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Report of the Working Group on Anchovy (WGANC)

13 - 16 June 2008

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1 Introduction

1.1 Terms of reference

Council resolution 2007/2/ACOM04:

The Working Group on Anchovy [WGANC] (Chair: Dankert Skagen*, Norway (to be confirmed)) will be established and will meet at ICES Headquarters, 13-16 June 2008 to:

a) collate, review and, when essential, revise working documents on data and/or assessments of the status and forecasts for (Generic ToR 1-4):

i) anchovy in Division IXa;

ii) anchovy in Subarea VIII (Bay of Biscay).

The assessments will be carried out in National Laboratories coordinated in the table below:

b) summarise the status of the stocks and catch options forecasts based on the update assessments and where it is part of the standard procedure, particularly include environmental, ecosystem and fisheries information.

WGANC will report by 19 June 2008 for the attention of ACOM.

These terms of reference are adapted to the situations where most assessments can be done beforehand and presented as Working Documents. For the Anchovy, notably the Anchovy in Subarea VIII, which is the main stock, the assessment and advice is a fast track in-year advice. The purpose is to translate recent survey and catch data into an advice once they are available. The surveys, which are the backbone of the assessment, were finished just a few days before the meeting. Therefore, the main issue at the meeting was to consider the recent data and to perform an assessment and catch forecast based on preliminary results from the surveys. The second issue was to report on recent progress in scientific work relating to assessing and advising on anchovy.

1.2 Comments to the new WG structure and working schedule.

The time for the meeting was constrained by the timing of the surveys on one hand and the need for managers to implement the advice immediately on the other. It was possible to address the terms of reference at this meeting, but only because no major obstacles appeared. Any difficulties with data or model assumptions, or even major alterations of the state of the stock that would require a different advice, would have precluded finalizing the task. It is hardly possible to start the meeting closer to the finalizing of the surveys. Hence, an extension of the meeting time will have to lead to a delayed advice. There is a clear trade-off between the timing of the advice and the risk that no advice can be provided, which will happen once unforeseen problems appear, and also the risk of errors in the advice.

Previously, the assessment WG has served a forum for communication of developments both in biology, ecology, assessment and management of anchovy. With the new working group structure, the short meeting for updating the assessment cannot serve that purpose. The WGANC considers that it is important that these aspects are taken care of. Parts of the issues will be picked up by the WGACEGG, in particular analyses of survey data and the integration of the survey results in an environmental and ecological context. There is, however, also a strong need for a benchmark workshop to consolidate implications in the assessment of the revisions of egg survey calculation methods, definition of reference points as well as the development of management strategies. Finally, it is noted that there is a strong interaction between WGANC and various bodies in the EC, where cooperation and coordination should be ensured and double work avoided. In particular, when the fishery can be reopened and the information on incoming year classes improves (See Section 3.4.4.), there will be an need for an updated advice for the fishery in the spring.

2 Anchovy general

The distribution of anchovy in Atlantic European waters is nowadays mainly concentrated in two well defined areas; the Bay of Biscay and the Gulf of Cádiz (Figure 2.1). However, some residual coastal populations exists along the Iberian coast (see Figure 2.1 and Section 4), as well as in the English Channel, Celtic Sea and North Sea (Beare *et al*. 2004; ICES 2007a). Anchovy population in the northern areas seems to show an increase in recent years (Beare *et al*. 2004; ICES, 2004), although time series of anchovy abundance in those areas are incomplete, making it difficult to analyze the abundance trends. Within the Iberian peninsula and outside the main nucleus of the Bay of Biscay and the Gulf of Cádiz, resilient anchovy populations have been detected in all fishery independent surveys (ICES, 2007b) and previous records on large catches in ICES area IXa North and Central North (Section 4.2.2.1) suggest that abundance in those areas have been high in early years of the time series. In the south, outside the Gulf of Cádiz anchovy is abundant to the East of the Strait of Gibraltar, in the Mediterranean Sea (GFCM, 2002) as well as in northern Africa, where a combined Spanish-Morocco fishery produces landings of up to 12000 tn (Millan, 1992; García-Isarch *et al*., 2008).

Despite the known fluctuations in anchovy distribution and abundance along the Atlantic European waters (see also Section 3.7.3.1), and even in the current low abundance situation in the Bay of Biscay, both the Bay of Biscay and the Gulf of Cádiz continue to be regarded as the main nucleus for Atlanto-European anchovy. Migration intensity between those main nucleus and surrounding areas are however unknown and data for Atlanto-European anchovy outside the main nucleus is scarce and is not routinely reported to ICES WGANC. This WG recommends that anchovy landings, length and age distribution are routinely recorded in the different EU sampling plans, and reported to this WG.

3 Anchovy in Subarea VIII (Bay of Biscay)

3.1 ACFM advice for 2007 and STECF recommendations

In July 2005 the fishery was closed due to the low levels of biomass of the anchovy population. This closure has been prolonged stepwise, and is at present valid until July 2008.

In December 2006, the EU Council decided to continue the fishery closure and established a zero TAC for the Bay of Biscay anchovy in 2007. In addition, the EU Council stated that *to gather information on the state of the stock, after consultation of the STECF and under the supervision of the Commission, a maximum of 10 % of the French and Spanish fishing effort (20 Spanish vessels and 8 French vessels) may be deployed in zone VIII for experimental fishing with scientific observers on board from 15 April until 15 June 2007. Catch reports have to be submitted to the Commission every 15 days by the Member States con-*

cerned. The Commission will suspend the experimental fishery once sufficient data has been collected. The Commission will then, as appropriate, adopt the decision foreseen in Article 5(5) of this Regulation on the basis of an STECF advice.

Accordingly, in an attempt to maximise the utility of any information from the fishery for stock assessment, the STECF convened an expert working group in February 2007. The STECF considered that *the current spring surveys are already sufficient to assess the status of the stock in spring and provide management advice for the rest of the year* and that *a free commercial fishery would not provide any useful additional data for an evaluation of stock status or incoming year-class strength in 2007.* Therefore, the STECF recommended that *the commercial vessel effort proposed for such a fishery would be better deployed in a "consort" role to provide supporting fishing and surveying activity for the existing research vessel surveys in the spring of 2007 (PELGAS, PELACUS and BIOMAN)* and that *if additional commercial vessel effort beyond that to support the surveys is allowed to take place in 2007, a multi-vessel acoustic/fishing survey ("Rake" survey) should be carried out by commercial vessels.*

In April 2007, the Commission and the concerned member states agreed the conditions for the 10 fishing vessels (7 Spanish and 3 French vessels) participating in the consort surveys for the BIOMAN and PELGAS Spring surveys and for the experimental fishing of the remaining 18 vessels (13 Spanish and 5 French vessels). The Spanish purse seines not participating in the consort surveys collaborated in a rake survey, whereas the French vessels conducted an experimental fishing.

The STECF met again in June 2007 to assess the anchovy spawning stock biomass based on the information from the spring scientific surveys and to analyse the value of the information gathered by the commercial vessels. The STECF noted that *there are clear signs that the stock situation has improved compared to 2005. However, spawning stock biomass remains very low and maximum protection of the remaining spawning population is required.* STECF recommended that *the fishery should remain closed in 2008 until reliable estimates of the 2008 SSB and 2007 year class become available based on the results from the spring 2008 acoustic and DEPM surveys. This implies a closure of the fishery until at least July 2008.*

Following the STECF advice and after close examination of the submissions made by member states, the Commission decided on 19th July 2007 that the Bay of Biscay anchovy fishery will not be reopened until the end of the year.

In October 2007 ICES stated: *Based on the most recent estimates of SSB, ICES classifies the stock as being at risk of reduced reproductive capacity. SSB in 2007 is estimated to be between* $\boldsymbol{B}_{lim}$ *and* $\boldsymbol{B}_{pa}$*, and is estimated at 27% higher than in 2006. Low recruitment since 2001 and almost complete recruitment failure of the 2004 year class are the primary causes of the stock collapse.*

The ACFM advice was: *ICES recommends that the fishery should remain closed in 2008 until reliable estimates of the 2008 SSB and 2007 year class, based on the results from the spring 2008 acoustic and DEPM surveys, become available. This implies a closure of the fishery until at least July 2008.*

The ICES advice was endorsed by STECF and the Council of fishing ministries the European Union decided to keep the closure of the fishery until June 2008, when a revision ought to be made according to the scientific information collected during the first half of 2008 and to the degree of formulation of a multiannual plan for the management of anchovy (Council Regulation Nº 40/2008 of TACs and Quotas). There was no experimental fishery in spring 2008.

During the first half of 2008 a couple of meetings to deal with a Long Term Management plan for the anchovy fishery were convened by STECF (see section 3.7.2).

3.2 The fishery in 2007 and 2008

There was no commercial fishery for anchovy in the Bay of Biscay in 2007 and 2008. The text below refers to the fishery prior to the closure.

3.2.1 Fishing fleets

Two fleets operate on anchovy in the Bay of Biscay: Spanish purse seines and French fleet constituted of purse seiners and pelagic trawlers. The pattern of each fishery has not changed in recent years.

Spanish purse seine fleet: The Spanish fleet is composed of purse seiners (of about 200 boats) (Table 3.2.1.1) that operate at the south-eastern corner of the Bay of Biscay (in Divisions VIIIc and b), mainly in spring, when usually more than 80 % of the Spanish annual catches occurred. The major part of this fleet goes for tuna fishing in summer time and by then they use small anchovies as live bait for its fishing. These catches are not landed but the observations collected from logbooks and fisherman interview (up to 1999) indicate that they are supposed to be less than 5 % of the total Spanish catches. The Spanish fleet did not go to fish in Subarea VIIIa since 2002. The number of Spanish purse seiners is decreasing since 1997.

French fleet: the main catches are produced by pair trawlers. The French fishery starts normally at the beginning of the year in the centre of the Bay of Biscay. Progressively, the fishery is moving towards the south of the Bay of Biscay (generally in April). After a voluntary break of the pelagic fishery (bilateral agreement) in April and May, the fishery moves north, and reaches sometimes the northern part of VIIIa in August or September. Later, the fishery moves to the centre of the bay. The major fishing areas are the north of the VIIIb in the first half of the year and VIIIa, mainly, during the second half. Area VIIIc is prohibited to the French pelagic fleet. A part of pelagic trawlers are opportunistic and polyvalent: looking at annual catches vessel by vessel, a high number of them can catch a small amount of anchovy at least once a year. Therefore the number of French pelagic trawlers involved in the anchovy fishery is variable: it depends on the biomass of fish available (Duhamel E. *et al*, WD 2004).

Table 3.2.1.1 shows for the French fleet, the number of vessels that have caught a significant amount of anchovy each year, and not the total number of vessels. A threshold of 50 tons per year has been decided to separate target trawlers to occasional ones. Because of the low biomass during the last 3 years and the ban on the anchovy fishery for the second half of years 2005 and 2006, it has been necessary to consider a lower threshold of annual catches to select commercial vessels that really target anchovy in these years. This has been made by decreasing the threshold of 50 tons per years to 10 tons. Since 1995 the number of pelagic trawlers was quite stable (about 50).

French purse seiners are also opportunistic and they always operate around their home harbor, in coastal waters. Catches of anchovy by purse seiners are not regular because their real target species is sardine. Some French purse seiners located in the Basque country fish mainly in spring in VIIIb and the Brittanish one fish occasionally anchovy during autumn in the north of the Bay of Biscay. The total number of French purse seiners are slightly increasing since 2000 (33 in 2000; 41 estimated in 2004), but it does not imply a real increase in term of catches as their real target is still sardine.

3.2.2 Catches

3.2.2.1 Catch statistics

Historically catches peaked in the sixties (Table 3.2.2.1 and Figure 3.2.2.1), dropped to low values in the eighties and recover in the context of the current international mixed fishery in the nineties. Since 2002 a progressive decrease of catches occurred until the collapse of the fishery in 2005, after which repeated closures of the fishery are taking place in the context of management to rebuild the anchovy population.

In the period before recent closures of the fishery (1992-2004), most of Spanish landings (85 %) were usually caught in divisions VIIIc and VIIIb in spring, while 35 % of the French landings are caught in divisions VIIIb in the first half of the year and 65% in summer and autumn in division VIIIa (Table 3.2.4.1).

<u>Catches in 2007 :</u> The fishery was still closed in 2007 just an experimental fishery was allowed during spring. After the STECF advice in June from the spring survey's SSB estimates, the fishery was totally closed in July 19th 2007.

No catches have been taken during the first half of 2008 given the closure of the fishery decided by the EU fishery Council.

3.2.2.2 Discards

There are no estimates of discards in the anchovy fishery but it did not appear to be a significant problem.

3.2.3 Experimental fishing

An experimental fishery took place during spring 2007. Fishermen were allowed to sell their catches under strict conditions, in order to avoid a too strong fishing pressure on an uncertain biomass and to avoid scientific surveys disturbance. Landings by France amounted to 140 tons during this experimental fishery. Spanish fishermen did not participate in this experimental fishery and therefore, no significant landings were reported for Spain. Around 1 ton was caught when they performed a Rake survey in 2007 to locate fish concentrations.

A proper report of this French fishery and the Spanish Rake surveys were included in last year reports (ICES 2007 sections 10.2.3). For the purposes of the current update assessment no input from these experimental fisheries are included in the assessment.

3.2.4 Catch numbers at age

Table 3.2.4.1 records the age composition of the international catches since 1987, on a half-yearly basis. Usually 1-year-old anchovies have dominated in the catches during both halves of most of the years. The few cases when 2 years old anchovies are predominant in the international catches during the first half of the year are indicative of failures of the 1 year old recruits as in 1999, 2002 and 2005. Figure 3.2.4.1 show the Spanish and French catch at age compositions of the first half of the year since 1987.

No age composition of the French experimental fishery catches during the first half of 2007 was available for the WG.

The catches of anchovy corresponding to the Spanish live bait fishery have not been provided since 2000. The data available for the period 1987 – 1999 was included in table 10.3.1.3 of last year report. These are traditionally catches of small anchovy mainly of 0 and 1 year old groups amounting about 5 hundred tonnes or less.

3.2.5 Weights and lengths at age in the catch

The series of mean weight at age in the fishery by half year, from 1987 to 2006, is shown in Table 3.2.5.1 The French mean weights at age in the catches are based on biological samplings from scientific survey and commercial catches.

Spanish mean weights at age were calculated from routine biological sampling of commercial catches.

Sampling during second half of 2006 was very poor because of the low level of catches (closure in July). Therefore, the weights at age for this period are not accurate. This has no impact on assessment as these data are not used in Bayesian model.

3.3 Biological data

3.3.1 Maturity at age

As reported in previous years reports, anchovies are fully mature as soon as they reach 1 year old, at the following spring after they hatched. No difference in specific fecundity (number of eggs per gram of female body weight) according to age has been found so far (Motos, 1994).

3.3.2 Natural mortality and weight at age in the stock

Natural mortality and growth are combined in the "g" parameter used in the two-stage biomass dynamic model. The value for natural mortality is fixed (M = 1.2) and the growth (G) is determined by the historical weights at age. Thus the "g" parameter is estimated from the subtraction: M – G (see section 3.5.1).

3.4 Fishey independent information

3.4.1 DEPM surveys

DEPM (Daily Egg Production Method) surveys to estimate the spawning stock biomass (SSB) in the Bay of Biscay anchovy have been implemented from 1987 to 2008 with a gap in 1993 (Table 3.4.1.1)

3.4.1.1 Methodological issues

In 2007 and 2008 DEPM surveys, the daily egg production (P0) and daily mortality rates (Z) were estimated by fitting an exponential mortality model to the egg abundance by cohorts and corresponding mean age using a Generalized Linear Model with Negative Binomial distribution and log link instead of fitting a Weighted Non Linear Regression Model as was used in the historical series. That fitting was recommended and adopted by the SGSBSA in 2003 to improve the method but this change does not affect to the P0 and z estimates which means that the present estimates are comparable with the ones estimated in the past.

The method related to the spawning fraction has been revised in WGACEGG (ICES, 2007b). This revision will lead to changes in the spawning stock biomass estimates provided by the DEPM. However a full revision for all years has not been completed. Once finished, it will be made available to WGACEGG for review and adoption.

3.4.1.2 DEPM survey 2008

3.4.1.2.1 Description of survey

The research survey BIOMAN 2008 for the application of the Daily Egg Production Method (DEPM) in the Bay of Biscay anchovy has been conducted in May 2008 from the 6th to the 26th covering the whole spawning area of the species. This year two vessels were use: the R/V Investigador to sample the plankton (544 stations) and the R/V Emma Bardán to sample the adults (39 pelagic hauls).

The area covered was the southeast of the Bay of Biscay, which corresponds to the main spawning area and season of anchovy. The limit of the spawning area was well delimited: 3º33′W to the West in the Cantabrian Coast and 48º10′N to the North in the French platform. The survey started from the West of Santander (4º14′W), and covered the Cantabrian Coast eastwards up to Pasajes. Then, the survey continued to the north, in order to find the Northern limit of the spawning area (Figure 3.4.1.1). The species composition in the trawl hauls is shown in Figure 3.4.1.2.

The samples obtained were fixed in formaldehyde. After 6h of fixing, anchovy, sardine and other species eggs were identified and sorted out. All the samples were sorted on-board.

The Continuous Underway Fish Egg Sampler (CUFES) was also used to record the eggs found at 3m depth (1,200 stations). The samples obtained were immediately checked under the microscope so that presence/absence of anchovy eggs was detected in real time. This allowed knowing whether there were anchovy eggs in the area. When no anchovy eggs were found in 6 consecutive CUFES samples in the oceanic area transect was left.

3.4.1.2.2 Egg production estimate

The total area surveyed was 69, 150 Km2 and the spawning area was 33,502Km2.

From 544 PairoVET, 237 were positive for anchovy eggs (43%) with an average of 7 eggs/0.1m2 per station and a maximum of 306 eggs/0.1m2 in the area of Cap Breton once passed the isoline of 200m in transect 29. (The highest observation in Figure 3.4.1.3)

The anchovy eggs were concentrated in two principal areas: the area of Cap Breton and the area of influence of the Gironde River in the area of 50m depth, close to the coast. Egg abundance was scarce across the Cantabrian coast.

Once the staged eggs were transformed into daily cohort abundances using the Bayesian ageing method, Daily egg production (P0) and daily mortality rates (Z) were estimated by fitting an exponential mortality model to the egg abundance by cohorts and corresponding mean age with a glm (generalized linear model) with a negative binomial and log link. Ptot was calculated as the product of the spawning area and the daily egg production rate (P0).

Two different estimates of P0 and z were presented to the WG (Santos WD, Annex 3), based on the inclusion or exclusion of a station which shows a large abundance of eggs in the second daily cohort. The different estimates of P0 and z did not show large differences, and the WD recommended using the estimates excluding the station to estimate z, considered as an outlier. However, the WG decided to use the estimate without excluding any station, because the observed situation is common in DEPM surveys, there was no clear indication that the station could be considered erroneous, and because the error distribution used (negative binomial, recommended by ICES SGSBSA and WGACEGG; ICES 2004; ICES, 2007b) is considered to be robust to stations that show large abundances. The influence of this station in the estimate is minor. The estimates are given in Table 3.4.1.2 and the final mortality curve model used is shown in Figure 3.4.1.3.

3.4.1.2.3 Adult sampling and adult parameters

The adult samples were obtained on-board the pelagic trawler R/V Emma Bardán. This vessel was covering the same area as the plankton vessel. When the plankton vessel encountered areas with anchovy eggs, the R/V Emma Bardán was direct to those areas to fish. The fishing hauls for adult sampling are summarised in Annex I (Santos WD, Annex 3).

From the 39 pelagic trawl hauls 29 had anchovy but only on 20 was found a minimum of 60 anchovies that is the minimum to consider the sample for the analysis. The spatial distribution of the samples and their composition is showed in Figure 3.4.1.2. Figures showing, the positive hauls for anchovy and the capture, the adults mean weight and adults mean size, are in Santos WD, Annex 3. Figure 3.4.1.4 shows the age composition by haul.

As the adult samples are not fully processed yet, the DF estimate was obtained from a linear regression model between DF and sea surface temperature (SST), following the procedure used in STECF (2006). The coefficient of determination of the relation between DF and SST was 35%, and the predicted Daily Fecundity value predicted by this regression is 67.44 egg/gram (CV = 0.041), with 95 % confidence intervals 42.5 and 92.4 eggs/gram.

3.4.1.2.4 SSB estimate

A preliminary SSB estimate is obtained as the ratio between the total daily egg production (Ptot) and the daily fecundity (DF) estimates from the linear regression model. The preliminary biomass estimate in that manner is 26,461 t with a coefficient of variation of 19% what is similar to the last year estimate (25,973 t; CV 14%).

Approximately 58% (CV=10%) of the population in millions of individuals (71% in mass) is older than one year. This indicates a new failure in the recruitment, as in the last years.

3.4.2 Acoustic survey 2008

3.4.2.1 Description of survey

The 2008 acoustic survey PELGAS08 (Massé & al. - WD 2008 Annex 4) was carried out in the Bay of Biscay from April 26th to May 26th 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.

Another acoustic survey (PELACUS0408) was carried out just before PELGAS08 (28 March – 23 April) and surveyed the Galician and Cantabrian area. This area does not cover the main distribution area for Bay of Biscay anchovy, but nevertheless provide some information on the distribution, abundance and biology of anchovy in the southern limit of the Bay of Biscay anchovy (see Section 2 for general distribution of anchovy in Atlanto-European waters). Anchovy in PELACUS0408 was only observed in a few trawls in the Galician area and in the southern Bay of Biscay area (Figure

3.4.2.1). Abundance in the Galician area and in VIIIc was similar to previous years (300 and 470 tn respectively), while abundance in the southern VIIIb area (not fully covered by this survey) is higher than in previous years (12000 tn). Size structure show average to large individuals in the Galician area and in VIIIc (modes of 16.5 and 15.5 cm respectively), and large individuals in southern Bay of Biscay (mode of 18 cm).

In the rest of the section, results will refer to the PELGAS08 survey, as those are the ones used for assessment.

To obtain an optimal horizontal and vertical description of the pelagic ecosystem in the area, two types of actions were combined: i) Continuous acquisition by storing acoustic data (from five different frequencies : 18, 38, 70, 120 & 200 kHz) and 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 characterize the higher level predators of the pelagic ecosystem.

A consort survey was organized with French pair trawlers. This approach, in the continuity of last year survey, was officially decided three weeks before the PELGAS survey and organized taking into account the last year experience. They were this year equipped with a precision weighting machine and a calibrated echo-sounders (Simrad ER60 – 70 kHz) able to store data at a standard format. Their consort surveying and fishing operations can be so considered this year as qualitative and quantitative as well. The catches and biological data have been directly used at the same level than Thalassa one for identification and biological characterization. The echo sounder was implemented on a small towed body and because of a non sufficient stability during the first 2 weeks (15m vessel length) the data was stored only during small sequences when notable echo-traces were observed and mainly after fishing. Commercial vessel acoustic data will be processed later in order to compare the echo types and energies to Thalassa one in identical place or similar conditions. They were not available for the present WG.

The four commercial vessels (two pair trawlers) participating to PELGAS08 survey were:

- "le Natif / la Roumasse" from St Gilles Croix de vie (from 27th april to 12th may)
- "Cintharth / Marilude" from La Turballe (from 15th to 21th may)

The collaboration between Thalassa and commercial vessels was excellent. It was a very good opportunity to explain to fishermen our methodology and more, to verify that both scientists and fishermen observe the same types of echo-traces and that the catches were well comparable (in proportion of species and, most of the time, in quantity as well).

Only 3 days of rather bad weather occurred during the first week of survey but it didn't disturb that much the stability and it was considered that the whole potential area for anchovy distribution was covered in suitable conditions and its biomass estimate by acoustic was possible. The operations carried out by Thalassa and by professional vessels were all carried out during day time.

Acoustic data were collected by Thalassa along 2800 nautical miles, upon which 1850 nautical miles will be used for biomass estimate (Figure 3.4.2.2). A total of 102 hauls were carried out during the assessment coverage including 46 hauls by Thalassa and 56 hauls by commercial vessels (Figure 3.4.2.3). Except 3 hauls considered as non valid, 99 were usable for assessment. It was impossible to process separately estimates using only Thalassa hauls or both as it was done last year because the fishing strategy has been followed all along the survey in order to profit of the best efficiency of each vessel. Taking into account the fact that pair trawlers are more efficient at surface than back trawlers, the commercial vessels carried out mostly surface hauls when Thalassa fish preferably in the bottom layer. The decision on fishing were all taken from Thalassa in order to maximize the number of samples, in term of identification and biological parameters as well.

A total of 19 690 fish were measured (including 3 897 anchovy and 4 375 sardine) and 1747 otoliths were collected for age determinations (908 anchovy and 839 sardine).

3.4.2.2 Distribution (anchovy and others)

According to Thalassa catches (mainly close to the bottom) and commercial vessels one (mainly close to the surface), a distribution of species observed during the survey can be seen on Figure 3.4.2.3.

Anchovy was observed along the coast from Bayonne (43° 40 N) to Rochebonne (46°00 N), mostly mixed with sardine and sometimes with horse mackerel in the south of the Gironde then often alone until Rochebonne where it was mixed with sprat. On the platform, anchovy was quite omnipresent between 50m and 100m depth but always mixed with horse mackerel or sardine. Echo-traces were most of the time separated vertically as already described by Massé (1996), horse mackerel close to the bottom and anchovy as soft and small schools 15 to 25 m above. Anchovy was totally absent in the area called "Fer à cheval" and very rare southern along the shelf break, except some rare small surface schools.

The spatial extent of the low salinity is from the coast to the isobath 50 m approx, where as the plume (salinity <34) may extent to the isobath 100 m. Surface fluorescence was maximum close to Belle-Ile and at the shelf break around 46°N. There was low fluorescence in the low haline coastal waters, probably because of the strong discharge. A coastal current oriented to the North was evidenced by deploying buoys, which is associated to the low salinities of the river discharges.

It can be also noticed that Temperature and salinity recorded during PelGas were affected by weather conditions before and during the survey. At the start of the survey in the South, temperature were low (14-15°C) due to low heating and strong mixing before and during the first week of the survey. Then good weather resulted in sea surface warming and therefore the North of the Bay shows higher sea surface temperatures (16-17°C) than the Southern part. High river discharge gave low salinity plumes oriented to the north for Adour, Gironde and Loire. The spatial extent of the low salinity is from the coast to the isobath 50 m approx, where as the plume (salinity <34) may extent to the isobath 100 m.

Anchovy eggs abundance was close to the average of the time series since 2000. Eggs were abundant on Plateau des Landes around 44°N and around the Gironde plume. North of Gironde, eggs were coastal only and in low quantity. Both abundance and spatial distribution display an average pattern. This year, some eggs were found on the south coast of Brittany but in a low quantity

About top predators, 2559 seabird and cetacean sightings have been recorded during the Pelgas 2008 survey. Twenty-seven bird species and nine cetacean species have been identified.

3.4.2.3 Stock estimate

It was not possible to process all the acoustic data for the time of WGANC. Nevertheless, all the southern area was processed and anchovy was rather absent in the northern one. Therefore it is possible to consider that the southern coverage is sufficient to be representative of the anchovy biomass in May 2008.

As the previous years, after echogram scrutiny, the global area has been split into strata where coherent communities were observed (species associations) in order to minimize the variability due to the variable mixing of species (Figure 3.4.2.4.). Allocation to species was therefore done using the standard method (Massé,J, WD2001) and biomass were estimated for main pelagic species according to aggregation categories and identification hauls (Table 3.4.2.1.).

The anchovy biomass was estimated to 37 358 t with a coefficient of variation of 12.4% (the method is detailed in Petitgas *et al.*, 2003) meaning that the anchovy biomass according to acoustic data and pelagic hauls should be between 28 093 and 46 623t. Anchovy distribution is shown in Figure 3.4.2.5

An anchovy biomass estimate in tons and in number has been processed for each area at age group (table 3.4.2.2.), using length distributions at each closest haul and global age/length key. Length distribution of anchovy is shown in Figures 3.4.2.6 and 3.4.2.7.

The length and age distribution as observed during PELGAS08, showed two distinctive strata with considerable anchovy biomass: the south coastal area and the Gironde one (see Figure 3.4.2.5). Estimates have been calculated in numbers for each area and the results are shown in table 3.4.2.3. It shows that 86 % of age 1 in 2008 were concentrated in Gironde area and that only big 2 and 3 years old were present in the southern area (Figures 3.4.2.8).

3.4.2.4 Conclusion

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

3.4.3 Historical series DEPM & acoustic surveys

Acoustic surveys were carried out from 1989 to 1998 by IFREMER, covering the main anchovy area distribution in the southern part of Bay of Biscay. Sampling strategy and echo-sounders were different of those used nowadays, but were considered reliable for biomass estimation because of appropriate calibration of systems and adapted sampling strategy. A new series started in 2000 covering the whole Bay of Biscay with a constant sampling strategy and simultaneous data collecting for ecosystem purposes.

Biomass estimates have been revised recently (ICES, 2007b) for the last series (2000 – 2008) using new tools for stratification of areas, systematic ways of calculation and use of identification hauls through a common data base (BARACOUDA) and benefits from new incoming information. They are presented together with DEPM estimates in Figure 3.4.3.1.

Geographic distribution maps are presented in Figures 3.4.3.3.and 3.4.3.2 Anchovy seems to be more concentrated in the southern area and more coastal nowadays.

It must be noticed that recent observations showed that anchovy may have rapid local displacement. The small fishes localized in the south of Gironde area at the beginning of the PELGAS08 survey (Figure 3.4.2.4.) were localized again 10 days later during the BIOMAN08 survey (Figure 3.4.1.1, Figure 6 Santos wd, Annex 3) 20 nautical miles further North. The same group was localized again at the very end of PELGAS08, 10 days later, 15 nm southern and a little bit more offshore. This suggests this fish performs fast movements at a local scale which cannot be considered as real migration, but more as responses to changes in local environmental conditions in order to remain in a suitable habitat. Indeed, the river plume as observed by satellite imagery showed drastic changes between the beginning and the end of PELGAS survey. This strengthens the idea that a direct assessment survey must be carried out in the shortest possible time window.

DEPM surveys have been carried out since 1987 by AZTI-tecnalia, covering the southeast of the Bay of Biscay, which corresponds to the main spawning area and spawning season for anchovy. Small changes have been done in the sampling strategy and the methodology all along the series being the final population estimates comparable.

The development of the stock as it is seen in the two surveys is shown in Figures 3.4.3.1 and 3.4.3.4. The general trend is similar for both DEPM and acoustic based SSB estimates (see also section 3.5.2 and 3.5.4, and a revision and comparison of the series in ICES, 2007b). A shrinkage of the distribution area during the recent period of low recruitment is evident in both surveys. The fraction of age 2 fish has increased recently, which is how one would expect the effect of the closure of the fishery to materialize in the survey results.

3.4.4 Juveniles surveys

3.4.4.1 Background and history

Nowadays two acoustic surveys are taken place on anchovy juveniles in the Bay of Biscay in Autumn:

- The JUVENA series (acoustic surveys for anchovy juveniles) aim at estimating the abundance and spatial distribution of anchovy juveniles during early autumn in the Bay of Biscay. The series in conducted by AZTI (Spain) as result of the demand of the Basque and Spanish fisheries ministers for monitoring of the anchovy population. The series began in 2003 and its fifth survey took place in autumn 2007 (Table 3.4.4.1) (Boyra *et al*., 2004, 2005a, 2005b, Boyra & Uriarte, 2005 and Boyra *et al*., 2007; see a review in ICES, 2007b). The long term objective of this survey-project is to provide an estimate of the strength of the anchovy recruitment entering the fishery the next year (as 1 year old) so as to help on the provision of scientific advice to managers. In addition, the spatial distribution of the juvenile population, the growth condition and the hydrological characterization are studied. The survey is presented, reviewed and coordinated within WGACEGG (ICES, 2007b). Some revisions and improvements were undertaken since 2005 in the estimation procedures and surveying coverage, following suggestions and share expertise in STECF, WGHMSA and WGACEGG. Recommendations from WGACEGG have been progressively implemented in the JUVENA surveys, and a revision of the whole time series, with the exception of 2006 was presented to the 2007 WGACEGG meeting (ICES, 2007b). Results of the 2006 survey were revised in the interim time between WGACEGG and WGANC and are presented in this year WGANC meeting.

- The PELACUS-2007 cruise (autumn PELACUS), included in the IEO project ECOPEL (pelagic fish community and ecosystem), aims to study the abundance and distribution of anchovy juveniles, as well as the recruitment process. The cruise has been carried out in 2006 and 2007 on board RV "Thalassa" between September and October in the southern Bay of Biscay. In 2007 the PELACUS-1007 survey was planned 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, discussed in WGACEGG 2006 (ICES, 2007); 2) permanent communication and transfer of information between the research vessels involved in the respective cruises during the campaigns; 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.

3.4.4.2 Surveys in 2007

3.4.4.2.1 JUVENA Series and the survey in 2007.

The JUVENA series, up to the last survey in autumn 2007, has been discussed and reported in WGACEGGs (ICES, 2007b). A final revision of the 2006 estimate was not available at the time of last WGACEGG meeting, but has been made available to the WGANC 2008 meeting (Boyra *et al*., WD2008), in order to complete the revision of the JUVENA series and compare the index of juvenile abundance with the one year old estimates provided by ICES anchovy assessment. The revision of the 2006 survey was required to overcome the bad functioning of one the 38 KHz transducers mounted in one of the two vessels participants in the survey, as reported to WGACEGG (ICES, 2007b). Such a revision was possible thanks to several common tracks done in parallel between the two vessels for inter-calibration purposes (see detailed inter-calibration results in the WD attached to this report).

In 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 4100 n.mi., along the continental shelf and shelf break of the Bay of Biscay. The survey grid provided an effective sampling distance of 1500 n.mi. and a coverage of about 22000 n.mi.2, from the 5º W in the Cantabrian area up to 47º 20′ N at the French coast (Figure 3.4.4.1). Seventy hauls were done during the survey to identify the species detected by the acoustic equipment, 37 of which resulted positive of anchovy.

The biomass of juveniles estimated for this 2007 is 13 000 tones, a low value in comparison with the previous values of the temporal series of JUVENA, only higher than the 2004 estimate (Table 3.4.4.2 where the JUVENA series is also included). This value is about one order of magnitude less than the higher estimates of the series (the ones corresponding to 2003 and 2005) and suggests that a high recruitment was unlikely to happen in 2008. The spring surveys in 2008 confirmed this.

3.4.4.2.2 PELACUS 2007.

The autumn PELACUS survey has been carried out for the years 2006-2007 (ICES, 2007b). Results of this survey have so far been used to obtain information on juvenile anchovy distribution and habitat, environmental conditions in the Bay of Biscay pelagic ecosystem in autumn and to study the anchovy recruitment process in the Bay of Biscay and cross-validate the results of the JUVENA series. Both the JUVENA and the PELACUS surveys provide complementary information on the juvenile distribution and habitat, and their comparison have so far allowed to improve the survey design required to estimate juvenile abundance (ICES, 2007b).

Results of the PELACUS 1007 have been presented in WGACEGG (ICES, 2007b) and are summarised in Figures 3.4.4.3 and 3.4.4.4 and Table 3.4.4.4. 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, anchovy was detected in the inner shelf, from the coast up to the 100 m isobath, showing a clear coastal-offshore gradient in terms of modal size (and age), which ranged from 11 to 16 cm of modal size (Figure 3.4.4.4). Total anchovy biomass was estimated as 16900 tn, of which 3039 tn corresponded to juveniles (Table 3.4.4.2.).

3.4.4.2.3 Balance of juvenile index series; current status and potential use for management.

As pointed out by WGACEGGs report (ICES, 2007b), the Bay of Biscay juvenile Index of anchovy 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 past interim workshops and the last WGACEGGs meeting, the main sources of differences between the surveys have been identified and are mainly allocated to differences in coverage as well as to small methodological problems. Recommendations on how to improve the survey coverage have been produced, and the main methodological problems identified have been overcome.

The series of JUVENA acoustic estimates of anchovy juvenile abundance in the Bay of Biscay is shown in Table 3.4.4.3. Although the survey have suffered some modifications in methodology and coverage,, both the WGMHSA and WGACEGGs concluded that the result of the juveniles survey can be used as an index of the evolution of juvenile abundance (ICES, 2007a and 2007b).. The question remaining is the validity of the obtained juvenile abundance index as an index of recruitment strength (ICES, 2007b).

Figure 3.4.4.3 compares the times series of the JUVENA anchovy juveniles abundance index with the estimates of biomass at age 1 (median values) produced by Bayesian assessment included in this report. The JUVENA index shows two minima at 2004 and 2007, which coincides with the lower recruitment estimated in 2005 and 2008. However, the correlation between the whole JUVENA series and the assessment-based estimates of recruitment are not statistically significant at 5% significance level

(R=0.76, P(R)=0.134). The lack of statistical significance in this analysis may be mainly due to the few observations available and to the characteristics of the period analysed (lack of contrast in the recruitment levels). The series of recruitment estimates on the period covered by the JUVENA surveys are of similar levels and among the lowest of all the time series since 1987 (see Section 3.7.3.1). Therefore taking into account the usual variability of both the acoustic index and the recruitment estimates and the low number of estimates available, the lack of statistical significance is not surprising.

The WG discussed the above results in the perspective of its performance and potential use for management, making the following concluding remarks:

- Using the JUVENA juvenile index to estimate recruitment at age 1 for the following year appears to be promising, as. so far some general parallelism of the trends in the series has been seen. However, the lack of contrast in the estimated recruitments for this short period prevents a sufficient statistical analysis of the performance of the index.
- The ability of the JUVENA index to predict a large recruitment has not been confirmed yet. A high juvenile abundance observation should be confirmed by the following spring surveys. Until the performance of this index has been validated, a high juvenile abundance observation should not be used as a basis for a decision to re-open the fishery. The WG encourages the continuity of the series both for the quality of the information achieved and for the potential use in assessment and management advice, once its performance is evaluated, Coordination with PELACUS10 survey at ICES WGACEGG is also encouraged, to ensure cross-validation of the estimates and maximize the amount of information gathered on juvenile anchovy habitat.

In summary, the results from the five years of the JUVENA abundance indices of anchovy juveniles are encouraging, but the short life of this series and the lack of contrast prevents yet a proper evaluation of its performance as a predictor of the age 1 entering the population and the fishery the next year.

3.5 State of the stock

3.5.1 Method

The assessment for the Bay of Biscay anchovy population is based on a two-stage biomass-based model, where the population dynamics are described in terms of biomass with two distinct age groups, recruits or fish aged 1 year, and fish that are 2 or more years old. The biomass decreases exponentially on time by a factor g accounting for intrinsic rates of growth (G) and natural mortality (M) which are assumed year- and age-invariant.

Two periods are distinguished within each year. The first begins on 1 January, when it is assumed that age incrementing occurs and age 1 recruits enter the exploitable population, and runs to the date when the monitoring research surveys (acoustics and DEPM) take place. The second period covers the rest of the year (from 15th May to 31st December). Catch is assumed to be taken instantaneously within each of these periods.

The observation equations consist on log-normally distributed spawning stock biomass from the acoustics and DEPM surveys, where the biomass observed is proportional to the true population biomass by the catchability coefficient of each of the surveys, and the beta distributed age 1 biomass proportion from the acoustics and DEPM surveys, with mean given by the true age 1 biomass proportion in the population.

The model unknowns are the initial population biomass (in 1987), the recruitment each year, the catchability of the surveys and the variance related parameters of the observation equations. The model can be cast into a Bayesian state-space model framework where inference on the unknowns is done using Markov Chain Monte Carlo (MCMC).

A first version of this model was used for the benchmark assessment in WGMHSA in 2005 (ICES 2005) and it was adopted by ACFM as the official assessment for the stock in 2006 (ICES 2006). Last year, the assessment presented in the WGMHSA (ICES 2007) was just an update of the benchmark assessment. A modified version of the two-stage biomass-based model was published at the beginning of this year (Ibaibarriaga et. al 2008). The differences between both models consist on:

a) parameterization of the recruitment process. In Ibaibarriaga *et. al* (2008) recruitment is modelled as a log-normal process, so that the parameters to estimate are the mean recruitment (in log scale) and its precision (inverse of variance) together with the yearly deviations of the recruitment with respect to the mean. Alternatively, in WGMHSA, yearly recruitments are estimated.

b) process errors. The model used in WGMHSA includes log normally distributed process errors into the dynamics of the age 1 population during the first period (from the beginning of the year until surveys take place). This implies 2 new unknown states to be estimated for each of the years. These process errors are not included into Ibaibarriaga *et. al* (2008).

c) estimation of g. The model in Ibaibarriaga *et. al* (2008) allows to estimate the parameter g accounting for growth and natural mortality, which is not possible in the model used in WGMHSA.

d) the unknowns and the prior distributions. The differences into the model specifications explained above lead to different parameters to estimate. In addition, some of the prior distributions and their hyper-parameters were different. For instance, the distribution of the initial biomass which is normally distributed in WGMHSA, is log-normal in Ibaibarriaga et. al (2008) and the hyper-parameters of the gamma distributions of the precision of the biomass from the surveys are chosen to have mean 10 in WGMHSA, whereas in Ibaibarriaga *et. al* (2008) are selected to have median 10.

Further details of each of the models can be found in the WGMHSA report (ICES 2007) and in Ibaibarriaga *et. al* (2008) respectively.

The working group considered the published version of the model more adequate than the one previously used in ICES. On the one hand, the parameterization of the recruitment process is more general and could allow the introduction of different functional forms if wanted, and on the other hand, the possibility of estimating g is desirable, although there is no enough information on the surveys themselves by now to overcome the indeterminacy of the results. In addition, since little gain was obtained by including process errors into the age 1 biomass during the first period, it was considered more adequate to assume deterministic exponentially decreasing biomass population dynamics. Therefore, the working group decided to present an update assessment of the Bayesian two-stage biomass-based model (BBM) based on the published version.

The high posterior correlations between the surveys′ catchability parameters, annual recruitments, total initial biomass, the rate of biomass decrease (if estimated, as in Ibaibarriaga et. al 2008) and the age 1 biomass process errors in the first period (if estimated as in WGMHSA 2007) illustrate the indeterminacy of the problem. Inference on recruitment levels will be dependent on the assumptions made on the surveys′ catchabilities, on the rate of biomass decrease and on the prior distributions for recruitments. So, without any additional information, given the near impossibility of determining the absolute level of the population, the estimated recruitment values should be considered as relative rather than as absolute values. For the time being, and for consistency with the past practices, the update assessment considers the DEPM as absolute and g fixed at 0.68, which means that the assessment presented is scaled with respect to these assumptions. Figure 3.5.1.1 shows the comparison of the posterior distribution of spawning stock biomass from WGMHSA (ICES 2006) and from Ibaibarriaga et. al (2008), when the DEPM catchability parameter is taken as 1, g is fixed at 0.68 and the first set of priors of each model is used. Under these assumptions the resulting posterior SSB distributions are almost the same, ensuring the consistency with past assessments.

3.5.2 Data and model exploration

The input data entering into the assessment of the anchovy stock consist on total biomass and biomass at age one as estimated by the research surveys conducted in spring, namely, DEPM and acoustic surveys (see sections 3.4.1 and 3.4.2) and on catch information from the different fleets exploiting the stock that are described in section 3.2. In addition, the age composition and the mean weights at age derived from the biological sampling of the catches are also used.

The historical series of spawning stock biomass (SSB) from the DEPM and acoustic surveys are compared in detail in section 3.4.3. The acoustic estimates since 2000 were revised and presented to WGACEGG (ICES 2007b). Except in some of the years, like 1994, 1998 or 2004, in which there are some discrepancies, the trends in biomass from both surveys are similar. In particular, in the last years a parallel trend but with larger biomass estimates from the acoustic surveys is apparent. The agreement between both surveys is higher when estimating the age structure of the population. Figure 3.5.2.1 compares the historical series of the proportion of age 1 biomass of DEPM and acoustic surveys.

Figure 3.5.2.2 shows the historical series of age 1 and total catches in the first period (1st January-15th May) and of the total catches in the second period (15th May-31st December), which are used in BBM. Catches in the second period are larger than in the first period and most of the catches in the first period correspond to age 1. In the last years due to the low level of the population and various fishery closures, the catches have been very low being zero in the last year.

In previous years different model options were explored regarding the catchability assumptions from the surveys and different set of priors fro the BBM. However, this year, given the update nature of the assessment and the reduced time available for the meeting, no alternative options have been explored and only the assessment update is presented.

3.5.3 Final assessment

The final assessment for the Bay of Biscay anchovy population is an update of last year assessment based on the Bayesian two-stage biomass-based model (BBM) as it has been published in Ibaibarriaga et. al (2008) with the DEPM taken as absolute, g fixed at 0.68 and the first set of priors.

The data used for the assessment are given in Table 3.5.3.1. Note that the SSB and biomass at age 1 estimates from acoustic surveys between 2000 and 2007 have been revised according to WGACEGG (ICES 2007).

Figures 3.5.3.1 and 3.5.3.2 compare prior and posterior distribution of the parameters. Summary statistics (median and 95% credible intervals) of the posterior distributions of recruitment (age 1 in mass at the beginning of the year), SSB and harvest rates are shown in Table 3.5.3.2 and Figure 3.5.3.3. The largest credible intervals correspond to the period in which some data is missing. In general recruitment is highly variable from year to year. However, in the last seven years it has been kept at very low levels, being recruitment in 2005 the lowest of the historical series (posterior median of around 5100 tones and 95 % credible interval between 3200 and 8100 tones). Though there were no catches in the last year, and so the harvest rate in 2008 is zero, SSB has decreased slightly since last year until a level similar to 2006 (around 24 000 tones). In order to analyse the biomass trends in relative terms, median and 95% posterior credible intervals of the ratio of spawning stock biomass with respect to 1989 spawning stock biomass, in which Blim is based (ACFM 2003), are given in Table 3.5.3.2. At the end of the eighties and afterwards, since 2002, the medians of these ratios have been close to 1 and always below 2.

Figure 3.5.3.5 shows the posterior distribution of current level of spawning stock biomass in 2008. Current state of the population is summarized in Table 3.5.3.3. Recruitment in 2008 has been the second lowest of the historical series with a posterior median of 9500 tones and 95% credible interval between 6100 and 15 600 tones. The estimated level of biomass in 2008 is 24 100 tones and the 95% credible intervals are 16 700 and 36 500 tones. In relative terms the median of the ratio of SSB in 2008 with respect to 1989 biomass (used for defining Blim) is 1.3 (with a 95% interval between 0.7 and 2.1) indicating that current level of the population is slightly above the biomass in 1989. The biological risk, defined as the probability of SSB being below Blim (21 000 tones) is 23%. The posterior distribution of the 2008 SSB is shown in Figure 3.5.3.5

3.5.4 Quality of the assessment

3.5.4.1 Reliability of the assessment and uncertainty of the estimation

The Bayesian two-stage biomass-based model (BBM) forms a simple but powerful tool to assess the Bay of Biscay anchovy stock. The observation equations of the model refer just to the age 1 biomass proportion and total biomass indices from the research surveys (DEPM and acoustics). Therefore, the results are completely driven by the surveys, and the reliability of the current assessment depends on the reliability of the surveys themselves. This year revised estimates from the acoustic surveys from 2000 to 2007 have been reported together with CV for biomass. Figure 3.5.4.1 shows the posterior distribution of spawning stock biomass from BBM in comparison to the estimates from the DEPM and acoustic surveys with their corresponding confidence intervals. In most of the years the SSB estimates of the surveys taking into account their standard errors fall within the 95% credible intervals from the assessment. Only in 2000, when DEPM was too low, and in 2002, when acoustic SSB was too high, as demonstrates by subsequent surveys are out of the 95% assessment intervals. Therefore, the working group emphasizes the importance of the continuity of the series of estimates from direct surveys, both in terms of total biomass and disaggregated by age in order to be able to assess the stock efficiently. In this model catch data are just accounted for in the development of the dynamics of the population. This basically means that the population has to be large enough to support the observed catches. However, it is necessary to continue the collection of total landings and catch at age data. This will allow on the one hand further work on BBM exploring the possibility of incorporating catch data in the observation equations in order to evaluate whether additional information can be extracted from the catch data, and on the other hand, the use of age disaggregated models as exploratory tools on the international seasonal fisheries.

The assessment is scaled by the assumption of absolute catchability of DEPM surveys. However, the current perception of the population in relative terms (with respect to the definition of Blim) is insensitive to the use of the DEPM survey as absolute or relative. It is the absolute level of the assessment results (i.e. the mass in tonnes corresponding to the spawning population) what is dependent on the catchability assumptions of the assessment. This implies that the absolute level of the harvest rate, defined as the ratio between total annual catches and spawning stock biomass, is also dependent on the catchability assumption. It therefore must be emphasized and admitted explicitly that the assessment should always be examined in relative terms, exploring the trends in biomasses or harvest rates even under the assumption of DEPM being an absolute abundance estimate.

Another important assumption of the current assessment is that both the natural mortality and growth rates are constant across ages and from year to year. This may imply some artificial reduction of the posterior probabilities profiles of the outputs from the assessment.

The DEPM series of biomass are under revision due to changes in the procedures for Daily Fecundity estimates. This may imply the revision of the current precautionary reference points for management.

The BBM framework provides a statistically well founded basis to BBM. This allows directly inferring the uncertainties of the estimates from the posterior distribution, including additional information through the prior distribution and projecting future states of the population. The BBM entails changes in both the methodology used for projecting the population forward and establishing catch options and in the terminology the assessment and consequent advice is given. Concepts such as fishing mortality or selectivity at age are not used in the model. Alternatively, harvest rates, defined as the ratio between total annual catches and spawning stock biomass, are used. The state of the stock is given in terms of spawning biomass, recruitment is understood as biomass at age 1 at the beginning of the year and management options may be given in terms of catches. On the other hand, due to the Bayesian framework, all the results are given in stochastic terms and deterministic points estimates are replaced by summary statistics of the posterior distributions of the parameters, such as medians and 95%.

3.5.4.2 Changes in methodology

The assessment model has been slightly modified according to Ibaibarriaga et. al (2008) as explained in section 3.5.1. However, under the assumptions of DEPM biomass catchability equals to 1 and g fixed to 1, there are no differences between the posterior distributions obtained from both models, ensuring the consistency of the results.

3.5.4.3 Changes in perceived state of the stock

Figure 3.5.4.2 shows a retrospective analysis of the performance of the BBM. The assessments up to 2007 are based on the model used in WGMHSA (ICES 2007), whereas the assessment in 2008 is based on Ibaibarriaga et. al (2008). There are no clear patterns in the perception of the stock from year to year. Except in 2000 the SSB estimates in the assessment year are within the credible intervals of the SSB in the assessment performed in the following year.

3.6 Prediction

3.6.1 Recruitment prediction

The prediction of the population for next year in order to explore catch options requires predicting recruitment entering the population. In this section we describe the state of the art of various methods that aim at providing advice on the incoming recruitment.

3.6.1.1 Environmental indices

Three environmental recruitment indices have been considered during the last ten years:

a) Borja (1998) developed a wind based upwelling index along the French and Spanish coasts from March to July. The index showed a positive relationship in the past with the strength of recruitment, but it failed to predict the strong years classes of 1999 and 2000 and became not significant (in statistical terms). The succession of weak classes in recent years at low levels of this upwelling index has rendered it again statistically significant (at alpha 8%), but with coefficient of determination of past recruitments about 15%.

b) Allain *et al.* (2001) presented upwelling and stratification breakdown indices. The indices performed well over the period 1987-2002, but subsequently failed to explain the recent low levels of recruitments. The modification of the 3D hydrodynamic model of IFREMER on which the model was based (Lazure and Dumas, in press) led to re-compute and re-elaborate the series.

c) The revision of the work in Allain *et al.* (2001) indices was made available by Huret & Petitgas WD 2007 (ICES 2007). They elaborated new "upwelling" and "stratification" indices according to the new hydrodynamic model and propose an adults spatial indicator.

The reliability of all these indices is considered insufficient for their consideration in the provision of management advice and no update has been provided on their performance to this working group. In addition, at the time of this working group none of these indices has covered the period of the year over which they are calculated, and therefore, cannot be made available to this working group. Recent reviews have suggested that comparison with global indexes and correlation analysis may not be the best approach to understand and consequently predict recruitment in small pelagic fish (Freon *et al*., 2005; Barange *et al*., in press). Other approaches like the analysis of habitat suitability and/or coupled hydrodynamic – population production models may provide an improved understanding of the underlying mechanism, and therefore have the potential to improve the knowledge on recruitment process and improve the predictive capacities (Werner *et al*., 2001; Lett *et al., in press*).

Recognizing the importance of improving the knowledge on recruitment process, and the implications of recruitment forecasting for anchovy management, the Working Group encourages the continuity and diversification of studies analysing the relation between recruitment and environmental variables, as well as studies aiming at understanding the mechanics of the recruitment process.

3.6.1.2 Juveniles surveys

As discussed in section 3.4.4 the results of the acoustic surveys on anchovy juveniles, and particularly the JUVENA series, suggest that they may become helpful in the provision of advice about the incoming recruitment to the population before the management year. However, the short nature of this series and the lack of contrast in the range of recruitment observations prevents yet a proper evaluation of its performance as a predictor of the age 1 entering the population and the fishery the next year. Therefore they can not yet be incorporated in the formulation of management advice.

In addition, any information concerning the 2009 recruitment at age 1 is to be obtained in the next autumn surveys. At the time of this working group, no information (even in qualitative terms) is available for next year coming recruitment and therefore current management advice cannot be based on the juvenile acoustic surveys.

3.6.1.3 Recruitment options in predictions

Following last year's practice in WGMHSA (ICES 2007a), the working group constructed a recruitment scenario based on the posterior distributions of the past recruitment series to explore alternative catch options, see discussion below.

3.6.2 Method

The Bayesian two-stage biomass-based model used for the assessment of the stock was used to project the population one year forward from the current state and to analyse the probability of the population in 2009 of being below the biological reference point Blim (21 000 tonnes) under a recruitment scenario based on the past recruitment series and under alternative catch options for the second half of 2008 and the first half of 2009.

The predictive distribution of recruitment at age 1 (in mass) in January 2009 could be defined as a mixture of the past series of posterior distributions of recruitments as follows:

$$R_{2008} = \sum_{y=1987}^{2007} w_y \ p(R_y|\cdot\ ),$$

where $p(R_y\,|\cdot)$ denotes the posterior distribution of recruitment in year y and w_y are the weights of the mixture distribution, such that $\sum w_y = 1$. These weights can be based on information about incoming recruitment or on assumptions regarding different scenarios.

Figure 3.6.2.1 shows the mixture distribution of recruitment in case all the years are equally weighted. The density has at least four well defined peaks of decreasing height. The local minima between the peaks could be used to split the recruitment in four regimes that can be interpreted as corresponding to very low, low, medium and high recruitments. Looking at the correspondence of each year's posterior median recruitment and these peaks, it is remarkable that since 2002 all median recruitments fall in the first peak (very low recruitment), with the sole exception of the 2004 recruitment, which falls in the second peak corresponding to a low recruitment.

Given the absence of any information about the next coming year recruitment and the repeated low levels of recruitment since 2002, the WG decided to make the projections assuming that recruitment at age 1 for 2009 will be similar to the recent years since 2002. The mixture recruitment distribution was constructed giving equal weight to the posterior recruitment distributions from 2002 to 2008 and weight zero for all the previous years. The resulting recruitment distribution is shown in Figure 3.6.2.2. The median of the distribution is 21300 tonnes.

Starting from the posterior distribution of SSB in 2008 and the recent year's recruitment regime the population was projected one year forward.

Since the fishery has been closed for the first half of 2008, no catches were considered from the 15th May 2008, in which SSB is estimated, to the end of June 2008. Total allowable catch between 1st July 2008 and 30th June 2009 were explored from 0 (fishery closure) to 10 000 tonnes with a step of 1 000 tonnes. In addition, the effect of the percentage of those total allowable catches corresponding to the second half of 2008 was also studied by considering percentages from 0 to 100% with a step of 5%. The timing within the year in which the catches in the second half of 2008 and the first half of 2009 were assumed to occur were computed as the average time points from the historical series from 1987 to 2004 (2005-2008 were not considered as the fishery was closed during all or some part of the year). Similarly, the percentage of catches in the first half of 2009 taken before the 15th May, when SSB is estimated, was assumed to be equal to the average from the historical series between 1987 and 2004 (58%). Probability of SSB in 2009 being below Blim was derived for each of the catch options and percentage of catch corresponding to the second half of 2008.

3.6.2.1 Results

Under the recent years recruitment regime, the probability of SSB in 2009 being below Blim is always larger than 25%, even in case no catches are allowed (Figure 3.6.2.3, Table 3.6.2.1). Table 3.6.2.2 shows the predicted median SSB values in 2009. The probability increases rapidly as total catch increases getting to around 50% when total catch is around 14 000 tonnes. The probability of falling below Blim is almost insensitive to the allocation into semesters.

ICES advice according to the precautionary approach aims at having a high probability of SSB being above Blim. Most often, this is operationalized by requiring that the point estimate of SSB resulting from the advice should be above Bpa. For the Anchovy in Subarea VIII, the assessment and prediction are probabilistic from the outset. A plausible interpretation of the precautionary approach in this context, with a Blim that is defined as a specific number, would be that in the distribution of the predicted SSB, there should be a less than 5% probability of being below Blim. At present, the probability of being below Blim is far above 5% even without fishery, If in the future the Blim is defined in probabilistic terms, for example by referring to the SSB in a certain year, the precautionary criterium might be a low probability that the advice leads to an SSB below that in the reference year, taking the distributions of both into account. Exploratory runs indicate that of being below Blim with this definition would be in the same range as the present result in the present situation.

3.7 Management considerations

3.7.1 Reference points for management purposes

Reference points, B_{pa} and B_{lim}, were defined by ACFM (October 2003):

	ICES considers that:	ICES proposes that:
Limits reference points	B_{lim} is 21,000 t, the lowest observed biomass in 2003 assessment.	B_{pa}= 33,000 t.
	There is no biological basis for defining F_{lim}.	F_{pa} be established between 1.0-1.2.
Target reference points		

Technical basis:

$B_{lim} = B_{loss}$ = 21,000 t.	$B_{pa} = B_{loss}$ * 1.645.
	F_{pa}= F for 50% spawning potential ratio, i.e., the F at which the SSB/R is half of what it would have been in the absence of fishing

Precautionary reference points were not revised by the WG this year.

Because the assessment provides the probability distributions for the SSB, the rationale to maintain a Bpa under the assumption that being at Bpa would imply a low risk to Blim becomes irrelevant. Hence, the WGANC suggests that the Bpa is abandoned as a reference point.

B_{lim} is defined by ICES as the SSB below which recruitment becomes impaired (ICES CM 2003/ACFM:15). For stocks with a clear plateau in the S/R scatter plot (a wide dynamic range of SSB, but no evidence that recruitment is impaired) it was recommended to identify B_{loss} as a candidate value of B_{lim}, below which the dynamics of the stock is unknown. For anchovy it was considered that "the dynamic range in SSB and R has been relatively large, but there is no clear signal in the S/R relationship. Furthermore, the assessment time-series is relatively short. B_{loss} should be maintained as B_{lim}." Hence B_{lim} was set equal to B_{loss} = 21 000 t, which was the lowest spawning biomass (SSB) in the ICA 2003 assessment (corresponding to year 1989).

Since 2002, due to a successive series of low recruitments, the anchovy spawning stock biomass has been around the precautionary reference points: B_{pa} and B_{lim}. In 2005, the population level was estimated as the lowest in the historical series, the biomass being far below B_{lim}, In 2006, 2007 and 2008, the SSB has been between B_{lim} and B_{pa} The current definition of Blim is Bloss, and the current series of low recruitments at SSBs near Blim supports a value of Blim at or above the current level of 21000 tonnes. According to the current assessment the SSB in 1989 is now estimated at about 18600 t., close to the current B_{lim} definition. Thus, the new assessment model does not change the perception of the stock and subsequently, the current B_{lim} (set at 21,000 t) should still be valid.

ICES advice according to the precautionary approach aims at having a high probability of SSB being above Blim. Most often, this is operationalised by requiring that the point estimate of SSB resulting from the advice should be above Bpa. For the Anchovy in Subarea VIII, the assessment and prediction are probabilistic from the outset. A plausible interpretation of the precautionary approach in this context, with a Blim that is defined as a specific number, would be that in the distribution of the predicted SSB, there should be a less than 5% probability of being below Blim. At present, the probability of being below Blim is far above 5% even without fishery, If in the future the Blim is defined in probabilistic terms, for example by referring to the SSB in a certain year, the precautionary criterium might be a low probability that the advice leads to an SSB below that in the reference year, taking the distributions of both into account. Exploratory runs indicates that of being below Blim with this definition would be in the same range as the present result in the present situation.

Future changes in assessment practise or historical data may change the absolute level of the estimated biomasses. At present, the DEPM survey data are taken as absolute, implying that the results in absolute terms to a large extent are scaled to these data. However, it is likely that the estimate of the present SSB relative to previous SSBs will be robust to such changes. Both because of this and because the assessment is Bayesian, producing distributions rather than point estimates, a future revision of reference points may take that into account, for example by classifying the state of the stock according to the probability that it is lower than it was in e.g. 1989.

3.7.2 Development of management plans

3.7.2.1 Summary of development and status.

The past management regime which has been based on fixed annual TAC does not account for variability in recruitment. When a sequence of poor year class occurs, the fishery is unconstrained and likely to lead to overexploitation and subsequent depletion of the stock. With the decline of the fishery since 2002, a poor recruitment sequence since 2002 and the collapse and closure of the fishery in 2005, the need to review the management of this stock has been raised by both scientific working groups (ICES and STECF) and the fishing industry (SWW RAC) as the current management is not adequate to deal with the occurrence of a stock collapse.

The management cycle of the Bay of Biscay anchovy stock has traditionally run from January to December. The only scientific knowledge on which the management advice is based consists on the spring research surveys (DEPM and acoustics) and there is no information on the next year incoming recruitment. So, in last years' ICES advice has consisted on a preliminary TAC that should be revised at mid-year, once the population estimates from spring surveys become available. Since 2005 the succession of fishery closures has lead the management advice to be moved to June concerning the catch options for the period July to June next year. This has been already adopted by the STECF, both in ad-hoc assessments and when evaluating long-term management plans. If juvenile survey indices would become operative as predictors of recruitment, a forecast and management of the fishery during the first next semester would be available. Hence, the natural calendar for providing advice could be moved again from January to December, with a mid-year revision if necessary.

The STECF advice in June 2007 mentions: "there is presently no agreed comprehensive long-term management plan for this stock and recommends that alternative or complementary management measures to output control (TAC) need to be further investigated to maintain the longer-term viability of the stock (closed seasons, closed areas, minimum size, etc.). These should only be considered after the stock has recovered to biologically safe levels, and would need to be scientifically evaluated prior to adoption."

The SWW RAC have also proposed several possible elements for a long-term management plan including harvest control rules (HCR), spatial and temporal closures, control on effort and capacity, market measures and cohabitation.

The latest work regarding development of management plan has been performed by STECF in April and June 2008 (STECF-SGRST 2008) as part of the Commission effort to make a proposal for a long-term management plan for the anchovy. The group performed a thorough evaluation of three basic harvest control rules (HCR) both in biological and socio-economical terms. The work and reports of these working groups are not finished yet and therefore have not been evaluated yet by STECF.

3.7.2.2 Harvest Control Rules.

In the last years a series of possible harvest control rules (HCR) and several technical measures have been proposed and partly evaluated, being presented to both ICES and STECF (see Uriarte & Ibaibarriaga, 2007 for a detailed summary).

In general two types of HCRs have been considered so far:_

(a) constant harvest strategies, where the TAC is defined as a proportion of the SSB where the harvest rate decreases linearly depending on the SSB with respect to the biological reference points B_{lim} and B_{pa} (Roel *et al*. 2003 and Ibaibarriaga *et al*. 2005).

(b) constant harvest above an escapement, where the TAC is a fraction of the SSB that remains above an escapement value (STECF-SGRST 2008).

Alternatively, HCRs that in the short term aim at keeping a constant biological risk (probability of SSB being below B_{lim}) have also been suggested by the SWW RAC and tested in STECF-SGRST 2008.

3.7.2.3 Other management measures and future developments.

The following long-term management plans have been proposed but not yet evaluated:

The use of time/area closures to protect spawners and/or juveniles, allowing a larger portion of the newly recruited individuals to spawn. For example, the closure of a nursery area like the area around the Gironde estuary should be considered whenever the assessment reveals in spring a critical level of biomass. Another approach could involve control measures such as special fishing permits rules for waters outside 12 miles limit or VMS (Vessel Monitoring System) monitoring.

Provisions on capacity and effort to adapt them to catch possibilities. An annual adjustment of effort would reflect the fluctuating nature of the annual biomass available for fishing. As this fishery is mainly conducted by vessels with opportunistic fishing strategy throughout the year, this would possibly involve redeployment plans. A long-term management plan would also evaluate if the sizes of the current fleets are adequate to catch the levels of anchovy that would result from a long term plan.

A revision of the market rules for anchovy, including for example a reduction of the number of anchovy per kg for pelagic trawlers, reducing the catch of immature fish to protect ages 0 and 1 before spawning.

Apart from this proposed management plans, the current situation with an elongated recruitment failure period may require further changes in the management procedure, which are discussed in section 3.7.3 below.

3.7.3 Recent recruitment failure

3.7.3.1 Evidence for a recruitment failure

Bay of Biscay anchovy recruitment has been among the lowest of the time series since 2002, with a series of two (2002 and 2003) and four (2005-2008) consecutive recruitment failures, this later series being the largest series of consecutive recruitment failures since anchovy assessment started (see Figure 3.6.1.3. in Section 3.6.1.3). As all short lived species, anchovy stock is very dependent on recruitment, and therefore these recruitment failures lead to the low biomass levels observed in recent years.

Both recruitment variability and stock collapses generated by periods of recruitment failures are common characteristics of other small pelagic stocks worldwide (Barange *et al.*, *in press*). Environmental shifts, fishing pressure, or a combination of both, have been often reported as the causes of consecutive recruitment failures and their associated crisis (Freon *et al.*, 2005). Also, depensatory effects (Allee effects) can affect a stock at low population levels, reducing the potential to recover from low stock biomass levels (Liermann and Hilborn, 1997; Mullon *et al.*, 2005).

Periods of low abundance of small pelagic species can be related to changes in the pelagic ecosystem, and at the same time have a strong influence on the system itself. The transfer of energy from lower to upper trophic levels in coastal pelagic ecosystems generally depends on a low number of species with a large biomass (Wasp-waist ecosystems; Rice, 1995), and the decline of one of such species often leads to the rise of another (see a review in Barange *et al.*, *in press*). This phenomenon is known as species alternation, and affects many sardine and anchovy populations worldwide (see for example Lluch-Belda *et al.*, 1992; Chavez *et al.*, 2003; MacCall, *in press*). Species alternation is often accompanied by other changes in the food web (e.g. Swartzlose *et al.*, 1999; Heymans *et al.*, 2004, van der Lingen *et al.*, 2006) that overall affects the efficiency of the energy transmission through the food web, and therefore the carrying capacity of the ecosystem (van der Lingen *et al.*, 2006). New stable trophic webs are established, which can delay or prevent the recovery of a given stock, extending in time the periods of low abundances (as long as 20 years in the case of Californian sardine or Chilean anchovy; see reviews in Freon *et al.*, 2005; Barange *et al.*, *in press*). Also, different changes in behavior characteristics which can affect stock recovery have been reported for depleted stocks. For example, changes in school composition (School trap theory, Bakun and Cury, 1999; Bakun, 2001) or changes in migration pattern due to lack of adults (Entrainment hypothesis, Petitgas *et al.*, 2006) have been described for different small pelagic populations, and have a negative impact on recovery.

Environmental indices do also suggest that some changes may have occurred between the nineties and the current first decade of the 2000 millennium over the Bay of Biscay. According to WKLTVSWE (ICES 2007d) report, in the current decade the NAO(North Atlantic Oscillation index) and EA(Eastern Atlantic pattern) indexes have opposite signs (negative and positive respectively), and different from the previous decade, the change begin more clear at the late years of the past decade. Also the POL(Polar / Eurasia pattern) show similar changes around the same time. The East Atlantic pattern (EA) and the Polar/Eurasia (POL) patterns both are related significantly to the long Recruitment index series of anchovy (ARI – from Borja *et al.*

1998) although significance is lost when the comparison is done on the the short series of recruitments arising from the ICES assessment (since 1987). This relationship might be partly related to their relationship with the Landes and Spring upwelling indexes in the region.

Since 1998, Borja's upwelling index has been continuously below average (mean of 525, versus the long term mean of 716). While in the period 1989-1997 the average value of this index was above the mean (996). The change in these two periods occurred before the current low levels of Recruitment installed, but suggest that some environmental changes may be occurring as well.

On the other hand the evolution of the mean stratification of the water column reflected by Huret & Petitgas (1997WD to the past year report ICES2007a) show this index to be low (below average) in 2001, 2002, 2004, 2007 most of them being typical examples of failures of recruitment for anchovy. All these observations suggest that environment may also be playing a role in this apparent regime shift in the recruitment levels of anchovy.

For the case of Bay of Biscay anchovy, some alternation between sardine and anchovy have been detected in the past (Bode *et al*., 2006). Increase of sardine biomass off the Iberian peninsula, as well as some signals of increase in the Armorican shelf has also been observed, although the acoustic data on the abundance of sardine in this later area does not show a stable trend. Also, a reduction of the distribution of anchovy in the Bay of Biscay has been observed both in the acoustic and egg production survey (see Section 3.4.3 and ICES, 2007b) and changes in the school composition have also been described (Masse and Gerlotto, 2003). Changes in global and local environmental indexes have also been described for the Bay of Biscay (North Atlantic Oscillation index and Polar Eurasia and East Atlantic patterns, ICES2007d; upwelling and stratification index Borja *et al*., 1998, Alain *et al*, 2001 and Huret and Petitgas, 2007). In some cases, a relation between local indexes and anchovy recruitment has also been established (Borja *et al*., 1998, Alain *et al*, 2001 and Huret and Petitgas, 2007), although results of these analysis are not yet conclusive. However, other changes in the food web that support a shift in the species composition has not been described for this area, and no mechanistic hypothesis that can defend a shift of species have been provided. Under this scenario, main conclusions that can be extracted in relation to recent anchovy recruitment failures can be summarized as follows:

- The present recruitment failure period for Bay of Biscay anchovy is the longest observed in the time series. Also, the distribution and spawning area of anchovy in the Bay of Biscay in recent years has been reduced in comparison with the years previous to the recruitment failure. At the same time sardine in the Iberian peninsula shows an increasing trend, which may also be happening in the Armorican shelf, although results in this area are not conclusive.
- Upwelling and stratification indexes in the Bay of Biscay, have shown low values in recent periods, which is supposed to affect recruitment negatively.
- No other changes in the biological composition of the pelagic community of the Bay of Biscay have been reported.
- With the data available, it is not possible to conclude that there has been a shift in the Bay of Biscay pelagic ecosystem. However, there are signals suggesting some mechanisms preventing the recovery of the stock, and that anchovy in the Bay of Biscay may be facing a phase of low abundance. Also,

> this WG recognizes that identifying a "change of phase" while it is in progress is a challenging task, as it is widely recognized in the scientific community.

The implications of a possible change of phase in Bay of Biscay anchovy are discussed in Section 3.7.3.2 below. In order to overcome the difficulties in supporting or rejecting the possibility of a change of phase, the WG recommends compiling and investigating all information on recent changes in the pelagic community, and report them to next WG meeting.

3.7.3.2 Implications for management

It is likely that the closure of the fishery for the last two years led to an improved survival and accordingly an increase in the relative abundance of anchovy older than age 1. However, the recruitment has remained low since 2002 and SSB in 2008 remains at similar low levels as in the two previous years. Given the low recruitment in 2008, the contribution of older fish to the spawning in 2009 will be crucial.

As discussed in Section 3.7.3, the stock may have entered a different recruitment regime, with generally lower recruitment than previously and consequently lower SSBs, even without a fishery. It is not possible to predict how long this regime will last. Clearly, with this reduced recruitment, the stock cannot sustain a fishery at the previous level.

Following the precautionary approach the recruitment in 2009 should be assumed to be low as there is no indication suggesting recruitment might improve in 2009. Then, the probability that SSB in 2009 will be below B_{lim} is larger than 25%, even in case of no catches. Hence, according to the current assessment, the situation is similar to the one that last year led to the advice the closure of the fishery for one additional year. As such the WG considers the stock to have reduced reproductive capacity, and suggests that the fishery should remain closed until reliable estimates of the 2009 SSB and 2008 year class, based on the results from the spring 2009 acoustic and DEPM surveys, become available.

As noted in Section 3.4.4. the juvenile surveys that are developing may give a first indication of next years recruitment. Since the experience with these surveys is limited to a period with poor recruitment, an indication of a better juvenile abundance in the autumn should be confirmed by the surveys in May before the fishery is reopened.

As discussed in Section 3.7.3, the reason for the recruitment failure is by no means clear. However, it has lasted longer than one could expect if it were just random variations. It is not clear how the stock will respond to exploitation in this situation. Hence, there is no firm basis for revising the current Blim. The stock may recruit at the present level even at biomasses below the current Blim, but it is also possible that the SSB resulting from a low recruitment in itself causes further low recruitments. The stock is now concentrated in smaller areas than previously, see e.g. Figures 3.4.3.2 and 3.4.3.3.

Management may have to adapt to the current situation, *inter alia* by developing harvest rules adapted to the stock distribution and stock dynamics as it appears at present. Such rules should include criteria for reopening the fishery, which should include improved recruitment, but also could include criteria related to area distribution, species alternation and environmental conditions (Barange & al, in press). From the scientific point of view, further work is needed to be able to evaluate such rules, in particular with respect to the stock-recruit dynamics under a low recruitment regime. This task is far outside the scope of the present WGANC.

The biomass points of reference sets the limits to exploitation according to the precautionary approach To fulfil its obligation to advise according to the precautionary approach, ICES considers that the advice should imply a less than 5% probability of bringing the SSB below Blim. However managers may wish to consider different allowable levels of risks for reopening the fishery. In searching for acceptable compromises between risks and social impacts of the management decisions, risk should include both the probability of inducing a prolonged recruitment failure and the cost of such a failure (ICES 2007c). Table 3.6.2.2.1 gives some indication of the probability of having SSB below Blim in 2009 with various catch levels in the coming year. The management considerations might also include additional measure like area and seasonal closures and access limitations.

The scientific monitoring of the population required for a good management advice should include monitoring of adult stock by acoustic and DEPM methods in spring. These surveys are the only reliable basis for monitoring the state of the stock and should be maintained. In addition obtaining a recruitment index (through an acoustic survey as is now in progress, or improved environmental models) would enhance a lot the quality of the advice for management since the population is dominated by the recruits. Simulations have shown that such an index would improve the performance of any harvest control rules. However the utility of any recruitment estimator would depend on its ability to predict the recruitment with sufficient precision. (see for example: De Oliveira *et al*., 2005)

4 Anchovy in Division IXa

4.1 ACFM Advice Applicable to 2007 and 2008

ICES advice in December 2005 (ICES, 2005 a) stated that the state of the anchovy stock in Division IXa is unknown because of the inadequacy of the available information to evaluate the spawning stock or fishing mortality relative to risk (precautionary limits). So far, these shortcomings are preventing the provision of explicit management objectives for this stock and the estimation of appropriate reference points.

Accordingly, ICES advice in relation to the exploitation boundaries of this stock stated that catches in 2007 should be restricted to 4,800 t (mean catches from the period 1988-2006, excluding 1995, 1998, 2001, and 2002, the years when catches were probably influenced by exceptionally high recruitment), and that this catch level should be maintained until the response of the stock to the fishery is known.

Given the high natural mortality experienced by this stock, its high dependence upon recruitment (the fishery depends largely on the incoming year class, the abundance of which cannot be properly estimated before it has entered the fishery), and the large inter-annual fluctuations observed in the spawning stock, ICES is aware that the state of this resource can change quickly. Therefore an in-year monitoring and management, or alternative management measures should be considered. However, such measures should take into account the data limitation on the stock.

The agreed TAC for anchovy since 2002 (for Subareas IX and X and CECAF 34.1.1) is of 8,000 t. Anchovy catches in Division IXa in 2007 (6,454 t) accounted for 43% increase in relation to the levels recorded in relation to 2006 (4,491 t) and 2005 (4,515 t) levels, but still somewhat lower than recent maxima in 2001 (9,098 t) and 2002 (8,806 t). For 2008 this TAC has been agreed again in 8,000 t, with national catch quotas being established at 3,826 t for Spain and 4,174 t for Portugal.

4.2 The Fishery in 2007

4.2.1 Fleet composition and métiers

Anchovy harvesting along the Division was carried out in 2007 by the following fleets:

- Portuguese purse-seine fleet
- Portuguese trawl fleet
- Portuguese artisanal fleet
- Spanish purse-seine fleet
- Spanish trawl fleet (in Subarea IXa-South)

Data on number and technical characteristics for the Portuguese fleets fishing in 2007 are not available for this working group. Nevertheless, size and characteristics of these fleets should not be very distinct from the described ones the previous year for the fleets fishing sardine (ICES, 2007 a). So, the purse- seine fleet (n =121 in 2006) presently ranges in size from 10.5 to 27 m (mean vessel length = 20 m) and between 71 to 447 HP (mean = 249) in vessel engine power.

Details on the purse-seine vessels operated by Spain in the Gulf of Cadiz, differentiated between total operative fleet and fleet targeting anchovy, are given in **Table 4.2.1.1** and **Figure 4.2.1.1**. The evolution of the number of vessels by fleet type exploiting this fishery through the historical series is available for the period 1999-2007. During this period the number of purse-seine vessels has oscillated between 145 (in 2004) and 104 (in 2000) vessels, and the vessels within this fleet targeting anchovy between 90 (2001) and 135 (2004) vessels. As it has been previously reported (ICES, 2007 a), the observed fluctuations during this period were mainly motivated by the ending of the fifth EU-Morocco Fishery Agreement (in 1999, which affected the heavy-tonnage fleet in the following two years), the rising of the light-tonnage purse seiners on those dates, and the fluctuations showed by the multipurpose vessels (see **section 4.2.4.2**).

In 2007, the entire Spanish purse-seine fleet fishing in the Gulf of Cadiz was composed by 112 vessels, with 88 vessels dedicated in a greater or lesser extent to the anchovy fishing. These vessels fishing for anchovy account for more than 85% of the whole fleet during the available series, evidencing the importance of anchovy as a target species in the Gulf of Cadiz purse-seine fishery (**Figure 4.2.1.1)**.

A first attempt of identifying *métiers* in the Gulf of Cadiz purse-seine Spanish fishery was presented in the 2007 WGMHSA meeting (ICES, 2007 a). This study (see also Silva *et al*., 2007, for details) focused on the application of a non-hierarchical clustering data-mining technique (*CLARA*, *C*lustering *LAR*ge *A*pplications) for classifying the fishing trips of the Spanish purse-seine fleet operating in the Subdivision IXa South from 2003 to 2005. The classification of individual trips was only based on the species composition of landings from logbooks, hence the preliminary character of this study. Up to four clusters (catch profiles) were identified from each of the annual datasets according to the targeted species: 1) trips targeting anchovy, 2) trips targeting sardine; 3) trips targeting a mackerel species mixture; and 4) trips targeting an anchovy and sardine mixture. The first three groupings were considered as clearly identifiable *métiers* according to the knowledge on the fishery. The 2007 WGMHSA, however, encouraged the realisation of a more sound analysis of fleet segmentation by taking into account additional information on technical characteristics of sampled vessels, home and landing ports, and location of catches, if available, in order to identify more properly the different components of the Gulf of Cadiz purse-seine fishery (ICES, 2007 a). No comparable information on Portuguese *métiers* has been provided to this WG.

4.2.2 Catches in 2007

4.2.2.1 Landings in Division IXa

Anchovy total landings in 2007 were 6,454 t, which represented a 43% increase with regard to the 2006 (4,515 t) and 2005 (4,515 t) landings but they are still at lower levels that the recorded ones in 2001 (9,098 t) and 2002 (8,806 t), respectively (**Table 4.2.2.1**, **Figure 4.2.2.1**). The contribution by each subdivision to the total catch was not very different from last year excepting the relative increase of catches from Subdivision IXa-CN.

As usual, the anchovy fishery in 2007 was almost exclusively harvested by purse seine fleets (94% of total catches). Portuguese and Spanish purse-seine landings accounted for 55% and almost the total of their respective national total catches (**Table 4.2.2.2**). However, unlike the Spanish Gulf of Cadiz fleet, the remaining purse-seine fleets in the Division only target anchovy when its abundance is high. The Portuguese artisanal anchovy fishery in 2007 experienced a very important increase in their national landings as compared with the previous years (376 t, 43%). Landings from this fishery as well as from the trawls (both Spanish and Portuguese) were still small in relation to the whole anchovy fishery in the Division.

4.2.2.2 Landings by Subdivision

The anchovy fishery was mainly located in 2007 in the Subdivision IXa South (5,610 t, *i.e.*, 87% of total catch in the whole Division, **Table 4.2.2 3**, **Figure 4.2.2.1**). As observed in recent years, the bulk (99%) of these catches was fished in the Spanish Gulf of Cadiz (5,576 t vs 34 t landed in the Algarve). The relative importance of landings in the remaining Subdivisions was negligible excepting in the IXa-CN, where 833 t were landed.

