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Report of the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VIII and IX (WGACEGG)

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Contents

Executive summary

This year (2008) the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VIII and IX (WGACEGG) meeting received and reviewed a large amount of survey's direct estimates of sardine and anchovy population applying both the acoustic and DEPM methods in a coordinated fashion:

Table: Surveys covered in WGACEGGs during 2008 meeting.

Country	Spring Acoustic Surveys	Month	Divisions
France	PELGAS 08	5	VIIIa , VIIIb, VIIIc (East)
Spain	PELACUS04 08	4	IXa Noth, VIIIc
Portugal	PELAGO 08	4	IXaCentral N., S., IXa South
Country	Spring DEPM Surveys	Month	Divisions
Spain	BIOMAN 08	5	VIIIa , VIIIb, VIIIc (East)
Spain	SAREVA0408	4	IXa Noth, VIIIc, VIIIb
Portugal	Portuguese DEPM	2	IXaCentral N., S., IXa South
Spain	BOCADEVA 08	7	IXa South
Country	Autumn Acoustic Surveys	Month	Divisions
Spain	JUVENA 08	9	Subarea VIII
Spain	PELACUS 1008	10	Subarea VIII
Portugal	SAR07NOV	10	IXaCentral N., S., IXa South
Spain	PACAS experiments	07 & 10	IXa South (Cadiz)

For the first time, all spring acoustic surveys produced estimates of most pelagic species in all areas. The DEPM based surveys produced Biomass estimates for sardine and anchovy, although the sardine estimates and the BOCADEVA08 anchovy estimates were not yet available to the WG as a result of ongoing laboratory work (mainly concerning adults). Finally Acoustic surveys on sardine and anchovy juveniles took place in 2008 both in Subareas VIII and IX, although the Portuguese survey was not yet available to the WG, being the 2007 survey the one being reported instead by IPIMAR. The surveys were carried out following the standard procedures described and adopted in earlier years in the WG, although further documentations of these procedures is foreseen to be completed in next year's. The degree of coordination of the surveys achieved through this WG was considered satisfactory and the group endorses the continuity of such coordination which allows synoptic coverage of all areas IX and VIII.

In spring, and according to the acoustic and DEPM surveys, quite different abundance status and distribution were found for sardine and anchovy: Acoustic estimates yielded for sardine order of magnitude higher abundances (about 845,000 t) than for anchovy (about 80,500 t) across the whole subareas IX and VIII (Table 4.2.2). Sardine estimates have decreased by about 40% in region IXa compared with past year estimates, but have increased by about 40% in the Spanish area of IXa (North) and VIIIc. In addition sardine in VIIIb and VIIIa is estimated among the highest levels of the series available from PELGAS for this region since 2000 In comparison to the 2007, last triennial DEPM sardine egg production estimate has increased in the Portuguese and Spanish regions around the Iberian Peninsula. DEPM surveys for anchovy revealed quite similar low levels of egg production and biomass in the Bay of Biscay as in the last years (around 25,000 t, using the historical average estimates for spawning frequency).

In autumn, acoustic surveys for juveniles in the Bay of Biscay (JUVENA– AZTI and PELACUS 10 – IEO; **Sections 4.4.1 and 4.4.2**) pointed out to the presence of anchovy juveniles in the off shore regions in the southeast of the Bay (pure juvenile concentrations) and in coastal areas close to Gironde and more to the North (mixed with adults). The abundances were of similar low levels as the past year 2007. JUVENA pointed out a biomass of juveniles about one order of magnitude less than the higher estimates of the available series since 2003. So no recovery of recruitment can be presumed from it. PELACUS 10 abundance estimates were lower than the ones obtained in JUVENA but the comparative analysis of the two surveys (**Section 4.4.3**) explain much of such a difference in terms of the higher degree of coverage of the juvenile distribution area of the JUVENA survey and of its closer to surface echosounding capabilities.

In Portuguese waters the coverage of the SAR07NOV survey (**Section 4.4.4**) showed that sardine distribution spread out all over the sampled area, but with higher densities in the subarea IXa-CN, mainly between Figueira da Foz and Peniche, where the bulk of young of the year sardines concentrated, along with the 2004 cohort (3 year-old). As usual anchovy concentrations were mainly present in the Gulf of Cadiz, and in less abundance off Lisbon

The coordination of the acoustic surveys both in spring and autumn for 2009 was set during the meeting (**Section 4.6**). Although the autumn Portuguese survey may not continue next year, because of the lack of funding, the WG endorsed its continuity at least over selected recruitment areas in order to produce a recruitment index for sardine. Concerning the DEPM only the application for anchovy in subarea VIII will take place in 2009, because for sardine those surveys take place triennially.

With the review of the implementation of these surveys and their coordination for 2009 (Section 4.6) **Long ToR a)** was satisfied.

A major challenge to this working group was to Produce a common Regional database (from the Acoustic+CUFES and Pairovet sampling) with common format (spatial resolution or grids, units etc) (**Short ToRs a), b)** and **c**), in or order to allow a synoptic regional representation (by maps and graphics) of the spatial distribution and abundance of sardine and anchovy in relation to the pelagic ecosystem for ICES areas VIII and IXa (**Long ToRs d)** and **e**). This challenge appears as a result of a revision of the scope and future of this working group undertaken in 2007, by which the WG considered the convenience of strengthening the global regional perspective of the results of the surveys producing a synoptic overviews of both the spatial distribution of sardine and anchovy and of the accompanying pelagic ecosystem. The general format and inputting procedure at an agreed spatial resolution (grid) was adopted for the two surveying methods (**Section 4.1)**. Little global or cross analysis has been done yet during this year about the spatial distribution of the main pelagic species, since setting up the standard database and procedures took much of the time of the working group. However synoptic maps of the spatial distribution of sardine and anchovy and other species (as Sprat, mackerel, chub mackerel -*Scomber colias*-, horse mackerel, blue chub mackerel -*Trachurus picturatus*-, and *Trachurus mediterraneus*, Blue whiting and Bogues -*Boops boops*) from the acoustic records during spring acoustic surveys are presented in **Section 4.2.4** based on the energy allocation to species. Similar maps for egg abundance of sardine and anchovy from CUFES are demonstrated in that Section. The DEPM has also produced egg abundance distribution for the entire covered areas in **Sections 4.3.2.2** and **4.3.3.2** for anchovy and sardine respectively. Finally, some synoptic maps were also produced based already in the common database at the agreed spatial grid from spring acoustic surveys (for sA and egg from CUFES, **Section 4.5**). Although sardine spreads across all regions anchovy is clearly restricted to the Gulfs of Cadiz and Biscay. Maps for other surveys or species based on the common database were not accomplished during this working group because of lack of time. The WG considered this a very fruitful and challenging work for future analysis.

Some reviews of the time-series of SSB estimates from acoustic and Daily Egg Production Method (DEPM) SSB estimators have been reported to the Group (**Section 5**):

- In spite of having finished the revision of Spawning Frequency estimates, the revision of the series of SSB estimate for the Bay of Biscay anchovy was not ready to this working group because it is pending of new Egg Production estimates according to improved statistical P_0 and Egg mortality estimation procedures, incorporating information from all surveys together, as made recently for sardine The WG endorsed the scientific work supporting the review, and recommended providing a full review of new DEPM SSB estimates to the next Working Group on Anchovy [WGANC].
- The DEPM estimate of sardine biomass in Spanish Atlantic waters in 2005 has been revised downwards to about 106,000 t (CV=47%) (Section 5.2) mainly because of the doubling the Spawning fraction from the preliminary value, what drives downward the estimate despite some increase in the Daily egg Production estimates. The WG endorsed it.
- A Revision of the JUVENA 2006 abundance estimation of juvenile anchovy was presented following an inter-calibration exercise between the two vessels taking part in that survey, according to the relative recording of their 38 kHz transducers (Section 5.3). This led to an upward revision of the preliminary estimate. The analysis procedure was revised by the members of the WGACEGG, considering it correct in general terms, but it was noted the high CV obtained for the correction factor (2 with a CV of about 40%) and hence further work if possible may be welcome.

Inter-calibrations of vessels between coordinated surveys have also been made during the 2008 acoustic spring and autumn surveys which were presented and discussed during the WG. An inter-calibration the RV "Thalassa" and RV "Noruega", off northern Portugal took place in April 2008 at the beginning of the joint spring surveys by IPIMAR and IEO. Final analysis is still pending of completion (**Section 6.2.1**). An inter-calibration of the RV "Thalassa" and RV "Enma Bardán" in the Bay of Biscay anchovy juvenile surveys (PELACUS10 and JUVENA) took also place for a full day in October 2008, but the results were not analysed yet (**Section 6.2.2**). This analysis will be conducted jointly next year 2009 by IEO and AZTI.

Updating the group on advances and improvements of acoustic and DEPM methods was also covered during this meeting (**Long ToR b**).

Concerning DEPM: Several Advances in DEPM were summarized in **Section 6.1.1** regarding Egg mortality and daily Egg Production estimates (P_0) using GLMs and Spatially explicit GAMs respectively. Advances in software in open source frame was also commented (http://ichthyoanalysis.wiki.sourceforge.net). Advances in spawning frequency estimation are also briefly commented here as well.

In addition testing the influence of distinct selections of incubation temperature on Egg production is shown for the Portuguese DEPM survey (**Section 6.1.2**) and for the Bay of Biscay survey (**Section 6.1.3**). In former case the little stratification implies very little affect on the ageing and Egg Production estimates of sardine in that region. For the Bay of Biscay a model is proposed to select an incubation temperature and it is compared with the SST-1 value adopted so far. The results show sensitivity of the Egg production estimates to this election but generally smaller than 10%.

Finally, a method for facilitating batch fecundity measurements in sardine using digital image analysis software (ImageJ; rsb.info.nih.gov/ij/) has been presented (**Section 6.1.4**). The method gives a chance for increasing precision of the fecundity estimates and to save time and money in this laboratory process.

Concerning acoustic advances:

A workshop on the precision of the acoustic abundance estimations was conducted in the frame of the WGACEGG during the first day of the meeting (**Annex 6**). The objectives were: (1) review the sources of error of the acoustic and DEPM abundance estimations; (2) identify and describe the theoretical bases of the main techniques currently used to calculate variance for abundance estimation surveys and (3) discuss the weaknesses and strengths of each method. A comparative table was built with the different sources of error for each abundance estimation method, which evidenced the notable differences between the sources or error of both methods due to their different nature. In the subsequent Sections, the workshop was focused only on acoustic surveys. The most studied source error is the one associated to spatial interpolation. Two methods were described and contrasted for computing spatial interpolation errors: linear geostatistics and GAM. The two techniques are suitable to analyse this type of error, being geostatistics simpler to apply in good conditions and providing GAM more flexibility in complex situations. Concerning the other sources of error associated with acoustic surveys, the sizing and species identification errors have been evaluated. The studies on these errors were based on re-sampling techniques, conditional simulations and the combination of GAM and re-sampling. The errors estimated in the frame of this WK were in general in agreement with bibliography. The work plan for the coming years includes to complete the Workshop with presentations of variance estimation in DEPM surveys and to conduct a Workshop in 2009 for geostatistical calculation of variance in acoustic based abundance estimations.

The problem of small pelagics Target Strength measurements in the Bay of Biscay was also revisited in the WG (**Section 6.2.5**) concerning available literature and procedures for direct estimation of TS (concerning pulse length duration, minimum TS threshold, min/max echolength and max. phase deviation, etc). It was noted that TS-length equations established for tropical anchovy species generally predict lower TS (up to 7 dB) than equations currently used for clupeids in European waters. A recommendation to obtain specific small pelagics TS measurements in more controlled environments is made.

The problem of acoustic surveying of the Gulf of Cádiz waters for juveniles was dealt based on an experimental surveys carried out by IEO within the shallowest waters of the Gulf of Cadiz (**Section 6.2.4**). Two Pilot acoustic experiments (PACAS) of about a week each were conducted in July and October 2008 with the research vessels RV "Francisco de Paula Navarro" (Navarro) and RV "Emma Bardán" (Bardán), respectively. Relevant amount of schools were recorded in shallow waters (up to 6–7 m depth) Initially RV "E. Bardán" seems to be a more suitable vessel than Navarro in terms of on-board usual equipment for both acoustics and fishing, although the former has serious restrictions for accommodation of enough scientific staff.

Finally and Concerning **Long ToR c)** advances in developing a framework to cross-validate and integrate egg production and acoustic methods for the estimation of Spawning stock biomass and its distribution were presented to the group through the work (**Section 7.1**) of Quantitative combination of acoustic and CUFES data for the quality control of acoustic survey estimates: A procedure was presented to quantitatively combine the CUFES and acoustic data, which was applied to the acoustic and CUFES data of IFREMER's spring acoustic surveys 2001–2006. This is made by comparing maps of an index of daily egg production from corrected CUFES data with maps of anchovy acoustic fish abundance to derive an index of daily specific fecundity (DF) over the survey area. The comparison of this DF with literature references serves as a quality control indicator of the acoustic survey estimate.

1 Opening of the meeting

The 2008 meeting of WGACEGG was opened at Nantes, on the morning of Monday 24 November, using its first day to have the Workshop on variance estimation of the acoustic surveys, and on Tuesday 25 November, the General WGACEGG's meeting was opened with the presentation of this year ToRs (see Agenda in Annex 2)

2 Adoption of the agenda

The Agenda for WGACEGG 2008 meeting (see Annex 2) was adopted by consensus and it was used to organize the WG scientific presentations, discussion and report writing.

3 Introduction

3.1 Terms of Reference

Long-term Terms of Reference:

a) plan, coordinate and review acoustic and egg surveys in ICES Areas VIII and IX and standardize analysis procedures;

b) update on innovations on sampling and estimation methods for DEPM and acoustics;

c) develop a framework to cross-validate and integrate egg production and acoustic methods for the estimation of Spawning stock biomass and its distribution;

d) produce an annual synoptic overview of distribution, abundance and population structure of sardine and anchovy in relation to the pelagic ecosystem for ICES Areas VIII and IXa;

e) integrate biological/environmental information from surveys and additional sources to improve the understanding of the spatial distribution and dynamics of sardine and anchovy in relation to the pelagic ecosystem in ICES Areas VIII and IXa.

2008 Terms of Reference:

a) Produce and adopt a general grid to use in order to obtain a synoptic presentation of results from DEPM and acoustic surveys;

b) Adopt a general data format for data submission to the WG grid database;

c) Produce technical specifications for the development of a common database for acoustic data;

d) Establish links with other WG and projects identified in 2007 WGACEGG meeting;

e) Evaluate different procedures to obtain variance estimation for acoustic surveys;

f) Provide first results on the inter-calibration of Spanish and Portuguese acoustic surveys.

WGACEGG will report by 19 December 2008 for the attention of the Living Resources Committee.

3.2 Links with other groups

WGACEGG is naturally linked with other groups.

It provides/revises abundance estimates from surveys (acoustics and DEPM) and standardizes protocols. This work has a strong link with WGANSA, which deals with assessment of sardine and anchovy within ACOM. The fact that WGANSA meets prior to WGACEGG and makes use of survey estimates prior being reviewed by WGACEGGs, pushes the latter group to report more on protocols and methods because many estimates are in advance delivered in the former group. According to that, standardization, documentation and incorporation of any improvements of methods applied on Acoustic and DEPM surveys has to be one of the basic goals one of the WGACEGGs, assuring the quality of inputs for assessment and coordination of surveys related to WGANSA. Given the strong link between the two Working Groups, methods of surveys and justification for changes and revisions of survey series should be better allocated to and referenced from the WGACEGG report.

A major objective of WGACEGG is to plan surveys and standardize protocols at regional scale for egg and acoustic surveys as well as provide ways for integration of these. There are potential links with WGFAST in particular acoustic methodological questions. There are also potential links with PGEGGS and WGMEGGS on matters that are cross-cutting for egg surveys. A Working Group TGISUR has been set up in ICES to steer all survey groups and WGACEGG could therefore actively contribute to TGISUR work.

WGACEGG also compiles data at regional scale on fish and egg distributions as well as on basic environmental parameters (CTD).This work has a strong input to ecological analysis dealing with habitat mapping (in particular spawning habitats), climate change, species interactions, physical-biological interactions On these topics the list of groups for potential interaction could be: WGFE, WGLESP, WGOOFE, SGCC, WGPBI, WGRP, TGHEAD.

Among the groups outside ICES there are three which deserve special attention to WGACEGG give the strong coincidences in their area of interests, and for which cooperation is desired and progressing at different stage:

GFCM/SAC Acoustic+DEPM surveys for SPF in the Mediterranean Common participants Actions to be further developed: Chairs in contact and mutual exchange of ongoing activities of the groups.

DCR/MEDIAS Acoustic methods standardization Actions: Common participants and Attendees and Chairs in contact. There is an initiative within WGACEGGs for 2009 to carry out a workshop on the use of geostatistics for acoustics variance estimation during the next WGACEGG. Or a joint workshop could be organized with MEDIAS to take place some when earlier (see inner plan of actions).

COST/FRESH DEPM reproductive parameters Action: Coordination in place to promote an international Workshop on Egg production methods (Done)

3.3 Report structure

The report is structured in five big blocks:

- First the introductory chapters (1–3) appear up to here concerning the agenda, terms of reference and links with other groups, setting the role of the working group within ICES or even the connections with groups beyond ICES.

- Next the Acoustic and Egg surveys are described in Chapter 4, including here the structure of the database being generated this year by the first time (Section 4.1) according to **short ToRs a) – c)**. Acoustic surveys in the first half of 2009 (Section 4.2) are followed by the description of the DEPM surveys applied in the same period (Section 4.3) and finally by the acoustic surveys in autumn 2009 Section 4.4. This linked to the joint synoptic overview of results for the different species and groups of surveys across the whole region from south of Brittany to Cadiz (Section 4.5) serves to answer **Long ToRs a)**, **d)** and **e)** Planning of next year surveys is presented in Section 4.6.
- In chapter 5 Any Revision or update of survey's time-series estimates is presented.
- In Chapter 6 goes the review on methodological progress and improvements achieved for the DEPM and Acoustic surveys (in Sections 6.1 and 6.2 respectively), answering thus **Long ToR b)**. In this chapter there are sub-Sections for reporting the workshop on variance estimation of the acoustic surveys and the Inter-calibration of Spanish and Portuguese Spring acoustic surveys (**short Tor's e) and f**). However and concerning the reporting of the workshop variance estimation of the acoustic surveys it deserved more space and therefore the report of the workshop itself has been included in **Annex 6**
- And in chapter 7 the Progress in Cross-validation and integration of acoustic and egg production surveys are reported. This shows the work towards answering **Long ToR c).**

Finally the conclusions and references follow. And in annex 4 the Recommendations are provided Finally Annex 6 includes the report of the workshop variance estimation of the acoustic surveys (**short ToR e)**

4 Recent fishery-independent surveys of sardine and anchovy stocks in ICES Areas VIII and IX

4.1 Common Data base from Surveys on pelagics in Subareas VIII and IX

WGACEGGs has agreed on spatial grid cells and formats for the generation of a common database aiming at fulfilling the following long ToRs

a) produce an annual synoptic overview of distribution, abundance and population structure of sardine and anchovy in relation to the pelagic ecosystem for ICES Areas VIII and IXa;

b) integrate biological/environmental information from surveys and additional sources to improve the understanding of the spatial distribution and dynamics of sardine and anchovy in relation to the pelagic ecosystem in ICES Areas VIII and IXa.

This follows a decision taken in 2007: By which the group agreed "to create a common Regional database (Acoustic+CUFES and Pairovet sampling) with common format (spatial grids, units etc), and common analysis tools. Such database should allow a synoptic regional representation (by maps and graphics) of the spatial distribution, abundance and population structure of sardine and anchovy in relation to the pelagic ecosystem for ICES Areas VIII and IXa. Data should be submitted in the agreed data format before coming to the WG to some persons in charge of compiling and producing the common data files and synoptic presentations (Produce regional maps of the different species). The idea is to be able to present and detect during the WG meetings interesting regional features in order to promote subsequently some interesting joint scientific research in the interim periods between meetings (via workshops or e-mail+lab working)."

The idea was therefore to have a dataset to promote joint species or ecosystem research for the members of the WG

The group is nowadays considering making use of the WGACEGG SharePoint-site to store the database and at the same time several questions have raised regarding the restricted or open access nature of the database to non members of the WGACEGGs (either within or outside ICES community). By the time being the database will be stored in the WGACEGG SharePoint-site of 2008 in the folder termed Data. Once solved this question with the ICES secretariat the WG will adopt a definitive resolution about these issues of data storing and access, which will be duly reported in 2009 WG's report.

The following Sections describe the common grid of the database and the generation of inputs to it from the original survey's databases (Section 4.1.1), the structure of the Acoustic (Section 4.1.2), CUFES, Calvet and adult data files (Section 4.1.3).

4.1.1 Common grid design and allocation of inputs

To achieve the combination at regional scale of the data of the DEPM and acoustic-CUFES surveys, the group agreed to block average the data on a common grid. Because of the differences in the dimension of the shelf in the different areas, a zone-dependent varied size grid was discussed. This resulted difficult to implement. Rather, a small sized grid was agreed. Data averaging in small blocks has the drawback of having either no data in the blocks or the average depending on one high value. Also, the position of the origin of the grid conditions the block averaging. To mitigate these effects, the origin of the grid is randomized in a larger block that is made of 4 blocks as shown on **Figure 1.1.1_1**. This will have the effect of local smoothing and deconditioning the averaging from the origin of the grid. The procedure applied is the following: (i) 200 grids are generated each with a different origin; (ii) blocking is performed for each, (iii) all grids are then superposed with the same origin and (iv) the mean in each cell is calculated over all the grids. The grid mesh is 0.25°x0.25°, the lower left corner of the grid is positioned at 10.2°W and 35.8°N

The above blocking procedure has been applied to the 2008 surveys for Calvet hauls, CUFES samples and acoustic sA data. The Calvet data are from the DEPM surveys; the CUFES and acoustic data from the acoustic surveys. The cells containing less than 3 samples for Calvet et CUFES were not retained because of too few observations. For acoustic data, the cells containing less than 5 samples were not retained. The number of observations per cell is between 3 to 18 for CUFES, 3 to 12 for CALVET and 5 to 32 for acoustic data (**Figure 4.1.1_2**). The larger number of observations in particular areas is due to overlap in the sampling between institutes, or aggregated sampling. The regional scale spatial distribution pattern for sardine as derived from the acoustic surveys with the blocking procedure is shown on **Figure 4.1.1_3** (see also Section 4.5). Such maps can be produced for other species (e.g. *Sprattus sprattus*, S*comber scombrus, Trachurus*,…) and also in each year since 2000 when surveys began to be effectively coordinated by ICES. Therefore the common gridding procedure offers the capability to analyse variability across years in a series of maps for the different species of the pelagic ecosystem.

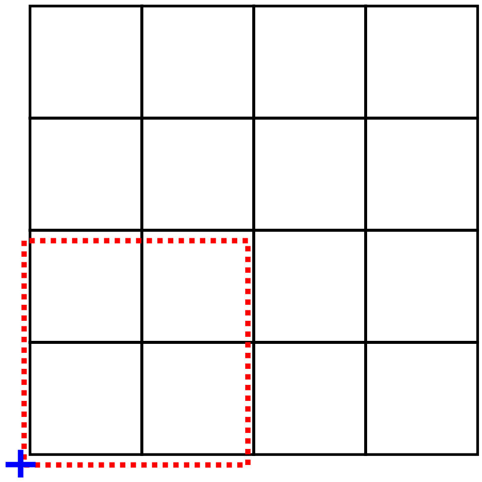


Figure 4.1.2_1. Schematic of the standard grid (black: 0.25°x0.25°), the large block (dashed red line) in which the grid origin is randomized. The cross (blue) shows the position at which the origin of the grid is positioned to present the final results.

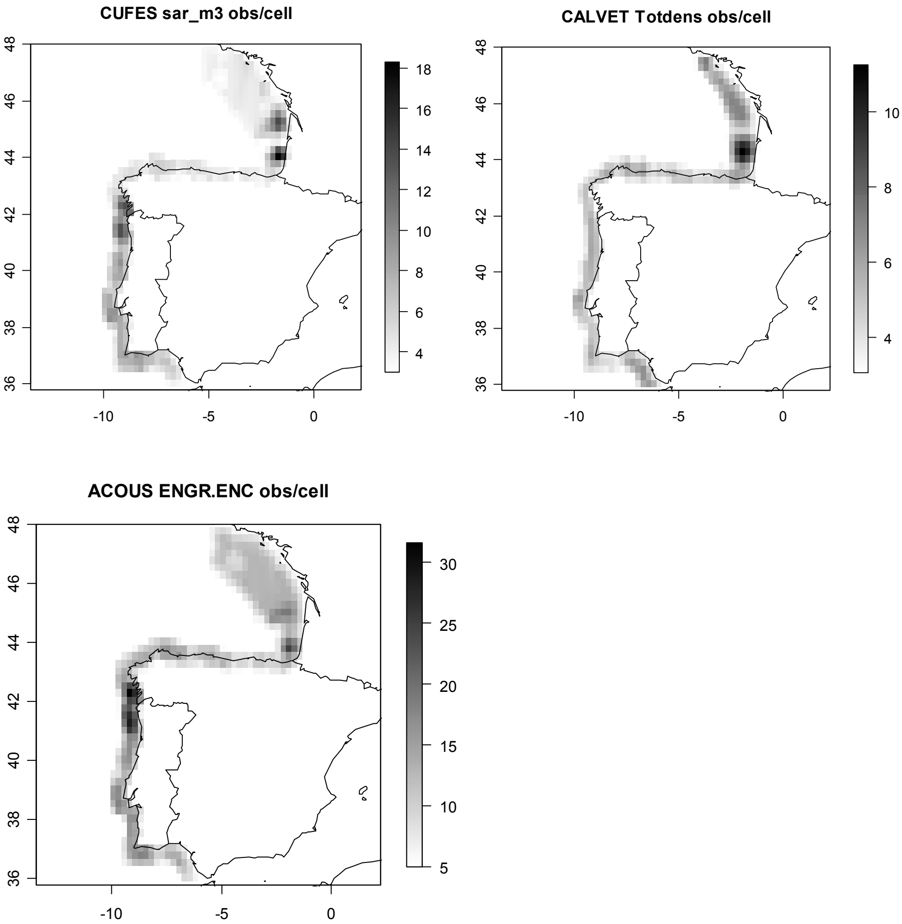


Figure 4.1.2_1. Average number of samples per cell for the CUFES, acoustic and CALVET data, after randomizing the origin of the grid. The CUFES data are those of the acoustic survey.

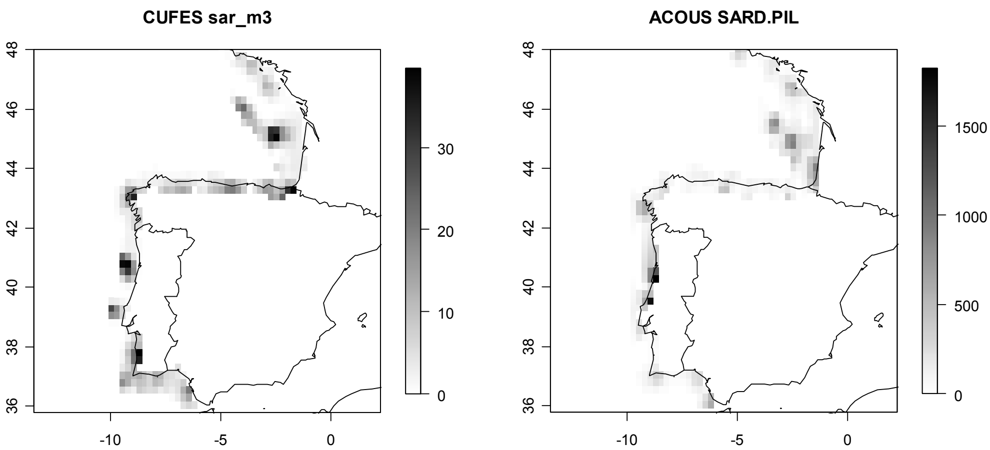


Figure 4.1.2_3. Distribution pattern of sardine eggs (left CUFES data) and adults (right acoustic sA) as derived by the blocking procedure applied on the 2008 acoustic surveys.

4.1.2 Common acoustic database

A common database for acoustic surveys was suggested during WGACEGG in 2006 (WD Petitgas *et al.,* 2006). The objective was to store acoustic energies, fishing hauls data and both the way they were used to allocate species to energies or expert judgements made in assigning echotraces to species. Taking into account the fact that acoustic surveys are more and more becoming essential as a monitoring tool in the Ecosystem Approach to Fisheries management, it seemed essential that acoustic survey data will be interpreted fully for all species present. Such a database would allow later processing, comparisons between procedures and discussions when scrutinising echograms.

A workshop took place in Palma de Mallorca in November 24 and 25 2007 which showed that it was possible and that the format problems could be solved. Nevertheless, this project did not progress enough to be able to build this database at the date of the working group. Keeping in mind that scrutinizing echograms is essential in the reliability of acoustic biomass estimates. A recommendation was done to do next year a new workshop for common scrutinizing regional echotraces and species identifications.

Nevertheless, a first step was done to decide the structure of data files which must be generated from each survey for the next WG in order to produce the common grid (see Section 4.1.2.) and make possible a first cross analysis between parameters. The raw data will remain private data for each institution, whereas the "common grid" (integrated data inside squares) will be in open access to WG members.

The minimum database which was agreed is structured in 3 files:

Acoustic data (results in NASC per species for each ESDU):

survey	text	
institution	text	
year	yyyy	
month	mm	
day	dd	
time	hh.hh	decimal hours
latitude (mid pos)	ddd.ddddd	decimal degree
longitude (mid pos.)	ddd.ddddd	decimal degree
depth	dddd.d	m
length EDSU	d.d	nmi
species	text	(zero nasc included)
Nasc	dddddd.d	m^2/nm^2
T°	dd.dd	°c
sal	dd.ddd	psu
Fluo	ddd.ddd	mg/m3
chlorophyle	ddd.ddd	mg/m3

Catch data:

survey	text	
institution	text	
year	yyyy	
month	mm	
day	dd	
time	hh.hh	decimal hours
latitude (mid pos)	ddd.ddddd	decimal degree
longitude (mid pos.)	ddd.ddddd	decimal degree
depth	dddd.d	m
gear	d.d	nmi
species	text	(zero nasc included)
Catch (weight)	dddddd.d	kg
Catch (number)	ddddddd	
Mean length	dd.dd	cm
Mean weight	dd.ddd	psu

CUFES data:

survey	text	
institution	text	
year	yyyy	
month	mm	
day	dd	
time	hh.hh	decimal hours
latitude (mid pos)	ddd.ddddd	decimal degree
longitude (mid pos.)	ddd.ddddd	decimal degree
depth	dddd.d	m
volume filtered	dddddd.d	m3
length EDSU	d.d	nautical miles
species	text	
density	dddddd	eggs/m^3 (zero counts included)
T°	dd.dd	°c
sal	dd.ddd	psu
Fluo	ddd.ddd	NTU

The formal reference used for species to be taken into account will be the following new codification:

sardine	*Sardina pilchardus*	pil
anchovy	*Engraulis encrasicolus*	ane
mackerel	*Scomber scombrus*	mac
chub mackerel	*Scomber colias*	mas
horse mackerel	*Trachurus trachurus*	hom
bogue	*boops boops*	bog
blue whiting	*Micomesistius poutassou*	whb
sprat	*Sprattus sprattus*	spr
blue chub mackerel	*Trachurus picturatus*	jaa
	capros aper	boc
	Trachurus mediterraneus	hmm

4.1.3 Common DEPM database

Following discussion on the format and construction of a grid for producing regional scale gridded data to be utilized for exploration of the information within the WG, it was agreed to consider the DEPM variables that are presented in Table 4.1.3.1. The next step will be to test the gridding routine with the different variables available and assess the results of this approach for the intended analyses.

Table 4.1.3.1. DEPM variables to consider for data gridding.

Variable name	Type	Units	Size	Description	Example
survey	varchar	txt	16	reference of survey	SAREVA0408
Vessel	varchar	Txt	20	name of vessel	CornideSaavedra
Institute	varchar	Txt	12	name of institute	IEO
Sampler	varchar	Txt	12	PairoVET 150µm mesh, 2 rings	PVET150_2
Transect	number	none	4	transect reference	17
Station	number	none	4	station reference	35
Year	number	none	4	year	2008
Month	number	none	2	month	04
Day	number	none	2	day	28
Hour	number	dec	4	start hour in decimal	17.58 = 17:35
Lat	number	dec	4	latitude in decimal, for CUFES middle	43.56
Long	number	dec	4	longitude in decimal, negative for W, for CUFES middle	- 9.3
SST	number	ºC	4	sea surface temperature	12.45
SSS	number	none	4	sea surface salinity	35.65
SSF	number	volts	4	sea surface fluorescence	0.22
SSC	number	mg m^{-3}	4	sea surface chlorophyll (from sensor)	1.39
EfArea	number	m^{-2}	4	effective area sampled by the net	0.057
VolFiltr	number	m^{-3}	4	volume of water filtered per sample	1.98
SarEgg	number	none	4	total number of sardine egg per sample	133
EngEgg	number	none	4	total number of anchovy egg per sample	61
OtherEgg	number	none	4	egg of other species (not sardine or anchovy) per sample	84
SampDep	number	metres	4	maximum depth the sampler reached	3.0
BottDep	number	metres	4	site depth, for CUFES middle	156.4
FWeight	number	grams	4	W: female mean weight per haul	65.87
SexRatio	number	none	4	R: Sex ratio in weight per haul, weight of females/weight females+males	0.56
Fecundity	number	none	5	F: predicted number of hydrated oocytes per batch per female (mean value per haul)	26612
SpawnFrac	number	none	4	S: spawning fraction per haul using day1 & day2 POFs	0.12

4.2 Spring Acoustic Surveys

Three acoustic surveys were carried out from the Bay of Biscay to the Bay of Cadiz during spring 2008:

- PELAGO08 by IPIMAR from the Bay of Cadiz to the North of Portugal
- PELACUS0408 by IEO from south of Galicia to the south of Bay of Biscay
- PELGAS08 by IFREMER from the south of the Bay of Biscay to south of Brittany

Acoustic energies, catches and number of eggs were gathered before and during the working group in order to have a global view. Transects are presented in **Figure 4.2.4.1**. An overlap was achieved at the end of PELAGO and beginning of PELACUS with an inter-calibration objective between RV "Thalassa" and RV "Noruega". Pelagic hauls were performed in order to identify species according to observed echoes. Catches are presented in **Figure 4.2.4.2**.

Number of nautical miles surveyed and hauls carried out during each survey are presented in **Table 4.2.1**. The biomass estimates resulting from acoustic and hauls data are gathered in **Table 4.2.2**.

Table 4.2.1. Number of nautical miles surveyed and number of identification hauls carried out during spring acoustic surveys in 2008.

	NB NAUTICAL MILES	NB HAULS	*RATIO*
PELGAS08	1850	99	*18.69*
PELACUS08	1092	54	*20.22*
PELAGO08	968	49	*19.76*
Total	3910	202	*19.36*

Table 4.2.2. Biomass estimates calculated for main species during spring acoustic surveys in 2008. The addition in the last lines was done admitting that TS values applied for some species were different in some areas. Coding of the species: PIL-*Sardina pilchardus*, ANE-*Engraulis encrasicolus*, MAC-*Scomber colias*, HOM-*Trachurus trachurus*, MAS-*Scomber scombrus*, SPR-*Spratus spratus*, BOG-*Boops boops*, HMM- *Trachurus mediterraneus*, JAA- *Trachurus picturatus.*

	PIL	ANE	MAC	HOM	MAS	SPR	BOG	HMM	JAA
PELGAS08	460 727	37 574	340 619	98 153	1 833	49 117	0	0	0
PELACUS08	140 287	3 225	365 490	37 102	3 617	0	28 982	0	8 477
PELAGO08	244 000	39 700	114 690	17 950	67 811	0	20 530	8 884	57 241
Total	845 014	80 499	820 799	153 205	73 261	49 117	49 512	8 884	65 718

4.2.1 Portuguese Spring acoustic survey: PELAGO08

This survey was carried out with the RV "Noruega" and covered the traditional area surveyed by IPIMAR (the Atlantic-Iberian Portuguese continental shelf waters and the Spanish Gulf of Cadiz –**Figure 4.2.4.1**) from the 31 March to 5 April 2008. The surveys followed the standard methodology adopted by the Planning Group for Acoustic Surveys in ICES Subareas VIII and IX (ICES, 1986; 1998) and recommendations given by this WG (ICES, 2006, 2007). The acoustic system is a Simrad EK500 controlling a 38 kHz split-beam and 120kHz single beam transducers. Acoustic data were stored in *.HAC format using Movies+ software.

The ‘multi-species’ or ‘pelagic community’ approach that has been started in the PELAGO07 Spring Portuguese survey off southern Iberia (ICES, 2007) was enforced on the whole surveyed region in order to provide abundance indices of the most abundant neritic species. Additionally, given the prevalence and the high abundance of chub mackerel (*Scomber colias*) in the previous spring surveys (ICES, 2007) it was decided that this species would be sampled for biological parameters in a similar way to what is done for sardine and anchovy. Overall, 49 trawl samples stations (**Figure 4.2.4.2** “catches”) were used for species identification, 9 of them being demersal. A total of 968 nautical miles obtained along 68 transects were processed for the abundance estimation of the various species considered

Environmental and surface plankton sampling was performed by CUFES (Continuous Underway Fish Egg Sampler) performed along the acoustic tracks. The sampling unit for CUFES was 18 minutes of integration along the acoustic track, that for a speed of 10 knots correspond to a distance of 3 nautical miles.

QTC (Quest tangent) bottom characterization devices were coupled to each of the frequencies of the Simrad EK500 echosounder. The QTC device operated from Porto to Cadiz, in order to complement the work started in the SAR07NOV survey (**Section 4.4.4**) in which the QTC was only used on the northern Portuguese continental shelf. Ground-truth samples were taken on regular spaced stations using a Smith-McIntire dredge.

Results of PELAGO08

Trawl samples and acoustic backscatter of the pelagic community

The distribution of the different pelagic species encountered in trawl samples during this survey can be observed in **Figures 4.2.4.2**. The trawls and the acoustic backscatter apportioned to each species (**Figures 4.2.4.3** to **4.2.4.12** – figures with acoustic density of each species) suggest an increasing trend in diversity from the Sub areas IXa-CN to IXa-S.

Distribution and abundance of sardine

Overall, sardine was the most abundant species (**Table 4.2.1.1**). Nevertheless a drastic reduction in biomass respective to the PELAGO07 (ICES, 2007) survey was observed (**Figure 4.2.1.1**).

Table 4.2.1.1. Pelago08, biomass (tons) from all the pelagic species detected: PIL: *Sardina pilchardus*; ANE: *Engraulis encrasicolus*; MAC: *Scomber scombrus*; MAS: Scomber colias; HOM: *Trachurus trachurus*; JAA: *Trachurus picturatus*; BOG: *Boops boops*. HMM: *Trachurus mediterraneus*.

PELAGO08	PIL	ANE	MAC	HOM	MAS	BOG	HMM	JAA
Tonnes	244 000	39 700	114 690	17 950	67 811	20 530	8 884	57 241

The estimates of numbers and biomass in the Subarea IXa-CN (**Figure 4.2.1.2**), respectively 3303 million individuals and 170 thousand tonnes were bellow the mean historical values observed in the region. In the Subarea IXa-CS the low values of sardine backscatter resulted in one of the lower estimates of the historical series: (13 thousand tonnes, 1493 million individuals). In the southern Iberian shelf, the reduction of sardine was also evident with the pooled results of Cadiz and Algarve (sub-area IXa-S) having a pooled estimate of 61 thousand tonnes and 2235 million individuals.

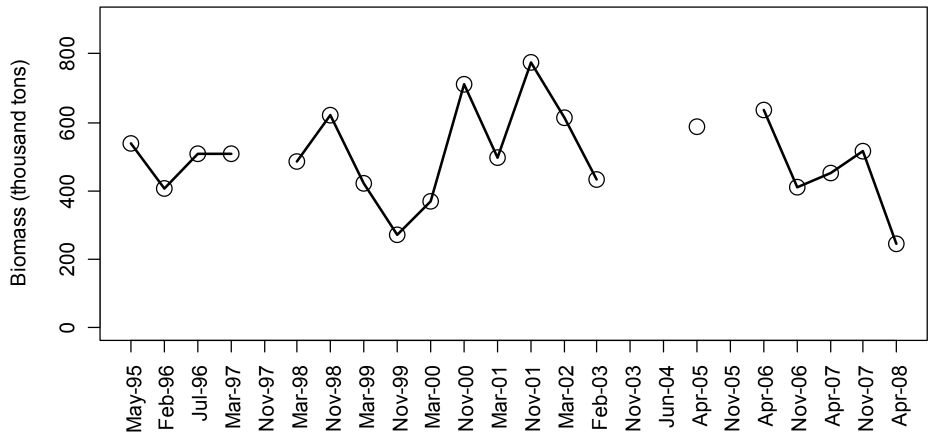


Figure 4.2.1.1. Evolution of sardine biomass estimated by acoustic surveys in the ICES Subarea IXa. Missing values represent surveys with incomplete coverage.

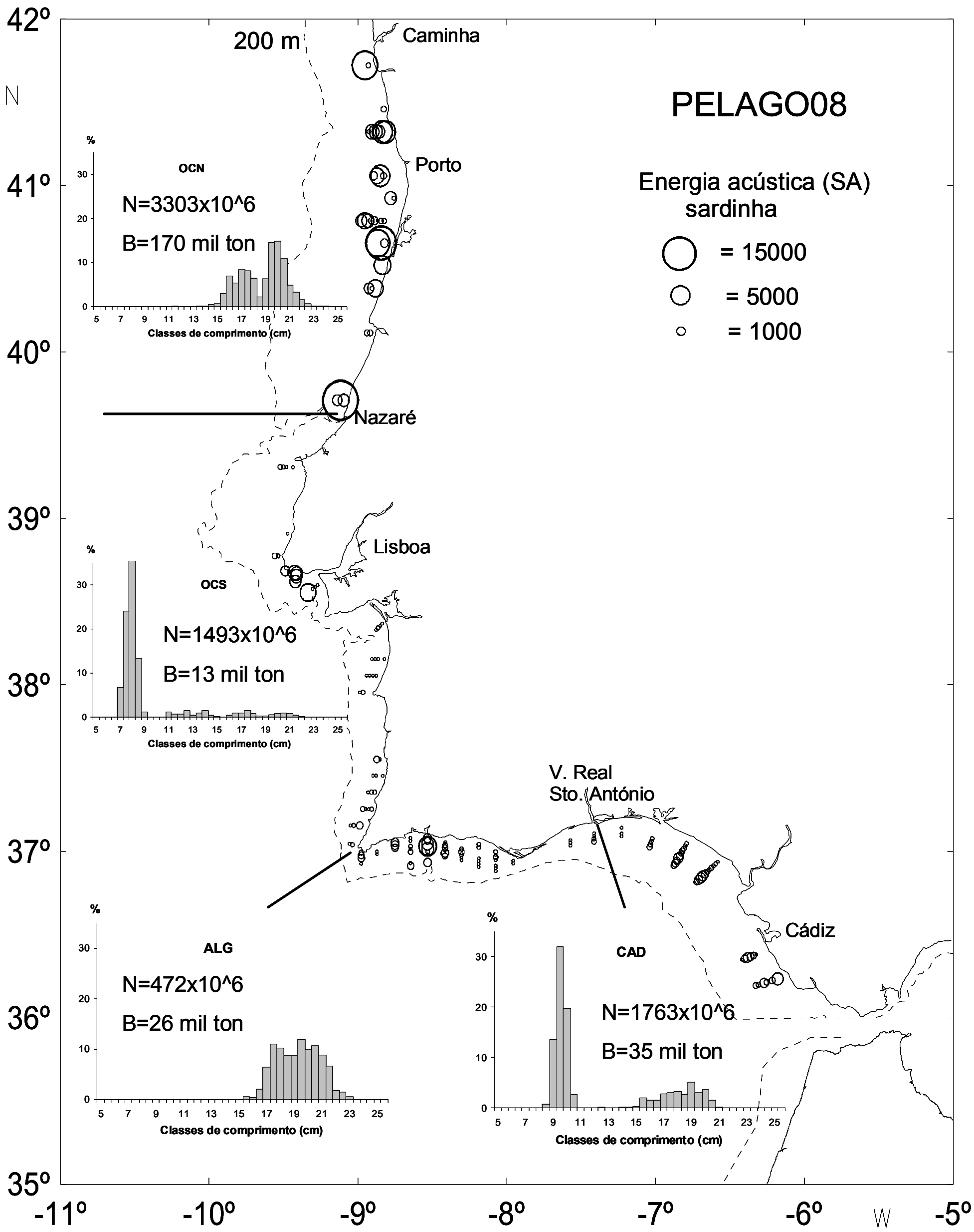


Figure 4.2.1.2. NASC (m^2mni^{-2}) attributed to sardine in the PELAGO08 survey. The histograms show the estimated abundance in number per length class in each region.

Recruitment and age structure of sardine

The age structure was dominated by 1-year-old fish but in low absolute numbers (3.9 million, representing 55% of total fish numbers), confirming previous indications of a poor 2007 recruitment (**Figure 4.2.1.3**). Age 1 fish was evenly distributed by the western Portuguese areas and the Gulf of Cadiz. 4-year-olds (2004 year class) were abundant in subdivision IXaCN but not in the remaining areas. The apparent disappearance of this strong cohort in subdivisions IXaCS and Algarve is not consistent with the findings of the previous surveys and needs to be investigated further.

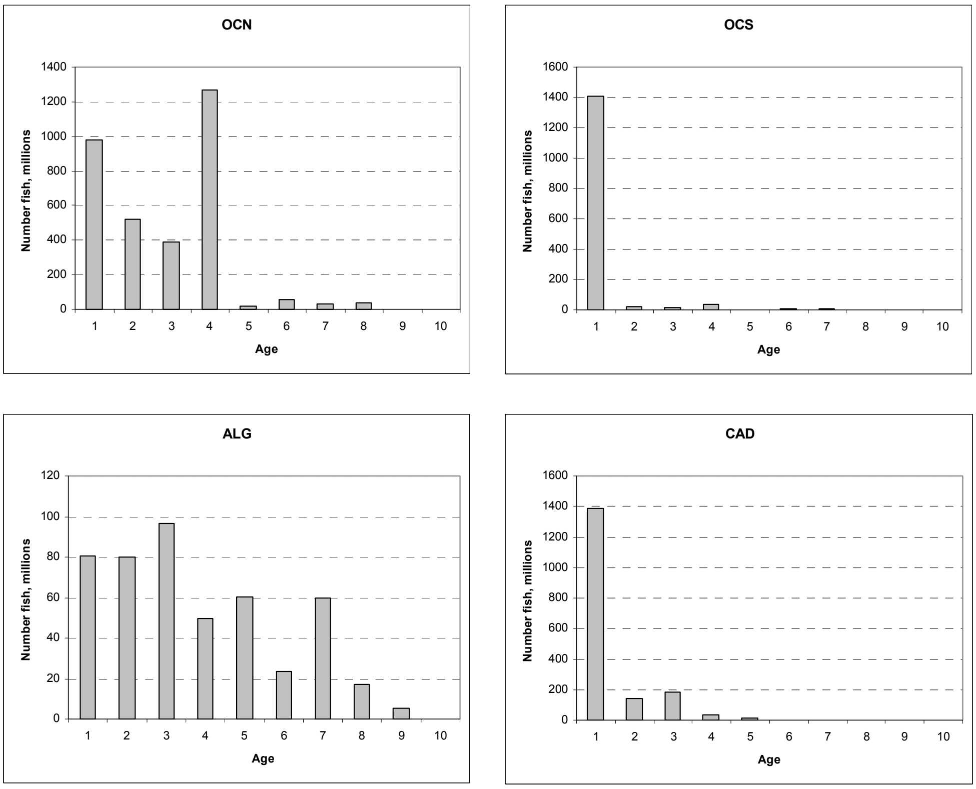


Figure 4.2.1.3. Age-disaggregated abundance of sardine per subarea in the ICES Area IXa estimated in the PELAGO08 survey.

Distribution and abundance of anchovy

The main area of anchovy distribution was as usual the Gulf of Cadiz. Overall in the southern Iberian shelf, anchovy were estimated in 2032 million individuals, corresponding to 34.2 thousand tonnes (**Figure 4.2.1.4**). Anchovy was also found in the surroundings of the Tagus Estuary yielding 252 million individuals and 2.5 thousand tonnes. Off Porto and Figueira da Foz in the Subarea XIa-CN, anchovy yielded 69 million individuals and 3 thousand tonnes.

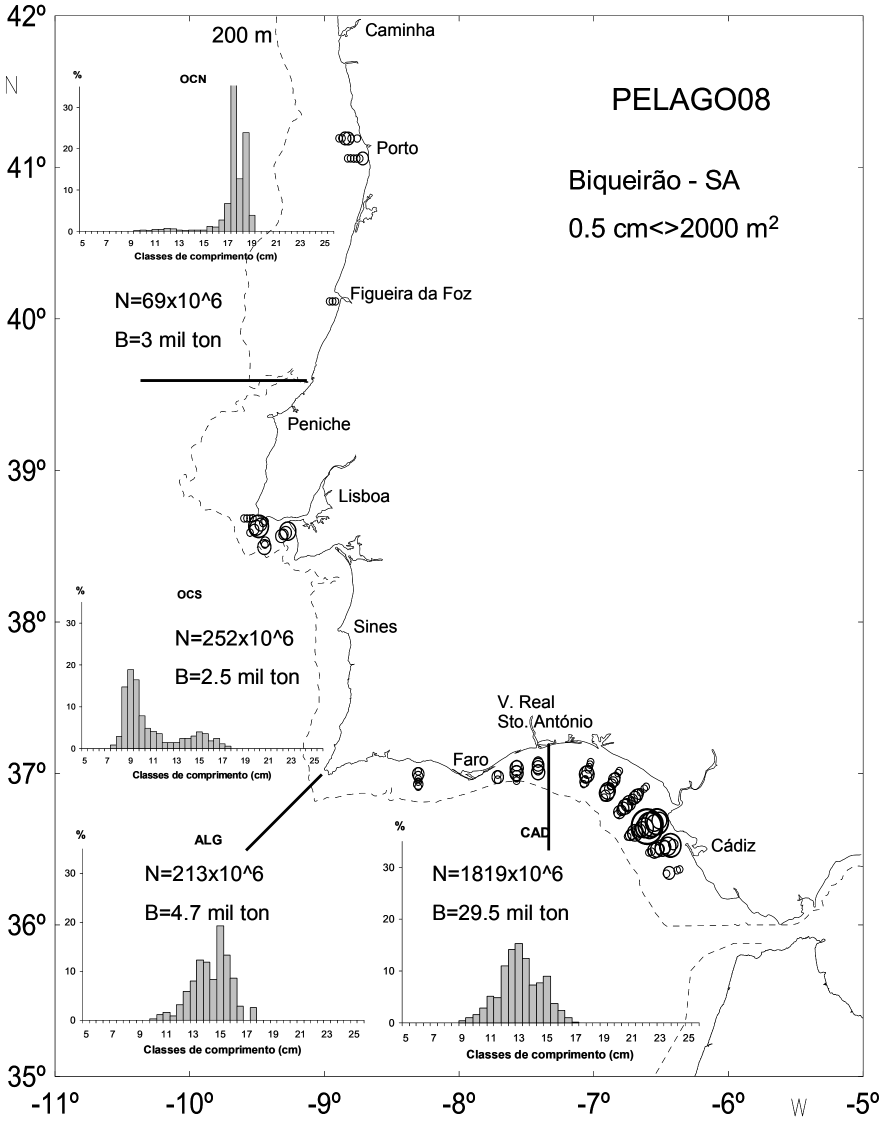


Figure 4.2.1.4. NASC (m^2mni^{-2}) attributed to anchovy in the PELAGO08 survey. The histograms show the estimated abundance in number per length class in each region.

Distribution and abundance of the remaining pelagic species

The distribution of the pelagic species whose abundance was calculated is shown in terms of their NASC in **Figures 4.2.4.5** to **4.2.4.12** (Figures in **Section 4.2.4**). The species whose abundance was estimated were *Scomber colias, Scomber scombrus, Trachurus trachurus, Trachurus picturatus, Trachurus mediterraneus and Boops boops*. These results are listed in the **Table 4.2.1.1.**

Distribution of surface, temperature, salinity, fluorescence and sardine and anchovy eggs (**Figures 4.2.1.5, 4.2.4.13, 4.2.4.14**)

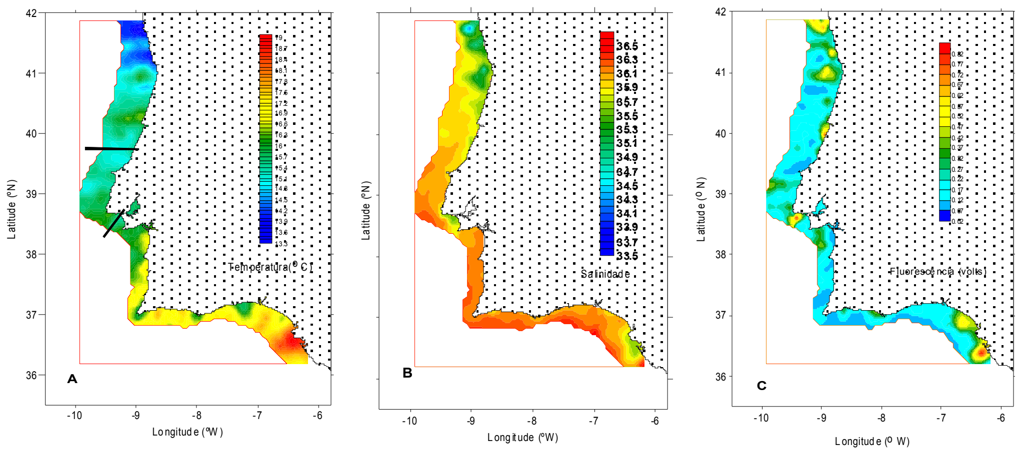


Figure 4.2.1.5. Distribution of surface temperature (A), salinity (B) and fluorescence (C) from the CTF sensors associated with the CUFES system (black lines indicate the location of interruption of the survey due to weather).

Surveying was interrupted during a few days in two occasions because of bad weather, for this reason some caution is recommended when looking at the distributions of surface temperature, salinity and fluorescence mapped as if they were sequential (locations of the interruptions are marked in the maps) (**Figure 4.2.1.5**). During April 2008 high levels of precipitation were observed in whole Portugal and in some regions these values were well above average winter records. The less saline, river plumes were apparent in the regions adjacent to the main estuaries and the higher values of fluorescence were registered in the vicinities of these regions of fresh-water influence, richer in nutrients (in particular in the shadow zones of capes and in the shallower waters). The SST distribution map shows the NW coast occupied by waters of temperature below 16°C; towards the northern limit of the survey the temperature observed did not exceed 14.5°C. South of Lisbon values up to 17°C were registered and close to Cadiz, 18 to 19°C was reached. The range of SST values observed was within the interval typical for this period of the year and usually lower than autumn observations (**Section 4.4.4**). The pattern of sardine egg distribution showed a dense coverage in the whole S and SW regions, up until Lisbon (**Figure 4.2.4.13**). Spots of higher abundance occurred in Cadiz, western Algarve, the SW shore, north of Lisbon and NW coast. The regions with higher egg densities were in general associated with higher acoustic energy attributed to sardine with the exception for the SW coast were eggs appear often, despite the fact that dense sardine schools are seldom detected. The spawning area observed in April was smaller than in January/February (**Section 4.3**), and that is in agreement with the fact that the peak spawning period for sardine in this region is known to occur in January/February. The distribution of anchovy eggs (**Figure 4.2.4.14**), within the limits of the IPIMAR survey, was only of some significance in the Gulf of Cadiz, including eastern Algarve, and off Lisbon (regions where populations of anchovy occur); spring acoustic campaign takes place before the peak spawning (summer) of the species in the Atlantic southern Iberia.

4.2.2 Spanish Spring acoustic survey: PELACUS08

PELACUS0408 spring acoustic survey took place on-board the RV "Thalassa" from 28 March to 21 April 2008. The survey followed the standard methodology adopted by the Planning Group for Acoustic Surveys in ICES Subareas VIII and IX (ICES, 1986; 1998) and recommendations given by this WG (ICES, 2006, 2007). The scientific echosounder was a Simrad EK60 working at five frequencies (18, 38, 70, 120 and 200 kHz). Acoustic data were stored as *.raw format using SonarData Echoview software. The area of the continental shelf covered extended from 30 to 200 m depth, from northern Portuguese waters to southern French waters (**Figure 4.2.4.1**., *red tracks*). The survey design comprises 53 tracks, plus 23 tracks inside the Rias area (Galician waters). A total of 1092 nautical miles were processed in order to estimate the abundance (number of individuals) and biomass (tons) of the nine fish pelagic species (pelagic community) detected during the survey: sardine (*Sardina pilchardus*), anchovy (*Engraulis encrasicolus*), horse mackerel (*Trachurus trachurus*), mackerel (*Scomber scombrus*), chub mackerel (*Scomber colias*), blue horse mackerel (*Trachurus picturatus*), bogue (*Boops boops*) blue whiting (*Micromesistius poutassou*) and *Capros aper* (**Table 4.2.2.1**). The number of pelagic hauls carried out to identify pelagic echotraces and to get biological data from the main pelagic species were 63, 54 of them in Spanish continental shelf (**Figure 4.2.4.2**). The total number of pelagic trawls has increased steadily during the last four years (**Table 4.2.1**).

Table 4.2.2.1. Pelacus0408, abundance (nº individuals in millions) and biomass (tons) from all the pelagic species detected: Sp: *Sardina pilchardus*; Ee: *Engraulis encrasicolus*; Ss: *Scomber scombrus*; Sc: *Scomber colias*; Tt: *Trachurus trachurus*; Tp: *Trachurus picturatus*; Bb: *Boops boops*; Mp: *Micromesistius poutassou*; Ca: *Capros aper*.

PELACUS08	SP	EE	SS	SC	TT	TP	BB	MP	CA
Abundance	1816	97	1372	17	348	56	177	8	2557
Biomass	140287	3225	365490	3617	37102	8477	28982	4624	165392

Sardines were present in 38 of the 63 trawl hauls completed during the survey. Sardine abundance was estimated at 1 816 million individuals, while biomass was estimated to be 140.3 thousand tonnes (**Table 4.2.2.1**). Half of the fish (53% by number and 49% of the biomass) were found in Galician waters (ICES Subdivisions IXaN, VIIIcW) very close to the coast in high densities. In the Cantabrian and Basque Country areas sardine was found more widely distributed, throughout the whole shelf (**Figure 4.2.4.4**).

Sardine ranged in length from 14.5 to 25.5 cm with two modes at 17.5 and 21.5 cm. Comparing with data from last year's (2005, 2006 and 2007) it can be appreciated how sardine this year (2008) were more abundant and bigger (**Figure 4.2.2.1 and 4.2.2.2**). Applying the ALK obtained from the fish sampled during the survey, most fish (33% by number and 35% of the biomass) in the entire surveyed area were assigned to age-class 4 (2004 year class) (**Figure 4.2.4.15**). Considering the age distribution by subarea, the largest proportion of older fish (up to 9 years old although in very small numbers) was found in Cantabrian and Basque Country waters (ICES Subdivision VIIIcE). No fish older than 7 years were found in Galician waters (ICES Subdivisions IXaN and VIIIcW). Age 4 fish predominated in all areas with the exception of the Basque country, where both the 2006 and the 2004 year classes were noticeable (29% and 22% by number, respectively).

Anchovies were present in 10 of the 63 trawl hauls carried out and was only found near the French border (eastern Cantatrice) and in the Rias (Galician waters (3 225 tons; 97 million individuals) (**Table 4.2.2.1**; **Figure 4.2.4.3**).

In 2008, sardine eggs were concentrated along the coast with low zero values near the edge of the shelf (this was not the case in 2007, when an anomalous high presence of eggs was found throughout the whole shelf). In Galicia, sardine egg presence was larger than that usually found for the area (**Figure 4.2.4.13**).

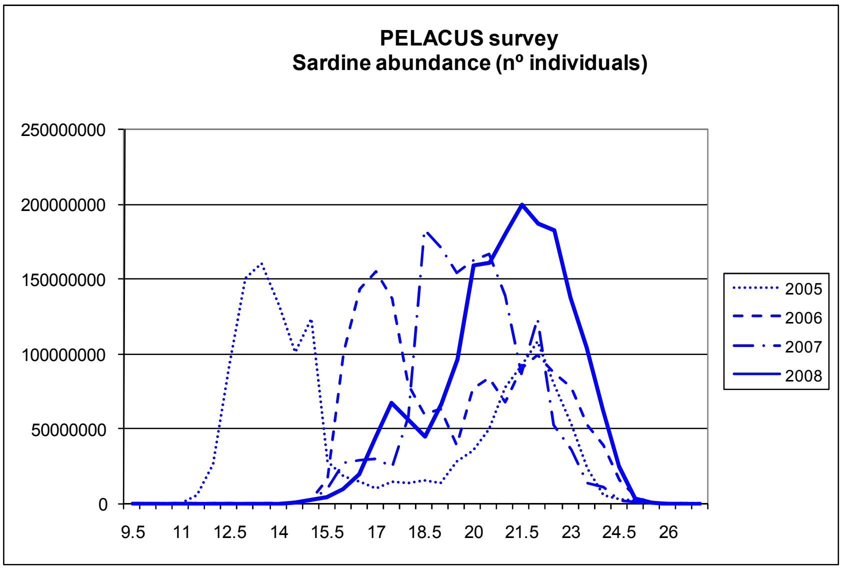


Figure 4.2.2.1. Sardine abundance (nº individuals) by length class estimated in the Pelacus acoustic surveys from 2005 to 2008.

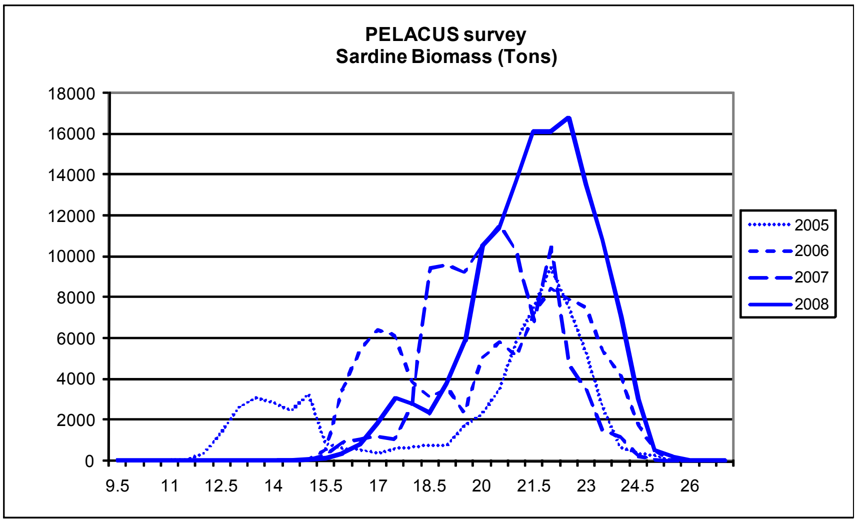


Figure 4.2.2.2. Sardine biomass (tons) by length class estimated in the Pelacus acoustic surveys from 2005 to 2008.

4.2.3 French spring acoustic survey: PELGAS08

The French acoustic survey (PELGAS) is routinely carried out each year in spring in the Bay of Biscay and information on pelagic fish species distribution and abundance is available, with a time-series starting in 2000. The 2008 survey (PELGAS08) took place from the 26 April to 26 May on-board the RV "Thalassa". The objectives, methodology employed and sampling strategy are described in the working document (Massé *et. al.*, WGACEGG08).

The particularity of PELGAS08 compared to previous years (2000 to 2007) is that pelagic pairtrawlers followed the "Thalassa" transects and that identification hauls were carried out both by "Thalassa" and the commercial vessels (figures 4.2.3.1.). In order to minimize the error of identification, the respective hauls were decided according to the echoes and the respective performances of each gear. Therefore, surface hauls were preferentially carried out by pairtrawlers which are more efficient (less avoidance to the vessels) and hauls close to the bottom by "Thalassa".

The main target was to study the abundance and distribution of pelagic fish in the Bay of Biscay and to study the pelagic ecosystem as a whole. The target species were mainly anchovy and sardine but were considered in a multispecies context. To obtain an optimal horizontal and vertical description of the pelagic ecosystem in the area, two types of actions were combined: i) Continuous acquisition by storing acoustic data (from five different frequencies: 18, 38, 70, 120 and 200 kHz) and pumping seawater under the surface, in order to evaluate the distribution of fish eggs using CUFES system, and ii) discrete sampling at stations (by trawls, plankton nets, CTD). Concurrently, a visual counting and identification of cetaceans and of birds (from board) was carried out in order to characterize the higher level predators of the pelagic ecosystem. More detailed objectives and method are described in the Working Document provided during the WG (Massé et. al. WD 2008).

