	0.134
4	209339	0.067	0.084	1	0.36	0.134
5	91460	0.073	0.090	1	0.35	0.134
6	96280	0.077	0.096	1	0.32	0.110

2018		
Age	Number	F
0	4391480	0.042
1		0.126
2		0.206
3		0.238
4		0.238
5		0.238
6		0.195

Table 6.2. Sardine in 8.c and 9.a: Output data for short-term catch predictions.

B1+_2017	F2017	Catch_2017	B1+_2018	Fsq	Fmult	F	Catch_2018	B1+_2019	Catch_2019	Change_B1+_2018-2019(%)	Change_Catch_2016-2018(%)
146831	0.18	23000	151884	0.23	0	0	0	171018	0	13	-100
				0.23	0.1	0.023	3337	168559	3724	11.0	-85.3
				0.23	0.2	0.046	6617	166145	7275	9.4	-70.8
				0.23	0.3	0.069	9842	163776	10663	7.8	-56.5
				0.23	0.4	0.092	13012	161449	13893	6.3	-42.5
				0.23	0.5	0.115	16128	159166	16974	4.8	-28.8
				0.23	0.6	0.138	19191	156923	19910	3.3	-15.2
				0.23	0.7	0.161	22203	154722	22710	1.9	-1.9
				0.23	0.8	0.184	25165	152561	25378	0.4	11.1
				0.23	0.9	0.207	28076	150438	27921	-1.0	24.0
				0.23	1	0.230	30939	148354	30344	-2.3	36.6
				0.23	1.1	0.253	33755	146308	32653	-3.7	49.1
				0.23	1.2	0.276	36524	144299	34852	-5.0	61.3
				0.23	1.3	0.299	39247	142325	36946	-6.3	73.3
				0.23	1.4	0.322	41925	140387	38941	-7.6	85.2
				0.23	1.5	0.345	44559	138484	40840	-8.8	96.8
				0.23	1.6	0.368	47149	136615	42647	-10.1	108.2
				0.23	1.7	0.391	49698	134779	44368	-11.3	119.5
				0.23	1.8	0.414	52205	132976	46005	-12.4	130.5
				0.23	1.9	0.437	54671	131204	47562	-13.6	141.4
				0.23	2	0.460	57097	129464	49044	-14.8	152.2

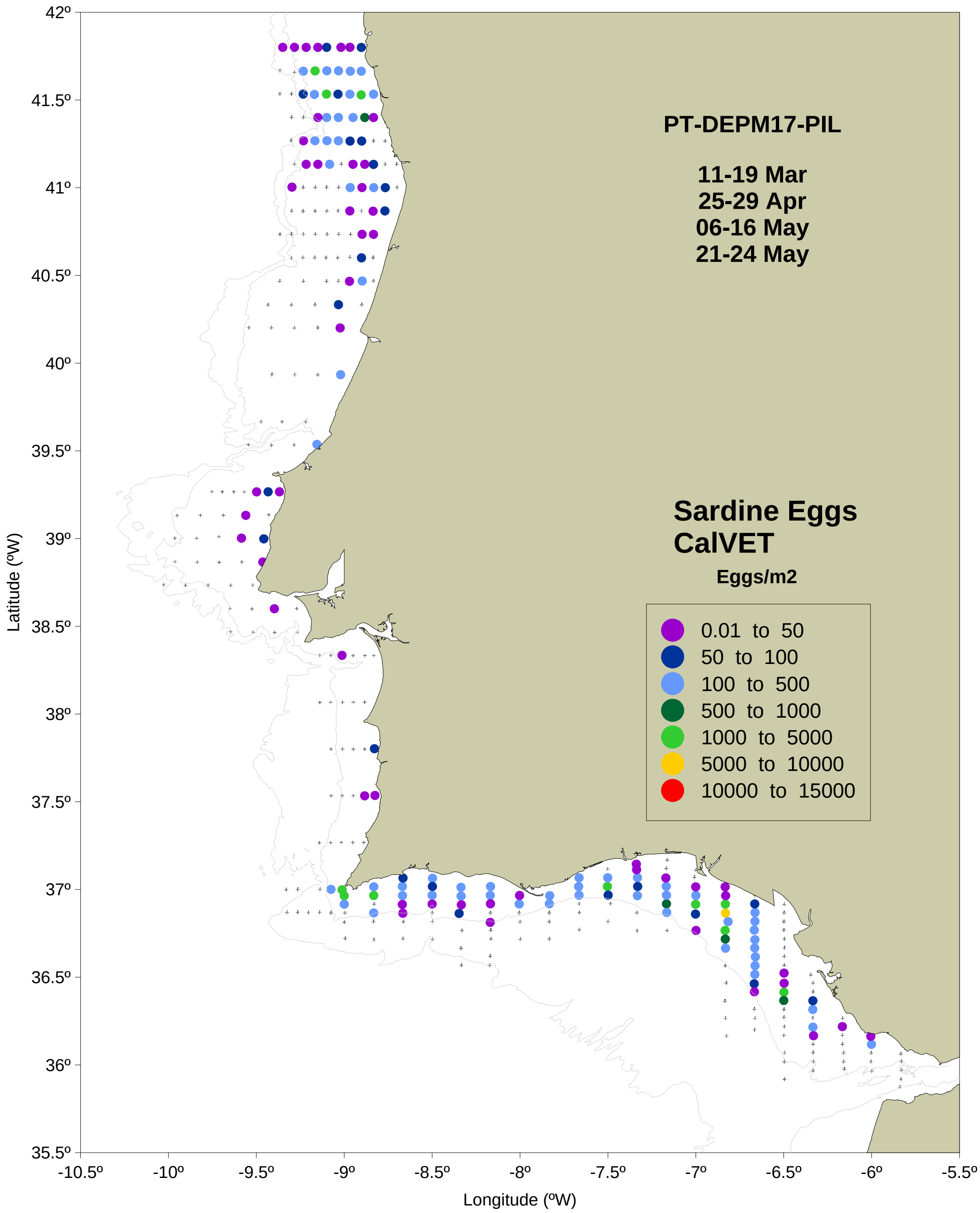


Figure 2.1. Sardine egg abundance distribution (eggs/m²) obtained from CalVET samples collected in the PT-DEPM17 survey.

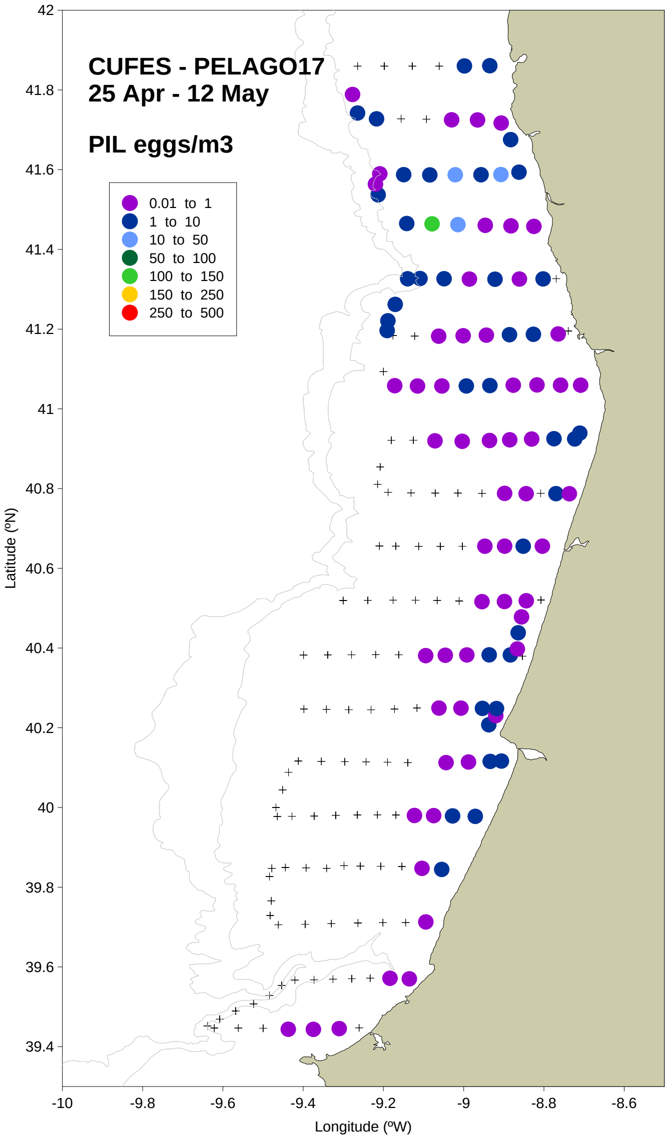


Figure 2.2. Sardine egg abundances distributions (eggs/m³) in the NW shelf obtained from CUFES sampling during PELAGO17 surveying.

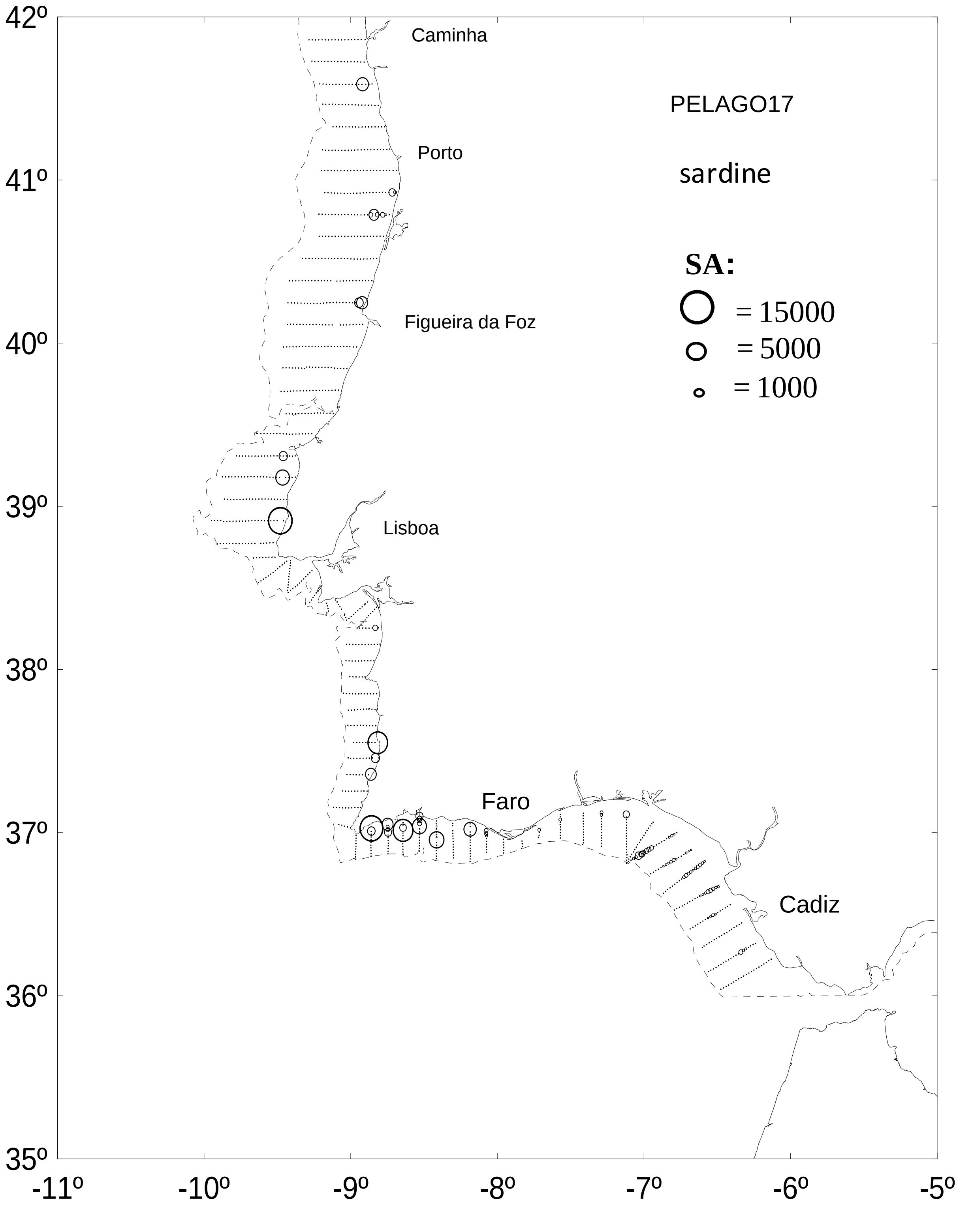
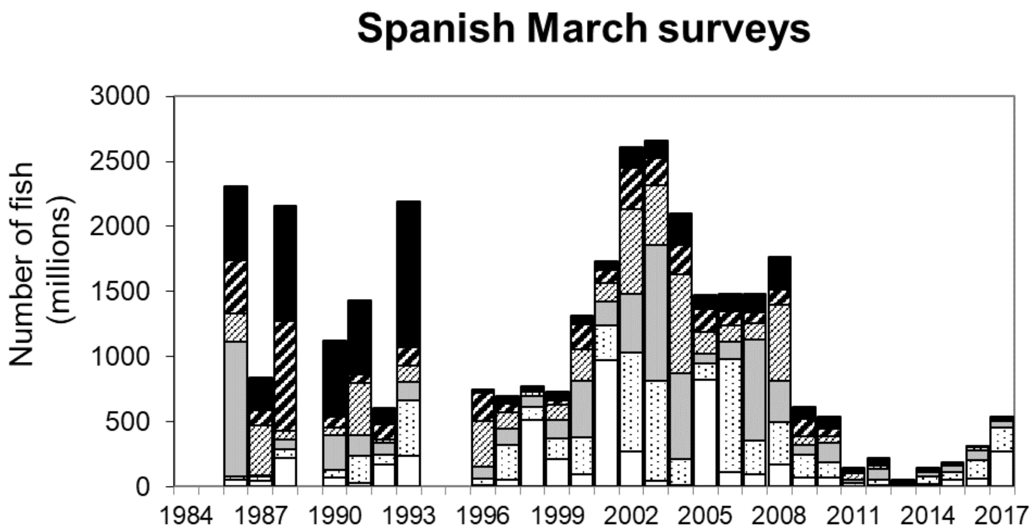


Figure 3.1. PELAGO17: Sardine acoustic energy spatial distribution. Circle area is proportional to the acoustic energy (S_A m²/nm²).



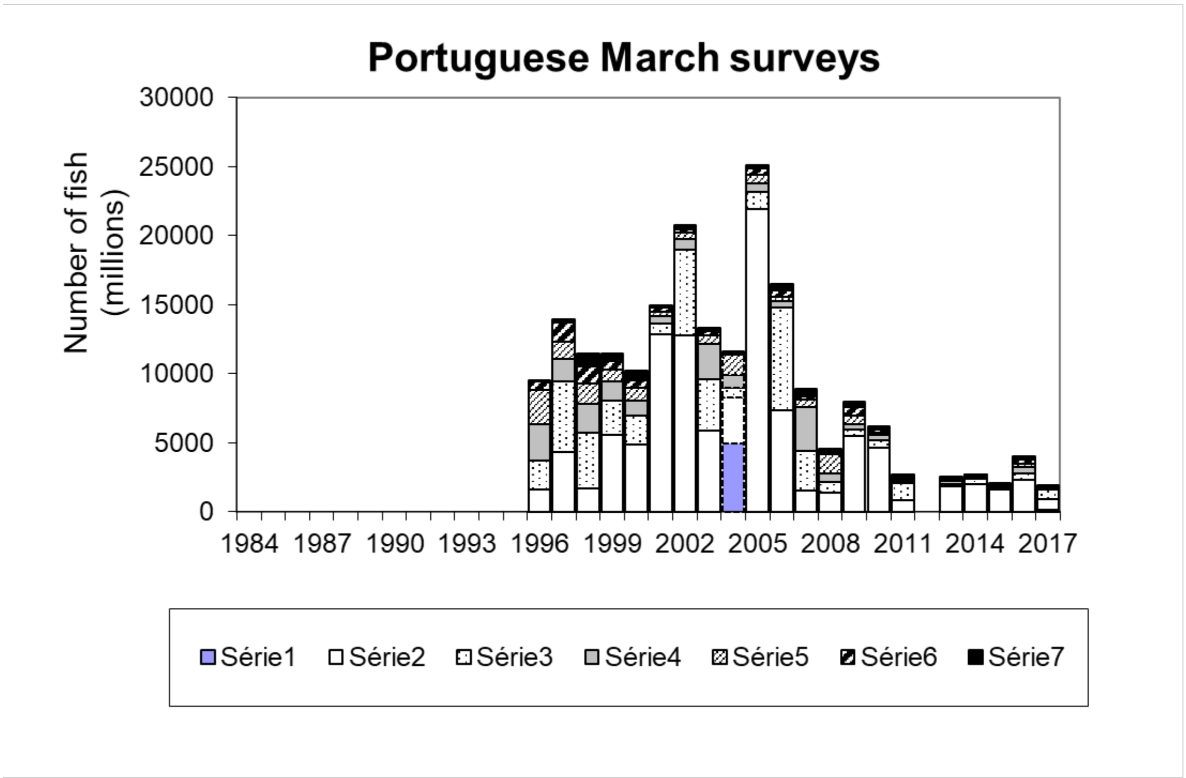


Figure 3.2. Sardine in 8.c and 9.a: Total abundance and age structure (numbers) of sardine estimated in the acoustic surveys. The Spanish March survey series covers area 8.c and 9.a-N (Galicia) and the Portuguese March surveys covers the Portuguese area and the Gulf of Cadiz (subdivisions 9-CN, 9a-CS, 9a-S-Algarve and 9a-S-Cadiz). Portuguese acoustic survey in June 2004 was considered as indications of the population abundance and is not included in assessment. Estimates from Portuguese acoustic surveys are not available for 2012 (year without survey).

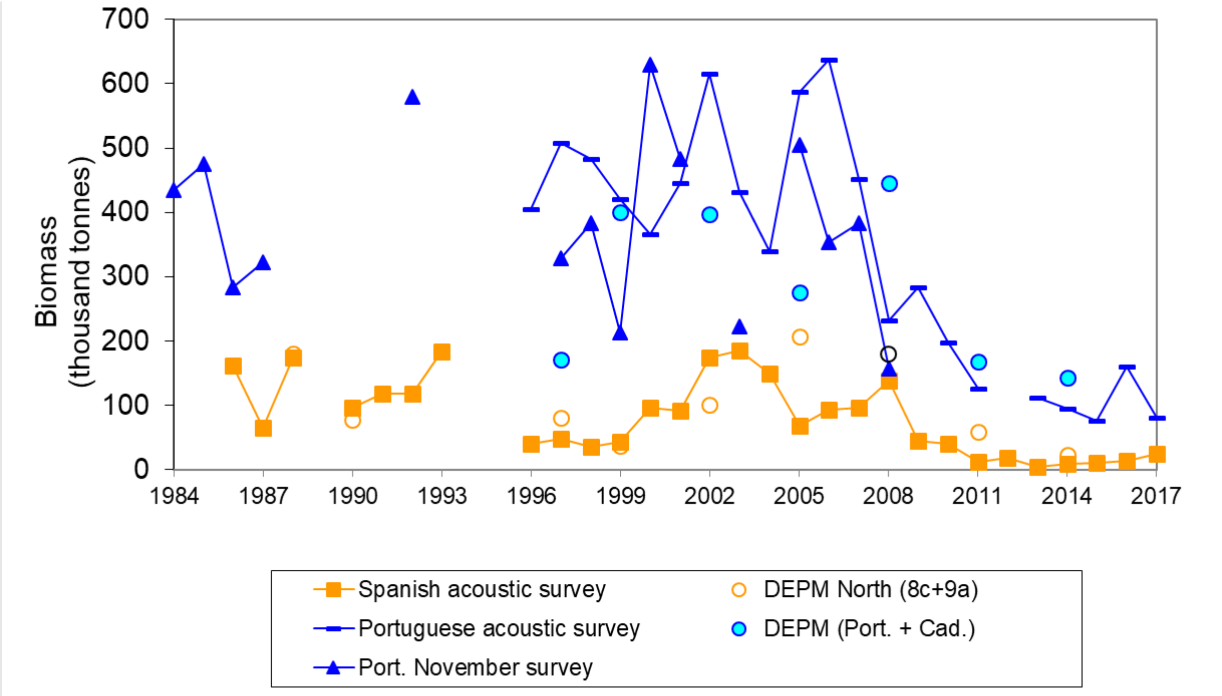


Figure 3.3. Sardine in 8.c and 9.a: Total sardine biomass (thousand tonnes) estimated in the different series of acoustic surveys and SSB estimates from the DEPM series covering the northern area and the west and southern area of the stock. For 2017, values for DEPM surveys are not available for the moment.

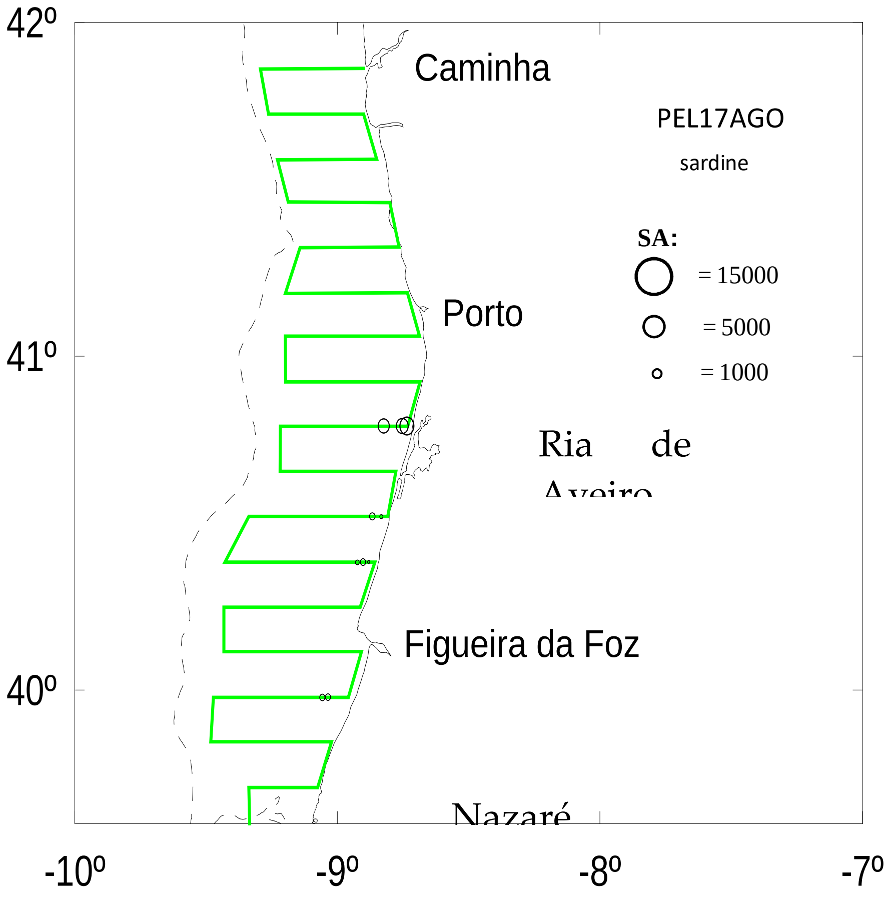


Figure 3.4. Sardine acoustic energy spatial distribution in the additional acoustic survey carried out by IPMA in August 2017 off the Occidental North area of the Portuguese coast. Circle area is proportional to the acoustic energy (S_A m²/nm²). The green line represents the acoustic transect (performed until Nazaré).

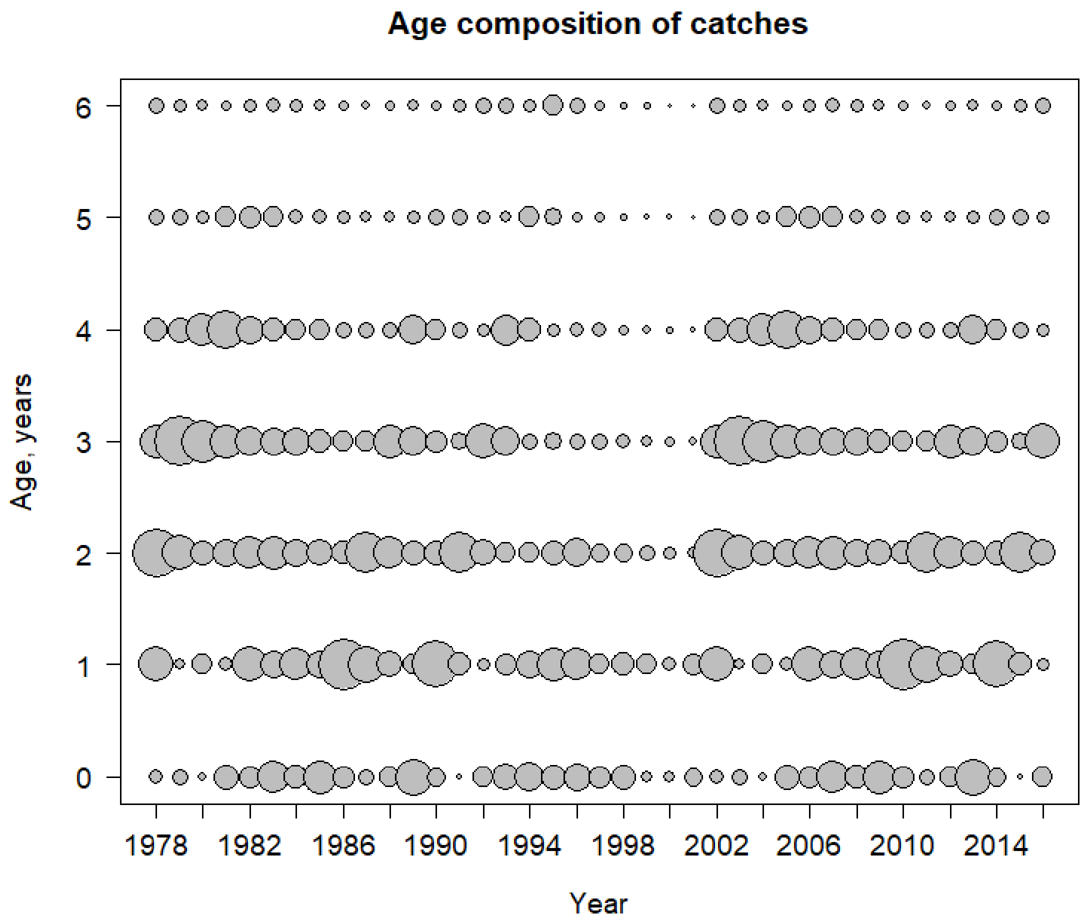


Figure 4.1. Sardine in 8.c and 9.a: Catches-at-age for 1978–2016.

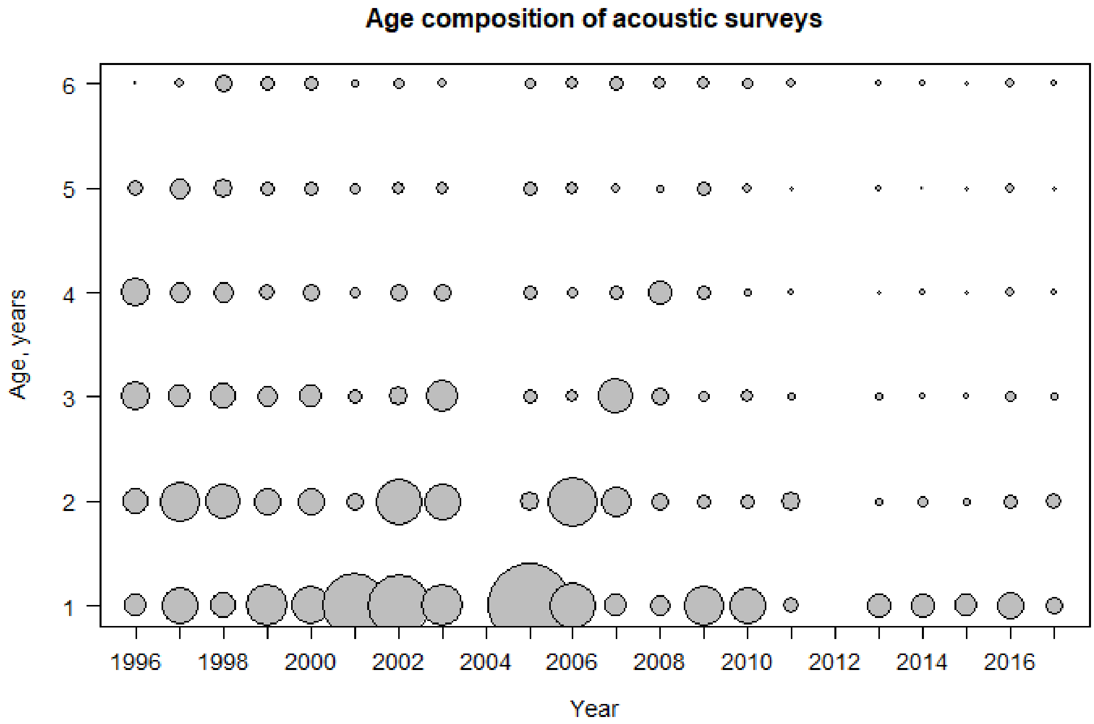


Figure 4.2. Sardine in 8.c and 9.a: Abundance-at-age in the joint Spanish-Portuguese spring acoustic survey 1996–2017.

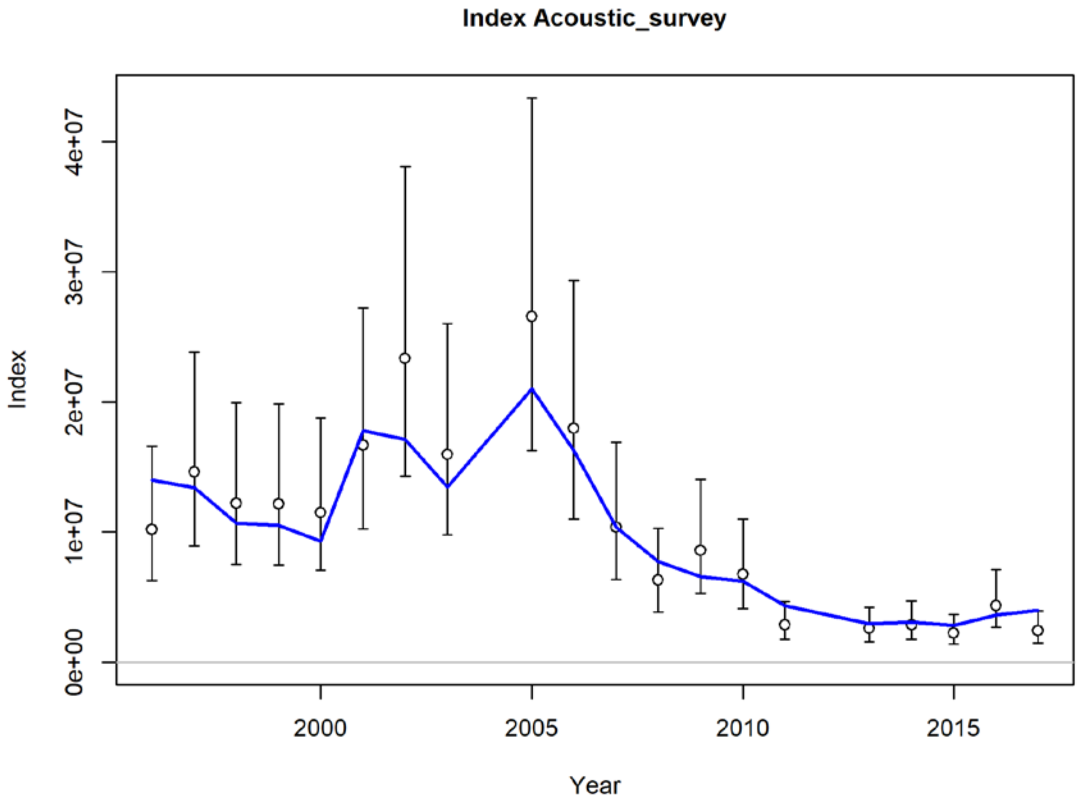


Figure 4.3. Sardine in 8.c and 9.a: Model fit to the acoustic survey series. The index is total abundance (in thousands of individuals). Bars are standard errors re-transformed from the log scale.

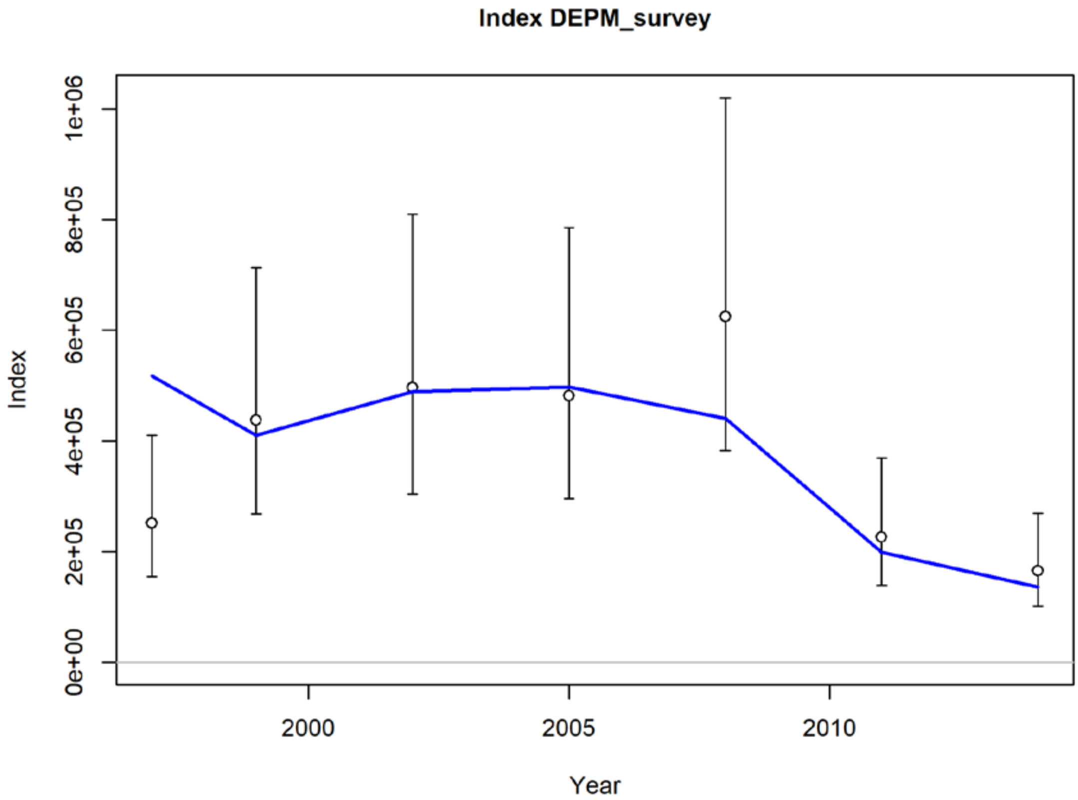


Figure 4.4. Sardine in 8.c and 9.a: Model fit to the DEPM survey series. The index is SSB (in thousand tons). Bars are standard errors re-transformed from the log scale.

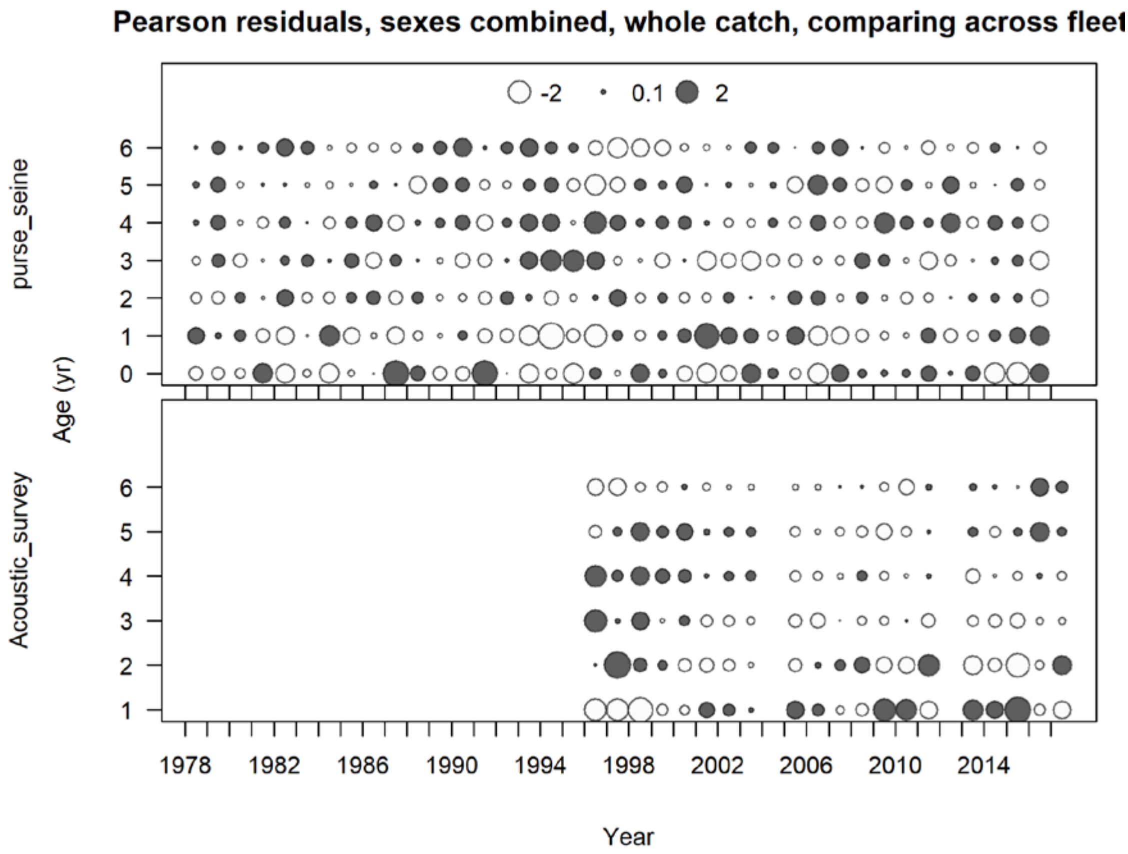


Figure 4.5. Sardine in 8.c and 9.a: Model residuals from the fit to the catch-at-age composition (top) and the acoustic survey age composition (bottom).

