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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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Executive summary

This year the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VIII and IX (WGACEGG) meeting was provided with a large volume of information not only on the state of the sardine and anchovy population in the area covered by the EG, but also on reviews of the time series of SSB estimates from acoustic and Daily Egg Production Method (DEPM) SSB estimators. Conclusions on the status of the population and the methods used can be found in Section 9 of this report. In this summary, the status of anchovy and sardine populations from Fishery independent indexes is presented.

Anchovy populations

The Bay of Biscay anchovy has gone through a crisis in recent years, which has led to the lower estimates of SSB of the time series and closure of the fishery. Recruitment since 2006 has been poor and the SSB levels have therefore not recovered. Both DEPM and acoustic estimates of SSB for 2007 show a slightly higher SSB value in comparison with 2006 (40 000 t and 26 000 t respectively). Taking this into account the associated variances, values and trends between acoustic and DEPM-based SSB estimates are similar since the crisis. Nevertheless, the fact that the absolute value of Blim is between the actual SSB estimates from both methods, creates some management problems. Estimates of recruitment from an index of juvenile abundance are not yet considered to be robust. Juvenile abundance index for 2007 shows a lower value in comparison with previous estimates, therefore there is no indication of a possible higher recruitment for 2008. Other indirect signals from the acoustic survey show that situation in the Bay of Biscay anchovy may be slightly improving, like the wider distribution of the population and the structure of the schools, but current fishery independent estimates indicates that the SSB values continue to be amongst the lowest of the available time series.

The Gulf of Cádiz anchovy shows in comparison, a better perspective from the different acoustic estimates available (IPIMAR and IEO) and from the observed distribution of eggs (from Continuous, Underway Fish Egg Sampler (CUFES)). Acoustic surveys from IPIMAR and IEO provide similar biomass estimates (40 000 t and 30 000 t respectively), and a similar spatial distribution of the stock (mainly located in the Spanish waters of the Gulf). These estimates indicate a slight increase in relation to the previous years. The distribution of eggs this year also shows a large coverage, although DEPM based SSB estimates will not be available until late 2008/2009, from the survey that will be carried out in 2008. For previous DEPM estimates, the value was also coincident with the acoustic estimation; therefore fishery independent SSB estimates seem to provide a coherent view in this area. Nevertheless, the time series of the DEPM survey is reduced to just one year and therefore proper comparisons are not yet possible; as some differences between the IPIMAR and IEO acoustic estimates have appeared in the past.

Sardine population

The state of the Atlanto-Iberian sardine stock from fishery independent SSB indexes continues to provide a general positive perspective, although some discrepancies and spatial differences in the perception exist. Estimates of sardine SSB in the Armorican shelf are now routinely presented both to this EG and to Working Group on Widely Distributed Stocks (WGWIDE) and Working Group on Anchovy (WGANC). The short time series available in this area (from 2000) indicates a general decrease of

sardine abundance, with an estimate for 2007 of 126 000 t. Nevertheless, the large variability in the SSB estimates obtained in some years (e.g. 2003) seem to indicate that the population in this area may not always be available (at least in the same percentage) to the acoustic survey. Also, the northern limit of the sardine distribution in the Armorican shelf is not attained in the survey, therefore uncertainties in the percentage of the population that can be missing, exist. Estimates of SSB from the north Iberian coast and the north-west corner indicate a slight increase in SSB (96 000 t for 2007), but also show a patchy and concentrated distribution, with the population constrained to coastal areas and some spots in the north-west corner. Also, the percentage of old fish continues to be low in comparison with early years of the time series. Distribution of eggs from CUFES indicates an anomalous wide distribution and large abundance for 2007 in the north Iberian area, although conclusions on spawning intensity will have to wait until the 2008 DEPM survey. Sardine SSB estimates in the western Iberian façade show an average state of the stock in this area (344 000 t), but also indicates a weak recruitment. Estimates in the Cádiz also indicate an average state of the stock in the area, and in general are coherent between the surveys (107 000 t and 87 000 t for the IPIMAR – April and IEO – June survey).

Main methodological issues discussed

- The BoB anchovy juvenile Index has suffered large and thoughtful reviews in the past years**.** The possibility of comparing the juvenile time series (JUVENA) with another survey with similar objectives carried out simultaneously (PELACUS) has allowed cross-validation of the surveys, and has yield an improvement of the methods required to obtain a stable and unbiased juvenile abundance index.. Both the JUVENA and PELACUS cruises have provided different results in the past two years. Nevertheless, during interim workshops and this year WG meeting, the main sources of differences between the surveys have been identified and are mainly due to coverage and small methodological problems. Recommendations on how to improve the survey coverage have been produced, and the main methodological problems identified have been overcome. Despite the advances, the time series of juvenile abundance index is still under revision, and therefore it is not yet considered as a consolidated assessment tool. However, the EG continues to recommend seeking a direct index of recruitment, and endorses the improvements introduced in the juvenile surveys.
- A thoughtful revision of BoB anchovy fecundity has led to an increase in spawning frequency estimates of around 60%. This yielded SSB estimates lower than previously, of about 30–50% lower than the SSB estimates provided by acoustics. The EG endorses the scientific work supporting the review, and therefore recommends providing a full review of DEPM-based BoB anchovy SSB estimates to the next Working Group on Anchovy [WGANC] meeting, in order to include it in anchovy assessment. An assessment of the effect of the DEPM-based estimate of SSB in the general BoB anchovy assessment is also recommended, together with an analysis of the effects of using both acoustic and DEPM indexes as absolute or relative in the assessment tuning.

1 Opening of the meeting

The 2007 meeting of WGACEGG was opened at Palma de Mallorca, Spain, on the morning of Monday 26 November, with the presentation of this year ToRs, and a summary of the achievements of last year's WG meeting (see Agenda on Annex 2)

2 Adoption of the agenda

The Agenda for the WGACEGG 2007 meeting (see Annex 2) was adopted by consensus and was used to organise the WG scientific presentations, discussion and report writing.

3 Introduction

3.1 Terms of Reference

The **Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VIII and IX** [WGACEGG]. (Chair: M. Bernal, Spain) will meet in Palma de Mallorca, Spain from the 26–30 November 2007 to:

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

b) plan and coordinate acoustic surveys in ICES Areas VIII and IX and standardize analysis procedures;

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

d) explore the possibilities to integrate egg production and acoustic based Spawning-stock biomass estimates;

e) finalize new egg production procedures and associated software developed under SGSBSA;

f) integrate biological/environmental information from surveys and additional sources to study the relationships between sardine and anchovy and the pelagic community in ICES Areas VIII and IX.

WGACEGG will report by 21 December 2007 for the attention of the Living Resources Committee.

3.2 Links with other groups

WGACEGG has a natural link with WGMHSA, which is responsible for the assessment of sardine and anchovy in Atlantic European waters. Communication between the two groups is strengthened by the fact that several members of the survey group are also members of the assessment group. A problem in the communication of the two groups is related to the annual calendar, with spring acoustic and DEPM surveys being first reported to the assessment group and then to the group that is responsible for them. This has also led to some duplication in the presentation and reporting of survey information between these two groups (and also the STECF summer meetings for anchovy). In terms of presentation, it is anticipated that the overlap will be reduced in the future, since WGACEGG decided to substitute national by regional presentations of seasonal surveys (see Section 8.4). In terms of reporting, it remains unclear the degree to which overlap between WGACEGG and WGMHSA can be reduced: although the former is the natural place to provide details on surveys, the latter report must be read autonomously (having

already led the reviewers to request more detailed information on surveys methods for sampling and estimation).

In addition to the links with WGMHSA, the WG identified a series of other groups and projects with which some or closer interaction is desirable. Table 3.2.1 lists these groups and projects, identifies the thematic areas with interest to the WG and proposes possible links/interactions to be pursued in the future.

Table 3.2.1. List of groups (or projects) with interest to WGACEGG and possible links/interactions in the area of small pelagic fish (SPF).

GROUP OR PROJECT	TOPIC OF INTEREST TO WG	POSSIBLE LINK/INTERACTION
WGFAST/WGFTFB	Acoustic technology	Technical questions/request advice
PGEGGS	DEPM methodology	Chairs in contact, possible mutual revision of reports
WGACEGG	Horse mackerel DEPM (south), methodological comparisons AEPM/DEPM	Common participants, Chairs in contact, possible mutual revision of reports
GFCM/SAC	Acoustic+DEPM surveys for SPF in the Mediterranean	Common participants, Chairs in contact
DCR/MEDIAS	Acoustic methods standardisation	Common participants
WKSPMAT	Sardine and anchovy maturity	Surprising lack of coordination at proposal stage; Possible participation of members
COST/FRESH	DEPM reproductive parameters	Promote international WK on SPF
WGFE/WGLESP	Distribution, habitat and spatial dynamics	Participate in WK or promote jointly; Ask questions/revision of ecological results
WKSPCLIM	Distribution and habitat of SPF	Support and member participation
EU/NWAfrica agreement	Acoustic surveys for SPF in northern Africa	Promote close coordination; Invite observers from Morocco/Mauritania to future meetings

3.3 Report structure

This year WG report structure follows the structure adopted in the first WG meeting (ICES, 2007). Sections 1 to 3 are introductory sections, which includes this year ToR's and the known and desired links between this WG and other ICES WG and scientific communities. Section 4 presents the available information on fishery independent surveys for both sardine and anchovy in the different areas covered by this WG, and using both acoustic and egg production surveys. As in previous years, an overall global view of the pelagic community is initially presented using information from both methods, and then detailed information (when available) from each method and for each specie is presented. Section 5 is new this year, and encompasses the different reviews carried out in the different methods and species SSB estimation. Section 6 presents the planning and coordination of the surveys for next year, which is of special relevance, as a new triennial sardine DEPM survey, as well as a new Gulf of Cádiz anchovy DEPM survey is expected for 2008. Section 7 shows the methodological/analytical advances related to the different methods carried out in

the interim meetings period, while Section 8 shows the advances in the integration between acoustic and egg production methods. Sections 7 and 8, especially Section 7, benefit this year from the near conclusion of a number of dedicated PhD studies, from which a number of scientific papers and WD were presented to the Working Group. Finally, Section 9 summarises the main conclusions of the meeting and Section 10 includes the references cited in the text. Recommendations from this WG meeting are summarised in Annex 4.

4 Recent fisheries independent surveys of sardine and anchovy stocks in ICES areas VIII and IX

4.1 Introduction

4.1.1 General distribution of species in areas VIII and IX

A general distribution of the different pelagic species in ICES Areas VIII and IX from survey trawls performed at the spring acoustic surveys of each institute (IFREMER, IEO and IPIMAR) during 2007 can be observed in Figures 4.1.1.1 (in Kg) and 4.1.1.2 (in number of fish).

Compared with other adjacent areas in the European Atlantic waters, the Bay of Biscay and the Iberian Peninsula show high pelagic fish diversity. The target species for this WG show a different distribution, with sardine (blue) spreading through all the covered area (and beyond), while anchovy shows two local population at the Bay of Biscay and the Gulf of Cadiz. In the Portuguese Subareas IXa-CN and IXa-CS, because the survey is targeted on sardine, most of the fishing stations are located near shore, where the probability of finding sardine is higher. Thus, fishing station reflects the fish pelagic community located close to the coast, which, in general is dominated by sardine. In the Portuguese Subarea IXa-S a pelagic community approach has been adopted for the last survey with a higher number of trawls covering all the continental shelf, and then in this last subarea the pelagic community is reflected. The Spanish and French acoustic surveys (including the Spanish survey in the Gulf of Cádiz), although having as target species sardine and/or anchovy, performed the hauls with the aim of detect all the pelagic species presented in the areas (to identify echotraces). Sardine and anchovy are accompanied by other pelagic species like mackerel (*Scomber scombrus*), predominantly off the North Iberian coast and Bay of Biscay, horse mackerel (*Trachurus trachurus*), spread through the Iberian Peninsula, the Armorican shelf and beyond, a local population of sprat (*Sprattus sprattus*) in the Bay of Biscay, and other species like chub mackerel (*Scomber japonicus/colias*) abundant in the Gulf of Cadiz and south Portugal, bogue (*Boops boops*), *Trachurus picturatus and Capros aper.* The rest of pelagic species less frequent in the catches have been reflected in the map as "others" and include: *Trachurus mediterraneus, Micromesistius potassou, Macroramphosus scolopax, Ammodytes tobianus* and hake (*Merluccius merluccius*). The distribution of these species shows the different dynamics, which can be described within the context proposed by SGRESP (ICES 2005d).

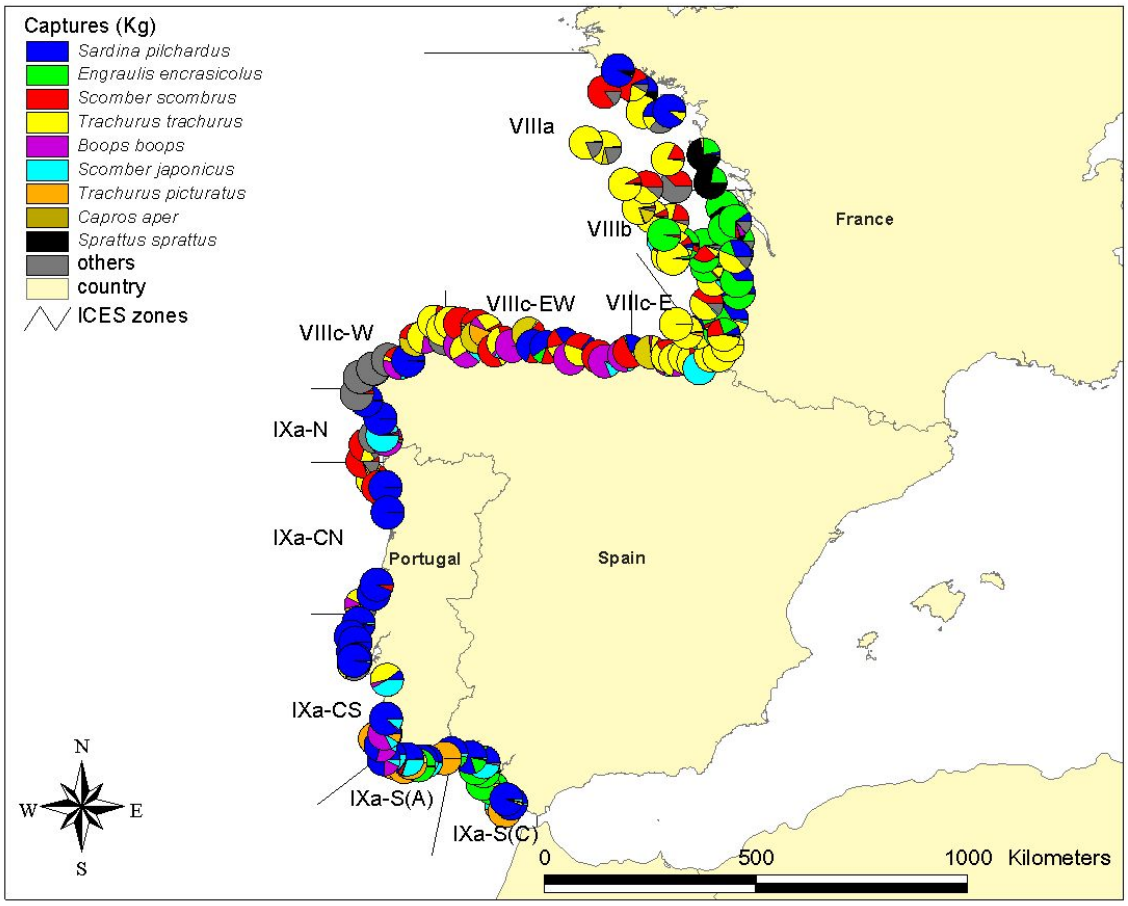


Figure 4.1.1.1. Species distribution (percentages in weight) along the acoustic surveys in the Atlantic waters of the Iberian Peninsula and Armorican shelf.

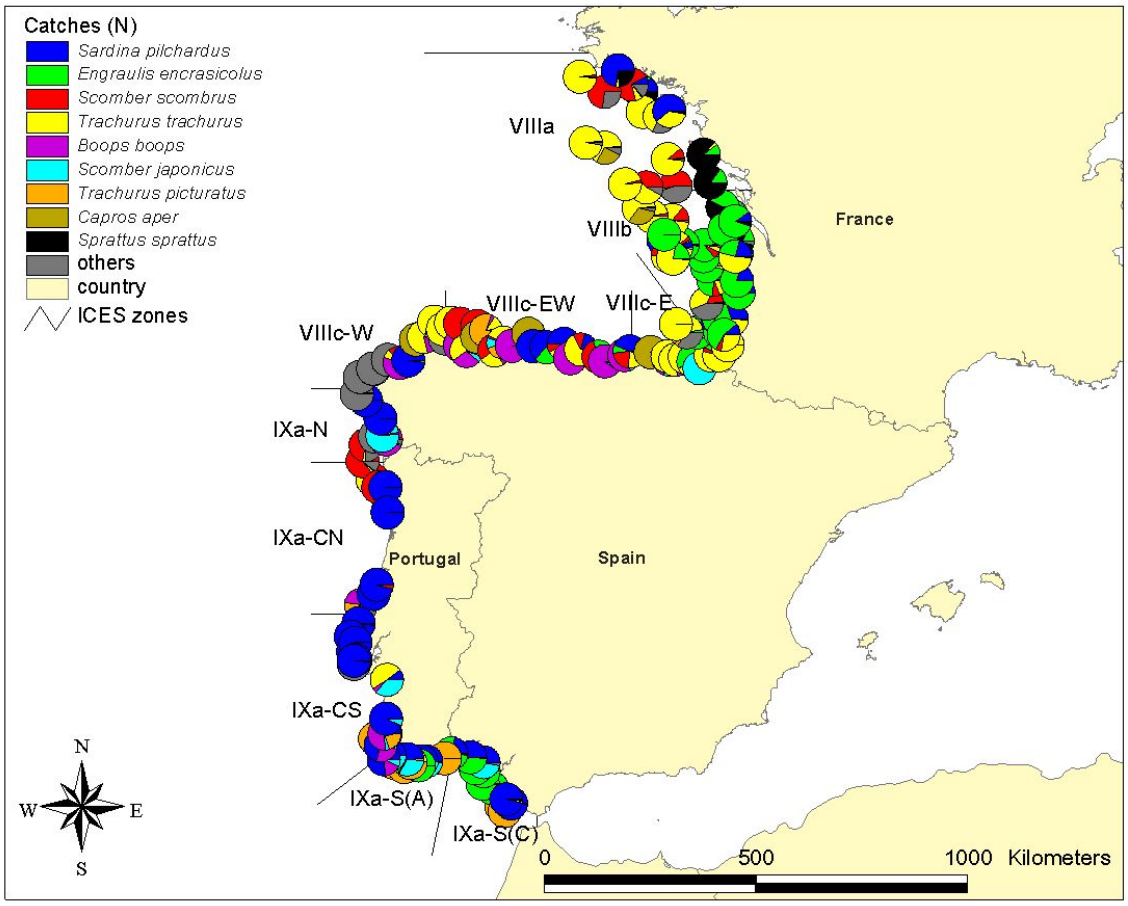


Figure 4.1.1.2. Species distribution (percentages in numbers) along the acoustic surveys in the Atlantic waters of the Iberian Peninsula and Armorican shelf.

4.2 Anchovy surveys in areas VIII and IX

4.2.1 General anchovy distribution

The results on anchovy egg densities, from CUFES, for the three acoustic surveys carried out during spring 2007 (IPIMAR, IEO and IFREMER) covering the whole region from Gibraltar to Brest, are presented in Figures 4.2.1.1. The 2007 surveys showed the highest numbers recorded for anchovy eggs from CUFES in spring time. The highest egg abundances were observed, as expected, in NE Bay of Biscay, overlapping with the adult distribution, as well as in the Gulf of Cádiz, coinciding with the region of high acoustic energy from anchovy in the south (see Figure 4.2.1.2). Contrasting with previous surveys it is noticeable the occurrence of eggs almost all along the Portuguese coast with a peak of abundance off the mouths of the rivers Sado and Tejo. Adult anchovy were observed in this region and in eastern Algarve. The area around the NW corner of the Peninsula was void of anchovy eggs.

Acoustic energy in sA (m^2/mn^2; NASC, Nautical Area Scattering Coefficient) allocated to anchovy (*Engraulis encrasicolus*) during the spring acoustic surveys carried out by the IPIMAR (April), IEO (April) and IFREMER (May) in their respective areas has been plotted in Figure 4.2.1.2. The covered area was the continental shelf (till the 200 m isobaths) and it could be noted that the higher integration values (red and green dots) for this species are located in the Bay of Biscay (France), principally in Subarea VIIIb, and the Gulf of Cadiz, principally in Subarea IXa-S(C) (Spain). In the

Cantabrian Sea, density is scarce, although a little bit higher than last year (ICES, 2007) and in front of Lisbon (Portugal) a small density of anchovy has been detected this year. Values are practically nulls in the rest of the prospected area. Null values (black points) describe as well the tracks performed in every survey. In the Bay of Biscay (Subarea VIII) a gap could be observed in the data (no data) due to bad weather conditions during the survey. Values higher than 1000 m^2/mn^2 are located in the Gulf of Cadiz (maximum of 1800) and in the Bay of Biscay (maximum of 1559 m^2/mn^2).

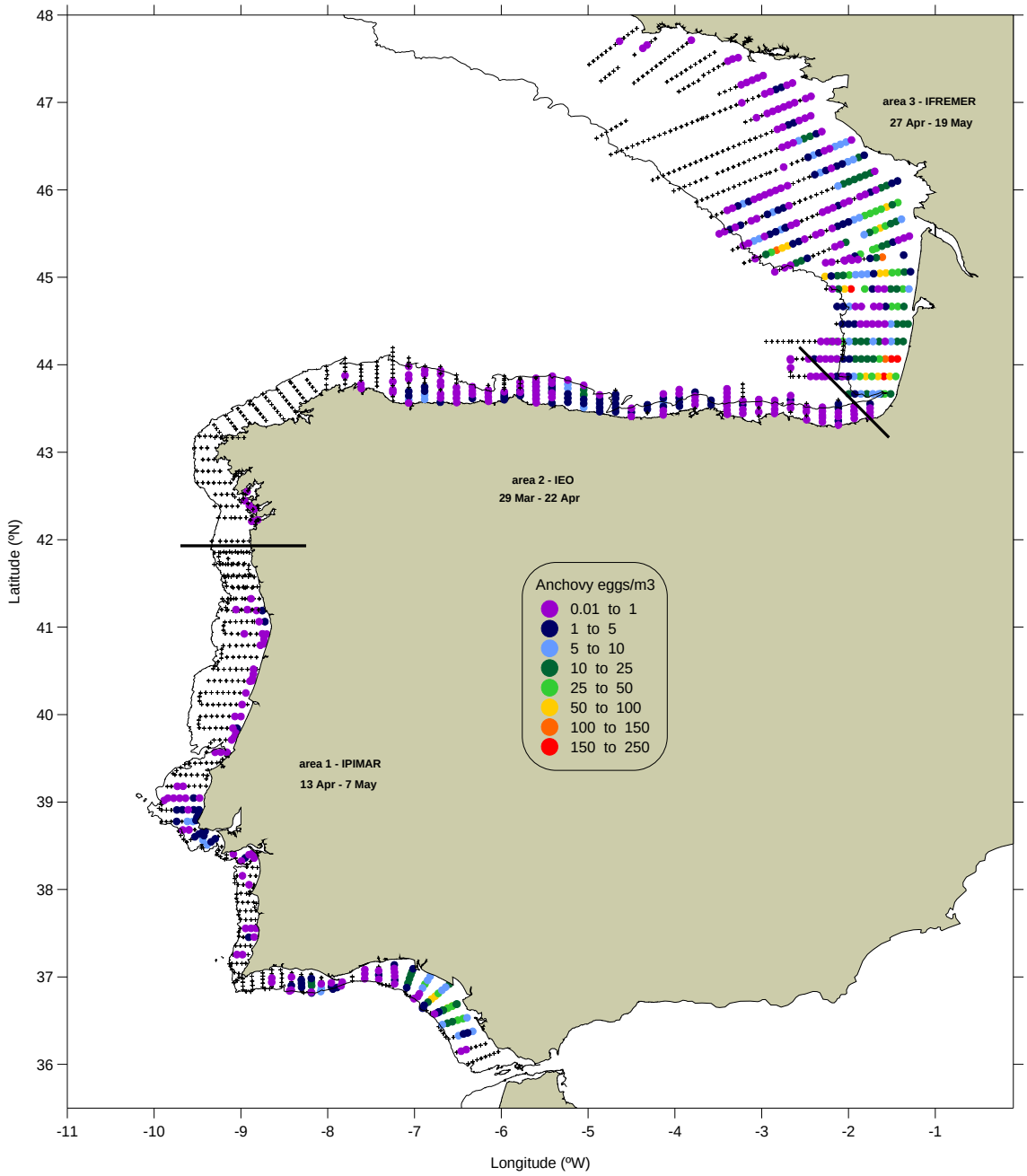


Figure 4.2.1.1. Anchovy egg distribution from CUFES sampling during the acoustics surveys carried out by IPIMAR, IEO and IFREMER in April–May 2007.

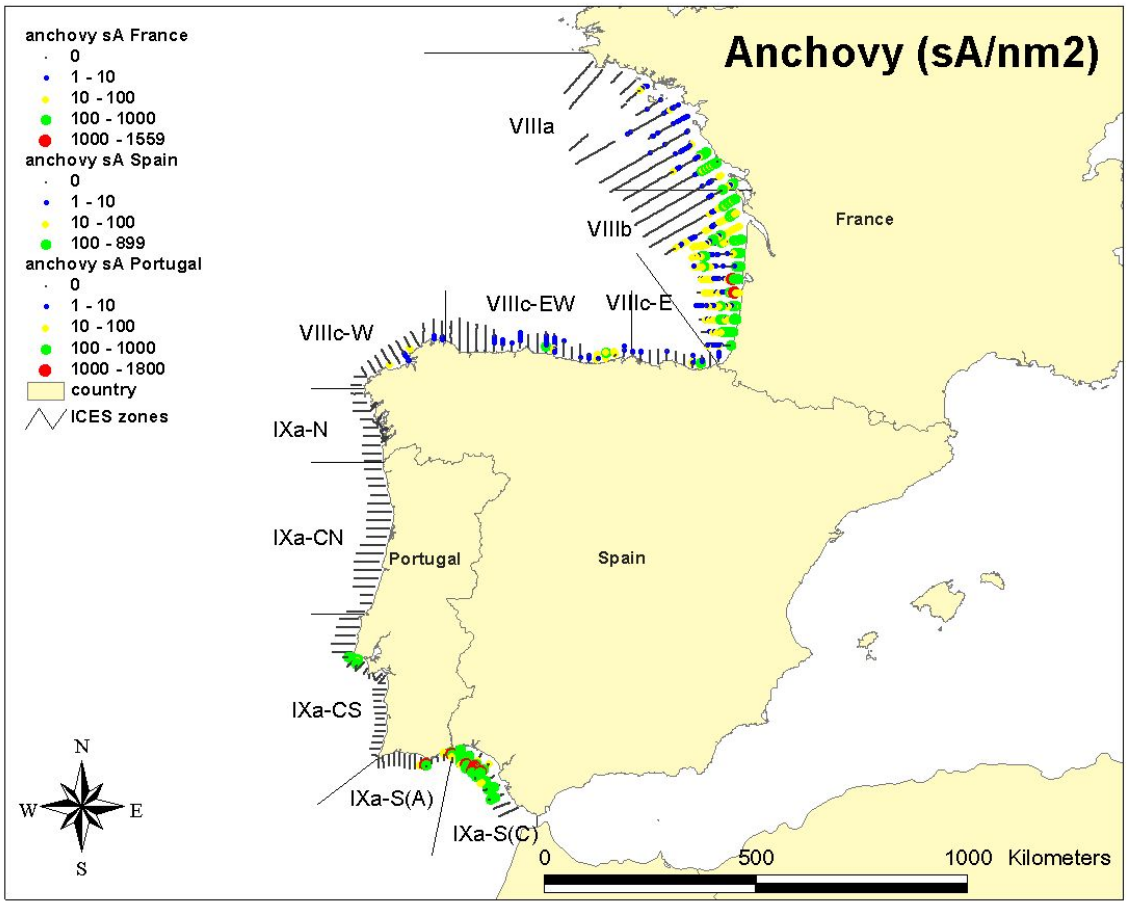


Figure 4.2.1.2. Acoustic energy allocated to anchovy in the 2007 combined coverage of the Atlantic Iberian Peninsula and Armorican shelf.

4.2.2 Anchovy surveys in area VIII

4.2.2.1 Distribution and abundance of spawning population from egg production surveys

4.2.2.1.1 Egg distribution and estimates of egg production (CUFES + pairovet)

The DEPM survey BIOMAN 2007 was carried out on board RV "Investigador#2 from the 3 – 23 May on the Bay of Biscay in the main spawning area of anchovy. A total of 420 and 835 samples were taken with a vertical tow PairoVET net (2-CalVET nets) and CUFES sampler respectively.

The anchovy eggs were concentrated in two principal areas: the area of Cap Breton between 43º50' N and 44º15' on the isoline of 200m, and at costal areas in the Gironde area between 45ºN and 46º10' until the isoline of 100m. Egg abundance was low across the Cantabric coast. From the 420 PairoVET samples, 235 stations were positive for anchovy eggs with an average of 16 eggs per station and a maximum of 308 eggs/0.1m² in the Gironde area (Figure 4.2.2.1.1.1).

Temperature and salinity profiles were obtained in every PairoVET station using a jointed CTD RBR-XR420. In addition, surface temperature and salinity were recorded in each station with a manual thermosalinometer. In some pre-selected points, water was filtered from the surface to obtain chlorophyll samples. Sea surface temperature and salinity in the area ranged from 13.8 to 17.5ºC and from 29.4 to 35.8 PSU respectively during the survey (Figure 4.2.2.1.1.2)

The anchovy eggs staged in the laboratory were transformed into daily cohort abundances using the ageing Bayesian method (ICES, 2007). Daily egg production (P_0) and mortality (z) rates were estimated by fitting an exponential mortality model to the egg abundance by cohorts and corresponding mean age. The model was fitted in two ways: a) As a weighted Non Linear Regression model and b) As a generalised linear model (GLM) with negative binomial distribution and log link. The ageing process and the GLM fitting were repeated until the value of z converged. In both cases the calculations were done in the positive strata and the eggs younger than 4 hours and older than the 90% of the incubation time were removed to avoid errors.

For both models the hourly mortality rate resulted to be non-significantly different from zero. Therefore, it was decided to fix z based on the past historical series and then, to estimate P_0 from the exponential mortality model based on the assumed value of z. Natural logarithm of z depending linearly on sea surface temperature (SST) was applied as was proposed for pelagic fish eggs in Pepin (1991). The average SST in the survey was 15.38ºHence, C., the expected daily mortality rate was 0.203. Based on this fixed value of z and using a generalised linear model the resulting P_0 was 4.51 eggs/0.1 m^2 per day and the total egg production was 1.55 E+12 eggs/day. Note that the coefficient of variation of z is assumed to be zero since z was considered as a known fixed parameter. However, this is a clear underestimation of the variability, which should be incorporated into the estimate in future applications.

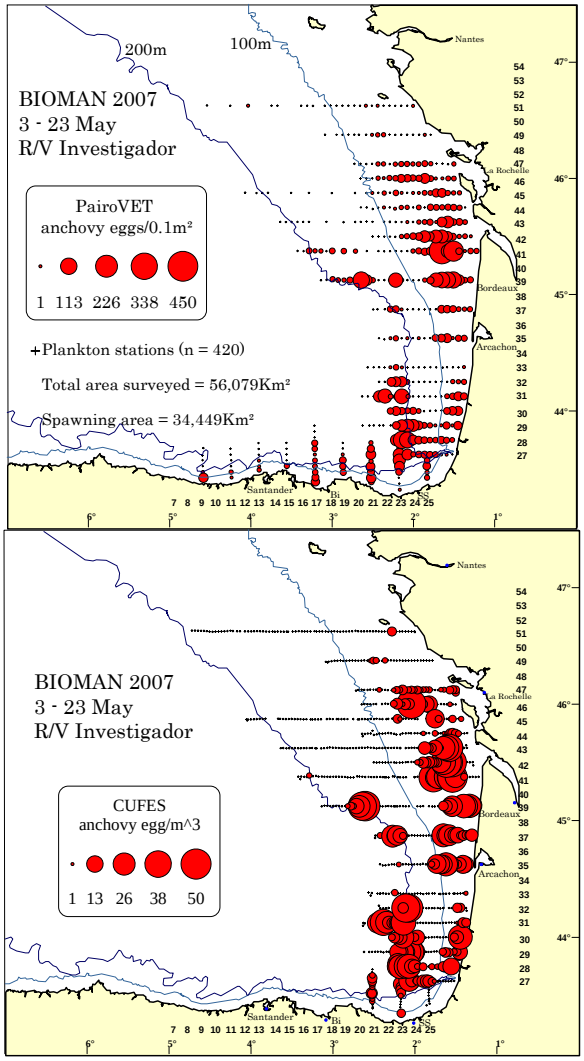


Figure 4.2.2.1.1.1. Plankton stations and egg abundances from the DEPM survey BIOMAN07 obtained with the PairoVET net (eggs/0.1m², on the top panel) and with CUFES (eggs/ m³, on the bottom panel).

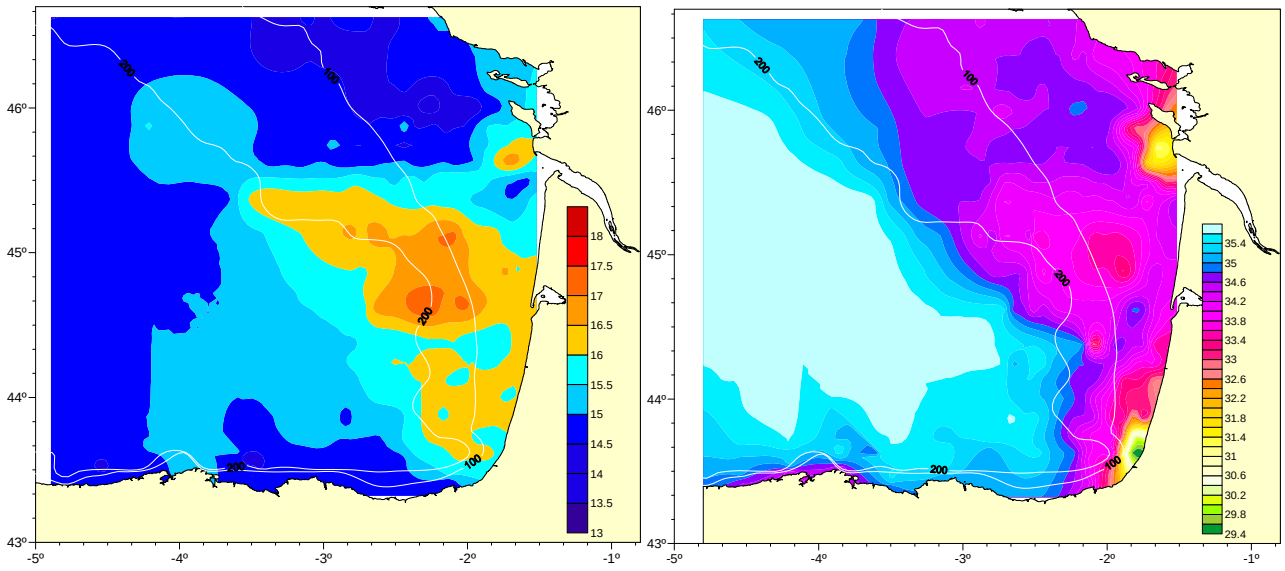


Figure 4.2.2.1.1.2. Sea surface temperature and sea surface salinity observed during the survey BIOMAN 07.

4.2.2.1.2 Distribution and estimates of adult parameters

The adult samples were obtained from three sources: samples taken directly during BIOMAN07 DEPM survey on-board RV "Emma Bardán" (10 samples), from the consorts' purse seines accompanying BIOMAN 07 (34 samples) and from the French acoustic survey conducted by Ifremer on-board RV "Thalassa" (16 samples). Those last samples were not selected for the analysis due to the differences in space and time with the egg stations. A Biological sampling was performed for the 34 selected samples for the analysis (Figure 4.2.2.1.2.1, including collection of otolith samples to produce the Age Length Key (**ALK**). For that propose 1,977 otoliths readings from the 10 samples collected on board RV "Emma Bardán" and 24 on the 4 consorts' purse-seines were available. To estimate the populations at age 5 regions were defined according to the egg and adult samples distribution**.** The species composition of the fishing hauls from the RV "Emma Bardán" and the four consort purse-seines accompanying BIOMAN 07 are showed in Figure 4.2.2.1.2.2.

On board RV "Emma Bardán" the gonads from the females were preserved in formaldehyde and transformed to fresh weight by multiplying them by 0.98. This factor was calculated as the mean factor from 1997 to 2006.

On board the 4 purse seines the total length of anchovy was measured in fresh and the gonad of the females was kept in formaldehyde. Afterwards, the total weight was estimated from a relationship length-weight applying a multiplicative model, one for males and another for non hydrated females. The gonad free weight of the hydrated females was obtained from a relationship gonad free weight-length from the frozen females. The total weight of those was estimated as the gonad free weight plus the gonad weight.

On board the 4 purse seines extra samples from each haul were frozen to obtain otoliths to estimate the percentage and the numbers at age of the population. Body weight, gonad weight and length were corrected for the decrease in weight due to freezing by multiplying them by 1.0134.

Total weight of hydrated females (W_f) was corrected for the increase of weight due to hydration. Data on gonad-free-weight (Wgf) and correspondent total weight (W) of non hydrated females was fitted by a linear regression model. The distribution of the anchovy females mean weight per haul is showed in Figure 4.2.2.1.2.3.

For the **Batch Fecundity (F)** estimates, the hydrated oocyte method was followed (Hunter *et al.*, 1985; Lasker, 1985). 103 hydrated females from 13 samples, ranging from 8 to 50 grams gonad free weight were examined. A linear regression between female weight and hydrated oocytes was fitted to the subset of hydrated females to estimate the batch fecundity of all mature females and an analysis was conducted to verify if there were differences in the batch fecundity in the 5 regions defined. No significant differences were found, so a unique stratum was considered for estimating the batch fecundity.

To estimate **Spawning Frequency (S**), i.e. the proportion of females spawning per day, an interim model on which S is linearly dependent on SST was used, while a revision of the estimator of S is being carried out (see Section 7.1.3). The interim model gave an estimate of S of 0.249 with a CV 0.13

The **Sex Ratio (R)** was estimated as the average ratio between the average female weight and the sum of the average female and male weights of the anchovies in each of the samples.

All the adult parameters estimates and the proportion and numbers at age are showed in Table 4.2.2.1.2.1.

For more details on the estimation of the adult parameters and numbers at age see the working document Santos *et al* (WD 2007) presented at this WGACEGG 2007 meeting held at Palma de Mallorca from the 25–30 November.

Table 4.2.2.1.2.1. DEPM 2007 estimates of the adult parameters in the total area with correspondent Standard error (S.e.) and coefficient of variation (CV).

Parameter	Estimate	S.e.	CV
R	0.54	0.0058	0.0109
S	0.25	-	0.3200
F	11,897	949	0.0798
Wf	26.56	1.92	0.0724
Wt	20.65	1.82	0.0882

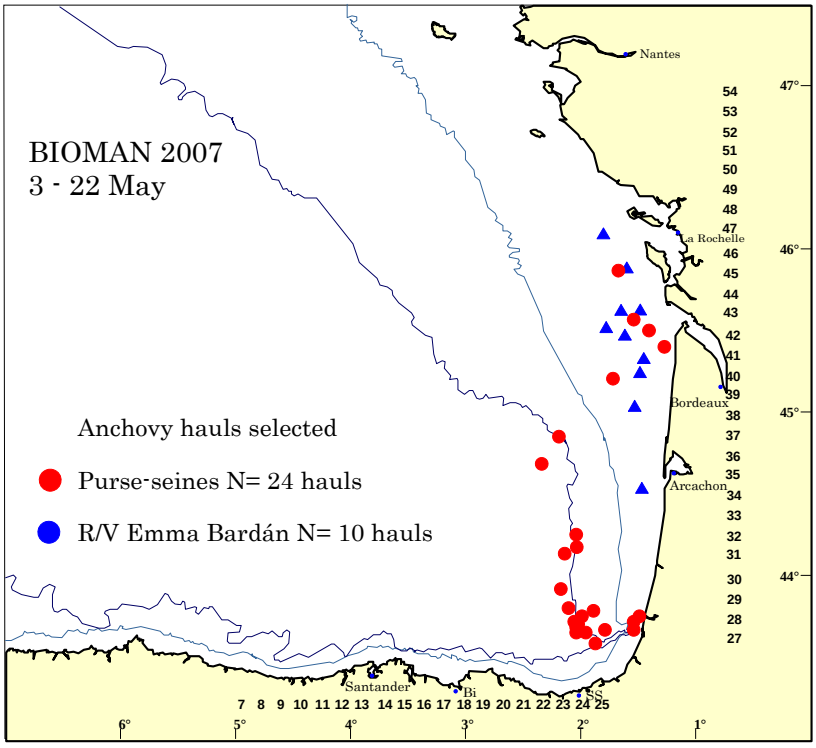


Figure 4.2.2.1.2.1. Adult simples selected for the SSB analysis.

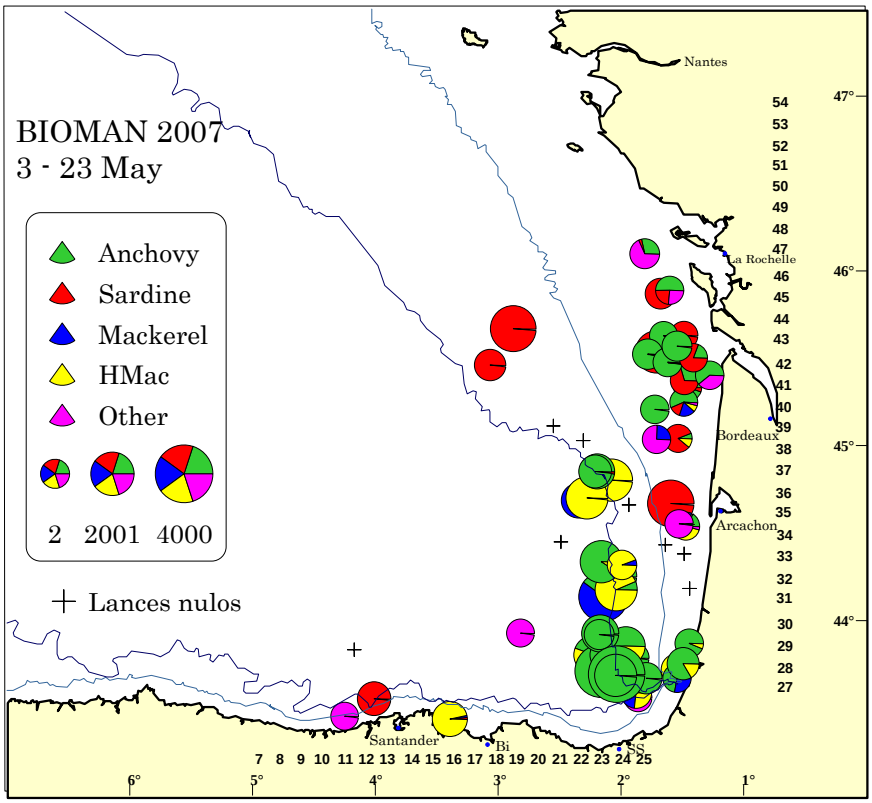


Figure 4.2.2.1.2.2. Species composition of the fishing hauls from the RV "Emma Bardán" and the four consort purse-seines accompanying BIOMAN 07.

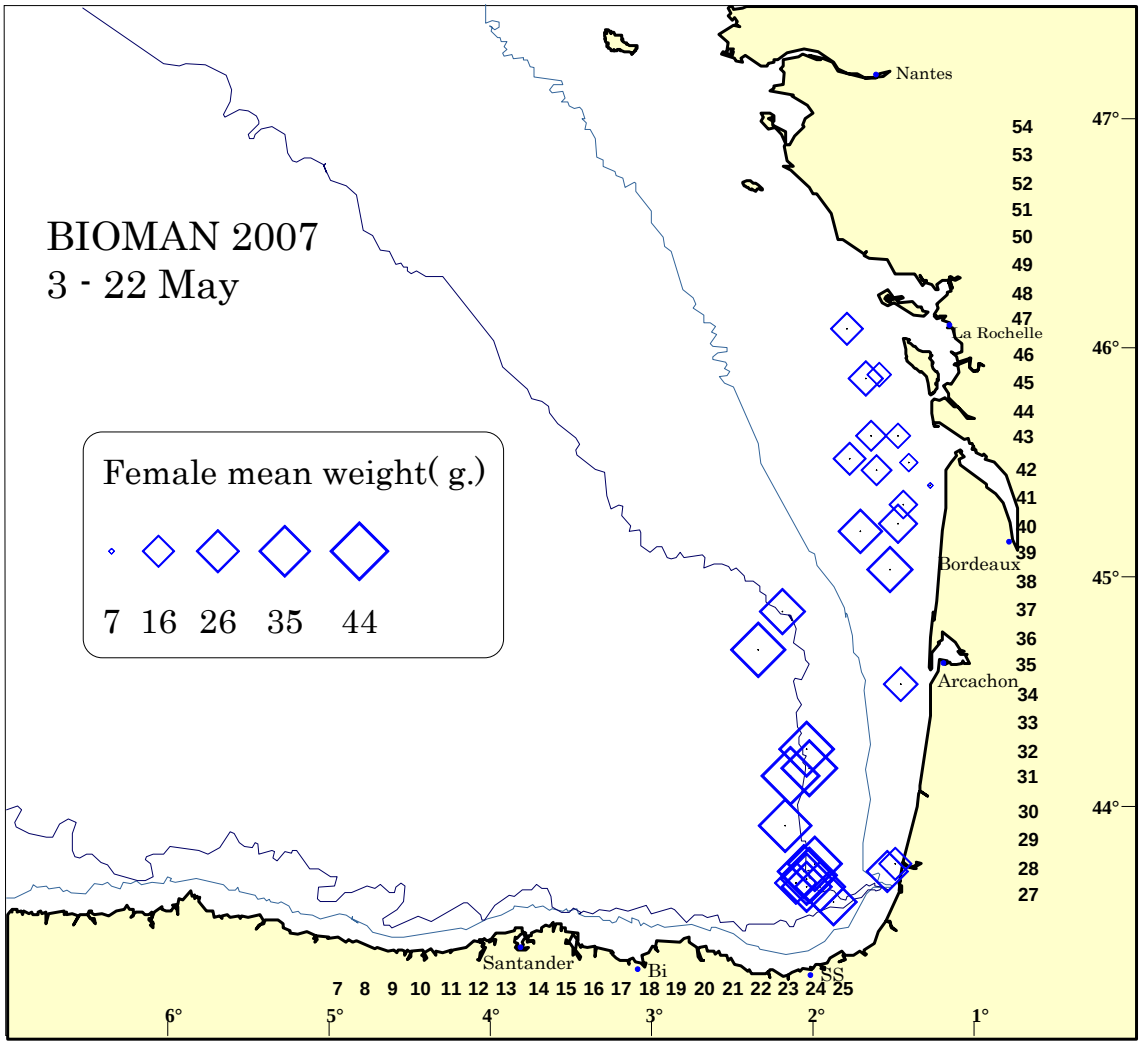


Figure 4.2.2.1.2.3. Female mean weight distribution.

4.2.2.1.3 Spatial distribution and biomass estimates of the target species

Overall, these results lead to an average **Daily Fecundity** estimate of 60 eggs/gram and a **Spawning Biomass** estimate of **25, 973 tonnes** (CV=0.14).

Table 4.2.2.1.3.1 shows the 2007 biomass estimates and the proportion by age and numbers-at-age estimates. A historical perspective of the biomass estimates in relation to previous ones can be seen in Figure 4.2.2.1.3.1. A comparison of the SSB and the numbers at age of 2007 and the last three years is showed in Table 4.2.2.1.3.2.

Table 4.2.2.1.3.1. SSB 2007 estimates and the proportion by age and population at age estimates, with the correspondent standard error (S.e.) and coefficient of variation (CV).

Parameter	estimate	S.e.	CV
BIOMASS	**25,973**	3,701	0.1425
Wt	20.65	1.82	0.0882
POPULATION	1,268	215	0.1693
Pa 1	0.71	0.05	0.0636
Pa 2	0.25	0.04	0.1429
Pa 3	0.04	0.02	0.5516
Nage 1	902	175	0.1943
Nage 2	317	58	0.1830
Nage 3	50	30	0.5950

Table 4.2.2.1.3.2. Comparison of the SSB and the numbers at age of 2007 and the last three years.

Parameter	DEPM 04	DEPM 05	DEPM 06	DEPM07
SSB (ton.)	19,489	8,000	21,436	**25,973**
Nº AGE 1	837	95	998	**902**
Nº AGE 2	115	189	157	**317**
Nº AGE 3	28	8	50	**50**

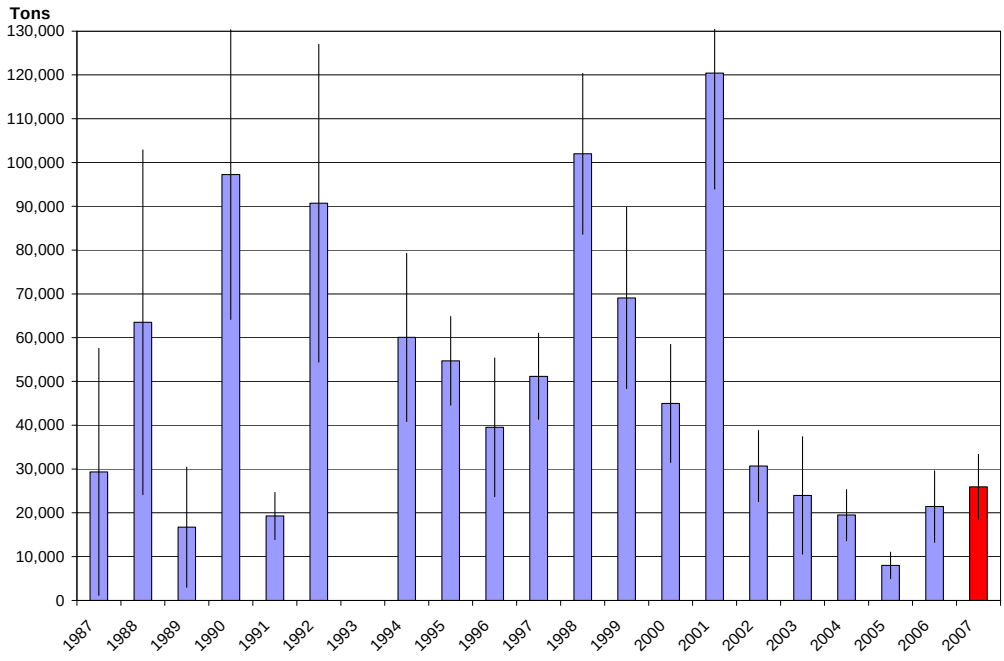


Figure 4.2.2.1.3.1. Series of Biomass estimates (tonnes) obtained from the DEPM since 1987. Most of them are full DEPM estimates, except in 1996, 1999, 2000 and 2007, which were deduced indirectly.

4.2.2.2 Distribution and abundance of spawning population from acoustic surveys

The 2007 acoustic survey PELGAS07 (Massé *et al*., WD 2007) was carried out in the Bay of Biscay from 26 April – 26 May on board the French research vessel "Thalassa". The objective was the same than since 2000, 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 multi-species context. The survey was carried out in good conditions, at least for the anchovy distribution area for which the biomass assessment was possible. Some bad weather occurred during the second half of the survey, when the potential are of anchovy presence was already covered.

To obtain an optimal horizontal and vertical description of the pelagic ecosystem in the area, two types of actions were combined: i) Continuous acquisition of acoustic data (from five different frequencies: 18, 38, 70, 120 and 200 kHz) and egg abundances, obtained pumping sea-water 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 characterise the higher level predators of the pelagic ecosystem.

4.2.2.2.1 Distribution of total acoustic energy

All the acoustic data along the transects that were processed have been scrutinised (Figure 4.2.2.2.1.1.). Acoustic energies (Sa) have been cleaned by sorting only fish energies (excluding bottom echoes, parasites, plankton, etc.) and classified into 8 categories of echo-traces:

D1 – energies attributed to horse mackerel, mackerel and gadoids corresponding to cloudy schools or layers close to the bottom or of small drops in a 10m height layer close to the bottom.

D2 – energies attributed to anchovy, sprat, sardine and mackerel corresponding to the usual echo-traces observed in this area since more than 15 years, constituted by schools, mainly situated between the bottom and 50 meters above. These echoes are typical of coastal areas and sometime more offshore.

D3 – energies attributed to blue whiting and myctophids offshore.

D4 – energies attributed to sardine, mackerel or anchovy corresponding to small and dense echoes, very close to the surface. These echoes were rather rare compared to previous years.

D5 – energies attributed to small horse mackerel only when they were gathered in very dense schools (rather absent this year)

D6 – energies attributed exclusively to sardine according to several identifications both by purse seine and pelagic pair trawlers during the survey.

D7 – energies attributed exclusively to mackerel according to several commercial vessels identifications (both by purse seine and pelagic pair trawlers) during the survey.

D8 – energies attributed to a mix of mackerel and horse-mackerel, characterised by small dots close to the bottom, mainly offshore and in the north of the Bay of Biscay.

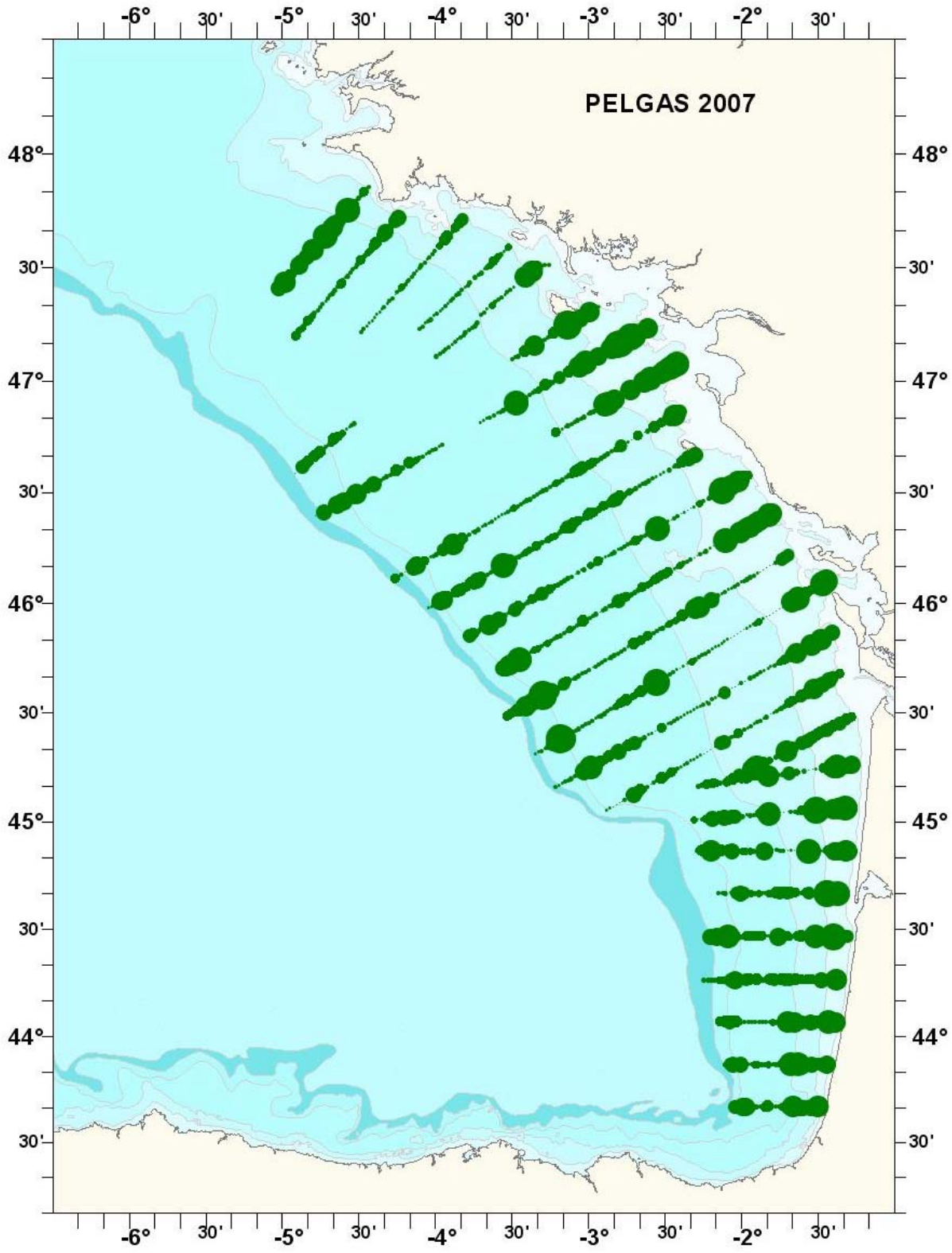


Figure 4.2.2.2.1.1. Acoustic energies (Sa) collected along the transects during PELGAS07 survey.

