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Report of the Working Group on Anchovy and Sardine (WGANSA)

24–28 June 2010

Vigo, Spain

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CIEM Conseil International pour l'Exploration de la Mer

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Executive summary

The Working Group on Anchovy and Sardine (WGANSA) met at IPIMAR, Lisbon 24-28 June 2010, chaired by Dankert Skagen, Norway. There were 10 participants from France, Portugal, Spain and Norway. The main task was to assess the state of the stock and to provide short term predictions for the stocks of Anchovy in Subarea VIII and in Division IXa, and for Sardine in Divisions VIIIc and IXa. All assessments were updates of previous assessments.

The time interval between finalizing the key surveys and the managers decision is short, and the timing of the WG has been problematic. This year, it was held 9 days later than last year, which allowed a better control of the input to the assessment.

The Anchovy in Subarea VIII is improving, as the recruitment in 2010 is at an intermediate level, breaking a long series of poor recruitments. Hence, it can be recommended to open the fishery again. Reasons for the recent recruitment failure are not known, despite extensive investigations.

The information on the Anchovy in Division IXa, where the Gulf of Cadiz is the main fishing area, is limited, and no analytic assessment can be done. The available catch and survey data give somewhat conflicting results, but there are some indications that the stock may be declining. Therefore, a more conservative advice may be appropriate.

The Iberian Sardine has had a series of poor year classes since 2005. The stock is still near the long term average, but is expected to decline unless a new strong year class appears. The stock probably is lightly exploited, and the current fishing mortality is probably sustainable even with a low recruitment, while maintaining catches at the current level would imply increasing fishing mortalities and further reduction of the SSB.

Sardine also appears to the North of the assessment area, in the Bay of Biscay, Celtic sea, and Western Channel, and the southern North Sea. There is no request for advise for sardine in that area at present, but the WG has collected relevant information from the Bay of Biscay (catch numbers at age and acoustic survey estimates) over some years. The catch data series is still very short, and there are some strong year effects in the survey, probably due to inadequate coverage in time and space in some years. An analytic assessment as basis for advice is still not possible, but should be so within a few years if data continue to be collected. Extending the survey coverage into the Celtic Sea and English Channel was attempted this year, and is strongly encouraged.

1 Introduction

1.1 Terms of reference

The WGANSA met at ICES headquarters 15 20 June 2009 to address the terms of reference in Council decision :2009/2/ACOM16 The **Working Group on Anchovy and Sardine** [WGANSA] (Chaired by: Dankert Skagen, Norway) will meet in Lisbon, Portugal, 24–28 June 2010 to:

a) address generic ToRs for Fish Stock Assessment Working Groups (see table below);

The assessments will be carried out on the basis of the stock annex in National Laboratories, prior to the meeting.

ToR a) includes assessments for Anchovy in the Bay of Biscay, Anchovy in Division IXa and Sardine in Divisions VIIIc and IX a.

In correspondences with ACOM, and in consultation with the European Commission, it was agreed that WGANSA should deliver the assessment results for the Bay of Biscay anchovy at noon the last day of the meeting, to enable the commission to provisionally set a TAC according to the proposed harvest rule.

1.2 Organizing the report

Each of the stocks is handled in a separate section. The report is split in a main part, describing recent developments, assessments, predictions and management considerations, and stock annexes describing material of more permanent nature, including general biological characteristics, fleet descriptions, standard procedures for producing input data for assessments (catch and survey data) and the methods for analytic assessment and prediction.

Survey reports are presented to the WG as Working Documents. These Working Documents are included in the report as annexes. They are in principle the responsibility of the authors, but have been carefully scrutinized and approved by the WG and constitute a major contribution to the results.

1.3 Comments to the new WG structure and working schedule

The time for the meeting is constrained by the timing of the surveys on one hand and the need for managers to implement the advice immediately on the other. The timing issues relate to the anchovy in particular, since a TAC is to be set based on the outcome of the assessment by 1. July. Compared to last year, the meeting was 9 days later. Although the time schedule still is tight, the time to finalize the survey results now allowed a careful and controlled analysis of the survey data. Therefore, it is recommended to maintain the present timing of the meeting. The results of the Bay of Biscay anchovy assessment is presented to managers at the last day of the meeting. This result has not been subject to a normal review process by ICES, and should be regarded as preliminary in the meantime.

1.4 Intercatch.

The WG made some progress in implementing Intercatch as its standard tool for reporting and assembling catch data. However, due to the tight time schedule, importing the catch data into Intercatch was not the highest priority. For the Sardine, as in previous years, catch data has been included successfully with assistance from the ICES staff. For anchovy in the Bay of Biscay, 2010 is the first year with catches, and time has not permitted including them in Intercatch so far. Developing the logisitics for including Bay of Biscay anchovy catches in Intercatch will be done intersessionally. For Anchovy in Division IXa, the intention is to implement Intercatch intersessionally. So far little progress has been made due to shortage of manpower.

1.5 Sardine and anchovy outside the assessment areas.

Both species exist outside the areas for which assessments are requested and made. Last year, some of these 'other' stocks were handled in some depth in the report. This year, information has been updated, but the WG did not have the manpower to allocate to more in-depth analysis.

Contributions on the occurrence of sardine and anchovy and historical records of sardine and anchovy fisheries outside the core areas still are most welcome, to build up an understanding of the distribution dynamics of these species.

Anchovy is found in small amounts in other areas, typically associated with river outlets. In some years, the amount is sufficient to support a fishery.

There are also regular fisheries for sardine in in Divisions VIIIa and b, and in Subarea VII. Last year, the possibility of making an analytic assessment of the sardine in these areas was explored. It was concluded that the data were still insufficient for that purpose. The time series of catches at age is still short, as is the survey data series, and there are some strong year effects in the survey. This year, the information has been updated with another year, but no new attempts have been made to assess the stock.

1.6 Data Collection Framework (DCF).

In 2008, the European Council established the Community framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy (Council Regulation (EC) No 199/2008). This new framework takes into consideration the most recent developments in fisheries management such as the fleet-based approach and the ecosystem approach and also is based on the experience gained during the implementation of the old data collection regulation (Council Regulation (EC) 1543/2000), in place since 2001.

The new Data Collection Framework took effect from the 1 January 2009 and under the new regulations, Member States are required to establish multiannual datasets (instead of annual), aggregated and that should incorporate biological and economic information more extensively than before. Member States are required to draw up collection programmes and ensure the quality and increased availability of data.

The sampling unit under the DCF stops being the species and becomes the fishing trip for which all species should be sampled concurrently. MS must ensure that the number of fishing trips sampled shall ensure good coverage of the metier with the metier being defined as "*a group of fishing operations targeting a similar (assemblage of) species, using similar gear, during the same period of the year and/or within the same area characterised by a similar exploitation pattern*" (Commission Decision 2008/949/EC).

In the case of sardine and anchovy, both species are classified as belonging to Group 1 (*Species that drive the international management process including species under EU management plans or EU recovery plans or EU long term multiannual plans or EU action plans for conservation and management based on Council Regulation (EC) No 2371/2002 of 20 De-*

cember 2002 on the conservation and sustainable exploitation of fisheries resources under the common fisheries policy (2)).

Under the new DCR, sampling for length distributions and to obtain biological parameters has suffered some changes for sardine in Spain and Portugal.

In both cases, to obtain the catch length distribution, there has been an important decrease in the number of samples (ca 59% in Portugal and 17% in Spain, from 2008 to 2009) and individual fish measured (reduction of more than the half in Portugal and 22% in Spain from 2008 to 2009). The biological sampling has remained stable since is carried out on a stock basis and no by metier.

1.7 Pelagic ecosystem dynamics

The study of anchovy and sardine population dynamics are particularly difficult due to their regular migrations and recruitment variability. Both species usually share the same areas with other pelagic species such as sprat, mackerel and horse mackerel, at least for a period of their life. They are sometimes competitors, both targeted by the same commercial fleets and often preys of the same predators. As each species is usually taken into consideration by itself, the dynamics are explained using single-species models that do not take species interactions into account. WG members consider that ecosystem models are needed to improve our understanding of the dynamics of the pelagic system population. A long series of pelagic acoustic surveys is now available from Gibraltar to Brittany (ECOCADIZ, PELAGO, PELACUS, PELGAS) where data are concurrently collected on several ecosystem components. A shift between sardine and anchovy has often been considered over the word but this hypothesis is now being reconsidered. When setting targets for fisheries management, considering both the effects of fishing on the target species and the effect of fishing on their prey and predator populations is crucial and often, it will alter the perception of the suitability of different management options.

2 Anchovy in the Bay of Biscay (Subarea VIII)

2.1 ACOM advise for 2009 and 2010 and STECF recommendations and Political decisions

The closure of the fishery in July 2005 and July 2006, due to the low levels of biomass of the anchovy population and the failure of the fishery, was sustained until June 2009.

In June 2009, ICES advice stated that "Based on the most recent estimates of SSB, ICES classifies the stock as being at risk of reduced reproductive capacity. Although median SSB in 2009 is estimated to be above Blim, this estimate has a 47% probability of being below Blim. Low recruitment at age 1 since 2002 and almost complete recruitment failure of the 2004 year class are the primary causes of the low stock size". According to that state of the stock, ICES advice to the EC was: "There is a 37% risk that SSB in 2010 will be below Blim even with no catch. ICES advises on the basis of exploitation boundaries in relation to precautionary limits that the fishery should remain closed until the stock condition has improved. The stock condition can be reevaluated when estimates of the 2010 SSB and 2009 year class are available based on the spring 2010 acoustic and DEPM surveys. This implies a closure of the fishery until at least July 2010. "

According to that advice the EC closed the fishery in July 2009 until December 2009.

ICES advice in June 2009 was based on the assumption that a new weak recruitment would be happening again in 2010 (Similar to the levels occurring since 2002). In November 2009, a report provided by AZTI suggesting that a low recruitment level was not the most likely one for 2010 was submitted to its clients (Spanish and Basque governments) (Uriarte *et al*. 2009, in background documents), based on environmental indications (Fernandes *et al*. 2010) and on a direct estimation of juveniles by the Acoustic JUVENA survey in 2010 (ICES 2009- WGACEGG), both pointing out that a medium level of recruitment was more likely to happen). It suggested that an uncertain recruitment level scenario (whatever past recruitment could be happening in 2010) could be a better basis of recruitment scenario for 2010. Risks for different catch options for the first half of 2010 under this alternative recruitment scenario were included in that report.

Subsequently in December 2009 (doc 5032/10 PECHE 1; http://register.consilium.europa.eu/pdf/en/10/st05/st05032.en10.pdf), "The Council and the Commission have exceptionally agreed the temporary re-opening of the anchovy fishery in the Bay of Biscay following encouraging indications, based on the results of the research survey 'Juvena09', which preliminary point to a strong incoming recruitment that might increase the stock in 2010 in a substantial manner . They also agree that this agreement is conditional upon a careful validation by STECF of the above-mentioned results using all available scientific information, specially the results of the 2010 spring surveys and the most complete catch data gathered during the fishery. Should the scientific advise indicate that the stock recovery is not confirmed, the Council and the Commission agree that the TAC should be reduced in accordance with the proposed multiannual plan for this stock.".

Neither ICES nor STECF were involved in this process. Both were reluctant to use the juvenile index as an indicator of future recruitment until experience had been gained with the performance of the survey with a better recruitment which should have been confirmed by an ordinary assessment.

The TAC for reopening the fishery was set at 7000 t.

The EC has formulated a draft proposal for a multiannual management plan for anchovy, which at present is subject to revision and agreement between the EC, the Council and the Parliament, according to the procedures established in the Lisbon treaty. The plan is expected to be approved during the next year.

2.2 The fishery in 2009 and 2010

2.2.1 Fishing fleets

For the period July 2006 and December 2009, there was no commercial fishery for anchovy in the Bay of Biscay, due to the closure of the fishery.

Two fleets used to operate on anchovy in the Bay of Biscay before the closure: Spanish purse seines (operating mainly during spring) and the French fleet constituted of purse seiners (the Basque ones operating mainly in spring and the Breton in autumn) and pelagic trawlers (mainly during the second half of the year). A more complete description of the fisheries is made in the stock annex.

With the reopening of the fishery, in January 2010, the total number of fishing licences for anchovy in Spain was 168, distributed by regions or provinces as follows:

GALICIA	ASTURIAS	CANTABRIA	VIZCAYA	GUIPUZCOA	TOTAL
51	7	43	26	41	168

For France the number of purse seiners able to catch anchovy is around 30. The exact number of vessels is not fixed, due to important movements in this fleet actually. Most of them are based in Brittany; two new ones will join the fleet soon. The number of Basque purse seiners decrease progressively and some of them will also join the north of the Bay of Biscay in near future. The real target specie of these vessels is sardine and anchovy is opportunistic.

The number of pelagic trawlers decreased drastically during the last 3 years because they were targeting mainly anchovy and tuna. Actually, 15 pairs of trawlers (30 vessels) are able to target anchovy.

2.2.2 Catches

Following the closure of the fishery since July 2006, there was no commercial catches for anchovy in the Bay of Biscay in 2009. Historical catches by countries since 1960 are presented in Table 2.2.2.1, and Figure 2.2.2.1 shows the historical evolution of the fishery between 1940-2010.

It must be noticed that some catches appeared in October 2009 in the VIIh, very close to the limit with the VIIIa. About 400 tons of very big anchovy (25 ind/kg) were caught, mainly by purse seiners, during two weeks.

In 2010 the fishery was reopened with a TAC of 7000 t. Catches were allowed since the 01 of March. By the 10th of June the Spanish fishery reached its annual quota of 5,400t. and was subsequently closed. According to Spanish fishermen organizations' reports to Southwestern RAC, the Spanish catches up to 15 of May were of 2,207 t (an input required for the BBM model, as representative of the catches until mid spawning time). Most of the French fishery started the first of June (with the entry of the pelagic trawlers to the fishery). According to the developing of that fishery, it is suspected that by the end of June its national quota of 1,600 t will be exhausted.

2.2.3 Catch numbers at age

No catches at age in recent years due to fishery closures.

Table 2.2.3.1 records the age composition of the international catches since 1987, on a half-yearly basis. One year old anchovies have dominated in the catches during both halves of most of the years, except in some years with recruitment failure. See the stock annex for methodological issues.

Based on direct biological sampling of catches and age readings, about 70% of the catches were based on the 2009 year class (age 1 fishes). About 1,479 t of the 2,207 t caught up to 15 of May belonged to age 1. This provisional rough estimation was necessary as an input for the BBM assessment. Definitive data for 2010 will be delivered in 2011.

2.2.4 Weights and lengths at age in the catch

The series of mean weight at age in the fishery by half year, from 1987 to 2006, is shown in Table 2.2.4.1. See the stock annex for methodological issues.

Table 2.2.2.1: Annual catches (in tonnes) of Bay of Biscay anchovy (Subarea VIII)
As estimated by the 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	0	1,128
2006	913	840	0	1,753
2007	140 **	1.2 **	0	141
2008	0	0	0	0
2009	0	0	0	0
2010	1,600	5,400		7,000
AVERAGE (1990-04)	6,394	26,337	318	32,824

** Experimental Fishery

Table 2.2.3.1: 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 (International). No catches in 2009

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 2.2.3.1. (Cont. 1): Bay of Biscay Anchovy (Spain).

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 2.2.3.1. (Cont. 2): Bay of Biscay Anchovy (France).

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 2.2.4.1: 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

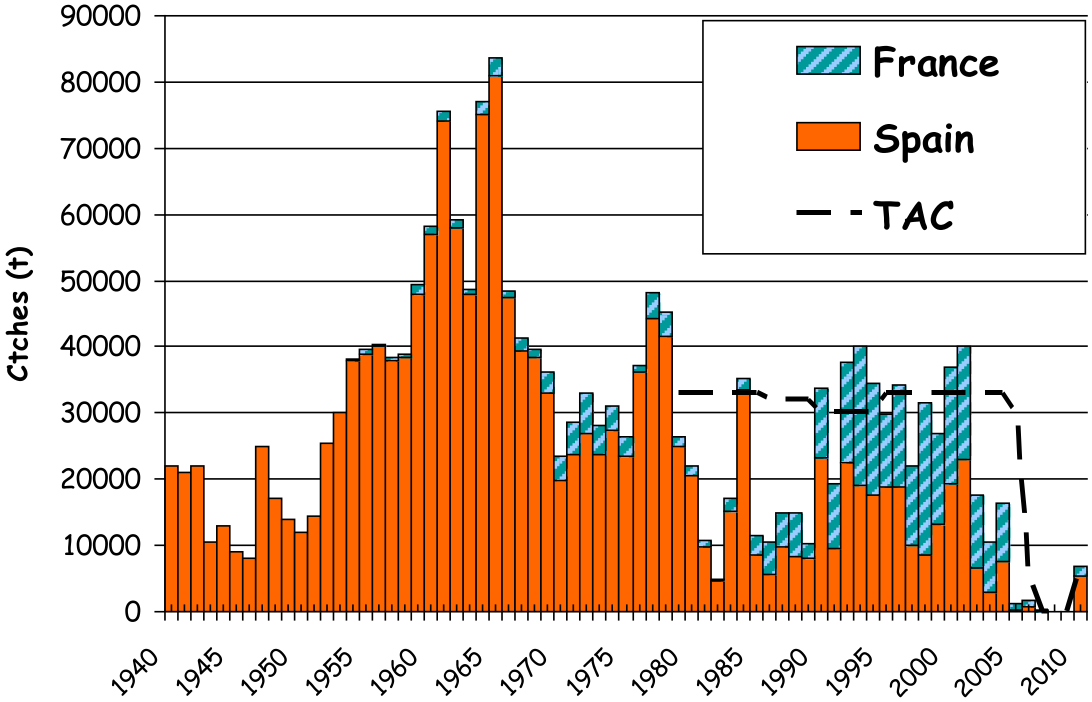


Figure 2.2.2.1 Historical evolution of anchovy catches in subarea VIII by countries (1940-first half of 2010).

2.3 Biological data

2.3.1 Maturity at age

As reported in previous year reports, anchovies are fully mature as soon as they reach their first year of life, in the spring the year after the hatch. See stock annex for details.

2.3.2 Natural mortality and weight at age in the stock

Natural mortality is fixed at 1.2, see stock annex for further information.

In the Bayesian Biomass Model the parameter *g* describes the annual change in mass of the population by encapsulating the growth in weight (G) and the natural Mortality (M) of the population as G-M (0.52-1.2=-0.68).

Explorations of the most likely levels of natural mortality, after 5 years of fishery closure, have been presented to the group in two WD (Petitgas *et al.* WD2010, from the acoustic French survey and Uriarte *et al.* WD2010 from both DEPM and Acoustic survey abundance indexes). Both WD show that the analysis of the available data up to 2009 (so excluding the current evaluation of the stock) indicates a level of natural mortality of about 0.85 for all ages together (with a CV of 22%), so lower than the current M at 1.2. For a constant catchability across ages of surveys, which is the current assumption for the assessment BBM model, the level of natural mortality is higher for ages 2+ than for age 1 (around 0.7 for age 1 and between 1.15 and 1.35 for age 2+, depending on the concrete modelling). Compatibility of surveys abundances with the constant catchability by ages is optimized through this pattern of natural mortalities at age. These results suggest that Natural Mortality may increase with age for anchovy, particularly after its second spawning, being anchovy an intermediate small pelagic fish between capelin (which die after it first spawning) and sardines or sprats. This finding is similar to the one shown for sandeels (Cook 2004) and in line with the expectation of increasing mortality at senescence for the short living species (Beverton, 1963). The working group endorsed this type of analysis and considered that the evidences presented demanded a revision of the natural mortality parameter for this stock. The inclusion of a new value(s) of natural mortality in the assessment of this fishery will be subject to the approval of the next Benchmark for this species.

2.4 Fishery Independent Data

2.4.1 DEPM survey 2010

All the methodology for the survey and the estimates performance are described in the stock annex - Bay of Biscay Anchovy (Subarea VIII). A detailed report of the survey and results 2010 is attached as **Annex 3: Santos *et al.* – WD 2010.**

2.4.1.1 Description of survey

The 2010 anchovy DEPM survey was carried out in the Bay of Biscay from 5th to the 20th of May, covering the whole spawning area of the species, following the procedures described in the stock annex. Two vessels were used at the same time and place: the R/V Investigador to collect the plankton samples and the pelagic trawler Emma Bardán to collect the adult samples. Specifications could be seen in table 2.4.1.1.1

This year the mean SST of the survey (13.8ºC) was one of the lowest of the historical series (1987-2010) together with the one of 2004 (13.7ºC).

2.4.1.1 Egg production estimate

The total area surveyed was 61,940 Km² and the spawning area was 37,633Km². A total of 484 vertical plankton tows were completed; 64% were positive for anchovy eggs with an average of 12 eggs/0.1m² per station.

The anchovy eggs were concentrated principally in the area of the French continental shelf between Cap Breton and Arcachon, mostly between the isoline of 100m depth and crossing the shelf brake until 35nm after, and the area of influence of the Gironde river between 45º22'N and 46ºN (Fig. 2.4.1.2.1).

The estimates of daily egg production, daily egg mortality rates and total egg production are given in Table 2.4.1.2.1 and the mortality curve model used is shown in Figure 2.4.1.2.2. Total egg production in 2010 (2.32.E+12egg/day) was 30% higher than last year estimate in the same manner.

2.4.1.2 Adult sampling and adult parameters

The fishing hauls from the adult sampling are summarized in **WD - Santos *et al.* 2010 (Annex III)**. From 34 pelagic trawl hauls obtained with the research pelagic trawler, 30 had anchovy and were used for the analysis. Apart from those, 9 samples were obtained from the purse seines fleet but were not used for the analysis yet. Figures showing the positive hauls for anchovy and the catches are in **WD - Santos *et al.* 2010 (Annex III)**. The spatial distribution of the samples and their species composition is showed in figure 2.4.1.3.1, the adults mean weight and adults mean size distribution are in figures 2.4.1.3.2 and 2.4.1.3.3 respectively. Figure 2.4.1.3.4 shows the age composition by haul.

As the adults samples are not fully processed yet, the DF is estimated from the historical series. Since 2005, when the advice started demanding SSB estimates in June, the provisional Daily Fecundity (DF) estimates were obtained from a linear regression model between DF and sea surface temperature (SST) as described in the stock annex. However the historical series of DF is being revised within WGACEGG (ICES 2009). Until DF is fully revised and its relationship with temperature corroborated by WGACEGG, the WGANSA decided to use the historical mean of DF (63.39 egg/ g per day) to obtain the preliminary SSB estimate for June.

2.4.1.3 Preliminary Spawning Stock Biomass estimate and population at age

In 2010 the preliminary SSB estimated was 36,627 t with a CV of 22%, (Tab. 2.4.1.4.1) (Fig. 2.4.1.4.1), higher than last year estimate given in June (27,994 t; CV 23%).

To estimate the numbers at age, 2 strata were defined. (Fig.2.4.1.4.2). 86% of the anchovy in numbers are individuals of age 1(81%in mass) (Tab.2.4.1.4.2). This indicates a recovery of the recruitment. The age structure of the population since 2005 indicates that the closure of the fishery had a positive effect in sustaining the recent levels of biomass (Fig. 2.4.1.4.3)

Table 2.4.1.1.1: Bay of Biscay: Details obtained in anchovy DEPM Survey 2010.

Parameters	Anchovy DEPM survey
Surveyed area	(43º17' to 47ºN & 4º30′ to 1º30' W)
R/V	*Investigador & Emma Bardán*
Date	5-20/05/10
Eggs	R/V INVESTIGADOR
Total egg stations	484
% st with anchovy eggs	64%
Anchovy egg average by st	12 eggs/0.1m^2
Max. anchovy eggs in a St	126 eggs/0.1m^2
Total anchovy egg collected	5,588 eggs
North spawning limit	46º15′N
West spawning limit	3º12′W
Total area surveyed	60,940 Km^2
Spawning area	37,633 Km^2
CUFES stations	1,156
Adults	R/V EMMA BARDAN
Pelag. trawls + p. seine hauls	34 + 9
With anchovy	30 + 9
Selected for analysis	30 + 6*

*Not included yet in this report analysis

Table 2.4.1.2.1: Bay of Biscay: Daily egg production estimates (P_0), daily egg mortality rates (z) and total egg production (P_{tot}) with their correspondent standard error (s.e.) and coefficient of variation (CV) for 2010.

Parameter	Value	s.e.	CV
P_0	61.70	7.71	0.12
z	0.34	0.002	0.16
P_{tot}	2.32.E+12	3.E+11	0.12

Table: 2.4.1.4.1: Bay of Biscay: Preliminary biomass estimate (SSB) for 2010 obtained as the ratio between estimates of P_{tot} derived from the GLM and the mean of DF (Daily Fecundity).

P_{tot} (eggs/day)			DF (eggs/gram)			SSB (Ton.)		
Model	Estimate	Var	Model	Estimate	Var	Estimate	Var	CV
GLM	2.32E+12	8.4E+22	DF=histor.mean	63.39	139	36,627	6.7.E+07	0.2241

Table: 2.4.1.4.2: Bay of Biscay: SSB 2010 estimates, percentage at age, numbers at age, mean weight by age class, SSB at age in mass and percentage at age in mass and the correspondent standard error (s.e.) and coefficient of variation (CV).

Parameter	Estimate	s.e.	CV
Biomass (Tons)	36,627	8,208	0.2241
Total mean W (g)	18.70	1.35	0.0720
Population (millions)	1,959	461.0	0.2354
Percent age 1	86%	0.0162	0.0188
Percent age 2	13%	0.0149	0.1147
Percent age 3+	1%	0.0023	0.3151
Numbers at age 1	1,689	398.9	0.2361
Numbers at age 2	255	66.8	0.2618
Numbers at age 3+	14	5.6	0.3933
Weight at age 1	17.6		
Weight at age 2	24.5		
Weight at age 3+	41.0		
SSB at age 1 in mass	29,801		
SSB at age 2 in mass	6,241		
SSB at age 3+ in mass	585		
Percent age 1 in mass	81.4%		
Percent age 2 in mass	17.0%		
Percent age 3+ in mass	1.6%		

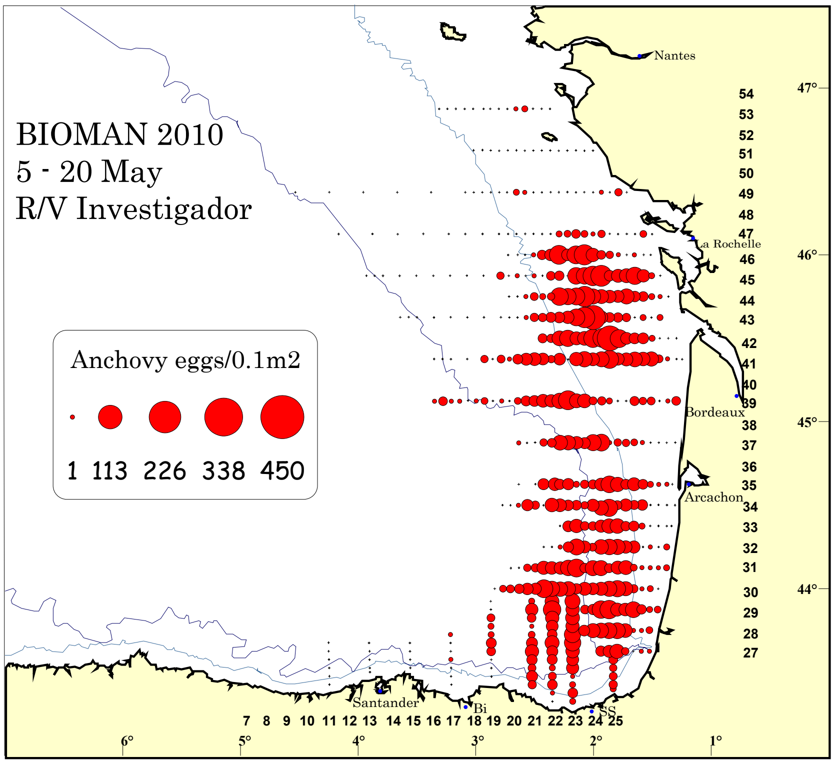


Figure 2.4.1.2.1: Bay of Biscay anchovy: Distribution of egg abundances (eggs per 0.1m²) from the DEPM survey BIOMAN10 obtained with PairoVET.

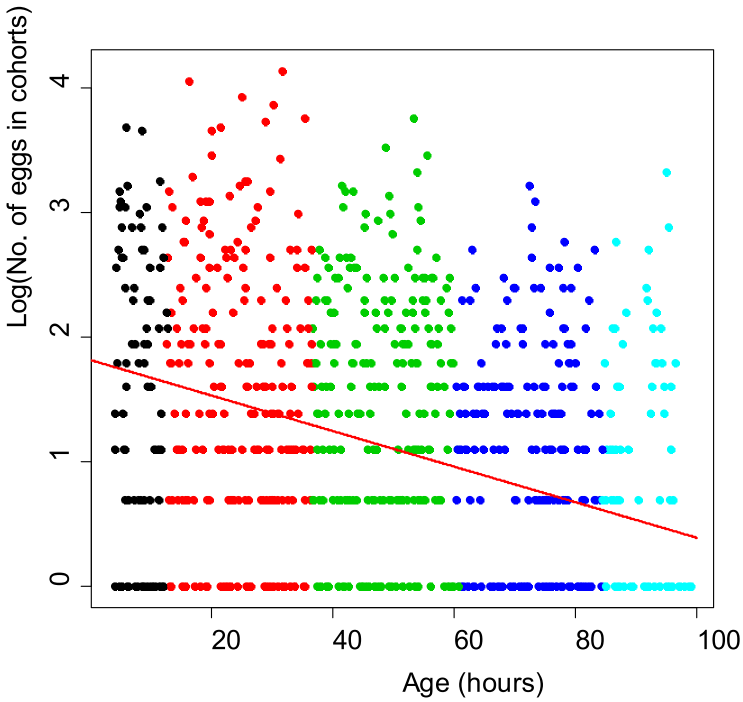


Figure 2.4.1.2.2: Bay of Biscay anchovy: Exponential mortality model adjusted applying a GLM to the data obtained in the ageing, following the Bayesian method. (Spawning peak 23:00h).The red line is the adjust line. The different colours are the different cohorts

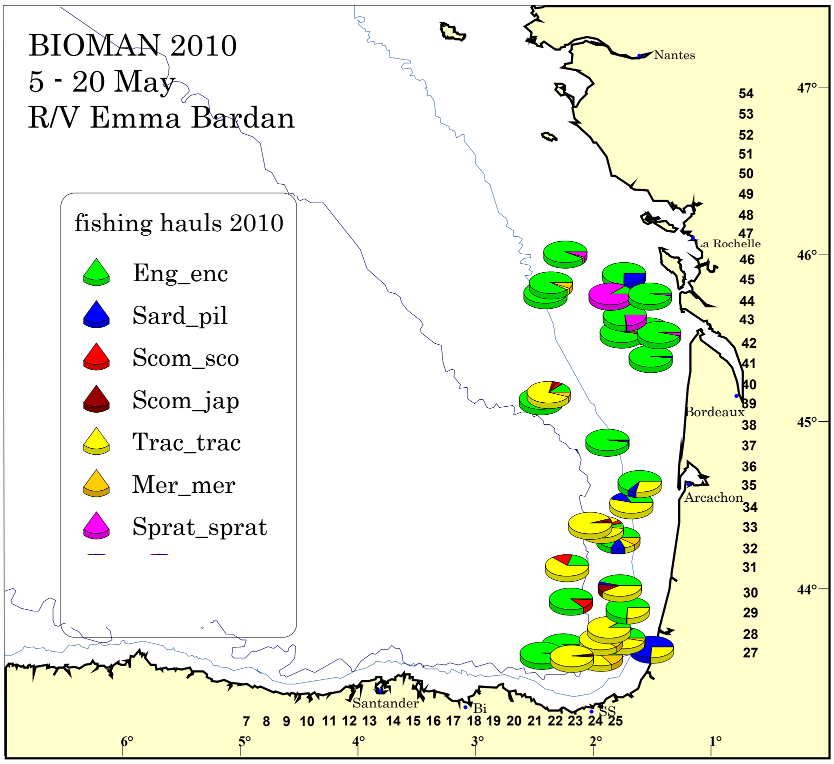


Figure: 2.4.1.3.1: Bay of Biscay anchovy: Species composition of the 34 pelagic trawls from the R/V Emma Bardán during BIOMAN2010.

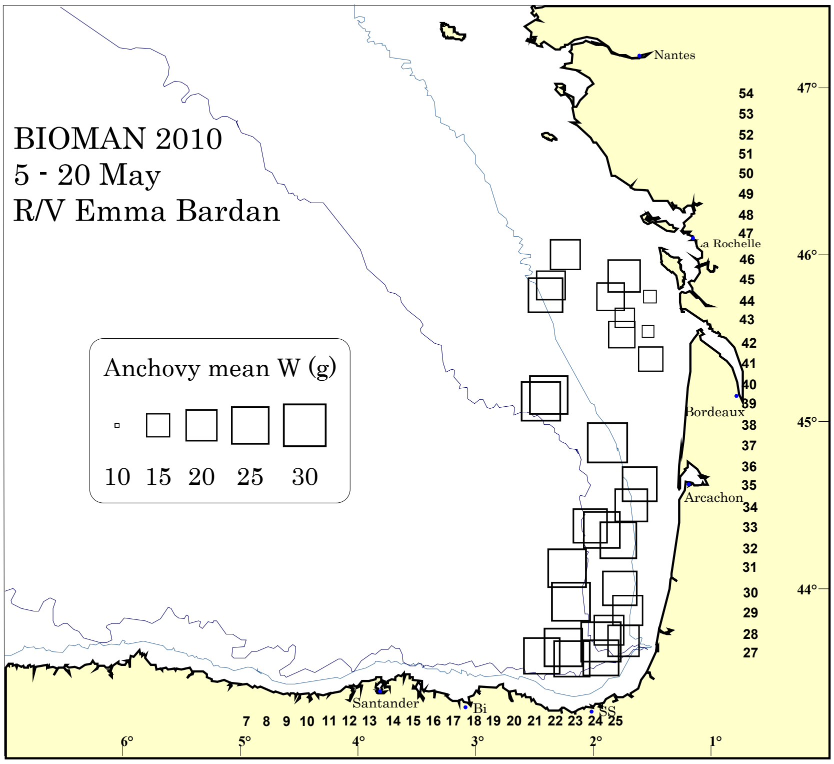


Figure 2.4.1.3.2: Bay of Biscay anchovy: Anchovy (male and female) mean weight per pelagic trawl in 2010.

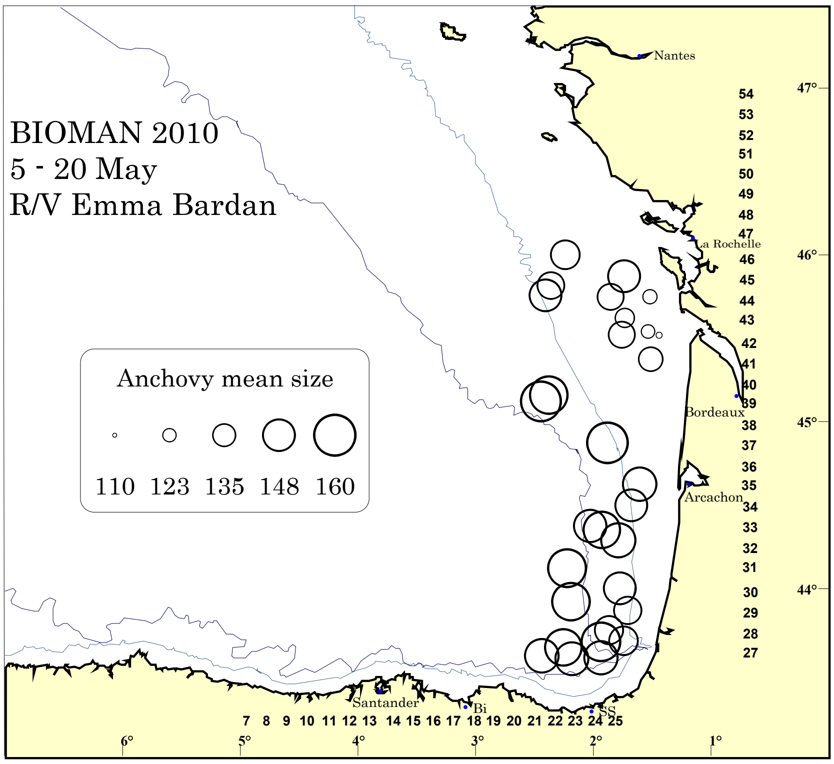


Figure 2.4.1.3.3: Bay of Biscay anchovy: Anchovy (male and female) mean size per pelagic trawl in 2010.

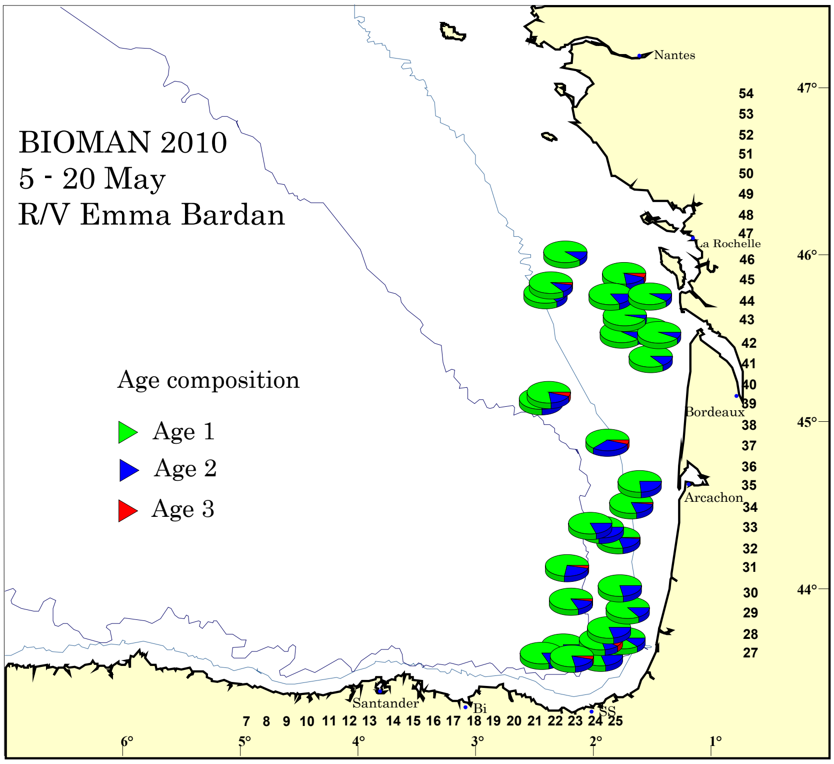


Figure 2.4.1.3.4: Bay of Biscay anchovy: Age composition per haul in percentage in 2010.

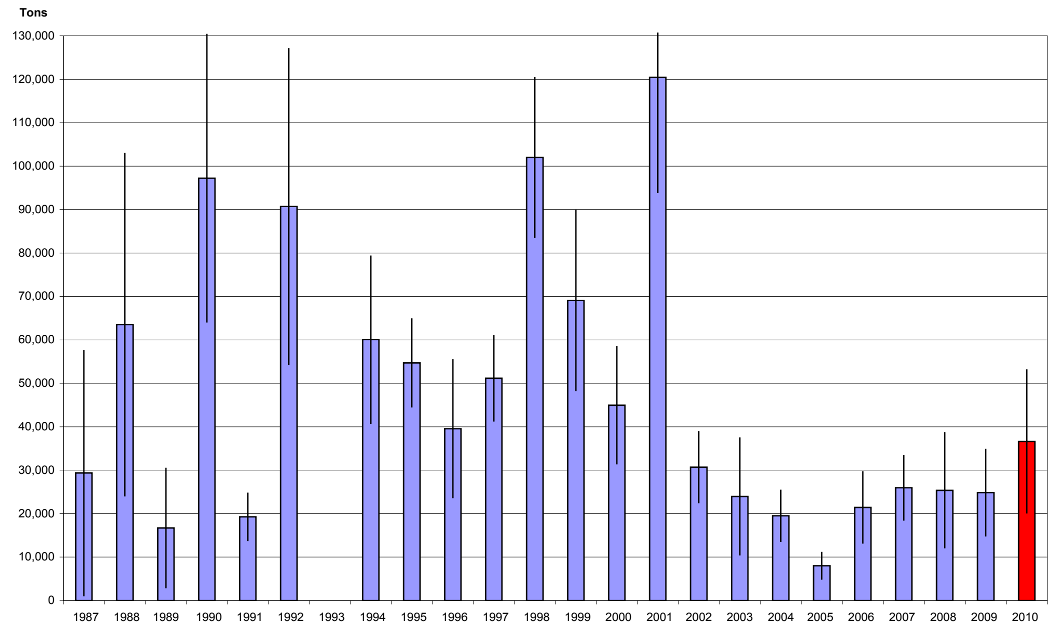


Figure 2.4.1.4.1: Bay of Biscay anchovy: Series of Biomass estimates (tonnes) obtained from the DEPM since 1987. Most of them are full DEPM estimates, except in 1996, 1999 and 2000 which were deduced indirectly.

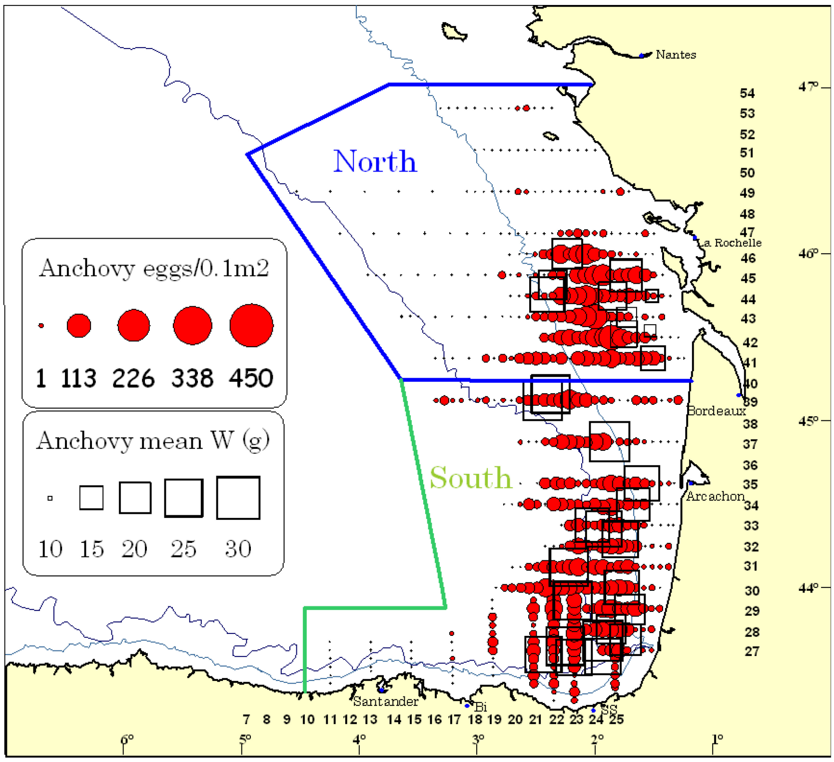


Figure 2.4.1.4.2: Bay of Biscay anchovy: Two strata were defined to estimate the numbers at age in 2010: North and South. The circles are the anchovy egg abundances and the squares are the mean weight per haul of the anchovy adults.

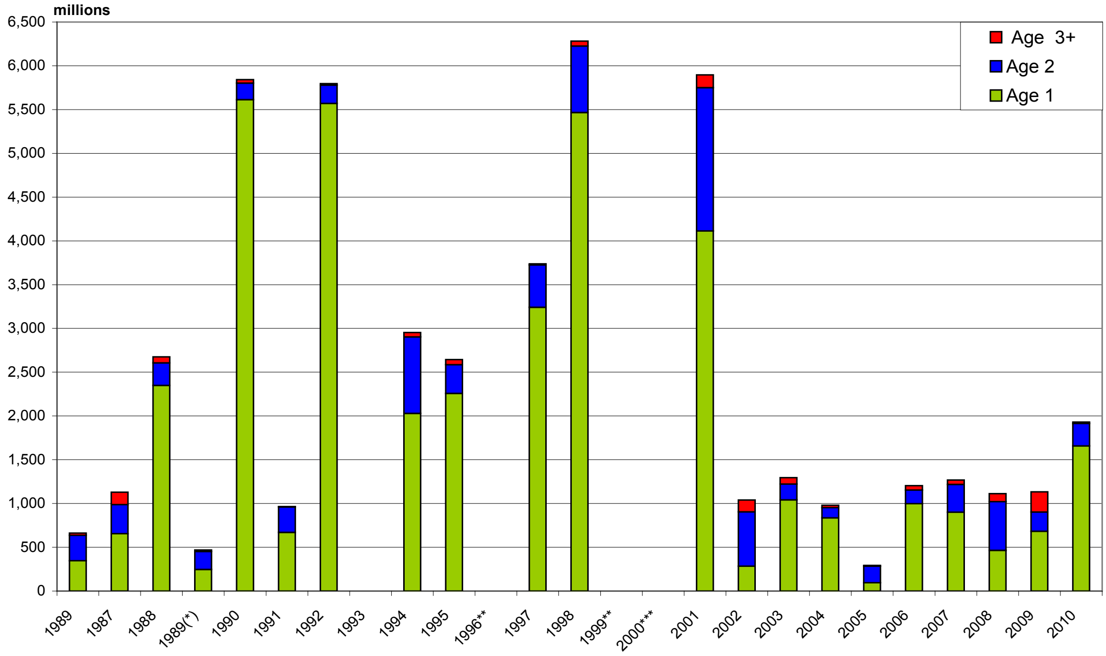


Figure 2.4.1.4.3: Bay of Biscay anchovy: Historical series of numbers at age from 1987 to 2010.

2.4.2 Acoustic survey 2010

2.4.2.1 Description of survey

The acoustic survey PELGAS10 was carried out in the Bay of Biscay from April 26th to June 5th 2010 on board the French research vessel Thalassa. The objectives and methods are described in Stock annex, and a detailed report of the survey is attached as Annex 2: Massé & Duhamel - WD 2010 . The protocol for these spring surveys is described in annex 6 of WGACEGG 2009 (PELGAS sea survey protocol, Doray, Massé, & Petitgas in ICES 2009)

Details of the 2010 survey are presented in table 2.4.2.1.

As in the 3 previous years a consort survey was organized with French pair trawlers during the 22 first days and a purse seiner during 3 days . With this approach, in the continuity of last years survey, the commercial vessels hauls were used for echo identification and biological parameters at the same level those by Thalassa.

The collaboration between Thalassa and commercial vessels was excellent. It was once more a very good opportunity to explain to fishermen our methodology and furthermore, to verify that both scientists and fishermen observe the same types of echo-traces and have similar interpretations. Some fishing operations were done in parallel by Thalassa and commercial vessel in order to check if the catches were well comparable (in proportion of species and, most of the time, in quantity as well). As last year, the fishing operations by commercial vessels were carried out only during day time (as for Thalassa) each time it was necessary and preferentially at the surface or in mid-water, since the pair trawlers are more efficient at surface than single back trawlers.

Acoustic data were collected by Thalassa along 33 transect (2256 nm) perpendicular to bathymetry, upon which 1972 nautical miles (daylight surveyed selected miles during the global coverage) were used for biomass estimate (Figure 2.4.2.1). A total of 103 hauls were carried out during the assessment coverage, 95 were valid including 49 hauls by Thalassa and 46 hauls by commercial vessels (figure 2.4.2.2).

Eggs were counted all along the transects by CUFES and sorted onboard. Mammals and birds were identified and counted when weather conditions permitted (sea surface sometimes rough and fog).

2.4.2.2 Distribution (anchovy and others)

Globally, anchovy and sardine were well present this year from the south (sardine inshore and anchovy offshore) to the north (sardine quite exclusively offshore). About other species, the main characteristics of this survey is that horse mackerel and mackerel were very rare, unlike blue whiting was permanently present on the platform from 50m depth to the shelf break north of 45° N, scattered in small dots echoes close to the bottom and where numerous hauls identified constantly a mix of blue whiting and hake. Blue whiting was historically present along the shelf break, but very occasionally on the platform.

As last year, two main anchovy concentrations (Figures 2.4.2.3.) were observed:

- Offshore on the southern platform, big anchovy was well present between 100m and 120m depth. They were often mixed with sardine at the surface and with horse mackerel in the water column between the bottom and 50 to 70 m above. Nevertheless, anchovy echo-traces this year appeared in a non traditional way. If they were sometimes distributed as soft and small schools in a layer between 20 and 40 m above the bottom, as it is usually the case, most of them appeared this year as very big and dense schools, which is very unusual. Their geographic distribution was therefore not on a continuous way as usual, but as patches of very dense schools.

- Small anchovies were observed in front of the Gironde, from the coast between 45° N and 46° 30 N until 100 m depth. It was, mixed with sardine in the southern end and with sprat in the Northern end.

These two areas were covered in good weather conditions and acoustics and fishing operations were all valid.

2.4.2.3 Stock estimate

As the previous years, after echogram scrutiny, the global area was split into strata where coherent communities were observed (species associations) in order to minimize the variability due to the variable mixing of species (Figure 2.4.2.1.). Allocation to species was therefore done using the standard method (Massé,J, WD2001 and stock annex) and biomass were estimated for main pelagic species in each strata according to aggregation categories and identification hauls (anchovy and sardine in Table 2.4.2.2. and WD Massé & Duhamel 2010).

The anchovy biomass index was estimated to 86 354 t with a coefficient of variation of 14.7% (the method is detailed in Petitgas *et al.*, 2003) meaning that the anchovy biomass index according to acoustic data and pelagic hauls should be between 61 000t and 112 000t. Anchovy distribution is shown in Figure 2.4.2.3 and the time series of acoustic biomass estimates is in table 2.4.2.4

The anchovy biomass estimate in tons and in number was processed for each area at age group (Ttable 2.4.2.3.), using length distributions at each closest haul and global age/length key for each of the two zones. Length and age distributions of anchovy are shown in Figures 2.4.2.4. and 2.4.2.5.

Two distinctive strata can be distinguished, the south offshore area with very big anchovies both at the bottom and at the surface and the Gironde and coastal area where smaller fish were observed (see Figure 2.4.2.6). Estimates have been calculated in numbers for each area and percentages and mean weights are shown in Table 2.4.2.3.

Last year 95 % of the recruitment was only visible in front of the Gironde. This year it is visible in the whole area with 69 % of age 1 (in number) in front of the Gironde and 31 % in the south.

In the Gironde area, 92 % of the fish was 1 year old (mean length 12.3 cm) and only 7% at age 2. In the south, 70 % of the fish was at age 1 (mean length 15.1 cm) and 26 % at age 2 (see table 2.4.2.3.).

2.4.2.4 Conclusion

The anchovy biomass from the PELGAS10 survey has been estimated at 86 000t with 48 000 t of anchovies offshore and 38 000 t in the Gironde area. The number of 1 year old anchovies this year seems to be medium (4 100 millions fish against 1174 in 2009 and 960 millions in 2008) compared to good years (about 10 000 millions fish). They represent 75% of the biomass (84% in numbers).

Looking at the numbers at ages since 2000 (Figure 2.4.2.8.), the 1 year old class is the first good recruitment since 2001 and 2 years old are still well present considering the low level of 1 year old in 2009.

Table 2.4.2.1. Details obtained in the PELGAS acoustic Survey 2010 during the assessment coverage

Parameters	PELGAS acoustic survey
Survey area	(43º30' to 49º00'N & 1º10' to 6º00' W)
R/V	THALASSA
commercial vessels	Magayant / Tangaroa : 26/04 to 06/05/2010 Morgane / Virginie : 07/05 to 17/05/2010 Etoile pôlaire : 17 & 18/05/2010 Vag a Lamm : 23/05/2010
Date	26/04 – 05/06/2010
Acoustic	**THALASSA**
Miles used for assessment	1 972 NM
Nb of fish measured	27 464
- anchovy	7 091
- sardine	4 702
Nb of otoliths	1 945
- anchovy	928
- sardine	1 017
Nb of trawl hauls	52
- nb of surface and pelagic hauls	3
-Nb of hauls closed to the bottom	46
- nb of cancelled hauls	3
Nb CUFES samples	875
CTD stations	119
consort	**Commercial vessels**
dates	26/04 – 23/05/2010
Number of trawl hauls	51
- nb of surface and pelagic hauls	18
-Nb of hauls closed to the bottom	24
- Nb of purse seine hauls	4
- nb of cancelled hauls	5
Nb of fish measured	6 222
- anchovy	1 751
- sardine	2 657

Table 2.4.2.2. biomass of anchovy and sardine per strata during PELGAS10

		PELGAS10	Area	**anchovy**	**sardine**
Classical	**Pel10_1**	North offshore	1 679	616	991
	Pel10_2	North coast	3 492	1 821	345 186
	Pel10_3	Gironde	2 313	28 407	26 837
	Pel10_4	South coast	1 227	6	43 358
	Pel10_5	South offshore	3 492	43 426	11 538
surface	**Pel10_6**	North offshore	1 679		8 615
	Pel10_7	North coast	3 492		1 412
	Pel10_8	Gironde	2 313	7 365	484
	Pel10_9	South coast	1 227		
	Pel10_10	South offshore	3 492	4 714	18 659
		Total		**86 354**	**457 081**
		C.V.		**0.147**	**0.091**

Table 2.4.2.3. : anchovy age distribution (in numbers and in tonnes) and mean weight during PELGAS10

AGE	Gironde & coastal (Nb * 1000)	(%)	Mean weight (g)	Abundance index (t)	South offshore (Nb * 1000)	(%)	Mean weight (g)	Abundance index (t)	Total (Nb * 1000)	(%)	mean Weight (g)	Abundance index (t)
1	2 827 453	92.17%	11.96	33 835	1 275 200	69.5%	24.10	30 727	4 102 653	83.69%	15.7	64 562
2	222 605	7.26%	18.00	4 007	479 137	26.12%	29.62	14 194	701 742	14.32%	25.9	18 201
3	16 723	0.55%	20.71	346	66 431	3.62%	38.32	2 545	83 155	1.70%	34.8	2 891
4	731	0.02%	27.06	20	13 411	0.73%	49.25	661	14 142	0.30%	48.1	681
total	3 067 512			38 208	1 834 531			48 145	4 902 043			86 354

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
anchovy	113 120	105 801	110 566	30 632	45 965	14 643	30 877	40 876	37 574	34 855	86 354
CV anchovy	0.064	0.141	0.113	0.132	0.167	0.171	0.136	0.100	0.162	0.112	0.147
Sardine	376 442	383 515	563 880	111 234	496 371	435 287	234 128	126 237	460 727	479 684	457 081
CV sardine	0.083	0.117	0.088	0.241	0.121	0.135	0.117	0.159	0.139	0.098	0.091
Sprat	30 034	137 908	77 812	23 994	15 807	72 684	30 009	17 312	50 092	112 497	67 046
CV sprat	0.098	0.155	0.120	0.198	0.178	0.228	0.162	0.132	0.268	0.108	0.108
Horse mackerel	230 530	149 053	191 258	198 528	186 046	181 448	156 300	45 098	100 406	56 593	11 662
CV HM	0.079	0.204	0.156	0.137	0.287	0.160	0.316	0.065	0.455	0.09	0.18.8
Blue Whiting	-	-	35 518	1 953	12 267	26 099	1 766	3 545	576	4 333	48 141
CV BW	-	-	0.386	0.131	0.202	0.593	0.210	0.147	0.253	0.219	0.074

Table 2.4.2.4 : Acoustic abundance indices since 2000

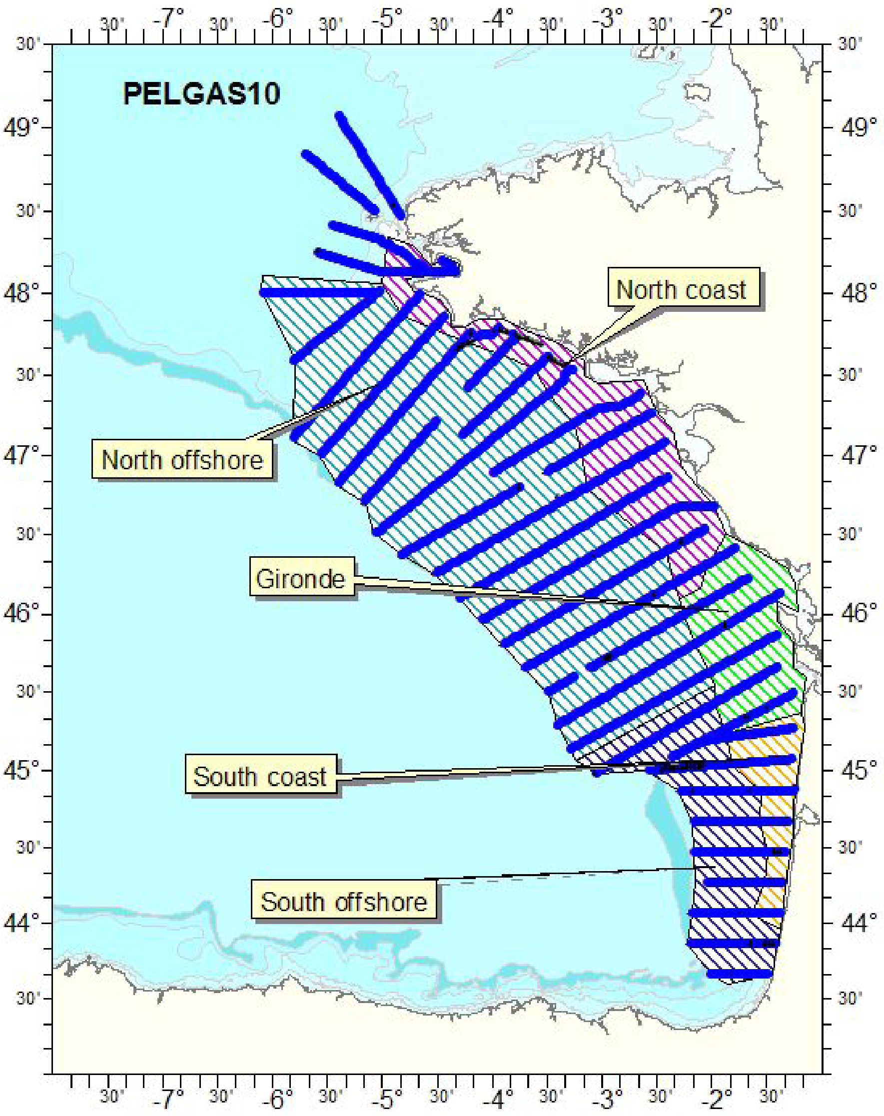


Figure 2.4.2.1. coherent strata, in terms of echoes and species distribution, taken into consideration for multi-species biomass estimate from acoustic and catches data during PELGAS10 survey

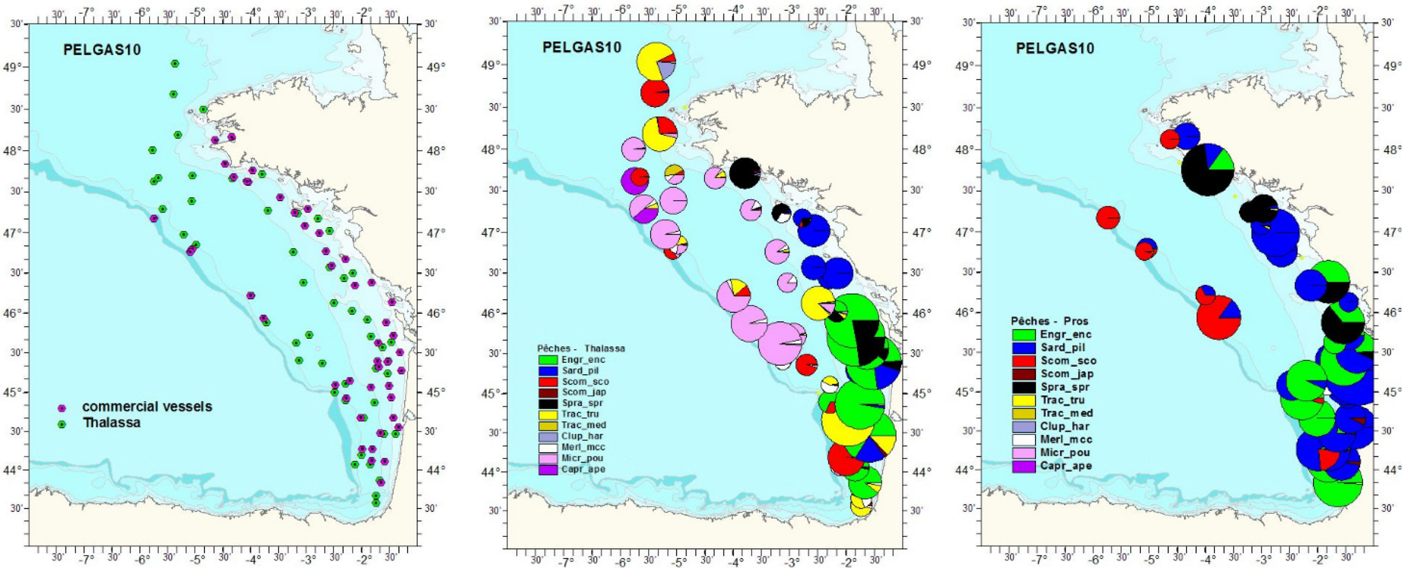


Figure 2.4.2.2 fishing operations carried out by Thalassa and commercial vessels during consort survey PELGAS10

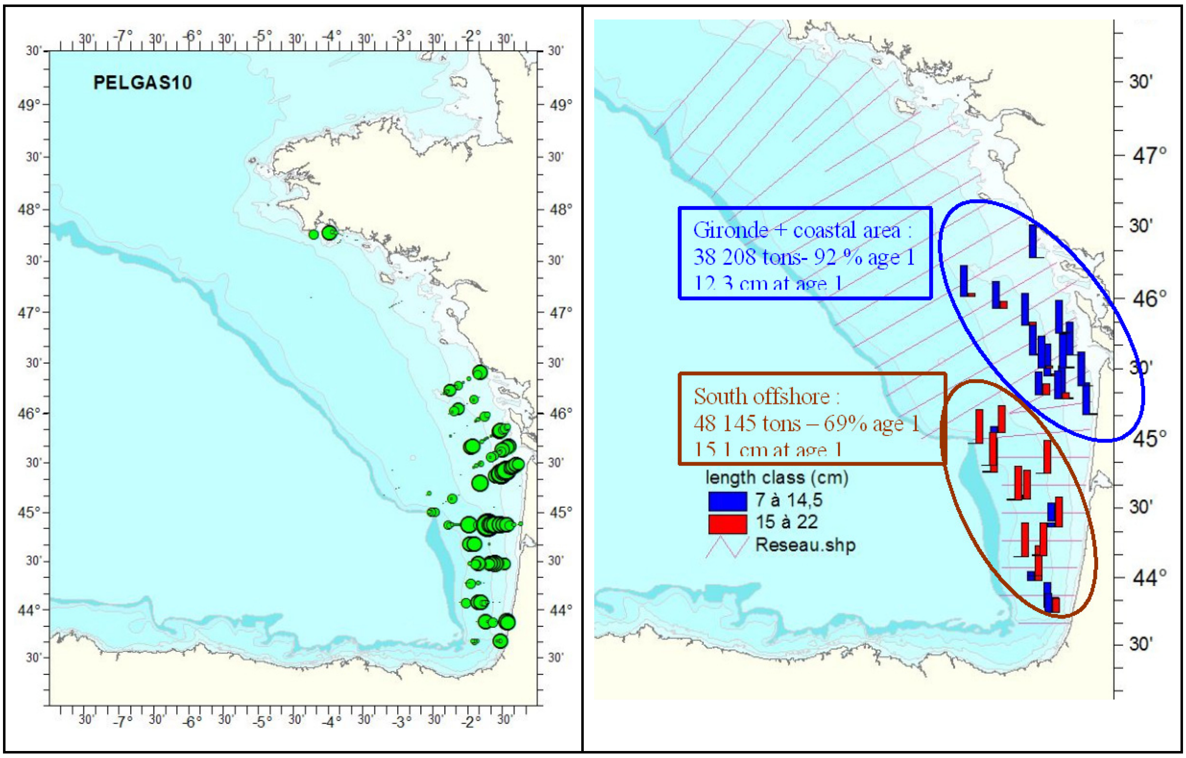


Figure 2.4.2.3. Anchovy distribution (left) observed during PELGAS10 survey and length distributions showing the two groups.

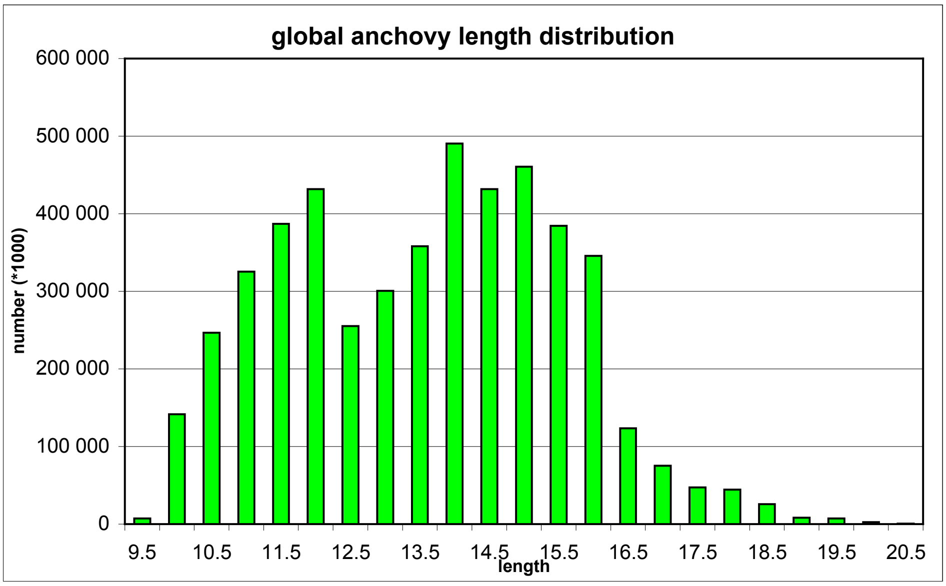


Figure 2.4.2.4. global length structure of anchovy during PELGAS 09 (in numbers)

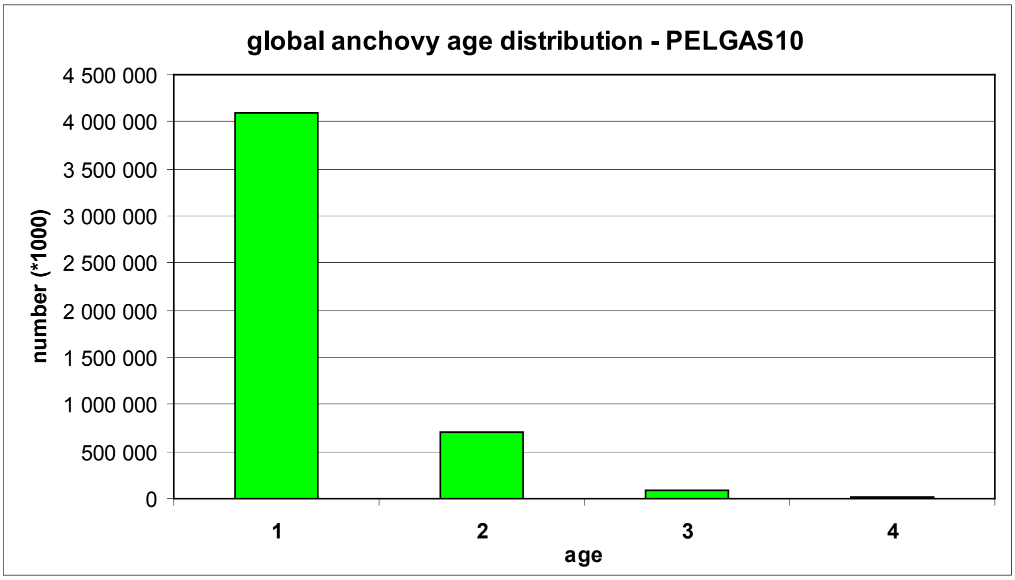


Figure 2.4.2.5. . global age structure of anchovy during PELGAS10 (in numbers)

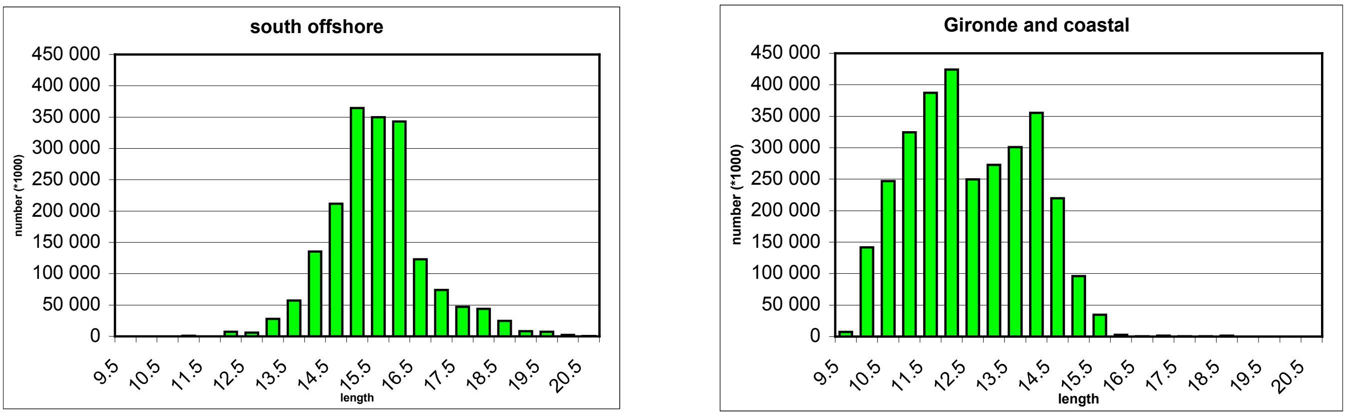


Figure 2.4.2.6. : length structure of anchovy during PELGAS 09 according to the two main areas where anchovy occurred

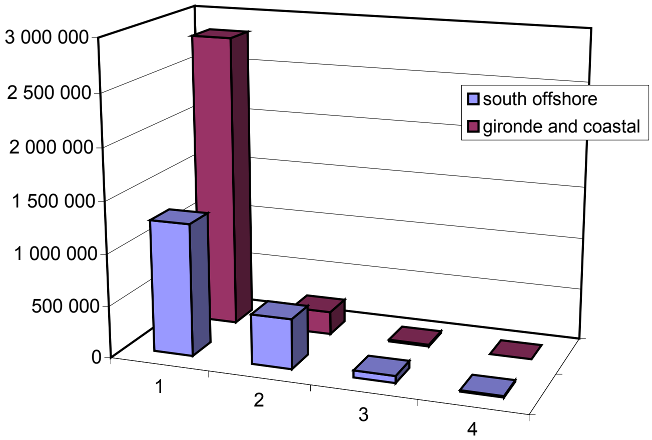


Figure 2.4.2.7. : numbers at age during PELGAS10 according to the two main areas where anchovy occurred.

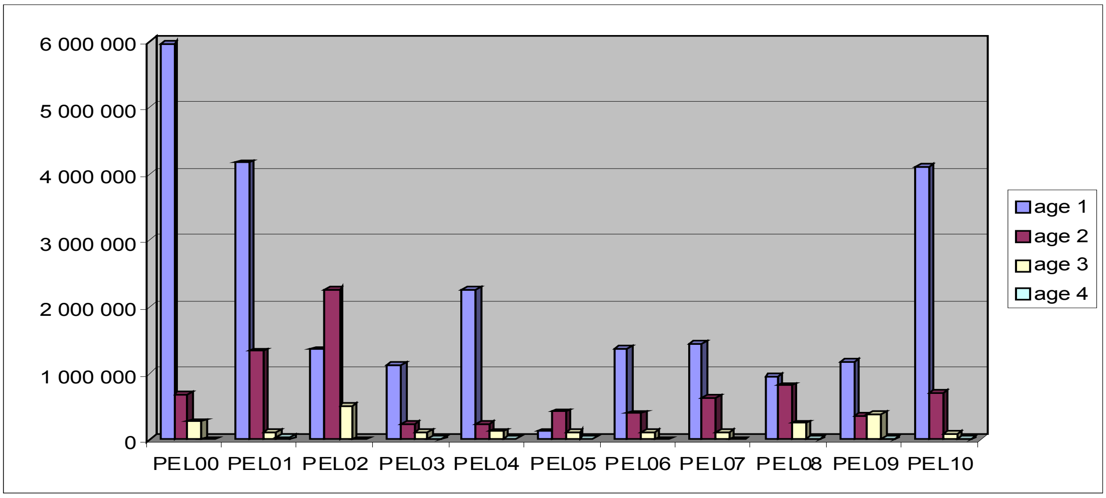


Figure 2.4.2.8. demographic structure of anchovy in the bay of Biscay (numbers at age) since 2000.

2.4.3 Juvenile Acoustic Surveys

See background methodology for these surveys in the Stock Annex.

2.4.3.1 Surveys in 2009: JUVENA2009 and PELACUS10_2009

The JUVENA and PELACUS10 survey series, including the last surveys in autumn 2009, have been reported and discussed in WGACEGG (ICES, 2009). These two Spanish surveys will be merged into a single survey in 2010 (JUVENA2010), assuring the continuity of the series.

In 2009 both surveys were coordinated, according to the design made in ICES WGACEGG, and they made a combined coverage of a wide area within the Bay of Biscay in September and beginning of October (Figure 2.4.3.1.1).

JUVENA, as for the last three previous years, took place onboard two vessels equipped with scientific acoustic equipments and with two different fishing gears: purse seining, with the rented commercial vessel Itsas Lagunak, and pelagic trawling with the R/V Emma Bardán. The survey took place during 30 days from August 26th to September 25th, sampling 2,300 n.m, in transects along the continental shelf and shelf break of the Bay of Biscay, from the 5º30′ W in the Cantabrian area up to 47º 30′ N at the French coast. 67 hauls were done during the survey to identify the species detected by the acoustic equipment.

PELACUS10 took place from September 15th to October 9th, on board the R/V Thalassa, sampling 630 n.m, in transects along the continental shelf and shelf break of the Bay of Biscay, from the 5º30′ W in the Cantabrian area up to 46º 30′ N at the French coast. 47 hauls were done during the survey to identify the species detected by the acoustic equipment.

The WGACEGG report (ICES 2009) discusses the parallelism and differences of both acoustic surveys. The comparison of species composition of the fishing hauls showed a general consistency between both surveys. The distribution of sA (m^2•nm^{-2}) attributed to anchovy showed also high consistency (Figure 2.4.3.1.1). Anchovy juveniles were found in both surveys off the Cantabrian Sea and French shelves near the surface (between 15 and 25 m depth). Anchovy adults (age 1+) were found close to the bottom in the inner shelf in the Cantabrian Sea and French waters. In the outer part of the French shelf juveniles and adults were observed near the bottom. The area located to the North of 47ºN was covered only by JUVENA. In this northern part, the distribution of anchovy over the shelf was similar, although juveniles were not detected off the shelf.

The results of anchovy biomass from JUVENA and PELACUS surveys for the common area were 161 and 115 thousand tonnes respectively. WGACEGG examined this difference and considered that it could be explained as a result of the three weeks delay between both surveys due to (a) advection losses through the northern boundary that was sampled only by JUVENA09 and (b) the decrease of the TS value of anchovy due to swim bladder compression.

WGACEGG concluded that: there had been

- A globally successful coordination of the JUVENA09 and PELACUS1009 cruises, although limited by the lag in time between the two surveys.
- Mostly complete coverage of the area occupied by anchovy juveniles.

- General consistency in the spatial distribution of anchovy and other pelagic species.
- Sufficient agreement in juvenile abundance in the common surveyed area of the two surveys.

Both surveys resulted in the highest estimates of juvenile abundances in their respective series. The total estimate of abundance of juveniles from JUVENA was about 178,000 t (over the whole covered area), 30% higher than the next higher estimate of the series. PELACUS started in 2006, but the last year 2009 achieved its widest coverage of the area. JUVENA surveys provide the longest series of juvenile abundance index (since 2003) and its historical perspective and behaviour in relation to the next coming recruitment is presented in the section below.

2.4.3.2 JUVENA Series and past performance and potential use

The JUVENA acoustic survey was designed to estimate the abundance of the anchovy juvenile population and their growth condition at the end of the summer in the Bay of Biscay, with the aim of assessing the strength of the recruitment entering the fishery the next year as a way to improve the management advice for the anchovy fishery. The series (from 2003 to 2009) of JUVENA acoustic estimates of anchovy juvenile abundance in the Bay of Biscay is shown in Figure 2.4.3.2.2 and Table 2.4.3.1.

Despite the improvements in survey design and methodology incorporated throughout the series, both the WGMHSA and WGACEGG concluded that the result of the juveniles survey can be used as an index of the evolution of anchovy juvenile abundances in the bay of Biscay (ICES, 2007a and 2007b). The question remaining was the validity of the obtained juvenile abundance index as an index of recruitment strength (ICES, 2007b). ICES (2009) considers "these surveys as a promising approach to providing the information necessary to revise the TAC at the beginning of the year. However, the series so far covers only a period where the recruitment has been low. It is not known how a medium or strong year class will show in the survey. Therefore, until at least one medium or strong year class has been both measured in the survey and confirmed in the subsequent assessment, ICES will not be in the position to advice on a revised TAC for the first half year on the basis of the survey".

Figure 2.4.3.3 compares the times series of the JUVENA anchovy juveniles abundance index with the estimates of biomass at age 1 (median values) from this year s assessment (section 2.5). The high estimate of anchovy juveniles in JUVENA2009 has been followed by a recovery of anchovy recruitment at age 1 in 2010, in addition the low juvenile abundance indexes of 2004, 2007 and 2008 are associated with by the lowest recruitments estimated by the assessment since 2003. The correlation between the JUVENA series and the assessment estimates of recruitment at age 1 is statistically significant with a 99% of confidence (r=0.900, P(r=0)=0.006). Among several candidate models the best fitting was achieved for a multiplicative model that resulted in $R(ICES) = 86.224*Juvena^{0.514212}$ (Anova P(F=0)=0.001, Figure 2.4.3.2.4).

Moreover, the addition of the 2010 recruitment has increased the contrast in the range of recruitments entering the series, with a medium size recruitment level. The WG still notices the convenience of more medium or high recruitments entering in the series, in order to better define the relationship between the JUVENA indices and the actual recruitment levels, however past arguments for not taking into account the JUVENA indices for management advice are not valid any longer and it seems now convenient to consider its potential uses to provide indications of the next coming recruitment.

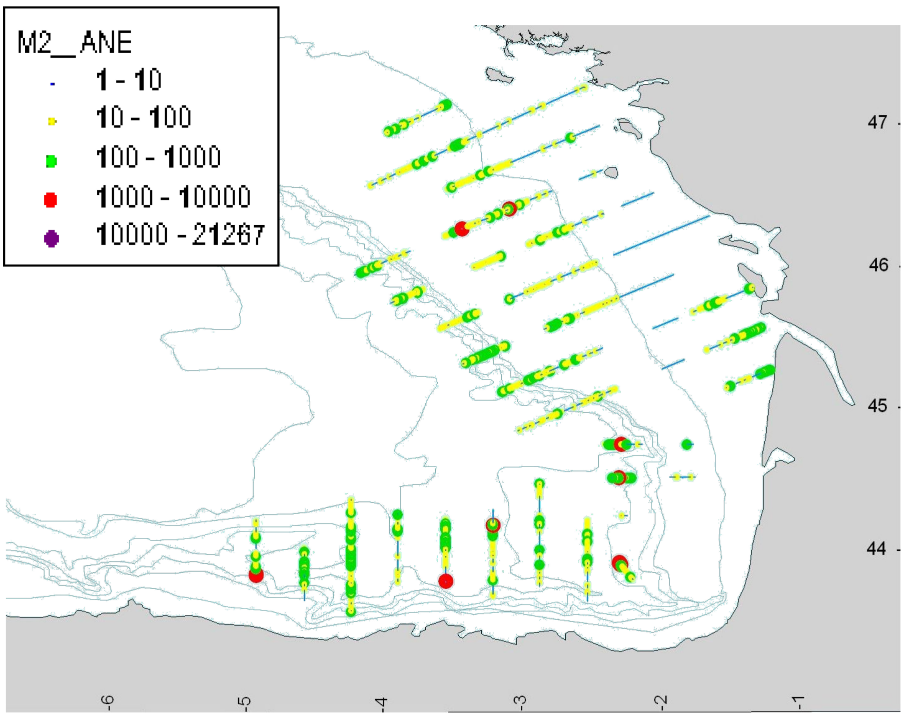
A WD (Ibaibarriaga *et al*. WD2010) discussed several potential uses of the JUVENA index among others. In a short term stochastic prediction perspective and within the range of observed values, the JUVENA index could be used to narrow the distribution of the next recruitment. The new recruitment distribution would be normal or log-normal according to the fitted linear model (which would be updated every year) and its predictive variance. Hence, the predictive distribution is used to provide a refined recruitment scenarium for the stochastic short term projections for the following year in December. It has to be taken into account that the number of observations is still low and therefore the predictive power of the model is still limited.

Alternatively a qualitative use of this index could be devised. For the range of recruitments covered JUVENA has adequately pointed out the lower levels of recruitments (Figure 2.4.3.3). Therefore, in case the JUVENA index is low and closer to the lowest levels (as in 2004), the likelihood of the next year recruitment being low will be high. On the contrary if the JUVENA index is above the low levels from 2003 to 2008, a medium or high recruitment scenario is more likely. In those occasions a scenario of the type of recruitment entering the fishery the next year could be selected with some confidence and the basis for the management advice could be revised accordingly.

In a long term perspective, the former WD (and De Oliveira 2005) showed that predictors of recruitment with CV of 50% or lower can be useful for improving the management of this species. The CV of projections arising from the current fitting of the lineal model are around 30-40%, so it is presumed that it could serve to improve the performance of long term HCR (see section 2.7).

Table 2.4.3.1: Synthesis of the abundance estimation (acoustic index of biomass) for anchovy juveniles and adults over the seven years of JUVENA surveys.

year	Sampled area	Posit area	Size juve	Biom juv	Biom_adul
2003	1,122	3,476	7.9	98,601	1,383
2004	849	1,907	10.6	2,406	3,451
2005	1,678	7,790	6.7	134,131	20,369
2006	1,808	7,063	8.1	78,298	45,422
2007	1,541	5,677	5.4	13,121	35,109
2008	1,555	6,895	7.5	20,879	40,735
2009	2,306	12,984	9.1	177,885	21,634



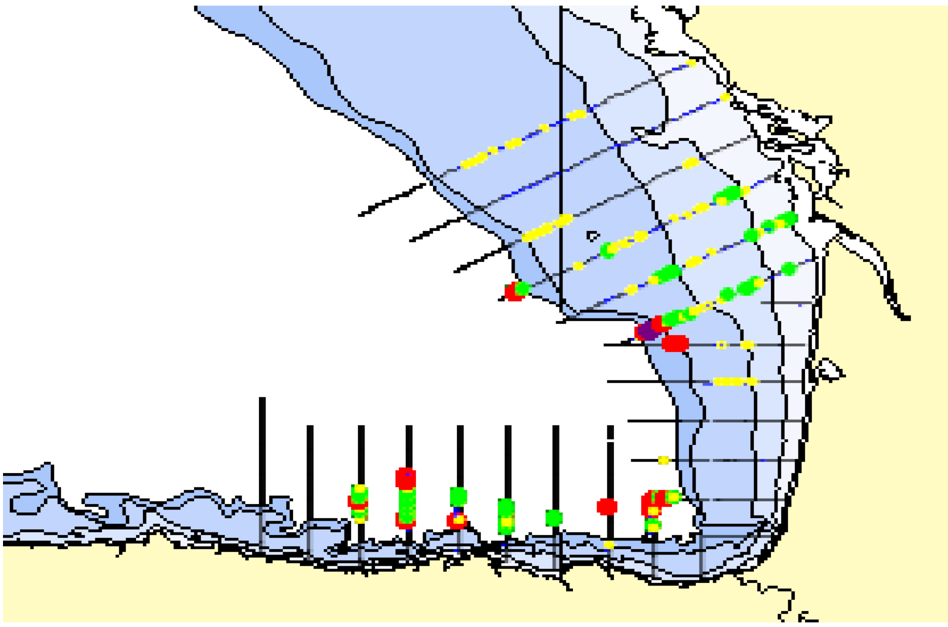


Figure 2.4.3.1 Effective acoustic coverage of the surveys on Juvenile anchovy in September-October 2009, with indication of the NASC attributed to anchovy. Top panel: JUVENA, bottom panel: PÈLACUS10

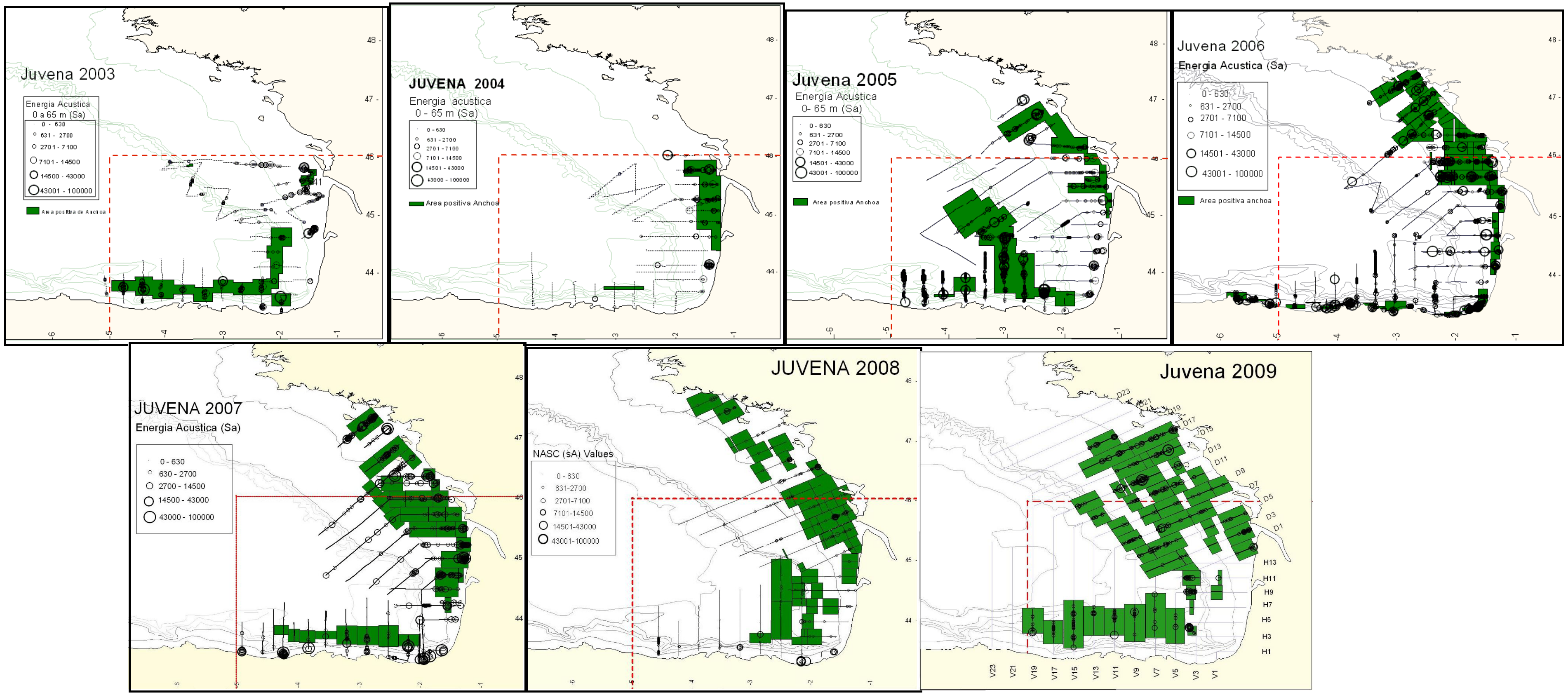
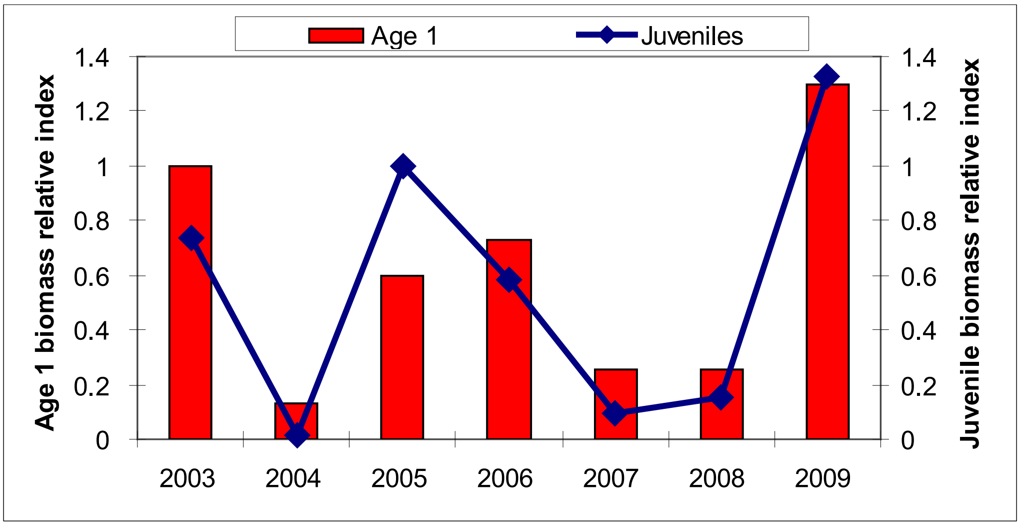


Figure 2.4.3.2: Positive area of presence of anchovy and total acoustic energy echo-integrated (from all the species) for the seven JUVENA surveys.