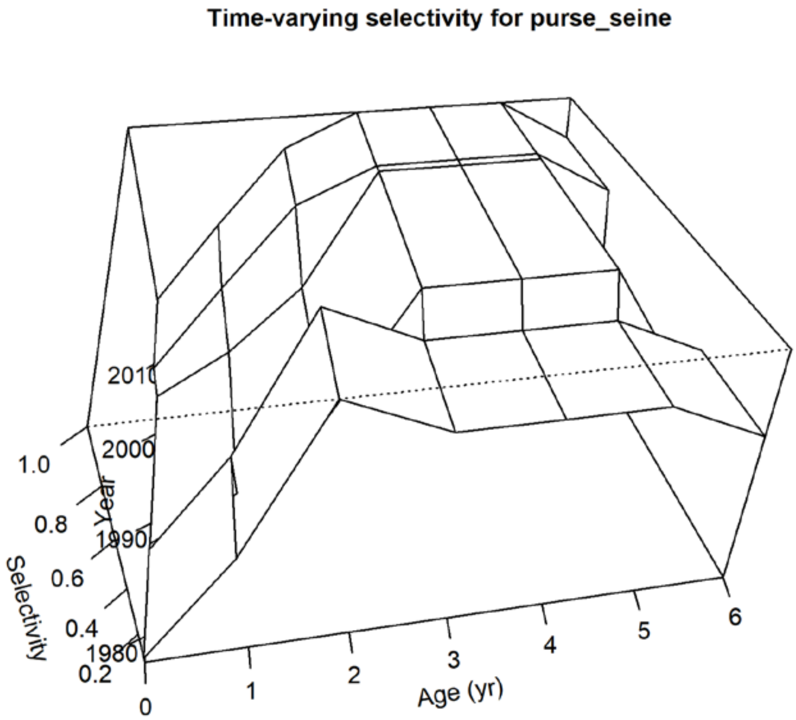
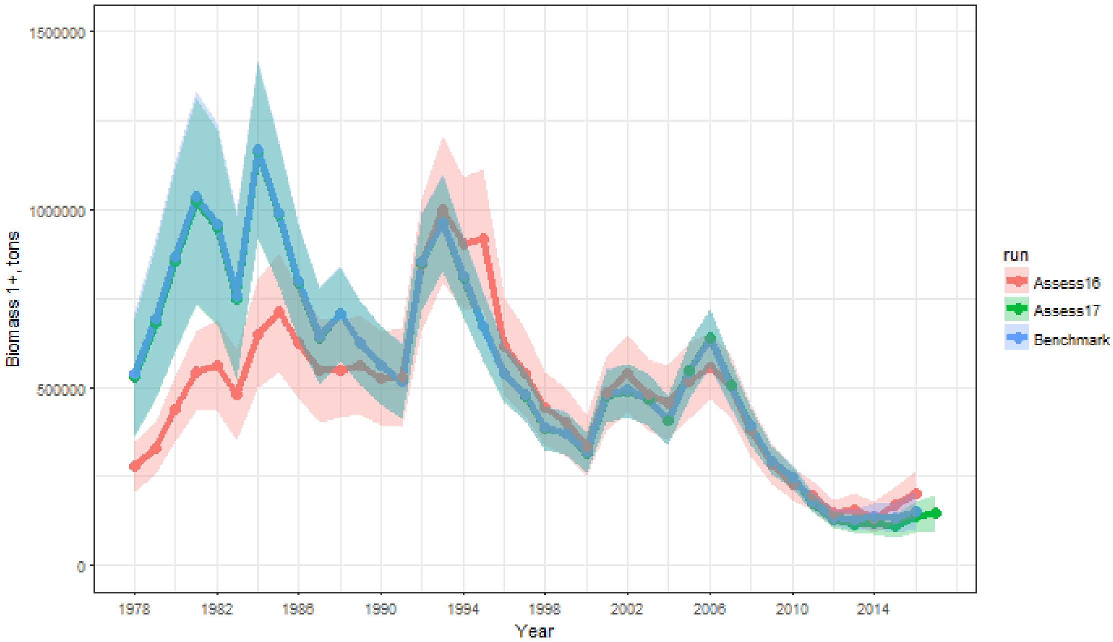
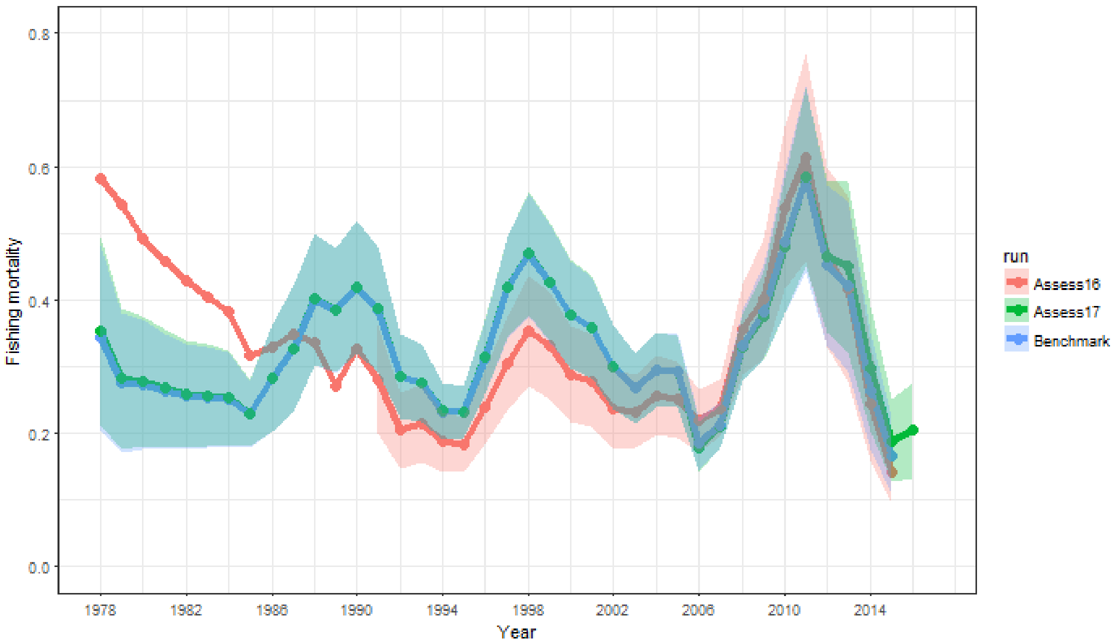


Figure 4.6. Sardine in 8.c and 9.a: Selectivity-at-age in the fishery showing the three blocks of fixed selectivity, 1978–1987, 1988–2005 and 2006–2016.


1500000
1000000
500000
0
Biomass 1+, tons
1978
1982
1986
1990
1994
1998
2002
2006
2010
2014
Year
run
Assess16
Assess17
Benchmark


0.8
0.6
0.4
0.2
0.0
Fishing mortality
1978
1982
1986
1990
1994
1998
2002
2006
2010
2014
Year
run
Assess16
Assess17
Benchmark

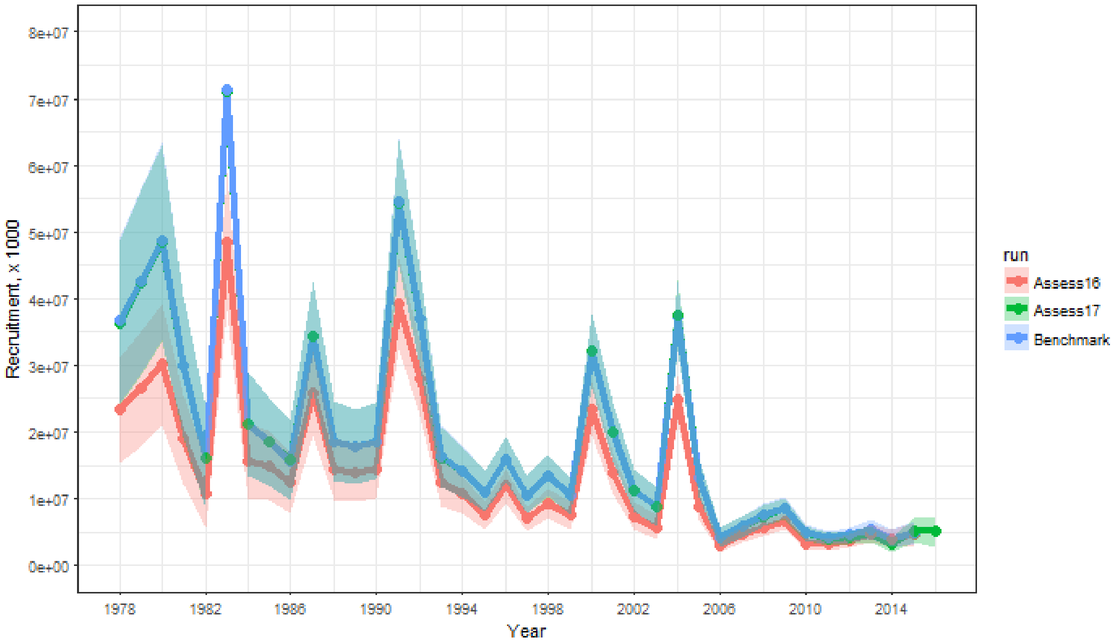
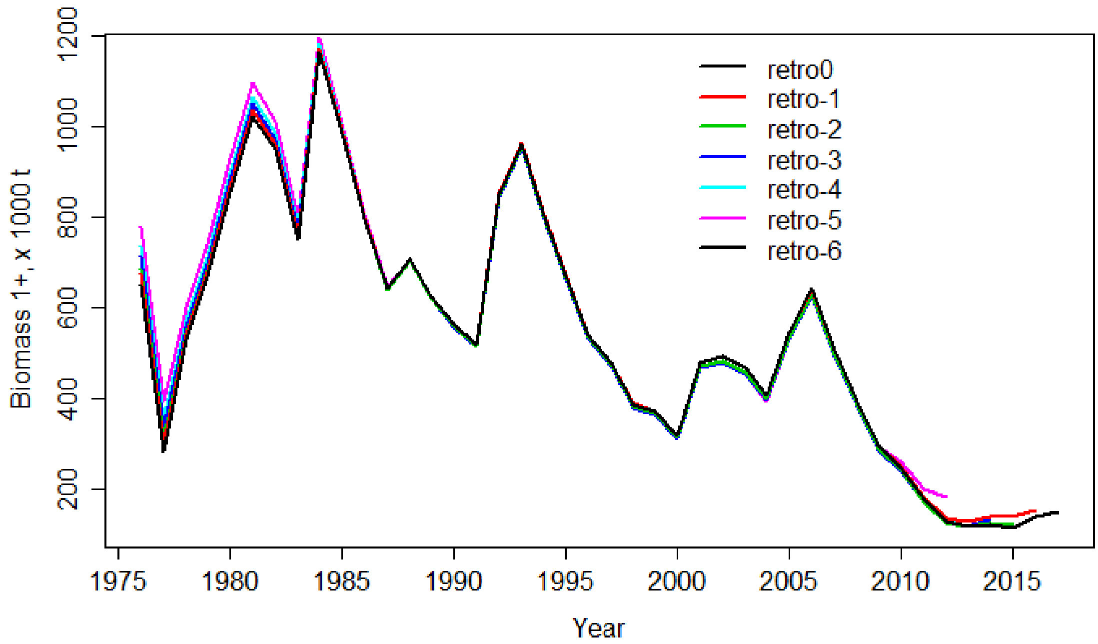


Figure 4.7. Sardine in 8.c and 9.a: Historical B1+ (top), F (middle) and recruitment (bottom) trajectories in the period 1978–2016 (B1+ is estimated up to 2017). The WG2016 assessment and the benchmark2017 assessments are shown for comparison.



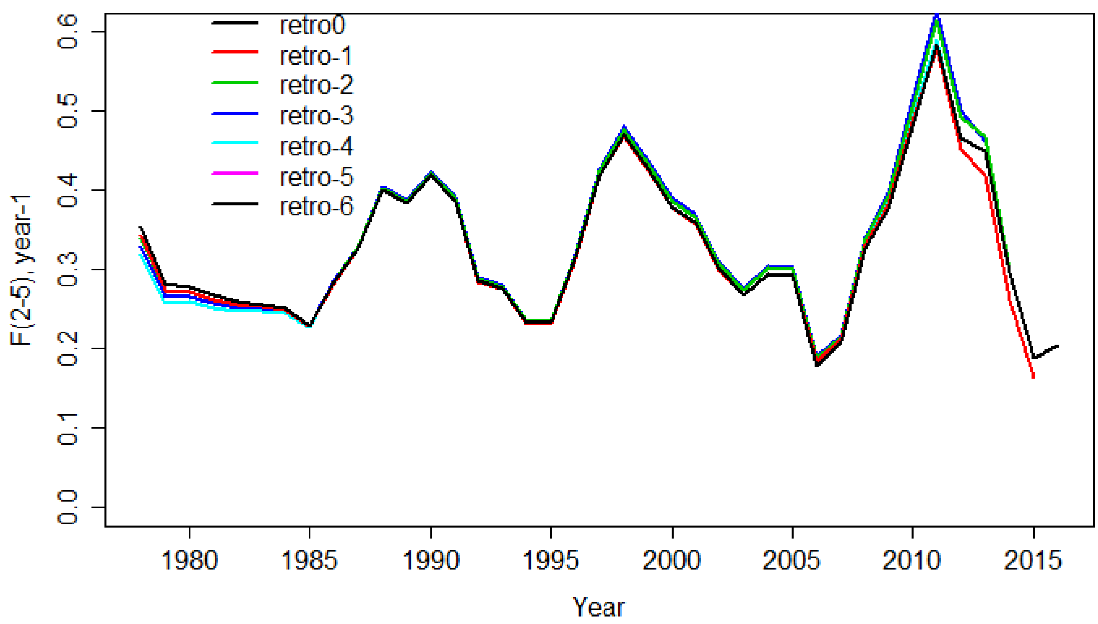


Figure 5.1. Sardine in 8.c and 9.a: Retrospective error for the B1+ (above) and for F(2–5) (below) in the assessment.

Working Document presented to WGHANSA: IPMA Pelagic Surveys

IPMA Pelagic Surveys in the Atlantic Iberian Waters of ICES area 9a (River Minho - Cabo Trafalgar): PELAGO17 acoustic estimations for sardine and anchovy and PT-DEPM17-PIL summary

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Abstract

In 2017, the acoustic PELAGO and the sardine DEPM surveys were delayed owing to technical problems with the vessel and to the installation of transducers and the upgrade of the echosounder installed onboard, and were therefore carried out partially concurrently. During the combined survey, acoustic sampling was conducted during the day while during the night, plankton samples and CTDF casts were obtained for the DEPM (sardine and horse-mackerel). Fishing hauls were carried out to serve the objectives of both methods. This document presents the geographic distribution, the abundance and biomass acoustic estimations for sardine and anchovy whilst at present the DEPM results are still incompletely available. A summary of the work developed during the surveys, by geographical area, is presented in Table 1.1.

The main objective of the PELAGO17 survey was to describe the sardine and anchovy spatial distributions and to estimate their abundance off the Portuguese and the Spanish Gulf of Cadiz shelves. The estimated sardine biomass was 81 thousand tonnes for the whole area, representing a significant reduction in relation to the PELAGO16 survey (172 thousand tonnes). The reduction in biomass was verified in the whole surveyed area, with lower expression in the OCS zone. The decrease in numbers was even more significant due to the low abundance of small sardines (< 16 cm), in particular in the main recruitment areas (OCN and CAD). Anchovy biomass also decreased in relation to the PELAGO16 survey (29.3 thousand tonnes, comparing with 65.4 thousand tonnes).

The DEPM survey in the southern stratum was conducted in mid March (17-19) and the western shores were monitored in April-May simultaneously to PELAGO (25Apr-24May). Since the period of surveying was quite lengthy the weather and oceanographic settings observed in the different regions varied appreciably. The southern coast in March was monitored under typical spring conditions, with mild temperatures, while later, in May-June, the water column was much warmer (and stratified). The northwestern shores were surveyed during a very unsettled period with strong winds and, at times, rough sea. The varied sea conditions may have affected fish behaviour and distribution and its availability for fishing. The DEPM sampling was conducted quite late in the sardine spawning season.

Preliminary results on egg distribution showed low sardine egg abundances in the western coast and average results for the southern stratum. Conversely, the data available so far, seems to indicate higher than usual anchovy egg densities, in particular for the NW platform, where schools of anchovy were observed. The fact that the surveys took place later than normal and that the temperatures were warmer than during the regular period of monitoring may have had an effect on the egg observations which were carried out more into the anchovy spawning season, in the west, and late in the season for sardine.

1. Introduction

The acoustic surveys, PELAGO series, and the DEPM surveys (for sardine and horse-mackerel) are funded via EU-DCF and national programs and coordinated with the surveys from Spain and France within ICES. The campaigns PELAGO and PT-DEPM-PIL (aiming at sardine) are discussed and reported to WGACEGG (Working Group on Acoustics and Egg Surveys). The Portuguese acoustic survey, takes place each year during spring covering the shelf waters of Portugal and Cadiz Bay. The main objectives of PELAGO surveys include monitoring the abundance distribution through echo-integration, and the study of several biological parameters for sardine (*Sardina pilchardus*), anchovy (*Engraulis encrasicolus*), mackerel (*Scomber scombrus*), chub-mackerel (*Scomber colias*), horse-mackerel (*Trachurus trachurus*) and other small pelagic fishes. Surveying also considers continuous observations of fish egg and larvae along the acoustic transects (CUFES-Continuous Underway Fish Egg Sampler) and hydrological and biological characterization of the water column. Additionally, census of marine birds and mammals are conducted during the survey trajectory.

Surveys directed at the estimation of the spawning stock biomass (SSB) through the Daily Egg Production Method (DEPM) are conducted on a triennial basis and in different years for sardine and for horse-mackerel. The Portuguese survey, PT-DEPM-PIL, is scheduled to occur during sardine peak spawning in the area from Cadiz to the Portugal-Galicia border. IPMA's survey is coordinated with its IEO congener which monitors the Cantabrian and Galician waters. The DEPM methodology involves surveying of the target species distribution area for plankton collection (and CTD casts) along a pre-defined grid of stations for spawning area definition and egg density and production estimations. Concurrently fish hauls are performed for adult parameter estimation: female mean weight, sex-ratio, batch fecundity and daily spawning fraction.

In 2017, operational constraints delayed the DEPM survey and therefore, after the first DEPM leg, in the south, in March, the decision was to carry out both, DEPM and PELAGO surveys thereafter, concurrently using the same vessel. The PELAGO17 survey was delayed about one month to enable the installation of transducers and upgrade of the echosounder. The survey ended up the 7 June, only 15 days before WGHANSA. Despite all efforts to speed up the data logging and the acoustic data processing, preliminary estimations of sardine and anchovy biomass were only achieved during the WG meeting and only for three of the 4 surveyed areas, because difficulties were encountered in the biomass estimation in the Occidental North area (OCN). Final estimations presented in this report include the re-analysis of the echograms for the OCN area with the use of additional information on the fishery samples and the distribution of eggs collected along the survey.

Table 1.1. PT-DEPM17-PIL and PELAGO17 survey summary information by area.

	OCN (NW)	OCS (SW)	ALG (S)	Cadiz (S)
Vessel	Noruega	Noruega	Noruega	Noruega
Dates	25-29/4+6-11/5 (DEPM + acoustics)	12-16/5+ 21-24/5 (DEPM + acoustics)	17-19/03 (DEPM); 25/5 (DEPM rep) 3-6/6 (acoustics)	11-15/3 (DEPM); 28-31/5 (acoustics)
SURVEY EGGS & HYDROGRAPHY	**OCN (NW)**	**OCS (SW)**	**ALG (S)**	**Cadiz (S)**
SST (ºC) max/mean/min	17.6/16.2/14.0	19.6/17.7/16.4	21.0/19.2/16.9	22.5/20.8/19.0
SST (ºC) max/mean/min (march)	-	-	16.5/16.0/14.8	18.7/16.1/14.6
Transects CalVET	15	13	12+5*	10
CalVET – n stations	112	69	73+25*	100
Positive samples PIL	54	14	34+6*	46
Positive samples ANE	75	18	24+12*	42
Tot eggs PIL	870	56	1233+23*	1744
Tot eggs ANE	4201	403	215+96*	1426
Max eggs/m2 per sample PIL	23.33	1.62	56.02	112.48
Max eggs/m2 per sample ANE	7.33	19.01	9.05	27.50
CTDF casts	112	69	73+25	100
Transects CUFES DEPM	15	13	12+4	10
CUFES samples - DEPM	139	96	107+30	141
Transects CUFES PELAGO	17	30	15	11
CUFES samples - PELAGO	169	215	99	116
Tot eggs PIL	3002	na yet	na yet	na yet
Tot eggs ANE	27860	na yet	na yet	na yet
Max eggs/m3 per sample PIL	112.27	na yet	na yet	na yet
Max eggs/m3 per sample ANE	290.53	na yet	na yet	na yet
Bongo samples	9	6	7	10
SURVEY ACOUSTICS & FISH	**OCN (NW)**	**OCS (SW)**	**ALG (S)**	**Cadiz**
Number of acoustics transects (nm)	17(453)	29(415)	14(166)	11(194)
Number hauls R/V (pelagic/bottom)	8/6	18/1	21/4 (10/1 only DEPM)	10/6 (2/3 only DEPM)
Number hauls (CV) - PIL	6	5	5	0
Number hauls (CV) - HOM	4	0	2	0
Number RV (+) trawls - PIL	6	6	18 (8 only DEPM)	13 (4 only DEPM)
Number RV (+) trawls - HOM	7	6	13 (10 only DEPM)	5 (3 only DEPM)
Number RV (+) trawls - MAC	2	2	0	1
Number RV (+) trawls - MAS	7	8	17 (9 only DEPM)	4 (2 only DEPM)
Number RV (+) trawls - ANE	6	0	1	10 (3 only DEPM)
Depth range (m) in (pelagic/bottom) RV fishing operations	14-110/ 83-149	19-164/ 88	23-52/ 74-99	19-52/ 56-104
Period of the day covered by RV fishing hauls (pelagic/bottom)	08:27-17:54/ 09:50 -17:49	7:19-19:51/ 16:33	7:33-19:57/ 7:35-17:29	7:21-17:56/ 7:52-13:37
Total number fish sampled - PIL	470	537	1243	634
Total number fish sampled - HOM	423	188	554	144
Total number fish sampled - MAC	0	4	0	0
Total number fish sampled - MAS	106	197	561	39
Total number fish sampled - ANE	399	0	0	367
Number otoliths collected - PIL	415	523	941	377
Number otoliths collected – HOM	351	181	487	144
Number otoliths collected - MAC	0	4	0	0
Number otoliths collected - MAS	80	146	430	39
Number otoliths collected - ANE	164	0	0	163
Number ovaries preserved - PIL	210	272	413	66
Number ovaries preserved - HOM	210	83	150	30

Notes:
Surveys were partially concurrent (during the period: 25Apr-24May).
* - some stations repeated after first coverage
CV – Commercial vessels
RV – Research vessel

2. Acoustic Survey

Material and methods

Acoustics

Survey execution and abundance estimation followed the methodologies adopted by the ICES WGACEGG. The survey area, over the shelf until the 200 m isobath, was covered following a parallel grid with a mean distance between transects of 8 nautical miles. Average survey speed was 8 knots and the acoustic signals were integrated over one nautical mile intervals. Echo integration was carried out with a scientific echo sounder Simrad 38 kHz and 120 KHz EK60 scientific echo sounder, used for the first time. The acoustic data was recorded in MOVIES+ (Weill *et al*., 1993), which was also used to integrate the fish acoustic energy. The echogram bottom was manually corrected prior to the acoustic energy extraction. An acoustic calibration with a copper sphere was carried out, following the standard procedures (Foote *et al.*, 1981). For presentation purposes and results comparison, the surveyed area was divided, as usual, into 4 sub-areas or regions: OCN (from Caminha to Nazaré), OCS (from Nazaré to Cape S. Vicente), Algarve (from Cape S. Vicente to V. R. Santo António) and Cadiz (from V. R. Santo António to Cape Trafalgar).

Difficulties were encountered in the biomass estimation in the Occidental North area (OCN) since the fishing hauls were not always successful. Therefore, for this particular survey, final estimations used additional information on fishery samples and the distribution of eggs collected along the survey. Some schools were assigned directly to sardine, due to morphologic and density characteristics of the schools, typical for adult sardine in this region. Additionally, an important school, in the north (transect 3) was also attributed to sardine, due to a great amounted of sardine eggs (CUFES), in the vicinity (Figure 3.5) which may have drifted from the school location.

The OCN area includes the main recruitment area for sardine in the west Portuguese coast and is considered an important area for the distribution of this species and in recent years also for anchovy. In order to further validate PELAGO17 estimations, the OCN zone was surveyed again during August. Results are annexed to this report (Annex 1).

Adult fish

To collect the biological data, pelagic and bottom trawls were used. The trawl samples were also used to identify the species and to split the acoustic energy by species and by length, within each species. Fishing was carried out according to the echogram information. Nevertheless, due to the presence of fixed commercial fishing gears or irregular and rocky bottoms, it was not always possible to make hauls in some areas. Biological sampling of sardine, anchovy, horse-mackerel, mackerel and chub-mackerel was performed in each haul, when present. Ovaries from sardine and horse-mackerel were preserved for fecundity and spawning fraction estimations. In addition, otoliths were collected for sardine, anchovy, horse-mackerel, mackerel and chub-mackerel. Otoliths are used for age reading and for the production of Age Length Keys (ALK's). For sardine and anchovy, the abundance (x 1 000) by age group and area is estimated from the combination of the ALK and the estimates of abundance at length from the echo-integration in each area.

Results

Fish trawling, biological data, and pelagic community

On the whole, 74 fishing hauls were obtained during the whole survey, 57 from pelagic and 17 from bottom trawling, the first 16 hauls corresponding to the first survey leg exclusive of DEPM (Table 1.1. and Figure 2.1). Samples from these hauls provided individual biological data for 5866 fish (of sardine, anchovy, horse-mackerel, mackerel and chub mackerel), and 4445 otoliths from these 5 pelagic species were collected for age determination.

The part of the survey during which DEPM was applied, included 52 hauls, 27 (52%) of which were positive for sardine, and from which 17 samples will be used for the estimation of the adult parameters. These survey samples were complemented with 16 samples provided by the commercial fleet (mostly from purse seine) (Figure 2.9). On the whole, 961 ovaries were preserved for histological processing and fecundity and spawning fraction estimation (Table 1.1.). These DEPM estimates are at present not available.

During the PELAGO17, 62% of the hauls were positive for sardine, but the latter represented only about 15% of the fish caught (in numbers), their availability in the trawls continuing in a downward trend in the latest surveys; sardine were caught in very low numbers in the Occidental North (OCN) area, and were present mainly in the hauls carried out in Occidental South and Southern (ALG, CAD) areas (Figure 2.2). Anchovy were present in 28% of the hauls, almost exclusively concentrated in Occidental North (OCN) and South areas, but represented more than 60% (in numbers) of the fish caught during the survey (Figure 2.2). As for the other pelagic (horse-mackerel, mackerel and chub mackerel), they were caught in less numbers (about 13% in number), with chub mackerel present mainly in the Occidental South (OCS) and Algarve areas but with an increasing presence in the Occidental North (OCN) area.

Sardine and anchovy biomass, abundance and distribution

Figures 2.3 and 2.4 show sardine and anchovy distribution of acoustic energy; both species presenting a patchy pattern. In particular, sardine energy in the Occidental North (OCN) area was very scarce, restricted to only a few transects. Main sardine acoustic energy was located between Peniche and Lisboa, South of Sines, and in the Western part of Algarve (Figure 2.3). As for anchovy, acoustic energy in the West coast was concentrated in the area between Porto and Nazaré, while in the South coast, it was located exclusively eastern to Faro, and mainly in the Cadiz Spanish waters (Figure 2.4).

The sardine biomass estimate of 81 thousand tonnes for the whole area (Table 2.1) is a significant reduction in relation to the 2016 PELAGO survey (172 thousand tonnes). This biomass reduction is mainly due to a strong reduction in the Occidental zones, 11.9 thousand tonnes comparing with 30 thousand tonnes in 2016 survey. The present biomass for this zone is similar to the one obtained on the PELAGO13 survey (9 thousand tonnes).

In the total area, the biomass estimate (81 thousand) compares with the total biomass estimated for the PELAGO15 survey (78 thousand tonnes). Table 2.1 presents the sardine abundance and biomass in each zone.

The estimated biomass of anchovy for the whole surveyed area was 29.3 thousand tonnes corresponding to an estimated abundance of 2869.8 million fish (Table 2.2). The occurrence of this species was detected in the OCN, ALG and CAD areas, being most abundant in CAD (1717.8 million fish, 12.6 thousand tonnes) and OCN (1015.1 million fish, 15.5 tonnes) and much less abundant in ALG (136.9 million fish, 1.2 thousand tonnes).

Table 2.1. Pelago17: Estimated sardine abundance and biomass by each surveyed area and total.

Sardine	OCN	OCS	ALG	CAD	TOTAL
Number (thousand)	232 547	604 613	823 248	361 162	2 021 570
Biomass (tones)	11 878	30 233	34 116	4 757	80 984

Table 2.2. Pelago17: Estimated anchovy abundance and biomass by each surveyed area and total.

Anchovy	OCN	OCS	ALG	CAD	TOTAL
Number (thousand)	1 015 135	-	136 892	1 717 806	2 869 833
Biomass (tonnes)	15 481	-	1 208	12 589	29 288

Sardine: length and age composition

Figures 2.5 and 2.6 present the length and age composition of sardines for each of the areas surveyed. Small sardines (<16 cm) were almost only observed in the Cadiz Spanish waters and in Algarve areas, and thus almost completely absent from the West coast. In the Occidental North (OCN) and Cadiz (CAD) areas, as observed in the latest surveys, most sardines were young, aged up to 2 years old (93% in biomass), with a modal age of 2 and 1, respectively. In the Occidental South (OCS) and Algarve areas, sardine presented a wider age distribution (up to age group 8), modal age being of 1 and 2 years-old, respectively.

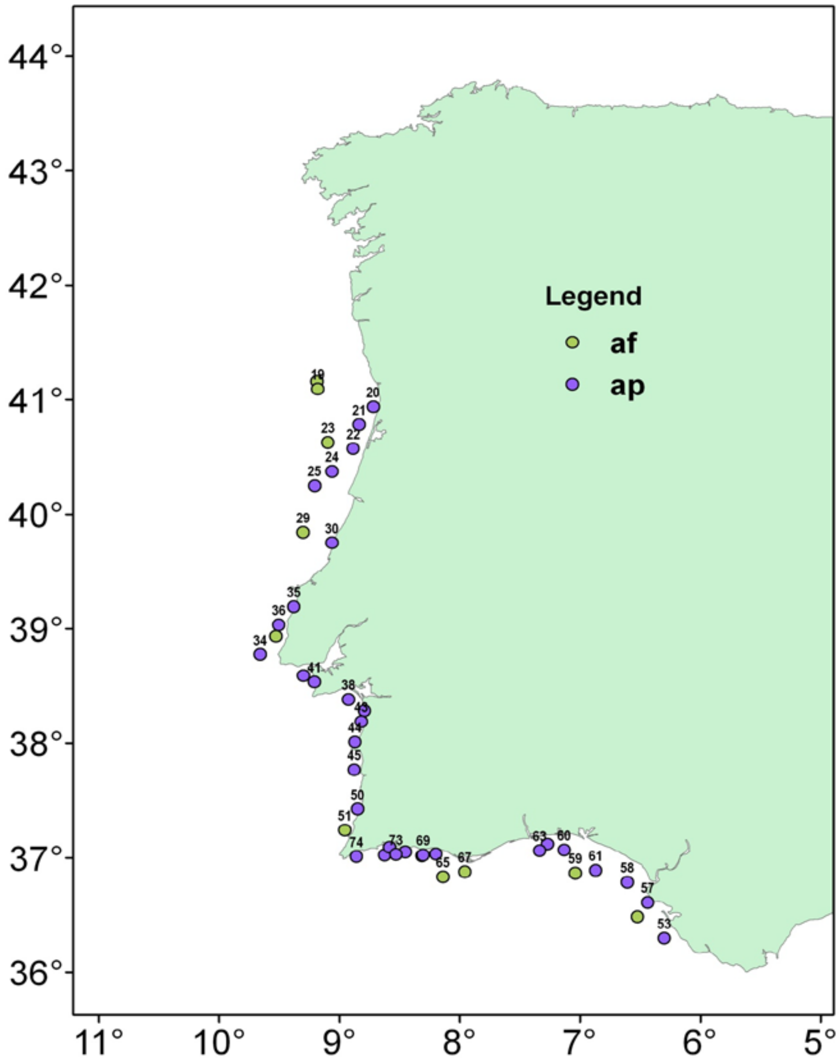


Figure 2.1. PELAGO17: RV "Noruega" fishing trawl location (with more than 30 fish caught): af-bottom trawl; ap – pelagic trawl

Anchovy: distribution, abundance, length and age composition

Anchovy abundance and biomass estimates by length class in each of the three anchovy occurrence areas are presented in Figure 2.7. In OCN the length mode was around 13.0 cm and in ALG 11.0 cm. In CAD length distribution was trimodal, being the modes around 8.5, 11.0 and 14.5 cm

From the otoliths structure analysis of the survey sampled anchovy, age was attributed to the fish and age length keys (ALK's) were obtained for each area. ALK's allowed to estimate the anchovy abundance and biomass composition by age group in each occurrence area of this species, which are presented in Figure 2.8. For the ALG area it was attributed the same ALK of the neighboring CAD area.

Age group 1 was predominant in all the three areas, both in abundance (OCN: 988.4 millions; ALG: 133.6 millions and CAD: 1644.5 millions), as in biomass (OCN: 15 thousand tonnes; ALG: 1.2 thousand tonnes and CAD: 11.4 thousand tonnes).

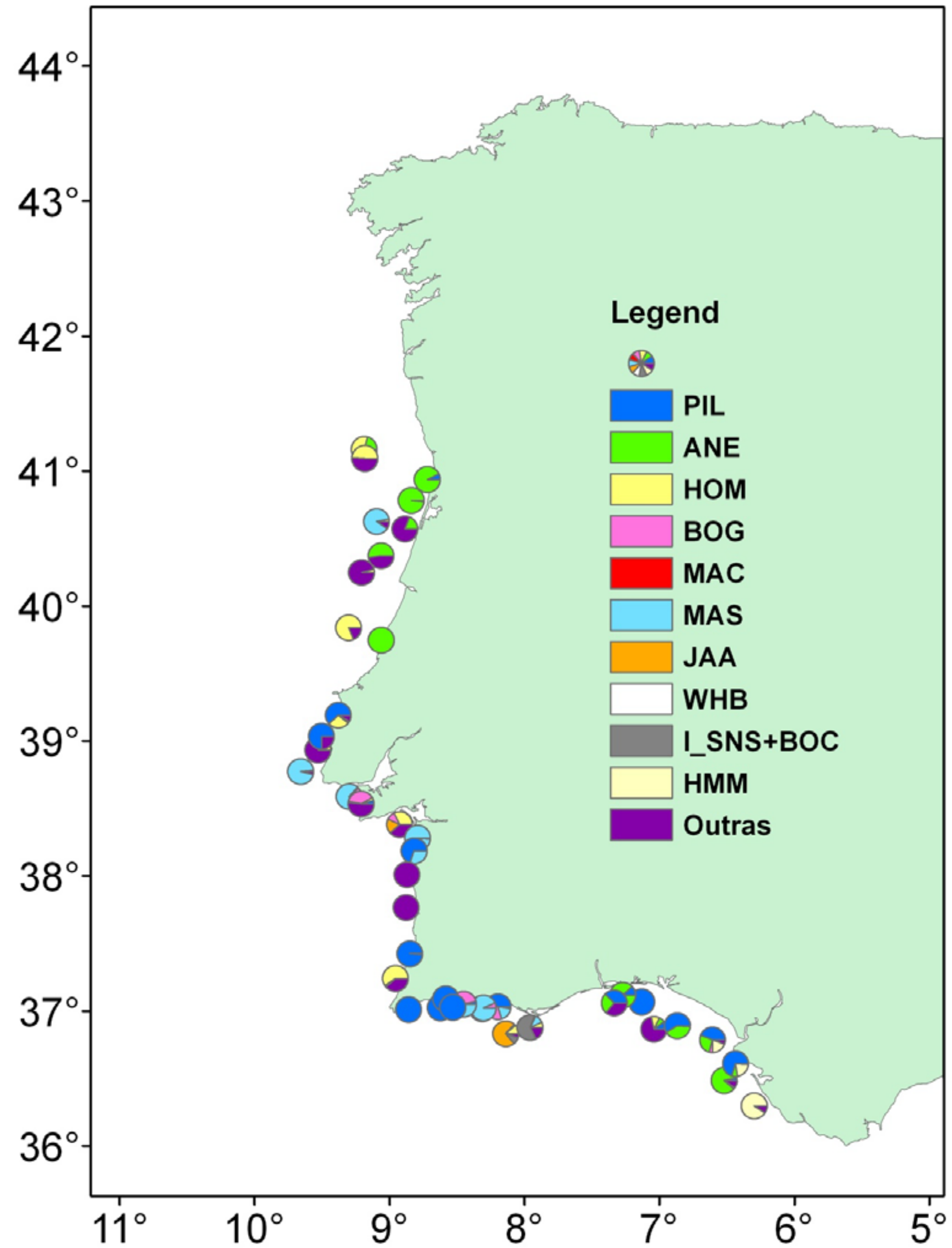


Figure 2.2. PELAGO17: Fishing haul species composition (in number). (PIL-sardine, ANE-anchovy; BOG-bogue, HOM-horse mackerel, MAC-mackerel, MAS-chub mackerel, WHB- blue whiting, JAA-black jack mackerel, HMM- Mediterranean horse mackerel, SNS- snipe fish, BOC- boar fish).

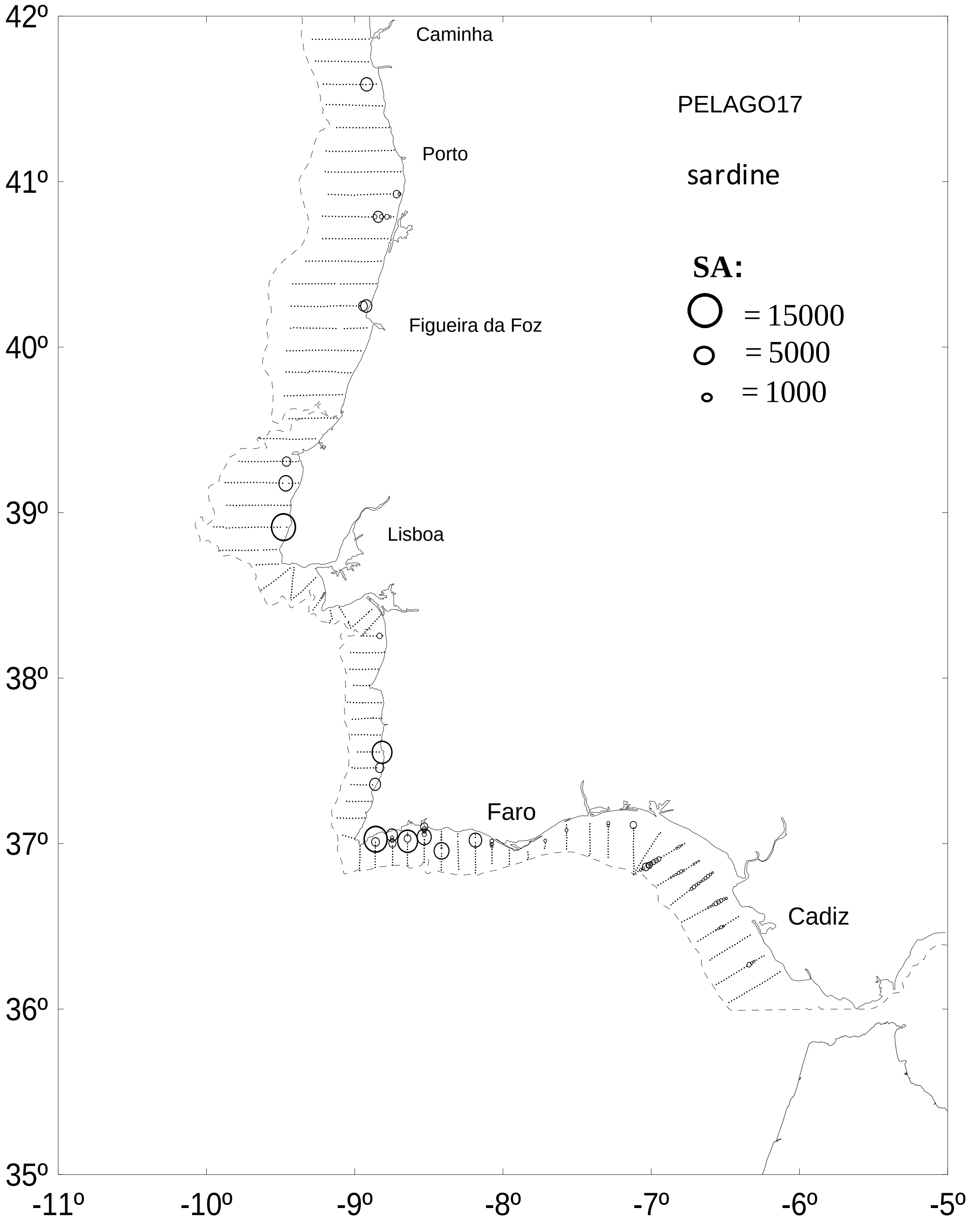


Figure 2.3. PELAGO17: Sardine acoustic energy spatial distribution. Circle area is proportional to the acoustic energy (S_A m²/nm²).

