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Report of the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy (WGMHSA)

5 - 14 September 2006

Galway, Ireland

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

International Council for the Exploration of the Sea
Conseil International pour l’Exploration de la Mer
H.C. Andersens Boulevard 44-46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

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0 Executive Summary

The Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy (**WGMHSA**) met in Galway from 4-15 September, to assess and provide catch options for these four widely distributed pelagic species in the Northeast Atlantic Ocean. The WG reports on the status of **7 stocks** (see Fig. 0.1 for stock definitions), and in case of Sardine also on the status of the species distributed outside current stock definition. This year a **benchmark** analytical assessment is available for Sardine and **update** analytical assessments are available for Northeast-Atlantic Mackerel and Anchovy in Biscay. Due to its depleted state Anchovy in Biscay is now on the observation list. **Exploratory analysis** continued on western and southern Horse mackerel stocks and Gulf of Cadiz anchovy. All these assessments are still in a developmental stage, whilst no assessment was possible for North Sea horse mackerel due to lack of coherent data.

Northeast-Atlantic (NEA) Mackerel. This species is distributed in the whole ICES area and currently supports one of the most valuable European fisheries (with around 500 kt annual landings). Mackerel is fished by a variety of fleets (ranging from open boats using hand lines on the Iberian coasts to large freezer trawlers and Refrigerated Sea Water (RSW) vessels in the Northern Area. The stock is historically divided into three components, with the North Sea component considered to be over fished since the late 1970s, and the Western component contributing the vast majority of biomass and catch to the stock. The quality of sampling data remains good. The NEA mackerel assessment was treated as an update, with new inputs to the assessment coming only from fishery dependent data. However there has been some progress made on the putative effect of different misreporting levels on the assessment, and its interpretation for advice. There are a number of issues outlined which will need to be addressed in the Benchmark in 2007, and the WG has made a number of recommendations for intercessional work. The WG concludes that the accuracy of landings and estimates of total discards are still inadequate.

Horse Mackerel. For North Sea horse mackerel effort was applied this year finalise whether there were any coherence in the available data. The data exploration again showed inconsistent signals in the catch at age data and a survey index, which may be missing an important component of the stock due to seasonal migration. The WG concluded that more intensive age sampling and a directed survey will need to be available before an analytical assessment can be attempted for this stock. The exploratory analysis for western horse mackerel was refined to incorporate information on age structure into the egg abundance index. This allows in an indirect way the assessment to be scaled. The assessment indicates that the current level of biomass is at or above that in 1982. However large uncertainty surrounds the estimates of stock parameters. The analyses confirms strong recruitment of the 2001 year class however this is not estimated to be the same order of magnitude as the 1982 year class. An exploratory analyses was conducted for southern horsemackerel. The 2 surveys were surveys combined a clear cohort signal was evident. However the previously adopted AMCI approach required strong conditioning and gave unrealistic results, so the data were explored in an XSA model. A declining trend in SSB is still apparent.

Sardine The results of the SARDYN project were presented and were not conclusive with respect to the most suitable assessment model and the level of migration between areas. Both single area and multi area assessments were considered. The multi area assessments required either strong conditioning or assumptions on fixed migration rates from expert judgement. However in a bayesian framework, useful indications on the probability of emigration from the Biscay shelf to the Cantabrian Sea could be made. The single area AMCI model was explored in detail and some changes in conditioning were made. The most significant of these was the merging of the 2 Spring surveys and the treatment of the DEPM as relative. Although much progress has been made with these issues, there remain some outstanding issues with the final assessment, which will require further exploration.

Anchovy is a short-lived species, showing large fluctuations in biomass. This is driven by recruitment which in turn might be driven by a combination of environmental factors. In Bay of Biscay Anchovy catches consist mainly of 1- and 2-yr old fish. In 2005 there was a failure of the commercial fishery for the Biscay stock, and this prompted much intercessional work since May 2005. Exploration of both the old ICA assessment and new Bayesian biomass based model (BBM) are provided. This included the sensitivity of the Bayesian production model to informative priors, and the effect and consequences of treating both surveys as relative measures of stock abundance. The prognosis for Bay of Biscay Anchovy is that the stock is still in a depleted state, although recruitment in 2006 shows improvement. The assessment of Anchovy in Cadiz is developed further this year with a standardisation of the CPUE index. However this exploratory assessment is sensitive to new information in 2006.

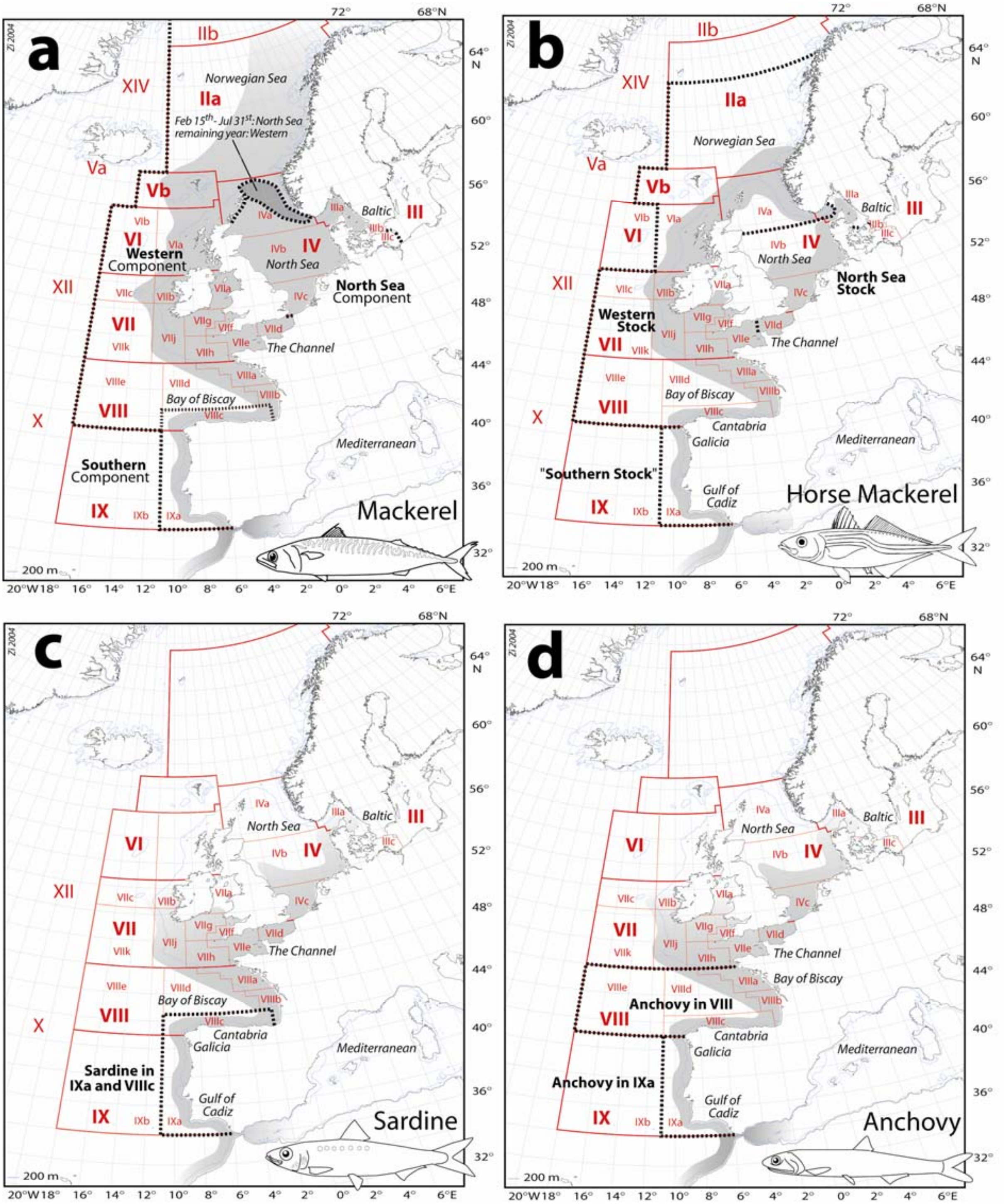


Figure 0.1: Distribution of the four species assessed by the ICES Mackerel, Horse Mackerel, Sardine and Anchovy WG: Stock and component definitions as used by the 2004 WG. Map source: GEBCO, polar projection, 200 m depth contour drawn. a: Northeast Atlantic Mackerel (with North Sea, Western and Southern component), b: Horse Mackerel: North Sea, Western and "Southern" stock, c: Sardine, d: Anchovy: Stock in area VIII and stock in IXa.

1 Introduction

1.1 Terms of Reference

The **Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine, and Anchovy** [WGMHSA] met in Galway, Ireland from 5–14 September 2006 to address the following terms of reference, as decided by the 93rd Statutory Meeting:

a) assess the status of and provide management options for 2007 for the stocks of mackerel, sardine stock in Divisions VIIIc and IXa, western horse mackerel, southern horse mackerel, anchovy in Subarea VIII and anchovy in Division IXa;

b) carry out in-depth exploratory assessments for Sardine and anchovy in Subarea VIII;

c) for the stocks mentioned in a) perform the tasks described in C.Res. 2ACFM01.

In resolution 2ACFM01 the following general terms of reference are relevant to this working group

1) based on input from e.g. WGRED and for the North Sea NORSEPP, consider existing knowledge on important environmental drivers for stock productivity and management and if such drivers are considered important for management advice incorporate such knowledge into assessment and prediction, and important impacts of fisheries on the ecosystem;
2) Evaluate existing management plans to the extent that they have not yet been evaluated. Develop options for management strategies including target reference points if management has not already agreed strategies or target reference points (or HCRs) and where it is considered relevant review limit reference points (and come forward with new ones where none exist) – following the guidelines from SGMAS (2005, 2006), AGLTA (2005) and AMAWGC (2004, 2005, and 2006); If mixed fisheries are considered important consider the consistence of options for target reference points and management strategies. If the WG is not in a position to perform this evaluation then identify the problems involved and suggest and initiate a process to perform the management evaluation;
3) where mixed catches are an important feature of the fisheries assess the influence of individual fleet activities on the stocks and the technical interactions;
4) update the description of fisheries exploiting the stocks, including major regulatory changes and their potential effects. Comment on the outcome of existing management measures including technical measures, TACs, effort control and management plans. The description of the fisheries should include an enumeration of the number, capacity and effort of vessels prosecuting the fishery by country;
5) where misreporting is considered significant provide qualitative and where possible quantitative information, for example from inspection schemes, on its distribution on fisheries and the methods used to obtain the information; document the nature of the information and its influence on the assessment and predictions;
6) provide for each stock information on discards (its distribution in time and space) and the method used to obtain it. Describe how it has been considered in the assessment;
7) report as prescribed by the Secretariat on a national basis an overview of the sampling of the basic assessment data for the stocks considered;
8) provide specific information on possible deficiencies in the 2006 assessments including, at least, any major inadequacies in the data on landings, effort or discards; any major inadequacies in research vessel surveys data, and any major difficulties in model formulation; including inadequacies in available software. The consequences of these deficiencies for both the assessment of the status of the stocks and the projection should be clarified.

Term of reference a is addressed under the respective stocks. The WG clarified with ACFM chair that there must have been an error in ToR b as a benchmark assessment had been attempted on Bay of Biscay Anchovy in 2006. Due to the current depleted state of the stock the WG treated Bay of Biscay anchovy as a stock on the Observation list, and in addition to ToR a, a special request was responded to, This is dealt with in section 1.x

The structure of Sections 7 and 8 address term of reference b, with special consideration given to the results of the “Sardyn” project. Using new information from “Sardyn”, data and model exploration focused on the spatial dynamics of the assessed component of the Sardine population in VIIIc and IXa.

The NEA mackerel assessment was treated as an update, with new inputs to the assessment coming only from fishery dependent data. The western horse mackerel assessment model has been refined in an attempt to address the scaling issues, and some HCR scenarios are presented, however the production of quantitative short term advice still remains problematic. A quantitative assessment for North sea horse mackerel is still not possible due to the lack of coherent catch at age data and a suitable index. An update assessment was performed for Southern Horsemackerel where the surveys were merged. Anchovy in Cadiz was also treated as an update assessment.

Where relevant terms of reference 1-6 are addressed under the respective stocks. An overview of the input data and their shortcomings (addressing terms of reference 7-8) is given in Section 1.3, and an overview of the assessment methods in Section 1.4.

The present report is structured as last year. Specific attention has again been given to the explicit treatment of uncertainties in either the input data or the assessment assumptions.

1.2 Participants

Esther Abad	Spain
Pablo Abaunza	Spain
Sergei Belikov	Russia
Miguel Bernal	Spain
Lisa Borges	The Netherlands
Andy Campbell (part time)	Ireland
Mariella Canales	Chile
Bruno Caneco (part time)	Portugal
Carryn Cunningham (part time)	South Africa
Mark Dickey-Collas	The Netherlands
Leonie Dransfeld	Ireland
Erwan Duhamel	France
Afra Egan	Ireland
Emma Hatfield	UK (Scotland)
Leire Ibaibarriaga	Spain
Svein A. Iversen	Norway

Jan Arge Jacobsen (part time)	Faroe Islands
Ciarán Kelly (Chair)	Ireland
Jacques Massé	France
Alberto Murta	Portugal
Fernando Ramos	Spain
Beatriz Roel	UK (England and Wales)
Begoña Santos	Spain
Evgeny Shamray	Russia
John Simmonds	UK (Scotland)
Alexandra Silva	Portugal
Dankert Skagen	Norway
Per Sparre	Denmark
Andres Uriarte	Spain
Dimitri Vasilyev	Russia

1.3 Quality and Adequacy of Fishery and Sampling data.

1.3.1 Sampling data from commercial fishery

The Working Group again carried out a brief review of the sampling data and the level of sampling on the commercial fisheries. Sampling coverage in 2005 increased for mackerel to 83% but the intensity of sampling with numbers measured and aged has decreased since last year. The proportion of the sampled horse mackerel catch has again increased after the low sampling intensity in 1999 and a decrease in 2004. In 2005 the sampling level was 78% and this is still considered inadequate for some Divisions and periods (especially in the juvenile areas). Sardines continue to be well sampled with samples now provided by Portugal, Spain and France. However, to facilitate age-structured assessment, samples should be obtained from all countries with catches of sardines, which includes Ireland, the Netherlands and the UK. The EU data collection regulation does not require sampling of sardines north of VIIIc. Anchovy sampling continues at a high level. A short summary of the data, similar to that presented in recent Working Groups is shown in the relevant stock sections. Sampling programmes by EU countries have been partially funded under the EU sampling directive and this has contributed to the improvement in sampling levels. Under this data collection regulation fish in EU countries are supposed to be sampled in the country into which they are landed.

The sampling programmes on the various species are summarised as follows:

Mackerel

Year	Total catch t (WG Catch)	% Catch covered by sampling programme*	No. Samples	No. Measured	No. Aged
1992	760,000	85	920	77,000	11,800
1993	825,000	83	890	80,411	12,922
1994	822,000	80	807	72,541	13,360
1995	755,000	85	1,008	102,383	14,481
1996	563,600	79	1,492	171,830	14,130
1997	569,600	83	1,067	138,845	16,355
1998	666,700	80	1,252	130,011	19,371
1999	608,928	86	1,109	116,978	17,432
2000	667,158	76	1,182	122,769	15,923
2001	677,708	83	1,419	142,517	19,824
2002	717,882	87	1,450	184,101	26,146
2003	617,330	80	1,212	148,501	19,779
2004	611,461	79	1,380	177,812	24,173
2005	543,486	83	1,229	164,593	20,217

*** Percentage related to Working Group catch**

In 2005, 83% of the total catch was covered by the sampling programmes. This constitutes a small increase to last year's coverage, however sampling intensity has decreased with lower numbers of samples and numbers of fish aged and measured than in 2004. Denmark, Spain, Portugal and Russia carried out intensive programmes and covered 100% of their catches. Ireland, Norway and Scotland also sampled their entire catch thoroughly with over 90% of their catches covered, however, the Netherlands only sampled 58% of their catch. England & Wales continued to sample only a small fraction of their catches, while France, the Faroe Islands, Northern Ireland, Belgium, Iceland and Sweden did not sample any catches. This is despite there being significant catches taken by the first three of those countries.

The sampling summary of the mackerel catching countries is shown in the following table.

Country	Official Catch	% of catch sampled*	No. samples	No.measured	No. Aged
Belgium	1	0	0	0	0
Denmark	23,212	100	21	1,788	1,788
UK (England & Wales)	14,677	4.3	60	8,069	1,797
Faroe Islands	9,769	0	0	0	0
France	16,338	0	0	0	0
Germany	19,040	65	28	10,366	1012
Ireland	45,687	95	35	5,114	2,303
Iceland	363	0	0	0	0
Norway	119,678	99	240	49,753	1,459
Portugal	1,509	100	261	24,441	1,368
Poland	570	0	0	0	0
Russia	40,495	100	62	19,330	1904
UK (Scotland)	129,990	91	116	16,237	3,487
Spain*	52,753	100	360	26,076	3,949
Sweden	3,204	0	0	0	0
The Netherlands	25,1262	58	46	3,419	1,150
UK (Northern Ireland)	8,038	0	0	0	0
Total	510,445	83	1,229	164,593	20,217

*** Percentage based on Working Group catch ** Values related to official catches**

The following text table shows sampling levels of mackerel by relating numbers measured and numbers aged to the size of the catch in each ICES division. Insufficient sampling was carried out in divisions IIIa, IVb-c, VIIc,d and VIIIa,d amounting to a total catch of 27,000t. Divisions IIIb and VIIa,g,k were also not sampled, however these areas represent only minor catches of 210 t.

Area	Official Catch	WG Catch	No samples	No aged	No measured	No aged/ 1000 tonnes**	No measured/ 1000 tonnes**
IIa	54,025	54,025	72	1,838	20,033	34	371
IIIa	1,026	1,026	0	0	0	0	0
IIIb	1	1	0	0	0	0	0
IVa	202,662	250,396	307	4,884	61,548	24	304
IVb	314	252	0	0	0	0	0
IVc	783	547	1	25	64	32	82
Vb	2,496	104	4	216	658	87	264
VIa	117,416	91,361	93	3,203	14,227	27	121
VIIa	174	174	0	0	0	0	0
VIIb	24,470	26,246	27	1,629	3,784	67	155
VIIc	1,489	2,259	0	0	0	0	0
VIId	5,787	6,470	12	300	985	52	170
VIIe	727	908	35	399	5,489	549	7,551
VIIf	366	366	25	1,398	2,580	3,817	7,044
VIIg	32	32	0	0	0	0	0
VIIh	823	2,033	1	25	43	30	52
VIIj	29,097	35,637	22	725	3,998	25	137
VIIk	0	2	0	0	0	0	0
VIIIa	10,442	13,028	8	200	502	19	48
VIIIb	2,923	7,716	53	661	3,186	226	1,090
VIIIc east	151	38,377	166	2,043	13,145	53	343
VIIIc west	0	4,625	83	666	5,899	144	1,275
VIIId	989	1,284	0	0	0	0	0
IXa central-north	1,509	1,509	261	1,368	24,441	907	16,201
IXa north	0	5,107	59	637	4,011	125	785
	0	0	0	0	0		
Total	457,704	543,486	1,229	20,217	164,593	44	360

**** Values related to official catches**

Horse Mackerel

The following table shows a summary of the overall sampling intensity on horse mackerel catches in recent years:

Year	Total catch t (WG Catch)	% Catch covered by sampling programme *	Samples	Measured	Aged
1992	436,500	45	1,803	158,447	5,797
1993	504,190	75	1,178	158,954	7,476
1994	447,153	61	1,453	134,269	6,571
1995	580,000	48	2,041	177,803	5,885
1996	460,200	63	2,498	208,416	4,719
1997	518,900	75	2,572	247,207	6,391
1998	399,700	62	2,539	245,220	6,416
1999	363,033	51	2,158	208,387	7,954
2000	272,496	56	1,610	186,825	5,874
2001	283,331	64	1,502	204,400	8,117
2002	241,336	72	1,768	235,697	8,561
2003	241,830	79	1,568	200,563	12,377
2004	216,361	68	1,672	213,066	16,218
2005	234,876	78	2,315	241,629	15,866

*** WG catches**

The decrease in overall sampling levels on horse mackerel seen in 2004 was reversed in 2005. The large numbers of samples and measured fish are due mainly to intensive length measurement programs in the southern areas. In 2005, 72 % of the horse mackerel measured were from Division IXa.

Countries that carried out comprehensive sampling programmes (>90%) in 2005 were Norway, Spain, Ireland, and the Netherlands. In 2005, France and UK (England & Wales) took considerable catches but no samples were available. Some of these catches may be landed outside these countries. The lack of sampling data for relatively large portions of the horse mackerel catch continues to have a serious effect on the accuracy and reliability of the assessment and the Working Group remain concerned about the low number of fish that are aged.

The following table shows the most important horse mackerel catching countries and the summarised details of their sampling programme in 2005:

Country	**Official catch t**	**% Catch covered by sampling programme ***	**Samples**	**Measured**	**Aged**
Belgium	6	0	0	0	0
Denmark	14,197	85	10	845	394
UK (England & Wales)	7,419	0	0	0	0
Faroe Islands	3,695	0	0	0	0
France	15,926	0	0	0	0
Germany	18,982	65	47	18,758	1,496
Ireland	35,361	92	36	5,881	2,135
UK (Northern Ireland)	426	0	0	0	0
Norway	25,113	99	11	1,492	288
Portugal	13,307	76	1,569	159,387	2,153
UK (Scotland)	142	0	0	0	0
Spain*	26,440	98	566	43,408	3,119
Sweden	239	0	0	0	0
The Netherlands	69,024	92	82	12,329	1,975
Total*	234,876	78	2,321	242,100	11,560

*** WG catches**

The following tables have information broken down by horse mackerel stock.

The horse mackerel sampling intensity for the Western stock (N.B. this now includes VIIIc – see section 3) was as follows:

Country	**Official catch t**	**% Catch covered by sampling programme ***	**Samples**	**Measured**	**Aged**
Belgium	<1	0	0	0	0
Denmark	10,210	91	7	648	197
UK (England & Wales)	3,560	0	0	0	0
Faroe Islands	3,695	0	0	0	0
France	10,690	0	0	0	0
Germany	16,734	70	35	13,481	995
Ireland	35,361	92	36	5,881	2,135
UK (Northern Ireland)	426	0	0	0	0
Norway	25,113	98	11	1,492	288
UK (Scotland)	142	0	0	0	0
Spain*	16,636	100	387	28,593	2,552
Sweden	148	0	0	0	0
The Netherlands	43,445	92	54	8,437	1,275
Total*	181,994	82	530	58,532	7,442

*** WG catches**

The horse mackerel sampling intensity for the North Sea stock (IVb,c, VIId and the eastern part of IIIa) was as follows:

Country	**Official catch t**	**% Catch covered by sampling programme ***	**Samples**	**Measured**	**Aged**
Belgium	6	0	0	0	0
Denmark	3,987	71	3	197	197
UK (England & Wales)	3,859	0	0	0	0
France	5,236	0	0	0	0
Germany	2,248	37	12	5,277	501
Sweden	91	0	0	0	0
The Netherlands	25,579	91	28	3,892	700
Total*	29,771	48	43	9,366	1,398

*** WG catches**

The horse mackerel sample intensity for the North Sea stock was again low and only a small improvement from 2004 (38%). There were no samples from any quarters in Division IIIa, and only during the first quarter in Division IVc.

The sampling intensity for the Southern stock (N.B. this no longer includes VIIIc) was as follows:

Country	**Official catch t**	**% Catch covered by sampling programme ***	**Samples**	**Measured**	**Aged**
Portugal	13,307	76	1,569	159,387	2,153
Spain*	9,804	98	179	14,815	567
Total*	23,111	84	1,748	174,202	2,720

*** WG catches**

The horse mackerel sampling intensity for the Southern stock was lower than in 2004 (when it was 99% coverage).

A significant proportion of the unsampled horse mackerel catches are taken by foreign flagged freezer trawlers landing into the Netherlands. **The Working Group strongly recommends that the Netherlands samples these landings**.

The sampling intensity of horse mackerel for the different Divisions was as follows

Division	WG Catch	Sampled Catch	% Catch covered by sampling programme	Nº samples	Nº measured	Nº measured / 1000 tons*	Nº aged	Nº aged / 1000 tons*
IIa	176	0	0	0	0	**0**	0	**0**
IIIa	357	0	0	0	0	**0**	0	**0**
IVa	26,315	24,937	95	11	1,492	**57**	288	**11**
IVb	2,780	558	20	4	257	**92**	222	**80**
IVc	11,112	1,617	15	4	383	**34**	100	**9**
VIa	22,055	19,735	89	22	3,320	**151**	1,151	**52**
VIIa	60	0	0	0	0	**0**	0	**0**
VIIb	22,166	19,667	89	20	3,429	**155**	1,218	**55**
VIIc	1,106	0	0	0	0	**0**	0	**0**
VIId	15,522	12,081	78	35	8,726	**562**	1,076	**69**
VIIe	9,937	5,969	60	17	4,299	**433**	466	**47**
VIIf	1	0	0	0	0	**0**	0	**0**
VIIg	3	0	0	0	0	**0**	0	**0**
VIIh	32,699	27,114	83	20	3,860	**118**	739	**23**
VIIj	25,981	17,687	68	29	4,714	**181**	623	**24**
VIIIa	23,217	17,690	76	24	8,825	**380**	405	**17**
VIIIb	2,953	1,851	63	39	2,717	**920**	567	**192**
VIIIcE	6,025	6,023	100	208	14,903	**2,474**	1,099	**182**
VIIIcW	8,750	8,750	100	140	10,973	**1,254**	886	**101**
VIIId	550	0	0	0	0	**0**	0	**0**
IXaN	9,382	9,382	100	173	14,344	**1,529**	567	**60**
IXaCN	5,561	5,247	94	1,010	100,510	**18,074**	2,153	**387**
IXaCS	4,437	3,010	68	150	12,172	**2,743**	2,153	**485**
IXaS	3,731	1,806	48	409	46,705	**12,518**	2,153	**577**
sum	234,876	183,124	78	2,315	241,629	**1,029**	15,866	**68**

*** Values related to WG catch**

Coverage and sampling intensity in 2005 improved across the North Sea, in Divisions VIIh and VIIj, and in Divisions VIIIa and VIIIb. It decreased in parts of Division IXa. Despite an increase in coverage in the North Sea, the numbers measured per 1000 t are still low. The working group therefore remains concerned about the low sampling intensity in some Divisions.

Sardine

The sampling programmes on the assessed sardine stock in VIIIc and IXa are summarised as follows.

YEAR	TOTAL CATCH T	% CATCH COVERED BY SAMPLING PROGRAMME	SAMPLES	MEASURED	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

The summarised details of individual sampling programmes in 2005 are shown below. These catches cover all areas where sardine is caught. Landings from the Netherlands (in IV, VII and VIII) have been provided this year to the WG for the first time and are included in the table.

COUNTRY	OFFICIAL CATCH T	% CATCH COVERED BY SAMPLING PROGRAMME	SAMPLES	MEASURED	AGED
Spain	40,753	100	424	47,775	3,238
Portugal	57,490	100	501	68,625	6,515
France	26,324	58.7	47	3,381	1,382
UK (England	3,457		0	0	0
Ireland	1,448		0	0	0
Germany	221		0	0	0
The Netherlands	2,232[1]		0	0	0
Total	136,120	84	972	119,781	11,135

[1]Preliminary figures

The overall sampling levels for sardine are adequate for the stock in area VIIIc and IXa. Length distributions and catch-at-age data for 2005 in areas VIIIa,b were reported to the WG by France. Catches of sardine in Area VII are not sampled. This is considered to be relevant given that catches in this area can be important in some years.

Anchovy

The sampling programmes carried out on anchovy in 2005 are summarised below. The programmes are shown separately for Subarea VIII and for Division IXa. Sampling throughout Divisions VIIIa, VIIIb and VIIIc appears to be satisfactory.

The overall sampling levels for recent years are shown below

YEAR	TOTAL CATCH VIII+IXA	% CATCH COVERED BY SAMPLING PROGRAMME	SAMPLES	MEASURED	AGED
1992	40,800	92	289	17,112	3,805
1993	39,700	100	323	21,113	6,563
1994	34,600	99	281	17,111	2,923
1995	42,104	83	?	?	?
1996	38,773	93	214	17,800	4,029
1997	27,440	76	258	18,850	5,194
1998	31,617	100	268	15,520	5,181
1999	40,156	100	397	33,778	10,227
2000	39,497	99	209	18,023	4,713
2001	49,247	58	317	28,615	4,683
2002	26,313	94	216	45,909	4,685
2003	15,864	96	205	22,081	5,324
2004	22,200	97	304	22,436	6,553
2005	5,643	98	145	8,918	3,601

The sampling programmes for France and Spain in Subarea VIII in 2005 are summarised below.

COUNTRY	DIVISION	OFFICIAL CATCH	% CATCH COVERED BY SAMPLING PROGRAMME	SAMPLES	MEASURED	AGED
France	VIII a, b	952	100	23	1,115	653
Spain*	VIII a	0	-	-	-	-
Spain*	VIII b	75	100	15	818	770
Spain*	VIII c	101	100	8	733	340
Total	VIII	1,128	100	46	2,766	1,713

*** WG catches**

The sampling programmes for the fisheries in Division IXa in 2005 are summarised below.

COUNTRY	DIVISION	OFFICIAL CATCH	% CATCH COVERED BY SAMPLING PROGRAMME	SAMPLES	MEASURED	AGED
Spain*	IXa	4,389	100	49	6,152	1,888
Portugal	IXa	126	0	0	0	0
Total	IXa	4,515	97.2	49	6,152	1,888

*** WG catches**

No catches of anchovy from Portugal were sampled for length and age in Division IXa in 2005.

1.3.2 Catch data

Recent working groups have on a number of occasions discussed the accuracy of the catch statistics and the possibility of large scale underreporting or species and area misreporting. These discussions applied particularly to mackerel and horse mackerel in the northern areas.

The working group considers that the best estimates of catch it can produce are likely to be an underestimate. Anecdotal information from the UK, and the specific changes reported by the UK in 2005 (see Section 2.8.2), suggest substantial under reporting in the catches. Numerical information is not available for most countries (see section 2.8.3. and 2.8.4 for a discussion on the implications for the assessment of NEA mackerel.

For mackerel and horse mackerel it was concluded that in the southern areas the catch statistics appear to be satisfactory.

For sardines and adult anchovy the WG assumption is that the landings figures are not significantly under reported.

1.3.3 Discards

In pelagic fisheries discarding occurs in a sporadic way compared to demersal fisheries. This is because the nature of pelagic fishing is to pursue schooling fish, creating hauls with low diversity of species and sizes and consequently often extreme fluctuation in discard rates (100% or null discards). The sporadic occurrence of these extreme discard behaviours (such as slippage) may be considered statistically as rare events, which may require specific statistical assumptions and analysis methodologies. Furthermore, the estimators normally used in demersal fisheries to raised sampled discard data to population levels, such as effort or catch related variables, may not be applicable to pelagic fisheries.

Discard estimates of pelagic species from pelagic fisheries and demersal fisheries have been published by several authors. Discard percentages of pelagic species from demersal fisheries were estimated between 3% to 7% (Borges et al., 2005) of the total catch in weight, while from pelagic fisheries were estimated between 4% to 11% (Pierce et al., 2002; Hofstede and Dickey-Collas, 2006). Slipping estimates has only been published for the Portuguese purse seine fishery targeting sardine, with values at around 60% of the total catch (Stratoudakis et al., 2002). Nevertheless, the majority of these estimates were obtained without careful examination of the issues described previously and are therefore open to criticism.

Discard estimates for some countries for mackerel, horse mackerel, anchovy and sardine were provided to the working group. These data included sampling levels and raised discard estimates. The raising methods used, namely the estimators used as a proxy of fishing activity, are not clear. In addition, the associated sampling levels are low, and therefore the data should be treated with caution. The necessary steps involved in providing discard data to stock assessments require further research.

Because of the potential importance of significant discards levels on pelagic species assessments the **Working Group again recommends that observers should be placed on board vessels in those areas in which discarding may be a problem. Existing observer programmes should be continued.**

Mackerel

The Netherlands, Germany and Scotland provided 2005 discard data on mackerel to the working group. Age and length disaggregated data was only available from the Scottish fishery in the first quarter in area IVa and VIa, a fishery having 29% and 71% of total catches for these areas, respectively. Discard estimates were available from the German freezer trawlers in the first quarter in areas IVa, VIa and VIIj, and in the fourth quarter in area VIIIa. The Netherlands provided discard estimates for the following areas: IVa-c, VIa, VIIb-e,h,j and VIIIa.

Horse Mackerel

In the past discards of juvenile horse mackerel have been thought to constitute a problem. However, in recent years a targeted fishery has developed on juveniles, including 1-year old fish. Therefore discarding of juveniles is now thought to be unlikely. In 2005 the Netherlands and Germany provided discard data on horse mackerel to the working group. Horse mackerel catches of the Netherlands and Germany represent app. 40% of the total catch.

Sardine

A discard programme, sampling purse seine vessels, has recently started in Portugal. Nevertheless, discard estimates are still not available to the working group. Germany has provided discard estimates of sardine. However, the German catch data is not in the assessment area of sardine.

Anchovy

An onboard observer programme was conducted in 2005 to estimate discards by the Spanish fisheries (trawl, purse seine and artisanal) in the Gulf of Cadiz (see Section 11.2.3). Preliminary discard estimates for purse seine vessels show that 10.1% of anchovy catch in numbers and 10.7% in weight is discarded. Such ratios should be, however, considered with caution given the extremely high CV associated to the estimates (CV= 157.2 for discarded catch in weight). There are no recent estimates of discards in the French and Spanish anchovy fishery in the Bay of Biscay. It is not known if discarding in this fishery is significant.

1.3.4 Age-reading

Reliable age data are an important pre-requisite in the stock assessment process. The accuracy and precision of these data, for the various species, is kept under constant review by the Working Group.

Mackerel

It is now five years since the last age reading workshop and, therefore, **the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine, and Anchovy again recommends that institutes examine their otolith preparation technique for mackerel before a new mackerel otolith exchange be carried out to evaluate the otolith processing techniques of all institutes that are providing age data to this Working Group.**

Horse mackerel

At the 2004 WG meeting possible age reading problems were identified in the age compositions of Dutch and German samples collected in Divisions VIId,e,h (ICES, 2005/ACFM:08 and Zimmermann *et al*., W21/04). The German catches contained a very high proportion of the 2001 year class, while the Dutch samples contained high proportions of both the 2001 and 2002 year class. A preliminary small-scale otolith exchange after the WG meeting indicated that 2 age readers assigned ages according to the German age reading method but the other 2 readers according to the Dutch age reading method. This is probably due to the known difficulty of interpreting the juvenile rings in the otoliths. The accuracy in age reading is likely to improve once these year classes are mature, because then the interpretation of the rings at the time they were juveniles becomes easier. In 2005 the age distribution from Dutch and German samples from the same area was again significantly different.

A workshop on age reading horse mackerel will take place in the Netherlands in November 2006 to detect, evaluate and try to solve the observed problems in age reading across all the horse mackerel stocks.

Anchovy

For the Bay of Biscay anchovy, two exchanges of otoliths took place some years ago, of which results were available at the previous meeting (Astudillo et al. 1990 & Villamor et al. WD 1996). An exchange of otoliths for anchovy in IXa (Cadiz) has also taken place (Garcia 1998).

In 2001 a new exchange, followed by a workshop in 2002 on age determination of otoliths from anchovy took place. The major goal was to identify major difficulties in age determination and standardise anchovy otolith ageing criteria for the Bay of Biscay and for division IXa (Uriarte 2002).

In 2005 an otolith exchange programme for anchovy from the Bay of Biscay took place. The results of this exchange were submitted to the 2006 ICES Planning Group on Commercial Catch, Discards and Biological Sampling (PGCCDBS) held in February 2006. The exchange was made between French and Spanish institutes monitoring anchovy. Two readers from each institute (AZTI, IEO, IFREMER) read a total of 510 otoliths to evaluate current precision in otolith age reading of anchovy and detect major difficulties. The major findings were that:

- The average percentage agreement (90.9 %) and CV (13.9%) are quite good and quite similar to the results achieved in the 2002 workshop (agreement of 92% with a CV of 10%)
- During the first half of the year the percentage agreement is high (93%) and precision is high (CV low, 8.1%) with a small amount of bias (0.03).
- During the second half of the year the percentage agreement is lower (87.7%) and precision decreases (to 22%) with a small amount of bias (0.04). However, already noticeable since age 2: there are two sets of readers diverging during the second half of the year on the allocation of a certain amount of otoliths either to age 1 or 2.
- Depending on the correct reading of those otoliths the percentage in the catches of 2 year olds could have doubled or halved for the second half of the year.
- The ultimate reasons for these discrepancies have not yet been examined over individual otolith cases of disagreement and their examination is left for the next workshop.

A workshop is planned to take place in the autumn of 2006 to examine the results from the exchange programme and to improve the consistency and accuracy of age readers. **The WG recommends that this workshop should, in particular, address the abnormal abundance of 2-ring fish observed in the 2006 spring surveys to determine whether it is the result of incorrect age determination.**

The working group endorses the workshop initiative.

Sardine

A workshop on sardine age reading took place in June 2005 to discuss the results of an otolith exchange carried out during 2004. The otolith exchange and workshop aimed to evaluate readers' agreement and ageing precision, to assess the extent of ageing difficulties previously identified (identification of the first annual ring and ageing of older individuals) and to propose guidelines for their minimization. The consistency of age readings in time (comparison of the 1980s, 1990s and 2004) and in space (comparison with Mediterranean and northwest African areas) was also explored and the consequences of the assumed birth date for the estimation of growth were discussed. In addition, profiting from the experience of the workshop attendants, biological sampling methodologies (assignment of sexual maturity stages, visceral fat and stomach condition) were listed and discussed and standard protocols have been recommended.

A total of 555 otolith pairs, grouped into 10 sets according to the different objectives and areas, were read by thirteen readers (from seven Institutes across five countries) following a common age reading protocol. For each otolith, the number of hyaline rings, the type of edge (hyaline/opaque), the age group (years) and the readability level (1-good, 2-medium, 3-difficult) were recorded. The modal age of each otolith, based on readings of five experienced readers, was assumed as the true age.

Otolith readability declined from the northern to the southern areas in the Atlantic and was intermediate in the northwestern Mediterranean samples. The exclusion of difficult otoliths did not affect the estimates of the mean length-at-age but improved their precision considerably. Within the Atlantic Iberian area, both the agreement among experienced readers and the CV by age group declined in comparison to the last workshop. Two possible explanations are the shorter experience of some current readers and the fact that most samples were collected when the edge type classification is more uncertain (transition between winter/summer). Difficulties in the identification of the first annual ring and ageing of older fish still persist while the identification of the otolith edge and whether to decide to account it for age assignment are additional problems. To minimize these problems, the workshop recommends that readers use either the anterior or posterior margin of the otolith to identify the edge type and follow its seasonal evolution in each area.

Overall, agreement with age readings from the 1980s and the 1990s was lower than current levels of between-reader agreement in samples from similar areas. The small sample sizes prevent firm conclusions about bias but the observed systematic differences in some ages/periods advise a more thorough evaluation of this issue.

Otoliths from the Mediterranean area showed generally low agreement levels (comparable to otoliths from southern Portugal) mainly due to the identification of the first annual ring. The workshop recommended the use of the diameter of the opaque core measured in juvenile fish otoliths as a gauge to help ageing older individuals. Agreement between readers from the Atlantic Iberian and the NW African areas was noticeably low. Iberian readers assigned older ages to otoliths from the NW African areas while Moroccan readers assigned younger ages to the otoliths from the Iberian areas, indicating different age reading criteria. The high opacity of otoliths from the NW African areas raises serious difficulties in ageing. The use of alternative preparation techniques, such as soaking in water/alcohol, was recommended to enhance ring visibility in these otoliths.

The age reading protocol for sardine was updated and a standard sheet for recording age reading results was prepared. The organization of reference collections of otoliths (>80% agreement) within each area is recommended.

1.3.5 Biological data

The main problems in relation to other biological data identified by the Working Group are listed by species.

Mackerel

There is inadequate sampling for stock weights during the spawning season. This applies particularly to the North Sea, where insufficient fish were sampled for the 9+ group.

Horse Mackerel

WGMEGS investigated the possibility to apply feeding state and lipid content as proxies for fecundity. Samples were collected during the 2004 egg survey and showed a constant decline in lipid content suggesting that the peak occurred prior to sampling. If lipid content is to be used as an indication of fecundity, sampling should be carried out during the peak period. Therefore samples will be collected both prior to and during the 2007 survey (ICES 2006/LRC:09).

Sardine

The need to revise maturity and weight at age estimates was highlighted at the 2004 WG meeting. A revision of maturity ogives and stock weights for the Iberian sardine stock was carried out within the framework of the project "SARDYN". Results of this revision are presented in Section 8.4.3. and in WD Silva *et al* 2006.

Anchovy

There are no problems with regard to biological data for anchovy.

1.3.6 Quality Control and Data Archiving

Current methods of compiling fisheries assessment data. Information on official, area misreported, unallocated, discarded and sampled catches have again this year been recorded by the national laboratories on the WG-data exchange sheet (MS Excel; for definitions see text table below) and sent to the species co-ordinators. Co-ordinators collate data using the latest version of *sallocl* (Patterson, 1998) which produces a standard output file (*Sam.out*). However only sampled, official, WG catch and discards are available in this file. Efforts were made to use the Intercatch system this year on a trial basis. However there still remain several issues to be sorted with how to input data.

There are at present no defined criteria on how to allocate samples of catch numbers, mean length and mean weight at age to unsampled catches, but the following general process is implemented by the species co-ordinators. Searches are made for appropriate samples by gear (fleet), area, and quarter, if an exact match is not available the search will move to a neighbouring area, if the fishery extends to this area in the same quarter. More than one sample may be allocated to an unsampled catch, in this case a straight mean or weighted mean of the observations may be used. If there are no samples available the search will move to the closest non-adjacent area by gear (fleet) and quarter, but not in all cases. For example in the case of NEA mackerel samples from the southern area are not allocated to unsampled catches in the western area. It would be very difficult to formulate an absolute definition of allocation of samples to unsampled catches which was generic to all stocks, however full documentation of any allocations made are stored each year in the data archives (see below). It was noted that when samples are allocated the quality of the samples may not be examined (i.e. numbers aged) and that allocations may be made notwithstanding this. The Working Group again encourages national data submitters to provide an indication of what data could be used as representative of their unsampled catches. Definitions of the different catch categories as used by the WGMHMSA

Official Catch	Catches as reported by the official statistics to ICES
Unallocated Catch	Adjustments to the official catches made for any special knowledge about the fishery, such as under- or over-reporting for which there is firm external evidence. (can be negative)
Area misreported Catch	To be used only to adjust official catches which have been reported from the wrong area. (can be negative). For any country the sum of all the area misreported catches should be zero.
Discarded Catch	Catch which is discarded
WG Catch	The sum of the 4 categories above
Sampled Catch	The catch corresponding to the age distribution

Quality of the Input data. Primary responsibility for the accuracy of national biological data lies with the national laboratories that submit such data. Each species co-ordinator is responsible for combining, collating, and interpolating the national data where necessary to produce the input data for the assessments. A number of validation checks are already incorporated in the data submission spreadsheet currently in use, and these are checked by the co-ordinators who in the first instance report anomalies to the laboratory which provided the data.

The working group acknowledges the effort some members have made to provide “corrected” data, which in some cases differ significantly from the officially reported catches. Most of this valuable information is gathered on the basis of personal knowledge of the fishery and good relations between the responsible scientist and the fishermen. The WG is aware of the problem that this knowledge might be lost if the scientist resigns, and asks the national laboratories to ensure continuity in data provision. In addition the working group recognises and would like to highlight the inherent conflict of interest in obtaining details of unallocated catches by country and increasing the transparency of data handling by the Working Group. The Working group is unsure of how this issue is handled in Intercatch, and would appreciate information on such from the secretariat.

The quality and format of input data provided to the species co-ordinators is still highly variable. Table 1.3.6.1 gives an overview of possible problems by nation. From this and the text tables given in section 1.3.1 it can be seen that sampling deficiencies have overall been reduced, partly due to the implementation of the EU sampling regulation for commercial catch data. However, some nations have still not or inadequately aged samples, others have not even submitted any data. This is regarded to be problematic for France and the Faroes in the case of Mackerel; Denmark, England, France, Faroes and Sweden in the case of Horse Mackerel; England and Ireland in the case of Sardine, and Portugal in the case of Anchovy. However, under the EU directive for sampling of commercial catch the responsibility lies within the member state where the catch is landed. This would imply for instance that the Netherlands should be sampling French, UK and German mackerel and horsemackerel catches landed into the Netherlands. For sardine in the northern areas, more nations have provided catch data than last year, but the sampling in this area is still poor. This might become problematic if catches in this currently unregulated fishery continue to rise. This table will be updated every year to continue to track improvements. For anchovy, a complex method of catch sampling based on stratifying by commercial size-categories is used. Although a documented programme such as *sallocl* is not used to combine these data it was felt that such a programme would not improve the quality of this data.

The Working Group documents sampling coverage of the catches in two ways. National sampling effort is tabulated against official catches of the corresponding country (section 1.3.1). Furthermore tables showing total catch in relation to numbers of aged and measured fish by area give a picture of the quality of the overall sampling programme in relation to where the fisheries are taking place. These tables are shown in section 1.3.1 as text tables under Mackerel and Horse Mackerel.

Transparency of data handling by the Working Group and archiving past data. The current practice of data handling by the working group has been the same for a number of years. Data received by the co-ordinators which is not reproduced in the report is available in a folder called “archives” under the working group and year directory structure. This archived data contains the disaggregated dataset, the allocations of samples to unsampled catches, the aggregated dataset and (in some cases) a document describing any problems with the data in that year.

Prior to 1997, most of the data was handled in multiple spreadsheet systems in varying formats. These are now stored in the original format, separately for each stock and catch year.

Table 1.3.6.2 gives an overview on data collected up to and including Sept. 2005. It is the intention of the Working group that in the interim period until the proposed standard database is developed (see below) the previous years archived data will be copied over to the current year directory and updated at the working group. Thus the archive for each year will contain the complete dataset available. Further, it should be backed up on Compact Disk. **The WG recommends again that archives folder should be given access only to designated members of the WGMHSA**, as it contains sensitive data.

The WG continues to ask members to provide any kind of national data reported to previous working groups (official catches, working group catches, catch-at-age and biological sampling data), to fill in missing historical disaggregated data. However, there was little response from the national institutes. **The WG recommends that national institutes increase national efforts to gain historical data, aiming to provide an overview which data are stored where, in which format and for what time frame.** The working Group still sees a need to raise funds (possibly in the framework of a EU-study) for completing the collection of historic data, for verification and transfer into digital format. This is particularly relevant now given that for the 2005 mackerel assessment the time series had to be truncated due to poor data in the earliest years.

Review of recommended progress and future developments

The Working Group will endeavour to use the Intercatch system in 2007, however this will only be done if a thorough validation can be conducted against the current system (Sallocl in most cases). This will involve significant extra effort on behalf of at least one of the species coordinators, and a learning process for all species coordinators. The WG requests that the ICES secretariat, should make appropriate resources available to facilitate this process in a timely fashion (i.e. not one week before the WG).

1.4 Checklists for quality of assessments

To further continue the systematic documentation of assessment procedures and quality, checklists as suggested by the HAWG (ICES 2000) were updated for mackerel and anchovy in Biscay and added for horse mackerel and Sardine (Tables 1.4.1-1.4.6)

1.5 Comment on update and benchmark assessments

For this year, ICES had scheduled a benchmark assessment for Sardine and Anchovy in Biscay, an update assessment for NEA mackerel, and all other assessments as experimental. The WG through communication with ACFM chair agreed that there must have been a mistake as Anchovy was scheduled for a Benchmark in 2005. It was agreed that due to the depleted state of the Biscay anchovy stock that this would be treated as on the “Observation list” in 2006. The rest of the assessments are as per the ToR’s. It should be noted that the Benchmark for Sardine refers only to VIIIc and IXa. This is for a number of reasons but primarily as this is the only area where sufficient data exist. A brief overview is given below; details are given in the respective sections.

NEA mackerel: Update: Benchmark done in 2004. Next benchmark planned in 2007. Further exploration of the effect of under reported catches is provided in the report.

North Sea horse mackerel*:* Exploratory: The data are sparse and of variable quality. This year, the IBTS survey was again examined. The analysis of the data reveal that they are insufficient for an age based analytical assessment. Length based assessments based on survey data may still be explored, but the necessary data are not available to the WG. This stock assessment may be more productively explored in SGASAM.

Western horse mackerel: Exploratory. The historic catch data are dominated by the very strong 1982 year class going through the fishery. Catch data was explored by means of a modified SAD assessment which accounts for the age structure in population in the relationship between the egg abundance and the SSB. This has helped to scale the assessment.

Southern horse mackerel*:* Exploratory: The AMCI approach required strong conditioning and gave unrealistic results. With the surveys combined a clear cohort signal was evident. It was decided to explore this along with the catch at age data in an XSA model.

Sardine: Benchmark assessment. The results of the SARDYN project were presented and were not conclusive with respect to the most suitable assessment model and the level of migration between areas. Both single area and multi area assessments were considered. The AMCI model was explored in detail and some changes in conditioning were made. The most significant of these was the merging of the 2 Spring surveys and the treatment of the DEPM as relative. Although much progress has been made with these issues, there remain some outstanding issues with the final assessment, which will require further exploration.

Anchovy in VIIIb: Observation list. Exploration of both the old ICA assessment and new Bayesian biomass based model (BBM) are provided. This included the sensitivity of the Bayesian production model to informative priors, and the effect and consequences of treating both surveys as relative measures of stock abundance.

Anchovy IXa*:* Exploratory: Seasonal separable model applied using a single standardised CPUE index. The results are sensitive to the inclusion of a 2006 acoustic survey, which is only available as a biomass index.

1.6 The ICES stock handbook

As in previous years and due to time constraints, the working group could not begin to create the stock handbook for WGMHSA. Therefore the "static" parts of the report have remained in the body of the report. With the current workload, it is unlikely that the stock handbook can be created during the working group session and thus intersessional work is required to create the handbook.

1.7 Reference points relevant for WG MHSA

No revisions of the reference points have been considered at this meeting. An elaboration on reference points is given in the 2004 years WG report.

1.8 Long term management strategies

1.8.1 Answer to special request on Anchovy

A special request on anchovy was received which stated "*we would therefore appreciate ICES views on the conclusions and recommendations given by the Group last June in addition to task already agreed (Ref your letter 5154 dated 20 Mars 2006) as apart of the preparation for the December meeting on surveys*" and additionally requested "*We would appreciate that ICES could address these issues on coordination and views on anchovy surveys in the Bay of Biscay and report by November 2006*". The WGMHSA notes that the ToRs for WGACEGG are formulated to address survey coordination issues on this stock. However in order to assist ICES in delivering the reply in a timely fashion the WGMHSA prepared a summary table which details surveys which collect information on anchovy in Biscay (Table 1.8.1). The WG considers that surveys supporting the assessment and the proposed HCR management strategies currently being developed are essential. This is because successful management of this stock requires in-year information and in-year management action. WGMHSA considers that surveys that provide the following information are required:-

- Information on anchovy SSB and recruitment, which forms the main part of the exploited SSB each year. In this context, both spring and autumn surveys are recommended to be continued, in order to obtain annual biomass, and juveniles/recruitment abundance index time series of sufficient length to allow verification of observations against "converged" population estimates from stock assessments.
- Information on ecological parameters to explain the recruitment processes which have been identified as being particularly environmentally dependent and important for management advice on this stock.

1.9 Relevant information on ecological/environmental studies related to small pelagic species.

As stated in previous reports, there are different sources of ecological/environmental information relevant to this WG. Within ICES, recent Working and Study groups that have been specifically set up to investigate ecological or environmental questions include the extinct SGSBSA and SGRESP and their successors WGACEGG and WGLESP. In addition there are eco-region description groups NORSEPP, REGSNS and PGNSP. Specific workshops like WKIMS were set up to provide a framework for the correlation between environmental index and fish distribution at the appropriate scale. More general oceanographic and/or environmental groups are also of interest to this WG, like WGOH, which provides a yearly summary on climatic conditions in the North Atlantic, and WGRED which aimed to provide a description of the different regional ecosystems included in the ICES areas. WGRED report covers nine ecological regions, of which one general area (Oceanic and deep sea area) and four different regions (Norwegian Sea, Faroe Plateau Ecosystem, Celtic Seas and North Sea) are of importance for the assessment of the pelagic species covered by WGMHSA. WGRED attempts to provide the different assessment groups with material to generate a more environmental oriented assessment of the fisheries in the ICES area, as requested by ACFM.

Nevertheless, despite the increasing pressure on working groups to consider their allocated stocks within the context of the ecosystem and the effort of the different ecosystem description groups; the impact of ecosystem change and ecosystem vulnerability on the assessments of WGMHSA is still minimal. This is primarily due to the lack of an interaction between the general ecological and oceanographic groups and the assessment groups, which still tend to work in isolation. The provision of the data by the ecosystem groups and the summaries they provide are still largely unsuitable for consideration and adoption by assessment working groups. Assessment working groups need information on vulnerabilities and sensitivities of ecoregions to exploitation and indices and mechanisms of changes in productivity. Also it appears that scale is a problem, with oceanographic groups studying changes in the ecosystem at scales larger than the ones useful for assessment. This is the case with main oceanic indices such as NAO that operate on a larger scale then the response of fish behaviour to environmental change.

Although assessment working groups are generally populated by scientists with a "stock assessment" slant, WGMHSA has a history of using and investigating environmental drivers and changes in productivity. These investigations include:

- the upwelling index for Bay of Biscay anchovy recruitment
- the link between the influx of water into the North Sea and horse mackerel catches

- the investigations of the between year egg mortality and fish natural mortality in North East Atlantic mackerel
- the variability of NEA mackerel migration along the western shelf
- the variability in migrations of sardine in the Iberian area
- fecundity in horse mackerel and proxies for fecundity
- the search for more robust indices of recruitment in all stocks
- initiating work on the interactions of multispecies catches of the fleets that target small pelagics

Apart from these specific issues, other more general ecological issues like the effect of climate change in the different marine communities is to some extent taken into account and being addressed by WGMHSA by monitoring changes in productivity. Northerly shifts on the distribution of different fish communities, as well as changes in spawning seasons, changes in the spawning ground characteristics and migration patterns are continuously being addressed by this group in order to improve the assessment of the different species.

The work on ecological/environmental studies within WGMHSA has fed into and been used by groups such as SGPRISM, SGRESP, SPACC and other GLOBEC groups. Interaction between these groups and WGMHSA is much larger than with the general oceanographic or environmental groups, mainly due to sharing common objectives and scientists of similar profiles. This is reflected by the participation by the membership of WGMHSA of projects such as UNCOVER which looks at the dynamics of stock recovery in variable ecosystems, and RECLAIM which looks at climate effects on the productivity of pelagic and demersal fish stocks. A good example of such work, is the dedicated workshop on identifying mesoscale oceanographic features such as fronts, eddies and upwelling events which operate on the same temporal and spatial scale as the patterns in fisheries population dynamics (WKIMS; ICES CM 2006/OCC:01). The workshop aimed to identify these features and develop numerical indices which can be used for comparison with relative distribution of different life stages of fish communities.

The working group thus recommends improved coordination between assessment working groups and the ecological/oceanographic working groups, with clearly defined deliverables. In particular, with the development of tools and the analysis for

i) the detection and enumeration of environmental variability and changes in productivity

ii) highlighting vulnerabilities of ecosystems to overexploitation and impact on trophic diversity.

Table 1.3.6.1. Overview of the availability and format of data provided to the species co-ordinators and possible problems (e.g. inconsistencies, missing data) Grey fields in the last column indicate poor sampling level.
Catch year 2005.

A. Mackerel

Country	Data supplied	Data exchange sheet	Aged Samples	Problems
Belgium	NO	-	-	NO
Denmark	YES	YES	YES	NO
England&Wales	YES	YES	YES	YES
Faroes	YES	YES	NO	YES
France	YES	YES	NO	YES
Germany	YES	YES	YES	NO
Iceland	NO	-	-	NO
Ireland	YES	YES	YES	NO
Netherlands	YES	YES	YES	NO
Northern Ireland	YES	YES	NO	YES
Norway	YES	YES	YES	NO
Poland	NO	-	-	NO
Portugal	YES	YES	YES	NO
Russia	YES	YES	YES	NO
Scotland	YES	YES	YES	NO
Spain	YES	YES	YES	NO
Sweden	YES	YES	NO	NO

B. Horse Mackerel

Country	Data supplied	Data exchange sheet	Aged Samples	Problems
Belgium	NO	-	-	NO
Denmark	YES	YES	YES	NO
England & Wales	YES	YES	NO	NO
Faroe Islands	YES	YES	NO	NO
France	NO	N	NO	YES
Germany	YES	YES	YES	NO
Ireland	YES	YES	YES	NO
NORWAY	YES	YES	YES	NO
Netherlands	YES	YES	YES	NO
Portugal	YES	YES	YES	NO
Scotland	YES	YES	NO	NO
Spain	YES	YES	YES	NO
Sweden	No	-	-	YES
UK (NI)	YES	YES	No	NO

C. Sardine

Country	Data supplied	Data exchange sheet	Aged Samples	Problems
France	YES	YES	YES	NO
England&Wales	YES	YES	NO	NO
Ireland	YES	NO	NO	NO
Netherlands	YES	NO	NO	NO
Germany	YES	YES	NO	NO
Portugal	YES	YES	YES	NO
Spain	YES	YES	YES	NO

C. Anchovy

Country	Data supplied	Data exchange sheet	Aged Samples	Problems
France	YES	YES	YES	NO
Portugal	YES	YES	NO	YES
Spain	YES	YES	YES	NO

Table 1.3.6.2: Available disaggregated data for the WG MHSA per Sept. 2005
X: Multiple spreadsheets(usually xls); W: WG-data national input spreadsheets (xls);
D: Disfad and Alloc-outputs (ascii/txt)

Stock		Catchyear	Format			Comments
			X	W	D	
Horse Mackerel: Western and North Sea						
	HOM_NS+W	1991	X			Files from Svein Iversen, April 1999
		1992	X			Files from Svein Iversen, April 1999
		1993	X			Files from Svein Iversen, April 1999
		1994	X			Files from Svein Iversen, April 1999
		1995	X			Files from Svein Iversen, April 1999
		1996	X			Files from Svein Iversen, April 1999
		1997	X	W	D	Files from Svein Iversen, April 1999
		1998		W	D	Files provided by Pablo Abaunza Sept 1999
		1999		W	D	Files provided by Svein Iversen Sept 2000
		2000	X	W	D	Files provided by Svein Iversen Sept 2001
		2001	X	W	D	Files provided by Svein Iversen Sept 2002
		2002	X	W	D	Files provided by Svein Iversen Sept 2003
		2003	X	W	D	Files provided by Svein Iversen Sept 2004
		2004	X	W	D	Files provided by Svein Iversen Sept 2005
		2005	X	W	D	Files provided by Svein Iversen Sept 2006
Horse Mackerel: Southern						
	HOM_S	1992	X			WG Files on ICES system [Database.92], March 1999
		1996	X			Source?
		1997		(W)	D	WG Files on ICES system [WGFILES\HOM_SOTH], March 1999
		1998		W	D	Files provided by Pablo Abaunza Sept 1999
		1999		W	D	Files provided by Pablo Abaunza Sept 2000
		2000	X	W		Files provided by Pablo Abaunza Sept 2001
		2001	X	W		Files provided by Pablo Abaunza Sept 2002
		2002	X	W		Files provided by Pablo Abaunza Sept 2003 (D incl. in NS+W)
		2003	X	W		Files provided by Pablo Abaunza Sept 2004 (D incl. in NS+W)
		2004	X	W		Files provided by Pablo Abaunza Sept 2005 (D incl. in NS+W)
		2005	X	W		Files provided by Pablo Abaunza Sept 2006 (D incl. in NS+W)
North East Atlantic Mackerel						
	NEAM	1991	X			North Sea +Western WG Files on ICES system [Database.91], March 1999
		1992	X			North Sea +Western WG Files on ICES system [Database.92], March 1999
		1993	X			North Sea +Western WG Files on ICES system [Database.93], March 1999
		1997		W	D	Files from Ciaran Kelly, April 1999
		1998		W	D	Files from Ciaran Kelly, Sept 1999
		1999		W	D	Files provided by Ciaran Kelly, Sept 2000, revisions Sept 2004
		2000		W	D	Files provided by Ciaran Kelly, Sept 2001, revisions Sept 2004
		2001		W	D	Files provided by Ciaran Kelly, Sept 2002, revisions Sept 2004
		2002		W	D	Files provided by Ciaran Kelly, Sept 2003, revisions Sept 2004
		2003		W	D	Files provided by Leonie Dransfeld, Sept 2004
		2004		W	D	Files provided by Leonie Dransfeld, Sept 2005
		2005		W	D	Files provided by Leonie Dransfeld, Sept 2006
	Western Mackerel subset					
		1997		(W)	D	Files from Ciaran Kelly, April 1999; (W) contained in NEAM
		1998		(W)	D	Files from Ciaran Kelly, Sept 1999; (W) contained in NEAM
		1999		(W)	D	Files provided by Ciaran Kelly, Sept 2000; (W) contained in NEAM
		2000	X	(W)		Files provided by Guus Eltink, Sept 2001; (W) contained in NEAM
		2001	X	(W)		Files provided by Guus Eltink, Sept 2002; (W) contained in NEAM
	Southern Mackerel subset					
		1991	X			WG Files on ICES system [Database.91], March 1999
		1992	X			WG Files on ICES system [Database.92], March 1999
		1993	X			WG Files on ICES system [Database.93], March 1999
		1994	X			WG Files on ICES system [Database.94], March 1999
		1995	X			WG Files on ICES system [Database.95], March 1999
		1996	X			WG Files on ICES system [Database.96], March 1999
		1997	X	(W)		WG Files on ICES system [WGFILES\MAC_SOTH], March 1999
		1998	X	(W)		Files provided by Mane Martins; (W) contained in NEAM
		1999	X	(W)		Files provided by Begoña Villamor, Sept 2000; (W) contained in NEAM
		2000	X	(W)		Files provided by Begoña Villamor, Sept 2001; (W) contained in NEAM
		2001	X	(W)		Files provided by Guus Eltink, Sept 2002; (W) contained in NEAM
Sardine						
		1992	X			WG Files on ICES system [Database.92], March 1999
		1993	X			WG Files on ICES system [Database.93], March 1999
		1995	X			files provided by Pablo Carrera Sept 2001
		1996	X			files provided by Pablo Carrera Sept 2001
		1997		W	D	W for Portugal only, files provided by Pablo Carrera and Kenneth Patterson
		1998		W	D	files provided by Pablo Carrera Sept 1999
		1999		W		files provided by Pablo Carrera Sept 2000
		2000		W	D	files provided by Pablo Carrera Sept 2001
		2001		W	D	files provided by Alexandra Silva, Sept. 2002
		2002		W	D	files provided by Alexandra Silva, Sept. 2003
		2003		W	D	files provided by Alexandra Silva, Sept. 2004
		2004		W	D	files provided by Alexandra Silva, Sept. 2005
		2005		W	D	files provided by Alexandra Silva, Sept. 2006
Anchovy						
	Anchovy in VIII	1987-95	X			revised data, all in one spreadsheet, provided by Andres Uriarte Sept 1999
		1996	X			file provided by Andres Uriarte Sept 1999
		1997	X	W	D	files provided by Andres Uriarte Sept 1999
		1998	X	W		files provided by Andres Uriarte Sept 1999
		1999	X	W		files provided by Andres Uriarte Sept 2000
		2000	X	W		files provided by Andres Uriarte Sept 2001
		2001	X	W		files provided by Andres Uriarte Sept 2002
		2002	X	W		files provided by Andres Uriarte Sept 2003
		2003	X	W		files provided by Andres Uriarte Sept 2004
		2004	X	W		files provided by Andres Uriarte Sept 2005
		2005	X	W		files provided by Andres Uriarte Sept 2006
	Anchovy in IX					
		1992	X			files in WK3-format provided by Begoña Villamor Sept 1999
		1993	X			files in WK3-format provided by Begoña Villamor Sept 1999
		1994	X			files provided by Begoña Villamor Sept 1999
		1995	X			files provided by Begoña Villamor Sept 1999
		1996	X			files provided by Begoña Villamor Sept 1999
		1997	X	W		W for Spain only, files provided by Begoña Villamor Sept 1999
		1998	X	W		W for Spain only, files provided by Begoña Villamor Sept 1999
		1999	X	W		W for Spain only, files provided by Begoña Villamor Sept 2000
		2000	X	W		W for Spain only, files provided by Begoña Villamor Sept 2001
		2001	X	W		W for Spain only, files provided by Fernando Ramos Sept 2002
		2002	X	W		W for Spain only, files provided by Fernando Ramos Sept 2003
		2003	X	W		W for Spain only, files provided by Fernando Ramos Sept 2004
		2004	X	W		W for Spain only, files provided by Fernando Ramos Sept 2005
		2005	X	W		W for Spain only, files provided by Fernando Ramos Sept 2006

Table 1.4.1. Checklist for North-East Atlantic Mackerel assessments

1. General

step	*Item*	*Considerations*
1.1	Stock definition	Assessments are performed for mackerel *(Scomber scombrus)* over the whole distribution area. Stock components are separated on the basis of catch distribution, which reflects management considerations and different historical information for the components rather than biological evidence: Western component: spawning in Sub-areas and Div. VI, VII, VIIIabde, distributed also in IIa, Vb, XII, XIV; North Sea component: spawning in IV and IIIa (but as the North Sea component is relatively small, most of the catches in IVa and IIIa are considered as belonging to the Western component); Southern component: spawning in VIIIc and IXa. Possible problems with species mixing *(S. japonicus)* in the Southern part of the area.
1.2	Stock structure	
1.3	Single/multi-species	Single species assessments

2. Data

step	*Item*	*Considerations*
2.1	Removals: catch, discarding, misreporting	Catch estimates are based on official landings statistics and are augmented by national information on misreporting and discarding. In the 2005 data the age structure of the discards from one fleet (Scotland) was available. This age structure was not applied to other discarded catches. Discarding is considered a problem in the fishery. Separation of the different mackerel stock components is on the basis of the spatial and temporal distribution of catches (see above). The ICA assessment in 2004 accepted by ACFM shows that the Egg Survey is estimated with a Q of 1.3, suggesting that bias in the catches or at least unaccounted mortality from all sources exceeds bias in the Egg Survey which is itself believed to be an underestimate (of very approximately 40% see Egg Survey below), leading to uncertain estimates of unaccounted mortality which is of the order of an amount equal of the reported catch. This discussed in section 2.2.1 and section 2.8.2.6 of this report.
2.2	Indices of abundance	
	Catch per unit effort	CPUE (at age) information for the Southern area only

	Gear surveys (trawl, longline)	Trawl surveys for juvenile mackerel, which give indications of recruit abundance and distribution. These are currently not used for the assessment, but did accurately predict the weak 2000 year class, and also the strong 2002 year class. The surveys have estimated the 2003 year class as mid range with the 2004 estimate higher than average. The use of these surveys needs further investigation.
	Acoustic surveys	Experimental surveys in 1999 to 2004 by Norway, Scotland, Spain, Portugal and France. Results from the North Sea have been tested in an assessment but not fully evaluated. These are not currently used in the assessment.
	Egg surveys	The triennial egg survey for mackerel and horse mackerel currently provides the only fishery independent SSB estimate used in the assessment. The survey has been conducted in the western area since 1977, and in the southern area since 1992. In its present form the survey aims at covering the whole spawning time (January - July) and area (South of Portugal to West of Scotland) for both components since 1995. The most recent survey was carried out in 2004, and used in the assessment in this year. Applied method: Annual Egg Production Method. Similar egg surveys are also carried out on a roughly triennial basis in the North Sea, but these have only a partial spatio-temporal coverage and are not currently used in the assessment An analysis carried out by Portilla for WGMEGS (ICES 2005) indicates that egg mortality which is not currently included in the survey estimates is of the order of 30%, and would lead to a corresponding underestimate of the biomass. Furthermore, an additional study by Mendiola and Alvarez (WD 2005), carried out on mackerel from the southern spawning component, indicated a faster egg development time than that used in the calculation of egg production by the WGMEGS. This was calculated to lead to an underestimate of the egg production by between 7 and 12%. These two studies indicate that the egg production might be underestimated by 40% but these estimates are very uncertain.
	Larvae surveys	None
	Other surveys	Russian aerial surveys have been conducted annually in July since 1997 in international waters in the Norwegian Sea and in part of the Norwegian and Faroese waters (Div. IIa). This gives distribution and biomass estimates, not currently used in the assessment. The aerial surveys now include Norwegian & Faroese participation.
2.3	Age, size and sex-structure: catch-at-age, weight-at-age,	Catch at age: derived from national sampling programmes. Sampling programmes differ largely by country and

	Maturity-at-age, Size-at-age, age-specific reproductive in-formation	sometimes by fishery. Sampling procedures applied are either separate length and age sampling or representative age sampling. 83% of the catch was sampled for length and age in 2005 (was 79% for 2004). Total number of samples taken (2005): 1,229; total number of fish aged:20,217; total number of fish measured: 164,593. Weight at age in the stock: Stock weights were available from national sampling programmes in 2005. Western component: based on Dutch and Irish samples from March, April and May Div. VIIbj. Southern component: based on Spanish samples in the first half of the year in Div. VIIIc. North Sea components: based on the sample catches collected by the Norwegians and Dutch during the 2005 North Sea egg survey for age classes 0-8, the weights for 9+ from the samples collected during the 2002 egg surveyThe separate component stock weights were then weighted by the relative proportion of the SSB estimates (from egg surveys) for the respective components (Western / Southern / North Sea from egg surveys in 2004 and 2005respectievely: 83.1% / 9.4% / **7.5**%). Weight at age in the catch: derived from the total international catch at age data weighted by catch in numbers. In some countries, weight at age is derived from general length-weight relationships, others use direct measurements. Maturity at age: based on biological samples from commercial and research vessels; weighted maturity ogive according to the SSB biomass in the three components. As there was no new data there was no change in the estimated maturity ogive in 2005 even though the weighting changed between the Western / Southern / North Sea component as described above.
2.4	Tagging information	Used as indicator for the mixing of the Southern and Western components; used to estimate total mortality; for exploratory assessment runs (WINBUGS ICA and AMCI).
2.5	Environmental data	Not currently used but under investigation
2.6	Fishery information	Several scientists involved in the assessment of this stock are familiar with the fishery. Most major mackerel fishing nations have placed observers aboard the fishing vessels. Anecdotal information on the fishery may be used in the judgement of the assessment.

3. Assessment model

step	*Item*	*Considerations*
3.1	Age, size, length or sex-structured model	Current assessment model: ICA Exploratory analyses: AMCI & ISVPA/TISVPA & WINBUGS ICA
3.2	Spatially explicit or not	No
3.3	Key model parameters: natural mortality, vulnerability, fishing mortality, catchability	Natural mortality: fixed parameter over years and ages (M=0.15) based on tagging data. Selection at age: Reference age 5 for which selection is set at 1. Selection at final age set to 1.2. One period of 14 years of separable constraint (including the egg survey biomass estimates from 1992 onwards). The separable period is increased by one year for each new assessment, as it is based on a perceived change in fishing pattern from 1992 onwards. Population in final year: 13 parameters. Population at final age for separable years: 13 parameters. Recruitment for survivors year: Total number of parameters: 50 Total number of observations: 173 Number of observations per parameter: 3.5
	Recruitment	No recruitment relationship fitted.
3.4	Statistical formulation: - what process errors - what observation errors - what likelihood distr.	Model is in the form of maximum log likelihood. Terms are weighted by manually set weights. Index for biomass from egg surveys is given a weight of 5 and each catch at age observation in the separable period is given a weight of 1 except 0-group, which is down-weighted to 0.01 and the 1-group which is down-weighted to 0.1. The survey biomass estimate was treated as relative from 1999 to 2005
3.5	Evaluation of uncertainty: - asymptotic estimates of variance, - likelihood profile - bootstrapping - bayes posteriors	Maximum likelihood estimates of parameters and 95% confidence limits are given. Total variance for the model and model components given, both weighted and unweighted. (weighted is currently incorrectly calculated in the model) Several test statistics given (skewness, kurtosis, partial chi-square). Historic uncertainty analysis based on Monte-Carlo evaluation of the parameter distributions. (this failed this year and was replaced by WINBUGS ICA)
3.6	Retrospective evaluation	Currently retrospective analysis is carried out (in FLICA) because the assumptions concerning the separable period have been very variable over recent years. Historic realisations of assessments are routinely presented and form a direct overview on the changes in the perception of the state of the stock. These are presented for SSB, fishing

		mortality and recruitment. The quality of the assessment was evaluated by comparing the first estimates of recruitment in a certain year with the second , the third, etc. estimates for that same year from following WG meetings. These figures indicate the precision and bias in successive estimates of recruitment.
3.7	Major deficiencies	• selection at final age not well determined • separable period changes every year • weighting for catch data much higher than for survey data (50 to 5) • weighting for survey indices and catch data are not related to variability in the data • correlation structure of parameters not properly assessed and presented • area misreporting of catch is a minor problem • In the past catches at age have been treated as being not biased, but information from many sources now indicates substantial unaccounted mortality of which an important part may be because catches could be seriously underestimated • simpler assessment models currently not evaluated • Assessment is over sensitive to recent survey SSBs

4. Prediction model(s) – SHORT TERM

step	*Item*	*Considerations*
4.1	Age, size, sex or fleet-structured prediction model	Age-structured model, by fleet and area fished. Because of the uncertainty in levels of catch these should be used only in a relative sense to indicate the direction and relative magnitude of exploitation options.
4.2	Spatially explicit or not	Not
4.3	Key model (input) parameters	Stock weights at age: average from last 3 years Natural mortality at age: average from last 3 years (fixed) Maturity at age: average from last 3 years Catch weights at age: average from last 3 years Proportion of M and F before spawning: 0.4 Fishing mortalities by age: From ICA (from 14 year separable model) Numbers at age: from ICA, final year in assessment; ages 2 to 12+ 0-group is GM recruitment whole period except last 3 years *1-group is GM recruitment applying mortality at age 0*
4.4	Recruitment	Geometric mean over whole period except last 3 years.
4.5	Evaluation of uncertainty	Uncertainty in model parameters is NOT incorporated, though sometimes a limited number of sensitivity analyses may be performed, usually with regard to recruitment level.

4.6	Evaluation of predictions	Predictions are not evaluated retrospectively (this is tricky to do in terms of catches, but some evaluation in terms of population numbers at age should be done).
4.7	Major Deficiencies	Catches are likely to be underestimated (see above) this leads to a perception that the current assessment gives biased estimates of SSB but provided the bias is sufficiently constant F maybe unbiased and trend in SSB and F will be unbiased SSB estimates from egg surveys are only available every 3 years. Assessment/Prediction mismatch: In particular, stock estimates are based on a separable model, which is then treated in a non-separable way in the short term predictions. Catch options: no unique solution for catches by fleet when management objectives are stated in terms of F_{adult} and $F_{juvenile}$. No stochasticity/uncertainty reflected in short term predictions. Intermediate year: general problem- whether to use status quo F or a TAC constraint for intermediate year Software: MFDP programme

5. Prediction model(s) – MEDIUM TERM

No medium term projections were carried out this year.

Table 1.4.2. Checklist for assessments of Western Horse Mackerel

1. General

step	*Item*	*Considerations*
1.1	Stock definition	Stock caught in divisions IIa, IIIa (western part), IVa, Vb, VIa, VIIa–c, e–k and VIIIa-e
1.2	Stock structure	No sub-populations have been defined.
1.3	Single/multi-species	Single species assessment

2. Data

step	*Item*	*Considerations*
2.1	Removals: catch, discarding, fishery induced mortality	Discards are not included but are considered not relevant. Misreporting of juvenile catch taken in VIIe,h and VIId (mostly North Sea stock). Catches outside the area covered by the TAC.
2.2	Indices of abundance	Series of tri-ennial AEPM surveys since 1983 (with a gap in 1986). Acoustic and bottom trawl surveys do not cover the entire distribution of the stock. Not used in the assessment.
	Catch per unit effort	Series of catch per unit effort fromVIIIc. Not used in assessment.
	Gear surveys (trawl, longline)	
	Acoustic surveys	French acoustic spring survey indices available (PELGAS) only covering VIIIa & b.
	Egg surveys	Total egg production estimate used in the assessment as a relative index of SSB.
	Larvae surveys	None.
2.3	Age, size and sex-structure: catch-at-age, weight-at-age, Maturity-at-age, Size-at-age, age-specific reproductive information	A large portion of the catch remains un-sampled. Catch-at-age data has improved in recent years. However, the number of age readings for some of fishing areas is not satisfactory. Proportion mature at-age data have not been provided since 1993. Weight-at-age in the stock data are based on a small sample.

2.4	Tagging information	None.
2.5	Environmental data	The availability of western horse mackerel in the Norwegian NEZ in the third/fourth quarter seems to be linked with the modelled influx of Atlantic water to the North Sea the first quarter (Iversen et.al. 2002).
2.6	Fishery information	Directed trawl fishery operated by Ireland, Denmark, Scotland, England & Wales, The Netherlands, France and Germany. Norway operates a directed purse-seine fishery. Spain operates both purse-seines and trawlers. A varying proportion of the total catch is caught in the area where juveniles are distributed (Divisions VIIa,e,f,g,h and VIIIa,b,d).

3. Assessment model

step	*Item*	*Considerations*
3.1	Age, size, length or sex-structured model	Age-structured. A linked separable VPA and ADAPT VPA model (SAD), so that different structural models are applied to the recent and historic periods. The separable component is short (currently 4 years) and applies to the most recent period, while the ADAPT VPA component applies to the historic period. Model estimates from the separable period initiate a historic VPA for the cohorts in the first year of the separable period.
3.2	Spatially explicit or not	No
3.3	Key model parameters: natural mortality, vulnerability, fishing mortality, catchability	Natural mortality is fixed at 0.15, catchability for the AEPM is estimated. The parameters treated as “free” in the model (i.e. those estimated directly) are: (1) Fishing mortality year effects for the final four years for which catch data are available; (2) Fishing mortality age effects (selectivities) for ages 1-10 (except for selectivity at age 7 which is set to 1); (3) scaling parameter for fishing mortality at age 10 relative to the average for ages 7-9 (ignoring the 1982 year-class where applicable); (4) fishing mortality on the 1982 year-class at age 10 in 1992; (5) catchability linking the egg production estimates and the SSB estimates from the model.
	Recruitment	No stock recruitment relationship is assumed.
3.4	Statistical formulation: - what process errors - what observation errors - what likelihood distr.	The estimation is based on maximum likelihood. There are three components to the likelihood that correspond to the egg estimates, catches for the separable period, and catches for the plus-group. The variance of each component is estimated. A penalty term to incorporate

		information on changes in maturity/g relative to the age-structure of the stock was included in the objective function of the 2006 SAD version.
3.5	Evaluation of uncertainty: - asymptotic estimates of variance, - likelihood profile – bootstrapping - bayes posteriors	Asymptotic estimates of variances by the inverse of the Hessian matrix.
3.6	Retrospective evaluation	Historic retrospective last performed in 2003 showed a consistent retrospective pattern.

4. Prediction model(s) – SHORT TERM

Step	*Item*	*Considerations*
4.1	Age, size, sex or fleet-structured prediction model	Given uncertainty in stock numbers and F no short-term predictions were conducted for this stock since 2003 (ICES CM 2004/ACFM:08).
4.2	Spatially explicit or not	N/a
4.3	Key model (input) parameters	N/a.
4.4	Recruitment	N/a
4.5	Evaluation of uncertainty	N/a
4.6	Evaluation of predictions	N/a
4.7	Major deficiencies	N/a

5. Prediction model(s) – MEDIUM TERM

No medium term predictions are conducted.

Table 1.4.3 Checklist for assessments of Sardine in Area VIIIc and IXa

1. General

step	*Item*	*Considerations*
1.1	Stock definition	The stock is distributed in the Iberian Peninsula. Some mixing with adjacent populations from French waters (Divisions VIIIb) and northern Morrocco is acknowledged, but is considered not to affect the assessment. The assessment is believed to reflect the dynamics of sardine in Iberian waters.
1.2	Stock structure	No subpopulations have been defined, although life-history properties indicate some heterogeneity across the stock area.
1.3	Single/multi-species	Single species assessment

2. Data

step	*Item*	*Considerations*
2.1	Removals: catch, discarding, fishery induced mortality	Discards are considered not relevant. The fishery statistics are considered accurate and landings are representative of catches. 99% of the landings are from purse-seiners.
2.2	Indices of abundance	Acoustic and DEPM (Daily Egg Production Method) surveys.
	Catch per unit effort	None.
	Gear surveys (trawl, longline)	Pelagic and bottom trawls. In some cases (opportunistically) purse seining.
	Acoustic surveys	Series of spring acoustic surveys covering the whole stock area since 1996 (gap in 2004). Two surveys, one covering the northern Spanish waters (Divisions VIIIc and IXaN) and another covering the Portuguese waters and Gulf of Cadiz (the remaining area of Division IXa) are carried out each year. Data (numbers-at-age) from the two surveys are combined (summed) in a single index of stock abundance.
	Egg surveys	SSB estimates from triennial DEPM surveys since 1997 covering the whole stock area.
	Larvae surveys	None.
2.3	Age, size and sex-structure: catch-at-age, weight-at-age,	Biological sampling of the catches is generally good. Sampling levels improved across the time series.

	Maturity-at-age, Size-at-age, age-specific reproductive information	Calibration of age readings and maturity criteria are done regularly between Portuguese and Spanish laboratories responsible for sampling. A revision of maturity and stock weights at-age for 1996 – 2005 was presented this year.
2.4	Tagging information	None.
2.5	Environmental data	No environmental data is currently used in the assessment.
2.6	Fishery information	Sardine is mainly exploited by purse-seine fisheries in both Spanish and Portuguese waters. The fishery operates across the whole area and all year round but 60% of the landings occur in the second semester. Seasonal closures of 1-2 months during winter are observed in some areas. A total of 547 vessels with lengths in the range 6-38 m and 16-1100 HP contributed to landings in 2005.

3. Assessment model

step	*Item*	*Considerations*
3.1	Age, size, length or sex-structured model	The stock is assessed using an age structured model (AMCI -Assessment Model Combining Information from various sources, Skagen, 2004).
3.2	Spatially explicit or not	No
3.3	Key model parameters: natural mortality, vulnerability, fishing mortality, catchability	Natural mortality is 0.33 for all ages and years. Both the fishery selection and survey catchability are assumed equal for ages 4 and 5. Selection-at-age is allowed to change gradually across the period using the recursive updating algorithm in AMCI, with a gain factor of 0.2 for all ages and years, providing a fishing mortality model close to separable. Survey catchability-at-age assumed constant over time. Catchability of the DEPM survey assumed constant over time. 0-group catches downweighted (0.1). Equal weights for surveys and equivalent to catch data.
	Recruitment	No stock recruitment relationship is assumed.
3.4	Statistical formulation: - what process errors - what observation errors - what likelihood distr.	No process errors are assumed. Observation errors are not assumed to follow specific statistical distributions. The objective function is a sum of squared log residuals for catch numbers-at-age, survey indices-at-age and DEPM indices of SSB (not a likelihood function).
3.5	Evaluation of uncertainty: - asymptotic estimates of variance, - likelihood profile – bootstrapping	Asymptotic estimates of variances and correlations by the inverse of the Hessian matrix. Median and 90% limits of SSB, R and F trajectories estimated by non-parametric

	- bayes posteriors	bootstrap of catch and survey residuals and log-normal parametric bootstrap (CV=0.3) of DEPM estimates.
3.6	Retrospective evaluation	One year retrospective analysis.

4. Prediction model(s) – SHORT TERM

Step	*Item*	*Considerations*
4.1	Age, size, sex or fleet-structured prediction model	Age-structured deterministic short term prediction.
4.2	Spatially explicit or not	No
4.3	Key model (input) parameters	Weight-at-age in the stock and in the catches and selection-at-age were calculated as the arithmetic mean value of the last three years (2003 – 2005). The maturity ogive corresponds to the 2005 values. Natural mortality was 0.33 and the proportion of F and M before spawning was 0.25. F_{sq} was the average F 2003-2005, unscaled.
4.4	Recruitment	The 2005 recruitment estimate was replaced by the geometric mean of 1994 – 2003 (excluding the high 2000 value). Estimates of age 1 in 2006 were recalculated, projecting this mean value with F_{age0}2005. Recruitments for 2006 and 2007 were calculated as the geometric mean recruitment for 1994 – 2004. This procedure is identical to previous years.
4.5	Evaluation of uncertainty	No.
4.6	Evaluation of predictions	No.
4.7	Major deficiencies	The outcome of deterministic predictions has a high uncertainty due to the use of assumed values of recruitment, the projection of current levels of fishing mortality and possible bias in the assessment.

5. Prediction model(s) – MEDIUM TERM

No medium term predictions are conducted.

Table 1.4.4. Checklist for assessments of Anchovy in Area VIII

1. General

step	*Item*	*Considerations*
1.1	Stock definition	The stock is distributed in the Bay of Biscay. It is considered to be isolated from a small population in the English Channel and from the population(s) in the IXa.
1.2	Stock structure	No subpopulations have been defined, although morphometrics and meristic studies suggest some heterogeneity at least in morphotipes.
1.3	Single/multi-species	Single species assessment

2. Data

step	*Item*	*Considerations*
2.1	Removals: catch, discarding, fishery induced mortality	Discards are not included but are considered not relevant for the two fleets. The fishing statistics are considered accurate and the fishery is well known.
2.2	Indices of abundance	Series of DEPM surveys since 1987 (with a gap in 1993). Series of acoustic surveys since 1983 (although not covering all the years).
	Catch per unit effort	Series of catch per unit effort for the French trawlers and Spanish purse seine fleets (although not standardized). They are not used in assessment.
	Gear surveys (trawl, longline)	Pelagic trawls and in some cases (opportunistically) purse seining.
	Acoustic surveys	French acoustic spring survey indices available since 1989 (PELGAS) (which are used in the assessment). Some previous indices are available since 1983 (before the period of the assessment). A series of Spanish acoustic autumn surveys on juveniles started in 2003 (JUVENA) for estimating the strength of recruitment for management (currently in period of testing its performance).
	Egg surveys	Daily Egg Production Method (DEPM) applied to estimate the SSB available since 1987 with a gap in 1993. Estimates in 1996, 1999 and 2003 are based on regression models of previous DEPM SSB on daily egg production and spawning area or total egg production.

	Larvae surveys	None.
2.3	Age, size and sex-structure: catch-at-age, weight-at-age, Maturity-at-age, Size-at-age, age-specific reproductive information	Biological sampling of the catches has been generally sufficient, except for 2000 and 2001. An increase of the sampling effort seems 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. Age reading is considered accurate. Cross reading exchanges and a workshop between Spain and France will take place this year.
2.4	Tagging information	None.
2.5	Environmental data	Environmental data recorded in the spring surveys encompasses: temperature, salinity, etc. Environmental indices (upwelling, stratification) affecting recruitment are reported (Borja et al. 1996, 1998; Allain et al. 2001) but with poor performance (not used in predictions of the population).
2.6	Fishery information	Two main fisheries: A Spanish purse seine fishery operating mainly in Spring and a French one using mainly pelagic trawling and operating mainly in winter, summer and autumn. A small fleet of French purse seiners fishery operates in the South of the Bay of Biscay (Spring) and in the North (2nd half of the year). See review in Uriarte et al. (1996).

3. Assessment model

step	*Item*	*Considerations*
3.1	Age, size, length or sex-structured model	The assessment model up to 2004 has been Integrated Catch-at-age Analysis (ICA). Since 2005, the stock has been assessed using the Bayesian biomass-based model. Both models are age structured. However, whereas ICA used 5 age classes in catches and 2-3 ages in surveys the biomass-based model only distinguishes age 1 biomass from the rest of the population in surveys.
3.2	Spatially explicit or not	No
3.3	Key model parameters: natural mortality, vulnerability, fishing mortality, catchability	Both in ICA and in the Bayesian biomass-based model natural mortality is fixed at 1.2, catchability for the DEPM biomass is set to 1 because it is assumed to be an absolute indicator of Biomass and catchability of the acoustic biomass survey is estimated. Furthermore in the Bayesian biomass-based model DEPM

		and acoustic surveys assumed to provide unbiased proportion of age 1 biomass estimates. In ICA fishing mortality is assumed to be separable. In the Bayesian biomass-based model catches are used as an offset and are not used for tuning
	Recruitment	No stock recruitment relationship is assumed. However, below Blim (21 000 tonnes) the possibility of a good recruitment is assumed to be diminished.
3.4	Statistical formulation: - what process errors - what observation errors - what likelihood distr.	ICA: Maximum likelihood is used. No process errors are assumed. Observation errors of the DEPM and acoustics biomass and numbers at age and of the catch at age are assumed to be log normally distributed. The likelihood functions incorporates weighting factors to translate the validity of the information used into the tuning of the assessment Bayesian biomass-based model: It is set within framework of Bayesian state-space models. Log-normal process errors for recruitment in the first period of the year (until the peak of the spawning season in mid-May) Log-normal observation errors for the total biomass from DEPM and acoustic surveys. Beta observation errors for the proportion of age 1 biomass from DEPM and acoustic surveys. Prior distributions for the catchability of the biomass from the DEPM and acoustic surveys are Log-normal, for the precision of the observation equations of biomass from the DEPM and acoustic surveys are Gamma, for the parameter defining the precision of the proportion of age 1 biomass from the DEPM and acoustic surveys is Normal, for the initial biomass is Normal, for the recruitment is Log-normal and for the parameter defining the precision of the process errors is Gamma.
3.5	Evaluation of uncertainty: - asymptotic estimates of variance, - likelihood profile – bootstrapping - bayes posteriors	ICA: Asymptotic estimates of variances by the inverse of the Hessian matrix. Bayesian biomass-based model: Bayesian posterior distributions of the parameters provide direct evaluation of the uncertainty in the assessment.
3.6	Retrospective evaluation	Not done so far

4. Prediction model(s) – SHORT TERM

Step	*Item*	*Considerations*
4.1	Age, size, sex or fleet-structured prediction	No short term prediction has been conducted for this stock in the last two years (2005 and 2006), for the unability to predict recruitment at age 1 next year (which

	model	is bulk of the population). Previously deterministic projections have been carried out based on age predictions models and using CEFAS deterministic projections (MFDP). In 2004 stochastic projections based on the Bayesian biomass-based model were explored.
4.2	Spatially explicit or not	No
4.3	Key model (input) parameters	For the deterministic projections: recruitment at age 0 in the assessment year, separable fishing mortality and catch constrain for the assessment year. For the stochastic projections: prior distribution of recruitment at age 1 and catch constrain for the assessment year.
4.4	Recruitment	Geometric mean or more precautionary levels, according to the complementary information that might be available to the WG. Due to the high variability of the incoming year recruitment, additional information for predicting recruitment is necessary. Prediction based on environmental indices is on state of refinement, however, their predictive capabilities in the last years has failed. Since 2003 Spanish autumn acoustic surveys on juveniles are conducted. However, a longer time series is required in order to assess their ability on indicating the future recruitment strength.
4.5	Evaluation of uncertainty	In 1999 short term sensitivity analysis (Cook 1993) was used. In 2004 stochastic projections based on the Bayesian biomass-based allowed to incorporate the uncertainty on recruitment based on the posterior distribution of historical series of recruitment. No forecast made during the last two years.
4.6	Evaluation of predictions	Not properly.
4.7	Major deficiencies	

5. Prediction model(s) – MEDIUM TERM

Given the short living of the species, no medium term predictions are conducted.

Table 1.8.1 Anchovy biscay, Detailed list of surveys which gather information which is useful for stock assessment

Survey name	Series commenced	Periodicity	Timing	Duration	Type	CV	Area coverage	Survey objective	Used in assessment?	Coordination with other surveys
BIOMAN	1987	Annual	Q2	3 weeks	DEPM	20-25%	Bay of Biscay, entire adult distribution	Spawning Biomass and population at age of anchovy for tuning assessment: Egg production and Daily Fecundity and lenght and age composition of anchovy	Yes	with IFREMER(PELGAS), Triennial makerel EPM and collaborates with sardine egg surveys
JUVENA	2003	Annual	Q3	3-4 weeks	acoustic	not available	95% of juvenile area distribution (South of 46ºN and East of 5ºW). Area nowadays expanded to 100% juv. Distrib.	Juvenile abundance index for the assessment and forecast of recruitment and to help management of anchovy; length and age distribution of anchovy	Not yet, but Intended, being nowadays in testing period of the survey results	Standed alone up 2005, but facilitated information to JUVAGA. In 2006 coordinates with PELACUS 06 10 in terms of inter calibration
PELGAS	2000 (1989 for reduced are	Annual	Q2	30 days	acoustic + multidis ciplinary	depending on species, <25% for anchovy	depending on considered species, 100% for anchovy	stock assessment by acoustics for anchovy, sardine, sprat and horse mackerel - Eggs distribution by CUFES for sardine & anchovy - Length distribution for all species - age distribution and genetics for sardine and anchovy - ecosystemic approach (hydrology - zooplancton - birds and mammals counting) -	yes only for anchovy for the time being	coordinated with AZTI (BIOMAN) for anchovy assessment and with IEO (spring PELGACUS) and IPIMAR (spring acoustic survey) for a global multispecific coverage
JUVAGA	2003	biAnnual	Q3	15 days	acoustic + multidis ciplinary	?	opportunistic study areas in the Bay of Biscay	understanding of mechanisms leading juveniles to recruitment	no	with AZTI (JUVENA) for real time information and better choice of studied areas
CENTINELA	2005	Ad hoc	Q4	2 weeks	Acousti c - like	not available	Bay of Biscay, (South of 47ºN and East of 4ºW	Anchovy distribution in late autumn and qualitative information on its abundance	Not. Only qualitative information	Not in principle. It was an ad hoc survey with commercial fishing vessels
PELACUS	1983	Annual (alhtough there are some years missing)	Q1/Q2	4 weeks	Acousti c and multidis ciplinary	not available	West Iberian, Cantabrian Sea, Southeast of Bay of Biscay. (From northern Portugal, Porto area, until South of France, Arcachon)	Spawning Biomass, population at age and distribution of pelagic species. Specially directed to sardine	Not in anchovy. Yes in sardine assessment	Coordination with Portuguese acoustic surveys SAR, French acoustic surveys PELGAS, DEPM sardyne SAREVA and the triennial mackerel and horse mackerel egg surveys CAREVA and JUREVA.
PELACUS10/JU VAGA	2006	Annual	Q3/Q4	4 weeks	Acousti c and multidis ciplinary	?	1st part south Bay of Biscay then 2nd part opportunistic study areas	1st part assessment of juveniles then 2nd part understanding of mechanisms leading juveniles to recruitment	not yet but the 1st part may be in the future	collaboration for the 2nd part between IEO, IFREMER & AZTI. This survey will probably replace JUVAGA

2 Northeast Atlantic Mackerel

2.1 ICES advice applicable to 2005 and 2006

The internationally agreed TAC's have covered the total distribution area of the Northeast Atlantic mackerel stock since 2001. The advice for this stock includes the three stock components: Southern, Western and North Sea mackerel. In parts of the year these components mix in the distribution area. The advised TAC is split into a Northern (IIa, IIIa,b,d, IV, Vb, VI, VII, VIIIa,b,d,e, XII, XIV) and a Southern (VIIIc, IXa) part on the basis of the catches the previous three years in the respective areas (Figure 2.1.1). The three components have overlapping distributions and a part of the Southern component is fished in the northern area.

The different agreements cover the total distribution area of Northeast Atlantic mackerel, while each agreement in some cases covers different parts of the same ICES Divisions and Subareas. The agreements also provide flexibility of where the catches can be taken.

The TACs agreed by the various management authorities and the advice given by ACFM for 2005 and 2006, as well as the WG catch estimate for 2005 are given in the text table below.

Agreement	Areas and Divisions	TACs in 2005	TACs in 2006
Coastal states agreement (EU, Faroes, Norway)	IIa, IIIa, IV, Vb, VI, VII, VIII, XII, XIV	354,942	373,535
NEAFC agreement	International waters of IIa, IV, Vb, VI, VII, XII, XIV	40,185	42,289
EU-NO agreement[1)]	IIIa, IVa,b	1,865	1,865
EU autonomous[2)]	VIIIc, IXa	24,873	26,176
Total		421,865	443,865

<table>
<tr><th>Stock compo-nents</th><th>ACFM advice 2005</th><th>ACFM advice 2006</th><th>Areas used for allocations</th><th>Prediction basis</th><th>WG catch in 2005</th></tr>
<tr><td>North Sea</td><td>Lowest possible level</td><td>Lowest possible level</td><td rowspan="2">IIa, IIIa, IV, Vb, VI, VII, VIIIa,b,d,e, XII, XIV</td><td rowspan="2">Northern</td><td rowspan="2">493,868</td></tr>
<tr><td>Western</td><td rowspan="2">Reduce F in the range 0.15 – 0.20</td><td rowspan="2">Reduce F in the range 0.15 – 0.20</td></tr>
<tr><td>Southern</td><td>VIIIc, IXa</td><td>Southern[3)]</td><td>49,618</td></tr>
<tr><td></td><td>320-420</td><td>373-487</td><td></td><td></td><td>543,486</td></tr>
</table>

1) Fixed quota to Sweden.

2) Includes 3,000 t of the Spanish quota that can be taken in Spanish waters VIIIb.

3) Does not include the 3,000 t of Spanish catches taken in Spanish waters of VIIIb under the southern TAC.

The TAC for the Southern area applies to Division VIIIc and IXa, although 3,000 t of this TAC could be taken from Division VIIIb (Spanish waters), which is included in the Northern area. However, these catches (3,000t) have always been included by the Working Group in the provision of catch options for the Northern area.

In addition to the TACs and the national quotas, the following additional management measures are advised as stated by ACFM (2005). These measures are mainly designed to afford maximum protection to the North Sea spawning component while it remains in it's present depleted state while at the same time allowing fishing on the western component while it is present in the North Sea, as well as to protect juvenile mackerel.

- There should be no fishing for mackerel in Divisions IIIa and IVb,c at any time of the year.

- There should be no fishing for mackerel in Division IVa during the period 15 February – 31 July.

- The 30 cm minimum landing size at present in force in Subarea IV should be maintained.

Various national measures such as closed seasons and boat quotas are also in operations in most of the major mackerel catching countries.

2.2 The Fishery in 2005

2.2.1 Catch Estimates

The total estimated working group catch for NEA mackerel in 2005 was 543,500 t which was almost 70,000 t lower than catches in 2004 (611,000 t). The 2005 catch corresponds to a TAC for the whole stock distribution area of 421,865 t, and represents a TAC overshoot of over 120,000 t. The combined fishable TAC as best ascertained by the Working Group (Section 2.1) agreed for 2006 amounts to 443,865 t. Of this TAC, the UK and Ireland have agreed not to fish 35,134 t.

Catches reported in this and previous working group reports are considered to be best estimates. In some cases catch figures are available from processors, and where available discard estimates are included (see 1.3.3 and 2.2.2 for further discard information on mackerel). In most cases catch information comes only from official logbook records of catches. The text table below gives a brief overview of the basis for the catch estimates.