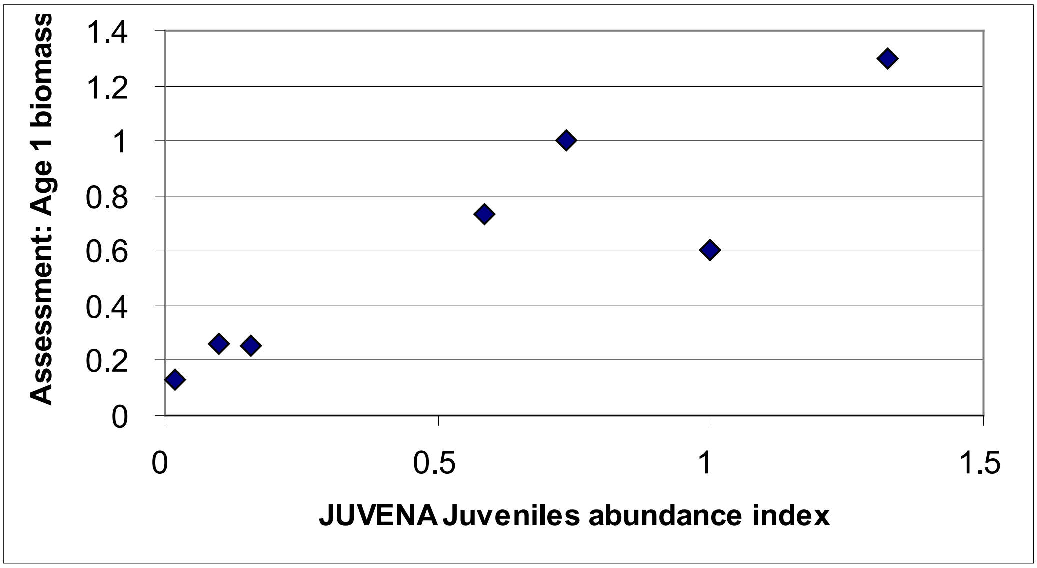


Figure 2.4.3.3 Upper panel: comparison of the times series of the JUVENA anchovy juveniles abundance index with the assessment at age 1 in the following year (median values) produced by Bayesian assessment included in this report. Bottom panel: scatter plot of the paired series. The comparisons are made in relative terms, scaling the series to their maximum estimate.

$r=0.900, \quad r^2=0.81 \quad P(r=0)=0.006$.

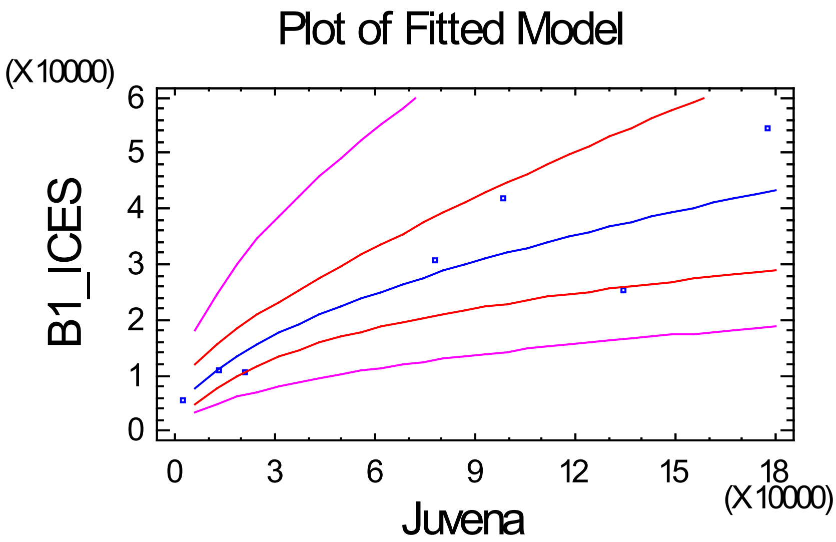


Figure 2.4.3.4. Fitting of the Recruitment at age 1 (first January) resulting from the BBM assessment performed in ICES this year, as a function of the Index of anchovy juveniles provided by JUVENA series, according to a multiplicative model of the form: Y = a*X^b. (P(F=0)=0.001). The model fitted ln(B1_ICES) = 4.45695 + 0.514212*ln(Juvena), standard errors for the intercept of 0.797636 and for the slope of 0.0748843.

2.4.4 A pilot sentinel surveys experience on sardine and anchovy

Considering that ideally, only monitoring throughout the entire life cycle could provide accurate biological data usable for integration in models for management strategies evaluations, a French pilot program has been implemented in the Bay of Biscay for sardine and anchovy since 2009. An innovative data collection strategy for additional information through a partnership between fishermen and scientists has been developed by making commercial vessels actors of the monitoring of the sardine and anchovy populations through "Sentinel" surveys. These surveys combine acoustic acquisitions, fishing operations for biological sampling and physical parameters collection on board commercial vessels with the contribution of one scientist onboard. Such surveys are carried out since April 2009 regularly throughout the year by pelagic pair trawlers and purse seiners, subsidised by the French Ministry, in two key areas known as potential recruitment areas, south of Brittany and in front of the Gironde. An ad hoc sampling strategy is adopted by the team "Captain/Scientist" according to the situation, in order to benefit from the fishermen experience through a rigorous scientific approach. The data collected (acoustics, biological data such as length, age distributions, sexual maturity, index of condition, etc.) are therefore validated by both scientists and fishermen. Preliminary analysis show accurate biological and new knowledge on the species distribution (figure 2.4.4.1.). During these first surveys it has been possible for example to see 0 group anchovies which could correspond to the juveniles observed in September by the Juvena survey and also to detect the presence or not of sardine in the south of Brittany according to seasons and supposed migration patterns. This type of surveys provide also an important tool to improve the communication between fishermen and scientists.

2.5 State of the stock

2.5.1 Method

The update assessment for the Bay of Biscay anchovy population is based on a two-stage biomass-based model (BBM) (Ibaibarriaga *et al*. 2008) and it is described in the stock annex. This method was approved in the Benchmark Workshop on Short-lived species (WKSHORT) that took place in August 2009.

2.5.2 Final assessment

The input data entering into the assessment of the anchovy stock consist of:

- total biomass estimated by DEPM and acoustics surveys
- proportion of the biomass at age 1 estimated by the DEPM and acoustic surveys
- total catch during the first period (from 1st January to 15th May)
- total catch during the second period (from 15th May to 31st December)
- catch at age 1 (in mass) during the first period (from 1st January to 15th May)

The historical series of spawning stock biomass (SSB) from the DEPM and acoustic surveys are shown in Figure 2.5.2.1. 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. This year both surveys' SSB estimates are larger than in the previous five years, but they differ significantly in the amount of increase. Similar discrepancies occurred in 1994, 1998, 2000, 2002 and 2004. The agreement between both surveys is higher when estimating the age structure of the population. Figure 2.5.2.2 compares the historical series of the proportion of age 1 biomass of DEPM and acoustic surveys.

Figure 2.5.2.3 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. After various fishery closures due to the low level of the population, this year the fishery was re-opened with a TAC of 7000t. This year the total catch in the first period was approximately 2200t.

The data used for the assessment are given in Table 2.5.2.1.

Figures 2.5.2.4 and 2.5.2.5 compare prior and posterior distribution of the parameters. Summary statistics (median and 95% probability intervals) of the posterior distributions of recruitment (age 1 in mass at the beginning of the year), SSB (at spawning time which is assumed to be 15th May) and harvest rates (catch/SSB) are shown in Table 2.5.2.2 and Figure 2.5.2.6. The largest probability intervals correspond to the period in which some data is missing. In general recruitment is highly variable from year to year. Recruitment in 2010 is larger than the recruitment in the previous seven years (2002-2009). The median SSB in 2010 has increased since last year from a level around B_{lim} (21 000 tones) to 51 350 tones. In order to analyse the biomass trends in relative terms, median and 95% posterior probability intervals of the ratio of spawning stock biomass with respect to 1989 spawning stock biomass, in which B_{lim} is based (ICES 2003), are given in Table 2.5.2.2. For the first time since 2002, the median of this ratio in 2010 has been above 2.

Figure 2.5.2.7 shows the posterior distribution of current level of spawning stock biomass in 2010. Current state of the population is summarized in Table 2.5.2.3. Recruitment in 2010 has been the higher since 2002 with a posterior median of 54 500 tones and 95% probability interval between 35 000 and 84 500 tones. The estimated level of biomass in 2010 is 51 350 tones and the 95% probability intervals are 34 100 and 77 700 tones. In relative terms the median of the ratio of SSB in 2010 with respect to 1989 biomass (used for defining B_{lim}) is 2.9 (with a 95% interval between 1.6 and 4.7) indicating that current level of the population is above the biomass in 1989. The biological risk, defined as the probability of SSB in 2010 being below B_{lim} (21 000 tones) is 0.

2.5.3 Quality of the assessment

2.5.3.1 Reliability of the assessment and uncertainty of the estimation

Compared to commonly used assessment methods in ICES, the Bayesian two-stage biomass-based model (BBM) entails changes in both the methodology used for projecting the population forward and establishing catch options and in the terminology in which the assessment and consequent advice is given. 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. 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 percentiles.

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). Figure 2.5.3.1.1 shows the posterior distribution of spawning stock biomass from BBM in comparison to the estimates from the DEPM and acoustic surveys (corrected by their catchability, which is assumed to be 1 for the DEPM and estimated as 1.17 for the acoustic survey). In most of the years the SSB estimates of the surveys taking into account their standard errors fall within the 95% probability intervals from the assessment. Figure 2.5.3.1.2 shows the posterior distribution of age 1 proportion in mass from BBM in comparison to the estimates from the DEPM and acoustic surveys. In all the years the age 1 biomass proportion estimates of the surveys are within the 95% probability intervals from the assessment. Pearson residuals of the four indices do not reveal any clear pattern (Figure 2.5.3.1.3). This could need a deeper analysis in the next years.

The critical situation of the stock in the last years and the subsequent fishery closure has forced the stock assessment to be conducted just after the spring surveys as soon as the results from the surveys are available in order to provide management advice for the second half of the year. However, it has to be noted that the indices provided in such a short time are preliminary (particularly DEPM) and might be changed later on. As a result the stock assessment has to be considered also as preliminary.

In this model catch data are accounted for in the development of the dynamics of the population. Therefore, now that the fishery is opened, it is necessary to continue the collection of total landings and catch at age data.

The assessment is scaled by the assumption of absolute catchability of DEPM surveys. The current perception of the population in relative terms 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) that 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.

Other important assumptions of the current assessment are that the natural mortality and growth rates are constant across ages and from year to year and that the catchability of the surveys is constant across ages. This may imply some artificial reduction of the posterior probabilities profiles of the outputs from the assessment. In addition, the value assumed for g (natural mortality and growth) could be another source of uncertainty in the current assessment. The 5 years fishery closure has allowed new studies on the natural mortality (see section 2.3.3) indicating that it might be different by age and lower than the currently assumed rate. Using a new vector of natural mortality at age would change the trends in biomass even in relative terms (SSB with respect to SSB in 1989).

The DEPM series of biomass are under revision due to changes in the procedures for spawning frequency estimates (WGACEGG ICES 2009). This may imply the revision of the current precautionary reference points for management.

2.5.3.2 Changes in methodology

The methodology is the same as described in Ibaibarriaga *et al.* (2008) and in the stock annex. The only change is that, as in the last year, longer runs (500 000 draws) with longer burn-in period (100 000 draws) and higher thinning (1 out of 40 draws was kept) were conducted to ensure convergence.

2.5.3.3 Changes in perceived state of the stock

Figure 2.5.3.3.1 shows a retrospective analysis of the performance of the BBM from 2001 to 2009. The proportion of error regarding the median SSB ranges from -0.31 to 0.32 with an average of 0.09 (Table 2.5.3.3.1). However, except in 2001 the SSB estimates in the assessment year are within the probability intervals of the SSB in this year assessment (upper panel in Figure 2.5.3.3.1) and in all the years the SSB estimates in this year assessment are always within the 95% probability intervals of the assessment year (lower panel in Figure 2.5.3.3.1).

Table 2.5.2.1: 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	NA	NA
1988	0.3253	0.1774	2602	3864	10954	53087	63500	NA	NA
1989	0.2820	0.2328	1723	3876	4442	7282	16720	6476	15500
1990	0.3070	0.2057	9314	10573	23574	90650	97239	NA	NA
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	NA	NA	NA	NA
1994	0.2331	0.2050	3795	13602	20150	34674	60062	NA	35000
1995	0.2917	0.1751	5718	14550	14815	42906	54700	NA	NA
1996	0.2756	0.1978	4570	9246	23833	NA	39545	NA	NA
1997	0.2078	0.2624	4323	7235	13256	38536	51176	38498	63000
1998	0.1992	0.2567	5898	7988	23588	80357	101976	NA	57000
1999	0.2304	0.2626	2067	10895	15511	NA	69074	NA	NA
2000	0.2569	0.1999	6298	12010	24882	NA	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	0.3178	0.0594	20	67	73	16025	25973	26230	40876
2008	0.2610	0.1991	0	0	0	7579	25377	10400	37574
2009	0.2610	0.1994	0	0	0	9299	24846	11429	34855
2010	0.2976	NA	1479	2207	NA	29801	36627	64564	86355

h1 and h2 denote the fractions from the beginning of year to the time point w ithin each period w hen commercial catch is assumed to take place

Table 2.5.2.2: Bay of Biscay anchovy: Median and 95% probability 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	14250	17400	25541	18420	22325	32300	0.460	0.666	0.807	0.967	1.282	1.755
1988	35280	41490	50710	31480	36110	45050	0.329	0.410	0.471	1.761	2.054	2.354
1989	9287	11850	16120	13730	17590	24900	0.334	0.473	0.606	1.000	1.000	1.000
1990	80250	89470	104200	58100	65780	77680	0.440	0.519	0.588	2.711	3.735	4.914
1991	19790	25580	34150	23290	30150	41080	0.448	0.610	0.789	1.131	1.717	2.453
1992	79930	132700	231303	54400	98315	178600	0.209	0.380	0.687	2.930	5.525	10.411
1993	37929	92400	129400	82570	96030	115103	0.344	0.412	0.480	3.623	5.512	7.380
1994	39070	48400	64960	49710	58380	77810	0.434	0.578	0.679	2.214	3.356	4.825
1995	34830	53765	98711	27820	45945	88620	0.331	0.639	1.056	1.481	2.605	5.194
1996	41710	69060	93271	51340	60260	74850	0.442	0.549	0.644	2.468	3.414	4.657
1997	38430	51630	71100	37870	50460	69870	0.293	0.406	0.541	1.843	2.856	4.302
1998	54150	82010	125003	47970	74230	114800	0.275	0.425	0.658	2.464	4.150	6.857
1999	48099	79670	119403	54980	76470	103003	0.256	0.345	0.480	2.697	4.293	6.320
2000	104600	127750	150000	99730	117900	133400	0.277	0.313	0.370	4.412	6.693	8.805
2001	73759	83800	100300	90419	99380	112000	0.358	0.404	0.444	3.997	5.673	7.409
2002	10340	13010	18190	31750	36770	45580	0.384	0.476	0.551	1.504	2.096	2.851
2003	23280	29500	36920	27740	33430	42091	0.249	0.313	0.378	1.307	1.902	2.621
2004	34090	42040	53800	32430	40120	52530	0.310	0.406	0.502	1.540	2.285	3.232
2005	3506	5468	8094	12230	17110	24950	0.047	0.068	0.095	0.599	0.969	1.497
2006	17370	25165	36260	19560	27190	38451	0.046	0.065	0.090	0.933	1.535	2.389
2007	21920	30660	43120	27360	37080	51200	0.003	0.004	0.005	1.336	2.089	3.133
2008	7285	10880	16710	20120	27235	38030	0.000	0.000	0.000	0.989	1.532	2.323
2009	7334	10610	15690	16300	22000	30800	0.000	0.000	0.000	0.785	1.246	1.877
2010	34920	54490	84531	34140	51350	77662	0.028	0.043	0.065	1.611	2.922	4.728

Table 2.5.2.3: Bay of Biscay anchovy: Summary table of the current state of the stock from BBM.

R_{2010}	Median	54 490
	95 % C.I.	(34 920, 84 531)
SSB_{2010}	Median	51 350
	95 % C.I.	(34 140, 77 662)
SSB_{2010} / SSB_{1989}	Median	2.922
	95 % C.I.	(1.611, 4.728)
$P(SSB_{2010} < 21\ 000)$		0

Table 2.5.3.3.1: Bay of Biscay anchovy: Results of the retrospective analysis of the BBM giving the percentage of error of the SSB estimates in the last assessment year with respect to the SSB estimates in current assessment

YEAR	SSB WGANSA2010	SSB ASSESSMENT YEAR	% ERROR
2001	82840	16540	0.166
2002	48135	-11365	-0.309
2003	33550	-120	-0.004
2004	31910	8210	0.205
2005	11690	5420	0.317
2006	22995	4195	0.154
2007	28590	8490	0.229
2008	25420	1815	0.067
2009	22460	-460	-0.021
2010	51350		

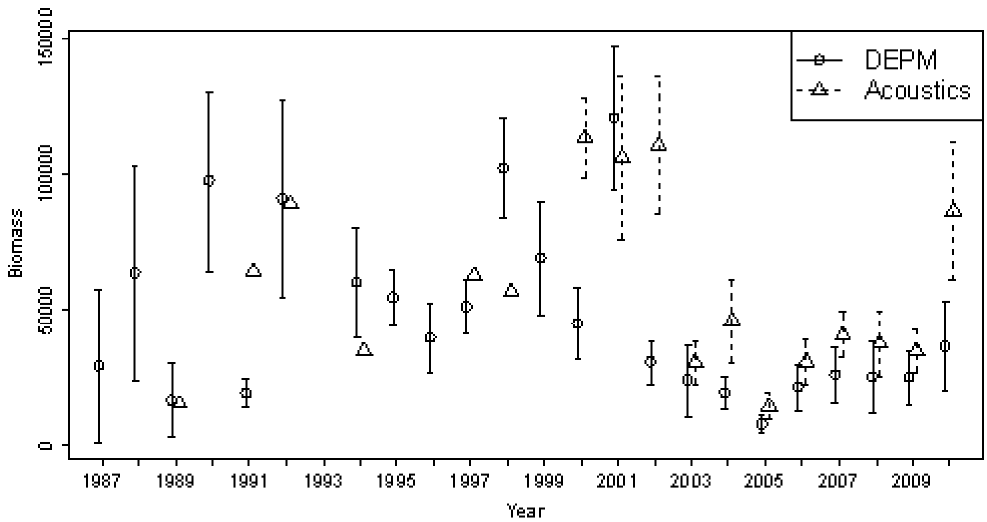


Figure 2.5.2.1: Bay of Biscay anchovy: Historical series of spawning stock biomass estimates and the corresponding confidence intervals from DEPM (solid line and circles) and acoustics (dashed line and triangles).

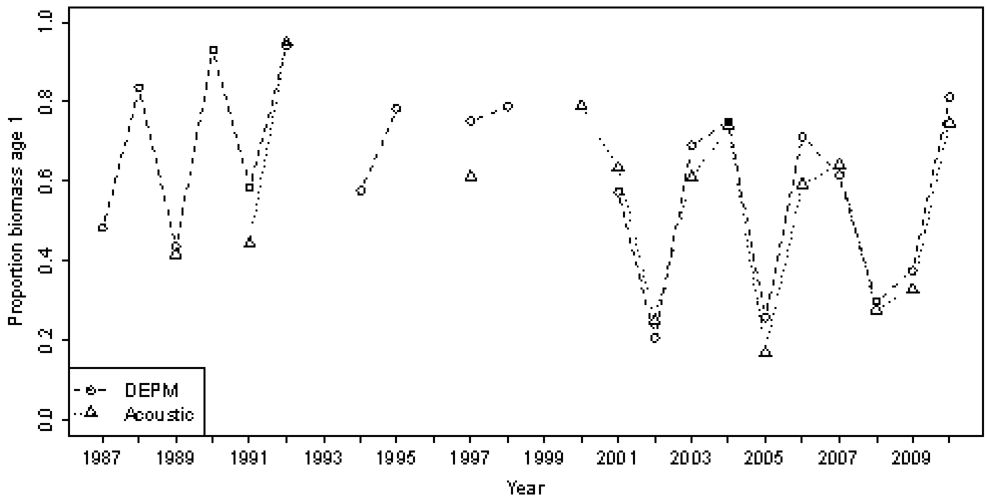


Figure 2.5.2.2: Bay of Biscay anchovy: Historical series of age 1 biomass proportion estimates from DEPM (dashed line and circles) and acoustics (dotted line and triangles).

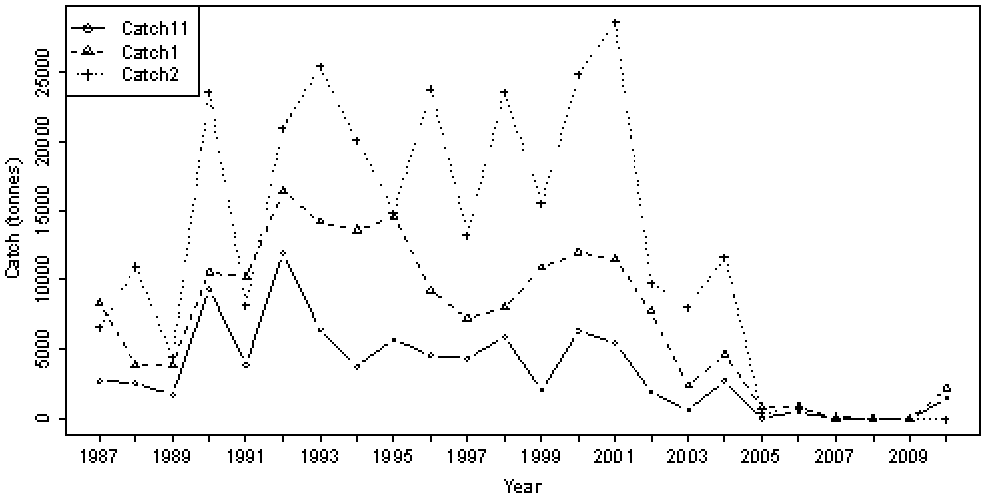


Figure 2.5.2.3: Bay of Biscay anchovy: Historical series of age 1 and total catch in the first period (1st January-15th May) (solid line and open circle and dashed line and triangle respectively) and of total catch in the second period (15th May-31st December) (dotted line and cross).

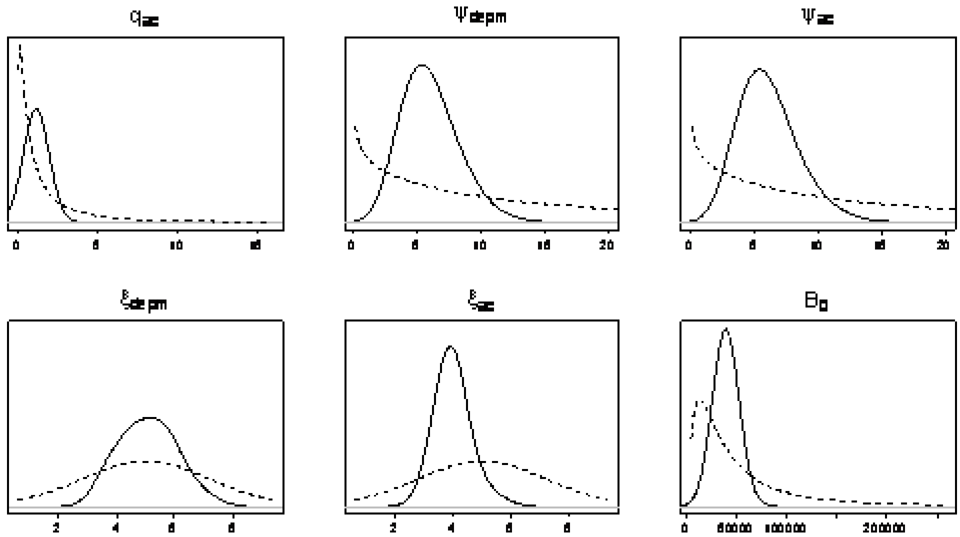


Figure 2.5.2.4: Bay of Biscay anchovy: Comparison between the prior (dotted line) and posterior distribution (solid line) for some of the parameters of BBM.

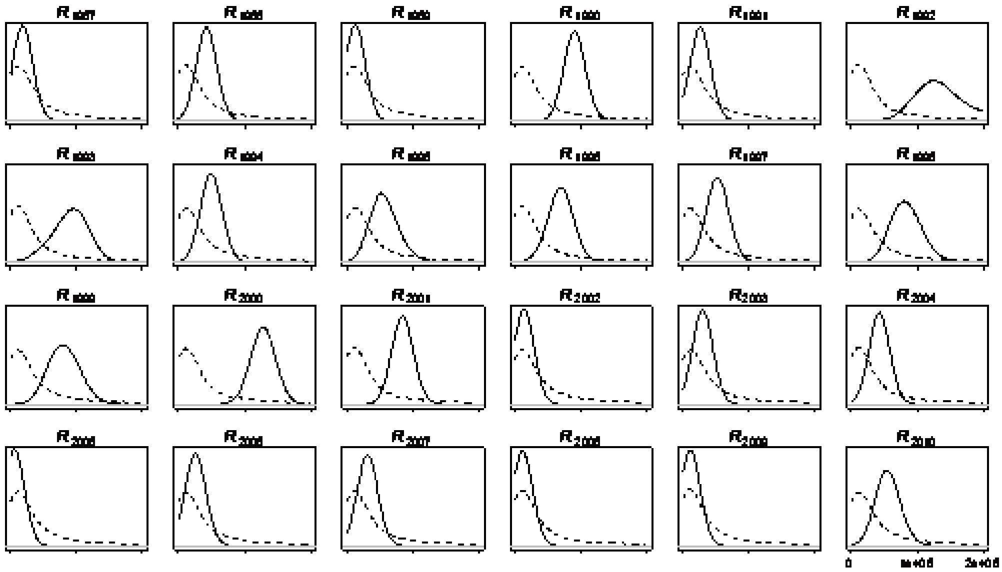


Figure 2.5.2.5: Bay of Biscay anchovy: Comparison between the prior (dotted line) and posterior distribution (solid line) for recruitment in BBM.

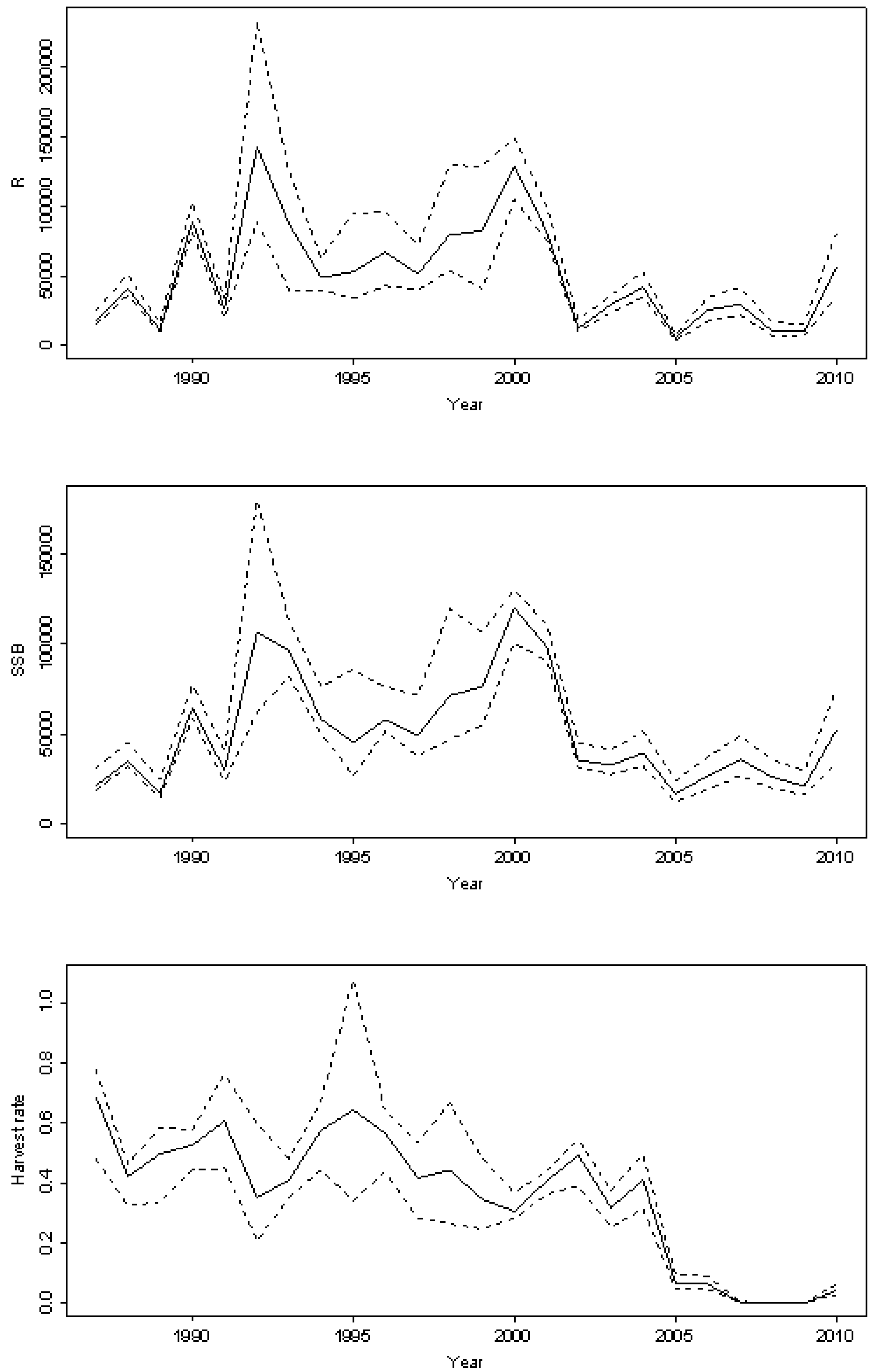


Figure 2.5.2.6: Bay of Biscay anchovy: Posterior median (solid line) and 95% probability intervals (dashed lines) for the recruitment (age 1 in mass in January), the spawning stock biomass and the harvest rates (Catch/SSB) from the BBM. The horizontal line in the mid panel represents Blim (21 000 t).

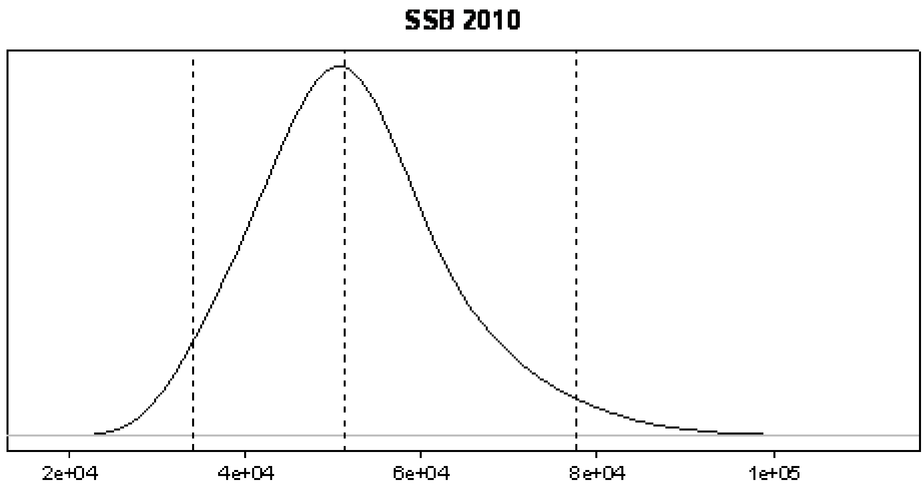


Figure 2.5.2.7: Bay of Biscay anchovy: Posterior distribution of spawning biomass in 2010 from BBM. Vertical dashed lines correspond to posterior median and 95% probability intervals.

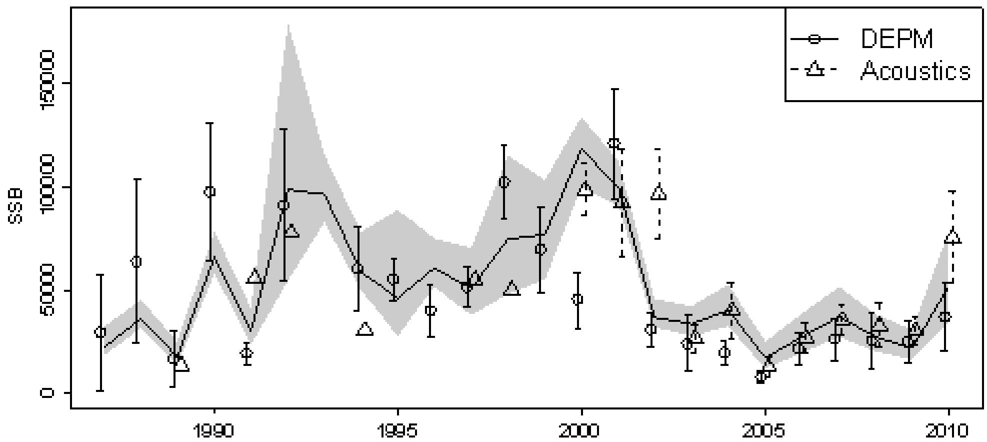


Figure 2.5.3.1.1: Bay of Biscay anchovy: Comparison of the SSB posterior 95% probability intervals from the BBM (grey area) and the SSB indices corrected by their catchability with the corresponding confidence intervals from DEPM (open circle and solid line) and Acoustics (triangle and dashed line).

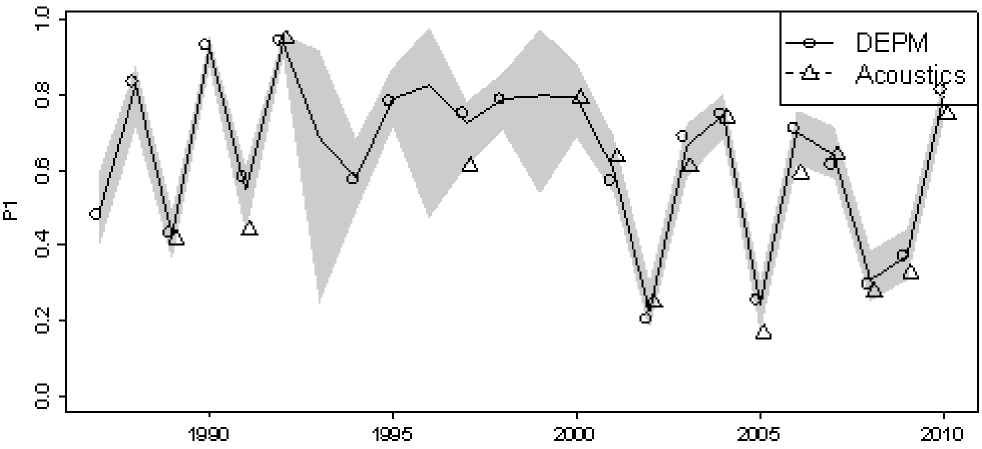


Figure 2.5.3.1.2: Bay of Biscay anchovy: Comparison of the age 1 biomass proportion posterior 95% probability intervals from the BBM (grey area) and the point estimates from DEPM (open circle) and Acoustics (triangle).

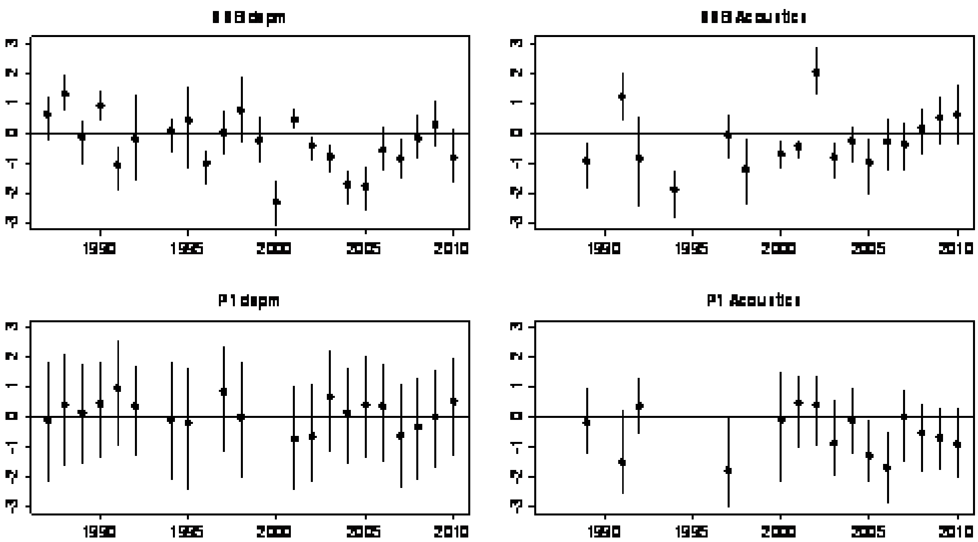


Figure 2.5.3.1.3: Bay of Biscay anchovy: Pearson residual medians and 95% probability intervals to the four indices used in the BBM.

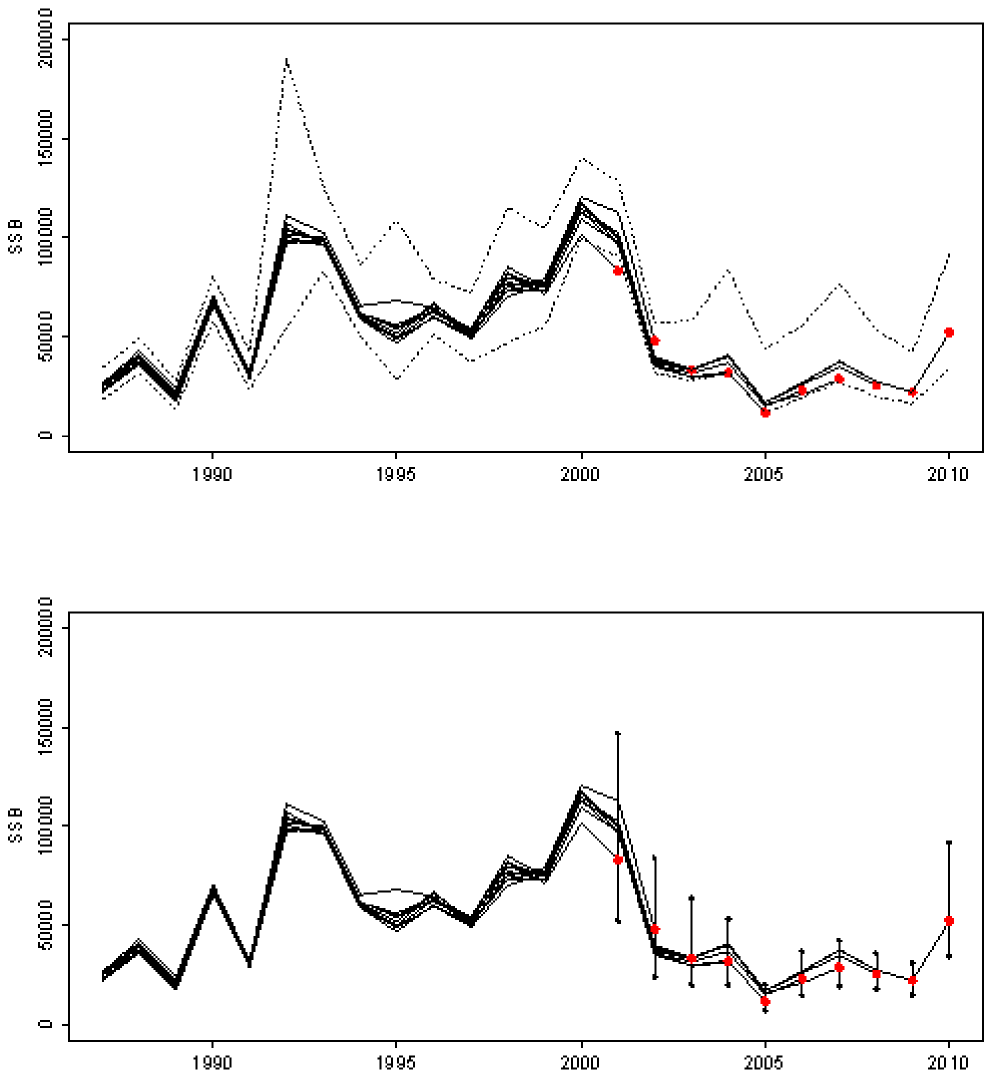


Figure 2.5.3.3.1: Bay of Biscay anchovy: Retrospective analysis for the BBM. Solid lines represent the SSB medians for each annual assessment. The red solid circles are the SSB median from the last year of each annual assessment. The dashed lines in the upper panel represent the 95% probability intervals for the assessment in 2009, whereas the vertical segments in the lower panel represent the 95% probability intervals in the last assessment year.

2.6 Short Term Prediction

2.6.1 Recruitment prediction

The prediction of the population for next year in order to explore catch options requires predicting recruitment entering the population.

After a series of consecutive low recruitments (2002-2009) this year recruitment has increased to intermediate levels. At the time of the Working Group meeting, there are no indications whether next year this increase will be maintained or whether a new low recruitment will occur. Therefore the WG decided to make the projections under two different recruitment scenarios: (a) an undetermined recruitment, where all the past recruitments are equally likely and (b) low recruitment similar to the ones between 2002 and 2009. This last scenario, which is more conservative, is the same as taken in last years' advice (ICES 2009). The resulting recruitment distributions are shown in figure 2.6.3.1. The median of the undetermined recruitment distribution is 43 600 tones and of the 2002-2009 recruitment distribution is 18 300 tones.

The construction of alternative recruitment scenarios based on the recruitment indices from juvenile acoustic surveys and from environmental variables is discussed in sections 2.4.3 and 2.7.

2.6.2 Method

The method for predicting the population is based on the Bayesian two-stage biomass-based model and it is described in detail in the stock annex. This method was approved in the Benchmark Workshop on Short-lived species (WKSHORT) that took place in August 2009.

2.6.3 Results

Starting from the posterior distribution of SSB in 2010 the population was projected one year forward under the two recruitment scenarios (undetermined and same as 2002-2009).

Under the assumption that the TAC of 7000 t is completely taken by the end of June, the catches from the 15th May to the end of June in 2010 were around 4800 t. Total allowable catch between 1st July 2010 and 30th June 2011 were explored from 0 (fishery closure) to 33 000 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 2010 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 2010 and the first half of 2011 were assumed to occur were computed as the average time points from the historical series from 1987 to 2004 (2005-2009 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 2011 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 2011 being below Blim was derived for each of the catch options and for the percentages of catch corresponding to the second half of 2010.

Figure 2.6.3.2 shows the distribution of SSB in 2011 in the absence of fishing from 15th May 2009 to 15th May 2010 for both recruitment scenarios. Under this condition the probability that SSB in 2011 is below Blim is around 1% and 0.5% for the undetermined and the 2002-2009 recruitment scenarios respectively.

The probability of SSB in 2011 being below Blim is given in Figure 2.6.3.3 and Table 2.6.3.1. For the undetermined recruitment scenario the probability of SSB being below Blim is below 0.05 up to catches of 10 000t. Then, it increases up to 0.2 for catches of 30 000t. For the low (2002-2009) recruitment scenario the probability of SSB being below Blim increases rapidly as total catch increases getting to 0.05 around a catch of 5000 t and reaching 0.5 when total catch is around 30 000 tonnes. The probability of falling below Blim is almost insensitive to the allocation into semesters. The corresponding predicted median SSB values in 2011 are shown in Table 2.6.3.2.

Table 2.6.3.1: Bay of Biscay anchovy: Probability of SSB in 2011 of being below B_{lim} under the undetermined and the 2002-2009 recruitment scenarios under different catch options from 1st July 2010 to 30th June 2011 and alternative catch allocation by semesters.

P(SSB<B_{lim})			% CATCHES IN THE 2nd SEMESTER 2010										
			0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
R undetermined	TOTAL CATCH (July 2010 - June 2011)	0	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
		5000	0.014	0.014	0.014	0.015	0.015	0.016	0.016	0.016	0.016	0.017	0.017
		10000	0.036	0.037	0.038	0.039	0.041	0.042	0.042	0.044	0.045	0.046	0.047
		15000	0.071	0.073	0.075	0.077	0.080	0.082	0.084	0.086	0.088	0.091	0.093
		20000	0.112	0.115	0.118	0.121	0.124	0.128	0.134	0.136	0.140	0.144	0.147
		25000	0.159	0.163	0.167	0.171	0.175	0.179	0.184	0.188	0.192	0.196	0.200
		30000	0.202	0.208	0.214	0.220	0.224	0.228	0.234	0.238	0.243	0.247	0.251
R 2002-2009	TOTAL CATCH (July 2010 - June 2011)	0	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012
		5000	0.039	0.040	0.041	0.041	0.043	0.044	0.045	0.047	0.048	0.049	0.050
		10000	0.092	0.093	0.095	0.098	0.100	0.103	0.106	0.108	0.110	0.113	0.115
		15000	0.170	0.176	0.180	0.185	0.189	0.194	0.198	0.201	0.206	0.211	0.217
		20000	0.257	0.265	0.273	0.280	0.288	0.296	0.302	0.310	0.318	0.322	0.329
		25000	0.352	0.361	0.368	0.378	0.386	0.397	0.405	0.413	0.420	0.429	0.435
		30000	0.439	0.448	0.458	0.465	0.476	0.484	0.492	0.499	0.507	0.515	0.522

Table 2.6.3.2: Bay of Biscay anchovy: Median SSB in 2011 under the undetermined and the 2002-2009 recruitment scenarios under different catch options from 1st July 2010 to 30th June 2011 and alternative catch allocation by semesters.

SSBmedian			% CATCHES IN THE 2nd SEMESTER 2010										
			0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
R undetermined	TOTAL CATCH (July 2010 - June 2011)	0	57949	57949	57949	57949	57949	57949	57949	57949	57949	57949	57949
		5000	55263	55212	55161	55110	55059	55008	54957	54906	54855	54804	54753
		10000	52577	52475	52373	52271	52169	52067	51965	51863	51761	51659	51557
		15000	49891	49738	49585	49432	49279	49126	48973	48820	48667	48513	48360
		20000	47205	47001	46797	46593	46389	46185	45980	45776	45572	45368	45164
		25000	44519	44264	44009	43754	43498	43243	42988	42733	42478	42223	41968
		30000	41833	41527	41221	40914	40608	40302	39996	39690	39384	39078	38771
R 2002-2009	TOTAL CATCH (July 2010 - June 2011)	0	39300	39300	39300	39300	39300	39300	39300	39300	39300	39300	39300
		5000	36614	36563	36512	36461	36409	36358	36307	36256	36205	36154	36103
		10000	33927	33825	33723	33621	33519	33417	33315	33213	33111	33009	32907
		15000	31241	31088	30935	30782	30629	30476	30323	30170	30017	29864	29711
		20000	28555	28351	28147	27943	27739	27535	27331	27127	26923	26719	26514
		25000	25869	25614	25359	25104	24849	24594	24339	24083	23828	23573	23318
		30000	23183	22877	22571	22265	21959	21652	21346	21040	20734	20428	20122

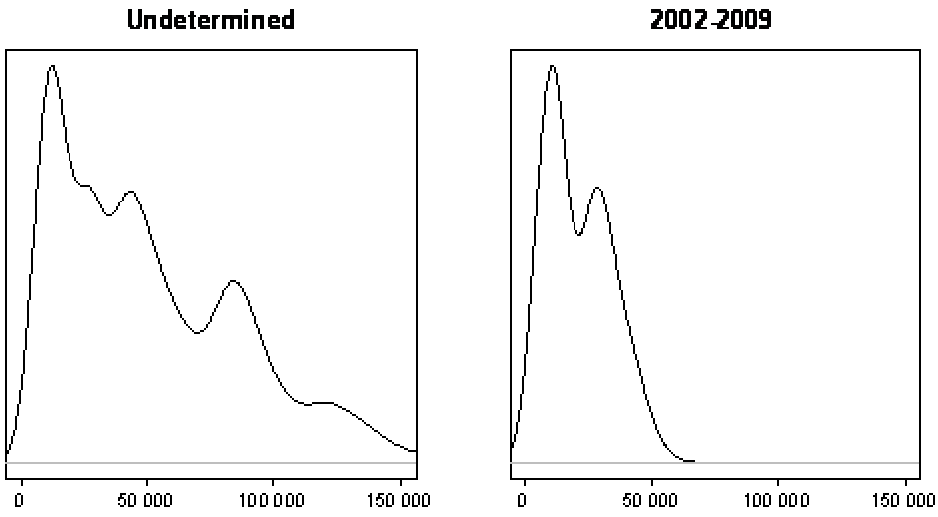


Figure 2.6.3.1: Bay of Biscay anchovy: Recruitment (age 1 mass in January) scenarios for 2011. The left panel corresponds to the undetermined recruitment case where all the past years are equally weighted and the right panel is the 2002-2009 case which is constructed as a mixture distribution of the recruitment posterior distribution of years 2002-2009.

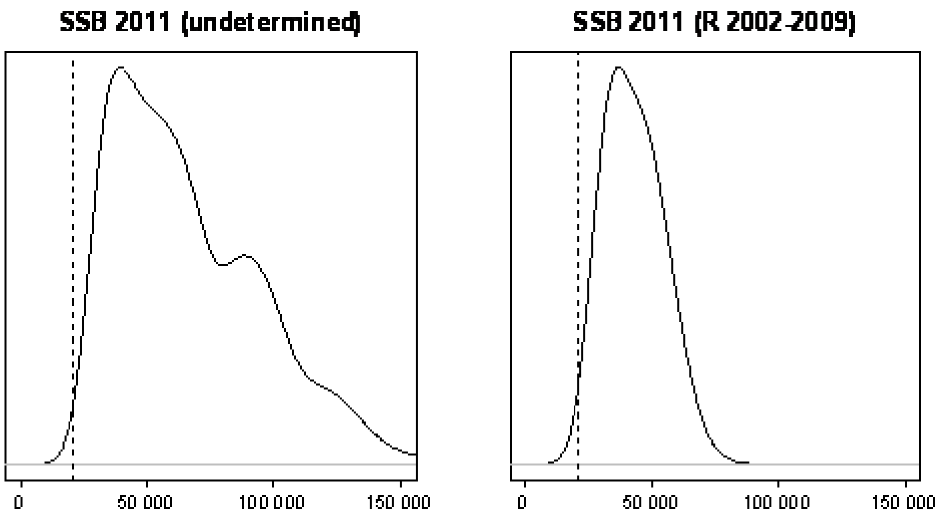


Figure 2.6.3.2: Bay of Biscay anchovy: Distribution of SSB in 2011 constructed from the posterior distribution of SSB in 2010 and the undetermined (on the left) and 2002-2009 (on the right) recruitment scenarios in the absence of fishing. The vertical dashed line represents Blim (21 000 t).

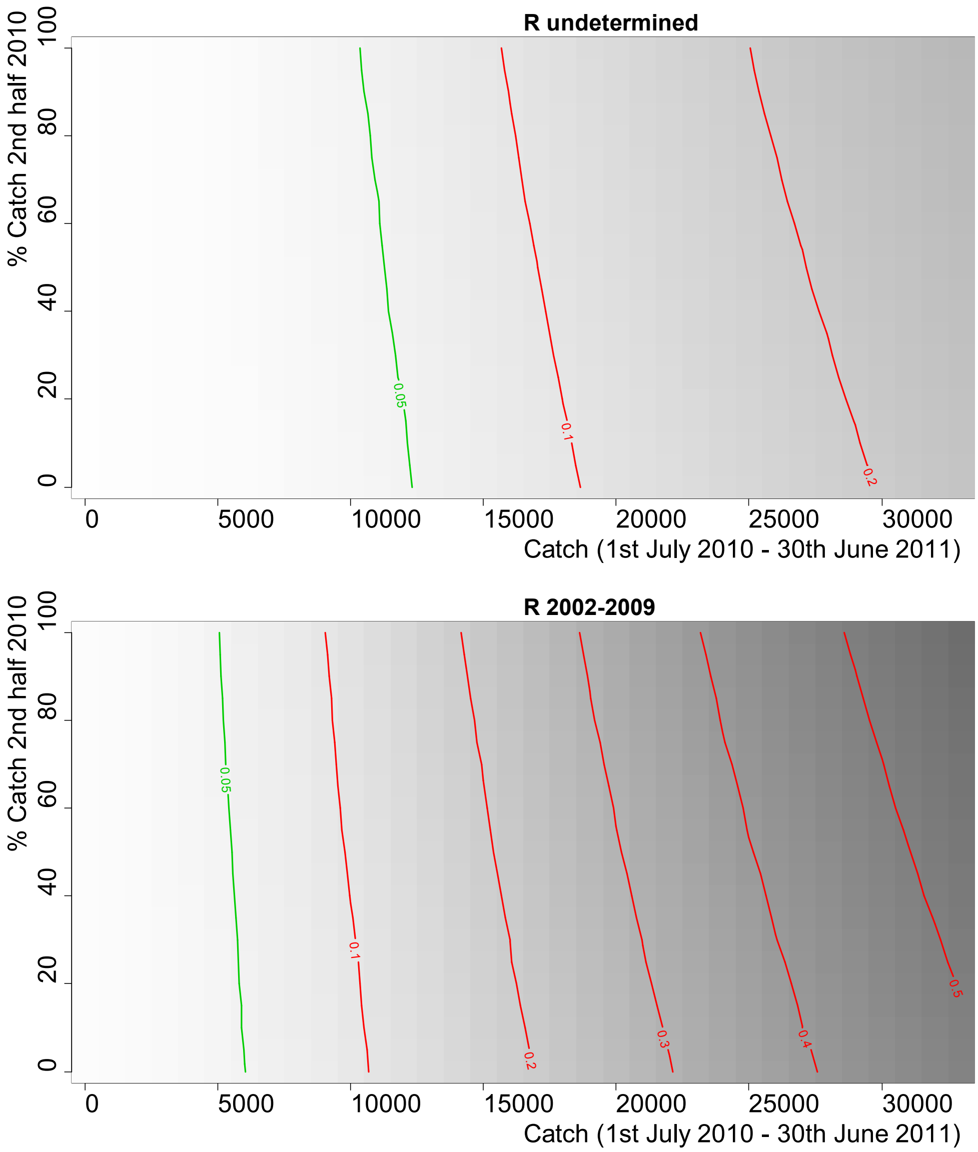


Figure 2.6.3.3: Bay of Biscay anchovy: Contour plots of probability of SSB in 2011 of falling below Blim depending on the total catch from 1st July 2010 to 30th June 2011 (x-axis) and the percentage of catch corresponding to the second half of 2010 (y-axis). The top panel corresponds to the undetermined recruitment scenario and the bottom panel for the 2002-2009 recruitment scenario.

2.7 Reference points and management plans

The precautionary reference points and their definitions are found in the Stock annex. Precautionary reference points were not revised by the WG this year.

The precautionary reference points were set according to stock estimates with ICA and within the standard framework related to deterministic stock assessments. For the anchovy, a Bayesian assessment is now well established, and the reference points may need to be revisited within that conceptual framework.

Because the assessment provides the probability distributions for the SSB, the rationale to maintain a B_{pa} under the assumption that being at B_{pa} would imply a low risk to B_{lim} becomes irrelevant. Furthermore, under the MSY framework for advice, Bpa is in principle redundant, and will be substituted by a $B_{trigger}$ below which fishing mortality should be reduced below F_{MSY}.

B_{lim} is defined by ICES as the SSB below which recruitment becomes impaired (ICES 2003). 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. When defining the reference points for anchovy -in 2003 -, 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).

The B_{lim} is set with reference to a particular year where a normal recruitment occurred at the historical low SSB. The assessment provides a probability distribution of SSB_{1989} which is updated every year. An alternative would therefore be to consider the current SSB relative to SSB_{1989} in probabilistic terms. This is now done routinely by considering the distribution of the ratio $SSB_{current}/SSB_{1989}$. The median and 95% probability intervals of such ratio for the current assessment is presented in **Table 2.5.2.2.** and the distribution for 2010 indicates that there is a 0 probability of being below the 1989 SSB.

MSY and the precautionary approach.

According to the recent advisory practice (ICES advice 2010, Book1, Section 1.2 General context of ICES advice), the ICES MSY approach for short-lived stocks is aimed at achieving a target escapement (BMSY-escapement, the amount of biomass left to spawn), which is more robust against low SSB and recruitment failure than a fishing mortality approach.

This applies to the Bay of Biscay anchovy. Hence, defining an FMSY is irrelevant, and advice aiming at MSY is equivalent to the precautionary approach advice.

Short term advice

Providing a risk adverse advice according to the precautionary approach has two separate aspects, and the anchovy requires special considerations on both.

1. For *tactical advice* in the short term perspective, when the stock is so small that there may be a risk of being below the limit biomass, the default advice by ICES, in the absence of an adopted harvest rule approved by ICES, is to rebuild the stock as estimated to above B_{pa} within a short time frame. For

anchovy, where the risk to Blim is calculated as part of the short term prediction, this translates into recommending a TAC which implies a low risk of leading below Blim, for selected scenario(s) of recruitment.

2. When *evaluating a harvest control rule* or management strategy, one will consider a plausible range of future natural variations (recruitment, weight, maturity) and require that the rule should imply a low probability that the modelled 'real' stock falls into an unwanted state of reduced productivity, when the rule is practised based on uncertain observations of the state of the stock . Low probability is usually interpreted as SSB < B_{lim} at least once over a time period in less than 5% of the cases (ICES 2008a) .

With respect to tactical advice on the anchovy in the absence of a harvest rule, the Bayesian assessment model provide estimates of the uncertainty which are expressed as posterior distributions of the interest parameters. The posterior distributions express the uncertainty of the results given the uncertainty of the data and the prior assumptions, and presumably represent more realistic estimates of the uncertainty than the assumptions underlying the distance between B_{lim} and B_{pa} in the common deterministic framework. The distribution, and in particular the outer percentiles are sensitive to the "a priori" assumptions. The distribution of the predicted biomass after the TAC is taken is also broadened by the uncertainty in future recruitments.

At the time when the short term prediction is made, there is nothing to indicate the strength of the incoming year class. The immediate option would therefore be to assume a distribution of recruitments representing all previous year classes. However, there has recently been a period with recruitment failure, the reasons for which are poorly known. The last year class was of intermediate level, but it is not clear whether this is just coincidental or represents a transition to a normal recruitment pattern. Therefore, the conservative option (low recruitment), based upon only the recent weak year classes may still be adequate.

To base the advise routinely on the 5-percentile of the SSB distribution relative to B_{lim} may not be adequate both because the distribution represents a broader range of uncertainty, because of the additional recruitment uncertainty and because the 5 - percentile is poorly estimated and highly sensitive to assumptions. Uncritical use of the 5-percentile as a criterium may lead to an advice to close the fishery far more often than necessary if the distribution is broad enough. For small pelagics, which are inherently highly variable, the 5% of risk may be unnecessarily high. Instead a reference could be searched in the added risk due to catches. In addition, the combination of a low risk level and a conservative recruitment assumption may be overly precautious.

Management plans.

A draft management plan has now been proposed by the EC in cooperation between science (STECF) and stakeholders (Southwestern RAC). This plan has not yet been formally adopted by the EU, and it has not been presented to ICES for evaluation. The plan is based on a constant harvest rate, and sets a TAC as a percentage of the point estimate of the SSB as assessed at the start of the TAC period which runs from 1st July to 30th June, but with an upper bound on the TAC (of 33,000 t), and with a minimum TAC level (of 7000 tonnes) applicable at SSB estimates between 24000 tonnes and 33000 tonnes. It is understood that the TAC this year will be set according to this draft plan.

The draft plan has a clause to revise it within 3 years after it has been accepted, and WGANSA assumes that future revisions will take recent scientific developments into account. It is not a task for ICES in general and WGANSA in particular to develop a revised plan. ICES has been open to assist in such development by providing scientific insight on opportunities and limitations, in a dialogue process with managers and stakeholders, as outlined by SGMAS (ICES 2008) and practised for a number of stocks.

The WGANSA highlights some fields of development which may be relevant for future management plan developments:

1 Recruitment indicators.

1a The JUVENA survey now has been conducted for 7 years. So far, ICES has abstained from using it as a recruitment indicator, because the experience was limited up to 2009 to a period with only poor recruitment. The last year class, which was of intermediate strength, was associated with the highest survey index in the series. The correlation between survey index and recruitment now appears to be quite strong and it is statistically significant. Although the predictive power of the survey may still be limited, it is likely that this survey can serve to select, at least in a qualitative way, likely scenarios of next coming recruitment to improve the basis for the management advice for next year (see section 2.4.3).

1b Environment index. This is a procedure to predict year class strength in 3 categories (low, intermediate and high) based on a range of environmental indicators (Fernandes *et al*. 2010). Its historical performance looks promising.

Both these indicators open opportunities to consider future management plans with half-yearly decisions and/or revisions of the TAC. Some examples of possible implications were presented in (L. Ibaibarriaga, A. Uriarte, S. Sánchez, J. A. Fernandes and X. Irigoien. 2010. Use of juvenile abundance indices for the management of the Bay of Biscay anchovy. Working document to WGANSA 2010).A general outline of such adaptive management of short lived species is suggested by ICES in the ACOM report (ICES advice 2010, Book1, Section 1.2 General context of ICES advice)

In 2010 managers decided to open the fishery with a low TAC based on the combination of the Juvena index and the environment index. ICES was not involved in that process.

2 Revision of DEPM data.

There is an ongoing revision of the method to compute the stock abundance from the DEPM data. The procedures for the estimation of the Spawning frequency (S) for the Bay of Biscay anchovy have been revised due to a better understanding of the POF degeneration cycle (Al-day *et al*. 2008) and its application to the estimation of S (Uriarte *et al*. submitted). This will affect the past Spawning Biomass estimates of anchovy by the DEPM leading to a reduction of those estimates. This may lead to a rescaling of the historical series of SSB and recruitments from the assessment as well. This will have implications for reference points that are set in absolute terms, including the reference points embedded in the draft management plan. Implementing this change in methodology, which from a scientific perspective is a clear improvement, will therefore have implications for future management plans.

3 Improvements in assessment methods and revisions of natural mortality.

There is ongoing work to further develop the Bayesian Biomass method currently used to assess the stock(L. Ibaibarriaga, C. Fernández and A. Uriarte. 2010. Gaining information from commercial data for the assessment of the Bay of Biscay anchovy. Working document to WGANSA 2010.) This work is still in progress. The WGANSA considers this a promising development, which will improve at least some theoretical shortcomings. The assessment will be conducted with the current method until a new method has been formally approved, e.g. through a new Benchmark assessment. The new method may lead to revision of growth- and or natural mortality parameters, which will have implications for simulations of future management plans. The closure of the fishery has allowed assessing likely levels of natural mortality for the stock all ages and even by ages (Petitgas *et al*. WD and Uriarte *et al*. WD), there are indications for a lower levels of natural mortality than the one currently assumed. These changes may affect the biomass levels of the assessment with implication for the long term management plan.

4 Bay of Biscay anchovy is one of the few stocks considered by ICES where uncertainties are considered explicitly in the assessment. Hence, there is information available not only on the point estimates of biomasses, but also on their distributions. This opens for opportunities to properly evaluate risks in terms of the combination of likelihood and costs, which may give a firmer basis for rational decisions about management plans. This would facilitate managers finding the probabilities of an unacceptable low stock abundance which imply the best counterbalance between the biological, economic and social concerns.

A rational basis for deciding on management plans is to simulate its performance under a variety of likely scenarios. This field has developed rapidly in recent years, and there is a good deal experience both within and outside ICES, on methods as well as on critical conditions for reaching management objectives (SGMAS - ICES 2008). Such simulations were made for the current draft plan, but will need to be extended and adapted to the new developments outlined above when revising the plan. This implies a considerable amount of work. The WGANSA has no views on how this work should be organized, but notes that ICES on some occasions has assisted in such processes, and that an assessment working group sometimes can be a good forum for coordination and exchange of ideas on the scientific aspects of the process.

3 Anchovy in Division IXa

3.1 ACFM Advice Applicable to 2009 and 2010

ICES advice from ACFM recommendations in December 2005 (ICES, 2005 a) firstly stated that, at present, 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 from 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 since 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 ICES Sub-areas IX and X and EC waters of the CECAF Sub-area 34.1.1) is of 8,000 t. Anchovy catches in Division IXa in 2009 (3,013 t) accounted for 14% decrease in relation to the value recorded in 2008 (3,508 t) and both consecutive annual landings are amongst the lowest levels recorded in the recent years. For 2010 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.

3.2 The Fishery in 2009

3.2.1 Fleet composition in 2009

Number and technical characteristics of the purse-seine vessels operated by Spain in the Gulf of Cádiz, differentiated between total operative fleet and fleet targeting anchovy are summarised in **Table 3.2.1.1** and **Figure 3.2.1.1**. In 2009, the entire Spanish purse-seine fleet fishing in the Gulf of Cadiz was composed by 90 vessels, with 84 vessels dedicated in a greater or lesser extent to the anchovy fishing.

Details of the fleets' dynamics in terms of number of operative vessels over time in recent years are given in the Stock Annex.

3.2.2 Catches in 2009

3.2.2.1 Landings in Division IXa

Anchovy total landings in 2009 were 3,013 t, which represented a 14% decrease with regard to the 2008 landings (3,508 t). These landings were amongst the lowest annual levels ever recorded in the most recent historical series (**Table 3.2.2.1.1**, **Figure 3.2.2.1.1**). The contribution by each subdivision to the total catch was somewhat different to the observed one in the last year, and characterized in 2009 by the strong drop of landings in the Subdivisions IXa-CN and CS and the continued decrease in landings from Subdivision IXa-S (Cádiz) since last year. Contributions by all Subdivisions but Subdivision IXa-S (Cádiz) not surpassed 1% of total landings from Division.

As usual, the anchovy fishery in 2009 was almost exclusively harvested by purse seine fleets (99% of total catches). Portuguese and Spanish purse-seine landings accounted for 41% and almost all of their respective national total catches (**Table 3.2.2.1.2**). 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 2009 experienced a 73% decrease in their national landings as compared with the previous year, although still represents an important contribution in the Portuguese anchovy fishery (38 t, 53%). This artisanal fishery supossedly also uses small artisanal purse-seine gears for fishing anchovy (Alexandra Silva, pers. comm.), which may significantly increase the 41% contribution of the purse-seine landings in the Portuguese fishery up to 94%. In any case, landings from this fishery as well as from the trawlers (both Spanish and Portuguese) were still small in relation to the whole anchovy fishery in the Division.

3.2.2.1.1 Landings by Subdivision

The anchovy fishery was mainly located in 2009 in the Subdivision IXa South (2,954 t, *i.e.*, 98% of total catch in the whole Division, **Table 3.2.2.1.1.1**, **Figure 3.2.2.1.1**). As observed in recent years, the bulk (99%) of these southern catches was fished in the Spanish Gulf of Cadiz (2,922 t *vs* 32 t landed in the Algarve). The relative importance of landings in the remaining Subdivisions was negligible, slightly outstanding the IXa-CN, where 35 t were landed.

The Spanish fishery in 2009 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 19 t in Subdivision IXa North, *i.e.*, southern Galician waters). Despite this, as advanced in the **Section 3.2.1.1** above, the Gulf of Cadiz fishery experienced a marked (43%) decrease in 2008 catches in relation to the year before (from 5,576 t in 2007 to 3,168 t in 2008), a decrease that still continues in 2009 (an 8% decrease which rendered 2,922 t). The possible causes of such a decrease are described in **Section 3.2.4**.

The Portuguese anchovy fishery has historically shown alternate periods of relatively high and low landings in each of their three Subdivisions, with the anchovy fishery being located either in the IXa South (before 1984), or in the IXa Central-North (from 1984 to 1997, and in 2007 and 2008), or mainly distributed in both Subareas (from 1998 to 2003, and in 2009), (see **Table 3.2.2.1.1**, Pestana, 1989, 1996; ICES, 2007 a).

The Gulf of Cadiz Spanish purse-seine fishery was closed from December 2008 to February 2009 (3 months) and in December 2009, 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*". The expected subsidized 3-month closure from mid-autumn in 2009 to mid-winter in 2010 was restricted to one month only, in December 2009, although the fishery was practically closed since November 2009 until February 2010 for persistent bad sea conditions during all those months. The above management plan was firstly implemented in 2004 and since then the fishery closures (with a duration of the last 45 days in the year in 2004 and 2005, the last 2 months in 2006, and 3 months from mid November 2007 to mid February 2008) 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 was given in ICES (2007 a). The effects of these closures on the purse-seine quarterly landings in 2004-2009 as compared with preceding years are shown in **Figure 3.2.2.1.1.1**. 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 closures in the 2009 annual landings, affecting both the beginning and end of 2009, was more evident in the fourth quarter than in the first one, probably because of the abovementioned persistent bad sea conditions which occurred since November. Impacts of this management measure in the fishing effort will be discussed in **Sections 3.2.4** and **3.7.2**, and in the Stock Annex.

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 usually 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 2009 is shown in **Table 3.2.2.1.1.1**. 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 during the second semester. Portuguese catches from the IXa Central-North and Central-South were mainly landed during the first quarter, whereas catches from the Southernmost sub-area were landed during the second semester. Anchovy fishery season in the Spanish part of the IXa South (Gulf of Cadiz) occurred throughout the second and third quarters, mainly in the spring months.

3.2.2.2 Catch Numbers at Age

Catch-at-age data from the whole Division IXa in 2009 are only available from the Spanish Gulf of Cadiz fishery (Subdivision IXa South). Problems with ageing/reading Gulf of Cádiz anchovy otoliths were revisited in 2009 during the *Workshop on Age reading of European anchovy* (WKARA; ICES, 2010), although such problems still persist. Description of annual trends of catch-at-age data from this fishery through the available data series is given in the Stock Annex. Data from the Spanish fishery in Subdivision IXa North are not available since commercial landings used to be negligible.

Total catch in the Gulf of Cadiz in 2009 was estimated at 217 million fish, which represents only a 4.3% overall decrease in numbers with respect to 2008 (227 millions), but is still accounting for, as also occurred in 2008, a 65.4% decrease when compared with the catch at age in 2007 (628 millions). The 2008 and 2009 levels are both close to the recent minima recorded in 1993 (207 millions), 1995 (69 millions), and 2000 (320 millions). In relation to the previous year, the aforementioned landed numbers in 2009 are the result of: a strong (83.1%) drop in landings of the 0 age-group (from 57 millions in 2008 to 10 millions in 2009); a 35.3% decrease in 2 years old anchovies (from 31 millions in 2008 to 20 millions in 2009); a 33.7% increase of 1 year olds (from 138 to 185 millions), and an unexpected increase of 3 year olds (from only 0.4 millions in 2008 to almost 3 millions in 2009, the highest value ever recorded in the series).

Landings of the 0 age-group anchovies in 2009 were restricted to the second half of the year (although mainly during the fourth quarter), whereas 1 and 2 year-old catches were present throughout the year. Three year-old anchovies occurred again in the fishery (years when they occurred in the fishery was in 1992 and 2008). These older anchovies were fished throughout the three first quarters in the year (**Table 3.2.2.2.1**, **Figure 3.2.2.2.1**).

3.2.2.3 Mean Length- and Mean Weight at Age

Length Distributions by Fleet

Gulf of Cadiz anchovy quarterly length distributions from the Spanish fishery in 2009, the only available for this WG, are shown in **Table 3.2.2.3.1** and **Figure 3.2.2.3.1**. 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. In 2009, however, lower estimates for both variables were recorded in the second and fourth quarters.

Gulf of Cadiz anchovy mean length and weight in the 2009 annual catch (12.2 cm and 12.5 g) are, jointly with the 2008 estimates, the highest ones ever recorded in the historical series (see next paragraph and ICES, 2007 a).

Mean Length- and Mean Weight at Age in Landings

Annual mean length and weight at age of Gulf of Cadiz anchovy were as follows (**Tables 3.2.2.3.2** and **3.2.2.3.3**, **Figure 3.2.2.3.2**):

Age group 0: mean length and weight in 2009 were 10.2 cm and 7.2 g respectively. Through the available data series (1988 onwards) these estimates have ranged between 5.8 cm and 1.3 g (1996), and 10.6 cm and 7.9 g (2008). A noticeable increasing trend has been observed in both estimates in the most recent years. The 2008 and 2009 estimates are between the highest ones in the historical series.

Age group 1: mean length and weight in 2009 were 12.1 cm and 12.1 g respectively. Mean lengths and weights have oscilated between 8.9 cm-6.4 g (1996) and 12.5 cm-13.6 g (2008). Both estimates for this age group show a strong increase since 2008 in relation to the last years. The 2008 and 2009 estimates are also between the highest ones ever recorded in the historical series.

Age group 2: mean length and weight in 2009 were 13.8 cm and 17.6 g respectively. Mean lengths have oscillated between 13.5 cm-14.9 g (1998) and 16.9 cm-33.5 g (1989). Since 2002 both estimates have experienced a remarkable decreasing trend which also showed a slight recovery in 2008.

Age group 3: mean length and weight in 2009 were 14.9 cm and 21.5 g respectively. The first previous occurrence of this age group in the fishery was in 1992 (with mean annual estimates of 16.9 cm and 30.2 g) and most recently in 2008 (15.4 cm, 25.5 g).

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 – 2009 period, 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. Three year olds occurred in a more or less constant way only through 2009. In this year, these eldest anchovies in the fishery showed larger sizes a weights between the second and fourth quarters, mainly in the second quarter.

3.2.3 Discards

See the Stock Annex for previous available information on discards.

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

New data on anchovy discarding are being gathered again since the fourth quarter in 2009 on within the Spanish National Sampling Scheme framed into the EC Data Collection Regulation (DCR). Eight (8) purse-seine fishing trips were sampled from a total of 1540 trips carried out during that quarter. Preliminary information on these sampled trips are available but the resulting discard estimates have not been merged with landings in the present WG due to uncertainties in the adequacy of the raising methodology used (*i.e.*, estimation of total discards for the whole fleet by raising sampling with anchovy landings as commercial discarded species) and the own low representativity of the sampled trips. So, sampled mean weights of retained and discarded anchovy catches from these trips were only 49.69 and 0.76 kg, respectively. The estimated anchovy discard ratio for the fourth quarter in 2009 was 0.015 yielding total estimated discards for the species of only 1.7 t (but with a CV= 59%). The size composition of discarded anchovies from the pooled set of sampled trips ranged between the 9.5 and 16 cm size classes, with 2 modes at 11 and mainly at 13.5 cm size classes, well above the legal size at 10 cm. Therefore, reasons other than the capture of undersized fish (*e.g.*, market prices, etc.) seems also to motivate the anchovy discarding. Additionally, anchovy slipping of partially undersized fish was directly observed in one of the sampled trips confirming that such practices are not uncommon and that they should also be taken into consideration as an added mortality.

3.2.4 Effort and Catch per Unit Effort

Annual and half-year standardised CPUE series (1988 – 2009) for the whole Spanish purse-seine fleet fishing Gulf of Cádiz anchovy (Subdivision IXa-South) were computed from the quotient between the sum of raw quarterly catches and that of standardised quarterly efforts within the respective time period. Details of data availability and the standardisation process are commented in the Stock Annex. Results on goodness of fit of the generalised modelling used for CPUE and effort standardisation as assessed by ANOVA and model graphical diagnosis are shown in **Table 3.2.4.1** and **Figure 3.2.4.1**. The resulting estimates are shown in **Table 3.2.4.2**.

Series of standardised overall annual effort and CPUE and the historical series of landings from this fishery are shown in **Figures 3.2.4.2**. **Figures 3.2.4.3** and **3.2.4.4** show annual and quarterly trends of these variables by purse-seine fleet type. A more detailed description of the fleets' dynamics over time and the impact of the recent closures in effort and CPUE is shown in the Stock Annex.

In 2009 the overall fishing effort of the Spanish purse-seine fleet fishing anchovy in the Gulf of Cádiz fishing ground was estimated in 4,667 standardised fishing days, which accounted for a slight 2.2% increase with respect to the effort exerted in the previous year (4,568 fishing days in 2008), but is still lower to the levels recorded in 2007 (6,917 fishing days) and before. As also occurred in 2008, a combination of fishing closures, both in the beginning and in the end of the year, together with a period of persistent bad weather at the end of the 2009 fishing season, and joined to the displacement of a part of the fleet to the Moroccan fishing grounds (benefiting from fishing licenses under the EC-Morocco Fishery Agreement) at the same time of the reopening of the Gulf of Cádiz fishery in March, may be the responsibles for the observed decrease in the fishing effort in the last two years. The annual CPUE, however, was maintained at a level similar (0.626 t/fishing day) to the one recorded the previous year (0.693 t/fishing day).

3.3 Biological Data

3.3.1 Weights at age in the stock

Weights at age in the stock are shown in **Table 3.5.1**. See the Stock Annex for comments on computation and trends.

3.3.2 Maturity at Age

Annual maturity ogives for Gulf of Cadiz anchovy are shown in **Table 3.3.2.1**. See the Stock Annex for comments on computation and trends in the maturity ogives of Gulf of Cádiz anchovy.

Maturity stage assignment criteria were agreed between national institutes involved in the biological study of the species during the *Workshop on Small Pelagics (Sardina pilchardus, Engraulis encrasicolus) maturity stages* (WKSPMAT; ICES, 2008 a).

3.3.3 Natural Mortality

Natural mortality is unknown for this stock. By analogy with anchovy in Sub-area VIII, natural mortality is probably high (a half-year M=0.6 has been used in previous years for the data exploration, see **Table 3.5.1** and Stock Annex).

3.4 Fishery-Independent Information

3.4.1 Acoustic Surveys

A description of the available acoustic surveys providing estimates for anchovy in Division IXa is given in the Stock Annex (see also ICES, 2007 b). Survey's methodologies deployed by the respective national Institutes (IPIMAR and IEO) are also thoroughly described in ICES (2008 c, 2009 b).

Results from the Spring Portuguese (*PELAGO 09*) and Spanish (*PELACUS 0409*) acoustic surveys in 2009 were previously described in the last year's WGANSA and WGACEEG reports (ICES, 2009 a, b), but they will be summarised herein again for comparison purposes. Detailed information in the present section will be provided for only those surveys carried out during the 2009-2010 WGANSA intersessional time.

Portuguese Surveys

The Spring Portuguese acoustic survey (*PELAGO* survey series) has been the only acoustic survey carried out during the 2009-2010 WGANSA intersessional time, namely the April 2010 *PELAGO10* survey, carried out with the R/V 'Noruega' and following the standard methodology firstly adopted by the Planning Group for Acoustic Surveys in ICES Sub-Areas VIII and IX (ICES 1986, 1998) and further improved and coordinated by the WGACEGG (see, for instance, ICES 2008 c and 2009 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. Additional results from this survey concerning to sardine are shown in this report in **Section 5.3.2**. As commented below, no Autumn acoustic survey belonging to the *SAR* survey series was carried out in 2009.

***SAR* autumn survey series:**

At present, the Autumn 2008 survey (*SAR08OUT*; from 2nd to the 27th of October 2008), aimed to cover the sardine early spawning and recruitment season in the Division IXa, has been the last survey within its series. No anchovy acoustic estimates were however provided by IPIMAR from this survey since the species was not a target in that ocassion (ICES, 2009 a, b). **Figure 3.4.1.1** shows the historical series of anchovy acoustic estimates from Autumn Portuguese surveys in the Division IXa available so far. See also **Section 3.4.3** and the Stock Annex for additional considerations on the consistence and potential of this survey series as a anchovy recruitment survey and its continuity in time.

***PELAGO10* spring survey:**

Figure 3.4.1.2 summarises the main results from the April 2009 survey (*PELAGO09*) for comparison with the present year's data.

The April 2010 survey (*PELAGO10*) took place from the 6th of April to the 6th of May and covered the Iberian Portuguese and Gulf of Cádiz waters ranging from 20 to 200 m depth. Marques *et al*. (WD 2010) give a complete description of the survey and its results.

Anchovies were present in only 5 from 26 trawls completed during the survey: one off Lisbon and the others off the South coast. The anchovy total biomass estimated during this survey for the whole Division IXa was 8.6 thousand tonnes (1,026 million fish), which represent strong 53.3% and 68.0% decreases in biomass and numbers respectively in relation to the 2009 estimates (26.8 thousand tonnes, 2,196 million fish), (**Figure 3.4.1.3**).

According to the distribution of the NASC coefficients (m^2/mn^2) attributed to anchovy, the species, as usual, was mainly distributed off the Gulf of Cádiz (Subdivision IXa-South(C)), although showing much lower densities that in previous years. So, in this Subdivision anchovy occurred in 3 isolated nuclei placed respectively between Lagos and Portimão (close to San Vicente Cape), between the Tinto-Odiel river mouth and the Doñana National Park, and in front of the Cádiz Bay.

Anchovy estimates this year has been provided by IPIMAR for the whole Subdivision IXa-South only, without the usual additional distinction between Algarve and Cádiz areas within the Subdivision. For this Subdivision were only estimated 7.4 thousand tonnes (963 million fish), representing 70.1% and 53.4% decreases in biomass and abundance, respectively, in relation to the 2008 estimates. Size histogram from the estimated population from this Subdivision shows a main modal size at 11 cm and a size range between the 6.5 and 14.0 cm size classes. This size composition evidences for the spring in 2010 very scarce contributions of both small and, above all, larger anchovies (with the absence of anchovies larger than 14 cm) as compared with the populations estimated in previous years for the same area. No geographical pattern in size distribution may be inferred from the available data as they have been provided to the WG excepting the occurrence of anchovy juveniles (10 cm modal size class) in one pelagic trawl hauled nearby the Guadalquivir river mouth which could be the responsible for the smallest modal component in the abovementioned length frequency distribution.

In the Subdivision IXa-CN the species was absent, whereas in the Subdivision IXa-CS characteristic echo-traces attributable to the species were again detected in the Cascais-Lisbon zone, where the species usually occurs, but this year rendering estimates of only 1.2 thousand tonnes and 62 million fish (**Figure 3.4.1.3**).

Figure 3.4.1.4 and **Table 3.4.1.1** tracks the historical series of anchovy acoustic estimates from Spring Portuguese surveys in the Division IXa carried out so far.

Spanish Surveys

The *ECOCÁDIZ 0609* survey, which acoustically samples the shelf waters off the Subdivision IXa-South, was conducted in the early summer in 2009. As a novelty, this conventional survey was complemented the last year by an almost synchronous one, the *ECOCÁDIZ-COSTA 0709* survey, carried out with a small-draught vessel, the R/V 'Francisco de Paula Navarro', aiming to sample shallower waters than 20 m depth that are not sampled by those larger flag research vessels, either Spanish or Portuguese, that routinely survey the study area. Additionally, in October 2009 a new Autumn survey (*ECOCÁDIZ-RECLUTAS 1009*, onboard the R/V 'Emma Bardán'), aimed to acoustically estimate the abundance and biomass of Gulf of Cádiz anchovy recruits, was also conducted although unsuccessfully. Although acoustic estimates from this autumn survey are available they have not been provided to this WG awaiting their revision by the 2010 WGACEEG in November. Reasons for such a decision are commented in **Section 3.4.3** and in the Stock Annex.

The only Spanish survey carried out so far in waters of the Division IXa in the first semester in 2010 has been the 2010 early Spring survey belonging to the *PELACUS* series, the *PELACUS 0410* survey, carried out on board R/V 'Thalassa'. This survey yearly samples the waters off the Subdivisions IXa-North and Sub-area VIIIc since 1983.

Protocols and methods adopted by IEO for the Spanish acoustic surveys are described in ICES (2009 b). The main results from these surveys are as follow:

PELACUS 0410

Figure 3.4.1.5 summarises the main results from the April 2009 survey (*PELACUS 0409*) for comparison with the present year's data. In that survey anchovy was almost absent in the Subdivision IXa North, showing an accidental presence in the Galician Ría de Arousa, rendering an acoustic estimate of only 26 t.

The Spring 2010 survey, *PELACUS 0410*, was carried out between 27th March to 20th April. Iglesias *et al.* (WD 2010 a) provide a detailed description of the survey's methods and results. Additional results concerning to sardine are also shown in **Section 5.3.2**.