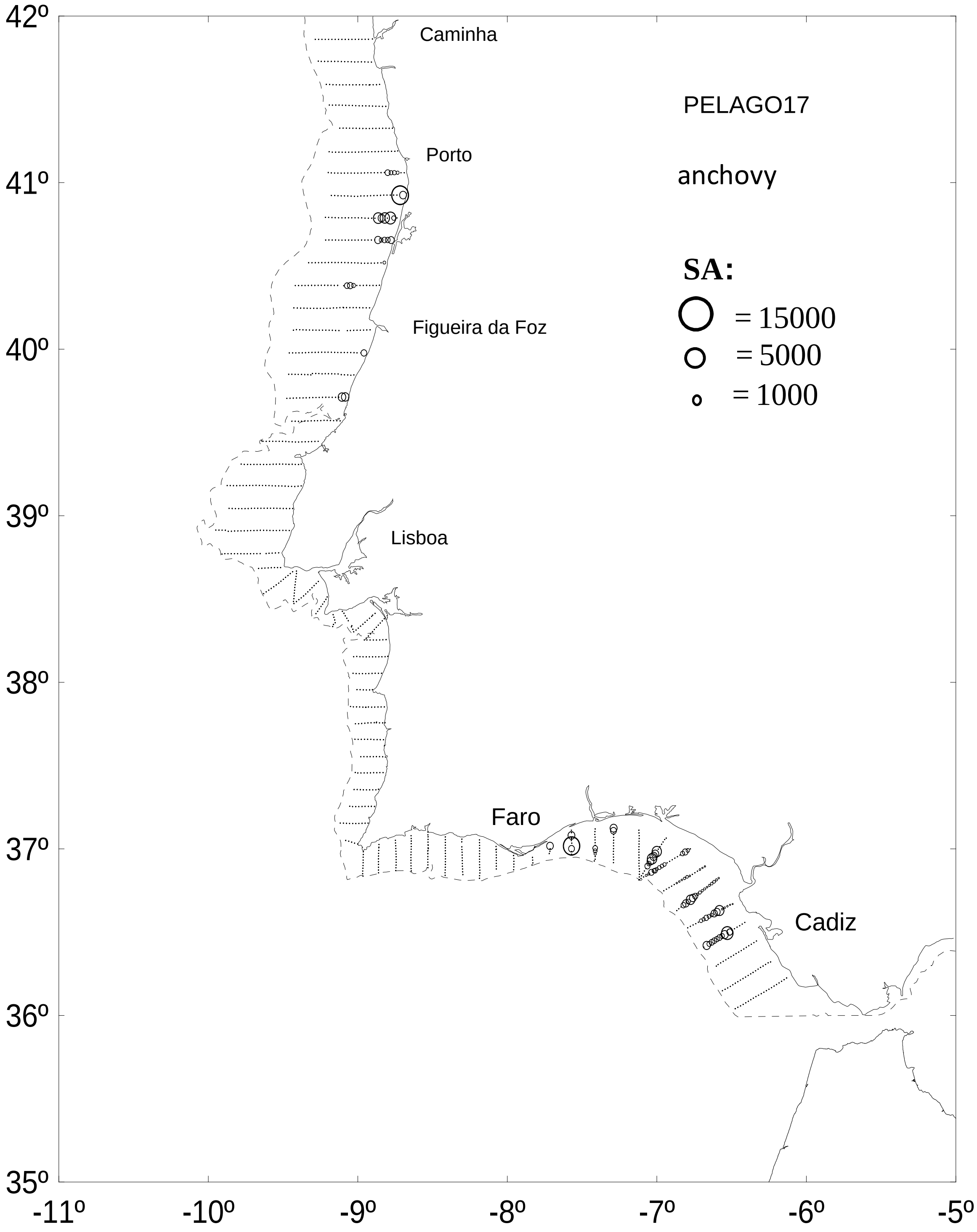


Figure 2.4. PELAGO17: Anchovy acoustic energy spatial distribution. Circle area is proportional to the acoustic energy (S_A m²/nm²).

Figure 2.5. PELAGO17: Sardine (abundance and biomass) length distribution, for each area.

Figure 2.6. PELAGO17: sardine (abundance and biomass) age distribution, for each area.

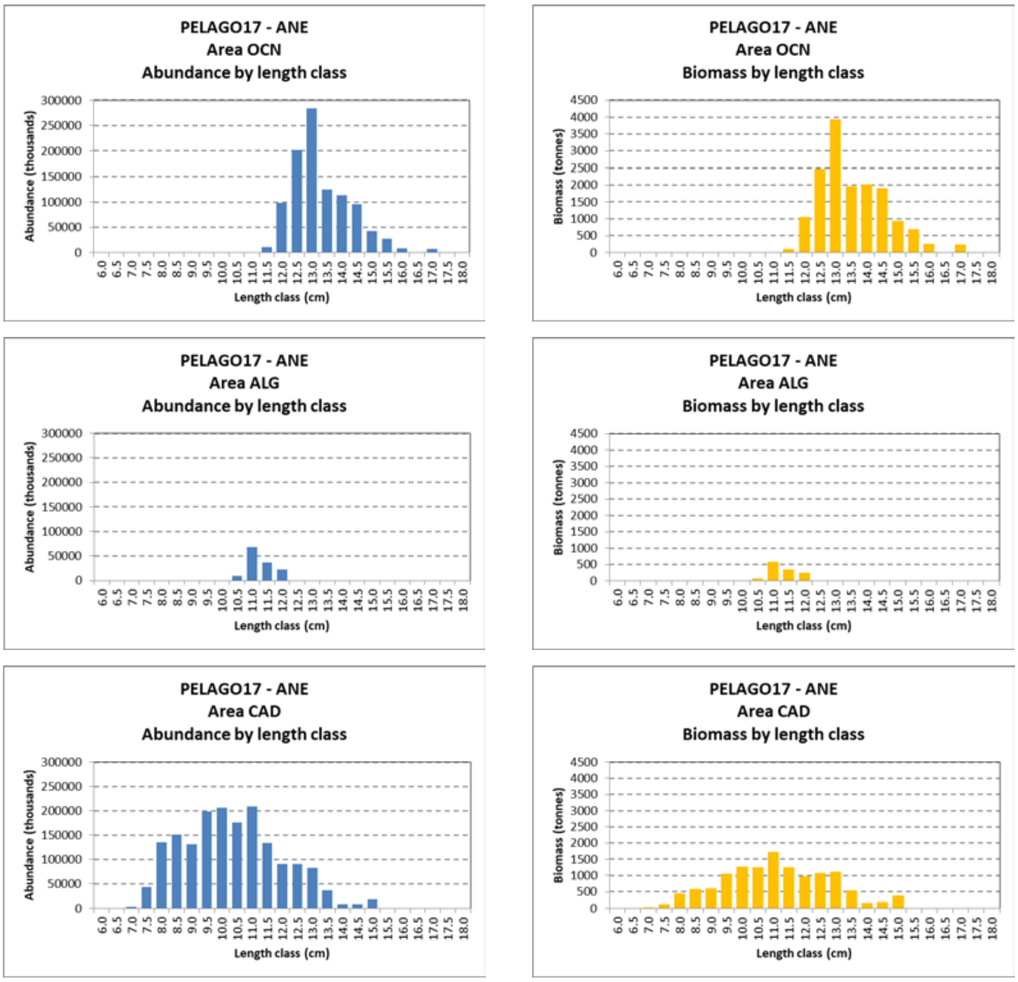
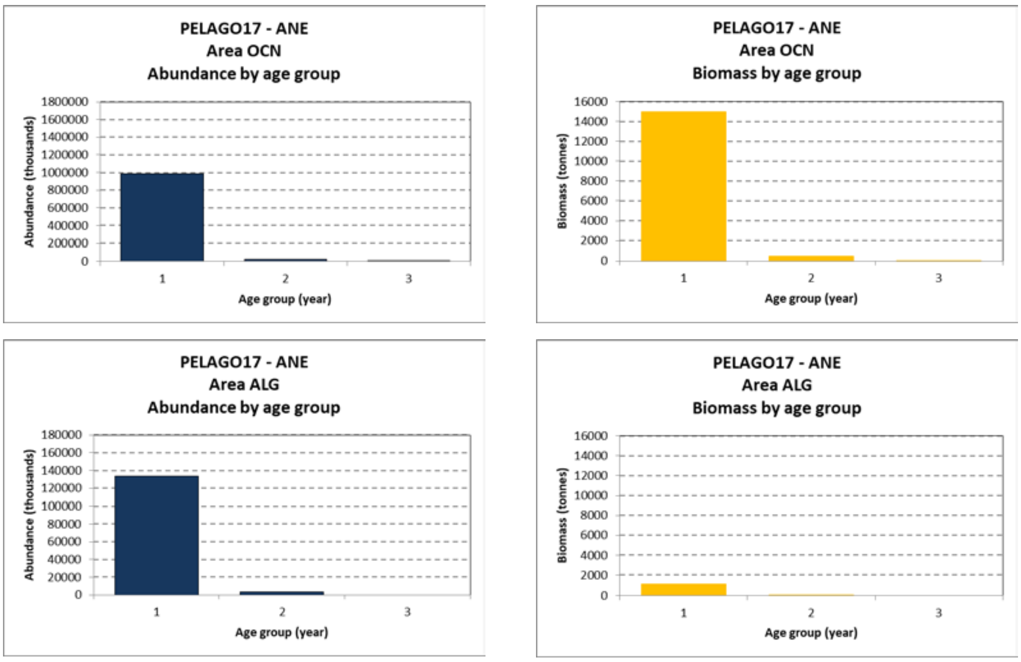


Figure 2.7. PELAGO17: Estimated anchovy abundance and biomass composition by length class in each occurrence area.



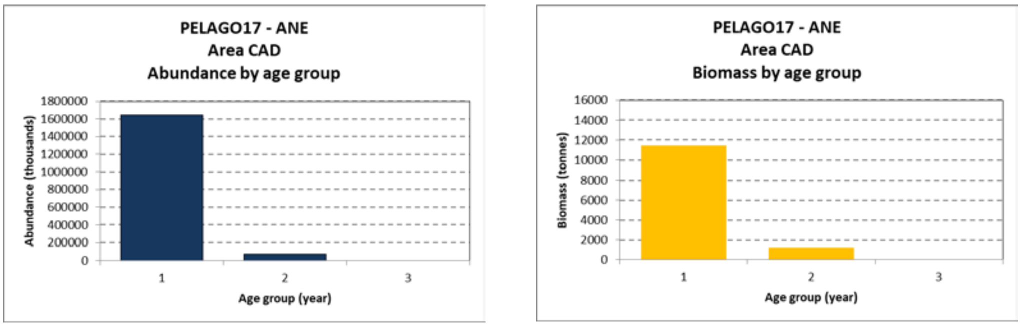


Figure 2.8. PELAGO17: anchovy estimated abundance and biomass by age group in each sampled area.

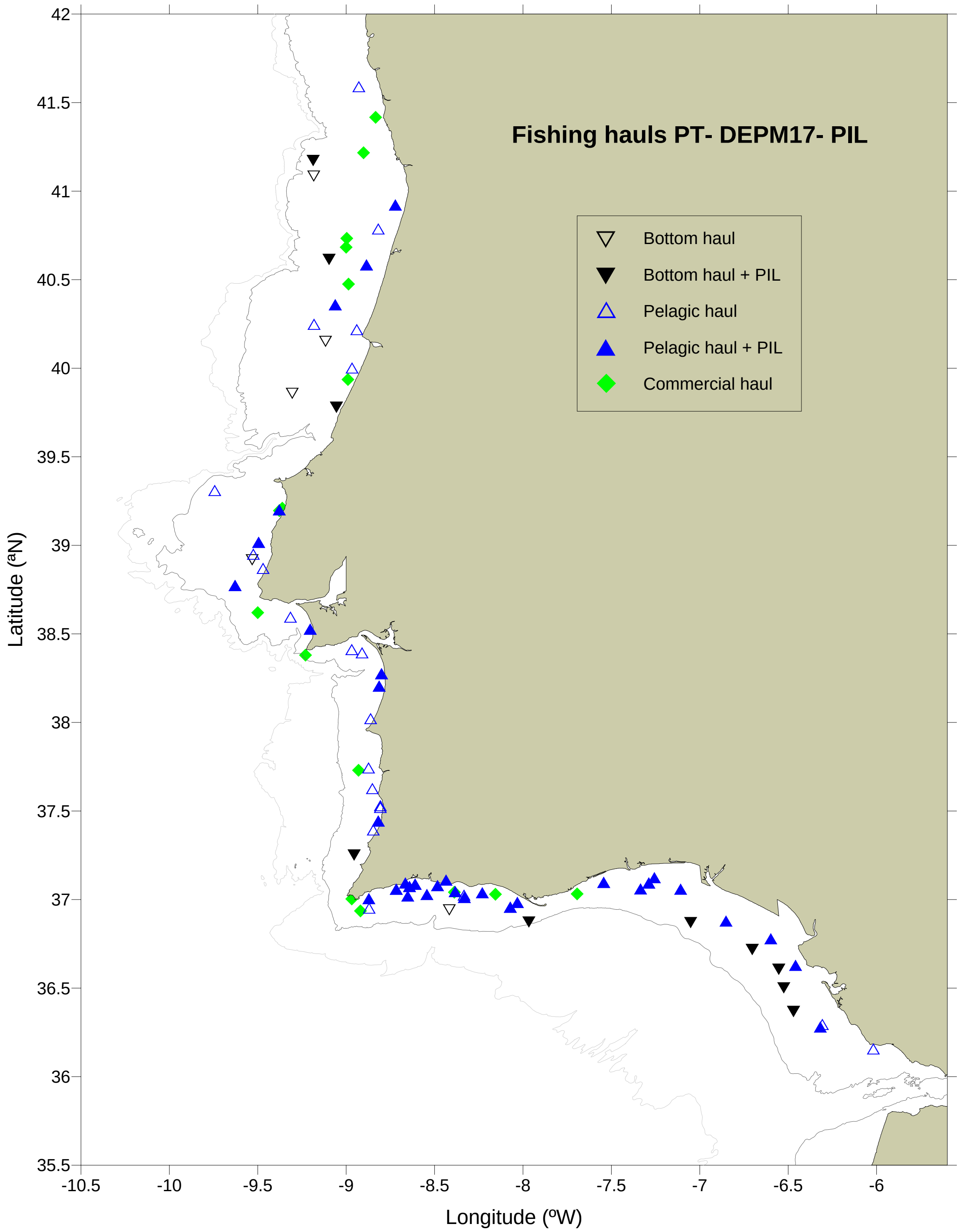


Figure 2.9. DEPM: Location of the fishing hauls for the application of the DEPM, from the RV "Noruega" (bottom and pelagic trawl; black and blue triangles, respectively) and from the commercial fleet (green diamonds); open symbols: trawls with no sardine; filled symbols: trawls with sardine.

3. Plankton and environmental surveying

Material and methods

Gear for plankton and hydrology surveying:

- CUFES: mesh size 335 µm, continuous sampling at the surface (~ 3m)
- CalVET: adapted structure (double nets CalVET (25cm mouth opening) + CTDF), mesh size 150 µm, vertical tows through the whole water column
- BONGO: double nets with 60cm mouth opening (mesh size: 200, 500µm), oblique tows through the whole water column
- continuous surface observations of temperature, salinity and fluorescence using onboard sensors associated to the CUFES system
- temperature, salinity and fluorescence (chlorophyll) profiles using a CTDF probe (RBR - Concerto)

During the joint surveys the day was occupied with the regular CUFES surveying along the acoustic transects. Zooplankton samples and temperature, salinity and fluorescence observations were gathered. The data, together with GPS information, were compiled using the EDAS software. DEPM sampling was carried out when acoustics surveying was not running, mainly during the night period. On the pre-defined stations along the DEPM transects CalVET samples (every 3 or 6 nmiles and down to 200m maximum) and CTDF casts were obtained. In addition, CUFES samples were gathered continuously along the path between the vertical plankton tows. To complete the zooplankton surveying, oblique zooplankton tows through the whole water column, were undertaken with Bongo nets at inner and mid shelf locations, alternately, one per transect. The plankton samples were preserved onboard with buffered formaldeyde solution at 4% in distilled water for further processing in the laboratory. While only DEPM sampling was being carried out (southern coast in mid March) plankton surveying was conducted day and night.

Results

Temperature, salinity and fluorescence (chlorophyll$_a$) distributions

In 2017, both, the DEPM and the PELAGO, surveys took place later than planned and since they were partially joint, the southern shores were sampled in two occasions (mid March and late May-early June) while the western coast was surveyed once but with some interruptions due to weather and logistics constraints (see table 1.1 for details) which led to spatial and temporal discontinuites in sampling. Surface temperature, salinity and fluorescence distributions are shown in figures 3.1 and 3.2. During the first coverage of the southern stratum (figure 3.1) the observations indicated a typical spring situation with temperatures between 14 and 17.5°C and fluorescence patches associated to, still clear, river plumes. During the second passage the sea surface temperatures were, on average, 2-3ºC degrees higher and the phytoplankton signatures were very weak. In the western coast, monitored during an extended period, the surface temperatures ranged from 13.5ºC to 17.5ºC, in the NW, and 17 ºC to 19 ºC, in the SW. When sampling took place in the northern most region, the colder waters of continental origins and associated peaks of fluorescence were very evident. Overall, for the main period of the surveys, and since they finished later than in previous years, the water temperature was higher than usually is during corresponding campaigns within the historic series.

Egg distribution and preliminary production estimation (P0)

Zooplankton samples were collected with CalVET and Bongo nets and the CUFES system, a summary of the information gathered is presented in Table 1.1. The data available at present include the egg abundances obtained from the CUFES samples associated to the acoustics transects in the NW region (OCN) and egg abundances and staging for sardine from the CalVET paired samples.

In 2017, the plankton sampling for DEPM was reduced, during the period of the joint sampling for acoustics and DEPM, to avoid further delay in the PELAGO survey, consequently the CalVET results available for spawning area definition and egg production estimation are limited. When all CUFES samples, from PELAGO surveying, are analised the spawning area resolution may be improved. The egg abundance distributions for sardine and anchovy available at present are depicted in figures 3.3, 3.5 and 3.6.

A total of 350 CalVET samples were collected along 50 of the regular 59 transects of the sardine DEPM survey grid. The gaps in the sampling grid, in particular from Cabo Mondego to Cabo Carvoeiro and in the SW shore, limit an accurate definition of the spawning area. Sardine egg abundance in the western stratum was lower than in the other years of the historic series with the exception of 2011. Despite the low egg densities the percentage of positive stations (38%) was not among the lowest indicating a scattered egg distribution which is noticeable in the map of figure 3.3 where it can be observed that for many CalVET samples the number of eggs collected was quite low (resulting possibly from low and spread fish and egg abundances and egg dispersal). Nonetheless, a small area of higher abundances was observed to the north of Douro (also observed in the densities from the CUFES samples) and some patches were also detected in the southern coast, in Cadiz Bay and Algarve. The low egg abundances during this year´s survey in the west coast may be attributable to low sardine abundance and/or low reproductive activity during the survey period which was conducted late in the usual spawning season. In the southern stratum, sampled for DEPM in mid March, the egg densities and spawning area size (46% of positive stations) were within the range observed for other years of the DEPM historic series and slightly higher than during the last DEPM survey, in 2014. Preliminary egg production results obtained using the traditional methodology (not considering the external mortality model adopted for the revision presented at the last bench mark meeting) and a single mortality estimate for both strata, indicate one of the lowest estimates of the series for the west coast and a value for the south within the range of the results obtained for other years of the DEPM series (figure 3.4) (P0_tot South: 1.4 x 10^{12} eggs/day; P0_tot West: 0.5 x 10^{12} eggs/day). Final egg production estimates will only be available when the spawing area definition can be completed using the CUFES results and the calculations attained using the three strata information (south, west and north) and the methodology considering the mortality estimation using the external model which considers the values for the whole data series and the water temperature as covariate. The final estimates will be presented at the 2017 WGACEGG meeting in November.

As it has happened for the more recent years the anchovy egg abundances in CUFES samples during PELAGO surpassed the sardine egg densities. This pattern was very clear in the NW this year (Figures 3.5 and 3.6), where a record number of anchovy eggs were collected, over an extended area but in particular, inshore, and from Aveiro to the South, where schools of anchovy were also observed. The high anchovy egg abundances observed in the NW region likely reflected the survey timing, further into the usual anchovy spawning season.

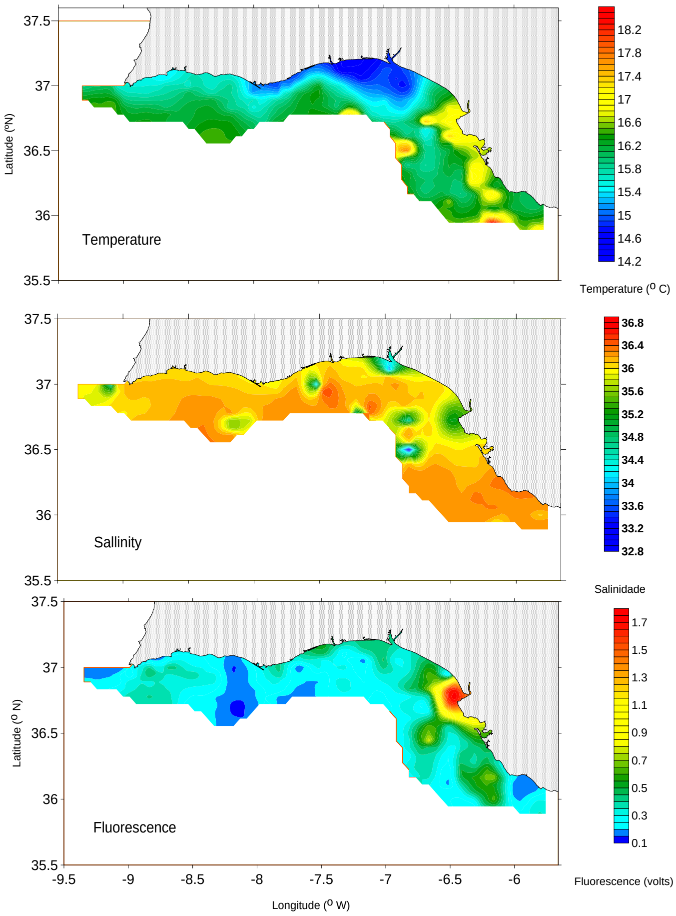


Figure 3.1. Surface temperature (top panel), salinity (mid panel) and fluorescence (bottom panel) distributions obtained by the sensors associated to the CUFES system during the DEPM survey in the period 17-19 March 2017.

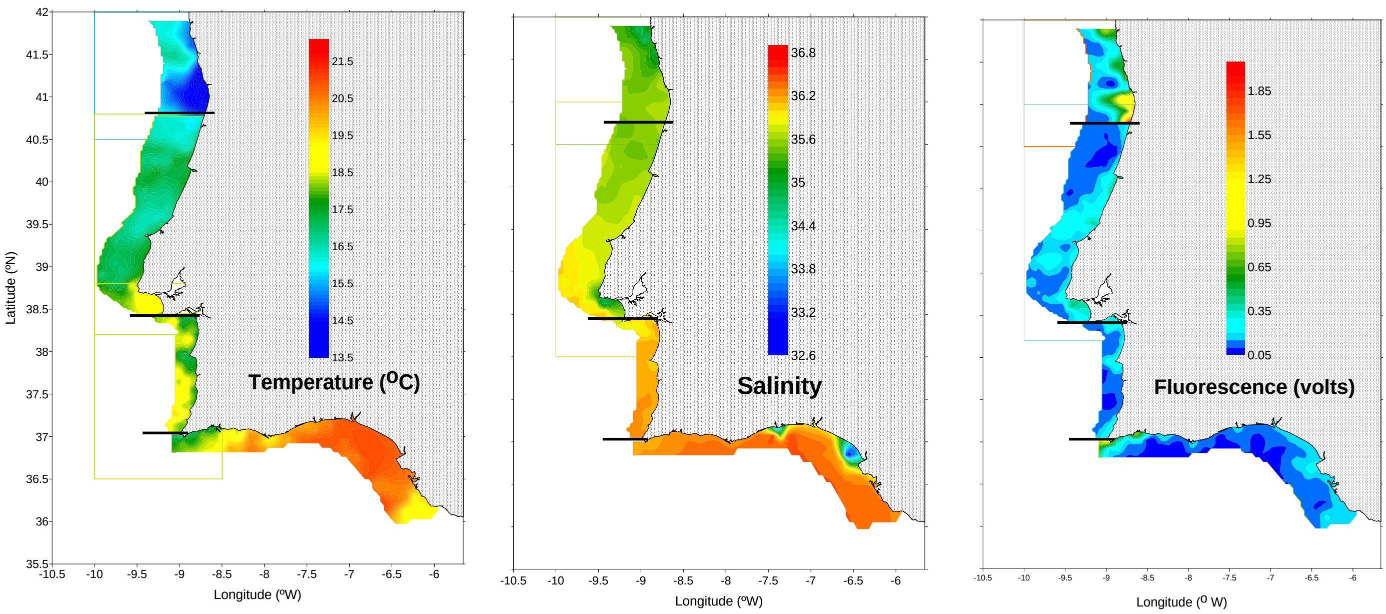


Figure 3.2. Surface temperature (left panel), salinity (centre panel) and fluorescence (right panel) distributions obtained by the sensors associated to the CUFES system during the joint DEPM+PELAGO survey in the west (25Apr-24May) and PELAGO in the south (28May-6Jun).

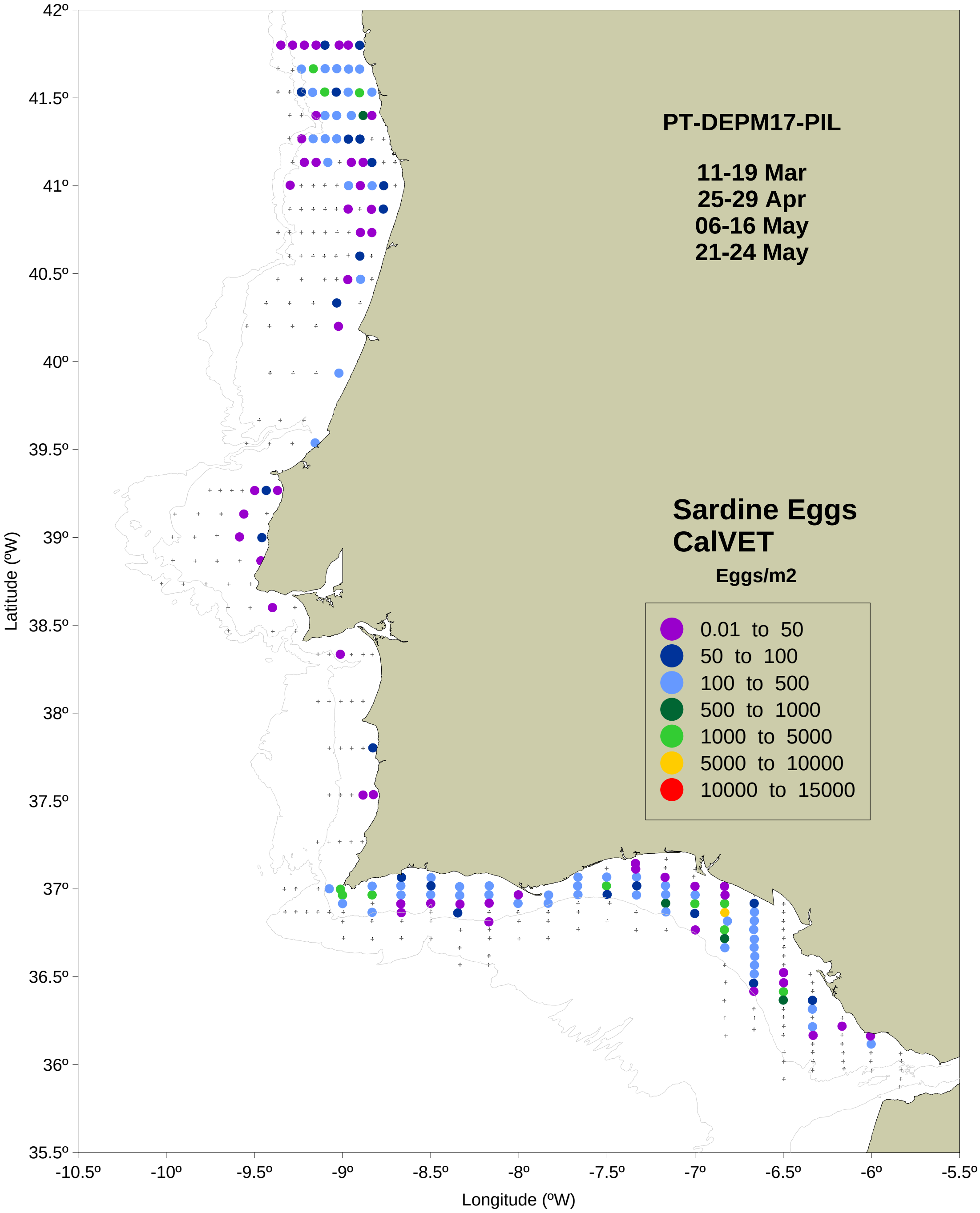


Figure 3.3. Sardine egg abundance distribution (eggs/m²) obtained from CalVET samples.

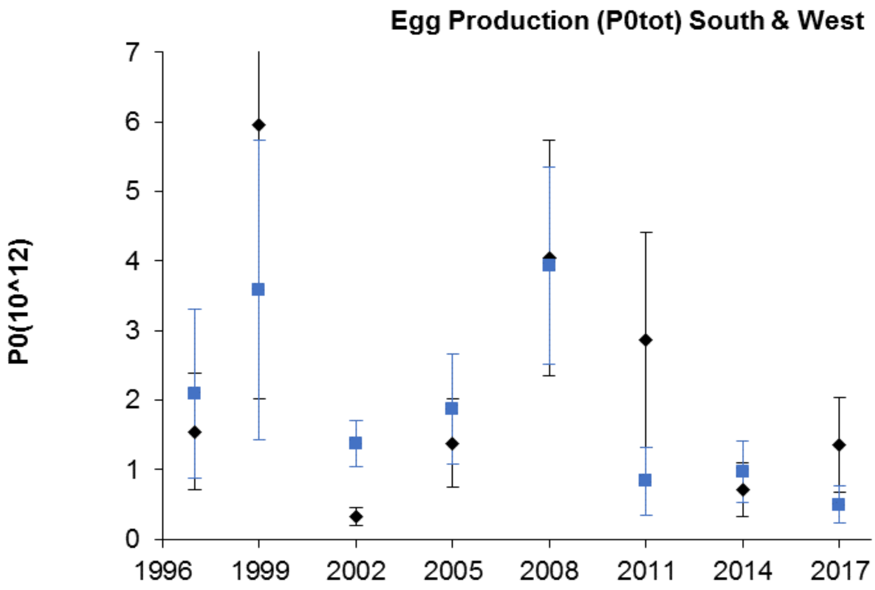


Figure 3.4. Sardine egg production (eggs/day) estimates for the southern (black) and western (blue) strata (ICES 9a south) during the DEPM series (1997-2017) using the traditional methodology.

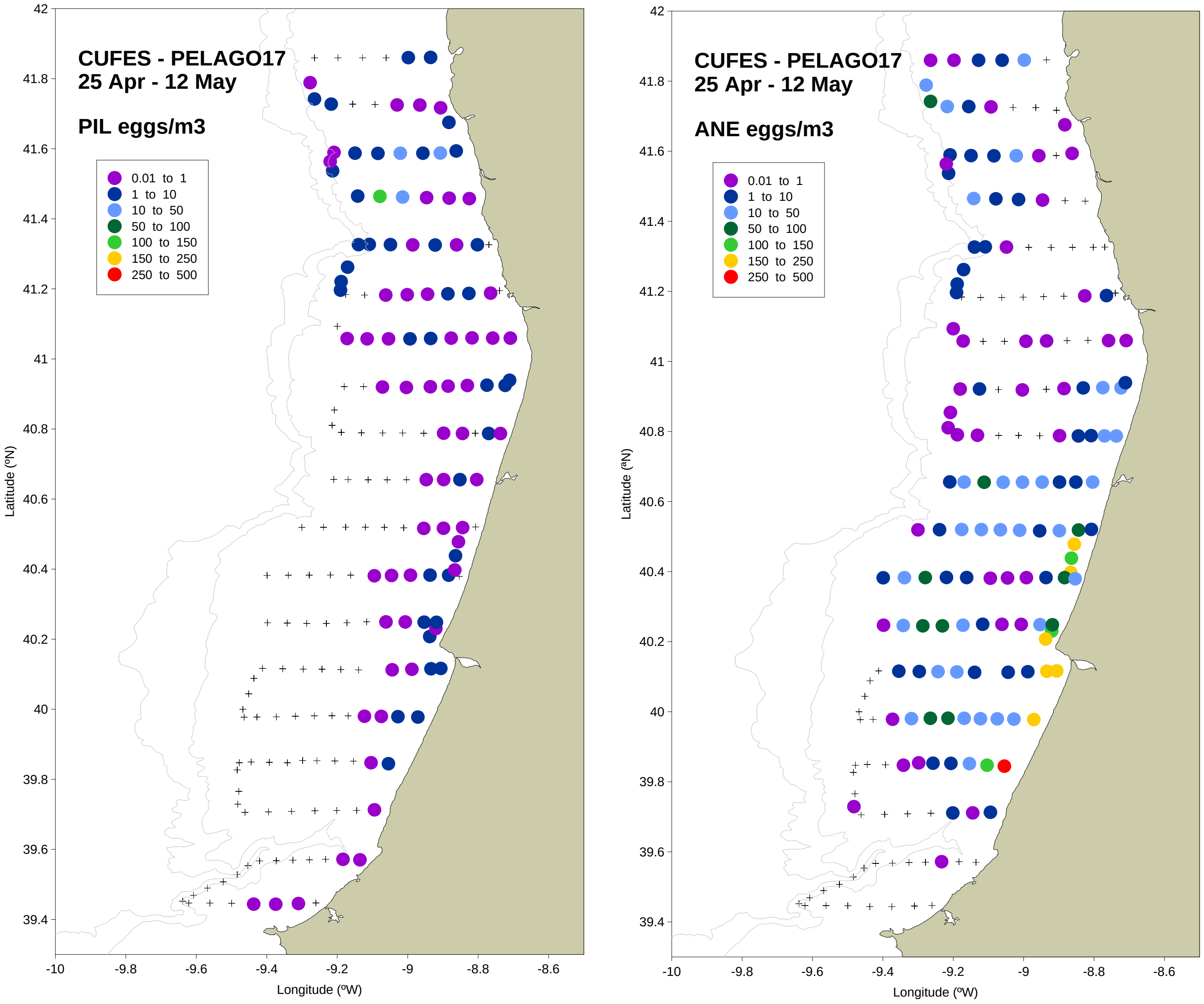


Figure 3.5. Sardine (left panel) and anchovy (right panel) egg abundances distributions (eggs/m^3) in the NW shelf obtained from CUFES sampling during PELAGO surveying.

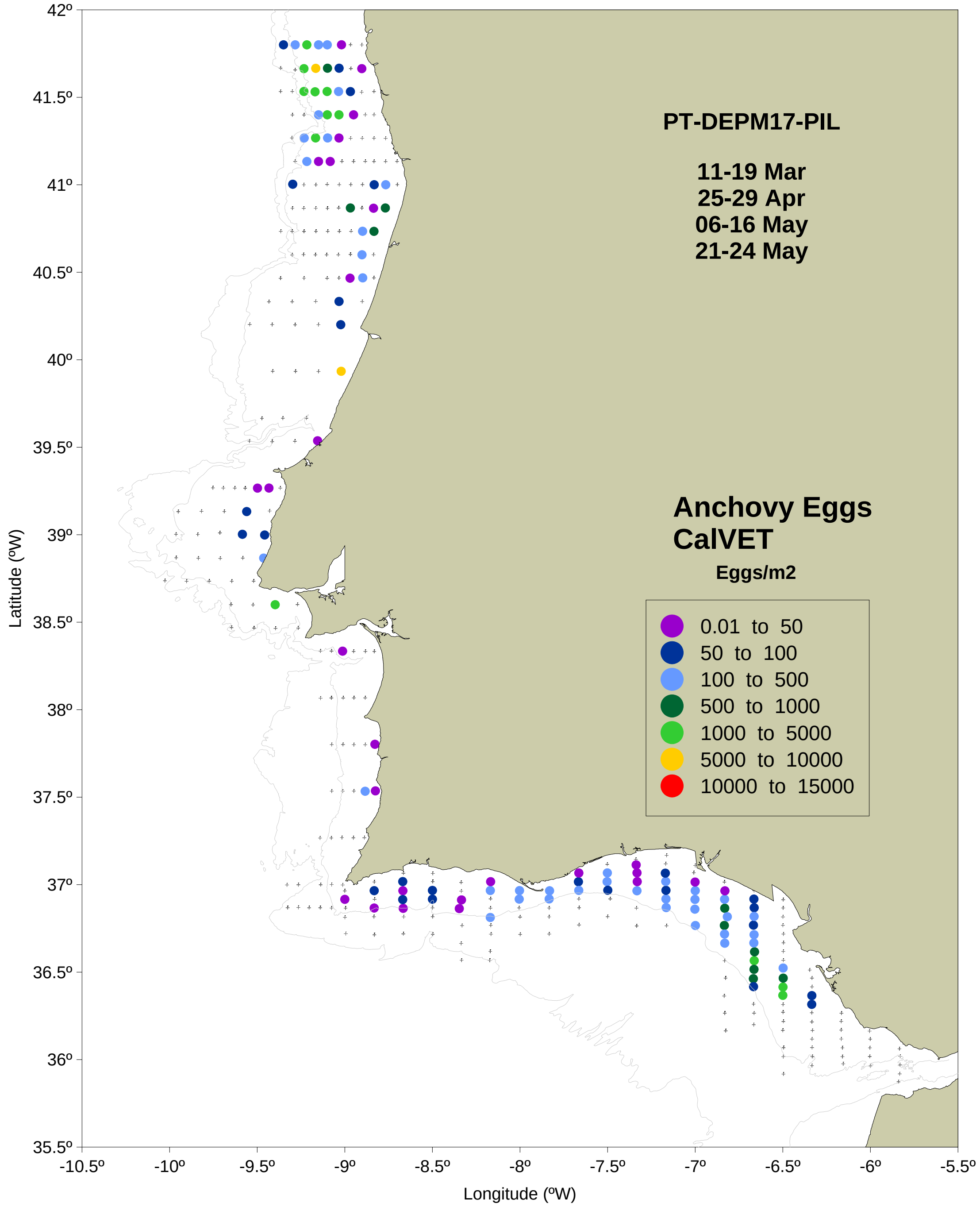


Figure 3.6. Anchovy egg abundance distribution (eggs/m²) obtained from CalVET samples.

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Foote, K. G., Knudsen, H. P., Vestnes, G., Brede, R., Nielsen, R. L., 1981. Improved Calibration of Hydroacoustic Equipment with Copper Sphere. *ICES, CM* 1981/B:20, 18p.

Weill, A., Scalabrin, C. and Diner, N., 1993. MOVIESB: An acoustic detection description software. Application to shoal species classification. *Aquatic Living Resources* 6: 255-267.

ANNEX 1

PEL17AGO synthetic report survey

PEL17AGO survey was carried out onboard RV "Noruega" from 21th to 31th August 2017 (sampling between 22 and 30 August). The survey covered the Portuguese shelf from Caminha to Nazaré, which corresponds to the Occidental Central North zone (OCN). The main objective was to estimate the sardine abundance and biomass in this area and compare it with the estimates from PELAGO17 survey, since the OCN zone was sampled with very bad weather and under technical problems of the vessel.

The acoustic transects were similar to those performed in the PELAGO17 survey (17 for the OCN zone) and the same methodology was followed. To collect the biological data, 23 fishing hauls were undertaken, of which 12 pelagic and 11 bottom trawls (Figure 1). The trawl samples were used to identify the species and to split the acoustic energy by species and by length, within each species. Fishing was carried out according to the echogram information.

Figure 2 shows the proportion, in number, of the main pelagic species caught in the surveyed area. In the northern part of OCN there was a predominance of the pelagic crab, *Polybius henslowi*, and this species appeared frequently also in the remaining surveys area. Only 3 fishing trawls caught a significant number of sardines (more than 30 individuals), and low numbers occurred in 7 other hauls. Besides *P. henslowi*, samples were dominated either by horse mackerel or chub mackerel in the more coastal hauls and blue whiting in the off-shore hauls. The frequency of anchovy was low.

Figure 3 presents the sardine acoustic energy for each mile along the acoustic transect showing a very localized distribution in the vicinity of Ria de Aveiro, and some acoustic energy south of Figueira da Foz. The distribution of sardine shoals in the northern limit of Ria de Aveiro shows a geographical consistency when compared to PELAGO17.