The Spanish fishery in 2007 followed the same distribution pattern described for recent years (see ICES, 2007 a), with almost all anchovy being fished in the Gulf of Cadiz waters (only 4 t in Subdivision IXa North, *i.e.*, southern Galician waters). The Portuguese anchovy fishery has historically shown alternate periods of relatively high and low landings in each of their three Subdivisions, anchovy fishery being located either in the IXa South (before 1984), or in the IXa Central-North (from 1984 to 1997, and in 2007), or mainly distributed in both Subareas (from 1998 to 2003), (see **Table 4.2.2.4**, Pestana, 1989, 1996; ICES, 2007 a).

The Gulf of Cadiz Spanish purse-seine fishery was closed from mid November 2007 to mid February 2008 (3 months) as part of the management measures included within the *"Plan for the conservation and sustainable management of the purse-seine fishery in the Gulf of Cadiz National Fishing Ground"*. This management plan was firstly implemented in 2004 on October 30th and since then the fishery closures (that lasted 45 days in 2004 and 2005, and the last 2 months in 2006) are accompanied by a subsidized tie-up scheme for the purse-seine fleet. A more detailed description of this plan and the impact of the previous closures in landings and fishing effort were given in ICES (2007 a). The effects of these closures on the purse-seine quarterly landings in 2004-2007 as compared with preceding years are shown in **Figure 4.2.2.3**. The years included in this Figure are those when the whole purse-seine fleet has been exerting its greatest fishing capacity. The impact of the 2007 closure in landings was still relatively high but somewhat lower than in the two preceding years. Impacts of this management measure in the fishing effort will be discussed in **Section 4.2.4**.

In Portugal, a closure of the purse-seine fishery has been agreed by the producers organisations in the northern Portuguese coast (north of the 39º42" north, i.e. subdivision IXa Central-North) since 2003. This closure lasts for 2 months, although since 2006 it may be selected between 1st of February and 30th of April (*i.e.* boats stopped fishing in February to March or in March to April). Effects of these closures in the anchovy landings in the IXa Central-North area have not been analysed although they should be low since no targeted fishery to anchovy is presently developed there.

Seasonal distribution of catches by country and Subdivision in 2007 is shown in **Table 4.2.2.3**. Anchovy catches were recorded throughout the year in all Subdivisions,, although with a different intensity. The scanty catches from the northernmost Spanish Subdivision (South Galicia) were mainly landed in the third quarter, those from Portuguese waters of the IXa Central-North during the fourth quarter, whereas catches from the Central-South and South areas were mostly allocated between the first and second quarters. Anchovy fishery season in the Spanish part of the IXa South (Gulf of Cadiz) occurred throughout the first half of the year, mainly in the spring months.

4.2.2.3 Catch Numbers at Age

Catch-at-age data from the whole Division IXa in 2007 are only available from the Spanish Gulf of Cadiz fishery (Subdivision IXa South). Data from the Spanish fishery in Subdivision IXa North are not available since commercial landings used to be negligible.

The age composition of the Gulf of Cadiz anchovy in Spanish landings from 1995 to 2007 (years considered in the exploratory assessment) is presented in **Table 4.2.2.4**. **Figure 4.2.2.4** extends backwards the historical series until 1988 (see ICES, 2007 a, for tabulated data from years not shown in this report). The catch-at-age series shows that 0, 1 and 2 age groups support the Gulf of Cadiz anchovy fishery and that the success of this fishery largely depends on the abundance of 1 year-old anchovies. The contribution of age-2 anchovies usually accounts for less than 1% of the total annual catch (except in 1997, 1999, and the 2001-2003 period, with contributions oscillating between 2% and 7%). Likewise, age-3 anchovies only occurred in the first quarter in 1992 but their importance in the total annual catch that year was insignificant. Inter-annual variations in the contribution of each age group in landings throughout the historical series are described in ICES (2007 a).

Total catch in the Gulf of Cadiz in 2007 was estimated at 628 million fish, which represents a 23.7% overall increase in numbers with respect to 2006 (508 millions), and a level approaching to the recent maxima recorded in 2001 (723 millions) and 2002 (800 millions). The aforementioned landed numbers are the result of a generalized increase in landings of all the age groups, specially the 0 and 1 age-groups.

Landings of the 0 age-group anchovies are restricted to the second half of the year (mainly during the fourth quarter), whereas 1 and 2 year-old catches are present throughout the year. However, catches of 0 year olds in the fourth quarter in 2005 and 2006 were drastically reduced and those of 2 year fish completely absent, either in the same quarter (2005) or even through the whole second half year (2006). As stated above, both age groups were again well represented in the 2007 landings, (**Table 4.2.2.4**).

4.2.2.4 Mean Length- and Mean Weight at Age

4.2.2.4.1 Length Distributions by Fleet

Length distributions for the Spanish fishery in Subdivision IXa North are only available for the 1995-1999 period and they were characterised, with the exception of 1998, by fish larger than 12.5 cm (ICES, 2007 a). Portugal has not provided length distributions of their anchovy landings in Division IXa neither to the WGMHSA nor the present WG due to their scarce catches.

Annual length compositions of anchovy landings in Division IXa were routinely provided to the WGMHSA by Spain for the Subdivision IXa South. This series dates back to 1988. Gulf of Cadiz anchovy quarterly length distributions in 2007 are shown in **Table 4.2.2.5** and **Figure 4.2.2.5**. The historical series of annual size composition of landings until 2006 is reported in ICES (2007 a).

Smaller anchovy mean sizes and weights in the Gulf of Cadiz fishery are usually recorded in the first and fourth quarters as a consequence of a higher number of juveniles captured. This situation slighltly changed in 2006 and 2007, when smaller mean quarterly estimates from both variables were recorded during the second half year (**Table 4.2.2.5**, **Figure 4.2.2.5**).

Gulf of Cadiz anchovy mean length and weight in the 2007 annual catch (10.7 cm and 8.2 g) were similar to those estimated in the last years (see next paragraph and ICES, 2007 a).

4.2.2.4.2 Mean Length- and Mean Weight at Age in Landings

Mean length- and mean weight-at-age data are only available for Gulf of Cadiz anchovy catches (**Tables 4.2.2.6** and **4.2.2.7**, **Figure 4.2.2.6**). The analysis of small samples of otoliths from Subdivision IXa North in 1998 and 1999 rendered estimates of mean sizes at ages 1, 2 and 3 of 15.5 cm, 17.6 cm and 17.9 cm respectively (ICES, 2000, 2001). A sample of 78 otoliths from the same area was collected during the PELACUS 0402 acoustic survey. Mean lengths at age 1 and 2+ were 13.7 cm and 17.0 cm (Begoña Villamor, pers. comm.). Comparisons of these estimates with the ones from the Gulf of Cadiz anchovy indicate that southern anchovies attain smaller sizes at age.

Annual mean length and weight at age of Gulf of Cadiz anchovy were as follows (**Figure 4.2.2.6**):

Age group 0: mean length and weight in 2007 were 9.8 cm and 5.9 g respectively. Through the available data series (1988 onwards) these estimates have ranged between 5.8 cm and 1.3 g (1996), and 10.5 cm and 6.9 g (1989). A slight increasing trend has been observed in both estimates in the most recent years.

Age group 1: mean length and weight in 2007 were 10.7 cm and 8.3 g respectively. Mean lengths and weights have oscillated between 8.9 cm-6.4 g (1996) and 12.0 cm-12.4 g (2001). Both estimates for this age group show a slight decreasing trend in the last years.

Age group 2: mean length and weight in 2007 were 14.1 cm and 19.0 g respectively. Mean lengths have oscillated between 13.5 cm-14.9 g (1998) and 16.9 cm-33.5 g (1989). Since 2001 both estimates have experienced a remarkable decreasing trend.

Seasonally, 0 age-group anchovies off the Gulf of Cadiz are larger (and usually also heavier) in the fourth quarter. This general pattern was apparent in 2006 and 2007, but it was not so in 2004 and 2005, when weights in the fourth quarter were rather similar to those estimated in the third quarter. The 1 and 2 year-old anchovies exhibit a clear and persistent pattern through the years, showing the larger mean length and heavier mean weight in the second half in the year.

4.2.3 Discards

No information on anchovy discarding in the Division IXa has been available until 2005. That year several pilot surveys for estimating discards in the Gulf of Cadiz Spanish fisheries (trawl, purse-seine and artisanal) were conducted by an IEO observer's programme onboard commercial vessels lasting five months and covering the whole study area. Preliminary results (average estimates from 6 purse-seine trips – 13 hauls –, not raised to total annual landings) from these pilot surveys were described in ICES (2006 a) although there were concerns about the reliability of such estimates and the ratios derived from them due to their extremely high associated CVs. On the other hand, discarded anchovies were of commercial and legal size, between 10 and 15 cm (mode at 12.5 cm), but reasons for discarding anchovy were not reported to that WG. Anchovy catches in sampled trips from the bottom otter-trawl fleet were negligible. New data on anchovy discarding are expected to be gathered since 2009 on within the Spanish National Sampling Scheme framed into the EC Data Collection Regulation (DCR).

There is no information about the continuity of this sampling programme in the near future.

4.2.4 Effort and Catch per Unit Effort

4.2.4.1 Data availability and standardisation

The annual series of both nominal fishing effort (number of fishing trips) and CPUE indices of anchovy in Division IXa are available for the Gulf of Cadiz Spanish purse-seine fishery since 1988. The data series from the Spanish purse-seine fishery off southern Galician waters (Subdivision IXa North) only comprise the 1995-1999 period whereas no data from the Portuguese purse-seine fisheries along the Division are available. Causes for this scarcity or even absence of data from the later fisheries must be found in their low anchovy annual catches during the last 3-4 decades and mainly by the fact that these fisheries target sardine (see **Section 4.2.2** and **Table 4.2.2.1**).

Regarding the Gulf of Cadiz anchovy Spanish fishery, data on annual values of nominal effort (fishing trips targeting on anchovy) and CPUE by fleet type have routinely been provided to the WGMHSA (ICES, 2007 a). The series of effective effort and CPUE from all of the Spanish fleets exploiting the Gulf of Cadiz anchovy were provided for the first time to the WGMHSA in 2004. For such a purpose, vessels from single-purpose fleets were additionally differentiated according to their tonnage in heavy- (≥30 GRT) and light- (<30 GRT) tonnage vessels, rendering a total of 11 fleet types.

The standardisation procedure was performed in the last years by fitting quarterly log-transformed CPUE's from fleet types composing the fishery to a GLM (Robson, 1966; Gavaris, 1980) which only included the effects of quarter and fleet type (without any interaction), (ICES, 2007 a). This year the GLM fitting was performed with the following modifications to the original version: (a) the effect of missing values in the nominal CPUE data was smoothed by adding a constant value to data before their log-transformation. In this case, this constant was computed as the 10% of the average value for the whole nominal CPUE series resulting in log(CPUE adjusted) data. (b) the model includes this year the year, quarter, fleet type and first order interaction effects.

Reference fleet (*métier* or fleet type), year and season used in the standardisation were the Barbate's single-purpose high-tonnage fleet, the first year in the series, 1988, and the first quarter in the year, respectively.

The updated series (1988-2007) of standardised effort and CPUE from all of the fleets exploiting the fishery have been provided to the WG this year. Parameter estimates resulting from the generalised linear modelling used for CPUE standardisation are not shown in the present report. Instead, goodness of fit of this model as assessed by ANOVA and model graphical diagnosis (residuals plots and profile plots of estimated marginal means of the dependent variable) are shown in **Table 4.2.4.1** and **Figure 4.2.4.1**. The model as implemented shows a relatively acceptable fit to observed data, explaining about 84% of the total variance (adjusted R^2= 0.84). Predicted versus observed data and residuals plots seems to corroborate the appropriateness of the chosen model. Profile plots of marginal means indicate that interaction between factors may be relevant as evidenced by the intersection between profiles of marginal means.

Annual and half-year standardised CPUE series for the whole fleet were computed from the quotient between the sum of raw quarterly catches and that of standardised quarterly efforts within the respective time period. The resulting estimates are shown in **Table 4.2.4.2**.

4.2.4.2 The Gulf of Cádiz purse-seine Spanish fishery: recent trends in overall and fleet type estimates of fishing effort and CPUE

Series of standardised overall annual effort and CPUE and the historical series of landings are shown together in **Figure 4.2.4.2**. Landings associated to the sampled fishing effort are also included in the Figure in order to show the sampling coverage of the fishing effort. An almost complete coverage of the whole fleet is evidenced since 1999 on, whereas some gaps in the information on effort occur in preceding years, mainly in the 1988-1993 period. Therefore any interpretation about trends during the above period should be taken with caution.

The fleets' behaviour in 1995 and 2000-2001 was mainly driven by a drastic reduction of the fishing effort exerted by the Barbate's heavy-tonnage purse-seiners which was coincident with the two minima in landings in 1995 and 2000. This fleet segment (the main responsible for anchovy exploitation in both the Moroccan and Gulf of Cadiz fishing grounds in previous years) accepted a subsidised tie-up scheme in those years because the corresponding fourth and fifth EU-Morocco Fishery Agreements either ended (1995) or ended and was not then renewed (2000). During the 2000-2001 period, the void left by these vessels in the fishing grounds was rapidly occupied by fleets with a lighter tonnage and lower fishing capacity, that were already experiencing remarkable increases in their exerted fishing efforts since 1999, due to the high anchovy yields recorded the previous year (**Figure 4.2.4.3**). From 2002 onwards Barbate's heavy-tonnage purse-seiners were fishing again in the Gulf of Cadiz gradually increasing their effort levels, at least until 2004. This last trend is accompanied by a progressive decrease in the effort by smaller vessels. Overall, such shifts in the fleet dynamics do not seem to affect the total fishing effort since the annual values are maintained at quite high levels since 1997 (even with a 45 day-fishing closure in late 2004). In 2005 and 2006, however, the possible combination of a fishing closure in the fourth quarter and the reduction of the number of active vessels fishing anchovy (from 135 vessels in 2004 to only 106 vessels in 2005 and 96 in 2006) led to a marked decrease in fishing effort. Such a decreasing trend seemed to have affected all the fleet segments in 2005, whereas in 2006 the reduction in the annual effort was only evident in the Barbate's home-based fleets. In 2007, however, generalised and remarkable increased effort levels were again exerted by all the fleet segments, despite the recent (April 2007) incorporation of the Barbate's heavy-tonnage purse-seiners to the Moroccan fishing grounds after the sign of a new Fishery Agreement and the implementation of a new fishing closure.

As for the CPUE, the high yields estimated in 2001 and 2002 showed a remarkable decrease in 2003 and 2004, they increased in 2005, slightly decreasing again in 2006 and 2007. This general trend was also observed in each of the fleet types but the multipurpose type, which still mantains the decreasing trend observed in recent years, and the westernmost fleets in 2006 and 2007, which showed the same or slightly higher yield levels than in previous years.

4.2.4.3 The Gulf of Cadiz purse-seine Spanish fishery: impact of closures in autumn 2004-2007 in fishing effort and CPUE

Figure 4.2.4.4 shows the quarterly purse-seine landings and quarterly estimates of standardised effort and CPUE for the 2002-2007 period. The fishery closure during the last 45 days in 2004 not caused a serious impact neither in the standardised overall effort exerted during the fourth quarter in that year (997 fishing trips), as compared with those estimated for the same quarter in 2002 (1,272 trips) and 2003 (807 trips), nor in the contribution of this quarter (15%) to the total fishing effort in 2004 (6,824 fishing trips). In 2002 (total annual effort of 7,876 trips) and 2003 (6,823 trips) the relative importance of their respective fourth quarters in terms of fishing activity was 16% and 12%.

The 2005 closed season (also the last 45 days in the year) caused however a stronger impact in the fishing effort exerted in the fourth quarter (215 fishing trips) and in the contribution of this quarter (6%) to the total annual effort (3,824 fishing trips).

In 2006, the closed season lasted for the 2 last months of the year. Fourth quarter effort levels were the lowest ever recorded in the available historical series (only 41 fishing days), and they only accounted for 1% of the total annual effort (5,077 fishing days).

Unlike 2004, the 2005 and 2006 annual efforts were noticeably (mainly in 2005) affected by such a disminution of the effort levels in their respective fourth quarters, although other additional causes than the fishing closure (*e.g.*, reduction in the number of active vessels and, possibly the decrease of effective fishing days because of bad weather as well) should also be taken into consideration to explain this trend.

In 2007 the closed season extended from mid November to mid February the next year, therefore the 2007 fourth quarter was affected by only 45 days of closure. The impact of such a measure was much lower than in preceding years as demonstrated by the 596 fishing days exerted in the fourth quarter that accounted for 9% of the total annual effort (6,949 fishing days). In some extent, the situation in 2007 showed very similar to the described one for 2004 and pre-management plan years.

As noted in **Subsection 4.2.2.1.1** (see also **Figure 4.2.2.1.**), the effects of the 2004 closure in landings were not so evident at a seasonal scale, since the relative importance of autumn landings in 2004 was even greater (12%) than in preceding years (10% in 2002, 9% in 2003). In absolute terms the fourth quarter catches in 2004 (633 t) were either at the same level than its counterpart in 2002 (780 t) or even higher than in 2003 (412 t). As a consequence, the autumn CPUE in 2004 (0.621 t/fishing day) was higher than in preceding years in spite of the closure (0.613 t/fishing day in 2002, 0.511 t/fishing day in 2003). However, this was not the case in 2005 and 2006, when landings in their respective fourth quarters were the lowest recorded in the recent analysed series both in absolute (77 t and 9 t) and relative terms (2% and 0.2%). The low effort levels together with even more diminished catches in the fourth quarter resulted in a relatively low autumn CPUE both in 2005 (0.358 t/fishing day) and 2006 (0,223 t/fishing day). The parallel increase of catches and effort in the 2007 fourth quarter resulted in a seasonal yield (0.589 t/fishing day) similar to those recorded in 2004 and before.

4.3 Biological Data

4.3.1 Weights at age in the stock

Weights at age in the stock correspond to yearly estimates calculated as the weighted mean weights-at-age in the catches for the second and third quarters.

4.3.2 Maturity at Age

Previous biological studies based on commercial samples of Gulf of Cadiz anchovy (Millán, 1999) indicate that its spawning season extends from late winter to early autumn with a peak spawning time for the whole population occurring from June to August. Length at maturity was estimated in that study at 11.09 cm in males and 11.20 cm in females. However, it was evidenced that size at maturity may vary between years, suggesting a high plasticity in the reproductive process in response to environmental changes.

Annual maturity ogives for Gulf of Cadiz anchovy are shown in **Table 4.3.2.1**. They represent the estimated proportion of mature fish at age in the total catch during the spawning period (second and third quarters) after raising the ratio of mature-at-age by size class in monthly samples to the monthly catch numbers-at-age by size class.

4.3.3 Natural Mortality

Natural mortality is unknown for this stock. By analogy with anchovy in Subarea VIII, natural mortality is probably high (M=1.2 is used for the data exploration, see **Section 4.5.1**).

4.4 Fishery-Independent Information

4.4.1 Acoustic Surveys

A summary list of the available acoustic surveys providing estimates for anchovy in IXa is given in the text table below.

Surveys	Year/ Quarter	1993	....	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Portuguese Surveys	Q1				Mar		Mar	Mar	Feb					
	Q2									Jun	Apr	Apr	Apr	Apr
	Q3													
	Q4			Nov		Nov	Nov		Nov		Nov	Nov	Nov	
Spanish Surveys	Q1							Feb						
	Q2	Jun								Jun		Jun		
	Q3												Jul	
	Q4													

The Portuguese surveys series (*SAR* and *SARNOV* series) correspond to those ones routinely performed for the acoustic estimation of the sardine abundance in Division IXa off the Portuguese continental shelf and Gulf of Cadiz, during March-April (sardine late spawning season) and November (early spawning and recruitment season). Since 2007 on, the Spring surveys are being planned as 'pelagic community' surveys. This shift in planning mainly entailed, as compared with previous years, a substantial increase in the number of fishing stations in the Subdivision IXa-South, where the species diversity is higher, changing the series its former name by the one of *PELAGO* surveys. Anchovy estimates from these survey series started to be available since November 1998.

Spanish 'pelagic community' acoustic surveys have been conducted in Subdivision IXa North and Division VIIIc since 1983 (the spring *PELACUS* series). Results from these surveys for the Subdivision IXa North have shown the scarce presence or even the absence of anchovy in this area (Carrera, 1999, 2001; Carrera *et al.*, 1999). This situation still continues in the most recent years (surveys in the 2003-2008 period, see Porteiro *et al.*, 2005; Iglesias *et al.*, 2007; this present WG). For these reasons, this series has not included in the table above.

Spanish acoustic surveys in the Gulf of Cadiz waters (Subdivision IXa-South) have been sporadically conducted from 1993 to 2003. A consistent yearly series of early summer acoustic surveys (*ECOCÁDIZ* series) estimating the anchovy abundance in the Subdivision IXa South (Algarve and Gulf of Cadiz) started in 2004. Surveys in this new series are also planned under the 'pelagic community' approach. Unfortunately, this series may show, as it happened in 2005 and it will happens in 2008 as well, some gaps in those years coinciding (same dates and surveyed area) with the conduction of the (initially triennial) anchovy DEPM survey because of the available ship time.

As for the text table, acoustic estimates from surveys on a black background are those ones used since last year as tuning series in the exploratory assessment of anchovy in Subdivision IXa South (Algarve and Gulf of Cadiz, see **Section 4.5.1**). They correspond to the spring Portuguese survey series. Those surveys from the November series in bold letter provided anchovy estimates but they are not presently considered in the assessment. Surveys on a white background were carried out but did not provide any anchovy acoustic estimate because of its very low presence and/or for an incomplete geographical coverage (some areas were not covered). Surveys in light grey only covered the Spanish waters of the Gulf of Cadiz and the one in dark grey the whole Subdivision IXa South.

4.4.1.1 Description of surveys

Results from the spring Portuguese (*PELAGO07*) and spring (*PELACUS0407*) and summer (*ECOCÁDIZ 0707*) Spanish acoustic surveys in 2007 were reported in the last year's WGMHSA and WGACEEG reports (ICES, 2007 a, b). Information in the present section will be referred to those surveys carried out during the intersession time between the 2007 WGACEEG and the present 2008 WGANC meetings. A detailed description of surveys methodologies deployed by the respective national Institutes (IPIMAR and IEO) is given in ICES (2007 b) and summarised by Ramos *et al* WD, Annex 2.

Portuguese Surveys

Two Portuguese acoustic surveys have been carried out since the last year's WGACEEG meeting: one survey in November 2007 (*SAR07NOV*) and the other one in April 2008 (*PELAGOS08*). Both surveys were carried out with the R/V 'Noruega' and followed the standard methodology adopted by the Planning Group for Acoustic Surveys in ICES Subareas VIII and IX (ICES 1986, 1998) and WGACEGG (see, for instance, ICES 2007 b). The surveyed area usually includes the waters of the Portuguese continental shelf and those of the Spanish Gulf of Cadiz (Subdivisions IXa Central-North, Central-South, and South), between 20 and 200 m depth.

The autumn Portuguese *SAR07NOV* acoustic survey was conducted between 24 October and 17 November 2007, with the main objective of observing and estimating the sardine recruitment to the fishery. Ship time limitations prevented from surveying the whole survey area, the acoustic sampling being restricted to those areas where sardine recruitment is more frequently observed. This decision led to the western coast from the south of Cabo Espichel southwards and the southwestern Algarvian coast till Albufeira were not sampled. Conversely, the sampling intensity by fishing stations was increased, as it is planned in the *PELAGO* surveys, in the Subarea IXa South aiming to obtain a better understanding of the pelagic fish assemblages in an area characterised by a high species diversity.

Between mid-April and mid-May 2008 was also carried out the *PELAGO08* acoustic survey under the abovementioned 'pelagic community' survey approach, but no additional information on the performance of this survey, but the anchovy estimates, is available for this WG.

CUFES sampling was carried out during both surveys but information of anchovy egg densities is still not available.

Spanish Surveys

The only Spanish survey carried out in waters of the Division IXa in the first half in 2008 was the *PELACUS0408* survey, performed on board R/V *Thalassa* between 28th March and 23rd April. This survey samples the waters off the Subdivision IXa-North and VIIIc since 1983.

4.4.1.2 Results

Portuguese Surveys

SAR07NOV autumn survey:

As described for previous autumn surveys (and for spring-summer ones as well) anchovy mainly occurred in the fishing stations carried out in the Gulf of Cadiz area, mainly in the Spanish waters, and in a lesser quantity along the Lisboan coast, between Cascais and Cabo Raso (Figure 4.4.1.1).

Total anchovy abundance and biomass estimated during the survey were estimated at 1,921 million fish and 24.8 thousand tonnes. It should be noted that these estimates don't correspond to total estimates for the sampled area usually surveyed in the Portuguese surveys since about two thirds of the Subarea IXa-CS and about the half of the Subarea IXa-S(A) were not acoustically sampled. Nevertheless, anchovy in the Spanish waters of the Gulf of Cadiz (Subarea IXa-S(C)) was abundant, with estimated abundance and biomass of 1,386 millions and 16.1 thousand tonnes. In the Algarve (Subarea IXa-S(A)) were estimated 475 million fish and 7.6 thousand tonnes. In the western coast, between Cascais and Cabo Raso (Subarea IXa-CS), the species only recorded 58.6 millions and 1.1 thousand tonnes (Figure 4.4.1.2).

Bimodal size compositions for the anchovy population in the Cascais-Cabo Raso area and the Spanish part of the Gulf of Cadiz denoted the possible ocurrence in such areas of recruitment areas. So, their respective histograms were featured by a smaller modal class either at 11 cm (Cádiz) or 11.5 cm (Lisbon), and a larger one either at 13 cm (Cádiz) or 14.5 cm (Lisbon). Anchovy size composition in the Algarve area showed only one mode at 13 cm (Figure 4.4.1.2.1).

PELAGO08 spring survey:

The survey found out anchovy concentrations - apart from the ones usually occurring in front of Lisbon (north of the Subarea IXa-CS), eastern Algarve (east of the IXa-S(A)) and Gulf of Cadiz (IXa-S(C)) - in front of Porto and Figueira da Foz, in the Subarea IXa-CN (Figure 4.4.1.2.2). Such observations indicate a more spread northernwards distribution than the observed one in recent years. As usual, the highest records of acoustic energy attributed to the species were again observed in the Spanish part of the Gulf of Cadiz (IXa-S(C)).

The anchovy total biomass estimated during the survey for the whole Division IXa was 39.7 thousand tonnes (2,353 million fish), a biomass level almost identical to the one recorded the previous year, but coupled to a slight diminution in abundance, which suggests the occurrence of a population composed by larger fish. Anchovy was mostly concentrated, as usual, in the Spanish Gulf of Cadiz (Subarea IXa-S(C)), accounting for 77% (1,819 millions) and 74% (29.5 thousand tonnes) of the total estimated abundance and biomass in the Division, respectively. The Algarve (Subarea IXa-S(A)) yielded 4.7 thousand tonnes (212 millions), the Subarea IXa-CS (concentrated only in the Cascais-Cabo Raso area) 2.5 thousand tonnes (252 millions), and the Subarea IXa-CN (only two spots at Porto and Figueira da Foz) 3.0 thousand tonnes (69 millions), (Figure 4.4.1.2.2).

The anchovy length composition along the Division showed a general southward decreasing size gradient. So, the size histogram from the population in the Subarea IXa-CN showed two modes, the smaller one at 12 cm and the most important and larger at 17.5 cm. In the IXa-CS anchovy presented two well marked modes, the first and stronger one placed at 9 cm, indicating the occurrence of an important and late recruitment event in the population, and a larger scondary mode at 15 cm with a lower relative importance. Gulf of Cadiz anchovy population (IXa-S) was featured by a mixed size composition, with a clearly defined mode at 13 cm and secondary modes at 11 and 15 cm (Figure 4.4.1.2.2).

Spanish surveys

PELACUS 0408

Anchovy acoustic estimates for the Subdivision IXa North were only 306 t (10 million fish), mainly concentrated in the northernmost part of the area. The size composition in the population (with sizes between 13.5 and 20 cm) was a mixed one, with modal components at the 15, 16.5 and 19 cm size classes.

Some comments on recent trends in acoustic estimates

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 Subarea IXa South only (Spanish surveys) are shown in Table 4.4.1.1. The estimates from the 2006 Spanish survey have been re-calculated under the "multi-species approach" and the WGACEEG recommended TS values set. Such estimates, therefore, differ from those ones previously reported either to WGMHSA or WGACEEG. Something similar also happens with the estimates from the 2004 Spanish survey (in this case are considered the estimates derived from using the accepted TS (b20) value of –72.6 dB instead of the formerly used of –71.2 dB) although these last estimates are pending of a further revision.

The estimates from those surveys covering the whole southernmost subarea (the IXa South, whose population is explored by an analytical assessment) 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 (mainly the Autumn Portuguese one) which makes difficult to follow any clear trend. Biomass estimates from 1998 to 2003 in these Subdivision IXa-South have oscillated between 21 and 34 thousand tonnes. However, available estimates in 2004 and 2005 have decreased down to 18–14 thousand tonnes, evidencing a possible decline in the (spawning) population levels. In the 2005 WGMHSA and WGACEEG meetings was warned that the picture of an alarming decreasing trend just in 2004–2005 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, 2006 b) or to the echo-traces discrimination between fish and plankton (2005 Portuguese survey, Marques *et al*., 2005; ICES, 2006 b). 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. Despite these facts a decline in the spawning population in 2005 was corroborated by two different direct sources, the Spring Portuguese acoustic survey and the Spanish DEPM one, which both yielded an estimated SSB at 14 thousand tonnes (ICES 2006 c, 2007 a, b).

Notwithstanding the above, the 2005-2008 Portuguese spring survey seasons were coincident and their estimates, therefore, comparable, and they indicate an evident recovered population in 2006 and 2007-2008 up to a level close (2006) or even somewhat higher (2007, 2008) to the average estimate in the (Portuguese) historical series.

The high 2006 estimate from the Spanish survey 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 in 2007 and then a slight decrease of 4 thousand tonnes in 2008) than the trend exhibited by its Spanish counterparts (a 7.6 thousand tonnes decrease). 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 happened that year for such differences is a matter of concern and some working hypothesis were drawn in the last year's WGACEEG for explaining the above differences (see ICES, 2007 b and Ramos *et al.* WD, Annex 2 for a more detailed description).

As recommended by the WGACEEG, the aforementioned discrepancies strengthen the necessity of an extended sampling coverage to shallower waters (<20 m depth) 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, and they will be tested by the IEO this year during 2 pilot experiments acoustically surveying the shallower Spanish waters of the Gulf of Cádiz (see also Section 4.4.3).

4.4.2 Egg Surveys

Spanish Surveys

Final estimates from the first full-scale DEPM survey for the Gulf of Cádiz anchovy carried out in June 2005 (*BOCADEVA* 0605) were reported both to the 2006 WGACEGG and 2007 WGMHSA (ICES, 2006 c, 2007 a), (**Table 4.4.2.1**). No DEPM survey has been carried out in 2007 since the triennial periodicity of the series. The next DEPM survey will be carried out between 21st June to 4th July this year.

4.4.3 Recruitment surveys

As described in **Section 4.4.1**, anchovy population estimates in the Subdivision IXa South by direct methods are available from the Portuguese acoustic survey series since 1998. Although Portugal provides such estimates as aggregated ones, an estimation of the recruits either from their autumn (as age-0 recruits in the year) or spring surveys (as age-1 fish in the next year) may be derived after the application of Spanish age-length keys. However, such keys are based on commercial samples from purse-seine catches and therefore they may result in a biased picture of the population structure because of a different catchability. Since 2005 otolith collections from these surveys are being provided by IPIMAR to IEO in order to derive their corresponding age-length keys. Age reading is in progress and is expected that disaggregated acoustic estimates will be provided to this WG in the near future. Regardless the above and the considerations about the suitability of the sampling coverage in these surveys for sampling this population fraction (mainly age-0 fish or even adult fish in shallow waters), the series of point estimates is at present scattered and scarce, at least for the November series (see **Table 4.4.11**).

Despite such limitations, during the 2007 WGACEGG 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 Atlanto-Iberian sardine (and anchovy) recruitment international survey in the future. Requirements to be fullfilled by this survey are listed in ICES (2007 b). As anchovy is concerned, the surveys should cover the species' potential recruitment grounds in the Gulf of Cadiz, from the 100 m isobath or even less up to below the 20 m isobath to accommodate the potential presence of juvenile anchovy at lower depths. As stated in the 2007 WGACEEG report, this new survey could provide a (local) recruitment index for anchovy (and probably for sardine as well) useful for management decisions.

This survey would obviously require the inshore extension of the surveyed area 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 order to the IEO (as proposed responsible for this survey) properly plan this kind of surveys in advance, 2 short pilot experiments will be carried out during this year aimed to testing the potential, as acoustic sampling platforms of shallow waters, of two smaller research vessels (R/V Francisco de Paula Navarro and R/V Emma Bardán) than the R/V Cornide de Saavedra and R/V Noruega usually utilised in conventional surveys. Proposed dates for each of these experimentes are 8 days in mid-July and mid-October, respectively.

4.5 Data exploration

Data availability and some fishery (recent catch trajectories) and biological evidence have been the basis for a data exploration of anchovy in Subdivision IXa South (Algarve and Gulf of Cadiz) (Ramos *et al.*, 2001; ICES, 2002).

4.5.1 Methods

An *ad hoc* seasonal separable model implemented and run on a spreadsheet has been used in the last years for data exploration of anchovy catch-at-age data in IXa South since 1995 onwards. Given the nature of stock, short-lived, data in this model are analysed by half-year-periods, those from the Algarvian anchovy being previously compiled by applying Gulf of Cadiz ALKs (**Table 4.5.1.1.1**; **Figure 4.5.1.1.1**). Weights at age in the catches are estimated as usual, whereas weights at age in the stock correspond to yearly estimates calculated as the weighted mean weights-at-age in the catches for the second and third quarters.

The separable model has been fitted this year to the updated half-year catch-at-age data until 2007 and to the available acoustic estimates of anchovy aggregated biomass from the spring Portuguese surveys series only (including the acoustic estimate one year ahead of the assessment's last year (this year the April 2008 survey; **Table 4.5.1.1.1**; **Figure 4.5.1.1.2**).

Reasons for the choice of the tuning index were: (a) the Spanish acoustic survey series (2004, 2006, 2007), was not used as a tuning index because of its shortness; (b) neither the DEPM-based anchovy SSB was considered since it has only one data point, but it was provided for comparison with the acoustic and model-predicted biomass estimates; (c) both Portuguese acoustic surveys series (spring and autumn surveys) were used as tuning indices in the past, assuming the same catchability coefficient. However, each survey series cover different fractions of the population so, the assumption of same catchability is probably inappropriate. Given that the model is unlikely to be able to estimate the extra parameter and that the sprig survey series has a better coverage both in space and time, only this survey series is used for the time being in the exploration.

The exploratory runs are performed under the following assumptions:

– Assessment only tuned by Spring Portuguese acoustic surveys (for the reasons above).
– Catches at age are assumed by the model to be linked by the Baranov catch equations.
– The relationship between the index series and the stock sizes is assumed linear.
– A constant selection pattern is assumed for the whole period.
– F values for 1995 (assessment's first year) are computed as an average of the Fs in subsequent years.
– F in the 2nd half-year in the assessment's last year (2007) estimated as a ratio of the F estimated in the 1st half by applying the ratio of seasonal Fs in the previous year (2006; affected by a closure as well).
– No available Cages for the first half in the year ahead of the assessment's last year (i.e. 2008): assumed as the same ones that in first half in 2007.
– Wagesstock in 2008: average of the estimates in the 3 last years in the assessment (2005-2007).
– F in the 1st half year in 2008: average of estimated 1st half-year Fs counterparts for the same period of years (2005-2007).
– Log-residuals of Cages in 2008 excluded from the minimisation routine whereas the residuals from the 2008 biomass acoustic estimate are included in the model fitting.

Parameters estimated are selectivity at age for both half-year-periods in relation to the reference age (age 1), recruitment, an average SSB, survey catchability (Q) and annual F values per half-year-period. Parameters are estimated by minimising the sum of squares of the log-residuals from the catch-at-age and the acoustics biomass data.

4.5.2 Exploratory runs

The same three exploratory analyses carried out in the last year's WGMHSA (ICES, 2007 a) has been performed this year:

RUN 1: Acoustic surveys as a relative tuning index and a weighting factor= 1.

RUN 2: Acoustic surveys as a relative tuning index and a weighting factor= 6.

RUN 3: Acoustic surveys as an absolute tuning index and a weighting factor= 1.

An upweighting factor of 6 for the acoustic estimates in RUN 2 was selected in order to balance the influence of their annual residuals in relation to those from catches at age (3 age groups x 2 semesters in a year). The rational for RUN 3 is the similarity between the estimates by the Portuguese survey and the Spanish DEPM in 2005 (14,000 and 14,200 tonnes respectively).

Figure 4.5.1.2.1 shows the trends exhibited by the main model outputs from all the runs (see **Tables 4.5.1.2.1** to **4.5.1.2.3** for details), including the last year's RUN 1 (see ICES, 2007 a), with similar settings than this year's RUN 1, for comparison. Residuals from the model fit to the catch at age data are plotted in **Figure 4.5.1.2.2**. Estimated half-year fishing mortalites (F) and fitted seasonal selection pattern estimated in each run by the separable model are shown in **Figure 4.5.1.2.3**.

Using the tuning index as absolute (*i.e.*, RUN 3) drops up the absolute levels of recruitment and population biomass, notably decreasing the fishing mortality. Conversely, the two remaining runs using the relative tuning index (RUN 1 and 2) show a downscaled perception of the levels of recruitment and population biomass and somewhat higher fishing mortalities. In any case, the change to very low F values in recent years is very unrealistic. At this point it must be reminded that the second semesters are not tuned by any index and the model in these cases follows to the trajectory of catches. As stated previously for the Biscay anchovy, such decreases in these model outputs are explained by the fact that the absolute level of the population is relying heavily on the level of catches at age. In this context, the assessment is reduced to a virtual population estimate, scaled to the level of catches, just tuned to relative trend series (from surveys). For a short living species as anchovy no convergence properties exist for a VPA estimate and scaling the population levels just to the VPA catch levels is inadequate. On the other hand, the patterns found in the catch at age residuals over time suggest some model misspecification (i.e. the assumption of a constant selection pattern).

The estimated selectivity for age 2 is similar for the different runs. However, a low selectivity at age 2, given the catch data and the level of natural mortality adopted, might be more in agreement with the perception of the impact of the fishery on the stock. Direct evidences from acoustic surveys (at the peak of the fishing season) show that larger and older anchovies are more common in the westernmost waters of the Subdivision, where there is no fishery targeting anchovy.

The acoustic estimates of biomass predicted by the model only fit reasonably well to the observed values in the RUN 2, when the tuning index is upweighted and used as relative. This was not the case for the remaining runs. The fit of the average biomass as estimated by the model to the acoustic data was also poor (**Figure 4.5.1.2.4**). The point estimate of the acoustic survey catchability coefficient (Q around 3 according to the run considered; **Tables 4.5.1.2.1** and **4.5.1.2.2**) seemed high, which resulted in an acoustic estimate of biomass much higher than the one estimated by the assessment model.

4.5.3 Conclusions of the Exploratory Assessments

The exploratory assessment is not recommended as a basis for predictions or advice. The immediate reason is that it estimates a large drop in fishing mortality and rapid increase in stock abundance in recent years, which is not supported by the data or the development of the fishery. The residuals show large clusters over time, indicating that the selection may not be constant.

In more general terms, estimating the parameters in a separable model with only a biomass index as supporting information is close to over-parametrisation, and the fact that only 2-3 ages are represented in the fishery makes the situation worse. Hence, the assessment becomes unstable and very sensitive to the assumptions made. Examination of the data indicates that almost all catches are from age 1, plus age 0 in the second semester. The ratio between catches at age 1 and age 2 indicates a total annual mortality in the order of 3-5, which is hardly realistic. To accommodate the trends in the survey data, the model estimates a far lower selection at age 2 than at age 1, which is not compatible with the preferences in the fishery. An alternative explanation to this discrepancy can be migration out of the relatively limited fishing area, for which there is at least some evidence in the age composition by area in the surveys.

Hence, the main problems with this assessment seem to be linked to the nature of the stock and the kind of data that can be accessible. An in-depth evaluation of the possibilities of handling these problems by other kinds of assessment models was out of reach for the WGANC. In order to make progress, a benchmark process needs to be launched. In that context, it may be productive to consider a wide range of assessment approaches in an open-minded way. It is noted that most of the signals in the data are found in the catches at age 1 in both semesters and at age 0 in the second semester, in addition to the trends in the survey biomass measurements. It might be worth exploring the time signal in these data. Production models should also be explored, but large fluctuations of the catches over time give some doubts about the stability of the carrying capacity.

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

4.6 Predictions

As stated in the previous section the exploratory assessment is not recommended as a basis for predictions. Nevertheless, the most recent direct acoustic estimates indicate that the stock in Subdivision IXa South is in a relatively stable situation (about 30 thousand tonnes as an average for the 2006-2008 period), a situation that could be reversed if the fishery, as evidenced by the increased effort levels reached in 2007, is still expanding its fishing capacity.

4.7 Management considerations

4.7.1 Stock definitions

A summarised description of the distribution of the main anchovy populations in NE Atlantic European waters is given in **Section 2**. It should be reminded that the exploratory assessment herein presented was only performed for the anchovy population nucleus in the Gulf of Cádiz (Subdivision IXa-South), the remaining resilient anchovy populations along the Atlantic Iberian façade of the Division being out of the scope of this assessment. As forwarded in **Section 2** and further commented in **Section 4.5.2** migration between the main nucleus in the Gulf of Cádiz and adjacent areas, although is still unknown, might be one of the causes explaining the discrepancies found in the assessment and it should be properly studied.

4.7.2 Reference points for management purposes

It is not possible to determine limit and precautionary reference points based on the available information.

4.7.3 Harvest Control Rules

Harvest control rules cannot be provided, as reference points are not determined.

4.7.4 Current management situation

Portuguese producers organisations traditionally agree a voluntary closure of the purse-seine fishery in the northern part (north of the 39º 42″ North) of the Portuguese coast. This closure usually lasted from the 1st of February to 31 of March. Since 2006, the closure, also lasting 2 months, may however be selected between 1st of February and 30th of April (i.e. boats stopped fishing in February to March or in March to April).

The regulatory measures in force for the Spanish anchovy purse-seine fishing in the Division are the same as for the previous years and are summarised as follows:

Minimum landing size: 12 cm total length in VIIIc and IXa North, 10 cm in Gulf of Cadiz (IXa South).

Minimum vessel tonnage of 20 GRT with temporary exemption.

Maximum engine power: 450 h.p.

Purse-seine maximum length: 450 m.

Purse-seine maximum height: 80 m.

Minimum mesh size: 14 mm

Fishing time limited to 5 days per week, from Monday to Friday.

Cessation of fishing activities from Saturday 00:00 h to Sunday 12:00 h.

Fishing prohibition inside bays and estuaries.

In the Gulf of Cadiz (Subdivision IXa South) the Spanish purse-seine fleet was performing a voluntary closure of three months (December to February) until 1997. Since 2004 two complementary sets of management measures affecting directly to the Gulf of Cadiz fishery have been implemented and are still in force. The first one was the new *"Plan for the conservation and sustainable management of the purse-seine fishery in the Gulf of Cadiz National Fishing Ground"*. This plan is in force during 12 months since October the 30th and includes a fishery closure (basically aimed to protect the anchovy recruitment) of either 45 days (between 17th of November to the 31st of December in 2004 and 2005), two months (November and December in 2006) or three months (mid November 2007 to mid February 2008), which is accompanied by a subsidized tie-up scheme for the purse-seine fleet. The plan also includes additional regulatory measures on the fishing effort (200 fishing days/vessel/year as a maximum) and daily catch quotas per vessel (3000 kg of sardine, 3000 kg of anchovy, 6000 kg of sardine-anchovy mixing but in no case each of these species can exceed 3000 kg). A new regulation approved in October 2006 establishes that up to 10% of the total catch weight could be constituted by fish below the established minimum landing size (10 cm) but fish must always be ≥9 cm.

Impacts of the autumn fishery closures in landings and fishing effort by the Spanish Gulf of Cadiz purse-seine fishery has been described in **Sections 4.2.2.1.1** and **4.2.4.3** and indicate that such closures did not cause serious effects in the reduction of the exerted fishing effort, at least in the last year, but only halting the possibility of expanding even more the fishing capacity of the fleets up to the recent maxima reached in the 1998-2002 period.

The second management action in force since 15th of July 2004 is the delimitation of a marine protected area (fishing reserve) in the mouth and surrounding waters of the Guadalquivir river, a zone that plays a fundamental role as nursery area of fish (including anchovy) and crustacean decapods in the Gulf (**Figure 4.7.4.1**). Fishing in the reserve is only allowed (with pertinent regulatory measures) to gill-nets and trammel-nets, although in those waters outside the riverbed. Neither purse-seine nor bottom trawl fishing is allowed all over this MPA.

The effects of such closures and MPA in the Gulf of Cádiz anchovy recruitment are not still possible to be directly assessed. In any case, the implementation of both of these measures should benefit the stock.

4.7.5 Scientific advice and contributions

The WG considers that from a conservation point of view the implemented plan should be beneficial for the stock. However, the plan has not been formally evaluated. Given the current uncertainty in the stock status, the WGANC still recommends that effective effort should not increase above recent levels. Further, the WG recommends that the fishery should not be allowed to further expand until the stock is properly assessed and there is evidence that the stock could support higher fishing pressure.

Given that the catch are comprised almost entirely of a single age group (age 1), in order to advise on sustainable harvest levels 2 years ahead of the most recent catch data an estimate of incoming recruitment is required. Currently the spring Portuguese survey tracks the population best. Notwithstanding the above, a series of pilot acoustic surveys in shallow waters leading to a new proposal of a Gulf of Cádiz anchovy recruitment survey series has been presented to this WG. Therefore, if an index were to be used as an estimate of recruitment (at age 0 or 1 depending on the survey series) strength, in-year management of this stock would be more appropriate.

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

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Table 3.2.1.1: Bay of Biscay Anchovy. Evolution of the French and Spanish fleets in Sub-area VIII. Fishery closed in 2006 and 2007 (from Working Group members). Units: numbers of boats.

	France				Spain *	
Year	**P. seiner**	**P. trawl**		**Total**	**P. seiner**	**Total**
1960	-	-			571	571
1972	-	-			492	492
1976	-	-			354	354
1980	-	-			293	293
1984	-	-			306	306
1987	-	-			282	282
1988	-	-			278	278
1989	18	6	(1,2)	24	215	239
1990	25	48	(1,2)	73	266	339
1991	19	53	(1,2)	72	250	322
1992	21	85	(1,2)	106	244	350
1993	34	108	(1,2)	142	253	395
1994	34	77	(1,2)	111	257	368
1995	33	44	(1,2)	77	257	334
1996	30	60	(1,2)	90	251	341
1997	27	52	(1,2)	79	267	346
1998	29	44	(1,2,3)	73	266	339
1999	30	49	(1,2)	79	250	329
2000	32	57	(1,2)	89	238	327
2001	34	60	(1,2)	94	220	314
2002	32	47	(1,2)	79	215	294
2003	19	47	(1,2)	66	208	274
2004	31	54	(1,2)	85	201	286
2005	8	41	(1,2,4)	49	197	246
2006	1 **	6 **	(1,2,4)	7 **	0	7
2007	0	0	(1,2,4)	0	0	0

* Spanish purse seiners are those with licences that landed anchovy
(1) Only purse seiners having catched anchovy at least once a year but fishing sardine most of the time
(2) only trawlers that targeted anchovy (annual catch > 50 t)
(3) doubtful in term of separation between gears because of misreporting
(4) Provisional estimate
** French number of Boats involved in the experimental fishery; not the actual size of the fleet

Table 3.2.2.1: Bay of Biscay Anchovy. Annual catches in tonnes (Sub-area VIII) as reported by Working Group members).

COUNTRY	FRANCE	SPAIN	SPAIN	INTERNATIONAL
YEAR	**VIIIab**	**VIIIbc, Landings**	**Live Bait Catches**	**VIII**
1960	1,085	57,000	n/a	58,085
1961	1,494	74,000	n/a	75,494
1962	1,123	58,000	n/a	59,123
1963	652	48,000	n/a	48,652
1964	1,973	75,000	n/a	76,973
1965	2,615	81,000	n/a	83,615
1966	839	47,519	n/a	48,358
1967	1,812	39,363	n/a	41,175
1968	1,190	38,429	n/a	39,619
1969	2,991	33,092	n/a	36,083
1970	3,665	19,820	n/a	23,485
1971	4,825	23,787	n/a	28,612
1972	6,150	26,917	n/a	33,067
1973	4,395	23,614	n/a	28,009
1974	3,835	27,282	n/a	31,117
1975	2,913	23,389	n/a	26,302
1976	1,095	36,166	n/a	37,261
1977	3,807	44,384	n/a	48,191
1978	3,683	41,536	n/a	45,219
1979	1,349	25,000	n/a	26,349
1980	1,564	20,538	n/a	22,102
1981	1,021	9,794	n/a	10,815
1982	381	4,610	n/a	4,991
1983	1,911	12,242	n/a	14,153
1984	1,711	33,468	n/a	35,179
1985	3,005	8,481	n/a	11,486
1986	2,311	5,612	n/a	7,923
1987	4,899	9,863	546	15,308
1988	6,822	8,266	493	15,581
1989	2,255	8,174	185	10,614
1990	10,598	23,258	416	34,272
1991	9,708	9,573	353	19,634
1992	15,217	22,468	200	37,885
1993	20,914	19,173	306	40,393
1994	16,934	17,554	143	34,631
1995	10,892	18,950	273	30,115
1996	15,238	18,937	198	34,373
1997	12,020	9,939	378	22,337
1998	22,987	8,455	176	31,617
1999	13,649	13,145	465	27,259
2000	17,765	19,230	n/a	36,994
2001	17,097	23,052	n/a	40,149
2002	10,988	6,519	n/a	17,507
2003	7,593	3,002	n/a	10,595
2004	8,781	7,580	n/a	16,361
2005	952	176	n/a	1,128
2006	913	840	n/a	1,753
2007	140 **	1.2 **	n/a	141
2008 (up to June)	0	0		0
AVERAGE (1990-04)	6,394	26,337	318	32,824

** Experimental Fishery

Table 3.2.4.1: Bay of Biscay Anchovy. Catches at age of the fishery in the Bay of Biscay on half year basis as reported up to 1998 to ICES WGs and updated since then. N.

INTERNACIONAL

YEAR	1987		1988		1989		1990		1991		1992		1993		1994	
Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
Age 0	0	38,140	0	150,338	0	180,085	0	16,984	0	86,647	0	38,434	0	63,499	0	59,934
1	218,670	120,098	318,181	190,113	152,612	27,085	847,627	517,690	323,877	116,290	1,001,551	440,134	794,055	611,047	494,610	355,663
2	157,665	13,534	92,621	13,334	123,683	10,771	59,482	75,999	310,620	12,581	193,137	31,446	439,655	91,977	493,437	54,867
3	31,362	1,664	9,954	596	18,096	1,986	8,175	4,999	29,179	61	16,960	1	5,336	0	61,667	1,325
4	14,831	58	1,356	0	54	0	0	0	0	0	0	0	0	0	0	0
5	8,920	0	99	0	0	0	0	0	0	0	0	0	0	0	0	0
Total #	431,448	173,494	398,971	529,130	294,445	219,927	915,283	615,671	663,677	215,579	1,211,647	510,015	1,239,046	766,523	1,049,714	471,789
Internat Catches	11,718	3,590	10,003	5,579	7,153	3,460	19,386	14,886	15,025	4,610	26,381	11,504	24,058	16,334	23,214	11,417
Var. SOP	100.7%	100.4%	98.3%	101.9%	98.5%	99.3%	100.7%	99.1%	97.6%	98.5%	99.6%	99.9%	101.1%	99.5%	101.0%	100.2%
Annual Catch		15,308		15,581		10,614		34,272		19,635		37,885		40,392		34,631

YEAR	1995		1996		1997		1998		1999		2000		2001		2002	
Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
Age 0	0	49,771	0	109,173	0	133,232	0	4,075	0	54,357	0	5,298	0	749	0	267
1	522,361	189,081	683,009	456,164	471,370	439,888	443,818	598,139	220,067	243,306	559,934	396,961	460,346	507,678	103,210	129,392
2	282,301	21,771	233,095	53,156	138,183	40,014	128,854	123,225	380,012	142,904	268,354	64,712	374,424	98,117	217,218	77,128
3	76,525	90	31,092	499	5,580	195	5,596	3,398	17,761	525	84,437	18,613	19,698	5,095	37,886	3,045
4	4,096	7	2,213	42	0	0	155	0	108	0	0	0	4,948	0	76	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total #	885,283	260,719	949,408	619,034	615,133	613,329	578,423	728,837	617,948	441,092	912,725	485,584	859,417	611,639	358,390	209,832
Internat Catches	23,479	6,637	21,024	13,349	10,704	11,443	12,918	18,700	15,381	11,878	22,536	14,458	23,095	17,054	11,102	6,406
Var. SOP	101.5%	98.2%	99.5%	100.4%	99.7%	102.1%	100.6%	94.8%	102.0%	103.0%	100.8%	97.6%	100.8%	101.1%	97%	102%
Annual Catch		30,116		34,373		22,147		31,617		27,259		36,994		40,149		17,507

YEAR	2003		2004		2005		2006		2007	
Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
Age 0	0	7,530	0	11,184	0	0	0	0	0	0
1	50,327	133,083	254,504	252,887	7,818	0	48,718	3,894	0	0
2	44,546	87,142	85,679	20,072	32,911	0	17,172	991	0	0
3	34,133	11,459	12,444	1,153	6,935	0	6,465	320	0	0
4	887	1,152	4,598	16	586	0	49	2	0	0
5	0	0	0	0	0	0	0	0	0	0
Total #	129,893	240,366	357,225	285,312	48,250	0	72,405	5,207	0	0
Internat Catches	4,074	6,521	9,183	7,177	1,127	0	1,657	95	141	0
Var. SOP	100%	100%	100%	100%	103%	0%	103%	0%	0%	0%
Annual Catch		10,595		16,360		1,127		1,752		141

Table 3.2.4.1 (Cont. 1): Bay of Biscay Anchovy.

SPAIN

YEAR		1987		1988		1989		1990		1991		1992		1993		1994	
Periods		1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
Age	**0**	0	35,452	0	141,918	0	174,803	0	11,999	0	81,536	0	13,121	0	63,499	0	59,022
	1	134,390	40,172	210,641	47,480	110,276	13,165	719,678	234,021	210,686	21,113	751,056	72,154	578,219	75,865	257,050	47,065
	2	119,503	7,787	61,609	2,690	92,707	9,481	47,266	43,204	139,327	1,715	131,221	5,916	266,612	11,904	315,022	24,971
	3	27,336	1,664	7,710	596	8,232	1,986	8,139	4,999	2,657	61	10,067	1	967	0	44,622	1,325
	4	14,831	58	1,356	0	54	0	0	0	0	0	0	0	0	0	0	0
	5	8,920	0	99	0	0	0	0	0	0	0	0	0	0	0	0	0
Total #		304,980	85,134	281,414	192,684	211,270	199,435	775,083	294,222	352,670	104,425	892,344	91,192	845,798	151,268	616,694	132,383
Catch Spain		8,777	1,632	6,955	1,804	5,377	2,981	16,401	7,273	8,343	1,583	21,047	1,621	17,206	2,272	15,219	2,478
Var. SOP		100.7%	99.7%	97.9%	100.6%	97.1%	99.5%	100.9%	99.5%	94.7%	98.2%	99.3%	100.5%	100.8%	100.2%	101.3%	99.6%
Annual Catch			10,409		8,759		8,358		23,674		9,926		22,669		19,479		17,697

YEAR		1995		1996		1997		1998		1999		2000		2001		2002	
Periods		1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd haf
Age	**0**	0	31,101	0	52,238	0	91,400	0	4,075	0	29,057	0	439	0	748	0	239
	1	367,924	17,611	542,127	72,763	296,261	123,011	217,711	57,847	134,411	87,191	389,515	71,547	378,136	54,151	31,347	40,149
	2	206,387	1,333	163,010	12,403	74,856	9,435	41,171	9,515	231,384	37,644	199,233	8,640	327,090	43,487	98,700	22,621
	3	57,214	90	14,461	499	1,927	195	4,002	9	10,051	525	50,834	2,085	18,854	464	13,702	2,041
	4	4,096	7	2,213	42	0	0	155	0	108	0	0	0	4,948	0	0	0
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total #		635,621	50,142	721,810	137,945	373,044	224,041	263,039	71,445	375,954	154,416	639,583	82,711	729,029	98,851	143748.2	65049.3
Catch Spain		18,322	902	16,774	2,361	6,420	3,897	6,818	1,812	10,323	3,287	17,087	2,143	20,314	2,738	4,745	1,774
Var. SOP		102.1%	100.1%	99.5%	100.4%	99.5%	98.7%	98.9%	99.8%	102.1%	101.7%	101.1%	100.7%	102.1%	101.7%	101%	101%
Annual Catch			19,224		19,135		10,317		8,630		13,610		19,230		23,052		6,519

YEAR		2003		2004		2005		2006		2007	
Periods		1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
Age	**0**	0	49	0	115	0	0	0	0	0	0
	1	11,761	4,895	183,853	18,994	1,096	0	21,276	355	0	0
	2	32,566	1,068	71,589	482	4,631	0	7,708	25	0	0
	3	28,809	272	7,461	23	266	0	3,587	7	0	0
	4	434	0	4,340	16	16	0	0	0	0	0
	5	0	0			0	0	0	0	0	0
Total #		73,569	6,285	267,243	19,630	6,009	0	32,571	387	0	0
Catch Spain		2,848	154	7,081	498	176	0	833	7	1	0
Var. SOP		100%	101%	101%	101%	101%	0%	101%	103%	0%	0%
Annual Catch			3,002		7,580		176		840		1

Table 3.2.4.1 (Cont. 2): Bay of Biscay Anchovy.

FRANCE

YEAR	**1987**		**1988**		**1989**		**1990**		**1991**		**1992**		**1993**		**1994**	
Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
Age 0	0	2,688	0	8,419	0	5,282	0	4,985	0	5,111	0	25,313	0	0	0	912
1	84,280	79,925	107,540	142,634	42,336	13,919	127,949	283,669	113,191	95,177	250,495	367,980	215,836	535,182	237,560	308,598
2	38,162	5,747	31,012	10,644	30,976	1,290	12,216	32,795	171,293	10,866	61,916	25,530	173,043	80,073	178,415	29,896
3	4,026	0	2,245	0	9,863	0	36	0	26,522	0	6,893	0	4,369	0	17,045	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total #	126,468	88,360	140,797	161,697	83,175	20,492	140,200	321,449	311,007	111,154	319,303	418,823	393,248	615,255	433,020	339,406
Catch France	2,941	1,958	3,048	3,775	1,776	479	2,985	7,613	6,682	3,027	5,334	9,883	6,851	14,062	7,994	8,939
Var. SOP	100.4%	101.0%	99.0%	102.5%	102.6%	97.8%	99.2%	98.7%	101.3%	98.6%	100.5%	99.8%	101.6%	99.4%	100.3%	100.4%
Annual Catch		4,899		6,822		2,255		10,598		9,708		15,217		20,914		16,934

YEAR	**1995**		**1996**		**1997**		**1998**		**1999**		**2000**		**2001**		**2002**	
Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd haf
Age 0	0	18,670	0	56,936	0	41,832	0	0	0	25,300	0	4,859	0	1	0	29
1	154,437	171,470	140,882	383,401	175,109	316,877	226,107	540,293	85,656	156,115	170,418	325,413	82,210	453,527	71,864	89,243
2	75,914	20,438	70,085	40,753	63,327	30,579	87,683	113,710	148,628	105,260	69,121	56,072	47,334	54,630	118,518	54,507
3	19,311	0	16,631	0	3,653	0	1,594	3,389	7,710	0	33,603	16,528	844	4,631	24,184	1,005
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	76	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total #	249,662	210,578	227,598	481,089	242,089	389,288	315,384	657,392	241,994	286,676	273,142	402,873	130,388	512,789	214641	144783
Catch France	5,157	5,735	4,251	10,987	4,284	7,546	6,099	16,888	5,058	8,591	5,449	12,316	2,782	14,316	6,357	4,631
Var. SOP	99.4%	97.9%	102.8%	99.8%	100.0%	103.9%	102.5%	94.3%	101.7%	103.4%	99.8%	97.0%	100.5%	101.3%	95%	102%
Annual Catch		10,892		15,238		11,830		22,987		13,649		17,765		17,097		10,988

YEAR	**2003**		**2004**		**2005**		**2006**		**2007**	
Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
Age 0	0	7,481	0	11,069	0	0	0	0	0	0
1	38,567	128,188	70,651	233,893	6722	0	27,442	3,539	0	0
2	11,981	86,074	14,091	19,590	28281	0	9,464	966	0	0
3	5,324	11,187	4,983	1,130	6669	0	2,878	313	0	0
4	453	1,152	258	0	570	0	49	2	0	0
5	0				0	0	0	0	0	0
Total #	56,325	234,082	89,982	265,683	42,242	0	39,833	4,820	0	0
Catch France	1,226	6,367	2,102	6,679	952	0	824	88	140	0
Var. SOP	100%	100%	100%	100%	104%	0%	100%	100%	0%	0%
Annual Catch		7,593		8,781		952		912		140

Table 3.2.5.1: Bay of Biscay Anchovy. Mean weight at age in the international catches in Sub-area VIII on half year basis.

INTERNATIONAL

YEAR	1987		1988		1989		1990		1991		1992		1993		1994	
Sources	Anon. (1989 & 1991)		Anon. (1989)		Anon. (1991)		Anon. (1991)		Anon. (1992)		Anon. (1993)		Anon. (1995)		Anon. (1996)	
Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
Age 0	0.0	11.7	0.0	5.1	0.0	12.7	0.0	7.4	0.0	14.4	0.0	12.6	0.0	12.3	0.0	14.7
1	21.0	21.9	20.8	23.6	19.5	24.9	20.6	23.8	18.5	25.1	19.6	23.0	15.5	20.9	16.8	25.3
2	32.0	34.2	30.3	30.4	28.5	35.2	28.5	27.7	25.2	29.0	30.9	28.8	27.0	29.4	26.8	28.1
3	37.7	39.2	34.5	44.5	29.7	42.7	44.8	40.8	28.2	39.0	37.7	27.4	30.5	0.0	30.7	30.0
4	41.0	40.0	37.6	0.0	27.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	42.0	0.0	48.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	27.3	20.8	24.6	10.7	23.9	15.6	21.3	24.0	22.1	21.1	21.7	22.5	19.6	21.2	22.3	24.3
SOP	11,795	3,605	9,828	5,685	7,043	3,434	19,515	14,752	14,668	4,538	26,264	11,497	24,314	16,257	23,440	11,442
mean weight 3+	39.3	39.2	35.0	44.5	29.7	42.7	44.8	40.8	28.2	39.0	37.7	27.4	30.5	30.5	30.7	30.0

YEAR	1995		1996		1997		1998		1999		2000		2001		2002	
Sources:	Anon. (1997)		Anon. (1998)		Anon. (1999)		Anon (2000)		WG data		WG data		WG data		WG data	
Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
Age 0	0.0	15.1	0.0	12.0	0.0	11.6	0.0	10.2	0.0	15.7	0.0	19.3	0.0	14.3	0.0	9.5
1	22.5	26.9	19.1	23.2	14.4	20.3	21.8	23.7	17.1	27.0	21.7	28.2	22.7	27.5	25.0	28.8
2	32.3	31.3	29.3	27.7	26.9	30.1	24.3	27.7	29.8	33.5	29.1	33.0	31.8	31.1	31.6	33.4
3	36.4	36.4	35.0	35.7	32.0	29.7	31.9	28.7	34.7	38.9	32.8	36.9	36.3	38.6	42.8	36.5
4	37.3	29.1	46.1	39.7	0.0	0.0	31.9	0.0	55.9	0.0	0.0	0.0	40.7	0.0	45.6	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	26.9	25.0	22.2	21.6	17.3	19.1	22.5	24.3	25.4	27.7	24.9	29.0	27.1	28.2	30.9	30.6
SOP	23,830	6,520	21,066	13,139	10,672	11,687	12,996	17,727	15,686	12,229	22,715	14,106	23,272	17,247	11,073	6,415
mean weight 3+	36.5	35.9	35.8	36.0	32.0	29.7	31.9	28.7	35.3	38.9	32.6	36.9	36.3	38.6	43.4	36.5

YEAR	2003		2004		2005		2006		2007	
Sources:	WG data		WG data		WG data		WG data		WG data	
Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half *	1st half	2nd half *	1st half *	2nd half *
Age 0	0.0	15.4	0.0	15.5	0.0	0.0	0.0	0.0	na	na
1	21.0	25.4	21.7	24.9	19.3	0.0	20.3	17.8	na	na
2	36.2	29.5	35.7	33.5	24.5	0.0	27.7	19.7	na	na
3	40.3	36.4	39.3	40.7	27.6	0.0	31.3	19.7	na	na
4	36.9	37.9	44.0	42.8	24.5	0.0	37.3	34.3	na	na
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	na	na
Total	31.4	27.1	26.0	25.2	24.1	0.0	23.0	18.2	na	na
SOP	4,078	6,524	9,271	7,181	1,162	0	1,667	95	na	na
mean weight 3+	40.3	36.4	40.6	40.7	27.3	0.0	31.3	19.7	na	na

* Fishery Closed: Very poor data due to the nule or very small catches

Table 3.4.1.1: Bay of Biscay anchovy: Summary results from DEPM surveys with numbers at age

YEAR		**1987**	**1988**	**1989***	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996****	**1997**
Period of year		2 - 7 Jun	21 - 28 May	10 - 21 May	4 - 15 May	16May-07Jun	16May-13Jun	No survey	17 May-3June.	11 - 25 May	18 - 30 May	9 - 21 May
Julian Mid Day		155	145	136	130	148	151		146	138	144	135
Positive area (km2)		23,850	45,384	17,546	59,757	24,264	67,796		48,735	31,189	28,448	50,133
Surveyed area (km2)		34,934	59,840	37,930	79,759	84,032	92,782		60,330	51,698	34,294	59,587
Po (Egg per 0.05 m^2)		4.60	5.52	2.08	3.78	2.55	4.27		3.93	4.98	4.87	2.69
Ptot(Total DEP) (*E-12)		2.20	5.01	0.73	5.02	1.24	5.81		3.83	3.09	2.77	2.70
	C.V.	0.39	0.24	0.40	0.15	0.06	0.14		0.14	0.07	0.16	0.07
Daily Fecundity		81.30	81.40	62.3	52.20	67.50	71.60		62.85	56.72		53.21
	C.V.	0.36	0.23	0.13	0.36	0.15	0.24		0.07	0.06		0.06
SSB (tonns)		**29,365**	**63,500**	**11,861**	**97,239**	**19,276**	**90,720**	**--**	**60,062**	**54,700**	**39,545**	**51,176**
	C.V.	0.48	0.31	0.41	0.17	0.14	0.20		0.17	0.09	0.16	0.10
Total (millions)		**1,129**	**2,675**	**470**	**5,843**	**966**	**5,797**	**--**	**2,954**	**2,644**		**3,738**
	C.V.					0.14	0.25		0.19	0.11		0.16
Numb. at age (millions)	**Age 1**	**656**	**2,349**	**246**	**5,613**	**671**	**5,571**		**2,030**	**2,257**		**3,243**
	C.V.					0.16	0.26		0.23	0.13		0.17
	Age 2	**331**	**258**	**206**	**190**	**290**	**209**		**874**	**329**		**482**
	C.V.					0.17	0.22		0.19	0.23		0.10
	Age 3+	**142**	**68**	**18**	**40**	**5**	**17**		**49**	**58**		**13**
	C.V.					0.42	0.51		0.30	0.30		0.27

YEAR	**1998**	**1999****	**2000*****	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Period of year	18 May - 8 Jun	22 May - 5 Jun	2 - 20 May	14 May - 8 June	6-21 May	22May-9Jun	2 - 22 May	8 - 28 May	4 -24 May	3-23 May	6-26 May
Julian Mid Day	149	149	131	147	134				132		
Positive area (km2)	73,131	51,019	37,883	72,022	35,980	42,535	23,124	27,863	24,614	34,449	33,502
Surveyed area (km2)	83,156	61,533	63,192	92,376	56,176	70,041	53,285	61,619	53,991	56,079	69,150
Po (Egg per 0.05 m^2)	3.83	3.65	3.45	5.89	3.28	2.53	1.82	0.79	2.16		2.49
Ptot(Total DEP) (*E-12)	5.6	3.72	2.61	8.48	2.34	2.15	0.842	0.44	1.07	1.6	1.67E+12
	0.05	0.09	0.19	0.09	0.13	0.28	0.115	0.16	0.17		0.040783
Daily Fecundity	56.54			70.75	76.41	89.91	43.64	55.74	50.1	59.8	67.4
	0.06			0.06	0.04	0.04	0.09	0.10	0.09	0.14	0.04
SSB (tonns)	**101,976**	**69,074**	**44,973**	**120,403**	**30,697**	**23,962**	**19,498**	**8,002**	**21,436**	**25,973**	**24,712**
	0.09	0.15	0.15	0.11	0.13	0.28	0.15	0.19	0.19	0.20	
Total (millions)	**6,282**			**5,897**	**1,039**	**1,296**	**980**	**292**	**1,204**	**1,268**	**1,040**
	0.13			0.15	0.15	0.29	0.20	0.20	0.25	0.17	0.21
Numb. at age (millions)	**5,467**			**4,114**	**284**	**1,042**	**837**	**95**	**998**	**902**	**435**
	0.15			0.21	0.30	0.30	0.23	0.26	0.29	0.19	0.24
	760			**1,638**	**621**	**180**	**115**	**189**	**157**	**317**	**520**
	0.14			0.13	0.13	0.34	0.19	0.19	0.24	0.18	0.23
	56			**145**	**134**	**74**	**28**	**8**	**50**	**50**	**85**
	0.36			0.27	0.14	0.38	0.26	0.37	0.24	0.59	0.25

(*) Likely sub estimate according to authors (Motos &Santiago,1989). It is inputted into ICA raised by 1 sd.

(**) Estimates based on a log lineal model of biomass as function of positive spawning area and Po (Egg production per unit area).

(***) Estimates based on a log lineal model of biomass as function of positive spawning area and Po (Egg production per unit area) and Julian day of the mid day of the survey.

Table 3.4.1.2: Bay of Biscay anchovy: P_0, z and P_{tot} estimates.

	ALL STATIONS		
	Value	**S.e.**	**CV**
P_0	53,27	4,5573	0,0856
z	0,32	0,0020	0,1487
Ptot	1,78,E+12	1,53,E+11	0,0856

Table 3.4.2.1 – biomass estimate using Thalassa acoustic data along transects and all the consort identification fishing operations (Thalassa + pair trawlers)

STRATA Biomass (tons)	Anchovy	Blue whiting	Sardine	Mackerel (jap)	Mackerel (sco)	Sprat	Horse mackerel (med)	Horse mackerel (tra)
south coastal	17 767	0	61 917	496	1 138	0	113	2 407
south offshore	1 988	5	8 027	154	21 269	0	0	3 695
Gironde	17 403	0	46 624	25	4	380	29	5
Fer a cheval	0	4	151 101	428	18 623	0	0	41 818
Central coastal	199	821	25 723	0	667 187	9 333	0	4 331
Total	37 358	830	423 253	1 103	709 479	9 714	141	52 255
c.v. (%)	*12.4*	*25.2*	*14.2*	*26.8*	*62.8*	*24.8*	*21.8*	*55.2*

Table 3.4.2.2. - age distribution of anchovy in numbers as estimated from PELGAS08 survey according to bottom depth

	Biomass	numbers	G1	G2	G3	G4
Inshore (1, 3, 5, 6 & 8)	35 642	1 987 923	956 138	777 850	237 784	16 151
Offshore (2,4,7,9 &10)	1 715	50 847	2 523	36 453	11 180	690
Total	**37 358**	**2 038 770**	958 661	814 303	248 965	16 841
% (numbers)			47.0 %	39.9 %	12.2 %	0.8 %
Mean weight (g)			11.46	26.92	27.31	27.43
Mean length (g)			11.48	15.43	15.55	15.63
Coefficient of variation	*0.12*	*0.15*				

Table 3.4.2.3. - age distribution of anchovy in numbers as estimated from PELGAS08 survey according to separate distribution Gironde – southern coastal

	age 1	age 2	age 3	age 4	Total
Gironde	826 388	327 517	95 442	6 335	1 255 682
southern coastal	83 526	372 738	117 906	8 172	582 342
other areas	48 747	114 048	35 617	2 334	200 746
Total Bay of Biscay	958 661	814 303	248 965	16 841	2 038 770
	age 1	age 2	age 3	age 4	
Gironde	86.2	40.2	38.3	37.6	
southern coastal	8.7	45.8	47.4	48.5	
other areas	5.1	14.0	14.3	13.9	
Total Bay of Biscay	100.0	100.0	100.0	100.0	

Table 3.4.4.1: Summary of the JUVENA acoustic surveys on juvenile anchovy carried out in the last years.

JUVENA SURVEYS SERIES

SURVEY	**VESSEL**	**GEAR**	**PERIOD**	**Area in Bay of Biscay**
JUVENA 2003	Divino Jesús de Praga	Purse seine	17 September - 15 October	South 46ºN East 5ºW
JUVENA 2004	Nuevo Erreinezubi	Purse seine	19 September - 20 October	South 46ºN East 5ºW
JUVENA 2005	Gure Aita José	Purse seine	12 September - 07 October	South 47ºN East 5ºW
	Mater Bi	Purse seine		
JUVENA 2006	Itxas Lagunak	Purse seine	13 September - 15 October	South 47º30'N East 6ºW
	Enma Bardan	Pelagic trawling		
JUVENA 2007	Gure Aita José	Purse seine	3 - 30 September	South 47º30'N East 5ºW
	Enma Bardan	Pelagic trawling		

Table 3.4.4.2: Synthesis of the abundance estimation (acoustic index of biomass) for the four years of JUVENA surveys estimated (Values from ICES 2007b and Boyra et al. 20078 WD).

Year	Region	<sA>	Area	<length>_juv	<lenght>_adul	Biom_juv	Biom_adul
2003	South	369	3303	8.2		97,498	0
2003	North	444	173	11.1	14.1	1,103	1,383
2003	**TOTAL**					**98,601**	**1,383**
2004	South	1	47	6		1.9	0
2004	North	562	1860	11	13.8	2,404	3,451
2004	**TOTAL**					**2,406**	**3,451**
2005	South	722	5390	6.64		125,922	0
2005	North	326	2400	9.83	11.91	8,208	20,369
2005	**TOTAL**					**134,131**	**20,369**
2006	South	366	1200	7.2	11.5	22,672	179
2006	North	391	5863	11.2	12.4	55,626	45,243
2006	**TOTAL**					**78,298**	**45,422**
2007	South	186	1812	9.0	12.5	6,381	757
2007	North	248	3865	10.3	14.4	6,740	34,352
2007	**TOTAL**					**13,121**	**35,109**

Table 3.4.4.3: PELACUS10 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

Table 3.5.3.1: Bay of Biscay anchovy: Input data for BBM.

			CATCH DATA			DEPM		ACOUSTICS	
Year	**h1**	**h2**	**C(y,1,1)**	**C(y,1,1+)**	**C(y,2,1+)**	**B(y,1)**	**B(y,1+)**	**B(y,1)**	**B(y,1+)**
1987	0,3068	0,1940	2711	8318	6543	14235	29365		
1988	0,3253	0,1774	2602	3864	10954	53087	63500		
1989	0,2820	0,2328	1723	3876	4442	7282	16720		
1990	0,3070	0,2057	9314	10573	23574	90650	97239		
1991	0,2347	0,1984	3903	10191	8196	11271	19276	28322	64000
1992	0,2542	0,2184	11933	16366	21026	85571	90720	84439	89000
1993	0,2368	0,2378	6414	14177	25431				
1994	0,2331	0,2050	3795	13602	20150	34674	60062		35000
1995	0,2917	0,1751	5718	14550	14815	42906	54700		
1996	0,2756	0,1978	4570	9246	23833		39545		
1997	0,2078	0,2624	4323	7235	13256	38536	51176	38498	63000
1998	0,1992	0,2567	5898	7988	23588	80357	101976		57000
1999	0,2304	0,2626	2067	10895	15511		69074		
2000	0,2569	0,1999	6298	12010	24882		44973	89363	113120
2001	0,2984	0,2195	5481	11468	28671	69110	120403	67110	105801
2002	0,1833	0,2389	1962	7738	9754	6352	30697	27642	110566
2003	0,2997	0,2795	625	2379	8101	16575	23962	18687	30632
2004	0,2989	0,2126	2754	4623	11657	14649	19498	33995	45965
2005	0,1138	0,0741	102	790	372	2063	8002	2467	14643
2006	0,3266	0,0741	484	815	947	15280	21436	18282	30877
2007	0,3131	0,0594	20	67	73	16025	25973	26230	40876
2008	0,2607		0	0	0	7696	26461	11021	37358

Table 3.5.3.2: Bay of Biscay anchovy: Median and 95% credible intervals for recruitment, spawning stock biomass, harvest rates (Catch/SSB) and the ratio of SSB with respect to SSB in 1989 as resulted from BBM.

	R (tonnes)			SSB (tonnes)			Harvest rate			SSB/SSB_{1989}		
Year	2,50%	Median	97,50%	2,50%	Median	97,50%	2,50%	Median	97,50%	2,50%	Median	97,50%
1987	14050	17528	26445	18452	22651	34128	0,805	0,656	0,435	0,824	1,245	1,668
1988	36002	42448	58120	31677	37147	51754	0,468	0,399	0,286	1,576	2,015	2,330
1989	9277	12269	19995	14141	18642	30193	0,588	0,446	0,275	1,000	1,000	1,000
1990	79786	89241	106954	58704	66186	81330	0,582	0,516	0,420	2,309	3,572	4,803
1991	19070	25592	35110	23537	30429	43675	0,781	0,604	0,421	0,964	1,640	2,414
1992	81805	134874	235294	56886	100214	182876	0,657	0,373	0,204	2,563	5,323	9,862
1993	36925	91918	132837	81315	97267	117981	0,487	0,407	0,336	3,036	5,230	7,339
1994	37796	49182	66639	49469	59760	79257	0,682	0,565	0,426	1,876	3,212	4,826
1995	34982	57854	108835	27917	49920	97017	1,052	0,588	0,303	1,280	2,618	5,416
1996	35715	67859	94623	51344	60500	78517	0,644	0,547	0,421	2,050	3,254	4,615
1997	36675	51127	71851	36921	50204	71573	0,555	0,408	0,286	1,489	2,672	4,249
1998	53513	81926	136616	47206	74076	124322	0,669	0,426	0,254	2,047	3,874	7,127
1999	37459	78932	118902	52917	75436	102308	0,499	0,350	0,258	2,249	3,940	6,193
2000	101421	126819	149964	97217	116958	132228	0,379	0,315	0,279	3,618	6,223	8,493
2001	73569	84119	102642	89715	98870	113063	0,447	0,406	0,355	3,313	5,324	7,113
2002	10058	12955	18748	31121	36551	46391	0,562	0,479	0,377	1,262	1,966	2,713
2003	22513	28569	35779	26934	32573	41317	0,389	0,322	0,254	1,071	1,749	2,451
2004	32600	40428	53725	30775	38440	52016	0,529	0,424	0,313	1,260	2,050	3,042
2005	3201	5057	8144	11077	15962	24413	0,105	0,073	0,048	0,485	0,840	1,397
2006	15222	22502	34712	17253	24560	37141	0,102	0,072	0,047	0,713	1,295	2,224
2007	18372	27202	41992	23144	32989	49579	0,006	0,004	0,003	0,976	1,730	2,939
2008	6096	9506	15607	16721	24101	36532	0,000	0,000	0,000	0,719	1,262	2,130

Table 3.5.3.3: Bay of Biscay anchovy:Summary table of the current state of the stock from BBM.

R_{2008}	**Median**	9 506
	95 % C.I.	(6 096, 15 607)
SSB_{2008}	**Median**	24 101
	95 % C.I.	(16 721, 36 532)
SSB_{2008} / SSB_{1989}	**Median**	1,262
	95 % C.I.	(0.716, 2.130)
$P(SSB_{2008} < 21\ 000)$		0,228

Table 3.6.2. 1: Bay of Biscay anchovy: Probability of SSB in 2009 of being below Blim under the recent year recruitment scenario under different catch options from 1st July 2008 to 30th June 2009 and alternative catch allocation by semesters.