4.2.2.2.2 Species composition and length/age composition

Acoustic data were collected along a total amount of about 412 hours from which 1447 nautical miles are usable for evaluation. A total of 48 pelagic hauls were carried out upon 39 were usable (Figure 4.2.2.2.2.1) for identification of echo-traces.

As previous years (except in 2003, see WD-2003) the global area has been split into several strata where coherent communities were observed (species associations) in order to minimize the variability due to the variable mixing of species. Figure 4.2.2.2.2.2 shows the strata considered to evaluate biomass of each species. For each stratum, energies where converted into biomass (Table 4.2.2.2.2.1.) by applying catch ratio, length distributions and weighted by abundance of fish in the haul surrounded area.

The Pelgas07 acoustic survey has been carried out in good conditions, at least for the anchovy distribution area for which the biomass assessment was possible. Some bad weather occurred mainly during the second half of the survey, when the potential area of anchovy presence was already covered.

The biomass estimated during spring 2007 is globally higher than the biomass observed in 2006 and much higher than in 2005, but still below the period 2000–2004. In spring 2007, the anchovy spatial distribution was broad but generally not dense. It was present all along the coast from Bayonne to l'Ile d'Yeu mixed with sardine or sprat and offshore mainly in "fer à cheval" area or in the southern platform mixed with horse mackerel.

The anchovy biomass from the Pelgas07 survey has been estimated at 41 000t. The number of 1 year old anchovy was estimated at 1 437 millions fish. The global population observed in the Bay of Biscay was composed of 66.2% of age 1 (bigger than 2005 year class), 29.1% of age 2 and 4.7% of age 3+. The mean length of age 3 seems to be lower than age 2.

The slight increase in anchovy SSB is also accompanied by a more traditional school pattern, similar to the ones observed in the 'healthy' years during the 90s or beginning of 2000.

Table 4.2.2.2.2.1. Biomass estimates in tons per species from acoustic survey PELGAS07.

STRATA	AREA (NM²)	ANCHOVY	SARDINE	SPRAT	HORSE MACKEREL
1	581	362	541		4 427
2	1 116	7 869	2 958		3 154
3	588	13 001	14 741	7	47
4	3 076	7 643	12 498		5 824
5	2 323	11 763	833	14 070	400
6	4 832	12	40 407		11 787
7	1 250	177	35 657	3 235	1 923
8	5 111	49	18 602		17 535
Total	18 876	40 876	126 237	17 312	45 098

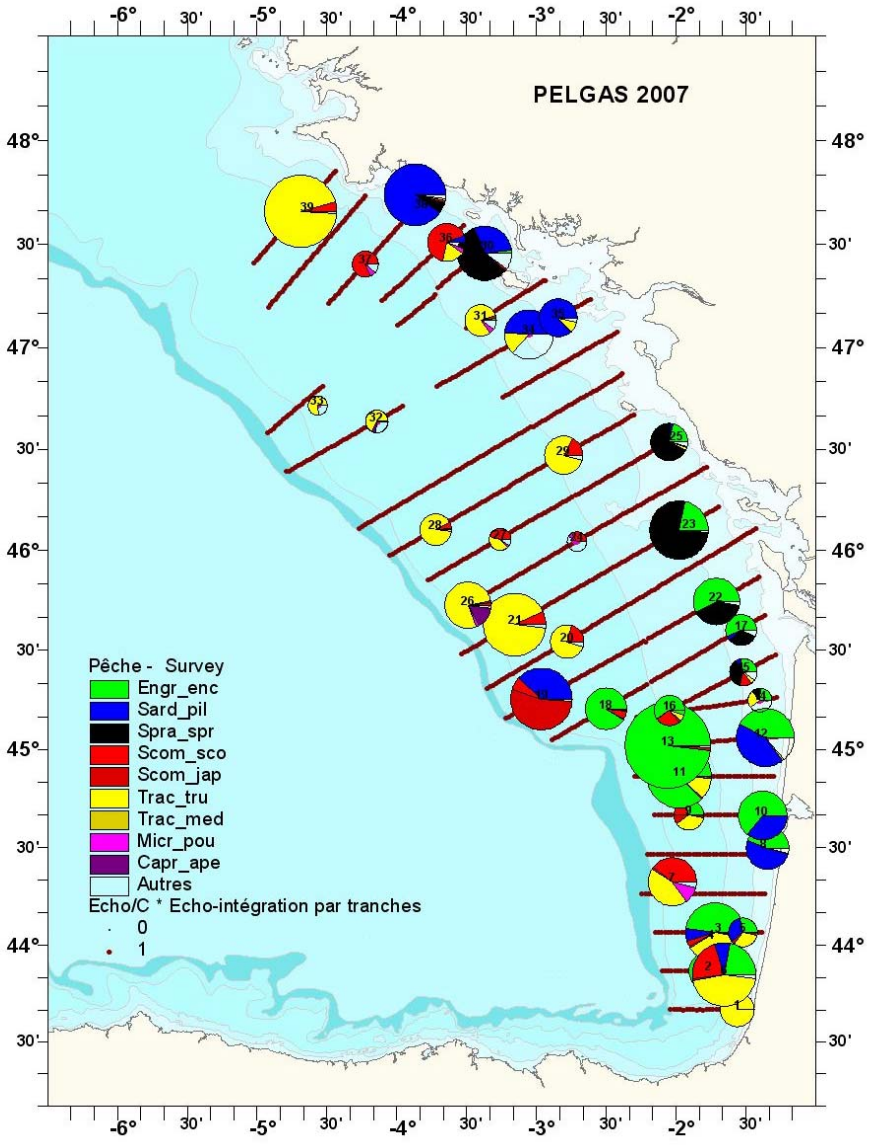


Figure 4.2.2.2.2.1. Acoustic and CUFES transects and identification hauls carried out during PELGAS07 survey on board "Thalassa".

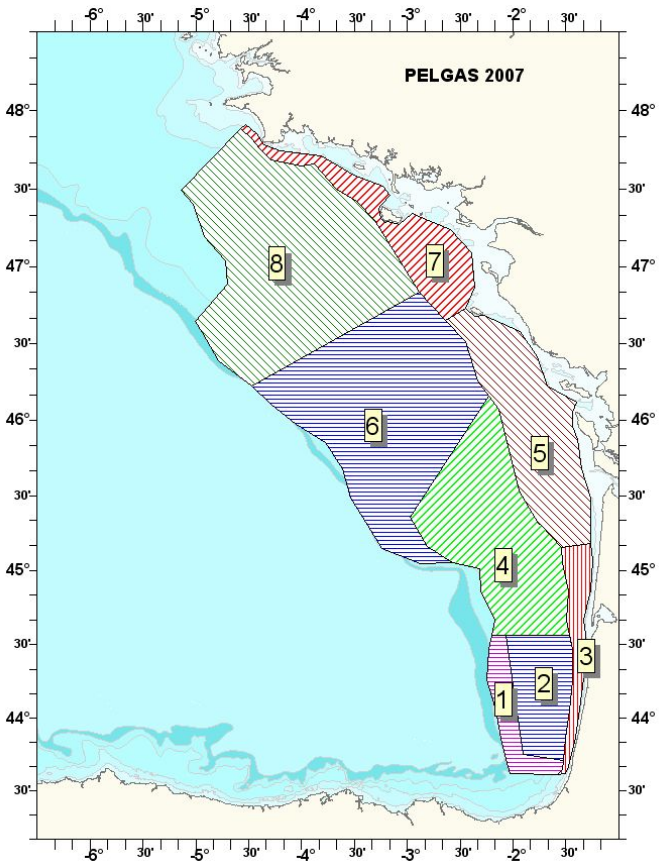


Figure 4.2.2.2.2.2. Strata used for acoustic biomass estimated from PELGAS07 survey data, taking into account echogram scrutiny and coherent communities which were observed (species associations).

4.2.2.2.3 Spatial distribution and biomass estimates of the target species

A total of 18221 fish were measured (including 5629 anchovy and 3378 sardine) and 1365 otoliths were collected for age determinations (796 anchovy and 569 sardine).

Anchovy was observed (Figure 4.2.2.2.3.1) all along the coast from Bayonne (43° 40 N) to l'Ile d'Yeu (46°40 N), mostly mixed with sardine in the south of the Gironde and with sprat in the north. On the platform, anchovy was omnipresent and usually mixed with horse mackerel. Echo-traces were most of the time vertically spatialized, horse mackerel closed to the bottom and anchovy as soft and small schools 15 to 25 m above.

In the area called "Fer à cheval", anchovy was predominant between 90 m and 140 m bottom depth (between 44° 40 N and 45° 30 N), most of the time pure and observed as soft high "candles" between 10 m and 50 m above the bottom. The presence of anchovy was alternate with mixed mackerel and horse mackerel.

It must be noticed that contrary to what was observed during the recent years (ICES, 2007) the aggregation pattern of anchovy during this PELGAS07 survey was more similar to the 1980s and 1990s than during the last 5 years. During the last surveys (until 2006), anchovy appeared more and more often close to the surface as very small schools or even scattered. This year they seemed to gather in small schools aligned 15 to 20 m above the bottom as it was the case in the 80s and 90s (Massé, 1996) and almost no surface schools were observed.

A biomass estimate in tons and in numbers, mean weights and mean length at age group have been processed for each area and gathered in Table 4.2.2.2.3.1. Length distributions of anchovy are shown in Figure 4.2.2.2.3.2, as usual, small fish is mainly present in the coastal area whereas bigger fish are offshore. According to this different length structure, the age/length key has been applied and numbers per age are presented in Figure 4.2.2.2.3.3.

Table 4.2.2.2.3.1. Age distribution of Anchovy inshore and offshore during PELGAS07.

	BIOMASS	NUMBERS	G1	G2	G3	G4
Inshore (3, 5 and 7)	24 941	1 588 074	1 155 812	359 792	69 546	2 925
Offshore (1,2,4,6,8)	15 935	582 136	281 180	272 235	26 643	2 078
Total	**40 876**	**2 170 211**	**1 436 992**	**632 027**	**96 190**	**5 003**
% (numbers)			66.22%	29.12%	4.43%	0.23%
Mean weight (g)			*16.54*	*23.33*	*19.70*	*24.17*
Mean length (cm)			*13.50*	*14.97*	*14.23*	*15.13*
Coefficient of variation	*0.099*	*0.100*				

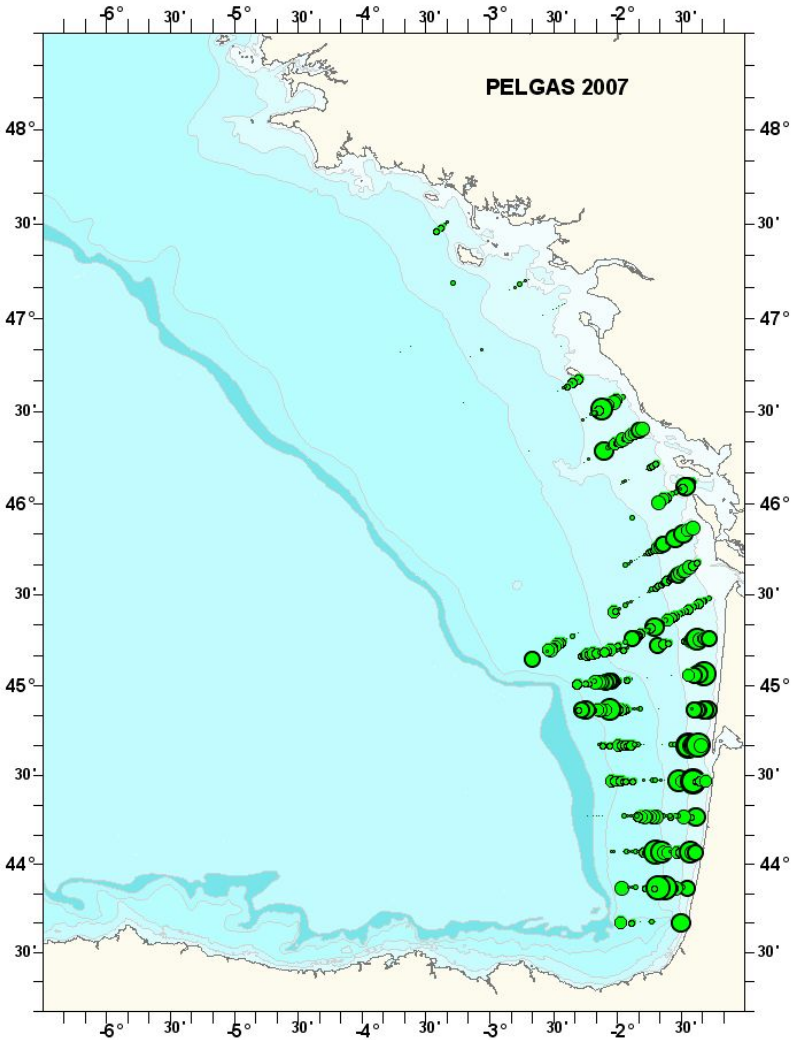


Figure 4.2.2.2.3.1. Anchovy distribution from acoustic and identification hauls during PELGAS07 survey.

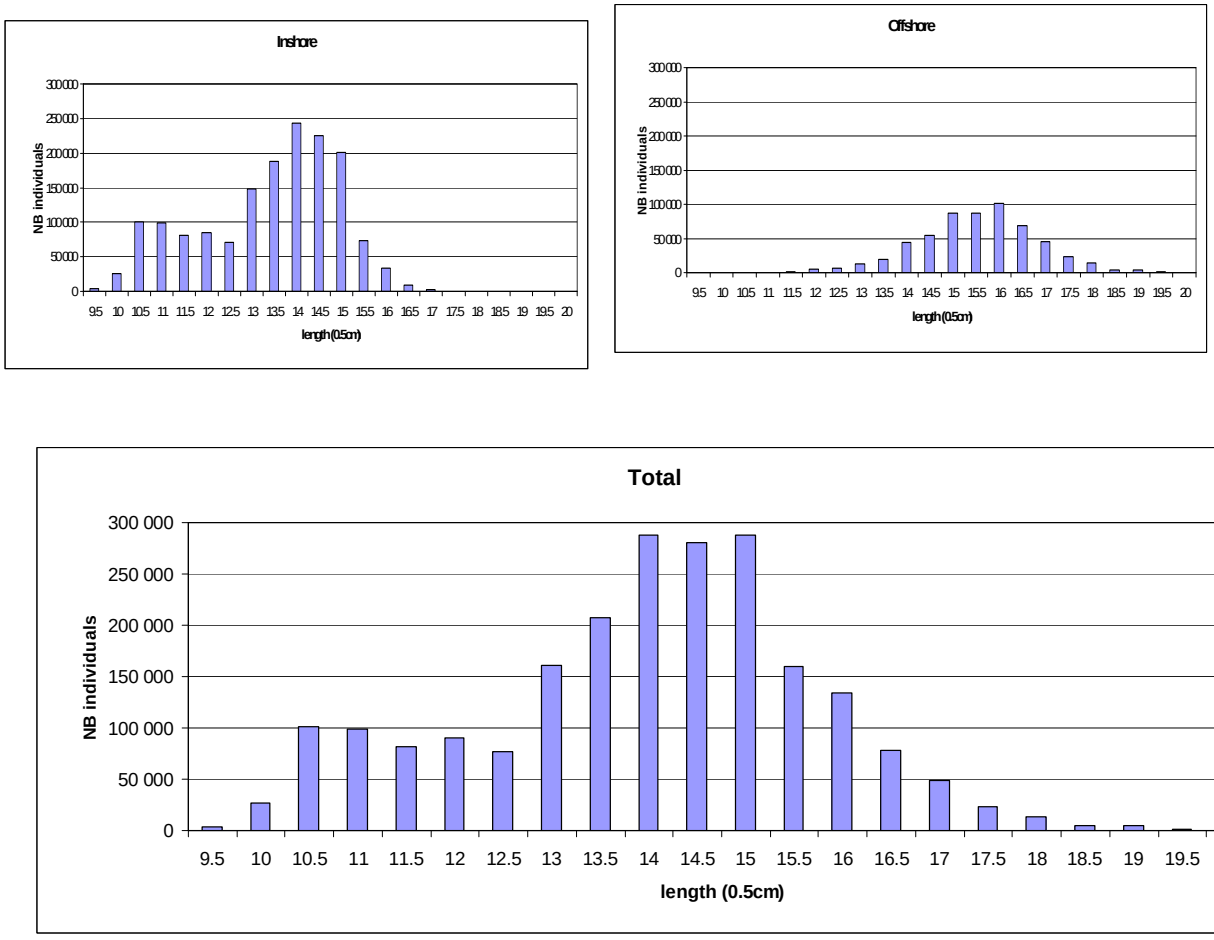
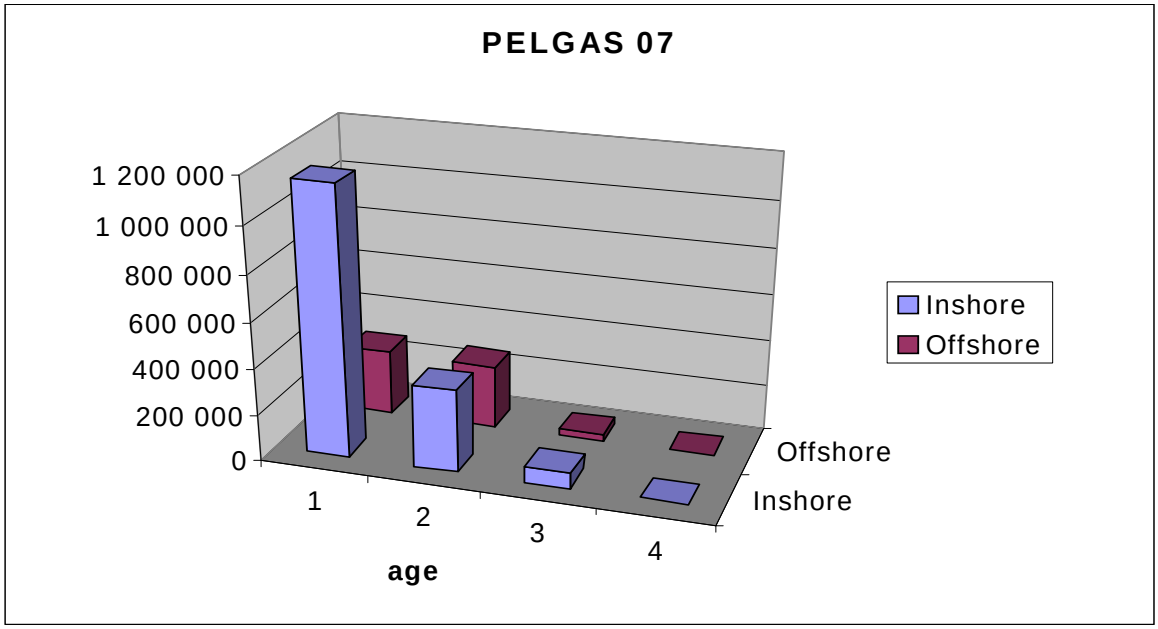


Figure 4.2.2.2.3.2. Anchovy length distribution in numbers from acoustic PELGAS07 survey – inshore (strata 3, 5 and 7) and offshore (strata 1, 2, 4, 6 and 8) at the top and global below.



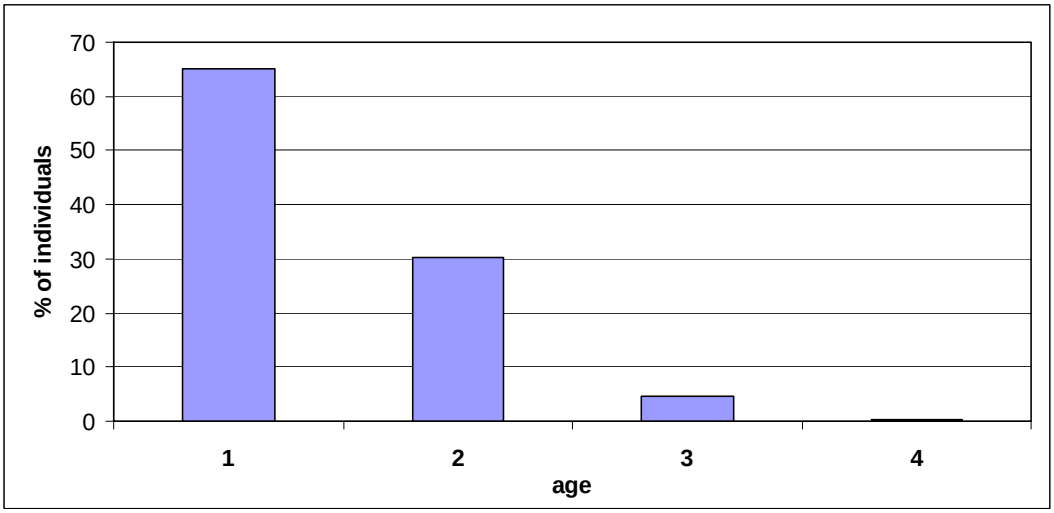


Figure 4.2.2.2.3.3. Anchovy age distribution in numbers from acoustic PELGAS07 survey – inshore (strata 3, 5 and 7) and offshore (strata 1, 2, 4, 6 and 8) at the top and global below.

4.2.2.2.4 PELGAS07 Consort survey

In the frame of the experimental fishery allowed in May 2007, commercial vessels were used as consorts during PELGAS survey. In addition to the French vessels (2 pair trawlers), 3 Spanish purse seiners were included in the process the day before the beginning of the survey. Finally, 6 commercial vessels (2 French pair trawlers, 1 coastal French purse seiner and 3 Spanish purse seiners) were part of this consort survey.

The commercial vessels were not equipped with scientific echo-sounder and so only their fishing operations could be considered. Further investigations of the differences in catchability between gears and vessels should be carried out before a fully use of the results of these fishing operations can be done.

During the first half of the survey, 68 identification hauls were carried out by commercial vessels: 32 hauls from the Pair trawlers, 23 from the Spanish purse seiners and 13 from the French purse seiners (Figure 4.2.2.2.4.1). Commercial vessels were not able to fish during the third week due to poor weather conditions.

Spanish purse seiners were mainly fishing sardine on rare mid-water schools whereas pelagic trawlers were fishing more anchovy on small echo-traces more close by the bottom. The French small purse seiner was exclusively fishing in shallow waters along the coast (where Thalassa was not efficient). The Spanish fishermen commented that anchovy was not schooling at the surface when the moon was in the ascendant phase.

For coherent assessment comparison, the acoustic biomass estimate was only calculated on the basis of Thalassa data collected with the same strategy as during previous years. As an exercise (see the reason below) estimates were computed using consort fishing operations as extra identification hauls (Figure 4.2.2.2.4.2.). Despite the differences between purse seiners and pair trawlers catches, results (Table 4.2.2.2.4.1.) were very similar because the main quantitative aspect was driven by acoustic data and fishing operations were only used to split energies into species and most of commercial vessels catch confirmed Thalassa catches.

During the last week of the survey, the whole fleet came back in potential anchovy areas in order to have particular observations on vertical eggs distribution and anchovy day and night behaviour. It has been a great opportunity to compare pelagic trawl and purse seine catches in the same small area in traditional conditions and during the descendant phase of the moon. These data are not yet analysed, species composition of catches seem to be more similar than during the first part of the survey. A total of 38 hauls were carried out during these last 6 days, including 9 by Thalassa, 14 by pair trawlers hauls and 15 by Spanish purse seiner shoots (Figure 4.2.2.2.4.3).

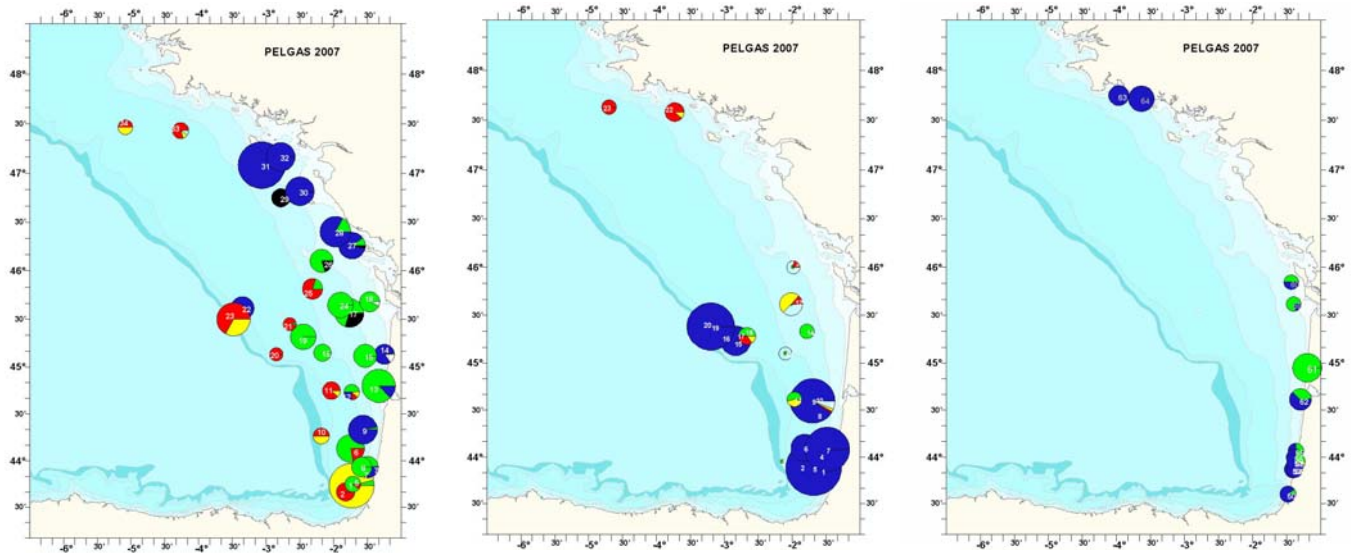
The consort survey permitted to 6 commercial vessels (French and Spanish) to participate to the PELGAS survey in a very good spirit of collaboration. It was a great opportunity for fishermen to share opinions and experiences in real conditions, observing the same echoes at the same time, fishing together in similar areas. This experience proved to each other that the scientific observations and fishing operations were compatible with the commercial ones. This participation increased the mutual confidence in both fishing efficiency and echoes observations.

If such an action is repeated in the future, commercial vessels should be equipped with scientific echo-sounders in order to take into account not only qualitative data but also the quantitative aspect provided by the acoustic energies and therefore

increase the precision of assessment by a better sampling strategy. In addition, the number of commercial fishing vessels participating in this survey should be reduced in accordance with the scientific objectives proposed (e.g. for identification of schools taking in consideration the different catchabilities of the anchovy metiers with two pair trawlers and one purse seiner is sufficient).

Table 4.2.2.2.4.1. Different attempts to use consort commercial catches in addition to Thalassa samples. These results should be considered as preliminary, using all available data without checking validity or any correction for catchability. Therefore they must be taken with caution.

STRATA	THALASSA HAULS	THALASSA + PAIR TRAWLERS	THALASSA + PAIR TRAWLERS + FR PURSE SEINERS	THALASSA + FR+SP PURSE SEINERS	THALASSA + ALL CONSORT
1	362	204	204	362	204
2	7869	7985	7985	4792	5758
3	13001	10951	9231	9678	9231
4	7643	6916	6916	6722	6515
5	11763	12432	13624	14352	14165
6	12	2	2	9	2
7	177	93	88	158	87
8	49	26	26	49	26
Total	40876	38610	38077	36123	35989



a) Pair trawlers (nb: 32) **b) Spanish purse seiners (nb: 23)** **c) French purse seiners (nb: 13)**

Figure 4.2.2.2.4.1. Fishing operations carried out by commercial vessels during consort survey PELGAS07.

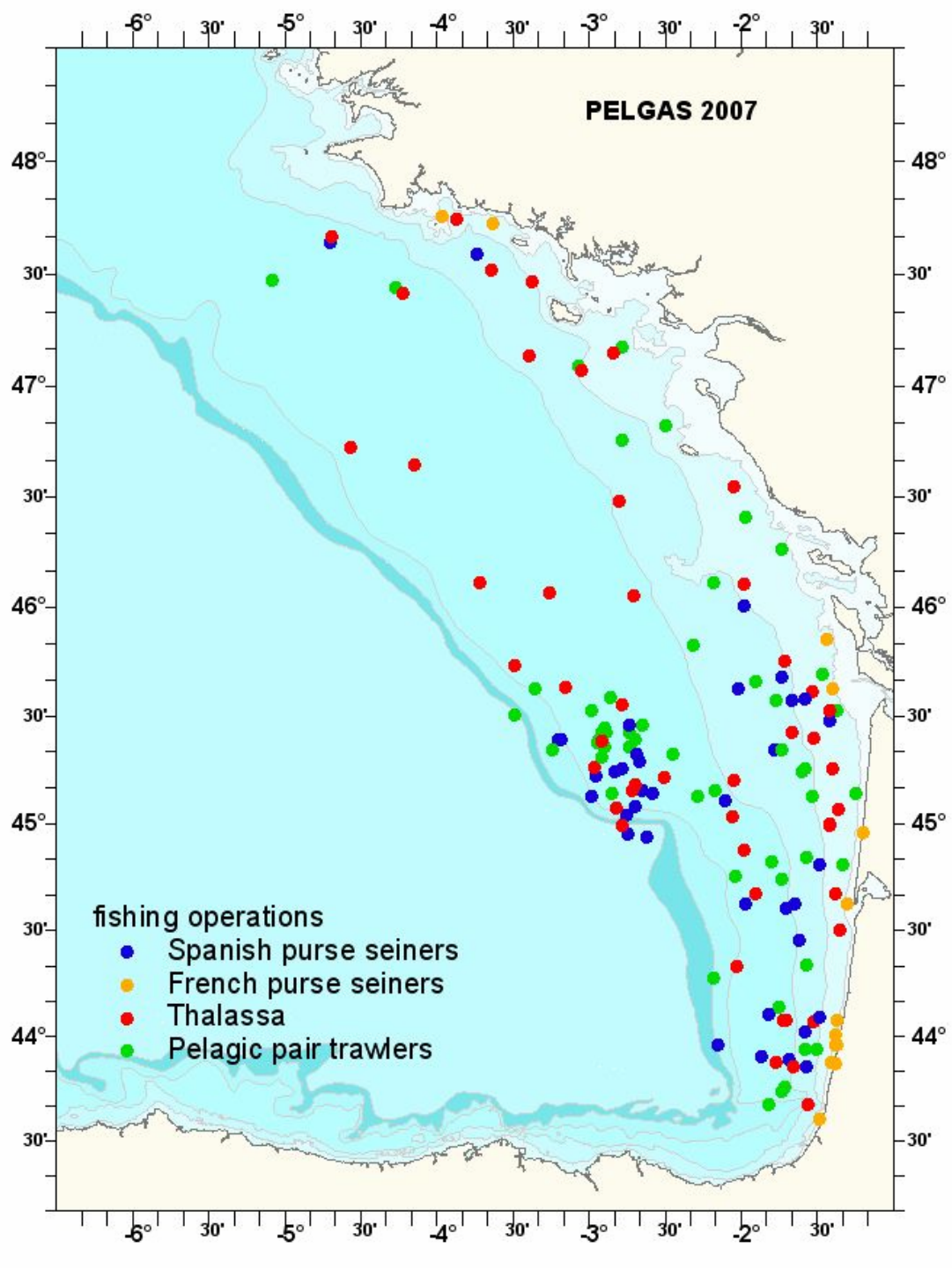
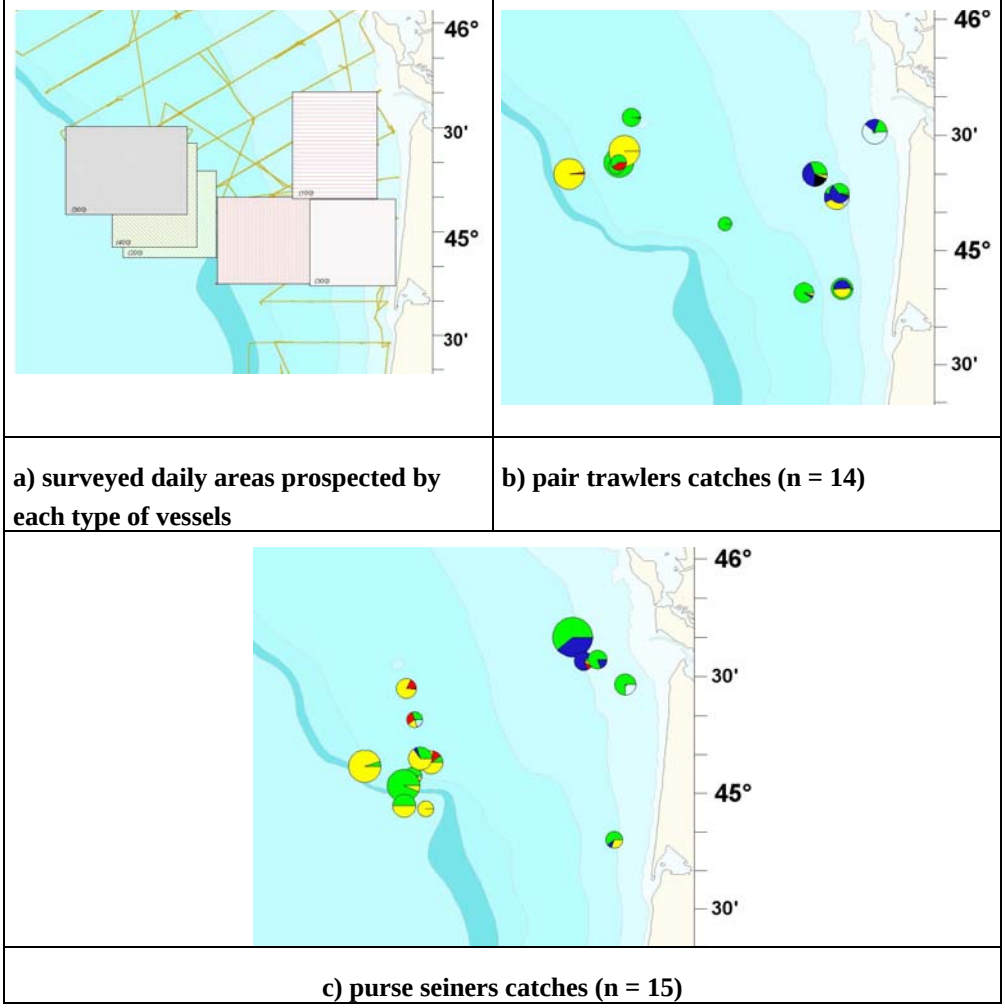


Figure 4.2.2.2.4.2. Fishing operations carried out by THALASSA and the consort commercial vessels during the PELGAS07 survey.



a) surveyed daily areas prospected by each type of vessels

b) pair trawlers catches (n = 14)

c) purse seiners catches (n = 15)

Figure 4.2.2.2.4.3. Fishing operations carried out by commercial vessels during the last week of the PELGAS07 survey in order to compare specific catchability.

4.2.2.3 Distribution and abundance of juveniles from acoustic surveys

4.2.2.3.1 JUVENA results

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 (being 5º W and 46º N the limits of the minimum sampling area). The long term objective of the project is to be able to assess the strength of the recruitment entering the fishery the next year.

This year 2007, as happened in year 2006, the survey took place onboard two vessels equipped with scientific acoustic equipments and with two different fishing gears: the purse seiner Gure Aita Joxe (GAJ) and the pelagic trawler "Emma Bardan" (EB). The survey took place during 28 days in September, surveying 4,100 nmi., along the continental shelf and shelf break of the Bay of Biscay, that provided an effective sampling distance of 1,500 nmi. and a coverage of about 22,000 nmi.^{2}, from the 5º W in the Cantabrian area up to 47º 20' N at the French coast. Seventy hauls were done during the survey to identify the species detected by the acoustic equipment, 37 of which resulted positive of anchovy.

In the Cantabrian zone, anchovy was distributed off the shelf, in an area limited by the longitudes 2º00′ and 4º15′ W, and the latitudes 43º35′ and 43º50′ N (Figure 4.2.2.3.1.1). There, anchovy was found forming monoespecific aggregations of small juveniles (4 cm length) very close to the surface. At the French shelf, anchovy was found North of 44º20′ N, distributed from the coast to the 100 m isobath. This anchovy was predominantly juvenile at the southern part (Les Landes), was a mixed composition of juveniles and adults at the central part (Garonne), and was predominantly adult at the North (Loire). In the French shelf, anchovy was found mixed with other species, mainly sardine, horse mackerel, sprat and mackerel.

The biomass of juveniles estimated for this 2007 is 13000 tones, a low value in comparison with the values of the temporal series of JUVENA, only higher than the 2004 estimate (Table 4.2.2.3.1.1). This value is about one order of magnitude less than the higher estimates of the series (the ones corresponding to 2003 and 2005). This value suggests a new scenario of low recruitment entering the stock in 2008, and points towards the continuation of even the increase of the crisis of the abundance of spawners that it is suffered since 2003. Details of the survey results can be found in the working document in the Annex.

Table 4.2.2.3.1.1. Synthesis of the biomass estimation (in metric tones) for the five years of JUVENA surveys. (*Note: the estimated biomass values of 2006 are under a revision process and are not definitive yet; see the WK in the Annex for the details).

AÑO	REGION	s_A	AREA	<SIZE>_JUV	<SIZE>_ADUL	BIOM_JUV	BIOM_ADUL
2003	South	369	3,303	8.2		97,498	0
	North	444	172	11.1	14.1	1,103	1,383
	TOTAL		3,475			98,601	1,383
2004	South	1	47	6		1	0
	North	562	1,860	11	13.8	2,404	3,451
	TOTAL		1,907			2,406	3,451
2005	South	722	5,390	6.64		125,922	0
	North	326	2,400	9.83	11.91	8,209	20,369
	TOTAL		7,790			134,131	20,370
2006*	South	230	1,200	7.19	11.46	13,224*	105*
	North	167	5,373	11.05	12.33	30,897*	23,857*
	TOTAL		6,573			44,121*	23,961*
2007	South	186	1,812	9.0	12.5	6,381	757
	North	248	3,865	10.3	14.4	6,740	34,352
	TOTAL					13,121	35,109

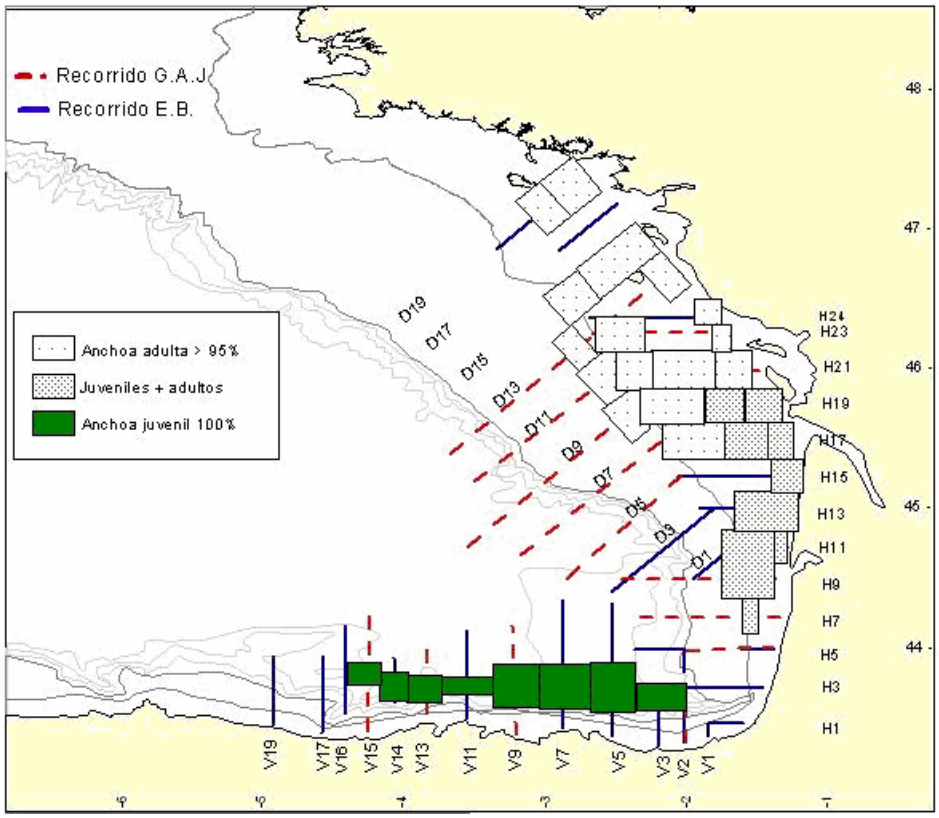


Figure 4.2.2.3.1.1. Area of distribution of anchovy, differentiating regions of pure juveniles, mixed juveniles and adults and more than 95% of adults.

4.2.2.3.2 PELACUS1007 results

Cruise objectives and logistics

The PELACUS-1007 cruise (autumn PELACUS) is framed within the activities of the IEO project ECOPEL, which aim is the study of the fisheries of small pelagic fishes under the ecosystem approach perspective. The cruise was carried out on board RV "Thalassa" from 17 September to 17 October 2007 in the southern Bay of Biscay.

The PELACUS-1007 was designed and carried out in coordination with the Juvena-07 cruise, conducted in the same area approximately at the same period and with similar objectives. The coordination involved: 1) an agreed sampling strategy, as was consented in the WGACEGG meeting in 2006 held in Lisbon; 2) permanent communication and transfer of information between the research vessels involved in the respective cruises during the campaigns (RV "Thalassa" for PELACUS-1007 and RV "Emma Bardán" for Juvena07); and 3) joint re-analysis of the acoustic and fishing haul data acquired during the cruises (Workshop on juvenile acoustic cruises carried out in 2007; 12–14 November, held in the Centro Oceanográfico de Gijón; See Section 4.2.2.3.3).

The specific accomplished objectives of the cruise were:

1) Estimation of abundance / spatial distribution of young-of-the-year (juveniles) and adults of anchovy, and other small pelagic fishes in the southern Bay of Biscay (coast-shelf-ocean, eastward of 3ºW, southward of 47ºN –ICES areas VIIIc_East and VIIIb)

2) Biological condition (size-weight-age keys, sex and sex maturity) of the captured species. Besides for anchovy, stomach content and daily growth rate from otoliths reading.

3) Distribution of sardine and anchovy eggs from CUFES

4) Characterisation of oceanographic conditions and distribution of plankton, from pico- to macro-plankton (i.e. icthyo).

5) Cartography and abundance of top predators (marine birds and mammals)

In summary, the sampling strategy focused on the characterisation of oceanographic conditions and components of the pelagic ecosystem (from picoplankton to fish) at regional scale and meso-scales in the zones of Cap Breton (43.5º N, 2º W) and Garonne river plume (around 45.5 N), where the higher abundance of anchovy was found.

Oceanographic conditions and distribution of plankton

Upwelling conditions in the Cantabrian and Les Landes regions prevailed during the first leg of the cruise (17 September – 4 October) due to the influence of north-east winds. Due to the influence of upwelling, sea surface temperatures (SST) in coastal areas (<100 m isobath) were about 15°C in the Cantabrian Sea and around 17ºC in Les Landes (Figure 4.2.2.3.2.1). Thermal stratification was intense over the shelf: temperature gradient between the surface and 50 m depth was around 5ºC. In any case, SST in the sampling area was lower than that register in the precedent year.

Surface salinity was around 34.2 in the proximity of outflows from the Adour and Garonne rivers. Anyway, the area influenced by river plumes was more extensive, but of lower intensity, than that registered in the autumn of 2006 (Figure 4.2.2.3.2.1).

Geostrophic circulation was persistently clockwise (southerly over the French shelf and westerly in the Cantabrian). Meso-scale activity associated to eddies was similar in terms of intensity, but the distribution of cyclonic and anti-cyclonic eddies differed largely from that observed in the precedent year (Figure 4.2.2.3.2.2).

In vivo fluorescence, proxy for phytoplankton biomass, was relatively high in the Cantabrian and French shelves subjected to the influence of coastal upwelling. The highest concentrations were found sub-surface, at 20 m depth (Figure 4.2.2.3.2.3).

Zooplankton biomass (still pending in deep analysis) was lower than that observed in the previous year. It was noticeable the presence of gelatinous zooplankton in the outer shelf. The size-fraction with higher biomass was 500–1000 μm (Figure 4.2.2.3.2.3).

It was noticeable the detection of northern krill (*Meganyctiphanes norvegica*) in the slope off the Cap Breton canyon area. A large (1 nautical mile length, 30 m depth) swarm of northern krill was acoustically detected and confirmed with fishing hauls over the slope off 2ºW. The presence of krill was concurrent with observation of marine mammals, in a convergence area associated with an anti-cyclonic eddy.

During the second leg of the cruise, upwelling tended to relax but still persisted in the Cantabrian sea, off Cape Peñas area (around 5ºW), river plumes tended to expand southward and the meso-scale structures detected in the Cap Breton area moved northward.

Acoustic prospection

During the first leg, 1410 nautical miles were prospected using multi-frequency (18, 38, 70, 120 and 200 kHz) echosounder, 787 of which were used for biomass estimation purposes. In the second leg 849 nautical miles were prospected, catered in the positives areas of anchovy juvenile presence (Garonne, Les Landes and Cap Breton).

The maximum and average values of the nautical area backscattering coefficient (s_A) were 10268 and 197 $m^2 \cdot nm^2$ respectively. The highest s_A values were recorded in the inner shelf off La Gironde estuary (average s_A of 302 $m^2 \cdot nm^2$). The highest values in this area were registered for sardine, anchovy and horse mackerel (average s_A of 155, 62 and 36 $m^2 \cdot nm^2$ respectively).

Fishing hauls

During the first leg, 43 effective fishing hauls were conducted. The largest haul (96% total weight, 620 kg) was performed best of the zone VIIIc-East and corresponded to *Capros aper*. At the east in the zone VIIIc-East, (*Trachurus trachurus*) represented el 84% de la total capture (766 kg). In zone VIIIb, *Trachurus trachurus* represented to 29% of the total capture (11700 kg); *Sardina pilchardus*, 25%; *Scomber scombrus*, 22% and *Engraulis encrasicolus*, 6% (Figure 4.2.2.3.2.4).

In the second leg, a total of 19 fishing hauls were carried out.

Anchovy biomass and spatial distribution

Anchovy was localised in two zones: North of cape Breton – Les Landes (CP-LL) and in the zone off La Gironde (G) estuary. In CP-LL, anchovy was detected close to the coast (<50 m isobath), presenting a modal size between 10–13 cm. In the G zone, it was detected in the inner shelf, from the coast up to the 100 m isobath, showing a neat coastal-offshore gradient in terms of modal size (and age), which ranged from 11 to 16 cm of modal size (Figure 4.2.2.3.2.5).

It was estimated a total anchovy biomass of 16900 T, of which 3039 corresponded to juveniles (Tables 4.2.2.3.2.1 and 4.2.2.3.2.2).

Other pelagic fishes

Sardina pilchardus. It was distributed all along the French shelf. The highest abundance was detected off La Gironde. Modal size varied between 12–22 cm, but in contrast with 2006 not a clear spatial pattern of distribution of sizes was observed. It was estimated a total biomass of 139311 T. A large number of sardine eggs were collected by means of the CUFES system.

Trachurus trachurus. It was detected all along the prospected area, with the highest abundances in the inner part of the French shelf. Modal size was 26 cm; although in the outer part of the shelf off La Gironde, above the 120 m isobath, the modal size was significantly lower (10 cm). It was estimated a biomass of 51748 *mediterraneus*, T., *T.,* was detected in front of La Gironde (total biomass: 450 T).

Micromesistius poutassou. It was localised over the slope in the French shelf. MNodal size was about 15 cm, and estimated biomass was 7398 T.

Boops boops. It was found in the zone of Cape Breton – Les Landes and in the coastal area off La Gironde. Modal sizes varied between 15 and 32 cm, and estimated biomass was 5871 T.

Table 4.2.2.3.2.1. Distribution of nautical area backscattering coefficient (s_A) by zones, for the different pelagic species considered. T: total; ee: *Engraulis encrasicolus;* sp*: Sardina pilchardus*; ss: *Scomber scombrus*; sj: *Scomber japonicus*; tt: *Trachurus trachurus;* tm: *Trachurus mediterraneus*; bb: *Boops boops*; mp*: Micromesistius poutassou.* C: Cantabric (Sections V12 a V00), 88 nm; L-A: Landes-Arcachon (H2-H12), 259 nm; G-INT: inner shelf (isobath <100m) Garonne (H14-H24), 259 mn; G-EXT: outer shelf Garonne (isobath >100m), 181 mn.

	T	EE	SP	SS	SJ	TT	TM	TP	BB	MP
C										
Max	2839.0	0.0	2853.2	1.0	0.0	610.0	0.0	0.0	9.6	1034.0
Med	78.9	0.0	40.0	0.0	0.0	25.7	0.0	0.0	0.4	12.8
L-A										
Max	7540.0	101.9	2217.3	147.2	14.8	5396.4	104.0	0.0	180.4	2074.1
Med	185.7	1.0	65.7	0.9	0.1	99.0	1.2	0.0	2.5	15.3
G-INT										
Max	8096.0	2056.6	4681.6	8096.0	178.5	3150.0	10.3	0.0	65.8	139.0
Med	301.9	62.1	154.7	35.6	6.2	39.3	0.2	0.0	1.1	2.7
G-EXT										
Max	10268.1	445.2	450.6	1841.1	0.0	7976.5	0.0	0.0	0.3	789.6
Med	122.1	7.0	7.0	11.5	0.0	48.3	0.0	0.0	0.0	0.0

Table 4.2.2.3.2.2. Biomass (T, tons) for anchovy by age (0, juveniles; 1+, adults) in Cape Breton – Les Landas and Garonne.

Zone Cape Breton – Les Landes (polígons S7-S8)

AGE	BIOMASS (T)
0	323
1+	91

Zone Garonne (polígons S1 – S6)

AGE	BIOMASS (T)
0	2716
1+	13770

Total

AGE	BIOMASS (T)
0	3039
1+	13771

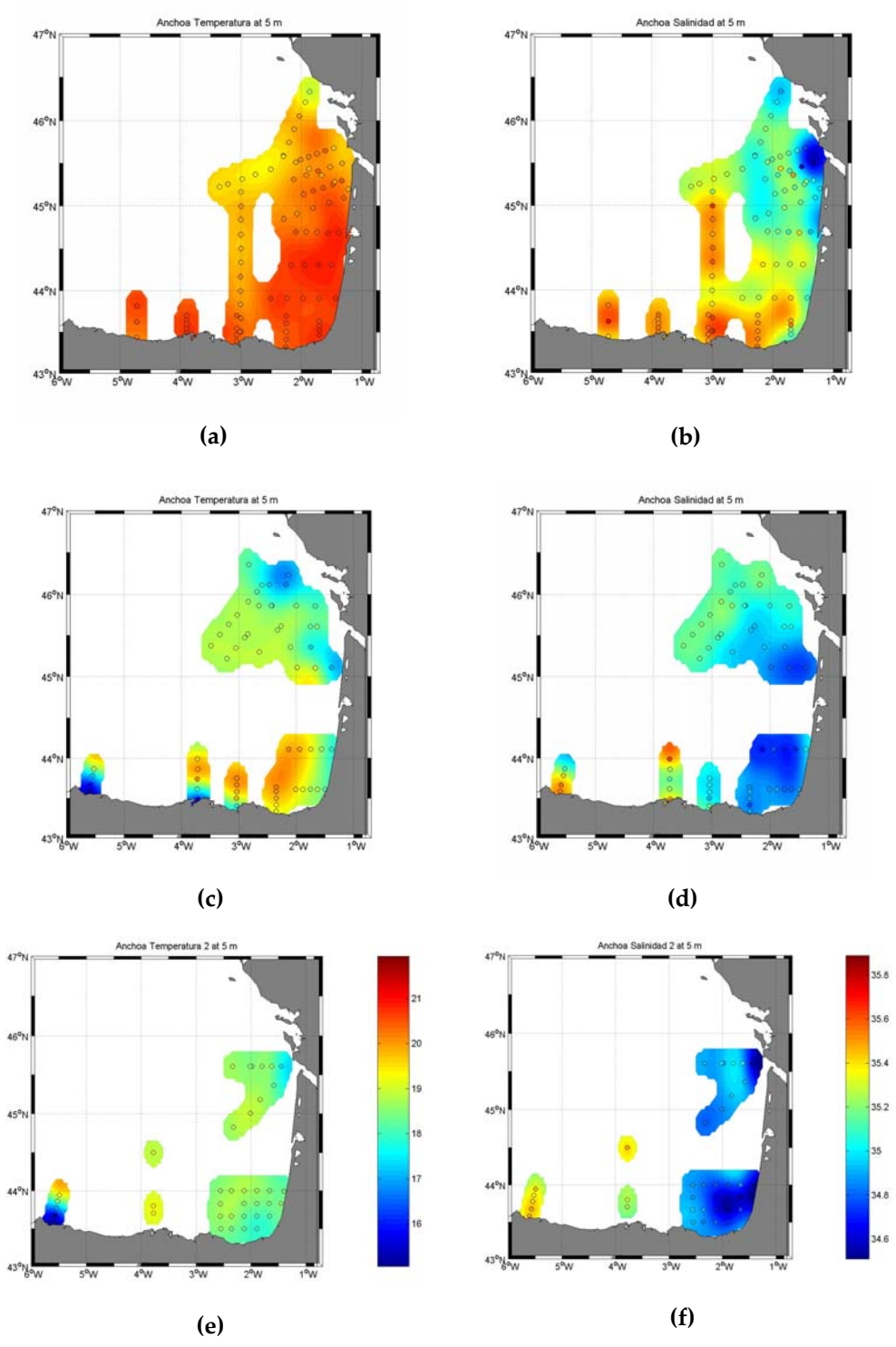
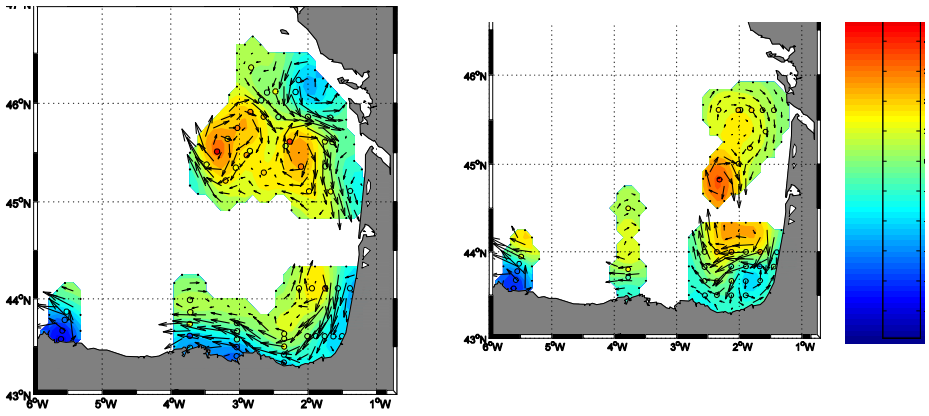


Figure 4.2.2.3.2.1. Temperature (left) and salinity (right) at 5 dbar in September-October of 2006 (a and b) and 2007, in the first (c and d) and second (e and f) legs of the PELACUS cruises.



(a) (b)

Figure 4.2.2.3.2.2. Geostrophic field (dynamic height and currents) at 5 dbar during the first (a) and second (b) legs during the PELACUS-1007 cruise.