Figure 4 shows the length class composition of the sardine abundance in the area. The size distribution in August shows the presence of recruits (14-16 cm) not detected in late April-early May during the PELAGO17. The sizes within the second mode (16.5-20.5 cm) are consistent with the length distribution observed in the PELAGO17 plus the expected growth.

The sardine abundance estimated at the OCN zone during the PEL17AGO in August was 162935 thousand individuals, corresponding to biomass of 9642 tonnes. These new estimates are of the same order of magnitude as the PELAGO17 estimate for the same area (232547 thousand and 11878 tonnes), and confirm the strong biomass reduction in the Occidental North zone in 2017 compared with 2016 (30 thousand tonnes).

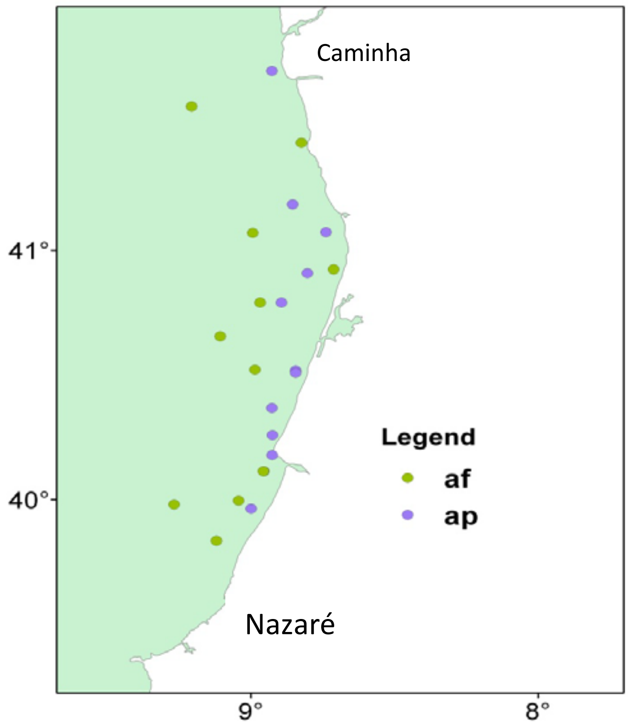

Figure 1 – RV “Noruega”Fishing trawl location in the PEL17AGO survey: af- bottom trawl; ap – pelagic trawl.

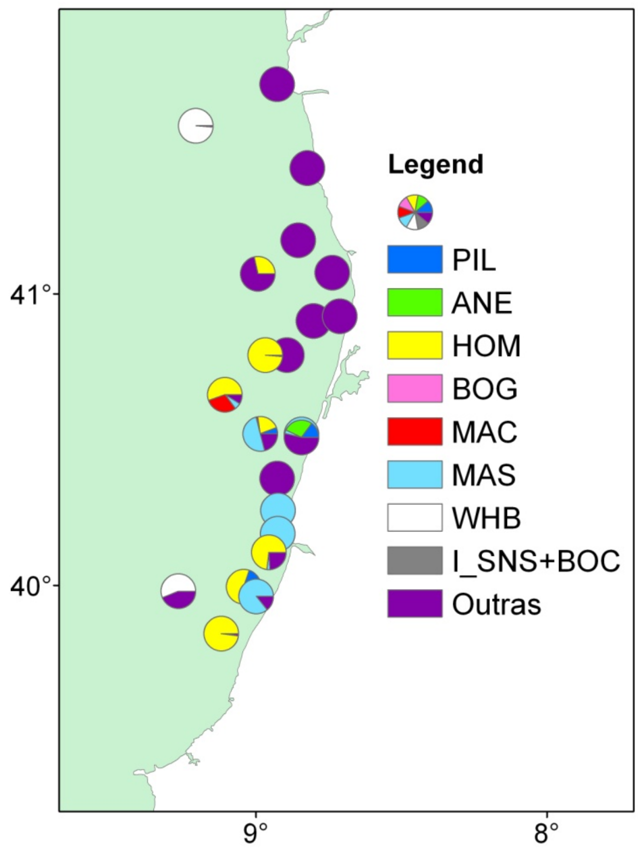

Figure 2 – Fishing haul species composition (in number) in the PEL17AGO survey. (PIL-sardine, ANE-anchovy; BOG-bogue, HOM-horse mackerel, MAC-mackerel, MAS-chub mackerel) WHB- blue whiting, JAA- black jack mackerel, SNS- snipe fish, BOC- boar fish).

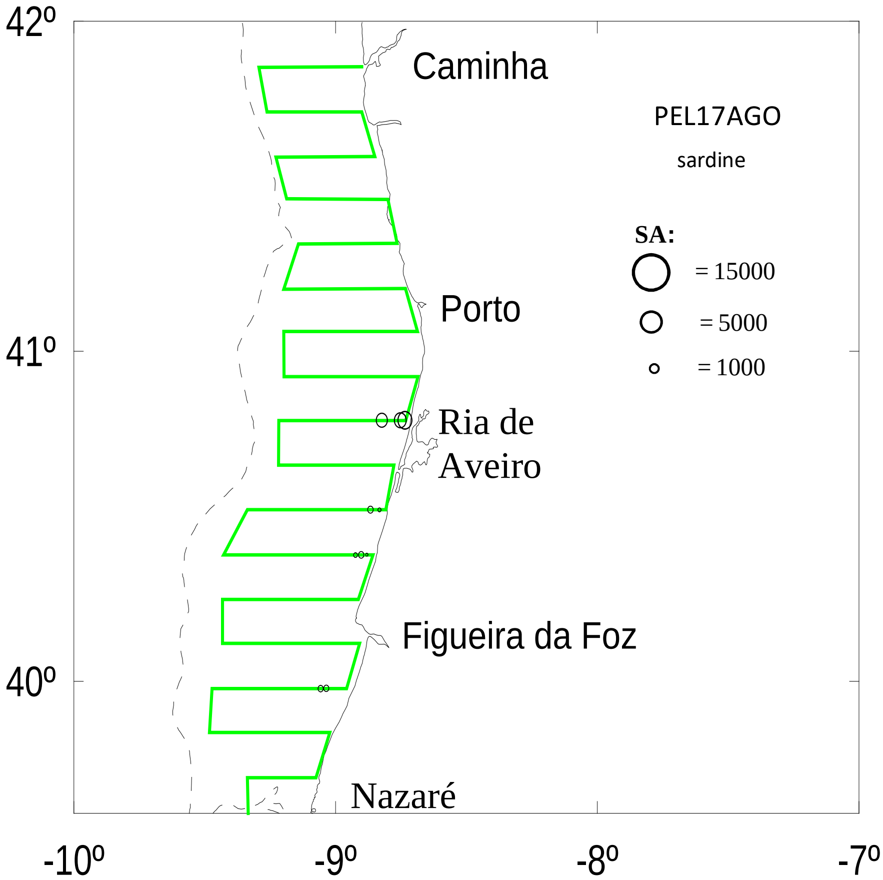

Figure 3 – Sardine acoustic energy spatial distribution. Circle area is proportional to the acoustic energy (S_A m²/nm²). The green line represents the acoustic transect (performed until Nazaré).

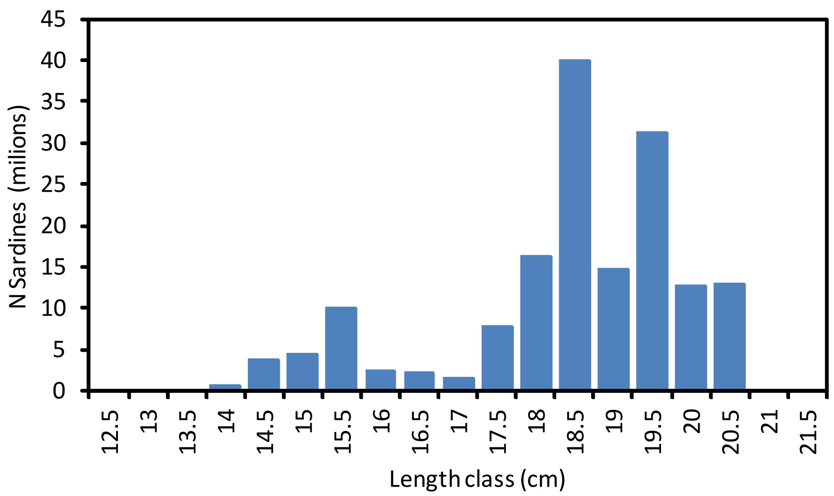

Figure 4 – Sardine biomass length distribution in the Portuguese Occidental North zone estimated in the PEL17AGO survey.

IPMA Pelagic Surveys in the Atlantic Iberian Waters of ICES area 9a (River Minho - Cabo Trafalgar): PELAGO17 acoustic estimations for sardine and anchovy and PT-DEPM17-PIL summary

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Abstract

In 2017, the acoustic PELAGO and the sardine DEPM surveys were delayed owing to technical problems with the vessel and to the installation of transducers and the upgrade of the echosounder installed onboard, and were therefore carried out partially concurrently. During the combined survey, acoustic sampling was conducted during the day while during the night, plankton samples and CTDF casts were obtained for the DEPM (sardine and horse-mackerel). Fishing hauls were carried out to serve the objectives of both methods. This document presents the geographic distribution, the abundance and biomass acoustic estimations for sardine and anchovy whilst at present the DEPM results are still incompletely available. A summary of the work developed during the surveys, by geographical area, is presented in Table 1.1.

The main objective of the PELAGO17 survey was to describe the sardine and anchovy spatial distributions and to estimate their abundance off the Portuguese and the Spanish Gulf of Cadiz shelves. The estimated sardine biomass was 81 thousand tonnes for the whole area, representing a significant reduction in relation to the PELAGO16 survey (172 thousand tonnes). The reduction in biomass was verified in the whole surveyed area, with lower expression in the OCS zone. The decrease in numbers was even more significant due to the low abundance of small sardines (< 16 cm), in particular in the main recruitment areas (OCN and CAD). Anchovy biomass also decreased in relation to the PELAGO16 survey (29.3 thousand tonnes, comparing with 65.4 thousand tonnes).

The DEPM survey in the southern stratum was conducted in mid March (17-19) and the western shores were monitored in April-May simultaneously to PELAGO (25Apr-24May). Since the period of surveying was quite lengthy the weather and oceanographic settings observed in the different regions varied appreciably. The southern coast in March was monitored under typical spring conditions, with mild temperatures, while later, in May-June, the water column was much warmer (and stratified). The northwestern shores were surveyed during a very unsettled period with strong winds and, at times, rough sea. The varied sea conditions may have affected fish behaviour and distribution and its availability for fishing. The DEPM sampling was conducted quite late in the sardine spawning season.

Preliminary results on egg distribution showed low sardine egg abundances in the western coast and average results for the southern stratum. Conversely, the data available so far, seems to indicate higher than usual anchovy egg densities, in particular for the NW platform, where schools of anchovy were observed. The fact that the surveys took place later than normal and that the temperatures were warmer than during the regular period of monitoring may have had an effect on the egg observations which were carried out more into the anchovy spawning season, in the west, and late in the season for sardine.

1. Introduction

The acoustic surveys, PELAGO series, and the DEPM surveys (for sardine and horse-mackerel) are funded via EU-DCF and national programs and coordinated with the surveys from Spain and France within ICES. The campaigns PELAGO and PT-DEPM-PIL (aiming at sardine) are discussed and reported to WGACEGG (Working Group on Acoustics and Egg Surveys). The Portuguese acoustic survey, takes place each year during spring covering the shelf waters of Portugal and Cadiz Bay. The main objectives of PELAGO surveys include monitoring the abundance distribution through echo-integration, and the study of several biological parameters for sardine (*Sardina pilchardus*), anchovy (*Engraulis encrasicolus*), mackerel (*Scomber scombrus*), chub-mackerel (*Scomber colias*), horse-mackerel (*Trachurus trachurus*) and other small pelagic fishes. Surveying also considers continuous observations of fish egg and larvae along the acoustic transects (CUFES-Continuous Underway Fish Egg Sampler) and hydrological and biological characterization of the water column. Additionally, census of marine birds and mammals are conducted during the survey trajectory.

Surveys directed at the estimation of the spawning stock biomass (SSB) through the Daily Egg Production Method (DEPM) are conducted on a triennial basis and in different years for sardine and for horse-mackerel. The Portuguese survey, PT-DEPM-PIL, is scheduled to occur during sardine peak spawning in the area from Cadiz to the Portugal-Galicia border. IPMA's survey is coordinated with its IEO congener which monitors the Cantabrian and Galician waters. The DEPM methodology involves surveying of the target species distribution area for plankton collection (and CTD casts) along a pre-defined grid of stations for spawning area definition and egg density and production estimations. Concurrently fish hauls are performed for adult parameter estimation: female mean weight, sex-ratio, batch fecundity and daily spawning fraction.

In 2017, operational constraints delayed the DEPM survey and therefore, after the first DEPM leg, in the south, in March, the decision was to carry out both, DEPM and PELAGO surveys thereafter, concurrently using the same vessel. The PELAGO17 survey was delayed about one month to enable the installation of transducers and upgrade of the echosounder. The survey ended up the 7 June, only 15 days before WGHANSA. Despite all efforts to speed up the data logging and the acoustic data processing, preliminary estimations of sardine and anchovy biomass were only achieved during the WG meeting and only for three of the 4 surveyed areas, because difficulties were encountered in the biomass estimation in the Occidental North area (OCN). Final estimations presented in this report include the re-analysis of the echograms for the OCN area with the use of additional information on the fishery samples and the distribution of eggs collected along the survey.

Table 1.1. PT-DEPM17-PIL and PELAGO17 survey summary information by area.

	OCN (NW)	OCS (SW)	ALG (S)	Cadiz (S)
Vessel	Noruega	Noruega	Noruega	Noruega
Dates	25-29/4+6-11/5 (DEPM + acoustics)	12-16/5+ 21-24/5 (DEPM + acoustics)	17-19/03 (DEPM); 25/5 (DEPM rep) 3-6/6 (acoustics)	11-15/3 (DEPM); 28-31/5 (acoustics)
SURVEY EGGS & HYDROGRAPHY	**OCN (NW)**	**OCS (SW)**	**ALG (S)**	**Cadiz (S)**
SST (ºC) max/mean/min	17.6/16.2/14.0	19.6/17.7/16.4	21.0/19.2/16.9	22.5/20.8/19.0
SST (ºC) max/mean/min (march)	-	-	16.5/16.0/14.8	18.7/16.1/14.6
Transects CalVET	15	13	12+5*	10
CalVET – n stations	112	69	73+25*	100
Positive samples PIL	54	14	34+6*	46
Positive samples ANE	75	18	24+12*	42
Tot eggs PIL	870	56	1233+23*	1744
Tot eggs ANE	4201	403	215+96*	1426
Max eggs/m2 per sample PIL	23.33	1.62	56.02	112.48
Max eggs/m2 per sample ANE	7.33	19.01	9.05	27.50
CTDF casts	112	69	73+25	100
Transects CUFES DEPM	15	13	12+4	10
CUFES samples - DEPM	139	96	107+30	141
Transects CUFES PELAGO	17	30	15	11
CUFES samples - PELAGO	169	215	99	116
Tot eggs PIL	3002	na yet	na yet	na yet
Tot eggs ANE	27860	na yet	na yet	na yet
Max eggs/m3 per sample PIL	112.27	na yet	na yet	na yet
Max eggs/m3 per sample ANE	290.53	na yet	na yet	na yet
Bongo samples	9	6	7	10
SURVEY ACOUSTICS & FISH	**OCN (NW)**	**OCS (SW)**	**ALG (S)**	**Cadiz**
Number of acoustics transects (nm)	17(453)	29(415)	14(166)	11(194)
Number hauls R/V (pelagic/bottom)	8/6	18/1	21/4 (10/1 only DEPM)	10/6 (2/3 only DEPM)
Number hauls (CV) - PIL	6	5	5	0
Number hauls (CV) - HOM	4	0	2	0
Number RV (+) trawls - PIL	6	6	18 (8 only DEPM)	13 (4 only DEPM)
Number RV (+) trawls - HOM	7	6	13 (10 only DEPM)	5 (3 only DEPM)
Number RV (+) trawls - MAC	2	2	0	1
Number RV (+) trawls - MAS	7	8	17 (9 only DEPM)	4 (2 only DEPM)
Number RV (+) trawls - ANE	6	0	1	10 (3 only DEPM)
Depth range (m) in (pelagic/bottom) RV fishing operations	14-110/ 83-149	19-164/ 88	23-52/ 74-99	19-52/ 56-104
Period of the day covered by RV fishing hauls (pelagic/bottom)	08:27-17:54/ 09:50 -17:49	7:19-19:51/ 16:33	7:33-19:57/ 7:35-17:29	7:21-17:56/ 7:52-13:37
Total number fish sampled - PIL	470	537	1243	634
Total number fish sampled - HOM	423	188	554	144
Total number fish sampled - MAC	0	4	0	0
Total number fish sampled - MAS	106	197	561	39
Total number fish sampled - ANE	399	0	0	367
Number otoliths collected - PIL	415	523	941	377
Number otoliths collected – HOM	351	181	487	144
Number otoliths collected - MAC	0	4	0	0
Number otoliths collected - MAS	80	146	430	39
Number otoliths collected - ANE	164	0	0	163
Number ovaries preserved - PIL	210	272	413	66
Number ovaries preserved - HOM	210	83	150	30

Notes:
Surveys were partially concurrent (during the period: 25Apr-24May).
* - some stations repeated after first coverage
CV – Commercial vessels
RV – Research vessel

2. Acoustic Survey

Material and methods

Acoustics

Survey execution and abundance estimation followed the methodologies adopted by the ICES WGACEGG. The survey area, over the shelf until the 200 m isobath, was covered following a parallel grid with a mean distance between transects of 8 nautical miles. Average survey speed was 8 knots and the acoustic signals were integrated over one nautical mile intervals. Echo integration was carried out with a scientific echo sounder Simrad 38 kHz and 120 KHz EK60 scientific echo sounder, used for the first time. The acoustic data was recorded in MOVIES+ (Weill *et al*., 1993), which was also used to integrate the fish acoustic energy. The echogram bottom was manually corrected prior to the acoustic energy extraction. An acoustic calibration with a copper sphere was carried out, following the standard procedures (Foote *et al.*, 1981). For presentation purposes and results comparison, the surveyed area was divided, as usual, into 4 sub-areas or regions: OCN (from Caminha to Nazaré), OCS (from Nazaré to Cape S. Vicente), Algarve (from Cape S. Vicente to V. R. Santo António) and Cadiz (from V. R. Santo António to Cape Trafalgar).

Difficulties were encountered in the biomass estimation in the Occidental North area (OCN) since the fishing hauls were not always successful. Therefore, for this particular survey, final estimations used additional information on fishery samples and the distribution of eggs collected along the survey. Some schools were assigned directly to sardine, due to morphologic and density characteristics of the schools, typical for adult sardine in this region. Additionally, an important school, in the north (transect 3) was also attributed to sardine, due to a great amounted of sardine eggs (CUFES), in the vicinity (Figure 3.5) which may have drifted from the school location.

The OCN area includes the main recruitment area for sardine in the west Portuguese coast and is considered an important area for the distribution of this species and in recent years also for anchovy. In order to further validate PELAGO17 estimations, the OCN zone was surveyed again during August. Results are annexed to this report (Annex 1).

Adult fish

To collect the biological data, pelagic and bottom trawls were used. The trawl samples were also used to identify the species and to split the acoustic energy by species and by length, within each species. Fishing was carried out according to the echogram information. Nevertheless, due to the presence of fixed commercial fishing gears or irregular and rocky bottoms, it was not always possible to make hauls in some areas. Biological sampling of sardine, anchovy, horse-mackerel, mackerel and chub-mackerel was performed in each haul, when present. Ovaries from sardine and horse-mackerel were preserved for fecundity and spawning fraction estimations. In addition, otoliths were collected for sardine, anchovy, horse-mackerel, mackerel and chub-mackerel. Otoliths are used for age reading and for the production of Age Length Keys (ALK's). For sardine and anchovy, the abundance (x 1 000) by age group and area is estimated from the combination of the ALK and the estimates of abundance at length from the echo-integration in each area.

Results

Fish trawling, biological data, and pelagic community

On the whole, 74 fishing hauls were obtained during the whole survey, 57 from pelagic and 17 from bottom trawling, the first 16 hauls corresponding to the first survey leg exclusive of DEPM (Table 1.1. and Figure 2.1). Samples from these hauls provided individual biological data for 5866 fish (of sardine, anchovy, horse-mackerel, mackerel and chub mackerel), and 4445 otoliths from these 5 pelagic species were collected for age determination.

The part of the survey during which DEPM was applied, included 52 hauls, 27 (52%) of which were positive for sardine, and from which 17 samples will be used for the estimation of the adult parameters. These survey samples were complemented with 16 samples provided by the commercial fleet (mostly from purse seine) (Figure 2.9). On the whole, 961 ovaries were preserved for histological processing and fecundity and spawning fraction estimation (Table 1.1.). These DEPM estimates are at present not available.

During the PELAGO17, 62% of the hauls were positive for sardine, but the latter represented only about 15% of the fish caught (in numbers), their availability in the trawls continuing in a downward trend in the latest surveys; sardine were caught in very low numbers in the Occidental North (OCN) area, and were present mainly in the hauls carried out in Occidental South and Southern (ALG, CAD) areas (Figure 2.2). Anchovy were present in 28% of the hauls, almost exclusively concentrated in Occidental North (OCN) and South areas, but represented more than 60% (in numbers) of the fish caught during the survey (Figure 2.2). As for the other pelagic (horse-mackerel, mackerel and chub mackerel), they were caught in less numbers (about 13% in number), with chub mackerel present mainly in the Occidental South (OCS) and Algarve areas but with an increasing presence in the Occidental North (OCN) area.

Sardine and anchovy biomass, abundance and distribution

Figures 2.3 and 2.4 show sardine and anchovy distribution of acoustic energy; both species presenting a patchy pattern. In particular, sardine energy in the Occidental North (OCN) area was very scarce, restricted to only a few transects. Main sardine acoustic energy was located between Peniche and Lisboa, South of Sines, and in the Western part of Algarve (Figure 2.3). As for anchovy, acoustic energy in the West coast was concentrated in the area between Porto and Nazaré, while in the South coast, it was located exclusively eastern to Faro, and mainly in the Cadiz Spanish waters (Figure 2.4).

The sardine biomass estimate of 81 thousand tonnes for the whole area (Table 2.1) is a significant reduction in relation to the 2016 PELAGO survey (172 thousand tonnes). This biomass reduction is mainly due to a strong reduction in the Occidental zones, 11.9 thousand tonnes comparing with 30 thousand tonnes in 2016 survey. The present biomass for this zone is similar to the one obtained on the PELAGO13 survey (9 thousand tonnes).

In the total area, the biomass estimate (81 thousand) compares with the total biomass estimated for the PELAGO15 survey (78 thousand tonnes). Table 2.1 presents the sardine abundance and biomass in each zone.

The estimated biomass of anchovy for the whole surveyed area was 29.3 thousand tonnes corresponding to an estimated abundance of 2869.8 million fish (Table 2.2). The occurrence of this species was detected in the OCN, ALG and CAD areas, being most abundant in CAD (1717.8 million fish, 12.6 thousand tonnes) and OCN (1015.1 million fish, 15.5 tonnes) and much less abundant in ALG (136.9 million fish, 1.2 thousand tonnes).

Table 2.1. Pelago17: Estimated sardine abundance and biomass by each surveyed area and total.

Sardine	OCN	OCS	ALG	CAD	TOTAL
Number (thousand)	232 547	604 613	823 248	361 162	2 021 570
Biomass (tones)	11 878	30 233	34 116	4 757	80 984

Table 2.2. Pelago17: Estimated anchovy abundance and biomass by each surveyed area and total.

Anchovy	OCN	OCS	ALG	CAD	TOTAL
Number (thousand)	1 015 135	-	136 892	1 717 806	2 869 833
Biomass (tonnes)	15 481	-	1 208	12 589	29 288

Sardine: length and age composition

Figures 2.5 and 2.6 present the length and age composition of sardines for each of the areas surveyed. Small sardines (<16 cm) were almost only observed in the Cadiz Spanish waters and in Algarve areas, and thus almost completely absent from the West coast. In the Occidental North (OCN) and Cadiz (CAD) areas, as observed in the latest surveys, most sardines were young, aged up to 2 years old (93% in biomass), with a modal age of 2 and 1, respectively. In the Occidental South (OCS) and Algarve areas, sardine presented a wider age distribution (up to age group 8), modal age being of 1 and 2 years-old, respectively.

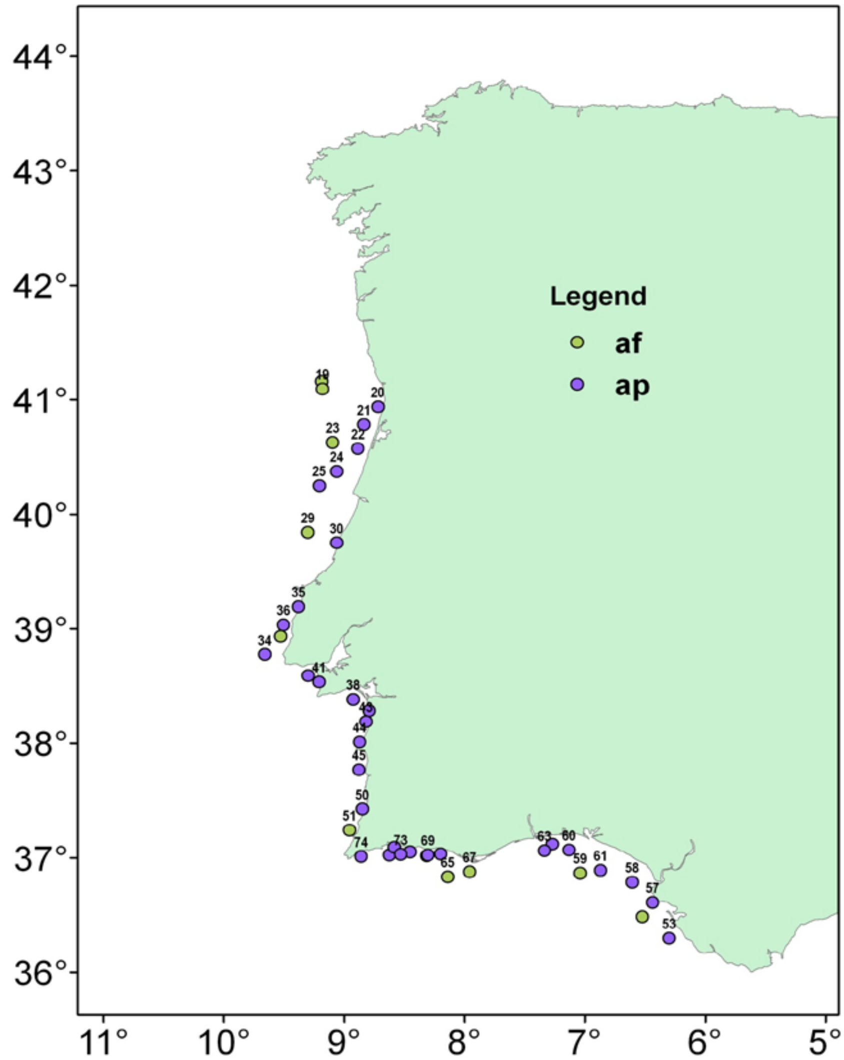


Figure 2.1. PELAGO17: RV "Noruega" fishing trawl location (with more than 30 fish caught): af- bottom trawl; ap – pelagic trawl

Anchovy: distribution, abundance, length and age composition

Anchovy abundance and biomass estimates by length class in each of the three anchovy occurrence areas are presented in Figure 2.7. In OCN the length mode was around 13.0 cm and in ALG 11.0 cm. In CAD length distribution was trimodal, being the modes around 8.5, 11.0 and 14.5 cm

From the otoliths structure analysis of the survey sampled anchovy, age was attributed to the fish and age length keys (ALK's) were obtained for each area. ALK's allowed to estimate the anchovy abundance and biomass composition by age group in each occurrence area of this species, which are presented in Figure 2.8. For the ALG area it was attributed the same ALK of the neighboring CAD area.

Age group 1 was predominant in all the three areas, both in abundance (OCN: 988.4 millions; ALG: 133.6 millions and CAD: 1644.5 millions), as in biomass (OCN: 15 thousand tonnes; ALG: 1.2 thousand tonnes and CAD: 11.4 thousand tonnes).

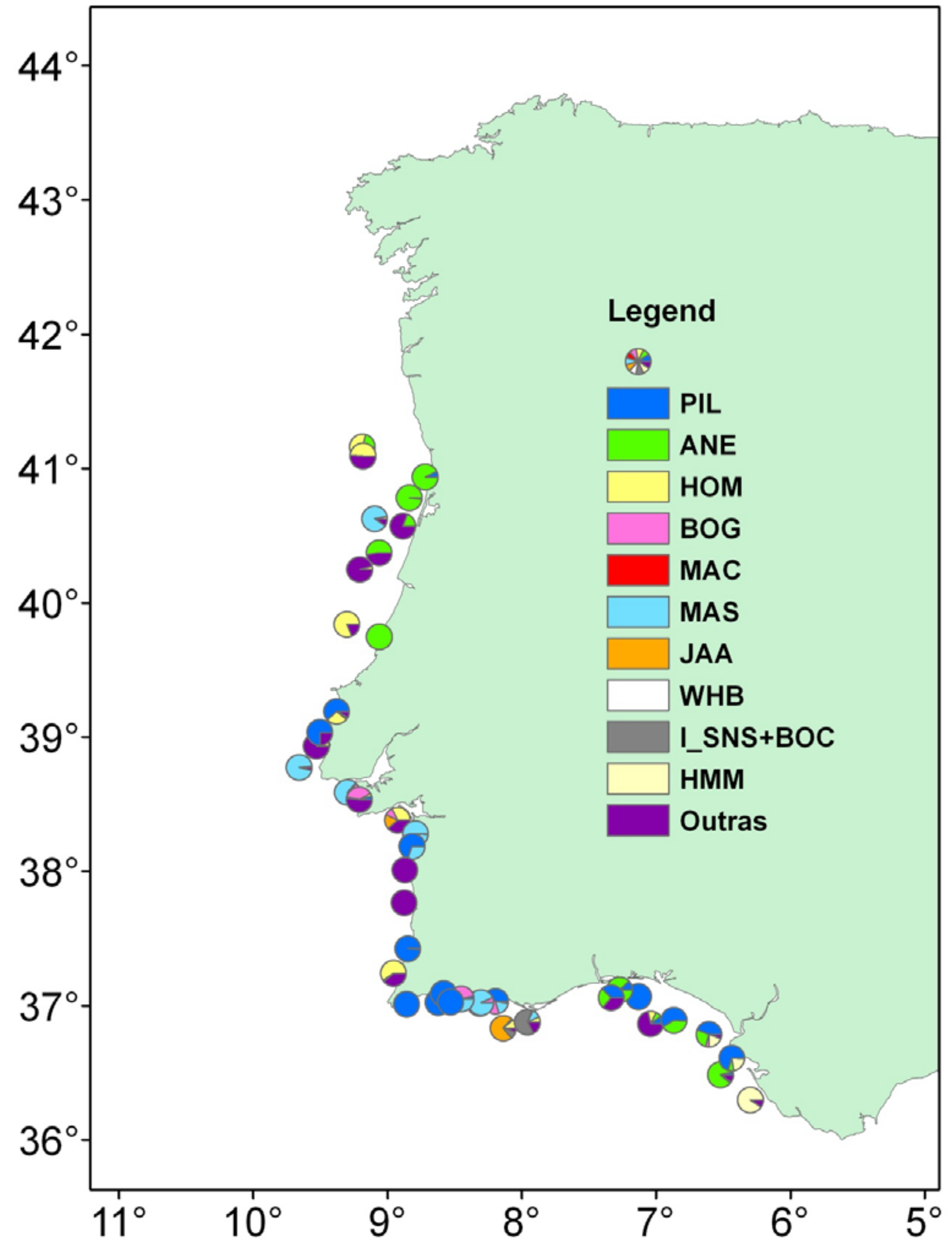


Figure 2.2. PELAGO17: Fishing haul species composition (in number). (PIL-sardine, ANE-anchovy; BOG-bogue, HOM-horse mackerel, MAC-mackerel, MAS-chub mackerel, WHB- blue whiting, JAA-black jack mackerel, HMM- Mediterranean horse mackerel, SNS- snipe fish, BOC- boar fish).

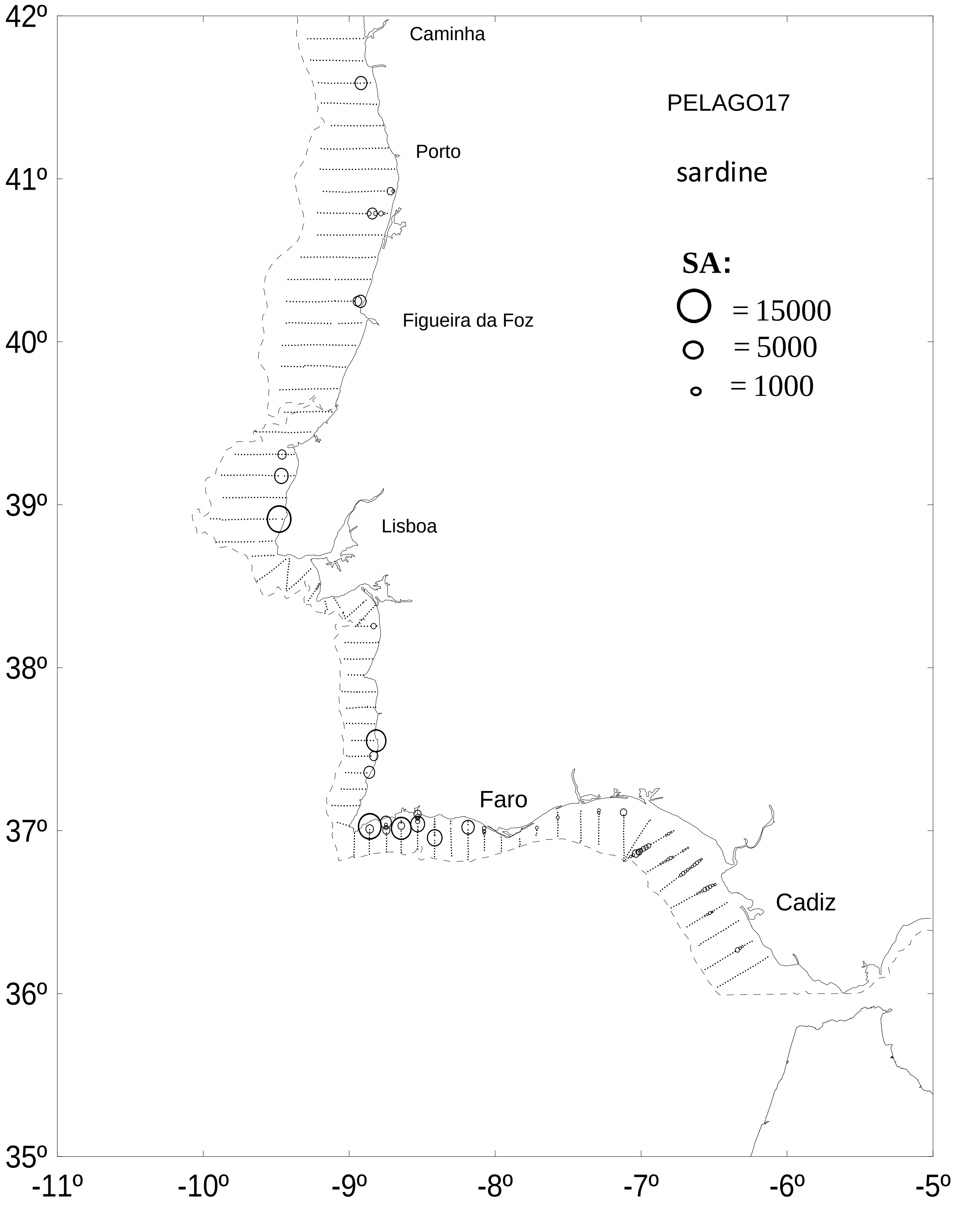


Figure 2.3. PELAGO17: Sardine acoustic energy spatial distribution. Circle area is proportional to the acoustic energy (S_A m^2/nm^2).

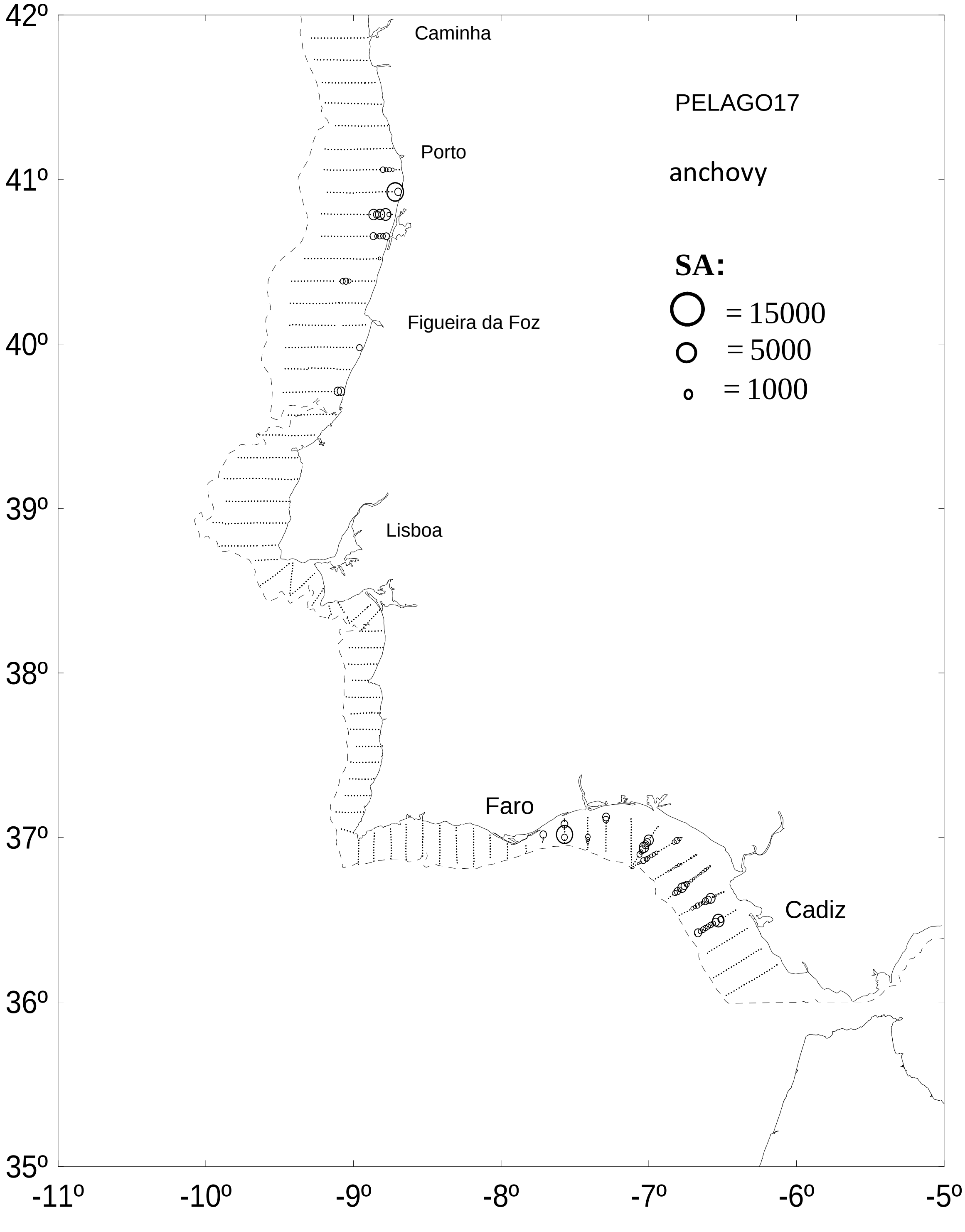


Figure 2.4. PELAGO17: Anchovy acoustic energy spatial distribution. Circle area is proportional to the acoustic energy (S_A m²/nm²).

Figure 2.5. PELAGO17: Sardine (abundance and biomass) length distribution, for each area.

Figure 2.6. PELAGO17: sardine (abundance and biomass) age distribution, for each area.