In the Subdivision IXa North, anchovy was found in this last survey in only two hauls from the 11 ones carried out in this area, concretely in the Ría de Arousa and Ría de Muros, but only one of these two hauls was considered valid because of its representativeness for the assessment purposes. Anchovy biomass and abundance were estimated at only 90 t and 2.9 million fish, respectively. Anchovy size composition ranged between 13 and 21 cm size classes with a mode at 15 cm (**Figure 3.4.1.6**). The population in this area was dominated by age 2 and 3 fish. These fishes seem to correspond to small residual populations inside the rías.

ECOCÁDIZ 0609

The *ECOCÁDIZ 0609* survey was carried out between 27th June and 6th July 2009 onboard the Spanish R/V 'Cornide de Saavedra' acoustically surveying the waters of the Gulf of Cadiz, both Spanish and Portuguese, between the 20 and 200 m isobaths. A detailed description of methods and results from this survey was previously reported in the 2009 WGACEEG (ICES, 2009 b) and in Iglesias *et al*. (WD 2010 b). Fishing stations in this survey were carried out using a 20 m-vertical opening pelagic trawl instead of the one used as standard in these surveys (the 10 m-vertical opening 'Pedreira' gear) due to serious damages suffered by this latter gear in a previous survey.

Twenty eight (28) valid and representative fishing stations (from a total of 30 fishing operations) were carried out during this survey, anchovy ocurring in 23 trawls (82.1% ocurrence). Although anchovy occurred almost all over the shelf of the sampled area, fishes were mainly distributed in the Spanish waters off the Gulf, with the highest densities occurring in the coastal central part of the sampled area. In the Portuguese waters the species was widely distributed but in somewhat deeper waters and showing lower densities, excepting the area comprised between Alfanzina and Cabo San Vicente, where relatively high S_A values attributed to the species were also recorded. Seven coherent post-strata ("polygons") were differentiated according to the combined criteria of the S_A values distribution and the (homogeneous) size composition in the fishing stations (**Figure 3.4.1.7**). Unlike previous surveys, estimates from this survey provided to this WG have not been possible to be shown by each of the 2 subareas or regions usually considered: "Portugal" (from Cape S. Vicente to Vila Real de Santo Antonio) and "Spain" (from Ayamonte to Cape Trafalgar). Instead, estimates from the total area and by polygon are presented. The acoustic estimates by homogeneous stratum are shown in Iglesias *et al*. (WD 2010 b). A total of 21,580 t and 1,137 million fish were estimated for this species for the whole surveyed area.

The size class range of the assessed population varied between 11 and 18.5 cm classes, with a modal class at 14 cm (**Figure 3.4.1.8**). Nevertheless, as usual, size- and age-based estimates suggest an westward increasing size (-age) gradient, with the largest (and oldest) anchovies being more abundant in the westernmost limit of their distribution, and an area concentrating relatively recent recruited anchovies (first spawners) located in shallow waters close to the Guadalquivir river (**Figures 3.4.1.8** and **3.4.1.9**).

Figure 3.4.1.10 and **Table 3.4.1.1** tracks the (short) historical series of anchovy acoustic estimates from the *ECOCÁDIZ* acoustic survey series carried out so far. Anchovy estimates show a decreasing trend in the most recent years with available data, with the 2009 estimate being amongst the lowest ones in the series, although still close to the average value for the previous surveys within its series (about 28 thousand tonnes and 2 thousand million fish).

ECOCÁDIZ-COSTA 0709

The *ECOCÁDIZ-COSTA 0709* survey was planned as a complementary one to the conventional *ECOCÁDIZ 0609* survey and conducted almost synchronously (from 2nd to 9th July 2009). It was carried out with the IEO's R/V 'Francisco de Paula Navarro' in waters shallower than 50 m depth off the central part of the study area (**Figure 3.4.1.11**). Navarro's acoustic equipment (a not calibrated non-scientific echosounder *SIMRAD ES60*) and its configuration was the same used in the *PACAS 0708* survey (the first of two pilot experiments for acoustic surveying of Gulf of Cádiz shallow waters, <20 m depth, conducted in 2008) and described in the 2008 WGACEGG report (ICES, 2008 c). Unfortunately, the 'Navarro' was also only equipped for the 2009 survey with its standard configuration for bottom-trawl fishing which consists in the great vertical opening *GOC 73* trawl gear (3.5 m standard mean vertical opening, 20 mm mesh size in the inner small-meshed codend) and the *Morgére WH-S(8)* trawl doors (2.6 m^2, 350 kg). Some arrangements in the floating rope (by increasing the number of floats) allowed to achieve a 5 m mean vertical opening but they did not give any chance for the midwater fishing, with all the fishing operations being therefore performed over or very close to the bottom. Neither CUFES nor CTD sampling, nor census of apical predators were carried out with the R/V 'Navarro'. A description of the methods and results from this survey is shown in Ramos *et al*. (WD 2010).

Four valid hauls (from 7 fishing operations) were carried out in this shallow waters' survey, all of them capturing anchovy. These hauls were only restricted to the 17-29 m depth range which prevented from interpreting echograms for those *ESDU*s included into the bathymetric range comprised between 25-50 m. The estimated *NASC*s from such *ESDU*s were coded as *NI* (*i.e.*, not identified). Fortunately, the not identified ESDUs were previously assessed in the conventional survey and, therefore, this loss of information may be considered unrelevant (**Figure 3.4.1.12**).

Anchovy was distributed all over the sampled coastal waters, with the highest densities occurring just in the central part of the sampled area (in front of the Guadalquivir river mouth; **Figure 3.4.1.13**). Four coherent post-strata were differentiated. The acoustic estimates for each of these strata are given in Ramos *et al.* (WD 2010). A total of 3,571 t and 246 millions of fish have been estimated for this species for this coastal area with depths below 20-25 m depth. The size class range of the assessed population varied between 9.5 and 16 cm classes, showing a bimodality at 11 and 13 cm size classes. As also observed in the conventional survey, size- and age-based estimates suggest an westward increasing size (-age) gradient, with the largest (and oldest) anchovies being more abundant in the westernmost limit of the sampled area, and the smaller and younger first spawners located in shallow waters close to the Guadalquivir river (**Figures 3.4.1.14** and **3.4.1.15**).

Table 3.4.1.2 shows tentative estimates for the combination of standard and coastal surveys for those species which coincided in both surveys (data in red bold italics). Given that the acoustic equipment used in the coastal survey *ECOCÁDIZ-COSTA 0709* was not properly calibrated, the resulting estimates from this survey shoul be considered for the time being as orientative ones. The Portuguese estimates from the *PELAGO 09* survey have also been included in that table for comparison for those coinciding assessed species. By summing up the new coastal estimates to those from the conventional survey still yields differences with those estimates from the Portuguese survey, conducted about 2 months before. For the purposes of comparing trends and for the abovementioned reasons the WG preferred to maintain the estimates obtained from the standard survey. Nevertheless, results from this survey demonstrate that these coastal shallow waters, not covered by conventional surveys, may sustain a relatively important biomass. The continuity of this complementary coastal survey in the next years is however not guaranteed.

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 excepting Subdivision IXa N (Portuguese surveys) or from the Subarea IXa South only (Spanish surveys) are shown in **Table 3.4.1.1** and **Figures 3.4.1.1**, **3.4.1.4**, and **3.4.1.10**.

The estimates from those surveys covering the whole southernmost subarea (the IXa South, whose population has usually been 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. Spring biomass estimates from 1998 to 2003 in the Subdivision IXa-South oscillated around 25 thousand tonnes. However, available estimates, either from Portuguese or Spanish surveys, in 2004 and 2005 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, ICES, 2006 b) or to the echo-traces discrimination between fish and plankton (2005 Portuguese survey, 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 the possibility of such a decline in the spawning population in 2005 should not be forgotten.

Notwithstanding the above, the 2005-2009 Portuguese spring survey seasons were coincident and their estimates, therefore, comparable, and they indicate an evident recovered population since 2006 which reachs levels either close (2006, 2009) or even somewhat higher (2007, 2008) to the average estimate in the (Portuguese) historical series (25.6 thousand tonnes). The high 2006 estimate from the Spanish survey reinforces the above statement on a population recovery that year in this 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 was a matter of concern and some working hypothesis were drawn in the 2007 WGACEEG for explaining the above differences (see ICES, 2007 b, 2008 b for a more detailed description). WGACEEG strengthened 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 (see, for instance, Guillard and Lebourges (1998), Guennégan *et al*. (2004), Brehmer *et al*. (2006), and Ramos *et al*. (WD 2010), amongst others).

Regardless the above discrepancies observed in the 2007 estimates, the provision to the present WG of the recent 2010 Spring Portuguese acoustic estimate may leads to a change in the perception on the relative stability of the stock in recent years. Attempting to analyse the possible causes explaining such a strong decrease (from 24.7 thousand tonnes in 2009 to 7.4 thousand tonnes in 2010, *i.e.* about 70% decrease), both size composition (**Figures 3.4.1.16** and **3.4.1.17**) and age structure (**Figures 3.4.1.18**, **3.4.1.19**, and **3.4.1.20**) of the estimated populations through the historical series has been analysed. The age structure of the anchovy population in Subdivision IXa South, as estimated from the Portuguese acoustic survey series, is not available. As an alternative, this age structure has been estimated by applying the Spanish Gulf of Cádiz commercial age-length keys for the second quarter in the year to the corresponding estimated population numbers by length class. Unfortunately, age structure for the 2010 survey has not been estimated because of the commercial age-length key is not yet available. It should also be taken into consideration that such keys are based on commercial samples from purse-seine catches and therefore they may result in a biased picture of the population structure because of a different catchability.

Our comments herein will be mainly focused in the last years in the series. So, the size composition of the estimated population in 2010 - the only information available on its structure - it was characterised by a very low number of both small and larger anchovies than in 2009, with larger anchovies than 14 cm being absent, suggesting a low recruitment in 2009 and probably a weak population structure sustaining a very low biomass level in 2010.

The population age structure in previous years suggests a strong 2000, (exceptionally) 2001, and 2006 year classes, with the last one still being present in 2009 (as age 3 anchovies). The strength of both 2007 and 2008 year classes decreased in relation to that observed for the 2006 year class: population numbers of age 1 anchovies in 2008 and 2009 showed 50.3% and 56.7% decreases in relation those ones estimated in 2007, suggesting very low recruitments in 2007 and 2008 as well.

3.4.2 Egg Surveys

Spanish Surveys

Anchovy DEPM surveys in the Division are only conducted by IEO for the SSB estimation of Gulf of Cádiz anchovy (Subdivision IXa-South, *BOCADEVA* survey series). So far, only 2 surveys have been carried out within this series with a triennial periodicty: *BOCADEVA 0605*, conducted in 2005, and *BOCADEVA 0608* in 2008. The next survey in this series is planned to be conducted in 2011. The methods adopted for both the conduction of the survey and the estimation of parameters are described in the Stock Annex and in ICES (2009 a,b). Revised results from these surveys were reported in the last year's WG report (ICES 2009 a).

The high uncertainty associated to the estimates (especially to those ones related to the egg sampling in the 2005 survey) was matter of concern for the last year's WGANSA and it was recommended that the appropriateness of the egg sampling scheme were revised in the 2009 WGACEGG. It was concluded by this last working group last year that reducing the variance in future surveys can probably be attained by increasing the number of stations in the actual positive spawning areas (adaptive sampling) and perhaps by applying GAM based estimators.

3.4.3 Recruitment surveys

As described in **Section 3.4.1**, 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, following the same approach described in the previous section. Because of the possible biases derived from the application of commercial age-length keys, the WG encourages to IPIMAR to provide to this WG structured acoustic estimates 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 3.4.1.1** and **Figure 3.4.1.1**).

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 were 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 were carried out during 2008 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 (see ICES, 2008 c).

ECOCÁDIZ-RECLUTAS 1009

The first of these series of Gulf of Cádiz anchovy recruitment surveys (*ECOCÁDIZ-RECLUTAS 1009*) was carried out between 26th October-05th November on board R/V 'Emma Bardán'. Following the above mentioned WGACEEG recommendations, the survey, aimed to acoustically estimate the abundance and biomass of Gulf of Cádiz anchovy recruits, was planned to be conducted throughout the easternmost Portuguese waters and those waters off the central part of the Spanish Gulf of Cádiz, waters that, from previous ancillary information, were expected to include the main Gulf of Cádiz anchovy recruitment area.

The shortness of the available ship-time to cover a more intensive acoustic sampling grid (*i.e.* 4 nm spaced transects from 100 to 7-10 m depth) than the one conventionally planned in standard surveys and some other unforeseen circumstances (*e.g.*, a one-day technical stop for crew replacement, 2-day military manoeuvres just in the middle of both the survey area and calendar) prevented finally from covering the whole survey area. For the above reasons, the surveyed area was restricted to a relatively small central area in front the Guadalquivir river mouth rendering a very probable underestimation of the recruits abundance. Therefore, although acoustic estimates are available, they have not been provided to this WG awaiting for an appropriate revision by this year's WGACEEG. Continuity of this survey in following years is not assured at all and will necessarily depend on external (EC) funding.

3.5 Data exploration

Data availability and some fishery (recent catch trajectories) and biological evidences 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).

For the time being, no analytical assessment model have been successfully applied. An *ad hoc* seasonal (half-year) 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 Subdivision IXa-South since 1995 onwards. The separable model is fitted to the updated half-year catch-at-age data until the year before the WG 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). More details on the model settings and assumptions and its performance are described in the Stock Annex.

The exploratory assessments performed so far with this *ad hoc* model has not been recommended as a basis for predictions or advice. The immediate reason is that it usually estimated 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 showed large clusters over time, indicating that the selection may not be constant, one of the model's assumptions.

In more general terms, estimating the parameters in a separable model with only a biomass index as supporting information is close to over-parametisation, and the fact that only 2-3 ages are represented in the fishery makes the situation worse. Hence, the assessment became unstable and very sensitive to the assumptions made,especially to the choice of input data for the last semester in the most recent year. Examination of the data indicates that almost all catches are from age 1, plus age 0 in the second semester (**Table 3.5.1**, **Figure 3.5.1**). 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 estimated 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 length (-age) composition by area in the surveys. So, 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. Therefore, there is some uncertainty about the stock identity.

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. As a final consequence, the exploratory model utilised so far does not provide any reliable information about the true levels of both stock, F and Catch/SSB ratios since the assessment is not still properly scaled.

For all the above reasons last year was preferred to do not perform any exploratory assessment with this model. Instead of this, the provision of advice last year relied in an update of the qualitative assessment carried out in 2008 and accepted by the Review Groups of the 2008 and 2009 WGANC (2008 & 2009 RGANC). This qualitative assessment is based on the joint analysis of trends showed by the available data, both fishery-dependent and –independent information (*i.e.*, landings, fishing effort, cpue, survey estimates). A summary of these trends is shown in the **Figure 3.5.2**. They indicate a relatively stable stock status with little change until 2009. There were no evidence of serious problems: landings in 2008 and 2009 experienced a sharp decline, although caused by a parallel fall in the fishing effort, cpue is maintained relatively stable, and survey estimates, although variable, did not show trends. The DEPM estimates are highly uncertain (mainly the 2005 one), and hence ratios of catch in Subdivision IXa-South to DEPM SSB, although are reasonably low, they should be considered with caution. Notwithstanding the above, acoustic estimates suggested that the stock was harvested until 2009 up to relatively acceptable levels. As commented above, the situation seems to have changed in 2010 regarding the population at sea, this population exhibiting a strong decrease in its population levels in relation to previous years. Population age structure, as estimated by the recent surveys, suggests the occurrence of consecutive relatively low recruitments since 2007 resulting in a probable feeble population structure in the spring of 2010. There are inconsistencies in the evidence, but there are indications, in particular in the Portuguese survey index and in the age composition in the catches, that the recruitment may have been reduced in the most recent years and that the stock is declining. New evidences may be obtained by the acoustic survey that is planned for July 2010. In addition, provisional age distributions may be derived from the length composition in the Portuguese survey once age-length keys from the fishery in the spring 2010 become available.

An in-depth evaluation of the possibilities of handling the above problems on the performance and suitability of the analytical model by other kinds of assessment models was out of reach for the WGANSA. 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.

3.6 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 was reduced in 2010 from a relatively stable situation (about 30 thousand tonnes as an average for the 2006-2009 period) until 2009.

3.7 Management considerations

3.7.1 Stock definitions

A summarised description of the distribution of the main anchovy populations in NE Atlantic European waters is given in **Section 2** and in the Stock Annex.

3.7.2 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 last two months in the first quarter in the year. Since 2006 half of the fleet stops one month and the remaining vessels stop the other month.

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, 1st December 2008 to 28th February 2009), which is accompanied by a subsidized tie-up scheme for the purse-seine fleet. The expected subsidized 3-month closure from mid-autumn in 2009 to mid-winter in 2010 was restricted to one month only, in December 2009, although the fishery was practically closed since November 2009 until February 2010 for persistent bad sea conditions during all those months. 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 $\geq$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 3.2.2.1.1** and **3.2.4** and indicate that such closures did not cause serious effects in the reduction of the exerted fishing effort, at least in the last years, but only halting the possibility of expanding even more the fishing capacity of the fleets up to the recent maxima reached in the 1999-2007 period (see **Figure 3.2.4.4**).

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 sourrounding 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 3.7.2.1**). 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.

Results from the data exploration described in **Section 3.5** suggest that the stock may be declining due to a reduced recruitment. Although new survey data that become available in July 2010 for this stock may change the perception of the stock, a precautionary advice would be to reduce the fishery.

3.7.3 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 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, the 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, although taking into consideration the recommendations given on this subject in **Section 3.4.2**.

Table 3.2.1.1. Anchovy in División IXa. Subdivision IXa South. Spanish purse-seine fleet composition in the Gulf of Cadiz (Subdivision IXa-South) in 2009. The fleet is differentiated into total fleet and vessels targeting anchovy. 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 because of the lower number of missing data. Storage: catches are dry hold with ice (1 fishing trip equals to 1 fishing day). Similar tables for yearly data since 1999 are shown in the Stock Annex.

Total number of operative purse-seiners

2009	Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total
<10	2	4	8	0	0	14
11-15	1	14	27	12	1	55
16-20	0	0	2	16	1	19
>20	0	0	0	2	0	2
Total	3	18	37	30	2	90

Purse-seiners targeting anchovy

2009	Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total
<10	1	4	8	0	0	13
11-15	1	13	26	10	0	50
16-20	0	0	2	16	2	20
>20	0	0	0	2	0	2
Total	2	17	36	28	2	85

Table 3.2.2.1.1. Anchovy in Division IXa. Portuguese and Spanish annual landings (tonnes), (from Pestana, 1989 and 1996, and WGMHSA, WGANC and WGANSA 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
2008	211	87	37	335	5	3168	3173	3508
2009	35	5	32	72	19	2922	2941	3013

(-) Not available
(0) Less than 1 tonne

Table 3.2.2.1.2. Anchovy in Division IXa. Catches (tonnes) by gear and country in 1988-2009.

Country/Gear	1988*	1989*	1990*	1991*	1992	1993	1994	1995*	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
SPAIN	4263	5454	6131	5711	3028	1961	3153	5900	1823	4664	9349	6000	2191	8244	7891	4791	5187	4389	4383	5580	3173	2941
Artisanal IXa North																4	1				1	0.1
Purse seine IXa North		118	220	15	33	1	117	5329	44	63	371	413	10	27	21	19	2	4	15	4	4	18
Purse seine IXa South	4263	5336	5911	5696	2995	1630	2884	496	1556	4410	7830	4594	2078	8180	7847	4754	5177	4385	4367	5575	3168	2922
Trawl IXa South						330	152	75	224	190	1148	993	104	36	23	14	6	0.2	0.4	0.3	0.1	0.02
PORTUGAL	458	496	541	210	275	23	237	7056	2771	632	1613	1408	310	855	915	478	657	126	108	874	335	72
Trawl					4	9	1		56	46	37	43	6	16	13	7	5	7	27	14	9	4
Purse seine	458	496	541	210	270	14	233	7056	2621	579	1541	1346	297	806	888	287	455	62	57	484	185	30
Artisanal					1	1	3		94	7	35	20	7	32	13	184	197	57	24	376	141	38
Total	4721	5950	6672	5921	3303	1984	3390	12956	4594	5295	10962	7409	2502	9098	8806	5269	5844	4515	4491	6454	3508	3012

* Portuguese catches not differentiated by gear

Table 3.2.2.1.3. Anchovy in Division IXa. Quarterly anchovy catches (tonnes) by country and Sub-division in 2009.

COUNTRY	SUBDIVISIONS	QUARTER 1		QUARTER 2		QUARTER 3		QUARTER 4		ANNUAL (2009)	
		C(t)	%	C(t)	%	C(t)	%	C(t)	%	C (t)	%
SPAIN	IXa North	0.5	2.8	0.4	2.2	8	45.0	9	50.0	18	0.6
	IXa South	530	18.1	1279	43.8	1006	34.4	107	3.7	2922	99.4
	TOTAL	531	18.1	1279	43.5	1014	34.5	116	4.0	2941	100.0
PORTUGAL	IXa Central North	17	47.1	8	24.1	5	13.1	5	15.7	35	49.0
	IXa Central South	5	95.2	0.01	0.3	0	0.0	0.2	4.6	5	6.7
	IXa South	3	8.9	1	2.5	11	34.6	17	53.9	32	44.3
	TOTAL	24	33.5	9	13.0	16	21.7	23	31.9	72	100.0
TOTAL	IXa North	0.5	2.8	0	2.2	8	45.0	9	50.0	18	0.6
	IXa Central North	17	47.1	8	24.1	5	13.1	5	15.7	35	1.2
	IXa Central South	5	95.2	0.01	0.3	0	0.0	0.2	4.6	5	0.2
	IXa South	533	18.1	1280	43.3	1017	34.4	124	4.2	2954	98.1
	TOTAL	555	18.4	1289	42.8	1030	34.2	139	4.6	3012	100.0

Table 3.2.2.2.1. Anchovy in Division IXa. Subdivision IXa South. Spanish catch in numbers ('000) at age of Gulf of Cadiz anchovy (1995-2009) 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	0	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	0	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
2008	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	38173	19304	0	57477	57477
	1	38742	51510	30608	17435	90251	48043	138295
	2	10220	13400	5137	2214	23620	7351	30970
	3	245	149	0	0	394	0	394
	Total (n)	49206	65059	73918	38953	114266	112871	227137
	Catch (t)	590	1117	909	552	1707	1461	3168
	SOP	552	1056	852	518	1608	1369	2978
	VAR.%	107	106	107	107	106	107	106
2009	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	1143	8552	0	9695	9695
	1	24402	93317	64150	3072	117719	67222	184941
	2	11236	6842	1944	28	18079	1972	20051
	3	1463	364	846	1	1827	846	2673
	Total (n)	37101	100523	68084	11652	137624	79736	217360
	Catch (t)	530	1279	1006	107	1809	1113	2922
	SOP	486	1194	937	100	1680	1037	2717
	VAR.%	109	107	107	107	108	107	108

Table 3.2.2.3.1. Anchovy in Division IXa. Length distribution ('000) of anchovy catches in Division IXa by country and Subdivisions in 2009. Only data available for length composition of catches from the Spanish fishery in the Gulf of Cádiz (Subdivision IXa-South).

2009	Q1	Q2	Q3	Q4	TOTAL
Length (cm)	SPAIN IXa South	SPAIN IXa South	SPAIN IXa South	SPAIN IXa South	SPAIN IXa South
3.5					
4					
4.5					
5					
5.5					
6					
6.5					
7			5		5
7.5		98	14		112
8	10	104	273	33	421
8.5	21	328	486	22	856
9	79	826	731	321	1957
9.5	339	2162	900	1600	5001
10	552	6013	1747	1733	10045
10.5	293	10616	4460	2192	17561
11	1308	18092	6120	1808	27329
11.5	4217	15947	4853	1811	26828
12	5596	11641	5924	1092	24253
12.5	6440	8495	8876	543	24354
13	6047	9548	9182	200	24977
13.5	5340	6587	9299	142	21367
14	4380	4259	5612	46	14297
14.5	1343	2383	4598	92	8417
15	558	2455	3352	9	6375
15.5	576	618	954	4	2152
16	1	303	659	4	967
16.5		49	32	1	82
17			4		5
17.5					
18					
18.5					
19					
19.5					
20					
20.5					
21					
21.5					
22					
Total N	37101	100523	68084	11652	217360
Catch (T)	530	1279	1006	107	2922
L avg (cm)	12.7	11.9	12.6	10.8	12.2
W avg (g)	13.1	11.9	13.8	8.6	12.5

Table 3.2.2.3.2. Anchovy in Division IXa. Subdivision IXa South. Mean length (TL, in cm) at age in the Spanish catches of Gulf of Cadiz anchovy (1995-2009) 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. Data from 1988 to 1994 has been previously reported in WGMHSA reports.

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

2008	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			10.3	11.3		10.6	10.6
	1	11.2	12.7	13.1	13.7	12.1	13.3	12.5
	2	13.8	14.6	14.5	14.5	14.2	14.5	14.3
	3	15.7	14.9			15.4		15.4
	Total	11.8	13.1	11.7	12.6	12.5	12.0	12.3

2009	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			8.5	10.4		10.2	10.2
	1	12.3	11.7	12.6	12.0	11.8	12.6	12.1
	2	13.5	14.1	14.4	14.4	13.8	14.4	13.8
	3	14.6	15.3	15.2	15.5	14.7	15.2	14.9
	Total	12.7	11.9	12.6	10.8	12.1	12.3	12.2

Table 3.2.2.3.3. Anchovy in Division IXa. Subdivision IXa South. Mean weight (in kg) at age in the Spanish catches of Gulf of Cadiz anchovy (1995-2009) 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. Data from 1988 to 1994 has been previously reported in WGMHSA reports.

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

2008	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.007	0.009		0.008	0.008
	1	0.009	0.015	0.015	0.017	0.012	0.016	0.014
	2	0.018	0.022	0.021	0.021	0.020	0.021	0.020
	3	0.027	0.023			0.026		0.026
	Total	0.011	0.016	0.012	0.013	0.014	0.012	0.013

2009	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.004	0.008		0.007	0.007
	1	0.012	0.011	0.014	0.011	0.011	0.014	0.012
	2	0.015	0.020	0.020	0.019	0.017	0.020	0.018
	3	0.019	0.026	0.023	0.023	0.021	0.023	0.022
	Total	0.013	0.012	0.014	0.009	0.012	0.013	0.012

Table 3.2.4.1. Anchovy in Division IXa. Subdivision IXa South. ANOVA results of the GLM used for standardisation of CPUE data for Spanish fleets operating in the Gulf of Cadiz.

ANOVA: Test of between-subjects effects
Dependent variable: LNCPUEadj

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta-Squared	Noncentrality Parameter	Observed Power (a)
Corrected Model	1189.636	337	3.530	17.081	3.071E-191	0.901	5756.325	1.000
Intercept	3087.284	1	3087.284	14938.528	0	0.960	14938.528	1.000
YEAR (AÑOCOD)	234.620	21	11.172	54.060	9.576E-126	0.643	1135.260	1.000
QUARTER (TRIMCOD)	7.025	3	2.342	11.331	3.0185E-07	0.051	33.993	0.999
FLEET (FLEETTYPE)	419.477	10	41.948	202.974	1.34E-189	0.763	2029.736	1.000
YEAR*QUARTER (AÑOCOD * TRIMCOD)	29.493	63	0.468	2.265	3.9765E-07	0.185	142.707	1.000
YEAR*FLEET (AÑOCOD * FLEETTYPE)	479.844	210	2.285	11.056	3.412E-122	0.787	2321.835	1.000
QUARTER*FLEET (TRIMCOD * FLEETTYPE)	19.177	30	0.639	3.093	1.1227E-07	0.128	92.794	1.000
Error	130.199	630	0.207					
Total	4407.119	968						
Corrected Total	1319.835	967						

a Computed using alfa = ,05
b R squared = ,901 (Adjusted R squared = ,849)

Table 3.2.4.2. Anchovy in Division IXa. Subdivision IXa South. Standardised effort (no. of standardised fishing trips fishing anchovy) and CPUE (Tonnes/fishing trip) data for Spanish fleets opertating in the Gulf of Cadiz. Color intensities denote increasing problems in sampling coverage of fishing effort. (SP: single purpose; MP: multi purpose; HT: heavy GRT; LT: light GRT).

	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	3877	-	57	-	580	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	3877	?	3877	636	**4513**
1989	4558	-	176	-	917	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	4558	?	4558	1092	**5650**
1990	4709	-	163	-	1439	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	4709	?	4709	1601	**6311**
1991	4433	-	95	-	3094	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	4433	?	4433	3189	**7622**
1992	3970	-	210	-	1407	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	3970	?	3970	1617	**5587**
1993	2348	-	13	-	594	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	2348	?	2348	607	**2955**
1994	2175	-	113	-	1015	*n.a.*	*n.a.*	0	225	46	-	2175	225	2400	1174	**3574**
1995	1378	-	13	-	381	*n.a.*	*n.a.*	0	14	24	-	1378	14	1392	419	**1810**
1996	3505	-	99	-	1929	*n.a.*	*n.a.*	0	84	67	-	3505	84	3589	2095	**5684**
1997	2241	39	118	-	1908	*n.a.*	*n.a.*	0	80	16	-	2241	119	2360	2043	**4402**
1998	2172	81	0	2412	0	*n.a.*	*n.a.*	0	192	37	-	2172	2685	4857	37	**4894**
1999	1770	138	8	2255	0	663	586	0	285	247	-	1770	3342	5112	842	**5954**
2000	259	834	1.6	2270	0	1845	181	0	613	0	-	259	5563	5822	183	**6004**
2001	178	1042	141	1430	0	2331	52	95	1099	29	265	540	5901	6441	223	**6663**
2002	2975	593	46	1123	0	2160	13	17	466	0	124	3116	4342	7458	59	**7517**
2003	2505	439	16	1220	0	1379	0	76	739	0	0	2581	3776	6357	16	**6373**
2004	3031	520	17	728	0	1611	48	189	858	19	0	3220	3717	6937	84	**7021**
2005	2472	662	0	500	0	1222	0	173	527	0	0	2645	2910	5555	0	**5555**
2006	3229	439	0	494	0	1477	0	264	1306	0	0	3493	3716	7209	0	**7209**
2007	1651	681	16	946	0	1693	0	300	1631	0	0	1951	4950	6901	16	**6917**
2008	1319	449	0	623	0	1137	0	185	854	0	0	1504	3064	4568	0	**4568**
2009	1442	455	0	518	0	1289	0	152	812	0	0	1594	3073	4667	0	**4667**

	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	1.069	-	0.138	-	0.152	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	1.069	?	1.069	0.151	**0.940**
1989	1.103	-	0.119	-	0.241	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	1.103	?	1.103	0.221	**0.933**
1990	1.107	-	0.163	-	0.295	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	1.107	?	1.107	0.281	**0.898**
1991	1.178	-	0.142	-	0.128	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	1.178	?	1.178	0.128	**0.739**
1992	0.712	-	0.096	-	0.124	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	0.712	?	0.712	0.121	**0.541**
1993	0.585	-	0.102	-	0.097	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	0.585	?	0.585	0.097	**0.485**
1994	0.991	-	0.160	-	0.353	*n.a.*	*n.a.*	0	0.177	0.107	-	0.991	0.177	0.915	0.325	**0.721**
1995	0.145	-	0.171	-	0.164	*n.a.*	*n.a.*	0	0.082	0.018	-	0.145	0.082	0.144	0.156	**0.147**
1996	0.226	-	0.282	-	0.212	*n.a.*	*n.a.*	0	0.124	0.129	-	0.226	0.124	0.224	0.213	**0.220**
1997	1.553	0.179	0.298	-	0.262	*n.a.*	*n.a.*	0	0.099	0.100	-	1.553	0.126	1.481	0.263	**0.916**
1998	3.098	0.435	0	0.205	0	*n.a.*	*n.a.*	0	0.223	0.159	-	3.098	0.213	1.503	0.159	**1.493**
1999	2.128	0.263	0.237	0.231	0	0.142	0.146	0	0.155	0.156	-	2.128	0.208	0.873	0.150	**0.771**
2000	0.244	1.209	0.095	0.201	0	0.163	0.133	0	0.365	0	-	0.244	0.358	0.353	0.132	**0.346**
2001	3.402	2.281	0.950	0.232	0	0.963	0.143	2.286	1.558	0.110	2.073	2.541	1.129	1.248	0.651	**1.228**
2002	1.782	1.051	0.421	0.201	0	0.577	0.167	0.417	0.655	0	0.940	1.740	0.553	1.049	0.367	**1.044**
2003	1.366	0.629	0.165	0.313	0	0.291	0	0.534	0.311	0	0	1.342	0.341	0.747	0.165	**0.746**
2004	1.222	0.687	0.055	0.255	0	0.330	0.132	0.391	0.358	0.072	0	1.173	0.372	0.744	0.103	**0.736**
2005	1.134	0.628	0	0.503	0	0.454	0	0.595	0.491	0	0	1.099	0.509	0.790	0	**0.790**
2006	0.673	0.574	0	0.814	0	0.490	0	0.685	0.487	0	0	0.674	0.542	0.606	0	**0.606**
2007	1.215	0.939	0	0.771	0	0.589	0	1.111	0.534	0	0	1.199	0.654	0.808	0	**0.806**
2008	0.947	0.753	0	0.578	0	0.473	0	1.014	0.577	0	0	0.956	0.564	0.693	0	**0.693**
2009	0.9212	0.4767	0	0.983	0	0.4337	0	0.316	0.322	0	0	0.864	0.503	0.626	0	**0.626**

Table 3.3.2.1. Anchovy in Division IXa. Subdivision IXa South. Maturity ogives (ratio of mature fish at age) for Gulf of Cadiz anchovy.

Year	Age		
	0	1	2+
1988	0	0.82	1
1989	0	0.53	1
1990	0	0.65	1
1991	0	0.76	1
1992	0	0.53	1
1993	0	0.77	1
1994	0	0.60	1
1995	0	0.76	1
1996	0	0.49	1
1997	0	0.63	1
1998	0	0.55	1
1999	0	0.74	1
2000	0	0.70	1
2001	0	0.76	1
2002	0	0.72	1
2003	0	0.69	1
2004	0	0.95	1
2005	0	0.95	1
2006	0	0.77	1
2007	0	0.91	1
2008	0	0.97	1
2009	0	0.99	1

Table 3.4.1.1. Anchovy in Division IXa. Historical series of overall and regional acoustic estimates of anchovy abundance (N, millions) and biomass (B, tonnes) in Division IXa from Portuguese (*SAR-PELAGO* series) and Spanish surveys (*ECOCÁDIZ* series, only for IXa-South, shadowed). See also Figures 3.4.1.4 and 3.4.1.10.

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
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
Apr.09	N	127	0****	159	286	1910	2069	2196
Jul. 09	N	-	-	35	-	1102	1137	-
Apr. 10	N	0	62	0	62	963	963	1026

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
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
Apr.09	B	2089	0****	3759	5848	20986	24745	26834
Jul. 09	B	-	-	1075	-	20506	21580	-
Apr. 10	B	0	1188	0	1188	7395	7395	8583

*** 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: shallow waters between 20 and 30 m depth were not acoustically sampled. ****Possible underestimation: although no echotraces attributable to the species were detected in this area, however, the loss o pelagic gear samplers prevented from confirming directly this.**

Table 3.4.1.2. Anchovy in Division IXa. Subdivision IXa South. *ECOCÁDIZ-COSTA 0709* Summer Spanish acoustic coastal survey in Subdivision IXa South in 2009. Tentative population numbers and biomasses (in red bolded italics) resulting from the combination of standard and coastal surveys' estimates for those species coinciding in both surveys. Also the estimates from the Spring Portuguese survey *PELAGO 09* for the same area are included for comparison (only available estimates for 3 species).

Species/Survey	Sardine	Anchovy	Chub mack.	Medit Horse-mack	Bogue
ECOCÁDIZ-COSTA 0709 Biomass (t)	7165	3571	1830	2892	1970
ECOCÁDIZ 0609 Biomass (t)	37020	21580	56276	2705	3412
ECOCÁDIZ 2009 Biomass (t)	*44185*	*25151*	*58106*	*5597*	*5382*
PELAGO 09 Biomass (t)	97700	24800	82000	-	-
ECOCÁDIZ-COSTA 0709 Abundance (million fish)	131	246	19	23	24
ECOCÁDIZ 0609 Abundance (million fish)	649	1137	629	28	42
ECOCÁDIZ 2009 Abundance (million fish)	*780*	*1383*	*648*	*51*	*66*
PELAGO 09 Abundance (million fish)	1845	2069	628	-	-

Table 3.5.1. Anchovy in Division IXa. Anchovy in Subdivision IXa South (Algarve + Gulf of Cadiz). Updated input values usually needed for running the *ad hoc* seasonal separable assessment model with indication of the runs performed in last years.

Anchovy IXa-South (Algarve+Gulf of Cadiz)
Years: 1995-2009
Fleets: All

Half-year landings (in tonnes, 1995-2009)

1995		1996		1997		1998		1999		2000		2001	
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
265	305	848	983	2018	2596	3957	5586	3633	2309	1083	1276	4285	4370

2002		2003		2004		2005		2006		2007		2008		2009	
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
4740	3523	3567	1401	3361	2257	3835	787	3961	430	3831	1779	1720	1484	1843	1151

Half-year Catch in number (in millions) at age (1995-2009)

	1995		1996		1997		1998		1999		2000		2001	
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
0	0	34.50	0	495.13	0	335.67	0	465.60	0	126.26	0	129.46	0	161.95
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
2	0.19	0	0.90	1.21	32.46	12.41	12.03	1.51	32.29	2.65	3.51	0.55	19.70	5.29
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	2002		2003		2004		2005		2006		2007		2008		2009	
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
0	0	77.89	0	95.72	0	123.63	0	38.75	0	12.45	0	62.11	0	58.31	0	11.53
1	546.23	195.09	333.99	73.28	323.34	97.73	449.28	37.39	450.39	41.93	455.32	107.16	91.06	48.79	119.50	68.87
2	8.50	9.93	13.15	0.63	1.81	0.92	3.21	0.33	5.27	0.00	6.76	0.63	23.83	7.45	18.64	2.01
3	0	0	0	0	0	0	0	0	0	0	0	0	0.40	0	1.90	0.86

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	2008	2009	
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	5.38	7.18	4.12	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	14.93	12.19	0.6
2	22.55	19.98	20.90	20.45	19.99	23.62	31.78	28.29	26.79	21.87	22.62	20.97	20.39	21.77	20.26	0.6
3	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	23.09	24.21	0.6

Acoustic Biomass estimates (tonnes) in Sub-division IXa South (Algarve+Gulf of Cadiz) (Portuguese surveys). Only Spring surveys series was considered in the last year's assessment.

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
30695	24763	-	-	33909	24913	25580	21335	-	24565	-	-	-

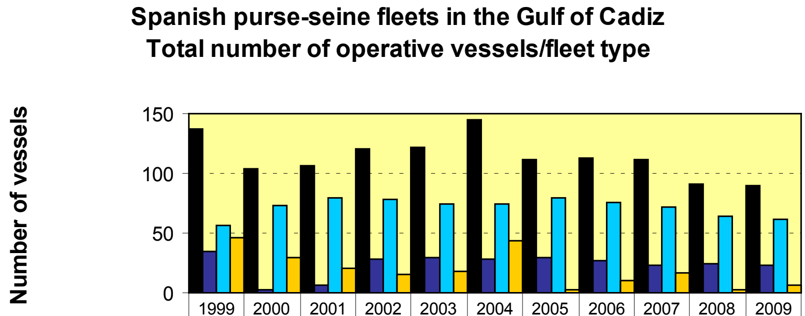
Apr.-05	Nov.-05	Apr.-06	Nov.-06	Apr.-07	Nov.-07	Apr.-08	Nov.-08	Apr.-09	Nov.-09	Apr.-10
14041	-	24082	-	38020	23723	34162	-	24745	-	7395

DEPM Biomass estimates (tonnes) in Sub-division IXa-South (Algarve+Gulf of Cádiz) (Spanish surveys). Not included in the exploratory analytical assessment.

Jun.-05	Jun.-06	Jun.-07	Jun.-08
14637	-	-	31527

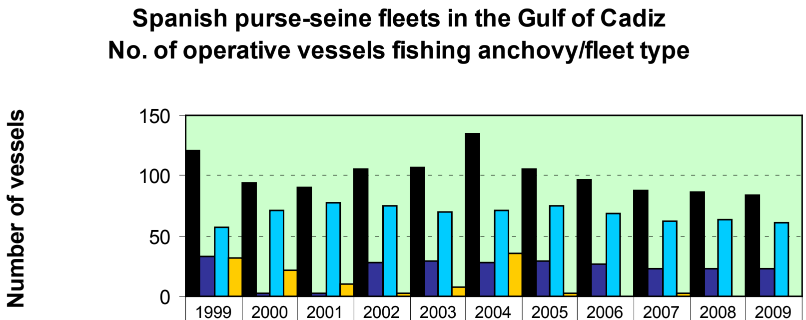
Exploratory runs with the seasonal separable model

	Portuguese March Ac. Surv.	Biomass index	Weighting factor for index	F assumptions	Wage stock
RUN1	1999-2010	Relative	1	2009Fratio for FHY2-2009. FHY1-2010 average FHY1 in 3 last years (07-09).	Wage stock in 2010 as the average in 06-09
RUN2		Relative	6		
RUN3		Absolute	1		



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total	137	104	106	121	122	145	111	113	112	91	90
SP Heavy Tonn.	34	2	6	28	29	28	29	27	23	25	23
SP Light Tonn.	57	73	80	78	75	74	79	76	72	64	61
Multipurpose	46	29	20	15	18	43	3	10	17	2	6

Year



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total	121	94	90	105	107	135	106	96	88	86	84
SP Heavy Tonn.	33	2	2	28	29	28	29	27	23	23	23
SP Light Tonn.	57	71	78	75	70	71	75	69	62	63	61
Multipurpose	32	21	10	2	8	36	2	0	3	0	0

Year

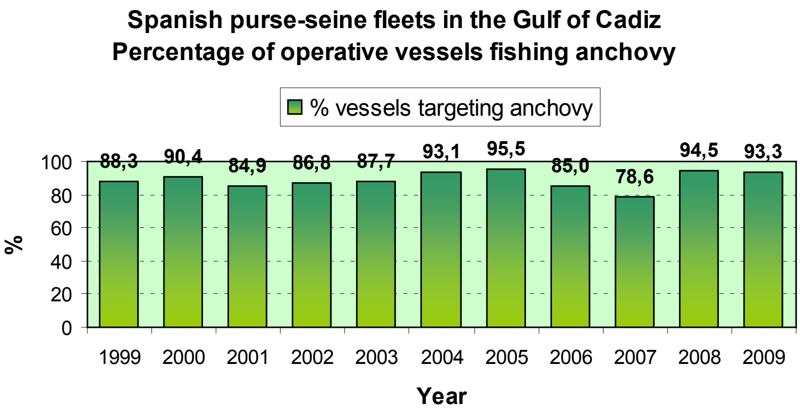
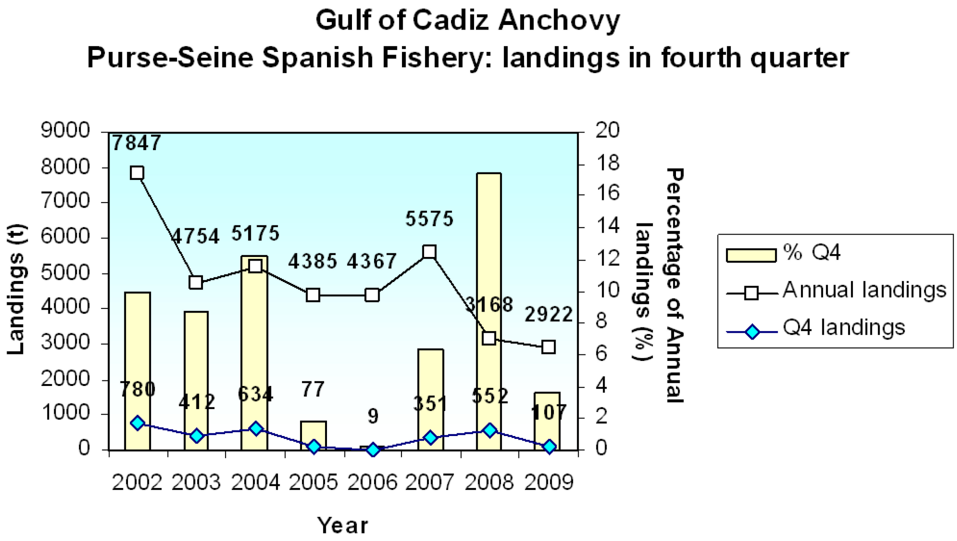


Figure 3.2.1.1. Anchovy in División IXa. Subdivision IXa-South. Spanish purse-seine fishery. Fleet composition operating in the Gulf of Cadiz fishery since 1999. The fleet is differentiated into total fleet and vessels targeting anchovy. The categories include both single purpose purse-seiners and trawl and artisanal vessels fishing with purse-seine in some periods through the year (multi-purpose vessels).



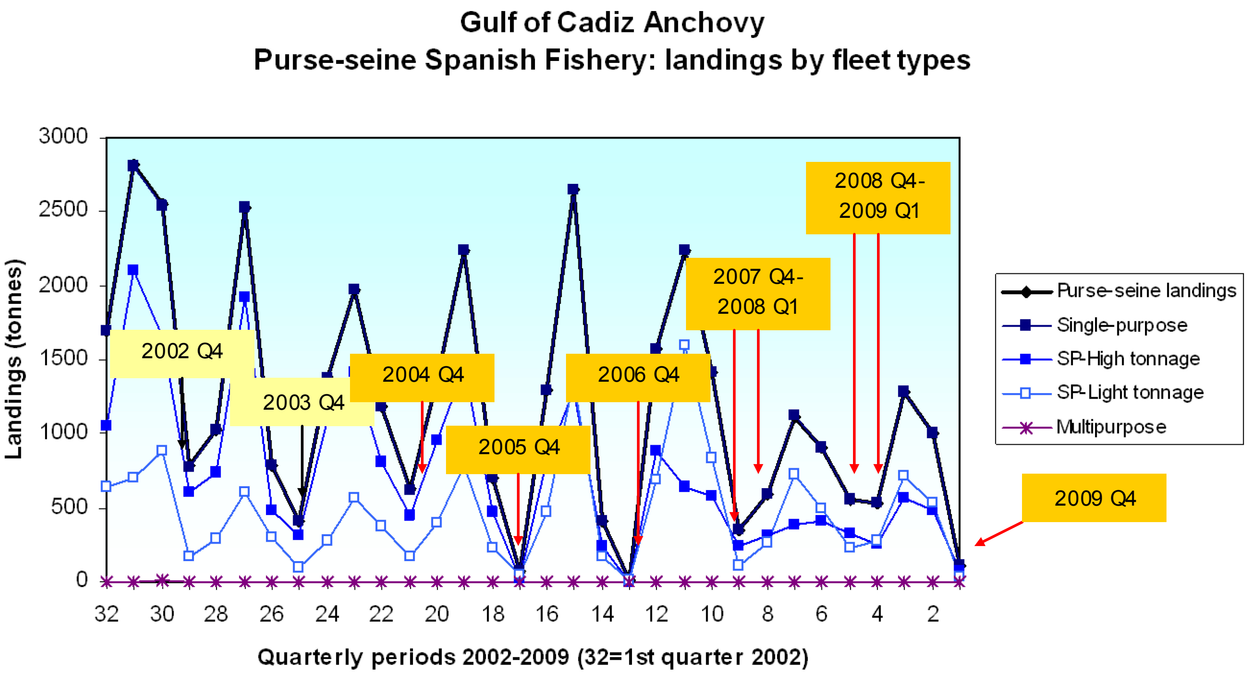


Figure 3.2.2.1.1.1. Anchovy in Division IXa. Subdivision IXa-South. Spanish purse-seine fishery. Upper panel: comparison of annual purse-seine landings with catches landed in the fourth quarter to assess the effects of the closed season in the fourth quarter in 2004-2009. Bar chart represents the relative 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 implemented since 2004 on.

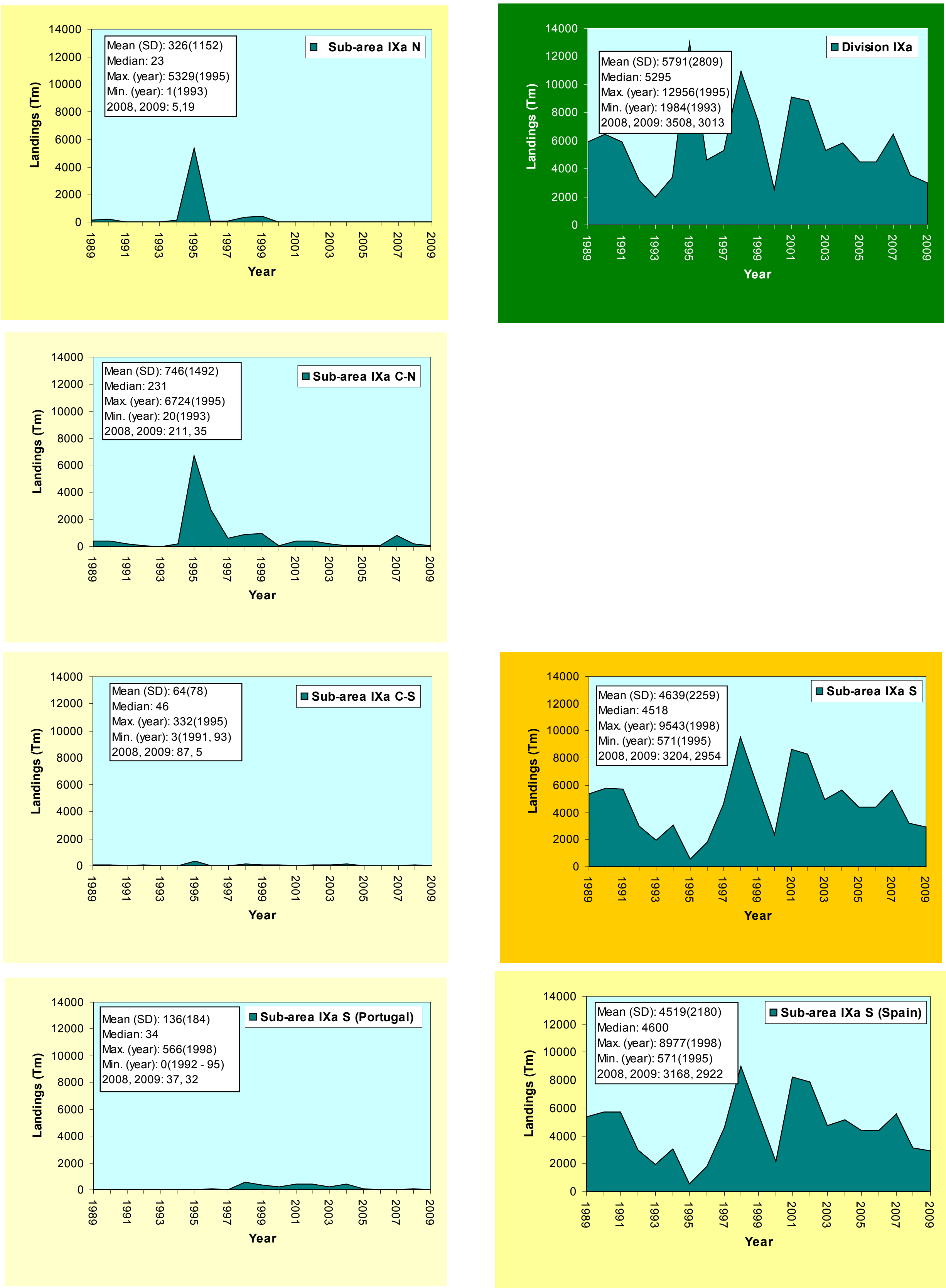


Figure 3.2.2.1.1. Anchovy in Division IXa. Recent series of Portuguese and Spanish (1989-2009) anchovy landings in Division IXa. Sub-areas arranged according to its geographical location along the Atlantic Iberian Peninsula. Series for the whole Division and for the whole Sub-area IXa-South are also shown.

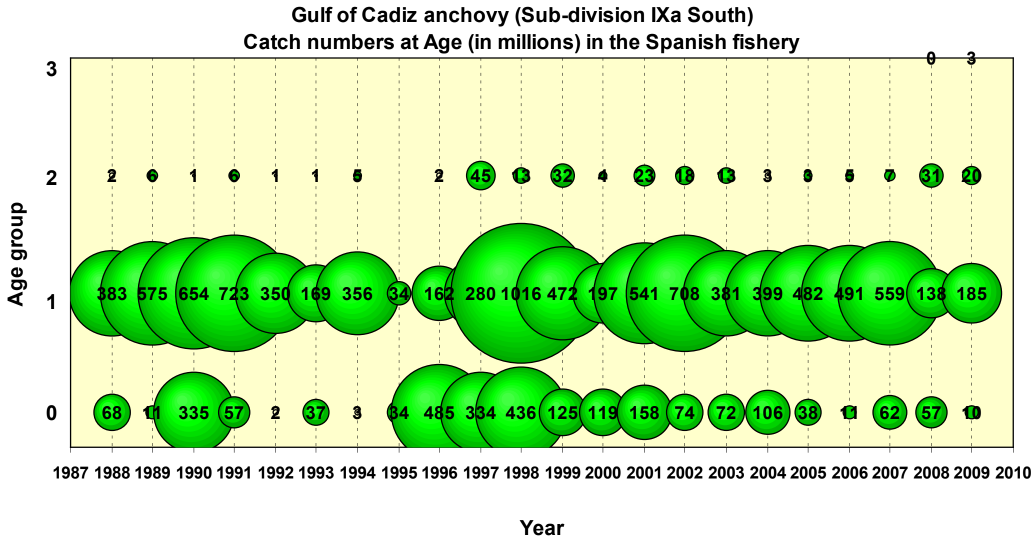


Figure 3.2.2.2.1. Anchovy in Division IXa. Subdivision IXa-South. Spanish fishery (all fleets). Age composition in Spanish landings of Gulf of Cadiz anchovy (1988-2009). Data for 1994 and second half in 1995 estimated from an iterated ALK by applying the Kimura and Chikuni's (1987) algorithm.

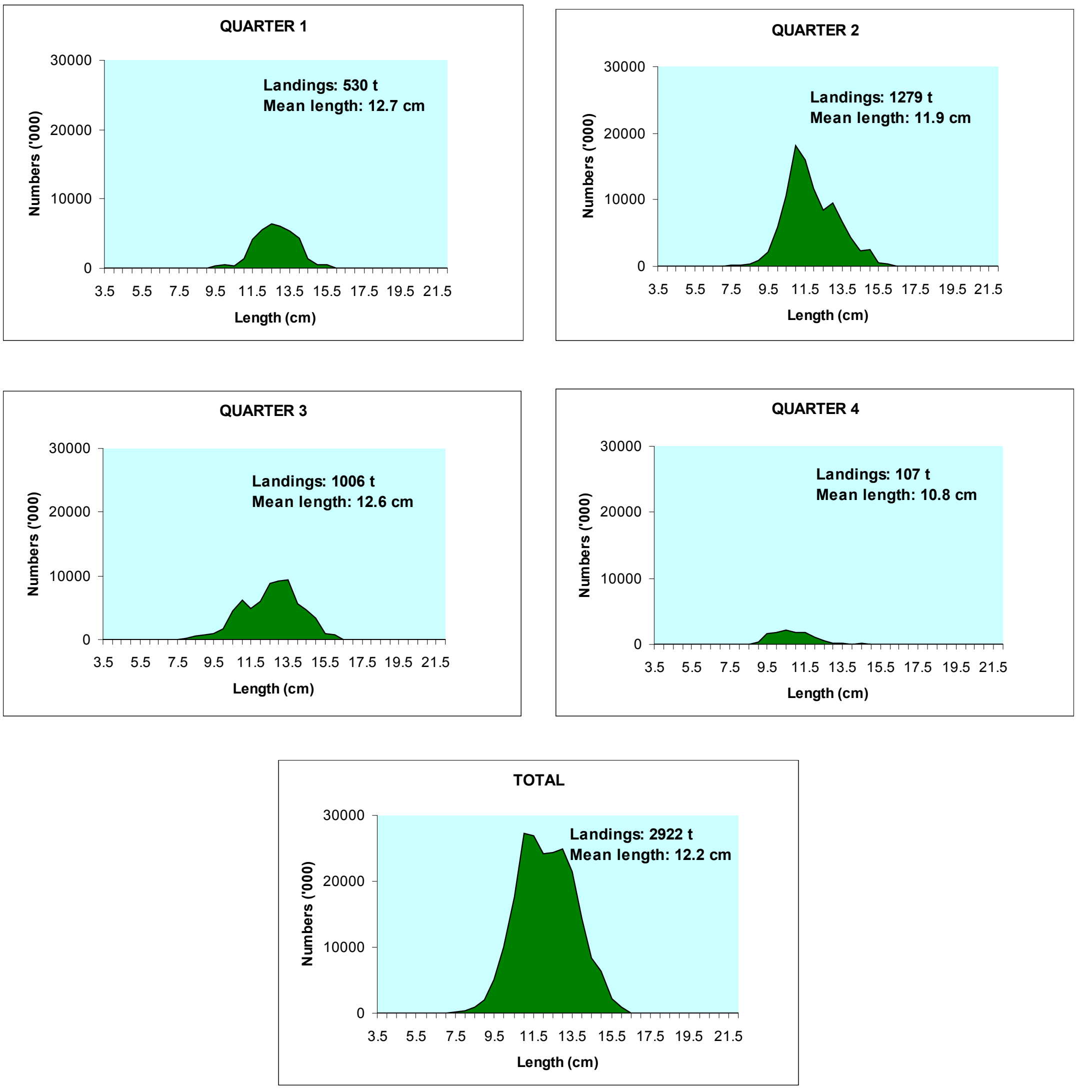
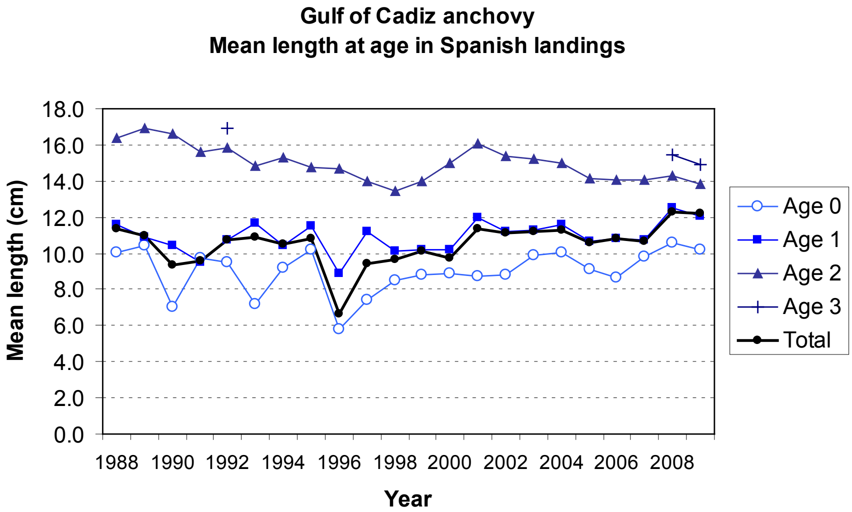


Figure 3.2.2.3.1. Anchovy in Division IXa. Subdivision IXa-South. Spanish fishery (all fleets). Quarterly and annual length distributions ('000) of Spanish landings of Gulf of Cadiz anchovy in 2009. Without data for the Spanish Subdivision IXa-North (Western Galicia) and for all the Portuguese Subdivisions.



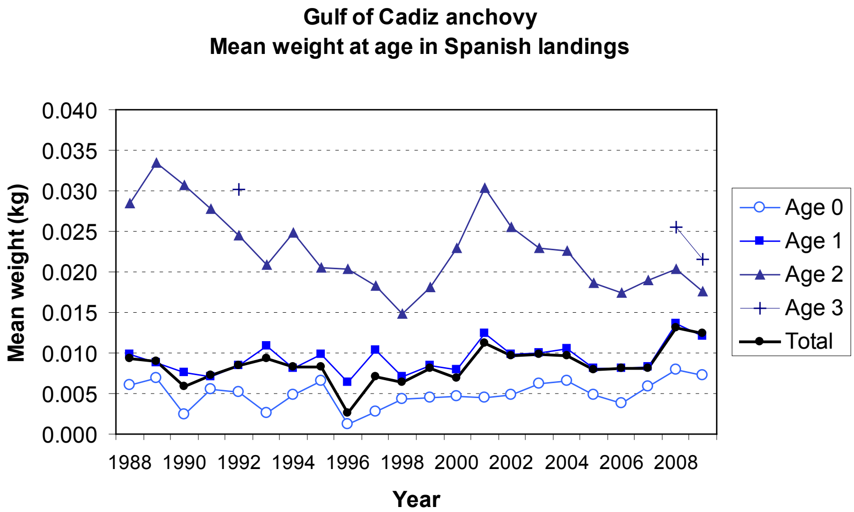


Figure 3.2.2.3.2. Anchovy in Division IXa. Subdivision IXa-South. Spanish fishery (all fleets). Annual mean length (TL, in cm) and weight (kg) at age in the Spanish landings of Gulf of Cadiz anchovy (1988-2009). Data for 1994 and second half in 1995 estimated from an iterated ALK by applying the Kimura and Chikuni's (1987) algorithm.

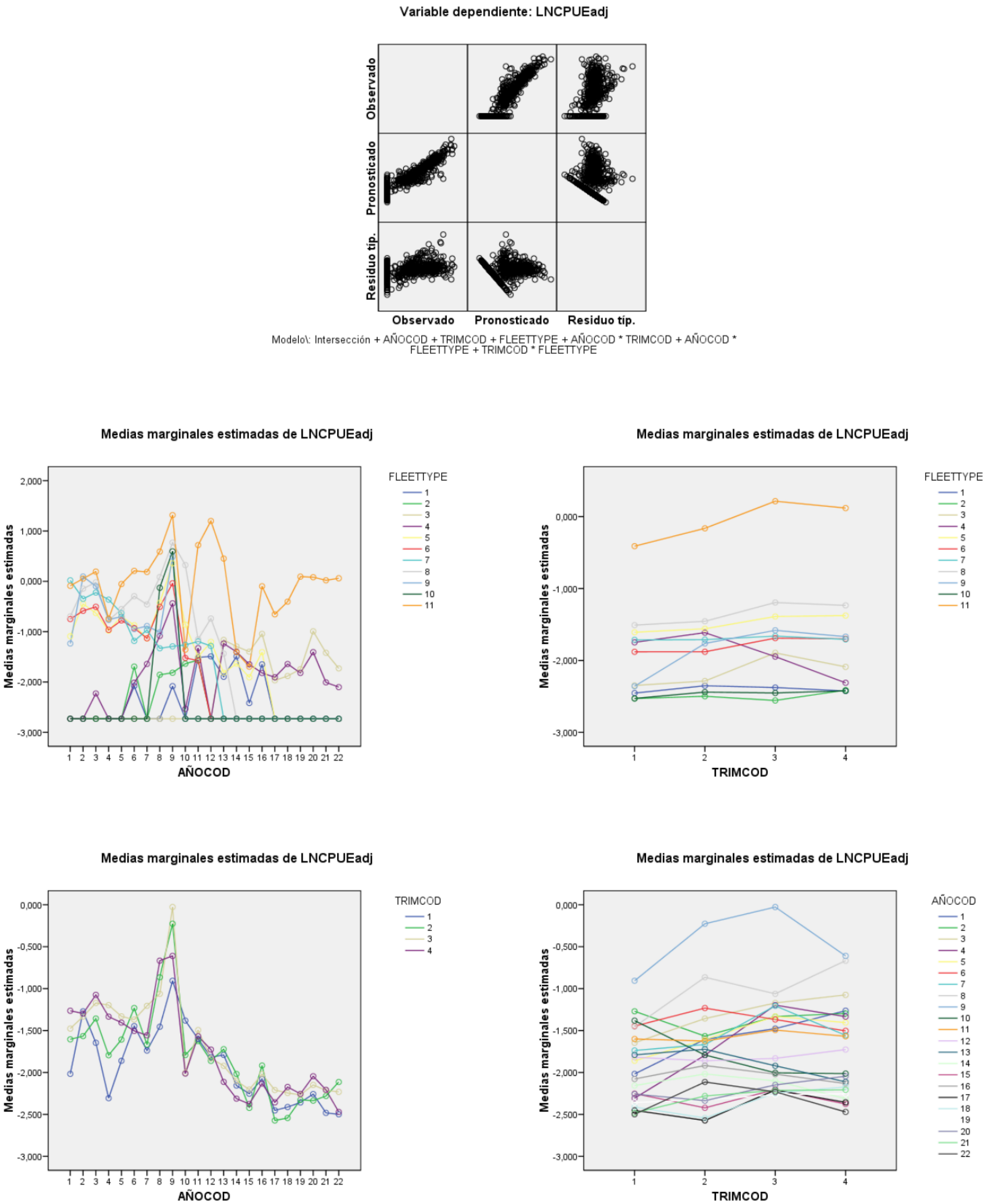


Figure 3.2.4.1. Anchovy in Division IXa. Subdivision IXa-South. Spanish purse-seine fishery. Residuals and Profile plots for the GLM used for the standardisation of anchovy CPUE data from the Spanish fleets operating in the Gulf of Cadiz.

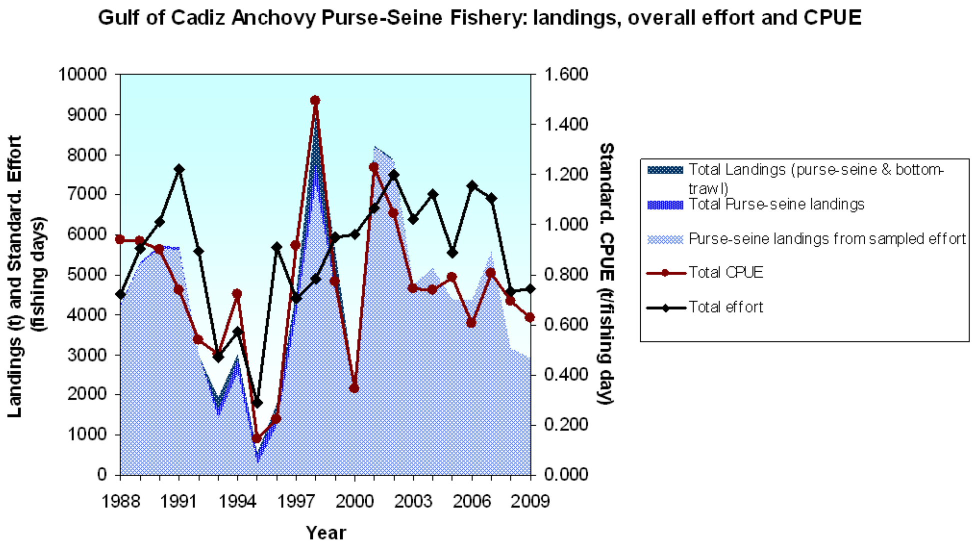
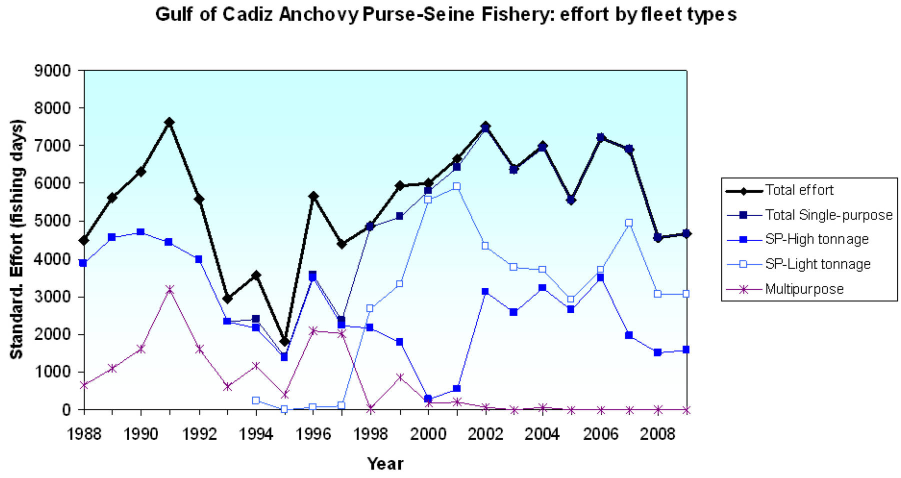


Figure 3.2.4.2. Anchovy in Division IXa. Subdivision IXa-South. Spanish purse-seine fishery. Trends in Gulf of Cadiz anchovy annual landings, and purse-seine fleets' standardised overall effort and CPUE. Landings are differentiated in total landings (purse-seine and bottom trawl fleets), purse-seine landings, and purse-seine landings corresponding to the sampled fishing effort.



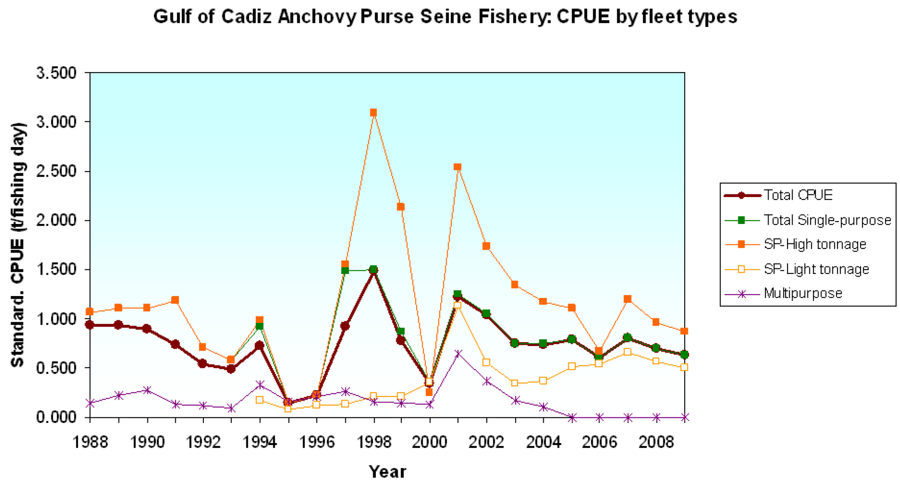


Figure 3.2.4.3. Anchovy in Division IXa. Subdivision IXa-South. Spanish purse-seine fishery. Trends in annual series of anchovy-specific standardized effort (upper panel) and standardized CPUE (bottom panel) by fleet type. Single-purpose fleet is also differentiated in heavy and light GRT vessels.

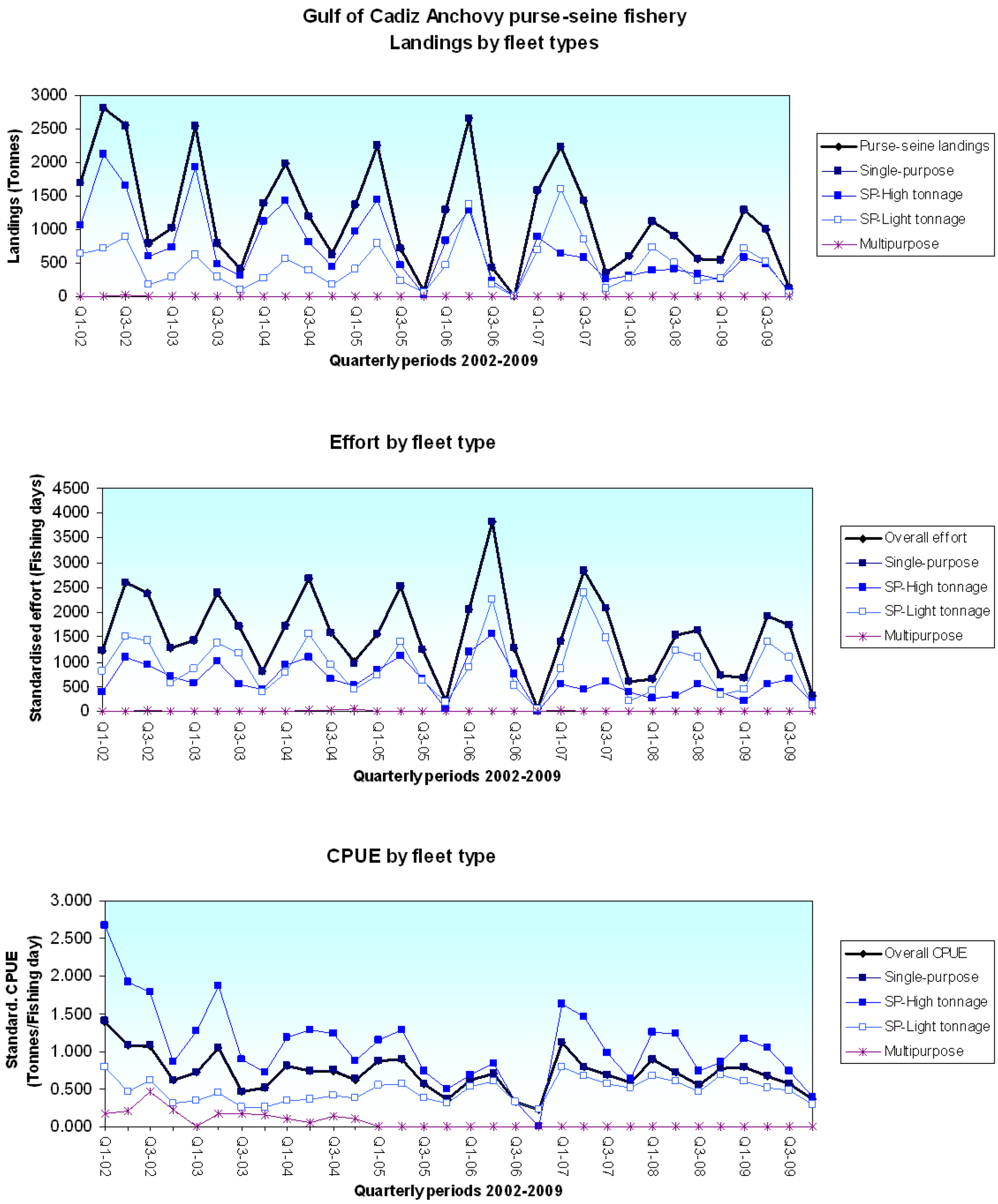


Figure 3.2.4.4. Anchovy in Division IXa. Subdivision IXa-South. Spanish purse-seine fishery. Trends in quarterly series of anchovy landings (upper panel), standardized effort (middle panel) and standardized CPUE (bottom panel) by fleet type during the period 2002-2009 are showed for visual inspection of the possible impact of fishing closures. Single- purpose fleet is also differentiated in heavy and light GRT vessels. The following purse-seine fishery closures are implemented since 2004:

2004, 2005: 15th November-31st December;

2006: 1st November-31st December;

2007-2008: 15th November 2007-15th February 2008;

2008-2009: 1st December 2008-28th February 2009;

2009-2010: 1st -31th December (but fishery, in practice, was still closed until 28th February 2010 for persistent bad sea conditions).

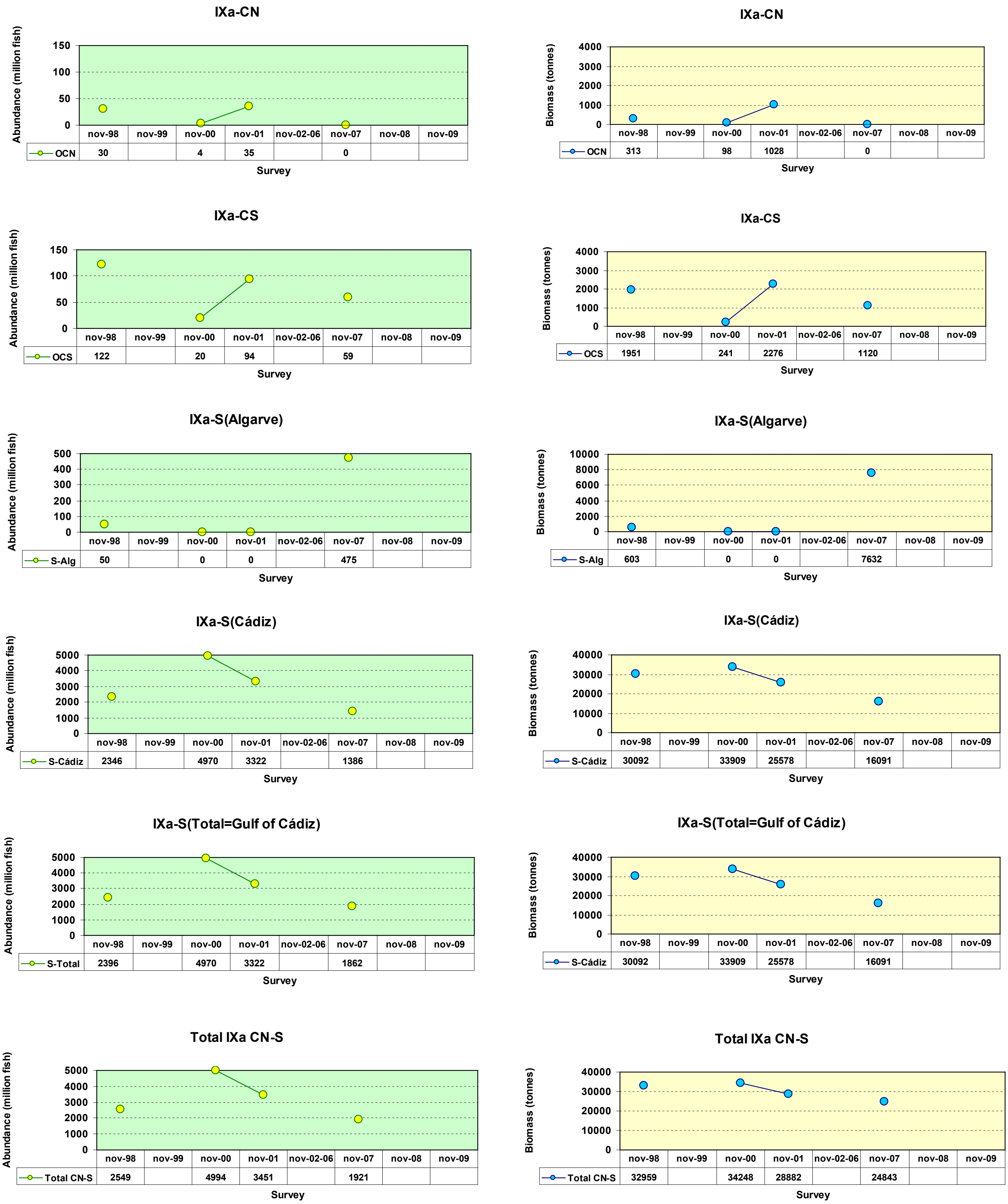


Figure 3.4.1.1. Anchovy in División IXa. Historical series of anchovy acoustic estimates (abundance in million fish, biomass in tonnes) from Autumn Portuguese surveys in the Division IXa. Note the different scale on the y-axis and how the missing data in the x-axis for the period 2002-2006 has been graphically solved.

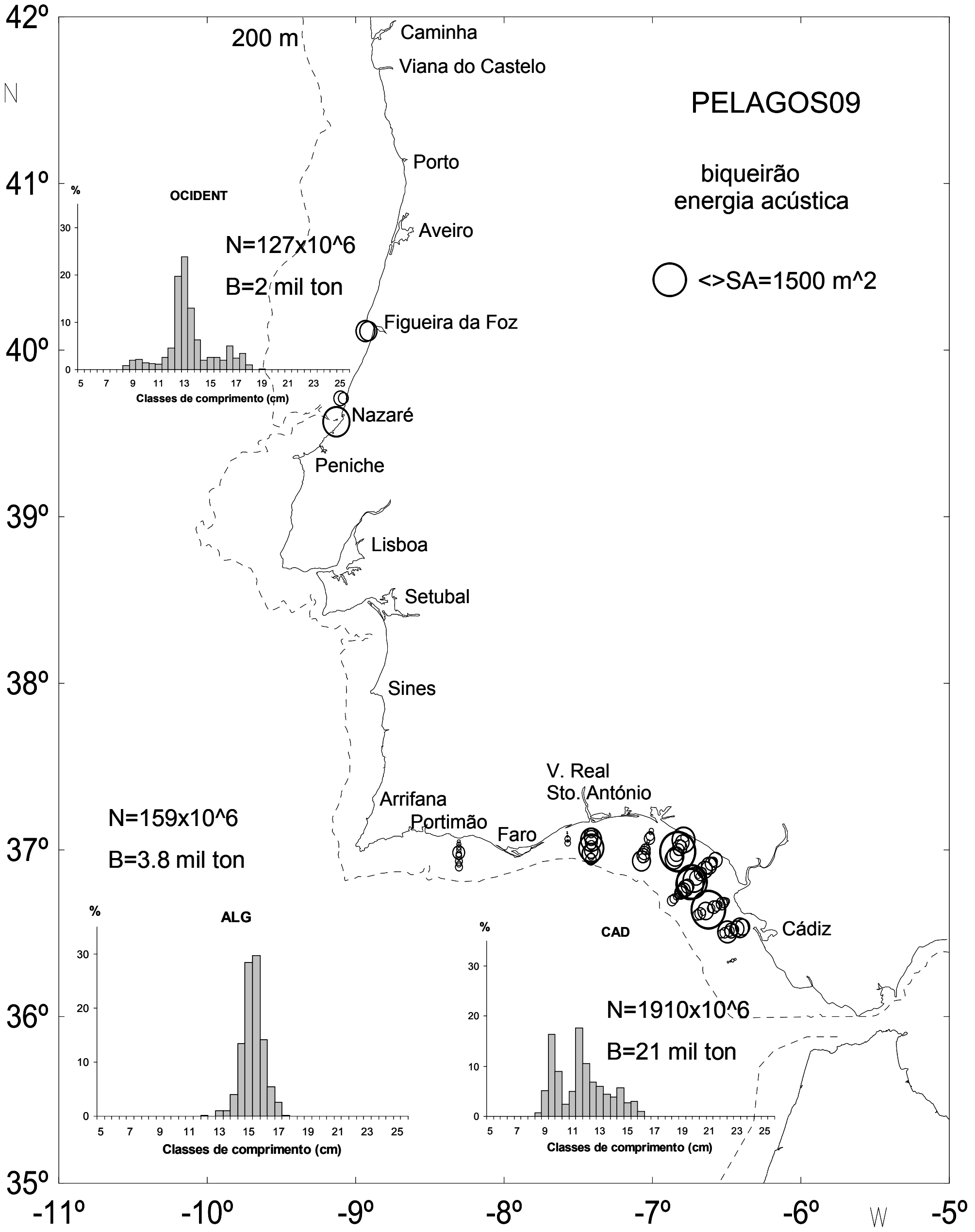


Figure 3.4.1.2. Anchovy in Division IXa. *PELAGO09* Spring Portuguese acoustic survey in Division IXa in 2009. Distribution of the *NASC* coefficients (m²/mn²) attributed to anchovy, acoustic estimates and size composition of the estimated populations by subareas.

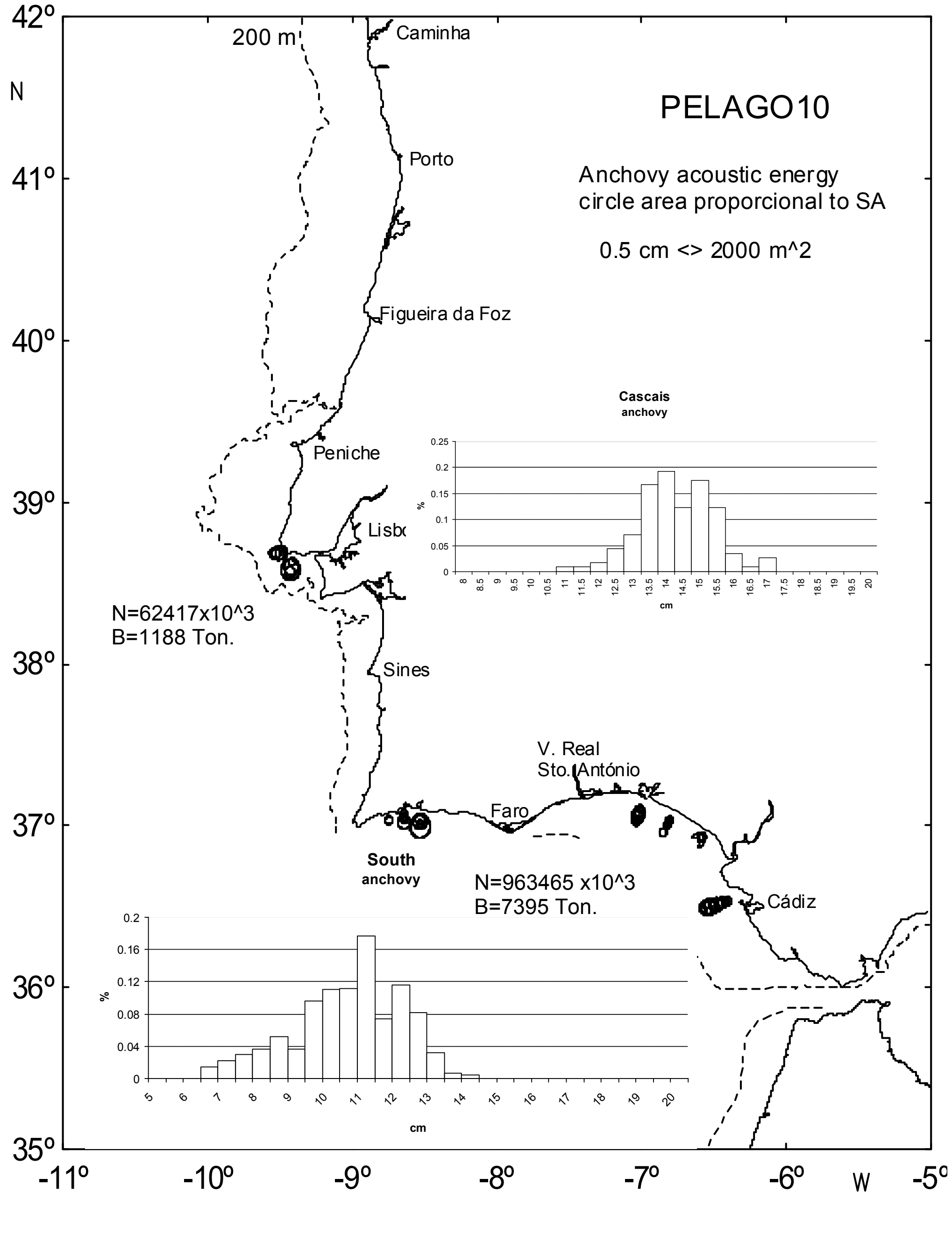
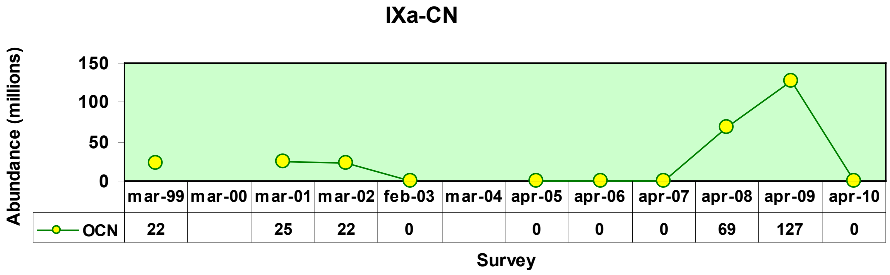


Figure 3.4.1.3. Anchovy in Division IXa. *PELAGO10* spring Portuguese acoustic survey in Division IXa in 2010. Distribution of the *NASC* coefficients (m^2/mn^2) attributed to anchovy, acoustic estimates and size composition of the estimated populations by subareas.