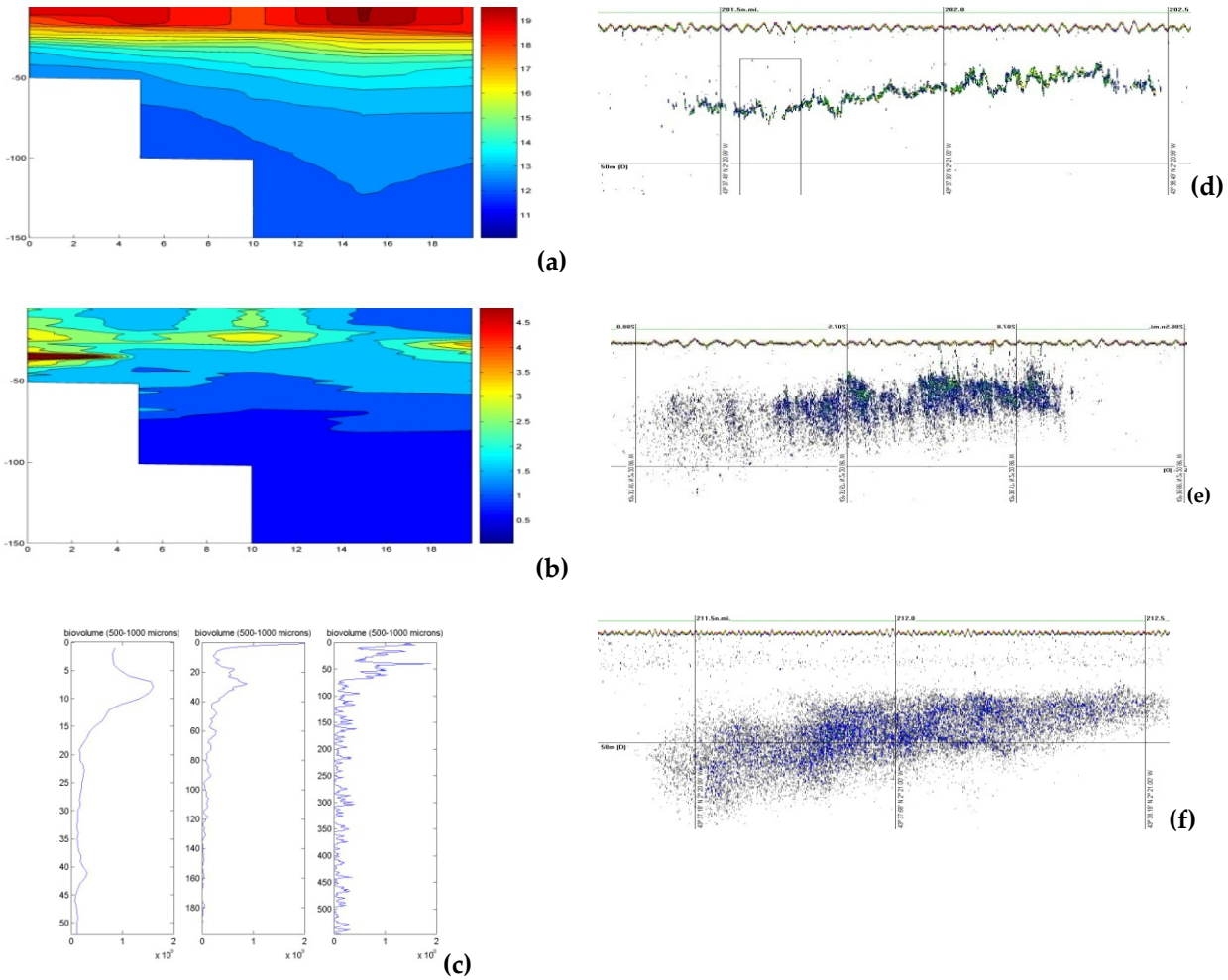


Figure 4.2.2.3.2.3. (a) Temperature (°C), (b) in vivo fluorescence (arbitrary units) along the across-shelf transect off 2°W longitude; (c) bio-volume (µm³) of particles in the range 0.5–1 mm of equivalent spherical diameter from LOPC (laser optical plankton counter in the coastal, mid-shelf and slope oceanographic stations. Echograms at 38 kHz of the same swarm of northern krill (*Meganyctiphanes norvegica*) at different times; (d) sunset (20 GMT); (e) night (21 GMT); (f) during the fishing haul operation (22 GMT). Vessel speed was 10 knots in d and e, and 4 knots in f.

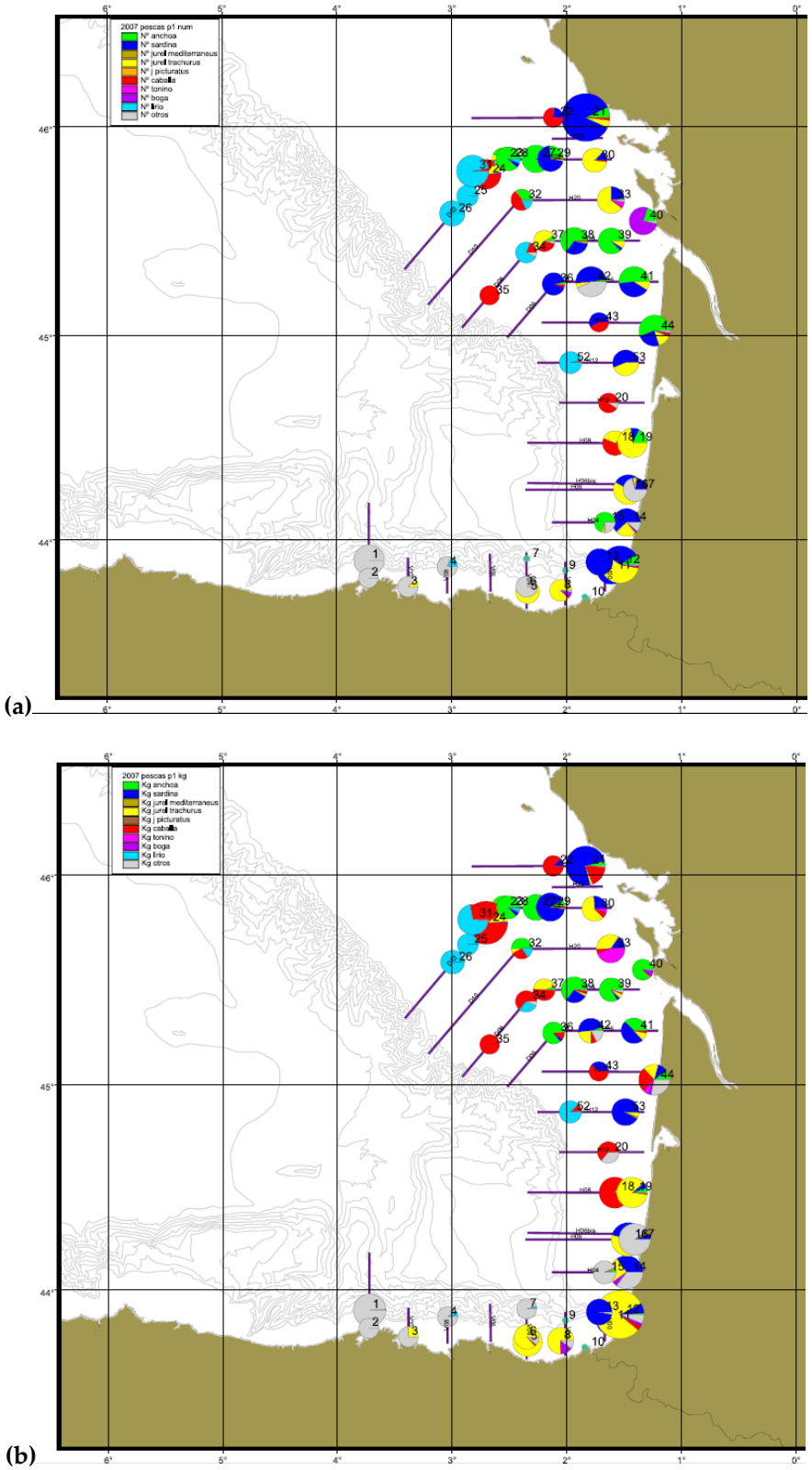


Figure 4.2.2.3.2.4. Spatial distribution of fishing hauls during the first leg f the PELACUS-1007 cruise. Size of the charts is proportional to (a) abundance (b) weight.

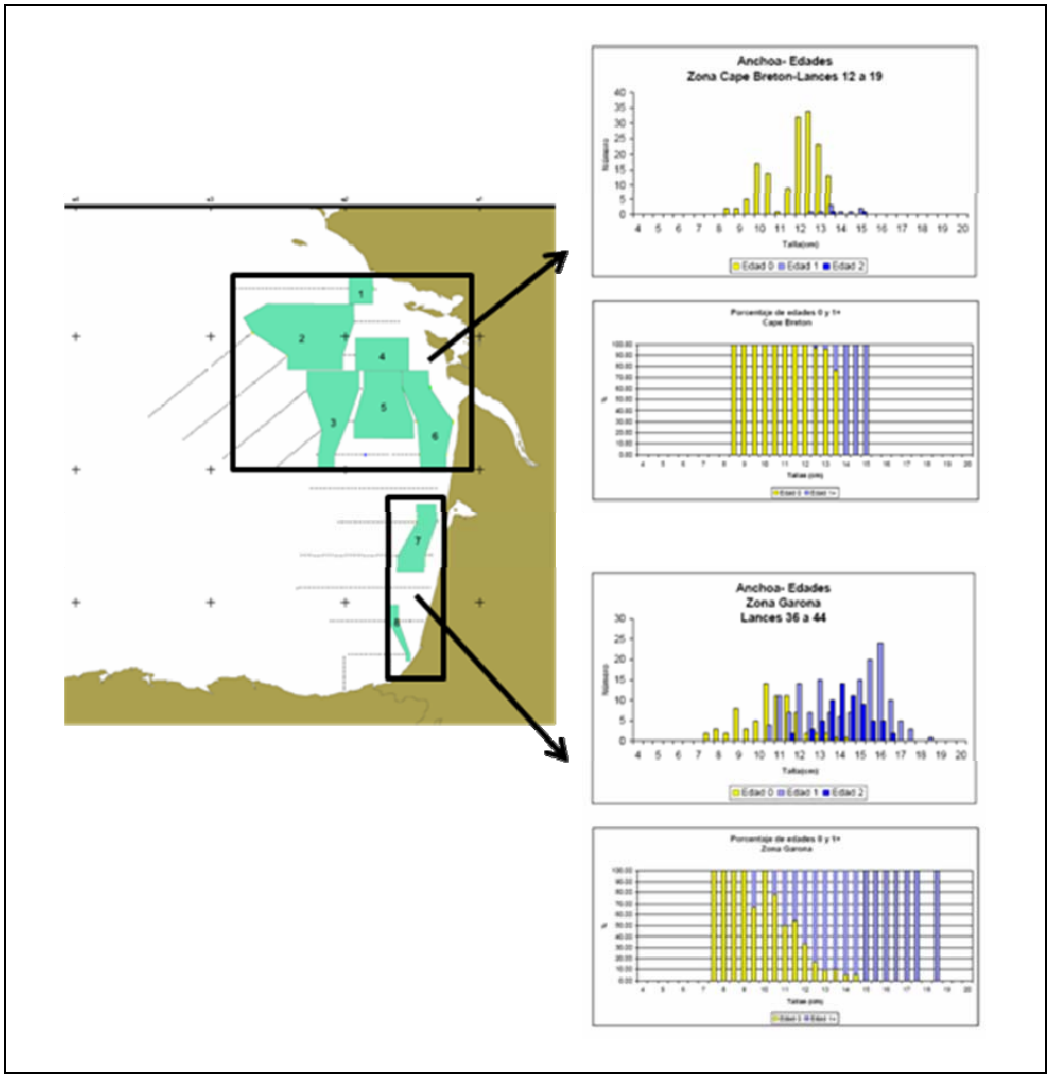


Figure 4.2.2.3.2.5. Anchovy. Distribution of homogenate areas (polygons) for the estimation of biomass (left) and size-age keys applied in each area (Cape Breton – Les Landes and Garonne) (right).

4.2.2.3.3 Comparison of anchovy juvenile survey results

OBJECTIVE

As a consequence of the divergent results obtained by anchovy juvenile acoustic surveys carried out in the Bay of Biscay in 2006 (JUVENA06 conducted by AZTI and PELACUS1006 conducted by IEO), an acoustic WK was promoted, during the ICES WGACEEG06 meeting held at Lisbon, to try to resolve the observed divergences. This acoustic WK was held in Nantes in 16–20 April 2007 (Workshop on anchovy juvenile acoustics surveys carried out in the Bay of Biscay in 2006: JUVENA06 and PELACUS1006 cruises, WD presented to the WGACEGG, Palma de Mallorca 2008). Apart from the analysis of the differences of the 2006 survey, during the Nantes-WK it was agreed to perform a cross validation of both 2007 surveys in order to be able to solve or at least explain any possible divergences that may appear between the estimates before they are delivered to the Administrations and the scientific community. After the end of both surveys, a second WK was held in Gijón from 12 to 14 of November 2007 (Workshop on anchovy juvenile acoustics surveys carried out in the Bay of Biscay in 2007: JUVENA07 and PELACUS1007 cruises, WD presented to the WGACEGG, Palma de Mallorca 2008). The objective of the Gijón-WK was to warranty the consistency of both surveys, and to check that they were able to detect the same targets, both applying valid methods to produce coherent results. What follows is a summary of the results of the Gijón-WK.

In this section the results of the intercallibration planned in the Nantes WK and a comparison of the final results obtained in the 2007 surveys are presented.

MATERIALS AND METHODS

The cross validation of the results obtained in both cruises was performed in three steps that covered the different aspects that had to be checked:

1. Comparison of the global estimation results
2. Comparison of the data acquisition
3. Comparison of the processing methods

1. Comparison of the global biomass estimation results

The abundance estimations obtained in both surveys were compared for different areas, for anchovy juveniles and adults.

2. Comparison of the data acquisition: inter-calibration

During the inter-calibration, two different exercises were carried out:

a. Echointegration of the bottom echo

This exercise involved the echointegration of the whole water column including the echo of the bottom with the acoustic equipment onboard RV "Emma Bardán" and RV "Thalassa". A transect of 10 nmi., was covered successively by both vessels, following exactly the same path. This exercise, if successful, should be able to assure a consistent data acquisition of the acoustic equipment of both teams, without interference of any possible avoidance reactions of fish schools.

b. Echointegration of a common transect

Both vessels went in parallel, distant apart about 100 m laterally and about 250 m longitudinally along a chosen transect. The transect was divided in legs of 5

nmi, and each vessel was taking the lead alternatively in each leg. The echointegration by layers of the whole water column was compared (avoiding in this exercise the echointegration of the bottom). The aim of this exercise was to compare the data acquired almost simultaneously by both vessels. It may also, in combination with exercise 1.a, provide evidence of different avoidance reactions for each vessel.

3. Comparison of the processing methods

This exercise was planned to be done jointly by both teams in the laboratory after the surveys and before delivering of the data results. The main idea was to revise and analyze the data together in order to be able to solve any possible discrepancy before the estimations are made public. The exercise had two parts as well:

a. Common scrutiny of echograms

A common echogram scrutiny was carried out on a number of relevant echograms, to assure consistent echo-traces classification, mainly for anchovy juveniles and adults.

b. Cross validation of abundance estimation methodology

A portion of the sampled transects of both surveys was selected to process these data separately by both institutes after the survey. Eight contiguous transects were selected, four from each survey: H13, H15, H17 and H19 from JUVENA07, and H14, H16, H18 and H20 from PELACUS1007. Each institute provided both total and allocated to species NASC values, proportion of anchovy and length distribution in order to compare the sequence of estimation process in each case. In case of divergent results, this method should provide a way to identify its causes.

Results

1. Comparison of the global results

The comparison of biomass estimates produced by both surveys is presented in Table 4.2.2.3.3.1. For adults, the large divergences found can be attributed to the larger northward coverage of the JUVENA07 cruise. After excluding this northern contribution, there was general agreement between adult estimates.

In the case of juveniles, the discrepancies between both cruises were higher. In the Cantabrian area, they could be explained by the extremely close to the surface distribution of anchovy juvenile shoals, that couldn't be detected by the transducers located on the hull of the RV "Thalassa" (PELACUS1007) (Figure 4.2.2.3.3.1 and Figure 4.2.2.3.3.2) –i.e. blind zone of the RV "Thalassa" from the surface down to 10 m depth versus 6 m for the RV "Enma Bardán". In the area of Les Landes, a similar effect was observed. In this area, the juveniles were also located close to the surface. In some echograms acquired during the PELACUS107 cruise these shoals of anchovy juveniles were apparently detected, but their proximity to the transducers face made them indistinguishable from bubbles, so they were discarded for biomass estimation purposes. In the Garonne area, the divergence between both estimates cannot be explained by any of the previous reasons. More work need to be done to try to explain the observed discrepancies. Among the reason to explain them can be pointed out the different energy allocation criteria (e.g. definition of shoal parameters, consideration of all the small pelagic fishes community or only the

objective species, direct allocation of energy to anchovy or allocation by regions) (see paragraph 3 below).

2. Comparison of the data acquisition

During the common survey time a full day of both teams was devoted to the inter-calibration activities planned in the Nantes WK. The inter-calibration was done on the 27 September along the transect H24.

a. Echointegration of the bottom echo

The configuration parameters of the acoustic equipment onboard both vessels are presented in Table 4.2.2.3.3.2. The rough weather conditions during the inter-calibration exercise were not adequate and, as the Emma Bardán is a small vessel, the pitch and roll due to wind and waves caused continuous losses of the bottom echo for this vessel (see Figure 4.2.2.3.3.3). This made impracticable the direct comparison of echointegration values, as the "Emma Bardán" echograms had frequent gaps. For this reason, a selection was made of the portions of the echograms that were free of these discontinuities. Once selected, the average echointegrated energy inside the portions was calculated (Figure 4.2.2.3.3.4). The comparison showed a similar tendency of the energy detected by both echosounders. However, a constant bias can be observed, probably produced by the higher tilt angle of the RV "Emma Bardán" acoustic beam caused by the higher pitch and roll suffered by this vessel. Thus, although the technique seems promising for these types of inter-calibration exercises, no conclusive results could be obtained from this analysis. It is recommended that a new inter-calibration is conducted in good weather conditions in order to produce more conclusive results concerning this issue.

b. Echointegration of a common transect

The fail in the bottom echointegration due to the rough weather conditions precluded the continuation of this analysis.

3. Comparison of the processing methods

a. Common scrutiny of echograms

The common scrutiny of the echograms revealed the possible causes of the divergences observed in the comparison of the global biomass estimates. First, we examined the echograms corresponding to the Cantabrian and Landes areas. In those areas, the JUVENA07 survey detected a region occupied by pure juvenile anchovy that the PELACUS1007 was unable to detect. The scrutiny of the echograms in this area showed that most of the acoustic energy was located in the upper 10 m of the water column (Figure 4.2.2.3.3.5). This layer is inside the blind zone of the RV "Thalassa" due to the fact that the echosounder is installed 6 m depth (that is, 3 m deeper than the one in the RV "Emma Bardán"). Figures 4.2.2.3.3.6 and 4.2.2.3.3.7 show the echotraces detected near the surface by both vessels. It can be appreciated that the echotraces detected by the EB are well separated from the transducer while those detected by the "Thalassa" are partially inside the near field in front of the transducer face, making it impossible to distinguish them from the surface bubbles.

In the Garonne, the differences between both estimations are much lower, especially for adults (Table 4.2.2.3.3.1). Here, the scrutiny revealed different

allocation methods used by each team. These different allocation criteria may explain the differences observed in the juvenile abundance estimation. The main methodological differences detected are listed in Table 4.2.2.3.3.3.

b. Cross validation of abundance estimation methodology

The time devoted to the cross validation exercise was not enough to quantitatively clarify the divergences. This work will have to be done next year 2008.

Conclusions

- The comparison of overall anchovy biomass estimation reveals a significant difference between both surveys, being the estimation provided by JUVENA07 higher than the one provided by PELACUS-1007.
- The discrepancies are of a lower magnitude than the ones obtained in the anchovy juvenile cruises carried out in 2006.
- The main biomass estimation divergences between both surveys have been caused by the different coverage and sampled volume:
    - Time constrains made impossible to the PELACUS-1007 survey to reach the northern area, thus causing a reduced coverage for this survey. This problem can be solved by increasing the prospecting time.
    - The close-to-the-surface distribution of southern anchovy juveniles made them invisible and/or indistinguishable from the surface bubbles. To solve this potential problem for future years, the echosounders at the RV "Thalassa" have to be deployed at a lower depth. A towed body is suggested as a possible solution.
- If restricted to the common surveyed-sampled area, the adult anchovy abundance estimations are of the same range for both surveys.
- The remaining divergences are attributed to methodological differences between both surveys.
- At this moment, the discrepancies between surveys are considered to be explained at a qualitative level. For a complete resolution of these discrepancies, the cross validation of abundance estimation methodology exercise has to be finished.
- It is recommended that the cross validation exercise is completed during 2008 and the results presented to the WGACEGG meeting at the end of the year.

Table 4.2.2.3.3.1.

	Juvenile biomass		Adult biomass	
Regions	JUVENA	PELACUS10	JUVENA	PELACUS10
Cantabric	5355	-	0	-
Landes	1026	323	757	91
Garonne	6506	2700	17308	13770
Loire	235	-	17045	-

Table 4.2.2.3.3.2. Configuration parameters of the acoustic equipment onboard the vessels of both surveys.

	THALASSA	EMMA BARDÁN
sound speed	1516.93	1527.97
transducer draft	6.15	3.15
sample interval	0.000256	0.000256
transmit power	2000	1200
pulse length	1024	1024
transducer gain	25.55	24.22
absorption coefficient	0.008553	0.007328
s_A correction	-0.86	-0.57

Table 4.2.2.3.3.3. Methodological differences of JUVENA and PELACUS10 surveys.

	JUVENA	PELACUS-10
Type of echointegration	Echointegration by layers.	Partly echointegration by schools with a 2x2 m minimum school dimension threshold, partly echointegration by layers
Type of allocation of energy to species	Relatively frequent direct assignations, especially to discard species difficult to capture. Single species approach.	All the energy is split using exclusively the information provided by the fishing hauls. Occasionally, direct assignations to schools. Multi species approach.
Vertical coverage	From 6 m depth to 1 m above the bottom.	From 10 m depth to 1 m above the bottom.
Fishing gears	Pelagic trawl (15 m vertical opening, 0.4 cm mesh size) and purse seine.	Pelagic trawl (30 m vertical opening, 1 cm mesh size).

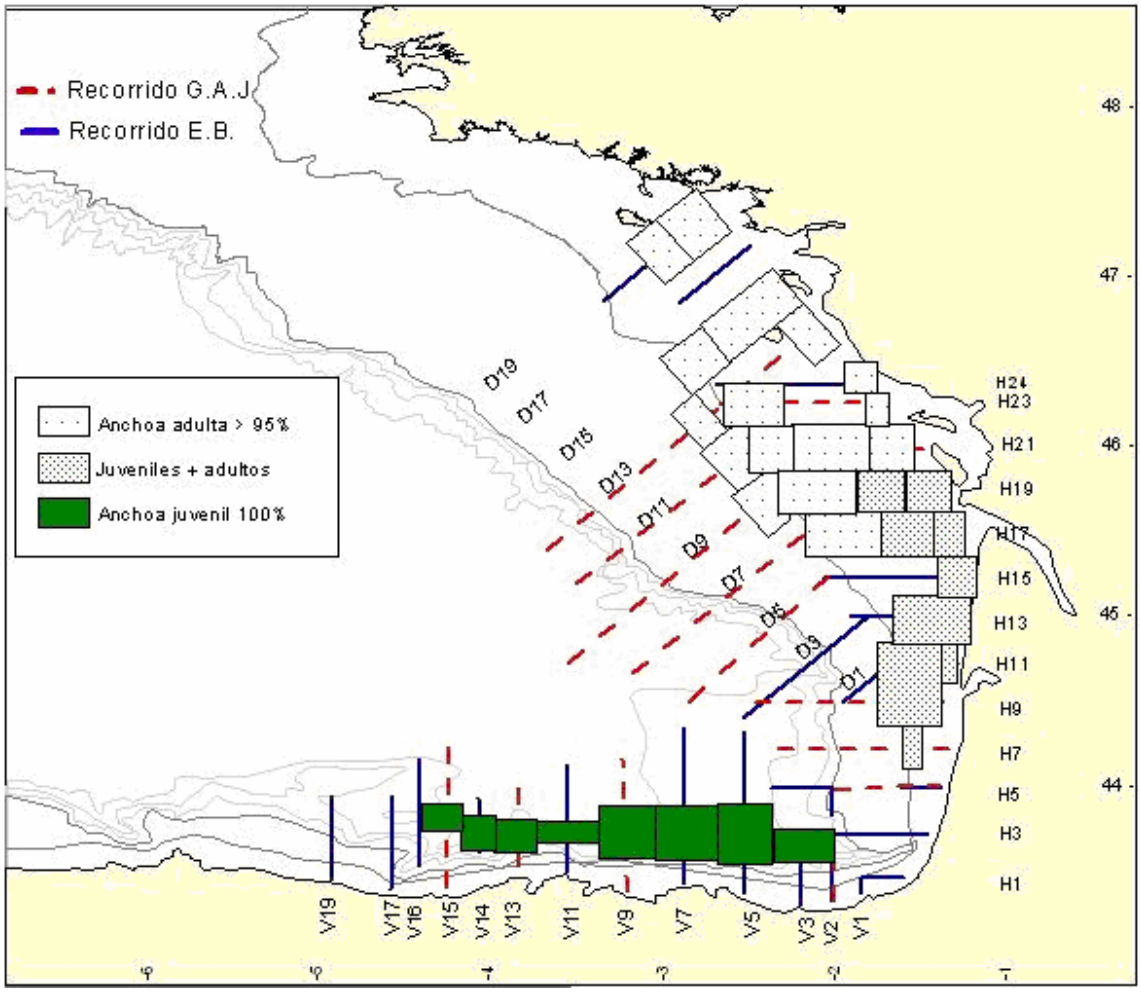


Figure 4.2.2.3.3.1. Spatial distribution of anchovy found in JUVENA 2007 survey.

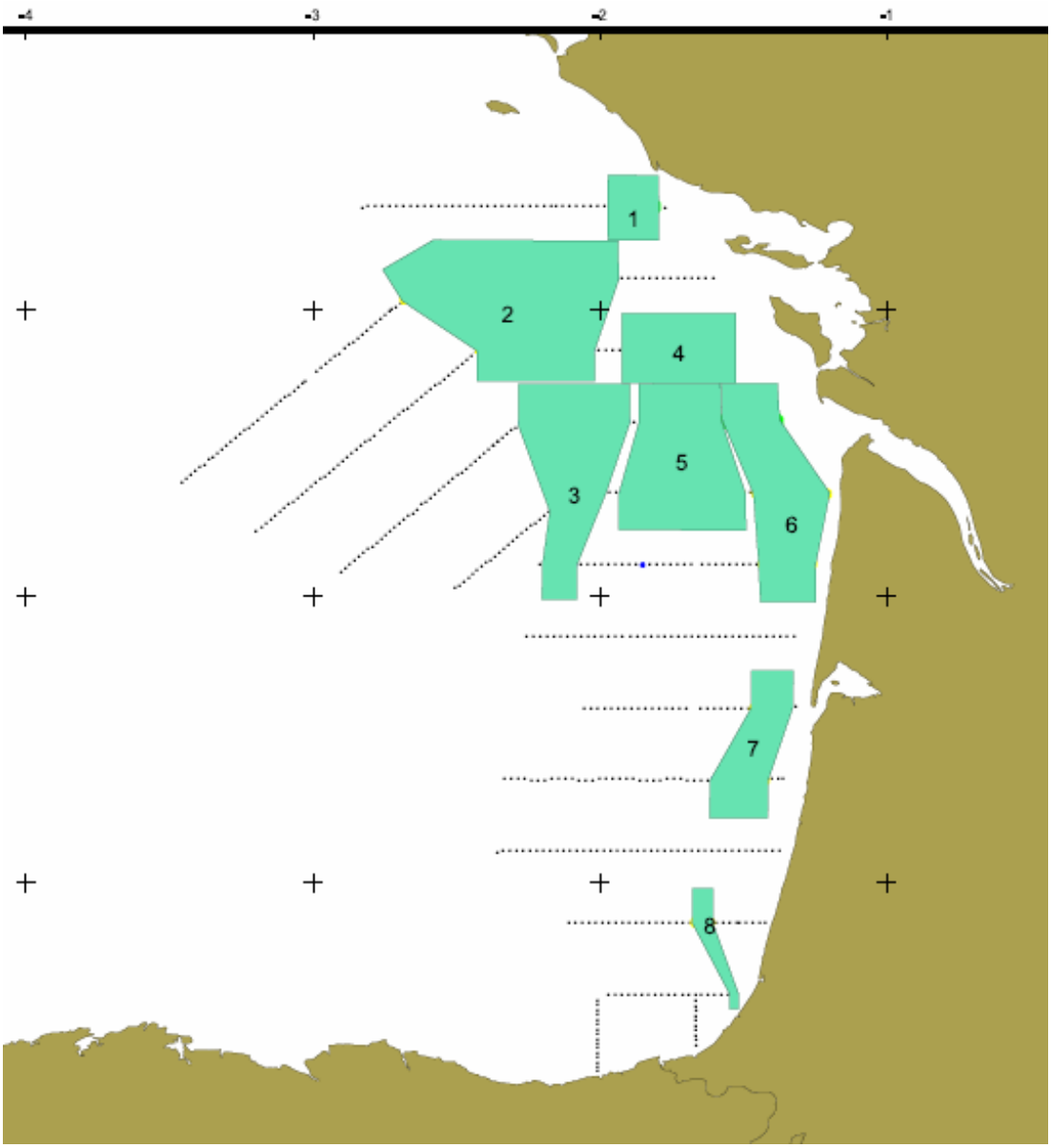


Figure 4.2.2.3.3.2. Spatial distribution of anchovy found in PELACUS-10 2007 survey.

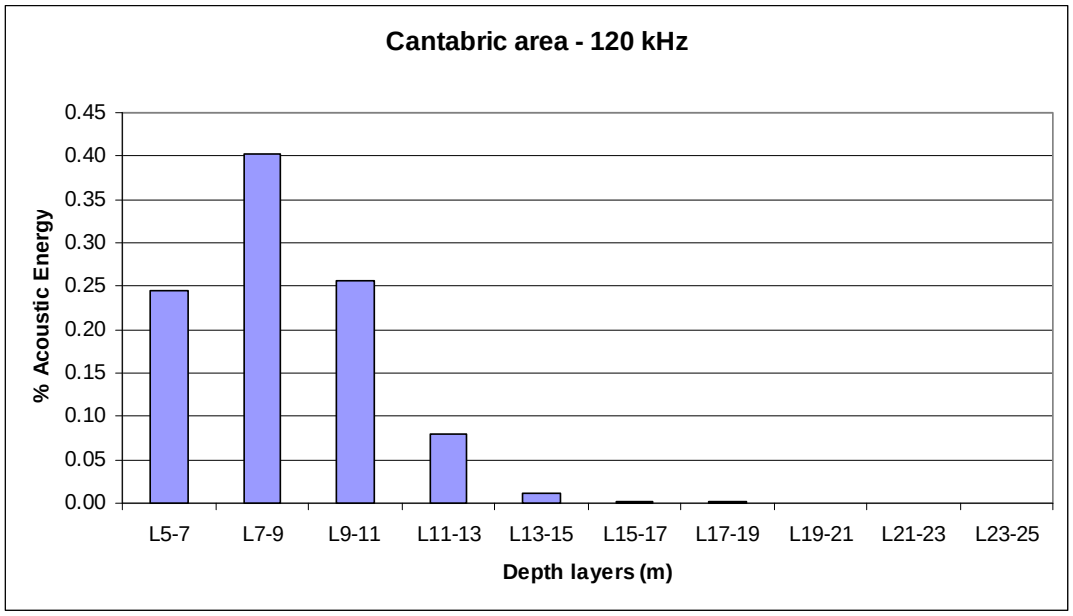


Figure 4.2.2.3.3. Vertical distribution of acoustic energy detected by JUVENA 2007 survey in the Cantabric area. The energy corresponded to pure juvenile anchovy, captured by both types of fishing gears.

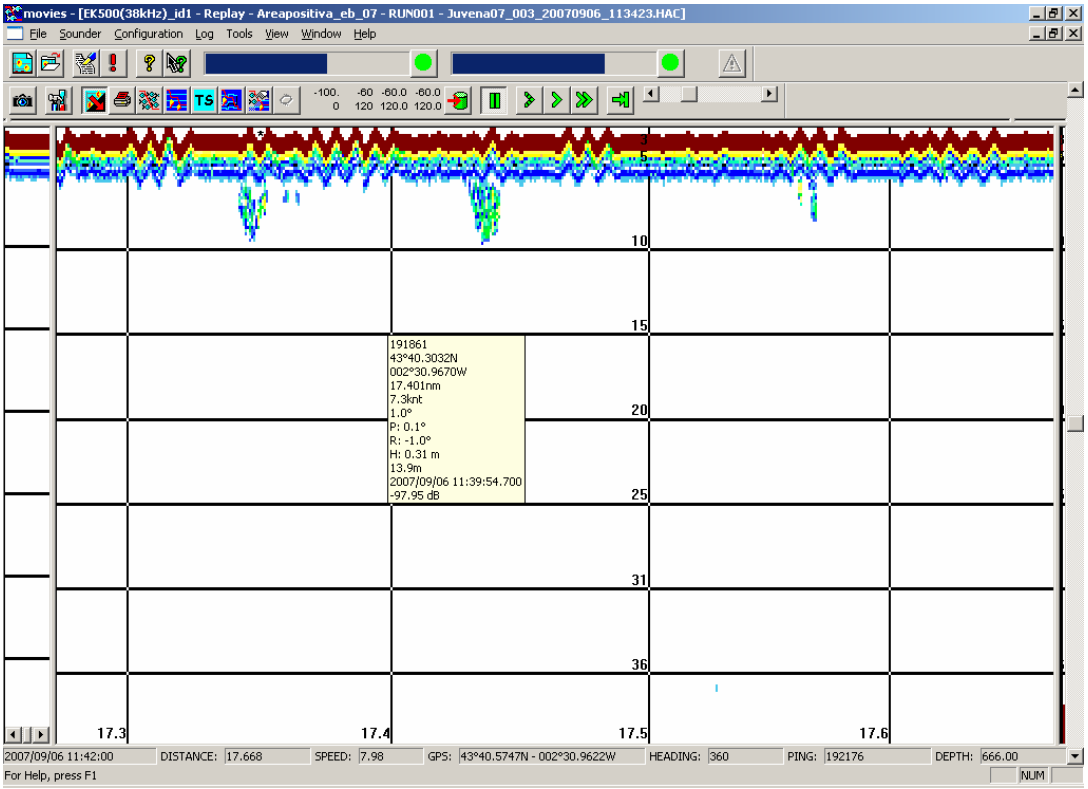


Figure 4.2.2.3.4. Example of the pure juvenile anchovy aggregations detected by JUVENA 2007 survey in the Cantabric area.

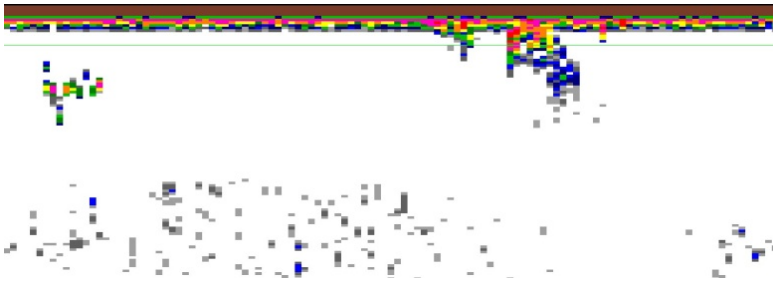


Figure 4.2.2.3.3.5. Example of surface detections made by PELACUS-10 2007 survey in the southern area. They were unassigned because of the proximity to the surface and the absence of fishing haul.

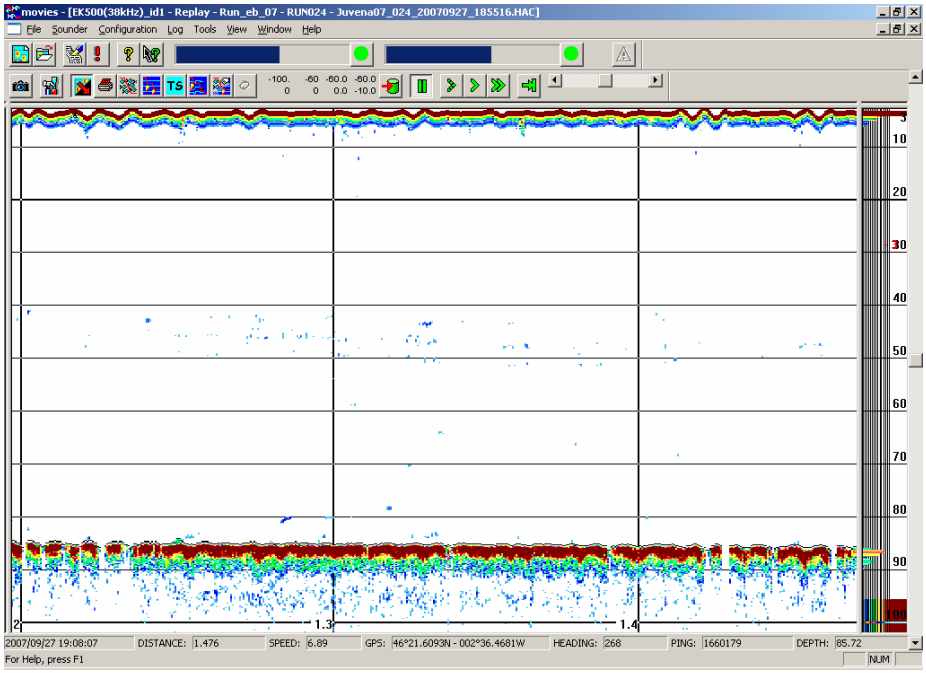


Figure 4.2.2.3.3.6. Example of echogram showing the effect of pitch and roll on the bottom detection exercise.

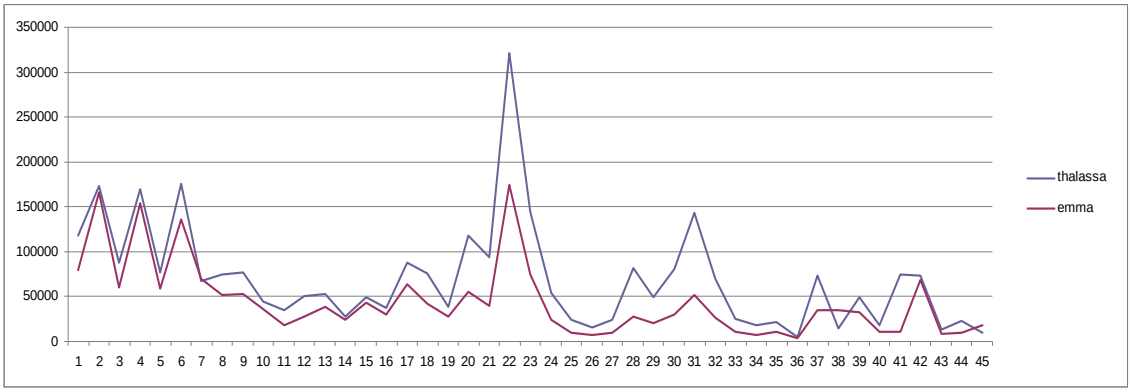


Figure 4.2.2.3.3.7. Comparison of bottom echointegrated energy for both vessels.

4.2.3 Anchovy surveys in area IX

4.2.3.1 Distribution and abundance of spawning population from egg production surveys

4.2.3.1.1 Egg distribution and estimates of egg production

No DEPM survey was carried out in 2007. Next DEPM survey is expected to take place in 2008. Egg distribution is therefore based on CUFES data from the acoustic surveys.

Anchovy egg densities from the two surveys (from IPIMAR, acoustics, and from IEO, acoustics and DEPM) conducted in the area of southern Iberia (Gibraltar to Cape S. Vincente) in 2007 is presented in Figures 4.2.3.1.1.1. and 4.2.3.1.1.2. The first survey took place at the beginning of the spawning season for the species in the area. Nevertheless, the number of stations with eggs and the values of density were considerable, and higher than in previous spring campaigns. In early July the anchovy egg densities were even higher than in May and reached peak values within the series of records for this region. The area of higher abundance was, in both surveys, between Cádiz and Huelva (coinciding with the region with higher acoustic energy for anchovy) but virtually the whole region from Gibraltar to Cape S. Vicente was occupied with anchovy eggs; the exceptions were the eastern and western limits during the May campaign.

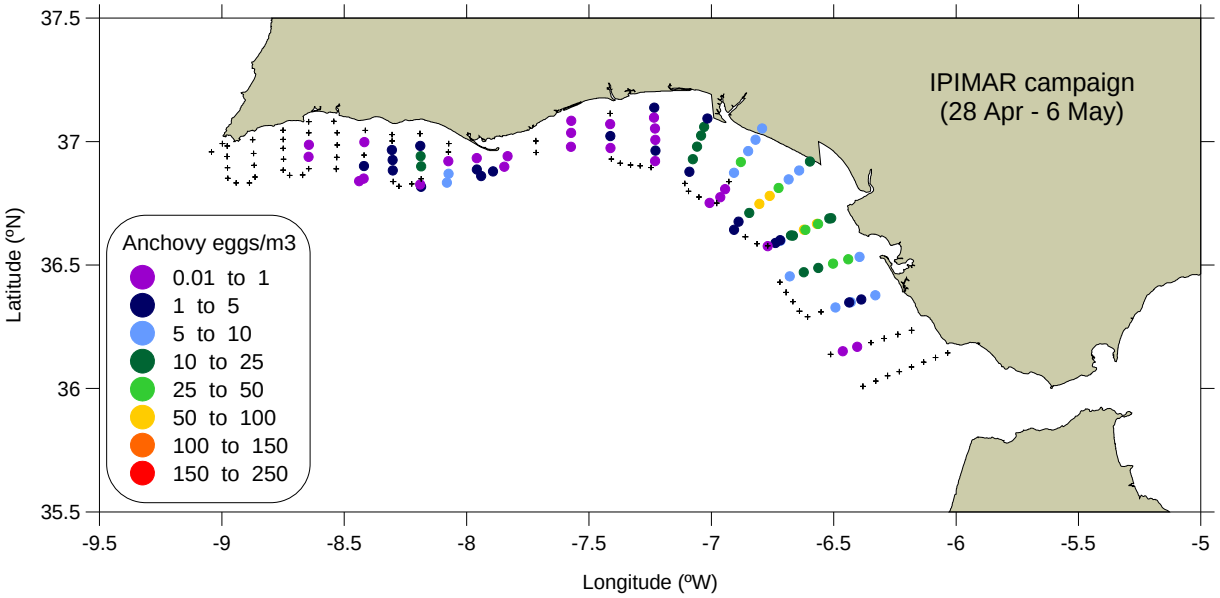


Figure 4.2.3.1.1.1. Egg distribution from CUFES sampling, IPIMAR survey (28 April – 6 May).

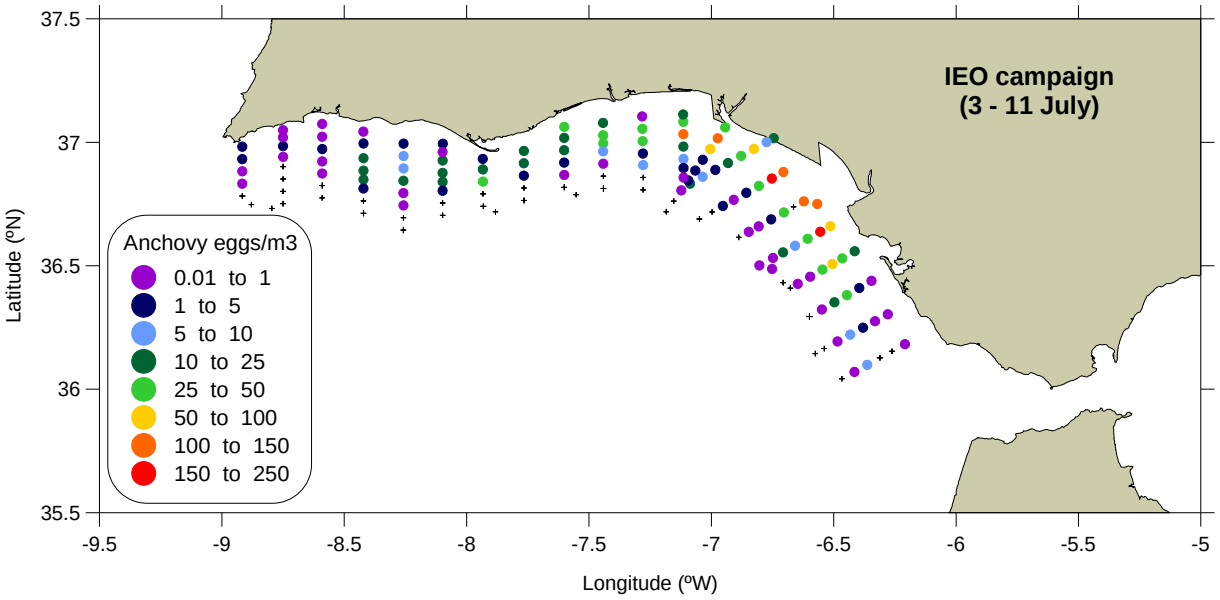


Figure 4.2.3.1.1.2. Egg distribution from CUFES sampling, IEO survey (3 – 11 July).

4.2.3.1.2 Distribution and estimates of adult parameters

No anchovy DEPM survey in area IX was carried out in 2007 and therefore no new estimates of adult fecundity is available. Next DEPM survey for anchovy in this area will be carried out in 2008 and the results are expected to be presented in 2008/2009.

4.2.3.1.3 Spatial distribution and biomass estimates of the target species

No anchovy DEPM survey in area IX was carried out in 2007 and therefore no new estimates of DEPM-based SSB is available. Next DEPM survey for anchovy in this area will be carried out in 2008 and the results are expected to be presented in 2008/2009.

4.2.3.2 Distribution and abundance of spawning population from acoustic surveys

Two Portuguese and one Spanish acoustic surveys have been carried out during the WG intersession time: the Portuguese surveys were carried out by IPIMAR in November 2006 (*SAR06NOV*) and in April 2007 (*PELAGO 07*), whereas the Spanish one (*ECOCÁDIZ 0707*) was carried out by IEO in July 2007. Portuguese surveys were carried out with the RV "Noruega" and acoustically sampled the Atlantic-Iberian continental shelf waters of its EEZ and the waters belonging to the Spanish Gulf of Cadiz (ICES Subdivisions IXa Central-North, Central-South, and South), between 20 and 200 m depth. The Spanish survey, carried out on-board RV "Cornide de Saavedra", constrains its sampled area to only the Portuguese Algarve and Spanish Gulf of Cadiz waters (i.e. ICES Subdivision IXa South), also surveying waters between 20 and 200 m depth. All these surveys follow 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 methodological differences between these recent surveys are not considered by the WG members as important as to prevent from any comparison between their results and they are basically due to:

- The echo-sounder and working frequencies used (IPIMAR surveys: Simrad EK 500 working at 38 and 120 KHz; IEO survey since 2007 onwards: Simrad EK 60 working at 18, 38, 70, 120, and 200 KHz).
- The fishing gear used as sampler for echo-trace identification/confirmation and gathering biological data (IPIMAR surveys: bottom- and pelagic-trawl gears; IEO surveys: pelagic trawl).
- The software used for data storage and post-processing (IPIMAR surveys: Movies+ software; IEO surveys: SonarData EchoView software).
- The set of species-specific TS-length relationships: at present, the new IPIMAR spring survey series, *PELAGO*, takes into account the same agreed species-specific *TS* values than the IEO surveys, but for mackerel ($b_{20IPIMAR}$= –82.0 *vs* b_{20IEO}= –84.9).

Regarding their respective objectives, the *SAR* Portuguese November surveys, as presently planned, are mainly aimed at the mapping of the spatial distribution of sardine *Sardina pilchardus*, and anchovy *Engraulis encrasicolus*, and the provision of acoustic estimates of their abundance and biomass by length class and age groups (for the time being age-structured estimates are only available for sardine). Although the main objective of the *ECOCÁDIZ* Spanish surveys was formerly the mapping and the size-based and age-structured acoustic assessment of the anchovy SSB, and hence the survey's dates, mapping and acoustic estimates of all of those species susceptible of being assessed (according to their occurrence frequency and abundance levels in

fishing stations) are also obtained. This same 'multi-species' or 'pelagic community' approach has also been adopted in the new *PELAGO* Spring Portuguese survey series, at least for the time being for the southern area, which has involved a substantial increase in the number of fishing stations as compared with previous surveys. In any case, the progressive inclusion of alternative (continuous and discrete) samplers for collecting ancillary information on the physical and biological environment (including top predators) are shaping these surveys as true 'pelagic ecosystem surveys'.

Results from the above surveys have been previously reported this year to the ICES WGMHSA (ICES, 2007) besides to this WG (see presentation by V. Marques and Ramos *et al.*, WD). As for the results from the *ECOCÁDIZ 0707* survey, the information provided to this WG is a corrected version of the one previously presented in the 2007 WGMHSA after detecting errors in some data files which fed the software package used for the initial acoustic assessment (see Ramos *et al*., WD).

Unfortunately, due to problems with the pelagic net during the *SAR* November 2006 survey, fewer trawls than planned were performed in the Cádiz area, and no anchovy acoustic estimate from this survey has been provided to the WG. A summarised description of the results from the 2007 spring-summer surveys is given below.

4.2.3.2.1 Distribution of acoustic energy allocated to anchovy

November 2006 Portuguese survey (*SAR06NOV*)

The November 2006 Portuguese survey, *SAR06NOV*, took place from the 27 October to the 22 November. As stated above, problems with the pelagic trawl in the Cádiz area and the scarcity of anchovy during this survey were the causes that prevented from mapping the acoustic energy allocated to the species as well as to provide any acoustic estimate.

April 2007 Portuguese survey (*PELAGO 07*)

The April 2007 survey (*PELAGOS07*) took place from 11 April to 8 May. Anchovy was almost exclusively concentrated between Faro and Cadiz (IXa South) being absent along the remaining Portuguese south-western coast just up to and in front of Lisbon (between Cascais and Cabo Raso), where small nuclei of density were also found (Figure 4.2.3.2.1.1). As usual, the main concentrations were found in the Spanish waters of the Gulf of Cadiz.

July 2007 Spanish survey (*ECOCÁDIZ 0707*)

The *ECOCÁDIZ 0707* was carried out in the Subdivision IXa south (southern Atlantic waters off the Iberian Peninsula) from 3–12 July 2007. Although it occurred almost all over the shelf of the sampled area, anchovy still was mainly distributed in the Spanish waters off the Gulf of Cadiz (23–160 m depth), with the highest densities occurring in the central part of the sampled area, mainly between 40 and 115 m depth. Two additional nuclei of high density were recorded in front the Bay of Cadiz between 30 and 100 m depth, and in front of the Coto de Doñana coast between 40 and 80 m depth. In this last area were also recorded the highest densities of anchovy eggs, although in shallower waters than 40 m depth. Unlike the spatial pattern observed in April, in the Portuguese waters the species was widely distributed (20–220 m) but in low densities, except in the area comprised between Albufeira and Cabo Santa María between 70 and 170 m depth, where, surprisingly, the highest S_A values attributed to the species in the survey were recorded (Figure 4.2.3.2.1.2).

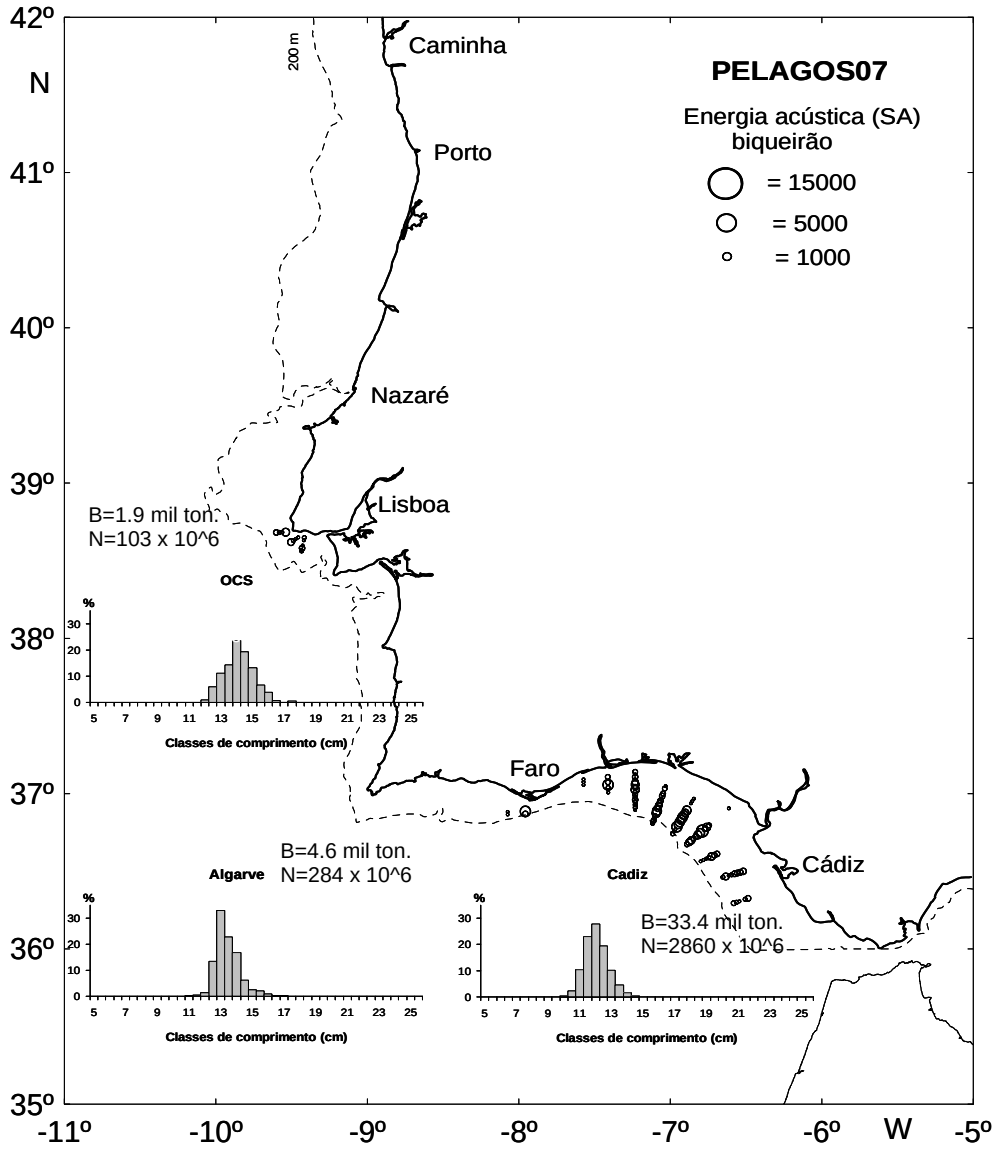
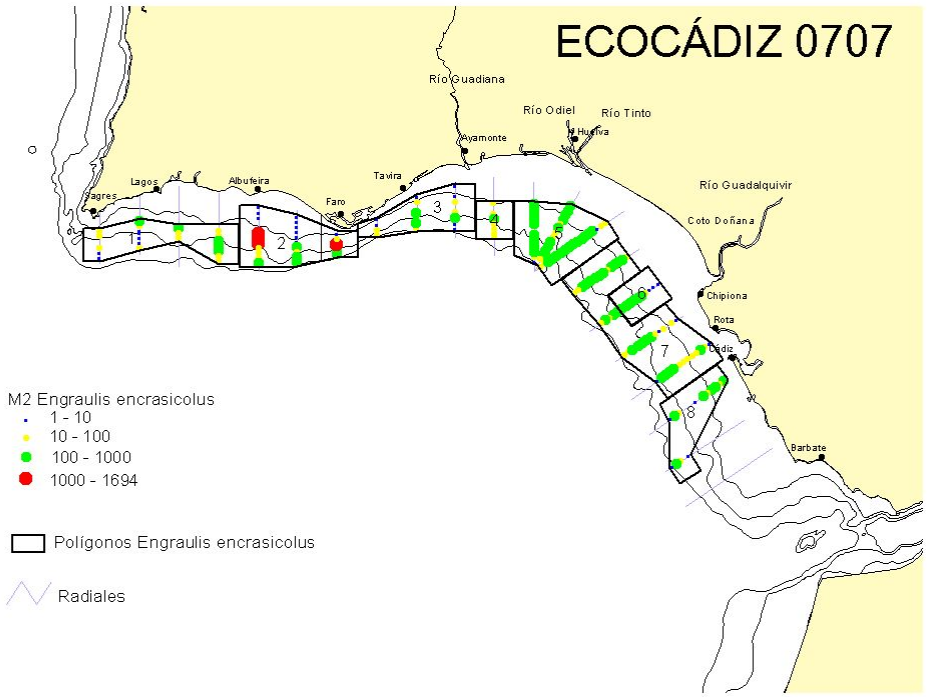


Figure 4.2.3.2.1.1. Anchovy in Division IXa. Distribution of the nautical area-scattering coefficients (NASC or S_A) per nautical mile attributed to the species during the April 2007 Portuguese survey. Circle diameter is propotional to the acoustic energy.