Country	Official Log Book	Other Sources	Discard information made available to the WG[2]
Germany	Y (landings)		Y
Norway[1]	Y (catches)		
UK	Y (landings)	Y	Y
Ireland	Y (landings)		
Denmark	Y (landings)	Y (sale slips)	
Faroe[1]	Y (catches)	Y (coast guard)	
Netherlands	Y (landings)	Y	Y
Spain		Y	
Portugal		Y (sale slips)	
France	Y (landings)		
Russia[1]	Y (catches)		
Sweden	Y (landings)		

[1]In the Russian, Norwegian and Faroese fleets discarding is illegal, which means officially landings are equal to catches.

[2]Note that this column represents the countries submitting information on discarding and not the occurrence of discarding itself. For other countries there is no information available.

From this table it can be seen that discard or slipping estimates are not available from many countries, and in most cases figures are only available from the logbooks. The working group considers that the best estimates of catch it can produce are likely to be an underestimate for the following reasons:

Estimates of discarding due to high-grading or slipping are not available for most countries, and anecdotal information suggests that slipping may be widespread especially in the Q4 fishery in IVa and the Q1 fishery in VIa. Since about 1985 the Japanese market preferred mackerel that weighed more than 600g (G-6 fish) and paid considerable more for such fish. This resulted in slipping of catches when the percentage of G-6 was low. The slipped fish resulted in an extra unknown fishing mortality. Norway therefore introduced a special regulation to prevent the slipping limiting the percentage of G-6-fish. This regulation worked during 1988-2002. Since then the prices has been better for smaller fish and a special regulation was not needed.

- Confidential information suggests substantial under reported catches for which numerical information is not available for most countries.
- Reliance on logbook data from EU countries implies (even with 100% compliance) a precision of 89% from 2004 and 82% previous to this (Council Regulation (EC) No’s 2807/83 & 2287/2003). Given that over reporting of mackerel landings is unlikely for economic reasons, the WG considers that where based on logbook figures, the reported landings may be an underestimate of up to 18% (11% from 2004). Where inspections were not carried out there is a possibility of a 56% under reporting, without there being an obvious illegal record in the logsheets. Without information on the percentage of the landings inspected it is not possible for the working group to evaluate the underestimate in its figures due to this technicality. EU catches represent about 65% of the total estimated NEA mackerel catch.
- The precision in the logbook records from countries outside the EU has not been evaluated.

The total catch estimated by the Working Group to have been taken from the different ICES areas is shown in Table 2.2.1.1. and illustrates the development of the fisheries since 1969.

The total catch recorded from the North Sea (Sub-area IV and Division IIIa) (Table 2.2.1.3) in 2005 was about 252,000 t, which is 65,000 t less than the catches in 2004. There had been a trend of increasing catches in this area since 1996, but this trend reversed in the last three years with a decline in catches since 2002. Misreporting of catches taken in this area into VIa was 38,000 t. This component of the catch is highly variable and depends on the availability of mackerel to the fleet. The catches taken from Div Vb and Sub area II (54,000 t) were similar to last years’ catches but were substantially lower than in the mid to late nineties. The catch taken in the western area (Sub-area VI, VII and Divisions VIIIa,b,d,e) decreased by almost 50,000 t to around 187,500 t.

Catches in divisions VIIIc and IXa have continued to increase and are close to 50,000 t in 2005. The “Prestige” oil spill in 2003 had caused a closure of the fishery in the first quarter of that year and resulted in the lowest catches in the area for the last 10 years. Following a reopening of the fishery, catches increased in 2004 and 2005 and are now similar to levels recorded prior to the oil spill.

The total area misreported and unallocated catch during 2005 obtained by numerical methods by the WG was app. 63,000 t, which is substantially higher than the value given in for catches in 2004 by the 2005 WG. New sources of information on misreporting from the U.K have become available and resulted in a readjustment of catch figures for areas IVa and VIa from 1999 to 2004. The resulting changes in catch figures are documented in tables 2.2.1.1 and 2.2.1.3-4. This amount does not represent the full extent of unrecorded catches, but only the component for which numerical information is available. The bullet points above indicate substantial opportunities for unrecorded catches (see section 2.8.2 for further discussion on the effects of under reporting of catches on the assessment).

The quarterly distributions of the catches since 1990 are shown in the text table below.

YEAR	Q1	Q2	Q3	Q4
1990	28	6	26	40
1991	38	5	25	32
1992	34	5	24	37
1993	29	7	25	39
1994	32	6	28	34
1995	37	8	27	28
1996	37	8	32	23
1997	34	11	33	22
1998	38	12	24	27
1999*	36	9	28	27
2000*	41	4	21	33
2001*	40	6	23	30
2002*	37	5	29	28
2003*	36	5	22	37
2004*	37	6	28	29
2005	46	6	25	23

* Revised for additional unallocated catches

These catches are shown per statistical rectangle in Figs 2.7 1.1 to 2.7.1.4. and are discussed in more detail in Section 2.7.1. It should be noted that these figures are a combination of official and WG catches and may not indicate the true location of the catches or represent the location of the entire stock. Of the total catch, 46% was taken during the 1st quarter as the shoals migrate from Div. IVa through Sub-area VI to the main spawning areas in Sub-area VII. Only a small proportion of the total catch was taken in quarter 2 (6%) with a decrease in catches taken in Sub-area VII compared to previous years. In quarter 3 and quarter 4 catches were 25% and 23% of the total catches respectively with most catches taken from Division IVa. In the south, the mackerel fishery took mainly place in VIIIc in the first and second quarter (87%).

National catches

The national catches recorded by the various countries for the different areas are shown in Tables 2.2.1.2 - 2.2.1.5. As has been stated in previous reports these figures should not be used to study trends in national figures. This is because of the high degree of misreporting and “unallocated” catches recorded in some years due to some countries exceeding their quota. The main mackerel catching countries in recent years continue to be Scotland, Norway, Spain Ireland, , Netherlands and Russia. Significant catches were also taken by Denmark, Germany, France, England & Wales and the Faroe Islands (combined catch 85,000 t).

The main catches taken in IVa were recorded by Norway (106,000 t), and Scotland (73,000 t) while substantial catches were also recorded by Denmark (23,000 t) and Ireland (16,000 t). The total catch estimated to have been taken from the Western areas (Table 2.2.1.4) was ca. 188,000 t. with most of the catches taken by Scotland (72,000 t) and Ireland (30,000 t). The Netherlands have increased their catches in this area this year to 33,000 t. Germany (16,000 t), France (15,000 t) and England (11,000 t) also continue to have important fisheries in this area. The misreported catches from IVa are 38,000 t which is more than twice the levels reported in 2004 and more similar to levels reported in previous years.

2.2.2 Discard estimates

Discarding of small mackerel has historically been a major problem in the mackerel fishery and was largely responsible for the introduction of the south-west mackerel box. In the years prior to 1994 there was evidence of large-scale discarding and slipping of small mackerel in the fisheries in Division IIa and Sub-area IV, mainly because of the very high prices paid for larger mackerel (>600 g) for the Japanese market. This factor was put forward as a possible reason for the very low abundance of the 1991 year class in the 1993 catches. The difference in prices has decreased since 1994 and discarding has been reduced in these areas.

In some of the horse mackerel directed fisheries e.g. those in Subareas VI and VII mackerel is taken as by-catch. Reports from these fisheries have suggested that discarding may be significant because of the low mackerel quota relative to the high horse mackerel quota - particularly in those fisheries carried out by freezer trawlers in the fourth quarter. The level of discards is greatly influenced by the market price and by quotas.

With a few exceptions since 1978 estimates of discards were provided to the Working Group for the areas VI, VII/VIIIa,, and IV/III (Tab. 2.2.1.1) but the Working Group considers the estimates for this area as incomplete. No data about discards are available for the areas I/II/Vb and VIIIc/IXa. In 2005 discard data for mackerel were provided by three nations: Scotland, the Netherlands and Germany. Discard figures amount to app. 20,000 tonnes as the sum given by the three countries. The 2005 discard values are twice as high as figures reported in 2004.

The only discard age disaggregated data made available to the group is from Scotland and is data on the Scottish fishery in divisions IVa and VIa in the first quarter. In both divisions the majority of fish discarded were three year old fish with four and five year old discards also being abundant. In division IVa a high proportion of the discards were also one year olds (>25%). The percentage length compositions of the Scottish discards for both areas are shown in table 2.4.2.1.

2.2.3 Fleet Composition in 2005

Details about vessels operated by the different nations targeting mackerel are given in table 2.2.3.1.

In the Norwegian Sea (Sub-area II) catches are mainly taken by the Norwegian fleet (purse seiners >21 m) and Russian freezer trawlers (55-80 m) that target mackerel, blue whiting and herring at the same time.

The fishery in the North Sea, Skagerrak, and Kattegat (Sub-areas IV and III) is exploited by the Norwegian and Danish purse-seine fleets and pelagic fleets from Scotland, Ireland, Denmark, Faroes and England. Large freezer trawlers (>85m) from the Netherlands, with some operating under the German and English flags, also fish in this area.

To the west of the British Isles (sub-divisions VI, VIIb,c) catches are predominantly taken by the Scottish and Irish pelagic trawl fleet,while sub-divisions VIId-j are also fished by the English fleet and French and German freezer trawlers. The Spanish fleet operates in the Bay of Biscay (VIII) and Division IX and consists of demersal trawlers, purse-seiners between 10-32 m and a large artisanal fleet with vessels between 2 and 34 m.

2.2.4 *Scomber* Species Mixing

Scomber sp.

As in previous years, there were both Spanish and Portuguese fisheries for Spanish mackerel, *Scomber japonicus*, in the south of Division VIIIb, in Division VIIIc and Division IXa. Figure 2.2.4.1 shows the annual landings by ICES Divisions since 1982. The greatest catches came from Division IXa for the whole period. The distribution of catches in Division IXa varies from the minimum value (373 t) in 1983 to the maximum (15,717 t) in 2005. Since 2002, the highest catches correspond to the IXa South area (Table 2.2.4.1).

Table 2.2.4.1 shows the Spanish landings by sub-division in the period 1982-2005. The total Spanish landings of *S. japonicus* in 2005 were 4,184 t, showing an increasing smooth slope trend since 1999, as in the first period of the series (1982-1992). From 1993 to 1998, very high catches were obtained, with the maximum of the whole period (10,903 t) in 1994. More than 95% of the catches were obtained by purse seiners and the main catches were taken in the second half of the year, mainly in autumn (80%), when the *S. scombrus* catches were lowest. *S. japonicus* is not a target species to the Spanish purse seine fleet in these areas.

Data of monthly landings by gear and area were obtained from fishing vessel owner's associations and fishermen's associations through the existing information network of the IEO and AZTI (Advisory Organisations to Fisheries and Oceanography Administration) in all Cantabrian and Galician ports. In the ports of Cantabria and Northern Galicia (Sub-division VIIIc West) catches of *S. scombrus* and *S. japonicus* are separated by species, since each of them is important in a certain season of the year. In the ports of Southern Galicia (Sub-division IXa North) the separation of the catch of the two species is not registered at all ports, for which reason the total separation of the catch is based on the monthly percentages of the ports in which they are separated and on the samplings carried out in the ports of this area. There is no problem in the mackerel species identification in the Spanish fishery in Divisions VIIIbc and Sub-division IXa North.

In Subdivision IXa South, the Gulf of Cadiz, there is a small Spanish fishery for mixed mackerel species which had a catch of 307 t of *Scomber japonicus* in 2005. Every year, a bottom trawl survey is carried out in the Gulf of Cadiz. In 2005, catches of *S. japonicus* made up on average 66.67 % and *S. scombrus* 33.33 % of the total catch in weight of both species in the survey (M. Millán, pers. comm). From 1992 to 1997 surveys, the catch of *S. scombrus* was scarce or even non-existent (about 1% of the total catch of both species). Since 1998 to 2000, this proportion of the *S. scombrus* has progressively increased, accounting for 61 % in 2000. From 2002 to 2004 the catch of *S. Scombrus* was very scarce, as in the period 1992-1997. This proportion is used to estimate Spanish commercial catches of *S. japonicus* in this area, however, due to the uncertainties in this proportion rate, the estimated *S. scombrus* catches in the Gulf of Cádiz have never been included in the mackerel catches reported to this Working Group by Spain.

Portuguese landings of *S. japonicus* from Division IXa (CN, CS and S) in 2005 were 14,905 t, showing a similar level to the 2004 (12,425 t) and 1999 (13,877 t) catches, the highest ones since 1982. The distribution of the catches is very variable, especially those in subdivision IXa Central-South, with an alternation of increasing and decreasing steep slope trends. During the whole period, catches are higher in the southern areas than in the northern ones (Table 2.2.4.1). These species are landed by all fleets but the purse seiners accounted approximately for 65-70 % of total weight. *S. japonicus* is not a main target species to the Portuguese fleet.

Landing data are collected from the auction market system and sent to the General Directorate for Fisheries where they are compiled. This includes information on the landings per species by day and vessel. Probably, there is no misidentification of mackerel species in the Portuguese fishery in Division IXa.

Unless stated otherwise, references to mackerel in this report refer to *Scomber scombrus* only. As stated in a paragraph above, the catches from the Gulf of Cadiz have never been included in this report.

2.3 Stock Components

2.3.1 Biological evidence for stock components

No new biological evidence has been presented to assist in stock component definition for mackerel.

2.3.2 Allocation of Catches to Component

Since 1987 all catches taken in the North Sea and Division IIIa have been assumed to belong to the Western stock. This assumption also applies to all the catches taken in the international waters. It has not been possible to calculate the total catch taken from the North Sea stock component separately but it has been assumed to be 10,000 t for a number of years. This is because of the very low stock size and because of the low catches taken from Divisions IVbc. This figure was originally based on a comparison of the age compositions of the spawning stock calculated at the time of the North Sea egg surveys. This assumption has been continued for the catches taken in 2005. This figure will be revised in the Benchmark. An international egg survey carried out in the North Sea during June 1999 again provided a very low index of stock size in the area (<100,000t) (ICES 2002, G: 06)). New egg surveys in the North Sea carried out during June 2002 and 2005 and the SSB adopted at 210,000 t and 220,000 respectively, indicating an increase SSB from 70,000 t in 1999 (See Section 2.5.2).

Prior to 1995 catches from Divisions VIIIc and IXa were all considered belonging to the southern mackerel stock, although no separate assessment had been carried out on the stock. In 1995 a combined assessment was carried out in which all catches from all areas were combined, i.e. the catches from the southern stock were combined with those from the western stock. The same procedure was carried out by the 1997 - 2005 Working Groups and again by the present Working Group, - the new population unit again being called the Northeast Atlantic mackerel unit.

The TAC for the Southern area applies to Divs.VIIIc and IXa. Since 1990, 3,000 t of this TAC, which has been set at 25,000 t in 2005, have been permitted to be taken from Div.VIIIb in Spanish waters. This area is included in the "Western management area”. These catches (3,000 t) have always been included by the Working Group in the western component and are therefore included in the provision of catch options for the Northern area.

2.4 Biological Data

2.4.1 Catch in numbers at age

The 2005 catches in numbers-at-age by quarter for NE Atlantic mackerel (Areas II, III, IV, V, VI, VII, VIII and IX) are shown in Table 2.4.1.1. This catch in numbers relates to a tonnage of 543,486 t, which is the WG estimate of the total catches from the stock in 2005.

Age distributions of catches were provided by Denmark, England & Wales, Ireland, Netherlands, Norway, Portugal, Russia, Scotland, Spain and Germany. There are gaps in the overall sampling for age from countries which take substantial catches, notably France, the Faroe Islands, Northern Ireland and Sweden (amounting to a total catch of over 37,000 t) while England & Wales provide aged data for only 4% of their catches. In addition there were insufficient samples to cover Divisions IIIa, VIIb-d and VIIId amounting to a total catch of 13,000t. Minor catches from Divisions IIIb and IVb-c and VIIa with a total catch of >1,000 t were also not sampled. Catches for which there were no sampling data were converted into numbers-at-age using data from the most appropriate fleets (for further details on sampling quality see Section 1.3).

The percentage catch by numbers-at-age is given in Table 2.4.1.2. The age structure of the 2005 catches of NE Atlantic mackerel is mainly composed of 2-7 year old fish. These age groups constitute 90 % of the total. Overall, 43% of the catch was made up of three year old fish indicating that the strong 2002 year class is now dominating the catches. The year class of 2001, which was also the result of good recruitment, was less represented with 19% of the catch consisting of 4 year old fish. Age 1 fish account for only 3% of the total catch numbers, which is slightly higher than in 2004 (1%) but still substantially lower than in 2003 when, the age 1 group contributed 11% to total catch numbers. Highest proportions of 1 year olds in 2005 were caught in the English Channel (VIId-e), the eastern Celtic Sea (VIIf) and west of Portugal (IXa). The proportion of two year old fish was also low with only 9% of the catches belonging to this age group in this area.

In the southern North Sea and the English Channel (IVc and VIId,e) where mackerel are caught as a by-catch in fisheries for horse-mackerel the proportion of fish in the age range 1 to 3 was higher than elsewhere contributing up to 50 % of the total catches.

2.4.2 Length composition by fleet and country

Length distributions of the 2005 catches were provided by England & Wales, Germany, Ireland, Netherlands, Norway, Portugal, Russia, Scotland and Spain.

The length distributions were available from most of the fishing fleets and account for ca. 90% of the catches. These distributions are only intended to give a very rough indication of the size of mackerel by the various fleets and do not reflect the seasonal variations, which occur in many of the landings. More detailed information on a quarterly basis is available for most of the fleets on the working group files. The length distributions by country and fleet for 2005 catches and discards are shown in Table 2.4.2.1.

2.4.3 Mean lengths

The mean lengths-at-age in the catch per quarter and ICES division for 2005 for the NE Atlantic mackerel are shown in Table 2.4.3.1. These data continue the long time series and may be useful in investigating changes in relation to stock size. Overall, the mean length for one to seven year old fish was shorter than in the previous year.

Mean weights in the catch

The mean weights-at-age in the catch per quarter and ICES Division for NE Atlantic mackerel in 2005 are shown in Table 2.4.3.2. Compared to last year’s data mean weights-at-age are lower for the 1 -7 year age classes.

Mean weights in the stock

In this working group the mean weights-at-age are calculated with the following method: The estimated stock weights for NE Atlantic mackerel and the Western, Southern and North Sea components given in the text table below are calculated on a relative weighting, proportional to the egg production in the North Sea, the Western and the Southern areas. For the Western and Southern areas egg production of the 2004 international egg survey is used from WGMEGS (2005/G:09). The North Sea egg production is derived from the 2005 North Sea egg survey (2006/G:09). The weighting factors have changed from last year’s working group due to the inclusion of the North Sea egg production estimate in 2005.

AGE	NORTH SEA	WESTERN COMPONENT	SOUTHERN COMPONENT	NEA MACKEREL
0	0.000	0.060	0.000	0.000
1	0.114	0.163*	0.169	0.074
2	0.233	0.238	0.169	0.168
3	0.271	0.338	0.210	0.238
4	0.341	0.381	0.315	0.336
5	0.400	0.398	0.368	0.381
6	0.445	0.484	0.397	0.401
7	0.489	0.506	0.448	0.481
8	0.467	0.560	0.482	0.501
9	0.509*	0.546	0.497	0.550
10	0.606*	0.573	0.543	0.550
11	0.643*	0.597*	0.555	0.576
12+	0.550*	0.060	0.558	0.590
Weighting of stock	**0.075**	**0.83**	**0.094**	

*No age available, mean of last three years

For the 2005 western stock weights the working group uses stock weights based on Dutch and Irish mean weights-at-age from commercial catch data collected in Divisions VIIb and VIIj over the period March to May. Results were weighted by the number of observations from each country. Mean weights-at-age for the North Sea component are based on the sample catches collected by the Norwegians and Dutch during the 2005 North Sea egg survey for age classes 0-8, the weights for 9+ were taken from the samples collected during the 2002 egg survey (ICES CM 2003/G:7). For the southern component, stock weights are based on samples taken in VIIIc in the first half of the year 2005. For a complete time series on mean weights-at-age in the three components and their relative weighting for the stock weights see the 2004 WHMHSA report (ICES CM 2005/ACFM:8).

2.4.4 Maturity Ogive

The weighting for the maturity ogive for NEA mackerel is calculated as described above for the stockweights using the egg production from the 2004 international egg survey for the western and southern component and the 2005 North Sea egg survey for the North Sea component, The weighting factors have changed from last year’s working group due to the inclusion of the North Sea egg production estimate in 2005, but the effect on the overall Maturity Ogive is very small. For a complete time series on proportion mature at age (MATPROP) in the three components and their relative weighting in the stock see the 2004 WHMHSA report (ICES CM 2005/ACFM:8).

AGE	NORTH SEA[1]	WESTERN COMPONENT[2]	SOUTHERN COMPONENT[3]	NEA MACKEREL
0	0.00	0.00	0.00	0.00
1	0.00	0.08	0.02	0.07
2	0.37	0.60	0.54	0.58
3	1.00	0.90	0.70	0.89
4	1.00	0.97	1.00	0.98
5	1.00	0.97	1.00	0.98
6	1.00	0.99	1.00	0.99
7	1.00	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00
9	1.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00
11	1.00	1.00	1.00	1.00
12+	1.00	1.00	1.00	1.00
Weighting of stock	**0.075**	**0.83**	**0.094**	

[1]ICES fisheries assessment database kept constant 1972-recent, [2]Data from ICES 2001 WG, [3]Revised from 1998 onwards (WG1999 section 2.4.4).

2.4.5 Natural Mortality and Proportion of F and M

The value for natural mortality used by the WG for all components of the NE Atlantic mackerel stock is 0.15. This estimate is based on the value obtained from Norwegian tagging studies carried out in the North Sea (Hamre, 1978). The proportion of F and M before spawning for NE Atlantic mackerel is taken as 0.4. As can be seen from the text table in section 2.1, the proportion of catches taken in quarter 1 and 2 varies between the years. In 2005 the proportion of catches in quarter 1 has increased and is now 46%. The working group therefore recommends that the proportion of F and M will be revaluated for the forthcoming benchmark assessment. Assumptions on natural mortality have been explored in section 2.8.8.

2.5 Fishery-Independent Indices

2.5.1 Egg survey estimates of spawning biomass in 2004

The Working Group on Mackerel and Horse Mackerel Egg Surveys (WGMEGS) is primarily responsible for the planning and analysis of the ICES Triennial mackerel and horse mackerel egg surveys. The WGMEGS met in March this year (ICES 2006/LRC:09) to plan the next egg surveys in the western and southern spawning areas in 2007. No revisions were made to the conclusions or estimates of egg production, fecundity and SSB done during the 2005 meeting (ICES 2005/G:09):

- Total annual egg production for mackerel in the western area in 2004 was calculated as 1.2018×10^{15} eggs. This can be compared to the 1.209×10^{15} eggs in 2001.
- Total annual egg production for mackerel in the southern area in 2004 was calculated as 0.126×10^{15} eggs. This can be compared to the 0.283×10^{15} in 2001.
- The SSB of western component for 2004 was estimated a 2.468 million tonnes, with a variance of approximately 723,500 tonnes.
- The equivalent value for the southern spawning component was 280,300 tonnes with a variance of 70,900 tonnes.

2.5.2 Mackerel fecundity and mackerel atresia

No revisions are made to the fecundity and atresia calculations given in ICES (2005/G:09):

2.5.3 Quality and reliability of the 2004 Egg Survey in the light of the previous surveys

In general the quality and reliability of the egg surveys has been maintained and improved. However, there was a reduction in survey effort in 2004 compared to 2001, when additional EU funding was made available. This led to a small increase in the variance in the estimate of the egg production. While the fecundity sampling was considerably improved. The deployment of the new Gilsons free methodology made it possible to collect large numbers of good quality samples for both fecundity and atresia. The triplication and analysis in a range of laboratories improved the reliability of the estimate, which was broadly similar to that in 1998 and 2001. The WGMEGS has expressed concern about the future of the egg surveys. Despite the fact that this survey is required and funded under the minimum program of the EU data regulation COUNCIL REGULATION (EC) No 1543/2000 CEFAS have withdrawn from the survey. This entails the loss of one complete survey, and the loss of considerable experience in histological analysis. In addition CEFAS will no longer be able to provide adult mackerel at the start of the spawning season for fecundity estimation. The WG regret this decision, and hope that CEFAS may be able to review this at some point and return to the survey. The likely impact will be to decrease the accuracy of the survey and make it more vulnerable to operational difficulties. WGMHSA have shown in previous studies that this survey is the dominant factor affecting the precision of the assessment, and it is particularly important that it is continued if a three year management regime is to be considered. If the results of the survey deteriorate, the consequences will be a less precise assessment leading to greater risk to the stock and the need for exploitation at a lower fishing mortality if the same risk level is to be maintained.

The possibility of bias in the Egg Survey is discussed in the report of the WGMEGS (ICES 2005). The report states that the WG has always considered that the egg production estimates, from which the SSB is derived, were likely to be underestimated. This is firstly because the total spawning area and season is probably not completely covered during the different surveys. Secondly, and probably more importantly, the egg production estimate is not adjusted for egg mortality in the 1A and 1B stages used to derive biomass. An analysis carried out by Portilla for this group WD 2005 indicates that this mortality is in the order of 30%, and would lead to a corresponding underestimate of the biomass. Furthermore, an additional study by Mendiola and Alvarez (WD 2005), carried out on mackerel from the southern spawning component, indicated a faster egg development time than that used in the calculation of egg production by the WGMEGS. This was calculated to lead to an underestimate of the egg production by between 7 and 12%. These two studies indicate that the egg production might be underestimated by around 40%. Section 2.8 has examined some of the issues raised by this work.

2.5.4 Results from the 2005 mackerel egg survey in the North Sea

Netherlands (“Tridens”) and Norway (“Johan Hjort”) carried out an egg survey giving an egg production of $155*10^{12}$ eggs corresponding to a SSB of 223,000 tons standard fecundity 1401 eggs/g/female observed in 1982 (Adoff and Iversen, 1983. A new fecundity study was carried out based on samples collected in the North Sea in 2005. The fecundity was estimated at 1359 oocytes/g/female (ICES, 2006/LRC:09). This is 3% lower than that observed in 1982. The egg productions and corresponding SSB since 1980 are given in Table 2.5.4.1.

The next egg survey in the North Sea is planned to take place in 2008.

Both “Tridens” and “Johan Hjort” trawled mackerel during the survey. The combined age distribution was weighted according to the egg production obtained in the areas covered by the two vessels and the numbers of North Sea spawners by age were calculated (Table 2.5.4.2).

How to include the SSB in the North Sea in the NEA mackerel assessment will be revisited next year when NEA mackerel is up for a benchmark assessment.

2.5.5 Southern component: CPUE from bottom trawl surveys

There are two survey series: The Spanish September-October survey and the Portuguese October survey. The two sets of Autumn surveys covered Sub-divisions VIIIc East, VIIIc West and IXa North (Spain) from 20-500 m depth, using Baka 44/60 gear and Sub-divisions IXa Central North, Central South and South (Portugal), from 20-750 m depth, using a Norwegian Campell Trawl (NCT), that is a trawl net having a 14 m horizontal opening, rollers on the ground-rope and has been fitted with a 20 mm mesh size cod end. The same sampling methodology is used in both surveys but there were differences in the gear design. The Spanish survey used a bottom trawl gear called “Baka” (similar to the gear normally used in these waters by the commercial trawl fleet) aimed at benthic and demersal species, therefore the scope of the survey must be kept in mind, regarding the validity of the abundance indices obtained for pelagic species. In addition, no work is carried out at less than 80 m depth, which results in an incomplete coverage of the whole area of mackerel juvenile distribution. Comparative data analysis of Baka and GOV gears are described in Section 2.7.2.

Table 2.5.5.1 and **Figure 2.5.5.1** show the numbers at age per half hour trawl from the Spanish bottom trawl surveys from 1984 to 2005 in September-October and the numbers at age per hour trawl from the Portuguese bottom trawl autumn surveys from 1986 to 2005. Both are carried out during the fourth quarter when the recruits have entered the area and the adults are very scarce in this area. The historical series of abundance indices from the Spanish trawl surveys indicates that 1992, 1996, 1997, 2000, 2002 and 2005 were those with the highest values of juvenile presence (0 and 1). The series of the Portuguese October survey shows very high values of recruitment (age 0) in 1988, 1992, the period 1995 to 1999, 2001 and 2002. These peaks reflect local abundance. See next section 2.5.6 for the use of this information as recruitment index.

2.5.6 Preliminary Analysis of Quarter 4 Western Bottom Trawl Surveys as recruit index.

An extensive investigation of potential use of the 0 group surveys was carried out. Initially the data were analysed by national survey, by stat rectangle and latitudinal area. The survey series has gaps and changes in survey intensity over time. The best indications of recruitment (compared with the current assessment) were obtained when the stations were treated as identically distributed independent estimates of abundance, and a simple mean of all stations. This suggests that the random error associated with encounter with mackerel is the overriding dominant source of variability, and differences between survey catchability and spatial effects are less important. Figure 2.5.6.1 illustrates the time series. The early part of the series is sparsely populated (some surveys are missing) and poorly resolved, this could be due to either low frequency of occurrence of large values (except 1985) due to lower station numbers, or a shift in performance. From 1991 onwards the survey appears to be more stable, though station numbers only settle down by 1994. Analysis was carried out from 1991 onwards.

A simple regression analysis is illustrated in Figure 2.5.6.2 and potential recruit estimates for 2004 and 2005 are given. It can be seen that the r^2 is poor and the estimates for these two years depend heavily on the single large value. The scatter of data indicates that high values in the index can indicate high recruitment, and low values are indicators of low recruitment, (see 2000, 2002 and 2003 values in Figure 2.5.6.1)

An alternative approach is to consider that the rank of the survey index is a better indicator of the rank of the recruitment. While rank correlation does not improve *per se*, the process more or less resolves large, small and intermediate values without the problems needed in a direct classification to a small number of categories. The process is

$$R_y = ranked[R_{ICA} i][nt[Rank[I_y] * Y_{ICA} / Y_{survey}]$$

Where R_y is recruitment in year y, R_{ICA} is the recruit series (without the last two years) from ICA, Y_{ICA} and Y_{survey} are the number of years in ICA and the survey series.

A scatter plot of estimated recruitment and realised recruitment is illustrated in Figure 2.5.6.3, a regression line is included to show the relationship implied, For indication estimated values for 2004 and 2005 are placed on the diagram assuming no error in the estimates (on a 1:1 line).

A retrospective analysis of this method is shown in Figure 2.5.6.4.

The performance is summarised in the text table below. Using the 2006 assessment as a reference the performance of the recruitment estimates from analytic retrospectives are compared for the 7 preceding years. Two metrics are used, mean bias between the estimates of 0 group in both terminal and preceding years, and the route mean squared error (RMSE) between the estimates of 0 group in both terminal and preceding years. These are presented for four options. 1) The assessment directly (which has already been rejected), 2) the use of geometric mean, (the current method) 3) replacement of only 0 group in the terminal year, 4) replacement of 0 group in both terminal and preceding year. While the values in the table can be compared across methods, their relative importance is difficult to assess. To facilitate this, the differences have been scaled by the observed recruitment values over the same period. The bias is expressed as a percentage of mean recruitment over the 7 years, and the RMSE is expressed as the percentage of the variability in recruitment expressed relative to the standard deviation of the recruitment.

	ASSESSMENT	REPLACE TERM 0,1 WITH GEOMEAN	REPLACE TERM YEAR WITH RANK 0	REPLACE TERM YEAR WITH RANK 0,1
Bias	1,981,755	144,611	837,416	227,880
MSQ Err	5,655,070	6,850,448	2,132,149	1,985,119
Rel Bias	49%	4%	21%	6%
Rel Variability	204%	101%	77%	71%

Use of the assessment data directly is clearly the worst decision and has been correctly rejected by the WG. Replacement of both 0 and 1 group by geometric mean has been the least biased method over the last 7 years, but it does not explain any of the variability. Replacement of only 0 group gives 20% bias but reduced deviation from the assessed recruitment. The use of replacement of both 0 and 1 group increases the bias by 2% but reduces the variability by a modest 30%. Most interestingly this performance is much better in the last four years (see Figures 2.5.6.1 and 2.5.6.4c) and because, unlike an assessment, the survey is not subject to retrospective revision, this improvement may continue.

In conclusion, the current replacement of recruits using the geometric mean is supported over use of assessment data. For the future, the rank based recruit index method looks promising; it is intrinsically unbiased relative to the assessment, and has the useful property of being unable to give previously unrealised recruitment. Currently recruitment in 2004 and 2005 are both estimated as well below geometric mean by the unreliable assessment and well above geometric mean by the recruit index (see Figure 2.5.6.3. The next two years provide a good opportunity to assess the performance of this index.

2.5.7 Mortality estimates from tag recaptures.

A Working document by Skagen (WD 14/06) describes the most recent update of mortality estimates from tag recaptures. Norway has conducted a tagging programme on mackerel for more than 30 years. Each year, a number of mackerel (normally about 20 000) have been tagged with internal steel tags on the spawning grounds West of Ireland in May. Tags were previously mostly recovered from fish meal factories, where they were extracted with magnets from the fish meal. In recent years, most recovered tags come from selected landing sites, where metal detectors are installed at the conveyor belts.

Mortalities between consecutive tag releases can be derived without knowing the amount of fish screened for tags, hence the whole material of recovered tags could be used. Such estimates only consider the fractional representation of tags from two different releases in subsequent recaptures, within the same year class, and therefore are independent of how the fishery is performed and where and when the fishery takes place, unless that leads to different representation of tags released in two consecutive years within the same year class.

Calculations were done by year class. The age of each released tag was derived from length and age-length keys at tagging time. Age of recaptured tags was either measured directly if otholiths were available, if not, it was derived from the age at release as estimated from the length at release.

A detailed description of the method is given in WD 15/06. In short, the total mortalities was calculated according to the Jolly-Seber principle as:

$$Z(y_i,y_j,a_i) = log\{\Sigma r(y_i,y_k,a_i)/\Sigma r(y_j,y_k,a_j)*R(y_j,a_j)/R(y_i,a_i)\}$$

where $R(y_i,a_i)$ is the number of tags that were released in year y_i at age a_i, and $r(y_i,a_i,y_k)$ be the number of such tags that are recaptured in year y_k. .

To obtain measures of the uncertainty of the estimates, bootstrapping was done at two stages of the process:

1) For recaptured tags where age at recapture was not available, length at release time had to be converted to age using the age length key from the release. Hence, each fish would contribute to several year classes. In the bootstrap, each fish was given an age by drawing randomly from the age distribution at length in the age-length key.

2) Each raw number $r(y_i,y_k,a_i)$ was assumed to be Poisson distributed, and substituted by a random number drawn from a Poisson distribution with the raw estimate as parameter.

Data for one year mortalities $(y_j=y_i+1)$ are presented here. No tags were released in 1987, i.e. mortalities for 1986 and 1987 could not be estimated.

The results are presented here as mean ± standard deviations of the annual total mortality over the age range 4-8. More detailed results are given in the WD. There are some strong year effects, probably due to variable mortality in the tagging process, and recent trends can hardly be inferred from these data. The general impression is that Z has fluctuated mostly in the range 0.3 – 0.4, which is slightly below what one would expect from the analytic assessment (mean Z estimated by ICA over the period covered is 0.4)

2.5.8 Biomass estimates from tag recaptures.

Last year, a working document by Antsalo & al described estimates of stock biomass from tag recaptures. This study indicated that the spawning biomass has declined gradually over time, but that this trend may have been reversed at the end of the 1990s. They also suggest that the biomass is larger and has fluctuated more than estimated by the ICA assessment. No new information is available on this subject this year.

2.5.9 Acoustic estimates of mackerel biomass

In September 2001 during the WGMHSA meeting it was suggested to establish The Planning Group on Aerial and Acoustic Surveys for Mackerel (PGAAM) with the main purpose to coordinate a number of surveys on pelagic species that could provide information on the distribution and abundance of mackerel; to standardize the procedure of surveys and to utilize the findings of the EU SIMFAMI project to provide tools to identify mackerel echo-traces. The PGAAM met four times and detailed results of the PGAAM have been presented in its group reports for the years 2002–2005. In 2006 the PGAAM disbanded and the relevant terms of reference have been passed to the PGNAPES and PGHERS from 2006.

None of the acoustic surveys are considered to cover the entire stock and therefore they are not used in the routine assessment as indicators of abundance. There are also methodological problems still unsolved, for example related to inaccessibility to acoustics when the mackerel is spread instead of forming distinct schools, and how target strength is influenced by behaviour. A time series of at least 5-6 years will be needed before the data can be used to tune the assessment. However, they do give useful information of abundance and distribution within localised areas. Biomass estimates for mackerel are very sensitive to the uncertain target strength used.

At the last PGAAM meeting (2005) it was suggested that WGHMSA should consider the use of acoustic survey data as tuning indices for the assessment of the mackerel stock. The WG considers that this should be investigated as part of the benchmark assessment at the 2007 WG meeting.

2.5.9.1 Acoustic survey in the North Sea

Mackerel has been measured acoustically by Norway in October-November in the Northern North Sea each year since 1999. In this season, the fishery is concentrated in this area. The results of these surveys were summarised in a Working Document by Korneliussen & al, presented to the PGAAM in May 2005 but were revised late 2005 – see Section 2.7.5. Details of the spatial distribution are given in Section 2.7.4. The biomass estimates are given in Table 2.5.9.1. These estimates cannot be taken as absolute for a number of reasons: The target strength for mackerel, and its relation to mackerel behaviour, is poorly known. Mackerel that is scattered without forming distinct schools will not be recorded. In the samples used both for converting integrated acoustic abundance (s_A) to biomass and to obtain age distributions, large fish are likely to be under-represented. Obtaining samples by pelagic trawling was problematic, and samples from the commercial purse seine fleet operating in the area at the time of the survey showed a mean length about 5 cm larger than the samples by the research vessel trawl.

2.5.9.2 Acoustic estimates of mackerel in the Iberian Peninsula and Bay of Biscay

Mackerel has been measured acoustically by Spain in March-April in the North and Northwest of Iberian Peninsula since 1999. Mackerel are abundant in this area in spring, when they come to the area to spawn. Details are available in the working document on acoustic surveys (Iglesias et al., 2005, WD to WGMHSA 2005). The results of the 2001 to 2006 surveys are presented in this study, leaving the re-evaluation of the 1999 and 2000 surveys pending.

In all years, mackerel are distributed throughout the whole area surveyed, and the highest concentrations are found in Division VIIIc (Table 2.5.9.2), coinciding with the main spawning ground in the Southern Area (ICES 2005). Mackerel abundance has varied considerably from

2001 to 2006, with higher values in 2002 and 2003 coinciding with a high abundance of juveniles (Table 2.5.9.3). Regarding biomass, a maximum was reached in 2002 (1,534,793 t) with a large reduction in 2005 (409,493 t) followed by a further large reduction in 2006 (146,572 t) with respect to 2003 and 2004 (907,814 t and 945,619 t respectively) values. Estimates from the 2006 survey were revised after the survey was finished, as an error in the on-board calibration of the echosounder was detected. The fall in abundance and biomass registered in the last two years, as Figure 2.5.9.1 shows, may be partly because the dates on which the survey was carried out were the latest of the whole series (April). Historically, the commercial catches of this species have usually come mainly in March and April, with a peak in the latter of the two months (Villamor et al. 1997; ICES 2005). Nevertheless, from 2004 onwards, and even more markedly in 2005 and 2006, catches were mainly taken in March (64% in 2005 and 70% in 2006), while catches in April fell sharply (by 18% in 2005 and by 16% in 2006). Another important detected fact is the increase of catches in February and even in January in 2006. This may suggest that in those most recent years, possible temporary shifts in the mackerel migration to the Southern component spawning area has occurred. Their arrival and their post-spawning northward migration seem to be earlier than in previous years, although biological studies are necessary to confirm this. If so, this fact may have had an influence on the detection of the species and on the low estimate of its biomass in 2005 and 2006 compared with previous years, since the survey was conducted on these dates.

The IPIMAR surveys have not so far been used to develop biomass estimates for species other than sardine, due to the lack of targeted fishing. In the future it is hoped that attempts will be made to carry out more targeted hauls, with the aim of producing biomass estimates for other species than sardine. However, due to the low mackerel abundance and the tendency to be mixed with other species, it is unlikely that a reliable acoustic abundance index may be obtained for this species.

The IFREMER annual survey in the French Biscay area is targeted at all pelagic fish resources. However, in that area mackerel are widely scattered and mixed in with the plankton and other fish. This lack of aggregation into schools, combined with the low target strength value and the difficulty of acoustic separation means that estimates of biomass are still very difficult to derive.

2.5.10 Conclusions to fishery independent data

The mackerel Egg Survey currently provides the best source of tuning data for the assessment. Altogether, there is evidence in these fishery independent measurements that the NE Atlantic mackerel stock is underestimated by the current analytic assessment.

2.6 Effort and Catch per Unit Effort

The effort and catch-per-unit-effort from the commercial fleets is only provided for some fleets in the southern area.

Table 2.6.1 and **Figure 2.6.1** show the fishing effort data from Spanish and Portuguese commercial fleets. The table includes Spanish effort of the hand-line fleets from Santoña and Santander (Sub-division VIIIc East) from 1989 to 2005 and from 1990 to 2005 respectively, for which mackerel is the target species from March to May. The Figure also shows the effort of the Avilés and A Coruña trawl fleets (Sub-division VIIIc East and VIIIc West) from 1983 to 2005. The effort of the Avilés trawl fleet has not been available since 2004. The Spanish trawl fleet effort corresponds to the total annual effort of the fleet for which demersal species are the main target. The Vigo purse-seine fleet (Sub-division IXa North) from 1983 to 2004 for which mackerel is a bycatch is also presented. In 2003, the effort of the Spanish fleets was lower due to the spatial and temporal closure during the first and the second quarter imposed by the presence of oil in the water, due to the *Prestige* oil spill. The effort of the hand-line fleet showed an increasing trend from 1993 to 1998. Since then, the trend has been variable, with a decrease in 2004 and 2005 with respect to 2002. The effort of the trawl fleets is rather stable during all periods with a smooth decreasing trend especially since 1995. The purse-seine fleet effort fluctuated during the period presented here.

Portuguese mackerel effort from the trawl fleet (Sub-division IXa Central-North, Central-South and South) during 1988 - 2001 is also included. The effort for this fleet varied between the lowest value (38,719 fishing hours) in 1994 to the highest one (86,020 fishing hours) in 1998. 1992 and 2001 also showed high effort values. Since 2002 the effort data has not been available.

Figure 2.6.2 and **Table 2.6.2** show the CPUE corresponding to the fleets referred to in Table 2.6.1. The CPUE of the Spanish hand-line fleets shows an increasing general trend, with ups and downs through the whole series. In 2005, the CPUEs of the handline fleets show the highest values of the two series, Santoña and Santander hand-line fleets. The CPUE of the trawl fleets, like the hand-line fleets, presents an increasing general trend, especially since 1995 and more noticeably for Avilés fleet, although this is not reliable because catches of this fleet have been estimated since 1994. A Coruña trawl fleet, with a smoother increasing slope, shows a maximum CPUE value in 2005. The CPUE of the Portuguese trawl fleet is variable, with a decreasing trend and the maximum value in 1991 and the minimum in 1998. The CPUE of the purse-seine fleet shows fluctuations during the period 1983 to 1995 and since 1996 to 2002 the CPUE of this fleet has shown an increasing trend. In 2003 a fall was seen in the CPUE of this fleet, slightly increasing in 2004.

Catch-per-unit-effort, expressed as the numbers fish at each age group, for the hand-line and trawl fleets is shown in **Table 2.6.3**.

2.7 Distribution of mackerel in 2005 – 2006

2.7.1 Distribution of commercial catches in 2005

The distribution of the mackerel catches taken in 2005 is shown by quarter and rectangle in Figures 2.7.1.1 – 4. These data are based on catches reported by Denmark, Faroes, Germany, Ireland, Netherlands, Norway, Portugal, Russia, Sweden, Spain and the UK. In these data the Spanish catches are not based on official data. Not all official catches are included in these data. The total catches reported by rectangle were approximately 494,000 tonnes including Spanish WG data, the total working group catches were 543,486 tonnes. The main data missing from this series are from France and Belgium, who did not supply this data to the WG.

First Quarter 2005 (251,730 t)

There was twice as much area mis-reporting between Divisions IVa and VIa in 2005 than in 2004, giving apparent large catches just west of 4^{o} W. The overall distribution of catches remained similar from 1995 to 2005, with the majority of catches along the western shelf edge between the Celtic Sea and Shetland, concentrating north of Scotland. The continuing location of catches along the shelf suggests that the pattern and timing of the pre-spawning migration has remained relatively constant over the last decade. Fishing also continued in the western Channel (VIIe), the southern Celtic Sea (VIIh) and SW of Brittany (VIIIa). In the southern area catches were concentrated along the coasts of northern Spain and Portugal (VIIIc, IXa). The catch distribution is shown in Figure 2.7.1.1.

Second Quarter 2005 (30,479 t)

Catches in this quarter have fluctuated considerably in the last five years. A steady decrease was seen from 2000 to 2003 with an increase in 2004. There was a decrease in 2005. The general distribution of catches was broadly similar to 2004, with the main catch area being along the north of the Iberian Peninsula. Catches in the Bay of Biscay, and Iberian Peninsula were lower than in 2004. The catch distribution is shown in Figure 2.7.1.2.

Third Quarter 2005 (137,025 t)

The general distribution of catches was similar to 2004, with the main catches being taken in international waters (IIa) and off the Norwegian coast (IVa). Catches decreased in the international waters (IIa) from last year due to quota restrictions, and unlike in the previous two years the offshore catch was slightly more concentrated along the south-eastern edge. The extent of fishing off Norway was lower than in 2004. Some catches continue to be taken in the Skagerrak and also off Cornwall. Scattered catches on the western side of the British Isles and in the Iberian area were quite similar to recent years. The catch distribution is shown in Figure 2.7.1.3.

Fourth Quarter 2005 (124,253 t)

The general distribution of catches did not change between 2004 and 2005. Most catches were taken in the area west of Norway across to Shetland. Catches west of Shetland decreased in scale compared to 2004. There were almost no catches taken west of Scotland, continuing a recent trend in this quarter, but catches west of Ireland were similar to those between 1999 and 2003. Catches seen in the English Channel were again reduced in 2004 indicating a further reduction of the fishery in this area. Catches in the southern North Sea also declined further from 2004 catches. The catch distribution is shown in Figure 2.7.1.4.

2.7.2 Distribution of juvenile mackerel

Surveys in winter 2005/2006

Data is presented to this WG from 2005/2006 and is shown in Fig.2.7.2.1-6. They are derived from the mean catch rates h^{-1} rectangle $^{-1}$ from following bottom trawl surveys: Portugal (Q4), Spain (Q4), France (Q4), Ireland (Q4), Scotland (Q4), Scotland (Q1) and Norway (Q1).

Fourth Quarter 2005

Age 0 fish in quarter 4, 2005 (Fig 2.7.2.1)

- Catch rates were highest across the area extending from the NW of Ireland to the NW of Scotland, and the distribution was more extensive than for the previous few years. However there were few recruits in the Celtic Sea compared to 2004. Rates increased from 2004 to 2005.
- In divisions VII and VIII catch rates were considerably lower than in 2004, with very low abundance in the Celtic Sea. However, more fish were close to the French coast than in 2004.
- Catch rates were double those of 2004 in northern Portugal,.

Age 1 fish in quarter 4, 2005 (Fig 2.7.2.2)

- In the Celtic Sea catch rates were low in most areas but appeared to be slightly higher than in 2004. In the Bay of Biscay reasonable numbers were caught along the French coast, but rates were slightly lower than in 2004.
- Catch rates off NW Ireland, NW Scotland and the Hebrides were double those of 2004.

The bottom trawl surveys have picked up both strong and weak recruiting year classes that have been seen to follow through into the adult catches. Increased catch rates in the 2005 surveys suggest a further improvement in recruitment to the reasonable recruitment seen in 2004. These data should be considered in conjunction with the first quarter and first winter data (see Figs. 2.7.2.5 and 2.7.2.6) presented below.

First quarter 2006

Age 1 fish in quarter 1, 2006 (Fig 2.7.2.3)

- High catch rates were recorded off NW Ireland, N and NW of Scotland and off the Hebrides. Catch rates were similar from 2004 and are more similar to the levels noted in 2003.
- Low catch rates were recorded between Shetland and the Norwegian coast, but the area coverage was more restricted than in 2005.
- No data were available from the Celtic Sea in time for WGMHSA.

Age 2 fish in quarter 1, 2006 (Fig 2.7.2.4)

- Catch rates off NW Ireland/Hebrides area were ten times higher than in 2004.
- In the North Sea very weak catch rates were encountered compared to 2005. The area coverage was more restricted than in 2005

As in previous years the data for the two quarters have also been merged to provide a picture over the entire area for which data were available. As the fish change age on the 1st of January, these fish are described as first and second winter fish (figures 2.7.2.5 & 6).

It should be noted that not all these surveys use the same survey gears. Most surveys in the western area use an IBTS GOV trawl (although with various non-standard modifications). The Irish surveys have historically used a smaller version of the GOV, but now use a standard one. The Portuguese gear is quite similar to the GOV. The Spanish surveys in the Cantabrian Sea use the *Bacca* trawl. This is towed slower and has a much lower headline height, and has a very low catchabilty for young mackerel. The conversion factor calculated in the EU SESITS project for this gear, against the GOV was 8.45. This correction has not been applied to date for the data used here, but will be considered for future use.

As noted in previous reports, the coverage of the western area in the fourth quarter remains reasonably good. The gaps in the area west of Ireland are now surveyed. Most of the inner part of the Celtic Sea/Western Approaches is also being surveyed.

The WG notes that there are still problems in the delivery of these data for inclusion in the WGMHSA report. These surveys were able to detect the weak 2000 year class in 2000/2001 and the large 2002 year class in 2002/2003, much earlier than they have shown up in the catches. Early warning of recruitment failures or success would seem critical for a 3 year assessment/management cycle for this species (for further discussion on the use of the trawl surveys as a recruitment index see section 2.5.6).

Therefore, all nations carrying out bottom trawl surveys in the western area or the northern North Sea are requested to provide the mackerel recruit data for Q4 surveys by the end of January 2007 and for Q1 surveys by the end of May 2007, to John Simmonds, together with their best estimates of their full survey time series.

2.7.3 Distribution and migration of adult mackerel

In previous years (see 2004 WGMHSA report) the WG explored information on the timing of the migration of adult mackerel from IVa to the west at the onset of the spawning migration. In this update year no new information was presented on the timing of this migration. It is therefore unknown if the timing of this migration has changed in 2005.

2.7.3.1 Commercial trawl survey in the Norwegian Sea in 2005

A survey was carried out in the Norwegian Sea by two Norwegian commercial vessels from 15 July-6 August 2006. Figure 2.7.3.1 shows the distribution of mackerel superimposed on sea surface temperature (SST) and there is a very obvious preference by mackerel for the warmer water masses. The mackerel were mainly feeding on *Calanus finmarchicus* and were distributed in Atlantic watermasses south and east of the front area. The dominating year classes were 2001 and 2002.

2.7.4 Aerial surveys

No Russian summer aerial and acoustic surveys for pelagic species in the Norwegian Sea were carried out in 2006. However scientific observers collected biological samples for the pelagic species in the area onboard commercial vessels. These data can be used for biological and stock assessment purposes and will be presented to the 2007 WGMHSA meeting.

2.7.5 Acoustic surveys

Four acoustic surveys were carried out on mackerel. None of these surveys are considered to cover the entire stock and therefore they are not used in the routine assessment as indicators of abundance. However, they do give useful information of abundance and distribution within localised areas. Biomass estimates for mackerel are very sensitive to the uncertain target strength used. The surveys were:

- An acoustic survey by the Institute of Marine Research, Bergen in October/November 2005. This mainly covered the area between the Viking and Tampen Banks (north/central IVa) but scouting surveys covered a wider area (approx. 59 o - 62o N and 1oW - 4o 30’E This survey was a continuation of surveys from 1996-2004, with the main purpose of finding distribution of Atlantic mackerel during fall annually, and to estimate abundance through acoustic methods.
- An acoustic survey by IEO in ICES Divisions VIIIc and IXa in April 2006.
- Portuguese acoustic surveys by IPIMAR in March and November.
- French acoustic surveys by IFREMER in April/May

The IMR survey showed that the mackerel distribution in 2005 was grossly similar to 1999 – 2004, although with a slightly more Southerly distribution (Figure 2.7.5.1) and most of the schools were observed in Norwegian waters along the western side of the Norwegian trench. The acoustic biomass estimate of 348 thousand tonnes in 2005 was close to the 2004 estimate, but lower than in most previous years (Table 2.5.9.1). The ship covered only the Norwegian waters in 1999 and in 2002.

The abundance estimates were recalculated for all years, using a consistent methodology. Variance estimates were generated by bootstrap, with resampling of all single-mile sA values for each statistical rectangle. This was done to account for the clustering of schools, as it has been experienced that a large proportion of the total estimate relies on a very small number of single-mile registrations. The point estimates presented are the mean values of these bootstrap results.

There may be a potential problem of gear selectivity affecting the acoustic estimates. During these surveys the mackerel have been sampled with a small pelagic trawl (20 m opening) at a speed of 3-3.5 knots, and the age, length and weight have been measured for use in the biomass estimation. Slotte et al. (WD in PGAAM 2005) have demonstrated that the size, both in terms length (mean length and length-at-age) and condition (weight-at-length), of mackerel caught in the research vessel trawl hauls is significantly lower than that observed in the purse seine catches from nearby commercial vessels. By using data from purse seine caught mackerel instead of the trawl caught ones, the biomass during 1999-2003 increased by 30 % on average. These results also signify the importance of being careful with using research vessel trawl haul samples in any biological study concerning variations in growth and condition of high speed swimming species like mackerel.

As in 2003 and 2004, there was no sharp thermocline in the eastern part of the northern North Sea. Rather, the water was warm in the whole water column. Mackerel was found in the whole water column, while when there is a thermocline, the mackerel is normally found above it.

The IEO survey mainly aimed at the assessment of the sardine stock seem to be a good indicator of the biomass of the mackerel (Iglesias et al., WD 2005) in Divisions VIIIc and IXa in March and April. The methodology for the estimation of mackerel biomass by acoustic methods in the study area has now been standardised. The high abundance of this species in the Atlantic-Cantabrian Sea area during these months and their particular behaviour, with schools and aggregations close to the bottom, permits their detection by means of scientific echosound and fishing trawls for the purposes of identification with relative ease. The TS/L relationship used was the same as in the North Sea and as recommended by PGAAM. The use of several frequencies, mainly 38 and 120 kHz, helps in the identification of the echotraces of this species, above all when they are masked by plankton or bubbles. In the all surveys a reading threshold of echograms of -60 dB was chosen.

In 2001-2006, mackerel are distributed throughout the whole area surveyed (Figure 2.7.5.2), and the highest concentrations are found in Division VIIIc, coinciding with the main spawning ground in the Southern Area (ICES WGMHSA 2005). Since 2005, highest concentrations seemed to have moved towards the West, especially in 2006. Also, as we see in biomass by length class distribution (Figure 2.7.5.3), years 2005 and 2006 show extremely low values. An earlier post-spawning northward migration could be the reason, as it was mentioned in section 2.5.9.2., so that the maximum concentration of individuals in the area, do not match with the acoustic survey. Biomass by age class (Figure 2.7.5.4) for the whole Spanish area (VIIIc and IXa North) reflect a strong year class in 2002 (age 1 in 2003) and also in 2001 (age 1 in 2002), albeit less than in 2002, a weak year class in 2000 (age 1 in 2001) and also in 2004 (age 1 in 2005).

The age structure of the surveys is similar to the current perception of the age structure of the Northeast Atlantic mackerel stock, with a poor year class in 2000 while the year classes of 2001 and 2002 appear to be above the mean (ICES WGMHSA 2005). The similarity between the age structure of the survey and those of the catches used in the assessment indicates that the survey may potentially be a good candidate for use as an independent index of the fishery. On the other hand, it may also be a good candidate to be used as an index of recruitment to age 1, since the survey seems to detect year classes quite well.

The IPIMAR surveys have not so far been used to develop biomass estimates for species other than sardine, due to the lack of targeted fishing. In the future it is hoped that attempts will be made to carry out more targeted hauls, with the aim of producing biomass estimates for other species than sardine. However, due to the low mackerel abundance and the tendency to be mixed with other species, it is unlikely that a reliable acoustic abundance index may be obtained for this species.

The IFREMER annual survey in the French Biscay area is targeted at all pelagic fish resources. However, in that area mackerel are widely scattered and mixed in with the plankton and other fish. This lack of aggregation into schools, combined with the low target strength value and the difficulty of acoustic separation means that estimates of biomass are still very difficult to derive.

FUTURE of mackerel surveys. For the time being, the most important information from acoustic surveys relates to area distribution of mackerel. Using this information in assessments would require a more comprehensive coverage. This is problematic both because the area is very large, and because the behaviour of mackerel in some areas makes it difficult to measure. Hence, for the time being, it does not seem appropriate, from an assessment perspective, to recommend extension of acoustic surveys for mackerel as a high priority, in particular if that leads to lower priority to egg surveys. Future management regimes as outlined in Section 2.15 will require fishery independent information. Acoustic surveys may become more important in that context.

2.8 Data and Model Exploration

2.8.1 Introduction

This section provides an exploration of some of the data and modelling issues for NE Atlantic mackerel. It deals first with the uncertainty in the absolute level of the catch because there have been efforts to improve enforcement and to obtain data on some aspects of missing catch. This section looks first at estimates of underreporting from UK and examines the influence on the assessment. Then estimates of natural daily mortality of mackerel eggs have been examined and found to be significantly different among years. These data are then used to explore potential levels of missing biomass through unaccounted fishing mortality or natural mortality used in the assessment, though both intrinsic and extrinsic error analysis, using the ICA assessment normally used for NEA mackerel and a Bayesian implementation. Finally, to conclude the missing biomass components section, the Bayesian version of ICA is used to explore potential long term differences in catch or M using tag mortality data.

Exploration of the assessment is carried out with ISVPA and the Bayesian ICA, and Section 2.9 details the currently agreed update assessment using ICA.

2.8.2 Changes in catch and perception of stock following enforcement changes in UK

In October 2005 Scottish fisheries regulation enforcement officers obtained information from fisheries processors and found discrepancies between the official declared landing and the tonnages reported as processed by the factories.

Against this background, this WD explored:

- the extent of missing Scottish catch through data available from a number of sources, including the Sea Fish Industry Authority (SFIA) funding levy and the factory records obtained from Scottish Executive,
- the influence on the 2005 assessment of including these additional catch figures

Underreported catches

Several estimates of under reporting are available; each provides only point estimates though agreement between them is good. The Scottish Executive records are the landing records representing approximately 60% of the catch in Scotland from 2001 to 2005. The factor is derived from the sum of the tonnages declared in the original and amended records by year. A total of 950 records of mackerel landings were used. The SFIA levy is a tonnage based tax used to provide support for the SFIA and is taken on both UK landed and imported catches processed by UK processors. The levy is reported quarterly and may not be linked directly to quarterly landings as it is paid intermittently in arrears, though over time (the 6 years used) the totals should correspond. The levy is based on both herring and mackerel and is not reported separately by species. The factor is based on total landings into the UK of mackerel and herring and total declared landings into the UK. It is assumed that underreporting is a similar factor for both species. It is assumed that all the underreported landings are into Scotland. This assumption has a negligible effect on the totals. The details were provided in a WD to the WG (WD 11/06). Here only the results are reported.

The mean factor for Scottish landings into Scotland is obtained from the mean of the sources of observations. In 2002 to 2005 this is thought to be a good representation of the information. For 2001 there is greater uncertainty, the Scottish Executive factory inspectorate data may be for only part of the year and the differences are more considerable, nevertheless the mean has been used. For 1999 and 2000 there are no Scottish Executive factory inspectorate data and as the correspondence from the three sources in 2002 to 2005 was good, the available data have been used.

In addition to landings into UK, Scottish vessels also land abroad. There are few data on the validity of such landings, though what data there are, coming from the observer program, suggest landings are largely recorded correctly. The amount of landings into the UK and abroad fluctuates over years (Figure 2.8.2.1). It can be seen that the dominant feature of the destination for landings is the shift by the Scottish fleet from landing abroad, from 2000 to 2004, to landing into Scotland. There are almost no landings into England, Wales and Northern Ireland, and the English fleet lands abroad, usually into The Netherlands. There is a small foreign landing into Scotland, mostly Ireland, which, according to the Scottish Executive factory inspectorate data, is also subject to similar levels of underreporting as the Scottish component, however, this rather small amount has not been included in the analysis as no age data was available.

To obtain complete factors to account for all underreporting the destination of landings is combined by year with the factor estimated for Scottish landings, assuming that landings abroad are correctly reported. The resulting overall annual factor for underreporting by the Scottish mackerel fleet is given in Figure 2. This corresponds to an average of 1.3 times total landings which is about an additional 9% to the total catch of mackerel.

Effect of underreporting on the mackerel assessment

The influence of the underreporting on the assessment has been investigated by adding in additional catch-at-age, amending the mean weight-at-age and the total catch in tonnes, and carrying out an assessment using the 2005 WG data and model settings. Two scenarios for 1999 to 2004 were tested, one using the annual factors from Figure 2.8.2.2, the other the mean value of 1.3; the results were indistinguishable. These values correspond to a change of between 8 to 9% in total catch. There is uncertainty in the extent of underreporting prior to 1999 and there are no data available, so no certainty can be given to factors prior to this date. To investigate the sensitivity of the assessment and management information a small number of scenarios were tested, these involved declining or increasing the factor prior to 1999, with a minimum where underreporting declines to zero in 1998, or a maximum where it doubles in 1998. The underreporting factors by year are given in Figure 2.8.2.3.

The catch-at-age and mean weight-at-age in the assessment were modified with the factors given in Figure 2.8.2.3. The results of the assessments are given in Figure 2.8.2.4. The values of mean F4-8 are relatively insensitive to the changes, lying in all cases between 0.28 and 0.3. The magnitude of the changes in the historic stock size depends directly on the extent of underreporting (Figure 2.8.2.5), the higher stock coming from the greater underreporting factors. Recent history is very similar for all scenarios. The stock is always shown to be at its lowest in 2002, and shows similar changes in the last two years in all cases. However, because the underreporting can revise both current and historic estimates the scenarios were examined for changes in SSB relative to 1983, the year when the stock was previously at its lowest point. It is SSB in that year (or approximately that year) that provides the B_{loss} value used for B_{pa}. In all cases the SSB in the terminal year lies at between 0.84 and 0.92 of the SSB in the

'Bpa year'. Thus the 2005 WG conclusion that the stock was below Bpa in 2004 holds under all scenarios.

One of the reasons why the assessment, and particularly the fishing mortality, is insensitive to this level of underreporting is because one of the reasons for choosing the current assessment model was its relative insensitivity to this level of underreporting. The inclusion of additional landings also influences the model fit. Figure 2.8.2.6 shows the change in fitted sum of squares for different scenarios. Overall the model fits best when the greatest amount of historic underreporting is included, but the improved fit is contributed by the separable model, and the improvement may be caused more by adding increased catch from a single fleet rather than because of any improvement in the true fit. The survey fit improves with the addition of the underreported catch with a reduced historic scenario but the change in SSQ is small.

2.8.3 Exploratory analysis of missing biomass in NE Atlantic mackerel

The changes introduced by incorporating Scottish underreporting are small relative to the underlying impression of missing biomass by the Mackerel Egg surveys (WGMHSA, 2005).This section covers the initial data exploration of potential differences in missing catch or changes in natural mortality that might explain the abundances indicated by the egg surveys. The next section (2.8.4) collates all the information available and provides the best estimates of catch and natural mortality that can be obtained from the data. Here to try to quantify the extent of missing biomass and its potential to be explained by catch or natural mortality two methods were used;

3) Q factor between assessment and egg survey including egg mortality was estimated with the ICA model. In this case the amplitude probability distribution of values derived from an analysis of variance was used, this is termed an intrinsic error analysis.
4) The second method was a Bayesian approach using the same population model equations as ICA fitted using MCMC methods in WINBUGS (Anon 2004) (see section 2.8.8), In this case a Natural Mortality multiplier, (QM) and missing catch factor, (QC) were estimated together and separately, this is termed an extrinsic error approach.

2.8.3.1 Egg Mortality

The information on mortality which is common to both methods is drawn from the PhD. by Enrique Portilla [e.portilla@napier.ac.uk]. This thesis is currently being prepared for publication. Portilla (2006) has provided annual estimates of mean daily instantaneous mortality for the Western Survey area with standard errors. These are presented here in Table 2.8.3.1. It can be seen from this table that the annual daily mortality rates are significantly different in different years, suggesting that annual values are preferable to a mean value across years. There were insufficient resources to evaluate the total mortality by year for the 5 years, but the required annual total mortalities can be estimated by scaling the annual estimates by the total mortality mean for the period (available in Table 2.8.3.2 taken from Portilla (2006)). The across years mean total mortality of 0.37 experienced by eggs estimated by the survey can be compared with across years mean daily egg mortality rate of 0.48. Thus the total mortality which includes the length of time at stage is estimated as 0.77 times the daily mortality rate (ratio of 0.37 to 0.48), this value was used to rescale the annually varying estimates of daily mortality rate to give annually varying total mortality. For 2004 where no separate annual estimate was available the mean value of 0.37 was used directly. These values all derived from the Western Survey data were assumed to be representative of the slightly larger area for the full NEA Mackerel and used to determine the mean total mortality to be applied to the estimates of SSB from the Mackerel Egg Surveys used by WGMHSA(ICES 2005).

Much of the analysis reported below depends on the correct estimation of mortality (within its precision). Reported values of egg mortality are very diverse across areas and species (Bunn et al 2000), however, Ware and Lambert (1985), cited in Bunn et al, report a value of daily mortality of mackerel eggs at 0.44 which is very similar to the one found here (0.48). While the overall mortality has been estimated with sufficient precision to show that it differs from year to year, it has not been possible to estimate stage specific mortality and there is a possibility that because of this the estimates of SSB may be biased. For example Dickie-Collas et al (2003) report potential differences in mortality at stage, they indicate a significant possibility of lower mortality at stage I than at stage II in plaice, but they did not estimate the extent of the difference. If this reduced mortality at stage I was to occur for NEA mackerel, this would result in lower biomass estimate than the one used here. In contrast Mendiola and Alvarez (2005) in a WD to WGMEGS reported around a 7 to 12% underestimation in development time at stage, this effect would lead to greater estimates of egg production and greater SSB by these factors. So there are arguments for bias in both directions. All the subsequent analyses using this data explicitly include the variability in the estimates but do not allow for bias due to stage dependence or bias due to development rate errors. Nevertheless because there is no possibility of zero mortality over two days of development and the all the egg mortality is only responsible for half of the difference in SSB it is likely that the overall discrepancy reported here will be of the same order as that indicated in the analyses given below.

2.8.3.2 **Intrinsic error analysis**

Simmonds et al. (2003) provided estimates probability distributions of of SSB from the mackerel egg survey, these were estimated through Total Annual Egg Production, estimated Fecundity and estimated Atresia, but without including egg mortality. All these parameters were derived from station data from the Western Survey and then rescaled to represent probability distributions of the full NEA mackerel population. To simulate potential estimates of SSB from the egg survey including egg mortality the distribution of values produced by Simmonds et al. (2003) was combined with mortality estimates derived from a normal distribution with the mean and standard error given in Table 2.8.3.1 and rescaled to total mortality with the factor of 0.77. The CV due to the mortality estimate is around 5% compared with 24% for the estimates of TAEP, 1% for Fecundity and 3% for Atresia (Simmonds et al. 2003).

The error in the estimates of numbers of eggs still dominates the errors in the estimate of SSB but errors in mortality are the next most important component in the estimation process.

There are two components to the ICA assessment that directly affect the SSB. First, total landings, which have been found to be in error and probably are still be in error, and second, M, which is assumed in the current assessment to be 0.15. If mean M and total catch were known there is an expectation that the assessment would estimate the same SSB as the Egg Survey within the precision of the estimates. One method to determine the extent of the unaccounted biomass is to use the assessment to estimate the missing catch factor under varying assumptions of M. To this end the ICA model with 2005 WG settings was fitted to the simulated survey values with M set to 0.1, 0.15, 0.2 and 0.25. The estimated Q is then effectively approximately the missing catch factor under these assumptions of M. However, the ICA assessment failed to fit to the data in some cases, 100% fitted when M=0.1, 1% failed for M=0.15, the normal setting, rising to 7% and 26% as M was increased to 0.2 and 0.25 respectively. Only a negligible number would fit at M=0.3. A very reliable relationship between Q at M=0.25 and Q at M=0.1 was found (Figure 2.8.3.1) and the spread of values suggested there was a relationship between the estimated Q and the failure to fit. The straight line relationship shown in Figure 2.8.3.1 was used to estimate potential Qs for the failed fit.

2.8.3.3 Extrinsic error analysis (MCMC Bayesian)

The population model used in ICA, a 13 year separable VPA, was implemented in WINBUGS. The code was validated in R by comparing the population estimates and likelihood value when the fitted ICA values were used to initiate the model. The routine was tested through minimization in R and found to give slightly different results at a slightly lower sum of squares of residuals than ICA, but the differences were not substantial. Fuller details of the model are included in section 2.8.8.

Uninformative priors were used for all input parameters in the initial model and the model converged in around 4,000 iterations (Figure 2.8.3.2). Three chains were checked to ensure sufficient dispersion of starting data and that convergence had been reached. Once converged the model was run for an additional 10,000 iterations and the data used to estimate the missing catch was taken from all tree chains from sample 5,001 to 10,000. First the model was fitted with a proportionality factor, QMES, for the Mackerel Egg Survey. Then this parameter was set to unity and two additional parameters were added, QM and QC, multiplying factors for M and for Catch. Five runs were used to estimate missing catch alone, with M set to fixed values of 0.1, 0.15, 0.2, 0.25 and 0.3; in all cases QC was estimated using uninformative priors. QC was then set to unity and M was estimated with uninformative priors. A single run with an informative prior on M was also run again with an uninformative prior on QC. The prior used for M was a Normal distribution with mean 0.15 with CV of 0.075, truncated at M=0.1.

2.8.3.4 Results of Exploratory analyses for estimates of missing biomass

2.8.3.4.1 Results of Intrinsic Error Analysis

Results from the intrinsic error analysis are presented in Table 2.8.3.3, for estimates with and without the estimates for the values of Egg Survey that failed to fit. The resulting Missing Catch Factors can be seen as box plots in Figure 2.8.3.3 and percentiles in Table 2.8.3.3. The percentiles in brackets are those estimated without fitting from values of Q at lower M when ICA failed to fit. If no value in brackets is shown the percentiles are indistinguishable. Except for M= 0.25 all estimates of the missing catch factor show values significantly greater than 1 (i.e., there are significant amounts of missing catch). The median estimate for missing catch falls from a factor of two for the current assumed value of M=0.15 to about 1.4 at M=0.25 or rises to 2.3 at M=0.1.

The model fit and resulting Catch Factors are compared in Table 2.8.3.4 for the survey and for the full model. The poorest fits tend to be associated with the highest factors, suggesting that missing catches above a factor of 2.5 are unlikely. There are, however, a wide range of possibilities at low sums of squares. The fit is not heavily dependent on the chosen value of M. Table 2.8.3.4 shows there is a very small decline in the fitted sum of squares for decreasing M, this is driven by SSQ for survey, and the weighted SSQ for catch is almost flat. The reduction in SSQ with changing M is small, at 4 % in the fit to the full model. This improved fit is also indicated by the increased failure to fit the model at higher M. In order to check for the most likely outcome among a range of options of catch or M, the ICA algorithm was set up in a spreadsheet and checked to agree with ICA to better than 4 decimal places. Differences at this level are thought to be due to different optimization routines. The fit to the new Mackerel Egg Survey using the median of the 1,000 simulated values was tested under a range of proportionality factors for the Egg Survey, Catch, and M; the results are given in Table 2.8.3.5. This again suggests that the best fits are obtained when Catch factors are increased and M is decreased. However, the power of the analysis is poor and in all cases adding explanatory terms to the model reduces the power of the fit. In the absence of other information to the contrary this generally supports the possibility of the same or lower M and of higher levels of catch.

2.8.3.4.2 Results of Extrinsic Error Analysis

The results from the Bayesian MCMC fit to ICA are given in Table 2.8.3.6, for different priors on Qs for Mackerel Egg Survey (QMES), Catch (QC) and M (QM). If the catches are set to be absolute (QC=1) and M is set to 0.15, QMES is estimated at between 1.5 and 2.2. If QMES is set as absolute and M set to 0.15, the catch Q is estimated as being between 1.9 and 2.2. Only by increasing M to 0.3 can catches have a significant chance of including unity or the additional 9% of missing catch derived from the Scottish catches discussed above. If catches are constrained to be correct, QC=1, M is estimated as between 0.28 and 0.38. For completeness when both M and Catch Qs are both estimated, the model gives estimates of M that are close to the lower bound of the prior, and gives estimates of catch factors of between 2.8 and 3.2. This range depends on the exact nature of the lower bound on M, but these values are close to the upper limit.

Both the intrinsic and extrinsic error analyses conclude that the missing catch is significant though the intrinsic error analysis gives slightly different wider intervals and slightly lower median values for missing catch factors. This supports the general approach and this was then extended with the inclusion of tag mortality data.

2.8.4 Concluding estimates of SSB, missing catch and levels of natural mortality.

The Bayesian ICA model (see section 2.9) was extended in the WG to include estimates of mortality at age estimated from tags (Table 2.8.4.1), for years 1984, 1985, 1988-2002. This model was used with the egg survey data including total egg mortality, to estimate a missing catch factor (QC) and a multiplier for natural mortality (QM), assuming constant factors over the time series. The period with concurrent data from the egg survey and the tags was 1992 to 2002, this period will therefore dominate the conclusions, though the factors are assumed to apply throughout.

To ensure appropriate weight in the fitted model, variances were estimated for tag and separable model separately. The egg survey was assumed to fit with the catch data with a weight of 5 times the catch information as used in the standard ICA.

It can be seen in Table 2.8.4.1 that the mortality estimates are noisy, It was decided to fit the tag data without smoothing so that the variability could be estimated and used in the likelihood.

In all cases except for estimating the multiplier on M, uninformative priors were used. Figure 2.8.4.1 shows the comparison between prior and posterior for QM (the multiplier on M).

The model converges by 5,000 iterations and data from after this period are used to estimate parameters. There are reasonable estimates for QM and QC at 0.72 and 2.4 respectively (Table 2.8.4.2). The distribution around the mortality multiplier (QM) estimates is approximately twice as wide as that around the catch. The total mortality (mz) is estimated as about 0.34 (Table 2.8.4.2). The information strongly supports the inference that the currently used natural mortality may be a little too high as it has only a 16% probability of being too low. There is only a 5% chance of catches, (or mortality due to fishing) being lower than 1.6 times or 60% unreported for catch up to 2004. The stock size (SSB) is given in Table 2.8.4.3 and Figure 2.8.4.3a. The mean fishing mortality (Fbar 4-8) are given in Table 2.8.4.4 and Figure 2.8.4.3b. The fishing mortality is estimated as being very similar the that in the ICA assessment, largely because the model assumptions are similar. However, the SSB and catches are scaled to explain the missing biomass indicated by the survey and in agreement with the total mortality from the tags. The analysis indicated that the most likely level of missing mortality due to fishing is around a factor of 2.4 or 140% of catches to 2005.

The exact levels are rather poorly estimated, however, there is strong evidence of substantial unaccounted mortality, and that this much more likely to be due to catches rather than natural mortality. In this context the 9% found in Scotland is only a small part of the total. It is considered important that advice on the fishery be given with these issues in mind.

2.8.5 Summary of inferences from independent measurements of the stock

Fishery independent measures are described in sections 2.5 and 2.7. Information relevant to the assessment is summarised here. The recent estimates of egg survey SSB (Section 2.5.2) indicate a slight decreasing trend over the period 1992 to 2004, and indicate that the biomass is substantially lower than that indicated by the ICA assessment. The tagging data (Section 2.5.7) indicate that the level of the total mortality is line with what is estimated in the analytic assessment. No clear time trend of the mortality can be seen in the tagging data, but they are not suited to detect recent changes in mortality. Biomass estimates from the tag material (Section 2.5.8) indicate that the biomass is well above what is estimated in the ICA analytic assessment (using the index as either absolute or relative), that it has decreased throughout the 1990s but that it may have been increasing in the most recent years. Acoustic surveys (Section 2.7.9), on the other hand, suggest an overall declining trend in biomass in the Northern North Sea since 1999, but with some year-to-year variation.

2.8.6 Log catch ratios

In the 2004 Working Group meeting a benchmark assessment was carried out for NEA mackerel. Therefore, in ICES (2005 ACFM:08) extensive information is available on the analysis of log catch ratios. The main conclusion was that no increasing trend in F could be observed for the recent period. There is a discrepancy that is difficult to explain between the increasing trend in F from the run with the SSB index as relative and information from the log-catch ratios that does not indicate any increasing trend in F.

2.8.7 Exploratory assessment with ISVPA

Exploration runs with ISVPA (TISVPA) were made using similar settings as last year (age range from 0 to 12+; year range from 1972 to 2006; two selection patterns were fitted: 1972-1988 and 1989-2006; an unbiased model description in terms of residuals in logarithmic catch-at-age was ensured). The so called “mixed” version of the model, assuming errors both in catch-at-age data and in separable representation of fishing mortality (more precisely - of exploitation rates) giving equal was used.

The difference was that the “triple-separable” version of the ISVPA model - TISVPA - was also used. This version allows to take into account possible cohort-dependent peculiarities in selection pattern originating from possibly different interaction of different cohorts with fishing fleet, or by possible errors in aging of some cohort or by some other unclear reasons. This version of the model was first presented at the ICES Working Group on method of fish stock assessment (2006). In a few words, the model now can represent fishing mortality coefficients (more precisely – exploitation rates) as a product of three parameters: f(year)*s(age)*g(cohort). Different ways of normalization allow to get sub-models of two mechanisms of changes in selection pattern (or two sub-versions with respect to g-factors):

1 - model of “within-year effort redistribution by ages”

(normalization of s(a,y)=s(a)*g(cohort) to 1 by sum is hold for each year)

2- model of “gain (loss) in selection”

(only s(a) are normalized to 1 by sum, but not s(a,y)).

The first sub-model assumes that in each year more fishing-attractive cohorts borrow some amount of fishing effort from other cohorts by increasing its selection at the expense of diminished selections for other age groups in this year. The second one assumes that some cohorts has increased (or reduced) selections, but it does not cause direct change in selections for others. The first submodel was in used in exploration runs

An additional normalization (matrix of all g-factors is normalized to 1 by average, for details – see Appendix) is used in the model to balance the model parameters estimation procedures.

In the model the generation-dependent g-factors can be applied not to all age groups, but to some age “window”. This helps (1) to be closer to real situations (when it is known that only some range of age groups have peculiarities in their distribution) and (2) to diminish the influence of age groups having data of lower quality (usually - youngest and oldest ages). For age groups which are outside the chosen age range, the g-factors are stated to be unit, but in fact, as a result of global normalization of all g-factors to unit by average, they can get somewhat different values.

For mackerel data the age range for estimation (and application) of g-factors giving the best fit was found to be 0-8. It is illustrated by Figure 2.8.7.1, representing profiles of catch-at-age components of the model objective function for various choices of age ranges for estimation of g-factors.

Respective minima of the components of the model objective function for egg surveys and catch-at-age are in similar positions (see Figure 2.8.7.2)

Figure 2.8.7.3 compares the residuals in logarithmic catch-at-age for ordinary (“double-separable”) ISVPA and for TISVPA. As it can be seen, the generation- dependent factors effectively exclude cohort effects from residuals having place in the first half of years of the data.

Figure 2.8.7.4 shows the estimated values of g-factors and the selection matrix. The age-dependent (s(a)) components of the selection matrix for two periods are shown on Figure 2.8.7.5.

Despite of apparently better approximation of catch-at-age data by TISVPA in comparison to ordinary ISVPA, the results of assessment are not strongly influenced by g-factors (see Figure 2.8.7.6). Both versions of the model show the expected earlier increase in SSB due to abundant 2002 year class.

Figures 2.8.7.7 and 2.8.7.8 represent the results of retrospective runs and the bootstrap-derived estimates of confidence intervals. Retrospective runs show that the more “recent” is the assessment the higher is the estimate of 2002 year class abundance.

The results of NEA mackerel assessment by means of ISVPA are given in Tables 2.8.7.1-2.8.7.4.

As it can be concluded from experiments made using the ISVPA model in its traditional form which uses ordinary separable representation of fishing mortality, as well as with its “triple-separable” form which takes into account possible generation-dependent factors in selection pattern, moderate cohort effect in catch-at-age residuals for NEA mackerel data does not constitute a significant problem for assessment of this stock by means of separable cohort models.

2.8.8 Exploratory assessment using WINBUGS version of ICA.

As indicated above WINBUGS provides a framework for the fitting of models within a MCMC Bayesian framework. While the running of models within WINBUGS is slower than some other modelling methods, writing the code is quicker and implementing the MCMC components is not required. In addition some standard diagnostics are already implemented. The WINBUGS scripting control allows for automated model runs and the CODA software for R allows simple extraction of the data in a moderately efficient way. The model code (equations and observation calculations) is given in Table 2.8.8.1, this code has been numerically evaluated in R by putting converged values of the estimated parameters from ICA in as starting values and checking that the results in terms on N and F at age and the estimated likelihood agree to 5 figures. The only difference is that instead of weighting 0 group in the catches at 1/100 of normal weight this age group in the catch has been ignored in the likelihood. While the model has been numerically validated and it provides some advantages over ICA through incorporation of other factors and errors, it is currently regarded as a preliminary model of the stock.

For this implementation mimicking ICA all the priors used in this fit are uninformative. The model convergence is illustrated in Figure 2.8.8.1. The Metropolis data selection which shows the proportion of chain values retained, shows quite a lot of variability in comparison to similar plot for the similar model in Figure 2.8.3.2, which suggests some difficulties in fitting the model. The increased difficulty is probably because there is no egg survey value for the terminal year. The within and among chain variance criteria (Gelman Rubin statistic) do converge, the red line is asymptotic to unity and both blue and green lines are asymptotic (Figure 2.8.8.1b), The three chains converge by around 5000 iterations (Figure 2.8.8.1c). Bayesian P value calculated for the model give a value of 48% which suggests the model over 30,000 iterations per chain represents the data reasonably well.

The Q on the egg survey (QMES in Figure 2.8.8.2) is estimated at 1.35, which, as expected, is very similar to the value estimated by ICA. Figure 2.8.8.3 shows the estimated selection pattern in the 14 years of the separable selection pattern for the fishery. The SSB, Fbar 4-8 and recruitment are given in Tables 2.8.8.2-4 and Figures 2.8.8.3. The correlation between SSB and Fbar in the terminal year is seen to be considerable (see Figure 2.8.8.4). This assessment model gives similar results to ICA. It has been used with additional parameters in Sections 2.8.3 and 2.8.4. The other advantage of this model is the explicit inclusion of distributions of all parameters estimated. This framework has been particularly useful in examining other aspects in Sections 2.8.3 and 2.8.4

2.8.9 **Conclusions to data and model exploration**

This year in addition to the catch and egg survey data traditionally used in the assessment, tag data has been included in then analyses and has allowed us to obtain estimates of total mortality and separate to some extent estimates of F and M. In conclusion, there is considerable evidence of additional unaccounted mortality well above the levels uncovered in the UK. There is little evidence that the natural mortality used in the assessment is too low, with only a 16% probability of an under estimate on M. The analysis indicates that unaccounted mortality attributed to fishing has a 95% probability of being greater than 1.6. This issue needs to be borne in mind when giving management advice (see section 2.13 Management considerations).

The exploratory assessments with ISVPA and Bayesian ICA do not show important differences in perception of the stock from the standard ICA (see Section 2.9). The exploratory runs TISVPA support the use of a separable model. While some development using these assessment tools may be applicable to a benchmark, in an update year, the WG considers that the ICA assessment is appropriate.

2.9 Stock Assessment

2.9.1 State of the Stock

This is an update assessment.

Tables 2.9.1.2-7 show the input data to the assessment. The possible inputs for ICA have not been discussed because an update assessment is applicable this year to NEA mackerel. The change in the inputs used in ICA this year relative to other years is given in Table 2.9.1.1. The only change compared to last year is:

1. The period of separable constraint was increased from 13 to 14 years to include the SSB index time series over the period 1992-2005
2. The landings data was updated to account for partial miss reporting (see section 2.8.2)

It is important to note that Section 2.8 describes the details of the model selection and the sensitivity to biases in the data; other aspects of uncertainty in the assessment of NEA mackerel are discussed in Section 2.9.2.

ICA fits to the catch-at-age data and the egg production estimates were used to examine the relationship between the indices and the catch-at-age data as estimated by a separable VPA. The model was fitted by a non-linear minimisation of:

$$\sum_{a=0}^{a=11}\sum_{y=1992}^{y=2005}\lambda_a(\ln(C_{a,y}) - \ln(F_y.S_a.\overline{N}_{a,y}))^2 +$$

$$\sum_{y=1992}^{y=2005}\sum(\ln(EPB_y) - \ln(Q\sum_a N_{a,y}.O_{a,y}.W_{a,y}.\exp(-PF.F_y.S_a - PM.M))^2$$

subject to the constraints

$S_5 = 1.0$

$S_{11} = 1.2$

where

$\overline{N}$ - mean exploited population abundance over the year.

N - population abundance on 1 January.

O - percentage maturity.

M - natural mortality.

F - fishing mortality at age 5.

S - selection at age over the time period 1992–2005, referenced to age 5.

λ - weighting factor set to 0.01 for age 0, to 0.1 for age 1 and 1.0 for all other ages.

a,y - age and year subscripts.

PF, PM - proportion of fishing and natural mortality occurring before spawning.

EPB - Egg production estimates of mackerel spawning biomass.

C - Catches in number at age and year.

Q - the ratio between egg estimates of biomass and the assessment model of biomass.

Tables 2.9.1.8 and 2.9.1.9 present the estimated fishing mortalities, and population numbers-at-age. Tables 2.9.1.10 and Figures 2.9.1.1–2.9.1.3 present the ICA diagnostic output. Figure 2.9.1.5 is a bubble plot of the catch at age residuals. The stock summary is presented in Table 2.9.1.11.

Figure 2.9.1.5 shows the catches from 1972 to 2005, the F(4-8) from 1977 to 2005, the recruitment from 1972-2005, the GM recruitment for 2005 and the SSB from 1980 to 2005, together with the egg survey SSB's from 1992 to 2005. In ICES (2005/ACFM:08 section 2.8) is explained why different year ranges have been used.

2.9.2 **Reliability of the Assessment and Uncertainty estimation**

The presented assessment in Section 2.9.1 is to be viewed with some caution. Section 2.8 on the data exploration and modelling provides extensive information on the aspects of the reliability of this assessment. 2.8.9 summarizes the conclusions of sections 2.8.2 – 2.8.8.

According to the assessment, the NEA mackerel stock has been relatively stable in the earlier period up to 1992, but then decreased gradually, and is now showing some indication of increasing biomass (Figure 2.9.1.6).

This year it was not possible to use ICA to investigate the precision of the assessment, since the bootstrap facility in ICA was unable to reach a final result (crashed). This is a problem encountered before in ICES working groups and is usually associated to assessments with large uncertainties, like the current mackerel assessment. Some comparable inference on the precision of the assessment may be drawn from the Bayesian version of ICA given in section 2.8.8. The precision of the SSB given in Table 2.8.8.1 suggests a CV of 44% this year, the year before the next egg survey is regarded as the least precise in the time series. The CV on the mean F is similar at 51%. However, these estimates still assume that reported catches and landings are accurate. The assessment is probably less certain than reflected by these variance estimates.

The SSB, F(4-8) and recruitment estimates as obtained by analytic retrospective (1998-2006), are shown in Figure 2.9.2.1. Although the recent evaluations of long-term trend in biomass are consistent, the change in 2000 reflected the reduction in egg survey estimates to 4 instead of 5 and shows the sensitivity of the last 5 years to the value obtained in 2004. The exploratory analyses (section 2.8) highlighted the potential considerable unaccounted mortality, assuming constant factors applied to catch or to natural mortality. This analysis, jointly with the investigations in last years working group, show that under these constant conditions F is estimated without bias.

The estimates of recruitment (Figure 2.9.2.1) are shown only for 0 group estimated for the preceding year, the terminal year estimate of 0 group is much more variable and is not used in any projection and does not contribute to estimates of biomass. Retrospective estimates by cohort are shown in Figure 2.9.2.2. In this Figure the values are given both as estimated abundance values and these data expressed as percentage change from year to year. These diagrams indicate the current difficulties in obtaining estimates of cohorts during the first three years of life (see also section 2.5.6).

The main conclusions on the quality of assessments from Figures 2.9.2.1 and 2.9.2.2 are:

- The last egg survey value is very important to the assessment. Revision to the stock trends in the medium term is possible when a new value is obtained. A new preliminary value should be available next year and it is particularly important that this is made available to the WG.
- Initial estimates of recruits are uncertain.
- F estimates are thought to be unbiased under the assumption of constant unaccounted mortality (see section 2.8.4).

The WG considers that the current use of the ICA model to be very sensitive to variability in the SSB estimates from egg surveys. However, it may be difficult to improve on this situation without additional resources. Increase reliability of data on catches, more fishery independent data - e.g. more frequent egg surveys, or some other index would help. There are three avenues to be explored

- Better or more frequent indices
- Improved assessment modelling methodology
- Design a management regime adapted to the uncertainty in the assessment process

The WG has explored all three of these areas, and will do so again next year as part of a benchmark assessment.

2.10 NE Mackerel Catch predictions for 2005

Table 2.10.2 lists the input data for the short term predictions.

Traditionally the ICA-estimated abundances of ages 2 to 12+ are used as the starting populations in the prediction. The recruitments of age 0 and the abundance at age 1 are routinely revised.

The working group considers that estimates of 0 and 1 from the assessment should not be used in the prediction. This aspect has been discussed in some detail in section 2.5.6 and both year classes are replaced in the projections. The following assumptions were made regarding recruitment at age 0 and the abundance at age 1 in 2006:

Age 0 - Traditionally the WG calculates the GM from the estimated 0-group (ICA), because currently no validated recruitment indices from surveys are available. Figure 2.9.15 shows the recruitment estimates of year classes 1972-2003 as obtained from this year's assessment. The value of 3786.7 million fish is calculated from the geometric mean of the North East Atlantic mackerel recruitments for the period 1972 - 2002, which value is used for the recruitment at age 0 for 2006 in the predictions.

Age 1 - As in previous years the WG has taken the abundance at age 1 to be the geometric mean recruitment at age 0 (3786.7 million fish) brought forward 1 year by the total mortality at age 0 in that year (see Table 2.10.2), this corresponds to 3236.8 million fish. Recruitment at age 0 in 2006 and 2007 was also assumed to be 3786.7 million fish.

As in previous years the exploitation pattern used in the predictions was the separable ICA F's, scaled to the F in the final year. As the model is fitted with 14 year separable period this effectively the mean exploitation from 1992 to 2005 inclusive.

Maturity at age was taken as an average of the values for the period 2003–2005.

Weight at age in the catch was taken as an average of the values for the period 2003–2005 for each area.

Weight at age in the stock was calculated from an average (2003–2005) of weights at age for the NEA mackerel stock.

The catch for 2006 is assumed to be 428.491 kt, which corresponds to the amount of the TAC of 408.737 kt expected to be taken in 2006 (see Section 2.1) plus an assumed amount of discards of 19.76 kt (see Section 1.3.3), this conforms to the same procedure as last year.

The catch in the intermediate year is taken as a TAC constraint, this is the standard practice for this stock and is particularly applicable this year as the fishery has been particularly constrained due to increased inforcement in the UK and the consequential reductions in quota uptake for 2006.

Predictions were calculated by the MFDP program.

A detailed single fleet management option table is presented: Table 2.10.3 with *catch constraint* fishing (Catch = 428.491kt) in 2006 and F=0.17 in 2007 and 2008. Table 2.10.4 provides multi option for 2007 with a catch constraint of 428.491kt in 2006 to give a range of F options from 0.0 up to 0.34.

As discussed in section 2.8 given the uncertainty in the recorded historic catch, advice of the exact level of a TAC is not appropriate. Therefore, to prepare ACFM to give advice on change in catch rather than on absolute values, a column giving the percentage change in catch associated with fishing mortality options has been included for information for managers.

This year's prediction indicates a reversal in the declining trend in SSB, this is partly due to the reduction in reported catch over the last four years and partly due to the increased estimated recruitment, particularly the 2002 year class..

The 2000 year class is now confirmed to be weak and will be 7 years old in the catches of 2007. The 2001 and 2002 year classes appear to be strong. These year classes will be respectively 6 and 5 years old in the catches of 2007. However, evidence is that 2003 year class which will be 4 years old in 2007 is weak. There is considerable conflict in the data regarding the strength of 2004 and 2005 year classes, the catches which are often in error indicate these to be weak year classes, the recruit index which needs further validation indicates both are above average, further information is needed before the status of these yearclasses can be resolved. The data from the catches 2001 to 2005 is sufficient to support the view that the stock is showing much more variable recruitment over recent four years compared to the previous 12 years.

2.11 Special Requests

None

2.12 Long Term Yield

Yield per recruit was calculated using MFYPR, the results are presented in Figure 2.12.1

2.13 Reference points for management purposes

The WG have not reconsidered the reference points this year as it is an update assessment for NEA mackerel. However the current practice of using the egg survey as relative with a relatively short time series where the estimates of catchability may be unstable (see Section 2.8.2) may lead to inconsistencies in successive assessments of recent SSB's relative to historical SSB. Due to potential unaccounted mortality there are uncertainties in the historic SSB. While the current biomass reference point may not be applicable in the long term its level relative to the current level of SSB estimated from the assessment is considered applicable. The estimates of F reference points are probably very much more reliable than the biomass reference points.

2.14 Management considerations

The WG provides an annual assessment of the state of the stock and catch predictions for two years ahead, in 2007 this year. In using this information there are a number of considerations:

> Over the last 15 years the indications are that the total adult mortality has been in the region of 0.35.
>
> Currently management advice for NE Atlantic mackerel is derived from an assessment based on reported catch. The WG has found substantial levels of unaccounted mortality, much of which has been linked to the catch (see section 2.8), this has been estimated

(with a 95% probability) to be more than 60% underestimated. While it has been possible to obtain some indications of the overall unaccounted mortality it has not been possible to obtain any estimates of changes in underreporting over time. In this context it is important that the short term projections should be interpreted as estimates of relative changes in stock rather than absolute measures of stock size and catch. For this reason the short term predictions are presented as percentage changes.

Estimates of F for NEA mackerel are more robust to underreporting than estimates of biomass.

Currently the stock appears to be subject to increased variability in recruitment.

As 2006 is one year before the next egg survey this year's assessment is particularly imprecise.

For 2007 the SSB is rising and catches at the current level are projected to give F = Fpa =0.17. A roll-over catch would potentially provide exploitation at Fpa.

2.14.1 Management Targets

The World Summit on Sustainable Development at Johannesburg 2nd to 4th September 2002, paragraph 31a, provided commitment to restoring fish stocks to levels that can produce maximum sustainable yields (MSY) by 2015.

A non-paper from the EU commission services (Annon 2006), Implementing sustainability in EU Fisheries: strategies for growth and employment expressed the view that : "in the long term, [fish] stock size depends on recruitment and natural and fishing mortality rates. Recruitment depends on various aspects of the environment and on stock size. Fmsy is the fishing mortality rate that will, on average, result in a stock size that produces the maximum sustainable yield. Fmsy is a more achievable measure than the stock size that produces maximum sustainable yield, because it is less dependent on the marine environment and ecosystem effects is a potentially manageable quantity."

In this context information on Fmsy may be required as a management objective. The WG is not able to provide a reliable estimate of Fmsy directly. This is for a complex of reasons which include an uncertain but high Fmax and an uncertain stock recruit relationship, leading to an unknown Fcrash. Nevertheless, the WG considers that under these circumstances $F_{0.1}$ which has been stable for at least the last 5 years at 0.19 would form a well estimated proxy for Fmsy. In addition this F should provide more stable catches than could be achieved at the unestimable Fmsy and is likely to be closer to the long term Fmey (maximum economic yield) than would Fmsy.

2.14.2 Medium term exploitation strategies

For the longer term, the WG has previously indicated that NEA mackerel may be a good candidate for multi-annual management strategies, and the WG still considers that development of this kind of strategy for mackerel is important and should initiated in dialogue with management and industry.

The motive for developing multi-annual management strategies would be to obtain more stable quotas and less dependence on annual assessments and predictions. In recent years, managers and industry have suggested regimes that would stabilise yearly quotas, and give more predictable conditions for the industry for many stocks, and one may expect a similar interest for the management of NEA mackerel.

The assessment of NEA mackerel is borderline with respect to estimating the present state of the stock and exploitation, due to the paucity of data apart from the catch information. This is because egg surveys are only available every third year. Thus when the assessment year is two years after the last egg survey, the assessment becomes unstable, and on some occasions, no approved assessment could be provided by ICES. Likewise, the perception of the stock may change considerably each time a new egg survey is presented.

In the 2004 report, some examples of possible triennial quota regimes were presented including testing robustness to underreporting (WD Roel in section 2.12 of 2004/ACFM:08 and Skagen WD20/04). Some further studies were presented to the WGMHSA last year. In particular, the relation between production and removal was explored (Section 2.8 2005 WG report and Skagen, WD 26/05). Since the preliminary work on HCRs for this stock there have been some developments: recruitment is currently more variable than that seen in the 15 years back to 1999; the stock has recently been at a lower biomass than previously observed; the extent of unaccounted mortality (including underreported catch); is greater than that previously considered. All these factors will influence the management of the NEA mackerel stock and the preliminary work carried out on management regimes needs to be re-evaluated before progressing. In the light of this it would be helpful if managers could outline potential objectives or criteria to be considered for optimised management.

In summary, multi-annual management strategies can reduce some of the problems for management and industry caused by the instability in mackerel assessments. The data and preliminary tools to evaluate such management regimes by simulations are available. Underreporting of catches, both at present and in the past causes problems that need further exploration. Further development along these lines should be done in dialogue with managers and industry, and ICES should invite the relevant parties to start this dialogue.

2.15 Considerations for intersessional work for NEA Benchmark

While many aspects of NEA Mackerel will be dealt with either immediately before or at the WG in 2007, there are some areas of data preparation and development that would be helpful if they could be completed well in advance of the WG and will be arranged by the people indicated.

- Collation of survey data for recruit indices. There are some concerns about the validity of the adhoc database currently used for survey data. Full historic data sets back to 1990 should be supplied by national data coordinators during early 2007 and once assembled circulated. (John Simmonds)
- Revision of discard estimates should be carried out. (Lisa)
- Good communications should be established to obtain the best preliminary egg survey estimates for the WG should be established (Chairs of WGMHAA, WGMEGS , FRS Aberdeen/John Simmonds)
- Examine incorporation of NS egg survey data from 1990. Data should be circulated to interested parties (Svein Iversen)
- Tag mortality estimates for recent years should be updated and circulated. (Dankert Skagen)

Specific issues for consideration in the benchmark are:-

1) Separable model assumptions

- Sensitivity of assessment and potential advice to underreporting
- Estimation of recruits for projections
- Reliability of the relative change in terminal year and historic reference values of biomass and F
- Evaluation of potential reliability and utility of advice in the context of management on a single and multi year management strategy.