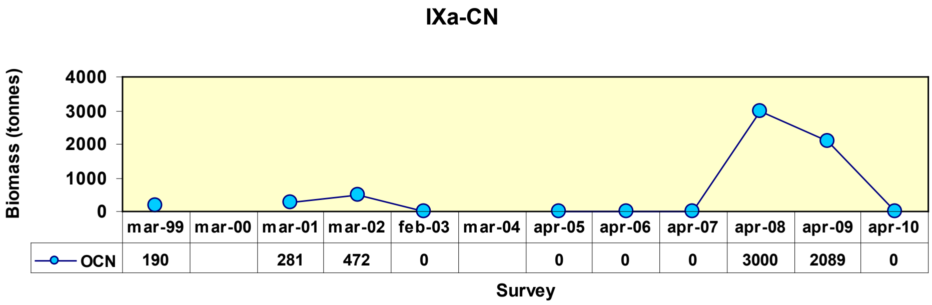
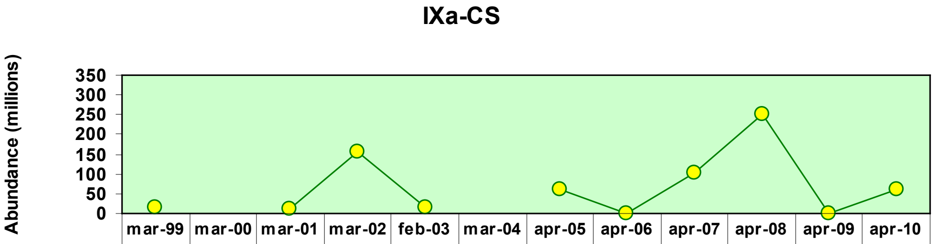
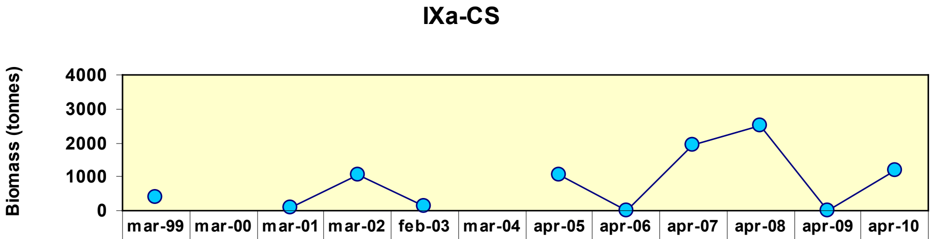


Figure 3.4.1.4. Anchovy in Division IXa. Historical series of anchovy acoustic estimates (upper pannel: abundance in million fish, lower pannel: biomass in tonnes) from Spring Portuguese surveys in the Division IXa (*SAR*-Spring/*PELAGO* survey series). Note the different scale on the y-axis. Although estimates from Subdivision IXa-South in 2010 were not separately provided for Algarve and Cádiz to this WG, the total estimated for the Subdivision was assigned (by assuming some overestimation) to the Cádiz area according to the observed acoustic energy distribution in the area. Subdivision IXa-CN.



	mar-99	mar-00	mar-01	mar-02	feb-03	mar-04	apr-05	apr-06	apr-07	apr-08	apr-09	apr-10
OCS	15		13	156	14		59	0	103	252	0	62

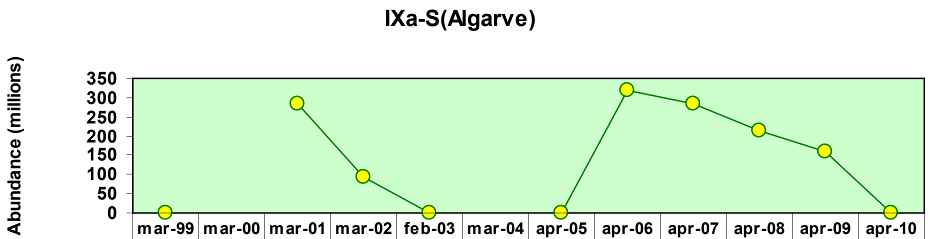
Survey



	mar-99	mar-00	mar-01	mar-02	feb-03	mar-04	apr-05	apr-06	apr-07	apr-08	apr-09	apr-10
OCS	406		87	1070	112		1062	0	1945	2505	0	1188

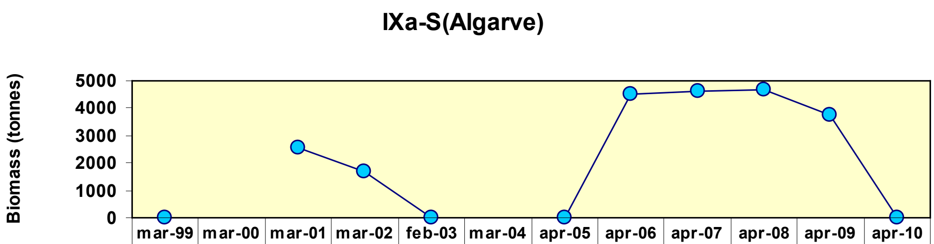
Survey

Figure 3.4.1.4. (cont'd). Subdivision IXa-CS.



	mar-99	mar-00	mar-01	mar-02	feb-03	mar-04	apr-05	apr-06	apr-07	apr-08	apr-09	apr-10
S-Alg	0		285	92	0		0	319	284	213	159	0

Survey



	mar-99	mar-00	mar-01	mar-02	feb-03	mar-04	apr-05	apr-06	apr-07	apr-08	apr-09	apr-10
S-Alg	0		2561	1706	0		0	4490	4607	4661	3759	0

Survey

Figure 3.4.1.4. (cont'd). Subdivision IXa-S (Algarve).

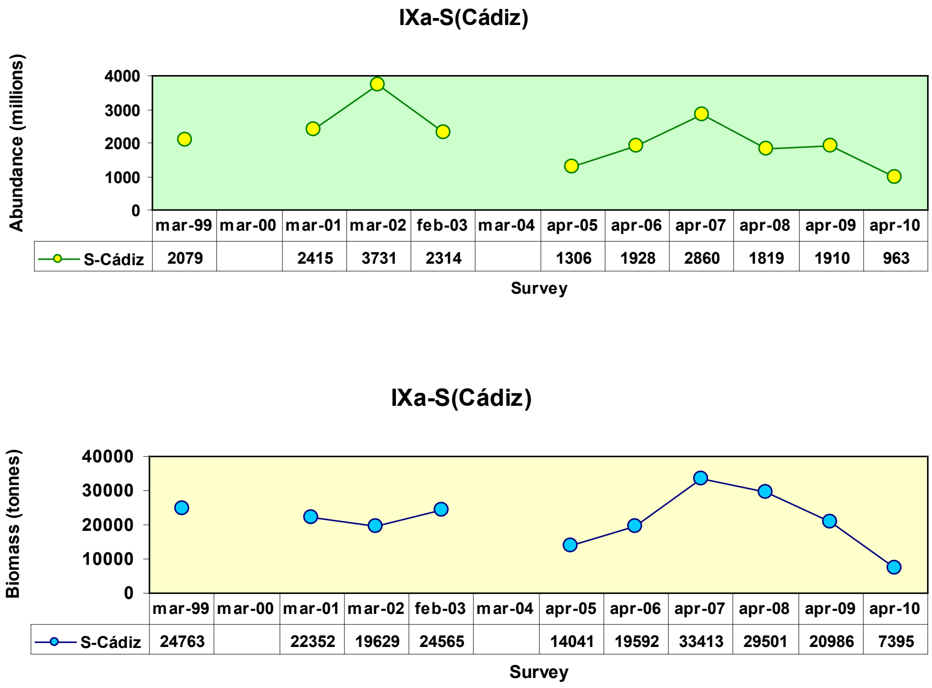


Figure 3.4.1.4. (cont'd). Subdivision IXa-S (Cádiz).

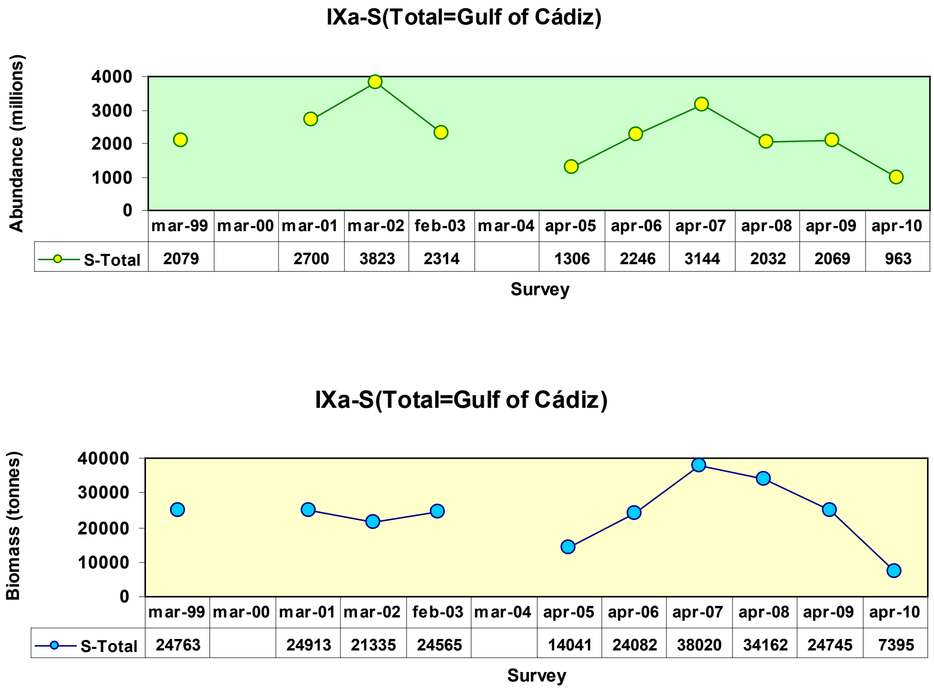
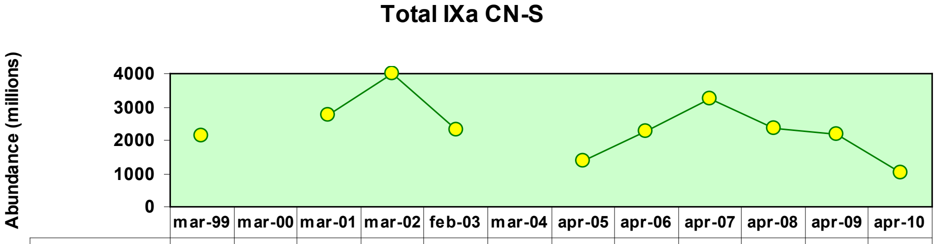
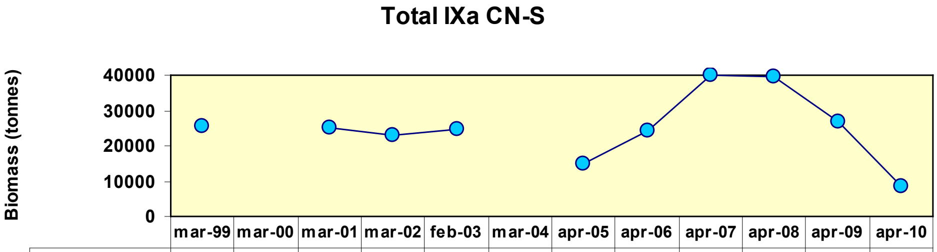


Figure 3.4.1.4. (cont'd). Subdivision IXa-S (Algarve + Cádiz).



	mar-99	mar-00	mar-01	mar-02	feb-03	mar-04	apr-05	apr-06	apr-07	apr-08	apr-09	apr-10
Total CN-S	2116		2738	4001	2328		1364	2246	3247	2353	2196	1026



	mar-99	mar-00	mar-01	mar-02	feb-03	mar-04	apr-05	apr-06	apr-07	apr-08	apr-09	apr-10
Total CN-S	25359		25281	22877	24677		15103	24082	39965	39667	26834	8583

Figure 3.4.1.4. (cont'd). Subdivision IXa-CN to S (total surveyed area).

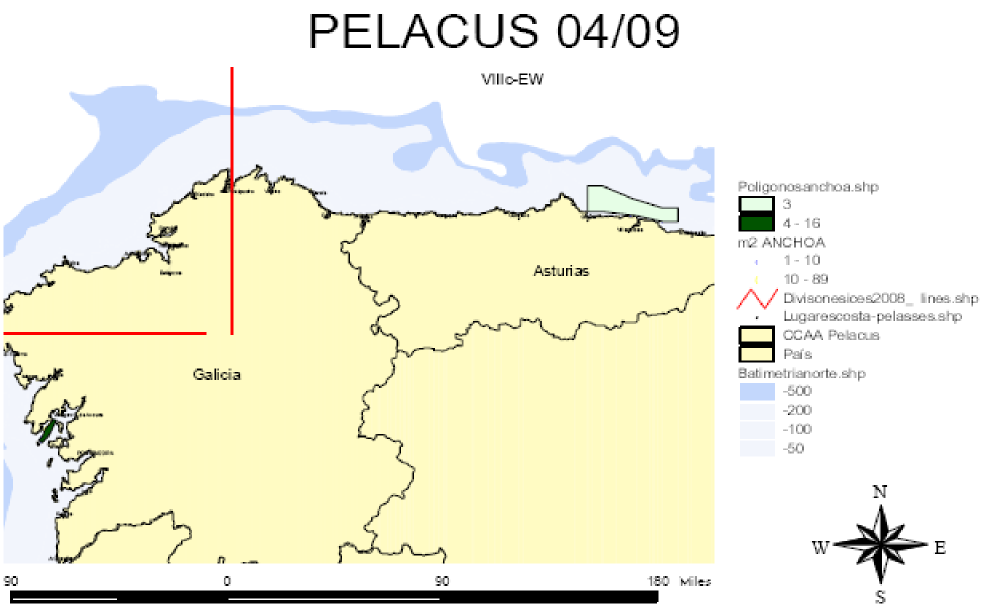
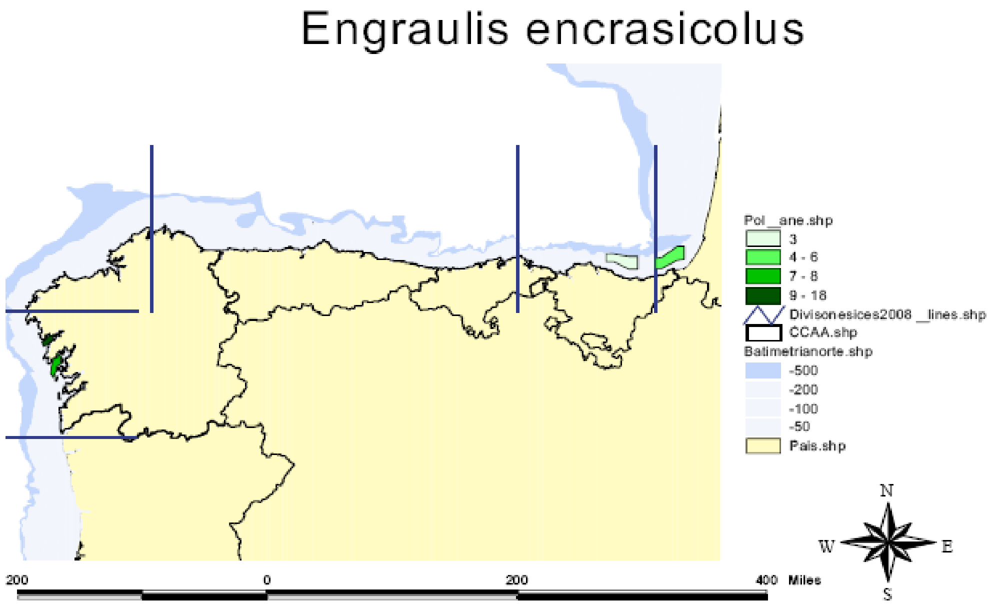


Figure 3.4.1.5. Anchovy in Division IXa. Subdivision IXa North. ***PELACUS 0409*** **Spring Spanish acoustic survey in Subdivision IXa North and Sub-area VIII c in 2009. Distribution of the** ***NASC*** **coefficients (m²/mn²) attributed to anchovy. Polygons (*i.e.*, coherent post-strata) encompass the observed echoes and homogenous size composition, and polygon colour indicates the mean value of** ***NASC*** **coefficients inside each polygon.**



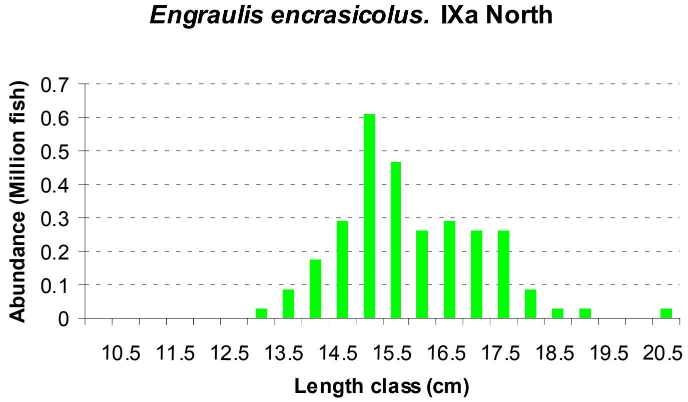


Figure 3.4.1.6. Anchovy in Division IXa. Subdivision IXa North. *PELACUS 0410* Spring Spanish acoustic survey in Subdivision IXa North and Sub-area VIII c in 2010. Upper pannel: distribution of the *NASC* coefficients (m^2/mn^2) attributed to anchovy. Polygons (*i.e.*, coherent post-strata) encompass the observed echoes and homogenous size composition, and polygon colour indicates the mean value of *NASC* coefficients inside each polygon. Lower pannel: size composition of the estimated anchovy population in the Subdivision IXa North during the survey.

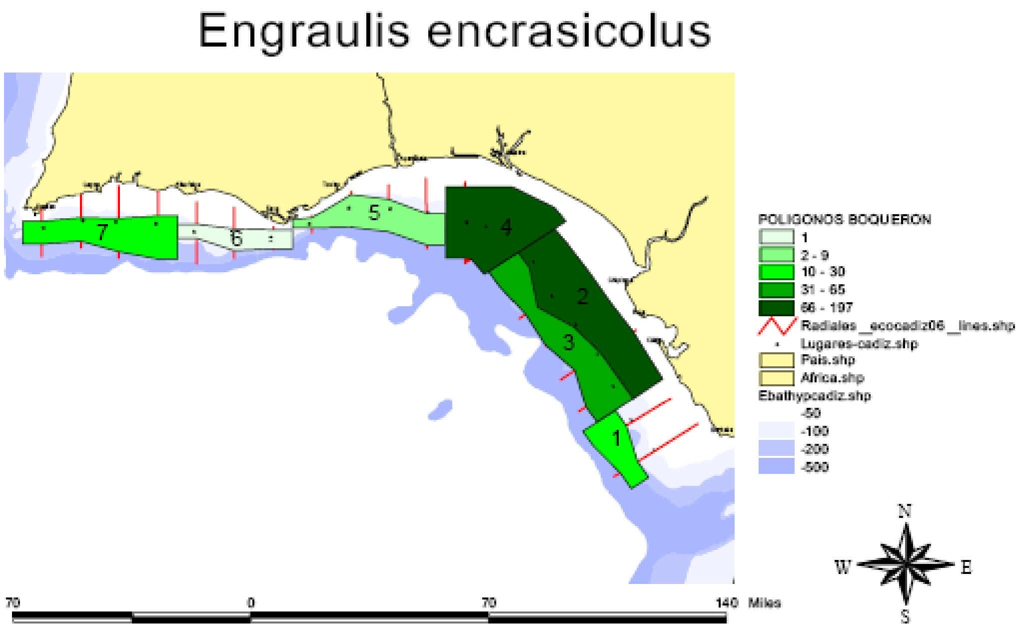


Figure 3.4.1.7. Anchovy in Division IXa. Subdivision IXa South. *ECOCÁDIZ 0609* Summer Spanish acoustic survey in Subdivision IXa South in 2009. Distribution of the *NASC* coefficients (m^2/mn^2) attributed to anchovy. Polygons (*i.e.*, coherent post-strata) encompass the observed echoes and homogenous size composition, and polygon colour indicates the mean value of *NASC* coefficients inside each polygon.

***ECOCÁDIZ 0609*: Anchovy (*E. encrasicolus*)**

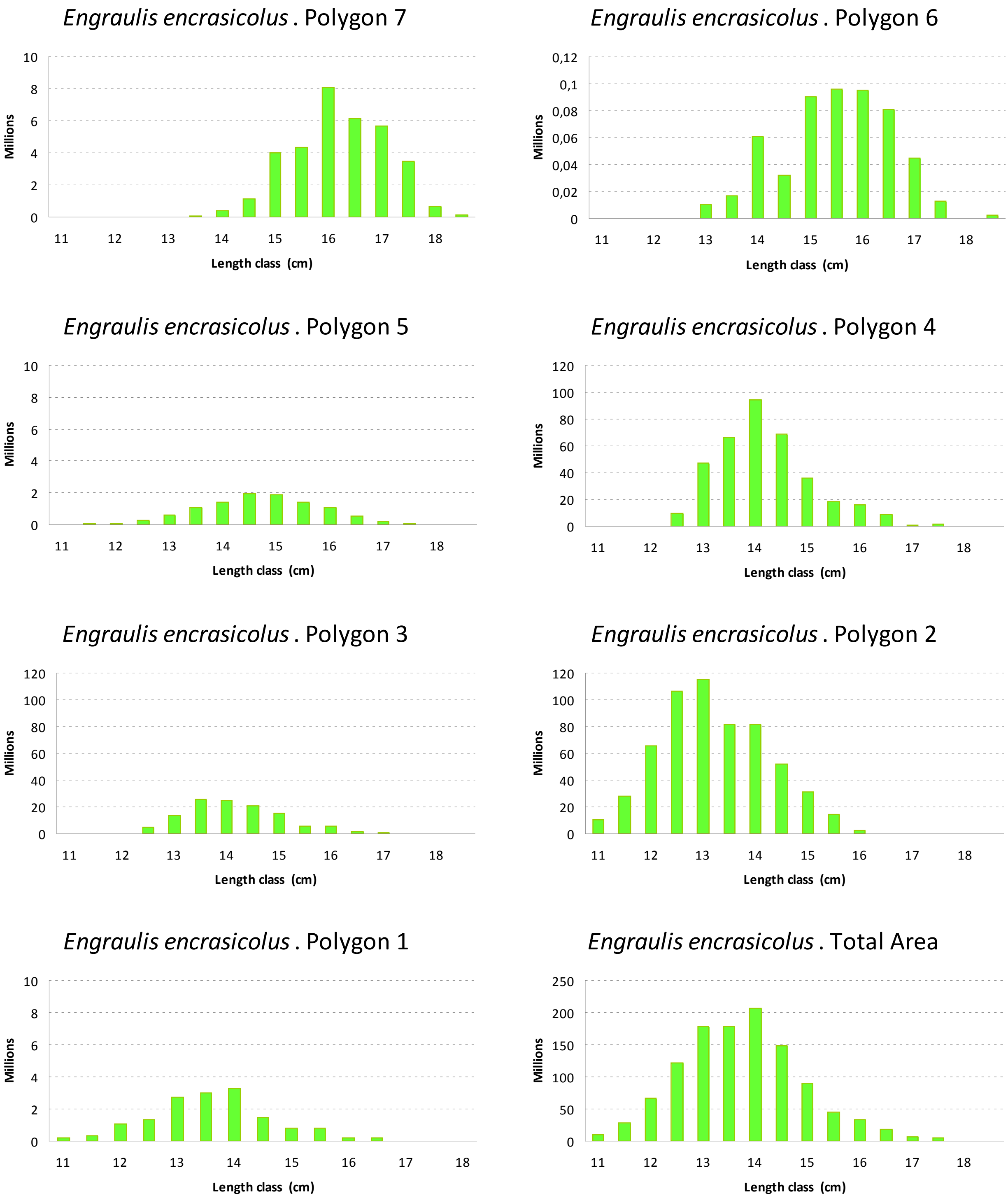


Figure 3.4.1.8. Anchovy in Division IXa. Subdivision IXa South. *ECOCÁDIZ 0609* Summer Spanish acoustic survey in Subdivision IXa South in 2009. Estimated anchovy abundances (in million fish) by length class (cm) and coherent post-stratum (ordered from west to east, numeration as in Figure 3.4.1.7) and total area. Note the different scales in the y-axis.

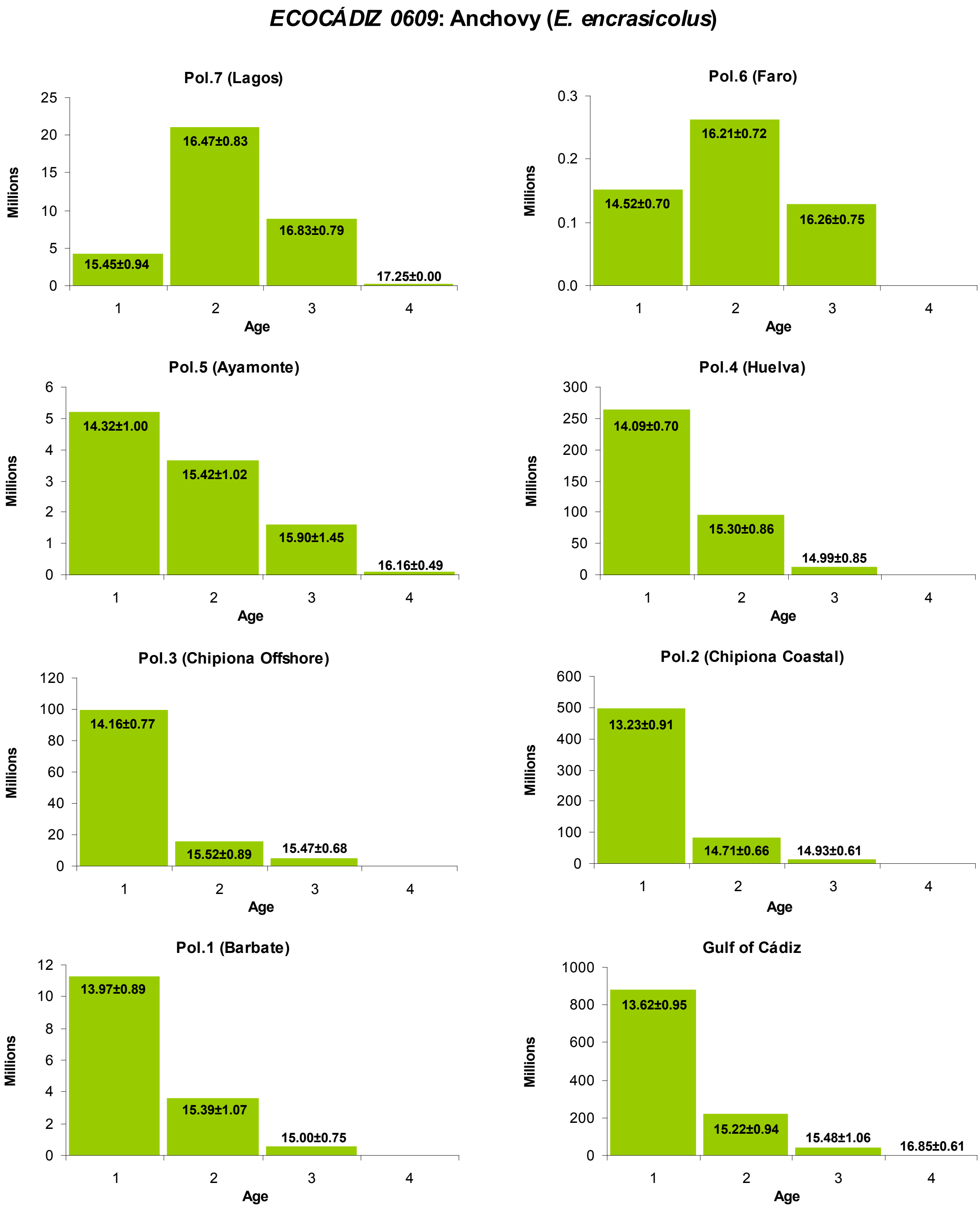


Figure 3.4.1.9. Anchovy in Division IXa. Subdivision IXa South. *ECOCÁDIZ 0609* Summer Spanish acoustic survey in Subdivision IXa South in 2009. Estimated anchovy abundances (million fish) and mean sizes (cm) by age class and coherent post-stratum (ordered from west to east, numeration as in Figure 3.4.1.7) and total area. Note the different scales in the *y* axis.

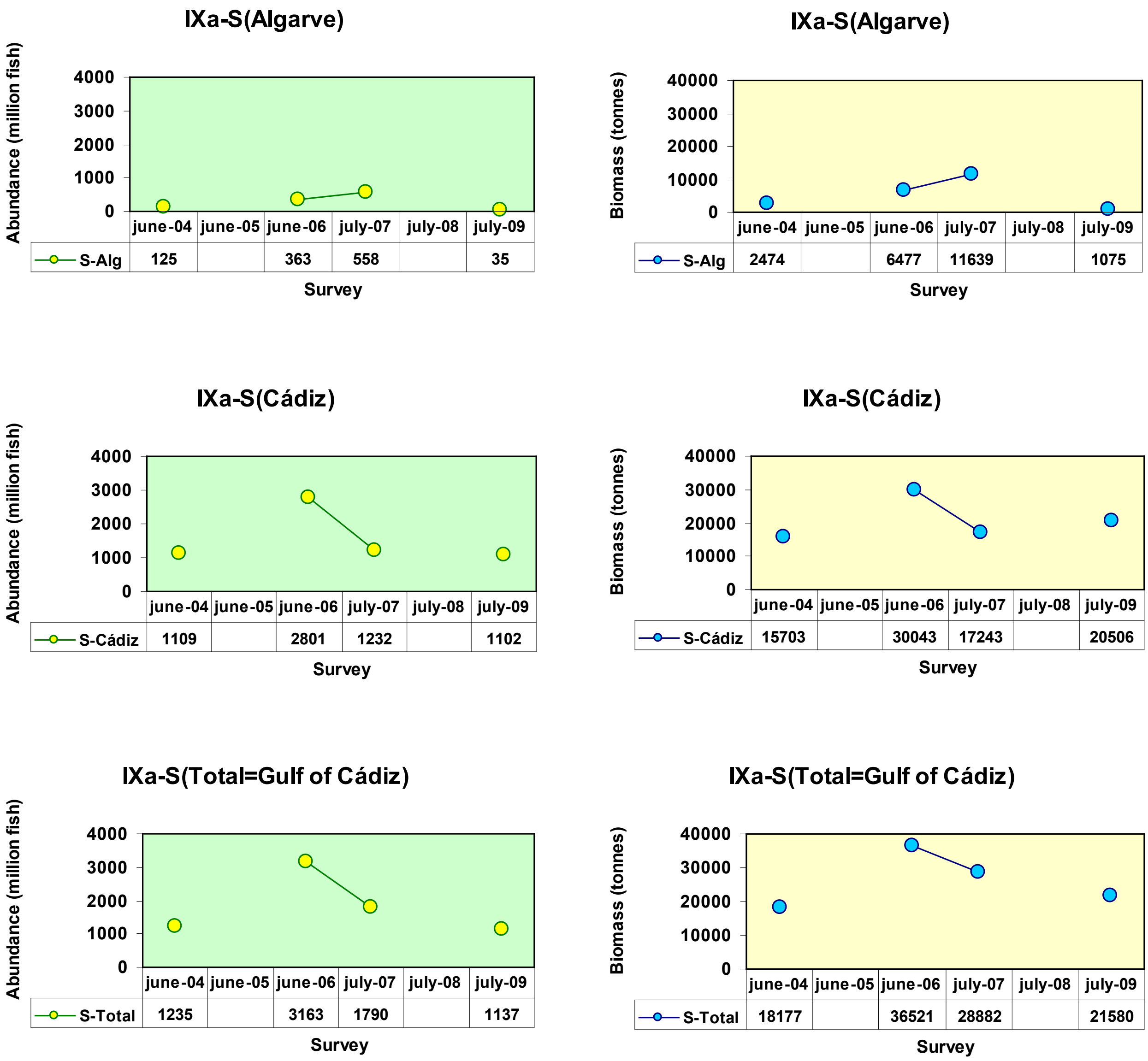


Figure 3.4.1.10. Anchovy in Division IXa. Subdivision IXa South. Historical series of anchovy acoustic estimates (abundance in million fish, biomass in tonnes) from Summer Spanish surveys in the Subarea IXa-South (*ECOCÁDIZ* survey series).

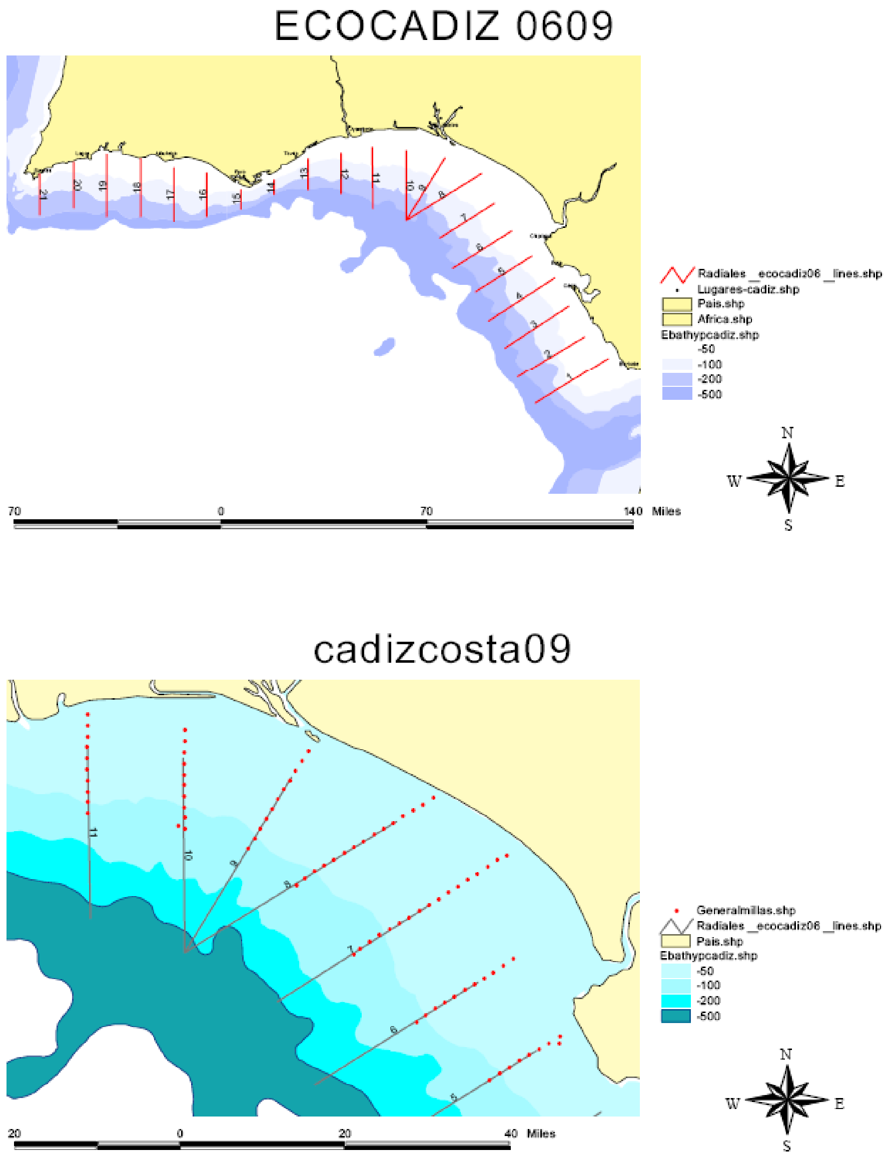


Figure 3.4.1.11. Anchovy in Division IXa. Subdivision IXa South. *ECOCÁDIZ-COSTA 0709* Summer Spanish acoustic coastal survey in Subdivision IXa South in 2009. Upper pannel: sampling grid for the conventional surveys of the *ECOCÁDIZ* series. Lower pannel: survey transects (red dotted lines) for the coastal survey superimposed for comparison to the sampling grid of the conventional survey (grey numbered lines).

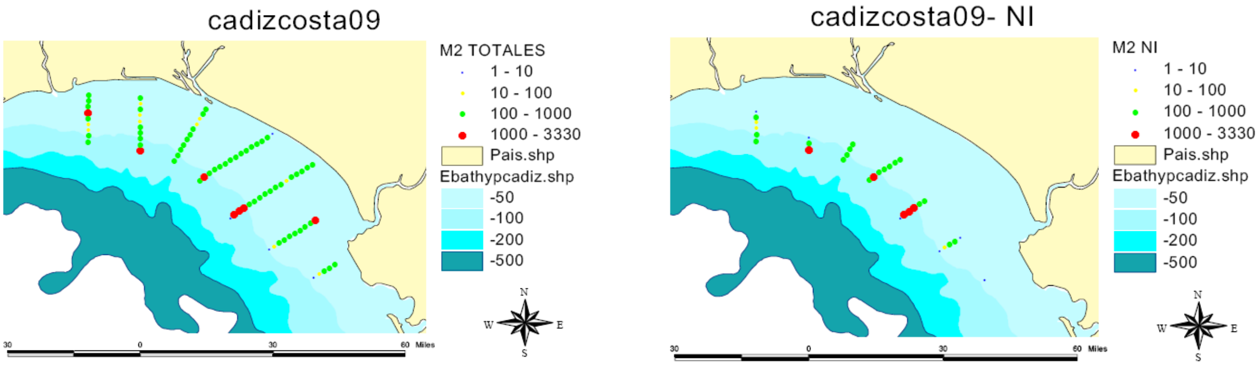


Figure 3.4.1.12. Anchovy in Division IXa. Subdivision IXa South. *ECOCÁDIZ-COSTA 0709* Summer Spanish acoustic coastal survey in Subdivision IXa South in 2009. Left: distribution of the total backscattering energy attributed to the pelagic fish species assemblage. Right: distribution of the Not Identified, *NI*, backscattering energy (see text for explanation).

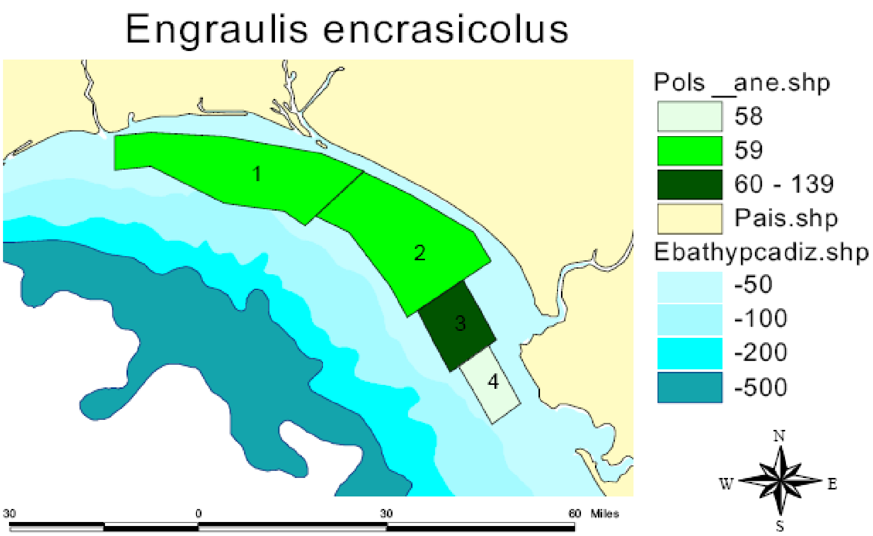


Figure 3.4.1.13. Anchovy in Division IXa. Subdivision IXa South. *ECOCÁDIZ-COSTA 0709* Summer Spanish acoustic coastal survey in Subdivision IXa South in 2009. Distribution of the *NASC* coefficients (m^2/mn^2) attributed to anchovy. Polygons (*i.e.*, coherent post-strata) encompass the observed echoes and homogenous size composition, and polygon colour indicates the mean value of *NASC* coefficients inside each polygon. Compare this figure with Figure 3.4.1.7.

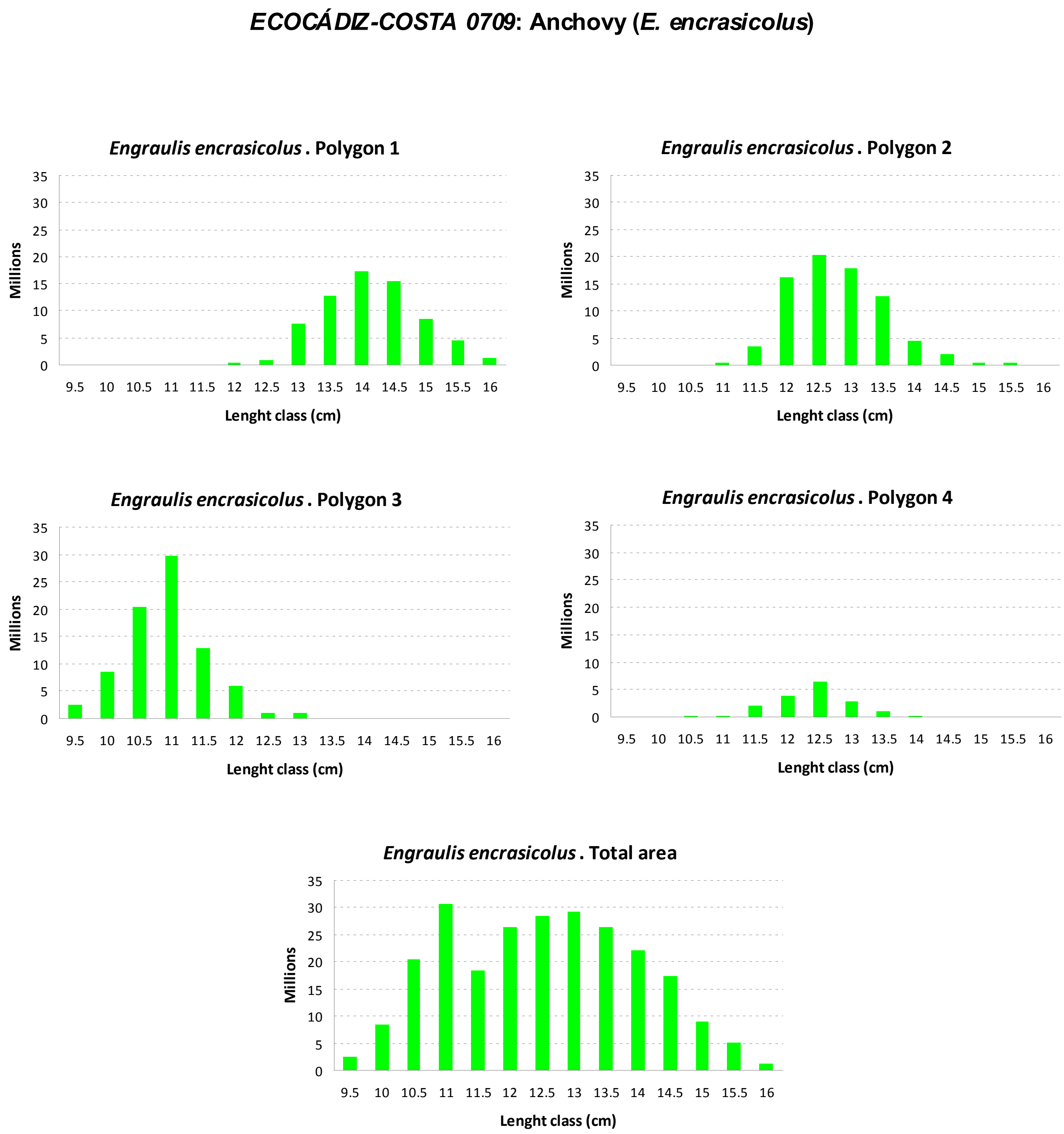


Figure 3.4.1.14. Anchovy in Division IXa. Subdivision IXa South. *ECOCÁDIZ-COSTA 0709* Summer Spanish acoustic coastal survey in Subdivision IXa South in 2009. Estimated anchovy abundances (in million fish) by length class (cm) and coherent post-stratum (ordered from west to east, numeration as in Figure 3.4.1.12) and total area.

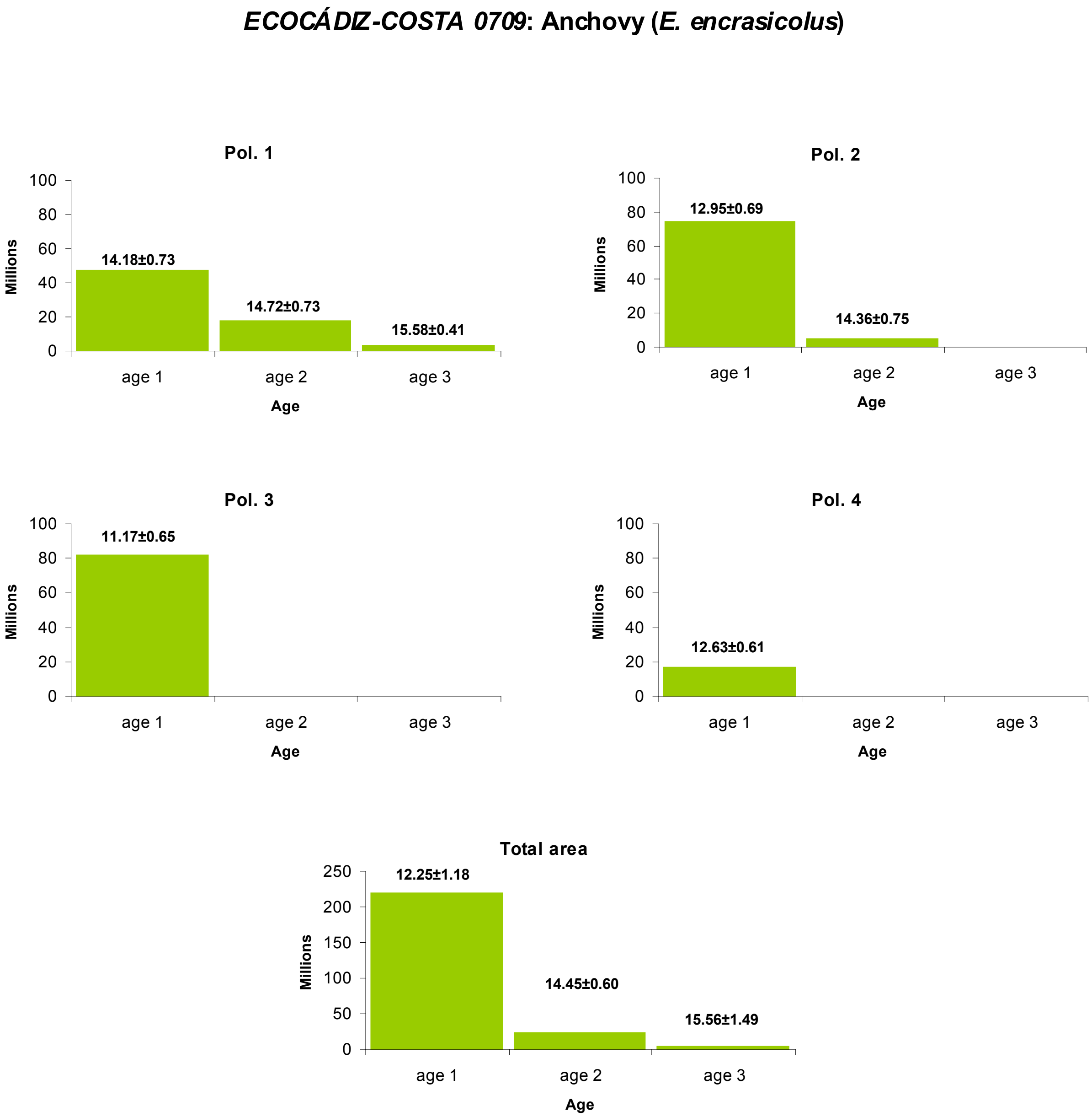


Figure 3.4.1.15. Anchovy in Division IXa. Subdivision IXa South. *ECOCÁDIZ-COSTA 0709* Summer Spanish acoustic coastal survey in Subdivision IXa South in 2009. Estimated anchovy abundances (million fish) and mean sizes (cm) by age class and coherent post-stratum (ordered from west to east, numeration as in Figure 3.4.1.12) and total area. Note the different scales in the *y* axis.

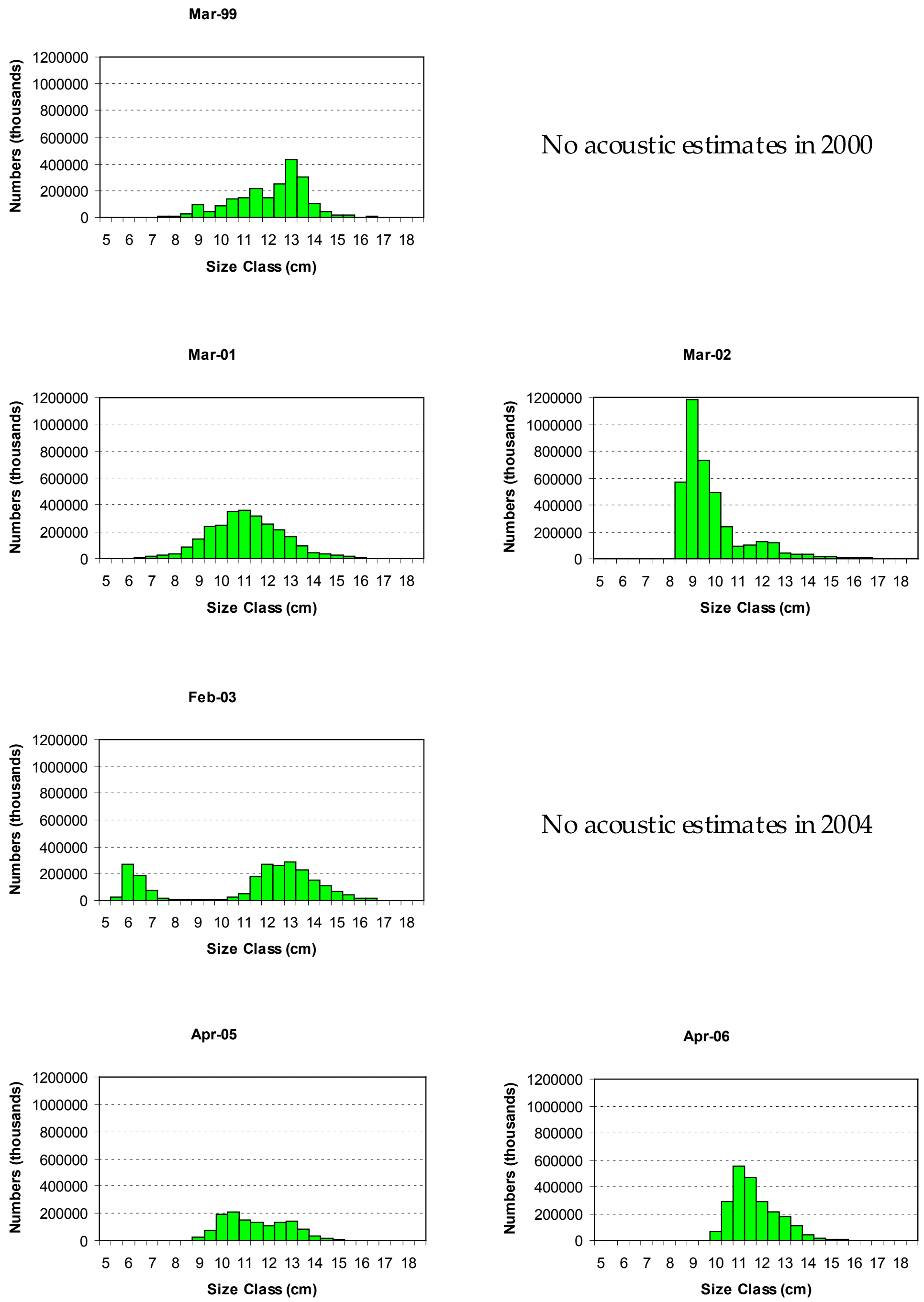


Figure 3.4.1.16. Anchovy in Division IXa. Subdivision IXa-South. Length composition of the estimated population from the Algarve + Gulf of Cádiz areas by the Portuguese Spring acoustic surveys (1999-2010).

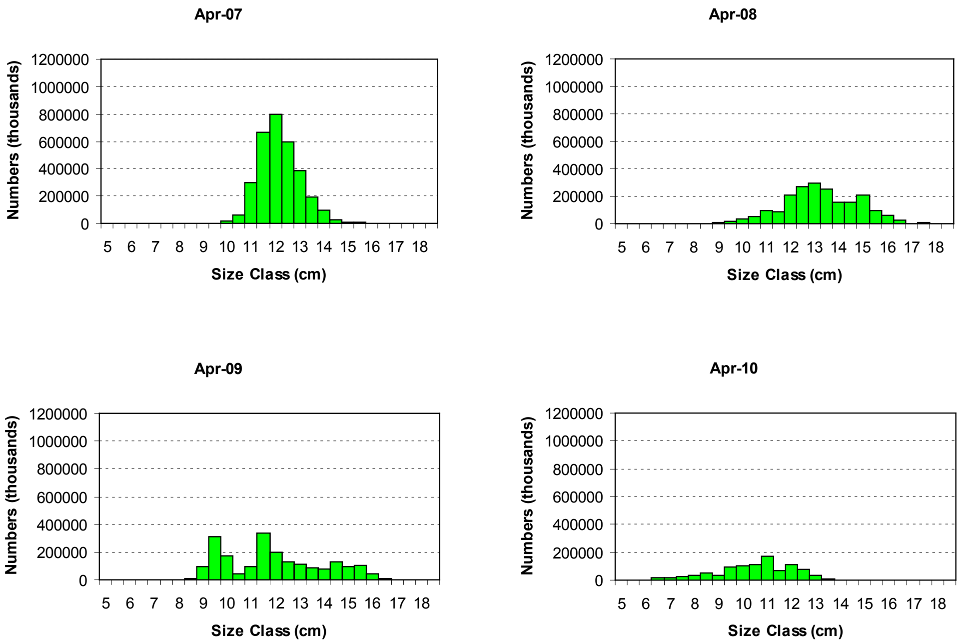


Figure 3.4.1.16 (cont'd).

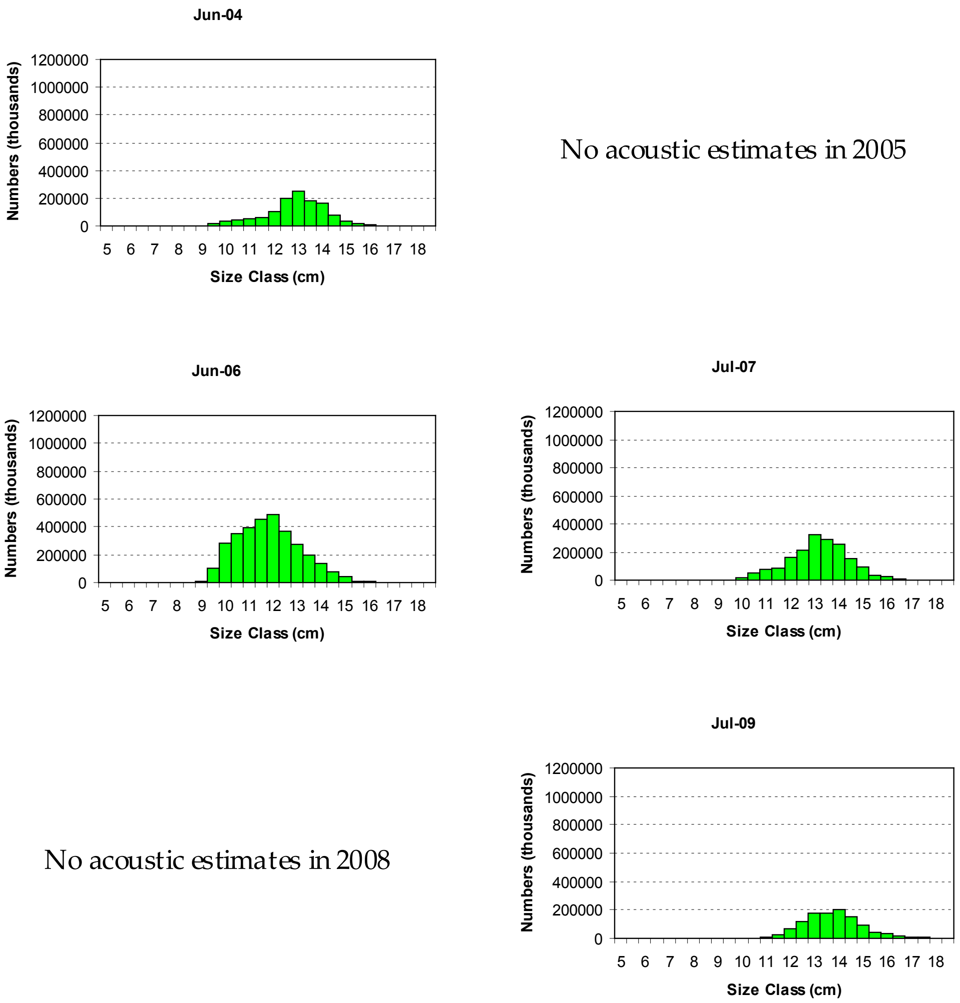


Figure 3.4.1.17. Anchovy in Division IXa. Subdivision IXa-South. Length composition of the estimated population from the Algarve + Gulf of Cádiz areas by the Spanish Summer acoustic surveys (2004-2009, but with gaps; 2010 survey not yet carried out by the time of the WG meeting). Note the same scale on y-axis than in Figure 3.4.1.16 for comparison.

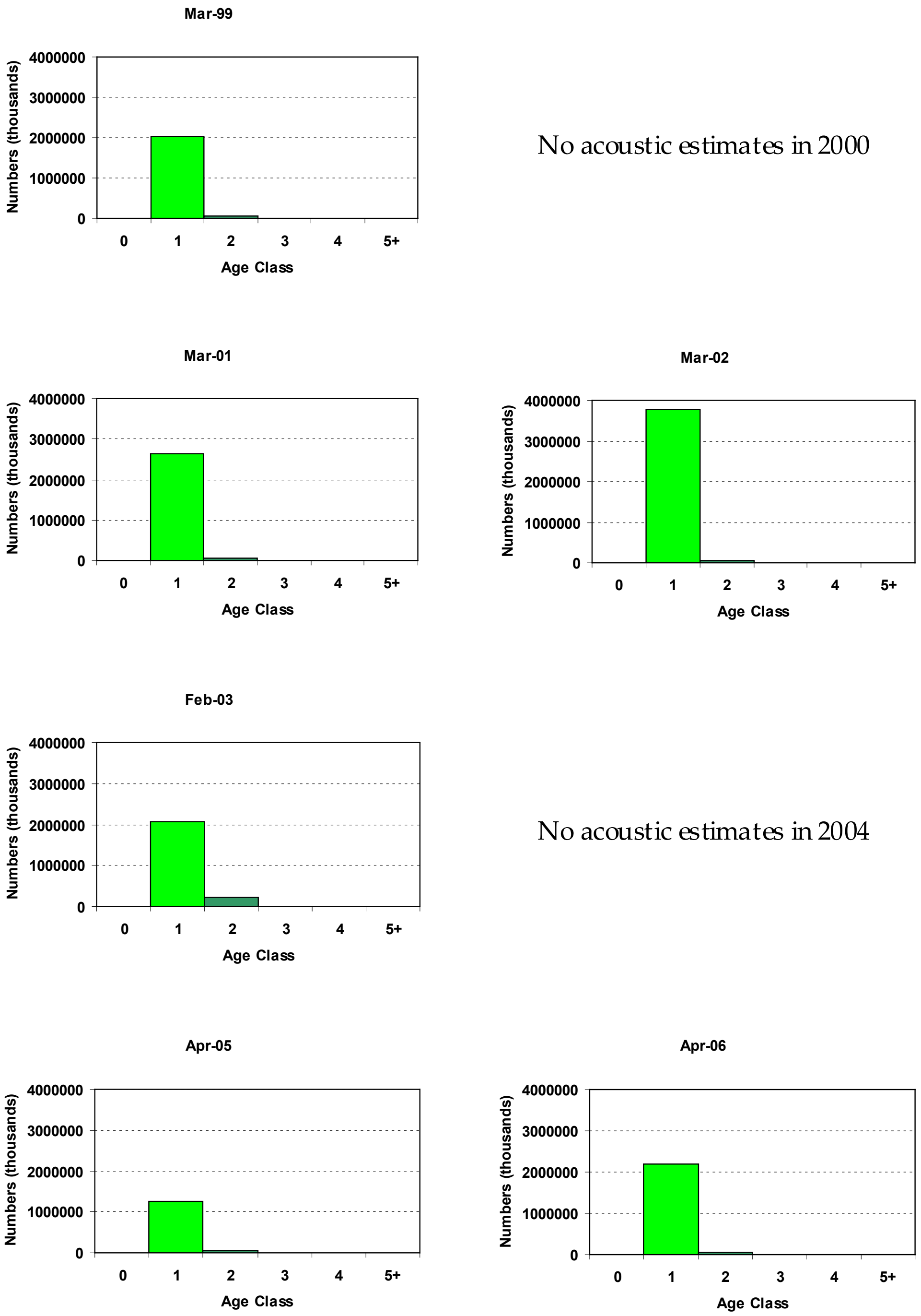
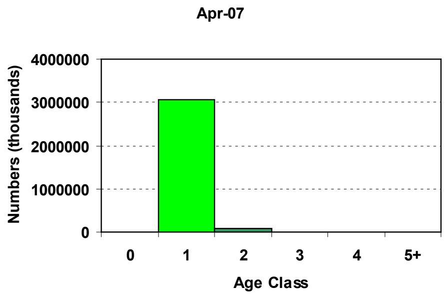
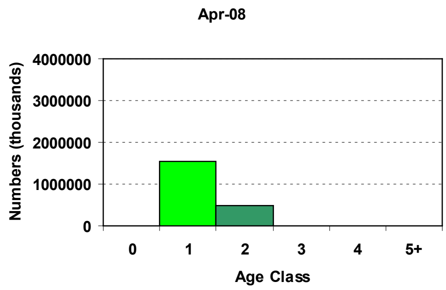
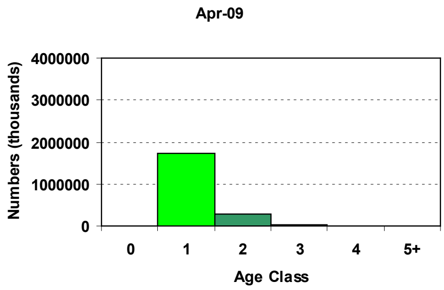


Figure 3.4.1.18. Anchovy in Division IXa. Subdivision IXa-South. Age structure of the estimated population from the Algarve + Gulf of Cádiz areas by the Portuguese Spring acoustic surveys (1999-2010). Population age structure was estimated from the application of Spanish commercial age-length keys in the second semester in the survey's year to the estimated population numbers by length class from the corresponding survey. The 2010 estimates were not computed because of the needed age-length key was not available.







Population numbers at age not yet available for the 2010 survey

Figure 3.4.1.18 (cont'd).

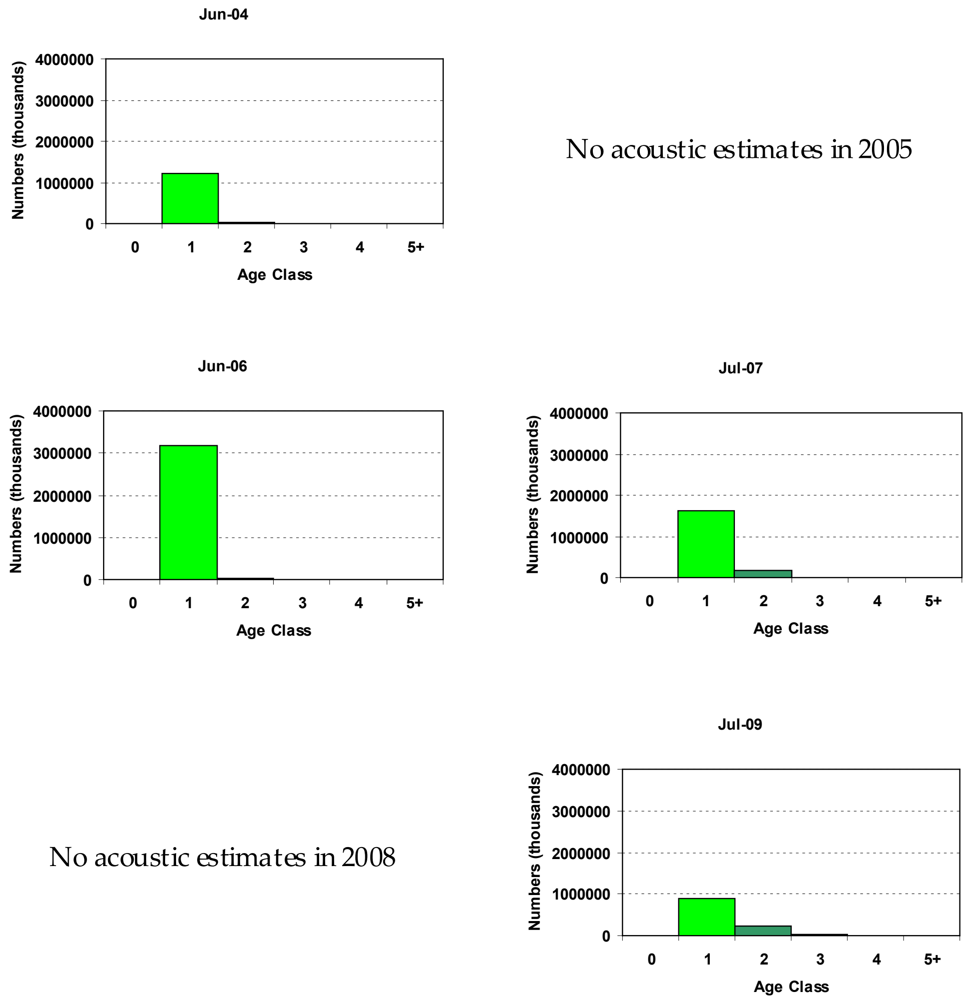
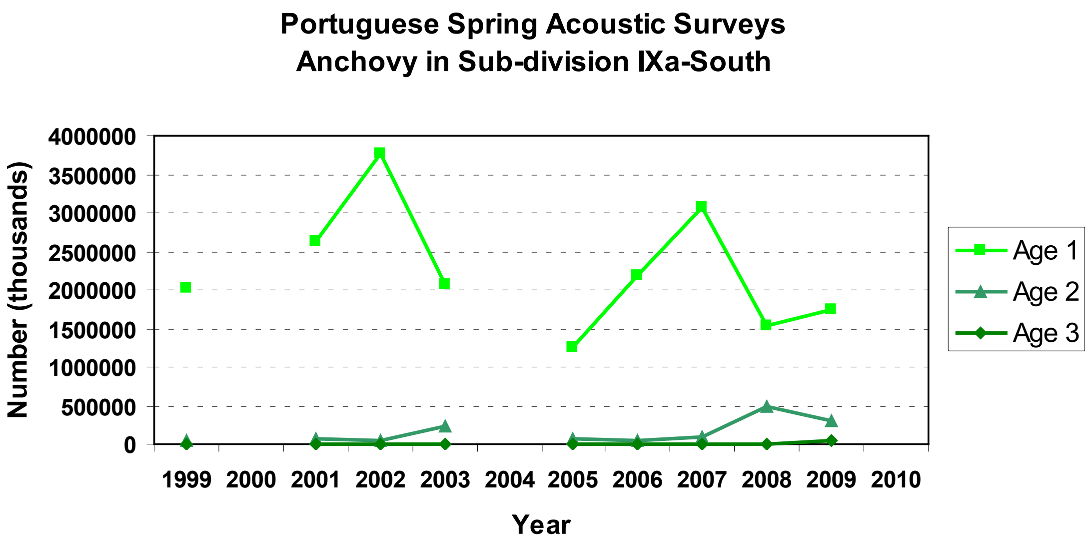


Figure 3.4.1.19. Anchovy in Division IXa. Subdivision IXa-South. Age structure of the estimated population from the Algarve + Gulf of Cádiz areas by the Spanish Summer acoustic surveys (2004-2009, but with gaps; 2010 survey not yet carried out by the time of the WG meeting). Note the same scale on the y-axis than in Figure 3.4.1.18 for comparison.



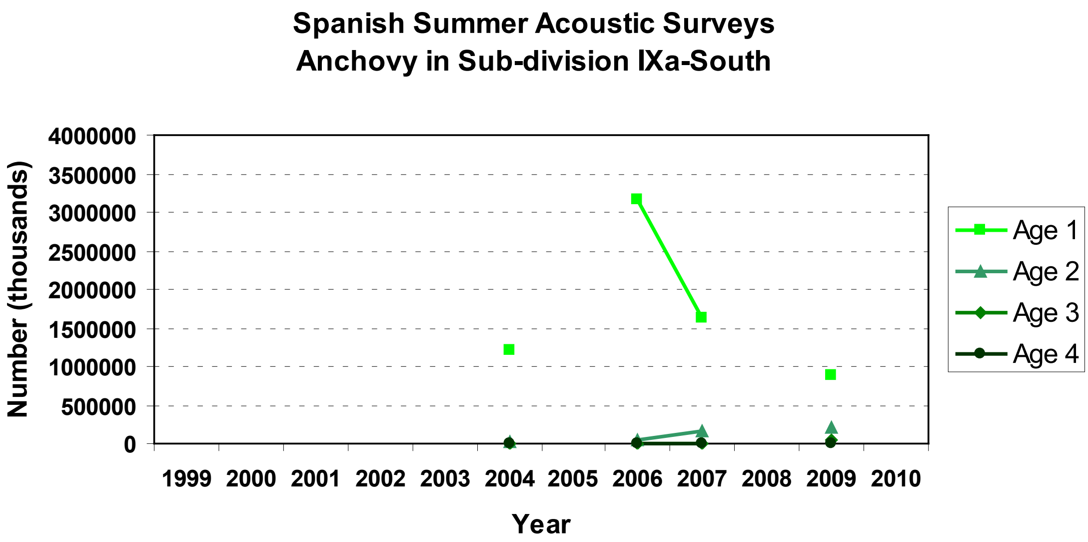
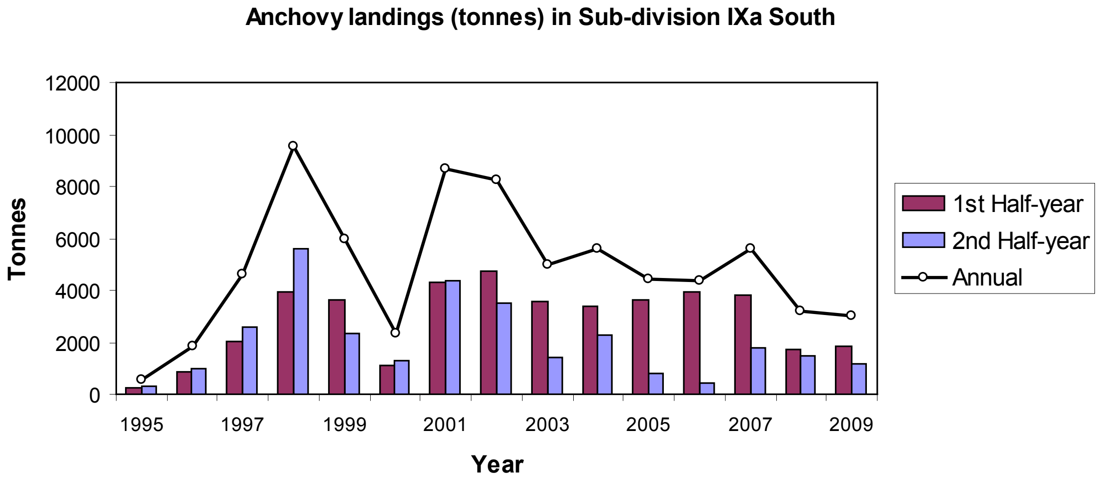
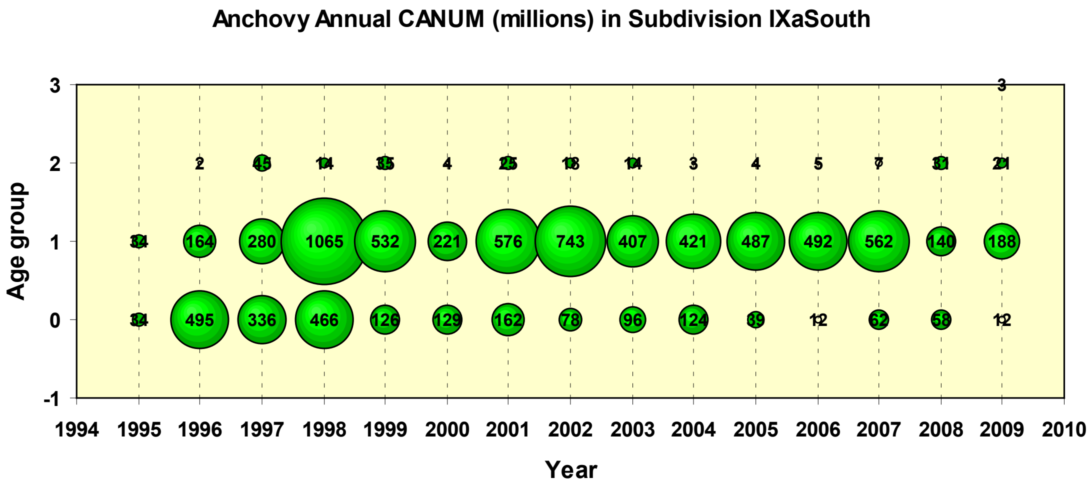


Figure 3.4.1.20. Anchovy in Division IXa. Subdivision IXa-South. Annual trends of the estimated population by age class from the Algarve + Gulf of Cádiz areas by the Portuguese Spring (upper plot) and Spanish summer (lower plot) acoustic surveys.





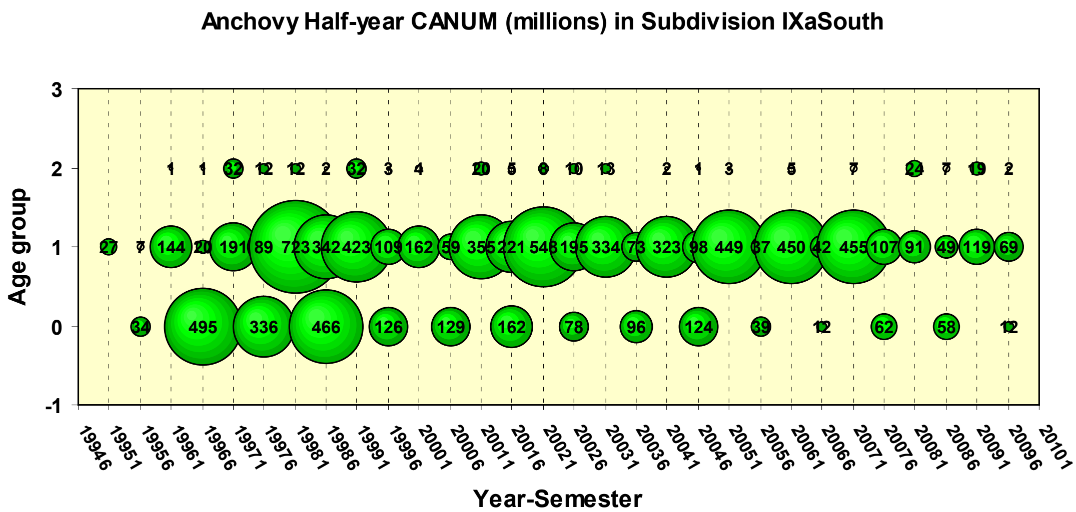
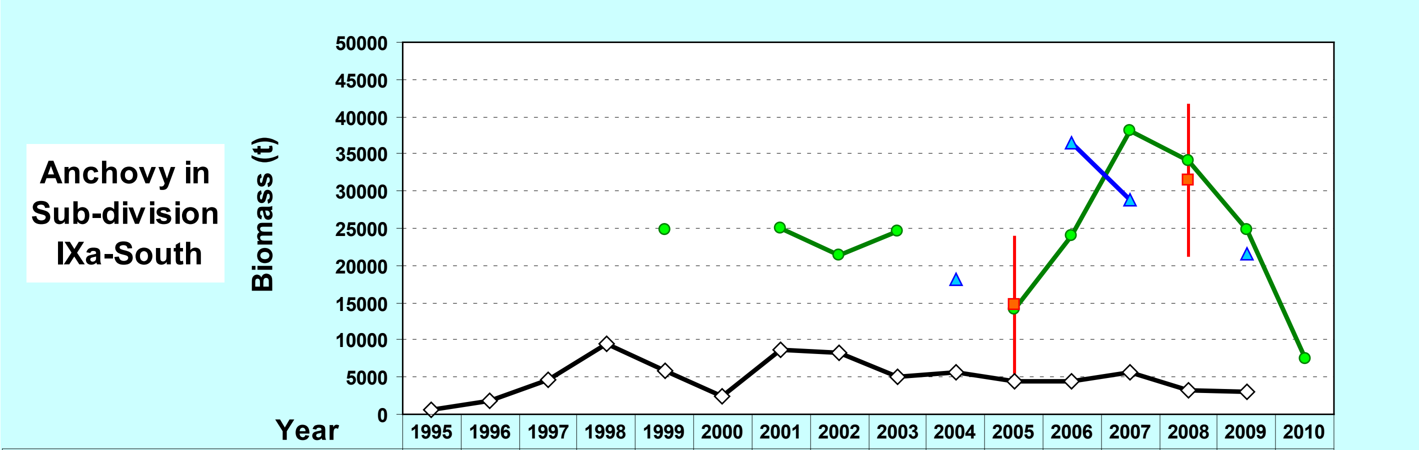


Figure 3.5.1. Anchovy in Division IXa. Subdivision IXa-South. Portuguese and Spanish fisheries (all fleets). Trends in Algarve + Gulf of Cadiz anchovy landings (upper panel) and catch-at-age numbers (both on an annual and half-year basis).



Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Spring Portuguese Acoustic Survey.					24763		24913	21335	24565		14041	24082	38020	34162	24745	7395
Summer Spanish Acoustic Survey										18177		36521	28882		21580	
Spring Spanish DEPM. Survey (SD)											14637			31527		
Total Landings	571	1831	4613	9543	5942	2360	8655	8262	4968	5617	4423	4381	5610	3204	2954	

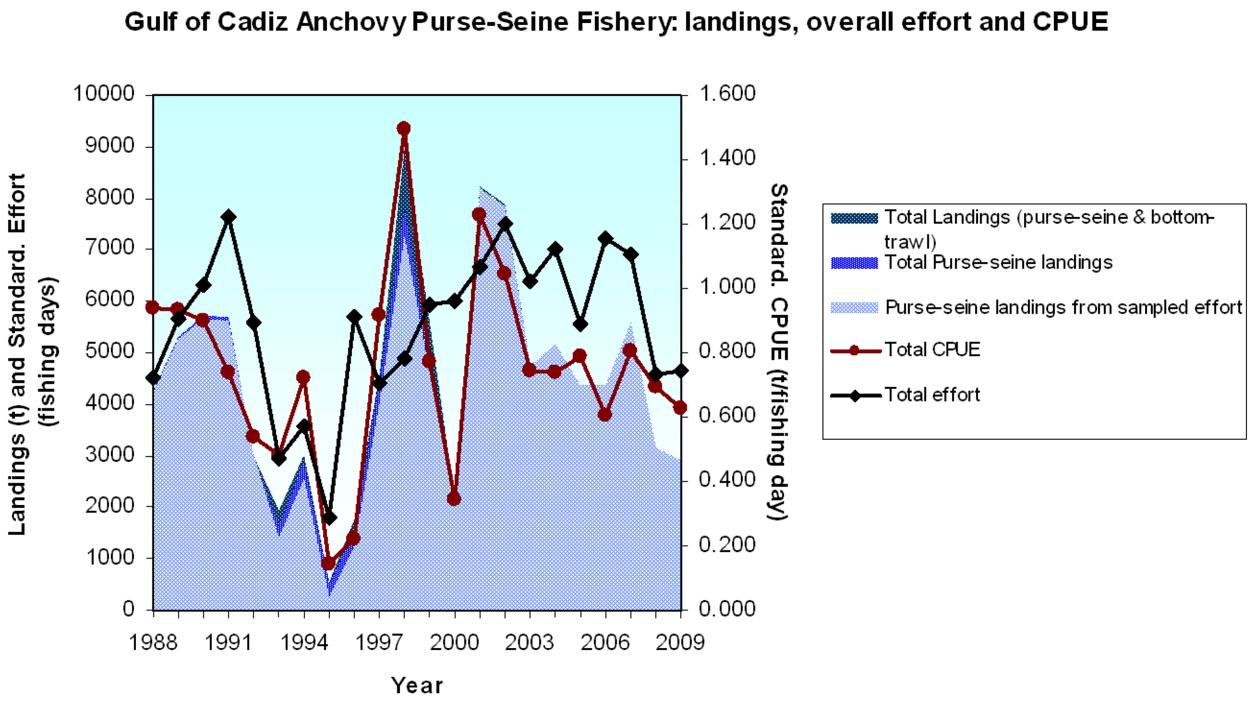


Figure 3.5.2. Anchovy in División IXa. Anchovy in Subdivision IXa-South. Information used in the Qualitative (Updated) Assessment. Upper panel: total annual landings (Algarve + Gulf of Cádiz) and available biomass estimates from research surveys series sampling the Subdivision used for comparative purposes. Lower pannel: total annual landings, standardised fishing effort (fishing days) and CPUE (tonnes/fishing day) exerted by the Spanish purse-seine fleet in the Subdivision (same figure as Figure 3.2.4.2).

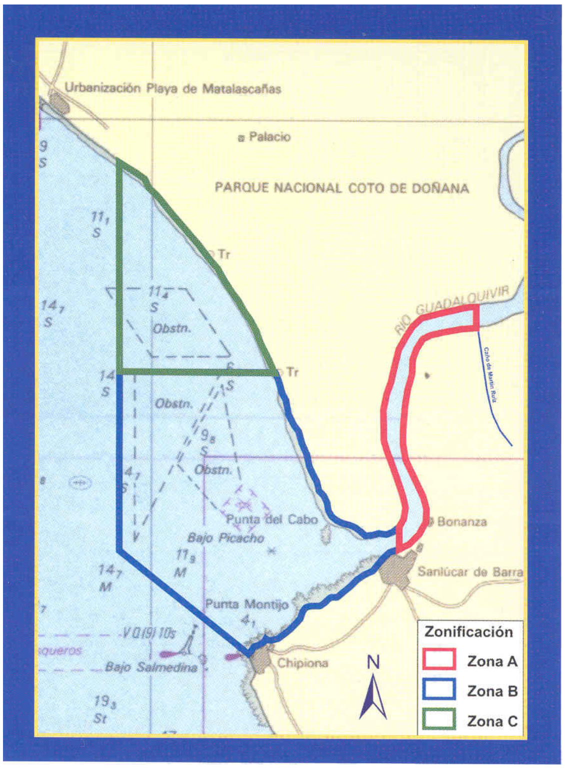


Figure 3.7.2.1. Anchovy in Division IXa. Subdivision IXa-South. Limits of the Fishing Reserve off the Guadalquivir river mouth (Spanish waters of the Gulf of Cadiz).

4 Sardine outside the Iberian Peninsula

4.1 The fisheries for sardine in the whole ICES area

4.1.1 Catches for sardine in the ICES area

Commercial catch data for 2009 were provided by Portugal, Spain, France and UK (England and Wales) (Table 4.1.1.1). Total reported catch was 102 223 tonnes, divided as follows: 60% of the catches by Portugal, 26% by Spain and 24% by France. The remaining 2% of catches are reported for divisions VIId-h by England and Wales. Catches in VIIIc and IXa amount to 94% of the total sardine catches (although it should be taken into account that not data were provided to the WG by Netherlands, Ireland and Germany this year). It should be noted that fishing activities are limited in both Spain and Portugal, while there are no catch regulations in place in the other countries. In 2009, there was a 24% decrease with respect to the total 2008 sardine catches reported in European waters. Portugal showed a 13% decrease while Spain showed a 16% decrease in catches with respect to 2008. Landings in France showed a 19% decrease and catches from England and Wales decreased by 9% in 2008.

4.2 Catch and survey data for sardine in areas VIIIa and VIIIb

4.2.1 Catch data in areas VIIIa and VIIIb

An update of the French and Spanish catch data series in Divisions VIIIa and VIIIb (from 1983 and 1996 for France and Spain, respectively) including 2009 catches was presented to this year´s WG (Table 4.2.1.1). Spanish catches are taken by purse seines from the Basque Country operating only in Division VIIIb. Spanish landings peaked in 1998 and 1999 with almost 8 thousand tonnes but have decreased in the last four years to below 1 thousand tonnes. In 2009, landings have decreased to 228 tonnes. The Spanish fishery takes place mainly during March and April and in the fourth quarter of the year.

French catches have increased along the series, with values ranging from 4 367 tonnes in 1983 to 20 627 tonnes in 2009 with some small fluctuations.

A total of 90% of the catches are taken by purse seiners while the remaining 10% is reported by pelagic trawlers (mainly pair trawlers). A substantial part of the French catches originates in divisions VIIh and VIIe, but these catches have been assigned to division VIIIa due to their very concentrated location at the boundary between VIIIa, VIIh and VIIe.

Both purse seiners and pelagic trawlers target sardine in French waters. Average vessel length is about 18 m. Purse seiners operate mainly in coastal areas (<10 nautical miles) while trawlers are allowed to fish within 3 nautical miles from the coast. Both pair trawlers and purse seiners operate close to their base harbour when targeting sardine. The highest catches are taken in the summer months. Almost all the catches are taken in south-west Brittany. Since 2005, due to the closure of the anchovy fishery in autumn, half of the purse seiners operating in the northern part of the Bay of Biscay stopped fishing during a month and a half in exchange for a financial compensation. This decrease in effort is apparent in the autumn landings recorded in those years. Purse seiners fish sardine in the northern part of the Bay of Biscay all year round (in larger quantities in spring and summer), while pelagic trawlers fish sardine in the central Bay of Biscay targeting small fish, mainly during spring.