Biomass estimates per species compared to previous years from 2000 are presented in **Table 4.2.3.1**. The coefficients of variation are calculated to take into account the echoes variability distribution and the species variability inside trawl catches in each area.

Table 4.2.3.1. Biomass estimates per species according to PELGAS08 acoustic survey and series of estimates since 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**
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**
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**
CV sprat	*0.098*	*0.155*	*0.120*	*0.198*	*0.178*	*0.228*	*0.162*	*0.132*	*0.268*
Horse mackerel	**230 530**	**149 053**	**191 258**	**198 528**	**186 046**	**181 448**	**156 300**	**45 098**	**100 406**
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**
CV BW	-	-	*0.386*	*0.131*	*0.202*	*0.593*	*0.210*	*0.147*	*0.253*

Anchovy was observed (**Figure 4.2.4.3**) along the coast from Bayonne (43° 40 N) to Rochebonne (46°00 N), mostly mixed with sardine and sometimes with horse mackerel in the south of the Gironde then often alone until Rochebonne where it was mixed with sprat. On the platform, anchovy was quite omnipresent between 50m and 100m depth but always mixed with horse mackerel or sardine. Echo-traces were most of the time traditionally vertically spatialized, horse mackerel closed to the bottom and anchovy as soft and small schools 15 to 25 m above. Offshore, in the area called "Fer à cheval", anchovy was totally absent and very rare southern along the shelf break except some rare small surface schools.

The anchovy biomass from the Pelgas08 survey has been estimated at 37 000t. The number of 1-year-old anchovy is at a medium level but still low compare to good years and was estimated at 960 million fish. The global population observed in the Bay of Biscay was composed of 47% of age 1, 40% of age 2 and 13% of age 3+ in numbers. Half of the biomass was in Gironde area and contained 87% of the recruitment (2007 year class). This fish was very small compare to 1-year-old in the past years.

The second half of the biomass was essentially big fish (2 and 3 years old) and distributed along the coast in the southern area.

The number of anchovy eggs collected by CUFES during the PELGAS08 (see WD2008 Massé et al) was very low compared to 2007 (which was a strong maximum for the time-series) but more classic compared to the average number since 2000. Anchovy eggs abundance was close to the average of the time-series since 2000. Eggs were abundant on Plateau des Landes around 44°N and around the Gironde plume (**Figure 4.2.4.14**). North of Gironde, eggs were coastal only and in low quantity. Both abundance and spatial distribution display an average pattern. This year, some eggs were found on the south coast of Brittany but in a low quantity.

Sardine was distributed closed to the French coast, particularly in the southern part of the Bay of Biscay (Landes) mixed with anchovy while along the southern Brittany coast pure sardine fishing hauls were obtained (**Figure 4.2.4.4**). In the offshore area, sardine was generally in the same area than Horse mackerel and mackerel, but generally at the surface whereas other species where closed to the bottom As usual, small sardine (with 75% of 1-year-old) were mainly closed to the coast, along the southern Lands coast and along the Brittany coast.

The series of sardine abundance as observed during the PELGAS surveys (since 2000) has been revised and consolidated during WGACEGG07 (see ICES report 2008). This has been done by taking advantage of a new active database and updating of the northern areas which were generally not totally processed at the WGHMSA calendar. With the exception of 2003 which was an atypical year in terms of environmental conditions and therefore fish distributions, the abundance of sardine present in the surveyed area in 2008 is one of the highest observed along the 9 year's series (460 727 tons). Except the 2003 survey which was not representative of the stock, the abundance of age 1 fish in 2006 and 2007 are very low compared to other years and 2008 seems to have one of the best recruitment.

Nevertheless, PELGAS surveys occurred each year in spring and an unknown part of this population seems to enter this area later some years. Therefore, 2006 and 2007 estimates can have been underestimated as 2005 and 2006 year class are well present in 2008 (2007 year class).

The number of sardine eggs collected by CUFES during the PELGAS08 survey was comparable to previous years (see WD2008 Massé et al) but of course still far below the maximum observed in 2000. Eggs were present on the whole platform (**Figure 4.2.4.13**) between 45° and 46°30N, then very abundant along the shelf break in the area called "fer a cheval" and northern. Then a new concentration was well visible along the South coast of Brittany. Adults which were present along the coast in the southern part were only small sardine and not already spawning.

4.2.4 Global approach

In order to have a global approach of the small pelagic fish communities in Atlantic NE, a common database of the main data collected during spring acoustic surveys have been built. Acoustic data (NASC in m^2/nm^2 for the main target species) and number of eggs filtered with CUFES have been collected from all members before and during the WG and maps have been drawn on a common scale.

A series of maps are presented:

Transects and identification hauls general patterns:

Figure 4.2.4.1. – Acoustic transects during PELAGO, PELACUS and PELGAS surveys in spring 2008.

Figure 4.2.4.2. Catches from identification pelagic hauls during PELAGO, PELACUS and PELGAS surveys in spring 2008.

Acoustic energies (sA in m^2/nm^2) per ESDU attributed to adult species :

Figure 4.2.4.3. – anchovy (Engraulis encrasicolus)

Figure 4.2.4.4. – sardine (*Sardina pilchardus*)

Figure 4.2.4.5. – Sprat (*Sprattus sprattus*)

Figure 4.2.4.6. – mackerel (*Scomber scombrus*)

Figure 4.2.4.7. – chub mackerel (*Scomber colias*)

Figure 4.2.4.8. – horse mackerel (*Trachurus trachurus*)

Figure 4.2.4.9. – blue chub mackerel (*Trachurus picturatus*)

Figure 4.2.4.10. – (*Trachurus mediterraneus*)

Figure 4.2.4.11. – Blue whiting (*Micomesistius poutassou*)

Figure 4.2.4.12. – Bogues (*Boops boops*)

Number of eggs (nb/m3) per ESDU (3 nautical miles)

Figure 4.2.4.13. – Sardine eggs

Figure 4.2.4.14. – Anchovy eggs

Age distribution

Figure 4.2.4.15. – Age distribution of sardine per ICES division

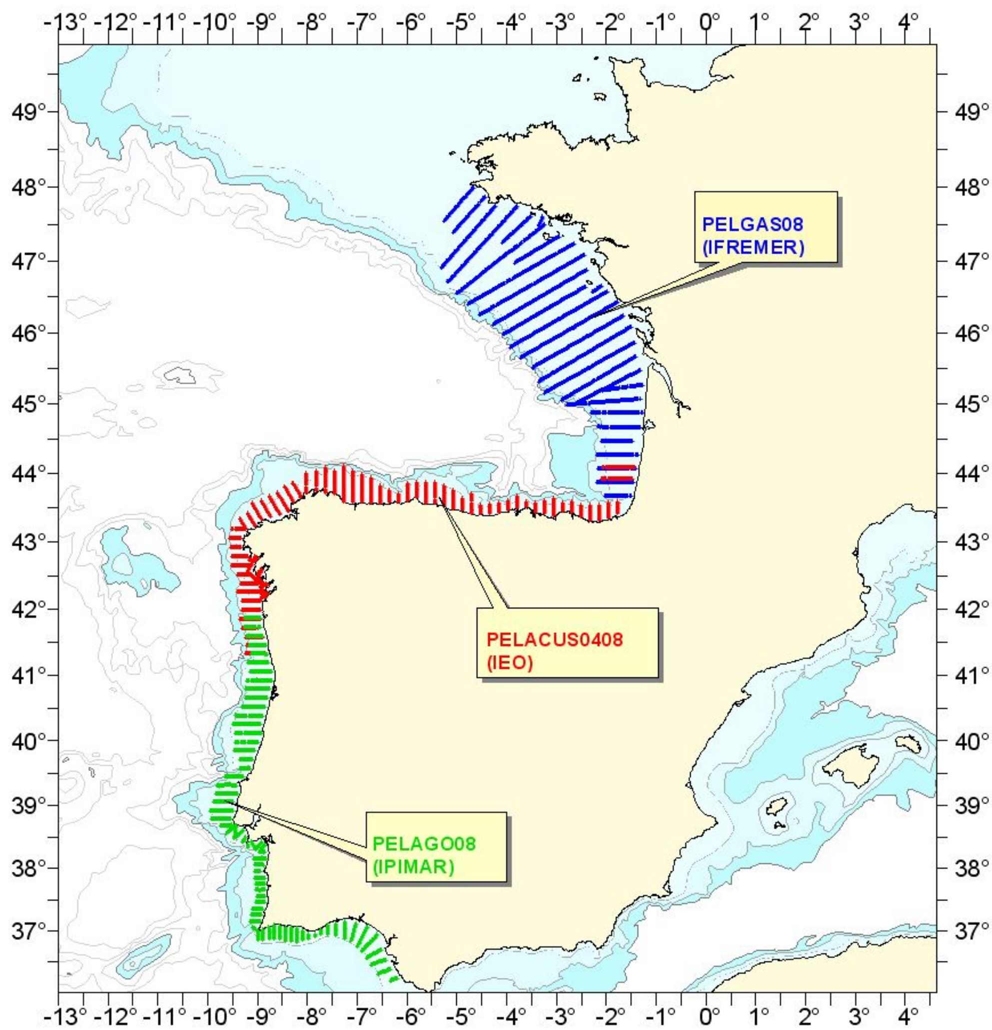


Figure 4.2.4.1. Transects surveyed by PELAGO, PELACUS and PELGAS surveys during spring 2008.

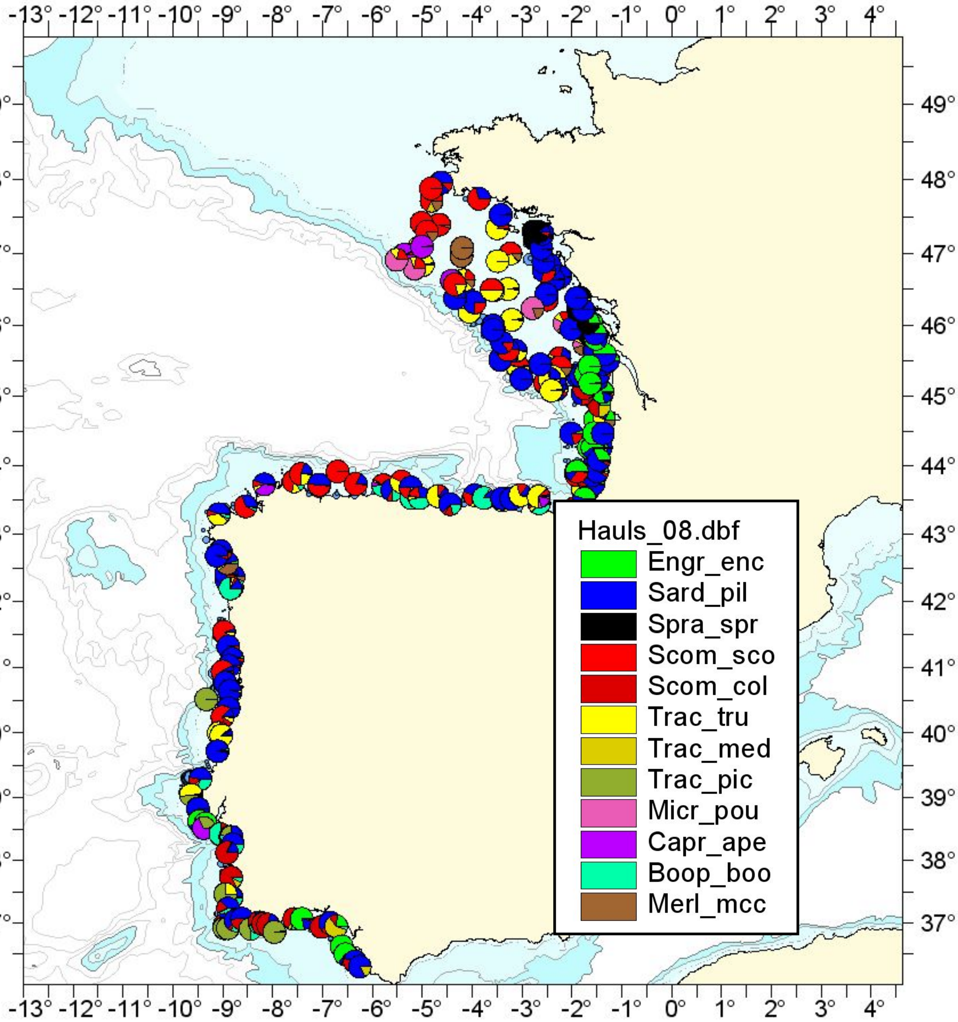


Figure 4.2.4.2. Catches from identification pelagic hauls during PELAGO, PELACUS and PELGAS surveys in spring 2008.

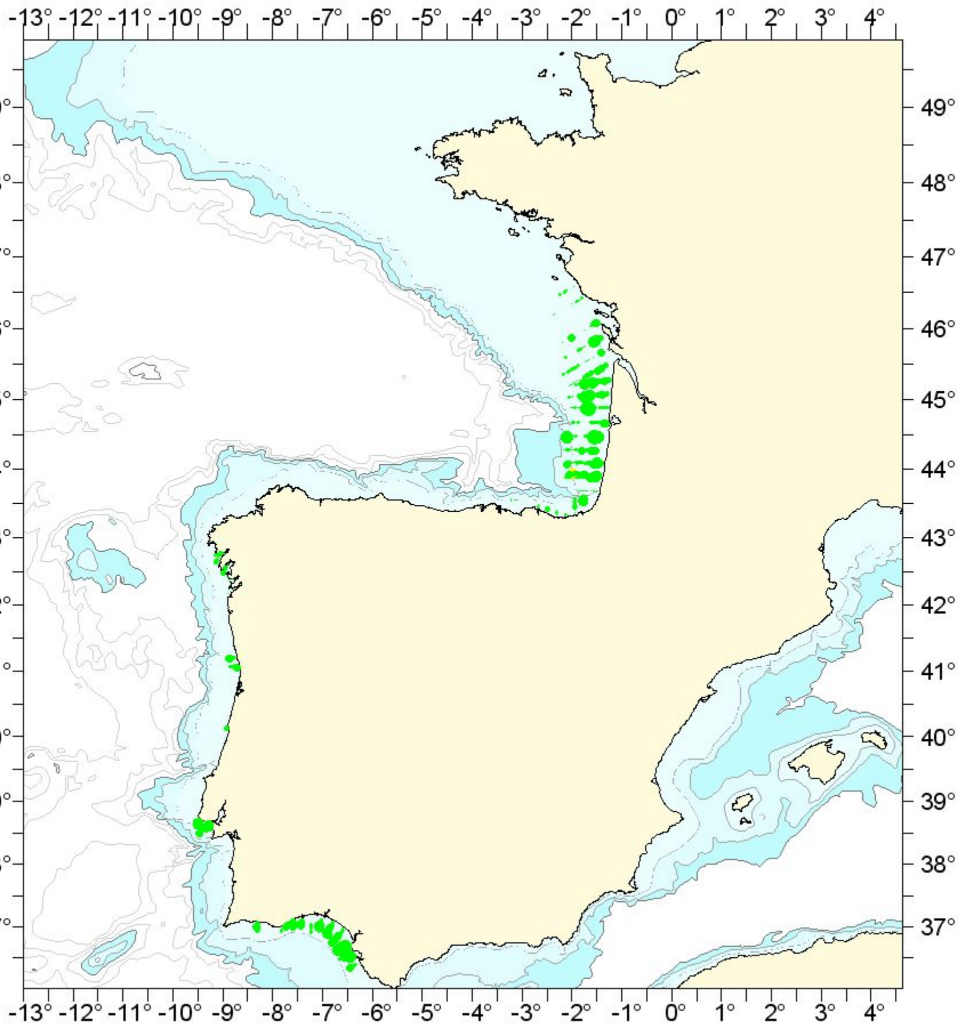


Figure 4.2.4.3. Acoustic energies (sA in m²/nm²) per ESDU attributed to anchovy (*Engraulis encrasicolus*).

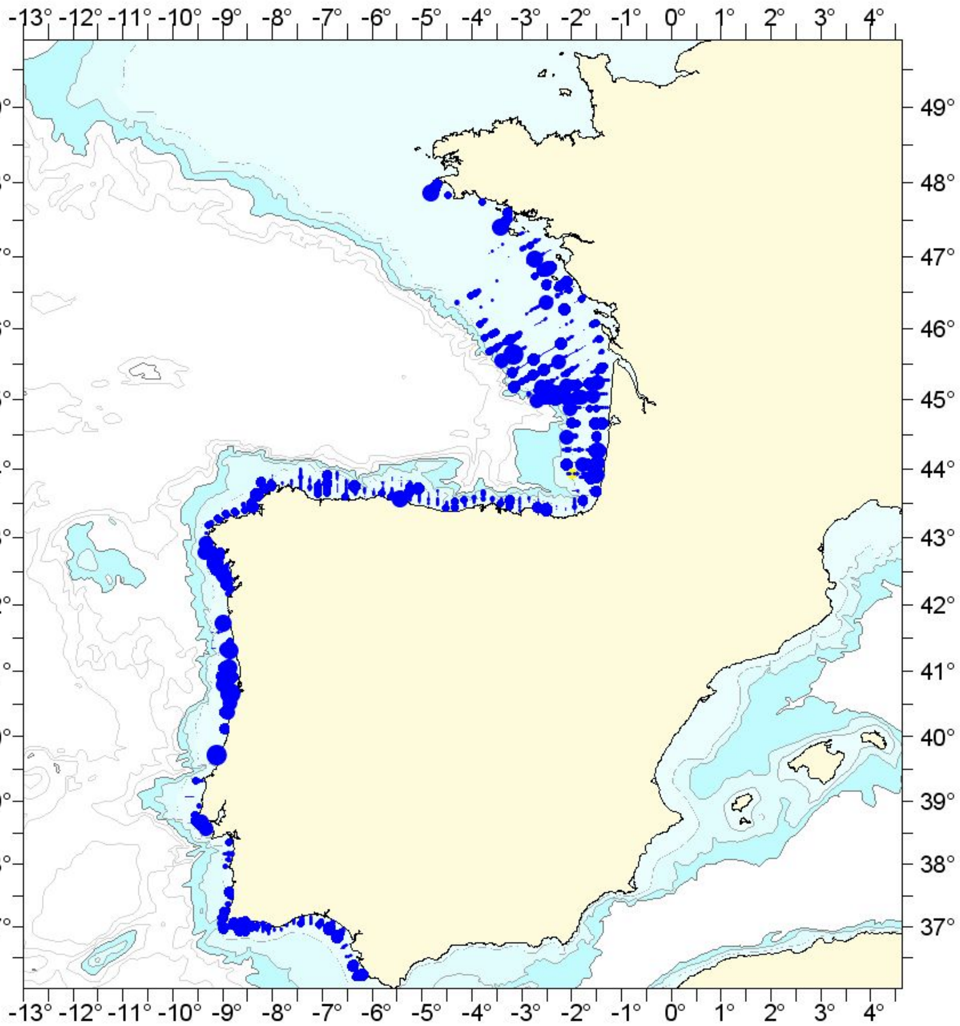


Figure 4.2.4.4. Acoustic energies (sA in m²/nm²) per ESDU attributed to sardine (*Sardina pilchardus*).

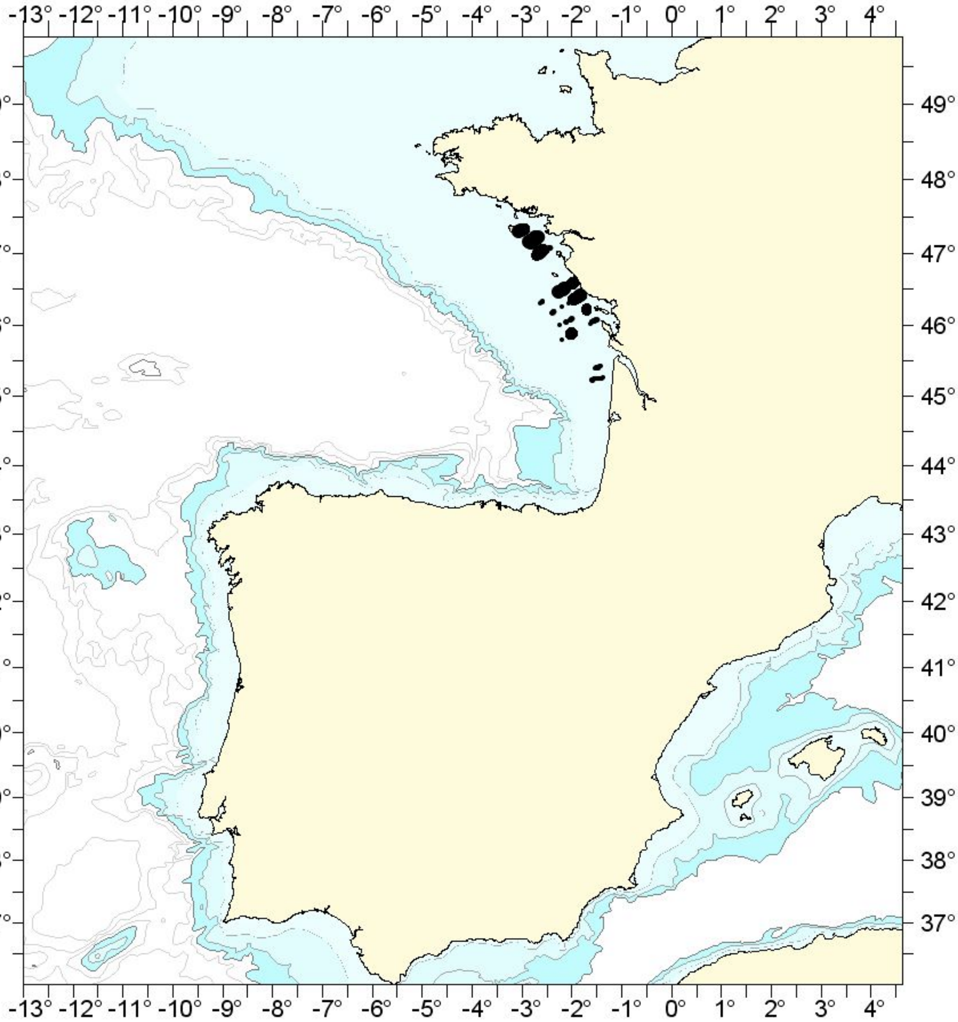


Figure 4.2.4.5. Acoustic energies (sA in m²/nm²) per ESDU attributed to Sprat (*Sprattus sprattus*).

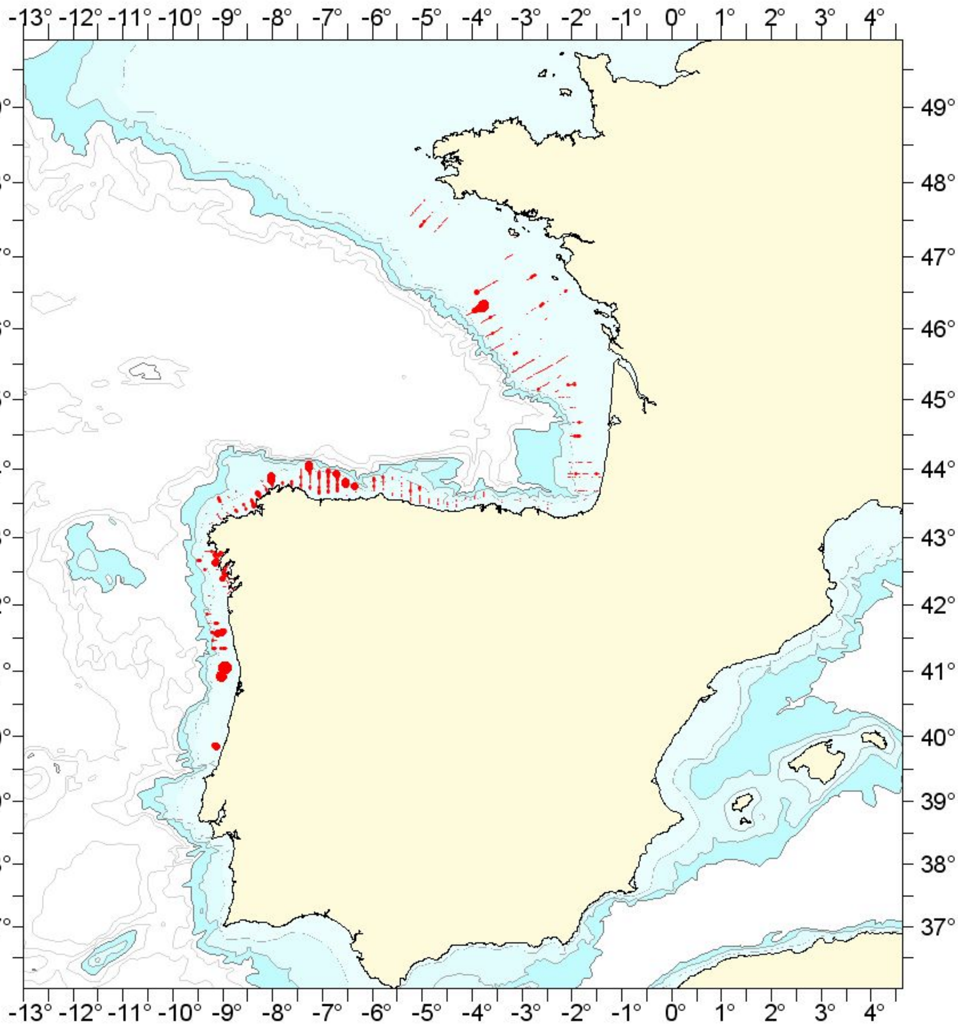


Figure 4.2.4.6. Acoustic energies (sA in m²/nm²) per ESDU attributed to mackerel (*Scomber scombrus*).

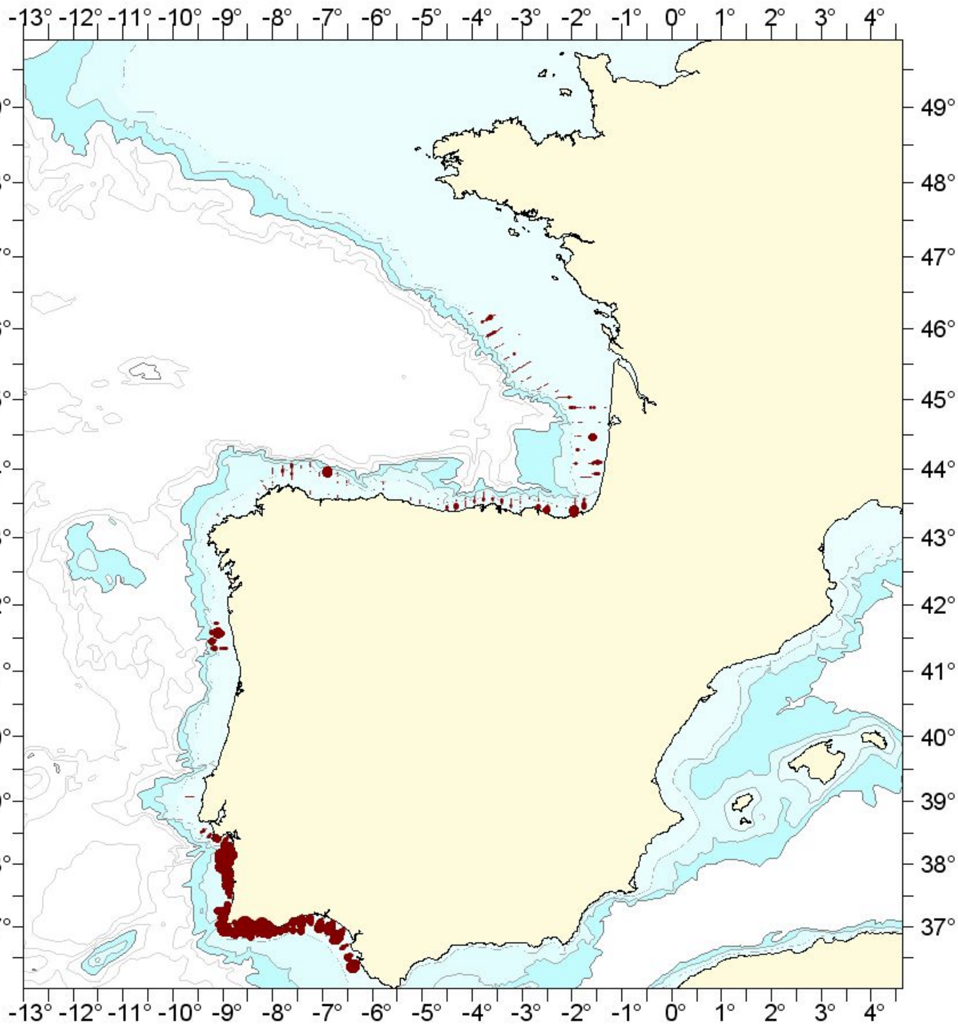


Figure 4.2.4.7. Acoustic energies (sA in m²/nm²) per ESDU attributed to chub mackerel (*Scomber colias*).

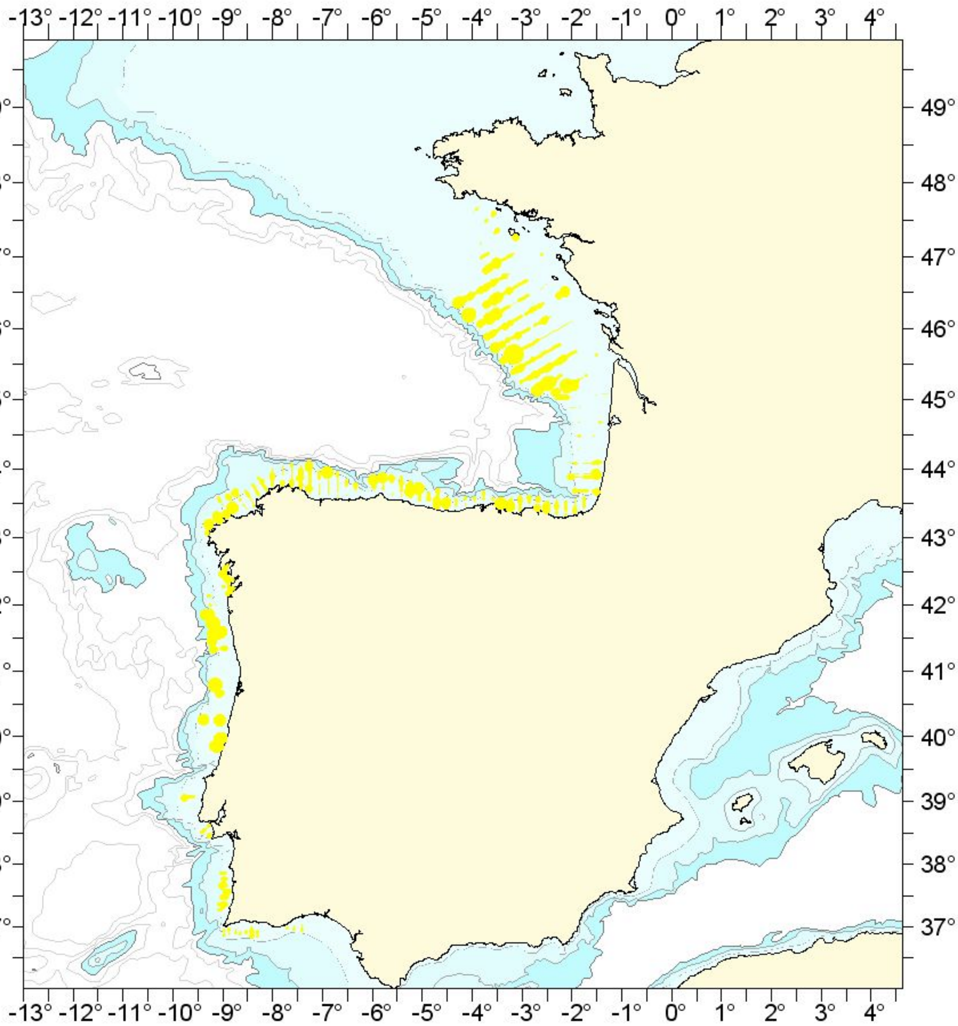


Figure 4.2.4.8. Acoustic energies (sA in m²/nm²) per ESDU attributed to horse mackerel (*Trachurus trachurus*).

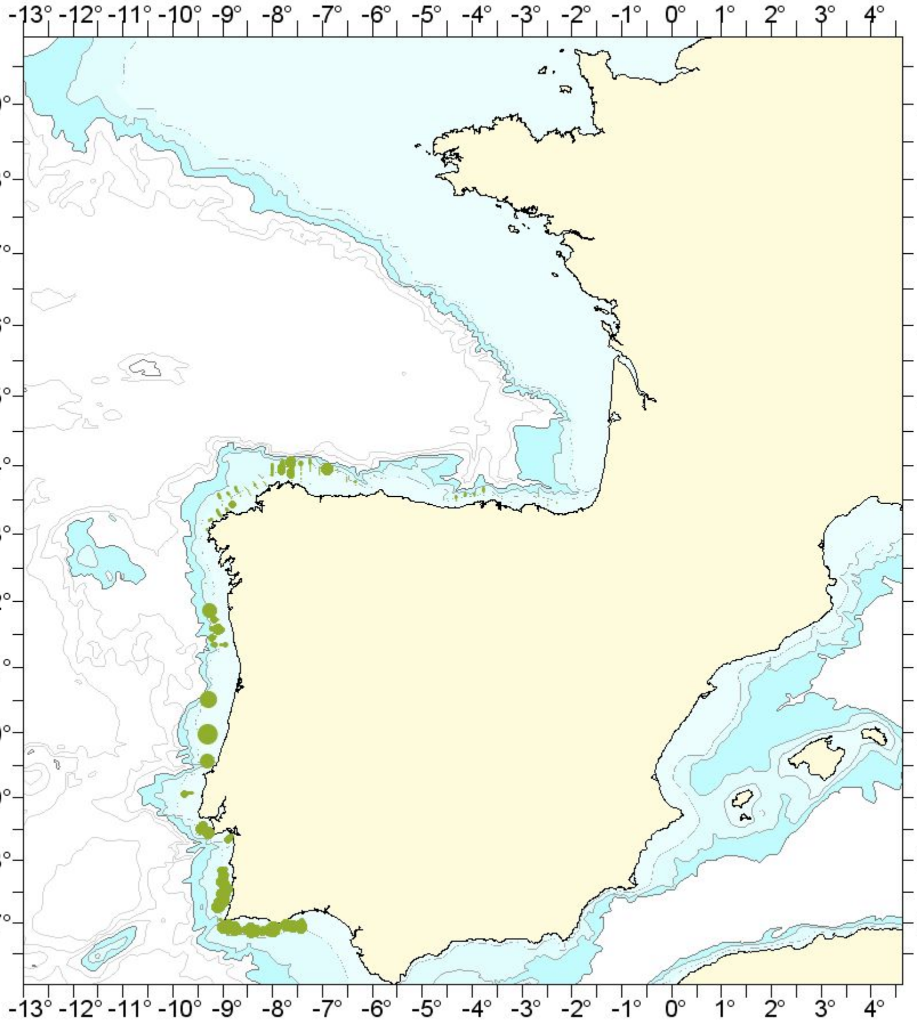


Figure 4.2.4.9. Acoustic energies (sA in m²/nm²) per ESDU attributed to blue chub mackerel (*Trachurus picturatus*).

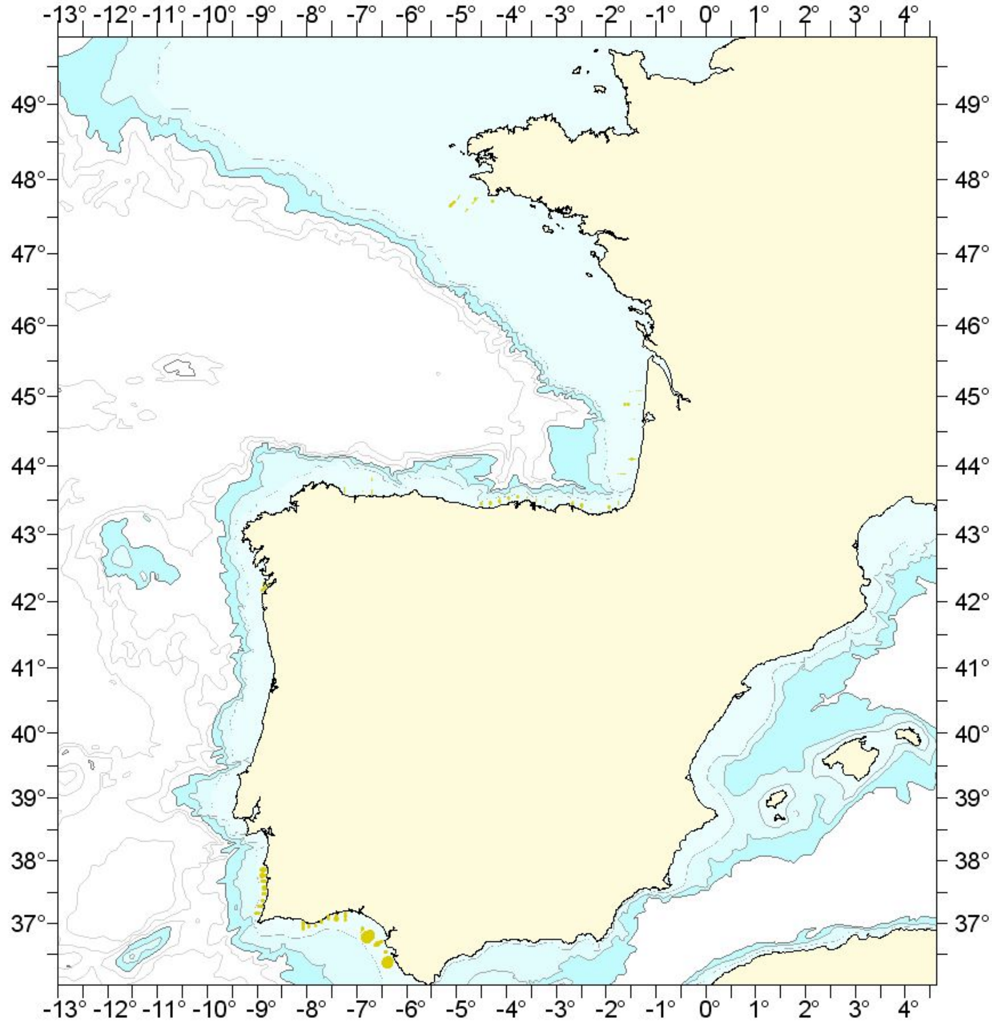


Figure 4.2.4.10. Acoustic energies (sA in m²/nm²) per ESDU attributed to *Trachurus mediterraneus*.

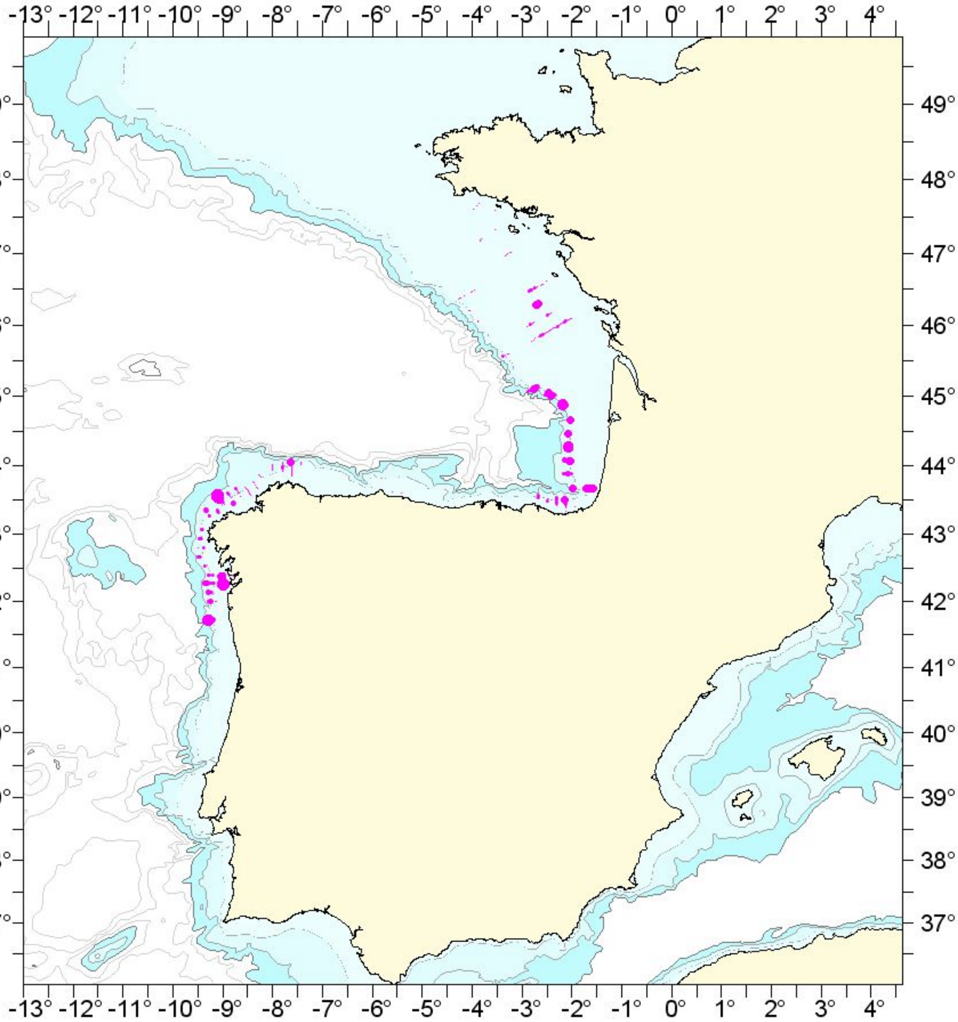


Figure 4.2.4.11. Acoustic energies (sA in m²/nm²) per ESDU attributed to Blue whiting (*Micomesistius poutassou*).

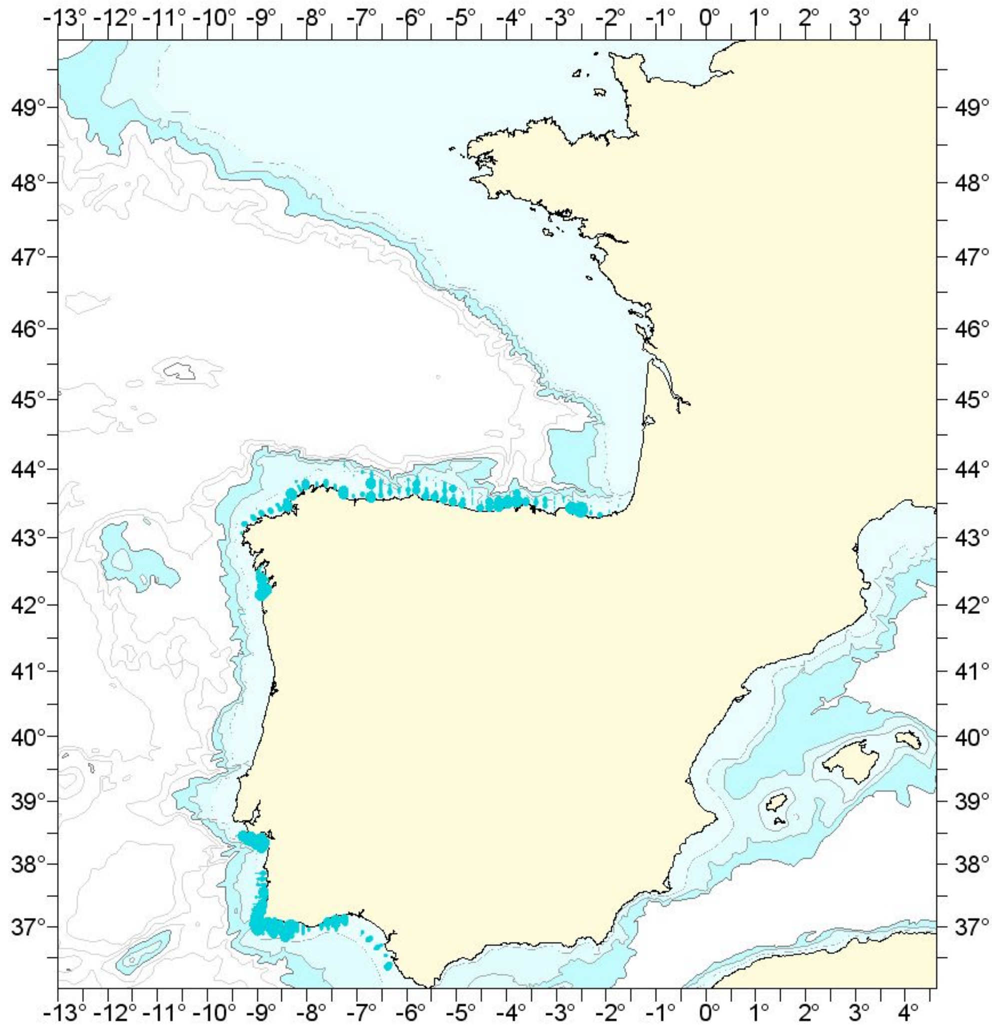


Figure 4.2.4.12. Acoustic energies (sA in m²/nm²) per ESDU attributed to bogues (*Boops boops*).

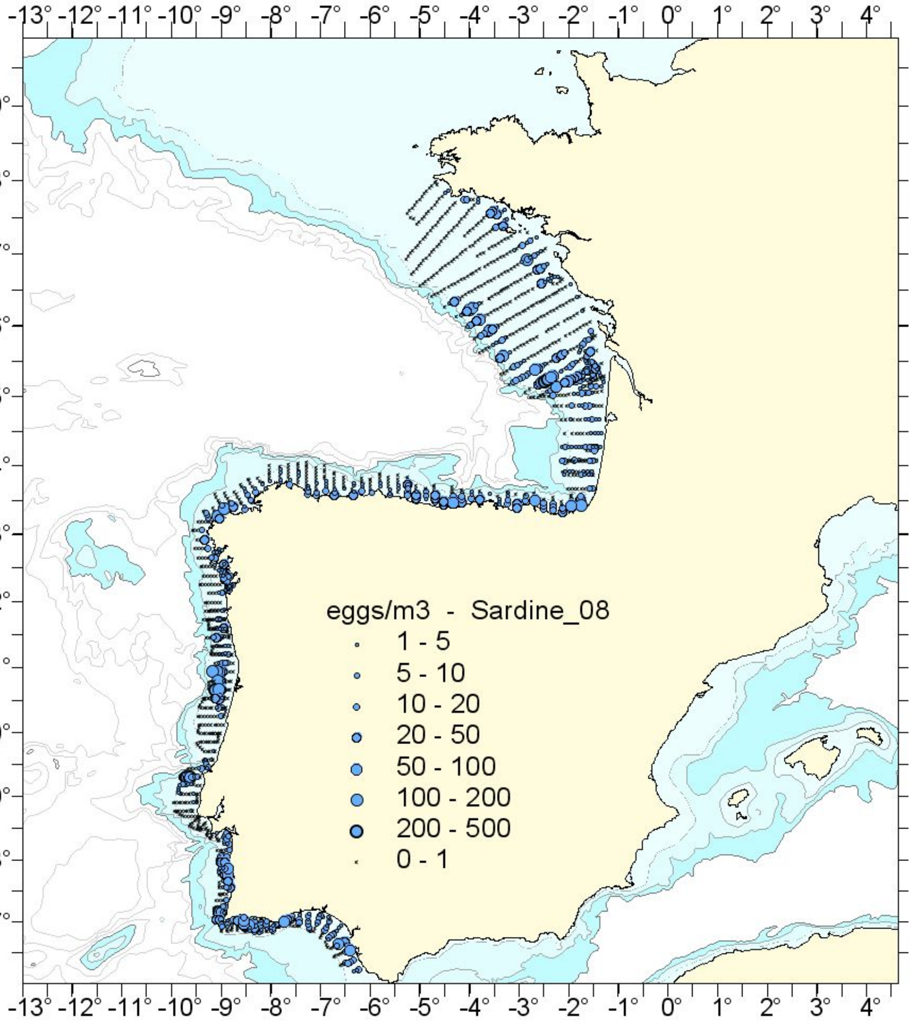


Figure 4.2.4.13. Number per m3 of sardine eggs as observed by CUFES during PELAGO, PELACUS and PELGAS surveys in spring 2008.

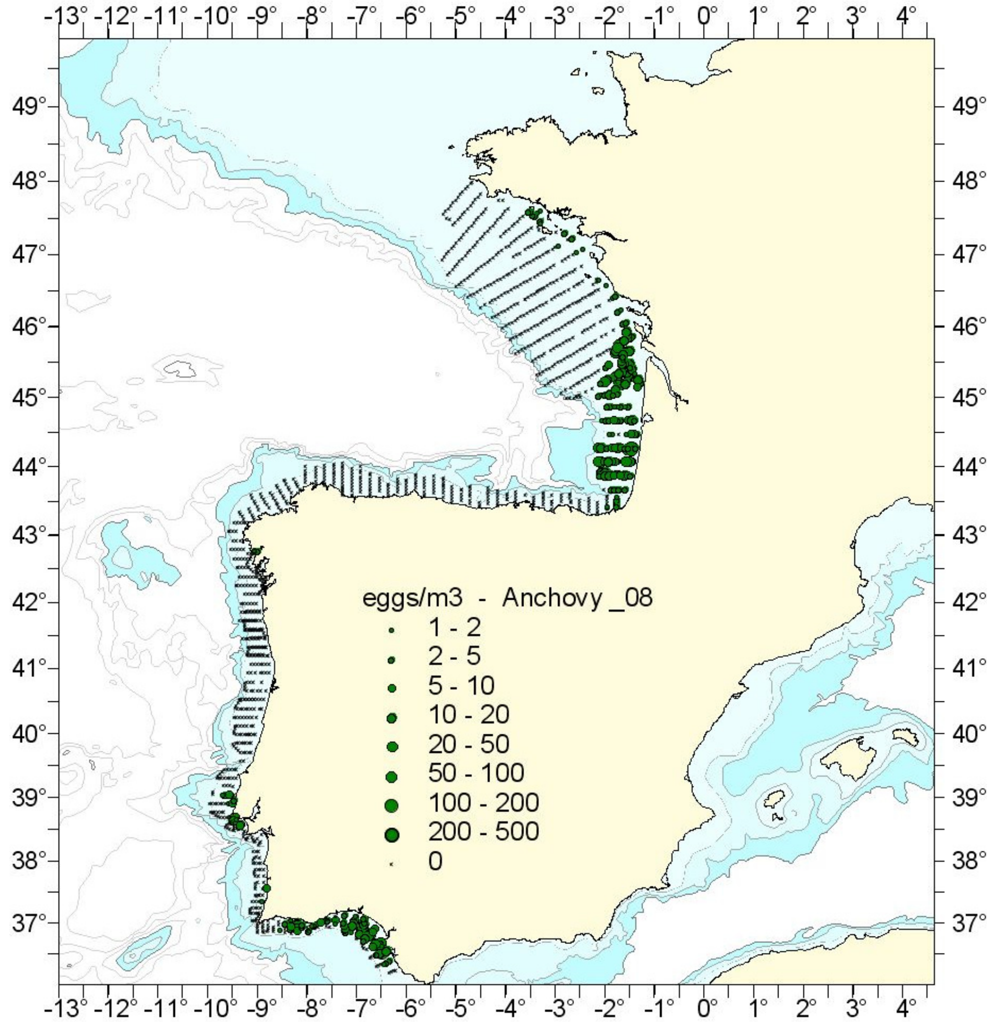


Figure 4.2.4.14. Number per m3 of anchovy eggs as observed by CUFES during PELAGO, PELACUS and PELGAS surveys in spring 2008.

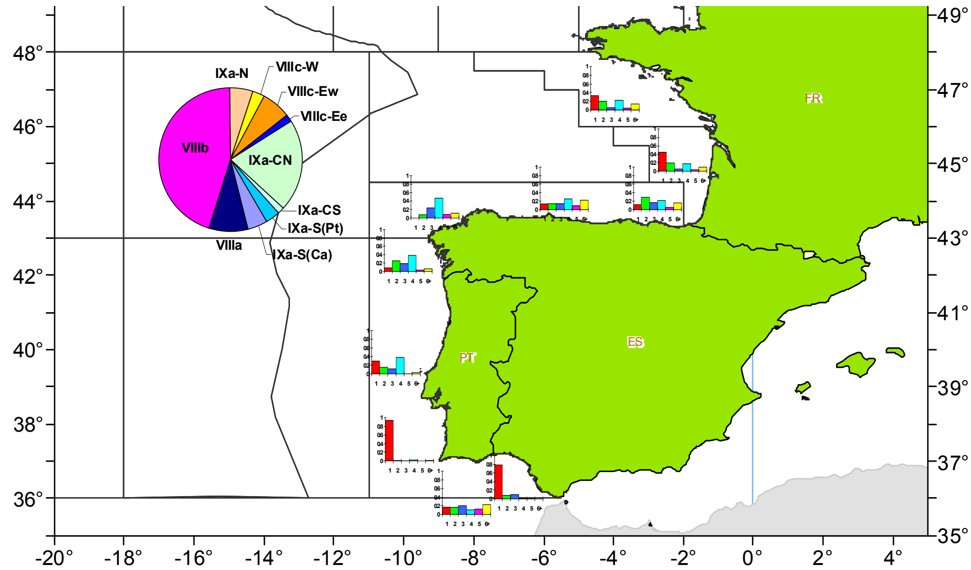


Figure 4.2.4.15. Age distribution of sardine per ICES division.

4.3 DEPM Surveys

4.3.1 DEPM general common methods: sampling and processing

The DEPM was for the first time applied to sardine in the Iberian Peninsula during the eighties. Then, and after an interruption of almost 10 years, another DEPM survey took place in 1997 in both Spain and Portugal, and since 1999, DEPM surveys are being carried out triennially covering the entire continental shelf of the Atlantic-waters of the Iberian Peninsula.

The DEPM has been applied annually to Anchovy since 1987 in the Bay of Biscay by AZTI and triennially in the Gulf of Cadiz by the IEO since 2005.

In 2008, four DEPM independent surveys were conducted in the Iberian Peninsula (ICES Areas VIII and IX) by the Spanish (IEO, AZTI) and the Portuguese (IPIMAR) institutions to estimate the population spawning biomass of either the sardine or the anchovy as main target species (**Table 4.3.1.1**) (see **Figures 4.3.2.2.1** and **4.3.3.2.1** for surveyed area).

The DEPM survey targeting the Atlantic-Iberian sardine covered the area from the Gulf of Cadiz to the Southern part of Brittany. The region on the Gulf of Cadiz to the northern Portugal/Spain border (River Minho) was surveyed by IPIMAR (Instituto de Investigação das Pescas e do Mar, Portugal), while IEO (Instituto Español de Oceanografía, Spain) covered the northwestern and north Iberian Peninsula and part of the Bay of Biscay (from 42°N to 45°N). The remainder area of the Bay of Biscay and the French coast from 45ºN to 48º latitude N, was covered by AZTI (Instituto Tecnológico Pesquero y Alimentario, Spain), that took the opportunity to carry out the DEPM for sardine together with the anchovy DEPM survey (main target species). The extension of the surveyed area almost up to Southern Brittany (following a recommendation from the previous meeting) resulted in a very good coverage of the species over most of its European Atlantic distribution (subareas IX and VIII) (see **Table 4.3.1.1**), except for the top Northwestern limits.

The DEPM survey targeting anchovy covered the bay of Biscay from 43ºN to 48ºN and from the French coast to 5ºW surveyed by AZTI (Instituto Tecnológico Pesquero y Alimentario, Spain) and the Gulf of Cadiz covered the continental shelf from Trafalgar to Cape of São Vicente (ICES Subdivision IXa South).

The sampling plan and methodology used have been standardized since 2002 in order to guarantee good coordination of the surveys and joint analyses of the data collected. **Table 4.3.1.1** summarizes the main characteristics of the sardine and anchovy eggs and adults 2008 surveys.

The methodology adopted in processing both sardine and anchovy adults data followed the general plan agree for previous surveys (cf. ICES, 2005, 2006 and 2007) and the most important information are gathered in **Table 4.3.1.2.**

Table 4.3.1.1. Common General Sampling DEPM 2008.

DEPM Surveys 2008	Sardine		Anchovy	
	Portugal (IPIMAR)	Spain (IEO)	Spain (AZTI)	Spain (IEO)
Survey area	Portugal & Gulf of Cadiz (~36–42ºN)	NW and N Spain & Bay of Biscay (9.5ºW - 42–45ºN)	Eastern Cantabrian Sea & Bay of Biscay (5ºW 43– 48ºN)	Gulf of Cádiz (36º18'–36º75'N –6º22'—8º92'W)
SURVEY EGGS	DEPM08	SAREVA0408	BIOMAN08	BOCADEVA0608
RV	Noruega	Cornide de Saavedra	Investigador	Cornide de Saavedra
Date	18 January–17 February	24 March–23 April	6–26 May	21 June –3 July
Transects (Sampling grid)	57 (8x3)	62 (8x3)	38 (15x3)	21 (8x3)
PairoVET stations (nets)	462 2	530 1	544 (2)	127 (1)
PairoVET stations with anchovy egg (%) + tot eggs from 2 nets	- -	14 469*2	44 4059	55 656
PairoVET stations with sardine egg (%) + tot eggs from 2 nets	46 13494	58 4962*2	55 11947	- -
Sampling maximum depth (m)	150	100	100	100
Hydrographic sensor	CTDF (FSI)	CTD (Seabird37) CTD SBE25	CTD (RBR)	CTD SBE25 CTD SBE37
Flowmeter	Y	Y	Y	Y
Clinometer	Y	Y	N	N
CUFES, mesh 335µm	3nmilles (sample unit)	3nmilles (sample unit)	1.5nm (sample unit)	3 nmiles (sample unit)
CUFES stations	497	510	544	121
CUFES stations with anchovy egg (%) + tot eggs	- -	- -	48 30940	46 9592
CUFES stations with sardine egg (%) + tot eggs	55 30339	54 30954	44 NA	- -
Environmental data	Fluorescence, Temp, Salinity	Fluorescence (surface only), Temp, Salinity	Temp, Salinity	Fluorescence (surface only), Temp, Salinity
Cont… on next page				

DEPM Surveys 2008	SARDINE		ANCHOVY	
	Portugal (IPIMAR)	Spain (IEO)	Spain (AZTI)	Spain (IEO)
SURVEY ADULTS	DEPM08	PELACUS0408	BIOMAN08	BOCADEVA0608
RV	Noruega	Thalassa, Cornide de Saavedra (3T)	Emma Bardán	Cornide de Saavedra
Gears	Pelagic and Bottom trawl, purse-seiner	Pelagic trawl	Pelagic trawl	Pelagic trawl
Date	18 January–17 February	24 March–23 April	6–26 May	21 June –3 July
Trawls	51 +34 (commercial purse-seiners)	44	39	26
Trawls time	During the whole day	During the whole day	From14:00h to 2:00h	During the day hours
Biological sampling:	On fresh material, on-board of the RV and on frozen for commercial; gonads fresh	On fresh material, on-board of the RV	On fresh material, on-board of the RV and frozen for otoliths	On fresh material, on-board of the RV
Sample size	60 indiv randomly (30 female minimum); extra if needed and if hydrated found	60 indiv randomly minimum (30 mature female); extra if needed and if hydrated found	60 indiv randomly minimum (25 mature female); extra if needed and if hydrated found	60 indiv randomly minimum (30 mature female); extra if needed and if hydrated found
Fixation	Buffered formaldehyde 4% (distilled water)	Buffered formaldehyde 4% (distilled water)	Buffered formaldehyde 4% (tap water)	Buffered formaldehyde 4% (distilled water)
Preservation	Ethanol 70º	Formalin	Formalin	No

NA: Not Available.

Table 4.3.1.2. Processing and analyses for eggs and adults.

DEPM Processing 2008	SARDINE			ANCHOVY	
	Portugal (IPIMAR)	Spain (IEO)	Spain (AZTI)	Spain (AZTI)	Spain (IEO)
EGGS					
PairofVET Eggs staged sardine (Gamulin and Hure, 1955) anchovy (Moser and. Ahlstrom,1985)	All (for 2 nets in 2008)	All (1net)	sample size 50 / 75 or all eggs		all
CUFES Eggs staged sardine (Gamulin and Hure, 1955) anchovy (Moser and. Ahlstrom,1985)	In the lab, all or sub-sample if more than 100 per sample	No	No		Three Development Stages
Temperature for egg ageing	Surface (continuous underway CTF at 3m)	10 m	10 m		5 m
Peak spawning hour	21	21	21	23	22
Egg ageing	Bayesian (Bernal 2008)	Bayesian (Bernal 2008)	Bayesian (Bernal 2008)		Bayesian (Bernal 2008)
Egg Production	GLM (and GAMs available)	GLM (and GAMs available)	GLM (and GAMs available)		GLM (and GAMs available)
ADULTS					
Histology: - Embedding material - Stain	Paraffin Haematoxilin-Eosin	Resin Haematoxilin-Eosin	Resin Haematoxilin-Eosin		Resin Haematoxilin-Eosin
S estimation	Day 1 and Day 2 POFs (according to Pérez et al. 1992a and Ganias et al. 2007)	Day 1 and Day 2 POFs (according to Pérez et al. 1992a and Ganias et al. 2007)	Day 1 and Day 2 POFs (according to Pérez et al. 1992a and Ganias et al. 2007)	A model based on the historical series between S &SST	Day 1 and Day 2 POFs (according to Motos 1994).
R estimation	The observed weight fraction of the females	The observed weight fraction of the females	The observed weight fraction of the females	Theoretical expected values assumed to be equal to 1:1 in numbers checked with observed	The observed weight fraction of the females, checking with the expected 1:1 in numbers
F estimation	On hydrated females (without POFs), according to Pérez et al. 1992b	On hydrated females (without POFs), according to Pérez et al. 1992b	On hydrated females (without POFs), according to Pérez et al. 1992b	On hydrated females (without POFs), according to Hunter *et al*, 1985)	On hydrated females (without POFs), according to Hunter and Macewicz 1980)

4.3.2 Anchovy 2008 DEPM Surveys

4.3.2.1 Environmental data; SST and SSS distribution maps

In the Bay of Biscay during BIOMAN 08 survey, mean sea surface temperature registered was 16.2ºC, in a range between 14.5 and 17.7ºC. Warmer waters occupied the area of influence of Adour and Gironde rivers and the North from the Gironde River up to 48 º N all along the coast. The remarkable patches of anchovy eggs are mostly in those areas with warmer waters. (**Figure 4.3.2.1.1**).

Mean sea surface salinity was 34.5 PSU with a range between 29.4 and 36.7 PSU. The lowest salinity waters were found in the same areas were the warmer waters were found due probably to the contribution of the Adour and Gironde rivers and were the majority of anchovy eggs were found. (**Figure 4.3.2.1.2**).

In the Gulf of Cadiz during BOCADEVA 08 survey the mean temperature registered was 21.2ºC, in a range between 18.1ºC and 23.6ºC. Warmer waters occupied the inner shelf regions, exception made for the Trafalgar and the Cape San Vicente regions. At these locations intense upwelling could be inferred, as opposed to the shelf break region where advection of cool, upwelled waters seemed responsible for the lower temperatures. (**Figure 4.3.2.1.1**).

Salinity shows evidently outstanding outliers, although describes a pattern with a lower surface salinity wedge over the shelf regions west of the Guadiana river mouth. A very small range of salinity was registered (36.1 – 36.6 USP), and the mean salinity was 36.2. (**Figure 4.3.2.1.2**).