Table 2.2.1.1 NEA Mackerel. Catches by area. Discards not estimated prior to 1978. (Data submitted by Working Group members.)

Year	Sub-area VI			Sub-area VII and Divisions VIIIa,b,d,e			Sub-area IV and III			Sub-area I,II & Divs.Vb[1]	Divs. VIIIc, IXa	Total		
	Landings	Discards	Catch	Landings	Discards	Catch	Landings	Discards	Catch	Landings	Landings	Landings	Discards	Catch
1969	4,800		4,800	47,404		47,404	739,175		739,175	7	42,526	833,912	0	833,912
1970	3,900		3,900	72,822		72,822	322,451		322,451	163	70,172	469,508	0	469,508
1971	10,200		10,200	89,745		89,745	243,673		243,673	358	32,942	376,918	0	376,918
1972	13,000		13,000	130,280		130,280	188,599		188,599	88	29,262	361,229	0	361,229
1973	52,200		52,200	144,807		144,807	326,519		326,519	21,600	25,967	571,093	0	571,093
1974	64,100		64,100	207,665		207,665	298,391		298,391	6,800	30,630	607,586	0	607,586
1975	64,800		64,800	395,995		395,995	263,062		263,062	34,700	25,457	784,014	0	784,014
1976	67,800		67,800	420,920		420,920	305,709		305,709	10,500	23,306	828,235	0	828,235
1977	74,800		74,800	259,100		259,100	259,531		259,531	1,400	25,416	620,247	0	620,247
1978	151,700	15,100	166,800	355,500	35,500	391,000	148,817		148,817	4,200	25,909	686,126	50600	736,726
1979	203,300	20,300	223,600	398,000	39,800	437,800	152,323	500	152,823	7,000	21,932	782,555	60600	843,155
1980	218,700	6,000	224,700	386,100	15,600	401,700	87,931		87,931	8,300	12,280	713,311	21600	734,911
1981	335,100	2,500	337,600	274,300	39,800	314,100	64,172	3,216	67,388	18,700	16,688	708,960	45516	754,476
1982	340,400	4,100	344,500	257,800	20,800	278,600	35,033	450	35,483	37,600	21,076	691,909	25350	717,259
1983	320,500	2,300	322,800	235,000	9,000	244,000	40,889	96	40,985	49,000	14,853	660,242	11396	671,638
1984	306,100	1,600	307,700	161,400	10,500	171,900	43,696	202	43,898	98,222	20,208	629,626	12302	641,928
1985	388,140	2,735	390,875	75,043	1,800	76,843	46,790	3,656	50,446	78,000	18,111	606,084	8191	614,275
1986	104,100		104,100	128,499		128,499	236,309	7,431	243,740	101,000	24,789	594,697	7431	602,128
1987	183,700		183,700	100,300		100,300	290,829	10,789	301,618	47,000	22,187	644,016	10789	654,805
1988	115,600	3,100	118,700	75,600	2,700	78,300	308,550	29,766	338,316	120,404	24,772	644,926	35566	680,492
1989	121,300	2,600	123,900	72,900	2,300	75,200	279,410	2,190	281,600	90,488	18,321	582,419	7090	589,509
1990	114,800	5,800	120,600	56,300	5,500	61,800	300,800	4,300	305,100	118,700	21,311	611,911	15600	627,511
1991	109,500	10,700	120,200	50,500	12,800	63,300	358,700	7,200	365,900	97,800	20,683	637,183	30700	667,883
1992	141,906	9,620	151,526	72,153	12,400	84,553	364,184	2,980	367,164	139,062	18,046	735,351	25000	760,351
1993	133,497	2,670	136,167	99,828	12,790	112,618	387,838	2,720	390,558	165,973	19,720	806,856	18180	825,036
1994	134,338	1,390	135,728	113,088	2,830	115,918	471,247	1,150	472,397	72,309	25,043	816,025	5370	821,395
1995	145,626	74	145,700	117,883	6,917	124,800	321,474	730	322,204	135,496	27,600	748,079	7721	755,800
1996	129,895	255	130,150	73,351	9,773	83,124	211,451	1,387	212,838	103,376	34,123	552,196	11415	563,611
1997	65,044	2,240	67,284	114,719	13,817	128,536	226,680	2,807	229,487	103,598	40,708	550,749	18864	569,613
1998	110141	71	110,212	105,181	3,206	108,387	264,947	4,735	269,682	134,219	44,164	658,652	8012	666,664
1999[2,3]	116,362	§	116,362	94,290	§	94,290	313,014	§	313,014	72,848	43,796	640,311	§	640,311
2000[2,3]	187,595	1	187,595	115,566	1,918	117,484	285,567	165	304,898	92,557	36,074	736,524	2084	738,608
2001[2,3]	143,142	83	143,142	142,890	1,081	143,971	327,200	24	339,971	67,097	43,198	736,274	1,188	737,462
2002[2,3]	136,847	12,931	149,778	102,484	2,260	104,744	375,708	8,583	394,878	73,929	49,576	749,131	23,774	772,905
2003[3]	142,728	91	142,819	89,492		89,492	334,639	9,390	357,766	53,701	25,823	660,119	9,481	669,600
2004[3]	134,251	240	134,491	99,922	1,862	101,784	300,768	8,870	316,620	62,486	34,840	639,248	10,972	650,221
2005	79,960	11,400	91,361	90,278	5,878	96,156	249,740	2,482	252,223	54,129	49,618	523,726	19,760	543,486

*Preliminary. [1]For 1976–1985 only Division IIa. Sub-area I, and Division IIb included in 2000 only [2] Data revised for Northern Ireland; [3]data revised for unallocated catch. [§] Discards reported as part of unallocated catches

Table 2.2.1.2 NEA Mackerel. Catch (t) in the Norwegian Sea (Division IIa) and off the Faroes (Division Vb). (Data submitted by Working Group members.)

Country	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Denmark	11,787	7,610	1,653	3,133	4,265	6,433	6,800	1,098	251		
Estonia									216		3,302
Faroe Islands	137				22	1,247	3,100	5,793	3,347	1,167	6,258
France		16				11		23	6	6	5
Germany, Fed. Rep.			99		380						
German Dem. Rep.			16	292		2,409					
Iceland											
Ireland											
Latvia									100	4,700	1,508
Lithuania											
Netherlands											
Norway	82,005	61,065	85,400	25,000	86,400	68,300	77,200	76,760	91,900	110,500	141,114
Russia									42,440	49,600	28,041
United Kingdom			2,131	157	1,413		400	514	802		1,706
USSR	4,293	9,405	11,813	18,604	27,924	12,088	28,900	13,631[2]			
Poland											
Sweden											
Misreported (IVa)											109,625
Misreported (VIa)											
Discards							2,300				
Total	98,222	78,096	101,112	47,186	120,404	90,488	118,700	97,819	139,062	165,973	72,309

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Denmark	4,746	3,198	37	2,090	106	1,375	7	1			
Estonia	1,925	3,741	4,422	7,356	3,595	2,673	219				
Faroe Islands	9,032	2,965	5,777**	2,716	3,011	5,546	3,272	4,730		650	30
France	5	0	270							2	0.6
Germany		1									
Iceland		92	925	357				53	122		363
Ireland					100				495	471	
Latvia	389	233									
Lithuania						2,085					
Netherlands		561			661			569		34	2,393
Norway	93,315	47,992	41,000	54,477	53,821	31,778	21,971	22,670	12,548	10,295	13,244
Russia	44,537	44,545	50,207	67,201	51,003	49,100*	41,566	45,811	40,026	49,489	
United Kingdom	194	48	938	199	662		54	665	510	1,945	
USSR[2]											40,491
Poland			22								
Sweden							8				
Unallocated											-2,393
Misreported (IVa)	-18,647			-177	-40,011						
Misreported (VIa)					-100						
Misreported (unknown)								-570		-400	
Discards											
Total	135,496	103,376	103,598	134,219	72,848	92,557	67,097	73,929	53,701	62,486	54,129

[2]Russia.

*Includes small bycatches in Sub area I & IIb

** Faroese catch revised from previously reported 7,628

Table 2.2.1.3 NEA Mackerel. Catch (t) in the North Sea, Skagerrak, and Kattegat (Sub-area IV and III). (Data submitted by Working Group members).

Country	1988	1989	1990	1991	1992	1993	1994	1995
Belgium	20	37		125	102	191	351	106
Denmark	32,588	26,831	29,000	38,834	41,719	42,502	47,852	30,891
Estonia					400			
Faroe Islands		2,685	5,900	5,338		11,408	11,027	17,883
France	1,806	2,200	1,600	2,362	956	1,480	1,570	1,599
Germany, Fed. Rep.	177	6,312	3,500	4,173	4,610	4,940	1,479	712
Iceland								
Ireland		8,880	12,800	13,000	13,136	13,206	9,032	5,607
Latvia					211			
Netherlands	2,564	7,343	13,700	4,591	6,547	7,770	3,637	1,275
Norway	59,750	81,400	74,500	102,350	115,700	112,700	114,428	108,890
Sweden	1,003	6,601	6,400	4,227	5,100	5,934	7,099	6,285
United Kingdom	1,002	38,660	30,800	36,917	35,137	41,010	27,479	21,609
USSR (Russia from 1990)								
Romania							2,903	
Misreported (IIa)							109,625	18,647
Misreported (VIa)	180,000	92,000	126,000	130,000	127,000	146,697	134,765	106,987
Unallocated	29,630	6,461	-3,400	16,758	13,566	-	-	983
Discards	29,776	2,190	4,300	7,200	2,980	2,720	1,150	730
Total	338,316	281,600	305,100	365,875	367,164	390,558	472,397	322,204

Country	1996	1997	1998	1999	2000	2001	2002	2003
Belgium	62	114	125	177	146	97	22	2
Denmark	24,057	21,934	25,326	29,353	27,720	21,680	34,375	27,508
Estonia		-	-					
Faroe Islands	13,886	3,288[2]	4,832	4,370	10,614	18,571	12,548	11,754
France	1,316	1,532	1,908	2,056	1,588	1,981	2,152	1,467
Germany, Fed. Rep.	542	213	423	473	78	4,514	3,902	4,859
Iceland				357				
Ireland	5,280	280	145	11,293	9,956	10,284	20,715	17,145
Latvia		-	-					
Netherlands	1,996	951	1,373	2,819	2,262	2,441	11,044	6,784
Norway	88,444	96,300	103,700	106,917	142,320	158,401	161,621	150,858
Sweden	5,307	4,714	5,146	5,233	4,994	5,090	5,232	4,450
United Kingdom	18,545	19,204	19,755	32,396[3]	58,282[3]	52,988[3]	61,781[3]	51,736
Russia		3,525	635	345	1,672	2		
Romania		-	-					
Misreported (IIa)	-	-	-	40,000				
Misreported (VIa)	51,781	73,523	98,432	59,882	8,591	39,024	49,918	46,407
Unallocated	236	1,102	3,147	17,344[4]	34,761[4]	24,873[4]	22,985[4]	25,405[4]
Discards	1,387	2,807	4,753		1,912	24	8,583	9390
Total	212,839	229,487	269,700	312,197	303,724	337,149	391,973	357,766

Country	2004	2005
Belgium	4.31	1
Denmark	25,665	23,212
Estonia		
Faroe Islands	11,705	9,739
France	1,538	1,004
Germany, Fed. Rep.	4,514	4,442
Iceland		
Ireland	18,901	1,5605
Latvia		
Netherlands	6366	3,915
Norway	147,069	106,434
Poland		109
Sweden	4,437	3,204
United Kingdom	50,474	37,118
Russia		4
Misreported (III)		
Misreported (IVa)	18,480	37,911
Unallocated	18,597[4]	7,043
Discards	8,870	2,482
Total	316,620	252,223

1Includes small catches in IIIb & IIId, 2Faroese catches revised from previously reported 1,367, 3Catches revised for Northern Ireland, 4Catches revised for unallocated catches.

Table 2.2.1.4 NEA Mackerel. Catch (t) in the Western area (Sub-areas VI and VII and Divisions VIIIa,b,d,e). (Data submitted by Working Group members).

Country	1985	1986	1987	1988	1989	1990	1991	1992	1993
Denmark	400	300	100		1,000		1,573	194	
Faroe Islands	9,900	1,400	7,100	2,600	1,100	1,000			
France	7,400	11,200	11,100	8,900	12,700	17,400	4,095		2,350
Germany	11,800	7,700	13,300	15,900	16,200	18,100	10,364	9,109	8,296
Ireland	91,400	74,500	89,500	85,800	61,100	61,500	17,138	21,952	23,776
Netherlands	37,000	58,900	31,700	26,100	24,000	24,500	64,827	76,313	81,773
Norway	24,300	21,000	21,600	17,300	700		29,156	32,365	44,600
Poland									600
Spain				1,500	1,400	400	4,020	2,764	3,162
United Kingdom	205,900	156,300	200,700	208,400	149,100	162,700	162,588	196,890	215,265
USSR									
Unallocated	75100	49299	26000	4700	18900	11,500	-3,802	1,472	0
Misreported (Iva)		-148,000	-117,000	-180,000	-92,000	-126,000	-130,000	-127,000	-146,697
Discards	4,500			5,800	4,900	11,300	23,550	22,020	15,660
Grand Total	467,700	232,599	284,100	197,000	199,100	182,400	183,509	236,079	248,785

Country	1994	1995	1996	1997	1998	1999	2000	2001	2002
Denmark	2,239	1,443	1,271	-	-	552	82	835	
Estonia		361		-	-				
Faroe Islands	4,283	4,248	-	2,448[1]	3,681	4,239	4,863	2,161	2,490
France	9,998	10,178	14,347	19,114	15,927	14,311	17,857	18,975	19,726
Germany	25,011	23,703	15,685	15,161	20,989	19,476	22,901	20,793	22,630
Ireland	79,996	72,927	49,033	52,849	66,505	48,282	61,277	60,168	51,457
Netherlands	40,698	34,514	34,203	22,749	28,790	25,141	30,123	33,654	21,831
Norway	2,552			-	-			223	
Spain	4,126	4,509	2,271	7,842	3,340	4,120	4,500	4,063	3,483
United Kingdom	208,656	190,344	127,612	128,836	165,994	127,094[2]	126,620[2]	139,589[2]	131,599[2]
USSR									
Unallocated	4,632	28,245	10,603	4,577	8,351	21,652[3]	31,564[3]	37,952[3]	27,558[3]
Misreported (IVa)	-134,765	-106,987	-51,781	-73,523	-98,255	-59,982	-3,775	-39,024	-43,339
Discards	4,220	6,991	10,028	16,057	3,277		1,920	1,164	15,191
Grand Total	251,646	270,476	213,272	196,110	218,599	204,884	297,931	280,553	248,374

Country	2003	2004	2005
Belgium		0.5	
Denmark	392		
Estonia			
Faroe Islands	2,260	674	
France	21,213	18,549	15,182
Germany	19,202	18,730	14,598
Ireland	49,715	41730	30,082
Jersey			9
Netherlands	23,640	21,132	18,819
Norway			
Poland			461
Spain	735	2,081	4,795
United Kingdom	130,762	122,311	115,683
USSR			
Unallocated	33,767[3]	27,999[3]	8,521
Misreported (VIa)	-46,407	-18,049	-37,911
Discards	91	2,102	17,278
Grand Total	232,311	236,275	187,517

[1]Faroese catches revised from 2,158; [2] Catches revised for Northern Ireland; [3] Catches revised for unallocated catches.

Table 2.2.1..5 NEA Mackerel. Catch (t) in Divisions VIIIc and IXa, 1977–2005. Data submitted by Working Group members.

Country	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Spain[1]	19,852	18,543	15,013	11,316	12,834	15,621	10,390	13,852	11,810	16,533	15,982	16,844	13,446
Portugal[2]	1,743	1,555	1,071	1,929	3,108	3,018	2,239	2,250	4,178	6,419	5,714	4,388	3,112
Spain[2]	2,935	6,221	6,280	2,719	2,111	2,437	2,224	4,206	2,123	1,837	491	3,540	1,763
Poland[2]	8	-	-	-	-	-	-	-	-	-	-	-	-
USSR[2]	2,879	189	111	-	-	-	-	-	-	-	-	-	-
Total[2]	7,565	7,965	7,462	4,648	5,219	5,455	4,463	6,456	6,301	8,256	6,205	7,928	4,875
TOTAL	27,417	26,508	22,475	15,964	18,053	21,076	14,853	20,308	18,111	24,789	22,187	24,772	18,321

[1]Division VIIIc.[2]Division IXa.

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
France[1]													
Spain[1]	16,086	16,940	12,043	16,675	21,146	23,631	28,386	35,015	36,174	37,631	30,061	38,205	38,703
Portugal[2]	3,819	2,789	3,576	2,015	2,158	2,893	3,023	2,080	2,897	2,002	2,253	3,119	2,934
Spain[2]	1,406	1,051	2,427	1,027	1,741	1,025	2,714	3,613	5,093	4,164	3,760	1,874	7,938
Total[2]	5,225	3,840	6,003	3,042	3,899	3,918	6,737	5,693	7,990	6,165	6,013	4,993	10,873
TOTAL	21,311	20,780	18,046	19,719	25,045	27,549	34,123	40,708	44,164	43,796	36,074	43,198	49,575

[1]Division VIIIc. [2]Division IXa.

Country	2003	2004	2005
France[1]	226	177	151
Spain[1]	17,381	28,428	42,851
Portugal[2]	2,749	2,289	1,509
Spain[2]	5,646	3,946	5,107
Total[2]	8,213	6,234	6,616
TOTAL	25,820	34,840	49,618

[1]Division VIIIc. [2]Division IXa.

Table 2.2.3.1. NEA Mackerel. Pelagic fleet composition in 2005 of nations catching mackerel.

Country	Details given	Length (metres)	Engine power (Horse Power)	Gear	Storage	Discard estimates	No vessels
Denmark	y	30-40	900-1500	Trawl	Tank	No	35
Denmark	y	45-65	1000->	Purse seine	Tank	No	9
Faroe Islands	y	40-62	515-1540 kW	Trawl	219-906	No	5
Faroe Islands	y	90	6468 kW	Trawl	1090	No	1
Faroe Islands	y	53-76	2208-8000 kW	Purse-seine/Trawl	1480-2600	No	8
France	n					No	
Germany	y	85-125	3200-11000	Single Midwater Trawl	Freezer	Yes	4
Ireland	y	>100	14400	Midwater Trawl	RSW/Freezer	no	1
Ireland	y	90-100		Midwater Trawl	RSW	no	0
Ireland	y	80-90		Midwater Trawl	RSW	no	0
Ireland	y	70-80	3000	Midwater Trawl	RSW	no	2
Ireland	y	60-70	2500-3000	Midwater Trawl	RSW	no	5
Ireland	y	50-60	1500-6000	Midwater Trawl	RSW	no	7
Ireland	y	40-50	700-1200	Midwater Trawl	RSW	no	9
Ireland	y	30-40	500-1200	Pair Midwater Trawl	RSW	no	6
Ireland	y	20-30	350-700	Pair Midwater Trawl	RSW	no	8
Ireland	y	20-30	350-700	Pair Midwater Trawl	Dry Hold	no	25
Ireland	y	<20	200-300	Demersal Trawl/HandLine	Dry Hold	no	22
Netherlands	y	55	2890	Pair Midwater Trawl	Freezer	Yes	2
Netherlands	y	88-140	4400-1045	Single Midwater Trawl	Freezer	Yes	13
Norway	y	≥21		Purse seiners		No	221
Norway	y	14-21		Purse seiners/fishnets		No	90
Norway	y	7-14		Purse seiners/trawlers		No	475
Norway	y	<7		Trawler		No	24
Portugal	y	10-40		Trawler	Freezer	No	14
Portugal	y	0-40		Trawler	Other	No	416
Portugal	y	0-30		Purse-seiner	Other	No	261
Russia	y	55-80	1000 to >5000	Single Midwater Trawl	Freezer	No	52
Spain	y	10 - 32	110 - 800	Single Bottom Trawl	Dry hold, ice	No	247
Spain	y	19.5 - 31.3	220 - 800	Pair Bottom Trawl	Dry hold, ice	No	74
Spain	y	6.5 - 27	16 - 650	Purse Seine	Dry hold, ice	No	408
Spain	y	4 - 27	5 - 750	Artisanal: Hook	Dry hold, ice	No	370
Spain	y	7 - 29	40 - 450	Artisanal: Gillnet	Dry hold, ice	No	593
Spain	y	2 - 34	4 - 900	Artisanal: Others	Dry hold,ice	No	4587
Sweden	n					No	
UK (England & Wales)	y	92.05	5053.5	Pair Midwater Trawl	Freezer	No	2
UK (England & Wales)	y	47.3	1992	Midwater Trawl	RSW	No	3
UK (Northern Ireland	n					No	
Scotland	y	<49m	2393.7	Trawl/Purse	655.0	Yes	3
Scotland	y	50 - 60m	4246.3	Trawl/Purse	1296.0	Yes	7
Scotland	y	60 - 70 m	6248.8	Trawl/Purse	1557.9	Yes	12
Scotland	y	>=70m	9429.3	Trawl	2196.0	No	4

Table 2.2.4.1. Catches in tonnes of Scomber japonicus in Divisions VIIIb, VIIIc and IXa in the period 1982-2005

Country	Sub-Divisions	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
	Division VIIIb	0	0	0	0	0	0	0	0	0	487	7	4
	VIIIc East	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892
	VIIIc west												
Spain	Total	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892
	IXa North												2557
	IXa South											895	800
	Total	0	0	0	0	0	0	0	0	0	0	895	3357
	Total Spain	322	254	656	513	750	1150	1214	3091	1923	1989	1761	5253
	IXa Central-North	-	0	236	229	223	168	165	281	228	137	914	543
Portugal	IXa Central-South	-	244	3924	4777	3784	5299	838	2105	5792	6925	5264	5019
	IXa South	-	129	3899	4113	4177	3409	2813	4061	2547	3080	2803	1779
	Total Portugal	664	373	8059	9118	8184	8876	3816	6447	8568	10142	8981	7341
	Division VIIIb										487	7	4
	VIIIc East	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892
	VIIIc west												
	Division VIIIc	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892
TOTAL	IXa North												2557
	IXa Central-North		0	236	229	223	168	165	281	228	137	914	543
	IXa Central-South		244	3924	4777	3784	5299	838	2105	5792	6925	5264	5019
	IXa South		129	3899	4113	4177	3409	2813	4061	2547	3080	3698	2579
	Division IXa	664	373	8059	9118	8184	8876	3816	6447	8568	10142	9876	10698
	Total	986	627	8715	9631	8934	10026	5030	9538	10491	12131	10742	12594

Country	Sub-Divisions	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	Division VIIIb	427	247	778	362	1218	632	344	426	99	157	40	222
	VIIIc East	1903	2558	2633	4416	1753	414	1279	1442	1130	1200	1482	1237
	VIIIc west			47	610	12	3	626	54	379	1325	1260	1913
Spain	Total	1903	2558	2679	5026	1765	418	1905	1496	1509	2525	2741	3150
	IXa North	7560	4705	5066	1727	412	104	531	1	54	33	6	504
	IXa South	1013	364	370	613	969	879	470	552	1512	948	882	307
	Total	8573	5068	5437	2340	1381	983	1001	553	1566	981	888	812
	Total Spain	10903	7872	8894	7729	4364	2033	3250	2475	3174	3663	3670	4184
	IXa Central-North	378	913	785	521	481	296	146	60	177	476	242	3033
Portugal	IXa Central-South	2474	1544	2224	2109	3414	10407	7450	2202	1380	3405	5990	5743
	IXa South	1578	1427	1749	2778	2796	3173	2924	1966	3744	4149	6193	6130
	Total Portugal	4430	3884	4759	5408	6690	13877	10520	4228	5301	8030	12425	14905
	Division VIIIb	427	247	778	362	1218	632	344	426	99	157	40	222
	VIIIc East	1903	2558	2633	4416	1753	414	1279	1442	1130	1200	1482	1237
	VIIIc west			47	610	12	3	626	54	379	1325	1260	1913
	Division VIIIc	1903	2558	2679	5026	1765	418	1905	1496	1509	2525	2741	3150
TOTAL	IXa North	7560	4705	5066	1727	412	104	531	1	54	33	6	504
	IXa Central-North	378	913	785	521	481	296	146	60	177	476	242	3033
	IXa Central-South	2474	1544	2224	2109	3414	10407	7450	2202	1380	3405	5990	5743
	IXa South	2591	1790	2120	3391	3764	4052	3395	2518	5256	5097	7075	6438
	Division IXa	13003	8952	10195	7748	8071	14860	11521	4781	6867	9011	13313	15717
	Total	15333	11756	13653	13137	11054	15909	13770	6703	8475	11693	16094	19089

Table 2.4.1.1 NE Atlantic Mackerel. Catch in numbers at age (000's)

For Quarters 1 to 4

Ages	IIa	IIIa	IIIb	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIId	IXacentral	Ixanorth	Total
		0.2		389.8	0.0	0.0		212.2	0.0					2.5						22.0	2.7	1578.7		15.5	2790.3	5013.8
1	639.2	18.7	0.0	14571.9	4.2	51.8	0.0	8070.3	8.1	1425.8	9.8	6546.5	1262.2	315.5	0.2		17.9		2679.0	701.7	2812.4	784.7	31.0	895.7	1735.6	42582.4
2	5038.7	730.7	1.1	58531.5	29.6	178.6	2.7	15622.1	7.2	2629.6	356.3	3612.7	716.5	496.7	5.0	101.2	5919.5	0.1	3743.4	4436.2	21038.9	2778.0	238.5	1965.0	3798.0	131977.7
3	67974.6	871.9	0.7	276960.0	333.2	504.3	110.4	119824.0	212.3	33892.3	2550.3	4611.9	691.1	513.4	40.0	2438.2	52353.6	3.6	11568.5	13335.2	55667.3	6186.0	1084.3	3162.6	6584.5	661473.7
4	25986.5	348.5	0.2	124608.8	167.8	406.6	40.1	44591.5	91.2	13784.4	1434.4	2982.3	496.6	287.0	18.9	1410.7	22861.2	0.7	9038.3	5681.4	26114.3	2921.4	979.2	130.9	3913.3	288296.1
5	6429.4	131.9	0.1	43881.8	43.4	178.4	15.0	23824.2	50.9	9830.3	891.7	1795.3	199.2	47.1	12.3	904.1	13082.5	0.6	4971.0	1483.2	7551.1	777.2	514.5	57.4	725.0	117397.7
6	7865.9	111.5	0.0	51147.7	42.7	153.2	21.3	22002.5	48.9	6268.7	555.6	1268.8	132.6	41.3	10.0	693.3	9372.7	0.4	3745.7	1748.2	12518.0	1030.7	398.4	40.2	811.7	120030.0
7	6422.9	37.3	0.0	23015.4	35.5	121.8	24.5	11588.8	23.7	3353.2	416.6	1057.8	109.4	12.0	6.5	112.7	4386.8	0.2	2364.0	867.6	7477.7	739.4	249.7	39.1	419.3	62881.9
8	2414.3	25.2	0.0	13756.1	18.9	74.7	16.1	7877.9	15.8	1847.0	233.3	503.7	43.2	21.6	4.4	69.7	4391.5	0.1	1999.7	612.2	3243.7	342.8	222.2	27.8	133.2	37895.1
9	2705.8	17.1	0.0	8698.2	10.9	54.8	16.3	5989.7	12.3	1130.9	139.0	334.9	32.0	0.9	2.3	227.6	813.2	0.1	1212.8	326.9	2034.2	201.3	138.3	9.3	24.2	24133.1
10	1056.7	13.7		10095.9	8.7	30.9	2.5	4641.8	10.1	378.8	73.1	208.3	16.4	1.3	1.3	27.5	796.3	0.0	584.8	154.5	534.7	82.0	67.1	6.7	30.3	18823.5
11	585.4	6.1		2920.0	6.1	18.8	0.6	2849.9	6.4	279.2	45.4	126.6	9.3	0.3	0.8	16.7	188.2	0.0	289.9	120.9	344.4	45.3	36.2	7.7	23.6	7927.7
12	623.1	5.5		1882.2	0.6	2.8	0.8	2000.4	4.8	234.9	7.9	138.6	15.4	0.2	0.1	2.5	72.7		74.6	56.3	379.6	39.7	3.8		13.0	5559.4
13	303.5	2.1		695.5	2.2	9.4	0.4	910.3	2.1	25.5	22.0	63.3	4.6	0.1	0.6	8.5	355.3		186.7	47.5	230.9	23.9	23.3		0.1	2917.7
14	67.6	0.0		465.9	1.5	16.4	1.4	350.6	0.7	53.6	20.3	121.1	7.8	0.1	0.4	8.4	85.3		103.2	23.6	25.9	6.7	12.9		0.0	1373.4
15	28.4	0.7		161.0			0.0	494.2	1.2					0.7					83.5	22.6	49.9	18.8	10.3		4.3	875.7
SOP	54025.0	1021.9	1.0	250582.3	255.8	546.7	103.6	90799.7	172.9	26255.1	2287.9	6473.2	918.8	362.9	32.9	2035.8	36141.4	1.8	13003.1	7739.1	38401.8	4625.3	1292.6	1508.4	5108.8	543674.0
Catch	54025.4	1026.0	1.0	250396.5	252.0	547.1	103.6	91360.6	174.4	26245.5	2259.0	6470.5	908.3	366.3	32.4	2032.7	35637.2	1.8	13028.4	7715.6	38376.8	4625.4	1284.0	1508.6	5107.4	543486.0
SOP%	100%	100%	100%	100%	99%	100%	100%	101%	101%	100%	99%	100%	99%	101%	99%	100%	99%	100%	100%	100%	100%	100%	99%	100%	100%	100%

Quarter 1

Ages	IIa	IIIa	IIIb	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIId	IXacentral	Ixanorth	Total
0				0.0																						0.0
1				2698.9		0.8		3106.7	7.8	1330.1	5.3			1.3			17.8		155.1	212.6	2018.5	347.0	31.0	354.1	1179.7	11466.8
2				4305.1		1.3		4022.4	6.6	1159.2	273.9	267.8	39.6	1.4	0.2	56.0	5457.6		581.0	1889.7	19303.3	1833.3	83.9	1066.6	2681.6	43030.4
3				78259.6	0.0	4.1		100188.7	211.5	30695.2	2290.9	912.8	138.7	1.5	2.2	1202.9	50441.7	0.6	4893.9	7924.5	50258.0	4372.3	685.6	1944.9	4647.1	339076.6
4				37093.2		3.1		40154.7	91.1	13386.8	1338.7	799.8	106.7	1.5	0.8	685.2	19973.3	0.1	3904.8	3004.2	20132.7	1847.1	657.0	62.8	2642.7	145886.3
5				14964.2		1.6		21773.1	50.8	9637.1	834.7	421.7	41.1	0.3	0.6	439.0	10847.4	0.1	2137.2	879.8	5534.3	391.5	346.7	28.5	384.7	68714.4
6				21151.7		1.4		20770.5	48.9	6166.6	513.1	362.4	35.9	0.3	0.4	336.0	6430.5	0.1	1582.8	974.7	9029.1	450.9	256.5	24.9	419.0	68555.5
7				11076.5		1.1		10290.3	23.7	3280.6	390.7	288.2	27.0	0.1	0.3	63.7	3286.8	0.0	920.8	474.9	5200.6	244.3	142.0	25.1	176.5	35913.1
8				7079.3		0.7		6768.8	15.7	1814.4	216.7	177.0	16.6	0.1	0.2	39.3	3150.4	0.0	894.0	367.7	2293.9	106.9	152.5	18.5	20.9	23133.5
9				3708.1		0.5		5071.1	12.3	1093.8	131.1	117.7	11.0	0.0	0.1	109.4	578.8	0.0	549.8	209.4	1416.4	64.6	94.5	6.0	1.7	13176.4
10				5814.4		0.3		4391.1	10.1	365.4	68.8	73.2	6.6	0.0	0.1	15.2	670.1		246.5	97.9	366.3	28.5	40.8	3.1	3.5	12201.8
11				1066.7		0.2		2580.8	6.4	271.2	42.8	44.5	4.0	0.0	0.0	9.2	111.5		138.7	70.6	242.2	16.1	22.5	4.5	2.5	4634.4
12				415.6		0.0		1894.5	4.8	233.7	7.3	6.5	0.6			1.4	29.9		12.7	25.6	266.6	12.5	1.8		1.3	2914.8
13				304.5		0.1		832.1	2.1	21.6	19.0	22.2	2.0	0.0	0.0	4.6	47.0		95.2	30.1	159.3	8.1	16.4			1564.3
14				396.1		0.1		309.9	0.7	49.7	19.0	22.2	3.7	0.0	0.0	4.6	47.0		43.5	14.9	5.5	0.6	6.1			923.7
15				28.1				471.4	1.2										51.7	14.2	35.0	6.1	10.3		0.8	618.9
SOP				68036.9	0.0	4.6		76365.7	172.4	24657.2	2097.0	1095.9	127.2	1.4	1.6	998.9	31295.8	0.3	5373.5	4105.1	30137.1	2441.5	853.8	775.0	3046.8	251587.6
Catch				68109.1	0.0	4.7		77066.0	173.9	24629.8	2070.7	1093.5	127.9	1.4	1.5	996.6	30792.4	0.3	5342.2	4092.1	30113.0	2441.4	851.3	775.0	3046.8	251729.6

Table 2.4.1.1 (continued.)

Quarter 2

Ages	IIa	IIIa	IIIb	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIId	IXacentral-	Ixanorth	Total
0		0.0		0.0										0.3												0.4
1		2.4		5.1	0.1			29.1		0.0				11.0						8.4	48.7	13.8		140.4	25.6	284.7
2	210.4	94.1		195.3	17.4	119.2	0.8	1207.5		0.9	0.6	839.2	38.1	47.5	2.6	0.4	460.2	0.1	1702.7	128.1	359.9	109.3	154.6	247.5	123.3	6059.4
3	7841.8	115.8		1913.5	299.9	332.8	67.1	246.6	0.0	51.1	43.5	2252.2	156.5	90.1	19.9	1.4	1898.7	2.9	3562.8	1237.4	3580.3	651.1	398.6	555.7	559.2	25879.8
4	3845.9	46.7		421.9	155.3	285.7	17.5	72.5		23.0	24.4	1928.9	107.0	44.6	10.1	1.4	2866.7	0.6	2646.3	1293.0	5673.8	816.4	322.1	37.2	966.2	21607.4
5	667.3	17.3		45.6	38.1	120.4	8.0	140.4		14.8	17.5	771.6	30.7	8.8	6.5	0.9	2217.0	0.5	1359.0	298.0	1970.3	358.1	167.7	10.2	308.5	8577.6
6	749.8	15.1		46.6	38.5	103.5	12.7	46.5		4.4	11.6	663.0	28.1	3.7	5.5	0.9	2916.9	0.3	1128.5	486.1	3428.0	554.8	141.9	8.6	362.9	10758.2
7	657.6	5.0		30.6	32.3	82.3	17.5	75.8		3.8	5.1	527.4	20.5	2.5	3.5	0.5	1092.2	0.2	807.1	210.8	2250.6	481.5	107.7	8.8	229.2	6652.5
8	309.4	3.4		22.3	16.9	50.5	13.4	42.2		0.5	3.5	323.9	12.7	2.5	2.4	0.4	1230.7	0.1	557.4	157.6	938.6	231.5	69.7	5.8	108.1	4103.6
9	150.7	2.3		19.6	9.5	33.6	13.1	34.8		0.2	0.2	215.4	7.6	0.9	1.2	0.2	233.5	0.0	326.8	59.8	611.5	134.9	43.8	2.3	21.0	1922.7
10	151.1	1.9		5.8	7.9	20.9	1.4	26.3		0.1	0.0	134.0	4.6	0.7	0.7	0.1	125.8	0.0	187.1	27.2	165.7	53.1	26.3	2.0	26.6	969.2
11	121.2	0.8		1.8	5.6	12.7		8.4		0.0	0.0	81.4	2.8	0.3	0.4	0.1	76.4	0.0	73.4	35.1	100.9	28.9	13.7	2.3	21.0	587.2
12	6.6	0.8		1.6	0.5	1.9		1.3		0.0	0.1	11.9	0.4	0.1	0.1	0.0	42.4		10.7	28.4	112.6	27.0	2.0		11.6	260.0
13	36.1	0.3		0.6	2.0	6.4		0.0		0.0	1.0	40.7	1.4	0.0	0.3	0.1	305.6		36.7	9.9	70.8	15.6	6.8			534.2
14	12.5	0.0		1.5	1.3	13.4	1.3	1.8		0.0		98.1	2.9	0.0	0.2	0.0	38.2		36.7	1.1	19.8	6.0	6.8		0.0	241.7
15		0.1		0.2																8.3	14.9	12.7			3.5	39.7
SOP	5679.6	134.4		896.6	232.0	357.2	58.0	556.9	0.0	33.6	38.2	2363.7	113.6	45.2	17.2	2.1	4809.7	1.5	3516.5	1312.2	7270.4	1383.4	438.7	243.9	1007.1	30512.2
Catch	5680.1	135.0		897.4	227.9	357.2	58.0	567.2	0.0	33.6	37.7	2364.5	115.2	48.1	17.0	2.1	4807.1	1.5	3481.9	1310.2	7270.4	1383.4	432.5	244.0	1007.2	30479.3
SOP%	100%	100%		100%	98%	100%	100%	102%		100%	99%	100%	101%	106%	99%	100%	100%	100%	99%	100%	100%	100%	99%	100%	100%	100%

Quarter 3

Ages	IIa	IIIa	IIIb	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIId	IXacentral-	Ixanorth	Total
0		0.1		29.2	0.0			101.4	0.0					0.7						2.7	2.7			15.4	100.9	253.1
1	639.2	15.9	0.0	1117.2	4.2	21.7	0.0	2321.0	0.3	0.0		3985.5	133.3	148.7						7.2	395.6	418.4		243.0	467.9	9918.9
2	4828.2	631.7	1.1	22314.4	12.1	35.8	1.9	4289.6	0.5	3.3	0.4	1528.1	81.0	348.2	1.8	1.0	1.1		224.4	35.7	562.6	825.3	0.0	411.0	883.3	37022.3
3	60132.7	749.2	0.7	85310.9	33.0	108.3	43.3	5602.7	0.6	58.0	33.3	888.2	116.0	310.5	15.7	3.6	7.8		578.6	79.5	716.2	1147.4	0.1	425.7	1229.1	157591.1
4	22140.6	299.0	0.2	39752.6	12.3	81.7	22.6	593.4	0.1	29.7	18.7	160.6	69.8	162.5	7.0	3.7	18.1		467.5	59.8	90.8	252.0	0.1	19.8	272.5	64534.9
5	5762.1	113.3	0.1	10464.9	5.2	40.4	7.0	257.9	0.0	18.0	13.4	369.2	41.8	33.6	4.6	2.2	16.6		243.5	15.7	11.7	25.9	0.0	11.1	27.8	17485.8
6	7116.1	95.7	0.0	14591.5	4.2	34.6	8.6	120.3	0.0	7.2	8.9	150.5	29.1	30.5	3.6	2.3	24.2		205.9	15.2	17.7	23.0	0.0	3.8	25.9	22518.9
7	5765.3	32.0	0.0	4737.5	3.2	27.6	7.0	121.1	0.0	6.1	3.9	149.3	20.5	6.7	2.4	1.4	7.1		156.3	11.6	7.6	12.1	0.0	4.0	11.7	11094.3
8	2104.9	21.6	0.0	2532.2	2.0	16.9	2.7	105.2	0.0	1.8	2.7	2.8	9.4	15.4	1.6	1.1	9.9		101.1	6.5	2.5	4.0	0.0	3.1	3.6	4950.8
9	2555.2	14.7	0.0	1807.1	1.3	13.4	3.2	92.5	0.0	1.1	0.1	1.9	7.2	0.0	0.9	0.5	0.8		63.6	4.0	1.4	1.5	0.0	0.7	1.3	4572.3
10	905.6	11.8		1995.8	0.8	7.0	1.1	24.7		0.7		1.2	4.1	0.0	0.5	0.3	0.3		38.2	2.3	0.2	0.3		1.2	0.1	2996.2
11	464.2	5.2		788.2	0.5	4.2	0.6	27.0		0.4		0.7	2.4	0.0	0.3	0.2	0.2		19.9	1.3	0.1	0.2		0.8	0.1	1316.4
12	616.5	4.7		877.2	0.1	0.6	0.8	11.8		0.1	0.1	73.2	2.7		0.1	0.0	0.3		2.9	0.2	0.1	0.2			0.1	1591.7
13	267.3	1.9		341.4	0.2	2.1	0.4	7.0		0.2	0.8	0.4	1.2	0.0	0.2	0.2	2.7		9.9	0.6	0.1	0.2			0.1	636.9
14	55.1	0.0		7.1	0.2	2.1	0.1	2.7		0.2		0.8	1.2	0.0	0.1	0.1	0.1		9.9	0.6						80.4
15	28.4	0.6		114.3			0.0	2.5												0.0	0.0	0.0			0.0	145.8
SOP	48344.1	879.4	1.0	78908.8	23.6	121.7	45.6	3591.1	0.4	42.0	29.2	1842.5	147.4	223.5	12.4	5.4	33.8		636.9	68.3	398.2	703.1	0.1	319.9	763.8	137139.4
Catch	48345.4	883.0	1.0	78885.6	23.8	122.0	45.6	3505.3	0.4	41.8	28.8	1841.7	142.8	226.6	12.2	5.4	33.7		627.8	67.7	397.5	703.1	0.1	319.9	763.4	137024.6
SOP%	100%	100%	100%	100%	101%	100%	100%	98%	100%	99%	99%	100%	97%	101%	98%	100%	100%		99%	99%	100%	100%	104%	100%	100%	100%

Table 2.4.1.1 (continued.)

Quarter 4

Ages	IIa	IIIa	IIIb	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIId	IXacentral-	Ixanorth	Total
0				360.5		0.0		110.9						1.5						19.3		1578.7		0.1	2689.4	4760.3
1		0.4		10750.8	0.0	29.3		2613.5	0.1	95.7	4.5	2561.0	1128.9	154.6	0.2				2523.9	473.6	349.6	5.5		158.2	62.4	20912.2
2		5.0		31716.7	0.1	22.2		6102.6	0.1	1466.2	81.5	977.6	557.8	99.7	0.4	43.8	0.7	0.0	1235.3	2382.7	813.2	10.1	0.0	239.9	109.8	45865.6
3		6.9		111476.2	0.3	59.2		13786.0	0.2	3087.9	182.4	558.8	279.9	111.2	2.3	1230.3	5.4	0.1	2533.3	4093.7	1112.8	15.2	0.1	236.3	149.1	138927.4
4		2.8		47341.0	0.1	36.1		3771.0	0.0	344.9	52.6	93.0	213.1	78.5	1.0	720.4	3.1		2019.7	1324.4	217.1	5.9	0.0	11.0	31.9	56267.7
5		1.3		18407.2	0.0	16.1		1652.8	0.0	160.4	26.2	232.9	85.6	4.4	0.6	462.1	1.5		1231.3	289.8	34.8	1.7	0.0	7.6	4.0	22620.1
6		0.8		15357.8	0.0	13.8		1065.2		90.5	22.0	93.0	39.4	6.8	0.4	354.1	1.0		828.5	272.3	43.3	2.1	0.0	3.0	3.9	18197.8
7		0.3		7170.9	0.0	10.8		1101.5		62.6	16.9	93.0	41.4	2.7	0.3	47.1	0.7		479.8	170.2	18.9	1.6	0.0	1.4	2.0	9222.1
8		0.2		4122.4	0.0	6.6		961.7		30.2	10.4		4.6	3.6	0.2	29.0	0.5		447.2	80.5	8.7	0.6	0.0	0.4	0.6	5707.3
9		0.1		3163.5	0.0	7.3		791.2		35.8	7.7		6.2		0.1	117.6	0.2		272.6	53.7	4.8	0.3	0.0	0.4	0.2	4461.7
10		0.1		2279.9		2.8		199.7		12.6	4.3		1.1	0.6	0.1	12.0	0.2		112.9	27.1	2.4	0.1		0.4	0.1	2656.3
11		0.1		1063.4		1.7		233.7		7.5	2.6		0.1		0.0	7.3	0.1		58.0	13.9	1.2	0.1		0.0	0.0	1389.6
12		0.0		587.9		0.3		92.8		1.1	0.4	47.0	11.7		0.0	1.1	0.0		48.4	2.0	0.3	0.0			0.0	792.9
13				49.0		0.8		71.2		3.7	1.3				0.0	3.6	0.0		44.9	7.0	0.7	0.0			0.0	182.3
14				61.3		0.8		36.2		3.7	1.3				0.0	3.6	0.0		13.1	7.0	0.7					127.7
15				18.5				20.3						0.7					31.8		0.0	0.0			0.0	71.3
SOP		8.0		102728.6	0.2	63.2		10282.4	0.1	1545.1	123.5	1171.1	530.6	92.7	1.8	1029.3	4.2	0.0	3476.5	2252.9	598.1	97.6	0.1	169.8	290.8	124466.7
Catch		8.0		102504.3	0.2	63.2		10222.1	0.1	1540.3	121.8	1170.6	522.4	90.1	1.7	1028.6	4.0	0.0	3576.5	2245.6	595.8	97.6	0.1	169.8	290.1	124253.0
SOP%		100%		100%	102%	100%		99%	104%	100%	99%	100%	98%	97%	98%	100%	95%	0%	103%	100%	100%	100%	0%	100%	100%	100%

Table 2.4.1.2 NE Atlantic mackerel. Percentage catch numbers-at-age.

Zeros represent values <1%.

Ages	IIa	IIIa	IIIb	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIId	IXacentral-	Ixanorth	Total
0		0%		0%	0%	0%		0%	0%					0%						0%	0%	9%		0%	13%	0%
1	0%	1%	1%	2%	1%	3%	0%	3%	2%	2%	0%	28%	34%	18%	0%		0%		6%	2%	2%	4%	1%	14%	8%	3%
2	4%	31%	51%	9%	4%	10%	1%	6%	1%	3%	5%	15%	19%	29%	5%	2%	5%	1%	9%	15%	15%	16%	6%	31%	18%	9%
3	53%	38%	30%	44%	47%	28%	44%	44%	43%	45%	38%	20%	18%	29%	39%	40%	46%	63%	27%	45%	40%	35%	27%	50%	31%	43%
4	20%	15%	9%	20%	24%	23%	16%	16%	18%	18%	21%	13%	13%	16%	18%	23%	20%	11%	21%	19%	19%	17%	24%	2%	19%	19%
5	5%	6%	6%	7%	6%	10%	6%	9%	10%	13%	13%	8%	5%	3%	12%	15%	11%	11%	12%	5%	5%	4%	13%	1%	3%	8%
6	6%	5%	2%	8%	6%	9%	8%	8%	10%	8%	8%	5%	4%	2%	10%	12%	8%	7%	9%	6%	9%	6%	10%	1%	4%	8%
7	5%	2%	1%	4%	5%	7%	10%	4%	5%	4%	6%	5%	3%	1%	6%	2%	4%	3%	6%	3%	5%	4%	6%	1%	2%	4%
8	2%	1%	1%	2%	3%	4%	6%	3%	3%	2%	3%	2%	1%	1%	4%	1%	4%	2%	5%	2%	2%	2%	6%	0%	1%	2%
9	2%	1%	0%	1%	2%	3%	6%	2%	2%	2%	2%	1%	1%	0%	2%	4%	1%	1%	3%	1%	1%	1%	3%	0%	0%	2%
10	1%	1%		2%	1%	2%	1%	2%	2%	1%	1%	1%	0%	0%	1%	0%	1%	0%	1%	1%	0%	0%	2%	0%	0%	1%
11	0%	0%		0%	1%	1%	0%	1%	1%	0%	1%	1%	0%	0%	1%	0%	0%	0%	1%	0%	0%	0%	1%	0%	0%	1%
12	0%	0%		0%	0%	0%	0%	1%	1%	0%	0%	1%	0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%
13	0%	0%		0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%		0%	0%	0%	0%	1%		0%	0%
14	0%	0%		0%	0%	1%	1%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%		0%	0%	0%	0%	0%		0%	0%
15	0%	0%		0%			0%	0%	0%					0%					0%	0%	0%	0%	0%		0%	0%

Table 2.4.2.1. NE Atlantic mackerel. Percentage length compositon in catches by country and gear in 2005. Zeros represent values <1%.

Length	Portugal	Spain			Netherlands	Norway	Scotland		England	Russia	Ireland	Germany
		seine	trawl	artisanal	pel. trawl	purse seine	pel. Trawl	discards	lines	pel trawl	pel trawl	all gears
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16		0	0		0							0
17		0	1									0
18			1									0
19			0	0		0					0	0
20			0		0	0	0				0	0
21	0	1	0		0	0	1	4			1	0
22	0	2	0	0		0	0	3	0		2	0
23	1	1	0			0	0	2	0		1	0
24	1	0	0	0	0	0	0	0	4	0	1	0
25	1	0	0	0	0	0	0	0	8	0	0	0
26	1	2	2	0	1	0	0	0	9		0	1
27	2	11	6	2	2	1	0	0	11	0	0	2
28	3	17	13	6	2	2	0		11	0	0	4
29	11	12	15	7	5	2	2	3	13	1	2	5
30	26	9	12	7	4	3	5	6	13	2	5	7
31	24	8	12	5	8	5	10	10	9	5	9	9
32	16	6	10	4	14	9	14	19	9	10	16	13
33	7	4	6	5	12	13	14	16	5	14	15	12
34	3	4	6	5	11	15	12	10	3	15	10	8
35	1	4	5	7	9	15	10	9	2	12	10	9
36	1	4	3	8	8	12	9	8	1	11	8	9
37	1	4	3	10	8	9	7	5	1	10	7	6
38	0	3	1	10	6	6	6	4	0	8	4	5
39	0	2	2	7	3	3	4	1	0	5	4	4
40	0	2	1	7	3	2	3	0	0	4	2	3
41	0	1	1	4	2	1	2	1	0	3	2	2
42	0	1	1	2	1	1	1	0	0	1	1	1
43	0	0	0	1	1	0	0	0	0	1	0	1
44	0	0	0	0	0	0	0		0	0	0	0
45	0	0	0	0	0	0	0		0	0	0	0
46	0	0	0	0	0	0	0			0	0	0
47	0					0					0	0
48												
49												
50												
51												
52												
53												
54												
55												
56												
57												
58												
59												
60												
Total	100	100	100	100	100	100	100	100	100	100	100	100

Table 2.4.3.1 NE Atlantic mackerel. Mean Length (cm) at age by area.

Quarters 1-4

Ages	IIa	IIIa	IIIb	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc e	VIIIc w	VIIId	IXacentra	Ixanor	Total
0		20.0		21.5	21.5	21.5		17.5	17.4					23.1						21.3	22.5	20.2		24.9	22.4	21.4
1	26.6	30.4	32.9	27.9	24.3	29.4	24.5	24.4	22.2	21.1	23.3	27.8	27.5	26.5	28.1	25.5	25.5	26.1	22.6	27.5	28.7	29.6	19.5	28.1	29.0	26.7
2	30.9	32.9	35.1	33.2	30.4	29.7	30.3	30.8	29.8	30.4	29.4	31.5	30.5	28.7	29.2	29.6	30.5	29.6	29.9	29.6	28.8	30.3	29.9	31.0	31.0	31.5
3	32.8	35.2	36.6	33.2	32.4	32.1	32.0	32.4	32.5	33.1	32.8	32.3	31.7	30.7	32.4	33.6	32.2	32.6	31.8	30.7	30.6	31.5	32.2	31.5	32.1	32.6
4	35.2	37.1	38.4	35.0	34.4	32.7	35.3	34.3	34.3	35.2	34.2	33.0	32.5	31.7	34.0	35.9	34.5	35.5	34.9	34.4	35.0	34.4	34.6	34.1	34.9	34.8
5	36.5	38.1	38.8	37.2	36.1	35.0	36.8	36.2	36.2	37.5	36.7	35.7	35.5	33.6	35.7	37.4	36.9	36.8	36.4	36.7	36.8	36.6	36.2	35.8	36.5	36.8
6	37.5	39.2	41.2	36.8	37.1	35.7	38.2	36.7	36.7	37.9	37.7	36.7	36.8	34.6	36.2	39.0	37.1	36.8	37.3	37.3	37.7	38.0	36.9	36.6	36.7	37.1
7	38.7	39.3	40.3	38.4	38.6	36.6	39.2	37.8	37.8	39.9	38.9	37.7	37.6	34.8	38.0	36.9	39.2	40.3	38.5	38.1	39.3	39.6	38.0	37.5	37.8	38.5
8	39.8	39.8	40.7	40.1	39.3	37.5	40.8	39.2	38.9	39.7	38.7	37.5	36.2	35.5	38.4	37.7	39.5	39.9	39.3	39.6	40.2	40.7	39.3	38.6	39.7	39.7
9	40.4	41.7	43.3	39.6	39.9	39.4	40.5	39.3	39.2	39.9	39.5	39.0	38.2	36.2	37.9	41.8	40.1	35.8	40.6	39.7	40.6	41.5	40.7	39.8	41.8	39.8
10	41.0	43.2	45.5	40.5	40.4	39.3	42.2	39.8	39.7	40.7	39.7	39.3	39.2	37.2	39.3	39.3	40.1	39.3	39.9	39.9	41.9	42.1	39.9	41.2	41.3	40.4
11	42.0	42.7	43.5	41.4	41.9	41.5	42.0	40.7	40.6	41.3	41.4	41.5	41.5	37.1	41.5	41.5	41.9	41.5	41.2	41.5	42.4	41.8	41.1	43.2	41.0	41.2
12	42.3	42.5		42.3	42.9	40.5	42.2	40.9	40.7	41.3	41.0	42.2	42.2	36.9	40.8	40.5	42.9	40.5	41.7	41.8	42.8	43.1	40.5		40.7	41.8
13	42.5	42.8		42.7	43.3	45.5	42.6	42.2	41.9	45.5	45.3	45.5	45.5	45.3	45.3	45.5	44.1	45.5	44.1	44.3	41.1	41.5	44.1		40.0	42.8
14	43.9	46.7		41.5	42.5	42.0	44.0	41.7	41.8	41.8	41.5	42.5	42.0	41.5	41.5	41.5	41.5	41.5	41.5	41.5	45.2	45.6	41.5		45.2	41.9
15	44.5	45.1		44.6	43.3	43.6	45.0	42.8	42.9					39.2					43.5	43.5	42.5	41.9	43.5		41.5	43.3

Quarter 1

Ages	IIa	IIIa	IIIb	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc e	VIIIc w	VIIId	IXacentra	Ixanor	Total
0				20.0																						20.0
1				22.5	23.0	29.4		22.0	22.0	20.8	20.9			23.4	25.5		25.5		19.5	25.0	28.6	29.0	19.5	26.1	28.6	24.2
2				30.2	29.5	29.9		29.9	29.7	29.3	29.1	29.7	29.3	28.1	28.9	29.5	30.5	28.0	30.9	28.3	28.6	29.6	31.5	30.5	30.8	29.4
3				32.7	32.5	32.2		32.4	32.5	33.2	32.8	32.1	31.6	31.4	32.4	33.5	32.2	32.7	32.5	30.2	30.3	31.1	32.6	31.1	32.0	32.1
4				34.6	34.3	32.8		34.3	34.3	35.2	34.2	32.8	32.8	32.5	34.2	35.8	34.6	35.9	35.0	34.2	34.7	33.7	35.2	33.5	34.6	34.6
5				36.7	36.3	35.0		36.2	36.2	37.5	36.7	35.0	35.0	36.8	35.9	37.3	37.2	36.9	36.4	36.7	36.5	35.2	36.5	35.5	35.3	36.7
6				36.5	36.7	35.7		36.7	36.7	37.9	37.7	35.7	35.9	36.5	36.3	38.8	37.2	36.9	37.0	37.3	37.6	36.7	37.2	36.5	35.5	36.9
7				38.4	37.6	36.6		37.8	37.8	39.9	39.0	36.6	36.5	38.8	38.5	37.1	39.8	40.8	38.4	38.3	39.3	38.9	38.4	37.4	36.4	38.6
8				40.6	39.4	37.5		39.0	38.9	39.7	38.7	37.5	37.4	39.1	38.7	37.8	39.9	40.2	39.8	39.7	40.3	40.3	40.1	38.5	38.8	39.8
9				39.4	39.4	39.6		39.2	39.2	40.0	39.6	39.0	39.1	41.2	37.1	41.6	40.3	35.0	40.9	40.1	40.6	41.3	41.5	39.7	41.4	39.7
10				41.4	40.7	39.3		39.8	39.7	40.7	39.7	39.3	39.3	39.4	39.3	39.3	40.2		39.9	39.9	41.8	42.1	40.0	40.8	41.5	40.7
11				40.8	42.0	41.5		40.6	40.6	41.3	41.4	41.5	41.5	40.3	41.5	41.5	42.2		41.0	41.3	42.3	42.0	40.9	43.1	41.1	40.9
12				42.0	42.6	40.5		40.8	40.7	41.3	40.9	40.5	40.5	40.5	40.5	40.5	43.4		40.5	41.6	42.8	42.9	40.5		40.1	41.2
13				42.2	44.1	45.5		42.0	41.9	45.5	45.5	45.5	45.5	45.5	45.5	45.5	45.5		43.8	44.2	41.2	41.8	43.6		46.5	42.4
14				41.1	41.5	41.5		41.7	41.8	41.8	41.5	41.5	42.1	41.5	41.5	41.5	41.5		41.5	41.5	44.6	45.6	41.5		45.6	41.4
15				43.9		43.9		42.7	42.9										43.5	43.5	42.5	42.0	43.5		41.5	42.8

Table 2.4.3.1 continued.

Quarter 2

Ages	IIa	IIIa	IIIb	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc e	VIIIc w	VIIId	IXacentra	Ixanor	Total
0		20.0		20.0										23.5												22.9
1		30.2		30.1	22.1			29.5	22.1	20.9	20.9			23.5						18.8	28.9	29.3		27.7	28.7	27.9
2	30.0	32.7		32.6	29.9	29.5	29.0	31.7	29.8	28.5	28.1	29.4	29.0	29.0	29.2	29.7	29.6	28.6	28.0	29.7	30.3	30.8	29.1	30.6	31.9	29.8
3	32.5	35.2		32.2	32.4	32.0	31.3	33.2	32.5	33.4	33.5	31.9	31.1	30.5	32.4	32.5	32.7	32.6	30.4	31.9	33.9	33.6	31.4	31.7	34.4	32.3
4	34.9	37.0		34.7	34.5	32.7	34.8	35.7	34.3	35.4	35.3	32.6	32.8	32.2	33.9	33.3	34.1	35.5	34.3	35.5	36.2	36.2	33.5	34.0	36.2	34.9
5	36.5	38.0		37.8	36.2	35.0	37.0	36.1	36.2	38.3	37.6	35.0	34.8	34.0	35.6	35.1	35.5	36.7	36.1	37.6	37.5	38.3	35.5	35.4	38.0	36.4
6	37.6	39.2		39.0	37.2	35.7	38.7	38.5	36.8	39.3	38.8	35.7	35.8	35.0	36.2	36.0	36.8	36.8	37.2	37.8	38.1	39.1	36.4	36.5	38.2	37.5
7	39.4	39.3		39.3	38.8	36.6	39.4	37.3	37.8	41.6	40.8	36.6	36.5	36.0	37.9	36.8	37.3	40.2	38.3	38.8	39.4	40.0	37.4	37.4	38.9	38.6
8	40.0	39.8		40.6	39.5	37.5	41.0	39.4	38.9	39.8	38.7	37.5	37.3	36.3	38.3	37.8	38.5	39.8	38.1	40.7	40.2	40.9	37.7	38.5	40.0	39.1
9	40.2	41.7		40.8	40.0	39.0	40.5	40.2	39.2	41.0	41.4	39.0	38.9	35.7	38.1	39.6	39.8	35.9	39.4	39.2	40.6	41.6	39.2	39.8	42.1	40.0
10	40.8	43.2		43.1	40.5	39.3	43.0	39.1	39.7	41.5	41.5	39.3	39.3	37.5	39.3	39.3	39.3	39.3	39.8	39.9	42.3	42.1	39.6	40.8	41.2	40.4
11	42.0	42.7		42.6	41.9	41.5	41.5	39.8	40.6	41.1	41.1	41.5	41.5	36.7	41.5	41.5	41.5	41.5	41.5	41.8	42.5	41.7	41.5	42.7	40.9	41.8
12	44.0	42.5		42.5	43.2	40.5	40.5	40.5	40.7	41.8	43.5	40.5	40.5	36.8	40.9	41.2	42.6	40.5	40.5	42.0	42.9	43.2	40.5		40.7	42.4
13	42.4	42.8		42.8	43.0	45.5	45.5	44.8	41.9	45.5	43.5	45.5	45.5	45.5	45.2	45.1	43.9	45.5	45.5	43.8	41.0	41.4	45.5		46.5	43.6
14	43.0	46.7		44.0	42.7	42.1	44.0	44.0	41.8	41.5	41.5	42.7	42.1	41.5	41.5	41.5	41.5	41.5	41.5	41.6	45.5	45.6	41.5		45.5	42.6
15		45.1		45.1	43.9			45.7	42.9											43.5	42.5	41.9			41.5	42.5

Quarter 3

Ages	IIa	IIIa	IIIb	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc e	VIIIc w	VIIId	IXacentra	Ixanor	Total
0		20.0		20.2	21.5	20.0		17.5	17.4					23.5						21.3	22.5			24.9	24.3	21.1
1	26.6	30.4	32.9	28.1	24.4	29.3	24.5	25.8	25.8	26.1		27.8	27.8	27.2						28.4	28.3	30.0		29.9	30.0	27.6
2	31.0	32.9	35.1	33.1	31.1	29.9	30.8	31.1	30.8	28.8	27.9	32.4	30.8	28.7	29.1	29.7	29.6		29.1	31.3	30.4	31.8	29.1	32.2	31.7	32.3
3	32.9	35.2	36.6	33.5	32.0	32.2	33.1	32.1	31.9	33.1	33.5	33.1	32.2	30.6	32.4	32.5	33.0		31.4	32.3	31.0	31.9	31.4	32.7	31.9	33.1
4	35.2	37.1	38.4	35.3	33.1	32.8	35.6	33.1	32.5	34.7	35.3	36.1	34.0	31.6	34.0	33.3	34.8		33.5	33.8	33.7	33.3	33.5	35.5	33.4	35.2
5	36.5	38.1	38.8	37.2	35.2	35.0	36.6	35.8	35.4	37.5	37.6	37.3	36.0	33.4	35.7	35.1	35.7		35.5	35.7	35.9	35.4	35.5	36.5	35.3	36.9
6	37.5	39.2	41.2	36.5	36.0	35.7	37.6	37.5	36.4	38.1	38.8	40.8	37.8	34.9	36.2	36.0	37.1		36.4	36.6	36.5	36.5	36.4	37.2	36.1	36.9
7	38.6	39.3	40.3	37.9	36.7	36.6	38.7	38.5	37.5	40.1	40.8	41.3	38.7	34.5	38.2	36.8	37.7		37.4	37.1	37.9	37.5	37.4	38.2	37.1	38.3
8	39.8	39.8	40.7	38.6	37.6	37.5	39.8	40.1	39.0	37.9	38.6	37.5	37.5	35.3	38.5	37.8	38.8		37.7	38.0	38.5	38.1	37.7	39.6	37.4	39.1
9	40.4	41.7	43.3	39.8	39.2	39.6	40.5	39.5	39.2	39.0	41.5	39.0	39.4	39.6	37.7	39.6	40.1		39.2	39.2	39.4	38.9	39.2	40.7	38.1	40.1
10	41.0	43.2	45.5	40.0	39.4	39.3	41.1	39.9	39.5	39.3		39.3	39.4	39.3	39.3	39.3	39.3		39.6	39.6	41.6	41.4	39.6	42.7	39.7	40.3
11	42.0	42.7	43.5	41.6	41.5	41.5	42.0	41.0	41.2	41.5		41.5	41.5	41.5	41.5	41.5	41.5		41.5	41.5	42.0	41.5	41.5	45.0	41.0	41.7
12	42.2	42.5		42.5	40.7	40.5	42.2	43.1	42.8	40.5	43.5	42.5	41.7	41.2	40.7	41.2	43.2		40.5	40.7	42.3	40.4	40.5		39.9	42.4
13	42.5	42.8		42.8	45.5	45.5	42.6	43.6	44.7	45.5	43.5	45.5	45.5	45.1	45.3	45.1	43.6		45.5	45.5	40.7	40.4	45.5		39.9	42.8
14	44.1	46.7		46.2	41.5	41.5	44.0	41.6	41.5	41.5		42.1	41.5	41.5	41.5	41.5	41.5		41.5	41.5			41.5		43.5	43.7
15	44.5	45.1		45.1	42.5	45.1	45.0	46.4	46.5											43.5	42.5	42.1			41.8	45.0

Table 2.4.3.1 continued.

Quarter 4

Ages	IIa	IIIa	IIIb	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc e	VIIIc w	VIIId	IXacentra	Ixanor	Total
0		21.9		21.6	21.5	21.5		17.4	17.4					22.8						21.3		20.2		23.4	22.4	21.5
1		30.2		29.2	28.3	29.4		25.9	25.8	26.1	26.1	27.8	27.4	26.1	28.1	25.5	25.5	26.1	22.8	28.8	29.4	29.0		30.2	29.8	27.7
2		34.8		33.8	33.6	30.5		30.9	31.1	31.2	30.4	32.5	30.7	28.6	30.1	29.7	28.4	31.3	32.2	30.6	30.6	32.0	29.1	32.0	31.5	33.0
3		28.4		33.5	34.3	32.4		32.4	32.0	32.2	32.1	33.2	31.9	31.1	32.4	33.6	31.7	32.1	32.6	31.3	31.2	32.4	31.4	32.5	31.7	33.2
4		37.4		35.2	35.3	32.9		34.7	32.8	33.9	33.3	36.5	31.7	31.7	34.3	36.0	33.8	33.9	35.6	34.0	33.7	35.0	33.5	35.5	33.5	35.1
5		39.0		37.6	36.9	35.0		36.4	35.7	36.3	35.4	37.3	35.8	34.5	36.1	37.5	36.3	36.0	36.8	35.6	35.5	37.7	35.5	36.5	35.6	37.4
6		39.4		37.5	36.8	35.8		37.3	38.9	37.4	36.8	41.0	37.7	33.2	36.6	39.1	36.8	38.0	38.3	36.5	35.9	38.5	36.4	37.3	36.4	37.6
7		40.4		38.5	38.5	36.6		38.2	39.6	38.8	36.6	41.5	38.4	34.2	38.7	36.6	38.5		39.2	36.7	37.2	39.1	37.4	37.8	37.5	38.5
8		41.0		40.0	39.9	37.5		40.1	40.8	37.9	37.5		25.8	35.5	38.8	37.5	39.0		40.3	37.6	37.5	39.7	37.7	39.8	38.2	40.0
9		41.1		39.7	40.2	40.7		39.4	39.4	37.7	37.6		34.2	39.4	38.0	41.9	40.7	36.0	41.7	38.7	39.1	39.9	39.2	40.9	39.4	39.8
10		40.0		38.8	40.4	39.3		39.7	40.5	39.3	39.3		37.9	36.5	39.4	39.3	40.5		40.1	39.6	40.1	41.2	39.6	42.5	41.0	38.9
11		43.5		41.9	41.2	41.5		41.1	40.9	41.4	41.5		38.5	41.5	41.3	41.5	42.5		40.9	41.5	41.6	41.6	41.5	44.5	41.7	41.7
12		42.1		42.2	42.5	40.6		43.2	43.6	40.5	40.5	42.5	42.5	41.2	40.9	40.5	42.5		42.3	40.5	41.2	41.2	40.5		40.7	42.3
13		46.4		44.9	44.5	45.5		44.0	42.5	45.5	45.5			45.5	45.5	45.5	45.5		43.4	45.5	44.7	40.9	45.5		40.6	44.2
14		46.4		43.0	42.5	41.5		41.5		41.5	41.5			41.5	41.5	41.5	41.5		41.5	41.5	42.3		41.5		43.5	42.2
15				42.5	42.5	42.5		46.5	46.5					39.2					43.5		42.5	41.8			42.0	44.1

Table 2.4.3.2. NE Atlantic mackerel. Mean weight (kg) at age.

Mean Weight at Age by Area (Kg)

Quarters 1-4

Ages	IIa	IIIa	IIIb	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc e	VIIIc w	VIIId	IXacentra	Ixanor	Total
0		0.083		0.080	0.080	0.080		0.031	0.031					0.086						0.068	0.074	0.053		0.116	0.075	0.067
1	0.139	0.259	0.331	0.178	0.122	0.215	0.137	0.111	0.081	0.074	0.085	0.165	0.159	0.139	0.175	0.112	0.112	0.125	0.086	0.150	0.169	0.197	0.038	0.175	0.185	0.152
2	0.298	0.348	0.412	0.341	0.238	0.189	0.280	0.238	0.210	0.222	0.182	0.255	0.231	0.180	0.175	0.180	0.209	0.200	0.184	0.189	0.169	0.212	0.181	0.234	0.226	0.270
3	0.368	0.430	0.471	0.353	0.308	0.262	0.314	0.277	0.279	0.282	0.272	0.273	0.256	0.224	0.263	0.262	0.246	0.265	0.238	0.211	0.209	0.236	0.243	0.244	0.250	0.307
4	0.449	0.502	0.544	0.398	0.373	0.268	0.420	0.338	0.338	0.349	0.314	0.277	0.271	0.253	0.304	0.319	0.315	0.356	0.307	0.301	0.316	0.306	0.299	0.317	0.316	0.367
5	0.485	0.549	0.566	0.483	0.416	0.322	0.455	0.402	0.400	0.443	0.401	0.364	0.365	0.305	0.354	0.396	0.407	0.399	0.359	0.371	0.368	0.369	0.350	0.371	0.361	0.435
6	0.516	0.603	0.683	0.463	0.446	0.352	0.490	0.418	0.420	0.449	0.420	0.405	0.421	0.344	0.374	0.485	0.402	0.406	0.394	0.390	0.396	0.409	0.375	0.388	0.369	0.440
7	0.560	0.617	0.655	0.526	0.508	0.380	0.507	0.463	0.464	0.534	0.478	0.442	0.452	0.342	0.448	0.394	0.503	0.551	0.432	0.417	0.446	0.459	0.412	0.416	0.400	0.498
8	0.612	0.616	0.643	0.594	0.522	0.387	0.560	0.525	0.507	0.552	0.495	0.387	0.386	0.368	0.440	0.398	0.505	0.527	0.441	0.464	0.480	0.496	0.442	0.459	0.462	0.542
9	0.630	0.726	0.791	0.580	0.555	0.525	0.551	0.526	0.517	0.559	0.527	0.491	0.462	0.364	0.443	0.552	0.541	0.363	0.519	0.489	0.494	0.523	0.527	0.505	0.540	0.555
10	0.645	0.807	0.932	0.614	0.568	0.476	0.641	0.548	0.541	0.579	0.503	0.476	0.477	0.413	0.477	0.476	0.557	0.476	0.496	0.490	0.542	0.546	0.497	0.583	0.514	0.587
11	0.695	0.749	0.749	0.679	0.660	0.646	0.702	0.584	0.578	0.619	0.642	0.646	0.644	0.415	0.645	0.646	0.666	0.646	0.600	0.574	0.559	0.533	0.598	0.656	0.501	0.631
12	0.649	0.752		0.731	0.757	0.655	0.645	0.592	0.575	0.608	0.656	0.636	0.636	0.395	0.647	0.654	0.676	0.654	0.642	0.567	0.577	0.582	0.654		0.493	0.648
13	0.740	0.783		0.734	0.696	0.771	0.752	0.654	0.641	0.771	0.759	0.771	0.771	0.759	0.753	0.770	0.667	0.771	0.733	0.708	0.512	0.523	0.733		0.580	0.683
14	0.776	0.892		0.614	0.719	0.577	0.627	0.611	0.634	0.602	0.532	0.616	0.576	0.532	0.532	0.532	0.532	0.532	0.532	0.535	0.681	0.686	0.532		0.697	0.607
15	0.930	0.852		0.820	0.742	0.791	0.987	0.650	0.692					0.527					0.664	0.636	0.564	0.538	0.664		0.521	0.684

Quarter 1

Ages	IIa	IIIa	IIIb	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc e	VIIIc w	VIIId	IXacentra	Ixanor	Total
0				0.083																						0.083
1				0.078	0.078	0.216		0.078	0.078	0.071	0.052			0.081	0.112		0.112		0.038	0.108	0.166	0.181	0.038	0.133	0.174	0.107
2				0.220	0.188	0.192		0.206	0.207	0.182	0.171	0.182	0.177	0.155	0.168	0.179	0.211	0.152	0.195	0.158	0.166	0.192	0.203	0.211	0.215	0.187
3				0.288	0.271	0.267		0.275	0.279	0.282	0.272	0.261	0.244	0.227	0.263	0.262	0.245	0.265	0.251	0.198	0.202	0.223	0.246	0.226	0.241	0.260
4				0.345	0.322	0.271		0.336	0.338	0.350	0.314	0.267	0.267	0.254	0.314	0.318	0.317	0.367	0.310	0.295	0.308	0.285	0.311	0.286	0.305	0.329
5				0.422	0.387	0.321		0.401	0.400	0.444	0.400	0.321	0.323	0.391	0.361	0.394	0.418	0.405	0.358	0.371	0.360	0.326	0.359	0.340	0.324	0.408
6				0.413	0.402	0.352		0.417	0.420	0.449	0.419	0.352	0.356	0.376	0.380	0.480	0.409	0.412	0.382	0.392	0.392	0.369	0.383	0.372	0.328	0.413
7				0.489	0.437	0.380		0.460	0.464	0.536	0.481	0.380	0.378	0.471	0.471	0.404	0.533	0.576	0.434	0.426	0.445	0.434	0.426	0.401	0.354	0.478
8				0.587	0.519	0.387		0.514	0.507	0.554	0.499	0.387	0.386	0.475	0.461	0.406	0.533	0.546	0.464	0.465	0.481	0.481	0.466	0.441	0.427	0.534
9				0.526	0.528	0.542		0.518	0.517	0.562	0.530	0.491	0.493	0.560	0.417	0.548	0.557	0.332	0.528	0.504	0.495	0.517	0.544	0.486	0.519	0.524
10				0.625	0.584	0.476		0.549	0.541	0.582	0.504	0.476	0.476	0.517	0.476	0.476	0.572		0.504	0.497	0.535	0.544	0.509	0.530	0.523	0.585
11				0.606	0.672	0.646		0.577	0.578	0.618	0.642	0.646	0.646	0.537	0.646	0.646	0.680		0.582	0.570	0.557	0.537	0.568	0.632	0.505	0.589
12				0.659	0.730	0.654		0.581	0.575	0.608	0.658	0.654	0.654	0.654	0.654	0.654	0.784		0.654	0.572	0.576	0.575	0.654		0.472	0.597
13				0.658	0.766	0.771		0.645	0.641	0.771	0.771	0.771	0.771	0.771	0.771	0.771	0.771		0.724	0.717	0.513	0.531	0.717		0.729	0.650
14				0.587	0.532	0.532		0.621	0.634	0.608	0.532	0.532	0.581	0.532	0.532	0.532	0.532		0.532	0.535	0.648	0.687	0.532		0.687	0.591
15				0.739		0.739		0.676	0.693										0.664	0.649	0.564	0.539	0.664		0.520	0.669

Table 2.4.3.2 (Contd)

Quarter 2

Ages	IIa	IIIa	IIIb	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc e	VIIIc w	VIIId	IXacentra	Ixanor	Total
0		0.083		0.083										0.087												0.086
1		0.256		0.254	0.079			0.188	0.080	0.052	0.052			0.088						0.043	0.172	0.187		0.165	0.175	0.166
2	0.233	0.344		0.342	0.223	0.181	0.215	0.242	0.208	0.158	0.145	0.180	0.172	0.175	0.174	0.182	0.182	0.163	0.147	0.183	0.199	0.217	0.169	0.223	0.239	0.197
3	0.326	0.429		0.297	0.312	0.257	0.266	0.289	0.279	0.273	0.271	0.255	0.228	0.206	0.263	0.262	0.263	0.265	0.206	0.236	0.287	0.283	0.238	0.248	0.303	0.280
4	0.408	0.501		0.382	0.379	0.265	0.355	0.367	0.339	0.346	0.339	0.264	0.266	0.246	0.301	0.280	0.299	0.354	0.284	0.328	0.346	0.352	0.275	0.308	0.349	0.334
5	0.449	0.548		0.522	0.423	0.322	0.425	0.368	0.399	0.470	0.444	0.321	0.318	0.294	0.351	0.333	0.356	0.397	0.342	0.397	0.389	0.415	0.331	0.346	0.405	0.372
6	0.482	0.603		0.557	0.455	0.352	0.467	0.463	0.420	0.441	0.422	0.352	0.351	0.327	0.372	0.362	0.386	0.405	0.372	0.399	0.408	0.440	0.361	0.378	0.412	0.401
7	0.556	0.617		0.530	0.520	0.380	0.485	0.405	0.463	0.573	0.539	0.380	0.375	0.361	0.440	0.393	0.413	0.547	0.409	0.438	0.450	0.470	0.394	0.407	0.432	0.443
8	0.573	0.615		0.570	0.537	0.387	0.549	0.492	0.507	0.569	0.530	0.387	0.384	0.362	0.434	0.401	0.433	0.524	0.390	0.505	0.478	0.503	0.388	0.445	0.469	0.453
9	0.581	0.725		0.577	0.562	0.491	0.529	0.531	0.518	0.619	0.552	0.491	0.487	0.347	0.450	0.500	0.504	0.366	0.486	0.456	0.492	0.526	0.489	0.493	0.545	0.504
10	0.599	0.807		0.750	0.577	0.476	0.629	0.475	0.540	0.637	0.637	0.476	0.476	0.405	0.476	0.476	0.476	0.476	0.482	0.478	0.556	0.546	0.479	0.533	0.512	0.518
11	0.666	0.749		0.744	0.661	0.646	0.646	0.515	0.577	0.623	0.623	0.646	0.646	0.397	0.646	0.646	0.646	0.646	0.646	0.552	0.563	0.530	0.646	0.611	0.500	0.618
12	0.810	0.752		0.750	0.772	0.654	0.654	0.558	0.575	0.668	0.579	0.654	0.654	0.384	0.645	0.637	0.601	0.654	0.654	0.556	0.580	0.585	0.654		0.495	0.593
13	0.666	0.783		0.781	0.687	0.771	0.771	0.744	0.641	0.771	0.617	0.771	0.771	0.768	0.750	0.737	0.651	0.771	0.771	0.633	0.507	0.517	0.771		0.729	0.650
14	0.810	0.892		0.621	0.752	0.587	0.619	0.619	0.633	0.532	0.532	0.635	0.587	0.532	0.532	0.532	0.532	0.532	0.532	0.548	0.693	0.686	0.532		0.683	0.612
15		0.852		0.851	0.739			0.896	0.692											0.614	0.562	0.536			0.520	0.563

Quarter 3

Ages	IIa	IIIa	IIIb	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc e	VIIIc w	VIIId	IXacentra	Ixanor	Total
0		0.083		0.082	0.080	0.083		0.032	0.031					0.088						0.068	0.074			0.117	0.100	0.071
1	0.139	0.261	0.331	0.196	0.123	0.215	0.137	0.132	0.131	0.125		0.165	0.165	0.149						0.168	0.169	0.212		0.220	0.211	0.165
2	0.301	0.349	0.412	0.354	0.259	0.196	0.307	0.256	0.245	0.163	0.140	0.289	0.233	0.179	0.171	0.182	0.180		0.169	0.218	0.214	0.256	0.169	0.284	0.254	0.322
3	0.373	0.430	0.471	0.377	0.274	0.268	0.387	0.286	0.276	0.270	0.270	0.309	0.268	0.223	0.263	0.262	0.264		0.238	0.248	0.229	0.260	0.238	0.300	0.259	0.368
4	0.456	0.502	0.544	0.446	0.300	0.273	0.471	0.322	0.295	0.325	0.339	0.399	0.315	0.251	0.307	0.280	0.315		0.275	0.280	0.313	0.304	0.275	0.395	0.308	0.444
5	0.489	0.549	0.566	0.528	0.362	0.322	0.489	0.412	0.391	0.436	0.444	0.447	0.376	0.302	0.355	0.333	0.369		0.331	0.336	0.396	0.381	0.331	0.437	0.377	0.506
6	0.520	0.604	0.683	0.495	0.369	0.353	0.524	0.473	0.393	0.402	0.421	0.625	0.465	0.355	0.375	0.362	0.396		0.361	0.366	0.419	0.422	0.361	0.469	0.406	0.502
7	0.560	0.617	0.655	0.561	0.388	0.380	0.563	0.516	0.446	0.511	0.539	0.647	0.497	0.336	0.454	0.393	0.432		0.394	0.383	0.478	0.468	0.394	0.512	0.446	0.558
8	0.618	0.616	0.643	0.582	0.400	0.387	0.617	0.595	0.509	0.463	0.530	0.387	0.387	0.366	0.445	0.401	0.448		0.388	0.397	0.510	0.491	0.388	0.580	0.461	0.591
9	0.633	0.727	0.791	0.644	0.505	0.543	0.638	0.574	0.542	0.491	0.531	0.491	0.501	0.500	0.435	0.500	0.505		0.489	0.485	0.548	0.529	0.489	0.638	0.489	0.633
10	0.652	0.808	0.932	0.636	0.485	0.477	0.657	0.562	0.507	0.476		0.476	0.480	0.476	0.476	0.476	0.476		0.479	0.479	0.662	0.654	0.479	0.757	0.567	0.638
11	0.702	0.749	0.749	0.748	0.648	0.646	0.702	0.654	0.654	0.646		0.646	0.646	0.646	0.646	0.646	0.646		0.646	0.628	0.685	0.662	0.646	0.904	0.631	0.727
12	0.648	0.752		0.752	0.661	0.655	0.645	0.781	0.775	0.654	0.577	0.633	0.641	0.637	0.649	0.637	0.584		0.654	0.613	0.704	0.602	0.654		0.572	0.706
13	0.750	0.783		0.784	0.772	0.771	0.752	0.757	0.764	0.771	0.617	0.771	0.771	0.737	0.757	0.737	0.625		0.771	0.768	0.612	0.600	0.771		0.571	0.768
14	0.768	0.892		0.866	0.534	0.532	0.760	0.553	0.532	0.532		0.587	0.532	0.532	0.532	0.532	0.532		0.532	0.532			0.532		0.778	0.725
15	0.930	0.852		0.851	0.747	0.852	0.987	0.133	0.100											0.614	0.713	0.693			0.677	0.855

Table 2.4.3.2 (Contd)

Quarter 4

Ages	IIa	IIIa	IIIb	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc e	VIIIc w	VIIId	IXacentra	Ixanor	Total
0		0.079		0.080	0.080	0.080		0.031	0.031					0.084						0.068		0.053		0.082	0.074	0.066
1		0.233		0.201	0.204	0.216		0.131	0.132	0.125	0.125	0.165	0.159	0.133	0.175	0.112	0.112	0.125	0.089	0.170	0.184	0.192		0.209	0.206	0.171
2		0.382		0.349	0.347	0.223		0.245	0.258	0.255	0.218	0.289	0.239	0.184	0.201	0.182	0.160	0.259	0.233	0.213	0.210	0.262	0.169	0.258	0.248	0.315
3		0.441		0.381	0.373	0.282		0.286	0.285	0.283	0.272	0.310	0.272	0.242	0.262	0.262	0.243	0.285	0.259	0.228	0.226	0.276	0.238	0.274	0.255	0.359
4		0.487		0.400	0.409	0.277		0.361	0.313	0.319	0.308	0.414	0.261	0.259	0.314	0.320	0.299	0.353	0.339	0.287	0.304	0.367	0.275	0.377	0.311	0.390
5		0.559		0.507	0.473	0.325		0.420	0.417	0.394	0.377	0.449	0.396	0.344	0.370	0.398	0.386	0.438	0.387	0.344	0.357	0.475	0.331	0.421	0.387	0.487
6		0.581		0.500	0.477	0.355		0.439	0.564	0.411	0.441	0.636	0.498	0.303	0.390	0.492	0.402	0.541	0.453	0.368	0.375	0.510	0.361	0.455	0.418	0.492
7		0.641		0.560	0.545	0.382		0.494	0.594	0.461	0.380	0.655	0.516	0.335	0.479	0.380	0.482		0.478	0.367	0.417	0.536	0.394	0.480	0.468	0.542
8		0.650		0.614	0.613	0.389		0.595	0.654	0.459	0.387		0.389	0.378	0.465	0.387	0.490		0.472	0.383	0.410	0.565	0.388	0.583	0.500	0.593
9		0.655		0.607	0.625	0.642		0.567	0.585	0.468	0.466		0.333	0.501	0.452	0.557	0.602	0.437	0.549	0.464	0.498	0.578	0.489	0.643	0.551	0.591
10		0.594		0.568	0.638	0.478		0.534	0.637	0.475	0.476		0.472	0.413	0.488	0.476	0.563		0.509	0.478	0.517	0.644	0.479	0.744	0.633	0.561
11		0.786		0.702	0.673	0.646		0.655	0.663	0.640	0.646		0.495	0.646	0.628	0.646	0.703		0.571	0.646	0.650	0.664	0.646	0.885	0.672	0.687
12		0.753		0.751	0.747	0.659		0.796	0.816	0.650	0.654	0.633	0.633	0.646	0.651	0.654	0.743		0.635	0.654	0.674	0.643	0.654		0.620	0.740
13		0.861		0.861	0.868	0.771		0.759	0.746	0.771	0.771			0.771	0.770	0.771	0.771		0.711	0.771	0.746	0.627	0.771		0.611	0.775
14		0.886		0.757	0.747	0.533		0.532		0.532	0.532			0.532	0.532	0.532	0.532		0.532	0.532	0.604		0.532		0.778	0.640
15				0.747	0.747	0.747		0.100	0.100					0.527					0.664		0.716	0.674			0.688	0.524

Table 2.5.5.1.- Southern Mackerel. CPUE at age from bottom trawl surveys.

October Spain Survey, Bottom trawl survey (Catch: numbers)

Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10+
1984	1	1.47	0.20	0.11	0.37	0.15	0.21	0.04	0.01	0.03	0.02	0.07
1985	1	2.65	1.60	0.02	0.06	0.37	0.14	0.09	0.03	0.02	0.03	0.08
1986	1	0.03	0.17	0.14	0.02	0.03	0.06	0.03	0.00	0.00	0.00	0.03
1987												
1988	1	0.29	0.03	0.03	0.01	0.02	0.01	0.01	0.01	0.00	0.00	0.00
1989	1	0.51	0.00	0.02	0.00	0.04	0.02	0.00	0.01	0.00	0.00	0.00
1990	1	0.40	0.94	0.04	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00
1991	1	0.13	0.27	0.22	0.27	0.34	0.07	0.03	0.01	0.03	0.00	0.01
1992	1	19.90	0.48	0.16	0.15	0.09	0.03	0.01	0.00	0.00	0.00	0.00
1993	1	0.07	1.26	0.79	0.03	0.06	0.02	0.01	0.00	0.00	0.00	0.01
1994	1	0.47	0.11	0.12	0.15	0.04	0.04	0.01	0.01	0.00	0.00	0.00
1995	1	0.92	0.03	0.19	0.16	0.05	0.01	0.01	0.00	0.00	0.00	0.00
1996	1	46.09	6.40	1.32	0.07	0.10	0.02	0.00	0.01	0.01	0.00	0.00
1997	1	5.73	27.11	6.28	0.67	0.39	0.00	0.00	0.00	0.00	0.00	0.00
1998	1	0.46	3.82	0.97	0.24	0.05	0.09	0.06	0.02	0.02	0.00	0.01
1999	1	3.93	0.98	2.42	0.53	0.12	0.01	0.00	0.00	0.00	0.00	0.00
2000	1	26.78	1.90	0.87	0.20	0.10	0.02	0.03	0.00	0.00	0.00	0.00
2001	1	0.31	1.21	1.07	0.32	0.15	0.08	0.00	0.00	0.00	0.00	0.00
2002	1	14.46	0.34	0.61	0.32	0.10	0.05	0.03	0.00	0.00	0.00	0.00
2003	1	1.43	3.34	0.71	0.15	0.07	0.01	0.02	0.00	0.00	0.00	0.00
2004	1	8.10	0.50	0.57	0.21	0.09	0.04	0.00	0.01	0.00	0.00	0.00
2005	1	52.94	1.06	0.87	0.73	0.12	0.01	0.02	0.00	0.00	0.00	0.00

October Portugal Survey, Bottom trawl survey (Catch: numbers)

Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10+
1986	1	0.52	2.76	1.00	0.51	0.04	0.01	0.01	0.00	0.00	0.00	0.00
1987	1	1.03	23.28	14.79	2.94	0.55	0.00	0.00	0.00	0.00	0.00	0.00
1988	1	86.47	24.55	0.35	0.33	0.04	0.01	0.00	0.00	0.00	0.00	0.00
1989	1	11.64	28.43	4.71	3.45	0.02	0.01	0.00	0.00	0.00	0.00	0.00
1990	1	1.34	2.99	1.75	0.09	0.01	0.00	0.00	0.00	0.00	0.00	0.00
1991	1	0.31	0.37	0.29	0.19	0.03	0.02	0.02	0.01	0.00	0.00	0.00
1992	1	123.55	2.74	0.66	0.30	0.06	0.01	0.01	0.00	0.00	0.00	0.00
1993	1	52.32	0.39	0.12	0.05	0.08	0.00	0.00	0.00	0.00	0.00	0.00
1994	1	12.21	0.77	0.30	0.11	0.04	0.05	0.02	0.01	0.00	0.00	0.00
1995	1	318.60	9.08	0.28	0.11	0.03	0.01	0.01	0.00	0.00	0.00	0.00
1996*	1	235.26	2.16	0.22	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1997	1	772.03	39.40	7.66	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1998	1	226.59	11.58	0.31	0.00	0.04	0.02	0.00	0.00	0.02	0.00	0.00
1999*	1	209.11	2.62	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000	1	23.23	2.26	0.03	0.04	0.14	0.07	0.00	0.02	0.00	0.00	0.00
2001	1	299.04	12.19	3.89	1.70	0.19	0.05	0.02	0.00	0.01	0.01	0.01
2002	1	116.57	18.54	0.21	0.27	0.00	0.02	0.00	0.00	0.00	0.00	0.00
2003**	1	1.59	6.92	0.07	0.08	0.00	0.03	0.00	0.00	0.00	0.00	0.00
2004**	1	42.89	11.64	7.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2005**	1	65.61	3.33	1.07	0.41	0.01	0.07	0.00	0.00	0.00	0.00	0.00

* DIFFERENT SHIP

** half hour trawl and different ship

Table 2.5.9.1. NEA mackerel. Area, time, length, weight and total biomass based on acoustic registrations 1999 – 2004

Year	Dates	Area	Biomass [x10^3 tonn]	Biomass Standard deviation
1999	12. Oct. – 22. Oct	Norwegian waters north of 59°N	733	160
2000	15. Oct – 5. Nov	North of 57°30’ N	549	66
2001	8. Oct. – 25. Oct.	North of 57°30’ N	372	60
2002	15. Oct – 3. Nov	North of 59°N partly with RV ”Scotia”	828	153
2003	16. Oct – 6. Nov	59-62°N; 1°W – 4°E partly with “Scotia”	606	105
2004	18. Oct – 8. Nov	59-62°N; 1^0 W – 4°E with RV “Scotia”	351	41
2005	26.Oct-18.Nov	59^{o}30’- 61^{o}30’N; 1^0 W – 4°E	348	59

Table 2.5.9.2. NEA mackerel. Spanish acoustic surveys from 2001 to 2006. Mackerel Abundance in number of individuals (millions) and Biomass in tons by ICES sub-divisions, only for the Spanish area.

	ICES IXa-N		ICES VIIIc-W		VIIIc-EW		VIIIc-EE		TOTAL	
	Abundance	**Biomass**	**Abundance**	**Biomass**	**Abundance**	**Biomass**	**Abundance**	**Biomass**	**Abundance**	**Biomass**
2001	19	7,384	311	120,096	1,232	489,058	362	119,111	1,926	735,650
2002			822	333,748	3,804	1,191,051	37	9,993	4,668	1,534,793
2003	4,584	376,561	1,070	184,428	876	202,487	540	144,340	7,072	907,815
2004	609	118,570	1,030	304,335	1,502	515,729	30	6,986	3,173	945,619
2005	156	45,566	233	12,983	602	228,628	164	32,314	1,157	409,493
2006	8	673	385	100,475	149	41,463	16	3,962	557	146,572

Table 2.5.9.3. NEA mackerel. Spanish acoustic surveys. Biomass (in number and weight), mean length and mean weight at age of mackerel from the acoustics surveys from 2001 to 2005 in ICES Sub-division IXa North and Division VIIIc.

	2001				**2002**				**2003**			
	Number	**L**	**W**	**Biomass**	**Number**	**L**	**W**	**Biomass**	**Number**	**L**	**W**	**Biomass**
AGE	**(millions)**	**(cm)**	**(g)**	**t ('000)**	**(millions)**	**(cm)**	**(g)**	**t ('000)**	**(millions)**	**(cm)**	**(g)**	**t ('000)**
1	29.03	25.94	126.21	3.66	621.44	23.33	80.54	50.05	5678.55	23.15	81.57	463.18
2	47.63	30.95	213.70	10.18	94.80	32.02	221.87	21.03	324.50	28.89	165.14	53.59
3	184.31	33.68	277.31	51.11	378.11	34.25	277.14	104.79	108.96	33.47	261.33	28.47
4	386.61	36.06	340.29	131.56	706.78	35.80	317.92	224.70	229.00	35.00	299.70	68.63
5	382.12	37.52	383.02	146.36	1065.88	36.85	348.00	370.93	265.16	37.09	359.09	95.22
6	393.57	37.98	397.69	156.52	604.56	38.24	390.93	236.34	230.14	37.95	385.71	88.77
7	202.67	39.50	446.73	90.54	674.54	39.07	419.19	282.76	94.25	39.76	443.38	41.79
8	143.52	40.01	464.48	66.66	191.43	39.88	447.20	85.61	88.53	40.11	454.61	40.25
9	83.71	40.51	481.74	40.33	158.39	40.30	461.39	73.08	19.55	41.47	505.14	9.88
10	17.00	40.16	469.27	7.98	100.16	41.04	490.19	49.10	10.00	41.93	519.88	5.20
11	26.28	42.12	541.39	14.23	53.95	41.41	503.95	27.19	13.98	42.61	549.62	7.69
12	12.26	41.90	533.82	6.54	12.38	43.50	586.72	7.26	3.80	41.50	503.13	1.91
13	1.88	41.50	517.12	0.97	0.00	0.00	0.00	0.00	3.69	43.11	566.94	2.09
14	6.14	43.50	596.47	3.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15+	9.41	42.76	568.10	5.35	2.90	45.46	676.91	1.96	2.00	43.34	578.06	1.15
TOTAL	1926.15	37.30	381.93	735.65	4665.31	35.49	328.98	1534.79	7072.12	25.53	128.37	907.82

Table 2.5.9.3 continued

	2004				2005			
	Number	**L**	**W**	**Biomass**	**Number**	**L**	**W**	**Biomass**
AGE	**(millions)**	**(cm)**	**(g)**	**t ('000)**	**(millions)**	**(cm)**	**(g)**	**t ('000)**
1	195.23	25.03	114.60	22.37	43.44	24.79	112.12	4.64
2	952.36	28.29	164.48	156.64	106.50	29.24	181.77	18.96
3	599.27	32.80	258.15	154.70	229.10	32.25	245.43	56.14
4	227.54	37.46	377.85	85.97	259.58	36.50	349.40	92.36
5	425.56	38.05	395.53	168.32	82.56	38.33	403.43	34.21
6	336.69	39.13	428.35	144.22	163.83	38.76	417.58	70.42
7	181.46	40.15	461.71	83.78	114.88	39.45	438.44	51.98
8	106.11	40.78	483.18	51.27	63.83	39.80	451.67	29.82
9	76.46	41.03	492.49	37.66	33.55	41.02	493.88	17.23
10	31.07	42.33	538.03	16.72	15.28	42.29	535.41	8.54
11	18.90	42.22	533.89	10.09	13.66	41.81	518.75	7.38
12	13.49	43.27	573.84	7.74	6.59	42.00	526.61	3.62
13	3.21	43.95	599.81	1.92	11.31	42.47	544.07	6.43
14	0.00	0.00	0.00	0.00	5.10	43.77	592.63	3.17
15+	5.92	46.45	710.52	4.21	7.34	43.72	594.87	4.59
TOTAL	3173.25	33.80	298.00	945.62	1156.55	35.91	346.65	409.49

Table 2.6.1. NE Mackerel (Southern component). Effort data by fleets.

	SPAIN					PORTUGAL
	TRAWL		HOOK (HAND-LINE)		PURSE SEINE	TRAWL
	AVILES (Subdiv.VIIIc East) (Days * 100 CV)	LA CORUÑA (Subdiv.VIIIc West) (Days * 100 CV)	SANTANDER (Subdiv.VIIIc East) (Nº fishing trips)	SANTOÑA (Subdiv.VIIIc East) (Nº fishing trips)	VIGO (Subdiv.IXa North) (Nº fishing trips)	(Subdiv.IXa CN,CS &S) (Fishing hours)
YEAR	ANNUAL	ANNUAL	MARCH to MAY	MARCH to MAY	ANNUAL	ANNUAL
1983	12568	51017	-	-	20	-
1984	10815	48655	-	-	700	-
1985	9856	45358	-	-	215	-
1986	10845	39829	-	-	157	-
1987	8309	34658	-	-	92	-
1988	9047	41498	-	-	374	55178
1989	8063	44401	-	605	153	52514
1990	8492	44411	322	509	161	49968
1991	7677	40435	209	724	66	44061
1992	12693	38896	70	698	286	74666
1993	7635	44479	151	1216	-	47822
1994	9620	39602	130	1926	392	38719
1995	6146	41476	217	1696	677	42090
1996	4525	35709	560	2007	777	43633
1997	4699	35191	736	2095	304	42043
1998	5929	35191	754	3022	631	86020
1999	6829	30131	739	2602	546	55311
2000	4453	30073	719	1709	413	67112
2001	2385	29923	700	2479	88	74684
2002	2748	21823	1282	2672	541	-
2003	2526	12328	265	759	544	-
2004	-	19198	626	2151	186	-
2005	-	20663	553	1504	*	-

- Not available

* Under revision

Table 2.6.2. NE Mackerel (Southern component). CPUE series in commercial fisheries.