$P(SSB<B_{lim})$		% CATCHES IN THE 2nd SEMESTER 2008										
		0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1
TOTAL CATCH (1 July 2008 - 30 June 2009)	0	0,262	0,262	0,262	0,262	0,262	0,262	0,262	0,262	0,262	0,262	0,262
	2000	0,308	0,309	0,309	0,310	0,311	0,312	0,312	0,313	0,314	0,314	0,315
	4000	0,345	0,345	0,347	0,348	0,350	0,351	0,353	0,354	0,355	0,357	0,358
	6000	0,380	0,382	0,383	0,385	0,386	0,388	0,390	0,392	0,393	0,394	0,396
	8000	0,409	0,411	0,414	0,415	0,418	0,420	0,423	0,425	0,428	0,429	0,431
	10000	0,436	0,437	0,440	0,443	0,445	0,448	0,452	0,454	0,456	0,459	0,462
	12000	0,463	0,467	0,471	0,474	0,477	0,481	0,484	0,487	0,491	0,495	0,498
	14000	0,494	0,498	0,502	0,506	0,510	0,516	0,519	0,525	0,529	0,533	0,537
	16000	0,527	0,532	0,536	0,541	0,546	0,551	0,556	0,563	0,569	0,575	0,581
	18000	0,560	0,568	0,574	0,581	0,586	0,592	0,600	0,608	0,615	0,621	0,629
	20000	0,599	0,607	0,616	0,622	0,631	0,638	0,646	0,652	0,660	0,667	0,675
	22000	0,640	0,648	0,656	0,664	0,673	0,682	0,691	0,700	0,709	0,718	0,724
	24000	0,680	0,691	0,700	0,709	0,718	0,726	0,732	0,741	0,750	0,757	0,766
	26000	0,721	0,729	0,737	0,747	0,755	0,764	0,773	0,780	0,787	0,795	0,802
	28000	0,756	0,765	0,775	0,781	0,790	0,798	0,805	0,813	0,819	0,826	0,833
	30000	0,788	0,797	0,805	0,812	0,819	0,827	0,834	0,839	0,845	0,851	0,857

Table 3.6.2.2. Bay of Biscay anchovy: Median SSB in 2009 under the recent year recruitment scenario under different catch options from 1st July 2008 to 30th June 2009 and alternative catch allocation by semesters.

SSB_{median}		% CATCHES IN THE 2nd SEMESTER 2008										
		0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
TOTAL CATCH (1 July 2008 - 30 June 200	0	28759	28759	28759	28759	28759	28759	28759	28759	28759	28759	28759
	2000	27685	27664	27644	27624	27603	27583	27562	27542	27521	27501	27481
	4000	26610	26570	26529	26488	26447	26406	26365	26325	26284	26243	26202
	6000	25536	25475	25413	25352	25291	25230	25169	25107	25046	24985	24924
	8000	24461	24380	24298	24217	24135	24053	23972	23890	23808	23727	23645
	10000	23387	23285	23183	23081	22979	22877	22775	22673	22571	22469	22367
	12000	22313	22190	22068	21945	21823	21700	21578	21455	21333	21211	21088
	14000	21238	21095	20952	20810	20667	20524	20381	20238	20095	19952	19810
	16000	20164	20000	19837	19674	19511	19347	19184	19021	18858	18694	18531
	18000	19089	18906	18722	18538	18355	18171	17987	17804	17620	17436	17252
	20000	18015	17811	17607	17403	17198	16994	16790	16586	16382	16178	15974
	22000	16940	16716	16491	16267	16042	15818	15593	15369	15144	14920	14695
	24000	15866	15621	15376	15131	14886	14641	14397	14152	13907	13662	13417
	26000	14791	14526	14261	13996	13730	13465	13200	12934	12669	12404	12138
	28000	13717	13431	13146	12860	12574	12288	12003	11717	11431	11146	10860
	30000	12643	12336	12030	11724	11418	11112	10806	10500	10194	9887	9581

Table 4.2.1.1. Anchovy in División IXa. Spanish purse-seine fleet composition in the Gulf of Cadiz (differentiated into total fleet and vessels targeting Gulf of Cadiz anchovy) since 1999. The categories include both single purpose purse-seiners and trawl and artisanal vessels fishing with purse-seine in some periods through the year (multi-purpose vessels). Length criteria refers to length between perpendiculars. Storage: catches are dry hold with ice (fishing trip equals to fishing day). No discard estimates.

Total number of operative purse-seiners

1999	Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total
<10	16	23	20	1	0	60
11-15	0	7	28	16	0	51
16-20	0	0	2	20	1	23
>20	0	0	0	3	0	3
Total	16	30	50	40	1	137

2000	Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total
<10	14	13	27	1	0	55
11-15	1	7	33	6	0	47
16-20	0	0	0	2	0	2
>20	0	0	0	0	0	0
Total	15	20	60	9	0	104

2001	Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total
<10	11	18	20	1	0	50
11-15	1	8	33	8	0	50
16-20	0	0	1	5	0	6
>20	0	0	0	0	0	0
Total	12	26	54	14	0	106

2002	Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total
<10	8	16	20	0	0	44
11-15	1	10	27	16	0	54
16-20	0	0	4	17	0	21
>20	0	0	0	2	0	2
Total	9	26	51	35	0	121

2003	Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total
<10	9	15	15	1	0	40
11-15	2	11	29	15	0	57
16-20	0	0	4	21	0	25
>20	0	0	0	0	0	0
Total	11	26	48	37	0	122

2004	Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total
<10	11	12	19	0	0	42
11-15	2	16	46	16	0	80
16-20	0	0	3	20	0	23
>20	0	0	0	0	0	0
Total	13	28	68	36	0	145

2005	Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total
<10	5	9	16	0	0	30
11-15	1	13	30	16	0	60
16-20	0	0	2	19	0	21
>20	0	0	0	0	0	0
Total	6	22	48	35	0	111

2006	Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total
<10	6	8	12	0	0	26
11-15	1	13	31	18	0	63
16-20	0	0	3	20	0	23
>20	0	0	0	1	0	1
Total	7	21	46	39	0	113

2007	Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total
<10	7	5	15	0	0	27
11-15	3	15	26	17	0	61
16-20	0	0	5	14	1	20
>20	0	0	0	4	0	4

Purse-seiners targeting anchovy

1999	Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total
<10	9	21	19	1	0	50
11-15	0	6	25	16	0	47
16-20	0	0	2	19	0	21
>20	0	0	0	3	0	3
Total	9	27	46	39	0	121

2000	Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total
<10	10	11	26	1	0	48
11-15	1	7	30	6	0	44
16-20	0	0	0	2	0	2
>20	0	0	0	0	0	0
Total	11	18	56	9	0	94

2001	Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total
<10	8	14	20	1	0	43
11-15	1	8	29	6	0	44
16-20	0	0	1	2	0	3
>20	0	0	0	0	0	0
Total	9	22	50	9	0	90

2002	Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total
<10	4	13	19	0	0	36
11-15	1	9	25	13	0	48
16-20	0	0	2	17	0	19
>20	0	0	0	2	0	2
Total	5	22	46	32	0	105

2003	Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total
<10	5	11	15	0	0	31
11-15	2	10	27	14	0	53
16-20	0	0	3	20	0	23
>20	0	0	0	0	0	0
Total	7	21	45	34	0	107

2004	Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total
<10	11	12	19	0	0	42
11-15	2	15	40	14	0	71
16-20	0	0	3	19	0	22
>20	0	0	0	0	0	0
Total	13	27	62	33	0	135

2005	Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total
<10	5	8	14	0	0	27
11-15	1	13	28	16	0	58
16-20	0	0	2	19	0	21
>20	0	0	0	0	0	0
Total	6	21	44	35	0	106

2006	Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total
<10	4	6	11	0	0	21
11-15	1	10	28	16	0	55
16-20	0	0	2	18	0	20
>20	0	0	0	0	0	0
Total	5	16	41	34	0	96

2007	Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total
<10	2	3	12	0	0	17
11-15	3	13	20	14	0	50
16-20	0	0	3	13	1	17
>20	0	0	0	4	0	4

Table 4.2.2.1. Anchovy in Division IXa. Portuguese and Spanish annual landings (tonnes), (from Pestana, 1989 and 1996, and WGMHSA and WGANC members).

	Portugal				Spain			
Year	**IXa C-N**	**IXa C-S**	**IXa South**	**Total**	**IXa North**	**IXa South**	**Total**	**TOTAL**
1943	7121	355	2499	9975	-	-	-	-
1944	1220	55	5376	6651	-	-	-	-
1945	781	15	7983	8779	-	-	-	-
1946	0	335	5515	5850	-	-	-	-
1947	0	79	3313	3392	-	-	-	-
1948	0	75	4863	4938	-	-	-	-
1949	0	34	2684	2718	-	-	-	-
1950	31	30	3316	3377	-	-	-	-
1951	21	6	3567	3594	-	-	-	-
1952	1537	1	2877	4415	-	-	-	-
1953	1627	15	2710	4352	-	-	-	-
1954	328	18	3573	3919	-	-	-	-
1955	83	53	4387	4523	-	-	-	-
1956	12	164	7722	7898	-	-	-	-
1957	96	13	12501	12610	-	-	-	-
1958	1858	63	1109	3030	-	-	-	-
1959	12	1	3775	3788	-	-	-	-
1960	990	129	8384	9503	-	-	-	-
1961	1351	81	1060	2492	-	-	-	-
1962	542	137	3767	4446	-	-	-	-
1963	140	9	5565	5714	-	-	-	-
1964	0	0	4118	4118	-	-	-	-
1965	7	0	4452	4460	-	-	-	-
1966	23	35	4402	4460	-	-	-	-
1967	153	34	3631	3818	-	-	-	-
1968	518	5	447	970	-	-	-	-
1969	782	10	582	1375	-	-	-	-
1970	323	0	839	1162	-	-	-	-
1971	257	2	67	326	-	-	-	-
1972	-	-	-	-	-	-	-	-
1973	6	0	120	126	-	-	-	-
1974	113	1	124	238	-	-	-	-
1975	8	24	340	372	-	-	-	-
1976	32	38	18	88	-	-	-	-
1977	3027	1	233	3261	-	-	-	-
1978	640	17	354	1011	-	-	-	-
1979	194	8	453	655	-	-	-	-
1980	21	24	935	980	-	-	-	-
1981	426	117	435	978	-	-	-	-
1982	48	96	512	656	-	-	-	-
1983	283	58	332	673	-	-	-	-
1984	214	94	84	392	-	-	-	-
1985	1893	146	83	2122	-	-	-	-
1986	1892	194	95	2181	-	-	-	-
1987	84	17	11	112	-	-	-	-
1988	338	77	43	458		4263	4263	4721
1989	389	85	22	496	118	5330	5448	5944
1990	424	93	24	541	220	5726	5946	6487
1991	187	3	20	210	15	5697	5712	5922
1992	92	46	0	138	33	2995	3028	3166
1993	20	3	0	23	1	1960	1961	1984
1994	231	5	0	236	117	3035	3152	3388
1995	6724	332	0	7056	5329	571	5900	12956
1996	2707	13	51	2771	44	1780	1824	4595
1997	610	8	13	632	63	4600	4664	5295
1998	894	153	566	1613	371	8977	9349	10962
1999	957	96	355	1408	413	5587	6000	7409
2000	71	61	178	310	10	2182	2191	2502
2001	397	19	439	855	27	8216	8244	9098
2002	433	90	393	915	21	7870	7891	8806
2003	211	67	200	478	23	4768	4791	5269
2004	83	139	434	657	4	5183	5187	5844
2005	82	6	38	126	4	4385	4389	4515
2006	79	15	14	108	15	4368	4383	4491
2007	833	7	34	874	4	5576	5580	6454

(-) Not available

(0) Less than 1 tonne

Table 4.2.2.2. Anchovy in Division IXa. Catches (tonnes) by gear and country in 1988-2007.

Country/Gear	1988*	1989*	1990*	1991*	1992	1993	1994	1995*	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
SPAIN	4263	5454	6131	5711	3028	1961	3153	5900	1823	4664	9349	6000	2191	8244	7891	4791	5187	4389	4383	5580
Artisanal IXa North																4	1			
Purse seine IXa North		118	220	15	33	1	117	5329	44	63	371	413	10	27	21	19	2	4	15	4
Purse seine IXa South	4263	5336	5911	5696	2995	1630	2884	496	1556	4410	7830	4594	2078	8180	7847	4754	5177	4385	4367	5575
Trawl IXa South						330	152	75	224	190	1148	993	104	36	23	14	6	0.2	0.4	0.3
PORTUGAL	458	496	541	210	275	23	237	7056	2771	632	1613	1408	310	855	915	478	657	126	108	874
Trawl					4	9	1		56	46	37	43	6	16	13	7	5	7	27	14
Purse seine	458	496	541	210	270	14	233	7056	2621	579	1541	1346	297	806	888	287	455	62	57	484
Artisanal					1	1	3		94	7	35	20	7	32	13	184	197	57	24	376
Total	4721	5950	6672	5921	3303	1984	3390	12956	4594	5295	10962	7409	2502	9098	8806	5269	5844	4515	4491	6454

* Portuguese catches not differentiated by gear

Table 4.2.2.3. Anchovy in Division IXa. Quarterly anchovy catches (tonnes) by country and Sub-division in 2007.

COUNTRY	SUBDIVISIONS	QUARTER 1		QUARTER 2		QUARTER 3		QUARTER 4		ANNUAL (2007)	
		C(t)	%	C(t)	%	C(t)	%	C(t)	%	C (t)	%
SPAIN	**IXa North**	1	12.0	1.2	29.5	2.0	48.3	0	10.2	4	0.1
	IXa South	1572	28.2	2233	40.1	1418	25.4	351	6.3	5576	99.9
	TOTAL	1573	28.2	2235	40.0	1420	25.5	352	6.3	5580	100.0
PORTUGAL	**IXa Central North**	9	1.1	158	19.0	41	4.9	625	75.1	833	95.3
	IXa Central South	5	64.1	1	14.1	1.6	21.6	0	0.2	7	0.8
	IXa South	5	14.7	20	58.2	4	12.1	5	15.0	34	3.9
	TOTAL	19	2.1	179	20.5	46	5.3	630	72.1	874	100.0
TOTAL	**IXa North**	0.5	12.0	1	29.5	2	48.3	0	10.2	4	0.1
	IXa Central North	9	1.1	158	19.0	41	4.9	625	75.1	833	12.9
	IXa Central South	5	64.1	1	14.1	1.6	21.6	0	0.2	7	0.1
	IXa South	1577	28.1	2253	40.2	1422	25.4	357	6.4	5610	86.9
	TOTAL	1592	24.7	2413	37.4	1467	22.7	982	15.2	6454	100.0

Table 4.2.2.4. Anchovy in Division IXa. Spanish catch in numbers ('000) at age of Gulf of Cadiz anchovy (Sub-division IXa-South, 1995-2007) on a quarterly (Q), half-year (HY) and annual basis. Data for 1994 (not shown) and second half in 1995 estimated from an iterated ALK by applying the Kimura and Chikuni's (1987) algorithm.

1995	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	11256	23241	0	34497	34497
	1	19579	6928	6851	602	26508	7453	33961
	2	189	0	0	0	189	0	189
	3	0	0	0	0	0	0	0
	Total (n)	19769	6928	18107	23843	26697	41950	68647
	Catch (t)	185	80	148	157	265	305	571
	SOP	184	79	148	157	264	305	568
	VAR.%	101	101	100	100	101	100	100

1996	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	413465	71074	0	484540	484540
	1	12772	130880	11550	7281	143652	18832	162483
	2	13	882	826	333	894	1159	2053
	3	0	0	0	0	0	0	0
	Total (n)	12785	131761	425842	78688	144546	504530	649076
	Catch (t)	41	807	585	348	848	933	1780
	SOP	36	743	621	306	779	926	1706
	VAR.%	114	109	94	113	109	101	104

1997	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	237283	96475	0	333758	333758
	1	67055	123878	69278	19430	190933	88708	279641
	2	22601	9828	11649	745	32429	12394	44823
	3	0	0	0	0	0	0	0
	Total (n)	89656	133706	318211	116650	223362	434860	658223
	Catch (t)	906	1110	2006	578	2016	2584	4600
	SOP	844	1273	1923	596	2117	2519	4635
	VAR.%	107	87	104	97	95	103	99

1998	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	75708	360599	0	436307	436307
	1	325407	384529	220869	84729	709936	305599	1015535
	2	11066	879	1316	0	11944	1316	13260
	3	0	0	0	0	0	0	0
	Total (n)	336473	385408	297893	445329	721881	743221	1465102
	Catch (t)	1773	2113	2514	2579	3885	5092	8977
	SOP	1923	2127	2599	2654	4050	5254	9304
	VAR.%	92	99	97	97	96	97	96

1999	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	40549	84234	0	124784	124784
	1	249922	115218	86931	20276	365140	107207	472348
	2	10982	18701	2450	146	29683	2596	32279
	3	0	0	0	0	0	0	0
	Total (n)	260904	133919	129931	104656	394823	234587	629410
	Catch (t)	1335	1983	1582	687	3318	2269	5587
	SOP	1330	1756	1391	673	3087	2064	5150
	VAR.%	100	113	114	102	107	110	108

2000	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	41028	77780	0	118808	118808
	1	75141	65947	46460	9949	141088	56409	197497
	2	638	2670	523	14	3307	537	3844
	3	0	0	0	0	0	0	0
	Total (n)	75779	68617	88011	87743	144395	175755	320150
	Catch (t)	329	660	655	537	989	1193	2182
	SOP	327	659	666	535	986	1201	2187
	VAR.%	101	100	98	100	100	99	100

2001	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	30987	127140	0	158126	158126
	1	98687	227388	177264	37992	326075	215256	541331
	2	4155	14028	4535	624	18183	5159	23342
	3	0	0	0	0	0	0	0
	Total (n)	102842	241416	212785	165756	344258	378541	722800
	Catch (t)	924	3031	3195	1066	3955	4261	8216
	SOP	908	3014	3145	1065	3922	4210	8132
	VAR.%	102	101	102	100	101	101	101

2002	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	45129	29271	0	74399	74399
	1	218090	304295	149120	36565	522385	185685	708070
	2	2004	6083	8808	620	8087	9428	17515
	3	0	0	0	0	0	0	0
	Total (n)	220094	310378	203057	66456	530471	269512	799984
	Catch (t)	1700	2814	2566	789	4515	3355	7870
	SOP	1617	2778	2524	818	3937	3342	7737
	VAR.%	105	101	102	96	115	100	102

2003	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	26034	45813	0	71847	71847
	1	96135	229184	49058	7028	325320	56087	381407
	2	10041	2587	481	0	12628	481	13109
	3	0	0	0	0	0	0	0
	Total (n)	106176	231772	75574	52841	337948	128415	466363
	Catch (t)	1025	2533	798	413	3557	1211	4768
	SOP	1031	2398	759	378	3430	1137	4567
	VAR.%	99	106	105	109	96	94	104

2004	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			31680	74278	0	105958	105958
	1	157200	165738	69542	6383	322937	75924	398862
	2	388	1419	248	534	1808	782	2590
	3	0	0	0	0	0	0	0
	Total (n)	157588	167157	101470	81195	324745	182665	507410
	Catch (t)	1382	1975	1192	634	3357	1826	5183
	SOP	1284	1844	1194	593	3129	1788	4916
	VAR.%	108	107	100	107	107	102	105

2005	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			24163	13743		37906	37906
	1	195482	249404	36999	371	444886	37370	482256
	2	2716	445	334	0	3161	334	3495
	3	0	0	0	0	0	0	0
	Total (n)	198198	249848	61496	14114	448046	75610	523656
	Catch (t)	1361	2241	705	77	3602	783	4385
	SOP	1302	2098	665	67	3401	732	4132
	VAR.%	105	107	106	115	106	107	106

2006	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	9552	1751	0	11303	11303
	1	152978	296608	41515	206	449586	41721	491307
	2	2944	2317	0	0	5261	0	5261
	3	0	0	0	0	0	0	0
	Total (n)	155922	298925	51068	1957	454847	53024	507871
	Catch (t)	1289	2655	414	9	3944	424	4368
	SOP	1206	2474	387	8	3680	395	4075
	VAR.%	107	107	107	108	107	107	107

2007	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	41020	20672	0	61692	61692
	1	222366	230200	89173	17477	452567	106650	559217
	2	1696	5016	594	35	6712	629	7342
	3	0	0	0	0	0	0	0
	Total (n)	224063	235216	130787	38185	459279	168971	628250
	Catch (t)	1572	2233	1418	351	3806	1770	5576
	SOP	1443	2061	1290	335	3504	1624	5128
	VAR.%	109	108	110	105	109	109	109

Table 4.2.2.5. 'Anchovy in Division IXa. Length distribution ('000) of Anchovy in Division IXa by country and Sub-divisions in 2007.

Length	QUARTER 1			QUARTER 2			QUARTER 3			QUARTER 4			TOTAL		
(cm)	SPAIN IXa North	PORTUGAL IXa CN,CS,S	SPAIN IXa South	SPAIN IXa North	PORTUGAL IXa CN,CS,S	SPAIN IXa South	SPAIN IXa North	PORTUGAL IXa CN,CS,S	SPAIN IXa South	SPAIN IXa North	PORTUGAL IXa CN,CS,S	SPAIN IXa South	SPAIN IXa North	PORTUGAL IXa CN,CS,S	SPAIN IXa South
3,5	-	-		-	-		-	-		-	-		-	-	
4	-	-		-	-		-	-		-	-		-	-	
4,5	-	-		-	-		-	-		-	-		-	-	
5	-	-		-	-		-	-		-	-		-	-	
5,5	-	-		-	-		-	-		-	-		-	-	
6	-	-		-	-		-	-		-	-		-	-	
6,5	-	-		-	-	237	-	-		-	-	8	-	-	246
7	-	-	719	-	-	1300	-	-		-	-	17	-	-	2036
7,5	-	-	1540	-	-	2343	-	-	88	-	-	121	-	-	4093
8	-	-	2270	-	-	10485	-	-	1113	-	-	316	-	-	14185
8,5	-	-	15445	-	-	21938	-	-	2336	-	-	1308	-	-	41028
9	-	-	35154	-	-	20354	-	-	10154	-	-	1930	-	-	67592
9,5	-	-	34447	-	-	18413	-	-	15630	-	-	2108	-	-	70598
10	-	-	31440	-	-	25768	-	-	15063	-	-	2330	-	-	74601
10,5	-	-	30360	-	-	24271	-	-	9721	-	-	3882	-	-	68235
11	-	-	30999	-	-	16517	-	-	7938	-	-	6410	-	-	61863
11,5	-	-	18156	-	-	21784	-	-	12123	-	-	6097	-	-	58160
12	-	-	15019	-	-	19622	-	-	17163	-	-	5833	-	-	57637
12,5	-	-	5444	-	-	13794	-	-	13948	-	-	3505	-	-	36691
13	-	-	2330	-	-	22635	-	-	11959	-	-	2607	-	-	39531
13,5	-	-	661	-	-	9776	-	-	6637	-	-	1025	-	-	18099
14	-	-	0	-	-	1004	-	-	4132	-	-	474	-	-	5609
14,5	-	-	0	-	-	1540	-	-	1583	-	-	183	-	-	3306
15	-	-	79	-	-	3391	-	-	1144	-	-	27	-	-	4641
15,5	-	-		-	-	0	-	-	53	-	-	2	-	-	56
16	-	-		-	-	44	-	-		-	-		-	-	44
16,5	-	-		-	-		-	-		-	-		-	-	
17	-	-		-	-		-	-		-	-		-	-	
17,5	-	-		-	-		-	-		-	-		-	-	
18	-	-		-	-		-	-		-	-		-	-	
18,5	-	-		-	-		-	-		-	-		-	-	
19	-	-		-	-		-	-		-	-		-	-	
19,5	-	-		-	-		-	-		-	-		-	-	
20	-	-		-	-		-	-		-	-		-	-	
20,5	-	-		-	-		-	-		-	-		-	-	
21	-	-		-	-		-	-		-	-		-	-	
21,5	-	-		-	-		-	-		-	-		-	-	
22	-	-		-	-		-	-		-	-		-	-	
Total N	-	-	224063	-	-	235216	-	-	130787	-	-	38185	-	-	628250
Catch (T)			1572			2233			1418			351			5576
L avg (cm)	-	-	10,2	-	-	10,7	-	-	11,3	-	-	11,2	-	-	10,7
W avg (g)	-	-	6,4	-	-	8,8	-	-	9,9	-	-	8,8	-	-	8,2

Table 4.2.2.6. Anchovy in Division IXa. Mean length (TL, in cm) at age in the Spanish catches of Gulf of Cadiz anchovy (Sub-division IXa-South, 1995-2007) on a quarterly (Q), half-year (HY) and annual basis. Data for 1994 (not shown) and second half in 1995 estimated from an iterated ALK by applying the Kimura and Chikuni's (1987) algorithm.

1995	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			10.3	10.2		10.2	10.2
	1	11.3	11.8	11.4	13.0	11.5	11.6	11.5
	2	14.7				14.7		14.7
	3							
	Total	11.4	11.8	10.7	10.2	11.5	10.4	10.9
1996	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			5.6	7.3		5.8	5.8
	1	7.4	8.5	12.9	13.7	8.4	13.2	8.9
	2	14.0	13.9	15.2	15.6	13.9	15.3	14.7
	3							
	Total	7.4	8.5	5.8	7.9	8.4	6.1	6.6
1997	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			7.1	8.1		7.4	7.4
	1	10.0	10.5	13.1	13.0	10.3	13.0	11.2
	2	13.4	14.0	15.0	15.1	13.6	15.0	14.0
	3							
	Total	10.9	10.8	8.7	8.9	10.8	8.8	9.5
1998	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			7.1	8.8		8.5	8.5
	1	9.5	9.2	11.9	12.2	9.3	12.0	10.1
	2	13.2	14.0	15.0		13.3	15.0	13.5
	3							
	Total	9.6	9.2	10.7	9.5	9.4	10.0	9.7
1999	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			7.7	9.3		8.8	8.8
	1	8.2	12.2	12.7	12.5	9.5	12.7	10.2
	2	13.4	14.1	15.2	14.9	13.8	15.2	13.9
	3							
	Total	8.4	12.5	11.2	10.0	9.8	10.6	10.1
2000	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			7.7	9.5		8.9	8.9
	1	8.2	10.9	11.9	12.5	9.4	12.0	10.2
	2	14.1	15.0	15.4	16.1	14.9	15.5	15.0
	3							
	Total	8.2	11.1	10.0	9.8	9.6	9.9	9.8
2001	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			9.9	8.4		8.7	8.7
	1	10.7	11.4	13.2	13.0	11.2	13.1	12.0
	2	15.5	16.2	16.3	16.2	16.0	16.3	16.1
	3							
	Total	10.9	11.7	12.8	9.5	11.4	11.3	11.4

2002	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			7.9	10.2		8.8	8.8
	1	10.7	10.6	12.8	13.6	10.6	12.9	11.2
	2	15.0	15.1	15.6	15.7	15.1	15.6	15.4
	3							
	Total	10.7	10.7	11.8	12.1	10.7	11.9	11.1
2003	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			9.6	10.1		9.9	9.9
	1	10.8	11.3	12.1	12.6	11.1	12.2	11.3
	2	15.1	15.4	16.5		15.1	16.5	15.2
	3							
	Total	11.2	11.3	11.3	10.4	11.3	10.9	11.2
2004	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			9.9	10.1		10.0	10.0
	1	10.9	11.8	12.7	13.3	11.4	12.8	11.6
	2	15.8	14.5	15.9	15.2	14.8	15.4	15.0
	3							
	Total	10.9	11.8	11.8	10.4	11.4	11.2	11.3
2005	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			9.0	9.4		9.1	9.1
	1	10.1	10.8	12.7	11.8	10.5	12.7	10.7
	2	13.9	14.3	15.2		14.0	15.2	14.1
	3							
	Total	10.2	10.8	11.3	9.4	10.5	10.9	10.6
2006	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			8.6	9.1		8.7	8.7
	1	10.7	10.8	11.1	10.2	10.8	11.1	10.8
	2	13.5	14.8			14.1		14.1
	3							
	Total	10.8	10.9	10.6	9.2	10.8	10.6	10.8
2007	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			9.5	10.4		9.8	9.8
	1	10.2	10.6	12.1	12.1	10.4	12.1	10.7
	2	13.2	14.3	14.7	14.4	14.0	14.7	14.1
	3							
	Total	10.2	10.7	11.3	11.2	10.5	11.3	10.7

Table 4.2.2.7. Anchovy in Division IXa. Mean weight (in Kg) at age in the Spanish catches of Gulf of Cadiz anchovy (Sub-division IXa-South, 1995-2007) on a quarterly (Q), half-year (HY) and annual basis. Data for 1994 (not shown) and second half in 1995 estimated from an iterated ALK by applying the Kimura and Chikuni's (1987) algorithm.

1995 AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
0			0.007	0.006		0.007	0.007
1	0.009	0.011	0.010	0.014	0.010	0.010	0.010
2	0.021				0.021		0.021
3							
Total	0.009	0.011	0.008	0.007	0.010	0.007	0.008

1996 AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
0			0.001	0.003		0.001	0.001
1	0.003	0.006	0.014	0.015	0.005	0.015	0.006
2	0.018	0.017	0.023	0.023	0.017	0.023	0.020
3							
Total	0.003	0.006	0.001	0.004	0.005	0.002	0.003

1997 AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
0			0.003	0.003		0.003	0.003
1	0.007	0.009	0.015	0.013	0.008	0.015	0.010
2	0.016	0.019	0.023	0.021	0.017	0.023	0.018
3							
Total	0.009	0.010	0.006	0.005	0.009	0.006	0.007

1998 AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
0			0.003	0.005		0.004	0.004
1	0.005	0.005	0.011	0.011	0.005	0.011	0.007
2	0.014	0.019	0.022		0.014	0.022	0.015
3							
Total	0.006	0.006	0.009	0.006	0.006	0.007	0.006

1999 AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
0			0.003	0.005		0.005	0.004
1	0.005	0.012	0.014	0.012	0.007	0.013	0.008
2	0.015	0.020	0.023	0.020	0.018	0.023	0.018
3							
Total	0.005	0.013	0.011	0.006	0.008	0.009	0.008

2000 AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
0			0.003	0.005		0.005	0.005
1	0.004	0.009	0.011	0.012	0.006	0.011	0.008
2	0.018	0.024	0.025	0.027	0.023	0.025	0.023
3							
Total	0.004	0.010	0.008	0.006	0.007	0.007	0.007

2001 AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
0			0.006	0.004		0.005	0.005
1	0.008	0.011	0.016	0.014	0.010	0.015	0.012
2	0.025	0.032	0.031	0.028	0.030	0.031	0.030
3							
Total	0.009	0.012	0.015	0.006	0.011	0.011	0.011

2002 AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
0			0.003	0.007		0.005	0.005
1	0.007	0.009	0.014	0.016	0.008	0.015	0.010
2	0.019	0.025	0.027	0.026	0.024	0.027	0.025
3							
Total	0.007	0.009	0.012	0.012	0.008	0.012	0.010

2003 AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
0			0.006	0.006		0.006	0.006
1	0.008	0.010	0.012	0.012	0.010	0.012	0.010
2	0.022	0.026	0.030		0.023	0.030	0.023
3							
Total	0.010	0.010	0.010	0.007	0.010	0.009	0.010

2004 AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
0			0.007	0.007		0.007	0.007
1	0.008	0.011	0.014	0.015	0.010	0.014	0.010
2	0.026	0.021	0.028	0.023	0.022	0.024	0.023
3							
Total	0.008	0.011	0.012	0.007	0.010	0.010	0.010

2005 AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
0			0.005	0.005		0.005	0.005
1	0.006	0.008	0.015	0.009	0.008	0.008	0.008
2	0.017	0.021	0.025		0.018	0.019	0.019
3							
Total	0.007	0.008	0.011	0.005	0.008	0.010	0.008

2006 AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
0			0.004	0.004		0.004	0.004
1	0.008	0.008	0.008	0.006	0.008	0.008	0.008
2	0.015	0.021			0.017		0.017
3							
Total	0.008	0.008	0.008	0.004	0.008	0.007	0.008

2007 AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
0			0.005	0.007		0.006	0.006
1	0.006	0.009	0.012	0.011	0.007	0.012	0.008
2	0.015	0.020	0.022	0.018	0.019	0.021	0.019
3							
Total	0.006	0.009	0.010	0.009	0.008	0.010	0.008

Table 4.2.4.1. Anchovy in Division IXa. ANOVA results of the GLM used for standardisation of CPUE data for Spanish fleets in Sub-division IXa-South (Gulf of Cadiz).

ANOVA:Tests of between-subjects effects
Dependent variable: Ln CPUE adjusted

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta-Squared	Noncentrality parameter	Observed power (a)
Corrected Model	1058.635	309	3.426	15.642	1.316E-164	0.895	4833.317	1.000
Intercept	2919.285	1	2919.285	13328.327	0.000E+00	0.959	13328.327	1.000
YEAR	225.509	19	11.869	54.189	3.260E-114	0.644	1029.588	1.000
QUARTER	6.119	3	2.040	9.312	5.100E-06	0.047	27.936	0.997
FLEET	362.676	10	36.268	165.584	2.143E-161	0.744	1655.841	1.000
YEAR * QUARTER	26.603	57	0.467	2.131	7.902E-06	0.176	121.457	1.000
YEAR * FLEET	418.126	190	2.201	10.047	2.038E-102	0.770	1909.003	1.000
QUARTER * FLEET	19.601	30	0.653	2.983	3.521E-07	0.136	89.492	1.000
Error	124.846	570	0.219					
Total	4102.766	880						
Corrected Total	1183.481	879						

a Computed using alfa = ,05

b R Squared = ,895 (Adjusted R squared = ,837)

Table 4.2.4.2. Anchovy in Division IXa. Standardised effort (no. of standardised fishing trips fishing anchovy) and CPUE (Tonnes/fishing trip) data for Spanish fleets in Sub-division IXa-South (Gulf of Cadiz) (SP: single purpose; MP: multi purpose; HT: heavy GRT; LT: light GRT). Color intensities denote increasing problems in sampling coverage of fishing effort.

	SUB-DIVISION IXa SOUTH (Gulf of Cadiz) PURSE SEINE															
FLEET	BARBATE			SANLÚCAR		P.UMBRÍA		I. CRISTINA			MEDIT.	SUBTOTAL	SUBTOTAL	TOTAL	TOTAL	OVERALL
	(SP-HT)	(SP-LT)	(MP)	(SP-LT)	(MP)	(SP-LT)	(MP)	(SP-HT)	(SP-LT)	(MP)	(SP-HT)	SP-HT	SP-LT	SP	MP	EFFORT
Year	No. fishing trips															
1988	5250	-	31	-	300	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	5250	?	5250	330	**5581**
1989	3306	-	66	-	322	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	3306	?	3306	388	**3693**
1990	4640	-	105	-	1635	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	4640	?	4640	1740	**6380**
1991	4507	-	64	-	759	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	4507	?	4507	823	**5330**
1992	4065	-	117	-	492	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	4065	?	4065	609	**4674**
1993	1998	-	10	-	189	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	1998	?	1998	199	**2197**
1994	1703	-	108	-	699	*n.a.*	*n.a.*	0	151	32	-	1703	151	1854	839	**2693**
1995	674	-	30	-	451	*n.a.*	*n.a.*	0	18	12	-	674	18	692	492	**1184**
1996	1250	-	188	-	1329	*n.a.*	*n.a.*	0	86	132	-	1250	86	1336	1648	**2985**
1997	5019	22	192	-	1172	*n.a.*	*n.a.*	0	50	16	-	5019	72	5091	1380	**6470**
1998	4588	54	0	2603	0	*n.a.*	*n.a.*	0	151	39	-	4588	2808	7396	39	**7435**
1999	3394	80	9	3604	0	484	648	0	205	320	-	3394	4373	7767	977	**8744**
2000	35	2075	0.4	2624	0	1155	134	0	856	0	-	35	6709	6744	134	**6878**
2001	160	1421	135	597	0	3082	12	147	1995	6	295	603	7095	7698	154	**7852**
2002	2489	684	38	758	0	3113	6	9	660	0	117	2615	5216	7831	45	**7876**
2003	2115	445	12	2128	0	1407	0	63	652	0	0	2178	4633	6811	12	**6823**
2004	2362	577	3	875	0	1876	30	141	952	7	0	2504	4280	6784	40	**6824**
2005	1088	389	0	620	0	1117	0	110	501	0	0	1198	2626	3824	0	**3824**
2006	910	291	0	1120	0	1412	0	210	1132	0	0	1120	3956	5077	0	**5077**
2007	1653	684	17	953	0	1701	0	309	1631	0	0	1962	4970	6932	17	**6949**

	SUB-DIVISION IXa SOUTH (Gulf of Cadiz) PURSE SEINE															
FLEET	BARBATE			SANLÚCAR		P.UMBRÍA		I. CRISTINA			MEDIT.	SUBTOTAL	SUBTOTAL	TOTAL	TOTAL	OVERALL
	(SP-HT)	(SP-LT)	(MP)	(SP-LT)	(MP)	(SP-LT)	(MP)	(SP-HT)	(SP-LT)	(MP)	(SP-HT)	SP-HT	SP-LT	SP	MP	CPUE
Year	Tonnes/fishing trip															
1988	0.790	-	0.255	-	0.295	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	0.790	?	0.790	0.291	**0.760**
1989	1.521	-	0.316	-	0.686	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	1.521	?	1.521	0.623	**1.427**
1990	1.124	-	0.251	-	0.259	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	1.124	?	1.124	0.259	**0.888**
1991	1.159	-	0.211	-	0.521	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	1.159	?	1.159	0.497	**1.057**
1992	0.695	-	0.172	-	0.355	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	0.695	?	0.695	0.320	**0.646**
1993	0.687	-	0.135	-	0.306	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	0.687	?	0.687	0.297	**0.652**
1994	1.266	-	0.167	-	0.512	*n.a.*	*n.a.*	0	0.265	0.154	-	1.266	0.265	1.184	0.454	**0.957**
1995	0.295	-	0.076	-	0.139	*n.a.*	*n.a.*	0	0.064	0.036	-	0.295	0.064	0.290	0.133	**0.224**
1996	0.634	-	0.149	-	0.308	*n.a.*	*n.a.*	0	0.121	0.065	-	0.634	0.121	0.601	0.270	**0.418**
1997	0.693	0.319	0.183	-	0.427	*n.a.*	*n.a.*	0	0.160	0.103	-	0.693	0.209	0.686	0.389	**0.623**
1998	1.467	0.648	0	0.190	0	*n.a.*	*n.a.*	0	0.285	0.151	-	1.467	0.204	0.987	0.151	**0.983**
1999	1.110	0.453	0.215	0.145	0	0.194	0.132	0	0.216	0.121	-	1.110	0.159	0.575	0.129	**0.525**
2000	1.806	0.486	0.377	0.174	0	0.261	0.180	0	0.261	0	-	1.806	0.297	0.304	0.180	**0.302**
2001	3.770	1.672	0.990	0.556	0	0.728	0.595	1.478	0.858	0.549	1.857	2.273	0.939	1.044	0.941	**1.042**
2002	2.129	0.911	0.512	0.298	0	0.401	0.322	0.788	0.462	0	0.994	2.074	0.460	0.999	0.484	**0.996**
2003	1.618	0.620	0.219	0.179	0	0.286	0	0.645	0.353	0	0	1.590	0.278	0.698	0.219	**0.697**
2004	1.568	0.619	0.340	0.213	0	0.283	0.209	0.522	0.322	0.188	0	1.509	0.323	0.761	0.214	**0.757**
2005	2.576	1.070	0	0.405	0	0.496	0	0.937	0.516	0	0	2.426	0.564	1.147	0	**1.147**
2006	2.388	0.866	0	0.359	0	0.512	0	0.859	0.562	0	0	2.101	0.509	0.860	0	**0.860**
2007	1.213	0.935	0	0.764	0	0.586	0	1.077	0.534	0	0	1.192	0.651	0.804	0	**0.802**

Table 4.3.2.1. Anchovy in Division IXa. Maturity ogives (ratio of mature fish at age) for Gulf of Cadiz anchovy (Sub-division IXa South).

Year	Age		
	0	1	2+
1988	0	0.82	1
1989	0	0.53	1
1990	0	0.65	1
1991	0	0.76	1
1992	0	0.53	1
1993	0	0.77	1
1994	0	0.60	1
1995	0	0.76	1
1996	0	0.49	1
1997	0	0.63	1
1998	0	0.55	1
1999	0	0.74	1
2000	0	0.70	1
2001	0	0.76	1
2002	0	0.72	1
2003	0	0.69	1
2004	0	0.95	1
2005	0	0.95	1
2006	0	0.77	1
2007	0	0.91	1

Table 4.4.1.1. Historical series of overall and regional acoustic estimates of anchovy abundance (N, millions) and biomass (B, tonnes) in Division IXa from Portuguese (*SAR-PELAGOS* series) and Spanish surveys (*ECOCÁDIZ* series, only for IXa-South).

Survey	Estimate	Portugal				Spain	S(Total)	TOTAL
		C-N	**C-S**	**S(A)**	**Total**	**S(C)**		
Nov. 98	N	30	122	50	203	2346	2396	2549
Mar. 99	N	22	15	*	37	2079	2079	2116
Nov. 99	N	-	-	-	-	-	-	-
Mar. 00	N	-	-	-	-	-	-	-
Nov. 00	N	4	20	*	23	4970	4970	4994
Mar. 01	N	25	13	285	324	2415	2700	2738
Nov. 01	N	35	94	-	129	3322	3322	3451
Mar. 02	N	22	156	92	270	3731 **	3823 **	4001 **
Nov. 02	N	-	-	-	-	-	-	-
Feb. 03	N	0	14	*	14	2314	2314	2328
Nov. 03	N	-	-	-	-	-	-	-
Mar. 04	N	-	-	-	-	-	-	-
Jun. 04* **	N	-	-	125	-	1109	1235	-
Nov. 04	N	-	-	-	-	-	-	-
Apr. 05	N	-	59	-	59	1306	1306	1364
Jun. 05	N	-	-	-	-	-	-	-
Nov. 05	N	-	-	-	-	-	-	-
Apr. 06	N	-	-	319	319	1928	2246	2246
Jun. 06	N	-	-	363	-	2801	3163	-
Nov. 06	N	-	-	-	-	-	-	
Apr. 07	N	0	103	284	387	2860	3144	3247
Jul. 07	N	-	-	558	-	1232	1790	-
Nov. 07	N	0	59	475	534	1386	1862	1921
Apr.08	N	69	252	213	534	1819	2032	2353

Survey	Estimate	Portugal				Spain	S(Total)	TOTAL
		C-N	**C-S**	**S(A)**	**Total**	**S(C)**		
Nov. 98	B	313	1951	603	2867	30092	30695	32959
Mar. 99	B	190	406	*	596	24763	24763	25359
Nov. 99	B	-	-	-	-	-	-	-
Mar. 00	B	-	-	-	-	-	-	-
Nov. 00	B	98	241	*	339	33909	33909	34248
Mar. 01	B	281	87	2561	2929	22352	24913	25281
Nov. 01	B	1028	2276	-	3304	25578	25578	28882
Mar. 02	B	472	1070	1706	3248	19629 **	21335 **	22877 **
Nov. 02	B	-	-	-	-	-	-	-
Feb. 03	B	0	112	*	112	24565	24565	24677
Nov. 03	B	-	-	-	-	-	-	-
Mar. 04	B	-	-	-	-	-	-	-
Jun. 04* **	B	-	-	2474	-	15703	18177	-
Nov. 04	B	-	-	-	-	-	-	-
Apr. 05	B	-	1062	-	1062	14041	14041	15103
Jun. 05	B	-	-	-	-	-	-	-
Nov. 05	B	-	-	-	-	-	-	-
Apr. 06	B	-	-	4490	4490	19592	24082	24082
Jun. 06	B	-	-	6477	-	30043	36521	-
Nov. 06	B	-	-	-	-	-	-	
Apr. 07	B	0	1945	4607	6552	33413	38020	39965
Jul. 07	B	-	-	11639	-	17243	28882	-
Nov. 07	B	0	1120	7632	8752	16091	23723	24843
Apr. 08	B	3000	2505	4661	10166	29501	34162	39667

*** Due to the distribution observed during the survey, the last transect (near the border with Spain) that normally belongs to the Algarve sub-area was included in Cadiz.** Corrected estimates after detection of errors in the sA values attributed to the Cadiz area (Marques & Morais, 2003). ***Possible underestimation due to the shallow waters between 20 and 30 m depth were not acoustically sampled. Moreover, 2004 estimates are pending of revision (application of recent IEO standards in the estimation process: delimitation of post-strata, increased number of assessed species, species-specific TS, etc).**

Table 4.4.2.1. Anchovy in División IXa. Gulf of Cadiz anchovy DEPM parameters and SSB estimates from the *BOCADEVA 0605* survey (June 2005).

Parameters	Estratum 1 (Spanish waters)	Estratum 2 (Portuguese waters)
Eggs		
Po (eggs/m^2/day)	241.8	19.3
P_{total} (eggs/day)	108.09 E+10	2.61 E+10
Z (day^{-1})	-0.04	0.006
Adults		
W (gr)	16.54	25.19
R	0.537	0.532
F (eggs/batch)	11470	13808
S	0.21	0.23
SSB (tons)	**13821.85 (0.607)**	**396.77 (0.817)**
Anchovy total SSB (GC 2005)		**14218,62 (0.613)**

Table 4.5.1.1.1. Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz) . Input values from the seasonal separable assessment model.

Anchovy IXa-South (Algarve+Gulf of Cadiz)
Years: 1995-2007
Fleets: All

Half-year Catch in number (in millions) at age (1995-2007)

	1995		1996		1997		1998		1999		2000		2001		2002		2003		2004		2005		2006		2007	
AGE	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
0	0	34.50	0	495.13	0	335.67	0	465.60	0	126.26	0	129.46	0	161.95	0	77.89	0	95.72	0	123.63	0	38.75	0	12.45	0	62.11
1	26.51	7.45	143.75	19.89	191.06	89.10	722.99	341.82	422.57	109.26	161.65	58.89	354.92	220.76	548.23	195.09	333.99	73.28	323.34	97.73	449.26	37.39	450.39	41.93	455.32	107.16
2	0.19	0.00	0.90	1.21	32.46	12.41	12.03	1.51	32.29	2.65	3.51	0.55	19.70	5.29	8.50	9.93	13.15	0.63	1.81	0.92	3.21	0.33	5.27	0.00	6.76	0.63

Mean weight at age in the stock (in g) and natural mortality (half-year) estimates

AGE	Mean weight													Natural mortality
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	
0	7.03	1.06	2.57	2.65	3.19	3.14	6.21	3.32	5.98	6.64	4.94	3.65	5.36	0.6
1	10.72	6.26	11.06	7.40	12.84	9.96	13.29	10.50	10.57	12.01	9.17	8.21	9.44	0.6
2	22.55	19.98	20.90	20.45	19.99	23.82	31.76	26.29	26.79	21.87	22.62	20.97	20.39	0.6

Acoustic Biomass estimates (tonnes) in Sub-division IXa South (Algarve+Gulf of Cadiz) (Portuguese surveys). Only Spring surveys series has been considered this year.

Nov.-98	Mar.-99	Nov.-99	Mar.-00	Nov.-00	Mar.-01	Nov.-01	Mar.-02	Nov.-02	Feb.-03	Nov.-03	Mar.-04	Nov.-04	Apr.-05	Nov.-05	Apr.-06	Nov.-06	Apr.-07	Nov.-07	Apr.-08
30695	24763	-	-	33909	24913	25580	21335	-	24565	-	-	-	14041	-	24082	-	38020	23723	34162

Exploratory runs with the seasonal separable model

	Portuguese March Ac. Surv.	Biomass Index	Weighting factor for index	F assumptions	Wage stock
RUN1	1999-2008	Relative	1	2006Fratio for FHY2-2007. FHY1-2008:average FHY1 in 3 last years (05-07).	Wage stock in 2008 as the average in 05-07
RUN2		Relative	6		
RUN3		Absolute	1		

Table 4.5.1.2.1. Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz) . Outputs from the seasonal separable assessment model. RUN1: Acoustic biomass index as relative and Weighting factor =1. See text for remaining settings.

Fishing Mortality per half-year period

	1995		1996		1997		1998		1999		2000		2001		2002		2003		2004		2005		2006		2007	
AGE	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
0	0.0000	0.1001	0.0000	0.0764	0.0000	0.1550	0.0000	0.1424	0.0000	0.1368	0.0000	0.0477	0.0000	0.1119	0.0000	0.1795	0.0000	0.1255	0.0000	0.1574	0.0000	0.0402	0.0000	0.0168	0.0000	0.0113
1	0.7972	1.0045	0.3428	0.7671	0.8663	1.5557	0.8721	1.4294	1.4871	1.3731	0.4616	0.4786	0.6516	1.1230	0.6591	1.8020	1.5382	1.2599	0.8395	1.5795	1.0250	0.4031	0.4914	0.1689	0.3314	0.1139
2	0.4093	0.2619	0.1760	0.2000	0.4448	0.4057	0.4478	0.3727	0.7636	0.3581	0.2370	0.1248	0.3346	0.2928	0.3384	0.4699	0.7898	0.3285	0.4311	0.4119	0.5263	0.1051	0.2523	0.0440	0.1702	0.0297

Population abundance (millions)

	1995		1996		1997		1998		1999		2000		2001		2002		2003		2004		2005		2006		2007	
AGE	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
0	0	1006	0	2060	0	3919	0	2433	0	1284	0	2239	0	1904	0	1187	0	1113	0	1454	0	1432	0	2806	0	4896
1	120	30	499	194	1047	242	1842	423	1158	144	615	213	1171	335	934	265	545	64	539	128	682	134	755	253	1514	597
2	1	0	6	3	50	17	28	10	56	14	20	9	72	28	60	23	24	6	10	4	14	5	49	21	117	54

Predicted Biomass Index values

	Mar. 99	Mar. 00	Mar. 01	Mar. 02	Feb. 03	Mar. 04	Apr. 05	Apr. 06	Apr. 07
Acoustic Index (tonnes)	27816	-	40886	26023	15548	-	10135	14615	36318

Fitted Selection Pattern

	1995-2007	
AGE	1st half	2nd half
0	0.0000	0.0996
1	1.0000	1.0000
2	0.5135	0.2608

Catchability indices

	Q
Acoustic Survey	3.4251

Table 4.5.1.2.1.(cont'd) Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz) . Outputs from the seasonal separable assessment model. RUN1: Acoustic biomass index as relative and Weighting factor =1. See text for remaining settings.

Average population Biomass (tonnes)

1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
418	1278	3553	4023	4031	2765	6020	3289	1663	1833	2356	3350	8302

Residuals about the model fit

Separable model residuals

	1995		1996		1997		1998		1999		2000		2001		2002		2003		2004		2005		2006		2007	
AGE	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
0		-0.741		1.465		-0.239		0.644		0.016		0.499		0.061		-0.642		-0.037		-0.278		-0.092		-1.040		0.401
1	-0.667	-0.691	0.260	-1.408	-0.913	-0.549	-0.151	0.279	-0.537	0.238	-0.078	-0.055	-0.204	0.208	0.448	0.075	-0.034	0.691	0.299	0.126	0.263	0.090	0.691	0.339	0.332	0.791
2	-0.309		0.202	1.159	0.864	1.023	0.437	-0.441	0.333	-0.210	0.089	-0.329	0.226	-0.038	-0.435	0.386	0.250	-0.716	-0.396	-0.027	-0.352	-0.056	-0.461		-0.724	-0.641

Biomass index residuals

	Mar. 99	Mar. 00	Mar. 01	Mar. 02	Feb. 03	Mar. 04	Apr. 05	Apr. 06	Apr. 07	Apr. 08
Acoustic Index (tonnes)	-0.116	-	-0.495	-0.199	0.457	-	0.326	0.499	0.046	-0.526

Table 4.5.1.2.2. Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz) . Outputs from the seasonal separable assessment model. RUN2: Acoustic biomass index as relative and Weighting factor =6. See text for remaining settings.

Fishing Mortality per half-year period

	1995		1996		1997		1998		1999		2000		2001		2002		2003		2004		2005		2006		2007	
AGE	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
0	0.0000	0.0935	0.0000	0.0816	0.0000	0.1595	0.0000	0.1473	0.0000	0.1246	0.0000	0.0486	0.0000	0.1094	0.0000	0.1694	0.0000	0.1139	0.0000	0.1184	0.0000	0.0236	0.0000	0.0130	0.0000	0.0130
1	0.7056	0.7212	0.3181	0.6292	0.9061	1.2298	0.8260	1.1355	1.3702	0.9606	0.3860	0.3745	0.6106	0.8439	0.6881	1.3061	1.5350	0.8785	0.6597	0.9129	0.6011	0.1823	0.2828	0.1002	0.2838	0.1005
2	0.2364	0.1269	0.1066	0.1107	0.3035	0.2164	0.2767	0.1998	0.4590	0.1690	0.1293	0.0659	0.2045	0.1485	0.2305	0.2298	0.5142	0.1546	0.2210	0.1606	0.2013	0.0321	0.0947	0.0176	0.0951	0.0177

Population abundance (millions)

	1995		1996		1997		1998		1999		2000		2001		2002		2003		2004		2005		2006		2007	
AGE	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
0	0	1140	0	2191	0	4065	0	2534	0	1455	0	2039	0	1958	0	1698	0	1182	0	1842	0	2078	0	3115	0	3280
1	134	36	570	227	1108	246	1902	457	1200	167	705	263	1066	318	963	266	787	93	579	164	898	270	1114	461	1688	697
2	1	0	10	5	67	27	39	16	81	28	35	17	99	44	75	33	39	13	21	9	36	16	124	62	229	114

Predicted Biomass Index values

	Mar. 99	Mar. 00	Mar. 01	Mar. 02	Feb. 03	Mar. 04	Apr. 05	Apr. 06	Apr. 07
Acoustic Index (tonnes)	24915	-	32434	22058	18309	-	13831	21073	36974

Fitted Selection Pattern

	1995-2007	
AGE	1st half	2nd half
0	0.0000	0.1297
1	1.0000	1.0000
2	0.3350	0.1760

Catchability indices

	Q
Acoustic Survey	2.7313

Table 4.5.1.2.2.(cont'd) Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz) . Outputs from the seasonal separable assessment model. RUN2: Acoustic biomass index as relative and Weighting factor =6. See text for remaining settings.

Average population Biomass (tonnes)

1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
518	1569	4208	4656	4976	3530	6562	3997	2717	2583	4014	6036	10591

Residuals about the model fit

Separable model residuals

	1995		1996		1997		1998		1999		2000		2001		2002		2003		2004		2005		2006		2007	
AGE	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
0		-0.801		1.340		-0.302		0.572		-0.021		0.575		0.054		-0.946		-0.005		-0.247		0.058		-0.888		0.664
1	-0.688	-0.667	0.193	-1.421	-0.999	-0.442	-0.146	0.328	-0.531	0.295	-0.068	-0.066	-0.062	0.442	0.386	0.231	-0.401	0.541	0.399	0.186	0.357	0.090	0.767	0.234	0.359	0.754
2	0.167		0.191	1.160	0.893	1.136	0.504	-0.405	0.348	-0.217	0.083	-0.389	0.345	0.131	-0.323	0.665	0.072	-0.810	-0.569	-0.156	-0.446	-0.144	-0.470		-0.840	-0.869

Biomass index residuals

	Mar. 99	Mar. 00	Mar. 01	Mar. 02	Feb. 03	Mar. 04	Apr. 05	Apr. 06	Apr. 07	Apr. 08
Acoustic Index (tonnes)	-0.006	-	-0.264	-0.033	0.294	-	0.015	0.133	0.028	-0.169

Table 4.5.1.2.3. Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz) . Outputs from the seasonal separable assessment model. RUN3: Acoustic biomass index as absolute and Weighting factor =1. See text for remaining settings.

Fishing Mortality per half-year period

	1995		1996		1997		1998		1999		2000		2001		2002		2003		2004		2005		2006		2007	
AGE	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
0	0.0000	0.0632	0.0000	0.0783	0.0000	0.1440	0.0000	0.1212	0.0000	0.0727	0.0000	0.0263	0.0000	0.0804	0.0000	0.1171	0.0000	0.0503	0.0000	0.0484	0.0000	0.0088	0.0000	0.0052	0.0000	0.0060
1	0.4293	0.3418	0.2443	0.4231	0.8496	0.7784	0.6662	0.6552	0.9342	0.3930	0.1797	0.1424	0.3874	0.4347	0.4221	0.6332	0.7734	0.2718	0.2771	0.2616	0.1933	0.0478	0.1040	0.0280	0.1206	0.0325
2	0.0837	0.0387	0.0476	0.0479	0.1657	0.0881	0.1299	0.0741	0.1822	0.0445	0.0350	0.0161	0.0755	0.0492	0.0823	0.0716	0.1508	0.0308	0.0540	0.0296	0.0377	0.0054	0.0203	0.0032	0.0235	0.0037

Population abundance (millions)

	1995		1996		1997		1998		1999		2000		2001		2002		2003		2004		2005		2006		2007	
AGE	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
0	0	1513	0	2555	0	4982	0	3411	0	2616	0	3833	0	2683	0	1642	0	2131	0	3972	0	5224	0	7663	0	10355
1	169	60	780	335	1296	304	2367	667	1659	358	1335	612	2049	763	1359	489	801	203	1112	463	2077	940	2842	1406	4184	2035
2	1	1	24	12	120	56	77	37	190	87	132	70	291	148	271	137	142	67	85	44	195	103	492	264	750	402

Predicted Biomass Index values

	Mar. 99	Mar. 00	Mar. 01	Mar. 02	Feb. 03	Mar. 04	Apr. 05	Apr. 06	Apr. 07
Acoustic Index (tonnes)	15698	-	26980	15825	10102	-	16017	23975	38746

Fitted Selection Pattern

	1995-2007	
AGE	1st half	2nd half
0	0.0000	0.1850
1	1.0000	1.0000
2	0.1950	0.1131

Catchability indices

	Q
Acoustic Survey	1.0000

Table 4.5.1.2.3.(cont'd) Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz) . Outputs from the seasonal separable assessment model. RUN3: Acoustic biomass index as absolute and Weighting factor =1. See text for remaining settings.

Average population Biomass (tonnes)

1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
802	2471	6098	7235	9777	8633	16812	9568	5440	7376	12614	18845	30457

Residuals about the model fit

Separable model residuals

	1995		1996		1997		1998		1999		2000		2001		2002		2003		2004		2005		2006		2007	
AGE	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
0		-0.707		1.227		-0.410		0.458		-0.092		0.545		0.034		-0.567		0.195		-0.152		0.113		-0.871		0.287
1	-0.534	-0.583	0.111	-1.496	-1.113	-0.366	-0.213	0.317	-0.628	0.204	-0.030	-0.044	-0.352	0.066	0.423	0.092	-0.009	0.688	0.455	0.138	0.483	0.123	0.753	0.362	0.236	0.783
2	1.138		0.083	1.024	0.845	1.247	0.532	-0.280	0.295	-0.073	0.021	-0.424	0.207	-0.014	-0.644	0.328	-0.138	-0.897	-0.621	-0.075	-0.529	-0.227	-0.342		-0.663	-0.563

Biomass index residuals

	Mar. 99	Mar. 00	Mar. 01	Mar. 02	Feb. 03	Mar. 04	Apr. 05	Apr. 06	Apr. 07	Apr. 08
Acoustic Index (tonnes)	0.456	-	-0.080	0.299	0.889	-	-0.132	0.004	-0.019	-0.415

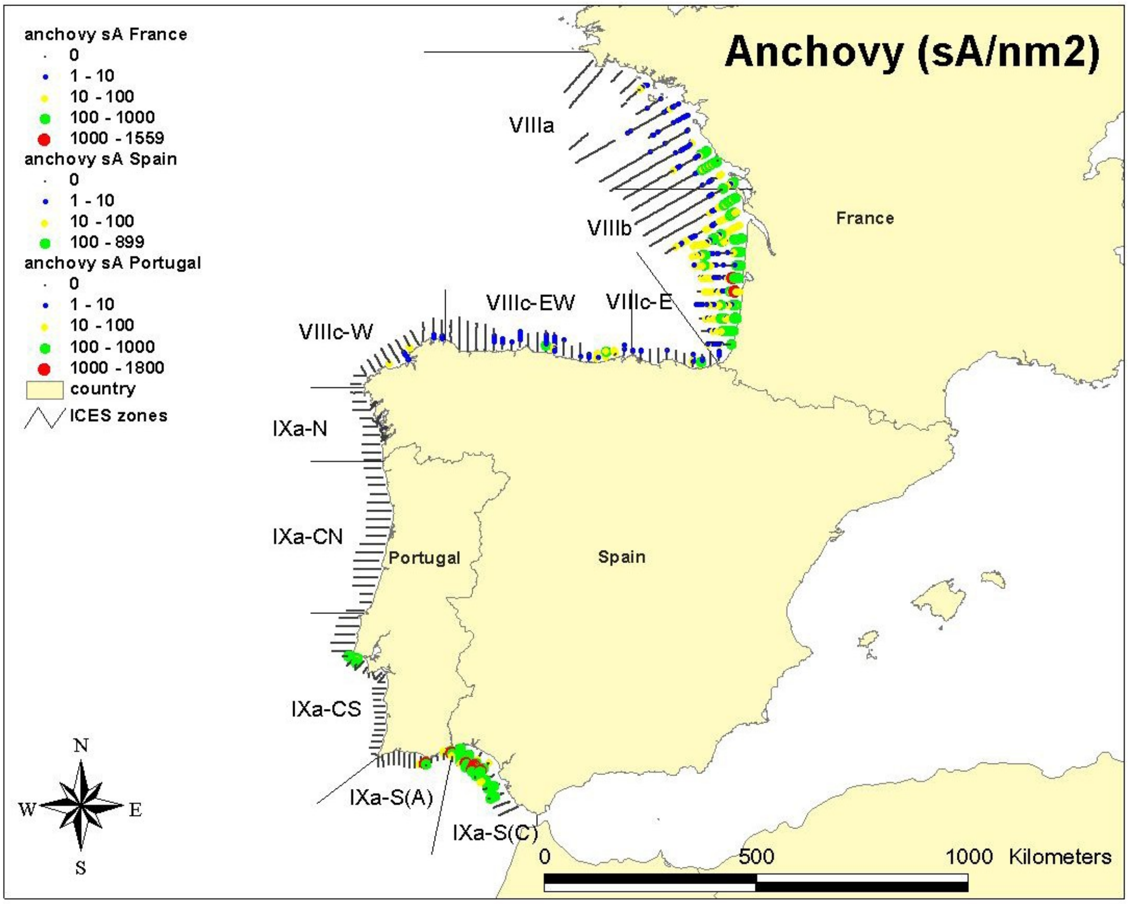


Figure 2.1: Distribution of acoustic energy allocated to anchovy from the combined 2007 acoustic surveys off Iberia and the Armorican shelf (from ICES, 2008).

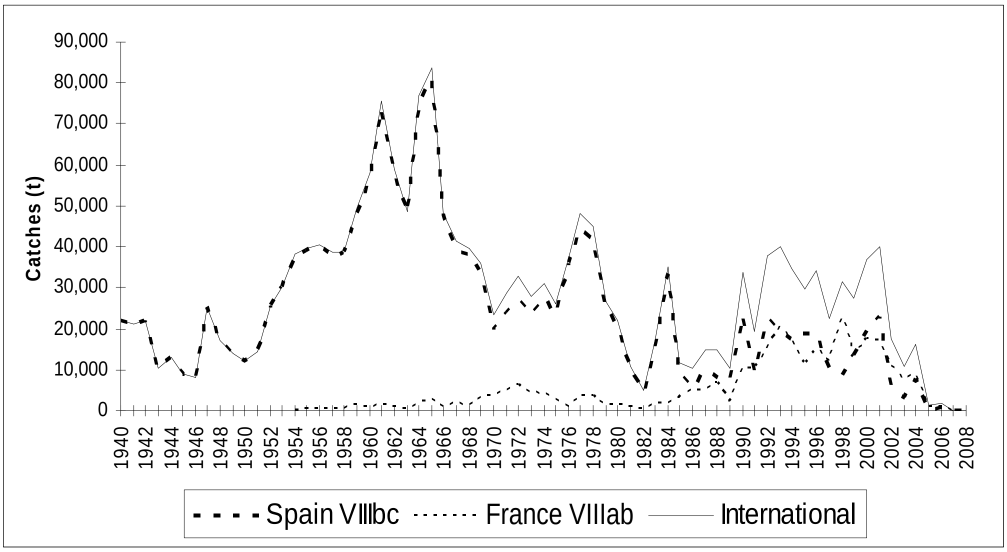


Figure 3.2.2.1 Bay of Biscay anchovy: Historical evolution of the fishery since 1940.

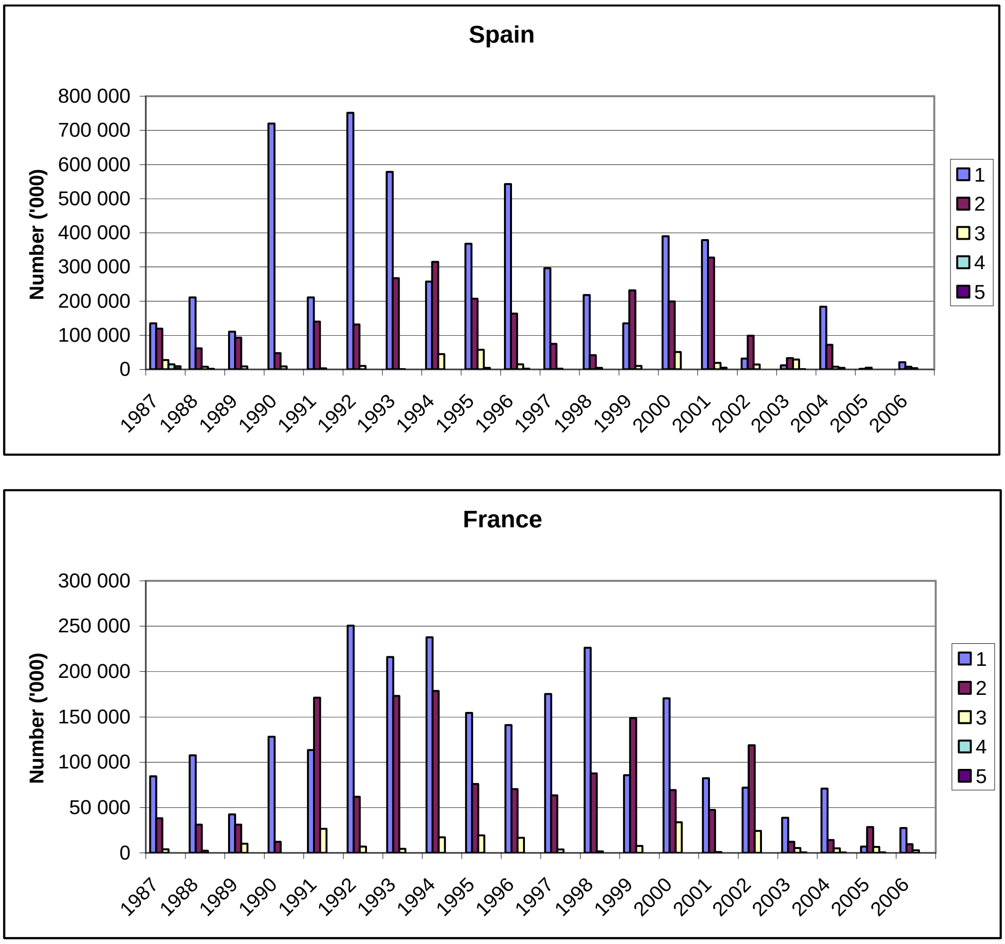


Figure 3.2.4.1. Bay of Biscay Anchovy. Spanish (upper panel) and French (Bottom panel) catch at age compositions of the first half of the year from 1987 to 2006.

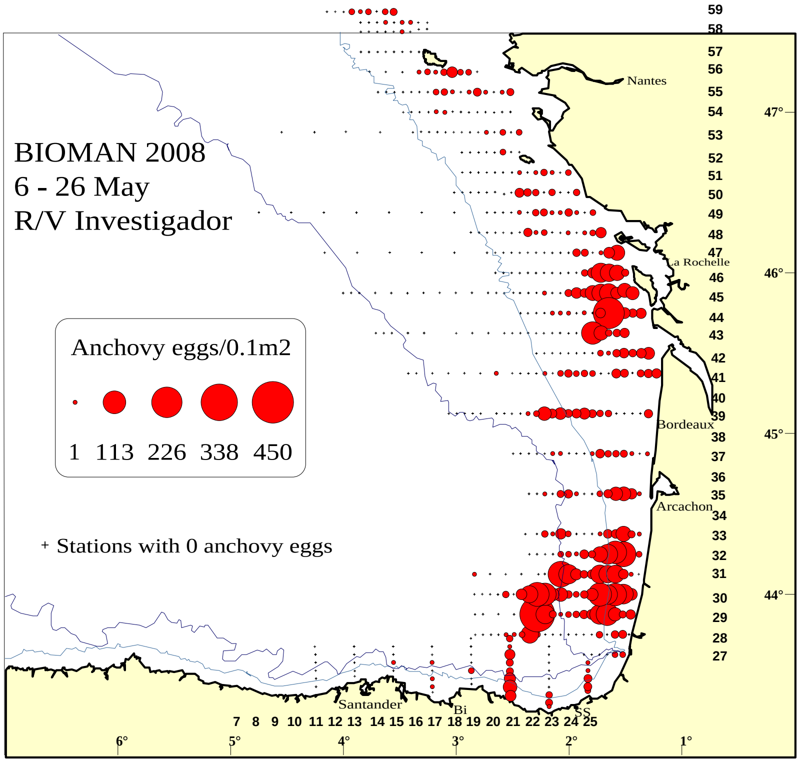


Figure 3.4.1.1: Bay of Biscay anchovy: Plankton stations and anchovy egg abundance (egg/0.1m²) from the DEPM survey BIOMAN 08 obtained with PairoVET.

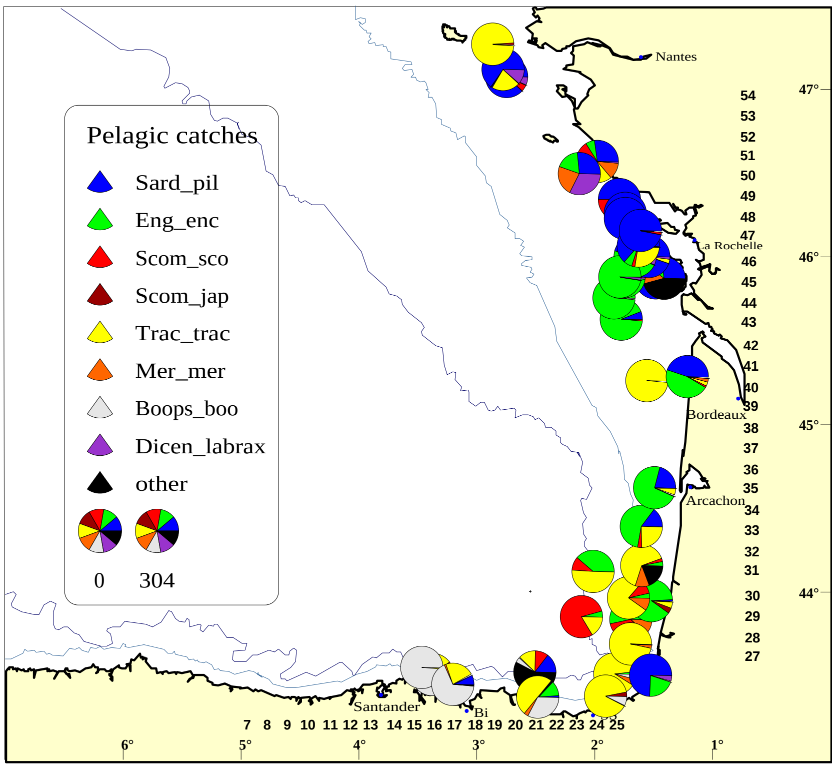


Figure 3.4.1.2: Bay of Biscay anchovy: Species composition of the 39 fishing pelagic trawls.

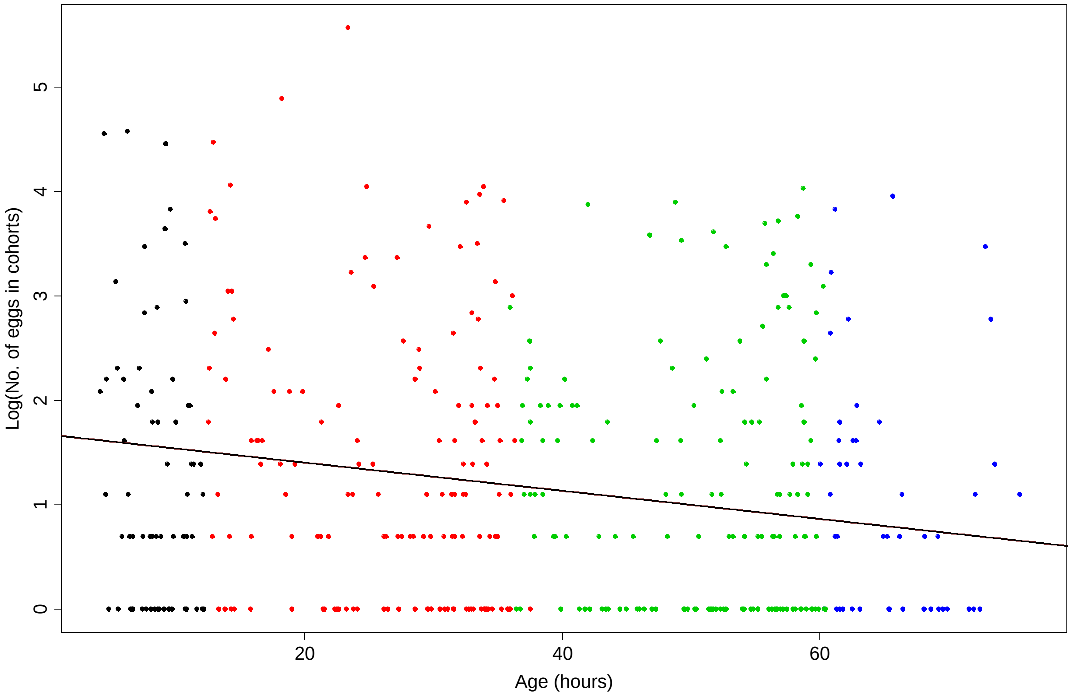


Figure 3.4.1.3: Bay of Biscay anchovy: Exponential mortality model applying a GLM to the data obtained in the ageing following the Bayesian method (spawning peak 23:00h).

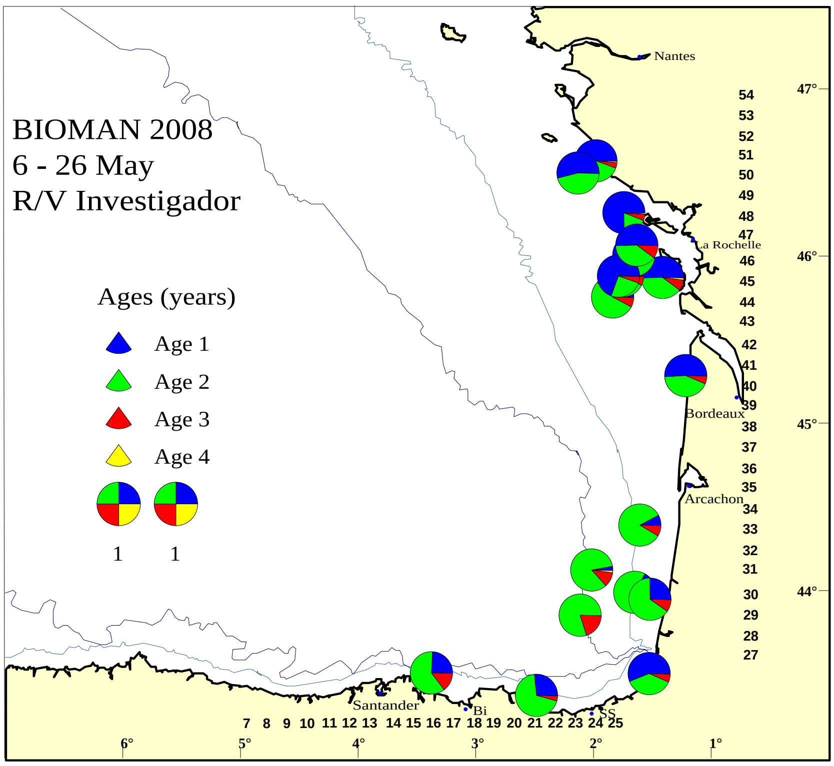


Figure 3.4.1.4: Bay of Biscay anchovy: Age composition by pelagic haul.

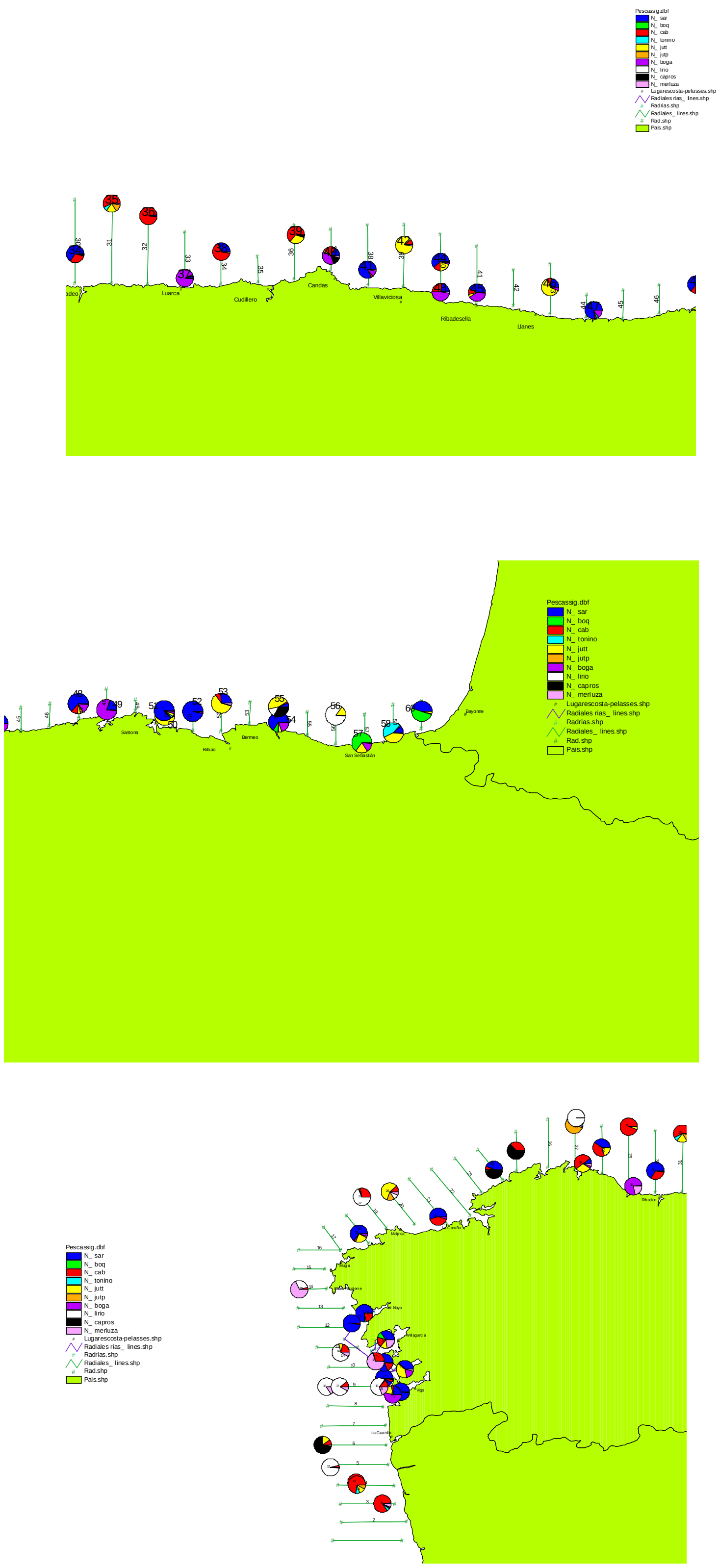
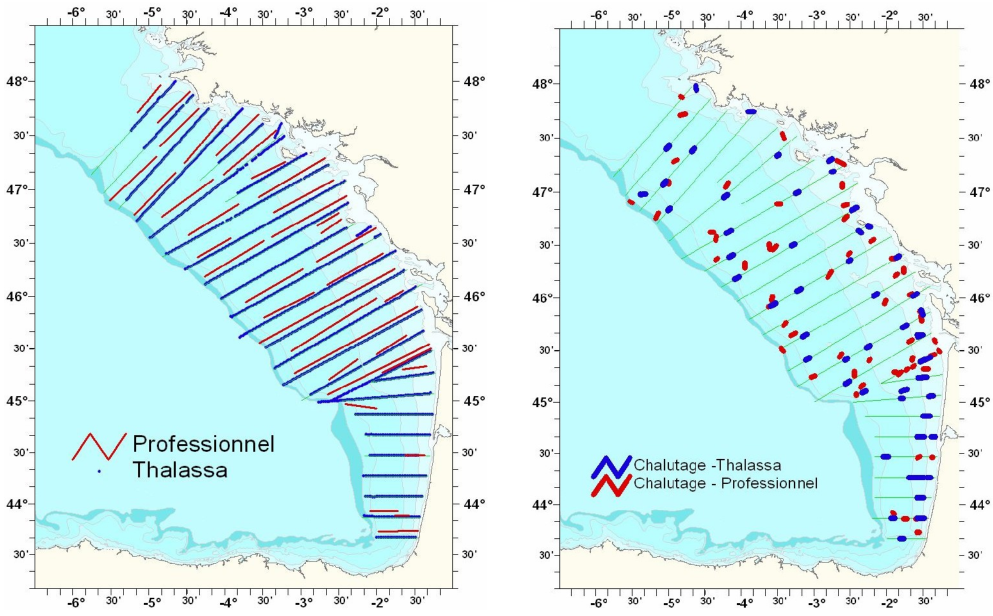
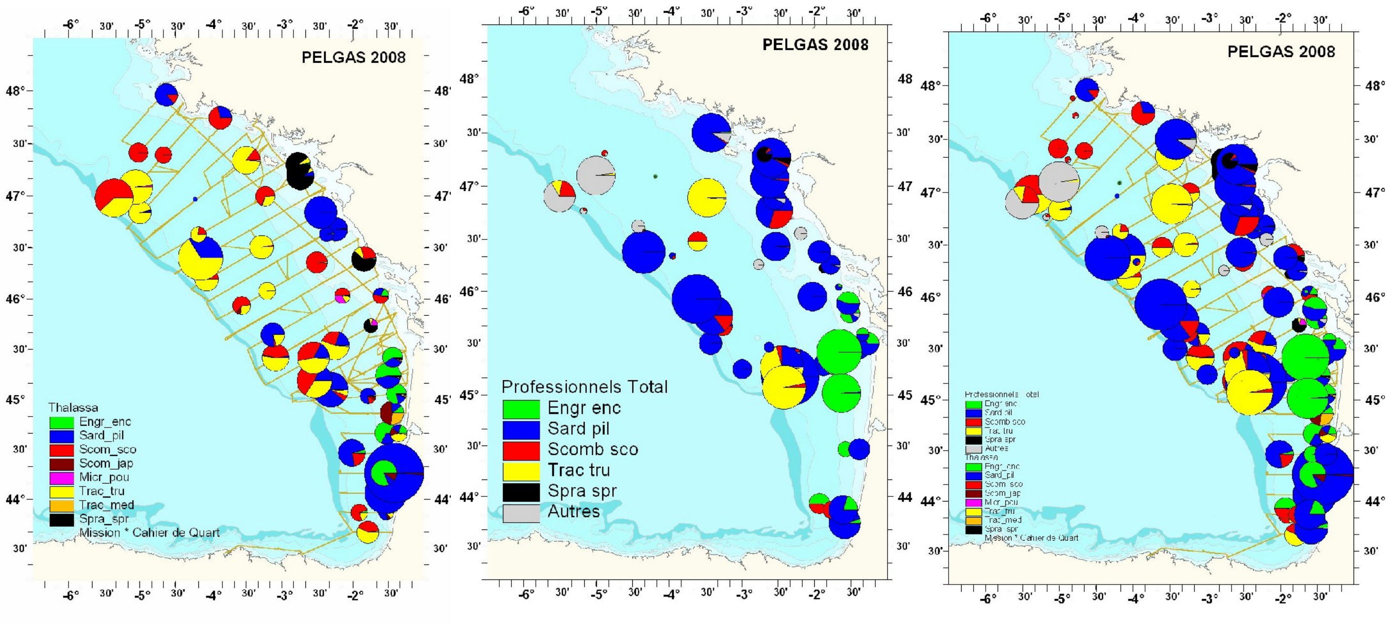


Figure 3.4.2.1: Composition of fishing hauls in PELACUS0408. In green the percentage of anchovy in numbers.