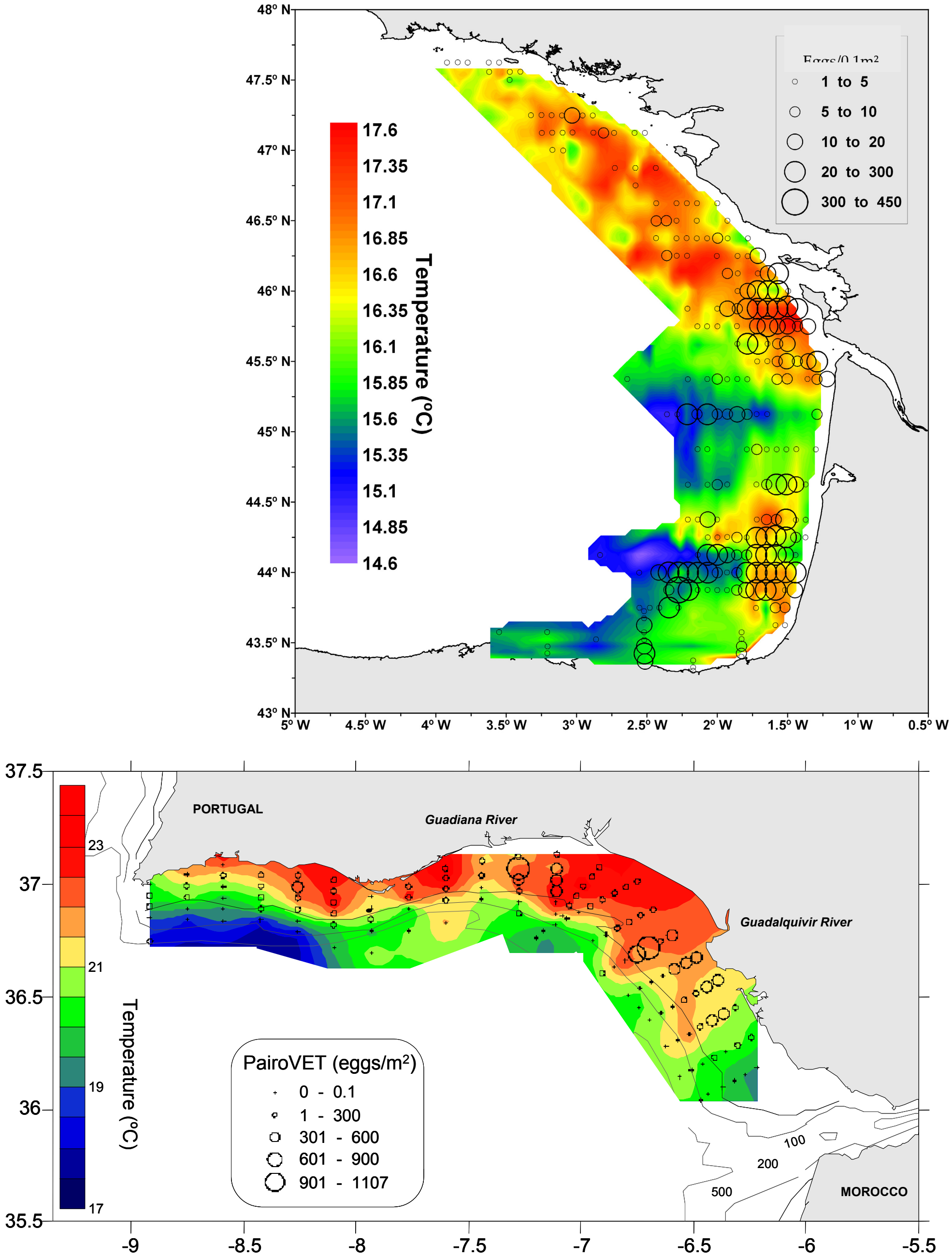


Figure 4.3.2.1.1. Sea surface temperature observed during DEPM anchovy surveys BIOMAN 08 and BOCADEVA-0608.

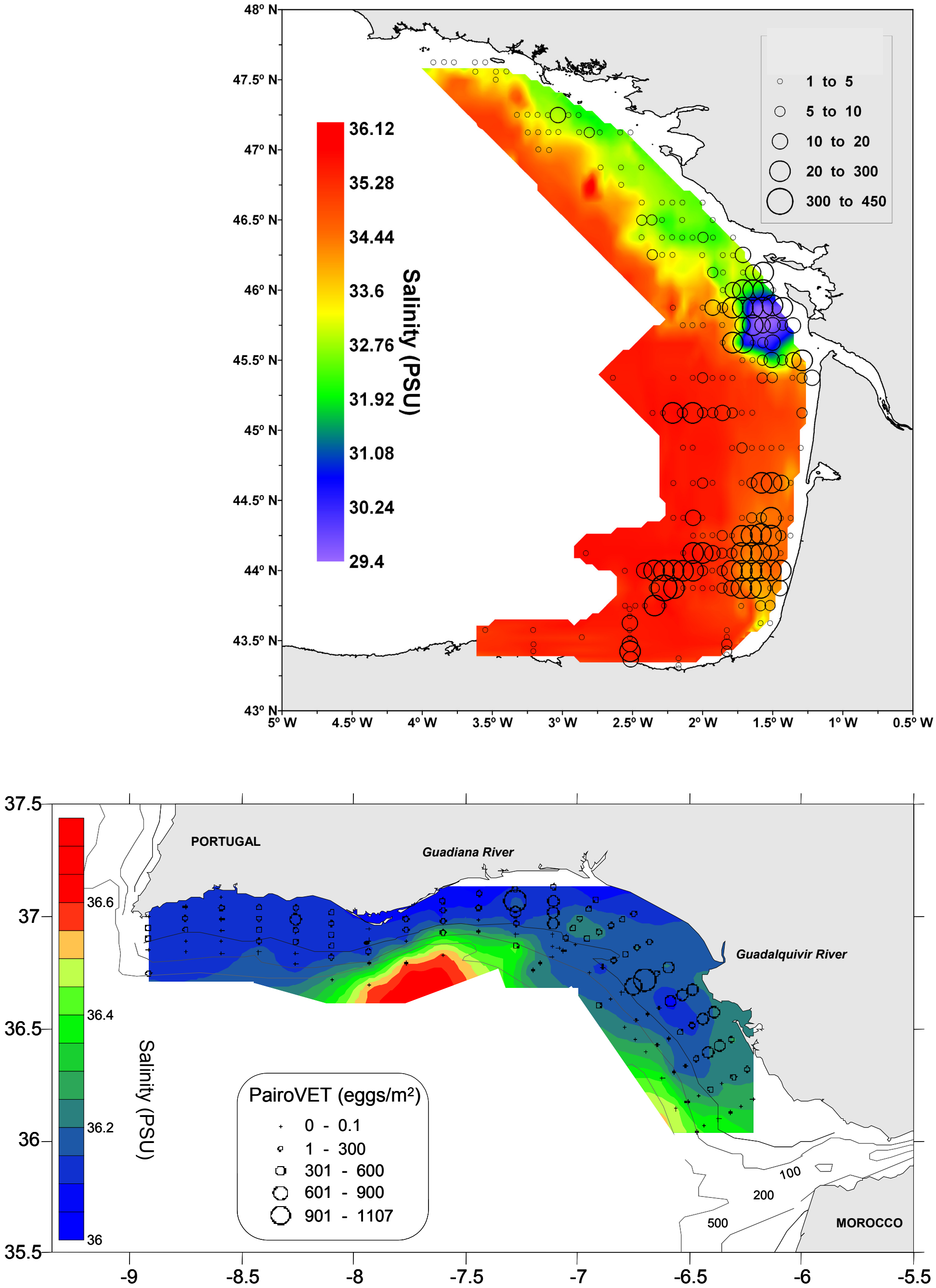


Figure 4.3.2.1.2. Sea surface salinity observed during anchovy DEPM surveys BIOMAN 08 and BOCADEVA-0608.

4.3.2.2 Egg data

The BIOMAN 08 survey prospecting the Bay of Biscay started at transect 11 at west of Santander covering the Cantabrian Coast eastwards. The western limit of the spawning area was located at the longitude of Ajo Cape (transect 15 at 3º33'W). Then, the survey continued to the North, until the northern limit of the spawning area was found at 47º37'N (**Figure 4.3.2.2.1**).

The anchovy eggs were concentrated in two principal areas: the area in front of Les Landes from the coast to the area passed the 200m isoline. There, the maximum number of eggs per station, during the whole survey, was 306 anchovy eggs/0.1m^2. The other principal area was the region of influence of the Gironde River in the area of 50m depth, close to the coast. From 46ºN to the north an area with stations with 1 or two anchovy eggs/0.1m^2 was found close to the French coast. Egg abundance was scarce across the eastern Cantabrian coast reduced mostly to the Basque Country area. (**Figure 4.3.2.2.1**).

From the 544 PairoVET samples obtained, 237 were positive for anchovy eggs (43%) with an average of 7 eggs/0.1m^2 per station and a maximum of 306 eggs/0.1m^2 in the area of Les Landes once passed the isoline of 200m in transect 29. In total there were caught 4,059 anchovy eggs.

71% of the anchovy eggs obtained were classified into 11 stages according to the degree of embryonic development. It has been found anchovy eggs in all the stages. The most abundant development stages were II (23%) and V (17%). The lowest abundant sages were I (0.8%) and XI (0.6%). (**Figure 4.3.2.2.3**).

CUFES was used to record the eggs found at 3m depth. The samples obtained were immediately checked under the microscope so that presence/absence of anchovy eggs was detected in real time. This allowed knowing whether there were anchovy eggs in the area. In consequence, transects were left when no anchovy eggs were found in 6 consecutive CUFES samples in the oceanic area. A total of 1,200 CUFES samples were obtained.

The distribution of anchovy obtained with this sampler (**Figure 4.3.2.2.2**) was the same as the one obtained with the PairoVET. The quantity of anchovy eggs was recorded per station but not the total sampled eggs of all species. Over the whole surveyed area the average CUFES egg density was 5.34 egg/m^3. The eggs obtained with CUFES were not classified in stages.

During the BOCADEVA survey, prospecting the Gulf of Cadiz, the anchovy eggs were caught mainly in the coastal area located between Cadiz and the mouth of the Guadalquivir River (radial 6). In this radial, the number of eggs was bigger (19% of the total). In general, abundances were bigger in the stations inside isobaths of the 100 m. A second area of high egg abundances were registered in radial 11, in front of the mouth of the Guadiana River. Also, all radials located in Portuguese waters were presence of anchovy eggs, although in a much smaller abundance. Anchovy larvae (265 in number) have been more abundant in the area between Cadiz and Huelva, and presented a less coastal distribution than eggs. (**Figure 4.3.2.2.1**).

93.4% of the anchovy eggs have been classified into 11 stages according to the degree of embryonic development. It has been found anchovy eggs in all the described stages. The most abundant development stages were II and III stages (14.8 and 29.7%, respectively). Although just 1 egg was found in stage I and eggs in the XI stage, right before the hatching, represented 1.4%. (**Figure 4.3.2.2.3**).

CUFES sampler was used as well in BOCADEVA08 survey. Anchovy eggs represented 55.7% of the total of caught fish eggs. The number of larvae caught during the continuous sampling was very low compared with the ones get with the PairoVET.

The spatial distribution of the anchovy eggs abundance (number/m^3) by CUFES shows a clear concentration area in a small coastal area between Huelva and Isla Cristina (radial 10 and 11). Only in these two radial almost 2,700 eggs have been caught, representing 34% of the total (**Figure 4.3.2.2.2**). The stations with bigger abundance (450 to 800 anchovy eggs) were close to coast (<100 m). In the rest of the sampling stations the eggs caught were lower. In general, a preference for the most coastal areas was observed. 12 anchovy larvae were only obtained and 133 larvae belonging to other fish species (91.7%). Station with bigger number of anchovy larvae was in radial 11, in front of Isla Cristina.

90.5% of the anchovy eggs caught by CUFES have been classified according to the embryonic development degree. A 61.6% (7,439) of the total of eggs were classified into category NE (No Embryo), that are eggs in which even there is not embryo as such. That category grouped stages I to III. 12.2% were classified into category EE (Early Embryo) eggs (grouped stages IV to VI). The rest was classified into category LE (Late Embryo) grouped stages VII to XI. (**Figure 4.3.2.2.4)**

The daily egg production, the daily mortality rates and the total egg production with their coefficient of variation (cv), for both surveys, BIOMAN08 and BOCADEVA08, are shown in **Table 4.3.2.2.1.**

Table 4.3.2.2.1. Daily egg production (P0) (eggs/m2 per day), daily egg mortality rates (z),percentage of anchovy eggs death per day, total egg production (Ptot)(eggs/day) and spawning area (km2) estimates from anchovy DEPM surveys BIOMAN08 and BOCADEVA-0608. In brackets their coefficients of variation.

		BOCADEVA-0608	
Parameter	BIOMAN 08	Area 1	Area 2
P0 (eggs/m2/day)	53.27 (0.23)	42.7 (0.45)	205.5 (0.40)
Z (day-1)	0.32 (0.39)	0.35 (1.22)	0.79 (0.49)
% death egg/day	73	70	45
Ptot (eggs/day)	1.78E+12	0.13E+12	1.31E+12
Spawning area(km2)	33,500	3,046	6,349

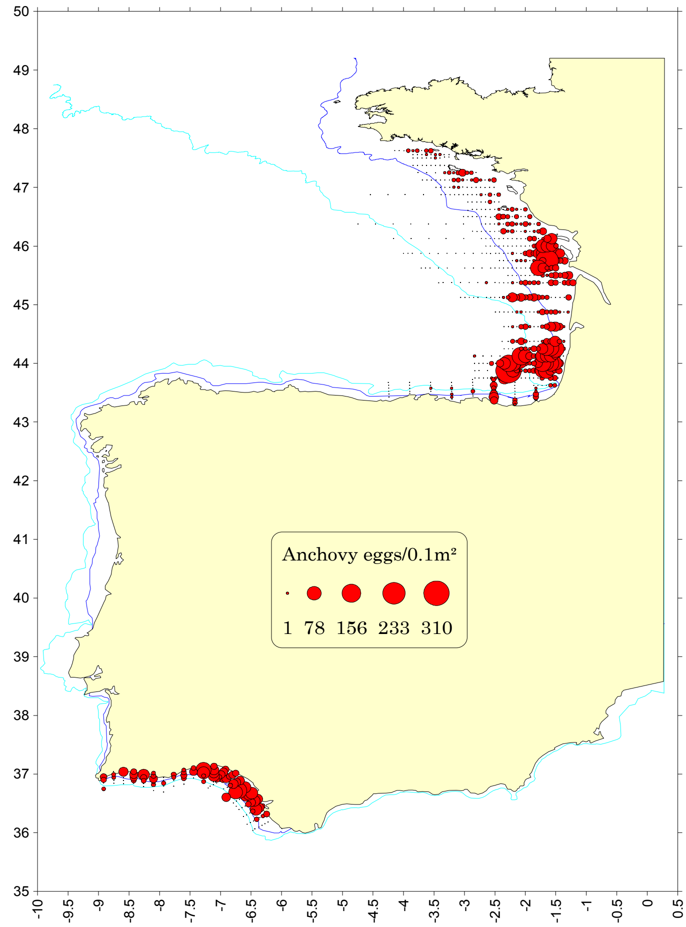


Figure 4.3.2.2.1. Anchovy eggs distribution and abundance (egg/0.1m²) found during anchovy DEPM surveys BIOMAN08 and BOCADEVA-0608 (PairoVET).

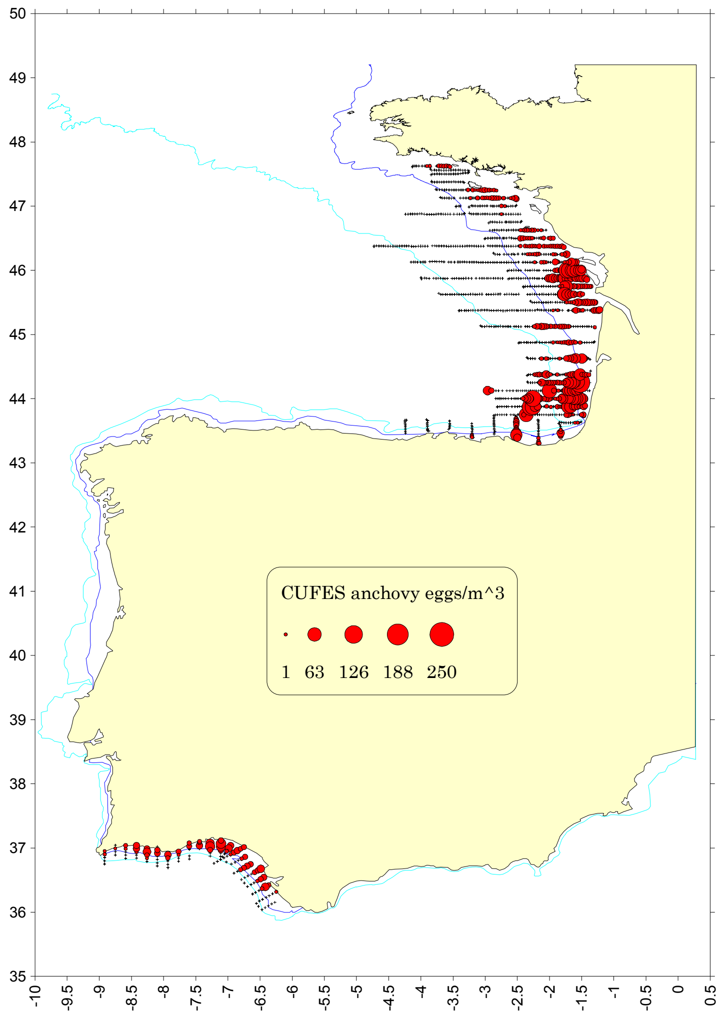
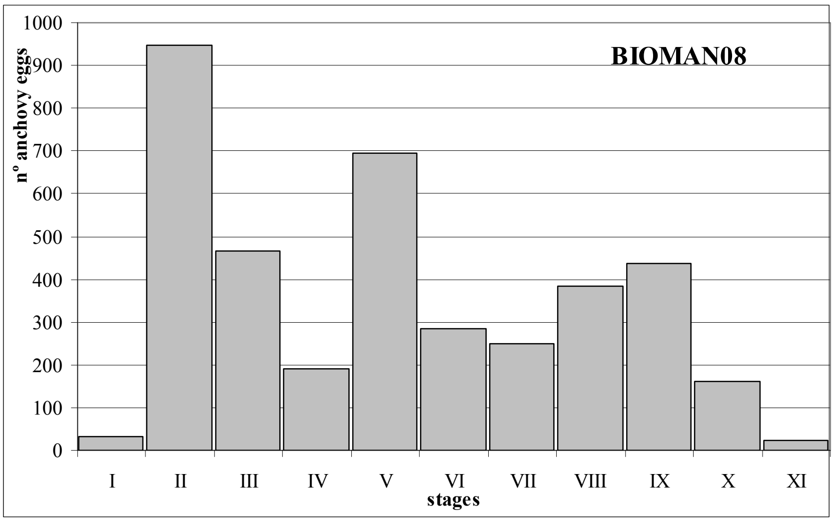


Figure 4.3.2.2.2. Anchovy eggs distribution and abundance (egg/m^3) found during anchovy DEPM surveys BIOMAN08 and BOCADEVA-0608 (CUFES).



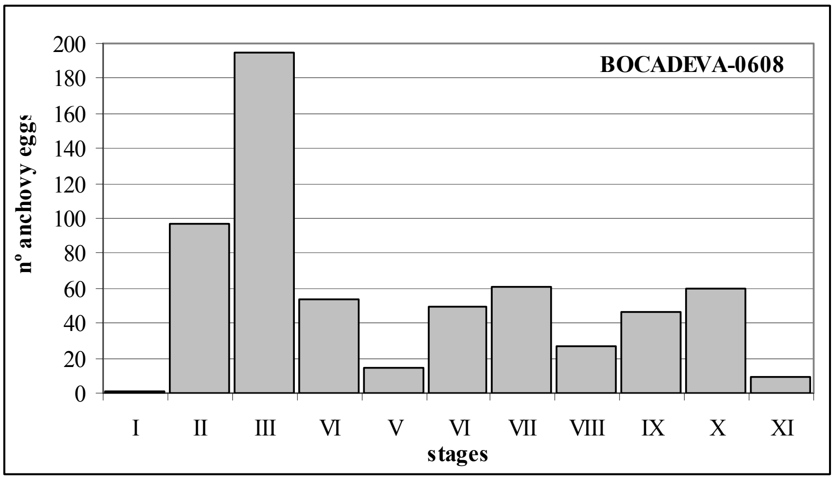


Figure 4.3.2.2.3. Number of anchovy eggs classified into the different stages (PairoVET), found during DEPM anchovy surveys BIOMAN08 and BOCADEVA-0608.

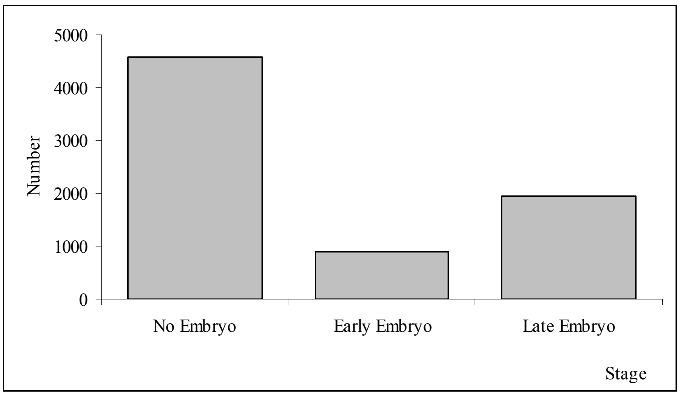


Figure 4.3.2.2.4. Number of anchovy eggs classified into the different stages found during BOCADEVA-0608 (CUFES).

4.3.2.3 Adult data and Spawning Stock Biomass estimates

In the Bay of Biscay during BIOMAN 08 survey, the adult samples were obtained on-board a pelagic trawl from the 6 to the 25 May coinciding with the plankton sampling. The spatial distribution of the fishing hauls are shown in **Figure 4.3.2.3.1**. The hauls are spread all along the spawning area and represent well the whole anchovy population.

In each haul immediately after fishing, anchovy were sorted from the bulk of the catch and a sample of near 2 Kg was selected at random. A minimum of 1 kg or 60 anchovies were weighted, measured and sexed and 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 proceed on the same manner. Sampling was stopped when more than 120 anchovies had to be sexed to achieve the target. Moreover, otoliths were extracted and read on-board to obtain the age composition per sample. The same was done for sardine. In addition in each haul 100 individuals of each species were measured and the gut content of anchovy, sardine, mackerel and horse mackerel were analysed.

From the 39 pelagic trawl hauls performed one of them was null and anchovy was found in 29 of them. 22 of those were selected for the analysis. Spatial distribution of samples and their species composition is showed in **Figure 4.3.2.3.2** There were found anchovy adults where the anchovy eggs were found, in the area in front of Les Landes from the coast to the area passed the 200m isobath and in the region of influence of the Gironde River in the area of 50m depth and close to the coast. Other species noticeable were horse mackerel in the south part of the Bay of Biscay and sardine in the North close to the coast just were the sardine eggs were found.

Figure 4.3.2.3.4 represents the anchovy size showing a clear difference between the bigger anchovies in the South including part of the Easter Cantabrian coast and smaller in the North. The anchovy size range was in the total area between 9.2 and 20.7 cm. There were two areas with anchovies clearly well defined with different sizes: the South area with anchovies with a range between 9.2cm and 17.7cm and a modal class of 14cm and the North with a range between 12.9cm and 20.2cm and a modal class of 16.4cm. The mean size distribution of anchovy is shown in **Figure 4.3.2.3.4.** This figure shows again the same pattern of small anchovies in the North and bigger in the South. This is also noticeable in **figure 4.3.2.3.3** representing the spatial distribution of female mean weights.

This year batch fecundity was estimate for first time applying a GLM with a Gamma distribution and "identity" link. Moreover, an analysis was conducted to verify if there were differences in the batch fecundity in the regions defined North of 45ºN and South of 45ºN. No significant differences were found, so a unique stratum was considered to estimate the batch fecundity

Until the new series of spawning frequency (S) is accepted and a revision of all the parameters of the DEPM is completed, in order to provide a preliminary SSB estimate, a model based on the historical series was considered. This model relates S linearly with Sea Surface Temperature (SST). Last year this model was accepted as more reliable than the one base on the average of S from the historical series. According to the survey mean temperature this model gave an estimate of 0.26 for the spawning frequency (CV 13%). This value is close to the historical mean of S (0.25).

Figure 4.3.2.3.5 shows the distribution of anchovy age composition in space. The majority of one year anchovies were found in the North and the oldest, anchovies of 2 and 3 years, are found in the South. The proportion by age and population at-age estimates are given in **Table 4.3.2.3.1**.

Table 4.3.2.3.1. SSB 2008 estimates and the correspondent coefficient of variation (CV) of the percentage by age and numbers at-age estimates, with the mean weight by age class, from DEPM survey BIOMAN 08 for the Bay of Biscay anchovy.

PARAMETER	ESTIMATE	CV
BIOMASS (Tons)	25,377	0.26
Tot. Mean W (g)	23.57	0.09
Population (millions)	1,086	0.28
Percentage. age 1	0.42	0.12
Percentage. age 2	0.51	0.09
Percentage. age 3	0.07	0.17
Numbers at-age 1	461	0.33
Numbers at-age 2	553	0.27
Numbers at-age 3	72	0.31
W age 1	15.86	
W age 2	27.20	
W age 3	29.41	

The adult parameters and the SSB estimates for BIOMAN 08 are shown in **Table 4.3.2.3.2.** The SSB estimates for the Bay of Biscay anchovy resulted in 25,377 t with CV of 26%, similar to the one estimated in June (26,461t) for the WGANC. And it is at the same level as last year estimate (25,973t).

Table 4.3.2.3.2. Adults' parameter estimates with their coefficient of variation in brackets, from anchovy DEPM surveys BIOMAN08 and BOCADEVA-0608.

PARAMETER	BIOMAN 08	BOCADEVA0608
Sex Ratio (R)	0.54 (0.01)	0.52 (0.21)
Female mean Weight (Wf)	26.48 (0.09)	24.01 (0.24)
Batch Fecundity (F)	13,247(0.10)	In process
Spawning Frequency (S)	0.26 (0.13)	In process
Daily Fecundity (DF)	70.33 (0.13)	In process
Spawning stock biomass (SSB)	25,377(0.26)	In process

In the area of Gulf of Cadiz during BOCADEVA08 survey the fishing stations were mostly conducted by trawling following isobaths in order to avoid the possible mixing of different population fractions occurring along the depth gradient. Nevertheless, the presence of fixed artisanal gears along the coastal fringe, between the 30 – 80 isobaths from the Guadalquivir River mouth to Ponta de Sagres, obliged to modify the direction and location of several fishing stations or even prevented from their conduction. (**Figure 4.3.2.3.1**).

The family more representative in catches was the Sparidae, with 11 species, followed by Carangidae and Centracanthidae, with three species each. From the total of fished species, chub mackerel (*Scomber colias*) was the species yielding the highest total catch in weight (1,688 kg), followed by anchovy (840 kg). In terms of the total catch in numbers, anchovy accounted for the 54% of the total and chub mackerel the 19%. The following two more important species were the blue jack mackerel (*T. picturatus*; 447 kg), and sardine (237 kg), both showing a similar number of fish captured.

These species showed great regional differences (Spain vs. Portugal) in their respective patterns of distribution of yields in numbers and weight. So, in the Spanish waters anchovy and chub mackerel accounted respectively for the 55% and 18% in weight. Conversely, chub mackerel and black jack mackerel represented 63% and 19% of the total yield in weight in Portuguese waters (**Figure 4.3.2.3.2**).

The anchovy mean yield (catch per hour of trawling) was estimated at 70 kg/h. The highest yields in weight were recorded in those fishing stations carried out in areas close to Matalascañas (264 kg/h), Cádiz (245 kg/h), and Quarteira (197 kg/h), and reaching more than 100 kg/h in front of Huelva and El Rompido. Regional differences in yields were also found: in Spanish waters the mean yield was estimated at 85 kg/h, almost the double than the one estimated in Portuguese waters (47 kg/h).

The highest anchovy yields in number were also recorded in the above mentioned areas, concretely in the area between Matalascañas and El Rompido in depth between 41–85 m, and in front of Cádiz between 41–55 m depth. In Portuguese waters the highest abundances were recorded at a greater depth, between 80–90 m depth in front of Quarteira.

The anchovy size range for the whole sampled area was comprised between the 9.5 and 18.5 cm size classes, locating the mean size at 13.76 ± 1.32 cm, with modal classes around to 12.5 and 14 cm. The Portuguese overall LFD was noticeably unimodal at 15 cm and with a mean size at 15.04 ± 1.19 cm. The Spanish overall LFD showed however bimodal, with modal classes at 12.5 and 14 cm size classes and a mean size 13.52 ± 1.20 cm (**Figure 4.3.2.3.4**).

Anchovy LFDs per fishing station showed a westward increasing gradient in size as it was also observed in previous surveys (both DEPM and Acoustic) carried out in the area. So, larger anchovies occurred in the westernmost part of the surveyed area, between Alfanzina and Portimao. Conversely, the smallest anchovies were captured between Coto de Doñana and Cádiz (**Figure 4.3.2.3.4**). This gradient is observed too in relation to the mean weight of the females, increasing this parameter in direction East to West (**Figure 4.3.2.3.3**).

Regarding the maturity stages, almost the whole (98%) of captured anchovies during the survey showed a full spawning activity (stages III to VI). The size range of these mature anchovies was between 99 and 182 mm TL. For the whole area the more important maturity stages in females were the stage IV (spawning) and V (partial post-spawning), accounting for 26% and 53%, respectively, whereas in males dominated the stages III (prespawning) and V (partial post-spawning), with a 16% and 73%, respectively.

Some of the adult parameters estimates for BOCADEVA 08 survey are shown in **Table 4.3.2.3.2.** The SSB estimate for the Gulf of Cadiz is not available yet, until all the adult parameters are processed.

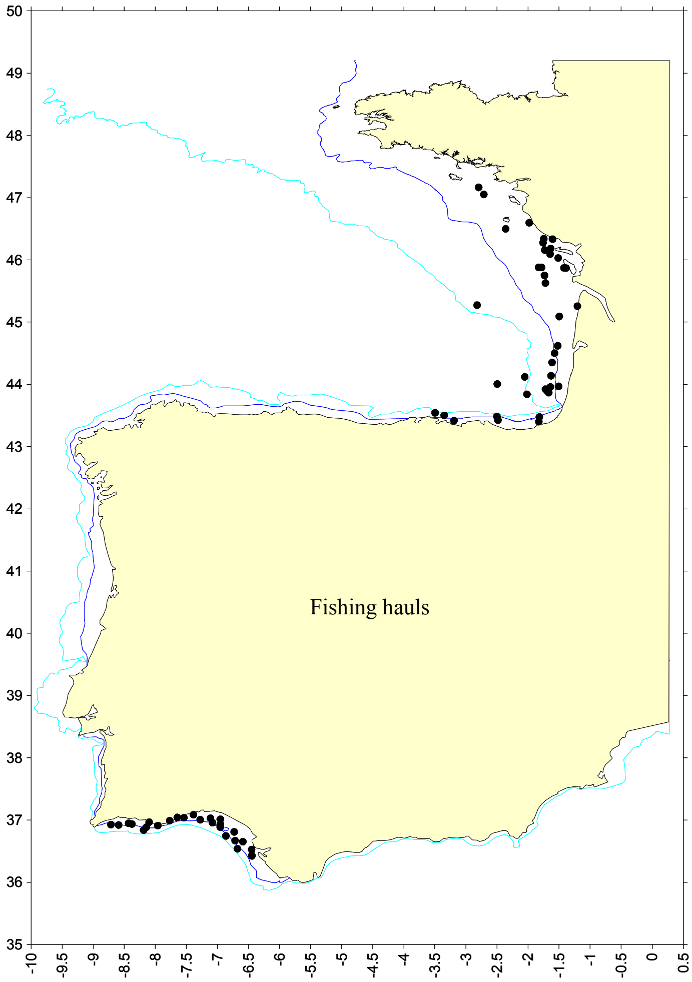


Figure 4.3.2.3.1. Spatial distribution of fishing hauls (pelagic trawls) carried out by AZTI (Bay of Biscay) and IEO (Gulf of Cadiz) during the anchovy DEPM surveys BIOMAN08 and BO-CADEVA-0608.

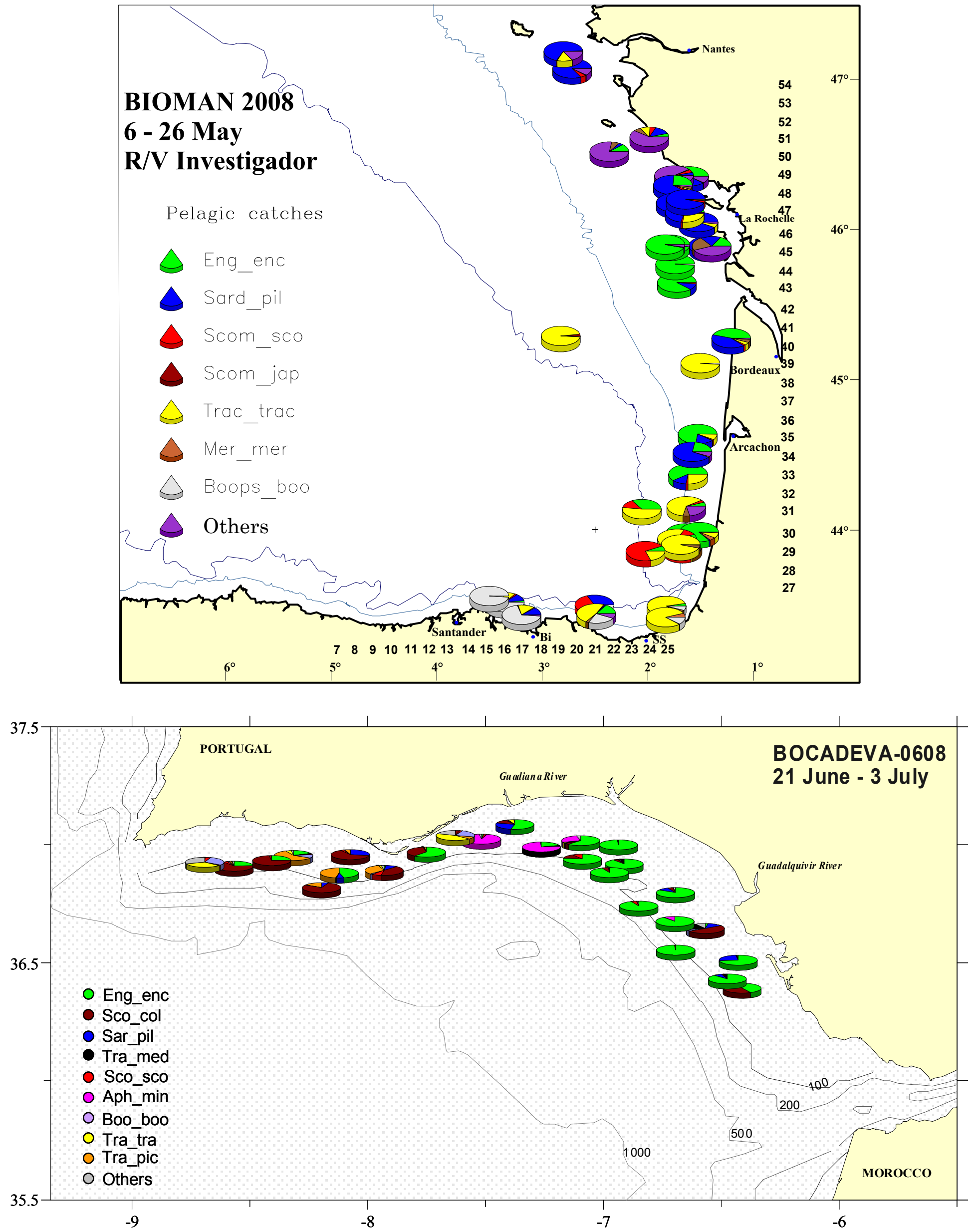
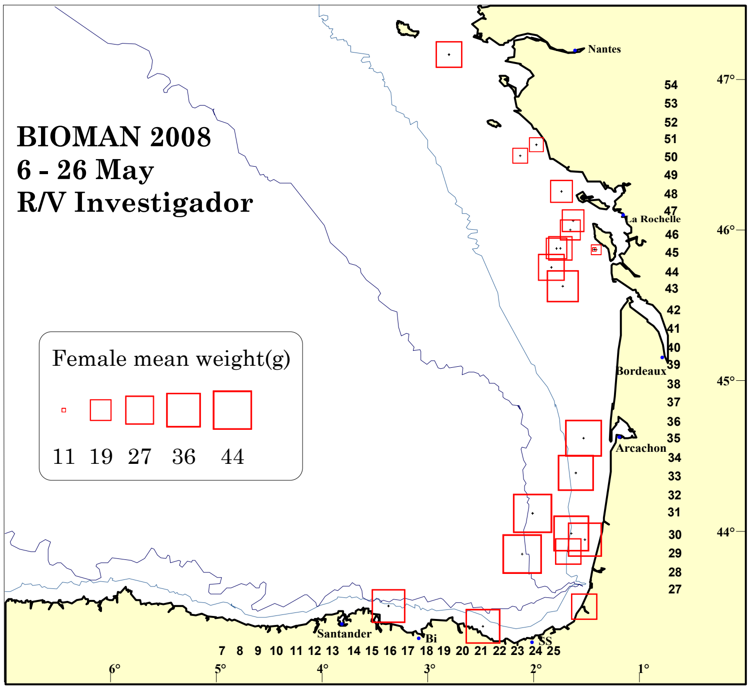


Figure 4.3.2.3.2. Species composition from the hauls carried out during the anchovy DEPM surveys BIOMAN08 and BOCADEVA-0608.



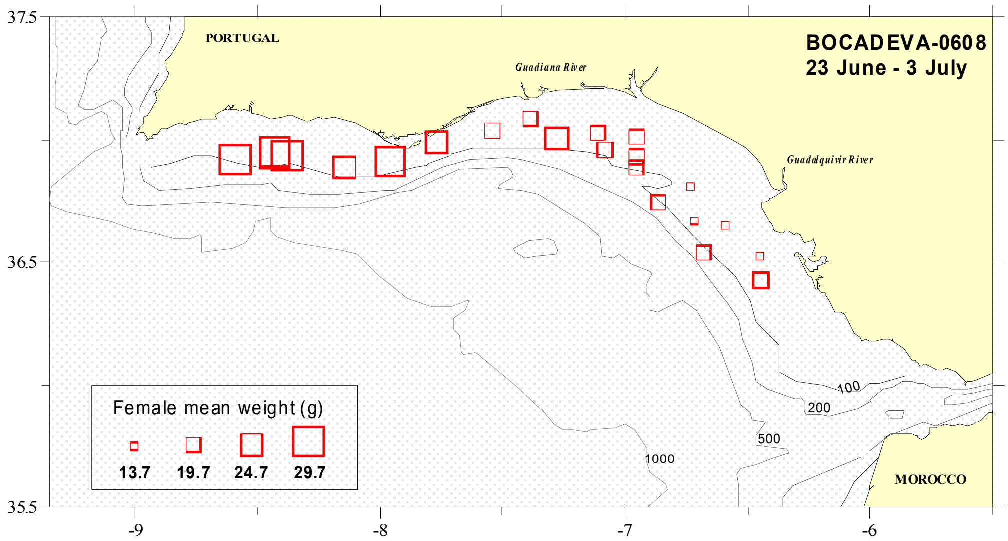
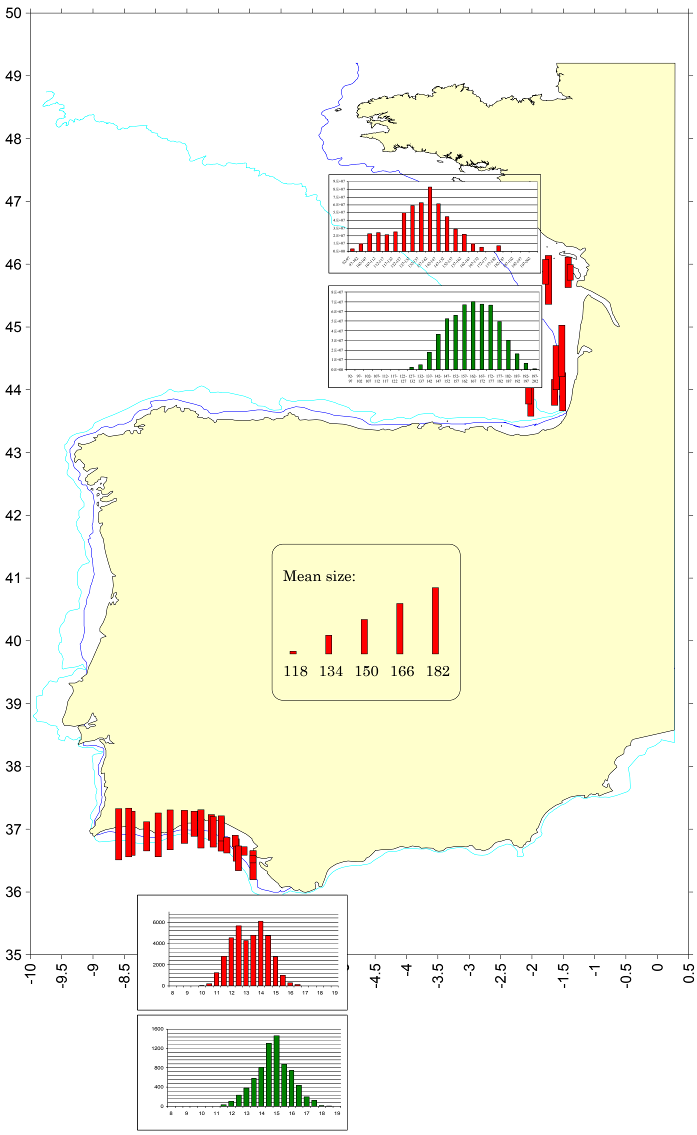


Figure 4.3.2.3.3. Spatial distribution of females mean weight (g) per haul from selected samples (DEPM anchovy surveys BIOMAN08 and BOCADEVA-0608).



1)

Figure 4.3.2.3.4. Spatial distribution of mean size (mm) per haul obtained during anchovy DEPM surveys BIOMAN08 and BOCADEVA-0608.

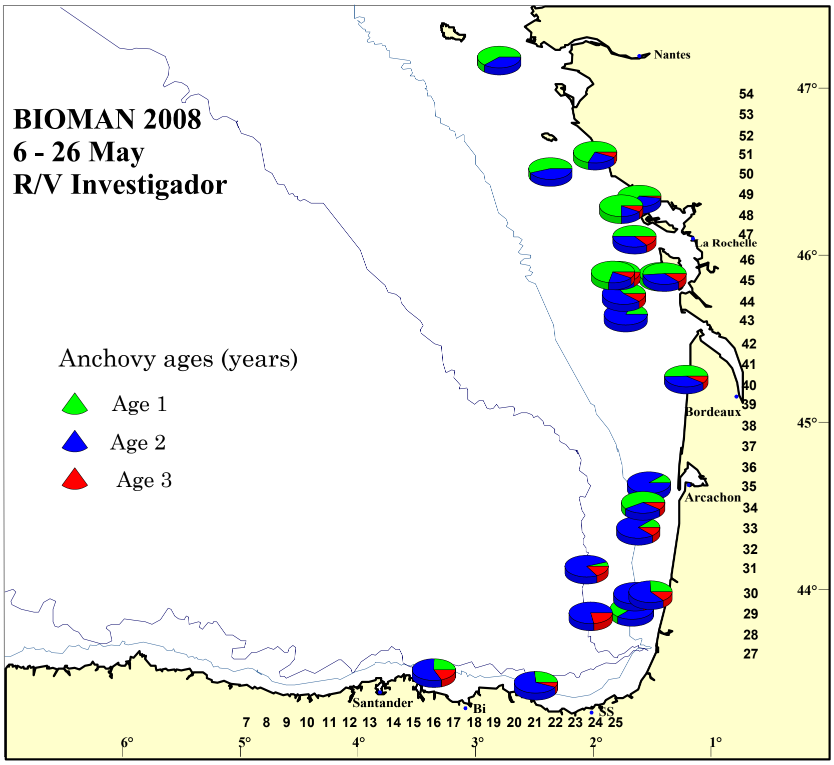


Figure 4.3.2.3.5. Distribution of anchovy age distribution in space encountering during DEPM survey BIOMAN08.

4.3.2.4 Historical perspective

The DEPM surveys to estimate the SSB in the Gulf of Cadiz was implemented in 2005. Another one was carried out in 2004 as an experimental DEPM and acoustic survey.

The DEPM surveys to estimate the SSB in the Bay of Biscay have been implemented from 1987 to 2008, with a gap in 1993. The whole series of DEPM biomass estimates are presented in **Figure 4.3.2.4.1**. Maps of egg abundance for the whole series are in **Figure 4.3.2.4.2**. A total of 21 years of SSB estimates and 18 years of population at ages (**Figure 4.3.2.4.3**) estimates are available for the assessment of this anchovy.

The SSB has suffered a strong decrease since 2001 because of repeated failures of recruitment (**Figure 4.3.2.4.3**). The decrease of Biomass led to a crash of the fishery in 2005 and 2006 which triggers the closure of the fishery in the second half of 2005 and permanently since July 2006.

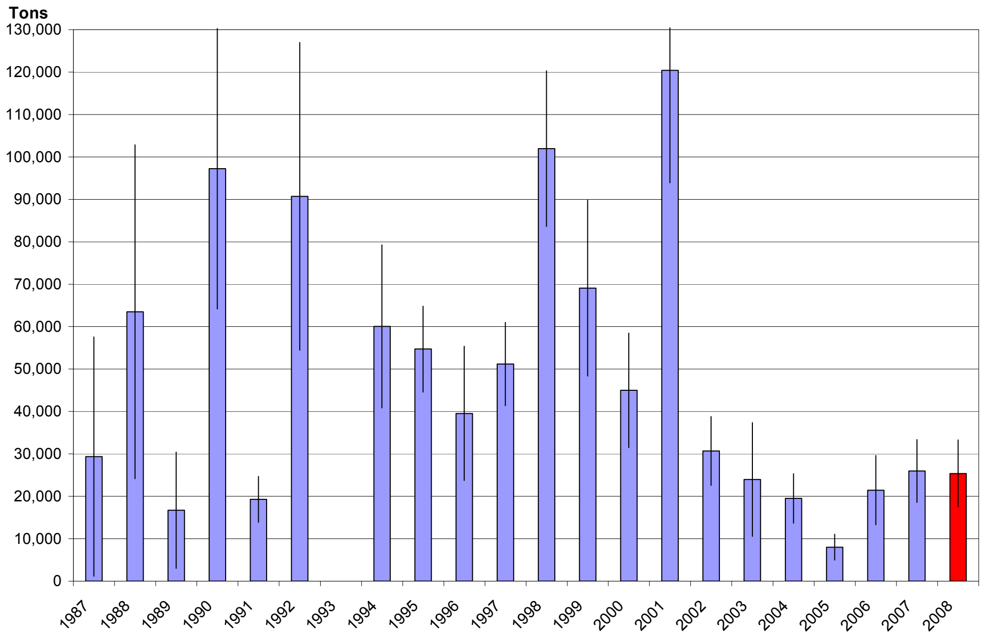
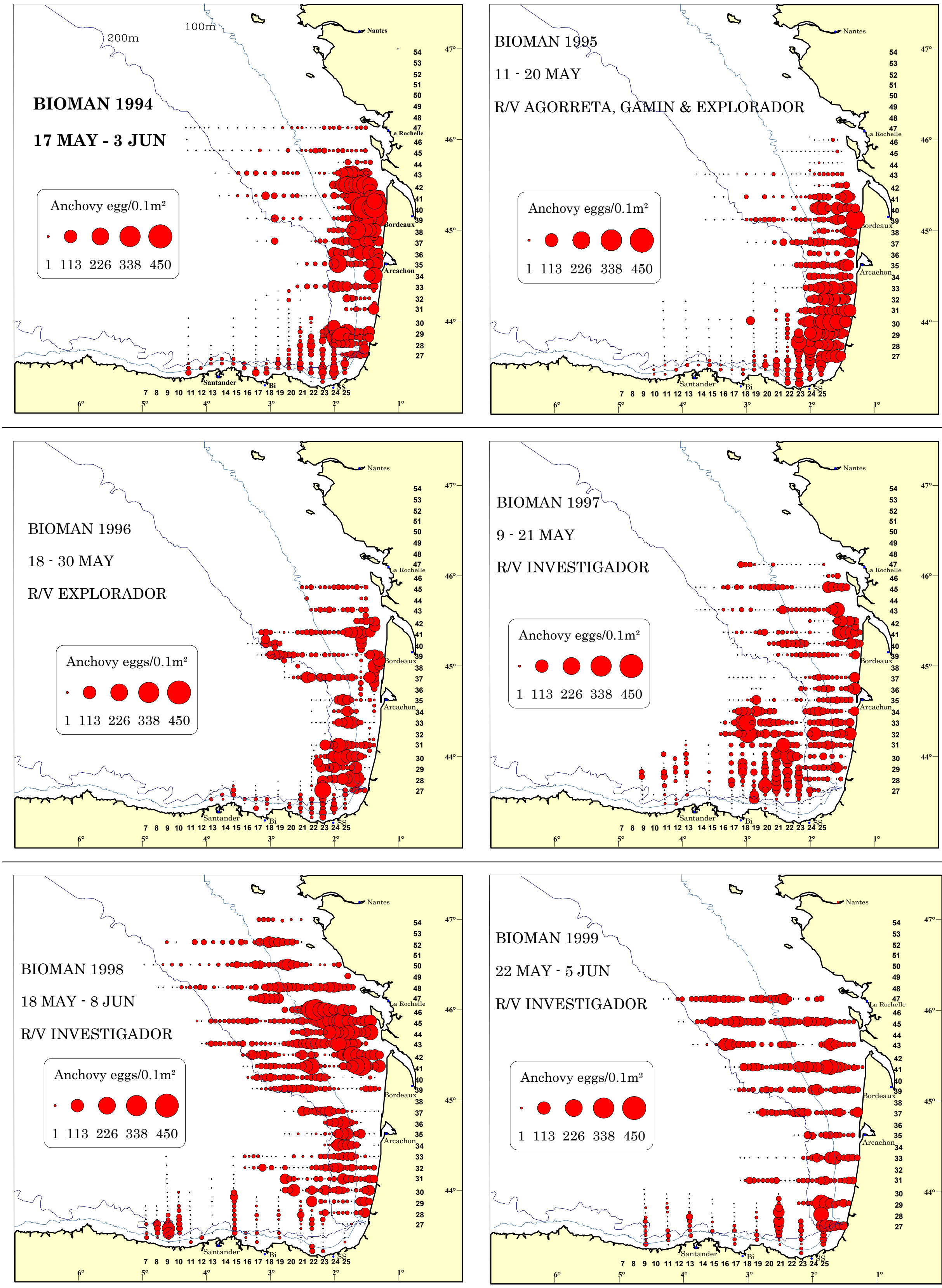
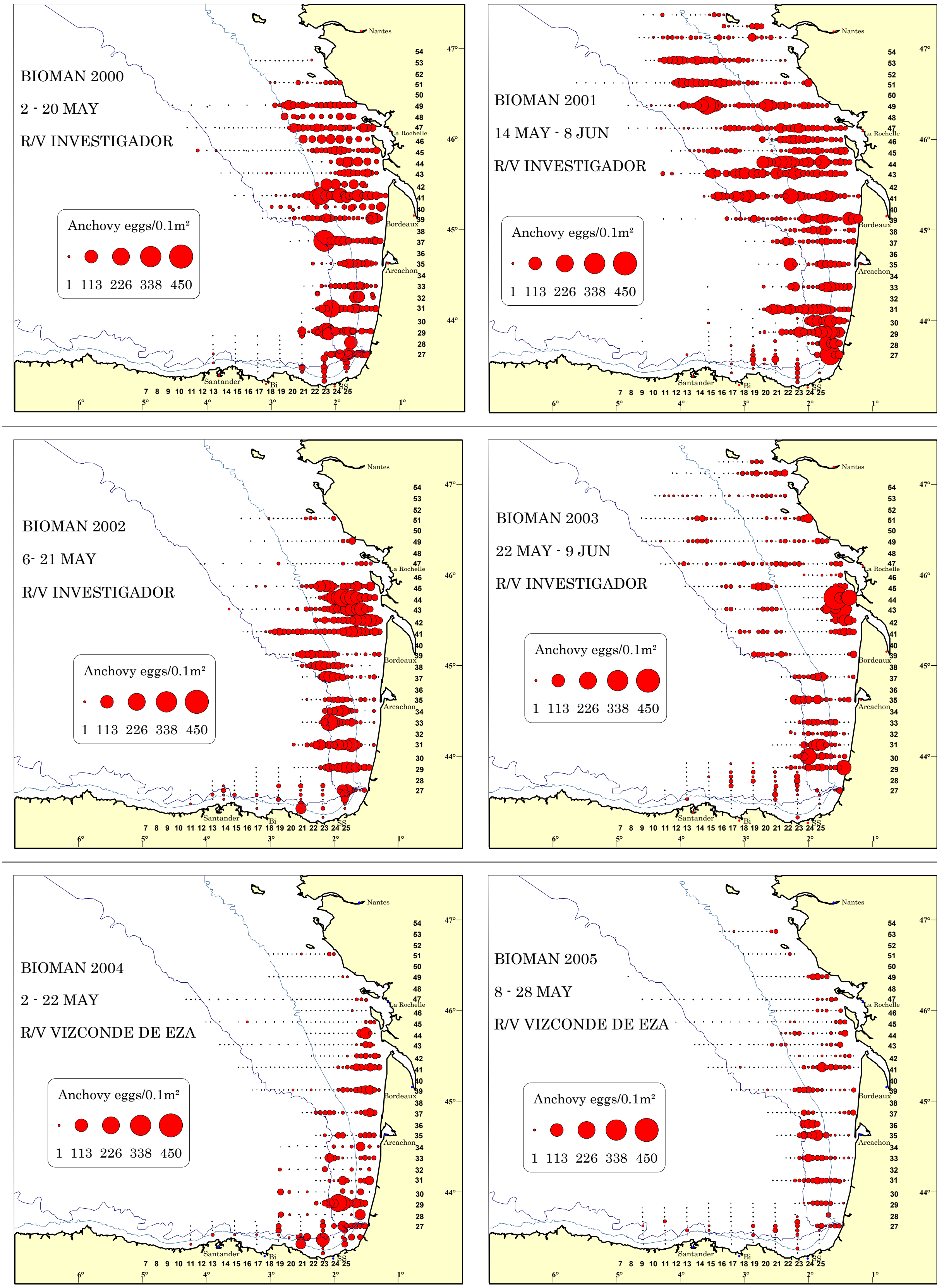


Figure 4.3.2.4.1. Series of DEPM biomass estimates (Tons) obtained from BIOMAN surveys for the Bay of Biscay anchovy.


BIOMAN 1994
17 MAY - 3 JUN
Anchovy egg/0.1m²
1 113 226 338 450
200m
100m
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
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
BIOMAN 2001
14 MAY - 8 JUN
R/V INVESTIGADOR
BIOMAN 2002
6- 21 MAY
R/V INVESTIGADOR
BIOMAN 2003
22 MAY - 9 JUN
R/V INVESTIGADOR
BIOMAN 2004
2 - 22 MAY
R/V VIZCONDE DE EZA
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°

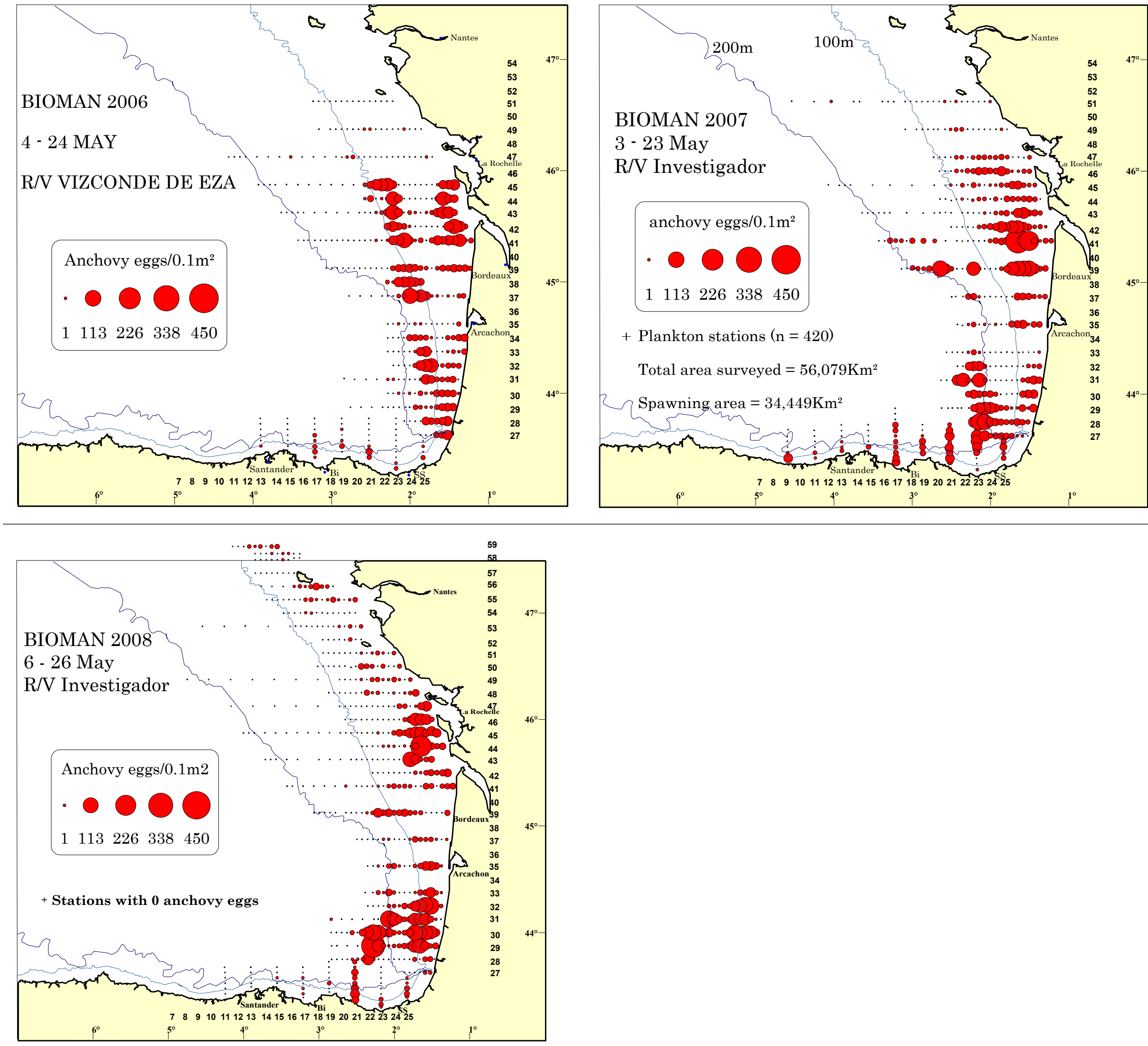


Figure 4.3.2.4.2. Anchovy egg abundance distribution from DEPM survey BIOMAN series.

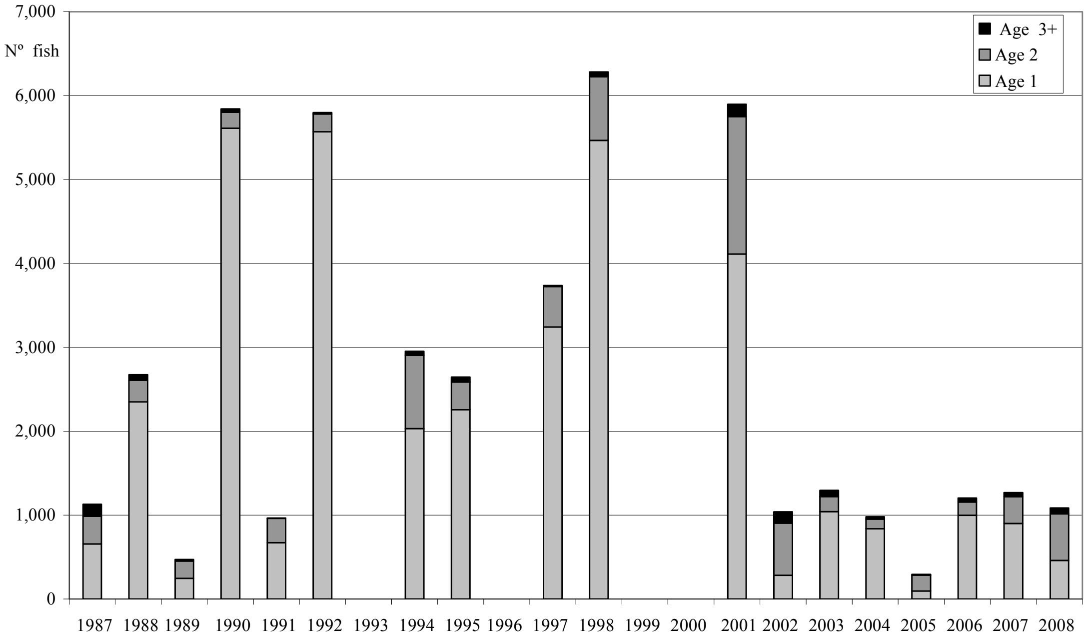


Figure 4.3.2.4.3. Historical series of population at-age estimates (nº of individuals) obtained from DEPM surveys "BIOMAN" for the Bay of Biscay anchovy.

4.3.3 Sardine 2008 DEPM Surveys

4.3.3.1 Environmental data; SST and SSS distribution maps

Sea surface temperature and salinity distributions are presented in **Figure 4.3.3.1.1**. These maps were derived from the data collected by the three independent surveys in contiguous zones, but there was some time-lag between sampling (surveying started in the south on the 17 January and finished at the northern limit on the 26 May; see Table 4.3.1.1), therefore some attention is recommended while interpreting the patterns displayed as the figures do not result from synoptic sampling. Despite this unavoidable limitation, the maps produced capture the main characteristics of the surface waters in the region. During the period of surveying the temperature ranged from 11.8 to 17.5ºC (only slightly colder than the observations compiled during spring 2007, *poster P09_P02, 2008 Eastern boundary upwelling ecosystems*). The higher temperature values were observed in the southern and northern extremes of the area studied (15–17.5ºC); the zone between Cape Carvoeiro (N of Lisbon) and Arcachon (N black line) was occupied by waters with surface temperatures between 11.8 and 15ºC. A band of colder temperature, than the surrounding waters, was apparent in the near shore region of the NW shelf and around the Galician coast. Some sharp contrasts in temperature are visible in the zones of transition between surveys. The salinity distribution obtained is smoother than the temperature contouring since this property suffers less temporal fluctuations and also develop more gradually in space. The lower salinities were observed over the inner French platform (~ 30–34); this quite extended plume of less saline water showed mild temperatures possibly because of spring atmospheric warming. Over the southern and SW shelves can be observed the influence of the waters from the Azores current and Gulf of Cadiz origins (warmer with higher salinity); towards the north this signal gets gradually weaker. In comparison with the conditions encountered during the previous sardine DEPM survey, in 2005 at a corresponding period of the year, in the S and W coasts in 2008 the waters of southern influence were more evident.

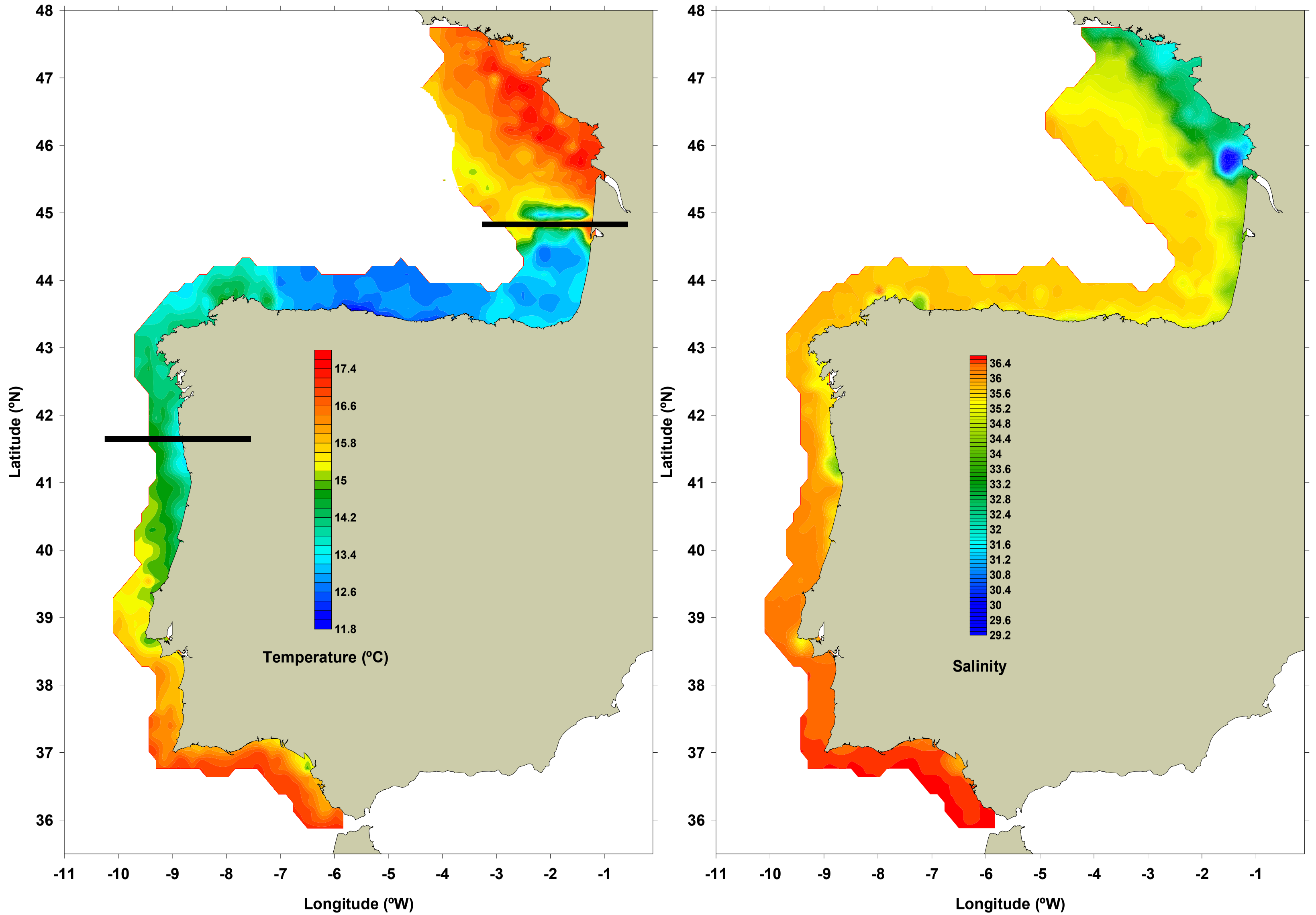


Figure 4.3.3.1.1 Distribution of sea surface temperature (left panel) and salinity (right panel), black lines show limits of surveys.