	SPAIN					PORTUGAL
	TRAWL		HOOK (HAND-LINE)		PURSE SEINE	TRAWL
	AVILES (Subdiv.VIIIc East) (Kg * 100 CV)	LA CORUÑA (Subdiv.VIIIc West) (Kg * 100 CV)	SANTANDER (Subdiv.VIIIc East) (Kg/Nº fishing trips)	SANTOÑA (Subdiv.VIIIc East) (Kg/Nº fishing trips)	VIGO (Subdiv.IXa North) (t/Nº fishing trips)	(Subdiv.IXa CN,CS &S) (Kg/Fishing hours)
YEAR	ANNUAL	ANNUAL	MARCH to MAY	MARCH to MAY	ANNUAL	ANNUAL
1983	14.2	22.8	-	-	1.3	-
1984	24.1	26.7	-	-	5.6	-
1985	17.6	25.4	-	-	4.2	-
1986	41.1	22.8	-	-	5.0	-
1987	13.0	24.4	-	-	2.1	-
1988	15.9	32.5	-	-	3.7	36.4
1989	19.0	28.7	-	1427.5	2.1	26.8
1990	82.7	39.5	739.6	1924.4	2.7	39.2
1991	68.2	36.3	632.9	1394.4	2.0	39.9
1992	35.1	13.3	905.6	856.4	3.9	21.2
1993	12.8	12.8	613.3	1790.9	-	16.9
1994	57.2	44.0	2388.5	1590.6	1.1	20.9
1995	94.9	36.1	3136.1	1987.9	0.3	24.5
1996	124.5	32.9	1165.7	1508.9	0.8	23.8
1997	133.2	38.6	2137.9	1867.8	1.7	18.5
1998	142.1	80.1	2361.5	2128.0	3.3	15.4
1999	136.4	43.9	2438.0	2084.7	3.6	23.9
2000	311.6	65.2	1795.5	1879.7	3.8	25.7
2001	222.9	61.1	2323.2	2401.0	3.8	26.4
2002	342.5	58.3	2062.3	1871.2	5.0	-
2003	357.0	51.9	1868.2	1413.5	1.0	-
2004	-	18.7	2046.2	1312.6	1.5	-
2005	-	143.0	3617.7	2424.8	*	-

- Not available
* Under revision

Table 2.6.3. NE Mackerel (Southern component). CPUE at age from fleets.

VIIIc East handline fleet (Spain:Santoña) (Catch thousands)

Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10	Catch age 11	Catch age 12	Catch age 13	Catch age 14	Catch age 15+
1989	605	0	0	3	74	142	299	197	309	441	134	67	27	23	19	7	27
1990	509	0	0	0	17	71	210	465	177	384	378	127	40	51	2	7	5
1991	724	0	0	52	435	785	473	309	323	100	98	150	29	3	7	7	18
1992	698	0	0	35	568	442	477	139	69	77	20	15	17	4	4	0	1
1993	1216	0	0	40	65	1043	621	1487	771	345	339	215	126	59	66	30	52
1994	1926	0	23	168	526	1060	2005	1443	1003	406	360	176	98	54	24	24	9
1995	1696	0	41	83	793	1001	789	1092	998	928	519	339	300	159	83	81	63
1996	2007	0	0	28	401	1234	865	701	1361	802	773	330	288	105	13	28	18
1997	2095	0	7	255	709	3475	2591	894	880	693	471	248	146	98	24	11	11
1998	3022	0	1	100	1580	2017	4456	3461	1496	1015	1006	594	428	443	155	114	296
1999	2602	0	1	230	1435	3151	2900	3697	1956	758	424	317	233	131	75	21	18
2000	1709	0	1	34	619	877	2098	1297	1822	913	282	125	122	62	42	26	9
2001	2479	0	8	208	1230	2978	2859	3030	1654	1477	783	177	196	157	75	74	74
2002	2672	0	4	167	692	1587	2517	1938	2291	1355	990	465	213	64	48	24	11
2003	759	0	1	62	151	481	605	589	318	329	116	64	36	14	5	3	1
2004	2151	0	2	124	1776	858	1503	1265	950	419	287	107	74	39	8	0	6
2005	1504	0	31	255	1886	2375	891	1673	1203	566	363	109	70	80	45	5	10

VIIIc East handline fleet (Spain:Santander) (Catch thousands)

Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10	Catch age 11	Catch age 12	Catch age 13	Catch age 14	Catch age 15+
1990	322	0	0	0	6	25	66	132	41	86	83	28	8	11	0	2	2
1991	209	0	0	5	45	96	60	39	43	14	14	23	4	1	1	1	4
1992	70	0	0	4	60	47	51	15	7	8	2	2	2	0	0	0	0
1993	151	0	0	1	2	43	26	63	33	15	15	9	5	3	3	1	2
1994	130	0	2	18	56	110	205	146	101	40	36	18	10	5	2	2	1
1995	217	0	3	33	171	168	144	225	227	222	107	70	56	22	9	11	9
1996	560	0	0	6	89	276	191	152	293	171	164	70	60	22	3	6	4
1997	736	0	0	22	170	963	754	368	472	398	328	170	100	74	18	8	10
1998	754	0	391	86	486	644	1419	1035	403	250	232	127	96	82	19	9	9
1999	739	0	24	211	668	1541	1006	1174	496	183	83	65	44	23	13	4	1
2000	719	0	0	2	110	285	781	534	777	388	133	62	58	35	21	13	3
2001	700	0	133	97	283	857	945	966	438	342	151	35	24	17	8	3	3
2002	1282	0	33	130	518	1254	1912	1194	1063	530	311	130	64	9	11	4	0
2003	265	0	3	51	80	297	332	304	133	122	32	17	9	3	1	0	0
2004	626	0	83	197	1034	586	920	557	335	98	58	12	5	2	0	0	0
2005	553	0	0	7	586	1562	579	1049	680	268	162	31	19	19	15	0	2

VIIIc East trawl fleet (Spain:Aviles) (Catch thousands)

Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10	Catch age 11	Catch age 12	Catch age 13	Catch age 14	Catch age 15+
1988	9047	0	333	25	78	126	28	34	31	15	6	1	0	1	2	0	1
1989	8063	0	535	201	66	38	53	17	23	29	7	3	2	2	2	0	4
1990	8492	1834	6690	145	123	147	158	181	21	24	17	6	1	2	3	5	24
1991	7677	95	2419	592	205	108	99	57	55	16	14	26	4	3	2	1	13
1992	12693	236	1495	329	122	65	115	56	38	52	16	19	27	13	4	0	2
1993	7635	3	31	48	8	49	20	37	20	11	13	7	6	9	5	3	9
1994	9620	0	83	317	299	180	302	204	144	56	45	21	12	7	3	4	1
1995	6146	0	9	139	261	168	125	177	156	147	74	50	44	20	10	11	9
1996	4525	0	327	126	274	527	149	81	134	70	63	27	21	8	1	2	3
1997	4699	368	786	934	183	391	167	48	49	43	37	22	14	13	3	2	5
1998	5929	0	537	1442	868	237	341	221	74	34	29	15	10	9	1	0	1
1999	6829	2	601	746	685	730	262	284	117	41	15	10	6	2	2	0	0
2000	4453	1	380	594	1889	629	878	268	297	128	41	16	12	10	4	2	0
2001	2385	0	139	475	573	536	166	131	45	24	10	2	1	1	0	0	0
2002	2748	0	76	371	604	457	486	313	299	162	103	43	25	13	6	4	3
2003	2526	0	13	7	39	216	519	548	332	330	83	45	30	10	0	0	0
2004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2.6.3. (Cont.)

VIIIc West trawl fleet (Spain:La Coruña) (Catch thousands)

Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10	Catch age 11	Catch age 12	Catch age 13	Catch age 14	Catch age 15+
1988	41498	0	6095	584	625	594	167	239	444	195	53	12	8	21	26	0	7
1989	44401	462	482	719	345	289	541	231	355	444	117	63	24	22	22	6	15
1990	44411	27	4535	939	175	235	370	624	184	409	405	145	45	69	5	9	5
1991	40435	1	39	454	573	839	551	445	504	165	165	266	53	4	10	11	23
1992	38896	1	154	102	298	251	355	128	61	84	25	32	38	14	6	0	2
1993	44479	0	307	440	118	528	188	265	98	41	33	21	11	3	4	2	3
1994	39602	0	237	1531	1085	821	1156	575	264	63	40	17	6	1	1	1	0
1995	41476	735	249	400	624	324	251	381	376	402	175	116	104	44	17	19	20
1996	35709	54	5865	104	562	695	148	77	127	65	59	27	20	8	1	2	2
1997	35191	13	626	1347	531	1234	493	136	140	114	88	49	32	25	6	3	6
1998	35191	3	6745	2965	2547	641	678	451	144	80	72	49	36	38	13	8	18
1999	30131	4461	444	292	409	512	314	399	220	112	85	74	59	34	20	6	17
2000	30073	40	9283	902	1932	642	781	170	158	79	24	12	11	9	5	4	3
2001	29923	0	184	886	1615	1799	814	648	201	128	48	11	7	9	4	4	7
2002	21823	12	52	993	1900	1263	762	120	69	25	17	7	4	0	1	0	0
2003	12328	0	51	410	149	368	310	277	130	144	63	36	19	8	5	3	14
2004	19198	0	112	452	363	75	124	94	61	25	21	6	7	2	1	0	1
2005	20663	113	33	159	389	176	39	46	29	13	7	3	2	1	1	0	1

IXa trawl fleet (Portugal) (Catch thousands)

Year	Effort (	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10	Catch age 11	Catch age 12	Catch age 13	Catch age 14	Catch age 15+
1988	55178	8076	4510	536	457	76	14	3	0	1	5	0	0	0	0	0	0
1989	52514	6092	6468	1080	572	185	51	15	4	7	4	3	0	0	0	0	0
1990	49968	2840	5729	1967	137	36	11	4	4	0	0	0	0	0	0	0	0
1991	44061	1695	2397	1904	1090	138	85	65	24	3	5	0	0	0	0	0	0
1992	74666	498	2211	1015	664	263	100	45	22	17	10	70	0	0	0	0	0
1993	47822	1010	2365	442	172	155	32	8	5	1	0	1	0	0	0	0	0
1994	38719	650	1128	1447	342	125	94	65	21	4	1	2	0	1	0	0	0
1995	42090	1001	2690	983	295	99	59	46	40	25	17	16	8	5	0	0	1
1996	43633	423	1293	778	490	269	86	88	129	98	109	66	34	17	6	0	1
1997	42043	318	885	1763	181	98	125	95	59	47	20	20	6	10	0	0	0
1998	86020	1873	3950	1265	171	47	39	40	56	23	14	19	51	32	13	0	5
1999	55311	2311	3615	1384	316	94	55	32	13	2	2	1	1	1	0	0	0
2000	67112	2730	6318	1328	424	226	135	71	40	20	9	13	4	11			
2001* **	74684	3030	5539	1665	382	195	149	65	42	24	3	2	0	0			

*** preliminary

Table 2.8.3.1. NE Atlantic mackerel estimated annual mean daily egg mortality

YEAR	DAILY MORTALITY	5% INTERVAL	95% INTERVAL	STANDARD ERROR
1992	0.58	0.47	0.69	0.055
1995	0.39	0.28	0.49	0.053
1998	0.61	0.50	0.71	0.052
2001	0.35	0.26	0.44	0.047
Mean	0.48			0.52

Table 2.8.3.2. NE Atlantic mackerel estimated numbers of eggs and total egg mortality experienced by eggs estimated by the survey assuming constant z across years (Table 5.3 in Portilla 2006), and estimated annual total mortality experienced by eggs estimated by the egg survey.

YEAR	TAEP NO MORTALITY	TAEP INC CONSTANT MORTALITY	MEAN TOTAL EGG MORTALITY FROM ALL YEARS	ANNUAL TOTAL EGG MORTALITY USED
1992	2.0e15	2.9e15		0.45
1995	1.9e15	2.7e15		0.30
1998	1.4e15	2.0e15	0.37	0.47
2001	1.2e15	1.8e15		0.27
2004	1.3e15	1.8e15		0.37

Table 2.8.3.3. NE Atlantic mackerel percentiles on the factors for missing catch estimated from Mackerel Egg surveys including egg mortality and with different assumptions of M. The percentiles in brackets are those estimated without fitting from values of Q at lower m when ICA failed to fit. If no value in brackets is shown the percentiles are indistinguishable.

	NATURAL MORTALITY (M)			
PERCENTILE	1	1.5	2	2.5
97.5%	3.1	2.7	2.3	1.9
75.0%	2.5	2.2	1.8	1.5
50.0%	2.3	2.0	1.7	1.4
25.0%	2.1	1.8	1.5	1.2 (1.3)
2.5%	1.8	1.5	1.2	1.0 (1.1)

Table 2.8.3.4. NE Atlantic mackerel mean sum of squares fit for ICA for different fixed levels of M, using only data sets that fit at all levels of M.

Natural Mortality (M)	Mean weighted SSQ for Catch	Mean SSQ for survey	Mean total weighted SSQ for model
0.1	1.687282	0.6237327	4.805946
0.15	1.681476	0.6378142	4.870547
0.20	1.680234	0.6517642	4.939055
0.25	1.685031	0.6649143	5.009602

Table 2.8.3.5 NE Atlantic mackerel Q Factors and SSQ fits in ICA assessment where Q factors have been allowed separately and together for the Mackerel Egg Survey (MES), M and Catch.

	SSQ	Weighted SSQ	Wt. D F	SSQ/ Wt. DF	Q MES	Q M	M	Q catch
WG2005 MES Survey and settings	8.8531	2.1050	108.4		1.360	1.000	0.15	1.000
New MES	9.0473	2.3676	108.4	0.02184	1.931	1.000	0.15	1.000
Q MES=1	8.8777	2.3508	107.4	0.02188	1.000	0.282	0.04	2.621
Q M only	8.8765	2.3508	108.4	0.02168	1.000	2.006	0.30	1.000
Q Catch only	9.0471	2.3676	108.4	0.02184	1.000	1.000	0.15	1.931
Q on M,C & MES	8.8056	2.3526	106.4	0.02210	1.910	0.018	0.00	1.512

Table 2.8.3.6. NE Atlantic mackerel results from estimates of missing catch, M, or bias in the egg survey, from Bayesian fit to model using ICA equations. Uninformative priors used in all cases except where QM and QC are estimated together. Intervals and median v included from intrinsic analysis (Figure 2.8.3.3) for comparison.

Parameters	Mean	Sd	MC error	2.5%	Median	97.5%
QMES est. M=0.15 QC=1	QMES= 1.774	0.1868	0.007692	1.422	1.767	2.161
QC est M=0.10 QMES=1	QC= 2.618	0.2479	0.01122	2.169 (1.8)	2.604 2.3	3.145 (3.1)
QC est M=0.15 QMES=1	QC= 2.249	0.2003	0.009098	1.868 (1.5)	2.24 (2.0)	2.66 (2.7)
QC est M=0.20 QMES=1	QC= 1.89	0.1987	0.009449	1.523 (1.2)	1.882 (1.7)	2.314 (2.2)
QC est M=0.25 QMES=1	QC= 1.53	0.1598	0.007506	1.239 (1.0)	1.522 (1.4)	1.876 (1.9)
QC est M=0.3 QMES=1	QC= 1.188	0.1511	0.01267	0.8986	1.186	1.525
QM est **M=0.15*QM** QMES=1 QC=1	QM= 2.201	0.1854	0.007271	1.846	2.196	2.579
QM est **M=0.15*QM** **QC=est**	QC= 3.243	0.2554	0.00977	2.787	3.225	3.798
QMES=1 QC est QM est QMES=1 Prior QM = (Normal Mu=1.0, Sd=.5 Truncated at 0.1)	QM= 0.1036	0.01455	5.22E-4	0.1	0.1	0.1617

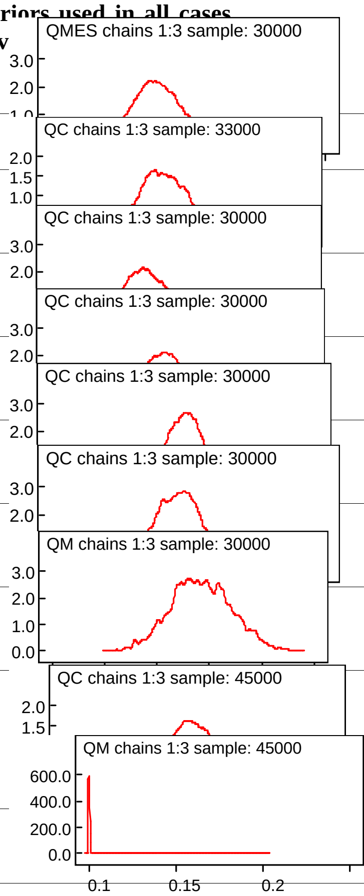
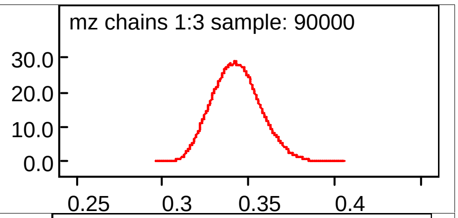


Table 2.8.4.1 NE Atlantic mackerel, tag based estimates of total mortality (note estimates for years 1986 and 1987 are unavailable)

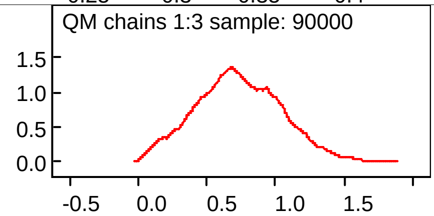
Year/Age	2	3	4	5	6	7	8	9	10
1984	0.002	0.471	0.519	0.579	0.689	-0.044	0.774	0.218	0.417
1985	0.299	0.645	0.427	0.476	0.41	0.334	0.291	0.309	0.003
1988	0.468	0.294	0.085	0.297	-0.029	0.013	0.12	0.133	0.221
1989	0.608	0.36	0.341	0.132	0.111	0.096	0.123	0.168	0.177
1990	0.164	0.358	0.471	0.383	0.945	0.107	0.613	0.802	0.353
1991	0.461	0.252	0.264	0.13	0.506	0.368	-0.014	-0.014	-0.059
1992	0.124	0.23	0.626	0.461	0.666	0.12	0.315	0.061	-0.025
1993	0.708	0.752	0.54	0.466	0.391	0.251	0.384	0.638	0.032
1994	0.413	0.212	0.396	0.312	0.538	0.495	0.405	0.381	-0.544
1995	0.206	0.23	0.219	-0.145	0.161	-0.124	-0.007	0.172	0.119
1996	0.042	0.325	0.348	0.182	0.801	0.57	0.207	0.747	1.205
1997	0.708	0.086	0.108	0.148	0.256	-0.383	0.304	0.027	0.132
1998	0.076	-0.035	0.387	0.649	0.084	0.246	0.507	0.253	0.805
1999	-0.492	0.773	0.683	0.486	0.055	1.017	0.375	0.091	0.57
2000	0.519	0.685	0.983	0.488	0.497	0.001	-0.552	-0.084	-0.083
2001	0.043	0.16	-0.337	-0.157	0.744	0.529	0.676	0.548	0.898
2002	0.437	0.282	0.031	0.099	0.509	0.005	0.178	0.317	0.000

Table 2.8.4.2 NE Atlantic mackerel estimated total mortality (mz) for ages and years with tag estimated mortality, Multipliers on natural mortality and catch (QM and QC) and parameter s for catch (sigy) and tag mortality (sigm) from ICA Bayesian assessment in WINBUGS including the estimation of mean levels of missing catch (QC) and natural mortality (QM).

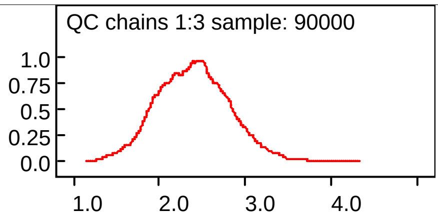
node	**mean**	**sd**	**MC error**	
mz	0.3429	0.01389	4.855E-4	
2.5%	**median**	**97.5%**	**start**	**sample**
0.3177	0.3424	0.3718	5001	90000



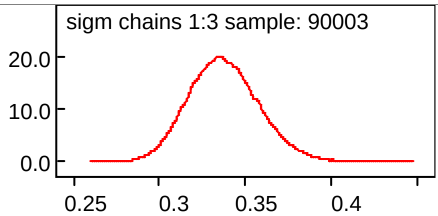
node	**mean**	**sd**	**MC error**	
QM	0.7329	0.3068	0.01219	
2.5%	**median**	**97.5%**	**start**	**sample**
0.1525	0.7219	1.353	5001	90000



node	**mean**	**sd**	**MC error**	
QC	2.398	0.4209	0.01664	
2.5%	**median**	**97.5%**	**start**	**sample**
1.605	2.392	3.259	5001	90000



node	**mean**	**sd**	**MC error**	
sigm	0.3377	0.02028	2.46E-4	
2.5%	**median**	**97.5%**	**start**	**sample**
0.3007	0.3367	0.3799	4001	69999



node	**mean**	**sd**	**MC error**	
sigy	0.1605	0.01222	2.082E-4	
2.5%	**median**	**97.5%**	**start**	**sample**
0.1386	0.1598	0.1865	4001	70080

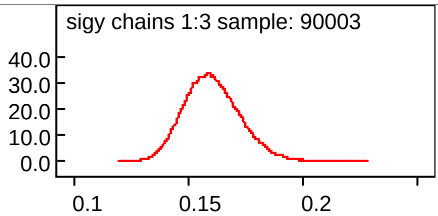


Table 2.8.4.3 NE Atlantic mackerel estimated SSB from Bayesian ICA in WINBUGS including the estimation of mean levels of missing catch (QC) and natural mortality (QM).

year	mean	sd	MC error	2.50%	median	97.50%	start	sample
1972	8.30E+06	924700	26130	6.72E+06	8.22E+06	1.03E+07	5001	90000
1973	8.59E+06	917600	25590	7.01E+06	8.51E+06	1.06E+07	5001	90000
1974	8.34E+06	875300	24350	6.83E+06	8.27E+06	1.03E+07	5001	90000
1975	7.85E+06	819500	22840	6.44E+06	7.79E+06	9.65E+06	5001	90000
1976	7.18E+06	754400	21100	5.89E+06	7.12E+06	8.84E+06	5001	90000
1977	6.86E+06	714800	20010	5.62E+06	6.80E+06	8.43E+06	5001	90000
1978	6.83E+06	696100	19520	5.62E+06	6.77E+06	8.36E+06	5001	90000
1979	5.89E+06	604200	1.70E+04	4.84E+06	5.84E+06	7.22E+06	5001	90000
1980	4.93E+06	512600	14450	4.04E+06	4.89E+06	6.06E+06	5001	90000
1981	5.05E+06	525400	14840	4.14E+06	5.01E+06	6.21E+06	5001	90000
1982	4.83E+06	502800	14210	3.96E+06	4.79E+06	5.94E+06	5001	90000
1983	5.38E+06	554200	15580	4.42E+06	5.33E+06	6.59E+06	5001	90000
1984	5.35E+06	553600	15540	4.40E+06	5.31E+06	6.57E+06	5001	90000
1985	5.31E+06	554600	15660	4.35E+06	5.27E+06	6.53E+06	5001	90000
1986	5.28E+06	545800	15390	4.33E+06	5.24E+06	6.47E+06	5001	90000
1987	5.24E+06	530900	14940	4.31E+06	5.20E+06	6.40E+06	5001	90000
1988	5.26E+06	530100	14950	4.34E+06	5.22E+06	6.42E+06	5001	90000
1989	5.38E+06	533100	15050	4.45E+06	5.35E+06	6.54E+06	5001	90000
1990	5.09E+06	4.94E+05	14100	4.23E+06	5.06E+06	6.17E+06	5001	90000
1991	5.70E+06	5.48E+05	15880	4.74E+06	5.66E+06	6.89E+06	5001	90000
1992	5.73E+06	544400	15970	4.78E+06	5.69E+06	6.91E+06	5001	90000
1993	5.34E+06	500800	14760	4.46E+06	5.30E+06	6.43E+06	5001	90000
1994	4.87E+06	448600	13040	4.09E+06	4.84E+06	5.85E+06	5001	90000
1995	5.11E+06	462300	13160	4.30E+06	5.08E+06	6.12E+06	5001	90000
1996	4.96E+06	4.40E+05	12380	4.19E+06	4.93E+06	5.92E+06	5001	90000
1997	5.01E+06	431200	12130	4.26E+06	4.98E+06	5.95E+06	5001	90000
1998	4.85E+06	402700	11520	4.15E+06	4.83E+06	5.72E+06	5001	90000
1999	5.05E+06	403600	11760	4.34E+06	5.03E+06	5.92E+06	5001	90000
2000	4.77E+06	372100	11350	4.11E+06	4.75E+06	5.57E+06	5001	90000
2001	4.91E+06	391100	12760	4.22E+06	4.89E+06	5.76E+06	5001	90000
2002	4.12E+06	376700	13340	3.47E+06	4.08E+06	4.95E+06	5001	90000
2003	4.29E+06	515800	19200	3.44E+06	4.23E+06	5.48E+06	5001	90000
2004	4.58E+06	715400	26480	3.40E+06	4.50E+06	6.23E+06	5001	90000

Table 2.8.4.4 NE Atlantic mackerel estimated Fbar 4-8 from Bayesian ICA in WINBUGS including the estimation of mean levels of missing catch (QC) and natural mortality (QM).

year	mean	sd	MC error	2.50%	median	97.50%	start	sample
1972	0.0915	0.02038	8.14E-04	0.05353	0.09111	0.1332	5001	90000
1973	0.1281	0.02419	9.66E-04	0.08166	0.1281	0.1763	5001	90000
1974	0.1525	0.02637	0.001053	0.1011	0.1528	0.2042	5001	90000
1975	0.205	0.03339	0.001334	0.1389	0.2056	0.2695	5001	90000
1976	0.2654	0.04295	0.001715	0.1804	0.2663	0.3484	5001	90000
1977	0.2039	0.03229	0.00129	0.1398	0.2047	0.2661	5001	90000
1978	0.204	0.03416	0.001366	0.136	0.2049	0.2696	5001	90000
1979	0.2716	0.04518	0.001807	0.1813	0.273	0.358	5001	90000
1980	0.2629	0.04426	0.00177	0.1744	0.2642	0.3474	5001	90000
1981	0.2431	0.04287	0.001715	0.1585	0.2439	0.326	5001	90000
1982	0.2362	0.04259	0.001704	0.1529	0.2368	0.3193	5001	90000
1983	0.2274	0.03859	0.001544	0.1515	0.2281	0.3024	5001	90000
1984	0.2382	0.03947	0.001579	0.1603	0.2389	0.3148	5001	90000
1985	0.2324	0.03727	0.00149	0.1587	0.2331	0.3045	5001	90000
1986	0.2443	0.03814	0.001524	0.1686	0.2451	0.3178	5001	90000
1987	0.2288	0.03613	0.001442	0.1575	0.2294	0.2987	5001	90000
1988	0.2544	0.04147	0.00165	0.1732	0.2549	0.335	5001	90000
1989	0.1925	0.03112	0.001231	0.1318	0.1927	0.2532	5001	90000
1990	0.1956	0.02978	0.001177	0.1367	0.1959	0.2535	5001	90000
1991	0.2425	0.03394	0.001333	0.1747	0.2432	0.3076	5001	90000
1992	0.2841	0.03971	0.001488	0.2058	0.2844	0.3606	5001	90000
1993	0.3558	0.04906	0.001854	0.2573	0.3566	0.4499	5001	90000
1994	0.3628	0.0514	0.001956	0.2606	0.3637	0.4619	5001	90000
1995	0.358	0.05297	0.002028	0.2527	0.3588	0.4598	5001	90000
1996	0.2866	0.04408	0.001689	0.1994	0.2869	0.3724	5001	90000
1997	0.2714	0.04032	0.001549	0.191	0.2722	0.349	5001	90000
1998	0.3042	0.04498	0.001737	0.2139	0.3052	0.3907	5001	90000
1999	0.288	0.04287	0.00166	0.2009	0.2893	0.3694	5001	90000
2000	0.3089	0.04641	0.001816	0.2149	0.3104	0.3963	5001	90000
2001	0.3501	0.0562	0.002219	0.2371	0.3519	0.4553	5001	90000
2002	0.3843	0.06869	0.002736	0.2491	0.3855	0.5153	5001	90000
2003	0.3409	0.07395	0.002929	0.2039	0.3389	0.4931	5001	90000
2004	0.2993	0.07815	0.003018	0.1654	0.293	0.4727	5001	90000

Table 2.8.7.1. NEA mackerel. TISVPA results

Year	R(0)	B	SSB (Jan.1)	SSB (sp.time)	F(4-8)
1972	2401	5912	4738	4333	0.016
1973	4730	5844	4989	4500	0.048
1974	4254	5734	4903	4388	0.082
1975	5170	5554	4735	4227	0.104
1976	5089	5353	4445	3821	0.232
1977	1004	4955	4076	3623	0.158
1978	3047	4570	4084	3572	0.182
1979	5231	4095	3637	3088	0.251
1980	5410	3707	3030	2621	0.209
1981	6866	3835	3074	2664	0.192
1982	2052	3651	2872	2492	0.201
1983	1508	3622	3026	2633	0.225
1984	7780	3253	2895	2486	0.264
1985	3393	3483	2810	2451	0.224
1986	3300	3476	2808	2478	0.214
1987	4565	3348	2855	2530	0.174
1988	3620	3373	2867	2469	0.227
1989	4570	3340	2794	2424	0.217
1990	3203	3105	2593	2250	0.200
1991	3438	3391	2903	2524	0.205
1992	4487	3504	2974	2539	0.288
1993	4855	3392	2818	2377	0.323
1994	3889	3213	2587	2171	0.352
1995	3623	3317	2721	2313	0.336
1996	3815	3066	2580	2225	0.289
1997	3085	3093	2567	2214	0.287
1998	3008	2894	2451	2077	0.313
1999	3585	2912	2452	2092	0.288
2000	1975	2731	2282	1913	0.338
2001	4662	2698	2332	1958	0.332
2002	10291	2493	2020	1648	0.433
2003	2955	2925	2018	1685	0.416
2004	1884	2917	2265	1973	0.328
2005	709	3224	2810	2469	0.255
2006			2872	2497	

Table 2.8.7.2. NEAmakerel. ISVPA. Residuals in LnC(a,y) and LnSSB(y)

	0	1	2	3	4	5	6	7	8	9	10	11	12	**AgeSUM**	**Residuals in LnSSB**
1972	0.476	-0.198	-0.102	-0.210	0.035	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0
1973	-0.242	0.337	-0.317	0.025	0.155	0.043	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0
1974	0.193	0.136	-0.370	-0.078	0.077	0.124	-0.082	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0
1975	-0.040	-0.320	-0.555	-0.078	0.372	0.299	-0.117	0.439	0.000	0.000	0.000	0.000	0.000	**0.000**	0
1976	0.053	0.247	0.026	0.070	0.112	0.138	-0.153	-0.077	-0.415	0.000	0.000	0.000	0.000	**0.000**	0
1977	0.054	0.082	0.170	-0.032	-0.096	-0.388	0.123	0.023	0.115	-0.050	0.000	0.000	0.000	**0.000**	0
1978	-0.344	0.315	0.529	0.057	-0.036	0.044	-0.196	-0.095	-0.249	-0.029	0.003	0.000	0.000	**0.000**	0
1979	-0.064	0.535	0.198	0.237	-0.230	-0.137	0.054	-0.097	-0.084	-0.249	-0.162	0.000	0.000	**0.000**	0
1980	-0.730	0.287	0.517	0.323	0.073	-0.020	0.004	0.099	0.068	-0.422	-0.198	0.000	0.000	**0.000**	0
1981	-0.349	0.215	0.116	-0.050	-0.267	-0.172	0.055	0.057	0.390	-0.018	0.025	0.000	0.000	**0.000**	0
1982	-0.136	-0.199	0.259	-0.013	-0.104	-0.262	-0.046	-0.080	0.209	0.433	-0.061	0.000	0.000	**0.000**	0
1983	-0.037	0.112	0.496	0.126	-0.075	-0.148	-0.239	-0.243	-0.115	-0.108	0.230	0.000	0.000	**0.000**	0
1984	1.036	0.063	0.073	0.229	-0.036	-0.263	-0.120	-0.166	-0.411	-0.184	-0.221	0.000	0.000	**0.000**	0
1985	1.032	-0.075	-0.682	-0.362	0.088	-0.003	-0.016	-0.092	0.170	-0.112	0.052	0.000	0.000	**0.000**	0
1986	0.584	-0.460	-0.016	-0.249	-0.032	0.220	0.254	0.101	0.032	-0.302	-0.134	0.000	0.000	**0.000**	0
1987	-1.700	-0.822	0.085	0.283	0.156	0.318	0.243	0.210	0.245	0.620	0.363	0.000	0.000	**0.000**	0
1988	0.215	-0.254	-0.426	-0.275	-0.192	0.207	0.235	-0.079	0.044	0.420	0.104	0.000	0.000	**0.000**	0
1989	0.545	-0.273	0.446	0.079	-0.195	-0.220	0.039	-0.067	-0.372	-0.123	0.141	0.000	0.000	**0.000**	0
1990	0.178	0.147	0.241	0.368	-0.010	-0.136	-0.297	0.035	0.019	-0.121	-0.425	0.000	0.000	**0.000**	0
1991	-0.694	-0.020	-0.008	-0.044	0.313	0.131	-0.013	-0.186	0.526	-0.214	0.208	0.000	0.000	**0.000**	0
1992	0.295	0.096	0.129	-0.020	-0.046	0.130	0.024	-0.092	-0.339	-0.014	-0.163	0.000	0.000	**0.000**	0.0833
1993	-0.751	0.096	0.238	0.180	-0.074	-0.062	0.146	0.139	-0.011	0.026	0.072	0.000	0.000	**0.000**	0
1994	-0.302	0.063	-0.064	0.214	0.075	-0.152	-0.059	0.164	0.197	0.083	-0.219	0.000	0.000	**0.000**	0
1995	-0.732	-0.252	0.294	0.055	0.106	-0.031	-0.143	0.085	0.225	0.303	0.090	0.000	0.000	**0.000**	0.1609
1996	0.102	0.315	-0.067	0.049	-0.084	-0.015	-0.285	-0.148	-0.237	0.307	0.064	0.000	0.000	**0.000**	0
1997	0.281	0.267	0.092	-0.099	0.096	-0.053	-0.036	-0.198	-0.292	-0.112	0.054	0.000	0.000	**0.000**	0
1998	0.678	-0.005	-0.057	-0.057	-0.014	0.105	-0.092	-0.048	-0.138	-0.117	-0.255	0.000	0.000	**0.000**	-0.2246
1999	0.712	-0.201	-0.281	-0.366	-0.067	0.112	0.099	-0.009	0.100	-0.128	0.029	0.000	0.000	**0.000**	0
2000	0.952	-0.110	-0.340	-0.059	-0.030	0.083	0.128	-0.048	-0.136	-0.200	-0.239	0.000	0.000	**0.000**	0
2001	-0.453	-0.056	-0.305	-0.150	0.041	0.088	0.261	0.342	0.104	-0.053	0.182	0.000	0.000	**0.000**	-0.0264
2002	0.029	0.296	-0.391	-0.037	0.029	-0.015	0.035	0.035	0.191	0.015	-0.188	0.000	0.000	**0.000**	0
2003	0.252	-0.158	-0.128	-0.492	-0.230	-0.030	0.109	0.001	0.131	0.381	0.164	0.000	0.000	**0.000**	0
2004	-1.093	-0.205	0.202	0.378	0.090	0.064	0.085	-0.003	0.031	-0.032	0.483	0.000	0.000	**0.000**	0.0343
2005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0
YearSUM	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	0.000	0

Table 2.8.7.3. NEA mackerel. TISVPA. Estimates of fishing mortality coefficients

F(a,y)	0	1	2	3	4	5	6	7	8	9	10	11	12
1972	0.003	0.008	0.026	0.058	0.082	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1973	0.005	0.017	0.021	0.058	0.107	0.132	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1974	0.006	0.025	0.044	0.042	0.094	0.151	0.167	0.000	0.000	0.000	0.000	0.000	0.000
1975	0.008	0.026	0.052	0.071	0.055	0.107	0.156	0.203	0.000	0.000	0.000	0.000	0.000
1976	0.013	0.055	0.089	0.144	0.159	0.106	0.188	0.331	0.377	0.000	0.000	0.000	0.000
1977	0.006	0.041	0.088	0.111	0.145	0.137	0.082	0.170	0.255	0.189	0.000	0.000	0.000
1978	0.017	0.032	0.105	0.179	0.184	0.207	0.175	0.121	0.222	0.249	0.266	0.000	0.000
1979	0.025	0.092	0.081	0.217	0.304	0.264	0.266	0.264	0.157	0.330	0.355	0.355	0.000
1980	0.014	0.079	0.138	0.094	0.203	0.240	0.188	0.223	0.191	0.238	0.255	0.255	0.255
1981	0.013	0.054	0.151	0.207	0.114	0.210	0.222	0.205	0.210	0.226	0.242	0.242	0.242
1982	0.007	0.049	0.101	0.228	0.253	0.118	0.195	0.243	0.194	0.215	0.230	0.230	0.230
1983	0.005	0.027	0.096	0.156	0.287	0.271	0.112	0.219	0.236	0.210	0.224	0.224	0.224
1984	0.014	0.025	0.061	0.175	0.233	0.373	0.311	0.150	0.255	0.246	0.263	0.263	0.263
1985	0.009	0.049	0.042	0.079	0.187	0.212	0.299	0.298	0.125	0.205	0.219	0.219	0.219
1986	0.009	0.035	0.091	0.061	0.093	0.190	0.192	0.321	0.274	0.190	0.203	0.203	0.203
1987	0.010	0.036	0.067	0.137	0.074	0.098	0.178	0.212	0.306	0.183	0.195	0.195	0.195
1988	0.014	0.056	0.102	0.151	0.258	0.116	0.139	0.305	0.315	0.271	0.291	0.291	0.291
1989	0.009	0.030	0.070	0.118	0.164	0.264	0.121	0.173	0.362	0.337	0.352	0.352	0.352
1990	0.007	0.034	0.072	0.130	0.174	0.198	0.300	0.141	0.187	0.339	0.354	0.354	0.354
1991	0.006	0.024	0.074	0.121	0.174	0.191	0.203	0.319	0.139	0.307	0.321	0.321	0.321
1992	0.008	0.028	0.067	0.165	0.214	0.254	0.259	0.286	0.425	0.375	0.393	0.393	0.393
1993	0.009	0.033	0.075	0.140	0.282	0.298	0.329	0.350	0.358	0.435	0.456	0.456	0.456
1994	0.010	0.037	0.083	0.148	0.219	0.365	0.358	0.414	0.406	0.466	0.488	0.488	0.488
1995	0.009	0.035	0.083	0.148	0.208	0.252	0.393	0.401	0.427	0.441	0.462	0.462	0.462
1996	0.010	0.031	0.073	0.136	0.193	0.221	0.249	0.404	0.379	0.382	0.400	0.400	0.400
1997	0.010	0.037	0.074	0.137	0.204	0.236	0.252	0.295	0.447	0.388	0.407	0.407	0.407
1998	0.011	0.042	0.103	0.160	0.236	0.290	0.313	0.349	0.379	0.463	0.486	0.486	0.486
1999	0.010	0.039	0.091	0.175	0.215	0.259	0.295	0.331	0.341	0.415	0.434	0.434	0.434
2000	0.008	0.041	0.102	0.187	0.290	0.288	0.324	0.387	0.402	0.465	0.488	0.488	0.488
2001	0.010	0.028	0.094	0.180	0.265	0.334	0.307	0.360	0.396	0.437	0.459	0.459	0.459
2002	0.007	0.044	0.079	0.215	0.335	0.403	0.477	0.455	0.495	0.557	0.586	0.586	0.586
2003	0.004	0.025	0.097	0.137	0.299	0.378	0.422	0.523	0.456	0.510	0.536	0.536	0.536
2004	0.009	0.013	0.049	0.148	0.164	0.292	0.341	0.395	0.447	0.401	0.420	0.420	0.420
2005	0.008	0.029	0.068	0.126	0.186	0.224	0.252	0.294	0.319	0.343	0.359	0.359	0.359

Table 2.8.7.4. NEA mackerel. TISVPA. Estimates of abundance-at-age

N(a,y)	0	1	2	3	4	5	6	7	8	9	10	11	12
1972	2400810	6133016	2429879	4606071	8593012	0	0	0	0	0	0	0	0
1973	4730326	2058346	5242715	2040878	3762342	6803012	0	0	0	0	0	0	0
1974	4254127	4053491	1734908	4430258	1656729	2882332	5116617	0	0	0	0	0	0
1975	5170138	3636793	3395050	1439214	3663004	1293513	2111669	3750419	0	0	0	0	0
1976	5088897	4415737	3060705	2803805	1157046	2946061	981351	1568681	2488083	0	0	0	0
1977	1004322	4323560	3567793	2406160	2078553	841210	2263957	709286	981527	1561433	0	0	0
1978	3047237	858939	3565265	2790681	1857155	1558154	645277	1785864	514249	644693	1117945	0	0
1979	5230510	2584003	711672	2660924	1997723	1334230	1085565	473614	1368923	363269	434209	736852	0
1980	5410277	4392132	1961910	559622	1790929	1308389	896475	711040	316726	1013498	232812	268933	502016
1981	6866177	4609342	3448226	1402701	430443	1248706	887622	639241	484158	223610	715368	158779	1001758
1982	2051970	5846123	3736485	2529228	986118	335114	885488	607933	445572	320996	153858	481991	820214
1983	1508063	1755014	4810915	2862568	1735427	666939	259904	629920	414037	308915	209989	105969	708644
1984	7779566	1291071	1468484	3647350	2087045	1132065	446016	202320	445778	285000	217903	140267	322341
1985	3392861	6515969	1082551	1186998	2576449	1429350	699563	286226	151663	309930	195807	147907	535634
1986	3300433	2868918	5348912	902698	955237	1823503	995865	447420	185287	113894	219753	134625	475611
1987	4564525	2804646	2399351	4206733	736160	749975	1268207	687883	274559	120700	83055	156320	383384
1988	3620276	3906421	2352605	1925886	3086407	584971	574721	891279	466973	166633	79744	56292	245594
1989	4570465	3067722	3199603	1861577	1450890	2097518	442541	422735	571829	291141	101649	50507	130096
1990	3202619	3885960	2571284	2517788	1417378	1075240	1422336	336627	307899	361583	182430	59903	100777
1991	3437868	2735862	3223347	2040070	1848479	1025823	768453	941793	250991	219366	225991	116838	208142
1992	4486550	2945054	2299989	2576379	1559863	1293589	719745	540715	605247	179013	142988	135947	226397
1993	4855454	3826472	2460881	1843699	1883409	1088816	848862	476622	353904	361182	106165	85524	200716
1994	3888789	4151085	3180120	1944444	1361256	1235452	702168	512280	281724	213349	200026	56926	160541
1995	3623097	3319414	3440455	2524545	1418313	933435	756671	426621	280843	154596	113002	110608	115833
1996	3815492	3097320	2770405	2686922	1866327	979708	627012	450848	241549	149317	79080	59970	100145
1997	3084571	3250528	2569949	2222183	2011324	1334894	677068	433759	266207	147891	81745	45016	80590
1998	3007865	2625611	2679766	2046839	1679206	1397438	913088	454877	285247	154672	88097	46336	64201
1999	3584609	2546226	2167483	2086742	1508493	1143041	886120	582582	278499	172099	85858	49134	94598
2000	1975427	3039050	2115581	1722497	1547895	1054897	748093	559304	360657	167470	100249	47559	85659
2001	4661911	1676938	2515188	1669202	1236197	1001032	672350	455312	329997	212956	94294	55665	111485
2002	10290801	3981436	1405035	1995678	1214739	812044	607787	406186	253525	187004	119678	48996	91172
2003	2955368	8793016	3255794	1131556	1391214	744465	468532	321824	220019	126169	91818	60122	74759
2004	1884163	2531950	7392181	2557832	872003	914861	441473	258062	164218	116214	57632	44079	52168
2005	708743	1612291	2154516	6023999	1835184	632141	582637	266166	149736	89741	67384	28394	38429
2006	0	605369	1348126	1731960	4570830	1311939	435066	389969	170713	93693	54824	40523	17075

Table 2.8.8.1 NE Atlantic mackerel WINBUGS ICA exploratory assessment ICA based VPA model code

```
######### population component of the likelihood
# Define the system process for the population data   oldest real age and last year in N[1,1])
# stop any negative population numbers that result from wide Gaussian priors (only required early in convergence)
for (i in 2:I3) {
N[1,i]<-max(Nstar[i-1],1)
}
for (i in 1:I2) {
N[i,1]<-max(Nstar2[i],1)
}
### set op selection period first
# start with matrix of Fs
for (i in 1:I3){
for (j in 1:I2){
F[j,i]<-FA[j]*FAV[i]                              # fishing mortality
INTF[j,i]<-F[j,i]/FA[j]
}
FP[i]<-FAP*FAV[i]                                 # fishing mortality
}
#Calculate N for ages 2 and greater and years before last year
for (i in 2:I3){
for (j in 2:I2){
N[j,i]<-N[j-1,i-1]*exp(F[j,i]+M[j,i])
}
}
for (i in 1:I3){
NP[i]<-CANUMP[i]*(FP[i]+MP[i])/FP[i]/(1-exp(-FP[i]-MP[i]))
}

#Then VPA part  start with Ns age 0 to max age minus 2
#Then get Fs from Ns
# Use mean F to set F on oldest real age and plus group
for (i in (I3+1):I1){
for (j in 2:(I2)){
N[j,i]<-N[j-1,i-1]*exp(M[j,i])+CANUM[j,i]*exp(M[j,i]/2)
F[j,i]<-log(N[j,i]/N[j-1,i-1])-M[j,i]
INTF[j,i]<-F[j,i]/FA[j]
}
# calculate mean F and use selection to get F oldest real age and plus group
FAV[i]<-mean(INTF[2:(I2-1),i])
# set Fs
F[1,i]<-FAV[i]*FA[1]
FP[i]<-FAV[i]*FAP
# then set Ns fopr oldest ages
N[1,i]<-CANUM[1,i]*(F[1,i]+M[1,i])/F[1,i]/(1-exp(-F[1,i]-M[1,i]))
NP[i]<-CANUMP[i]*(FP[i]+MP[i])/FP[i]/(1-exp(-FP[i]-MP[i]))
# now cycle back in years to complete VPA
}
## Observation process --------
#Part  1 MES - SSB index ### in this case 1 year back from start of sep period and survey
for (i in 1:I1){
for (j in 1:I2){
SSBa[j,i]<-N[j,i]*exp((-F[j,i]*FPROP-M[j,i]*MPROP))*WEST[j,i]*MATPROP[j,i] ## at spawning time
}
SSB[i]<-sum(SSBa[,i])+NP[i]*exp((-FP[i]*FPROP-MP[i]*MPROP))*WESTP[i]*MATPROPP[i] ## at spawning
time
Fbar[i]<-(F[4,i]+F[5,i]+F[6,i]+F[7,i]+F[8,i])/5 #### set here but should be parameter to be flexible
}
##### index crudely weight in the likelihood by doing loop WT value times (MESWT for survey)
for (i in 1:MEST) {
ObsMESMod[i]<-log(SSB[i*3-1]*QMES) ###### value should change depending on Egg survey year
for (j in 1:MESWT){
ObsMES[i] ~ dnorm(ObsMESMod[i],tauy)
}
}
# Part  2 Catch  #####
# don't bother including plus 0 group as this has zero error and is not in the likelihood
for (i in 1:I3){
for (j in 1:(I2-1)){
qObsCatchMod[j,i]<-log(N[j,i]*F[j,i]/(F[j,i]+M[j,i])*(1-exp(-F[j,i]-M[j,i])))
for (k in 1:CatchWT[j]){
ObsCatch[j,i] ~ dnorm(ObsCatchMod[j,i],tauy)
}
```

Table 2.8.8.2 NE Atlantic mackerel WINBUGS ICA exploratory assessment (2006 data) Estimated SSB

year	mean	sd	MC error	2.50%	median	97.50%	start	sample
1972	4.09E+06	44930	944.8	4.01E+06	4.09E+06	4.18E+06	10000	90003
1973	4.18E+06	52320	1091	4.08E+06	4.18E+06	4.29E+06	10000	90003
1974	4.03E+06	58700	1215	3.92E+06	4.03E+06	4.15E+06	10000	90003
1975	3.78E+06	62840	1295	3.66E+06	3.78E+06	3.91E+06	10000	90003
1976	3.46E+06	64230	1320	3.34E+06	3.46E+06	3.59E+06	10000	90003
1977	3.29E+06	65980	1352	3.17E+06	3.29E+06	3.43E+06	10000	90003
1978	3.25E+06	67230	1372	3.12E+06	3.25E+06	3.39E+06	10000	90003
1979	2.80E+06	66690	1358	2.67E+06	2.80E+06	2.94E+06	10000	90003
1980	2.35E+06	59870	1215	2.24E+06	2.35E+06	2.48E+06	10000	90003
1981	2.40E+06	66600	1345	2.28E+06	2.40E+06	2.54E+06	10000	90003
1982	2.31E+06	63120	1.27E+03	2.19E+06	2.31E+06	2.44E+06	10000	90003
1983	2.58E+06	59750	1.16E+03	2.47E+06	2.58E+06	2.71E+06	10000	90003
1984	2.58E+06	61450	1.12E+03	2.47E+06	2.58E+06	2.71E+06	10000	90003
1985	2.56E+06	71560	1.30E+03	2.43E+06	2.55E+06	2.71E+06	10000	90003
1986	2.55E+06	68780	1.25E+03	2.43E+06	2.55E+06	2.70E+06	10000	90003
1987	2.52E+06	68240	1.23E+03	2.40E+06	2.52E+06	2.67E+06	10000	90003
1988	2.53E+06	72570	1.31E+03	2.40E+06	2.53E+06	2.69E+06	10000	90003
1989	2.59E+06	74670	1.38E+03	2.46E+06	2.59E+06	2.75E+06	10000	90003
1990	2.44E+06	73560	1.39E+03	2.30E+06	2.43E+06	2.59E+06	10000	90003
1991	2.71E+06	90090	1.79E+03	2.55E+06	2.71E+06	2.90E+06	10000	90003
1992	2.72E+06	91700	2.02E+03	2.56E+06	2.72E+06	2.91E+06	10000	90003
1993	2.54E+06	86490	2.19E+03	2.39E+06	2.54E+06	2.73E+06	10000	90003
1994	2.34E+06	85210	2.50E+03	2.20E+06	2.33E+06	2.53E+06	10000	90003
1995	2.49E+06	100400	3.30E+03	2.33E+06	2.48E+06	2.71E+06	10000	90003
1996	2.43E+06	1.11E+05	3.87E+03	2.26E+06	2.42E+06	2.68E+06	10000	90003
1997	2.45E+06	1.28E+05	4.73E+03	2.27E+06	2.44E+06	2.74E+06	10000	90003
1998	2.37E+06	147500	5.73E+03	2.17E+06	2.35E+06	2.70E+06	10000	90003
1999	2.46E+06	191500	7.73E+03	2.21E+06	2.42E+06	2.88E+06	10000	90003
2000	2.28E+06	232700	9.65E+03	1.99E+06	2.24E+06	2.80E+06	10000	90003
2001	2.28E+06	318200	1.34E+04	1.89E+06	2.22E+06	2.97E+06	10000	90003
2002	1.87E+06	371700	1.58E+04	1.42E+06	1.80E+06	2.68E+06	10000	90003
2003	1.90E+06	545100	2.32E+04	1.23E+06	1.80E+06	3.07E+06	10000	90003
2004	2.06E+06	782800	3.32E+04	1.09E+06	1.92E+06	3.76E+06	10000	90003
2005	2.58E+06	1.21E+06	5.14E+04	1.06E+06	2.37E+06	5.25E+06	10000	90003

Table 2.8.8.3 NE Atlantic mackerel WINBUGS ICA exploratory assessment (2006 data) Estimated Fbar ages 4-8

year	mean	sd	MC error	2.50%	median	97.50%	start	sample
1972	0.0758	0.0024	4.79E-05	0.0712	0.0758	0.0805	10000	90003
1973	0.1095	0.0026	5.32E-05	0.1044	0.1095	0.1145	10000	90003
1974	0.1321	0.0027	5.50E-05	0.1268	0.1322	0.1373	10000	90003
1975	0.1796	0.0036	7.48E-05	0.1724	0.1797	0.1866	10000	90003
1976	0.2328	0.0046	9.49E-05	0.2236	0.2328	0.2416	10000	90003
1977	0.1795	0.0037	7.57E-05	0.1721	0.1795	0.1866	10000	90003
1978	0.1775	0.0036	7.22E-05	0.1703	0.1776	0.1844	10000	90003
1979	0.2364	0.0047	9.38E-05	0.2271	0.2365	0.2455	10000	90003
1980	0.2283	0.0047	9.36E-05	0.2189	0.2284	0.2373	10000	90003
1981	0.2098	0.0049	9.81E-05	0.2000	0.2099	0.2193	10000	90003
1982	0.2031	0.0049	9.77E-05	0.1933	0.2031	0.2126	10000	90003
1983	0.1969	0.0041	8.23E-05	0.1886	0.1969	0.2048	10000	90003
1984	0.2068	0.0040	8.15E-05	0.1986	0.2069	0.2146	10000	90003
1985	0.2028	0.0043	7.98E-05	0.1941	0.2029	0.2110	10000	90003
1986	0.2143	0.0052	9.21E-05	0.2037	0.2144	0.2240	10000	90003
1987	0.2007	0.0058	1.01E-04	0.1890	0.2008	0.2116	10000	90003
1988	0.2221	0.0077	1.27E-04	0.2065	0.2223	0.2368	10000	90003
1989	0.1682	0.0070	1.06E-04	0.1544	0.1683	0.1815	10000	90003
1990	0.1723	0.0067	1.09E-04	0.1589	0.1723	0.1854	10000	90003
1991	0.2159	0.0089	1.39E-04	0.1984	0.2158	0.2333	10000	90003
1992	0.2587	0.0169	1.69E-04	0.2267	0.2583	0.2932	10000	90003
1993	0.3225	0.0203	2.34E-04	0.2838	0.3221	0.3635	10000	90003
1994	0.3286	0.0209	2.96E-04	0.2882	0.3284	0.3702	10000	90003
1995	0.3257	0.0212	3.51E-04	0.2845	0.3257	0.3674	10000	90003
1996	0.2521	0.0173	3.27E-04	0.2177	0.2521	0.2861	10000	90003
1997	0.2445	0.0174	3.87E-04	0.2096	0.2447	0.2781	10000	90003
1998	0.2710	0.0203	5.29E-04	0.2286	0.2716	0.3088	10000	90003
1999	0.2677	0.0224	6.72E-04	0.2203	0.2687	0.3082	10000	90003
2000	0.3123	0.0306	0.001057	0.2449	0.3142	0.3659	10000	90003
2001	0.3517	0.0435	0.001656	0.2552	0.3545	0.4271	10000	90003
2002	0.4093	0.0675	0.002733	0.2680	0.4117	0.5319	10000	90003
2003	0.3812	0.0881	0.003678	0.2126	0.3775	0.5585	10000	90003
2004	0.3345	0.1104	0.004675	0.1546	0.3199	0.5875	10000	90003
2005	0.2862	0.1377	0.005824	0.1090	0.2576	0.6323	10000	90003

Table 2.8.8.4 NE Atlantic mackerel WINBUGS ICA exploratory assessment (2006 data) Estimated Recruitment age 0. (Estimates for 0 group in 2005 are not fully estimated in the model.

year	mean	sd	MC error	2.50%	median	97.50%	start	sample
1972	5.55E+06	97670	1956	5.37E+06	5.55E+06	5.76E+06	10000	90003
1973	1.90E+06	21820	437	1.86E+06	1.90E+06	1.94E+06	10000	90003
1974	4.22E+06	36320	7.30E+02	4.16E+06	4.22E+06	4.30E+06	10000	90003
1975	3.55E+06	37080	7.41E+02	3.48E+06	3.55E+06	3.63E+06	10000	90003
1976	4.32E+06	31740	634	4.26E+06	4.32E+06	4.39E+06	10000	90003
1977	4.31E+06	33080	6.56E+02	4.25E+06	4.31E+06	4.38E+06	10000	90003
1978	8.80E+05	15540	3.12E+02	8.51E+05	8.79E+05	912500	10000	90003
1979	2.82E+06	17470	3.46E+02	2.79E+06	2.82E+06	2.86E+06	10000	90003
1980	4.54E+06	19850	4.06E+02	4.51E+06	4.54E+06	4.59E+06	10000	90003
1981	4.89E+06	36390	7.40E+02	4.82E+06	4.89E+06	4.96E+06	10000	90003
1982	6.40E+06	1.76E+05	1.79E+03	6.11E+06	6.38E+06	6.79E+06	10000	90003
1983	1.83E+06	91280	1.04E+03	1.67E+06	1.82E+06	2.03E+06	10000	90003
1984	1.42E+06	80860	8.73E+02	1.28E+06	1.41E+06	1.59E+06	10000	90003
1985	6.20E+06	170300	1.84E+03	5.90E+06	6.19E+06	6.56E+06	10000	90003
1986	2.88E+06	130300	1.28E+03	2.65E+06	2.88E+06	3.16E+06	10000	90003
1987	2.99E+06	143600	1.46E+03	2.72E+06	2.98E+06	3.29E+06	10000	90003
1988	4.42E+06	202300	2.18E+03	4.05E+06	4.41E+06	4.84E+06	10000	90003
1989	3.08E+06	1.75E+05	1.81E+03	2.75E+06	3.07E+06	3.44E+06	10000	90003
1990	3.71E+06	222100	2.64E+03	3.30E+06	3.69E+06	4.17E+06	10000	90003
1991	2.83E+06	179600	2.37E+03	2.50E+06	2.83E+06	3.21E+06	10000	90003
1992	3.23E+06	204900	3.32E+03	2.86E+06	3.22E+06	3.66E+06	10000	90003
1993	3.93E+06	256500	4.90E+03	3.47E+06	3.91E+06	4.48E+06	10000	90003
1994	4.53E+06	306100	6.45E+03	4.00E+06	4.51E+06	5.19E+06	10000	90003
1995	3.65E+06	253700	5.87E+03	3.22E+06	3.63E+06	4.21E+06	10000	90003
1996	3.56E+06	288800	8.08E+03	3.09E+06	3.53E+06	4.20E+06	10000	90003
1997	3.62E+06	342500	1.06E+04	3.08E+06	3.58E+06	4.39E+06	10000	90003
1998	2.91E+06	341700	1.19E+04	2.41E+06	2.87E+06	3.69E+06	10000	90003
1999	2.70E+06	398900	14840	2.13E+06	2.64E+06	3.62E+06	10000	90003
2000	3.10E+06	586600	2.27E+04	2.31E+06	3.00E+06	4.44E+06	10000	90003
2001	1.28E+06	322800	1.29E+04	8.67E+05	1.23E+06	2.04E+06	10000	90003
2002	4.88E+06	1.51E+06	6.08E+04	2.97E+06	4.60E+06	8.38E+06	10000	90003
2003	7.37E+06	2.93E+06	1.19E+05	3.74E+06	6.81E+06	1.42E+07	10000	90003
2004	1.62E+06	850100	3.42E+04	6.45E+05	1.45E+06	3.62E+06	10000	90003
2005	2.00E+06	1.29E+06	5.03E+04	6.04E+05	1.71E+06	5.13E+06	10000	90003

Table 2.9.1.1 North East Atlantic Mackerel. Input parameters of the final ICA assessments for the years 1999-2006.

Assessment year	2006	2005	2004	2003	2002	2001	2000	1999
First data year	1972	1972	1972	1972	1972	1984	1984	1984
Final data year	2005	2004	2003	2002	2001	2000	1999	1998
No of years for separable constraint ?	14 (covering last 5 egg survey SSB's)	13 (covering last 5 egg survey SSB's)	12 (covering last 5 egg survey SSB's)	11 (covering last 4 egg survey SSB's)	10 (covering last 4 egg survey SSB's)	9 (covering last 3 egg survey SSB's)	8 (covering last 3 egg survey SSB's)	7 (covering last 3 egg survey SSB's)
Constant selection pattern model (Y/N)	S1(1992-2005)	S1(1992-2004)	S1(1992-2003)	S1(1992-2002)	S1(1992-2001)	S1(1992-2000)	S1(1992-1999)	S1(1992-1998)
S to be fixed on last age	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Age range in canum, weca, west, matprop	0-12+	0 - 12+	0 - 12+	0 - 12+	0 - 12+	0 - 12+	0 - 12+	0 - 12+
Natural mortality (M)	M=0.15 for all ages	M=0.15 for all ages	M=0.15 for all ages	M=0.15 for all ages	M=0.15 for all ages	M=0.15 for all ages	M=0.15 for all ages	M=0.15 for all ages
Proportion of F and M before spawning	0.4	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Reference age for separable constraint	5	5	5	5	5	5	5	5
First age for calculation of reference F	4	4	4	4	4	4	4	4
Last age for calculation of reference F	8	8	8	8	8	8	8	8
Shrink the final populations	No	No	No	No	No	No	No	No

Tuning indices

	2006	2005	2004	2003	2002	2001	2000	1999
SSB from egg surveys — Years	1992 + 1995 + 1998 + 2001 + 2004	1992 + 1995 + 1998 + 2001 + 2004	1992 + 1995 + 1998 + 2001 + 2004	1992 + 1995 + 1998 + 2001	1992 + 1995 + 1998 + 2001	1992 + 1995 + 1998	1992 + 1995 + 1998	1992 + 1995 + 1998
Abundance index	relative index: linear	relative index: linear	WG: absolute index ACFM: relative index	absolute index	absolute index	relative index: linear	relative index: linear	relative index: linear

Model weighting

	2006	2005	2004	2003	2002	2001	2000	1999
Relative weights in catch at age matrix	all 1, except 0-gr 0.01 and 1-gr 0.1	all 1, except 0-gr 0.01 and 1-gr 0.1	all 1, except 0-gr 0.01 and 1-gr 0.1	all 1, except 0-gr 0.01	all 1, except 0-gr 0.01	all 1, except 0-gr 0.01	all 1, except 0-gr 0.01	all 1, except 0-gr 0.01
Survey indices weighting — Egg surveys	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Stock recruitment relationship fitted?	No	No	No	No	No	No	No	No
Parameters to be estimated	50	48	45 (abs.) or 46 (rel.)	43	41	40	38	36
Number of observations	173	161	149	136	124	111	99	87

Table 2.9.1.2 North East Atlantic Mackerel. Catch in numbers at age

Output Generated by ICA Version 1.4

Mackerel NE Atlantic WG2006

Catch in Number

AGE	1972	1973	1974	1975	1976	1977	1978	1979
0	10.71	17.00	29.28	36.17	62.51	6.08	34.62	114.53
1	34.98	46.27	108.08	62.91	282.82	175.22	34.51	360.70
2	51.65	74.54	47.41	92.39	249.29	328.73	560.74	62.91
3	194.46	109.02	155.39	84.51	374.25	226.56	449.34	609.52
4	650.98	415.01	148.54	265.13	176.79	236.12	279.24	385.58
5	0.00	814.52	424.46	164.67	314.26	67.76	282.16	250.75
6	0.00	0.00	673.32	251.42	133.82	186.62	78.88	248.10
7	0.00	0.00	0.00	991.63	379.79	105.00	172.21	92.66
8	0.00	0.00	0.00	0.00	478.93	229.80	73.93	169.60
9	0.00	0.00	0.00	0.00	0.00	236.97	127.97	73.90
10	0.00	0.00	0.00	0.00	0.00	0.00	243.33	102.36
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	204.29
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

x 10 ^ 6

AGE	1980	1981	1982	1983	1984	1985	1986	1987
0	33.10	56.68	11.18	7.33	287.29	81.80	49.98	7.40
1	411.33	276.23	213.94	47.91	31.90	268.96	58.13	40.13
2	393.02	502.37	432.87	668.91	86.06	20.89	424.56	156.67
3	64.55	231.81	472.46	433.74	682.49	58.35	38.39	663.38
4	328.21	32.81	184.58	373.26	387.58	445.36	76.55	56.68
5	254.17	184.87	26.54	126.53	251.50	252.22	364.12	89.00
6	142.98	173.35	138.97	20.18	98.06	165.22	208.02	244.57
7	145.38	116.33	112.48	90.15	22.09	62.36	126.17	150.59
8	54.78	125.55	89.67	72.03	61.81	19.56	42.57	85.86
9	130.77	41.19	88.73	48.67	47.92	47.56	13.53	34.80
10	39.92	146.19	27.55	49.25	37.48	37.61	32.79	19.66
11	56.21	31.64	91.74	19.75	30.11	26.96	22.97	25.75
12	104.93	199.62	156.12	132.04	69.18	97.65	81.15	63.15

x 10 ^ 6

AGE	1988	1989	1990	1991	1992	1993	1994	1995
0	57.64	65.40	24.25	10.01	43.45	19.35	25.37	14.76
1	152.66	64.26	140.53	58.46	83.58	128.14	147.31	81.53
2	137.63	312.74	209.85	212.52	156.29	210.32	221.49	340.90
3	190.40	207.69	410.75	206.42	356.21	266.68	306.98	340.21
4	538.39	167.59	208.15	375.45	266.59	398.24	267.42	275.03
5	72.91	362.47	156.74	188.62	306.14	244.28	301.35	186.85
6	87.32	48.70	254.01	129.15	156.07	255.47	184.93	197.86
7	201.02	58.12	42.55	197.89	113.90	149.93	189.85	142.34
8	122.50	111.25	49.70	51.08	138.46	97.75	106.11	113.41
9	55.91	68.24	85.45	43.41	51.21	121.40	80.05	69.19
10	20.71	32.23	33.04	70.84	36.61	38.79	57.62	42.44
11	13.18	13.90	16.59	29.74	40.96	29.07	20.41	37.96
12	57.49	35.81	27.91	52.99	68.20	68.22	57.55	39.75

x 10 ^ 6

Table 2.9.1.2 (Cont'd)

AGE	1996	1997	1998	1999	2000	2001	2002	2003
0	37.96	36.01	61.13	67.00	36.34	26.03	70.41	14.41
1	119.85	144.39	99.35	73.60	102.41	40.31	222.21	182.12
2	168.88	186.48	229.77	132.99	142.90	158.94	69.73	265.15
3	333.37	238.43	264.57	223.64	275.38	234.19	366.98	88.95
4	279.18	378.88	323.19	261.78	390.86	297.21	349.85	290.23
5	177.67	246.78	361.94	281.04	295.52	309.94	262.49	230.57
6	96.30	135.06	207.62	244.21	241.55	231.80	236.93	180.48
7	119.83	84.38	118.39	159.02	175.61	195.25	151.24	132.35
8	55.81	66.50	72.75	86.74	106.29	120.24	118.81	93.17
9	59.80	39.45	47.35	50.61	52.39	72.20	79.92	74.78
10	25.80	26.73	24.39	30.36	31.28	42.53	43.78	45.79
11	18.35	13.95	16.55	17.05	18.92	20.55	21.61	25.69
12	30.65	24.97	22.93	32.45	34.20	40.71	40.26	30.89

x 10 ^ 6

AGE	2004	2005
0	5.17	5.01
1	24.62	42.58
2	425.83	131.98
3	499.45	661.47
4	142.79	288.30
5	244.88	117.40
6	138.00	120.03
7	84.00	62.88
8	61.43	37.90
9	37.61	24.13
10	32.82	18.82
11	15.38	7.93
12	18.15	10.73

x 10 ^ 6

Table 2.9.1.3 North East Atlantic Mackerel. Catch weights at age

Weights at age in the catches (Kg)

AGE	1972	1973	1974	1975	1976	1977	1978	1979
0	0.05200	0.05000	0.05100	0.05000	0.05900	0.05600	0.03600	0.01600
1	0.13500	0.14500	0.13600	0.14800	0.13700	0.13600	0.13500	0.13700
2	0.27700	0.19400	0.22900	0.17700	0.20700	0.16900	0.16100	0.16100
3	0.34100	0.28500	0.26100	0.25900	0.26300	0.27500	0.25000	0.24300
4	0.42300	0.36800	0.33400	0.32300	0.32000	0.33300	0.32500	0.31800
5	0.00000	0.44800	0.39200	0.34800	0.34600	0.35200	0.34500	0.34800
6	0.00000	0.00000	0.48100	0.43000	0.40600	0.40700	0.40300	0.40100
7	0.00000	0.00000	0.00000	0.48800	0.44300	0.44600	0.42100	0.41600
8	0.00000	0.00000	0.00000	0.00000	0.51800	0.54600	0.51800	0.50600
9	0.00000	0.00000	0.00000	0.00000	0.00000	0.53700	0.53600	0.51300
10	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.52900	0.53700
11	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.52200
12	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

AGE	1980	1981	1982	1983	1984	1985	1986	1987
0	0.05700	0.06000	0.05300	0.05000	0.03100	0.05500	0.03900	0.07600
1	0.13100	0.13200	0.13100	0.16800	0.10200	0.14400	0.14600	0.17900
2	0.24900	0.24800	0.24900	0.21900	0.18400	0.26200	0.24500	0.22300
3	0.28500	0.28700	0.28500	0.27600	0.29500	0.35700	0.33500	0.31800
4	0.34500	0.34400	0.34500	0.31000	0.32600	0.41800	0.42300	0.39900
5	0.37800	0.37700	0.37800	0.38600	0.34400	0.41700	0.47100	0.47400
6	0.45400	0.45400	0.45400	0.42500	0.43100	0.43600	0.44400	0.51200
7	0.49800	0.49900	0.49600	0.43500	0.54200	0.52100	0.45700	0.49300
8	0.52000	0.51300	0.51300	0.49800	0.48000	0.55500	0.54300	0.49800
9	0.54200	0.54300	0.54100	0.54500	0.56900	0.56400	0.59100	0.58000
10	0.57400	0.57300	0.57400	0.60600	0.62800	0.62900	0.55200	0.63400
11	0.59000	0.57600	0.57400	0.60800	0.63600	0.67900	0.69400	0.63500
12	0.58000	0.58400	0.58200	0.61400	0.66300	0.71000	0.68800	0.71800

AGE	1988	1989	1990	1991	1992	1993	1994	1995
0	0.05500	0.04900	0.08500	0.06800	0.05100	0.06100	0.04600	0.07200
1	0.13300	0.13600	0.15600	0.15600	0.16700	0.13400	0.13600	0.14300
2	0.25900	0.23700	0.23300	0.25300	0.23900	0.24000	0.25500	0.23400
3	0.32300	0.32000	0.33600	0.32700	0.33300	0.31700	0.33900	0.33300
4	0.38800	0.37700	0.37900	0.39400	0.39700	0.37600	0.39000	0.39000
5	0.45600	0.43300	0.42300	0.42300	0.46000	0.43600	0.44800	0.45200
6	0.52400	0.45600	0.46700	0.46900	0.49500	0.48300	0.51200	0.50100
7	0.55500	0.54300	0.52800	0.50600	0.53200	0.52700	0.54300	0.53900
8	0.55500	0.59200	0.55200	0.55400	0.55500	0.54800	0.59000	0.57700
9	0.56200	0.57800	0.60600	0.60900	0.59700	0.58300	0.58300	0.59400
10	0.61300	0.58100	0.60600	0.63000	0.65100	0.59500	0.62700	0.60600
11	0.62400	0.64800	0.59100	0.64900	0.66300	0.64700	0.67800	0.63100
12	0.69700	0.73900	0.71300	0.70800	0.66900	0.67900	0.71300	0.67200

Table 2.9.1.3 (Cont'd)

AGE	1996	1997	1998	1999	2000	2001	2002	2003
0	0.05800	0.07600	0.06500	0.06200	0.06300	0.06900	0.05200	0.08100
1	0.14300	0.14300	0.15700	0.17600	0.13500	0.17200	0.16000	0.17100
2	0.22600	0.23000	0.22700	0.23500	0.22700	0.22400	0.25600	0.27100
3	0.31300	0.29500	0.31000	0.30600	0.30600	0.30500	0.30700	0.33800
4	0.37700	0.35900	0.35400	0.36100	0.36300	0.37600	0.36700	0.38700
5	0.42500	0.41500	0.40800	0.40400	0.42700	0.42400	0.42500	0.43900
6	0.48400	0.45300	0.45200	0.45200	0.46300	0.47400	0.46000	0.47700
7	0.51800	0.48100	0.46200	0.50000	0.50100	0.49600	0.51200	0.52300
8	0.55100	0.52400	0.51800	0.53600	0.53400	0.54000	0.53700	0.57200
9	0.57600	0.55300	0.55000	0.56900	0.56700	0.57700	0.58000	0.61200
10	0.59600	0.57700	0.57300	0.58600	0.58600	0.60300	0.60100	0.63100
11	0.60300	0.59100	0.59100	0.60700	0.59400	0.61100	0.62900	0.64800
12	0.67000	0.63600	0.63100	0.68700	0.64400	0.66600	0.66500	0.71500

AGE	2004	2005
0	0.08600	0.06700
1	0.16000	0.15200
2	0.26700	0.27000
3	0.32600	0.30700
4	0.40200	0.36700
5	0.42200	0.43500
6	0.48800	0.44000
7	0.52300	0.49800
8	0.55700	0.54200
9	0.57500	0.55500
10	0.59800	0.58700
11	0.63300	0.63100
12	0.68600	0.65700

Table 2.9.1.4 North East Atlantic Mackerel. Stock weights at age

Weights at age in the stock (Kg)

AGE	1972	1973	1974	1975	1976	1977	1978	1979
0	0.00800	0.00800	0.00800	0.00800	0.00800	0.00800	0.00800	0.00800
1	0.13200	0.13200	0.13000	0.12900	0.12800	0.12700	0.11100	0.11000
2	0.17800	0.17700	0.17300	0.17100	0.17000	0.16700	0.17500	0.17400
3	0.24300	0.24200	0.23800	0.23600	0.23600	0.23300	0.23800	0.23700
4	0.41100	0.30100	0.29600	0.29400	0.29300	0.28900	0.30000	0.29900
5	0.00000	0.43800	0.32200	0.31800	0.31800	0.31300	0.34600	0.34500
6	0.00000	0.00000	0.46900	0.36500	0.36500	0.36100	0.38200	0.38000
7	0.00000	0.00000	0.00000	0.49700	0.41900	0.41600	0.41000	0.40800
8	0.00000	0.00000	0.00000	0.00000	0.51200	0.44600	0.43200	0.43000
9	0.00000	0.00000	0.00000	0.00000	0.00000	0.53000	0.45100	0.44900
10	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.51400	0.50400
11	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.51600
12	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

AGE	1980	1981	1982	1983	1984	1985	1986	1987
0	0.00800	0.00800	0.00800	0.00800	0.00000	0.00000	0.00000	0.00000
1	0.10900	0.08700	0.08600	0.08600	0.08100	0.08500	0.07700	0.07800
2	0.17300	0.18600	0.13500	0.17200	0.19400	0.16500	0.17900	0.14800
3	0.23600	0.25200	0.22100	0.23500	0.25300	0.29300	0.26700	0.24000
4	0.29700	0.31300	0.28000	0.28000	0.29500	0.30600	0.30400	0.28600
5	0.34300	0.32300	0.38500	0.33900	0.32400	0.34100	0.35600	0.37400
6	0.37900	0.37800	0.35300	0.37700	0.39300	0.38400	0.35100	0.38600
7	0.40700	0.41900	0.40800	0.40400	0.43600	0.43000	0.41600	0.41100
8	0.42900	0.43400	0.43700	0.43900	0.44100	0.45900	0.47300	0.42900
9	0.44800	0.44900	0.44600	0.50300	0.47900	0.46800	0.44300	0.48200
10	0.50300	0.44300	0.47900	0.47300	0.52000	0.55900	0.46800	0.49900
11	0.50800	0.52300	0.52600	0.55500	0.51000	0.57900	0.49700	0.47000
12	0.51800	0.53100	0.53400	0.56300	0.55000	0.60700	0.57500	0.54900

AGE	1988	1989	1990	1991	1992	1993	1994	1995
0	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	0.07200	0.07600	0.07400	0.07500	0.07800	0.07800	0.07900	0.08100
2	0.15600	0.17700	0.13800	0.15500	0.21200	0.19700	0.17800	0.16400
3	0.23700	0.24400	0.22200	0.23000	0.25900	0.26800	0.23700	0.26700
4	0.30100	0.30600	0.28700	0.30700	0.31000	0.31500	0.30100	0.32600
5	0.32900	0.35200	0.33900	0.35700	0.36200	0.36000	0.36100	0.39800
6	0.42300	0.38000	0.37300	0.40900	0.40200	0.41600	0.41300	0.44800
7	0.44500	0.42900	0.41400	0.43200	0.42400	0.45400	0.46600	0.49100
8	0.43200	0.47400	0.40900	0.50200	0.46200	0.46500	0.47000	0.50800
9	0.45500	0.45700	0.43700	0.54100	0.48700	0.48400	0.48300	0.54600
10	0.52200	0.46600	0.51400	0.56600	0.52200	0.51100	0.55000	0.51400
11	0.58900	0.51000	0.52300	0.56600	0.55200	0.58500	0.60800	0.61900
12	0.63200	0.59500	0.52900	0.59400	0.58300	0.57700	0.58400	0.63900

Table 2.9.1.4 (Cont'd)

AGE	1996	1997	1998	1999	2000	2001	2002	2003
0	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	0.07600	0.07600	0.07700	0.08100	0.07400	0.07800	0.07800	0.07400
2	0.13300	0.18600	0.14900	0.19400	0.18500	0.16400	0.18100	0.18100
3	0.25100	0.22800	0.22300	0.24200	0.23500	0.24100	0.23900	0.27300
4	0.31700	0.29600	0.28500	0.30100	0.28900	0.34200	0.31100	0.31600
5	0.36600	0.36100	0.34200	0.35300	0.35000	0.39000	0.36400	0.37100
6	0.44400	0.40200	0.40000	0.39600	0.39000	0.44600	0.41100	0.44600
7	0.46200	0.44500	0.42600	0.42300	0.42600	0.45900	0.43600	0.44600
8	0.50100	0.47800	0.46600	0.44000	0.44700	0.49900	0.46200	0.47500
9	0.56500	0.51900	0.50200	0.48500	0.48500	0.52900	0.50000	0.58400
10	0.57300	0.53700	0.54900	0.49800	0.49200	0.57600	0.52200	0.52700
11	0.61100	0.53200	0.52400	0.46500	0.53200	0.60300	0.53300	0.59900
12	0.63200	0.58500	0.58000	0.56500	0.54400	0.58600	0.56500	0.61000

AGE	2004	2005
0	0.00000	0.00000
1	0.05900	0.07400
2	0.13800	0.16800
3	0.24600	0.23800
4	0.31300	0.33600
5	0.35500	0.38100
6	0.41200	0.40100
7	0.46300	0.48100
8	0.46200	0.50100
9	0.50800	0.55000
10	0.52000	0.55000
11	0.53800	0.57600
12	0.59000	0.59000

Table 2.9.1.5 North East Atlantic Mackerel. Natural mortality at age

Natural Mortality (per year)

AGE	1972	1973	1974	1975	1976	1977	1978	1979
0	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
1	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
2	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
3	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
4	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
5	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
6	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
7	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
8	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
9	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
10	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
11	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
12	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000

AGE	1980	1981	1982	1983	1984	1985	1986	1987
0	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
1	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
2	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
3	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
4	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
5	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
6	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
7	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
8	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
9	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
10	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
11	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
12	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000

AGE	1988	1989	1990	1991	1992	1993	1994	1995
0	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
1	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
2	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
3	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
4	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
5	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
6	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
7	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
8	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
9	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
10	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
11	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
12	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000

Table 2.9.1.5 (cont'd)

AGE	1996	1997	1998	1999	2000	2001	2002	2003
0	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
1	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
2	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
3	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
4	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
5	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
6	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
7	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
8	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
9	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
10	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
11	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
12	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000

AGE	2004	2005
0	0.15000	0.15000
1	0.15000	0.15000
2	0.15000	0.15000
3	0.15000	0.15000
4	0.15000	0.15000
5	0.15000	0.15000
6	0.15000	0.15000
7	0.15000	0.15000
8	0.15000	0.15000
9	0.15000	0.15000
10	0.15000	0.15000
11	0.15000	0.15000
12	0.15000	0.15000

Table 2.9.1.6 North East Atlantic Mackerel. Proportion of fish spawning

Proportion of fish spawning

AGE	1972	1973	1974	1975	1976	1977	1978	1979
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0500	0.0500	0.0500	0.0600	0.0600	0.0600	0.0600	0.0600
2	0.5300	0.5400	0.5400	0.5500	0.5500	0.5500	0.5600	0.5600
3	0.9000	0.9000	0.9000	0.8900	0.8900	0.8900	0.8900	0.8900
4	0.9800	0.9800	0.9800	0.9800	0.9800	0.9800	0.9800	0.9800
5	0.9800	0.9800	0.9800	0.9800	0.9800	0.9800	0.9800	0.9800
6	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
12	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	1980	1981	1982	1983	1984	1985	1986	1987
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0600	0.0700	0.0700	0.0700	0.0700	0.0700	0.0700	0.0700
2	0.5700	0.5700	0.5700	0.5800	0.5800	0.5800	0.5800	0.5800
3	0.8900	0.8800	0.8800	0.8800	0.8800	0.8800	0.8800	0.8800
4	0.9800	0.9800	0.9800	0.9800	0.9700	0.9700	0.9700	0.9700
5	0.9800	0.9800	0.9800	0.9800	0.9700	0.9700	0.9700	0.9700
6	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
12	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	1988	1989	1990	1991	1992	1993	1994	1995
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0700	0.0700	0.0700	0.0700	0.0700	0.0700	0.0700	0.0700
2	0.5800	0.5800	0.5800	0.5800	0.5800	0.5800	0.5800	0.5800
3	0.8800	0.8800	0.8800	0.8800	0.8800	0.8800	0.8800	0.8800
4	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700
5	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700
6	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
12	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 2.9.1.6 (Cont'd)

AGE	1996	1997	1998	1999	2000	2001	2002	2003
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0700	0.0700	0.0700	0.0700	0.0700	0.0700	0.0700	0.0700
2	0.5800	0.5800	0.5800	0.5800	0.5800	0.5900	0.5900	0.5900
3	0.8800	0.8800	0.8600	0.8600	0.8600	0.8800	0.8800	0.8800
4	0.9700	0.9700	0.9800	0.9800	0.9800	0.9700	0.9700	0.9700
5	0.9700	0.9700	0.9800	0.9800	0.9800	0.9700	0.9700	0.9700
6	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
12	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	2004	2005
0	0.0000	0.0000
1	0.0700	0.0700
2	0.5900	0.5800
3	0.8800	0.8900
4	0.9700	0.9800
5	0.9700	0.9800
6	0.9900	0.9900
7	1.0000	1.0000
8	1.0000	1.0000
9	1.0000	1.0000
10	1.0000	1.0000
11	1.0000	1.0000
12	1.0000	1.0000

Table 2.9.1.7 North East Atlantic Mackerel. Biomass estimates from egg surveys

INDICES OF SPAWNING BIOMASS

INDEX1

	1972	1973	1974	1975	1976	1977	1978	1979
1	*******	*******	*******	*******	*******	*******	*******	*******

x 10 ^ 3

	1980	1981	1982	1983	1984	1985	1986	1987
1	*******	*******	*******	*******	*******	*******	*******	*******

x 10 ^ 3

	1988	1989	1990	1991	1992	1993	1994	1995
1	*******	*******	*******	*******	3370.0	*******	*******	2840.0

x 10 ^ 3

	1996	1997	1998	1999	2000	2001	2002	2003
1	*******	*******	3750.0	*******	*******	2900.0	*******	*******

x 10 ^ 3

	2004	2005
1	2750.0	*******

x 10 ^ 3

Table 2.9.1.8 North East Atlantic Mackerel. Fishing mortality at age

Fishing Mortality (per year)

AGE	1972	1973	1974	1975	1976	1977	1978	1979
0	0.00528	0.00376	0.00769	0.00780	0.01346	0.00647	0.01140	0.02326
1	0.00690	0.02692	0.02820	0.01947	0.07370	0.04510	0.04377	0.14912
2	0.02588	0.01730	0.03302	0.02881	0.09478	0.10897	0.18781	0.09947
3	0.05049	0.06640	0.04317	0.07202	0.14777	0.11087	0.20165	0.30186
4	0.09067	0.13727	0.11499	0.09146	0.19993	0.12417	0.18362	0.25180
5	0.00000	0.14834	0.19203	0.17062	0.14135	0.10388	0.20257	0.23593
6	0.00000	0.15815	0.16670	0.15754	0.19310	0.11070	0.16011	0.26036
7	0.00000	0.17657	0.22857	0.37048	0.35484	0.21583	0.13406	0.27004
8	0.00000	0.18239	0.23611	0.20979	0.29019	0.35588	0.21947	0.17920
9	0.00000	0.19759	0.25578	0.22726	0.18827	0.21533	0.32389	0.33490
10	0.00000	0.19489	0.25229	0.22416	0.18571	0.13648	0.33719	0.43843
11	0.00000	0.17801	0.23043	0.20474	0.16962	0.12465	0.24308	0.49492
12	0.00000	0.17801	0.23043	0.20474	0.16962	0.12465	0.24308	0.49492

AGE	1980	1981	1982	1983	1984	1985	1986	1987
0	0.00631	0.00832	0.00580	0.00491	0.04269	0.02636	0.01557	0.00157
1	0.10323	0.06332	0.03732	0.02939	0.02516	0.04860	0.02230	0.01475
2	0.22739	0.16745	0.12660	0.14841	0.06425	0.01958	0.09571	0.07317
3	0.13311	0.19242	0.22194	0.17083	0.21012	0.05369	0.04311	0.20102
4	0.24922	0.08789	0.21844	0.25876	0.21480	0.19517	0.08778	0.07855
5	0.24759	0.20496	0.09029	0.21622	0.26290	0.19991	0.22896	0.13224
6	0.19403	0.25179	0.22143	0.08714	0.24496	0.26073	0.23820	0.22413
7	0.22636	0.22606	0.24318	0.20683	0.12302	0.22958	0.30672	0.25639
8	0.23956	0.29390	0.25758	0.22925	0.20218	0.14464	0.22899	0.33367
9	0.19332	0.26968	0.32906	0.20503	0.22213	0.22346	0.13365	0.28001
10	0.28743	0.32372	0.27519	0.28959	0.22761	0.25706	0.22383	0.27562
11	0.43247	0.36577	0.32672	0.30605	0.27257	0.24029	0.23329	0.25978
12	0.43247	0.36577	0.32672	0.30605	0.27257	0.24029	0.23329	0.25978

AGE	1988	1989	1990	1991	1992	1993	1994	1995
0	0.01745	0.01653	0.00804	0.00293	0.00712	0.00882	0.00904	0.00923
1	0.03828	0.02306	0.04249	0.02288	0.02728	0.03381	0.03465	0.03540
2	0.06099	0.09741	0.09257	0.07930	0.06509	0.08065	0.08268	0.08445
3	0.11332	0.11674	0.16958	0.11745	0.12984	0.16088	0.16492	0.16845
4	0.23554	0.13089	0.15562	0.21834	0.19667	0.24368	0.24980	0.25514
5	0.13018	0.23288	0.16475	0.19504	0.25347	0.31405	0.32194	0.32882
6	0.17564	0.11418	0.24015	0.18801	0.27022	0.33481	0.34322	0.35056
7	0.27414	0.16075	0.13098	0.28177	0.30170	0.37381	0.38320	0.39140
8	0.32295	0.22680	0.19019	0.21687	0.31165	0.38614	0.39584	0.40431
9	0.35608	0.28348	0.25759	0.23887	0.33762	0.41832	0.42882	0.43800
10	0.25300	0.33757	0.20402	0.33230	0.33301	0.41261	0.42297	0.43202
11	0.28388	0.25432	0.27483	0.26985	0.30416	0.37686	0.38632	0.39459
12	0.28388	0.25432	0.27483	0.26985	0.30416	0.37686	0.38632	0.39459

Table 2.9.1.8 Cont'd

AGE	1996	1997	1998	1999	2000	2001	2002	2003
0	0.00672	0.00641	0.00734	0.00744	0.00866	0.00989	0.01128	0.01097
1	0.02575	0.02458	0.02813	0.02854	0.03319	0.03791	0.04323	0.04203
2	0.06143	0.05863	0.06712	0.06808	0.07918	0.09043	0.10314	0.10028
3	0.12254	0.11695	0.13388	0.13580	0.15794	0.18039	0.20574	0.20002
4	0.18560	0.17714	0.20278	0.20569	0.23923	0.27322	0.31163	0.30297
5	0.23920	0.22830	0.26135	0.26510	0.30832	0.35213	0.40162	0.39046
6	0.25501	0.24339	0.27862	0.28262	0.32870	0.37541	0.42818	0.41628
7	0.28472	0.27174	0.31108	0.31554	0.36699	0.41914	0.47805	0.46476
8	0.29411	0.28071	0.32134	0.32595	0.37910	0.43297	0.49382	0.48010
9	0.31862	0.30410	0.34811	0.35311	0.41068	0.46904	0.53497	0.52010
10	0.31427	0.29995	0.34337	0.34829	0.40508	0.46264	0.52767	0.51300
11	0.28704	0.27396	0.31361	0.31812	0.36998	0.42256	0.48195	0.46855
12	0.28704	0.27396	0.31361	0.31812	0.36998	0.42256	0.48195	0.46855

AGE	2004	2005
0	0.00949	0.00694
1	0.03638	0.02662
2	0.08678	0.06350
3	0.17311	0.12666
4	0.26220	0.19185
5	0.33793	0.24726
6	0.36027	0.26361
7	0.40223	0.29431
8	0.41550	0.30402
9	0.45012	0.32935
10	0.44398	0.32486
11	0.40551	0.29671
12	0.40551	0.29671

Table 2.9.1.9 North East Atlantic Mackerel. Population numbers at age

Population Abundance (1 January)

AGE	1972	1973	1974	1975	1976	1977	1978	1979
0	2190.5	4880.3	4113.0	5014.8	5035.6	1014.3	3288.7	5363.8
1	5473.9	1875.4	4184.7	3513.0	4282.7	4276.2	867.4	2798.5
2	2176.8	4679.0	1571.3	3501.7	2965.3	3424.3	3518.3	714.6
3	4250.7	1825.7	3958.2	1308.5	2928.3	2321.5	2643.0	2509.7
4	8078.6	3478.5	1470.4	3262.9	1048.0	2174.2	1788.4	1859.4
5	0.0	6350.7	2609.9	1128.1	2562.9	738.6	1652.8	1281.1
6	0.0	0.0	4712.5	1853.9	818.7	1915.2	573.0	1161.7
7	0.0	0.0	0.0	3433.3	1363.1	580.9	1475.7	420.2
8	0.0	0.0	0.0	0.0	2040.2	822.8	402.9	1110.8
9	0.0	0.0	0.0	0.0	0.0	1313.7	496.1	278.5
10	0.0	0.0	0.0	0.0	0.0	0.0	911.7	308.9
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	560.1
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

x 10 ^ 6

AGE	1980	1981	1982	1983	1984	1985	1986	1987
0	5664.0	7365.4	2080.8	1613.7	7398.8	3385.4	3482.6	5090.9
1	4510.5	4844.4	6286.9	1780.6	1382.1	6102.1	2838.1	2951.2
2	2075.0	3501.5	3913.8	5213.0	1488.2	1160.0	5003.0	2388.9
3	556.8	1422.7	2549.1	2968.0	3868.0	1201.2	979.1	3913.0
4	1597.3	419.5	1010.2	1757.3	2153.4	2698.3	979.8	807.1
5	1244.2	1071.5	330.7	698.9	1167.7	1495.2	1910.7	772.5
6	870.9	836.0	751.4	260.1	484.6	772.7	1053.8	1308.0
7	770.7	617.4	559.4	518.2	205.2	326.5	512.4	714.7
8	276.1	529.0	423.9	377.5	362.7	156.1	223.3	324.6
9	799.2	187.0	339.4	282.0	258.4	255.0	116.3	152.9
10	171.5	567.0	122.9	210.2	197.7	178.1	175.6	87.6
11	171.5	110.7	353.0	80.3	135.4	135.5	118.5	120.8
12	320.1	698.5	600.8	537.3	311.2	490.8	418.8	296.3

x 10 ^ 6

AGE	1988	1989	1990	1991	1992	1993	1994	1995
0	3588.5	4294.5	3258.3	3688.4	4480.7	5218.6	4438.0	4029.0
1	4374.9	3035.3	3635.7	2782.0	3165.4	3829.2	4452.2	3785.4
2	2502.9	3624.1	2552.9	2999.1	2340.3	2651.1	3186.3	3701.5
3	1911.1	2026.8	2829.8	2003.0	2384.6	1887.4	2105.1	2524.8
4	2754.7	1468.6	1552.3	2055.7	1533.0	1802.5	1383.1	1536.4
5	642.2	1873.4	1109.0	1143.5	1422.3	1083.9	1215.9	927.3
6	582.5	485.3	1277.5	809.5	809.8	950.1	681.5	758.5
7	899.7	420.6	372.6	864.8	577.4	532.0	585.1	416.1
8	476.0	588.7	308.3	281.4	561.6	367.5	315.1	343.3
9	200.1	296.7	403.9	219.4	194.9	353.9	215.0	182.5
10	99.5	120.6	192.3	268.7	148.7	119.7	200.5	120.5
11	57.2	66.5	74.1	135.0	165.9	91.7	68.2	113.0
12	249.6	171.2	124.6	240.4	279.0	232.9	192.5	130.7

x 10 ^ 6

Table 2.9.1.9 (cont'd)

AGE	1996	1997	1998	1999	2000	2001	2002	2003
0	3945.2	3204.6	3026.3	3400.8	1426.2	5087.1	9335.0	2882.7
1	3435.9	3372.9	2740.6	2585.7	2905.4	1217.0	4335.4	7944.6
2	3144.8	2882.1	2832.6	2293.4	2162.9	2419.1	1008.5	3573.6
3	2928.0	2545.5	2339.4	2279.8	1844.0	1719.9	1902.1	782.9
4	1836.2	2229.5	1949.1	1761.2	1713.1	1355.3	1236.0	1332.7
5	1024.6	1312.7	1607.4	1369.7	1234.1	1160.7	887.6	779.0
6	574.5	694.3	899.3	1065.3	904.4	780.4	702.5	511.3
7	459.8	383.2	468.5	585.8	691.2	560.3	461.4	394.1
8	242.2	297.7	251.3	295.4	367.8	412.2	317.2	246.2
9	197.2	155.3	193.5	156.9	183.5	216.7	230.1	166.6
10	101.4	123.4	98.6	117.6	94.8	104.8	116.7	116.0
11	67.3	63.7	78.7	60.2	71.4	54.4	56.8	59.2
12	131.8	111.8	91.4	127.7	118.6	126.5	112.7	88.4

x 10 ^ 6

AGE	2004	2005	2006
0	1827.9	780.2	3096.4
1	2454.1	1558.5	666.9
2	6556.5	2036.8	1306.1
3	2782.4	5174.2	1645.2
4	551.7	2014.1	3923.6
5	847.3	365.3	1431.0
6	453.8	520.1	245.6
7	290.2	272.4	343.9
8	213.1	167.1	174.7
9	131.1	121.1	106.1
10	85.2	72.0	75.0
11	59.8	47.1	44.8
12	58.3	44.8	58.8

x 10 ^ 6

Table 2.9.1.10 North East Atlantic Mackerel. Diagnostic output

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1992	0.2535	6	0.2226	0.2886	0.2372	0.2708	0.2540
2	1993	0.3140	6	0.2769	0.3561	0.2945	0.3349	0.3147
3	1994	0.3219	6	0.2841	0.3648	0.3021	0.3431	0.3226
4	1995	0.3288	6	0.2901	0.3727	0.3085	0.3505	0.3295
5	1996	0.2392	6	0.2105	0.2718	0.2241	0.2553	0.2397
6	1997	0.2283	6	0.2010	0.2593	0.2139	0.2436	0.2288
7	1998	0.2613	6	0.2304	0.2965	0.2450	0.2787	0.2619
8	1999	0.2651	6	0.2337	0.3007	0.2486	0.2827	0.2656
9	2000	0.3083	6	0.2718	0.3497	0.2891	0.3288	0.3090
10	2001	0.3521	6	0.3091	0.4011	0.3295	0.3763	0.3529
11	2002	0.4016	7	0.3484	0.4630	0.3735	0.4319	0.4027
12	2003	0.3905	8	0.3305	0.4613	0.3586	0.4251	0.3919
13	2004	0.3379	10	0.2740	0.4168	0.3036	0.3761	0.3399
14	2005	0.2473	13	0.1898	0.3220	0.2161	0.2829	0.2495
Separable Model: Selection (S) by age								
15	0	0.0281	42	0.0121	0.0652	0.0183	0.0432	0.0308
16	1	0.1076	14	0.0816	0.1420	0.0935	0.1240	0.1087
17	2	0.2568	6	0.2272	0.2903	0.2413	0.2734	0.2573
18	3	0.5123	6	0.4551	0.5766	0.4823	0.5441	0.5132
19	4	0.7759	5	0.6910	0.8712	0.7314	0.8232	0.7773
	5	1.0000	Fixed : Reference Age					
20	6	1.0661	5	0.9551	1.1901	1.0079	1.1277	1.0678
21	7	1.1903	5	1.0712	1.3226	1.1280	1.2561	1.1920
22	8	1.2296	5	1.1122	1.3593	1.1682	1.2941	1.2312
23	9	1.3320	4	1.2104	1.4659	1.2685	1.3987	1.3336
24	10	1.3138	4	1.1917	1.4485	1.2500	1.3809	1.3155
	11	1.2000	Fixed : Last true age					
Separable model: Populations in year 2005								
25	0	780237	160	33682	18073963	156995	3877635	2821477
26	1	1558456	49	585124	4150885	945431	2568969	1765793
27	2	2036789	19	1385936	2993290	1673549	2478869	2076464
28	3	5174161	12	4016222	6665953	4546803	5888081	5217563
29	4	2014146	11	1610591	2518817	1796996	2257536	2027295
30	5	365343	12	288639	462431	323954	412020	367993
31	6	520123	11	413655	653995	462761	584595	523686
32	7	272406	11	215988	343561	241988	306647	274322
33	8	167067	12	131686	211955	147966	188635	168303
34	9	121052	12	94677	154774	106787	137222	122007
35	10	71957	13	55490	93310	63022	82158	72592
36	11	47063	14	35718	62010	40885	54174	47531
Separable model: Populations at age								
37	1992	165883	16	120358	228626	140837	195382	168120
38	1993	91734	12	72100	116714	81127	103727	92429
39	1994	68202	10	55315	84093	61290	75894	68593
40	1995	113041	9	93287	136979	102489	124680	113585
41	1996	67339	9	56101	80828	61350	73913	67632
42	1997	63729	8	53787	75509	58446	69489	63968
43	1998	78701	8	66763	92775	72365	85592	78979
44	1999	60222	8	51320	70668	55503	65343	60423
45	2000	71443	7	61088	83552	65957	77384	71671
46	2001	54441	8	46488	63755	50227	59010	54618
47	2002	56773	8	48035	67100	52133	61826	56980
48	2003	59239	9	48954	71685	53747	65293	59520
49	2004	59768	11	47631	74996	53232	67105	60170

SSB Index catchabilities

INDEX1

Linear model fitted. Slopes at age :

50	1 Q	1.368	4	1.313	1.551	1.368	1.489	1.428

Table 2.9.1.10 (Cont'd)

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1992	1993	1994	1995	1996	1997	1998	1999
0	0.387	-0.788	-0.380	-0.846	0.437	0.638	1.090	1.051
1	0.055	0.080	0.045	-0.406	0.390	0.641	0.341	0.085
2	0.131	0.097	-0.059	0.202	-0.031	0.201	0.296	-0.053
3	0.277	0.022	0.030	-0.068	0.060	-0.092	-0.030	-0.186
4	0.045	0.092	-0.063	-0.159	-0.036	0.118	-0.030	-0.152
5	0.032	-0.109	-0.035	-0.260	-0.133	-0.011	0.050	-0.056
6	-0.135	0.013	0.002	-0.056	-0.224	-0.034	0.019	-0.001
7	-0.207	-0.032	0.088	0.124	0.121	-0.007	0.014	0.073
8	-0.012	-0.117	0.099	0.062	-0.030	-0.021	0.122	0.124
9	-0.017	0.072	0.134	0.135	0.176	0.038	-0.114	0.151
10	-0.070	0.027	-0.114	0.073	0.012	-0.109	-0.092	-0.060
11	0.010	0.078	0.001	0.099	0.159	-0.020	-0.177	0.108