(a) Acoustic transects network (b) Fishing operations

Figure 3.4.2.2 – acoustic transects surveyed by Thalassa (blue) and commercial vessels (red) and fishing operations carried out by Thalassa (blue) and commercial vesssels (red) during PELGAS08 survey



(a) Thalassa (nb :46) *(b) Pair trawlers (nb : 56)* *(c) all together (nb :102)*

Figure 3.4.2.3 – catches by species as observed through the pelagic trawl hauls carried out by Thalassa (a), commercial vessels (b) and all together (c) during PELGAS08 survey.

zone	Area (nm²)
south coastal	1371.6
south offshore	1367.1
Gironde	2453.3
Fer a cheval	3124.6
Central coastal	2326.2

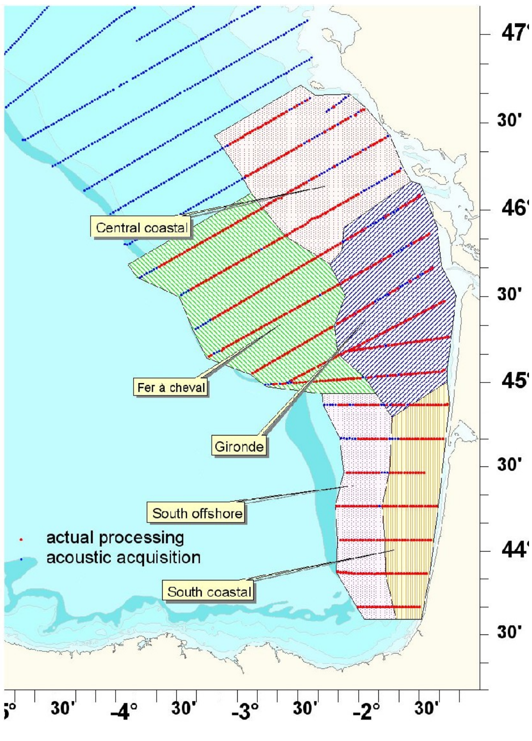


Figure 3.4.2.4. – coherent strata, in terms of echoes and species distribution, taken into consideration for multi-species biomass estimate from acoustic and catches data during PELGAS08 survey.

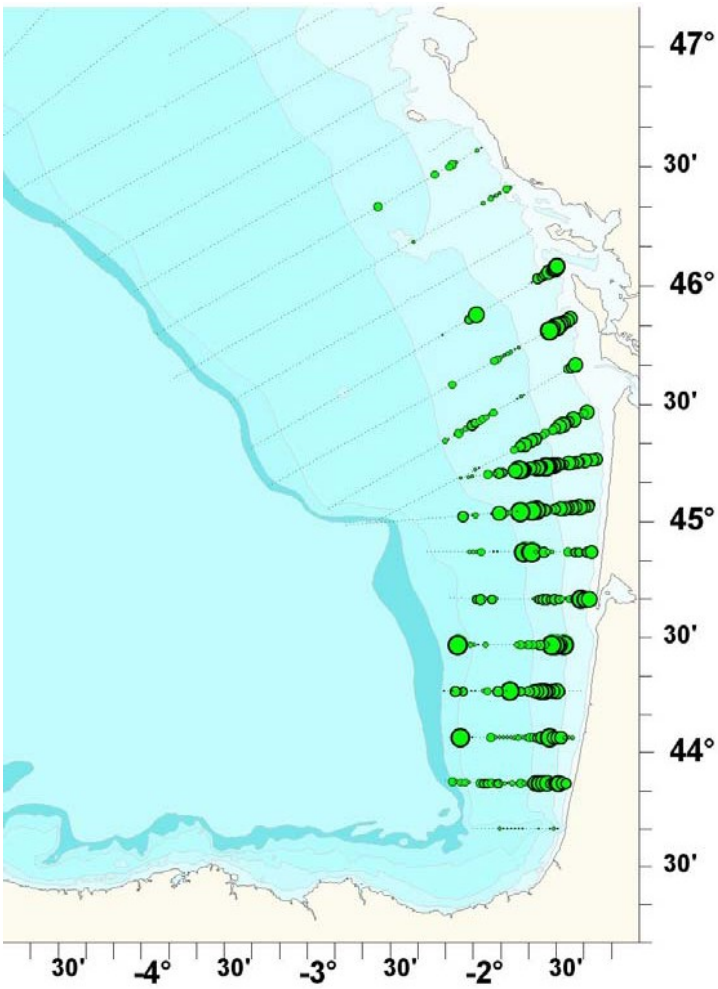


Figure 3.4.2.5. – Distribution of anchovy from biomass estimate for each ESDU. Two main areas are underligned : Gironde & southern coastal

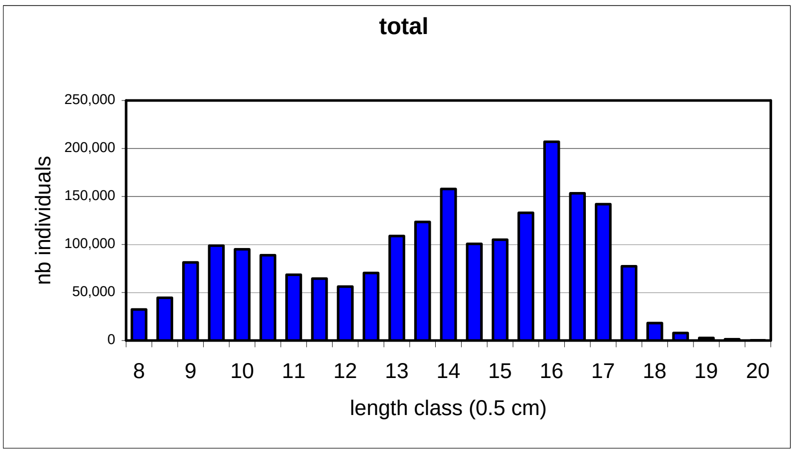


Figure 3.4.2.6. – Anchovy length distribution as observed during PELGAS08 survey.

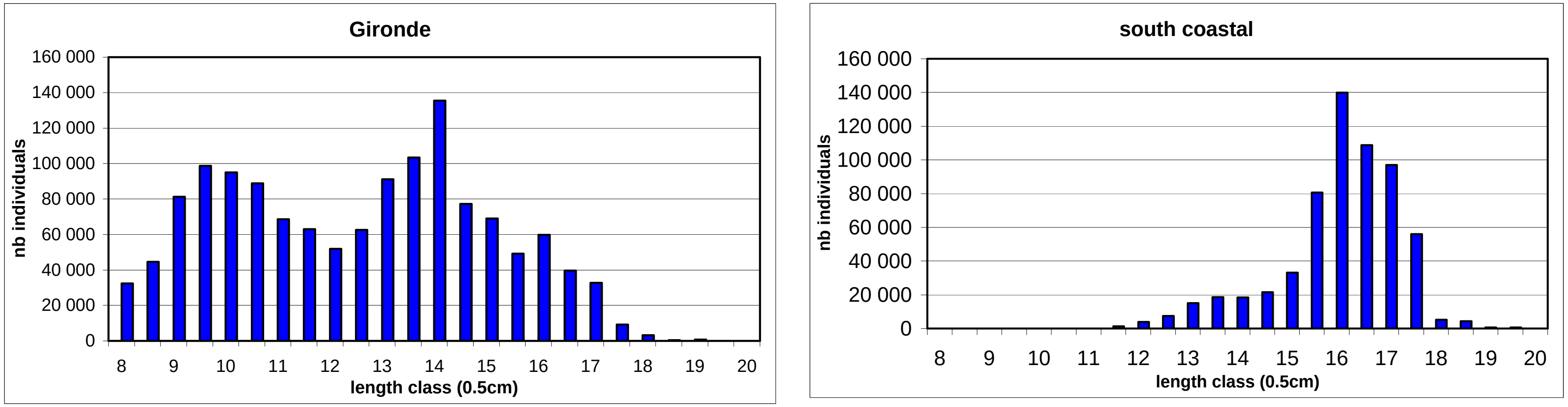


Figure 3.4.2.7. – Anchovy length distribution according to the 2 main anchovy areas : Gironde (left) and southern coastal (right).

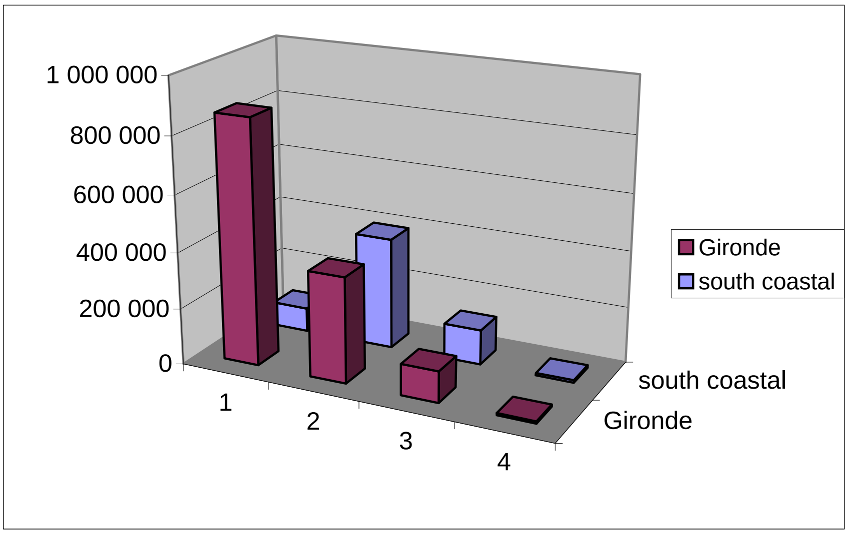


Figure 3.4.2.8. – age distribution of anchovy in numbers as estimated from PELGAS08 survey according to separate distribution : Gironde – southern coastal.

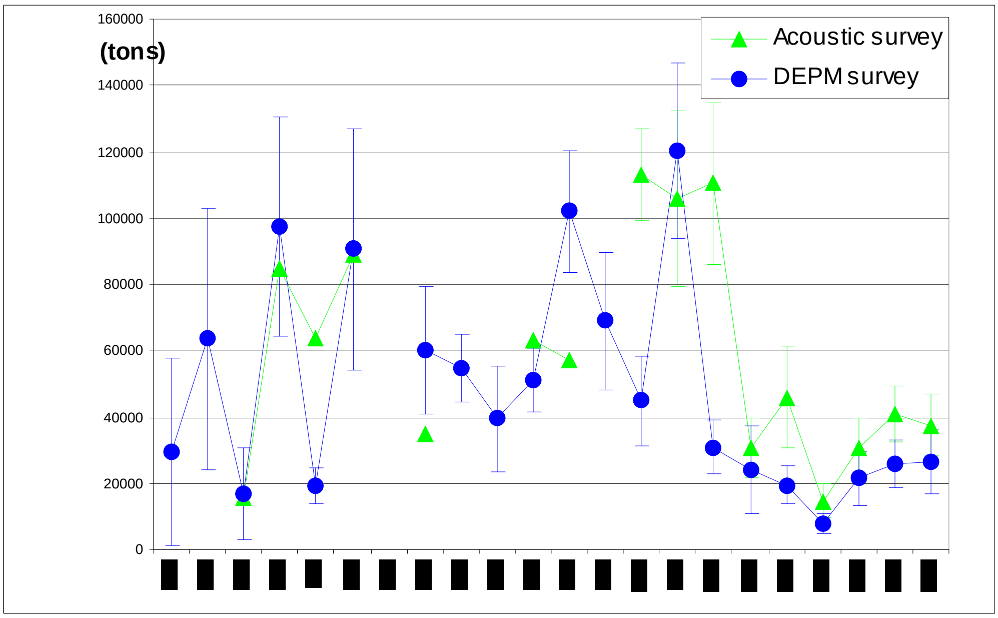
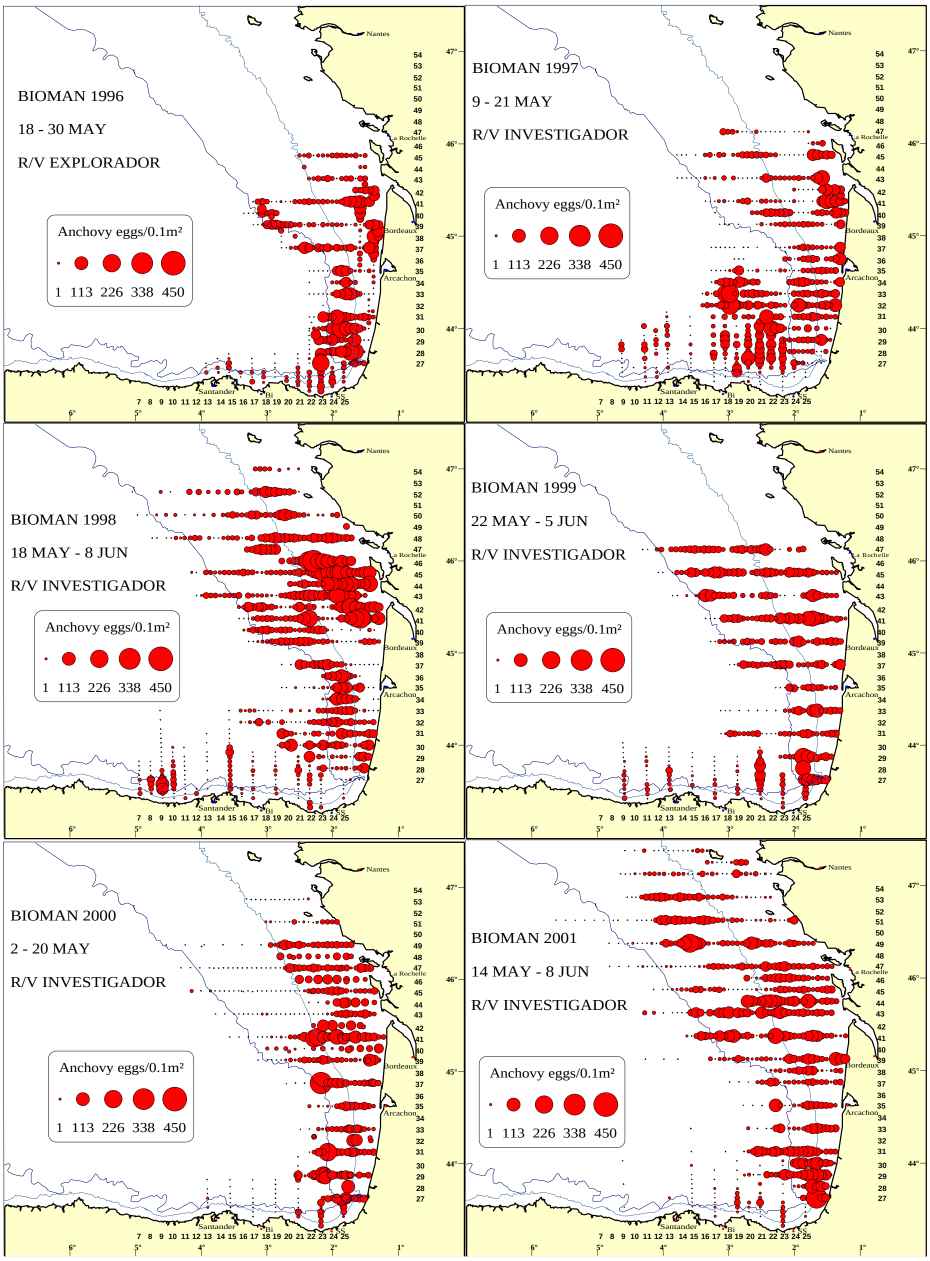


Figure 3.4.3.1: Bay of Biscay anchovy: Biomass estimates from DEPM (BIOMAN) and acoustics (PELGAS) surveys since 1987


BIOMAN 1996
18 - 30 MAY
R/V EXPLORADOR
Anchovy eggs/0.1m²
1 113 226 338 450
BIOMAN 1997
9 - 21 MAY
R/V INVESTIGADOR
Anchovy eggs/0.1m²
1 113 226 338 450
BIOMAN 1998
18 MAY - 8 JUN
R/V INVESTIGADOR
Anchovy eggs/0.1m²
1 113 226 338 450
BIOMAN 1999
22 MAY - 5 JUN
R/V INVESTIGADOR
Anchovy eggs/0.1m²
1 113 226 338 450
BIOMAN 2000
2 - 20 MAY
R/V INVESTIGADOR
Anchovy eggs/0.1m²
1 113 226 338 450
BIOMAN 2001
14 MAY - 8 JUN
R/V INVESTIGADOR
Anchovy eggs/0.1m²
1 113 226 338 450
Nantes
La Rochelle
Bordeaux
Arcachon
Santander
Bi
47°
46°
45°
44°
6°
5°
4°
3°
2°
1°

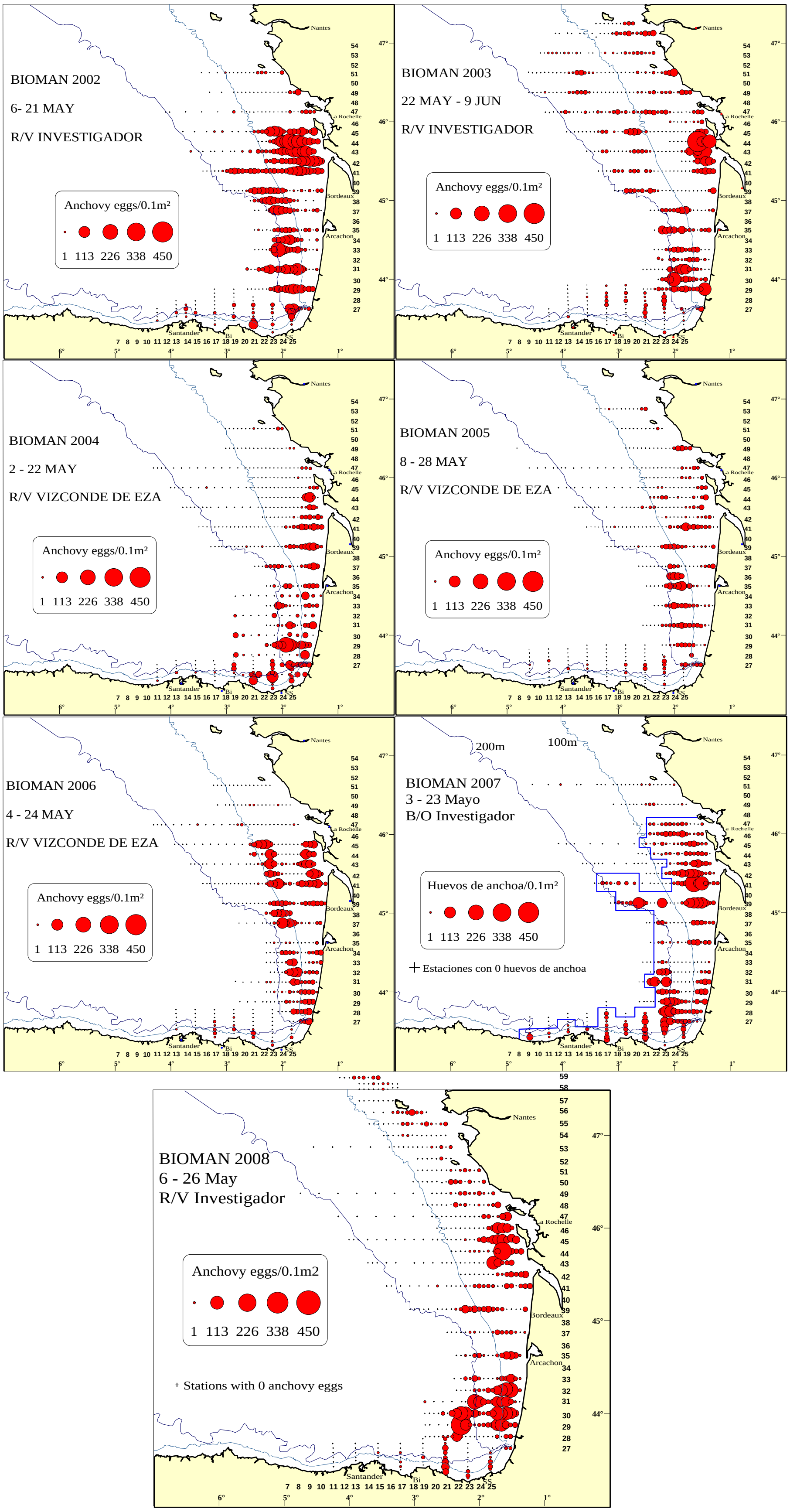


Figure 3.4.3.2: Bay of Biscay anchovy: Anchovy eggs distribution from DEPM BIOMAN08 surveys from 1996 to 2008

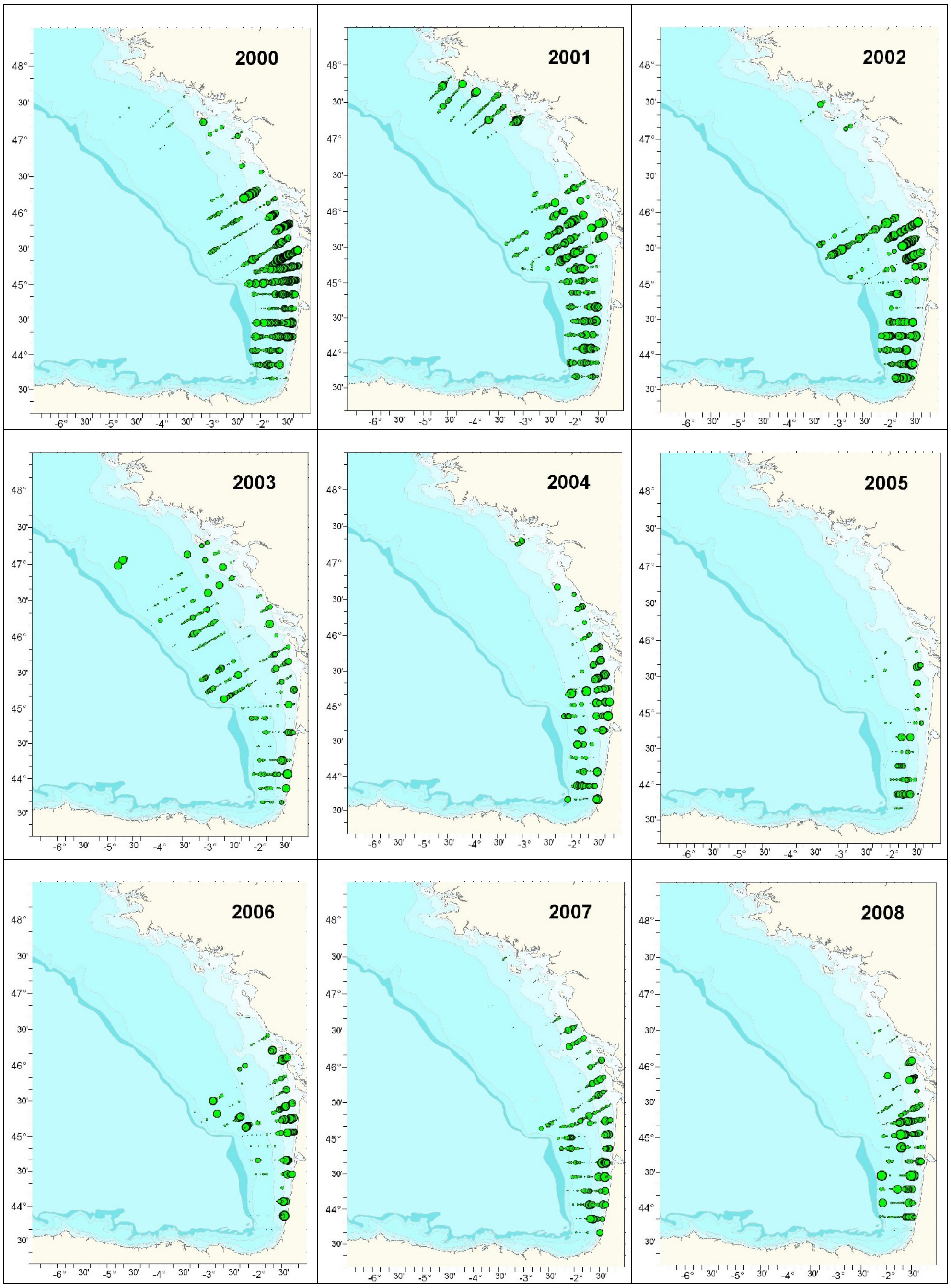


Figure 3.4.3.3: Bay of Biscay anchovy: Anchovy adults distribution from acoustic PELGAS surveys since 2000 to 2008.

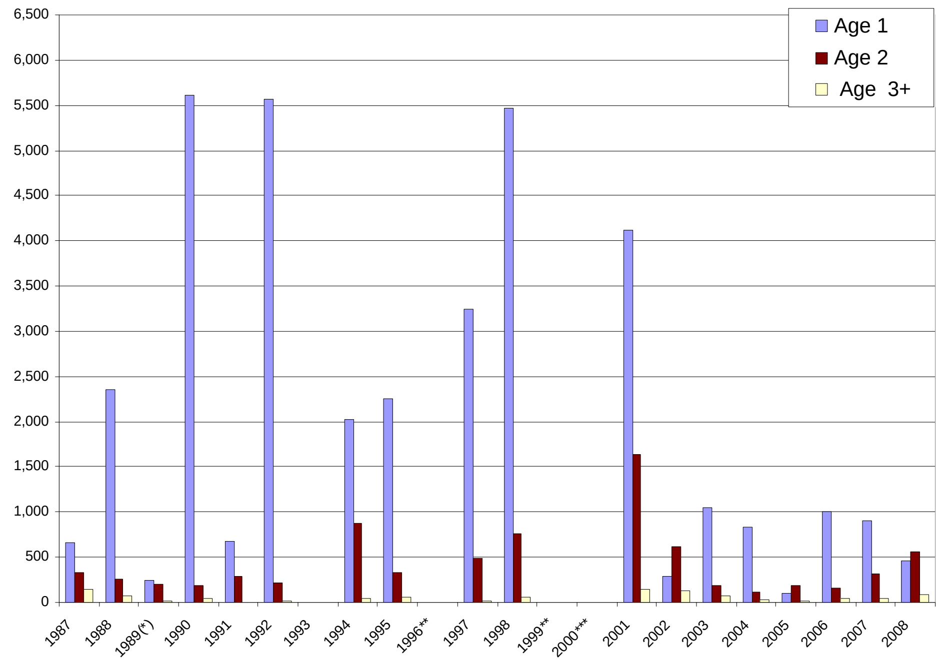


Figure 3.4.3.4: Bay of Biscay anchovy: Age distribution (in numbers) estimated from DEPM BIOMAN surveys from 1987 to 2008.

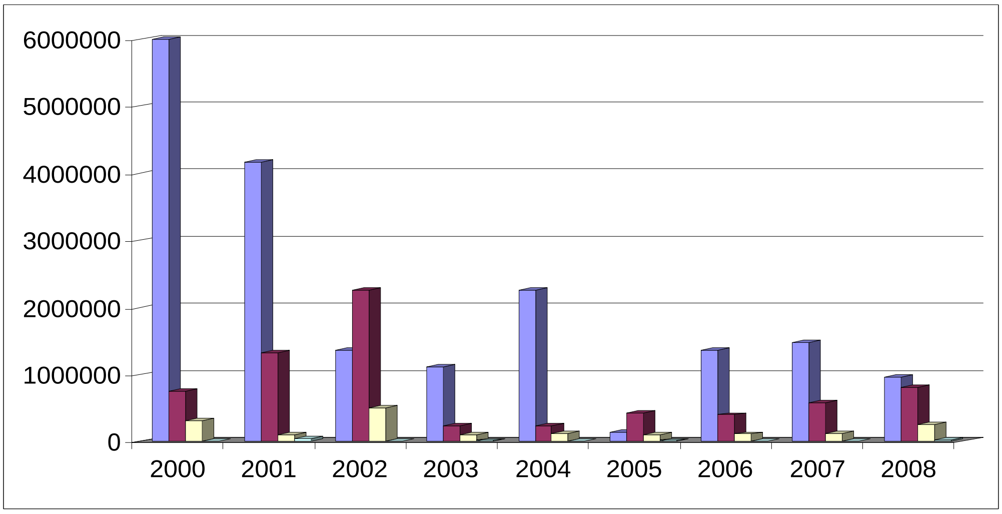


Figure 3.4.3.5: Bay of Biscay anchovy: Age distribution (in numbers) as estimated from acoustic PELGAS surveys since 2000 to 2008.

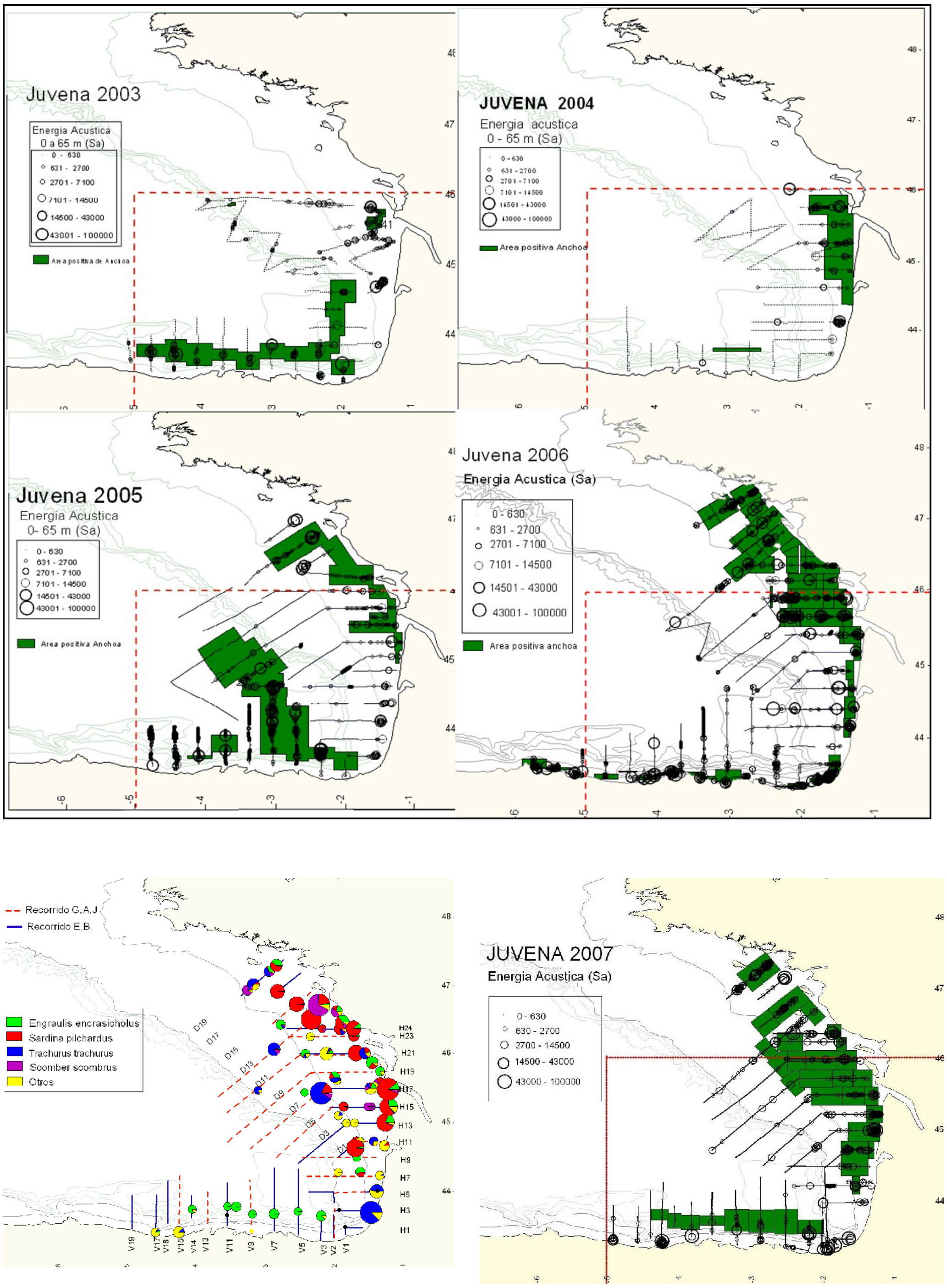


Figure 3.4.4.1: JUVENA surveys up to 2007: Positive area of presence of anchovy and total acoustic energy echo-integrated (from all the species). The area delimited by the dashed line is the minimum or standard area used for inter annual comparison. For 2007 also the fishing hauls and the species composition are sown at the bottom.

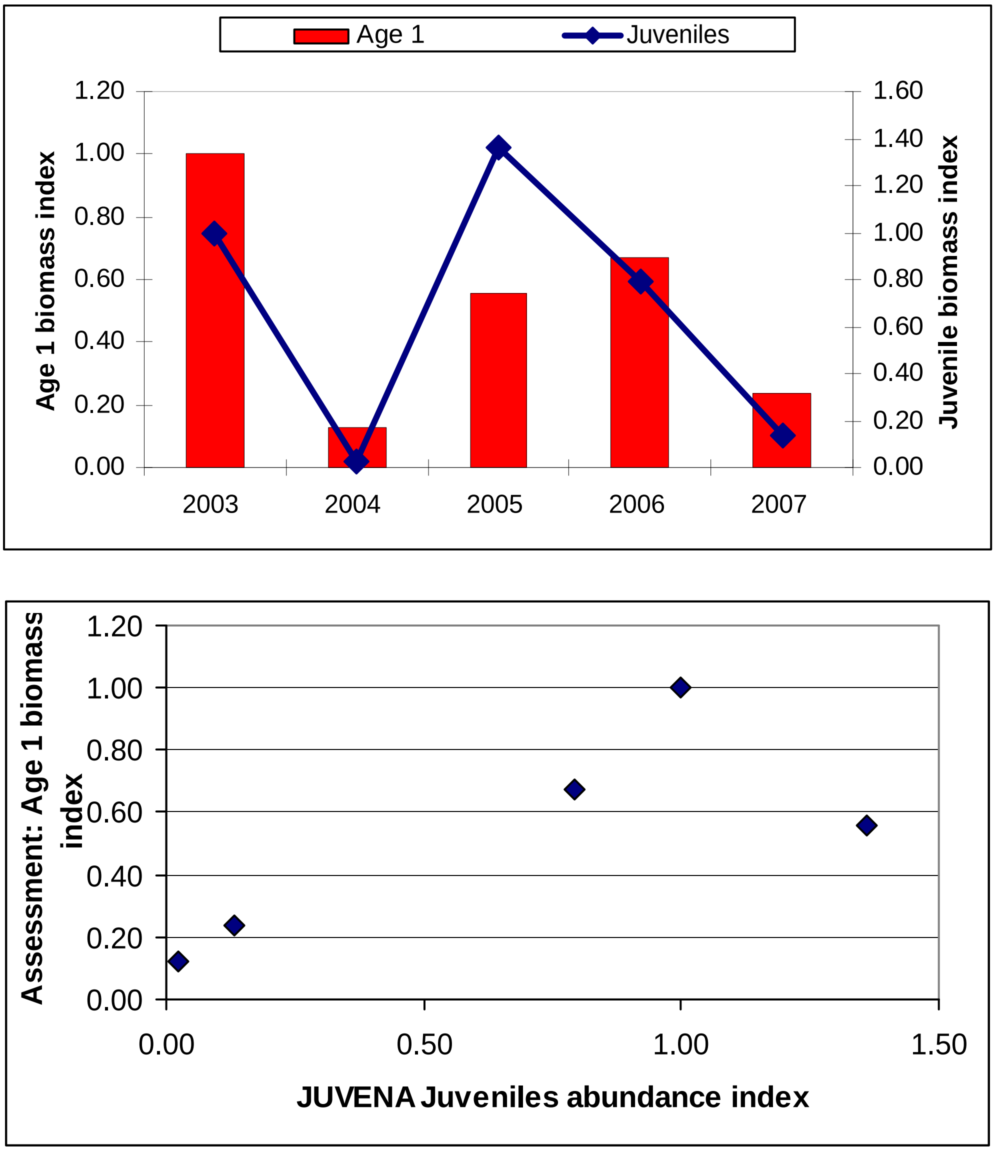


Figure 3.4.4.2 Upper panel: comparison of the times series of the JUVENA anchovy juveniles abundance index with the assessment at age 1 in the following year (median values) produced by Bayesian assessment included in this report. Bottom panel: scatter plot of the series. The comparisons are made in relative terms, scaling the series to the estimates in 2003. R=0.76, R2=0.58 P(R=0)=0.134.

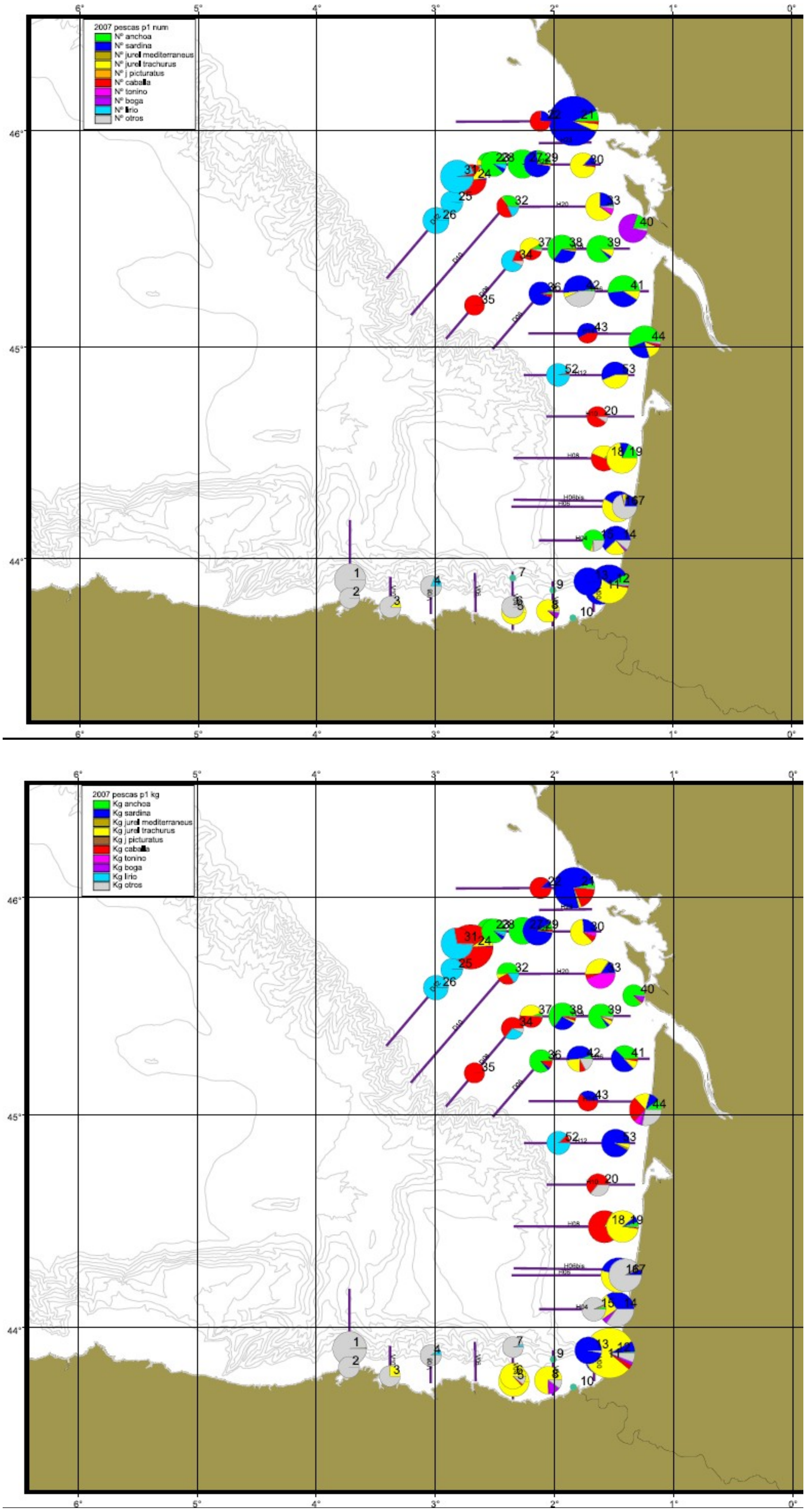


Figure 3.4.4.3: Spatial distribution of fishing hauls during the first leg f the PELACUS - 1007 cruise. Size of the charts is proportional to (a) abundance (b) weight.

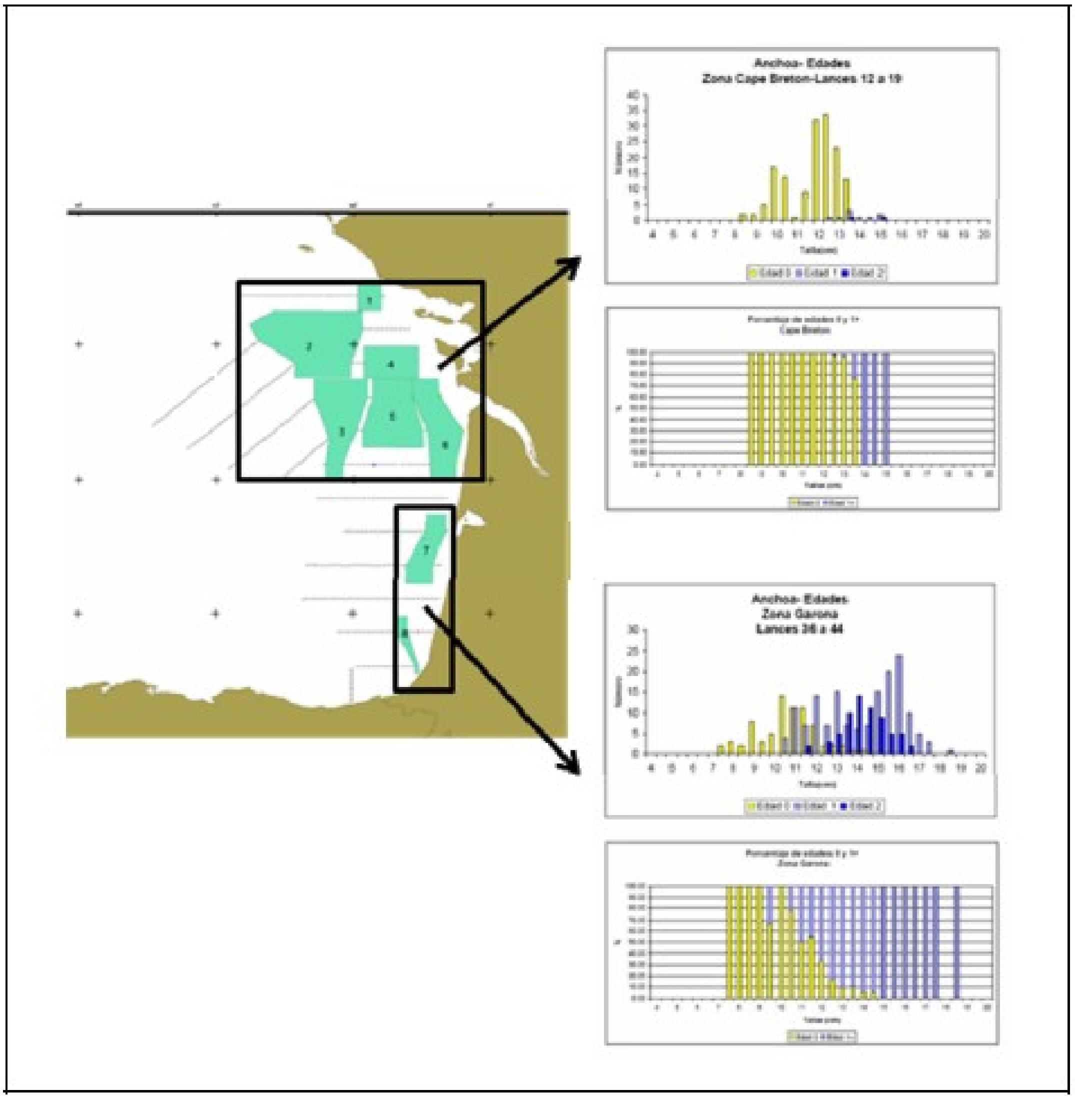


Figure 3.4.4.4: Anchovy. Distribution of homogenate areas (polygons) for the estimation of biomass (left) and size - age keys applied in each area (Cape Breton – Les Landes and Garonne) (right).

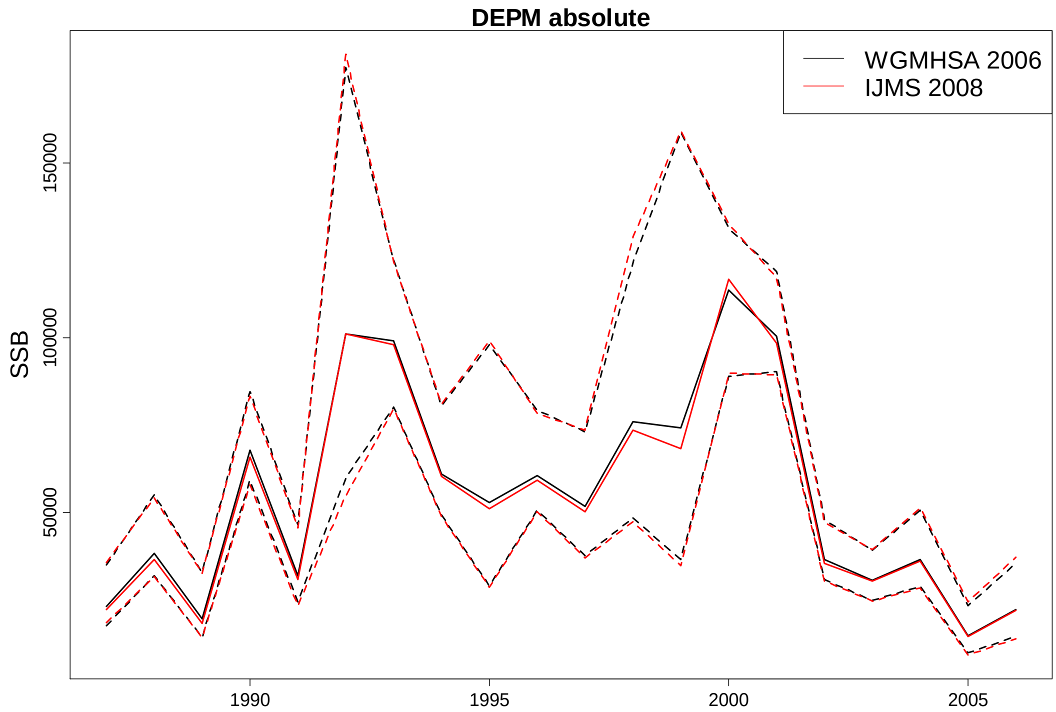


Figure 3.5.1.1: Bay of Biscay anchovy: Comparison of spawning stock biomass posterior median (solid lines) and corresponding 95 % credible intervals (dashed lines) from WGMHSA (ICES 2006) (black) and from Ibaibarriaga *et. al* (red).

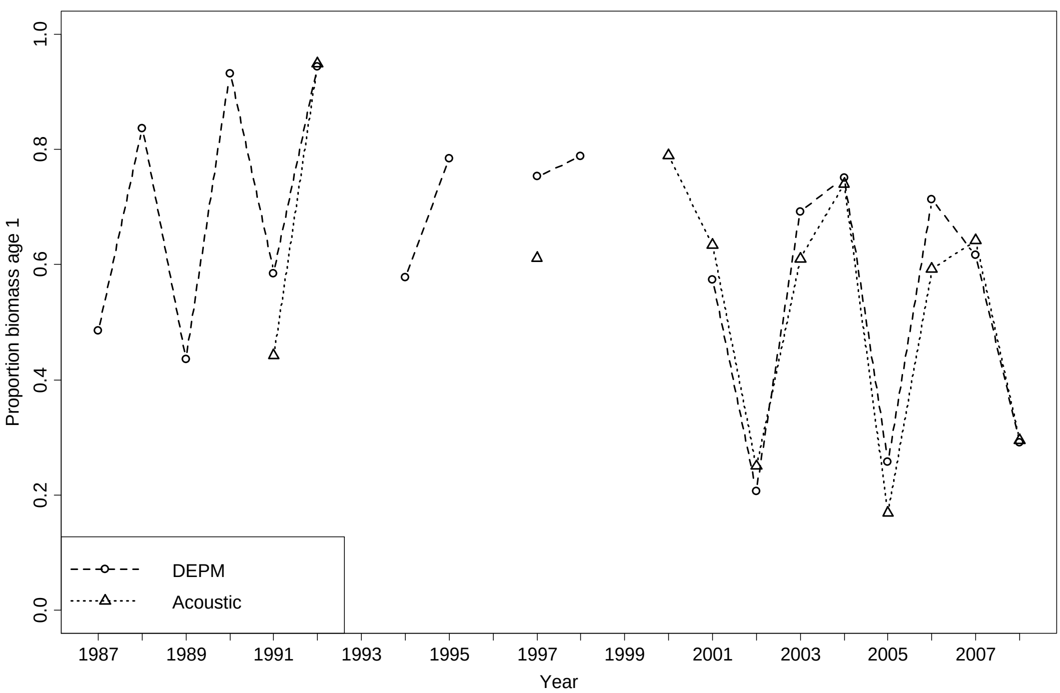


Figure 3.5.2.1: Bay of Biscay anchovy: Historical series of age 1 biomass proportion estimates from DEPM (dashed line and circles) and acoustics (dotted line and triangles).

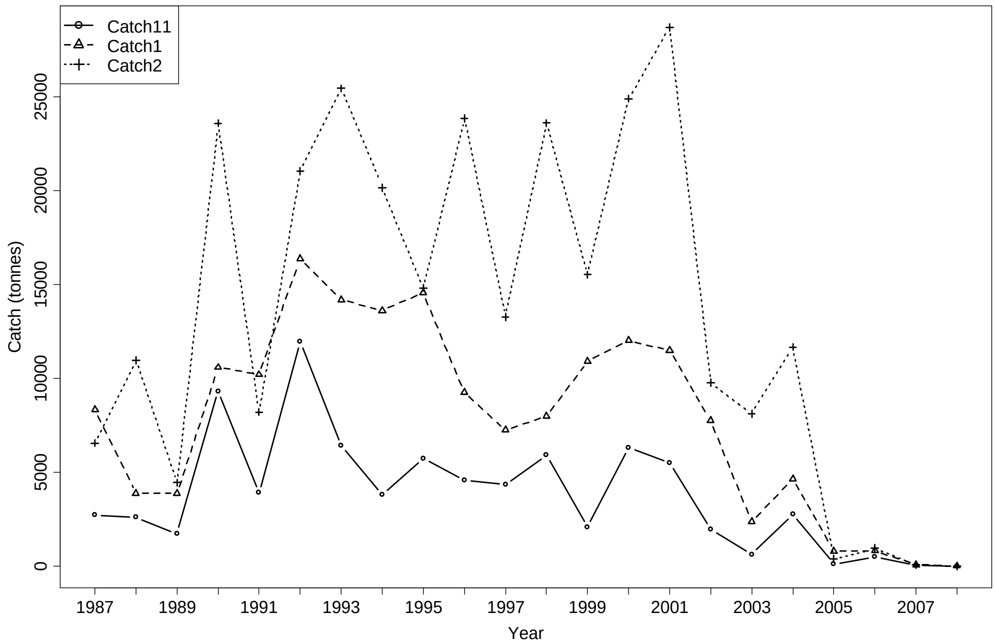


Figure 3.5.2.2: Bay of Biscay anchovy: Historical series of age 1 and total catch in the first period (1st January-15th May) (solid line and open circle and dashed line and triangle respectively) and of total catch in the second period (15th May-31st December) (dotted line and cross).

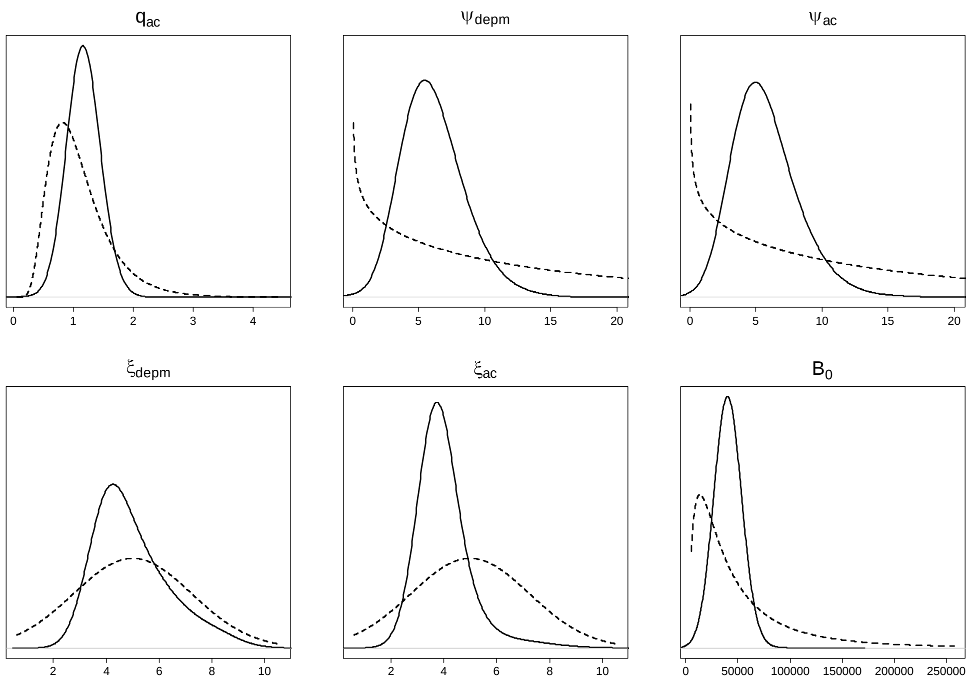


Figure 3.5.3.1: Bay of Biscay anchovy: Comparison between the prior (dotted line) and posterior distribution (solid line) for some of the parameters of BBM.

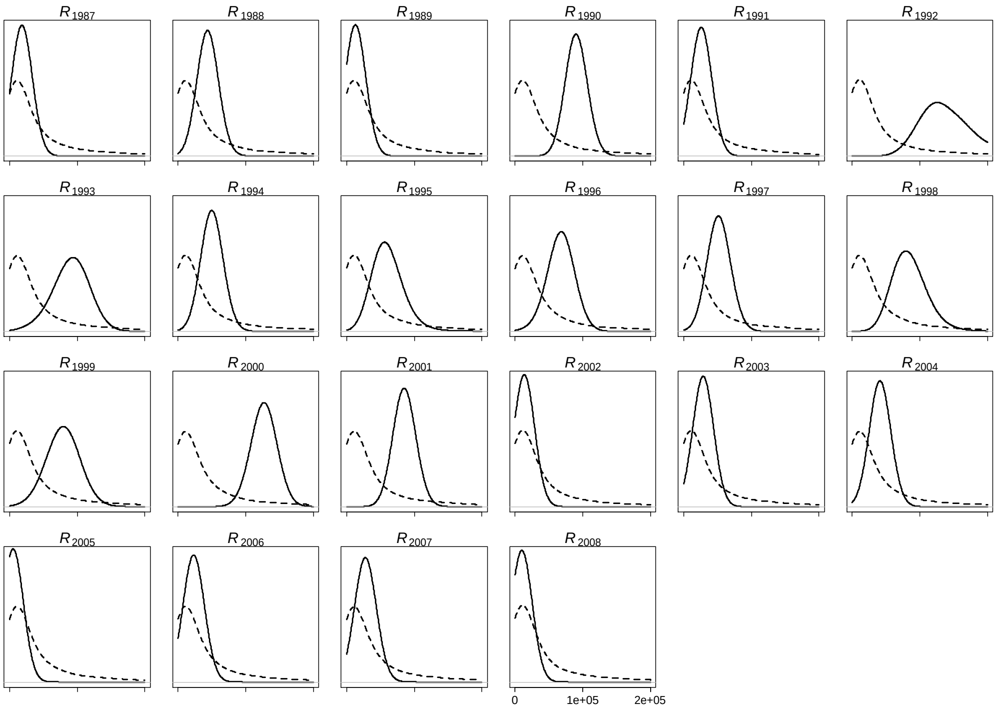


Figure 3.5.3.2: Bay of Biscay anchovy: Comparison between the prior (dotted line) and posterior distribution (solid line) for recruitment in BBM.

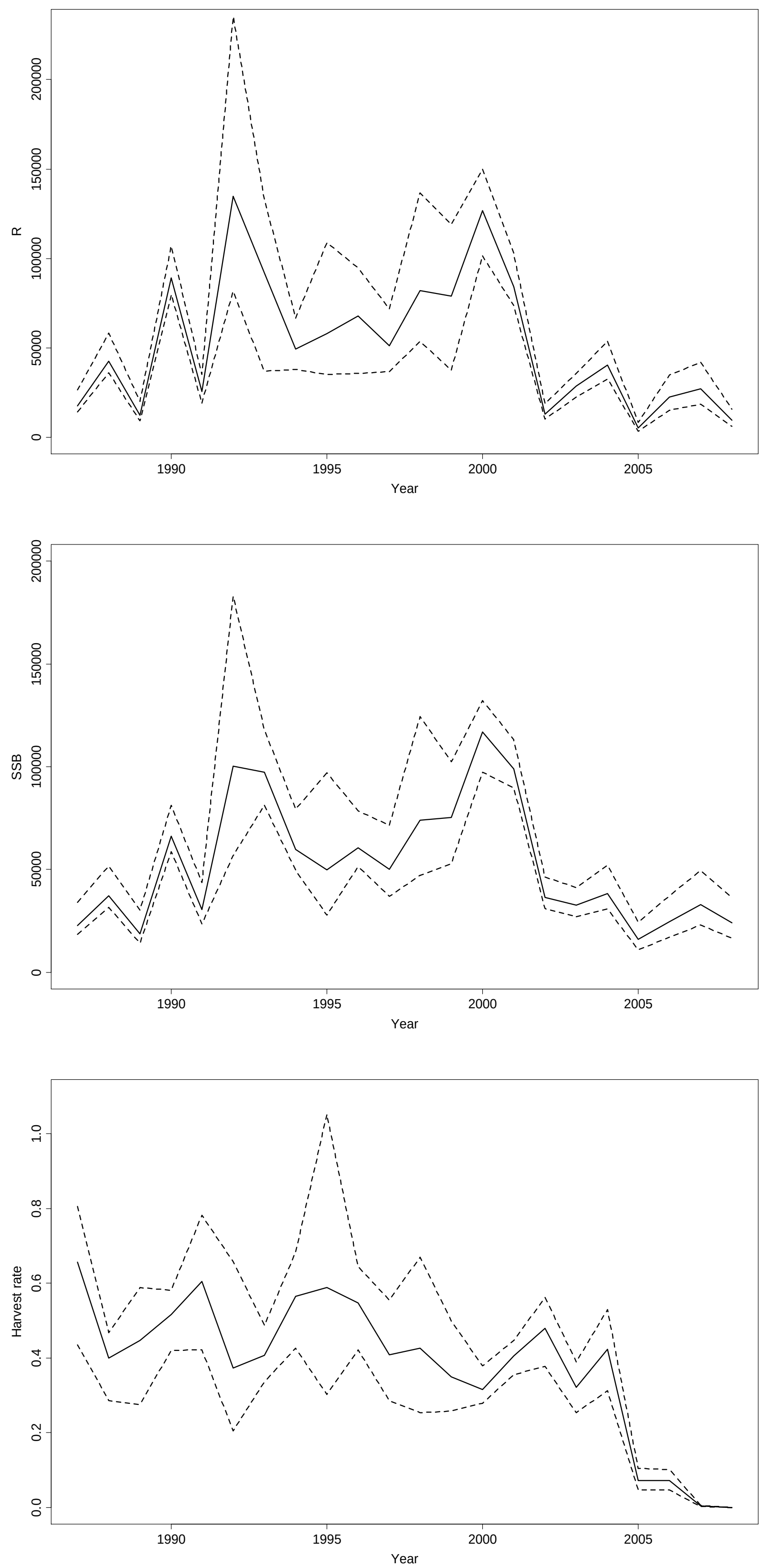


Figure 3.5.3.3: Bay of Biscay anchovy: Posterior median (solid line) and 95% credible intervals (dashed lines) for the recruitment (age 1 in mass), the spawning stock biomass and the harvest rates (Catch/SSB) from the BBM.

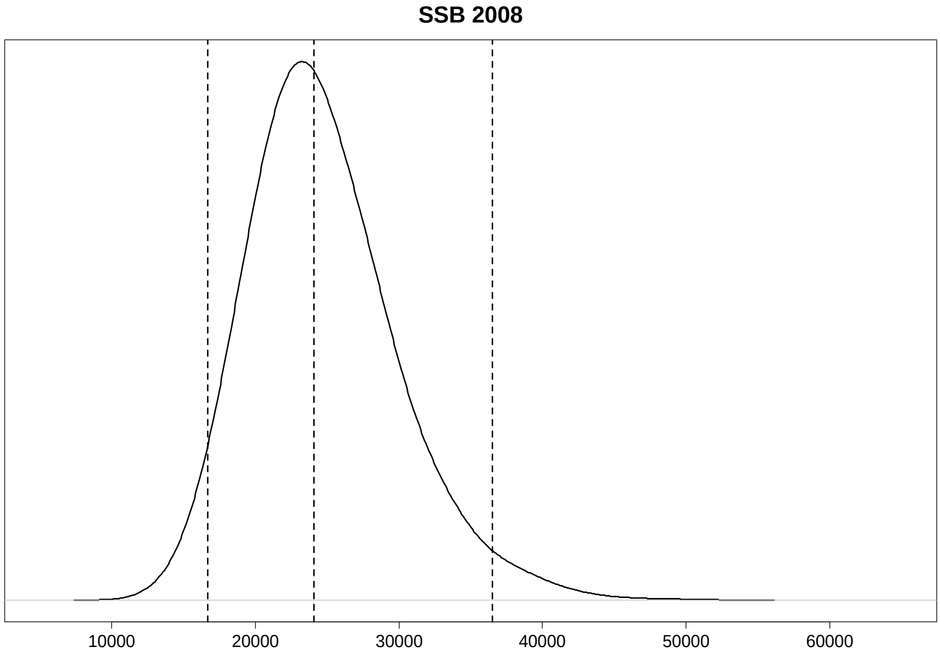


Figure 3.5.3.5: Bay of Biscay anchovy: Posterior distribution of spawning biomass in 2008 from BBM. Vertical dashed lines correspond to posterior median and 95% credibility intervals.

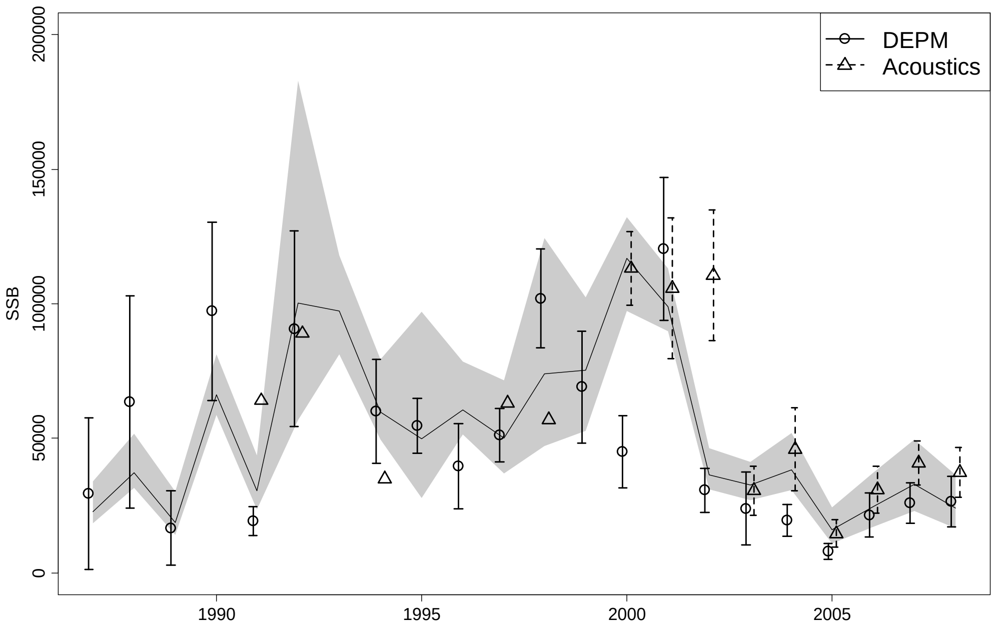


Figure 3.5.4.1: Bay of Biscay anchovy: Comparison of the SSB posterior 95% credible intervals from the BBM (grey area) and the SSB point estimates with their corresponding confidence intervals from DEPM (open circle and solid line) and Acoustics (triangle and dashed line).

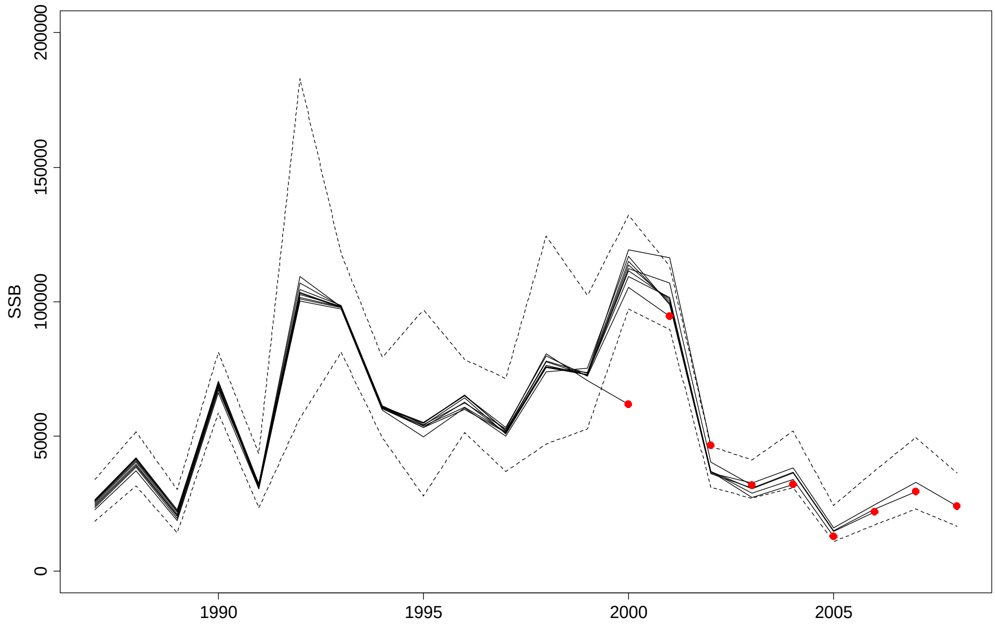


Figure 3.5.4.2: Bay of Biscay anchovy: Retrospective analysis for the BBM. Solid lines represent the SSB medians for each annual assessment. The red solid circles are the SSB median from the last year of each annual assessment. The dashed lines represent the 95% credible intervals for the assessment in 2008.

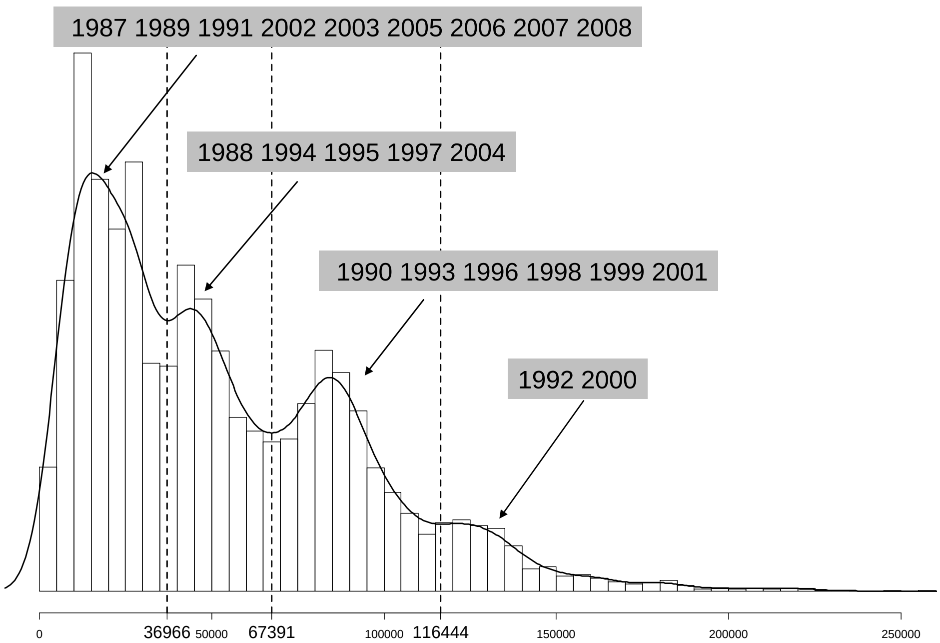


Figure 3.6.2.1: Bay of Biscay anchovy: Mixture distribution of recruitment when all the recruitment posterior distributions of the historical series are equally weighted. The vertical lines repersent the local minima that define each of the recruitment peaks. The arrows indicate the years whose posterior recruitment medians fall into each of the peaks.

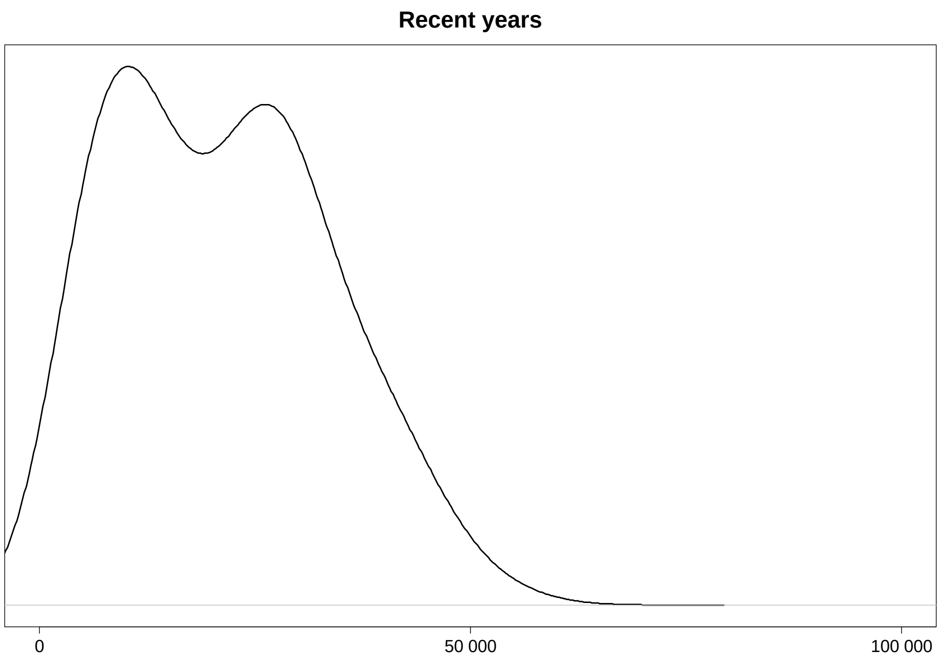


Figure 3.6.2.2: Bay of Biscay anchovy: Recruitment scenario for 2009 constructed as a mixture distribution of the recruitment posterior distribution of recent years (2002-2008).

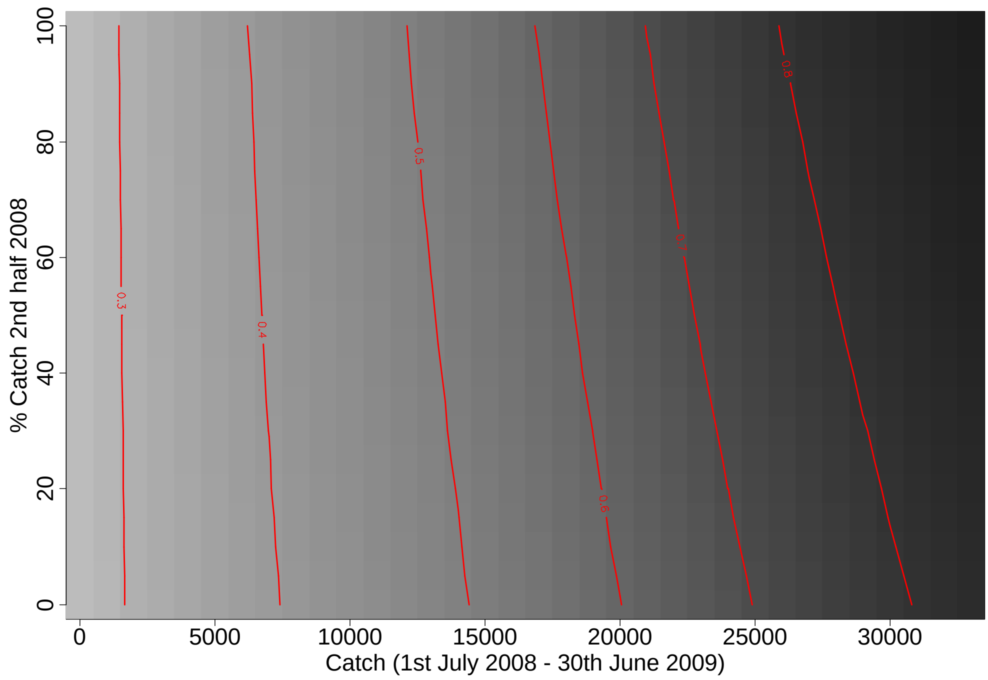
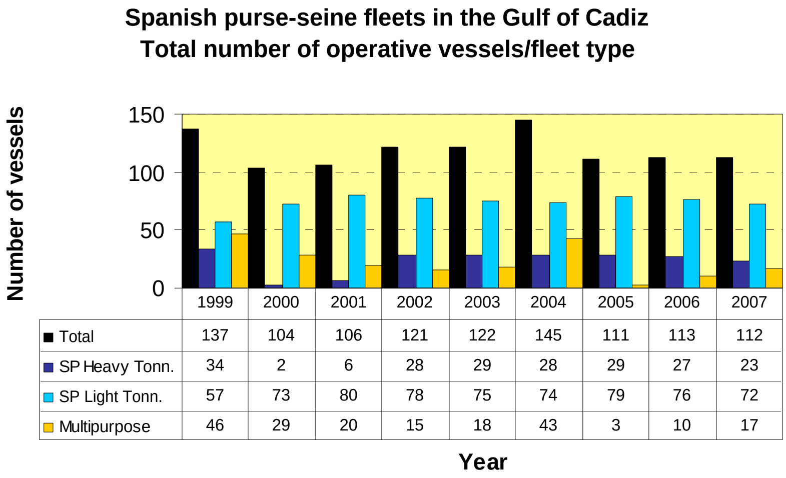
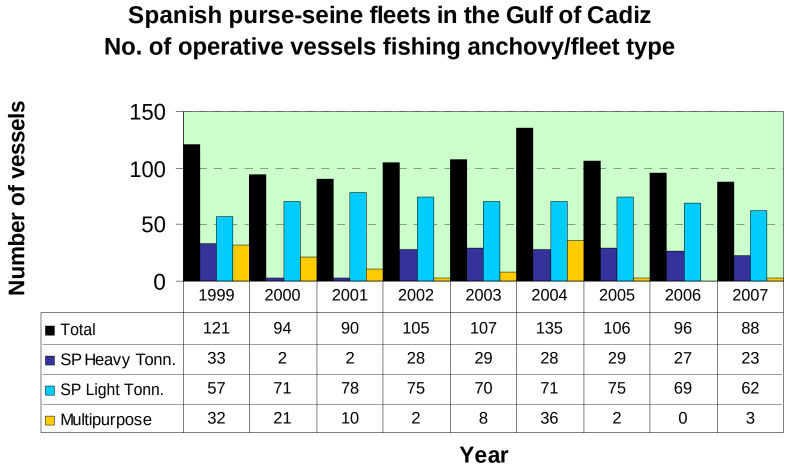


Figure 3.6.2.3: Bay of Biscay anchovy: Contour plots of probability of SSB in 2009 of falling below Blim depending on the total catch from 1st July 2008 to 30th June 2009 (x-axis) and the percentage of catch corresponding to the second half of 2008 (y-axis).



	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total	137	104	106	121	122	145	111	113	112
SP Heavy Tonn.	34	2	6	28	29	28	29	27	23
SP Light Tonn.	57	73	80	78	75	74	79	76	72
Multipurpose	46	29	20	15	18	43	3	10	17



	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total	121	94	90	105	107	135	106	96	88
SP Heavy Tonn.	33	2	2	28	29	28	29	27	23
SP Light Tonn.	57	71	78	75	70	71	75	69	62
Multipurpose	32	21	10	2	8	36	2	0	3

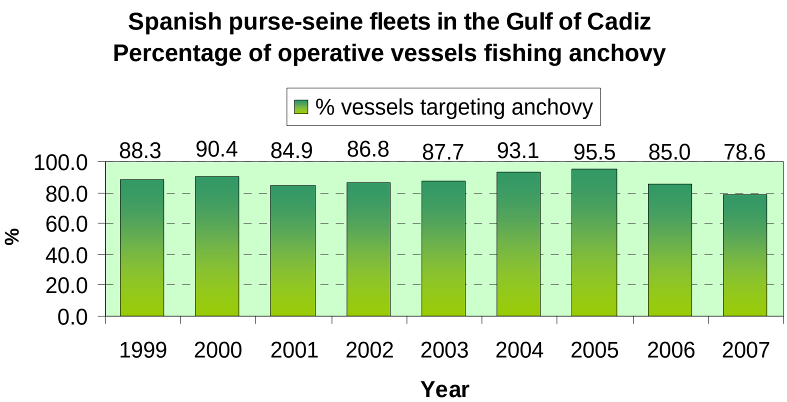


Figure 4.2.1.1. Anchovy in División IXa. Spanish purse-seine fleet composition in the Gulf of Cadiz (differentiated into total fleet and vessels targeting Gulf of Cadiz anchovy) since 1999. The categories include both single purpose purse-seiners and trawl and artisanal vessels fishing with purse-seine in some periods through the year (multi-purpose vessels). Length criteria refers to length between perpendiculars. Storage: catches are dry hold with ice (fishing trip equals to fishing day). No discard estimates.