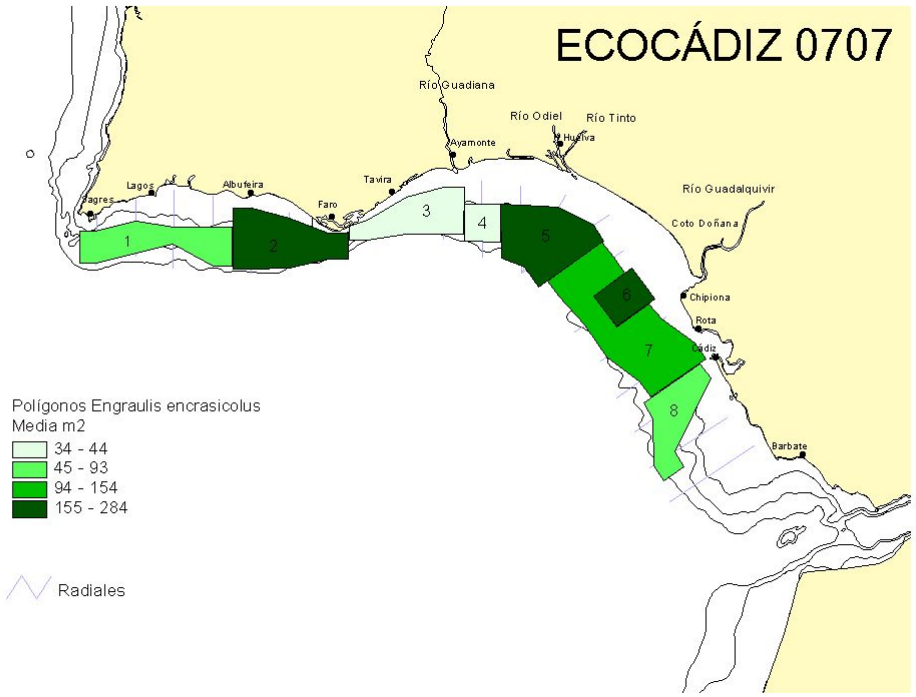


Figure 4.2.3.2.1.2. Anchovy in Subdivision IXa south. Distribution of the nautical area-scattering coefficients (NASC or SA) attributed to the species during the July 2007 Spanish survey. Homogeneous size-based post-strata used in the biomass/abundance estimates are also shown. Top: NASC values by ESDU. Circle diameter and colour scale are proportional to the acoustic energy. Bottom: strata coloured according to their average NASC values.

4.2.3.2.2 Species composition and length/age composition

November 2006 Portuguese survey (*SAR06NOV*)

As noted above, due to a problem with the pelagic net, fewer trawls than planned were performed in the Spanish waters of the Gulf of Cádiz. A total of 27 trawl hauls were finally performed of which 21 were pelagic and 6 took place at the bottom (Figure 4.2.3.2.2.1). Sardine was present in 18 fishing stations, being predominant in the Subdivision IXa Central North (between Póvoa de Varzim and Lisbon) where it presented a coastal distribution, in depths mainly around 70–80 m, but mainly mixed with chub mackerel (*Scomber japonicus*). In Subdivision IXa Central South sardine was scarce, being almost absent between Setúbal and Cape S. Vicente. Anchovy was also absent in the hauls carried out along to these two Subdivisions. Catches from hauls from the southwestern and southern Atlantic waters of the Iberian Peninsula were composed by a species mixing. In Algarve the biggest concentrations of sardine were found between Portimão and Faro and near Vila Real de Santo António. In the Spanish waters of the Gulf of Cádiz area, sardine was also scarce, being found mainly in the transects closer to the border with Portugal. In these southernmost waters, hauls were dominated by mid-sized pelagic fish species such as blue jack mackerel *Trachurus picturatus* and chub mackerel. Anchovy occurrence in these waters was only occasional. Species composition in hauls in November suggests a possible change in the pelagic fish assemblages, mainly in the Subdivision IXa Central North, with an increase in the occurrence of mid-size pelagic fish species usually found in the southern waters (blue jack mackerel and chub mackerel), possibly due to the high SST recorded in the area.

No length composition was derived for anchovy from this survey given their scarcity.

April 2007 Portuguese survey (*PELAGO 07*)

Forty eight fishing stations (35 pelagic trawls, 13 bottom trawls) were considered as valid ones during the April 2006 Portuguese survey (Figure 4.2.3.2.2.2). Sardine was found again throughout the surveyed area mainly distributed in the inner shelf off the Subdivision IXa Central North (from Póvoa de Varzim to Lisbon), where it was the dominant species in hauls and anchovy was absent. Haul catches in the IXa Central South were characterised by their multispecies nature (sardine, very scarce between Cape Espichel and Sines, anchovy, occasionally found in front of Lisbon, horse mackerel, *Trachurus trachurus*, blue jack mackerel, *picturatus, T.*, chub mackerel, bogue, *Boops boops*, blue whiting, *Micromesistius poutassou*, boarfish, *Capros aper*, Snipefish, *Macrorhamphosus scolopax*). In the Subdivision IXa South, the multispecies nature of the species composition of hauls still maintains although anchovy dominance in hauls progressively increases towards the easternmost waters and blue whiting, boarfish and snipefish disappear.

The anchovy length composition showed a spatial gradient, with the modes of the size distributions increasing from the Spanish waters of the Gulf of Cadiz (12 cm), through Algarve (13 cm), to the Cascais area (14 cm), (Figure 4.2.3.2.1.1).

July 2007 Spanish survey (*ECOCÁDIZ 0707*)

Thirty one fishing stations were considered as valid ones for the purposes of the acoustic assessment (Figure 4.2.3.2.2.3). From the set of more frequent species stood especially out chub mackerel (present in 29 from 31 hauls), followed by mackerel, *Scomber scombrus*, bogue (21 hauls), anchovy (19 hauls), Mediterranean horse-mackerel, *Trachurus mediterraneus* (18 hauls), and sardine (17 hauls). The most

abundant species in hauls were anchovy (52% of the total number), chub mackerel (23%), and sardine (20%). Blue jack-mackerel accounted for 3% in caught numbers, and the remaining species do not reach 1%. At first sight, some inferences on the species' distribution might be carried out from the combination of information from fishing hauls and the regional contributions to the total energy attributed to each species. So, sardine, round sardinella, *Sardinella aurita*, anchovy, horse mackerels species and mackerel seemed to show greater densities (or simply were only present) in the Spanish waters, whereas chub mackerel, blue jack-mackerel and bogue might be considered as typically "Portuguese species" in this survey.

As usual, size- and age-based estimates suggest an westward increasing size (-age) gradient, with the largest (and oldest) anchovies being more abundant in the westernmost limit of their distribution, and a recruitment area located in shallow waters close to the Guadalquivir river (Table 4.2.3.2.2.1, Figure 4.2.3.2.2.4).

Table 4.2.3.2.2.1. Anchovy in Subdivision IXa South: estimated abundance (thousands of individuals) and biomass (tonnes) by age groups in the July 2007 Spanish acoustic survey.

	ALGARVE	CÁDIZ	TOTAL
AGE CLASS	Number	Number	Number
0	0	0	0
I	416816	1201826	1618642
II	136258	30380	166637
III	4582	254	4836
TOTAL	557655	1232460	1790115

Age class	ALGARVE	CÁDIZ	TOTAL
	Weight	Weight	Weight
0	0	0	0
I	7717	15572	23289
II	3143	605	3748
III	142	7	149
TOTAL	11002	16183	27185
SOP(%)	94,53	93,85	94,12

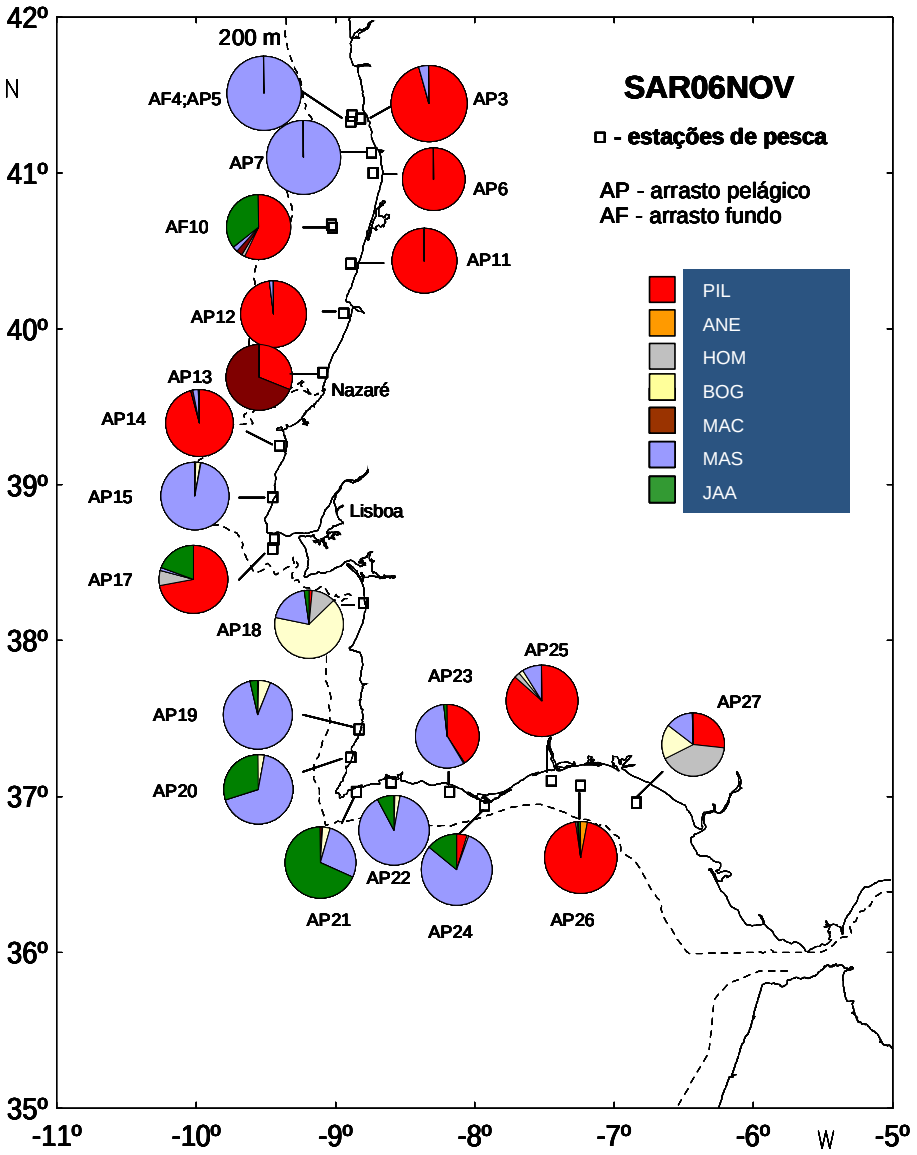


Figure 4.2.3.2.2.1. Anchovy in Division IXa: fishing trawl location and haul species composition during the November 2006 Portuguese survey. (AP- Pelagic trawl; AF- Bottom trawl).

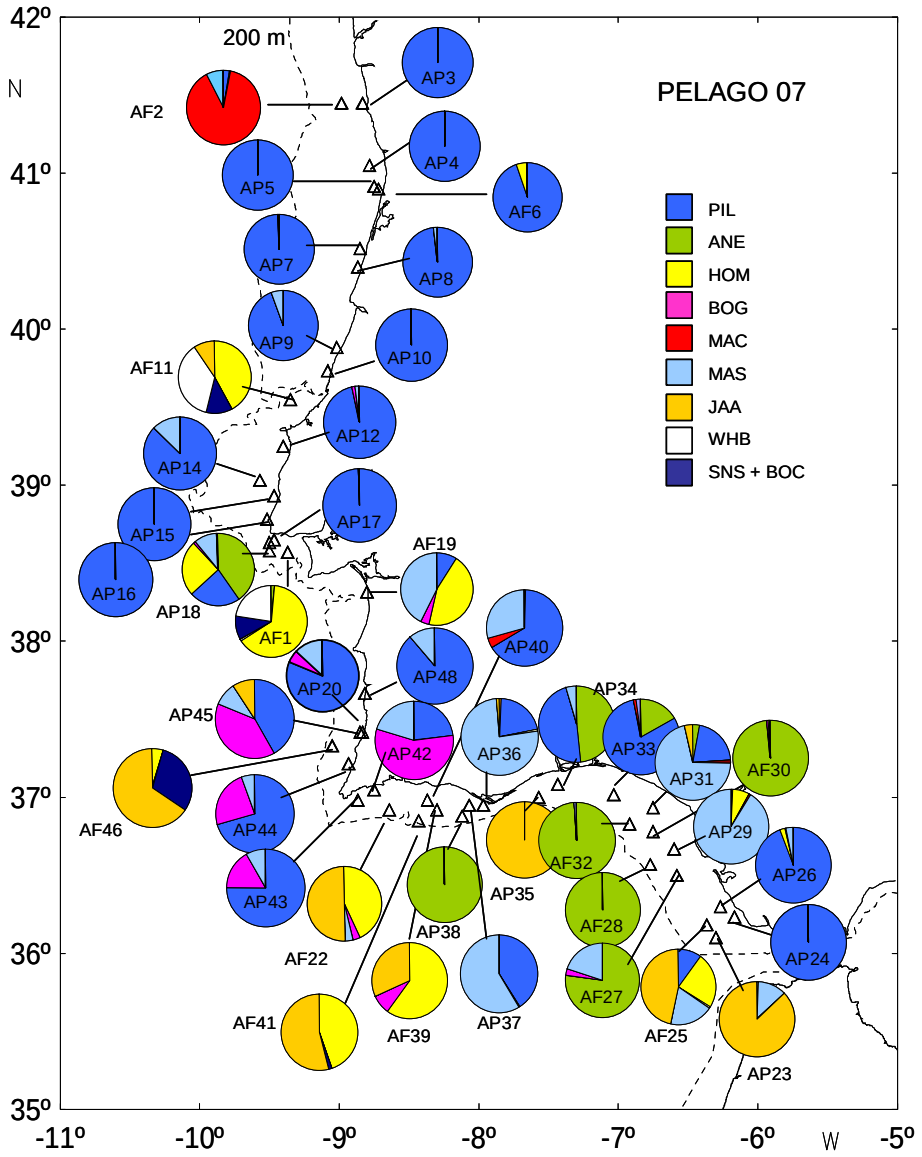


Figure 4.2.3.2.2.2. Anchovy in Division IXa: fishing trawl location and haul species composition during the April 2007 Portuguese survey. (AP- Pelagic trawl; AF- Bottom trawl).

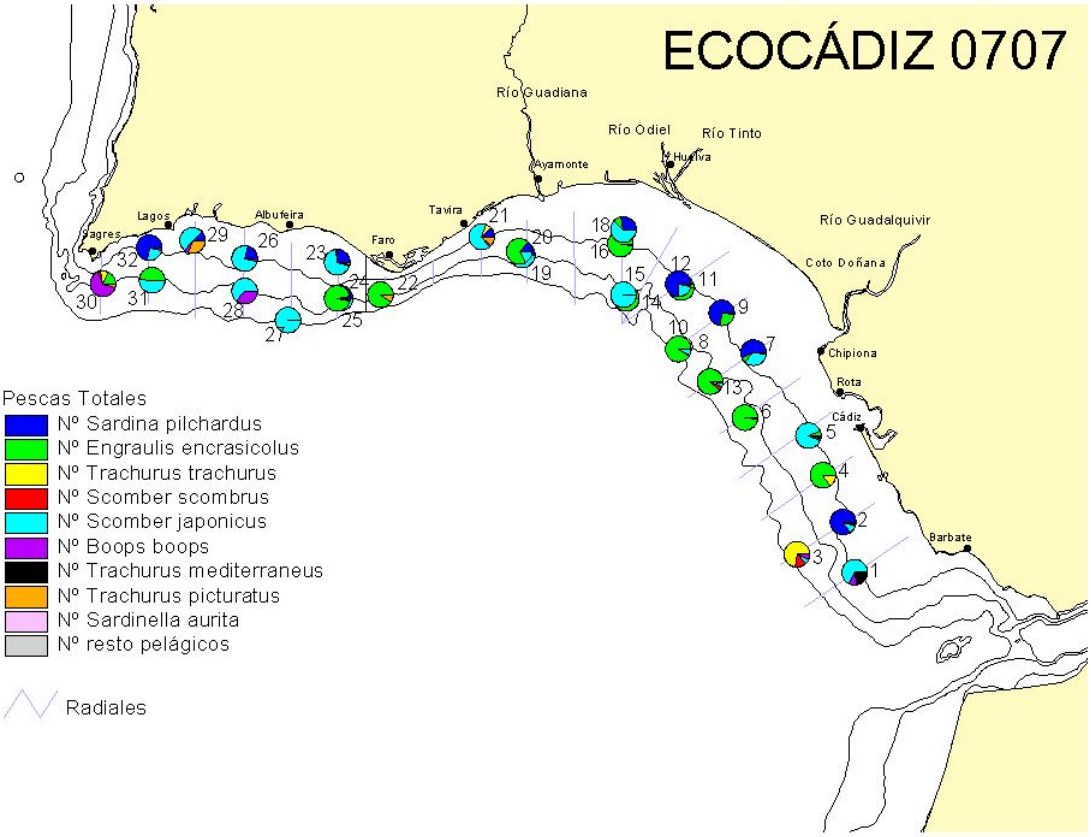


Figure 4.2.3.2.2.3. Anchovy in Subdivision IXa South: fishing trawl location and haul species composition during the July 2007 Spanish survey.

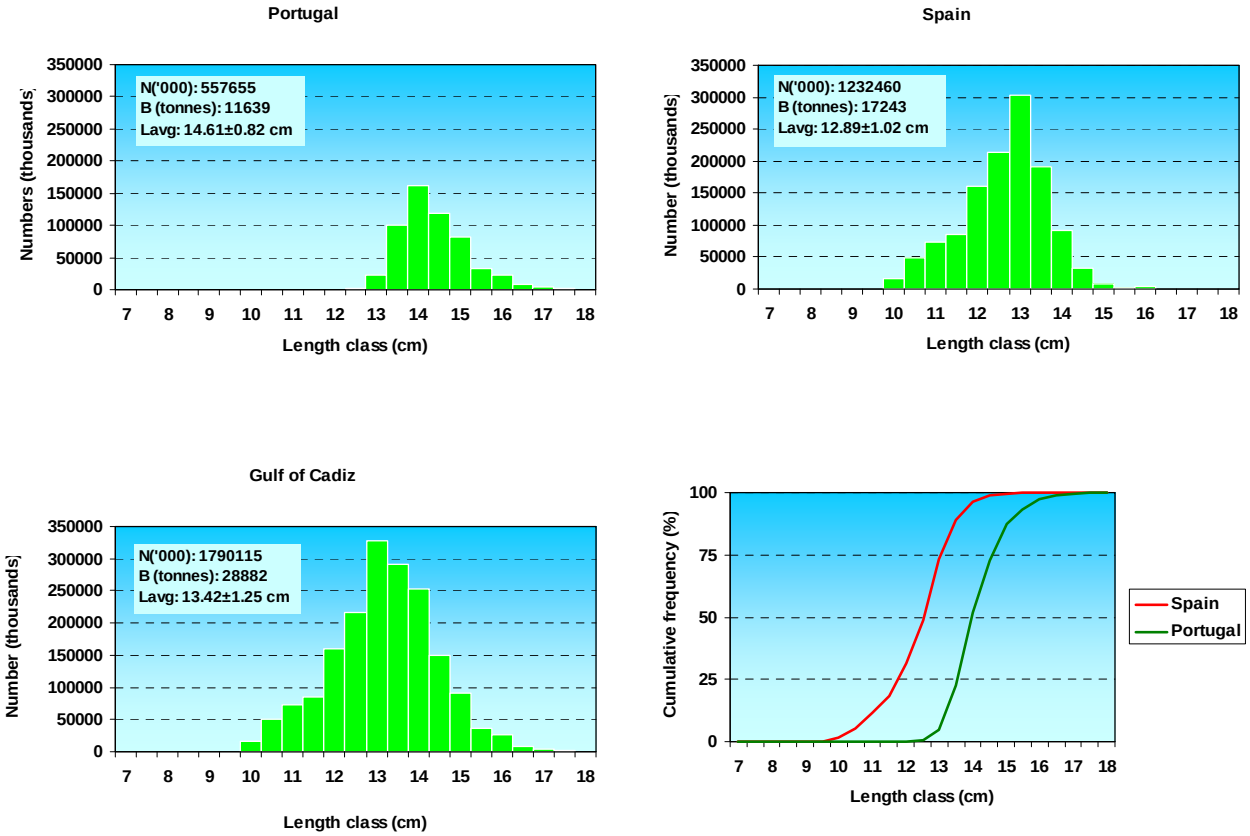


Figure 4.2.3.2.2.4. Anchovy in Subdivision IXa South: estimated abundance by length class by region and total area during the June 2006 Spanish acoustic survey. Bottom right: cumulative frequency (%) by length class and region.

4.2.3.2.3 Spatial distribution and biomass estimates of the target species

November 2006 Portuguese survey (SAR06NOV)

No anchovy acoustic assessment is available from this survey because of the reasons given in previous sub-sections.

April 2007 Portuguese survey (PELAGO 07)

The anchovy total estimated biomass was 40 thousand tonnes (3,247 million fish), which represents a 54% increase in relation to the average value for the entire time series (24.9 thousand tonnes), and it was almost entirely located in the Subdivision IXa south (96.8% and 95.1% of the total estimated abundance and biomass in the whole Division). As in previous years, the area with the highest anchovy abundance and biomass was the Spanish waters off the Gulf of Cadiz (33.4 thousand tonnes, 2,860 million fish), accounting for 88 and 84% of the total estimated abundance and biomass (Table 4.2.3.2.3.1, Figure 4.2.3.2.1.1). The Portuguese coast presented an anchovy distribution pattern similar to the one described in previous years, with a low occurrence in front of Lisbon (between Cascais and Cabo Raso, 1.9 thousand tonnes and 103 million fish), and a somewhat denser concentrations in the Algarve (between Faro and the Guadiana river mouth, 4.6 thousand tonnes, 284 million fish).

July 2007 Spanish survey (*ECOCÁDIZ 0707*)

Anchovy total biomass in the Subdivision was estimated at 28.9 thousand tonnes (1,790 million fish), values somewhat lower when compared to the 38.0 thousand tonnes estimated shortly before in the Portuguese survey. The Spanish Gulf of Cadiz contributed with the 60% (17.2 thousand tonnes) of the total biomass and 69% of the total abundance (1,232 million fish), (Table 4.2.3.2.3.2).

The historical series of total and regional acoustic estimates of anchovy abundance (millions) and biomass (tonnes) either from the whole Division IXa (Portuguese surveys) or from the Subdivision IXa South only (Spanish surveys) are shown in Tables 4.2.3.2.3.1 and 4.2.3.2.3.2.

The estimates from those surveys covering the whole southernmost subdivision (the IXa South) show through the series that either the bulk (about or higher than 90% of both the total abundance and biomass) or even the whole of the anchovy population is concentrated in the Spanish waters of the Gulf of Cadiz. The series show several gaps which makes difficult to follow any clear trend. Biomass estimates from 1998 to 2003 in this Subdivision have oscillated between 21 and 34 thousand tonnes. However, available estimates in 2004 and 2005 have decreased down to 13–14 thousand tonnes, evidencing a possible decline in the population levels. The picture of an alarming decreasing trend just in 2004–2005 was warned in the 2005 WGMHSA and WGACEGG that it should be initially considered with caution for several causes. Firstly, the estimates themselves in such years seemed to be affected by problems related either to the sampling coverage of shallow waters (2004 Spanish survey, Ramos *et al*., 2004; ICES, 2006a) or to the echo-traces discrimination between fish and plankton (2005 Portuguese survey, Marques *et al*., 2005; ICES, 2006a). Secondly, the survey season for the Spanish surveys (late spring-early summer) entailed a 2–3 months delay relative to the usual March (since 2005 in April) Portuguese survey series which involves an additional mortality affecting the population estimates and a probable different population structure. Notwithstanding the above, the 2005, 2006 and 2007 Portuguese spring survey seasons were coincident and their estimates, therefore, comparable, and they indicate an evident recovered population in 2006 and 2007 up to a level close or even somewhat higher to the average estimate in the (Portuguese) historical series. The close similarity between the 2006 estimates from the Portuguese and Spanish surveys reinforces the above statement on a population recovery that year in the subdivision. However, the inter-annual trend depicted by the 2006 and 2007 Portuguese surveys is much more marked (an increase of about 14 thousand tonnes) than the trend exhibited by its Spanish counterparts (only a 3.5 thousand tonnes increase). Furthermore, the increased value in the 2007 population numbers, as estimated by the Portuguese survey, was in disagreement with the opposite trend observed from the Spanish surveys. What has happened this year for such differences is a matter of concern and some working hypothesis has been drawn this year for explaining the above differences.

A wider distribution for anchovy along the subdivision is only recorded in some years of the time series (in boldfaced red in Tables 4.2.3.2.3.1 and 4.2.3.2.3.2). However, the lack of correspondence between this species' spreading and both the survey season and the magnitude of the resulting estimates suggests that such increases in the occupied area by the species should be driven by other factors than seasonal and/or density-dependence related ones (Ramos *et al*., 2005). From the spatial patterns exhibited during the summer surveys in 2006 and 2007 by small and mid-sized pelagic fishes, Ramos *et al*. (2008 WD) suggest that the spatial dynamics of anchovy abundance and biomass (and probably sardine as well) in summer may be

controlled by a combination of local environmental forcing and a competitive exclusion or top-down (predation) mechanisms driven by mid-sized pelagic fish foraging (mainly by the chub mackerel, *Scomber japonicus*, acting alone or in combination with blue jack mackerel, *Trachurus picturatus*, and other *Trachurus* species). Other evidences from other direct sources quoted by the authors demonstrated, at least for anchovy, that the species exhibited some local displacements to shallower areas, not covered by any survey, which may be one of the possible causes for the unexpected differences found in the estimates from relatively consecutive surveys.

All of these facts strengthen the necessity of an extended sampling coverage to shallower waters than those usually sampled in surveys surveying the Gulf of Cadiz shelf (both Spanish and Portuguese surveys). Sampling schemes aiming to solve this problem with the conventional vertical acoustics has been previously described by Guillard and Lebourges (1998), Guennégan *et al.* (2004), and Brehmer *et al.* (2006), amongst others.

Table 4.2.3.2.3.1. Anchovy estimated abundance (millions) and biomass (tonnes) in Division IXa from Portuguese acoustic surveys by area and total. Regional and total estimates for the Subdivision IXa south on coloured background. Red bolded cells correspond to surveys covering the whole subdivision with estimates from each of the regions in the subdivision.

SAR-PELAGO SERIES		PORTUGAL				SPAIN	IXA SOUTH	TOTAL DIVISION
SURVEY	ESTIMATE	CENTRAL-NORTH	CENTRAL-SOUTH	SOUTH (ALGARVE)	TOTAL	SOUTH (CADIZ)		
Nov. 1998	Number	30	122	50	203	2346	2396	2549
	Biomass	313	1951	603	2867	30092	30695	32959
March 1999	Number	22	15	*	37	2079	2079	2116
	Biomass	190	406	*	596	24763	24763	25359
Nov. 2000	Number	4	20	*	23	4970	4970	4994
	Biomass	98	241	*	339	33909	33909	34248
March 2001	Number	25	13	285	324	2415	2700	2738
	Biomass	281	87	2561	2929	22352	24913	25281
Nov. 2001	Number	35	94	-	129	3322	3322	3451
	Biomass	1028	2276	-	3304	25578	25578	28882
March 2002	Number	22	156	92	270	3731 **	3823 **	4001 **
	Biomass	472	1070	1706	3248	19629 **	21335 **	22877 **
Feb. 2003	Number	0	14	*	14	2314	2314	2328
	Biomass	0	112	*	112	24565	24565	24677
April 2005	Number	0	59	0	59	1306	1306	1364
	Biomass	0	1062	0	1062	14041	14041	15103
April 2006	Number	0	0	319	319	1928	2246	2246
	Biomass	0	0	4490	4490	19592	24082	24082
April 2007	Number	0	103	284	387	2860	3144	3247
	Biomass	0	1945	4607	6552	33413	38020	39965

*** Due to the distribution observed during the survey, the last transect (near the border with Spain) that normally belongs to the Algarve Subarea was included in Cadiz. ** Corrected estimates after detection of errors in the S_A values attributed to the Cadiz area (Marques and Morais, 2003).**

Table 4.2.3.2.3.2. Anchovy estimated abundance (millions) and biomass (tonnes) in Subdivision IXa South from Spanish acoustic surveys by area and total.

SPANISH SURVEYS	ESTIMATE	PORTUGAL: SOUTH (ALGARVE)	SPAIN: SOUTH (CADIZ)	TOTAL IXA SOUTH	SAMPLING GRID	SAMPLED DEPTH RANGE
June 1993	Number	-	462	-	Zig-zag	20–500 m
	Biomass	-	6569	-		
June 2004 *	Number	91	804	894	Parallel	30–200 m
	Biomass	1793	11376	13168		
June 2006	Number	103	2384	2487		20–200 m
	Biomass	1844	25924	27769		
July 2007	Number	558	1232	1790		
	Biomass	11639	17243	28882		

*** Possible underestimation due to the shallow waters between 20 and 30 m depth were not acoustically sampled. Moreover, 2004 and 2006 estimates are pending of revision (application of recent IEO standards and WGACEGG recommendations in the estimation process: delimitation of post-strata, increased number of assessed species, species-specific TS, etc).**

4.3 Sardine surveys in areas VIII and IX

4.3.1 General sardine distribution

The distribution of sardine egg densities, from CUFES, obtained during the three acoustic surveys (~Gibraltar – Brest) carried out during spring 2007 (IPIMAR, IEO and IFREMER) is represented in Figure 4.3.1.1. Sardine eggs were distributed over the platform throughout the whole region. Scarce numbers or even absence was registered for some stations on the French mid shelf, for the northern border Spain – Portugal (recurrent pattern) and for the outer shelf of NW Portugal (where smaller (younger) sardines were present). Hot spots for sardine eggs were observed close to Cádiz, just north of Lisbon, off the Galician Rias and east of Gijón. All these areas corresponded to high values of acoustic energy attributed to sardine. Also in French waters the higher abundances overlapped with higher sardine biomass. In some areas such as SW Portugal, Cabo Ortegal – Cabo Peñas and off the mouth of the Gironde, eggs were collected but the adult sardines were not detected by the echosounder.

Acoustic energy in sA (m^2/mn^2; NASC, Nautical Area Scattering Coefficient) allocated to sardine (*Sardina pilchardus*) during the spring acoustic surveys carried out by IPIMAR (April), IEO (April) and IFREMER (May) in their respective areas has been plotted in Figure 4.3.1.2. Sardine is found all over the prospected area, from Subarea VIIIa in Bay of Biscay till Subarea IXa-S, in the Gulf of Cadiz. In the Bay of Biscay sardine covers all the continental shelf, while in the Iberian Peninsula it can be found, principally, near to the coast. The higher values (more than 10000 m^2/mn^2) are located in Portuguese waters (IXa-CN and CS). In the Bay of Biscay (Subarea VIII) a gap could be observed in the data (no data) due to bad weather conditions during the survey.

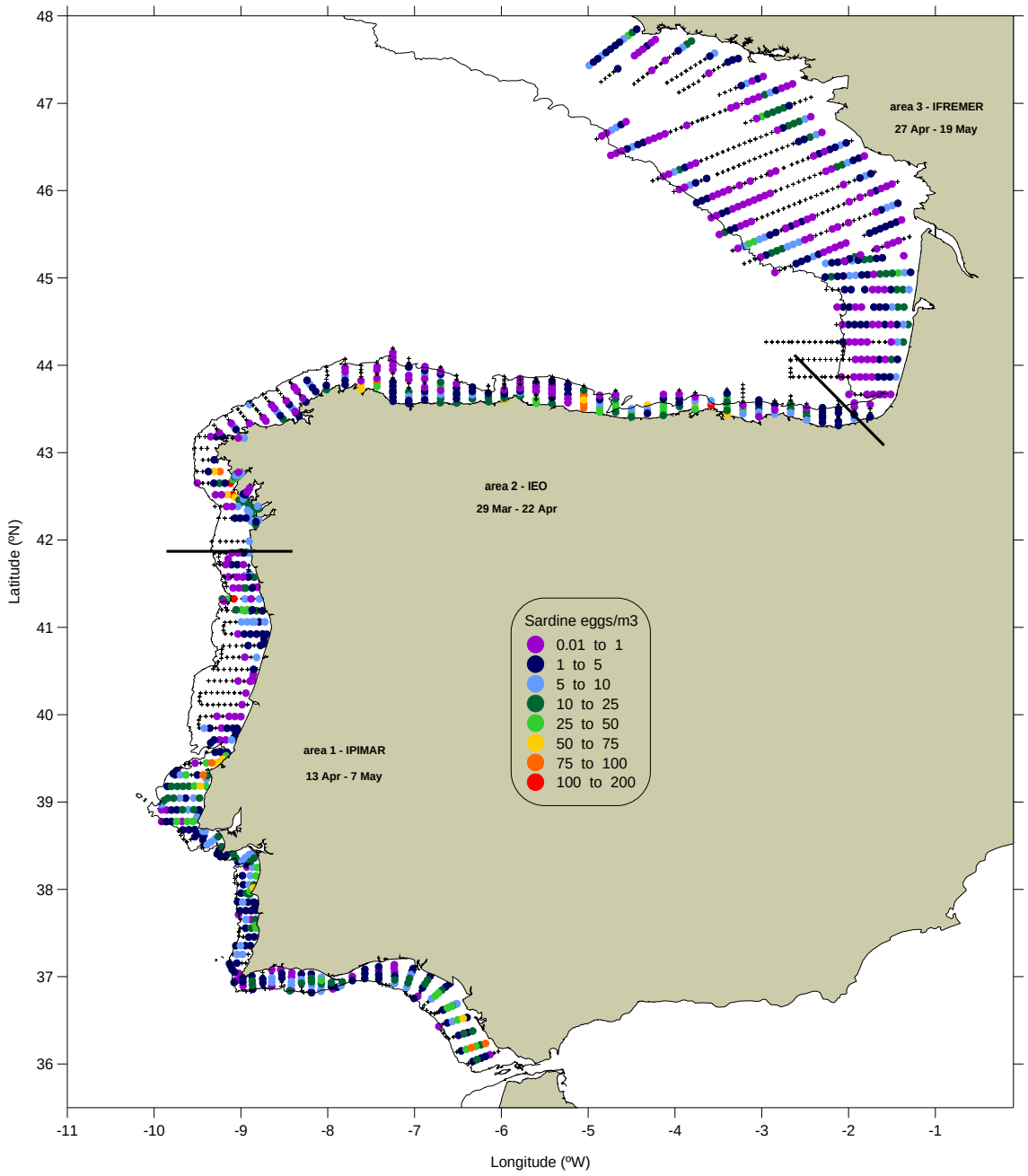


Figure 4.3.1.1. Sardine egg distribution from CUFES sampling during the acoustics surveys carried out by IPIMAR, IEO and IFREMER in April-May 2007.

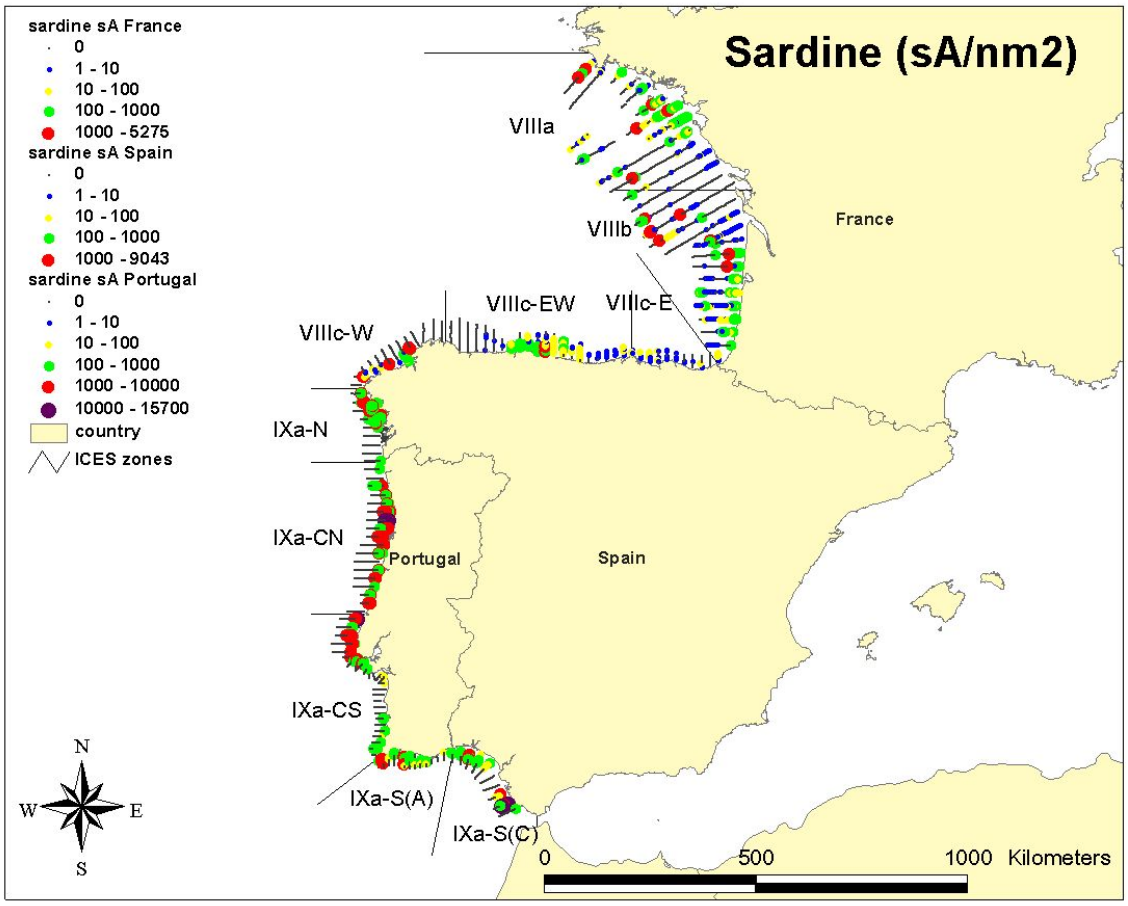


Figure 4.3.1.2. Acoustic energy allocated to sardine in the 2007 combined coverage of the Atlantic Iberian Peninsula and Armorican shelf.

4.3.2 Sardine surveys in area VIIIa+b

4.3.2.1 Distribution and abundance of sardine eggs

The CUFES and PairoVET stations carried out by AZTI during BIOMAN 07 were collected from the 3 – 23 May and the CUFES stations obtained by IFREMER during PELGAS 08 were collected between 27 April and 19 May so there is a difference in the dates in the collection of samples and in the area covered (i.e. AZTI covering the Cantabric coast and IFREMER covering areas further to the North). However the distribution of sardine eggs encountered in the Bay of Biscay by the two vessels and the two samplers (Figure 4.3.2.1.1) could be considered as similar, covering the areas from the French coast to the isobath of 100m from 43º50`N to 47º30′ and close to the shelf edge from 45ºN to 47º50′N. This distribution fit well with the sardine adult distribution encountered in the same area (i.e. Figure 4.2.2.1.2). As these surveys are not directed to this specie in particular it can be seen that they didn't covered the entire sardine spawning area in the Bay of Biscay that could be expected to reach areas more to the North.

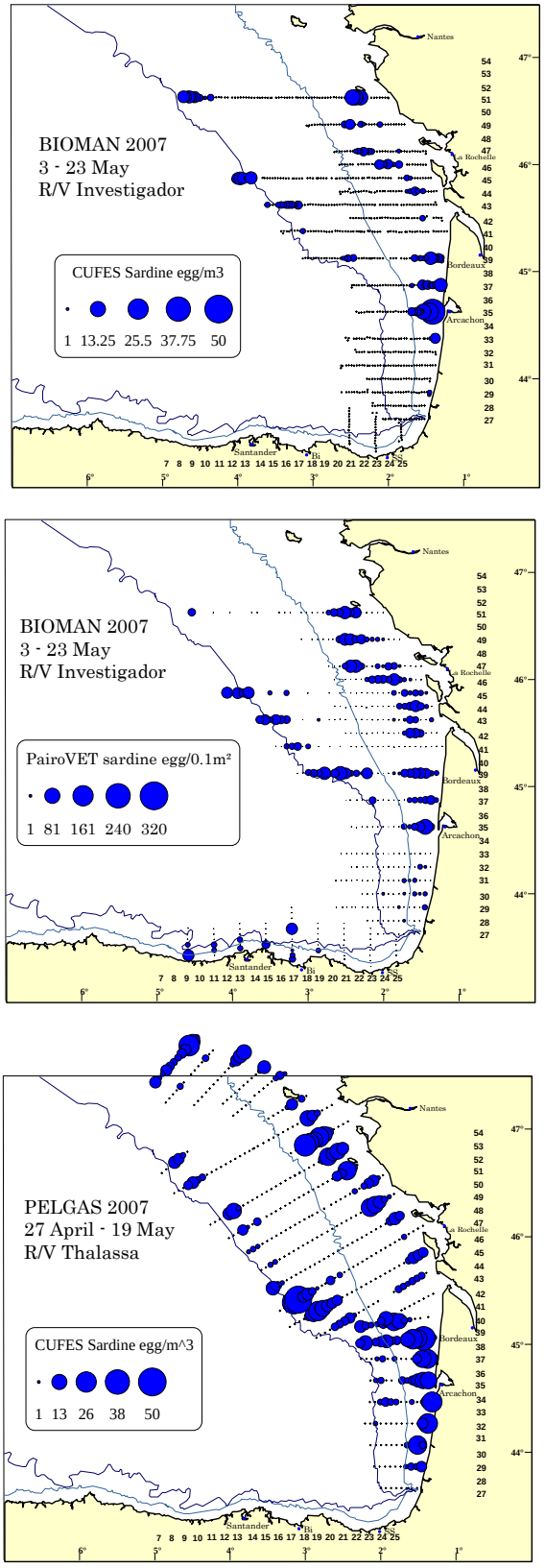


Figure 4.3.2.1.1. Plankton stations and sardine egg abundances from the DEPM survey BIOMAN07 obtained with the PairoVET net (eggs/0.1m², on the top left panel) and with CUFES (eggs/ m³, on the top right panel) and on the bottom, sardine egg abundance obtained with CUFES (eeg/m³) during the Acoustic survey PELGAS 08.

4.3.2.2 Distribution and abundance of spawning population from acoustic surveys

The French acoustic survey (PELGAS) is routinely carried out each year in spring in the Bay of Biscay and information on sardine distribution and abundance is available, with a time series starting in 2000. The 2007 survey (PELGAS07) took place from the 26 April to 26 May on board the RV "Thalassa". The objectives, methodology employed and sampling strategy are described in Section 4.2.2.2.

These results have already been reported in WGHMSA report (2007).

4.3.2.2.1 Distribution of acoustic energy allocated to sardine

Sardine was distributed all along the coast 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 4.3.2.2.1.1). In the offshore area, sardine was generally mixed with horse mackerel in the south and with mackerel in front of the Gironde. It was rarely found as isolated big schools near the surface. Small fish were found along the southern Landes coast. The distribution of sardine observed during PELGAS07 was similar to the one observed in previous surveys although small fish is generally found also along the Brittany coast which was not the case in 2007.

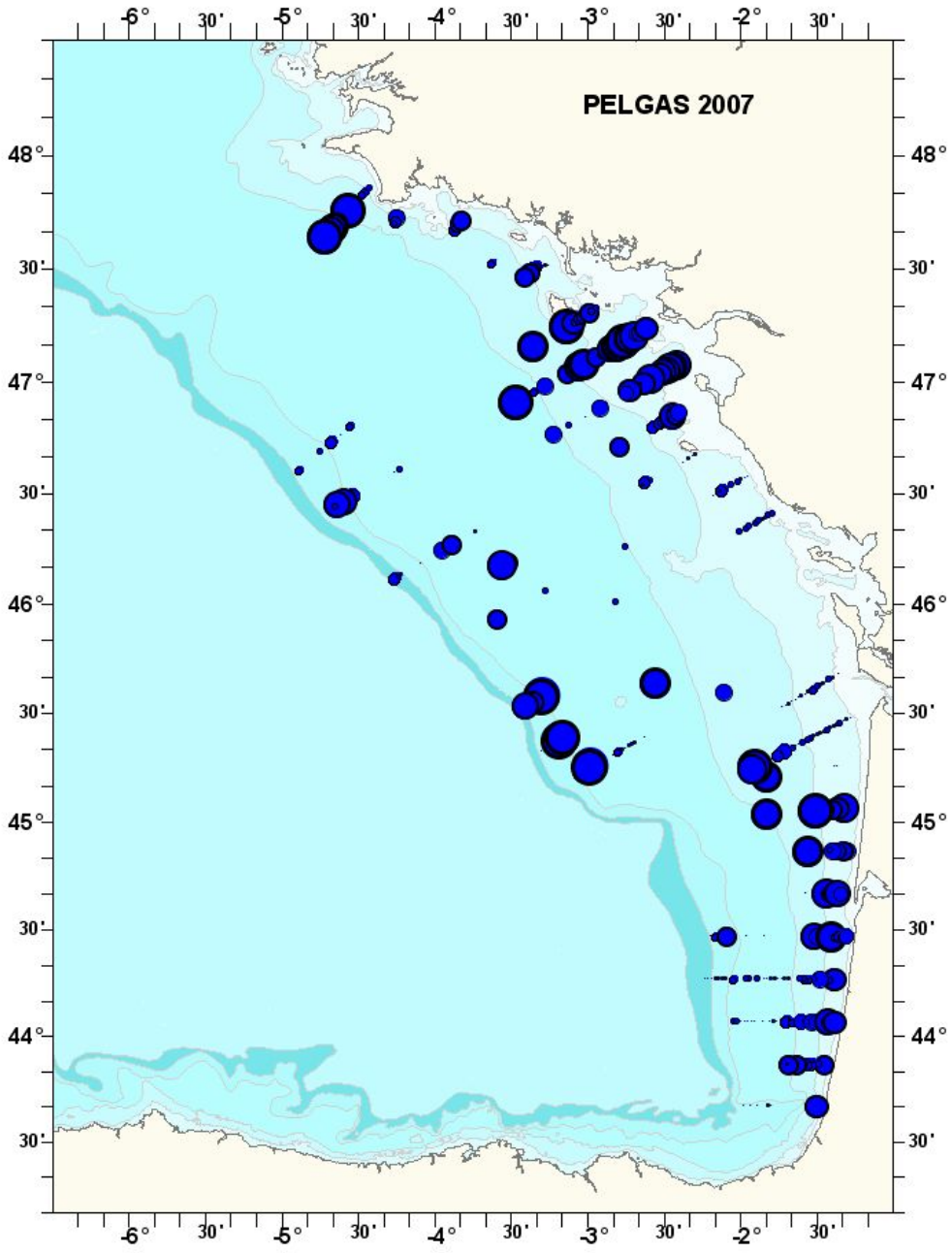


Figure 4.3.2.2.1.1. Sardine general: Distribution of sardine as observed during the French acoustic survey PELGAS07.

4.3.2.2.2 Species composition and length/age composition

Sardine ranged in length from 14.5 to 24.5 cm and showed a bimodal length distribution with a mode at 15.5. cm (juvenile fish) and another at 20.5 cm (adult fish) (Figure 4.3.2.2.2.1). Figure 4.3.2.2.2.2., shows sardine length distribution by subdivision and depth strata. Adult fish dominated the population in division VIIIa in offshore waters (depth > 60 m) while young fish dominated in division VIIIb in inshore waters. Both juvenile and adult fish were present in division VIIIa in waters less than 60 m depth but in waters deeper than 60 m in division VIIIb. Applying the Age/Length key obtained from the fish sampled during the survey, most fish in the entire surveyed area were assigned to age class 3 (2004 year class) (Figure 4.3.2.2.2.3.), although age 1 fish were also abundant.

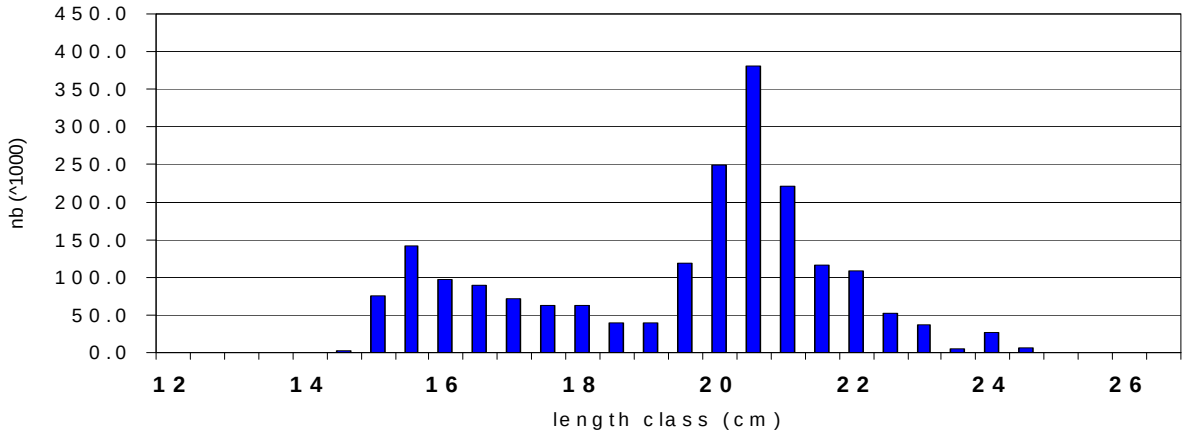


Figure 4.3.2.2.2.1. Sardine length distribution in numbers of fish as observed during the French acoustic survey PELGAS07 for divisions VIIIa and VIIIb.

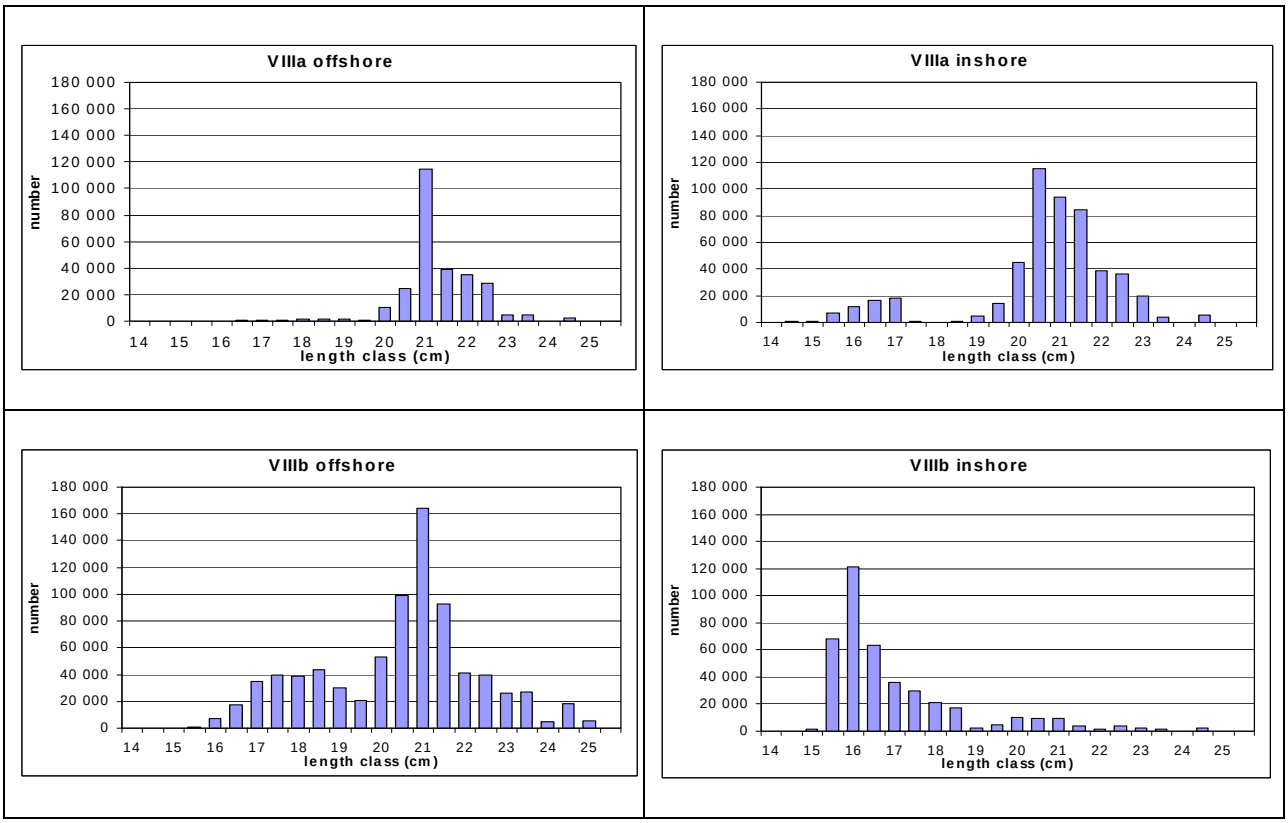


Figure 4.3.2.2.2.2. Sardine length distribution by division: VIIIa (North of 46° N) and VIIIb (South of 46° N) and depth strata: inshore (depth<60m) and offshore (depth>60m) as observed during the French PELGAS07 survey.

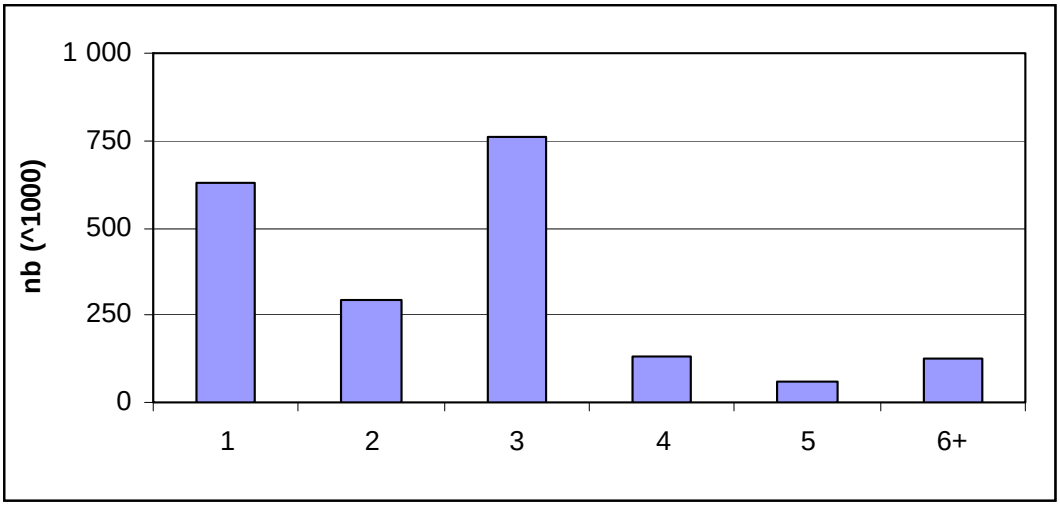


Figure 4.3.2.2.2.3. Sardine age distribution in numbers of fish for divisions VIIIa and VIIIb as observed during the French PELGAS07 survey.

4.3.2.2.3 Spatial distribution and biomass estimates of the target species

The time series of abundance and age distributions for sardine in VIIIa and VIIIb has been revised for the last 8 years and is reported in Section 5.2. With the exception of 2003 which was an atypical year, the abundance of sardine estimated during PELGAS07 was the lowest observed since 2000 (126 237 tonnes).

4.3.3 Sardine surveys in areas VIIIc and IXa north

4.3.3.1.1 Distribution and abundance of spawning population from egg production surveys

No DEPM surveys in 2007, next survey to be carried out in 2008 (see section on planning).

4.3.3.2 Distribution and abundance of spawning population from acoustic surveys

PELACUS spring acoustic surveys have been carried out since 1983 with the main aim of acoustically assessing the pelagic resources inhabiting shelf waters in ICES subdivisions IXa-N (south Galicia) and VIIIc (Cantabrian Sea). Since 1997, the survey has been carried out onboard the RV "Thalassa". The survey was originally mainly targeted at sardine (*Sardina pilchardus*), although other pelagic species of commercial interest such as anchovy (*Engraulis encrasicolus*), mackerel (*Scomber scombrus*), horse mackerel (*Trachurus trachurus*) and blue whiting (*Micromesistius poutassou*) were also evaluated. PELACUS0407, carried out from the 27 March to the 23 April 2007, obtained for the first time abundance and biomass estimates for all the main pelagic species found in the area not just those of economic value.