Age	2000	2001	2002	2003	2004	2005
0	1.158	-0.580	-0.323	-0.706	-1.132	0.000
1	0.150	-0.042	0.265	-0.512	-1.196	0.113
2	-0.069	-0.202	-0.276	-0.179	-0.174	0.125
3	0.094	-0.121	0.108	-0.396	0.193	0.144
4	0.141	-0.016	0.126	-0.112	0.186	-0.127
5	-0.032	-0.036	-0.043	-0.019	0.078	0.454
6	0.022	0.017	0.036	0.105	0.075	0.067
7	-0.120	0.086	-0.080	-0.033	-0.066	-0.029
8	-0.018	-0.117	0.028	0.060	-0.096	-0.074
9	-0.096	-0.048	-0.109	0.169	-0.165	-0.272
10	0.059	0.160	-0.021	0.051	0.140	0.011
11	-0.086	0.160	0.063	0.216	-0.190	-0.351

SPAWNING BIOMASS INDEX RESIDUALS

INDEX1

	1972	1973	1974	1975	1976	1977	1978	1979
1	*******	*******	*******	*******	*******	*******	*******	*******

	1980	1981	1982	1983	1984	1985	1986	1987
1	*******	*******	*******	*******	*******	*******	*******	*******

	1988	1989	1990	1991	1992	1993	1994	1995
1	*******	*******	*******	*******	-0.0685	*******	*******	-0.1458

	1996	1997	1998	1999	2000	2001	2002	2003
1	*******	*******	0.1612	*******	*******	-0.0119	*******	*******

	2004	2005
1	0.0650	*******

Table 2.9.1.10 (Cont'd)

```
PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)
 -----------------------------------------------------

 Separable model fitted from 1992  to 2005
 Variance                           0.0221
Skewness test stat.                -0.9873
Kurtosis test statistic             2.9731
Partial chi-square                  0.2320
Significance in fit                 0.0000
Degrees of freedom                      **


 PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES
 -----------------------------------------------

   DISTRIBUTION STATISTICS FOR   INDEX1


 Linear catchability relationship assumed

 Variance                           0.0704
Skewness test stat.                 0.1597
Kurtosis test statistic            -0.5293
Partial chi-square                  0.0188
Significance in fit                 0.0000
Number of observations                   5
Degrees of freedom                       4
Weight in the analysis              5.0000

 ANALYSIS OF VARIANCE
--------------------------

 Unweighted Statistics


Variance
                                       SSQ     Data    Parameters d.f. Variance
Total for model                      13.0860     173          50  123   0.1064
Catches at age                       13.0297     168          49  119   0.1095

SSB Indices
  INDEX1                              0.0563       5           1    4   0.0141

 Weighted Statistics


Variance
                                       SSQ     Data    Parameters d.f. Variance
Total for model                       4.0377     173          50  123   0.0328
Catches at age                        2.6302     168          49  119   0.0221

SSB Indices
  INDEX1                              1.4075       5           1    4   0.3519
```