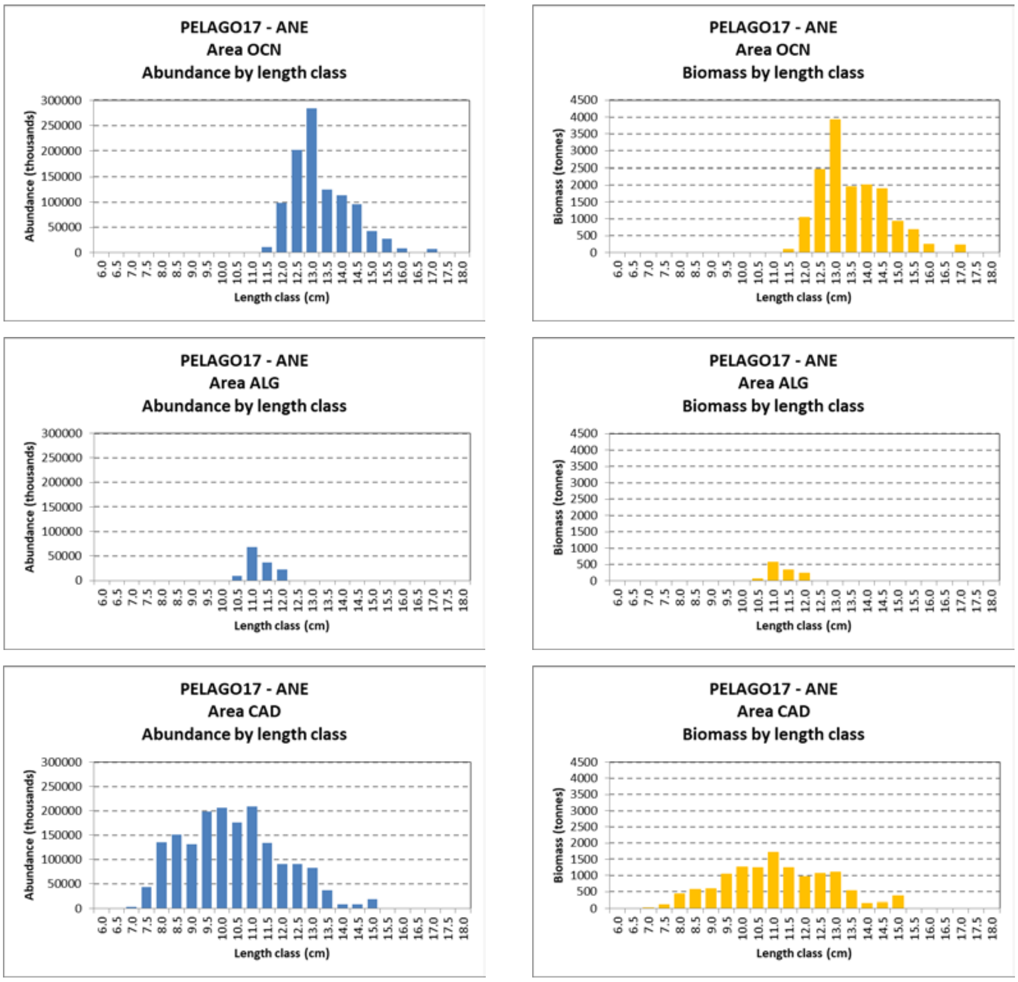
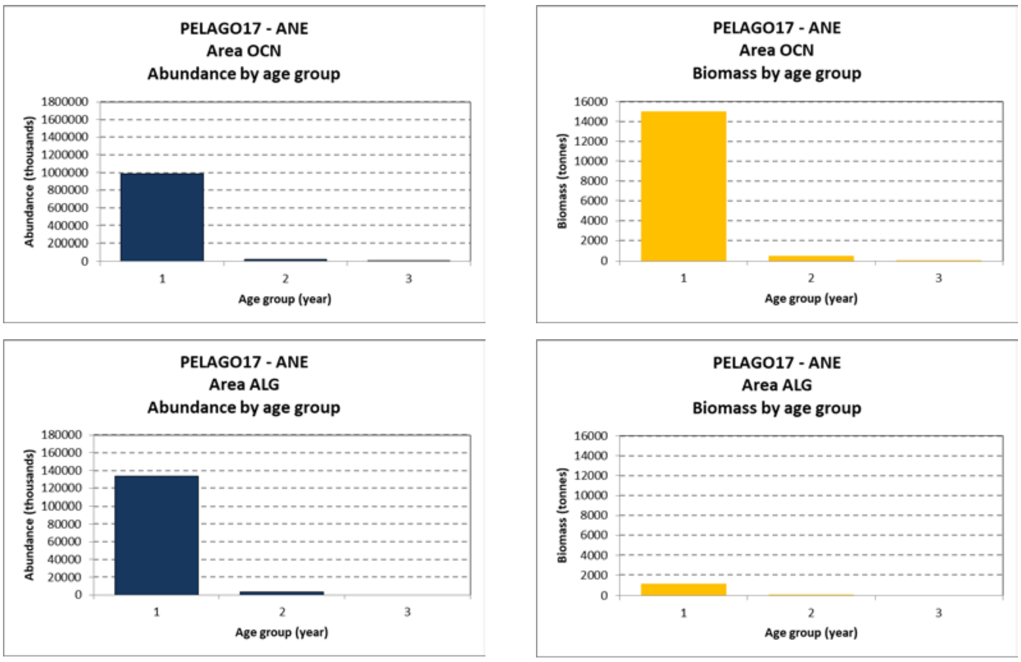


Figure 2.7. PELAGO17: Estimated anchovy abundance and biomass composition by length class in each occurrence area.



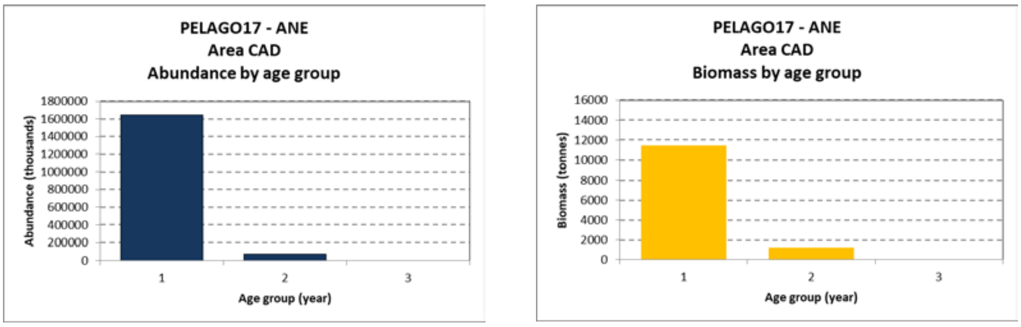


Figure 2.8. PELAGO17: anchovy estimated abundance and biomass by age group in each sampled area.

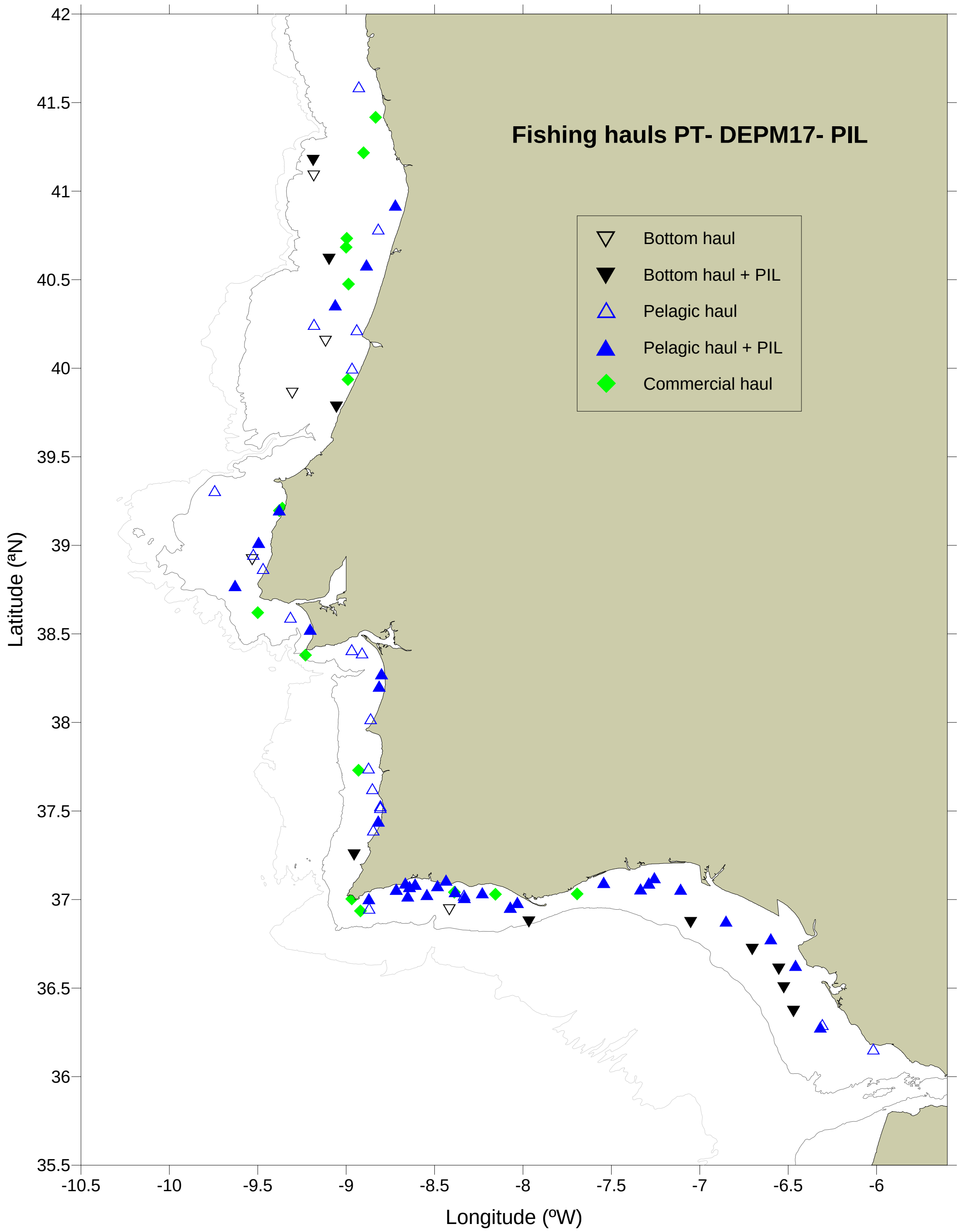


Figure 2.9. DEPM: Location of the fishing hauls for the application of the DEPM, from the RV "Noruega" (bottom and pelagic trawl; black and blue triangles, respectively) and from the commercial fleet (green diamonds); open symbols: trawls with no sardine; filled symbols: trawls with sardine.

3. Plankton and environmental surveying

Material and methods

Gear for plankton and hydrology surveying:

- CUFES: mesh size 335 µm, continuous sampling at the surface (~ 3m)
- CalVET: adapted structure (double nets CalVET (25cm mouth opening) + CTDF), mesh size 150 µm, vertical tows through the whole water column
- BONGO: double nets with 60cm mouth opening (mesh size: 200, 500µm), oblique tows through the whole water column
- continuous surface observations of temperature, salinity and fluorescence using onboard sensors associated to the CUFES system
- temperature, salinity and fluorescence (chlorophyll) profiles using a CTDF probe (RBR - Concerto)

During the joint surveys the day was occupied with the regular CUFES surveying along the acoustic transects. Zooplankton samples and temperature, salinity and fluorescence observations were gathered. The data, together with GPS information, were compiled using the EDAS software. DEPM sampling was carried out when acoustics surveying was not running, mainly during the night period. On the pre-defined stations along the DEPM transects CalVET samples (every 3 or 6 nmiles and down to 200m maximum) and CTDF casts were obtained. In addition, CUFES samples were gathered continuously along the path between the vertical plankton tows. To complete the zooplankton surveying, oblique zooplankton tows through the whole water column, were undertaken with Bongo nets at inner and mid shelf locations, alternately, one per transect. The plankton samples were preserved onboard with buffered formaldeyde solution at 4% in distilled water for further processing in the laboratory. While only DEPM sampling was being carried out (southern coast in mid March) plankton surveying was conducted day and night.

Results

Temperature, salinity and fluorescence (chlorophyll$_a$) distributions

In 2017, both, the DEPM and the PELAGO, surveys took place later than planned and since they were partially joint, the southern shores were sampled in two occasions (mid March and late May-early June) while the western coast was surveyed once but with some interruptions due to weather and logistics constraints (see table 1.1 for details) which led to spatial and temporal discontinuites in sampling. Surface temperature, salinity and fluorescence distributions are shown in figures 3.1 and 3.2. During the first coverage of the southern stratum (figure 3.1) the observations indicated a typical spring situation with temperatures between 14 and 17.5ºC and fluorescence patches associated to, still clear, river plumes. During the second passage the sea surface temperatures were, on average, 2-3ºC degrees higher and the phytoplankton signatures were very weak. In the western coast, monitored during an extended period, the surface temperatures ranged from 13.5°C to 17.5°C, in the NW, and 17 °C to 19 °C, in the SW. When sampling took place in the northern most region, the colder waters of continental origins and associated peaks of fluorescence were very evident. Overall, for the main period of the surveys, and since they finished later than in previous years, the water temperature was higher than usually is during corresponding campaigns within the historic series.

Egg distribution and preliminary production estimation (P0)

Zooplankton samples were collected with CalVET and Bongo nets and the CUFES system, a summary of the information gathered is presented in Table 1.1. The data available at present include the egg abundances obtained from the CUFES samples associated to the acoustics transects in the NW region (OCN) and egg abundances and staging for sardine from the CalVET paired samples.

In 2017, the plankton sampling for DEPM was reduced, during the period of the joint sampling for acoustics and DEPM, to avoid further delay in the PELAGO survey, consequently the CalVET results available for spawning area definition and egg production estimation are limited. When all CUFES samples, from PELAGO surveying, are analised the spawning area resolution may be improved. The egg abundance distributions for sardine and anchovy available at present are depicted in figures 3.3, 3.5 and 3.6.

A total of 350 CalVET samples were collected along 50 of the regular 59 transects of the sardine DEPM survey grid. The gaps in the sampling grid, in particular from Cabo Mondego to Cabo Carvoeiro and in the SW shore, limit an accurate definition of the spawning area. Sardine egg abundance in the western stratum was lower than in the other years of the historic series with the exception of 2011. Despite the low egg densities the percentage of positive stations (38%) was not among the lowest indicating a scattered egg distribution which is noticeable in the map of figure 3.3 where it can be observed that for many CalVET samples the number of eggs collected was quite low (resulting possibly from low and spread fish and egg abundances and egg dispersal). Nonetheless, a small area of higher abundances was observed to the north of Douro (also observed in the densities from the CUFES samples) and some patches were also detected in the southern coast, in Cadiz Bay and Algarve. The low egg abundances during this year´s survey in the west coast may be attributable to low sardine abundance and/or low reproductive activity during the survey period which was conducted late in the usual spawning season. In the southern stratum, sampled for DEPM in mid March, the egg densities and spawning area size (46% of positive stations) were within the range observed for other years of the DEPM historic series and slightly higher than during the last DEPM survey, in 2014. Preliminary egg production results obtained using the traditional methodology (not considering the external mortality model adopted for the revision presented at the last bench mark meeting) and a single mortality estimate for both strata, indicate one of the lowest estimates of the series for the west coast and a value for the south within the range of the results obtained for other years of the DEPM series (figure 3.4) (P0_tot South: 1.4 x 10^{12} eggs/day; P0_tot West: 0.5 x 10^{12} eggs/day). Final egg production estimates will only be available when the spawing area definition can be completed using the CUFES results and the calculations attained using the three strata information (south, west and north) and the methodology considering the mortality estimation using the external model which considers the values for the whole data series and the water temperature as covariate. The final estimates will be presented at the 2017 WGACEGG meeting in November.

As it has happened for the more recent years the anchovy egg abundances in CUFES samples during PELAGO surpassed the sardine egg densities. This pattern was very clear in the NW this year (Figures 3.5 and 3.6), where a record number of anchovy eggs were collected, over an extended area but in particular, inshore, and from Aveiro to the South, where schools of anchovy were also observed. The high anchovy egg abundances observed in the NW region likely reflected the survey timing, further into the usual anchovy spawning season.

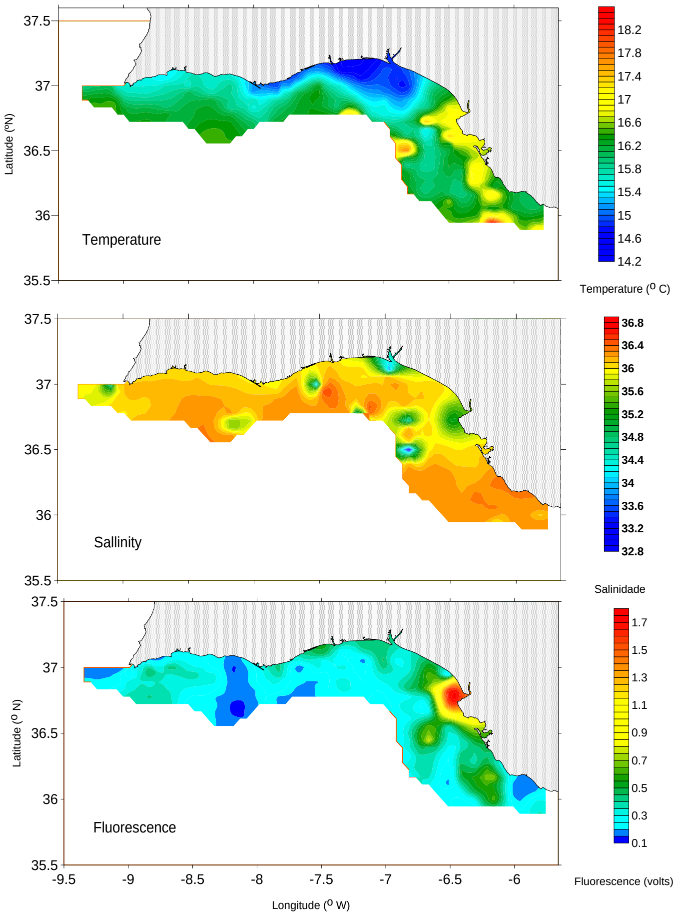


Figure 3.1. Surface temperature (top panel), salinity (mid panel) and fluorescence (bottom panel) distributions obtained by the sensors associated to the CUFES system during the DEPM survey in the period 17-19 March 2017.

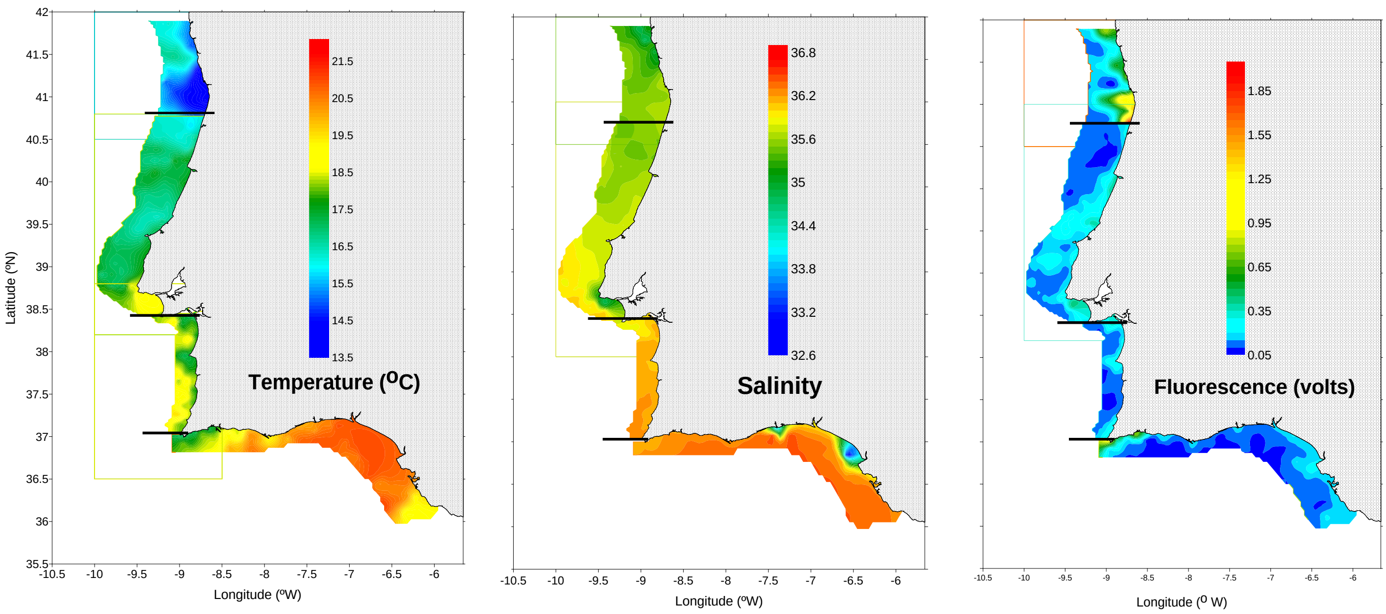


Figure 3.2. Surface temperature (left panel), salinity (centre panel) and fluorescence (right panel) distributions obtained by the sensors associated to the CUFES system during the joint DEPM+PELAGO survey in the west (25Apr-24May) and PELAGO in the south (28May-6Jun).

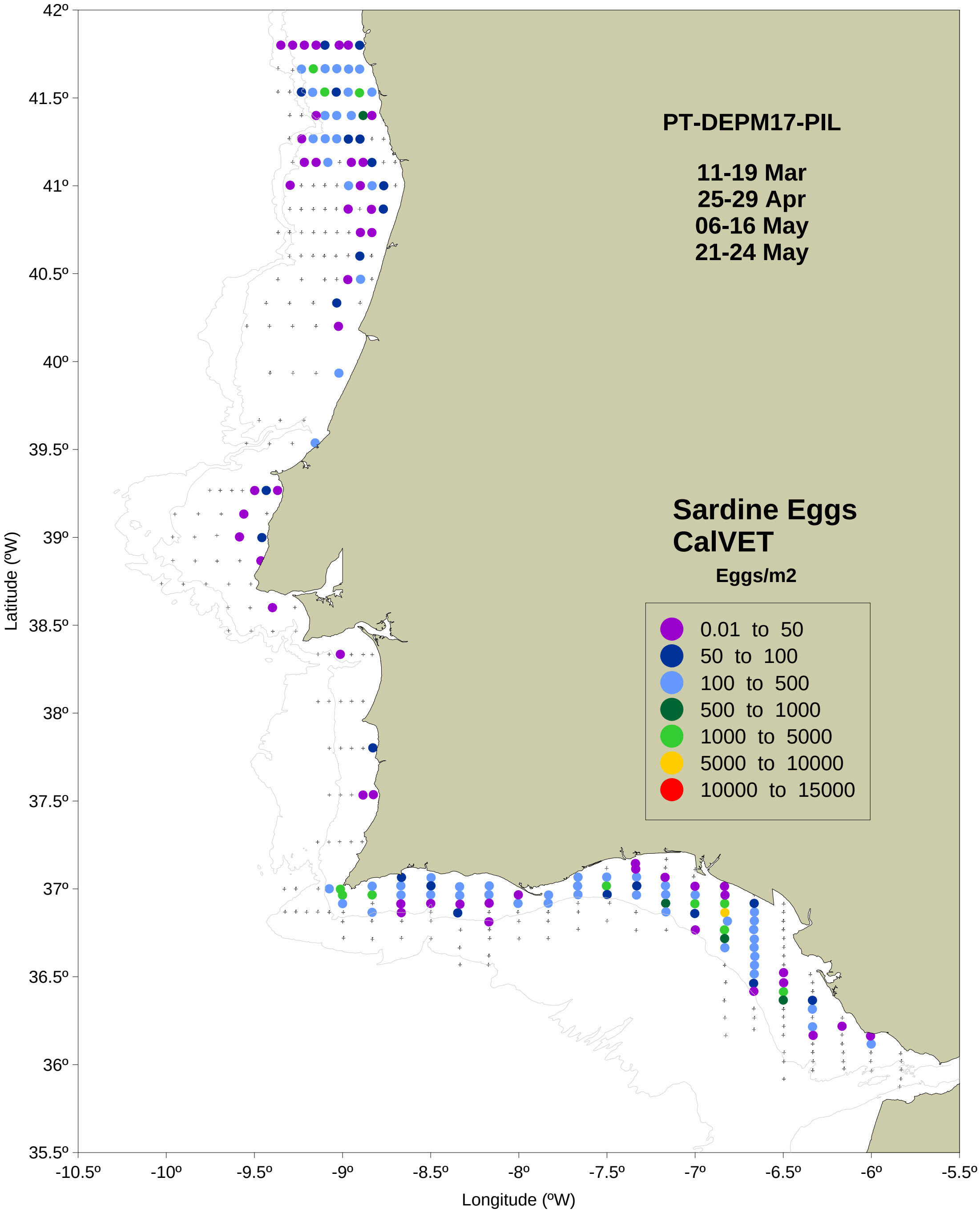


Figure 3.3. Sardine egg abundance distribution (eggs/m^2) obtained from CalVET samples.

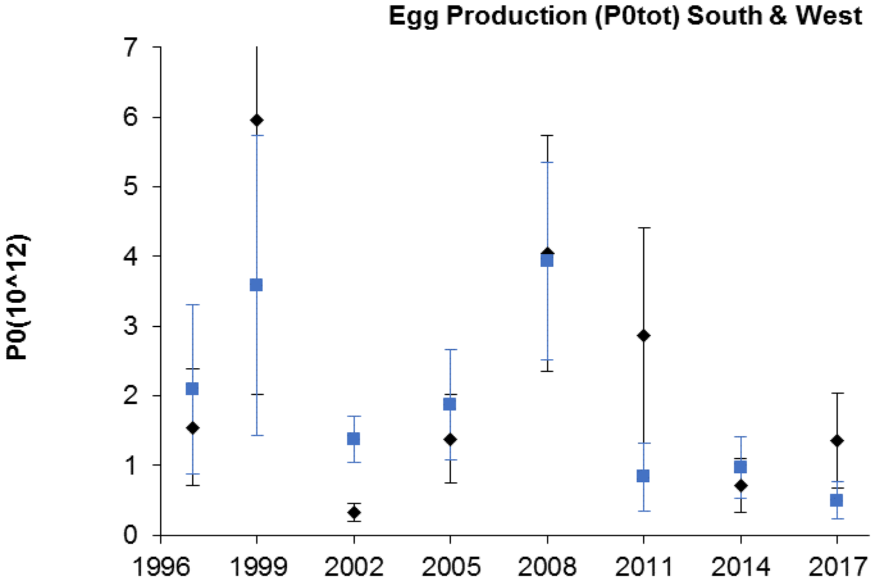


Figure 3.4. Sardine egg production (eggs/day) estimates for the southern (black) and western (blue) strata (ICES 9a south) during the DEPM series (1997-2017) using the traditional methodology.

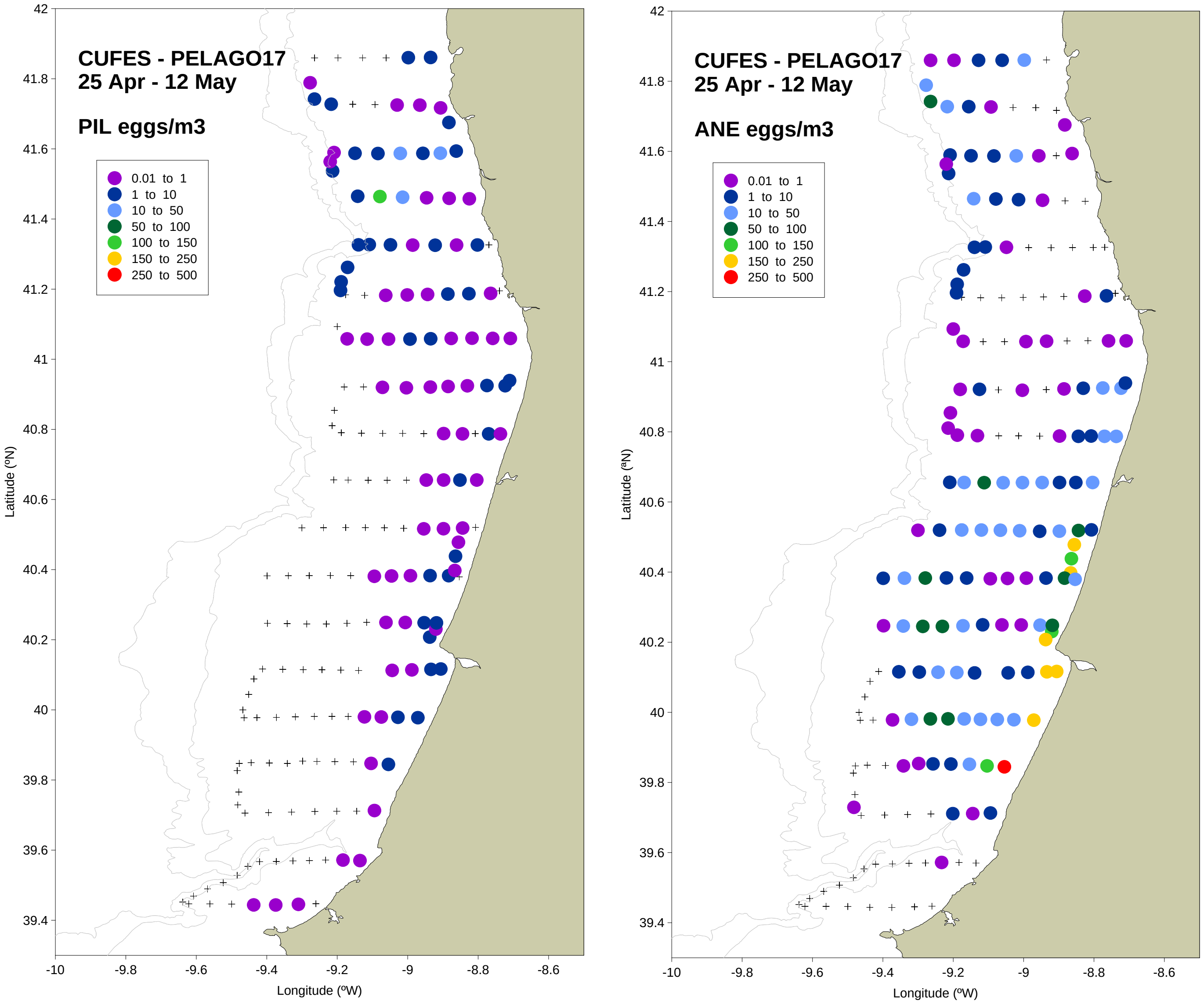


Figure 3.5. Sardine (left panel) and anchovy (right panel) egg abundances distributions (eggs/m^3) in the NW shelf obtained from CUFES sampling during PELAGO surveying.

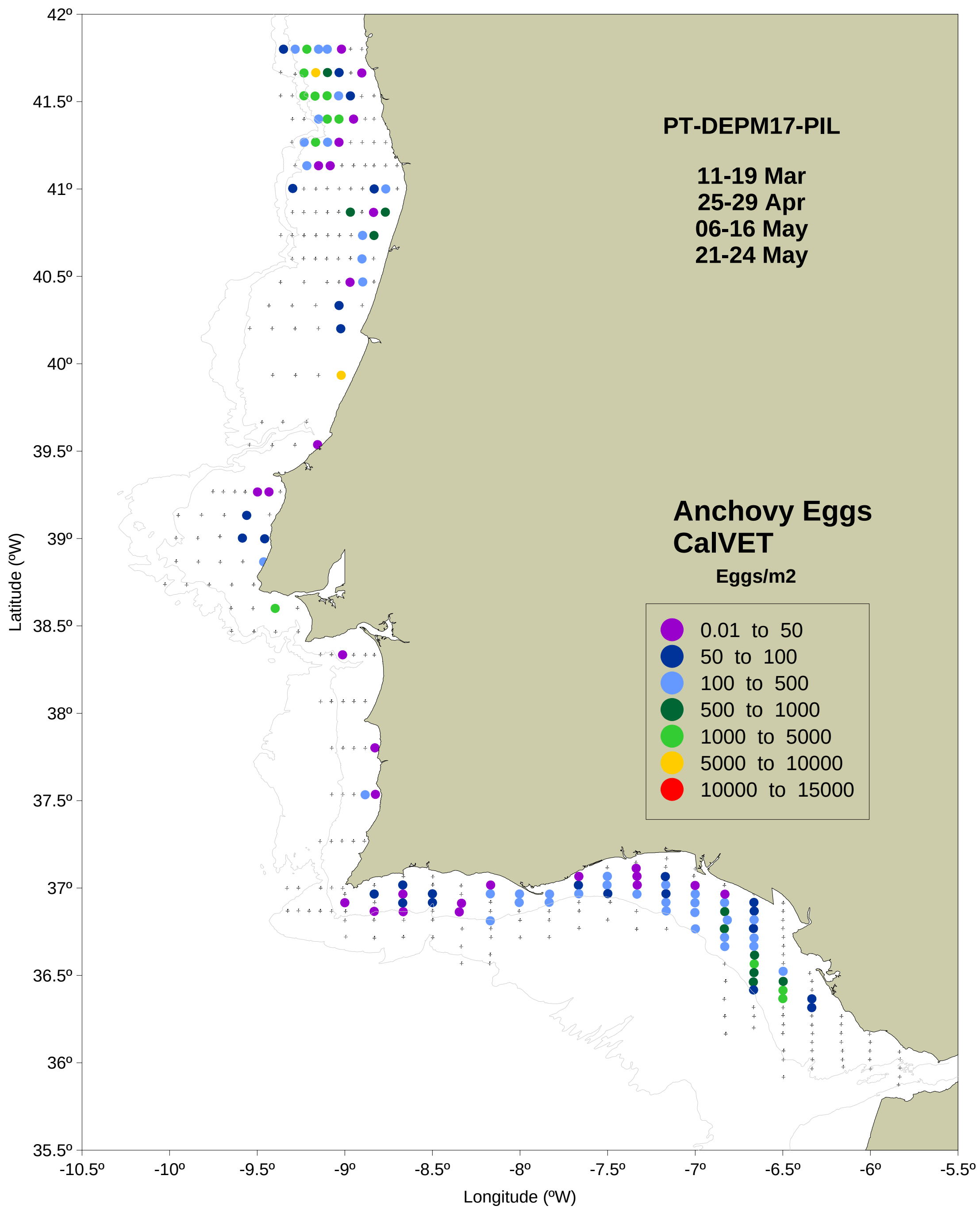


Figure 3.6. Anchovy egg abundance distribution (eggs/m²) obtained from CalVET samples.

References

Checkley, D. M. Jr; P. B. Ortner; L. R. Settle and S. R. Cummings. 1997. A continuous, underway, fish egg sampler. *Fisheries Oceanography* 6 (2): 58-73.

Foote, K. G., Knudsen, H. P., Vestnes, G., Brede, R., Nielsen, R. L., 1981. Improved Calibration of Hydroacoustic Equipment with Copper Sphere. *ICES, CM* 1981/B:20, 18p.

Weill, A., Scalabrin, C. and Diner, N., 1993. MOVIESB: An acoustic detection description software. Application to shoal species classification. *Aquatic Living Resources* 6: 255-267.

ANNEX 1

PEL17AGO synthetic report survey

PEL17AGO survey was carried out onboard RV "Noruega" from 21th to 31th August 2017 (sampling between 22 and 30 August). The survey covered the Portuguese shelf from Caminha to Nazaré, which corresponds to the Occidental Central North zone (OCN). The main objective was to estimate the sardine abundance and biomass in this area and compare it with the estimates from PELAGO17 survey, since the OCN zone was sampled with very bad weather and under technical problems of the vessel.

The acoustic transects were similar to those performed in the PELAGO17 survey (17 for the OCN zone) and the same methodology was followed. To collect the biological data, 23 fishing hauls were undertaken, of which 12 pelagic and 11 bottom trawls (Figure 1). The trawl samples were used to identify the species and to split the acoustic energy by species and by length, within each species. Fishing was carried out according to the echogram information.

Figure 2 shows the proportion, in number, of the main pelagic species caught in the surveyed area. In the northern part of OCN there was a predominance of the pelagic crab, *Polybius henslowi*, and this species appeared frequently also in the remaining surveys area. Only 3 fishing trawls caught a significant number of sardines (more than 30 individuals), and low numbers occurred in 7 other hauls. Besides *P. henslowi*, samples were dominated either by horse mackerel or chub mackerel in the more coastal hauls and blue whiting in the off-shore hauls. The frequency of anchovy was low.

Figure 3 presents the sardine acoustic energy for each mile along the acoustic transect showing a very localized distribution in the vicinity of Ria de Aveiro, and some acoustic energy south of Figueira da Foz. The distribution of sardine shoals in the northern limit of Ria de Aveiro shows a geographical consistency when compared to PELAGO17.

Figure 4 shows the length class composition of the sardine abundance in the area. The size distribution in August shows the presence of recruits (14-16 cm) not detected in late April-early May during the PELAGO17. The sizes within the second mode (16.5-20.5 cm) are consistent with the length distribution observed in the PELAGO17 plus the expected growth.

The sardine abundance estimated at the OCN zone during the PEL17AGO in August was 162935 thousand individuals, corresponding to biomass of 9642 tonnes. These new estimates are of the same order of magnitude as the PELAGO17 estimate for the same area (232547 thousand and 11878 tonnes), and confirm the strong biomass reduction in the Occidental North zone in 2017 compared with 2016 (30 thousand tonnes).

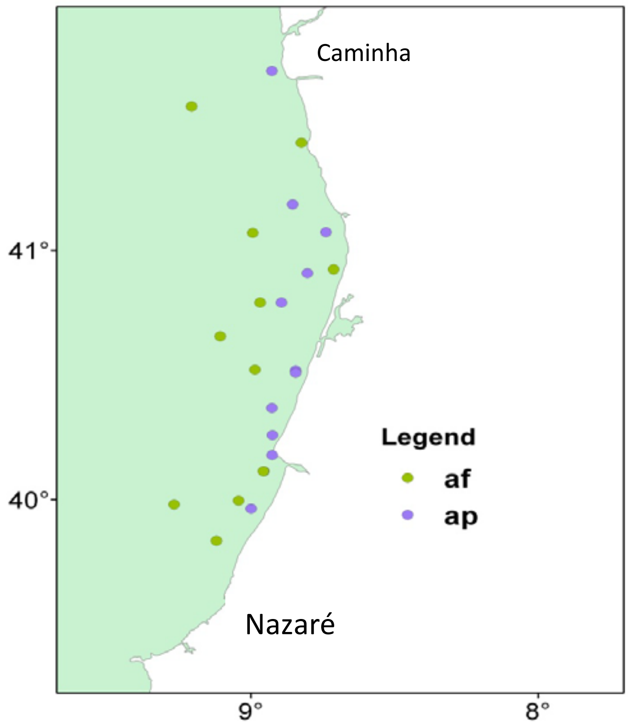


Figure 1 – RV "Noruega"Fishing trawl location in the PEL17AGO survey: af- bottom trawl; ap – pelagic trawl.

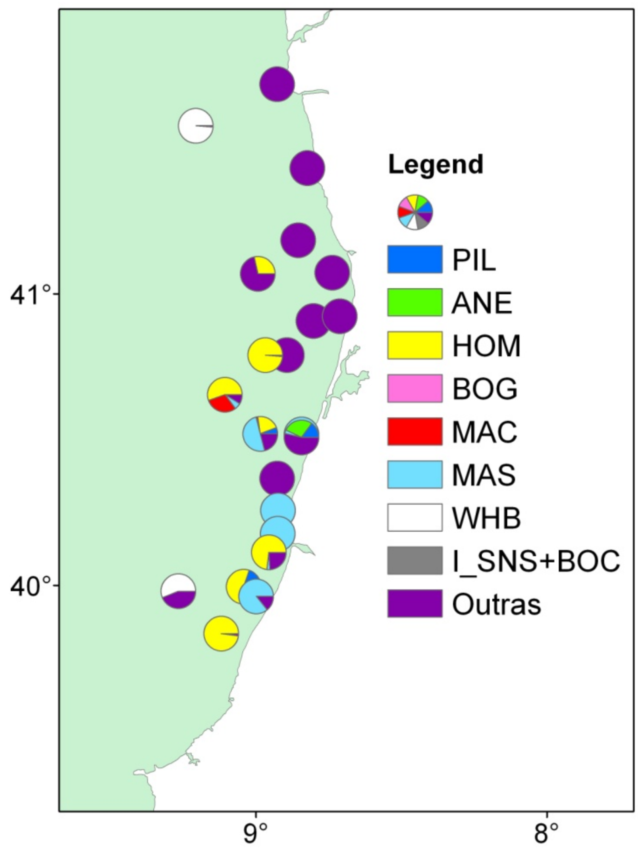


Figure 2 – Fishing haul species composition (in number) in the PEL17AGO survey. (PIL-sardine, ANE-anchovy; BOG-bogue, HOM-horse mackerel, MAC-mackerel, MAS-chub mackerel) WHB- blue whiting, JAA- black jack mackerel, SNS- snipe fish, BOC- boar fish).