Figure 4.2.1.2. shows French annual sardine landings by the different fleet components. Catches by purse seiners have been increasing, while catches by pelagic trawlers have remained stable for the last 8 years.

Numbers by length-class for divisions VIIIa,b by quarter are shown in Tables 4.2.1.2 and 4.2.1.3 for France and Spain (only VIIIb), respectively. French catches in divisions VIIIa and VIIIb showed a bimodal (modes at 17 and 20.5 cm) distribution while sardine taken by Spanish vessels in 2009 have a wide range of sizes.

4.2.2 Acoustic survey in areas VIIIa and VIIIb

Numbers at age for ICES subdivisions VIIIa and VIIIb estimated from the spring French acoustic surveys in 2010 have been made available to the WG. These data together with numbers at age estimated from both Spanish and Portuguese spring acoustic surveys for 2010 for subdivisions VIIIc and IXa are shown in Figure 4.2.2.1. This figure shows the importance of each age class within each subarea in relation to the total sardine population in that subarea (i.e. the proportion of all age classes within subarea sum to 1) and in addition, a pie chart is included to represent the contribution of each subarea to the total estimated biomass. This figure shows that the signal of the latest strong cohort (2004) is now only apparent in south Galicia (and to a lesser extent in north Galicia). The other areas show now the influence of different pulses of recruitment, for example in the east Cantabria fish of the 2007 cohort predominates reflecting the influence of the 2007 strong recruitment in French waters. In western Portugal there has been a shift in predominance from the 2004 to the 2005 cohort which could reflect the influence of the strong 2005 recruitment pulse in Cádiz.

4.2.2.1 French Spring Acoustic survey 2010

The French acoustic survey PELGAS takes place every spring in the Bay of Biscay on board the R/V Thalassa with the main objective of studying the abundance and distribution of pelagic fish in the Bay of Biscay and to study the pelagic ecosystem as a whole. In 2010, PELGAS09 took place from the 26th April to 5th June and detailed objectives, methodology and sampling strategy are described in the WD-Massé and Duhamel (2010) presented in this group.

Target species were anchovy and sardine but both species were considered in a multi-species context. To obtain an optimal horizontal and vertical description of the pelagic ecosystem in the area, two types of actions were combined:

i) continuous acquisition by storing acoustic data (from five frequencies: 18, 38, 70, 120 & 200 kHz),

ii) using the CUFES system, pumping sea-water under the surface, in order to evaluate the distribution of fish eggs, and iii) discrete sampling at stations (by trawls, plankton nets, CTD). Concurrently, a visual census of marine mammals and seabirds took place in order to characterise the top predators of the Bay of Biscay pelagic ecosystem.

Sardine was found (mostly in pure schools) in three main areas: in the southern part of the Bay of Biscay (close to the bottom and near the surface), around the Loire plume, and in the west and south-west of Brittany. In the 2010 survey, sardine was mostly absent from the offshore waters except near the surface around 46°N (farther north than “Fer à cheval”) (Figure 4.2.2.1.1).

Sardine ranged in length from 11 to 25.5 cm and showed a trimodal distribution (with modes at 12, 16.5 and 19 cm). The smallest fish were found near the Gironde.

Age 2 fish (2008 cohort) predominated in the survey and confirms the 2008 strong recruitment. Age 3 fish were also abundant (corresponding to the strong 2007 cohort) that has been apparent also in previous years (Figure 4.2.2.1.2).

The estimated sardine biomass was 457 081 tons, one of the highest values of the PELGAS series, but very similar to the values estimated in the last 3 years. It should be noted that PELGAS surveys do not cover the whole area of potential presence of sardine and therefore, it is possible that in some years, the specie could be also present further north, in the Celtic sea, SW of Cornouailles or Western Channel where some fishery takes place. The PELGAS estimate is representative of the sardine present in the surveyed area at the time of the survey and can be therefore considered as an estimate of the Bay of Biscay (VIIIab) sardine population.

4.2.3 Biological data

4.2.3.1 Catch numbers at length and age

Tables 4.2.3.1.1 and 4.2.3.1.2 shows the catch-at-age in numbers for each quarter of 2009 for French and Spanish landings respectively. In France, fish of age 2 and to a lesser extent 1 dominated the fishery in 2009 while in Spain fish of age 1 and age 2 predominated.

4.2.3.2 Mean length and mean weight at age

Mean length and mean weight at age by quarter in 2009 are shown in Tables 4.2.3.2.1 and 4.2.3.2.2 for French landings and in Tables 4.2.3.2.3 and 4.2.3.2.4 for Spanish landings.

4.3 Data Exploration

Results from the data exploration carried out during the WG last year and presented in last year´s report suggest that the catch at age series is still too short and the model was sensitive to assumptions to estimate fishing mortality in 2000 and 2001 when only survey data was available. Some exploratory runs were redone with updated catch and survey data. They led to results in line with what was obtained last year. In particular, the estimated catchabilities (around 5-6) are far higher than would be expected since other surveys for sardine with comparable methodology give catchabilities close to 1. Time did not allow a further exploration of the reason for these catchability estimates, but there is some suspicion that they may be related to large year effects with skewed distribution in the survey data.

In future exploration, it is suggested to look closely at causes of the year effect in survey coverage and performance, which may lead to a rational basis for discarding survey data that are not representative for the stock as a whole. Likewise, prolonging the time series should help to stabilize estimates of both survey catchability and selectivity in the fishery.

Although there is at present no request for estimates of this stock, WGANSA attempts to have the ground prepared if such requests appear. Therefore, the time series are updated, and continuation of the surveys is encouraged.

This year CEFAS has started a survey programme for the northern part of the area (Celtic sea and Western Channel). In 2010 a first exploratory survey was carried out with commercial pair trawlers. The survey was planned as a close cooperation with the PELGAS survey. A standardized survey is planned in 2011 with R/V Endeavour, coordinated with PELGAS11. WGANSA welcomes and supports this initiative, which will contribute to a far more complete coverage of the stock and a better basis for monitoring the stock.

Table 4.1.1.1: Sardine general: 2009 commercial catch data from the ICES area, available to the Working Group. Unit Tonnes.

Divisions	UK (Engl&Wal)	France	Spain	Portugal	Total
IVa					
IVb					
IVc		77			77
VIa					
VIIa					
VIIb					
VIIc					
VIId	58	2760			2818
VIIe	1493	295			1788
VIIf	906				906
VIIg		10			
VIIh	2				2
VIIi					
VIIj		348			
VIIIa					0
VIIIb			228		228
VIIIc		20627			20627
VIIId					
VIIIe			11963		
IXaN			7226		7226
IXaCN				36 212	36212
IXaCS				20 838	20838
IXaS-Alg				4 785	4785
IXaS-Cad			6716		6716
Total	2459	24116	26133	61835	102223

Table 4.2.1.1: Sardine general: Landings by France (1983-2009)

and Spain (1996-2009) in ICES divisions VIIIa and VIIIb

Year	Catch (tonnes)	
	France	Spain*
1983	4,367	n/a
1984	4,844	n/a
1985	6,059	n/a
1986	7,411	n/a
1987	5,972	n/a
1988	6,994	n/a
1989	6,219	n/a
1990	9,764	n/a
1991	13,965	n/a
1992	10,231	n/a
1993	9,837	n/a
1994	9,724	n/a
1995	11,258	n/a
1996	9,554	2,053
1997	12,088	1,608
1998	10,772	7,749
1999	14,361	7,864
2000	11,939	3,158
2001	11,285	3,720
2002	13,849	4,428
2003	15,494	1,113
2004	13,855	342
2005	15,462	898
2006	15,916	825
2007	16,060	1,263
2008	21,104	717
2009	20,627	228

* all landings from division VIIIb

n/a = not available

Table 4.2.1.2: Sardine general: French catch length composition (thousands) by ICES divisions VIIIa,b in 2009.

Length	1st quarter	2nd quarter	3rd quarter	4th quarter	Total
7					
7.5					
8					
8.5					
9					
9.5					
10	16	31	7	2	57
10.5	94				94
11	132				132
11.5	297				297
12	239	157	27	9	432
12.5	304	93	20	7	425
13	325	1 311	263	91	1 990
13.5	341	1 562	310	108	2 320
14	365	1 907	379	126	2 777
14.5	231	2 319	449	141	3 140
15	266	1 545	396	132	2 339
15.5	655	2 003	1 078	346	4 081
16	543	2 917	4 479	822	8 761
16.5	485	5 401	5 870	1 062	12 819
17	736	7 145	11 084	1 642	20 608
17.5	1 150	6 990	10 378	1 752	20 269
18	1 096	4 822	10 216	1 562	17 696
18.5	469	3 507	8 729	1 048	13 754
19	1 191	5 860	15 197	1 219	23 468
19.5	1 488	6 139	15 813	922	24 361
20	1 830	5 889	24 373	1 805	33 897
20.5	1 800	5 601	20 369	3 374	31 144
21	2 744	6 173	17 843	3 342	30 102
21.5	2 189	3 727	14 855	2 750	23 521
22	2 307	3 756	8 421	1 568	16 051
22.5	1 809	3 394	7 142	1 242	13 587
23	1 550	738	6 803	1 064	10 157
23.5	851	123	3 140	887	5 001
24	698	282	2 956	710	4 645
24.5	160	159	262	266	846
25	53	203	1 047	89	1 391
25.5	106				106
26					
26.5					
27					
Total	26 522	83 754	191 903	28 089	330 268
Mean L	20.	18.8	20.1	20.2	19.8
sd	3.07	2.50	2.02	2.35	2.34
Catch	**1 769**	**4539**	**12 442**	**1877**	**20 627**

Table 4.2.1.3: Sardine general: Spanish catch length composition (thousands) in ICES division VIIIb in 2009.

Length	1st quarter	2nd quarter	3rd quarter	4th quarter	Total
7					
7.5					
8	9				9
8.5	336				336
9	542				542
9.5	697				697
10	370				370
10.5	353				353
11	499				499
11.5	405				405
12	499				499
12.5	233				233
13	259				259
13.5	73	114			187
14	38	388			426
14.5	5	794			799
15	2	657			659
15.5	3	468			470
16	1	130			130
16.5		8			8
17		82			82
17.5		21			21
18		159			159
18.5		280		2	283
19		312		10	322
19.5		192		18	210
20		156		53	209
20.5		57		63	119
21		36		96	132
21.5		35		82	117
22		33		79	112
22.5		16		42	58
23		1		34	35
23.5				13	13
24					
24.5				1	1
25					
25.5					
26					
26.5					
27					
Total	4 323	3 938		495	8 756
Mean L	10.9	16.5		21.6	14.
sd	1.43	2.24		1.05	3.78
Catch	**41**	**146**		**41**	**228**

Table 4.2.3.1.1: Sardine general: French 2009 landings in divisions VIIIa and VIIIb:

Catch in numbers (thousands) at age.

Age	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Whole Year
0			6011	1301	7312
1	6045	31792	48878	7202	93917
2	7081	29794	73047	8693	118615
3	3148	7538	27970	4074	42729
4	1729	3030	14441	2552	21752
5	4494	7325	7396	1495	20709
6	1533	1845	6169	1119	10666
7	1077	1040	4814	1015	7945
8	899	843	2525	460	4726
9	324	268			592
10	103	73	262	22	460
11	37	5	393	155	590
12					
13					
14					
Total	26469	83552	191903	28089	330013
Catch (Tons)	1769	4539	12442	1877	20627

Table 4.2.3.1.2: Sardine general: Spanish 2009 landings in ICES division VIIIb:
Catch in numbers (thousands) at age.

Age	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Whole Year
0					
1	4323	2670		24	7017
2		974		259	1233
3		138		82	219
4		101		109	210
5		38		19	57
6		10		3	12
7		7			7
8		0			0
9					
10					
11					
12					
13					
Total	4323	3938		495	8756
Catch (Tons)	41	146		41	228

Table 4.2.3.2.1: Sardine general: French 2009 landings in divisions VIIIa and VIIIb:

Mean length (cm) at age.

Age	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Whole Year
0			15.7	15.4	15.6
1	15.1	15.8	17.3	17.0	16.6
2	18.8	18.6	19.3	19.6	19.1
3	20.3	20.1	20.1	20.3	20.1
4	21.1	20.7	21.2	21.3	21.1
5	21.2	20.9	21.4	21.5	21.2
6	21.7	21.3	21.9	22.1	21.8
7	22.1	21.7	21.9	22.2	22.0
8	22.3	21.6	22.1	22.1	22.1
9	22.2	21.8			22.0
10	22.7	23.0	23.9	23.9	23.5
11	22.5	22.5	23.8	23.5	23.6
12					
13					
14					

Table 4.2.3.2.2: Sardine general: French 2009 landings in divisions VIIIa and VIIIb:

mean weight (kg) at age.

Age	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Whole Year
0			0.032	0.030	0.032
1	0.029	0.033	0.045	0.042	0.039
2	0.059	0.056	0.064	0.067	0.062
3	0.075	0.073	0.073	0.075	0.073
4	0.085	0.081	0.087	0.088	0.086
5	0.087	0.083	0.090	0.091	0.087
6	0.095	0.089	0.097	0.100	0.096
7	0.100	0.094	0.098	0.101	0.098
8	0.103	0.093	0.101	0.100	0.100
9	0.101	0.096			0.099
10	0.110	0.114	0.130	0.130	0.123
11	0.107	0.107	0.127	0.123	0.125
12					
13					
14					

Table 4.2.3.2.3: Sardine general: Spanish 2009 landings in ICES division VIIIb:

Mean length (cm) at age.

Age	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Whole Year
0					
1	10.9	15.1		20.5	12.5
2		19.1		21.1	19.5
3		20.2		22.0	20.9
4		21.2		22.3	21.8
5		21.4		22.9	21.9
6		22.2		23.9	22.5
7		22.2			22.2
8		23.3			23.3
9					
10					
11					
12					
13					
14					

Table 4.2.3.2.4: Sardine general: Spanish 2009 landings in ICES division VIIIb:

mean weight (kg) at age.

Age	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Whole Year
0					
1	0.010	0.026		0.070	0.016
2		0.056		0.076	0.060
3		0.066		0.087	0.074
4		0.078		0.091	0.085
5		0.080		0.098	0.086
6		0.089		0.113	0.094
7		0.090			0.090
8		0.104			0.104
9					
10					
11					
12					
13					
14					

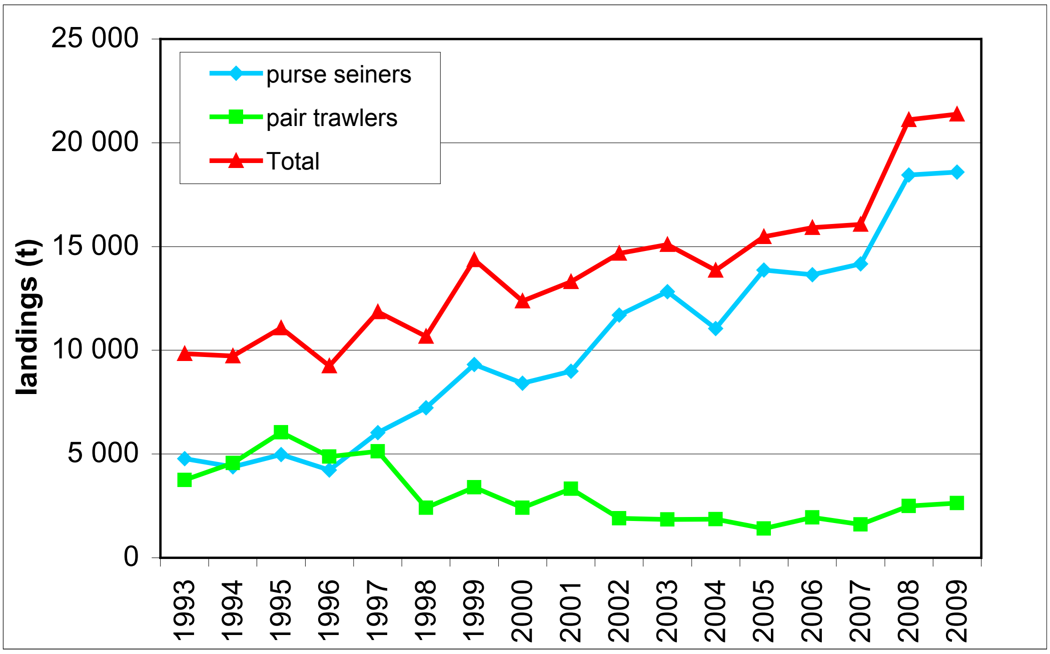


Figure 4.2.1.2: Sardine general: French landings in divisions VIIIa and VIIIb. Annual sardine landings (by different French fleet components since 1993).

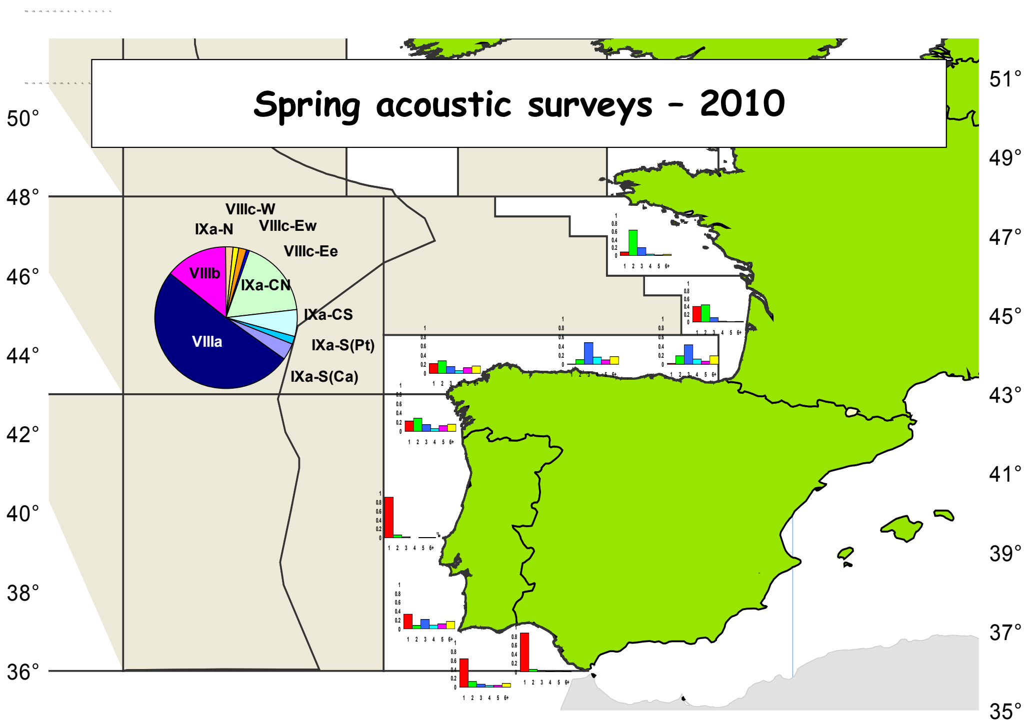


Figure 4.2.2.1: Sardine general: Sardine age frequency distribution by subarea showing the importance of each age class in each subarea in relation to the total sardine population in that subarea as estimated by the spring surveys carried out by France, Spain and Portugal (2010). Age categories are: 1, 2, 3,…and 6+. The pie chart represents the contribution of each subarea to the total biomass.

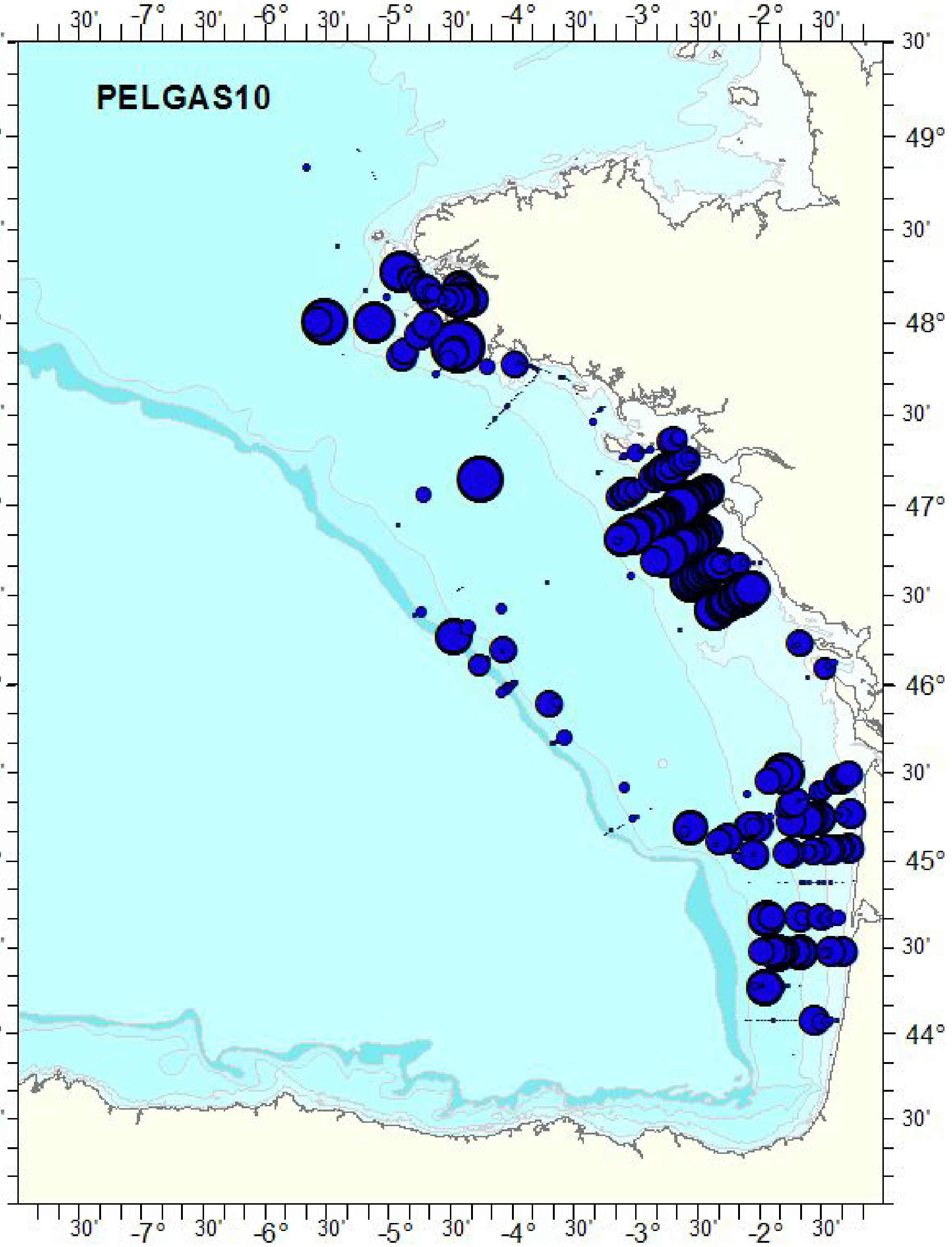


Figure 4.2.2.1.1: Sardine general: Distribution of sardine as observed during the French acoustic survey PELGAS10.

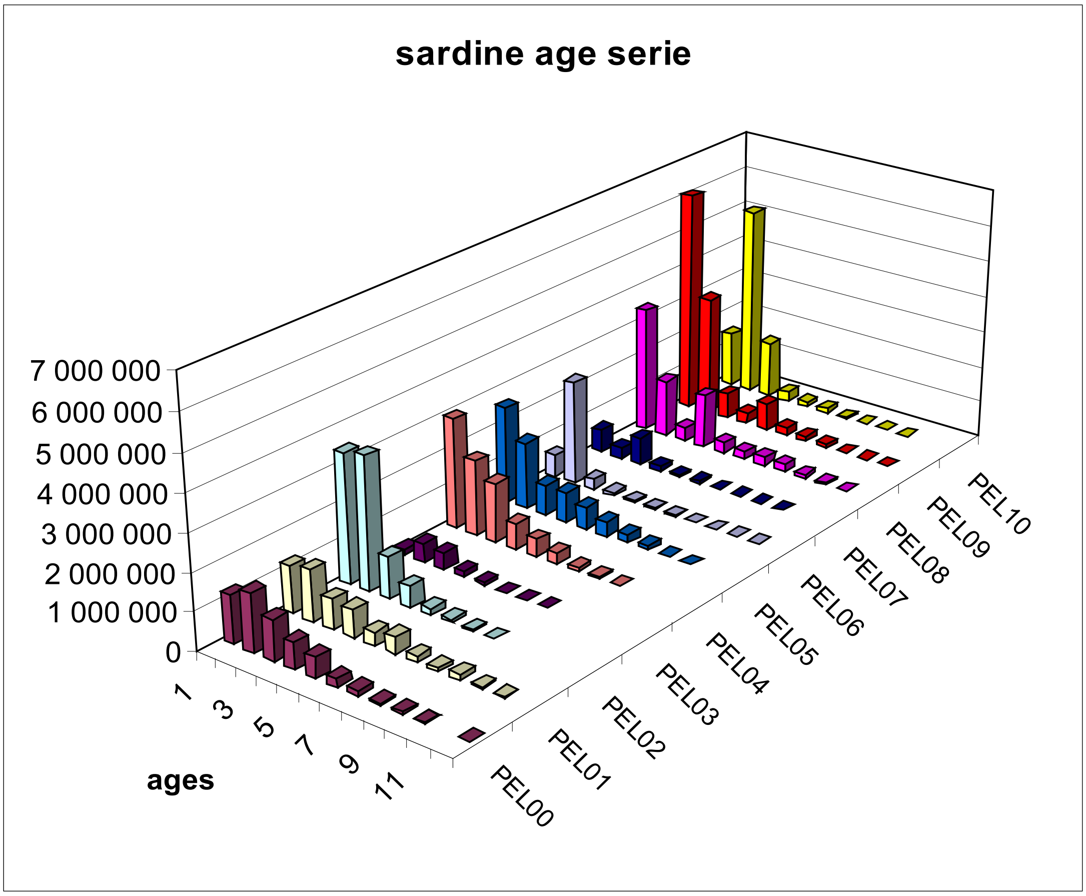


Figure 4.2.2.1.2: Sardine general: Sardine age distribution in numbers of fish for divisions VIIIa and VIIIb in the French acoustic surveys PELGAS 2000 – 2010.

5 Sardine in VIIIc and IXa

5.1 ACFM Advice Applicable to 2009

For 2010, ICES advised that as the current fishing mortality does not appear detrimental for the development of the stock, which is largely driven by the incoming recruitment, ICES recommended that the current level of fishing mortality could be maintained as a guide for management. This corresponds to a catch of 75 thousand tonnes in 2010.

In the absence of defined reference points, the state of this stock cannot be evaluated with regard to these. SSB has declined since 2006 due to successive low recruitments and SSB in 2009 was below the long-term average. Fishing mortality in 2008 was 40% higher than in 2007, but is still below the historical average.

There are no management objectives for this stock and there is no TAC. The stock is managed by Portugal and Spain through minimum landing size, maximum daily catch, days fishing limitations, and closed areas.

5.2 The fishery in 2009

5.2.1 Catches by fleet and area

As estimated by the Working Group, sardine landings in 2009 have decreased in comparison with those of 2008 (Tables 5.2.1 and 5.2.2, Figure 5.2.1). Total 2009 landings in divisions VIIIc and IXa were 87 740 t, i.e. a decrease of 14% with respect to the 2008 values (101 464 tonnes). The bulk of the landings (99%) were made by purse-seiners. In Spain, landings of sardine (25 905 tonnes) showed a 15% decrease with respect to the values from 2008 (30 468 tonnes). All ICES subdivisions showed a decrease in catches (12% in subdivision VIIIc, 23% in IXaN and 10% in IXaS-Cadiz). In Portugal, landings in 2009 (61 835 tonnes) were 13% lower than the landings in 2008 (70 997 tonnes). This decrease in landings originated in all subdivisions with the exception of IXaCS that remained stable. There was a 20% decrease in catches in IXaCN and a 3% decrease in IXaS.

Table 5.2.1 summarises the quarterly landings and their relative distribution by ICES Subdivision. Sixty-five percent of the catches were landed in the second semester (37% in the third quarter) and more than 41% of the landings took place off the northern Portuguese coast (IXaCN). This value is slightly lower than the one reported for last year. The percentage of catches in the northern area of the stock (VIIIc and IXaN) (22%) has slightly decreased from last year. The southern areas accounts for 13% of the total values in 2009, slightly above the value in 2008.

5.2.2 Fleet Composition in 2009

Details about the vessels operated by both Spain and Portugal targeting sardine are given in table 5.2.1.1. In northern Spanish waters, sardine is taken by purse seine. The total number of vessels with license for this gear in 2009 has remained unchanged with respect to 2008 (with a total number of 306 vessels), ranging in size from 8 to 38 m (mean vessel length = 22 m) and in power between 25 and 1100 (mean = 326 HP).

Half of the purse seiners (53%) are licensed in Galicia, where most of the smaller boats are found since part of the fishing takes place inside the rías. Purse seiners from the Basque Country (26% of the fleet) and Cantabria (18%) are bigger (they generally take longer trips while fishing). The remaining 3% of the fleet is licensed in Asturias.

In the Gulf of Cadiz, purse seiners taking sardine are generally targeting anchovy (n = 99) and range in size from 10 to 25 m with a mean vessel length of 16 m (horse power between 28 and 510 with a mean of 188). In Portuguese waters, fleet data from 2009 indicate that sardine is taken by coastal purse seiners (number of licenses= 159) ranging in size from 10.5 to 27 m (mean vessel length = 20 m). Vessel engine power ranges between 71 and 447 (mean = 249).

5.3 Fishery independent information

Figures 5.3.1 and 5.3.2 show the time series of fishery independent information for the sardine stock.

5.3.1 DEPM – based SSB estimates

DEPM surveys were carried out in 2008 by both Spain and Portugal and results from both surveys were presented in last year´s report and are therefore only summarized here (see Table 5.3.1.1).

The 2008 DEPM-based SSB estimate was the largest since 1997 and this increase was particularly evident in the southern area (with a six fold increase in relation to the 2005) and in the western area.

5.3.2 Acoustic surveys

During 2009, two acoustic surveys were carried to estimate small pelagic fish abundance in IXa and VIIIc (one in Portuguese waters and one in Spanish waters). The April-May 2010 Portuguese survey (PELAGOS10) took place onboard the RV "Noruega" while the Spanish survey (PELACUS0410) took place in March-April onboard the RV "Thalassa".

Both surveys were conducted following the methodology applied in previous years and agreed and revised at the WGACEGG.

5.3.2.1 Portuguese spring acoustic survey

PELAGOS10 survey took place from the 6th of April to the 6th of May and covered the Portuguese and Gulf of Cádiz waters ranging from 20 to 200 m depth. Detailed objectives, methodology and sampling strategy are described in the WD-Marques *et al.* (2010) presented in this group. A total of 26 fishing stations were carried out with sardine being present in 18 of those. Sardine was manly distributed over the western coast from Caminha to Cape Espichel. In the northern west area, sardine was detected mainly near the coast, being more abundant between Porto and Figueira da Foz. In the southern west area, sardine was scarce while in the Algarve fish was found in bigger concentrations in the western part (Figure 5.3.2.1.1). Total estimated sardine biomass in the surveyed area was 179 thousand tonnes corresponding to 5 933 million individuals (Table 5.3.2.1.1). These values represent a decrease of 30% in biomass and 7% in numbers compared with the values estimated by last year spring survey (Figures 5.3.1. and 5.3.2). Age 1 fish (2009 year class) dominated in all areas with the exception of the southern west area where the 2007 cohort was also important.

Not data on sardine egg distribution derived from the CUFES sampling during this survey was presented to the WG. Data are being processed and will be available for the WGACEGG meeting in November.

5.3.2.2 Spanish spring acoustic survey

The Spanish survey took place onboard the RV "Thalassa" from the 27th March to 20th April. The area covered extended from the Galician-Portugal border to southern French waters and from 30 to 200 m depth. Detailed objectives, methodology and sampling strategy are described in the WD-Iglesias *et al.* (2010) presented in this group.

Sardines were present in 34 of the 63 trawl hauls completed during the survey (62 in Spanish waters). Sardine abundance was estimated as 539 million individuals, while biomass was estimated to be 39.7 thousand tonnes (Table 5.3.2.2.1). More than half of the fish (58% by number and 53% of the biomass) were found in Galician waters (ICES subdivisions IXaN and VIIIcW) and mostly very close to the coast. In the Cantabrian and Basque Country areas sardine was found more widely distributed, throughout the whole shelf (Figure 5.3.2.2.1). These figures represent a decrease of 11% in biomass and 12% in abundance in relation to the estimated values in 2009.

Sardine ranged in length from 13.5 to 25.5 cm with a mode at 21 cm (Figure 5.3.2.2.2). Applying the ALK obtained from the fish sampled during the survey, most fish (28% by number and 30% of the biomass) in the entire surveyed area were assigned to age class 3 (2007 year class) (Table 5.3.2.2.1). By sub-area, age 2 fish predominated in Galician waters (ICES sub-areas IXa-N and VIIIcW), while age 3 fish predominated in Cantabrian waters (almost 45% in biomass and 47% in abundance in VIIIcE-w and 41% and 43% respectively in VIIIcE-e).

In 2010 there was a increase in the number of eggs and in the number of positive stations. Sardine eggs showed a wide distribution on the shelf on the Cantabrian Sea but were found closer to the coast in Galician waters (Figure 5.3.2.2.3).

In the 2009 survey, no sardine at all were found in northern Galician waters (VIIIcW). This year, additional effort was directed to improve the prospection of coastal waters and sardine (although not in big numbers) was detected in these areas. Sardine distribution area seems to have shrunk to coastal areas in recent years, making it less available to the acoustic survey but not to the fishery.

5.4 Biological data

5.4.1 Catch numbers at length and age

Tables 5.4.1.1a,b,c,d show the quarterly length distributions of landings from each subdivision. Annual length distributions were bimodal in Spain with the exception of subdivision VIIIcE which showed a trimodal distribution (modes at 10.5, 14.5 and 22 cm). Modes were 18 and 22.5 cm for VIIIcW, 13.5 and 21 for IXaN and 15.5 and 19.5 cm for IXaS Cádiz. For Portugal, single modes were observed for IXaCS at 20.5 cm and for IXaS-Algarve at 19.5 cm while IXaCN showed a bimodal length distribution (at 13 and 20 cm).

Table 5.4.1.2 shows the catch-at-age in numbers for each quarter and subdivision. In Table 5.4.1.3, the relative contribution of each age group in each Subdivision is shown as well as their relative contribution to the catches. The last strong 2004 year class (5-group in 2009) has ceased to dominate the catches in 2009 although it is still apparent in IXaN and VIIIcW. In VIIIcE age 2 fish (2008 year class) and to a lesser extent age 1 fish (2007 year class) dominates the catches in number while age 2 fish (and ages 3 and 4) also dominates in IXaS Algarve. Age 1 fish (2009 year class) dominates the catches in Cádiz while age 0 fish predominates in IXaCN.

0-group catches are concentrated in Subdivision IXaCN. Older fish (age groups 5 and 6+) concentrate in IXaCS.

5.4.2 Mean length and mean weight at age

Mean length and mean weight at age by quarter and Subdivision are shown in Tables 5.4.2.1 and 5.4.2.2.

5.4.3 Maturity and stock weights at age

The maturity ogive and stock weights for 2009 are show below. Maturity at age 1 has increased over the last year, but remains lower than the historical average (60.7 %).

Age	0	1	2	3	4	5	6+
% mature fish	0	47.0	99.2	99.8	99.9	99.9	100

Age	0	1	2	3	4	5	6+
Weight, kg	0.020	0.041	0.065	0.075	0.079	0.083	0.100

5.4.4 Natural mortality

Natural mortality was estimated at 0.33 by Pestana (1989), and is considered constant for all ages and years.

5.5 Effort and catch per unit effort

No new information on fishing effort review has been presented to the WG.

5.6 Data and model exploration

This year, the assessment of sardine is an update. Catch and acoustic survey data were updated with the estimates from 2009 and 2010, respectively.

5.6.1 Data exploration

Sardine catch-at-age data and abundance-at-age data from the combined spring acoustic survey are presented in Figures 5.6.1.1 and 5.6.1.2 and listed in Tables 5.6.1.1 f,g, respectively. Both catches and abundance data support earlier indications of very poor year classes in the period 2006 – 2007. The 2009 recruitment is comparatively higher according to the 2010 acoustic survey, although far from the level of recent strong recruitments. Figures 5.6.1.3 to 5.6.1.5 show the mean weights-at-age in the catch and in the stock and maturity ogive (data listen in Table 5.6.1.1.a,b,c).

Assumptions about natural mortality and acoustic survey catchability were briefly explored (Silva and Santos, WD2010). The WG agrees there is a need to re-visit the M assumption of the sardine assessment; recent data, covering the whole stock area can be incorporated in the estimation of M and alternative approaches to calculate M may be explored. Variation of M by age is a plausible hypothesis for small pelagics and should be investigated taking into account data on feeding behaviour of sardine predators.

From the exploration of survey data, differences in catchability between the Spanish and Portuguese surveys and changes in catchability over time show some consistency with survey methodology and design. However, the drop in catchability of the 6+ group (see section 5.6.3) does not appear to be a methodological effect. There may be several biological reasons for the survey to miss part of the oldest age groups; among those, differences in distribution/behaviour of older sardines compared to younger ones and/or directional large-scale migrations are plausible explanations. The WGANSA considers this an important issue that should be further explored and recommends this is done by WGACEGG.

5.6.2 Stock assessment

The final stock assessment was an update assessment made with AMCI for one area.

The following data were used:

- Catch numbers at age: 1978-2009
- Combined March acoustic survey: Indices from the Spanish march survey, covering Division VIIIc and Subdivision IXaN, and the Portuguese March survey, covering the remainder of Division IXa, added together without weighting, for the years 1996 to 2010.
- DEPM estimates of spawning biomass, covering VIIIc and IXa, for the years 1997, 1999, 2002, 2005 and 2008

The model was conditioned as follows:

- Selection at age in the fishery at age 4 equal to age 5
- Selection at age in the fishery in 2009 equal to that in 2008
- Survey catchability at age 4 equal to age 5
- DEPM survey as a relative index of SSB
- Selection at age was allowed to change gradually, using the recursive updating algorithm in AMCI, with a gain factor of 0.2 for all ages and years
- Survey catchability assumed constant over time.
- Catchability of the DEPM survey constant over time.
- Natural mortality: Constant at 0.33 (Pestana, 1989).

The following model parameters were estimated:

- Initial numbers in 1978 and recruitments each year except in 2010. Recruitment in 2010 was assumed at $4*10^9$
- Initial selection at age in the fishery, for all ages, but assumed equal for ages 4 and 5. Selection in 2009 assumed equal to 2008.
- Survey catchability at age, for all ages, but assumed equal for ages 4 and 5
- Catchability for the DEPM survey.
- Annual fishing mortalities.

The objective function was a sum of squared log residuals for catch numbers at age, survey indices at age and DEPM indices. Catches at age 0 were down-weighted by a factor of 0.1. The weighting specified was equal for all other observations. The internal weighting in AMCI implies that the set of all acoustic survey observations (6 ages x 13 years), and the set of DEPM observations (5 years), each are given the same weight as each year of catch numbers at age (7 ages) in the objective function. Therefore, catch-at-age data has considerable more weight than either survey on the model fit. The DEPM has the same weight as the acoustic survey.

Results from the assessment are listed in Table 5.6.1.1d-i. Summary plots are presented in Figure 5.6.2.1. Residuals for the catches, acoustic survey and DEPM survey are shown in Figures 5.6.2.2 to 5.6.2.4, respectively. Fishing mortalities at age are shown in Figure 5.6.2.5, and the survey catchability-at-age in Figure 5.6.2.6.

Catch and acoustic survey residuals from this year's assessment are comparable to those obtained last year. These residuals do not raise serious concern as they are generally small. As noted in previous assessments, there is some clustering of mostly negative or mostly positive values in both the catches and the acoustic survey. A large negative residual in the 6+ group in the 1996 survey has also been noticed in previous assessments. The reasons for both this residual and for the weak pattern observed in both catch and survey residuals are unclear and a closer examination of their origin is recommended.

Residuals for the DEPM survey are higher than those of last year's assessment and show an upward trend across the time series. A high residual, 0.42, is observed for the 2008 survey.

As in previous assessments, selection shows an increase up to ages 3-4 years (constrained to be equal at ages 4 and 5) and declines sharply in the 6+ group. Survey catchability is the highest at age 1, relatively flat from ages 2 to 5 (constrained to be equal at ages 4 and 5) and also drops in the 6+ group (see section 5.6.1.1).

Results from this year's assessment show some differences compared to those of last year's assessment for the most recent years (see Section 5.6.3). SSB in 2009 is estimated to be 316 thousand tonnes, being 33% below the historical mean (477 thousand tons, mean of 1978 – 2008). SSB shows a declining trend since 2006 due to the lack of strong recruitments since 2004. From 2008 to 2009, SSB dropped 104 thousand tonnes. Fishing mortality ($F_{2\text{-}5}$) in 2009 is estimated to be 0.27 year^{-1}, being at the historical mean. F_{2009} is comparable to F_{2008} reflecting the decline of catches along with the decline of stock abundance. The 2009 recruitment (6273 billion individuals, CV=18%) is estimated to be at the level of the geometric mean of historical recruitments and is 57% higher than the 2008 recruitment. An average 2009 recruitment is supported by the 2010 Spring acoustic survey (at age 1).

Coefficients of variation of the estimated parameters, as derived from the Hessian matrix, are given in Table 5.6.2.1. Correlations between parameter estimates as derived from the Hessian were all below 0.35. It should be noted that since the objective function is not a proper likelihood function due to the externally set weighting of the observations, these CVs and correlations can only be taken as indicative of the uncertainties in the results.

Bootstrap estimates of uncertainty in SSB, recruitment and fishing mortality were made by re-sampling the residuals of all data around the model values. The main results from 100 replicas are shown in Figure 5.6.2.7. 90% confidence limits for the recruitment are narrow, except in the last year of the assessment and both SSB and fishing mortality seem to be estimated with a reasonable and consistent precision across the time series.

5.6.3 Reliability of the assessment

The results from this year's assessment are more comparable to those of WG2008 than to last year's assessment (Figure 5.6.2.1). Last year, the inclusion of the SSB estimate from the 2008 DEPM survey in the assessment shifted the SSB and recruitment upwards and the fishing mortality downwards with some influence backwards to 2002 (ICES, 2009). This effect is not noticeable in this year's assessment. A likely explanation is the 2010 acoustic survey indicates a decline in abundance, catches also decline, supporting the downward stock trend seen in recent years and contradicting the high SSB estimate obtained in the 2008 DEPM survey. As a consequence, residuals of the DEPM survey are higher in this year's assessment and the historical SSB, F and Recruitment estimates are closer to the trajectories obtained in WG2008 (i.e. prior to the inclusion of the 2008 DEPM estimate). A strong influence of DEPM estimates the year they are included in the assessment for the first time, has been noted in the past.

This assessment is an update and therefore, comments reported in previous WGs (e.g. ICES 2006, 2007, WG reports) are still applicable. The abrupt decline of selection and catchability for the 6+ group is still a matter of concern. As discussed in section 5.6.1.1, methodological aspects may contribute to the unusual survey catchability but a combination of biological aspects is also likely. Estimates of catchability for ages fully selected to the fishery (2-5- years) are close to 1, indicating that the survey is providing a reliable index of the major part of the population. This further supports the current assumption of equal catchability at ages 4 and 5 in the assessment.

In previous years there has been a weak retrospective pattern; recruitment and SSB tend to be adjusted downwards and F tends to be adjusted upwards as new years are included in the assessment. Since 2008 there is no clear pattern and the 2010 assessment is very close to the 2008 assessment.

5.6.4 Catch predictions (Divisions VIIIc and IXa)

Catch predictions were carried out using results from the final AMCI assessment. Predictions were carried with the following assumptions:

- the input value for the 2009 recruitment was that estimated in the assessment, R_{2009}=6273 million individuals;
- Input values for 2009, 2010 and 2011 recruitments were set equal to the geometric mean of the period 1996-2009, $R_{GM(96-09)}$ = 4569 million individuals;
- Weights-at-age in the stock and in the catch were calculated as the arithmetic mean value of the last three years (2007-2009);
- The maturity ogive corresponded to the mean values of the period 2000-2009 (for which there are annual observations);
- As in the assessment, input value for natural mortality was 0.33 and input values for the proportion of F and M before spawning were 0.25;
- The exploitation pattern and F_{sq} were the average F(2007-09) unscaled. F_{sq}= 0.24 year^{-1}

The 2009 recruitment estimated by the assessment model was used in the prediction since it is supported by data from the April 2009 acoustic survey (at age 1) (see also section 5.3). For 2010 – 2012, the assumed recruitment was based on the period 1996-2009, when the declining trend of the time series has apparently stopped (Figure 5.7.1).

In last year's assessment, a long-term average (19 years) of the maturity ogive was used in the catch prediction, to decrease the influence of extensive inter-annual variations observed in the historical series. The RG recommended the use of a more recent average (3 or 5 years) to account for any possible trend over time. In fact, the maturity ogive shows weak long-term trends, negative at Age 1 and positive at Age 2 but also extensive variation at Age 1 in the last 5 years. Therefore, the WG considered that a mean of the last 10 years would be adequate to take account of both the long term trend and the short term variability.

The remaining assumptions are equal to those used in catch predictions performed last year.

We note that the Fsq assumption in 2010 (0.24) is consistent with regulations enforced by Spain and Portugal for the purse seine fishery.

In Portugal, catches in 2010 are limited to 55 thousand tonnes (applicable to vessels associated in Producers Organizations, producing 95% of the national catches). Therefore, total catches should not exceed 58 thousand tonnes. In Spain, catch limits are set by vessel/day which has not generally been attained in average, and there is no overall annual limit. Nevertheless, assuming that the Spanish catches comprise 30% of the total, as in the last 3 years, leads to a total catch in 2010 of 83 thousand tonnes, which is the same as predicted with an Fsq=0.24.

Input values are shown in Table 5.7.1.1. and results are shown in Table 5.7.1.2. The predicted catches with Fsq (0.24) for 2010 are 83 thousand tonnes. Predicted SSB for 2010 is 317 thousand tonnes, which is below the historical mean. If fishing mortality remains at the Fsq level (0.24), the predicted yield in 2011 (88 thousand tonnes) is 6% lower than the catch level in recent years (average of 95 thousand tonnes, 2005 – 2009). Predicted SSB for 2011 is 344 thousand tonnes, which means an increase of 9% with respect to the estimated 2009 SSB.

As in previous years, it should be pointed out that the outcome of short term deterministic predictions has a high uncertainty due to the use of assumed values of recruitment, possible bias in the assessment and the assumption that current levels of fishing mortality will remain constant in 2010 and 2011.

5.7 Reference points and harvest control rules for management purposes

Precautionary reference points have so far not been defined for this stock.

The yield per recruit curve for this stock shows a very gradual rise of the yield towards high fishing mortality. F_{max} is not defined while the $F_{0.1}$ value is around 0.5, which is higher than the highest F on record (0.39). Therefore, the F maximizing the long term yield is the highest F that does not lead to impaired recruitment, making MSY and the precautionary approach equivalent objectives.

There are no clear indications of a stock-recruit relationship. A Ricker curve can be fit to the data but the parameters are poorly determined/highly correlated and a strong negative trend in time is seen in the residuals (Figure 5.7.1). Alternative stock recruitment curves were explored but either convergence was not achieved (segmented regression) or a poorer fit was obtained (Beverton and Holt).

Other potential F reference points as suggested by WKFRAME (e.g. Fmsy, $F_{SPR40\%}$, ICES CM 2010/ACOM:54) were calculated based on the yield/spawner per recruit curves in combination with a Ricker stock recruitment relationship. The results showed the Fmsy level was similar to that of F0.1 and for the same reasons, not a suitable candidate for a target fishing mortality. The $F_{SPR40\%}$ value is in the upper part of the historical range of Fs; it might be considered as an upper bound to a target fishing mortality after possible bias and uncertainty in the stock recruitment relationship are taken into account.

Work is in progress to develop harvest rules for this stock, although the process still is in an early stage. In that context, a Blim value is the most important. The obvious candidate would be Bloss, which is estimated at 263 thousand tonnes. Historical recruitment shows a long term decrease and a pattern of sporadic strong values at intervals from 4 – 7 years. Preliminary simulations were carried out with HCS (Skagen, 2010. HCS: Manual and program available from the author), assuming that recruitment will remain at the geometric mean of the recent period, 1993 – 2008 (excluding sporadic strong recruitments across this period) and including random variation around this mean value. The results indicated that F values between 0.2 and 0.3 $year^{-1}$ may be a reasonable compromise between high yield and low risk in the medium term (20 years) for Blim set at Bloss.

5.8 Management considerations

No TAC is set to manage the stock. Limitations to fishing effort implemented in Portugal and Spain since 1997 continued to be in effect during 2009. Catch limitations are still in place in Spain. A catch limit of 55 thousand tonnes was set for the Portuguese fishery for 2010.

The Spawning Stock Biomass of this stock, 316 thousand tonnes in 2009, is 33% below the average of the historical series (472 thousand tonnes) due to the lack of strong recruitments in the last five years (2005 – 2009). Fishing mortality in 2009, 0.27 year-1 is at the historical average. It is also at the same level as that in 2008, reflecting the decline of catches along with the decline in stock abundance. With a fishing mortality at 0.24, which is the average for 2007 - 2009, short term predictions indicate that SSB in 2010 will be similar to that in 2009 (317 thousand tonnes). SSB is expected to increase 9% in 2010 but to decline again in 2011 (5%) if recruitment continues at the average level of recent years. Fishing at a level of 0.24 $year^{-1}$ implies a reduction in catches for 2011 to 88 thousand tonnes.

The short term perspective of the stock in this assessment has improved slightly compared to the perspective obtained last year due to the moderate strength of the incoming 2009 recruitment. Nevertheless, the strength of this recruitment is still uncertain. SSB is substantially below the historical average but F_{2009} is moderate taking into account historical values. If a strong recruitment does not come into the stock in the near future, catches at the recent average (96 thousand tonnes) will lead to a further decline in biomass and an escalating fishing mortality.

In the past, extended periods of successive low recruitments combined with high fishing mortality have led to periods of minimum SSB in the stock history. In the most recent of these periods (late 1990s) the sardine fisheries experienced a critical phase, which was mainly felt in the northern Spanish areas. Hence, fishing mortality should not increase above the 2007 – 2009 level of 0.24, corresponding to a catch of less than 88 thousand tonnes in 2010.

The WG considers that the management of this stock would be facilitated if a management plan were developed. Such development is in progress. So far it is on an early stage, mostly concentrating on developing adequate models for recruitment and other aspects of preparing a sound scientific basis for future dialogue and development process.

5.9 Benchmark

A benchmark was proposed for sardine in 2012. The last benchmark for Sardine in VIIIc-IXa took place in 2006. Although the later assessments have been accepted, there are still unsolved problems: maturity-at-age shows extensive year-to-year variations which may reflect sampling variability and there are some trends in survey residuals and mismatch between DEPM and acoustic survey results in specific years. There are also problems with the modelling of selectivity and survey catchability in the plus group. Harvest control rules are being discussed and are likely to be requested at some stage. Design of simulations need to be clarified in time, for example modelling of recruitment. Reference points are not defined for this stock, and need to be considered.

It should also be noted that data on sardine in the northern areas (ICES Sub-area VIIIa,b, see section 4) of the Iberian Peninsula is accumulating. At present, there is no request to provide advice for sardine in the north. There is some connection between sardine distributed in the two areas and the extent of this connection could also be reviewed in the benchmark.

Finally, the current assessment tool, AMCI (Skagen, 2005) may be reconsidered before the benchmark, since it is not going to be maintained in the future.

The WG discussed topics that might be considered in the benchmark taking into account exploration of data and model assumptions carried out within the WG and inter sessionally in the past few years. Following this discussion, the following list of topics was built:

Data

- Revision of the maturity ogive and consideration of alternative indices of reproductive potential;
- Revision of the assumption of constant maturity and weights-at-age between years in the earlier period of the assessment;
- Revision of the catchability pattern of acoustic surveys taking into account survey methodology and possible changes in fish distribution/behaviour;

Assessment model/software

- Evaluate alternative assessment models/tools;

Model assumptions

- Combination of the Spanish and Portuguese acoustic surveys in a single index of abundance;
- Variation in the Selectivity over time and age;
- Weighting of the different sets input data to the assessment (i.e. catches-at-age, acoustic survey, DEPM survey);
- Review the natural mortality assumption;

Reference points and HRs

- Review reference points and harvest rules for sardine management, if required.

Other

- Review the extent of connection between sardine in the Iberian Peninsula and sardine distributed to the north, particularly in the Bay of Biscay;
- Review information on environmental influences on the stock, links with recruitment and stock distribution/possibility to incorporate environmental data into the assessment
- Review information on consumption by sardine predators (and its variation in space and time) to continue the exploration of M at age.

Table 5.2.1: Sardine in VIIIc and IXa: Quaterly distribution of sardine landings (t) in 2009 by ICES Sub-Division. Above absolute values; below, relative numbers.

Sub-Div	1st	2nd	3rd	4th	Total
VIIIc-E	1640	865	1245	1756	5505
VIIIc-W	591	1825	2896	1147	6458
IXa-N	563	2204	2574	1885	7226
IXa-CN	3486	6548	13986	12193	36212
IXa-CS	4256	4664	7407	4511	20838
IXa-S (A)	896	1277	1322	1289	4785
IXa-S (C)	730	1215	2783	1989	6716
Total	12161	18598	32212	24770	87740

Sub-Div	1st	2nd	3rd	4th	Total
VIIIc-E	1.87	0.99	1.42	2.00	6.27
VIIIc-W	0.67	2.08	3.30	1.31	7.36
IXa-N	0.64	2.51	2.93	2.15	8.24
IXa-CN	3.97	7.46	15.94	13.90	41.27
IXa-CS	4.85	5.32	8.44	5.14	23.75
IXa-S (A)	1.02	1.46	1.51	1.47	5.45
IXa-S (C)	0.83	1.38	3.17	2.27	7.65
Total	13.86	21.20	36.71	28.23	

Table 5.2.1.1: Sardine in VIIIc and IXa: Spanish and Portuguese composition of the fleet licensed to catch sardine in 2009. Length category: range (average) in m, Engine power category: range (average) in HP.

Country	Details given	Length (metres)	Engine power (Horse Power)	Gear	Storage	Discard estimates	No vessels
Spain (northern)	yes	8-38 (22)	25 – 1100 (326)	Purse seine	Dry hold with ice	No	306
Spain (Gulf of Cadiz)	yes	10-25 (16)	28-510 (188)	Purse seine	Dry hold with ice	No	99
Portugal	yes	10.5 – 27 (20)	71 – 447 (249)	Purse seine	Dry hold with ice	No	159

Table 5.2.2: Sardine in VIIIc and IXa: Iberian Sardine Landings (tonnes) by sub-area and total for the period 1940-2009.

	Sub-area										
Year	VIIIc	IXa North	IXa Central North	IXa Central South	IXa South Algarve	IXa South Cadiz	All sub-areas	Div. IXa	Portugal	Spain (excl.Cadiz)	Spain (incl.Cadiz)
1940	66816		42132	33275	23724		**165947**	**99131**	**99131**	**66816**	**66816**
1941	27801		26599	34423	9391		**98214**	**70413**	**70413**	**27801**	**27801**
1942	47208		40969	31957	8739		**128873**	**81665**	**81665**	**47208**	**47208**
1943	46348		85692	31362	15871		**179273**	**132925**	**132925**	**46348**	**46348**
1944	76147		88643	31135	8450		**204375**	**128228**	**128228**	**76147**	**76147**
1945	67998		64313	37289	7426		**177026**	**109028**	**109028**	**67998**	**67998**
1946	32280		68787	26430	12237		**139734**	**107454**	**107454**	**32280**	**32280**
1947	43459	21855	55407	25003	15667		**161391**	**117932**	**96077**	**65314**	**65314**
1948	10945	17320	50288	17060	10674		**106287**	**95342**	**78022**	**28265**	**28265**
1949	11519	19504	37868	12077	8952		**89920**	**78401**	**58897**	**31023**	**31023**
1950	13201	27121	47388	17025	17963		**122698**	**109497**	**82376**	**40322**	**40322**
1951	12713	27959	43906	15056	19269		**118903**	**106190**	**78231**	**40672**	**40672**
1952	7765	30485	40938	22687	25331		**127206**	**119441**	**88956**	**38250**	**38250**
1953	4969	27569	68145	16969	12051		**129703**	**124734**	**97165**	**32538**	**32538**
1954	8836	28816	62467	25736	24084		**149939**	**141103**	**112287**	**37652**	**37652**
1955	6851	30804	55618	15191	21150		**129614**	**122763**	**91959**	**37655**	**37655**
1956	12074	29614	58128	24069	14475		**138360**	**126286**	**96672**	**41688**	**41688**
1957	15624	37170	75896	20231	15010		**163931**	**148307**	**111137**	**52794**	**52794**
1958	29743	41143	92790	33937	12554		**210167**	**180424**	**139281**	**70886**	**70886**
1959	42005	36055	87845	23754	11680		**201339**	**159334**	**123279**	**78060**	**78060**
1960	38244	60713	83331	24384	24062		**230734**	**192490**	**131777**	**98957**	**98957**
1961	51212	59570	96105	22872	16528		**246287**	**195075**	**135505**	**110782**	**110782**
1962	28891	46381	77701	29643	23528		**206144**	**177253**	**130872**	**75272**	**75272**
1963	33796	51979	86859	17595	12397		**202626**	**168830**	**116851**	**85775**	**85775**
1964	36390	40897	108065	27636	22035		**235023**	**198633**	**157736**	**77287**	**77287**
1965	31732	47036	82354	35003	18797		**214922**	**183190**	**136154**	**78768**	**78768**
1966	32196	44154	66929	34153	20855		**198287**	**166091**	**121937**	**76350**	**76350**
1967	23480	45595	64210	31576	16635		**181496**	**158016**	**112421**	**69075**	**69075**
1968	24690	51828	46215	16671	14993		**154397**	**129707**	**77879**	**76518**	**76518**
1969	38254	40732	37782	13852	9350		**139970**	**101716**	**60984**	**78986**	**78986**
1970	28934	32306	37608	12989	14257		**126094**	**97160**	**64854**	**61240**	**61240**
1971	41691	48637	36728	16917	16534		**160507**	**118816**	**70179**	**90328**	**90328**
1972	33800	45275	34889	18007	19200		**151171**	**117371**	**72096**	**79075**	**79075**
1973	44768	18523	46984	27688	19570		**157533**	**112765**	**94242**	**63291**	**63291**
1974	34536	13894	36339	18717	14244		**117730**	**83194**	**69300**	**48430**	**48430**
1975	50260	12236	54819	19295	16714		**153324**	**103064**	**90828**	**62496**	**62496**
1976	51901	10140	43435	16548	12538		**134562**	**82661**	**72521**	**62041**	**62041**
1977	36149	9782	37064	17496	20745		**121236**	**85087**	**75305**	**45931**	**45931**
1978	43522	12915	34246	25974	23333	5619	**145609**	**102087**	**83553**	**56437**	**62056**
1979	18271	43876	39651	27532	24111	3800	**157241**	**138970**	**91294**	**62147**	**65947**
1980	35787	49593	59290	29433	17579	3120	**194802**	**159015**	**106302**	**85380**	**88500**
1981	35550	65330	61150	37054	15048	2384	**216517**	**180967**	**113253**	**100880**	**103264**
1982	31756	71889	45865	38082	16912	2442	**206946**	**175190**	**100859**	**103645**	**106087**
1983	32374	62843	33163	31163	21607	2688	**183837**	**151463**	**85932**	**95217**	**97905**
1984	27970	79606	42798	35032	17280	3319	**206005**	**178035**	**95110**	**107576**	**110895**
1985	25907	66491	61755	31535	18418	4333	**208439**	**182532**	**111709**	**92398**	**96731**
1986	39195	37960	57360	31737	14354	6757	**187363**	**148168**	**103451**	**77155**	**83912**
1987	36377	42234	44806	27795	17613	8870	**177696**	**141319**	**90214**	**78611**	**87481**
1988	40944	24005	52779	27420	13393	2990	**161531**	**120587**	**93591**	**64949**	**67939**
1989	29856	16179	52585	26783	11723	3835	**140961**	**111105**	**91091**	**46035**	**49870**
1990	27500	19253	52212	24723	19238	6503	**149429**	**121929**	**96173**	**46753**	**53256**
1991	20735	14383	44379	26150	22106	4834	**132587**	**111852**	**92635**	**35118**	**39952**
1992	26160	16579	41681	29968	11666	4196	**130250**	**104090**	**83315**	**42739**	**46935**
1993	24486	23905	47284	29995	13160	3664	**142495**	**118009**	**90440**	**48391**	**52055**
1994	22181	16151	49136	30390	14942	3782	**136582**	**114401**	**94468**	**38332**	**42114**
1995	19538	13928	41444	27270	19104	3996	**125280**	**105742**	**87818**	**33466**	**37462**
1996	14423	11251	34761	31117	19880	5304	**116736**	**102313**	**85758**	**25674**	**30978**
1997	15587	12291	34156	25863	21137	6780	**115814**	**100227**	**81156**	**27878**	**34658**
1998	16177	3263	32584	29564	20743	6594	**108924**	**92747**	**82890**	**19440**	**26034**
1999	11862	2563	31574	21747	18499	7846	**94091**	**82229**	**71820**	**14425**	**22271**
2000	11697	2866	23311	23701	19129	5081	**85786**	**74089**	**66141**	**14563**	**19644**
2001	16798	8398	32726	25619	13350	5066	**101957**	**85159**	**71695**	**25196**	**30262**
2002	15885	4562	33585	22969	10982	11689	**99673**	**83787**	**67536**	**20448**	**32136**
2003	16436	6383	33293	24635	8600	8484	**97831**	**81395**	**66528**	**22819**	**31303**
2004	18306	8573	29488	24370	8107	9176	**98020**	**79714**	**61965**	**26879**	**36055**
2005	19800	11663	25696	24619	7175	8391	**97345**	**77545**	**57490**	**31464**	**39855**
2006	15377	10856	30152	19061	5798	5779	**87023**	**71646**	**55011**	**26233**	**32012**
2007	13380	12402	41090	19142	4266	6188	**96469**	**83088**	**64499**	**25782**	**31970**
2008	13636	9409	45210	20858	4928	7423	**101464**	**87828**	**70997**	**23045**	**30468**
2009	11963	7226	36212	20838	4785	6716	**87740**	**75777**	**61835**	**19189**	**25905**

Div. IXa = IXa North + IXa Central-North + IXa Central-South + IXa South-Algarve + IXa South-Cadiz

Table 5.3.1.1. DEPM estimates of sardine spawning biomass (in thousand tonnes) and CV (between brackets) for the Spanish (north) and Portuguese surveys (Portugal and Gulf of Cadiz) over 1997-2008, using traditional estimation.

YEAR	NORTH	SOUTH	WPOR	TOTAL
1997	20.7 (84)	246.9 (47)	75.0 (44)	352.6
1999	13.4 (77)	199.3 (48)	56.3 (37)	269
2002	50.7 (33)	121.5 (48)	281.4 (37)	453.6
2005	154.5 (29)	48.3 (45)	215.8 (39)	418.6
2008	142 (30)	300 (28)	245 (26)	687

Table 5.3.2.1.1: Sardine in VIIIc and IXa: Sardine Assessment from the 2010 Portuguese spring acoustic survey (PELAGOS10). Number in thousand fish and biomass in tonnes.

AREA		1	2	3	4	5	6+	Total
Oc. Norte	Biomass	107699	10908	3170	295	867	1614	124552
	%	86	9	3	0	1	1	
	No fish	4078055	282801	74038	4951	14612	26278	4480735
	%	91	6	2	0	0	1	
Oc.Sul	Biomass	6645	3417	10673	4576	6770	10848	42928
	%	15	8	25	11	16	25	
	No fish	303694	72957	197276	77183	110146	160845	922102
	%	33	8	21	8	12	17	
Algarve	Biomass	2174	2760	1571	982	1199	2606	11291
	%	19	24	14	9	11	23	
	No fish	339530	67749	34608	20231	22758	45481	530355
	%	64	13	7	4	4	9	
Cadiz	Biomass	10575	5757	3161	1498	3139	2260	26390
	%	40	22	12	6	12	9	
	No fish	2547495	160756	80475	33516	62133	44117	2928493
	%	87	5	3	1	2	2	
Total	Biomass	116517	17085	15414	5852	8835	15067	178771
Portugal	%	65	10	9	3	5	8	
	No fish	4721278	423507	305921	102365	147516	232604	5933192
	%	80	7	5	2	2	4	
Total	Biomass	127093	22842	18574	7350	11975	17327	205161
	%	62	11	9	4	6	8	
	No fish	7268774	584263	386396	135882	209649	276721	8861685
	%	82	7	4	2	2	3	

Table 5.3.2.2.1:Sardine in VIIIc and IXa: Sardine abundance in number (thousands of fish) and biomass (tons) by age groups and ICES subdivision in PELACUS0410.

AREA VIIIcE east	1	2	3	4	5	6	7	8	9	10	TOTAL
Biomass (tonnes)	69	981	2655	776	505	697	338	319	203	0	6543
% Biomass	1.1	15.0	40.6	11.9	7.7	10.7	5.2	4.9	3.1	0.0	100
Abundance (in '000)	1423	15695	35715	9549	5578	7294	3376	3020	1821	0	83471
% Abundance	1.7	18.8	42.8	11.4	6.7	8.7	4.0	3.6	2.2	0.0	100
Medium Weight (gr)	48.5	62.5	74.3	81.3	90.5	95.6	100.1	105.5	111.5	0.0	80.1
Medium Length (cm)	18.1	19.9	21.2	21.9	22.8	23.3	23.7	24.2	24.7	0.0	20.2

AREA VIIIcE west	1	2	3	4	5	6	7	8	9	10	TOTAL
Biomass (tonnes)	25	1017	5371	1900	1293	1511	417	195	112	117	11959
% Biomass	0.2	8.5	44.9	15.9	10.8	12.6	3.5	1.6	0.9	1.0	100
Abundance (in '000)	539	14826	68484	22846	13965	15865	4150	1833	1070	1110	144687
% Abundance	0.4	10.2	47.3	15.8	9.7	11.0	2.9	1.3	0.7	0.8	100
Medium Weight (gr)	46.3	68.6	78.4	83.2	92.6	95.3	100.4	106.6	104.4	105.6	86.2
Medium Length (cm)	17.7	20.6	21.6	22.1	23.0	23.3	23.7	24.3	24.1	24.2	22.3

AREA VIIIcW	1	2	3	4	5	6	7	8	9	10	TOTAL
Biomass (tonnes)	1248	2167	1641	680	1358	1289	238	202	202	0	9026
% Biomass	13.8	24.0	18.2	7.5	15.0	14.3	2.6	2.2	2.2	0.0	100
Abundance (in '000)	28342	36817	19796	8313	16868	14835	2547	2035	2035	0	131589
% Abundance	21.5	28.0	15.0	6.3	12.8	11.3	1.9	1.5	1.5	0.0	100
Medium Weight (gr)	44.0	58.9	82.9	81.8	80.5	86.9	93.5	99.3	99.3	0.0	78.5
Medium Length (cm)	17.4	19.4	22.1	22.0	21.8	22.5	23.1	23.6	23.6	0.0	21.5

AREA IXaN	1	2	3	4	5	6	7	8	9	10	TOTAL
Biomass (tonnes)	1766	2970	2191	904	1815	1673	302	260	260	0	12141
% Biomass	14.5	24.5	18.1	7.4	14.9	13.8	2.5	2.1	2.1	0.0	100
Abundance (in '000)	40506	50482	26478	11090	22635	19387	3249	2619	2619	0	179065
% Abundance	22.6	28.2	14.8	6.2	12.6	10.8	1.8	1.5	1.5	0.0	100
Medium Weight (gr)	43.6	58.8	82.8	81.5	80.2	86.3	93.1	99.2	99.2	0.0	72.2
Medium Length (cm)	17.3	19.4	22.1	21.9	21.8	22.4	23.1	23.6	23.6	0.0	20.8

TOTAL SPAIN	1	2	3	4	5	6	7	8	9	10	TOTAL
Biomass (tonnes)	3108	7134	11859	4261	4971	5171	1295	976	777	117	39669
% Biomass	7.8	18.0	29.9	10.7	12.5	13.0	3.3	2.5	2.0	0.3	100
Abundance (in '000)	70811	117819	150474	51798	59046	57380	13322	9506	7545	1110	538811
% Abundance	13.1	21.9	27.9	9.6	11.0	10.6	2.5	1.8	1.4	0.2	100
Medium Weight (gr)	43.9	60.6	78.8	82.3	84.2	90.1	97.2	102.7	102.9	105.6	84.8
Medium Length (cm)	17.4	19.6	21.7	22.0	22.2	22.8	23.4	23.9	23.9	24.2	22.1

Table 5.4.1.1: Sardine in VIIIc and IXa: Sardine length composition (thousands) by ICES subdivision in 2009.

				Total				
Length	**VIIIc E**	**VIIIc W**	**IXa N**	**IXa CN**	**IXa CS**	**IXa S**	**IXa S (Ca)**	**Total**
6.5	23 697							23 697
7								
7.5	23 697							23 697
8	47 393							47 393
8.5	142 180							142 180
9	236 967							236 967
9.5	308 057				40			308 097
10	308 057			181	160			308 398
10.5	332 734	4 116	25 277	2 572	40			364 739
11	246 275	6 836	806 015	13 036	80			1072 243
11.5	150 508	9 469	1281 272	22 699	80			1464 028
12	267 032	29 642	2940 700	48 467	55	14	22 741	3308 651
12.5	173 519	26 827	5266 264	58 549	95		90 964	5616 218
13	56 553	70 810	7840 118	90 847	40	6	225 173	8283 547
13.5	410 905	108 901	8185 125	58 792	192		607 131	9371 046
14	1159 005	551 357	4533 801	51 836	311	32	1372 893	7669 236
14.5	2347 281	431 486	2823 509	37 266	281	27	3511 928	9151 778
15	2028 455	856 257	3020 607	29 455	404	86	6136 050	12071 315
15.5	1582 786	1152 612	1495 763	22 368	305	95	6546 790	10800 720
16	746 879	2328 745	1495 102	18 947	642	338	4331 531	8922 184
16.5	472 723	1715 789	611 444	12 892	257	526	4831 889	7645 520
17	651 255	3195 068	688 596	11 432	1 423	1 230	2934 131	7483 135
17.5	765 507	2346 514	682 493	18 370	1 135	2 019	7464 708	11280 747
18	1651 327	3397 478	1115 991	29 258	2 005	3 372	10035 031	16234 461
18.5	2306 435	1552 371	1725 464	29 734	5 360	5 956	16064 777	21690 097
19	3196 795	1391 915	2867 493	26 388	15 147	9 811	19665 623	27173 171
19.5	3675 913	925 980	3560 936	43 172	32 144	12 834	20018 889	28269 867
20	5748 525	1251 628	7429 925	66 171	54 677	12 066	13433 140	27996 133
20.5	5577 670	2475 641	8187 208	63 031	60 071	9 748	7621 121	23994 491
21	7404 614	4295 368	12003 696	42 966	53 751	6 155	4100 484	27907 034
21.5	7382 241	8118 684	9997 753	21 293	26 184	2 988	1632 917	27182 060
22	7830 018	11731 179	10632 189	12 467	14 084	1 373	373 464	30594 774
22.5	6284 974	11831 960	5606 446	6 291	4 797	460	125 978	23860 906
23	4992 762	8236 433	5172 346	4 376	1 568	85		18407 570
23.5	2926 220	4408 311	2018 338	2 785	327	38		9356 020
24	1181 077	2339 120	1052 193	1 730				4574 120
24.5	539 422	508 594	103 921	371	267			1152 574
25	183 472	138 196		42				321 710
25.5	43 465							43 465
26								
26.5								
27								
27.5								
28								
28.5								
29								
Total	73406 395	75437 287	113169 985	847 786	275 923	69 260	131147 353	394 353 989
Mean L	20.3	21.1	18.6	16.6	20.6	19.9	18.6	19.4
sd	3.06	2.52	3.87	3.47	1.15	1.19	1.82	3.08
Catch	**5505**	**6458**	**7226**	**36212**	**20838**	**4785**	**6716**	**87740**

Table 5.4.1.1a: Sardine in VIIIc and IXa: Sardine length composition (thousands) by ICES subdivision in the first quarter 2009.

				First Quarter				
Length	**VIIIc E**	**VIIIc W**	**IXa N**	**IXa CN**	**IXa CS**	**IXa S**	**IXa S (Ca)**	**Total**
6.5	23 697							23 697
7								
7.5	23 697							23 697
8	47 393							47 393
8.5	142 180							142 180
9	236 967							236 967
9.5	308 057							308 057
10	308 057							308 057
10.5	332 734	4 116		472				337 322
11	246 275	6 836		1 179				254 290
11.5	150 508	9 469		2 488				162 465
12	267 032	29 642		6 022				302 696
12.5	172 246	26 827		4 761	40			203 874
13	51 313	70 810		13 122		6	123 714	258 965
13.5	82 838	30 247		14 390	42		247 428	374 945
14	31 995	101 771		26 870	120	12	1113 432	1274 200
14.5	37 492	28 774		22 236	201	18	371 145	459 866
15	103 951	50 820		13 714	160		2126 419	2295 064
15.5	206 498	80 115		5 242	244	37	1867 354	2159 490
16	194 905	98 518	3 259	2 630	305	126	2367 154	2666 898
16.5	165 529	60 644		628	110	172	859 090	1086 173
17	89 852	93 810	21 078	319	663	274	1223 539	1429 535
17.5	125 112	31 612	27 272	148	620	632	23 272	208 669
18	320 460	49 053	105 623	459	1 002	959	422 082	899 638
18.5	560 817	103 425	108 000	732	2 688	1 803	645 263	1422 728
19	1293 303	103 430	271 845	1 696	6 880	2 710	1317 182	2997 046
19.5	1343 427	184 194	235 819	4 077	11 859	3 216	1896 122	3678 714
20	2103 916	258 779	429 767	5 543	14 821	2 776	1384 603	4200 205
20.5	1528 264	414 423	443 227	4 192	14 803	1 585	582 587	2989 080
21	2126 454	619 517	541 495	2 495	9 066	941	1059 791	4359 759
21.5	2236 707	1285 246	454 857	781	3 147	691	159 067	4140 495
22	2798 338	1312 814	1079 329	638	1 832	252	52 692	5245 895
22.5	2339 878	1147 091	704 925	233	772	39		4192 938
23	1874 824	673 629	1203 990	53	139	16		3752 651
23.5	1091 967	520 005	723 677	53	65	3		2335 770
24	289 626	194 667	417 592					901 885
24.5	179 911	58 252	32 643		98			270 904
25	83 604							83 604
25.5	25 848							25 848
26								
26.5								
27								
27.5								
28								
28.5								
29								
Total	23545 672	7648 536	6804 398	135 175	69 677	16 269	17841 936	56 061 662
Mean L	20.2	21.4	22.1	15.1	20.2	19.7	17.5	19.7
sd	3.66	2.38	1.54	2.48	1.17	1.19	2.26	3.33
Catch	**1 640**	**591**	**563**	**3 486**	**4 256**	**896**	**730**	**12 161**

Table 5.4.1.1b: Sardine in VIIIc and IXa: Sardine length composition (thousands) by ICES subdivision in the second quarter 2009.

	Second Quarter							
Length	**VIIIc E**	**VIIIc W**	**IXa N**	**IXa CN**	**IXa CS**	**IXa S**	**IXa S (Ca)**	**Total**
7								
7.5								
8								
8.5								
9								
9.5								
10								
10.5								
11								
11.5								
12								
12.5								
13	5 240							5 240
13.5	328 067	22 460						350 527
14	1061 537					4		1061 541
14.5	2172 295			64			154 700	2327 059
15	1816 809		23 704	320	53	38	618 802	2459 726
15.5	1307 877		41 448	1 315	22	34	610 671	1961 367
16	427 448		89 265	4 691	296	142	570 377	1092 219
16.5	98 844		128 910	4 363	106	255	1217 776	1450 254
17	317 164		389 003	3 043	269	517	3219 217	3929 213
17.5	292 076		380 673	2 336	302	509	4851 800	5527 696
18	830 025		868 379	1 757	182	996	5144 766	6846 105
18.5	1073 038		1071 355	1 703	939	2 101	3595 101	5744 237
19	1229 624	66 785	1975 508	2 738	1 796	3 630	1682 307	4962 388
19.5	981 353	13 167	1989 806	10 034	5 399	4 201	1106 536	4110 495
20	1020 289	112 218	4120 627	19 921	10 675	3 169	854 836	6141 735
20.5	873 440	449 847	3679 553	18 479	14 474	1 960	407 045	5444 798
21	727 788	1275 027	4812 100	13 466	12 427	689	79 096	6920 593
21.5	568 867	2635 423	3989 756	5 351	7 953	267	214 397	7422 014
22	513 395	4516 831	3050 665	2 721	2 702	111	73 286	8159 710
22.5	554 393	4611 922	1326 492	1 419	1 557			6495 783
23	411 542	3212 303	946 537	942	626			4571 950
23.5	234 661	1654 046	168 628	767	35			2058 137
24	79 421	675 528	94 842	1 035				850 826
24.5	27 419	83 369		312	73			111 173
25	2 504	181		42				2 727
25.5	1 247							1 247
26								
26.5								
27								
27.5								
28								
28.5								
29								
Total	16956 363	19329 107	29147 251	96 819	59 884	18 624	24400 713	90008 760
Mean L	18.1	22.5	20.8	20.0	20.8	19.5	18.1	19.9
sd	2.92	0.89	1.40	1.79	1.01	1.07	1.21	2.47
Catch	**865**	**1 825**	**2 204**	**6 548**	**4 664**	**1 277**	**1 215**	**18 598**

Table 5.4.1.1c: Sardine in VIIIc and IXa: Sardine length composition (thousands) by ICES subdivision in the third quarter 2009.

				Third Quarter				
Length	**VIIIc E**	**VIIIc W**	**IXa N**	**IXa CN**	**IXa CS**	**IXa S**	**IXa S (Ca)**	**Total**
7								
7.5								
8								
8.5								
9								
9.5								
10								
10.5			25 277	412				25 689
11			806 015	4 399				810 414
11.5			1281 272	7 996			22 741	1312 009
12			2158 790	10 840	55		90 964	2260 649
12.5	1 273		2095 576	7 481	55		204 669	2309 054
13			2737 761	5 802			477 559	3221 122
13.5			2409 722	7 831	110		1010 350	3428 013
14	65 473		2312 538	5 425	191	16	2277 990	4661 634
14.5	137 494		2036 417	5 677		8	5398 483	7578 079
15	52 379		1926 783	7 748	191	48	3636 919	5624 069
15.5	13 095		837 094	9 644		24	1744 717	2604 574
16	59 105		681 773	5 277		47	1390 763	2136 966
16.5	82 110		52 071	3 267	32	86	445 602	583 168
17	161 266			6 026	383	322	2269 499	2437 496
17.5	294 580		48 087	13 742	36	675	4180 203	4537 323
18	472 566		15 016	23 124	419	1 138	6942 833	7455 095
18.5	542 069	48 090	342 932	20 790	544	1 533	9294 241	10250 200
19	380 274	96 180	468 831	15 203	2 458	2 162	9096 584	10061 692
19.5	689 117	194 491	1143 398	17 669	6 377	3 118	4524 824	6578 994
20	875 941	486 647	2658 867	25 404	15 953	2 806	1987 565	6053 183
20.5	1242 561	1388 876	3328 894	25 960	20 426	2 609	492 713	6502 038
21	1483 324	2196 994	5188 423	16 619	21 742	1 762	57 102	8965 966
21.5	1862 413	3741 404	3753 577	6 965	10 159	748		9375 266
22	1457 198	5196 276	3894 058	2 269	6 718	354		10556 873
22.5	1419 485	5670 235	1553 032	393	1 801	88		8645 034
23	1016 695	4294 307	897 188	263	495			6208 948
23.5	770 530	2065 668	34 525	38	200			2870 961
24	378 547	1412 731						1791 278
24.5	152 715	254 574			96			407 385
25	58 556	81 821						140 377
25.5	8 585							8 585
26								
26.5								
27								
27.5								
28								
28.5								
29								
Total	13677 351	27128 294	42687 917	256 264	88 442	17 544	55546 321	139402 133
Mean L	21.3	22.5	17.9	17.8	20.9	19.9	17.6	19.0
sd	1.97	1.01	3.99	3.05	1.04	1.21	1.95	3.31
Catch	**1 245**	**2 896**	**2 574**	**13 986**	**7 407**	**1 322**	**2 783**	**32 212**

Table 5.4.1.1d: Sardine in VIIIc and IXa: Sardine length composition (thousands) by ICES subdivision in the fourth quarter 2009.

				Fourth Quarter				
Length	**VIIIc E**	**VIIIc W**	**IXa N**	**IXa CN**	**IXa CS**	**IXa S**	**IXa S (Ca)**	**Total**
7								
7.5								
8								
8.5								
9								
9.5					40			40
10				181	160			341
10.5				1 688	40			1 728
11				7 458	80			7 538
11.5				12 215	80			12 295
12			781 910	31 605		14		813 529
12.5			3170 688	46 306			20 504	3237 498
13			5102 357	71 923	40		5 858	5180 178
13.5		56 194	5775 403	36 571	40		115 115	5983 323
14		449 586	2221 263	19 541			120 506	2810 896
14.5		402 712	787 092	9 289	80		211 722	1410 895
15	55 316	805 437	1070 120	7 673			164 650	2103 196
15.5	55 316	1072 497	617 221	6 167	40		108 789	1860 030
16	65 421	2230 227	720 805	6 348	40	23	503 595	3526 459
16.5	126 240	1655 145	430 463	4 634	9	13	411 663	2628 167
17	82 973	3101 258	278 515	2 044	108	117	752 453	4217 468
17.5	53 739	2314 902	226 461	2 144	177	203	979 756	3577 382
18	28 276	3348 425	126 973	3 918	403	280	3555 096	7063 370
18.5	130 511	1400 856	203 177	6 508	1 189	519	6131 018	7873 778
19	293 594	1125 520	151 309	6 752	4 012	1 308	7922 816	9505 310
19.5	662 016	534 128	191 913	11 392	8 508	2 300	5905 658	7315 915
20	1748 379	393 984	220 664	15 303	13 229	3 315	3394 117	5788 991
20.5	1933 405	222 495	735 534	14 400	10 369	3 595	2618 139	5537 937
21	3067 048	203 830	1461 678	10 387	10 516	2 763	436 928	5193 149
21.5	2714 254	456 611	1799 563	8 196	4 925	1 282		4984 831
22	3061 087	705 258	2608 137	6 839	2 833	656		6384 810
22.5	1971 218	402 712	2021 997	4 246	667	333		4401 173
23	1689 701	56 194	2124 631	3 119	307	69		3874 021
23.5	829 062	168 592	1091 508	1 928	27	35		2091 152
24	433 483	56 194	539 759	695				1030 131
24.5	179 377	112 399	71 278	59				363 113
25	38 808	56 194						95 002
25.5	7 785							7 785
26								
26.5								
27								
27.5								
28								
28.5								
29								
Total	19227 009	21331 350	34530 419	359 529	57 920	16 824	33358 383	108881 433
Mean L	21.7	18.	17.1	15.3	20.5	20.5	19.1	18.7
sd	1.43	2.06	4.24	3.45	1.28	1.07	1.16	3.15
Catch	**1 756**	**1 147**	**1 885**	**12 193**	**4 511**	**1 289**	**1 989**	**24 770**

Table 5.4.1.2: Sardine in VIIIc and IXa: Catch in numbers (thousands) at age by quarter and by subdivision 2009

								First Quarter
Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
0								
1	4 332	859	352	110 779	1 714	340	6 727	125 103
2	3 839	1 145	554	4 839	6 912	3 421	4 999	25 710
3	2 571	823	400	3 063	11 621	2 111	3 150	23 739
4	2 978	1 462	1 344	8 547	26 338	4 262	1 899	46 831
5	3 734	2 819	3 066	6 164	12 378	3 600	1 066	32 827
6	2 316	232	412	684	3 579	1 098		8 322
7	1 847	158	339	422	3 271	952		6 987
8	1 276	103	223	331	3 332	420		5 686
9	543	48	114	205	327	19		1 255
10	108			140	206	46		500
11								
12								
Total	23 546	7 649	6 804	135 175	69 677	16 269	17 842	276 961
Catch (Tons)	1 640	591	563	3 486	4 256	896	730	12 161

								Second Quarter
Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
0								
1	8 935	56	3 561	11 291	957	697	10 542	36 038
2	3 524	1 430	4 686	9 988	5 466	4 322	8 663	38 080
3	1 282	2 069	2 366	7 575	8 690	5 465	2 693	30 141
4	689	4 512	5 079	29 849	17 086	4 265	1 650	63 129
5	1 020	9 355	11 165	30 620	16 918	1 968	853	71 899
6	607	843	989	2 198	4 509	800		9 945
7	473	505	824	2 332	3 244	754		8 132
8	296	386	427	1 400	2 292	302		5 102
9	122	174	50	302	532	49		1 228
10	9				192			201
11				1 264				1 264
12								
Total	16 956	19 329	29 147	96 819	59 884	18 624	24 401	265 160
Catch (Tons)	865	1 825	2 204	6 548	4 664	1 277	1 215	18 598

								Third Quarter
Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
0	341	24	17 890	50 942	619	230	12 442	82 488
1	2 526	2 971	8 117	75 774	5 466	3 919	30 585	129 357
2	5 058	3 887	3 495	47 222	14 695	3 793	5 581	83 731
3	1 079	4 986	4 373	14 168	18 859	4 372	2 639	50 477
4	1 739	10 016	4 779	42 364	33 242	2 323	3 529	97 992
5	1 523	3 318	2 474	21 606	5 574	1 652	614	36 762
6	465	833	643	1 781	5 517	343	157	9 740
7	427	869	515	1 121	2 898	280		6 110
8	393	224	401	633	1 489	632		3 772
9	126			653	41			821
10								
11					41			41
12								
Total	13 677	27 128	42 688	256 264	88 442	17 544	55 546	501 289
Catch (Tons)	1 245	2 896	2 574	13 986	7 407	1 322	2 782	32 211

								Fourth Quarter
Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
0	256	11 403	19 091	262 580	650	167	1 669	295 817
1	1 542	7 718	4 174	25 754	5 039	1 194	17 917	63 340
2	8 419	460	1 751	14 676	14 199	3 523	5 071	48 098
3	2 461	449	1 791	5 012	5 654	2 416	3 184	20 967
4	3 544	788	2 622	18 536	11 298	3 142	4 092	44 021
5	1 680	283	3 133	29 671	16 522	3 380	1 028	55 697
6	460	96	733	2 079	1 822	2 013	397	7 600
7	392	91	669	799	1 650	548		4 150
8	347	43	565	423	562	440		2 380
9	126				236			362
10					289			289
11								
12								
Total	19 227	21 331	34 530	359 529	57 920	16 824	33 358	542 720
Catch (Tons)	2 505	1 147	1 885	12 193	4 511	1 289	1 989	25 518

								Whole Year
Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
0	597	11 427	36 981	313 522	1 268	397	14 111	378 304
1	17 335	11 605	16 204	223 597	13 177	6 150	65 771	353 839
2	20 840	6 921	10 486	76 725	41 273	15 059	24 314	195 618
3	7 393	8 327	8 931	29 819	44 823	14 364	11 666	125 324
4	8 950	16 779	13 824	99 296	87 963	13 992	11 169	251 973
5	7 957	15 775	19 838	88 061	51 393	10 600	3 561	197 185
6	3 848	2 004	2 778	6 742	15 427	4 254	554	35 607
7	3 139	1 622	2 347	4 673	11 062	2 534		25 378
8	2 312	756	1 616	2 786	7 674	1 794		16 940
9	918	221	164	1 160	1 136	68		3 667
10	118			140	686	46		989
11				1 264	41			1 305
12								
Total	73 406	75 437	113 170	847 786	275 923	69 260	131 147	1 586 130
Catch (Tons)	5 505	6 459	7 226	36 212	20 838	4 785	6 716	87 740

Table 5.4.1.3: Sardine in VIIIc and IXa: Relative distribution of sardine catches. Upper pannel, relative contribution of each group within each subdivision. Lower pannel, relative contribution of each subdivision within each Age Group.