4.3.3.2 Egg data

Sardine egg distribution, obtained from the PairoVET and CUFES systems, for the whole area covered by the three surveys (see **Table 4.3.1.1**) is presented in **Figure 4.3.3.2.1**. The main sampler for the DEPM is the PairoVET net that collects eggs through the water column at point stations, the CUFES system operates at the surface collecting eggs while the vessel is underway; the latter sampling strategy is auxiliary intended to help defining the limits of the spawning area. Egg counts for the samples from the CUFES system are not yet available for all institutes and therefore are represented here as presence/absence information. The egg distribution pattern derived from the observations from both samplers is very similar. Almost the entire shelf (from coast to slope) was occupied by sardine eggs; zones of weaker density or gaps in the distribution were nevertheless observed, mainly in the NW coast, and that was particularly evident off southern Galicia (this is a recurrent feature). Spots of higher density occurred off Cadiz, W Algarve, in the W coast, south of Lisbon and over the NW wider platform, and in the W Cantabrian Sea. The opportunity that arose from the extension of the northern limit of the survey allowed a coverage that resulted in 1403 PairoVET hauls and 1889 CUFES samples. The percentage of stations with sardine eggs was 51% for the vertical tows and 55% for the surface samples (the overlapping region of IEO and AZTI surveys in the inner part of the Bay of Biscay was considered for only one of the surveys). In total approximately 34500 sardine eggs were captured (with PairoVET nets) in the area studied.

All calculations for area delimitation, egg ageing and model fitting for egg production (P0) estimation were carried out using the R packages (*geofun, eggsplore and shachar*) available at *ichthyoanalysis* (http://sourceforge.net/projects/ichthyoanalysis). The model of egg development with temperature was derived from the incubation experiment data available within the *sardata*, R library. Egg ageing was achieved by a multinomial Bayesian approach described by Bernal *et al*. (2008); a normal probability distribution was used with peak spawning assumed to be at 21:00h with 2h standard deviation. The exponential model: $E[P] = P_0 e^{-Z\ age}$ was fitted by Generalized Linear Model (GLM), with a negative binomial function [depm.control (spawn.mu=21; how.complete=0.95; spawn.sig=2), initial z =0.01].

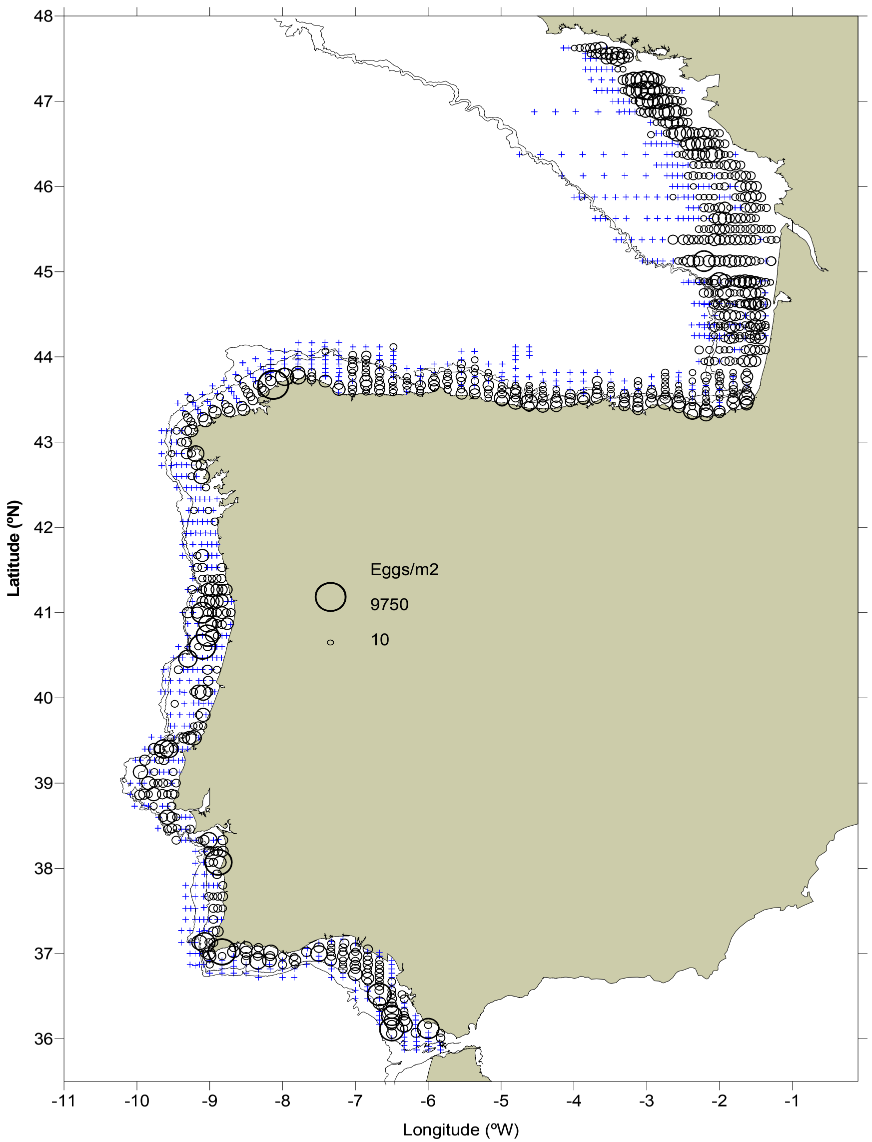
Egg production estimates for the region as a whole (or particular strata selection) are not yet available, for this reason the results presented in **Table 4.3.3.2.1**, derive from the analyses undertaken by each institute separately. Comparing to previous DEPM surveys, the Total P0 estimates were higher in 2008 than in previous campaigns, and this was particularly clear for the area sampled by IPIMAR. Daily egg productions per square metre were also higher for these S and W areas. The results here presented are preliminary and it was agreed that a joint analysis of the data will take place in 2009 within the framework of a dedicated workshop. The whole set of data will be explored together and further analyses, such as spatial modelling, will be conducted in order to obtain egg production estimation for the whole region covered by the coordinated surveys.

Table 4.3.3.2.1. Results DEPM 2008, egg parameters for sardine.

Parameter	IPIMAR		IEO		AZTI*
	South	W Portugal	NW and N Spain	France (to 44.9°N)	(43.4° - 47.6°)N (-4.2°–1.5°)W
P0 (eggs/m2/day)	584.06 (29)	242.26 (23)	134.9 (15)	160.6 (21)	176.6 (15)
Z (hour-1)	0.034 (26)	0.029 (22)	0.016 (21)	0.019 (23)	0.013 (33)
Daily mortality rate (%)	44.2	49.9	68.1	63.1	73.2
P0 tot (eggs/day) (x1012)	5.24 (29)	4.89 (23)	3.66 (15)	1.28 (21)	5.97 (9)
Survey area (Km2)	18670	31895	48704	9953	69150
Positive area (Km2)	8977 (48%)	20175 (63%)	27149 (56%)	7964 (80%)	33807 (49%)

***Overlapped with DEPM IEO**

Different grid spacing



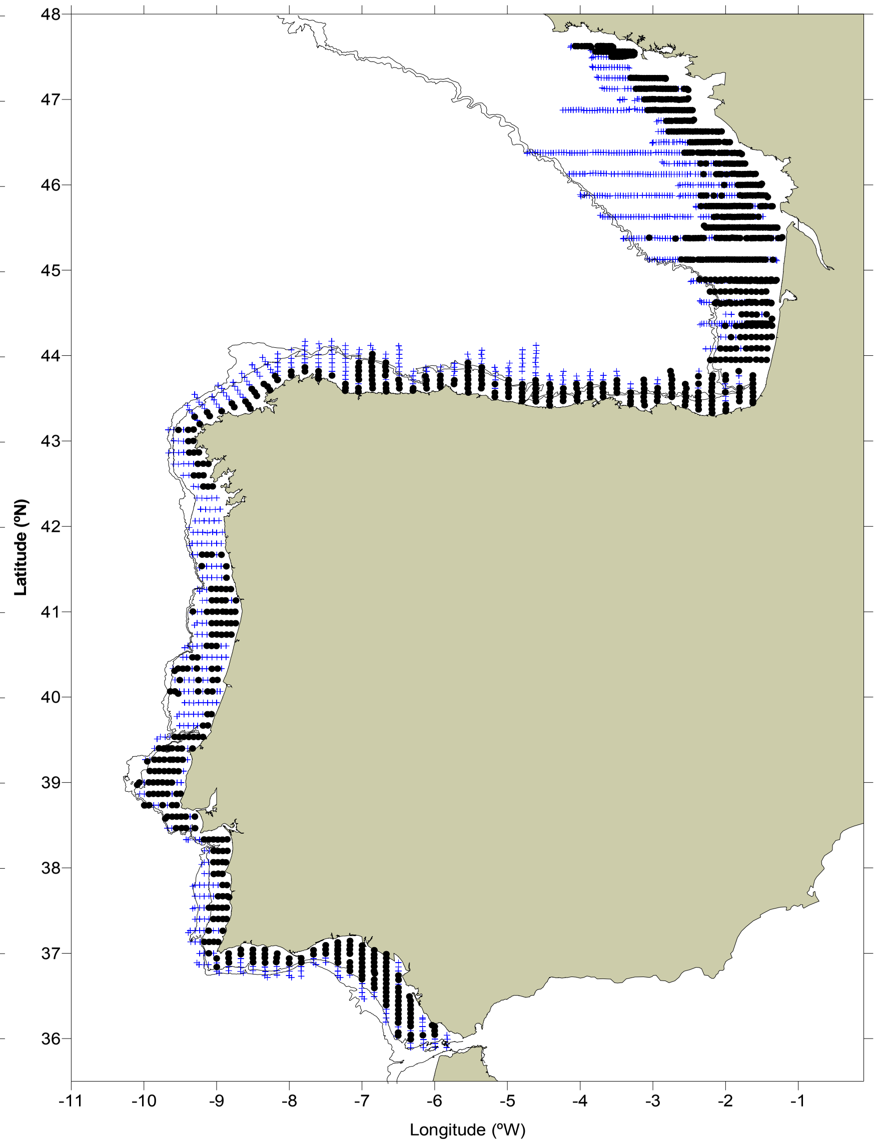


Figure 4.3.3.2.1. Sardine egg distribution. Left panel: Egg/m² from PairoVET sampling; Right panel: Egg presence/absence from CUFES sampling; (+, egg absence).

4.3.3.3 Adults data

During the 2008 sardine DEPM surveys in the Iberian Peninsula an effort was made by the three institutions to guarantee at least the same level of sampling already achieved in the 2002 and 2005 surveys, and effectively the objectives were more than accomplished. On the whole, around 100 fishing hauls which caught sardines were performed during the surveys (complemented by ca. 30 samples obtained from the Portuguese purse-seine fleet) and those are quite well distributed along the whole surveyed area (**Figure 4.3.3.3.1**). It should be noted that the surveys from AZTI and IEO overlapped to some extent in the inner part of the Bay of Biscay, and therefore the respective information related to the adults' parameters should not be considered as entirely independent for that area. On the whole, almost 9000 sardines were sampled and more than 3700 ovaries were collected and preserved for histology.

Figure 4.3.3.3.2 shows the spatial distribution of the mean female weight in the sampled sardines. As in other sardine DEPM years, the Cantabrian Sea presented the larger mean female weight values of the whole Iberian Peninsula (ICES, 2006). However, this year's spatial differences appeared somewhat less contrasted than before because the females collected off the Portuguese coast presented in 2008 notably higher mean weights than reported in previous surveys (in fact, the highest values of the historical series, ICES, 2006). The minimum mean weights were observed in the Gulf of Cadiz, in the Bay of Biscay (mainly its inner part) and in the North of Portugal (indicating possible recruitment areas). The female weights observed in the Galician NW coast showed to be intermediate between the North coast of Portugal and the West Cantabrian Sea. These observations are confirmed by the data available from the length and age structure of the females sampled (**Figures 4.3.3.3.1** and **4.3.3.3.3**, respectively). The latter indicate that the area covered by AZTI was dominated by 1 year-old females (70%), whereas almost half of the females caught off the Portuguese West coast were 4 years-old (likely still representing the 2004 strong recruitment).

The laboratory processing and data analysis of the adults' samples is currently in progress in the three institutions (in particular for the fecundity and spawning fraction estimation) and therefore the results provided in this report are still preliminary (**Table 4.3.3.3.1** shows the adult parameters estimates for the three institutions). With ca. 50% of the samples from the IEO processed, the N and NW coast of Spain present values of sex ratio (R=0.52, CV=1%), mean female weight (W=76.6 g, CV=5%), batch fecundity (F=29500 eggs/batch, CV=7%) and spawning fraction (S=0.15, CV=15%) similar to those obtained in previous years. The mean female weight estimated for the area surveyed by AZTI (W= 58.9 g) is also very similar to the one for the area covered by IEO. However, when only the part of the French waters surveyed by IEO is considered, the adult parameters reported have lower values in the mean weight (W=52.7 g) and batch fecundity (F=22400 eggs/batch), which is in agreement with the smaller/younger individuals observed in the inner part of the Bay of Biscay. As for the Portuguese coast and Gulf of Cadiz, the results show the highest values of mean female weight (W=58.2 g, CV=3%) and batch fecundity (F=23150 eggs/batch, CV=3%) from the whole historical series (ICES, 2006). Moreover, the relative fecundity appeared to be lower in the South than the West Atlantic coast (see WD Angelico *et al.*, from this meeting).

4.3.3.4 Spawning Stock Biomass (SSB)

Considering that the spawning fraction (S) estimates from IPIMAR and AZTI are still to be completed no estimate for SSB is presented in this report. These estimates are foreseen to be provided in 2009 within the framework of a dedicated workshop (see ToRs for 2009).

Table 4.3.3.3.1. Results DEPM 2008, adult parameters for sardine.

ADULTS 2008	IPIMAR	IEO *	AZTI
Survey trawls	51 (44+)	44 (41+)	39 (26+)
Commercial trawls	34		0
Total sardine sampled	4906	2895	1134
Female for histology	2397	834	514
Hydrated females	231	247	In process
VARIABLE			
Female Weight (g)	58.16 (2.8)	76.6 (5)	58.9
Batch Fecundity (*10^3)	23.15 (2.8)	29.5 (7)	In process
Sex Ratio	0.54 (3.3)	0.52 (1)	In process
Spawning Fraction	In process	0.15 (15)	In process

*** 50% samples processed**

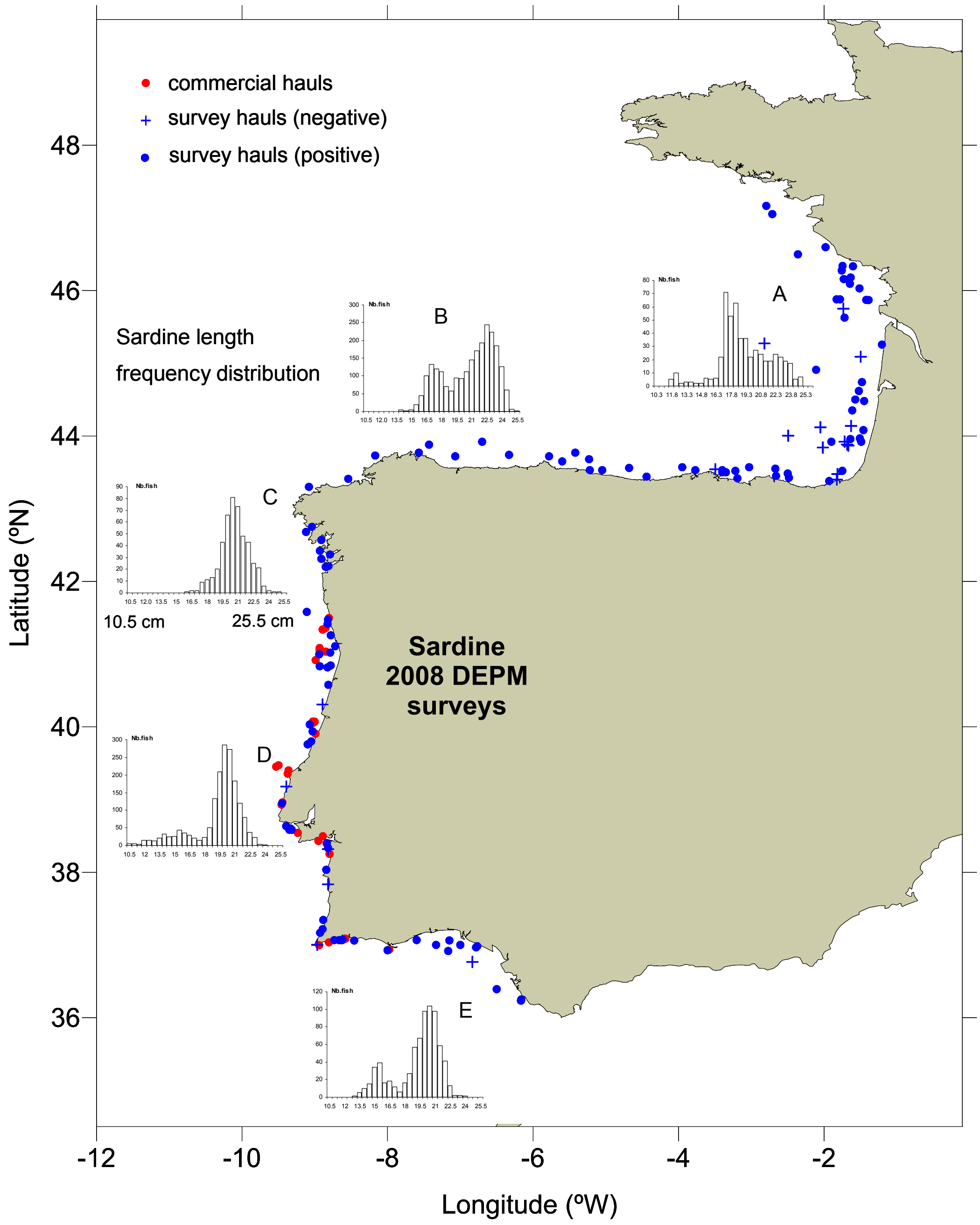


Figure 4.3.3.3.1. Spatial distribution of the fishing hauls carried out by the three institutions and length frequency distribution of the sampled sardine in A) the Eastern Cantabrian Sea and the Bay of Biscay (AZTI), B) the Northern Spain and Bay of Biscay (IEO), C) the North-Western Spain (Galician coast) (IEO), D) the Portuguese West coast (IPIMAR) and E) the Portuguese South coast and Gulf of Cadiz (IPIMAR). Commercial hauls: from the purse-seine fleet; survey hauls (negative): without sardine; survey hauls (positive): with sardine; the negative hauls from IEO are not indicated; the AZTI and IEO surveys overlapped in the inner part of the Bay of Biscay.

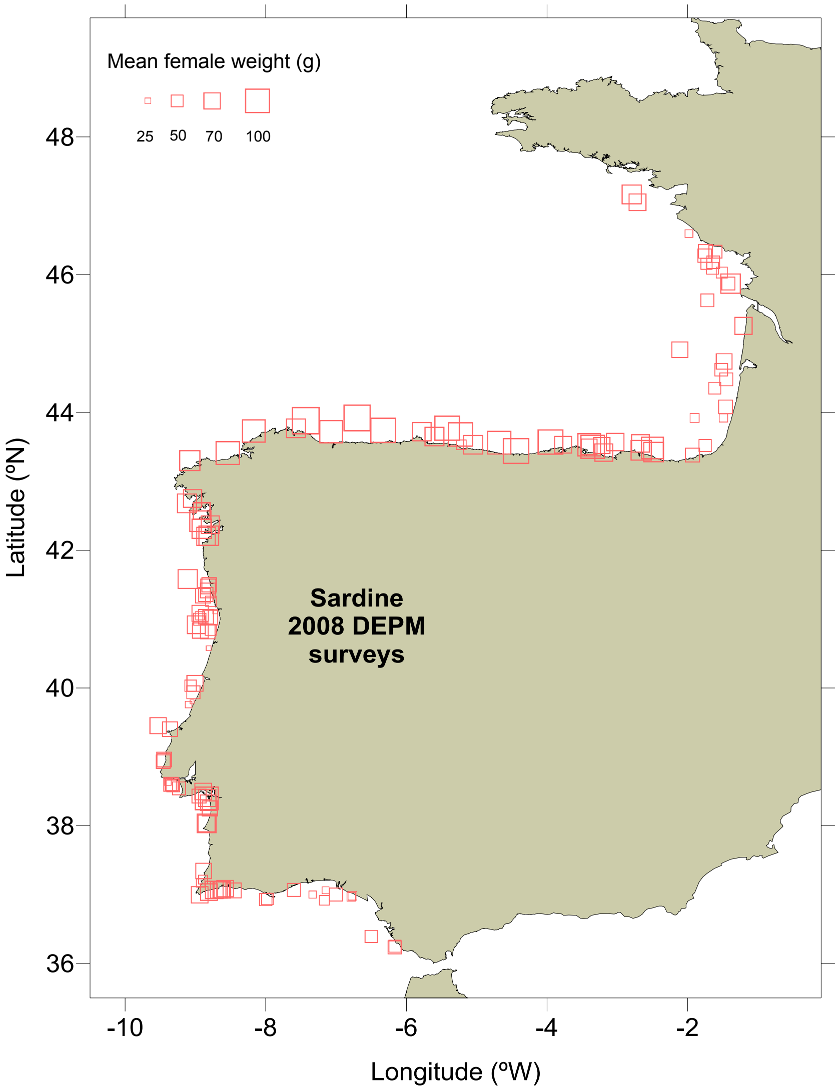


Figure 4.3.3.3.2. Spatial distribution of sardines mean female weight (per haul). The size of the squares is proportional to the weight of the females (in grams).

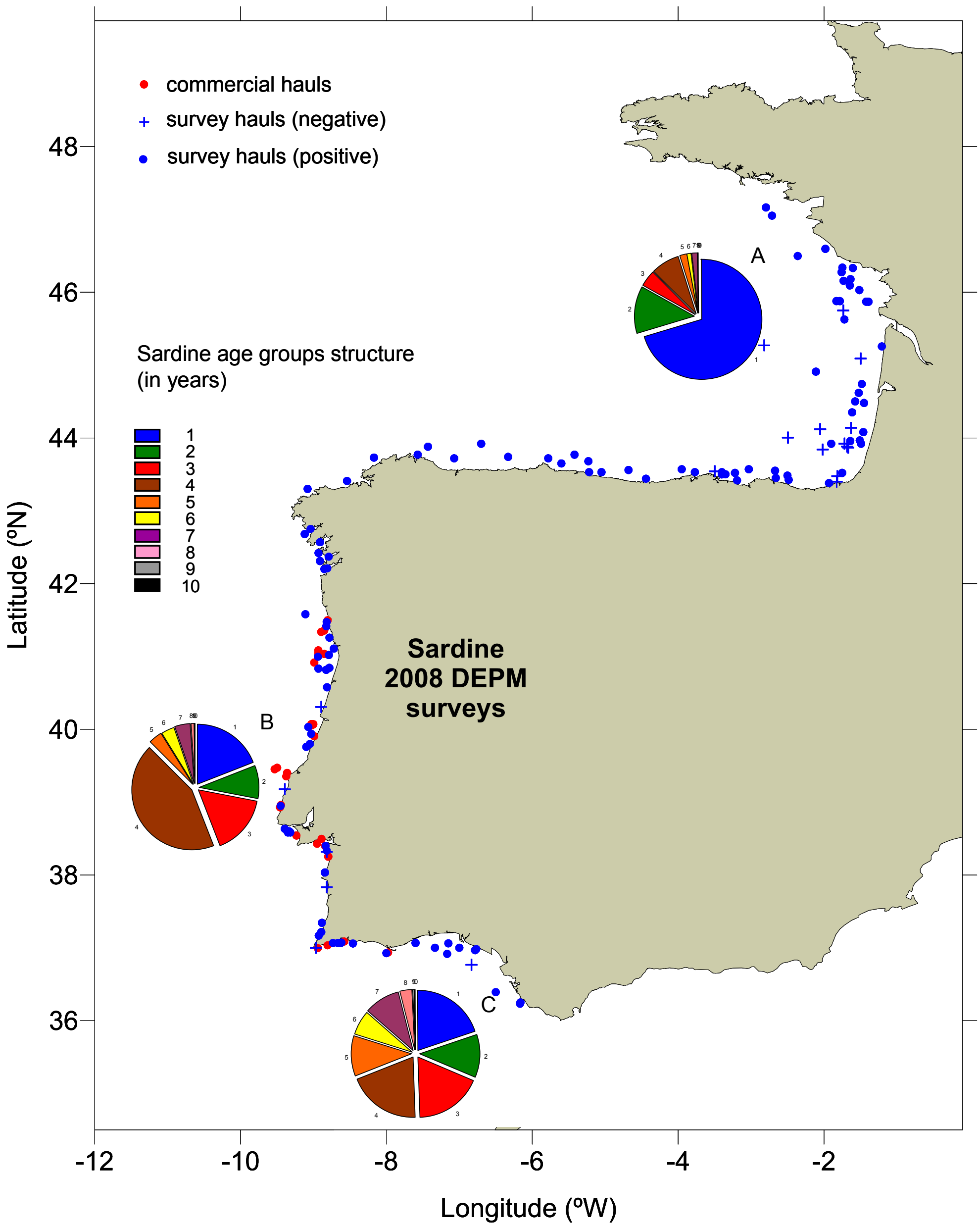


Figure 4.3.3.3.3. Structure in age groups of the sampled sardine in A) the Eastern Cantabrian Sea and the Bay of Biscay, B) the Portuguese West coast and C) the Portuguese South coast and Gulf of Cadiz (the information from the area covered by the IEO is at present not available).

4.4 Autumn Acoustic Surveys

4.4.1 Autumn acoustic surveys in subarea VIII: PELACUS1008

The PELACUS1008 cruise took place from 17 September to 16 October 16 2008 in eastern Cantabrian and southern French shelves and oceanic waters (eastward of 3° W and southward of 47° N). It is the third of the autumn PELACUS cruises organized by the Instituto Español de Oceanografía (IEO) with the aim of studying the oceanographic conditions (hydrography and distribution of plankton components from pico- to macro-plankton) and the distribution of small pelagic fish, specially anchovy juveniles and adults, in the southern Bay of Biscay in autumn.

General oceanographic conditions during the cruise

The influence of the river plume from the Garonne extended northward up to 47° N; its intensity was similar than in 2007. The run-off from the Adour was also perceptible but less intense than in 2007. Anyway, the situation differed markedly from that observed in 2006, when only the effect of the Garonne river plume was detected (**Figure 4.4.1.1**. upper row).

Surface temperature showed a marked zonal gradient, from 20.5°C in the Cape Breton area to 16.5 °C off La Gironde. The temperature field differed clearly from that observed in 2007, when coastal upwelling was persistent all over the cruise in the Cantabrian and French shelves, and 2006, when temperatures were homogeneously high all along the Bay of Biscay (**Figure 4.4.1.1**. middle row).

The geostrophic circulations was lighter than in previous years (2006 and 2007), and preferentially southward in the French slope (SSH in **Figure 4.4.1.1**. lower row). Mesoscale anticyclone (i.e. convergence) structures were observed at the oceanic side off Cape Breton canyon and over the outer shelf off Arcachon (**Figure 4.4.1.1**. lower row).

The time-series of the fields of S, T and SSH evidence the high degree of physical variability, both at regional and intermediate scales that are taken in the Bay of Biscay during autumn.

Distribution of acoustic energy (nautical area backscattering coefficient, s_A)

Acoustic energy (s_A, $m^2 \cdot NM^{-2}$) attributable to fish concentrates mostly at the slope in the easternmost Cantabrian sea (off Cape Breton) (transects V06 and V04) and in the inner French shelf (<100 m isobath), specially off Arcachon (transects H06 to H12) and to the north off La Gironde (transects D06 to D12) (**Figure 4.4.1.2.** left).

Acoustic energy assigned to anchovy (both juveniles and adults) concentrates in two well defined areas: at the slope in the eastern Cantabrian sea (transects V06 and V04) and to the north off La Gironde (transects D02 to D08) (**Figure 4.4.1.2.** right).

Fishing hauls

A total of 60 fishing hauls for identification and biological characterization of echotraces were conducted during the PELACUS1008 cruise (**Figure 4.4.1.3**. left). The most abundant species in the hauls were sardine (*Sardina pilchardus*), horse mackerel (*Trachurus trachurus*) and anchovy (*Engraulis encrasicolus*). Northern krill (*Meganyctiphanes norvegica*) was also clearly detected and confirmed by fishing hauls at the slope in the eastern Cantabrian Sea and off Arcachon.

Positive hauls of anchovy were located in the Cape Breton area and off La Gironde (**Figure 4.4.1.3.** right). Almost pure anchovy juveniles were caught at the surface in the cape Breton area, while anchovy juveniles and adults were close to the bottom and mixed with other species, mainly sardine and horse mackerel, in the hauls conducted off La Gironde.

Biomass of anchovy juveniles and adults

The main areas where anchovy was distributed were cape Breton and off la Gironde (**Figure 4.4.1.4.** left). The age-length distribution was different in each of these areas (**Figure 4.4.1.4** right). This pattern of age-length distribution (i.e. age 1+ individual from 10 cm length in the northern area and from 13 cm length in the southern area) (**Figure 4.4.1.5**) was also observed in the previous year (PELACUS1007 cruise).

Biomass of anchovy in the prospected area was 22,963.9 t (**Table 4.4.1.1**), of which 11,379.5 t were assigned to juveniles (age 0) and 11,584.4 to adults (age 1+). In the southern area, total biomass of anchovy was 1,281.4 t, of which the higher part (1,048.5 t) was attributed to juveniles. In the northern area, total anchovy biomass was 21,682.4 t, of which 10,331.0 t were attributed to juveniles and the remainder (11,351.5 t) to adults.

Pattern of shoals of anchovy juveniles in the eastern Cantabrian

A transect along the slope in the eastern Cantabrian sea, were anchovy juveniles were detected close to the surface (between 15–25 m depth), was conducted during the last days of the cruise (**Figure 4.4.1.6**). A change in the pattern of aggregation of anchovy juveniles was observed, both between the first days of the cruise (during the prospection along-transects V06 and V04) and during the last days of prospection in this along-slope transect, and during the sampling of this along-slope transect (in an eastward direction). These observations suggest a change in behaviour of anchovy juveniles that requires further analysis.

Table 4.4.1.1. Biomass of anchovy, split between juveniles (age 0) and adults (age 1+), for each polygon (Figure 4).

Polygon	Age 0	Age 1+	Total
P1	990.7	0.0	990.7
P2	9.3	223.9	242.2
P3	16.0	0.0	16.0
P4	10.7	0.0	10.7
P5	21.9	0.0	21.9
Cape-Breton	1048.5	232.9	1281.4
P6	1388.1	1888.0	3276.1
P7	1458.7	1984.1	3442.8
P8	6251.2	1788.6	8309.8
P9	742.2	5580.2	6322.5
P10	62.5	31.3	93.8
P11	158.3	79.2	237.5
Garonne	**10331.0**	**11351.5**	**21682.4**
TOTAL	**11379.5**	**11584.4**	**22963.9**

Figure captions and Tables (PELACUS1008 cruise)

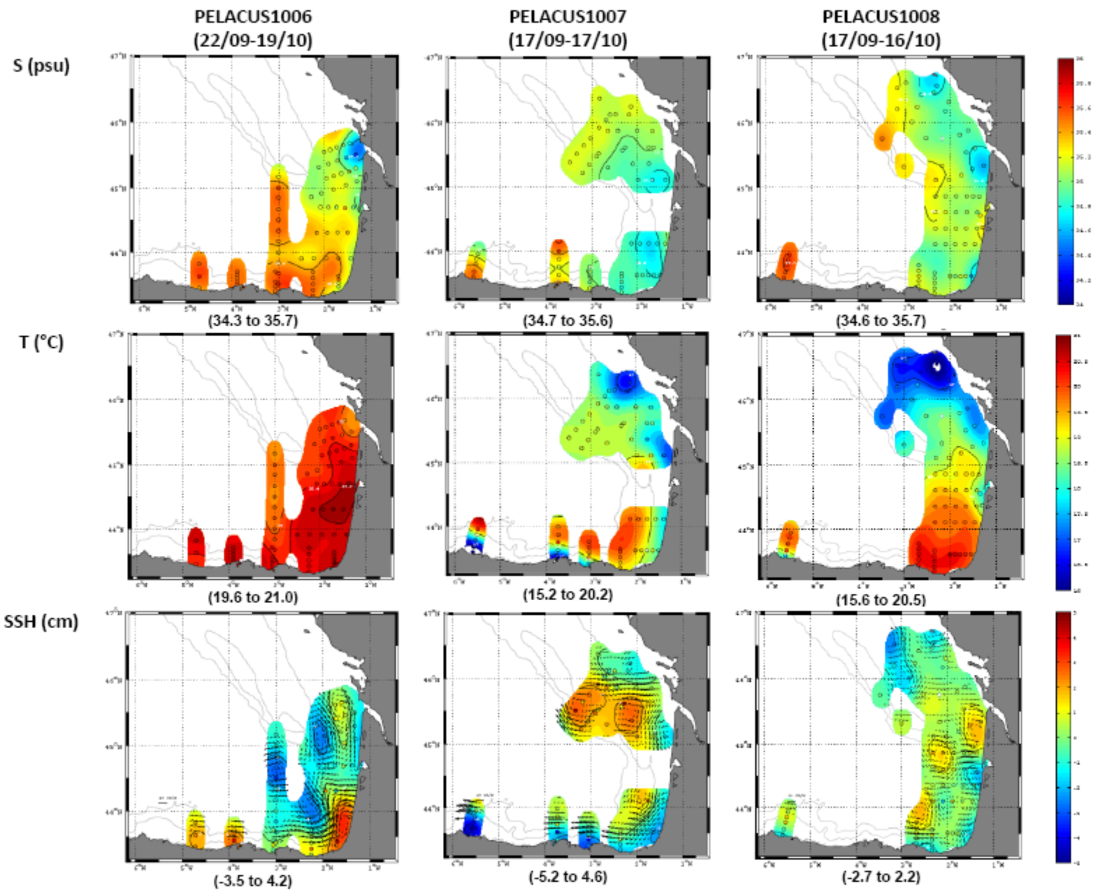


Figure 4.4.1.1. Surface (5 dbar) salinity (S; usp), temperature (T; °C) and sea surface height anomaly (SSH; cm) (from top to bottom) in the Bay of Biscay during the PELACUS cruises of 2006, 2007 and 2008 (from left to right).

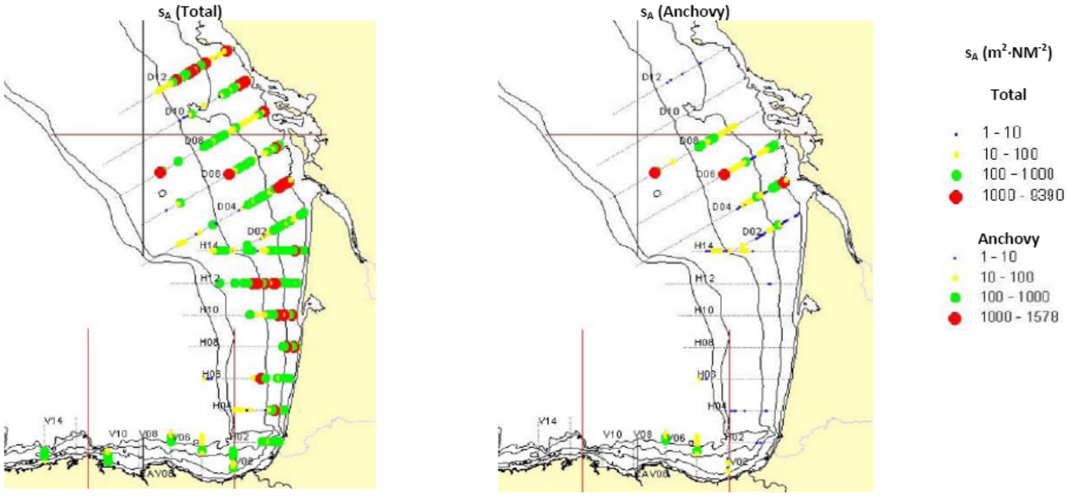


Figure 4.4.1.2. Distribution of nautical area backscattering coefficient (s_A, $m^2 \cdot NM^{-2}$) during the PELACUS1008 cruise. Total s_A attributable to fish (left) and anchovy (right). Note the different scale of each chart.

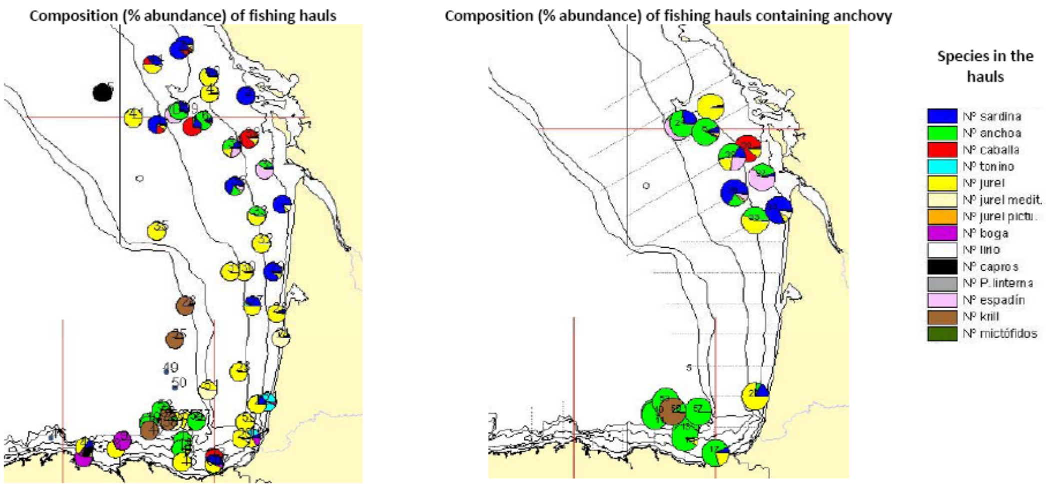


Figure 4.4.1.3. Distribution of fishing hauls and species composition of each haul (in percentage of abundance) for the identification of echotraces conducted during the PELACUS1008 cruise. Total number of hauls (left) and hauls containing anchovy (right).

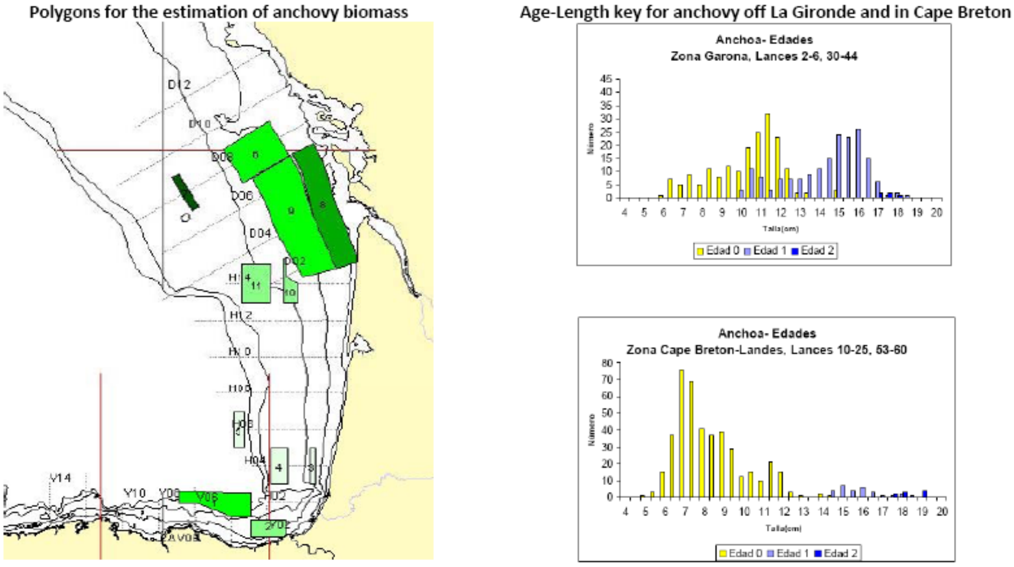


Figure 4.4.1.4. Distribution of polygons for the estimation of biomass of anchovy (left) and length-age distribution applied to split the population in juveniles (age 0) and adults (age 1+) (right-top, for the zone off La Gironde; right-bottom, for the zone of Cape Breton.

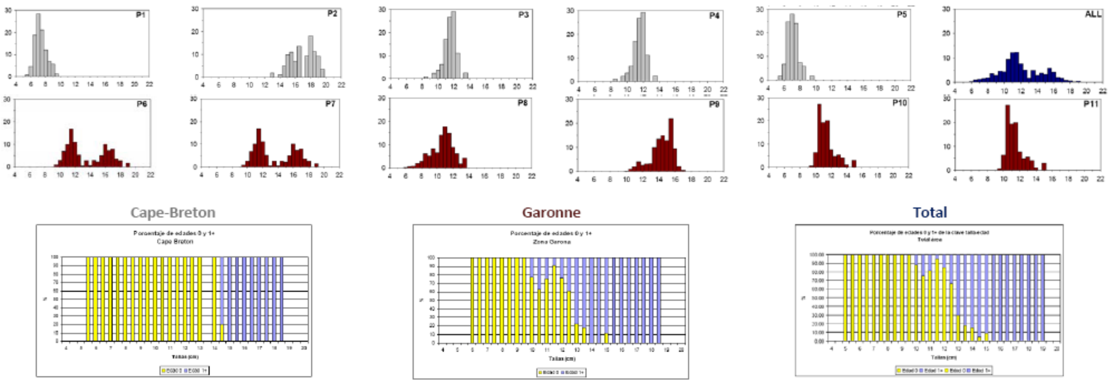


Figure 4.4.1.5. Length distribution in each of the polygons depicted to estimated anchovy biomass (in grey: polygons P1 to P5, Cape Breton area; in red: polygons P6 to P11; in blue: size distribution for all the data pooled together). Length-age keys for Cape Breton area, off La Gironde and total.

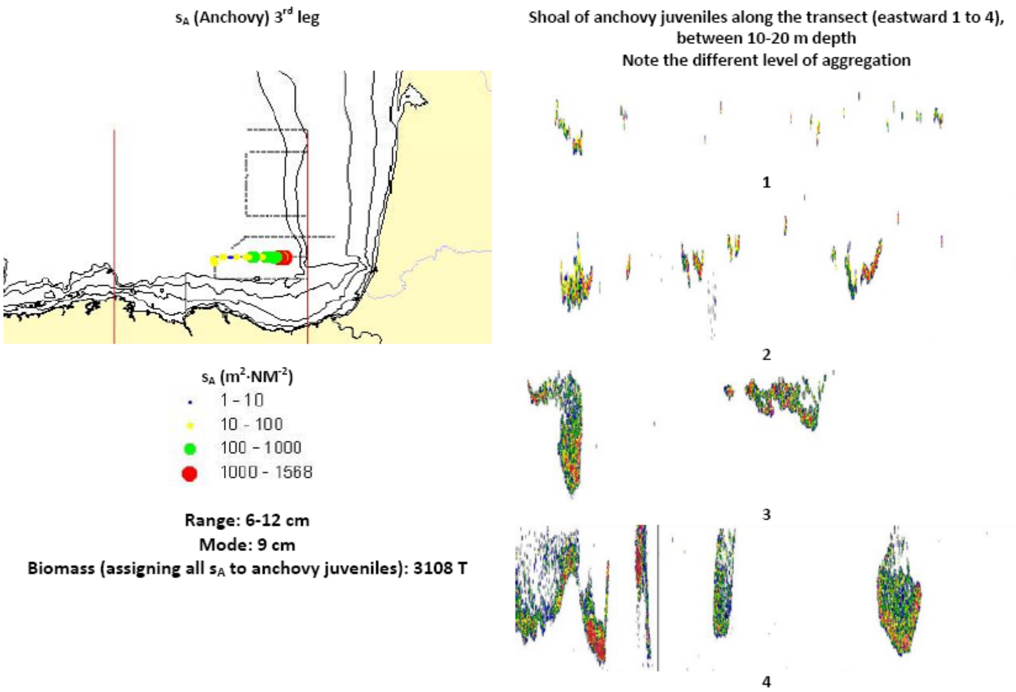


Figure 4.4.1.6. Distribution of sA in the slope at the eastern Cantabrian sea and estimation of biomass of anchovy juveniles in this area (left). Echograms attributable to anchovy juveniles.

4.4.2 Autumn acoustic surveys in subarea VIII: JUVENA08

The JUVENA survey for abundance estimation of juvenile anchovy took place onboard two vessels equipped with scientific acoustic equipments and with two different fishing gears: purse-seiner Itsas Lagunak and pelagic trawler “Emma Bardan”. The survey took place during 30 days from 26 August to 26 September (one week earlier than the earliest starting in the whole series), surveying 1,500 nm ((**Figure 4.4.2.1**) which provided a coverage of about 22,500 nm.[2] along the continental shelf and shelf break of the Bay of Biscay, from the 5° W in the Cantabrian area up to 47° 45′ N at the French coast. 85 hauls were done during the survey to identify the species detected by the acoustic equipment, 39 of which resulted positive of anchovy.

Anchovy was found distributed along the different areas according to the following scheme (**Figure 4.4.2.2**):

- South (Cantabric Sea and coast of Les Landes up to Arcachon): Juvenile anchovy was distributed mainly off-the-shelf, but penetrating sometimes shelf waters in front of the French coast, in an area limited by the longitudes 1°50′ and 2°50′ W, and the latitudes 43°40′ and 45°00′ N. There, anchovy was found forming aggregations of pure juveniles (4 cm length; see **Figures 4.4.2.3** and **4.4.2.4**) mixed with small quantities of small horse mackerel, very close to the surface.
- Central (Garonne): Anchovy, mixed juveniles and adults, was detected on the shelf between 45° and 46° N and from the coast to the 90 m isobath.

- North (North of 46°15’): In this area, coverage took place only to bathymetries of 100 m. The proportion of anchovy in the fishing stations was less than in the Central area. It was mainly adult anchovy (**Figure 4.4.2.3**).
-

The biomass of juveniles estimated for this 2008 is 20,879 tones (**Table 4.4.2.1**), a low value compared with the values of the temporal series of JUVENA, only higher than the 2004 and 2007 estimates (**Figure 4.4.2.5**). This value is about one order of magnitude less than the higher estimates of the series (the ones corresponding to 2003, 2005 and 2006). This value suggests a new scenario of low recruitment entering the stock in 2009, and points towards the continuation of the crisis of recruitment to spawning suffered since 2003.

Table 4.4.2.1. Synthesis of the abundance estimation (acoustic index of biomass) for the six years of surveys.

AÑO	REGION	S_A	AREA	<LENGTH>_JUV	<LENGTH>_ADUL	BIOM_JUV	BIOM_ADUL
2003	Standard	464	3,475	8.78	14.11	98,601	1,383
	Extended	0	0			0	0
	TOTAL		3,475			98,601	1,383
2004	Standard	309	1,907	9.31	9.18	2,406	3,451
	Extended	0	0			0	0
	TOTAL		1,907			2,406	3,451
2005	Standard	444	6,325	8.08	12.4	130,146	9,117
	Extended	368	1,464	9.77	13.32	3,985	11,253
	TOTAL		7,790			134,131	20,370
2006	Standard	325	2,680	8.58	12	41,441	10,665
	Extended	78	3,893	10.3	12	36,858	34,758
	TOTAL		6,573			78,299	45,422
2007	Standard	219	3,458	10.65	12.97	12,804	7,349
	Extended	243	2,220	9.63	15.05	317	27,760
	TOTAL		5,678			13,121	35,109
2008	Standard	337	5,226	9.03	12.14	17,379	22,798
	Extended	602	1,670	6.91	14.03	3,500	14,922
	TOTAL		6,895			20,879	37,721

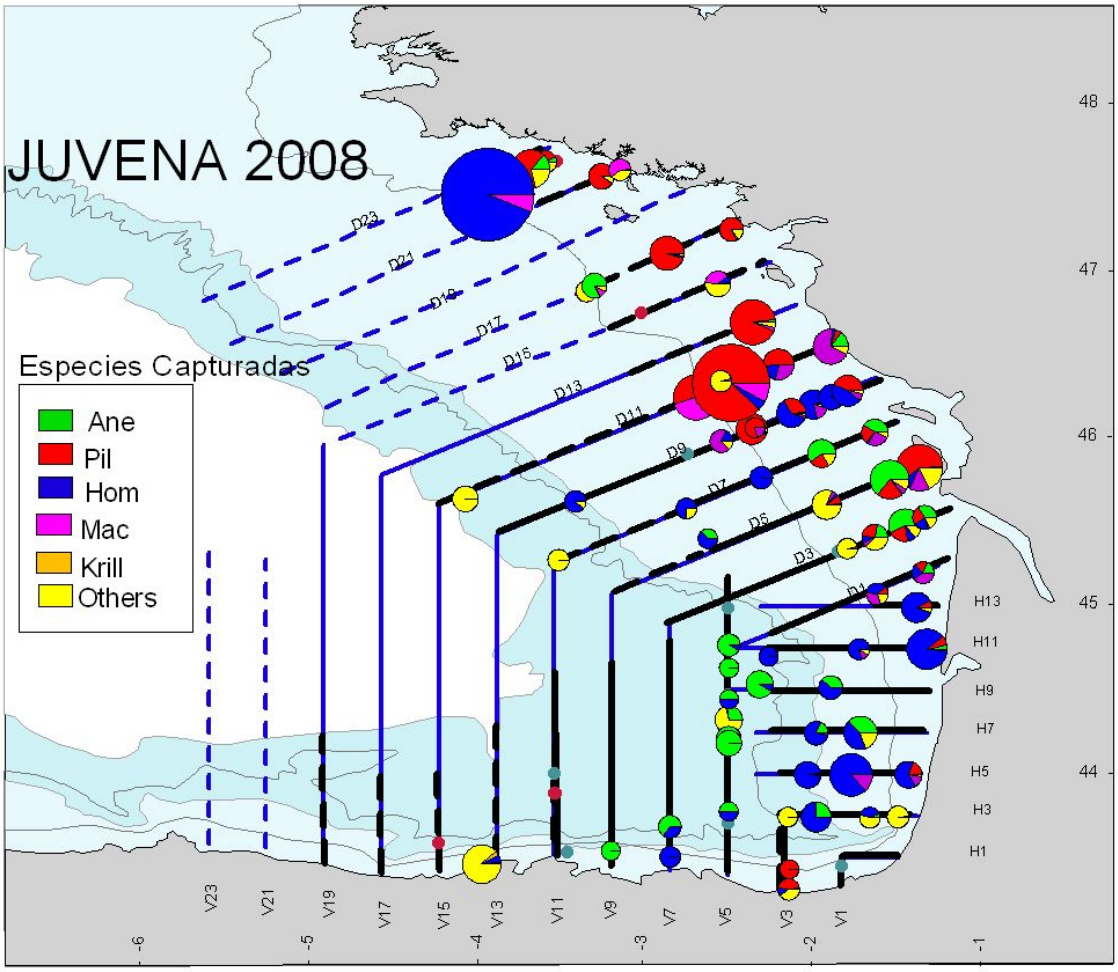


Figure 4.4.2.1. JUVENA2008 acoustic surveys and fishing hauls with species composition.

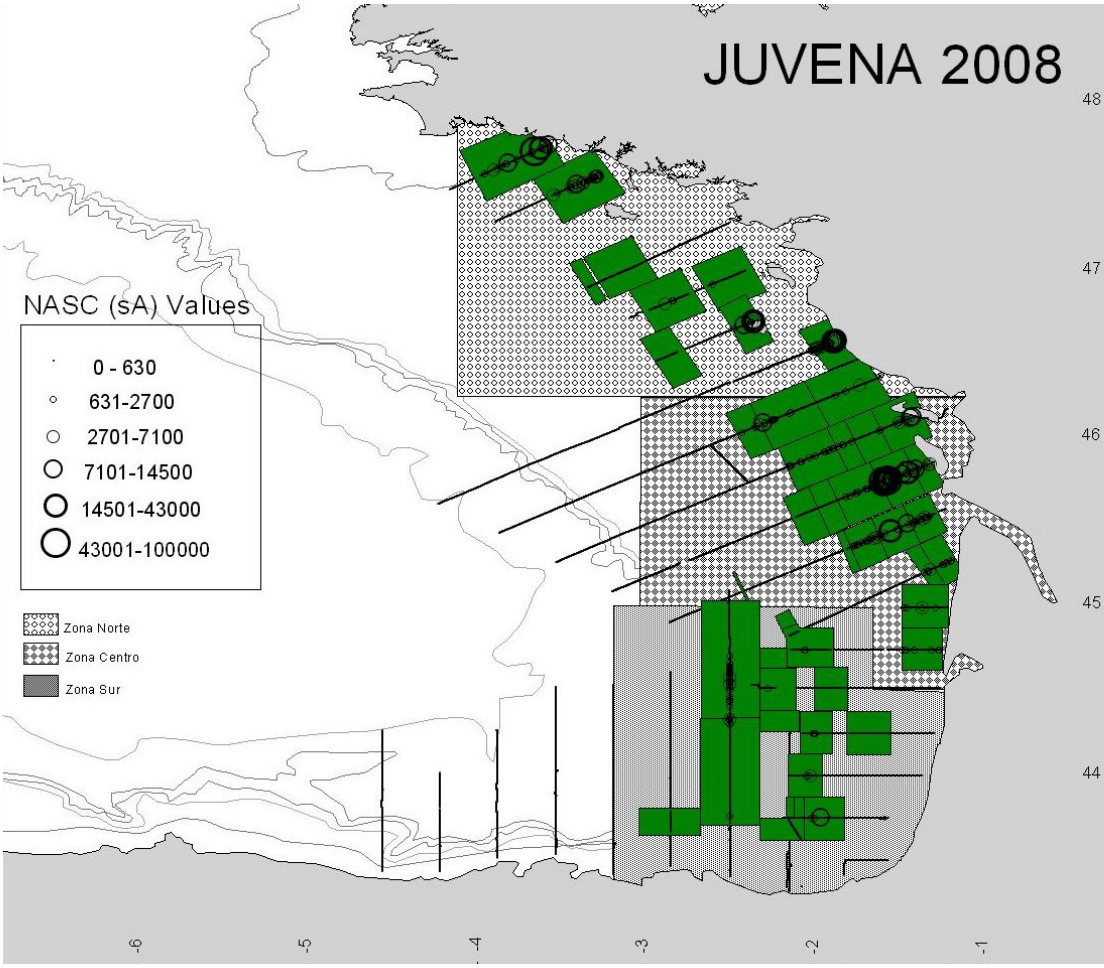


Figure 4.4.2.2. Total acoustic energy (NASC) and the three subareas of the positive area for anchovy.

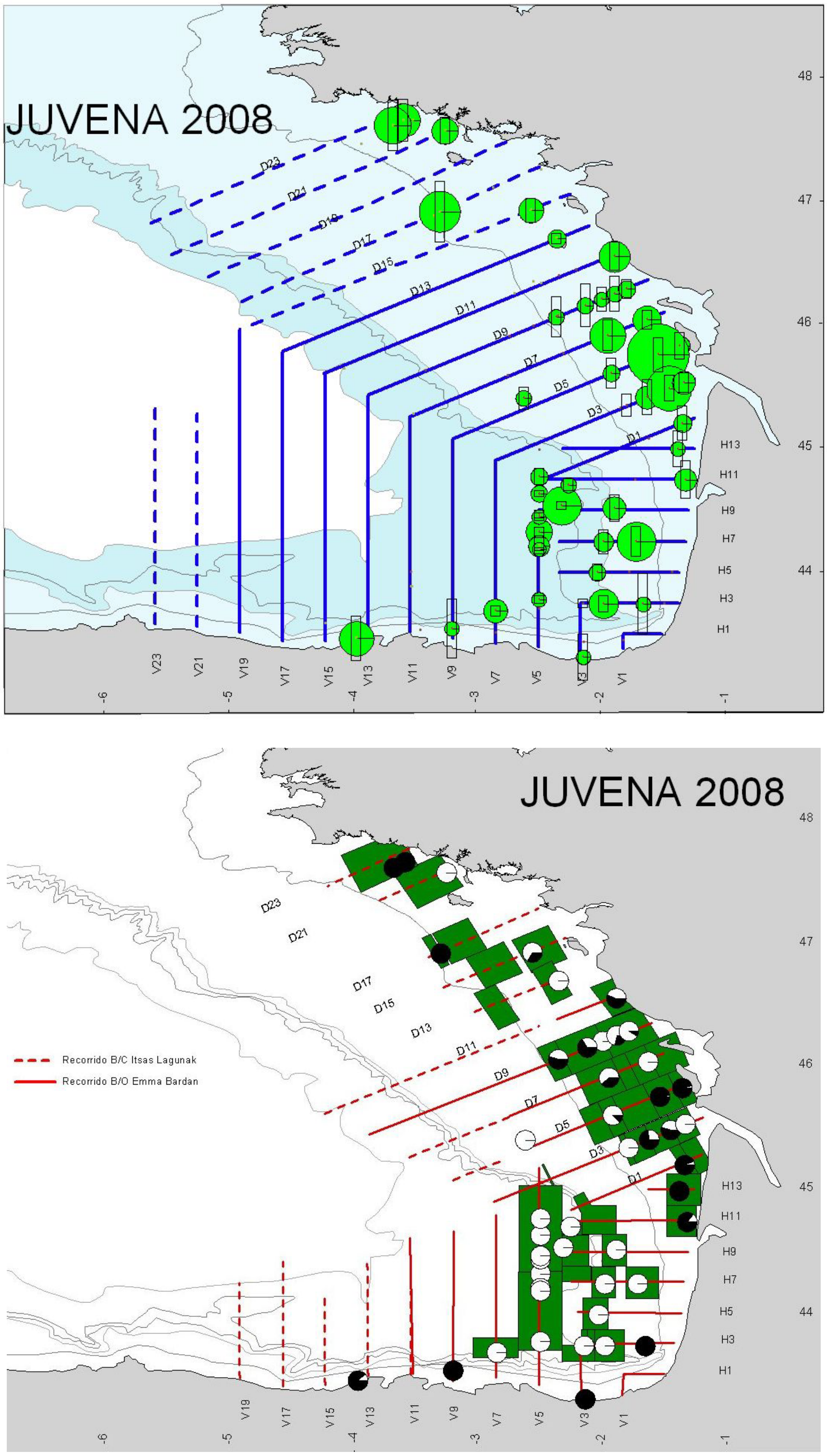


Figure 4.4.2.3. Top: Captures of anchovy and mode of the standard length in each haul. Bottom: positive area of distribution of anchovy, with the charts representing the percentage of juveniles (white) and adults (black) in the fishing hauls.

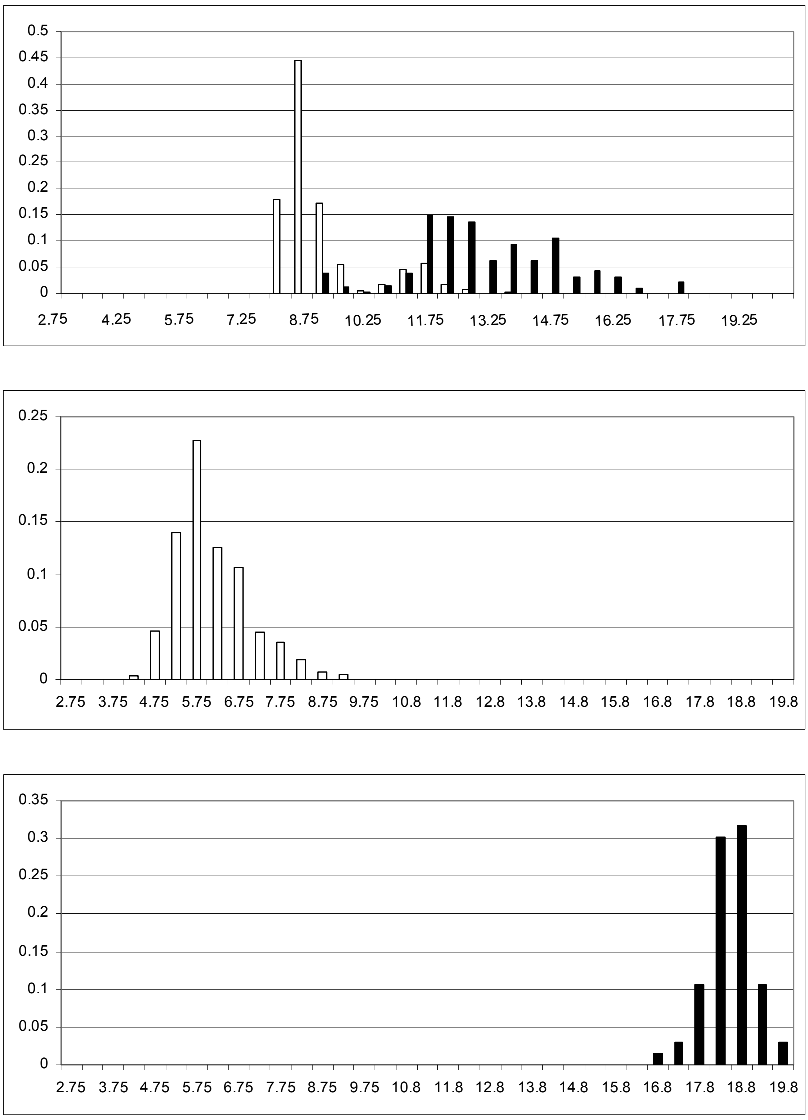


Figure 4.4.2.4. Typical size distributions of anchovy in hauls of the North (top), Garonne (center) and South (bottom) areas.

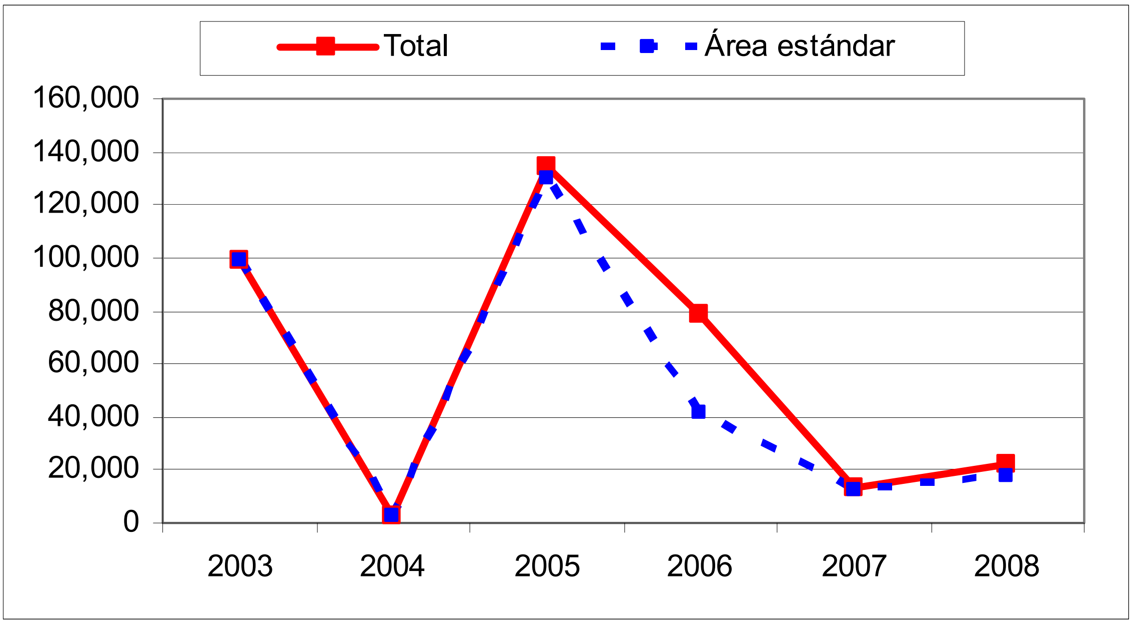


Figure 4.4.2.5. JUVENA Series of juvenile anchovy biomass index (autumn each year).

4.4.3 Comparison and analysis of juvenile surveys in the Bay of Biscay

This Section presents the comparison between the two surveys of juvenile anchovy made in autumn in the Bay of Biscay, PELACUS10, conducted by IEO, and JUVENA, conducted by AZTI. Both surveys were partially coordinated (see **Section 4.6.1.2** in this report), shared a common sampling design (**Figure 4.4.3.1**), and made a full day inter-calibration between the vessels (although these data have not been able to be analysed yet).