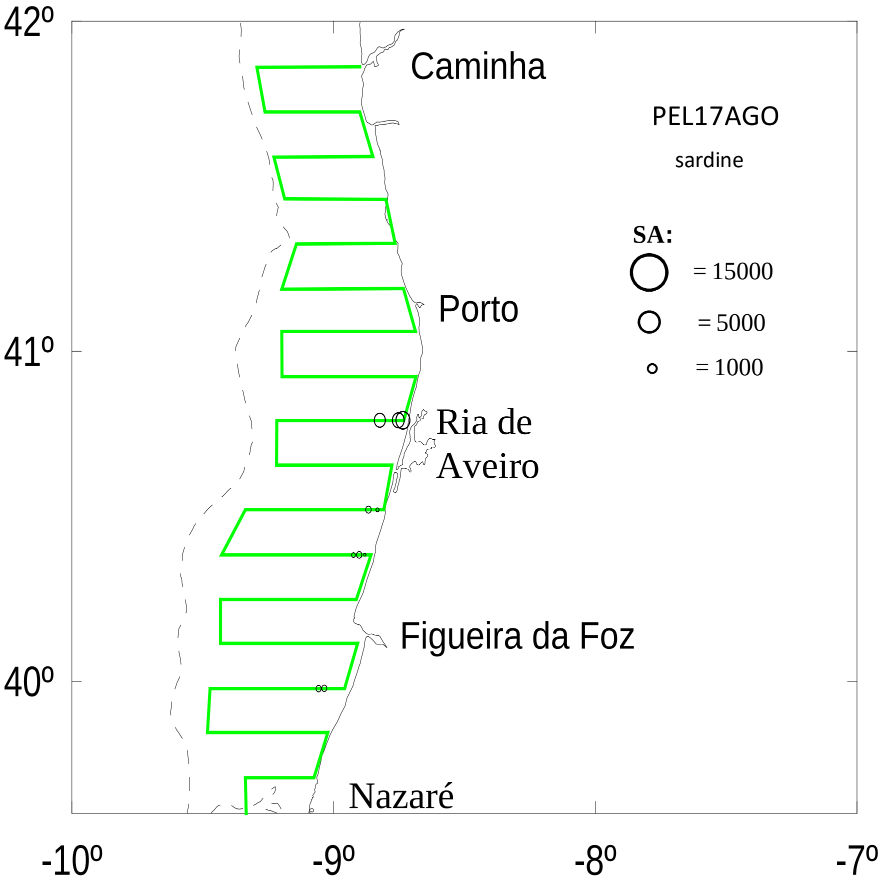


Figure 3 – Sardine acoustic energy spatial distribution. Circle area is proportional to the acoustic energy (S_A m^2/nm^2). The green line represents the acoustic transect (performed until Nazaré).

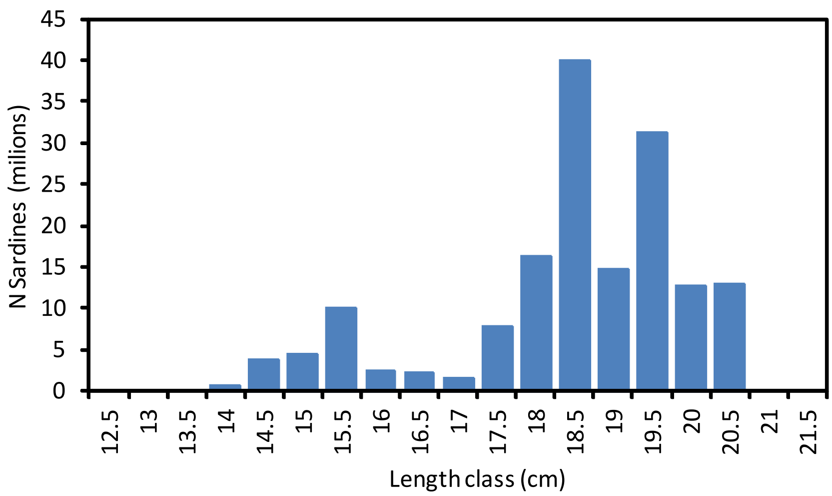


Figure 4 – Sardine biomass length distribution in the Portuguese Occidental North zone estimated in the PEL17AGO survey.

Annex 6: In-year advice for anchovy (*Engraulis encrasicolus*) in the Bay of Biscay

Introduction

In 2015 the management calendar for the Bay of Biscay anchovy was changed from July–June to January–December. Since then, the European Commission requests ICES to provide management advice for the January–December fishing period according to a harvest control rule. This harvest control rule is based on the expected biomass in the management year, which must incorporate the latest available information on recruitment from the autumn juvenile acoustic surveys JUVENA. Therefore, the Bay of Biscay anchovy assessment and short-term forecast cannot be conducted at the WGHANSA meeting in June and they are carried out by correspondence in November, once all the survey indices used in the assessment have been presented and discussed at WGACEGG.

This document summarises the new information available in November 2017 and presents the final assessment and short-term forecast for the Bay of Biscay anchovy stock in order to provide management advice for 2018.

The fishery in 2016

Fishery data in 2016 were presented in the main text Section 3.2 (ICES, WGHANSA 2017).

The fishery in 2017

The provisional catches during the first semester 2017 were 22 770 t, from which 22 249 t corresponded to Spain and 521 t to France. The 47% of the catches (in mass) during the first semester were age 1.

In the second half of 2017 around 2840 t were caught until mid-November, from which 2631 t corresponded to France and 209 t to Spain. The French landings included 666 tonnes caught in ICES Subarea 7.e, outside but near the border of ICES Subarea 8, that were reallocated in Subarea 8. Theses catches were realised in August and September. As in previous years the WG considered that these catches correspond to the same fishery operating in the upper limit of Subarea 8 and in the same period. For the time being the WG decided to reallocate them into Subarea 8, but the WG recommends continuing exploring the catches in the upper limit of Subarea 8 in order to evaluate their impact.

It must be emphasised that 2017 fishery data are preliminary. Official logbook data for the Spanish fleet were not available and the length distributions of the Spanish catch data were not fully processed. In addition, 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 June, when most of the French catches take place. For the assessment, 2017 November and December catches were assumed to be 3.6% of the total annual catch (which is the average of the percentage of the catches in November and December in 2010–2016, after the re-opening of the fishery). Therefore, the total catch in November and December was taken as 963 tonnes (instead of the 68 tonnes observed until mid-November), resulting in 3735 tonnes for the second semester 2017.

Fishery-independent data

The most recent fishery-independent data used in the assessment consists of the spring acoustic survey PELGAS 2017, the daily egg production method (DEPM) survey BIOMAN 2017 and the autumn juvenile acoustic survey JUVENA 2017. All these survey results were presented at and endorsed by WGACEGG 2017 and are briefly summarised below. In addition, the 2004 and 2006 total and age-structure estimates from the DEPM survey BIOMAN were updated, which supposed very minor changes.

Spring acoustic survey: PELGAS 2017

The results of the PELGAS 2017 survey were presented in June during WGHANSA (main text Section 3.3.2).

DEPM survey: BIOMAN 2017

The preliminary DEPM biomass estimate given in June during WGHANSA was based on a mean of the historical daily fecundity estimates of the last seven years (2010–2016) (main text Section 3.3.1). The full application of the DEPM is described in Santos *et al.*, 2017, WD to WGACEGG.

The estimates of the actual daily fecundity from the examination of anchovy samples collected during the BIOMAN2017 were of 64.16 eggs per gram of mature anchovy (CV=6.2%). This value is below the mean of the last seven years (70.71 eggs/gram), which was used to provide the June preliminary estimates. Table 1 show the estimates of the parameters defining the daily fecundity. Sex ratio of females was around 53% and mean female weight was about 18.6 grams (CV=7.3%). The batch fecundity estimated around 6694 eggs per spawning female (CV=10.5%). The spawning frequency resulted in an estimate of about 34% of mature females spawning per day (CV=3.7%).

The total egg production and the daily fecundity estimates, along with their standard error and coefficients of variations, are given in Table 1. The ratio between them resulted in a final DEPM biomass estimate of 94 759 t with a CV of 12%. This is the fourth largest value in the historical series.

The age structure (percentages in numbers and in mass), the weight-at-age and the length-at-age were also calculated (Table 2). The percentage of age 1, age 2 and age 3+ individuals were respectively 79%, 16% and 4%. However, regarding the age structure in mass, the percentage of age 1, age 2 and age 3+ were 66%, 26% and 8%.

Autumn juvenile acoustic survey: JUVENA 2017

The survey JUVENA 2017 took place between the 31st August and 9th October on board the chartered RV Ramon Margalef and the RV Emma Bardán, both equipped with scientific echosounders (Boyra *et al.*, 2017, WD to WGACEGG). The survey coverage and acoustic estimation procedures followed the standards agreed in the stock annex. The biomass of juveniles estimated for 2017 is around 725 400 tonnes, which represents the highest biomass value of the temporal series well above the mean of the temporal series and just above the value recorded in 2015 (Table 3).

State of the stock

This year no preliminary assessment was carried out in June (ICES, WGHANSA 2016). This section presents the final assessment of the Bay of Biscay anchovy conducted in November.

Stock assessment

The input data entering into the assessment of the anchovy stock consist of:

- total biomass estimated by DEPM and acoustic surveys (BIOMAN and PELGAS) with their corresponding coefficients of variation;
- proportion of the biomass at-age 1 estimated by the DEPM and acoustic surveys (BIOMAN and PELGAS);
- juvenile abundance index from JUVENA;
- total catch by semester;
- proportion (in mass) of the age 1 in the catch by semester (in 2017 only for the first semester);
- growth rates by age estimated from the weights-at-age of the stock.

The historical series of spawning–stock biomass (SSB) from the DEPM and acoustic surveys are shown in Figure 1. The trends in biomass from both surveys are similar. From 2003 to 2017 a parallel trend but with larger biomass estimates from the acoustic surveys is apparent, except in 2016 that the DEPM biomass estimate was larger than the acoustic biomass. This resulted in a relative decrease in biomass from 2015 larger for acoustics than for the DEPM. In addition, from 2016 to 2017 the acoustics biomass increases, whereas the DEPM biomass decreases. The largest discrepancy between the SSB estimates from the DEPM and acoustic surveys occurred in 1991, 2000, 2002, 2012 and 2015.

The agreement between both surveys is usually higher when estimating the relative age composition of the population. In 2017, both surveys indicate that the age 1 biomass proportion is around 0.65, which is around the average of the time-series (Figure 2).

The historical series of the juvenile abundance index from the autumn acoustic survey JUVENA is shown in Figure 3. The 2017 survey index is the highest in the time-series, just above the index observed in 2015.

Figure 4 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 2017 the preliminary total catch was around 22 800 t in the first half of the year and 3700 t in the second half. The latter was under the assumption that the November and December catches are the 3.6% of the total catch (according to the average % of November and December catches in 2010–2016). Definitive 2017 catch estimates will be provided in June 2018. Regarding the age structure of the catches, age 1 proportion in the catches in the first semester in 2017 is 0.47 which is close to the average age 1 proportion in the time-series (Figure 5).

Historical series of intrinsic growth rates by age (computed from the weights-at-age of the stock) suggest a larger growth at-age 1 than at-age 2+ (Figure 6).

The data used for the December assessment are given in Table 4.

Figure 7 compares prior and posterior distribution of some of the parameters estimated. Summary statistics (median and 90% probability intervals) of the posterior distributions of the parameters estimated are given in Tables 5 and 6. Recruitment (age 1 in mass at the beginning of the year), SSB (at spawning time which is assumed to be 15th May) and fishing mortality by semester from the final assessment are shown in

Figure 8. The estimated level of SSB in 2017 is 101 800 tonnes and the 90% probability interval is around 71 400 and 141 700 tonnes. This probability interval is amongst the widest in the time-series, accounting for the discrepancies observed in the surveys the last two years. The posterior median of the recruitment in 2018 is around 98 700 tonnes and the 90% probability interval is 48 000 and 202 400. The posterior distribution of recruitment is wider than the posterior distribution of previous recruitments because only the JUVENA 2017 survey provides direct information about 2018 recruitment. Assuming no fishing takes place in 2018, the SSB in 2018 is estimated at 139 700 tonnes with a 90% probability interval around 85 500 and 238 400 tonnes (Figure 9).

The final estimates are compared with the last year's December assessment (ICES, WGHANSA 2015) in Figure 10. In general, the results from both assessments are similar except to small changes in the perception of the last three years. Recruitment in 2017 has been revised slightly upwards, whereas recruitment in 2015 and 2016 are smaller in this assessment than in last year's assessment. As a result, biomass in 2015 and 2016 are also smaller than the last year's assessment. There are almost no differences in the fishing mortality in the first semester and the major change in the fishing mortality of the second semester occurs in 2016, where fishing mortality in the second semester is revised upwards in the current assessment.

Reliability of the assessment and uncertainty of the estimation

Compared to commonly used assessment methods in ICES, the Bayesian two-stage biomass-based model (CBBM) entails changes in both the methodology used for projecting the population forward and establishing catch options and in the terminology in which the assessment and consequent advice is given. The state of the stock is given in terms of spawning biomass, recruitment is understood as biomass at-age 1 at the beginning of the year and management options may be given in terms of catches. Due to the Bayesian framework, all the results are given in stochastic terms and deterministic point estimates are replaced by summary statistics of the posterior distributions of the parameters, such as medians and percentiles.

In 2017, the biomass indices from DEPM and acoustics point out to a decrease of 38% and an increase of 50% with respect to 2016 indices. The age 1 biomass proportion estimated from both surveys, suggest recruitment around the average (age 1 biomass proportion around 0.64 in both surveys). On the contrary, the juvenile abundance index from JUVENA in 2016 indicated a medium-good recruitment (being the fourth largest of the time-series observed since 2003). From the assessment results, recruitment in 2017 is 45% larger than in 2016 and biomass is 2% lower than in 2016. The final assessed biomass is between the biomass estimated in the DEPM and acoustics surveys (i.e. they have positive and negative residuals respectively) and the final recruitment in 2017 is lower than estimated by JUVENA (positive residual).

However, overall, the Pearson residuals for all the observations used in the assessment are within -2 and 2, showing no major discrepancies between the observed and modelled quantities (Figure 11) and indicating that the model estimates are a compromise between all surveys inputs and catch estimates and all along the time-series.

The residuals of the age 1 proportion (in mass) in the catch of the first semester have been negative from 2010 (fishery reopening) to 2015. This was thought to be due to a likely change of the selection at-age 1 during the first semester, which is assumed to be constant along the time-series in the assessment model. However, in 2016 and 2017 the residuals of the age 1 proportion in mass in the catch of the first semester were positive.

Given that the number of years since the fishery reopening is low, this pattern should be further investigated in future years.

The catch data for 2017 are preliminary and the definite data will be available for WGHANSA 2018. As a result, the fishing mortality estimates in 2017 must be considered also as preliminary.

In 2015 the WG tested the sensitivity of the assessment to the reallocation of the French catches near the border of Subarea 8, and the influence was demonstrated to be low. In 2017 no sensitivity analysis was done, but 666 tonnes were reallocated from Subarea 7 to Subarea 8. This should be further investigated in the next coming years, especially if the reallocated catches exceed the limits of the historical series.

The assessment scale is given by the survey catchability estimates. It therefore must be emphasized and admitted explicitly that the assessment should always be examined in relative terms, exploring the trends in biomasses or harvest rates.

Short-term prediction

As the assessment, the short-term forecast for this stock can be conducted in June or in November. In June, there is no indication on next year recruitment, so the forecast has usually been based on an assumed undetermined recruitment scenario in which all the past recruitments were equally likely. In November the forecast can be based on the next year recruitment distribution derived from the November assessment. This year no short-term prediction was conducted in June. The short-term prediction presented here is based on the results from the final assessment described in the previous section.

Recruitment in 2018 is estimated in the assessment and it is mainly informed by the latest JUVENA juvenile abundance index and the parameters of the JUVENA observation equations. Figure 12 shows the posterior distribution of recruitment in 2018 from the assessment in November. The median recruitment (age 1 biomass on 1st January) in 2018 for the November projections is around 98 700 t.

The method for the short-term projections based on the November assessment is described in the stock annex approved in October 2013.

The European Commission requested ICES to provide advice based on the harvest control rule (HCR) named G3 with a harvest rate of 0.4 (STECF, 2013; 2014).

The full formulation of this HCR is as follows:

$$TAC_{y+1} = \begin{cases} 0 & \text{if } \widehat{SSB}_{y+1} \leq 24000 \\ -2600 + 0.40 \cdot \widehat{SSB}_{y+1} & \text{if } 24000 < \widehat{SSB}_{y+1} \leq 89000 \\ 33000 & \text{if } \widehat{SSB}_{y+1} > 89000 \end{cases}$$

where $\widehat{SSB}_{y+1}$ is the expected spawning–stock biomass in year $y+1$. See also Figure 14 for a graphical representation.

In this rule, the TAC from January to December is based on the spawning biomass $\widehat{SSB}_{y+1}$ 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 inter-dependent and vary together. This leads to seek the value of fishing mortality during the first semester solving the system for the median values of recruitment 2018, biomass at age 2+ at the beginning of 2018, 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 was assumed to be 60% following STECF (2013; 2014). The simulations done by STECF for similar HCR suggested that the performance of the HCR was not dependent on the assumed split of the catches by semesters.

According to HCR G3 with harvest rate of 0.4, the TAC for the fishing season running from 1 January to 31 December 2018 should be established at 33 000 t, which is the maximum possible. Under the assumption that 60% of the annual catches are taken in the first semester, the median SSB in 2018 is around 125 800 t with a 90% probability interval 71 700 and 224 400 t. The probability of SSB in 2018 being below B_{lim} is below 0.001 (Figures 13 and 15).

Starting from the posterior distribution of recruitment (age 1 biomass) and biomass at-age 2+ on the 1st January 2018 the population was projected forward for one year. Total allowable catch during 2018 were explored from 0 (fishery closure) to 70 000 tonnes with a step of 5000 tonnes for a range of percentages of catches being taken in the first semester from 0 to 1 with a step of 0.1. Probability distributions of SSB in 2018 were derived for each of the catch options. For all cases, the probability of SSB in 2018 being below B_{lim} is below 0.02 (below the established threshold of 0.05) and the corresponding median SSB values in 2018 are above 88 000 t (Table 7 and Figure 16).

References

ICES. 2016. In press. Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas 7, 8 and 9 (**WGACEGG**), 14–18 November 2016, Capo Granitola, Italy. ICES CM 2016/ SSGIEOM:31. 326 pp.

Table 1. Bay of Biscay anchovy: All the parameters to estimate de anchovy biomass using the Daily Egg Production Method (DEPM) for November 2016: P_{tot} (total egg production), R (sex ratio), S (Spawning frequency), F (batch fecundity), Wf (female mean weight), DF (daily fecundity) and Wt (total mean weight (female and male) with correspondent Standard errors (S.e.) and coefficients of variation (CV).

Parameter	estimate	S.e.	CV
Ptot	6.05E+12	6.33E+11	0.1047
R'	0.53	0.0030	0.0056
S	0.34	0.0124	0.0368
F	6,694	705	0.1053
Wf	18.60	1.37	0.0734
DF	64.16	4.01	0.0624
BIOMASS (Tons)	**94,759**	11,553	0.1219
Wt	13.703	1.44	0.1050

Table 2. Bay of Biscay anchovy: November 2017 biomass estimate and correspondent standard error (S.e.) and coefficient of variation (CV) of the percentage, numbers, weight, length and Biomass at-age estimates.

Parameter	estimate	S.e.	CV
BIOMASS (Tons)	**94,759**	11,553	0.1219
total mean Weight	13.703	1.44	0.1050
Population (millions)	6,926	1245	0.1797
Percentage at age 1	0.79	0.040	0.0500
Percentage at age 2	0.16	0.029	0.1811
Percentage at age 3+	0.04	0.010	0.2329
Numbers at age 1	5,502	1,198.7	0.2179
Numbers at age 2	1,114	150.7	0.1353
Numbers at age 3+	309	59.2	0.1913
Percent. at age 1 in mass	0.659	0.038	0.0580
Percent. at age 2 in mass	0.263	0.029	0.1086
Percent. at age 3+ in mass	0.079	0.013	0.1608
Biomass at age 1 (Tons)	62,488	9,061	0.1450
Biomass at age 2 (Tons)	24,824	3,590	0.1446
Biomass at age 3+ (Tons)	7,447	1,422	0.1910

Biological Features Corrected		S.e.	CV
Weight at age 1 (g)	11.40	1.23	0.1076
Weight at age 2 (g)	22.22	1.05	0.0473
Weight at age 3 (g)	23.94	0.80	0.0336
Lenght at age 1 (mm)	120.34	4.08	0.0339
Lenght at age 2 (mm)	148.19	1.98	0.0134
Length at age 3 (mm)	153.35	1.31	0.0085

Table 3. Bay of Biscay anchovy: Synthesis of the abundance estimation (acoustic index of biomass) for the JUVENA surveys.

Year	Area+ (mn2)	Size juveniles (cm)	Biomass juveniles (year y)	Biomass Recruits (year y+1)
2003	3,476	7.9	98,601	30,429
2004	1,907	10.6	2,406	4,086
2005	7,790	6.7	134,131	18,049
2006	7,063	8.1	78,298	22,545
2007	5,677	5.4	13,121	9,205
2008	6,895	7.5	20,879	10,216
2009	12,984	9.1	178,028	47,374
2010	21,110	8.3	599,990	110,008
2011	21,063	6	207,625	42,433
2012	14,271	6.4	142,083	34,198
2013	18,189	7.4	105,271	52,344
2014	37,169	5.9	723,946	139,062
2015	21,867	6.8	462,340	
2016	16,933	7.3	371,563	
2017	19,808	6.6	725,403	

Table 4. Bay of Biscay anchovy: Input data for CBBM.

	BIOMAN			PELGAS			JUVENA	CATCH				GROWTH	
	DEPM survey			Acoustic survey			Acoustic	Semester1		Semester2		G1	G2+
Year	Age1	Total	cv	Age1	Total	cv	Age0 previous year	Age1	Total	Age1	Total	Age1	Age2+
1987	10637	21943	0.480	NA	NA	NA	NA	4561	11719	2219	2666	0.405	0.141
1988	37813	45230	0.310	NA	NA	NA	NA	6739	10002	4018	4404	0.266	0.125
1989	4128	9477	0.410	6476	15500	NA	NA	3026	7153	643	1086	0.323	0.129
1990	71142	74371	0.208	NA	NA	NA	NA	17337	19386	12080	14347	0.566	0.130
1991	7821	13295	0.271	28322	64000	NA	NA	6150	15025	2743	3087	0.626	0.198
1992	56202	60332	0.125	84439	89000	NA	NA	19737	26381	9939	10829	NA	NA
1993	NA	NA	NA	NA	NA	NA	NA	12152	24058	12589	15255	NA	NA
1994	23739	37777	0.204	NA	35000	NA	NA	8236	23214	8849	10408	0.594	0.283
1995	28416	36432	0.159	NA	NA	NA	NA	11600	23479	4961	5629	NA	NA
1996	NA	26148	0.260	NA	NA	NA	NA	13007	21024	10397	11864	NA	NA
1997	21098	29022	0.110	38498	63000	NA	NA	6730	10600	8675	9852	0.911	0.324
1998	68015	78277	0.101	NA	57000	NA	NA	9620	12918	14811	18481	NA	NA
1999	NA	45932	0.244	NA	NA	NA	NA	3681	15381	6136	10617	NA	NA
2000	NA	28321	0.245	89363	113120	0.064	NA	12036	22536	11463	14354	NA	NA
2001	45779	75826	0.126	67110	105801	0.141	NA	10379	23095	13828	17043	0.649	0.266
2002	4330	22462	0.147	27642	110566	0.113	NA	2585	11089	3720	6405	0.249	0.032
2003	11401	16109	0.173	18687	30632	0.132	NA	1055	4074	3376	6405	0.769	0.206
2004	9042	11496	0.117	33995	45965	0.167	98601	5467	9183	6285	7004	0.410	0.157
2005	1441	4832	0.202	2467	14643	0.171	2406	146	1127	0	0	0.277	0.205
2006	10085	15113	0.238	18282	30877	0.136	134131	982	1659	69	95	0.493	-0.307
2007	7946	13060	0.178	26230	40876	0.1	78298	42	141	0	0	0.524	0.146
2008	3940	12898	0.200	10400	37574	0.162	13121	0	0	0	0	0.458	0.333
2009	5460	12832	0.140	11429	34855	0.112	20879	0	0	0	0	0.618	0.439
2010	25543	31277	0.159	64564	86355	0.147	178028	3099	6111	3544	3971	0.325	0.276
2011	112202	135732	0.160	115379	142601	0.077	599990	3701	10913	3256	3576	0.465	-0.123
2012	8936	26663	0.202	73843	186865	0.046	207625	948	8600	3869	5753	0.777	0.307
2013	24090	54686	0.179	42508	93854	0.128	142083	1759	10928	1722	3144	0.670	0.013
2014	59283	91299	0.125	86670	125427	0.063	105271	4188	14274	4752	5278	0.427	0.101
2015	113677	181063	0.101	313249	372916	0.074	723946	9524	19416	4976	8838	0.257	0.143
2016	65312	152049	0.114	35604	89727	0.130	462340	5024	15380	2501	3991	0.765	0.456
2017	62488	94759	0.122	83713	134500	0.154	371563	10741	22770	NA	3735	NA	NA
2018	NA	NA	NA	NA	NA	NA	725403	0	0	0	0	NA	NA

(Note: catch 0 values in 2016 and 2017 are not taken into consideration for the assessment).

Table 5. Bay of Biscay anchovy: Median and 90% probability intervals for some of the parameters estimated in the CBBM.

	5.00%	Median	95.00%	Meaning of parameter
qdepm	0.587	0.709	0.854	Catchability of the DEPM B index
qac	1.128	1.358	1.641	Catchability of the Acoustic B index
qrobs	0.004	0.071	1.292	Parameter of the observation equation for the juvenile index
krobs	1.097	1.376	1.642	Parameter of the observation equation for the juvenile index
psidepm	3.102	5.656	10.163	Precision (inverse of variance) of the observation equation of DEPM B index
psiac	4.127	7.432	13.201	Precision (inverse of variance) of the observation equation of Acoustic B index
psirobs	1.301	2.867	5.922	Precision (inverse of variance) of the observation equation of juvenile index
xidepm	3.281	3.963	4.701	Variance-related parameter for the observation equation of DEPM age 1 proportion
xiac	2.919	3.566	4.197	Variance-related parameter for the observation equation of Acoustic age 1 proportion
xicatch	2.310	2.683	3.043	Variance-related parameter for the observation equation of age 1 proportion in the catch
B0	16438	21359	27825	Initial biomass
mur	10.212	10.498	10.779	Median (in log scale) of the recruitment process
psir	0.757	1.179	1.743	Precision (in log scale) of the recruitment process
sage1sem1	0.396	0.468	0.560	Age 1 selectivity during the 1st semester
sage1sem2	0.954	1.176	1.450	Age 1 selectivity during the 2nd semester
G1	0.492	0.557	0.623	Intrinsic growth at age 1
G2	0.176	0.237	0.301	Intrinsic growth at age 2+
psig	18.135	26.557	37.199	Precision of the observation equations for intrinsic growth at ages 1 and 2+

Table 6. Bay of Biscay anchovy: Median and 90% probability intervals for recruitment, spawning–stock biomass, fishing mortalities by semester and harvest rates (Catch/SSB) as resulted from CBBM. Note that the SSB estimates in 2018 are derived assuming that no fishing has occurred in 2018.

	R (tonnes)			SSB (tonnes)		
Year	5.00%	Median	95.00%	5.00%	Median	95.00%
1987	12048	15954	21526	16262	21323	27993
1988	25759	31327	38665	23978	29503	37147
1989	6546	9210	13019	11200	16009	22500
1990	59045	67698	79236	46266	53860	64402
1991	17108	22665	30337	22453	29950	40131
1992	70791	89195	113974	56066	74129	97651
1993	49736	63656	79614	61686	73971	89605
1994	33284	41520	51619	39417	48731	60446
1995	35015	46381	60576	29954	42071	57005
1996	40205	50566	62564	39589	48210	60133
1997	31001	40013	52410	35325	45889	60762
1998	72376	94282	121976	72224	94311	122455
1999	28973	43329	61881	52965	69174	90055
2000	72871	89726	109228	76202	92637	111368
2001	61898	73387	87723	78445	90201	105266
2002	9288	12941	18087	31785	38873	47715
2003	15585	19641	24547	22666	27635	34118
2004	24457	30078	37595	24587	30671	38852
2005	2618	3994	5903	10341	14381	19619
2006	12051	16655	22963	15062	20302	27115
2007	15891	21779	29921	23225	30570	40155
2008	6242	9084	12786	18810	24355	31422
2009	7084	9998	14011	15852	20340	25905
2010	36249	46944	61564	37831	48495	62319
2011	87926	110955	140449	95138	117509	146590
2012	34369	44890	59058	79591	97605	120779
2013	28804	37843	49786	55012	68881	86609
2014	52810	69521	90454	65246	84158	107292
2015	89627	115878	150862	104208	132564	168884
2016	39837	54170	74611	78747	103546	135333
2017	55042	78528	111180	71394	101786	141714
2018	47951	98670	202431	85546	139741	238424

	fsem1			fsem2			Harvest rate		
Year	5.00%	Median	95.00%	5.00%	Median	95.00%	5.00%	Median	95.00%
1987	0.924	1.216	1.576	0.233	0.332	0.473	0.514	0.675	0.885
1988	0.782	1.010	1.286	0.256	0.351	0.476	0.388	0.488	0.601
1989	0.680	0.934	1.296	0.121	0.177	0.271	0.366	0.515	0.736
1990	0.976	1.215	1.503	0.489	0.655	0.875	0.524	0.626	0.729
1991	0.858	1.137	1.488	0.186	0.265	0.384	0.451	0.605	0.807
1992	0.862	1.169	1.571	0.227	0.333	0.497	0.381	0.502	0.664
1993	0.665	0.851	1.066	0.398	0.530	0.698	0.439	0.531	0.637
1994	0.908	1.151	1.429	0.420	0.577	0.793	0.556	0.690	0.853
1995	1.097	1.501	2.055	0.219	0.327	0.517	0.511	0.692	0.972
1996	0.930	1.206	1.570	0.462	0.643	0.885	0.547	0.682	0.831
1997	0.475	0.639	0.845	0.368	0.536	0.772	0.337	0.446	0.579
1998	0.334	0.449	0.597	0.308	0.449	0.662	0.256	0.333	0.435
1999	0.395	0.523	0.700	0.283	0.396	0.558	0.289	0.376	0.491
2000	0.574	0.720	0.903	0.273	0.362	0.488	0.331	0.398	0.484
2001	0.551	0.667	0.809	0.372	0.473	0.597	0.381	0.445	0.512
2002	0.447	0.551	0.675	0.377	0.487	0.629	0.367	0.450	0.550
2003	0.300	0.380	0.478	0.451	0.602	0.799	0.307	0.379	0.462
2004	0.666	0.859	1.105	0.407	0.569	0.798	0.417	0.528	0.658
2005	0.114	0.157	0.222	0.000	0.000	0.000	0.057	0.078	0.109
2006	0.178	0.239	0.323	0.007	0.010	0.014	0.065	0.086	0.116
2007	0.010	0.013	0.017	0.000	0.000	0.000	0.004	0.005	0.006
2008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2010	0.312	0.405	0.523	0.125	0.175	0.246	0.162	0.208	0.266
2011	0.233	0.299	0.381	0.046	0.063	0.085	0.099	0.123	0.152
2012	0.157	0.197	0.247	0.112	0.146	0.188	0.119	0.147	0.180
2013	0.287	0.365	0.458	0.083	0.111	0.146	0.162	0.204	0.256
2014	0.364	0.468	0.606	0.102	0.140	0.194	0.182	0.232	0.300
2015	0.331	0.427	0.553	0.107	0.146	0.199	0.167	0.213	0.271
2016	0.256	0.339	0.447	0.069	0.094	0.128	0.143	0.187	0.246
2017	0.421	0.579	0.813	0.057	0.084	0.127	0.187	0.260	0.371
2018	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 7. Bay of Biscay anchovy: Probability of SSB being below B_{lim} (top) and median SSB (bottom) for alternative annual catches in 2018 and allocations by semester.

SSB	% CATCHES IN THE 1st SEMESTER 2018										
R estimated / TOTAL CATCH 2018	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
0	139741	139741	139741	139741	139741	139741	139741	139741	139741	139741	139741
5000	139741	139394	139046	138698	138350	138000	137651	137300	136949	136599	136247
10000	139741	139046	138350	137651	136949	136247	135544	134840	134134	133433	132733
15000	139741	138698	137651	136599	135544	134487	133433	132383	131324	130260	129190
20000	139741	138350	136949	135544	134134	132733	131325	129903	128475	127048	125629
25000	139741	138000	136247	134487	132733	130970	129190	127403	125629	123839	122062
30000	139741	137651	135544	133433	131325	129190	127048	124913	122770	120631	118460
35000	139741	137300	134840	132383	129903	127403	124913	122416	119905	117363	114791
40000	139741	136949	134134	131325	128475	125629	122770	119905	116996	114053	111146
45000	139741	136599	133433	130260	127048	123839	120632	117363	114053	110780	107482
50000	139741	136247	132733	129190	125629	122062	118460	114791	111146	107482	103723
55000	139741	135896	132032	128117	124197	120266	116262	112234	108223	104090	99973
60000	139741	135544	131325	127048	122770	118460	114053	109675	105238	100735	96139
65000	139741	135192	130615	125985	121352	116630	111872	107110	102210	97288	92302
70000	139741	134840	129903	124913	119905	114791	109675	104473	99216	93834	88442

P(SSB<B_{lim})	% CATCHES IN THE 1st SEMESTER 2018										
R estimated / TOTAL CATCH 2018	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
35000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
40000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001
45000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001
50000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.002
55000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.002	0.004
60000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.002	0.004	0.006
65000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.004	0.006	0.011
70000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.002	0.004	0.008	0.018

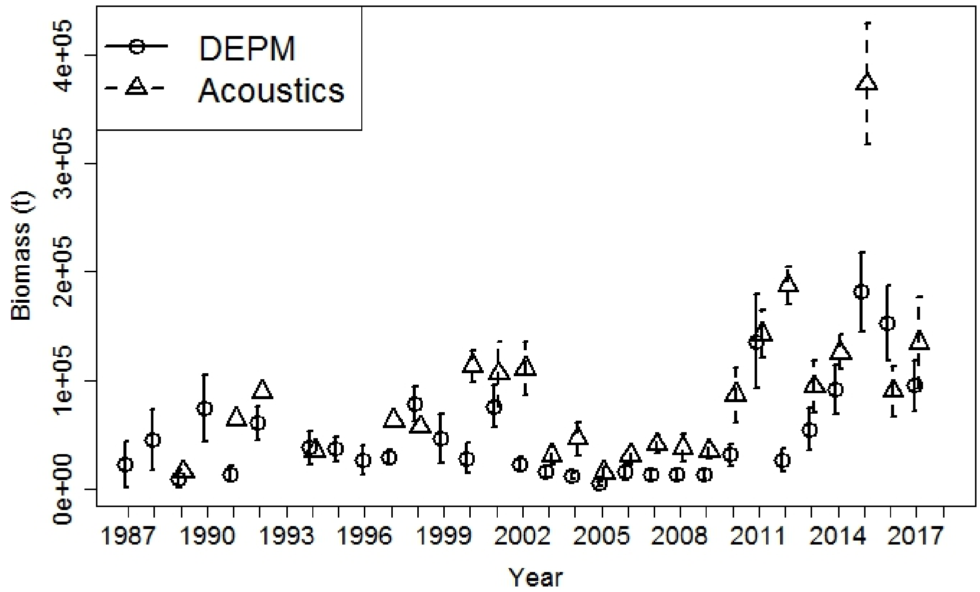


Figure 1. Bay of Biscay anchovy: Historical series of spawning–stock biomass estimates and the corresponding confidence intervals from DEPM (solid line and circles) and acoustics (dashed line and triangles).

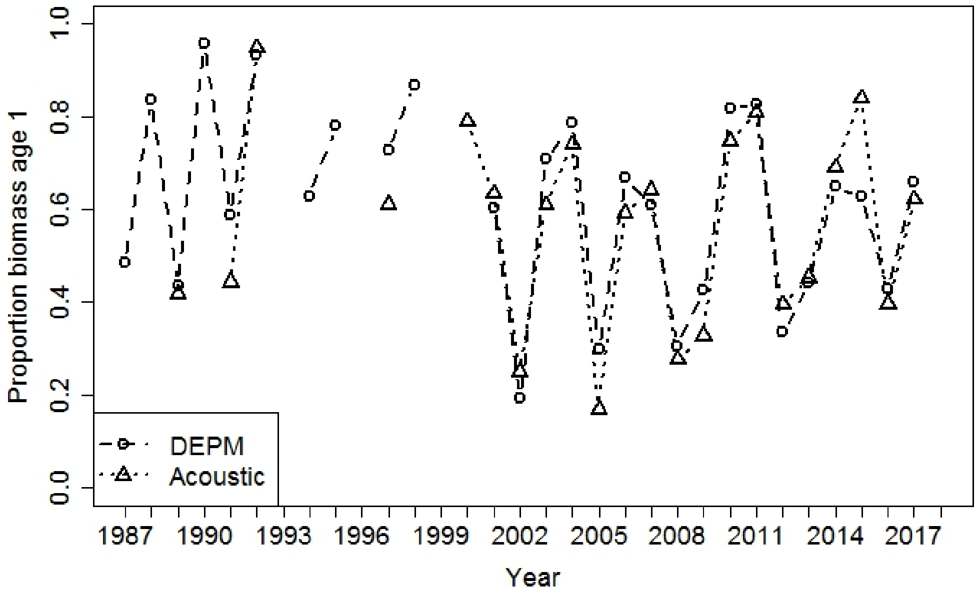


Figure 2. Bay of Biscay anchovy: Bay of Biscay anchovy: Historical series of age 1 biomass proportion estimates from DEPM (dashed line and circles) and acoustics (dotted line and triangles).

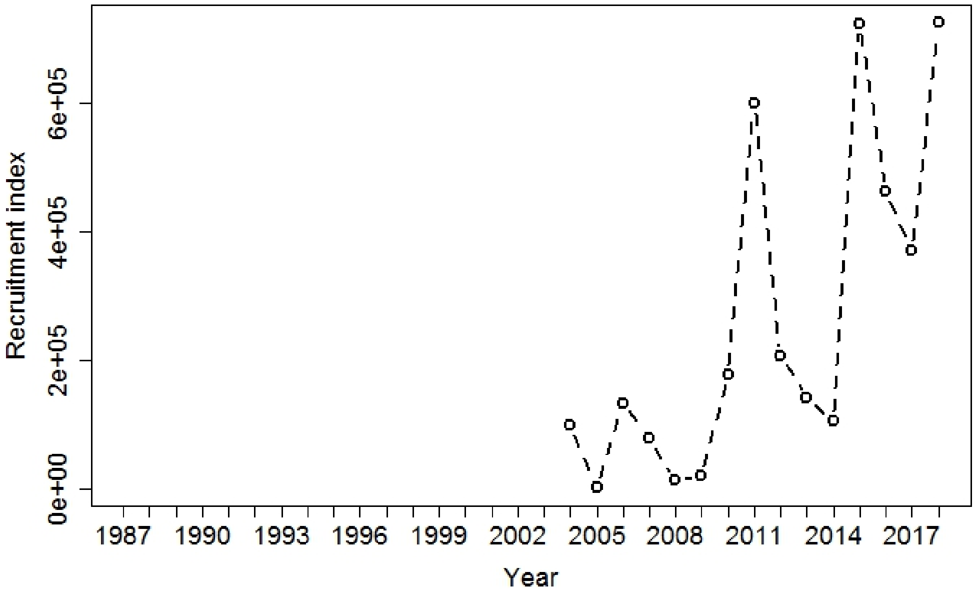


Figure 3. Bay of Biscay anchovy: Historical series of the juvenile abundance index from the autumn acoustic survey JUVENA that is related to recruitment (age 1) next year.