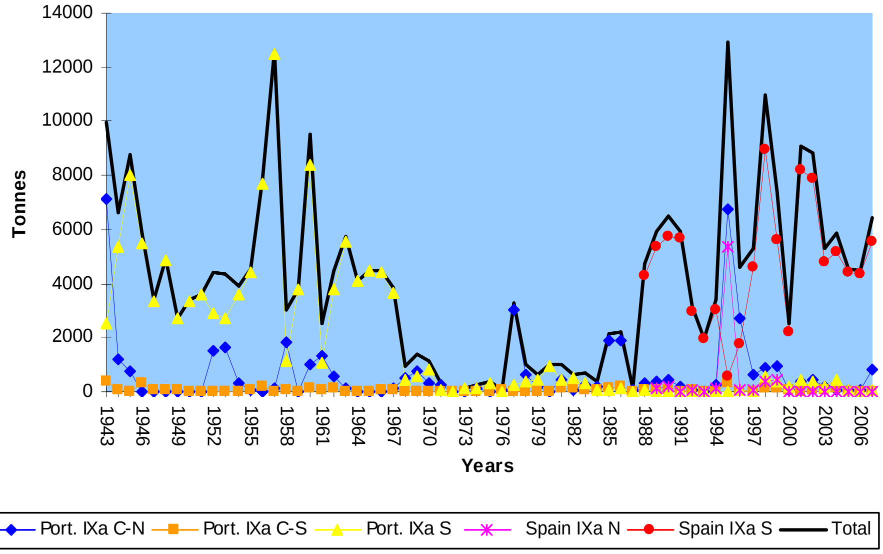
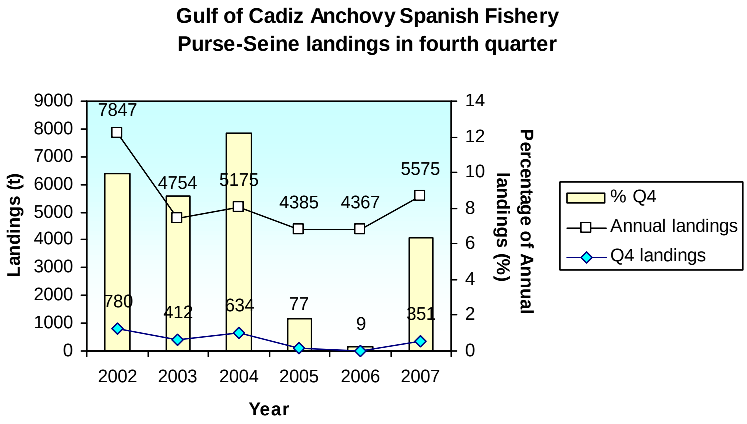


Figure 4.2.2.1.1. Anchovy in Division IXa. Historical series of Portuguese and Spanish anchovy landings in Division IXa (1943-2007).



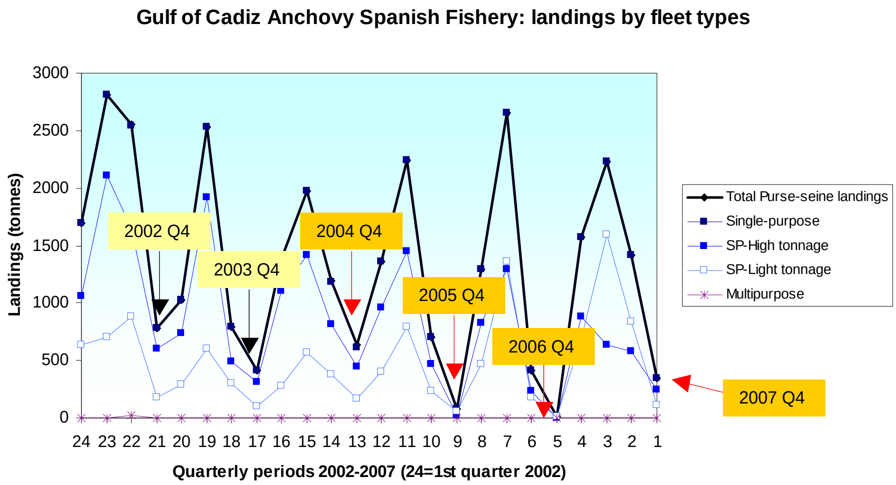


Figure 4.2.2.3. Anchovy in Division IXa. Gulf of Cadiz Anchovy (Subdivision IXa-South). Upper panel: comparison of annual purse-seine landings with catches landed in the fourth quarter to assess the effects of the closed season in the fourth quarter in 2004-2007. Bar chart represents the relative importance of landings in the fourth quarter in relation to the annual landings. Lower panel: trends in quarterly series of landings by fleet type. Single-purpose fleet is also differentiated in heavy and light GRT vessels. Fishery closures since 2004 on.

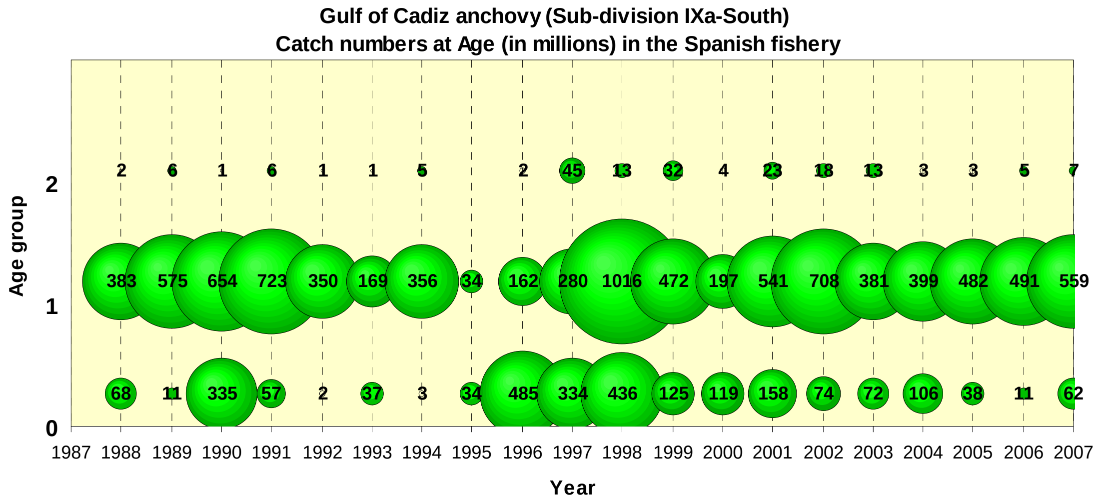


Figure 4.2.2.4. Anchovy in Division IXa. Age composition in Spanish landings of Gulf of Cadiz anchovy (Sub-division IXa-South; 1988-2007). Data for 1994 and second half in 1995 estimated from an iterated ALK by applying the Kimura and Chikuni's (1987) algorithm.

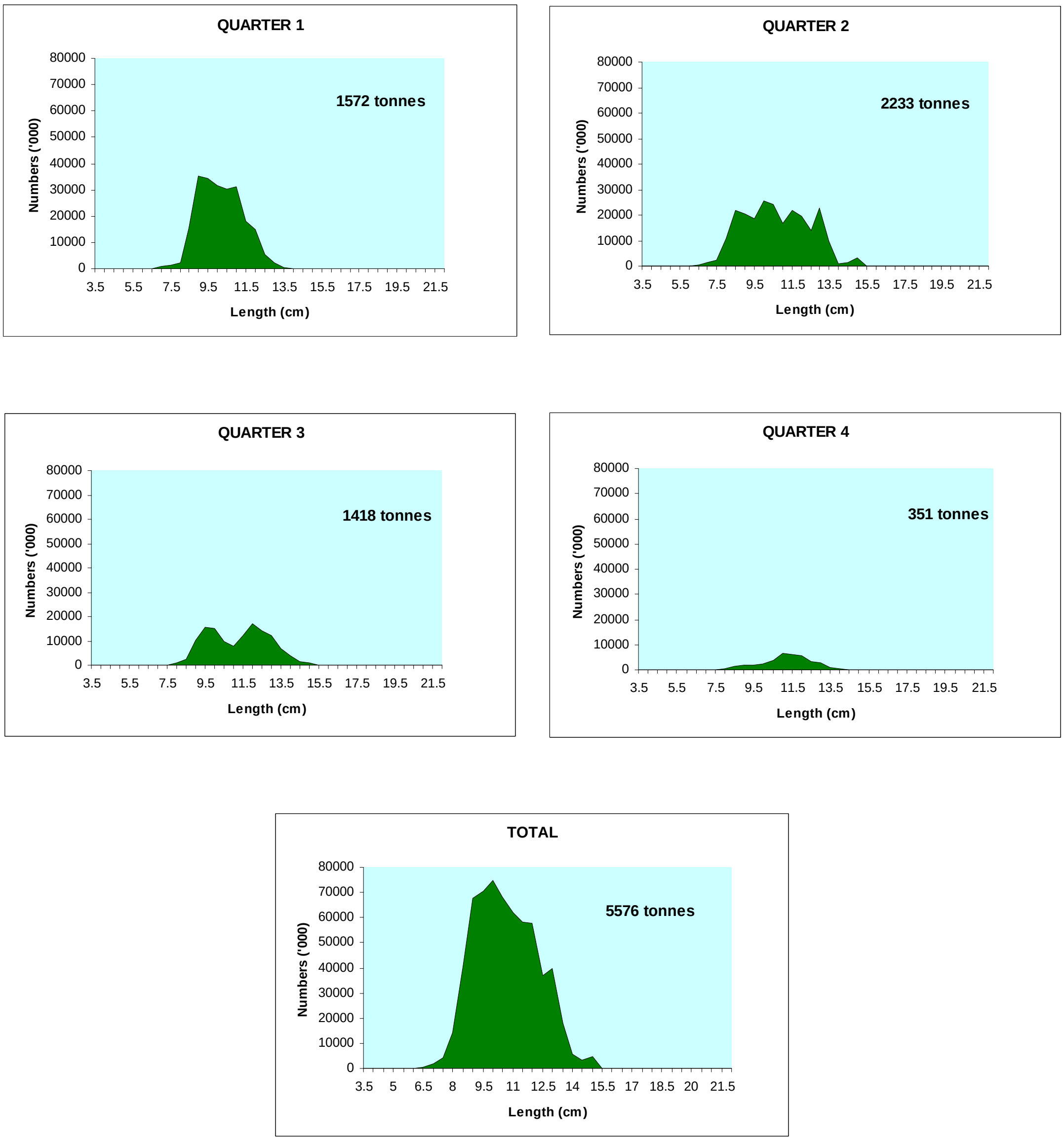
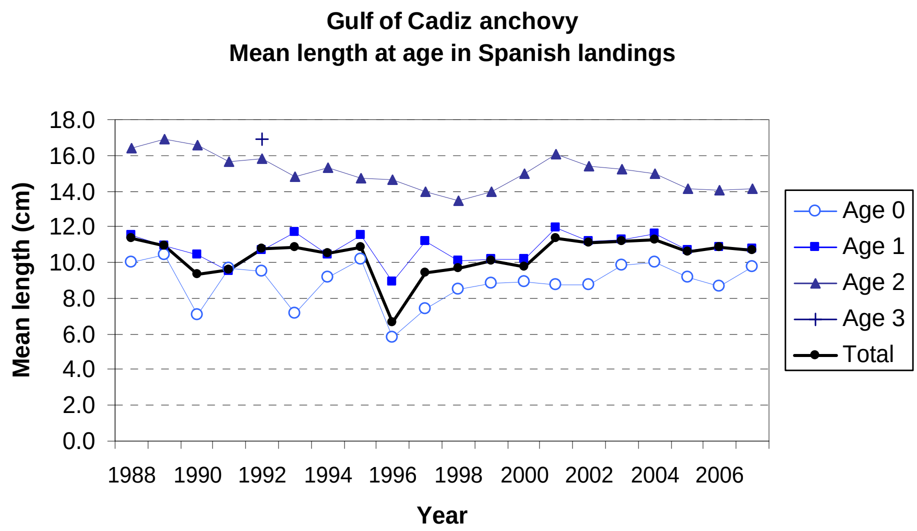


Figure 4.2.2.5. Anchovy in Division IXa. Length distribution ('000) of the Spanish quarterly and annual landings of anchovy in Sub-division IXa South (Gulf of Cadiz) in 2007. Without data for Sub-division IXa North (Western Galicia).



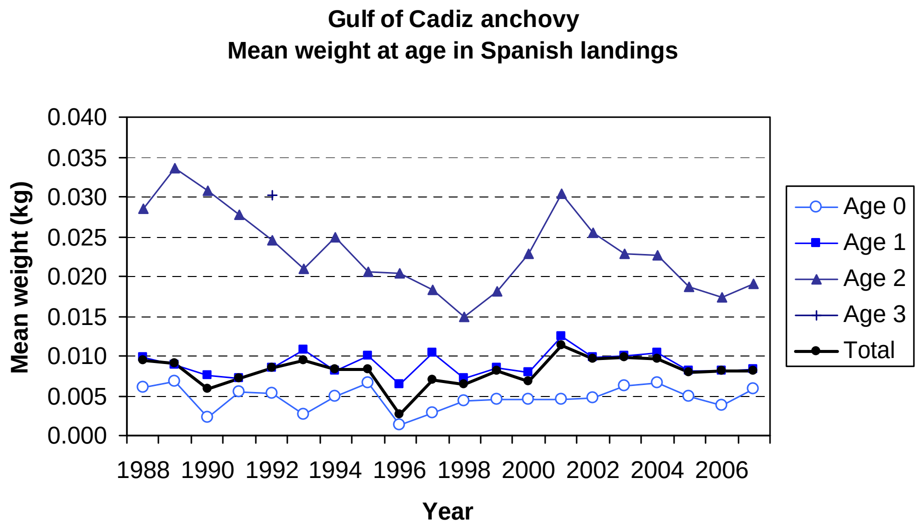


Figure 4.2.2.6. Anchovy in Division IXa. Annual mean length (TL, in cm) and weight (kg) at age in the Spanish landings of Gulf of Cadiz anchovy (Sub-division IXa-South, 1988-2007). Data for 1994 and second half in 1995 estimated from an iterated ALK by applying the Kimura and Chikuni's (1987) algorithm.

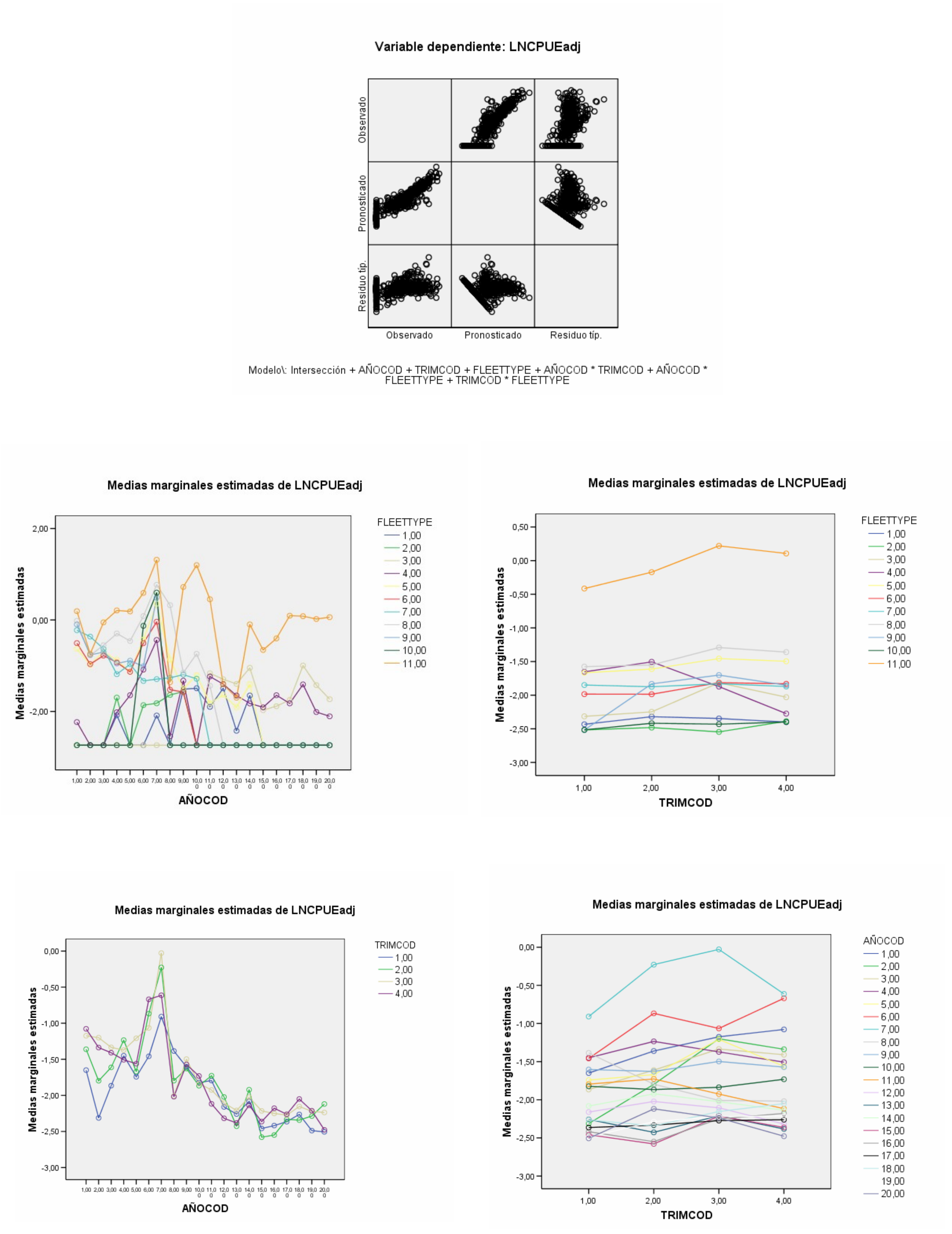


Figure 4.2.4.1. Anchovy in Division IXa. Residuals and Profile plots for the GLM used for the standardisation of the Spanish fleets' CPUE data in Sub-division IXa-South (Gulf of Cadiz).

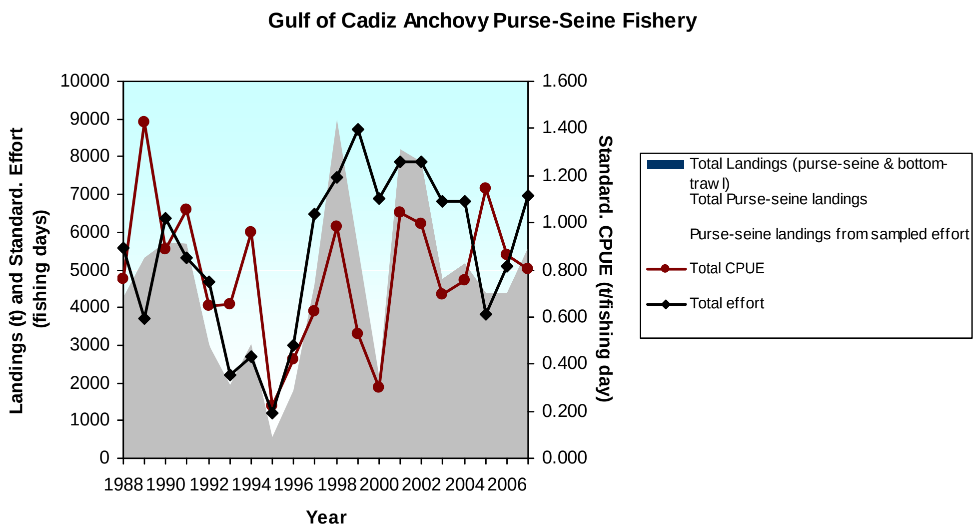


Figure 4.2.4.2. Anchovy in Division IXa. Gulf of Cadiz anchovy purse-seine Spanish fishery. Trends in annual landings, overall effort and CPUE. Landings are differentiated in total landings (purse-seine and bottom trawl fleets), purse-seine landings, and purse-seine landings corresponding to the sampled fishing effort.

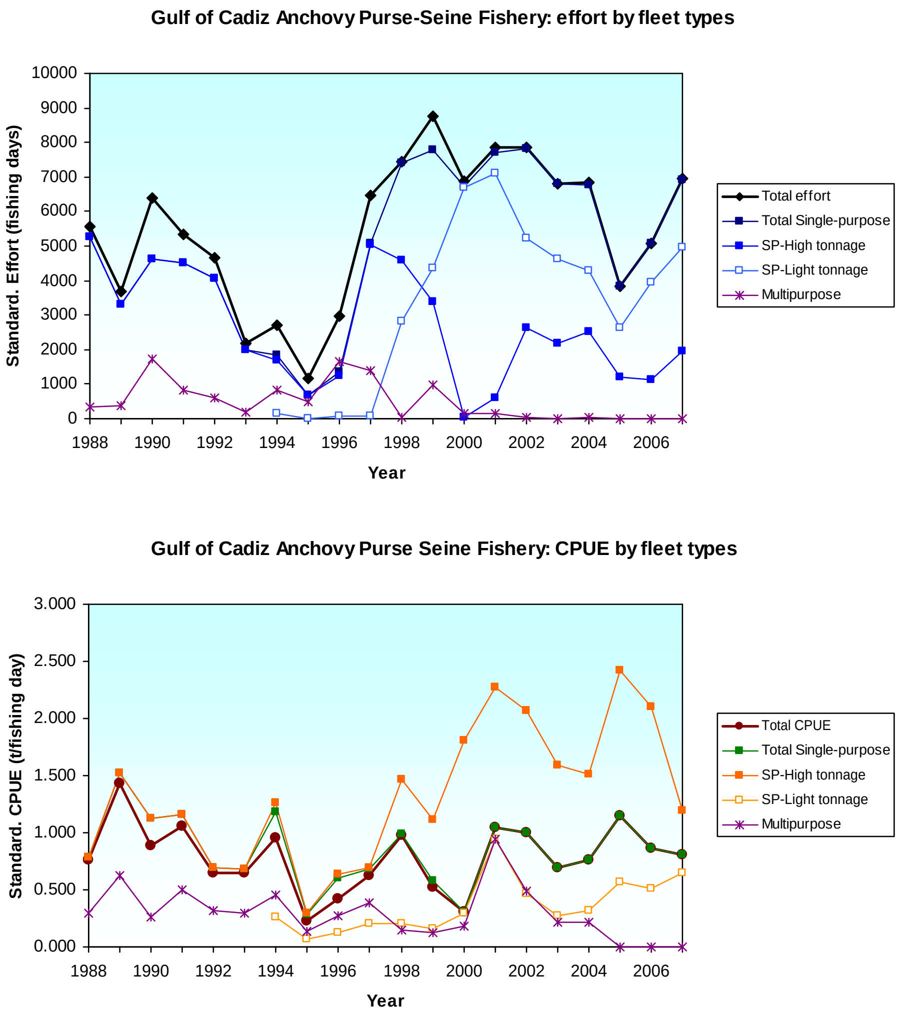


Figure 4.2.4.3. Anchovy in Division IXa. Gulf of Cadiz anchovy purse-seine fishery. Trends in annual series of effort (upper panel) and CPUE (bottom panel) by fleet type. Single-purpose fleet is also differentiated in heavy and light GRT vessels.

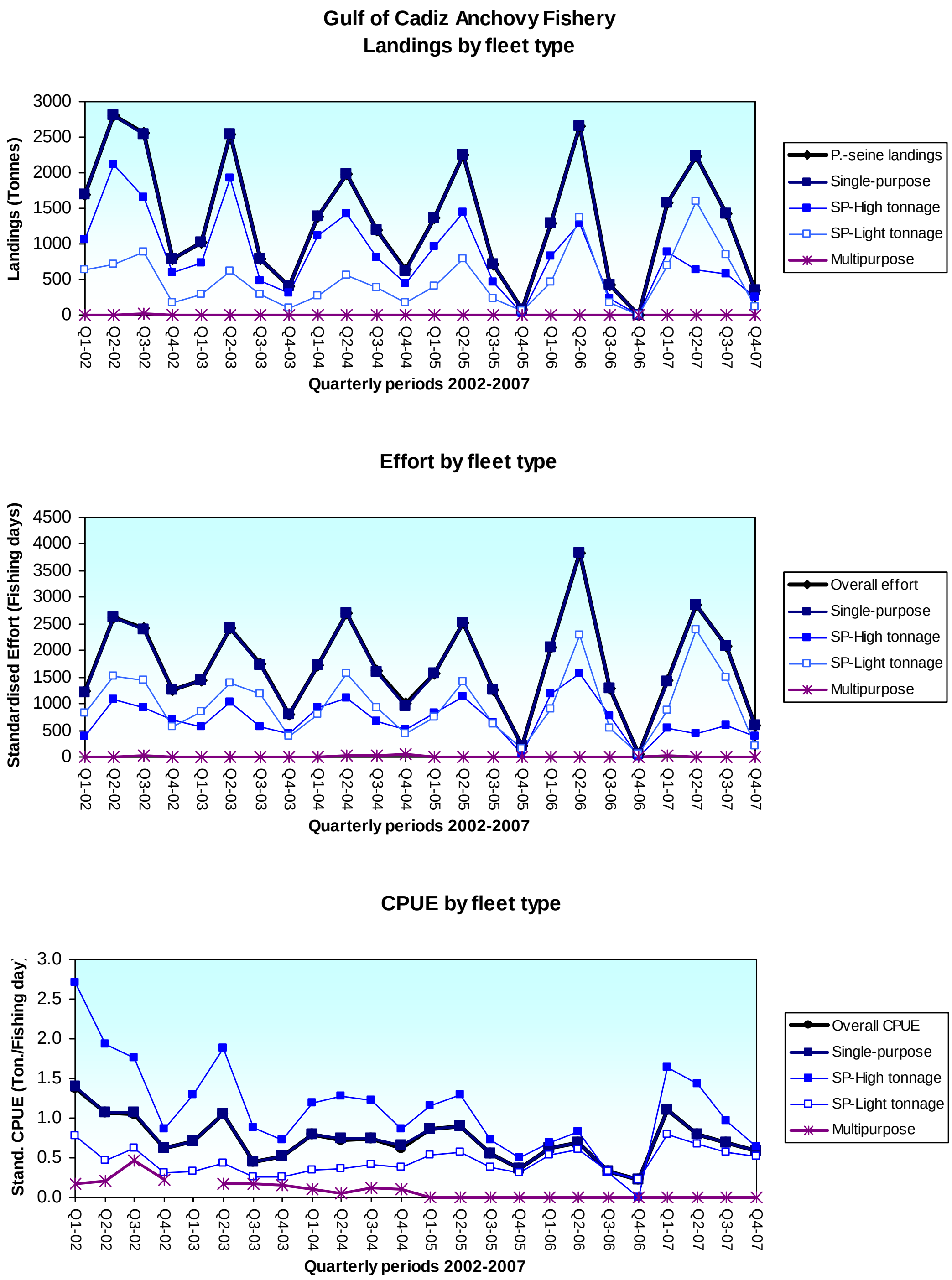


Figure 4.2.4.4. Anchovy in Division IXa. Gulf of Cadiz anchovy purse-seine fishery. Trends in quarterly series of landings (upper panel), effort (middle panel) and CPUE (bottom panel) by fleet type during the 2002-2007 period. A purse-seine fishery closure was implemented during the fourth quarter in 2004, 2005, and 2006 (2004-2005: 15th November-31st December; 2006: 1st November-31st December), and through 2007 fourth quarter and 2008 first quarter (15th November-15th February). Single- purpose fleet is also differentiated in heavy and light GRT vessels.

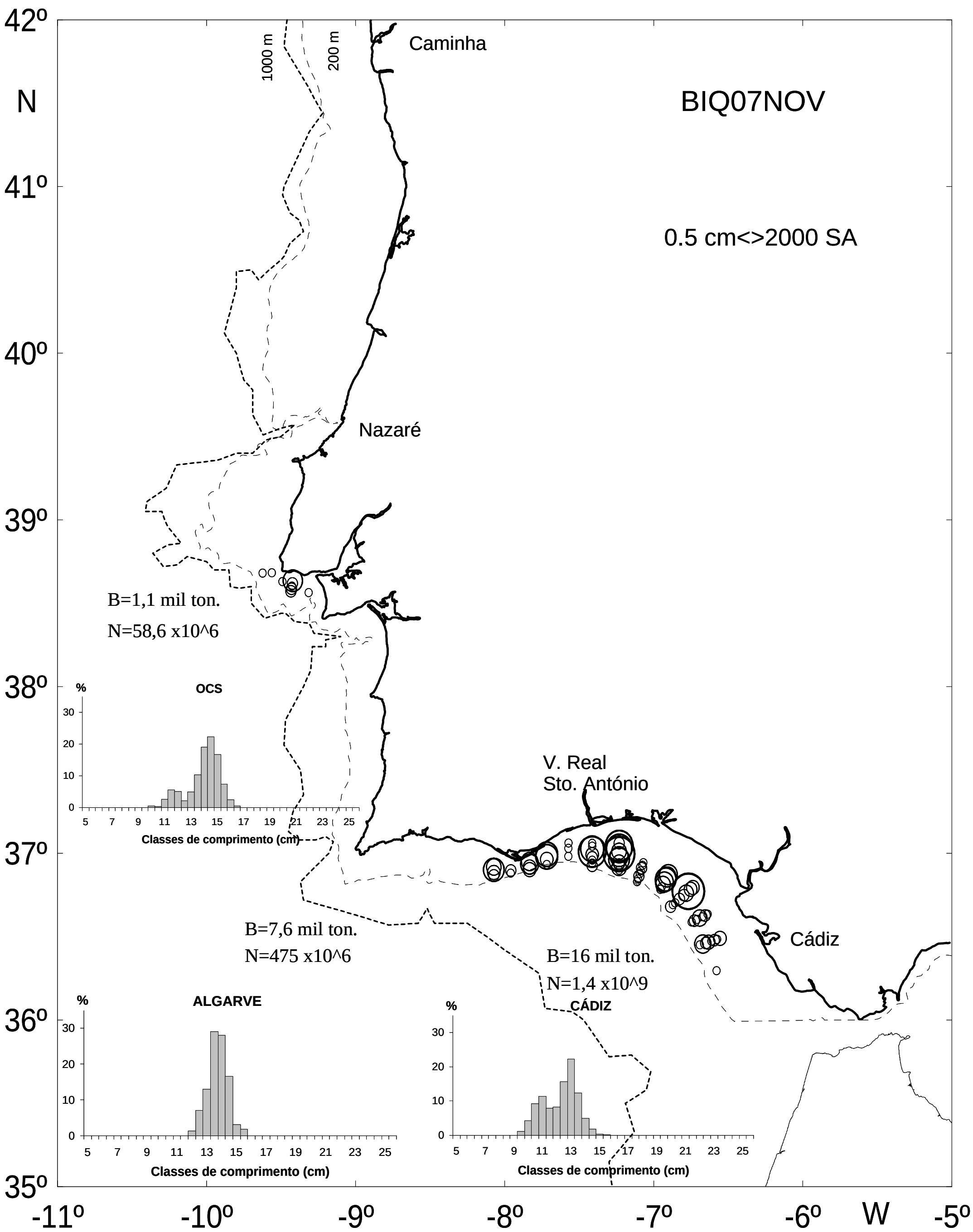


Figure 4.4.1.1. ***SAR07NOV*** **autumn Portuguese acoustic survey in Division IXa. Distribution of the NASC coefficients (m^2/mn^2) attributed to anchovy, acoustic estimates and size composition of the estimated populations by subareas (source: Vitor Marques, IPIMAR, pers. comm.).**

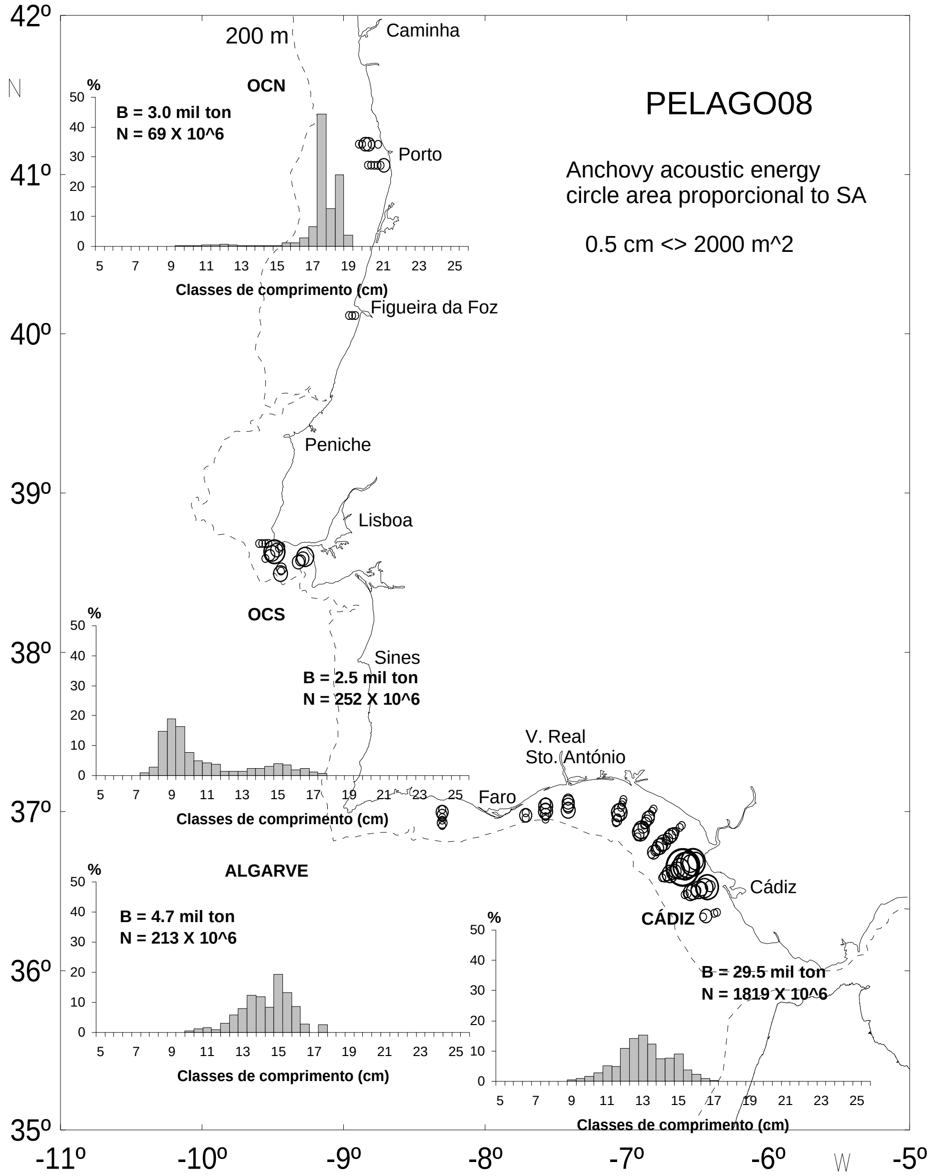


Figure 4.4.1.2. ***PELAGO08*** **spring Portuguese acoustic survey in Division IXa. Distribution of the NASC coefficients (m^2/mn^2) attributed to anchovy, acoustic estimates and size composition of the estimated populations by subareas (source: Vitor Marques, IPIMAR, pers. comm.).**

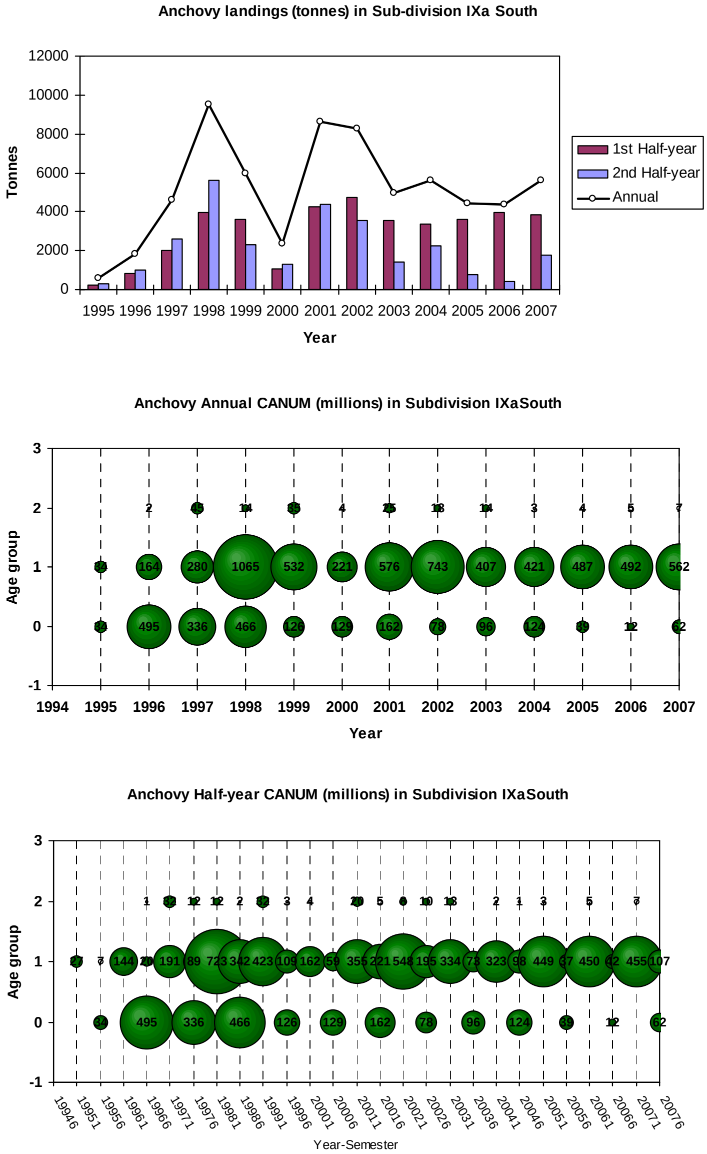


Figure 4.5.1.1.1. Anchovy in Division IXa. Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz). Trends in landings (upper panel) and catch-at-age numbers (both on an annual and half-year basis).

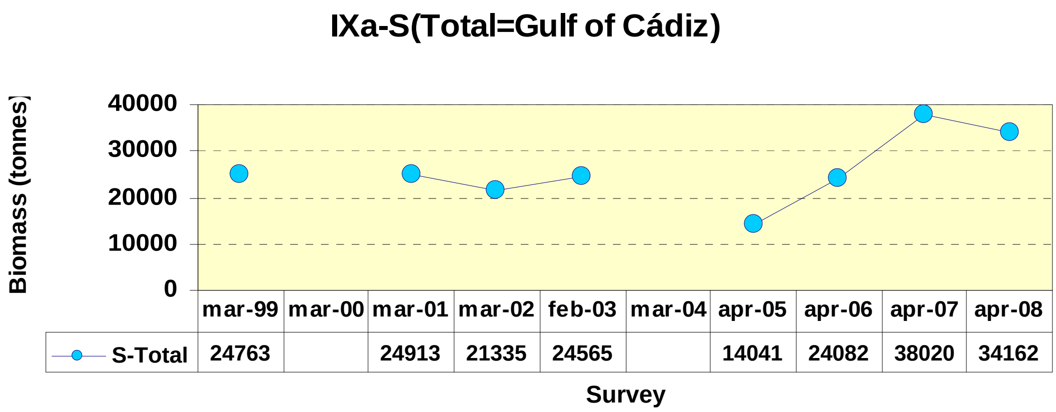
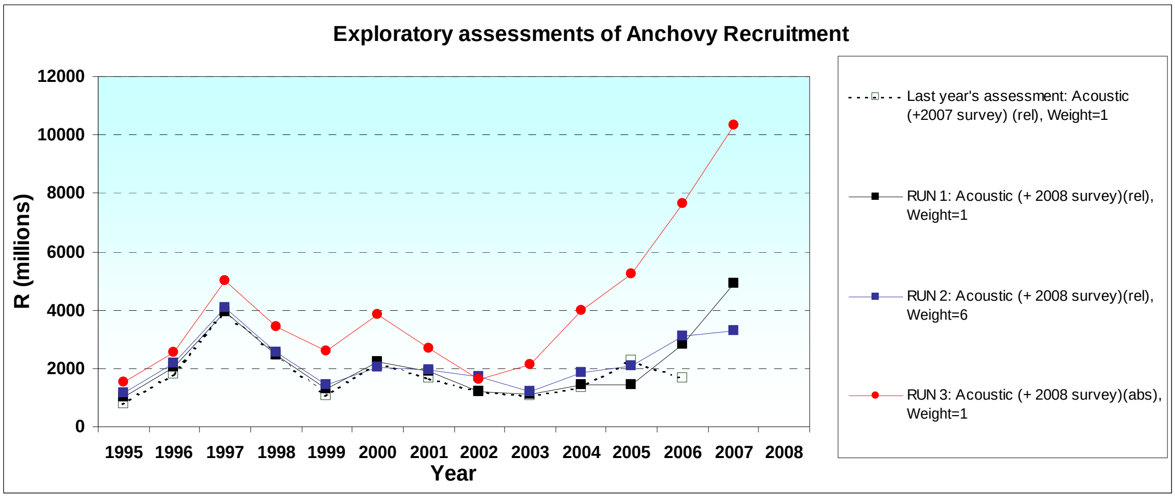
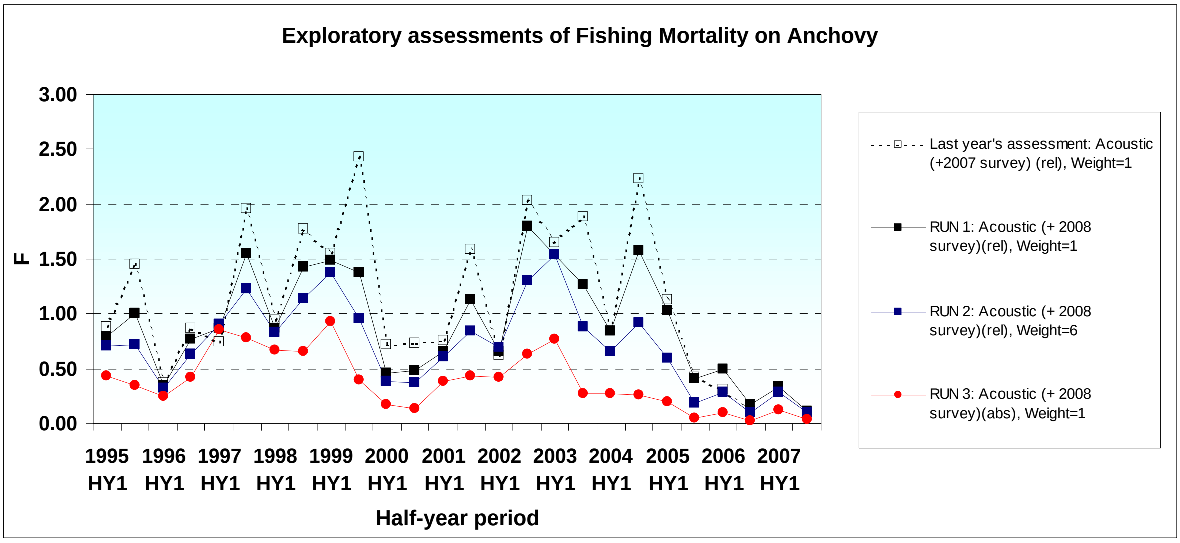


Figure 4.5.1.1.2. Anchovy in Division IXa. Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz). Trends in tuning indices (aggregated biomass) used in data explorations: Spring Portuguese Acoustic Surveys estimates.





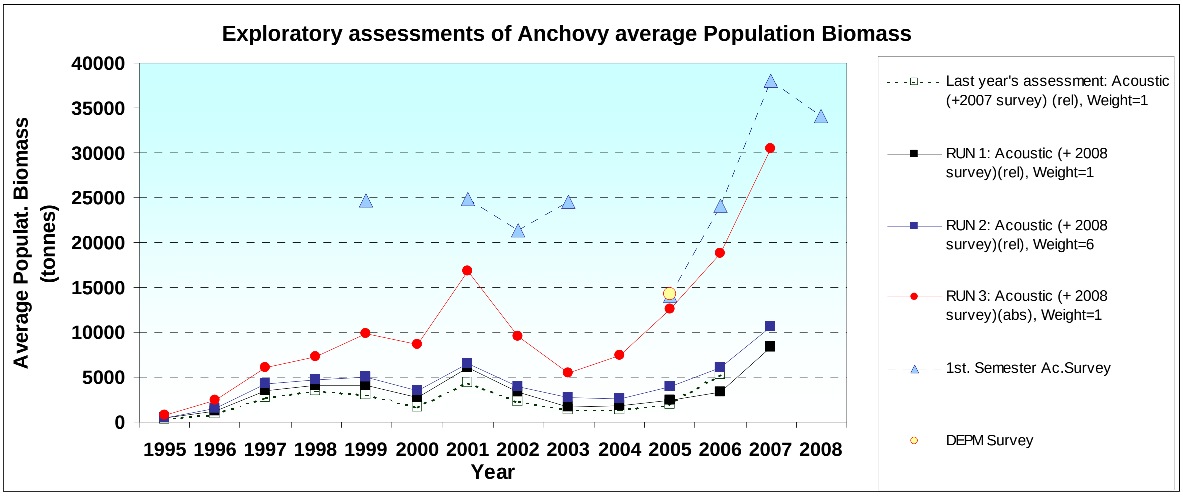
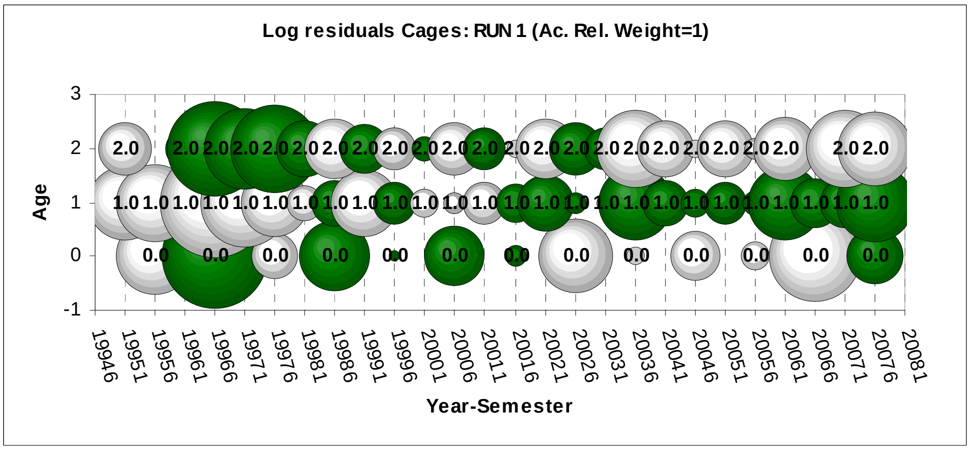
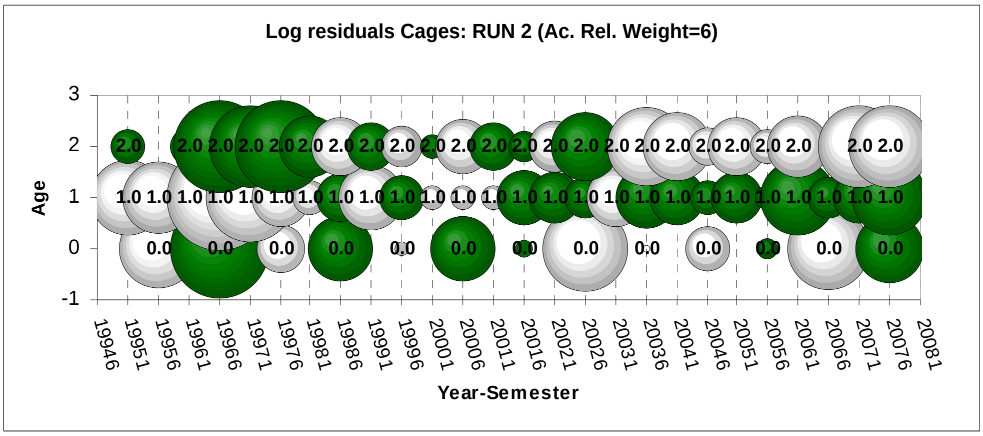


Figure 4.5.1.2.1. Anchovy in Division IXa. Anchovy in Sub-division IXa South(Algarve+Gulf of Cadiz). Comparison of last year's exploratory assessment with the new input data in 2007.





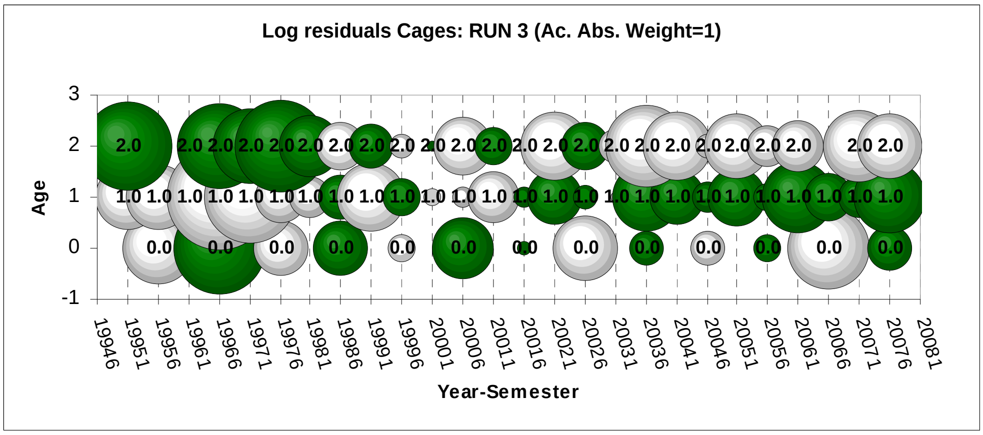


Figure 4.5.1.2.2. Anchovy in División IXa. Anchovy in Sub-division IXa South. Results from data exploration with the *ad-hoc* seasonal separable model. Log-residuals from catch-at-age data. Bubble size proportional to the log residual level. Negative values in white. Range of values by run are: RUN 1: -1.4 to 1.5; RUN 2: -1.4 to 1.3; RUN 3: -1.5 to 1.2.

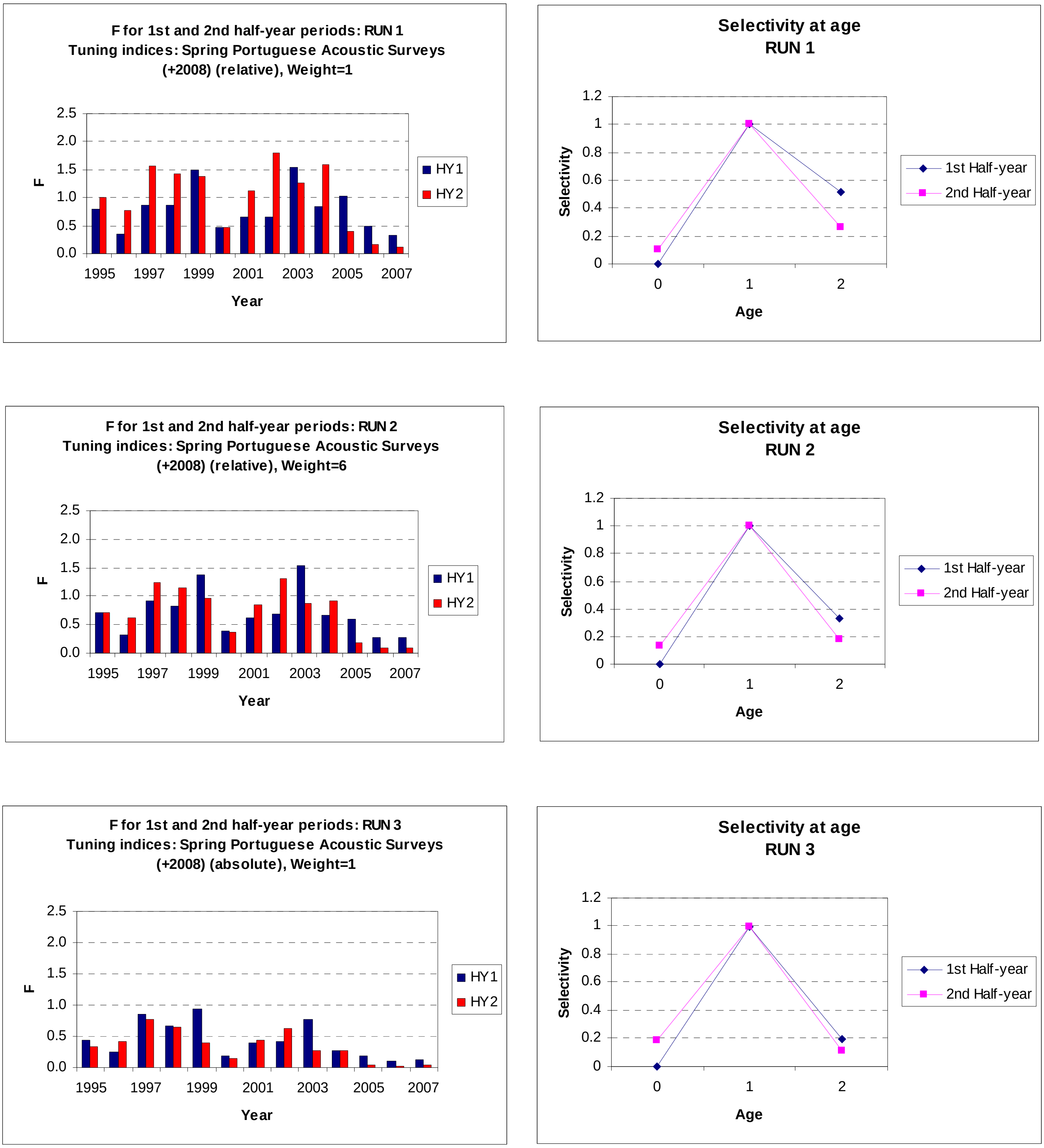
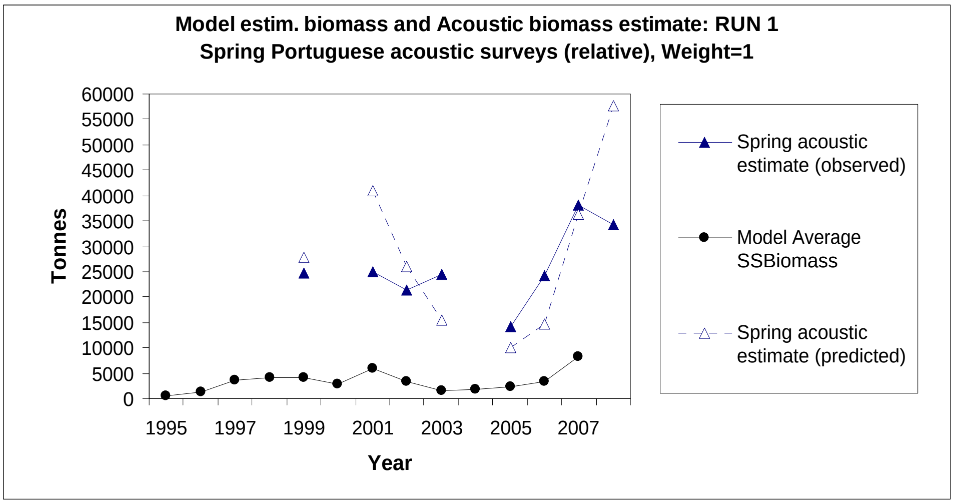
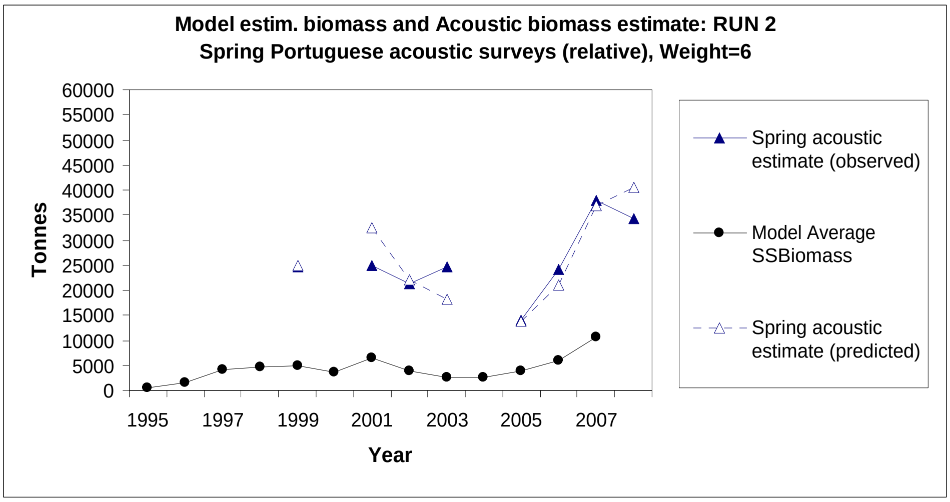


Figure 4.5.1.2.3. Anchovy in División IXa. Anchovy in Subdivision IXa South. Results from data exploration with the *ad-hoc* seasonal separable model. Estimated fishing mortalities (F) and fitted selection pattern by the separable model.





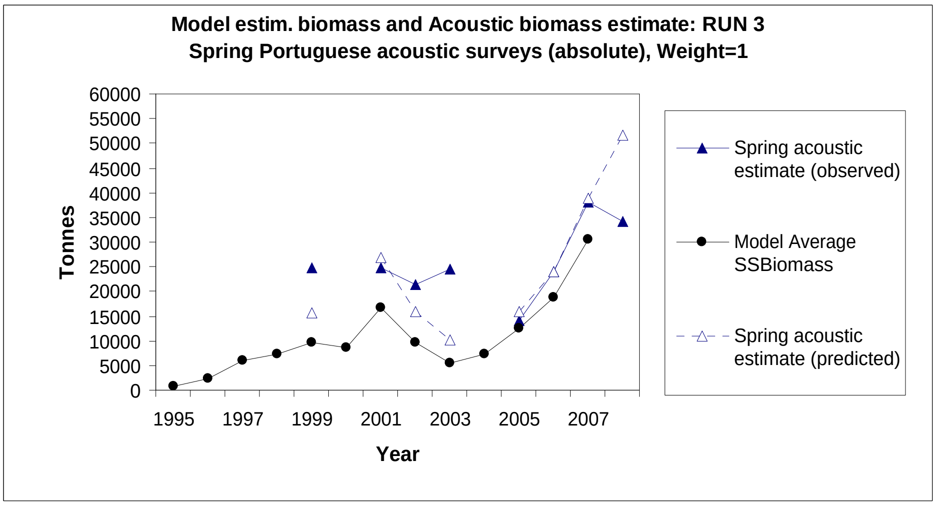


Figure 4.5.1.2.4. Anchovy in División IXa. Anchovy in Sub-division IXa South. Results from data exploration with the *ad-hoc* seasonal separable model. Model estimated biomass and acoustic biomass estimates.

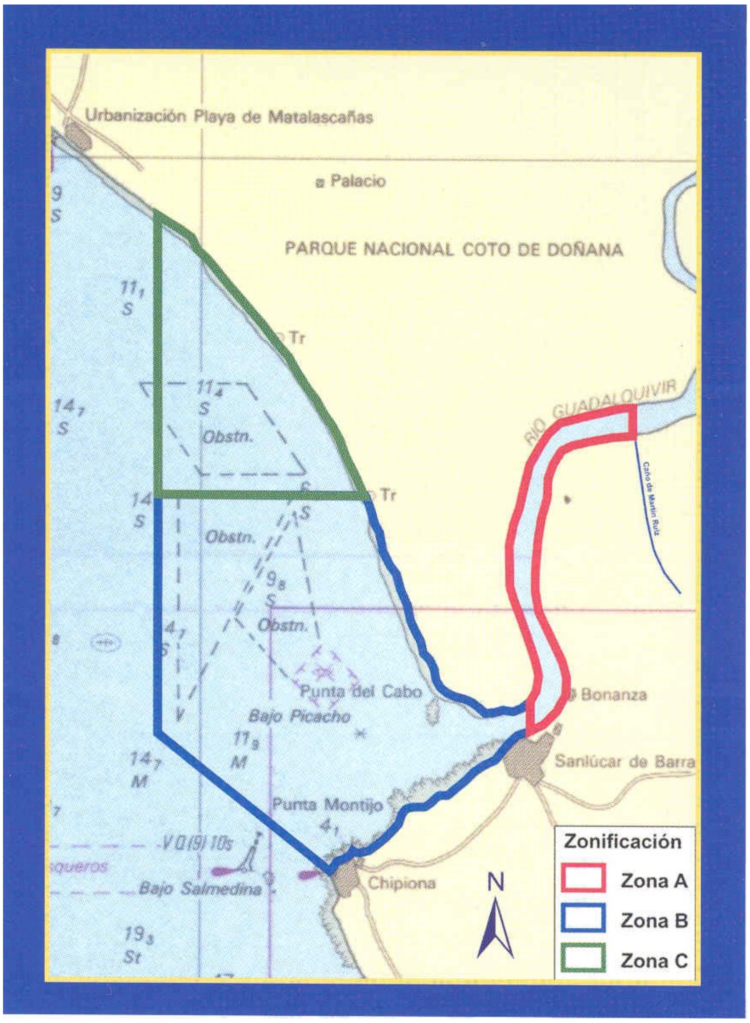


Figure 4.7.4.1. Anchovy in Division IXa. Limits of the Fishing Reserve off the Guadalquivir river mouth (Spanish Gulf of Cadiz. Sub-division IXa South).

Annex 1: Working Document to WGANC 13/6/08 – 16/6/08 at Copenhagen, Denmark

Revision of the JUVENA 2006 biomass estimation and

comparison between JUVENA and DEPM indices

By

G. Boyra, U. Martínez and A. Uriarte

Introduction: Inter-calibration between vessels in JUVENA 2006

IN past WGACEGGS (ICES 2007b) a need for final revision of the juvenile abundance index from JUVENA 2006 (Boyra 2006 and 2007) was pointed out, given the bad performance of one of the two echosounders intervening in the survey. This paper presents such a revision according to the inter-calibration exercise between the two vessels participating in the survey.

During the JUVENA 2006 survey, an inter-calibration exercise between both vessels was carried out in order to check for possible biases in acoustic collection. For this exercise, about the 20% of the transects were covered simultaneously by both vessels (Figure 1; Table 1). In the common transects, the vessels were travelling about 100 m apart side by side, each vessel taking the lead alternatively each 10 n.mi. The acoustic sampling procedure in these intercalibration transects was the same as in the other regular ones.

The processing of the intercalibration data was made only for the positive anchovy areas. For each positive stratum, a layer echointegration was performed in both 38 and 120 kHz frequencies. The configuration parameters for ecointegration were the same as in the regular acoustic processing procedure, except that the ESDU was made equal to 1 n.mi.

The acoustic energies (NASC) collected by both vessels were compared. The ratios of energy at the same frequency for different vessels were computed, as well as the ratios of energies at different frequencies for each vessel. Those records presenting large differences between both vessels were discarded as outliers, considering that they would likely be produced by different targets.

The intercalibration results between both vessels evidenced that the EB was systematically collecting less energy than the IL (Table 1). The detected energy of the IL at 38 kHz was three times higher than the EB one, if we look at the mean ratios. However, the mean values are very much influenced by the extreme values, as, for instance, the stratum named h3e, in which the energy ratio between vessels at 38 kHz is equal to 9. In this stratum, it has to be taken into account that the IL presented an unusually extreme high value in the 38 kHz, comparing with the 120 kHz, thus invalidating it as a representative value. To avoid this and other outlier values, the medians of the ratios were also computed. If we take the medians into account, the ratio of performance between 38 kHz echosounders of both vessels was of about 60%; whereas for 120 kHz it was of 10%.

The results of the intercalibration analysis were discussed with colleagues from Ifremer, Genavir and IEO during the Acoustic Workshop promoted by the ICES WACEGG, 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 a short pulse duration for this frequency (see the configuration parameters of the echosounders of both vessels in Table 2). As a result of this misconfiguration, it is thought that the abundance provided by the 38 kHz echosounder may be underestimated.

On the other hand, the configuration and calibration datasets of the rest of the echosounders appeared to be correct. Moreover, analyzing the ratios at 120 kHz (Table 2), the highest outlier (stratum h5i) seemed to be produced by the detection of different targets by both vessels. Discarding this outlier, neither the mean nor the median of the ratios were significantly different from 1 at the 95.0% confidence level. This suggests that both 120 kHz echosounders were performing equivalently and were suitable for the bias correction of the 38 kHz ecosounder. As a consequence, it was decided to reprocess the acoustic data collected by EB based on the 120 kHz echosounder.

Material and Methods

The correction of the R/V Emma Bardán abundance estimation for year 2006 involved two different analyses. In a first round, the transects covered by EB were reprocessed based on the 120 kHz echosounder, being the corresponding energy converted to biomass by applying the TS for this frequency. Unfortunately, there was a large uncertainty in the revision estimate itself made based on the 120 kHz data because of the uncertainty of the Ts value of anchovy for this frequency. In consequence, a new procedure was applied to correct the estimation, based directly apply detection biass of the EB 38 kHz echosounder, as quantified by comparison with the IL 38 kHz echosounder in the inter calibration exercise carried out during the survey.

Correction based on the 120 kHz data

The transects covered by the EB were reprocessed based on the 120 kHz echosounder. From the total 1,310 n.mi. covered during the survey, 790 had to be reprocessed (the 60% of the coverage) based on the 120 kHz recordings, while the remaining 40% was left unchanged.

Different alternative procedures were explored to obtain an appropriate TS value for the target species at 120 kHz. The TS values for anchovy reported in bibliography (Table 3) covered a range of almost 8 dB, making it difficult to make a choice. Therefore, the TS values of the main target species at this frequency were obtained by an optimization process, trying to maximize the internal consistency of the JUVENA series. An iterative process was followed, in which the optimum TS values at 120 kHz were those that produced a biomass estimate as close as possible to the biomass obtained with the 38 kHz echosounder in the same transects. The optimization was applied to a selection of strata of Juvena 2005 and 2006 surveys that presented well configured and calibrated data sets for both 38 and 120 kHz (Table 4).

The values were initialized according to: $TS_{120}=TS_{38}$-3dB. Then, the iterative process was applied, trying to minimize the following objective function:

$$\sum_{strata}(\log(Biomass_{38}) - \log(Biomass_{120}))^2$$

Two additional restrictions for the TS values were that (1) the optimum values had to be not farther than 10 dB from the initial ones, and (2) the TS for anchovy should be less or equal than the TS for sardine.

Correction based on the 38 kHz data

The data recorded by both vessels during the intercalibration exercise was integrated and compared to estimate the detection bias of the 38 kHz echosounder at the EB. Only those transects with perfectly simultaneous coverage and consistent calibration of both vessels were chosen for this analysis. The full extension of these transects from the coast to the continental shelf break was considered, in order to compare at the same time the detection capability of the water column and the bottom echo for each echosounder.

Data was echointegrated by 0.1 n.mi. with a threshold of -60 dB. Two integration methods were applied on the data (see Table 6):

- Echointegration by layers of the full water column.
- Echointegration by layers of the bottom echo.

The mean 38 kHz echosounder energy ratios between vessels were calculated. Three averaging statistics were considered for the ratios:

– Mean1: the mean of the ratios of each individual nautical mile

– Mean2: the ratio of the mean energy of the full transect.

– Median: the median of the ratios of each individual nautical mile

Preliminary evaluation of the recruitment prediction capability

In order to evaluate the recruitment prediction capability of JUVENA, the index of juvenile abundances were compared to the abundance estimates of age 1 recruits by means of the DEPM. A simple regression of both variables was performed for a preliminary evaluation of the relationship of both variables.

Results

Correction based on the 120 kHz data

A quite different frequency acoustic response was found between the echograms from coastal and oceanic areas. This may be caused by different behaviour of anchovy in the coastal areas, where it is mixed with other species (mostly predators). The divergent acoustic response made it hard to fit both areas at the same time (Figure 2 and Table 4). The use of logarithmic residuals in the objective function was devoted to reduce the effect of the (massive) oceanic transects, as the TS values were to be applied on 2006, that is, mainly coastal or continental shelf data.

With the imposed restrictions to the TS values, the optimization affected only to the values of anchovy and sardine, leaving the rest with their initialized value, 3 dB less than the TS at 38 kHz. The combination of optimized 120 kHz TS values obtained is presented in Table 5.

As stated below, there was a large uncertainty in the revision estimate itself made based on the 120 kHz data because of the uncertainty of the Ts value of anchovy for this frequency, both in bibliography (Table 3) and in the optimization process (Table 5). In consequence, as the use of the 120 kHz frequency for reprocessing made us face uncertainties higher than the ones we wanted to solve, this correction procedure was discarded. A new procedure was explored, based on the 38 kHz echosounders.

Correction based on the 38 kHz data

Both the ratio of the mean values (mean 2) and the median of the individual values appeared to be less sensitive to extreme values (Table 4) and, thus, preferable than the mean of the individuals (mean 1).

Echointegration of the water column was noisier than the bottom echo due to the situation of both vessels, about 100 m apart side to side. In this situation, the vessels were not detecting exactly the same schools, whereas the type of bottom was very similar, as it tends to change gradually with the distance. Nevertheless, despite this difference, both echointegration procedures provided consistent results, being the bottom echo echointegration much less variable (Table 6). Consequently, the bias of the EB echosounder was finally inferred from the ratio of bottom echoes (mean 2) as IL/EB = 2.0 (see Table 6).

With the compensation of this bias, the estimation of the 2006 biomass estimation was corrected, obtaining a definitive value for the temporal JUVENA series (see Table 7 for examining the complete series).

Preliminary evaluation of the recruitment prediction capability

The comparison between the abundance of age 1 anchovy in spring and the age 0 anchovy the previous autumn can be observed in Figure 3. The simple regression between the variables (Figure 4) showed that there exists a positive correlation between the (correlation coefficient = 0.92), with a coefficient of determination of 85 % and a p-value = 0.025, that is, a statistically significant relationship at the 95% confidence interval. This result shows a promising recruitment foreseen capability for the JUVENA index.

References:

Boyra, G., Martínez, U., Cotano, U. and Uriarte, A. (2006) Acoustic surveying of anchovy Juveniles in the Bay of Biscay: JUVENA 2006 Survey Report. Working Document to ICES WGACEGGS meeting 27/11/06 – 1/12/06 at Lisbon, Portugal.

Boyra, G., Martínez, U., Cotano, U. and Uriarte, A., 2007: Review of the JUVENA 2006 Abundance Estimates (Including an Appendix with the Inter-calibration Results). Working Document to the plenary STECF Plenary Meeting JUNE, 2007 (at Ispra Italy, 18-22 June 2007).

ICES 2007 b. Report of the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES areas VIII and IX (WGACEGG). ICES CM 2007/LRC:16

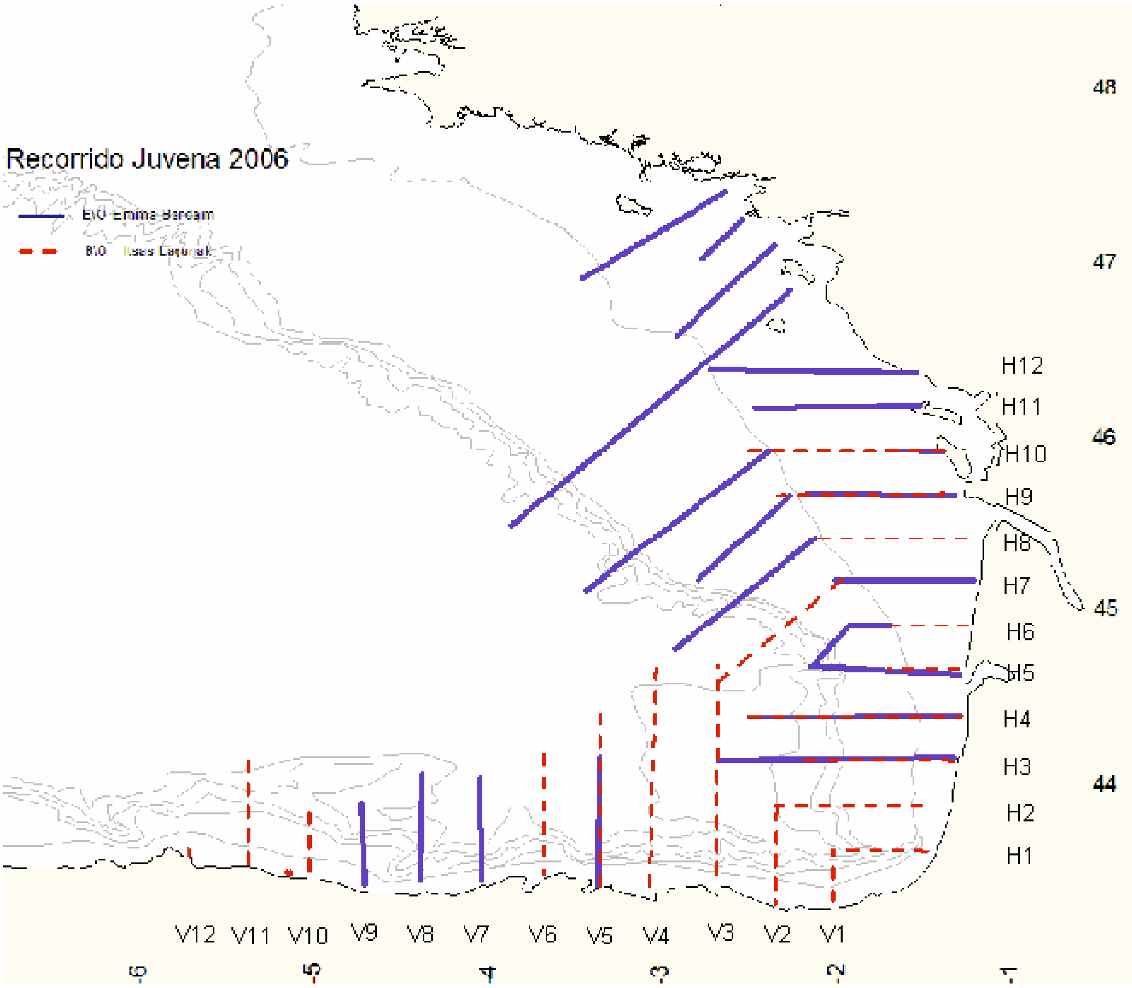


Figure 1. Transects covered by the two vessels involved in the JUVENA06 survey. The common transects were used for the intercalibration exercise between vessels.

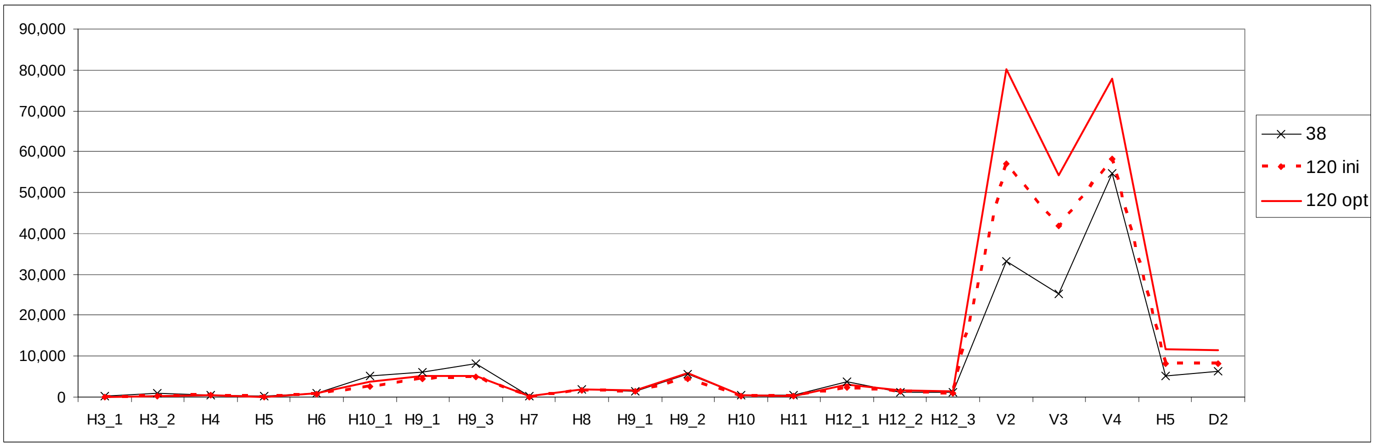


Figure 2. Fitting of the biomass at 120 kHz to the biomass at 38 kHz for the selected strata in the optimization processs. The initial 120 kHz biomass and the optimized one are shown, along with the 38 kHz calculated biomass.

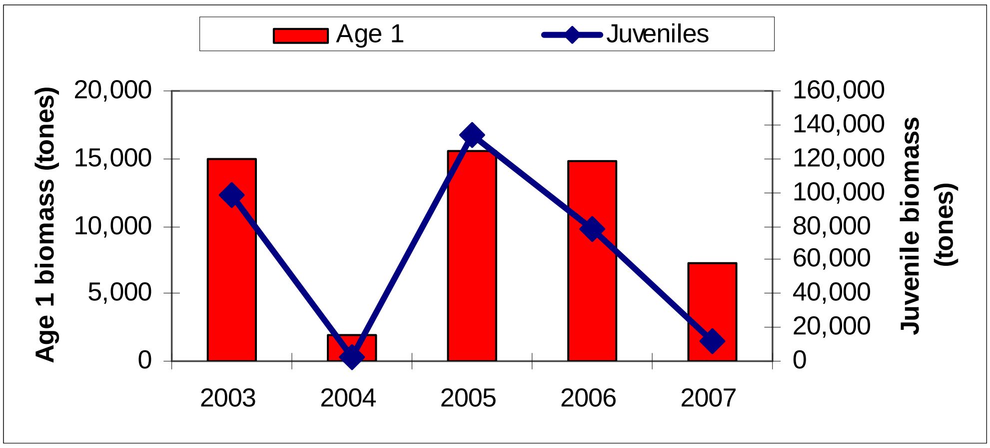


Figure 3. Comparison of the abundances of age 1 anchovy (DEPM) in spring and age 0 anchovy (JUVENA) during the previous autumn.

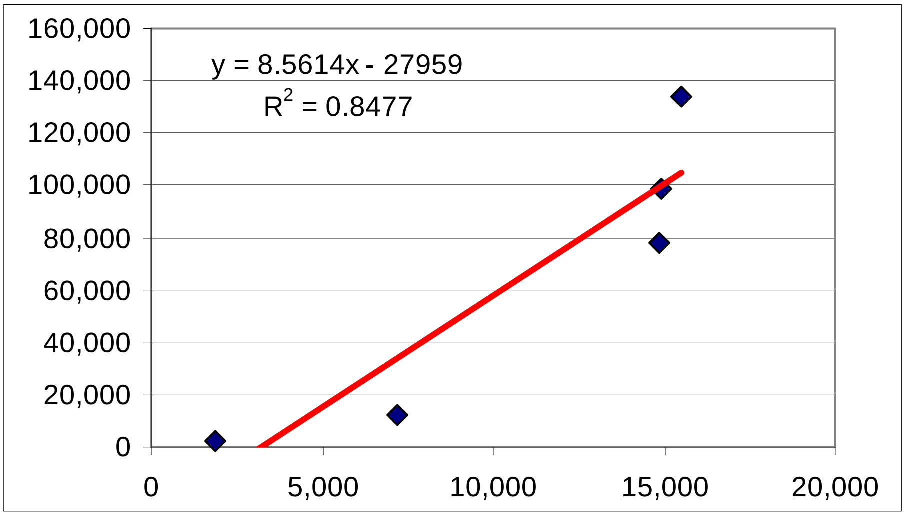


Figure 4. Simple linear regression between the variables: abundance of age 1 anchovy (DEPM) in spring and abundance of age 0 anchovy (JUVENA) during the previous autumn.

Table 1

Selected strata for the intercalibration exercise. EB stands for B/O Emma Bardán and IL stands for purse seiner Itsas Lagunak. It is shown the acoustic energy (NASC) registered in each stratum, as well as the energy ratios between vessels and different frequencies in the same vessel. N is the number of effective nautical miles (after discarding the outliers) in each stratum. Finally, the column "Lead" designates the vessel that took the lead in each stratum: 1, EB; 2, IL; 0, non simultaneous coverage.

Stratum	Lead	EB38	IL38	EB120	IL120	N	EB38/EB120	IL38/IL120	IL38/EB38	IL120/EB120
h3e	1	30	283	32	31	4	0,9	9,0	9,4	1,0
h4i	2	196	141	119	49	4	1,6	2,9	0,7	0,4
h5e	1	153	177	68	48	9	2,2	3,7	1,2	0,7
h5i	2	68	505	22	147	9	3,1	3,4	7,4	6,7
h6	0	147	174	52	56	7	2,8	3,1	1,2	1,1
h10i	2	519	1046	199	220	1	2,6	4,7	2,0	1,1
h10e	1	362	566	107	128	7	3,4	4,4	1,6	1,2
h9i	2	500	606	305	198	7	1,6	3,1	1,2	0,6
h9	0	234	819	79	220	27	3,0	3,7	3,5	2,8
Mean values		245	480	109	122	8	2,4	4,2	3,1	1,7
Median values		196	505	79	128	7	2,6	3,7	1,6	1,1

Table 2

Configuration parameters of the acoustic equipment of the Juvena06 vessels.

	Itsas Lagunak		Emma Bardán	
Frequency (kHz)	Puse duration (us)	Power (W)	Puse duration (us)	Power (W)
38	1024	1200	256	600
120	1024	250	256	500

Table 3

Values of TS of anchovy (in dB) obtained from bibliography , according to the TS- length relationship: TS = a log(L) - b. Consulted bibliography: 1, Zhao (pers. com.); 2, Machias et al. (2000); 3, Gutierrez and MacLennan (1998); 4, Barange et al. (1996); 5, ICES WGACEGG 2006 Report; 6, Simmonds and MacLennan (2005).