Given the temporal delay between both surveys (JUVENA started almost three weeks earlier) it was not possible to achieve the coordination levels recommended by WGACEGG (ICES, 2006). Thus, each survey provides its own independent abundance estimates of juvenile and adult anchovy. Another issue to consider is that PELACUS10 devoted less time than JUVENA to the abundance estimation coverage, thus covering a smaller area (**Figure 4.4.3.2**). In addition to these, there are also some methodological differences between both surveys that have to be taken into consideration. JUVENA is conducted on-board two small vessels, a purse seiner and a pelagic trawler, both with acoustic sensors deployed at about 2.5 m depth, and PELACUS uses a single pelagic trawler with the sensors at 6 m depth.

The comparison of species composition of the fishing hauls (**Figure 4.4.3.3**) showed a general consistency between both surveys. It should be noted that the presence of juvenile anchovy were found by both surveys off-the-shelf in the Cantabria Sea, although in JUVENA, as the transects reached further offshore, the positive area found in that region was wider (**Figure 4.4.3.4**). In the Garonne plume, the spatial distribution of anchovy detected by both surveys was similar, occupying the continental shelf from shallow waters to the isobaths of about 90 m. There was consistency in the size distribution of the anchovies caught in these two areas. The area located to the North of 47º N was covered only by JUVENA. Here, the small amounts of juvenile anchovy found were located exclusively in shallow waters.

As happened in previous years, there were discrepancies in the abundance estimates made by each survey, being higher for JUVENA (**Table 4.4.3.1**). However, it is convenient to split these abundance estimations by areas in order to analyse the discrepancies in detail:

- The North was no covered by PELACUS, thus the about 18,000 tonnes of anchovy estimated by JUVENA cannot be contrasted.
- In the South is found the highest discrepancy in abundance estimates between surveys. Here, the anchovy detected by JUVENA was located in the first 25 m of the water column (**Figures 4.4.3.5** and **4.4.3.6**), thus, the small proportion of these juveniles that were deep enough to appear in the echograms of PELACUS, would be attached to the near field zone of the transducer, very difficult to distinguish from the interferences. This is likely to explain a large part of the differences in the estimations of this area. In addition, the coverage of PELACUS in this area didn't cover the full positive area found in JUVENA (**Figure 4.4.3.4**).
- In the Garonne area the coverage was about the same for both surveys. Here, the divergences between anchovy estimates are moderate. However there is still a difference of about 30% (higher for JUVENA) considering juveniles and adults together. This difference is not considered large, considering the typical level of variability of acoustic surveys and may be explained by differences in fishing efficiency of the vessels (considering the different fishing gears used) and/or the ability of the smaller JUVENA vessels to prospect very shallow waters (from 8 to 20 m depth) that were not covered by PELACUS10. This will be checked in the analysis of the intercalibration data that will be done in 2009.

In summary, it can be concluded that:

- There is a different coverage between surveys
- General consistency in the spatial distribution of anchovy and other pelagic species
- Agreement in juvenile abundance in the common area
- Divergences in the adult abundances in the common area
- The intercalibration process, to be finished in 2009, is expected to solve the remaining discrepancies.

Table 4.4.3.1. Abundance estimates of both surveys in the different regions of the sampling area.

	JUVENA		PELACUS10	
Region	Biom_juv	Biom adults	Biom_juv	Biom adults
South	**9,224.20**	**0**	**1,048.50**	**232.9**
Garonne	8,154.50	22,798.40	10,331.00	11,584.40
North	3,499.90	14,922.10	-	-
TOTAL	**20,878.60**	**37,720.50**	**11,379.50**	**11,817.30**

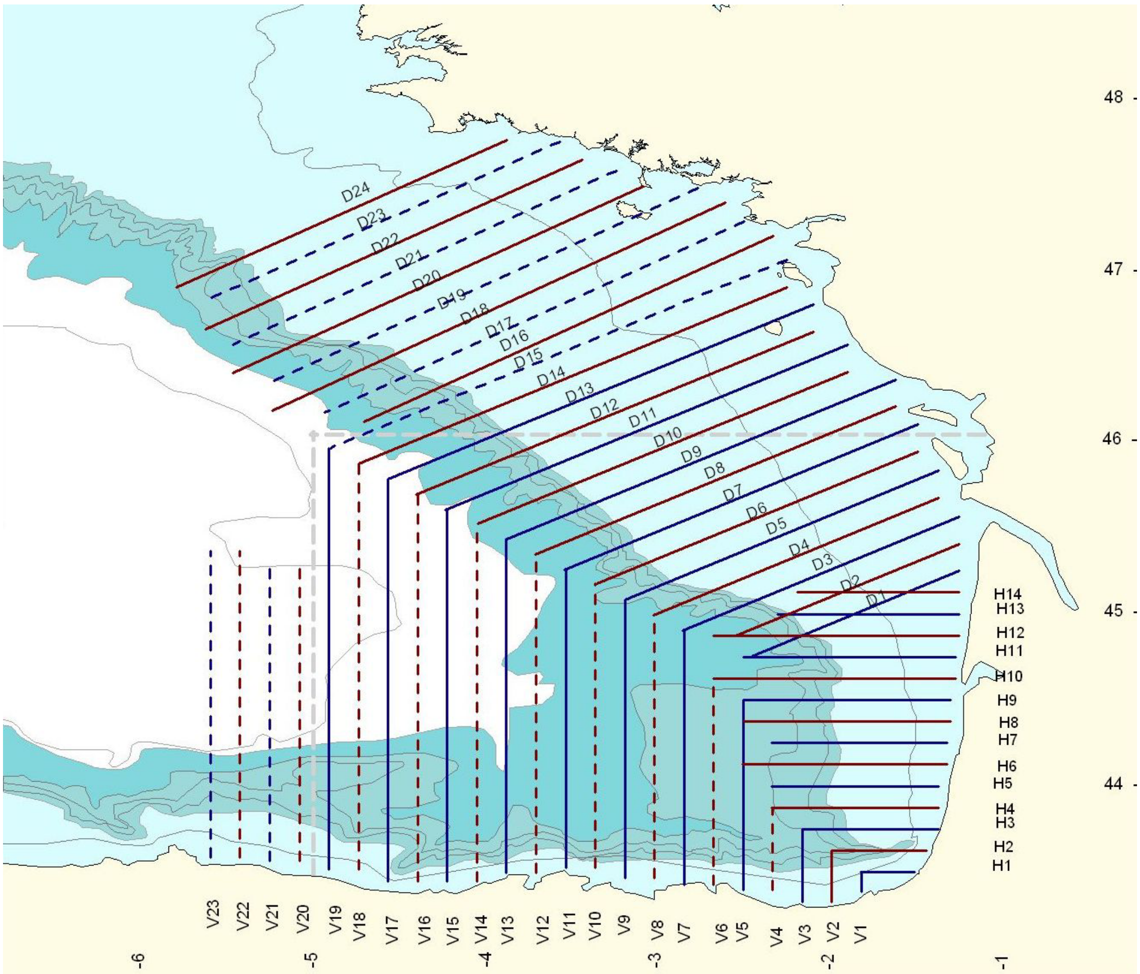


Figure 4.4.3.1. Common sampling design for both surveys. The even transects were covered by PELACUS and the odd ones by JUVENA. For each survey, the coverage of dashed transects was considered optional.

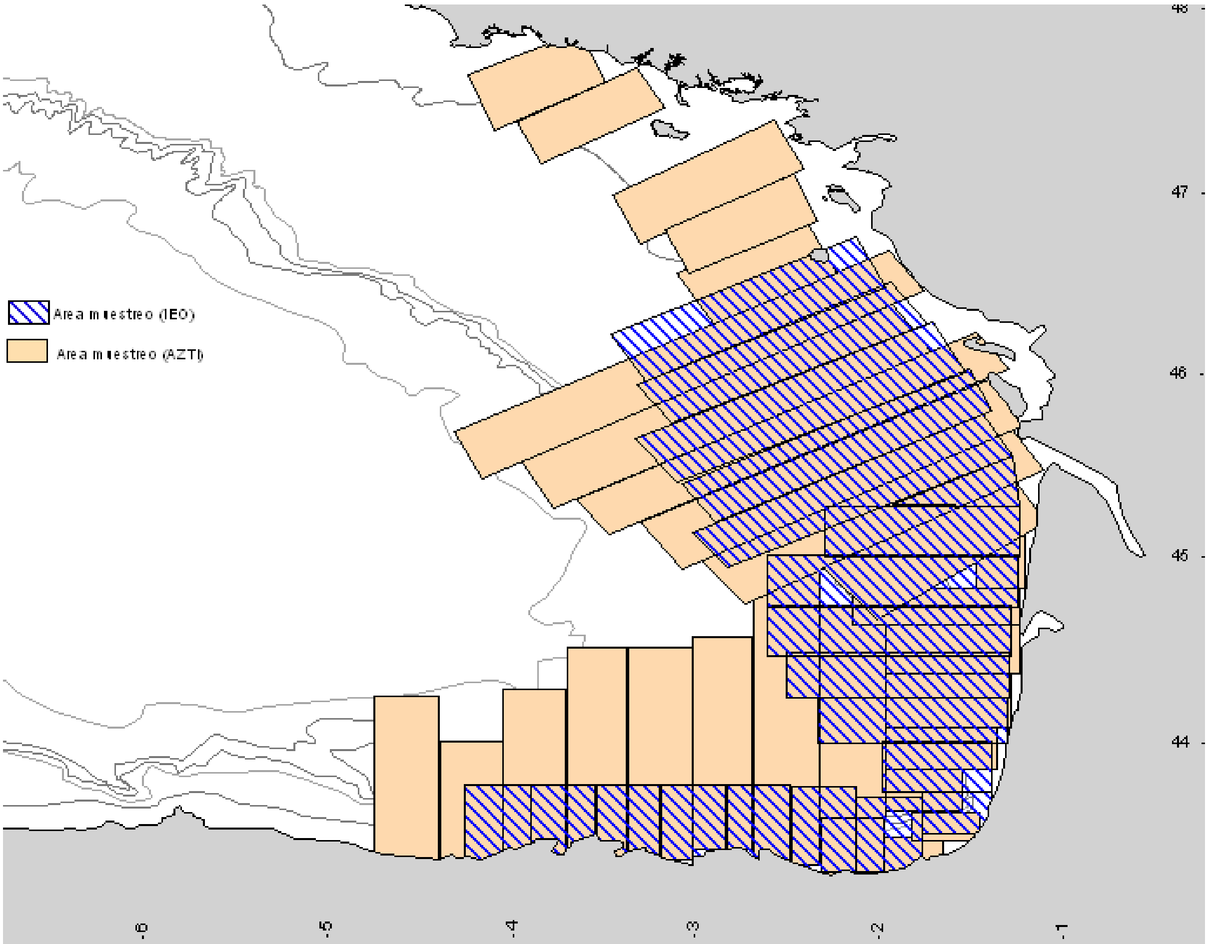


Figure 4.4.3.2. Sampled areas for JUVENA (solid pink rectangles) and PELACUS10 (blue lined rectangles).

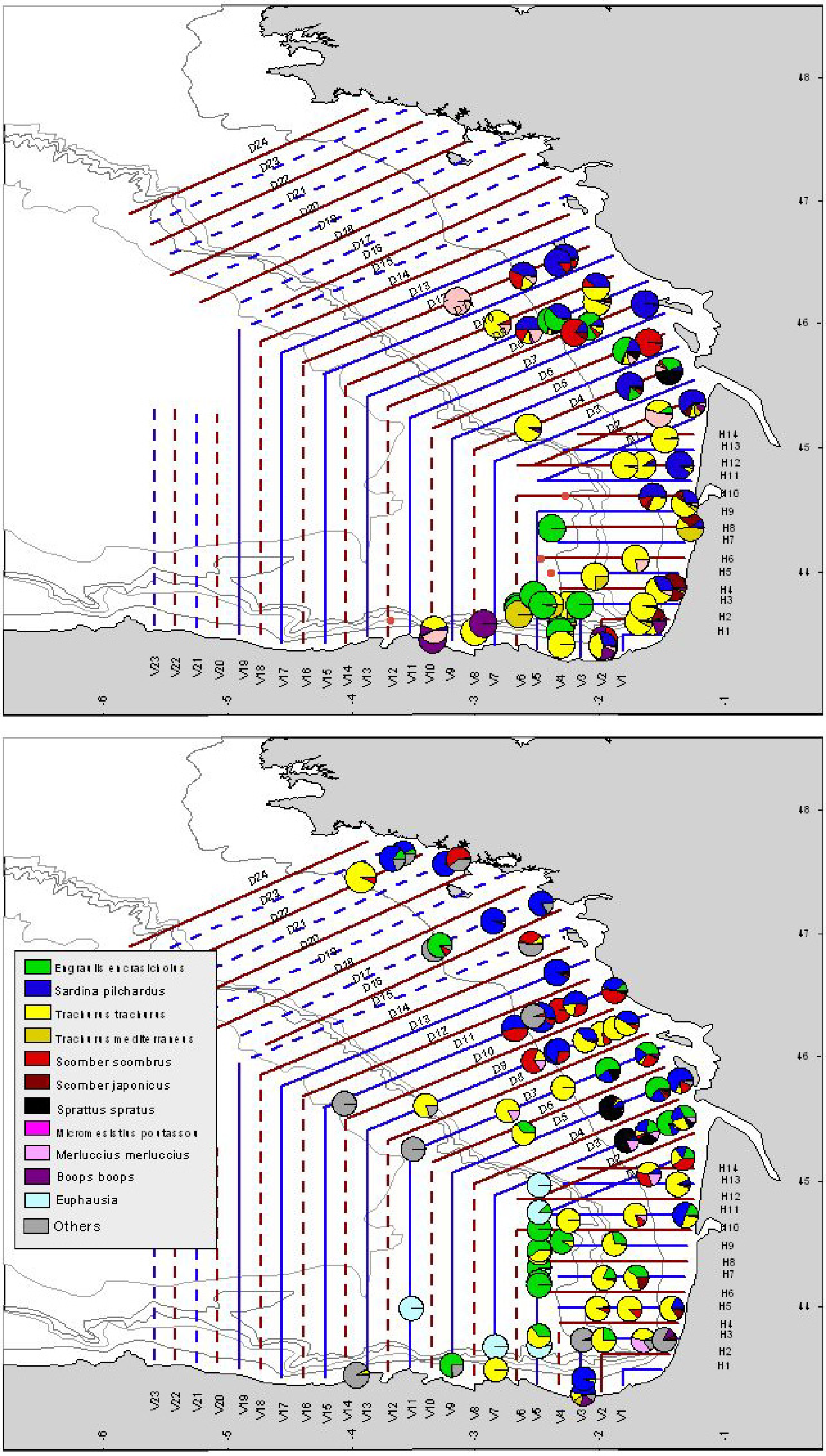


Figure 4.4.3.3. Top: species composition of the hauls in PELACUS10 survey. Bottom: species composition of the hauls in JUVENA survey.

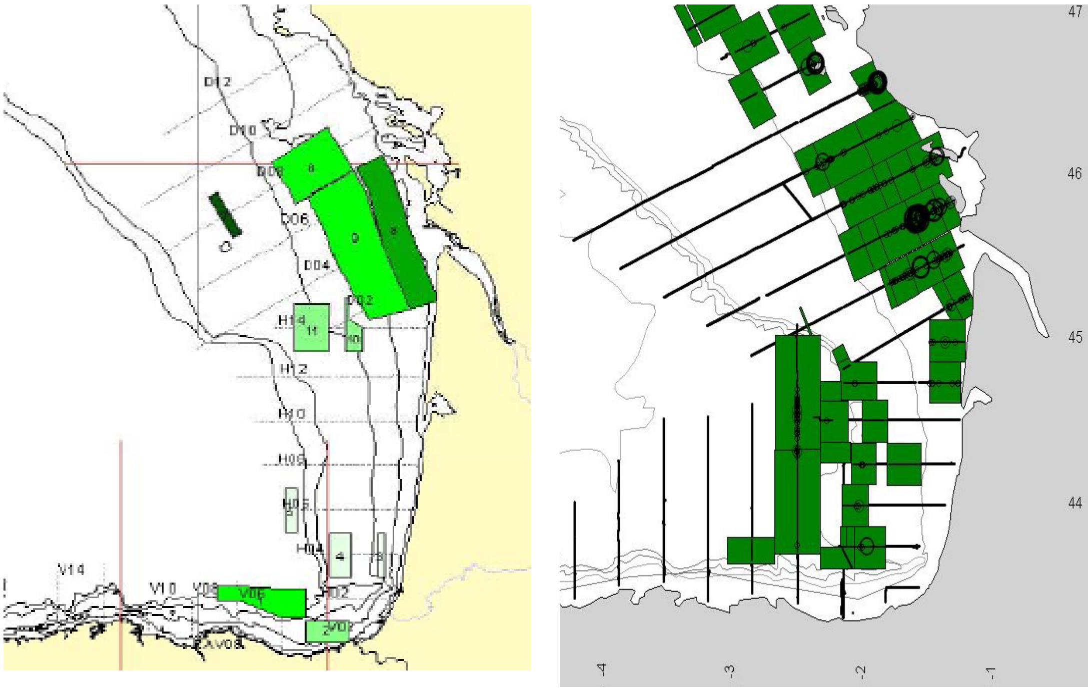


Figure 4.4.3.4. Positive anchovy area in PELACUS10 survey (left) and in JUVENA survey (right).

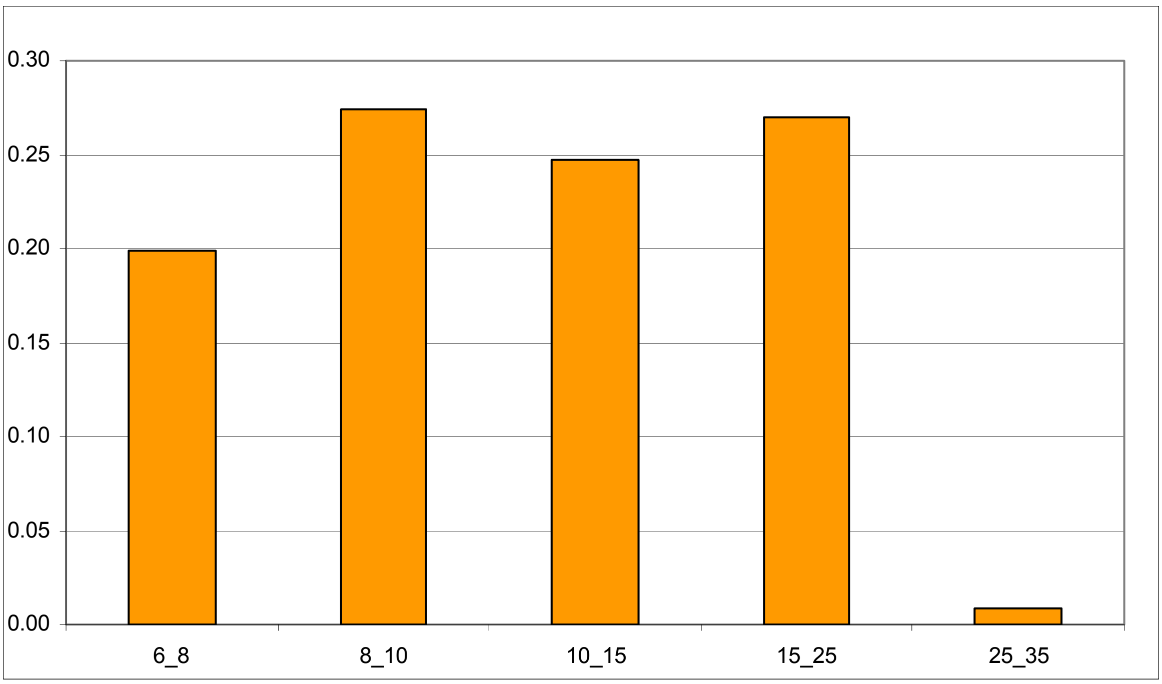


Figure 4.4.3.5. Vertical distribution of the energy attributed to anchovy in the Southern area in JUVENA survey. The columns represent the percentages of anchovy sA in increasing depth layer (in meters), from 6 to 35 meters depth. There was no anchovy found deeper than 35 m in this area.

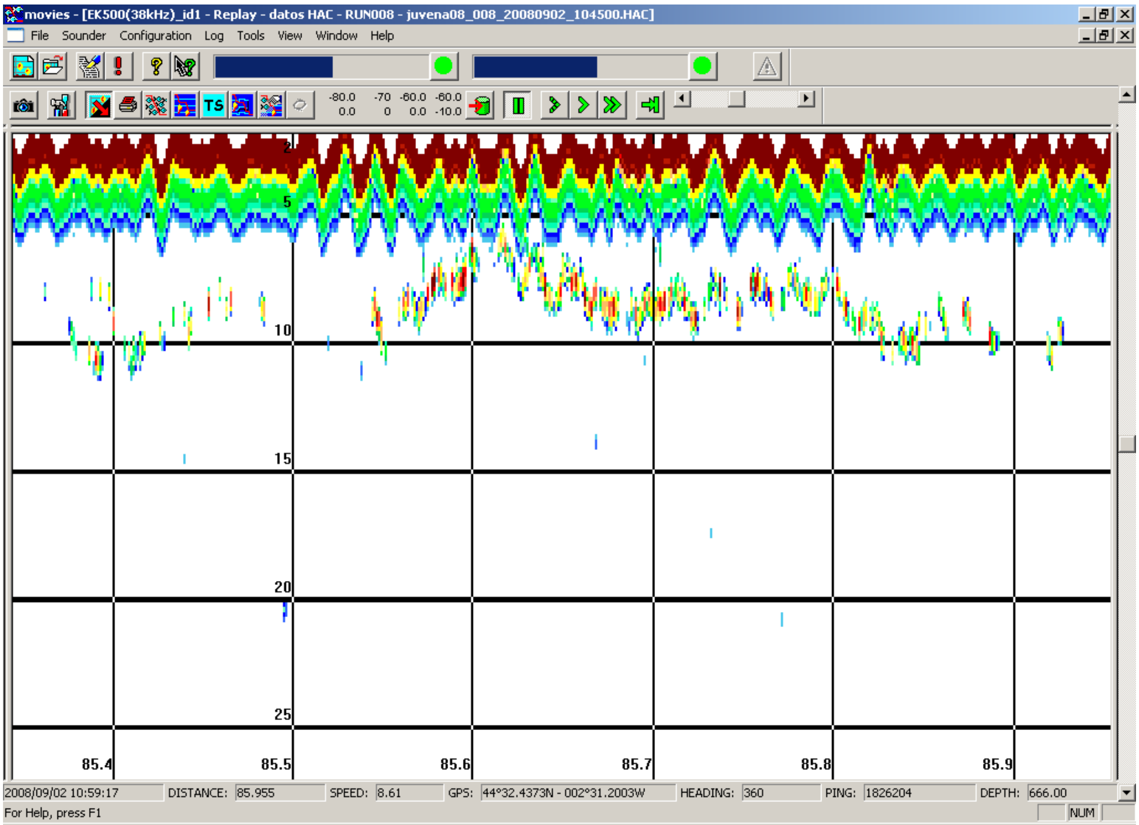


Figure 4.4.3.6. Sample echogram detected in one of the vessels of JUVENA survey showing the typical superficial distribution of juvenile anchovy in the Southern area, sometimes even touching the near field of the transducer.

4.4.4 Autumn acoustic surveys in the area IXa: SAR07NOV

Two autumn acoustic surveys have been carried out during the WG intersession time off the Portuguese coast and Gulf of Cadiz by IPIMAR: the *SAR07NOV* surveys in November 2007 and the *SAR08OCT* in October 2008. Regarding their respective objectives, the *SAR* Portuguese November surveys, are mainly aimed at the provision of acoustic abundance and mapping estimates of sardine (*Sardina pilchardus)*, and anchovy (*Engraulis encrasicholus)* and to observe the annual sardine recruitment strength. As the results of the last survey (*SAR08OCT*) are very preliminary it was preferred to present this survey results in the next year meeting.

These surveys were carried out with the RV "Noruega" in the same area as the PELAGO08 survey (**Figure 4.2.4.1**). The surveys followed the standard methodology adopted by the Planning Group for Acoustic Surveys in ICES Subareas VIII and IX (ICES, 1986; 1998) and recommendations given by this WG (ICES, 2006 a, b). The echosounder was a Simrad EK 500 working at 38 and 120 KHz. Acoustic data were stored in *.HAC format using Movies+ software In the northern Portuguese continental shelf, between Caminha and Figueira da Foz, a QTC (Quest Tangent) device was coupled to the EK500 echosounder in order to obtain information about bottom characteristics during the *SAR07NOV* survey. Ground-truth samples were taken on *ad hoc* selected stations using a Smith-McIntire dredge.

Pelagic and demersal trawlnets were used for echo-trace identification/confirmation and for the gathering of biological data. The SAR07NOV had 33 trawl stations Due to bad weather and time constrains the SAR07NOV survey covered only 46 of the 69 planned transects.

Results from the *SAR07NOV* survey

Distribution and abundance of sardine in the SAR07NOV survey

Sardine distribution was present all over the sampled area, but with higher densities in the Subarea IXa-CN, mainly between Figueira da Foz and Peniche (**Figure 4.4.4.1**). In this subarea the biomass was estimated in 258 thousand tonnes, corresponding to 4634 million individuals. South of IXa-C, between Nazaré and Cabo Espichel) sardine biomass was estimated in 114 thousand tonnes, corresponding to 2141 million individuals In Subarea IXa-S biomass was estimated in 144 thousand tonnes and 2913 million individuals.

Recruitment, and age structure of sardine

In every subarea, the length structure of sardine was bimodal because of the presence of young-of the year (**Figure 4.4.4.1**). The age-disaggregated data (**Figure 4.4.4.2**) shows that the 2004 cohort, at the time of the survey (3-year-old fish) continues to dominate the population in the IXa-CN subarea. In the Cadiz region of the IXa-S subarea, it is the 2005 cohort that dominates. These results also confirm that the 2006 recruitment was very low in all IXa area, whereas the 2007 recruitment was in the median levels of the series.

Distribution and abundance of anchovy:

As occurred in previous years, anchovy was mainly present in the Gulf of Cadiz, and in less abundance off Lisbon (**Figure 4.4.4.3**). In the Subarea IXa-S the biomass and numbers were estimated in 23.6 thousand tonnes and 1861 million individuals, respectively. In the Subarea IXa-CS, the estimated numbers and biomass were 58.6 million and 1.1 thousand tones.

Distribution and abundance of chub mackerel:

Chub mackerel was abundant in the Subareas XIa-CN and XIa-CN, especially between Aveiro and Lisbon (**Figures 4.4.4.4**). In this region the abundance amounted to 159 thousand tonnes and 1200 million individuals. In the South the abundance was estimated in 79.2 thousand tonnes and 700 million individuals. This was the first time that the abundance of chub mackerel was estimated for the whole sampled area.

Distributions of sea surface temperature, salinity, fluorescence and sardine eggs (**Figure 4.4.4.5**)

The October–November period in 2007 was quite dry compared with equivalent periods for previous years, in particular for the northern area of Portugal. The autumn of 2006 was, in contrast, very rainy Probably as a consequence of less input of fresh water into the coastal region the salinity and fluorescence plumes associated with the main rivers, during the 2007 campaign, were less clear than during surveying in the autumn of 2006. SST values in the W coast in 2007 were on average 1.5–2°C below the records of 2006. During the October 2007 campaign a band of water of low temperature was observed in the NW shore. This structure may have been the result of a mixture with (lower temperature) bottom water brought to the surface close to the coast;

associated with this colder water appeared the highest values of fluorescence. Considering the whole area surveyed, SST varied from 14.8 to 20.2°C; in the SE region the SST values were the typical of post-summer (very warm and usually higher than during spring period). During November 2006, almost the whole area surveyed showed water temperatures above 18°C. Looking at the common area surveyed during both autumn campaigns in 2006 and 2007, the extent covered by sardine eggs was lesser for the latter. Areas of egg absence were observed in the NW shore where sardine schools were detected by the echosounder but fishing hauls carried out concurrently showed a large proportion of juvenile fish.

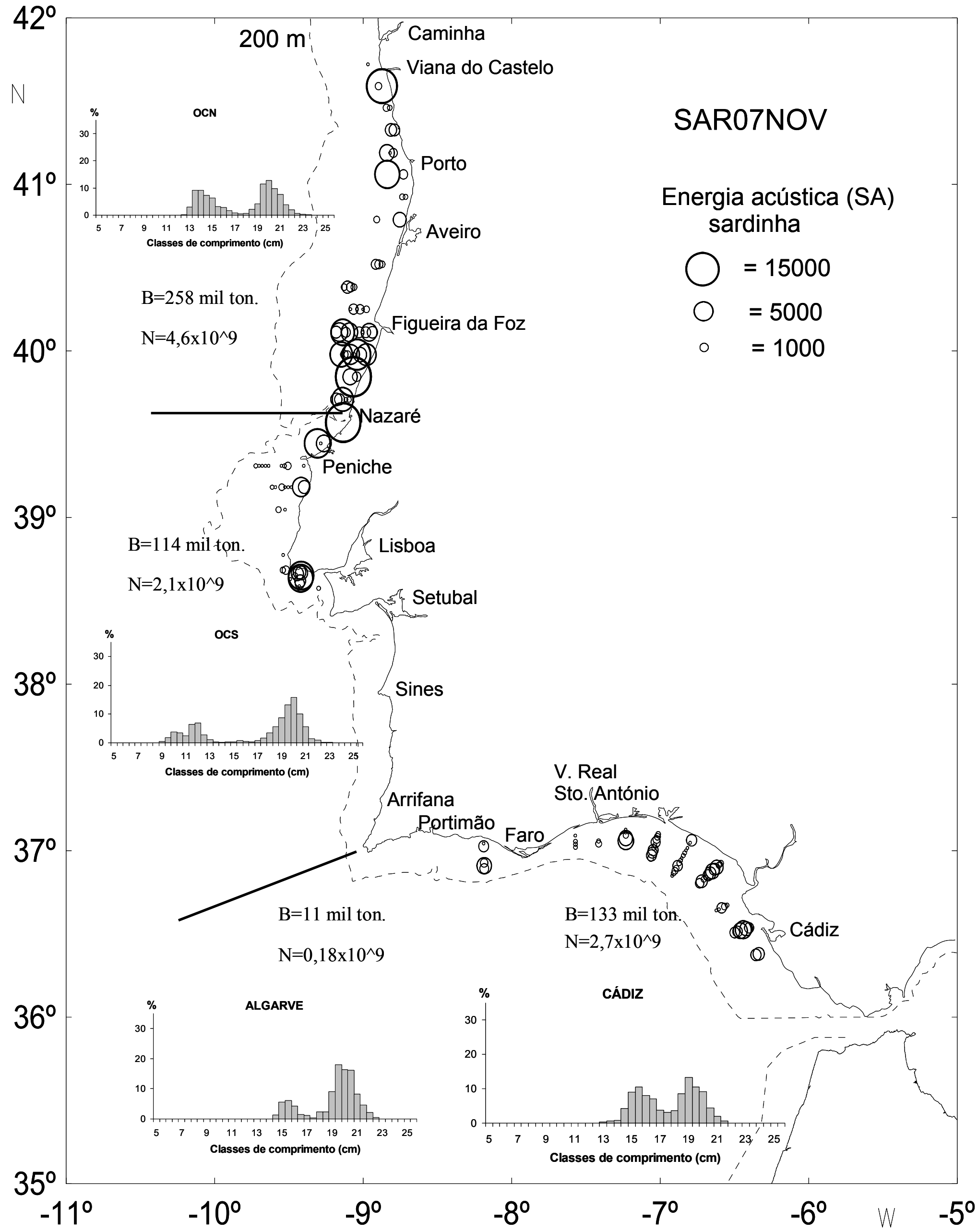


Figure 4.4.4.1. NASC (m^2mni^{-2}) attributed to sardine in the *SAR07NOV* survey. The histograms show the estimated abundance in number per length class in each region.

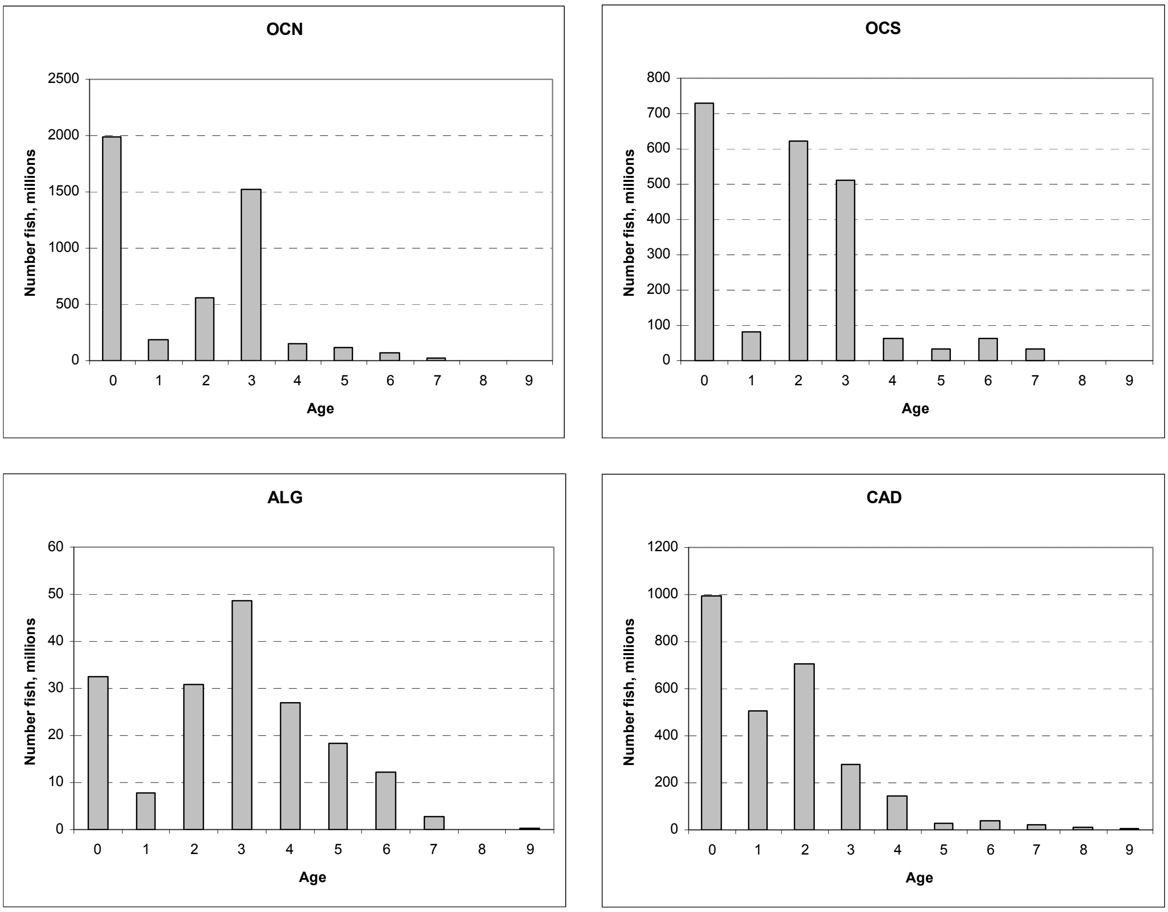


Figure 4.4.4.2. Age disaggregated estimates of sardine abundance in each subarea for the *SAR07NOV* survey.

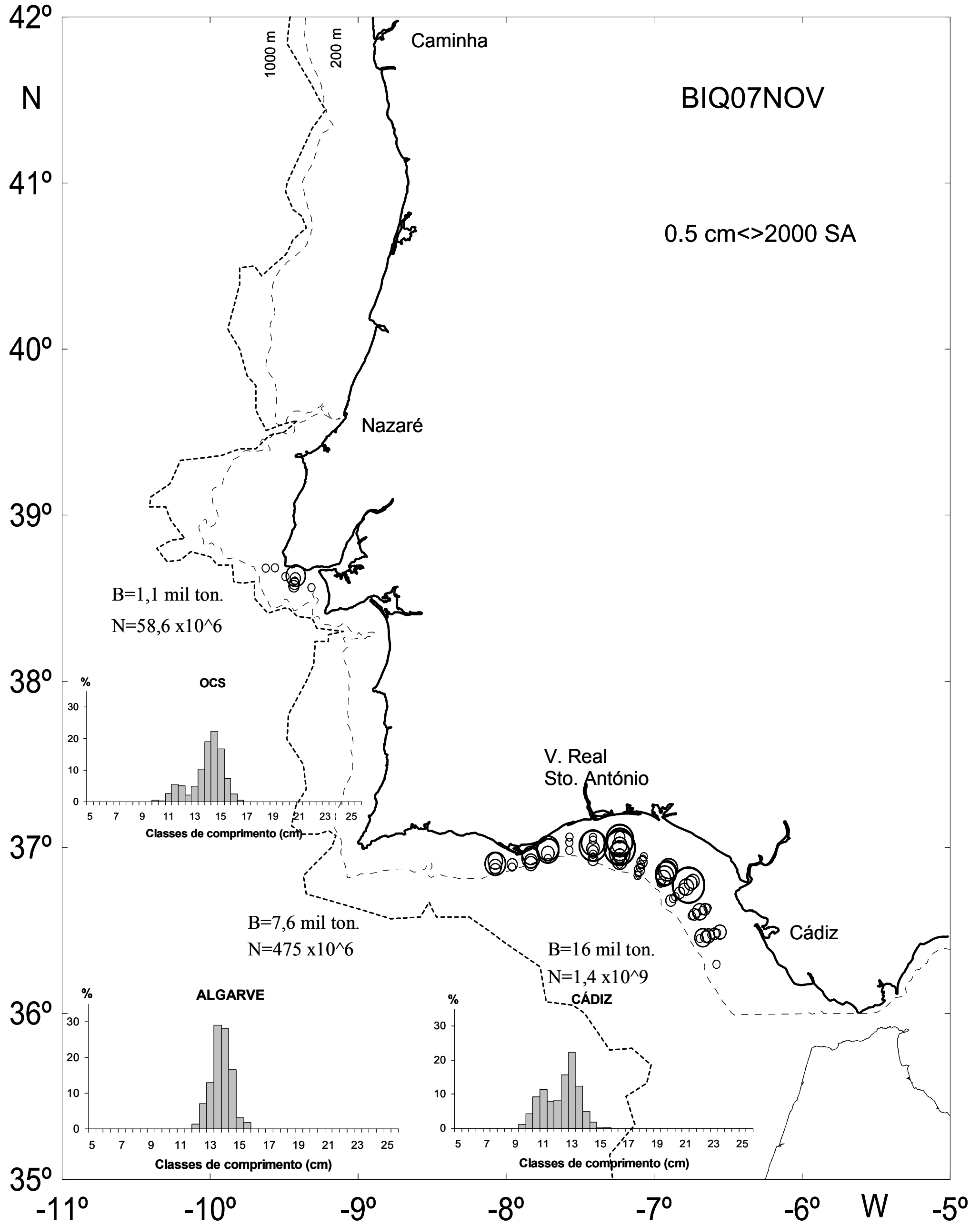


Figure 4.4.4.3. NASC (m^2mni^{-2}) attributed to anchovy in the *SAR07NOV* survey. The histograms show the estimated abundance in number per length class in each region.

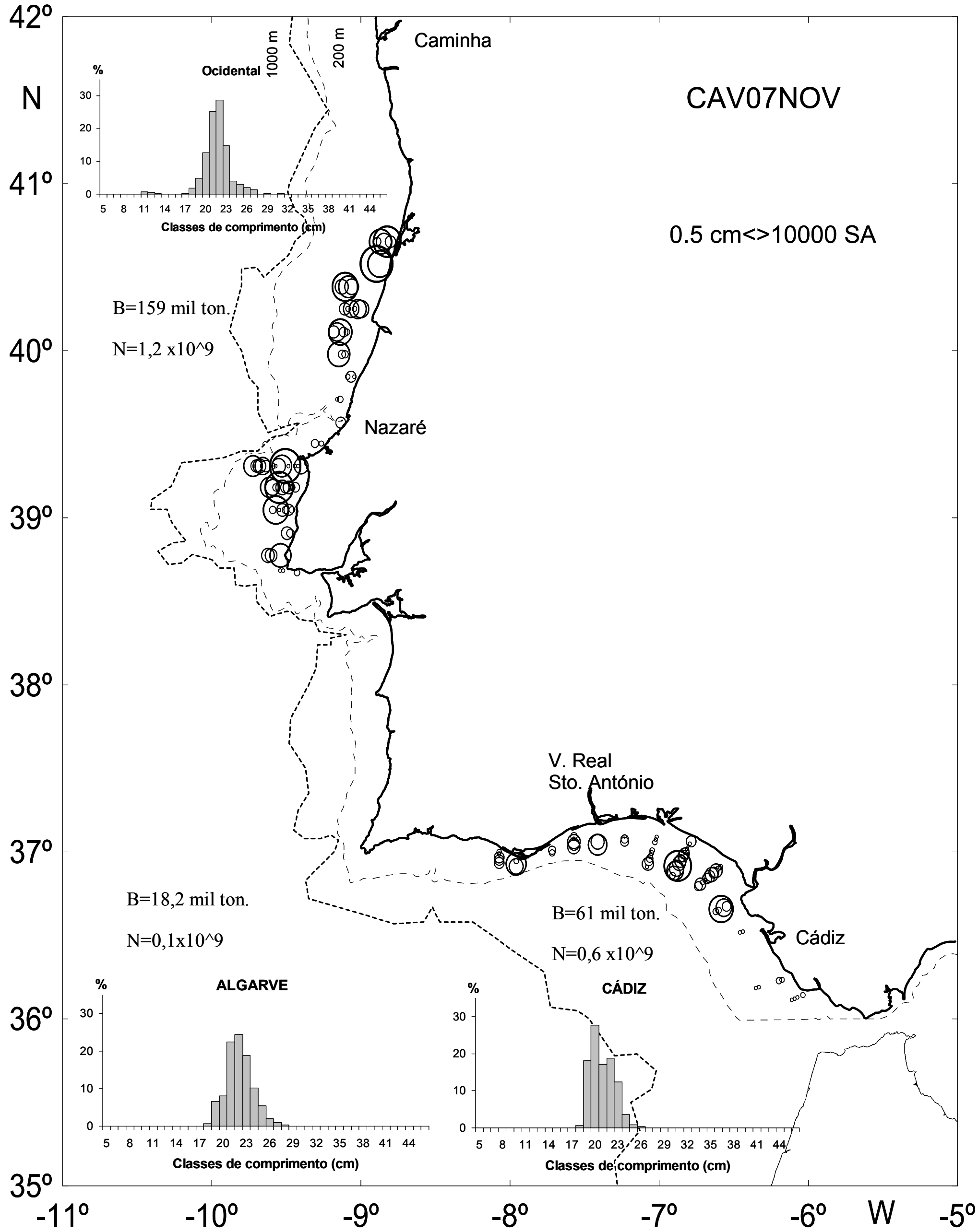


Figure 4.4.4.4. NASC (m^2mni^{-2}) attributed to chub mackerel in the *SAR07NOV* survey. The histograms show the estimated abundance in number per length class in each region.

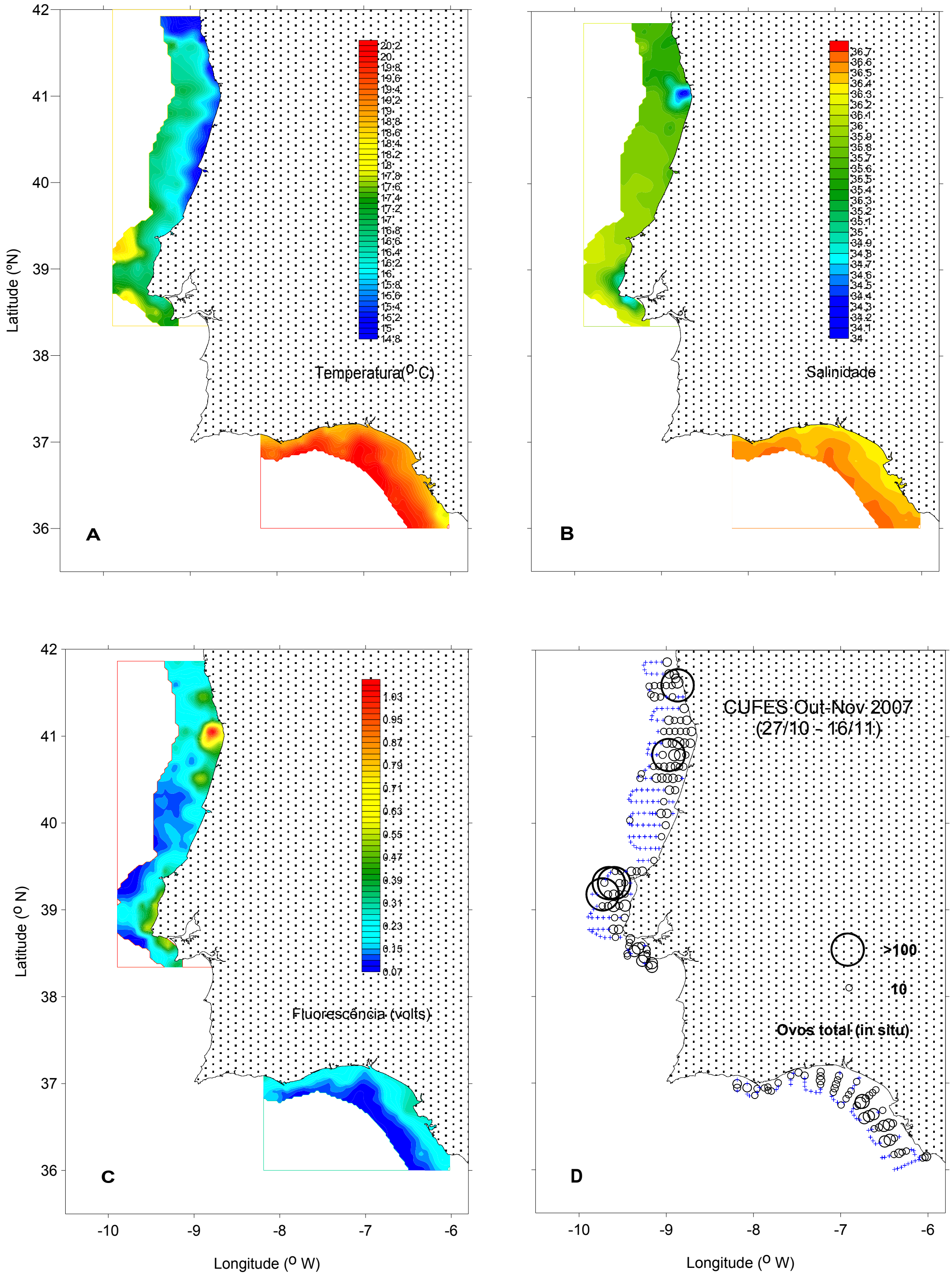


Figure 4.4.4.5. SAR07NOV: Distribution of sea surface temperature (A), sea surface salinity (B), sea surface fluorescence (C) and number of eggs (*in situ* counts) collected with the CUFES system.

4.5 Spatial distribution of sardine and anchovy (perspective of pelagic ecosystem)

The common grid approach adopted by the group this year allows mapping of the spatial distribution of sardine and anchovy using the coordinated spring acoustic surveys in 2008 of Ipimar, Ieo and Ifremer, with the acoustic sA density value for adults and the CUFES density for their eggs (**Figure 4.5.1**). Similar maps can be produced for the DEPM coordinated surveys in spring 2008, but were not produced because of the lack of time, although general Egg distributions for these two species are shown above in **Figures 4.3.2.2.2** and **4.3.3.2.1** (for anchovy and sardine respectively).

According to the synoptic acoustic maps for 2008 (**Figure 4.5.1**) anchovy is restricted to the SE corner of the Bay of Biscay and the gulf of Cadiz compared with sardine which has a wider distribution. Egg and adult distributions for anchovy tend to match better than for sardine at this large regional scale. Sardine eggs show high concentrations along the North coast of Spain where adults are in low abundance. This is also observed south of Lisbon where eggs are present when adults are not. The mismatch between egg and acoustic records for sardine in these two areas is endorsed by the egg distribution from Pairovet during the DEPM surveys made in spring in these areas (some weeks earlier –off Portugal– or concurrently or a bit later –in Subarea VIII than the acoustic survey), because they show egg concentrations in these two areas as well.

Maps as those in **Figure 4.5.1** can be produced for other species (e.g. *Sprattus sprattus, Scomber scombrus, Trachurus*,…) and also in each year since 2000 when surveys began to be effectively coordinated by ICES. Therefore the common gridding procedure offers the capability to analyse variability across years in a series of maps for the different species of the pelagic ecosystem.

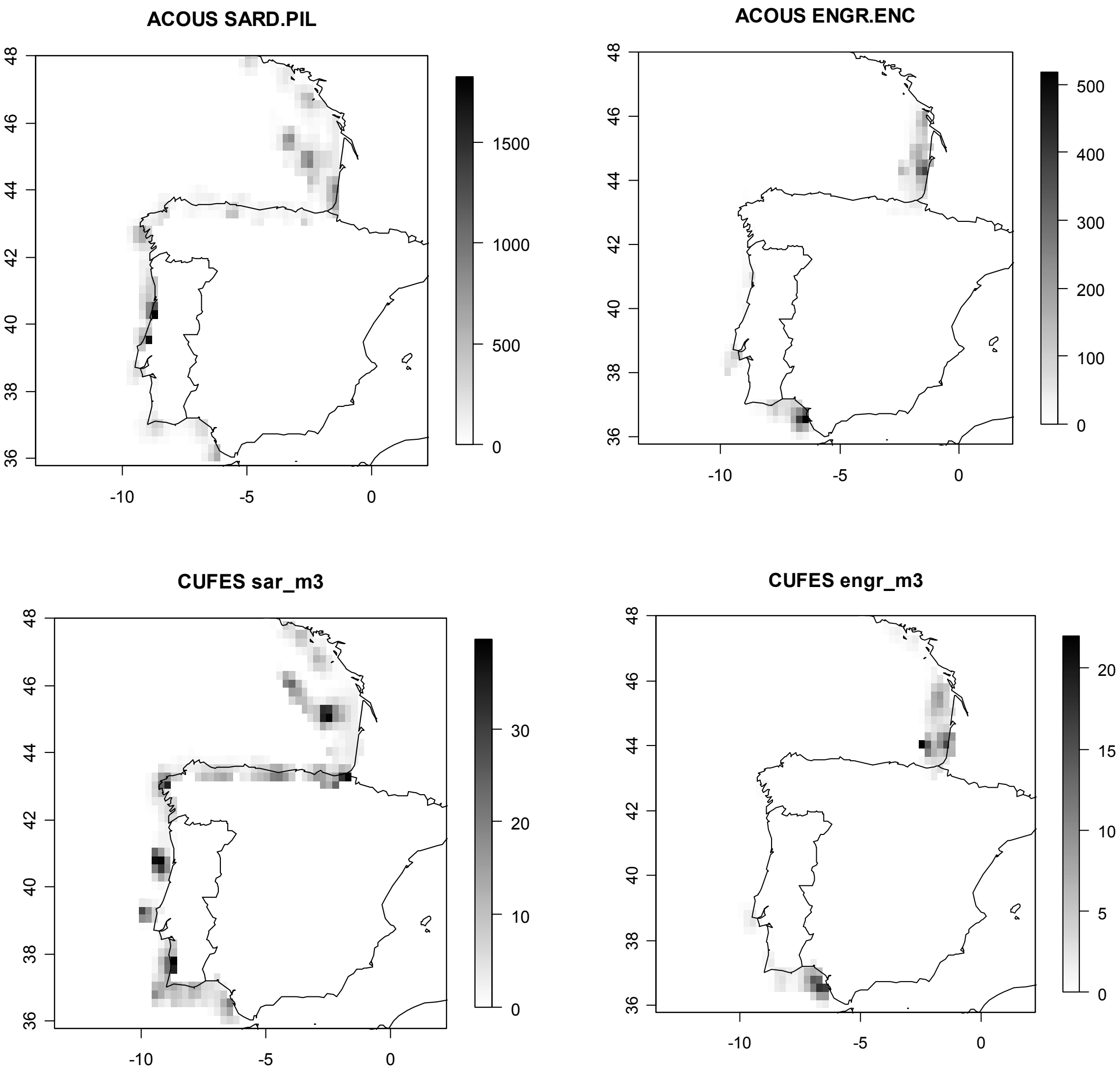


Fig 4.5.1. spatial distribution of sardine (left) and anchovy (right) from spring coordinated surveys of Ipimar, Ieo and Ifremer: acoustic density sA value for adults (left) and CUFES egg density at 3m depth (right).

4.6 Planning and coordination of surveys in 2009

4.6.1 Planning and coordination of acoustic surveys in region VIII and IX

4.6.1.1 Spring surveys

The joint planning and coordination of spring acoustic surveys of IPIMAR (PELAGO), IEO (PELACUS) and IFREMER (PELGAS) within this working group (see Section 6.1.2 of ICES, 2007), culminated in the first characterization of the pelagic fish community on the continental shelf extending from Trafalgar to Brest, i.e. from 36º N to 48º N (**Section 4.5** of this report) For the 2009 surveys, the effort initiated in 2008 in collecting intensive acoustic, trawl, eggs and oceanographic (through CUFES and associated sensors) data will be maintained with the prospect of creating a regional time-series with annual periodicity of fish distribution and of its environment.

IPIMAR and IEO will plan a repetition of the inter-calibration (IC) exercise performed during the 2008 PELACUS and PELAGO surveys (**Section 6.2.1** of this report). The IC exercise will take place in the same location but ideally reducing to a minimum the time delay between the two vessels' coverages. This would reduce the changes in distribution and catchability of the pelagic species that occurred during 2008. The general procedure will be similar to what was done in 2008 but increased effort will be put into obtaining trawl samples for species identification, even at low acoustic backscatter.

Coordination between PELACUS (IEO) and PELGAS (IFREMER) will also be ensured, both in terms of equipment and methods, and in terms of survey coverage.

4.6.1.2 Autumn surveys

In the WGACEGG meeting held in Lisbon in 2006, it was recommended a general procedure for the coordination of juvenile anchovy surveys in the Bay of Biscay (ICES, 2006). Some of the recommendations have been implemented in the survey planning of both JUVENA and PELACUS-10 during years 2007 and 2008, thus improving the common coverage and efficiency. The successfully adopted coordination activities since then were:

- Common sampling design. Both surveys agreed a common sampling scheme of alternate transects, with an inter-transect distance of 15 nm. for each survey, resulting in an inter-transect distance of 7.5 nm. when combining both surveys together.
- A common protocol of data acquisition and processing was adopted.
- A workshop was conducted in 2007 to try to explain the divergent results obtained in the previous year (ICES, 2007).
- A full day inter-calibration exercise at sea was carried out during the 2007 and 2008 surveys to assure correct and consistent equipment performance and processing methodology.
- A cross validation exercise was conducted after the surveys to confront the results and explore possible divergences and their causes.
- Common presentation of the results of both surveys in this WG (see Section 4.4.3).
- In 2008, modification of the common sampling design to a more efficient one by changing the direction of the transects to be perpendicular to the isobaths.

Unfortunately, as happened in 2007 due to differences in survey schedule, it was not possible to completely adopt the common survey strategy as was recommended in WGACEGG 2006.

The benefits obtained by the coordination in the surveys of 2007 were:

- Increased robustness of both estimates. The comparison of results conducted at the end helped to understand the weaknesses and strengths of both surveys, pointed out possible uncertainties and the way to overcome them by ensemble of information of both surveys.
- Complementary surveys. The differences between the cruises make them complementary since the information collected for each survey is useful for the other:
  - PELACUS benefits of the higher spatial coverage of JUVENA, obtaining information of the abundance of anchovy in the northern area and also in shallow waters (up to 10 m depth) and in the surface layer (down from 3 m depth) surface waters that they have difficulties to sample.
  - JUVENA benefits of the ecological approach of PELACUS-10, obtaining information for a larger number of ecosystem components and at higher spatial resolution in some areas that help to explain the observed dynamics.
- Possibility of integration of results within a denser grid and for a common sampling design, thus potentially increasing the precision of estimates, although this has not been feasible given the shift in dates between both survey's coverage.
- Possibility of sharing the haul information to improve echotraces characterization and the split of the acoustic energy.
- Potentially wider coverage, in order to assure the complete coverage of the potential area of distribution of anchovy.

The WGACEGG considers that the existence of these juvenile surveys is very positive for the understanding of the dynamics of the anchovy resource and of the pelagic ecosystem and of the Bay of Biscay. There is general agreement that it has been a big effort by both parts to coordinate efforts, but that there is still scope for further coordination / collaboration. The group also thinks that there has been a significant improvement in the explanations of the discrepancies and that is necessary to make more effort to try to completely understand them.

According to all these considerations, the WGACEGG recommends:

- To continue carrying out prospection surveys of juvenile anchovy in the Bay of Biscay.
- To continue carrying out processes studies to improve the understanding of juvenile ecology.
- To complete the cross validation of JUVENA and PELACUS-10 in order to understand the biomass estimation discrepancies.
- To try to strength further the coordination of the surveys in order to achieve wider spatial coverage to cover the whole potential area of distribution of anchovy juveniles.

Concerning the coordination for next year, the planning and coordination is postponed to the first part of the year 2009 between IEO and AZTI since at the moment of the meeting there is no confirmation of continuation of the anchovy juveniles' survey by the IEO in the 2009. Anyway, several coordination issues that will be discussed in this planning meeting will be:

- Deployment of the "Thalassa" transducers at a lower depth for detection near the surface.
- Finish the cross validation of the 2006–2008 data: quantitatively explain the discrepancies.
- Synchronize the schedule of both surveys.
- Maintain the intercalibration activities.
- Try to increase the coordination to achieve a wider coverage.

4.6.2 Planning and coordination of DEPM surveys in region VIII and IX

In 2009 the annual anchovy DEPM in the Bay of Biscay by AZTI will take places in May, as yearly, covering the usual spawning grounds in the Spanish eastern Cantabrian Sea and the southern French coast (ranging from 5°W to 48°N). The next anchovy DEPM in the Gulf of Cadiz will take place in 2011 by IEO.

The next triennial sardine DEPM survey will take place in 2011 covering the area from the Gulf of Cadiz to the inner part of the Bay of Biscay (Atlanto-Iberian stock). The region from the Gulf of Cadiz to the northern Portugal until Spanish border (Miño River) will be surveyed by IPIMAR while IEO will cover the northwestern Iberian Peninsula and the inner part of the Bay of Biscay.

Thus in 2011, both sardine and anchovy egg production surveys will be carried out in regions VIII and IX, so coordination will be planned in detail in the 2010 WGACEGG meeting. Even though the state of survey coordination is good and survey plans and analysis methods have been discussed in previous WGACEGG meetings. In addition, the possibility of expanding sardine DEPM through the French shelf until 48°N is desirable.

5 Revision and update of survey's time-series estimates

5.1 Revision of Anchovy DEPM based SSB estimates in the Bay of Biscay

The procedures for the estimation of the Spawning frequency (S) for the Bay of Biscay anchovy have been revised because of a better understanding of the POF degeneration cycle (Alday *et al.,* 2008) and its application to the estimation of S (Uriarte *et al.,* Wd 2007 and in preparation). This will affect the past Spawning Biomass estimates of anchovy by the DEPM leading to a reduction of those estimates.

A partial revision of the series of SSB for anchovy was presented to last WGACEGG (ICES, 2007) based on the new estimates of S and a revision of P_0 and P_{tot} using GLM estimates and GAMs from 1995 to 2007. This revision leads to an average decrease of SSB for anchovy by about 35%. WGACEGG acknowledged the suitability of those changes and recommended a complete revision of the historical SSB series (1987–2007) for the WGANC 2008 meeting.

In spite of having finished the revision of Spawning Frequency estimates (**Figure 5.1.1.**); the revision of the series of SSB estimate for the Bay of Biscay anchovy is not ready to this working group because it is pending new Egg Production estimates according to:

- New Egg incubation temperatures for the stations and surveys.
- Revision of the Cutting points of the upper and lower tails of Observed Egg abundance-at-ages by cohorts and stations.
- New global P0 and Egg mortality estimation procedures, Incorporating information from all surveys together to give a best estimate of Z (with its likely temperature dependency)

For 2008 the Spawning frequency has rose up to about 49% (CV=8%) while the average of the new S series up to 2007 is 40.4% (CV=4%). This year's estimate is most likely bias: the difference may be due to having got our samples from only pelagic trawling and with fishing hauls restricted to a period close to the spawning activity (between 18:00 and 02:00). This probably has induced strong oversampling of active spawners in the current year leading to a likely overestimate of S.

Given the pronounced affect that the changes of Spawning Frequency estimates will have on the Spawning Biomass estimates of anchovy from the DEPM (see preliminary revision in **Figure 5.1.2**), and the incomplete revision of the implementation of this Method concerning the Egg Production estimates, the provision of the definitive new SSB estimates are delayed until all basic changes are included.

The WG recommends such a revision to be made during next year 2009 for its reporting to WGANSA. A publication in a peer review journal of the new S estimation is required as well as assurance of the quality of the new changes in S.

While reporting the new series of SSB estimates the implications for the assessment may be great and the need in such a case for a changing in the reference points for management should at the same time be fully evaluated.

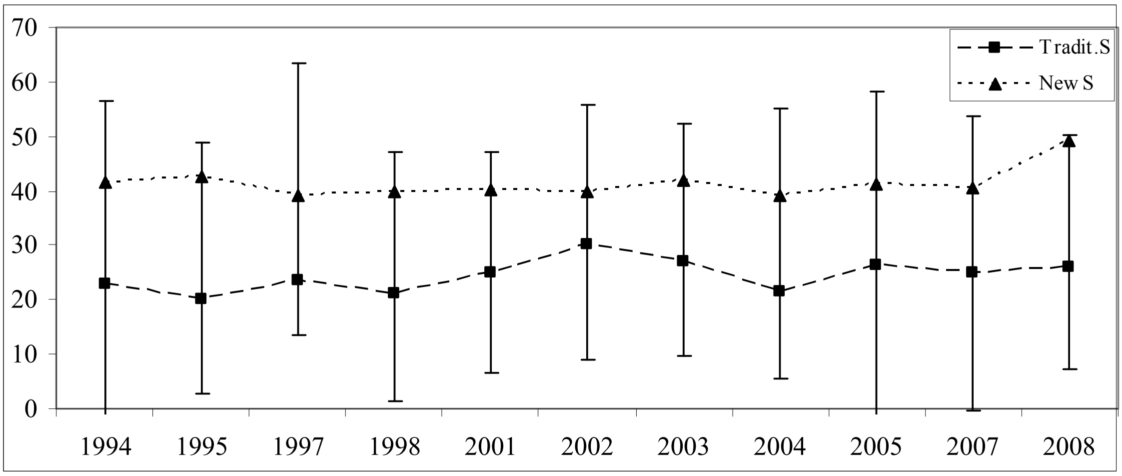


Figure 5.1.1. Past and new spawning fraction estimates for the Bay of Biscay anchovy. New estimates based on the incidence of spawning cohorts Day (0+1)/2 are presented.

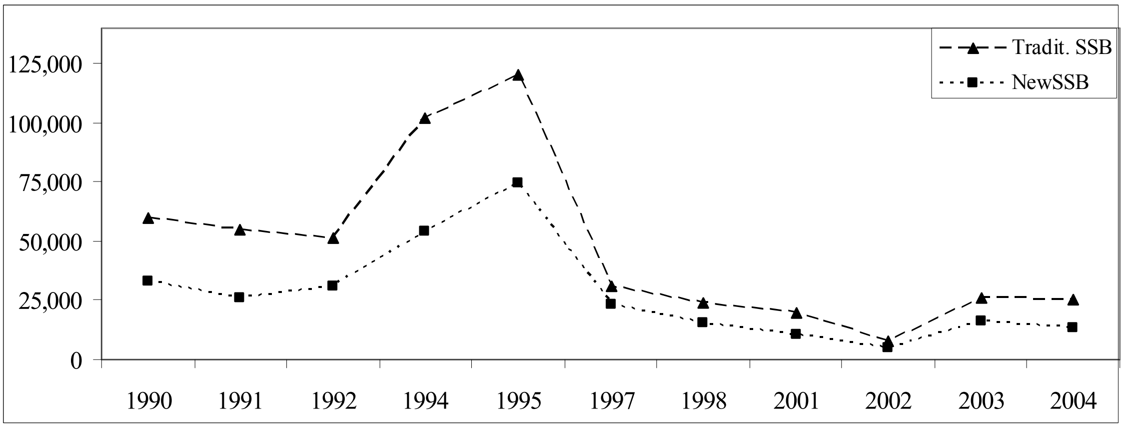


Figure 5.1.2. Past reported and new Spawning Biomass estimates for anchovy in the Bay of Biscay anchovy (the later according to the new estimates of spawning frequency).