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
0	1%	15%	33%	37%	0%	1%	11%	24%
1	24%	15%	14%	26%	5%	9%	50%	22%
2	28%	9%	9%	9%	15%	22%	19%	12%
3	10%	11%	8%	4%	16%	21%	9%	8%
4	12%	22%	12%	12%	32%	20%	9%	16%
5	11%	21%	18%	10%	19%	15%	3%	12%
6+	14%	6%	6%	2%	13%	13%	0%	5%
	100%	100%	100%	100%	100%	100%	100%	100%

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
0	0%	3%	10%	83%	0%	0%	4%	100%
1	5%	3%	5%	63%	4%	2%	19%	100%
2	11%	4%	5%	39%	21%	8%	12%	100%
3	6%	7%	7%	24%	36%	11%	9%	100%
4	4%	7%	5%	39%	35%	6%	4%	100%
5	4%	8%	10%	45%	26%	5%	2%	100%
6+	13%	6%	8%	20%	44%	11%	1%	100%

Table 5.4.2.1: Sardine VIIIc and IXa: Sardine Mean length (cm) at age by quarter and by subdivision in 2009.

								First Quarter
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0								
1	13.9	15.8	18.9	14.1	16.2	16.2	16.0	14.3
2	19.9	20.7	19.7	16.7	19.0	18.4	17.4	18.4
3	20.7	21.8	21.5	20.0	19.9	19.8	18.2	19.9
4	21.7	22.3	22.4	20.3	20.4	19.8	20.3	20.5
5	22.1	22.6	22.5	20.5	20.7	20.1	20.8	21.1
6	22.6	23.1	22.8	21.5	21.0	20.6		21.6
7	22.9	23.3	22.8	21.2	21.2	20.9		21.7
8	23.0	23.1	23.2	21.5	21.1	20.8		21.7
9	23.6	23.6	23.7	22.0	22.7	21.8		23.1
10	25.2			23.1	23.4	21.4		23.5
11								
12								

								Second Quarter
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0								
1	15.7	17.0	18.6	16.8	16.9	16.8	17.7	17.0
2	19.4	21.3	19.7	18.1	19.8	18.7	18.0	18.8
3	20.5	22.2	21.0	20.0	20.5	19.6	18.6	20.2
4	21.4	22.5	21.3	20.7	20.9	19.9	19.3	20.8
5	21.8	22.7	21.4	20.9	20.9	20.3	20.4	21.2
6	22.4	23.1	22.0	21.3	21.4	20.5		21.6
7	22.6	23.2	21.9	21.4	21.6	20.6		21.6
8	23.0	23.1	22.1	21.1	21.7	21.2		21.7
9	23.4	23.5	23.5	21.7	22.0	20.3		22.3
10	25.0				23.3			23.4
11				23.9				23.9
12								

								Third Quarter
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	15.5	18.8	13.6	12.9	14.2	16.0	15.1	13.4
1	19.2	21.0	19.6	17.2	19.3	18.6	18.0	17.8
2	21.0	22.0	21.3	18.9	20.4	19.8	18.9	19.6
3	22.0	22.6	21.2	20.2	21.0	20.3	19.1	20.8
4	22.5	22.8	21.6	20.6	21.0	20.4	19.3	21.0
5	22.7	22.7	22.3	21.1	21.5	20.5	19.9	21.4
6	23.4	23.0	22.0	21.6	21.4	20.6	20.4	21.7
7	23.5	23.3	21.9	21.3	21.9	21.0		22.1
8	23.7	24.3	22.1	21.7	22.2	21.9		22.3
9	24.7			21.7	23.3			22.3
10								0.0
11					23.3			23.3
12								

								Fourth Quarter
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	16.3	16.9	13.7	13.4	12.3	16.6	17.0	13.6
1	20.0	18.2	18.2	19.0	19.2	19.2	18.9	18.9
2	21.2	21.8	22.1	20.0	20.1	19.8	19.5	20.3
3	22.0	22.4	21.9	21.0	20.4	20.3	19.8	20.8
4	22.4	22.5	22.2	21.2	20.9	20.7	19.7	21.2
5	22.8	22.6	22.9	21.5	21.0	21.0	20.1	21.4
6	23.5	23.4	23.0	22.7	21.7	21.3	20.5	22.0
7	23.5	23.7	23.1	22.9	21.6	21.5		22.3
8	23.7	24.7	23.2	23.4	22.3	21.7		22.8
9	24.6				22.3			23.1
10					22.5			22.5
11								
12								

								Whole Year
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	15.9	17.8	13.6	13.3	13.2	16.3	16.0	13.5
1	17.2	18.0	18.8	15.9	18.7	18.4	17.6	16.7
2	20.4	21.4	20.7	18.9	20.0	19.2	18.5	19.5
3	21.3	22.2	21.4	20.3	20.6	19.9	18.9	20.5
4	22.0	22.5	21.9	20.7	20.8	20.2	19.7	20.9
5	22.4	22.7	22.3	21.1	20.9	20.5	20.3	21.3
6	23.0	23.1	22.5	21.8	21.3	20.9	20.5	21.7
7	23.1	23.4	22.4	21.6	21.6	20.9		21.9
8	23.4	23.8	22.6	21.7	21.6	21.5		22.0
9	24.1	23.5	23.6	21.8	22.3	20.7		22.6
10	25.1			23.1	23.0	21.4		23.2
11				23.9	23.3			23.9
12								

Table 5.4.2.2: Sardine VIIIc and IXa: Sardine Mean weight (kg) at age by quarter and by subdivision in 2009.

	First Quarter							
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0								
1	0.025	0.032	0.052	0.020	0.033	0.032	0.032	0.021
2	0.062	0.068	0.059	0.033	0.051	0.045	0.040	0.047
3	0.069	0.079	0.076	0.055	0.058	0.056	0.045	0.058
4	0.081	0.084	0.086	0.057	0.062	0.056	0.059	0.063
5	0.083	0.087	0.087	0.059	0.064	0.059	0.062	0.069
6	0.089	0.093	0.090	0.067	0.067	0.062		0.075
7	0.092	0.096	0.090	0.065	0.070	0.065		0.076
8	0.093	0.094	0.095	0.067	0.069	0.064		0.075
9	0.099	0.100	0.101	0.072	0.084	0.073		0.091
10	0.120			0.083	0.092	0.070		0.094
11								
12								

	Second Quarter							
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0								
1	0.031	0.045	0.055	0.038	0.041	0.047	0.046	0.041
2	0.059	0.080	0.064	0.048	0.067	0.061	0.049	0.057
3	0.071	0.090	0.077	0.067	0.074	0.069	0.054	0.071
4	0.081	0.094	0.081	0.073	0.078	0.072	0.059	0.076
5	0.086	0.096	0.082	0.075	0.079	0.075	0.069	0.080
6	0.093	0.101	0.088	0.080	0.085	0.077		0.085
7	0.096	0.102	0.087	0.082	0.087	0.078		0.086
8	0.100	0.102	0.089	0.078	0.088	0.084		0.087
9	0.106	0.106	0.106	0.085	0.091	0.075		0.093
10	0.126				0.111			0.111
11				0.116				0.116
12								

	Third Quarter							
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	0.035	0.061	0.023	0.019	0.026	0.043	0.031	0.022
1	0.064	0.086	0.072	0.046	0.066	0.064	0.053	0.052
2	0.086	0.099	0.091	0.061	0.078	0.074	0.060	0.069
3	0.099	0.109	0.090	0.075	0.085	0.079	0.062	0.083
4	0.107	0.111	0.094	0.079	0.085	0.080	0.064	0.085
5	0.110	0.110	0.104	0.085	0.091	0.081	0.070	0.090
6	0.120	0.115	0.100	0.093	0.090	0.083	0.075	0.094
7	0.122	0.119	0.099	0.089	0.097	0.087		0.100
8	0.125	0.135	0.101	0.094	0.101	0.097		0.104
9	0.142			0.094	0.116			0.103
10								
11					0.116			0.116
12								

	Fourth Quarter							
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	0.038	0.043	0.021	0.018	0.017	0.049	0.045	0.019
1	0.071	0.054	0.059	0.059	0.063	0.066	0.057	0.059
2	0.083	0.098	0.103	0.070	0.073	0.071	0.062	0.074
3	0.093	0.107	0.101	0.081	0.076	0.075	0.065	0.080
4	0.099	0.110	0.106	0.085	0.082	0.079	0.064	0.085
5	0.111	0.113	0.117	0.089	0.083	0.080	0.067	0.089
6	0.124	0.126	0.119	0.107	0.092	0.083	0.071	0.097
7	0.128	0.132	0.121	0.111	0.090	0.084		0.103
8	0.131	0.150	0.122	0.119	0.099	0.087		0.111
9	0.148				0.099			0.116
10					0.103			0.103
11								
12								

	Whole Year							
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	0.036	0.043	0.022	0.018	0.022	0.046	0.033	0.020
1	0.038	0.061	0.065	0.034	0.059	0.061	0.051	0.041
2	0.076	0.090	0.079	0.059	0.070	0.063	0.052	0.065
3	0.082	0.101	0.088	0.072	0.075	0.071	0.056	0.075
4	0.093	0.104	0.091	0.077	0.077	0.070	0.062	0.079
5	0.095	0.098	0.091	0.081	0.078	0.072	0.067	0.083
6	0.098	0.107	0.099	0.090	0.083	0.077	0.072	0.088
7	0.101	0.112	0.100	0.087	0.085	0.076		0.089
8	0.105	0.113	0.104	0.087	0.083	0.084		0.090
9	0.113	0.104	0.102	0.088	0.092	0.074		0.097
10	0.121			0.083	0.102	0.070		0.100
11				0.116	0.116			0.116
12								

Table 5.6.1.1.a Sardine in VIIIc and IXa: Mean weights-at-age (kg) in the catch.

Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6+
1978	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1979	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1980	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1981	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1982	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1983	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1984	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1985	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1986	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1987	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1988	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1989	0.013	0.035	0.052	0.059	0.066	0.071	0.100
1990	0.024	0.032	0.047	0.057	0.061	0.067	0.100
1991	0.020	0.031	0.058	0.063	0.073	0.074	0.100
1992	0.018	0.045	0.055	0.066	0.070	0.079	0.100
1993	0.017	0.037	0.051	0.058	0.066	0.071	0.100
1994	0.020	0.036	0.058	0.062	0.070	0.076	0.100
1995	0.025	0.047	0.059	0.066	0.071	0.082	0.100
1996	0.019	0.038	0.051	0.058	0.061	0.071	0.100
1997	0.022	0.033	0.052	0.062	0.069	0.073	0.100
1998	0.024	0.040	0.055	0.061	0.064	0.067	0.100
1999	0.025	0.042	0.056	0.065	0.070	0.073	0.100
2000	0.025	0.037	0.056	0.066	0.071	0.074	0.100
2001	0.023	0.042	0.059	0.067	0.075	0.079	0.100
2002	0.028	0.045	0.057	0.069	0.075	0.079	0.100
2003	0.024	0.044	0.059	0.067	0.079	0.084	0.100
2004	0.020	0.040	0.056	0.066	0.072	0.082	0.100
2005	0.023	0.037	0.055	0.068	0.074	0.075	0.100
2006	0.031	0.042	0.056	0.068	0.073	0.078	0.100
2007	0.028	0.054	0.071	0.074	0.085	0.086	0.100
2008	0.025	0.043	0.066	0.074	0.075	0.083	0.100
2009	0.020	0.041	0.065	0.075	0.079	0.083	0.100

Table 5.6.1.1.b Sardine in VIIIc and IXa: Mean weights-at-age (kg) in the stock.

Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6+
1978	0	0.015	0.038	0.050	0.064	0.067	0.100
1979	0	0.015	0.038	0.050	0.064	0.067	0.100
1980	0	0.015	0.038	0.050	0.064	0.067	0.100
1981	0	0.015	0.038	0.050	0.064	0.067	0.100
1982	0	0.015	0.038	0.050	0.064	0.067	0.100
1983	0	0.015	0.038	0.050	0.064	0.067	0.100
1984	0	0.015	0.038	0.050	0.064	0.067	0.100
1985	0	0.015	0.038	0.050	0.064	0.067	0.100
1986	0	0.015	0.038	0.050	0.064	0.067	0.100
1987	0	0.015	0.038	0.050	0.064	0.067	0.100
1988	0	0.015	0.038	0.050	0.064	0.067	0.100
1989	0	0.015	0.038	0.050	0.064	0.067	0.100
1990	0	0.015	0.038	0.050	0.064	0.067	0.100
1991	0	0.019	0.042	0.050	0.064	0.071	0.100
1992	0	0.027	0.036	0.050	0.062	0.069	0.100
1993	0	0.022	0.045	0.057	0.064	0.073	0.100
1994	0	0.031	0.040	0.049	0.060	0.067	0.100
1995	0	0.029	0.050	0.062	0.072	0.079	0.100
1996	0	0.021	0.042	0.050	0.057	0.065	0.077
1997	0	0.024	0.032	0.052	0.059	0.064	0.072
1998	0	0.029	0.037	0.048	0.054	0.059	0.066
1999	0	0.024	0.040	0.052	0.059	0.067	0.073
2000	0	0.017	0.043	0.056	0.061	0.067	0.067
2001	0	0.021	0.041	0.060	0.071	0.072	0.074
2002	0	0.024	0.040	0.055	0.068	0.074	0.074
2003	0	0.019	0.043	0.053	0.065	0.070	0.076
2004	0	0.020	0.045	0.061	0.069	0.076	0.100
2005	0	0.019	0.045	0.059	0.068	0.073	0.079
2006	0	0.030	0.042	0.060	0.068	0.068	0.075
2007	0	0.039	0.054	0.062	0.070	0.076	0.077
2008	0	0.017	0.052	0.065	0.070	0.080	0.087
2009	0	0.020	0.053	0.060	0.065	0.069	0.076

Table 5.6.1.1.c. Sardine in VIIIc and IXa: Annual maturity ogives 1978 – 2009.

Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6+
1978	0.00	0.65	0.95	1.00	1.00	1.00	1.00
1979	0.00	0.65	0.95	1.00	1.00	1.00	1.00
1980	0.00	0.65	0.95	1.00	1.00	1.00	1.00
1981	0.00	0.65	0.95	1.00	1.00	1.00	1.00
1982	0.00	0.65	0.95	1.00	1.00	1.00	1.00
1983	0.00	0.65	0.95	1.00	1.00	1.00	1.00
1984	0.00	0.65	0.95	1.00	1.00	1.00	1.00
1985	0.00	0.65	0.95	1.00	1.00	1.00	1.00
1986	0.00	0.65	0.95	1.00	1.00	1.00	1.00
1987	0.00	0.65	0.95	1.00	1.00	1.00	1.00
1988	0.00	0.65	0.95	1.00	1.00	1.00	1.00
1989	0.00	0.23	0.83	0.91	0.92	0.94	0.98
1990	0.00	0.60	0.81	0.88	0.89	0.94	0.99
1991	0.00	0.74	0.91	0.96	0.97	1.00	1.00
1992	0.00	0.79	0.91	0.95	0.98	1.00	1.00
1993	0.00	0.47	0.93	0.94	0.97	0.99	1.00
1994	0.00	0.80	0.89	0.96	0.96	0.97	1.00
1995	0.00	0.73	0.98	0.97	0.99	1.00	1.00
1996	0.00	0.54	0.93	0.99	0.99	1.00	1.00
1997	0.00	0.64	0.94	1.00	1.00	1.00	0.99
1998	0.00	0.69	0.85	0.96	0.98	0.99	0.99
1999	0.00	0.84	0.99	1.00	1.00	1.00	1.00
2000	0.00	0.47	0.92	0.96	0.97	0.98	0.98
2001	0.00	0.43	0.82	0.94	0.97	0.97	0.98
2002	0.00	0.59	0.93	0.98	0.99	1.00	1.00
2003	0.00	0.50	0.94	0.97	0.99	0.99	0.99
2004	0.00	0.49	0.94	0.97	0.98	0.99	1.00
2005	0.00	0.19	0.85	0.97	0.99	0.99	1.00
2006	0.00	0.89	0.99	1.00	1.00	1.00	1.00
2007	0.00	0.75	0.98	0.99	1.00	1.00	1.00
2008	0.00	0.29	0.94	0.99	1.00	1.00	1.00
2009	0.00	0.47	0.99	1.00	1.00	1.00	1.00

Table 5.6.1.1d

Run id 20100624 203608.529								
Stocknumbers at age,								
in area 1								
Data by 1. Jan., except at youngest age which are								
at recruitment time								
	1978	1979	1980	1981	1982	1983	1984	1985
0	11748	13802	15005	9527	6953	20110	8560	6543
1	7611	9326	11007	12154	7556	5610	16306	7010
2	3723	4176	5165	6504	6923	4451	3422	9851
3	1248	1804	2049	2750	3236	3517	2387	1911
4	633	623	905	1143	1442	1736	1940	1336
5	194	331	318	512	622	790	984	1125
6	81	146	248	327	461	596	783	1023
	1986	1987	1988	1989	1990	1991	1992	1993
0	5460	9148	5884	5853	5532	12766	10582	4721
1	5369	4437	7249	4641	4636	4380	10152	8504
2	4350	3226	2683	4368	2784	2737	2740	6457
3	5534	2306	1723	1433	2306	1440	1566	1607
4	1074	2992	1237	909	735	1121	768	861
5	776	576	1628	662	476	354	602	421
6	1265	1150	985	1439	1167	873	713	769
	1994	1995	1996	1997	1998	1999	2000	2001
0	4631	3920	4980	3888	3965	3855	10763	7393
1	3808	3816	3244	4101	3169	3166	3096	8680
2	5388	2562	2569	2196	2684	2028	2019	1972
3	3705	3387	1607	1603	1296	1529	1181	1185
4	832	2110	1888	868	805	618	774	610
5	448	471	1177	1014	415	364	295	378
6	681	691	706	1089	1175	922	763	635
	2002	2003	2004	2005	2006	2007	2008	2009
0	4074	2861	11945	5343	1688	2326	4005	6273
1	6039	3351	2333	9704	4372	1394	1892	3186
2	5581	3928	2170	1505	6309	2888	917	1190
3	1204	3469	2439	1336	929	3950	1788	525
4	660	700	2020	1407	792	563	2358	978
5	324	369	394	1121	816	473	331	1278
6	617	592	599	610	1054	1188	1056	842
2010								
0	4000							
1	4991							
2	2005							
3	681							
4	287							
5	530							
6	1222							

Table 5.6.1.1e

Total yearly fishing mortalities at age								
	1978	1979	1980	1981	1982	1983	1984	1985
0	0.07	0.06	0.05	0.07	0.05	0.04	0.03	0.03
1	0.27	0.26	0.20	0.23	0.20	0.16	0.17	0.15
2	0.39	0.38	0.30	0.37	0.35	0.29	0.25	0.25
3	0.36	0.36	0.25	0.32	0.29	0.26	0.25	0.25
4	0.32	0.34	0.24	0.28	0.27	0.24	0.22	0.21
5	0.32	0.34	0.24	0.28	0.27	0.24	0.22	0.21
6	0.27	0.29	0.19	0.25	0.26	0.24	0.22	0.18
Fref	0.35	0.36	0.26	0.31	0.30	0.26	0.23	0.23
	1986	1987	1988	1989	1990	1991	1992	1993
0	0.04	0.07	0.07	0.07	0.07	0.06	0.05	0.05
1	0.18	0.17	0.18	0.18	0.20	0.14	0.12	0.13
2	0.30	0.30	0.30	0.31	0.33	0.23	0.20	0.23
3	0.28	0.29	0.31	0.34	0.39	0.30	0.27	0.33
4	0.29	0.28	0.30	0.32	0.40	0.29	0.27	0.32
5	0.29	0.28	0.30	0.32	0.40	0.29	0.27	0.32
6	0.21	0.21	0.22	0.23	0.27	0.18	0.16	0.18
Fref	0.29	0.29	0.30	0.32	0.38	0.28	0.25	0.30
	1994	1995	1996	1997	1998	1999	2000	2001
0	0.03	0.02	0.03	0.04	0.06	0.05	0.05	0.04
1	0.07	0.07	0.06	0.09	0.12	0.12	0.12	0.11
2	0.13	0.14	0.14	0.20	0.23	0.21	0.20	0.16
3	0.23	0.25	0.29	0.36	0.41	0.35	0.33	0.25
4	0.24	0.25	0.29	0.41	0.46	0.41	0.39	0.30
5	0.24	0.25	0.29	0.41	0.46	0.41	0.39	0.30
6	0.11	0.11	0.11	0.13	0.14	0.12	0.11	0.09
Fref	0.21	0.22	0.25	0.34	0.39	0.35	0.33	0.26
	2002	2003	2004	2005	2006	2007	2008	2009
0	0.03	0.04	0.04	0.04	0.03	0.04	0.06	0.06
1	0.10	0.10	0.11	0.10	0.08	0.09	0.13	0.13
2	0.15	0.15	0.16	0.15	0.14	0.15	0.23	0.23
3	0.21	0.21	0.22	0.19	0.17	0.19	0.27	0.27
4	0.25	0.25	0.26	0.21	0.19	0.20	0.28	0.28
5	0.25	0.25	0.26	0.21	0.19	0.20	0.28	0.28
6	0.08	0.08	0.09	0.08	0.08	0.09	0.14	0.14
Fref	0.22	0.21	0.22	0.19	0.17	0.18	0.27	0.27
	2010							
0	0.06							
1	0.13							
2	0.23							
3	0.27							
4	0.28							
5	0.28							
6	0.14							
Fref	0.27							

Table 5.6.1.1f

YEARLY CATCH NUMBERS BY FLEET 1								
IN AREA 1								
**************************								
Modelled catches by year, fleet 1 area 1								
	1978	1979	1980	1981	1982	1983	1984	1985
0	691	757	620	568	310	811	270	195
1	1547	1840	1681	2167	1172	731	2231	823
2	1045	1142	1150	1721	1745	970	655	1847
3	328	470	394	640	705	702	454	358
4	149	155	165	239	295	316	322	220
5	46	82	58	107	127	144	163	185
6	17	31	37	62	91	110	131	148
	1986	1987	1988	1989	1990	1991	1992	1993
0	209	553	380	356	339	732	510	213
1	757	606	1009	661	714	489	1007	869
2	981	712	592	997	673	480	434	1121
3	1178	503	394	353	644	319	317	387
4	234	625	271	212	209	243	156	204
5	169	120	357	155	135	77	122	100
6	209	186	168	256	234	124	89	109
	1994	1995	1996	1997	1998	1999	2000	2001
0	120	87	132	139	213	188	486	251
1	210	210	164	317	300	307	304	785
2	582	282	292	338	480	332	319	255
3	660	653	342	415	376	390	286	229
4	151	404	409	250	258	178	213	137
5	81	90	255	292	133	105	81	85
6	62	64	62	111	132	89	70	48
	2002	2003	2004	2005	2006	2007	2008	2009
0	112	101	462	173	41	88	228	357
1	492	285	204	794	303	102	203	341
2	648	458	267	183	697	343	160	208
3	198	566	414	201	125	574	368	108
4	126	131	394	233	115	88	497	206
5	62	69	77	185	118	74	70	269
6	40	41	46	42	68	91	115	92
2010								
0	227							
1	534							
2	350							
3	140							
4	60							
5	112							
6	133							
Observed catches by year, fleet 1 area 1								
	1978	1979	1980	1981	1982	1983	1984	1985
0	869	674	857	1026	62	1070	118	268
1	2297	1536	2037	1935	795	577	3312	564
2	947	956	1562	1734	1869	857	487	2371
3	295	431	379	679	709	803	502	469
4	137	189	157	195	353	324	301	294
5	42	93	47	105	131	141	179	201
6	16	36	30	76	129	139	117	103
	1986	1987	1988	1989	1990	1991	1992	1993
0	304	1437	521	248	258	1581	498	88
1	755	543	990	566	602	477	1002	566
2	1027	667	535	909	517	436	451	1082
3	919	569	439	389	707	407	340	521
4	333	535	304	221	295	266	186	257
5	196	154	292	200	151	75	111	114
6	167	171	189	245	248	105	81	120
	1994	1995	1996	1997	1998	1999	2000	2001
0	121	31	277	209	449	246	490	220
1	60	189	101	549	366	475	355	1172
2	542	281	348	453	502	362	314	256
3	1094	830	515	391	352	340	256	196
4	272	473	653	337	234	177	194	126
5	113	70	197	225	179	106	98	75
6	72	64	47	70	106	73	64	50
	2002	2003	2004	2005	2006	2007	2008	2009
0	107	198	590	169	18	199	298	378
1	587	319	181	1006	250	82	219	354
2	754	446	264	266	777	313	183	196
3	181	518	387	207	129	536	370	125
4	112	114	378	191	108	80	412	252
5	56	61	78	117	121	83	65	197
6	40	51	55	46	81	121	109	84
Residuals: log (Obs/mod), fleet 1 area 1								
	1978	1979	1980	1981	1982	1983	1984	1985
0	0.23	-0.12	0.32	0.59	-1.61	0.28	-0.83	0.32
1	0.4	-0.18	0.19	-0.11	-0.39	-0.24	0.4	-0.38
2	-0.1	-0.18	0.31	0.01	0.07	-0.12	-0.3	0.25
3	-0.11	-0.09	-0.04	0.06	0.01	0.13	0.1	0.27
4	-0.08	0.2	-0.05	-0.2	0.18	0.03	-0.07	0.29
5	-0.08	0.12	-0.21	-0.02	0.03	-0.02	0.09	0.08
6	-0.04	0.15	-0.22	0.2	0.35	0.23	-0.11	-0.36
	1986	1987	1988	1989	1990	1991	1992	1993
0	0.37	0.96	0.32	-0.36	-0.27	0.77	-0.02	-0.88
1	0	-0.11	-0.02	-0.16	-0.17	-0.02	0	-0.43
2	0.05	-0.07	-0.1	-0.09	-0.26	-0.1	0.04	-0.04
3	-0.25	0.12	0.11	0.1	0.09	0.24	0.07	0.3
4	0.35	-0.16	0.11	0.04	0.34	0.09	0.18	0.23
5	0.15	0.25	-0.2	0.26	0.11	-0.02	-0.1	0.13
6	-0.23	-0.08	0.12	-0.04	0.06	-0.17	-0.09	0.1
	1994	1995	1996	1997	1998	1999	2000	2001
0	0.01	-1.03	0.74	0.41	0.74	0.27	0.01	-0.13
1	-1.25	-0.11	-0.48	0.55	0.2	0.44	0.16	0.4
2	-0.07	0	0.18	0.29	0.04	0.09	-0.02	0.01
3	0.5	0.24	0.41	-0.06	-0.07	-0.14	-0.11	-0.15
4	0.59	0.16	0.47	0.3	-0.1	-0.01	-0.09	-0.08
5	0.33	-0.25	-0.26	-0.26	0.3	0.01	0.19	-0.12
6	0.15	0	-0.27	-0.46	-0.22	-0.2	-0.09	0.05
	2002	2003	2004	2005	2006	2007	2008	2009
0	-0.05	0.67	0.24	-0.02	-0.82	0.82	0.27	0.06
1	0.18	0.11	-0.12	0.24	-0.19	-0.21	0.08	0.04
2	0.15	-0.03	-0.01	0.38	0.11	-0.09	0.13	-0.06
3	-0.09	-0.09	-0.07	0.03	0.03	-0.07	0.01	0.15
4	-0.11	-0.14	-0.04	-0.2	-0.06	-0.09	-0.19	0.2
5	-0.1	-0.12	0.02	-0.46	0.02	0.12	-0.07	-0.31
6	0	0.21	0.17	0.09	0.18	0.28	-0.06	-0.09

Table 5.6.1.1g

RESULTS FOR SURVEY FLEET 1								
**********************************								
Modelled surveys indices by year, fleet 1								
	1994	1995	1996	1997	1998	1999	2000	2001
0	-1	-1	-1	-1	-1	-1	-1	-1
1	-1	-1	5156	6489	5001	4997	4886	13721
2	-1	-1	2522	2141	2605	1975	1968	1932
3	-1	-1	1465	1448	1163	1382	1070	1084
4	-1	-1	1964	891	821	634	796	634
5	-1	-1	1225	1041	423	374	304	393
6	-1	-1	320	492	530	417	346	288
	2002	2003	2004	2005	2006	2007	2008	2009
0	-1	-1	-1	-1	-1	-1	-1	-1
1	9561	5303	3690	15365	6935	2210	2983	5023
2	5483	3858	2129	1478	6206	2837	892	1158
3	1107	3190	2240	1231	858	3644	1632	479
4	690	732	2110	1477	834	592	2454	1018
5	339	386	411	1177	860	497	345	1331
6	281	269	272	278	480	540	477	381
2010								
0	-1							
1	7869							
2	1951							
3	622							
4	299							
5	552							
6	552							
Observed surveys indices by year, fleet 1								
	1994	1995	1996	1997	1998	1999	2000	2001
0	-1	-1	-1	-1	-1	-1	-1	-1
1	-1	-1	1636	6401	2146	5926	6673	19660
2	-1	-1	2136	3501	4118	2713	2456	1037
3	-1	-1	2505	1677	2271	1595	1657	702
4	-1	-1	3257	1384	1468	969	999	480
5	-1	-1	600	1426	1206	624	721	374
6	-1	-1	37	264	1005	533	681	250
	2002	2003	2004	2005	2006	2007	2008	2009
0	-1	-1	-1	-1	-1	-1	-1	-1
1	13041	5885	-1	22922	7455	1645	4020	7096
2	6998	4584	-1	1302	8309	3085	1098	667
3	1164	3568	-1	685	577	4001	998	419
4	1131	1009	-1	763	443	637	1972	691
5	566	570	-1	653	578	283	211	773
6	442	338	-1	369	607	704	494	497
2010								
0	-1							
1	7340							
2	702							
3	537							
4	188							
5	269							
6	366							
Survey residuals by year, fleet 1								
	1994	1995	1996	1997	1998	1999	2000	2001
0	0	0	0	0	0	0	0	0
1	0	0	-1.15	-0.01	-0.85	0.17	0.31	0.36
2	0	0	-0.17	0.49	0.46	0.32	0.22	-0.62
3	0	0	0.54	0.15	0.67	0.14	0.44	-0.43
4	0	0	0.51	0.44	0.58	0.42	0.23	-0.28
5	0	0	-0.71	0.31	1.05	0.51	0.86	-0.05
6	0	0	-2.16	-0.62	0.64	0.25	0.68	-0.14
	2002	2003	2004	2005	2006	2007	2008	2009
0	0	0	0	0	0	0	0	0
1	0.31	0.1	0	0.4	0.07	-0.3	0.3	0.35
2	0.24	0.17	0	-0.13	0.29	0.08	0.21	-0.55
3	0.05	0.11	0	-0.59	-0.4	0.09	-0.49	-0.13
4	0.49	0.32	0	-0.66	-0.63	0.07	-0.22	-0.39
5	0.51	0.39	0	-0.59	-0.4	-0.56	-0.49	-0.54
6	0.45	0.23	0	0.29	0.24	0.27	0.03	0.27
2010								
0	0							
1	-0.07							
2	-1.02							
3	-0.15							
4	-0.46							
5	-0.72							
6	-0.41							

Table 5.6.1.1h

SPAWNING STOCK BIOMASS					
Year	Modelled		Expected	Observed/q	
	Total		By fleet	By fleet	
1978	306	1	306	-1	
1979	376	1	376	-1	
1980	465	1	465	-1	
1981	583	1	583	-1	
1982	616	1	616	-1	
1983	572	1	572	-1	
1984	626	1	626	-1	
1985	731	1	731	-1	
1986	681	1	681	-1	
1987	576	1	576	-1	
1988	502	1	502	-1	
1989	421	1	421	-1	
1990	383	1	383	-1	
1991	389	1	389	-1	
1992	507	1	507	-1	
1993	564	1	564	-1	
1994	569	1	569	-1	
1995	625	1	625	-1	
1996	425	1	425	-1	
1997	377	1	377	320	
1998	326	1	326	-1	
1999	327	1	327	251	
2000	263	1	263	-1	
2001	305	1	305	-1	
2002	444	1	444	424	
2003	454	1	454	-1	
2004	455	1	455	-1	
2005	370	1	370	391	
2006	586	1	586	-1	
2007	567	1	567	-1	
2008	421	1	421	641	
2009	317	1	317	-1	
2010	319	1	319	-1	

Table 5.6.1.1i

SUMMARY TABLE				
Year	Recruits	SSB	F	Catch
	age 0		2-5	SOP
1978	11748	306	0.35	173
1979	13802	375	0.36	162
1980	15004	465	0.26	204
1981	9527	583	0.31	242
1982	6952	615	0.30	214
1983	20110	571	0.26	176
1984	8559	626	0.23	215
1985	6542	730	0.23	219
1986	5459	680	0.29	192
1987	9148	576	0.29	176
1988	5884	501	0.30	157
1989	5852	421	0.32	146
1990	5531	383	0.38	142
1991	12766	389	0.28	132
1992	10581	506	0.25	131
1993	4721	563	0.30	144
1994	4631	569	0.21	138
1995	3919	624	0.22	126
1996	4979	424	0.25	115
1997	3887	376	0.34	117
1998	3965	326	0.39	112
1999	3855	327	0.35	95
2000	10763	263	0.33	87
2001	7393	305	0.26	102
2002	4074	444	0.22	101
2003	2860	454	0.21	99
2004	11945	454	0.22	98
2005	5342	369	0.19	97
2006	1688	586	0.17	88
2007	2326	566	0.18	97
2008	4004	420	0.27	103
2009	6273	316	0.27	88
2010	4000	319	0.27	0

Table 5.6.2.1: Sardine in VIIIc and IXa: Coefficient of variation of estimated parameters from the inverse Hessian

Run id 20100624 194244.094			
Coeff. of variation and correlations from inverse Hessian			
	Parameter	Param. value	CV
1	Initial number 1978 age1	7610.90	0.046
2	Initial number 1978 age2	3722.96	0.036
3	Initial number 1978 age3	1248.17	0.042
4	Initial number 1978 age4	633.23	0.118
5	Initial number 1978 age5	193.64	0.083
6	Initial number 1978 age6	80.96	0.131
7	Recruitment age0 1978	11748.21	0.036
8	Recruitment age0 1979	13802.36	0.044
9	Recruitment age0 1980	15004.96	0.037
10	Recruitment age0 1981	9527.04	0.037
11	Recruitment age0 1982	6952.94	0.052
12	Recruitment age0 1983	20110.18	0.078
13	Recruitment age0 1984	8559.56	0.070
14	Recruitment age0 1985	6542.72	0.100
15	Recruitment age0 1986	5459.86	0.101
16	Recruitment age0 1987	9148.10	0.097
17	Recruitment age0 1988	5884.38	0.078
18	Recruitment age0 1989	5852.99	0.054
19	Recruitment age0 1990	5531.73	0.077
20	Recruitment age0 1991	12766.21	0.069
21	Recruitment age0 1992	10581.47	0.097
22	Recruitment age0 1993	4721.08	0.030
23	Recruitment age0 1994	4631.05	0.035
24	Recruitment age0 1995	3919.64	0.049
25	Recruitment age0 1996	4979.49	0.039
26	Recruitment age0 1997	3887.90	0.059
27	Recruitment age0 1998	3965.32	0.088
28	Recruitment age0 1999	3855.41	0.092
29	Recruitment age0 2000	10763.08	0.062
30	Recruitment age0 2001	7393.25	0.027
31	Recruitment age0 2002	4074.06	0.104
32	Recruitment age0 2003	2860.78	0.100
33	Recruitment age0 2004	11945.39	0.050
34	Recruitment age0 2005	5342.65	0.088
35	Recruitment age0 2006	1688.08	0.107
36	Recruitment age0 2007	2326.39	0.032
37	Recruitment age0 2008	4004.47	0.075
38	Recruitment age0 2009	6273.20	0.177
39	F-select year 1978 age 0	0.43	0.105
40	F-select year 1978 age 1	0.89	0.043
41	F-select year 1978 age 2	1.30	0.153
42	F-select year 1978 age 3	1.20	0.092
43	F-select year 1978 age 4	1.05	0.046
44	F-select year 1978 age 6	0.90	0.055
45	F year 1978	0.35	0.038
46	F year 1979	0.36	0.040
47	F year 1980	0.26	0.100
48	F year 1981	0.31	0.030
49	F year 1982	0.30	0.017
50	F year 1983	0.26	0.070
51	F year 1984	0.23	0.079
52	F year 1985	0.23	0.025
53	F year 1986	0.29	0.087
54	F year 1987	0.29	0.035
55	F year 1988	0.30	0.038
56	F year 1989	0.32	0.036
57	F year 1990	0.38	0.097
58	F year 1991	0.28	0.082
59	F year 1992	0.25	0.081
60	F year 1993	0.30	0.081
61	F year 1994	0.21	0.031
62	F year 1995	0.22	0.042
63	F year 1996	0.25	0.097
64	F year 1997	0.34	0.077
65	F year 1998	0.39	0.037
66	F year 1999	0.35	0.091
67	F year 2000	0.33	0.049
68	F year 2001	0.26	0.086
69	F year 2002	0.22	0.068
70	F year 2003	0.21	0.046
71	F year 2004	0.22	0.103
72	F year 2005	0.19	0.061
73	F year 2006	0.17	0.083
74	F year 2007	0.18	0.058
75	F year 2008	0.27	0.044
76	F year 2009	0.27	0.018
77	Joint Spring Acoustic age 1	1.67	0.064
78	Joint Spring Acoustic age 2	1.04	0.075
79	Joint Spring Acoustic age 3	0.98	0.217
80	Joint Spring Acoustic age 4	1.12	0.025
81	Joint Spring Acoustic age 6	0.48	0.073
82	Q for ssb year 1988	1.07	0.035

Table 5.7.1.1: Sardine in VIIIc and IXa: Input data for short term catch predictions

MFDP version 1a

Run: sarsoth2010

Time and date: 21:23 26/06/2010

Fbar age range: 2-5

2010

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	4569	0.33	0.00	0.25	0.25	0.000	0.06	0.024
1	4991	0.33	0.51	0.25	0.25	0.025	0.12	0.046
2	2005	0.33	0.93	0.25	0.25	0.053	0.20	0.067
3	681	0.33	0.98	0.25	0.25	0.062	0.24	0.074
4	287	0.33	0.99	0.25	0.25	0.068	0.25	0.080
5	530	0.33	0.99	0.25	0.25	0.075	0.25	0.084
6	1222	0.33	0.99	0.25	0.25	0.080	0.12	0.100

2011

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	4569	0.33	0.00	0.25	0.25	0.000	0.06	0.024
1	.	0.33	0.51	0.25	0.25	0.025	0.12	0.046
2	.	0.33	0.93	0.25	0.25	0.053	0.20	0.067
3	.	0.33	0.98	0.25	0.25	0.062	0.24	0.074
4	.	0.33	0.99	0.25	0.25	0.068	0.25	0.080
5	.	0.33	0.99	0.25	0.25	0.075	0.25	0.084
6	.	0.33	0.99	0.25	0.25	0.080	0.12	0.100

2012

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	4569	0.33	0.00	0.25	0.25	0.000	0.06	0.024
1	.	0.33	0.51	0.25	0.25	0.025	0.12	0.046
2	.	0.33	0.93	0.25	0.25	0.053	0.20	0.067
3	.	0.33	0.98	0.25	0.25	0.062	0.24	0.074
4	.	0.33	0.99	0.25	0.25	0.068	0.25	0.080
5	.	0.33	0.99	0.25	0.25	0.075	0.25	0.084
6	.	0.33	0.99	0.25	0.25	0.080	0.12	0.100

Input units are millions and kg - output in kilotonnes

Table 5.7.1.2: Sardine in VIIIc and IXa: Results for short term catch predictions.

MFDP version 1a

Run: sarsoth2010

Sardine (VIIIc+IXa), 2006 WG

Time and date: 21:23 26/06/2010

Fbar age range: 2-5

2010

Biomass	SSB	FMult	FBar	Landings
432	317	1	0.24	83

2011					2012	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
445	360	0	0.00	0	494	405
.	359	0.1	0.02	9	486	396
.	357	0.2	0.05	19	479	388
.	355	0.3	0.07	28	471	380
.	354	0.4	0.10	37	464	371
.	352	0.5	0.12	46	457	364
.	350	0.6	0.14	54	450	356
.	349	0.7	0.17	63	443	348
.	347	0.8	0.19	71	437	341
.	345	0.9	0.22	80	430	334
.	344	1	0.24	88	424	327
.	342	1.1	0.26	96	417	320
.	341	1.2	0.29	104	411	314
.	339	1.3	0.31	111	405	307
.	337	1.4	0.33	119	399	301
.	336	1.5	0.36	126	393	294
.	334	1.6	0.38	134	387	288
.	333	1.7	0.41	141	381	282
.	331	1.8	0.43	148	376	277
.	330	1.9	0.45	155	370	271
.	328	2	0.48	162	365	265

Input units are millions and kg - output in kilotonnes

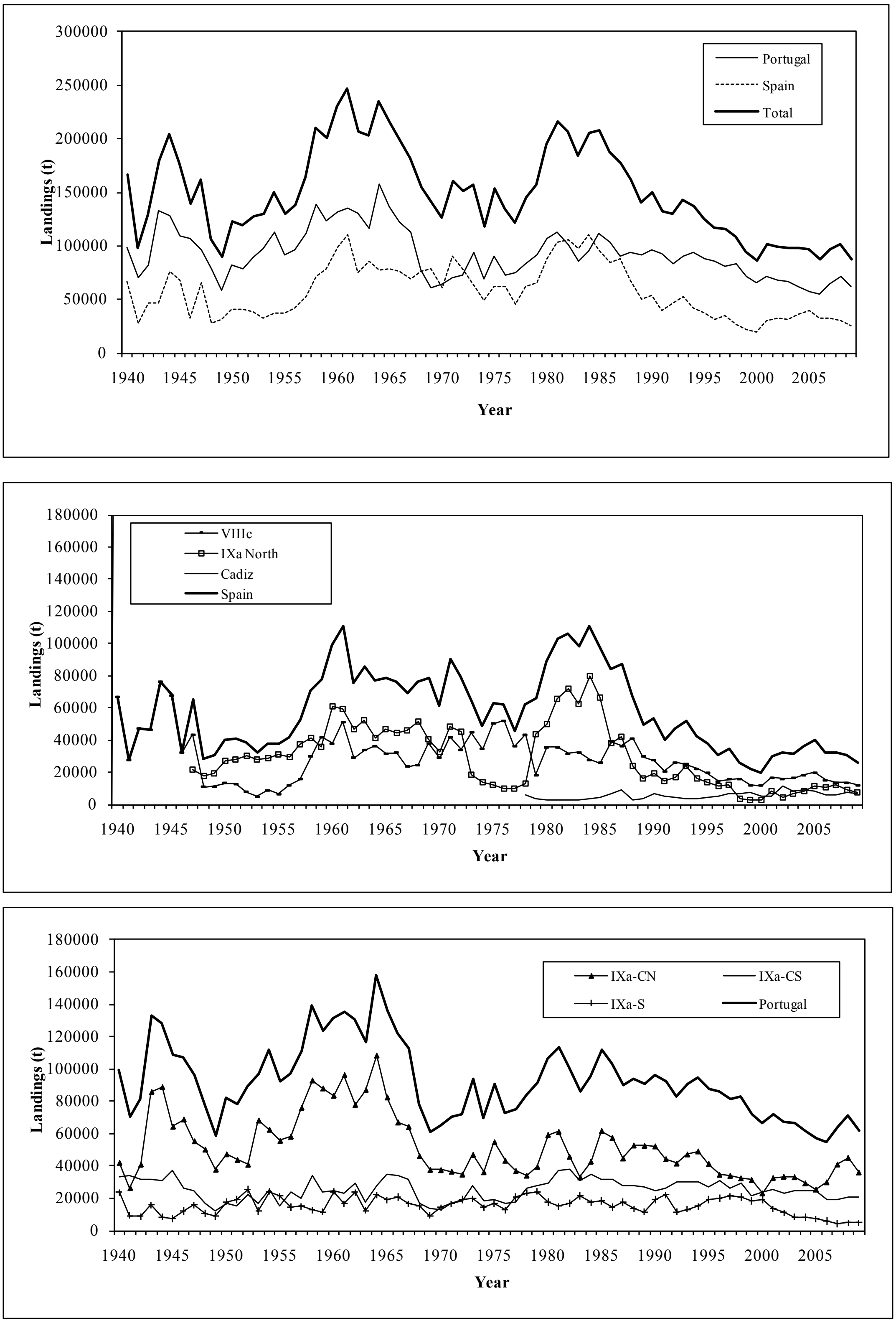


Figure 5.2.1: Sardine in VIIIc and IXa: Annual landings of sardine, by country (upper pannel) and by ICES subdivision and country

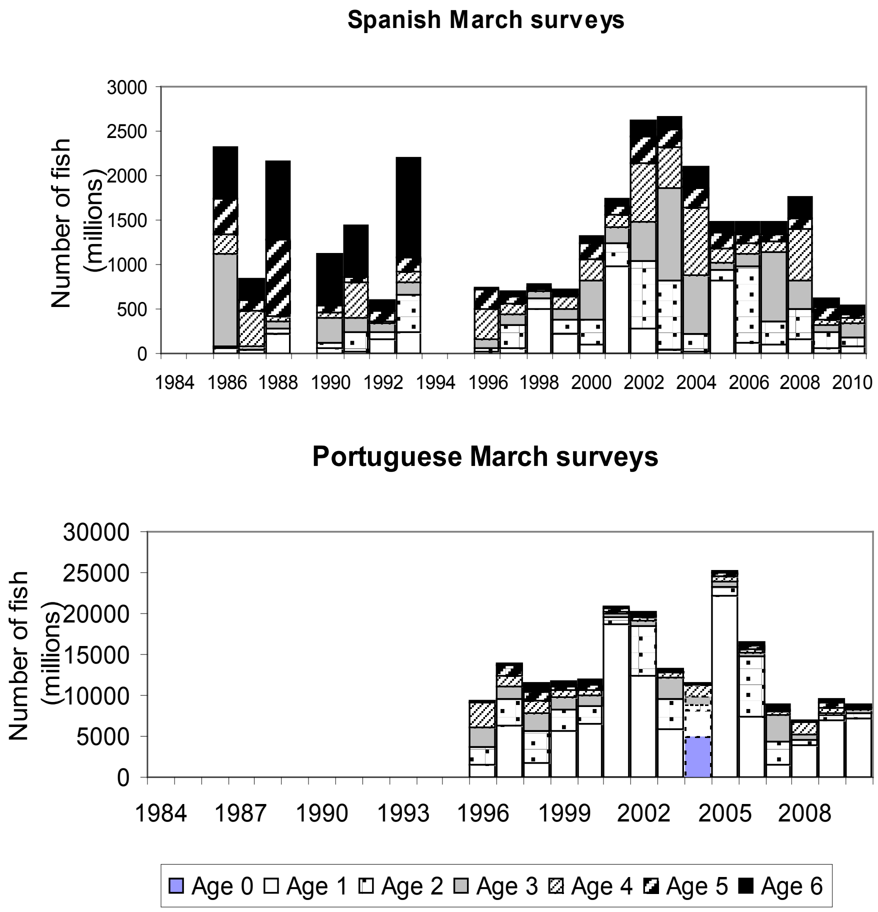


Figure 5.3.1: Sardine in VIIIc and IXa: Total abundance and age structure (numbers) of sardine estimated in the acoustic surveys. The Spanish March survey series covers area VIIIc and IXa-N (Galicia) and the Portuguese March surveys covers the Portuguese area and the Gulf of Cadiz (Subdivisions IXa-CN, IXa-CS, IXa-S-Algarve and IXa-S-Cadiz). Estimates from Portuguese acoustic surveys in June 2004 are considered as indications of the population abundance and are not included in assessment.

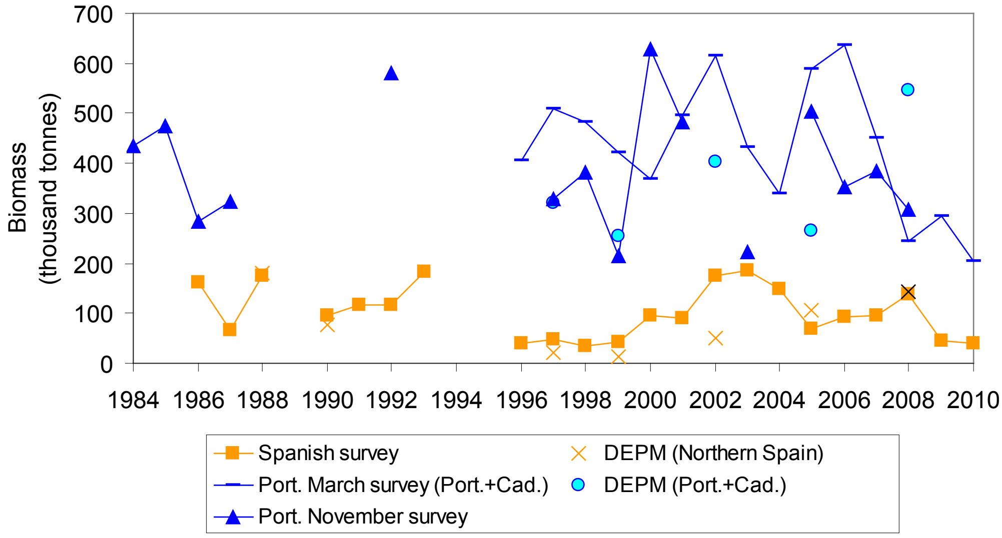


Figure 5.3.2: Sardine in VIIIc and IXa: Total sardine biomass (thousand tonnes) estimated in the different series of acoustic surveys and SSB estimates from the DEPM series covering the northern area and the west and southern area of the stock.

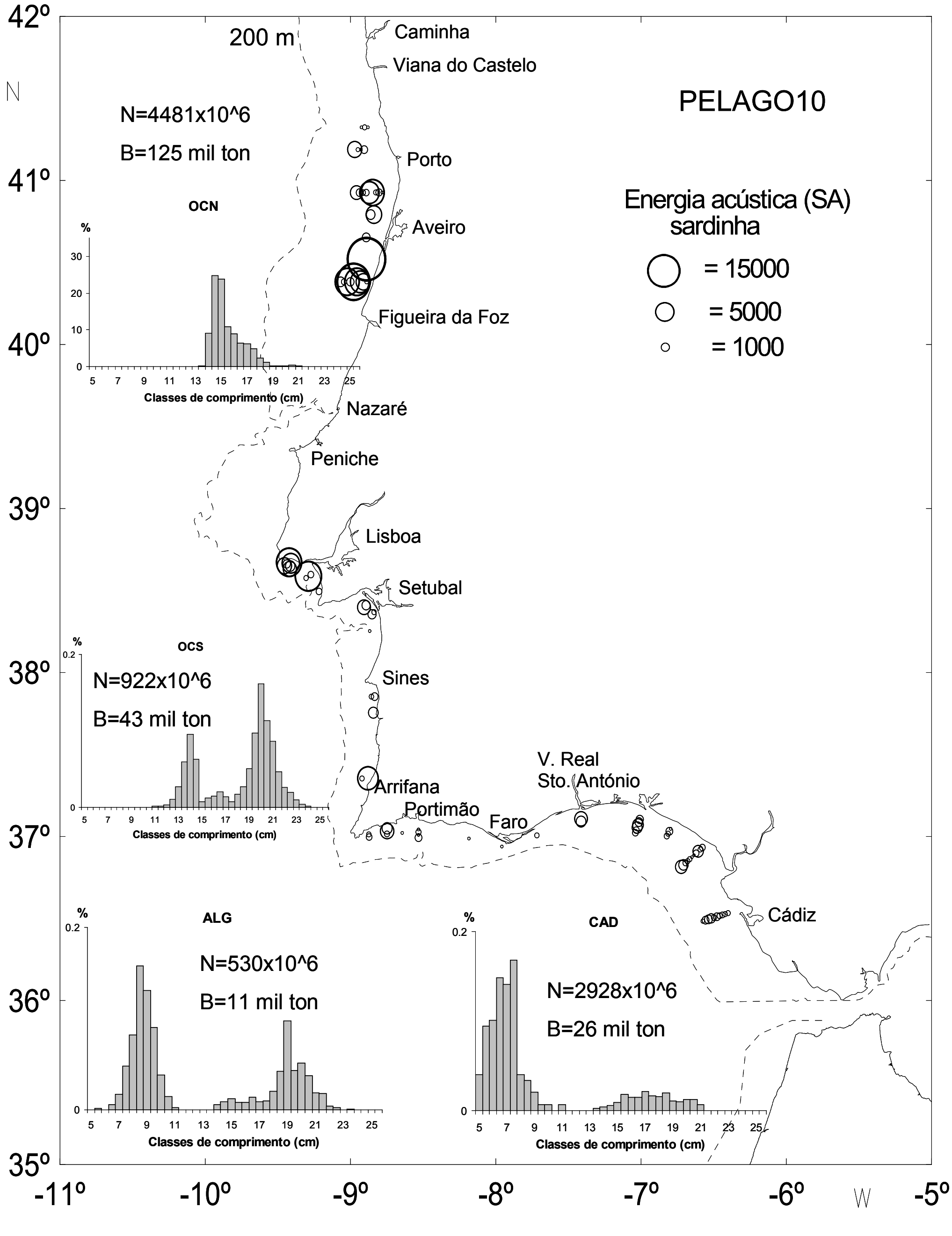


Figure 5.3.2.1.1: Sardine in VIIIc and IXa: Portuguese spring acoustic survey in 2010. Acoustic energy by nautical mile and abundance (in millions), biomass (in thousand tons) and length structure by area. Circle area is proportional to the acoustic energy (S_A m²/nm²).

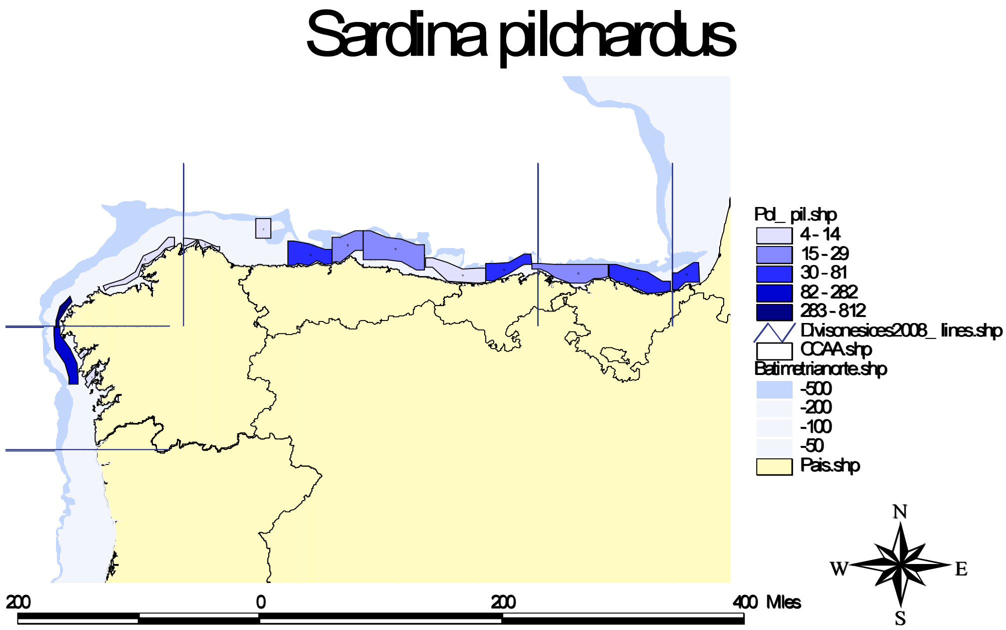
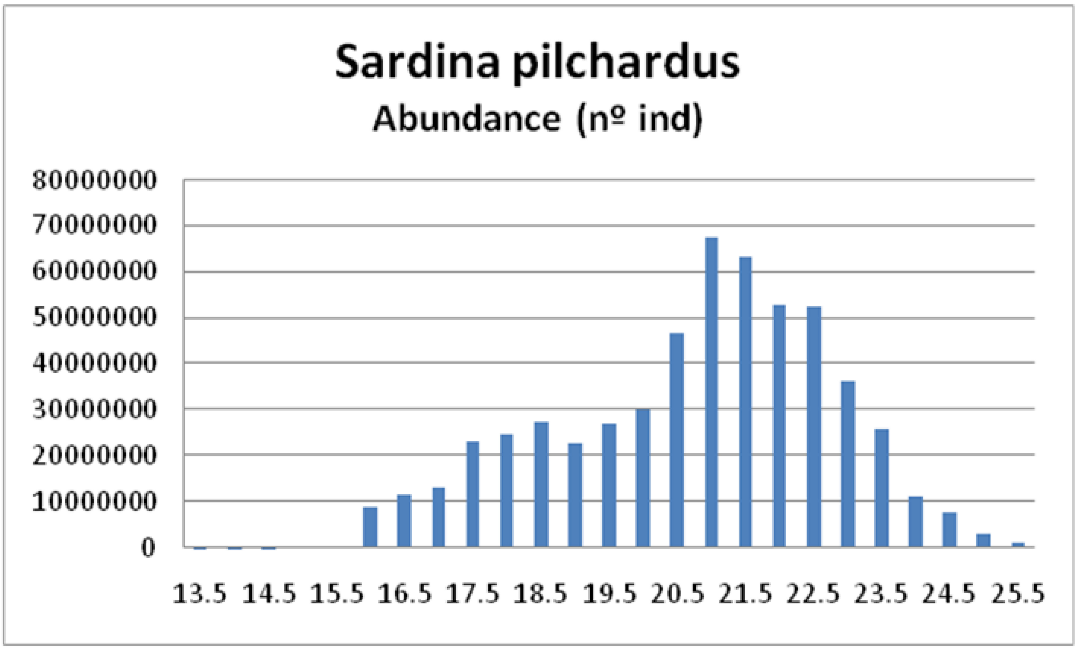


Figure 5.3.2.2.1: Sardine in VIIIc and IXa: Spatial distribution of energy allocated to sardine during the PELACUS0410 cruise. Polygons are drawn to encompass the observed echoes, and polygon colour indicates integrated energy in m² within each polygon.



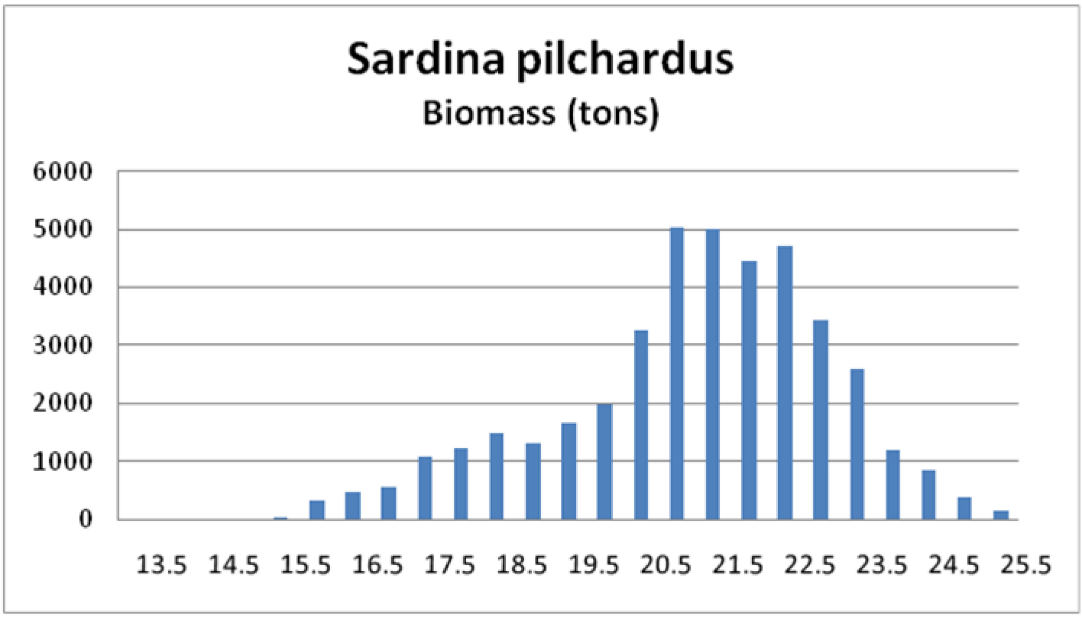


Figure 5.3.2.2.2: Sardine in VIIIc and IXa: Sardine length distribution (cm) in numbers (top) and biomass in tonnes (bottom) during the PELACUS0410 survey.

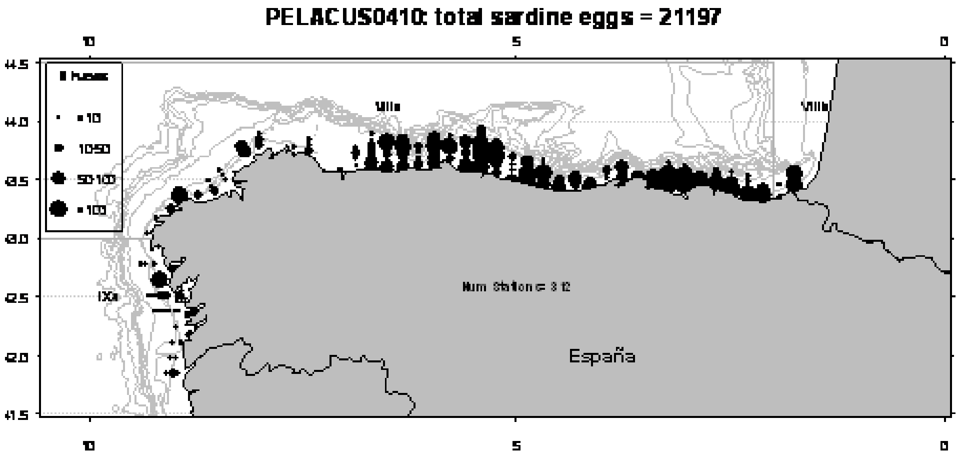


Figure 5.3.2.2.3: Sardine in VIIIc and IXa: Total number of sardine eggs obtained during the PELACUS0410 survey. Circles indicate positive stations with diameter proportional to egg abundance.

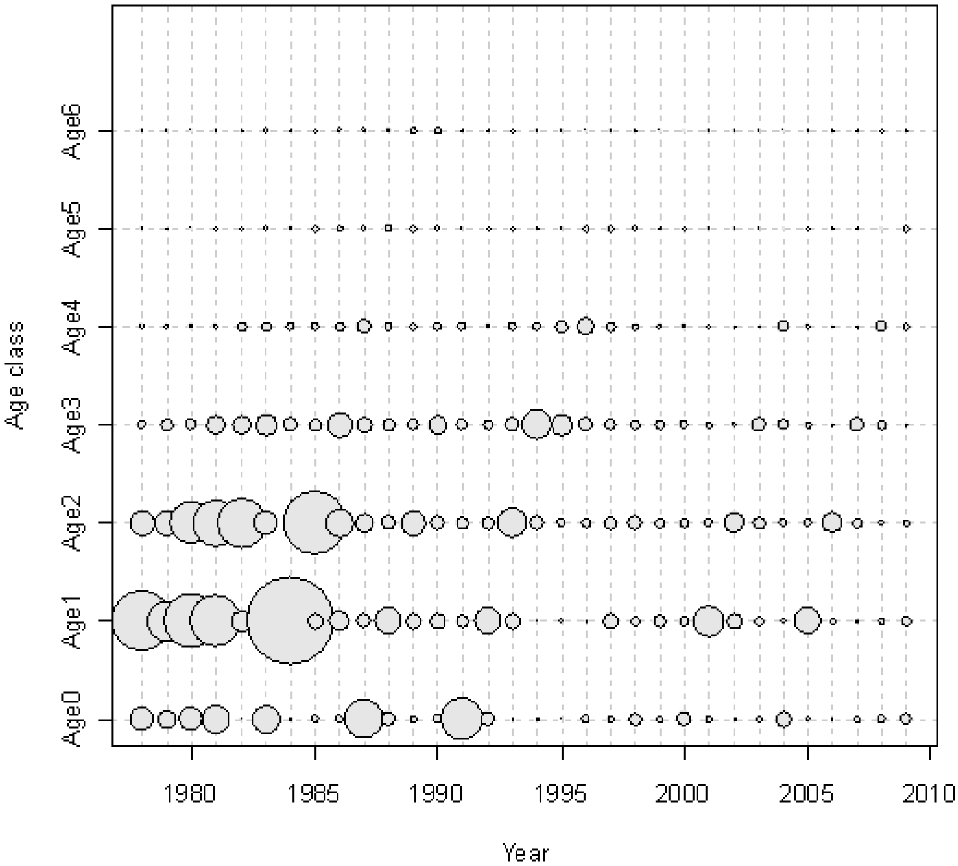


Figure 5.6.1.1: Sardine in VIIIc and IXa: Catches-at-age for 1978-2009.

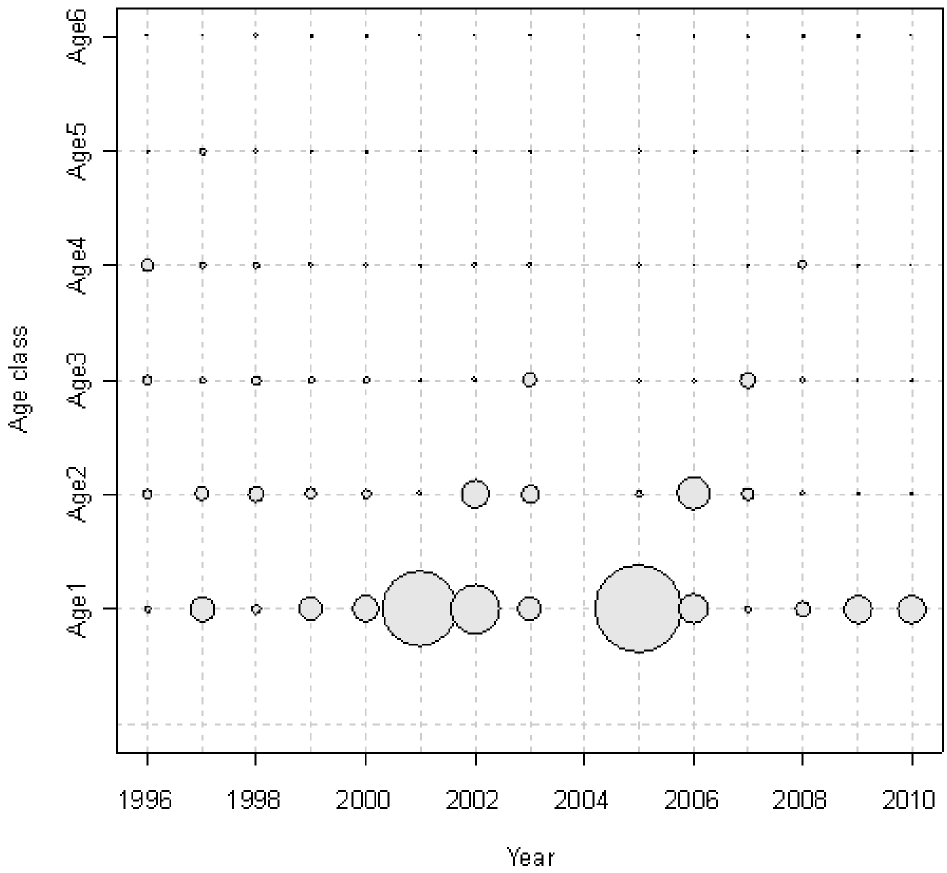


Figure 5.6.1.2: Sardine in VIIIc and IXa: Abundance-at-age in the joint Spanish-Portuguese spring acoustic survey 1996-2010.

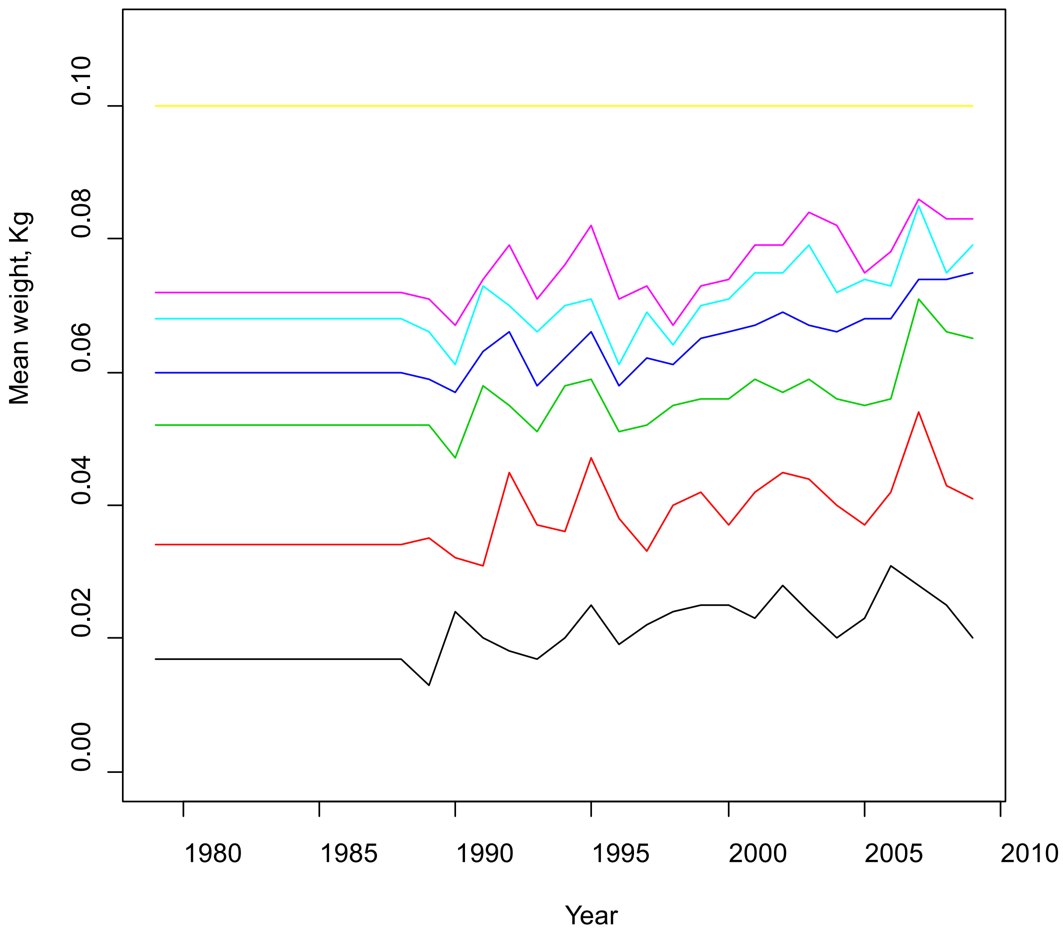


Figure 5.6.1.3: Sardine VIIIc and IXa: Mean weight-at-age in the catches 1978 – 2009.

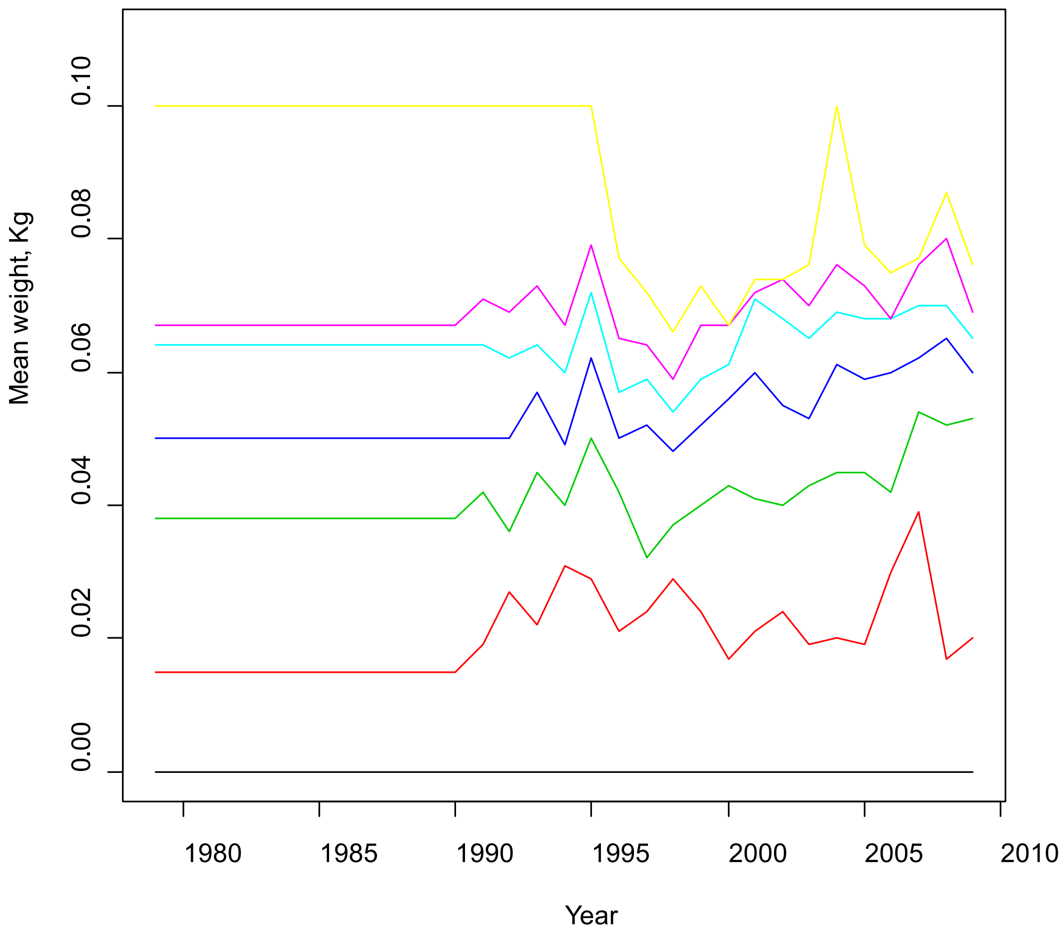


Figure 5.6.1.4: Sardine VIIIc and IXa: Mean weight-at-age in the stock 1978 – 2009.

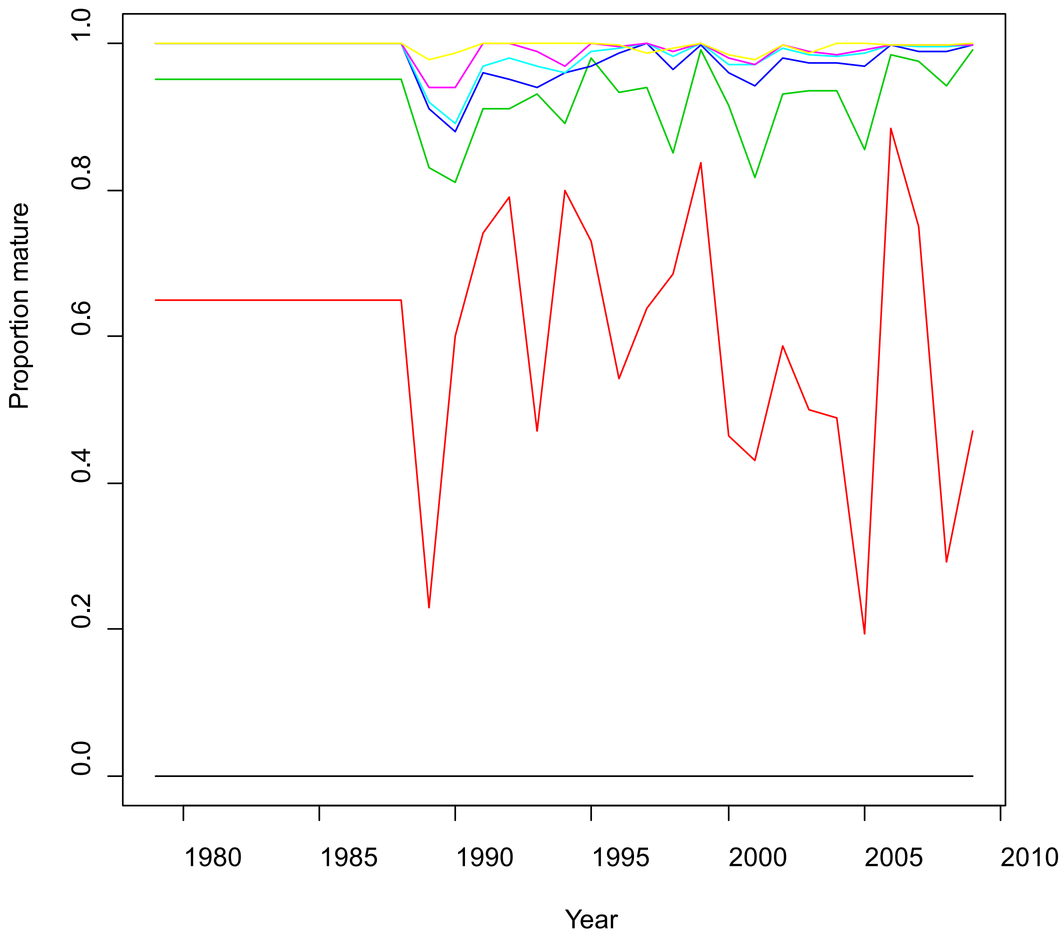


Figure 5.6.1.5: Sardine VIIIc and IXa: Maturity ogives 1978 – 2009.

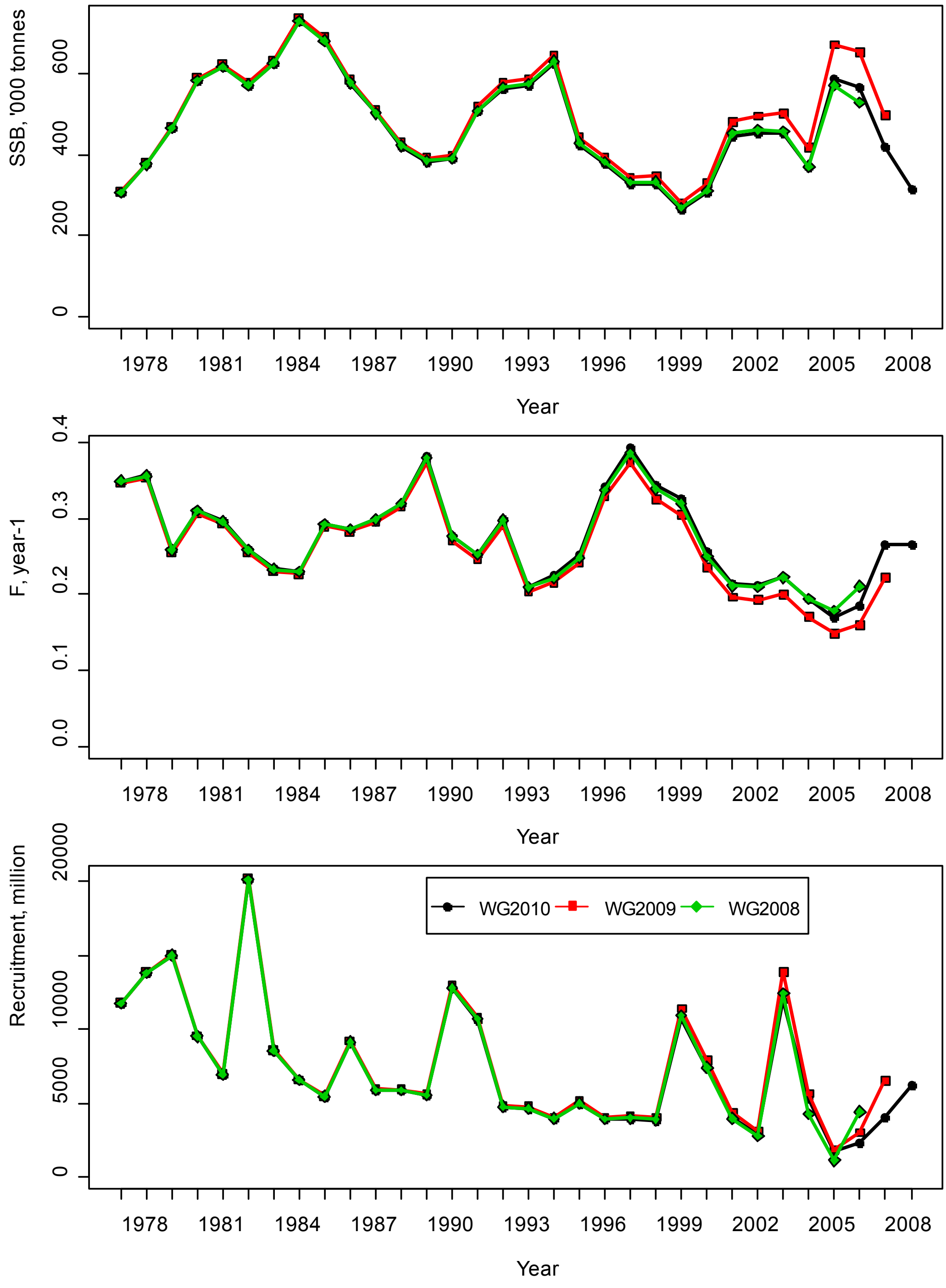


Figure 5.6.2.1: Sardine VIIIc and IXa: SSB (top), F (middle) and recruitment (bottom) trajectories in the period 1978 – 2009 from the sardine AMCI final assessment (WG2010). The WG2009 and WG2008 assessments are shown for comparison.

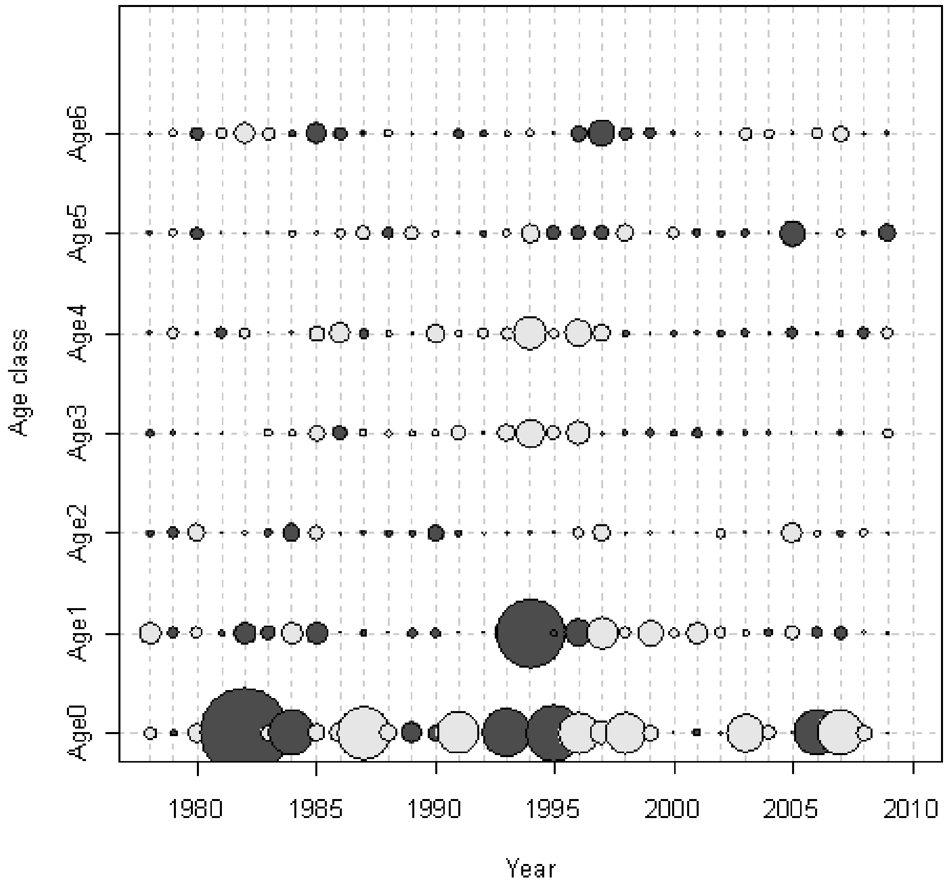


Figure 5.6.2.2: Sardine VIIIc and IXa: Catch residuals 1978 – 2009 (unweighted, negative in black, positive in grey) for the final AMCI assessment. Values are in the range [-1.6, 0.96], the 25% and 75% quantiles are -0.1, 0.2, respectively.