SPECIES	B (DB)	A	LOCATION	FREQUENCY (KHZ)	SOURCE
Engraulis japonicus	71.5	20	Japan	120	1
Engraulis encrasicolus	79.46	19.26	Mediterranean	120	2
Engraulis ringens	76.2	20	Perú	120	3
Engraulis ringens	78.9	20	Perú	38	3
Engraulis capensis	76.1	20	Southafrica	38	4
Anchovy in general	72.6	20	-	38	5
Clupeids in general	71.9	20	-	38	6

Table 4

Selection of strata used in the optimization process for the TS values at 120 kHz. NASC values as well as the biomass estimates at both frequencies are shown for each stratum.

Year	Stratum	Zone	s_A 38	s_A 120	Biom38	Biom120
2005	H7	Coastal	283,45	34,09	164	56
2005	H8	Coastal	283,45	34,09	982	336
2005	H9_1	Coastal	140,87	53,53	434	413
2005	H9_2	Coastal	176,91	52,6	147	99
2005	H10	Coastal	173,69	60,79	1.028	1.014
2005	H11	Coastal	565,69	138,61	5.229	3.666
2005	H12_1	Coastal	605,76	215,3	6.156	5.208
2005	H12_2	Coastal	818,69	238,94	8.270	5.257
2005	H12_3	Coastal	224,33	72,14	147	128
2005	V2	Oceanic	152,51	89,66	1.773	1.976
2005	V3	Oceanic	34,65	119,19	1.473	1.688
2005	V4	Oceanic	458,57	136,76	5.682	5.847
2005	H5	Oceanic	311,23	93,89	423	380
2005	D2	Oceanic	274,69	40,54	509	216
2006	H3_1	Coastal	638,60	197,38	3.691	3.046
2006	H3_2	Coastal	179,21	84,98	1.268	1.701
2006	H4	Coastal	186,64	72,10	1.220	1.347
2006	H5	Coastal	2670,84	2218,68	33.272	80.248
2006	H6	Coastal	510,78	369,73	25.206	54.315
2006	H10_1	Coastal	955,58	474,23	54.706	77.789
2006	H9_1	Coastal	231,63	177,55	5.115	11.602
2006	H9_3	Coastal	277,24	174,78	6.408	11.482

Table 5

Optimized b_{20} values for 120 kHz according to the different regions involved in the optimization process and the corresponding year 2006 estimated biomass values for each one.

b20 opt @ 120 kHz (dB)	Region	Year	Biom juveniles (tones)	Biom adults (tones)
-74.1	Ocean	2005	32,243	15,625
-76.7	Shelf	2005	42,090	22,516
-78.9	Shelf	2006	55,595	32,233
-77.1	All	2005+2006	44,121	23,961

Table 6

Synthesis of the abundance estimation (acoustic index of biomass) for the four years of JUVENA surveys estimated.

Ratios (IL38/EB38)	Transect	N (n.mi.)	**Water column**	**Bottom echo**
mean1	h4	14.3	4.5	2.9
mean2	h4	**14.3**	2.5	2.9
median	h4	14.3	3.2	2.9
std dev	h4	14.3	4.3	0.5
var. Coef.	h4	14.3	96%	17%
mean1	h5	15.4	8.9	1.4
mean2	h5	15.4	2.3	1.3
median	h5	15.4	2.5	1.3
std dev	h5	15.4	22.4	0.3
var. Coef.	h5	15.4	251%	23%
mean1	h9	29.5	17.2	2.0
mean2	h9	29.5	2.9	2.0
median	h9	29.5	2.2	1.8
std dev	h9	29.5	86.1	0.6
var. Coef.	h9	29.5	501%	32%
mean1	all	59.2	11.9	2.1
mean2	all	59.2	2.9	**2.0**
median	all	59.2	2.5	1.8
std dev	all	59.2	61.8	0.8
var. Coef.	all	59.2	519%	38%

Table 7

Optimized b_{20} values for 120 kHz according to the different regions involved in the optimization process and the corresponding year 2006 estimated biomass values for each one.

Year	Region	<sA>	Area	<length>_juv	<lenght>_adul	Biom_juv	Biom_adul
2003	South	369	3303	8.2		97,498	0
2003	North	444	173	11.1	14.1	1,103	1,383
2003	TOTAL					98,601	1,383
2004	South	1	47	6		1.9	0
2004	North	562	1860	11	13.8	2,404	3,451
2004	TOTAL					2,406	3,451
2005	South	722	5390	6.64		125,922	0
2005	North	326	2400	9.83	11.91	8,208	20,369
2005	TOTAL					134,131	20,369
2006	South	366	1200	7.2	11.5	22,672	179
2006	North	391	5863	11.2	12.4	55,626	45,243
2006	TOTAL					78,298	45,422
2007	South	186	1812	9.0	12.5	6,381	757
2007	North	248	3865	10.3	14.4	6,740	34,352
2007	TOTAL					13,121	35,109

Working document to the ICES Working Group on Anchovy (WGANC). ICES Headquarters, Copenhaguen, Denmark, 13-16 June 2008.

Distribution pattern of anchovy abundance and biomass in Division IXa from research surveys in 2007 and 2008

By

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ABSTRACT

A total of 4 acoustic surveys (3 Portuguese and 1 Spanish) rendering seasonal estimates of anchovy abundance, either for almost the whole Division IXa (spring and autumn Portuguese surveys) or only for the Subarea IXa South (Algarve + Gulf of Cadiz areas, early summer Spanish survey), were carried out during 2007 and the first half in 2008. In the November 2007 ICES WGACEGG meeting was presented - after detecting some computational errors - a corrected version of the estimates from the early summer 2007 Spanish survey previously provided to the September 2007 WGMHSA meeting. Anchovy total estimates from these surveys with indications of its general distribution patterns were as follow:

Portuguese surveys surveying almost the whole Division (except Subarea IXa North):
PELAGO07 (2007 Spr. Port. Surv.): **3247 million fish**; **40.0 thousand tonnes**. Most of anchovy in Gulf of Cadiz. Present but relatively scarce in front of Lisbon.
SAR07NOV (2007 Aut. Port. Surv.): **1921 million fish**; **24.8 thousand tonnes**. Most of anchovy in Gulf of Cadiz. Present but relatively scarce in front of Lisbon.
PELAGO08 (2008 Spr. Port. Surv.): **2353 million fish**; **39.7 thousand tonnes**. Most of anchovy in Gulf of Cadiz. Present but relatively scarce in front of Lisbon and in northernmost coastal waters denoting a northernwards expansion of the population in the Division.

Spanish survey surveying the Subarea IXa South only:
ECOCÁDIZ 0707 (2007 Summ. Sp. Surv.): **1790 million fish; 28.9 thousand tonnes**. Anchovy all over the Gulf of Cadiz, also widely distributed through the Algarve, but mainly concentrated in the Spanish waters.

INTRODUCTION

The present working document compiltates the results on direct estimates of anchovy abundance and its distribution pattern throughout the Division IXa from reseach surveys conducted during the intersessional time between the September 2007 WGMHSA meeting (ICES, 2007 a) and the present June 2008 WGANC one. In the interim, a great part of this information was previously analysed and reported to the November 2007 WGACEGG meeting (ICES, 2007 b), including a corrected version of the 2007 Spanish acoustic survey (*ECOCÁDIZ 0707* survey) estimates provided previously to the 2007 WGMHSA meeting (see ICES 2007 a and Ramos *et al*., 2007 a for the former version and ICES 2007 b and Ramos *et a*l., 2007 b for the corrected one).

As novel information provided to ICES after the WGACEGG meeting, the WD presents the results from two new Portuguese acoustic surveys carried out in November 2007 (*SAR07NOV*) and in April 2008 (*PELAGO08*).

The first anchovy DEPM Spanish survey in Subarea IXa South dates back to June 2005 (*BOCADEVA 0605*). A new DEPM survey (*BOCADEVA 0608*, 21 June - 4 July) will be carried out just after this year's WGANC meeting. Notwithstanding the above, information on the distribution pattern of anchovy egg densities is available from the CUFES sampling carried out in the *PELAGO07* and *ECOCÁDIZ 07*07 acoustic surveys. No information is still available on the anchovy spawning season in 2008.

Since this year's exploratory assessment on anchovy in Subarea IXa South (Algarve + Gulf of Cadiz) specially benefits from recent direct estimates in 2007 and 2008, those estimates obtained in 2007, although already presented in different ICES WG, will be revisited again jointly with the new information in this WD for comparative purposes and description of recent trends.

Much of the text and graphical information used for the preparation of the present WD has been directly extracted with minor modifications from the information reported in the 2007 WGACEEG report.

MATERIAL AND METHODS

Three Portuguese and one Spanish acoustic surveys have been carried out during 2007 and the first half in 2008:

A) Portuguese IPIMAR surveys:

Research vessel: RV *Noruega*.
Sampled area: Atlantic-Iberian continental shelf waters of its EEZ and the waters belonging to the Spanish Gulf of Cadiz (ICES Subareas IXa Central-North, Central-South, and South).
Sampled depth range: 20 – 200 m.
Surveys:

- ***PELAGO07***: April 2007
- ***SAR07NOV***: November 2007
- ***PELAGO08***: April 2008

B) Spanish IEO surveys:

Research vessel: RV *Cornide de Saavedra*.
Sampled area: both Portuguese (i.e. Algarve area) and Spanish waters of the Gulf of Cadiz (ICES Subarea IXa South).
Sampled depth range: 20 – 200 m.
Surveys:

- ***ECOCÁDIZ 0707***: July 2007
- No conventional acoustic survey in July 2008. Ship time in July 2008 will be invested in an anchovy DEPM survey (***BOCADEVA 0608***).

All these surveys followed the standard methodology adopted by the Planning Group for Acoustic Surveys in ICES Subareas VIII and IX (ICES, 1986; 1998) and recommendations given by the WGACEGG (ICES, 2006 b,c). The methodological differences between these recent surveys are not considered by the WGACEGG members as important as to prevent from any comparison between their results, such differences being 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_{20} IPIMAR= – 82.0 vs b_{20} IEO= – 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, speciallly the computation of a sardine recruitment index (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 (Subarea IXa South), 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 AND DISCUSSION

1.- General distribution and species composition of the pelagic fish assemblages in Division IX: an overview of the results from the 2007 spring-summer acoustic surveys (after ICES, 2007 b).

Figure 1 shows the general distribution of the pelagic fish species in ICES Areas VIII and IX as inferred from their relative importance in survey trawls performed at the 2007 spring acoustic surveys of each institute (the IFREMER's *PELGAS07*, the IEO's *PELACUS 0407* and the IPIMAR's *PELAGO07*). Compared with other adjacent areas in the European Atlantic waters, the Bay of Biscay and the Atlantic waters of the Iberian Peninsula show high pelagic fish diversity. Anchovy and sardine showed in 2007 a different distribution, with sardine spreading through all the covered area (and beyond), while anchovy basically showed two local populations at the Bay of Biscay and the Gulf of Cadiz.

In the Portuguese Subareas IXa-CN and IXa-CS, because the *PELAGO07* survey is targeted on sardine, most of their fishing stations are located near shore, where the probability of finding sardine is higher (see **Figure 2** for more details). Thus, the fishing station reflects the fish pelagic community located close to the coast, which, in general is dominated by sardine. In the Subarea IXa-S a pelagic community approach was adopted for this 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 early summer *ECOCÁDIZ 0707* 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).

Anchovy and sardine 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*), blue jack mackerel (*Trachurus picturatus*) and boarfish (*Capros aper*). The rest of pelagic species less frequent in the catches have been reflected in the map as “others” and include: Mediterranean horse-mackerel (*Trachurus mediterraneus*), blue whiting (*Micromesistius potassou*), snipefish (*Macroramphosus scolopax*), sandeel (*Ammodytes tobianus*) and hake (*Merluccius merluccius*).

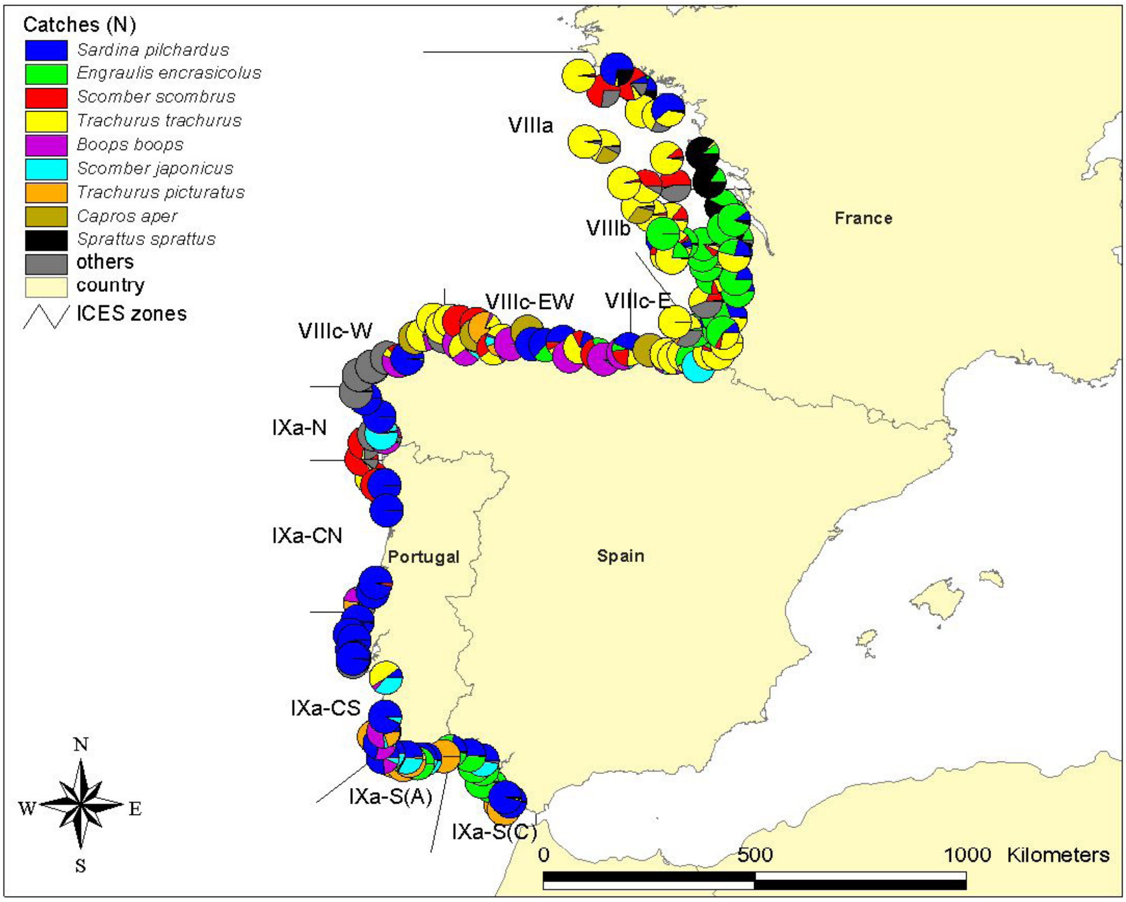


Figure 1. Species distribution (percentage in numbers in fishing stations) along the spring acoustic surveys in the Atlantic waters of the Iberian Peninsula and Armorican shelf (*PELGAS07*, *PELACUS 0407*, *PELAGO07* surveys; source: ICES, 2007 b).

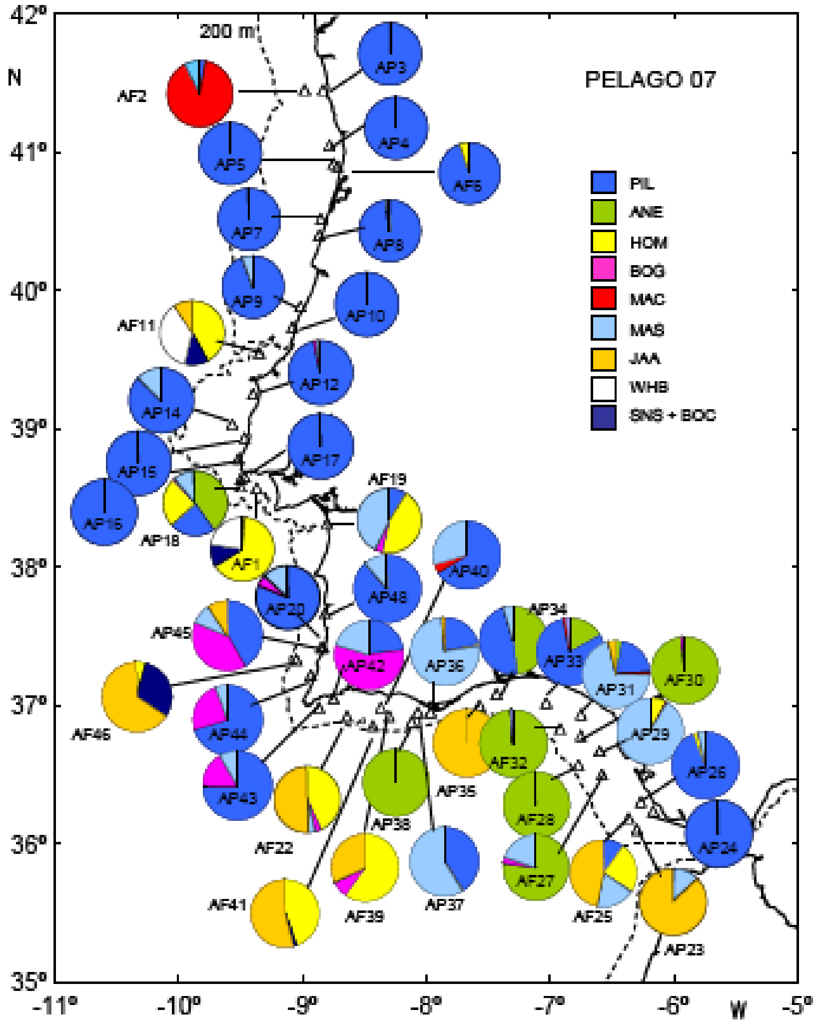


Figure 2. *PELAGO07* spring Portuguese acoustic survey in Division IXa. Location of valid fishing stations and species composition (percentages in number. AP: pelagic trawl, AF: bottom trawl; source: ICES, 2007 b).

For the southernmost subarea in Division IX (Subarea IXa South), the *ECOCÁDIZ 0707* survey provides additional seasonal information on the pelagic fish assemblage in summer, which esentially maintains the same structure found some months before during the April Portuguese survey (**Figure 3**). Thus, from the set of more frequent species in the *ECOCÁDIZ 0707* survey stood especially out chub mackerel, followed by mackerel, bogue, anchovy, Mediterranean horse-mackerel, and sardine. 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.

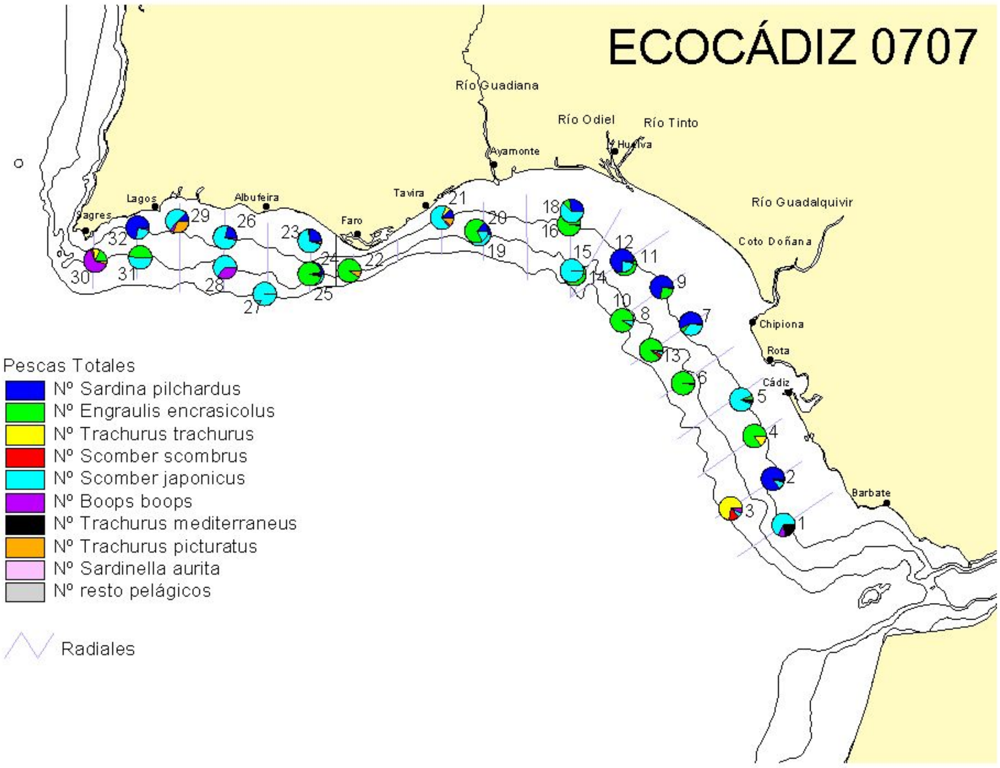


Figure 3. *ECOCÁDIZ 0707* summer Spanish acoustic survey in Subarea IXa South. Location of valid fishing stations and species composition (percentages in number), (sources: Ramos *et al*., 2007 b; ICES, 2007 b).

Unfortunately, this review on the spatio-temporal species composition of the European southern Atlantic pelagic fish assemblages has to be restricted to the 2007 spring and summer seasons, since data on this issue are not still available from IPIMAR neither for the 2007 November- nor 2008 April Portuguese surveys (*SAR07NOV* and *PELAGO08*).

2.- Anchovy distribution as inferred from the combined analysis of acoustic energy and egg densities (after ICES, 2007 b, and new data from IPIMAR).

2.1.- 2007 spring surveys.

Figure 4 shows for comparative purposes the acoustic energy in sA (m^2/mn^2; NASC, Nautical Area Scattering Coefficient) allocated to anchovy during the 2007 spring acoustic surveys carried out by the IPIMAR (April), IEO (April) and IFREMER (May) in their respective areas. The higher integration values (red and green dots) for this species were located in the Bay of Biscay (France), principally in Subarea VIIIb, and in the Gulf of Cadiz (Division IXa), principally in Subarea IXa-S(C) (Spain). In the Cantabrian Sea, density was scarce, although a little bit higher than in 2006 (ICES, 2007 a). In front of Lisbon (Portugal), between Cascais and Cabo Raso, a small density of anchovy was also detected in 2007. Values were practically null in the rest of the prospected area. Null values (black points) also describe 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), (ICES, 2007 b).

The results on anchovy egg densities, from CUFES, for the above three acoustic surveys covering the whole region from Gibraltar to Brest, are presented in **Figure 5**. 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**). 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.

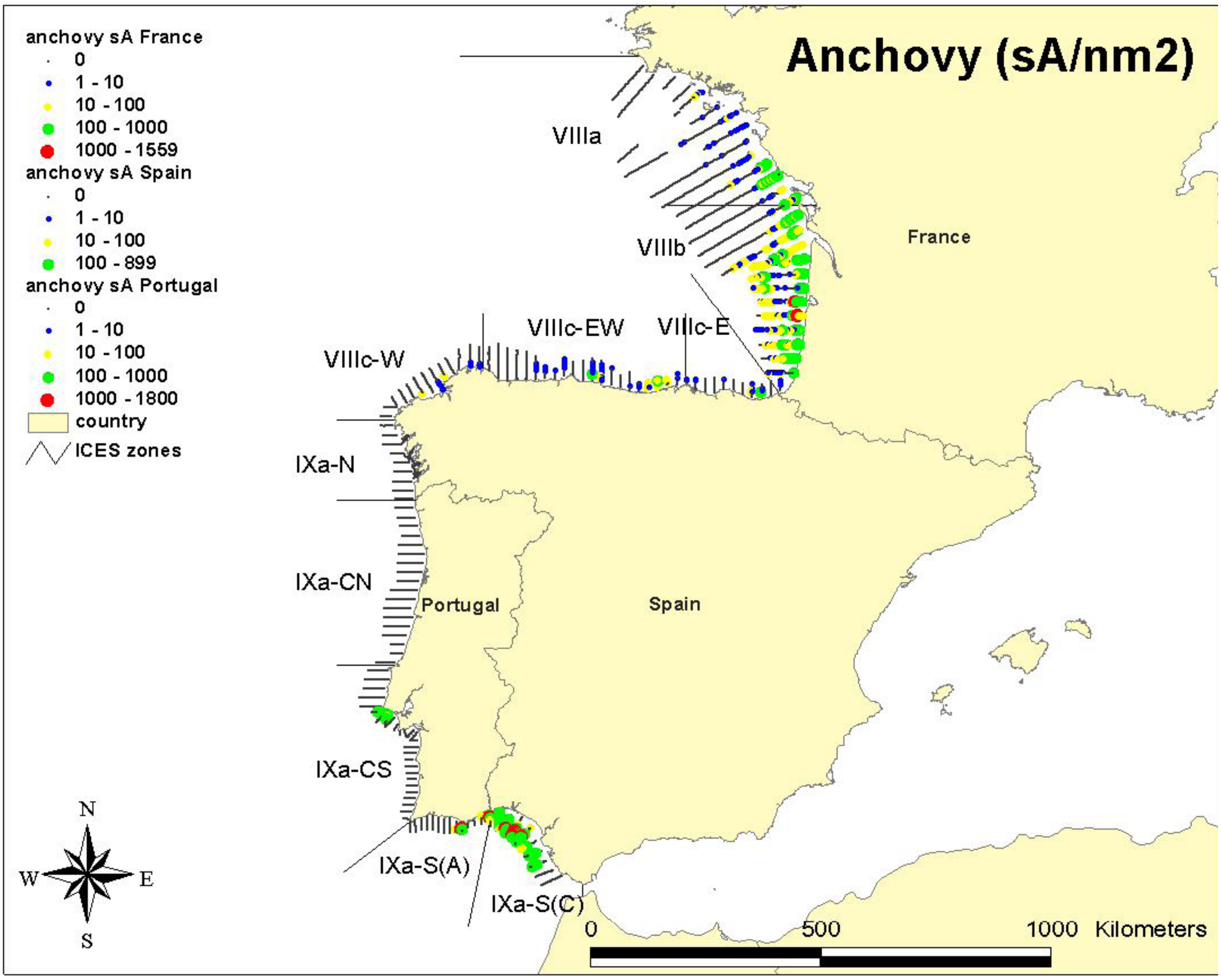


Figure 4. Acoustic energy allocated to anchovy in the 2007 spring combined coverage of the Atlantic Iberian Peninsula and Armorican shelf (source: ICES, 2007 b).

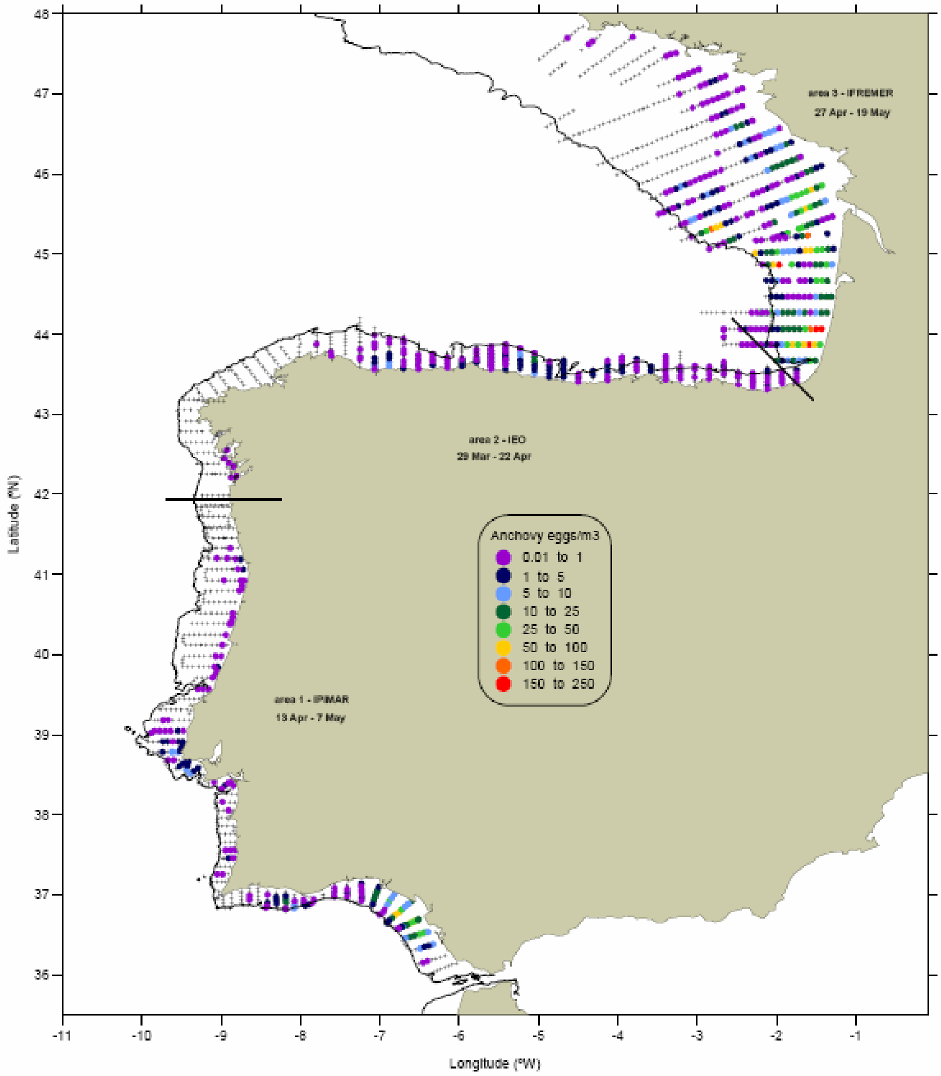
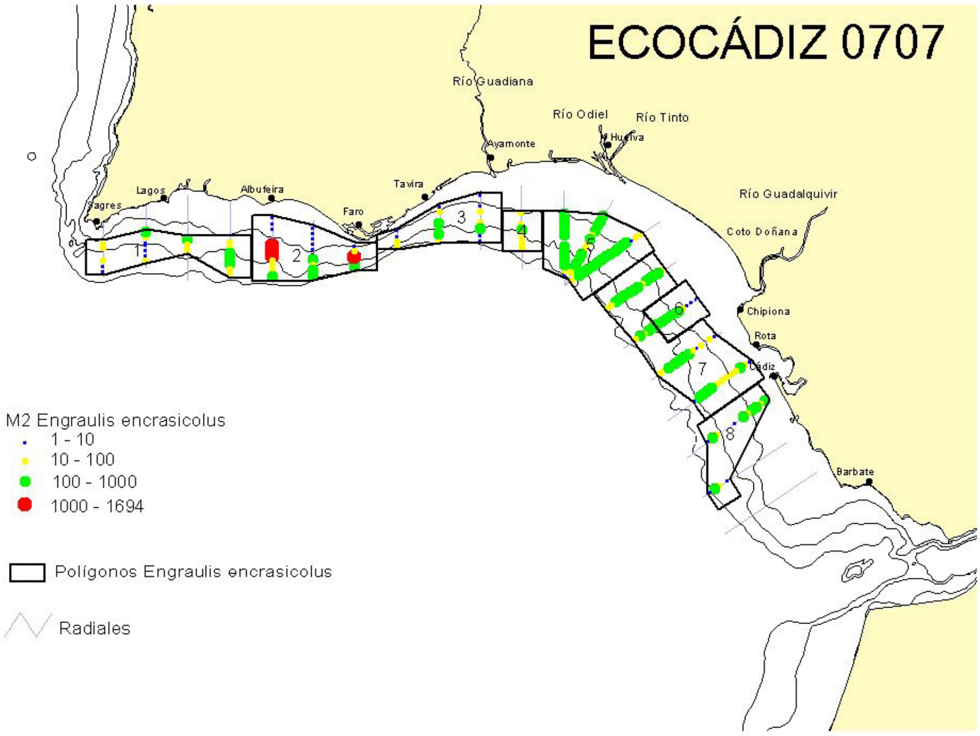


Figure 5. Anchovy egg distribution from CUFES sampling during the 2007 spring acoustic surveys carried out by IFREMER (*PELGAS07*), IEO (*PELACUS 0407*) and IPIMAR (*PELAGO07*), (source: ICES, 2007 b).

2.2.- 2007 early summer survey (only Subarea IXa South).

The *ECOCÁDIZ 0707* was carried out in the Subarea IXa South from 3 – 12 July 2007. Although anchovy occurred almost all over the shelf of the sampled area, the species 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, the species was widely distributed (20– 220 m) in the Portuguese waters 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 sA values attributed to the species in the survey were recorded (**Figure 6**).



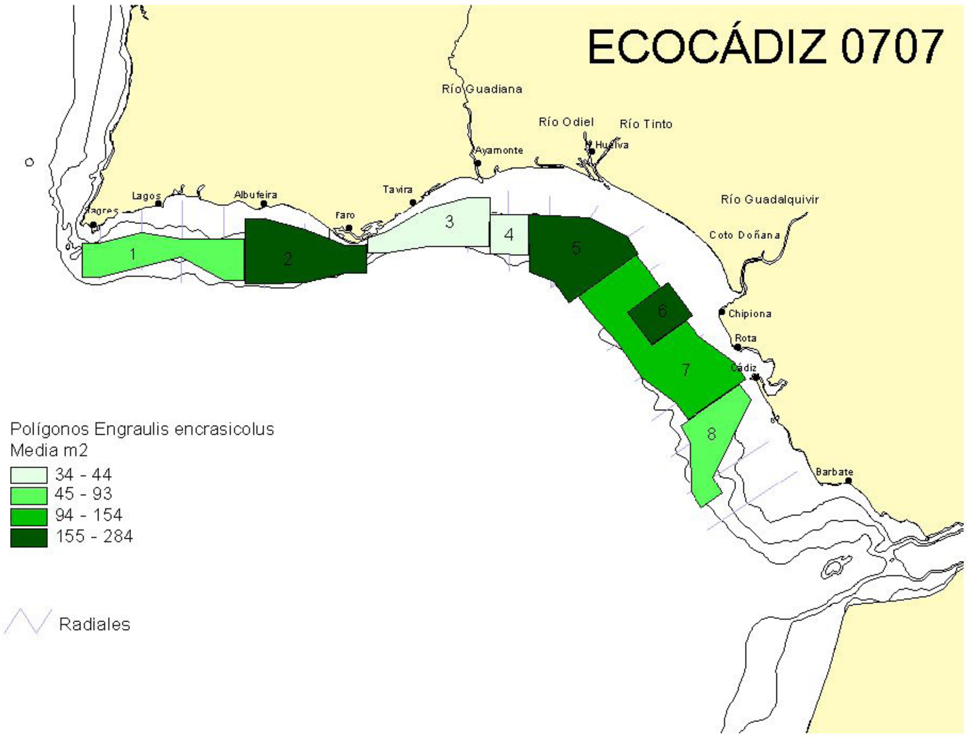


Figure 6. *ECOCÁDIZ 0707* summer Spanish acoustic survey in Subarea IXa South. Distribution of the NASC coefficients (m^2/mn^2) attributed to anchovy. Homogeneous size-based post-strata used in the abundance/biomass estimates are also shown. Top: NASC values by EDSU. Circle diameter and colour scale proportional to the acoustic energy. Bottom: strata coloured according to their average NASC values (source: ICES, 2007 b).

A further seasonal comparison of the distribution of anchovy egg densities in Subarea IXa South is possible from CUFES data from the Portuguese *PELAGO07* and the Spanish *ECOCÁDIZ 0707* acoustic surveys (**Figure 7**). The first survey took place at the beginning of the spawning season for the species in the area. Nevertheless, as stated before, the number of stations with eggs and the values of density were considerable, and higher than in previous spring surveys. 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 Portuguese spring survey. No information on anchovy eggs is still available from the *PELAGO08* survey.

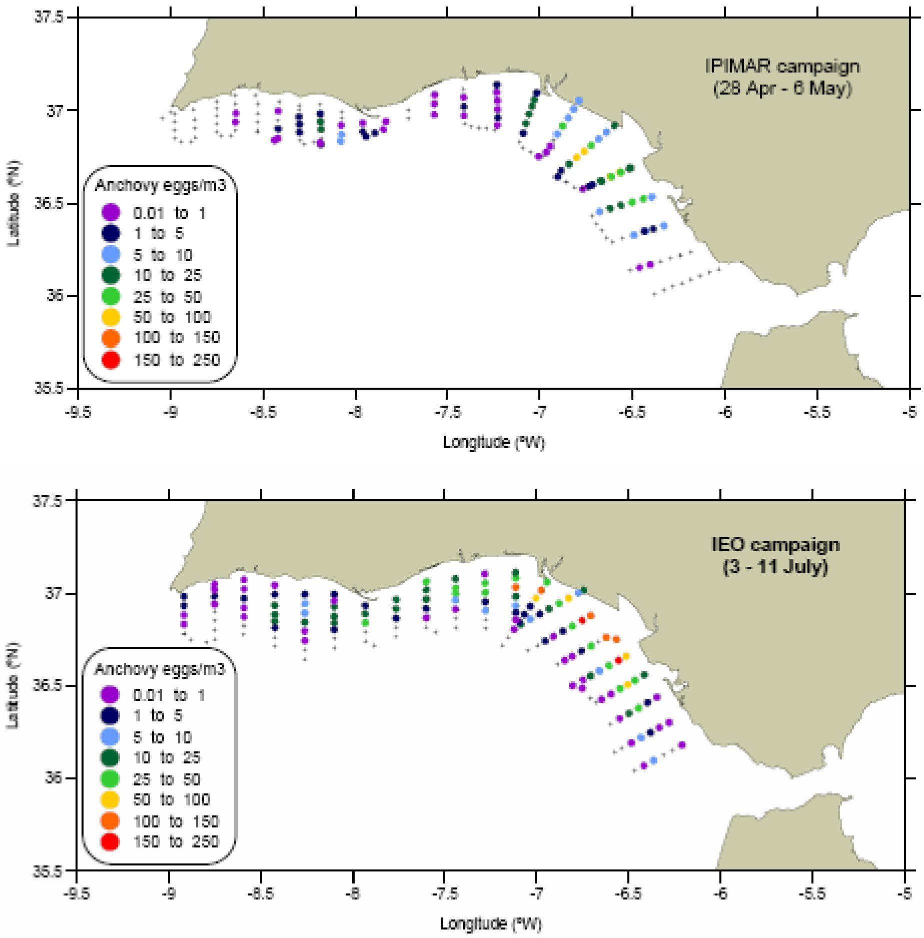


Figure 7. Anchovy egg distribution in Subarea IXa South from CUFES sampling during the 2007 spring Portuguese acoustic survey (*PELAGO07*, upper panel) and early summer Spanish acoustic survey (*ECOCÁDIZ 0707*, lower panel), (source: ICES, 2007 b).

2.3.- 2007 autumn survey.

The autumn Portuguese *SAR07NOV* acoustic survey was conducted between 24 October and 17 November 2007, with the main objective of observing and estimating the sardine recruitment to the fishery. Ship time limitations prevented from surveying the whole survey area, the acoustic sampling being restricted to those areas where sardine recruitment is more frequently observed. This decision led to the western coast from the south of Cabo Espichel southwards and the southwestern Algarvian coast till Albufeira were not sampled. Conversely, the sampling intensity by fishing stations was increased, as happened in the *PELAGO07*, in the Subarea IXa South with the aim to obtain a better understanding of the pelagic fish assemblages in an area characterised by a high species diversity. CUFES sampling was carried out during the survey but information of anchovy egg densities, if they occurred, is still not available.

As described in previous autumn (and spring-summer) surveys anchovy mainly occurred in the fishing stations carried out in the Gulf of Cadiz area, mainly in the Spanish waters, and in a lesser quantity along the Lisboan coast, between Cascais and Cabo Raso (**Figure 8**).

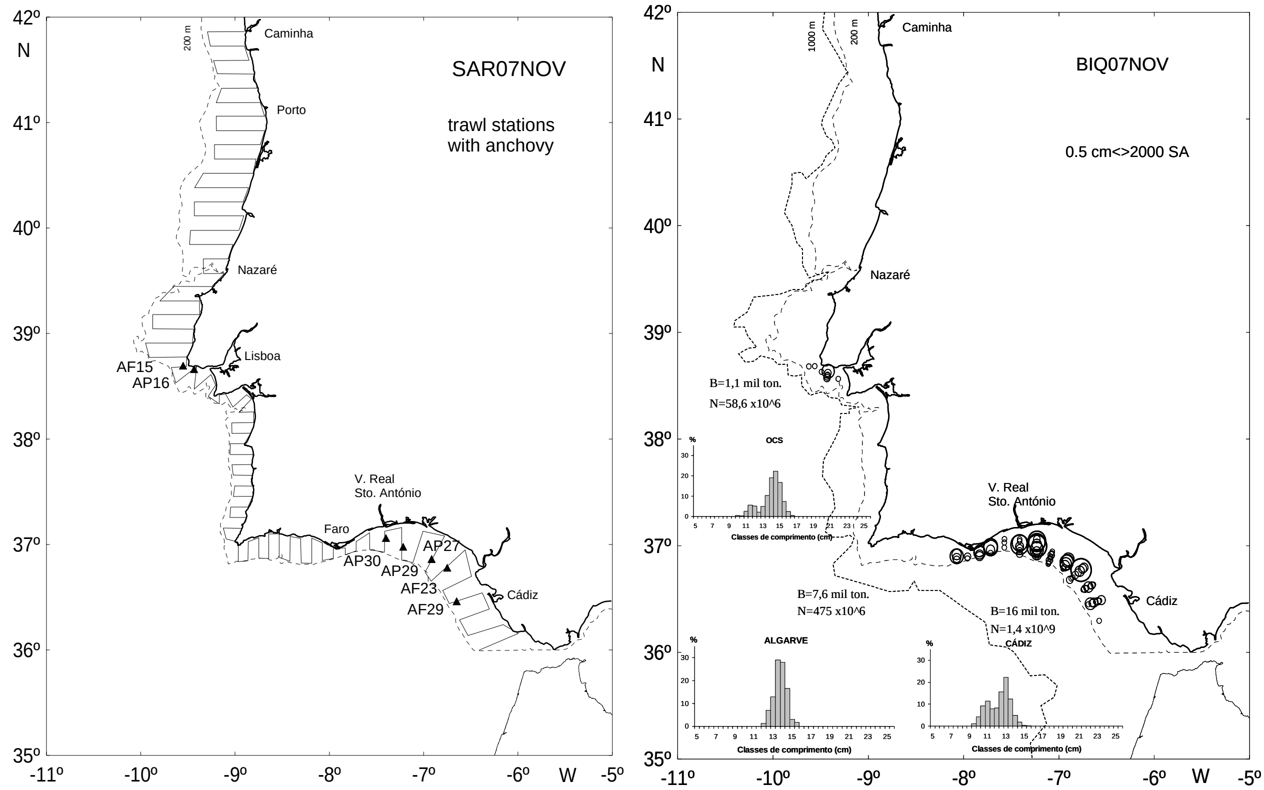


Figure 8. *SAR07NOV* autumn Portuguese acoustic survey in Division IXa. Anchovy positive fishing stations (left panel) and distribution of the NASC coefficients (m^2/mn^2) attributed to the species (right panel). Acoustic estimates and size composition of the estimated populations by subareas will be presented in the section 3 (source: Vitor Marques, IPIMAR, pers. comm.).

2.4.- 2008 spring surveys.

During the preparation of the present WD the only information available from research surveys on anchovy in Division IXa is the one from the spring Portuguese acoustic survey, *PELAGO08*. The survey was carried out between mid April-early May and found out anchovy concentrations - apart from the ones usually occurring in front of Lisbon (north of the Subarea IXa-CS), eastern Algarve (east of the IXa-S(A)) and Gulf of Cadiz (IXa-S(C)) - in front of Porto and Figueira da Foz, in the Subarea IXa-CN (**Figure 9**). Such observations indicate a more spread northernwards distribution than the observed one in recent years. As usual, the highest records of acoustic energy attributed to the species were again observed in the Spanish part of the Gulf of Cadiz (IXa-S(C)).

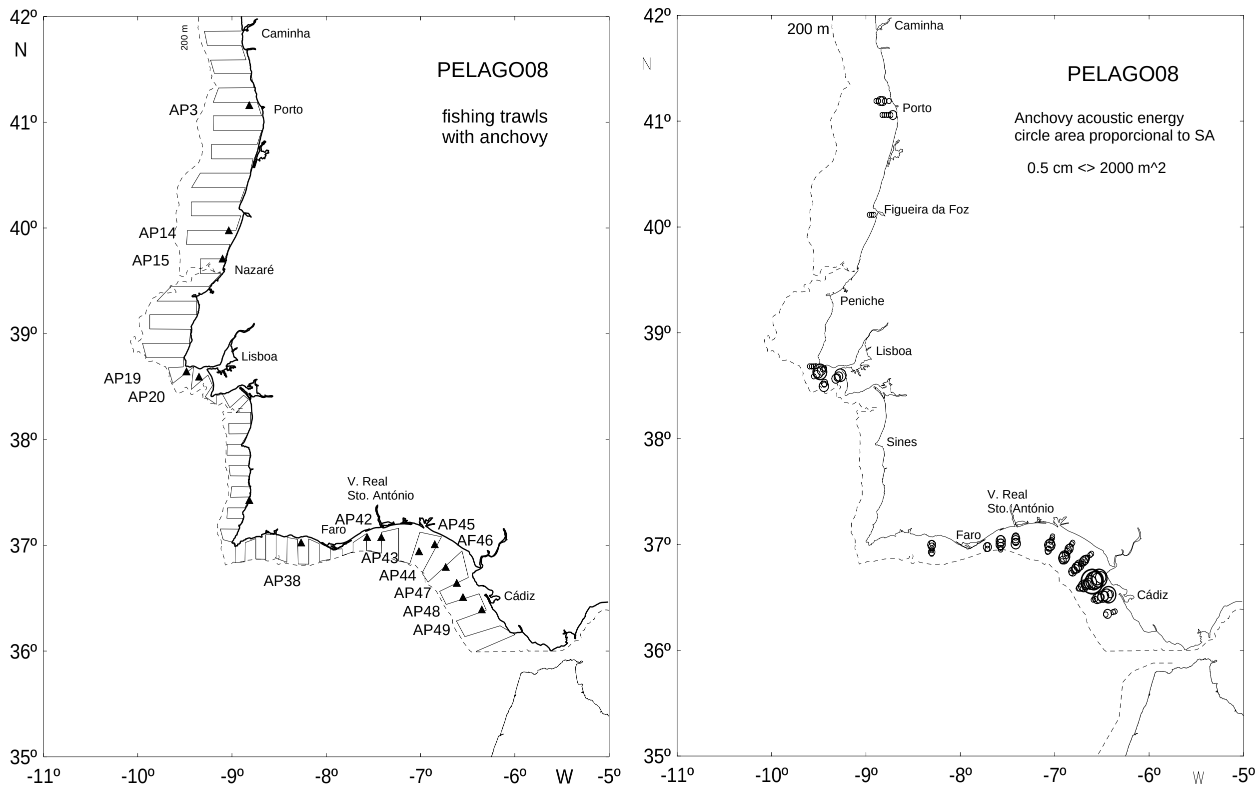


Figure 9. *PELAGO08* spring Portuguese acoustic survey in Division IXa. Anchovy positive fishing stations (left panel) and distribution of the NASC coefficients (m^2/mn^2) attributed to the species (right panel), (source: Vitor Marques, IPIMAR, pers. comm..).

3.- Acoustic estimates of anchovy abundance and biomass and its population structure in Division IXa.

3.1.- 2007 spring survey.

The anchovy total biomass estimated during the *PELAGO07* survey for the whole Division IXa was 40 thousand tonnes (3,247 million fish), which represents a 42.3% increase in relation to the average value for the entire time series (28.1 thousand tonnes), and it was almost entirely located in the Subarea IXa South (96.8%, i.e. 3,144 millions, and 95.1%, i.e. 38 thousand tonnes, of the total estimated abundance and biomass in the whole Division, respectively). As in previous years, the area with the highest anchovy abundance and biomass was the Spanish waters off the Gulf of Cadiz (Subarea IXa-S(C), 33.4 thousand tonnes, 2,860 million fish), accounting for 88% and 84% of the total estimated abundance and biomass (**Figure 10**). 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).

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 11**).

3.2.- 2007 early summer survey (only Subarea IXa South).

Anchovy total biomass in the Subarea IXa South was estimated during the *ECOCÁDIZ 0707* survey 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), (**Figure 10**). As usual, size- and age-based estimates still suggested a 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 (**Figure 11**, **Figure 13**).

3.3.- 2007 autumn survey.

Total anchovy abundance and biomass estimated during the SAR07NOV survey were estimated at 1,921 million fish and 24.8 thousand tonnes. It should be noted that these estimates don't correspond to total estimates for the sampled area usually surveyed in the Portuguese surveys since about two thirds of the Subarea IXa-CS and about the half of the Subarea IXa-S(A) were not acoustically sampled. Nevertheless, anchovy in the Spanish waters of the Gulf of Cadiz (Subarea IXa-S(C)) was abundant, with estimated abundance and biomass of 1,386 millions and 16.1 thousand tonnes. In the Algarve (Subarea IXa-S(A)) were estimated 475 million fish and 7.6 thousand tonnes. In the western coast, between Cascais and Cabo Raso (Subarea IXa-CS), the species only recorded 58.6 millions and 1.1 thousand tonnes (**Figure 10**).

Bimodal size compositions for the anchovy population in the Cascais-Cabo Raso area and the Spanish part of the Gulf of Cadiz denoted the possible ocurrence in such areas of recruitment areas. So, their respective histograms were featured by a smaller modal class either at 11 cm (Cádiz) or 11.5 cm (Lisbon), and a larger one either at 13 cm (Cádiz) or 14.5 cm (Lisbon). Anchovy size composition in the Algarve area showed only one mode at 13 cm. (**Figure 11**)

3.4.- 2008 spring surveys.

The anchovy total biomass estimated during the *PELAGO08* survey for the whole Division IXa was 39.7 thousand tonnes (2,353 million fish), a biomass level almost identical to the one recorded the previous year, but coupled to a slight diminution in abundance, which suggests the occurrence of a population composed by larger fish. Anchovy was mostly concentrated, as usual, in the Spanish Gulf of Cadiz (Subarea IXa-S(C)), accounting for 77% (1,819 millions) and 74% (29.5 thousand tonnes) of the total estimated abundance and biomass in the Division, respectively. The Algarve (Subarea IXa-S(A)) yielded 4.7 thousand tonnes (212 millions), the Subarea IXa-CS (concentrated only in the Cascais-Cabo Raso area) 2.5 thousand tonnes (252 millions), and the Subarea IXa-CN (only two spots at Porto and Figueira da Foz) 3.0 thousand tonnes (69 millions), (**Figure 10**).

The anchovy length composition along the Division showed a general southward decreasing size gradient. So, the size histogram from the population in the Subarea IXa-CN showed two modes, the smaller one at 12 cm and the most important and larger at 17.5 cm. In the IXa-CS anchovy presented two well marked modes, the first and stronger one placed at 9 cm, indicating the occurrence of an important and late recruitment event in the population, and a larger scondary mode at 15 cm with a lower relative importance. Gulf of Cadiz anchovy population (IXa-S) was featured by a mixed size composition, with a clearly defined mode at 13 cm and secondary modes at 11 and 15 cm (**Figure 12**).

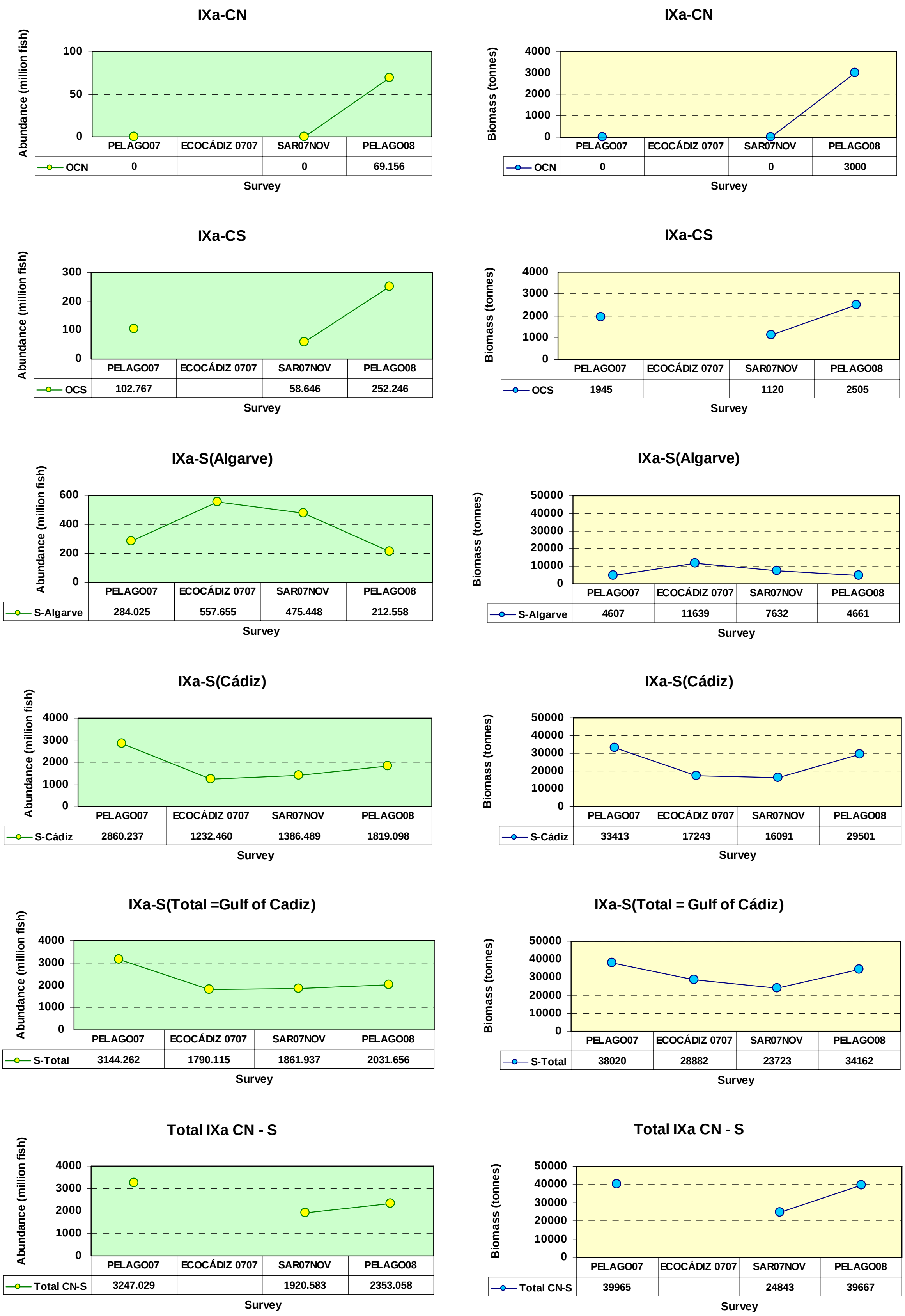


Figure 10. Recent trends (2007 and first half 2008) in acoustic estimates of anchovy abundance (million fish) and biomass (tonnes) in the Division IXa. Note the different scale on the y-axis (source: ICES, 2007 b and Vitor Marques, IPIMAR; pers. comm..).

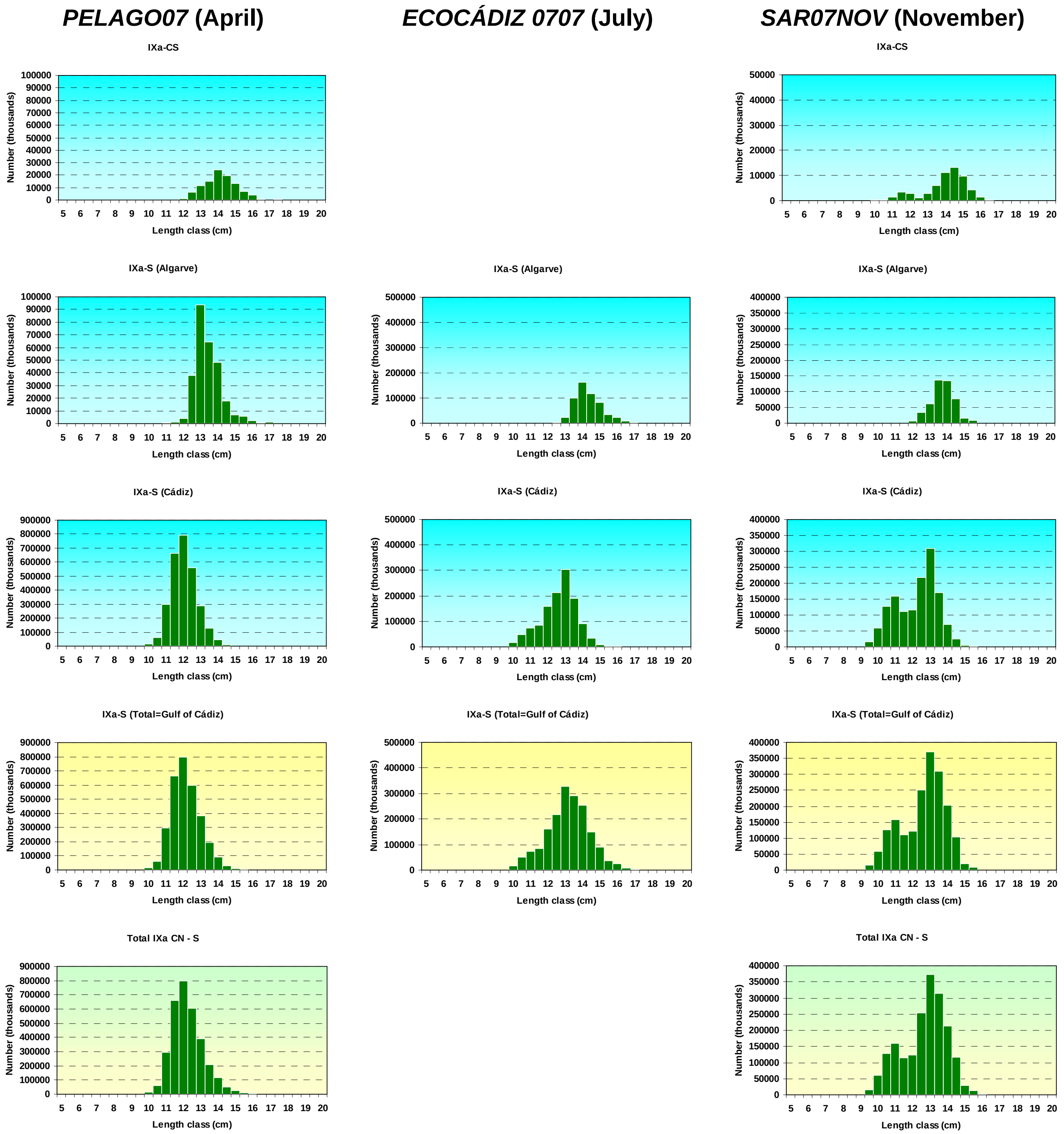


Figure 11. Estimated abundances by size class in the 2007 acoustic surveys. Note both the different scales in the y-axis depending on the Subarea and survey and the two last rows showing respectively subtotals for the entire Subarea IXa-S (=Algarve + Cádiz areas) and totals for the whole sampled area in the Portuguese surveys (from Subarea IXa-CN to Subarea IXa-S), (source: ICES, 2007 b and Vitor Marques, IPIMAR, pers. comm.)

PELAGO08 (April)

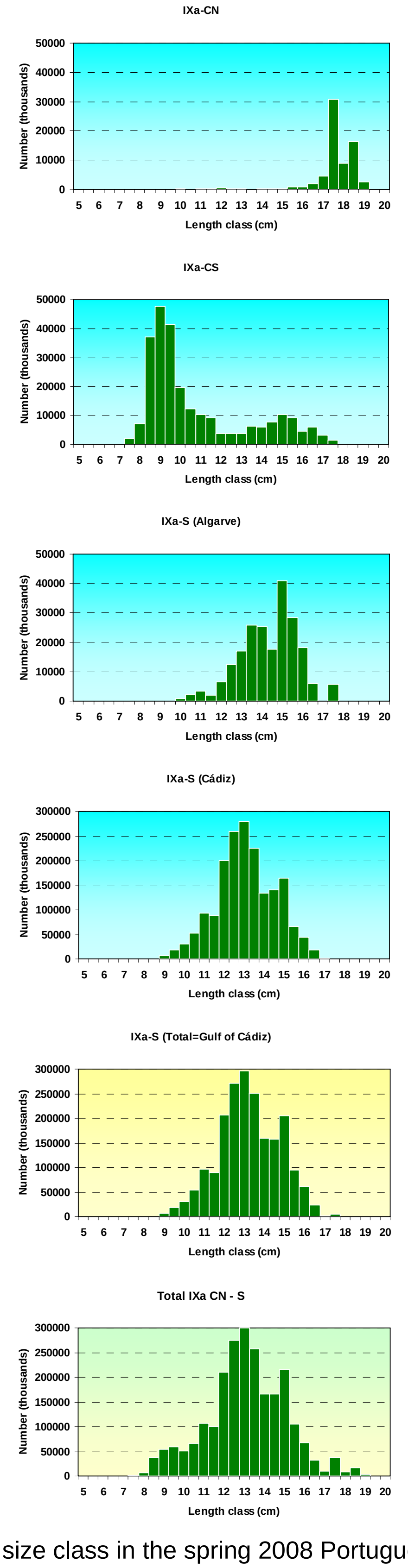


Figure 12. Estimated abundances by size class in the spring 2008 Portuguese acoustic survey, *PELAGO08*. Note both the different scales in the y-axis depending on the Subarea and the two last rows showing respectively subtotals for the entire Subarea IXa-S (=Algarve + Cádiz areas) and totals for the whole sampled area in the Portuguese surveys (from Subarea IXa-CN to Subarea IXa-S), (source: Vitor Marques, pers. comm.).

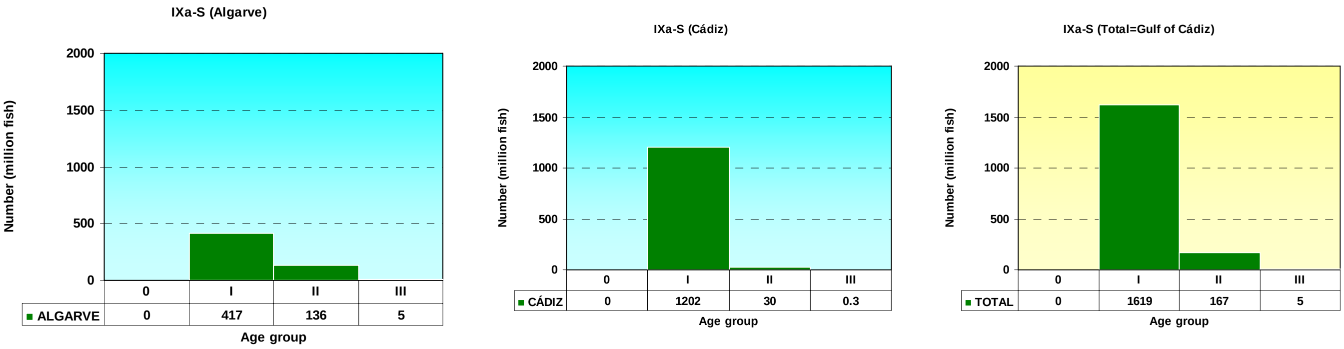


Figure 13. Estimated abundances by age group in the early summer 2007 Spanish acoustic survey, *ECOCÁDIZ 0707* (source: ICES, 2007 b).

4.- Time series of acoustic estimates.

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 Subarea IXa South only (Spanish surveys) are shown in **Table 1** and **Figures 14**, **15** and **16**. The estimates from the 2006 Spanish survey have been re-calculated under the "multi-species approach" and the WGACEEG recommended TS value set. Such estimates, therefore, differ from those ones previously reported either to WGMHSA or WGACEEG. Something similar also happens with the estimates from the 2004 Spanish survey (in this WD the estimates derived from using the accepted TS (b20) value of –72.6 dB instead of the formerly used of –71.2 dB is included) although these last estimates are pending of a further revision.

Table 1. Historical series of overall and regional acoustic estimates of anchovy abundance (millions) and biomass (tonnes) in Division IXa from Portuguese (*SAR-PELAGOS* series, upper pannel) and Spanish surveys (*ECOCÁDIZ* series, lower pannel).

Portuguese survey	Estimate	Portugal				Spain	S(Total)	TOTAL	Sampled depth range	b_{20} Anchovy
		C-N	C-S	S(A)	Total	S(C)				
Nov. 1998	Number	30	122	50	203	2346	2396	2549	20-200 m	-71.2
	Biomass	313	1951	603	2867	30092	30695	32959		
Mar. 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		
Mar. 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		
Mar. 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	-	59	-	59	1306	1306	1364		
	Biomass	-	1062	-	1062	14041	14041	15103		
April 2006	Number	-	-	319	319	1928	2246	2246		
	Biomass	-	-	4490	4490	19592	24082	24082		
April 2007	Number	0	103	284	387	2860	3144	3247		-72.6
	Biomass	0	1945	4607	6552	33413	38020	39965		
Nov. 2007	Number	0	59	475	534	1386	1862	1921		
	Biomass	0	1120	7632	8752	16091	23723	24843		
April 2008	Number	69	252	213	534	1819	2032	2353		
	Biomass	3000	2505	4661	10166	29501	34162	39667		

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

Spanish Surveys	Estimate	Portugal: Algarve	Spain: Gulf of Cadiz	IXa South	Sampled depth range	$b_{20\ \mathrm{Anchovy}}$
June 2004 *	Number	125	1109	1235	30-200 m	-72.6
	Biomass	2474	15703	18177		
June 2006	Number	363	2801	3163	20-200 m	
	Biomass	6477	30043	36521		
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 estimates are pending of revision (application of recent IEO standards in the estimation process: delimitation of post-strata, increased number of assessed species, species-specific TS, etc).

The estimates from those surveys covering the whole southernmost subarea (the IXa South, whose population is explored by an analytical assessment) 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 (mainly the Autumn Portuguese one) 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 18–14 thousand tonnes, evidencing a possible decline in the (spawning) population levels. In the 2005 WGMHSA and WGACEEG meetings was warned that the picture of an alarming decreasing trend just in 2004–2005 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, 2006 b) or to the echo-traces discrimination between fish and plankton (2005 Portuguese survey, Marques *et al.*, 2005; ICES, 2006 b). 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. Despite these facts a decline in the spawning population in 2005 was corroborated by two different direct sources, the Spring Portuguese acoustic survey and the Spanish DEPM one, which both yielded an estimated SSB at 14 thousand tonnes.

Notwithstanding the above, the 2005-2008 Portuguese spring survey seasons were coincident and their estimates, therefore, comparable, and they indicate an evident recovered population in 2006 and 2007-2008 up to a level close (2006) or even somewhat higher (2007, 2008) to the average estimate in the (Portuguese) historical series. The high 2006 estimate from the Spanish survey 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 in 2007 and then a slight decrease of 4 thousand tonnes in 2008) than the trend exhibited by its Spanish counterparts (a 7.6 thousand tonnes decrease). 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 happened that year for such differences is a matter of concern and some working hypothesis were drawn in the last year's WGACEEG for explaining the above differences.

A wider distribution for anchovy along the subdivision is only recorded in some years of the time series. 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 in the Subarea IXa-S, Ramos *et al*. (2007 b) suggested that the spatial dynamics of anchovy abundance and biomass (and probably sardine as well) in summer may be controlled in recent years in this area 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) (see, for example, Quiñones *et al*., 1997; Bertrand *et al*., 2004, 2006). Other evidences from other direct sources quoted by the authors demonstrated, at least for anchovy, that the species exhibited in summer 2007 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.

5.- CONCLUSIONS

The waters of the Division IXa (Atlantic façade of the Iberian Peninsula and Gulf of Cádiz) show a high diversity of pelagic fish species, in comparison with other pelagic assemblages 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 in the Division is mainly confined to one defined area 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 this area. A persistent but secondary spot of anchovy occurrence is also found in recent years in front of Lisbon. In 2008, new although residual and scattered nuclei of anchovy density have been observed in the northernmost waters as a probable consequence of favourable environmental conditions.

The situation of the anchovy population extracted from the acoustic surveys is as follows: anchovy in Division IXa and specially Gulf of Cádiz anchovy show in comparison to the Bay of Biscay anchovy a better perspective from the different acoustic estimates available (IPIMAR and IEO) and from the observed distribution of eggs (from CUFES). Spring acoustic surveys from IPIMAR and IEO in 2007 provided relatively close biomass estimates (40,000 t and 29,000 t respectively, although the later one is only for the Subarea IXa-S), and a similar spatial distribution of the stock (mainly located in the Spanish waters of the Gulf). These estimates seems to indicate: (a) a slight increase in 2007 in relation to previous years, (b) such increase is still maintained in 2008 (40,000 t), although supported by a lower population number than in the preceeding year, (c) such biomass vs abundance relationship in 2008 suggests an increased mean size in the spawning population probably related with a more feeble year class and the maintaining of the population by the larger (-older) fish.

The distribution of eggs in 2007 also showed 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 (14,219 tonnes in 2005) was also coincident with the Portuguese acoustic estimation (14,041 tonnes); 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 recent past.

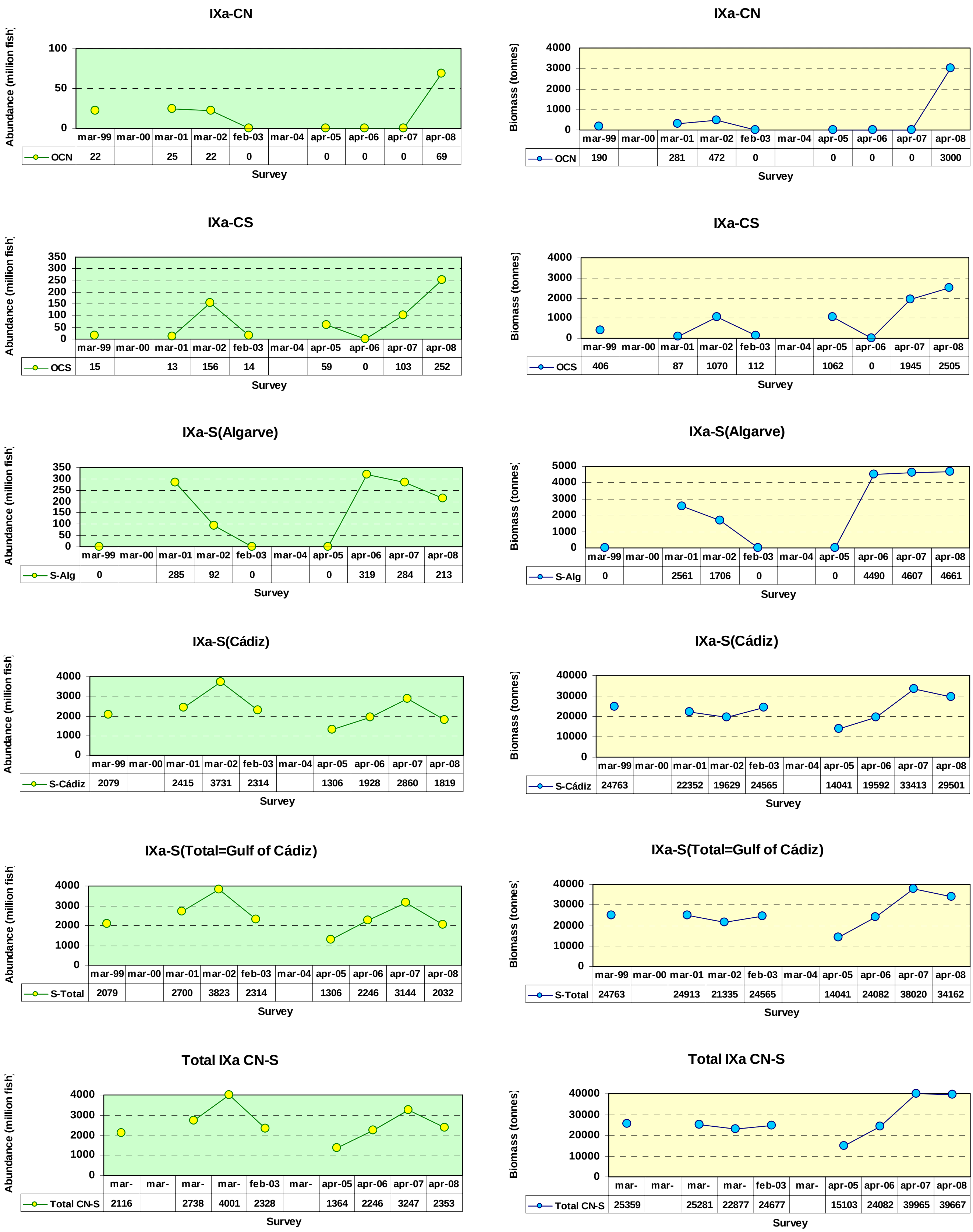


Figure 14. Historical series of anchovy acoustic estimates (abundance in million fish, biomass in tonnes) from Spring Portuguese surveys in the Division IXa. Note the different scale on the y-axis (source: ICES, 2007 b and Vitor Marques, IPIMAR; pers. comm.).

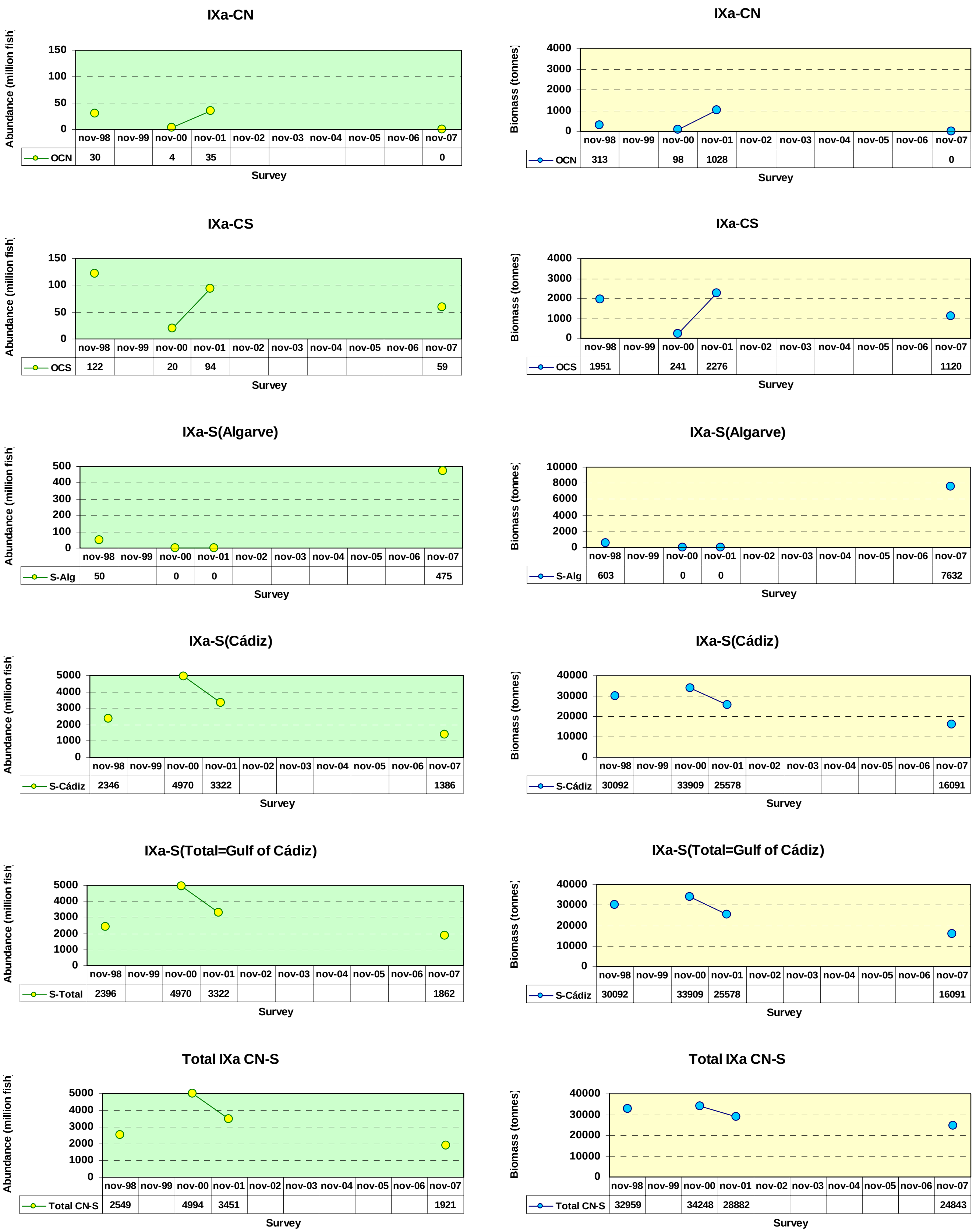


Figure 15. Historical series of anchovy acoustic estimates (abundance in million fish, biomass in tonnes) from Autumn Portuguese surveys in the Division IXa. Note the different scale on the y-axis (source: ICES, 2007 b and Vitor Marques, IPIMAR; pers. comm.).

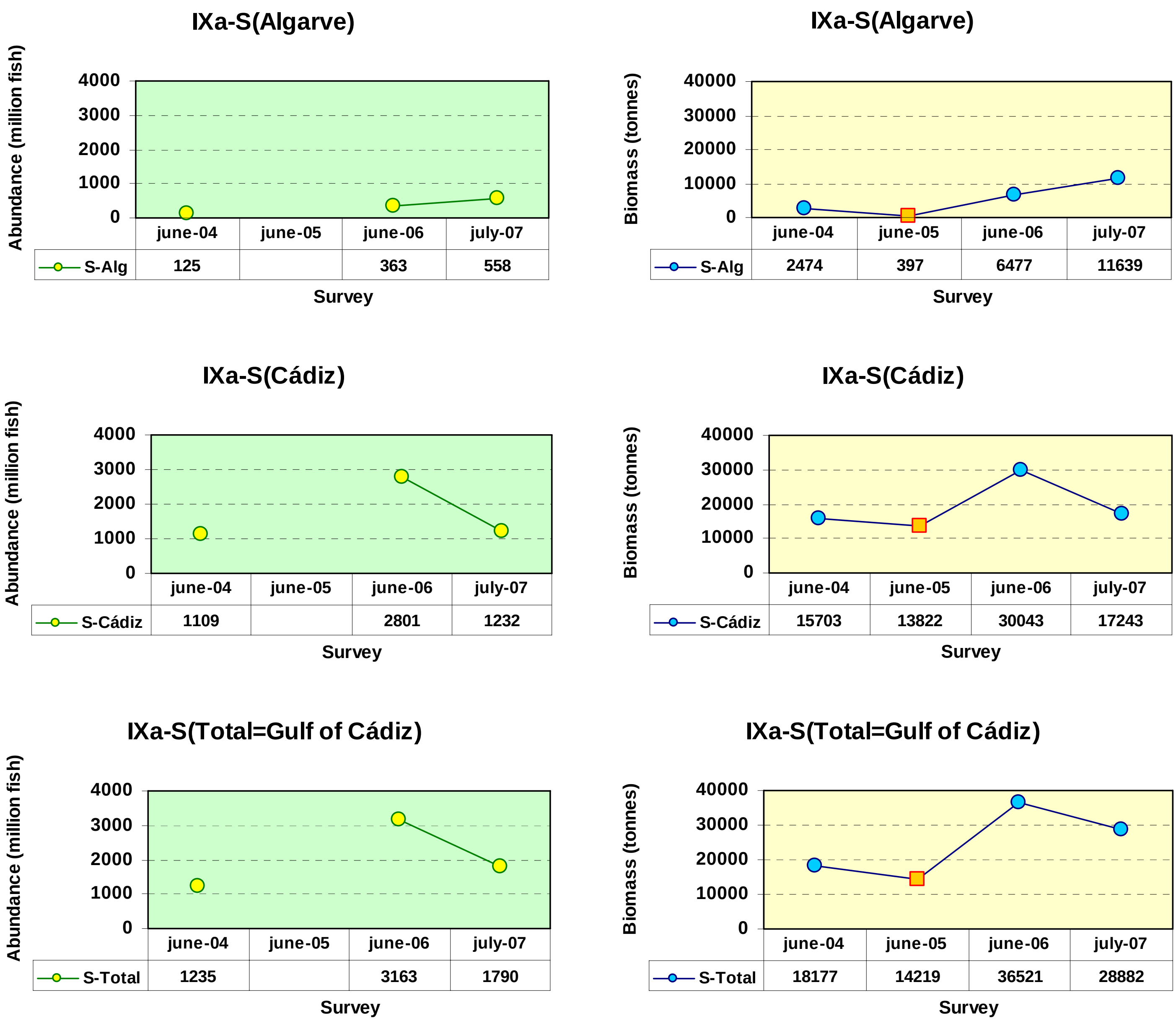


Figure 16. Historical series of anchovy acoustic estimates (abundance in million fish, biomass in tonnes) from Summer Spanish surveys in the Subarea IXa-South. 2004 estimates are pending of further revision (application of recent IEO standards in the estimation process: delimitation of post-strata, increased number of assessed species, species-specific TS, etc). 2005 estimates correspond to those from the anchovy DEPM survey (depicted by a different symbol and color). 2006 and 2007 acoustic estimates are revised (or corrected) ones after application of the new IEO-WGACEEG standards. (Note the different scale on the y-axis (source: ICES, 2007 b).