5.2 Revision of DEPM on sardine in 2005 and the series

In 2006 WGACEGGS meeting (ICES, 2006b) were presented both preliminary estimates of Adult Parameters and Total Egg Production for sardine in Northern Spanish waters (ICES Division VIIIc and IXa North) during 2005 But due to a low value of Spawning Fraction, a review of adult parameter estimates was recommended. As result of this a review both adult parameter and Daily Egg Production estimates were made.

In relation to estimation of Daily Egg Production parameters: Total surveyed area was estimated at 41,756 km^2 and Spawning area at 13,971 km^2. Moreover mortality was estimated at -0.011 h^{-1} (CV= 42%) and the Daily Egg Production (P_o) was estimated at 250.6 egg/m^2 (CV=21%) Finally, the Total Egg Production (P_{tot}) has been estimated at 3.50 x10^{12} eggs/day (CV = 21%).

This estimate of egg production is approximately 40% bigger that of the one presented in the 2006 WGACEGGS meeting mainly due to an underestimation of spawning area in the previous estimation. (**Table 5.2.1**).

In relation to the review in estimation of adult parameters for sardine in 2005 Mean female weight (W) was estimated at 83.8 g (CV=4%), Sex-ratio of mature population (R) was estimated at 0.53 (CV=0.5%), Mean Batch fecundity (F) was estimated at 34,386 eggs (CV=3%) and Spawning fraction (S) was estimated at 0.153 (CV=10%).

Results of review of adult parameters shown that Sex-ratio, Batch Fecundity and Female mean weight values are similar that the preliminary results presented in the 2006 WGACEGGS meeting. However the review estimation of Spawning fraction (S=0.15) is approximately double that the preliminary estimation (S=0.063) presented in the 2006 meeting. (**Table 5.2.2**).

Finally as a result of reviews of 2005 DEPM parameters for sardine in Atlantic Spanish waters a new estimation of Spawning Stock Biomass (SSB) was made.

The spawning biomass was estimated at 106.2 x10^3 t with a coefficient of variation of 47%. The update 2005 sardine spawning biomass estimate (106.2 x10^3 t) is lower that preliminary estimation presented in 2006 meeting. This decrease of sardine Spawning Stock Biomass in relation with the preliminary estimation presented in 2006 meeting (154.5 x10^{3}t) should be due mainly to variation of the Spawning fraction and the Daily egg Production estimates. Nevertheless, sardine spawning biomass estimate (106.2 x103t) was higher than 2002 estimation SSB (50.7 10^{3}t) and the highest value in the temporal series (1997–2005). (**Table 5.2.3)** (**Figure 5.2.1**).

Table 5.2.1. DEPM parameter estimates for the sardine off the North Atlantic Spanish coast in 2005. First column shows the Preliminary estimates of Daily Egg Production parameters presented in 2006 WGACEGGS meeting and second column shows the update results of DEPM parameter estimates for sardine in 2005. Coefficients of variation are in brackets.

Parameter	Preliminary estimates	Update estimates
Surveyed area (km^2)	36760	41756
Spawning area (km^2)	10033	13971
Daily Egg Production (P_0) (eggs/m^2/day)	209.6	250.6 (21)
Mortality (z) (h^{-1})	-0.009	-0.011 (41%)
Total Daily Egg Production (P_{tot}) (eggs/day)	2.1 x10^{12} (23%)	3.5 x10^{12} (21%)

Table 5.2.2. Adult parameter estimates for the sardine off the North Atlantic Spanish coast in 2005. First column shows the Preliminary estimates of adult parameters presented in 2006 WGACEGGS meeting and second column shows the update results of adult parameter estimates for sardine in 2005. Mean female weight is measured in grams, Batch fecundity in number of eggs * 1000 per batch, Spawning fraction and sex ratio are percentages and spawning biomass is estimated in 1000 tonnes. Coefficients of variation are in brackets (%).

Parameter	Preliminary estimates	Update estimates
Mean female weight (W)	78.6 (5%)	83.8 (4%)
Batch fecundity (F)	32.3 (4%)	34.4 (3%)
Spawning fraction (S)	0.063 (16%)	0.15 (10%)
Sex ratio (R)	0.53 (0.4%)	0.53 (0.5%)

Table 5.2.3. Sardine Spawning Biomass off north Spain, estimated by DEPM. Spawning biomass is measured in 1000 tonnes. Coefficient of Variation (%) in brackets.

Year	SSB
1997	20.7 (84%)
1999	13.4 (77%)
2002	50.7 (33%)
2005	106.2 (47%)

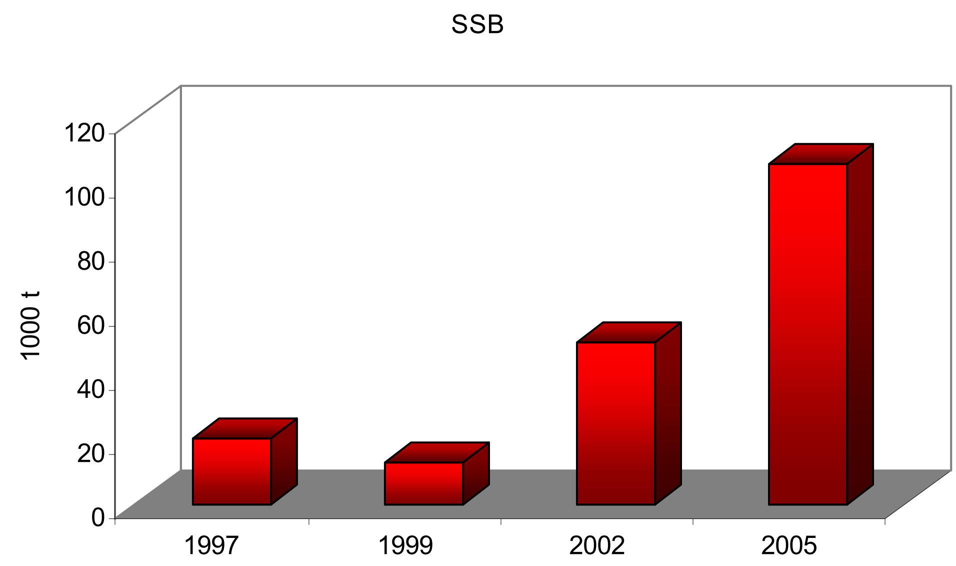


Figure 5.2.1. Series of biomass estimates (10^3 tonnes) for the Northern Spanish Coast sardine since 1997.

5.3 Revision of the JUVENA acoustic estimates of anchovy juveniles in 2006

During the JUVENA 2006 survey, an inter-calibration exercise between the two vessels being used in the survey was carried out in order to check for possible biases in acoustic collection. The inter-calibration results evidenced that the RV "Enma Bardan" (EB) was systematically collecting less energy than the rented commercial vessel Itsas Lagunak (IL), in spite that both vessels were equipped with scientific and calibrated acoustic transducers.

The results of the inter-calibration analysis were discussed between colleagues of AZTI, Ifremer, Genavir and IEO during the WGACEGG-promoted Acoustic Workshop held in Nantes, France, in April 2007. Here, it was agreed that the most likely reason for the detected bias was the erroneous configuration of the 38 kHz echosounder in the EB, produced by the choice of a short pulse duration for this frequency. A revision of the initial estimate was produced based on the 120 kHz transducer collected data and it was presented in WGACEGG meeting in Palma de Mallorca (November 2007). Nevertheless, these results were still inconclusive because of the uncertainty about the appropriate TS value at 120 kHz for anchovy. Thus, the WGACEGG recommended further revision of the data. (ICES, 2007).

Subsequently in 2008, the bias of the EB in that survey was re-estimated based on the inter-calibration data between 38 kHz transducers taking into account the acoustic energy backscattered from both the water column and the bottom echo (details were presented in a working document to this WG –Boyra *et al.*,). A bias correction factor of 2 was estimated for the EB. The corrected estimation is already included in the JUVENA series of abundance estimations of anchovy presented in this report (Section 4.2.2). The correction factor showed a CV of about 40%. As this error applies to the EB that covered about 60% of the positive area, this implies an imprecision of about 25% of the estimate of this year associated to this problem.

The analysis procedure was revised by the members of the WGACEGG, considering it correct in general terms. Nevertheless, given the high CV of the obtained correction factor, further work may be welcome to increase the precision of the year 2006 estimate.

6 Method improvements of Acoustic and DEPM surveys

6.1 Progress in DEPM-based estimates

6.1.1 Advances in DEPM estimation

A large number of advances in relation to the DEPM estimators have been made in recent years, some of them within the ICES community and under the auspicious of various ICES study and working groups dedicated to the issue (WKSB – ICES, 2000; SGSBSA – ICES, 2006; WGACEGG – ICES, 2008). In this Section, a brief and sequential review of the main advances and changes in DEPM methodology proposed by these groups is presented, together with a review of the accompanying scientific production.

The first review of recent advances developed within the ICES-DEPM community was published in 2004 (Stratoudakis *et al.*, 2004). In this work, an outline of a the main aspects of the DEPM in Atlanto-Iberian waters being under review was presented, and include; a) spatially explicit estimators of daily egg production and daily fecundity using GAMs, b) incorporation of CUFES sampler to improve precision of the estimates, c) improvement of the statistical methods to assign ages to staged eggs, and d) improvement of the estimation of spawning fraction by reduction of sampling bias and improvement of Postovulatory Follicles (POF) ageing. By the time of that review, only some advances on egg ageing (Bernal *et al.*, 2001) have reached the mainstream journals, while advances on spatial modelling of egg production and improvement of the estimation of spawning fraction were still being developed. The main novelty at the time was to present the potential to convert the DEPM into a spatially and environmentally explicit method, and examples of spatially explicit estimators of egg production and population fecundity were presented. However, an evaluation of the robustness of the methods to structural uncertainty of the spatially explicit estimators, as well as to basic assumptions common to all DEPM applications were required before the methods could be adopted routinely. Two years later, a review of the main sources of uncertainty and bias in the DEPM estimators, not only in Atlanto-Iberian waters, but also in DEPM applications worldwide, was published (Stratoudakis *et al.*, 2006). Main sources of uncertainty and potential bias in this review were attributed to; a) the tales of the mortality model used to estimate egg production and b) sampling and methodological problems associated to the estimation of daily spawning fraction.

Because these two reviews, efforts were placed in three main lines; a) solving the consecutive steps required for the implementation of robust spatially explicit DEPM models, b) evaluating the potential bias in the estimation of spawning fraction and propose an alternative, more robust estimator of spawning fraction, and c) use of CUFES as a secondary or even primary sampler for the estimation of egg production.

The implementation of spatially explicit DEPM estimators was tackle within a dedicated EU project, and as a result, a number of papers have been published or submitted recently; new methods to analyse egg development and assign ages to staged eggs for sardines and anchovies (Bernal *et al.*, 2008; Ibaibarriaga *et al.*, 2008), aggregated mortality estimators for Atlanto-Iberian sardine (Bernal *et al.*, submitted) and spatially and environmentally explicit egg production estimators for Atlanto-Iberian sardine (Bernal *et al.*, submitted). Also dedicated software packages were developed and an open source software project was started, with routines that allow implementing most of the methods included in those papers (http://ichthyoanalysis.wiki.sourceforge.net). Altogether, the methods developed in these works allow overcoming all requirements to implement robust estimators of spatially explicit egg production. However, robust estimators of spatially explicit daily fecundity have not yet being fully developed

In relation to the development of robust estimators of spawning fraction, advances were made both in the estimation of spawning fraction of sardine and anchovy. A thoughtful review of the estimation process for the case of Bay of Biscay anchovy ended up with the discovery of POF degeneration rates much faster than those previously obtained (Alday *et al.*, 2008), with an important effect on the final estimates of spawning fraction (Uriarte *et al.,* in preparation).. Overall, one main conclusion is that, laboratory experiments of degeneration rates allow implementing more robust estimators of spawning fraction, although the implementation on different species (sardine) and other areas (anchovy in the Gulf of Cádiz and in the Mediterranean Sea) is still pending.

Finally, the implementation of CUFES within the DEPM shows contrasting results. The use of CUFES as a secondary sampler has been adopted by all the ICES-DEPM community, although without taking full advantage of its potential (as for example in Lo, 2004). However the potential use of CUFES as the main sampler to obtain egg production estimates is still under development. Advances on modelling the vertical distribution of eggs (Petitgas *et al.*, 2006) has been published recently, and the use of CUFES abundances to provide indices of egg production is being used to check acoustic estimates of biomass (Petitgas submitted), but a full implementation of DEPM based on egg samples taken from CUFES has not yet being developed.

6.1.2 Testing incubation temperature from different depth strata for egg ageing; IPIMAR´s sardine DEPM 2005

Following the adaptation in 2005, of the original double CalVET sampler that was in use by IPIMAR for DEPM plankton sampling, it became possible to carry out CTDF profiling simultaneously with the ichthyoplankton surveying. The new system includes the 2 nets and a FSI (3” MCTD) CTD with a fluorescence sensor. For the two most recent DEPM sardine surveys (2005 and 2008) the adapted system was used and as a result in 2005, 408 profiles of CTDF were obtained (462 in 2008). In 2005, the data collected allowed gathering of 57 transects of temperature, salinity and chlorophyll$_{_a}$ distribution covering the whole region surveyed (from Cadiz to about 42ºN). The hydrological information assembled is of great value for characterizing the winter water structure over the shelf and to contribute for describing sardine spawning habitat in the region (maximum sampling depth -150m). For DEPM the primary objective of registering sea temperature at the plankton stations is to allow egg ageing, by using egg stages of development and mathematical models, developed after laboratorial egg incubation experiments at controlled temperatures (Bernal *et al* 2008). These models describe the egg development relationship with environment temperature allowing assignment of ages (in hours) to the eggs collected.

In recent years the temperature used for egg ageing in the Portuguese DEPM has been the sea surface temperature obtained by the CT sensor associated to the CUFES system. Two main reasons have supported this option, practicability (because the data are promptly available) and the surmise that due to water column mixing during the winter period, surface temperature would represent fairly the temperature of the depth stratum occupied by the eggs of sardine.

By processing the CTDF data gathered in 2005 it was possible to characterize the structure of the water column during the period of the survey for the area studied. It was also possible to test the use of temperature values from different depth strata for egg ageing, and assess for eventual deviations in the P0 estimates obtained using the different values.

Figure 6.1.2.1 show two examples of the distributions of temperature, salinity, density and chlorophyll$_{_a}$ obtained as a result of the CTDF profiles undertaken together with the plankton sampling. The Sections presented were selected to highlight the degree of temperature stratification encountered during the winter campaign in 2005. Vertical stratification was weak and apparent essentially in the vicinities of the main estuaries (Section 6 shown is located off river Douro). Spatial patterns in temperature such as the occurrence of fronts were observed in some regions associated with local features. In **Figure 6.1.2.1**, (transect 56, off Portimão, southern Portugal) it is noticeable the presence of slightly colder water over the shelf and warmer waters (saltier waters of southern origins) over the slope and beyond. The spatial pattern obtained for the distribution of temperature difference (top – bottom) (**Figure 6.1.2.2**) draw attention to the weak thermal stratification observed over the entire area of the survey.

For the exercise of testing the use of values of temperature from different depth strata for egg ageing it were considered four sets of data: (1) surface temperature from 3m (CT underway pumping system associated with CUFES), (2) surface temperature average of top 5m (from the CTDF), (3) integrated temperature for whole water column and (4) average temperature of surface mixed layer (defined as the layer above density differences between consecutive measurements lower than 0.1). Sardine eggs are known to be released at the bottom and move up to the top layers (usually top 50m depth), in hours, where they stay for the duration of development at a level dependent on the density of the water column and on the characteristics of the egg. Quotient analysis of sardine egg density in relation to temperature is shown in **Figure 6.1.2.3**; from the observation of these plots it is apparent that little differences exist in the distribution of eggs with temperature considering the four situations analysed; larger number of eggs were associated with temperatures ranging from 13.7–14.9°C.

The results obtained for P0 estimates (IPIMAR, sardine 2005 DEPM survey) using the different temperature values are presented in **Table 6.1.2.1**. It becomes clear from this analysis that due to water mixing, at the majority of the sampling points where sardine eggs occurred, the P0 estimates obtained using temperature values from different depth strata showed negligible differences. It seems therefore acceptable to use surface temperature for the sardine egg ageing procedure, for the region considered and at this period of the year; this conclusion should not be generalized for other areas because temperature stratification may occur during the spawning period.

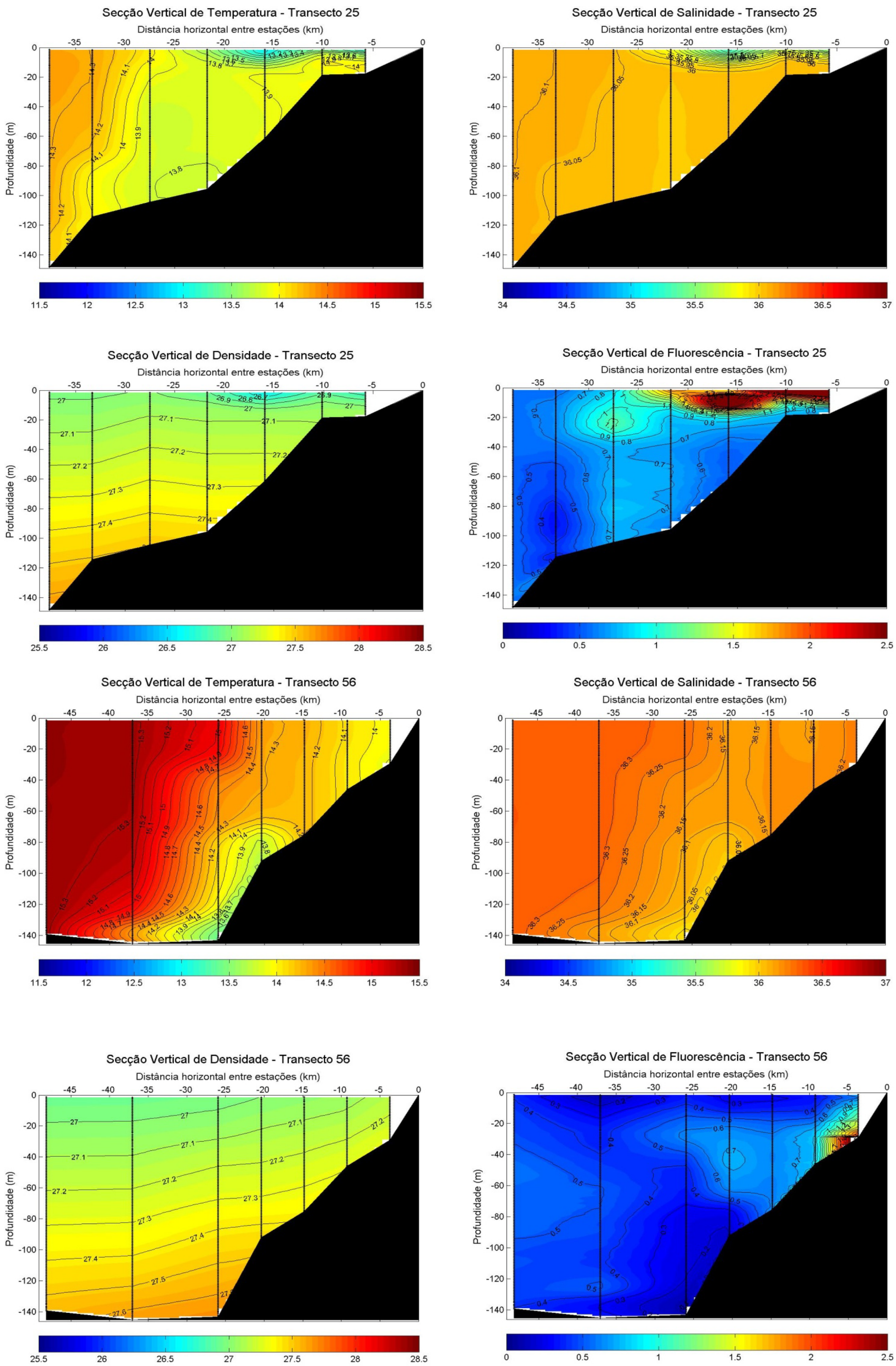


Figure 6.1.2.1. Temperature (°C), salinity, density (kgm^{-3}) and chlorophyll$_a$ (g m^{-3}) distributions in two sampling Sections (top: northern Portugal, off river Douro, and south Portugal, off Portimão) conducted during the IPIMAR sardine 2005 DEPM survey.

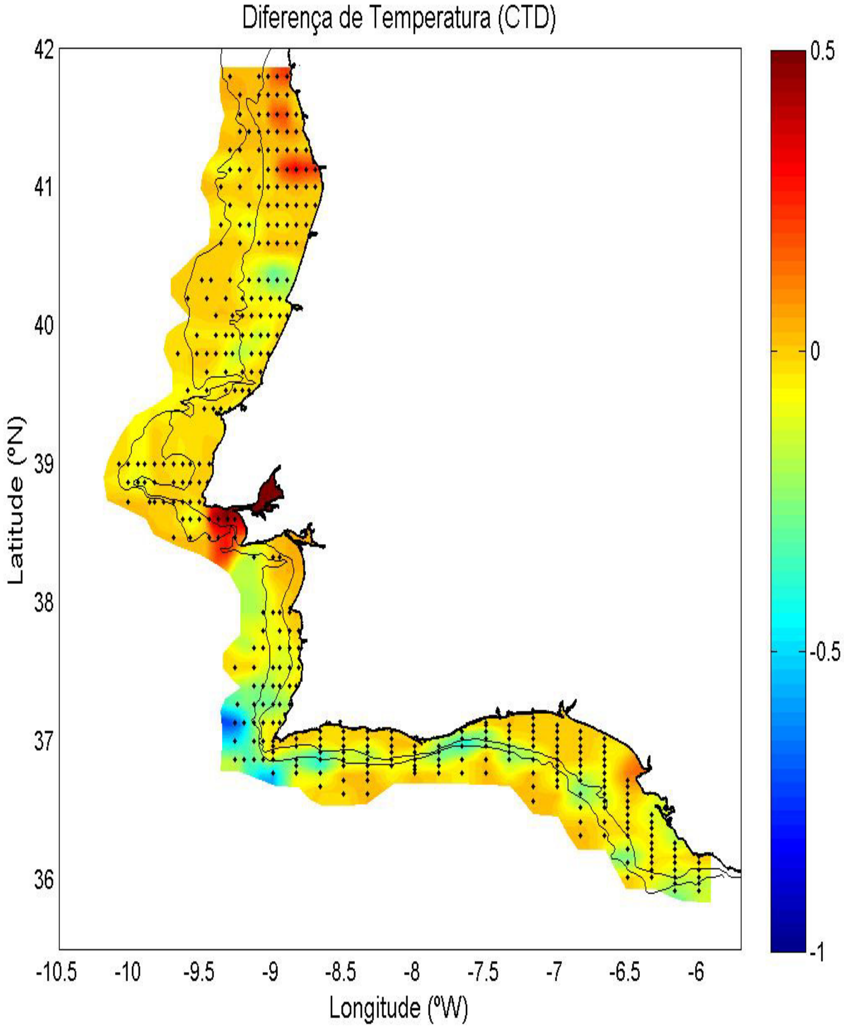


Figure 6.1.2.2. Temperature difference (top-bottom) for the area of the survey, IPIMAR sardine 2005 DEPM.

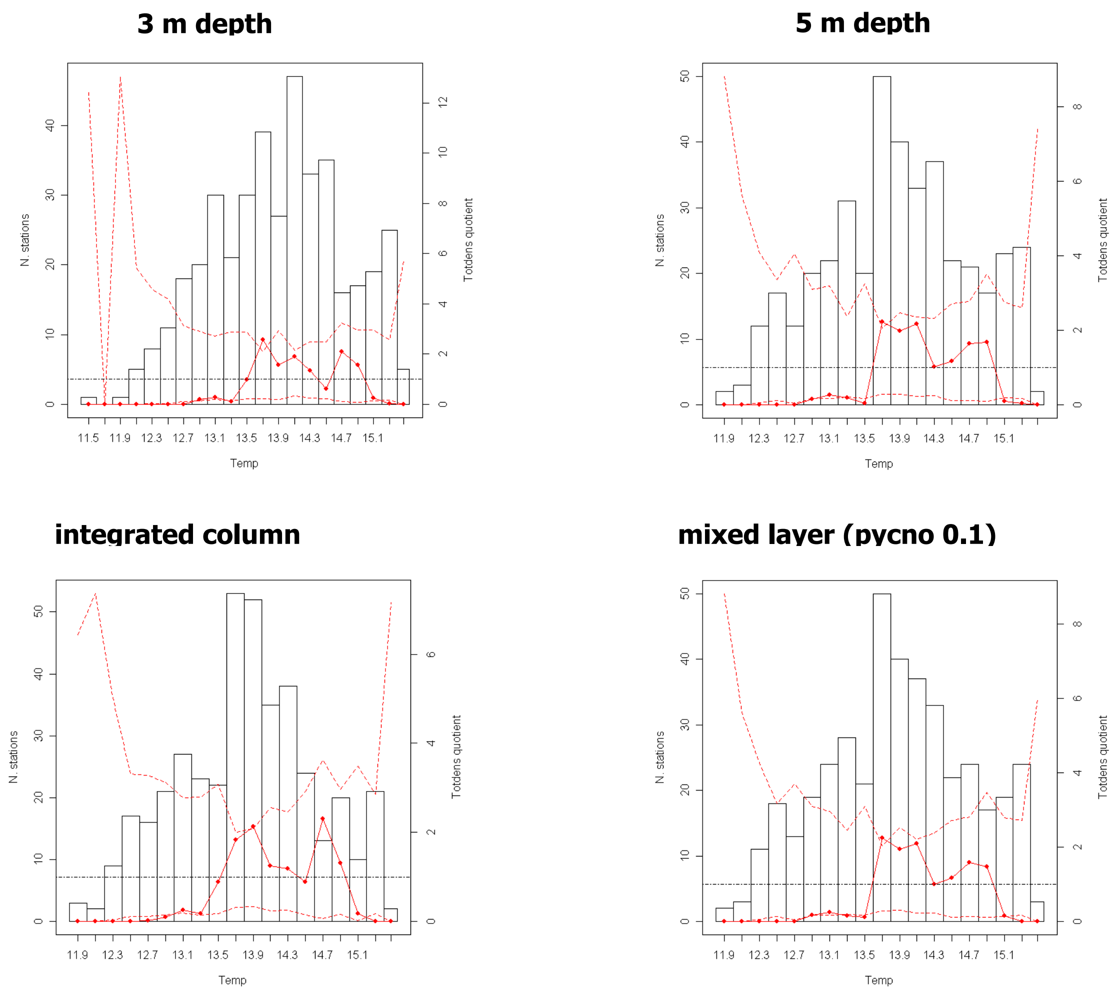


Figure 6.1.2.3. Quotient analysis of sardine egg density in relation to temperature. Temperature values were calculated for different depth strata (top left: surface 3 m from CT; top right: surface average 5m from CTD; bottom left: average of whole water column; bottom right: average surface mixed layer).

Table 6.1.2.1. Egg parameters for IPIMAR sardine 2005 DEPM obtained using temperature values for egg ageing from different depth strata (3m, 5m, average value for whole water column, mixed layer considering a 0.1 difference between consecutive measurements in density as the value defining the depth of the mixed layer). Surveyed area 46405 km²; positive area 19215 km².

Variable	Temperature 3m (CT continuous)	Temperature 5m (CTD)	Temperature integrated column (CTD)	Temperaure mixed layer (0.1 pycno) (CTD)
P0 (egg/m2/day) (cv %)	220.67 (21)	216.64 (21)	217.46 (21)	216.79 (21)
Z (hour^{-1}) (cv)	0.020 (26)	0.019 (27)	0.019 (27)	0.019 (27)
P0 total (eggs/day)	4.24 (21)	4.16 (21)	4.17 (21)	4.17 (21)

6.1.3 Analysis of the sensitivity of incubation temperature on anchovy egg production estimates.

The Daily Egg Production Method applied every year for the estimation of egg production of anchovy (Engraulis encrasicolus) in the Bay of Biscay includes an ageing procedure of eggs in order to convert assigned stages to ages. The Bayesian ageing is commonly applied for this task, but requires the incubation temperature of eggs. This temperature is usually considered to be the value found at 10 metres depth, where maximum concentrations of eggs are typically reported. As this temperature cannot always be recorded, the incubation temperature is estimated as SST minus 1ºC. However, eggs are considered to follow a gradient of temperature due to daily gradient of temperature, possible physical transport, and also different vertical distributions are found depending on the salinity of the area.

Peña et al (WD) state that observed eggs/stages per station should have information about their actual incubation temperature, which could be more valid than assuming a "hypothetic temperature". The WD presents a model for incubation temperature that maximizes the probability of finding those eggs at those stages, given sampling time and distribution of spawning time.

The following data are recorded at each station:

◎: sampling time

t: Sea Surface Temperature (SST)

n1, n2, …, n11: number of eggs at each stage

Assuming independence between eggs, the probability of observing n1, n2, …, n11 eggs at stages 1, 2, …,11 given the sampling time ◎ and temperature t is given by

$$P(n_1, n_2, ..., n_{11} \mid \tau, t) = \prod_{i=1}^{11} P(\, i \mid \tau, t)^{n_i}$$

where $P(\, i \mid \tau, t)$ denotes the probability that an egg is in stage *i* given the sampling time ◎ and temperature *t*. Furthermore, this probability can be computed as:

$$\begin{aligned} P(\, i \mid \tau, t) &= \int_a P(\, i, a \mid \tau, t) da \\ &= \int_a P(\, i \mid a, \tau, t) P(a \mid \tau) da \\ &= \int_a P(\, i \mid t, a) P(\tau - a) e^{-za} da \end{aligned}$$

where $P(\, i \mid t, a)$ is the probability modelled from the incubation experiment, $P(\, \tau - a)$ is the probability that the spawning took place at time $\tau - a$, and e^{-za} is the survival probability of the egg according to the hourly mortality rate z.

The model estimates a probability of observing the eggs at stages at sampling time associated across a range of temperatures from SST downwards (every 0.1°C). As a first approach, a wide range between SST and SST-5°C is considered. The distribution of probabilities shows a number of peaks, depending on the number of stages present (**Figure 6.1.3.1**). Global maximum and maximum closest to surface temperature are evaluated with two controlled simulations: simulation one assumes that three cohort of eggs are spawned in just one layer with a constant temperature of 14°C. Simulation 2 split the eggs into several layers with different temperatures. Both consider no transport, no change in temperature with time, and no vertical movement of the eggs. We then test real data from LHPR. In the three cases we compare the assumed incubation temperature (mean temperature weighted by number of eggs), with the different estimates (CTD temperature at 10 meters depth, SST-1°C and the two modelled temperatures). We also apply the model to estimate production and mortality for BIOMAN surveys between 1995 and 2007 and compare that with estimates using the normal approach (SST-1°C).

We firstly show the implication of the incubation temperature used in the ageing of the eggs. Higher temperatures move eggs towards younger cohorts and decrease the maximum age allowed. Results for simulation 1 and 2 (**Table 6.1.3.1**) and the LHPR data (**Table 6.1.3.2**) show a good fitting of the observed incubation temperature both for the modelled temperature selecting closer to surface maximum and the SST-1°C. We can consider that this model gives an estimate at least as good as the usual approach. The total maximum is more dependent on the stages present, and often underestimates the observed (weighted) incubation temperature. The estimator of the first Maximum (closest to surface) temperature is then retained for the final proposed model. The observed values (weighted mean temperature) for the LHPR exercise are higher than the estimated ones, suggesting eggs might come from areas of lower temperatures, a possibility consistent with the heating processes of spring when the survey is performed.

Finally, historical Egg production and mortality differences using SST-1°C and the modelled temperature (using only the maximum closest to surface algorithm) are compared (**Table 6.1.3.3**). Changes are smaller than 9% except for two years where the mortality was not significant using SST-1°C. The modelled temperature is higher than SST-1, moving eggs towards younger cohorts and cutting off older cohorts; this augments the estimated P_0 in general.

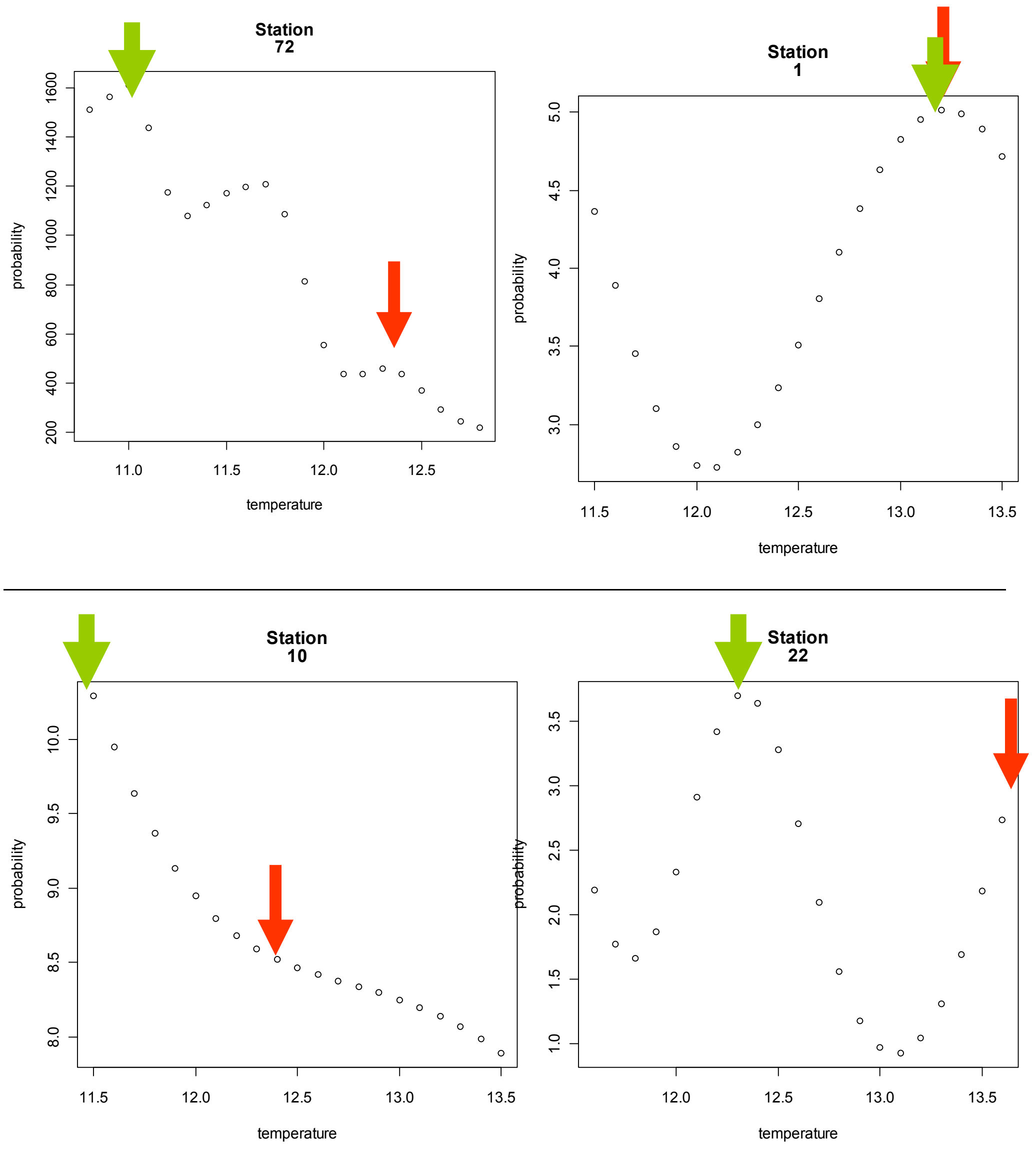


Figure 6.1.3.1. Examples of probability distributions obtained with the modelling; the red arrow shows the surface maximum and the green arrow corresponds to the total maximum.

Table 6.1.3.1. Results for Simulation two.

Time	Observed: weighted mean	SST-1	CTD 10m	Modelled Surface max	Modelled Total max
1	15.34	15.64	14.96	15.34	12.04
2	15.31	15.64	14.96	15.24	12.04
4	15.32	15.64	14.96	15.04	13.24
5	15.33	15.64	14.96	14.84	13.34
7	15.29	15.64	14.96	15.54	13.24
9.5	15.27	15.64	14.96	15.34	14.34
10.5	15.34	15.64	14.96	15.34	14.14
12.5	15.37	15.64	14.96	15.14	14.04
15	15.3	15.64	14.96	14.84	14.84
18	15.32	15.64	14.96	14.44	14.44

Table 6.1.3.2. Differences between observed and estimated Temperatures for the LHPR: mean (sd).

Observed/Estimates	CTD10m	SST–1	surface max. m.	total max m.
Weighted mean T	0.88(0.87)	0.35(0.67)	0.29(0.94)	3.19(1.63)

Table 6.1.3.3. Differences in percentages between estimated P0 and Z of BIOMAN data, when using the traditional incubation temperature (SST–1), and with the new modelled temperature (applied to a range of temperature from SST to SST-2°C). Tincub is the mean incubation temperature using SST-1 as estimate, and Tmod - (SST-1) is the difference in mean temperature using each estimate. Note that for 2005 and 2007 the mortality was not significant using SST-1.

YEAR	DIF P0	DIF Z	TINCUB	TMOD -(SST-1)
1995	3.29%	-1.37%	13.47614	0.34
1996	2.72%	-3.26%	14.18978	0.21
1997	8.91%	12.27%	14.18818	0.21
1998	-8.75%	-26.95%	15.86034	0.18
1999	2.36%	-2.85%	16.73922	0.09
2000	2.53%	-25.14%	15.4891	0.19
2001	7.29%	9.24%	16.11214	0.27
2002	7.58%	13.25%	13.90698	0.20
2003	3.15%	0.92%	16.61075	0.09
2004	8.64%	-0.66%	12.15246	0.18
2005	16.81%	46.58%	14.26252	-0.02
2006	3.85%	1.97%	14.92211	0.10
2007	9.18%	57.71%	14.65205	0.14

6.1.4 An Automated Fecundity Measurements for sardine

A method for facilitating batch fecundity measurements in sardine using digital image analysis software (ImageJ; rsb.info.nih.gov/ij/) has been presented. The method consists of an automated procedure that is capable of treating large series of digital microphotographs of ovarian whole mounts through recognizing, separating and counting only the eggs that belong to the spawning batch, i.e. the hydrated oocytes. To some extent the method resembles the autodiametric method (Thorsen and Kjesbu 2001), though its principles are quite different because it only targets the oocytes of the spawning batch and not all oocytes of the ovary. Specifically, the ImageJ routine included the following sequence of processes: opening of the image, adjustment of brightness and contrast, conversion of the image type to 8-bit, limiting of colour spectrum in a region that includes all the oocytes (thresholding), separation of individual particles among them (segmentation) and counting of all the particles at the size order of hydrated oocytes (650–4000 pixels^2) (**Figure 6.1.4.1**). Parameter values in each of these individual processes (e.g. brightness, thresholding, etc.) were selected so as to give a number of hydrated oocytes as close as possible to their actual number in the microphotograph. When this goal was achieved (using a subset of ~15 specimens) a macro was created through which the entire process was automated, from the opening of the image file to the calculation of batch fecundity (**ImageJ method**). Finally, this macro was applied to the entire database of digital microphotographs (almost 180 specimens).

The results of the ImageJ method were strongly correlated with those from the on-screen, “manual” counting of hydrated oocytes (**reference method**) (**Figure 6.1.4.2a**), which suggested that the ImageJ routine was highly reliable. On the other hand, even if the results of in-situ oocyte measurements under the stereoscope (**classic method**) were significantly related to the reference method the level of correlation was quite low (**Figure 6.1.4.2b**). This was mainly attributed to the use of different ovarian sub-samples, though a small portion of this disagreement might also be due to inefficiency of the classic method.

In addition to its potential to increasing accuracy in the counting of oocytes, the present method offers some significant advantages. After the parameterization of the software, which may be performed by using 10–15 specimens, and the development of the macro for the routine processing of the digital microphotographs, the process of analysing even large volumes of image files may be carried out quite easily and quickly. In particular, it has been estimated that the time needed (beyond the technical work required for the preparation of the whole mounts) to measure oocytes under the stereoscope requires about 5min/specimen, the on-screen counting requires about 3min/specimen, while the 179 images of the database were analysed using the macro of ImageJ in less than 2 hours (or even less depending on the computer's processing capacity). Thus, automation of the process could contribute in saving time and workload and the analysis could be performed 5 to 8 times faster compared to classic fecundity measurements. Furthermore, applications of this method may provide large archives of digital microphotographs to which someone can easily come-back for posterior analysis without depending on the status of stored biological material and the existing laboratory infrastructure (precision gauges, stereoscope, etc.).

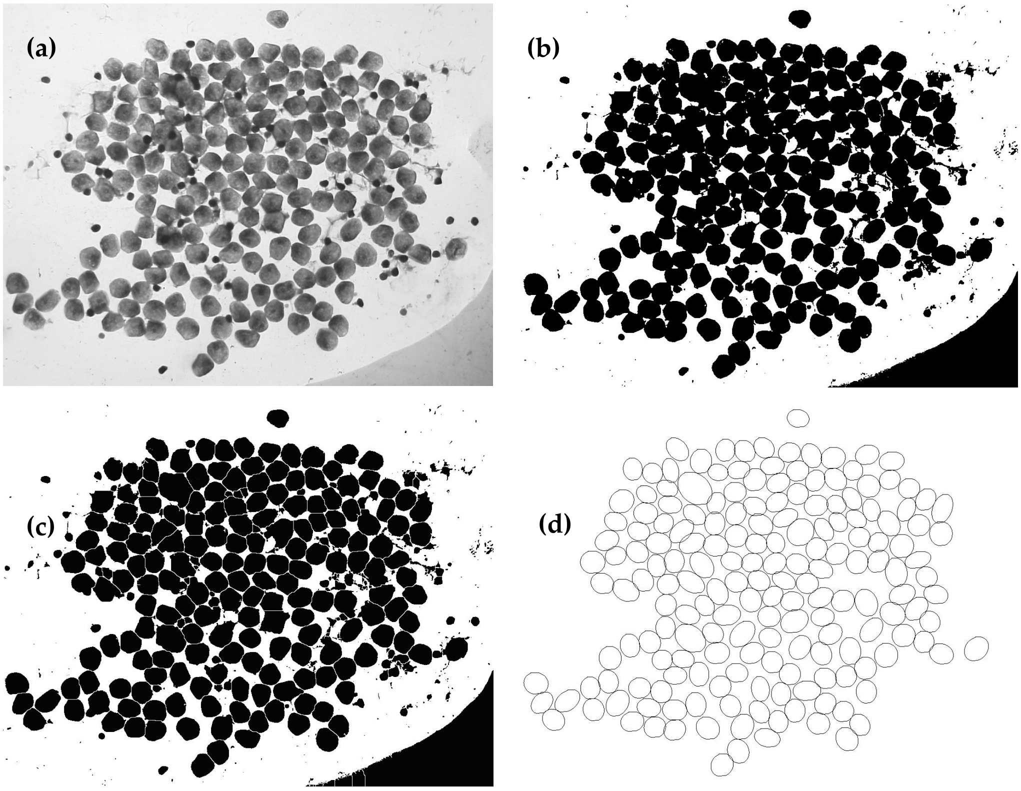


Figure 6.1.4.1. Consecutive phases of the processing of ovarian whole mounts of sardine, Sardina pilchardus, for the counting of hydrated oocytes through the macro of ImageJ: (a) converting image to the 8bit format, (b) thresholding, (c) particle segmentation and (d) counting of oocytes through selecting particles corresponding to the size and the degree of circularity of hydrated oocytes.

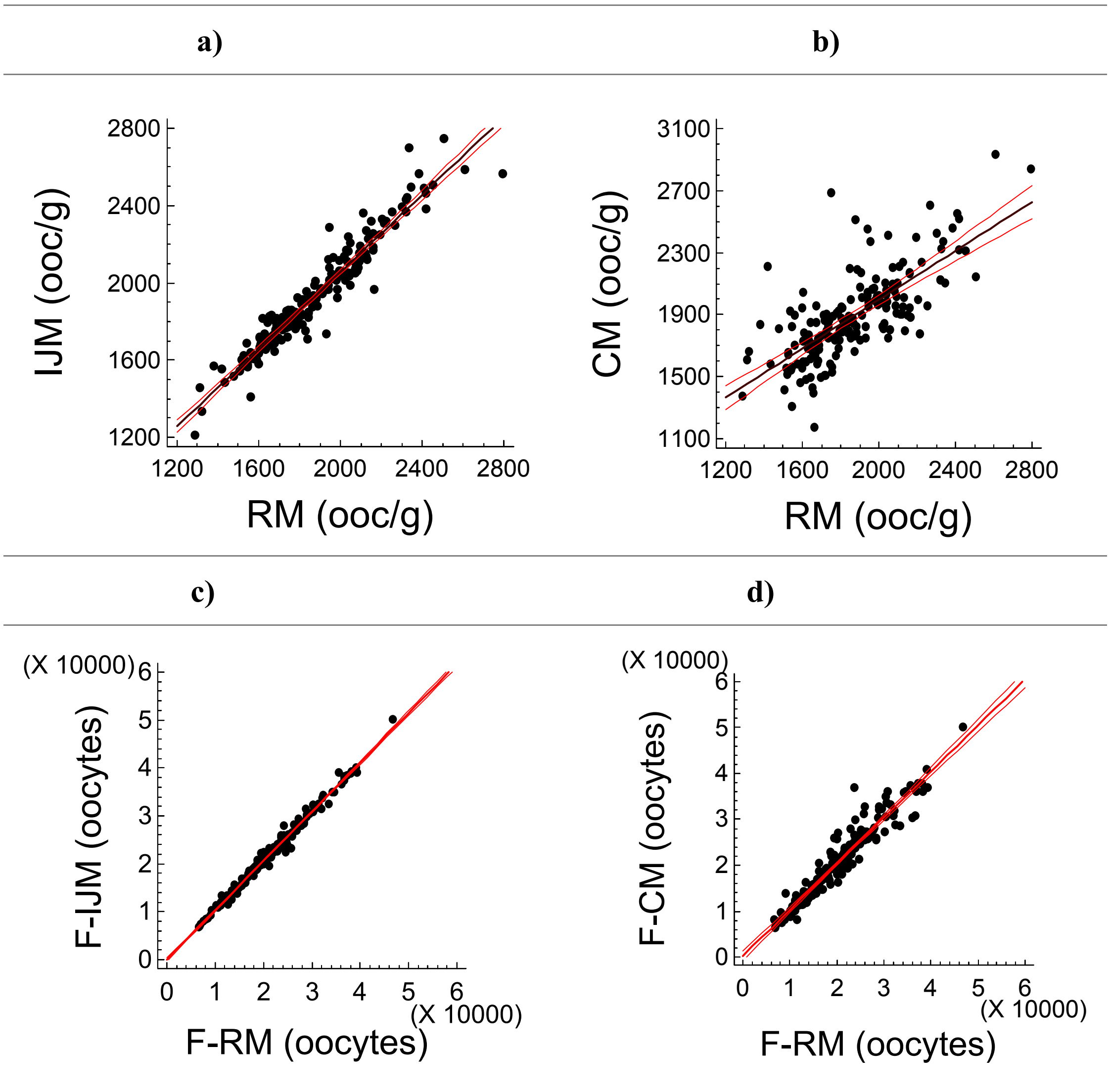


Figure 6.1.4.2. Relationship between the oocyte-densities (upper panels; a and b) and the fecundity values (down panels; c and (d) between the ImageJ method (IJM) and the reference method (RM) (left panels; a and c) and between the classic (CM) and the reference methods (right panels; b and d).

6.2 Progress in acoustic based estimates

6.2.1 Intercallibration of Spanish and Portuguese Spring acoustic surveys

The exercise of inter-calibration between the RV "Thalassa" and RV "Noruega", the two vessels from which estimates of abundance of sardine off the Iberian Peninsula are obtained for assessment purposes, was originally promoted by a request of WGMHSA, after the decision to use jointly the acoustic estimates for sardine by the surveys of IEO and IPIMAR in a single index of abundance (ICES, 2007). The inter-calibration (IC) was performed off northern Portugal (April 2008) at the beginning of the joint spring autumn surveys performed every year off the Iberian Peninsula by IPIMAR and IEO. Two exercises were performed in the IC:

1) Comparison of the independent estimations of sardine within the same area and within a limited time window;

2) Comparison of the data acquisition equipment.

Material and methods

Estimation of sardine: A "box" (**Figure 6.2.1.1**) consisting of six transects was sampled independently by the RV "Noruega" and "Thalassa" The covering of the box by "Thalassa" was performed in the S-N direction starting on March 30 and ending on April 2. Four fishing stations were performed in depths ranging 70 to 170 m according to the presence of echotraces. Commercial fishing gear deployed in the sampling region made fishing operations difficult and even impossible in several locations where identification of the echotraces was needed. RV "Noruega" covered the box N-S starting on April 2 and ending on April 4. Three trawl stations were performed, in the ranges of 40 to 73 m. Echogram scrutiny and abundance estimation were performed independently by each Institution.

Echo-integration of the bottom: The integration of the bottom was performed along two transects separated by 0.1 nautical miles (**Figures 6.2.1.1** and **6.2.1.2**). The two transects were covered twice by each vessel (one in each direction) obtaining two pairs of common integrated transects. Echointegration was performed for coincident 1' long EDSU. NASC per EDSU and NASC per ping per EDSU were calculated for both vessels. The configuration parameters of the acoustic equipment on-board both vessels are presented in **Table 6.2.1.1**. Calibration of the systems was performed independently for the two vessels.

Results

Abundance estimation of sardine:

- For RV "Thalassa", the total capture of sardine in the 4 trawls considered for analysis amounted to just 9 sardine individuals rendering a non-quantifiable abundance.
- For RV "Noruega", the three trawl stations performed yielded a total of 1207 individuals. The trawls were used to allocate echotraces to sardine, that were estimated in 892.6 million individuals and with a biomass of 51.9 thousand tonnes.

Echo integration of the bottom: The comparison of the integration of the bottom showed similar trends both within and between vessels (**Figure 6.2.1.3**). However, a bias was observed with "Thalassa" obtaining in average two times as much echo for the same portion of the bottom than "Noruega". The relative strength of the bias was variable, and apparently increased with the strength of the bottom.

Conclusions

In respect to the discrepancies observed in the estimation of sardine, these can be attributed to the different species compositions observed in the set of trawl hauls available for echogram scrutiny by each Institution. Apart from pure chance and the difficulty of fishing sardine echotraces in a region that was full of fishing gear, it is possible that the community composition had suffered significant changes within the 3 day-period that lagged from the start of "Thalassa" coverage to the end of "Noruega's" one. In summary, given the small amount of fish stations no conclusive results could be obtained from this analysis. It is therefore recommended that a new inter-calibration exercise should be performed during the next spring acoustic survey.

The preliminary analysis performed on the bottom-integration data were not sufficient to explain the differences observed. There are various potential sources of bias that could have been present: cruise track not being exactly the same, motion of the transducer and beam directivity problems due to the higher pitch and roll of RV "Noruega" and additionally differences between the theoretical and effective angles of the transducer. The data need to be analysed more thoroughly to evaluate all the possible causes. If no conclusion about the source of the differences is obtained, then the results will be presented for advice in the next meeting of WGFAST.

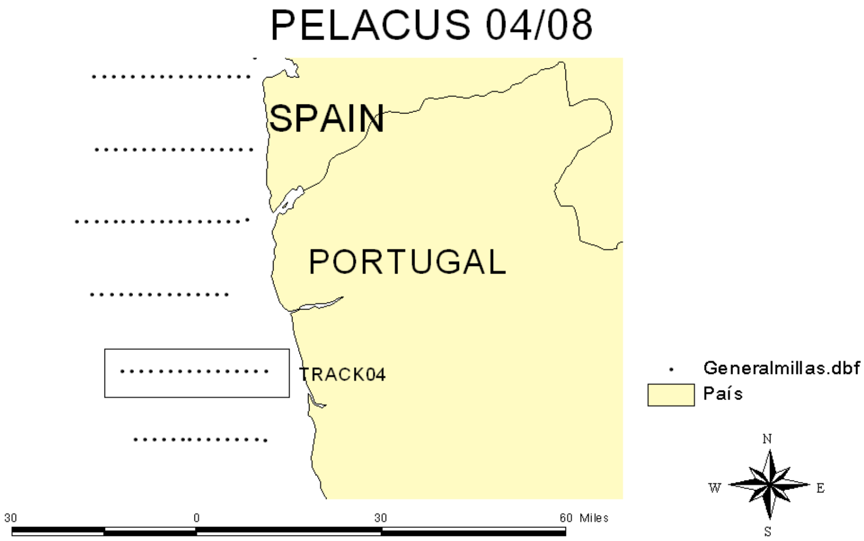
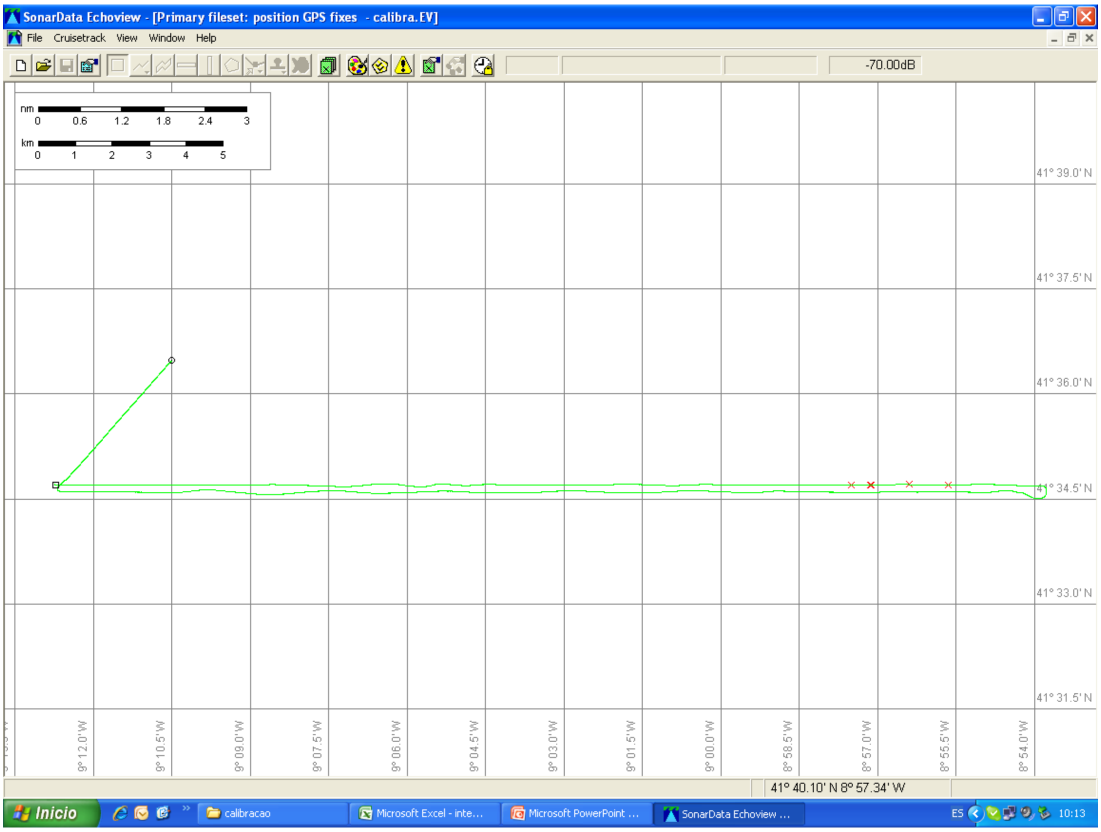


Figure 6.2.1.1. BOX of six transects sampled independently by the RV "Noruega" and "Thalassa" during the inter calibration exercise. The rectangle points out the place where the transects for the Echo-integration of the bottom took place



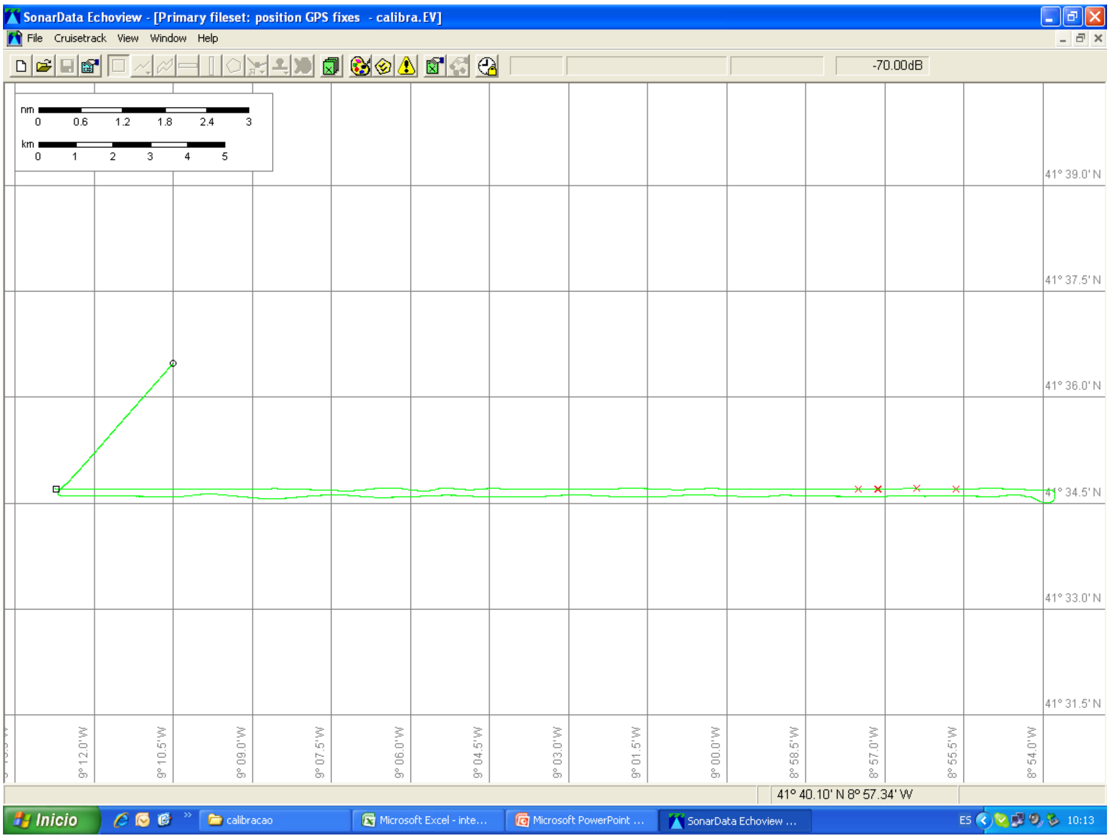
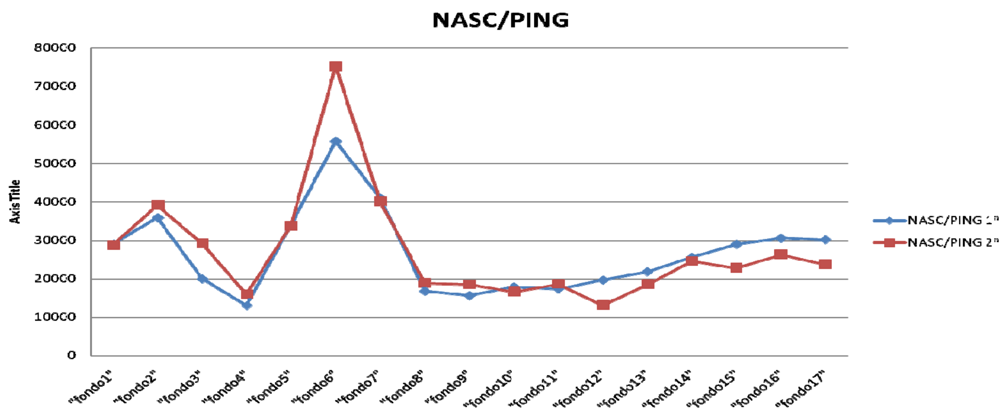
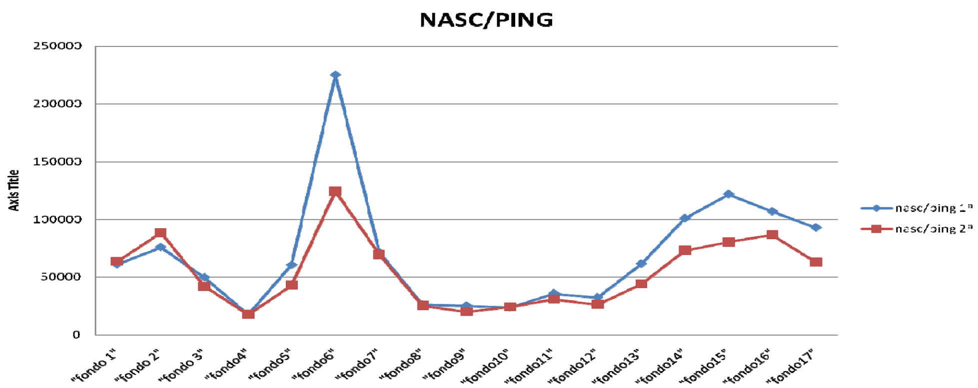


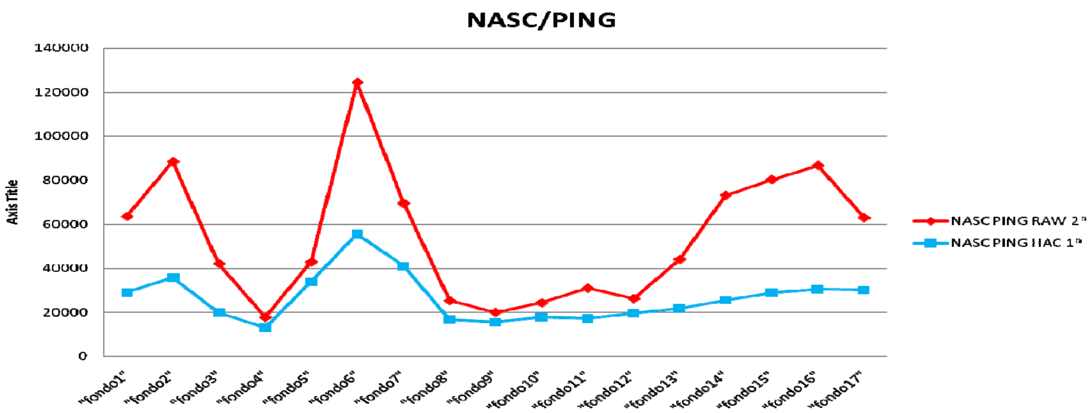
Figure 6.2.1.2. Cruise track of RV "Noruega" during the intercalibration of the bottom. The same track was covered by RV "Thalassa".



R/V "Noruega"



R/V "Thalassa"



R/V "Noruega" (blue) / Thalassa (red) NASC bias.

Figure 6.2.1.3. Bottom echointegration during for the two R/V "Noruega" and "Thalassa" for a selected two times coveraged transect in 2008 (north of Portugal). Upper panels results for "Noruega", mid panel results for "Thalassa" and bottom panel comparison of mean echointegration between the two vessels.

Table 6.2.1.1. Configuration parameters of the acoustic equipment on-board both vessels

	SOUNDER	PULSE DURATION	PRF	EQUIVALENT ANGLE (PSI)
Noruega	EK500	1 ms	1 s^{-1}	-20.2 dB
Thalassa	EK60	1 ms	maximum	-20.6 dB

6.2.2 Report of the intercallibration of the 2008 Bay of Biscay anchovy juvenile surveys (PELACUS10 and JUVENA)

A full day of both surveys was devoted this year 2008 for an inter-calibration exercise of the vessels. However, due to time constrains it was not possible to analyse the inter-calibration data before the dates of the WG. This analysis will be conducted jointly by IEO and AZTI next year 2009, and the results will be reported to the next WGACEGG meeting.

6.2.3 Pilot experiences of acoustic surveying of pelagic resources in the Gulf of Cádiz shallow waters (< 20 m depth): PACAS 0708 and PACAS 1008 surveys

Studies on small pelagic fish by acoustic surveying in the Gulf of Cádiz may be limited by the fact that the research vessels routinely used for such purposes are usually restricted to surveying areas with a bottom depth >20 m. This is just the case for the IEO's RV "Cornide de Saavedra" and in a lesser extent for the IPIMAR's RV "Noruega". The implementation of this sampling scheme usually results in an unsampled area, located in the central part of the study area (between Guadiana and Guadalquivir river mouths; **Figure 6.2.3.1**), which, depending on the research vessel, may represent a relatively large proportion of the continental shelf. The biomass in this area might be important and must be taken into account in assessment methods in order to avoid underestimation and misleading interpretations in population dynamics (Brehmer *et al.*, 2006). In fact, several evidences reported in the literature (García-Isarch *et al.*, 2003; Baldó *et al.*, 2006; ICES, 2007); emphasize the importance of this unsampled area as spawning, nursery and recruitment area for small pelagic fish species.