Table 2.9.1.11 North East Atlantic Mackerel. Stock summary table

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 4- 8	SoP (%)
1972	2190480	5480783	4038603	361262	0.0895	0.0181	99
1973	4880250	5385214	4128482	570719	0.1382	0.1605	100
1974	4113000	5276621	3976210	607473	0.1528	0.1877	99
1975	5014750	5101962	3724320	784329	0.2106	0.2000	100
1976	5035560	4820283	3400480	828434	0.2436	0.2359	99
1977	1014280	4519729	3230685	620016	0.1919	0.1821	99
1978	3288700	4166043	3192117	736519	0.2307	0.1800	99
1979	5363800	3728067	2740188	842739	0.3075	0.2395	100
1980	5664020	3387894	2300859	734950	0.3194	0.2313	99
1981	7365370	3535832	2349329	754045	0.3210	0.2129	99
1982	2080800	3454637	2256416	716987	0.3178	0.2062	99
1983	1613650	3550619	2529253	672283	0.2658	0.1996	99
1984	7398800	3299520	2528343	641928	0.2539	0.2096	99
1985	3385430	3501663	2493292	614371	0.2464	0.2060	100
1986	3482600	3475607	2483426	602201	0.2425	0.2181	100
1987	5090890	3317325	2455434	654992	0.2668	0.2050	100
1988	3588520	3385688	2461642	680491	0.2764	0.2277	100
1989	4294500	3446993	2520997	585920	0.2324	0.1731	99
1990	3258290	3207871	2368842	626107	0.2643	0.1763	99
1991	3688430	3509448	2632082	675665	0.2567	0.2200	99
1992	4480660	3607313	2638896	760690	0.2883	0.2667	100
1993	5218570	3512898	2467288	824568	0.3342	0.3305	100
1994	4437980	3343183	2268604	819087	0.3611	0.3388	100
1995	4028980	3491301	2402407	756277	0.3148	0.3460	100
1996	3945160	3254159	2364841	563472	0.2383	0.2517	100
1997	3204550	3344735	2424819	573029	0.2363	0.2403	100
1998	3026300	3181919	2333705	666316	0.2855	0.2750	100
1999	3400800	3254152	2383006	640309	0.2687	0.2790	99
2000	1426200	3025212	2175396	738606	0.3395	0.3245	99
2001	5087070	2915191	2145921	737463	0.3437	0.3706	99
2002	9335000	2589120	1731017	772905	0.4465	0.4227	99
2003	2882660	2927191	1712998	669600	0.3909	0.4109	99
2004	1827930	2804807	1884198	650221	0.3451	0.3556	99
2005	780230	3087917	2352719	543486	0.2310	0.2602	99

```
-----------------------------------------------------------------
No of years for separable analysis : 14
Age range in the analysis : 0  . . . 12
Year range in the analysis : 1972  . . . 2005
Number of indices of SSB : 1
Number of age-structured indices : 0

Parameters to estimate : 50
Number of observations : 173

Conventional single selection vector model to be fitted.

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Table 2.10.1 North East Atlantic Mackerel. Prediction: INPUT DATA

2006 Age	Stock size	Natural mortality	Maturity ogive	Prop. of F bef. spaw.	Prop. of M bef. spaw.	Weight in the stock	Exploit. pattern	Weight in catch
0	3786675	0.15	0	0.4	0.4	0.000	0.007	0.078
1	3236668	0.15	0.07	0.4	0.4	0.069	0.027	0.161
2	1306100	0.15	0.59	0.4	0.4	0.162	0.064	0.269
3	1645200	0.15	0.88	0.4	0.4	0.252	0.127	0.324
4	3923600	0.15	0.97	0.4	0.4	0.322	0.192	0.385
5	1431000	0.15	0.97	0.4	0.4	0.369	0.247	0.432
6	245570	0.15	0.99	0.4	0.4	0.420	0.264	0.468
7	343940	0.15	1	0.4	0.4	0.463	0.294	0.515
8	174690	0.15	1	0.4	0.4	0.479	0.304	0.557
9	106100	0.15	1	0.4	0.4	0.547	0.329	0.581
10	74954	0.15	1	0.4	0.4	0.532	0.325	0.605
11	44756	0.15	1	0.4	0.4	0.571	0.297	0.637
12	58783	0.15	1	0.4	0.4	0.597	0.297	0.686

2007 Age	Stock size	Natural mortality	Maturity ogive	Prop. of F bef. spaw.	Prop. of M bef. spaw.	Weight in the stock	Exploit. pattern	Weight in catch
0	3672928	0.15	0	0.4	0.4	0.000	0.010	0.073
1	.	0.15	0.07	0.4	0.4	0.070	0.035	0.163
2	.	0.15	0.59	0.4	0.4	0.167	0.075	0.263
3	.	0.15	0.88	0.4	0.4	0.253	0.147	0.323
4	.	0.15	0.97	0.4	0.4	0.313	0.228	0.386
5	.	0.15	0.97	0.4	0.4	0.363	0.274	0.430
6	.	0.15	0.99	0.4	0.4	0.423	0.298	0.477
7	.	0.15	1	0.4	0.4	0.448	0.332	0.521
8	.	0.15	1	0.4	0.4	0.466	0.341	0.558
9	.	0.15	1	0.4	0.4	0.531	0.373	0.592
10	.	0.15	1	0.4	0.4	0.523	0.354	0.614
11	.	0.15	1	0.4	0.4	0.557	0.329	0.641
12	.	0.15	1	0.4	0.4	0.588	0.329	0.693

2008 Age	Stock size	Natural mortality	Maturity ogive	Prop. of F bef. spaw.	Prop. of M bef. spaw.	Weight in the stock	Exploit. pattern	Weight in catch
0	3672928	0.15	0	0.4	0.4	0.000	0.010	0.073
1	.	0.15	0.07	0.4	0.4	0.070	0.035	0.163
2	.	0.15	0.59	0.4	0.4	0.167	0.075	0.263
3	.	0.15	0.88	0.4	0.4	0.253	0.147	0.323
4	.	0.15	0.97	0.4	0.4	0.313	0.228	0.386
5	.	0.15	0.97	0.4	0.4	0.363	0.274	0.430
6	.	0.15	0.99	0.4	0.4	0.423	0.298	0.477
7	.	0.15	1	0.4	0.4	0.448	0.332	0.521
8	.	0.15	1	0.4	0.4	0.466	0.341	0.558
9	.	0.15	1	0.4	0.4	0.531	0.373	0.592
10	.	0.15	1	0.4	0.4	0.523	0.354	0.614
11	.	0.15	1	0.4	0.4	0.557	0.329	0.641
12	.	0.15	1	0.4	0.4	0.588	0.329	0.693

Input units are thousands and kg - output in tonnes

Table 2.10.2 NE Atlantic Mackerel Short term prediction single option table,
Catch constraint of 428491 t in 2006, and F= F management target = 0.17 for 2007, 2008

Year:	2006	F multiplie	0.6919	Fbar:	0.18				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
0	0.0048	16854	1315	3786675	0	0	0	0	0
1	0.0184	54856	8832	3236668	223330	226567	15633	211807	14615
2	0.0439	52163	14049	1306100	212024	766245	124387	709052	115103
3	0.0876	128329	41536	1645200	415139	1453260	366706	1321483	333454
4	0.1327	453669	174814	3923600	1262091	3818971	1228436	3410587	1097072
5	0.1711	209399	90460	1431000	528039	1392840	513958	1224967	452013
6	0.1824	38106	17846	245570	103058	243114	102027	212848	89325
7	0.2036	58992	30361	343940	159359	343940	159359	298573	138339
8	0.2103	30854	17186	174690	83735	174690	83735	151241	72495
9	0.2279	20134	11691	106100	58072	106100	58072	91216	49926
10	0.2248	14050	8505	74954	39901	74954	39901	64520	34346
11	0.2053	7733	4929	44756	25556	44756	25556	38827	22170
12	0.2053	10157	6967	58783	35074	58783	35074	50995	30427
Total		1095295	428491	16378036	3145376	8704220	2752842	7786115	2449284

Year:	2007	F multiplie	0.6533	Fbar:	0.17				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
0	0.0045	15916	1241	3786675	0	0	0	0	0
1	0.0174	51934	8361	3243601	223808	227052	15667	212347	14652
2	0.0415	103262	27812	2734993	443981	1604529	260469	1486220	241263
3	0.0828	79426	25707	1075849	271473	950333	239801	865851	218483
4	0.1253	142131	54768	1297222	417273	1262630	406146	1130953	363790
5	0.1615	410464	177320	2957276	1091235	2878415	1062135	2541169	937691
6	0.1722	152823	71572	1038001	435614	1027621	431258	903353	379107
7	0.1923	28678	14759	176125	81605	176125	81605	153589	71163
8	0.1986	40497	22557	241492	115755	241492	115755	210059	100688
9	0.2152	21962	12752	121834	66684	121834	66684	105277	57622
10	0.2122	12946	7837	72712	38707	72712	38707	62904	33486
11	0.1938	8452	5387	51527	29422	51527	29422	44906	25641
12	0.1938	11905	8167	72578	43305	72578	43305	63252	37740
Total		1080396	438242	16869886	3258862	8686849	2790953	7779880	2481327

Year:	2008	F multiplie	0.6533	Fbar:	0.17				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jar	SSB(Jan)	SSNos(ST	SSB(ST)
0	0.0045	15916	1241	3786675	0	0	0	0	0
1	0.0174	51948	8364	3244470	223868	227113	15671	212404	14656
2	0.0415	103589	27900	2743667	445389	1609618	261295	1490934	242028
3	0.0828	166727	53964	2258369	569862	1994893	503378	1817551	458629
4	0.1253	93399	35990	852450	274205	829718	266893	743189	239059
5	0.1615	136716	59061	984999	363464	958732	353772	846403	312323
6	0.1722	318848	149327	2165669	908859	2144012	899771	1884742	790963
7	0.1923	122456	63024	752072	348460	752072	348460	655842	303874
8	0.1986	20975	11683	125075	59953	125075	59953	108795	52149
9	0.2152	30718	17837	170411	93272	170411	93272	147252	80596
10	0.2122	15056	9114	84563	45016	84563	45016	73156	38944
11	0.1938	8303	5292	50616	28902	50616	28902	44112	25188
12	0.1938	14434	9902	87995	52504	87995	52504	76688	45757
Total		1099085	452699	17307031	3413753	9034819	2928884	8101069	2604166

Input units are thousands and kg - output in tonnes

Table 2.10.3 **NORTH EAST ATLANTIC MACKEREL.**

One area management option table.

OPTION: **Catch constraint 428kt in 2006**

2006				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
3145376	2449284	0.6919	0.18	428491

2007					2008		% Change in 2007 landings
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**	
3258862	2628420	0	0	0	3805817	3117654	-100%
.	2613287	0.0653	0.017	46762	3763914	3061162	-89%
.	2598249	0.1307	0.034	92842	3722636	3005885	-78%
.	2583306	0.196	0.051	138252	3681974	2951794	-68%
.	2568459	0.2613	0.068	183003	3641917	2898862	-57%
.	2553705	0.3267	0.085	227106	3602456	2847063	-47%
.	2539045	0.392	0.102	270569	3563581	2796370	-37%
.	2524478	0.4573	0.119	313405	3525282	2746758	-27%
.	2510003	0.5227	0.136	355622	3487551	2698203	-17%
.	2495619	0.588	0.153	397231	3450377	2650680	-7%
.	2481327	0.6533	0.17	438242	3413753	2604166	2%
.	2467125	0.7186	0.187	478663	3377669	2558637	12%
.	2453012	0.784	0.204	518505	3342116	2514071	21%
.	2438989	0.8493	0.221	557776	3307086	2470447	30%
.	2425055	0.9146	0.238	596486	3272571	2427742	39%
.	2411209	0.98	0.255	634643	3238561	2385936	48%
.	2397450	1.0453	0.272	672257	3205050	2345008	57%
.	2383778	1.1106	0.289	709336	3172029	2304939	66%
.	2370192	1.176	0.306	745888	3139490	2265709	74%
.	2356692	1.2413	0.323	781922	3107425	2227298	82%
.	2343277	1.3066	0.34	817446	3075827	2189689	91%

Input units are thousands and kg - output in tonnes

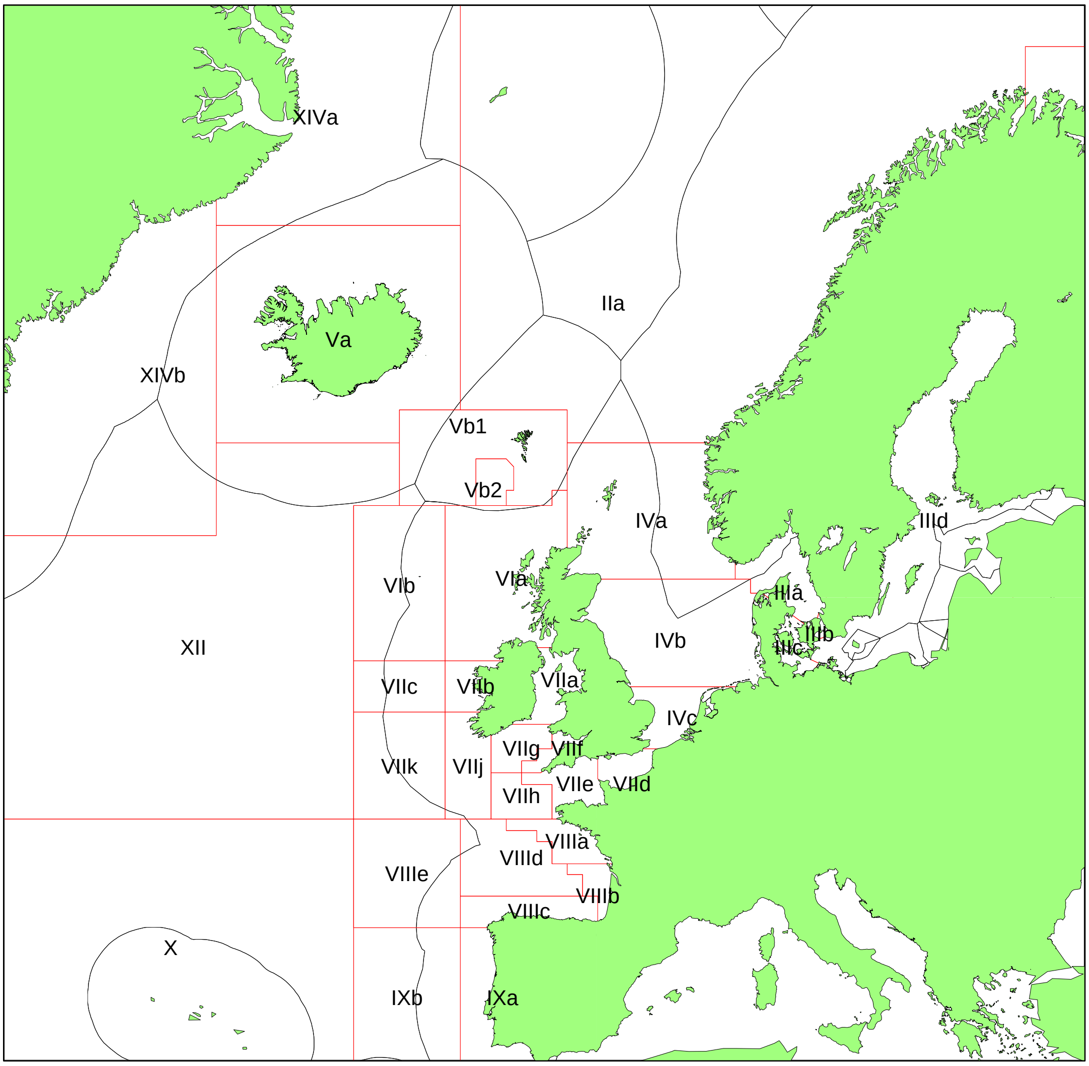


Figure 2.1.1. Map of approximate national zones and ICES Divisions and Subareas. Note that EU region is considered as one zone in this map.

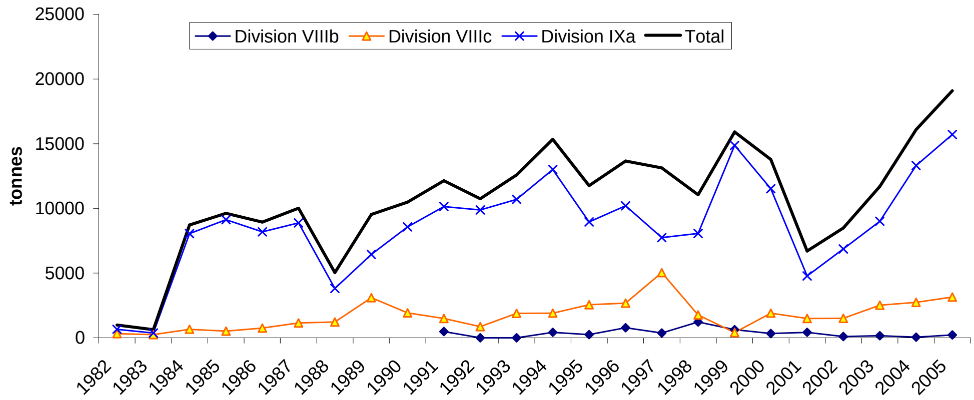
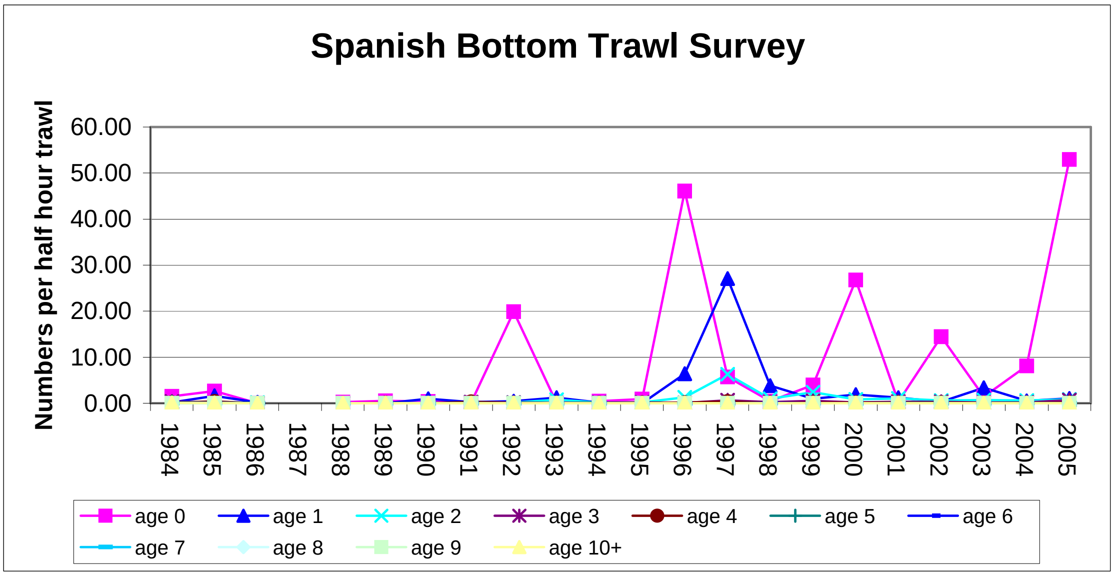


Figure 2.2.4.1 Annual landings of Scomber japonicus by ICES divisions since 1982 to 2005.



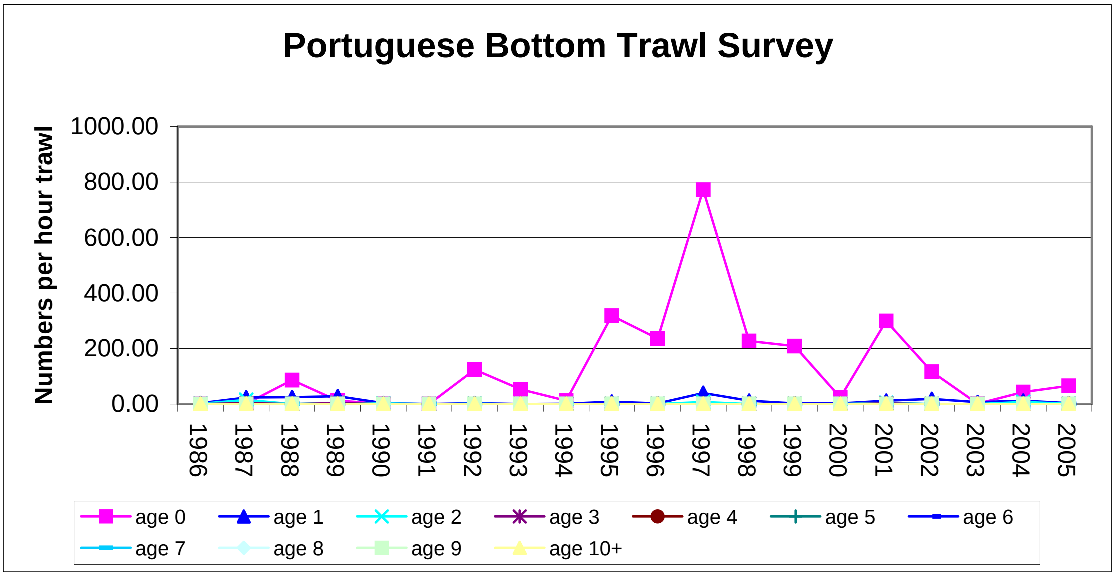


Figure 2.5.5.1 Mackerel numbers at age from the Spanish and Portuguese bottom trawl surveys from 1984 to 2005 in Autumn.

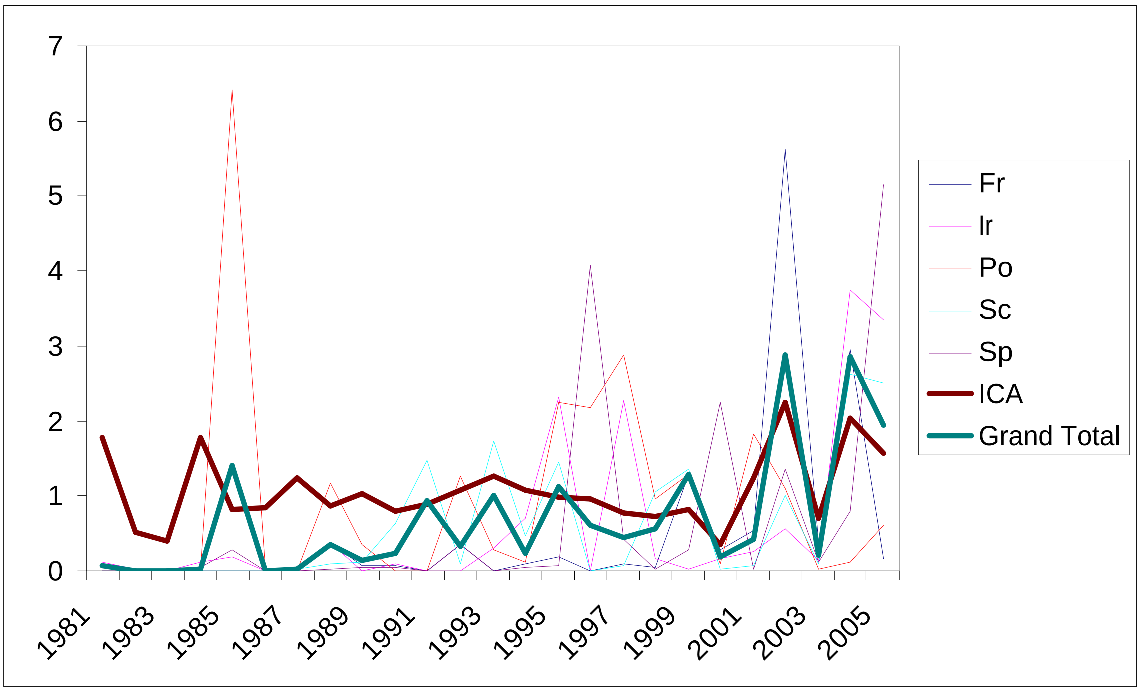


Figure 2.5.6.1 NE Atlantic mackerel, time series of mean catch of 0 group individual fourth quarter national trawl surveys compared with mean across all surveys (Grand Total) and current ICA estimate of 0 group excluding last two years.

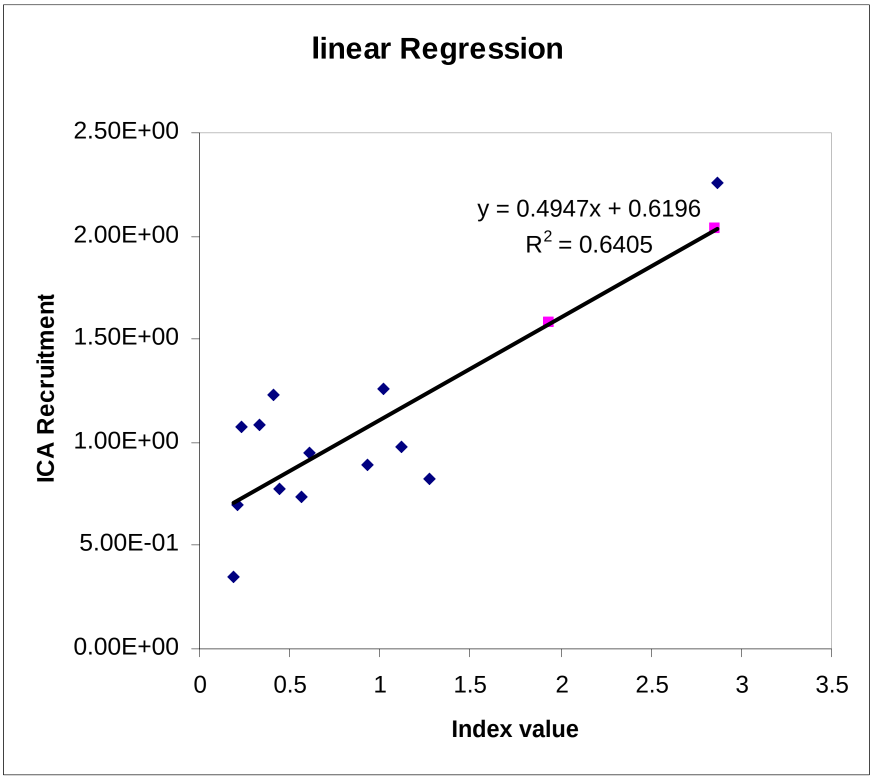


Figure 2.5.6.2 NE Atlantic mackerel, linear regression estimator of ICA recruitment from)group index and estimated values for 2004 and 2005

Figure 2.5.6.3. NE Atlantic mackerel, scatter plot of estimated recruitment via survey rank and ICA estimated recruitment, and the implied fitted line. Estimates of recruitment (via rank method) for 2004 and 2005 placed on the graph for illustration as 1:1 estimates

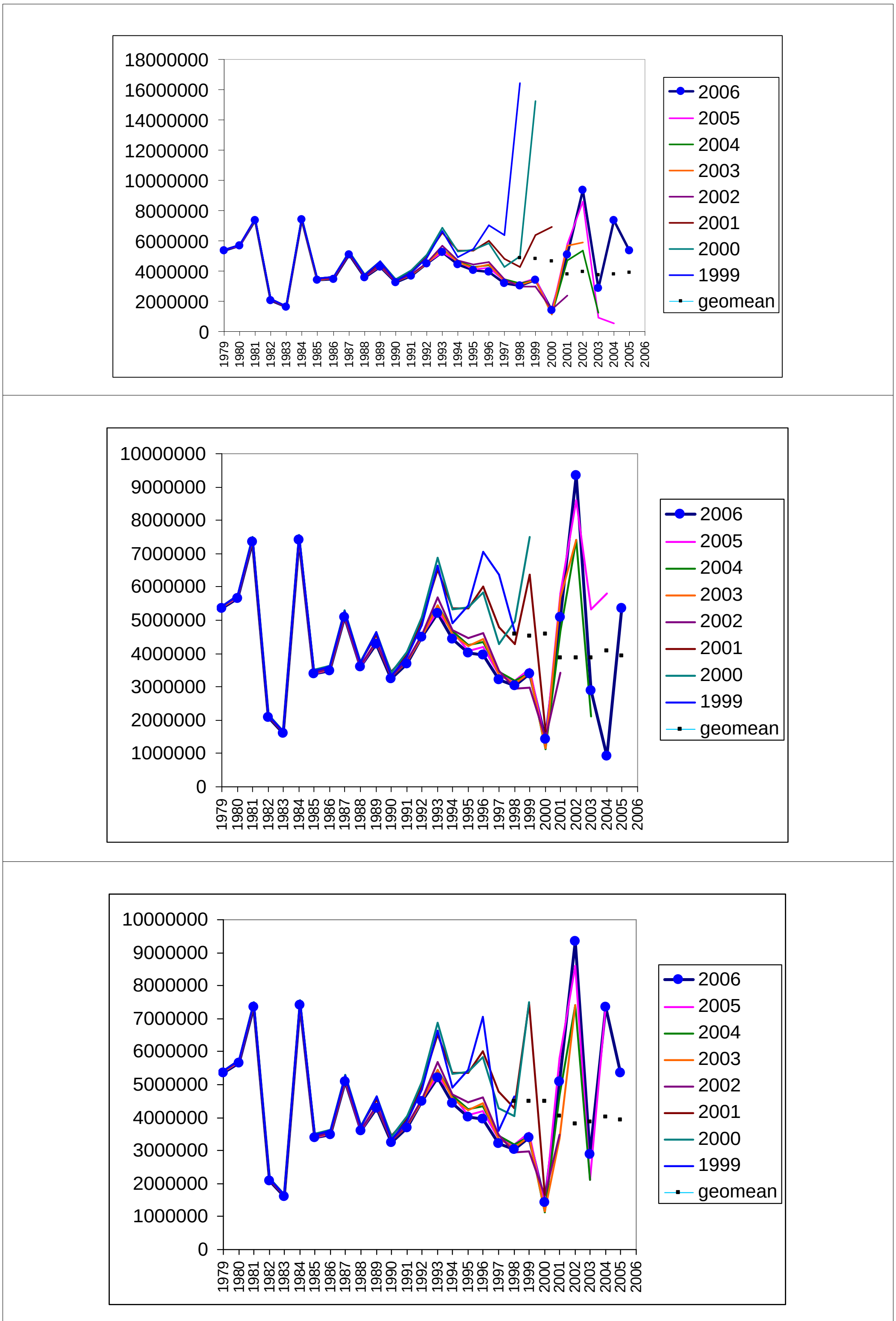


Figure 2.5.6.4 NE Atlantic mackerel, analytical retrospective for recruitment, a) assessment, b) replacement of 0 group in final year with survey rank based recruitment, c) replacement of 0 and 1 group in final year with survey rank based recruitment. Dots on each graph show geometric mean recruitment currently used for projections

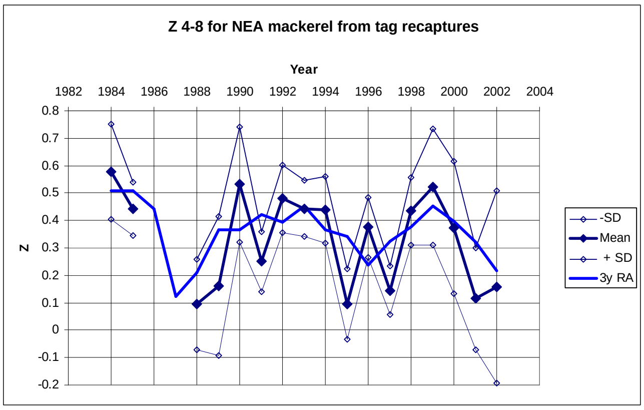
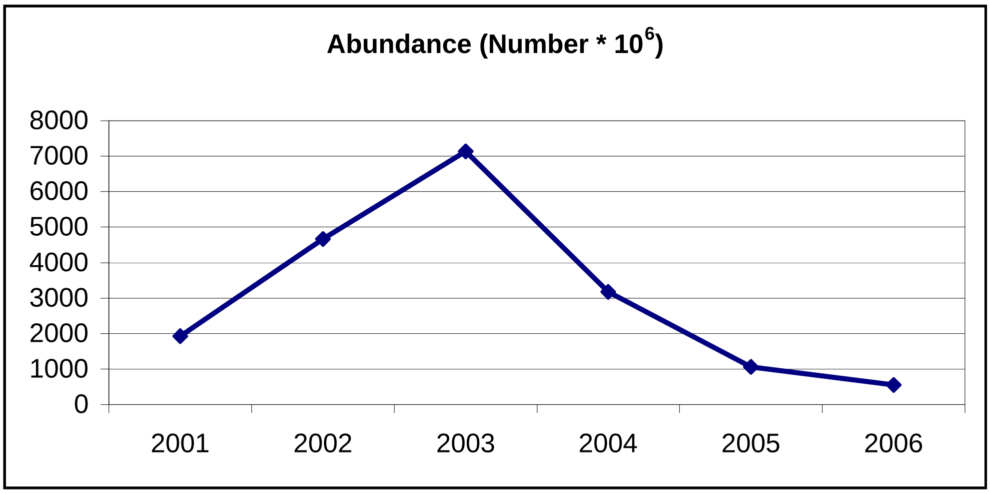


Figure 2.5.7. NEA mackerel: Mortality estimates (mean and SD) from bootstrapped tag return data, for pooled ages 4-8.



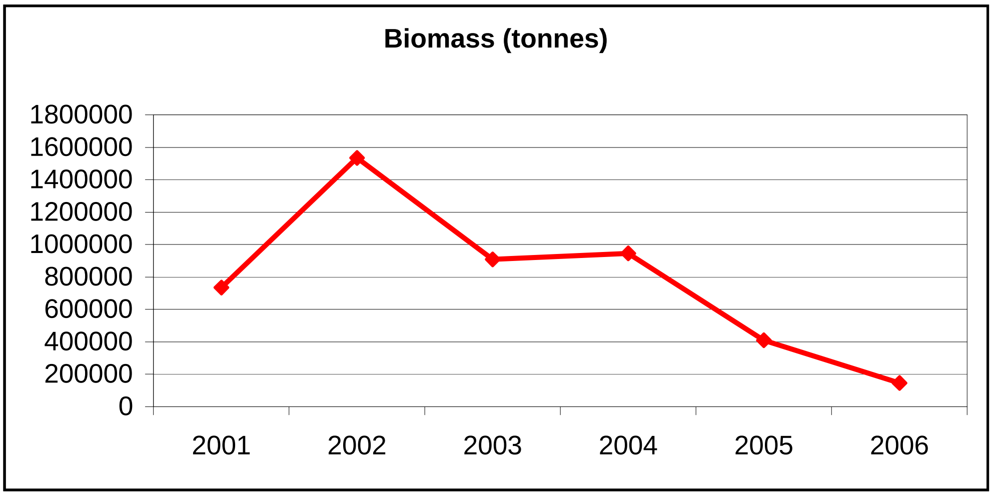


Figure 2.5.9.1. NEA mackerel. Spanish acoustic surveys from 2001 to 2006. Mackerel Abundance in number of individuals (millions) and Biomass in tons.

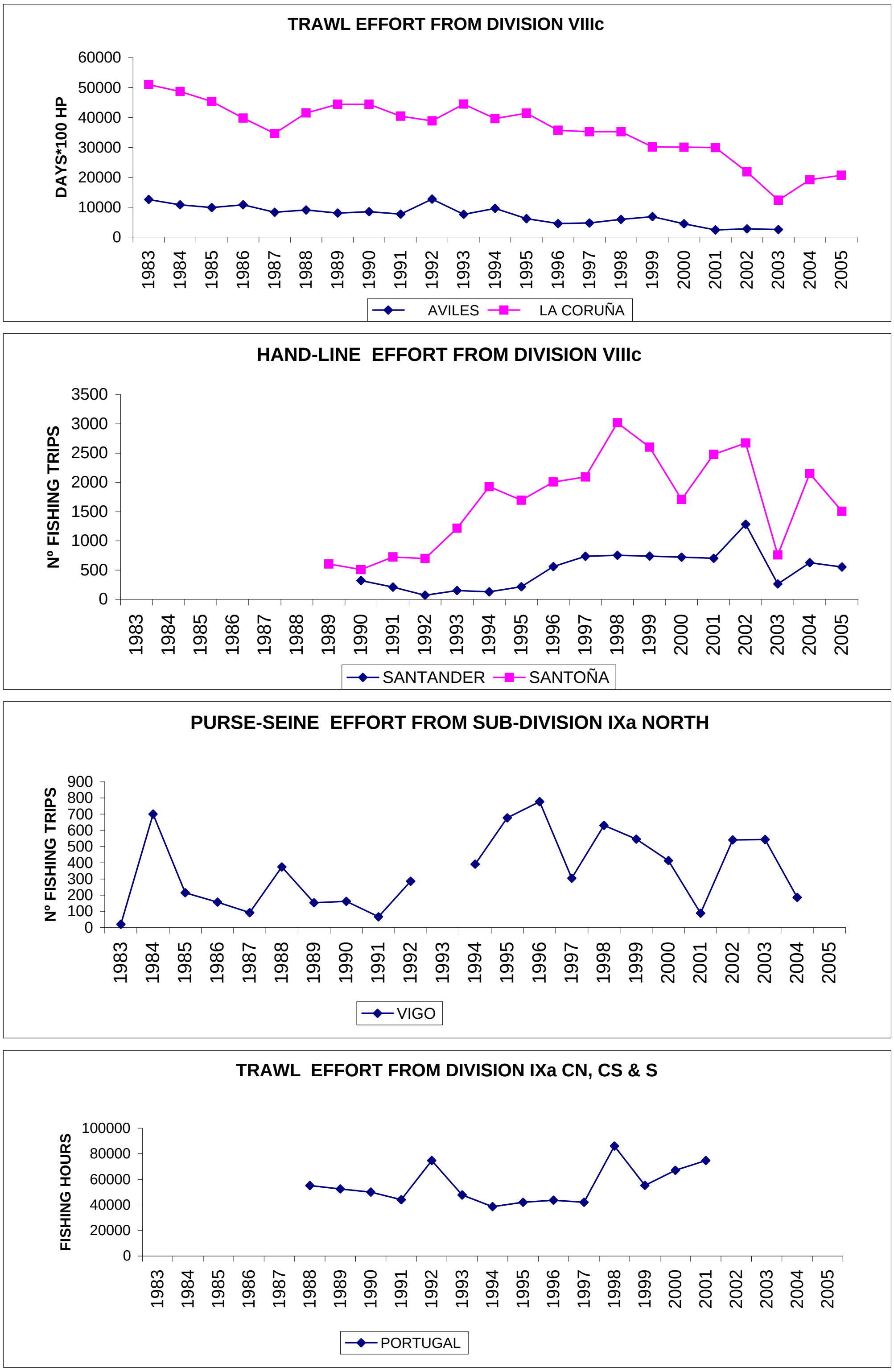


Figure 2.6.1. NE Mackerel (Southern component). Effort data by fleets and area.

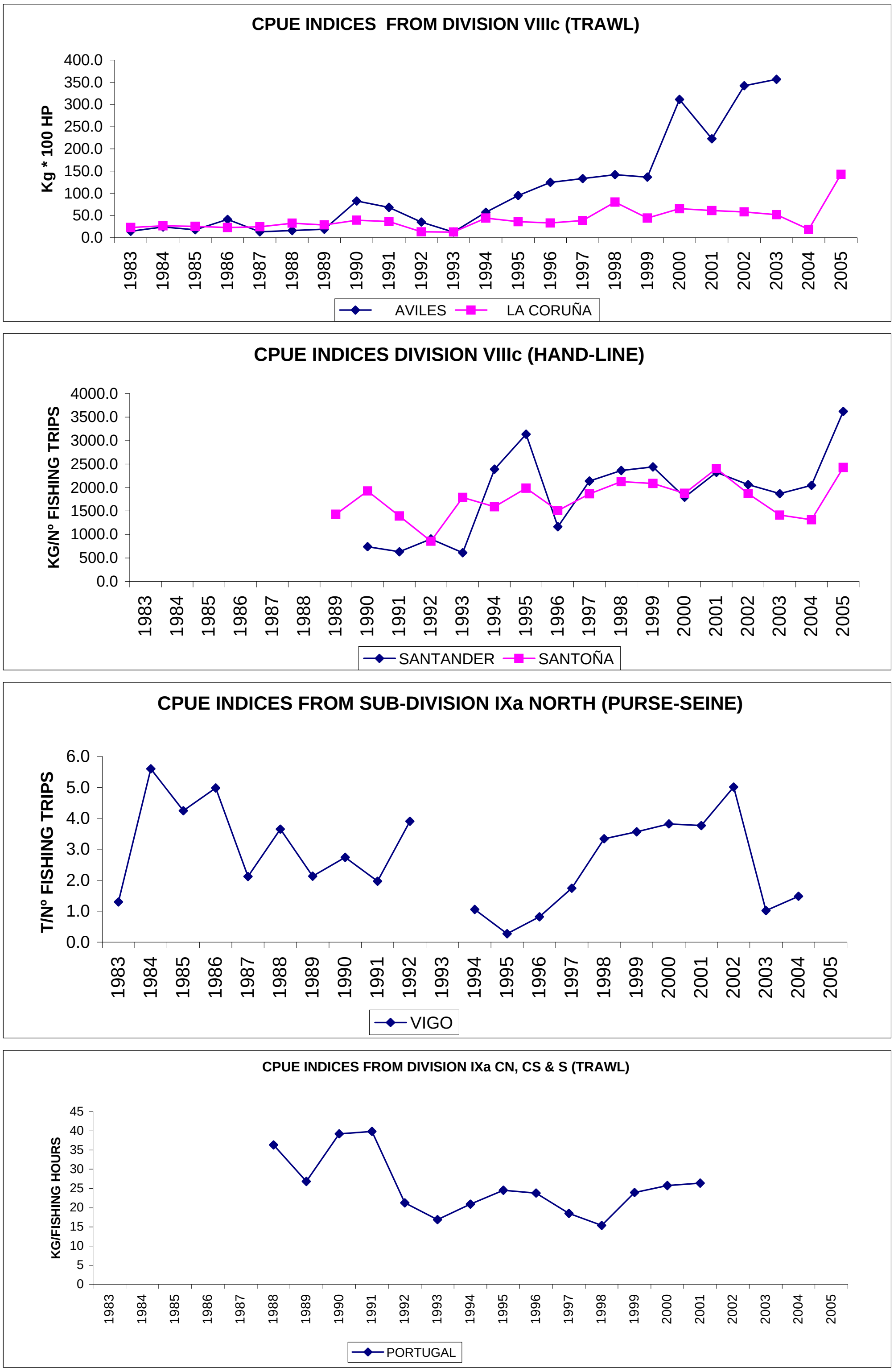


Figure 2.6.2. NE Mackerel (Southern component). CPUE indices by fleets and area.

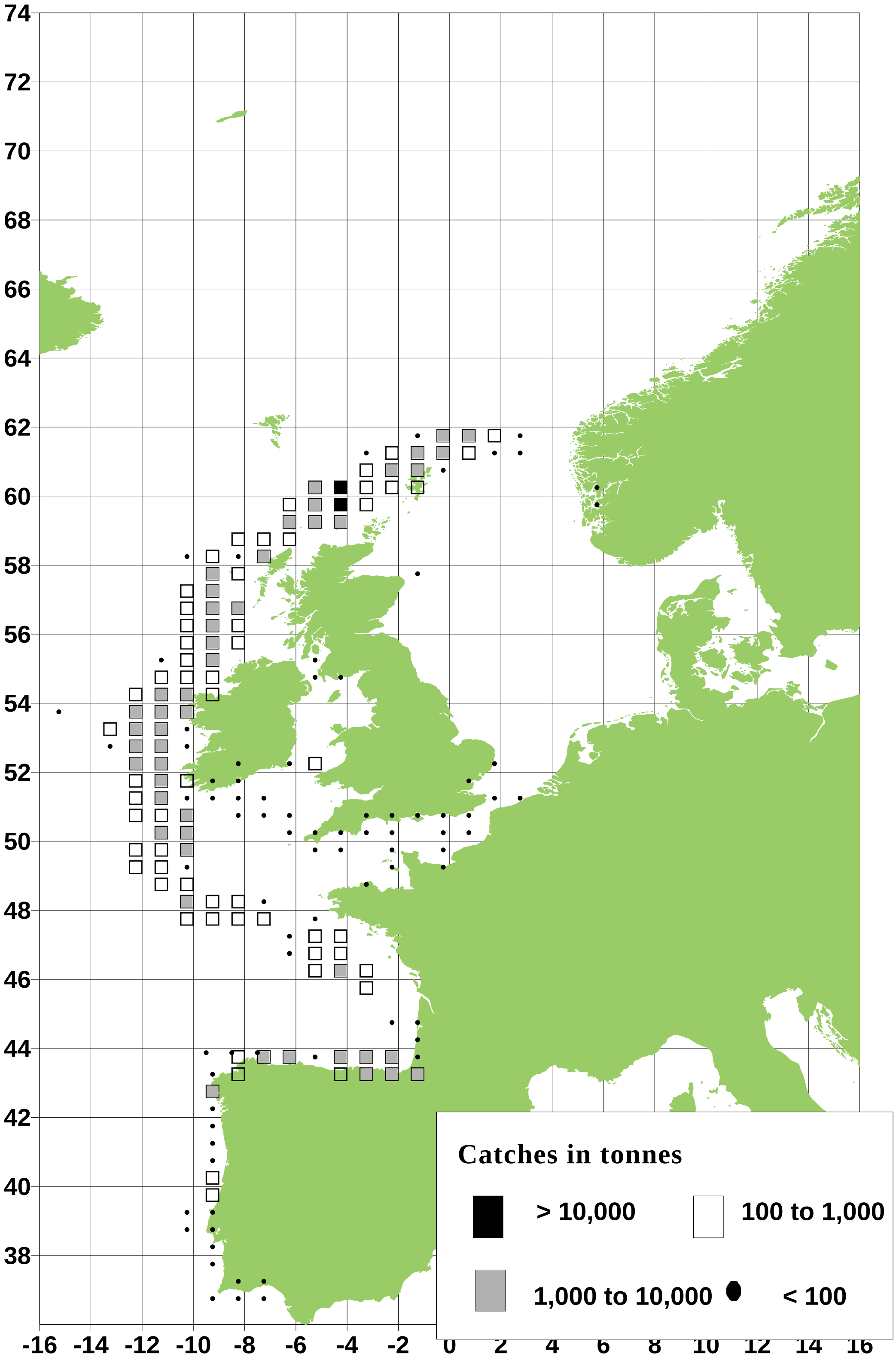


Figure 2.7.1.1. NEA Mackerel. Commercial catches in quarter 1 2005.

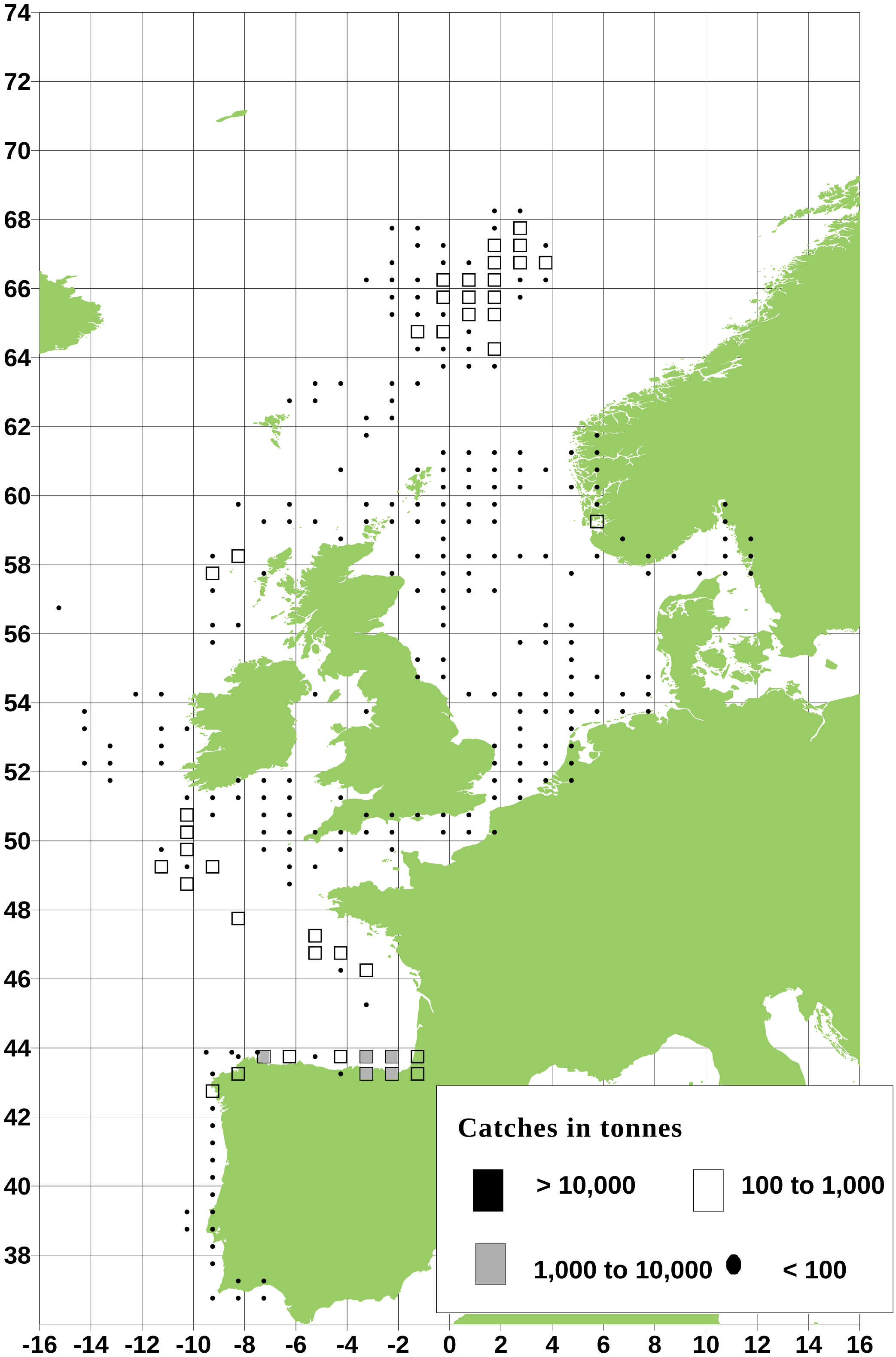


Figure 2.7.1.2. NEA Mackerel. Commercial catches in quarter 2 2005.

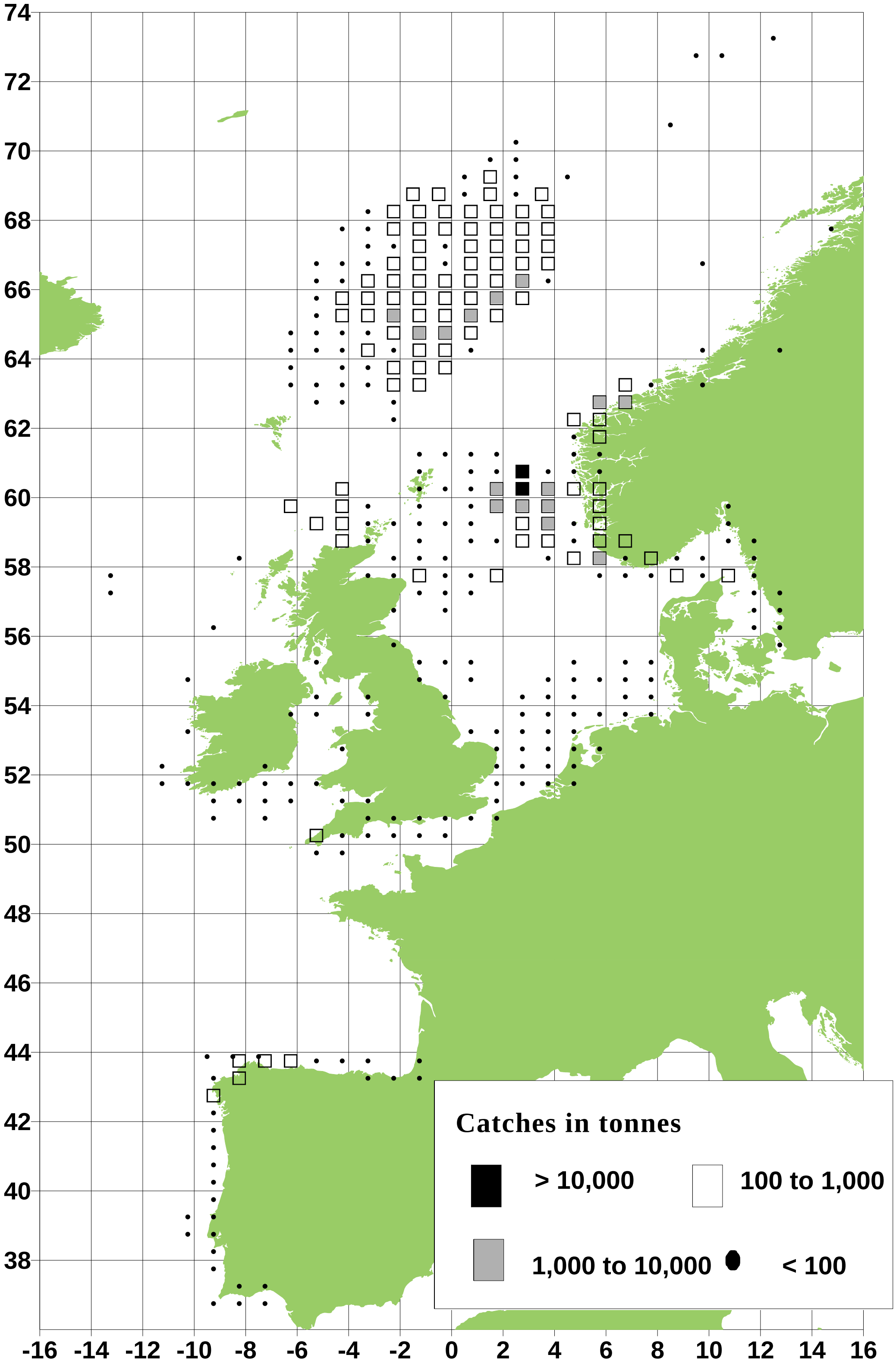


Figure 2.7.1.3. NEA Mackerel. Commercial catches in quarter 3 2005.

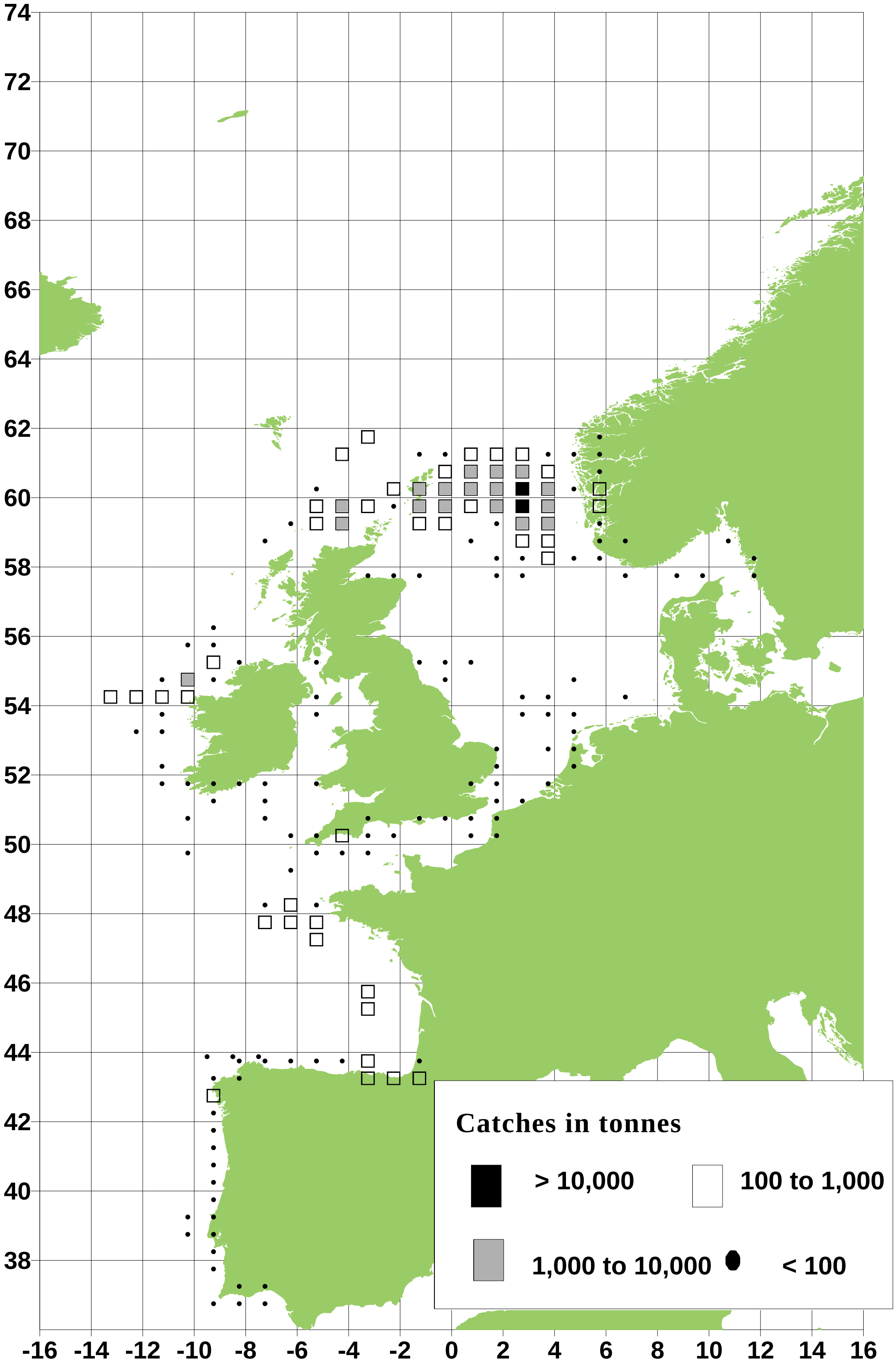


Figure 2.7.1.4. NEA Mackerel. Commercial catches in quarter 4 2005.

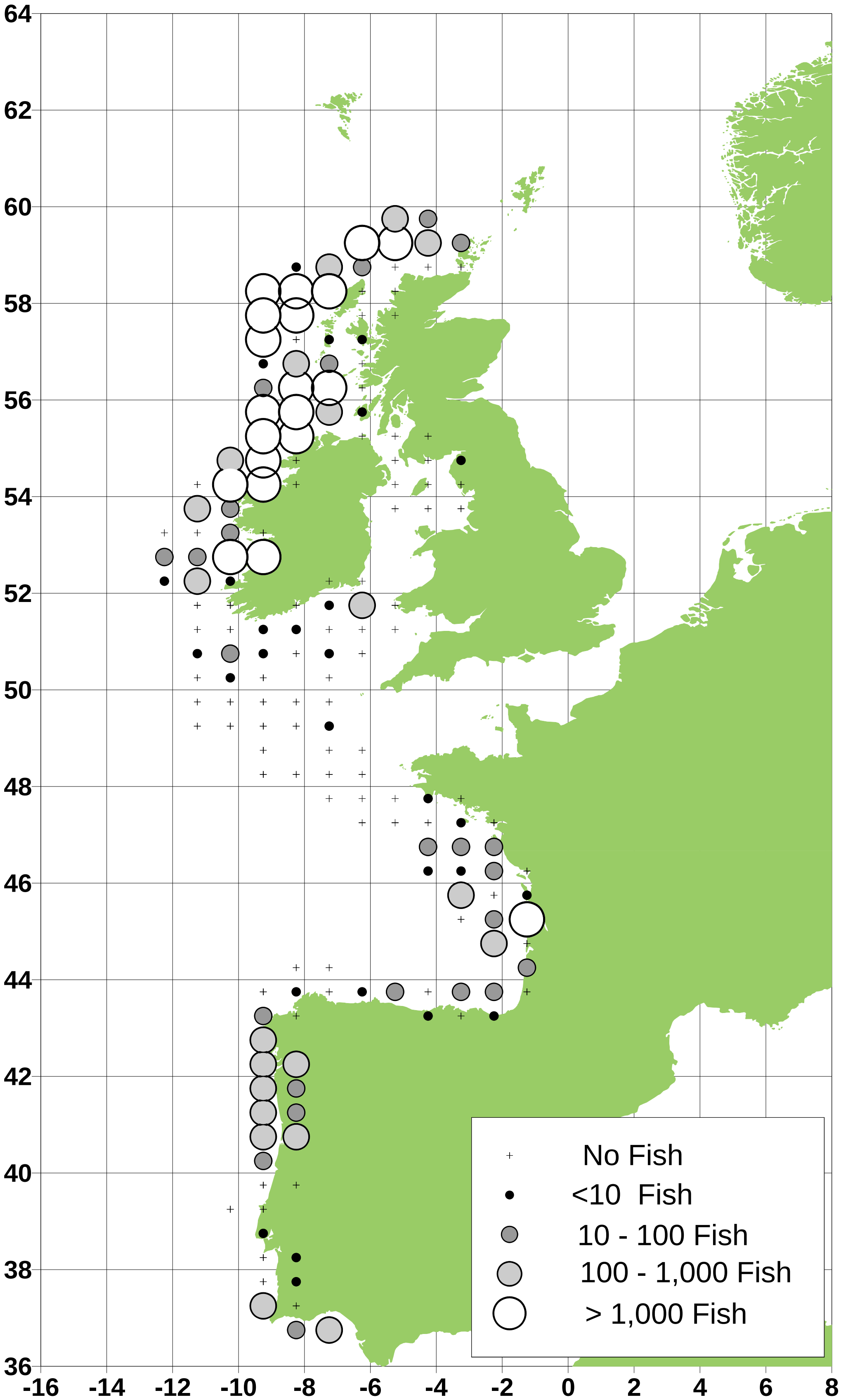


Figure 2.7.2.1. NEA Mackerel. Distribution of mackerel recruits, 2005 year class age 0 in quarter 4, 2005.

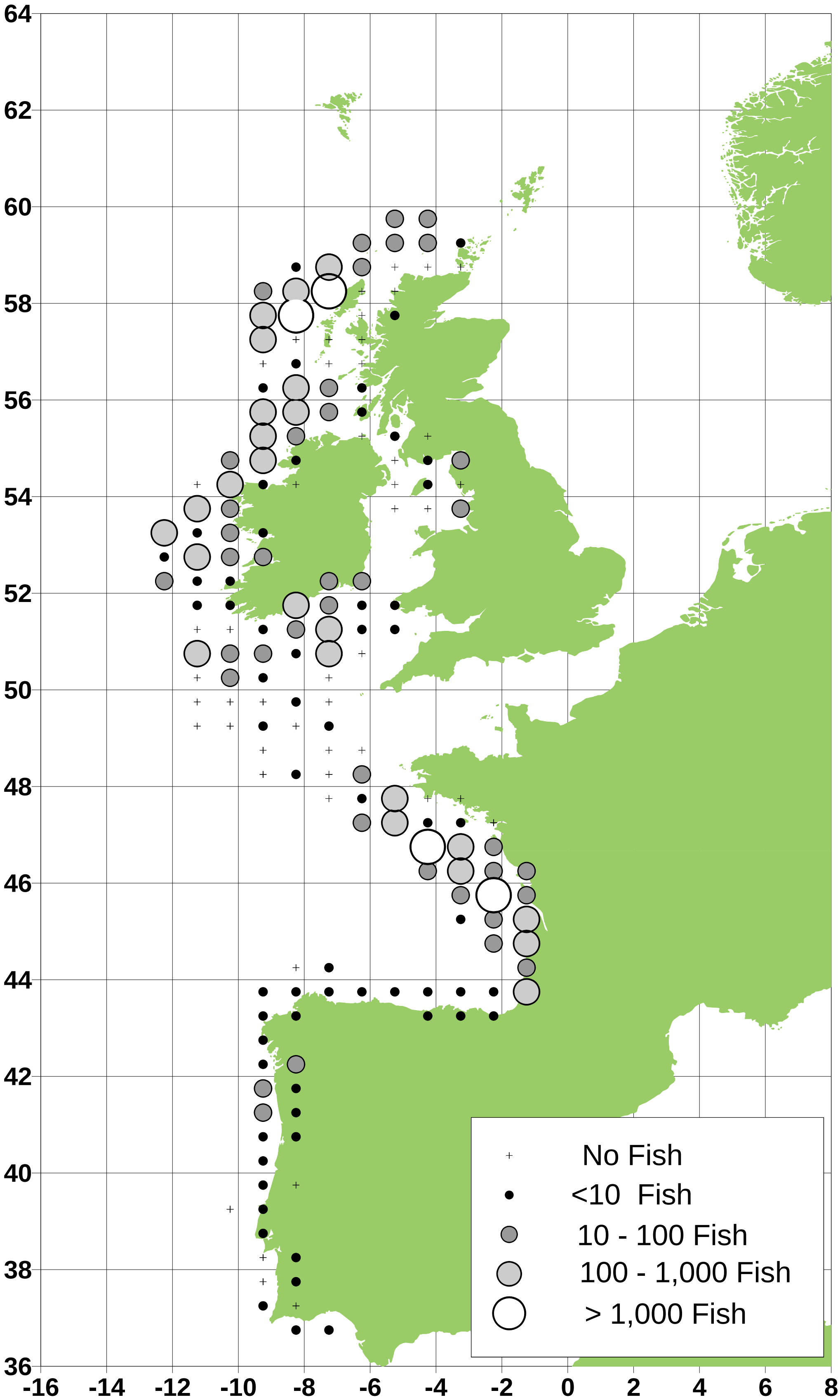


Figure 2.7.2.2. NEA Mackerel. Distribution of mackerel recruits, 2004 year class age 1 in quarter 4, 2005.

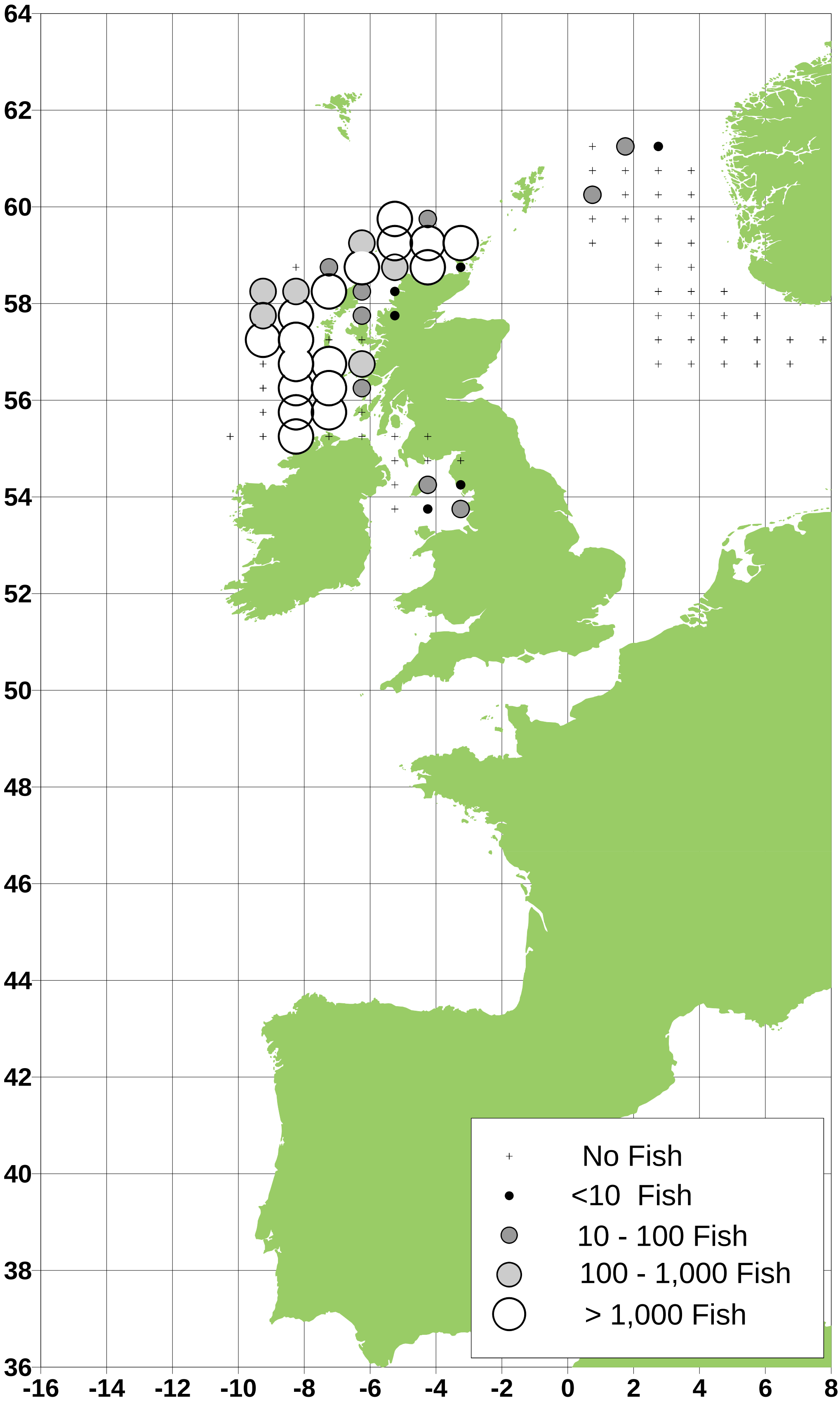


Figure 2.7.2.3. NEA Mackerel. Distribution of mackerel recruits, 2005 year class age 1 in quarter 1, 2006.

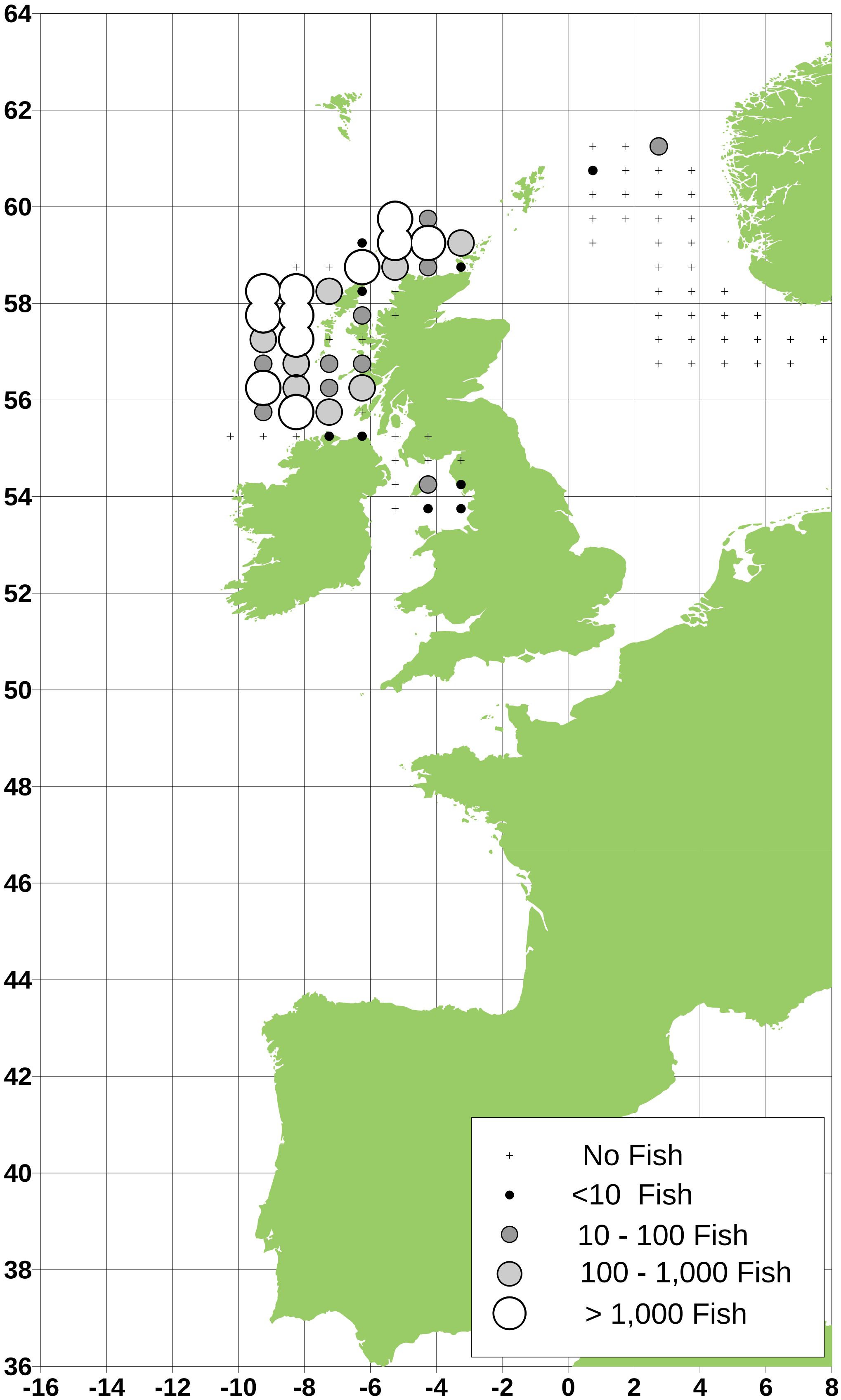


Figure 2.7.2.4. NEA Mackerel. Distribution of mackerel recruits, 2004 year class age 2 in quarter 1, 2006.

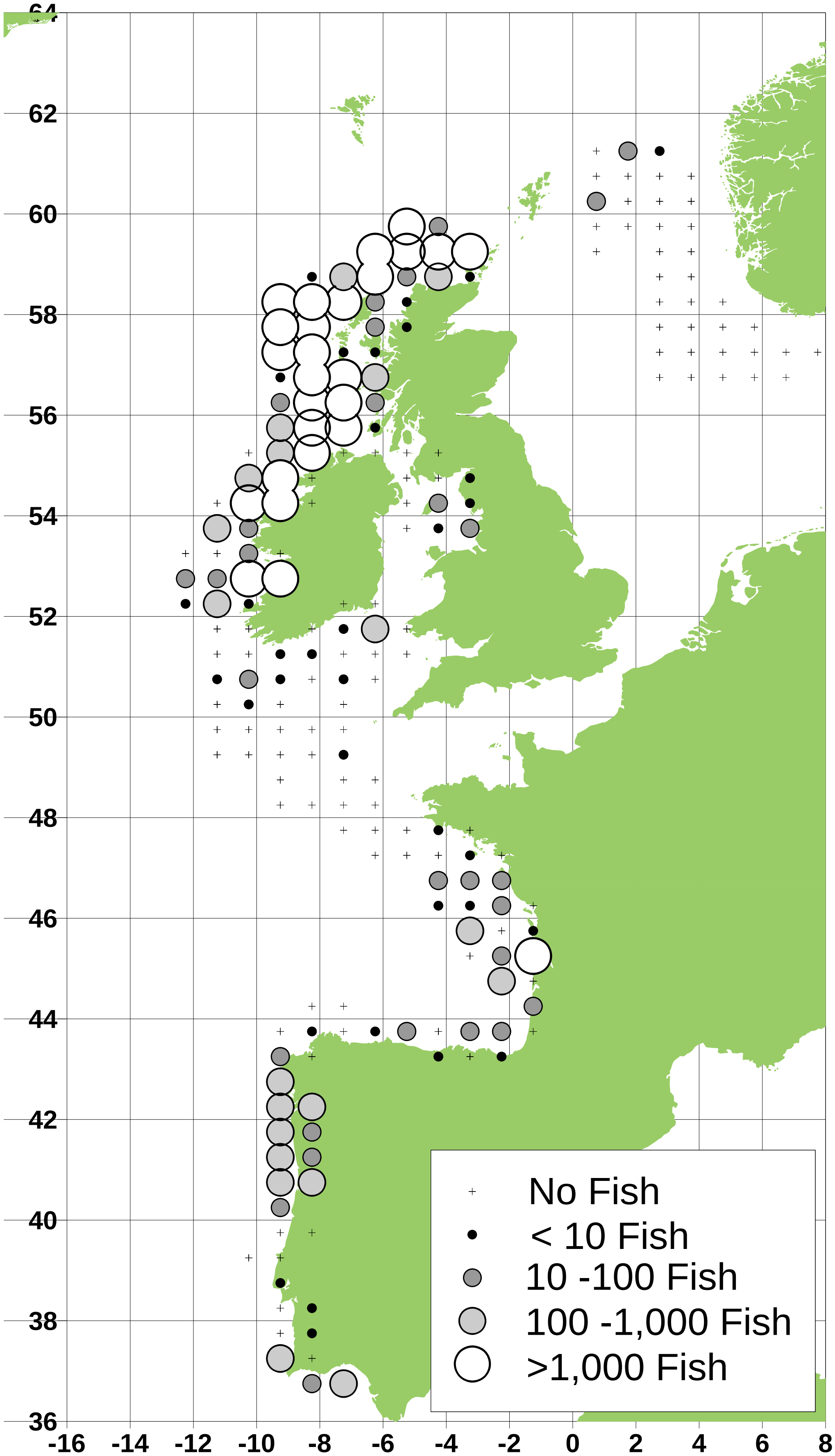


Figure. 2.7.2.5. NEA Mackerel. Distribution of mackerel recruits. 2005 year class in 1st winter (2005/2006)

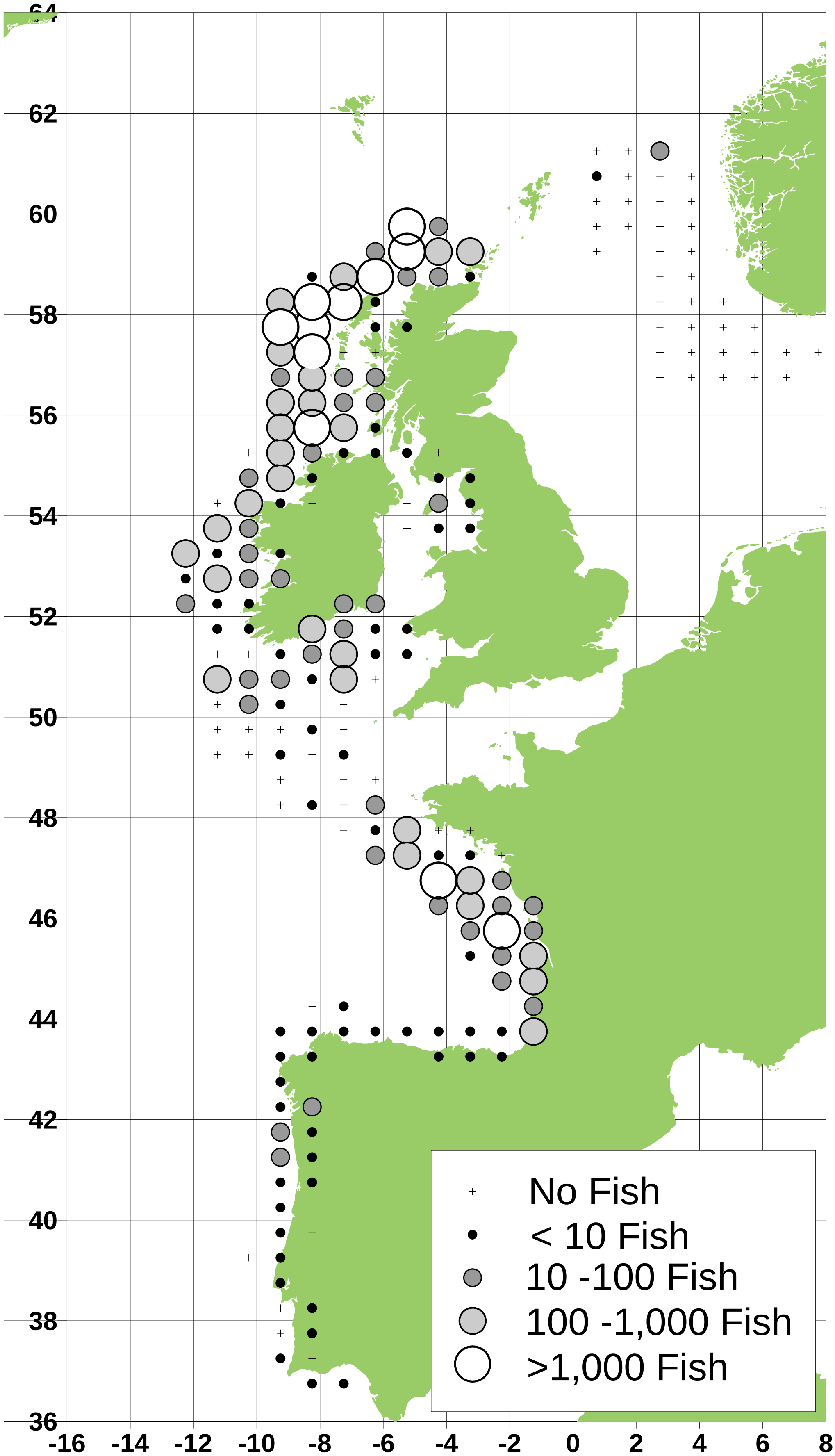


Figure. 2.7.2.6. NEA Mackerel. Distribution of mackerel recruits. 2004 year class in 2nd winter (2005/2006)

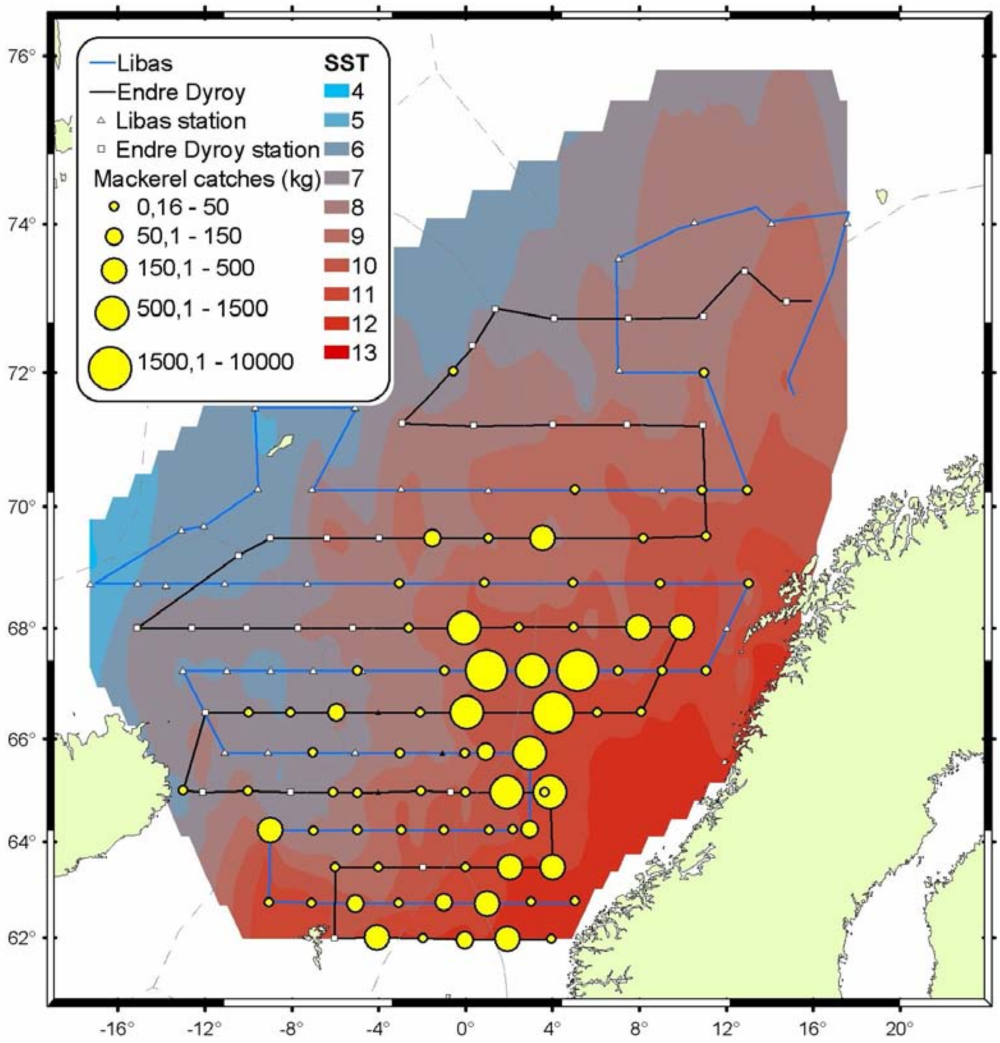


Figure 2.7.3.1. NEA mackerel. Distribution of mackerel superimposed on sea surface temperature (SST) in the Norwegian Sea during a survey by two Norwegian commercial vessels carried out from 15 July-6 August 2006.

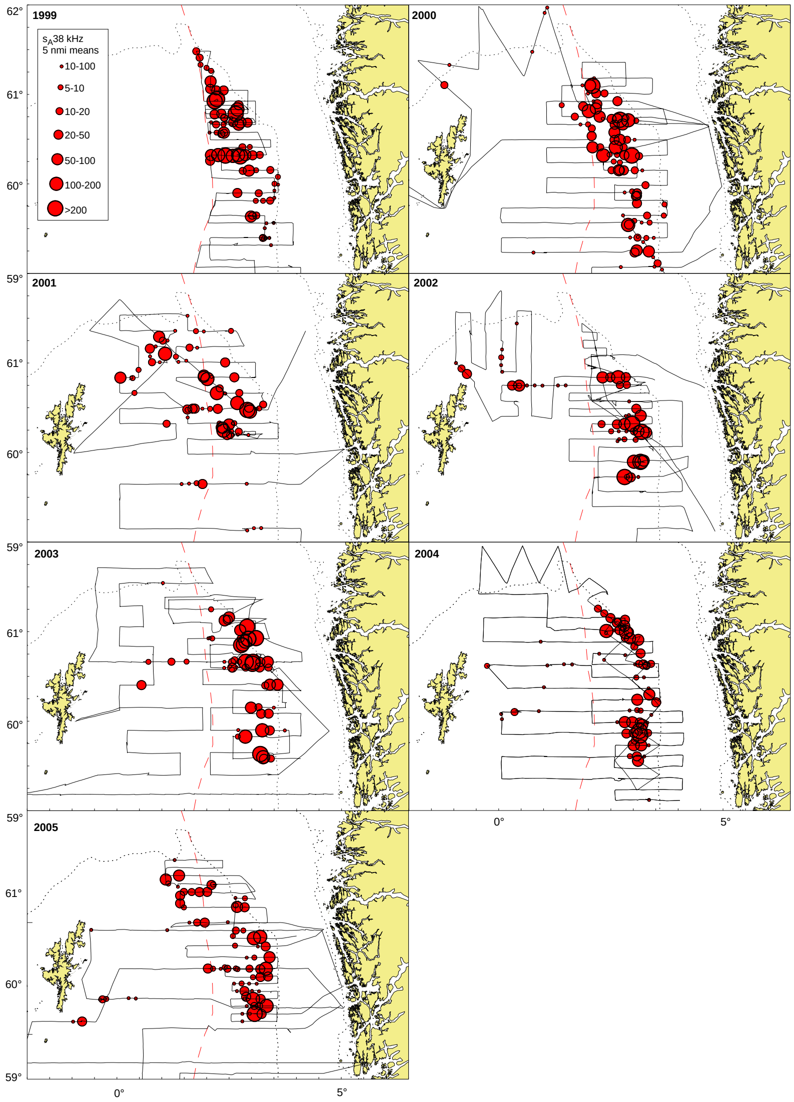


Figure 2.7.5.1. NEA mackerel. Norwegian acoustic survey for mackerel in the northern North sea in October-November. Cruise track and 5-mile s_A values

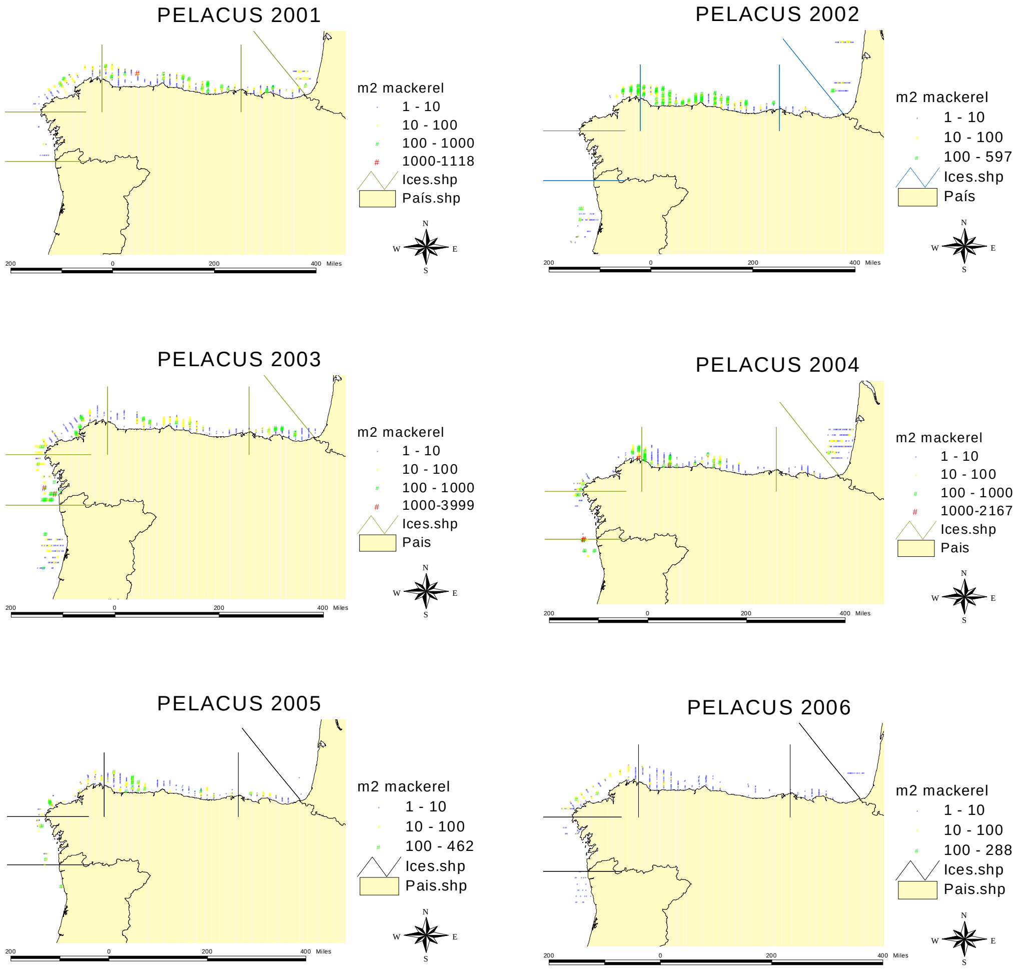


Figure 2.7.5.2. NEA mackerel. Mackerel distribution derived from backscattered energy (NASC). Spanish acoustic surveys PELACUS 2001-2006.

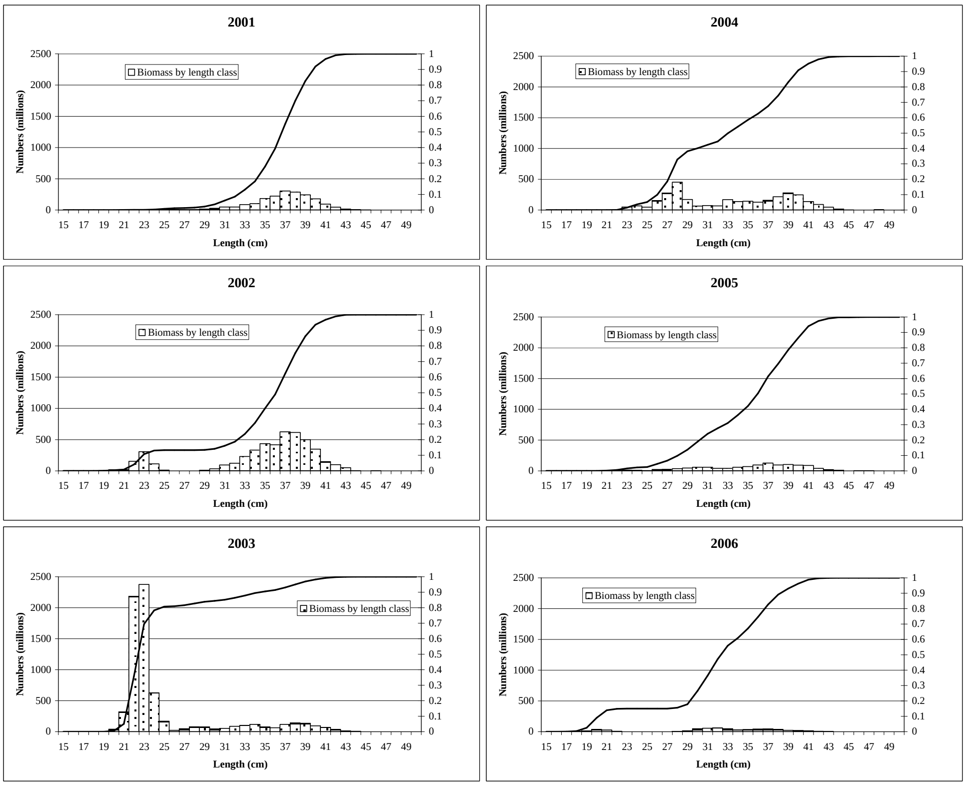


Figure 2.7.5.3. NEA mackerel. Mackerel length distribution for the Spanish acoustic survey from 2001 to 2006 in Sub-division IXa North and Division VIIIc (Spanish waters). The line denotes the cumulative frequency.

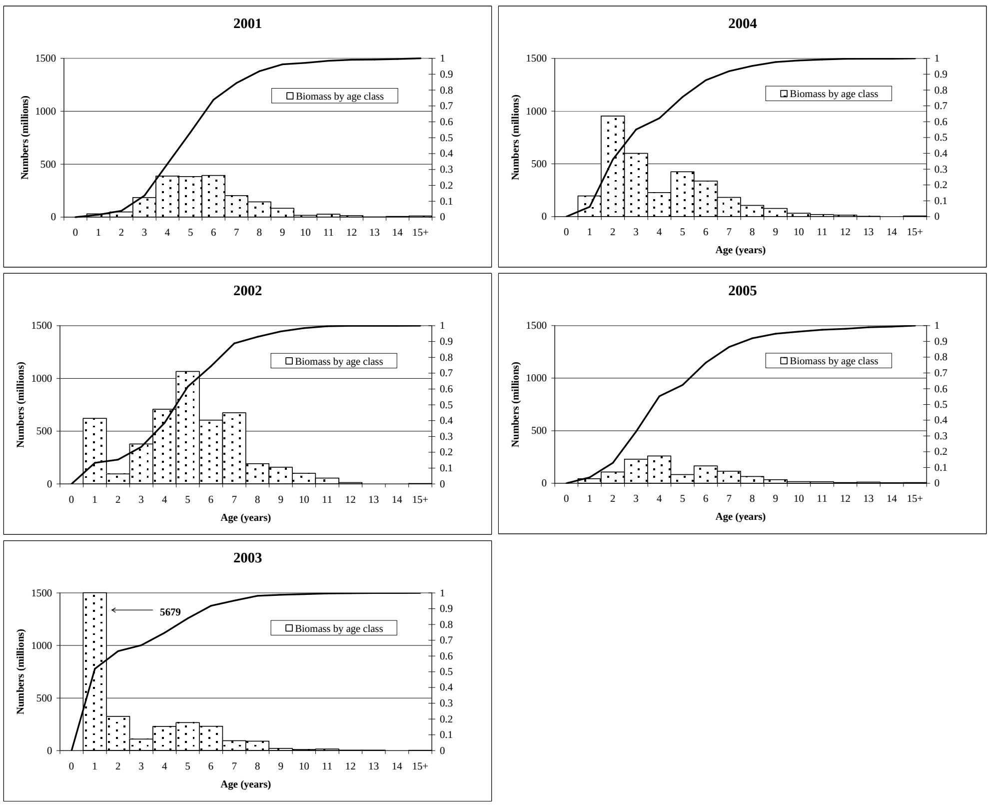


Figure 2.7.5.4. NEA mackerel. Mackerel age distribution for the Spanish acoustic survey from 2001 to 2005 in Sub-division IXa North and Division VIIIc (Spanish waters). The line denotes the cumulative frequency.

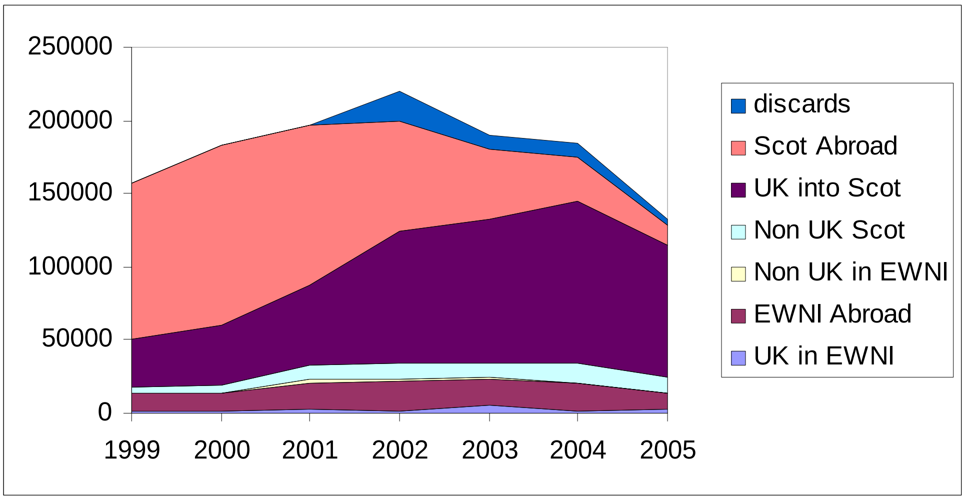


Figure 2.8.2.1. NE Atlantic mackerel catches of mackerel by region and by 'fleet' into the UK and abroad by UK vessels.

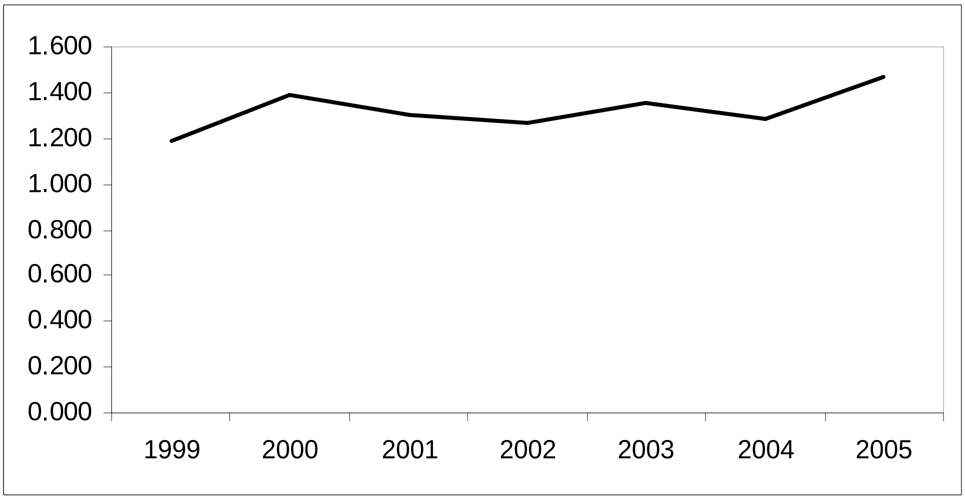


Figure 2.8.2.2. NE Atlantic mackerel under reporting factor by year for total Scottish fishery 1999 to 2005, with an overall average of 1.3.

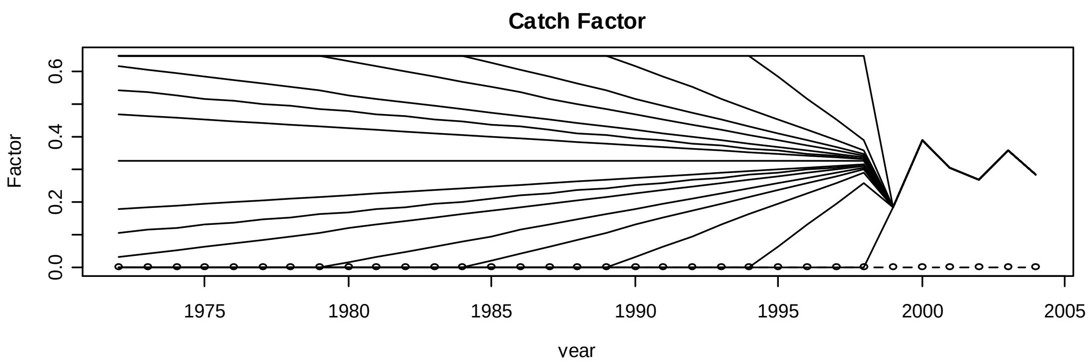


Figure 2.8.2.3. NE Atlantic mackerel seventeen underreported catch factor scenarios by year, based on values in Figure 2.8.2.2. from 1999 to 2005 and 17 scenarios prior to 1999. Maximum scenario is a doubling in and prior to 1998, minimum scenario is zero underreporting in and prior to 1998. Intermediate scenarios are linear change with year.

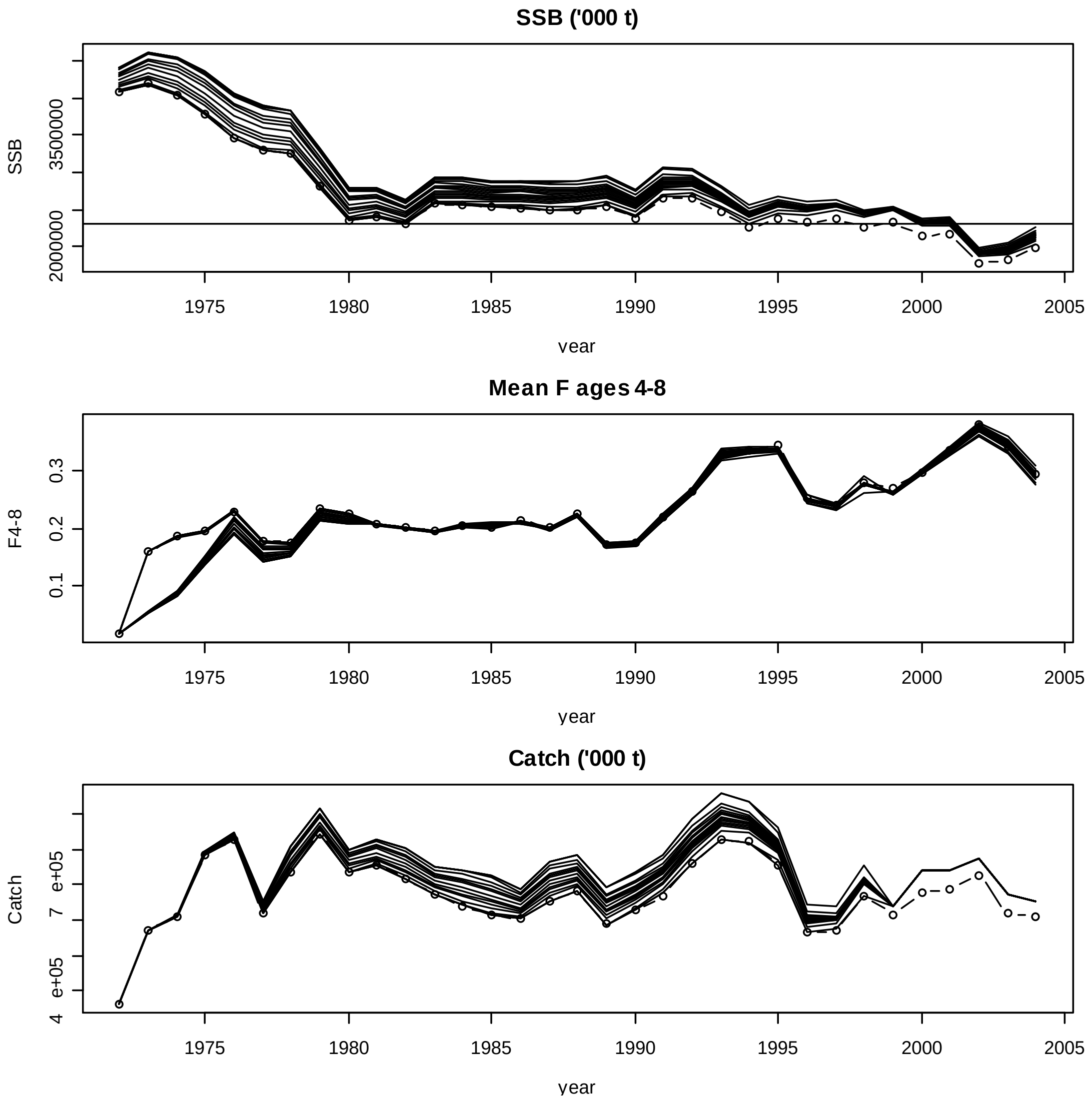


Figure 2.8.2.4. NE Atlantic mackerel SSB, Fbar and catch in tonnes for seventeen scenarios of underreported catch from Figure 4. The dotted line is the 2005 WGMHSA assessment.

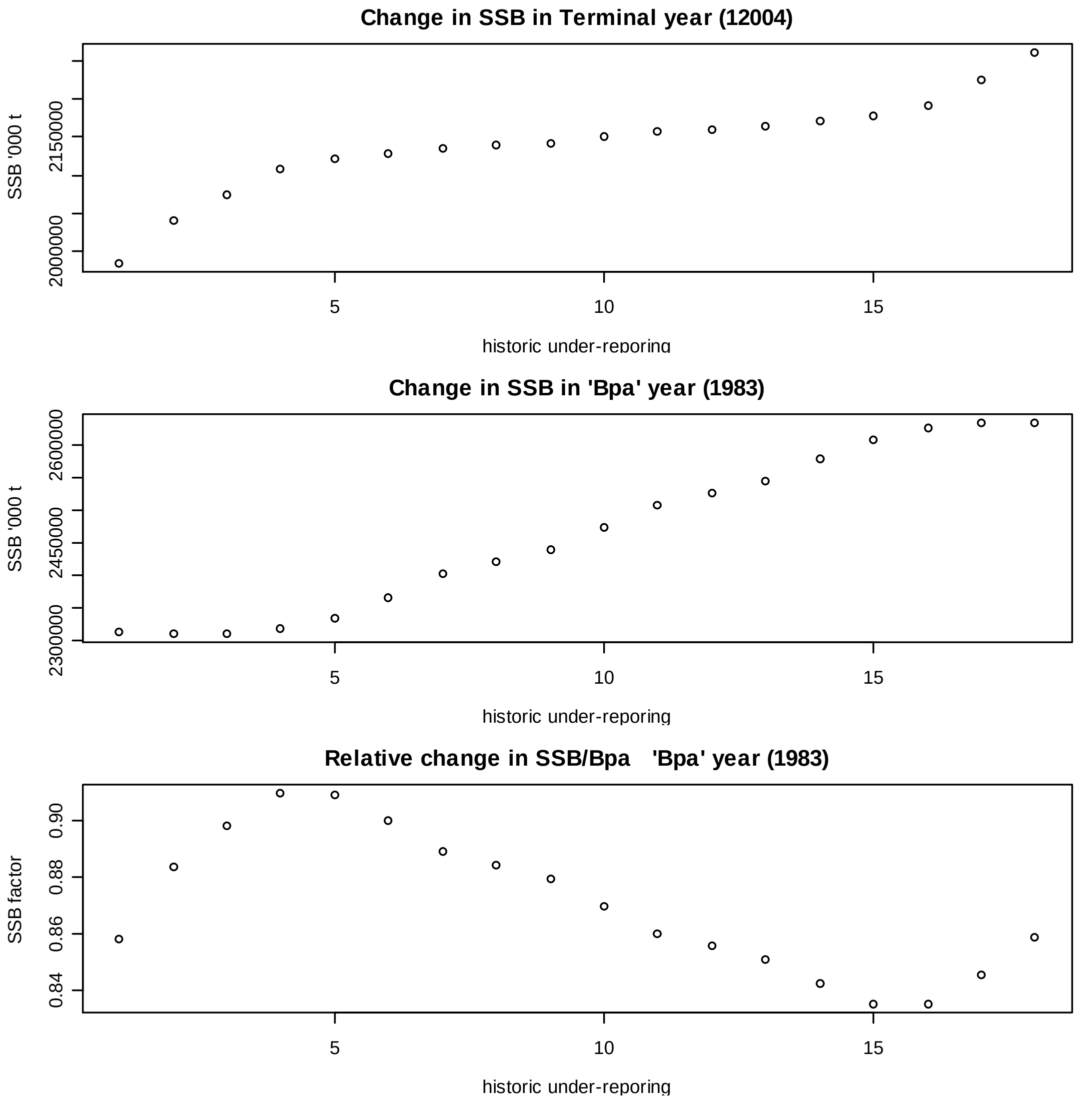


Figure 2.8.2.5. NE Atlantic mackerel changes in estimates of SSB in terminal year, 1983 (‘Bpa year’) and the change in SSB in terminal year relative to the SSB in 1983. 1) for 2005 assessment, 2-9) declining underreporting with history, 10) constant underreporting with time and 11-18) increasing underreporting with history.

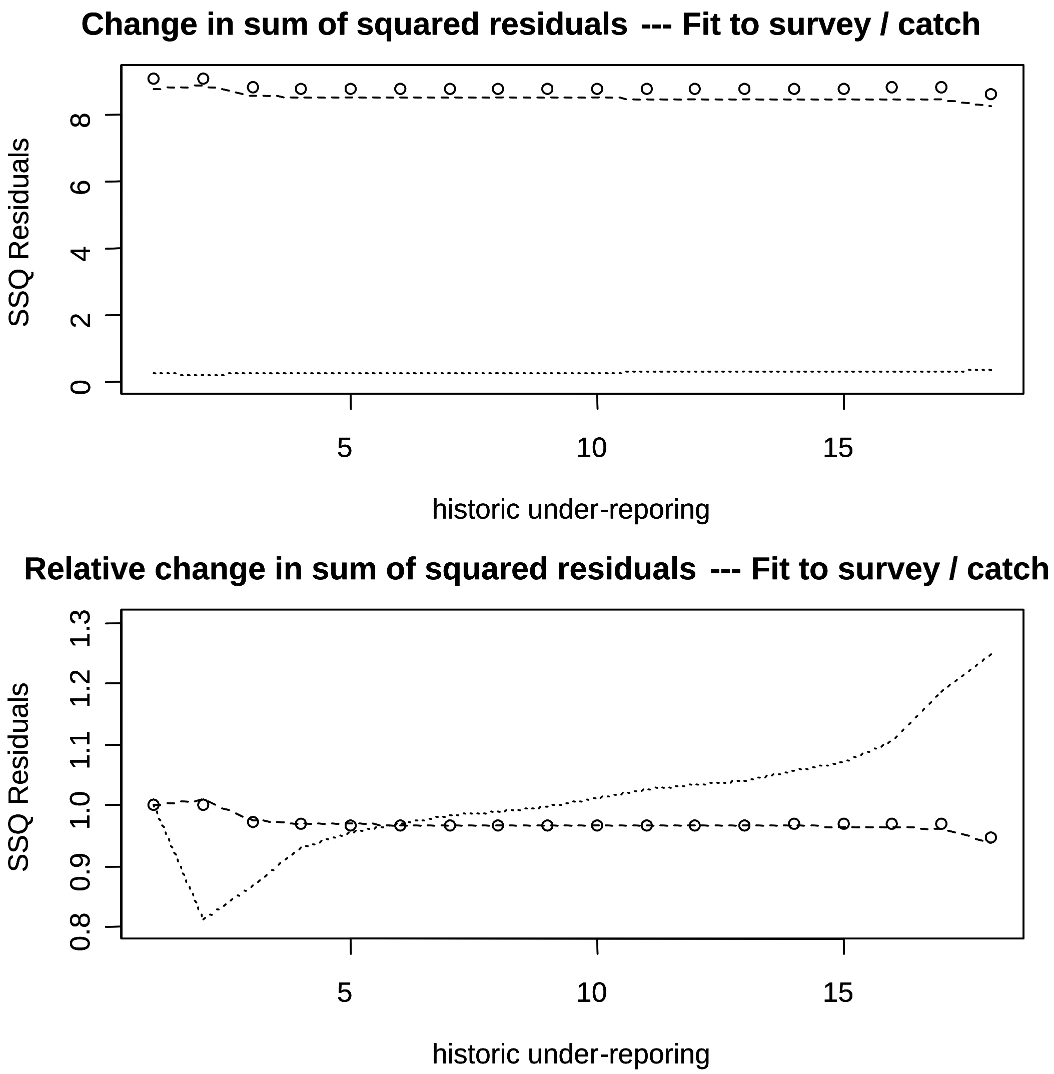


Figure 2.8.2.6. NE Atlantic mackerel changes in fitted sum of squared residuals in ICA, circles - total, dashes - separable catch and dots - survey. Top panel fitted values, lower panel change relative to the 2005 WG assessment. Plotted against different historic underreporting scenarios 1) for 2005 assessment, 2-9) declining underreporting with history, 10) constant underreporting with time and 11-18) increasing underreporting with history.

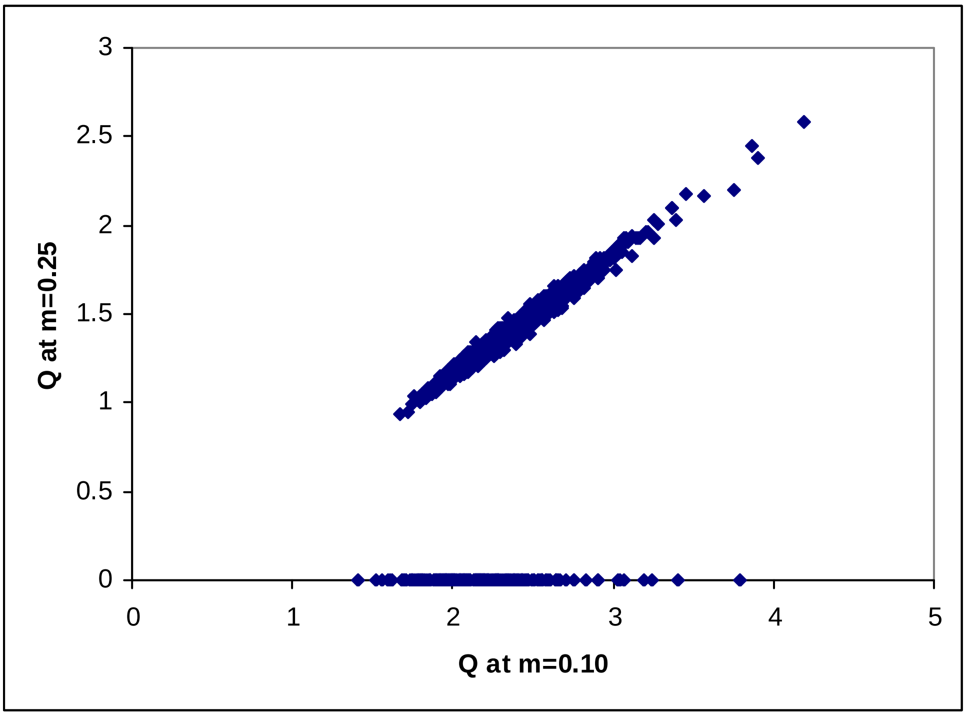


Figure 2.8.3.1. NE Atlantic mackerel, relationship between estimates of Q at M=0.1 and Q at M=0.25 showing the good linear relationship when fits occur at both values of m and the lower range of values of Q at m=0.1 at which fitting failed at M=0.25

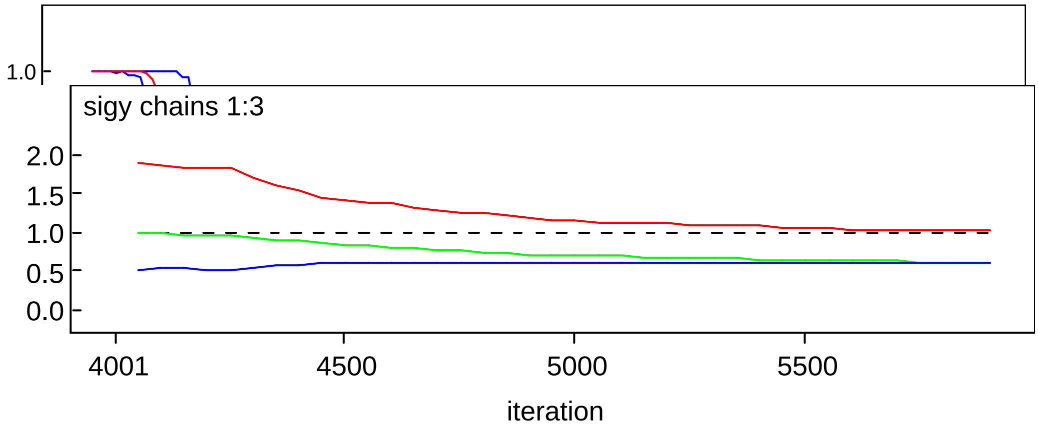


Figure 2.8.3.2 NE Atlantic mackerel example of fit criteria in WINBUGS. Upper panel) Metropolis convergence criteria from ICA separable model, showing convergence by about 4,000 iterations, Data used is from 5,001 to 15,000. Lower panel) Gelman Rubin statistic (for model s) which examines variance within and across chains, red line should be above 1 and asymptotic to it, green and blue lines should be asymptotic to a final value.

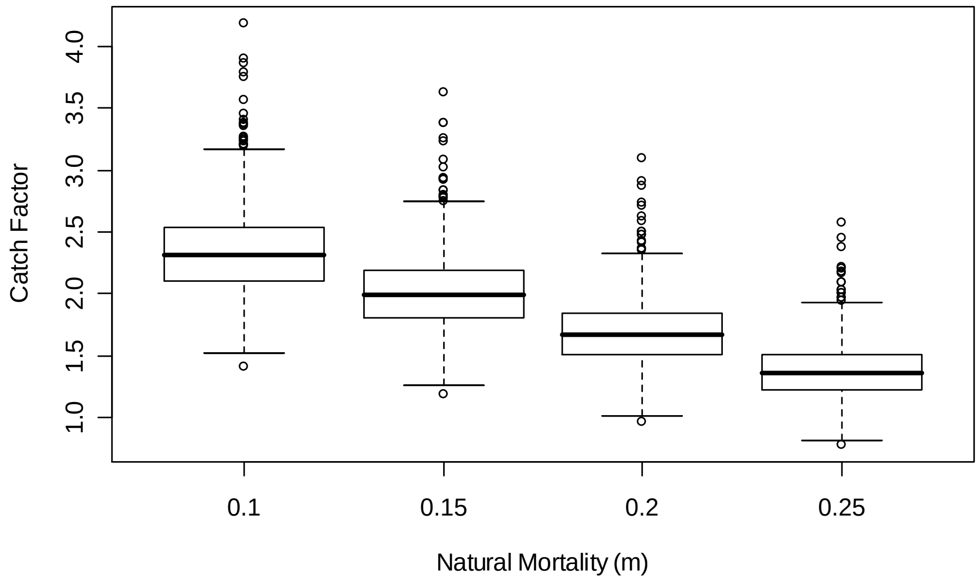


Figure 2.8.3.3. NE Atlantic mackerel box and whisker plots from the intrinsic error analysis estimated missing catch for different assumptions of M from 0.1 to 0.25.

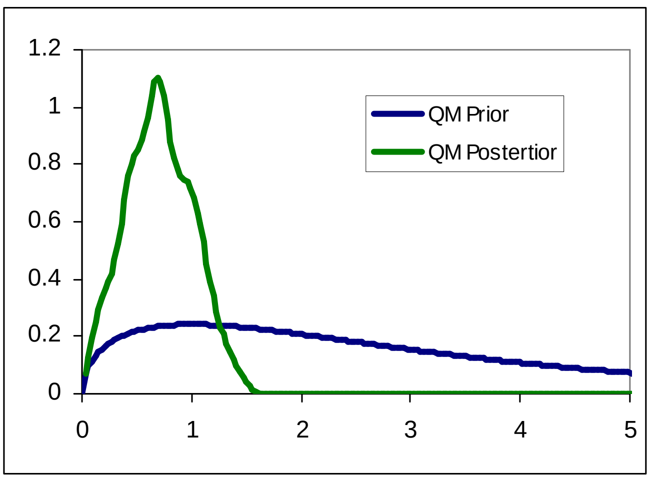


Figure 2.8.4.1. NE Atlantic mackerel comparison of gamma prior and fitted posterior for the multiplier for constant natural mortality (M) in the model. M is 0.15 times the posterior distribution.

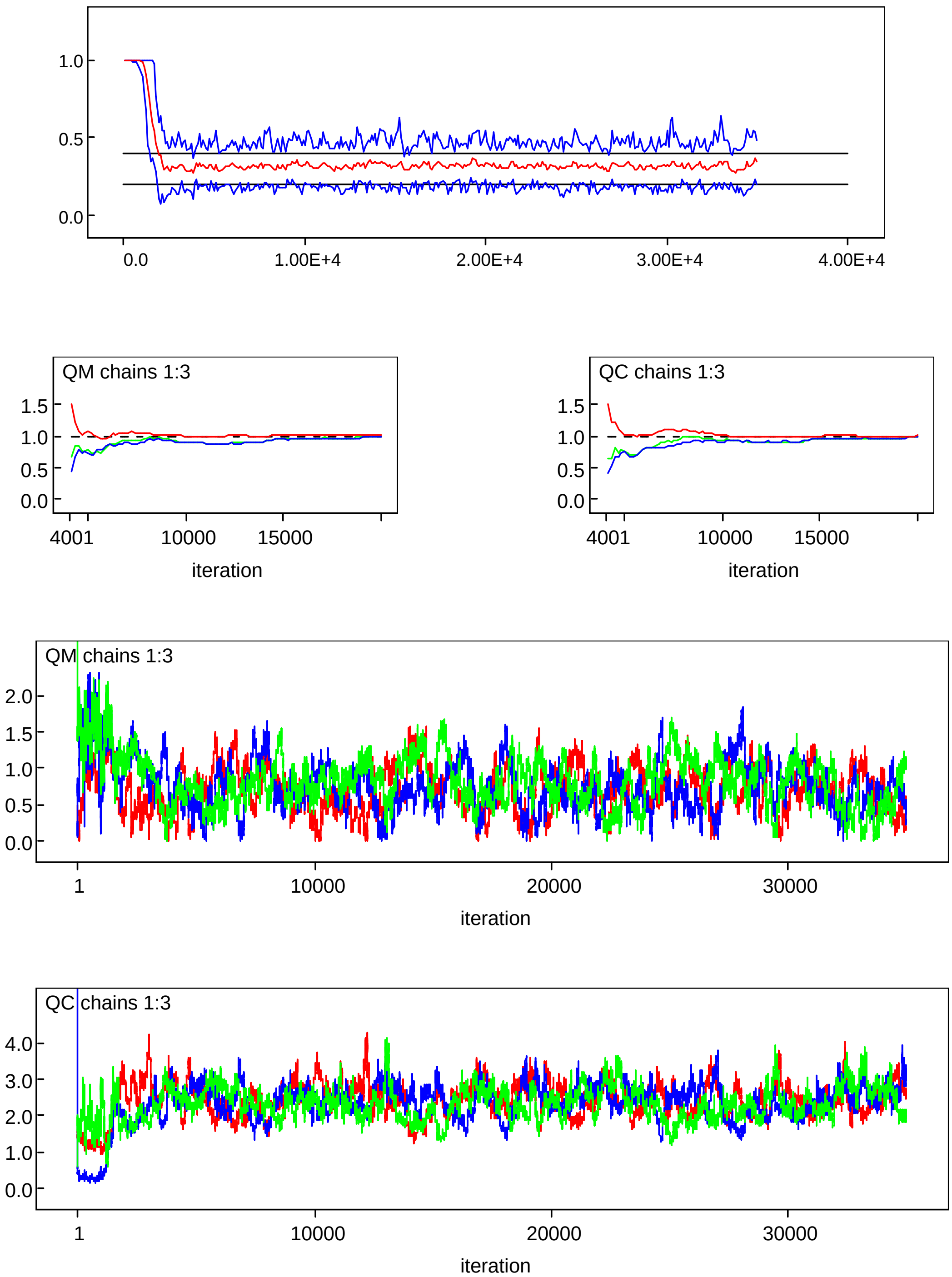
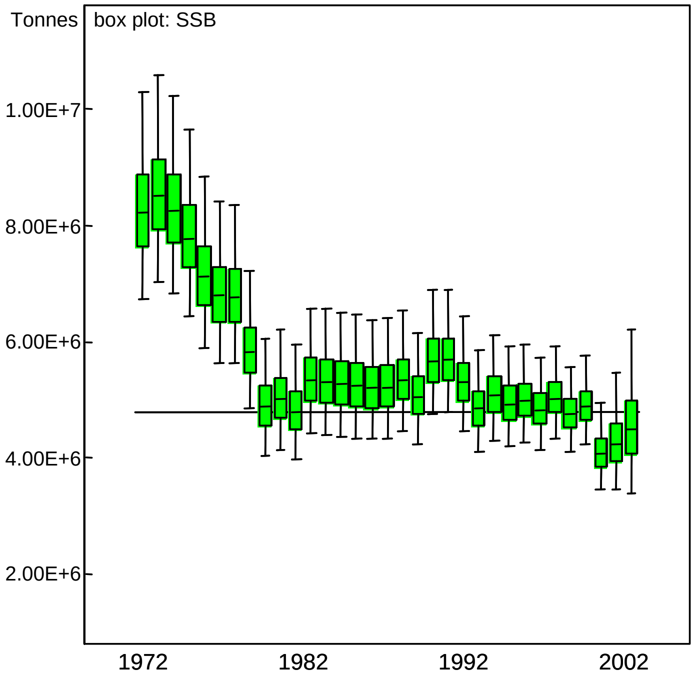


Figure 2.8.4.2 NE Atlantic mackerel convergence criteria in WINBUGS a) Metropolis convergence criteria from ICA separable model with added parameters QM and QC and added data on total mortality, showing convergence by about 3,000 iterations, b) Gelman Rubin statistic (for QM and QC) which examines variance within and across chains, red line should be above 1 and asymptotic to it, green and blue lines should be asymptotic to a final value. c) Chain history for QM and QC. Data used is from 5,001 to 35,000.



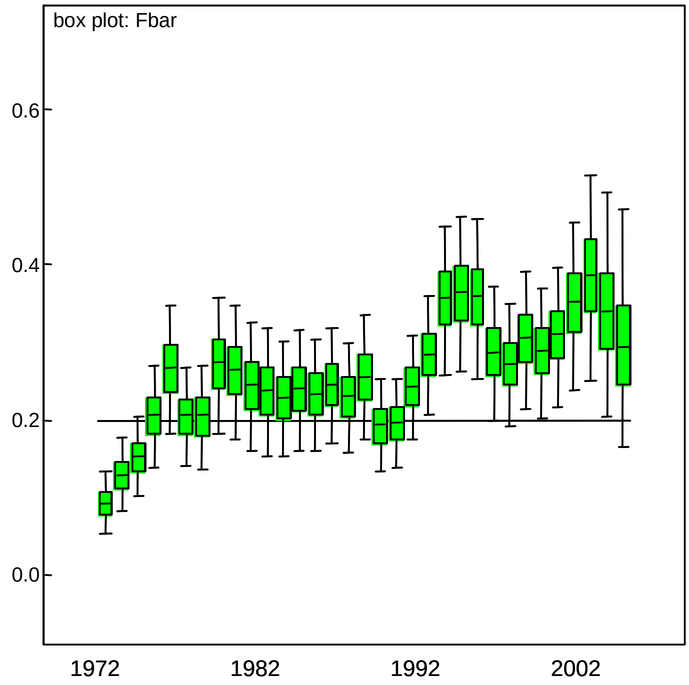


Figure 2.8.4.3 NE Atlantic mackerel (2005 WG data) Estimated SSB and Fbar4-8 from ICA Bayesian assessment in WINBUGS including the estimation of mean levels of missing catch (QC) and natural mortality (QM).

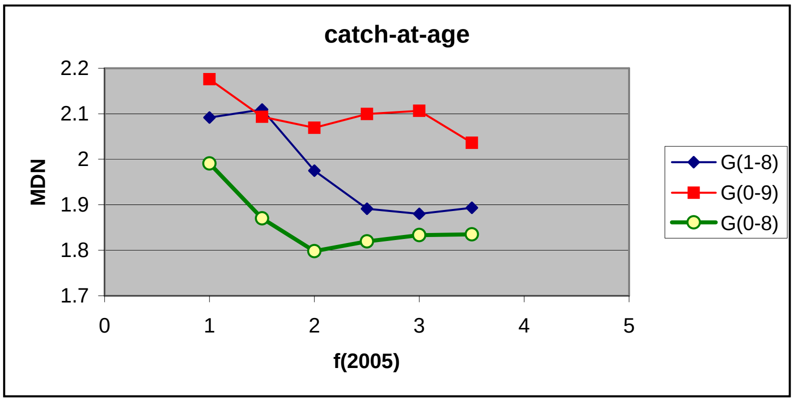


Figure 2.8.7.1. NE Atlantic mackerel, profiles of catch-at-age component of the TISVPA loss function for various age ranges of application of generation-dependent factors in separable representation.

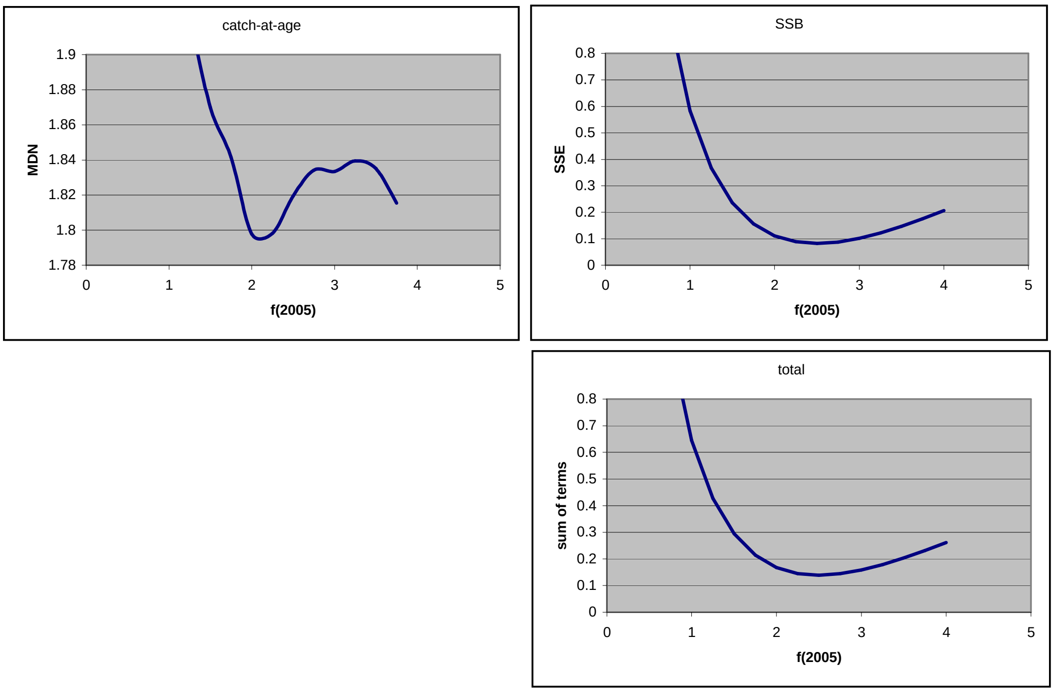


Figure 2.8.7.2. NE Atlantic mackerel profiles of components of the TISVPA loss function

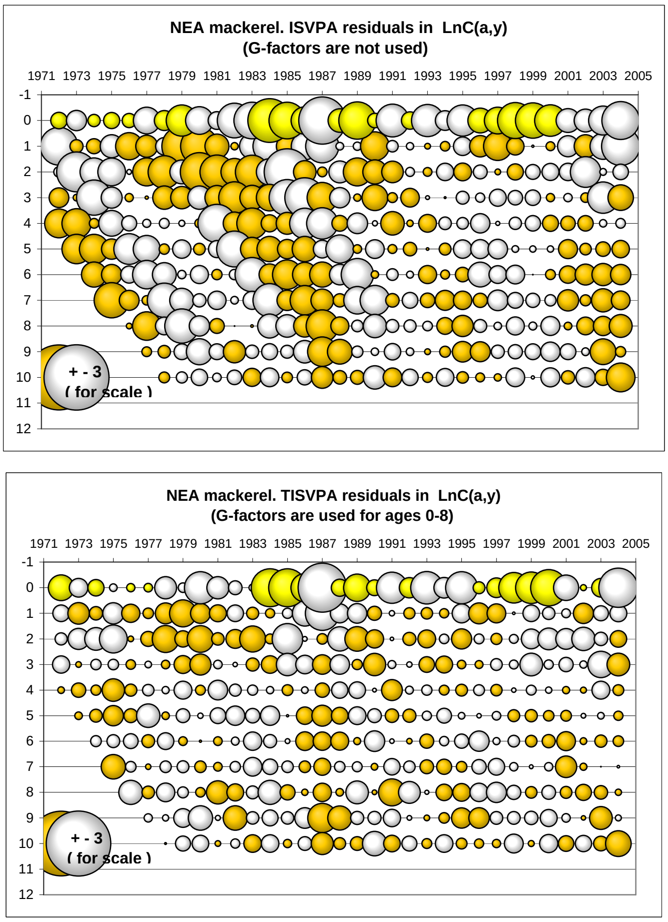


Figure 2.8.7.3. NE Atlantic mackerel residuals in log-catch-at-age for ISVPA and TISVPA

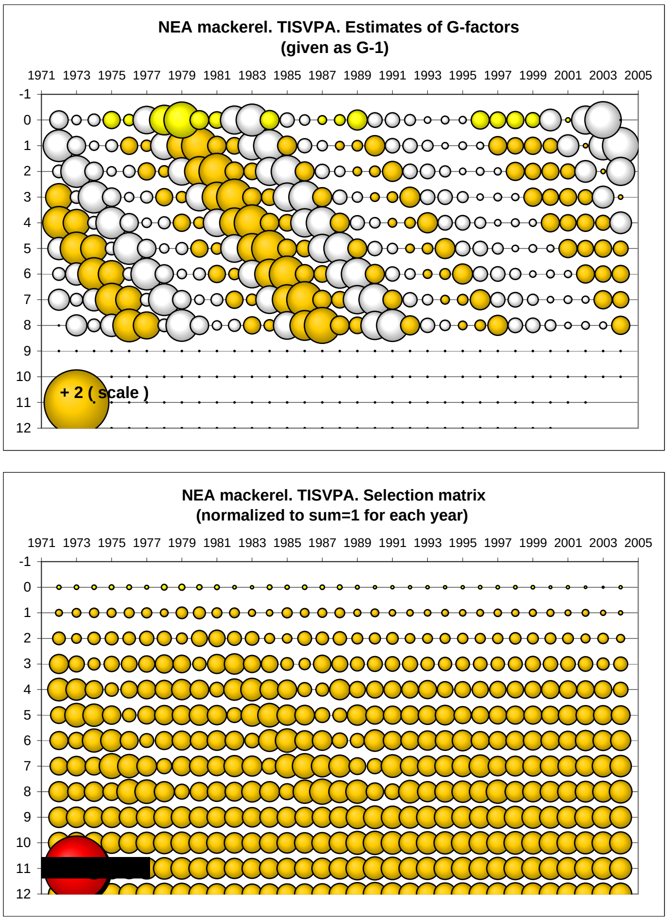


Figure 2.8.7.4. NEA mackerel. TISVPA. Estimates of G-factors and selection matrix

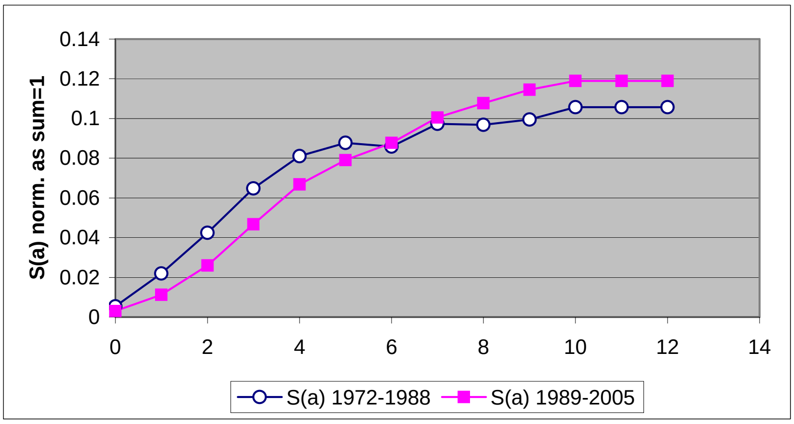


Figure 2.8.7.5. NEA mackerel. TISVPA. The estimates of age-dependent components of the selection matrix for two periods.

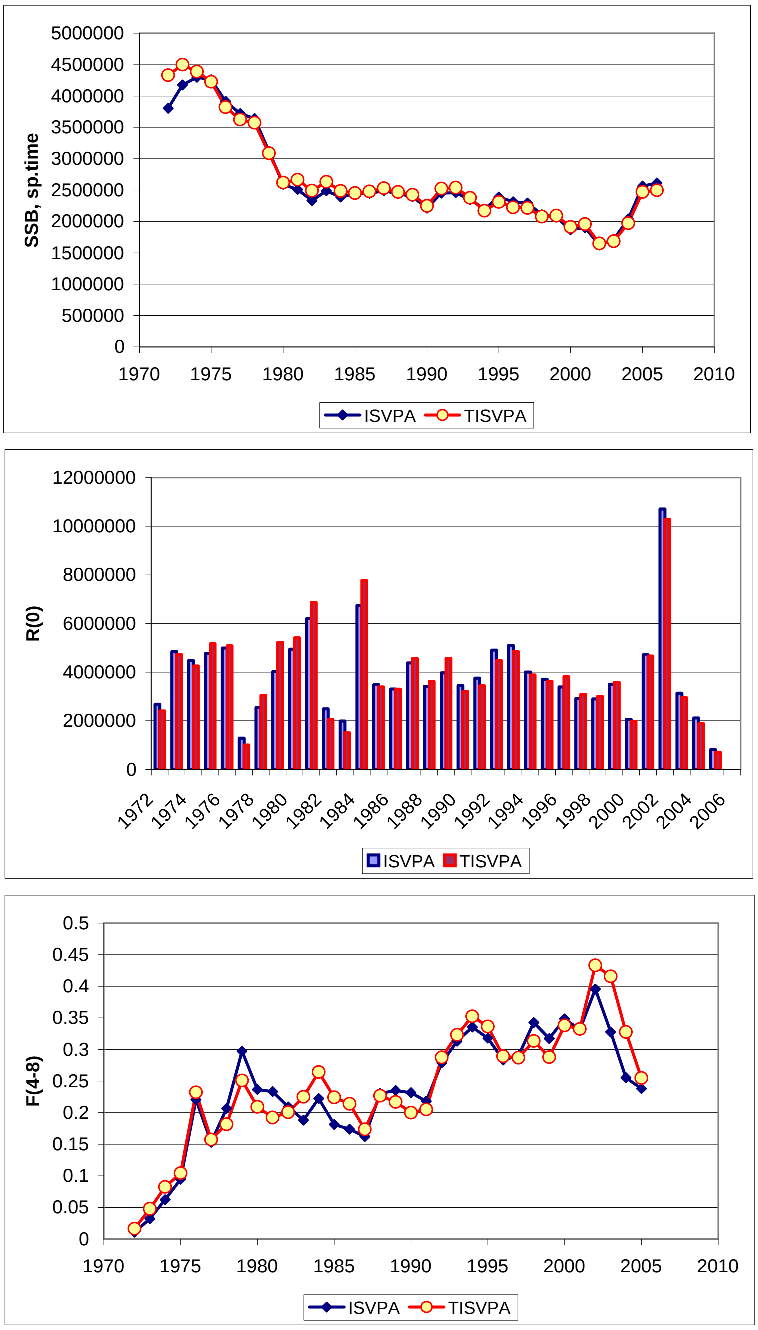


Figure 2.8.7.6. NE Atlantic mackerel ISVPA and TISVPA - derived estimates of SSB, F and R(0)

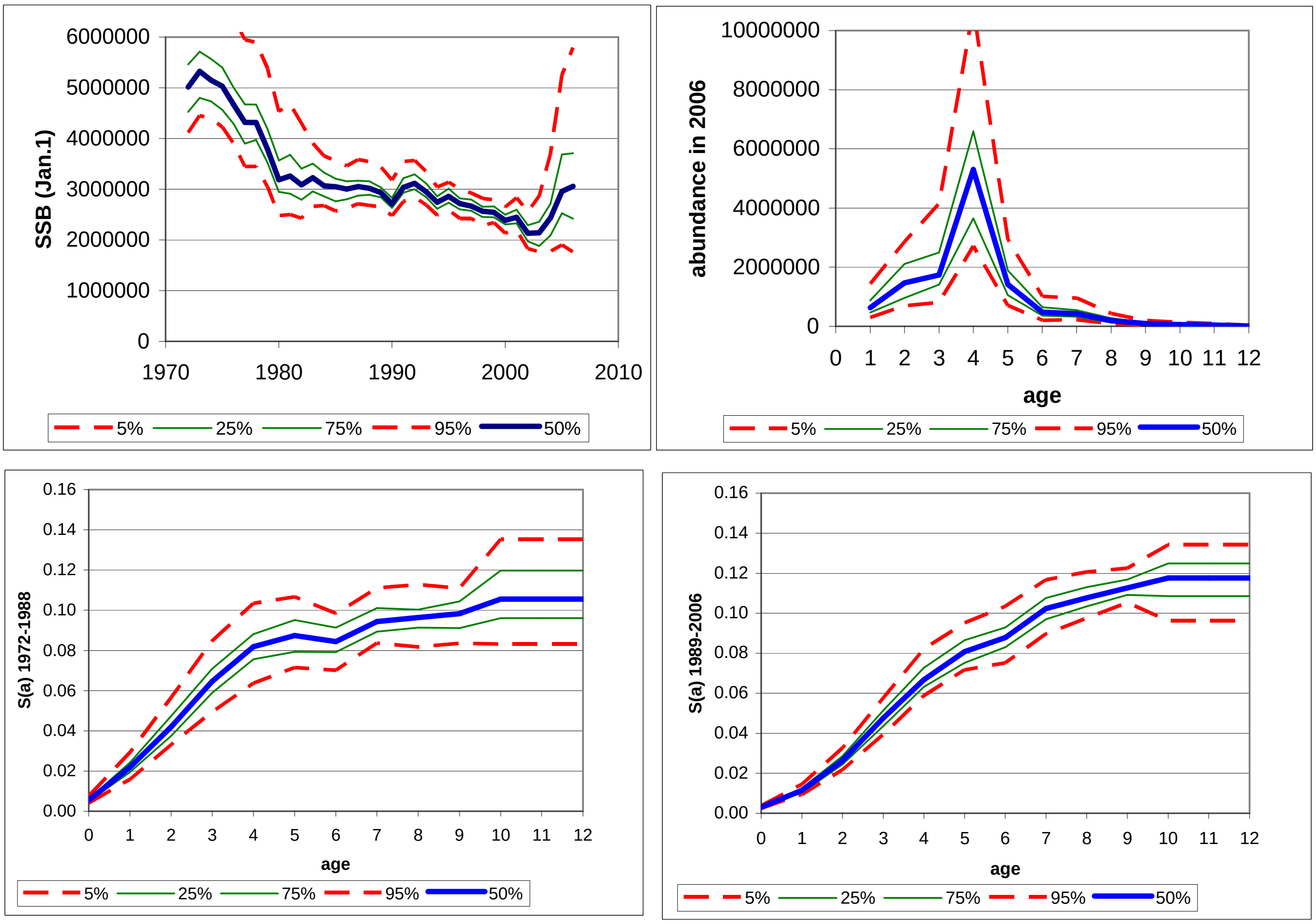


Figure 2.8.7.7. NE Atlantic mackerel. TISVPA. Bootstrap.

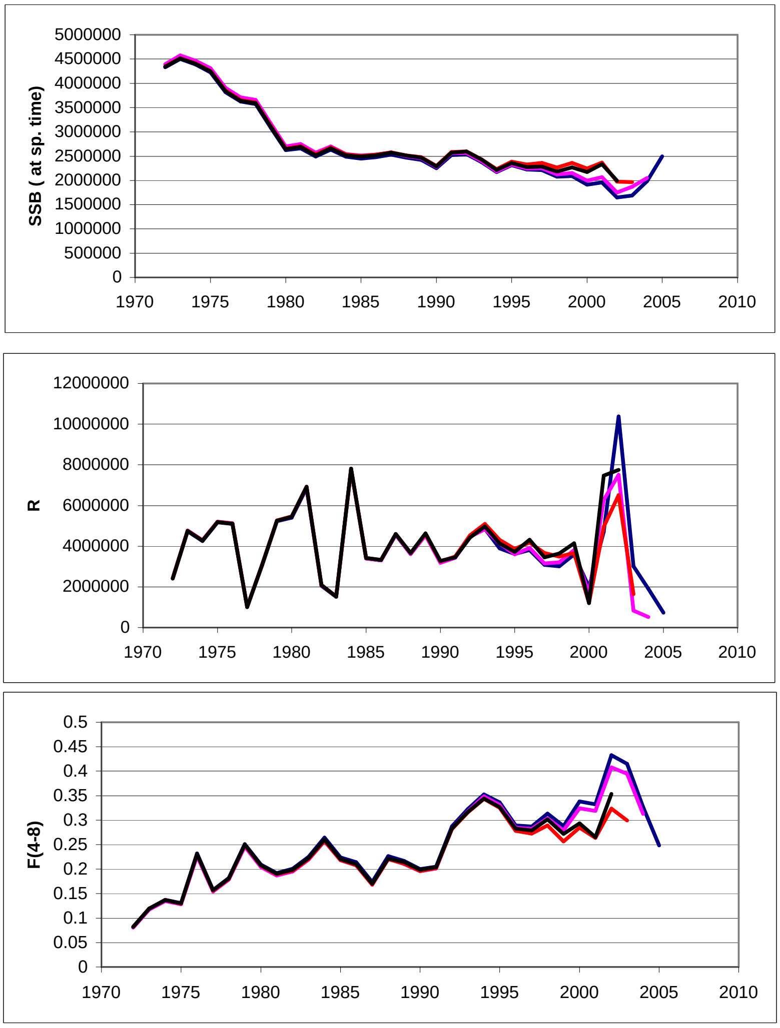


Figure 2.8.7.8. NE Atlantic mackerel. TISVPA. Retrospective Runs

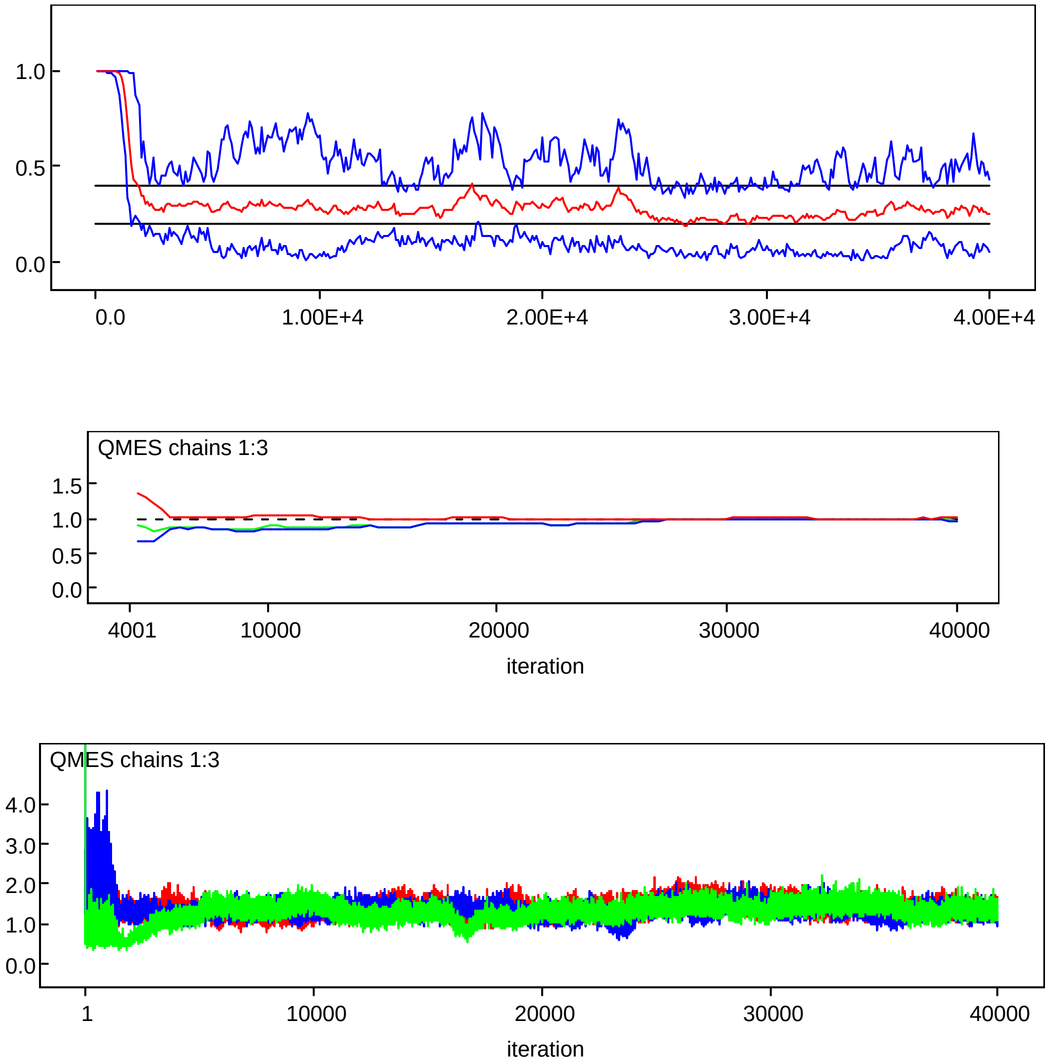
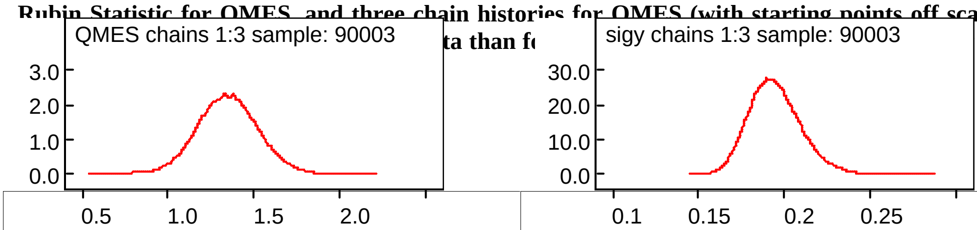


Figure 2.8.8.1 NE Atlantic mackerel WINBUGS ICA exploratory assessment (2006 data) Convergence of model is illustrated by a) Metropolis acceptance rates, which are variable suggesting some difficulties, b) Gelman Rubin Statistic for QMES and three chain histories for QMES (with starting points off scale).This model has ... ta than f ... in the penultimate



node	mean	sd	MC error	
QMES	1.347	0.1792	0.005772	
2.5%	median	97.5%	start	sample
0.9904	1.346	1.702	10000	90003

node	mean	sd	MC error	
sigy	0.1945	0.01504	3.265E-4	
2.5%	median	97.5%	start	sample
0.1682	0.1934	0.2275	10000	90003

Figure 2.8.8.2 NE Atlantic mackerel WINBUGS ICA exploratory assessment (2006 data). distributions of QMES and model s

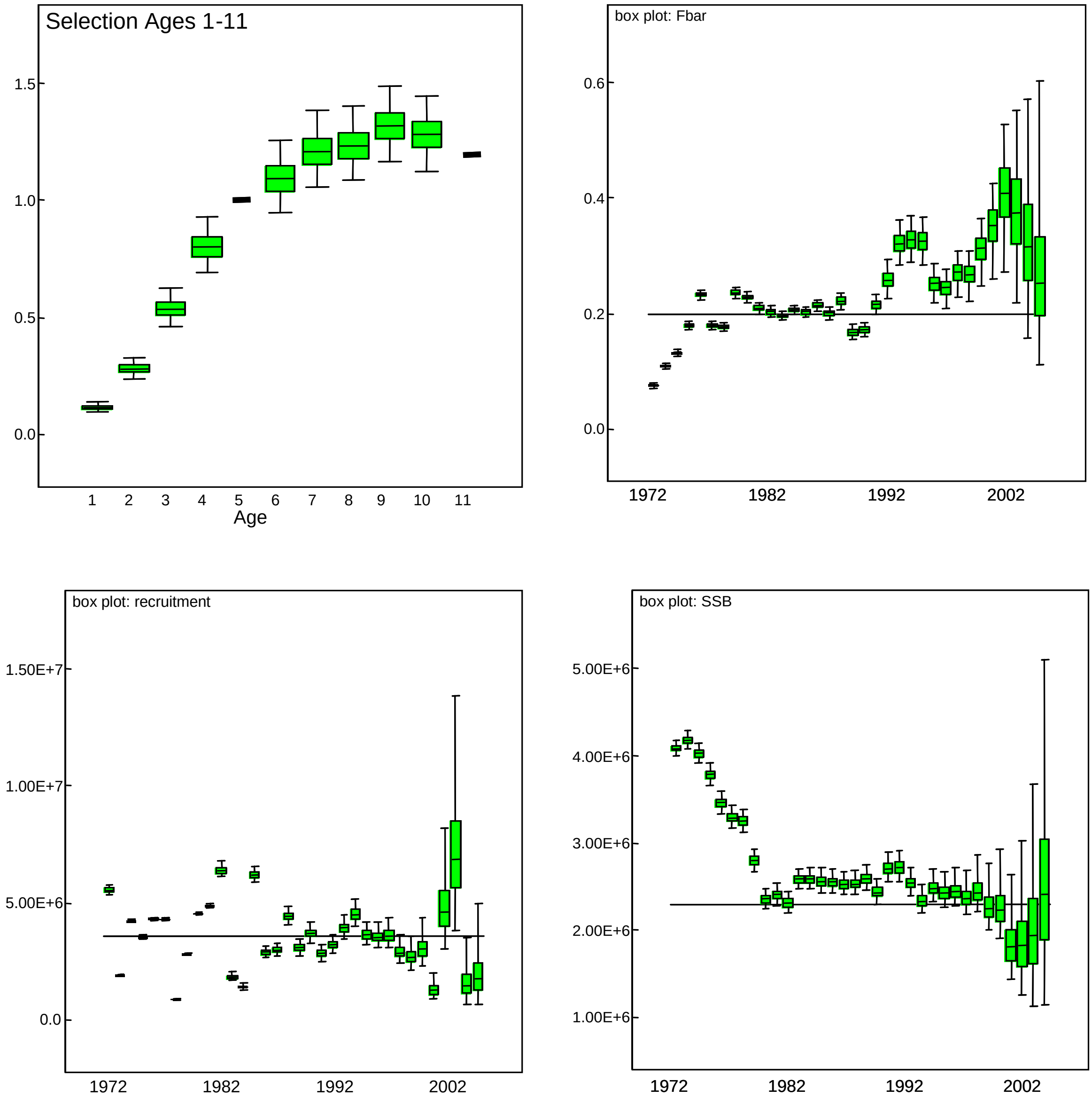


Figure 2.8.8.3 NE Atlantic mackerel WINBUGS ICA exploratory assessment (2006 data) a) Selection pattern ages 1-11, with age 5 set to 1 and ages 11 and 12 set to 1.2. b) Fbar ages 4-8, with reference line set at 0.2 (upper limit of management) c) Recruitment, final year recruitment (unreliably estimated and not full represented in the model) d) SSB, with reference line at Bpa= 2.3Mt

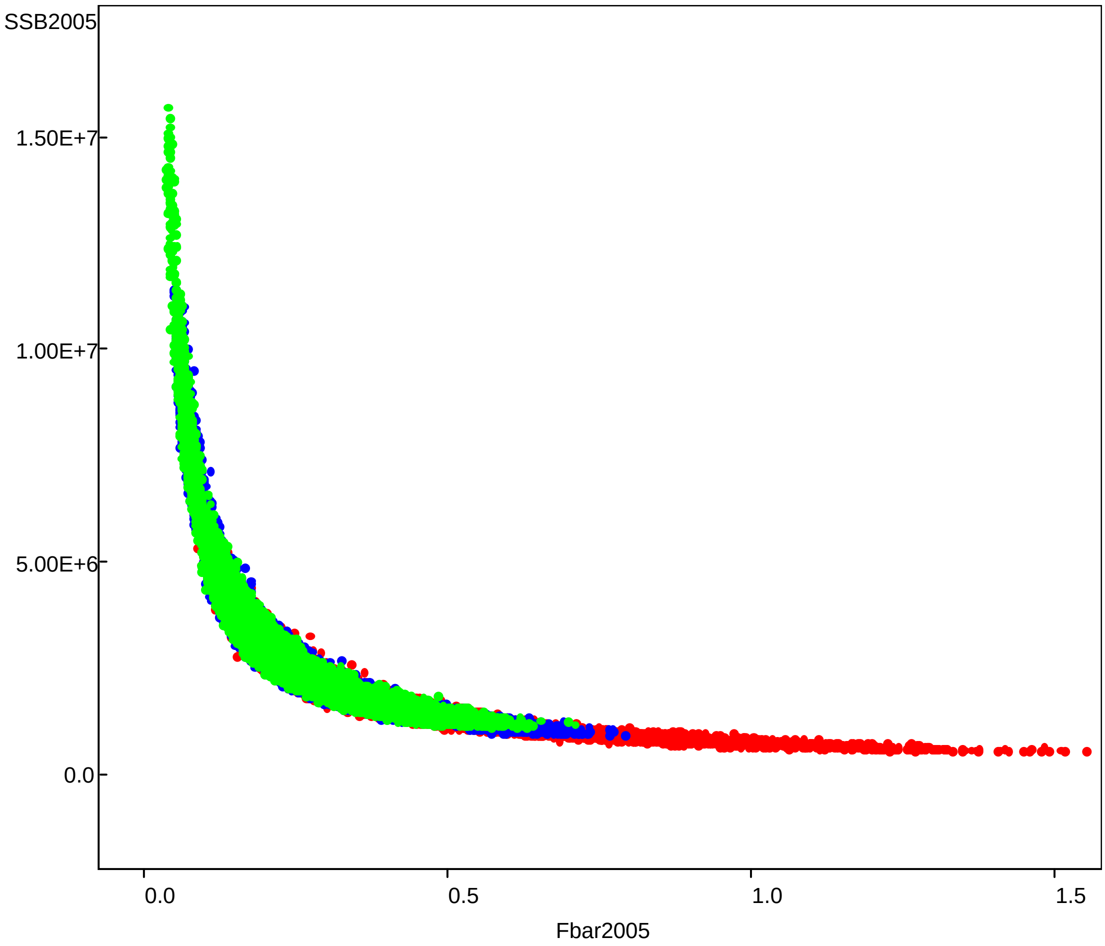


Figure 2.8.8.4 NE Atlantic mackerel WINBUGS ICA exploratory assessment, plot of estimated SSB verses estimated Fbar 4-8 for 2005. The different colours are from different chains. The main area, using more than 95% of values, is covered by all three chains but the extremes of the tails are explored by individual chains only.

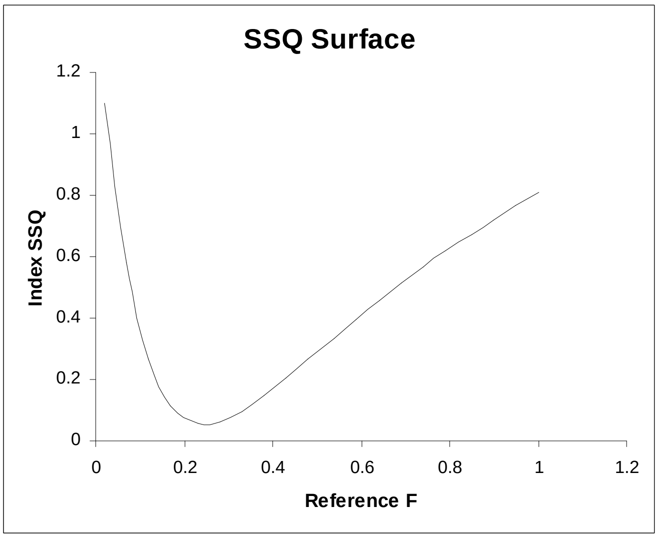
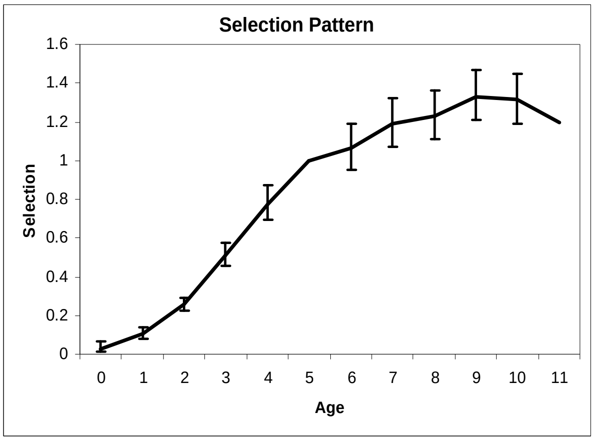


Figure 2.9.1.1 NEA mackerel. The sum of squares surface for the ICA separable VPA fit to the egg survey biomass estimates (period of separable constraint 1992-2005).



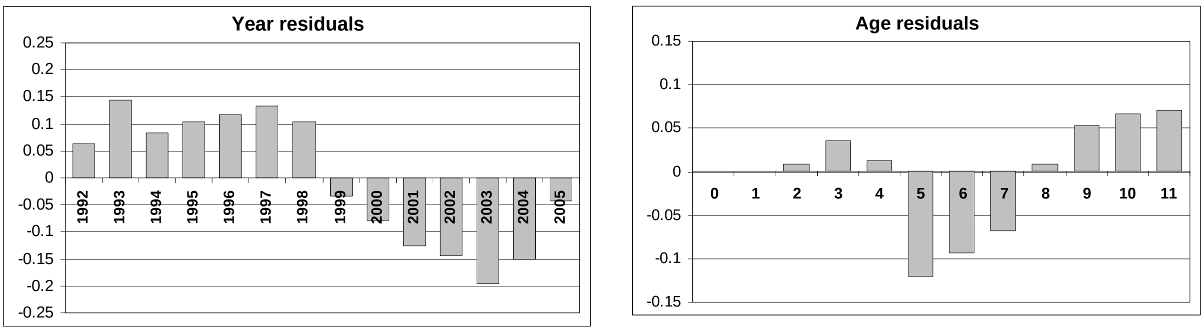


Figure 2.9.1.2 NEA mackerel. The catch at age residuals and ages fitted by ICA. SSB estimates from egg surveys covering the range 1992-2005 are used in the biomass index and there is only one period of separable constraint (1992-2005).

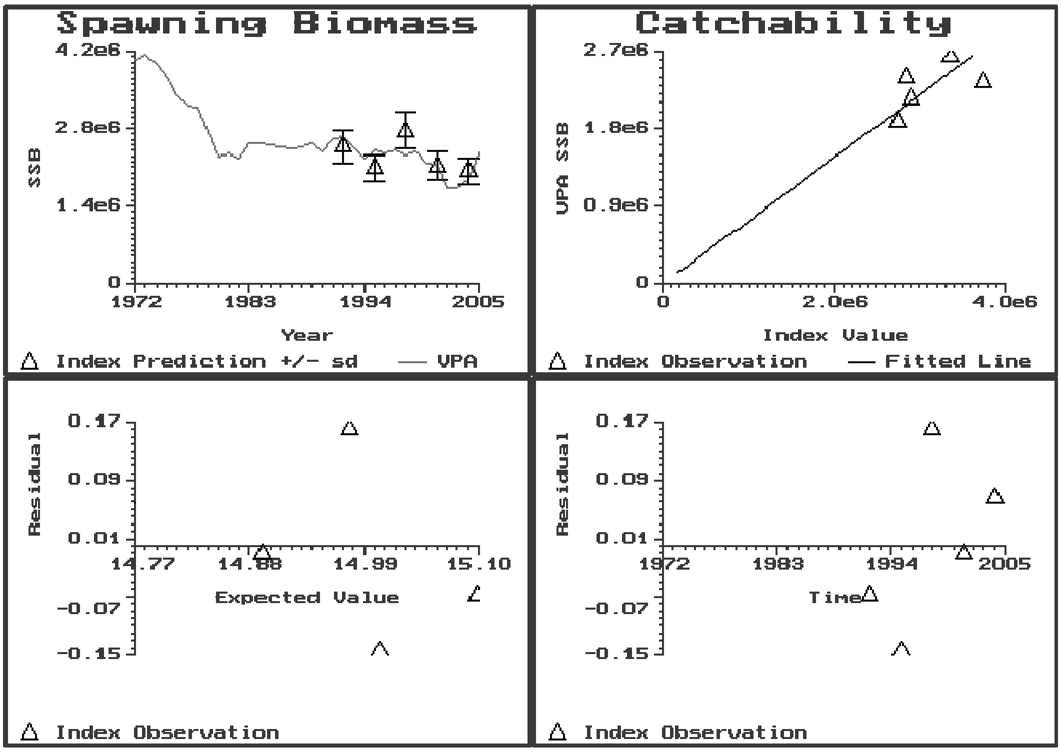


Figure 2.9.1.3 NEA mackerel. The diagnostics for the egg production index as fitted by ICA. SSB estimates from egg surveys covering the range 1992-2005 in the biomass index and there is only one period of separable constraint (1992-2005).

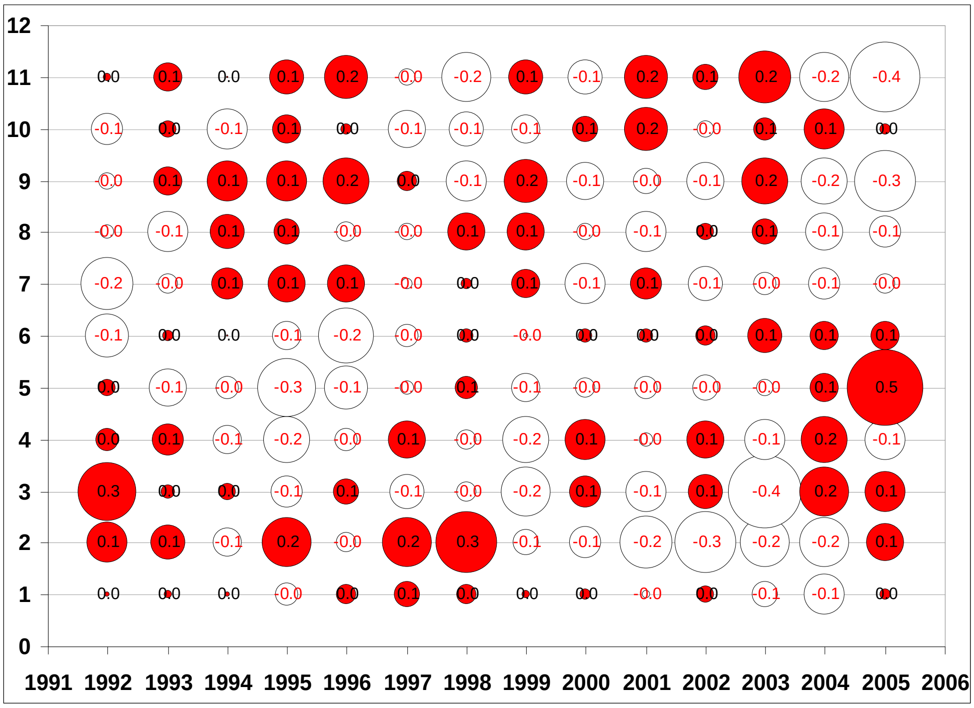


Figure 2.9.1.4 NEA mackerel. The catch at age residuals and ages fitted by ICA covering the period of separable constraints. Residuals at age 0 and 1 down weighted respectively 0.01 and 0.1.

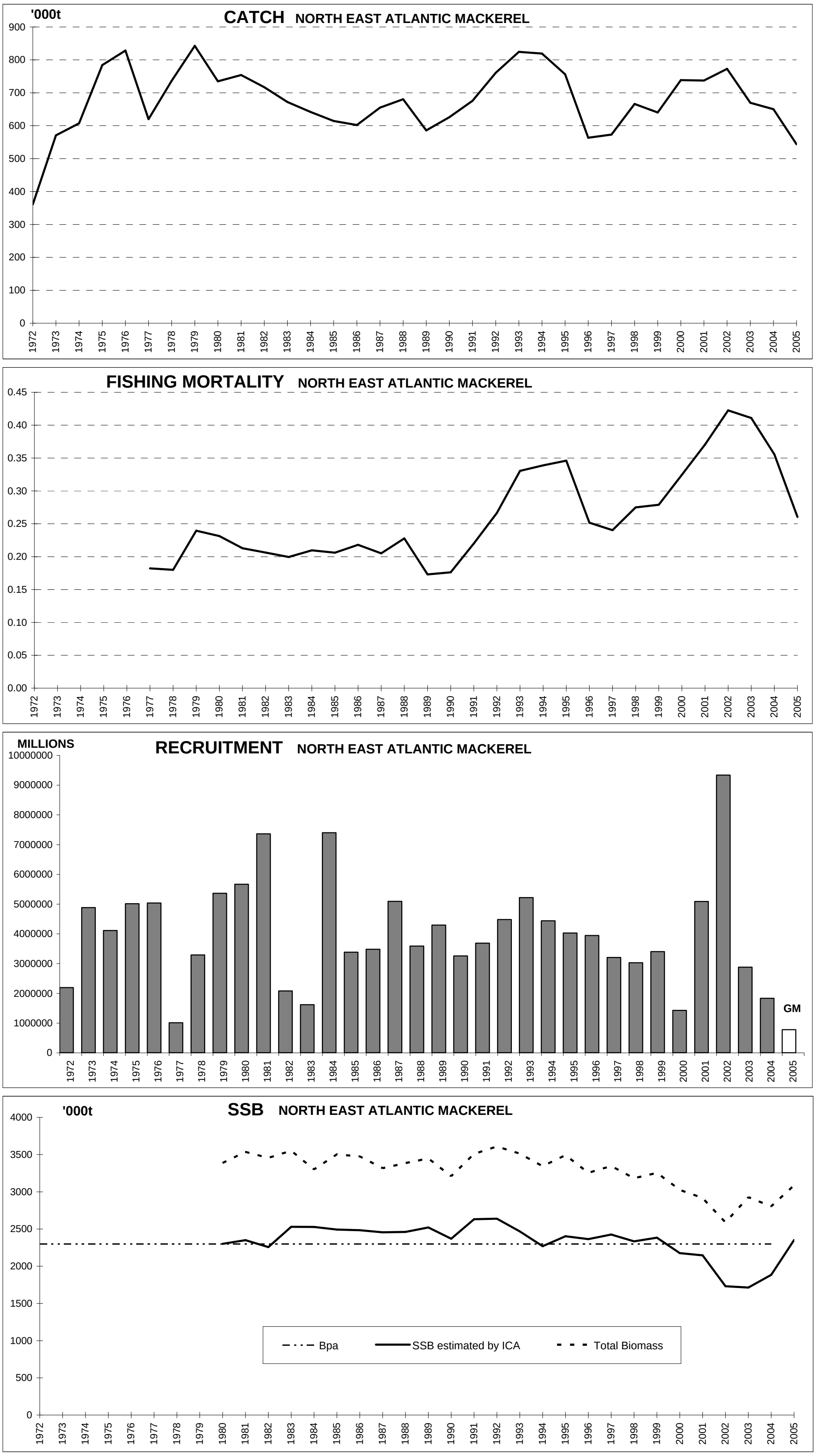


Figure 2.9.1.5 NEA mackerel. Catch, SSB, F and recruitment (ICA) for the period 1972-2005.
Biomass estimates from egg surveys in 1992, 1995, 1998, 2001 and 2004 are used for the assessment

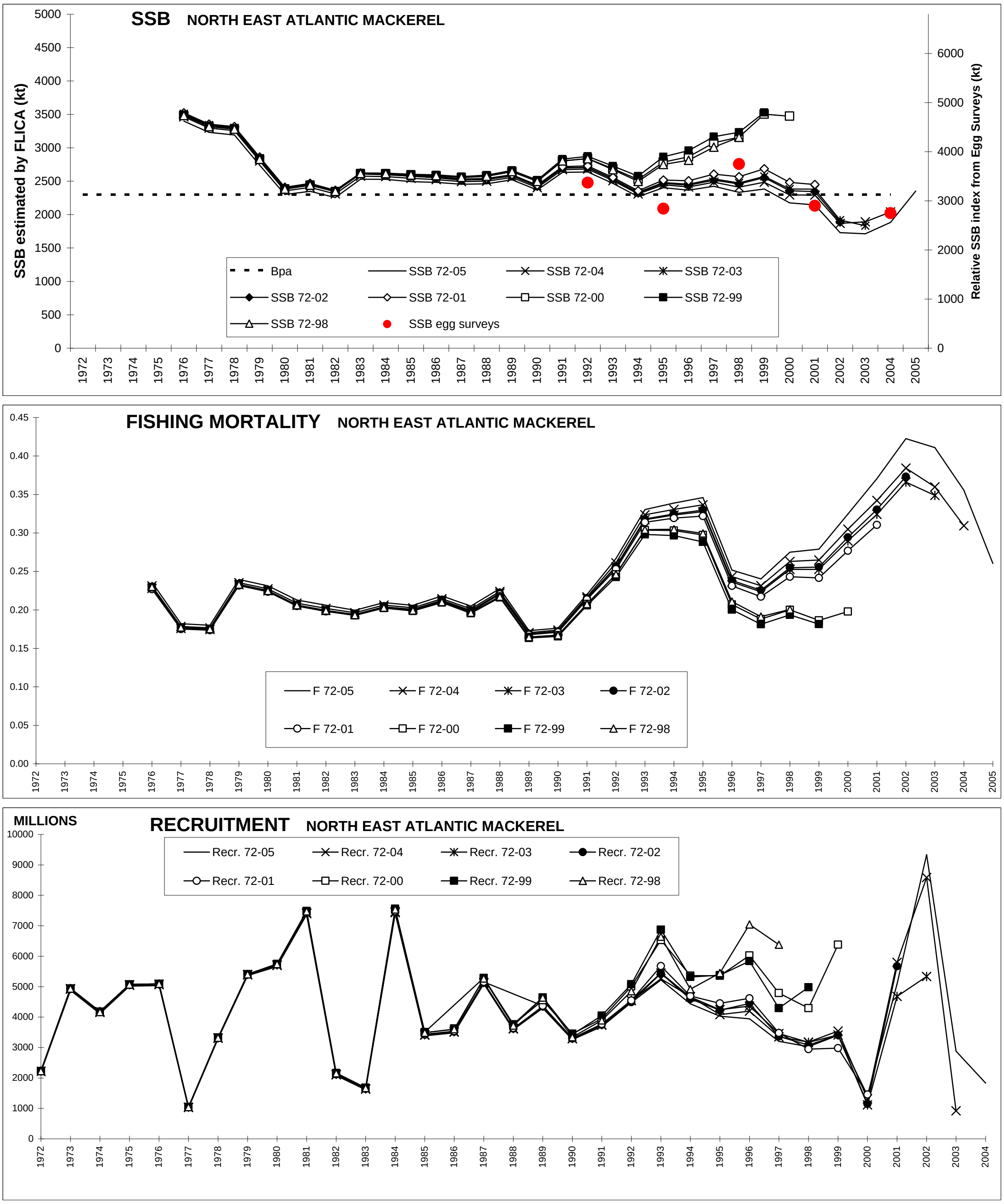


Figure 2.9.2.1 **NEA mackerel. Retrospective analysis by FLICA. Egg survey SSB's are used as relative SSB index. Periods of separable constraint used were from 1992 up to final assessment year.**

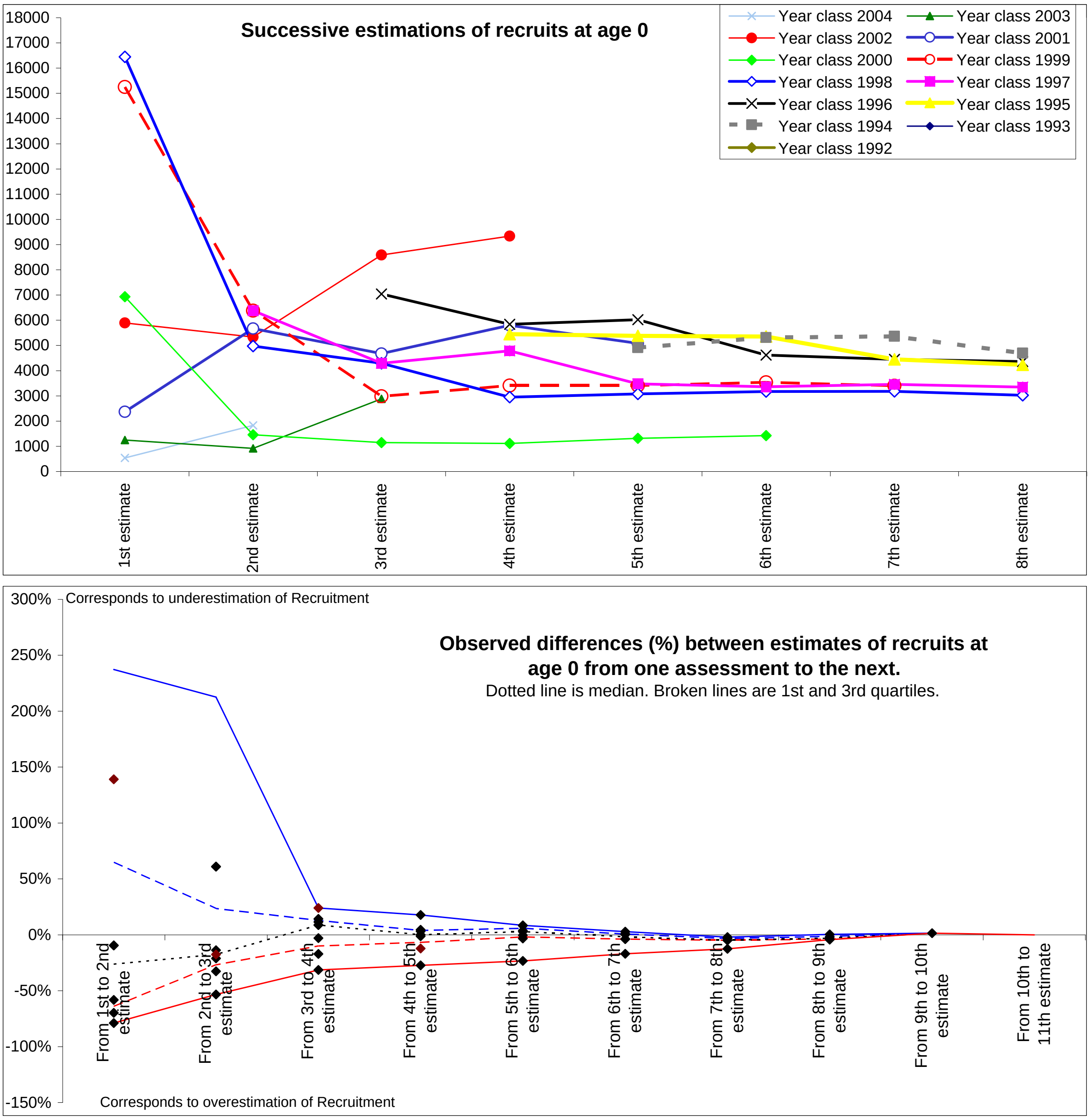
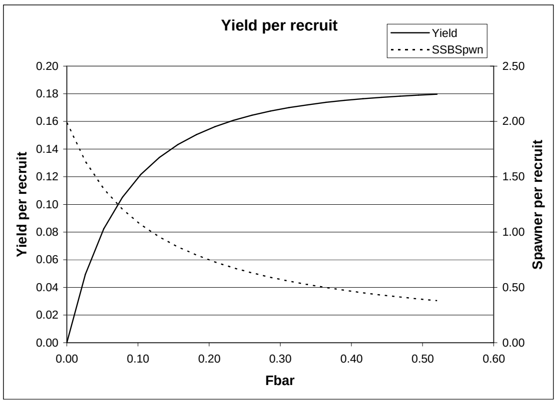
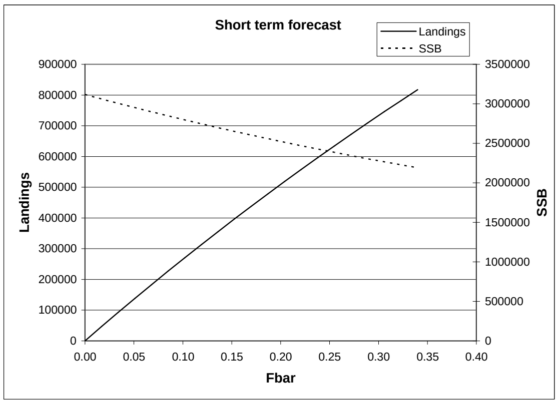


Figure 2.9.2.2 NEA mackerel. At the annual WG meetings the recruitment strength at age 0 is estimated of all year classes (except last year). The first estimation of a year class strength is based on the catch in numbers at age 1 and at age 0 the year before; the second estimation of same year class is one year later and is then based on the catch in numbers c age 2, of age 1 the year before and of age 0 two years before; etc. (see upper panel
The maximum observed differences (%) between year class estimates of recruits at age 0 from one assessment to the next are shown in the lower panel. The dotted line is the median and the broken lines are the 1st and 3rd quartiles. The spread indicates the precision of the successive estimates of recruitment; the median indicates the bias in the successive estimates of recruitment. Data are obtained from the ICES quality control tables





MFYPR version 2a
Run: TAC Constraint
Time and date: 17:12 12/09/2006

Reference point	F multiplier	Absolute F
Fbar(4-8)	1.0000	0.2602
FMax	3.1784	0.8271
F0.1	0.7183	0.1869
F35%SPR	0.8605	0.2239

Weights in kilograms

Fhigh	5.1972	0.9643

Weights in kilograms

MFDP version 1a
Run: TAC Constraint
Mackerel NE Atlantic WG2006
Time and date: 16:48 12/09/2006
Fbar age range: 4-8

Input units are thousands and kg - output in tonnes

Figure 2.12.1 NE Atlantic mackerel yield per recruit and short term prediction (see also section 2.10)

3 Horse Mackerel

3.1 Fisheries in 2005

The total international catches of horse mackerel in the North East Atlantic are shown in Table 3.1.1 and Figure 3.3.1. The total catch from all areas in 2005 was 234,876 tons which is 18,500 tons more than in 2004, which was the lowest catch since 1986. Ireland, Denmark, Scotland, England and Wales, France, Germany and the Netherlands have a directed trawl fishery and Norway a directed purse seine fishery for horse mackerel. Spain and Portugal have directed trawl and purse seine fisheries. In earlier years most of the catches were used for meal and oil while in later years most of the catches have been used for human consumption.

The quarterly catches of horse mackerel by Division and Sub-division in 2005 are given in Table 3.1.2 and the distribution of the fisheries are given in Figure 3.1.1.a–d. The figures are based on data provided by Denmark, England and Wales, Faroe Islands, Ireland, Germany, Netherlands, Norway, Portugal and Spain representing 98 % of the total catches.

The geographical distribution of the catches was similar to previous years. In 2005 about 123,000 tons of horse mackerel was caught in the juvenile area (Divisions VIIa,d,e,f,g,h, VIIIa,b,c,d and IXa). About 39 % of this catch in numbers was from the 2001 year class. In 2004 the corresponding catch was 133.000 tons and 39% of that catch in numbers was from the 2001 year class. In 2005 about 15% in catch in numbers of North Sea horse mackerel and 36% of catch in numbers of the western stock were of the 2001 year class.

The French, Dutch and German fleets operated mainly west of the Channel, in the Channel area, and in the southern North Sea. The Spanish and Portuguese fleets operated mainly in their respective waters. Ireland fished mainly west of Ireland and Norway in the north eastern part of the North Sea. As usual the catches in the North Sea were from two separate areas (Figs 3.1.1a-c), a northern corresponding to the northern part of Division IVa which is assumed to be from the western stock and a more southern distribution from IVb,c and VIId) assumed to be from the North Sea stock..

First quarter: 78,300 tons. This is 14,000 tons more than in 2004. The fishery was mainly carried out west of Ireland, south of England, in the Channel, along the Spanish and Portuguese coast (Figure 3.1.1.a). Some catches were taken in the northern part of the North Sea. This is assumed to be western horse mackerel on its way back to the spawning area.

Second quarter: 25,800 tons. This is 3,800 tons more than in 2004. As usual, rather low catches were taken during the second quarter, which is the main spawning period. Most of the catches were taken south of Ireland, in the Bay of Biscay and along the Spanish and Portuguese coast (Figure 3.1.1.b).

Third quarter: 18,700 tons. This is 11,500 tons less than in 2004. As usual the catches were distributed over a relatively larger parts of the distribution area. Small catches were taken in the northern North Sea and in the Norwegian Sea (Figure 3.1.1.c).

Fourth quarter: 112,000 tons. This is 12,000 tons more than in 2004 and the catches were distributed similar to the third quarter but now including relatively large catches both in the northern part of the North Sea and in the other areas (Figure 3.1.1.d).

3.2 Stock Units

The Working Group considers the horse mackerel in the north east Atlantic as separated into three stocks: the North Sea, The Southern and the Western stocks (ICES 1990/Assess: 24, ICES 1991/Assess: 22).. Western horse mackerel are thought broadly to have similar migration patterns as NEA mackerel. Results from an EU funded project (HOMSIR, QLK5-Ct1999-01 438) demonstrated that Division VIIIc is part of the distribution area of the western horse mackerel stock (ICES 2004/ACFM:08). The boundaries for the different stocks are given in Figure 3.2.1.

3.3 Allocation of Catches to Stocks

Based on spatial and temporal distribution of the horse mackerel fishery the catches were allocated to the three stocks as follows:

Western stock: Divisions IIa, IIIa (western part), Vb, IVa, VIa, VIIa–c,e–k and VIIIa-e. Allthough it seems strange that only catches from western part of Division IIIa are allocated to this stock. The reason for this is that the catches in the western part of this Division taken in the fourth quarter usually are taken in neighbouring area of catches of western fish in Division IVa. The Working Group is not sure if catches in Divisions IIIa and IVa the first two quarters are of western or North Sea origin. Usually this is a minor problem because the catches here during this period are small. As in most years the Working Group allocated the 2005 catches from the two first quarters in IVa (1,300 tons) and Div IIIa (72 tons) to the western and the North Sea stock respectively.

North Sea stock: Divisions IIIa (eastern part), IVb,c and VIId. All catches from these Divisions were allocated to the North Sea stock.

Southern stock: Division IXa. All catches from these areas are allocated to the southern stock. As mentioned before based on the HOMSIR results Division VIIIc is considered part of the distribution area of the western horse mackerel stock.

The catches by stock are given in Table 3.3.1 and Figure 3.3.1.

3.4 Estimates of discards

Over the years only one and in later years two countries have provided data on discards and the amount of discards given in Table 3.1.1 are therefore not representative for the total fishery. No data about discard were provided during 1998-2001. During the later years only the Netherlands and Germany have provided discard data. Based on the limited data available it is impossible to estimate the amount of discard in the horse mackerel fisheries (see section 1.3.3).

3.5 *Trachurus* Species Mixing

Trachurus spp.

Three species of genus Trachurus: *T. trachurus*, *T. mediterraneus* and *T. picturatus* are found together and are commercially exploited in NE Atlantic waters. Studies on genetic differentiation showed that the three species are very well identified excluding any doubt about the status of their category as species (Cárdenas et al., 2005).

Following the Working Group recommendation (ICES 2002/ACFM: 06), special care was again taken to ensure that catch and length distributions and numbers at age of *T. trachurus* supplied to the Working Group did not include *T. mediterraneus* and *T. picturatus*. Spain provided data on *T. mediterraneus* and Portugal on *T. picturatus*.

Table 3.5.1 shows the catches of *T. mediterraneus* by Sub-divisions since 1989. The catches of Trachurus Mediterraneus in Divisions VIIIa,b and Subdivision VIIIc East decreased significantly since 1999, and they maintained at similar low level until 2005. In Sub-divisions

VIIIc West, IXa North and IXa South there are no landings of this species. Since 2000 it is noted the presence of very scarce catches in Sub-area VII.

As in previous years in both areas, more than 95% of the catches were obtained by purse seiners and the main catches were taken in the second half of the year.

Catches and length distributions of *T. mediterraneus* in the Spanish fishery in Divisions VIIIa,b and c were reported separately from the catches and length distributions of *T. trachurus*. Data of monthly catches by gear and area were obtained from fishing vessel owner's associations and fishermen's associations through the existing information network of the IEO and AZTI (Advisory Organisations to Fisheries and Oceanography Administration) in all ports of the Cantabrian and Galician ports. *T. mediterraneus* is only landed in ports of the Basque country, Cantabria and Asturias. In ports of the Basque country the landings of *T. mediterraneus* and *T. trachurus* appear separately, except for some small categories, in which the separation is made on the basis of samplings at ports and information reported by fishermen. In the ports of Cantabria and Asturias the separation of these two spcecies in the landings is not registered in all the ports, therefore the total separation of the landings is based on the monthly percentages of the ports in which these landings are separated and also on samplings made at ports of this area.

A fishery for *T. picturatus* only occurred in the southern part of Division IXa, as in previous years. Data on *T. picturatus* in the Portuguese fishery for the period 1986-2005 are also given in Table 3.5.1. Catches and length distributions of *T. trachurus* for the Portuguese fishery in Division IXa do not include data for *T. picturatus*. Landings data are collected from the auction market system and sent to the General Directorate for Fisheries to be compiled. This includes information on landings per species by day and vessel.

Information on the amounts and distribution of catches of *T. mediterraneus* and *T. picturatus* is available for at least 16 years (see ICES Working Group reports since 1990 onwards). Taking into account that the assessment is only made for *T. trachurus*, the Working Group recommends that the TACs and any other management regulations which might be established in the future should be related only to *T. trachurus* and not to *Trachurus spp*. More information is needed about the *Trachurus spp* before the fishery and the stock can be evaluated.

3.6 Length Distribution by Fleet and by Country:

Denmark, Germany, Ireland, Netherlands, Norway, Portugal and Spain provided length distribution data for parts or for the total of their catches in 2005. These length distributions cover 86 % of the total landings and are shown in Table 3.6.1.

3.7 Egg surveys

The Working Group on Mackerel and Horse Mackerel Egg Surveys (WGMEGS) met in March this year (ICES 2006/LRC:09) to plan the next egg surveys in the western and southern spawning areas in 2007. No revisions were made to the conclusions or estimates of egg production, fecundity and SSB done by the 2005 meeting (ICES 2005/G:09):

- Total annual egg production for horse mackerel in the western area in 2004 was calculated as 0.678×10^{15} eggs which is similar to the production obtained in 2001, 0.684×10^{15} eggs.
- Total annual egg production for horse mackerel in the southern area in 2004 was calculated as 0.248×10^{15} eggs which is 45% more than the production obtained in 2001, 0.171×10^{15} eggs.

Table 3.1.1 HORSE MACKEREL general. Catches (t) by Sub-area. Data as submitted by Working Group members. Data of limited discard information are only available for some years.

Sub-area	1979	1980	1981	1982	1983	1984
II	2	-	+	-	412	23
IV + IIIa	1,412	2,151	7,245	2,788	4,420	25,987
VI	7,791	8,724	11,134	6,283	24,881	31,716
VII	43,525	45,697	34,749	33,478	40,526	42,952
VIII	47,155	37,495	40,073	22,683	28,223	25,629
IX	37,619	36,903	35,873	39,726	48,733	23,178
Total	137,504	130,970	129,074	104,958	147,195	149,485

Sub-area	1985	1986	1987	1988	1989	1990
II	79	214	3,311	6,818	4,809	11,414
IV + IIIa	24,238	20,746	20,895	62,892	112,047	145,062
VI	33,025	20,455	35,157	45,842	34,870	20,904
VII	39,034	77,628	100,734	90,253	138,890	192,196
VIII	27,740	43,405	37,703	34,177	38,686	46,302
IX	20,237	31,159	24,540	29,763	29,231	24,023
Total	144,353	193,607	222,340	269,745	358,533	439,901

Sub-area	1991	1992	1993	1994	1995	1996	1997
II + Vb	4,487	13,457	3,168	759	13,133	3,366	2,617
IV + IIIa	77,994	113,141	140,383	112,580	98,745	27,782	81,198
VI	34,455	40,921	53,822	69,616	83,595	81,259	40,145
VII	201,326	188,135	221,120	200,256	330,705	279,109	326,415
VIII	49,426	54,186	53,753	35,500	28,709	48,269	40,806
IX	21,778	26,713	31,944	28,442	25,147	20,400	27,642
Total	389,466	436,553	504,190	447,153	580,034	460,185	518,882

Sub-area	1998	1999	2000	2001	2002	2003	2004
II + Vb	2,538	2,557	1,169	60	1,324	24	47
IV + IIIa	31,295	58,746	31,583	19,839	49,691	34,226	30,540
VI	35,073	40,381	20,657	24,636	14,190	23,254	21,929
VII	250,656	186,604	137,716	138,790	97,906	123,046	116,139
VIII	38,562	47,012	54,211	75,120	54,560	41,711	24,125
IX	41,574	27,733	27,160	24,912	23,665	19,570	23,581
Total	399,698	363,033	272,496	283,357	241,335	241,831	216,361

Sub-area	2005[1]
II + Vb	176
IV + IIIa	40,564
VI	22,055
VII	107,475
VIII	41,495
IX	23,111
Total	234,876

[1]Preliminary.

Table 3.1.2 **HORSE MACKEREL general. Quarterly catches (1000 t) by Division and Subdivision in 2005.**

Division	1Q	2Q	3Q	4Q	TOTAL
IIa+Vb	+	0	0.1	0	0.2
IIIa	0	0.1	0.1	0.2	0.4
IVa	1.2	0.1	0.2	24.8	26.3
IVbc	4.8	1.2	1.5	6.4	13.9
VIId	4.5	0.3	0.2	10.5	15.6
VIa,b	5.7	+	1.4	15.0	22.1
VIIa–c,e–k	43.1	10.2	1.7	37.1	91.9
VIIIa,b,d,e	12.3	3.4	0.5	10.3	26.5
VIIIc	2.5	3.7	5.7	2.8	14.8
IXa	4.2	6.6	7.3	5.0	23.1
Sum	78.3	25.8	18.7	112.0	234.8

Table 3.3.1 HORSE MACKEREL general. Landings and discards (t) by year and Division, for the North Sea, Western, and Southern horse mackerel stocks.
(Data submitted by Working Group members.)

Year	IIIa	IVa	IVb,c	Discards	VIId	**North Sea Stock**	IIa	IIIa	IVa	VIa,b	VIIa-c,e-k	VIIIa,b,d,e	VIIIc	Disc	**Western Stock**	**Southern Stock** (IXa)	All stocks
1982	2,788[1]		-		1,247	4,035	-		-	6,283	32,231	3,073	19,610	-	61,197	39,726	104,958
1983	4,420[1]		-		3,600	8,020	412		-	24,881	36,926	2,643	25,580	-	90,442	48,733	147,195
1984	25,893[1]		-		3,585	29,478	23		94	31,716	38,782	2,510	23,119	500	96,744	23,178	149,400
1985	-		22,897		2,715	26,750	79		203	33,025	35,296	4,448	23,292	7,500	103,843	20,237	150,830
1986	-		19,496		4,756	24,648	214		776	20,343	72,761	3,071	40,334	8,500	145,999	31,159	201,806
1987	1,138		9,477		1,721	11,634	3,311		11,185	35,197	99,942	7,605	30,098	-	187,338	24,540	223,512
1988	396		18,290		3,120	23,671	6,818		42,174	45,842	81,978	7,548	26,629	3,740	214,729	29,763	268,163
1989	436		25,830		6,522	33,265	4,809		85,304[2]	34,870	131,218	11,516	27,170	1,150	296,037	29,231	358,533
1990	2,261		17,437		1,325	18,762	11,414	14,878	112,753[2]	20,794	182,580	21,120	25,182	9,930	398,645	24,023	441,430
1991	913		11,400		600	12,000	4,487	2,725	63,869[2]	34,415	196,926	25,693	23,733	5,440	357,288	21,778	391,066
1992			13,955	400	688	15,043	13,457	2,374	101,752	40,881	180,937	29,329	24,243	1,820	394,793	26,713	436,548
1993			3,895	930	8,792	13,617	3,168	850	134,908	53,782	204,318	27,519	25,483	8,600	458,628	31,945	504,190
1994			2,496	630	2,503	5,689	759	2,492	106,911	69,546	194,188	11,044	24,147	3,935	413,022	28,442	447,153
1995	112		7,948	30	8,666	16,756	13,133	128	90,527	83,486	320,102	1,175	27,534	2,046	538,131	25,147	580,034
1996	1,657		7,558	212	9,416	18,843	3,366		18,356	81,259	252,823	23,978	24,290	16,870	420,942	20,400	460,185
1997			14,078	10	5,452	19,540	2,617	2,037	65,073[3]	40,145	318,101	11,677	29,129	2,921	471,700	27,642	518,882
1998	3,693		10,530	83	16,194	30,500	2,540[4]		17,011	35,043	232,451	15,662	22,906	830	326,443	41,574	398,523
1999			9,335		27,889	37,224	2,557[5]	2,095	47,316	40,381	158,715	22,824	24,188		298,076	27,733	363,033
2000			25,954		22,471	48,425	1,169[6]	1,105	4,524	20,657	115,245	32,227	21,984		196,911	27,160	272,496
2001	85	69	8,157		38,114	46,356	60	72	11,456	24,636	100,676	54,293	20,828		212,090	24,911	283,357
2002			12,636	20	10,723	23,379	1,324	179	36,855	14,190	86,878	32,450	22,110	305	194,292	23,665	241,336
2003	48	623	10,309		21,098	32,078	24	1,974	21,272	23,254	101,948	21,732	19,979		190,183	19,570	241,831
2004	351		18,348		16,455	35,154	47		11,841	21,929	98,984	8,353	15,772	701	157,627	23,581	216,361
2005	357		13,892	62	15,460	29,711	176		26,315	22,054	91,431	26,483	14,775	760	181,994	23,111	234,876

[1]Divisions IIIa and IVb,c combined.
[2]Norwegian catches in IVb included in Western horse mackerel.
[3] Includes Norwegian catches in IVb (1,426 t).
[4]Includes 1,937 t from Vb.
[5]Includes 132 t from Vb.
[6]Includes 250 t from Vb.

Table 3.5.1 Catches (t) of *Trachurus mediterraneus* in Divisions VIIIab, VIIIc and IXa and Sub-area VII in the period 1989-2005 and *Trachurus picturatus* in División IXa, Subarea X and in CECAF Division 34.1.1 in the period 1986-2005.

	Divisions	Sub-Divisions	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
T. mediterraneus	**VII**		**-**	**-**	**-**	0	0	0	0	0	0	0	0	0	0	0	59	1	1	0	0	1
	VIIIab		**-**	**-**	**-**	23	298	2122	1123	649	1573	2271	1175	557	740	1100	988	525	525	340	53	155
	VIIIc	VIIIc East	-	-	-	3903	2943	5020	4804	5576	3344	4585	3443	3264	3755	1592	808	1293	1198	1699	841	1005
		VIIIc west	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Total	-	-	-	3903	2943	5020	4804	5576	3344	4585	3443	3264	3755	1592	808	1293	1198	1699	841	1005
	IXa	IXa North	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		IXa C, N & S	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Total	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL		**-**	**-**	**-**	**3926**	**3241**	**7142**	**5927**	**6225**	**4917**	**6856**	**4618**	**3821**	**4495**	**2692**	**1854**	**1820**	**1724**	**2039**	**894**	**1162**
T. picturatus	**IXa**		367	181	2370	2394	2012	1700	1035	1028	1045	728	1009	834	526	320	464	420	663	773	508	409
	X Azorean Area		3331	3020	3079	2866	2510	1274	1255	1732	1778	1822	1715	1920	1473	690	563	1089	5000	1509	1244	1089
	34.1.1 Madeira's area		2006	1533	1687	1564	1863	1161	792	530	297	206	393	762	657	344	646	385	358	572	653	409
	TOTAL		**5704**	**4734**	**7136**	**6824**	**6385**	**4135**	**3082**	**3290**	**3120**	**2756**	**3117**	**3516**	**2657**	**1354**	**1672**	**1894**	**6021**	**2854**	**2405**	**1906**

(-) Not available

Table 3.6.1 Horse mackerel general. Length distributions (%) catches by fleet and country in 2005. (0:0= <0.05%)

	Neth	Germany						Ireland	Denmark	Norway	Spain					Portugal
	P.trawl	Trawl						Trawl	Trawl	P.seine	P.seine	Dem.trawl	Hook	Gill net	?	All
cm	All	Div VIa	VIId	Div VIIe	Div VIIh	Div VIIj	Div VIIIa	All	All	IVa	All	All	All	All	All	IXa
5																
6																
7											0.0					
8											0.0					
9											0.0					
10											0.3					0.1
11											1.6					1.4
12											5.1					11.0
13											5.4					14.5
14											7.8	0.1				7.1
15	0.0										11.8	1.3				2.9
16	0.1							0.0			9.8	1.0				2.1
17	0.2			14.5				0.0			5.3	0.2				2.8
18	0.4		0.0	0.4				0.0			4.6	0.2				2.7
19	0.7		0.9	0.4		0.1		3.2			5.8	0.1		0.3		1.9
20	2.0		1.9	0.9		0.1		9.2			5.6	0.1		0.6		0.7
21	9.3		5.4	1.7	0.1	2.0	0.2	6.1			2.7	0.2		0.6		0.8
22	20.3		22.1	9.7	2.2	14.5	2.7	12.1			2.5	0.3		1.4	0.0	0.8
23	18.7		23.6	24.1	26.7	33.2	27.8	15.9			3.2	0.3		2.1	0.0	1.4
24	14.1	1.8	15.9	21.1	40.6	24.2	44.0	14.1			3.5	0.4	0.7	2.4	0.0	2.8
25	7.7	5.2	11.7	12.9	22.2	10.7	20.4	10.3			4.8	3.0	1.3	8.3	0.3	4.0
26	6.9	7.7	8.7	8.9	5.5	5.8	4.0	8.7			5.0	5.4	3.8	10.1	0.4	5.5
27	6.0	6.1	4.5	4.5	2.2	4.1	0.7	6.3		0.2	4.8	7.7	8.5	9.3	2.3	6.8
28	5.0	5.5	2.0	0.7	0.4	2.8	0.3	4.2		0.5	3.6	8.8	9.3	7.3	8.1	8.0
29	3.5	13.0	1.4	0.2	0.1	1.4		2.4	0.2	1.6	2.6	10.3	9.1	8.2	10.9	7.4
30	1.8	14.1	0.8	0.1	0.1	0.7		1.7	0.2	6.4	1.7	9.8	11.8	10.1	19.6	5.9
31	1.4	11.1	0.4			0.1		1.0	0.4	13.1	1.1	15.1	17.3	6.3	20.3	3.5
32	0.6	6.8	0.1	0.0		0.2		1.0	2.7	15.8	0.7	12.1	14.4	7.5	13.7	2.0
33	0.4	7.3	0.1			0.1		1.0	9.5	14.7	0.4	8.4	9.2	7.0	10.0	1.3
34	0.4	7.3	0.2			0.0		1.1	15.1	12.9	0.2	5.8	5.4	4.5	6.3	0.9
35	0.2	5.5	0.0			0.0		0.7	20.3	11.0	0.1	3.3	2.9	2.7	2.7	0.6
36	0.2	5.0	0.1			0.0		0.5	15.4	9.6	0.0	2.3	2.0	1.2	4.4	0.5
37	0.2	2.7						0.2	11.2	6.2	0.0	1.3	2.0	1.7	0.7	0.3
38	0.0	0.5	0.0					0.2	11.6	4.1	0.0	1.0	0.9	2.6	0.1	0.1
39	0.0	0.5							5.3	2.6	0.0	0.9	0.8	2.1	0.1	0.1
40								0.1	4.8	0.7		0.3	0.5	1.7		0.0
41									2.1	0.4		0.2		1.1		0.0
42+									1.4	0.1		0.1		0.6		0.0

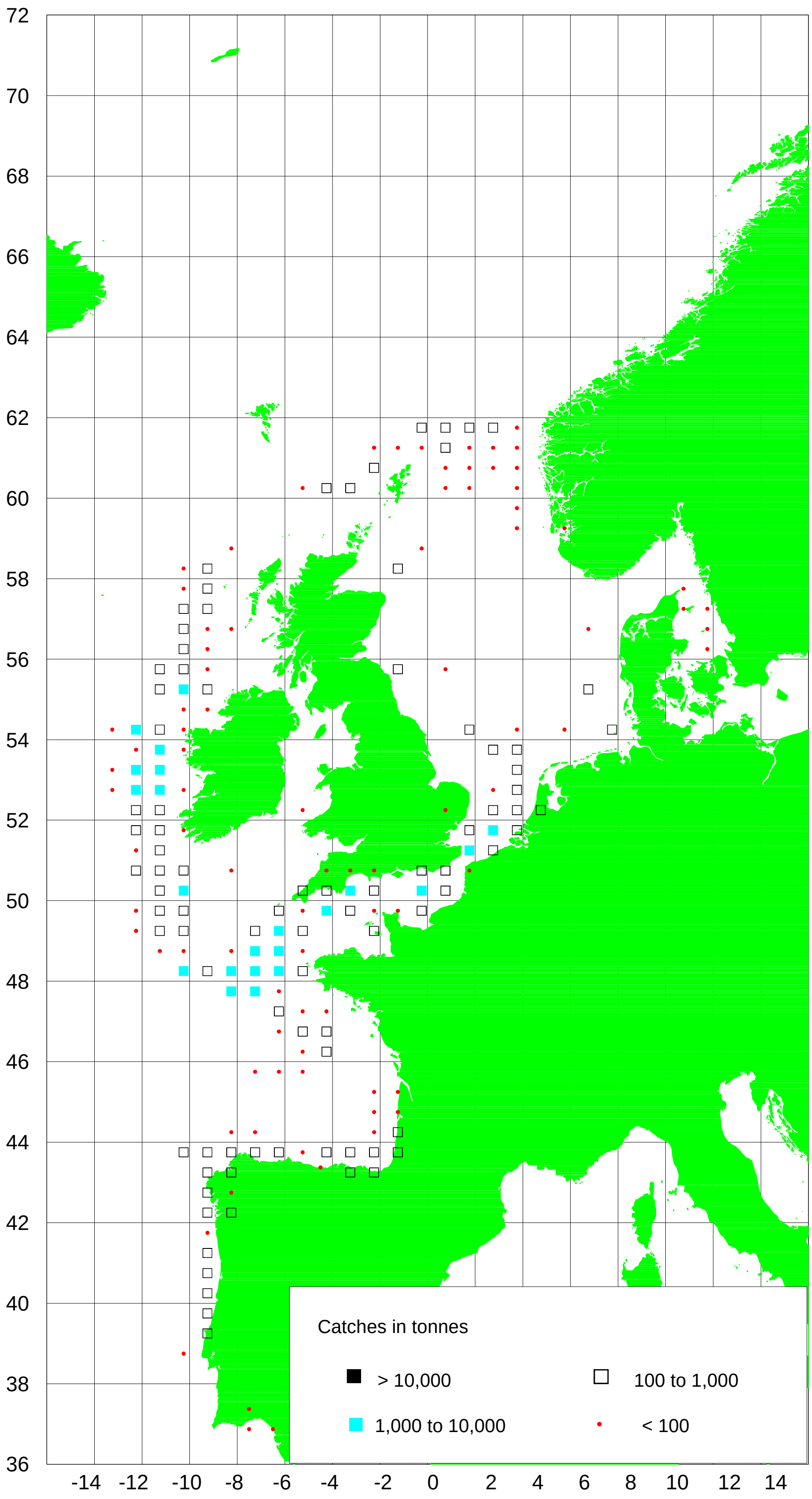


Figure 3.1.1a Horse Mackerel general. Commercial catches in quarter 1 2005.

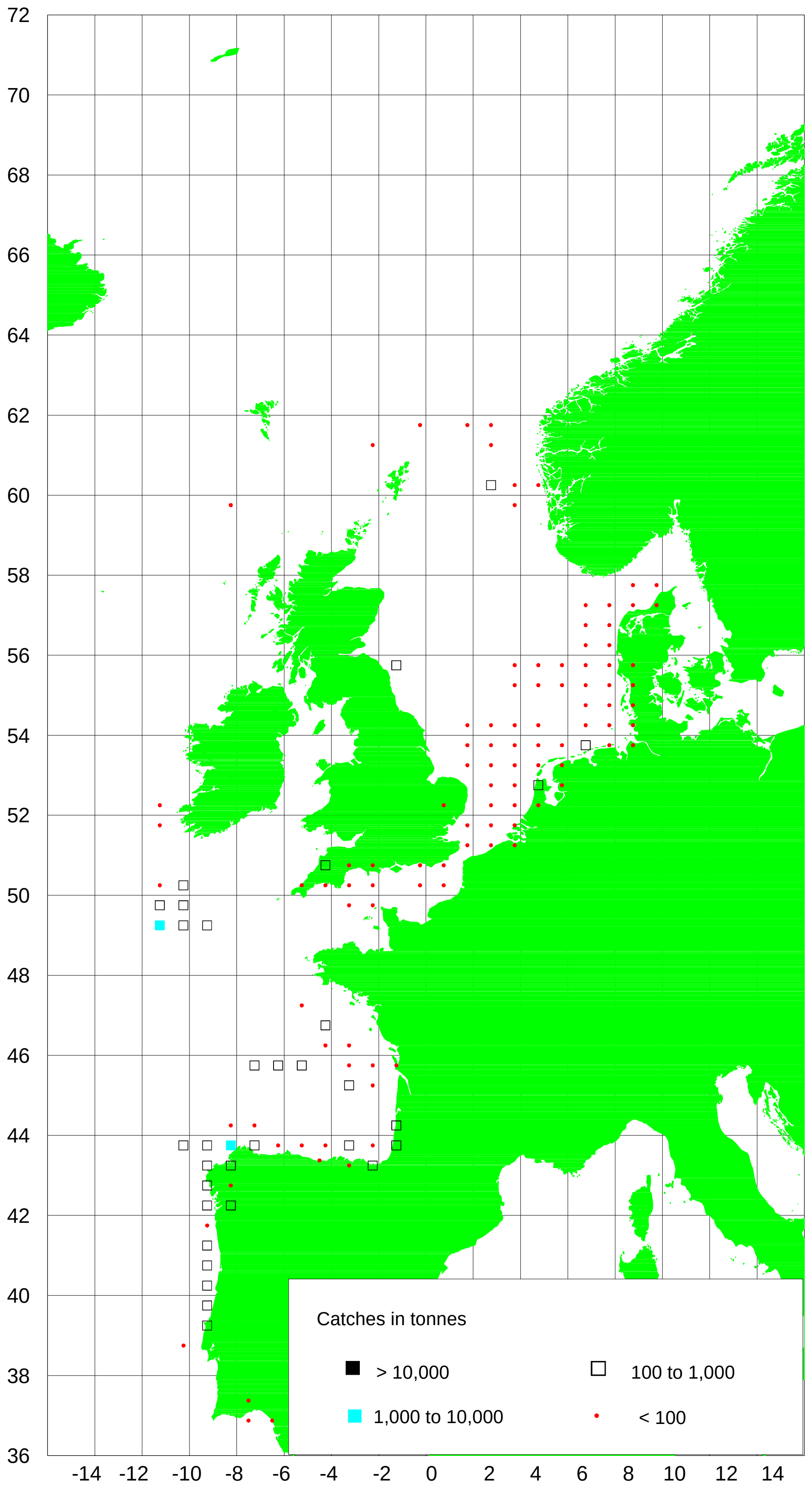


Figure 3.1.1b Horse Mackerel general.Commercial catches in quarter 2 2005.

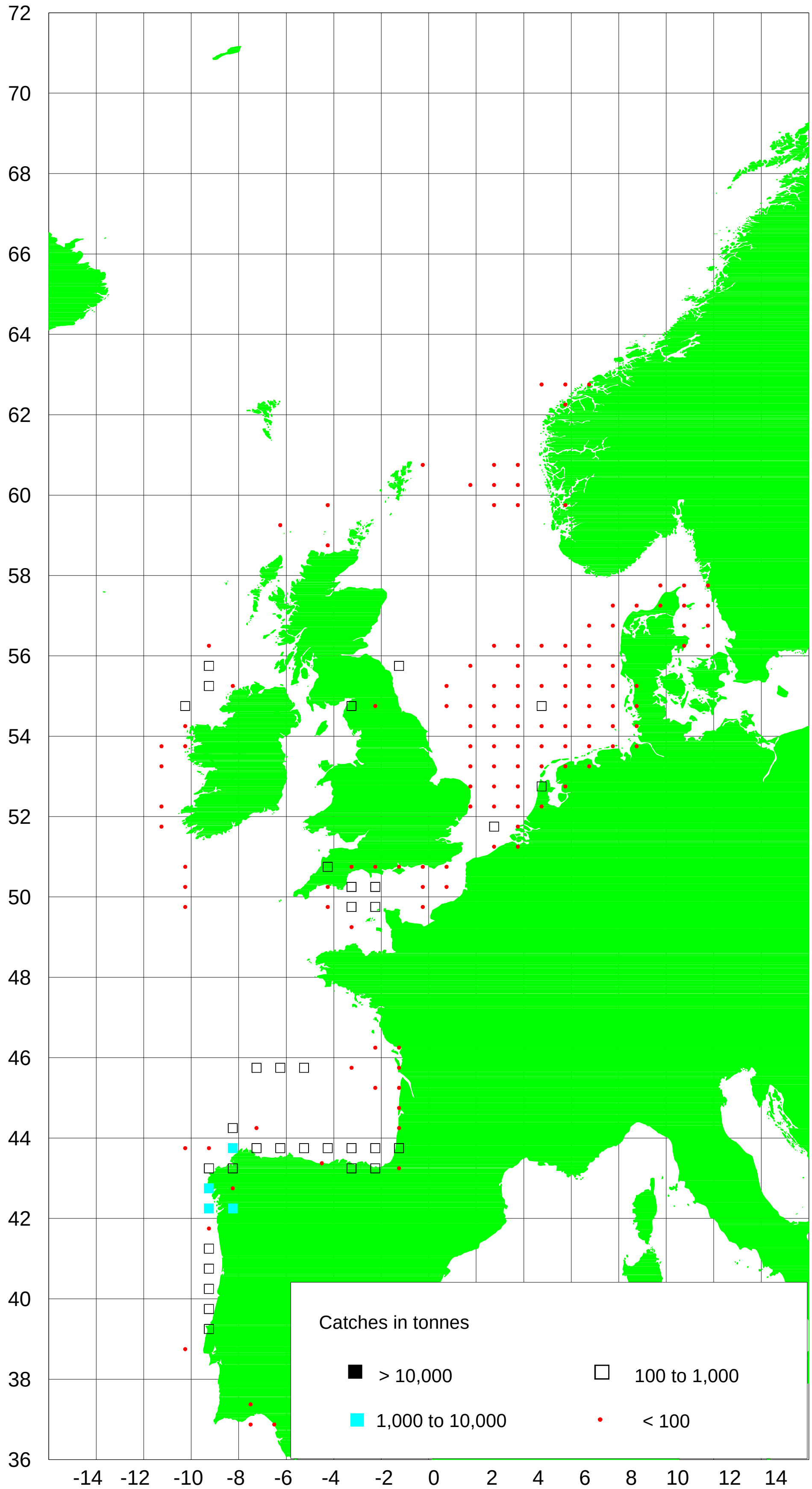


Figure 3.1.1c Horse Mackerel general. Commercial catches in quarter 3 2005.

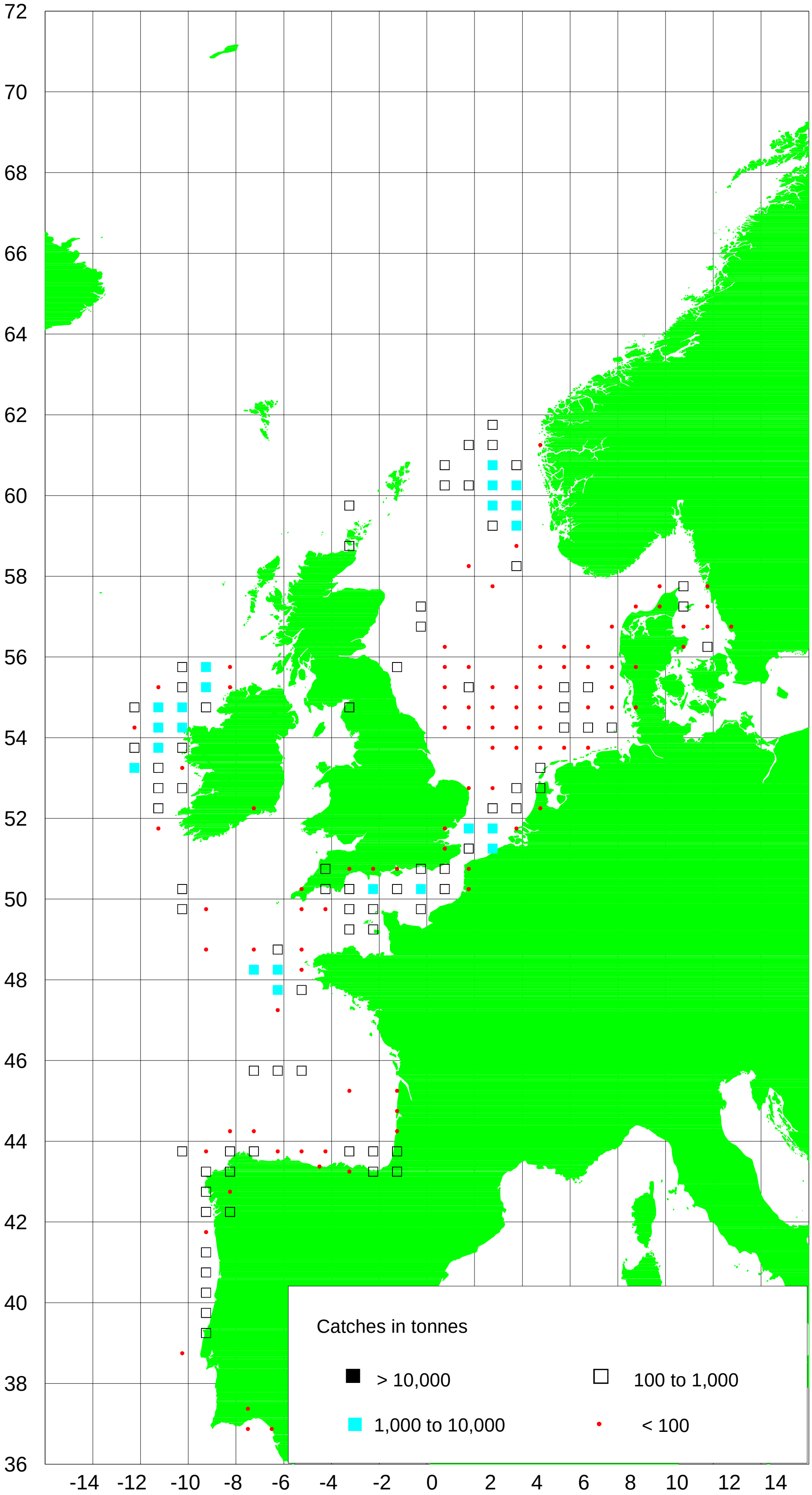


Figure 3.1.1d Horse Mackerel general. Commercial catches in quarter 4 2005.

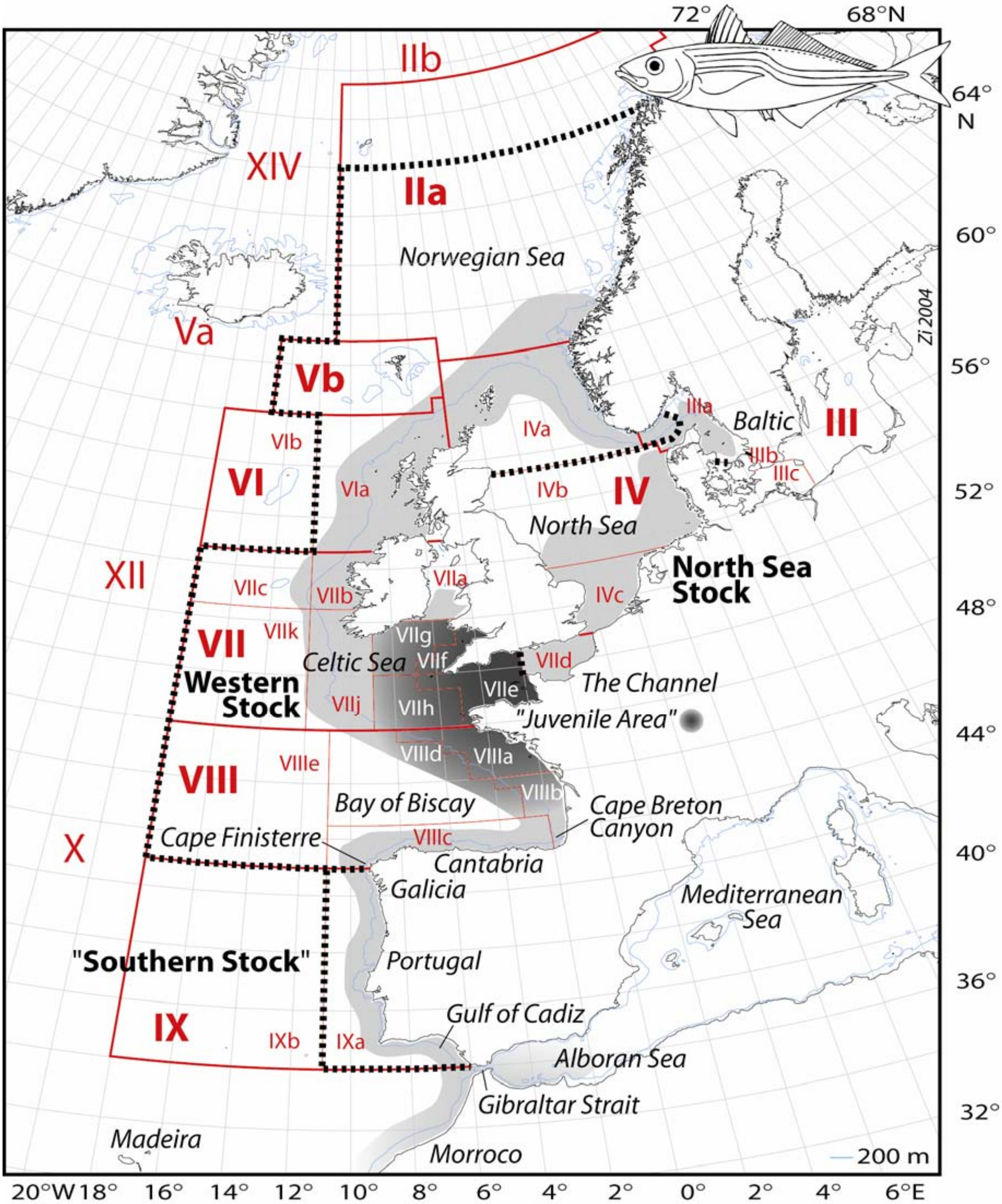


Fig 3.2.1: Distribution of Horse Mackerel in the Northeast-Atlantic: Stock definitions as used by the 2004 WG MHSA. Note that the "Juvenile Area" is currently only defined for the Western Stock distribution area – juveniles do also occur in other areas (like in Div. VIId). Map source: GEBCO, polar projection, 200 m depth contour drawn.

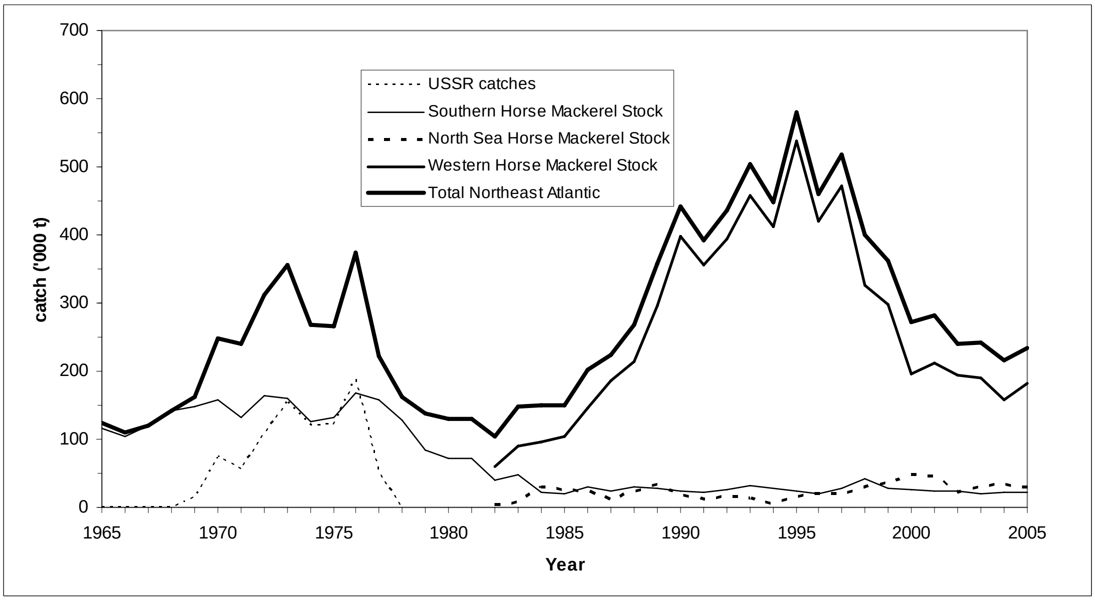


Figure 3.3.1 Horse mackerel general. Total catches in the northeast Atlantic during the period 1965 - 2005. The catches taken by the USSR and catches taken from the southern, western and North Sea horse mackerel stocks are shown in relation to the total catches in the northeast Atlantic. Caches from Div. VIIIc are transferred from southern stock to western stock from 1982 onwards.

4 North Sea Horse Mackerel (Divisions IIIa (Excluding Western Skagerrak), IVbc and VIId

4.1 ICES advice Applicable to 2005

The ICES advice has been the same since 2002. Also for 2004 and 2005 ICES *recommended that catches should not be more than the 1982-1997 average of 18 000 t, in order to avoid an expansion of the fishery until there is more information about the structure of horse mackerel stocks, and sufficient information to facilitate an adequate assessment.* The TAC for this stock should apply to all areas in which North Sea horse mackerel are fished, i.e., Divisions IIIa, (eastern part), IVbc, and VIId.

EU has since 1987 set three TACs for horse mackerel in different EU waters. Two of these TACs cover part of the North Sea stocks and thereby do not correspond to the distribution areas of neither the North Sea stock nor the western and southern stocks (see section 5.1).

4.2 The Fishery in 2005 on the North Sea stock

Catches taken in Divisions IVb, c and VIId are regarded as belonging to the North Sea horse mackerel and in some years also catches from Division IIIa - except the western part of Skagerrak. Table 3.3.1 shows the catches of this stock from 1982–2005. The catches was relatively low during the period 1982-1997 with an average at 18,000 tons. The catch increased from 1998 until record high in 2000 (48,400 tons). In 2004 the catch was 35,154 tonnes, which is almost 3,000 tons more than in 2003. In 2005 the catch was reduced to 29,231tons.

In previous years most of the catches from the North Sea stock were taken as a by-catch in the small mesh industrial fisheries in the fourth quarter carried out mainly in Divisions IVb and VIId, but in recent years a large part of the catch has been taken in a directed horse mackerel fishery for human consumption.

4.3 Fishery-independent Information

4.3.1 Egg Surveys

No egg surveys for horse mackerel have been carried out in the North Sea since 1991. Such surveys were carried out during the period 1988-1991. SSB estimates are available historically. However, they were calculated assuming horse mackerel to be a determinate spawner. New information indicates that horse mackerel is probably an indeterminate spawner. Therefore it is not possible currently to provide a realistic estimate of the spawning biomass. The mackerel egg surveys in the North Sea do not cover the spawning area of horse mackerel.

4.4 Biological Data

4.4.1 Catch in Numbers at Age

Catch in numbers at age by quarter and annual values for 2005 were calculated according to Danish samples collected in Division IVb, Dutch samples from Division IVb,c and Dutch and German samples collected in Divison VIId. Annual catch numbers at age are given in Table 4.4.1.1. Table 4.4.1.2 shows catch number by quarter and by area in 2005. For the earlier years age compositions were presented based on samples taken from smaller Dutch commercial catches and research vessel catches. These are available for the period 1987–1995, and covered only a small proportion of the total catch, but give a rough indication of the age composition of the stock (Figure 4.4.1.1). Therefore age estimations prior 1995 are not considered to be representative for the entire fishery.

Since 1996 the Dutch samples have been the main basis for calculating catch in numbers. In later years also Germany and now Denmark have provided some aged samples. In 2004 and 2005 the coverage was 38 % and 48% respectively and as shown in the text table below the lowest on record (see section 1.3). If a dependable analytical assessment is to be done in the future the sampling needs to be improved considerably

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
% of landings covered	62	55	57	66	77	71	50	60	67	38	48
Samples from	RV	RV+FV	FV	FV	FV	FV	FV	FV	FV	FV	FV

(RV = Research Vessel, FV = Commercial fishing Vessels)

4.4.2 Mean weight at age and mean length at age

Table 4.4.2.1 shows weight and length by quarter and by area in 2005. The annual average values are shown in Table 4.4.1.2.

4.4.3 Maturity at age

No data have been made available for this Working Group.

4.4.4 Natural mortality

There is no specific information available about natural mortality of this stock.

4.5 Data exploration

4.5.1 Commercial catch data

Estimates of the age composition of the catch are available since 1995. However, the age composition for 1995 and 1996 was partly based on research vessel samples, which may not be representative for the commercial fishery. The catch-at-age pattern can be seen in Figure 4.5.1.1. The catch-at-age pattern appears to have changed during the period from 1995 to 2005, with a large reduction in mean age, mean length and mean weight. More younger age groups appear in the catch in recent times, especially in 2000 and 2001. This coincides with the disappearance of the large 1982-year class (see also Figure 4.4.1.1.). The change in pattern around the year 2000 could reflect a change in the fishery, a change in abundance, or a change in sampling. From 1997 onwards sampling did not change, so a change in the fishery or a change in abundance seem more likely. In recent years, a fishery for human consumption fishery has developed. This fishery targets at small size horse mackerel for the Japanese market (Eltink, pers. com.). However, a change in abundance cannot be excluded. The overall impression from Figure 4.5.1.1. is rather confusing, as e.g. year class 1998 appearing as a large one in the years 2000 and 2001 disappears in 2002. In general, it is not possible to trace the cohorts in this balloon diagram, which may be caused by age reading problems; it has been noted that 2-year olds may have been interpreted as 1-year olds, especially in the case of slow growing fish of an abundant year class (Eltink, pers. com.; see also section 1.3.4). As the number of samples is small, they may not be representative for the entire stock.

Figure 4.5.1.2. displays the log catch ratios by year class. The picture is rather chaotic: there is no uniform slope (reflecting total mortality Z), neither over the ages nor over the year classes. No clear age at full selection can be deduced from this figure. Selection at age seems to vary

by year, and the more recent year classes seem to have higher catches than the older year classes (indicating either increased fishing or increased year class strength); however, this impression may also be an artefact of the low sampling level. The problem with age reading (see section 1.3.4) in 2001 may also confuse the picture. In general the slopes are rather flat; however, this does not necessarily indicate low total mortality (Z), because such a pattern could also arise from increasing selection at age. Because of the lack of any pattern in selection (over time or age), any analytical assessment model will suffer from either being too simplistic in its assumptions about selection or from over-parameterisation (e.g. in case selection would be estimated for each year and age).

Figure 4.5.1.3. displays the smoothed (running average over 3 years) log catch ratios. From this, total mortality (Z) seems to be low at the youngest as well as the oldest ages; at intermediate ages Z is around 0.5. The pattern over time is rather strange; in early years Z is a bit lower, except for ages 9-10 and 11-12. Total mortality is very low (negative!) for ages 2-3 and 12-13. Total mortality becomes more equal between the ages over time.

The group has decided that the catch data are not suitable for the use in an analytical assessment.

4.5.2 IBTS survey data

From an initial exploration of the length frequency distribution of the quarter 3 mean catch rates by year, using the North Sea IBTS data from 1995 to 2005, it was concluded that the 0-group is clearly separated from the older fish, with the boundary at 14 cm. Therefore we decided to derive three indices from these data: (a) for fish <14 cm, (b) for fish ≥14 cm and <23 cm, and (c) for fish ≥23 cm. At 23 cm half of the fish are mature. These three groups roughly correspond to (a) 0-group fish, (b) 1-, 2-, and possibly 3-year old juveniles, and (c) adults respectively. The mean catch rates in quarter 3 are plotted by ICES rectangle in the North Sea by year for each of these three groups separately (Figure 4.5.2.1). The rectangle shows the sub-areas of IVb and IVc used in the last years report.

A subset of ICES rectangles was selected in which hauls were taken in each of the years 1995-2005 and in which each of the three groups were reasonably abundant. These rectangles are represented as a shaded area in Figure 4.5.2.1. Indices were based on this subset of rectangles under the expectation that they might be representative for the development of the stock (Figure 4.5.2.2.a). The peak of 0-group fish in 2001 comes back as a peak of older juveniles in 2002; however, the peak of 0-group fish in 1997 is not seen back in 1998 as older juveniles but appears to come back from 1999 onwards as adults. It is thought that juveniles often stay in area VIId and do not come back into the North Sea before they are adult (Eltink, pers. com.). Figure 4.5.2.2.a. also shows that abundance of adult fish has decreased considerably over time, and there is only a slight trace in 2004 of the 2001 year class coming in. Although the commercial catch data seemed to indicate a large year class born in 1998 (seen in the catches in 2000 and 2001, see Figure 4.5.1.1.), there is no indication of this year class being large in the IBTS data. Figure 4.5.2.2.b shows ln(Index(y,a)/Index(y-1,a-1)), which should be index for the total mortality. As can be seen, no consistent pattern can be detected, for either ln(Index(y,2)/Index(y-1,1)) or ln(Index(y,3)/Index(y-1,2)) .