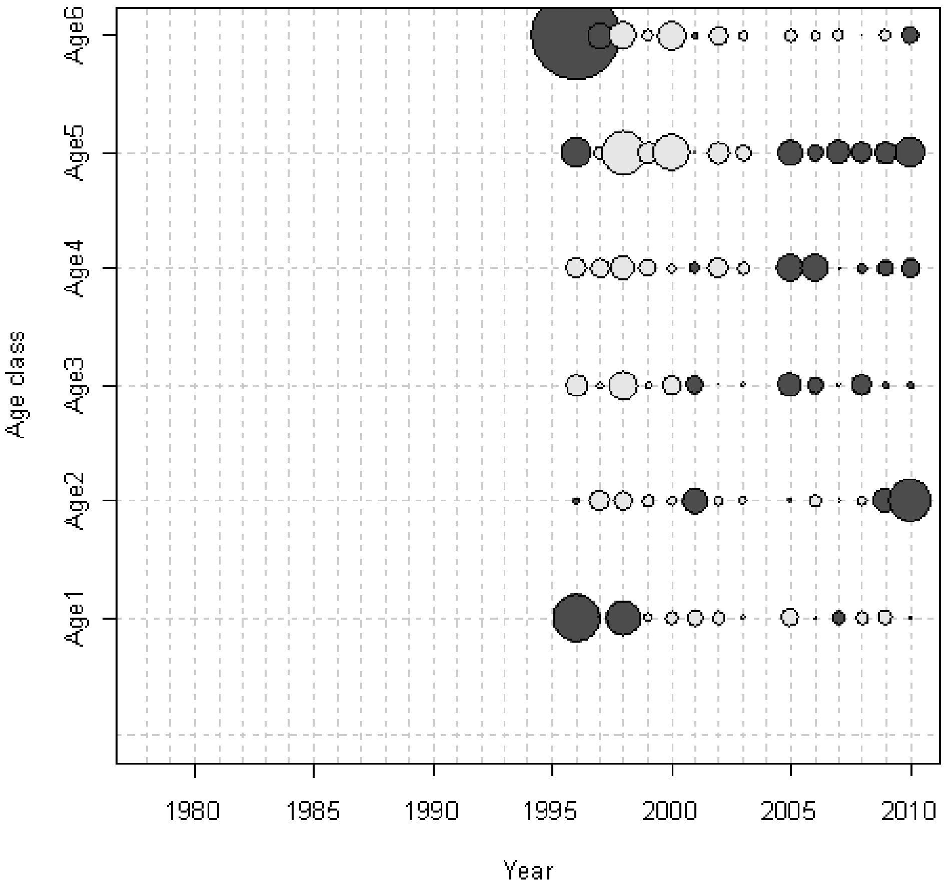


Figure 5.6.2.3: Sardine VIIIc and IXa: Survey residuals (for the combined Iberian spring acoustic survey 1996 - 2010) for the final assessment. Negative residuals in black, positive in grey, values in the range [-2.2, 1.0], the 25% and 75% quantiles are -0.26, 0.31, respectively.

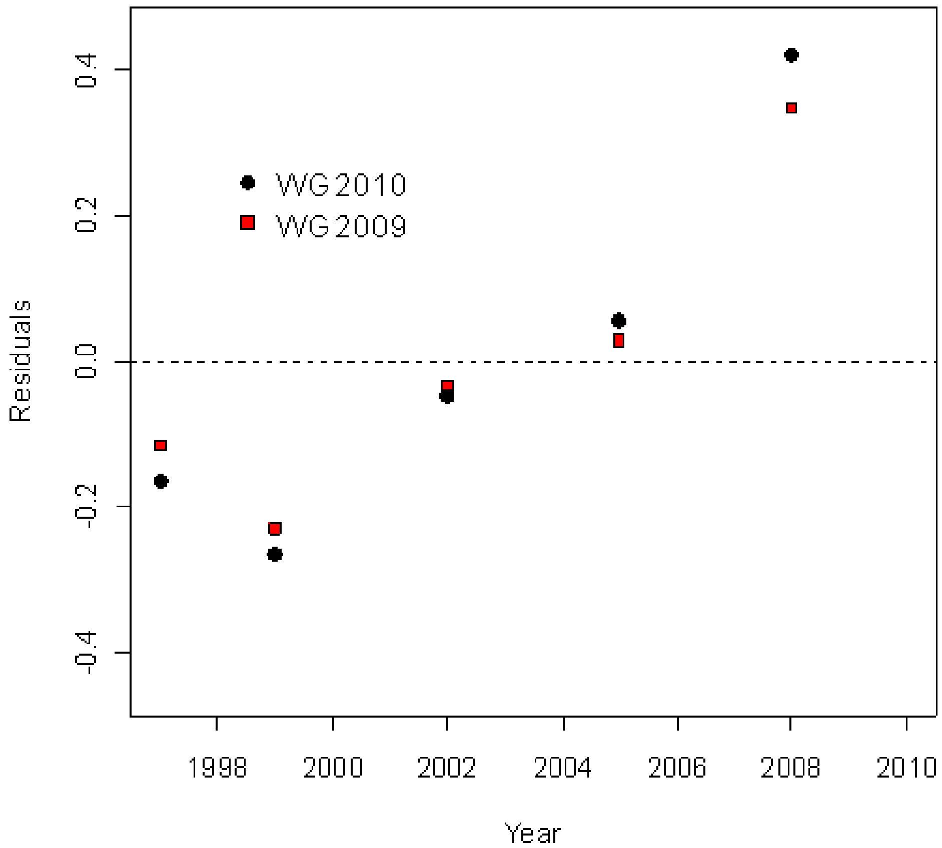


Figure 5.6.2.4: Sardine VIIIc and IXa: DEPM survey residuals (unweighted, log-scale) in the final assessment model. Residuals from the 2009 assessment are shown for comparison.

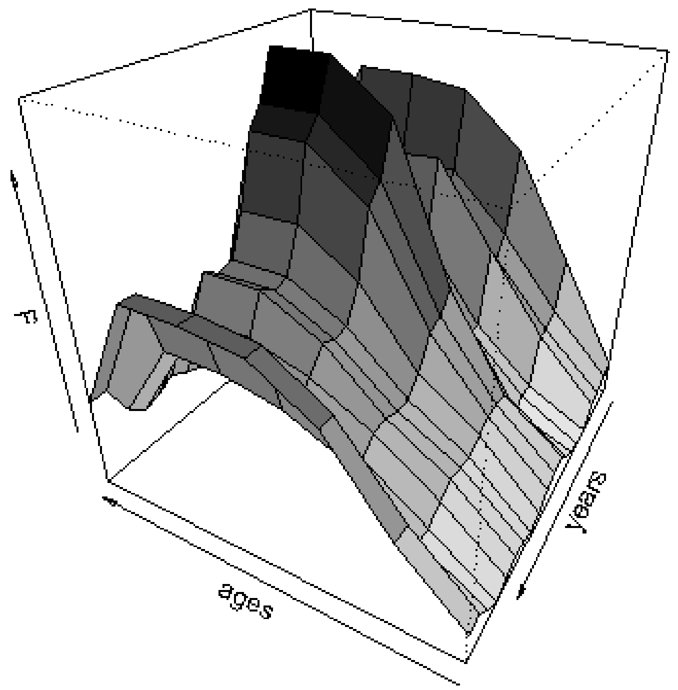


Figure 5.6.2.5: Sardine VIIIc and IXa: Year and age specific fishing mortalities estimated by the final assessment model for the period 1978 – 2009 and age groups 0-6+.

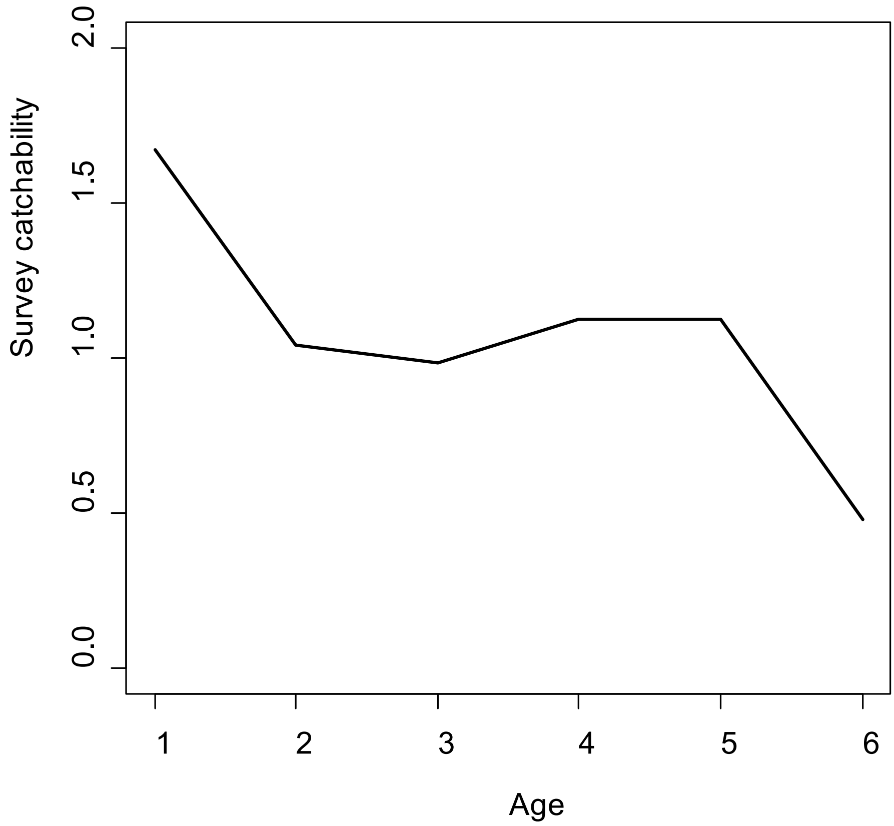


Figure 5.6.2.6: Sardine VIIIc and IXa: Survey catchability for ages 1 to 6+ in the final assessment model.

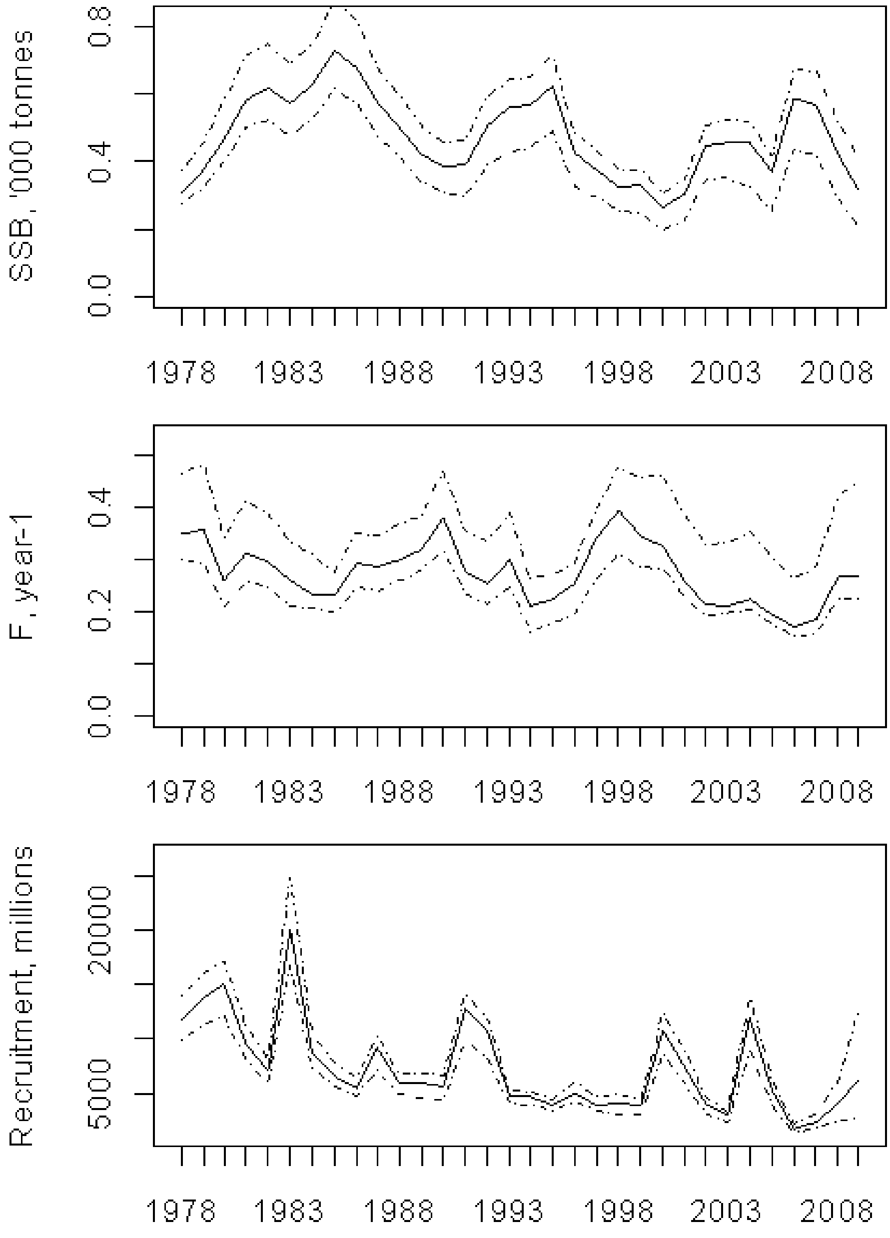


Figure 5.6.2.7: Sardine VIIIc and IXa: Bootstrap trajectories of SSB, recruitment and F for the final assessment model. Dotted lines represent the 5% and 95% quantiles of the distribution.

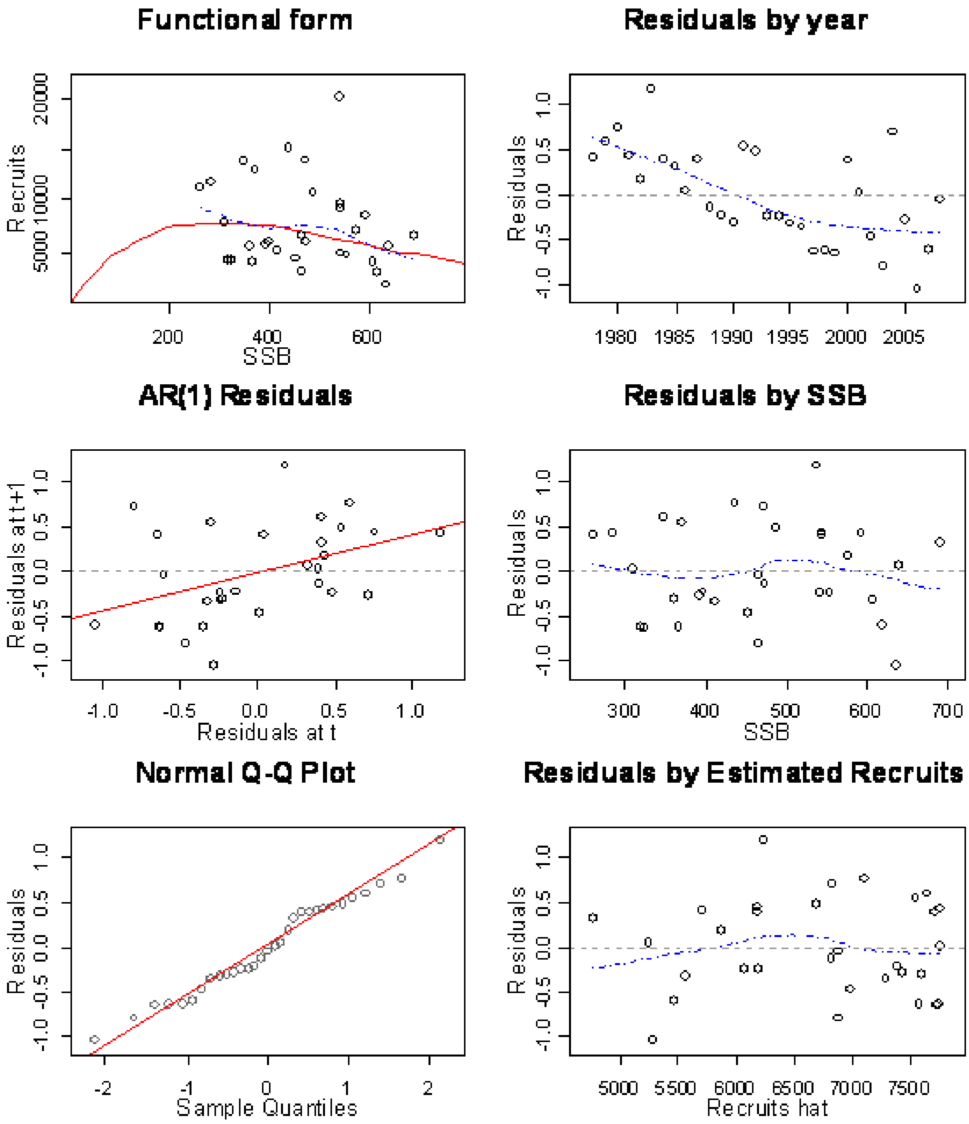


Figure 5.7.1. Fitted model and residual plots for a Ricker curve fitted to sardine stock-recruitment data 1978 – 2008.

6 Stock Data Problems Relevant to Data Collection – EG NAME: WGANSA (wg on the assessment of anchovy and sardine)

Stock	Data Problem	How to be addressed in DCR	By who
Stock name	***Data problem identification***	***Description of data problem and recommend solution***	***Who should take care of the recommended solution and who should be notified on this data issue.***
Sardine in subareas VIII and VII	*Sardine populations are expanding and fisheries increasing to the North of Iberian Region. Advice may be required in the future for this species in those areas. But the survey coverage of the sardine north of the Iberian Peninsula is incomplete.*	*DEPM and acoustic surveys in Subarea VIII usually leave northwest of division VIIIa uncovered, due to have anchovy as primary target species. And no survey is made in subarea VII for sardine. DEPM surveys for sardine around the Iberian Peninsula are made every three years. Next one will be in 2011.* ***The proposal is to coordinate research institutes in 2011 to expand current acoustic and DEPM surveys in VIII to completely cover that region and for relevant parts of subarea VII to be covered in cooperation with interested northern countries.A standardized survey is planned in 2011 by CEFAS coordinated with PELGAS11. WGANSA welcomes and supports this initiative***	*ICES ACOM, SSGESST and PGCCDBS should support the idea of such a Survey and communicate to RCM and to relevant bodies accordingly* *ACOM to contact National delegates about this initiative and to encourage attending WGACEGG in 2010 to further concrete and planify it for 2011* *The same idea was recommended by WGANSA and WGACEGGs. in 2009*
Sardine in VIIIc and IXa ***Anchovy in IXa.***	*Both for sardine and anchovy in the area, an indication of the strength of incoming year classes would improve the advice on management.* *Such a survey would also support studies of ecological process in the area and their relation to recruitment*	***The WG recommends DCR to economically support an autumn acoustic survey for provision of recruitment indices for sardine and anchovy*** ***Since the recruitment area for sardine is located in Western Portugal and Gulf of Cadiz, and the Gulf of Cadiz is the main location of anchovy in Division IXa, this problem could be addressed by a coordinated survey between IPIMAR and IEO.***	*ICES ACOM, SSGESST and PGCCDBS should support the idea of such a Survey and communicate to RCM and to relevant bodies accordingly* *The same idea was recommended by WGANSA and WGACEGG in 2009*
Anchovy in Subarea VIII	The French pilot 'sentinel' surveys carried out in collaboration between fishermen and scientists since 2009 provide additional acoustical, biological data on migration, growth and survival for both anchovy and sardine which are crucial for a better use of scientific spring and autumn surveys.	The WG recommends the continuation this consort survey through DCR or national fundings.	

Stock	Data Problem	How to be addressed in DCR	By who
Anchovy in Subarea VIII	Since 2007, the collaboration between the R/V Thalassa and commercial vessels has increased considerably the reliability of the abundance index estimate, particularly in terms of echoe determination (on average	The WG recommends the continuation through DCR or national fundings.	
Anchovy in Subarea VIII	*For the future management of this stock, a continuation of surveys to monitor anchovy juveniles in autumn is mandatory in order to provide indications of the incoming recruitment for the next year*	***DCR to economically support the continuation and coordination of the acoustic assessment of juveniles in the Bay of Biscay (termed JUVENA survey)***	*ICES ACOM, SSGESST and PGCCDBS should support the idea of such a Survey and communicate to RCM and to relevant bodies accordingly* *The same idea was recommended by WGANSA and WGACEGG in 2009*
Sardine	*The last benchmark for Sardine in VIIIc-IXa took place in 2006. Some unsolved problems remain in the assessment of sardine, notably on stock identity, maturity, natural mortality, catchability patterns and combination of surveys.* *The current assessment tool (AMCI) will not be maitained, and alternative tools should be explored.* *Reference points and harvest rules may be relevant items.*	*A benchmark in 2012 for sardine is recommended*	*ACOM*
Sardine	*Age reading has not been standardized between the VIIIc- IXa stock and outside areas (VII and VIIIa,b)*	*A workshop in 2011 on sardine age reading is recommended, to standardize age reading methodology and criteria between the different areas.*	*ICES council.* *Already approved by PGCCDBS*

It has been noted that extensive year-to-year variability in sardine maturity ogives may be due to sampling. Such variability has a strong influence on the assessment and catch predictions for the stock. WGANSA asks WGACEGG to review the estimation of maturity ogives for sardine taking into account macroscopic and microscopic data collected within acoustic and DEPM surveys.	WGACEGG
For Ancovy in Subarea VIII and several other stocks, the standard assessment procedure produces results in probabilistic terms. WGANSA recommends ACOM to provide guidelines, on a generic level, on how to adapt PA and MSY advice to probabilistic assessments and predictions.	ACOM
WGANSA recommends that next years working group is in late June, as this year. There is a substantial amount of work needed to assemble and analyze both acoustic and egg survey data after the survey to provide survey estimates of stock abundance. The time until late June is needed to do this work properly. The surveys cannot be conducted earlier due to the biology of the stock.	ACOM and ICES secretariat
Recommendations for sentinel survey : The French pilot surveys "Sentinel" carried out in collaboration between fishermen and scientists since 2009 seem to be very promising. They may provide acoustic and biological information on migration, growth and survival of anchovy and sardine in the Bay of Biscay which are crucial for a better use of scientific spring and autumn surveys. WGANSA recommends to continue this surveys.	ICES secretariat, , Delegates (??)
Consort survey during the Pelgas survey : Since 2007, the Pelgas survey is carried out in collaboration between the R/V Thalassa and commercial vessels. This increased considerably the reliability of the abundance index estimate, particularly in terms of echoe determination (on average, 100 fishing hauls in the last years instead of the 50 hauls in the years before the consort survey started) and the number of biological samples collected. In addition, it increased the dialogue and confidence between fishermen and scientists. Therefore, WGANSA recommends the continuation of this consort survey.	ICES secretariat, Delegates (??)

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24 – 28 June 2010

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Annex 2 Direct assessment of small pelagic fish by the PELGAS10 acoustic survey

Jacques Massé, Erwan Duhamel.

Abstract:

An acoustic survey was carried out in the Bay of Biscay from April 25st to June 5th on board the French research vessel Thalassa. The objective of PELGAS10 survey was to study the abundance and distribution of pelagic fish in the Bay of Biscay. The target species were mainly anchovy and sardine and were considered in a multi-specific context. To assess an optimum horizontal and vertical description of the area, two types of actions were combined: i) Continuous acquisition by storing acoustic data from five different frequencies and counting the number of fish eggs using CUFES system, and discrete sampling at stations. Commercial vessels were accompanying Thalassa all along the survey such as to double the number of identifications hauls and increase the reliability of identification of echoes. This WD report acoustic assessments and length distributions of main species, age distribution for anchovy and sardine and some environmental data. Anchovy recruitment seems to be medium, with an index of abundance of 86 000 tons. Concerning sardine, the strong 2008 cohort is predominant, and the biomass has been calculated at a level of 457 000 tons, which is almost constant since 3 years.

Annex 3 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 2010 for the application of the Daily Egg Production Method (DEPM) in the Bay of Biscay anchovy has been conducted in May 2010 from the 5th to the 20th covering the whole spawning area of the species. Two vessels were used: the R/V Investigador to collect the plankton samples and the pelagic trawler Emma Bardán to collect the adult samples. The total area covered was 61,940Km^2 and the spawning area was 37,633t. During the survey 484 plankton samples were obtained and 34 pelagic trawls were performed, from which 30 were with anchovy and were selected for the analysis. Moreover 9 samples were obtained from the purse seines fleet.

In the cantabrian coast the spawning limit was observed at 3º12'W and the North limit was encountered at 46º15' in front of La Rochelle. The mayor abundance of eggs was encountered between Cap Breton and Arcachon and in the influence area of the Gironde River.

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 is estimated as a mean of the historical DF series. The resulting preliminary biomass estimate is 36,627 t with a coefficient of variation of 22%. This estimate is 30% higher than the last year estimate in that manner (27,994 t, C.V.: 23%) and a 50% higher than the definitive estimate given in November 2009.

Approximately 86% of the anchovy are individuals of age 1 in numbers and the contribution in mass of those is 81%. The contribution in mass of anchovies of age 2+ is 19%. This indicates a recovery of the recruitment levels in comparison with previous years.

The complete estimate of the anchovy biomass will be obtained from both the BIOMAN survey (DEPM) carried out by AZTI and the PELGAS survey (Acoustic) carried out by IFREMER and the commercial catch. This analysis will take place during this ICES WGANSA from 24 to 28 of June at Lisbon.

Annex 4 Sardine acoustic survey carried out in April 2010 off the Portuguese Continental Waters and Gulf of Cadiz, onboard RV "Noruega"

Vítor Marques, Alexandra Silva, Maria Manuel Angélico, Rula Dominguez and Eduardo Soares

(INRB-IPIMAR)

Av. Brasília, 1449-006, Lisboa, Portugal

Abstract

The main results of the Portuguese acoustic survey directed to sardine and anchovy estimates in ICES sub area IX shows a reduction in sardine and anchovy biomass. The sardine abundance was the lowest of the time series, following the tendency of the last three years. In the Occidental north zone, the distribution area was very narrow. Age 1 sardines (2009 year class) were predominant in all areas; although this year-class is more abundant than the 2006-2007 year classes at the same age, it is substantially less abundant than strong year-classes in recent years (2000, 2004). The anchovy abundance suffered a strong reduction in relation to the last years, especially in the Cadiz Bay area.

Surface temperature and salinity were within the usual range found during the spring period. The buoyant plume, usually present off the Douro-Minho region, was particularly noticeable this year due to the rainy winter; higher sardine abundance was registered south of this plume.

Egg data from CUFES samples taken in this survey are being processed. Data obtained in the horse-mackerel DEPM survey (January 2010, Calvet stations) shows a comparable spawning area but low sardine egg abundance compared to sardine DEPM surveys in previous years.

Annex 5 Sardine and anchovy in Galicia and Cantabrian waters: results from the Spanish acoustic survey PELACUS410. Working document to WGANSA 2010.

M. Iglesias, M.B. Santos, M. Bernal, J. Miquel, D. Oñate, C. Porteiro and I. Riveiro. 2010.

Abstract

Results of the Spanish spring acoustic survey PELACUS0410 carried out from the 27th March to the 20th April gave values of 39,669 tons of sardine (539 million fish) in the northwest and northern Spanish waters. Most fish was found in south Galician waters (ICES sub-areas IXa-N) and consisted of age 2 fish (fish born in 2008). Age 2 sardine also predominated in ICES sub-area VIIIcW but not in the Cantabrian Sea where older fish (age 3) were more abundant (ICES sub-areas VIIIcE-w y VIIIcE-e). There has been a decrease in the abundance and biomass of sardine estimated in PELACUS0410 compared to the values obtained in previous surveys. These figures seem to indicate that the last strong sardine recruitment (2004) probably halted the stock's downward trend apparent since 2001 in Spanish waters. But there is also evidence that the effect of the 2004 recruitment in the surveyed area was not at the level of the previous strong recruitment (2000) since both biomass and abundance values are now at their lowest since 2001. Few anchovy (225 tons corresponding to 8 million fish) were detected during the survey, and occupied two separate areas: south Galicia (ICES sub-areas IXa-N) and the Basque country/French border (ICES sub-area VIIIcE-e and ICES Division VIIIb). In the latter area, age 1 fish dominated the sample.

Stock Annex – Anchovy in Division IXa

Quality Handbook	**Stock Annex: 3**

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Anchovy in Division IXa
Working Group:	WGANSA (Working Group on the Assessment of Anchovy and Sardine)
Date:	24th June 2010
Revised by	Fernando Ramos (updated)

A. General

A.1. Stock definition

The distribution of anchovy in the Division IXa is nowadays mainly concentrated in the Spanish waters of the Gulf of Cádiz (Sub-division IXa-South(Cádiz), **Figure A.1.1**). Outside the main nucleus of 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 areas IXa North, Central North and South (Algarve) 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 (Millán, 1992; García-Isarch *et al*., 2008).

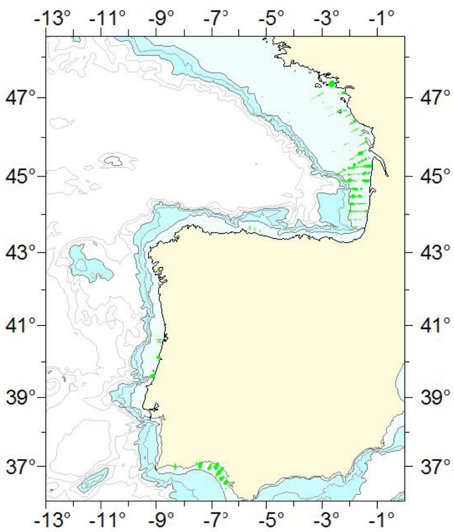

Figure A.1.1. Distribution of acoustic energy allocated to anchovy from the combined 2009 acoustic surveys off Iberia and the Armorican shelf (from ICES, 2009b).

Despite the known fluctuations in anchovy distribution and abundance along the Atlantic European waters, 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 WG on the assessment of these stocks (WGMHSA, WGANC, WGANSA).

A.2. Fishery

Anchovy harvesting along the Division IXa is at present carried out by the following fleets:

- Portuguese purse-seine fleet
- Portuguese finfish trawl fleet
- Portuguese artisanal fleet (although fishing with artisanal purse-seines)
- Spanish purse-seine fleet
- Spanish trawl fleet (in Subarea IXa-South (Cádiz))

Purse-seine fleets are the main responsibles for the anchovy fishery in the Division (usually more than 90% of total annual landings in the Division). Spanish fleets operate in Sub-divisions IXa-North (Southern Galicia) and IXa-South (Gulf of Cádiz), and the Portuguese ones along its national fishing grounds (Sub-divisions IXa-Central North, -Central South and South (Algarve)). Most of the fishery for this anchovy stock in the Division takes place in Sub-division IXa-South (C), where anchovy is the target species. The fleets in the northern part of Division IXa occasionally target anchovy when abundant, as occurred in 1995.

Data on number and technical characteristics for the Portuguese fleets are available for 2006 (ICES, 2007 a). The Portuguese 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. 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 lasts two months in the first quarter in the year. Since 2006 half of the fleet stops one month and the remaining vessels stop the other month.

Details on the purse-seine vessels operated by Spain in the Gulf of Cadiz (the main responsible for the anchovy harvesting in the whole Division), differentiated between total operative fleet and fleet targeting anchovy, are given in **Table A.2.1** and **Figure A.2.1**.

Table A.2.1. Anchovy in Division IXa. Spanish purse-seine fleet composition in the Gulf of Cadiz (differentiated into total fleet and vessels targeting anchovy) since 1999. Length criteria refers to length between perpendiculars.

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

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

Table A.2.1 (cont'd).

Total number of operative purse-seiners

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
Total	10	20	46	35	1	112

2008	Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total
<10	1	0	1	0	0	2
11-15	2	16	15	3	0	36
16-20	0	3	18	15	0	36
>20	0	0	1	15	1	17
Total	3	19	35	33	1	91

2009	Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total
<10	2	4	8	0	0	14
11-15	1	14	27	12	1	55
16-20	0	0	2	16	1	19
>20	0	0	0	2	0	2
Total	3	18	37	30	2	90

Purse-seiners targeting anchovy

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
Total	5	16	35	31	1	88

2008	Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total
<10	1	0	1	0	0	2
11-15	2	16	14	3	0	35
16-20	0	3	18	15	0	36
>20	0	0	1	11	1	13
Total	3	19	34	29	1	86

2009	Engine (HP)					
Length (m)	0-50	51-100	101-200	201-500	>500	Total
<10	1	4	8	0	0	13
11-15	1	13	26	10	0	50
16-20	0	0	2	16	2	20
>20	0	0	0	2	0	2
Total	2	17	36	28	2	85

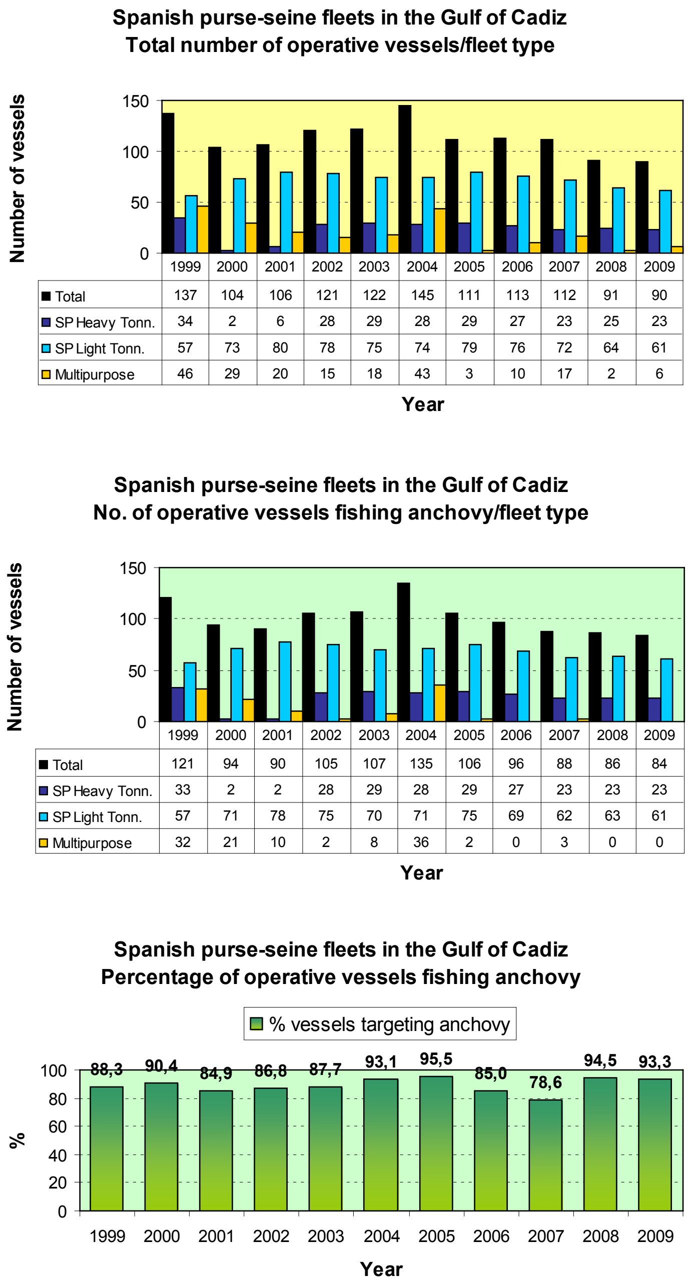

Figure A.2.1. Anchovy in División IXa. Spanish purse-seine fleet composition in the Gulf of Cadiz (Sub-division IXa-South) since 1999. The fleet is differentiated into total fleet and vessels targeting anchovy. The categories include both single purpose purse-seiners and trawl and artisanal vessels fishing with purse-seine in some periods through the year (multi-purpose vessels).

A first attempt of identifying *métiers* in this last fleet/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*, Clustering *LAR*ge *A*pplications) for classifying the fishing trips 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 (*Scomber* spp.) 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. A similar study using the same techniques and for the same period of years was also carried out by Silva *et al*. (2009) for classifying the fishing activities of the Portuguese purse-seine fleet operating off the Portuguese continental coast. In this case, the analysed database was composed by official daily landings (also equivalent to an individual fishing trip) per vessel. The analysis of the purse-seine trips also produced four fishing activities that remained consistent over the period. Around 72 % of the trips were classified as targeting sardine. The other clusters were directed towards horse mackerel, Spanish mackerel (*Scomber colias*) and a mixture of small pelagic species.

Since 1999 the number of Gulf of Cádiz Spanish purse-seiners 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: acceptation of tie-up scheme in 2000 and 2001), the rising of the light-tonnage purse seiners on those dates, and the fluctuations showed by the multipurpose vessels. In 2009, the entire Spanish purse-seine fleet fishing in the Gulf of Cadiz was composed by 90 vessels, with 84 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. Since 2008 the EU–Morocco Fishery Agreement was renewed, and part of the fleet (the heavier/larger vessels) devoted to the anchovy fishing in the Moroccan grounds, wich entailed an important reduction of the fishing effort in the Gulf of Cádiz.

The regulatory measures in place for the Spanish anchovy purse-seine fishing in this Division were the same as for the previous years and are summarized as follows:

- Minimum landing size: 10 cm total length;
- Minimum vessel tonnage of 20 GRT with temporary exemption;
- Maximum engine power: 450 h.p;
- Purse-seine maximum length: 450 m;
- Purse-seine maximum depth: 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 hrs to Sunday 12:00 hrs;
- Fishing prohibition inside bays and estuaries.

Until 1997, the Spanish purse-seine fleet voluntary closed the fishery each year from December to February in the Gulf of Cadiz (Sub-division IXa-South(C)). Since 2004, two complementary sets of management measures have been in force in this part of the Sub-division. The first one is 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 from 30th October 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; 1st December 2008 to 28th February 2009), accompanied by a subsidized tie-up scheme for the purse-seine fleet. The expected subsidized 3-month closure from 2009 mid-autumn to the 2010 mid-winter was restricted to one month only, in December 2009, although the fishery was practically closed since November 2009 until February 2010 for persistent bad sea conditions during all these months. This plan also includes additional regulatory measures on the fishing effort (200 fishing days/vessel/year as a maximum) and daily catch quotas per vessel (6000 kg of sardine-anchovy mixing, but the catch of each of these species cannot exceed 3000 kg). A new regulation approved in October 2006 establishes that up to 10% of the total catch weight may contain fish below the established minimum landing size (10 cm), but fish must always be ≥9 cm.

The effort exerted by the entire purse-seine fleet since 1997 has been high (even with the fishing closures since 2004 on). While the effects of the fishery closures have not been formally evaluated, it appears that they have limited a further expansion of effort.

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 sourrounding 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 A.2.2**). 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.

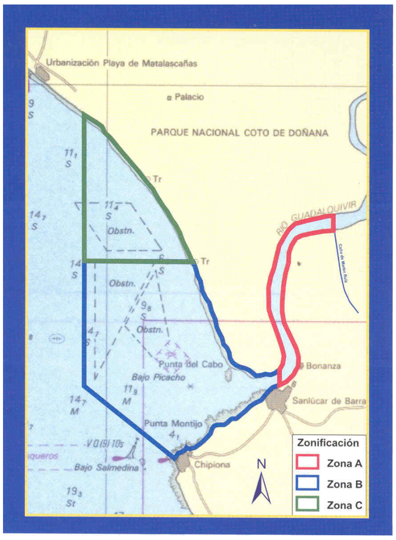

Figure A.2.2. Anchovy in Division IXa. Limits of the Fishing Reserve off the Guadalquivir river mouth (Spanish Gulf of Cadiz. Sub-division IXa South).

A.3. Ecosystem aspects

Anchovy is a prey species for other pelagic and demersal species, and for cetaceans and sea-birds. The recruitment depends strongly on environmental factors.

The anchovy population in Sub-division IXa-South appears to be well established and relatively independent of populations in other parts of the Division. These other populations seem to be abundant only when suitable environmental conditions occur.

B. Data

B.1. Commercial catch

Portuguese annual landings from their respective Sub-divisions are available since 1943. Spanish landings started to be available since 1989. **Figure B.1.1** describes the most recent (1989 – 2009) landings trajectory for the period with available data for the whole Division. Landings for the whole Division oscillate between 13 thousand tonnes (1995) and 2 thousand tonnes (1993). Average landings are estimated at 5.8 thousand tonnes. Landings in 2009 were below this average (3,0 thousand tonnes). By comparing the figures from **Figure B.1.1** is evidenced that the bulk the fishery recently occurs in the Southernmost Sub-division.

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. Slipping practices were probable but they were not directly evidenced by sampling onboard. New data on anchovy discarding are being gathered again since the fourth quarter in 2009 on, within the Spanish National Sampling Scheme framed into the EC Data Collection Regulation (DCR). Preliminary information on these sampled trips are available but the resulting discard estimates have not been merged with landings in the present WG due to uncertainties in the adequacy of the raising methodology used (*i.e.*, estimation of total discards for the whole fleet by raising sampling with anchovy landings as commercial discarded species) and the own low representativity of the sampled trips. So, the estimated anchovy discard ratio for the fourth quarter in 2009 was only of 0.015, yielding total estimated discards for the species in this season of only 1.7 t (CV=59%). Anchovy slipping of undersized fish was also observed confirming that such practice is not uncommon.

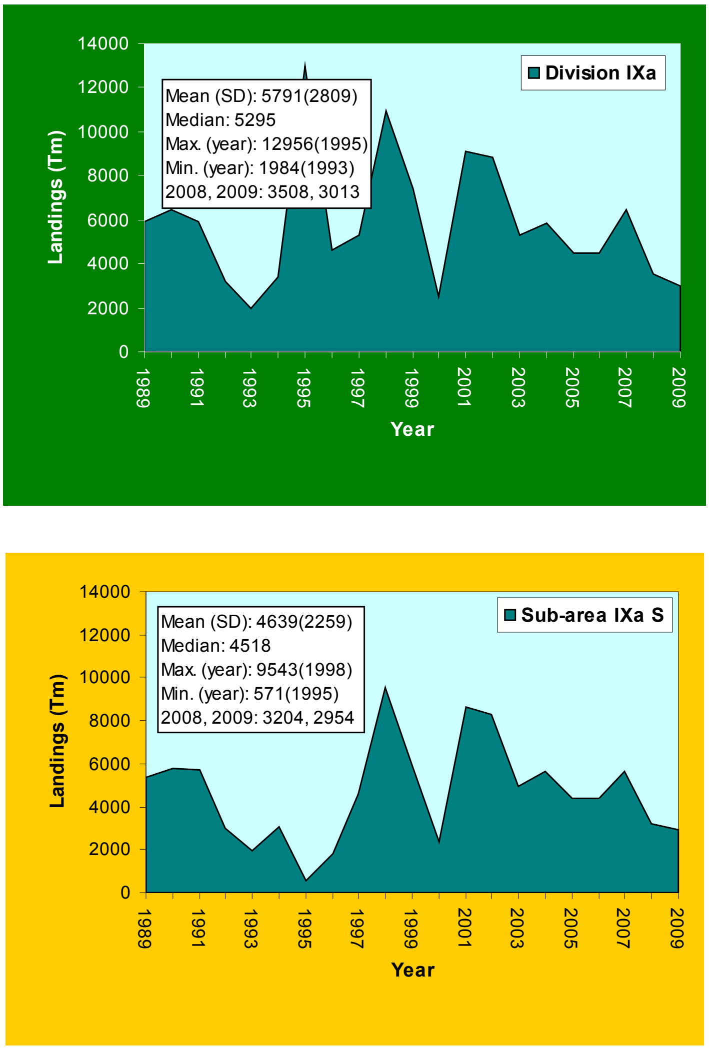

Figure B.1.1. Anchovy in Division IXa. Recent (1989-2009) series of anchovy landings in Division IXa (upper panel). Series for the whole Sub-area IXa-South is also shown (lower panel).

B.2. Biological

Annual and quarterly length compositions of anchovy landings in Division IXa are routinely provided by Spain for its Sub-division IXa-South(C). This series dates back to 1988. Length distributions for the Spanish fishery in Sub-division IXa-North are only available for the 1995-1999 period and they were characterised, with the expcep-tion of 1998, by fish larger than 12.5 cm (ICES, 2007 a). Portugal does not currently provide neither length distributions nor catches at age of their anchovy landings in Division IXa due to their scarce catches.

Catches at age from the whole Division IXa are only available from the Spanish Gulf of Cadiz fishery (Sub-division IXa South (C)). Problems with ageing/reading Gulf of Cádiz anchovy otoliths were revisited in 2009 during the Workshop on Age reading of European anchovy (WKARA; ICES, 2010), although such problems still persist.

The age composition of the Gulf of Cadiz anchovy in Spanish landings is available since 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, the 2001-2003 period, and 2008 and 2009, with contributions oscillating between 2% and 14%). Likewise, age-3 anchovies only occurred in the first quarter in 1992, first semester in 2008, and during the whole 2009, but their importance of this age class in the total annual catch those years was insignificant. Inter-annual variations in the contribution of each age group in landings throughout the historical series are described in ICES (2007 a, 2008 a). Weights at age in the stock for the Gulf of Cádiz anchovy correspond to yearly estimates calculated as the weighted mean weights-at-age in the catches for the second and third quarters (throughout the spawning season).

Catches at age from the Spanish fishery in Sub-division IXa North are presently not available since commercial landings used to be negligible. Mean length- and mean weight-at-age data are only available for Gulf of Cadiz anchovy catches. 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.

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 routinely provided to ICES. 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. In 2008 the anchovy maturity stage assignment criteria were agreed between national institutes involved in its biological study during the *Workshop on Small Pelagics (Sardina pilchardus, Engraulis encrasicolus) maturity stages* (WKSPMAT; ICES, 2008 c)

Natural mortality is unknown for this stock. By analogy with anchovy in Sub-area VIII, natural mortality is probably high (M=1.2 is used for the data exploration).

B.3. Surveys

B.3.1. 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	2009	2010
Portuguese Surveys	Q1				Mar		Mar	Mar	Feb							
	Q2									Jun	Apr	Apr	Apr	Apr	Apr	Apr
	Q3															
	Q4			Nov		Nov	Nov		Nov		Nov	Nov	Nov	Nov		
Spanish Surveys	Q1							Feb								
	Q2	Jun								Jun		Jun			Jun	
	Q3												Jul		Jul	
	Q4														Oct	

The IPIMAR's 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 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 Sub-division 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 by IEO in Sub-division IXa North and Division VIIIc since 1983 (the spring *PELACUS* series). Results from these surveys for the Sub-division 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 2003-2009 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 (Sub-division IXa-South) have been sporadically conducted by IEO 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 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. (R/V *Cornide de Saavedra*). In 2009 two additional surveys to the conventional one were also conducted, but mainly restricted to the Spanish waters. So, in July 2009 a complementary and almost synchronous survey to the *ECOCÁDIZ 0609* conventional survey was carried out with a small-draught vessel, R/V *Francisco de Paula Navarro*, aiming to survey shallower waters than 20 m depth not sampled by no vessel, either Spanish or Portuguese, routinely surveying the study area (*ECOCÁDIZ-COSTA 0709* survey). The acoustic estimates from this survey have been provided to the WG separately from their conventional counterparts pending of an appropriate (inter-) calibration of data for a further merging of estimates if possible. Therefore, the comparisons of trends between survey series described in the report are based on estimates derived from the respective national standard or conventional surveys.

In October 2009 a new Autumn survey (*ECOCÁDIZ-RECLUTAS 1009*, R/V *Emma Bardán*), aimed to acoustically estimate the abundance and biomass of Gulf of Cádiz anchovy recruits, was planned to be conducted in the main Gulf of Cádiz anchovy recruitment area. A series of unforeseen circumstances prevented finally from covering the whole survey area, with this area finally being restricted to only a relatively small central area in front the Guadalquivir river mouth that entailed a very probable underestimation of the recruits abundance. Continuity of this survey in following years will necessarily depend on external (EC) funding.

As for the text table, acoustic estimates from surveys on a black background are those ones used since 2007 as tuning series in the exploratory assessment of anchovy in Sub-division IXa South (Algarve and Gulf of Cadiz). 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 Sub-division IXa South.

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 as important as to prevent from any comparison between their results, such differences being basically due to:

- The <u>echo-sounder and working frequencies</u> used (IPIMAR surveys: Simrad EK 500 working at 38 and 120 KHz; IEO surveys since 2007 onwards: Simrad EK 60 working at 18, 38, 70, 120, and 200 KHz).
- The <u>fishing gear</u> used as sampler for echo-trace identification/confirmation and gathering biological data (IPIMAR surveys: bottom and pelagic trawl gears; IEO surveys: pelagic trawl).
- The <u>software</u> used for data storage and <u>post-processing</u> (IPIMAR surveys: Movies+ software; IEO surveys: SonarData EchoView software).
- The set of <u>species-specific TS-length relationships</u>: at present, the new IPIMAR spring survey series, *PELAGOS*, 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 autumn 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'.

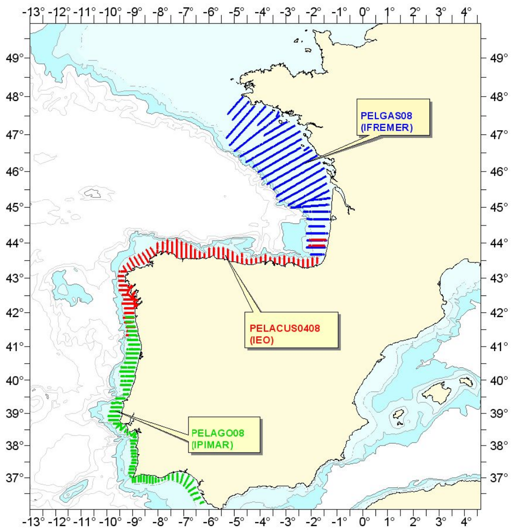

Figure B.3.1.1. Transects surveyed by the Spring *PELAGOS*, *PELACUS* and *PELGAS* surveys. The early Summer *ECOCÁDIZ* surveys samples the same area that the *PELAGOS* one in the Gulf of Cádiz waters (from Cape San Vicente to Cape Trafalgar).

B.3.2. DEPM Surveys

The Daily Egg Production Method (DEPM) for estimation of anchovy spawning biomass of the Gulf of Cádiz (South-Atlantic Iberian waters) is conducted every three years by IEO (Spain) since 2005. The first survey of this series was in 2005 (*BOCADEVA 0605*) and the second one in 2008 (*BOCADEVA 0608*). As described for the acoustic surveys, methods adopted for Gulf of Cádiz anchovy DEPM surveys follow the standards and recommendations given by the WGACEGG. **Figure B.3.2.1** shows the grid of eggs sampling with the PairoVET sampler. **Table B.3.2.1** summarises the methodology used in these surveys (*BOCADEVA 0608* used as example) in order to obtain the eggs and adults samples.

Table B.3.2.1 ***BOCADEVA 0608*** **Gulf of Cádiz anchovy DEPM survey. General sampling.**

Parameters	Anchovy DEPM survey *BOCADEVA0608*
Survey area	(36°18’- 36°75’N – 6°22’- 8°92’W)
R/V	*Cornide de Saavedra*
Date	21/06-03/07
Eggs	
Transects (Sampling grid)	21 (8x3)
Pairovet stations (150 μm)	127
Sampling maximum depth (m)	100
Hydrographic sensor	CTD SBE25 and CTD SBE37
Flowmeter	Yes
CUFES stations	121
CUFES (335μm)	3 nmiles (sample unit)
Environmental data	Fluorescence(surface only),Temperature, Salinity
Adults	
Gears	Pelagic trawl
Trawls	26
Trawls time	During the daylight hours
Biological sampling:	On fresh material, on board of the R/V
Sample size	60 indiv randomly (30 female minimum); extra if needed and if hydrated found
Fixation	Buffered formaldehyde 4% (distilled water)
Preservation	Formalin

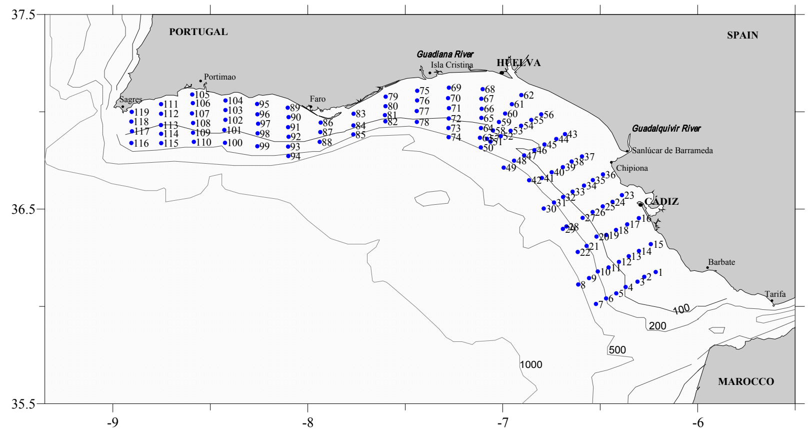

Figure B.3.2.1. Sampling grid adopted in the ***BOCADEVA*** **anchovy DEPM surveys series.**

Anchovy biomass estimation from these surveys was based on procedures and software adapted and developed during the WKRESTIM that took place between 27-30/04/2009 in Madrid (with e-participation of IPIMAR members from Lisbon). All calculations for area delimitation, egg ageing and model fitting for egg production (P_0) estimation were carried out using the R packages (*geofun, eggsplore and shachar*) available at *ichthyoanalysis* (http://sourceforge.net/projects/ichthyoanalysis). The surveyed area (*A*) was calculated as the sum of the area represented by each station. The spawning area (*A+*) was delimited with the outer zero anchovy egg stations, and was calculated as the sum of the area represented by those stations. The model of egg development with temperature was derived from the incubation experiment carried out in Cádiz in July 2007 (Duarte *et al*., 2007). A multinomial model was applied (Ibaibarriaga *et al.*, 2007, Bernal *et al.* 2008) considering only the interaction Age*Temp (other interactions were not significant). Egg ageing was achieved by a multinomial Bayesian approach described by Bernal *et al.* (2008) and using *in situ* SST; a normal probability distribution was used with peak spawning assumed to be at 22:00h with 2h standard deviation. This method uses the multinomial development model and the assumption of probabilistic synchronicity (assuming a normal distribution). Daily egg production (P_0) and mortality (z) rates were estimated by fitting an exponential mortality model to the egg abundance by cohorts and corresponding mean age. The model was fitted using a generalized linear model (GLM) with negative binomial distribution. The ageing process and the GLM fitting were iterative until the value of z converged. Finally, the total egg production was calculated as: $P_{tot} = P_0\ A+$

The adult parameters estimated for each fishing haul considered only the mature fraction of the population (determined by the fish macroscopic maturity data). Before the estimation of the mean female weight per haul (*W*), the individual total weight of the hydrated females was corrected by a linear regression between the total weight of non-hydrated females and their corresponding gonad-free weight (*Wnov*). The sex ratio (*R*) in weight per haul was obtained as the quotient between the total weight of females on the total weight of males and females. The expected individual batch fecundity for all mature females (hydrated and non-hydrated) was estimated by modelling the individual batch fecundity observed (*Fobs*) in the sampled hydrated females and their gonad-free weight (*Wnov*) by a GLM. The fraction of females spawning per day (*S*) was determined, for each haul, as the average number of females with Day-1 or Day-2 POF, divided by the total number of mature females (the number of females with Day-0 POF was corrected by the average number of females with Day-1 or Day-2 POF, and the hydrated females were not included). The mean and variance of the adult parameters for all the samples collected was then obtained using the methodology from Picquelle and Stauffer (1985; i.e., weighted means and variances). All estimations and statistical analysis were performed using the R software. The spawning biomass was computed according to:

$$SSB = \frac{P_0 * Area+}{(F * S * R)/W}$$

The high uncertainty associated to the estimates (especially to those ones related to the egg sampling in the 2005 survey) was matter of concern for the last year's WGANSA and it was recommended that the appropiateness of the egg sampling scheme were revised in the 2009 WGACEGG. It was concluded by this last working group last year that reducing the variance in future surveys can probably be attained by increasing the number of stations in the actual positive spawning areas (adaptive sampling) and perhaps by applying GAM based estimators.

B.4. Commercial CPUE

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 (Sub-division 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.

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 ICES. 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). Since 2008 the GLM fitting is 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 (ICES, 2008 b). 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 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 (1988-2009) of standardised effort and CPUE from all of the fleets exploiting the fishery is provided to the WG each year. Annual and half-year standardised CPUE series for the whole fleet are computed from the quotient between the sum of raw quarterly catches and that of standardised quarterly efforts within each of the respective time periods.

According to literature, CPUE indices have been considered, as not reliable indicators of abundance for small pelagic fishes (Ulltang, 1982, Csirke 1988, Pitcher 1995, Mackinson *et al*. 1997). At present, the series of CPUE indices is only used for interpreting the fleet's dynamics.

B.5. Other relevant data

C. Historical Stock Development

Model used:

For the time being, no analytical assessment model have been successfully applied. An exploratory assessment is under development. This exploratory assessment carried out so far is only performed for the anchovy population nucleus in the Gulf of Cádiz (Sub-division IXa-South: Algarve + Cádiz zones), the remaining resilient anchovy populations along the Atlantic Iberian façade of the Division being out of the scope of this assessment. The model used is an *ad hoc* seasonal separable model implemented and run on a spreadsheet 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. 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 model is at present fitted to the updated half-year catch-at-age data until the assessment's last year 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).

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 1 data point until the last year, 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 was recently used.

The exploratory runs were recently 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 estimated as a ratio of the F estimated in the 1st half by applying the ratio of seasonal Fs in the previous year (affected by a closure as well in the last years).

–No available Cages for the first half in the year ahead of the assessment's last year: assumed as the same ones that in first half in the assessment's last year.

–Wagesstock in the year ahead of the assessment's last year: average of the estimates in the 3 last years in the assessment.

–F in the 1st half year of the assessment's last year: average of estimated 1st half-year Fs counterparts for the same period of years.

– Log-residuals of Cages in the year ahead of the assessment's last year excluded from the minimisation routine whereas the residuals from the biomass acoustic estimate in the year ahead of the assessment's last year are included in the model fitting.

Runs explored last years consisted in:

- **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 (around 14,000 tonnes).

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.

The exploratory assessments performed so far with this *ad hoc* model has not been recommended as a basis for predictions or advice. The immediate reason is that it usually estimated 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 showed large clusters over time, indicating that the selection may not be constant, one of the model's assumptions. Migration between the main nucleus in the Gulf of Cádiz and adjacent areas might be one of the causes explaining the discrepancies found in the assessment and it should be properly studied. The exploratory model utilised so far does not provide any reliable information about the true levels of both the stock, F and Catch/SSB ratios since the assessment is not still properly scaled.

For all the above reasons in 2009 was preferred to do not perform any exploratory assessment with this model. Instead of this, the provision of advice relies in an update of the qualitative assessment carried out in 2008 and accepted by the Review Groups of the 2008 and 2009 WGANC (2008 RGANC). This qualitative assessment is based on the joint analysis of trends showed by the available data, both fishery-dependent and –independent information (*i.e.*, landings, fishing effort, cpue, survey estimates).

Advice is framed in a precautionary manner to limit exploitation and, accordingly, the basis for advice is average catches over a reference period, as was done last year.

Software used: the exploratory model is implemented and run in a MicroSoft Excel spreadsheet.

Model Options chosen:

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes			
Canum	Catch at age in numbers			
Weca	Weight at age in the commercial catch			
West	Weight at age of the spawning stock at spawning time.			
Mprop	Proportion of natural mortality before spawning			
Fprop	Proportion of fishing mortality before spawning			
Matprop	Proportion mature at age			
Natmor	Natural mortality			

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1			
Tuning fleet 2			
Tuning fleet 3			
….			

D. Short-Term Projection

Model used:

Software used:

Initial stock size:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock recruitment model used:

Procedures used for splitting projected catches:

E. Medium-Term Projections

Model used:

Software used:

Initial stock size:

Natural mortality:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock recruitment model used:

Uncertainty models used:

1. Initial stock size:
2. Natural mortality:

3. Maturity:

4. F and M before spawning:

5. Weight at age in the stock:

6. Weight at age in the catch:

7. Exploitation pattern:

8. Intermediate year assumptions:
9. Stock recruitment model used:

F. Long-Term Projections

Model used:

Software used:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Procedures used for splitting projected catches:

G. Biological Reference Points

H. Other Issues

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Stock Annex – Sardine in Division VIIIc and IXa (Sar-Soth)

Quality Handbook Annex:_V___

Stock specific documentation of standard assessment procedures used by ICES.

This is a preliminary version of the stock annex for the sardine stock in Divisions VIIIc and IXa. The present text needs to be completed and reviewed by other people involved in sardine research.

Stock: Sardine in Divisions VIIIc and IXa (sar-soth).

Working Group: WGANSA

Date: 24 June 2010

Revised by:

Authors: Begoña Santos, Isabel Riveiro, Alexandra Silva.

A. General

A.1. Stock definition

Sardine (*Sardina pilchardus*, Walb) distribution in the North-East Atlantic covers a wide area, ranging from southern Mauritania to the northern part of the North Sea. The sardine stock assessed by ICES covers the Atlantic waters of the Iberian Peninsula (ICES areas VIIIc and IXa).

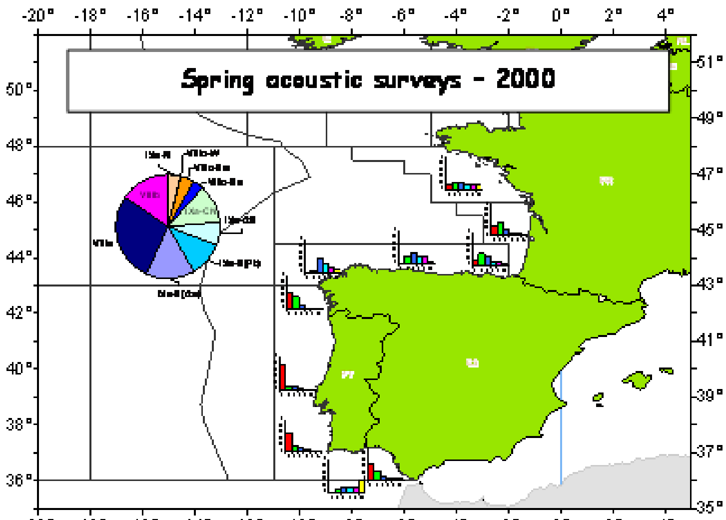
Sardine from ICES Divisions VIIIc and IXa is part of the north-Atlantic genetic stock, which spans the continental waters from the Agadir area in north Morocco to the North Sea. In addition to genetic similarity, there is other evidence of mixing between ICES Division VIIIa and b and the actual assessed stock area (ICES areas VIIIc and IXa): existence of a continuous distribution of both eggs and adult fish from south of the Iberian Peninsula to the British Isles and the similarity of body morphology, growth and other life history properties across the area (results of the EU Q5RS-CT-2002-00818 project SARDYN "*Sardine dynamics and stock structure in the North-East Atlantic*", Anon. 2006). Catch and survey_at_age data from French waters provides some support to this hypothesis by showing a connection between strong year classes observed in east Cantabrian Sea and southern French waters (Figure A.1). Some emigration of juvenile fish into the Cantabrian area is a likely hypothesis but mixing was shown to have limited influence on the dynamics of the overall stock.

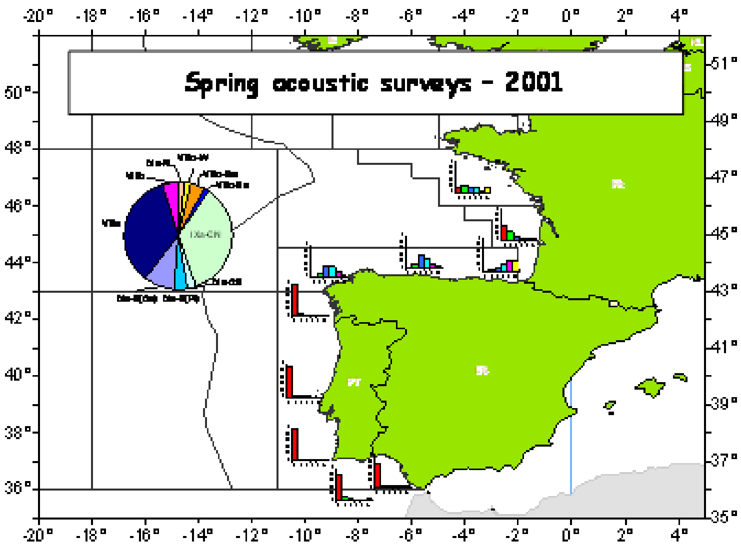
Genetic and life history characters provide also indication of some mixing that across the southern stock limit (Gulf of Cadiz) with sardine populations from southwest Mediterranean and northern Morocco (SARDYN project results). However, the absence of large sardine populations in these areas points to a limited potential to influence the dynamics of the Iberian stock.

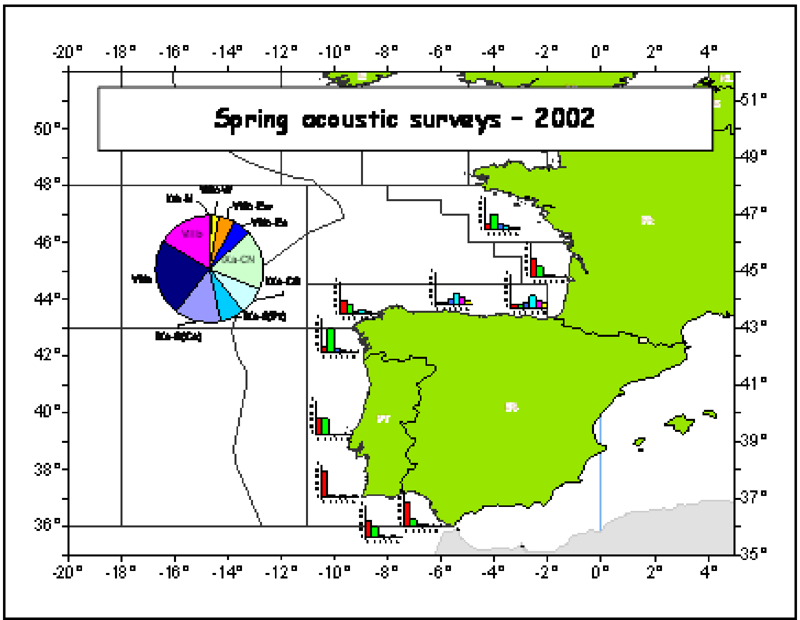
There are also indications of spatial population sub-structuring across Iberian waters: evidence of distinct recruitment pulses off the two main recruitment areas in some years (northern Portugal and the Gulf of Cadiz) and observation that these mainly influence the demography of adjacent populations but not that of distant ones. Persistent spatial differences in growth and spawning temperature tolerance have also been found and these together with the existence of a persistent gap in the spawning area corroborate the hypothesis of spatial heterogeneity of sardine populations. The northwest (Cape Finisterra) and southwest (Cape St. Vincent) corners of the Iberian Peninsula would be the most likely candidates for population discontinuities across the area. However, indirect evidence of movements from otolith chemistry and cohort analyses suggest that sardines recruiting on the western area move gradually north or south as they grow, crossing the above potential discontinuities.

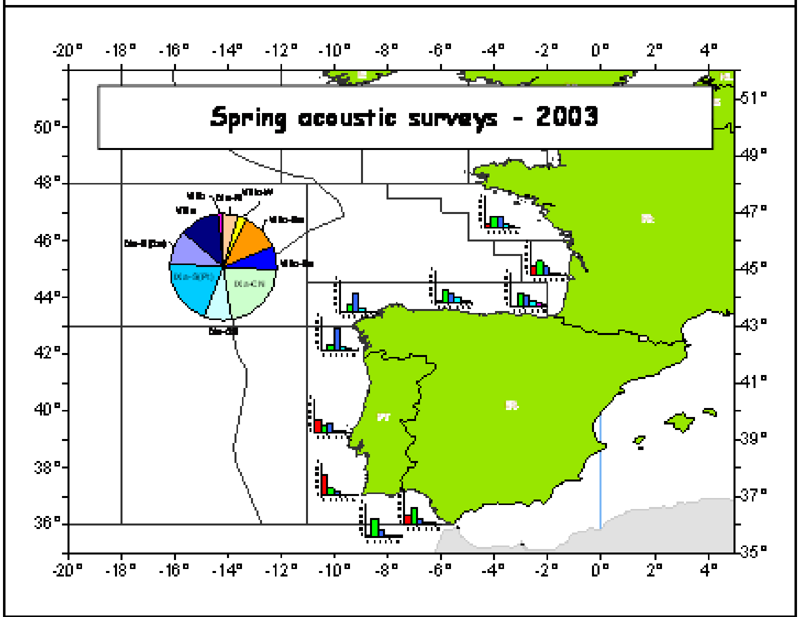
Despite the likelihood of some mixing across the stock borders and of some spatial heterogeneity in life history and dynamics, there is currently no evidence that the dynamics of the stock is strongly influenced by sardine populations outside the stock area. Therefore, the perception of the stock obtained from the assessment is considered unbiased by mixing.

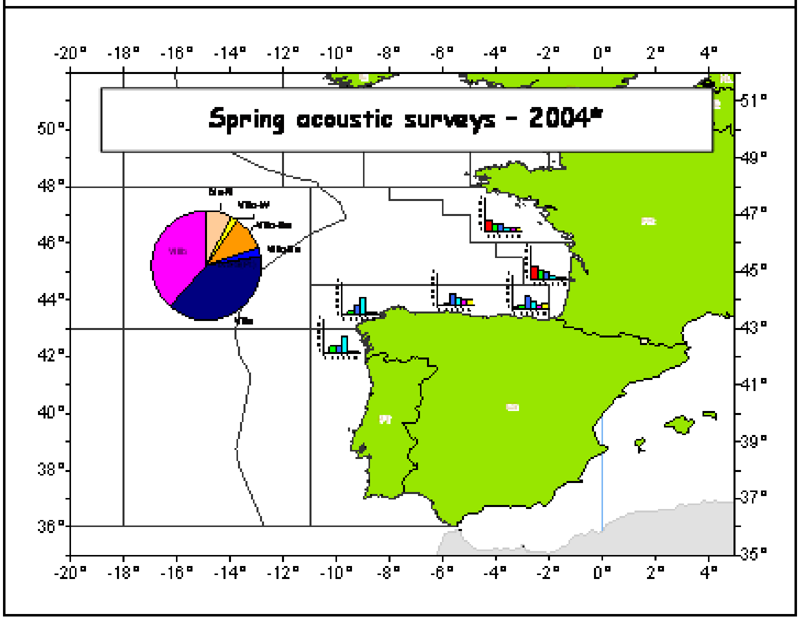
Figure A.1. Sardine age frequency distribution by subarea showing the importance of each age class in each subarea in relation to the total sardine population in that subarea as estimated by the spring surveys carried out by France, Spain and Portugal (2008). Age categories are: 1, 2, 3,…and 6+. The pie chart represents the contribution of each subarea to the total biomass.

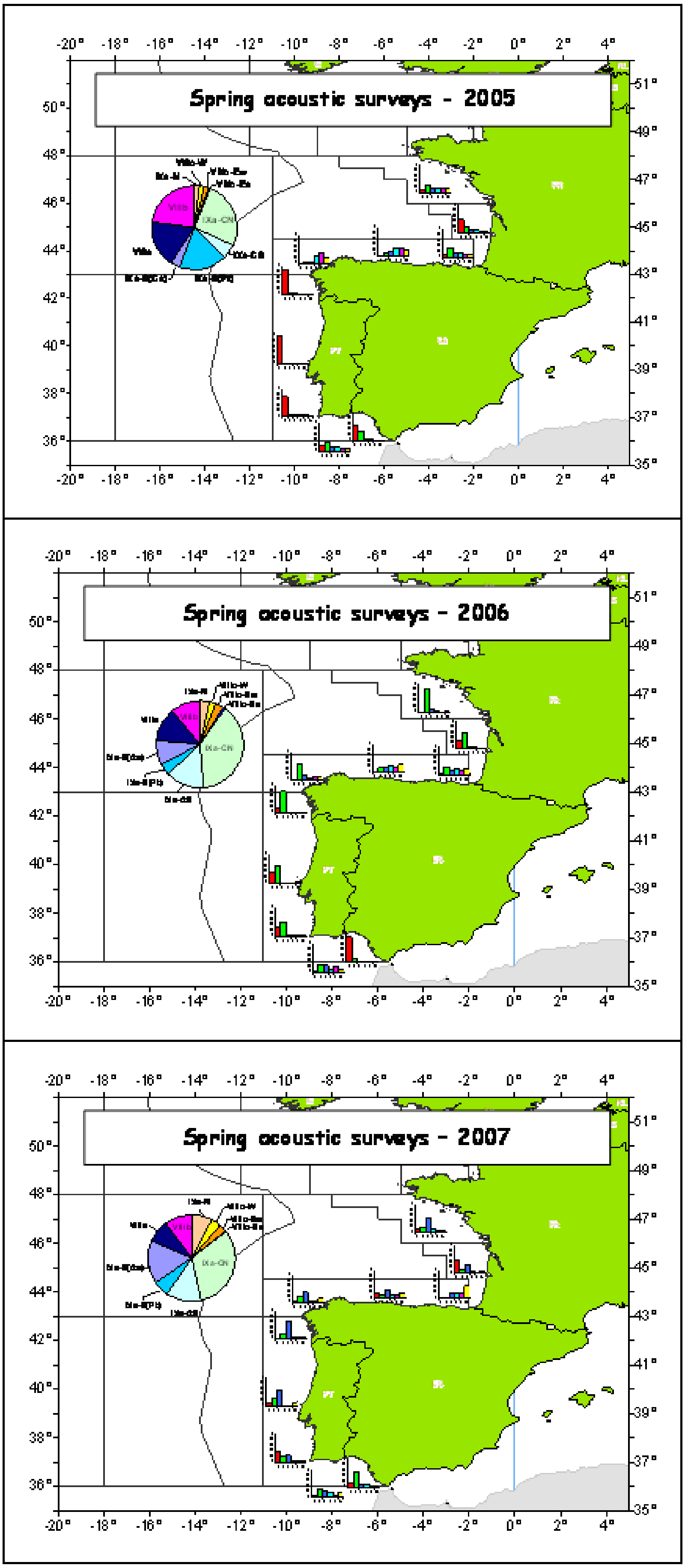


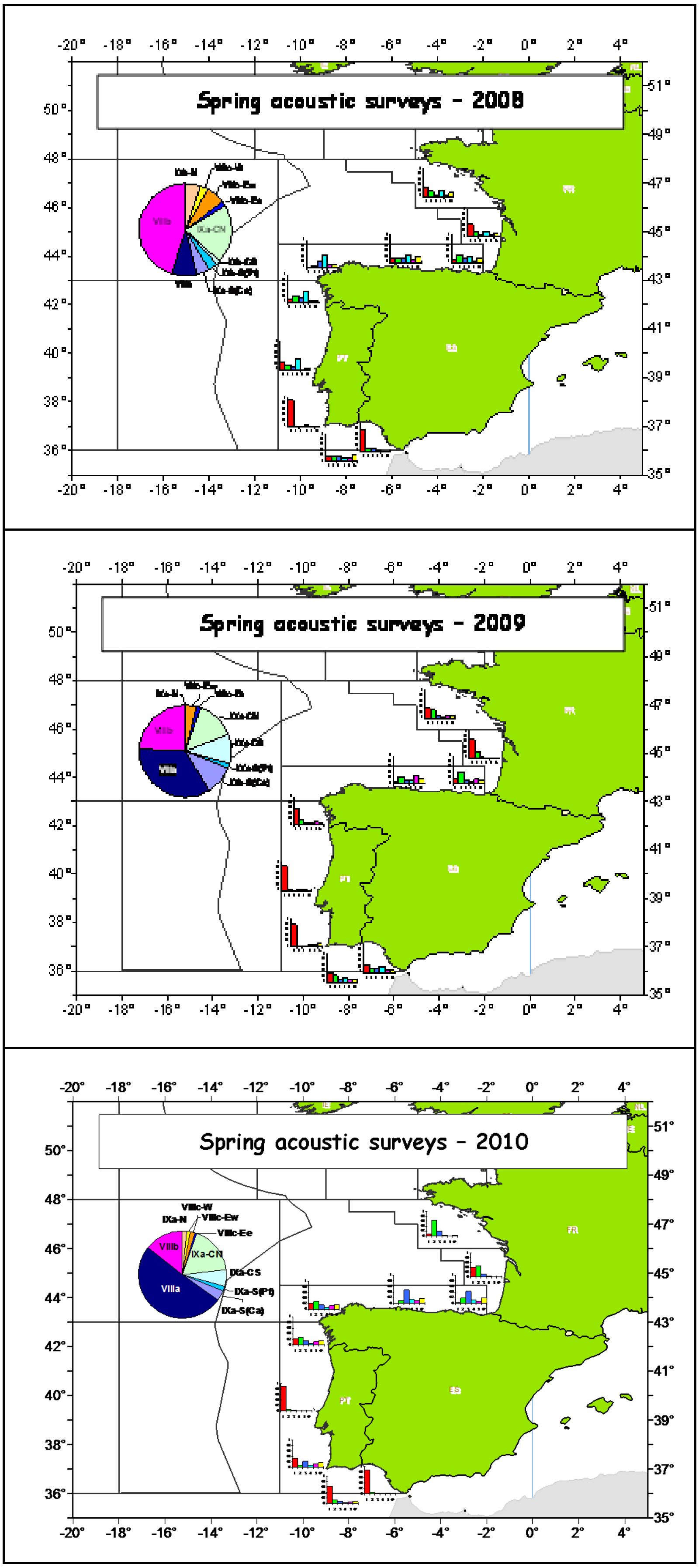



Spring acoustic surveys - 2002


Spring acoustic surveys - 2003


Spring acoustic surveys - 2004*


Spring acoustic surveys - 2005
Spring acoustic surveys - 2006
Spring acoustic surveys - 2007
IXa-CN


Spring acoustic surveys - 2008
Spring acoustic surveys - 2009
Spring acoustic surveys - 2010
VIIIb
VIIIa
IXa-CN
IXa-CS
IXa-S(Pt)
IXa-S(Ca)
IXa-N
VIIIc-W
VIIIc-Ew
VIIIc-Ee

A.2. Fishery

The bulk of the landings in both Spain and Portugal (99%) are made by purse-seiners.

The Spanish purse seine fleet targets anchovy (*Engraulis encrasicolus*), mackerel (*Scomber scombrus*) and sardine, (which occur seasonally in the area) and horse-mackerel (*Trachurus trachurus*) which is available all year-round (Uriarte *et al*., 1996; Villamor *et al*., 1997; Carrera and Porteiro, 2003). In summer, part of the fleet switches to trolling lines or bait boat for tuna fishing, a resource with a marked seasonal character. Since 2004, Spanish legislation requires that purse seiners must have at least, a length of 11 m in the Atlantic coast of Spain. Moreover, the gear must have a maximum length of 600 m, a maximum height of 130 m and minimum mesh size of 14 mm (see Table A.2.1). Because of this regulation, most of the effort and catches are registered in logbooks (which are mandatory for boats larger than 10 m). Analysis of these logbook data from 2003 to 2005 (Abad *et al*., 2008) showed that currently, sardine and horse-mackerel represent 75% of the total landings of the purse seine fleet, which is in accordance with the values observed in historical series of purse seine catch statistics, especially when the anchovy is scarce (ICES, 2007). Sardine catches show the highest values in summer and autumn and effort concentrates in southern Galician and western Bay of Biscay waters. Vessels can be characterized by 21 m length overall, 296 HP, and 57 gross tonnage.

In Portugal, sardine is the main target species of the purse seine fleet. The sardine fishery is of great social-economical importance for the fishing community and industry since it represents an important part of the fish production and a relevant supply for the canning sector. Other pelagic species such as chub mackerel (*Scomber japonicus*), horse mackerel and anchovy are also landed by the purse seine fishery. Currently, purse seiners in Portuguese waters have a length of about 20 m, an engine horsepower between 100 and 500 HP and use a minimum mesh size of 16 mm (see Table A.2.1). According to Stratoudakis and Marçalo (2002), fishing is usually close to the home port, on short (daily) trips where the net is set once or twice, usually around dawn. A large part of a typical fishing trip is spent searching for schools with echo-sounders and sonars. Once schools of pelagic fish have been detected, large nets (up to 800 m long and 150 m deep) are set rapidly with the help of an auxiliary small vessel, and hauled in a largely manual operation involving all members of the crew (usually between 15-20 people) (Mesquita, 2008).

Table B.2.1. Summary of the major existing regulatory mechanism for sardine

Species	Technical measure	National/European level	Specification	Note	Source/date of implementation
Sardine	Minimum size	European	11cm	10% undersized allowed	EU Reg 850/98 amended 1999, 2000, 2001, 2004
Sardine/Anchovy	Effort limitations	National (ES)	VIIIc, IXa: minimum vessel tonnage 20GRT, maximum engine power 450hp, max length purse seine 450m, max height purse seine 80m, minimum mesh size 14mm, max number of fishing days/week: 5, fishing prohibited in bays and estuaries		1997
Sardine	Catch limitation	National (ES)	max 7 000 kg/day/boat fish > 15cm, max 500 kg/day/boat fish between 11 and 15cm. IXaS Cadiz: in addition max 3 000 kg/day/boat		1997
Sardine/anchovy	Area closure	National (ES)	IXaS Cádiz: fishing closures implemented annually between November-February		2004 and 2005: 45 days closure; 2006: 60 dys; 2007-08: 90 dys; 2008-09: 90 dys; 2009-10: 30 dys.
Sardine/Anchovy	Effort limitations	National (PT)	IXa: max number of fishing days/week: 5, max number of fishing days/year: 180		1997
Sardine/Anchovy	Area closure	National (PT)	no purse-seine fishery north of 39°42'N between 1.February and 31.March	on voluntary basis	1997
Sardine	Catch limitation	National (PT)	55000 tons	only applicable to vessels associated under OP (Producer Organisation)	2010
All species	Mesh sizes	European	different specifications acc. to catch compositions		EU Reg 850/98 amended 1999, 2000, 2001, 2004
All species	Mesh openings	European	different specifications acc. to catch compositions		EU Reg 850/98 amended 1999, 2000, 2001, 2004

A.3. Ecosystem aspects

There are a number of studies investigating the role of sardine in the ecosystem both as predator and prey. Sardine is widely distributed all along the Atlantic Iberian shelf in waters ranging from 10 to 100 m (e.g. Porteiro *et al*., 1996). Analysis of its stomach contents and stable isotope signature indicate an omnivorous feeding behaviour, related to its ability to feed by particle-feeding and filter-feeding (more common as fish grow older, Bode *et al*., 2003), and its exploitation of a wide range of prey (both phytoplankton and zooplankton have been found in its diet, e.g. Bode *et al*., 2004). In addition, sardines have been found to ingest their own eggs (and probably those of other species) and this cannibalism may act as a density control mechanism (Garrido *et al*., 2007).

The composition of nitrogen isotopes in the muscle of sardine integrates fish diet over seasonal periods and reflects the composition of plankton over large shelf areas. A differential isotopic signature in high and low upwelling zones reflects low mobility of sardines during periods of low population size (Bode *et al*., 2007).

Sardine is prey of a range of fish and marine mammal species which take advantage of its schooling behaviour and availability. Sardine has been found to be important in the diet of common dolphins (*Delphinus delphis*) in Galicia (NW Spain) (Santos *et al*., 2004), Portugal (Silva, 2001) and the Atlantic French coast (Meynier, 2004). Also feeding on sardine but to a lesser extent are: harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*), striped dolphin (*Stenella coeruleoalba*), and white-sided dolphin (*Lagenorhynchus acutus*) (e.g. Santos *et al*., 2007).

Habitat modelling studies aim to identify which environmental processes could be defining the habitat of a species and eventually to be able to predict fish distribution. Zwolinski *et al* (2008) analysed the relationship between data on sardine distribution obtained by the Portuguese acoustic surveys and 4 environmental variables (subsurface salinity, temperature, chlorophyll concentration and plankton presence). Sardine showed a preference for waters with low temperature and salinity, high chlorophyll content and low planktonic backscattering energy.

Populations of planktivorous fish, such as the sardine, show large fluctuations in size and distribution over the Atlantic Iberian shelf (Carrera and Porteiro, 2003). Periods of good recruitments have helped develop new industries and led to the social and economic changes while periods of continuous low recruitments have brought economic hardship in many areas. This was the case of the Iberian sardine at the end of the 90s, when several successive poor recruitments led to an all time low of the stock biomass. Sardine is a batch spawner producing batches of eggs over an extended period of time (October to May) in Iberian waters with different peaks between southern and northern regions. Although the survival of offspring is highly dependent on favourable environmental conditions (concentrations of egg/larvae in suitable areas), sardine appears to show a wide range of temperature tolerance for both habitat and spawning distribution (Bernal, 1998). Even more, the presence of sardine larvae has been recorded by a recent study (Morais *et al*., 2009) inside the Guadiana estuary. The authors suggest that this is not an accidental occurrence but that in order to migrate to that location and remain in the estuary, counteracting river inflow, these late larvae must have employed active migration and retention strategies.

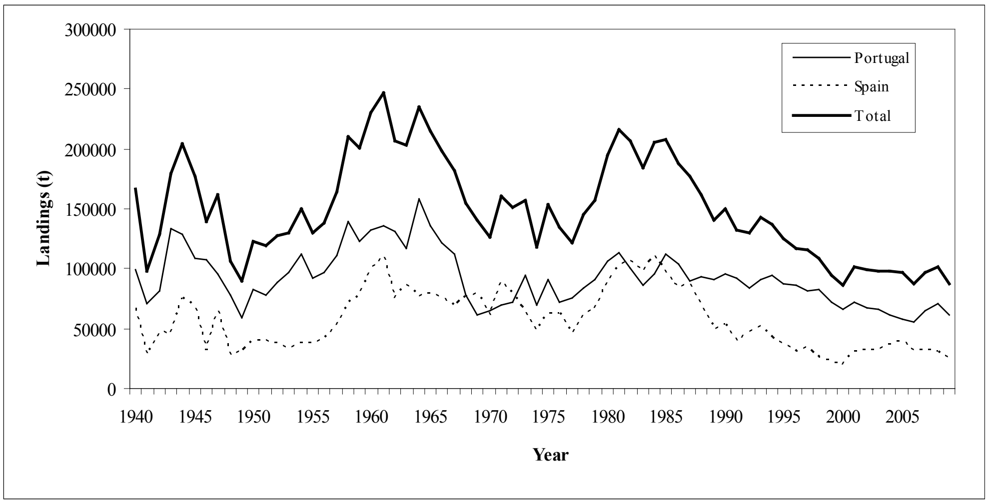
Upwelling intensity was shown to affect both positively and negatively sardine recruitment (Dickson *et al*., 1988; Roy *et al*., 1995) but the main direct effect was due to the transport of eggs and larvae offshore by northern winds (Guisande *et al*., 2001). In this way, strong upwelling during the recruitment season would decrease the probability of survival of sardine larvae as they are dispersed to outer shelf and oceanic zones. In contrast, southerly winds favour the progress of the poleward current, and tend to accumulate fish larvae near the coast where plankton biomass and production are high. At high population sizes, sardine spawning and distribution areas extend over the whole continental shelf and the adults display feeding migrations to the upwelling area off Galicia, while at low population sizes a reduction in the mobility of adult sardines between the Cantabrian Sea and Galicia is expected (Carrera and Porteiro, 2003).

B. Data

B.1. Commercial catch

Commercial catch data are obtained from the national laboratories of both Spain and Portugal. Annual landings are available since 1940 (see Figure B.1). Landings are not considered to be significantly under reported.

Figure B.1. Annual landings of sardine, by country.



Discards data on the fishery are not available and it is very difficult to measure. As with other pelagic fisheries that exploit schooling fish discarding occurs in a sporadic way and with often extreme fluctuation in discard rates (100% or null discards). Extreme discards occur especially when the entire catch is released ("slippage") which tend to be related to quota limitations, illegal size and mixture with unmarketable bycatch. Quantifying such discards at a population level is extremely difficult because they vary considerably between years, seasons, species targeted and geographical region. A discard programme, sampling purse seine vessels, has started in Portugal. Nevertheless, discard estimates are still not available to the working group. There is some slipping in northern Portugal (division IXa) but mostly in years with high recruitment. During a 12 week lasting study, the sampled fleet (nine vessels) landed 2196 t and released an estimated 4979 t (CV 33.6%) (Stratoudakis & Marcalo 2002). More than 95% of the total catch was sardine.