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Preliminary estimates of the Spawning Stock Biomass of the Bay of Biscay anchovy (*Engraulis encrasicolus*, L.) applying the DEPM

by

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Abstract

The research survey BIOMAN 2008 for the application of the Daily Egg Production Method (DEPM) in the Bay of Biscay anchovy has been conducted in May 2008 from the 6th to the 26th covering the whole spawning area of the species. A preliminary SSB estimate is obtained as the ratio between the total daily egg production (P_{tot}) and the daily fecundity (DF) estimates. P_{tot} is calculated as the product of the spawning area and the daily egg production rate (P_0), which is obtained from the exponential mortality model fitted as a Generalized Linear Model (GLM) to the egg daily cohorts. As the adults samples are not fully processed yet, the DF estimate is based on its relationship with the average Sea Surface Temperature (SST) inferred from the historical series as last year. The preliminary biomass estimate in that manner is 24,712 t with a coefficient of variation of 18% what is similar to the last year estimate (25,973 t; CV 14%).
Approximately a 58% (CV=10%) of the population in millions of individuals (71% in mass) is older than one year. This indicates a new failure in the recruitment, as in the last years.

1. INTRODUCTION

A research survey for the application of the Daily Egg Production Method (DEPM) for the Bay of Biscay anchovy, consisting of both ichthyoplankton and adult sampling, has been conducted by AZTI-Tecnalia. The survey took place from the 6th to the 26th of May covering the whole spawning distribution area of the species, these allows obtaining direct estimates of population biomass and age composition.

This survey, called BIOMAN08, has been founded by the Agriculture, Fisheries and Food Technology Department of the Basque Government and by the European Commission within the frame of the Data Collection Regulation. The General Secretariat of Marine Fisheries has also collaborated providing the R/V Emma Bardán.

In December 2007 the European Commission established a zero TAC for the Bay of Biscay anchovy until June 2008. Ministers agreed with the Commission's proposal. The situation will be reviewed once scientific advice from this DEPM survey and the Acoustic one performed by IFREMER (France) becomes available at the end of spring 2008

This working document describes the BIOMAN08 survey and provides a preliminary SSB estimate based on the ratio between the total daily egg production (P_{tot}) estimate and a preliminary daily fecundity (DF) estimate derived from the historical series. Besides the population at age estimates are obtained.

2. METHODOLOGY

The different sources of the samples obtained for the implementation of the DEPM in 2008 are summarised in **table 1**. There were collected ichthyoplankton samples to estimate the total egg production and the spawning area and adult samples to estimate the daily fecundity of the adults and the population at age estimates.

Table 1: Description of egg and adult samples obtained for the implementation of the DEPM in 2008

Parameters to estimate	Survey	Vessel	Date	Samples	Selected samples
Total egg production & Spawning area	BIOMAN08	R/V Investigador	6-26 May	544	544
Daily fecundity & Numbers at age	BIOMAN08	R/V E. Bardán	6 - 25 May	39	20

2.1 Collection of plankton samples

The survey BIOMAN08 has been carried out on board R/V Investigador from 6th to the 26th of May. The area covered was the southeast of the Bay of Biscay (**Figure 1**), which corresponds to the main spawning area and season of anchovy. The limit of the spawning area has been well delimited: 3º33'W to the West in the Cantabrian Coast and 48º10'N to the North in the French platform. The sampling was conducted in two phases:

- The first phase, from 6th to the 16th of May, covered the Cantabrian Coast from 4º14'W to the east, up to 45º38'N. There was a change of the scientific crew in the port of Le Verdon.

- The second phase, from 16th to 26th May, left from the port of Le Verdon to cover the remainder French coast up to 48º108'N and 4º45'W, getting back to the port of Pasajes where the survey finished.

Distributions of the vertical hauls performed with the PairoVET net are shown in **Figure 1**. The strategy of egg sampling was identical to that used in previous years (Uriarte *et al.*, 1999), i.e. a systematic central sampling scheme with random origin and sampling intensity depending on the egg abundance found. Stations were located every 3 miles, along 15-mile-apart transects perpendicular to the coast.

The sampling strategy was adaptive. The survey started from the West of Santander (transect R11, approx. 4º14'W), and covered the Cantabrian Coast eastwards up to Pasajes (transect R25) (**Figure 1**). Then, the survey continued to the north, in order to find the Northern limit of the spawning area. When the egg abundances found were relatively high, additional transects separated by 7.5 nm were completed.

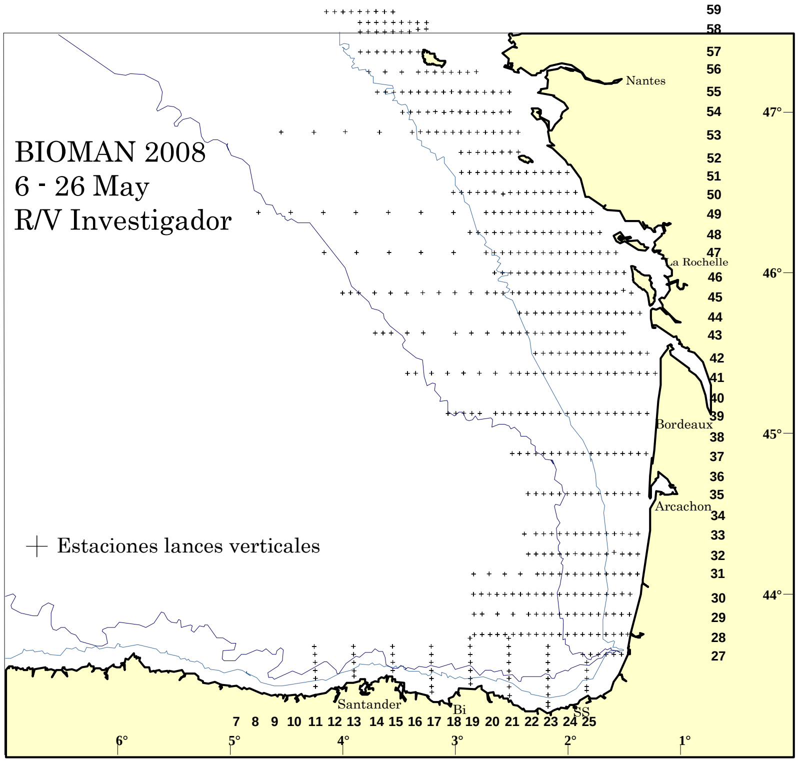


Figure 1: Plankton stations obtained during BIOMAN 08.

The samples obtained were fixed in formaldehyde 4% buffered with sodium tetra borate. After 6h of fixing, anchovy, sardine and other species eggs were identified and sorted out. All the samples were sorted on-board. Afterwards, in the laboratory a percentage of the samples were checked to find possible eggs left. The total number of PairoVET obtained was 544.

The Continuous Underway Fish Egg Sampler (CUFES) was also used to record the eggs found at 3m depth. The samples obtained were immediately checked under the microscope so that presence/absence of anchovy eggs was detected in real time. This allowed knowing whether there were anchovy eggs in the area. When anchovy eggs were not found in 6 consecutive CUFES samples in the oceanic area, transect was left.

2.2 Collection of adult samples

The adult samples were obtained on-board the pelagic trawler R/V Emma Bardán. This vessel was covering the same area as the plankton vessel. When the plankton vessel encountered areas with anchovy eggs, the R/V Emma Bardán was direct to those areas to fish. The hauls were consisted mainly of anchovy, sardine, mackerel, horse mackerel and hake (**Annex I**). In each haul 100 individuals of each specie were measure.
Immediately after fishing, anchovy were sorted from the bulk of the catch and a sample of near 2 Kg was selected at random. Sampling finished as soon as a minimum of 1 kg or 60 anchovies were sexed, and from those, 25 non-hydrated females (NHF) were preserved. Sampling was also stopped when more than 120 anchovies had to be sexed to achieve the

target of 25 NHF. Moreover, otholits were extracted to obtain the age composition per sample. 39 pelagic trawls were performed, from those 29 had anchovy but only on 20 were found a minimum of 60 anchovies what is the minimum to consider the sample for the analysis. The spatial distribution of the fishing hauls are shown in **Figure 2**.

Currently, the adult samples are being processed for the estimation of the daily fecundity and are not available to apply the complete DEPM to obtain the final SSB estimate.

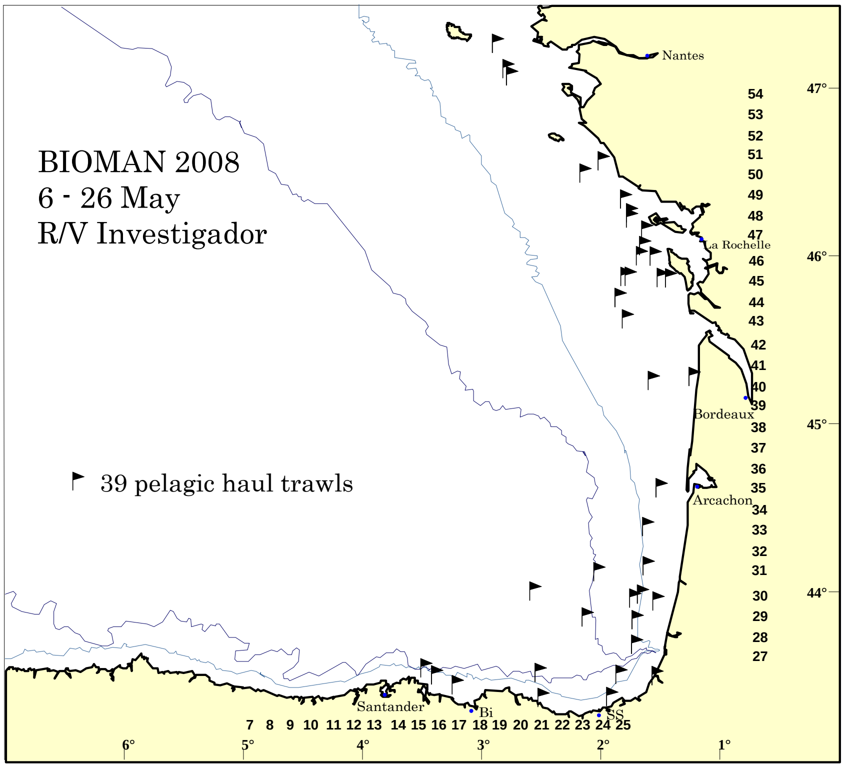


Figure 2: Spatial distribution of fishing hauls from R/V Emma Bardán.

2.3 Hydrographical parameters

At each PairoVET sampling station, sea surface temperature and salinity were measured with a manual thermosalinometer. In addition, temperature and salinity were recorded in the water column at each plankton haul using a CTD RBR XR420 and chlorophyll-a using a coupled fluorimeter.

CUFES had a CT to record temperature and salinity, a flowmeter to measure the volume of the filtered water and a GPS (Geographical Position System) to provide sampling position and time. All these data were registered at real time using the software EDAS.

An ADCP (Acoustic Doppler Current Profiler) allowed to record data on currents.
At some of the sampling stations additional samples of water were obtained in order to obtain chlorophyll samples for calibration.

2.4 Estimation of the spawning stock biomass

The Daily Egg Production Method (DEPM), first introduced by Parker (1980), consists on estimating the spawning stock biomass as the ratio between the total daily egg production and the daily fecundity estimates:

$$SSB = \frac{P_{tot}}{DF} = \frac{P_0 SA}{RSF/W_f}$$

The full application of the DEPM requires the estimation of all the parameters.

2.4.1 Preliminary SSB estimate based on the ratio between P_{tot} and a preliminary estimate of DF from the historical series

When all the anchovy eggs are sorted and staged, it is possible to estimate P_{tot} using the standard procedures. However, as the adult samples are not processed yet, DF has to be derived from the past historical series. The estimation of each of these parameters is as follows:

Total daily egg production is calculated as the product between the daily egg production and the positive area

$$P_{tot} = P_0 \; SA$$

A standard sampling station represents a surface of 45 nm^2 (i.e. 154 km^2). Since the sampling was adaptive, area per station changes according to the sampling intensity and the cut of the coast. The total area is calculated as the sum of the area represented by each station. The spawning area (SA) is delimited with the outer zero anchovy egg stations but it can contain some inner zero stations embedded. The spawning area is computed as the sum of the area represented by the stations within the spawning area.

The staged eggs are transformed into daily cohort abundances using the Bayesian ageing method developed within the GAM project (99/080). Daily egg production (P_0) and daily mortality (Z) rates are estimated by fitting an exponential mortality model to the egg abundance by cohorts and corresponding mean age.

The model is fitted as a Generalised Linear Model (GLM) with Negative Binomial distribution and log link.

The ageing process and the model fitting are repeated until convergence. Eggs younger than 4 hours and older than 90% of the incubation time are removed from the model fitting to avoid any possible bias.

In order to estimate Daily Fecundity from the historical series, the assumptions made is the same followed last year: DF is linearly dependent on Sea Surface Temperature (SST).

Then, SSB is just the ratio between the P_{tot} and DF estimates and its variance can be computed using the Delta method (Seber, 1982):

$$\hat{Var}[SSB] = \frac{\hat{Var}[Ptot]}{DF^2} + \frac{P_{tot}^{\ 2}\hat{Var}[DF]}{DF^4}$$

2.5 Numbers at age

For the purposes of producing population at age estimates, the age readings based on 1,745 otholits from 20 samples collected on board R/V Emma Bardán were available. Estimates of anchovy mean weights and proportions at age in the adult population were computed as a weighted average of the mean weight and age composition per samples where the weights were proportional to the population (in numbers) in each stratum. These weighting factors are proportional to the egg abundance per stratum divided by the numbers of samples in the stratum and the mean weight of anchovy per sample. Weighting factors were allocated according to the amount of samples in 2 strata defined in **figure 3**, and equally according to the relative egg abundance in those areas.

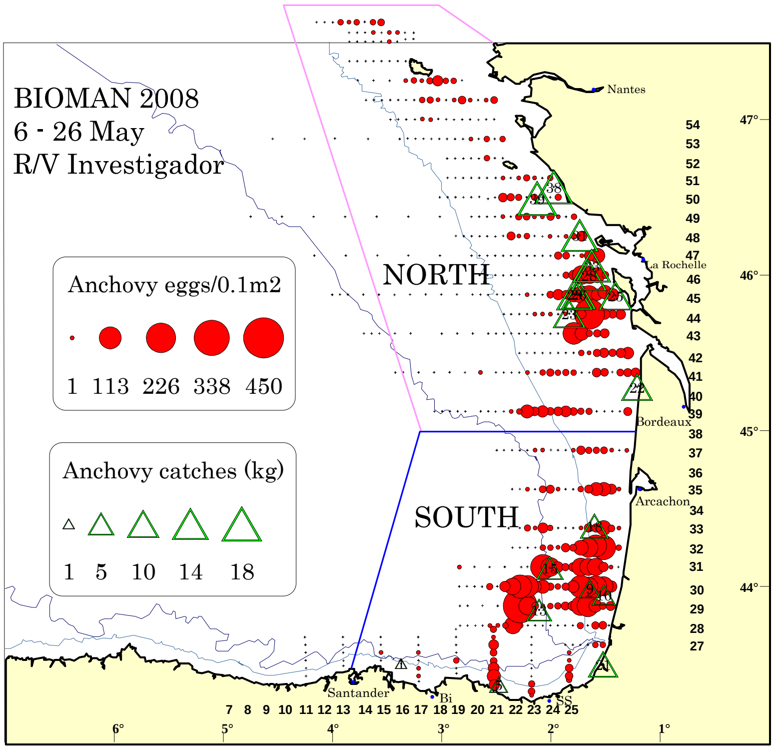


Figure 3: 2 strata defined for the estimation of the numbers at age

3. RESULTS

3.1 Egg sampling

The total area surveyed was 69, 150 Km^2 and the spawning area was 33,502Km^2.
A total of 544 vertical tows were completed using a PairoVET net 150µm (2-CalVET nets, Smith *et al.*, 1985). A total of 1,200 CUFES samples were obtained.
From 544 PairoVET, 237 were positive for anchovy eggs (43%) with an average of 7 eggs/0.1m^2 per station and a maximum of 306 eggs/0.1m^2. A total of 4,086 anchovy eggs were encountered.

The anchovy eggs were concentrated in two principal areas: the area of Cap Breton between 43º45' and 44º23' and from the coast to 43º30'W, once passed the isoline of 200m, and the area of influence of the Gironde river between 45º35'N and 46º07'W in the area of 50m depth, close to the coast. Egg abundance was scarce across the Cantabric coast. The maximum number of eggs encountered in a station was 306 eggs/0.1m^2 in a station located in the area of Cap Breton once passed the isoline of 200m in transect 29. (**Fig. 4**) As a result, immediately after the survey the total egg abundance (Ab_{tot}) calculated as the egg encountered in each station by the area represented by each station was 3.58 10^{12} eggs/0.1m^2. Last year was 4.22 10^{12} eggs/0.1m^2.

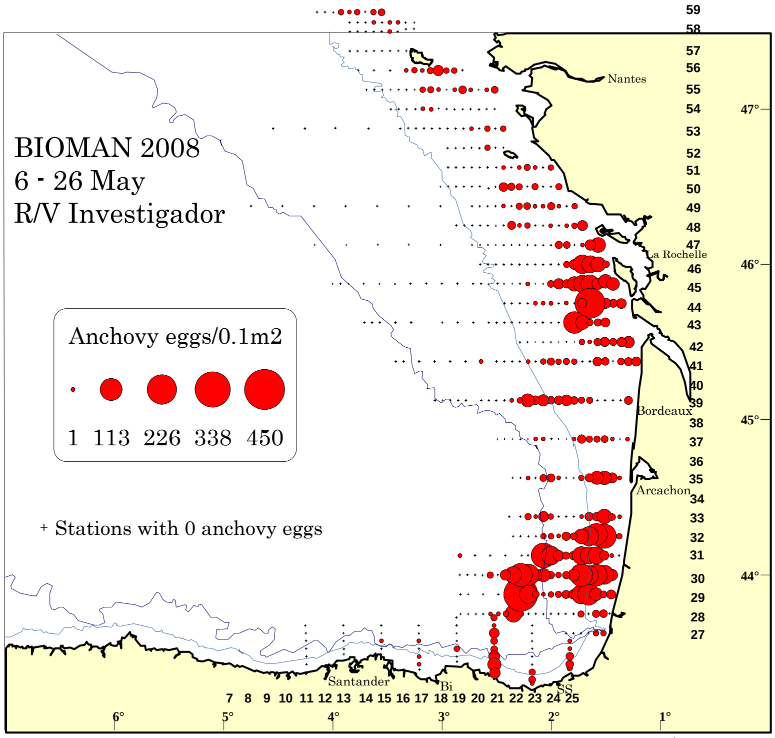


Figure 4: Plankton stations and egg abundances (eggs per 0.1m^2) from the DEPM survey BIOMAN08 obtained with PairoVET.

3.2 Adult sampling

The fishing hauls for adult sampling are summarised in **Annex I**. From the 39 pelagic trawl hauls performed on-board R/V Emma Bardán 29 had anchovy but only on 20 was found a minimum of 60 anchovies, what is the minimum to consider the sample for the analysis. The spatial distribution of the samples and their composition is showed in **figure 5. Figure 6** shows the positive hauls for anchovy and the capture, **figure 7** shows the mean weight, **figure 8** the mean size and **figure 9** the age composition.

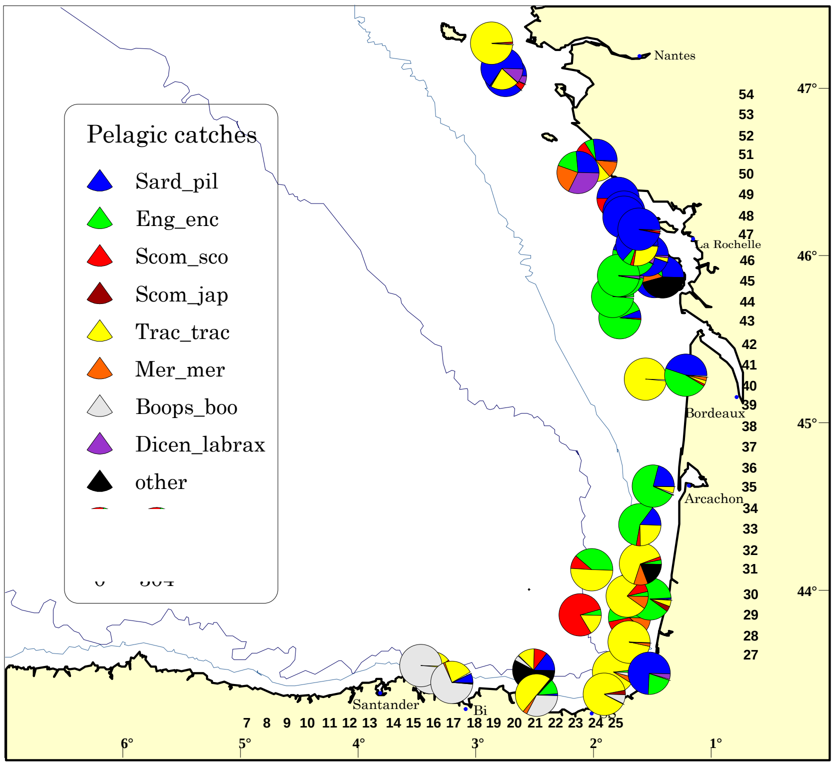


Figure 5: Species composition of the 39 fishing hauls from the R/V Emma Bardán.

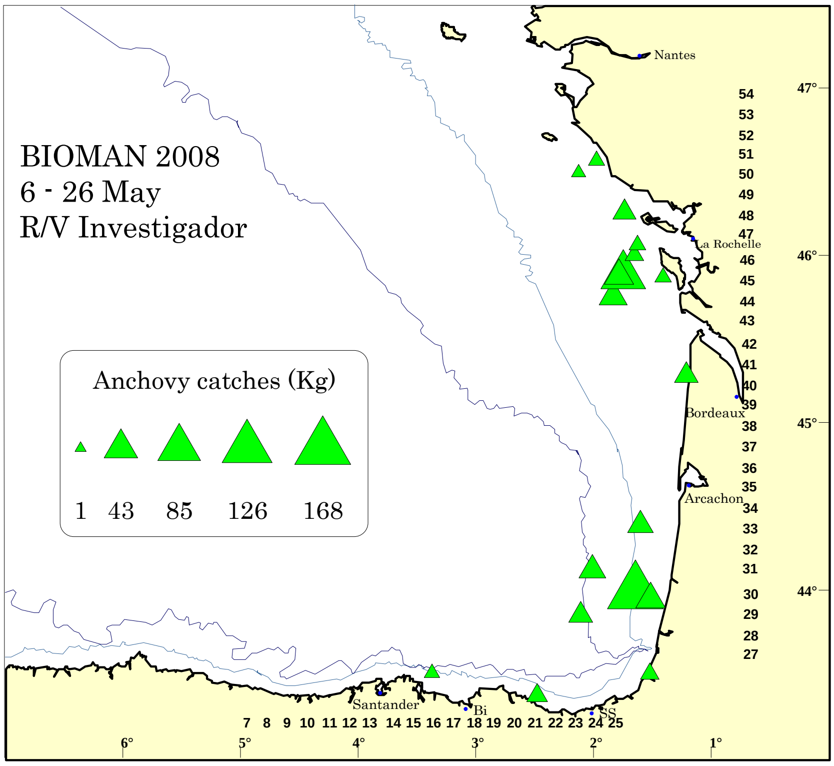


Figure 6: Anchovy catches in the fishing hauls.

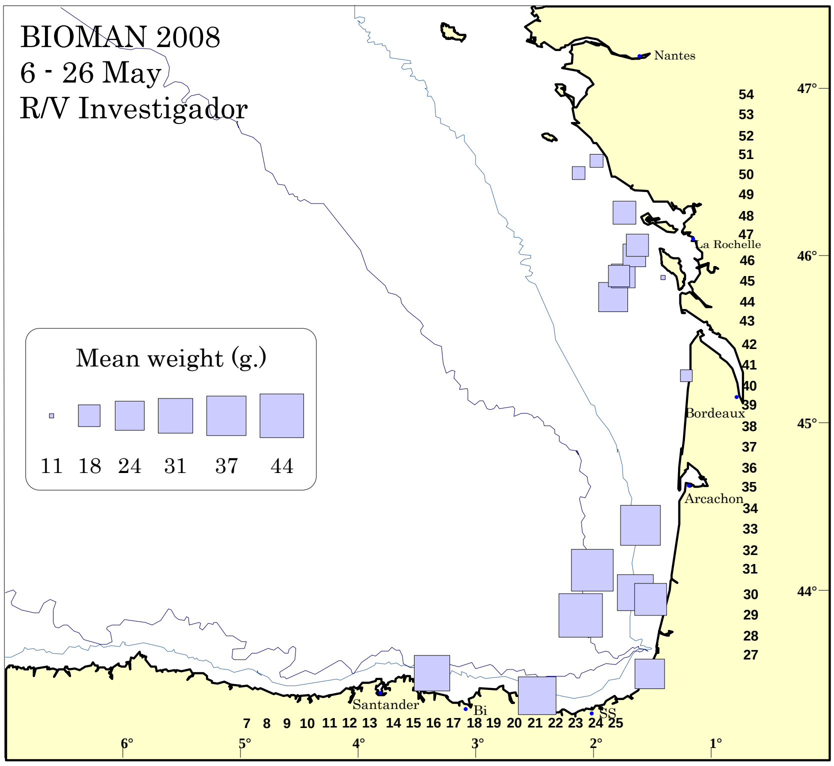


Figure 7: mean weight per haul

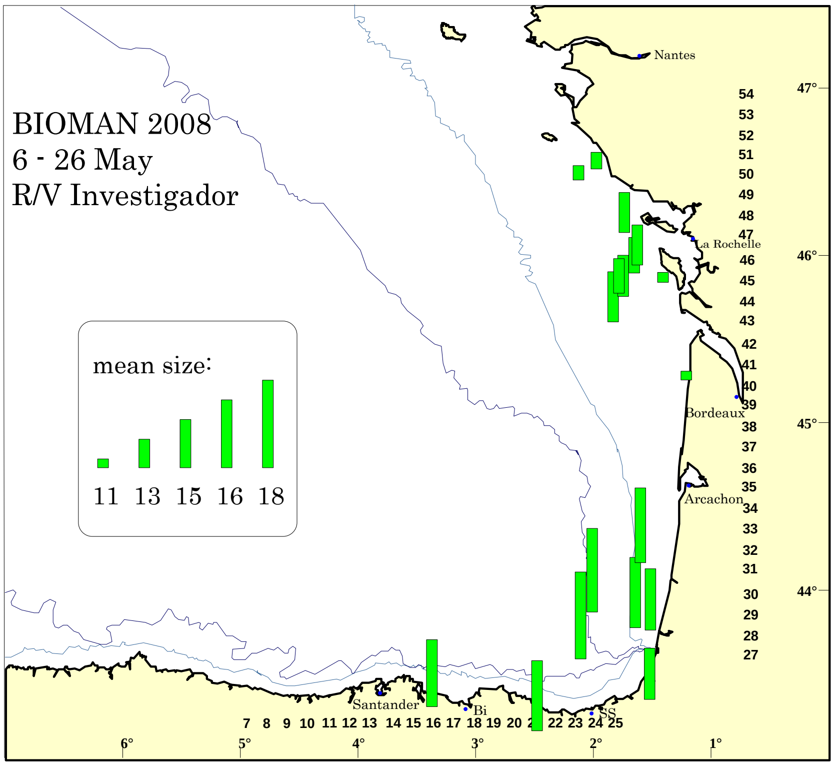


Figure 8: Mean size per haul

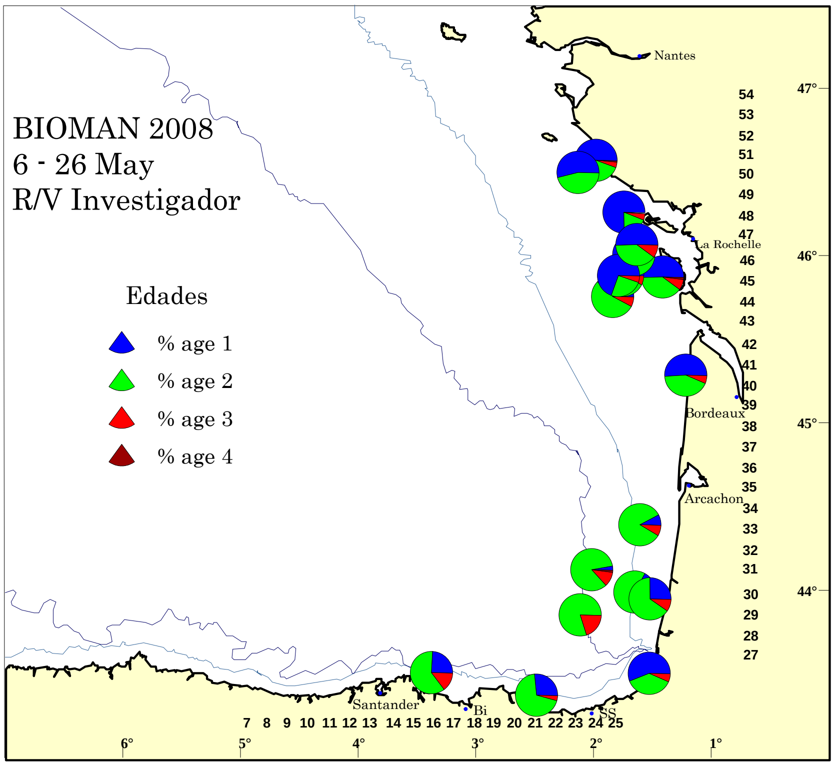


Figure 9: age composition per haul

3.3 Preliminary SSB estimate based on the ratio between P_{tot} and a preliminary estimate of DF from the historical series

3.3.1 Total egg production (P_{tot}) estimates

For the P_{tot} estimation, the staged eggs are transformed into daily cohort abundances, using the Bayesian ageing method. **Figure 10** shows the numbers of eggs by age (hours) and the different cohorts. There is a station (station 84) with a high number of eggs in cohort two in relation with the rest of stations. An exponential mortality model is adjusted to estimate P_0 and z, with a glm (generalised linear model) with a negative binomial and log link, with and without the station 84.(**Fig.11**)

The daily production and mortality estimates are influenced by the inclusion of that station or not. Considering that the great number of eggs of that station doesn't have to distortion mortality estimation but the daily egg production, it was considered to estimate mortality without that station and afterwards fix that mortality and estimate the daily egg production including the station 84.

Table 2 shows the daily egg production estimates (P_0), the daily egg mortality rates (z) and the total egg production and their coefficient of variation (CV) with all the stations, without the station 84 and finally fixing the mortality obtained without that station and calculating the daily egg production with all the stations. The coefficient of variation (CV) on the case of z fix is underestimated.

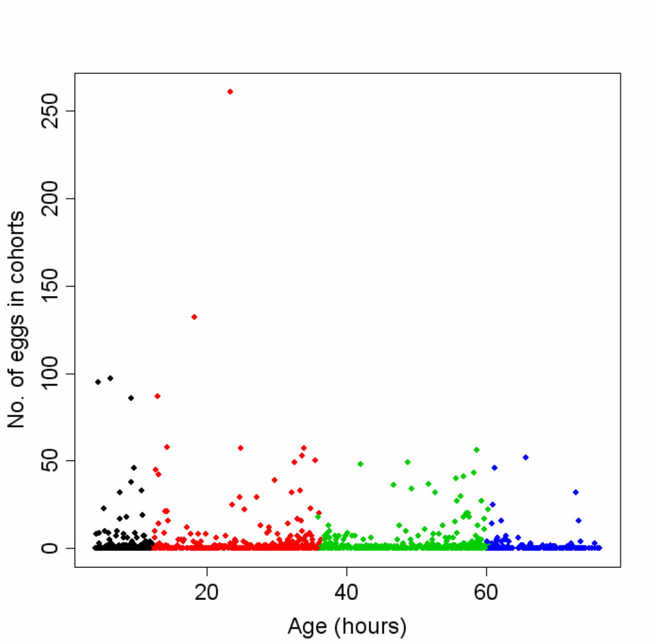


Figure 10: Daily cohort abundance

Table 2: P0, z and Ptot estimates

	ALL STATIONS		WITHOUT ST 84		ALL STATIONS	
	P0 & Z ESTIMATED		P0 & Z ESTIMATED		Z FIXED	
	Value	CV	Value	CV	Value	CV
P_0	53.27	0.09	46.62	0.09	49.75	0.04
z	0.32	0.15	0.28	0.17	0.28	0.00
Ptot	1.78.E+12	0.09	1.56.E+12	0.09	1.67.E+12	0.04

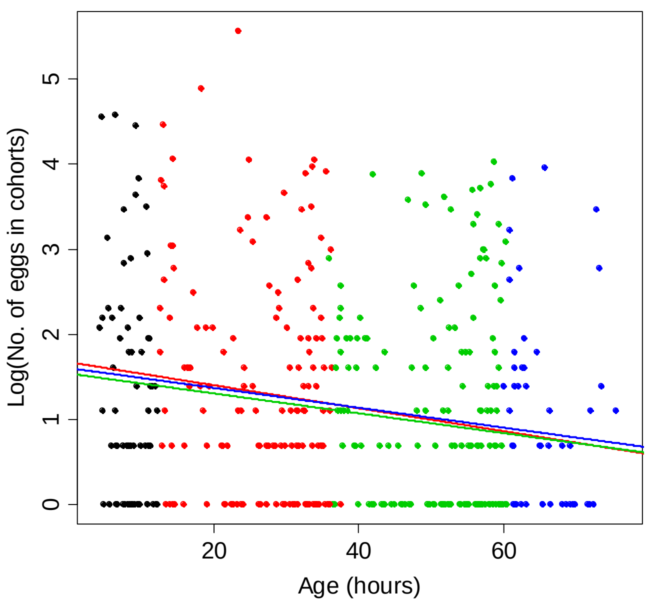


Figure11: exponential mortality models adjusted applying a GLM to the data obtained in the ageing following the Bayesian method (spawning pick 23:00h) The red line is the adjust with all the data the green one is without the station with high number of eggs and the blue one is the adjusted line fixing z but with all the data

3.3.2 Daily fecundity preliminary estimates

The DF estimate was obtained from a linear regression model between DF and sea surface temperature (SST). The coefficient of determination was 35%. The standard error corresponded to the prediction standard error (the value of June 1989 is omitted form the analysis because of poor reliability). (Fig.12; Table 3)

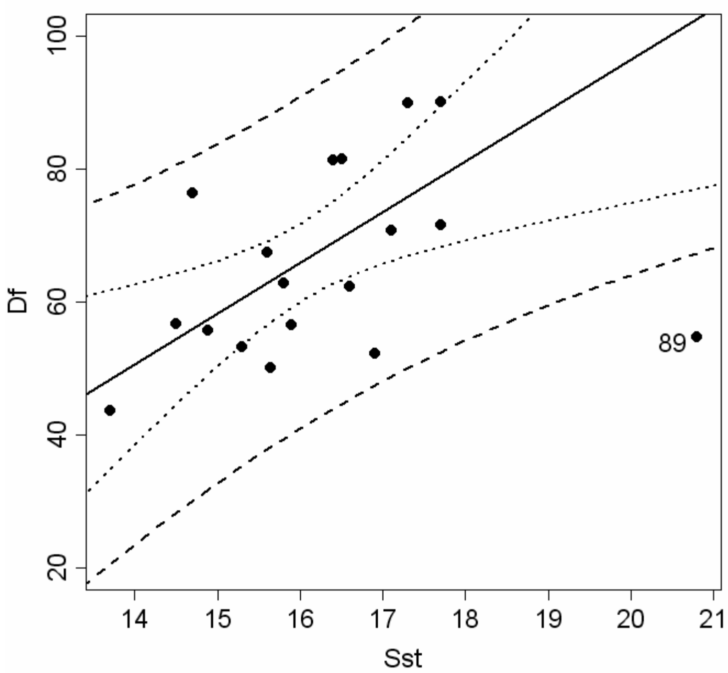


Figure 12: Linear regression model between DF and SST. The solid line represents the fitted line whereas the dotted and the dashed line represent the 95% confidence and prediction intervals, respectively. The points correspond to the observed points each year.

Table 3: Resultant parameters from the lineal regression model for DF

	Estimate	P-value
Intercept	-56.462	0.171
SST	7.649	0.007

The predicted Daily Fecundity value together with the coefficient of variation (CV) and the 95 % intervals for the confidence and the prediction from the model is showed below

	ESTIMATE	CONFIDENCE				PREDICTION			
	DF	SE	CV	Interval 95%		SE	CV	Interval 95 %	
df = a + b * sst	67.44	2.794	0.041	61.489	73.400	11.704	0.174	42.498	92.391

Preliminary biomass estimate for 2008 was obtained from DF predicted model, divided by the estimates of P_{tot} derived from GLM. Those results are showed in the table below for both cases with P_{tot} with z fixed and P_{tot} with not fixing z

	Ptot (eggs)			DF (eggs/gramme)			SSB (Ton.)		
	Model	Estimate	Var	Predic.Model	Estimate	Var.Pred.	Estimate	Var	Cv
z not fixed	glm	1.78E+12	2.33E+22	Df = a + b * sst	67.44	136.99	26,461	26,210,630	0.1935
z fixed	glm	1.67E+12	4.62E+21	Df = a + b * sst	67.44	136.99	24,712	19,406,424	0.1783

The biomass estimated and adopted resulted in 24,712 with a CV 18%.

3.4 Numbers at age

The percentages at age in the population were the average of proportions at age of samples, weighted by the population each sample represents. Given the fact that mean weights of anchovies changes between different strata (**Figure 4**), proportionality between the amount of samples and approximate biomass indices by strata was checked. The approximate index of biomass by strata was set equal to egg abundance by areas (assuming equal daily fecundity at each area) (**table 4**). According to that table samples selected can not be considered to be balanced between these strata and differential weighting factors were applied to each sample coming from one or the other stratum for the purposes of the number at age estimates. Mean weight, age composition and weighting factors by sample are presented in **table 4**. The proportion by age and population at age estimate are given in **table 5** for the case of z fixed that was the adopted one and in **table 6** for the case of z not fixed.

	South	North	
Estrata	**1**	**2**	**Addition**
Total egg abundance	2.32E+12	1.26E+12	3.58E+12
% egg abundance	65%	35%	100%
Nº of adult samples	8	10	18
%Egg/sample	0.08	0.04	
Proportion of SSB relative to estrata 2	**2.31**	**1.00**	3.31
W. factor proportional to the population	**2.31/wi**	**1/wi**	
Mean weight of anchovies by region	34.3	16.2	

Table 4: Balance of the adult sampling to egg abundance by 2 strata in the Bay of Biscay (see **figure 3**). The row of the table above the mean weights corresponds to the weighting factor of each of the samples by strata to obtain the preliminary population structure. Mean weight by strata arise from the adult samples selected for the analysis.

Parameter	Estimate	S.e.	CV
Biomass (Tons)	**24,712**	4,448	0.1800
Tot.mean W (g)	23.77	2.47	0.1038
Population (millions)	1,040	216.0	0.2078
Percent age 1	0.42	0.0523	0.1252
Percent age 2	0.50	0.0455	0.0909
Percent age 3	0.08	0.0114	0.1389
Numbers at age 1	435	105.4	0.2426
Numbers at age 2	520	117.9	0.2268
Numbers at age 3	85	21.3	0.2499
Weight at age 1	16.5		
Weight at age 2	28.7		
Weight at age 3	31.0		

Table 5: SSB 2008 estimates and the correspondent standard error (S.e.) and coefficient of variation (CV) of the proportion by age and population at age estimates, with the mean weight by age class when z is fixed to estimate P_0

Parameter	Estimate	S.e.	CV
Biomass (Tons)	**26,461**	5,028	0.1900
Tot.mean W (g)	23.77	2.47	0.1038
Population (millions)	1,113	241.0	0.2165
Percent age 1	0.42	0.0523	0.1252
Percent age 2	0.50	0.0455	0.0909
Percent age 3	0.08	0.0114	0.1389
Numbers at age 1	465	116.4	0.2501
Numbers at age 2	557	130.7	0.2348
Numbers at age 3	91	23.5	0.2572
Weight at age 1	16.5		
Weight at age 2	28.7		
Weight at age 3	31.0		

Table 6: SSB 2008 estimates and the correspondent standard error (S.e.) and coefficient of variation (CV) of the proportion by age and population at age estimates, with the mean weight by age class when z is not fixed to estimate P_0

3.5 Overview of past time series

In order to provide a broader point of view for the interpretation of current survey results, distribution maps of the anchovy egg abundances in the last 12 DEPM surveys were compiled and compared (**Fig 15**). The whole series of biomass estimates from the DEPM, including the current preliminary estimate for 2008, are presented in **figure 13**. The historical series of numbers at age is shown in **figure 14.**
The series of biomass estimates from the DEPM was completed with this year preliminary estimates. Values are shown in **table 7** and acronyms in **table 8.**

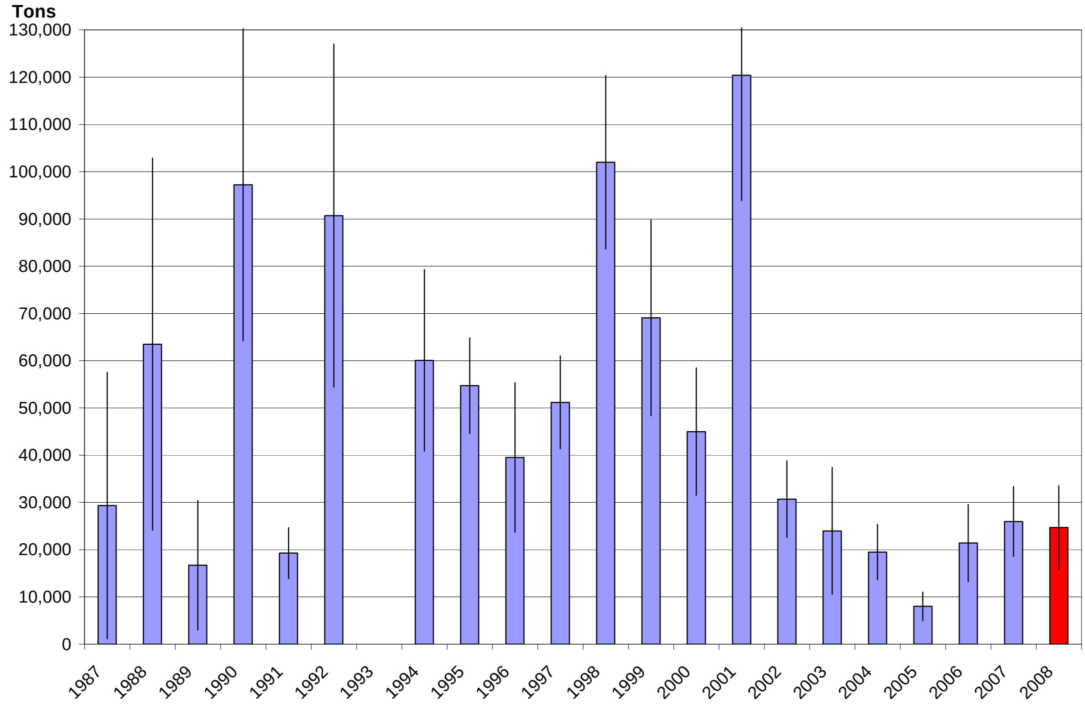


Figure 13: Series of Biomass estimates (tonnes) obtained from the DEPM since 1987. Most of them are full DEPM estimates, except in 1996, 1999, 2000 and 2007, which were deduced indirectly.

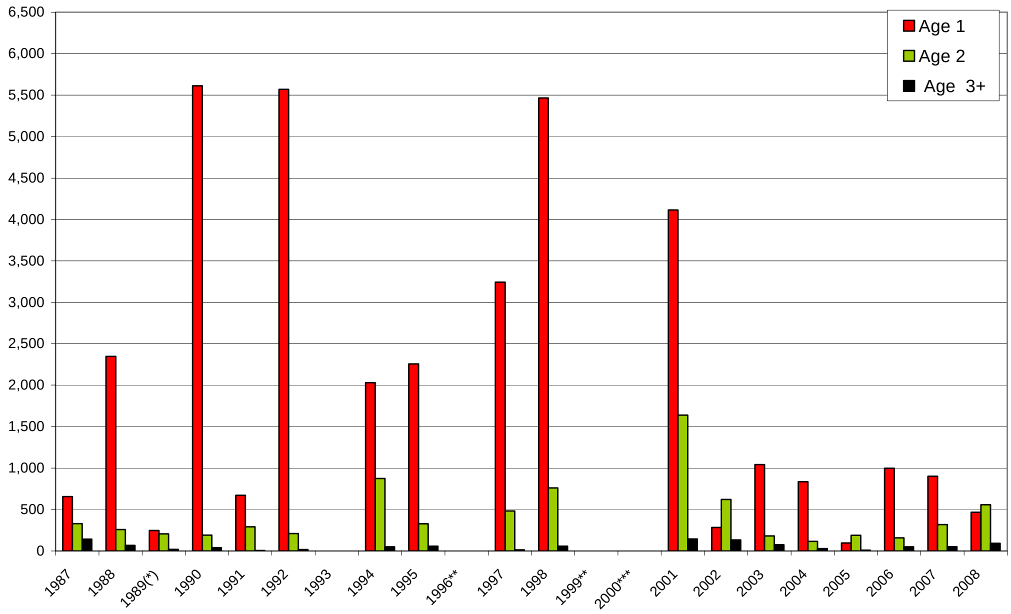


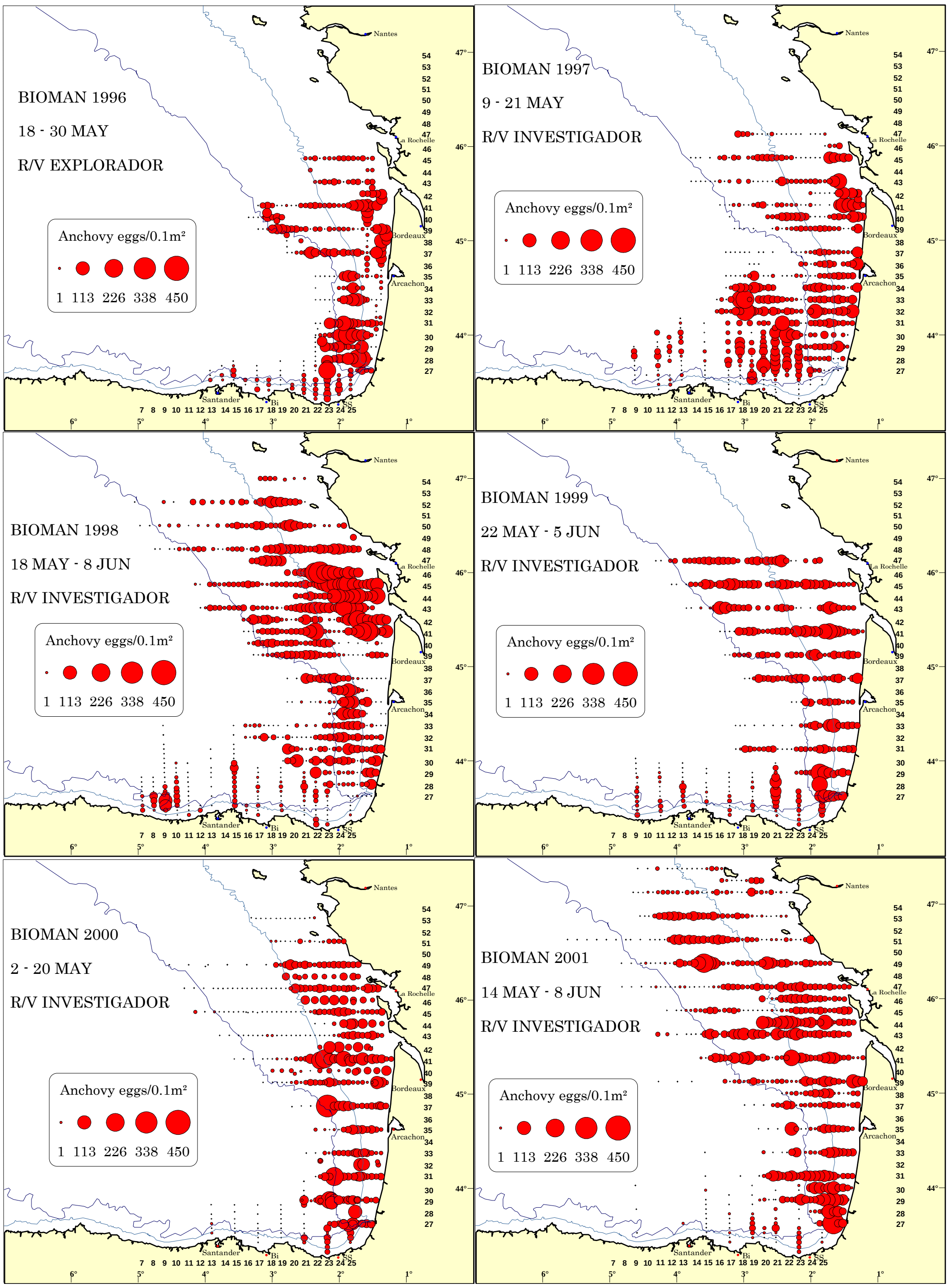
Figure 14: Historical series of numbers at age

Table 7: Historical series of DEPM surveys with their estimates and 2008 preliminary estimates.

Year	Actual dates	SSB	cv	Ptot	cv	P0	cv	Z	cv	Abtot	SA	DF	cv	SST[a]
1987	2 - 7 Jun	29,365	0.48	2.199	0.39	4.61	0.32	0.26	0.78	3.41	23,850	81.3	0.36	16.4
1988	21 - 28 May	63,500	0.31	5.010	0.24	5.52	0.21	0.18	0.68	10.41	45,384	81.4	0.23	16.5
1989	10 - 21 May	11,861	0.41	0.730	0.40	2.08	0.27	0.18	0.99	0.90	17,546	62.3	0.13	16.6
1989	14-24 Jun	10,058	0.55	0.83	-	1.50	0.30	0.94	0.41	0.79	27,917	54.8	0.28	20.8
1990	4 - 15 May	97,237	0.17	4.52	0.15	3.78	0.20	0.34	0.39	7.84	59,757	52.2	0.36	16.9
1990	29 May- 15 Jun	77,254	0.19	7.24	-	5.21	0.13	0.62	0.31	8.05	69,471	90.1	0.12	17.7
1991	16May-07Jun	19,276	0.14	1.24	0.06	2.55	0.22	0.22	0.65	3.18	24,264	67.5	0.15	15.6
1992	16May-13Jun	90,720	0.20	5.79	0.14	4.27	0.14	0.22	0.65	13.09	67,796	71.6	0.24	17.7
1994	17 May-3Jun	60,062	0.17	3.83	0.14	3.93	0.19	0.11	-	11.33	48,735	62.9	0.07	15.8
1995	11 - 25 May	54,701	0.09	3.09	0.07	4.96	0.12	0.19	0.34	8.75	31,189	56.7	0.06	14.2
1996	18 - 30 May	-	-	2.77	0.16	4.87	0.19	0.31	0.41	5.95	28,448	-	-	15.3
1997	9 - 21 May	51,176	0.10	2.70	0.07	2.69	0.14	0.19	0.47	7.12	50,133	53.2	0.06	15.1
1998	18 May - 8 Jun	101,976	0.09	5.59	0.05	3.83	0.12	0.28	0.25	11.96	73,131	56.5	0.06	16.5
1999	22 May - 5 Jun	-	-	3.59	0.09	3.52	0.08	0.12	0.40	9.06	51,019	-	-	17.1
2000	2- 20 May	-	-	2.61	0.19	3.45	0.28	0.18	1.02	7.95	37,883	-	-	16.5
2001	14-May - 8 Jun	120,403	0.11	8.48	0.09	5.89	0.11	0.45	0.20	12.36	72,022	70.8	0.06	16.8
2002	6 - 21 May	30,697	0.13	2.34	0.13	3.28	0.13	0.13	0.51	6.17	35,980	76.4	0.04	14.7
2003	22 may-9Jun	23,962	0.28	2.15	0.28	2.53	0.28	0.33	0.66	7.30	42,535	89.9	0.04	17.3
2004	2 - 17 May	19,498	0.15	0.84	0.11	1.82	0.11	0.10	-	2.80	23,124	43.6	0.09	13.7
2005	8 - 28 may	8,002	0.19	0.44	0.16	0.79	0.16	0.20	0.45	1.33	27,863	55.7	0.08	14.9
2006	4 - 24 may	21,436	0.19	1.07	0.17	2.16	0.17	0.27	0.40	2.66	24,614	50.1	0.1	15.6
2007	3-23 may	25,973	0.14	1.55	0.04	2.25	0.04	0.20	0.00	4.22	34,449	61.3	0.1	15.4
2008	6-26 may	**24,712**	0.18	1.67	0.04	2.49	0.04	0.28	0.00	3.58	33,502	67.4	0.04	16.2

Table 8: Parameters with the acronyms and meaning of the estimates and units

Acronyms	Estimates of...	Units
P_0	Daily Egg Production per surface unit	Eggs/0.05 m²/day
Z	Daly mortality of eggs	
SA	Positive Spawning Area	Km²
P_{tot}	Total Daily Egg Production of the Population	Eggs/day *10E+12
SST	Sea Surface Temperature	ºC
SSB	SPAWNING STOCK BIOMASS	tonnes
DF	Daily Fecundity of the Population	eggs/gramme
AB_{tot}	Total Egg Abundace in the area surveyed	eggs *10E+12


BIOMAN 1996
18 - 30 MAY
R/V EXPLORADOR
Anchovy eggs/0.1m²
1 113 226 338 450
BIOMAN 1997
9 - 21 MAY
R/V INVESTIGADOR
Anchovy eggs/0.1m²
1 113 226 338 450
BIOMAN 1998
18 MAY - 8 JUN
R/V INVESTIGADOR
Anchovy eggs/0.1m²
1 113 226 338 450
BIOMAN 1999
22 MAY - 5 JUN
R/V INVESTIGADOR
Anchovy eggs/0.1m²
1 113 226 338 450
BIOMAN 2000
2 - 20 MAY
R/V INVESTIGADOR
Anchovy eggs/0.1m²
1 113 226 338 450
BIOMAN 2001
14 MAY - 8 JUN
R/V INVESTIGADOR
Anchovy eggs/0.1m²
1 113 226 338 450
Nantes
La Rochelle
Bordeaux
Arcachon
Santander
Bi
SS
47°
46°
45°
44°
6°
5°
4°
3°
2°
1°

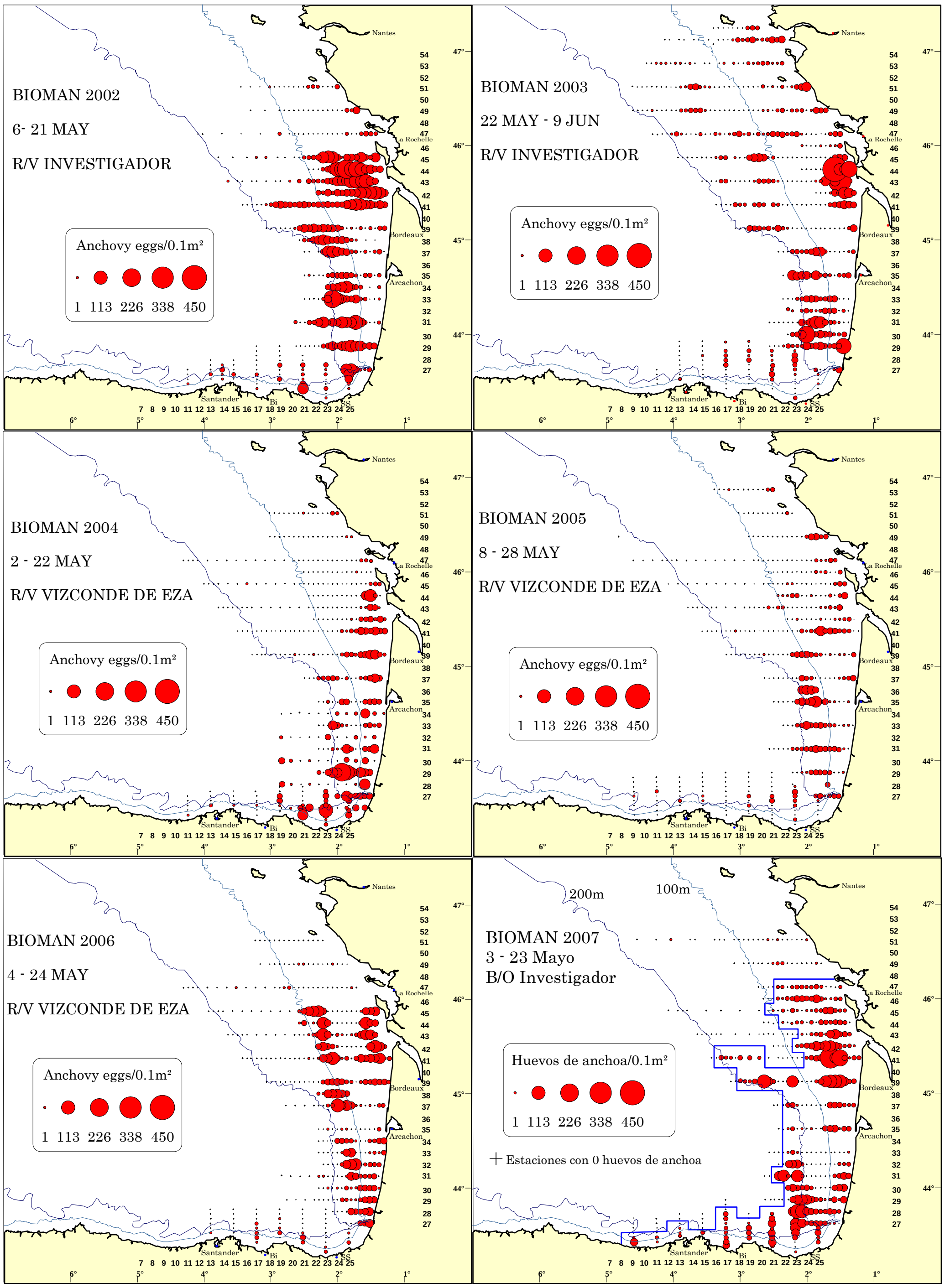


Figure 15: Anchovy egg distribution from 1996 to 2007.

4. DISCUSSION

The survey BIOMAN 08 has covered the spawning area satisfactory and the total egg production has been estimated in the distribution area of the population. Moreover it has obtained 29 positive anchovy samples and 20 were use for the analysis. Those were obtained simultaneously to the egg sampling. The anchovy egg distribution in 2008 occupies a similar extension than the last year and the total egg production is slightly higher.

To estimate the total egg production an exponential mortality model was applied.
The adjusted of the model was satisfactory after taken out a station with a high influence to estimate the daily egg mortality. However, this point was included to estimate the total egg production once the mortality was estimated and fixed without the critical point. The value of z obtained in that manner is significant different from cero; with a value of 0.28 (CV = 0.17%)
To estimate the DF a linear regression model between DF and sea surface temperature from the historical series was adjusted. This procedure was applied in the same manner last year.

The SSB obtained this year as the ratio between the total daily egg production and the daily fecundity estimates is 24,712 t with a CV of 18%.

Approximately a 58% (CV=10%) of the population in millions of individuals (71% in mass) is older than one year. This indicates a new failure in the recruitment, as in the last years.

The SSB estimates presented in this report are provisional. This provisional result from BIOMAN 08 based on the DEPM, doesn't show a significant recovery of the stock. Due to the same level of biomass obtained this year in relation with the last year.

The definitive perception of the status of the stock will be obtained from both the BIOMAN survey (MPDH) carried out by AZTI and the PELGAS survey (Acoustic) carried out by IFREMER. This analysis will take place during the ICES WGANC from 13 to 16 of June. After the review group will assess the report the 17th of June. The draft advice will be outlined in a posterior meeting on the 18th of June. The final advice will be adopted by the ACOM (Advisory Committee) on the 19th of June.

5. ACKNOWLEDGEMENTS

We thank all the crew of the R/V Investigador and Emma Bardán and all the personal that has participated in BIOMAN 08 for their excellent job and collaborative support. This work has been founded by the Agriculture, Fisheries and Food Technology Department of the Basque Government and by the European Commission within the frame of the National Sampling Programme. The General Secretariat of Marine Fisheries has also collaborated providing the R/V Emma Bardán.

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ANNEX I: Summary of fishing hauls

Nº	Barco	fecha	hora ini	hora fin	Latini	Longini	SST	FishT	Sonda	prof pesca	Eng_enc	Sard_pil	Scom_sco	Scom_jap	Trac_trac	Mer_mer	Boops_boo	Dicen_labrax	other	Total
1	Emma Bardán	07/05/2008	1:03	1:48	433009	31793	16.6	14.6	85	8	2.6	15.1	3.45	0	37.05	0	140.75			198.95
2	Emma Bardán	07/05/2008	17:55	18:45	433303	33173	13.4	13.8	109-90	23	0	0	0	0	0	0	15			15
3	Emma Bardán	08/05/2008	0:27	1:14	432361	31159	15.5	15.5	42-73	10	0	3.6	0	0.55	10.55	0.6	32.25		0.5	48.05
4	Emma Bardán	08/05/2008	19:51	21:10	432677	23000	15.75	12.4	92-212	80-135	0	0.669	0.435		0.558	0.026	0.169		2.55	4.407
5	Emma Bardán	08/05/2008	22:37	0:15	432895	22992	15.75	15.2	125-37	10	8.8	1.2	1	0.15	37.45	2.5	25.45			76.55
6	Emma Bardán	09/05/2008	22:10	23:01	432633	14910	15.7	14.1	93-132	10	0.15				5.8	0.32	0.25			6.52
7	Emma Bardán	10/05/2008	0:10	1:50	432532	14505	15.3	15.3	44-66	10	0			6.9	171.3	0.8	13.75			192.75
8	Emma Bardán	12/05/2008	18:20	19:14	435280	13962	17	13.2	105	88-113	0.83		0.54		0.02	0.18				1.57
9	Emma Bardán	12/05/2008	22:26	23:16	435576	13829	16.9	16.8	103-108	8	167.5	0.45	0.5		2.4			3.3		174.15
10	Emma Bardán	13/05/2008	1:40	2:15	435929	13048	16.5	16.1	58-56	8	28.85	0.4		1.4	1.6	0.2				32.45
11	Emma Bardán	13/05/2008	14:14	15:42	435290	14394	17.3	13	121-114	90-105	0.45		1.15		8.6	1.1				11.3
12	Emma Bardán	13/05/2008	20:00	21:15	435498	14147	18.1	13	112-114	95-105	0				83.1	2.25			0.3	85.65
13	Emma Bardán	14/05/2008	1:07	3:27	434935	20200	16.1	15.6	200	10	14.65		238.85		50.25					303.75
14	Emma Bardán	14/05/2008	21:55	22:56	440025	22718	15.3	14.6	>300	11	0									0
15	Emma Bardán	15/05/2008	2:57	3:45	440717	20503	16.1	15.6	220-160	10	21.3		5.5		28.3					55.1
16	Emma Bardán	15/05/2008	5:56	6:12	440741	23912	17	12.8	107-96		0.21		0.15		3.75	0.65			1.15	5.91
17	Emma Bardán	15/05/2008	19:49	21:02	441534	12677	17.6	12.8	50-85	42-64	0				10.4					10.4
18	Emma Bardán	15/05/2008	22:30	23:30	441889	13787	17.6	17.2	102	10	18.55	5.05	1.05		8.25					32.9
19	Emma Bardán	16/05/2015	1:24	2:10	443711	13371	17.3	16.4	84-64	10	59.15	17.7	0.35	0.8	4.25	0.05				82.3
20	Emma Bardán	17/05/2008	0:06	1:06	453771	14051	16.4	15.2	57-67	8	53.55	3.7	0.6							57.85
21	Emma Bardán	17/05/2008	3:00	4:05	453007	13761	16.1	15.8	54-45	9	5.9	20.65			0.2			1.2		27.95
22	Emma Bardán	17/05/2008	19:37	20:25	451385	11229	17	16.6	20	9	14.1	13.35	0.4		0.95	0.85		0.3		29.95
23	Emma Bardán	18/05/2008	0:35	2:30	454487	13862	16.4	16.2	50-65	8	25									25.0
24	Emma Bardán	18/05/2008	19:55	21:00	455224	12211	17.2	17	21-26		0.2	120								120.2
25	Emma Bardán	18/05/2008	22:25	22:46	455217	12249	17.2	16.4	21-23	7	3.4	7.5				3.8			12.65	27.35
26	Emma Bardán	19/05/2008	1:55	2:40	455270	14929	17.1	16.5	59-55	9	94.85	0.15						1.6		96.6
27	Emma Bardán	19/05/2008	20:01	20:54	460348	13007	17.6	17.4	22-30	7	0	88.15	0.1		3.1			1.65		93
28	Emma Bardán	19/05/2008	22:22	23:09	455989	13385	17.5	16.3	31-37	9	5.8	5.6			0.05			0.8		12.25
29	Emma Bardán	20/05/2008	3:09	4:00	455267	15235	17.3	16.2	63-56	8	28	0.05	0.1		0.01			0.6		28.76
30	Emma Bardán	20/05/2008	20:07	20:47	462031	14269	17	15.7	24-28	12	0	60	60		1.2					121.2
31	Emma Bardán	20/05/2008	22:35	23:28	461786	14727	16.6	16.5	26	8	13.15	38.85	1.5		0.8	1.2			0.85	56.35
32	Emma Bardán	21/05/2008	1:27	3:12	460529	14379	16.8	15.5	36-33	7	0.111	30.15	0.7		0.25	0.25		1.35		32.811
33	Emma Bardán	22/05/2008	0:30	1:32	460743	14016	17.3	16.8	25	8	3.6	34.8	1.4		15.05			0.45		55.3
34	Emma Bardán	22/05/2008	3:58	4:58	461233	14006	16.5	15.8	29-24	9	0.05	20.85	0.4		0.2					21.5
35	Emma Bardán	22/05/2008	22:25	23:13	470176	24114	17.2	16.8	37-32	10 6	0.3	113.65	6.6		0.5			8		129.05
36	Emma Bardán	23/05/2008	12:55	2:27	471282	24927	16.8	16.4	42-32	9	0.45	58	0.65		20	0.3		10.25		89.65
37	Emma Bardán	23/05/2008	4:00	4:55	471665	24700	16.4	16.1	47	7	0		0.25		17.6	0.15				18
38	Emma Bardán	23/05/2008	22:04	22:55	463753	15950	17.5	17.2	26	7	3.2	13.2	9.7		15.2	6.15		0.5		47.95
39	Emma Bardán	24/01/1900	1:00	2:40	463016	15586	17.2	16.6	28-40	10	1.85	2.85				2.4		3.5		10.6

Annex 4: Working Document for WGANC (Copenhagen June. 2008)

Direct assessment of anchovy and other pelagic species by the PEL-GAS08 acoustic survey

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1. Material and method

1.1 PELGAS survey on board Thalassa

An acoustic survey was carried out in the bay of Biscay from April 27st to May 26th on board the French research vessel Thalassa. The objective of PELGAS08 survey was to study the abundance and distribution of pelagic fish in the Bay of Biscay. The target species were mainly anchovy and sardine and were considered in a multi-specific context. The results have to be used during ICES working groups in charge of the assessment of sardine, anchovy, mackerel and horse mackerel and in the frame of the Ifremer fisheries ecology program "resources variability".

To assess an optimum horizontal and vertical description of the area, two types of actions were combined :

Continuous acquisition by storing **acoustic** data from five different frequencies and pumping sea-water under the surface, in order to evaluate the number of fish eggs using **CUFES** system (Continuous Under-water Fish Eggs Sampler), and discrete sampling at **stations** (by trawls, plankton nets, CTD).

Satellite imagery (temperature and sea colour) and modelisation were also used before and during the cruise to recognise the main physical and biological structures and to improve the sampling strategy.

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.

This survey was considered in the frame of the national FOREVAR program which is the French contribution to the international GLOBEC programme. Furthermore, this task is formally included in the first priorities defined by the Commission regulation (EC) No 1639/2001 of 25 July 2001 establishing the minimum and extended Community programmes for the collection of data in the fisheries sector and laying down detailed rules for the application of Council Regulation (EC) No 1543/2000.

The strategy was the identical to previous surveys (2000 to 2007) :

- acoustic data were collected along systematic parallel transects perpendicular to the French coast (figure 1). The length of the ESDU (Elementary Sampling Distance Unit) was 1 mile and the transects were uniformly spaced by 12 nautical miles covering the continental shelf from 20/25 m depth to the shelf break.

-acoustic data were collected only during the day because of pelagic fishes behaviour in this area. These species are usually grouped very close to the surface during night and so "disappear" in the blind layer for the echo sounder between the surface and 8 m depth.

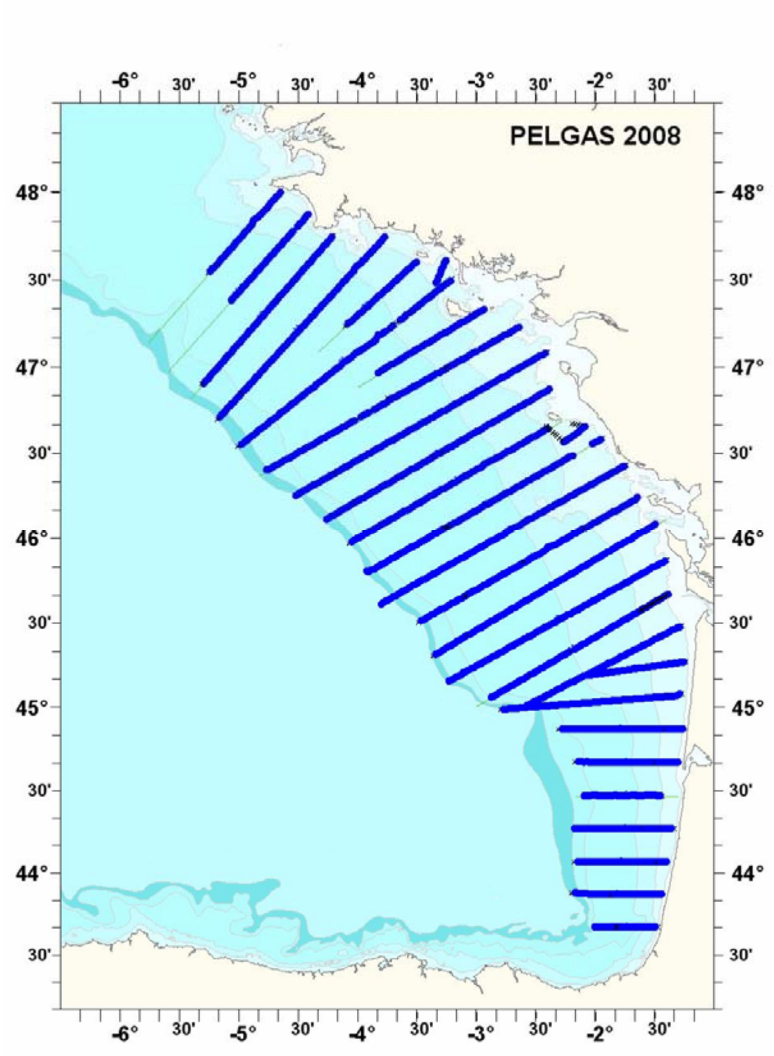


Figure 1 - Transects prospected during PELGAS08 by Thalassa.

Two echo-sounders were used during the whole survey (SIMRAD EK60 and OSSIAN 500). Energies and samples provided by split beam transducers (5 frequencies EK60, 18, 38, 70, 120 and 200 kHz) and simple beam (OSSIAN 49 kHz) were simultaneously visualised, stored using the MOVIES+ software and at the same standard HAC format.

The calibration method was the same that the one described for the previous years (see W.D. 2001) and was performed at anchorage at cap Machichaco on the north coast of Spain in optimum meteorological conditions.

Acoustic data were therefore collected by Thalassa along a total amount of 2800 nautical miles from which 1850 nautical miles on one way transect are usable for assessment. A total of 57 pelagic hauls were carried out upon 46 were usable (figure 2) for identification of echo-traces. A total of 19 690 fish were measured (including 3 897 anchovy and 4 375 sardine) and 1747 otoliths were collected for age determinations (908 anchovy and 839 sardine).

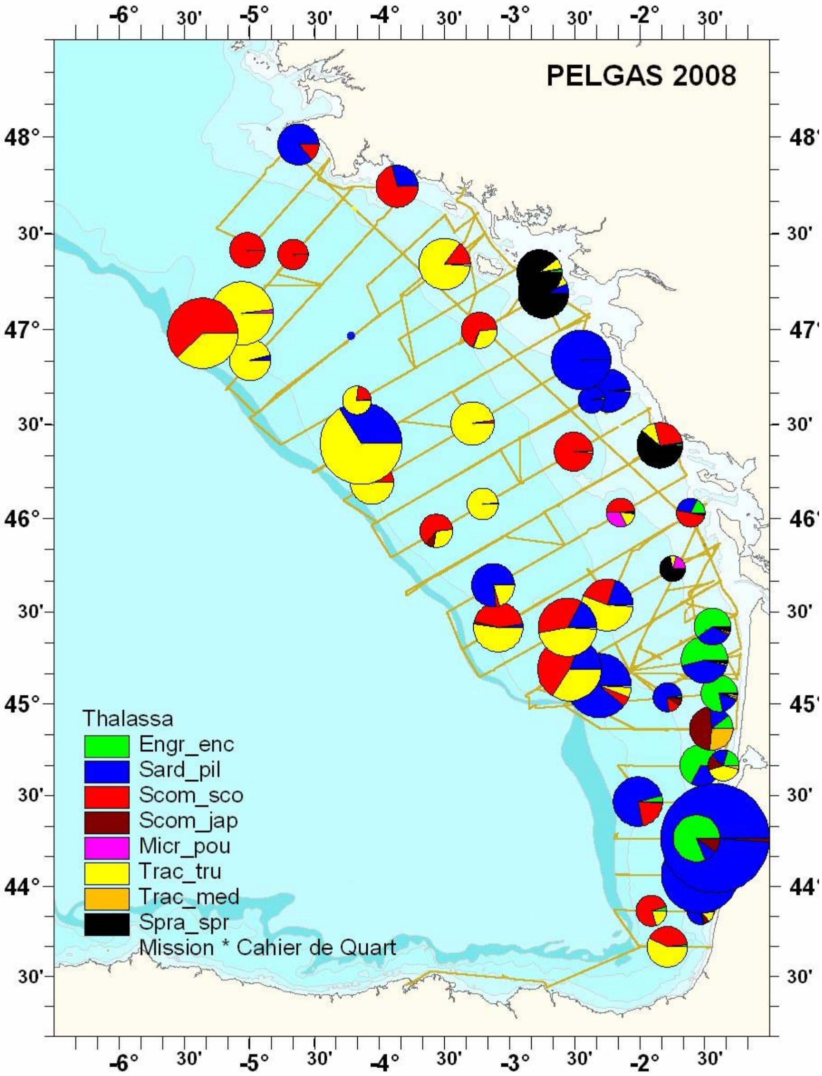


Figure 2: Species distribution according to Thalassa identification hauls

1.2 The consort survey

A consort survey was organised with French pair trawlers. This approach, in the continuity of last year survey, was officially decided three weeks before the PELGAS survey and organised taking into account the last year experience.

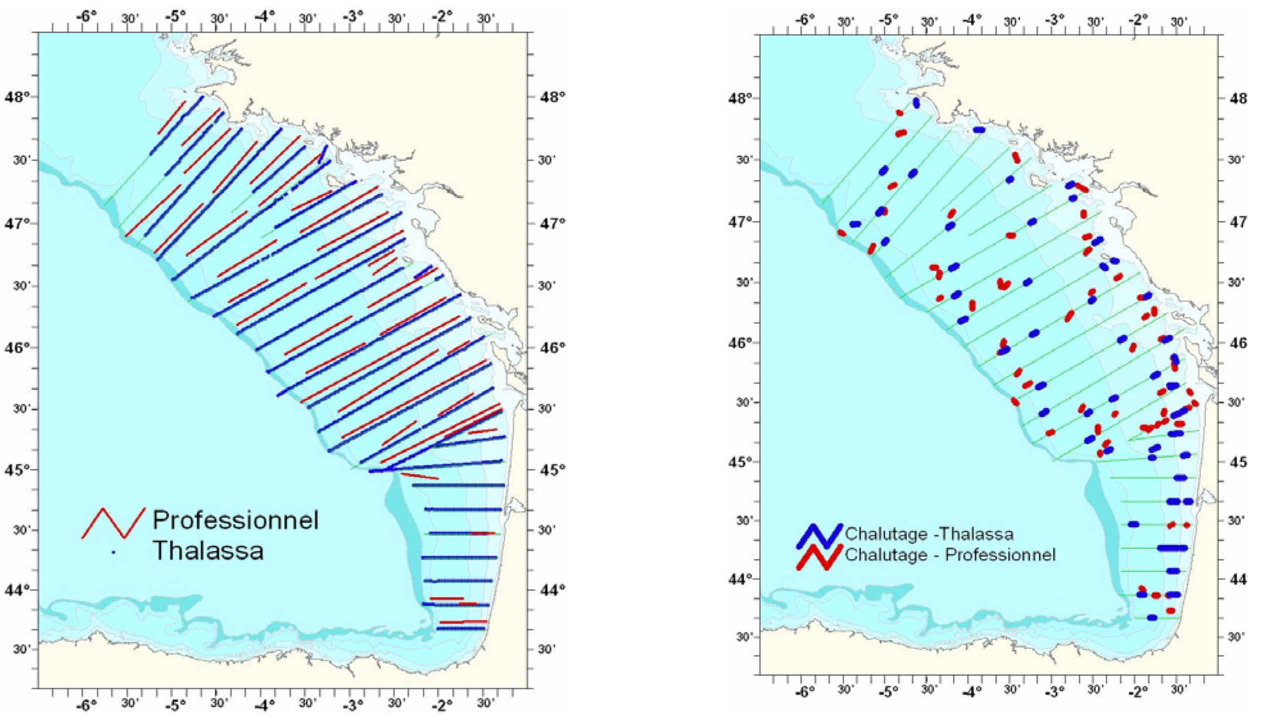
Four commercial vessels (two pair trawlers) participated to PELGAS08 survey:

> "le Natif / la Roumasse" from St Gilles Croix de vie (from 27th april to 12th may)

> "Cintharth / Marilude" from La Turballe (from 15th to 21th may)

Except 2 days of bad weather which forced professional vessels to stay in the closest harbour, these pair trawlers were permanently accompanying Thalassa during all the prospection

The transects network agreed for several years for Thalassa is 12 miles separated parallel transects. Professional vessels worked between standard transects and 4 NM northern (figure 3). Sometime, they carried out fishing operations on demand (complementary to Thalassa) or, sometime, according to their surveying 4 NM northern than our transects. Their pelagic trawl was about 30 m vertical opening and the mesh of their codend was similar to Thalassa (12 mm).



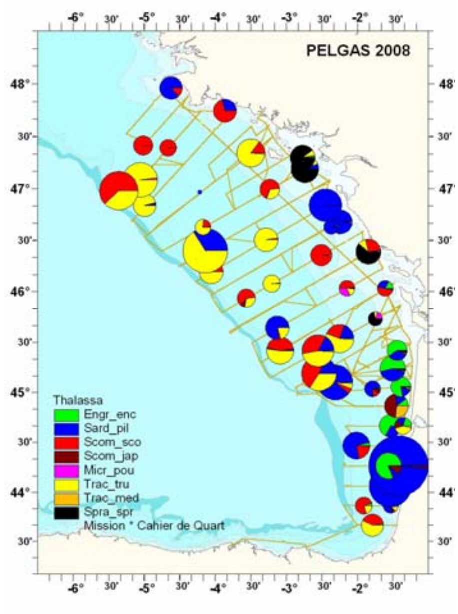
Acoustic transects network Fishing operations

Figure 3 – Transects network and fishing operations resulting of the combination of Thalassa and commercial vessels during PELGAS08 survey.

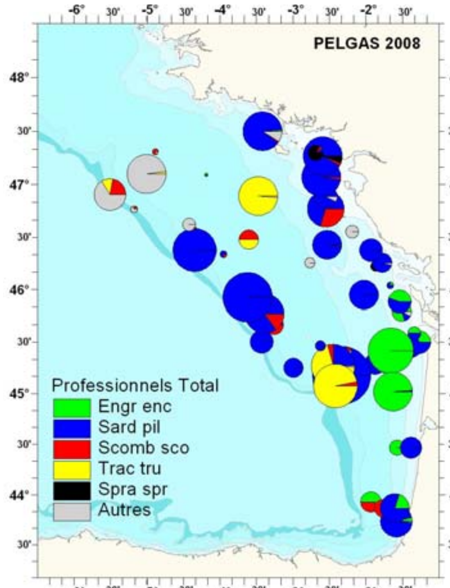
A scientific observer onboard had to report every half an hour their position and possible noticed echo traces. Their fishing operations were systematically previously agreed after a radio contact with Thalassa in order to confirm its utility. In some occasions, the use was to check the spread of a species already observed and identified by Thalassa (and therefore the spatial distribution), in others the objective was to enlarge the vertical distribution description by stratified catches. Globally, a great attention was taken on a good distribution of samples to avoid over-sampling on some situations. Sometime a biological sample was provided by commercial vessels to Thalassa to improve otolith collecting and sexual maturity (it was the case for some shallow water anchovy).