During the 2007 WGACEGG meeting, a general plan for the design and execution of a potential internationally coordinated sardine recruitment survey in future only covering the main recruitment areas for this species in ICES Division IXa was defined. In the Gulf of Cádiz the scope of this survey should also be extended to the provision of a recruitment index for anchovy (ICES, 2007). For the reasons given above, in this last area the inshore coverage should be extended below the 20 m isobath to accommodate the potential presence of anchovy juveniles (especially young anchovy) at lower depths. Furthermore, this inshore coverage also should be taken into account when planning the conventional "pelagic ecosystem" surveys.

The standard approach to tackle the problem of acoustically surveying shallow waters using vertical echosounding (VES) is based on the conduction of a survey of these waters with a small-draught vessel complementary to the "standard" survey carried out by the conventional research vessel (see *e.g.* Gerlotto *et al.*, 1992; Guillard and Lebourges, 1998; Brehmer *et al.*, 2006). The adoption by IEO of this approach as its standard sampling scheme for the acoustic surveying of the Gulf of Cádiz waters firstly required to assess the availability of small-draught vessels capable of conducting this kind of survey. In this context the *PACAS* experiments (*Pilot experiments of acoustic surveying of pelagic resources in the Gulf of Cádiz shallow waters (< 20 m depth)*) were planned during 2008 (Ramos *et al*., Presentation, this WG). The available research vessels selected as candidates to be tested in these pilot surveys were the IEO's RV "Francisco de Paula Navarro" and the Ministry of the Environment, and Rural and Marine Affairs's RV "Emma Bardán". Technical characteristics of these vessels compared with the ones of the bigger vessel routinely used by IEO in the study area (RV "Cornide de Saavedra") are shown in the text table below:

RV	LENGTH (M)	WIDTH (M)	DRAUGHT (M)	GRT	HP
Cornide de Saavedra	66,7	11,3	4,65	1113	2250
Fco. de Paula Navarro	30,5	7,4	4,26	178	750
Emma Bardán	29,0	7,5	3,90	200	900

As shown in the above table, the draughts of the selected vessels were not surprisingly much smaller than the one of the IEO's flagship. Moreover, ship-time available for each vessel was short: 7 days in July for the RV *Fco. de Paula Navarro* (*PACAS 0708* survey: 17 – 24 July) and 6 days in October for the RV *Emma Bardán* (*PACAS 1008* survey: 11 – 17 October). Initially, the main objectives of these experiments were established as follows:

- To assess the potential (equipment and facilities) of the research vessels under study as observational platforms for the acoustic surveying by VES of the Gulf of Cádiz coastal shallow waters (<20 m depth).
- To estimate and to map by VE-integration the abundance and biomass of the main neritic pelagic fish species in shallow waters (and biological information).However, some survey logistic-based limitations (*i.e.* short

ship-time available, very few suitable home-ports given the RV's draughts, working hours for the crew usually restricted to 8:00 to 18:00 hours, a limited (6 people in "*Navarro*") o very limited (3 people in "*E. Bardán*") accommodation of scientific staff for a 24 h stay on-board) led to reject the second main objective and to replace it by the following survey-specific objectives:

PACAS 0708 survey (RV "Francisco de Paula Navarro"):

- To assess the suitability of the available equipment for the (scientific) acoustic surveying and pelagic fishing.
- To assess the skills and capabilities of the RV captain and crew for the pelagic fishing (both at midwater and close to the bottom) in shallow waters through training.

PACAS 1008 survey (RV "Emma Bardán"):

- To mimic the acoustic surveying tracks and fishing operations as in the previous survey for comparison.
- To locate and identify the echotraces corresponding to anchovy and sardine recruits in the water column and their availability to the sampling gears.

Because the acoustic assessment itself was not considered a relevant issue for these experiences no extra-time was invested in the calibration of acoustic equipments although some tests for recording the "self-noise" generated either on or by the vessel were performed. Regarding the tested acoustic equipments, the RV "Francisco de Paula Navarro" was equipped for the *PACAS 0708* survey with its usual non-scientific echosounder *Simrad ES60 Single-Beam Multi-Purpose Fish-Finder*, only working with a *Simrad Single-Beam* 38 kHz GPT and transducer. An *ad hoc* configuration of both the echosounder's GPT and the *ES 60 BI500* software interfaces was arranged with the aim of exporting raw data files in a suitable way to the *Echoview* software implemented in the instrumentalist's portable computer (working with the combined system of *Echolog 60* and *Live Viewing Echoview*'s modules) and to one portable computer placed in the governing deck (working with an specifically developed software by the IEO's acoustic team). Such a configuration allowed a real time visualization (both in the acoustic laboratory and governing deck), scrutiny and quality control data while acoustic data were stored in *Echoview*. The RV "Emma Bardán" was equipped for the *PACAS 1008* survey with its usual scientific acoustic equipment (*Simrad EK60 Split-Beam Scientific Echosounder System*, with split-beam single-frequency GPTs and transducers for 38, 120 and 200 kHz working frequencies; *Simrad ER60 Scientific Echosounder Operating Software*). The raw files generated by the *ER60* software were also exported to the *Echoview* software.

Results from the respective tests for the RV's "self-noise" should wait for a pertinent comparison with known noise "signatures" of other research vessels, although data seem to suggest reasonably acceptable noise levels for the 38 kHz transducers at usual acoustic surveying speeds in both research vessels. As expected, "E. Bardán" behaved as a less noisy vessel than "Navarro".

The acoustic surveying was only restricted to the two closest transects to the home-port, Cádiz, (*PACAS 0708*), or to the closest one (*PACAS 1008*; **Figure 6.2.3.1**). Ship-time in both experiments was preferably invested in performing as many fishing operations as possible (aimed to training, to achieve a suitable gear rigging and/or gear monitoring by sensors, to search for recruits, etc.). The acoustic surveying was carried out at a mean speed of about 10 knots by "*Navarro*" and between 8.5 and 9 knots by "*E. Bardán*" and the shallowest limits surveyed by each of the vessels under study were of 6–7 m depth for the former vessel and about 10 m depth for the last one. For both vessels and surveys it was demonstrated that the acoustic surveying of very shallow waters in the study area is possible whenever the sea conditions are lower than 4 in the Douglas scale. Acoustic records from the autumn survey are not yet available and they were not provided to this WG. Nevertheless, the echograms recorded during summer experiment showed the occurrence of much contrasted situations in relation to the school number, size and density of schools. Anyway, the occurrence of relatively big and dense schools in conventionally unsampled shallow waters has been acoustically confirmed (**Figure 6.2.3.2**). Such data are therefore clearly indicative of the necessity of surveying these shallow waters in order to obtain an unbiased estimation of the population abundance of neritic species in the study area.

In relation to the sampler gears used by each research vessel, the "*Navarro*" was equipped with two different samplers: its standard configuration for bottom-trawl fishing and consisting in the great vertical opening *GOC 73* bottom-trawl gear (3.5 m standard mean vertical opening, 20 mm-mesh size in the inner small-meshed codend) and the *Morgére WH-S(8)* trawl doors (2,6 m^2, 350 kg), and because this research vessel is not equipped with any pelagic gear and it is not familiarised with this kind of fishing, it was also arranged with an *ad hoc* (and complicated) configuration consisting in the arrangement of the RV "Cornide de Saavedra's" smaller pelagic trawl gear, the *Pedreira* pelagic trawl gear (10 m vertical opening; 20 mm-mesh size in the inner small-meshed codend), with the *Morgére* doors. For the autumn experiment, the "*E. Bardán*" was only equipped with its standard configuration for pelagic fishing: the *Gloria 352* pelagic trawl gear (10–12 m standard mean vertical opening; 4 mm-mesh size in the inner small-meshed codend) with the *Poly-Ice Apollo* (3,0 m2; 350 kg) pelagic trawl doors. Gear geometry and performance while trawling were monitored either by *SCANMAR* sensors system ("*Navarro*") or *Simrad ITI* system ("*E. Bardán*").

Eleven and twelve valid fishing stations were carried out during summer and autumn experiments, respectively (**Figure 6.2.3.3**). In summer the eleven valid stations carried out by the "*Navarro*" were distributed between four *GOC 73* fishing stations (duration: 30–45 minutes; trawling speed: 3.2–3.6 knots; bottom depth: around 20 m; yields: 55–228 kg/h) and seven *Pedreira* ones (duration: 21–58 minutes; trawling speed: 3.4–4.1 knots; bottom depth: 19–69 m; yields: 4–98 kg/h). The fishing stations carried out in autumn with the *Gloria 352* gear by the "*E. Bardán*" were characterized as follows: duration: 39–67 minutes; trawling speed: 3.8–4.9 knots; yields: 6–1588 kg/h). Results from the gear monitoring during trawling in the *PACAS* surveys are only available for the WG for the summer experiment and showed that *GOC 73* gear performed according to its standards whereas the *Pedreira* gear showed rather unstable during the 15–25 first minutes of trawling (**Figure 6.2.3.4**). A preliminary data analysis from sensors recordings from the *Gloria 352* hauls also suggests an unstable behaviour during fishing and a usual vertical opening of only 6 m, shorter than its standard one of 10–12 m.

A between-gear comparison of the species composition in pooled catches by gear demonstrated that the "*Navarro*"'s *GOC 73* bottom-trawl gear behaved as a partial sampler of coastal pelagic species as expected given its only 3 m vertical opening (**Figure 6.2.3.5**). Irrespectively of the survey and the different gear catchability, pelagic gears surprisingly showed a very similar species composition, with typical neritic species well represented in catches from both gears. Nevertheless, catches with pelagic gears showed noticeable differences when compared along the depth gradient probably suggesting a different seasonal pattern in depth. So, the anchovy/sardine ratio in catches from the summer experiment seems to be rather similar and balanced in waters deeper and shallower than 25 m depth, whereas in autumn this ratio favours to anchovy in shallower waters (**Figure 6.2.3.6**).

The between-gear comparison for anchovy size composition evidenced a more mixed size composition as sampled by the *Pedreira* pelagic trawl gear than by the *GOC 73* botttom trawl gear in the summer *PACAS 0708* survey (**Figure 6.2.3.7**). During the autumn *PACAS 1008* survey the *Gloria 352* pelagic trawl gear sampled a rather homogeneous size composition only distorted by the catch of very tiny anchovies in the fishing station P04. Notwithstanding the above, fishing stations in the autumn experiment yielded as a whole a smaller mean size than in the summer experiment indicating that this survey was conducted close to the peak recruitment season (**Figure 6.2.3.7**). Anchovy size composition also showed some seasonal differences in the bathymetric gradient as evidenced from catches with the corresponding pelagic trawl gears (**Figure 6.2.3.8**). In the summer experiment anchovy showed a very consistent pattern of an increasing mean size with depth. Such a pattern was not so evident in autumn because the smallest anchovies were not captured in the shallowest waters but within the 20–30 m depth range.

For sardine, the *Pedreira* and *GOC 73* trawl gears yielded a very different size composition of the sampled population in the summer experiment: the *Pedreira* gear sampled a more complex size composition than the *GOC 73* gear although composed by relatively larger sardines (**Figure 6.2.3.9**). The species' size composition sampled by the *Gloria 352* pelagic trawls in autumn showed a larger mean size than in summer catches, although was still presenting a well represented small modal size class at 12 cm featuring to sardine recruits (**Figure 6.2.3.9**). In the bathymetric gradient the species also showed seasonal differences: in summer the pattern exhibited by sardine was identical with the anchovy's with a progressive increase in the mean size with an increasing depth. In autumn, sardine size composition along the depth range seems to resemble to the one previously described for anchovy, with the most of recruits concentrated in the 20 – 30 m depth range, although they were also occurring in shallower and deeper depths (**Figure 6.2.3.10**).

Although limited to a very located area the above results suggest that the surveyed area for sampling anchovy recruits might be restricted not beyond the 50 m isobath whereas for sardine the deeper limit should be established in deeper waters, perhaps at the 100 m isobath. In any case, complementary information on sardine distribution from the autumn Portuguese surveys will be necessary to properly plan future recruitment surveys in the Gulf of Cádiz.

These first impressions obtained from both experiments lead to initially consider to the RV *Emma Bardán* as a more suitable vessel than the RV *Fco. de Paula Navarro* in terms of their usual acoustic equipment (although the "*Emma Bardán*" would require a better monitoring system of the pelagic fishing) and pelagic trawl gear on-board used as sampler. Nevertheless, the *Emma Bardan*'s restrictions in the accommodation of scientific staff for a 24 h stay on-board (only 3 people) may be a serious limitation for the conduction of a survey according to the standards of a conventional "pelagic ecosystem" survey. Such restrictions should necessarily involve a re-adjustment of the conventional survey's objectives to the vessel's logistic and type of survey (either as a complement of the conventional summer survey or as a recruitment one). AZTI expertise achieved during the *JUVENA* surveys with this research vessel may be of a great help to accommodate the vessel's logistic to particular case of the acoustic surveying of the Gulf of Cádiz shallowest waters. Notwithstanding the above, the "*Navarro*", given its great manoeuvrability, is still an alternative candidate whenever it be conveniently equipped (implying certain investment) from an acoustic and fishing point of view.

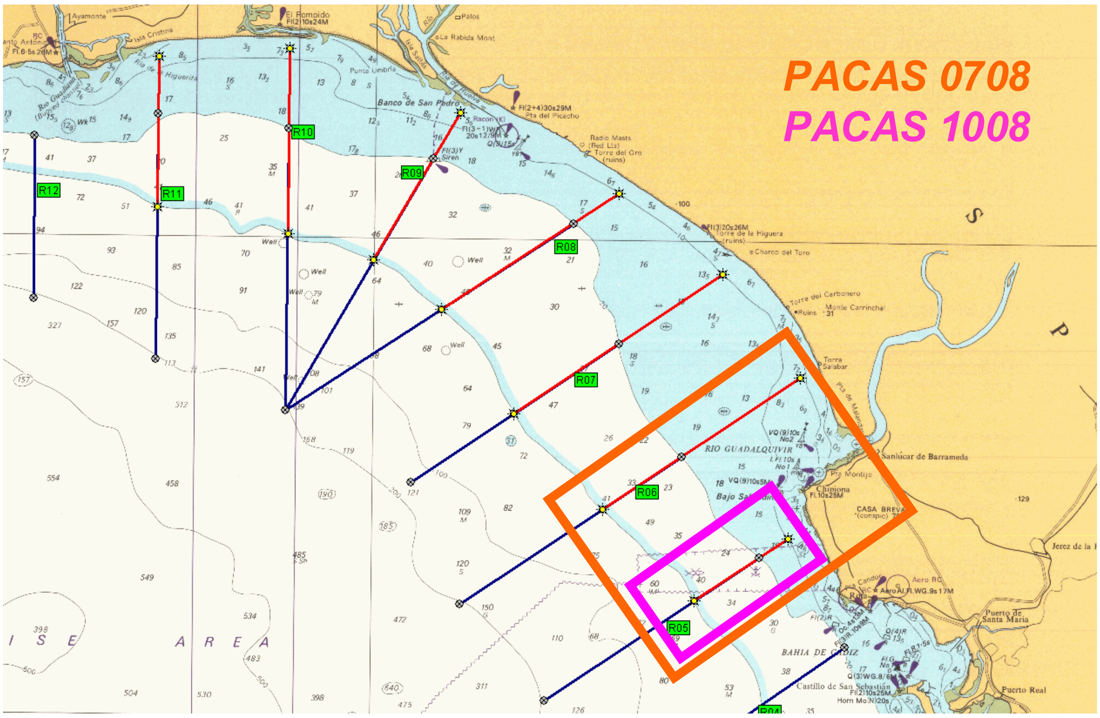


Figure 6.2.3.1. ***PACAS*** **surveys. Initially foreseen sampling grid for the** ***PACAS*** **pilot experiences (transects in red, inter-spaced 8 nm, from the 50 m depth towards the shallowest depth). This sampling grid partially overlaps with the one of the conventional IEO acoustic surveys in the area (in blue,** ***ECOCÁDIZ*** **surveys, from 20–200 m depth). Orange and purple boxes include to the acoustic transects finally surveyed in the** ***PACAS 0708*** **and** ***PACAS 1008*** **surveys, respectively.**

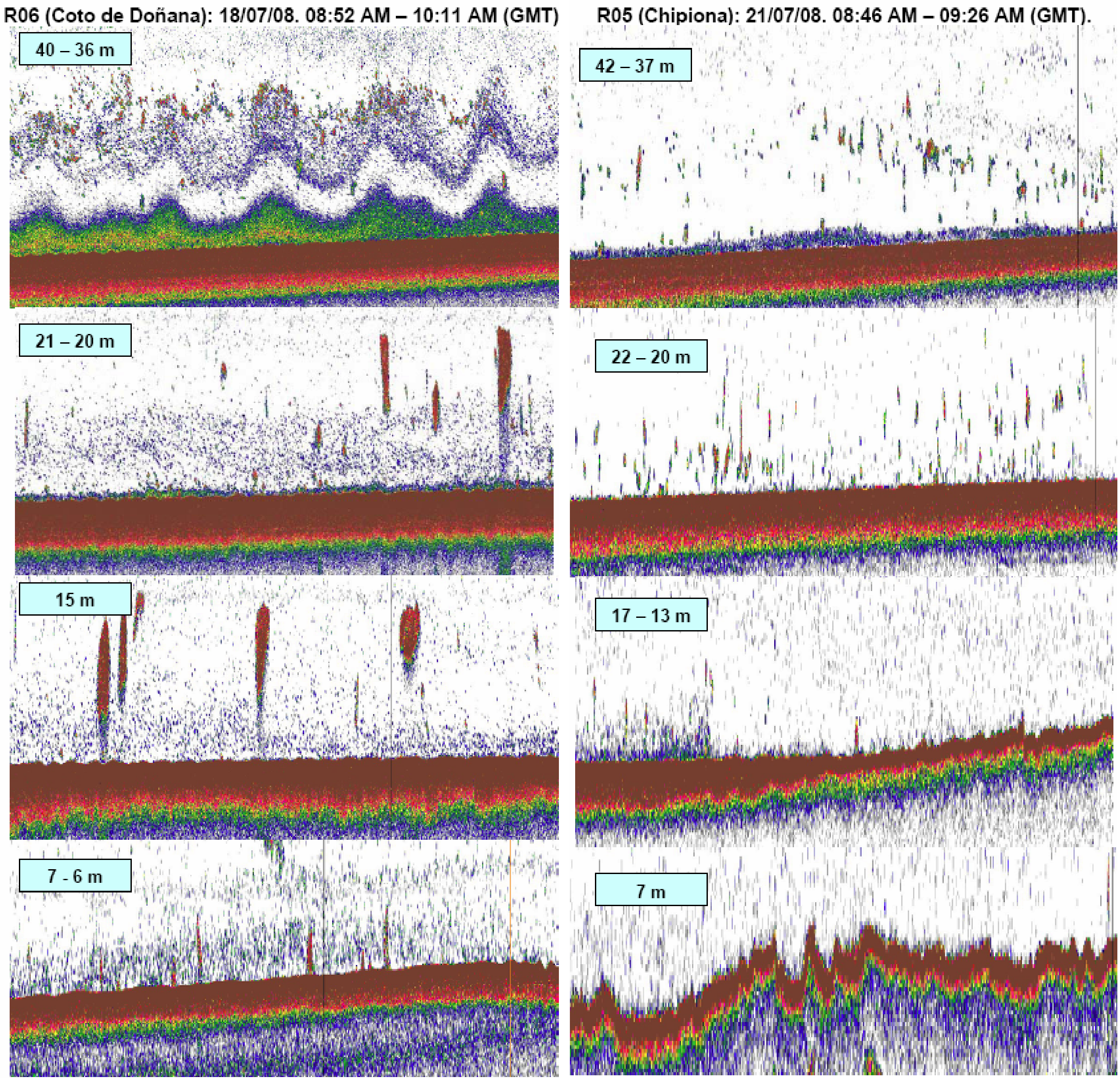


Figure 6.2.3.2. ***PACAS*** **surveys.** ***PACAS 0708*** **survey. Echograms recorded at different depth intervals during the acoustic surveying of transects** ***R05*** **and** ***R06*****. Results from the acoustic surveying of the transect** ***R05*** **during the** ***PACAS 1008*** **survey not available during the WG meeting.**

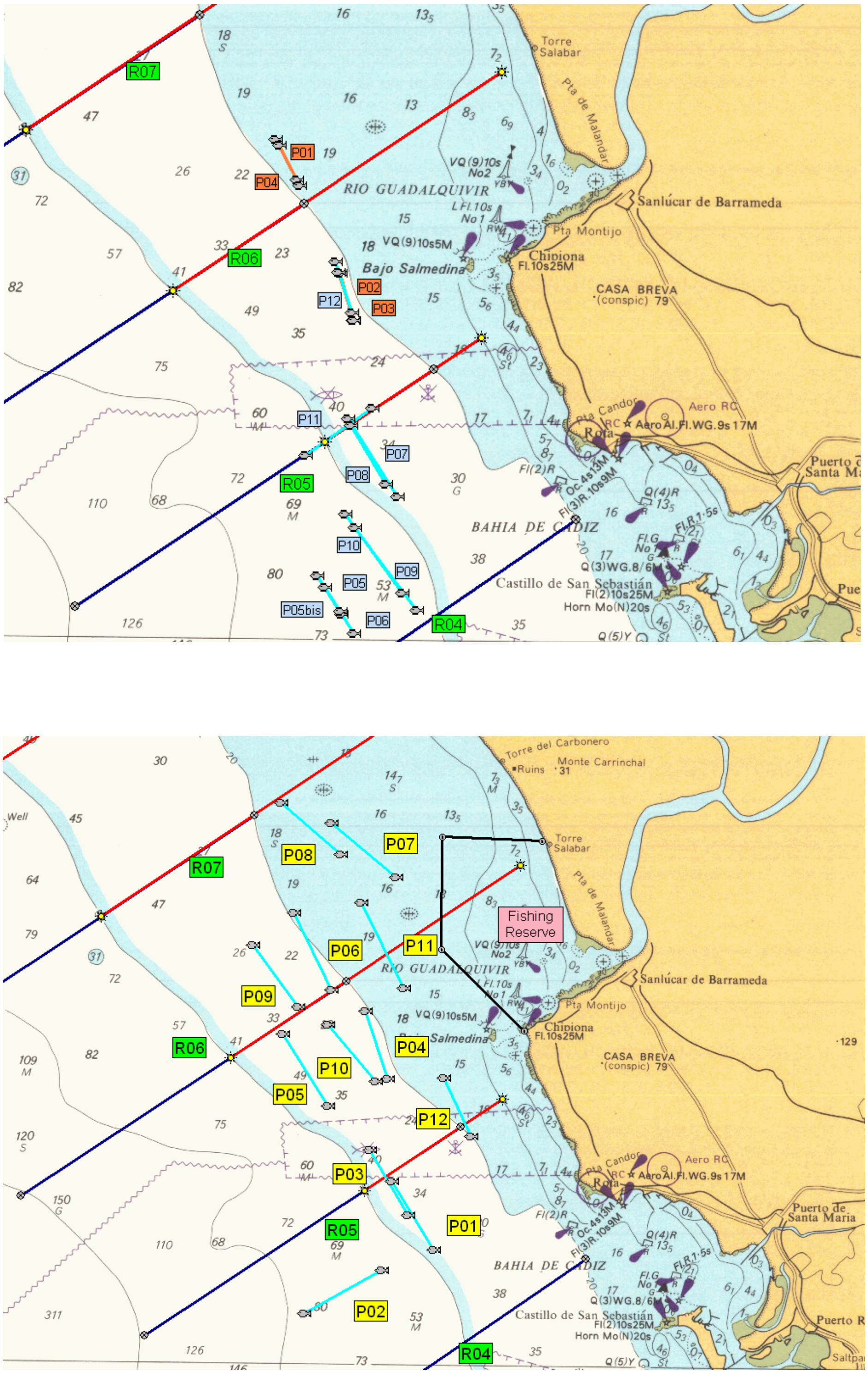
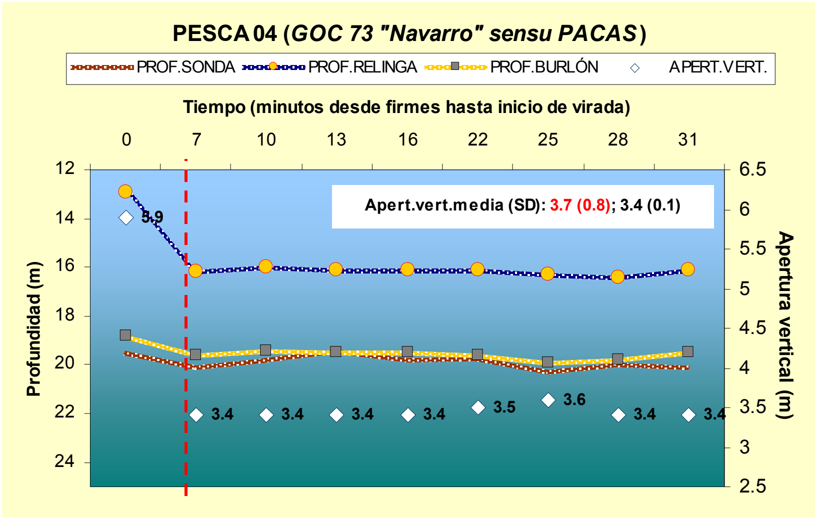


Figure 6.2.3.3. ***PACAS*** **surveys. Fishing stations (labelled as Pxx) carried out during the** ***PACAS 0708*** **(upper map) and** ***PACAS 1008*** **surveys (bottom map). Tracks of the fishing stations performed with a** ***GOC 73*** **trawl gear by the RV** ***Fco. de Paula Navarro*** **in orange. Tracks of fishing stations performed with the pelagic trawl gears** ***Pedreira*** **(light blue labels) and** ***Gloria 352*** **(yellow labels) in light blue. Limits of the area inside the Fishing Reserve of the Guadalquivir river mouth where only gillnet and trammelnet artisanal is allowed is also shown. Research fishing in this box was also prohibited during the** ***PACAS*** **surveys.**



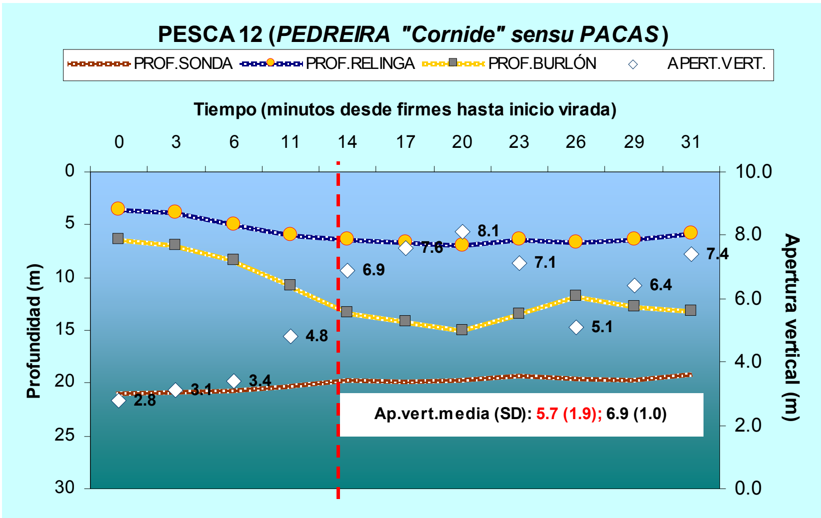
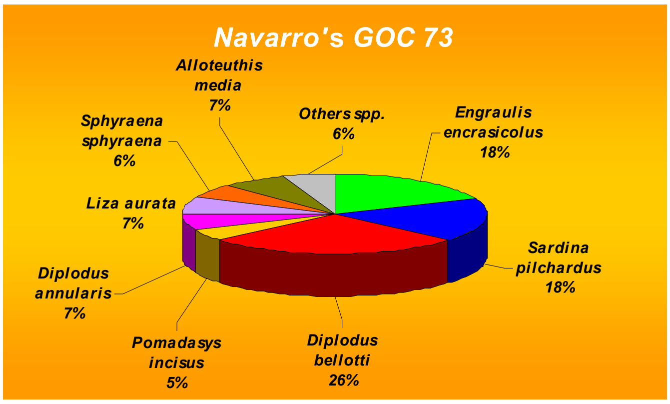
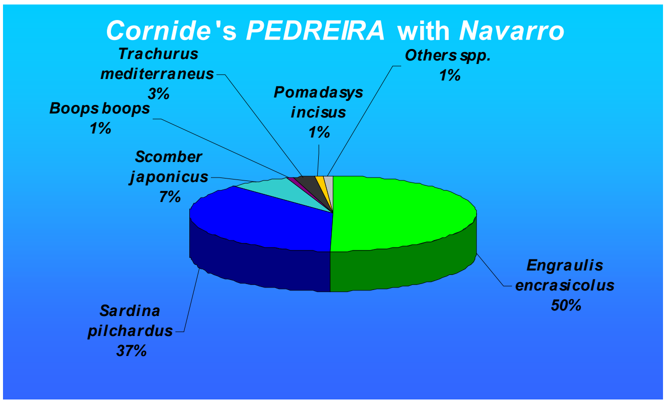


Figure 6.2.3.4. *PACAS* **surveys.** *PACAS 0708* **survey. Some examples of the gear monitoring with** *SCANMAR* **sensors during the execution of fishing hauls. Upper figure: fishing station P04 with the** *GOC 73* **bottom-trawl gear. Bottom figure: fishing station P12 with the** *Pedreira* **pelagic trawl gear. PROF.SONDA: bottom depth; PROF.RELINGA: depth of the float rope; PROF.BURLÓN: depth of the groundrope; APERT.VERT.: vertical opening . The dotted red line denotes the time when the gear started to behave relatively stable. Value in red corresponds to the mean vertical opening estimated by including all the recorded values.**





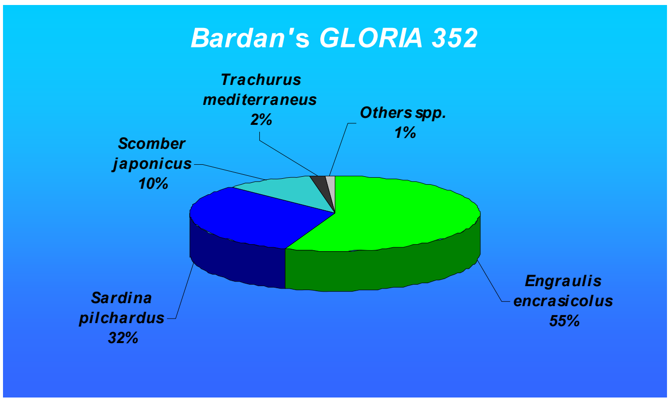


Figure 6.2.3.5. *PACAS* surveys. Species composition (% in number/h) for pooled data from hauls made with the *GOC 73* bottom-trawl gear, the *Pedreira* pelagic trawl gear (*PACAS 0708* survey), and the *Gloria 352* pelagic trawl gear (*PACAS 1008*).

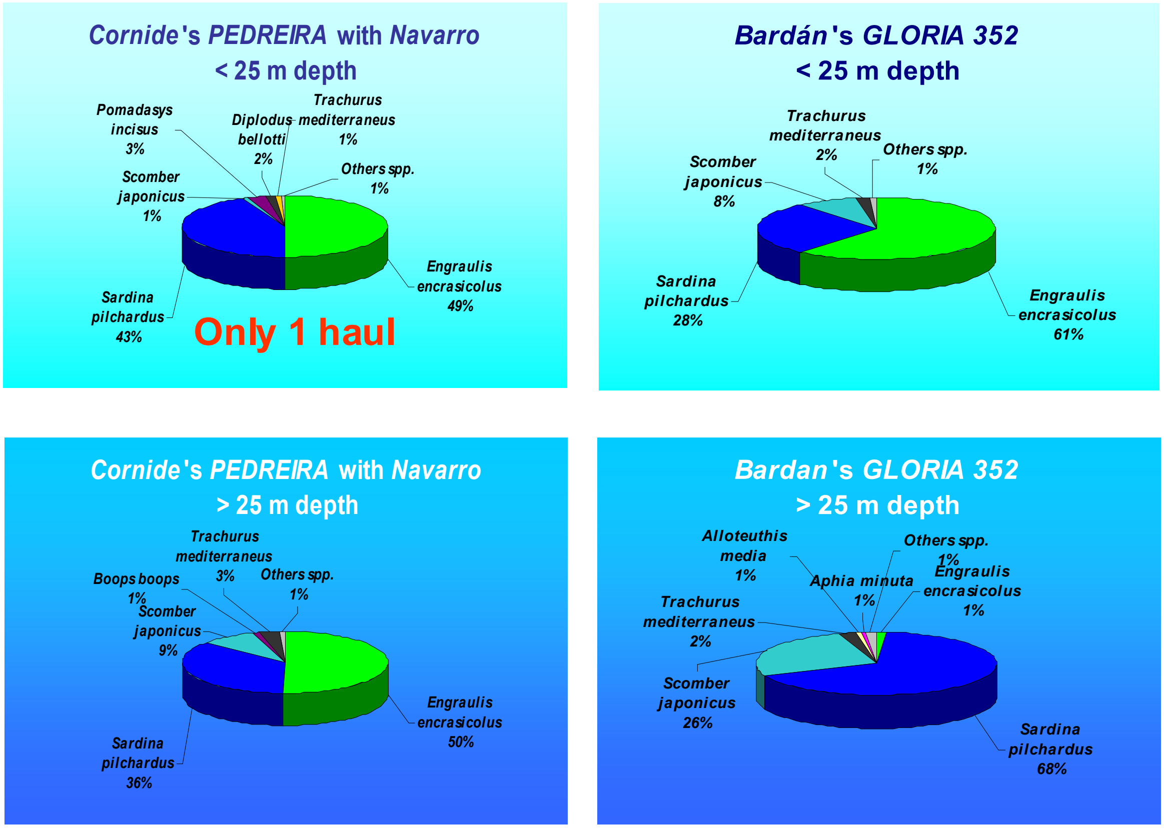


Figure 6.2.3.6. *PACAS* surveys. Species composition by depth strata (% in number/h) for pooled data from hauls made with the *Pedreira* (*PACAS 0708* survey) and the *Gloria 352* pelagic trawl gears (*PACAS 1008*).

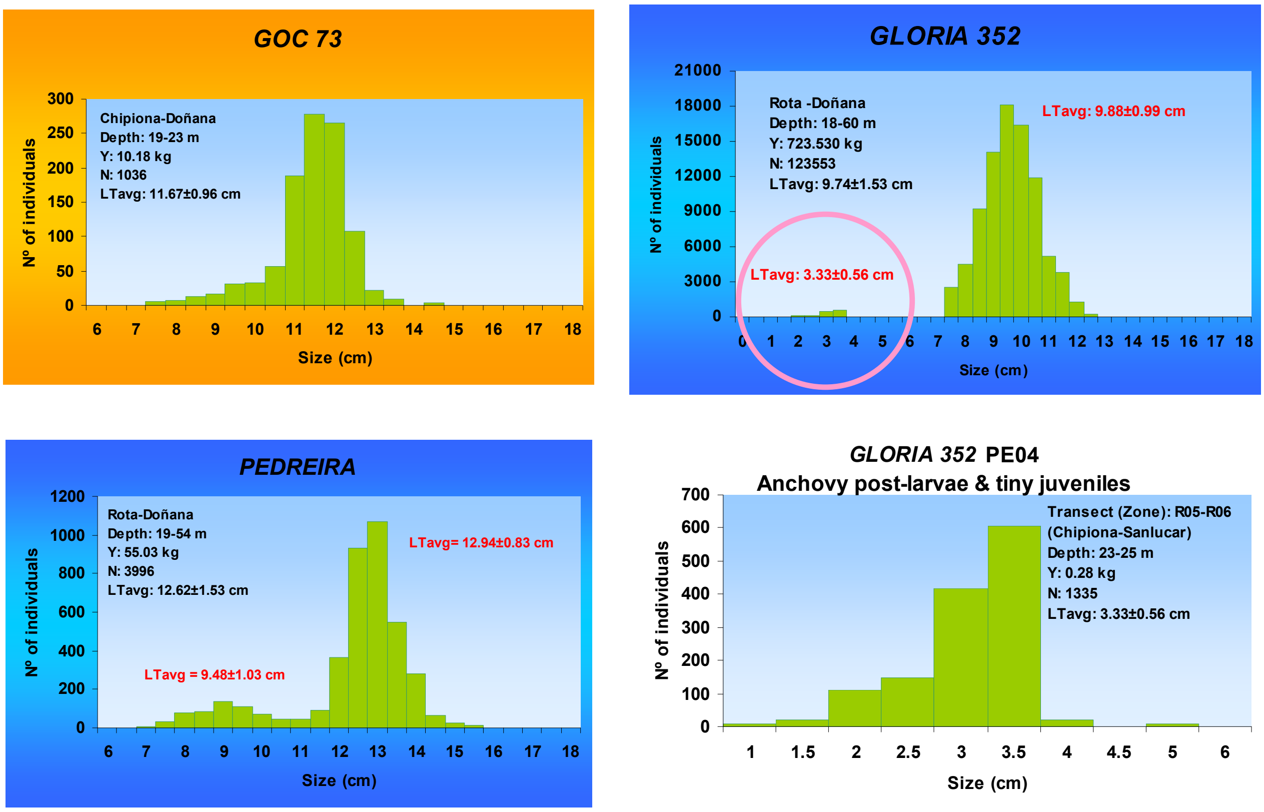


Figure 6.2.3.7. *PACAS* **surveys. Anchovy (***Engraulis encrasicolus***). Overall length frequency distribution by gear with indication of overall mean length and mean length by modal component. For the** *Gloria 352* **pelagic gear in the** *PACAS 1008* **survey is also shown the length composition from very tiny anchovies captured in fishing station P04.**

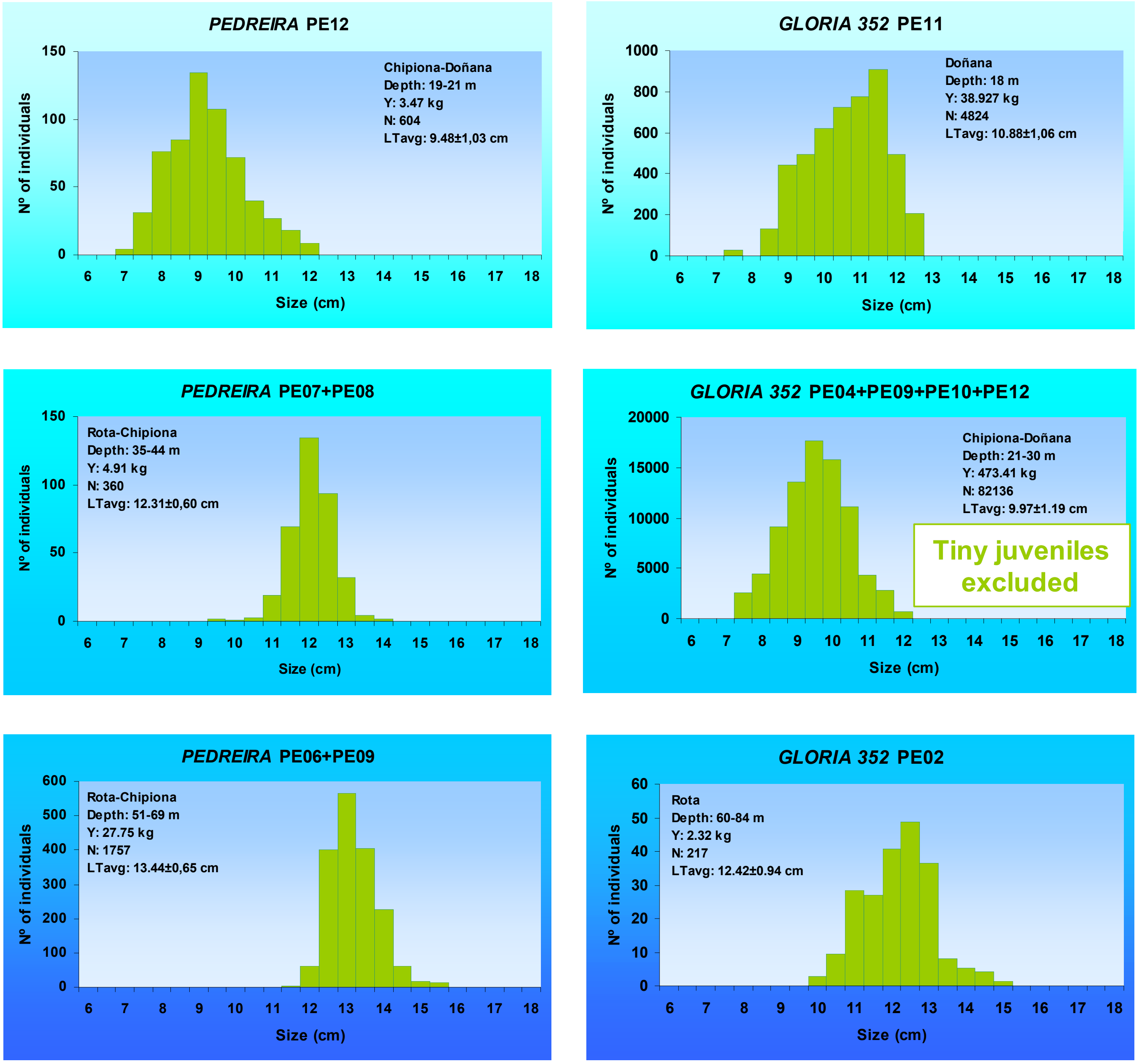


Figure 6.2.3.8. ***PACAS*** **surveys. Anchovy (*Engraulis encrasicolus*). Overall length frequency distribution by gear and depth range with indication of the mean length. For the *Gloria 352* pelagic gear in the *PACAS 1008* survey the length composition from very tiny anchovies captured in fishing station P04 was excluded.**

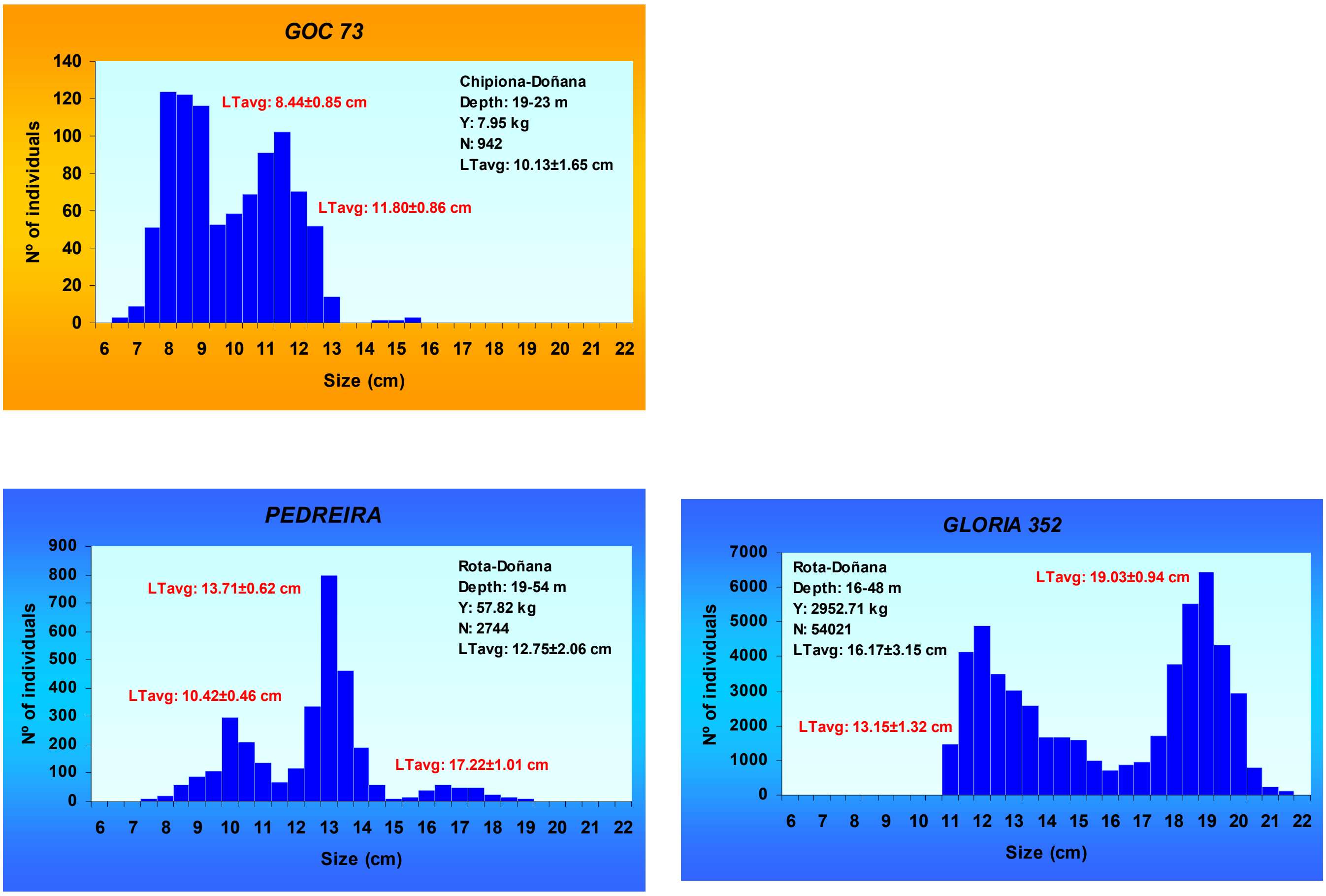


Figure 6.2.3.9. ***PACAS* surveys. Sardine (*Sardina pilchardus*). Overall length frequency distribution by gear with indication of overall mean length and mean length by modal component.**

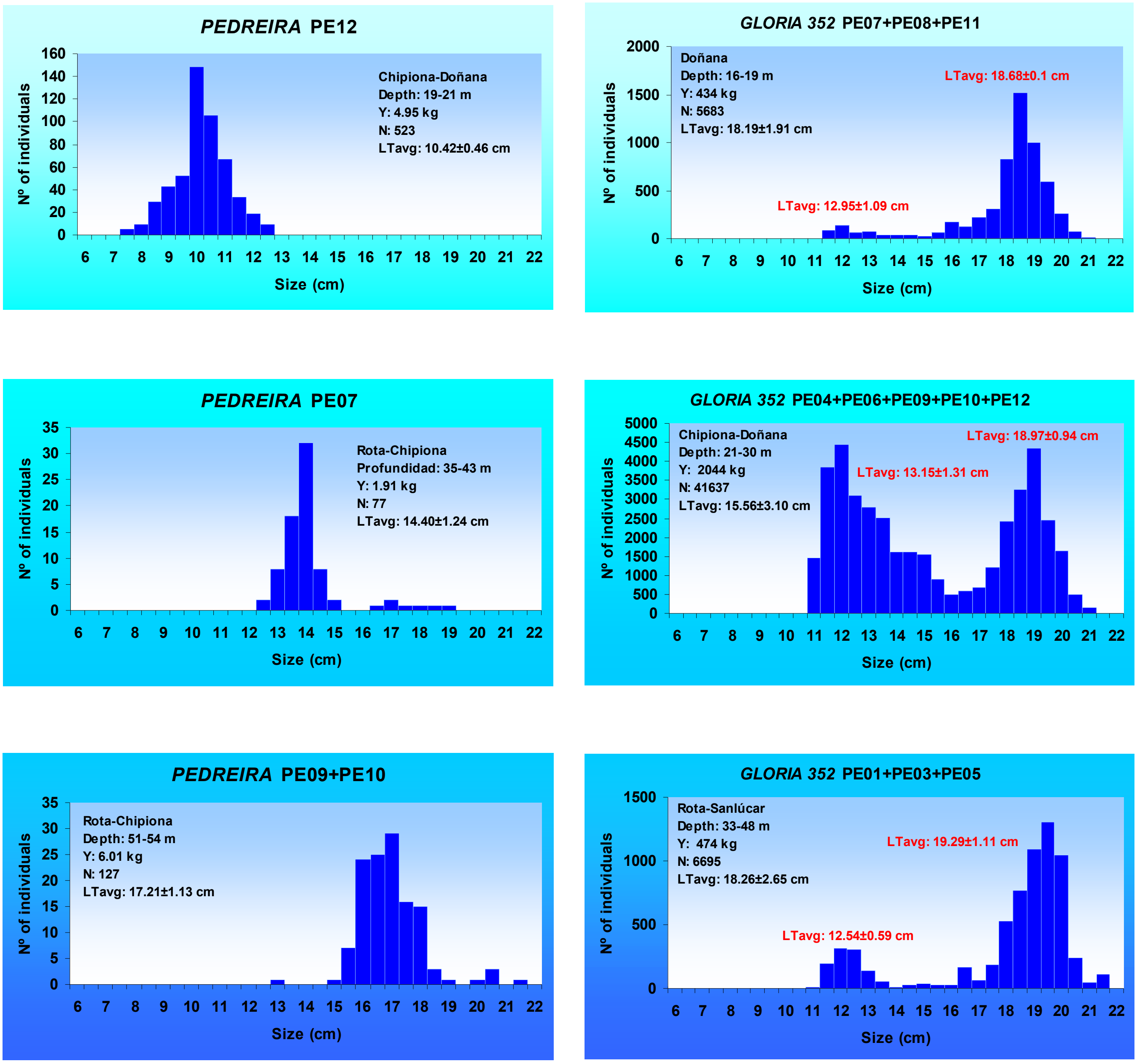


Figure 6.2.3.10. *PACAS* **surveys. Sardine (*Sardina pilchardus*). Overall length frequency distribution by gear and depth range with indication of the mean length.**

6.2.4 Summary Overview of the workshop on variance estimation of the acoustic surveys

The first day of WGACEGGs meeting (Monday 24 November 2008) was devoted to the Workshop on variance estimation of the acoustic surveys. Such a workshop was held to dealt with an initiative launched in 2007 about such an issue which was incorporated in the ToRs of this group for 2008 (Short ToR e). **Annex 6** give a summary of such a workshop.

6.2.5 Target strength of pelagic species

The importance of the accurate knowledge of the acoustic response of single fish (or Target Strength: TS) for acoustic target classification and abundance estimation it is acknowledged by the group. However, it is pointed out that TS values are known to vary dramatically according to, between other, depth, tilt angle or physiological condition of the fish. In-situ TS measurements are then not straightforward.

TS detection basics were presented and the importance of single targets detection parameters, was discussed (Doray and Massé, presentation), with special emphasis on pulse length duration, minimum TS threshold, min/max echo-length and maximum phase deviation.

Participants agreed on the facts that in-situ TS collection experiments should be conducted: i) with appropriate TS detection parameters, ii) on fish communities scattered enough to limit multiple targets detection, and iii) on roughly monospecific fish assemblages, with distinct length modes, to allow for the relation of modes in TS distributions to catches composition and/or theoretical TS values.

A literature review of the TS~length equations was presented, with special emphasis on small pelagic species (**Figure 6.2.5.1**, **Table 6.2.5.1**).

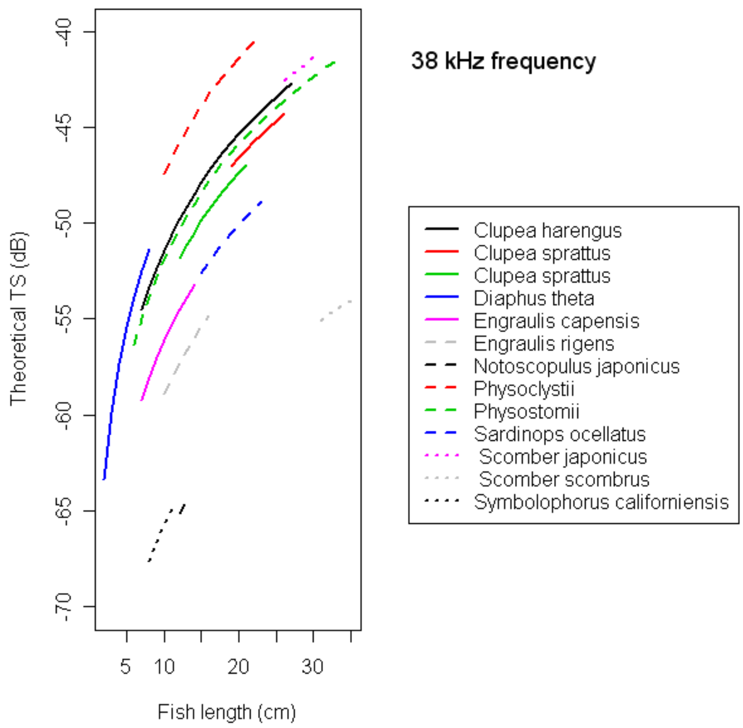


Figure 6.2.5.1. Overview of clupeids TS- length equations available in the literature.

Table 6.2.5.1. Parameters of TS- length (L) equations used for clupeid stock assessment in European waters (yellow) and in other areas. TS-length models of the form: TS = a x log10(L) – b.

Reference	f	spname	sp	Lmin	Lmax	Lmean	Location	DN	method	b	a
Edwards-al_84	38	Herring	Clupea harengus	7	27		N.E. Atlantic	A	cage?	71,5	20,1
Foote_87	38	Physostomes (clupeoids)	Physostomii	6	34			A	cage	71,9	20
Degnbol&al_85	38	Herring/sprat	Clupea sprattus	19	26	21	Kattegat/ Skagerak	A	comp	72,6	20
Edwards&al_84	38	Herring/sprat	Clupea sprattus	12	21	16.6	N.E. Atlantic	A	insitu	73,4	20
Barange&al_96	38	Pilchard	Sardinops ocellatus	15	23		S.E. Atlantic	N	insitu	76,1	20
Barange&al_96	38	Anchovy	Engraulis capensis	7	14		South Africa	N	insitu	76,1	20
Guttierez-MacLennan_98	38	Anchoveta	Engraulis rigens	10	16	12.8	Peru	A	cage	78,9	20
Yasuma-al_03	38	Myctophids	Symbolophorus californiensis	8	11				model	85,7	20
Yasuma-al_03	38	Myctophids	Notoscopulus japonicus	12	13				model	86,7	20

This exercise revealed large discrepancies in the theoretical TSs of fish of similar length. TS-length equations established for southern-hemisphere anchovy species hence generally predict lower TS (up to 7 dB) than equations currently used for clupeids in European waters.

Appropriate values for TS detection parameters were presented, based on the results of in-situ night-time TS measurements performed in the Bay of Biscay during the Pelgas'08 cruise (**Table 6.2.5.2**).

Table 6.2.5.2. Recommended parameters for small pelagics TS detection in the Bay of Biscay.

TS DETECTION PARAMETER	RECOMMENDED VALUES
Pulse length	0.5 ms
Min. echolength	0.8
Max. echolength	1.8
Min. TS threshold	-60 dB
Max. gain compensation	6 dB
Max. phase deviation	4 to 8

TS measurements were conducted in three different areas before and after identification trawl hauls. These experiments revealed the presence of a consistent dominant TS mode around –56 dB, which was likely produced by a mix of small pelagics and 'other targets'. These unidentified targets were seemingly produced by organisms comprising dense sound-scattering layers observed in the 3 studied areas (planktonic and micronektonic targets). The presence of these dense night-time sound-scattering layers is thought to generally harm any meaningful night-time measurements of small pelagics TS during conventional acoustical surveys.

Consequently, the need for specific small pelagics TS measurements conducted in controlled environments (e.g. purse-seine, aquaculture pen) in different areas was recognized by the group, to further investigate the adequacy of TS-length equation used for clupeids in European waters.

7 Progress in cross-validation and integration of acoustic and egg production surveys

7.1 Quantitative combination of acoustic and CUFES data for the quality control of acoustic survey estimates

Fish behaviour may cause bias in acoustic estimates of fish stocks, which is difficult to assess using the acoustic data alone. In contrast, fish eggs are passive particles that can be sampled with little avoidance. The combination of the CUFES (continuous underway fish egg sampler) with the acoustic sampling has the potential to cross-validate methodologies and address the question of bias in relative terms. For anchovy in the Bay of Biscay, the CUFES has been operated together with the acoustics along the transect lines of spring acoustic survey since 2001. A procedure was presented to quantitatively combine the CUFES and acoustic data, which was applied to the acoustic and CUFES data of IFREMER's spring acoustic surveys 2001–2006 (Petitgas *et al.,* -accepted-). First the subsurface CUFES egg concentrations are converted to vertically integrated egg abundances using a biophysical model of egg vertical distribution (Petitgas *et al.*, 2006). Then a procedure similar to the DEPM (Daily Egg Production Method) is applied to map an index of daily egg production. The data are gridded and egg abundance-at-age is averaged within blocks. The mortality curve that allows estimating egg production is fitted by block on the block averages of egg abundance-at-age. The dimension of the grid is optimized to allow for the lowest residuals in the mortality curves across the area. On the French shelf, the grid dimension was 0.4°x0.4°. The average egg production over the area derived in that way with CUFES correlated well with the historical values of DEPM-derived egg production in that area (**Figure 7.1.1**).

Maps of anchovy acoustic fish abundance and egg production are produced on that grid and combined to derive an index of daily specific fecundity (DF) over the survey area. The DF serves as a quality control indicator of the acoustic survey estimate (**Figure 7.1.2**). The DF is positioned relatively to the isometric line (Somarakis *et al.,* 2004) that relates egg production and DF for European anchovy. Over the series of surveys analysed the quality control indicator warned twice and the reasons why were understood to relate to interannual differences in the accessibility of the anchovy stock to the surveys.

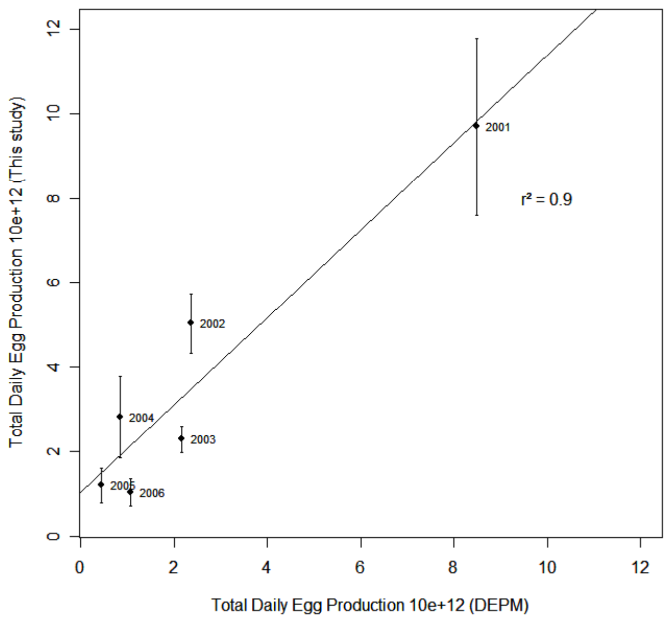


Figure 7.1.1. Relationship between CUFES-derived egg production and proper DEPM-derived egg production.

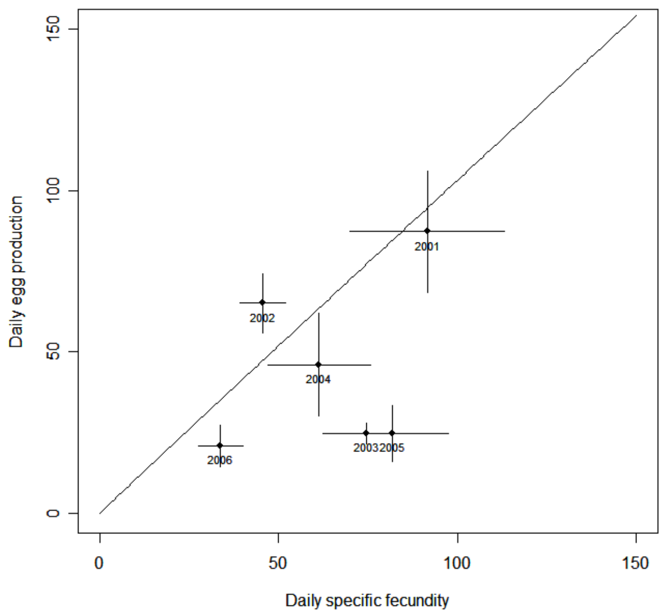


Figure 7.1.2. Position of the survey estimates in each year relatively to the isometric line between daily specific fecundity and daily egg production. The daily egg production is estimated using the CUFES values and the vertical egg distribution model. The Daily specific fecundity is estimated by the ratio of the CUFES-derived egg production and the acoustic estimate of spawning biomass.

8 Conclusions and interim Plan of actions for 2009

During 2008 the WGACEGG made a big effort to review and produce joint presentations of the large amount of survey's direct estimates on sardine and anchovy (by acoustic and DEPM methods) which had been made during 2008 in a coordinated fashion as had been designed in the previous meeting in 2007. Three coordinated acoustic Spring acoustic Surveys (of IPIMAR, IEO and IFREMER) covering all divisions in VIII and subdivisions in IXa allowed a synoptic vision not only of the anchovy and sardine populations but also of most pelagic species from Cadiz to French Brittany. This the first time that all the three coordinated surveys make a complete surveying of the pelagic community as a whole, which a product of the effort made in WGACEGG and in ICES in general towards achieving those ecosystem surveys.

Four DEPM surveys applied as well in a coordinated way by IPIMAR, IEO and AZTI produced the Daily Egg Production and Spawning Biomass estimates for sardine and anchovy in subareas IX and VIII, although part of the final biomass estimates were not yet available to the WG due to still ongoing laboratory work (mainly concerning adults) This is the first time that divisions VIIIb and VIIIa are covered by IEO (until 45º) and AZTI (45º–48º) so that this areas completes the traditional coverage restricted to IXa and VIIIc, at least in terms of Egg Production, while adult parameters are pending on any specific funding (so far such expansion to the north of the DEPM is not included in the DCR of the EC).

Finally Acoustic surveys on sardine and anchovy juveniles took place in 2008 both in Subareas VIII and IX, although the Portuguese survey was not yet available to the WG, being the 2007 survey the one being reported instead by IPIMAR.

The surveys were carried out following the standard procedures described and adopted in earlier years in the WG and the coordination of surveys was satisfactory. The coordination of autumn surveys allowed a cross checking and validation of results of the two surveys in division VIII (AZTI and IEO), however the degree of coordination designed in 2006 has not so far been achieved due to the uncoupled calendar of these surveys.

The WG endorsed the continuity of the coordination of the surveys: the coordination of the acoustic surveys both in spring and autumn for 2009 was set during the meeting (Section 4.6). Even though the autumn Portuguese survey may not continue in the next year the WG endorsed its continuity at least over selected recruitment areas in order to produce a recruitment index for sardine. Concerning the DEPM only the application for anchovy in subarea VIII will take place in 2009, because for sardine those surveys take place triennially. Next year ToRs and interim work (here below) include the conduction and reporting of the foreseen surveys for 2009 and finishing the work pending from 2008 (i.e. the estimation of Adult Fecundity and final Spawning Biomass for some applications of the DEPM in 2008 for sardine all areas and for anchovy in Cadiz).

The revision agreed in 2007, by which WGACEGG considered the convenience of strengthening the global regional perspective of the results of the surveys producing a synoptic overviews of both the spatial distribution of sardine and anchovy and of the accompanying pelagic ecosystem (Long ToRs e) and f) and producing a common Regional database (from the Acoustic+CUFES and Pairovet sampling) (Short ToRs a), b), and c) has been mostly achieved during this meeting. A date base with common format (spatial resolution or grids, units etc) has been adopted for the two surveying methods (Section 4.1). Little global or cross analysis has been done yet during this year about the spatial distribution of the main pelagic species, because setting up the standard database and procedures took much of the time of the working group. However synoptic maps of the spatial distribution of sardine and anchovy and other species (as Sprat, mackerel, chub mackerel -*Scomber colias*-, horse mackerel, blue chub mackerel -*Trachurus picturatus*-, and *Trachurus mediterraneus*, Blue whiting and Bogues -*Boops boops*) from the acoustic records during spring acoustic surveys are presented in Section 4.2.4 based on the energy allocation to species. Similar maps for egg abundance of sardine and anchovy from CUFES are shown in that Section. The DEPM has also produced egg abundance distribution for the entire covered areas in Sections 4.3.2.2 and 4.3.3.2 for anchovy and sardine respectively. Finally, some synoptic maps were also produced based already in the common database at the agreed spatial grid from spring acoustic surveys (for sA and egg from CUFES, Section 4.5). The WG considered this a very fruitful and challenging work for future analysis.

One objective of the WG is to evaluate and maximize the quality of the surveys, by performing and discussing inter-calibration between and within surveys, by discussing revisions of past series estimates according to past inter-calibration or new methods or works and by Updating the group on advances and improvements of acoustic and DEPM methods.