Survey design consisted of a systematic grid, normal to the coastline, with transects evenly distributed each 8 nm. The area of the continental shelf covered extended from 30 to 200 m depth, from northern Portuguese waters to southern French waters (Figure 4.3.3.2.1). During the survey, in addition to measuring the acoustic energy reflected by marine organisms, data are also routinely collected on the hydrography and hydrodynamics of the water masses (with rosettes and CTD), on the composition of the ichthyoplankton (using a Continuous Underwater Fish Egg Sampler, CUFES) and fish communities (from trawl stations). In 2007, data have been also collected on

the presence and behaviour of top predators (marine mammals and seabirds) for the first time in the historical series.

Acoustic methodology used in this survey was reported last year (ICES, 2007). The PESMA software (J. Miquel) was used to split total energy (NASC) by pelagic species and to estimate abundance and biomass by length according to the species frequency distribution at the hauls and to their target strength (TS).

Fishing trawls were conducted during daylight hours using a pelagic trawl, with the aim of identifying the fish responsible for echo traces detected during the track survey, and to provide information on the pelagic fish community at different depths and along the coast. Length frequency distributions (LFD) were obtained for all the fish species in the trawl (either from the total catch or from a representative random sample of 100–200 fish). Random samples of all the pelagic species consisting of up to 100 fish from each haul were weighed to obtain a length-weight relationship. Otoliths were also extracted from anchovy, sardine, horse mackerel, blue whiting and mackerel in order to estimate age and obtain the age-length key (ALK) for each species.

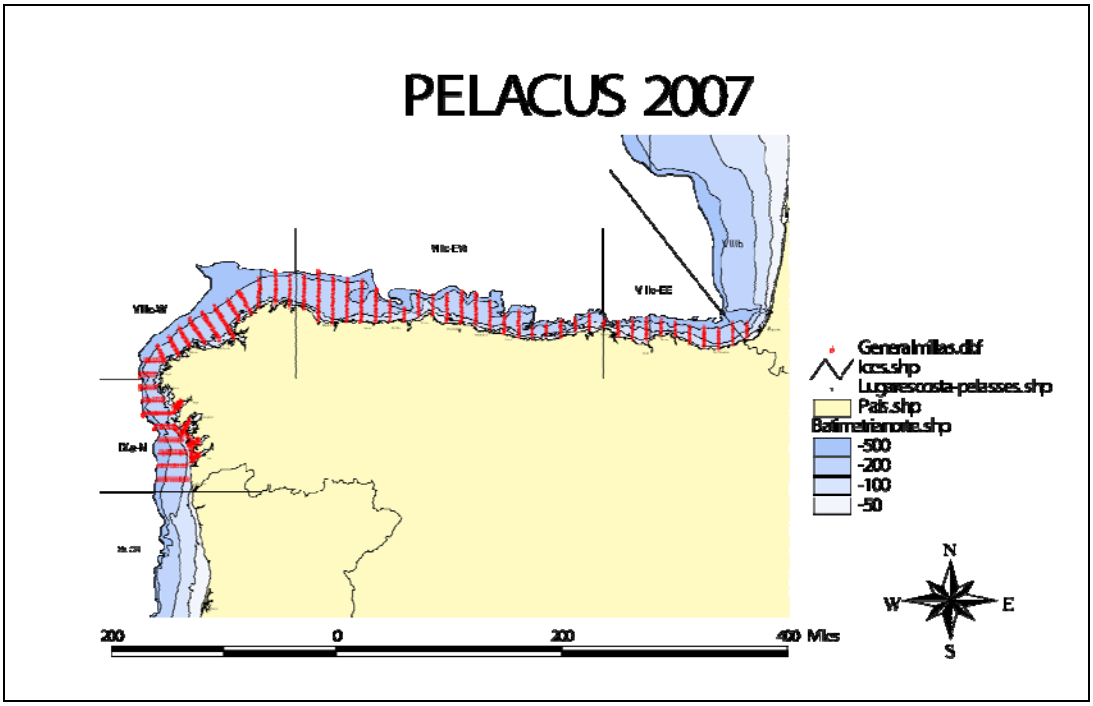


Figure 4.3.3.2.1. Survey tracks of Spanish spring acoustic survey PELACUS0407.

4.3.3.2.1 Distribution of acoustic energy allocated to sardine

Total sardine NASC (m^2/mn^2) detected during this survey has been of 75637, decreasing from last years. 86% of this NASC was detected in Galician waters (ICES Subareas IXa-N and VIIIc-W) near the coast and the rest of it from Cudillero to the French border. An empty area was detected between La Coruña and Cudillero (Figure 4.3.3.2.1.1).

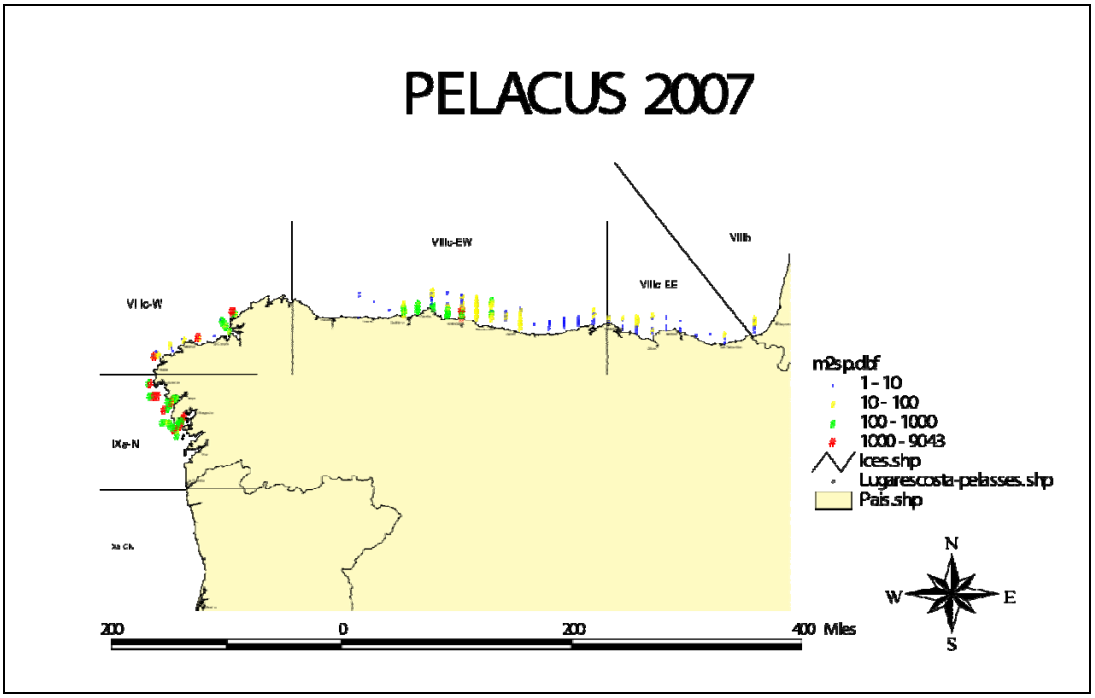


Figure 4.3.3.2.1.1. NASC (m^2/mn^2) allocated to sardine during PELACUS0407 Spanish acoustic survey.

4.3.3.2.2 Species composition and length/age composition

Up to ten pelagic species were detected in this area during the PELACUS0407 spring survey: *Sardina pilchardus, Engraulis encrasicolus, Scomber scombrus, Scomber colias, Trachurus trachurus, Trachurus picturatus, Trachurus mediterraneus, Boops boops, Micromesistius poutassou and Capros aper*. For all of them abundance and biomass were estimated (Table 4.3.3.2.2.1).

Sardines were present in 21 of the 53 trawl hauls completed during the survey (47 in Spanish waters) although only in 16 cases was the species caught in sufficient numbers to present a representative length distribution (Figure 4.3.3.2.2.1).

Sardine ranged in length from 14.5 to 25.5 cm without a clear mode (Figure 4.3.3.2.2.2). Applying the ALK obtained from the fish sampled during the survey, most fish (52% by number and 51% of the biomass) in the entire surveyed area were assigned to age class 3 (Figure 4.3.3.2.2.3). Considering the age distribution by subarea, the highest proportion of older fish (up to 10 years old although in very low numbers) was found in Basque Country waters (ICES Subarea VIIIc-Ee), the only subarea where age class 3 was not predominant. No fish older than 6 years were found in south Galician waters (ICES Subarea IXa-N). Age 3 fish predominated in Galician and Cantabrian waters but with a south-north gradient in importance (from almost 64% of both numbers and biomass in IXa-N, 38% of both estimates in VIIIc-W, to 33% of the biomass and 30% by number in VIIIcE-w).

Figure 4.3.3.2.2.3. Sardine relative abundance at age in each subarea (i.e. the proportions of all age classes within each subarea sum to 1) estimated in the PELACUS07 spring survey. The pie chart shows the contribution of each subarea to the total stock numbers.

4.3.3.2.3 Spatial distribution and biomass estimates of the target species

Sardine abundance was estimated as 1482*106 individuals (Table 4.3.3.2.3.1), while biomass was estimated to be 96,390 tons (Table 4.3.3.2.3.2). Sardine biomass was amongst the highest of all the pelagic species assessed in the survey (Table 4.3.3.2.2.1). Most fish (83% by number and 80% of the biomass) were found in Galician waters (ICES Subareas IXa-N, VIIIc-W) very close to the coast in high densities. Sardine was also found, although at lower densities, throughout the shelf in the Cantabrian and Basque Country areas (Figure 4.3.3.2.3.1).

Table 4.3.3.2.3.1. Estimated sardine abundance (nº fish) by length class and ICES subarea in PELACUS0407.

	ICES Subarea				
LENGTH CLASS	IXA-N	VIIIC-W	VIIIC-EW	VIIIC-EE	TOTAL
14.5	0	1321922	0	0	1321922
15	0	1195088	881095	0	2076183
15.5	2430811	3838932	3971492	0	10241235
16	4372084	6377380	15875301	0	26624765
16.5	2430811	2517011	24255550	0	29203372
17	11661705	3606703	14113111	0	29381519
17.5	13605791	4928625	6175870	0	24710286
18	41336982	14955581	1324104	0	57616667
18.5	160488408	22042155	443009	16523	182990095
19	138541641	30936546	1846690	0	171324877
19.5	134844729	17642299	1403681	0	153890709
20	124971547	34779052	2548597	66072	162365268
20.5	106471249	54300622	5802037	82595	166656503
21	67532905	47615985	22826447	303832	138279169
21.5	16932393	35114891	33818725	519227	86385236
22	40506247	39938120	42479375	678538	123602280
22.5	2430811	24855705	23865056	960642	52112214
23	0	6377380	28903222	1055212	36335814
23.5	0	2517011	10317538	907642	13742191
24	0	2411614	7956943	377096	10745653
24.5	0	0	1885725	176490	2062215
25	0	0	631698	54332	686030
25.5	0	0	0	27166	27166
Total	868558114	357272622	251325266	5225367	1482381369

Table 4.3.3.2.3.2. Estimated sardine biomass (tons) by length class and ICES subarea in PELACUS0407.

	ICES Subarea				
LENGTH CLASS	IXA-N	VIIIC-W	VIIIC-EW	VIIIC-EE	TOTAL
14.5	0.0	34.3	0.0	0.0	34
15	0.0	34.2	25.2	0.0	59
15.5	76.2	120.4	124.6	0.0	321
16	150.0	218.8	544.7	0.0	914
16.5	91.0	94.2	907.9	0.0	1093
17	475.0	146.9	574.8	0.0	1197
17.5	601.5	217.9	273.0	0.0	1092
18	1979.3	716.1	63.4	0.0	2759
18.5	8304.8	1140.6	22.9	0.9	9469
19	7731.9	1726.6	103.1	0.0	9562
19.5	8100.6	1059.8	84.3	0.0	9245
20	8066.3	2244.8	164.5	4.3	10480
20.5	7370.8	3759.1	401.7	5.7	11537
21	5006.0	3529.6	1692.1	22.5	10250
21.5	1341.8	2782.7	2680.0	41.1	6846
22	3426.5	3378.4	3593.4	57.4	10456
22.5	219.2	2241.1	2151.8	86.6	4699
23	0.0	612.1	2773.9	101.3	3487
23.5	0.0	256.8	1052.6	92.6	1402
24	0.0	261.2	861.8	40.8	1164
24.5	0.0	0.0	216.6	20.3	237
25	0.0	0.0	76.8	6.6	83
25.5	0.0	0.0	0.0	3.5	3
Total	52941	24576	18389	484	96390

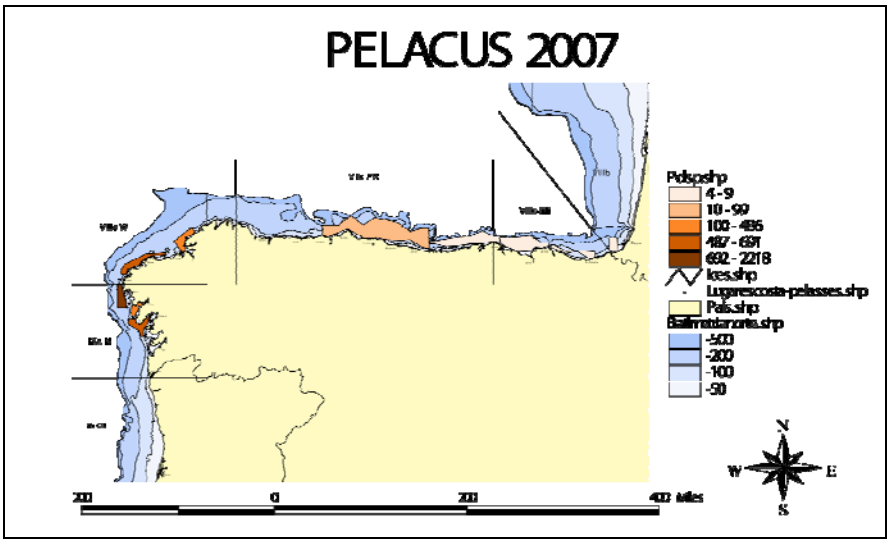


Figure 4.3.3.2.3.1. Spatial distribution of energy allocated to sardine during the PELACUS0407 cruise. Polygons are drawn to encompass the observed echoes, and polygon colour indicates integrated energy in m² within each polygon.

4.3.4 Sardine surveys in areas IXa south and IXb

4.3.4.1.1 Distribution and abundance of spawning population from egg production surveys

No DEPM surveys in 2007, next survey to be carried out in 2008 (see section on planning).

4.3.4.2 Distribution and abundance of spawning population from acoustic surveys

During 2007 two surveys were carried out in ICES area VIIIc and IXa: The Spring Portuguese survey PELAGO07 and the Summer Spanish ECOCÁDIZ0707.

PELAGO07

The Portuguese survey (PELAGO07) was carried out between 11 April and 8 May and covered the Atlantic-Iberian continental shelf waters and the Spanish Gulf of Cadiz.

The methodology used during the survey was the same as the previous years and is referred already in Section 4.2.3.2 (anchovy section). Although the survey was directed to sardine and anchovy, an effort was made to increase the sample trawls in the southern area in order to make a multispecific approach, following the WG 2006 recommendations. A total of 48 trawl hauls was performed.

The sardine population was clearly dominated by adults, although some young sardine (16 cm mode) was found near Lisbon.

As main conclusions we can point out that:

- Sardine abundance level was within the average of the historical series (452000 t in the total area, see Section 4.3.4.2.3).
- It was confirmed the low sardine recruitment in 2006 (some recruitment in the western central-south area - OCS)
- Sea Surface Temperature was lower than those observed in recent surveys, for the same season. It was observed a marked runoff of the Douro River. There was a possible upwelling event off the Algarve East part of the shelf.

ECOCÁDIZ0707

This survey was conducted by IEO between 3–12 July 2007 in the Portuguese and Spanish shelf waters (20–200 m isobaths) off the Gulf of Cadiz onboard the RV "*Cornide de Saavedra*". Although the survey season was coincident with the anchovy (*Engraulis encrasicolus*) peak spawning, aiming to achieve an acoustic estimate of its SSB in the study area, abundance and biomass estimates were estimated for all the mid-sized and small pelagic fish species susceptible of being acoustically assessed according to their occurrence and abundance levels in the study area (9 species). The distribution of these species was also inferred from the mapping of their back-scattering energies. Sardine (*Sardina pilchardus*) showed the highest densities in the Spanish waters, and the total biomass estimate for all the Gulf of Cádiz is 86.8 thousand tonnes (1699 million fish).

4.3.4.2.1 Distribution of acoustic energy allocated to sardine

PELAGO07

Sardine was distributed along the shelf, and was particularly abundant between Póvoa do Varzim and Lisboa being scarcely between Cape Espichel and Sines. Off the Algarve shelf the major sardine concentrations were found in the western part mainly

near Sagres. In the Spanish Gulf of Cadiz a large concentration of sardine was found near Cape Trafalgar (Figure 4.3.4.2.1.1).

ECOCÁDIZ0707

Sardine distributed in the sampled area in waters with depths between 20 and 220 m, showing the highest densities in the easternmost waters *(i.e.*, Spanish waters, overall bathymetric range: 20–160 m depth), between 31 and 86 m depth. In the Spanish waters the species also showed relatively very high densities in a shallow coastal area (23–48 m depth) between Rota and Matalascañas, but it was absent in front of the Bay of Cadiz. In the Portuguese waters (overall bathymetric range: 20–220 m), the species showed its higher densities in the westernmost area between 37 and 61 m depth (Figure 4.3.4.2.1.2).

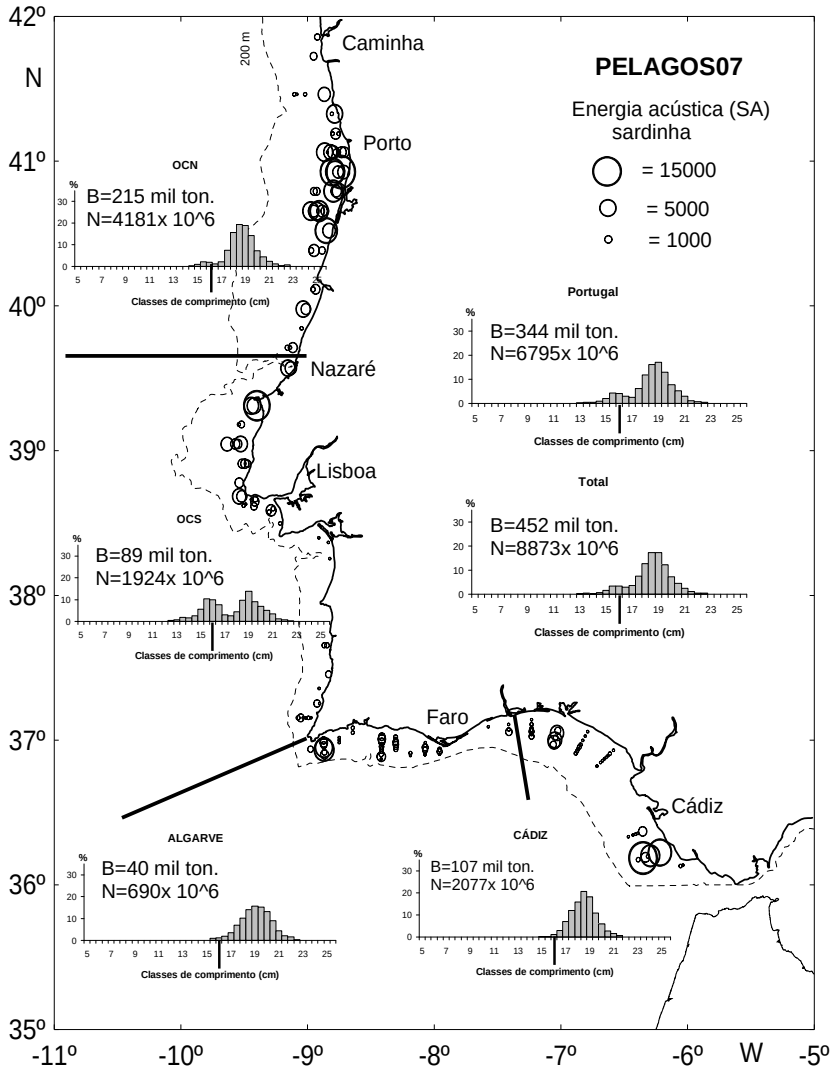


Figure 4.3.4.2.1.1. Distribution of the sardine acoustic energy per nautical mile (NASC) during the PELAGO 07 Portuguese survey. Circle diameter is propotional to the acoustic energy. Sardine length composition for each area.

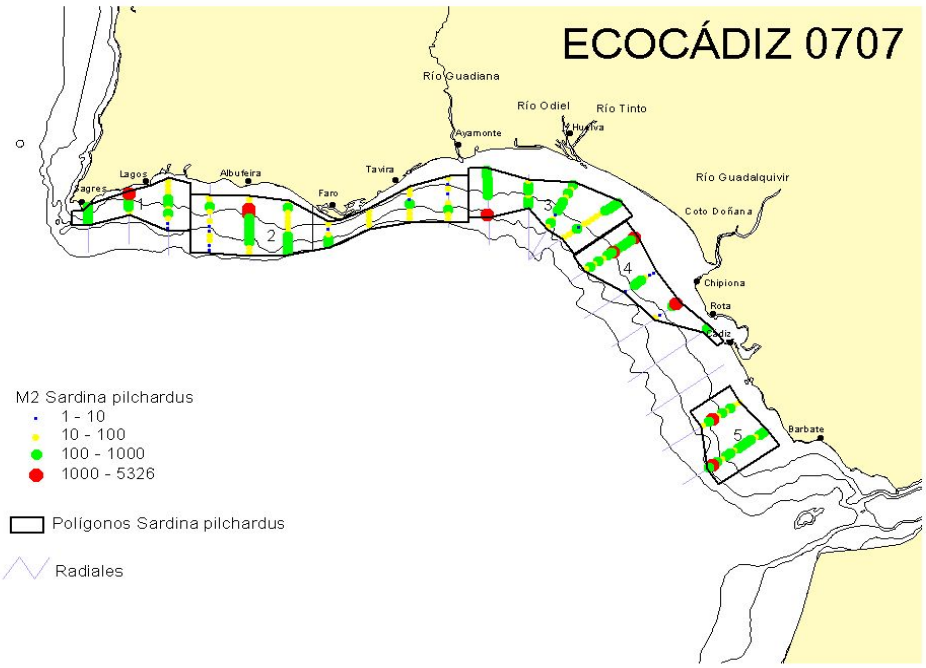


Figure 4.3.4.2.1.2. *ECOCÁDIZ 0707* survey: Sardine (*Sardina pilchardus*) NASC values distribution.

4.3.4.2.2 Species composition and length/age composition

PELAGO07

Forty eight fishing hauls (35 pelagic trawls, 13 bottom trawls) were performed during the April 2007 Portuguese survey (Figure 4.2.3.2.2.2 in anchovy section**)**. Sardine was the main species found in the Northern area inner shelf. In the Southern areas the haul catches were multispecific and sardine was usually found mixed mainly with horse mackerel, *Trachurus trachurus*, blue jack mackerel, *picturatus, T.*, chub mackerel, *Scombrus japonicus* and bogue, *Boops boops*. In the Gulf of Cadiz the multispecific nature of the hauls still maintains, although anchovy was the dominant species in the outer part of the shelf.

Sardine population was clearly dominated by adults in all the area (Figure 4.3.4.2.1.1) confirming the weak 2006 sardine recruitment. In the North-West (OCN) zone only 5% were considered as juveniles (length less or equal to 16 cm). The South-West (OCS) zone presented a bimodal length structure: the first mode (16 cm) corresponding to juveniles and the other mode (19 cm) to adult sardine. In this zone the proportion of juveniles was 33% which were mainly distributed between Ericeira and Cascais. In Algarve zone the sampled sardines were mainly adults and the juveniles represented only 2% of the total for this zone. The sardine population in the Gulf of Cadiz was also dominated by adults (only 2% of juveniles).

The sardine structure and abundance by age groups is presented in Figure 4.3.4.2.2.1 and reveals again the adults dominance.

ECOCÁDIZ0707

The size composition of the surveyed population evidences that the coastal area surrounding the Guadalquivir river estuary corresponds with a recruitment area for the species. Mean sizes per fishing station also seem to suggest a similar gradient to

the one described for anchovy, with larger sardines occurring in the westernmost waters (Figure 4.3.4.2.2.2).

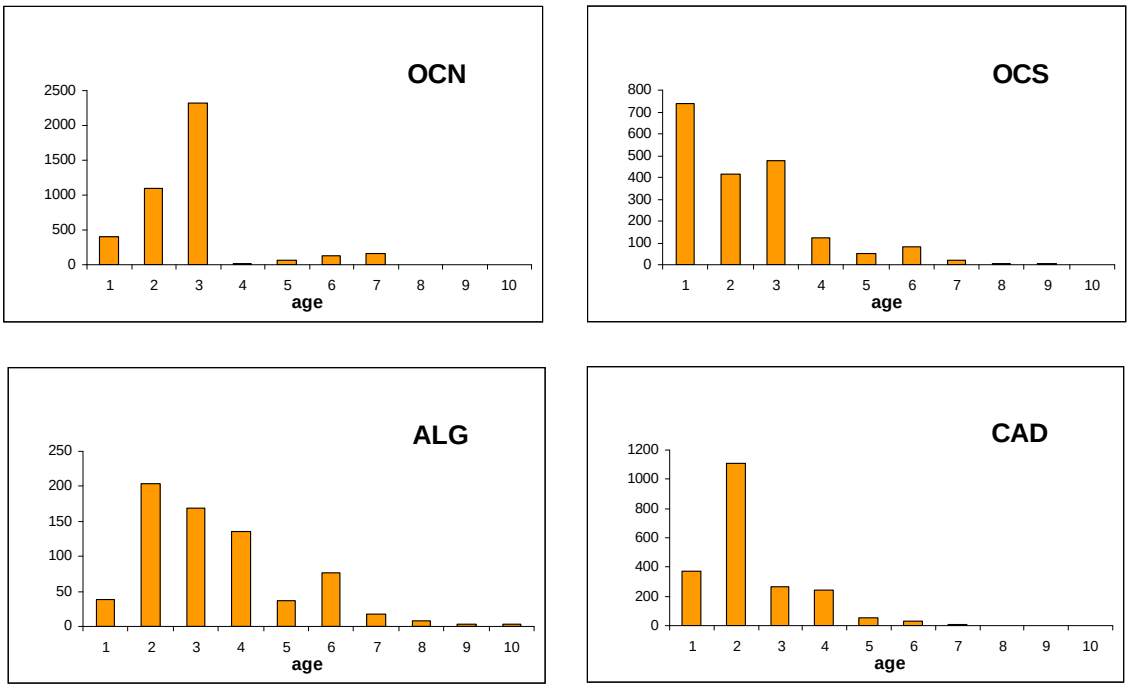


Figure 4.3.4.2.2.2. PELAGO 07 survey: sardine abundance by age groups in the four zones of the surveyed area.

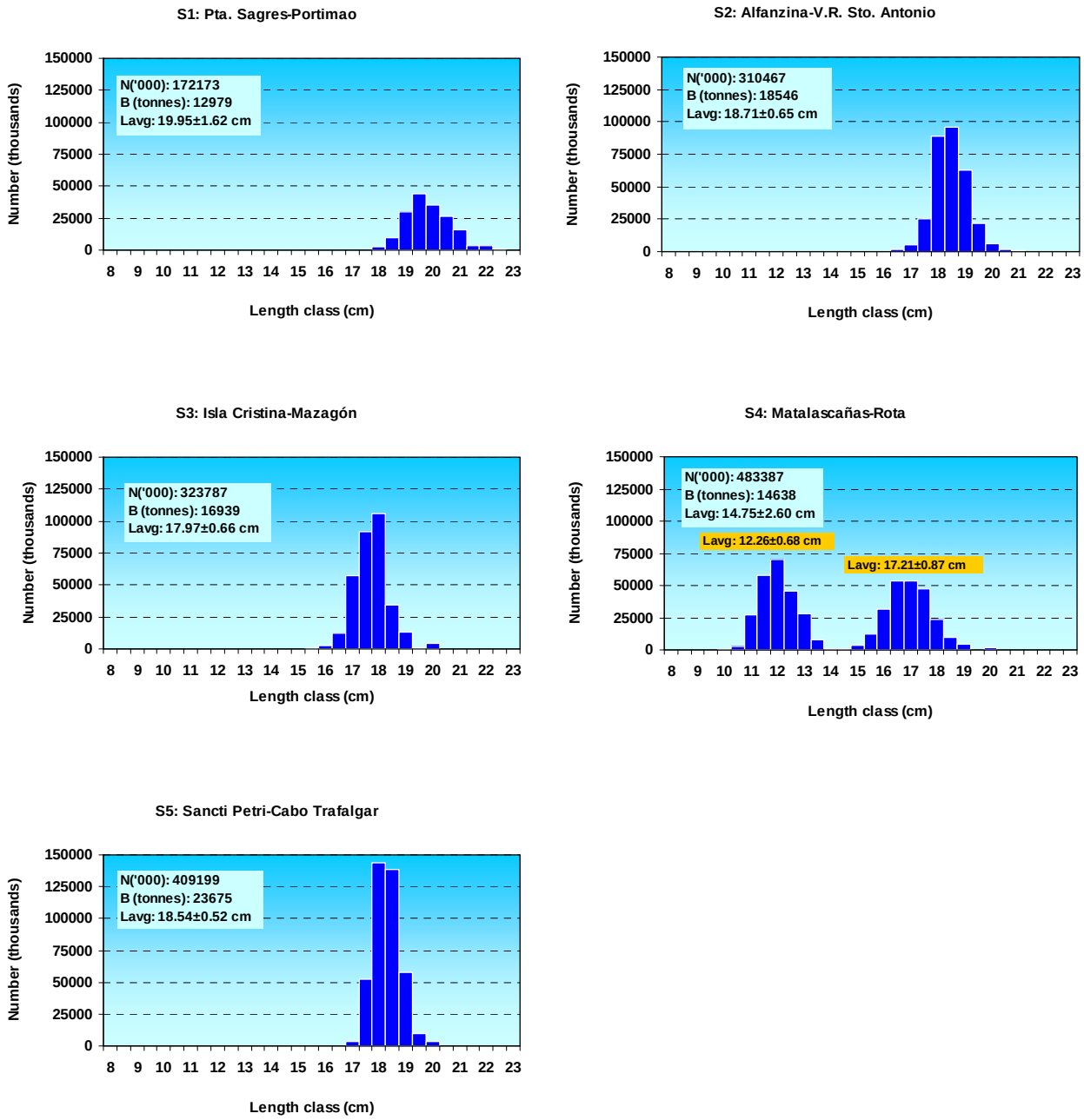


Figure 4.3.4.2.2.2. *ECOCÁDIZ 0707* survey: Sardine (*S. pilchardus*). Estimated abundance by length class by sector, region and total area.

4.3.4.2.3 Spatial distribution and biomass estimates of the target species

PELAGO07

The sardine biomass estimate for the total covered area was 452 thousand tonnes, corresponding to 8873 million individuals. Off the Portuguese shelf it was estimate a biomass of 344 thousand tonnes (6795 million individuals). These values are within the average of the historical series of the surveys abundance since 1995 (Figure 4.3.4.2.3.1).

In the OCN area (from Caminha to Nazaré) the biomass estimates for sardine was 215 thousand tonnes (4181 million individuals), within the average for this area.

In the OCS area (from Nazaré to Cape S. Vicente) the biomass estimated was a little higher than the biomass calculated for the last survey reaching 89 thousand tonnes (1924 million individuals).

In Algarve there was also a little increase in biomass, being estimated for this area 40 thousand tonnes, corresponding to 690 million sardines.

In the Spanish Gulf of Cadiz the sardine biomass estimated was in the average of the historical series of survey biomass, reaching 107 thousand tonnes (2077 million individuals).

Table 4.3.4.2.3.1. *ECOCÁDIZ 0707* survey. Sardine (*S. pilchardus*). Estimated abundance (N: thousands of individuals) and biomass (B: tonnes) by size class.

	ALGARVE		CÁDIZ		TOTAL	
L. CLASS (CM)	N	B	N	B	**N**	**B**
8						
8.5						
9						
9.5						
10			755	6	**755**	**6**
10.5			2266	22	**2266**	**22**
11			27181	301	**27181**	**301**
11.5			58101	742	**58101**	**742**
12			70013	1026	**70013**	**1026**
12.5			45843	767	**45843**	**767**
13			27777	528	**27777**	**528**
13.5			8256	177	**8256**	**177**
14	408	10	750	18	**1159**	**28**
14.5			750	20	**750**	**20**
15			3768	114	**3768**	**114**
15.5	408	14	12798	431	**13206**	**444**
16	306	11	34622	1292	**34928**	**1303**
16.5	2120	87	65889	2717	**68008**	**2804**
17	5076	231	114851	5220	**119927**	**5450**
17.5	24912	1244	191062	9544	**215973**	**10788**
18	90829	4973	273173	14957	**364001**	**19931**
18.5	106109	6353	182627	10934	**288736**	**17287**
19	92455	6039	76048	4967	**168503**	**11006**
19.5	65880	4683	10247	728	**76127**	**5412**
20	40887	3157	9596	741	**50483**	**3898**
20.5	28450	2381			**28450**	**2381**
21	16866	1527			**16866**	**1527**
21.5	3866	378			**3866**	**378**
22	3252	343			**3252**	**343**
22.5	816	93			**816**	**93**
23						
TOTAL	**482640**	**31525**	**1216373**	**55252**	**1699013**	**86777**

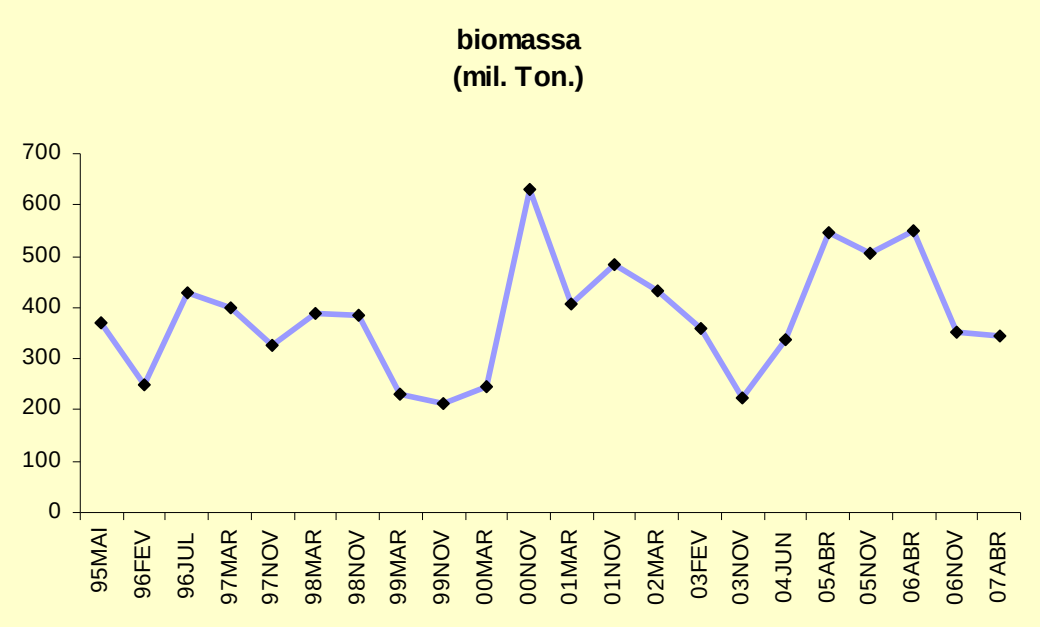


Figure 4.3.4.2.3.1. Sardine biomass evolution along the Portuguese survey series, from 1995 to 2007.

ECOCÁDIZ0707

The sardine acoustic estimates by region and total area for this survey were as follows (see also Table 4.3.4.2.3.1 and Figure 4.3.4.2.2.2):

Region	Abundance (millions)	Biomass (tonnes)	Mean Size (cm)
Portugal	483	31525	19,15±1,25
Spain	1216	55252	16,88±2,44
Gulf of Cadiz	1699	86777	17,53±2,40

5 Revision of time series estimates

5.1 Anchovy DEPM-based SSB estimates

A revision of the series of Spawning Biomass estimates of anchovy in the Bay of Biscay based on the Daily Egg Production method (DEPM) was presented to the WG (Uriarte *et al.*, WD) based on a revision of two key parameters: The spawning fraction (S) and the Total Daily Egg production. The revision of the estimation procedures of the spawning fraction (as described in Section 7.1.3) is based on a new improved approach for staging and ageing of POFs in the ovaries of post spawning females developed for the Bay of Biscay anchovy (Alday *et al.*, submitted). The new S estimates are based on the incidence of spawners day 1+0 in the population. The new estimates of S are quite high, around 0.41 and quite invariant throughout the study period (1990–2005). This supposes an increment of about 63% over the past spawning fraction estimates, leading to a subsequent reduction of former DEPM SSB estimates by about 39%. In this section we present the review made of the past series of Egg Production estimates which, combined with the review of Spawning frequency of Section 7.1.3), allows for a preliminary revision of the series of DEPM SSB estimates.

Total Egg Production Review

For the Bay of Biscay anchovy Daily Egg Production per surface unit (P0) have been based until 2006 on non least squares (NLS). Total Egg Production is afterwards produced by multiplication with the positive spawning area. In this section we present a revision of the P0 estimates with the three estimation methods NLS, GLM and GAM, the latter based on the assumption of a constant egg mortality Z in space (Uriarte *et al.*, WD2008). In all cases Staged eggs by station are transformed into daily cohort densities using a Bayesian method (Ibaibarriaga *et al.*, 2007). The negative binomial error distribution was used in the GLM and an over dispersed Poisson for the GAM. GAMs were fitted as a bivariate surface of Lat and Long. Confidence limits in are based on 2 standard errors of the Po and Z estimates (not available for GAM Po because bootstrapping was not performed).

The results for the period 1995–2007 show the highest variation of Ptot estimates among years (Table 5.1.1).

Usually GLM or GAM estimates are quite similar to the Non least squares estimates previously reported to ICES (Figure 5.1.1, with NLS estimates taken from Santos *et al.*, WD2007 to ICES WGMHSA). For some years in the period 1995–2000 the GLM and GAM estimates of Ptot are higher than the official reported NLS estimates (particularly in 1998 and 1999). Part of those differences may come from the application of different stratification procedures between original estimates and the current revision. So those differences deserve some further study, and by the moment they were presented for comparison purposes.

So far no major differences in Ptot arise by the application of GLMs or GAM methods to the estimation Ptot (with the exception of 1998 and 1999 which deserve further analysis.). The general trends and recent series of Ptot are not affected therefore by the statistically different estimation procedure of the Total Egg Production (Ptot).

Review of past series of Anchovy DEPM Spawning Biomass estimates

For a set of selected years for which both spawning fraction and Total Egg Production revisions are available a revision of the Spawning biomass can be delivered (Figure 5.1.2). When both the DEP and the S corrections are included the final effect is a remarkable decay of the SSB by about 35% regarding the original estimates reported previously to ICES assessment EGs. Certainly this drop is directly caused by the increase in the spawning fraction estimates (Section 7.1.3), being slightly mitigated by some increases in the Total Egg Production estimates.

The Working Group considered that the current revision of the DEPM anchovy Spawning Biomass is well supported on the review procedures for the estimation of spawning frequency (Alday *et al.*, submitted) and on the application of GLM procedures (as recommended by the study group on the spawning biomass of sardine and anchovy – SGSBSA – ICES 2005). Therefore the WG endorses the current revision and demands for it to be completed before June 2008, so that the new estimates could be available for the new ICES working group for the assessment of anchovy (WGANC).

Table 5.1.1. Different Total Egg Production Estimates for anchovy according to the different estimation procedures (Non least squares –ad hoc Reported estimates-, Generalized lineal model and General Additive Models (GAM)) (GLM and GAM estimates are based on a single strata, while NLS reported estimates may in some years be based on regionalized stratified estimations). NLS estimates taken from Santos *et al.* WD2007 to ICES WGMHSA).

	NON LEAST SQUARE				GENERAL LINEAL MODEL				GAM z=cte	
Year	Ptot	ptot.cv	z	z.cv	ptot	ptot.cv	z	z.cv	Ptot	z
1995	3,09E+12	0,0700	0,19	0,34	4,12E+12	0,0776	0,35	0,0895	3,52E+12	0,26
1996	2,77E+12	0,1600	0,31	0,41	2,61E+12	0,0857	0,30	0,1386	2,97E+12	0,34
1997	2,70E+12	0,0700	0,19	0,47	2,7E+12	0,0690	0,20	0,1632	2,75E+12	0,19
1998	5,59E+12	0,0500	0,28	0,25	8,36E+12	0,0599	0,40	0,0870	6,49E+12	0,21
1999	3,59E+12	0,0900	0,12	0,40	4,59E+12	0,0843	0,16	0,3450	4,58E+12	0,14
2000	2,61E+12	0,1900	0,18	1,02	2,91E+12	0,0864	0,08	0,6000	3,70E+12	0,24
2001	8,48E+12	0,0870	0,45	0,20	8,04E+12	0,0654	0,39	0,1033	7,63E+12	0,35
2002	2,34E+12	0,1270	0,13	0,51	2,24E+12	0,0762	0,16	0,2155	2,32E+12	0,18
2003	2,15E+12	0,2800	0,33	0,66	2,19E+12	0,0866	0,34	0,1674	2,15E+12	0,29
2004	8,42E+11	0,1100	0,10	-	7,94E+11	0,0506	0,22	0,0855	1,11E+12	0,39
2005	4,41E+11	0,1569	0,20	0,45	4,37E+11	0,0940	0,16	0,2722	4,37E+11	0,15
2006	1,07E+12	0,1674	0,27	0,40	1,21E+12	0,1016	0,27	0,1909	1,15E+12	0,25
2007	1,55E+12	0,0400	0,20	NA	1,45E+12	0,0400	0,20	NA	1,56E+12	0,20

For 2007 the Z is inferred from a lineal temperature dependent model of Z.

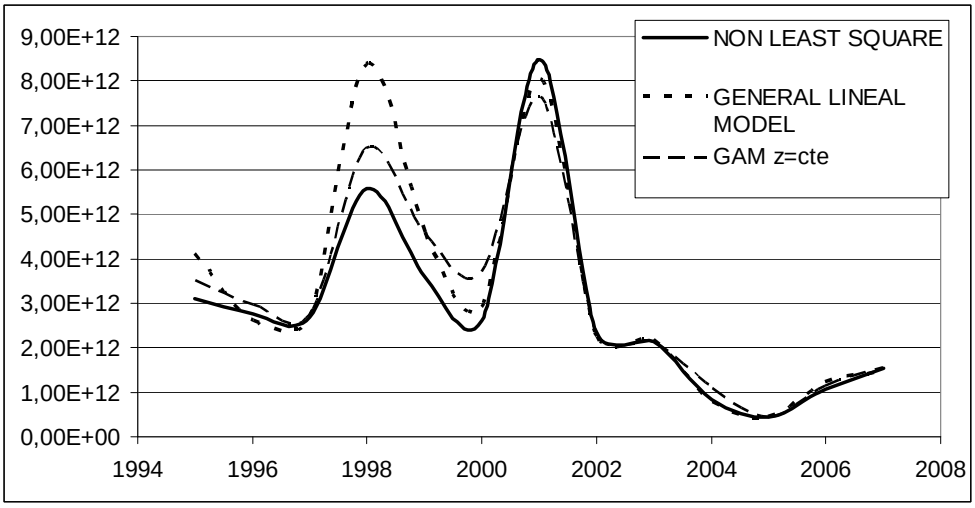


Figure 5.1.1. Past (Non least Squares) and New (GLM and GAM) estimates of total Egg Production of anchovy in the DEPM May cruises in the Bay of Biscay

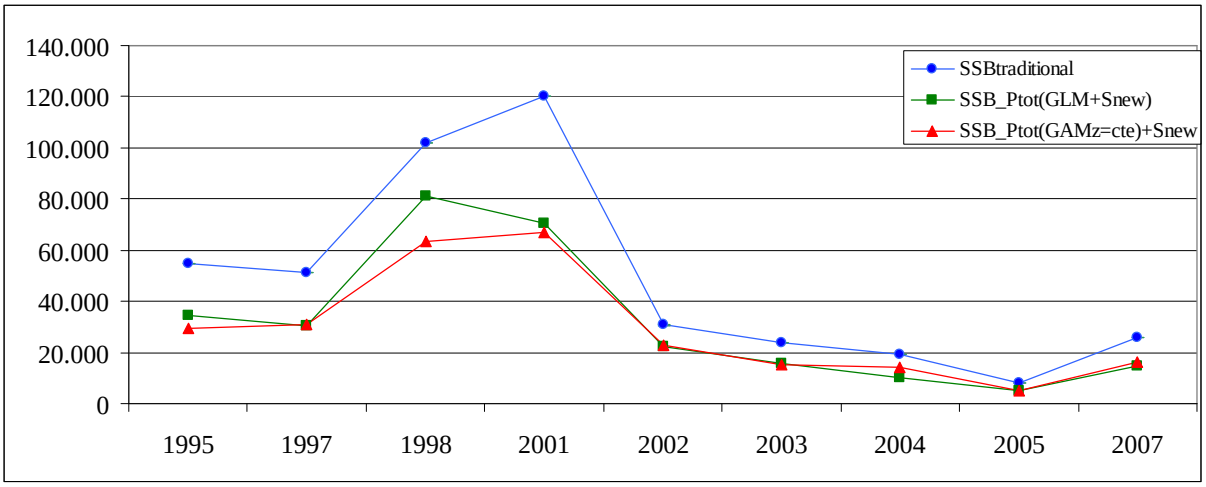


Figure 5.1.2. Spawning Biomass estimates based on Past (Non least Squares) and New (GLM and GAM) estimates of total Egg Production of anchovy for selected years after application of new spawning fraction estimates based on day 0+1 in the May DEPM cruises in the Bay of Biscay.

5.2 Revision of the PELGAS acoustic estimates of sardine and anchovy biomass

In order to store all the data collected along acoustic surveys and to give the possibility to recalculate specific biomass according to more accurate stratifications or improvements in scrutinizing echoes, Ifremer conceived a data base named BARACOUDA (see WD Petitgas *et al.* 2007 and Section 7.2.1.). All the acoustic and biological data collected by Ifremer during acoustic surveys since 1983 are now gathered in this database.

In the frame of this new tool, and to profit of gradual improvements in knowledge, estimates have been revised progressively from 2007 to the oldest one. Up to now, surveys since 2000 to 2007 have been revised and are considered now as the best estimates that can be calculated for these years.

The results for sardine and anchovy biomass are gathered in Table 5.2.1. For these new estimates, a coefficient of variation is also calculated taking into account the spatial distribution variance (Petitgas 2003) and the species composition of identification hauls variance (Massé and Retiere, 1995).

A comparison with previous Anchovy biomass estimates (produced in WGHMSA reports each year) is shown in Figure 5.2.1. Differences can be seen for the first three years but results are very similar for the last 5 years. In 2000 and 2002, the differences are mainly due to a better stratification and some minor detailed corrections. In 2001, a difference of about 30 000 t can be explained by a change in scrutiny criteria according to a particular type of echoes. It was already noticed at the 2001 WG (Copenhagen September 2001) that a part of the acoustic energy observed in anchovy areas was produced by very big, non identified schools corresponding to a doubtful amount of 35 000 t. These types of schools began to appear in 2001 and are still visible nowadays. Some hauls showed later that they were corresponding to small horse mackerel and this information was confirmed by commercial vessels. They were therefore deleted from anchovy biomass and attributed to horse mackerel.

A comparison with previous Sardine biomass estimates is shown in Figure 5.2.2. Differences are more significant. This can be explained by the fact that sardine biomass estimates were generally not provided to the WGHMSA but only biological data. The previous levels of biomass were at that time (until 2005) only calculated in

the anchovy positive areas and so did not take into account the Northern areas where sardine is often present.

Table 5.2.1. Revised biomass estimates from acoustic surveys PELGAS since 2000 to 2007 using Baracouda data base.

	ANCHOVY			SARDINE		
	PREVIOUS BIOMASS ESTIMATE (T)	NEW BIOMASS ESTIMATE (T)	CV	PREVIOUS BIOMASS ESTIMATE (T)	NEW BIOMASS ESTIMATE (T)	CV
2000	*98 484*	**113 120**	*0.06*	*286 391*	**376 442**	*0.09*
2001	*137 200*	**105 799**	*0.12*	*214 200*	**383 515**	*0.11*
2002	*97 051*	**110 566**	*0.11*	*301 023*	**563 880**	*0.09*
2003	*29 428*	**30 632**	*0.15*	*110 000*	**111 234**	*0.26*
2004	*46 018*	**45 965**	*0.17*	*323 021*	**496 371**	*0.13*
2005	*16 446*	**14 643**	*0.17*	*429 521*	**435 287**	*0.14*
2006	*30 649*	**30 877**	*0.14*	*229 071*	**234 128**	*0.12*
2007	*40 876*	**40 876**	*0.10*	*126 237*	**126 237**	*0.17*

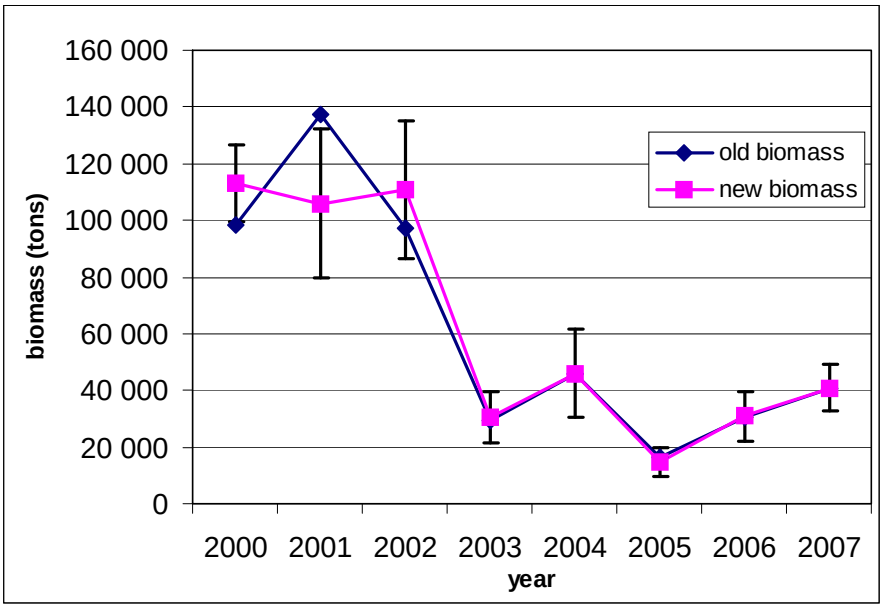


Figure 5.2.1. Comparison between previous biomass estimates of anchovy and new estimates using Baracouda and more accurate knowledge.

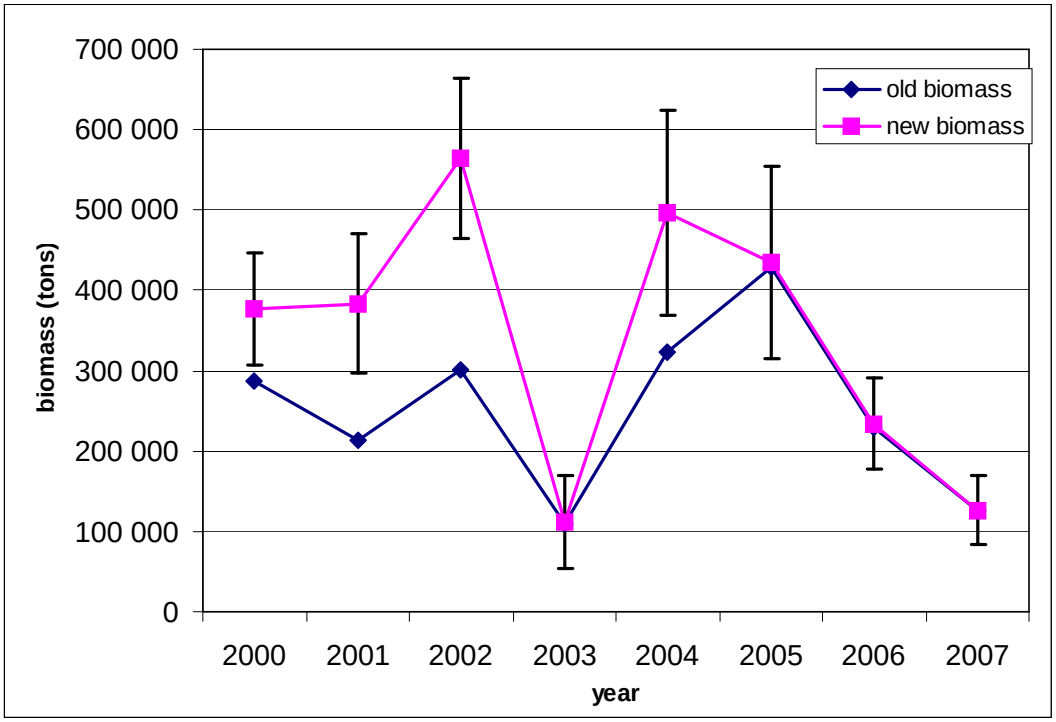


Figure 5.2.2. Comparison between previous biomass estimates of Sardine and new estimates using Baracouda and more accurate knowledge.

5.3 Revision of the JUVENA acoustic estimates of anchovy juveniles

Revision of biomass estimates for years 2003–2005

Along the first years of the temporal series of JUVENA, several changes in the methodology have been adopted, mostly with the aim to standardize the methods according to the criteria agreed in WGACEGG. These revisions have produced changes in the anchovy abundance estimations provided by JUVENA and may result confusing for the colleagues interested in the results of the temporal series. For this reason we present this summary of revisions that tries to provide a catalogue of the adopted changes with a brief explanation of each change.

Below is a brief summary of the changes in the estimations:

- The first JUVENA survey was conducted in year 2003. This year no abundance estimation was provided, as the method was still under development.
- In November 2004, after the second survey, the first preliminary results were presented in relative terms. Nevertheless at that time the estimations were under a strong process of revision that made the estimations highly uncertain.
- In November 2005, it was presented the first attempt for absolute biomass estimations of the years 2003 to 2005 (Table 5.3.1).
- In June 2006 the results are slightly modified due to a change in the resolution of the size-age key in the working sheets (Table 5.3.2).
- In November 2006, the results of the 2006 survey were presented incorporating a retrospective revision of the processing methodology of the

series following the recommendations of WGACEGG (Table 5.3.3). The changes were:

- change of TS values of species (notably for anchovy from -71.2 dB to -72.6 dB);
- change of the echo integration threshold from -70 dB to -60 dB;
- exhaustive subtraction of the plankton echoes.

Revision of the biomass estimates for year 2006

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 RV "Emma Bardan" (EB) was systematically collecting less energy than the RV "Iksas Laguna" (IL).

The results of the intercalibration analysis were discussed between colleagues from AZTI, Ifremer, Genavir and IEO during the WGACEGG-promoted Acoustic Workshop held in Nantes, France, in April 2007. It was agreed that the 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 according to the intercalibration results (Table 5.3.4) and it was presented to the STECF in June 2007.

Nevertheless, several irregularities appeared in the revision of the year 2006 biomass estimation process due to the hurry to have the revision ready before the results of the spring surveys. The irregularities were:

1) A dubious but huge aggregation that was assigned to anchovy in the first term was not subtracted from the revised estimation. It was agreed in the Nantes WK that it had to be subtracted.

2) An error in the calculations that was producing an overestimation of the revision of the 50% upwards.

In November 2007, along with the results of the 2007 survey, was presented the revision of the 2006 year estimate (Table 5.3.5), including (1) the correction of the 2006 estimates based on 120 kHz data, (2) a revised scrutiny of the echograms according to the Nantes acoustic workshop recommendations and (3) the application of an echointegration threshold of 1 m above the bottom.

However, these results are still inconclusive due to the uncertainty about the appropriate TS value at 120 kHz. Thus, the results for this year 2006 are still pending of further revision and are to be discussed inside the WGACEGG 2007. See the WD of JUVENA 2007 (Boyra, *et al.*, 2007) in the Annex of this report for the details of these analyses.

Table 4.3.3.2.3.1. Estimated sardine abundance (nº fish) by length class and ICES subarea in PELACUS0407.

Region	Dens (Sa/mn2)	Area (mn2)	E (Sa)	Peso Juv (g)	Peso Adul (g)	Talla Juv (cm)	Talla Adul (cm)	Biom Juv (índice)	Biom Adul (índice)
					2003				
Oceanica	40.51	2,910.40	139,716.37	3.31	7.09	8.20	8.73	100,707.04	1,494.58
Garona	44.40	737.80	32,758.32	7.73	17.51	10.78	13.98	4,368.75	8,124.06
Total	42.45	3,648.20	172,474.69	5.52	12.30	9.49	11.36	105,075.79	9,618.64
					2004				
Oceanica	0.85	499.80	426.02	1.15	0.00	5.99	0.00	209.69	0.00
Garona	30.44	2,026.40	69,931.49	7.61	15.62	10.66	13.28	1,956.19	3,910.98
Total	15.64	2,526.20	70,357.51	4.38	7.81	8.32	6.64	2,165.88	3,910.98
					2005				
Oceanico	72.11	5,394.77	260,732.42	1.51	0.00	6.36		138,997.98	0.00
Garona	32.59	1,927.50	56,647.16	6.08	10.48	9.56	11.84	6,359.28	12,007.11
Total	52.35	7,322.27	317,379.58	3.79	5.24	7.96	11.84	145,357.26	12,007.11

Table 5.3.2. Results presented to the STECF held in June 2006 at Ispra, Italy. Change of the resolution of the size-age key.