Figure 4.5.2.3. displays the length frequency distributions by year from the same subset of ICES rectangles (the shaded area in Figure 4.5.2.1). The 0-group fish are clearly separated from the older fish. Again the strong year classes of 1997 and 2001 can be seen, and again of those year classes only the 2001 year class is seen back a year later as juveniles. In some cases it seems possible to separate 1-year olds from older fish.

The IBTS data show no consistent signal that can be traced through the age groups (in this case size groups).

4.6 Future Prospects for the Assessment of North Sea Horse Mackerel

Over recent years various approaches to assess the stock of North Sea horse mackerel have not met with success. There are a range of reasons for this failure but primarily a lack of a coherent signal in the rate of decline of cohorts (in catch and survey) is the overriding problem.

The commercial catch-at-age data are not suitable for an analytical assessment.

The IBTS data proved useful for tracking developments in the stock. The length-based IBTS survey data should be explored with respect to their suitability for a length-based assessment; however, as no clear signal could be traced in these data (Figure 4.5.2.2.) the prospects are not that hopeful. Furthermore, age-length keys or growth parameters should be made available for the length based assessment. In 2004 the WG used an ICA type of stock assessment, which could be modified to work on length distributions, if the age/length key or growth parameters become available. The analysis might be extended to account for migration between IVc and VIId. In that case it is needed that survey data become available to the Working Group that give information on the migration from sub-area VIId.

The catches of the North Sea stock are split from the western stock dependent on time and location of the catch by the working group (section 3.3). The stock is thought to be separate from the western stock (see the HOMSIR project) but the catches can be mixed with those of the larger western horse mackerel stock. In addition the management and EU quota areas overlap. Other than the HOMSIR project, there is little extra information to justify the allocation to each stock, and there is no science to support the temporal stability of the separation. Additionally there are still problems associated with the ageing of the horse mackerel which would also smooth the cohort signals.

There are also no surveys that target horse mackerel. The IBTS is designed to sample gadoids and clupeiods, and horse mackerel that are caught in the IBTS are not aged. The egg survey of North Sea mackerel is of no utility because the spatial distribution of the spawning of North Sea mackerel is not the same as horse mackerel. The egg survey that used to occur stopped in the early 1990s. There are no horse mackerel acoustic surveys of the North Sea, and it would take a number of years of pilot studies to determine whether an acoustic survey was possible.

Some of these problems can be solved; such as the continued effort to improve the precision of the estimation of age. However, the allocation of catches to appropriate stock needs much more attention, and probably cannot be hindcaste in a robust manner. The lack of any suitable survey is also a problem which is unlikely to be solved until someone decides that the North Sea horse mackerel stock deserves the resources to execute a survey (of what ever type). Perhaps a more radical approach is required, and as methods are developed for turbot, flounder, mullet and other poorly sampled species, horse mackerel (in the North Sea) should be considered in the same context and perhaps moved into WGNEW.

4.7 Reference Points for Management Purposes

At present there is not sufficient information to estimate appropriate reference points.

4.8 Harvest Control Rules

No harvest control rules were considered since no assessment was carried out.

4.9 Management Measures and Considerations

No forecast for the North Sea stock has been made for 2005.

The data were insufficient to define a management plan for this stock.

The points listed below should be taken into account when considering management options for the North Sea horse mackerel:

1) The stock units are incompatible with the management units. EU has since 1987 set a TAC for EU waters in Division IIa and Sub-area IV. However, this TAC includes Divisions IIa and IVa and does not include Division VIId, compared to the areas where the North Sea horse mackerel is distributed in.

2) The current management area TAC does not constrain catches (Division VIId catches are taken from the western horse mackerel TAC).

3) Increase in catches during the last decade. Catches have remained high in last decade. The major part of the increased catches are taken in Division VIId in quarters 1 and 4.

4) Recent catches are above the advised TACs of 18,000t. The average annual catch in the period 1995-2005 was 30 000 tons.

5) The horse mackerel fishery creates by-catches of mackerel.

6) Management should take into account that the knowledge about this stock is limited, and consequently the dynamics (including growth, migrations and mix with the western stock) is not well understood. The stock is long-lived, so the F at MSY is probably low.

Table 4.4.1.1 North Sea horse mackerel stock. Catch in numbers (millions) at age, weight (kg) at age and length (cm) at age 1995-2005

N (millions) Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	1.76	4.58	12.56	2.30	12.42	70.23	12.81	60.42	13.81	15.65	7.82
2	3.12	13.78	27.24	22.13	31.45	77.98	36.36	16.82	56.15	17.54	52.39
3	7.19	11.04	14.07	36.69	23.13	28.41	174.34	19.27	23.44	34.38	29.82
4	10.32	11.87	14.93	38.82	17.59	21.42	87.81	11.90	33.21	14.51	27.80
5	12.08	9.64	14.58	20.79	23.12	31.27	18.51	5.61	26.93	27.77	12.58
6	13.16	12.49	12.38	12.10	26.19	19.64	11.49	5.83	10.59	20.17	16.66
7	11.43	7.96	10.12	13.99	20.64	19.47	18.25	5.54	6.33	10.58	5.19
8	12.64	6.60	8.64	10.79	21.75	9.00	14.70	10.48	9.56	3.82	2.86
9	7.25	1.48	2.45	8.26	12.91	11.50	10.22	6.33	10.90	5.37	2.43
10	5.87	5.31	0.75	4.01	8.21	8.96	9.98	6.75	1.51	10.95	3.80
11	0.01	0.29	0.34	2.72	2.14	6.98	9.58	5.12	3.43	6.22	5.76
12	8.84	1.28	0.25	0.71	0.43	3.07	5.35	3.02	3.29	4.47	2.31
13	0.20	8.92	0.00	1.81	1.40	1.61	3.73	2.17	2.25	6.16	4.13
14	4.37	8.01	1.38	0.31	3.78	0.00	1.95	1.29	3.40	2.25	2.50
15+	0.00	0.00	0.00	5.11	4.03	12.22	5.81	2.71	4.70	8.52	9.86

kg Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	0.076	0.107	0.063	0.063	0.063	0.075	0.055	0.066	0.073	0.076	0.079
2	0.126	0.123	0.102	0.102	0.102	0.101	0.072	0.095	0.105	0.104	0.077
3	0.125	0.143	0.126	0.126	0.126	0.136	0.071	0.129	0.123	0.120	0.103
4	0.133	0.156	0.142	0.142	0.142	0.152	0.082	0.154	0.137	0.147	0.132
5	0.146	0.177	0.160	0.160	0.160	0.166	0.120	0.172	0.166	0.174	0.158
6	0.164	0.187	0.175	0.175	0.175	0.194	0.183	0.195	0.181	0.198	0.196
7	0.161	0.203	0.199	0.199	0.199	0.198	0.197	0.216	0.195	0.225	0.251
8	0.178	0.195	0.231	0.231	0.231	0.213	0.201	0.227	0.212	0.229	0.270
9	0.165	0.218	0.250	0.250	0.250	0.247	0.235	0.228	0.238	0.256	0.280
10	0.173	0.241	0.259	0.259	0.259	0.280	0.246	0.251	0.259	0.291	0.291
11	0.317	0.307	0.300	0.300	0.300	0.279	0.260	0.302	0.245	0.301	0.344
12	0.233	0.211	0.329	0.329	0.329	0.342	0.286	0.292	0.295	0.300	0.361
13	0.241	0.258	0.367	0.367	0.367	0.318	0.287	0.318	0.356	0.302	0.332
14	0.348	0.277	0.299	0.299	0.299	0.325	0.295	0.319	0.319	0.338	0.376
15+	0.348	0.277	0.360	0.360	0.360	0.332	0.336	0.390	0.380	0.401	0.367

cm Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	19.2	19.2	19.2	19.2	19.2	19.0	18.7	17.1	20.2	19.8	20.5
2	22.0	22.0	22.0	22.0	22.0	21.5	20.4	21.4	22.4	22.2	21.5
3	23.5	23.5	23.5	23.5	23.5	23.9	20.6	22.9	23.8	23.6	23.0
4	24.8	24.8	24.8	24.8	24.8	24.9	21.3	24.9	24.6	25.2	24.7
5	25.5	25.5	25.5	25.5	25.5	26.0	25.0	26.2	26.2	26.6	25.5
6	26.4	26.4	26.4	26.4	26.4	27.8	27.4	26.6	27.3	27.5	27.8
7	27.2	27.2	27.2	27.2	27.2	28.3	28.0	27.4	28.2	28.9	30.4
8	29.2	29.2	29.2	29.2	29.2	28.6	28.4	28.2	29.0	29.2	31.2
9	29.5	29.5	29.5	29.5	29.5	30.0	29.7	29.2	29.9	30.5	31.8
10	29.5	29.5	29.5	29.5	29.5	31.3	30.2	30.8	30.8	31.5	32.3
11	30.6	30.6	30.6	30.6	30.6	31.4	30.7	32.5	30.8	32.0	34.4
12	32.1	32.1	32.1	32.1	32.1	33.7	32.0	33.8	31.9	31.8	36.2
13	33.3	33.3	33.3	33.3	33.3	33.5	31.7	33.8	32.9	32.0	34.2
14	31.1	31.1	31.1	31.1	31.1	33.4	32.1	32.4	32.7	33.0	34.9
15+	32.5	32.5	32.5	32.5	32.5	33.4	33.4	34.4	34.6	34.8	35.4

Table 4.4.1.2 North Sea Horse Mackerel catch in numbers (1000), mean weight and length at age by quarter and area in 2005

1Q			1000					Kg					Cm		
Ages	IIIa	IVb	IVc	VIId	Total	IIIa	IVb	IVc	VIId	Total	IIIa	IVb	IVc	VIId	Total
0	0.0	0.0	0.0	0.0		0.000	0.000	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00
1	0.0	0.0	0.0	0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00
2	0.0	5652.0	0.0	1146.9	6798.9	0.000	0.020	0.000	0.073	0.029	0.00	20.00	0.00	20.61	20.10
3	0.0	2868.0	839.2	909.8	4617.0	0.000	0.056	0.112	0.113	0.077	0.00	21.90	22.75	23.55	22.38
4	0.0	230.0	4615.0	2632.2	7477.1	0.000	0.072	0.145	0.137	0.140	0.00	23.50	25.55	25.32	25.41
5	0.0	0.0	3356.4	1230.9	4587.3	0.000	0.000	0.154	0.143	0.151	0.00	0.00	25.94	25.74	25.89
6	0.0	0.0	5873.8	4542.3	10416.1	0.000	0.000	0.201	0.189	0.196	0.00	0.00	28.14	27.66	27.93
7	0.0	0.0	1468.4	1400.9	2869.3	0.000	0.000	0.217	0.233	0.225	0.00	0.00	29.21	29.41	29.31
8	0.0	0.0	629.4	1146.2	1775.7	0.000	0.000	0.234	0.227	0.229	0.00	0.00	29.83	29.65	29.71
9	0.0	0.0	839.2	551.8	1391.0	0.000	0.000	0.249	0.223	0.239	0.00	0.00	30.25	29.19	29.83
10	0.0	0.0	1048.8	1443.5	2492.2	0.000	0.000	0.277	0.279	0.278	0.00	0.00	31.10	31.47	31.31
11	0.0	0.0	419.6	1740.7	2160.3	0.000	0.000	0.313	0.323	0.321	0.00	0.00	32.50	32.94	32.86
12	0.0	0.0	209.8	254.9	464.7	0.000	0.000	0.317	0.341	0.330	0.00	0.00	33.50	34.50	34.05
13	0.0	0.0	629.4	806.7	1436.1	0.000	0.000	0.322	0.372	0.350	0.00	0.00	33.17	34.13	33.71
14	0.0	0.0	419.6	1104.3	1523.9	0.000	0.000	0.350	0.383	0.374	0.00	0.00	33.00	34.46	34.06
15+	0.0	0.0	629.4	1230.6	1860.0	0.000	0.000	0.371	0.387	0.382	0.00	0.00	33.83	34.67	34.39

2Q															
Ages	IIIa	IVb	IVc	VIId	Total	IIIa	IVb	IVc	VIId	Total	IIIa	IVb	IVc	VIId	Total
0	0.0	0.0	0.0	0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00
1	0.0	0.0	0.0	21.0	21.0	0.000	0.000	0.000	0.089	0.089	0.00	0.00	0.00	20.50	20.50
2	656.6	1585.6	7228.0	269.4	9739.6	0.020	0.020	0.020	0.080	0.022	20.00	20.00	20.00	21.01	20.03
3	333.2	804.6	3739.4	247.8	5125.0	0.056	0.056	0.075	0.113	0.073	21.90	21.90	22.19	23.47	22.18
4	26.7	64.5	688.2	423.2	1202.7	0.072	0.072	0.097	0.133	0.107	23.50	23.50	24.19	25.02	24.43
5	0.0	0.0	286.6	106.1	392.7	0.000	0.000	0.115	0.148	0.124	0.00	0.00	8.73	25.87	13.36
6	0.0	0.0	501.6	252.1	753.7	0.000	0.000	0.201	0.189	0.197	0.00	0.00	28.14	27.66	27.98
7	2.0	4.7	125.4	77.8	209.8	0.292	0.292	0.217	0.233	0.225	32.50	32.50	29.21	29.41	29.39
8	1.0	2.4	53.8	63.6	120.7	0.357	0.357	0.234	0.227	0.234	34.50	34.50	29.83	29.65	29.86
9	1.0	2.4	71.7	30.6	105.6	0.355	0.355	0.249	0.223	0.245	35.50	35.50	30.25	29.19	30.11
10	1.0	2.4	89.6	80.1	173.0	0.316	0.316	0.277	0.279	0.279	35.50	35.50	31.10	31.47	31.36
11	3.9	9.5	35.8	96.6	145.8	0.360	0.360	0.313	0.323	0.324	35.50	35.50	32.50	32.94	33.07
12	2.0	4.7	17.9	14.2	38.8	0.368	0.368	0.317	0.341	0.335	37.00	37.00	33.50	34.50	34.47
13	2.9	7.1	53.8	44.8	108.6	0.321	0.321	0.322	0.372	0.342	34.50	34.50	33.17	34.13	33.69
14	1.0	2.4	35.8	61.3	100.5	0.375	0.375	0.350	0.383	0.371	36.50	36.50	33.00	34.46	34.01
15+	8.8	21.3	53.8	68.3	152.1	0.358	0.358	0.371	0.387	0.376	35.61	35.61	33.83	34.67	34.56

3Q															
Ages	IIIa	IVb	IVc	VIId	Total	IIIa	IVb	IVc	VIId	Total	IIIa	IVb	IVc	VIId	Total
0	0.0	0.0	0.0	0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00
1	0.0	0.0	219.0	54.6	273.6	0.000	0.000	0.089	0.089	0.089	0.00	0.00	20.50	20.50	20.50
2	0.0	0.0	2146.4	534.8	2681.2	0.000	0.000	0.099	0.099	0.099	0.00	0.00	22.21	22.21	22.21
3	6.0	0.0	2058.8	513.0	2577.8	0.214	0.000	0.111	0.111	0.111	27.80	0.00	23.25	23.25	23.26
4	23.4	0.0	2891.1	720.3	3634.8	0.264	0.000	0.121	0.121	0.122	29.70	0.00	24.11	24.11	24.15
5	29.6	0.0	394.2	98.2	522.0	0.265	0.000	0.162	0.162	0.168	27.90	0.00	26.25	26.25	26.34
6	47.3	0.0	0.0	0.0	47.3	0.307	0.000	0.000	0.000	0.307	31.10	0.00	0.00	0.00	31.10
7	58.4	77.7	70.1	0.0	206.2	0.325	0.292	0.292	0.000	0.301	31.70	32.50	32.50	0.00	32.27
8	31.5	38.9	35.0	0.0	105.4	0.333	0.357	0.357	0.000	0.350	32.20	34.50	34.50	0.00	33.81
9	11.1	38.9	35.0	0.0	85.0	0.344	0.355	0.355	0.000	0.354	32.00	35.50	35.50	0.00	35.04
10	25.7	38.9	35.0	0.0	99.7	0.387	0.316	0.316	0.000	0.334	33.30	35.50	35.50	0.00	34.93
11	26.8	155.5	140.2	0.0	322.5	0.397	0.360	0.360	0.000	0.363	33.90	35.50	35.50	0.00	35.37
12	45.8	77.7	70.1	0.0	193.7	0.419	0.368	0.368	0.000	0.380	34.00	37.00	37.00	0.00	36.29
13	9.5	116.6	105.1	0.0	231.2	0.395	0.321	0.321	0.000	0.324	33.90	34.50	34.50	0.00	34.48
14	15.4	38.9	35.0	0.0	89.3	0.479	0.375	0.375	0.000	0.393	36.10	36.50	36.50	0.00	36.43
15+	43.5	349.8	315.4	0.0	708.8	0.466	0.358	0.358	0.000	0.365	36.00	35.61	35.61	0.00	35.63

4Q															
Ages	IIIa	IVb	IVc	VIId	Total	IIIa	IVb	IVc	VIId	Total	IIIa	IVb	IVc	VIId	Total
0	0.0	0.0	0.0	0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00
1	0.0	0.0	0.0	7527.6	7527.6	0.000	0.000	0.000	0.079	0.079	0.00	0.00	0.00	20.54	20.54
2	0.0	0.0	0.0	33166.1	33166.1	0.000	0.000	0.000	0.101	0.101	0.00	0.00	0.00	22.14	22.14
3	6.7	0.0	0.0	17492.8	17499.6	0.214	0.000	0.000	0.117	0.117	27.80	0.00	0.00	23.36	23.36
4	26.1	0.0	0.0	15459.0	15485.1	0.264	0.000	0.000	0.133	0.133	29.70	0.00	0.00	24.49	24.49
5	33.0	0.0	0.0	7041.5	7074.5	0.265	0.000	0.000	0.163	0.163	27.90	0.00	0.00	25.91	25.92
6	52.9	0.0	0.0	5386.3	5439.1	0.307	0.000	0.000	0.195	0.196	31.10	0.00	0.00	27.37	27.41
7	65.2	414.7	1121.5	304.1	1905.6	0.325	0.292	0.292	0.253	0.287	31.70	32.50	32.50	29.60	32.01
8	35.2	207.3	560.8	51.2	854.6	0.333	0.357	0.357	0.238	0.349	32.20	34.50	34.50	29.61	34.11
9	12.4	207.3	560.8	69.0	849.6	0.345	0.355	0.355	0.240	0.346	32.00	35.50	35.50	29.76	34.98
10	28.8	207.3	560.8	235.9	1032.8	0.387	0.316	0.316	0.324	0.320	33.30	35.50	35.50	32.00	34.64
11	30.0	829.3	2243.1	26.5	3128.9	0.397	0.360	0.360	0.267	0.360	33.90	35.50	35.50	30.71	35.44
12	51.2	414.7	1121.5	28.0	1615.4	0.419	0.368	0.368	0.255	0.368	34.00	37.00	37.00	30.12	36.79
13	10.6	622.0	1682.3	39.7	2354.6	0.395	0.321	0.321	0.363	0.322	33.90	34.50	34.50	34.18	34.49
14	17.2	207.3	560.8	1.8	787.2	0.479	0.375	0.375	0.428	0.377	36.10	36.50	36.50	35.50	36.49
15+	48.7	1866.0	5046.9	173.3	7134.9	0.466	0.358	0.358	0.516	0.363	36.00	35.61	35.61	37.06	35.65

1-4Q															
Ages	IIIa	IVb	IVc	VIId	Total	IIIa	IVb	IVc	VIId	Total	IIIa	IVb	IVc	VIId	Total
0	0.0	0.0	219.0	7603.1	0.0	0.000	0.000	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00
1	656.6	7237.6	9374.4	35117.2	7822.1	0.000	0.000	0.089	0.079	0.079	0.00	0.00	20.50	20.54	20.54
2	346.0	3672.6	6637.4	19163.4	52385.7	0.020	0.020	0.038	0.100	0.077	20.00	20.00	20.51	22.08	21.49
3	76.3	294.5	8194.2	19234.7	29819.3	0.062	0.056	0.091	0.116	0.103	22.12	21.90	22.59	23.36	23.00
4	62.6	0.0	4037.2	8476.7	27799.7	0.197	0.072	0.133	0.133	0.132	27.53	23.50	24.93	24.60	24.69
5	100.2	0.0	6375.4	10180.7	12576.5	0.265	0.000	0.152	0.160	0.158	27.90	0.00	24.75	25.89	25.53
6	125.5	497.1	2785.4	1782.8	16656.2	0.307	0.000	0.201	0.193	0.196	31.10	0.00	28.14	27.51	27.77
7	67.8	248.6	1279.0	1261.1	5190.9	0.324	0.292	0.249	0.237	0.251	31.71	32.50	30.62	29.44	30.42
8	24.5	248.6	1506.7	651.4	2856.4	0.333	0.357	0.291	0.227	0.270	32.23	34.50	32.01	29.65	31.19
9	55.5	248.6	1734.1	1759.5	2431.2	0.345	0.355	0.291	0.225	0.280	32.14	35.50	32.33	29.25	31.82
10	60.7	994.3	2838.7	1863.8	3797.7	0.386	0.316	0.290	0.285	0.291	33.34	35.50	32.61	31.54	32.32
11	99.0	497.1	1419.4	297.0	5757.5	0.394	0.360	0.353	0.322	0.344	34.00	35.50	35.02	32.91	34.41
12	23.0	745.7	2470.6	891.2	2312.5	0.418	0.368	0.360	0.333	0.361	34.06	37.00	36.44	34.09	36.16
13	33.6	248.6	1051.3	1167.4	4130.5	0.386	0.321	0.321	0.371	0.332	33.98	34.50	34.13	34.13	34.20
14	101.0	2237.1	6045.5	1472.3	2500.9	0.476	0.375	0.364	0.383	0.376	36.11	36.50	34.98	34.46	34.90
15+	1832.2	17170.3	55968.2	110922.2	9855.9	0.456	0.358	0.360	0.403	0.367	35.97	35.61	35.41	34.95	35.39
	326.3	2446.7	10829.8	15628.7	29231.4	0.178	0.142	0.193	0.141	0.157	25.99	25.78	27.66	24.43	25.54

Table 4.4.2.1. (continued) North Sea Horse Mackerel catch in numbers (1000), mean weight and length at age by quarter and area in 2005

4Q	Catch number, 1000					Weight at age Kg					Length at age, Cm				
Ages	**IIIa**	**IVb**	**IVc**	**VIId**	**Total**	**IIIa**	**IVb**	**IVc**	**VIId**	**Total**	**IIIa**	**IVb**	**IVc**	**VIId**	**Total**
0	0.0	0.0	0.0	0	0	0.000	0.000	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00
1	0.0	0.0	0.0	7528	7528	0.000	0.000	0.000	0.079	0.079	0.00	0.00	0.00	20.54	20.54
2	0.0	0.0	0.0	33166	33166	0.000	0.000	0.000	0.101	0.101	0.00	0.00	0.00	22.14	22.14
3	6.7	0.0	0.0	17493	17500	0.214	0.000	0.000	0.117	0.117	27.80	0.00	0.00	23.36	23.36
4	26.1	0.0	0.0	15459	15485	0.264	0.000	0.000	0.133	0.133	29.70	0.00	0.00	24.49	24.49
5	33.0	0.0	0.0	7041.5	7074.5	0.265	0.000	0.000	0.163	0.163	27.90	0.00	0.00	25.91	25.92
6	52.9	0.0	0.0	5386.3	5439.1	0.307	0.000	0.000	0.195	0.196	31.10	0.00	0.00	27.37	27.41
7	65.2	414.7	1121.5	304.1	1905.6	0.325	0.292	0.292	0.253	0.287	31.70	32.50	32.50	29.60	32.01
8	35.2	207.3	560.8	51.2	854.6	0.333	0.357	0.357	0.238	0.349	32.20	34.50	34.50	29.61	34.11
9	12.4	207.3	560.8	69.0	849.6	0.345	0.355	0.355	0.240	0.346	32.00	35.50	35.50	29.76	34.98
10	28.8	207.3	560.8	235.9	1032.8	0.387	0.316	0.316	0.324	0.320	33.30	35.50	35.50	32.00	34.64
11	30.0	829.3	2243.1	26.5	3128.9	0.397	0.360	0.360	0.267	0.360	33.90	35.50	35.50	30.71	35.44
12	51.2	414.7	1121.5	28.0	1615.4	0.419	0.368	0.368	0.255	0.368	34.00	37.00	37.00	30.12	36.79
13	10.6	622.0	1682.3	39.7	2354.6	0.395	0.321	0.321	0.363	0.322	33.90	34.50	34.50	34.18	34.49
14	17.2	207.3	560.8	1.8	787.2	0.479	0.375	0.375	0.428	0.377	36.10	36.50	36.50	35.50	36.49
15+	48.7	1866.0	5046.9	173.3	7134.9	0.466	0.358	0.358	0.516	0.363	36.00	35.61	35.61	37.06	35.65
1-4Q															
Ages	**IIIa**	**IVb**	**IVc**	**VIId**	**Total**	**IIIa**	**IVb**	**IVc**	**VIId**	**Total**	**IIIa**	**IVb**	**IVc**	**VIId**	**Total**
0	0.0	0.0	219	7603	7822	0.000	0.000	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00
1	656.6	7237.6	9374	35117	52386	0.000	0.000	0.089	0.079	0.079	0.00	0.00	20.50	20.54	20.54
2	346.0	3672.6	6637	19163	29819	0.020	0.020	0.038	0.100	0.077	20.00	20.00	20.51	22.08	21.49
3	76.3	294.5	8194	19235	27800	0.062	0.056	0.091	0.116	0.103	22.12	21.90	22.59	23.36	23.00
4	62.6	0.0	4037	8477	12577	0.197	0.072	0.133	0.133	0.132	27.53	23.50	24.93	24.60	24.69
5	100.2	0.0	6375	10181	16656	0.265	0.000	0.152	0.160	0.158	27.90	0.00	24.75	25.89	25.53
6	125.5	497.1	2785	1783	5191	0.307	0.000	0.201	0.193	0.196	31.10	0.00	28.14	27.51	27.77
7	67.8	248.6	1279	1261	2856	0.324	0.292	0.249	0.237	0.251	31.71	32.50	30.62	29.44	30.42
8	24.5	248.6	1507	651	2431	0.333	0.357	0.291	0.227	0.270	32.23	34.50	32.01	29.65	31.19
9	55.5	248.6	1734	1760	3798	0.345	0.355	0.291	0.225	0.280	32.14	35.50	32.33	29.25	31.82
10	60.7	994.3	2839	1864	5757	0.386	0.316	0.290	0.285	0.291	33.34	35.50	32.61	31.54	32.32
11	99.0	497.1	1419	297	2313	0.394	0.360	0.353	0.322	0.344	34.00	35.50	35.02	32.91	34.41
12	23.0	745.7	2471	891	4130	0.418	0.368	0.360	0.333	0.361	34.06	37.00	36.44	34.09	36.16
13	33.6	248.6	1051	1167	2501	0.386	0.321	0.321	0.371	0.332	33.98	34.50	34.13	34.13	34.20
14	101.0	2237.1	6045	1472	9856	0.476	0.375	0.364	0.383	0.376	36.11	36.50	34.98	34.46	34.90
15+	83.4	2194.6	5938	1336	9552	0.456	0.358	0.360	0.403	0.367	35.97	35.61	35.41	34.95	35.39

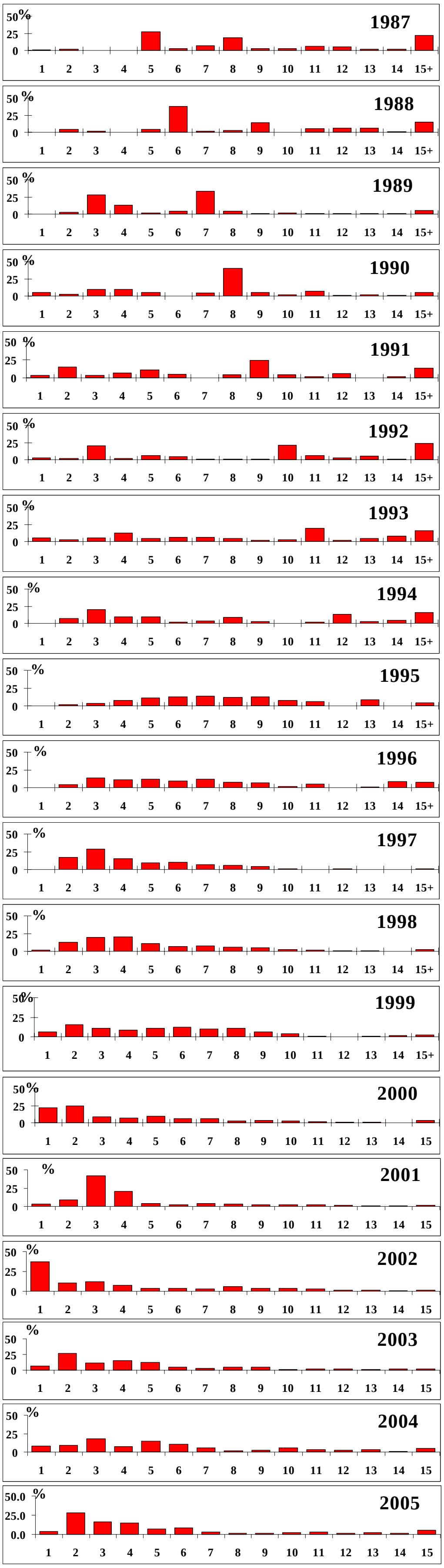


Figure 4.4.1.1 NORTH SEA HORSE MACKEREL age composition based on commercial and research vessel samples from 1987-2005.

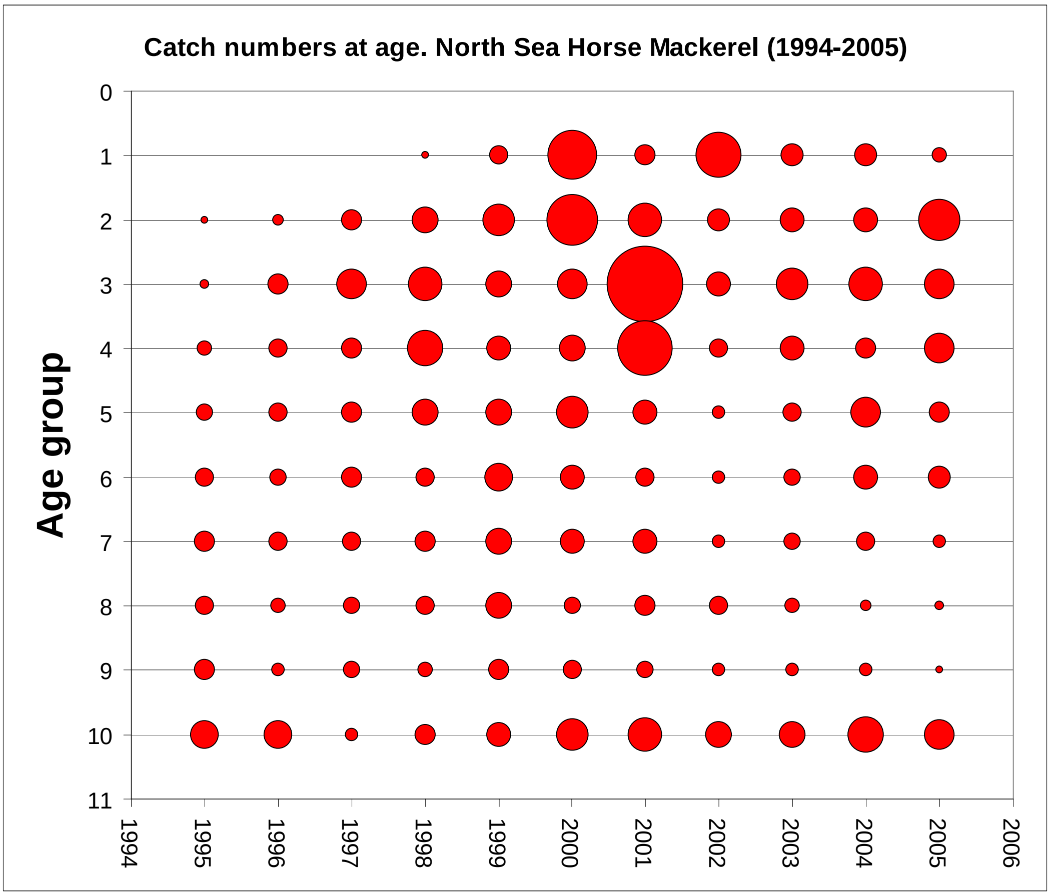


Figure 4.5.1.1. The catch-at-age of North Sea horse mackerel; note that the age composition for 1995 and 1996 was partly based on research vessel samples and may not be representative.

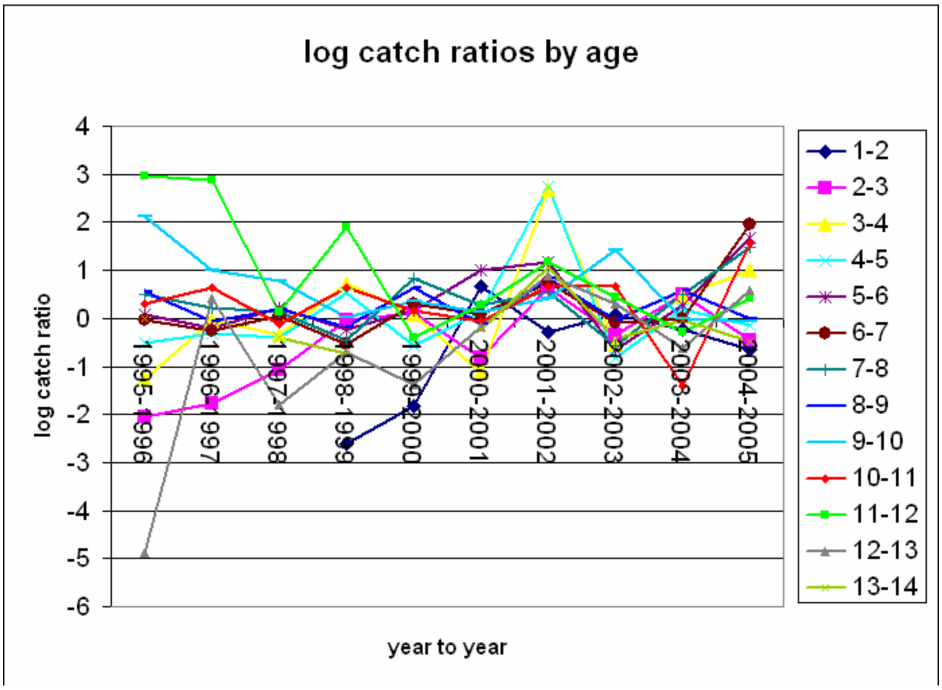


Figure 4.5.1.2. Log catch ratios of North Sea horse mackerel.

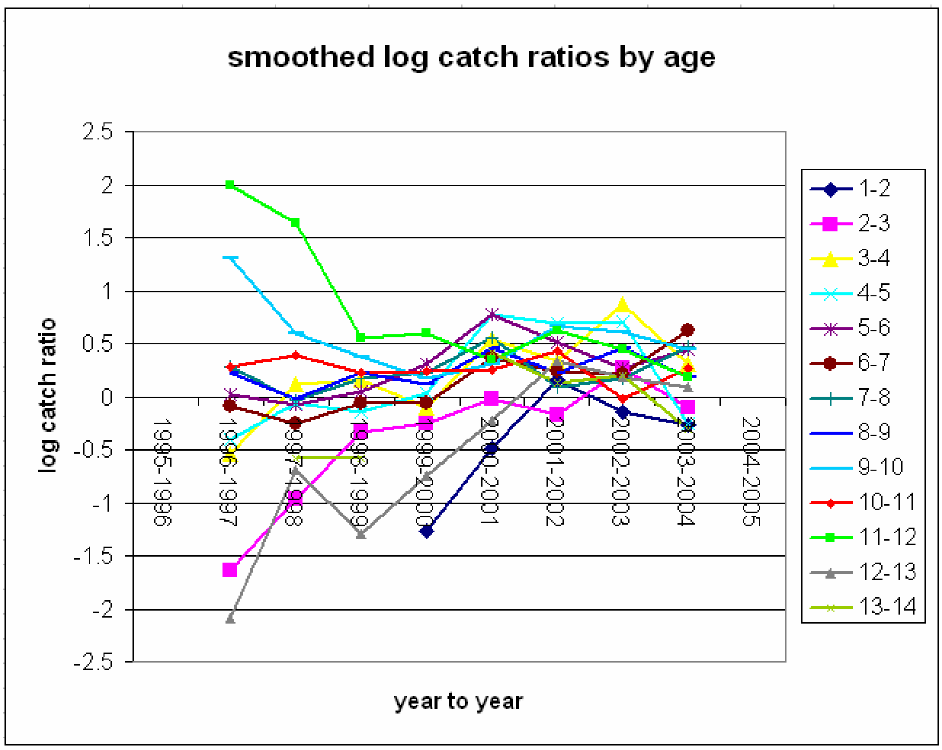


Figure 4.5.1.3. Smoothed (running average over 3 years) log catch ratios of North Sea horse mackerel.

Figure 4.5.2.1. (see below) Mean IBTS catch rates of horse mackerel in quarter 3 by year and by ICES rectangle (North Sea, sub-areas IVb and Ivc) for fish <14 cm, for fish ≥14 cm and <23 cm, and for fish ≥23 cm. Dark green rectangles roughly correspond to land; light grey rectangles are selected for the indices. In the bottom of each panel is the index (mean catch rate in numbers/hour) based on the shaded rectangles.

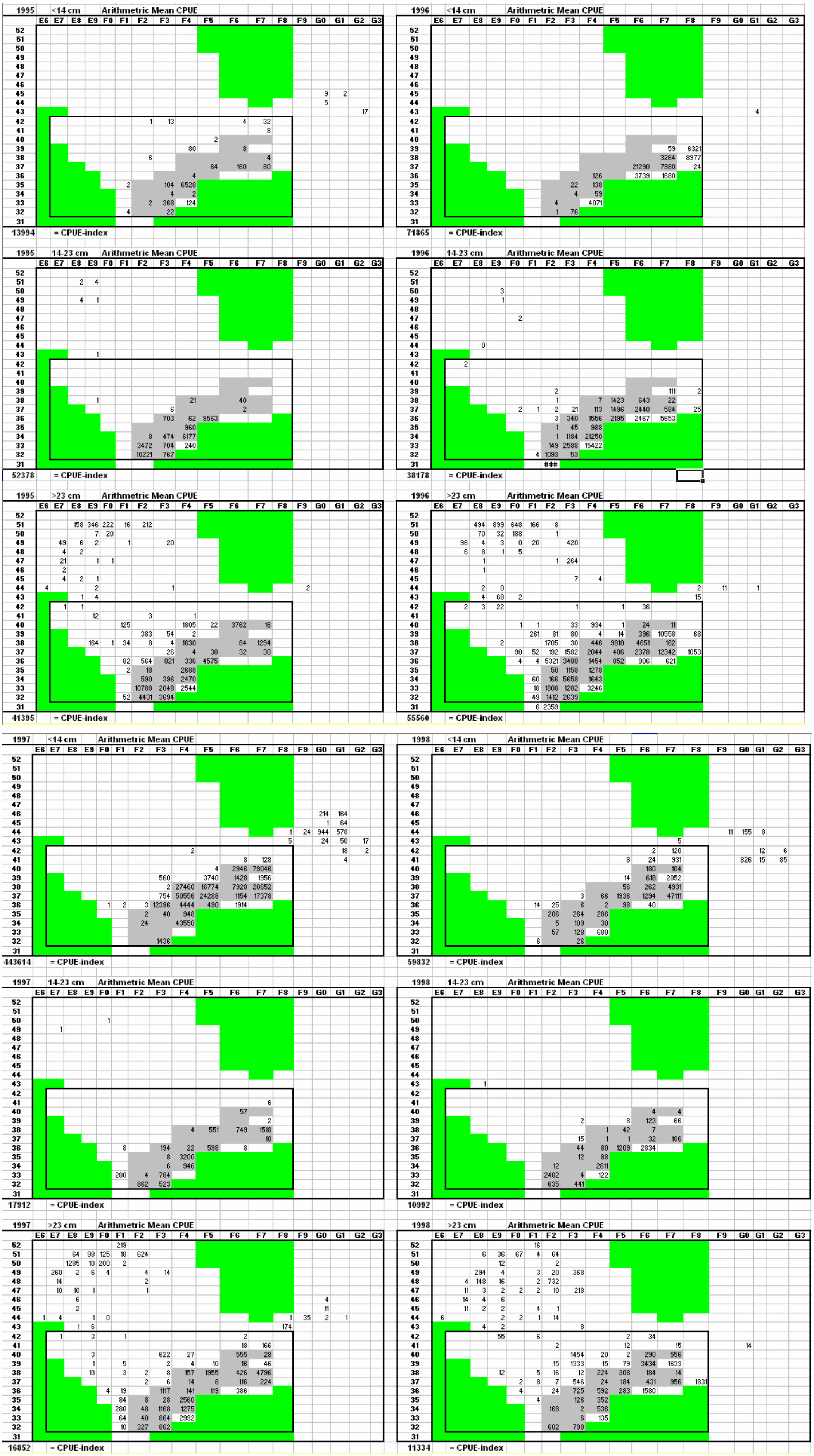

1995 <14 cm Arithmetic Mean CPUE
13994 = CPUE-index
1996 <14 cm Arithmetic Mean CPUE
71865 = CPUE-index
1995 14-23 cm Arithmetic Mean CPUE
52378 = CPUE-index
1996 14-23 cm Arithmetic Mean CPUE
38178 = CPUE-index
1995 >23 cm Arithmetic Mean CPUE
41395 = CPUE-index
1996 >23 cm Arithmetic Mean CPUE
55560 = CPUE-index
1997 <14 cm Arithmetic Mean CPUE
443614 = CPUE-index
1998 <14 cm Arithmetic Mean CPUE
59832 = CPUE-index
1997 14-23 cm Arithmetic Mean CPUE
17912 = CPUE-index
1998 14-23 cm Arithmetic Mean CPUE
10992 = CPUE-index
1997 >23 cm Arithmetic Mean CPUE
16852 = CPUE-index
1998 >23 cm Arithmetic Mean CPUE
11334 = CPUE-index

Figure 4.5.2.1.

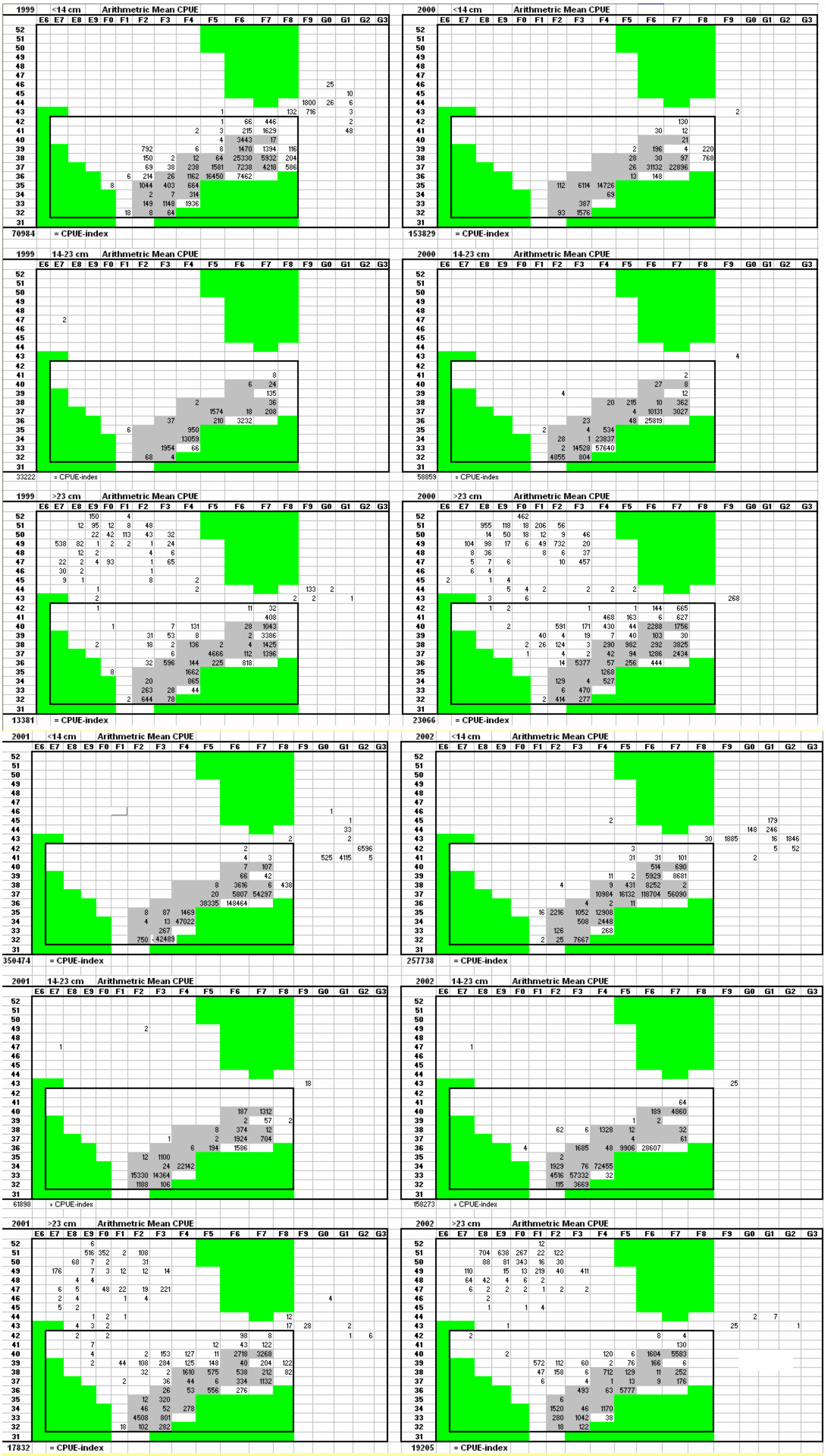

1999 <14 cm Arithmetic Mean CPUE
70984 = CPUE-index
2000 <14 cm Arithmetic Mean CPUE
153829 = CPUE-index
1999 14-23 cm Arithmetic Mean CPUE
33222 = CPUE-index
2000 14-23 cm Arithmetic Mean CPUE
58859 = CPUE-index
1999 >23 cm Arithmetic Mean CPUE
13381 = CPUE-index
2000 >23 cm Arithmetic Mean CPUE
23066 = CPUE-index
2001 <14 cm Arithmetic Mean CPUE
350474 = CPUE-index
2002 <14 cm Arithmetic Mean CPUE
257738 = CPUE-index
2001 14-23 cm Arithmetic Mean CPUE
61898 = CPUE-index
2002 14-23 cm Arithmetic Mean CPUE
158273 = CPUE-index
2001 >23 cm Arithmetic Mean CPUE
17832 = CPUE-index
2002 >23 cm Arithmetic Mean CPUE
19205 = CPUE-index

Figure 4.5.2.1.

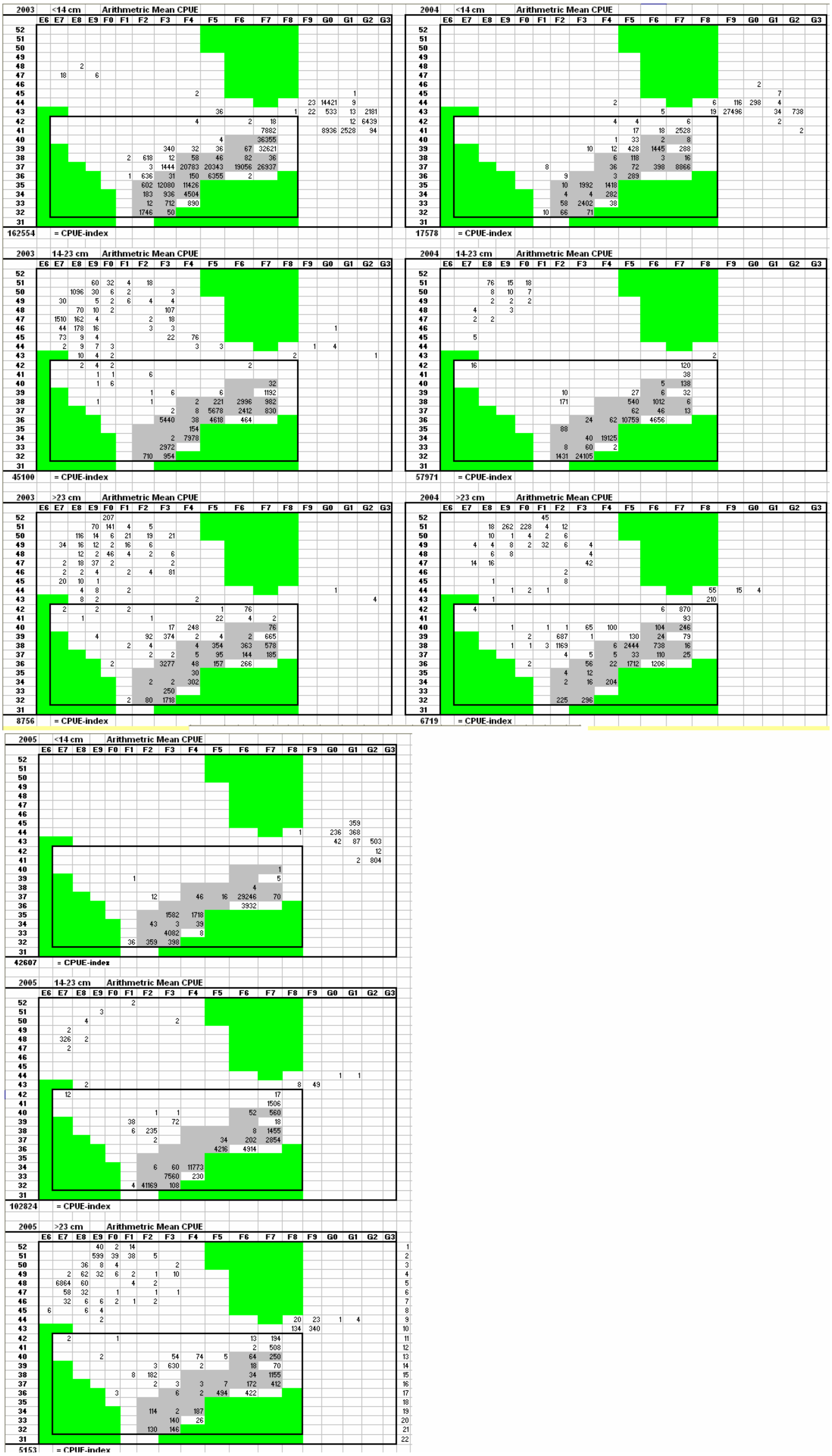

2003 <14 cm Arithmetic Mean CPUE
162554 = CPUE-index
2004 <14 cm Arithmetic Mean CPUE
17578 = CPUE-index
2003 14-23 cm Arithmetic Mean CPUE
45100 = CPUE-index
2004 14-23 cm Arithmetic Mean CPUE
57971 = CPUE-index
2003 >23 cm Arithmetic Mean CPUE
8756 = CPUE-index
2004 >23 cm Arithmetic Mean CPUE
6719 = CPUE-index
2005 <14 cm Arithmetic Mean CPUE
42607 = CPUE-index
2005 14-23 cm Arithmetic Mean CPUE
102824 = CPUE-index
2005 >23 cm Arithmetic Mean CPUE
5153 = CPUE-index

Figure 4.5.2.1.

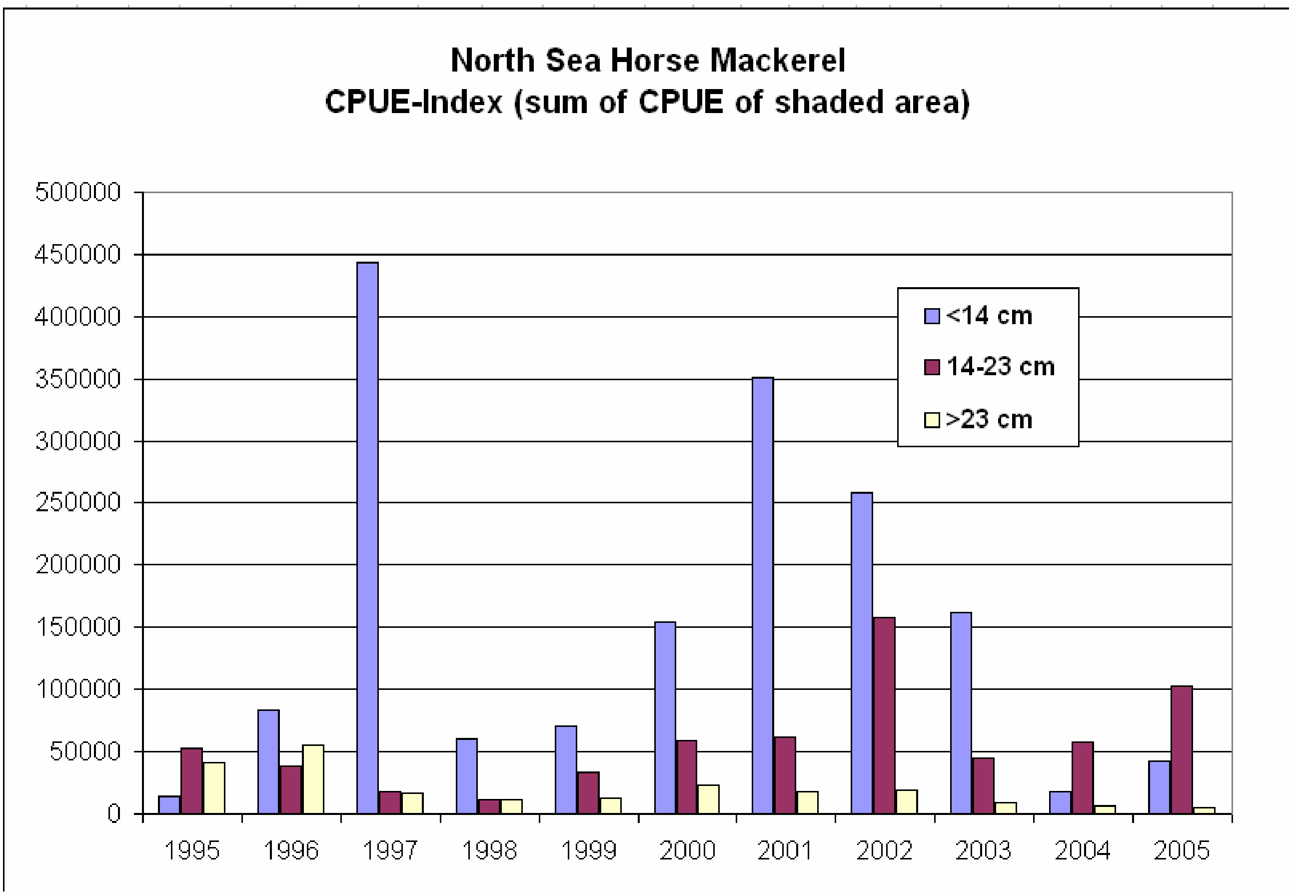


Figure 4.5.2.2.a. Indices are mean IBTS catch rates of horse mackerel in quarter 3 by year, in shaded ICES rectangles.

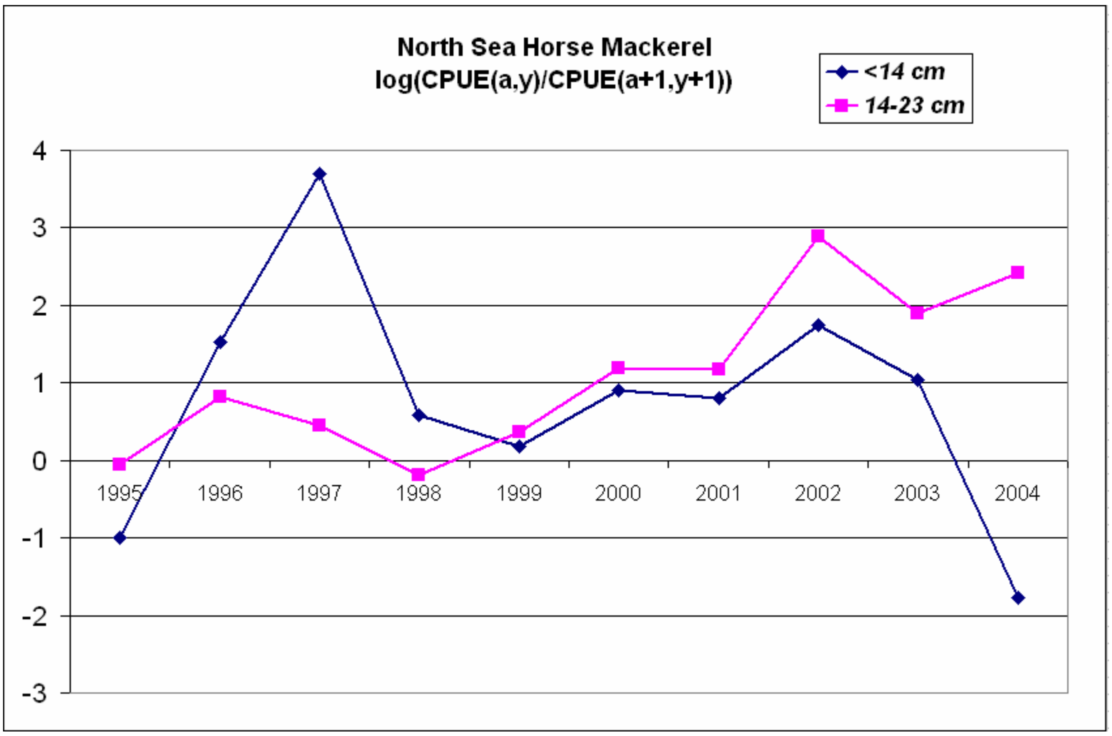


Figure 4.5.2.2.b. Log(Index(y,a)/Index(y+1,a+1)). Indices are mean IBTS catch rates of horse mackerel in quarter 3 by year, in shaded ICES rectangles.

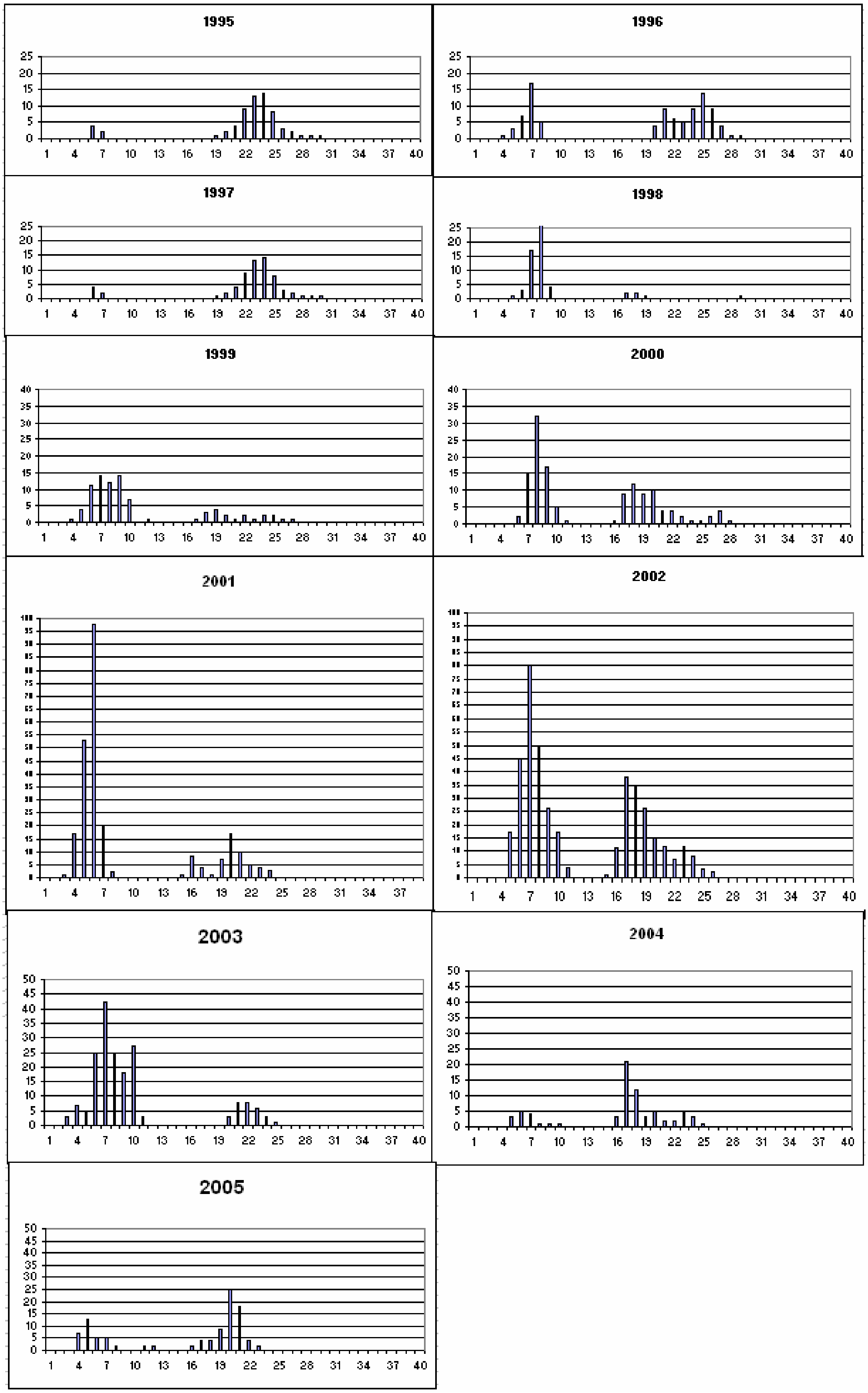


Figure 4.5.2.3. Length frequency distributions. Mean IBTS catch rates of horse mackerel in quarter 3 by year, in ICES rectangles shaded in Figure 4.5.2.1.

5 Western Horse Mackerel (Divisions IIa, IIIa (Western Part), IVa, Vb, VIa, VIIa-c, VIIe-k, AND VIIIa,b,d,e

5.1 ACFM Advice Applicable to 2005 and 2006

Previously ICES gave advice for the western stock excluding Division VIIIc, this changed in 2005, when ICES advised that catches in 2005 be limited to less than 150,000 t for the whole distribution of the stock.

EU has set TACs for western horse mackerel in EU waters since 1987. However, these TACs cover a mixture of western, North Sea and southern horse mackerel areas. These TACs were the same in 2005 and 2006, and can be summarised as follows:

Areas in EU waters.	TAC 2006	Stocks fished in this area
Div Vb, Sub areas VI and VII, Div VIIIa,b,d,e	137,000 t	Western & North Sea stocks
Div IIa and Subarea IV	42,727 t	Western & North Sea stocks
Division VIIIc and Subarea IX	55,000 t	Southern & Western stocks

The TAC for the western stock should apply to the distribution area of western horse mackerel i.e. Divisions IIa, IIIa (western part, second half of the year), IVa (second half of the year), Vb, VIa, VIIa-c,e-k, and VIIIa,-e. The TAC for the North Sea stock should apply to those areas where North Sea horse mackerel are fished i.e. Divisions IVa (first half of the year), IVb,c, IIIa (first half of the year) and Division VIId. The TAC for the southern stock should apply to Division IXa.

The catches of western horse mackerel in 2005 were about 182,000 t.

5.2 The Fishery in 2005 of the Western Stock

Information on the development of the fisheries by quarter and division is shown in Table 3.1.2 and in Figures 3.1.1.a–d. The total catch allocated to western horse mackerel (including Division VIIIc) in 2005 was approximately 182,000 t (Table 3.3.1) which is 24,300 tons more than in 2004.

Divisions IIa and Vb

The national catches in this area are shown in Table 5.2.1. The catches in this area have varied from year to year. During the 1990s the catches fluctuated between 800 tons and 14,000 tons. Catches in 2004 and 2005 were 47 and 176 t respectively.

Subarea IV and Division IIIa

The total catches of horse mackerel in Sub area IV and Division IIIa are shown in Table 5.2.2. The catches from Divisions IVa in 2005 were allocated to the western stock. The catches of the western stock in Division IVa fluctuated between 4,500 -135,000 tons during the period 1987-2005. These fluctuations are mainly due to the availability of western horse mackerel for the Norwegian fleet in October –November (see section 5.3.3).

Subarea VI

The catches in this area increased from 21,000 t in 1990 to a historical high level of 84,000 tons in 1995 and 81,000 tons in 1996 (Table 5.2.3). The catches then declined to a lower level. In 2005 the total catch was about 22,000 t.

Subarea VII

The total catches of horse mackerel in Sub area VII are shown in Table 5.2.4. All catches from Sub area VII except Division VIId were allocated to the western stock. The main catches are usually taken in directed trawl fisheries in Divisions VIIb,e,h,j. The catches of western horse mackerel in Sub-area VII (Table 3.3.1) increased from below 100,000 tons prior 1989 to about 320,000 tons in 1995 and 1997 and were 107,500 t in 2005.

Subarea VIII

The total catches of horse mackerel by country for Sub-area VIII are given in Table 5.2.5. All catches from this Sub area (including division VIIIc) are allocated to the western stock. The catches of horse mackerel in these areas usually fluctuate between 22,000 and 55,000 t, except for the record high catch in 2001 of 75,000 tons. In 2005 the catches were 41,500 t.

5.3 Fishery Independent information

5.3.1 Egg survey estimates of spawning biomass

The results of the 2004 egg survey are given in Section 3.7.

5.3.2 Other surveys for western horse mackerel.

Bottom trawl surveys:

Spanish bottom trawl surveys (DEMERSALES):

Due to the new definition of the boundaries of the western horse mackerel stock, the autumn Spanish bottom trawl surveys operating in Division VIIIc is now available as fishery independent information of this stock. The surveys cover the whole Division VIIIc and the Subdivision IXa North. It is directed to demersal resources and is carried out in September/October. This survey provides valuable information on horse mackerel dynamics in the study area such us its general distribution pattern or the gap in the catch length distribution observed between juveniles and young adults (18-23) cm, which roughly corresponds with length at first maturity (fig. 5.3.2.1). This gap could explain the characteristic exploitation pattern of horse mackerel in northern Iberian waters with two peaks corresponding to juveniles and adult ages. In number at age matrix some cohorts can be followed (figure 5.3.2.2) but there is almost no information on mortality along the cohorts showing almost flat slopes (fig. 5.3.2.3). The continental shelf in the North of Spain is narrow and it is likely that limited migrations occur between adjacent areas, mainly with the French continental shelf. This could explain the difficulties to see clear mortality patterns in the cohorts. Therefore, the analysis of these data could benefit if information from other surveys carried out in adjacent areas (mainly from Divisions VIIIa,b) is available (Velasco and Abaunza WD, 2006). Furthermore, the surveys are carried out at the recruitment season and an index of recruitment is provided (fig. 5.3.2.2). However, this recruitment index should be taken with caution since the sampling intensity near the coast (depth strata < 120 m), where many juveniles are distributed, is very low due to the rocky nature of the seashore. In the data provided the Subdivision IXa North, which is defined as southern stock area, is also included. This information will be amended for next year Working Group to correspond with Division VIIIc only (Western stock).

French bottom trawl surveys (EVHOE):

The surveys cover the Bay of Biscay (French continental shelf) and part of the Celtic Sea. It is carried out in autumn and it is directed to demersal resources. Information on horse mackerel distribution and length distributions are available (fig. 5.3.2.4). The survey is carried out during the recruitment season and the juveniles are the majority in the catches.

It might useful for the WG to collect all information available about horse mackerel from other bottom trawl surveys carried out in the distribution area of the western horse mackerel stock (e.g. IBTS).

Acoustic surveys:

French acoustic surveys:

Horse Mackerel data coming from the French acoustic PELGAS surveys are available as independent information about the western horse mackerel stock. This multidisciplinary survey is covering each spring Divisions VIIIa and VIIIb. Information on distribution and length distribution is available. Table 5.3.2.1 shows the length distributions of horse mackerel (in percentage) from 2000 to 2004. Real numbers at length estimates will be provided in the future, but actually only the length distribution in percentage are available. More detailed information of the surveys regarding the horse mackerel will be provided at WGACEGG next November 2006.

Spanish acoustic surveys:

Horse mackerel data coming from the Spanish acoustic PELACUS surveys are available as independent information about the western horse mackerel stock. This multidisciplinary survey is covering each spring Divisions VIIIc and Subdivision IXa North (Some years is also extended to the south of Subdivision IXa North and Division VIIIb). Information on distribution and abundance estimates are available since 1997. Figure 5.3.2.5 shows the biomass estimates of the historical series considering the Subdivision IXa North (Southern stock) and Division VIIIc (Western stock). The information will be splitted up by stock and it is expected to be presented at WGACEGG next November 2006.

5.3.3 Environmental Effects

Since the strong 1982 year class of the western stock started to appear in the North Sea in 1987 there has (except for 2000) been good correlation between the modelled influx of Atlantic water to the North Sea the first quarter and the horse mackerel catches taken in the Norwegian EEZ (NEZ) later the same year (Iversen *et al.* 2002). There was no obvious correlation for 2000, but for 2001 to 2004 the predicted and actual catches were similar. The actual catch in 2005 was approximately half of that predicted by the influx model but the fishery found large scale mixing of horse mackerel and mackerel, and thus the horse mackerel catch was constrained by the restrictive mackerel regulations. The projected catch of horse mackerel in 2006 is 29,000 t, similar to the catch in 2005.

5.4 Effort and catch per unit of effort.

Information on effort and catch per unit effort is only available from the southern limit of the stock distribution area. Since Division VIIIc is part of the western stock the bottom trawl fleet operating in Subdivision VIIIc West (north of the Galician coast) is exploiting the western stock. The previous effort series from this fleet has been revised with the aim to obtain a more reliable estimation and a new time series (used also in the rest of the species caught by this fleet) has been adopted. The effort decreased substantially since 2001, about 26%, and it maintained at this low level in 2005 (see the table below). The very low values obtained in 2003 can be in part explained by the imposing of closed areas and seasons in response to the Prestige oil spill effects. Catch per unit of effort was available for the old effort time series but due to the new effort estimates the CPUE values and the CPUE at age data are on revision and will be presented next year.

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Effort (Days/100*HP)	51017	48655	45358	39829	34658	41498	44401	44411	40435	38896	44479

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Effort	39602	41476	35709	35191	------	30131	30073	29923	21823	12328	19198	20663

5.5 Biological Data

5.5.1 Catch in numbers

Since 1998 there has been an increase in age readings compared with previous years. This has improved the quality of the catch at age matrix for recent years of the western horse mackerel. In 2004 the Netherlands (Divisions IVc, VIa, VIIb,d,e,h,j, VIIIa,d), Norway (Division IVa), Ireland (Divisions VIa and VIIb),Germany (Divisions VIa,VIIb,d,e,h,j) and Spain (Divisions VIIIb,c) provided catch in numbers at age. The catch sampled for age readings in 2004 covered 70 % of the total catch. This is lower than in 2003 (76%) and the number of age readings at least for parts of the fishing area are considered too small to be satisfactory (see section 1.3).

Catches from other countries were converted to numbers at age using adequate samples from other countries. Catch at age data from the juvenile areas, (Divisions VII,e,f,g,h and VIIIa-d) were only applied when converting catches from these divisions into catch in numbers at age. The procedure has been carried out using the specific software for calculating international catch at age (Patterson, WD 1998). The catch in numbers by year class for each of the fishing Divison is showed in Figure 5.5.1.1.

As last year both Germany and the Netherlands provided samples and age readings from Divisions VIIe,h. The samples were taken in similar areas at similar periods by the same fleet. The age distribution of the German and Dutch samples were significantly different in 2003. The Dutch samples were then dominated by one year old fish, while German samples were dominated by two year old fish (Zimmermann et al WD 2004). In 2004 the German samples from Divisions VIIe contained relatively more 1, 2 and 3 years old fish than the Dutch samples. For Divison VIIh the age distribution was pretty much the same. Catches from these areas were converted to numbers at age using the German and Dutch information weighed by sample number.

The total annual and quarterly catches in numbers for western horse mackerel in 2004 are shown in Table 5.5.1.1. The sampling intensity is discussed in Section 1.3.

The catch at age matrix shows the predominance and the dominance of the 1982 year class in the catches since 1984 (Figure 5.5.1.2). The 1982 year class has been included in the plus group since 1996. Since 2002 the 2001 year class of horse mackerel has been caught in considerable numbers. In 2004 large catches were taken of this year class. In the juvenile area 53% of the catch in number was of this year class. The total catch in the juvenile area was about 84,000 tons, which is 49% of the catch of the western stock. Even if the fisheries have been intensified in the juvenile areas since 2002 the high catch rates of the 2001 year class in these three years probably indicate that this is a strong year class. These catches were mainly taken in Divisions VIIh (57,700 tons) and VIIe (10,900 tons). A relative large number of the 2001 year class was also caught in Division VIa.

5.5.2 Mean length at age and mean weight at age.

Mean length at age and mean weight at age in the catches

The mean weight and mean length at age in the catches by year, and by quarter in 2004 are shown in Tables 5.5.2.1-5.5.2.3.

Mean weight at age in the stock

As for previous years the mean weight at age for the two years old was given a constant weight while the weight for the older ages is based on all mature fish sampled from Dutch freezer trawlers the first and second quarter in Divisions VIIj,k (Table 5.5.2.1). The mean weight by age groups in the stock and in the catches were lower than usual in 2001, but returned to normal in 2002-2004.

5.5.3 Maturity ogive

Due to difficulties in estimating a maturity ogive (ICES, 2000/ACFM:05 and ICES, 2000/G:01) the working group was unable to update the maturity ogive annually. Therefore the same maturity at age was used as last year.

5.5.4 Natural mortality

The natural mortalities applied in previous assessments of western horse mackerel are summarised and discussed in ICES (1998/Assess:06). The natural mortality is uncertain but probably low. In previous assessments the Working Group applied M=0.15.

5.6 Data exploration and preliminary modelling

The SAD assessment method combines a Separable VPA with an "ADAPT" model structure, and has been used by the working group since the 2000 meeting. At last year's meeting, the WG undertook a bench-mark assessment of the stock implementing a number of models. ACFM in the subsequent Technical Minutes (WGMHSA Review Group 2005), stated that the SAD model specifically purposely designed to assess this stock, was likely to be the most appropriate tool.

A detailed description of the SAD assessment model and rationale for its use is provided in the 2002 Working Group report (ICES CM2003/ACFM:07). Figure 5.6.1 presents an illustration of the model structure and the “free” parameters estimated by maximum likelihood (i.e. those estimated directly), and Table 5.6.1. summarises it’s main features.

In 2005 the WG identified aspects of the assessment that warranted further investigation/exploration:

- the availability of additional information, particularly in relation to fecundity, that would allow further evaluation of the scale of the model;
- an estimate of the variability in fecundity for horse mackerel stocks in the assessment period.

The new version of SAD assuming variable fecundity (sadVF) was expected to help scaling the assessment. Given indications that fecundity may not be constant over the period considered in the assessment (WGMHSA 2005 report, WGMEGGS 2005 report) a new version of the SAD model that takes into account changes in fecundity per gram with individual growth was implemented. The new version was based on the fact that the size structure of the stock would have changed as the strong 1982 year-class went through. There is evidence that standing stock fecundity per gram increases with fish weight (ICES CM 2002/G:06) and total realised fecundity (*trf)* would be expected to follow the same pattern. In line with this argument, the stock average fecundity would have increased as the 1982 year-class matured (as individuals gained weight) and then decreased when the strong year-class was fished out. Another piece of information available were the results from the application of the DEPM (Eltink 1991). Using their estimates of batch fecundity, spawning fraction and duration of the spawning season, mean total realised fecundity was estimated at 2080 oocytes/g-female for that year. This is likely to be an over-estimate as spawning fraction and batch fecundity were measured at peak spawning time so, it was introduced in the assessment model as a penalty term to provide an upper bound to estimate the intercept of the relationship between total realised fecundity per gram and fish weight.

The negative log-likelihood (-ln$L$) minimised is as follows:

$$
\begin{aligned}
-\ln L = \tfrac{1}{2} \sum_{y \in Y_{egg}} & \left\{ \frac{\left(\ln Egg_y - \ln E\hat{g}g_y\right)^2}{\sigma^2_{egg}} + \ln\left[2\pi\sigma^2_{egg}\right] \right\} \\
& + \tfrac{1}{2} \sum_{y=2000}^{2004} \sum_{a=1}^{10} \left\{ \frac{\left(\ln C_{y,a} - \ln \hat{C}_{y,a}\right)^2}{\sigma^2_{sep}} + \ln\left[2\pi\sigma^2_{sep}\right] \right\} \\
& + \tfrac{1}{2} \sum_{y=1983}^{2004} \left\{ \frac{\left(\ln C_{y,11+} - \ln \hat{C}_{y,11+}\right)^2}{\sigma^2_{11+}} + \ln\left[2\pi\sigma^2_{11+}\right] \right\} \\
& + \tfrac{1}{2} \left\{ [(\ln a_{obs} - \ln \hat{a}) / cva_{obs}]^2 + \ln(2\pi(cva_{obs})^2 \right\}
\end{aligned}
$$

where:

Egg_y	egg production estimate in year y;
$E\hat{g}g_y$	egg model estimate in year y computed as

$$
E\hat{g}g_y = \hat{a} \sum_{a=1}^{11+} w_a N_{y,a} m_a + b \sum_{a=1}^{11+} w_a^2 N_{y,a} m_a
$$

$\hat{a}$ is the estimated intercept corresponding to the fecundity vs female gram regression

b is the slope (based on historical data = 1543.28)

w_a is the weight at age

$N_{y,a}$ are the estimated numbers at age in year y and

m_a is the maturity at age

;

a_{obs}	is an upper bound for the intercept (= 1281.7);
cva_{obs}	is the CV of a_{obs};
Y_{egg}	set of years for which egg data are available (Y_{egg} = {1983, 1989, 1992, 1995, 1998, 2001, 2004} - the 1986 egg estimate is omitted for the reasons given in the 2002 Working Group report (ICES CM2003/ACFM:07));
$C_{y,a}$	observed catch in year y at age a;
$\hat{C}_{y,a}$	estimated catch in year y at age a; and
$\sigma^2_{egg/sep/11+}$	computed variance associated with the relevant component of the likelihood.

The "free" parameters estimated directly in the model are:

1) Fishing mortality year effects (F_y) for the final four years for which catch data are available;

2) Fishing mortality age effects (S_a, the selectivities) for ages 1-10 (excluding age 7, which is set at 1);

3) scaling parameter (F_{scal}) for fishing mortality at age 10 relative to the average for ages 7-9 (ignoring the 1982 year-class where applicable);

4) fishing mortality on the 1982 year-class at age 10 in 1992 ($F_{92,10}$) and

5) the intercept (a) for the fecundity / female gram relationship that links the egg production estimates and the SSB model estimates.

The slope parameter b of the relationship between *trf* per gram and fish weight was fixed in the penalty term. It was assumed that b would remain the same as for the standing stock fecundity. This is a defensible assumption because larger (older) fish are likely to spawn more often and for a longer period than younger ones therefore, the "true" slope is likely to be as steep or steeper than the value assumed (P. Witthames *pers comm.*). Only the data of standing stock fecundity (*ssf*) per g female were used to estimate the slope (b), and the model was as follows:

$$ssf = a + b*\mathrm{w}$$

In general terms the expression minimized was:

$$0.5*\{\mathrm{sum}(\log(v)) + \mathrm{sum}[\log(y)-\log(yhat)]\hat{\ }2/v\}$$

that corresponds to maximum-likelihood estimation assuming log-normal errors and where v is the estimated associated variance.

The intercept of the relationship between *trf* per gram and fish weight was expected to be higher than for the standing stock fecundity. In order to estimate the intercept (a) and corresponding CV (cva_{obs}), fecundity data per gram by observed fish weights were generated so that on average they resulted on *trf* = 2080 oocytes/g-female (Eltink 1991). The model described above was fitted to both the original (*ssf /g*) and simulated data. The CV is then simply s.d. of a divided by estimate of a.

Input data for the model were as presented in Tables 5.6.2 and 5.6.3. Mean weights at age in the stock are based on 1st and 2nd quarters data from Dutch freezer trawlers (div VIIk,j) . Natural mortality (constant at age and by year at 0.15), maturity-at-age and stock weights-at-age and the proportions of F and M before spawning (0.45), are assumed to be known precisely. Table 5.6.4 presents the Egg production estimates taken from ICES (2002:G06) and Section 5.1.1.

Results

Results are presented for the version of SAD implemented in 2005 assuming constant fecundity (SPALY) and for the new version which models fecundity per gram as a function of the age structure of the stock (SADVF).

Plots of the model fits to data for the three components of the likelihood, together with plots of normalised residuals, are shown in Figures 5.6.2 for SPALY and on 5.6.5 for SADVF. The SPALY provides reasonable fits to the eggs data. The patterns in the log-catch residuals in years 2003 and 2004 is suggesting the possibility of a change in selection between the two years which could be the result of the strong 2001 year-class appearing in the fishery. This could explain the large confidence intervals corresponding to the selection pattern and contribute to the uncertainty in estimated SSB for recent years (Fig. 5.6.3). The patterns are not apparent in the log-catch residuals for 2005. The residual plots for the plus-group catch appear free of systematic patterns apart from the early part of the series in Figure 5.6.2(c), likely caused by the 1982 plus-group population numbers having to be estimated directly from the plus-group catches to initiate the dynamic pool. The 1997 peak in estimated plus-group catch results from a high F in 1997 which is based on the plus-group catch data and the estimated numbers at age. As noted by ACFM in 2004 the error bars in the estimates of age 0 are large (Fig. 5.6.3 (c-d)) and that is related to the fact that age-0 catch is not fitted in the objective function given that this age group is very poorly represented in the catch.

In comparison with SPALY, the variable fecundity version of SAD does not fit well the early egg data and shows patterns in the residuals from the eggs' fit (Fig. 5.6.5). The 1997 peak noted in SPALY in the fit to the plus-group catch, is slightly less pronounced for SADVF. The log-catch residuals for the separable period look practically identical for the two models.

Figures 5.6.3 and 5.6.6 show the selectivity pattern for the separable period, the SSB and age-0 trajectories, with error-bars reflecting 95% confidence bounds for SPALY and SADVF respectively. In the case of SPALY, the CVs for the selectivity parameters are in the range 12-33% and are more imprecise for the young ages, 17-27% for the SSB estimates, and 7-55% for the age 0 estimates where the CVs increase substantially for the estimates corresponding to recent years. Point estimates and 95% confidence bounds for the model free parameters are given in the bottom two plots in Figure 5.6.4.

The selection pattern estimated by SADVF (Figure 5.6.6) for the separable period is low for the younger ages and high for the older ages which is the opposite to the selection estimated by SPALY. Comparison of the estimated numbers at age and Fs from the two models (Fig. 5.6.8) suggests that given constraints in SSB, the SADVF increases the numbers in younger ages in relation to the numbers in older ages in order to fit the catch at age. This results in low selection for younger ages. In the case of SPALY the opposite takes place: no constraints in SSB so the model raises the numbers at age to get the best possible fit to the catch data and the other pieces of information. That results in the selection pattern shown in Fig. 5.6.3 a), higher selection in younger ages compared with the older ones. However, for both models precision of the estimated selectivity is lowest for the younger ages. The selectivity parameters estimated by SADVF are in the range of 15-54%, wider than for SPALY. The SSB is now scaled lower than in SPALY, the corresponding CVs in the range of 11-37% comparatively less precise. The estimates for the age-0 follow a similar pattern than in SPALY with recent years estimates being very imprecise.

The results from both models suggest a relatively stable SSB but showing a declining trend since 1988 as the 1982 year-class gradually disappeared from the stock. Both models suggest an increase in biomass in 2005 although that may be interpreted with caution as the model estimates become more uncertain as the assessment moves away from the Egg survey year. The 2001 year-class is estimated as high by both models at a level comparable with 1993-4 strong year-classes and fishing mortality is estimated at about 0.1 by both models (considered low in relation to M= 0.15) but slightly increasing in 2005. Reviewers have commented that the assumed value for M should be investigated. However, there is no data available (such as tagging) that could assist to estimate M more accurately.

Nonetheless, the comparison between the two runs suggests a lower SSB level, a worse fit to the egg survey data, which is apparent in the pattern of residuals (Fig. 5.6.5) and less precise estimates of key parameters (Fig. 5.6.7) by the SADVF. By including auxiliary information on fecundity the SADVF model was constrained and not allowed to set the biomass at a high level, resulting in wider confidence intervals in model parameters. Basically by doing so the model was taken away from the 'true' minimum parameters' space. Incorporating biological information has resulted in a slightly worse fit to the data but there may be a case to sacrifice goodness of fit in favour of "biological realism". The Working Group supported this last approach because it takes into account available biological information and scales the assessment to SSB values that are more in agreement with the general perception of the stock. **State of the Stock**

5.7.1 Stock assessment

Due to the uncertainties presented in Section 5.6 no assessment is presented as a definitive state of the stock.

5.7.2 Reliability of the assessment

As there is no final assessment presented the issues relating to reliability are dealt with under section 5.6

5.8 Catch Prediction

To provide an illustration on the uncertainty in the assessment two deterministic short-term predictions were performed based on the results from the SAD-Variable Fecundity model.

Input data for the predictions

A conservative estimate of recruitment age-0 and of age 1 was adopted. The following estimates were adopted: recruitment age-0 corresponds to the geometric mean excluding 1982, 93-94 and

2001 year-classes. Age-1 results from discounting mortality from the GM recruitment estimated as explained above.

Natural mortality = 0.15 is assumed constant for all ages and the fractions of F and M taking place before spawning are equal to 0.45. Landings in 2006 are assumed = 180 thousand tons.

The remaining input values are shown in Table 5.8.1.

Prediction a): starting numbers at age correspond to the point estimates from the assessment.

Prediction b) a more conservative scenario using as starting numbers at age the 25th percentile of the corresponding normal distributions with mean equal to the point estimate and standard deviation estimated by the model (based on the Hessian matrix).

Results

The large uncertainty associated with 2007 catch levels is illustrated by the results shown in Tables 5.8.2-3. Scenario a) suggests that a catch well in excess of the 2005 TAC could be taken in 2007 and SSB would remain well above Blim (= 1256 thousand tons). On the other hand, the more conservative scenario b) suggests that for the stock to remain above Blim the 2007 catch should be < 34 thousand tons.Given the wide range of uncertainty regarding precautionary catch levels, advice on a specific figure cannot be provided.

5.9 Short and medium term risk analysis

For reasons stated above, these analyses have not been carried out for this stock.

5.10 Reference Points for Management Purposes

The absolute levels of SSB, F and R are considered uncertain. As this affects also the historic perception of the stock, a definition of reference points in absolute terms is currently not possible. The stock is characterised by infrequent, extremely large recruitments.

Biomass reference points. It could be assumed that the likelihood of a strong year class appearing would decline if stock size were to fall below the stock size at which the only such event has been observed. The WG therefore considers the biomass that produced the extraordinary 1982 yc as a good proxy for B_{lim}. This follows the rationale of SGPRP 2003 proposing to use the stock size in 1982 for B_{lim}. However, the method used to estimate the SSB in 1982 (based on the egg production estimate obtained by a survey) can not be applied any more because of the uncertainty of the fecundity type of the species, so B_{lim} can only be defined in relative terms.