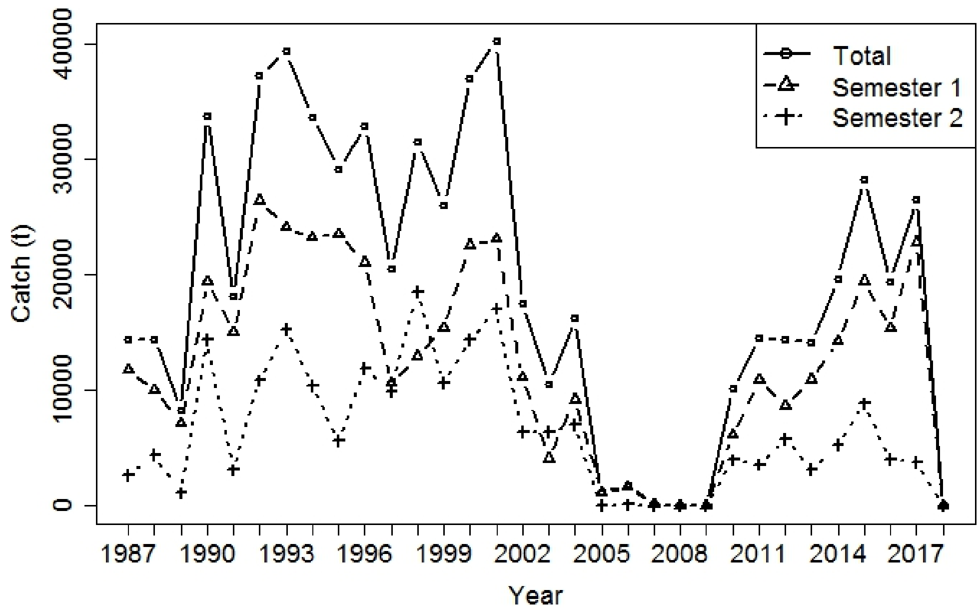


Figure 4. Bay of Biscay anchovy: Historical series of total catch (solid line) and catch by semesters (dashed and dotted lines for the first and second semester respectively). Note that the catch in 2017 is provisional and the catch in 2018 is set at zero.

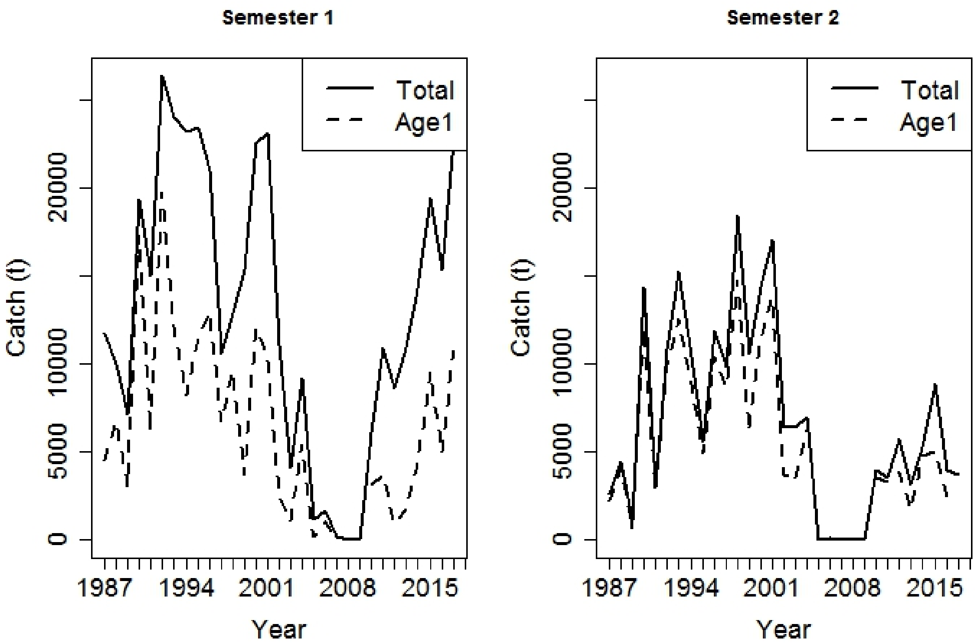


Figure 5. Bay of Biscay anchovy: Historical series of total (solid line) and age 1 (dashed line) catch (in tonnes). The left panel corresponds to the first semester and the right panel to the second semester. Note that the catch in 2017 is provisional.

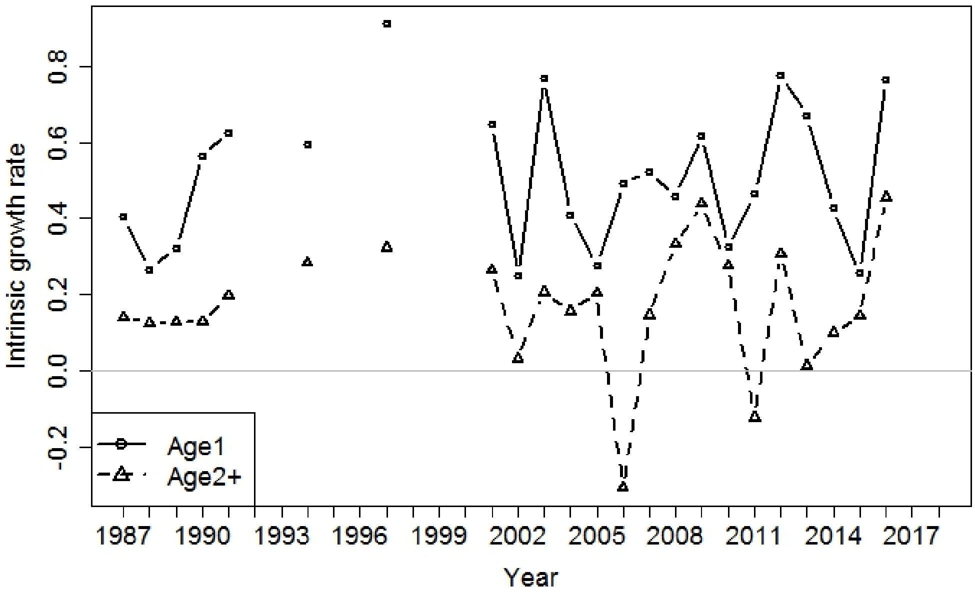


Figure 6. Bay of Biscay anchovy: Historical series of intrinsic growth rates by age as estimated from the mean weights-at-age of the stock.

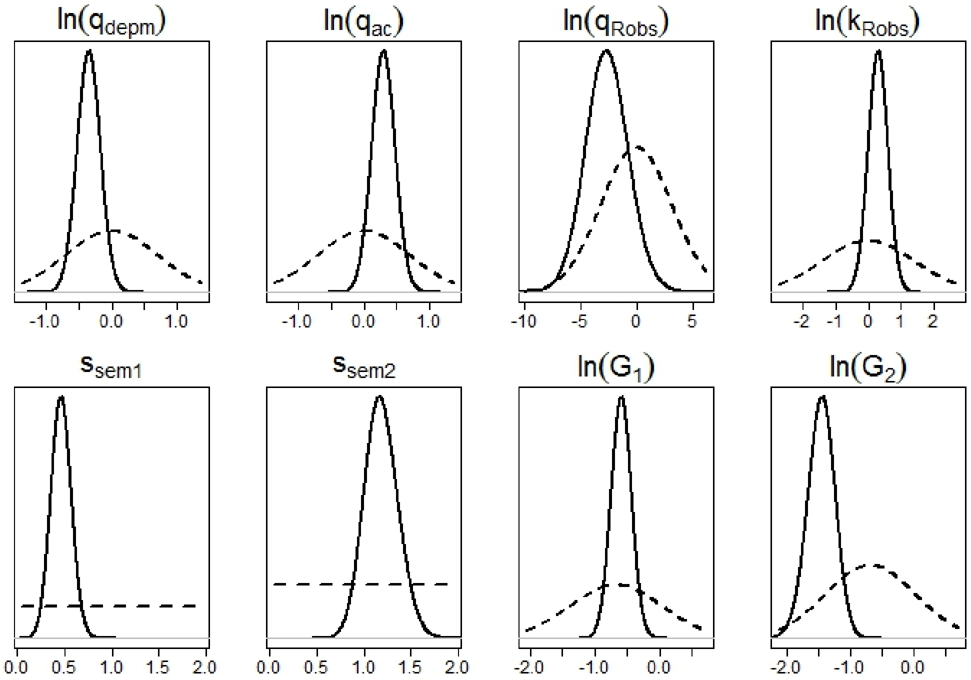
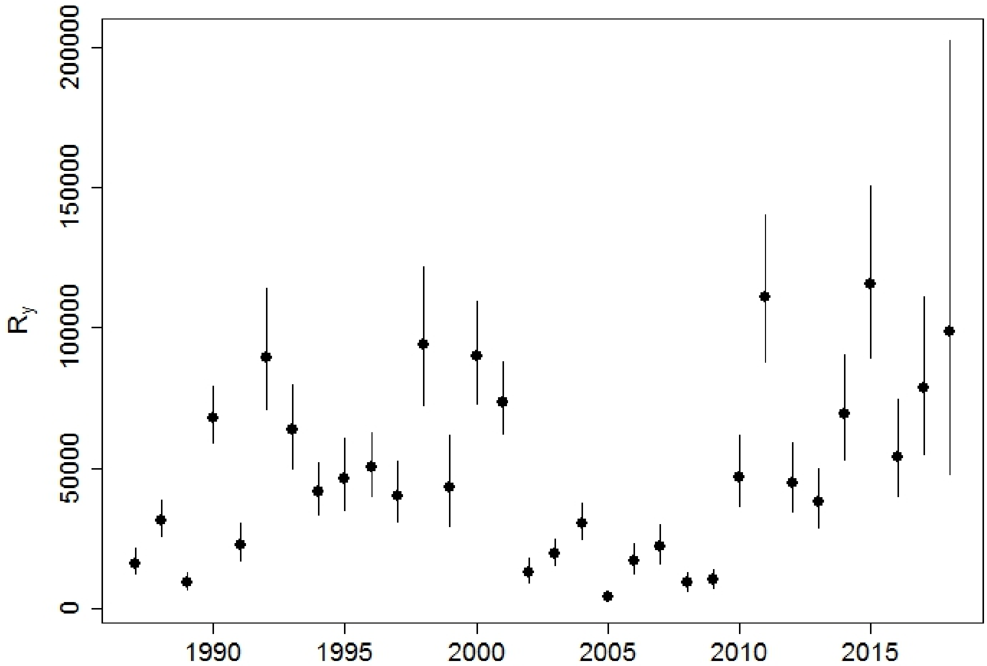


Figure 7. Bay of Biscay anchovy: Comparison between the prior (dotted line) and posterior distribution (solid line) for some of the parameters of CBBM.



R_y
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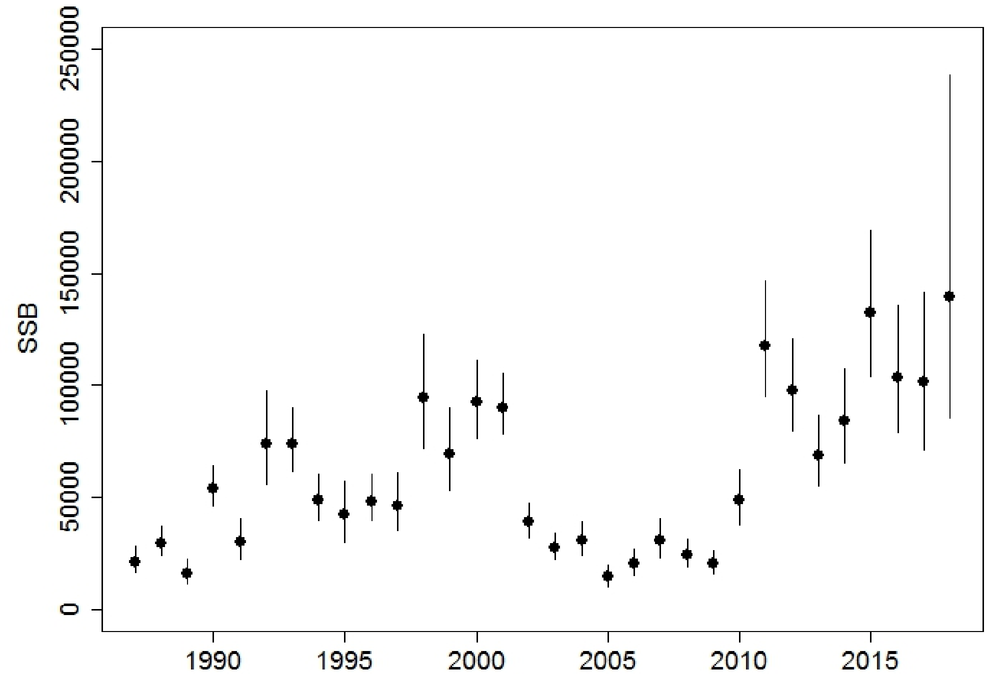

SSB
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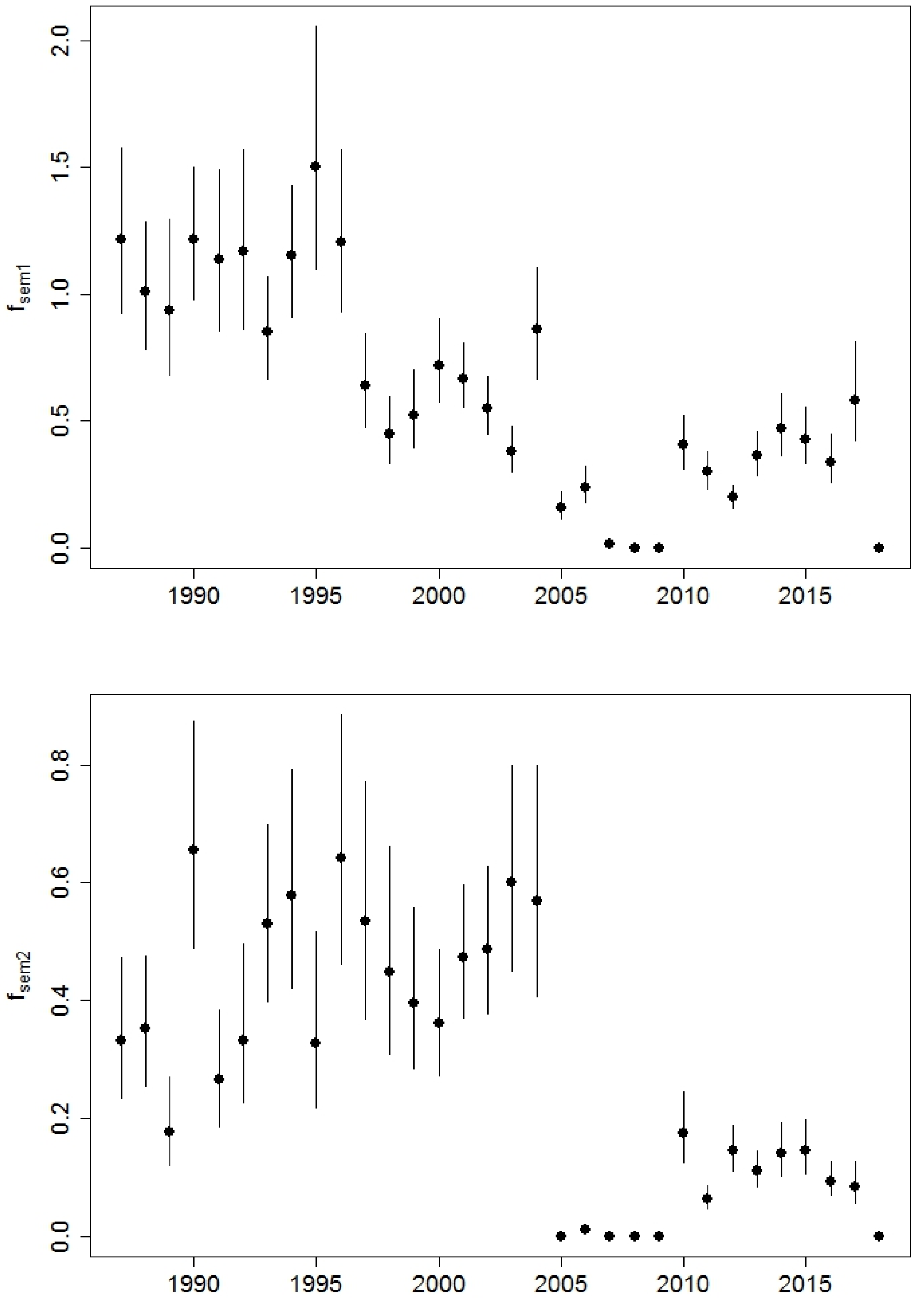


Figure 8. Bay of Biscay anchovy: Posterior median (bullet points) and 90% probability intervals (solid lines) for the recruitment (age 1 in mass in January), the spawning–stock biomass and the fishing mortality for the first and second semesters from the CBBM. It must be taken into account that the fishing mortalities in 2018 are fixed at zero and SSB in 2018 results from no fishing in 2018.

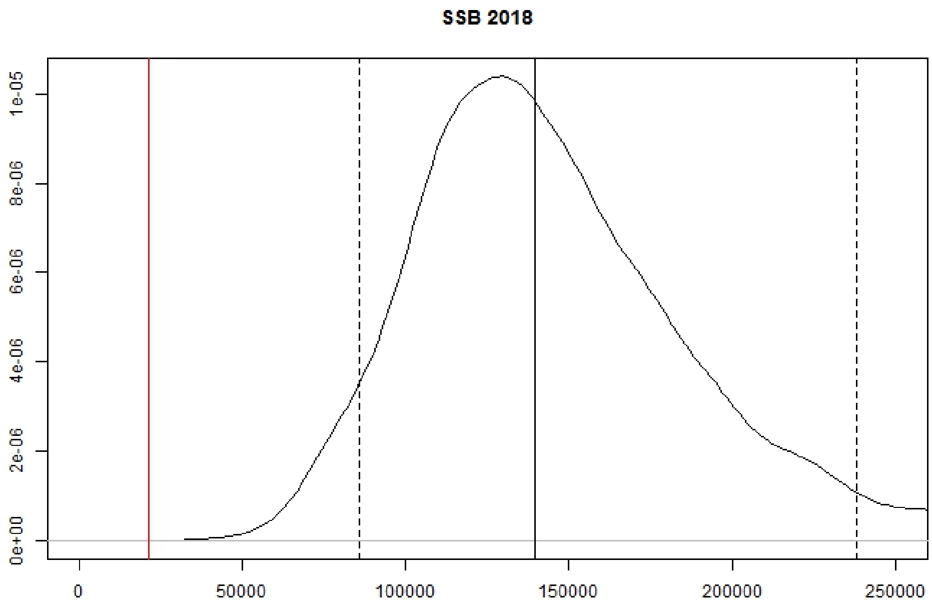
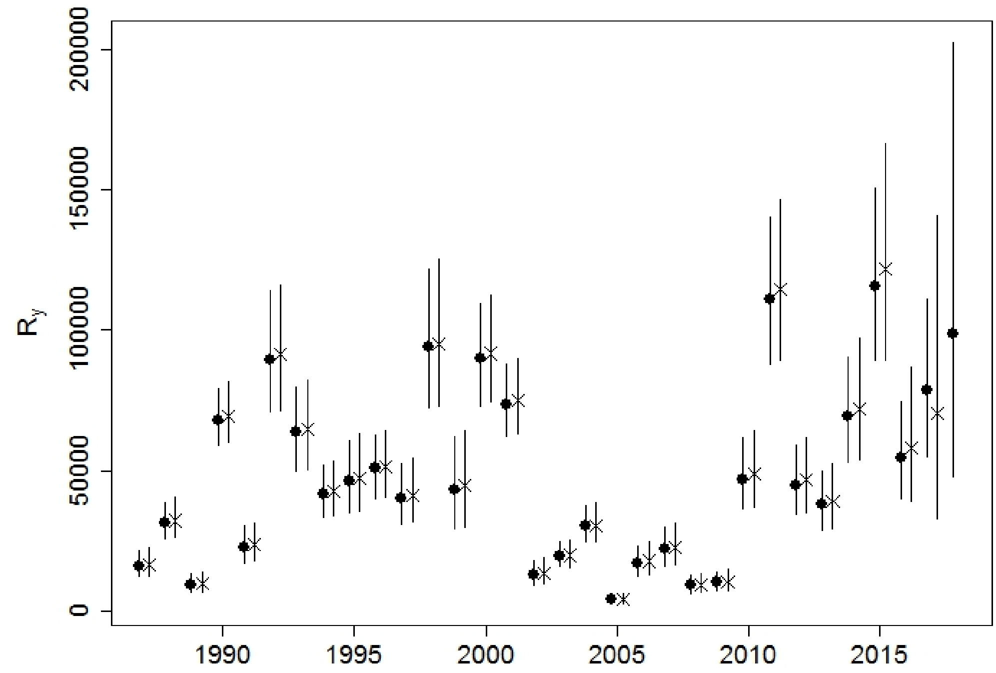


Figure 9. Bay of Biscay anchovy: Posterior distribution of SSB in 2018, under the assumption of no fishing during 2018. The red vertical line represents B_{lim} at 21 000 tonnes.



Ry
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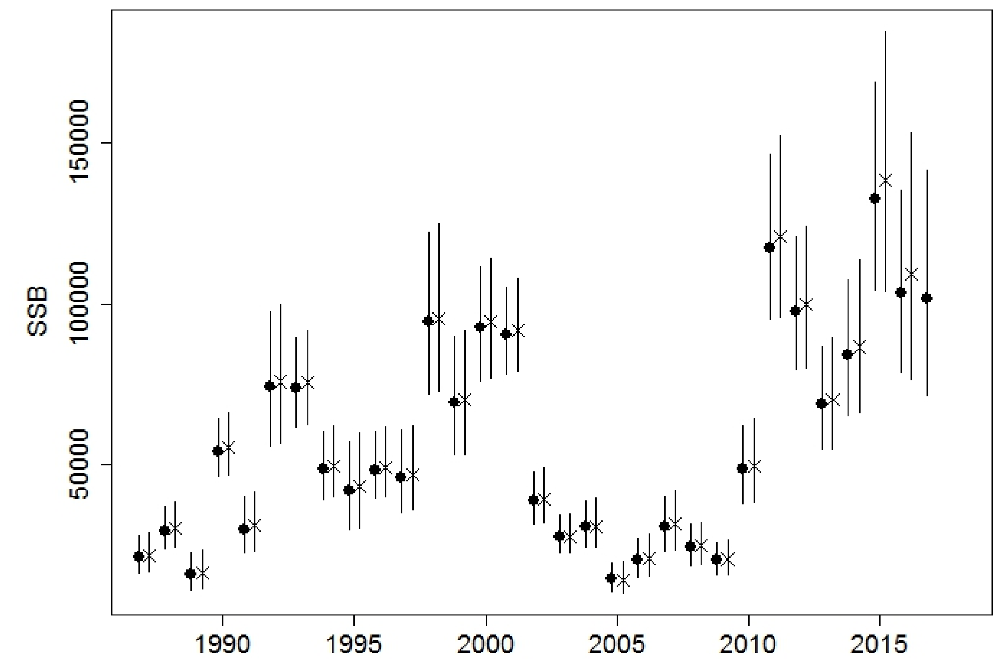

SSB
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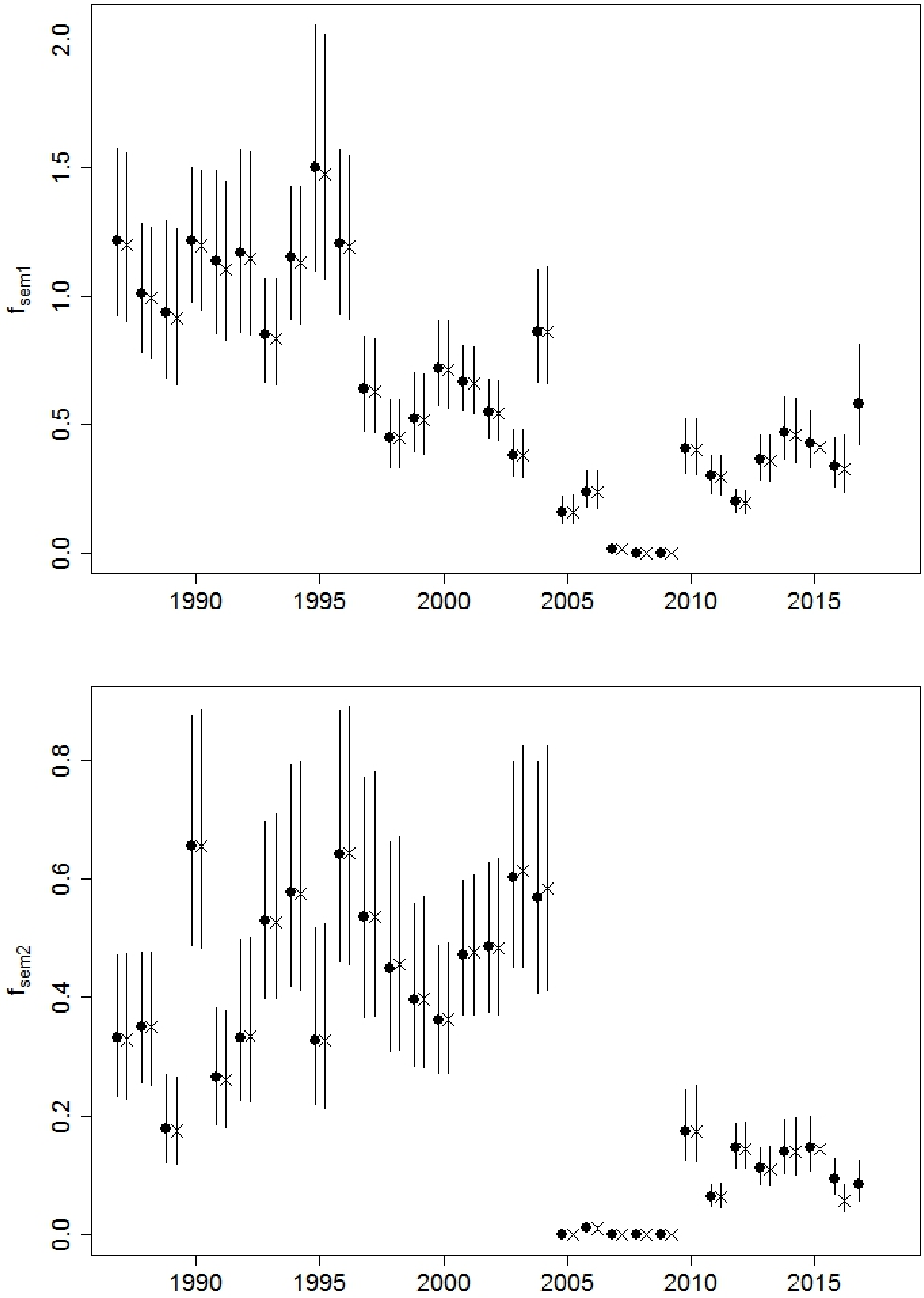


Figure 10. Bay of Biscay anchovy: From top to bottom comparison of the posterior median (points) and 90% probability intervals (solid lines) of the recruitment (age 1 in mass in January), the fishing mortality in the first and in the second semester and the spawning–stock biomass assessed in June (cross) and in December (bullet).

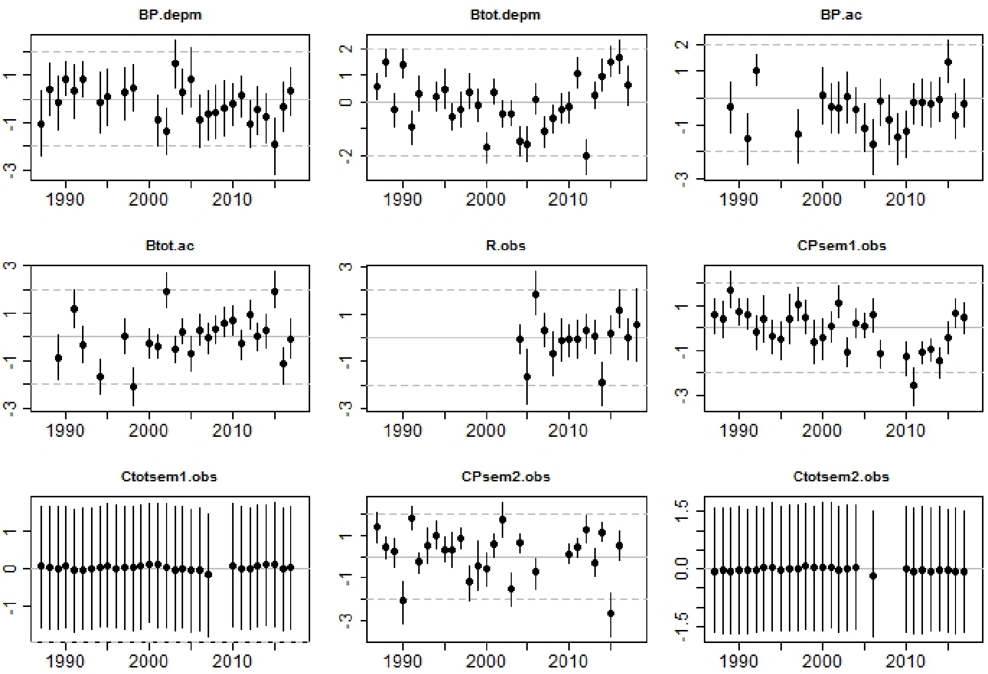


Figure 11. Bay of Biscay anchovy: Pearson residual medians and 90% probability intervals to the survey and catch observations used in the CBBM. From top to bottom and from left to right, residuals of the age 1 biomass proportion from the DEPM, total biomass from the DEPM, age 1 biomass proportion from the acoustic, total biomass from the acoustic, recruitment index, age 1 proportion in mass in the 1st semester catch, total catch in the 1st semester, age 1 proportion in mass in the 2nd semester catch and total catch in the 2nd semester.

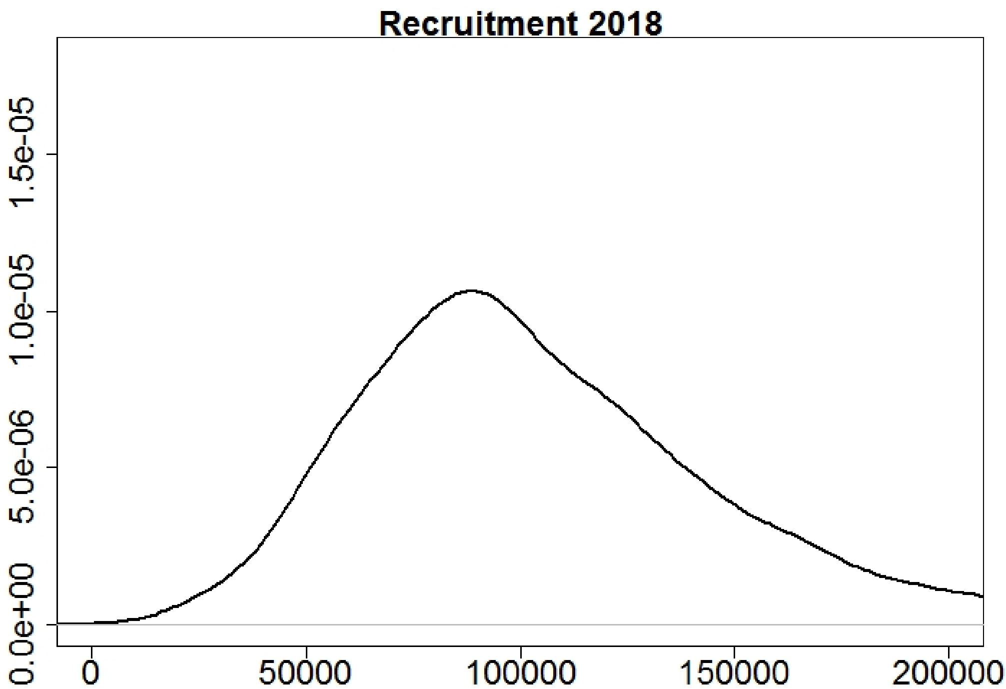


Figure 12. Bay of Biscay anchovy: Posterior distribution of recruitment (age 1 biomass at the beginning of the year) in 2018.

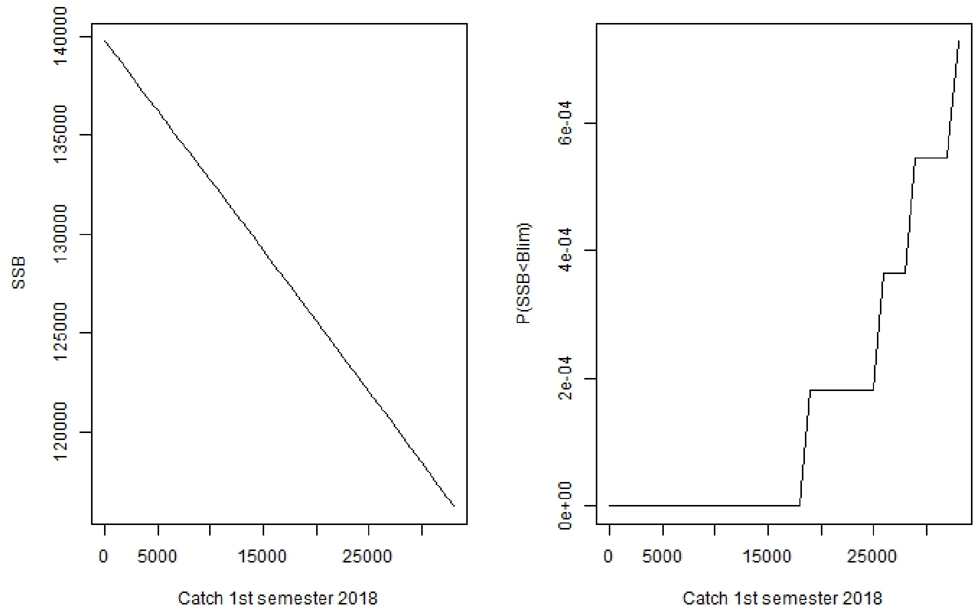


Figure 13. Bay of Biscay anchovy: SSB in 2018 (on the left) and probability of SSB in 2018 been below B_{lim} (on the right) depending on the total catches taken during the first half of the year 2018.

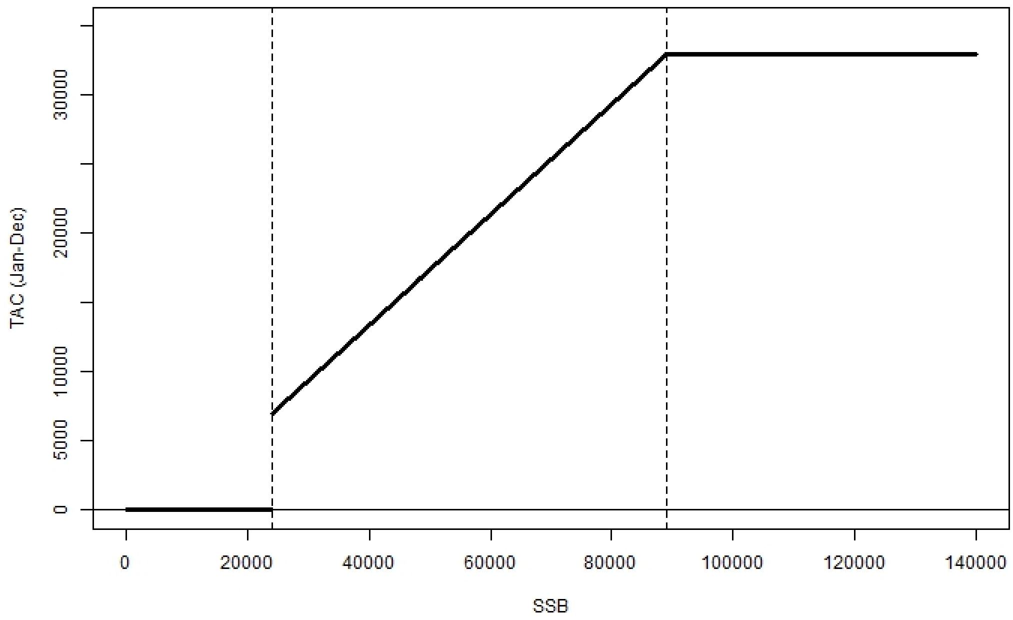


Figure 14. Bay of Biscay anchovy: Harvest control rule G3 with harvest rate of 0.4 according to which the TAC from January to December is set as a function of the expected spawning–stock biomass (on 15th May) in the management year.

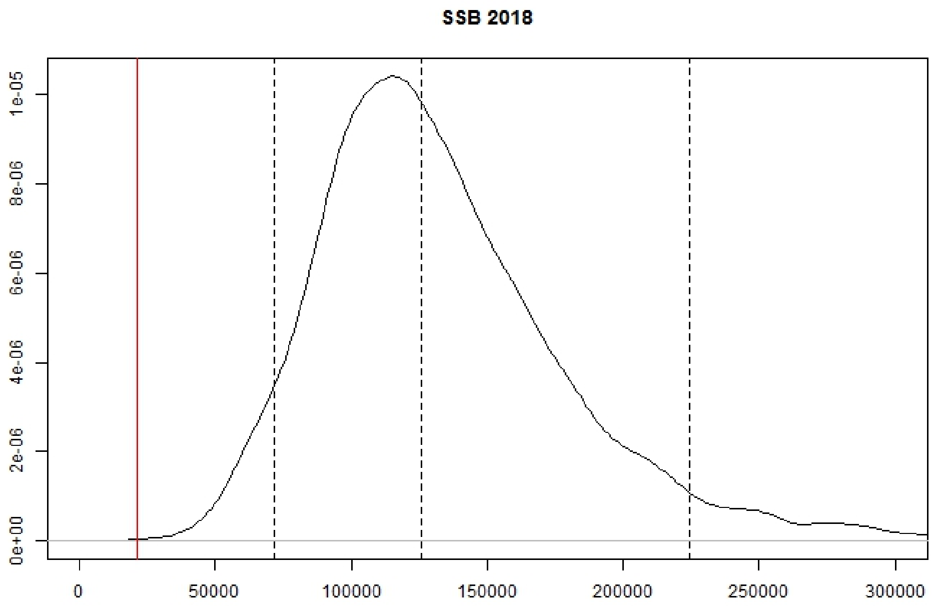
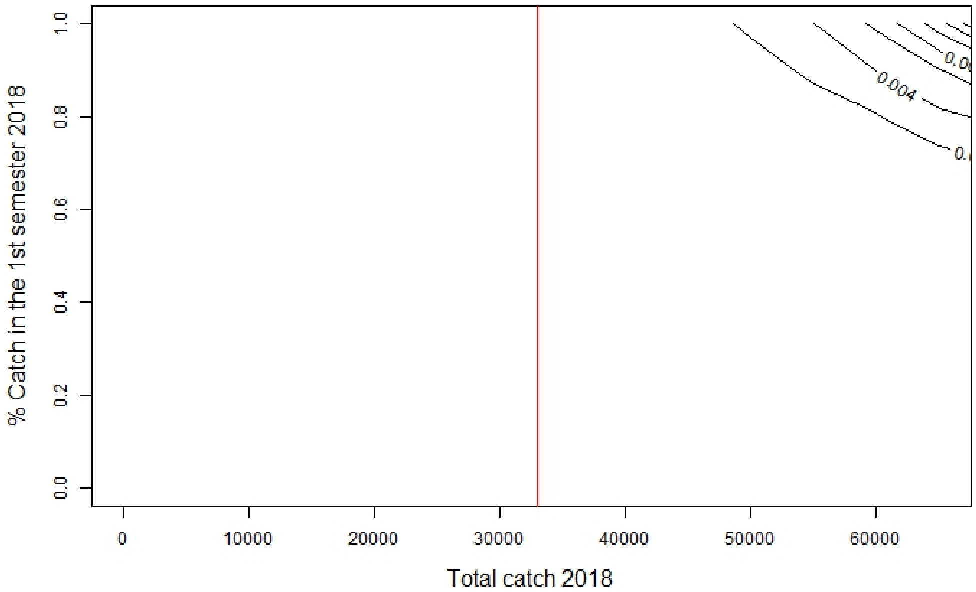


Figure 15. Bay of Biscay anchovy: Posterior distribution of SSB in 2018 if the annual catch is set according to the LTMP at 33 000 t and 60% of the catch is taken during the first semester. Vertical black dashed lines represent the 5, 50 and 95 posterior quantiles, whereas the red vertical line is B_{lim} (21 000 t).