Region	Density (Sa/mn2)	Area (mn2)	E (Sa)	Size juve (mm)	Size adult (mm)	Weight juve (g)	Weight adult (g)	Abund juve (index)	Abund adult (index)
						2003			
Oceanic	40,5	2.910,4	139.716,4	79,7		3,0		96.476,8	0,0
Garonne	44,4	737,8	32.758,3	109,5	14,0	7,8	16,6	6.238,5	14.944,3
Total		3.648,2						102.715,3	14.944,3
						2004			
Oceanic	0,9	499,8	426,0	59,9		1,2		213,7	0,0
Garonne	30,4	2.026,4	69.931,5	106,6	13,3	7,5	15,5	1.929,1	3.881,5
Total		2.526,2						2.142,9	3.881,5
						2005			
Oceanic	72,1	5.394,8	260.732,4	65,7		1,7	0,0	140.754,9	0,0
Garonne	32,6	1.927,5	56.647,2	102,9	12,0	7,5	11,1	6.450,0	13.630,8
Total		7.322,3						147.204,9	13.630,8

Table 5.3.3. First revision of the estimations according to the WGACEGG recommendations. Results presented in November 2006.

AÑO	REGION	SA	AREA	<TALLA>_JUV	<TALLA>_ADUL	BIOM_JUV	BIOM_ADUL	BIOM_TOTAL
2003	Sur	368.60	3,302.80	8.20		97,498.50	0.00	97,498.50
	Norte	444.40	172.50	11.10	14.10	1,103.00	1,383.50	2,486.50
	TOTAL		3,475.30			98,601.50	1,383.50	99,985.00
2004	Sur	0.90	47.00	6.00		1.90	0.00	1.90
	Norte	562.20	1,859.90	11.00	13.80	2,404.10	3,451.00	5,855.10
	TOTAL		1,906.90			2,406.00	3,451.00	5,857.00
2005	Sur	721.67	5,390.05	6.64		125,922.30	0.00	125,922.30
	Norte	326.00	2,399.93	9.83	11.91	8,208.80	20,369.80	28,578.60
	TOTAL		7,789.98			134,131.10	20,369.80	154,500.90
2006	Sur	366.05	1,200.49	7.21	11.46	19,893.33	175.73	20,069.06
	Norte	390.65	5,862.65	11.25	12.41	52,265.24	56,903.64	109,168.88
	TOTAL		7,063.14			72,158.57	57,079.38	129,237.95

Table 5.3.4. Revision of the 2006 estimation according to the reprocessing of the "Emma Bardan" data at 120 kHz. Presented in STECF in June 2007 at Ispra, Italy. This revision contains a calculation error.

YEAR	REGION		<SA>	AREA	<LENGTH>_JUV	<LENGHT>_ADUL	BIOM_JUV	BIOM_ADUL	BIOM_TOTAL
2003	South		369	3303	8.2		97,498.50	0	97,498.50
2003	North		444	173	11.1	14.1	1,103.00	1,383.50	2,486.50
2003	**TOTAL**						**98,601.50**	**1,383.50**	**99,985.00**
2004	South		1	47	6		1.9	0	1.9
2004	North		562	1860	11	13.8	2,404.10	3,451.00	5,855.10
2004	**TOTAL**						**2,406.00**	**3,451.00**	**5,857.00**
2005	South		722	5390	6.64		125,922.30	0	125,922.30
2005	North		326	2400	9.83	11.91	8,208.80	20,369.80	28,578.60
2005	**TOTAL**						**134,131.10**	**20,369.80**	**154,500.90**
2006	South	WRONG	322	1200	7.2	11.5	19,829.53	171.2203408	20,000.75
2006	North	WRONG	402	5691	11.2	12.4	110,535.85	80,733.85	191,269.70
2006	**TOTAL**	WRONG					**130,365.38**	**80,905.07**	**211,270.45**

Table 5.3.5. Results presented in November 2007 after the 2007 survey. This includes a partial revision of the 2006 estimates 120 kHz data, but as the results were inconclusive due to uncertainty about the appropriate TS value at this frequency is still provisional for 2006 year estimation. For that reason, the estimation for this year 2006 is presented within a range of uncertainty.

YEAR	BIOM_JUV	BIOM_ADUL
2003	98,601	1,383
2004	2,406	3,451
2005	134,131	20,370
2006	44,121 (32,243–55,595)	23,961 (15,625–32,233)
2007	13,121	35,109

6 Planning and coordination of next acoustic and egg production surveys

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

6.1.1 Juvenile surveys

6.1.1.1 Anchovy juvenile 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, 2007). Some of the recommendations have been implemented in the survey planning of both JUVENA and PELACUS-10 during 2007, thus improving the common coverage and efficiency. The successfully adopted coordination activities in 2007 were:

- Common sampling design. Both surveys agreed a common sampling scheme of alternate transects, with an inter-transect distance of 15 nmi., for each survey that leads to a common inter-transect distance of 7.5 nmi., when the data for both surveys are pooled together.
- A common protocol of data acquisition and processing was adopted by both surveys.
- A workshop was conducted before the surveys to try to explain the divergent results obtained in the previous year. See WD for the Nantes workshop in the Annex for details.
- A full day devoted to inter-calibration exercises was carried out during the surveys to assure correct and consistent equipment performance and processing methodology.
- A cross validation workshop was conducted after the surveys to deal to possible divergences in this year 2007 results (Section 4.2.2.3.3).

Unfortunately, due to differences in survey scheduled calendar, it was not possible to fully adopt the common survey strategy as recommended in WGACEGG 2006.

List of benefits obtained by the coordination activities carried out in 2007 surveys:

- Increased robustness of both estimates. The comparison of the survey results at the end of the survey helps the teams involved to understand the weaknesses and strengths of both surveys, helping to point out possible uncertainties and to overcome these uncertainties by the integration of information of both surveys.
- Complementary surveys. The different point of view makes both survey objectives complementary, being the information collected for each survey useful for the other one:
    - PELACUS benefits of the higher coverage of JUVENA, obtaining information of the abundance of anchovy in the northern area and also in shallow and close to the surface waters that they have difficulties to sample.
    - JUVENA benefits of the ecosystem approach adopted in PELACUS-10 (i.e. oceanography and plankton is considered, all the community

of small pelagic fish is sampled, cartography and abundance of top predators is also acquired), obtaining very important information that is difficult to collect due to logistic constraints of the JUVENA cruise.

- Possibility of integration of results with a denser common sampling design and thus an increase of the estimate precision.
- Possibility of sharing the haul information.
- Potentially wider coverage. This is an important issue as it would assure the complete coverage of the potential area of distribution of anchovy.

WGACEGG considers that the existence of these juvenile surveys is very positive for the increase in the general understanding of the dynamics of the resource. There is general agreement that it has been a big effort by both parts to coordinate both surveys, but it is also accepted that there is still further scope for coordination. 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 solve them.

According to all these considerations, the WGACEGG recommends:

1) To continue carrying out prospecting surveys of juvenile anchovy in the Bay of Biscay.
2) To continue carrying out processes studies to improve the understanding of juvenile ecology.
3) To complete the cross validation of JUVENA and PELACUS-10 in order to solve the biomass estimation discrepancies.
4) To try to go further in the coordination of the surveys to be able to achieve wider spatial coverage, in order to assure the complete coverage of the potential area of occupation of juvenile anchovy.

Concerning the coordination for next year, as at the moment of the meeting there is no confirmation of the participation of the IEO in the 2008 juvenile survey, the planning and coordination is postponed to the WK to be held in Lisbon in March 2008. In any case, several issues that will have to be discussed in this planning and coordination will be:

- Deployment of the "Thalassa" transducers at a lower depth for detection near the surface.
- Finish the cross validation of the 2006 and 2007 data: quantitatively explain the discrepancies.
- Synchronize the schedule of both surveys.
- Repeat the intercalibration activities as it was conducted this year 2007.
- Modificatioin of common sampling design to a more efficient one by changing the direction of the transects to be perpendicular to the isobaths.
- Try to increase the coordination to achieve a wider coverage.

Workshop in Lisbon

A workshop will be carried out in March 2008 in Lisbon, Portugal, to deal with several activities that were promoted during the WGACEGG. The objectives of the workshop will be:

- Calculate the variance of acoustic surveys (using geostatiscs and GAM) for acoustic energy by esdu and tentatively for fishing hauls.
- Present the results of the cross validation of JUVENA and PELACUS-10 for the years 2006 and 2007.
- Planning the coordination of juvenile anchovy surveys for 2008.
- Discuss the format for the common database and grid size for the integration of data.

Potential attendants: Guillermo Boyra (Chair), Juan Zwollinsky, Vitor Marques, Yorgos Stradourakis, Jacques Massé, Pierre Bellois, Pierre Petitgas, Enrique Nogueira, Magdalena Iglesias, Fernando Ramos and Marian Peña.

6.1.1.2 Sardine recruitment surveys

The autumn acoustic survey of IPIMAR has been performed off Portugal since 1984 (with various interruptions), providing the only fisheries-independent source of information for the incoming year class (i.e. sardine abundance at age 0) and comparable indices of abundance for the 1980s and 1990s off Portugal. In years of strong recruitment off northern Portugal (the most important recruitment ground for the Atlanto-Iberian stock – Silva 2007), the autumn acoustic survey has been useful to provide timely advice to the Portuguese administration and has facilitated national and international decisions that have reduced the waste of undersized fish and pacified the fishery. This is because new recruits usually concentrate in a relatively narrow area south of the Douro River and temporary closures or voluntary fleet dislocations can reduce the fishing pressure until young fish disperse to a wider area or attain commercial size.

In the last decade (from 1997 onwards) the survey area has been extended to cover also the Gulf of Cadiz (southern Spain), but due to logistic limitations (smaller duration of daylight and higher probability of bad weather than in spring) it has not been always possible to cover the entire area. In addition, during the 2006 benchmark assessment for sardine, the WGMHSA decided to remove the November Portuguese acoustic series from the assessment input data, considering that it did not provide an abundance index for the entire stock area and had limited impact on the model output (in the same assessment year was also decided to use the spring acoustic series of Spain and Portugal jointly as a single index of abundance at age – see following section).

Following the above modifications, it was proposed to the 2007 WGMHSA assessment group meeting to consider the re-organisation of the Portuguese autumn acoustic survey to become an internationally coordinated recruitment survey (providing a relative index of sardine abundance at age 0). Under such a scenario, covering the areas of northern Portugal, off Lisbon and the inner Gulf of Cadiz (all within IXa) would be sufficient to provide a recruitment index for the entire stock area, since there are no important sardine recruitment areas in the Cantabrian Sea (VIIIc). The WGMHSA indicated that it

> "… supports the re-organization of the Portuguese November survey as a recruitment survey since it will provide useful information for the assessment and may facilitate management by providing and early information about recruitment strength",

and recommended that the specific design of this survey and the possibility to initiate a similar series in southern Biscay during the pre-recruit surveys for anchovy that take place in September/October should be discussed within WGACEGG.

During the 2007 WGACEGG group meeting, existing experience from the Portuguese and Spanish acoustic surveys in IXa and from the French and Spanish pre-recruit autumn surveys in the Bay of Biscay was used to define a general plan for the design and execution of a potential sardine recruitment survey in the future. According to this plan, the autumn recruitment survey should:

- Be internationally coordinated, reporting to WGACEGG;
- Cover only the potential recruitment grounds of sardine within the Atlanto-Iberian stock area (northern Portugal, off Lisbon and Gulf of Cadiz);
- In the Gulf of Cadiz, if possible, extend its scope to consider both anchovy and sardine as the target species for providing indices of recruitment (given that anchovy abundance and recruitment off western Iberia is very limited);
- Limit its offshore coverage to the 100 m isobath or less (following review of data from past November surveys);
- If possible, extend its inshore coverage (especially in the inner Gulf of Cadiz) below the 20 m isobath to accommodate the potential presence of juvenile fish (especially young anchovy) at lower depths;
- Direct fishing hauls only to ground-truth echo-types likely to involve sardine and/or anchovy.

With these objectives in mind, the new survey could provide a recruitment index for sardine in the Atlanto-Iberian stock (useful for stock assessment), local indices independently for the three main recruitment grounds (useful for local management decisions and to compare the recruitment dynamics among grounds) and, eventually, a recruitment index for the anchovy stock in IXa. However, especially in the case of anchovy, this would require the inshore extension of the survey to the shallow waters of the inner Gulf of Cadiz and the respective ability to fish such targets (problems similar to those faced in the autumn pre-recruitment survey in the Bay of Biscay). In addition, to improve the synopticity of the survey and reduce the duration/cost further, it would be desirable that recruitment grounds in western and southern Iberia get covered by distinct research vessels originating from Portugal and southern Spain respectively (since the IPIMAR research vessel requires two days of steaming time to cover the Gulf of Cadiz region).

This re-organization would also allow making use of existing data of sardine at age 0 from past autumn surveys. Such estimates are readily available for northern Portugal (>10 surveys) and for the Gulf of Cadiz (<5 surveys), while for the Lisbon area would have to be estimated after revision of the geographical limits of echo-integration sectors. Finally, it is possible that recruitment indices can also become available for at least a couple of other incomplete autumn surveys (e.g. autumn 2002) that have never been used for assessment because they did not cover the entire Portuguese coast (but covered the respective recruitment grounds).

6.1.2 Pelagic community surveys

The spring acoustic surveys of IPIMAR (PELAGO), IEO (PELACUS and ECOCADIZ) and IFREMER (PELGAS) are becoming a group of spring acoustic surveys directed to

the pelagic community from Trafalgar to Brest (i.e. from 36º N to 48º N) whose joint planning and coordination increases over time. During 2008, fishing for all pelagic echo-types will be extended to the whole area (in the 2007 PELAGO survey it was successfully performed in south Iberia but not off western Portugal), while CTD casts will be obtained at night across the entire area. Given the 2008 DEPM application for sardine in the same area, it is possible that next year will provide the first set of data for the cross-validation of acoustic and DEPM results across the whole region (including data from CUFES in both surveys). In addition, coordinated action is planned at the intersection of the IPIMAR-IEO surveys and the IEO-IFREMER surveys respectively.

As proposed in the last year WG report, in spring 2008 an inter-calibration (IC) exercise will be performed between RV "Thalassa" and RV "Noruega" off northern Portugal. The exercise was originally promoted by a request of WGMHSA, after the assessment decision to use jointly the acoustic estimates for sardine by the surveys of IEO and IPIMAR in a single index of abundance. The IC will take place in 28–30/3/2008 off northern Portugal and will involve 6 parallel transects from 20 to 200 m. Each vessel will perform its routine acoustic operation but will also integrate the bottom. RV "Thalassa" will operate in an S-N direction while RV "Noruega" will operate in an N-S direction. Within the 6 transects box, IEO and IPIMAR will follow standard practices for fishing decisions (as performed during their regular surveys) and will provide estimates of sardine abundance (numbers and biomass) at length and age. CUFES data will be recorded in the same transects and compared among vessels. At the central area of the box, an IC of the bottom will take place, with both vessels sampling simultaneously the same track.

Coordination between PELACUS (IEO) and PELGAS (IFREMER) will also be ensured, both in terms of equipment and methods, and in terms of survey coverage. Bilateral agreements for the exchange of personnel and scientific gear are currently held by IEO and IPIMAR in relation to the PELACUS-PELGAS surveys. Also, this year the southern area of the Armorican shelf will be covered by the sardine DEPM survey (see Section 6.2 below), and so extra samples will be taken in this area, both within PELACUS and the DEPM surveys. These samples can be analysed together and compared to the ones obtained in the southern part of the PELGAS survey.

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

By the time of the Working Group the overview of DEPM surveys in 2008 and their coordination are as follows:

- **2008 DEPM Anchovy organisation**: Spain will carry out two surveys:
  - BOCADEVA; IEO, 1–15 July, on board the RV "Cornide de Saavedra", covering all IXa South.
  - BIOMAN; AZTI, 8–28 Mayo, on board RV "Miguel Oliver", covering the Spanish and French coasts from 4,5ºW to -47ºN and with Adult sampling on board the RV and potential cooperation with French acoustic survey PELGAS08.
  - Tables for Egg and adult sampling and processing to obtain DEPM parameters are provided along with further details, in Section 6.2.1.
- **2008 DEPM Sardine organisation:**

- Countries applying the DEPM to sardine are Portugal and Spain (as usual there will no connections between the two countries due to differences in coverage times by more than a month):
  - Portugal IPIMAR (15 January – 20 February) (Noruega).
    - Cadiz to IXa CN (Miño River, 42ºN) 36–42ºN
  - Spain IEO (4 – 28 Abril (Cornide).
    - 42 ºN to 45ºN
    - Adult sampling in cooperation with PELACUS0408
- In addition Spain AZTI might also apply the DEPM to sardine over the French shelf between 44ºN –48ºN if an extension of the budget for DEPM on anchovy survey (BIOMAN) will be approved by DCR (see recommendations Annex 4. I that case that would be made between 8 and 28 May on board the boat Miguel Oliver, with some Adult sampling on board Miguel Oliver and potential cooperation with French acoustic survey PELGAS08
- In all cases, the timing of processing would be: P0 is provided to the ICES Working Group on Widely distributed Stocks in September 2008. Adult parameters are intended to be available for the next ICES WGWIDE in September 2009. A review of the methods to obtain both P0 and adult parameters will be carried out in next WGACEGG meetings. Further details are provided in the Section 6.2.2.

A new workshop on R for DEPM applications will be carried in September for Sardine. Anchovy will also be dealt within that workshop, besides estimates will already be available by June 2008 to ICES.

6.2.1 Planning of next anchovy DEPM survey

The annual DEPM survey BIOMAN to estimate the spawning-stock biomass (SSB) of anchovy and the numbers-at-age of the population in the Bay of Biscay will be carried out from the 8–28 of May 2008. The survey is expected to be carried out on the RV "Miguel Oliver" (pelagic trawler) were the plankton and adult samples will be obtained. This survey will be in contact with the surveys PELGAS 08 and PELACUS 0408. For the time being and in the same manner as in the last years, extra adult samples will be obtained from the survey PELGAS 08, conducted by Ifremer, on-board RV "Thalassa" (pelagic trawls).

The triennial DEPM survey to estimate the SSB of anchovy in Cadiz will be carried out from the 1–15 July 2008 on board the RV "Cornide de Saavedra" (pelagic trawler) were the plankton and adult samples will be obtained.

For plankton and adult survey equipment and methodologies, for both surveys, see Tables 6.2.1.1 and 6.2.1.2 respectively.

Table 6.2.1.1. Survey dates and methodology for anchovy egg sampling and processing.

	ANCHOVY	
	Spain (IEO-Cadiz)	**Spain (AZTI)**
Years	2008	2008
Survey area	Gulf of Cadiz	Bay of Biscay
Survey period	July 1–15	May 8–28
Survey direction	E-W	S-N
Sampling grid (miles x miles)	8 x 3	15 x 3
Sampler	PairoVET	PairoVET
Mesh size (μm)	150	150
Weight on sampler (Kg)	20	45 kg
Type of haul	Vertical	Vertical
Sampling depth (m)	100	100
Towing speed (m/s)	1	1
Max acceptable angle	20º	15º
Hydrographical sensor	CTD Seabird37*	CTD (RBR) *
Flowmeter	Y	Y
Inclinometer	Y	N
Samplers used (# Nets)	1	2
Stages eggs (nº egg)	all	Sample size 50 / 75 or all egg
Use CUFES (mesh size)	Every 3nm (335 microns)	Every 1.5nm (335 microns)
Ageing	Bayesian (Ibaibarriaga 2007)	Bayesian (Ibaibarriaga 2007)
Egg Production	GLM (and GAMs available)	GLM (and GAMs available)

CTD coupled to PAIROVET.

Table 6.2.1.2. Survey dates and methodology for anchovy adult sampling and processing.

	ANCHOVY	
	Spain (AZTI)	**Spain (IEO-Cadiz)**
Target species	anchovy	anchovy
RV	"Miguel Oliver"	"Cornide"
Gears	Pelagic trawl	Pelagic trawl
Survey period	8–28 May	1–15 July
Sampling period (survey)	During the whole day	During day hours
Complementary samples	from RV Thalassa(pelagic trawler)	
Biological sampling: - Survey	- On fresh material (Miguel Oliver) or preserved material (Thalassa)	- On fresh material
- Commercial	-	-
Preservation	Buffered formaldehyde 4% (tap water)	Buffered formaldehyde 4% (distilled water)
Conservation	In formalin	In formalin
Histology: - Embedding material - Stain	 - Resin - Hematoxilin-Eosin	 - Resin - Hematoxilin-Eosin
S estimation	Day 0 and Day 1 POFs (revised method)	Day 1 and Day 2 POFs (according to Motos 1994)
R estimation	Theoretical expected values considering 1:1 numbers and the females and males sample mean weights	The observed weight fraction of the females, checking with the expected 1:1 in numbers
F estimation	On hydrated females (without POFs), according to Hunter and Macewicz 1980	On hydrated females (without POFs), according to Hunter and Macewicz 1980

6.2.2 Planning of next sardine DEPM survey

Sardine DEPM 2008

A DEPM survey for the Atlanto-Iberian sardine will take place in 2008 covering the area from the Gulf of Cadiz to the Bay of Biscay. The region from the Gulf of Cadiz to the northern Portugal/Spain border (River Minho) will be surveyed by IPIMAR (Instituto de Investigação das Pescas e do Mar, Portugal), while IEO (Instituto Español de Oceanografía, Spain) will cover the north-western 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 from 45ºN to 48º latitude N, will be covered by AZTI (Instituto Tecnológico Pesquero y Alimentario, Spain), conditioned to the extended budget, extending the annual Anchovy DEPM Survey up to 48ºN. Due to differences in the peak spawning period of sardine and logistics within the different institutes, it is not possible for the independent surveys to follow a tighter sequential schedule in time.

Plankton sampling design and adaptive decisions:

Plankton surveying will be undertaken following a pre-defined grid of sampling stations (Figure 6.2.2.1).

The inshore limit of transects will be determined by bottom depth (as close to the shore as possible), while the offshore extension will be decided adaptively. The scheme agreed during the SGSBSA, 2004 (ICES, 2005) for plankton sampling will be followed (in Table 6.2.2.1 is presented a summary of the equipment and methods adopted).

Acoustic Surveys:

During 2008 survey, IPIMAR will be using for the first time the acoustics echo-sounder (EK500) that will register throughout the survey, and acoustic energy data will be stored using the software Movies.

Adult Surveys:

The adult surveying by IPIMAR will take place simultaneously with the ichthyoplankton surveying, complemented by additional adult samples obtained from the purse-seine commercial fleet. In the case of IEO, the adult sampling will be performed at the same time than the ichthyoplankton surveying on board RV Cornide and in cooperation with the PELACUS0408 acoustic survey (on board RV "Thalassa"). For AZTI, and conditioned to the extended budget, the adult sampling will also be performed concurrently with the ichthyoplankton surveying on board the RV "Miguel Oliver" and extra adult samples will be obtained from the survey PELGAS 08, conducted by IFREMER, on-board RV "Thalassa" (pelagic trawls). The survey methodology and strategy used will follow the general plan agreed for previous surveys (cf. ICES 2005, 2006), and most important information is gathered in Table 6.2.2.2.

Processing of samples and analysis:

Considering that the histological processing and analysis is expected to last at least 6 months, it will not be possible to provide the results of the SSB estimate to the ICES assessment WG (WGMHSA) which will meet in September 2008. However, it is expected that egg productions and spawning areas could be presented in September 2008, and that some preliminary results on the adult parameters could also be provided during the next meeting of this WG (November 2008). The final estimates of SSB for the Iberian area are intended to be available for the next WGMHSA in September 2009.

Table 6.2.2.1. Planning of survey methodology and egg processing for sardine in 2008.

SARDINE			
	Portugal (IPIMAR)	**Spain (IEO)**	**Spain (AZTI)**
Survey:			
Survey area	Portugal and Gulf of Cadiz 36–42ºN	Galicia and Bay of Biscay 42–45ºN	Bay of Biscay 44–48ºN
RV	"Noruega"	"Cornide"	"Miguel Oliver"
Survey period*	January 15 /February 20(1)	April 4–28(1)	May 8–28(1)
Survey direction	N-S	W-E	S-N
Sampling grid transects spacing stations spacing	(8x3) 8 3 (2)	(8x3) 8 3(2)	(15x3) 15 3(2)
Sampler	PAIROVET (1 net for egg processing)	PAIROVET (1 net for egg processing)	PAIROVET (2 nets for egg processing)
Mesh size (μm)	150	150	150
Type of haul	Vertical	Vertical	Vertical
Sampling maximum depth (m)	150	100	100
Towing speed (m/s)	1	1	1
Max acceptable angle	20º	20º	15º
Hydrographic sensor	CTDF (FSI) (3)	CTD (Seabird37)(3)	CTD (RBR) (3)
Flowmeter	Y	Y	Y
Clinometer	Y	Y	N
Eggs staged (n egg) (stages from Gamulin and Hure, 1955)	all	all	sample size 50 / 75 or all eggs
CUFES, mesh 335μm	3 nmiles (sample unit)	3 nmiles (sample unit)	1.5 nmiles (sample unit)
Environm. data	fluorescence, temp, salinity	fluorescence (surface only), temp, salinity	fluorescence (surface only), temp, salinity
Processing			
Temperature for egg ageing	Surface and mean top 20 m	10 m	10 m
Egg ageing	Bayesian (Bernal 2007)	Bayesian (Bernal 2007)	Bayesian (Bernal 2007)
Egg Production	GLM (and GAMs available)	GLM (and GAMs available)	GLM (and GAMs available)

Table 6.2.2.2. Planning of survey methodology for sardine adult sampling and processing in 2008.

2008 DEPM surveys	IEO Vigo	IPIMAR	AZTI
Survey:			
RV	"Thalassa"	"Noruega"	"Miguel Oliver" and "Thalassa??"
Gears	Pelagic trawl	Pelagic and Bottom trawl	Pelagic trawl
Sampling period (survey)	During the whole day hours	During the day hours	During the whole day
Complementary samples		Opportunistic commercial purse seiners samples (during the whole day)	Opportunistic commercial purse seiners samples (during the whole day)
Biological sampling: - Survey	- On fresh material, on board of the RV	- On fresh material, on board of the RV	- On fresh material (Miguel Oliver) or *in toto* preserved (Thalassa) material
- Commercial		- On frozen material, at the institution laboratory (gonad preserved immediately on the harbour)	- On *in toto* preserved material
Preservation	Buffered formaldehyde 4% (distilled water)	Buffered formaldehyde 4% (distilled water)	Buffered formaldehyde 4% (tap water)
Conservation	In formalin	In alcohol 70º	In formalin
Processing:			
Histology: - Embedding material	- Resin	- Paraffin	- Resin
- Stain	- Haematoxilin-Eosin	- Haematoxilin-Eosin	- 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)
R estimation	The observed weight fraction of the females	The observed weight fraction of the females	Theoretical expected values considering 1:1 numbers and the females and males sample mean weights
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

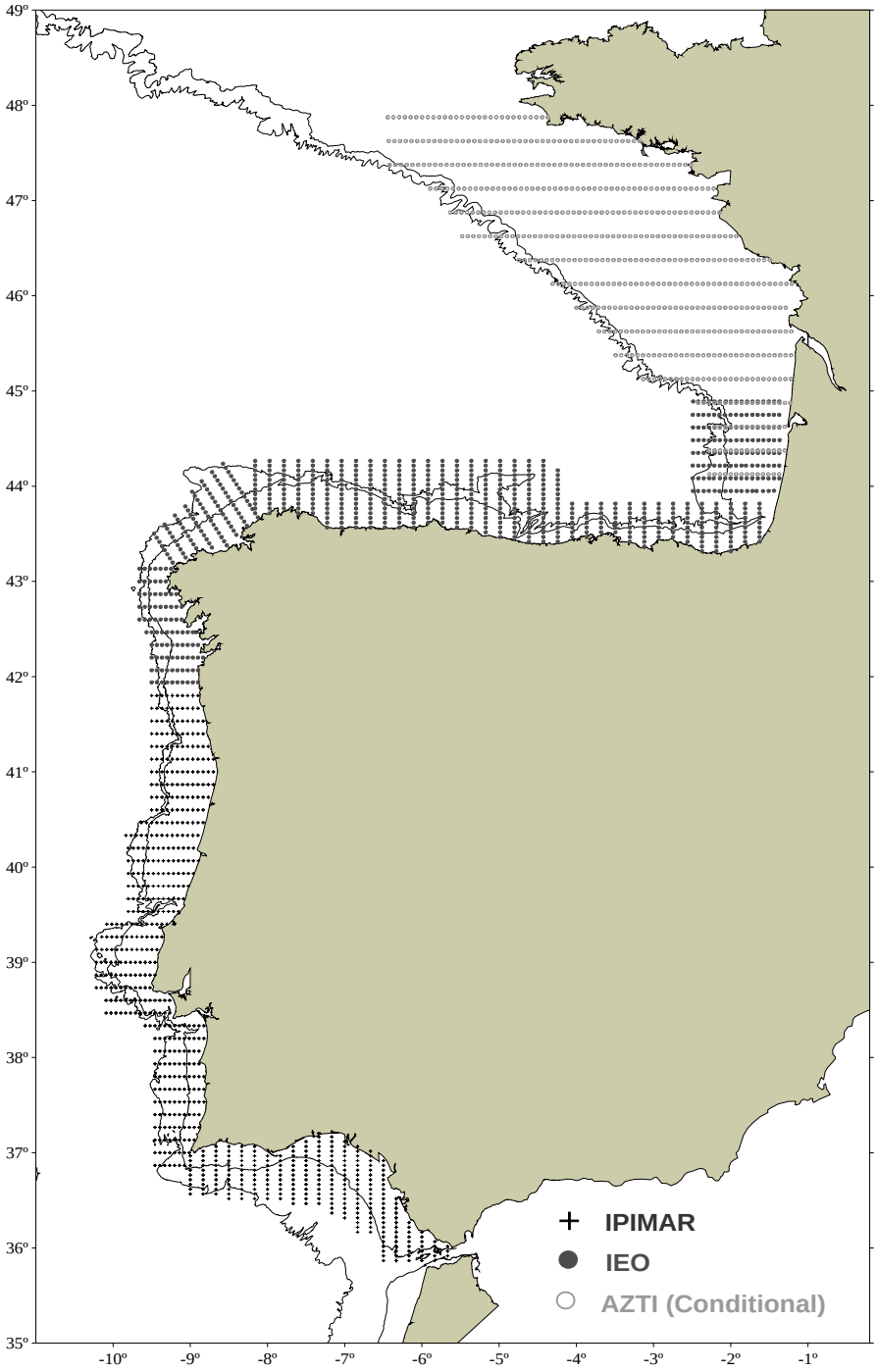


Figure 6.2.2.1. Grid of provisional PAIROVET sampling stations.

7 Progress in DEPM and acoustic estimation

7.1 Progress in DEPM-based estimates

7.1.1 Mortality estimation

Estimates of mortality are required to obtain egg production, and both estimates are usually obtained together while fitting a mortality curve to the abundance of eggs at age. However, estimates of mortality are often non-significative (i.e. statistically not significatively different from 0) or even biologically impossible (i.e. suggesting that the number of eggs increase with age). During this WG, a review of the mortality estimation process for Atlanto-Iberian sardine was presented (Bernal *et al.*, WD 2008a). The analysis presented was based on collapsing data from all available ichtyoplankton surveys in the Atlantic waters of the Iberian Peninsula within justified temporal and spatial strata (Table 7.1.1.1; also see Bernal *et al.*, 2007) , and estimating average mortality values within each strata. A total of 15 surveys were classified in two temporal strata (1985–1995 and 1995–2005) and three spatial strata (south – Gulf of Cádiz; West – Atlantic façade of the Iberian peninsula; and North – Cantabric area and Galicia), and a Generalised Linear Model (GLM, as suggested by ICES, 2004) structure was used to estimate mortality by strata and to test for significance of the temporal and spatial strata effects. Results suggest that average mortality is not significantly different between spatial strata, but significant differences were found in the two different periods. The mortality estimates for both periods is significatively different from zero, and biologically plausible. A number of robustness test were carried out, including a jacknife on surveys to detect the effect of a single survey on the estimation, and a number of analysis to see the effect of the tales on the mortality estimate (following Stratoudakis *et al.*, 2007). Although the survey coverage is different for all periods and area strata (See Table 7.1.1.1), the results obtained are considered the best average mortality estimates available, as they are based on the biggest database available and the estimates are proven robust to the different test performed.

The adoption of the results from this WD (Bernal *et al.*, WD, 2008a) implies a change in some of the basic concepts of the DEPM. In the current applications, both mortality and egg production are estimated for each survey, as variability in both parameters is expected. Nevertheless, the reliability of the mortality estimation is known to be low and results are often simply impossible to defend (see review in Bernal *et al.*, WD 2008a and references herein). In the revision proposed by Bernal *et al.*, (WD 2008a), this problem is solved by data aggregation and therefore the new mortality estimates are obtained separately from the egg production ones. The new estimates are average estimates and not yearly estimates as previously. This approach is related, but slightly different, to other attempts carried out in other stocks (see for example Lo *et al.*, 2004), in which information on plausible average mortality estimates are included in the egg production estimation process using a Bayesian framework. Although the approach presented in Bernal *et al.* (WD 2008a) is considered appropriate for the analysis of average mortality, and the results found are considered reliable, the implications of using average mortality estimates instead of yearly ones is not yet clear to this WG. Therefore the group recommends that further analysis are carried out, and a strategy is devised to incorporate the information provided by the average mortality estimates in a routine application for future DEPM estimations.

Table 7.1.1.1. List of surveys used for the analysis of Atlanta Iberian sardine mortality review.

	First period	Second period
North	sareggs0488.ieo sareggs0490.ieo	sareggs0397.ieo sareggs0399.ieo sareggs0599.azti sareggs0302.ieo sareggs0502.azti sareggs0405.ieo
West	sareggs0388.ipimar	sareggs0397.ipimar sareggs0199.ipimar calvet1199.ipimar calvet0300.ipimar sareggs0102.ipimar sareggs0205.ipimar
South	——	sareggs0397.ipimar sareggs0199.ipimar calvet1199.ipimar calvet0300.ipimar sareggs0102.ipimar sareggs0205.ipimar

7.1.2 GAM – based egg production estimation for Atlanto-Iberian sardine

A review of the estimates of egg production for Atlanto-Iberian sardine was presented in this WG (Bernal *et al*., WD 2008b). This review is based on the findings from a PhD on Atlanto-Iberian sardine egg production estimation (Bernal, 2007). The analysis presented is based on a series of new methods; i) a new sardine egg development model (Bernal *et al*., 2007b), ii) an analysis of sardine spawning habitat in the Atlantic waters of the Iberian peninsula (Bernal *et al*., 2007a), and iii) a review of sardine mortality estimates (see Section 7.1.1. and Bernal *et al*., WD 2008a). The analysis use a Bayesian ageing procedure (Stratoudakis *et al*., 2007) to provide ages to staged eggs, mortality estimates by period (see Section 7.1.1 and Bernal *et al*., WD 2008a) and provides spatially explicit egg production estimates based on a Generalised Additive Model (GAM) approach.

A representation of the spatially explicit egg production estimates is shown in Figure 7.1.2.1. Egg production in the different areas show large variability, with the northern and southern areas showing the largest range of total egg production, while the western area showing a more constant total egg production values, although with variability in the spatial distribution (Bernal *et al*., WD 2008b).

A comparison between the results obtained in Bernal *et al*. (WDb) and the traditional estimates of egg production for Atlanto Iberian sardine is shown in Figure 7.1.2.2. Results from both approaches are generally similar, although the new estimates are more precise than the previous ones. In some cases, some differences exist, but are generally within the wide confidence limits of the traditional estimate. Revised estimates are considered more robust to violations of the different assumptions

involved in the egg productions estimation process than the previous ones, as the different steps involved in the new estimation include robustness test (Bernal, 2007).

The results from Bernal *et al.* (WD 2008b) can be readily incorporated in the DEPM-based assessment of Atlanto-Iberian sardine. Nevertheless, there are some issues that need to be dealt with to obtain a revised series of DEPM-based SSB estimates for Atlanto-Iberian sardine:

- In order to obtain a fully spatially explicit estimate of Atlanto–Iberian sardine SSB based on the DEPM, a spatially explicit model of adult fecundity is required
- Although the new methods include spatial variability within the estimator, and are therefore expected to have lower variability than the traditional one, estimates of variance of the new method are considered too low, given the previous experience with Atlanto–Iberian sardine egg production estimators.

The WG therefore recommends that an analysis of the estimates of variance for the revised series is undertaken, and an analysis of the possibility of performing a spatially explicit model of Atlanto-Iberian sardine fecundity is performed. In the interim time, the WG recommends that the revised estimates of egg production are incorporated into the DEPM-based assessment, and are submitted both to WGMHSA and WGACEGG next meeting.

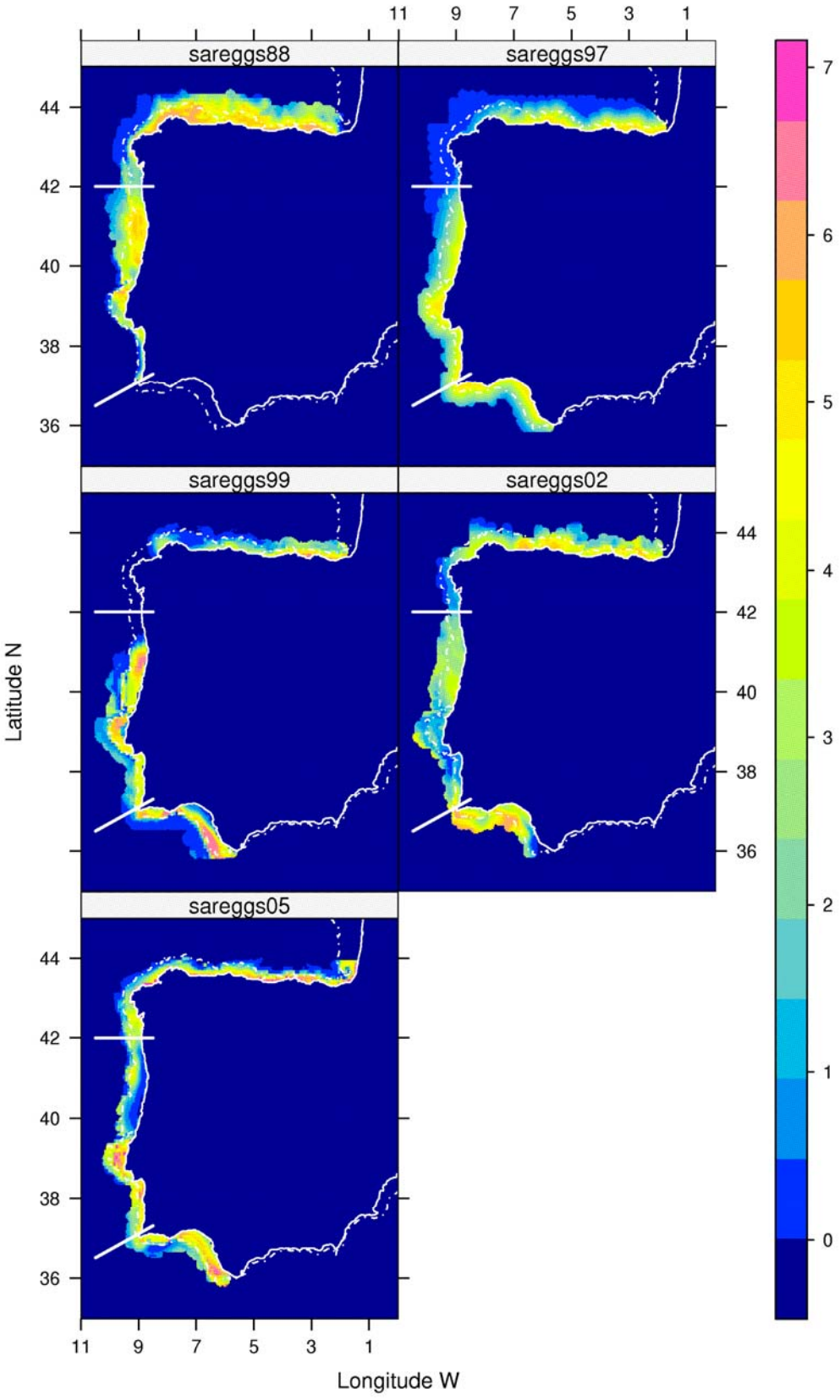


Figure 7.1.2.1. Predicted egg production fields of the Iberian Peninsula for the different DEPM surveys. On the right the log scales for all figures. White solid lines represent the limits between the North, West and South strata used in the analysis. No data in the south stratum is available in the 1988 survey.

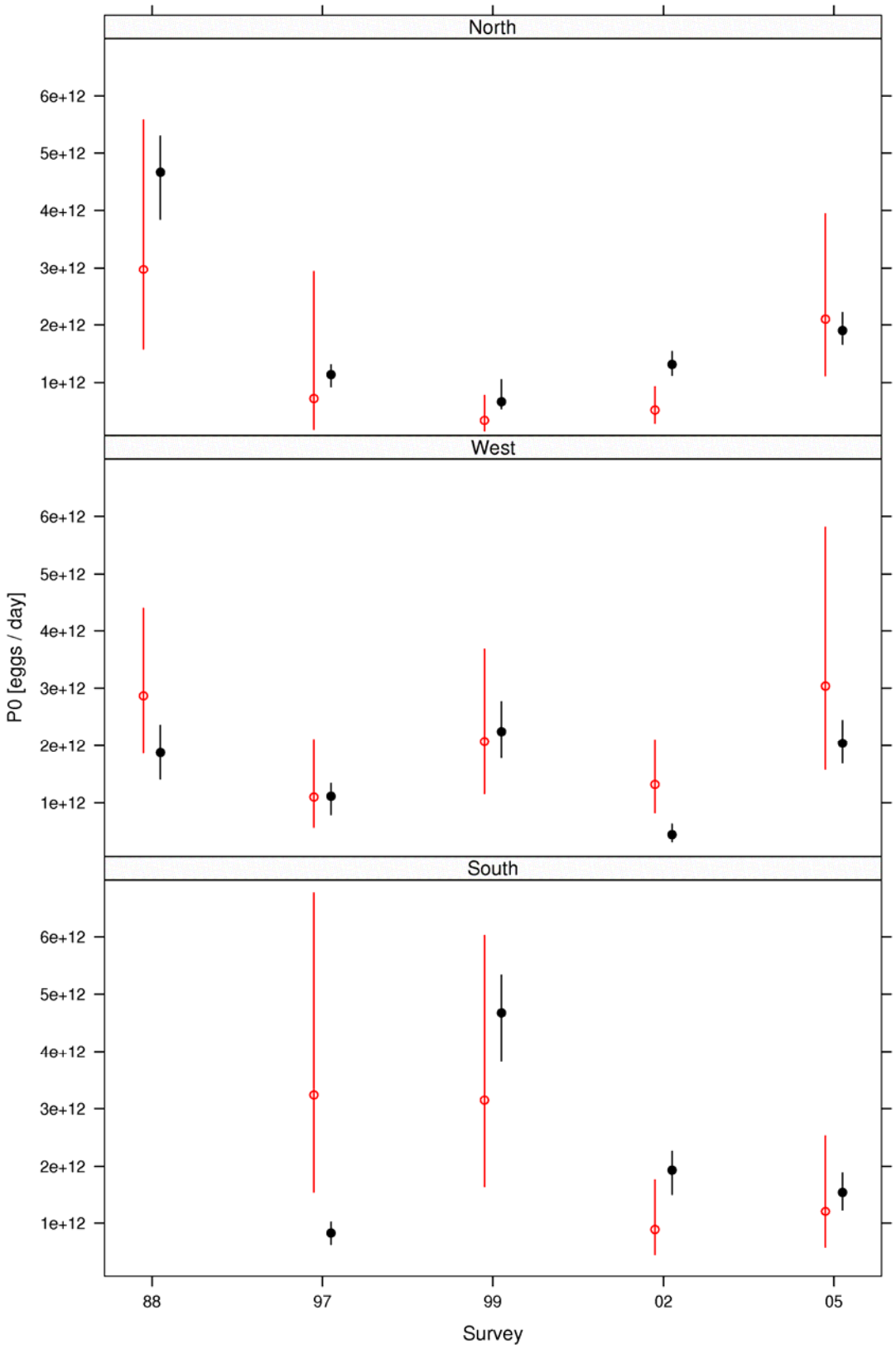


Figure 7.1.2.2. Egg production (eggs per day) for the three spatial strata for all the surveys. Black dots indicate the GAM based egg production; red dots indicate the traditional estimates. Horizontal bars indicate confidence intervals.

7.1.3 Review of the Spawning fraction estimates for the Bay of Biscay anchovy

Spawning fraction (S) is usually derived from the incidence of females with POFs belonging to a common cohort of a recently past spawners. In the DEPM applications made for the Bay of Biscay anchovy (started in 1987), S was initially derived from the average incidence of Day 1 past spawners, although since 1994 day 2 was also included in that estimation (Motos, 1994, 1996). In order to obtain unbiased estimates of the spawning frequency, the effect of over-sampling of day 0 spawners is usually corrected by replacing the observed Day 0 females by the expected not over-sampled values of spawning females (Picquelle and Stauffer, 1985; Santander *et al*., 1984, Motos 1994, Santiago and Sanz 1992).

During the last year, a new improved approach for the independent identification of the oocytes and POFs in the ovary analyses was developed for the Bay of Biscay anchovy (Alday *et al*., 2005 and see ICES CM 2006/LRC:18). By such approach, ovaries were divided into 8 stages regarding their oocyte maturation state and POFs have been classified using a set of 7 histological defined stages. The examination of several captivity experiments together with the results obtained from field samples led to some revision of the duration of POF stages and therefore of their ageing (or grouping of POFs into the same recent past spawning cohort) (Alday *et al.,* 2005 and submitted). Accordingly to this revised knowledge of POF degeneration, in 2007 a matrix system to allocate oocytes maturity stages and POF stages to daily spawning cohorts (daily ages) in relation to the time of capture of the sample was proposed and tested for the total set of samples collected from 1990 and 2005 (Alday *et al*., 2006WD to WGACEGG2007 – ICES CM 2006/LRC:18). It was noticed the existence of a small over-sampling of the spawning females during midnight (from 22.00 to 02.00 h) by about 10%. And therefore estimators of spawning frequency based on Day 0 or Day 1 can only be used out of those daytime intervals, otherwise a correction for the over sampling effect is required. Nevertheless, it was found that the mean incidence of day 0 and day 1 in the population was a more precise estimator than the traditional one (the incidence of day 1 – corrected by over sampling). However, given the small over sampling and high spawning frequencies observed on this anchovy population, the joint incidence of both (Day 0 and Day 1) spawning cohorts could be used as a rough estimator of the (double of) the spawning frequency, without introducing any other correction.

In this section we apply the ageing Matrices proposed for the oocytes and POFs for this anchovy to the collection of adult samples from 1990 to 2007 in order to get the annual estimates of spawning fraction (Uriarte *et al.,* WD 2008) (Table 7.1.3.1 for the oocyte stages and Table 7.1.3.2 for the POF stages according to the work of Alday *et al*., submitted and see ICES CM 2006/LRC:18). We have applied here the most simple and defensible matrices for ageing POF (called theoretical or T) by which for all overlapping periods of spawning cohorts within stages, pure gradual transition percentages between successive cohorts are applied. Some plausible alternative proposal for the overlapping periods led to very similar, almost identical, results (see Uriarte *et al.,* WD 2008).

These matrices allowed for the identification of a total of five spawning cohorts (two of them corresponding to pre-spawners – day -1 and 0 - and the others to post-spawners - day 1 to 3+).

In Table 7.1.3.3 and Figure 7.1.3.1 previous estimates of Spawning fraction are compared with the new estimates of S based on the incidence of day 1 (corrected) and day (0+1)/2. The spawning fraction per year resulting from the average incidence of

day 1 (corrected for oversampling) and of day 0 + 1 cohorts are very similar and quite invariant throughout the study period and around 40%. These revised estimates of S suppose an increment of about 64% over the past spawning frequency estimates, and they will induce a reduction of about 39% of the previous Spawning biomass estimates obtained by the DEPM.

The high Spawning fraction resulting for this anchovy is certainly higher that the ones reported for *Engraulis mordax* in the northern and south Pacific (Hunter and Macewicz, 1985 and Santander *et al.*, 1984) or for encrasicolus in the South Africa (Shelton *et al.*, 1993) usually below 20%. However similar or even higher spawning fractions are reported for other Engraulis such as: *Engraulis japonicus* (Tsuruta 1992, Tsuruta Hiroshe 1989, Funamoto *et al.*, 2004), *Encrasicholina purpurea* (Clarke 1987 and Clarke 1989) or Anchoa mitchilli (Luo and Musick 1991). Comparing with Mediterranean anchovies these values are just slightly above the highest reported S (of about 36%, Somarakis *et al.*, 2004) and it seems that in recent applications in the Aegean sea values around 38% have also been reported (Somarakis, *et al.*, 2006)

The Working Group endorsed the revision performed on the estimates of spawning frequency and considered that a full revision (with 2006 estimate) and including the full revision the Spawning Biomass should be made available and finished by June 2008 (beyond the current state of revision presented in Section 5.1).

Table 7.1.3.1. Conversion matrix of oocyte stages, into spawning cohorts, according to time of capture (based upon the knowledge of Motos 1996 and Alday *et al.*, in preparation)

Día -1	Estadíos ovocito				
Tramo hora	4	5	6	7	8
(00-02)	NA	100%	0%	0%	0%
(02-04)	NA	100%	100%	0%	0%
(04-06)	NA	100%	100%	0%	0%
(06-08)	NA	0%	0%	0%	0%
(08-10)	NA	0%	0%	0%	0%
(10-12)	NA	0%	0%	0%	0%
(12-14)	NA	25%	0%	0%	0%
(14-16)	NA	50%	0%	0%	0%
(16-18)	NA	100%	0%	0%	0%
(18-20)	NA	100%	0%	0%	0%
(20-22)	NA	100%	0%	0%	0%
(22-00)	NA	100%	0%	0%	0%

Día 0	Estadíos ovocito				
Tramo hora	4	5	6	7	8
(00-02)	NA	0%	100%	100%	100%
(02-04)	NA	0%	0%	100%	100%
(04-06)	NA	0%	0%	100%	100%
(06-08)	NA	100%	100%	100%	100%
(08-10)	NA	100%	100%	100%	100%
(10-12)	NA	100%	100%	100%	100%
(12-14)	NA	75%	100%	100%	100%
(14-16)	NA	50%	100%	100%	100%
(16-18)	NA	0%	100%	100%	100%
(18-20)	NA	0%	100%	100%	100%
(20-22)	NA	0%	100%	100%	100%
(22-00)	NA	0%	100%	100%	100%

Table 7.1.3.2. Conversion matrix of POF's stages, into spawning cohorts, according to time of capture (based upon the knowledge gained in a previous study Alday *et al.*, submitted).

Día 0	Estadíos							
Tramo hora	0	I	II	III	IV	V	VI	VII T*
(00-02)	0%	100%	100%	100%	100%	0%	0%	0%
(02-04)	0%	100%	100%	100%	100%	0%	0%	0%
(04-06)	0%	100%	100%	100%	100%	0%	0%	0%
(06-08)	0%	0%	0%	0%	0%	0%	0%	0%
(08-10)	0%	0%	0%	0%	0%	0%	0%	0%
(10-12)	0%	0%	0%	0%	0%	0%	0%	0%
(12-14)	0%	0%	0%	0%	0%	0%	0%	0%
(14-16)	0%	0%	0%	0%	0%	0%	0%	0%
(16-18)	0%	0%	0%	0%	0%	0%	0%	0%
(18-20)	0%	100%	100%	0%	0%	0%	0%	0%
(20-22)	0%	100%	100%	100%	0%	0%	0%	0%
(22-00)	0%	100%	100%	100%	0%	0%	0%	0%

Día 1	Estadíos							
Tramo hora	0	I	II	III	IV	V	VI	VII T*
(00-02)	0%	0%	0%	0%	0%	100%	100%	16,7%
(02-04)	0%	0%	0%	0%	0%	100%	100%	33,3%
(04-06)	0%	0%	0%	0%	0%	100%	100%	50,0%
(06-08)	0%	100%	100%	100%	100%	25%	0%	0%
(08-10)	0%	100%	100%	100%	100%	50%	0%	0%
(10-12)	0%	100%	100%	100%	100%	75%	0%	0%
(12-14)	0%	100%	100%	100%	100%	100%	0%	0%
(14-16)	0%	100%	100%	100%	100%	100%	20%	0%
(16-18)	0%	100%	100%	100%	100%	100%	40%	0%
(18-20)	0%	0%	0%	100%	100%	100%	60%	0%
(20-22)	0%	0%	0%	0%	100%	100%	80%	0%
(22-00)	0%	0%	0%	0%	100%	100%	100%	0%

Día 2	Estadíos							
Tramo hora	0	I	II	III	IV	V	VI	VII T*
(00-02)	0%	0%	0%	0%	0%	0%	0%	83,3%
(02-04)	0%	0%	0%	0%	0%	0%	0%	66,7%
(04-06)	0%	0%	0%	0%	0%	0%	0%	50,0%
(06-08)	0%	0%	0%	0%	0%	75%	100%	66,7%
(08-10)	0%	0%	0%	0%	0%	50%	100%	83,3%
(10-12)	0%	0%	0%	0%	0%	25%	100%	100%
(12-14)	0%	0%	0%	0%	0%	0%	100%	100%
(14-16)	0%	0%	0%	0%	0%	0%	80%	100%
(16-18)	0%	0%	0%	0%	0%	0%	60%	100%
(18-20)	0%	0%	0%	0%	0%	0%	40%	100%
(20-22)	0%	0%	0%	0%	0%	0%	20%	100%
(22-00)	0%	0%	0%	0%	0%	0%	0%	100%

Día 3	Estadíos							
Tramo hora	0	I	II	III	IV	V	VI	VII T*
(00-02)	100%	0%	0%	0%	0%	0%	0%	0%
(02-04)	100%	0%	0%	0%	0%	0%	0%	0%
(04-06)	100%	0%	0%	0%	0%	0%	0%	0%
(06-08)	100%	0%	0%	0%	0%	0%	0%	33,3%
(08-10)	100%	0%	0%	0%	0%	0%	0%	16,7%
(10-12)	100%	0%	0%	0%	0%	0%	0%	0%
(12-14)	100%	0%	0%	0%	0%	0%	0%	0%
(14-16)	100%	0%	0%	0%	0%	0%	0%	0%
(16-18)	100%	0%	0%	0%	0%	0%	0%	0%
(18-20)	100%	0%	0%	0%	0%	0%	0%	0%
(20-22)	100%	0%	0%	0%	0%	0%	0%	0%
(22-00)	100%	0%	0%	0%	0%	0%	0%	0%

Table 7.1.3.3. Past (Tradit) and New Spawning fraction estimates for the anchovy in the Bay of Biscay (Uriarte *et al.,* 2007 WD and in preparation). New estimates based on the incidence of past spawning cohorts Day 1 (corrected) and day (1+2)/2 are presented. Coefficient of Variation were not fully calculated for the new estimates.