Since 1999 (catch data 1998), both Spanish and Portuguese labs have used a common spreadsheet to provide all necessary landing and sampling data developed originally for the Mackerel Working Group (WGMHSA). The stock co-ordinators collates data using the latest version of SALLOCL (Patterson, 1998) which produces a standard output file (Sam.out). However it should be noted that only sampled, official, WG catch and discards are available in this file.

In addition, commercial catch and sampling data were stored and processed using the INTERCATCH software for the first time during the WGHMHSA in 2007. Comparisons were made between the SALLOCL and the INTERCATCH routines and a very good agreement was found (<0.3% discrepancies). These discrepancies are likely the results of the fact that for stocks where no allocations are required (as is the case of sardine), the SALLOCL application requires a 'dummy' allocation to be made in order for the program to run successfully. While a very small value is used for the allocation, it is likely to have some impact on the results and so will have added to the discrepancy when compared with the INTERCATCH output.

B.2. Biological

Catch-at-age data (catch numbers-at-age, mean weights-at-age in the catch, mean length-at-age) are derived from the raised national figures routinely provided by both Spain and Portugal. These data are obtained either by market sampling or by on-board observers. In Spain, samples for age length keys are pooled on a half year basis for each subdivision while length/weight relationships are calculated for each quarter. Age length key and length/weight relationship from Cádiz area (IXaS Cádiz) have also been used. In Portugal, both age length keys and length/weight relationships are compiled on a quarterly and subdivision basis.

Mean weights-at-age in the stock and proportions mature (maturity ogive) are derived from the March/April acoustics survey (see next paragraph).

Table B.2.1. Summary of the overall sampling intensity over recent years on the catches of the sardine stock in VIIIc and IXa.

Year	Total catch	% Catch covered	Nº samples	Nº fish measured	Nº fish aged
1992	164,000	79	788	66,346	4,086
1993	149,600	96	813	68,225	4,821
1994	162,900	83	748	63,788	4,253
1995	138,200	88	716	59,444	4,991
1996	126,900	90	833	73,220	4,830
1997	134,800	97	796	79,969	5,133
1998	209,422	92	1,372	123,754	12,163
1999	101,302	93	849	91,060	8,399
2000	91,718	94	777	92,517	7,753
2001	110,276	92	874	115,738	8,058
2002	99,673	100	814	96,968	10,231
2003	97,831	100	756	93,102	10,629
2004	91,886	100	932	112,218	9,268
2005	97,345	100	925	116,400	9,753
2006	87,848	100	927	122,185	9,165

B.3. Surveys

B.3.1. DEPM surveys

The Daily Egg Production Method started being applied to sardine in the Iberian Peninsula during the 80s but surveys were interrupted for almost 10 years. Current DEPM surveys started in 1997 for both Spain and Portugal and have been carried out triennially since 1999. Sampling design and methodology have been further standardised in 2002 in order to guarantee good coordination of the surveys and analyses of the data collected.

In 2008, four DEPM independent surveys were conducted in the Iberian Peninsula (ICES Areas VIII and IX) by the Spanish (IEO, AZTI) and the Portuguese (IPIMAR) fisheries institutions to estimate the population spawning biomass of both sardine and/or anchovy (ICES 2008). The 2008 DEPM survey targeting the Atlantic - Iberian sardine covered the area from the Gulf of Cadiz to the Southern part of Brittany. The region on the Gulf of Cadiz to the northern Portugal/Spain border (River Minho) was surveyed by IPIMAR in January-February, while IEO covered the northwestern and north Iberian Peninsula and part of the Bay of Biscay (from 42°N to 45°N) in April. The remainder area of the Bay of Biscay and the French coast from 45ºN to 48º latitude N, was covered by AZTI, that took the opportunity to carry out the DEPM for sardine together with anchovy (main target species). The extension of the surveyed area almost up to Southern Brittany (following a recommendation from the previous meeting) resulted in a very good coverage of the species over most of its European Atlantic distribution (subareas IX and VIII), except for the top Northwestern limits. The methodology adopted for the processing of sardine adults data followed the general plan agreed for previous surveys (cf. ICES, 2005, 2006 and 2007) and a summary is presented in Table B.3.1. (Taken from ICES 2008).

Table B.3.1. Processing and analysis for eggs and adults.

DEPM	Portugal (IPIMAR)	Spain (IEO)	Spain (AZTI)
EGGS			
PairoVET eggs staged sardine (Gamulin & Hure , 1955)	All		Sample size 50/75 or all eggs
CUFES egg staged sardine (Gamulin & Hure , 1955)	In the lab, all or subsample if more than 100 per sample	No	
Temperature for egg ageing	Surface (continuous underway CTF at 3 m)	10 m	
Peak spawning hour	21		
Egg ageing	Bayesian (Bernal *et al.* 2008)		
Egg production	GLM (and GAMs available)		
ADULTS			
Histology			
-Embedding material	Paraffin	Resin	
-Stain	Haematoxilin-Eosin	Haematoxilin-Eosin	
S estimation	Day 1 and Day 2 POFs (according to Pérez *et al.* 1992a and Ganias *et al.* 2007)		
R estimation	The observed weight fraction of the females		
F estimation	On hydrated females (without POFs), according to Pérez *et al.*, 1992b		

B.3.2. Acoustic surveys

B.3.2.1 Spring Acoustic Surveys

Portuguese and Spanish acoustic surveys are coordinated within WGACEGG (ICES, 2007). Surveys are undertaken within the framework of the EU DG XIV project "Data Directive". There are two spring annual surveys (one Portuguese and one Spanish) used in the assessment as a single index of abundance of the stock. It has been argued for many years that many of the problems with the assessment of Iberian sardine emerge from the use of local surveys to represent the stock as a whole. This is problematic both because a variable fraction of the stock may be covered by each survey. Since 1996, the spring surveys have been coordinated and performed in both areas in most years. There are some differences in survey methodology, and it is unclear to what extent that influences the efficiency of the survey. There is some indication from the results of the SARDYN project that the Spanish survey may have a higher local catchability than the Portuguese survey. During the benchmark assessment carried out in 2006 a joint survey data series was made as a weighted sum of the two spring surveys and results from the exploration of survey data provided some indication of similar catchabilities. In addition, preliminary runs with a range of weighting factors the Spanish surveys indicated that the actual catchability ratio made little difference to the final outcome of the assessment. Therefore, the stock was assessed with a joint spring survey derived by just adding the Spanish and the Portuguese results. In spite of this, the merging of data from these surveys remains an outstanding issue in the current assessment and in order to address this, two calibration exercises between the Spanish and Portuguese acoustic surveys have taken place in spring 2008 and again in 2009 with the simultaneous coverage of several transects by the RVs Thalassa (Spanish survey) and Noruega (Portuguese survey) off northern Portugal. Results from these exercises are analysed within WGACEGG.

In addition to the spring surveys, there is a Portuguese acoustic survey carried out in November and covering the Portuguese waters and, in most years, the Gulf of Cadiz. This survey follows the same methodology as the spring surveys and is also coordinated by WGACEGG. Since it covers only part of the stock area and may not take into account changes in distribution between years, it is currently not used in the assessment model. However, it covers the main recruitment areas of the stock and is therefore used as an additional information on recruitment strength. Outside the assessed stock area, the spring acoustic survey PELGAS (run by IFREMER) covers the area from the south of the Bay of Biscay to south of Brittany (Figure B.3.2.1).

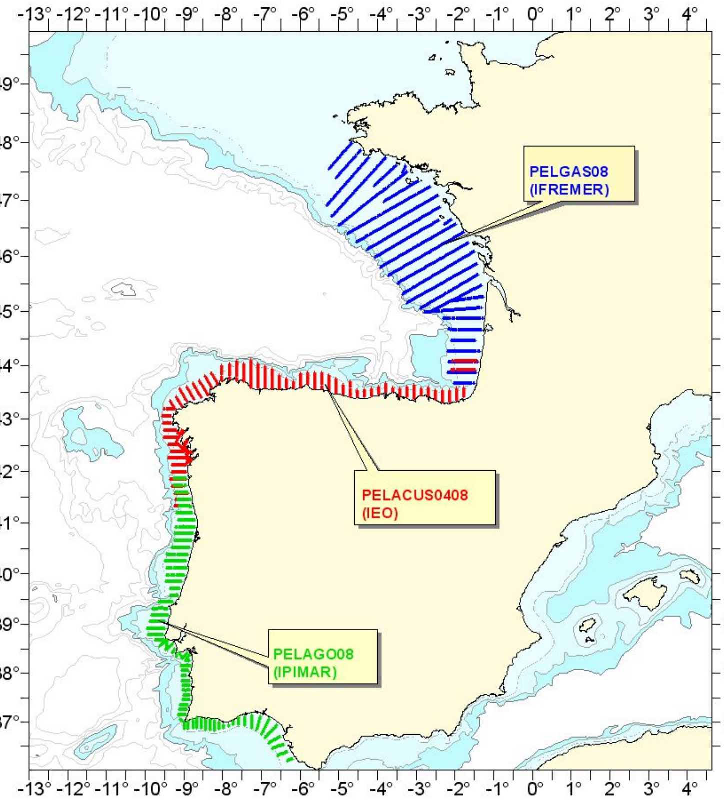


Figure B.3.2.1. Transects surveyed by PELAGO (Portugal), PELACUS (Spain) and PELGAS (France) surveys during spring 2008.

B.3.2.1.1 Portuguese Spring acoustic survey: PELAGOS

This survey is carried out with the RV "Noruega" and covers the Atlantic‐Iberian Portuguese continental shelf waters and the Spanish Gulf of Cadiz. The survey follows the standard methodology adopted by the Planning Group for Acoustic Surveys in ICES Subareas VIII and IX (ICES, 1986; 1998) and recommendations given by this WG (ICES, 2006, 2007). The acoustic equipment consists of a Simrad EK500 echosounder controlling a 38 kHz split‐beam and 120kHz single beam transducers. Acoustic data are stored in *.HAC format using Movies+ software. In addition to sardine, abundance indices are also provided for the most abundant neritic species following a 'pelagic community' approach that started in the 2007 survey.

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

Similar methodology, aims and sampling design is employed in the autumn survey although the continuation of this survey is in danger since it is not covered by the EU DG XIV project "Data Directive".

B.3.2.1.2 Spanish Spring acoustic survey: PELACUS

The spring acoustic survey PELACUS (on board the RV "Thalassa") follows the standard methodology adopted by the Planning Group for Acoustic Surveys in ICES Subareas VIII and IX (ICES, 1986; 1998) and recommendations given by this WG (ICES, 2006, 2007). The scientific echosounder is a Simrad EK60 working at five frequencies (18, 38, 70, 120 and 200 kHz). Acoustic data are stored as *.raw format using SonarData Echoview software. The area of the continental shelf covered extends from 30 to 200 m depth, from northern Portuguese waters to southern French waters. The survey design comprises 53 tracks, plus 23 tracks inside the Rías in (Galician waters).

The objective of the survey is the estimation of the abundance and biomass of the main fish pelagic species that form the pelagic community in northern Spanish waters: sardine, anchovy, horse mackerel (*Trachurus trachurus*), mackerel (*Scomber scombrus)*, chub mackerel (*Scomber colias*), blue horse mackerel (*Trachurus picturatus*), bogue (*Boops boops*), blue whiting (*Micromesistius poutassou*) and boarfish (*Capros aper*).

B.3.2.1.3 French spring acoustic survey: PELGAS

The French acoustic survey (PELGAS) is routinely carried out each year in spring in the Bay of Biscay and information on pelagic fish species distribution and abundance is available since 2000. The survey takes place onboard the R/V Thalassa. The main species targeted is anchovy but the survey is part of the IFREMER programs on data collection for monitoring and management of fisheries with an ecosystemic approach for fisheries and information is therefore also collected on other pelagic species, on egg presence and abundance, on top predators abundance and distribution and on environmental variables such as temperature, salinity, plankton, etc. The survey is planned with Spain and Portugal in order to have most of the potential area to be covered from Gibraltar to Brest with the same protocol for sampling strategy. Data are made available to the ICES working groups WGANSA, WGWIDE and WGACEGG.

Acoustic data are collected along systematic parallel transects perpendicular to the French coast. 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 m depth to the shelf break. Acoustic data are collected only during the day because of pelagic fishes behaviour in the area. These species are usually dispersed very close to the surface during the night and so "disappear" in the blind layer for the echo sounder between the surface and 8 m depth.

Since 2008, PELGAS survey has been accompanied by pelagic pairtrawlers that follow the R/V Thalassa transects. Identification hauls were carried out both by the R/V Thalassa and the commercial vessels being preferentially carried out by pairtrawlers which are more efficient (less avoidance to the vessels) and hauls close to the bottom being preferiantilly carried out by the R/V Thalassa.

B.4. Commercial CPUE

CPUE indices are not considered reliable indicators of abundance for small pelagic fish (Ulltang, 1982; Csirke, 1988; Pitcher, 1995; Mackinson *et al*., 1997) and are not used.

B.5. Other relevant data

C. Historical Stock Development

Model used: The stock is assessed using AMCI, an age structured model (AMCI, Assessment Model Combining Information from various sources, Skagen 2005). The model has large flexibility with the possibility for area and fleet disaggregation, different time steps, several stock-recruitment and fishing mortality models and objective functions.

For the assessment of this stock, no spatial disaggregation or fleet disaggregation is assumed and time steps are years. The population model is an exponential mortality model. The initial abundances in numbers of each year class are specified as parameters. The plus group is modeled as a dynamic pool. Selection-at-age is allowed to change gradually across the period using a recursive updating algorithm. This provides a fishery mortality model close to separable. Observation models describe the relation between the modelled population and the observed data through the estimation of catchability parameters. No process errors are assumed. Observation errors are not assumed to follow specific distributions. The objective function is a sum of squared log residuals. Asymptotic estimates of variance and correlations by the inverse of the Hessian matrix. Median and 90% limits of SSB, R and F trajectories estimated by non-parametric bootstrap of catch and survey residuals.

More detailed information on AMCI can be found in Skagen (2005).

Software used: **AMCI Version 2.4. Assessment model combining information from various sources. August 2005. D. Skagen, 2005.** Available in the ICES webpage (www.ices.dk) or from the author dankert@imr.no.

Model Options chosen:

The model is conditioned as follows:

- Selection at age in the fishery at age 4 equal to age 5
- Selection at age in the fishery in the last year of the assessment equal to that of the previous year
- Survey catchability at age 4 equal to age 5
- DEPM survey as a relative index of SSB
- Selection at age allowed to change gradually, using the recursive updating algorithm in AMCI, with a gain factor of 0.2 for all ages and years
- Survey catchability assumed constant over time.
- Catchability of the DEPM survey constant over time.
- Natural mortality: Constant at 0.33 (Pestana, 1989).

The following model parameters are estimated:

- Initial numbers in the first year of the assessment and recruitments each year
- Initial selection at age in the fishery, for all ages (but see above)
- Survey catchability at age, for all ages, but assumed equal for ages 4 and 5
- Catchability for the DEPM survey.
- Annual fishing mortalities.

The objective function is a sum of squared log residuals for catch numbers at age, survey indices at age and DEPM indices. 0-group fish are not fully selected by the fishery and catches at-age for this age group are very noisy and biased. Therefore, catches at age 0 are downweighed by a factor of 0.1. The internal weighting in AMCI implies that the set of all acoustic survey observations (number ages x number years), and the set of DEPM observations (number years), each are given the same weight as each year of catch numbers at age (number ages) in the objective function. Therefore, catch-at-age data has considerable more weight than either survey on the model fit. The DEPM has the same weight as the acoustic survey.

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1978-2009	0-6+	No
Canum	Catch at age in numbers	1978-2009	0-6+	Yes
Weca	Weight at age in the commercial catch	1978-2009	0-6+	Yes
West	Weight at age of the spawning stock at spawning time.	1978-2009	0-6+	Yes (fixed until 1988)
Mprop	Proportion of natural mortality before spawning	1978-2009	0-6+	No
Fprop	Proportion of fishing mortality before spawning	1978-2009	0-6+	No
Matprop	Proportion mature at age	1978-2009	0-6+	Yes (fixed until 1988)
Natmor	Natural mortality	1978-2009	0-6+	No

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Acoustic SSB spring survey (data summed from one Spanish and one Portuguese survey, the former covering also the Gulf of Cadiz)	1996 – 2010 (gap in 2004)	1-6+
Tuning fleet 2	DEPM SSB spring series (data summed from one Spanish and one Portuguese survey)	Triennial since 1997	
Tuning fleet 3			
….			

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Stock Annex – Bay of Biscay Anchovy (Subarea VIII)

Quality Handbook **Annex: 2**

Stock specific documentation of standard assessment procedures used by ICES

Stock: Bay of Biscay Anchovy (Subarea VIII)

Working Group: WGANSA (working group on the assessment of anchovy and sardine)

Date: 15^{th} to 20^{th} of June, 2009

Revised at: WGANSA2009, WKSHORT2009 and WGANSA2010

Authors by alphabetic order: E. Duhamel, L. Ibaibarriaga, J. Massé, L. Pawlowski, M. Santos and A. Uriarte.

A. General

A.1. Stock definition

Anchovy (*Engrulis encrasicolus, L*) stock in Subarea VIII (Bay of Biscay) is considered to be isolated from a small population in the English Channel and from the population in the area IXa. No subpopulations have been defined, although morfometrics and meristic studies suggest some heterogeneity at least in morphotipes (*Prouzet and Metuzals, 1994*; *Junquera and Perez-Gandaras, 1993*). Some genetic heterogeneity based on proteins allocime loci have been found between the Garonne spawning regions and southern regions in the Bay of Biscay (Adour and Cantabrian shores) (*Sanz et al., 2008*). Nevertheless, the evident inter connection of fisheries and rather homogenous recruitment pulses occurring in the Bay of Biscay lead ICES to consider that the anchovy in this area should be dealt as a single stock for assessment and management (ICES 2007).

A.2. Fishery

The fisheries were closed since June 2006 to December 2009 due to poor condition of the stock. It was reopened in January 2010 with a TAC of 7,000t. The fisheries for anchovy are targeted by purse-seiners and pelagic trawlers. The Spanish and French fleets fishing for anchovy in Subarea VIII are spatially and temporally quite well separated. The Spanish fleet (purse seine fleet) operates mainly in Divisions VIIIc and VIIIb in spring, while the French fleet (mainly pelagic trawlers) operates in Division VIIIa in summer and autumn and in Division VIIIb in winter and summer. A small fleet of French purse seiners operates in the South of the Bay of Biscay (VIIIb) in spring and in the North (VIIIa) during the autumn. An overview of the history of the fishery until the mid nineties and its spatial behaviour is found in Junquera (1986) and Uriarte *et al.* (1996) and for more recent perspective see ICES 2007 & 2008 or STECF 2008 for the international fishery and Uriarte *et al.* (2008) Villamor *et al.* (2008) for the Spanish fishery and Duhamel (2004) and Vermard *et al.* (2008) for the French pelagic trawlers. A recent updated information (2009) provided by the SWW RAC shows a 18% decrease in the fleet size operating on anchovy since the closure of the fishery (2005). This decrease is much more important for the pelagic trawlers' fleet (-

39%) than for the purse seiners (-11%). Since the fishery closure, the fleets have redeployed their effort mainly towards other small pelagic species (57%) and tunas (29%) (Table A.2.2).

Table A.2.1: Evolution of the French and Spanish fleets on anchovy in Sub-area VIII. Fishery closed in 2006, 2007 and 2008. 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		0	0	0
2008	0	0		0	0	0
2009						
2010	2	30	(2)	32		

*** Spanish purse seiners are those with licences that landed anchovy**

(1) Only purse seiners having catch 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 terms 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 A.2.2. Approximate figures for the anchovy fleet and fishing effort displacement for the the period 2005-2009 (based on reports from stakeholders 28th August 2009, provided by the SWW RAC). Report vers = report to add; bolincheurs sud bretagne = purse seiners in southern Brittany; chinchard = horse mackerel; maquerau = mackerel; thon rouge = bluefin tuna; thon blanc = albacore; Autres = others

Fishing ports	Seiners		Pelagic trawlers		report vers												number of targeted species
					sardine		chinchard		maquereau		thon rouge		thon blanc		autres		
	2005	2009	2005	2009													
Galice	67	61			1	15,3	1	15,3	1	15,3					1	15,3	4
Asturies	10	6			1	3,0	1	3,0									2
Cantabrie	54	47			1	9,4	1	9,4	1	9,4	1	9,4	1	9,4			5
Vizcaya	25	25			1	5,0	1	5,0	1	5,0	1	5	1	5			5
Guipuzkoa	52	44			1	8,8	1	8,8			1	8,8	1	8,8	1	8,8	5
StJean de Luz	8	8	4	4			1	12,0									1
la Turballe			39	23									1	11,5	1	11,5	2
St Gilles			24	14	1	0,0					1	0					2
Bolincheurs sud bretagne	8	8			1	2,7	1	2,7							1	2,7	3

2010 St jena de luz 2 Lorient 2 La Turbballe 20 St Gilles 6 (15 pairs of pair pelagic trawlers)

A.3. Ecosystem aspects

Anchovy is a prey species for other pelagic and demersal species in the Bay of Biscay, and also for cetaceans and birds.

The recruitment depends strongly on environmental factors. Two environmental recruitment indices have been considered during the last 10 years: i) Borja's *et al.* (1998) index, which is an upwelling index, and ii) Allain's *et al.* (2001) index, which is a combination of upwelling and stratification breakdown. Allain's model was reviewed by Huret & Petitgas (WD 2007 in ICES2008) including a) the previous "upwelling" index, plus a new "stratification" index according to a new hydrodynamic model and b) an adult spatial indicator. The role of the Eastern Atlantic pattern in relation to the Upwelling index and the recruitment of anchovy have also been recently pointed out (Borja *et al.*, 2008). Other approaches based on coupling spawning habitat with hydrodynamic and production models are being tried for this anchovy population with promising results (Allain *et al.*, 2007).

The significance and reliability of all these indices is considered still insufficient for their consideration in the provision of management advice and no update was provided on their performance for the meeting in 2010 of WGANSA. 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 (Barange et al., 2009).

Fernandes et al (2010) presents an alternative to attempt to relate environmental indices with recruitment by means of linear models. It uses machine-learning techniques to obtain the probability of having a recruitment discretized into low, medium and high classes depending on environmental variables. The proposed methodology consists of performing supervised predictors discretization, carrying out supervised predictors selection and learning a 'naive Bayes' classifier. The approach can be applied to a dataset where the values of the recruitment have been discretized by the end-user, or the recruitment discretization can be part of the proposed model-building process in a bootstrap scheme. The results up to now are promising.

B. Data

B.1. Commercial catches:

Fishery closed from July 2006 to December 2009. reopened with 7,000t the 1st of March 2010

Annual Landings are available since 1940. The fishing statistics are considered accurate. Discards are not measured and hence not included in the assessment, but nowadays they are considered not relevant for the two fleets. In the past (late eighties and early nineties for the French Pelagic trawlers and sixties and seventies for the Spanish Purse seine fleet) they seemed to be more relevant (according to disputes among fishermen), but were never quantified.

B.2. Biological

- Catches at length and catches at age are known since 1984 for Spain and since 1987 for France. They are obtained by applying to the monthly Length distributions half year or quarterly ALKs (and when possible monthly ALKs, as for the Spanish fishery in spring). Biological sampling of the catches has been generally sufficient, except for 2000 and 2001, when an increase of the sampling effort seemed useful to have a better knowledge of the age structure of the catches during the second semester in the North of the Bay of Biscay. Complete age composition and mean weight at age on half year basis, were reported in ICES (2008- WGANC report).
- Age reading is considered accurate. The most recent cross reading exchanges and workshop between Spain and France took place in 2005 and 2006 respectively (Uriarte *et al.,* 2006 and 2007). The overall level of agreement and precision in anchovy age reading determinations seems to be satisfactory: Most of the anchovy otoliths were well classified by most of the readers during the 2006 workshop (with an average agreement of 92.7 % and a CV of 9.2%). CVs were on average smaller than 15% for any age, although individual CVs for ages or readers might be 30-35%. A new otolith exchange and age reading workshop took place in November 2009.
- Anchovies are mature at their 1st year of life.
- Growth in weight and length are well known from Surveys and from the monitoring of the fishery (Uriarte *et al.*, 1996).
- Natural mortality is fixed at 1.2 as an average of varying values obtained under the assumption of past DEPM providing absolute estimates of the population in numbers at age (*Uriarte* et al., 1996). This parameter is considered to vary between years, but it is assumed to be constant for the assessment of the stock.
- In the Bayesian Biomass Model, the parameter *g* describes the annual change in mass of the population by encapsulating the growth in weight (G) and the natural Mortality (M) of the population as G-M (0.52-1.2=-0.68)

B.3. Surveys

Spring surveys: series of DEPM(Daily egg production method) and acoustic surveys in Spring every year.

The population is monitored by the two annual surveys carried out in spring on the spawning stock, namely, the Daily Egg Production Method (since 1987 with a gap in 1993) (Santiago and Sanz, 1992; Motos *et al.*, 2005) and the Acoustics surveys (regularly since 1989, although surveys were also conducted in 1983, 1984 and some in the seventies) (Massé 1988, 1994, 1996). Both surveys provide spawning biomass and population at age estimates. The surveys have shown pronounced inter-annual variability of biomass according to the pulse of recruitments, since one year old anchovies can conform up to more than 75% of the spawning population. Spawning area and biomass are positive and closely related, revealing expansion of the area occupied by the population when SSB increases (Uriarte *et al.*, 1996, Somarakis *et al.*, 2004).

This survey based monitoring system provides population estimates by the middle of the year, when about half of the annual catches have been already taken; and provide very little information about the anchovy population in the next year, since the bulk of it will consist of 1 year old anchovies being born at the time the surveys take place. Spawning Biomass in spring equals total stock biomass since all anchovies are mature (the youngest being 1 year old by then).

B.3.1 Anchovy Daily Egg Production Method

B.3.1.1 The DEPM model

The anchovy spawning stock biomass estimates is derived according to Parker (1980) and Stauffer & Picquelle (1980) from the ratio between daily production of eggs in the sea and the daily specific fecundity of the adult population:

Equation 1 $$SSB = P_{tot}/DF = \frac{P_0 \cdot A+}{k \cdot R \cdot F \cdot S/W}$$

Where,

SSB = Spawning stock biomass in metric tons

P_{tot} = Total daily egg production in the sampled area

P_0 = daily egg production per surface unit in the sampled area

A+ = Spawning area, in sampling units

DF = Daily specific fecundity. $DF = \frac{k \cdot R \cdot F \cdot S}{W}$

W = Average weight of mature females in grams,

R = Sex ratio, fraction of population that are mature females, by weight.

F = Batch fecundity, numbers of eggs spawned per mature females per batch

S = Fraction of mature females spawning per day

k = Conversion factor from gram to metric tons (10^6)

An estimate of an approximate variance and bias for the biomass estimator derived using the *delta* method (Seber, 1982, *in* Stauffer & Picquelle, *op. cit.*) was also developed by the latter authors.

Population estimates of numbers at age are derived as follows:

Equation 2 $$N_a = N \cdot E_a = \frac{SSB}{W_t} \cdot E_a$$

Where,

Na = Population estimate of numbers at age *a*.

N = Total spawning stock estimate in numbers. $N = \frac{SSB}{W_t}$

B = spawning stock biomass estimate.

Wt = average weight of anchovies in the population.

Ea = Relative frequency (in numbers) of age *a* in the population.

Variance estimate of the anchovy stock in numbers at age and total is derived applying the delta method.

B.3.1.2 Collection of plankton samples

Every year the area covered to collect the plankton samples is the southeast of the Bay of Biscay which corresponds to the main spawning area and season of anchovy.

Predetermined distributions of the vertical hauls that will be performed with the PairoVET net are shown in **Figure B.3.1.2.1**. The strategy of egg sampling is as follow: a systematic central sampling scheme with random origin and sampling intensity depending on the egg abundance found. Stations are located every 3 miles, along 15-mile-apart transects perpendicular to the coast. The sampling strategy is adaptive. When the egg abundances found are relatively high, additional transects separated by 7.5 nm are completed.

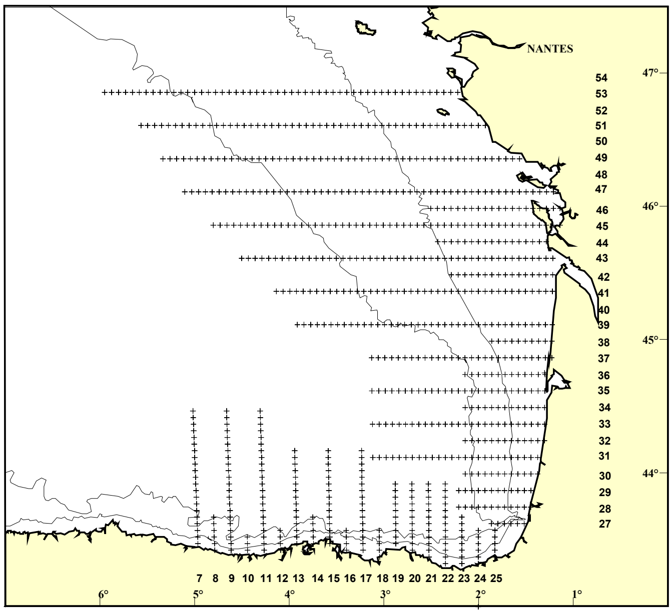


Figure B.3.1.2.1: Predetermined stations of the vertical hauls (PairoVET) that could be performed during the survey

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

A vertical plankton haul is performed in each sampling station, using a PairoVET net (2-Calvet nets, Smith *et al.*, 1985 in Lasker, 1985) with a mouth aperture of 0.05 m^2 each CalVET. The frame was equipped with nets of 150 µm. The net is lowered to a maximum depth of 100 m or 5 m above the bottom in shallower waters. After allowing 10 seconds at the maximum depth for stabilisation, the net is retrieved to the surface at a speed of 1 m s^{-1}. A 45 kg depressor was used to allow for correctly deploying the net. "G.O. 2030" flowmeters were used to know the amount of water filtered during the tow.

Immediately after the haul, the net is washed and the samples obtained are fixed in formaldehyde 4% buffered with sodium tetra borate in sea water. After 6h of fixing, anchovy, sardine and other species eggs are identified and sorted out on board. Afterwards, in the laboratory a percentage of the samples are checked to assess the quality of the sorting made at sea. According to that a portion of the samples are sorted again to assure no eggs are left. In the laboratory the anchovy eggs are staged (Moser and Alshtrom, 1985).

During the survey, the presence/absence of eggs was recorded per PairoVET station and the area where anchovy eggs occurred was quantified. The spawning area was delimited with the outer zero anchovy egg stations. It contains some inner zero egg stations embedded on it (Picquelle and Stauffer, 1985). Following the systematic central sampling scheme (Cochran, 1977) each station was located in the centre of a rectangle. Egg Abundance found at a particular station was assumed to represent the abundance in the whole rectangle. The area represented by each station was measured. A standard station has a surface of 45 squared nautical miles (154 km^2) = 3 (distance between two consecutive stations) x 15 (distance between tow consecutive transects) nautical miles. Since sampling was adaptive, station area changed according to sampling intensity.

Real depth, temperature, salinity and chlorophyll profiles are obtained in every station using a CTD RBR-XR420 coupled to the PairoVET. In addition, surface temperature and salinity is recorded in each station with a manual termosalinometer WTW LF197.Moreover current data are obtained all along the survey with an ADCP(Acoustic Doppler Current Profiles).In some point determinate previously to the survey, water is filtered from the surface to obtain chlorophyll samples.

B.3.1.3 Collection of adult samples

In 1987 and 1988 the samples were obtained from commercial purse seines, the adult sampling was opportunistic. From years 1989 to 2005 the adult samples were obtained both from commercial purse seines and a research vessel with pelagic trawl so the adult sampling was both opportunistic and directed. Since 2006 the samples are obtained from a research vessel with pelagic trawl but not from the purse seines due to the closure of the fishery so the adult sampling is only directed not opportunistic. Since the reopening of the fisheries in March 2010 the commercial purse seines are providing again samples for the analysis apart from the ones from the research vessels.

The research vessel pelagic trawler covers the same area as the plankton vessel. When the plankton vessel encountered areas with anchovy eggs, the pelagic trawler is directed to those areas to fish. In each haul 100 individuals of each species are measure. Immediately after fishing, anchovy is sorted from the bulk of the catch and a sample of near 2 Kg is selected at random. Sampling finished as soon as a minimum of 1 kg or 60 anchovies are sexed, and from those, 25 non-hydrated females (NHF) are preserved. Sampling is also stopped when more than 120 anchovies have to be sexed to achieve the target of 25 NHF. Moreover, otoliths are extracted to obtain the age composition per sample.

In the case the sample are obtained from the purse seines a sample of near 2kg is selected from the fishing and are directly kept in 4% formaldehyde. Afterwards, in the laboratory the samples are process in the same way as explained above.

B.3.1.4 Total daily egg production estimates

When all the anchovy eggs are sorted and staged, it is possible to estimate total daily egg production (P_{tot}). This is calculated as the product between the daily egg production (P_0) and the spawning area (SA)

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

A standard sampling station represents a surface of 45 nm² (i.e. 154 km²). 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 (ICES 2004) Daily egg production (P_0) and daily mortality rates (Z) 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.

B3.1.5 Adult parameters and Daily Fecundity estimates

The DF estimate for this WGANSA in June is obtained from a linear regression model between DF and sea surface temperature (SST). Two weeks after arriving from the survey the adult parameters are not processed yet, uniquely the anchovies were weighted, measured, sexed and the otoliths were extracted, consequently Daly Fecundity has to be derived from the past historical series. Afterwards in the ICES WGACEGG in November the complete DEPM with all the adult parameters estimates is presented and approval. This occurred since 2005 when the advice started demanding SSB estimates in June, however the historical series of DF is being revised within WGACEGG (ICES 2009). Until DF is fully revised and its relationship with temperature corroborated by WGACEGG, the WGANSA decided to use the historical mean of DF (63.39 egg/g per day) to obtain the preliminary SSB estimate for June.

From the whole set of adult samples gathered during the survey, a subset is chosen for final processing with the criterion of collection within ±5 days of the egg sampling in the same particular area. In the last years the samples are collected within the same day as the egg sampling. These samples are used to obtain adult parameters estimates leading to the estimate of Daily Fecundity, i.e. batch fecundity, spawning fraction, average female weight and sex ratio. These adult parameters are estimates for November as follows:

Sex Ratio (R): Given the large variability among samples of the sex ratio and taking into account that for most of the years when the DEPM has been applied to this population the final estimate has come out to be not significantly different from 50 % for each sex (in numbers), since 1994 the proportion of mature females per sample is being assumed to be equal to 1:1 in numbers. This leads to adopt as R the value of the average sample ratio between the average female weight and the sum of the average female and male weights of the anchovies in each of the samples.

Total weight of hydrated females is corrected for the increase of weight due to hydration. Data on gonad-free-weight (Wgf) and correspondent total weight (W) of non hydrated females is fitted by a linear regression model. Gonad-free-weight of hydrated anchovies is then transformed to total weight by applying the following equation:

$$W = -a + b * W_{gf}$$

For the **Batch fecundity (F)** estimates i.e. number of eggs laid per batch and female, the hydrated egg method was followed (Hunter et al, 1985). The number of hydrated oocytes in gonads of a set of hydrated females is counted. This number is deduced from a sub-sampling of the hydrated ovary: Three pieces of approximately 50 mg are removed from different parts of each ovary, weighted with precision of 0.1 mg and the number of hydrated oocytes counted. Sanz & Uriarte (1989) showed that 3 tissue samples per ovary are adequate to get good precision in the final batch fecundity estimate and the location of sub-samples within the ovary do not affect it. Finally the number of hydrated oocytes in the sub-sample is raised to the total gonad of the female according to the ratio between the weights of the gonad and the weight sub-sampled.

A linear regression between female weight and batch fecundity is established for the subset of hydrated females and used to calculate the batch fecundity of all mature females. The average of the batch fecundity estimates for the females of each sample as derived from the gonad free weight – eggs per batch relationship is then used as the sample estimate of batch fecundity.

Moreover, an analysis is conducted to verify if there are differences in the batch fecundity if strata are defined to estimate SSB.

To estimate **Spawning Frequency (S)**, i.e. the proportion of females spawning per day, until the new series of spawning frequency (S) is accepted a model based on the historical series was considered. This model relates S linearly with Sea Surface Temperature (SST).

Mean and variance of the adult parameters are estimated following equations for cluster sampling (as suggested by Picquelle & Stauffer, 1985):

Equation 3
$$Y = \frac{\sum_{i=1}^{n} M_i\, y_i}{\sum_{i=1}^{n} M_i}$$

Equation 4 $$Var(Y) = \frac{\sum_{i=1}^{n} M_i^2 (y_i - Y)^2}{\overline{M}^2 n(n-1)}$$

Where,

Y_i is an estimate of whatever adult parameter from sample *i* and M_i is the size of the cluster corresponding to sample *i*. occasionally a station produced a very small catch, resulting in a small sub-sample size. To reflect the actual size of the station and its lower reliability, small samples were given less weight in the estimate. For the estimation of W, F and S, a weighting factor was used, which equalled to 1 when the number of mature females in station *i* (M_i) was 20 or greater and it equalled to $M_i/20$ otherwise. In the case of R when the total weight of the sample was less than 800 g then the weighting factor was equal to total weight of the sample divided by 800g, otherwise it was set equal to 1. In summary for the estimation of the parameters of the Daily Fecundity we are using a threshold-weighting factor (TWF) under the assumption of homogeneous fecundity parameters within each stratum.

B.3.1.6 SSB estimates

In the WGANSA during June the Spawning Stock Biomass is preliminary estimates as the ratio between the total egg production (P_{tot}) and Daily Fecundity (DF) estimates and its variance is computed using the Delta method (Seber, *1982*):

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

The definitive SSB estimate with all the adult parameters is presented and approval at the WGACEGG during November.

B.3.1.7 Numbers at age

For the purposes of producing population at age estimates, the age readings based on otoliths from the adult samples collected 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 relative egg abundance and to the amount of samples in the strata defined for the proposed of the estimation of the numbers at age. These strata are defined each year depending on the distribution of the adult samples i.e. size, weight, age and the distribution of the anchovy eggs.

Mean and variance of the adult parameters of the Population in numbers at age and the Population length distribution (total weight, proportion by ages and length distribution) are estimated following equations 4 and 5 for cluster sampling.

B.3.2. Anchovy acoustic indices

Acoustic surveys are carried out every year in the Bay of Biscay in spring on board the French research vessel Thalassa. The objective of PELGAS surveys is to study the abundance and distribution of pelagic fish in the Bay of Biscay. The main target species is anchovy but it will be considered in a multi-specific context as species located in the centre of ecosystem.

These surveys are connected with IFREMER programs on data collection for monitoring and management of fisheries and ecosystemic approach for fisheries. This task is formally included in the first priorities defined by the Commission regulation EU N° 199/2008 of 06 November 2008 establishing the minimum and extended Community programmes for the collection of data in the fisheries sector and laying down detailed rules for the application of Council Regulation (EC) No 1543/2000. These surveys must be considered in the frame of the Ifremer fisheries ecology action "resources variability" which is the French contribution to the international Globec programme. It is planned with Spain and Portugal in order to have most of the potential area to be covered from Gibraltar to Brest with the same protocol for sampling strategy. Data are available for the ICES working groups WGANSA, WGWIDE and WGACEGG.

B.3.2.1. Method and sampling strategy

In the frame of an ecosystemic approach, the pelagic ecosystem is characterized at each trophic level. In this objective, to assess an optimum horizontal and vertical description of the area, two types of actions are 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 a 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 will be 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 (from board) and of birds (by plane) will be carried out in order to characterise the higher level predators of the pelagic ecosystem.

Satellite imagery (temperature and sea colour) and modelisation are 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) is carried out in order to characterise the top predators of the pelagic ecosystem.

The strategy was the identical to previous surveys (2000 to 2009):

- Acoustic data were collected along systematic parallel transects perpendicular to the French coast (figure 1.1.1). The length of the ESDU (Elementary Sampling Distance Unit) was 1 mile and the transects were uniformly spaced by 12 nautical miles covering the continental shelf from 20 m depth to the shelf break.

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

Two echo-sounders are usually used during surveys (SIMRAD EK60 for vertical echo-sounding and OSSIAN 500 on the pelagic trawl). In 2009 the SIMRAD ME70 has been used for multi-beam visualisation. Energies and samples provided by split beam transducers (5 frequencies EK60, 18, 38, 70, 120 and 200 kHz), simple beam (OSSIAN 49 kHz) and multibeam echo-sounder were simultaneously visualised, stored using the MOVIES+ software and at the same standard HAC format.

The calibration method is the same that the one described for the previous years (see W.D. 2001) with a tungsten sphere hanged up 20 m below the transducer and is generally performed at anchorage in front of Machichaco cap or in the Douarnenez bay, in the west side of Brittany, in optimum meteorological conditions.

Acoustic data are collected by Thalassa along the totality of the daylight route from which about 2000 nautical miles on one way transect are usable for assessment. Fish are measured on board (for all species) and otoliths (for anchovy and sardine) are collected for age determinations.

B.3.2.2. Echoes scrutinizing

Most of the acoustic data along the transects are processed and scrutinised during the survey and are generally available one week after the end of the survey (figure 2.2.1). Acoustic energies (Sa) are cleaned by sorting only fish energies (excluding bottom echoes, parasites, plankton, etc.) and classified into several categories of echo-traces according to the year fish (species) structures.

Some categories are standard such as:

D1 – energies attributed to mackerel, horse mackerel, blue whiting, divers demersal fish, corresponding to cloudy schools or layers (sometimes small dispersed points) close to the bottom or of small drops in a 10m height layer close to the bottom.

D2 –energies attributed to anchovy, sprat, sardine corresponding to the usual echo-traces observed in this area since more than 15 years, constituted by schools well designed, 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, just closed to the shelf-break.

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

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

Some particular categories are usually specifically designed according to several identifications during the survey (when Thalassa and/or commercial vessels hauls are available), such as:

D7 – energies attributed exclusively to sardine (big and very dense schools).

D5 – energies attributed to small horse mackerel only when they are gathered in very dense schools this category is usually used for typical echoes which occur along particular surveys. In the case of 2010, it was used to gather energies which occurred all along the transects in the. northern platform where a continuous cover of mainly blue whiting was observed.

B.3.2.3. Data processing

The global area is split into several strata where coherent communities are observed (species associations) in order to minimise the variability due to the variable mixing of species. For each stratum, a mean energy is calculated for each type of echoes and the area measured. A mean haul for the strata is calculated to get the proportion of species into the strata. This is obtained by estimating the average of species proportions weighted by the energy surrounding haul positions. Energies are therefore converted into biomass by applying catch ratio, length distributions and TS relationships. The calculation procedure for biomass estimate and variance is described in Petitgas et.al 2003.

The TS relationships used since 2000 are still the same and as following:

Sardine, anchovy & sprat : TS = 20 Log L – 71.2

Horse-mackerel : TS = 20 Log L – 68.7

Blue whiting : TS = 20 Log L – 67.0

Mackerel : TS = 20 Log L – 86.0

The mean abundance per species in a stratum (tons m.n.$^{-2}$) is calculated as:

$$M_e(k)=\sum_D \bar{s}_A(D,k)\bar{X}_e(D,k)$$

and total biomass (tons) by : $B_e=\sum_k A(k)Me(k)$

where,

k : strata index

D : echo type

e : species

S_A : Average S_A (NASC) in the strata (m2/n.mi.2)

X_e : species proportion coefficient (weighted by energy around each haul) (tons m^{-2})

A : area of the strata (m.n.^{2})

Then variance estimate is:

$$Var.M_e(k)=\sum_D \bar{s}_A^{\,2}(D,k)Var[X_e(D,k)]/n.cha(k)+\bar{X}_e^{\,2}\,\mathrm{var}[s_A(D,k)]/n.esu(D,k)$$

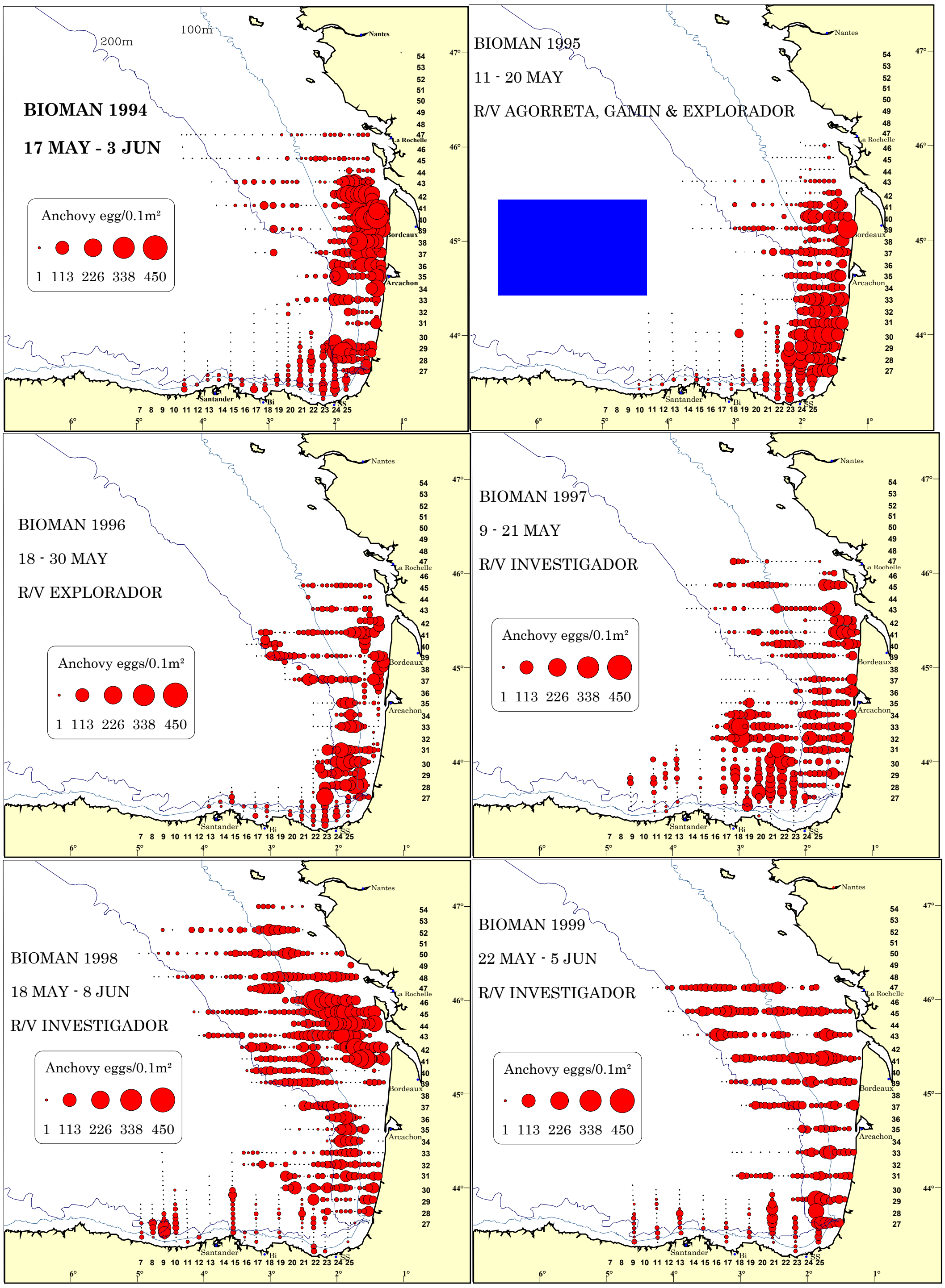
$$Var.B_e=\sum_k A^2(k)Var.Me(k)$$

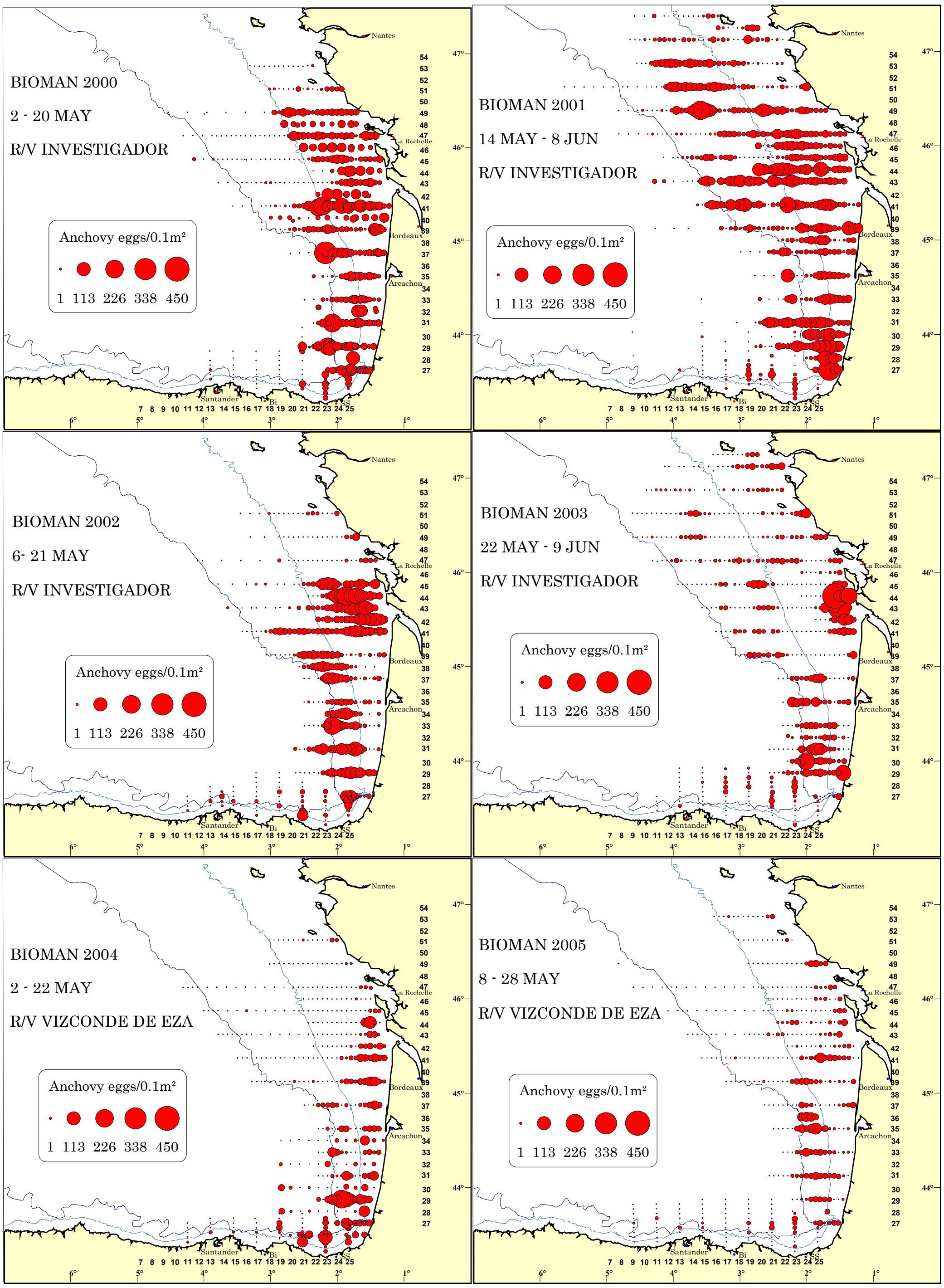
$$cv=\sqrt{Var.Be}/Be$$

At the end, density in numbers and biomass by length and age are calculated for each species in each ESDU according to the nearest haul length composition. These numbers and biomass are weighted by the biomass in each stratum and data are used for spatial distributions by length and age.

The detailed protocol for these surveys (strategy and processing) is described in annex 6 of WGACEGG report in 2009

B.3.3 Historical series DEPM and acoustic surveys




BIOMAN 2000
2 - 20 MAY
R/V INVESTIGADOR
BIOMAN 2001
14 MAY - 8 JUN
R/V INVESTIGADOR
BIOMAN 2002
6- 21 MAY
R/V INVESTIGADOR
BIOMAN 2003
22 MAY - 9 JUN
R/V INVESTIGADOR
BIOMAN 2004
2 - 22 MAY
R/V VIZCONDE DE EZA
BIOMAN 2005
8 - 28 MAY
R/V VIZCONDE DE EZA
Anchovy eggs/0.1m²
1 113 226 338 450
Nantes
La Rochelle
Bordeaux
Arcachon
Santander
Bi
47°
46°
45°
44°
6°
5°
4°
3°
2°
1°

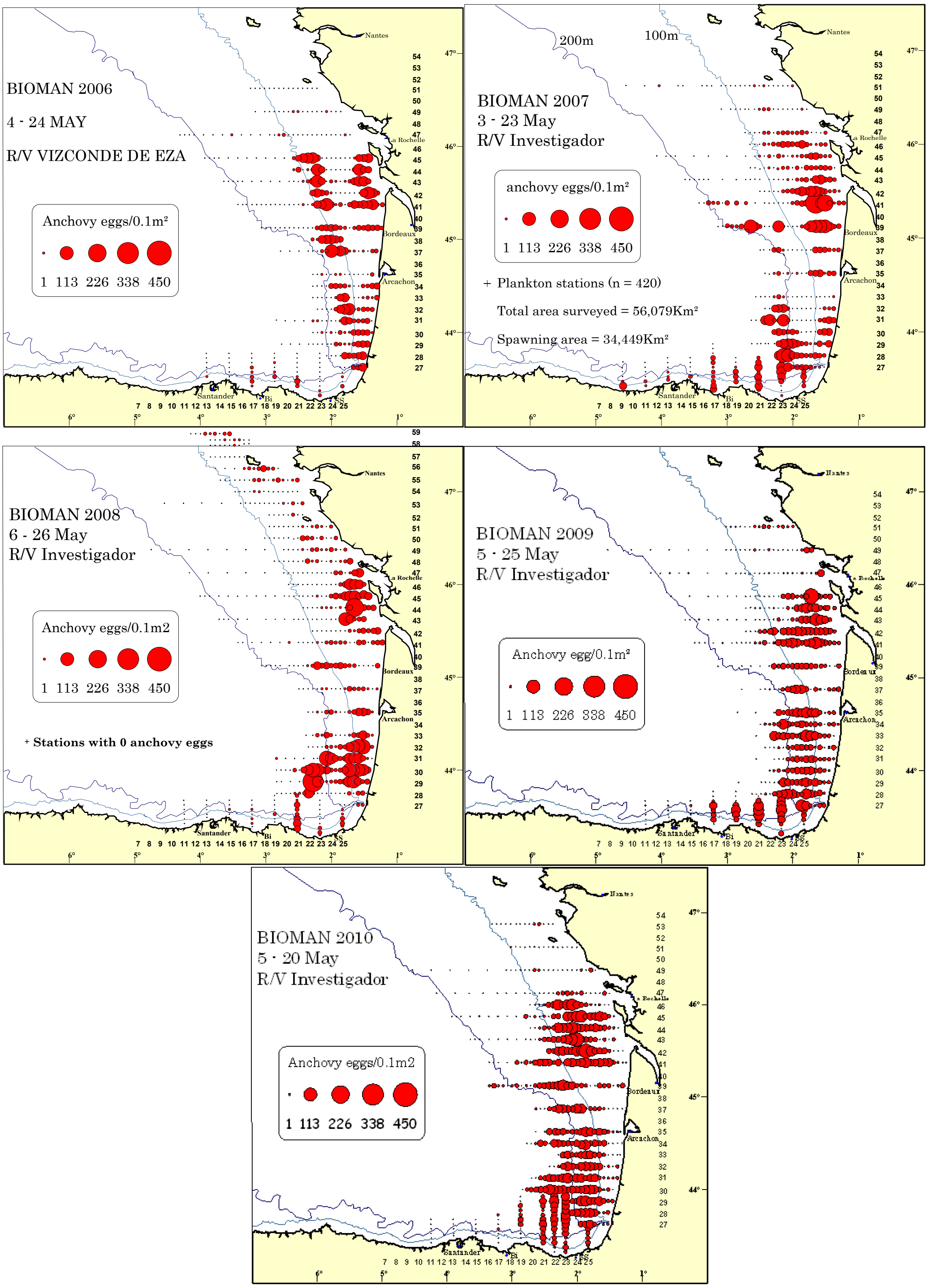
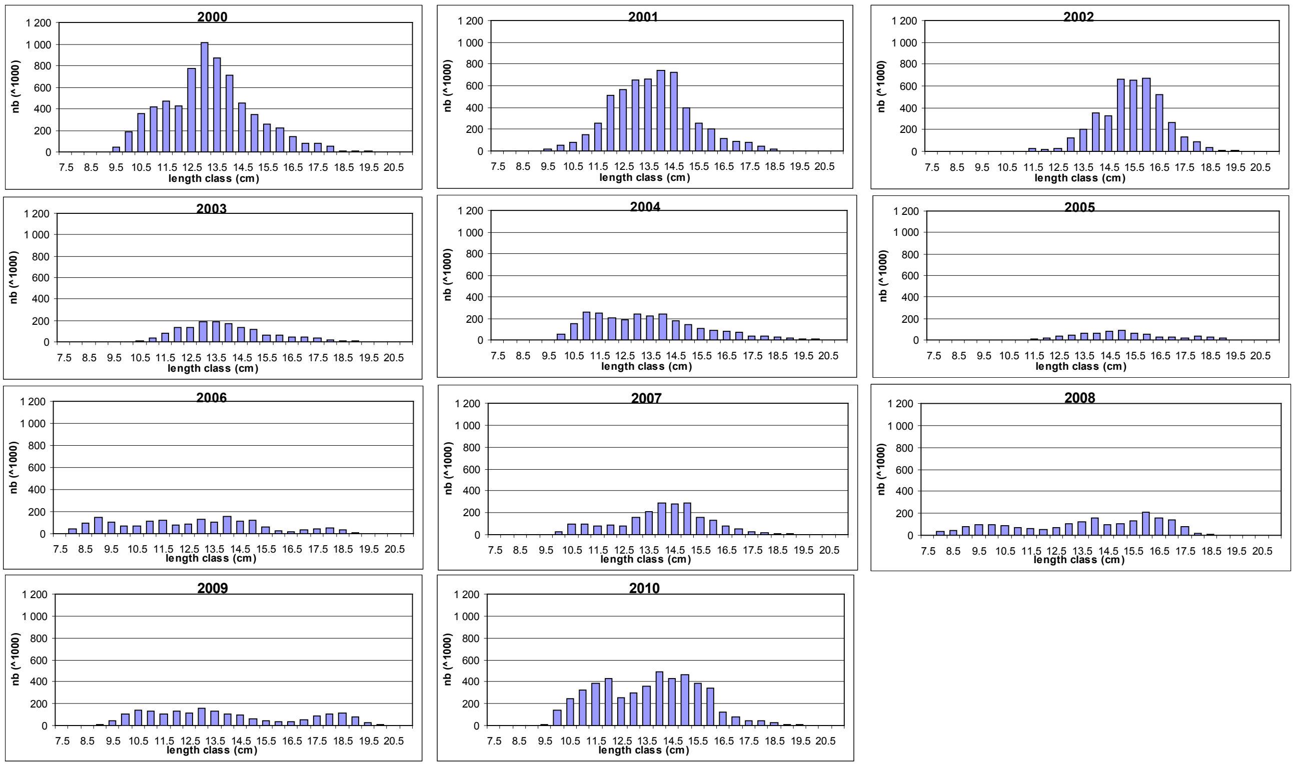
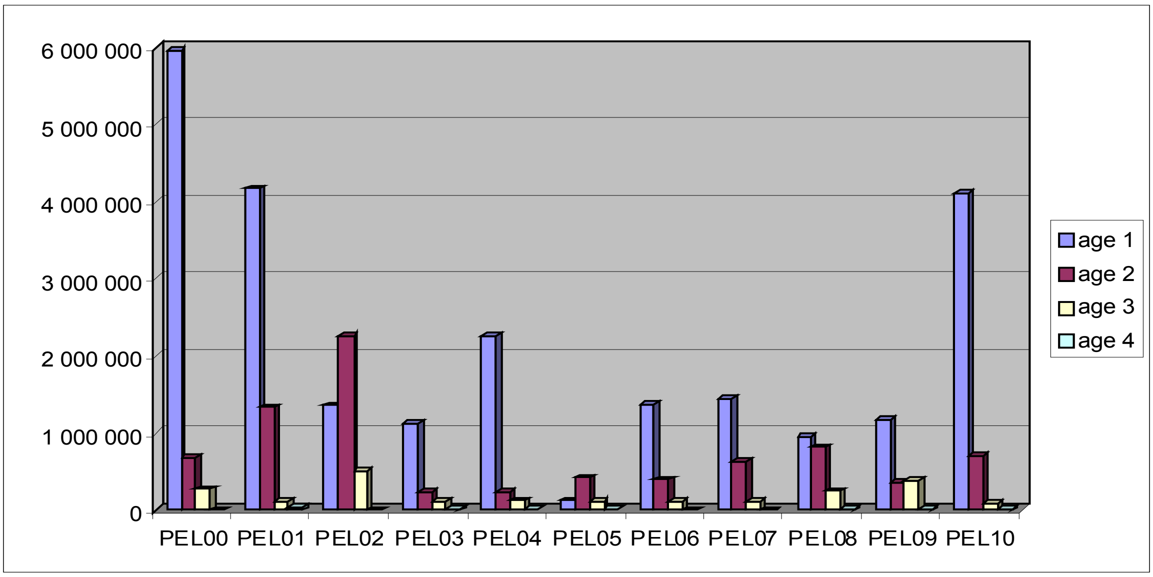
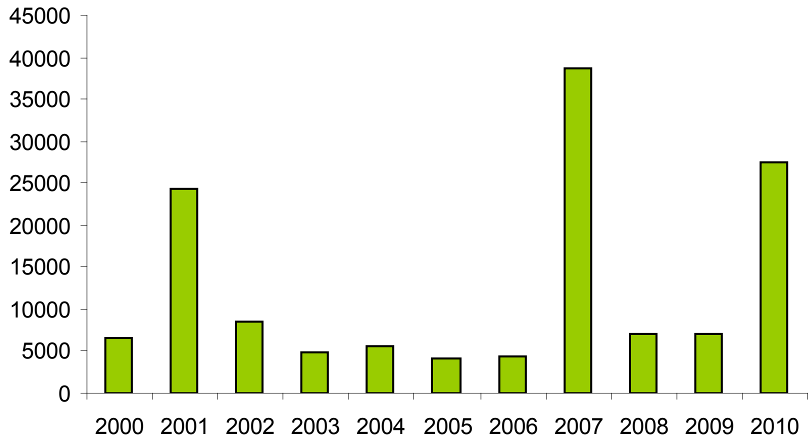


Figure B.3.3.1: Anchovy egg distribution from 1998 to 2009.The circles represent the anchovy egg abundance /0.1m² encountered in each plankton station.

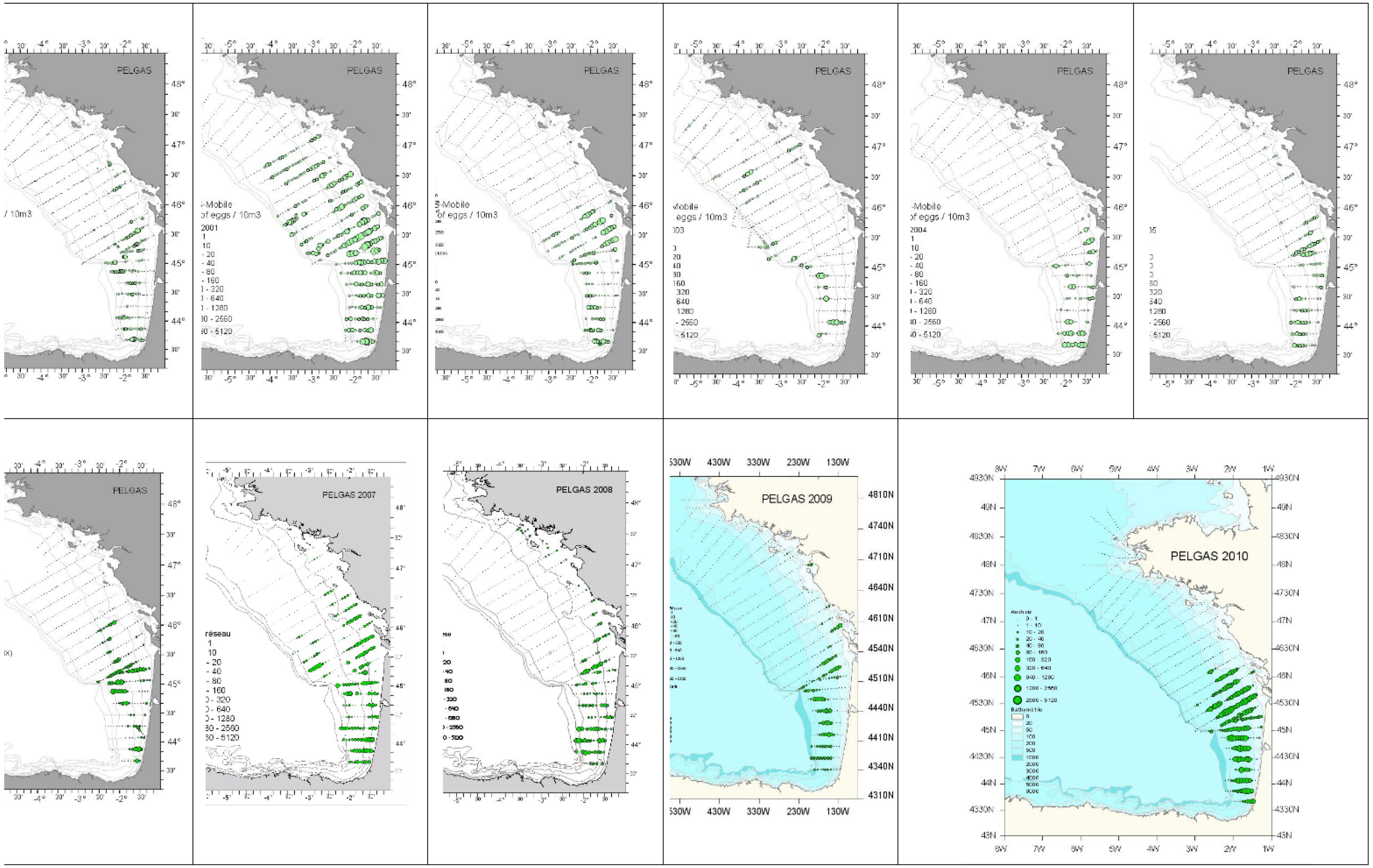


Length composition of adults of anchovy as estimated by acoustics since 2000 during PELGAS surveys.





Number of eggs observed during PELGAS surveys with CUFES from 2000 to 2010



Distribution of anchovy eggs observed with CUFES during PELGAS surveys from 2000 to 2010 (number for 10m³).

B.3.4 Autumn surveys on Juveniles, still under testing period

In recent years two series of acoustic surveys on juvenile anchovy (JUVENA and PELACUS10) have been launched in September-October, expecting that in the future the estimates can allow forecasting the strength of the anchovy recruitment which will enter the fishery the next year (ICES 2008 – WGACEGG report). Both surveys were coordinated with WGACEGG and are being merged nowadays. These surveys are expected to provide further insights on the recruitment process and additional knowledge on the biology and ecology of the juveniles Despite the encouraging results obtained with the series of 6 years of data available, the lack of sufficient contrast in the recent levels of recruitments prevents a proper evaluation of its performance as a predictor and the series are therefore not yet used for improving the management advice for the population (ICES 2008 - WGANC report).

B.3.4.1 Juvena survey

B.3.4.1.1 Data acquisition

JUVENA surveys take place annually since 2003, around September. In the period 2003 to 2005, the area was covered onboard commercial purse seiners. Since 2006 in addition to purse seiners, an oceanographic vessel, the R/V Emma Bardán, was incorporated to the survey. The abundance estimation is obtained by means of acoustic methodology (MacLennan and Simmonds, 1992). The acoustic equipment includes split beam echo sounders Simrad EK60 (Kongsberg Simrad AS, Kongsberg, Norway). The transducers of 38 kHz and 120 kHz (and 200kHz since 2006) were installed looking vertically downwards, aobut 2.5 m deep, at the end of a tube attached to the side of the purse seiners and at the hull in the case of the R/V Emma Bardan. The transducers were calibrated using standard procedures (Foote *et al.* 1987). Fishing was based on purse seining up to 2005 but since then onwarwds both pelagic trawling and purse seines are being used for species identification and biological sampling, along with hydrological recordings. In addition, the spatial distribution of the juvenile population is studied along with their growth condition. Two boats have been used since 2005 and therefore some extension of the northern limits of the surveys thus facilitated.

The water column was sampled to depths of 200 m. A threshold of -100 dB was applied for data collection. Acoustic back-scattered energy by surface unit (S_A, MacLennan *et al.* 2002) was recorded for each geo-referenced ESDU (Echointegration Sampling Distance Unit) of 0.1 nautical mile (185.2 m). Fish identity and population size structure was obtained from fishing hauls and echotrace characteristics. The commercial vessels used a purse seine of about 400 m of perimeter and 75 m height to fish the samples to depths of 50 m and the R/V Emma Bardan used a pelagic trawl. Acoustic data, thresholded to -60 dB, was processed using Movies+ software (Ifremer) for biomass estimation and the processed data was represented in maps using Surfer (Golden Software Inc., CO, USA) and ArcView GIS. Hydrographic recording was made with CTD casts.

B.3.4.1.2 Sampling strategy

The sampling area covered the waters of the Bay of Biscay (being 5º W and 47º45' N the limits). Sampling was started from the Southern part of the sampling area, the Cantabrian Sea, moving gradually to the North to cover the waters in front of the French Coast. The acoustic sampling was performed during the daytime, when the juveniles are supposed to aggregate in schools (Uriarte 2002 FAIR CT 97-3374) and can be distinguished from plankton structures.

The vessels followed parallel transects, spaced 15 nm., perpendicular to the coast along the sampling area, taking into account the expected spatial distribution of anchovy juveniles for these dates, that is, crossing the continental shelf in their way to the coast from offshore waters (Uriarte et al. 2001).

B.3.4.1.3 Other sources of information

During the summer, information from the commercial live bait tuna fishery was collected, in order to have knowledge about the spatial distribution and relative abundance of anchovy previous to the beginning of the survey. We continued collecting this information about the captures of the fleet during the survey it self. In addition we maintained a constant communication with the responsible of the survey Pelacus-10, conducted by the IEO and Ifremer, survey performed onboard R/V Thalassa with a double objective: juvenile abundance estimation and ecologic studies.

B.3.4.1.4 Biological processing

Each fishing haul was classified to species and a random sample of each species was measured to produce size frequencies of the communities under study. A complete biological sampling of the anchovy juveniles collected is performed in order to analyze biological parameters of the anchovy juvenile population, as the age, size or size-weight ratio. Using these and other environmental parameters we will try to obtain, in a long term, indexes of the state of condition of the juvenile population, in order to be able to improve the prediction of the strength of the recruitment.

B.3.4.1.5 Acoustic data processing

Acoustic data processing was performed by layer echo-integration by 0.1 nautical mile (s_A) of the first 65 m of the water column with Movies+ software, after noise filtering and bottom correction, increasing or decreasing this range when the vertical distribution of juveniles made it necessary.

The hauls were grouped by strata of homogeneous species and size composition. Inside each of these homogeneous strata, the echo-integrated acoustic energy s_A was assigned to species according to the composition of the hauls. Afterwards, the energy corresponding to each specie-size was converted to biomass using their corresponding conversion factor.

Each fish species has a different acoustic response, defined by its scattering cross section that measures the amount of the acoustic energy incident to the target that is scattered backwards. This scattering cross section depends upon specie *i* and the size of the target *j*, according to:

$$\sigma_{ij} = 10^{TS_j/10} = 10^{\{(a_i + b_i \log L_j)/10\}}$$

Here, L_j represents the size class, and the constants a_i and b_i are determined empirically for each species. For anchovy, we have used the following TS to length relationship:

$$TS_j = -72.6 + 20 \log L_j$$

The composition by size and species of each homogeneous stratum is obtained by averaging the composition of the individual hauls contained in the stratum, being the contribution of each haul weighted to the acoustic energy found in its vicinity (2 nm of diameter). Thus, given a homogeneous stratum with M hauls, if E_k is the mean acoustic energy in the vicinity of the haul k, w_i, the proportion of species i in the total capture of the stratum, is calculated as follows:

$$w_i = \sum_j w_{ij} = \sum_j \left(\frac{\sum_{k=1}^{M} \left(q_{ijk} \cdot E_k \big/ Q_k \right)}{\sum_{k=1}^{M} E_k} \right).$$

Being q_{ijk} the quantity (in mass) of species i and length j in the haul k; and Q_k, the total quantity of any species and size in the haul k.

In order to distinguish their own contribution, anchovy juveniles and adults were separated and treated as different species. Thus, the proportion of anchovy in the hauls of each stratum (w_{ij}) was multiplied by a age-length key to separate the proportion of adults and juveniles. Then, separated w_i were obtained for each.

Inside each homogeneous stratum, we calculated a mean scattering cross section for each species, by means of the size distribution of such specie obtained in the hauls of the stratum:

$$\langle \sigma_i \rangle = \frac{\sum_j w_{ij} \sigma_{ij}}{w_i}.$$

Let s_A be the calibration-corrected, echo-integrated energy by ESDU (0.1 nautical mile). The mean energy in each homogeneous stratum, $E_m = < s_A >$, is divided in terms of the size-species composition of the haul of the stratum. Thus, the energy for each species, E_i, is calculated as:

$$E_i = \frac{w_i \langle \sigma_i \rangle E_m}{\left(\sum_i w_i \langle \sigma_i \rangle \right)}$$

Here, the term inside the parenthesis sums over all the species in the stratum. Finally, the number of individuals F_i of each species is calculated as:

$$F_i = H \cdot l \frac{E_i}{\langle \sigma_i \rangle}$$

Where l is the length of the transect or semi-transect under the influence of the stratum and H is the distance between transect (about 15 nm.). To convert the number of juveniles to biomass, the size-length ratio obtained in each stratum is applied to obtain the average weight of the juveniles in the stratum:

$$< W_i > = a \cdot < L_i >^b$$

Thus, the biomass is obtained by multiplying F_i times $< W_i >$.

B.3.4.1.6 Commercial CPUE

According to literature, CPUE indices have been considered, as not reliable indicators of abundance for small pelagic fishes (Ulltang, 1982, Csirke 1988, Pitcher 1995, Mackinson et al. 1997). Current series of CPUE available for the Spanish Purse seine are not considered of utility for the monitoring of the fishery (Uriarte *et al.*, 2008).

C. Stock assessment method

Model used:

The assessment for the Bay of Biscay anchovy population is a Bayesian two-stage biomass-based model (BBM) (Ibaibarriaga et al., 2008), 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 recruit 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).

Software used:

The model is implemented in BUGS (www.mrc-bsu.cam.ac.uk/bugs/) and it is run from R (www.r-project.org) using the package R2WinBUGS.

Model Options chosen:

Catchability for the DEPM SSB is set to 1 because it is assumed to be an absolute indicator of Biomass and for consistency with the past practice in the assessment of this stock. Catchability of the acoustic SSB is estimated. DEPM and acoustic surveys are assumed to provide unbiased proportion of age 1 biomass estimates in the stock. The first set of priors as defined in Ibaibarriaga et al. 2008 is used. The length of the MCMC run, the burn-in period (removal of the first draws to avoid dependency on the initial values) and the thinning to diminish autocorrelation should be enough to ensure convergence and obtain a representative joint posterior distribution of the parameters.

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year. Yes/No
Caton	Catch in tonnes by periods	1987-2010	1 to 2+	Yes
Canum	Catch at age in numbers by periods	1987-2010	1 & 2+	Yes
Weca	Weight at age in the commercial catch by periods	1987-2010	1 to 2+	Yes
Mprop	Proportion of natural mortality before spawning	Not applicable		
Fprop	Proportion of fishing mortality before spawning	Not applicable		
Matprop	Proportion mature at age	Not applicable		
Natmor	Natural mortality M=1.2	1987-2010	1 to 2+	No
G	Intrinsic growth rate G= 0.52	1987-2010	1 to 2+	No

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	DEPM SSB spring series	1987-2010 (with gap in 1993)	
Tuning fleet 2	Acoustic SSB spring series	1989-2010 (with gaps)	
Tuning fleet 3	DEPM P1 (B1/SSB) spring series	1987-2010 (with gaps)	
Tuning fleet 4	Acoustic P1 (B1/SSB) spring series	1989-2010 (with gaps)	

Prior distributions of the parameters:

The current prior distributions (see table below) are described and justified in Ibaibarriaga *et al.* (2008) and ICES WGANC (2008)

Parameter	Prior 1	
	Hyper-parameters	Median (95% CI)
q_{surv}	$\mu_{q_{surv}} = 0$	1 (0.1, 16.0)
	$\psi_{q_{surv}} = 0.5$	
ψ_{surv}	$a_{\psi_{surv}} = 0.8$	10 (0.2, 65.1)
	$b_{\psi_{surv}} = 0.05$	
ξ_{surv}	$\mu_{\xi_{surv}} = 5$	5 (0.6, 9.4)
	$\psi_{\xi_{surv}} = 0.2$	
B_0	$\mu_{B_0} = 10.5$	36 316 (5 116, 257 806)
	$\psi_{B_0} = 1.0$	
μ_R	$\mu_{\mu_R} = 9.8$	9.8 (7.0, 12.6)
	$\psi_{\mu_R} = 0.5$	
ψ_R	$a_{\psi_R} = 4$	1.8 (0.5, 4. 4)
	$b_{\psi_R} = 2$	
g	$\mu_g = \log(0.7)$	0.7 (0.1, 5.0)
	$\psi_g = 1$	

The benchmark workshop recommended to conduct some sensitivity analysis on the prior distributions. In particular, to test the effect of having more informative priors on the surveys' catchability and precision and on the g parameter. If this is done, any changes in the prior distributions of the parameters should be documented and justified in the ICES anchovy assessment working group report (WGANSA).

D. Short-Term Projection

Model used:

The Bayesian two-stage biomass-based model (Ibaibarriaga *et al.* 2008) used for the assessment of the stock is used to project the population one year forward from the current state and to analyse the probability of the population in the next year 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 the current year and the first half of next year.

The predictive distribution of recruitment at age 1 (in mass) in January next year is 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.

Software used:

The projections are implemented in R (www.r-project.org)

Projection period:

One year ahead from the spawning period (15th May) in the last assessment year

Initial stock size:

Posterior distribution of SSB in the last assessment year

Maturity: NA

F and M before spawning: NA

Weight at age in the stock: NA

Weight at age in the catch: NA

Intrinsic growth rate (G):

Assumed constant same as in the assessment (G=0.52)

Natural mortality rate (M):

Assumed constant same as in the assessment (M=1.2)

Exploitation pattern:

Alternative options for splitting catches by periods are tested

Intermediate year assumptions: NA

Stock recruitment model used:

No implicit S/R model is used. Recruitment is sampled from the posterior distributions of past series recruitments. Different recruitment scenarios are constructed by giving different weights to the past series recruitments.

Procedures used for splitting projected catches: NA

E. Medium-Term Projections

No Medium term projections are applied to this fishery for the provision of advice by ICES. Long term projections (10 years ahead) were run by STECF in 2008 to set the basis of a management plan on anchovy to the EC, based on a Ricker stock recruitment relationship.

F. Long-Term Projections

No Long term projections are applied to this fishery for the provision of advice by ICES. Long term projections (10 years ahead) were run by STECF in 2008 to set the basis of a management plan on anchovy to the EC, based on a Ricker stock recruitment relationship.

G. Biological Reference Points

A stock/recruitment relationship is not explicitly used.

Current biological reference points for the Bay of Biscay anchovy were defined by ICES ACFM in October 2003 as follows:

	ICES considers that:	**ICES proposes that:**
Limits reference points	$\mathbf{B_{lim}}$ 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

H. Other Issues

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Annex 6 Technical Minutes

Anchovy in Subarea VIII (Bay of Biscay)

The update assessment for the Bay of Biscay anchovy population is based on a two-stage biomass-based model (BBM) published in Ibaibarriaga et al. (2008) and is described in the stock annex.

1) **Assessment type:** update
2) **Assessment**: analytical
3) **Forecast**: presented
4) **Assessment model**: Bayesian two-stage biomass-based model – tuning by DEPM and acoustic surveys
5) **Consistency**: Consistent with previous assessment. Forecast however dependent on which recruitment level is assumed.
6) **Stock status**: Median SSB in 2010 is estimated at 51,350 t, and it is above Blim with a 100% probability. This implies a recovery of population levels, in comparison with the last 5 years when the fishery was closed due to low biomasses. This recovery is due to the entry of a medium level of recruitment at age 1, the highest one recorded since 2002, when the series of previous successive recruitment failures started.
7) **Man. Plan.**: No management plan exists for this stock but the present closure of the fishery aims at protecting the remaining stock until a strong year-class recruits to the stock
8) **Reviewer: Henrik Sparholt**

General comments

These are well documented, well ordered and considered sections. They are easy to follow and interpret. The assumptions and conclusions are clearly presented and described.

The situation for Bay of Biscay anchovy seems to improve compared to the past 5 years. Now there is a potential for fishery.

Technical comments

The assessment has been performed correctly;.

The methodology is the same as described in Ibaibarriaga *et al.* (2008) and in the stock annex. The only change is that, as in the last year, longer runs (500 000 draws) with longer burn-in period (100 000 draws) and higher thinning (1 out of 40 draws was kept) were conducted to ensure convergence.

The forecast is made in two versions. One with long term “average” recruitment and one with recent “average” recruitment level so to say. The WGANSA do not state which they prefer. Both are also presented I n the advice for the ADG and ACOM to decide upon I suppose. I can see the dilemma, but I think that the uncertainty about which one to chose should be made by the experts, the WGANSA. Generally in ICES average recent recruitment are most often used in situations like this and they have shown to be most robust.

The precautionary reference points were set according to stock estimates with ICA and within the standard framework related to deterministic stock assessments. For the anchovy, a The Bayesian assessment, provides the probability distribution for SSB so the rationale to maintain a B_{pa} is debatable, as the WGANSA rightly states.

Being a short lived species the WGANSA is right in that an Fmsy is not relevant. One only needs the Blim and then probability of being above given a certain TAC. It is however a problem that the BBM are only giving partly correct probabilities as for instance the natural mortality values used are likely too high as also stated the WGANSA.

The data in the outlook table table in the advice are slightly different from the data given in WGANSA table 2.6.3.1 and 2. See for instance for Low R catch 10 000t the probability is 0.108 in the advice but 0.098 in the table 2.6.3.1.

Conclusions

The assessment of the present stock status and the forecast are accepted as an update assessment and forecast of the stock. I recommend to use the forecast with recent average R.

The outlook data given in the advice is slightly different from the data given in the WGANSA report. This needs to be clarified.

Anchovy in the Gulf of Cadiz

1) **ASSESSMENT TYPE:** update
2) **Assessment:** Accepted
3) **Forecast**: Not carried out
4) **Assessment model:** Qualitative analysis
5) **Consistency**: Highly consistent with previous assessment
6) Stock status: This year the Portuguese Spring survey showed a marked decline in biomass. In the landings the 0 age group was almost absent. These signals are worrying and indicate a strongly decreasing stock.
7) **Management plan:** none
8) **Reviewer:** Henrik Sparholt

General Comments

The report was well structured, well written and packed with information. This year when there seems to be problems for the stock the large amount of information presented is useful for the ADG when deciding on the advice.

Ageing is difficult due to southern habitat area. Catch at age data have, however, been produced.

In the absence of a stock assessment model, a qualitative assessment, based on the working group's evaluation of the available data, was appropriate and sufficient.

The big question is what the advice should be and what the precise basis for it should be. The commercial CPUE for a schooling species like this is a weak stock abundance indicator. Acoustic surveys and eggs surveys are much stronger indicators.

Conclusion

Available fishery independent data indicate a stock in problems. Effort was low in 2008 and 2009. CPUE relatively stable.

The ratio of catch in Area IXa south to fishery independent biomass estimates during 2008 and 2009 is reasonably low (about 0.2).

The qualitative assessment presented seems appropriate as an up-date assessment.

The big question is what to base a new advice on when it seems likely that ACOM will not use last year's approach for the advice because the stock suddenly is showing strong signs of problems.

Sardine in Divisions VIIIc and IXa

1) **Assessment type:** Update assessment
2) **Assessment**: presented and agreed
3) **Forecast**: presented and agreed
4) **Assessment model**: AMCI (Assessment model incorporating data from various sources)
5) **Consistency**: same as last year with addition of 1 extra year, except that maturity in the forecast this year is the mean over most recent 10 years and not about 20 years. The 2009 year class was accepted from the AMCI because it also was supported by acoustic 2010 data at age 1.
6) **Stock status**: SSB declined further in 2010. Fishing mortality in 2009 was comparable to that in 2008, being at the historical average around 0.25. The first estimates of the 2008 and 2009 year classes indicate that they may be around average. These year classes will contribute to the fisheries until 2012. No reference points defined for this stock.
7) **Man. Plan.**: no management plan exists for this stock.
8) **Reviewer:** Henrik Sparholt.

General comments

1) The TOR for this stock was met as it was an update assessment. The catch and abundance indices were updated appropriately.
2) The surveys are well described relative to the last survey conducted.
3) Regarding the short term forecast. The 2009 recruitment estimated by the assessment model was used in the prediction since it is supported by data from the April 2009 acoustic survey (at age 1). For 2010 – 2012, the assumed recruitment was based on the period 1996-2009, when the declining trend of the time series has apparently stopped. This seems as an appropriate approach.
4) In last year's forecast, a long-term average (19 years) of the maturity ogive was used in the catch prediction, to decrease the influence of extensive inter-annual variations observed in the historical series. The RG recommended the use of a more recent average (3 or 5 years) to account for any possible trend over time. In fact, the maturity ogive shows weak long-term trends, negative at Age 1 and positive at Age 2 but also extensive variation at Age 1 in the last 5 years. Therefore, the WG considered that a mean of the last 10 years would be adequate to take account of both the long term trend and the short term variability. This seems appropriate.
5) The main issue in last year's assessment was the high egg survey estimate from 2008 while the acoustic survey indicates a somewhat lower stock size. The new acoustic survey is even lower confirming that the egg survey in 2008 was an overestimate. The assessment seems to handle this conflict in data in an appropriate way.
6) The text about msy reference points is useful and appropriate, but the group do not conclude on any specific value.
7) The **Outlook table in the draft advice seems to be wrong in the column giving %changes** in SSB from 2011 to 2012. For instance for the option 0

fishing SSB in 2011 is 344 kt and SSB in 2012 is 327 kt and this is not a 3.4% increase. This has to be checked and corrected.

Conclusions

The assessment of the present stock status and the forecast are accepted as an up-date assessment and forecast of the stock.

The Outlook table column with %changes in SSB needs to be corrected!