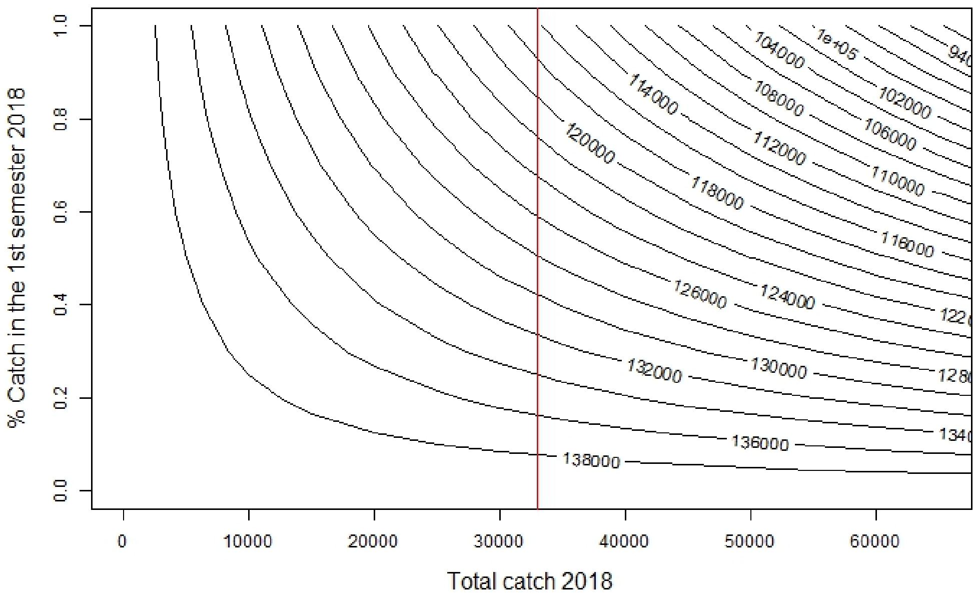


Figure 16. Bay of Biscay anchovy: Contour plots of probability of SSB in 2018 being below B_{lim} (on the top) and median SSB in 2018 (on the bottom) depending on the total catch in 2018 (x-axis) and the % of the catch in the first semester (y-axis). The vertical red line is set at 33 000 t.

Annex 7: Working Document: On the sustainability of a TAC of 15 000 tonnes for Anchovy in 9.a in 2017 given the available estimates of Biomass from surveys

Working Document to ICES WGHANSA 30/11/2017 by A. Uriarte (AZTI), F. Ramos (IEO), S. Garrido (IPMA) and M. Rincón (CSIC-ICMAN), L. Pawlowski (Ifremer) and A. Silva (IPMA)

1) The request

In November 2017, the Commission received a request from Portugal for a 20% increase in the 2017 TAC for anchovy in Division 9.a, attaching a scientific report prepared by IPMA as justification. An increase in the 2017 TAC would mean an adjusted TAC of 15 000 t. Such a request was passed to ICES for its consideration. ICES had received a similar request in July 2017 and, at that time, ICES advised that TAC of 15 000 t was not precautionary.

ICES asked WGHANSA to assess whether the evidence provided now in November 2017 by Portugal justifies a 20% TAC increase for 9.a anchovy in 2017, and whether such an increase is precautionary. This working document does not directly assess the Portuguese scientific report attached to the special request, because it expands further the basis of the analysis to include all surveys available in 2017 and potential harvest rates for the two regions of consideration within Division 9.a (the Southern and Western region) for a TAC of 15 000 t (see further explanations in the appendix 1 to this WD.

2) Statement of the problem

ICES in its answer to the July 2017 special request (ICES 2017) stated that "*catches of 15 000 tonnes in 2017, if taken entirely in the southern part of Division 9.a, cannot be considered sustainable*." Such statement came from the fact that the amount of catches by regions could not be clarified by June 2017.

In order to escape from the uncertainties about where the catches will take place, the reply now, in November 2017, will be based on the expected final distribution of the allowable catches for anchovy in 9.a between the 9.aSouth area and the 9.aWestern areas (the western waters of the Iberian peninsula, which includes here 9.a North, Central North and Central South, i.e. 9.a N, CN, CS; **Figure 2.1**). In this way, expected harvest by regions 9.aSouth and 9.aWest can be evaluated, using the ratio between those expected annual catches by regions and the estimates of anchovy biomass from the surveys carried out in Division 9.a by regions, which are currently all available.

Once assessed the harvest rates by regions, the advice will be based on considerations about sustainable harvest rates (HRs) as included in the 2016 July advice for southern area (9.aSouth) (ICES, 2016a), which stated:

a) Past HRs occurring in 9.aSouth were considered sustainable (ranging between 0.1 and 0.49, mean of 0.27, since 1999) as they lead in the long term to Spawning Biomass per Recruit above 50%.

b) The HRs that lead to Spawning Biomass per Recruit at 50% (in 9aSouth) are 0.78 (though not mentioned in the answer it appeared in the Figure 7.3.1.5 of the 2016 July advice for anchovy in 9.a).

In the WGHANSA 2016 report (ICES, 2016b) it was mentioned that the HRs analysis performed "is wide and general enough as to be applicable to any anchovy fishery mostly based on catches at age 1, and, therefore, applicable to the western areas as well." In addition, the average harvest rates for the Western and Southern regions are rather similar in both regions since 2007, being around 0.24–0.27 (0.26 for the entire 9.a Division, see Table 6.2 in the report mentioned above; ICES, 2016b)

Assuming this framework of sustainable HRs, we will assess whether expected final HRs by regions associated to the total allowable catches of 15 000 t for 2017 will fall within the range of sustainable HRs for the 9.aSouth by regions (and in the range of past estimates of HRs).

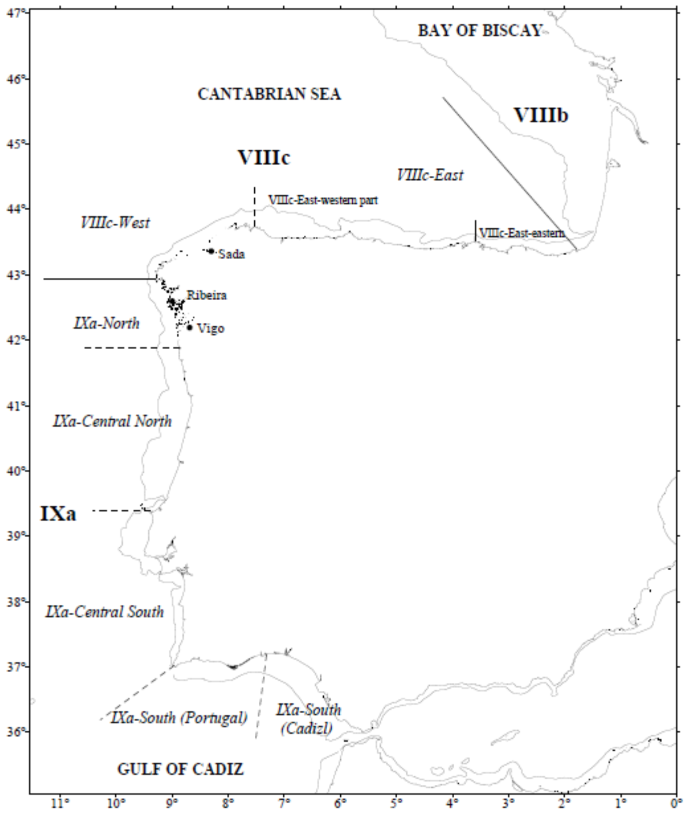


Figure 2.1. Anchovy in Division 9.a. ICES divisions and subdivisions in southern Europe. Note that Subdivision 9.a South (which includes the European waters of the Gulf of Cadiz) is also differentiated between Portuguese and Spanish waters.

3) Survey Inputs

By November 2017, results from all surveys covering parts of the 9.a Division are available and have been reviewed and approved during the WGACEGG meeting (Cádiz, 13–17 November 2017; ICES, 2017b):

- For 9.aWest:
    - *PELACUS* acoustic survey covering 9aNorth in April reported 3566 t
    - *PELAGO* acoustic survey (western coverage) covering 9aCentral South and Central North mainly in May reported 15481 t

The addition of both surveys carried out in spring amounts to 19 047 t in 9.aWest.

- For 9aSouth:
    - *PELAGO* acoustic survey (Southern coverage) covering 9.aSouth in May reported 13 797 tonnes;
    - *ECOCADIZ* acoustic survey covering 9.aSouth in July reported 12 229 tonnes;
    - *BOCADEVA* DEPM survey covering 9.aSouth in July reported 12 422 tonnes.

The three surveys consistently pointed out that on average the Biomass in 9.aSouth could be around 13 000 t (with mean of the three surveys equal to 12 816 t).

Table 3.1. Anchovy in Division 9.a. Biomass estimates (in tonnes) from each survey series on a regional basis.

Year	*PELACUS*	*PELAGO*	*PELAGO*	*ECOCADIZ*	*BOCADEVA*	9a South **Southern component**	9a West **Western component**	**DIVISION 9a**
	(ACOUS)	(ACOUS)	(ACOUS)	(ACOUS)	(DEPM)	**MEAN BIOMASS**	**PELACUS+PELAGO**	
	9a N	9a CN-CS	9a S	9a S	9a S	**9a S**	**9a N to 9a CS**	
1999		596	24763			24763	596	25359
2000								
2001		368	24913			24913	368	25281
2002		1542	21335			21335	1542	22877
2003		112	24565			24565	112	24677
2004				18177		18177		18177
2005		1062	14041		14637	14339	1062	15401
2006		0	24082	36521		30301	0	30301
2007	0	1945	38020	28882		33451	1945	35396
2008	306	5505	34162		31527	32845	5811	38655
2009	26	2089	24745	21580		23163	2115	25278
2010	42	1188	7395	12339		9867	1230	11097
2011	1508	27050	0		32757	16379	28558	44937
2012	45							
2013	0	4284	12700	8487		10593	4284	14878
2014		1947	28917	29219	31569	29902	1947	31849
2015		8237	33100	21305		27203	8237	35440
2016	205	38302	65345	34301		49823	38507	88331
2017	3566	15481	13797	12229	12422	12816	19047	31863

For consistency with the basis of the analysis carried out in WGHANSA 2015 and 2016 (ICES, 2015; 2016) we will adopt the sum of *PELACUS* and *PELAGO* (western coverage) anchovy estimate in 9.aWest and the mean of *PELAGO* (Southern coverage), *ECOCADIZ* and *BOCADEVA* anchovy biomass estimates for the 9.aSouth area, as the methods of computation of the corresponding stock biomass size indicators for each stock component (i.e., western and southern components).

The historical series of survey biomass estimates and stock size indicators (biomass estimates by regions) for southern and western components of the stock from 1999 to 2017 are presented in **Table 3.1**.

4) TAC and Catches by regions in 2017

Current TAC in Division 9.a is set to 12 500 t, the new TAC requested to be evaluated to ICES is 20% higher, i.e. rising up to 15 000 t.

Catches for both countries and regions are known until September 2017, and for Spain until mid-November as well (**Table 4.1**).

Table 4.1. Monthly catches of anchovy in Division 9.a by regions, as known to have occurred in 2017 by the time this WD was elaborated (source National directorate of fisheries).

Country	Region	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL	TOTAL-Sept
Portugal	9a South	16.2	11.2	22.0	12.2	19.1	8.8	10.8	24.0	4.1	NA	NA	NA	128.3	128.3
Portugal	9a West	523.6	368.6	242.8	36.9	217.9	117.6	598.1	2,700.6	1,962.9	NA	NA	NA	6,769.1	6,769.1
Total	9a Division	539.8	379.8	264.7	49.1	237.0	126.4	608.9	2,724.6	1,967.0	NA	NA	NA	6,897.3	6,897.3
Country	Region	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL	TOTAL-Sept
Spain	9a South	23.4	362.2	356.1	609.1	776.8	475.2	718.4	695.7	359.9	110.4	35.9	NA	4,523.2	4,376.8
Spain	9a West	0.0	5.5	301.2	0.0	0.5	0.0	0.0	0.0	0.0	74.9	76.1	NA	458.1	307.1
Total	9a Division	23.4	367.7	657.2	609.1	777.3	475.2	718.4	695.7	359.9	NA	NA	NA	4,981.3	4,684.0
Country	Region	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL	TOTAL-Sept
International	9a South	39.6	373.4	378.1	621.3	795.9	484.0	729.2	719.7	363.9	NA	NA	NA		4,505.1
International	9a West	523.6	374.1	543.9	36.9	218.4	117.6	598.1	2,700.6	1,962.9	NA	NA	NA		7,076.2
Total	9a Division	563.2	747.5	922.0	658.2	1,014.3	601.7	1,327.3	3,420.3	2,326.9	NA	NA	NA		11,581.3

Table 4.2. Historical records of Quarterly catches of anchovy in Division 9a by regions (from ICES WGHANSA reports).

		International Catches 9a South (CAD+Algarve)			
2001	1051.7	3233.4	3278.3	1091.4	8654.8
2002	1775.3	2964.3	2705.4	817.2	8262.2
2003	1027.5	2539.3	984.5	416.4	4967.7
2004	1384.4	1976.5	1553.4	703.1	5617.4
2005	1382.9	2252.5	705.5	81.8	4422.7
2006	1293.9	2657.2	415.2	15.1	4381.4
2007	1577.4	2253.3	1422.4	356.6	5609.6
2008	599.5	1120.6	910.7	573.6	3204.5
2009	533.2	1279.8	1016.8	124.3	2954.1
2010	66.8	1709.3	920.6	232.1	2928.8
2011	1327.3	2342.6	2053.2	571.4	6294.5
2012	1158.1	2433.3	1219.2	27.2	4837.8
2013	443.9	1835.9	2681.2	278.5	5239.6
2014	1754.3	3553.3	3304.5	439.0	9051.0
2015	1467.4	2386.0	1852.2	1174.2	6879.8
2016	1280.0	2231.7	2219.1	868.5	6599.2
MEAN	1132.7	2298.1	1702.6	485.6	5619.1
			MAX Q4th	1174.2	

		International Catches 9a West (N+CN+CS)			
2001	39.2	37.4	121.7	245.3	443.6
2002	89.4	17.7	216.7	219.7	543.4
2003	46.1	40.9	61.2	152.7	301.0
2004	55.8	63.7	12.4	94.5	226.4
2005	25.5	40.7	10.0	16.0	92.3
2006	67.6	19.0	5.1	18.2	109.9
2007	14.3	160.2	44.1	625.3	843.9
2008	149.7	42.5	6.9	104.2	303.3
2009	21.6	8.9	12.8	14.8	58.2
2010	11.1	26.8	156.4	86.8	281.1
2011	21.3	264.0	2112.5	1383.7	3781.5
2012	475.8	125.3	45.5	132.1	778.8
2013	109.0	68.9	121.2	93.4	392.5
2014	41.9	55.0	1180.3	4.2	1281.4
2015	472.9	880.6	1219.0	144.5	2717.0
2016	10.9	399.5	6291.9	438.1	7140.4
MEAN	103.3	140.7	726.1	235.9	1205.9
			MAX Q4th	1383.7	

According to the past series of catches by quarters of the international fishery (**Table 4.2**) and the actual percentages of catches by regions and countries until September 2017 (**Table 4.1**), we considered some scenarios of final realization of catches for a final TAC of 15 000 t in 2017 (as asked to be evaluated in the request):

Scenarios based on potential catches in the 9.aSouth region

- Scenario A: for Max Catch in 9.aSouth

According to the past series of catches by quarters of the international fishery in 9.aSouth, the historical maximum catch in the fourth quarter happened in 2015 and amounted to 1174 t (**Table 4.2**). If such a maximum would be equalled in 2017, from October to December, the total annual catch in 9.aSouth would result to be 5679 t. This value was calculated by adding the catches until the end of September (4505 t) to 1174 t.

For a total international TAC of 15 000 t, remaining allowable catches would be taken in the 9.aWest, i.e. 9321 t.

The likelihood of such scenario seems to be low, because in 9.aSouth most of the catches (about 90%) are obtained by the Spanish fishery, and currently it is known that catches from October until mid-November in the South Spanish fishery amount to only 146 t. In support of such consideration it should be noticed that the historical maximum in 9.aSouth happened in 2015, a year with rather high biomass level in the area (estimated to be around 27 203 t). As in 2017 the Biomass is assessed to be far below such level (around 12 816 t) it seems logical that the final actually realized catches will be far below such maximum past catches.

On the other hand the complementary catches in 9aWest (9321 t.) exceeds by about 500 t the expected catches of 8796.7 t obtained in Scenario D for this area.

- Scenario B: for the Expected Catch in 9.aSouth

This scenario is based on the consideration that most probably catches at the end of 2017 in the 9.aSouth regions would be those known until September plus those expected to happened in the fourth quarter (Q4) in the region. Historically the weighted mean value of the percentage of the catches Q4 over the total year catch amounts to 8.64%. This implies that mean historical percentage of the 4th Quarter catches over the sum of prior catches in Q1, Q2 and Q3 is 9.5% (=0.864/(1-0.864)). Such value, applied to the 2017 to the catches obtained until the end of September, leads to infer an expected catch in the fourth quarter of 427.2 t. Therefore, **the expected total annual catch is 4931.3 t for the 9.aSouth in 2017** (obtained by adding the catches until the end of September 4505.1 t to the 427.2 t).

For a total international TAC of 15 000 t remaining allowable catches would be taken in the 9.aWest, i.e. 10 068.7 t.

The estimated catches in the fourth quarter (427.2 t) for 9.aSouth seems rather consistent with the amount observed to happen until mid-November in the Southern Spanish fishery (only 146 t).

On the other hand, the complementary catches in 9.aWest (10 068.7 t.) are higher than the expected catches of 8796.7 t obtained in Scenario D for this area.

- Scenario C: for the Minimum Catch in 9.aSouth (Leading to a Max catch in 9.aWest):

This scenario is based on the consideration that no further catches would be taken until the end of the year in the 9.aSouth regions. Although this is unlikely, in some prior years the fishery used to be closed in December. This scenario assumes that known catches that occurred in 9.aSouth until mid-November in Spain (4532.2 t) and until the end of September in Portugal (128.3) would correspond to **a minimum total annual catch in 9.aSouth region (=4651.5 t).**

For a total international TAC of 15 000 t remaining allowable catches would be taken in the 9.aWest, i.e. 10 348.5 t. This amount would correspond with a maximum of catches in 9.aWest for a TAC of 15 000 t.

The complementary catches in 9.aWest (10 348.5 t.) are the highest estimates produced in the scenarios considered in this report and seem to be very unlikely to happen.

Scenarios based on potential catches in the 9.aWest region

- Scenario D: for Expected catch in 9.aWest (for mean Q4% catches since 2001):

This scenario is based on the consideration that most probably catches at the end of 2017 in the 9.aWestern regions would be those known until September plus those expected to happened in the fourth quarter (Q4) in the region. Historically the weighted mean value (weighted to the catches) of the percentage of the catches Q4 over the total year catch amounts to 19.56%. This implies that mean historical percentage of the 4th Quarter catches over the sum of prior catches in Q1, Q2 and Q3 is 24.31% (=0.1956/(1-0.1956)). Such value, applied to the 2017 to the catches obtained until the end of September, leads to infer an expected catch in the fourth quarter of 1720.5 t. Therefore, **the expected total annual catch is 8796.7 t for the 9.aWest in 2017** (obtained by adding the catches until the end of September 7076.2 t to the 1720.5 t).

For a total international TAC of 15 000 t remaining allowable catches would be taken in the 9.aSoutht, i.e. 6203.3 t. This value for 9.aSouth exceeds by about 500 t the maximum considered in scenario A (see summary in **Table 4.3**).

- Scenario E: for Max Catch in 9.aWest

According to the past series of catches by quarters of the international fishery in 9.aWest, the historical maximum catch in the fourth quarter happened in 2011 and amounted to 1384 t (**Table 4.2**). If such a maximum would be equalled in 2017, from October to December, **the total annual catch in 9.aWest would result to be 8460 t**. This value was calculated by adding the catches until the end of September (7076 t) to 1384 t.

For a total international TAC of 15 000 t remaining allowable catches would be taken in the 9.aSouth, i.e. 6540 t.

This estimate of a maximum value for 9.aWest is slightly below the expected catch for this area based on the mean percentage of catches in the fourth quarter (of scenario D) and hence is may be quite likely to happen and be exceeded in this particular year.

Following the comments above for each scenario, we gave flag the catches by scenario according to its likelihood of happening (**Table 4.3**): expected values are in green and the associated catches in the complementary region become in both cases maximum potential values for those regions (in yellow) to reach the TAC of 15 000 t. The maximum value for the western region defined in Case E seems quite likely to happen and being exceed as it is less that the expected value (case D). The highest catch values deduced for each region are well above the maximum potential catches deduced for those regions, and hence are flagged as unlikely.

Table 4.3. Summary scenarios of potential catches by regions at the end of 2017.

Catches	9aWest	9aSouth	TAC	Summary explanation
Case A	9,321	5,679	15,000	Maximum catches in 9aSouth (according to maxCatch in Q4)
Case B	10,069	4,931	15,000	Southern expected Catches for mean Q4% since 2001
Case C	10,349	4,651	15,000	Minimum catches in 9aSouth (from 0 catch in midNov & Dec)
Case D	8,797	6,203	15,000	Western expected Catches for mean Q4% since 2001
Case E	8,460	6,540	15,000	Maximum Catch in Western area according to max catch in Q4 since 2001

(white)	Unlikely Low
(green)	Likely values
(yellow)	Maximum potential values
(orange)	Unlikely maximum values

5) Expected Harvest rates by regions for a total TAC of 15 000 t in Division 9.a and assessment of their sustainability

Table 5.1 shows the historical catches, biomass by regions and associated harvest rates series, which are followed by the evaluation of the harvest rates for the five case scenarios defined above. Historical summary statistics (until 2016) are provided at the bottom of **Table 5.1**, with the means for the complete series, since 1999, and just since 2007 (the latter with their maximum and minimum values). The reason for making a mean with max and min restricted to the period after 2007, is because in the western region the first values of the series are too high to be credible and suggest that underestimates of the biomass in the western regions could have happened.

For the 9.aSouth regions the expected harvest rates up to those corresponding with the Maximum potential catches (so up to 0.48) fall within the range of historical HR values. The unlikely maximum value falls just above the upper bound of the range of past value (0.51 in comparison to the past max of 0.49).

For the 9.aWest regions all assessed harvest rates fall within the range of historical HR values (all below 0.66). The HRs associated to the Maximum potential catches reaches 0.53 and the unlikely maximum value falls just above it (0.54).

HR for the entire Division 9.a would be around 0.47, this is within the range of past historical values recorded in Southern region, even though it will be a historical maximum over the entire Division 9.a.

Sustainability of expected harvest rates for a total TAC of 15 000 t in Division 9.a

Based on the analysis of exploitation harvest rates (parallel to a Yield per recruit analysis) carried out in 2014 and 2015 (ICES, 2014; 2015) for a fishing pattern as in the fishery in the southern regions, **Figure 5.1**), it was concluded (as reported in the 2016 July advice for southern area 9.aSouth), that past HRs occurring in 9.aSouth were sustainable (ranging between 0.1 and 0.49, mean of 0.27, since 1999), as they lead in the long term to Spawning Biomass per Recruit above 50%.

Further explanations were given in the 2015 WGHANSA report (ICES, 2015; Section 4.5.3, page 127): "In the context of the Yield per Recruit analysis for Harvest Rates (….), all the range of HR resulting from the former sensitivity analysis on the different Catchability Q values, are at maximum, but generally well below the HR corresponding to the 50% SBR per recruit (= 0.78). As such, the Expected %SBR for the range of HR for this fishery resulting from sensitivity analysis above should generate Spawning Biomass per Recruit above 50% (….), thus the stock seems to be exploited sustainable, for any potential catchability value below or equal to 1.6".

Table 5.1. Historical series of Catches, Biomass and Harvest rates by regions and in Total for the Division 9.a. The five lines for 2017 correspond with the five scenarios devised for the total catches by regions in 2017 under a TAC of 15 000 t for the entire Division 9.a. Case A for a potential for Max Catch in 9.aSouth of 5679 t; Case B for the *ad hoc* expectation of Catch in 9.aSouth of 4931 t according to the historical weighted % of catches in the fourth quarter in this area and the earlier catches occurring in 2017; Case C for a minimum total annual catch in 9.aSouth of 4651.5 t; Case D for the *ad hoc* expectation of Catch in 9.aWest of 8797 t according to the historical weighted % of catches in the fourth quarter in this area and the earlier catches occurring in 2017; Case E for a potential for Max Catch in 9.aWest of 8460 t. In all of these cases Catches in the counterpart Western or Southern area are the remaining catches up to the 15 000 t tested TAC. Harvest rates in the western region in the first period of the series (1999–2003) were occasionally too high probably as a result of under-estimate of Biomass in those years.

			Western component			Southern component			Total Division		
		Year	Subdiv. 9.a N + 9.a CN + 9.a CS			Subdiv. 9.a S					
	TAC		Catches	Stock size	HR	Catches	Stock size	HR	Catches	Stock size	HR
		1999	1466	596	2.46	5942	24763	0.24	7409	25359	0.29
		2000	142		n.a	2360		n.a	2502		n.a
		2001	444	368	1.21	8655	24913	0.35	9098	25281	0.36
		2002	543	1542	0.35	8262	21335	0.39	8806	22877	0.38
		2003	301	112	2.69	4968	24565	0.20	5269	24677	0.21
		2004	226		n.a	5617	18177	0.31	5844	18177	0.32
		2005	92	1062	0.09	4423	14339	0.31	4515	15401	0.29
		2006	110	0		4381	30301	0.14	4491	30301	0.15
		2007	844	1945	0.43	5610	33451	0.17	6454	35396	0.18
		2008	303	5811	0.05	3204	32845	0.10	3508	38655	0.09
		2009	59	2115	0.03	2954	23163	0.13	3013	25278	0.12
		2010	281	1230	0.23	2929	9867	0.30	3210	11097	0.29
	7,600	**2011**	3782	28558	0.13	6294	16379	0.38	10076	44937	0.22
	8,600	**2012**	779		n.a	4810		n.a	5589		n.a
	8,800	**2013**	392	4284	0.09	5240	10593	0.49	5632	14878	0.38
	9,700	**2014**	1281	1947	0.66	9051	29902	0.30	10332	31849	0.32
	10,600	**2015**	2717	8237	0.33	6880	27203	0.25	9597	35440	0.27
	15,000	**2016**	7140	38507	0.19	6599	49823	0.13	13739	88331	0.16
Case A	15,000	**2017**	9321	19047	0.49	5679	12816	0.44	15000	31863	0.47
Case B	15,000	**2017**	10069	19047	0.53	4931	12816	0.38	15000	31863	0.47
Case C	15,000	**2017**	10349	19047	0.54	4651	12816	0.36	15000	31863	0.47
Case D	15,000	**2017**	8797	19047	0.46	6203	12816	0.48	15000	31863	0.47
Case E	15,000	**2017**	8460	19047	0.44	6540	12816	0.51	15000	31863	0.47

	Catches	Stock size	HR	Catches	Stock size	HR	Catches	Stock size	HR
Average (since 1999)	1,362	6,880	0.64	5,721	24,510	**0.27**	7,083	31,390	0.26
Average (Since 2007)	1,758	10,293	0.24	5,357	25,914	**0.25**	7,115	36,207	0.23
Max HR since 2007			0.66			**0.49**			0.38
Min HR since 2007			0.03			**0.10**			0.09

Legend:

- Likely values
- Maximum potential values
- Unlikely Low
- Unlikely maximum values

Confronting current HRs estimates by regions with past values of HRs and with the HR leading to a 50%SBR (of 0.78), we conclude that:

i) The potential HR for both areas are close to the maximum historical values but well below the threshold of 0.78;

ii) Most likely and Potential Maximum Harvest rates occurring in 9.aSouth region, on the southern stock component in 2017 (up to 0.48) following a TAC of 15 000 t, would be within HR assessed in the past and hence sustainable in the long terms. Furthermore all these values as well as the maximum unlikely HR value of 0.51 would be well below the HR leading to a 50%SBR (of 0.78), resulting in a %SBR above 50% for a range of plausible catchability of surveys.

iii) Assuming analysis of sustainable HR of anchovy in 9.aSouth is applicable to the anchovy fishery in 9.aWest, potential maximum harvest rates in 9.aWest region (up to 0.54) (applicable to the western stock component) in 2017 following a TAC of 15 000 t would be well below the HR leading to a 50%SBR (of 0.78) and hence can be considered sustainable[1].

iv) Assuming analysis of sustainable HR of anchovy in 9.aSouth is applicable to the entire Division 9.a, harvest rates in the entire Division 9.a (=0.47) in 2017 following a TAC of 15 000 t would be well below the HR leading to a 50%SBR (of 0.78) and hence can be considered sustainable.

Conclusion: TAC of 15 000 t for anchovy in Division 9.a in 2017 can be considered sustainable.

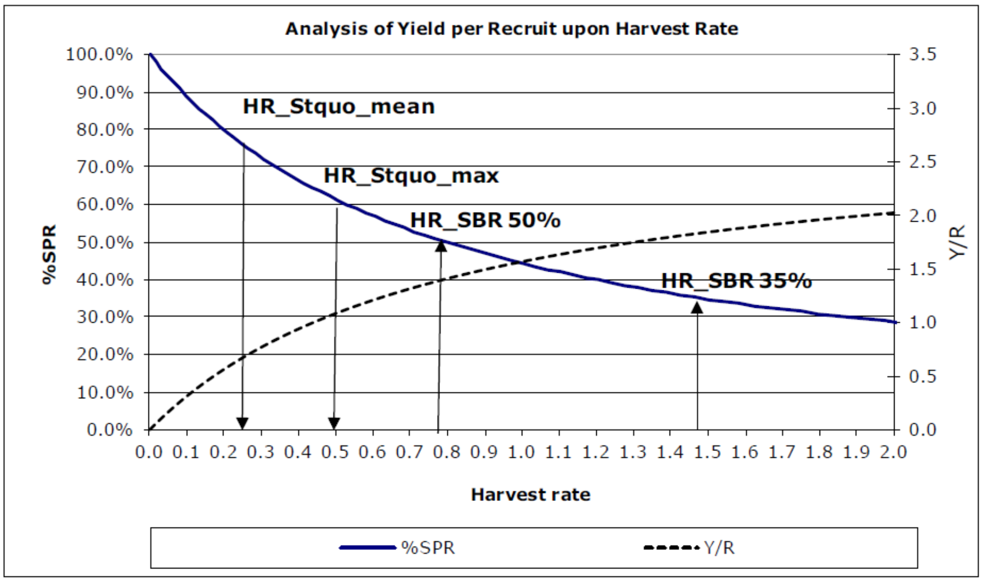


Figure 5.1. Anchovy in Division 9.a South. Reference points for Harvest Rates (HR) corresponding to a selectivity-at-age fitted with a presumed F-at-age 1 = 1.0. Figure taken from Figure 7.3.1.5 of the 2016 July advice for anchovy in 9.a).

[1] This statement is valid for a range of catchability values up to a maximum of 1.4 for the surveys used for the estimation of anchovy Biomass in the 9aWest region of Division 9a.

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Appendix 1

About the scientific report prepared by IPMA in support of the request to increase the TAC on anchovy in Division 9.a

The scientific report prepared by IPMA to the request supplies information to explore the possibility to increase the TAC on anchovy 9.a, particularly based on the estimates from the PELAGO2017 in 9.aWest (which was not available in June) and the associated expected harvest rates on the west coast population (in particular for 9.aCN which would remain in the range of the exploitation values of the last ten years if the increase would be around 10% of the TAC). In addition, considerations about stock identity and the length composition of catches in 2017 are provided (the later to suggest that only the mature fraction of the population is being exploited).

The reasons for the WD to not directly assessing the scientific report attached to the special request was that the basis of WGHANSA analysis expands further the basis of the ICES reply as it builds not only on the final estimates from PELAGO 2017 survey and potential harvest rates in the western area, but also on all surveys available in 2017 and potential harvest rates for the two regions of consideration within Division 9.a (the Southern and Western region) for a TAC of 15 000 t (as implied by the request).

Therefore going through the conclusions of the attached scientific report:

i) The distribution of the length classes of anchovy caught in the north of Portugal shows that the fishery is essentially exploiting the mature part of a strong cohort of the population already close to maximum longevity.

Comment: We discard going through this point because regardless this is probably true for the catches produced until August 2017, it would be likely that some of the catches in the autumn would be also produced on juveniles of the year as observed in the past years in the catches of the Western fishery (see the age composition of some past years Figure 4.2.5.2.1 of WGHANSA 2017 report). Our analysis was based on Harvest rates of a range of fishing patterns all including partial fishing on juveniles.

ii) Exploitation levels observed in the past in the west part of the anchovy stock (subdivision 9.a OCN and OCS) correspond to an average rate of 0.18 that appears to be sustainable. If the rate is kept at the average level of the 2005–2016 period (0.18), the catches in 2017 would be 2787 tonnes. If the rate is kept within the range of values recorded for the west coast of Portugal in the last decade, the catches would correspond to a maximum of 6657 tonnes.

Comment: Without discussing those statements, ICES reply was made on considerations of most likely and potential maximum catches and harvest rates by regions for TAC of 15 000t, because the request required such a comprehensive overview over the two regions of Division 9.a.

iii) The estimated biomass indices for 2017 for the west component of the stocks (9.aN + 9.aCN) were 19 047 t, corresponding to the third-highest value in the last two decades (212% above the historical average of the west component of the stocks). A TAC increase leading to a quota increase of 10% for Portugal will correspond to an exploitation rate of the west coast population in the order of the exploitation values of the last ten years. This situation suggests that there is some room for increasing fishing opportunities for 2017.

Comment: ICES reply incorporated that information but framed its answer on considerations of most likely and potential maximum catches and harvest rates by regions for TAC of 15 000 t, because the request required a 20% increase of TAC (not 10%).

iv) The differences in population dynamics and biology of the species on the west coast and in the Algarve and Cadiz suggest the possibility of differentiating their future management.

Comment: ICES WGHANSA has always considered seriously such possibility and have advocated for a separate analysis of the two regions since 2012 (at least), furthermore a Benchmark is taking place where such stock identity issue would be revised.

Technical Minutes of the Review Group on Anchovy-RGAnchovy

Review of Working Document to ICES WGHANSA 30/11/2017 entitled:

"On the sustainability of a TAC of 15 000 t for Anchovy in 9.a in 2017 given the available estimates of Biomass from surveys."

- RGAnchovy
- 30 November–2 December 2017
- Participants: Colin Millar, David Miller, Inigo Martinez, Sarah Millar and Ruth Fernandez from the ICES Secretariat
- Working Group: WGHANSA

Overview

The Review Group reviewed the above mentioned working document with consideration of the two questions described in the text of the special request:

a) Assess whether the evidence provided justifies a 20% TAC increase for 9.a anchovy in 2017; and

b) whether such an increase is precautionary.

The documents used to assess this request were:

- Working Document to ICES WGHANSA 30/11/2017:

https://community.ices.dk/Advice/Advice2017/ADGAnchovy/Advice_Drafting_Group%20Documents/special%20request%20on%20ane.27.9a/WD_AnePore_EU_SpecialRequest2017November_V3_edited.docx

- ICES advice for 9.a anchovy for 2018: http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2017/2017/ane.27.9a.pdf

- The data supporting the advice in the ICES stock assessment graphs database: https://sg.ices.dk/Manage/ViewGraphsAndTables.aspx?key=9054

General observations

ICES does not provide catch advice for this stock. The TAC in 2016 was 15 000, an increase on previous years. The TAC in 2017 was 12 500, a reduction from the previous year. The proposal is to increase the 2017 TAC back to 15 000 t.

The stock is documented in terms of two regions, 9.a west and 9.a south. Portugal has the most catches in 9.a west and Spain the most catches in 9.a south.

So far in 2017, total catch in Q1–Q3 is 11 500 t.

9.a West

9.a west catches have increased from low levels (typically <1000 t) to >7000 t in 2017, mostly over the last two years. In Q1–Q3 of 2017, the 9.a west catches already amount to ~7000 t.

Over the years 2014–2016, the catches in 9.a west have increased as the survey abundance has increased. The overall TAC for area 9.a has also increased over this period.

The 9.a west survey abundance estimate has decreased in 2017 to approximately 50% of the 2016 estimate.

9.a South

9.a south catches have been declining since 2014 and are projected to be lower again in 2017.

Over the years 2014–2017, the catches in 9.a south have been declining while the survey abundance has been variable.

The survey abundance in 9.a south increased from its second lowest value in 2013 (~10 500 t) to the highest value in the series in 2016 (~50 000 t), but declined in 2017 to the third lowest value in the series (~13 000 t).

9.a Total

If 2016 Q4 catches were repeated in 2017, then the total catch in 2017 would be approximately equal to the current TAC for 2017.

Catches in 9.a south are projected to be lower in 2017 than in previous years (~5000 t) allowing for a similar potential catch in 9.a west (7500 t) to that of 2016 in spite of a reduction in the overall TAC for 9.a.

Both 9.a south and 9.a west survey abundances have declined in in 2017 with respect to 2016 estimates.

Technical observations

The following are observations on harvest rates and scenarios given in the supporting document:

The max southerly catch scenario (A) projects 9.a west catches of >9000 t, a 30% increase on the 2016 catch and a three-fold increase on the 2015 catch for 9.a west.

Historical HR for the 9.a west and 9.a south combined are generally in the range 0.1 to 0.3 with the highest HR around 0.38. The new TAC implies a HR of 0.47, which would be the highest in the series.

The basis of whether a harvest rate of 0.47 is sustainable rests on the yield per recruit analysis taken from the 2016 July ICES advice, which suggests that HRs less than 0.78 are sustainable.

Conclusions

In terms of request part a. *Assess whether the evidence provided justifies a 20% TAC increase for 9.a anchovy in 2017*. The review group considers the following points relevant:

- The proposed increase does not seem to be supported by the available survey information.
- The resulting HR could possibly be the highest in the time-series.
- The reference point HR of 0.78 is beyond what has been observed in the past.

In terms of request part b. *whether such an increase is precautionary.* The working document did not address the issue of being precautionary, and instead focused on sustainability.

- It is the review group's opinion that it is not possible to assess if the proposed TAC of 15 000 is precautionary with the presented information.
- There are methods available for category 3–6 stocks not reliant on reference points; however, none of these have been applied.

Other comments

Given that ICES did not propose the initial catch advice of 12 500 t, we feel that we cannot say if an increase is justified. If ICES proposed the catch advice on a precautionary basis, for example, then an increase would typically require new survey information that showed there to be a change in the perception of the stock biomass. In the case of 9.a anchovy, both survey indices show a decline. So, if ICES had advised a catch advice of 12 500 t, then we would consider an increase not to be justified. However, as ICES did not suggest the initial catch advice (that lead to the allocated TAC) then we have no baseline to assess the increase from, and whether the stock size is increasing or decreasing may be of limited relevance.

The WD convincingly showed that the HR under the proposed TAC of 15 000 t is likely be around 0.5. This would be one of the highest observed HR and the highest total catch in the history of the stock. Nonetheless, this would still be lower than the proposed reference point of $HR_{50\%SBR}$ = 0.78. If ICES considers this reference point to be suitable, then the state of the stock in 2017 under the proposed increased TAC would remain below the possible reference point.

The idea that most of the fishing will likely occur on two-year old fish that would die anyway if not caught, ignores the potential role that forage fish such as anchovy play in the trophic system (Pikitch *et al.*, 2012; Smith *et al.*, 2011). Though the role of forage is uncertain (Dickey-Collas *et al.*, 2013; Hilborn *et al.*, 2017), given the current low biomass of sardine in the area, and the decline in the anchovy indices some consideration of the ecosystem approach to fisheries management may be appropriate in a precautionary context.

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