Some reviews of the time-series of SSB estimates from acoustic and Daily Egg Production Method (DEPM) SSB estimators have also been reported to the Group (Section 5):

- After revising the Spawning Frequency estimates of the Bay of Biscay anchovy, the revision of the series of SSB estimates are pending of new Egg Production estimates according to improved statistical P0 and Egg mortality estimation procedures. The WG endorsed the scientific work supporting the review, and recommended providing a full review of new DEPM SSB estimates to the next Working Group on Anchovy [WGANC].
- The DEPM estimate of sardine biomass in Spanish Atlantic waters in 2005 has been revised downward to about 106,000 t (CV=47%) (Section 5.2) mainly due to doubling the Spawning fraction from the preliminary value. The WG endorsed it.
- A Revision of the JUVENA 2006 abundance estimation of juvenile anchovy was presented following an inter-calibration exercise between the two vessels taking part in that survey, according to the relative recording of their 38 kHz transducers. WGACEGG considered correct the approach follow but the high CV obtained for the correction factor (2 with a CV of about 40%) suggest further work may be welcome.

Inter-calibrations of vessels between coordinated surveys have also been made during the 2008 acoustic spring and autumn surveys to assure coherent estimates of sufficient quality. An inter-calibration the RV “Thalassa” and RV “Noruega”, off northern Portugal took place in April 2008 at the beginning of the joint spring surveys by IPIMAR and IEO. Final analysis is still pending of completion in 2009. An inter-calibration of the RV “Thalassa” and RV “Enma Bardán” in the Bay of Biscay anchovy juvenile surveys (PELACUS10 and JUVENA) took also place for a full day in October 2008, but the results were not analysed yet but it will be made jointly next year 2009 by IEO and AZTI.

Updating the group on advances and improvements of acoustic and DEPM methods was also being sufficiently covered during this meeting (Long ToR b).

Concerning DEPM: Several Advances in DEPM in recent past years were summarized in Section 6.1.1 regarding Egg mortality and daily Egg Production estimates (P0) along with the advances in software (http://ichthyoanalysis.wiki.sourceforge.net). Advances in spawning frequency estimation are also briefly commented here as well. In addition new studies were reporting such as sensitivity analysis (and some modelling) to the incubation temperature on egg production are shown for the Portuguese DEPM survey and for the Bay of Biscay survey. Finally, a method for facilitating batch fecundity measurements in sardine using digital image analysis software (ImageJ; rsb.info.nih.gov/ij/) has been presented. Overall the group continue to have an active and critical review of the methods is nowadays implementing on the DEPM and a Workshop on the estimation of DEPM-based Spawning Stock Biomass of sardine and anchovy using R [WKRESTIM] is foreseen in March 2009, in Barcelona (see recommendations).

Concerning acoustic advances: A workshop on the precision of the acoustic abundance estimations was conducted in the frame of the WGACEGG during the first day of the meeting which has been reported in Annex 6. The objectives were to (1) review the sources of error of the acoustic and DEPM abundance estimations; (2) identify and describe the theoretical bases of the main techniques currently used to calculate variance for abundance estimation surveys (GAMs, Geostatistics) and (3) discuss the weaknesses and strengths of each method. They were satisfactorily covered and served to update the members of the group on the most recent advances applied to these problems. The work plan for the coming years includes to complete the Workshop with presentations of variance estimation in DEPM surveys and to conduct a Workshop in 2009 for geostatistical calculation of variance in acoustic based abundance estimations.

The problem of small pelagics Target Strength measurements in the Bay of Biscay was also revisited in the WG (Section 6.2.5) concerning available literature and procedures for direct estimation of TS (concerning pulse length duration, minimum TS threshold, min/max echolength and max. phase deviation, etc). It was noted that TS-length equations established for tropical anchovy species generally predict lower TS (up to 7 dB) than equations currently used for clupeids in European waters. A recommendation to obtain specific small pelagics TS measurements in more controlled environments is made.

The problem of acoustic surveying of the Gulf of Cádiz waters for juveniles was dealt based on two experimental surveys carried out by IEO within the shallowest waters of the Gulf of Cadiz (Section 6.2.4), using two different vessels in July and October 2008. Relevant amount of schools were recorded in shallow waters (up to 6–7 m depth) Initially RV E. Bardán seems to be a more suitable vessel than Navarro in terms of on-board usual equipment for both acoustics and fishing, although the former has serious restrictions for enough scientific staff accommodation.

Finally and Concerning Long ToR c) advances in developing a framework to cross-validate and integrate egg production and acoustic methods for the estimation of Spawning stock biomass and its distribution were presented to the group (Section 7.1) A procedure was presented to quantitatively combine the CUFES and acoustic data for the quality control of acoustic survey estimates, which was applied to the acoustic and CUFES data of IFREMER's spring acoustic surveys 2001–2006. This is made by comparing maps of an index of daily egg production from CUFES with maps of anchovy acoustic fish abundance to derive an index of daily specific fecundity (DF) over the survey area. The comparison of this DF with literature references serves as a quality control indicator of the acoustic survey estimate. The WG welcome this work and considers it has a great potential of improving both the acoustics and the DEPM estimates.

Finally WGACEGG has natural links with several groups dealing with assessment and ecology of small pelagics (WGANSA, WGFE, WGLESP, ETC.) and in addition is promoting joint workshops with other groups interested methods for direct surveying of small pelagics: A Working Group TGISUR has been set up in ICES to steer all survey groups and WGACEGG could therefore actively contribute to TGISUR work There is an initiative within WGACEGGs for 2009 to carry out a workshop in conjunction with MEDIAS on the use of geostatistics for acoustics variance estimation during the next WGACEGG. It is also being promoted in ICES – FRESH joint workshop Proposal (for March 2010): Egg production methods: review of statistical and biological associated methods and problems.

Plan of actions for 2009 (Internal Recommendations)	Action
0. To carry out the new foreseen surveys on adults with Acoustics (Sardine and anchovy all areas) and DEPM (Anchovy in the Bay of Biscay Spring) and on juveniles (with acoustics for anchovy in BoB)	IEO, IPIMAR and IFREMER first half of the year acoustic surveys. IEO and AZTI autumn acoustic surveys AZTI DEPM
1. To finish the estimation of Adult Fecundity and final Spawning Biomass for some applications of the DEPM in 2008 to be reported to WGANSA in June 2009 (	S and SSB for IPIMAR DEPM 2008 (sardine) S and SSB for IEO BOCADEVA and SAREVA 2008 (Sardine and anchovy) To be revised in the March workshop on DEPM application.
2. To finalize the revision of BoB anchovy DEPM based SSB estimates, and to incorporate the results of this revision on the assessment of BoB anchovy.	To Review the egg production estimation for this DEPM series. 2- To consolidate the series and to present the conclusions of this analysis to the 2009 WGANC meeting
3. To provide a new development model for sardine eggs in Cantabrian Sea	IEO will try to carry out an egg incubation Experiment Vigo for sardine
4. To increase both the acoustic sampling coverage and fishing for echotrace identification in the shallow waters (< 20 m depth) off the Division IXa during the national spring/summer "pelagic ecosystem" surveys, especially in the central part of the Gulf of Cádiz by the Spanish survey.	IEO will try to carry out an acoustic survey of shallow waters complementary to the conventional ECOCÁDIZ survey whenever ship-time for a small-draught's RV, equipment and personnel is available.

Plan of actions for 2009 (Internal Recommendations)	Action
5 The WG encourages to the involved national institutions to start (or continue) the series of autumn acoustic surveys aimed to the provision of regional recruitment indices for sardine (West Portugal by IPIMAR and Gulf of Cádiz by IEO) and anchovy (Gulf of Cádiz by IEO). For IPIMAR this new survey series would involve a re-organization of its SARNOV series by limiting the survey area to the sardine's main recruitment area in the West Portuguese waters whereas for IEO this series will be a new one and it will survey the Gulf of Cádiz anchovy/sardine recruitment areas. In both cases the surveys' planning should consider the peculiarities of the acoustic surveying of recruits of small-pelagic species in these areas.	IEO will try to carry out an anchovy/sardine recruitment survey in autumn in the Gulf of Cádiz whenever ship-time for a small-draught's RV, equipment and personnel are available.
6. To perform a new intercalibration between "Thalassa" and "Noruega" trying to overcome the limitations encountered during PELACOS08 and PELAGO08 (limited time overlap, …)	
7. To echo-integrate the bottom on selected parts of transects along the whole time-series of surveys in order to compare the performance of echosounders from year to year and in different weather conditions.	
8. To have new workshop about echotraces scrutinizing every two years in order to agree on identification of typical and questionable echotraces, and to continue to fill up the SIMFAMI database. With the aim of Standardized the scrutiny process and evaluating the quantitative consequences on the assessment of these species. Potential first day of next WGACEGG.	Evaluate the potential for inclusion of a seminar on that issue during the first day of our next WGACEGGs
9. To continue to analyse the discrepancies between autumn juvenile estimates (AZTI – IEO) by comparison of fishing hauls, species distributions, etc.	
10. To continue the analysis to correct the bias of the JUVENA 2006 estimate.	
11. To carry out a workshop on the use of geostatistics for acoustics variance estimation during the next WGACEGG. (a joint workshop could be organized with MEDIAS workshop)	J. Massé to contact MEDIAS about this proposal and submit a draft proposal to the group in the next weeks
12. To produce next year a precise acoustic survey protocol for each institution (acoustic acquisition, survey design, fishing gears, fishing strategy, etc.) that will be annexed to the future WGACEGG report.	
13. Present new results on the cross validation of CUFES, Egg Production and acoustics	
14. Expanding backward in time the WGACEGG's database on surveys on small pelagics in areas VIII and IX	

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Annex 2: Agenda

Initial agenda

Day	Time	Issue	Original Presentation by
25/11/2008	Time	Issue	Original Presentation by
GENERAL	09:00	Well come and adoption of the agenda and general structure of report	A. Uriarte
	09:30	Common Data base from Surveys on pelagics in Subareas VIII and IX (First Round)	J. Massé
	10:00	Discussion on the final structure of the Report	
	10:30	Coffee	
ACOUSTIC	10:45	Spring Acoustic Surveys in 2008 (3 hours) and CUFES	J. Massé
	12:30	Lunch Break	
ACOUSTIC	13:30	Spring Acoustic Surveys in 2008 (Cont …+discusion)	
ACOUSTIC	14:30	Intercallibration of Spanish and Portuguese Spring acoustic surveys	Iglesias & Juan
DEPM	15:00	Spring DEPM surveys in 2008	A. Lago
	16:00	Coffee	
DEPM	16:15	Spring DEPM surveys in 2008 (Cont …+discusion)	
GENERAL	18:15	Discussion on results, presentations and index of contents for surveys	All
GENERAL	18:30	Discussion section on Spatial distribution of sardine and anchovy (Ecosystem perspective)	Massé & Bernal
	19:00	Closure of the day	
26/11/2008			
ACOUSTIC	09:00	Autumn Acoustic surveys on juveniles IN Bay of Biscay (JUVENA & PELACUS10)	G. Boyra, M. Iglesias
ACOUSTIC	10:00	intercallibration and crossvalidation of the 2008 BoB anchovy juvenile surveys	Boyra & Nogueira
	10:30	Coffee	
ACOUSTIC	10:45	Revision of the JUVENA series of acoustic estimates of anchovy juveniles	Juan Zwolinski
ACOUSTIC	11:15		Boyra
ACOUSTIC	11:45	Considerations on Target strenght for the small pelagics	Mathieu Doray, J. Massé
	12:30	Lunch Break	
ACOUSTIC	13:30	PACAS surveys	F. Ramos
ACOUSTIC	14:00	Discusion on Acoustic Surveys and potential improved coordinations for future	
DEPM	14:30	Revision of Anchovy DEPM Spawning Frequency and SSB series	M. Santos & A. Uriarte
DEPM	15:00	revision of adult parameters for sardine in 2005 and new SSB estimates.	A. Lago
DEPM	15:30	comparison of egg ageing using CTD temperatures from dif. Depths	MManuel et all
DEPM	16:00	Coffee	
	16:15	Analysis of the sensitivity of incubation temperature on anchovy egg production estimates.	M. Peña et al.
DEPM	16:45	Reporting on advances on Egg Mortality estimations, Egg Production, GAMs etc	M . Bernal ???
	17:15	Automated Fecundity Measurements for sardine	Kostas, M. Manuel
DEPM	17:45	Discusion on DEPM adult and egg estimation methods	All
GENERAL	18:00	cross-validate and integrate egg production and acoustic methods	P. Petitgas
		Combining acoustic and CUFES data for the quality control of fish stock acoustic survey estim	P. Petitgas
	19:00	Closure of the day	
		Discussion on results, presentations and index of contents for surveys	
		Time for processing data and make comparisons between results	
27/11/2008			
GENERAL	09:00	General Discussion: on Common Grid	
	10:00	General Discussion: on Common Grid	J. Massé and Steering Gro
		Standard grid to obtain a synoptic presentation of results from DEPM and acoustic surveys;	
	10:30	Coffee	
	11:00	Split Groups on DEPM and ACOUSTICs	
		Dealing with particular methodological issues per discipline	
		Dealing with standard data base production and submission of data and format	
		Dealing with the joint and synoptic presentation of results	
	12:30	Lunch Break	
	13:30	Split Groups on DEPM and ACOUSTICs	
	14:30	Planning of Surveys and coordination for 2009	All
	16:00	Joint Reporting	All
	16:30	Review of the index of contents and Drafting the report	A. Uriarte
ACOUSTIC	17:30	Autumn Acoustic surveys on juveniles in Ixa PELAGO10	Juan Zwolinski
	19:00	Closure of the day	
28/11/2008			
	09:00	Balance of work	
		Closing standard data base production and submission of data and format	J. Massé and Steering Gro
		Closing the index of contents and the joint and synoptic presentation of results	A. Uriarte
		Linkages with FRESH and future workshops	A. Uriarte
		Other Issues: Sentiel survey, WGANSA, WGExpertise etc	A. Uriarte
		Future and perspective of work of the group	A. Uriarte
	10:30	Coffee	
	10:45	Going through the report	
	14:00	Closing the meeting	

Annex 2 (cont..): Actual Agenda of the meeting

Day	Time	Issue	Original Presentation by
25/11/2008	Time	Issue	Original Presentation by
GENERAL	09:30	Well come and adoption of the agenda and general structure of report	A. Uriarte
	10:00	Discussion on the final structure of the Report	
	10:30	Coffee	
	11:00	Common Data base from Surveys on pelagics in Subareas VIII and IX (First Round)	J. Massé
ACOUSTIC	11:45	Spring Acoustic Surveys in 2008 (3 hours) and CUFES	J. Massé
	12:30	Lunch Break	
ACOUSTIC	13:30	Spring Acoustic Surveys in 2008 (Cont …+discusion)	
ACOUSTIC	14:45	Actual presentation of the Spring acoustic Surveys	J. Massé
	16:00	Coffee	
DEPM	17:15	Spring DEPM surveys in 2008	A. Lago
	19:00	Closure of the day	
26/11/2008			
GENERAL	09:30	Discussion on advances and index of contents for surveys	All
ACOUSTIC	10:00	Autumn Acoustic surveys on juveniles IN Bay of Biscay (JUVENA & PELACUS10)	G. Boyra, M. Iglesias
	11:00	Coffee	
ACOUSTIC	11:30	intercallibration and crossvalidation of the 2008 BoB anchovy juvenile surveys	Boyra & Nogueira
ACOUSTIC	12:00	Revision of the JUVENA series of acoustic estimates of anchovy juveniles	Boyra
	13:00	Lunch Break	
GENERAL	14:00	Discusion on the Data base and grid cells and joint analysis	
ACOUSTIC	14:30	Considerations on Target strenght for the small pelagics	Mathieu Doray, J. Massé
ACOUSTIC	15:00	PACAS surveys	F. Ramos
DEPM	16:00	Coffee	
ACOUSTIC	16:30	Intercallibration of Spanish and Portuguese Spring acoustic surveys	Iglesias & Juan
DEPM	17:15	Revision of Anchovy DEPM Spawning Frequency and SSB series	M. Santos & A. Uriarte
DEPM	17:45	revision of adult parameters for sardine in 2005 and new SSB estimates.	Gerson
DEPM	18:10	comparison of egg ageing using CTD temperatures from dif. Depths	MManuel et all
	18:20	Analysis of the sensitivity of incubation temperature on anchovy egg production estimates.	M. Peña et al.
DEPM	18:50	Automated Fecundity Measurements for sardine	Kostas, M. Manuel
	19:10	Closure of the day	
27/11/2008			
DEPM	09:15	Reporting on advances on Egg Mortality estimations, Egg Production, GAMs etc	M . Bernal ???
GENERAL	09:45	cross-validate and integrate egg production and acoustic methods	P. Petitgas
GENERAL	10:15	Discussion section on Spatial distribution of sardine and anchovy (Ecosystem perspective)	Massé & Bernal
	10:30	Coffee	
ACOUSTIC	17:30	Autumn Acoustic surveys on juveniles in Ixa PELAGO10	Juan Zwolinski
	11:00	Split Groups on DEPM and ACOUSTICs	
		Dealing with standard data base production and submission of data and format	
		Time for processing data and make comparisons between results	
		Dealing with the Index of contents for the sections on Acoustics and DEPM surveys	
		Reviewing particular methodological issues per discipline and suggestions in these days	
		Dealing with the joint and synoptic presentation of results	
		Recomendations	
		Planning of Surveys and coordination for 2009	All
	12:30	Lunch Break	
	13:30	Split Groups on DEPM and ACOUSTICs	
	19:00	Closure of the day	

Friday Agenda

28/11/2008	Inititaitves	Issue	Responsible Chair
09:15	WGACEG(	Report of subgroups works	
09:45	WGACEG(	Data base, storing, access and conditions for use in research	
10:00	WGACEG(	Review of Index of contents, section drafting, WDd and Presentations delivered	
10:15	WK	Workshop on the estimation of DEPM-based Spawning Stock Biomass of sardine and anchovy using R [WKRESTIM]	M. Bernal
10:30	WK	ICES – FRESH joint workshop Proposal (2010): Egg production methods: review of statistical and biological associated methods & problems	Stylianos, Cindy Peter, A. Uriarte, M. Bernal? (Others?)
10:45		Coffee	
11:00		MARIFISH programme	M. Bernal
11:15	New Monit(	the possibility to build together (Spain, Portugal & French -AND- commercial fishing fleets) a "sentinelle" survey	J. Massé
11:30	ICES Expertise request	collecting descriptions of groups expertise (see below). We are asked to deliver the information by Nov 30.: activity: 5 bullet points, history, future) at least a list in the form key words for their groups	
11:45	ICES reque	Recomendations	
12:15	ICES reque	TORs 2009	
12:30	ICES reque	Venue of next WGACEGGs and dates	
12:45		Close the meeting	
	ICES meet	WGANSA Dates Venues Modification????	

Annex 3: WGACEGG terms of reference for the next meeting in 2009

200XX/2/LRCXXX The Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VIII and IX [WGACEGG]. (Chair: A. Uriarte, Spain) will meet in Lisbon, Portugal, from 16–20 November 2009 to:

Long-term Terms of Reference:

i) plan, coordinate and review acoustic and egg surveys in ICES Areas VIII and IX and standardize analysis procedures;

ii) update on innovations on sampling and estimation methods for DEPM and acoustics;

iii) develop a framework to cross-validate and integrate egg production and acoustic methods for the estimation of Spawning stock biomass and its distribution;

iv) produce an annual synoptic overview of distribution, abundance and population structure of sardine and anchovy in relation to the pelagic ecosystem for ICES Areas VIII and IXa;

v) integrate biological/environmental information from surveys and additional sources to improve the understanding of the spatial distribution and dynamics of sardine and anchovy in relation to the pelagic ecosystem in ICES Areas VIII and IXa.

2009 Short Terms of Reference:

a) To report on the results of the 2009 surveys: Either for adults with Acoustics (Sardine and anchovy all areas) and DEPM (Anchovy in the Bay of Biscay Spring), or for juveniles (with acoustics for anchovy in BoB);

b) To finish the estimation of Adult Fecundity and final Spawning Biomass for some applications of the DEPM in 2008 (Sardine all areas and anchovy in Cadiz);

c) to finish the revision of the series of DEPM for the anchovy in the Bay of Biscay;

d) To perform a new intercalibration between “Thalassa” and “Noruega” in spring acoustic surveys;

e) To continue cross validation of the autumn acoustic surveys on anchovy juveniles in the Bay of Biscay and the revision of the 2006 JUVENA’s point estimate;

f) To produce precise acoustic survey protocols for each institution (acoustic acquisition, survey design, fishing gears, fishing strategy, etc.) as a background reference of the procedures applied to be annexed to the next WGACEGG report;

g) To keep on producing the common database on a general grid in order to obtain a synoptic presentation of results of DEPM and acoustic surveys and analysis. Consolidate 2008 and 2009 database, and if possible expanding it backward in time;

h) Produce technical specifications for the development of a common database for acoustic data (delayed from 2008).

Supporting Information

PRIORITY:	The Group has high priority as it will be responsible for providing direct monitoring for two major small pelagic stocks (sardine and anchovy) in this area. These stocks are distributed across national boundaries. The most important part of its work will be to standardize, plan and analyse all the relevant surveys and to integrate these together to give the best possible advice to the WGANSA for integrated assessment purposes.
SCIENTIFIC JUSTIFICATION AND RELATION TO SCIENCE PLAN 2009–2013	Concerning the recently adopted ICES Science Plan 2009–20013 WGACEGG is expected to contribute particularly in the first thematic area entitled Understanding Ecosystem Functioning. The Acoustic and DEPM surveys being coordinated in this group and the synoptic overview of the pelagic community of Mid Southern European waters will provide useful insights not only for the direct monitoring and assessment of anchovy and sardine, but also about the spatial distribution patterns of adults and juveniles of these and connected pelagic species and their habitats. Monitoring the status of this population (with the best standard methods and practices – Long ToRs 1 to 3, and Short ToRs a) to f) and their occupation of the potential habitats (Long ToRs 4 and 5 and Short ToRs g) are very relevant to the topic about Fish life-history information in support of Ecosystem Approach to Management. Habitat mapping should also contribute to the topic of the role of coastal-zone habitat in population dynamics of commercially exploited Species. The aims of Long Term 5 to integrate biological/environmental information from surveys and additional sources to improve the understanding of the spatial distribution and dynamics of sardine and anchovy in relation to the pelagic ecosystem in ICES Areas VIII and IXa should also contribute to the topic of Integration of surveys and observational technologies into operational ecosystem surveys.
SCIENTIFIC JUSTIFICATION AND RELATION TO PAST ACTION PLAN OF ICES	In relation to the past action Plan of ICES: Long ToR 1) plan, coordinate and review acoustic and egg surveys in ICES Areas VIII and IX and standardize analysis procedures. Egg surveys for sardine and anchovy have been carried out since 1988 in Spain and Portugal, and since 1997 surveys were coordinated within different projects and the SGSBSA. A continuation of this planning and coordination, as well as analysis methodology standardization, will be carried out within WGACEGG (including CUFES sampling). Also the acoustic surveys in ICES Areas VIII and IX planned and coordinated with best standard methods within the group. This concerns to the Spanish (IEO, AZTI), Portuguese (IPIMAR) and France (IFREMER) acoustic surveys [Action Numbers 1.11; 1.13]. 2009 ToRs a) and b) relate to this Long ToR. Long ToR 2) update on innovations on sampling and estimation methods for DEPM and acoustics. Both newly developed DEPM and traditional egg production methods and associated robust and user-friendly software to perform egg production estimates are being developed and applied within the group. Improvement on acoustic estimation methods are also routinely presented in WGACEGG, from the interim work carried out in each institute. WGACEGG will continue to support the work on methodological improvements, by validation and testing of each of the methods. [Action Number 1.10]. 2009 ToRs c), d) and e) relate to this Long ToR by checking quality of the implementation of the acoustic surveys and providing the basic reference of practice to the group. Long ToR 3) Develop a framework to cross-validate and integrate egg production and acoustic methods for the estimation of Spawning stock biomass and its distribution. Both egg production and acoustic methods allow estimation of Spawning stock biomass and stock distribution by using different assumptions and techniques. Cross-validation of these methods should be performed in a broad framework, allowing the comparison and validation of

	each method basic assumptions and identification of possible sources of discrepancy and its affect on the estimates. WGACEGG will explore the possibility of using both methods to obtain an integrated estimate of SSB [Action Numbers 1.2; 1.11; 1.13]. Progress on this approach have presented this year and are expected to grow in next year and are relevant to the topic of Integration of surveys and observational technologies into operational ecosystem ToR 4) produce an annual synoptic overview of distribution, abundance and population structure of sardine and anchovy in relation to the pelagic ecosystem for ICES Areas VIII and IXa; WGACEGG will combine the results of each national survey to produce data at a regional scale, covering the area from the Strait of Gibraltar up to the English Channel. Within this framework, WGACEGG will provide an integrated synoptic view of the annual distribution and abundance of the sardine and anchovy population, which will be useful both for assessment purposes and for ecological studies. ToR 5) integrate biological/environmental information from surveys and additional sources to improve the understanding of the spatial distribution and dynamics of sardine and anchovy in relation to the pelagic ecosystem in ICES Areas VIII and IXa. Information obtained from the spatial structure of the sardine and anchovy communities, together with associated environmental information would be integrated, with the scope of improving the understanding of the pelagic community, using both sardine and anchovy as key species of this community. [Action Numbers 1.2; 4.11].
RESOURCE REQUIREMENTS:	None
PARTICIPANTS:	20–25
SECRETARIAT FACILITIES:	None
FINANCIAL:	None
LINKAGES TO ADVISORY COMMITTEES:	ACOM
LINKAGES TO OTHER COMMITTEES GROUPS:	WGANSA, WGLESP, WGFE, PGEGGS, WGEGGS, FAST/FTFB, TGISUR
LINKAGES TO OTHER ORGANIZATIONS:	Other countries/institutions applying the DEPM, or carrying out integrated acoustic-egg surveys worldwide. Linkages with Mediterranean small pelagic committees are also sought. Linkages with Northern Africa countries will be established based on EU cooperative projects. Participation in FRESH COST actions are also seek

Annex 4: Recommendations

WGACEGG 2008 Recommendations	Action
1. The WGACEGG endorses the recommends made by WGWIDE for the extension of Acoustic surveys on small pelagics to the North of the Bay of Biscay in order to achieve a synoptic view of sardine and anchovy given the distribution of these species over most of European Atlantic coast (at least in Spring).	
2. To carry out a Workshop on the estimation of DEPM-based Spawning Stock Biomass of sardine and anchovy using R [WKRESTIM] in March 2009, 23–26 (ICM Barcelona), chaired by M. Bernal. (see attached proposal)	1. To require support and approval to the Science Committee of ICES for such a Workshop. 2. National Scientific representatives should ask support to EC DCR programme for next year 2009 inclusion of the workshop among the funding activities
3. To endorse the ICES – FRESH joint workshop Proposal (2010): Egg production methods: review of statistical and biological associated methods and problems Venue: March 2010 in Greece Coordinators Stylianos Somarakis, Cindy van Damme, Peter Witthames, Andrés Uriarte and Miguel Bernal (see attached proposal)	1. To require support and approval to the Science Committee of ICES for such a Workshop. 2. National Scientific representatives should ask support to EC DCR programme for 2010, inclusion of the workshop among the funding activities
4. To submit to WGFAST the results of the inter-calibration between Thalassa and Noruega	1 Ask for advice to WGFAST on the results of the intercallibration between "Thalassa" and "Noruega" in 2008 (see Section 6.2.1)
5. To carry out a Workshop on Acoustic variance with geostatistics joined with MEDIAS in 2009.	1. To require support and approval to the Science Committee of ICES for such a Workshop, once the proposal is made (still awaiting for final drafting)

Annex 5: List of Working Documents and Presentations

List of Working Documents submitted to this Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VIII and IX [WGACEGG, 24–28 November 2008, Nantes (France)]. (Including a small abstract per WD:

Angelico M.M., Nunes C., Silva A., Stratoudakis Y. Portuguese Daily Egg Production Method 2008 for sardine.

Abstract: The Portuguese 2008 sardine DEPM survey took place in January/February covering the Atlantic waters from the entrance of the Strait of Gibraltar up to the northern border of Portugal with Spain. Surveying included a total of 462 CalVET stations of which 46% with eggs; total sardine eggs collected reached 13494 (2 nets). Fish samples came from 85 hauls (92% with sardine) undertaken by the research vessel and purse-seiners. Preliminary results showed the highest egg production within the DEPM dataseries. Egg production for the southern and west coast was similar. Estimates carried out using the egg data from only one net or aggregated numbers from the two nets showed little differences. Female weight and fecundity in 2008 were also the highest values in the historical series; higher relative fecundity was observed in the west coast. The information on the spawning fraction is not yet available therefore no SSB can be considered.

Boyra G., U. Martinez y A. Uriarte WD2008: Acoustic surveying of anchovy Juveniles in the Bay of Biscay: JUVENA 2008 Survey Report.

Abstract: The project JUVENA aims at estimating the abundance of the anchovy juvenile population and their growth condition at the end of the summer in the Bay of Biscay. The long-term objective of the project is to be able to assess the strength of the recruitment entering the fishery the next year. The biomass of juveniles estimated for this 2008 is 20,879 tones, a low value compared with the values of the temporal series of JUVENA, only higher than the 2004 and 2007 estimate. This value is about one order of magnitude less than the higher estimates of the series (the ones corresponding to 2003, 2005 and 2006). This value suggests a new scenario of low recruitment entering the stock in 2009, and points towards the continuation of the crisis of the abundance of spawners that it is suffered since 2003.

Boyra, G. and Uriarte., A. Revision of the JUVENA 2006 estimation.

Abstract: During the year 2006 JUVENA survey, an intercalibration exercise between both vessels was carried out in order to check for possible biases in acoustic collection. The intercalibration results evidenced that the EB was systematically collecting less energy than the IL. The most likely reason for the detection bias was the erroneous configuration of the 38 kHz echosounder in the EB, produced by the choice of short pulse duration for this frequency. A revision of the initial estimate was produced based on the 120 kHz transducer collected data and it was presented in WGACEGG meeting in Palma de Mallorca. Nevertheless, these results were still inconclusive due to the uncertainty about the appropriate TS value at 120 kHz. Consequently, the calculation of the bias of the EB was repeated based on the intercalibration data between 38 kHz transducers. This document presents the analysis to calculate the correction of the bias.

Díaz, P1., G. Costas, A. Lago de Lanzós, C. Franco, E. Tel, and P. Cubero, WD2008: Characterizing the spawning habitats of sardine from the northern coast of Spain in April 2008

Abstract: This document presents the results of the analysis from sardine (Sardina pilchardus) egg densities in relation to environmental (temperature, salinity) and geographic (longitude, depth) variables. Data were obtained from the SAREVA0408 ichthyoplankton survey conducted by IEO (Instituto Español de Oceanografía) in April 2008. Quotient analysis, temperature-salinity plots and time distribution for eggs per stage of development, were employed to study spawning habitat of the sardine off north Spanish Atlantic, Cantabrian waters and south of the Bay of Biscay.

Díaz, P., Lago de Lanzós, A., Costas, G., Franco, C., and Cubero, P., wd2008: Results of sardine daily egg production off the northern coast of Spain for April 2008.

Abstract: This document presents the results of the SAREVA0408 ichthyoplankton survey conducted by IEO (Instituto Español de Oceanografía). This survey was carried out onboard RV "Cornide de Saavedra" during April 2008. The covered area was the North and North-western Iberian Peninsula waters and the inner part of the Bay of Biscay (from 42°N to 45°N).The present paper includes data on sardine (Sardina pilchardus) egg distribution and abundance from the SAREVA0408 survey, as well as the estimation of daily egg production (DEPM) for sardine in the North Spanish Atlantic, Cantabrian waters and south of the Bay of Biscay.

M. Doray, J. Massé. 2008: On small pelagics Target Strength measurements in the Bay of Biscay

Abstract: knowledge of the acoustic response of single fish (or Target Strength: TS) is of prime importance for acoustic target classification and abundance estimation. However, TS values are known to vary dramatically according to, between other, depth, tilt angle or physiological condition of the fish. In-situ TS measurements are then not straightforward. They have to be conducted with appropriate TS detection parameters, on fish communities scattered enough to limit multiple targets detection. Studied fish communities should also be as monospecific as possible, with distinct length modes, to allow for the relation of modes in TS distributions to catches composition and/or theoretical TS values. We propose a literature review of the TS~length equations available in literature, with special emphasis on small pelagic species. This exercise reveals large discrepancies in the theoretical TSs of fish of similar length. TS-length equations established for tropical anchovy species hence generally predict lower TS (up to 7 dB) than equations currently used for clupeids in European waters. We then present TS detection basics and discuss the importance of single targets detection parameters, including: pulse length duration, minimum TS threshold, min/max echolength and maximum phase deviation. We recommend appropriate values for these parameters, based on the results of in-situ night-time TS measurements performed in the Bay of Biscay during the Pelgas'08 cruise. TS measurements were conducted in three different areas before and after identification trawl hauls. These experiments revealed the presence of a consistent dominant TS mode around –56 dB, which was likely produced by a mix of small pelagics and 'other targets'. These unidentified targets were seemingly produced by organisms comprising dense sound-scattering layers observed in the 3 studied areas (planktonic and micronektonic targets). The presence of these dense night-time sound-scattering layers hence compromised any meaningful measurements of small pelagics in-situ TS. We recommend specific small pelagics TS measurements to be conducted in more controlled environments (e.g. purse-seine, aquaculture pen) in different areas, to further investigate the adequacy of TS-length equation used for clupeids in European waters.

Ganias K., Vavalidis T., Nunes C., Stratoudakis Y. 2008: Automating batch fecundity measurements using digital image analysis systems: a case study in the Iberian sardine. Working Document to the ICES WGACEGG, 24–28 November 2008, Nantes (France):

Abstract: We present a routine procedure for measuring batch fecundity of multiple spawning fish with indeterminate fecundity like sardine, *Sardina pilchardus*, based on the processing of microphotographs of ovarian whole mounts with digital image analysis software. These measurements are compared with fecundity measurements derived by one-by-one counting of hydrated oocytes either directly under the stereoscope (classic method) or by examining digital microphotographs on a computer monitor (reference method). The results of these comparisons suggest that the automated procedure is capable of producing easily and quickly, accurate fecundity measurements fact which combined with the archiving of microphotographic material of fish ovaries makes the method rather appealing for future applications both in sardine and other multiple spawning fish.

Gersom Costas and José Ramón Pérez WD2008: UPDATE of 2005 Adult parameters for sardine in Atlantic Spanish waters (ICES Division IXa North and VIIIc).

Abstract: As a result the recommendation in 2006 WGACEGG meeting a review in the estimation of sardine adult parameters for 2005 DEPM is presented in this WD Similar values in the new adult parameter estimations in relation to values provided in 2006 meeting were obtained, except for the Spawning fraction value. The new Spawning fraction estimation (0.15) for sardine in Atlantic Spanish waters was twice in relation to previous estimation (0.063). Moreover in this review a significant decrease in the cv (Coefficient of variation) of adult parameter estimations for sardine was achieved.

G. Costas, A. Lago de Lanzós, J. R. Pérez, P. Díaz, and C. Franco, WD2008: UPDATE of estimates of the Spawning Stock Biomass for sardine (Sardina pilchardus, W.) off the North Atlantic Spanish Coast in 2005 applying the DEPM

Abstract: As a result of the review of 2005 adult parameters for sardine in Atlantic Spanish waters a new estimation of Spawning Stock Biomass (SSB) was made. Moreover a review of Total Daily egg production estimation (Po) for sardine was calculated. As result of this review the Po was estimated in 3.5 1012 (cv = 21). This estimation was higher that value provided in 2006 meeting as result of an underestimation of spawning area presented in 2006 meeting. The spawning biomass estimated in 106.2 103 t with a coefficient of variation of 47%. The 2005 sardine spawning biomass estimate (106.2 103 t) is lower than previous estimation presented in 2006 ICES WGACEGG. This decrease of sardine Spawning Stock Biomass in relation with preliminary estimation presented in 2006 meeting (154.5 103 t) should be due mainly to variation of the Spawning fraction estimate and the Po. The 2005 sardine spawning biomass estimate (106.2 103 t) was higher than 2002 estimation SSB (50.7 103 t) and the highest value in the temporal series (1997–2005).M.P. Jiménez, R. Sánchez, I. Muñoz and G. Costas, WD2008: Anchovy DEPM survey in the Gulf of Cadiz "BOCADEVA-0608": Eggs sampling and Daily Egg Production estimation. Abstract: This document presents the methodology and the results obtained during the BOCADEVA-0608 survey, carried out in the Gulf of Cadiz in June 2008. This is the second anchovy DEPM (Daily Egg Production Method) survey carried out in this area. This work presents anchovy egg abundances and distribution, eggs development staging results, current anchovy spawning area in ICES Subdivision IXa South and egg parameters estimates.

M.P. Jiménez, R. Sánchez, I. Muñoz, and G. Costas, WD2008: Anchovy DEPM survey in the Gulf of Cadiz "BOCADEVA-0608": Eggs sampling and Daily Egg Production estimation.

Abstract: This document presents the methodology and the results obtained during the BOCADEVA-0608 survey, carried out in the Gulf of Cadiz in June 2008. This is the second anchovy DEPM (Daily Egg Production Method) survey carried out in this area. This work presents anchovy egg abundances and distribution, eggs development staging results, current anchovy spawning area in ICES Subdivision IXa South and egg parameters estimates.

M. Millan 2008: Anchovy DEPM survey in the Gulf of Cadiz "BOCADEVA-0608": A summary of results from fishing stations and ongoing work in the adults sampling and processing.

Abstract: The present WD describes the applied methods, progresses carried out and preliminary results obtained from fishing stations and the biological sampling of Gulf of Cádiz anchovy adults during the DEPM (Daily Egg Production Method) BOCADEVA-0608 survey. This survey, the second one in the BOCADEVA series, was conducted in June 2008 surveying both Portuguese (Algarve) and Spanish waters of the Gulf of Cádiz. A summary of the characteristics of the available anchovy adult samples collected during the survey is also shown in this WD. Adult parameters have not yet been estimated awaiting appropriate data on modelling and/or histological processing and analysis.

Pérez, JR., Costas, G., Solla, A., Iglesias, L, Dueñas, C., and Barrado, J., WD2008: Preliminary results of the 2008 adult parameters for sardine North Atlantic Iberian waters (ICES Division IXa North and VIIIc).

Massé Jacques, Erwan Duhamel, Pierre Beillois, Patrick Grellier, Martin Huret, Gwenn Kervella Pierre Petitgas, "Direct assessment of pelagic species by the PELGAS08 acoustic survey".

Abstract: An acoustic survey was carried out in the Bay of Biscay from 26 April to 26 May 26 on board the French research vessel "Thalassa". The objective of PELGAS08 survey was to study the abundance and distribution of pelagic fish in the Bay of Biscay. The target species were mainly anchovy and sardine and were considered in a multi-specific context. To assess an optimum horizontal and vertical description of the area, two types of actions were combined: i) Continuous acquisition by storing acoustic data from five different frequencies and and counting the number of fish eggs using CUFES system, and discrete sampling at stations. A commercial pairtrawlers were accompanying "Thalassa" all along the survey such as to double the number of identifications hauls and increase the reliability of identification of echoes. This WD report acoustic assessments and length distributions of main species, age distribution for anchovy and sardine and some environmental data. Sardine recruitment seems one of the highest since 2000, anchovy one is still low and horse mackerel, mackerel and blue whiting are quite rare in the Bay of Biscay compared to nineties

M. Peña, A. Uriarte, M. Santos and L. Ibaibarriaga. Analysis of the sensitivity of incubation temperature on anchovy egg production. Working Document to the ICES WGACEGG, 24–28 November 2008, Nantes (France).

Abstract: The Daily Egg Production Method is yearly applied for the estimation of egg production of anchovy (Engraulis encrasicolus) in the Bay of Biscay. The Spawning Stock Biomass (SSB) is consequently calculated as the population responsible of that egg production. In order to get an estimation of the production and mortality, an ageing procedure of eggs is needed in order to convert assigned stages to ages. The Bayesian ageing is commonly applied for this task, but requires the incubation temperature of eggs. This temperature is usually considered to be the value found at 10 metres depth, where maximum concentrations of eggs are typically reported. However, this temperature cannot always be recorded. In cold years, this practice can sometimes produce unexpected too old cohorts. Physical transport of the eggs could be one of the explanations: as the eggs are transported from one area to another, they follow an unknown gradient of temperatures. We present a model to calculate the incubation temperature by station corresponding to the maximum probability (near the surface values) of finding the number of eggs by stages in the station, given sampling time and distribution of spawning time We thus, infer a temperature which maximizes the observation of eggs in the station. SST is nevertheless taken as an upper limit of the incubation temperature. The method minimizes the loss of egg due to misallocation to daily cohorts having a noticeable effect on the ageing of eggs. We present the variation in the Daily Egg Production and thus in the final estimate of SSB.

M. Santos, A. Uriarte and L. Ibaibarriaga. Spawning Stock Biomass estimates of the Bay of Biscay anchovy (*Engraulis encrasicolus*, L.) in 2008 applying the DEPM. Working Document to the ICES WGACEGG, 24–28 November 2008, Nantes (France).

Abstract: The research survey BIOMAN08 for the application of the Daily Egg Production Method (DEPM) for the Bay of Biscay anchovy was conducted in May 2008 from the 6–26 May covering the whole spawning area of the species. 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 mortality model fitted as a Generalized Linear Model (GLM) to the egg daily cohorts. Adult parameters, sex ratio, batch fecundity and weight of mature females were estimate based on the adult samples obtained during the survey and the spawning frequency estimate was based on its relationship with the average Sea Surface Temperature (SST) inferred from the historical series. The population at age was estimate as well. The spawning biomass estimate resulted in **25,377 t** with a **coefficient of variation of 26%.**

Sánchez Leal R.F., M. Paz Jiménez, F. Corregidor, V. Pita, 2008: Physical oceanography conditions during BOCADEVA0608 cruise.

Abstract: BOCADEVA0608 cruise was carried out on-board RV “Cornide de Saavedra” between 06:00 GMT 22 June and 20:00 GMT 2 July 2008. Hydrographic sampling consisted of 139 CTD stations conducted with a SBE25 and 116 CalVET stations profiled with a SBE37 probe. Temperature, salinity and fluorescence were recorded underway, as well as current velocities with a RDI 75 kHz OS ADCP. Cruise track and depth sounder data were also recorded in order to improve local bathymetric estimates. This document describes the data and characterizes oceanographic conditions at the time of the cruise based on these in situ and other remotely sensed data.

List of Presentations made to this Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VIII and IX [WGACEGG].

Joint presentation of the DEPM surveys on anchovy in the Bay of Biscay (Subarea VIII) and in Algarve and Cadiz (IXa South). M. Santos, M.Paz Gimenez

Joint presentation of the DEPM surveys on sardine in Subareas VIII and IXa (M. Manuel and A. Lago, M. Santos *et al.,*)

Joint presentation of the Acoustic surveys in First half of the year in Subareas VIII and IXa (J. Massé *et al.,*)

Intercallibration of Spanish and Portuguese Spring acoustic surveys (Iglesias and Marques):

Abstract: An inter-ship comparison has been carried out between the Portuguese RV "Noruega" and the French RV "Thalassa" in order to test the overall performance of the survey equipment of both vessels in the field. The inter-calibration exercise was performed off northern Portugal at the beginning of the joint spring autumn surveys performed every year off the Iberian Peninsula by IPIMAR and IEO (April 208). The comparison of the integration of the bottom showed similar trends both within and between vessels. However, a bias was observed with "Thalassa" obtaining in average 2 times as much echo for the same portion of the bottom than "Noruega". This preliminary analysis was not sufficient to explain the differences observed. There are various potential sources of bias that could have been present: cruise track not being exactly the same, motion of the transducer and beam directivity problems due to the higher pitch and roll of RV "Noruega" and additionally differences between the theoretical and effective angles of the transducer. Data need to be analysed more thoroughly to evaluate all the possible causes.

PELACUS 10 2008 survey (M. Iglesias):

Abstract: PELACUS0408 spring acoustic survey took place on-board the RV "Thalassa" from the 28 March to the 21 April 2008. The area of the continental shelf covered extended from 30 to 200 m depth, from northern Portuguese waters to southern French waters. The abundance (number of individuals) and biomass (tons) of the nine pelagic species detected during the survey were estimated: sardine (Sardina pilchardus), anchovy (Engraulis encrasicolus), horse mackerel (*Trachurus trachurus*), mackerel (Scomber scombrus), chub mackerel (*Scomber colias*), blue horse mackerel (*Trachurus picturatus*), bogue (*Boops boops*) blue whiting (Micromesistius poutassou) and Capros aper. The total number of pelagic trawls has increased steadily during the last four years. Sardine abundance was estimated at 1 816 million individuals, while biomass was estimated to be 140.3 thousand tonnes.

Acoustic surveying of anchovy Juveniles in the Bay of Biscay: JUVENA 2008 Survey Report. Boyra, G., Martínez, U. and Uriarte, A.

Intercalibration and crossvalidation of the 2008 BoB anchovy juvenile surveys (PELACUS and JUVENA). G. Boyra and E. Nogueira.

Pilot experiments of acoustic surveying of pelagic resources in the Gulf of Cádiz coastal shallow waters (< 20 m depth): "PACAS" surveys. F. Ramos, J. Miquel and M. Millán.

Abstract: The acoustic surveying of the Gulf of Cádiz waters by IEO is based on a sampling scheme which establishes its shallowest limit at 20 m depth. Such a scheme results in an

unsampled area, located in the central part of the study area, which may represent a relatively large proportion of the continental shelf. The problem of acoustically surveying these shallow waters using vertical echosounding has been tackled this year by IEO by firstly assessing the suitability of the available small-draught research vessels. Two PACAS experiments (Pilot experiments of acoustic surveying of pelagic resources in the Gulf of Cádiz shallow waters (< 20 m depth)) were therefore planned to be conducted between 17 – 24 July (PACAS 0708 survey) and between 11–17 October 2008 (PACAS 1008 survey) with the research vessels RV "Francisco de Paula Navarro" (Navarro) and RV "Emma Bardán" (Bardán), respectively. Bardán was equipped with its usual acoustic (EK60 multifrequency scientific echosounder) and fishing equipments whereas Navarro was equipped with ad hoc configurations both for acoustic surveying (a non-scientific echosounder) and pelagic fishing (other vessel's gear). The short ship-time available per survey was preferably invested in performing as many fishing operations for training as possible instead of the acoustic assessment. The echosounding of shallow waters (up to 6–7 m depth) evidenced that the population estimates for neritic species derived from conventional surveys may be underestimated. The shallowest limit for pelagic fishing was at around 16–18 m, although somewhat shallower depths might be reached with previous exploration. Initially Bardán seems to be a more suitable vessel than Navarro in terms of on-board usual equipment for both acoustics and fishing, although the former has serious restrictions for accommodation of enough scientific staff for the conduction of quasi-standard "pelagic ecosystem" surveys.

Revision of the anchovy SSB estimates by the DEPM in the Bay of Biscay. A. Uriarte and M. Santos

Revision of adult parameters for sardine in 2005 and new SSB estimates. Gerson Costas

Short-note on "comparison of egg ageing using CTD temperatures from dif. depths"; M Manuel *et al.*,

Analysis of the sensitivity of incubation temperature on anchovy egg production estimates. M. Peña *et al.*,

Automated Fecundity Measurements for sardine. G. Kostas

DEPM Advances M. Bernal:

Abstract: A summary of advances in the life of ICES related DEPM groups for sardine and anchovy was presented. Main advances in recent years include the potential transformation of DEPM into a spatially and environmentally explicit method, improvement in the precision of egg and POF ageing, and the research to incorporate CUFES as a quantitative sampling gear within the DEPM framework. Remaining issues include the implementation of a spatially explicit model for adult fecundity and to implement and evaluate the capability of CUFES as a primary sampler to obtain DEPM estimates.

Combining acoustic and CUFES data for the quality control of fish stock acoustic survey estimates P. Petitgas

Autumn Acoustic surveys on juveniles in IXa PELAGO10. Juan Zwolinski

On small pelagics Target Strength measurements in the Bay of Biscay. M. Doray, J. Massé.

Geostatistical estimation variance of survey estimates. P Petitgas

Methods for combining errors: geostatistical conditional simulations. M. Woillez

A species identification variance term for acoustic survey estimates. P Petitgas

Proposal for Sentinel Survey for small pelagics in the Bay of Biscay. J. Massé

Annex 6: Report of the Workshop on variance estimation for abundance indices from acoustic surveys

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A.6.1 Introduction

During the WGACEGG meeting held in Palma de Mallorca, Spain, in 2007, it was proposed to conduct a workshop on the precision of the acoustic abundance estimations carried out in the frame of this WG. The objectives of this workshop on variance of abundance estimations were:

1) Review the sources of error of the acoustic and DEPM abundance estimations.
2) Identify and describe the theoretical bases of the main techniques currently used to calculate variance for abundance estimation surveys.
3) Discuss the weaknesses and strengths of each method, and its appropriateness according to the type of data on which it will be applied on.

Initially, this WK was planned to deal only with acoustic data, but eventually, during the organization of the WK, it was decided to include also the DEPM surveys. Nevertheless, due to time constrains, it was not possible to prepare presentations for variance estimation in DEPM surveys and, thus, finally the DEPM was only covered in the first Section of the WK, concerning the revision of the sources of error.

The following Sections review the presentations and discussions made in the WK.

A.6.2 Sources of error in DEPM and acoustic surveys under the WGACEGG framework

The main objective of the surveys of WGACEGG is to provide abundance estimates of the surveyed stocks. These estimations are subject to different degrees of imprecision. In general, errors can be considered as the sum of two components: the random error, which is caused by the stochastic nature of sampling, and the systematic error or bias. The former can be reduced by collecting more samples, but not the latter.

The sources of imprecision depend on the methodology applied for the estimation of abundance. In the frame of the WGACEGG there are two types of methodologies for abundance estimation, acoustics and DEPM. Due to the completely different nature of these two techniques, the sources of error are also different. However, as both follow parallel steps in the estimation of abundance; we have used this structure to compare both methodologies and their associated sources of error at each step (see **Table A.6.2.1**).

As can be seen, the errors spread differently in each method. In acoustics, the samples are echoes obtained by sophisticated electronic sensors subject to a list of potential sources of bias of technical nature. In DEPM, the samples are plankton captured with nets and are free of these types of technical biases. Regarding the spatial error, a slight advantage of acoustics arises from its continuous sampling scheme against the discrete samples of the DEPM (there is scope for improvement here using the CUFES) In the species allocation step, acoustics face higher uncertainties than DEPM. Then, there is a step that exists only for DEPM, the estimation of the Daily Egg Production. This process is based in a model and contributes both with random and systematic errors to the variance. In the last step both methods suffer from large potential bias by the Target Strength (acoustics) and the Daily Fecundity (DEPM)

A.6.3 Methods for estimating interpolation variance of abundance data

Acoustic surveys sample a small proportion of the total volume (as small as the 0.01% of it, Simmonds and MacLennan, 2005). Therefore, there is need to interpolate the sampled values in order to obtain the total estimated abundances. The error associated to the sampling design is probably one of the main sources of error in the acoustic methodology. Fortunately, this interpolation error is probably the best understood, as there are several techniques that have been dealing with it in the last 15 years. In this WK, two techniques are presented for estimating this imprecision: the already well established geostatistical method and the emerging GAM techniques.

Table A.6.2.1. Comparison of methodology and sources of errors in acoustics and DEPM based abundance estimations.

Steps in acoustic-based estimation	Associated errors	Steps in DEPM-based estimation	Associated errors
Sampling -Sampling of echoes for fish school Energy (E). -Continuous sampling.	-Sampling error: about 15% -Different types of bias (Equipment sensitivity, Transducer motion 0-5%, The surface bubble layer 0-90%, Hydrographic conditions 3-10%, Fish migration 0-30%, Diurnal behavior rhythms, Avoidance reaction 0-50 %).	**Sampling** -Plankton Sampling for fish eggs abundance E. -Discrete sampling	Sampling error: 5-15 % (estimated with geostatistics)
Allocation to species Fish sampling to allocate E to species *i*. $E_i = \frac{w_i \langle \sigma_i \rangle E_m}{\left(\sum_j w_j \langle \sigma_j \rangle \right)}$	-Species proportions by fishing (0-50 %) -Species assignation through echo-integral partitioning -Length random sampling (5-20%)	**Allocation to species** -Sorting & Identification to allocate E to species *i*. -Staging and Ageing of eggs.	-Identification: 0-5% (bias by omission of fish eggs) -Staging: error 0-3 % -Ageing: 10% in correct allocation of egg to cohorts. Multinomial models function of Spawning time (small error) and Temperature (unknown error).
		Daily Egg Production Daily Egg Production P0 by species *i* from an exponential mortality model $E_i = P0_i * \exp(Z \cdot age)$	-Model error (unknown bias) -Parameter statistical estimation error in Z and P0: 10-20% (by GLM or GAM). -Egg recruiting to sampling: potential bias if correlation between TºC and Egg abundance
Conversion to biomass: Mean TS to obtain density by species $Biom = Area \cdot \frac{E_i}{4\pi \langle \sigma_i \rangle}$	-Fluctuation in the mean TS over the surveyed region (5-20%) -Target strength systematic errors 0-50% (or larger and also depends on the target strength of the other species in the community -Error in Total Area delimitation.	**Conversion to biomass** Fishing hauls to estimate daily fecundity to infer biomass by species $SSB = Area \cdot \frac{P0_i}{DF_i}$	-Error is a function of female total mean weight, batch fecundity, daily spawning fraction of females and sex ratio in weight. Small or variable errors but large potential bias in spawning frequency. -Error in Total Area delimitation. -Variance deduced by the Delta method or Bootstrapping

A.6.3.1 Linear geostatistics

The spatial variation of sA in acoustic surveys is a major component contributing to the variance of the abundance estimate. Over the past 10 years, fishery scientists gradually adopted geostatistical tools to estimate the estimation error corresponding to spatial interpolation. First, the relation between model-based variance estimates and covariance structure permits estimation of survey precision for non-random survey designs. The possibility of using spatial covariance for optimizing sampling strategy is a second motive for using geostatistics. Kriging also offers the advantage of weighting data values, which is useful when sample points are clustered. The presentation discussed the different geostatistical models that characterize spatial variation, and their variance formulae for many different survey designs. It also compared the concepts underlying design-based approaches including transitive geostatistics, geostatistical models and regression in classical statistics. The simplest yet flexible geostatistical model is that of the variogram with a quasi-stationarity assumption (for inter-point distances within elementary blocks). More complex geostatistical models can also be applied considering trend and proportional effects depending on the applications. The presentation was based on a review paper (Petitgas, 2001).

A discussion followed. The methods presented are linear and the ability to properly estimate the variogram was questioned for situations with skewed data. There are estimation procedures involving non linear approaches (e.g. transform and back-transform). Separating the variability between trend and error can also be done in a geostatistical model but a simple quasi stationary model (stationary for small distances, i.e. that for inter-point distances within elementary blocks) will provide a correct variance estimate for the entire area on which the abundance estimation is performed.

A.6.3.2. GAM

In most coastal small pelagic fish stocks, trends in distribution are typically driven by a response of the individuals to a varying environment. In these cases, if a function describing the trend can be adequately represented, its integral provides an unbiased estimate of abundance and its variance is a function of the quality of the fitted model (Wood and Horwood, 1995; Borchers *et al.*, 1997a). One of the major tasks of fitting a model to spatial data is the selection of the right function (Wood and Horwood, 1995). In cases in which there is no a priori knowledge of the relationships under study, spline functions are optimal candidates. Splines are functions that interpolate data without a rigid parametric structure with their shape being selected by a compromise between the prediction ability and model complexity. Additionally, when splines functions are embedded within a generalized additive model framework, they can be used with a wide range of distributions, enhancing the possibility to obtain an appropriate distribution for the data without the need to perform ad hoc transformations (Venables and Dichmont, 2004). Moreover, approximate confidence intervals can be calculated for the splines and the volume under them (Wood, 2006).

Data showing zero-inflated and positively skewed distributions, as is often the case for fisheries acoustic surveys, tend to provide imprecise estimates of their mean. To deal with such situations for independent and identically distributed random variables, Aitchison (1955) developed a more efficient estimator of the population mean. The model behind the estimator was a generalized form of the lognormal population in which a varying proportion of zero values was allowed. This estimator has gained popularity in the fisheries context and has been extended to allow the inclusion of covariates, and hence the possibility of estimating a non-constant mean. Additionally, within the framework of generalized linear (McCullagh and Nelder, 1997) or additive (Wood 2006) models, the distribution of the positive observations is no longer restricted to the lognormal distribution, accommodating several shapes of right skewed distributions.

Two-step GAM modelling performed for 18 sets of sardine data arising from 6 Portuguese acoustic surveys showed that the estimates of total backscatter obtained by integration of the fitted NASC surfaces were not significantly different from those obtained from the arithmetic mean estimator (an unbiased estimator) and were more precise (ICES, 2007).

A.6.3.3. Discussion

The GAM and the geostatistics approaches discussed during the workshop differ on their assumption of the underlying models. The GAM approach assumes that all information is in the mean structure and the stochastic process is white noise, whereas the intrinsic order-0 geostatistical model (that using the variogram, as opposed to intrinsic order-k models that are non stationary) assumes that there is a constant mean plus a zero mean intrinsically stationary process. The main differences between both techniques are summarized in the **Table A.6.3.3.1.**

Table A.6.3.3.1. Comparison of Geostatistics and GAM methods.

FEATURE	GEOSTATISTICS	GAM
Abundance estimates	Spatial average	Process mean
Estimated variance	Variance of estimation error	Variance of the estimator
Spatial considerations	Spatial correlation of the residuals around a local mean inside the boundary	Considers the observations as the noisy outcome of an average underlying function
Assumptions	Second order stationarity of the mean	Strict stationarity of the pdf, smooth changing mean
Checking the assumptions	Fitting the data to the variogram model	Independence and correct distribution of the residuals

The spatial process that is observed during acoustic surveys is composed by a large-scale "deterministic" plus a small scale stochastic process which cannot be decomposed uniquely (Cressie, 1991). According to Cressie (1991), a parsimoniously parametrized mean structure plus a suitable stationary error structure is probably the preferable model. However it is not clear how to quantify "parsimoniously parametrized" and "suitable stationary".

In geostatistics, the trend corresponds to a characteristic of the underlying model, namely the average over many realizations. Therefore it should have some consistency across years. The same applies to the variogram model. Some parameters of the models used in each year could perhaps be estimated using many years and this could be investigated in future. In GAM's there is no prior knowledge of the spatial trend, as it is a function of the species abundance, interaction with other species and with the surrounding environment. Therefore, the spatial structure of the mean can vary from survey to survey

A preliminary advantage of the geostatistical method is that it is simpler to apply in good conditions. That is, when the variogram shows structure of the data and the data do not show a trend structure (the variogram may accommodate a slowly varying trend: quasi-stationarity assumption), it may be simpler to use geostatistics to calculate the variance, taking into account the spatial correlation. In case there is no clear structure, or there is need to deal with spatial trends, the complexity of the problem increases, being both methods similarly complex to apply. In this case, the higher flexibility of the GAM and the possibility of applying different underlying pdfs may provide some advantage.

A.6.4. Methods for combining errors of different sources

The other errors involved in acoustic estimation of abundance have diverse sources as we described above. Up to date, the main tools used in all the attempts for dealing with other sources of errors have been resampling and simulations.

A.6.4.1. Conditional simulations

Geostatistical conditional simulations, which can reproduce the spatial variability of a variable, are particularly helpful to estimate the uncertainty associated with the combination of different sources of variability. Acoustic surveys offer an example of such complex situations, where different data (e.g. acoustic backscatter, fish length and fish age) need to be combined to estimate abundance and its associated uncertainty.

The uncertainty of Scottish herring acoustic survey estimates is investigated using these techniques (Woillez *et al.,* in press). A specific multivariate geostatistical model is used to describe the structural relationships, which includes highly skewed distributions for the acoustic backscatter data and incorporates relationships between depth, mean length and proportions at age. Conditional simulations, i.e. simulations which honour the data values known at the data points, are used to generate multiple realizations of acoustic backscatter, mean length and proportions at age. These are combined to produce multiple realizations of herring density over the sampled domain. Multiple realizations of total abundance and abundance-at-age are then provided. The uncertainty is assessed through basic statistics to track the significant variations of these values over the period 1989–2005. Higher CVs are found on average for extreme ages (age 1, 2i, 8 and 9+); otherwise, CVs are mostly around 12% for abundance-at-age and around 10% for total abundance.

A notable interest of such simulation methodology relies in the possibility of optimizing the survey design, i.e. the transects and trawls allocation, in order to obtain a more consistent data collection and more precise estimations. The relative importance of the different sources of variability can also be identified in order to point out the variables that support the major part of the uncertainty. It would be valuable to extend this methodology (assuming appropriate geostatistical models) to other important fish stocks.

A.6.4.2. Combining GAMs with resampling of the trawl stations

To transform acoustic backscatter to fish density requires the processing of information of the length distribution of the population in order to obtain the mean backscattering cross-Section of the fish. There are several ways of interpolating biological information over a region, the most common being the combination of the trawl data into regions with homogeneous length distributions (ICES, 2005a; Simmonds and MacLennan 2005). Other means of interpolation include nearest neighbour allocation, weighted or unweighted averages of the trawl length distributions by regions or strata, etc. If the length frequency distribution obtained through trawl sampling are not cross-correlated and do not show trends, i.e. a pattern in space or with environmental variables, then the variability of trawl samples can be evaluated by jackkinfe. Jackkinfe of the trawl stations can be combined with the simulations of the NASC surfaces to provide spatially indexed estimates of abundance with confidence intervals for numbers and biomass at length and age. Additionally, as the jackknife preserves the length distribution of the trawl samples, it can be used for inference about the regions exerting high leverage in the estimates of numbers, biomass and length distribution of the estimated population

The combination of NASC modelling and trawl resampling was applied to 18 sets of sardine data arising from six Portuguese acoustic surveys. The estimates of numbers and biomass had average relative standard errors of 22% and 19%, respectively, the most important contributor to this value being acoustic sampling.

A.6.4.3 Sampling variance of species identification in acoustic surveys

At sea during acoustic surveys, a small number of echotraces are identified to species by fishing. During data analysis, the process of echogram scrutiny leads to allocating echotrace backscattered energies to species. While the precision of survey estimates is generally based on the spatial variation in the energy, no variance term accounts for species identification and energy allocation. The presentation discussed how the sampling variance of species identification is developed under the method AICASA (acoustic image classification and species allocation: Petitgas *et al.*, 2003) in which automated procedures are used allowing energy allocation to be carried out by a non-expert. The procedures are based on the fact that at the sampling stage trawl hauls are associated to particular acoustic images. The procedures have two steps: the classification step corresponds to species identification and the aggregation step to energy allocation. A PCA-based classification is performed on the identified images (a PCA is applied on echotraces indices as derived after echointegration by schools) and results in defining groups of images. The sampling variability of the species identification is estimated by resampling among trawl haul variability in groups of acoustic images. The next step is to aggregate non-identified images to acoustic image groups, which results in post-stratifying the data. The estimation (map, abundance and variance per species) is then derived automatically and is conditioned by the post-stratification. The variance term relative to species identification contributed 60–80% of the total variance of the abundance estimate.

The method for species identification falls in the category of an unsupervised linear classification method. The step of aggregation of non-identified images to acoustic image groups could be ameliorated by using an assignment probability for each group. This should be useful when groups are partially overlapping.

A.6.4.3 Discussion

As happened in the interpolation techniques, here, the geostatistical simulation offers a priory an advantage to the regular one, in case of spatial structure of the data, as it naturally accounts for the spatial correlation of the data, providing realistic spatial distributions of populations.

A.6.5. Conclusions

In summary, measuring the error is a key issue in any survey that estimates fish abundance. For acoustics and DEPM, the errors are differently distributed along the methodological steps of each technique, with notable differences in the sources of them, due to the different nature of each. The most studied error is the one associated to spatial interpolation. The two techniques discussed in this WK are suitable to analyse this type of error, being geostatistics simpler to apply in good conditions and providing GAM more flexibility in complex situations. Nevertheless, it has to be taking into account that the complexity of the model used depends not only on the characteristics of the data but also on the objective of the analysis. Concerning the other sources of error associated with acoustic surveys, the sizing and species identification errors have been evaluated, their study mainly based on resampling and simulation techniques. The errors estimated in the frame of this WG are in general agreement with bibliography (**Table A.6.5.1**). However, there is lack of estimation of error of TS in the WGACEGG acoustic surveys, which is believed to be small in terms of random but important as potential bias.

Table A.6.5.1. Comparison of random error values (coefficient of variation) estimated in WGACEGG surveys and found in bibliography (Simmonds and MacLennan, 2005).

Steps in acoustic-based estimation	Random errors in bibliography	Random errors estimated in WGACEGG surveys
Sampling	-Sampling error. About 15%	-Spatial error GAM: 20% -Spatial error geostats: 4%
Allocation to species	-Species assignation through echo-integral partitioning -Length random sampling (5–20%)	-Species assignation: 16% Length distribution (GAM and resampling): 5%
Conversion to biomass:	-Fluctuation in the mean TS over the surveyed region (5–20%)	

A.6.6 Work plan for the coming years

- Complete the WK with presentations of variance estimation in DEPM surveys
- Conduct a WK in 2009 for geostatistic calculation of variance in acoustic based abundance estimations.

A.6.7 List of participants at the Workshop

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