It must be noticed that the commercial vessels were this year equipped with a precision weighting machine and a calibrated echo-sounders (Simrad ER60 – 70 kHz) able to store data at a standard format. Their consort surveying and fishing operations can be so considered this year as qualitative and quantitative as well. The catches and biological data have been directly used at the same level than Thalassa one for identification and biological characterisation. The echo sounder was implemented on a small towed body and because of a non sufficient stability during the first 2 weeks (15m vessel length) the data was stored only during small sequences when notable echo-traces were observed and mainly after fishing. Commercial vessel acoustic data will be processed later in order to compare the echo types and energies to Thalassa one in identical place or similar conditions. They were not available for the present WG.

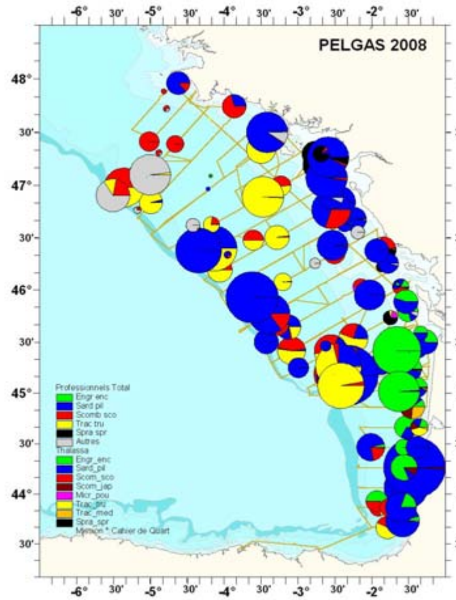
A total of 102 hauls were carried out during the assessment coverage including 46 hauls by Thalassa and 56 hauls by commercial vessels (figure 4a and 4b). The operations by professional vessels were carried out following during day time as Thalassa and preferentially at the surface each time it was necessary, taking into account the fact that pair trawlers are more efficient at surface than back trawlers.



a) Thalassa (nb :46)



b) Pair trawlers (nb : 56)



c) all fishing hauls (nb :102)

Figure 4 : fishing operations carried out by Thalassa and commercial vessels during consort survey PELGAS08

The collaboration between Thalassa and commercial vessels was excellent. It was a very good opportunity to explain to fishermen our methodology and more, to verify that both scientists and fishermen observe the same types of echo-traces and that the catches were well comparable (in proportion of species and, most of the time, in quantity as well).

	Thalassa	Commercial vessels	total
Surface trawls	4	24	28
Classic trawls	39	32	71
Total	43	56	99
+ null	3	0	3

2. Acoustics data processing

2.1 Echo-traces classification

All the acoustic data along the transects where anchovy was observed) were processed at the date of the meeting (figure 6) and have been scrutinised. Acoustic energies (Sa) have been cleaned by sorting only fish energies (excluding bottom echoes, parasites, plankton, etc.) and classified into 7 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 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 clupeids in coastal areas and sometime more offshore.

D3 – energies attributed to blue whiting and myctophids offshore.

D4 – energies attributed to sardine, mackerel or (rarely this year) anchovy corresponding to small and dense echoes, very close to the surface.

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

D6 – energies attributed to a mix, usually between 50 and 100 m depth when D1 and D2 were not separable

D7 – energies attributed exclusively to sardine according to several identifications during the survey (Thalassa and professional vessels).

It was not possible to process all the acoustic data for the time of WGANC. Nevertheless, all the southern area was processed (figure 6) and anchovy was rather absent in the northern one. Therefore it is possible to consider that the southern coverage is sufficient to be representative of the anchovy biomass in May 2008.

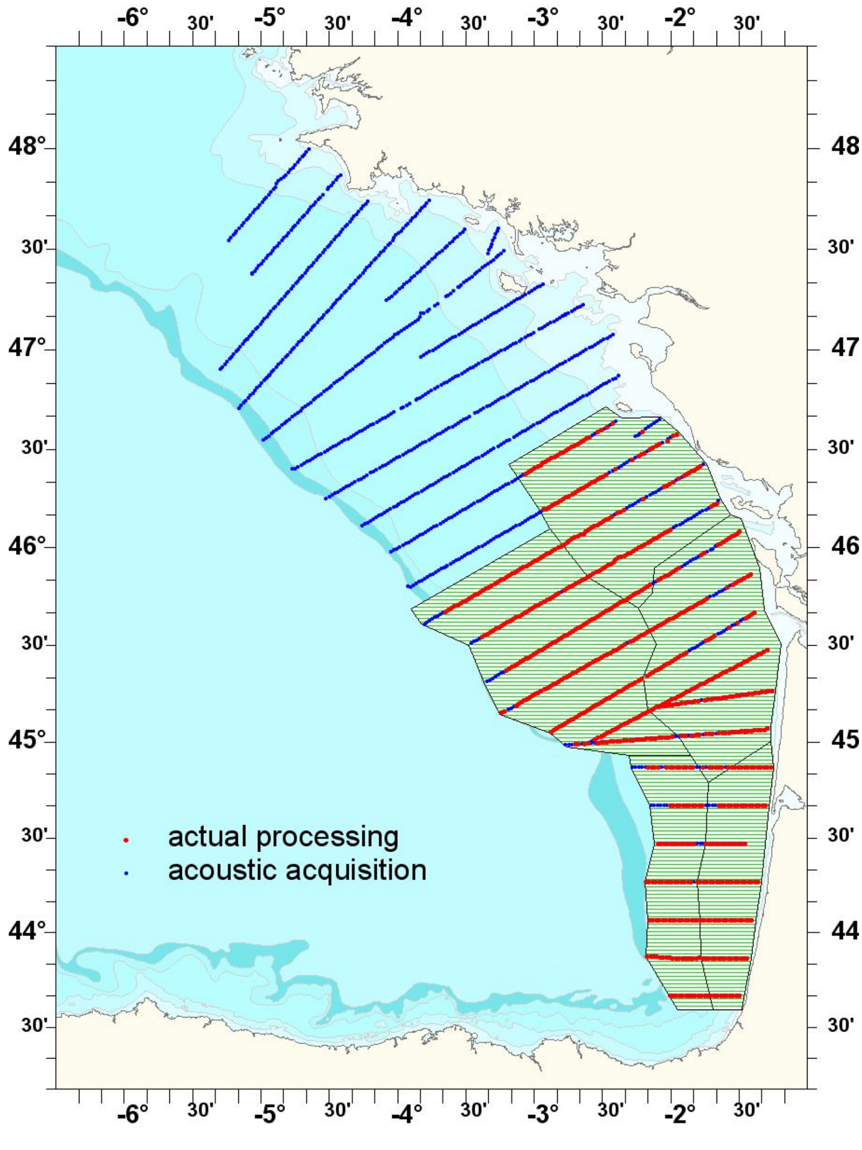


Figure 6 : Transects prospected during PELGAS08 (in blue) and fish presence along processed data at WGANC time.

2.2 Splitting of energies into species

As previous years (except in 2003, see WD-2003) The global area has been splitted into several strata where coherent communities were observed (species associations) in order to minimise the variability due to the variable mixing of species. Figure 7 shows the strata considered to evaluate biomass of each species. For each strata, energies where converted into biomass by applying catch ratio, length distributions and weighted by abundance of fish in the haul surrounded area.

zone	Area (nm²)
south coastal	1371.6
south offshore	1367.1
Gironde	2453.3
Fer a cheval	3124.6
Central coastal	2326.2

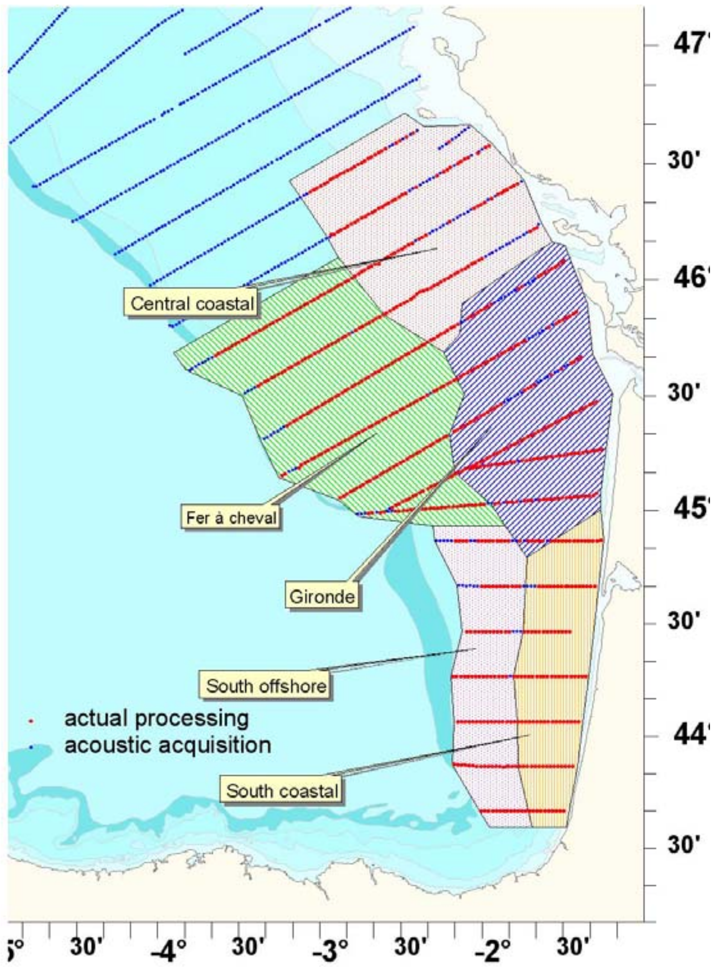


Figure 6 – coherent strata, in terms of echoes and species distribution, taken into consideration for multi-species biomass estimate from acoustic and catches data during PELGAS08 survey

3 Biomass estimates

According previous strata, using only Thalassa acoustic data and both Thalassa and consort fishing operations, biomass estimates have been calculated for each main pelagic species in the surveyed area (as processed at the time of the WGANC). It was impossible to process separately estimates using only Thalassa hauls or both as it was done last year because the fishing strategy has been followed all along the survey in order to profit of the best efficiency of each vessel and maximise the number of samples (in term of identification and biological parameters as well). Therefore, the commercial vessels carried out mostly surface hauls when Thalassa fish preferably in the bottom layer.

Biomass estimates are gathered below

STRATA Biomass (tons)	Anchovy	Blue whiting	Sardine	Mackerel (jap)	Mackerel (sco)	Sprat	Horse mackerel (med)	Horse mackerel (tra)
south coastal	17 767	0	61 917	496	1 138	0	113	2 407
south offshore	1 988	5	8 027	154	21 269	0	0	3 695
Gironde	17 403	0	46 624	25	4	380	29	5
Fer a cheval	0	4	151 101	428	18 623	0	0	41 818
Central coastal	199	821	25 723	0	667 187	9 333	0	4 331
Total	37 358	830	423 253	1 103	709 479	9 714	141	52 255
c.v. (%)	12.4	25.2	14.2	26.8	62.8	24.8	21.8	55.2

Table 5 – biomass estimate using Thalassa acoustic data along transects and all the consort identification fishing operations (Thalassa + pair trawlers)

The anchovy biomass was estimated to 37 358 t with a coefficient of variation of 12.4% meaning that the anchovy biomass according to acoustic data and pelagic hauls should be between 28 093 and 46 623t.

4 Anchovy data

4.1 Anchovy biomass

Anchovy was observed (figure 7) along the coast from Bayonne (43° 40 N) to Rochebonne (46°00 N), mostly mixed with sardine and sometimes with horse mackerel in the south of the Gironde then often alone until Rochebonne where it was mixed with sprat.

On the platform, anchovy was quite omnipresent between 50m and 100m depth but always mixed with horse mackerel or sardine. Echo-traces were most of the time traditionally vertically spatialized, horse mackerel closed to the bottom and anchovy as soft and small schools 15 to 25 m above.

In the area called "Fer à cheval", anchovy was totally absent and very rare southern along the shelfbreak except some rare small surface schools.

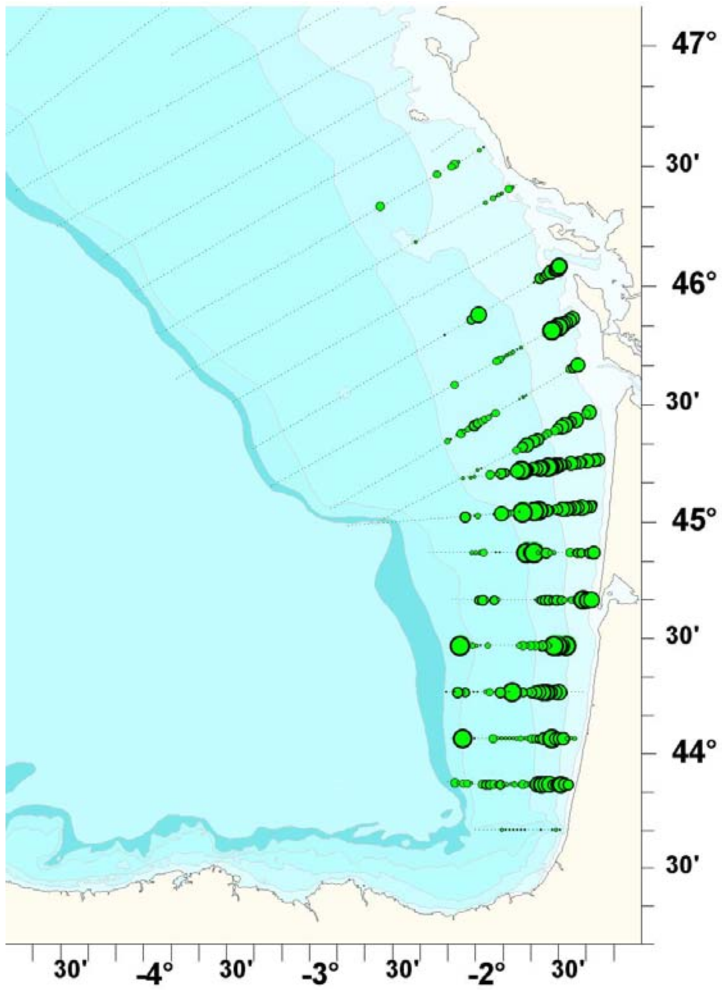
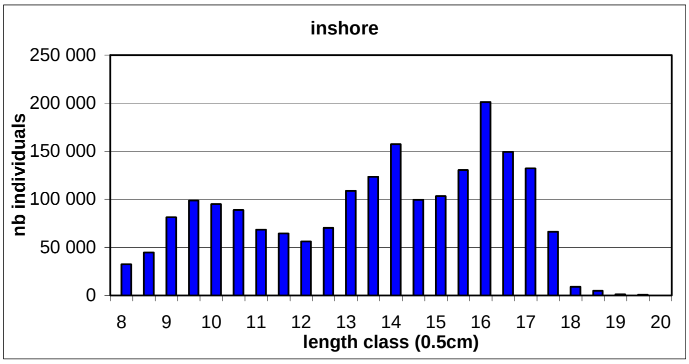


Figure 7 – Anchovy distribution according to PELGAS08 survey.

4.2 Anchovy length structure

Length distribution in the trawl haul were estimated from random samples. The population length distributions (figure 8.1) have been estimated by a weighted average of the length distribution in the hauls. Weights used are acoustic coefficients (Dev*Xe Moule in thousands of individuals per n.m.^{2}) which correspond to the abundance in the area sampled by each trawl haul. The global length distribution of anchovy is shown on figure 8.2. The series of length distributions in numbers as observed since 2000 are shown in figure 8.3.



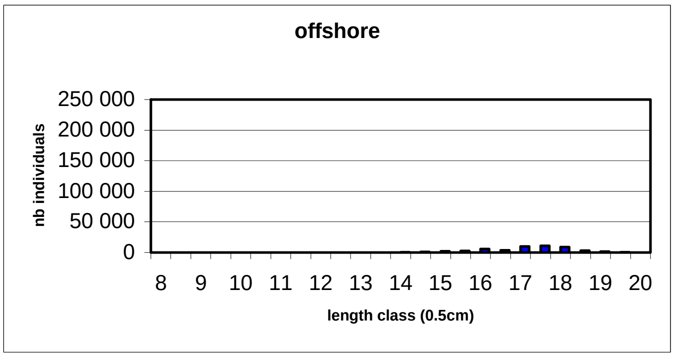


Figure 8.1 –length distribution of anchovy observed during PELGAS08 inshore (strata 1, 3, 5, 6, 8 & 10) and offshore (strata 2, 4, 7 & 9)

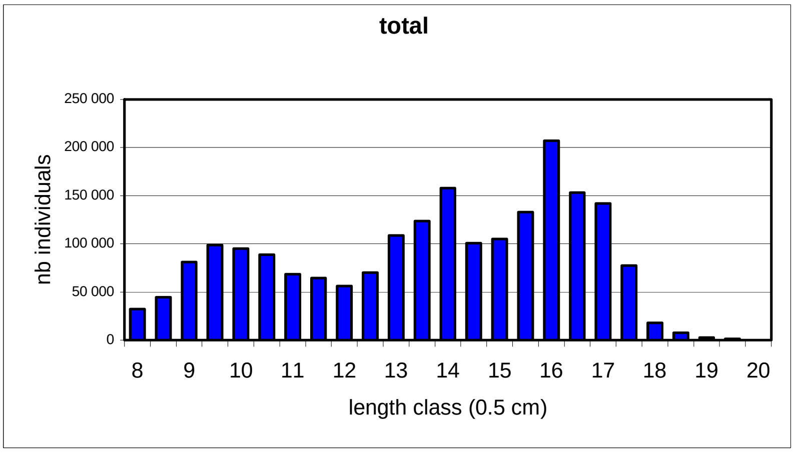


Figure 8.2:length distribution of global anchovy as observed during PELGAS08 survey

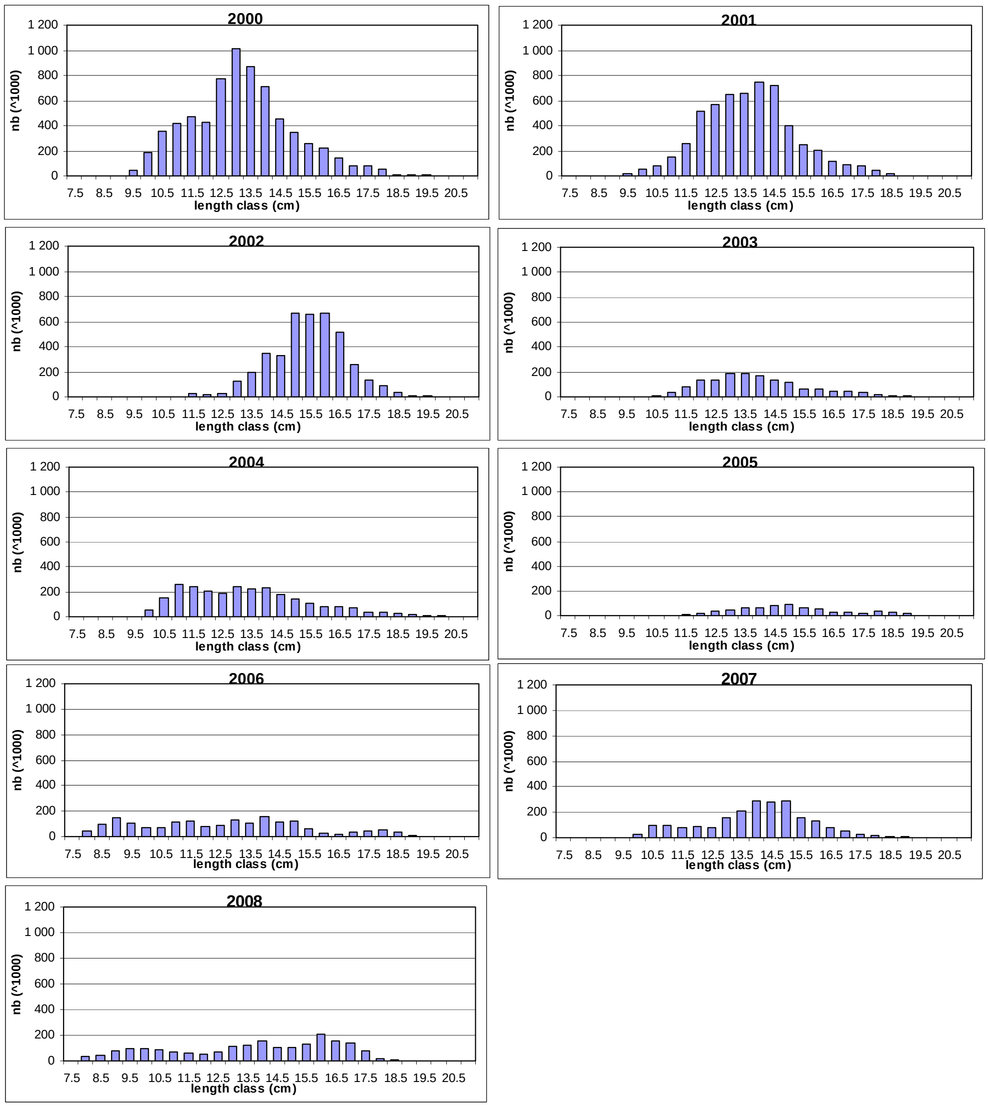


Figure 8.3. – length composition of anchovy as estimated by acoustics since 2000.

4.3 Demographic structure

An age length key was built for anchovy from the trawl catches (Thalassa hauls) and some samples from professional vessels. Sub-samples (908 otoliths for the whole survey) were taken from the previous samples, according to a stratified scheme based on length classes. The population length distribution was estimated by a weighted use of length distributions in the hauls. Weights used are acoustic coefficients (Dev*Xe*Moule in thousands of individuals per n.m.^{2}) which correspond to the abundance in the area sampled by each trawl haul.

Table 7 – anchovy age/Length key from PELGAS08 samples

NB Age	Age				
Longueur (1/2 cm)	1	2	3	4	Total
7.5	100.00%	0.00%	0.00%	0.00%	100.00%
8	100.00%	0.00%	0.00%	0.00%	100.00%
8.5	100.00%	0.00%	0.00%	0.00%	100.00%
9	100.00%	0.00%	0.00%	0.00%	100.00%
9.5	100.00%	0.00%	0.00%	0.00%	100.00%
10	100.00%	0.00%	0.00%	0.00%	100.00%
10.5	100.00%	0.00%	0.00%	0.00%	100.00%
11	77.78%	22.22%	0.00%	0.00%	100.00%
11.5	77.78%	22.22%	0.00%	0.00%	100.00%
12	60.00%	30.00%	10.00%	0.00%	100.00%
12.5	47.50%	40.00%	12.50%	0.00%	100.00%
13	54.90%	35.29%	9.80%	0.00%	100.00%
13.5	56.14%	36.84%	5.26%	1.75%	100.00%
14	57.58%	30.30%	12.12%	0.00%	100.00%
14.5	50.00%	36.76%	11.76%	1.47%	100.00%
15	35.29%	42.65%	20.59%	1.47%	100.00%
15.5	13.04%	60.87%	23.19%	2.90%	100.00%
16	5.63%	66.20%	26.76%	1.41%	100.00%
16.5	5.71%	75.71%	17.14%	1.43%	100.00%
17	1.49%	76.12%	20.90%	1.49%	100.00%
17.5	0.00%	80.39%	19.61%	0.00%	100.00%
18	0.00%	76.09%	21.74%	2.17%	100.00%
18.5	0.00%	76.00%	24.00%	0.00%	100.00%
19	0.00%	53.33%	40.00%	6.67%	100.00%
19.5	0.00%	57.14%	42.86%	0.00%	100.00%
20	0.00%	66.67%	33.33%	0.00%	100.00%
20.5	0.00%	100.00%	0.00%	0.00%	100.00%
Total	33.48%	49.61%	15.80%	1.10%	100.00%

Applying the age distributions to the abundance in biomass and numbers, the distribution in age of the biomass has been calculated and gathered in the table 8. The total biomass used here has been up-dated with the value obtained from the previous method based on strata.

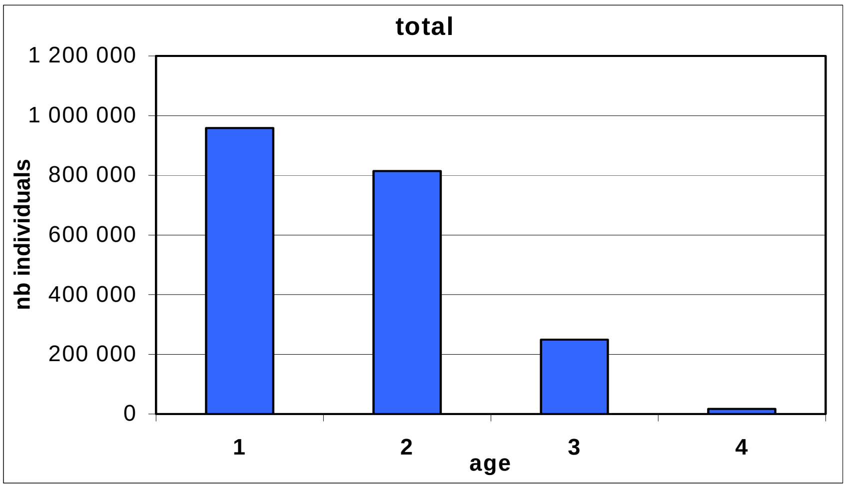


Figure 9.1 – Age proportions of global anchovy as observed during PELGAS08 survey

	Biomass	numbers	G1	G2	G3	G4
Inshore (1, 3, 5, 6 & 8)	35 642	1 987 923	956 138	777 850	237 784	16 151
Offshore (2,4,7,9 &10)	1 715	50 847	2 523	36 453	11 180	690
Total	37 358	2 038 770	958 661	814 303	248 965	16 841
% (numbers)			47.0 %	39.9 %	12.2 %	0.8 %
Mean weight (g)			11.46	26.92	27.31	27.43
Mean length (g)			11.48	15.43	15.55	15.63
Coefficient of variation	0.12	0.15				

Table 8 – Age distribution of Anchovy inshore and offshore during PELGAS08

Age distributions per area and global are shown in Figures 9.1 and 9.2. The age distributions compared from 2000 to 2008 are shown in Figure 9.3.

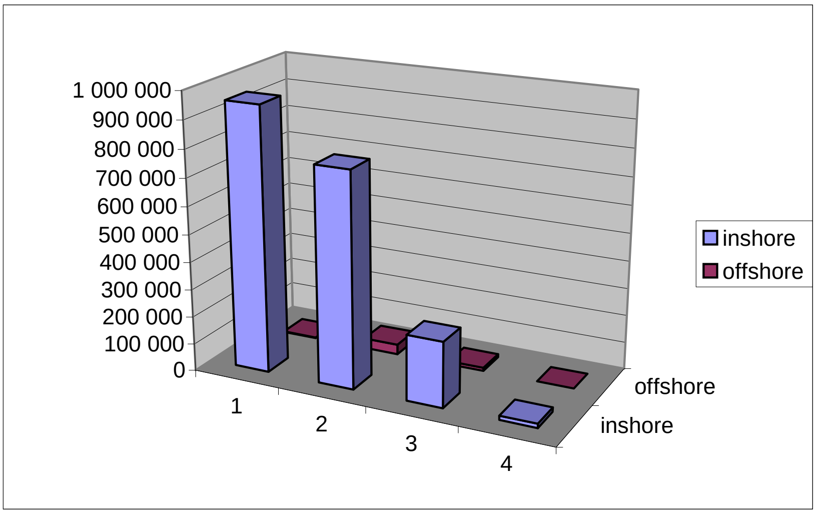
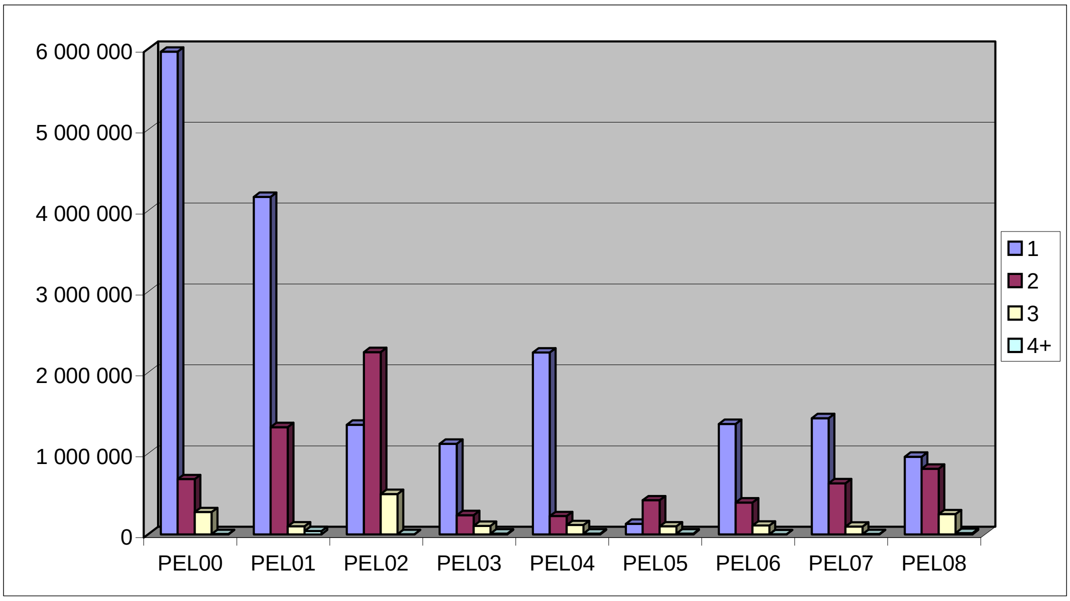


Figure 9.2– Number of anchovy per age group during PELGAS08 in numbers



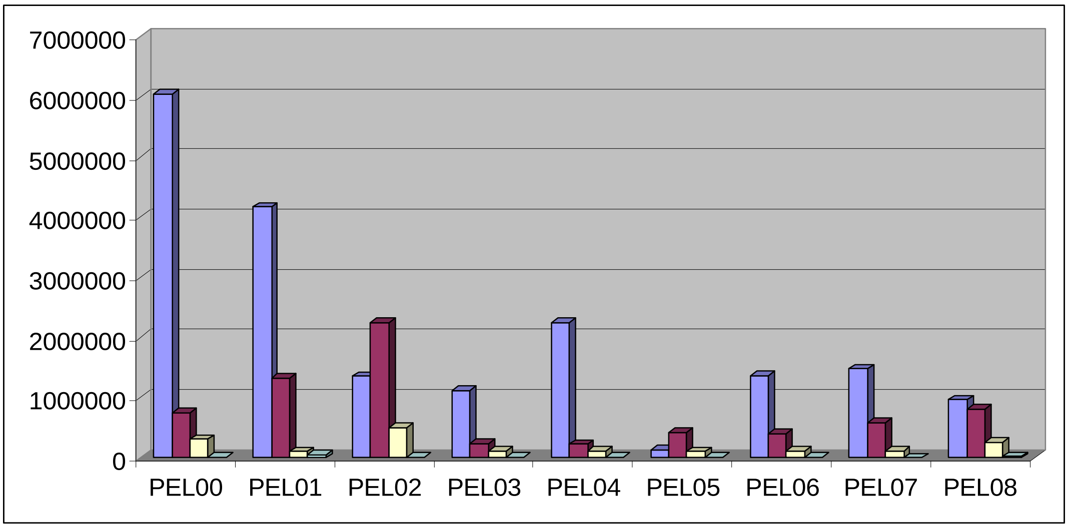


Figure 9.3 – Numbers at age of anchovy as observed during PELGAS surveys since 2000

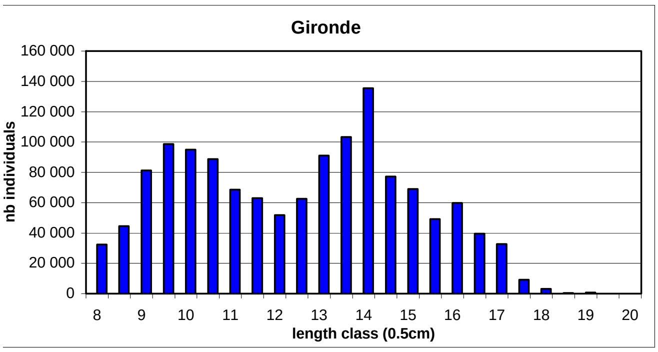
4.4 Strata comparison

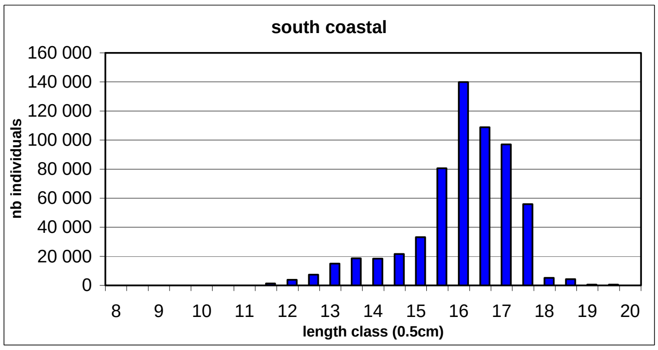
Because of the separate distribution of species as observed previously for assessment purposes, two distinctive strata could be considered as significant anchovy biomass : the south coastal area and the Gironde one. Length and age distributions have been separately analysed and show that 86 % of age 1 in 2008 was concentrated in Gironde area (table 8bis and figures .

Table 8bis. -age distribution of anchovy in numbers as estimated from PELGAS08 survey according to separate distribution Gironde – southern coastal

	age 1	age 2	age 3	age 4	Total
Gironde	826 388	327 517	95 442	6 335	1 255 682
southern coastal	83 526	372 738	117 906	8 172	582 342
other areas	48 747	114 048	35 617	2 334	200 746
Total Bay of Biscay	958 661	814 303	248 965	16 841	2 038 770

	age 1	age 2	age 3	age 4
Gironde	86.2	40.2	38.3	37.6
southern coastal	8.7	45.8	47.4	48.5
other areas	5.1	14.0	14.3	13.9
Total Bay of Biscay	100.0	100.0	100.0	100.0





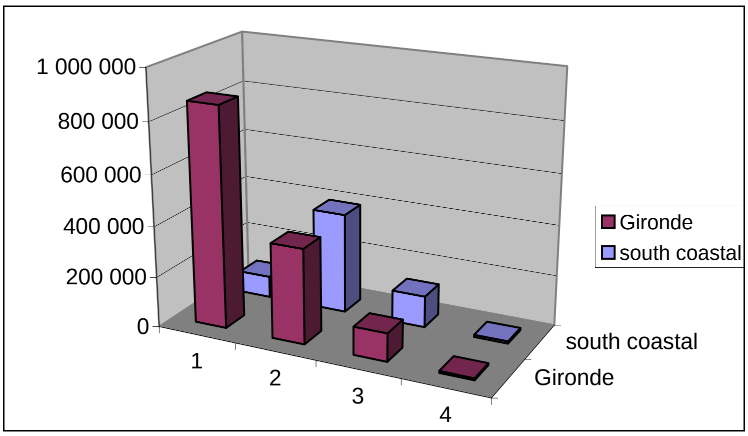


Figure 9.2. bis- length distribution and numbers at age during PELGAS08 according to the 2 main areas where anchovy occurred

4.5 Weight/Length key

Based on 3135 weight of individual fishes, the following weight/length key was established (figure 10) :

$$W = 0.0042\ L^{3.1888} \qquad \text{(with } R^2 = 0.9587\text{)}$$

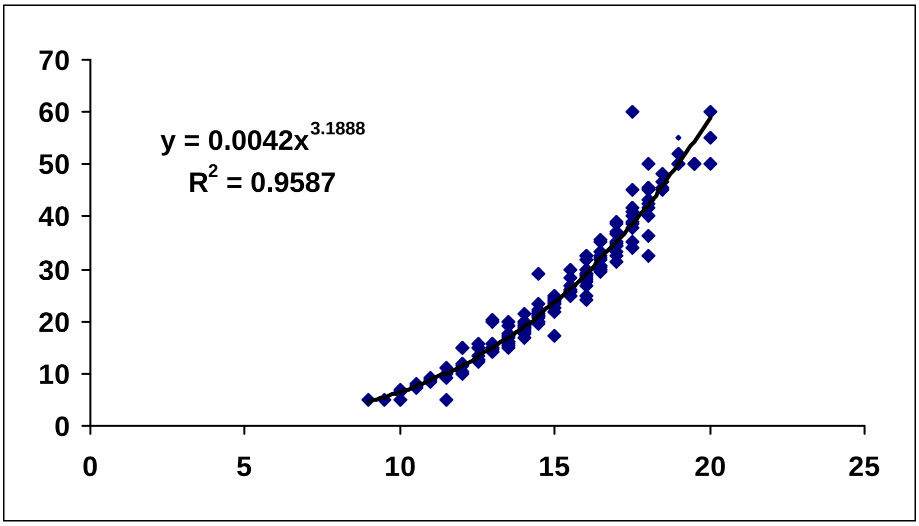


Figure 10 – Weight/length key of anchovy established during PELGAS08

4.6 Eggs

During this survey, in addition of acoustic transects and pelagic trawl hauls, 772 CUFES samples were collected and counted, 76 vertical plankton hauls and 99 vertical profiles with CTD were carried out. Eggs were sorted and counted during the survey.

The last week was spent prospecting the southern area (where eggs where more abundant) between the Gironde plume (figure 11) and the area called "Fer à cheval", a little bit offshore. The main objective was to study the nyctemeral behaviour of anchovy, the coherence between the eggs and the adults distribution, and to collect data on eggs density and vertical distribution with the multinet (MINOF, 27 hauls). The last experiments were carried out in order to validate a vertical model of egg distribution, which could be used in the future to extrapolate the CUFES data over the whole water column for a quantitative use.

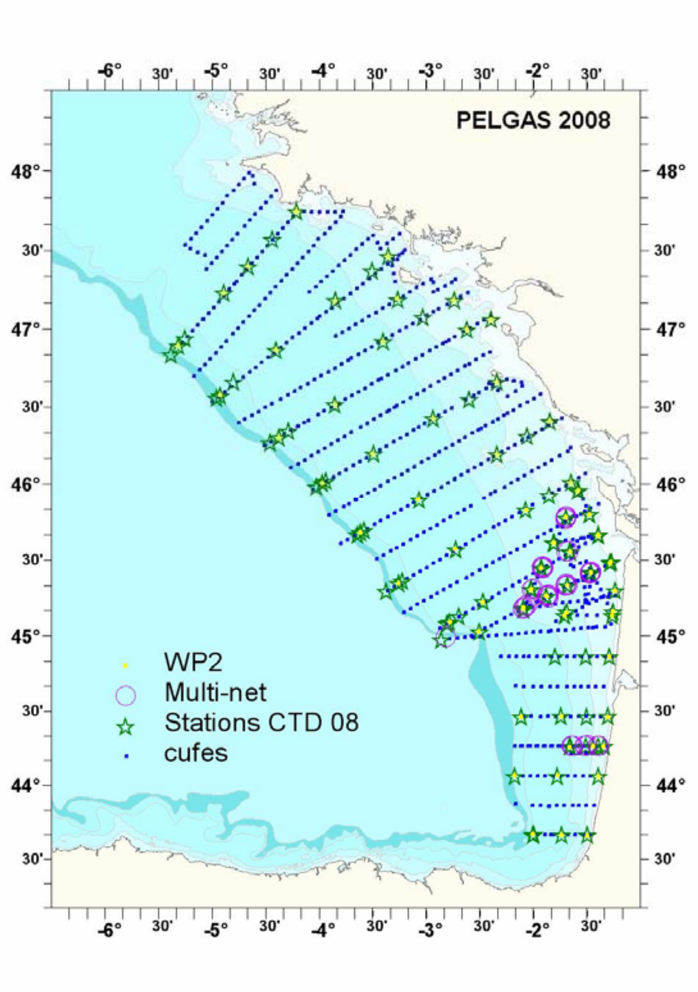


Figure 11 – Studied area prospected during the last week of the PELGAS08 with the CUFES network and hydrology stations.

The number of eggs collected by CUFES during the survey (figure 12, 13 and 14) was very low compared to 2007 (which was a strong maximum for the time series) but more classic compared to the average number since 2000.

Anchovy eggs abundance was close to the average of the time series since 2000. Eggs were abundant on Plateau des Landes around 44°N and around the Gironde plume. North of Gironde, eggs were coastal only and in low quantity. Both abundance and spatial distribution display an average pattern. This year, some eggs were found on the south coast of Brittany but in a low quantity

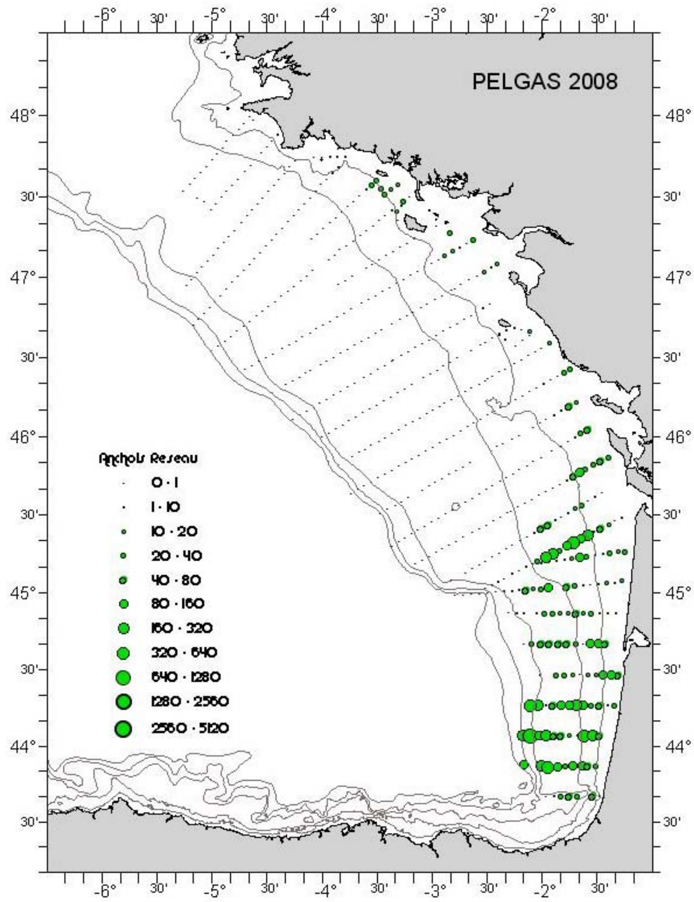


Figure 12 – Distribution of anchovy eggs observed with CUFES during PELGAS08.

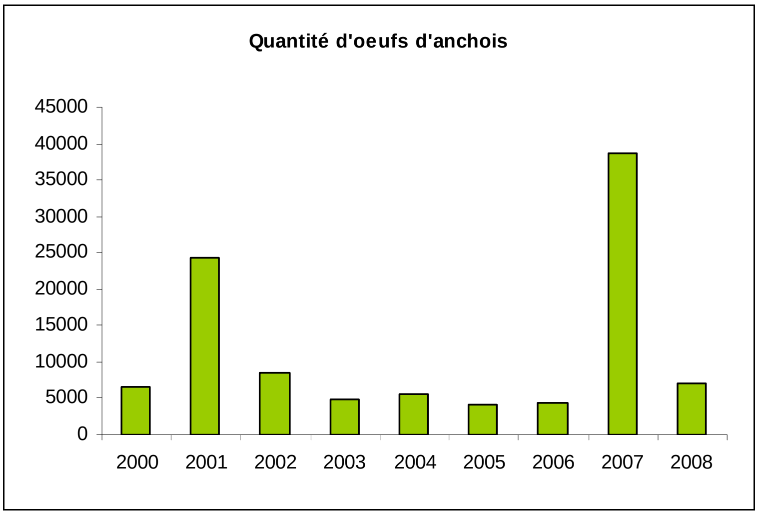
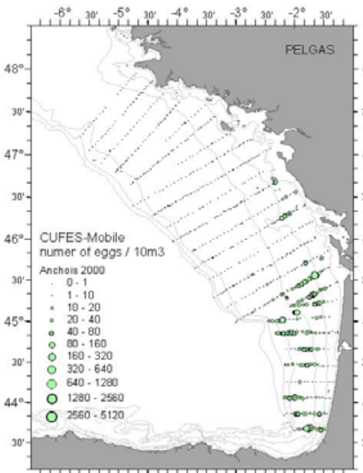
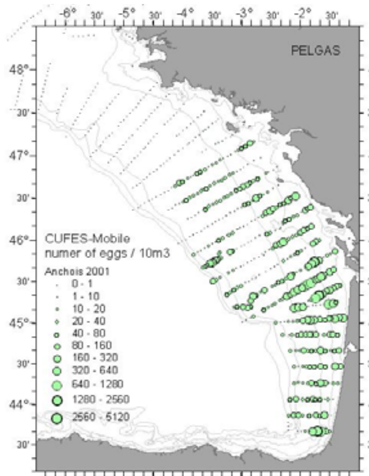


Figure 13 – Number of eggs observed during PELGAS surveys from 2000 to 2008

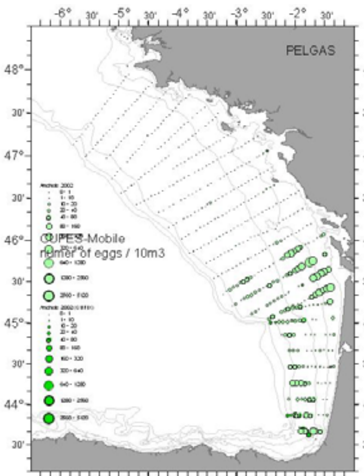
Annex 5:



Annex 6:



Annex 7:



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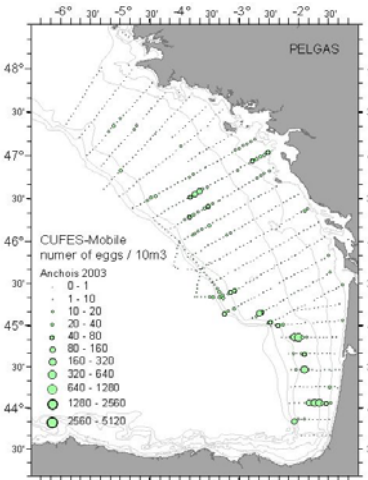

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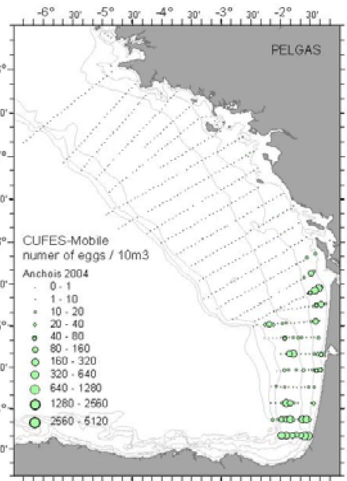

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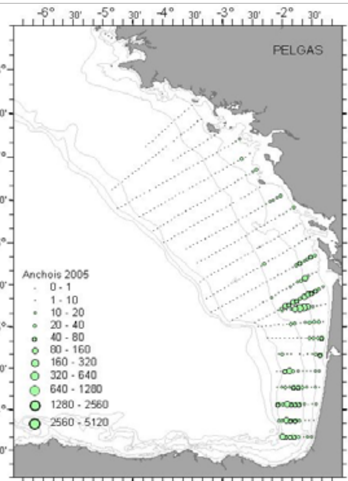

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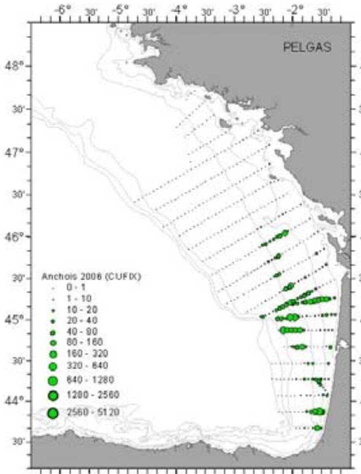

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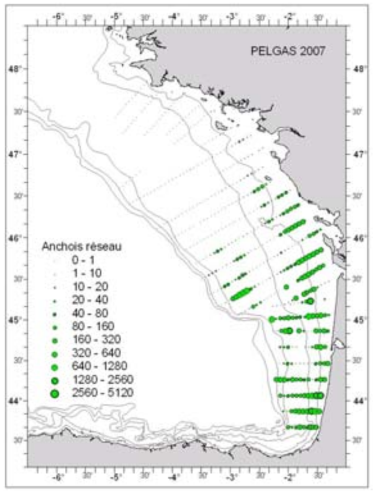


Annex 13:

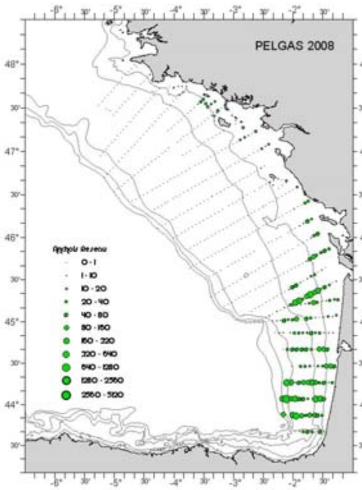


Figure. 14 – distribution of anchovy eggs observed with CUFES during PELGAS from 2000 to 2008 (number for 10m³).

5. Hydrological conditions

The spatial extent of the low salinity is from the coast to the isobath 50 m approx, where as the plume (salinity <34) may extent to the isobath 100 m. Surface fluorescence was maximum close to Belle-Ile and at the shelf break around 46°N. There was low fluorescence in the low haline coastal waters, probably because of the strong discharge. A coastal current oriented to the North was evidenced by deploying buoys, which is associated to the low salinities of the river discharges.

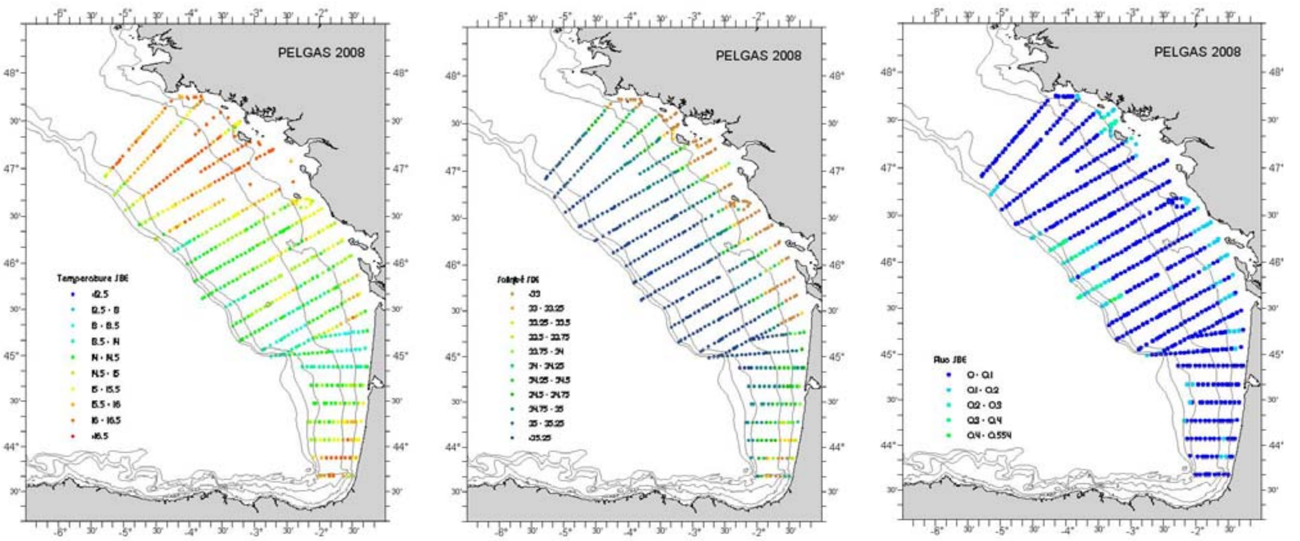


Figure 16 – Surface temperature, salinity and fluorescence observed during PELGAS08.

7 Top predators

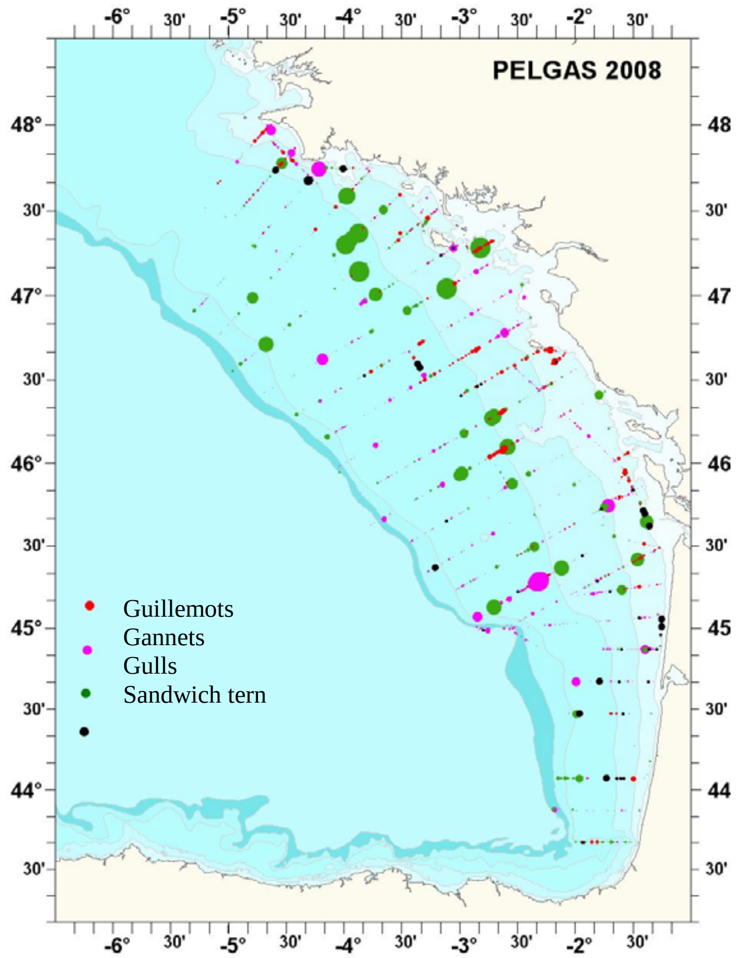
During the Pelgas 2008 survey, 2559 seabird and cetacean sightings have been recorded. Twenty-seven bird species and nine cetacean species have been identified.

7.1 Birds

The most abundant bird species were the lesser black-backed gull (Larus fuscus) with 2912 individuals, and the gannets (Morus bassana) with 2013 individuals. The more frequent other species were the Herring gull (Larus argentatus, 626), the northern fulmar (Fulmarus glacialis, 354), the guillemot (Uria aalge, 321), the common stern (Sterna hirundo, 94), the sandwich tern (Sterna sandevicensis, 75), the great skua (Catharacta skua, 75), the great black-backed gull (Larus marinus, 67), the Balearic shearwater (Puffinus mauritanicus, 62), the kittiwake (Rissa tridactyla, 43), the manx shearwater (Puffinus puffinus, 30).

Seagulls and gannet have a similar and homogeneous distribution in the area of the Bay of Biscay. Pod sizes of seagulls are significantly higher than that of gannet which observations are often represented by only one individual. The number of gannets seems to have increased compared to 2007.

The guillemot habitat is more coastal and this species is rarely observed over the 50 meters bathymetric line.

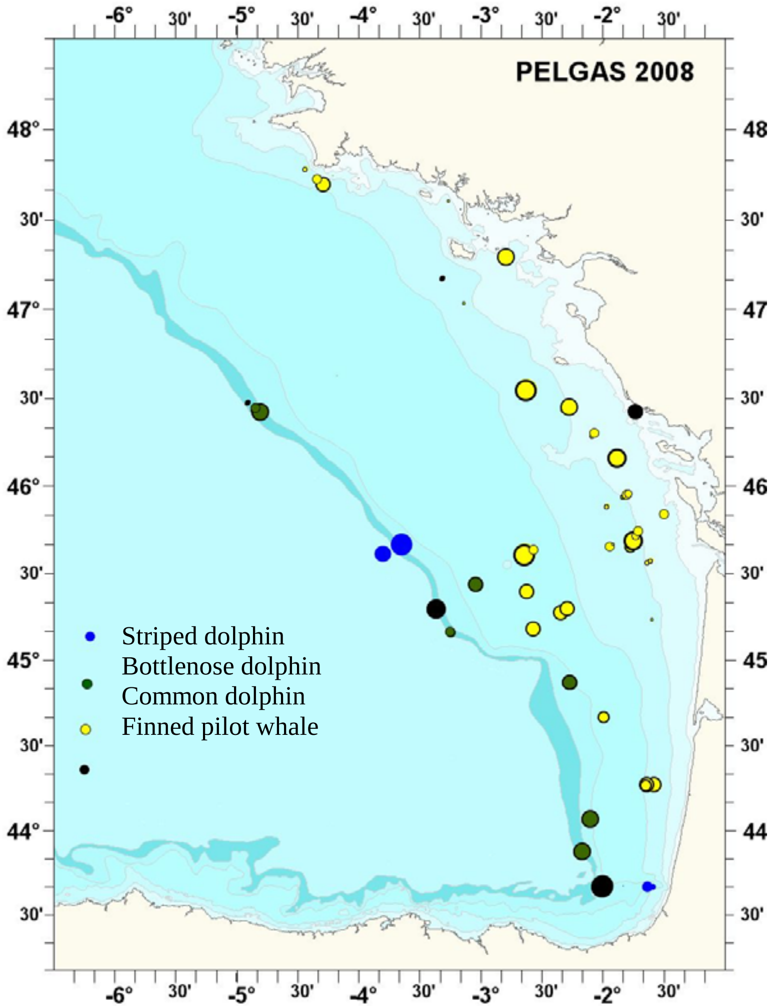


7.2 Mammals

The more frequent cetacean species is the common dolphin, Delphinus delphis with 1074 individuals. Then the striped dolphin (Stenella coeruleoalba, 321), the pilot whale (Globicephala melas, 238), the bottlenose dolphin (Tursiops truncatus, 226), the Risso's dolphin (Grampus griseus, 11), the minke whale (Balaenoptera acutorostrata, 5) and 1 sperm whale (Physeter macrocephalus).

Bottlenose dolphin, striped dolphin and pilot whale are distributed along the shelf edge in the southern Bay of Biscay and this distribution is similar to the year before.

The number of common dolphins have increased compared to year 2007, especially in the « Fer à Cheval » area, where they are together with the previous cited species. However, the distribution is similar to the last year and common dolphins occupy essentially the continental shelf both in the southern and northern parts of the Bay.



8 Conclusion

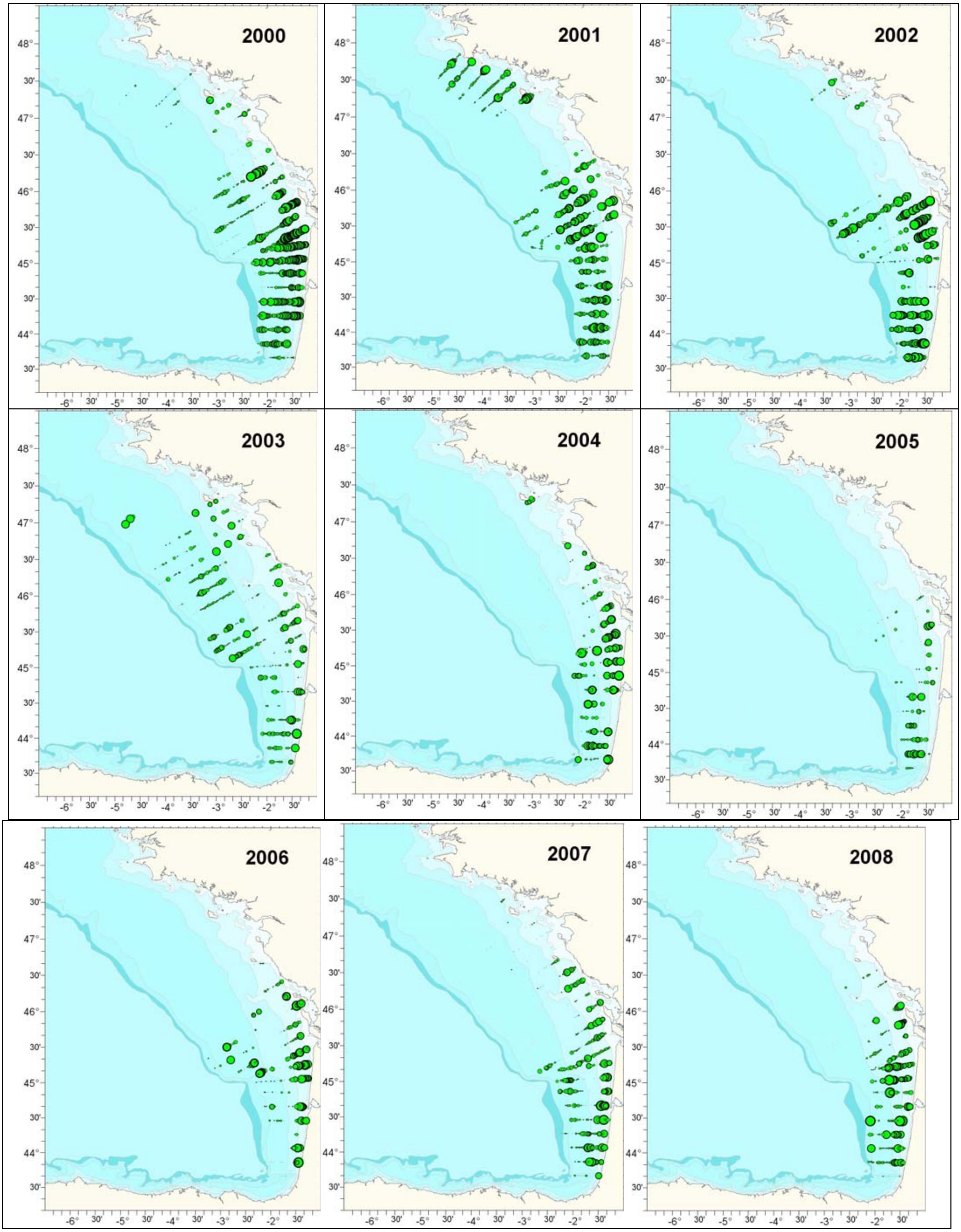
The Pelgas08 acoustic survey has been carried out in good conditions for the whole area, except 2 days of bad weather, in the southern area. The biomass estimated during spring 2008 is globally similar to the 2007 one. It was present along the coast from Bayonne to the Gironde mixed with sardine or sprat (but generally not dense) and on the platform but not deeper than 100m depth. It was quite absent along the shelf break, even if eggs were present (CUFES). Sardine was predominant all over the southern Bay of Biscay. Marine mammals were very present all over the survey.

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

It must be noticed that recent observations showed that anchovy may have rapid local displacement. The small fishes localised in the south of Gironde area at the beginning of the PELGAS survey (figure 3.4.2.4.) were localised again 10 days later during the BIOMAN survey 20 nautical miles northern. The same group was localised again at the very end of PELGAS08, 10 days later, 15 nm southern and a little bit more offshore. This suggests this fish performs fast movements at a local scale which cannot be considered as real migration, but more as responses to changes in local environmental conditions in order to remain in a suitable habitat. Indeed, the river plume as observed by satellite imagery showed drastic changes between the beginning and the end of PELGAS survey. This strengthens the idea that a direct assessment survey must be carried out in the shortest possible time window.

On another hand, it can be also noticed that Temperature and salinity recorded during PelGas were affected by weather conditions before and during the survey. At the start of the survey in the South, temperature were low (14-15°C) due to low heating and strong mixing before and during the first week of the survey. Then good weather resulted in sea surface warming and therefore the North of the Bay shows higher sea surface temperatures (16-17°C) than the Southern part. High river discharge gave low salinity plumes oriented to the north for Adour, Gironde and Loire. The spatial extent of the low salinity is from the coast to the isobath 50 m approx, where as the plume (salinity <34) may extent to the isobath 100 m.

The consort survey permitted to pair trawlers to participate to the PELGAS survey in a very good spirit of collaboration. This year, they were equipped of scientific echosounder and acoustic data will be considered in the near future. For the time being, only catches were included in the assessment process.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Annex 5: List of Participants

Working Group on Anchovy (WGANC)

ICES Headquarters 13-16 June 2008

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Annex 6: Technical Minutes from the Review Group on Anchovy (RGANC)

Review of ICES WGANC Report 2008.

Reviewers:	Martin Pastoors (chair)
	Larry Jacobson (USA)
	Hans Lassen (ICES secretariat??)
Chair WG:	Dankert Skagen (Norway)
Secretariat:	Mette Bertelsen

1. General

The Working Group is complimented for a clearly structured and understandable report. The review group is aware that the working group has operated under a tight time-pressure with the survey information just being available a day before the meeting.

Benchmark assessment proposal

Benchmarks to be performed before the next assessment

Stock	Problem	Last benchmark
Anchovy in the Bay of Biscay	* Include autumn survey in assessment model if possible, for potential use in predicting current recruitment and use by managers * Revise DEPM data based on updated estimates of effective fecundity. * Consider revisions to biomass dynamics model to more fully characterize uncertainty and avoid assumptions of constant somatic growth rates	??

Anchovy in the Bay of Biscay

ASSESSMENT TYPE	UPDATE
Assessment	Accept
Forecast	Alternative catch options in harvest table
Assessment model	Bayesian biomass dynamic model (2 stage)
Consistency	Highly consistent with last year
Stock status	Around Blim. Harvest rate is around zero.
Management plan	Under development in STECF groups

General

There are two annual acoustic surveys occurring are after the Spanish (spring) fishery and before the French (autumn) fishery. In addition, a daily egg production survey (DEPM) is carried out at about the same time as the spring acoustic survey. Age composition data from concurrent trawling are used to separate survey data into age 1 and age 1+ components.

The spring acoustic and DEPM surveys are the primary source of information. The fall acoustic survey has been conducted only five times.

Acoustic survey data used in the model are for age 1+ anchovies. DEPM measures age 1+ because anchovies are fully mature at age 1. The fishery takes age 1+ anchovies almost exclusively.

Autumn survey includes new recruits (age 0 anchovies) which are potentially important as a preview of recruitment to the fishable stock next year. Five years of age 0 fall survey data are available appear correlated with independent model based estimates of recruitment. However, the working group believes that there is too little data to draw conclusions about the veracity of the fall survey in predicting recruitment because there are few observations which were all collected during years when recruitment was relatively low.

Age 1 is the dominant part of the catch and SSB. The stock is believed to be fully recruited and fully mature at age 1. In contrast, few age 0 fish are taken in the commercial fishery although age 0 anchovies used to be caught for live bait in the tuna fishery.

Catch data are thought to be accurate.

Assessment method: Bayesian two-stage biomass dynamics model used in previous assessment and recently published. A few relatively minor modifications were made to the model to simplify it.

Model calculations are in 6-month time intervals with catch assumed to occur at the middle of each semester. SSB is estimated in the model at an average spawning time (May)

In modelling, the average time of the spring surveys in considered but variation among years in survey timing are ignored. In some cases, there may be as much as 1 month difference between years in survey timing. Differences in timing may affect results because mortality and growth rates are high (e.g. $M=1.2$ and $G=0.5\ y^{-1}$).

The ratio of new recruit biomass to biomass of older ages (based on concurrent trawling during the surveys) was used in the model to separate information from surveys for the two groups of anchovies.

Adult parameters used to estimated fecundity are not yet available for the 2008 egg survey. In lieu of adult parameters, a regression equation estimated with data for 1987-2007 was used to estimate SSB during the 2008 survey from estimated egg production.

The instantaneous growth rate g=M-G was fixed at 0.68 in the model because M is assumed to 1.2 and G was estimated to be approximately 0.5 (g = M-G = 1.2-0.5 or approximately 0.68.

The scale of estimated biomass is not directly linked to catch data in the familiar VPA-type manner. Catches are subtracted from biomass in the model and form a lower limit on total biomass but are not translated directly into biomass estimates. Rather, information about overall scale of the stock biomass comes from using the DEPM survey data as measures of absolute biomass. In other words, the DEPM estimates are necessary to estimate the scale, but not the trend, of anchovy stock biomass.

New information includes catches during 2007, which were zero because the fishery was closed, spring acoustic survey data for 2008, a preliminary DEPM spawning biomass estimate from May 2008, and fall acoustic survey data for age 0 anchovies during 2007. The fall survey data were not used in modelling. The net effects of the new data were modest in the sense that biomass estimates for 2008 are low as predicted in the last assessment.

Changes to the model were modest, primarily for simplification, and based on review of the published model and reviewer's comments. In particular, formal process errors for annual biomass were judged to be redundant and were dropped because recruitment estimators are themselves a type of annual process error. The parameter g was fixed at 0.68 and not estimated as a model parameter because it could not be reliably estimated in the model and was likely to be correlated with other estimated parameters. Priors for some parameters were adjusted. The net effect of all of these changes was very small.

Result of assessment:

Reviewers agreed that the assessment was successful in meeting the terms of reference for updated stock assessments. Modest changes to modelling approaches simplified and improved the assessment with little effect on results. New data included in the assessment confirmed projections from the last assessment. Qualitative analysis of the available data supports the model results. In particular, commercial catch rates were low during 2006, recent trends in survey data are very low, and length and age composition data indicate recent poor recruitments.

ACFM advised in October 2007 "that the fishery should remain closed in 2008 until reliable estimates of the 2008 SSB and 2007 year class, based on the results from the spring 2008 acoustic and DEPM surveys, become available. This implies a closure of the fishery until at least July 2008." One of the most important questions for the current assessment is whether the spring 2008 acoustic and DEPM surveys are valid and provide reliable estimates of the 2008 SSB and recruitment by the 2007 year class. Distribution maps indicate that the 2008 egg survey covered the geographical distribution of spawning anchovy relatively completely. The egg survey included a single station with high abundance which was discussed at length by the working group to decide whether the station should be included in the DEPM estimate. Reviewers agreed with the working group's decision to include all stations in the estimate for reasons summarized in the report. Similarly, distribution maps indicate that the 2008 acoustic survey covered the range of the stock. No major concentrations of anchovy were found. Both surveys during 2008 indicate low spawning biomass levels and poor recruitment of the 2007 year class.

All of the available data and model estimates indicate that recruitment has been very low since 2002 despite the fact that harvest rates have been very low and were zero in 2007.

The biomass reference point Blim for the stock is based on a previous estimate of biomass in 1989 when anchovies were at their lowest level since 1987. It was taken as a given in the assessment and used without adjustment.

The median estimate for 2008 biomass (24101 t) is slightly above Blim (21,000 t). Based on the posterior distribution, there is substantial probability (23%) that 2008 biomass was less than Blim.

Forecasting was for one year (till June 2009) and carried out under the assumption that recruitment in 2008 will be similar to recruitment during 2002-2007. In particular, the distribution of potential recruitments for forecasting was formed by combining the prior distributions of recruitments from the model during 2002-2007. In the last assessment, the distribution of potential recruitments was from all years with low recruitment (2002-2007 plus several years in the late 1980's) but this change had negligible effect. The distribution of combined posteriors for recruitment during all years seemed to indicate that the recruitments during 2002-2007 were distinctive as a group.

Forecasts made various assumptions about the catch during July 2008-June 2009 and calculated the probability under each level of assumed catch that biomass during 2009 would be less than Blim.

Technical comments

The estimated trends from the assessment model are relatively certain and there is no doubt that the stock is currently at a low level. There is more uncertainty than depicted in the assessment about the overall scale of stock biomass and estimated harvest rates.

Estimates of the scale of stock biomass from the model depend almost entirely on the assumption that DEPM data were unbiased estimates of stock biomass. The model assumed that q=1 for DEPM, without considering any uncertainty in the assumption. It would probably be better to use a prior for q with, for example, a mean of one and a realistic variance so that the posterior would include uncertainty in this key parameter.

The model was parameterized using a constant g=0.58. The factor g=M-G, where M is natural mortality and G is the instantaneous rate of change in biomass after recruitment, is the net effect of losses due to natural mortality and gains due to somatic growth. It is necessary to make an assumption about g in the model because it does not internally represent age structure due to variability in recruitment.

As described above, g=0.58 in the model because M is thought (and implicitly assumed) to about 1.2 and G is thought to be about 0.5 on average. The g factor was assumed to be constant in modelling because it was inestimable even with prior information.

The assumption of q known was necessary under the circumstances but the assessment understates uncertainty to the extent that the assumption changed the posterior distribution. It was argued, and reviewers agree, that indeterminacy in g was automatically accommodated in the model to some extent because DEPM data convey information about the scale of stock biomass and because the recruitment estimates can be viewed as nuisance parameters which automatically adjust for errors in other parts of the model. In other words, an error that made g to small by ½ would be compensated by recruitment estimates that are twice as large with no net effect on biomass and harvest rate estimates.

More importantly, the assessment understates uncertainty to the extent that g changed over time in the real anchovy stock. In real populations, g changes with time due with variability in recruitment because the somatic growth rate G is lower for older fish which grow slowly. Older fish are relatively common in the current stock, for example, because recruitment has been poor since 2002. It is therefore likely that average G in the stock is relatively low and g is relatively high making projections overly optimistic.

It is relatively easy to construct simple biomass dynamic models that contain all information about age structure, assume von Bertalanffy growth, and accommodate variability in G. These approaches have the additional advantage of estimating fishing mortality F in familiar terms and making the scale of recruitment estimates more reliable. There are at least two approaches, both of which are algebraically identical to a Leslie matrix stock population dynamics with von Bertalanffy growth. Both approaches convey the full effect of changes in G due to variability in recruitment. State-space, maximum likelihood and Bayesian implementations of both methods are reasonably straight-forward. Both approaches use standard exponential mortality calculations which are accurate under high mortality rates.

The first approach is Deriso-Schnute's delay-difference model (Deriso 1980; Schnute 1985)[1, 2], which is a single equation biomass dynamic model that assumes knife-edge selectivity. Delay-difference models are well known, two group (new recruits and survivors from the previous year), relatively widely used and reasonably easy to implement in WinBUGs, AD-Model Builder or any other programming language . The number of parameters that have to be estimated depends on the available data and the decisions involved are basically the same as made in the current anchovy stock assessment. Estimate fishing mortality rates as parameters or using an internal Newton step with a fixed number of iterations. Estimate catchability coefficients as parameters or using the closed form maximum likelihood estimator. It is possible to cast recruitment estimates as independent or autocorrelated parameters, or to make recruitment a function of past spawning biomass levels. Growth can be assumed zero making the delay-difference model strictly numerical and mathematically the same as the standard Baranov-type exponential mortality model. The "Collie-Sissenwine" or "Catch-Survey" (CS) model (Conser 1995) [3] recently used by Mesnill (2003; 2005)[4,5] is similar but less general than the delay-difference model with growth

[1] Deriso, R, B. 1980. Harvesting strategies and parameter estimation for an age-structured model. Can. J. Fish. Aquat. Sci., 37: 268-282.

[2] Schnute, J. 1985. A general theory for analysis of catch and effort data. Can. J. Fish. Aquat. Sci. 42: 414-429.

[3] Conser, R.J. 1995. A modified DeLury modeling framework for data limited assessment: bridging the gap between surplus production models and age-structured models. A working paper for the ICES Working Group on Methods of Fish Stock Assessment. Copenhagen, Denmark. Feb. 1995.

[4] Mesnil, B. 2003. The Catch-Survey Analysis (CSA) method of fish stock assessment: an evaluation using simulated data. Fish. Res. 63: 193-212.

turned off and using Pope-type approximations in place of the exponential mortality model. The CS model has seen recent use in US stock assessments for American lobster (ASMFC 2006)[6] and crabs (Zheng et al. 1997)[7] Delay-difference models have been used recently in stock assessments for Atlantic surfclams (NEFSC 2007)[8], ocean quahogs (NEFSC 2007)[9], butterfish (NEFSC 2003)[10] and Atlantic herring (Overholtz et al. 2008)[11].

The second approach is even more general and familiar. The idea is to set up a standard numerical population dynamics model (forward projecting) that assumed von Bertalanffy growth to calculate biomass and makes all of the necessary assumptions (e.g. knife-edge recruitment) that are either necessary or appropriate for the stock at hand. Estimate only the parameters for which data are available. Typically, von Bertalanffy growth parameters, M, fishery selectivity, and maturity would be assumed known. Estimated parameters typically include recruitments, catchability parameters and fishing mortality rates. As with the delay-difference model, fishing mortality rates can be cast as parameters or estimated in an internal Newton step—the model can even be set up using Pope-type approximations if you want to avoid estimated F parameters all together. Catchability coefficients can be estimated as parameters or using the closed form estimator. Fit the model to whatever data are available. For example, to fit the model to DEPM data, calculate the predicted spawning biomass from the model based on the estimated age structure in each year, von Bertlanffy growth curve, and maturity at age. Then calculate the likelihood or posterior probability of the model using the predicted and observed DEPM values. The advantage of the second approach is generality because any set of assumptions about growth,

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[5] Mesnil, B. 2005. Sensitivity of, and bias in, catch-survey analysis (CSA) estimates of stock abundance, p. 757-782. In: Fisheries Assessment and Management in Data-Limited Situations. pp. 757-782.

[6] Atlantic States Marine Fisheries Commission. 2006. American lobster stock assessment report for peer review. Stock Assessment Report No. 06-03 (Supplement). Atlantic States Marine Fisheries Commission, Washington, DC. 366p.

http://www.asmfc.org/speciesDocuments/lobster/annualreports/stockassmtreports/americanLobsterStockAssessmentReport06.pdf

[7] Zheng, J; Murphy, M.C., and Kruse, G.H. 1997. Application of a catch-survey analysis to blue king crab stocks near Pribilof and St. Matthew Islands . Alaska fish. Res. Bull. 4: 62-74. 1997.

[8] NEFSC. 2007. Assessment of Atlantic surflcams. In: 44th Northeast Regional Stock Assessment Workshop (44th SAW): 44th SAW assessment report. Northeast Fish. Sci. Cent. Ref. Doc. 07-10. 661p.

[9] NEFSC. 2007. Assessment of ocean quahogs. In: 44th Northeast Regional Stock Assessment Workshop (44th SAW): 44th SAW assessment report. Northeast Fish. Sci. Cent. Ref. Doc. 07-10.

[10] NEFSC. 2003. Atlantic butterfish, p. 1-73. In: Report of the 38th Northeast Regional Stock Assessment Workshop (38th SAW): Stock Assessment Review Committee (SARC) consensus summary of assessments. Northeast Fish. Sci. Cent. Ref. Doc. 04-03.

[11] Overholtz, W.J.; Jacobson, L.D.; Link, J.S. 2008. An Ecosystem Approach for Assessment Advice and Biological Reference Points for the Gulf of Maine-Georges Bank Atlantic Herring Complex. N. Am. J. Fish. Manage. 28: 247-257..

fishery selectivity, spawner-recruit relationships, etc. can be employed. Moreover, the simple model is embedded in a family of more complex and fully age structured models. In either case, any mixture of fixed and estimated parameters can be explored.

Conclusion

The updated assessment was accepted. The new work supports management recommendations made previously. The stock is still at about the Blim level. A review of environmental data showed no strong evidence for a fundamental change in the ecosystem, although the stock is experiencing a relatively prolonged period (about 7 y) of low recruitment and productivity.

Anchovy in the Gulf of Cadiz

ASSESSMENT TYPE	UPDATE
Assessment	Accepted
Forecast	Not carried out
Assessment model	Qualitative analysis
Consistency	Highly consistent with previous assessment
Stock status	No evidence of serious problems
Management plan	

General

The focus of the assessment was anchovies in area IXa south. Anchovy stocks in other parts of area IXa are less unimportant. The fishery in IXa south is minor compared to fisheries for other species, such as sardine.

Some survey information available from surveys used for other species. Data from a spring acoustic appear potentially most useful.

Ageing is difficult due to southern habitat area. Catch at age data have, however, been produced.

Despite the absence of age 2+ anchovies, stock definition is thought to be reasonable based on the geographic distribution of catches and survey data.

A variety of exploratory assessment models were examined but no analytical assessment models have been successfully applied. In particular, a separable model tuned to catch at age and acoustic data did not give reasonable results. A major problem in interpreting the available catch at age information is the remarkable disappearance of fish after age 1 due, apparently, to ontogenetic movement patterns.

Key conclusions about data trends and fishery conditions should be summarized in one section to summarize evidence and conclusions about stock status.

Technical comments

A great deal of information was presented but in a form that was difficult to understand. Future assessments should attempt to consolidate and reduce the size of the report. Figures clearly showing trends in catches for key areas should be presented in such a way that trends for different areas are clear. Survey data should be presented and plotted in such a way that differences between seasons and years are clear.

A simple two-stage biomass dynamic model (such as used for anchovy in the Bay of Biscay) might be applicable if more DEPM spawning biomass surveys are carried out and acoustic survey data continue to be collected.

In the absence of a stock assessment model, reviewers agreed that a qualitative assessment, based on the working group's evaluation of the available data, was appropriate and sufficient.

Conclusion

Available data indicate stable stock status with little change from the previous assessment. There is no evidence of serious problems. Catches, catch per unit effort, and survey trends are variable but show no trends. Length and age composition data indicate appreciable recent recruitment levels. The ratio of catch in Area IXa south to DEPM spawning biomass during 2005 (4423/14219=0.31) is reasonably low, although the DEPM estimate is highly uncertain (CV 62%).

It is important to continue the current spring acoustic survey, and to carry out more DEPM surveys on a regular basis, if possible.