Year	Tradit.S	CV	New S (0+1)	CV	New S (1)
1990	30,0	0,06	36,6		35,33
1991	23,0	0,12	41,2		39,88
1992	25,0	0,30	41,5		41,40
1994	22,8	0,07	41,5	0,03	39,85
1995	20,2	0,05	42,6	0,03	42,04
1997	23,5	0,05	39,2	0,04	38,27
1998	21,3	0,09	39,9	0,04	38,08
2001	24,8	0,18	40,2	0,04	39,85
2002	30,2	0,03	40,0	0,03	40,44
2003	27,1	0,03	42,0	0,02	39,41
2004	21,5	0,06	39,1	0,03	37,54
2005	26,2	0,04	41,1	0,04	40,70
2007	24,9	0,13	40,5		37,48

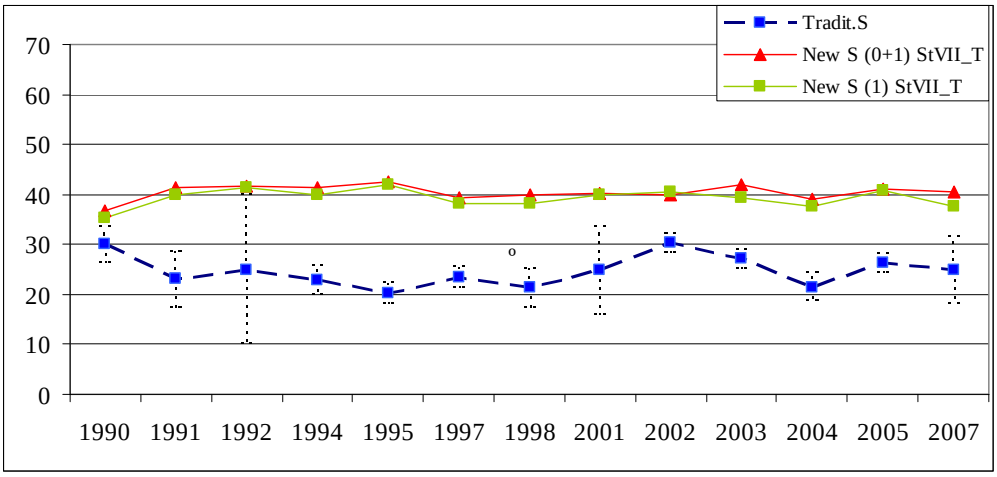


Figure 7.1.3.1. Past and new spawning fraction estimates for the Bay of Biscay anchovy. New estimates based on the incidence of past spawning cohorts Day 1 (corrected) and day (1+2)/2 are presented.

7.1.4 New egg development model for Gulf of Cádiz anchovy

Following a recommendation from last year WG (ICES, 2007), an incubation experiment for the Gulf of Cádiz anchovy was performed and the results have been presented to this year WG (Duarte *et al.,* WD). The experiment was performed following previous experiments for sardine (Bernal *et al.,* 2007a) and anchovy (Ibaibarriaga *et al.,* 2007), reported in previous years to this WG.

The data used to obtain the egg development model came from an incubation experiment carried out during July 2007. The samples of adults were obtained on board a commercial purse-seiner vessel in the Gulf of Cadiz. A total of 44 hydrated females and 15 ripe males were used for the experiment, and fertilization of eggs was carried out on board. Fertilized eggs were transported to the laboratory and reared up in an incubator, composed of five aquariums maintained at 5 different controlled temperatures (10, 14, 18, 22 and 26 ºC). Sampling frequency was about 1 hour through all the experiment and the assignment of stages was based in Moser and Alhstrom (1985) morphological keys. Different development models were implemented to the incubation data, including different flavours of the traditional method developed by Lo (1985) and the multinomial egg development model described in Ibaibarriaga *et al.* (2007) and Bernal *et al.* (2007), and recommended by this WG (ICES, 2007). Results of the multinomial egg development model for the Gulf of Cádiz anchovy are shown in Figure 7.1.4.1. In general, anchovy in the Gulf of Cádiz does not present big differences in the maximum probability attained by any stage at the different temperatures, with the exception of stage 11, which shows a fast transition rate and a low probability of appearance in the samples. In comparison with Bay of Biscay anchovy, egg development in the gulf of Cádiz is relatively similar, although slower for older stages (Figure 7.1.4.2). The new egg development model is adopted by the group as the appropriate model for anchovy in the Gulf of Cádiz, as the range of temperatures used represents the range of temperatures observed in the area. Further comparison between the models are desirable, specially to check if differences are statistically significant, using multinomial models.

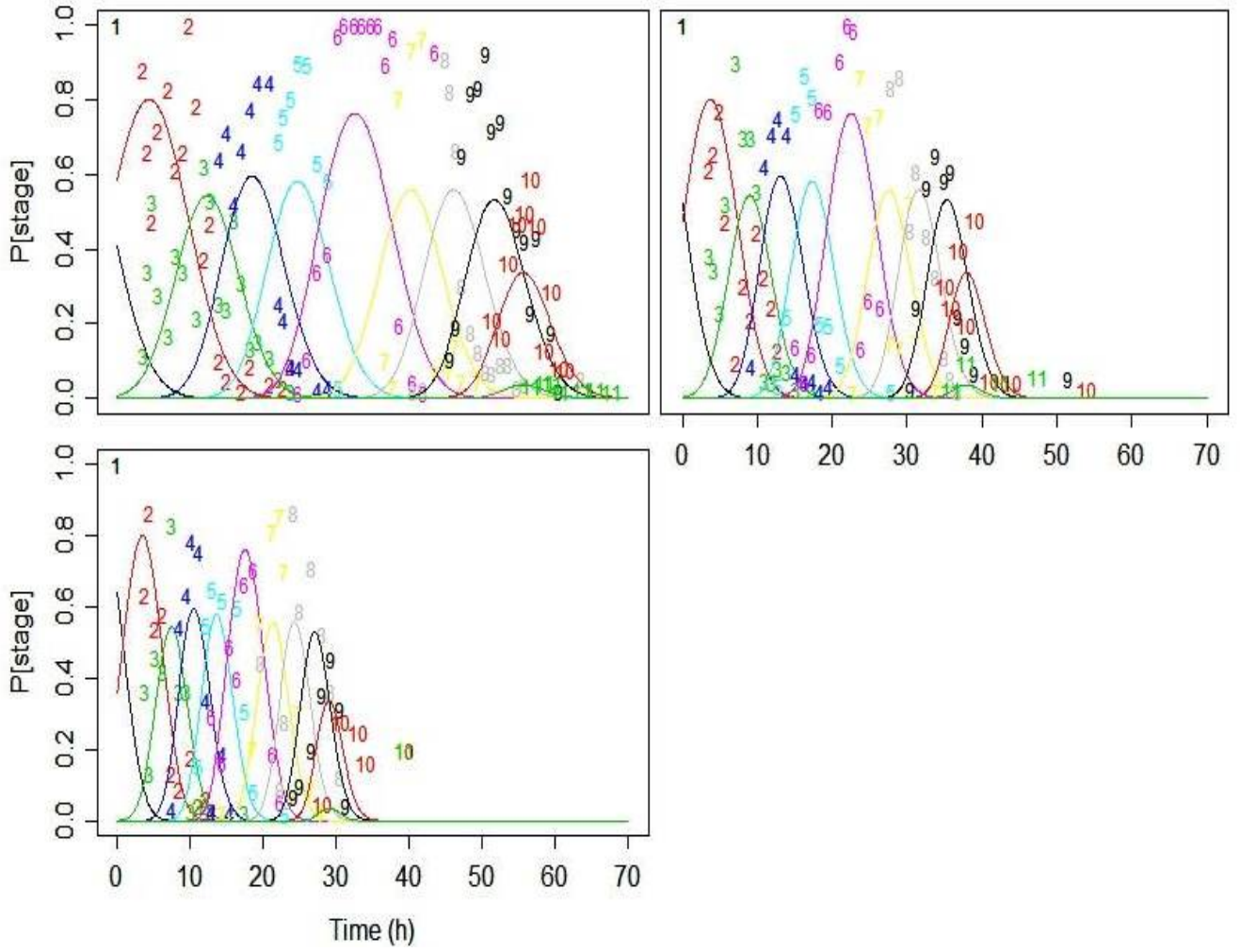


Figure 7.1.4.1. Multinomial model fitted to the Gulf of Cádiz Anchovy experiment incubation data. Each panel represents one of the three temperature incubation taken into account for the analysis (from left to right corresponds to 18 and 22ºC, and down to 26ºC). The numbers (1–11) within each plot represent the observed frequencies of the different stages (stage 1 to stage 11) at each sampling time. Each line represents the evolution of the modelled probability of eggs being in a given stage over age and temperature.

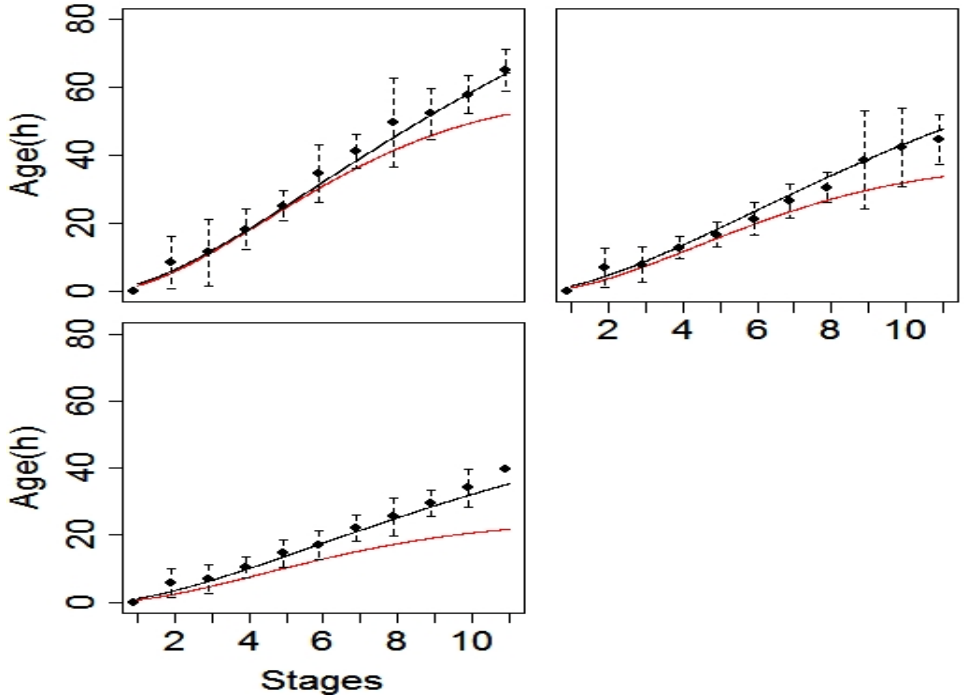


Figure 7.1.4.2. Lo's development model (Lo, 1985) fitted to the Gulf of Cádiz anchovy incubation data (black line) and to the Bay of Biscay anchovy incubation data (red line). Both lines represent each of the 3 analyzed temperatures (from left to right corresponds to 18.5ºC and 22.5ºC, and down to 26.5ºC), and points in black indicate the estimated mean age for each stage and temperature. Vertical lines show the observed stage duration defined as mean age ± 2*sd.

7.1.5 Using R to obtain estimates of SSB based on the Daily egg production method

In June 2007, a workshop to obtain DEPM-based SSB estimates for sardine and anchovy was carried out in Cádiz. Originally, the Workshop was an internal meeting organised by IEO, to analyse the DEPM surveys carried out at this Institute. However, invitations to IPIMAR, AZTI and other institutes were sent, and the final attendance to the meeting included 10 persons from IEO, 1 from AZTI, 2 from IPIMAR, 1 from the University of Cádiz and 1 from the Spanish Science Council (CSIC). Both ichthyoplankton and adult fecundity data from 3 stocks of anchovy (Bay of Biscay, Gulf of Cádiz and Gulf of Lyon) and the Atlanto-Iberian stock of sardine was analysed in common, using a series of routines in R included in the project ICTHYOANALYSIS (http://ichthyoanalysis.wiki.sourceforge.net/). This project was developed in cooperation with both SGSBSA and WGACEGG (ICES, 2004 and 2007), and allows to implement the methods agreed in the WG. Results of the workshop have been used to revise the series of estimates of both sardine and anchovy and to produce a preliminary estimation of anchovy egg production in the Gulf of Lyon.

Due to the usefulness of the software and its application in the stocks dealt with in this WG, the WG recommends that another Workshop is conducted in 2008, in which the data from the 2008 DEPM surveys will be jointly analysed by the different institutes.

7.1.6 Comparison between anchovy DEPM parameters in different Mediterranean areas

Since the early 1990s, the Daily Egg Production Method (DEPM) has been applied to several anchovy stocks in Mediterranean (Somarakis *et al.,* 2004). DEPM surveys in the Mediterranean stocks in the 90′s were largely experimental and often opportunistic with the main aim to develop and test the method rather than provide spawning stock biomass estimates (SSB) for the assessment of the stocks. Consequently, the DEPM has been applied once, twice or a maximum of three times in certain Mediterranean areas with no among-area standardization. Different techniques in several aspects of the method have been used in the Mediterranean and estimated parameters vary greatly among stocks and year of application. There is evidence that variability in biological production among sub-basins and/or years, which are prominent characteristic of the Mediterranean Sea, may directly affect anchovy egg production.

A summary of the adult reproductive parameters for the Mediterranean are presented in Table 7.1.6.1 with estimates of the same reproductive parameters for Cadiz (2005, similar values were found in 2004) and for the Bay of Biscay 2001–2004 (for further data see Somarakis *et al.,* 2004 and sections above for the anchovy in the Atlantic).

The table shows that on average Relative Batch fecundity of anchovy in Cadiz and the Bay of Biscay anchovy are a bit higher than in the Mediterranean (621 and 481 vs 377), however their values are within the range of the Mediterranean values and therefore are compatible. The same happens for the daily specific fecundity DSF in Cadiz and Bay of Biscay in comparison with the Mediterranean (75 and 104 vs 50.5 respectively). While Cadiz is within the range of the Mediterranean, the Bay of Biscay is well above and this is due to the revision of the Spawning Frequency estimates applied to this area. If a similar revision about the degeneration rates of POF were applicable to the Mediterranean then probably new ageing of POF would lead to a similar revision for the Mediterranean areas.

Table 7.1.6.1. Adult parameters estimates of the European anchovy DEPM applications in the Mediterranean Sea. R: sex ratio by weight. W: average weight of mature female (g). F: batch fecundity. CVs in parentheses. RF: relative fecundity (RF = F / W, eggs g^{-1}). DSF: daily specific fecundity, eggs produced per gram weight of the population (DSF = F S R / W).

	R	W	F	S	RF	DSF
Catalan Sea 1990	0.54	14.25	8 006	0.36	562	109
	(0.09)	(0.04)	(0.02)	(0.10)		
Catalan Sea and Gulf of Lions 1993	0.64	14.31	4 958	0.31	347	69
	(0.05)	(0.07)	(0.11)	(0.13)		
Catalan Sea and Gulf of Lions 1994	0.59	22.92	7 039	0.21	307	38
	(0.19)	(0.06)	(0.02)	(0.20)		
Ligurina and Tyrrhenian Sea 1993	0.63	14.17	4 894	0.32	345	70
	(0.05)	(0.07)	(0.10)	(0.11)		
Sicilian channel 1998	0.59	15.18	4 835	0.14	319	26
	(0.12)	(0.07)	(0.16)	(0.12)		
Sicilian channel 1999	0.55	14.08	5 871	0.17	417	39
	(0.10)	(0.08)	(0.11)	(0.10)		
Sicilian channel 2000	0.62	18.90	8 379	0.20	443	55
	(0.08)	(0.04)	(0.06)	(0.28)		
SW Adriatic 1994	0.55	18.57	11 866	0.16	639	57
	(0.05)	(0.03)	(0.03)	(0.08)		
Central Ionian Sea 1999	0.53	15.60	9 428	0.06	604	19
	(0.07)	(0.05)	(0.08)	(0.26)		
Central Aegean Sea 1999	0.47	15.77	4 725	0.13	300	18
	(0.09)	(0.03)	(0.06)	(0.21)		
NE Aegean Sea 1993	0.51	24.89	12 451	0.29	500	74
	(0.05)	(0.03)	(0.05)	(0.21)		
NW Aegean Sea 1993	0.60	20.88	10 474	0.26	502	78
	(0.05)	(0.03)	(0.04)	(0.20)		
NE Aegean Sea 1995	0.51	25.65	7 781	0.15	303	23
	(0.08)	(0.03)	(0.06)	(0.11)		
NW Aegean Sea 1995	0.61	22.72	5 128	0.13	226	18
	(0.03)	(0.03)	(0.10)	(0.23)		
E Aegean Sea 2003	0.65	15.36	3936	0.34	256	57
	(0.04)	(0.02)	(0.05)	(0.06)		
E Aegean Sea 2004	0.63	18.92	7053	0.44	373	103
	(0.08)	(0.04)	(0.05)	(0.05)		
E Aegean Sea 2005	0.47	15.74	3728	0.39	237	43
	(0.10)	(0.03)	(0.06)	(0.06)		
W Aegean Sea 2003	0.45	17.57	4446	0.34	253	39
	(0.10)	(0.05)	(0.06)	(0.10)		
W Aegean Sea 2004	0.57	16.73	5482	0.13	328	24
	(0.04)	(0.03)	(0.08)	(0.24)		
Aegean Sea 2005	0.48	13.52	3632	0.39	269	50
	(0.12)	(0.07)	((0.09)	(0.05)		

References for years 1990 to 1999 can be found at Somarakis *et al.*, (2004).

For Aegean Sea 2003 to 2005 Somarakis *et al.*, (2006).

7.1.7 DEPM application in the Mediterranean Iberian coast

Anchovy landings have been strongly decreasing since 1995 in the whole Catalan coast (NW Mediterranean – Spain) (Figure 7.1.7.1). These tendency is also important in the acoustic biomass estimations of this species in the Gulf of Lion (IFREMER data – SCSA/GFCM), where the commercial Spanish fleet obtains an important bulk of their landings.

Due to this situation of the anchovy population in the area the Catalan government has ask for an evaluation of the anchovy spawning biomass in their spawning areas off the NW Mediterranean.

The fact that in 1994 a DEPM application was performed in these areas allowed the possibility to compare the situation of the spawning stock nowadays with the one at the moment when landings of this species were the highest in the time series available (1988–2006) (see a comparison of survey areas in Figure 7.1.7.2).

In June 2007, during the peak spawning of anchovy a cruise to obtain the Egg Production (P0) and Spawning area (A) parameters needed for the DEPM model was performed.

The current state of this research only allows us to analyse these parameters for the area corresponding to the Catalan coast. The R package developed by M. Bernal (IEO Cadiz) has been used to obtain these results with data on abundances of anchovy eggs by age and sea temperature. To allow comparisons the same method has been applied to the data obtained during the 1994 cruise in the same area.

These preliminary results indicate a very important decrease in both parameters (80% for P0 and 30% for Area – Table 7.1.7.1). Taking into account the high correlation between SSB and both parameters in the other evaluations made with this species (Figure 7.1.7.3) we can foresee that probably the SSB of anchovy for 2007 would be near the 80% less than for 1994.

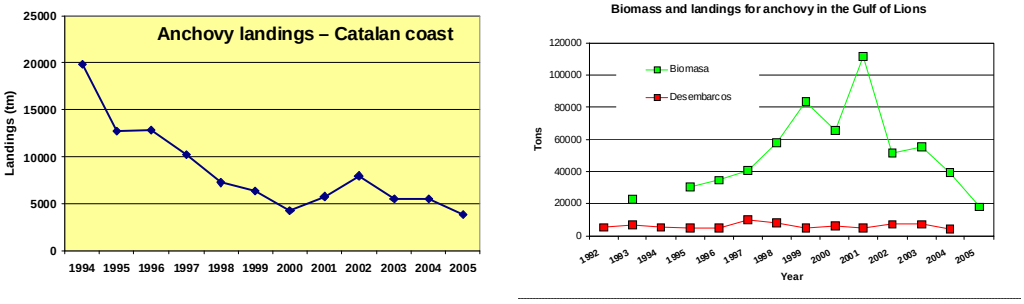


Figure 7.1.7.1. Anchovy landings in the Catalan coast (NW Mediterranean off Spain) and Anchovy Biomass and landings of French fleet in the Gulf of Lions.

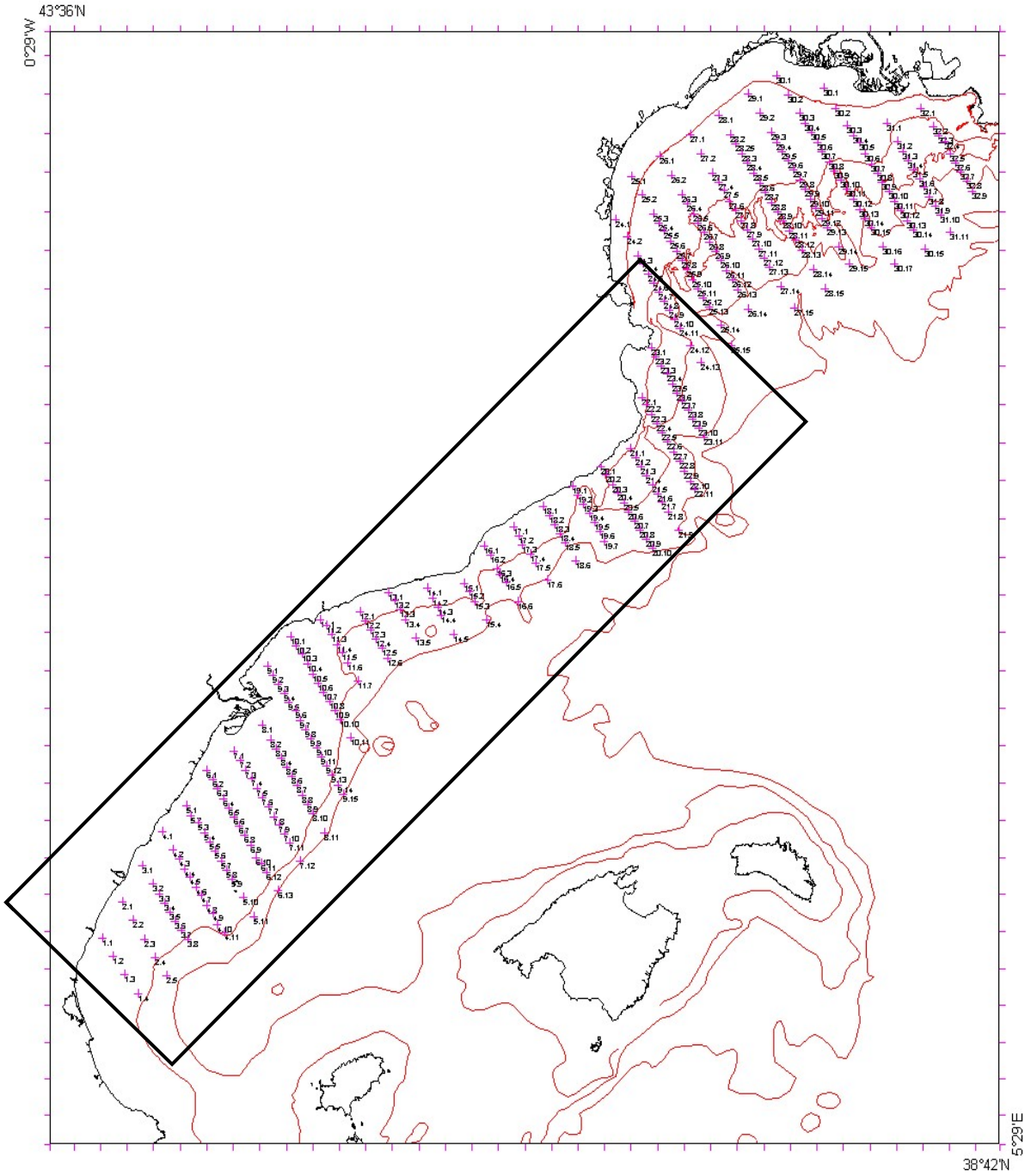


Figure 7.1.7.2. Survey map for Mediterranean Iberian anchovy DEPM attempts between 1994 and 2007.

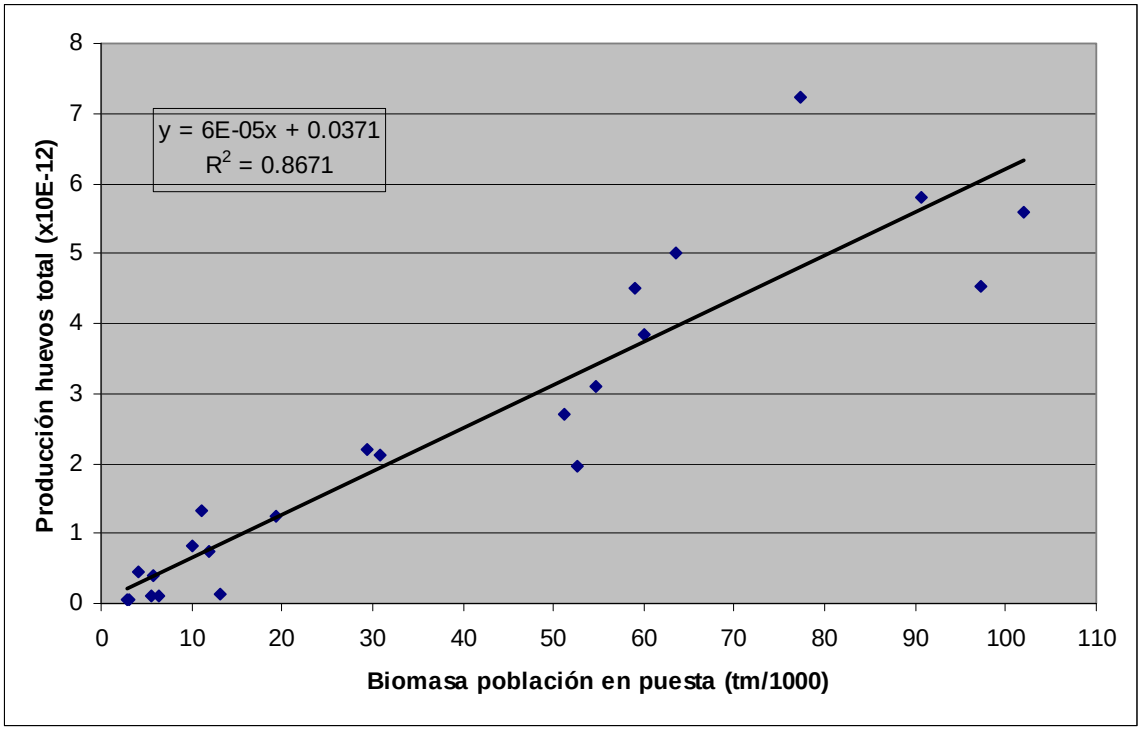


Figure 7.1.7.3. Relationship between P0 and Biomass in the Mediterranean and Atlantic Iberian anchovy population (ICES rep. 268).

7.1.8 Results of the first southern horse mackerel DEPM survey

The first campaign directed at the DEPM for horse-mackerel (*Trachurus trachurus*) of the southern stock was undertaken by IPIMAR during the period 3 February – 2 March 2007. The survey aimed at covering the entire region of the southern stock (Gibraltar- Cape Finisterra) but that was not possible to achieve within the time allocated for the campaign since sampling was prevented during several days due to adverse weather conditions. The survey did not cover the whole potential area of spawning for the species.

The sampling stations occupied and number of fishing hauls carried out during the survey are summarized in Figure 7.1.8.1 Egg distribution followed the pattern found for other campaigns with higher abundances on the south-western coast and just north of Lisbon. There was a high prevalence of horse-mackerel eggs off Galicia (samples collected by IEO).

In order to assess possible differences in egg capturability between the CalVET (used as main sampler for the first time) and the Bongo (40 cm diameter, used for AEPM surveys) nets, some oblique Bongo samples were taken. The results did not show a tendency for one sampler to be more efficient than the other for horse-mackerel egg collection (Figure 7.1.8.2.).

During this survey all egg stages of development were present in the samples taken with both nets (Figure 7.1.8.3). Despite that, early stages were not well represented and that causes difficulties for egg production estimates.

The analyses of the data on eggs and adults parameters referring to this campaign are underway and will be available for the next WGMEGS.

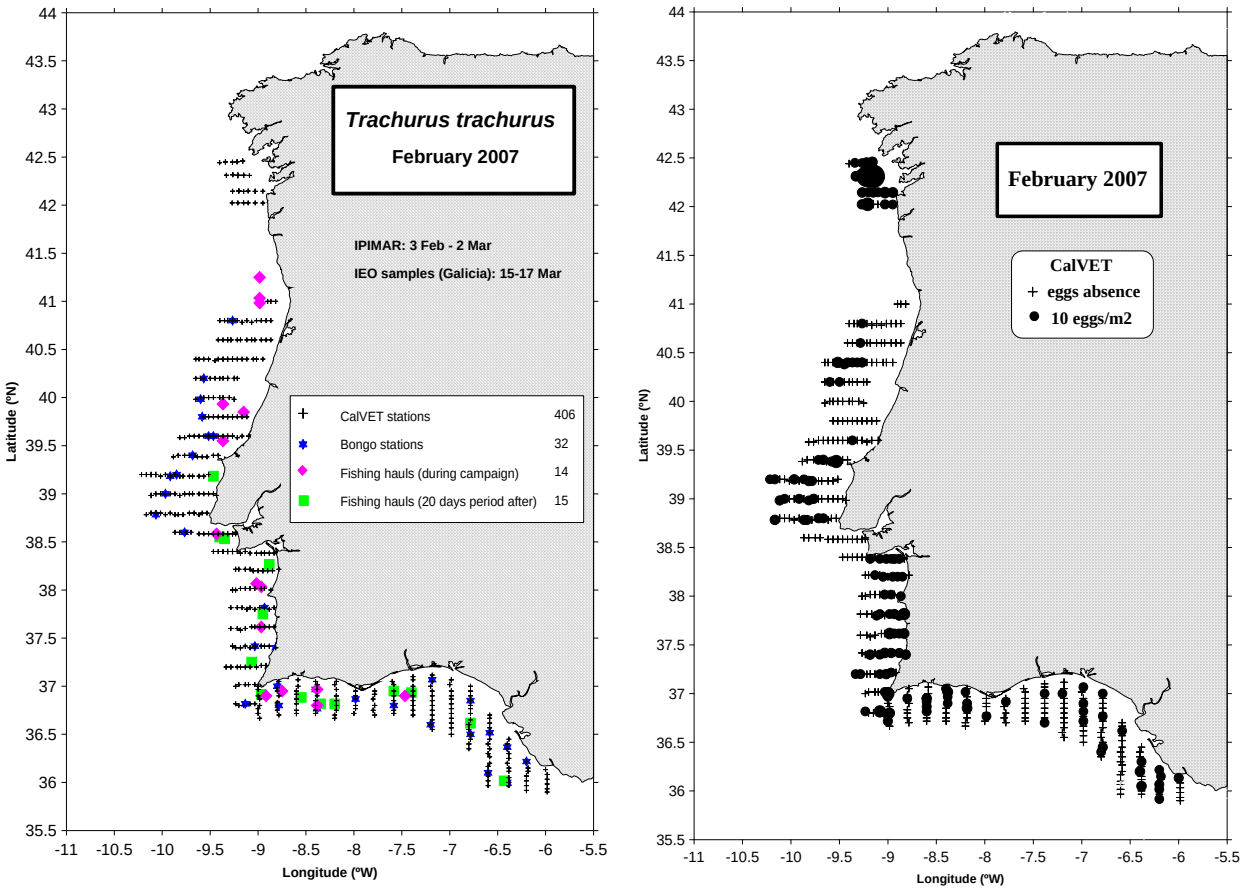


Figure 7.1.8.1. Left panel: Sampling stations (plankton and fishing hauls) carried out during IPIMAR horse-mackerel DEPM survey; Right panel: Horse-mackerel egg densities.

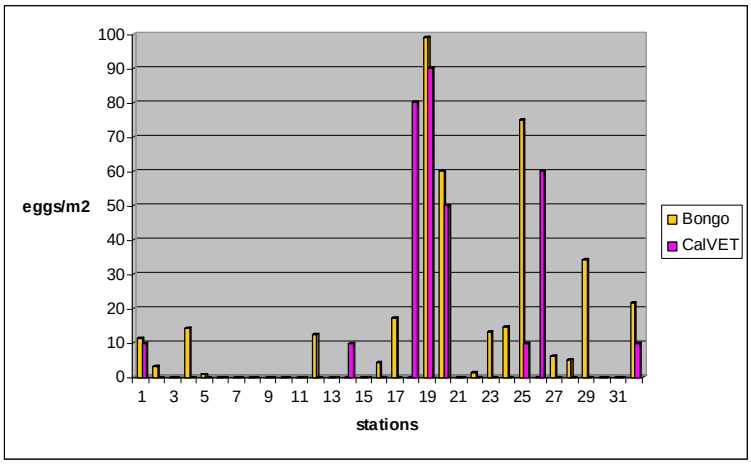


Figure 7.1.8.2. Horse-mackerel egg collection with CalVET and Bongo nets taken at adjacent points (32 pairs of stations).

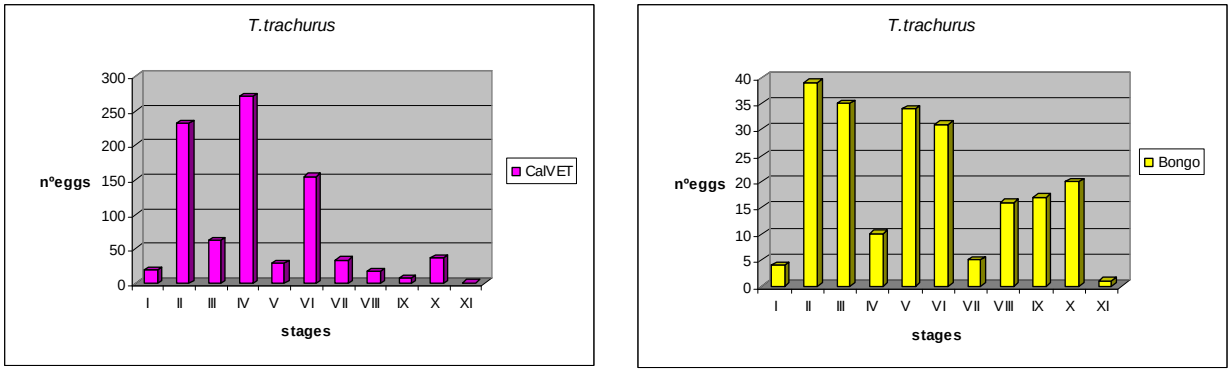


Figure 7.1.8.3. Stages horse-mackerel egg collection with CalVET (left panel) and Bongo (right panel) nets taken at adjacent points.

7.2 Advances in acoustic estimation

7.2.1 Analysis of data from different stocks/areas with Baracouda

One of the objectives of the Working Group (WGACEGG) is to standardise procedures between institutes and integrate their survey data in order to jointly produce regional scale maps of fish distributions. A common data base for acoustic surveys was suggested during WGACEGG in 2006 (WD Petitgas *et al.,* 2006) using an Ifremer attempt named Baracouda based on ACCESS software. This database structure allowed to store both acoustic energies and fishing hauls data. It also permitted to code numerically the different expert judgements made in assigning echo-traces to species, allowing later comparisons between procedures and discussions when scrutinising echograms.

A workshop took place in Palma de Mallorca from 24–25 November 2007 to try to fit data collected during the various acoustic surveys carried out by WGACEGG members in order to assess if such a tool could be suitable to every surveys and analyse the possible incompatible data, gap in information and ability to get output results.

The participants were:

Beillois Pierre, IFREMER France
Bernal Miguel, IEO Spain
Boyra Guillermo, AZTI Spain
Diaz Nuria, IEO Spain
Iglesias Magdalena, IEO Spain
Marques Vitor, IPIMAR Portugal
Martinez Udane, AZTI Spain
Massé Jacques, IFREMER France (Chair),
Miquel Joan, IEO Spain
Oñate Dolores, IEO Spain
Peña Marian, AZTI Spain
Ramos Fernando, IEO Spain
Stratoudakis Yorgos, IPIMAR Portugal
Tugores Pilar, IEO Spain
Zwolinski Juan, IPIMAR Portugal

A simplified data base called "WGACEG" has been elaborated and placed at participants' disposal for this workshop. A series of procedures have been carried out progressively (Figure 7.2.1.1.) in order to input all the data into the designed "Access" tables.

These tables will contain:

- survey identification
- catches
- length distribution
- age/length key
- weight/length key
- TS relationships
- Echo-integration configuration
- Echo-sounder characteristics
- sA/ESDU/echo trace type
- Echo-traces description
- Linkage between echo-traces and species
- Linkage between echo-traces and haul

Each institute made available text files according to the format previously agreed and four surveys (global or a single stratum) were considered for the exercise (Table 7.2.1.1.):

- ECOCÁDIZ survey from IEO South
- PELAGO survey from IPIMAR
- PELACUS survey from IEO North
- JUVENA survey from AZTI

During the Workshop, as a first step, the input data were minimized to the one essential to operate a primary assessment calculation in order to check the feasibility

and the credibility of the results. The input data were: acoustic energies (date, time, position, sA/ESDU), catches (catch/species, mean length), acoustic parameters (TS), association criteria species/sA (possible echo-trace classification and/or linkage with appropriate hauls). For a complete data base it would have been necessary to take also into account: the length distributions, the age/length keys and the weight/length key.

Such a data base is quite sophisticated and the diversity of each institution permitted to tackle a number of obstacles. Most of the problems were due to format particularities and solved during the Workshop. Biomass estimates were possible for three of the four examples and results seemed to be compatible. As an example, IEO results are presented in Figure 7.2.1.2., showing a rather good linkage. More analysis must be performed to explain the remaining discrepancies. One of the possible reasons could be the use of mean length per species per haul instead of using the length distribution. This exercise will be performed in the future to measure the bias induced by the mean length.

Nevertheless, the main objective which was to test the feasibility to input the necessary data from each institution was achieved and calculations were done showing that a common data base could be considered in the future. Baracouda was used as a prototype and permitted to highlight the possible problems.

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 seems essential that acoustic survey data will be interpreted fully for all species present in the water and not only for a few commercial (sometime only one) target species, leaving the rest of the echo-trace information lost for future analyses. Surveys carried out by WGACEGG members are now well targeting all the species and the allocation of S_A to specific biomass remains significant. It was agreed that the step of interpretation is by far the one leading to the most error in abundance estimation by species. A tool storing echogram scrutiny scenarios based for instance on the BARACOUDA structure, appears to be essential in the future. It could be used in international workshops on echogram scrutiny and provide a better quality control and international understanding of the interpretation of echoes into species from acoustic data, at regional scale.

A proposal has been already made to the RCM for the North Sea to develop acoustic databases, built from past work (SIMFAMI). WGACEGG agreed that such a common data base focused on sharing the interpreted acoustic data and the trawl haul catches was necessary, but emphasizes also the necessity to construct a database in which the interpretation of echo-traces to species would be stored.

Such a proposal was done to DCR just before the WG took place (WD P. Petitgas and J. Massé 2007). Taking into account the results of the Workshop and further discussions, WGACEGG supported this initiative and considered that this proposal was essential for the future of standardization and quality control of acoustic biomass estimates. As a first step it was decided to prepare for next year meeting a common database from Trafalgar to Brest, gathering S_A and biomass per species inside a standard geographical grid, which will be discussed and elaborated my mail in the near future.

Table 7.2.1.1. Number of data provided for each exercise during WGACEGG workshop on a common acoustic surveys data base.

	IEO (SOUTH)	IPIMAR	IEO (NORTH)	AZTI
Nb of ESDU	329	37	204	192
Nb hauls	48	2	11	47
Nb of transects	23	2	8	12

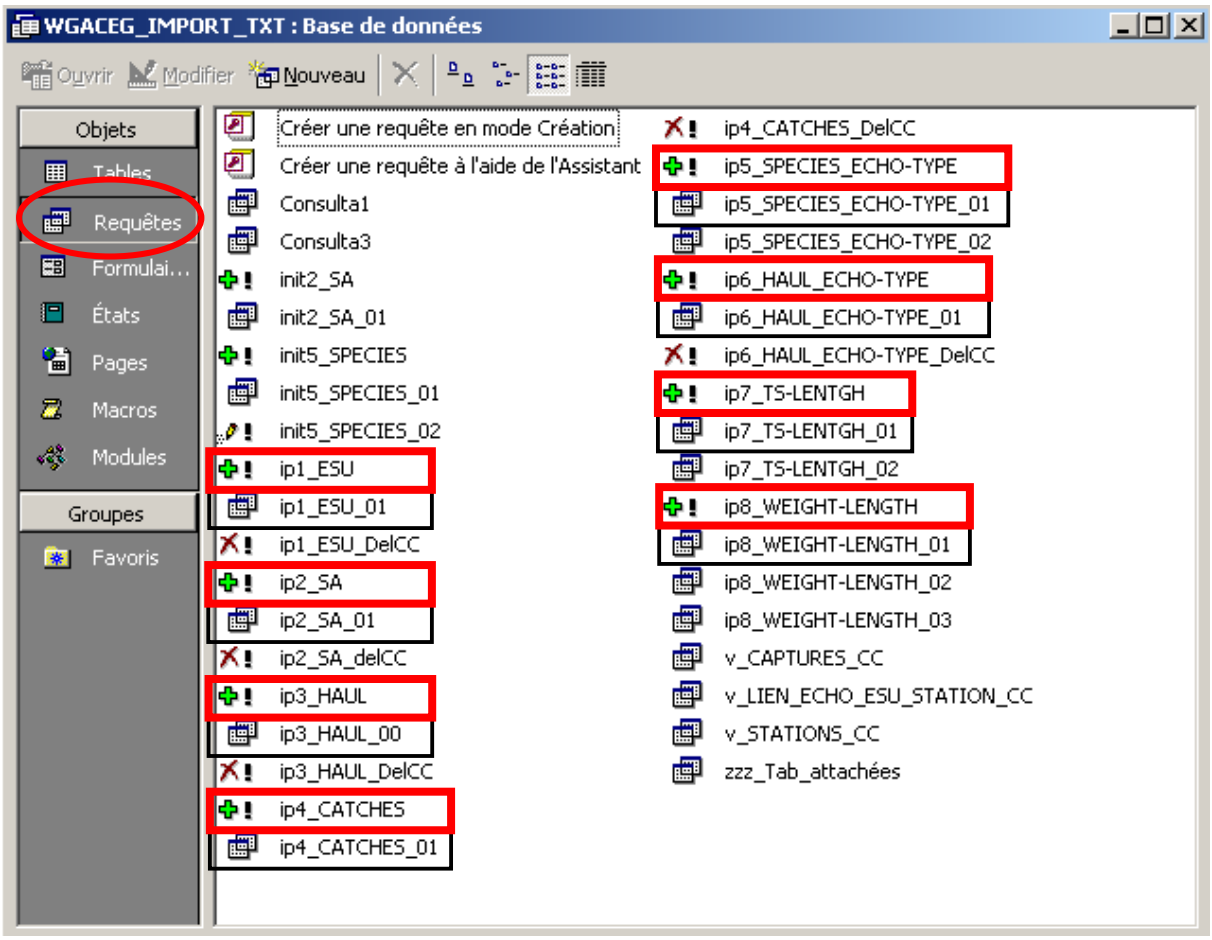


Figure 7.2.1.1. a - Series of procedures to be executed in order to input the data provided by each institute (TXT files).

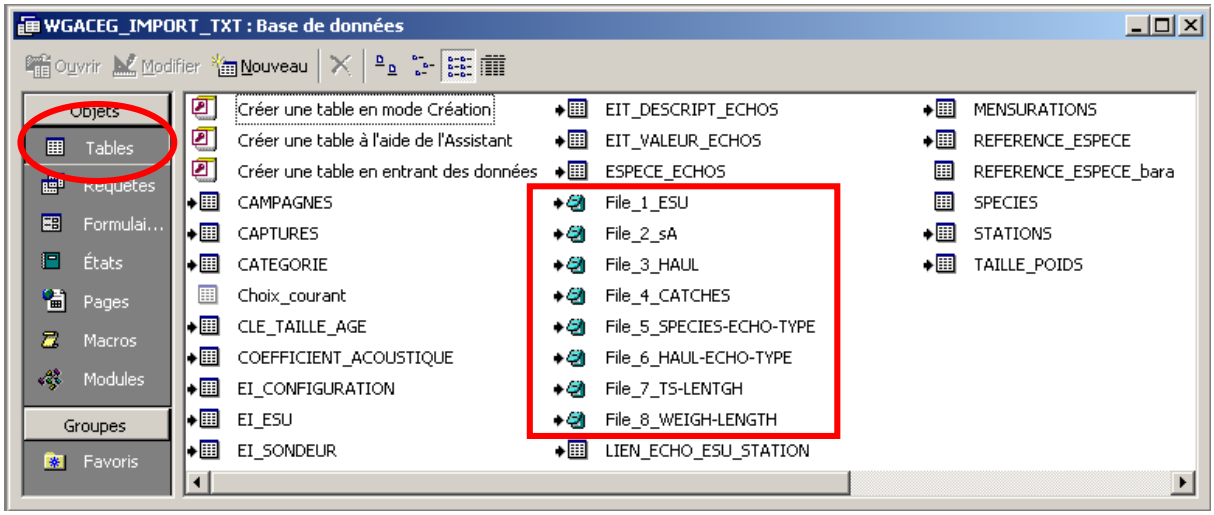


Figure 7.2.1.1. b - Series of txt.files which are imported by previous procedures in order to fill up the Access tables.

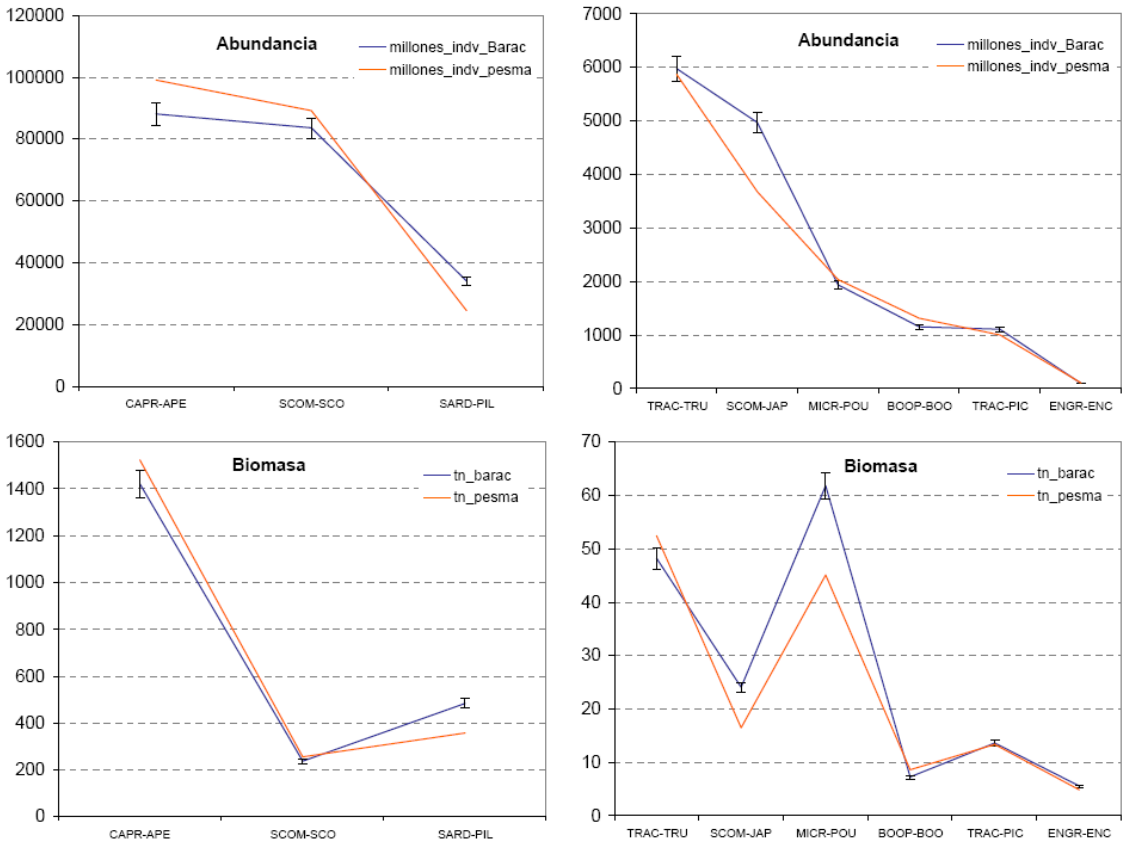


Figure 7.2.1.2. Comparison between biomass estimates provided by WGACEG common data base during the WGACEGG workshop and PESMA tool usually used by IEO on PELACUS2007 data.

7.2.2 Acoustic estimation with GAMs and resampling

A new procedure for estimating fish abundance at length and its variance was tested for a set of Portuguese sardine acoustic data. The method used generalized additive

models (GAM) to estimate a spatially indexed nautical area coefficient surface (NASC). A two-step GAM model (Borchers *et al.*, 1997), i.e. a model for presence and a model for acoustic density given presence, were fitted to sardine NASC per 1 nautical mille EDSU. GAM modelling of acoustic data is suggested as an alternative data to the traditional post-stratification of the survey area. Instead of obtaining average acoustic densities over regions or strata, surfaces of acoustic density were built by predicting from the fitted GAMs into a regular grid with 1 nautical mile node spacing (Figure 7.2.2.1). The resulting acoustic density surfaces were obtained by the product of the two models. To obtain numbers at length, each grid node was associated to the nearest trawl station; this procedure implicitly weights each length distribution by the echointegral of the surrounding area. Biomasses were obtained by applying the length/weight relationships to the numerical densities. Total abundance and biomass per length class were calculated by summing across the nodes. Confidence intervals for the integral of the acoustic density surfaces were obtained by 1000 simulations of the fitted model parameters as described in Wood (2006). The simulated density fields were combined with jack-knife realization of the trawl stations.

The procedure was tested in 6 data sets of acoustic surveys dedicated to sardine off Portugal and Gulf of Cadiz partitioned *a priori* in 3 large regions: Northwestern, Southewestern and Southern shelf. In terms of total reflection and sardine area of occupancy, the model based estimated and an arithmetic mean estimate did not differ significantly (Figure 7.2.2.2). The relative standard errors (RSE), and the range of confidence intervals (CI) of sardine total backscattering area were smaller for the model-based estimates (Figure 7.2.2.3). The variability in total number and biomass were largely dominated by acoustic sampling error and only a small amount of the error was due to the trawl allocation process. However in some cases, the length distributions of estimated populations were highly sensitive to a few particular trawls located in areas of high acoustic density (Figure 7.2.2.4). Nevertheless, the mean weights of sardine calculated by GAM and nearest neighbour allocation were not statistically different from the mean weights of fish given for assessment that were calculated by post-survey stratification and un-weighted average of the length frequency distribution within the strata.

Overall, GAMs proved to be a reliable way of obtaining acoustic density over a region, both in cases of strong or weak spatial trends. A gain in precision in relation to the arithmetic mean was obtained. The trawl allocation and re-sampling procedure was only one the many possible, e.g. nearest neighbour or weighting by echo-integral, un-weighted average, coherent areas, but the algorithm used has the possibility of accommodating different ways of trawl allocation. Additionally, other sources of variability might be included, such as the uncertainty in the partition of the species by trawls, the uncertainty in length/weight relationship parameters, or target strength.

The Working Group recommended a Workshop to test the applicability of the estimation procedure in other data sets and to compare the results with other means of estimation, in particular BARACOUDA.

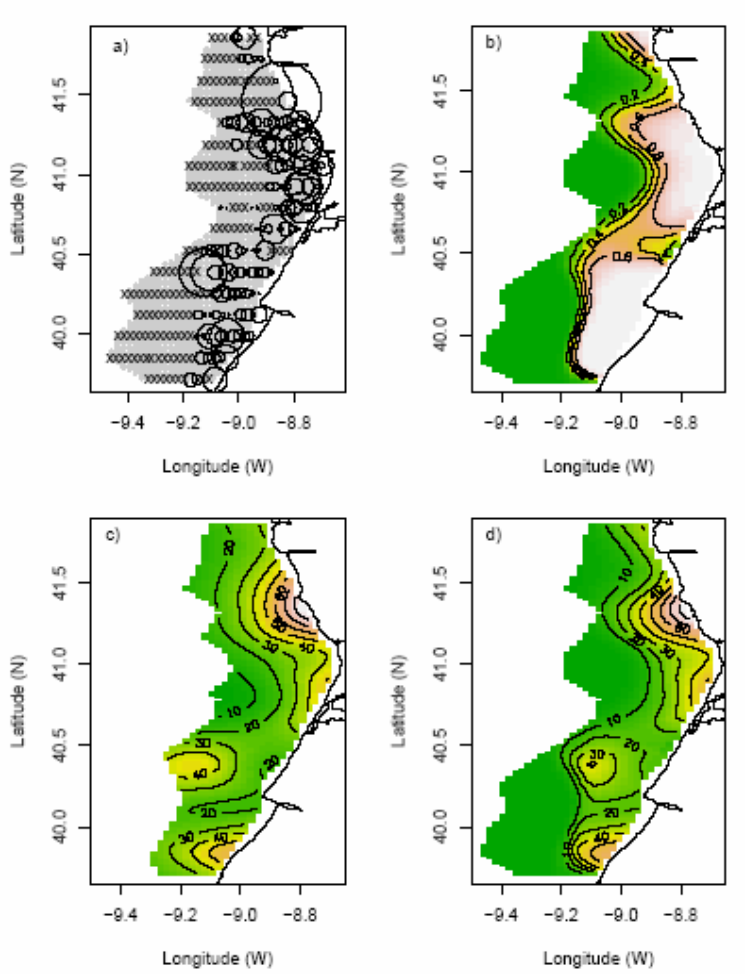


Figure 7.2.2.1. Building of a NASC surface. (a) Raw data superimposed on the prediction grid; ``x'' mark zero NASC and circles are proportional to square root values. (b) and (c) show respectively the predicted presence and acoustic density surfaces. (d) shows the NASC predictions surface obtained by the product of surfaces (b) and (c). NASC contours are in square root scale

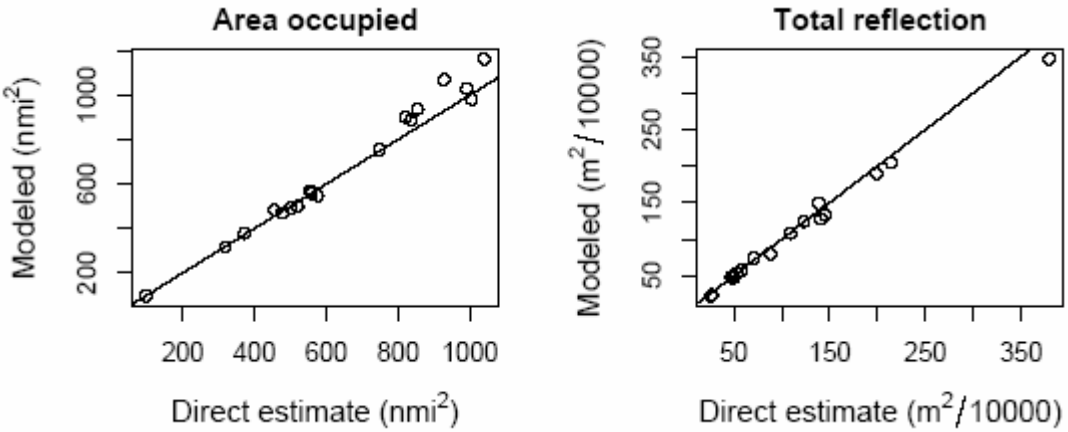


Figure 7.2.2.2. Comparison of the modelling and non-modelling estimates for: (a) area of occupancy, estimated by multiplying the proportion of positive samples and total grid area (x-axis) versus GAM estimated area (y-axis) and (b) total sardine backscattering area estimated as the product of the arithmetic mean and grid area (x-axis) versus GAM estimated backscattering area (y-axis).

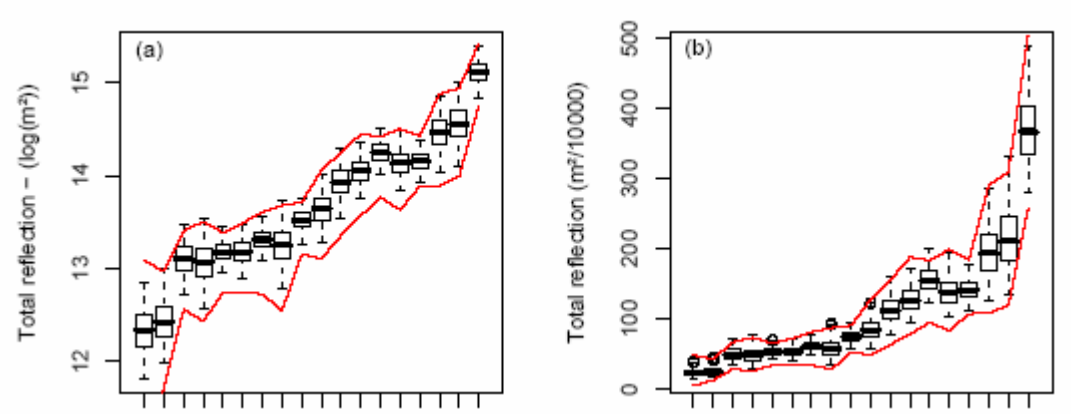


Figure 7.2.2.3. Representation of the quantile-based 95% confidence intervals for the total acoustic energy obtained from GAMs in (a) logarithmic and (b) linear scales shown as box plots. The bounding-lines in red show the confidence intervals for the mean-based estimator assuming independent and identically distributed data.

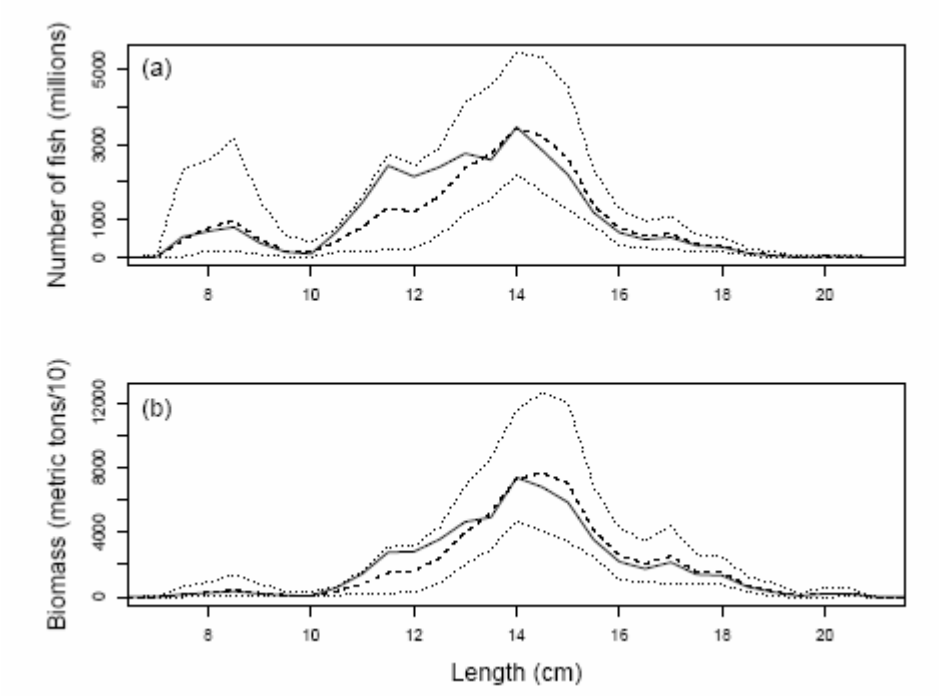


Figure 7.2.2.4. Length frequency distribution of the estimated population at the northern stratum autumn 2000 survey in (a) numbers and (b) biomass. The thick continuous lines represent the routine estimate for assessment. The doted lines mark the confidence boundaries obtained using GAMs and jack-knifed trawls constructed by joining the 99% quantiles for each individual 0.5 cm length class and the dashed lines represents the median. The wide confidence limits for numbers of fish between 7 and 10 cm is the result of acoustic data variability being boosted by the effect of a single trawl located in a region of high acoustic density.

8 Comparison and integration of acoustic and egg production surveys

8.1 Applications of CUFES onboard the surveys and potential uses for integration/cross validation

IFREMER reported to the WG the evolution of their use of CUFES system setting up on board RV "Thalassa" and in terms of using the collected data (WD Petitgas *et al.*,). They first reported the different changes that occurred during the PELGAS surveys series.

1) An outboard system has been systematically used from 2000 to 2005. Since 2002 an inboard system was used simultaneously during some periods in order to compare with the outboard one. After modifications, the inboard system was adopted and has been used since 2006.
2) Test have been done between 2002 and 2005 with 500 and 315 µm mesh size, in the concentrator and collector, using both an outboard system and a inboard system. The 315 µm mesh size has been adopted since 2006.

Studies have been carried out by IFREMER to use CUFES data, combined with a dynamic biophysical vertical egg distribution model (Petitgas *et al.*, 2006). Quantitative cross-validation with the acoustic fish abundance is underway.

The CUFES egg data assembled at regional scale by IPIMAR, IEO and IFREMER were used together with sea surface temperature, salinity and bottom depth, to estimate potential spawning conditions of sardine and anchovy in spring with the method of quotient plots. This method was initiated by GLOBEC (2005) and further developed to incorporate a significance test (ICES, 2006). Modelling of egg occurrence and concentration using regression techniques on hydrological parameters were performed (Planque *et al.*, 2007). Inter-annual variation in the use of potential spawning habitat was estimated.

A long-term comparison of egg distribution was performed that was based on ichthyoplankton survey data from the 70s and the 2000s CUFES data (Bellier *et al.*, 2007). Recurrent and occasional spawning sites were identified.

Building the capacity to cross validate the acoustic survey estimate with the CUFES egg data, IFREMER developed an estimate of fecundity to serve as an indicator of survey reliability.

The combination of the CUFES (continuous underwater fish egg sampler) with the acoustic sampling has the potential to cross-validate the acoustic methodology with another method and address the question of bias in relative terms. IFREMER is building the capacity to cross validate the acoustic survey estimate with the CUFES egg data. An estimate of fecundity is being developed to serve as an indicator of survey reliability.

IFREMER suggests that WGACEGG creates explicitly a common regional data base for CUFES data and updates the base in each year.

Characterising Sardine spawning habitat using PELACUS survey CUFES data

IEO presented to the WG a work in order to characterize Sardine (*Sardina pilchardus*) spawning habitat using Sardine egg densities and environmental and geographical data (Temperature, Salinity, Bottom depth, Time and Longitude degrees) collected from CUFES during PELACUS annual surveys on board RV "Thalassa" covering Spanish waters in ICES Divisions VIIIc and IXa North for the period 2000–2006 (not including 2003) (WD Costas *et al.*,). Single parameter quotient analyses (Van der

Lingen *et al*., 2001), Temperature-Salinity plots (GLOBEC, 2005) and Classification tree modelling were carried out using CUFES combined data for all PELACUS surveys. Table 8.1.1 shows a summary of these CUFES data for Sardine eggs in PELACUS surveys.

The results from the quotient analyses for temperature (Figure 8.1.1) showed a Sea surface Temperature preference ranged from 12.8–14.6°C, Sea surface Salinity preferences (Figure 8.1.2) were ranges from 33.75–34.25 psu and Bottom depth preferences (Figure 8.1.3) showed a primary peak at 75 m (Log (Depth) = 5.3) and a secondary peak in shallow waters (40 m).

The Temperature-Salinity plots (Figure 8.1.4) indicated that most stations are located along a sigma-t value of 27.

And finally the results of classification tree in order to predict presence/absence Sardine eggs in CUFES stations, using the underlying environmental characteristics as predictor variables. This analysis showed that the main predictor variables in relation of Sardine eggs presence were that Salinity was lesser than 35.465 psu and a Longitude degrees was bigger than -8.5 (terminal node 8) and in relation of Sardine eggs absence were that Salinity was bigger than 35.465 psu, Bottom depth bigger than 101 m and Longitude degrees was lesser than -6.5 (terminal node 1) (Figure 8.1.5, Figure 8.1.6). Results obtained are coherent with previous characterisation of sardine spawning grounds off Iberia (Bernal *et al.,* 2007).

Table 8.1.1. Summary of CUFES data for Sardine eggs in PELACUS surveys during period 2000–2006.

Year	N. stations	Positive stations	% Positive stations	Mean density (egg/m^3)	Mean density (Pos. stations)
2000	332	128	38	2.9	**7.6**
2001	268	187	70	8.2	**11.8**
2002	333	211	63	11.8	**18.7**
2004	397	276	69	6.1	**8.8**
2005	316	158	50	3.6	**7.2**
2006	**370**	**174**	**47**	**3.8**	**8.2**

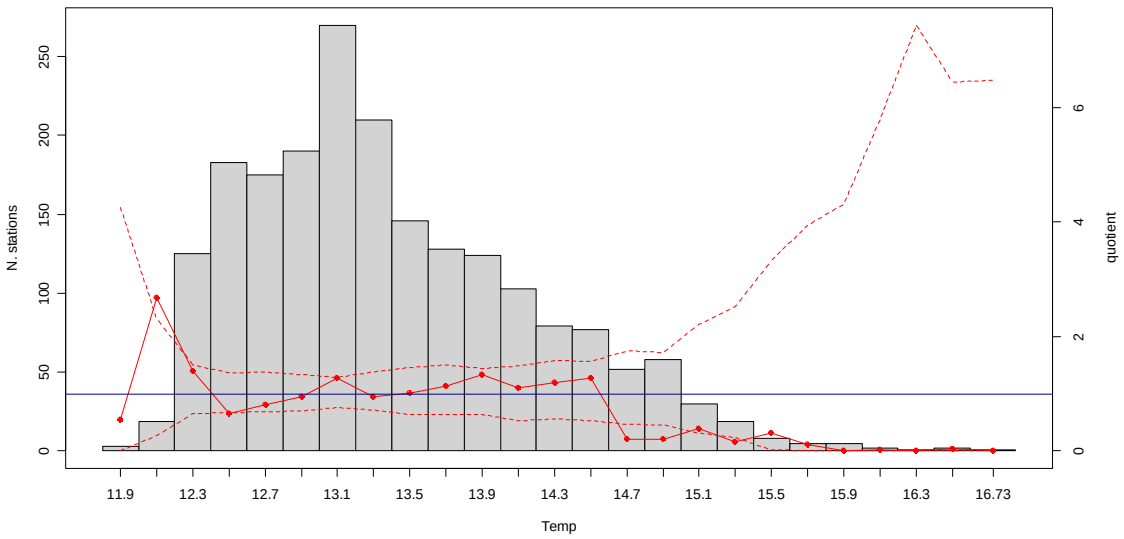


Figure 8.1.1. Quotient plot of Sardine egg density (eggs/m³) in relation to Sea Surface Temperature (ºC) in PELACUS surveys for the period 2000–2006. The horizontal line indicates a quotient value of 1. Dashed line means confidence interval of quotient line.

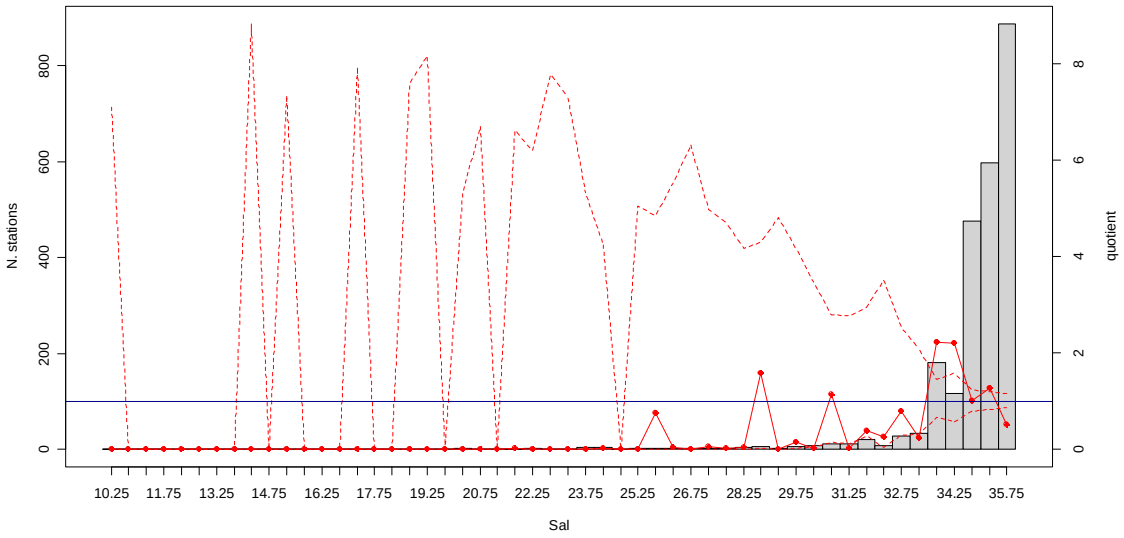


Figure 8.1.2. Quotient plot of Sardine egg density (eggs/m³) in relation to Sea Surface Salinity (psu) in PELACUS surveys for the 2000–2006 period. The horizontal line indicates a quotient value of 1. Dashed line means confidence interval of quotient line.

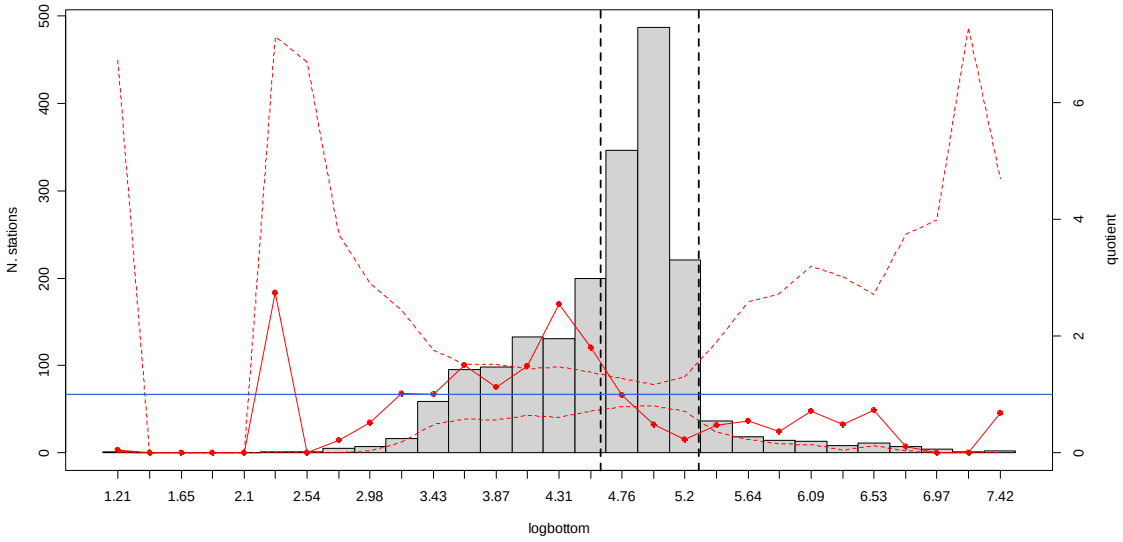


Figure 8.1.3. Quotient plot of Sardine egg density (eggs/m³) in relation to log (Bottom depth) in PELACUS surveys for the period 2000–2006. The horizontal line indicates a quotient value of 1. Dashed line means confidence interval of quotient line. Vertical dashed lines indicate Bottom depth of 100 m and 200 m.

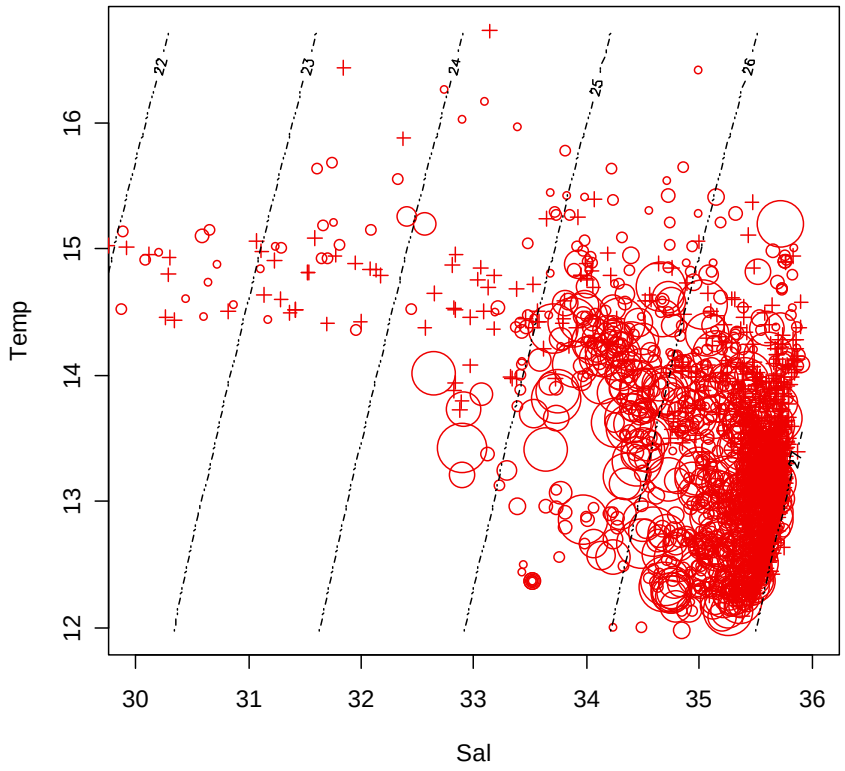


Figure 8.1.4. Temperature-Salinity plot (T-S plot) in PELACUS surveys for the period 2000–2006. Crosses indicate stations with less than 1 egg/m³ while red circles represent stations with larger abundances; circle size is proportional to egg density. Dotted lines are isolines of equal water density (sigma-t).

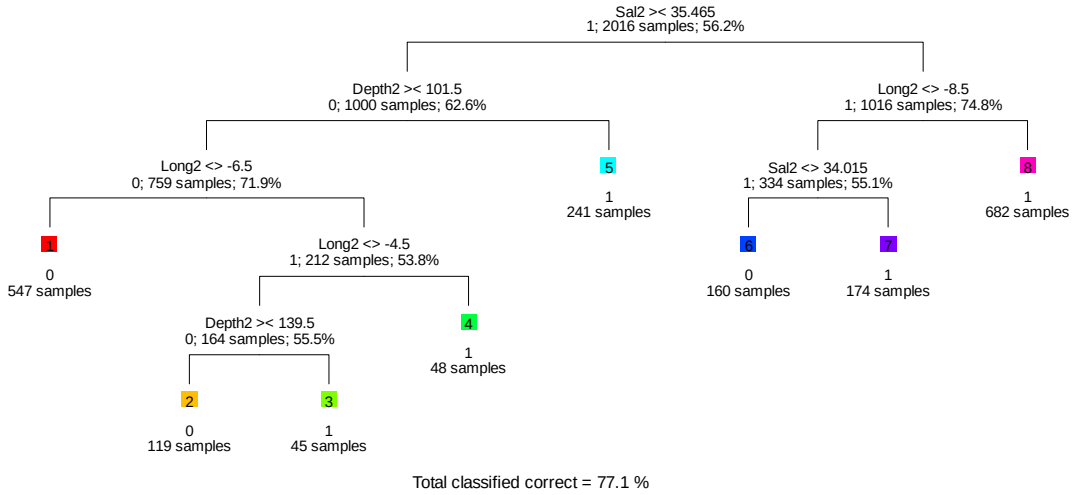


Figure 8.1.5. Classification tree for Sardine eggs. Displays the rpart-based model for the presence/absence (1/0) of Sardine eggs in CUFES station in relation to environmental and geographical parameters in PELACUS surveys for the period 2000–2006. The coloured labels of nodes indicate terminal nodes.

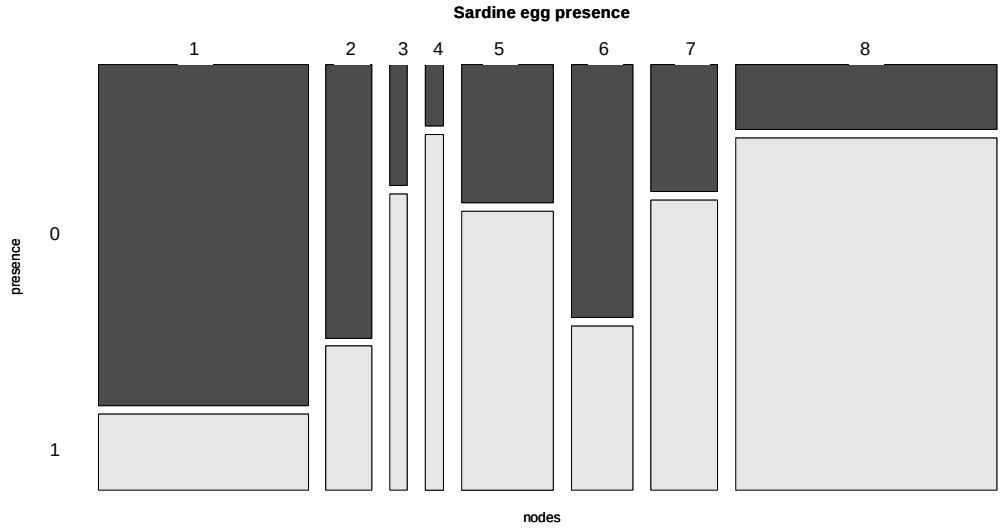


Figure 8.1.6. Results of classification tree of presence/absence (1/0) of Sardine eggs in CUFES station in PELACUS surveys for the period 2000–2006 depicted by a mosaic plot. Black boxes means absence of Sardine eggs (0) and grey boxes mean presence Sardine eggs (1). Box areas are proportional counts in each terminal node.

8.2 Sardine habitat from acoustic surveys

Relationships between sardine (*Sardina pilchardus*) distribution obtained acoustically and the environment off western Portugal (Figure 8.2.1) were explored using data

from seven acoustic surveys (spring and autumn of 2000, 2001, 2005 and spring 2007). Four environmental variables (sub-superficial salinity, temperature and chlorophyll concentration obtained with CUFES and planktonic acoustic backscatter in the water column) were related to the presence of sardine. Univariate quotient analyses revealed sardine preferences for waters with higher chlorophyll content, lower temperature and salinity and lower planktonic backscattering (Figure 8.2.2). Regression of sardine presence on the principal component rotated environmental variables confirmed quantitatively the above trends. These results are in line with a sardine diet based mainly on phytoplankton and small zooplankton that usually concentrate in productive, cooler and less saline coastal waters. Generalized additive models were used to construct multi-annual synoptic relationships to map sardine potential habitat (SPH). The models revealed a clear seasonal effect in the bathymetric and along-shelf extension of SPH off western Portugal. During autumn, SPH occupied a large part of the northern Portuguese continental shelf but was almost absent from the southern region, while in spring SPH extended further south but was reduced to a narrow band of shallow coastal waters in the north (Figure 8.2.3). This seasonal pattern agrees with the spatio-temporal variation of primary production and oceanic circulation off western Iberia. The northerly concentration of SPH during autumn can be linked to the onset of the downwelling season that coincides with the settlement of oligotrophic waters in the narrow southern shelf and the maintenance of higher production associated to nutrient input from river in the wider northern shelf. Shelf-wide spring phytoplankton blooms provide a suitable habitat for sardine across western Iberia, but the penetration of the Iberian poleward current onto the outer shelf of northwestern Iberia constrains spring production (and SPH) to the inner shelf.

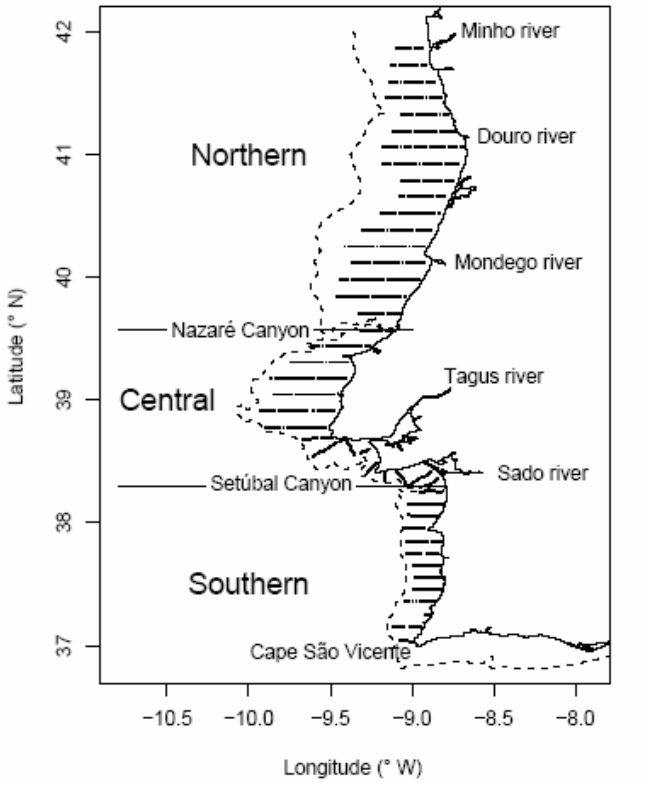


Figure 8.2.1. Survey region. The full and dashed lines represent the coast and the 200 m isobath contour respectively. The dots along parallel lines mark the acoustic samples (EDSUs) along the transects.

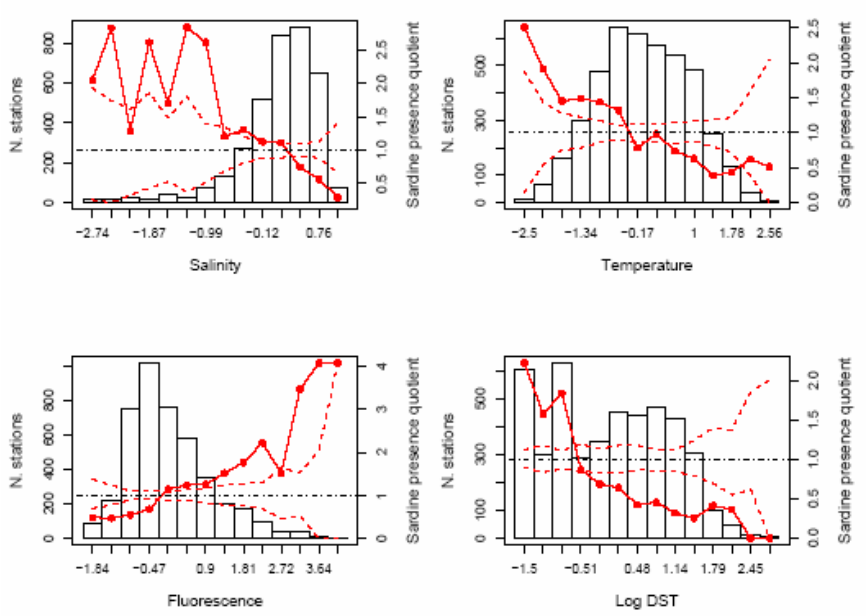


Figure 8.2.2. Quotient plot of sardine presence against annually standardized environmental variables for all years. Dashed lines limit the confidence envelope for quotient arising from random distributions.

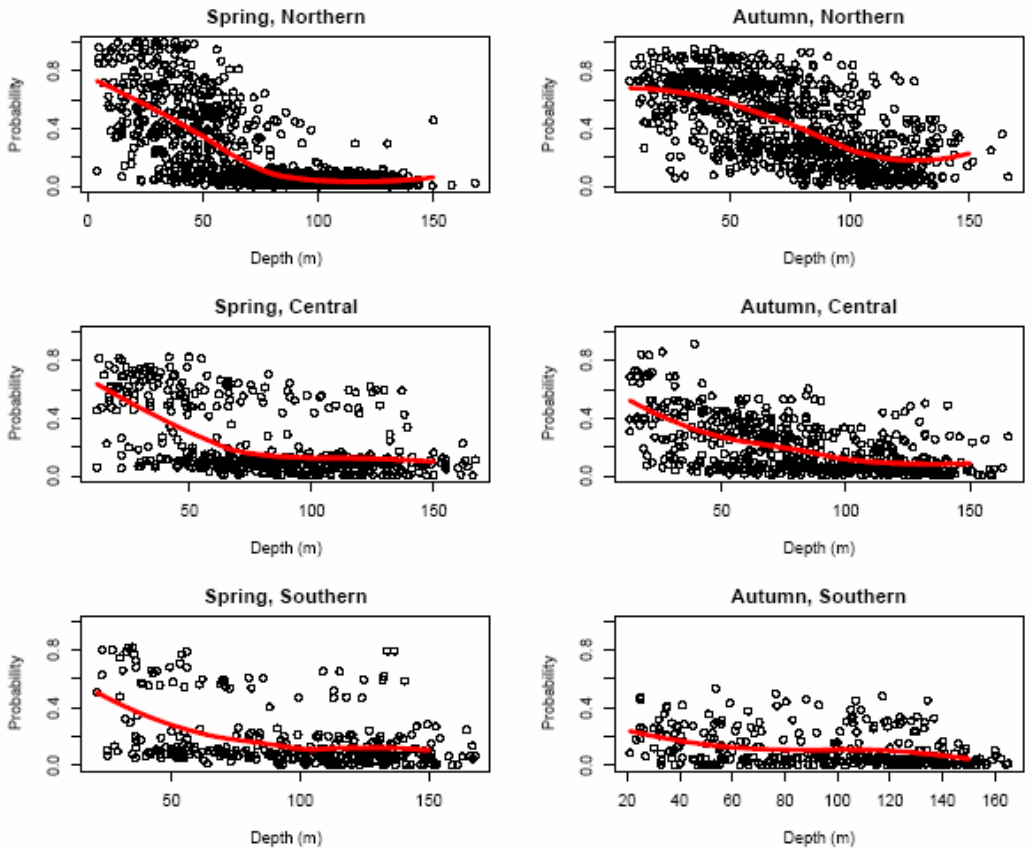


Figure 8.2.3. Fitted probability of sardine presence based on the spring and autumn GAMs in relation to depth and region. All survey data points are included. The superimposed line is a smoother capturing the mean trend.

8.3 Sardine dynamics analysed from catches and fishery independent data

A study on regional sardine dynamics across the Iberian-Biscay waters was presented to the WG. This study integrated area-based data from acoustic surveys and catches (compiled within the SARDYN project) to obtain information on the distribution, age structure and year-class strength by area and to infer possible age-related migrations between areas.

The results supported previous indications of a heterogeneous distribution of sardine biomass and substantial spatial variability in demographic structure and year-class dynamics. The main recruitment areas are located in northern Portugal, the Gulf of Cadiz and southern Gulf of Biscay while adults concentrate mainly in the Cantabrian Sea and south Portugal. The slope of year-class curves was also shallower in the latter two areas in consistency with the hypothesis of age-related immigration from neighbouring recruitment areas. Taking also into account the synchronicity in year-class strength between areas, plausible migration directions are from Cadiz to south Portugal and from north Portugal to south Galicia and into the Cantabrian Sea. However, the origin of Cantabrian sardine is still unclear and recent data suggests that some strong year classes appearing in this area may have recruited in the Gulf of Biscay. Finally, the fact that different recruitment pulses were noticeable in distinct regions suggests that migration paths may change over time.

8.4 Future plans

The working Group undertook a revision and a global discussion about the way the work of the working groups is seen and should evolve in next coming future. As a result of that discussion the Terms of Reference were slightly reformulated and enhance to better comprise the WG's views about its own commitments and future plans of works (see Section 3.1). In addition several practical considerations for improving the procedures of work for future were also outlined; a summary of which follows:

The WG will still cover the classical ToRs about revision and coordination of acoustic and egg surveys in ICES Areas VIII and IX, the update on methodological innovations on these methods and their cross validation and integration. Nevertheless, looking into the future, 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, as produced by the acoustic and egg surveys, both for the spring and autumn coverage's. To that purpose some concrete working proposals for next coming year, 2008 meetings, were set up:

- To create a common Regional data base (Acoustic+CUFES and Pairovet sampling) with common format (spatial grids, units etc), and common analysis tools. Such data base 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 email+lab working).

- To modify partly the schedule of work and dynamic of presentations during the WG meetings in order to focus more on global results of the surveys across the whole region and on methodological aspects. For instance Resource assessment presentations can be made in a common session for all institutes (joint successive presentations by methods for the results across areas) and single presentations could be restricted to main methodological issues.
- To accommodate partly the structure of the report to better reflect this regional perspective of the results and the methodological issues. A draft of the new structure of the report will be prepared and circulated by the new Chair before next year WG meeting.

Regarding the common data base: It should store all relevant information, and the product should be standardized and geo-referenced within a common spatial. Before the next coming meeting it would be necessary to define the Common Grid, the concrete grid dimensions and their geo-references. Data should be submitted in the agreed data format before coming to the WG and this data base will start with the most recent year of data (so with 2008 data for the next year) incorporating past years subsequently as soon as possible. The database storage and the access to the data should be discussed between WGACEGG and the ICES Data group. Methods to allocate biomass by rectangles may differ a bit from institutes and by methods. A procedure for submitting compiling the data and for producing the common maps will be agreed. And it was considered the convenience of setting responsible people for Acoustics, CUFES and Pairovet data sets (at least to start working). The persons in charge of compiling the data for these different data sources were also outlined, although a final proposal will be done before next WG meeting, making use of the different workshops programmed.

Levels of data to input:

Egg abundances from CUFES and PAIROVET by species,

Acoustic Energy Sa and biomasses from acoustic (by species).

Egg Production and Biomasses from DEPM (GAM based) for the target species.

Percentage of the different species by rectangles (fishing hauls)

Biomasses by age and length by rectangles.

Potential: to integrate the CTD data?: (at least at surface? SST, SSS%º ?)

Top predators and mammals and birds observations?

Etc.

The persons in charge should better define the input data and units.

- Certainly all those ideas require some more dynamic interseasonal work to push ahead some joint works or methodological discussions and updates, either by workshops or e-mail+lab work. As such, the following interseasonal activities were foreseen for 2008:
  - Workshop in March 2007 in Lisbon Chair (G. Boyra) (part for juveniles and part for every acoustic people) to
    - Update on the procedures to estimate variance of acoustic abundance estimates

  - Deal with Juvenile surveys and plan next year's surveys.
  - Look at the review of 2006 JUVENA estimate.
- Workshop on R script of DEPM (and should serve to produce the Egg Production and Biomass maps).
- Recommendation to endorse the realisation of workshop on reproductive biology of small pelagics of FRESH (Fish Reproduction and Fisheries) within COST action (FA0601) (see recommendations).

9 Conclusions

This year WG has made a large effort to provide a global coverage for the stocks included in the WG, by improving coordination, standardisation of tools used for the analysis and by analysing the different surveys in common. Based on this effort, the WG has produced a plan to change the operational structure of the group for the near future, in which data to the WG is provided at regional scale directly, allowing spending more time during the meeting to compare species and local differences. Conclusions for this year WG are therefore presented in a comparative way, setting the directions for future analysis in the Group.

Pelagic community in the Atlantic waters of the Iberian Peninsula and Armorican Shelf.

The Armorican shelf and the Atlantic waters of the Iberian Peninsula show a high diversity of pelagic species, in comparison with other pelagic communities of northern European waters. Although sardine and anchovy can be considered as dominant species in some specific areas, in most places they appear in conjunction with other species, in some cases being outnumbered by those species. Anchovy distribution is mainly confined to two defined areas in the Armorican shelf and in the Gulf of Cádiz, with the distribution of the biggest individuals delimiting the external limits (offshore limit and geographical limits) of the distribution in each nucleus. Sardine in comparison shows a wider and nearly continuous distribution through the area covered by this WG, although spawning grounds are also confined to localised areas in the Gulf of Cádiz, north-west Portuguese coast and Armorican shelf. The situation of both the sardine and anchovy population extracted from the acoustic and DEPM surveys are as follows:

Anchovy populations

Bay of Biscay anchovy has passed in recent years by a crisis which has lead to the lower estimates of SSB through the time series and the closure of the fishery. Recruitment since 2006 has been poor and the SSB levels have therefore not recovered. Both DEPM and acoustic estimates of SSB for 2007 show a slightly higher SSB value in comparison with 2006 (40000 t and 26000 t respectively). Taking into account the associated variances, values and trends between acoustic and DEPM-based SSB estimates are similar since the crisis. Nevertheless, the fact that the absolute value of Blim is between the actual SSB estimates from both methods creates some management problems. Estimates of recruitment from an index of juvenile abundance are not yet considered to be robust. Juvenile abundance index for 2007 show a low value in comparison with previous estimates, therefore there is no indication of a possible high recruitment for 2008. Other indirect signals from the acoustic survey show that situation in Bay of Biscay anchovy may be slightly improving, like the wider distribution of the population and the structure of the schools, but current fishery independent estimates indicate that the SSB values continue to be among the lowest of the available time series.

Gulf of Cádiz anchovy shows in comparison a better perspective from the different acoustic estimates available (IPIMAR and IEO) and from the observed distribution of eggs (from CUFES). Acoustic surveys from IPIMAR and IEO provide similar biomass estimates (40000 t and 30000 t respectively), and a similar spatial distribution of the stock (mainly located in the Spanish waters of the Gulf). These estimates indicate a slight increase in relation to previous years. The distribution of eggs this year also

show a large coverage, although DEPM based SSB estimates will not be available until late 2008/2009, from the survey that will be carried out in 2008. For the previous DEPM estimate, the value was also coincident with the acoustic estimation; therefore fishery independent SSB estimates seem to provide a coherent view in this area. Nevertheless, the time series of DEPM survey reduces to just one year and therefore proper comparison are yet meaningless, and some differences between the IPIMAR and IEO acoustic estimates have appeared in the past.

Sardine population

The state of the Atlanto-Iberian sardine stock from fishery independent SSB indexes continues to provide a general positive perspective, although some discrepancies and spatial differences in the perception exist. Estimates of sardine SSB in the Armorican shelf are now routinely presented both to this WG and to the assessment WG, and the short time series available in this area (from 2000) indicates a general decrease of sardine abundance, with an estimate for 2007 of 126000 t. Nevertheless, the large variability in the SSB estimates obtained in some years (e.g. 2003) seem to indicate that the population in this area may not always be available (at least in the same percentage) to the acoustic survey. Also, the northern limit of the sardine distribution in the Armorican shelf is not attained in the survey, and therefore uncertainties in the percentage of the population that can be missing exist. Estimates of SSB from the north Iberian coast and the north-west corner indicate a slight increase in SSB (96000 t for 2007), but also show a patchy and concentrated distribution, with the population constrained to coastal areas and some spots in the north-west corner. Also, the percentage of old fish continues to be low in comparison with early years of the time series. Distribution of eggs from CUFES indicates an anomalous wide distribution and large abundance for 2007 in the north Iberian area, although conclusions on spawning intensity will have to wait until the 2008 DEPM survey. Sardine SSB estimates in the western Iberian façade show an average state of the stock in this area (344000 t), but also indicate a weak recruitment. Estimates in Cádiz also indicate an average state of the stock in the area, and are in general coherent between surveys (107000 t and 87000 t for the IPIMAR – April and IEO – June survey).

Methodological advances and challenges for the future

A large number of reviews and methodological advances were presented to this WG, affecting both acoustic and DEPM based SSB estimates. Reviews presented include: i) a revision of sardine and anchovy acoustic SSB estimates from IFREMER, due to the implementation of a common database for all years of the IFREMER time series, ii) a revision of the Bay of Biscay anchovy juvenile abundance index time series, due to various methodological changes and some methodological problems, iii) a revision of anchovy DEPM estimates, due to a change in the methodology used for the estimation of egg production, and specially in the estimation of adult fecundity, and iv) a review of Atlanto-Iberian sardine egg production estimates, based on a review of mortality estimates and a spatially explicit egg production model. The main effects of the revisions are:

- The BoB anchovy juvenile Index has suffered large and thoughtful reviews in the past years. The possibility to compare the juvenile time series (JUVENA) with another survey (PELACUS) has allowed improvement of the methods and the analysis of results. The sources of differences between surveys have been identified and recommendations on improving coverage from the surveys have been produced. The WG continues to recommend seeking a direct index of recruitment, and values the

improvements introduced in the juvenile surveys. Despite the advances, the time series of juvenile abundance index is still under revision, and therefore it is not yet considered as a robust assessment tool.

- A thoughtful revision of BoB anchovy fecundity has led to an increase in spawning frequency estimates of around 60%. This yields SSB estimates lower than previous, and of about 30–50% lower than the SSB estimates provided by acoustics. The WG endorses the scientific work supporting the review, and therefore recommends providing a full review of DEPM-based BoB anchovy SSB estimates to next WGANC meeting, in order to include it in anchovy assessment. An assessment of the effect of the DEPM-based estimate of SSB in the general BoB anchovy assessment is also recommended, together with an analysis of the effects of using both acoustic and DEPM indexes as absolute or relative in the assessment tuning.

Also, the possibility of using spatial models of both egg production and acoustic data was presented to this group. GAM-based DEPM and acoustic estimates provide more precise and robust estimates, while offer a better spatial representation and the possibility to do area-based assessment and management.

Challenges for the future include changing the operational procedure of the WG, in order to be able to provide estimates at regional scale, and methods to compare and integrate them. The increasing implementation of spatial models will facilitate the comparison and integration of estimates, and will provide comparative ecological information between species and years. The inclusion of these methods as well as the reduction of the sources of bias in the different estimates is a main priority for next years.

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Annex 2: Agenda

Monday 26 November 2008:

09:00 – Presentation + SharePoint

09:10 – Overview of last year advances (M. Bernal)

09:20 – WGACEGGS 06: ToRs, Topics, special request and agenda (M. Bernal)

09:30 – Recent fishery independent surveys for sardine and anchovy in ICES areas VIII and IX

DEPM surveys

09:30 – Anchovy DEPM estimates 2006 in the Bay of Biscay (M. Santos):

10:00 – GC anchovy egg development model (M Bernal)

10:30 – Horse mackerel DEPM – based SSB estimates off Portugal (Murta *et al*.,)

11:00 – 11:30 Coffee break

DEPM surveys: revisions

11:30 – GC 2005 revised estimates of egg production and adult parameters (Millan, Bernal)

12:00 – Revision of BoB anchovy POF, DF, P0 (glm)

(Santos, Uriarte)

12:30 – Revision of Atlanto-Iberian egg production estimates (M Bernal)

13:00 – General discussion on DEPM surveys and revisions.

13:30 – 14:30 Lunch break

DEPM surveys: cont.

14:30 – Anchovy DEPM surveys in the Mediterranean Iberian area (I. Palomera)

15:00 – Results of the WS on application of ichthyoanalysis to the different stocks in WGACEGG (M Bernal)

15:30 – Planning of the 2008 Atlanto–Iberian DEPM sardine survey (Short by M. Manuel)

16:00 – Discussion on 2008 DEPM survey planning.

16:30 – 17:00 Coffee break

ACOUSTICS, database:

17:00 – Comparison between acoustic database proposals (J. Masse)

17:30 – Results of the database + analysis tools Workshop (J. Masse)

18:00 – Discussion on acoustic databases and tools

18:30 – 19:00: Summary of the day and Topics for subgroups

19:00 – End.

Tuesday 27 November 2008:

09:00 – ACOUSTICS: Juvenile surveys

09:00 – Proposal for a sardine recruitment index off western and southern Iberia (Y. Stratoudakis)

09:30 – PELACUS 1007 results (E. Nogueira)

11:00 – Coffee break

11:30 – ACOUSTICS: Juvenile revision

11:30 – Juvena 07 survey results (G. Boyra)

12:00 – Results of the Nantes Workshop (J. Masse)

12:30 – Discussion on Juvenile revision: data provided to the assessment WG and future of sardine recruitment index.

13:00 – ACOUSTICS: SSB estimates

13:00 – Gulf of Cádiz (GC) Results during ECOCÁDIZ 0607 (F. Ramos *et al.,*)

13:30 – 14:30 Lunch break

14:30 – ACOUSTICS: SSB estimates (cont)

14:30 – Sardine on 06/07 IPIMAR acoustic survey (V. Marques)

15:00 – Pelagic community in southern Iberia 06/07 (J. Zwolinski)

16:30 – 17:00 Coffee break

17:00 – INTEGRATION and overview of stocks

17:00 – Potential habitat for sardine from acoustic surveys (J. Zwolinski)

17:30 – Regional sardine demography and dynamics using catch data and acoustics (A Silva)

18:00 – Regional changes in demography and spawning habitat (M. Bernal, short)

18:15 – Use of CUFES to integrate acoustic and egg surveys (J. Masse, short)

18:30 – CUFES data in the PELACUS 04 cruise series (G. Costas)

18:30 – Summary of the day and Topics for subgroups (report structure it time permit)

19:00 – End

Wednesday 28 November 2008:

09:00 – ACOUSTICS: SSB estimates (cont)

09:00 – Galicia and Cantabric: PELACUS 0407 (M. Iglesias)

09:30 – Bay of Biscay (BoB): PELGAS 07 + consort + Revision (J. Masse)

11:00 – 11:30 Coffee break

11:30 – Plenary: future lines for WGACEGG, election of new Chair, links with other groups

12:30 – Additional work on acoustic surveys

12:30 – Sardine acoustic estimation with GAMs and resampling (J. Zwolinski)

13:00 – Anchovy schools characteristics in BoB (G. Boyra)

13:30 – Integration of acoustic with seabed characteristics (Y. Stratoudakis)

13:30 – 14:30 Lunch break

14:30 – Plenary I: 2007 topics, Report structure and organisation of subgroups

15:30 – Subgroup meetings

- 2007 surveys and revisions (acoustic and DEPM). Outstanding results and methodological issues
- juvenile surveys: differences and review

16:30 – 17:00 Coffee break

17:00 – Plenary II; proposed topics

- Evaluation of DEPM results for last year and of the DEPM revisions
- Evaluation of juvenile surveys and revisions
- Evaluation of pelagic community acoustic surveys and revisions
- Report structure (II), responsibilities by section and timetable for report discussion

19:00 – End

Thursday 29 November 2008:

09:00 – Plenary III; Update of tasks for the day.

- NEW CHAIRMAN ELECTION
- Liaison with other WG/species/areas

10:00 – Subgroup meeting and report writing

acoustics:

- 2008 acoustic coordination
- coordination PELAGO – PELACUS (north-west corner)
- coordination PELACUS-PELGAS (north-east corner)
- Juvenile survey coordination
- sardine recruitment survey
- acoustic database

DEPM:

- 2008 DEPM coordination
- Portugal – Spain

- IEO - AZTI BOB
  - Revision of anchovy spawning frequency)

11:00 – 11:30 Coffee break

11:30 – Subgroup meetings and report writing

13:30 – 14:30 Lunch break

14:30 – Plenary IV; Proposed topics:

- 2008 DEPM and acoustic coordination
- Integration between DEPM and acoustic surveys:
- Report structure II

15:30 – Subgroup meetings

16:30 – Coffee break

17:00 – Subgroup meetings and Report writing

19:00 – End

Friday 28 November 2008

09:00 – Plenary:

- Data format, tools, database (acoustic + CUFES)
- ToR's for 2008 WGACEGG meeting
- Questions on integration for the future (CUFES, others) (first to be treated on subgroups)
- COST actions
- Comments on 2007 horse mackerel survey
- State of report and deadlines

— Discussion of parts of the report not presented before

14:00 – Closing

Annex 3: WGACEGG Terms of Reference 2007

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 Nantes, France from the 24–28 November 2008 to:

Long 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 estimates for acoustic surveys;

f) Provide first results on the intercalibration of Spanish and Portuguese acoustic surveys.

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

Supporting Information

PRIORITY:	The Group has high priority as it will be responsible for providing integrated advice for two major and depleted 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 WGMHSA for assessment purposes. It will also capitalise on the successful work of SGSBSA and of the EU project PELASSES.
SCIENTIFIC JUSTIFICATION AND RELATION TO ACTION PLAN:	ToR a) 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 WGACEGAlso, G., attention will be paid to the coordination, planning and standardization of CUFES surveys through all VIII and IX ICES Areas. Planning and coordination of acoustic surveys in ICES Areas VIII and IX have been attempted within the EU project PELASSES. WGACEGG is expected to improve planning and coordination between Spanish (IEO, AZTI), Portuguese (IPIMAR) and France (IFREMER) acoustic surveys, as well as standardising methods and analysis procedures between these countries/institutes. ToR b) update on innovations on sampling and estimation methods for DEPM and acoustics. Both newly developed DEPM and traditional egg production methods have been explored in SGSBSA, and associated robust and user-friendly software to perform egg production estimates is under development. 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 ToR c) 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 impact on the estimates. Also, building from the knowledge of differences and sources of uncertainty/bias in each of the methods, WGACEGG will explore the possibility of using both methods to obtain an integrated estimate of SSB.

SCIENTIFIC JUSTIFICATION AND RELATION TO ACTION PLAN (CONTINUED)	ToR 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; 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 f) 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.
RESOURCE REQUIREMENTS:	None
PARTICIPANTS:	20–25
SECRETARIAT FACILITIES:	None
FINANCIAL:	None
LINKAGES TO ADVISORY COMMITTEES:	ACOM
LINKAGES TO OTHER COMMITTEES GROUPS:	WGMHSA, WGLESP, WGFE, PGEGGS, WGEGGS, FAST/FTFB
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 stablished based on EU cooperative projects. Participation in COST actions are also seek

Annex 4: Recommendations

RECOMMENDATION	ACTION
1. The WGACEGG recommends the extension of the application of the DEPM of sardine up to the northern part of the Bay of Biscay in 2008 and for the next triennial DEPM implementations in order to achieve a synoptic view of this species over most of its European Atlantic distribution (Subareas IX and VIII)	DEPM surveys in the Bay of Biscay (IEO targeting sardine and AZTI targeting anchovy) should be coordinated every three years (when the triannual sardine DEPM is carried out along the whole Iberian Peninsula) in order to extend its coverage over most of its European Atlantic distribution. Adult sampling for DEPM should be also coordinated with the acoustic surveys covered the area (both from IEO and IFREMER). Extra funding for the extra ichthyoplankton and adult hauls, collection and processing for sardine will be required
2. To incorporate the new egg development model obtained for the Gulf of Cádiz (GC) anchovy in the estimation of GC anchovy SSB.	
3. To provide a new development model for sardine eggs in Cantabrian Sea.	To carry out an egg incubation Experiment Vigo (IEO) for sardine.
4. To continue the revision of the methodology and sampling coverage used to obtain an index of anchovy juvenile abundance in the Bay of Biscay (BoB), and to evaluate the ability of the index to predict recruitment	1- To organise a workshop for the planning of 2008 BoB anchovy surveys 2- To continue with the intercallibration and crossvalidation of the 2008 BoB anchovy juvenile surveys (PELACUS and JUVENA), trying to ensure the best available coverage in coastal areas and in the northern limit by making use of the combined coverage of both RV 3- To analyse data from PELACUS and JUVENA in common.
5. To finalise the revision of BoB anchovy DEPM-based SSB estimates, and to incorporate the results of this revision on the assessment of BoB anchovy.	1- To further analyse the effect of the changes in the estimation of S through the time series of SSB estimates 2- To analyse the effects of changing the egg production estimation methods in the series of SSB estimates 3- To analyse the effects of the revised SSB series in the BoB assessment. 4- To present the conclusions of this analysis to the 2008 WGANC meeting
6. To continue with the revision of the new advances in acoustic and DEPM estimation, and providing the tools to incorporate these advances, specially the adoption of GAMs in routine acoustic and DEPM SSB estimation	1- To carry out a Workshop to assess different techniques for the incorporation of variance estimates in the acoustic estimator of SSB. 2- To carry out a Workshop to

	analyse DEPM based SSB estimates of sardine and anchovy, and incorporate the new methodological improvements presented in this year WG. 3- To discuss the common format and the development of a common database for next WGACEGG meetings. To propose coordinators for the data from different sources (acoustic, egg production, CUFES) and compile the data on this sources before the 2008 WGACEGG meeting.

Annex 5: List of Working Documents and Presentations

List of WG Documents:

Angélico, M.M, Nunes, C., Silva, A., and Stratoudakis, Y. Planning the 2008 Portuguese DEPM survey for sardine.

Bernal, M., Stratoudakis, Y., Wood, S., Ibaibarriaga, L., Uriarte, A., Valdés, L., and Borchers, D (WD 2008a) A review of sardine (Sardina pilchardus, Walb.) egg production estimates off Iberia (I): daily spawning synchronicity and egg mortality estimates.

Bernal, M., Stratoudakis, Y., Wood, S., Ibaibarriaga, L., Uriarte, A., Valdés, L., and Borchers, D (WD 2008b). A review of sardine (*Sardina pilchardus*, Walb.) egg production estimates off Iberia (II): Spatially explicit egg production estimates.

Boyra, G., Martínez, U., Cotano, U., Peña, M., and Uriarte, A. Acoustic surveying of anchovy Juveniles in the Bay of Biscay: JUVENA 2007 Survey Report (Includes an Appendix with the revision of the series).

Boyra, G., and Uriarte, A. Reprocessing of the JUVENA biomass estimation of year 2006.

Boyra, G. Martínez, U., and Uriarte, A. Summary of revisions of the estimations of JUVENA 2003–2007.

Duarte, J., Bernal, M., Jiménez, M.P., Canoura, J., García, E., Juárez, A., and Muñoz, I. (WD 2008) Egg development model for anchovy (*Engraulis encrasicolus*) in the Gulf of Cádiz.

Costas, G., Lago de Lanzós, A., Bernal, M., and Franco, C. Using CUFES to characterize Sardine spawning habitat in North Atlantic Spanish waters.

Iglesias, M., Miquel, J., Oñate, D., Bernal, M., Porteiro, C., Peleteiro, E., Nogueira, E., and Santos, B. SARDINE (*Sardina pilchardus*) IN IXa and VIIIc: Results from the Spanish Spring Acoustic Survey PELACUS0407.

Jimenez, M., and Duarte J. (WD 2008) "R" Workshop for Ichthyoplankton Data Analysis: The Anchovy (*Engraulis encrasicolus*) in the Gulf of Cádiz.

Millan, M., and Bernal, M. The 2005 Gulf of Cadiz anchovy DEPM-based adult parameters: corrected estimates after the October 2007 Workshop on the DEPM-based SSB estimation under "R" environment.

Petitgas, P., Bourriau, P., Massé, J., and Planque, B. Different uses of CUFES egg data collected during PelGas surveys, 2000–2007

Ramos, F., Miquel, J., Millán, M., Iglesias, M., Oñate, D., and Díaz, N. A corrected version of the acoustic assessment and distribution of the main pelagic fish species in the ICES Subdivision IXa South during the ECOCÁDIZ 0707 Spanish survey (July 2007).

Santos, M., Ibaibarriaga, L., and Uriarte, A. Preliminary estimates of the Spawning Stock Biomass of the Bay of Biscay anchovy in 2007 (*Engraulis encrasicolus*, L.) applying the DEPM.

Uriarte, A., Santos, M., Ibaibarriaga, L., and Alday, A. Revision of Some Parameters for the Application of the Daily Egg Production Method to the Bay of Biscay Anchovy (*Engraulis encrasicolus*, L.) and Revised SSB Estimates.

Zwolinski, J., Oliveira, P.B., Morais, A., Quintino, V., and Stratoudakis, Y. Sardine potential habitat and environmental forcing off western Portugal.

List of WG Presentations

Anon. Report on Anchovy Juveniles Acoustic Workshops.

Bernal, M., WGACEGG06.

Boyra, G., Martínez, U., Cotano, U., and Uriarte, A. Juvena 2007 Survey Report and Revision of 2006 Estimation.

Costas, G., Lago de Lanzós, A., Bernal, M., and Franco, C. Using CUFES to characterize sardine spawning habitat in North Atlantic Spanish waters.

Duarte, J. Anchovy Incubation Experiment.

Freitas, R., Marques, V., Quintino, V., Gaspar, M., Zwolinski, J., Rodrigues, A.M., and Stratoudakis, Y. Coupling acoustics for pelagic fish and seabed characterisation (project ACOSHELF).

Iglesias, M., Miquel, J., Bernal, M., Santos, M.B., Oñate, D., Diaz, N., and Tugores, P. Spanish spring acoustic survey PELACUS0407.

Lezama, A., and Boyra, G. Preliminar statistics and geostatistics of anchovy juvenile shcools in the Bay of Biscay.

Marques, V., Angélico, M.M., Zwolinski, J., and Stratoudakis, Y. Autumn 06 and Spring 07 IPIMAR acoustic surveys.

Massé, J., Beillois, P., and Duhamel, E. Revised PELGAS series from Baracouda data base.

Massé, P., and Petitgas, P. Available data bases for acoustic surveys.

Millán, M., and Bernal, M. The 2005 Gulf of Cadiz anchovy adult parameters: corrected estimates after the October 2007 Workshop on the DEPM-based SSB estimation under "R" environment.

Murta, A., Costa, A., Vendrell, C., and Angélico, M. M. *Trachurus trachurus* DEPM Campaign, IPIMAR 2007: observations and preliminary results.

Nogueira, E. Abundance and distribution of anchovy juveniles and adults in the Bay of Biscay Oceanographic conditions and the pelagic community, from plankton to top predators.

Ramos, F., Miquel, J., Millán, M., Iglesias, M., Oñate, D., and Díaz, N. A corrected version of the acoustic assessment and distribution of the main pelagic fish species in the ICES Subdivision IX a South during the ECOCÁDIZ 0707 Spanish survey (July 2007).

Santos, M., Ibaibarriaga L. and Uriarte, A. Revision of Ptot and SSB of DEPM Series.

Santos, M., Ibaibarriaga, L., and Uriarte, A. Preliminary anchovy DEPM estimates for 2007 in the Bay of Biscay.

Silva, A. Area-based sardine dynamics.

Stratoudakis, Y., Marques, V., Zwolinski, J., and Silva, A. Organizing future acoustic surveys in ICES Subarea IXa.

Uriarte, A., Alday A., and Santos, M. Revision of the spawning frequency estimates for the Bay of Biscay anchovy.

Zwolinski, J., Marques, V., Morais, A., and Stratoudakis, Y. Pelagic community in Southern Iberia.

Zwolinski, J., Fernandes, P., Marques, V. and Stratoudakis, Y. Hydroacoustic estimation of sardine (*Sardina pilchardus*) abundance off Portugal: assessing uncertainty.

Zwolinski, J., Morais, A., Oliveira, P., Quintino, V., and Stratoudakis, Y. Sardine potential habitat and environmental forcing off western Portugal.