Fishing mortality reference points. Again, there is high uncertainty about the absolute level of F at present and in the past. Current fishing mortalities cannot be compared to the estimates prior to 2002, because the age range for mean F was changed last year from F(4-10) to F(1-10) to include both the exploited age groups of the juveniles as the adults. No reliable estimate of total mortality is available for the stock, which could be used to judge the level of F. There are, however, indications that the assumed natural mortality (0.15) might be too high. However, there is insufficient data to estimate M.

ACFM has not defined any fishing mortality reference points for this stock in the past but in its advice it has used $\mathbf{F}_{0.1}$ as the highest F that is consistent with the Precautionary Approach.

5.11 Harvest control rules

The analyses that follow focuses in the development of harvest control rules (HCRs) for Western horse mackerel and are in line with requests from the Pelagic RAC to propose a management plan for Western horse-mackerel. The sections that follow are based on the results from Roel and De Oliveira (2006) and analyses using F-PRESS (Kelly and Codling) as a simulation framework and the same model settings used by Roel and De Oliveira .

Results from the 3-year TAC simulation testing (Roel & De Oliveira 2006)

The general features of the stock and the fishery taken into account in the study are the following:

- Horse mackerel is a spasmodic recruiter.
- The only fishery-independent information available is a survey estimate of annual egg production made every third year.
- Annual fecundity (which allows to translate egg numbers into SSB) is poorly estimated as horse mackerel is likely to be a indeterminate spawner.

Simulation testing

Operating model

•An age-structured underlying model. Parameterisation based on the results from 2005 assessment (Roel & De Oliveira 2006)

•Recruitment is modelled as a stochastic process based on a Ricker stock and recruit relationship and, a process that allows generating a very large recruitment with frequency of about 1 in 20 yrs.

•EGG^{true} is derived from SSB^{true} with process error and $EGG^{observed}$ is generated from EGG^{true}, with observation error.

•Fecundity is modelled as a function of the age composition of the stock and is consistent with the assessment model (see section 5.6 for a more detailed description).

•The assessment is simplified by introducing uncertainty and bias to generate a “perceived” SSB.

Fishery model

Both fisheries, the one that catches primarily juveniles and the one that catches adults, need to be regulated. Therefore, exploitation patterns estimated for each fleet were taken into account in the operating model. The WGMHSA (ICES 2003) examined the selectivity patterns in the juvenile and adult area fleets (Fig. 2) showing that the proportion of juveniles caught in the juvenile area is much larger compared to the adult area. The selection patterns derived from that analysis were used in the model.

Stock assessment

The assessment was simulated by introducing bias and error.

Implementation error model

For the purpose of this simulation testing exercise, the overshoot will be a function of the EU TAC, with random variation added (see 2005 WG report).

Performance statistics

The following performance statistics will be computed to provide managers and stakeholders with the tools to make an informed decision between the strategies presented:

Risk SSB<$B_{threshold}$: probability of the SSB falling at least once within the simulation period below one of the biomass reference points. $B_{threshold}$, equated to the biomass that produced the extraordinary 1982 year-class, should be kept consistent with the assessment results.

Mean catch: median value over 500 simulations of the average of 20 years of annual catch.

End SSB: median values over 500 simulations of the biomass at the end of the 20-year projection period.

Median interannual catch variability: median value over 500 simulations of the average 20-year interannual catch variability (*ICV*).

Stochasticity
See comments under operating model and formulation in the 2005 WG report.

Choice of simulation period
Given the spasmodic nature of recruitment, the simulation period needs to be sufficiently long on average for at least one major episodic events to be included. Managers may wish to consider how they want to make best use of an outstanding year class, so the simulation period should ideally see such a year class through until it has disappeared from the fishery. In practice, the simulation period should be fixed, and given that SAD models 10 true ages, the simulation period was fixed to 20 years.

TAC Strategies Tested

Results from 500 simulations are presented for three types of three-year TAC strategies:

1) Slope strategy a). The TAC is last year's TAC adjusted by a function of the trend in the last 3 egg survey data, *f*(*slope*), but subject to a minimum:

$$TAC_y = \max\left\lfloor \beta\, TAC_{y-1}\, f(slope)\, ;\, TAC_{\min} \right\rfloor$$

This formulation ensures a minimum TAC of TAC_{min}, unless the stock is depleted and is unable to support this minimum.

2) Slope strategy b). The TAC is a weighted average between a reference TAC, TAC_{ref}, and last year's TAC, which is adjusted by a function of the trend in the last 3 egg survey data, *f*(*slope*):

$$TAC_y = \beta\left\lfloor wTAC_{ref} + (1-w)TAC_{y-1}\, f(slope) \right\rfloor$$

The function of the slope, *f*(*slope*), which takes values between 0 and 1.4, is illustrated in Figure 4. This strategy caps the TAC upwards so that it cannot increase from one TAC year to the next by more than 40% but it can be decreased to zero where no minimum is imposed. Both the *TACmin* and the term that includes *TACref* ensure that fishery closures are kept to a minimum.

3) Constant proportion. The TAC is computed as a fraction, *α*, of the estimated SSB.

$$TAC_y = \alpha\, SSB_y$$

The results from the HCRs described above are presented for fractions (*γ*) taken by the juvenile area fleet equal to 0.3, 0.5 and 0.7 of the total TAC (Appendix).

The effects of overshooting the TAC were tested for the base case scenario.

Input data

Age	Sel Ad Fl	Sel Ad Fl	N at age	wt stock	wt catch
0	0	0	3792824	0	0.021
1	0	0.5004869	5472810	0	0.054
2	0.00361032	0.70677999	4796290	0.057	0.08
3	0.05658913	1	9372830	0.09	0.103
4	0.27037924	0.89861516	1389400	0.103	0.121
5	0.294215	0.93151315	1727880	0.126	0.138
6	0.57488253	0.8708306	957720	0.15	0.155
7	0.74411028	0.74922838	525810	0.158	0.167
8	0.99322926	0.68039835	436891	0.172	0.191
9	0.85054476	0.66246576	529486	0.184	0.208
10	0.85421785	0.32712628	871100	0.218	0.232
11+	1	0.22258683	1543850	0.247	0.299

Table 5.11.1. Selectivity at age for the adult and juvenile fleets, weight at age in the catch and in the stock and, initial numbers at age data used as starting values in the predictions.

<u>Results from the F-PRESS simulation framework</u>

Table 5.11.2 : Western Horse Mackerel – F-PRESS results for the constant catch strategy

Catch (kT)	Risk to SSB_{1982}	Yield (kT)	Variability in Yield
100	0.7	100	0
125	1.0	125	0
150	1.8	150	0
175	7.9	175	0
200	24.3	200	0.01
225	41.8	220	0.05
250	53.3	231	0.16
275	62.0	224	0.37
300	67.1	217	0.53

Table 5.11.3 : Western Horse Mackerel – F-PRESS results for the linear reduction HCR

Catch (kT)	Risk to SSB_{1982}	Yield (kT)	Variability in Yield
100	0.7	98	0.02
125	0.7	122	0.02
150	1.0	145	0.02
175	3.9	166	0.03
200	15.1	184	0.06
225	32.5	197	0.11
250	47.9	202	0.18
275	56.0	208	0.26
300	64.0	207	0.34

The F-PRESS stochastic simulation model (ICES 2006) has been applied to the Western Horse Mackerel stock in order to examine the robustness of simple catch strategies for the stock. The simulation used identical initialisation data and equivalent bias and noise estimates to the simulations of Roel and De Oliveira (2006) described in section 5.11.

Two approaches were taken: the constant catch strategy and a harvest control rule which reduces the catch on an annual basis when the simulated SSB falls below a predetermined value of SSB (B_{hcr}). Simulations were completed for a range of catches (100-300kT).

Reference : ICES 2006, Report of the Methods Working Group

Results

Given uncertainty on the actual biomass level of the stock the emphasis when presenting results was put on the performance statistics that relate to conservation and variability in TACs. Predicted SSB at the end of the projection period and the risk of falling below threshold SSB (B_{thr}) which corresponds to SSB in 1982 and to $B_{loss,}$, were presented for a range of average annual catch. The reference to B_{loss} is relative because it was estimated by the assessment model used. An evaluation of the HCRs presented follow.

- The slope function a) that results in a rapid increase when the slope is positive and slow decrease when the slope is negative (Fig. 5.11.1-2) performs better than the reverse function. Further comparisons are based on the slow decrease function of the slope.
- If stability in the catch is a management objective, slope strategy b) should be preferred to the slope a) strategy as it allows control on the fraction of the TAC that remains fixed from one period to the next (Fig. 5.11.4).
- If the assessment is not biased the constant proportion strategy outperforms the slope strategies (Fig. 5.11.3).
- If the assessment is biased that would have a negative effect on the performance of the constant proportion strategy, particularly when exploitation is moderate or high (5.11.6).The constant proportion strategy results in lower risk of SSB< B_{thr} throughout the projected period than the slope b) (weight = 0.5) for the assessment bias scenarios considered (5.11.6). At low or moderate levels of exploitation a strategy close to constant catch performs well compared to the more variable options considered (Fig. 5.11.5).
- An increase in the proportion of the catch taken in the juvenile area (from 30% to 70%) results in a slight increase in associated risk (Fig. 5.11.7).
- Overshooting the TAC at the levels seen historically (resulting from the mis-match between the fishery and management area) will practically double the risk associated with a given strategy.The HCRs presented still need to be tested against alternative recruitment scenarios such as no spasmodic large recruitment, more pessimistic Ricker curve and additional uncertainty in stock dynamics.

The results from the F-PRESS simulation testing are in broad agreement with those presented in section above by Roel & De Oliveira and indicate that for the constant catch strategy, the risk to SSB rises significantly when catches exceed 150kT. In the case of the harvest control rule, this limit is approximately 175kT.

5.12 Management considerations

There are indications that the 2001 year-class is strong given that this year class is now well recruited to the fishery. However, this year-class does not appear to be of the same order of magnitude as the 1982 year-class although is at similar level as those in the mid-90s. The current catch in the juvenile area accounts for 38% of the total catch and, according to the models the fishery is not particularly selecting this year-class therefore the WG has some confidence on the estimates of the strength of the 2001 year-class. Short-term predictions were performed in an attempt to provide some guidance on a sustainable catch in 2007. The results suggest that given the uncertainty in the current stock level it is not possible to provide a realistic short-term forecast.

So far, the juvenile fishery in the Western stock distribution area has mainly taken place in Divisions VIIe,f,g,h and VIIIa-d. From about 1994 onwards the fishery shifted from a fishery on adults towards a fishery on juveniles. This may be due to the lack of older fish (decline of the 1982 year class) and the development of a market for juveniles. The percentage of catch (in weight) in the juvenile areas increased gradually from about 40% in 1997 to about 65% in 2003 and dropped to 46% in 2005.

The TAC has only been given for parts of the distribution and fishing areas (EU waters). The Working Group advises that if a TAC is set for this stock, it should apply to all areas where western horse mackerel are caught, i.e. Divisions IIa, IIIa (western part), IVa, Vb, VIa, VIIa–c, e–k and VIIIa-e. Note that Div. VIIIc is now included in the Western stock distribution area. If the management area limits were revised, measures should be taken to ensure that misreporting of juvenile catch taken in VIIe,h and VIId (the latter then belonging to the North Sea stock management area) is effectively hindered. This could be done for example by imposing a separate TAC for the juvenile areas of both neighbouring stocks. This mis-match between TAC and fishing areas has resulted in the catch exceeding those advised by ICES.

Table 5.2.1 HORSE MACKEREL general. Landings (t) in Subarea II. (Data as submitted by Working Group members.)

Country	1980	1981	1982	1983	1984	1985	1986	1987
Denmark	-	-	-	-	-	-	-	39
France	-	-	-	-	1	1	-[2]	-[2]
Germany, Fed.Rep	-	+	-	-	-	-	-	-
Norway	-	-	-	412	22	78	214	3,272
USSR	-	-	-	-	-	-	-	-
Total	-	+	-	412	23	79	214	3,311

	1988	1989	1990	1991	1992	1993	1994	1995
Faroe Islands	-	-	9643	1,115	9,157[3]	1,068	-	950
Denmark	-	-	-	-	-	-	-	200
France	-2	-	-	-	-	-	55	-
Germany, Fed. Rep.	64	12	+	-	-	-	-	-
Norway	6,285	4,770	9,135	3,200	4,300	2,100	4	11,300
USSR / Russia (1992 -)	469	27	1,298	172	-	-	700	1,633
UK (England + Wales)	-	-	17		-	-	-	-
Total	6,818	4,809	11,414	4,487	13,457	3,168	759	14,083

	1996	1997	1998	1999	2000	2001	2002	2003
Faroe Islands	1,598	799[3]	188[3]	132[3]	250[3]	-		
Denmark	-	-	1,755[3]			-		
France	-	-	-			-		
Germany	-	-	-			-		
Norway	887	1,170	234	2,304	841	44	1,321	22
Russia	881	648	345	121	84[3]	16	3	2
UK (England + Wales)	-	-	-			-		
Estonia	-	-	22					
Total	3,366	2,617	2,544	2557	1175	60	1,324	24

	2004	2005[1]
Faroe Islands	-	-
Denmark	-	-
France	-	-
Germany	-	-
Norway	42	176
Russia		
UK (England + Wales)	-	-
Estonia	-	-
Total	42	176

[1]Preliminary.
[2]Included in Subarea IV.
[3]Includes catches in Division Vb.

Table 5.2.2 HORSE MACKEREL general. Landings (t) in North Sea Subarea IV and Skagerrak Division IIIa by country. (Data submitted by Working Group members). Catches partly concern the North Sea horse mackerel.

Country	1980	1981	1982	1983	1984	1985	1986	1987	1988
Belgium	8	34	7	55	20	13	13	9	10
Denmark	199	3,576	1,612	1,590	23,730	22,495	18,652	7,290	20,323
Faroe Islands	260	-	-	-	-	-	-	-	-
France	292	421	567	366	827	298	231[2]	189[2]	784[2]
Germany, Fed.Rep.	+	139	30	52	+	+	-	3	153
Ireland	1,161	412	-	-	-	-	-	-	-
Netherlands	101	355	559	2,029[3]	824	160[3]	600[3]	850[4]	1,060[3]
Norway[2]	119	2,292	7	322	[3]	203	776	11,728[4]	34,425[4]
Poland	-	-	-	2	94	-	-	-	-
Sweden	-	-	-	-	-	-	2	-	-
UK (Engl. + Wales)	11	15	6	4	-	71	3	339	373
UK (Scotland)	-	-	-	-	3	998	531	487	5,749
USSR	-	-	-	-	489	-	-	-	-
Total	2,151	7,253	2,788	4,420	25,987	24,238	20,808	20,895	62,877

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997
Belgium	10	13	-	+	74	57	51	28	-
Denmark	23,329	20,605	6,982	7,755	6,120	3,921	2,432	1,433	648
Estonia	-	-	-	293	-		17	-	-
Faroe Islands	-	942	340	-	360	275	-	-	296
France	248	220	174	162	302		-	-	-
Germany, Fed.Rep.	506	2,469[5]	5,995	2,801	1,570	1,014	1,600	7	7,603
Ireland	-	687	2,657	2,600	4,086	415	220	1,100	8,152
Netherlands	14,172	1,970	3,852	3,000	2,470	1,329	5,285	6,205	37,778
Norway	84,161	117,903	50,000	96,000	126,800	94,000	84,747	14,639	45,314
Poland	-	-	-	-	-	-	-	-	-
Sweden	-	102	953	800	697	2,087	-	95	232
UK (Engl. + Wales)	10	10	132	4	115	389	478	40	242
UK (N. Ireland)	-	-	350	-	-		-	-	-
UK (Scotland)	2,093	458	7,309	996	1,059	7,582	3,650	2,442	10,511
USSR / Russia (1992 -)	-	-	-						
Unallocated + discards	12,482[4]	-317[4]	-750[4]	-278[6]	-3,270	1,511	-28	136	-31,615
Total	112,047	145,062	77,904	114,133	140,383	112,580	98,452	26,125	79,161

Country	1998	1999	2000	2001	2002	2003	2004	2005[1]
Belgium	19	21	19	19	1,004	5	4	6
Denmark	2,048	8,006	4,409	2,288	1,393	3,774	8,735	4,258
Estonia	22	-	-					
Faroe Islands	28	908	24	-	699	809		35
France	379	60	49	48	-	392	174	3,876
Germany	4,620	4,071	3,115	230	2,671	3,048	4,905	1,811
Ireland	-	404	103	375	72	93	379	753
Netherlands	3,811	3,610	3,382	4,685	6,612	17,354	21,418	24,679
Norway	13,129	44,344	1,246	7,948	35,368	20,493	10,709	24,937
Russia	-	-	2	-	-	-		
Sweden	3,411	1,957	1,141	119	575	1,074	665	239
UK (Engl. + Wales)	2	11	15	317	1,191	1,192	2,552	1,778
UK (Scotland)	3,041	1,658	3,465	3,161	255	1	1	22
Unallocated + discards	737	-325	14613	649	-149	-14,009	-19,103	-21,830
Total	31,247	64,725	31583	19,839	49,691	34,226	30,435	40,564

[1]-Preliminary. [2] Includes Division IIa. [3] Estimated from biological sampling. [4] Assumed to be misreported. [5] Includes 13 t from the German Democratic Republic. [6] Includes a negative unallocated catch of -4000 t.

Table 5.2.3 HORSE MACKEREL general. Landings (t) in Subarea VI by country.
(Data submitted by Working Group members).

Country	1980	1981	1982	1983	1984	1985	1986	1987	1988
Denmark	734	341	2,785	7	-	-	-	769	1,655
Faroe Islands	-	-	1,248	-	-	4,014	1,992	4,450[3]	4,000[3]
France	45	454	4	10	14	13	12	20	10
Germany, Fed. Rep.	5,550	10,212	2,113	4,146	130	191	354	174	615
Ireland	-	-	-	15,086	13,858	27,102	28,125	29,743	27,872
Netherlands	2,385	100	50	94	17,500	18,450	3,450	5,750	3,340
Norway	-	5	-	-	-		83	75	41
Spain	-	-	-	-	-		-[2]	-[2]	-[2]
UK (Engl. + Wales)	9	5	+	38	+	996	198	404	475
UK (N. Ireland)						-	-	-	-
UK (Scotland)	1	17	83	-	214	1,427	138	1,027	7,834
USSR	-	-	-		-	-	-	-	-
Unallocated + disc.						-19,168	-13,897	-7,255	-
Total	8,724	11,134	6,283	19,381	31,716	33,025	20,455	35,157	45,842

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997
Denmark	973	615	-	42	-	294	106	114	780
Faroe Islands	3,059	628	255	-	820	80	-	-	-
France	2	17	4	3	+	-	-	-	52
Germany, Fed. Rep.	1,162	2,474	2,500	6,281	10,023	1,430	1,368	943	229
Ireland	19,493	15,911	24,766	32,994	44,802	65,564	120,124	87,872	22,474
Netherlands	1,907	660	3,369	2,150	590	341	2,326	572	498
Norway	-	-	-	-	-	-	-	-	-
Spain	-2	-2	1	3	-	-	-	-	-
UK (Engl. + Wales)	44	145	1,229	577	144	109	208	612	56
UK (N.Ireland)	-	-	1,970	273	-	-	-	-	767
UK (Scotland)	1,737	267	1,640	86	4,523	1,760	789	2,669	14,452
USSR/Russia (1992-)	-	44	-	-	-	-	-	-	-
Unallocated + disc.	6,493	143	-1,278	-1,940	-6,960[4]	-51	-41,326	-11,523	837
Total	34,870	20,904	34,456	40,469	53,942	69,527	83,595	81,259	40,145

Country	1998	1999	2000	2001	2002	2003	2004	2005[1]
Denmark	-	-	-	-	-	-	-	-
Faroe Islands	-	-	-	-	-	-	-	-
France	221	25,007	-	428	55	209	172	41
Germany	414	1,031	209	265	149	1,337	1,413	1,958
Ireland	21,608	31,736	15,843	20,162	12,341	20,915	15,702	12,395
Netherlands	885	1,139	687	600	450	847	3,701	6,039
Spain	-	-	-	-	-	-	-	-
UK (Engl. + Wales)	10	344	41	91	-	46	5	52
UK (N.Ireland)	1,132	-	-			453		210
UK (Scotland)	10,447	4,544	1,839	3,111	1,192		377	62
Unallocated +disc.	98	1,507	2,038	-21	3	-553	559	1,298
Total	34,815	65,308	20,657	24,636	14,190	23,254	21,929	22,055

[1]Preliminary.
[2]Included in Subarea VII.
[3]Includes Divisions IIIa, IVa,b and VIb.
[4]Includes a negative unallocated catch of -7000 t.

Table 5.2.4 HORSE MACKEREL general. Landings (t) in Subarea VII by country.
Data submitted by the Working Group members).

Country	1980	1981	1982	1983	1984	1985	1986	1987	1988
Belgium	-	1	1	-	-	+	+	2	-
Denmark	5,045	3,099	877	993	732	1,477[2]	30,408[2]	27,368	33,202
France	1,983	2,800	2,314	1,834	2,387	1,881	3,801	2,197	1,523
Germany, Fed.Rep.	2,289	1,079	12	1,977	228	-	5	374	4,705
Ireland	-	16	-	-	65	100	703	15	481
Netherlands	23,002	25,000	27,500[2]	34,350	38,700	33,550	40,750	69,400	43,560
Norway	394	-	-	-	-	-	-	-	-
Spain	50	234	104	142	560	275	137	148	150
UK (Engl. + Wales)	12,933	2,520	2,670	1,230	279	1,630	1,824	1,228	3,759
UK (Scotland)	1	-	-	-	1	1	+	2	2,873
USSR	-	-	-	-	-	120	-	-	-
Total	45,697	34,749	33,478	40,526	42,952	39,034	77,628	100,734	90,253

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997
Faroe Islands	-	28	-	-	-	-	-	-	-
Belgium	-	+	-	-	-	1	-	-	18
Denmark	34,474	30,594	28,888	18,984	16,978	41,605	28,300	43,330	60,412
France	4,576	2,538	1,230	1,198	1,001	-	-	-	27,201
Germany, Fed.Rep.	7,743	8,109	12,919	12,951	15,684	14,828	17,436	15,949	28,549
Ireland	12,645	17,887	19,074	15,568	16,363	15,281	58,011	38,455	43,624
Netherlands	43,582	111,900	104,107	109,197	157,110	92,903	116,126	114,692	81,464
Norway	-	-	-	-	-	-	-	-	-
Spain	14	16	113	106	54	29	25	33	-
UK (Engl. + Wales)	4,488	13,371	6,436	7,870	6,090	12,418	31,641	28,605	17,464
UK (N.Ireland)	-	-	2,026	1,690	587	119	-	-	1,093
UK (Scotland)	+	139	1,992	5,008	3,123	9,015	10,522	11,241	7,931
USSR / Russia (1992-)	-	-	-	-	-	-	-	-	-
Unallocated + discards	28,368	7,614	24,541	15,563	4,0103	14,057	68,644	26,795	58,718
Total	135,890	192,196	201,326	188,135	221,000	200,256	330,705	279,100	326,474

Country	1998	1999	2000	2001	2002	2003	2004	2005[1]
Faroe Islands	-	-	550	-	-	-	-	3,660
Belgium	18	-	-	-	1	-	+	+
Denmark	25,492	19,223	13,946	20,574	10,094	10,867	11,529	9,939
France	24,223	-	20,401	11,049	6,466	7,199	8,083	8,469
Germany	25,414	15,247	9,692	8,320	10,812	13,873	16,352	10,437
Ireland	51,720	25,843	32,999	30,192	23,366	13,533	8,470	20,406
Netherlands	91,946	56,223	50,120	46,196	37,605	48.222	41,123	31,156
Spain	-	-	50	7	0	1	27	12
UK (Engl. + Wales)	12,832	8,885	2,972	8,901	5,525	4,186	7,178	4,752
UK (N.Ireland)	-	-	-	-	-			217
UK (Scotland)	5,095	4,994	5,152	1,757	1,461	268	1,146	59
Unallocated + discards	12,706	31,239	1,884	11,046	2,576	24,897	18,485	18,368
Total	249,446	161,654	137,766	138,042	97,906	123,046	112,393	107,475

[1]Provisional.
[2]Includes Subarea VI.

Table 5.2.5 HORSE MACKEREL general. Landings (t) in Subarea VIII by country.
(Data submitted by Working Group members).

Country	1980	1981	1982	1983	1984	1985	1986	1987	1988
Denmark	-	-	-	-	-	-	446	3,283	2,793
France	3,361	3,711	3.073	2,643	2,489	4,305	3,534	3,983	4,502
Netherlands	-	-	-	-	-[2]	-[2]	-[2]	-[2]	-
Spain	34,134	36,362	19,610	25,580	23,119	23,292	40,334	30,098	26,629
UK (Engl. + Wales)	-	+	1	-	1	143	392	339	253
USSR	-	-	-	-	20	-	656	-	-
Total	37,495	40,073	22,684	28,223	25,629	27,740	45,362	37,703	34,177

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997
Denmark	6,729	5,726	1,349	5,778	1,955	-	340	140	729
France	4,719	5,082	6,164	6,220	4,010	28	-	7	8,690
Germany, Fed. Rep.	-	-	80	62	-		-	-	-
Netherlands	-	6,000	12,437	9,339	19,000	7,272	-	14,187	2,944
Spain	27,170	25,182	23,733	27,688	27,921	25,409	28,349	29,428	31,081
UK (Engl. + Wales)	68	6	70	88	123	753	20	924	430
USSR/Russia (1992 -)	-	-	-	-	-	-	-	-	-
Unallocated + discards	-	1,500	2,563	5,011	700	2,038	-	3,583	-2,944
Total	38,686	43,496	46,396	54,186	53,709	35,500	28,709	48,269	40,930

Country	1998	1999	2000	2001	2002	2003	2004	2005[1]
Denmark	1,728	4,818	2,584	582	-	-		-
France	1,844	74	7	5,316	13,676	-	2,161	3,540
Germany	3,268	3,197	3,760	3,645	2,249	4,908	72	4,776
Ireland	-	-	6,485	1,483	704	504	1,882	1,808
Netherlands	6,604	22,479	11,768	36,106	12,538	1,314	1,047	6,607
Russia	-	-	-	-	-	6,620		
Spain	23,599	24,190	24,154	23,531	22,110	24,598	16,245	16,624
UK (Engl. + Wales)	9	29	112	1,092	157	982	516	838
UK (Scotland)	-	-	249	-	-	-		-
Unallocated + discards	1,884	-8658	5,093	4,365	1,705	2,785	2,202	7,302
Total	38,936	46,129	54,212	76,120	54,560	41,711	24,125	41,495

[1]Preliminary.
[2]Included in Subarea VII.

Table 5.3.2.1.- length distribution (in proportion) of Horse Mackerel from French pelagic survey PELGAS (spring)

Length_cm	PEL00	PEL01	PEL02	PEL03	PEL04	PEL05	PEL06
8	0	0	0	0	0	0.05	0
9	0.08	0	0.11	0	0.18	2.15	0
10	0.45	0	0.84	0	5.17	13.05	0.06
11	5.69	0.24	5.70	0.00	22.16	16.63	0.29
12	28.82	1.75	20.21	0.02	21.85	5.13	2.06
13	33.54	7.45	35.02	1.81	15.99	0.68	3.38
14	8.35	9.92	16.68	0.84	9.44	0.09	1.35
15	5.97	7.99	6.90	1.65	3.38	0.33	1.61
16	2.40	1.13	0.48	17.68	0.31	1.58	3.78
17	1.24	7.87	0.40	29.88	0.66	2.84	6.55
18	0.04	16.69	0.34	24.53	1.83	4.02	3.35
19	0.02	14.36	0.12	10.85	8.44	4.39	6.72
20	0.07	6.76	1.21	5.21	7.59	4.31	17.73
21	0.30	5.82	3.72	1.31	1.51	12.93	12.46
22	0.53	4.61	3.71	0.49	0.40	16.29	11.84
23	1.69	2.97	1.83	0.29	0.22	6.23	12.92
24	3.69	3.47	0.83	0.52	0.12	2.70	6.68
25	3.44	3.21	0.59	0.84	0.22	0.93	2.81
26	1.33	2.05	0.50	1.14	0.18	1.85	1.67
27	0.62	0.68	0.26	1.03	0.08	1.86	1.36
28	0.49	0.43	0.19	0.78	0.12	0.63	1.13
29	0.40	0.24	0.20	0.40	0.03	0.58	1.15
30	0.18	0.05	0.06	0.38	0.06	0.28	0.49
31	0.24	0.14	0.03	0.19	0.04	0.14	0.36
32	0.12	0.10	0.03	0.06	0.01	0.07	0.06
33	0.08	0.62	0.02	0.03	0.01	0.08	0.11
34	0.05	0.69	0.02	0.04	0.00	0.07	0.05
35	0.04	0.46	0.01	0.01	0.00	0.04	0.05
36	0.02	0.27	0.01	0.01	0.00	0.04	0.01
37	0	0.03	0.00	0.02	0	0.03	0
38	0.03	0.00	0	0.01	0	0.02	0
39	0	0.00	0.00	0.00	0	0	0
40	0.04	0.01	0	0	0	0	0.00
41	0	0.00	0.00	0	0.00	0	0
42	0.03	0	0	0	0	0	0
43	0	0.00	0	0	0	0	0
total	100	100	100	100	100	100	100

Table 5.5.1.1 Western Horse Mackerel stock. Catch in numbers (1000) at age by quarter and area in 2005

1Q Ages	IVa	IIa	Vb	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIc east	VIIIc W	VIIIb	VIIId	Total
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	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	818.1	0.0	0.0	818.1
2	0.0	0.0	0.0	0.0	188.0	0.0	0.0	2604.2	0.3	2.8	72118.7	894.8	0.0	1038.0	10228.8	100.0	0.0	87175.8
3	64.0	1.9	0.0	254.9	339.8	2057.4	186.3	4586.0	0.5	4.9	130907.8	23955.3	17295.1	406.7	314.2	384.0	394.6	181153.3
4	533.1	15.6	0.0	2365.5	48.3	14824.2	1309.3	909.2	0.1	1.0	36412.5	53123.9	126830.9	1518.0	512.0	1946.3	2893.8	243243.7
5	214.2	6.3	0.0	987.0	1.2	5569.4	491.5	142.3	0.0	0.2	437.9	6017.9	0.0	467.2	118.8	520.7	0.0	14974.4
6	684.2	20.0	0.0	3206.8	3.7	11584.1	1072.0	515.7	0.1	0.6	4472.3	7236.1	0.0	358.7	206.5	253.3	0.0	29614.1
7	484.0	14.2	0.0	1877.6	0.0	6038.3	581.1	144.0	0.0	0.2	0.0	5864.8	0.0	457.0	280.0	303.0	0.0	16044.1
8	237.3	7.0	0.0	1000.5	1.9	3272.1	279.6	142.2	0.0	0.2	2235.8	3486.4	0.0	421.3	356.2	195.8	0.0	11636.2
9	220.1	6.4	0.0	1191.4	1.9	3131.8	303.0	81.2	0.0	0.1	2235.8	1653.3	0.0	482.1	346.4	270.3	0.0	9923.7
10	332.1	9.7	0.0	1654.7	1.9	3285.6	358.7	172.8	0.0	0.2	2235.8	1013.6	0.0	208.0	195.1	150.8	0.0	9619.0
11	443.8	13.0	0.0	2111.2	3.7	4704.7	435.8	227.8	0.0	0.2	4472.3	3590.6	0.0	972.9	898.9	492.9	0.0	18367.8
12	280.9	8.2	0.0	1142.1	0.0	3031.4	291.3	26.2	0.0	0.0	0.0	1084.8	0.0	149.8	165.2	83.5	0.0	6263.5
13	198.3	5.8	0.0	887.0	0.0	635.8	68.5	82.9	0.0	0.1	0.0	1560.0	0.0	105.4	183.4	52.6	0.0	3779.8
14	127.8	3.7	0.0	550.4	0.0	934.6	100.5	113.5	0.0	0.1	0.0	1756.7	0.0	36.2	38.1	13.5	0.0	3675.2
15+	827.6	24.2	0.0	4109.9	0.0	2891.6	314.7	126.5	0.0	0.1	0.0	1454.3	0.0	105.0	229.0	20.0	0.0	10102.8

2Q Ages	IVa	IIa	Vb	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIc east	VIIIc W	VIIIb	VIIId	Total
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	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	0.0	0.1	0.1	0.0	203.0	2164.1	0.0	0.0	16.9	2388.4
2	1233.5	0.0	0.0	0.0	0.0	0.0	0.0	114.6	0.3	1.9	1.5	0.0	5481.9	10358.8	1503.2	1503.2	457.0	20656.0
3	625.9	0.0	0.0	5.2	0.0	0.5	0.4	63.7	0.2	1.0	0.9	0.0	3045.4	270.6	852.8	852.8	253.9	5973.2
4	50.2	0.0	0.0	16.7	0.0	2.9	2.4	441.5	1.2	7.2	5.9	182.6	21115.2	1544.4	3081.0	3081.0	1760.3	31292.3
5	0.0	0.0	0.0	1.9	0.0	0.6	0.5	8.5	0.0	0.1	0.1	4762.5	406.2	496.5	876.4	876.4	33.9	7463.7
6	0.0	0.0	0.0	4.3	0.0	1.1	0.9	0.0	0.0	0.0	0.0	5310.4	0.0	311.5	732.8	732.8	0.0	7093.9
7	3.7	0.0	0.0	3.0	0.0	0.7	0.6	0.0	0.0	0.0	0.0	14979.3	0.0	392.2	908.6	908.6	0.0	17196.7
8	1.8	0.0	0.0	1.5	0.0	0.4	0.3	0.0	0.0	0.0	0.0	14065.9	0.0	314.0	934.6	934.6	0.0	16253.2
9	1.8	0.0	0.0	1.4	0.0	0.3	0.3	0.0	0.0	0.0	0.0	365.3	0.0	366.0	901.9	901.9	0.0	2539.1
10	1.8	0.0	0.0	2.1	0.0	0.4	0.3	0.0	0.0	0.0	0.0	4031.9	0.0	191.7	508.9	508.9	0.0	5246.0
11	7.4	0.0	0.0	2.8	0.0	0.5	0.4	0.0	0.0	0.0	0.0	6184.7	0.0	827.7	2452.4	2452.4	0.0	11928.2
12	3.7	0.0	0.0	1.8	0.0	0.3	0.3	0.0	0.0	0.0	0.0	3940.5	0.0	142.3	430.5	430.5	0.0	4949.8
13	5.5	0.0	0.0	1.2	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	104.8	442.2	442.2	0.0	996.0
14	1.8	0.0	0.0	0.8	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	31.4	79.3	79.3	0.0	192.9
15+	16.5	0.0	0.0	5.2	0.0	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	88.6	425.8	425.8	0.0	962.7

3Q Ages	IVa	IIa	Vb	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIc east	VIIIc W	VIIIb	VIIId	Total
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	419.5	6.7	177.7	0.0	603.9
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	250.6	0.0	0.0	0.2	0.3	41.7	8216.0	568.6	4267.9	0.0	13345.3
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2507.1	0.0	0.3	2.0	0.3	414.1	2283.9	1909.9	2811.3	1.0	9929.9
3	8.9	6.3	0.0	2558.7	0.0	92.0	0.0	6351.4	0.0	0.5	3.9	25.2	799.3	1103.6	3946.3	405.2	2.2	15303.3
4	34.4	24.6	0.0	7164.5	0.0	424.0	0.0	5014.1	0.0	0.4	3.5	124.2	724.6	2521.4	6565.6	0.8	5.1	22607.2
5	43.5	31.0	0.0	282.2	0.0	24.8	0.0	167.3	0.0	0.0	0.2	10.1	46.2	1600.2	2825.1	0.8	0.2	5031.6
6	69.6	49.7	0.0	0.0	0.0	21.5	0.0	0.0	0.0	0.0	0.0	8.1	0.0	1640.2	1623.7	1.1	0.1	3413.9
7	85.9	61.3	0.0	0.0	0.0	42.8	0.0	0.0	0.0	0.0	0.0	19.7	0.0	749.4	667.2	0.9	0.1	1627.2
8	46.4	33.1	0.0	0.0	0.0	49.0	0.0	83.6	0.0	0.0	0.0	18.6	8.5	814.1	708.0	1.1	0.0	1762.6
9	16.3	11.7	0.0	0.0	0.0	23.4	0.0	0.0	0.0	0.0	0.0	2.0	0.0	648.6	736.8	1.6	0.0	1440.4
10	37.9	27.0	0.0	0.0	0.0	35.2	0.0	0.0	0.0	0.0	0.0	6.7	0.0	297.4	419.0	1.2	0.0	824.5
11	39.5	28.2	0.0	0.0	0.0	35.2	0.0	0.0	0.0	0.0	0.0	9.0	0.0	681.2	923.9	1.4	0.0	1718.3
12	67.5	48.1	0.0	0.0	0.0	23.4	0.0	0.0	0.0	0.0	0.0	5.8	0.0	567.9	650.9	0.8	0.0	1364.5
13	13.9	9.9	0.0	0.0	0.0	11.7	0.0	0.0	0.0	0.0	0.0	0.8	0.0	155.1	432.6	0.4	0.0	624.5
14	22.7	16.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	149.1	200.5	0.2	0.0	388.7
15+	64.1	45.7	0.0	0.0	0.0	11.7	0.0	0.0	0.0	0.0	0.0	0.8	0.0	11.9	424.3	0.1	0.0	558.6

4Q Ages	IVa	IIa	Vb	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIc east	VIIIc W	VIIIb	VIIId	Total
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	207.3	0.0	449.0	0.0	656.3
1	0.0	0.0	0.0	0.0	2.8	0.0	0.0	1314.5	0.0	0.0	528.7	106.7	42.7	8591.1	5.4	26061.4	5.1	36658.4
2	0.0	0.0	0.0	37.8	65.4	27.7	0.0	16341.2	0.7	1.0	9266.5	106.7	6625.7	5068.2	271.6	2235.9	115.2	40163.5
3	1112.8	0.0	0.0	11860.2	56.2	3795.8	0.0	21205.9	0.6	1.8	36770.1	3510.2	26837.5	2061.4	324.1	455.1	201.3	108193.0
4	4316.8	0.0	0.0	46600.8	78.0	22748.4	0.0	24321.9	0.8	4.2	77745.3	17033.2	40412.6	1439.4	1075.0	28.7	468.0	236273.1
5	5452.8	0.0	0.0	12849.9	14.4	6371.8	0.0	3432.2	0.2	0.4	8092.2	256.0	3812.1	839.3	725.9	12.4	41.6	41901.1
6	8730.5	0.0	0.0	4986.8	9.5	10855.2	0.0	1542.8	0.1	0.3	6185.6	0.0	1206.0	629.1	799.8	10.8	31.9	34988.5
7	10770.4	0.0	0.0	8650.6	1.1	5333.6	0.0	463.9	0.0	0.1	1192.9	0.0	588.8	241.6	401.5	8.5	9.1	27662.0
8	5819.0	0.0	0.0	3847.1	0.1	3065.3	0.0	11.4	0.0	0.0	772.5	0.0	346.7	348.4	493.3	13.7	2.7	14720.1
9	2047.9	0.0	0.0	1703.0	0.0	3766.1	0.0	0.0	0.0	0.1	1003.5	0.0	0.0	308.8	437.4	12.4	6.3	9285.6
10	4750.6	0.0	0.0	2360.5	0.0	3676.7	0.0	0.0	0.0	0.0	741.5	0.0	0.0	122.3	268.7	9.4	4.6	11934.5
11	4951.4	0.0	0.0	1572.0	0.8	2424.3	0.0	420.5	0.0	0.1	1487.8	0.0	0.0	292.4	658.0	10.4	5.9	11823.6
12	8457.1	0.0	0.0	753.0	0.0	926.7	0.0	0.0	0.0	0.1	902.7	0.0	0.0	212.2	446.8	6.6	5.6	11710.8
13	1747.3	0.0	0.0	0.0	0.0	53.2	0.0	0.0	0.0	0.0	43.2	0.0	0.0	49.8	248.4	2.7	0.3	2144.9
14	2845.9	0.0	0.0	0.0	0.0	33.0	0.0	0.0	0.0	0.0	528.7	0.0	0.0	59.5	136.0	1.9	1.0	3606.0
15+	8034.4	0.0	0.0	0.0	0.0	204.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	243.6	0.6	0.0	8487.8

1-4Q Ages	IVa	IIa	Vb	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIc east	VIIIc W	VIIIb	VIIId	Total
0	0.0	0.0	0.0	0.0	2.8	0.0	0.0	1569.4	0.0	0.1	528.9	107.0	287.4	18971.1	1392.0	48627.2	22.0	71508.1
1	1233.5	0.0	0.0	37.8	253.4	27.7	0.0	21567.1	1.3	5.9	81388.8	1001.8	12521.6	18748.9	13913.6	19661.7	573.2	170936.4
2	1811.5	8.2	0.0	14678.9	396.0	5945.7	186.7	32206.9	1.3	8.2	167682.6	27490.7	47977.3	3842.4	5437.4	1559.0	852.0	310084.8
3	4934.5	40.2	0.0	56147.4	126.3	37999.6	1311.7	30686.7	2.2	12.7	114167.3	70463.9	189083.4	7023.1	11233.6	2861.9	5127.1	531221.5
4	5710.5	37.3	0.0	14121.1	15.6	11966.6	492.0	3750.3	0.2	0.7	8530.4	11046.5	4264.5	3403.2	4546.2	598.8	75.7	68559.2
5	9484.3	69.7	0.0	8197.9	13.2	22462.0	1073.0	2058.5	0.2	0.8	10657.9	12554.6	1206.0	2939.5	3362.8	279.9	32.0	74392.3
6	11343.9	75.4	0.0	10531.2	1.1	11415.4	581.6	607.8	0.0	0.2	1192.9	20863.8	588.8	1840.2	2257.4	332.3	9.1	61641.2
7	6104.5	40.1	0.0	4849.1	1.9	6386.8	279.9	237.2	0.0	0.2	3008.4	17570.9	355.2	1897.9	2492.1	227.1	2.7	43454.0
8	2286.2	18.1	0.0	2895.8	1.9	6921.7	303.3	81.2	0.0	0.1	3239.3	2020.6	0.0	1805.5	2422.5	301.2	6.3	22303.7
9	5122.5	36.8	0.0	4017.3	1.9	6997.9	359.1	172.8	0.0	0.2	2977.3	5052.2	0.0	819.5	1391.7	172.9	4.6	27126.5
10	5442.1	41.2	0.0	3686.0	4.5	7164.6	436.2	648.3	0.0	0.3	5960.2	9784.3	0.0	2774.2	4933.1	549.7	5.9	41430.5
11	8809.2	56.3	0.0	1896.8	0.0	3981.9	291.6	26.2	0.0	0.1	902.7	5031.1	0.0	1072.3	1693.5	100.7	5.6	23868.0
12	1965.1	15.8	0.0	888.2	0.0	700.8	68.5	82.9	0.0	0.1	43.2	1560.8	0.0	415.1	1306.6	65.7	0.3	7113.0
13	2998.3	19.9	0.0	551.2	0.0	967.7	100.6	113.5	0.0	0.1	528.7	1756.7	0.0	276.2	453.9	17.3	1.0	7785.2
14	8942.6	69.9	0.0	4115.0	0.0	3108.5	315.0	126.5	0.0	0.1	0.0	1455.1	0.0	209.9	1322.7	36.3	0.0	19701.6
15+	76188.5	528.8	0.0	126613.7	818.6	126046.7	5799.1	93935.3	5.4	30.0	400808.6	187760.0	256284.2	66665.7	58165.7	76018.3	6717.6	1482386.1
	26285.0	176.9	0.0	22109.5	60.6	22208.2	1118.9	10112.8	0.5	3.0	33079.3	25996.7	23028.0	6299.0	8891.7	2969.5	549.4	182889.0

Table 5.5.2.1 Western Horse Mackerel stock. Mean weight (Kg) in catch at age by quarter and area in 2005

1Q Ages	IVa	IIa	Vb	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIc eas	VIIIc W	VIIIb	VIIId	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.032	0.016	0.000	0.000	0.016
2	0.000	0.000	0.000	0.000	0.045	0.000	0.000	0.059	0.059	0.059	0.045	0.085	0.000	0.075	0.070	0.106	0.000	0.049
3	0.119	0.119	0.000	0.113	0.060	0.108	0.114	0.087	0.087	0.087	0.060	0.090	0.076	0.117	0.103	0.110	0.076	0.067
4	0.137	0.137	0.000	0.135	0.099	0.127	0.131	0.118	0.118	0.118	0.084	0.095	0.081	0.140	0.133	0.119	0.081	0.089
5	0.185	0.185	0.000	0.194	0.235	0.145	0.161	0.186	0.186	0.186	0.235	0.129	0.000	0.154	0.176	0.132	0.000	0.146
6	0.224	0.224	0.000	0.228	0.107	0.163	0.167	0.181	0.181	0.181	0.107	0.152	0.000	0.181	0.219	0.150	0.000	0.161
7	0.250	0.250	0.000	0.257	0.000	0.191	0.195	0.233	0.233	0.233	0.000	0.178	0.000	0.182	0.227	0.148	0.000	0.196
8	0.251	0.251	0.000	0.256	0.100	0.193	0.231	0.214	0.214	0.214	0.100	0.200	0.000	0.196	0.231	0.160	0.000	0.186
9	0.235	0.235	0.000	0.239	0.112	0.205	0.209	0.212	0.212	0.212	0.112	0.174	0.000	0.190	0.227	0.159	0.000	0.183
10	0.272	0.272	0.000	0.274	0.130	0.233	0.237	0.264	0.264	0.264	0.130	0.205	0.000	0.190	0.254	0.154	0.000	0.213
11	0.282	0.282	0.000	0.280	0.143	0.200	0.214	0.305	0.305	0.305	0.143	0.205	0.000	0.190	0.247	0.156	0.000	0.200
12	0.319	0.319	0.000	0.333	0.000	0.262	0.273	0.341	0.341	0.341	0.000	0.198	0.000	0.197	0.261	0.162	0.000	0.264
13	0.366	0.366	0.000	0.371	0.000	0.367	0.343	0.372	0.372	0.372	0.000	0.210	0.000	0.200	0.270	0.160	0.000	0.291
14	0.285	0.285	0.000	0.269	0.000	0.378	0.347	0.383	0.383	0.383	0.000	0.217	0.000	0.201	0.257	0.164	0.000	0.277
15+	0.369	0.369	0.000	0.371	0.000	0.387	0.347	0.387	0.387	0.387	0.000	0.370	0.000	0.225	0.287	0.198	0.000	0.371

2Q Ages	IVa	IIa	Vb	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIc eas	VIIIc W	VIIIb	VIIId	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.048	0.048	0.048	0.048	0.000	0.048	0.025	0.032	0.019	0.048	0.027
2	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.047	0.047	0.047	0.047	0.000	0.047	0.040	0.081	0.038	0.047	0.044
3	0.056	0.000	0.000	0.121	0.000	0.120	0.120	0.073	0.073	0.073	0.073	0.000	0.073	0.130	0.118	0.088	0.073	0.082
4	0.072	0.000	0.000	0.138	0.000	0.134	0.134	0.078	0.078	0.078	0.078	0.159	0.078	0.144	0.143	0.094	0.078	0.090
5	0.000	0.000	0.000	0.178	0.000	0.162	0.162	0.113	0.113	0.113	0.113	0.145	0.113	0.152	0.156	0.113	0.113	0.141
6	0.000	0.000	0.000	0.224	0.000	0.170	0.170	0.000	0.000	0.000	0.000	0.157	0.000	0.174	0.194	0.167	0.000	0.162
7	0.292	0.000	0.000	0.250	0.000	0.193	0.193	0.000	0.000	0.000	0.000	0.185	0.000	0.177	0.196	0.158	0.000	0.184
8	0.357	0.000	0.000	0.251	0.000	0.220	0.220	0.000	0.000	0.000	0.000	0.193	0.000	0.194	0.218	0.197	0.000	0.194
9	0.355	0.000	0.000	0.235	0.000	0.209	0.209	0.000	0.000	0.000	0.000	0.198	0.000	0.191	0.207	0.184	0.000	0.195
10	0.316	0.000	0.000	0.272	0.000	0.233	0.233	0.000	0.000	0.000	0.000	0.195	0.000	0.206	0.223	0.190	0.000	0.198
11	0.360	0.000	0.000	0.282	0.000	0.214	0.214	0.000	0.000	0.000	0.000	0.227	0.000	0.192	0.221	0.198	0.000	0.218
12	0.368	0.000	0.000	0.319	0.000	0.272	0.272	0.000	0.000	0.000	0.000	0.210	0.000	0.231	0.237	0.211	0.000	0.213
13	0.321	0.000	0.000	0.366	0.000	0.335	0.335	0.000	0.000	0.000	0.000	0.000	0.000	0.213	0.248	0.230	0.000	0.237
14	0.375	0.000	0.000	0.285	0.000	0.347	0.347	0.000	0.000	0.000	0.000	0.000	0.000	0.232	0.219	0.214	0.000	0.221
15+	0.358	0.000	0.000	0.369	0.000	0.342	0.342	0.000	0.000	0.000	0.000	0.000	0.000	0.269	0.273	0.249	0.000	0.264

3Q Ages	IVa	IIa	Vb	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIc eas	VIIIc W	VIIIb	VIIId	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.023	0.030	0.019	0.000	0.022
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.051	0.000	0.062	0.062	0.051	0.062	0.033	0.035	0.032	0.076	0.033
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.097	0.000	0.098	0.098	0.078	0.098	0.069	0.097	0.052	0.086	0.078
3	0.214	0.214	0.000	0.130	0.000	0.138	0.000	0.098	0.000	0.102	0.102	0.130	0.102	0.097	0.113	0.056	0.097	0.107
4	0.264	0.264	0.000	0.140	0.000	0.145	0.000	0.107	0.000	0.111	0.111	0.141	0.111	0.154	0.133	0.154	0.103	0.132
5	0.265	0.265	0.000	0.157	0.000	0.164	0.000	0.157	0.000	0.159	0.159	0.153	0.159	0.166	0.144	0.163	0.123	0.154
6	0.307	0.307	0.000	0.000	0.000	0.175	0.000	0.000	0.000	0.000	0.000	0.169	0.000	0.181	0.167	0.171	0.129	0.179
7	0.325	0.325	0.000	0.000	0.000	0.191	0.000	0.000	0.000	0.000	0.000	0.185	0.000	0.197	0.191	0.188	0.139	0.206
8	0.333	0.333	0.000	0.000	0.000	0.218	0.000	0.180	0.000	0.180	0.180	0.190	0.180	0.193	0.190	0.191	0.130	0.198
9	0.344	0.344	0.000	0.000	0.000	0.213	0.000	0.000	0.000	0.000	0.000	0.202	0.000	0.186	0.221	0.214	0.000	0.208
10	0.387	0.387	0.000	0.000	0.000	0.186	0.000	0.000	0.000	0.000	0.000	0.193	0.000	0.210	0.263	0.228	0.000	0.250
11	0.397	0.397	0.000	0.000	0.000	0.215	0.000	0.000	0.000	0.000	0.000	0.224	0.000	0.199	0.269	0.236	0.000	0.245
12	0.419	0.419	0.000	0.000	0.000	0.255	0.000	0.000	0.000	0.000	0.000	0.221	0.000	0.211	0.256	0.228	0.000	0.251
13	0.395	0.395	0.000	0.000	0.000	0.221	0.000	0.000	0.000	0.000	0.000	0.221	0.000	0.239	0.296	0.262	0.000	0.284
14	0.479	0.479	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.207	0.251	0.226	0.000	0.257
15+	0.466	0.466	0.000	0.000	0.000	0.283	0.000	0.000	0.000	0.000	0.000	0.283	0.000	0.338	0.388	0.281	0.000	0.400

4Q Ages	IVa	IIa	Vb	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIc eas	VIIIc W	VIIIb	VIIId	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.022	0.000	0.024	0.000	0.023
1	0.000	0.000	0.000	0.000	0.079	0.000	0.000	0.083	0.079	0.086	0.100	0.051	0.091	0.037	0.056	0.030	0.086	0.035
2	0.000	0.000	0.000	0.107	0.096	0.094	0.000	0.096	0.096	0.099	0.096	0.078	0.102	0.069	0.086	0.055	0.099	0.091
3	0.214	0.000	0.000	0.130	0.105	0.132	0.000	0.106	0.105	0.107	0.106	0.112	0.111	0.086	0.108	0.062	0.107	0.111
4	0.264	0.000	0.000	0.140	0.114	0.146	0.000	0.111	0.114	0.114	0.114	0.107	0.114	0.144	0.159	0.111	0.114	0.125
5	0.265	0.000	0.000	0.143	0.138	0.176	0.000	0.137	0.138	0.131	0.151	0.145	0.127	0.160	0.172	0.143	0.131	0.164
6	0.307	0.000	0.000	0.190	0.163	0.181	0.000	0.164	0.163	0.149	0.175	0.000	0.125	0.178	0.185	0.167	0.149	0.210
7	0.325	0.000	0.000	0.207	0.177	0.188	0.000	0.170	0.177	0.150	0.129	0.000	0.139	0.193	0.202	0.180	0.150	0.244
8	0.333	0.000	0.000	0.218	0.214	0.184	0.000	0.214	0.214	0.162	0.159	0.000	0.130	0.188	0.202	0.186	0.162	0.250
9	0.345	0.000	0.000	0.241	0.000	0.189	0.000	0.000	0.000	0.127	0.127	0.000	0.000	0.178	0.221	0.204	0.127	0.227
10	0.387	0.000	0.000	0.221	0.000	0.195	0.000	0.000	0.000	0.132	0.132	0.000	0.000	0.197	0.251	0.222	0.132	0.274
11	0.397	0.000	0.000	0.242	0.217	0.200	0.000	0.217	0.217	0.171	0.172	0.000	0.000	0.193	0.256	0.223	0.171	0.288
12	0.419	0.000	0.000	0.278	0.000	0.197	0.000	0.000	0.000	0.123	0.123	0.000	0.000	0.199	0.247	0.218	0.123	0.359
13	0.395	0.000	0.000	0.000	0.000	0.294	0.000	0.000	0.000	0.173	0.173	0.000	0.000	0.226	0.296	0.251	0.173	0.373
14	0.479	0.000	0.000	0.000	0.000	0.236	0.000	0.000	0.000	0.188	0.188	0.000	0.000	0.191	0.242	0.224	0.188	0.420
15+	0.466	0.000	0.000	0.000	0.000	0.259	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.315	0.394	0.292	0.000	0.459

1-4Q Ages	IVa	IIa	Vb	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIc eas	VIIIc W	VIIIb	VIIId	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.023	0.030	0.022	0.000	0.022
1	0.000	0.000	0.000	0.000	0.079	0.000	0.000	0.078	0.070	0.063	0.100	0.051	0.056	0.034	0.024	0.026	0.057	0.030
2	0.020	0.000	0.000	0.107	0.058	0.094	0.000	0.091	0.076	0.064	0.051	0.084	0.078	0.053	0.075	0.042	0.058	0.059
3	0.156	0.192	0.000	0.130	0.066	0.124	0.114	0.101	0.093	0.090	0.070	0.093	0.096	0.095	0.113	0.078	0.083	0.085
4	0.248	0.215	0.000	0.140	0.109	0.139	0.131	0.110	0.094	0.094	0.105	0.098	0.088	0.147	0.138	0.111	0.083	0.107
5	0.262	0.251	0.000	0.147	0.145	0.161	0.161	0.140	0.139	0.141	0.155	0.136	0.126	0.161	0.152	0.130	0.123	0.157
6	0.301	0.283	0.000	0.205	0.147	0.172	0.167	0.168	0.170	0.170	0.147	0.154	0.125	0.180	0.181	0.152	0.149	0.185
7	0.321	0.311	0.000	0.216	0.177	0.190	0.195	0.185	0.210	0.205	0.129	0.183	0.139	0.188	0.200	0.150	0.150	0.215
8	0.330	0.319	0.000	0.226	0.105	0.189	0.231	0.202	0.214	0.206	0.115	0.194	0.131	0.193	0.208	0.165	0.162	0.211
9	0.334	0.306	0.000	0.240	0.112	0.196	0.209	0.212	0.212	0.179	0.117	0.179	0.000	0.187	0.217	0.162	0.127	0.204
10	0.380	0.357	0.000	0.243	0.130	0.213	0.237	0.264	0.264	0.240	0.131	0.197	0.000	0.202	0.245	0.161	0.132	0.239
11	0.387	0.361	0.000	0.264	0.156	0.200	0.214	0.248	0.284	0.281	0.150	0.219	0.000	0.193	0.239	0.161	0.171	0.232
12	0.416	0.404	0.000	0.311	0.000	0.247	0.273	0.341	0.341	0.201	0.123	0.208	0.000	0.209	0.249	0.171	0.123	0.300
13	0.392	0.384	0.000	0.371	0.000	0.359	0.343	0.372	0.372	0.367	0.173	0.210	0.000	0.221	0.276	0.175	0.173	0.311
14	0.471	0.443	0.000	0.269	0.000	0.374	0.347	0.383	0.383	0.369	0.188	0.217	0.000	0.206	0.243	0.176	0.188	0.342
15+	0.457	0.432	0.000	0.371	0.000	0.378	0.346	0.387	0.387	0.387	0.000	0.370	0.000	0.252	0.335	0.222	0.000	0.407
	0.345	0.334		0.175	0.074	0.176	0.193	0.108	0.098	0.099	0.083	0.138	0.090	0.094	0.153	0.039	0.082	0.123

Table 5.5.2.2 Western Horse Mackerel stock. Mean length (Cm) in catch at age by quarter and area in 2005

1Q

Ages	IIa	IVa	Vb	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIc eas	VIIIcW	VIIIb	VIIId	Total
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.50	12.13	0.00	0.00	12.13
2	0.00	0.00	0.00	0.00	19.13	0.00	0.00	19.87	19.87	19.87	19.00	22.00	0.00	20.60	20.27	24.31	0.00	19.23
3	24.59	24.59	0.00	24.14	20.84	24.21	24.61	22.20	22.20	22.20	20.76	22.88	21.83	24.21	23.18	24.58	21.83	21.25
4	25.73	25.73	0.00	25.44	24.31	25.64	25.76	24.82	24.82	24.82	24.38	23.34	23.00	25.80	25.07	25.30	23.00	23.54
5	28.18	28.18	0.00	28.40	30.50	26.94	27.57	27.96	27.96	27.96	30.50	25.85	0.00	26.74	27.84	26.19	0.00	26.73
6	29.99	29.99	0.00	29.95	26.00	27.87	27.93	27.49	27.49	27.49	26.00	26.95	0.00	28.29	30.17	27.38	0.00	27.65
7	30.99	30.99	0.00	31.14	0.00	28.67	28.94	29.41	29.41	29.41	0.00	28.36	0.00	28.35	30.53	27.27	0.00	28.93
8	31.03	31.03	0.00	31.04	26.50	29.21	30.73	29.34	29.34	29.34	26.50	28.99	0.00	29.08	30.77	27.99	0.00	28.88
9	30.30	30.30	0.00	30.21	26.50	29.66	29.82	28.92	28.92	28.92	26.50	28.23	0.00	28.80	30.54	27.91	0.00	28.73
10	31.88	31.88	0.00	31.66	28.50	30.68	30.77	31.17	31.17	31.17	28.50	29.15	0.00	28.73	31.71	27.61	0.00	30.17
11	32.17	32.17	0.00	31.80	28.00	29.90	30.24	32.45	32.45	32.45	28.00	29.53	0.00	28.77	31.45	27.70	0.00	29.64
12	33.50	33.50	0.00	33.74	0.00	32.60	32.79	34.50	34.50	34.50	0.00	29.21	0.00	29.09	31.99	28.09	0.00	32.12
13	34.81	34.81	0.00	34.75	0.00	35.54	34.71	34.13	34.13	34.13	0.00	29.79	0.00	29.27	32.51	27.97	0.00	32.47
14	32.06	32.06	0.00	31.25	0.00	35.76	34.72	34.46	34.46	34.46	0.00	29.95	0.00	29.31	31.76	28.17	0.00	31.97
15+	34.96	34.96	0.00	34.70	0.00	36.12	34.85	34.67	34.67	34.67	0.00	35.60	0.00	30.53	33.10	30.13	0.00	35.18

2Q

Ages	IIa	IVa	Vb	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIc eas	VIIIcW	VIIIb	VIIId	Total
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.50	18.50	18.50	18.50	0.00	18.50	14.08	15.50	13.34	18.50	14.50
2	0.00	20.00	0.00	0.00	0.00	0.00	0.00	18.54	18.54	18.54	18.54	0.00	18.54	16.56	21.33	17.15	18.54	17.74
3	0.00	21.90	0.00	24.61	0.00	24.76	24.76	21.57	21.57	21.57	21.57	0.00	21.57	25.19	24.25	22.85	21.57	22.34
4	0.00	23.50	0.00	25.62	0.00	25.77	25.77	22.39	22.39	22.39	22.39	27.00	22.39	26.11	25.95	23.29	22.39	23.04
5	0.00	0.00	0.00	27.73	0.00	27.45	27.45	25.00	25.00	25.00	25.00	26.18	25.00	26.60	26.79	24.83	25.00	26.05
6	0.00	0.00	0.00	29.99	0.00	27.89	27.89	0.00	0.00	0.00	0.00	26.62	0.00	27.88	28.89	28.26	0.00	27.08
7	0.00	32.50	0.00	30.99	0.00	28.79	28.79	0.00	0.00	0.00	0.00	28.33	0.00	28.01	28.99	27.72	0.00	28.33
8	0.00	34.50	0.00	31.03	0.00	30.15	30.15	0.00	0.00	0.00	0.00	28.49	0.00	28.94	30.12	29.89	0.00	28.67
9	0.00	35.50	0.00	30.30	0.00	29.87	29.87	0.00	0.00	0.00	0.00	29.25	0.00	28.77	29.57	29.22	0.00	29.29
10	0.00	35.50	0.00	31.88	0.00	30.66	30.66	0.00	0.00	0.00	0.00	28.94	0.00	29.30	30.22	29.52	0.00	29.14
11	0.00	35.50	0.00	32.17	0.00	30.19	30.19	0.00	0.00	0.00	0.00	29.79	0.00	28.76	30.22	29.89	0.00	29.83
12	0.00	37.00	0.00	33.50	0.00	32.74	32.74	0.00	0.00	0.00	0.00	29.00	0.00	30.41	30.93	30.63	0.00	29.36
13	0.00	34.50	0.00	34.81	0.00	34.49	34.49	0.00	0.00	0.00	0.00	0.00	0.00	29.80	31.50	31.57	0.00	31.38
14	0.00	36.50	0.00	32.06	0.00	34.72	34.72	0.00	0.00	0.00	0.00	0.00	0.00	30.50	30.13	30.80	0.00	30.54
15+	0.00	35.61	0.00	34.96	0.00	34.76	34.76	0.00	0.00	0.00	0.00	0.00	0.00	32.32	32.57	32.56	0.00	32.61

3Q

Ages	IIa	IVa	Vb	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIc eas	VIIIcW	VIIIb	VIIId	Total
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.59	15.04	13.62	0.00	13.61
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.17	0.00	18.87	18.87	18.00	18.87	15.54	15.94	16.04	20.68	15.78
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.27	0.00	22.25	22.25	21.00	22.25	20.12	22.73	19.06	21.75	20.95
3	27.80	27.80	0.00	24.65	0.00	25.24	0.00	22.86	0.00	22.98	22.98	24.80	22.98	22.52	23.97	19.65	23.09	23.36
4	29.70	29.70	0.00	25.31	0.00	25.79	0.00	23.62	0.00	23.77	23.77	25.71	23.77	26.72	25.38	27.64	23.74	25.08
5	27.90	27.90	0.00	26.41	0.00	27.03	0.00	26.00	0.00	26.08	26.08	26.57	26.08	27.43	26.05	28.10	25.24	26.54
6	31.10	31.10	0.00	0.00	0.00	27.65	0.00	0.00	0.00	0.00	0.00	27.33	0.00	28.28	27.49	28.59	25.28	28.00
7	31.70	31.70	0.00	0.00	0.00	29.24	0.00	0.00	0.00	0.00	0.00	28.35	0.00	29.09	28.74	29.48	26.40	29.17
8	32.20	32.20	0.00	0.00	0.00	30.15	0.00	27.50	0.00	27.50	27.50	28.48	27.50	28.91	28.64	29.73	25.50	28.91
9	32.00	32.00	0.00	0.00	0.00	30.50	0.00	0.00	0.00	0.00	0.00	29.56	0.00	28.54	30.11	30.81	0.00	29.44
10	33.30	33.30	0.00	0.00	0.00	29.17	0.00	0.00	0.00	0.00	0.00	29.00	0.00	29.78	32.09	31.54	0.00	31.20
11	33.90	33.90	0.00	0.00	0.00	29.50	0.00	0.00	0.00	0.00	0.00	29.71	0.00	29.22	32.21	31.89	0.00	31.03
12	34.00	34.00	0.00	0.00	0.00	32.00	0.00	0.00	0.00	0.00	0.00	29.75	0.00	29.85	31.76	31.51	0.00	31.15
13	33.90	33.90	0.00	0.00	0.00	31.50	0.00	0.00	0.00	0.00	0.00	31.50	0.00	31.19	33.57	33.09	0.00	32.95
14	36.10	36.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29.59	31.56	31.40	0.00	31.26
15+	36.00	36.00	0.00	0.00	0.00	33.50	0.00	0.00	0.00	0.00	0.00	33.50	0.00	35.21	36.91	33.92	0.00	36.62

4Q

Ages	IIa	IVa	Vb	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIc eas	VIIIcW	VIIIb	VIIId	Western
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.44	0.00	14.49	0.00	14.16
1	0.00	0.00	0.00	0.00	20.64	0.00	0.00	20.79	20.64	21.27	22.50	18.00	21.85	16.16	18.79	15.83	21.27	16.20
2	0.00	0.00	0.00	23.00	22.15	22.00	0.00	21.99	22.15	22.90	22.61	21.00	23.08	20.16	21.80	19.46	22.90	21.94
3	0.00	27.80	0.00	24.71	23.11	24.93	0.00	23.21	23.11	23.77	23.67	23.88	23.92	21.65	23.53	20.24	23.77	23.80
4	0.00	29.70	0.00	25.45	23.97	25.88	0.00	23.81	23.97	24.35	24.56	23.54	24.41	26.04	27.02	24.52	24.35	24.80
5	0.00	27.90	0.00	26.09	25.36	27.78	0.00	25.33	25.36	25.27	25.76	26.25	25.05	27.02	27.79	26.75	25.27	26.41
6	0.00	31.10	0.00	28.31	26.12	28.04	0.00	26.13	26.12	25.96	26.97	0.00	24.79	28.14	28.49	28.35	25.96	28.47
7	0.00	31.70	0.00	29.52	27.37	28.44	0.00	26.73	27.37	26.64	26.05	0.00	26.40	28.88	29.36	29.09	26.64	29.89
8	0.00	32.20	0.00	30.20	29.50	28.18	0.00	29.50	29.50	27.67	27.83	0.00	25.50	28.67	29.36	29.47	27.67	30.27
9	0.00	32.00	0.00	31.02	0.00	28.53	0.00	0.00	0.00	25.94	25.94	0.00	0.00	28.14	30.13	30.33	25.94	29.53
10	0.00	33.30	0.00	30.38	0.00	28.81	0.00	0.00	0.00	26.37	26.37	0.00	0.00	29.15	31.58	31.28	26.37	30.82
11	0.00	33.90	0.00	31.78	29.50	29.08	0.00	29.50	29.50	28.32	28.29	0.00	0.00	28.95	31.70	31.21	28.32	31.52
12	0.00	34.00	0.00	32.50	0.00	28.95	0.00	0.00	0.00	25.50	25.50	0.00	0.00	29.23	31.37	31.03	25.50	32.66
13	0.00	33.90	0.00	0.00	0.00	33.56	0.00	0.00	0.00	29.50	29.50	0.00	0.00	30.55	33.51	32.57	29.50	33.68
14	0.00	36.10	0.00	0.00	0.00	31.00	0.00	0.00	0.00	28.50	28.50	0.00	0.00	28.83	31.19	31.24	28.50	34.63
15+	0.00	36.00	0.00	0.00	0.00	31.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	34.38	37.10	34.35	0.00	35.93

1-4Q

Ages	IIa	IVa	Vb	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIc eas	VIIIcW	VIIIb	VIIId	Total
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.54	15.04	14.24	0.00	13.90
1	0.00	0.00	0.00	0.00	20.64	0.00	0.00	20.37	20.04	19.46	22.50	18.00	19.05	15.65	13.71	14.91	19.14	15.28
2	0.00	20.00	0.00	23.00	19.91	22.00	0.00	21.75	20.76	20.08	19.41	21.89	21.06	18.19	20.75	17.72	19.42	19.63
3	27.07	25.65	0.00	24.69	21.16	24.69	24.61	22.99	22.53	22.51	21.40	23.01	23.00	22.42	23.94	21.68	22.21	22.26
4	28.16	29.21	0.00	25.43	24.10	25.79	25.76	23.79	23.12	23.26	24.50	23.40	23.24	26.25	25.68	24.67	22.91	24.13
5	27.95	27.91	0.00	26.26	25.75	27.39	27.57	25.46	25.54	25.84	26.00	26.00	25.06	27.11	26.52	26.06	25.15	26.47
6	30.78	31.02	0.00	28.95	26.08	27.95	27.93	26.47	26.63	26.97	26.56	26.81	24.79	28.21	28.20	27.47	25.95	27.99
7	31.57	31.67	0.00	29.81	27.37	28.56	28.94	27.36	28.56	28.46	26.05	28.34	26.40	28.65	29.17	27.35	26.63	29.22
8	32.00	32.16	0.00	30.37	26.64	28.73	30.73	28.70	29.34	29.06	26.84	28.59	25.55	28.91	29.64	28.23	27.64	29.25
9	31.40	31.84	0.00	30.69	26.50	29.05	29.82	28.92	28.92	27.76	26.33	28.42	0.00	28.59	29.97	28.10	25.94	29.16
10	32.92	33.21	0.00	30.91	28.50	29.69	30.77	31.17	31.17	30.30	27.97	28.98	0.00	29.31	31.26	27.97	26.37	30.30
11	33.36	33.76	0.00	31.79	28.27	29.62	30.24	30.54	31.74	31.72	28.07	29.69	0.00	28.90	31.01	27.96	28.32	30.27
12	33.93	33.99	0.00	33.25	0.00	31.74	32.79	34.50	34.50	28.73	25.50	29.05	0.00	29.70	31.47	28.56	25.50	31.78
13	34.24	33.99	0.00	34.75	0.00	35.33	34.71	34.13	34.13	34.01	29.50	29.79	0.00	30.27	32.71	28.74	29.50	32.78
14	35.34	35.93	0.00	31.25	0.00	35.60	34.72	34.46	34.46	34.04	28.50	29.95	0.00	29.49	31.22	28.81	28.50	33.14
15+	35.64	35.90	0.00	34.70	0.00	35.84	34.85	34.67	34.67	34.67	0.00	35.60	0.00	31.63	34.89	31.25	0.00	35.47
	32.15	32.10		27.21	21.48	27.85	28.81	23.25	22.80	22.95	22.38	25.64	23.13	21.22	25.91	16.59	22.58	24.17

Table 5.6.1 A summary of the main features of the SAD model used for the exploratory assessment of western horse mackerel.

Model	SAD
Version	2004 Working Group (WGMHSA)
Model type	A linked separable VPA and ADAPT VPA model, so that different structural models are applied to the recent and historic periods. The separable component is short (currently 4 years) and applies to the most recent period, while the ADAPT VPA component applies to the historic period. Model estimates from the separable period initiate a historic VPA for the cohorts in the first year of the separable period. Fishing mortality at the oldest true age (age 10) in the historic VPA is calculated as the average of the three preceding ages (7-9, ignoring the 1982 year-class where applicable), multiplied by a scaling parameter that is estimated in the model. In order to model the directed fishing of the dominant 1982 year-class, fishing mortality on this year-class at age 10 in 1992 is estimated in the model.
Data used	Egg production estimates, used as relative indices of abundance and catch-at-age data (numbers). Weights-at-age in the stock and maturity-at-age vary temporally, but are assumed to be known without error. Natural mortality and the proportions of fishing and natural mortality before spawning are fixed and year-invariant.
Selection	The separable period assumes constant selection-at-age, and requires estimation of fishing mortality age- and year-effects (the former reflecting selectivity-at-age) for ages 1-10 and the final four years for which catch data are available. Selectivity at age 7 is assumed to be equal to 1.
Fishing mortality assumptions	The fishing mortality at age 10 (the final true age) is equal to the average of the fishing mortalities at ages 7-9 (ignoring the 1982 year-class where applicable) multiplied by a scaling parameter estimated within the model. The fishing mortality at age 10 in 1992 (applicable to the 1982 year-class) is estimated separately. The plus-group fishing mortality is assumed equal to that of age 10.
Estimated parameters	The parameters treated as "free" in the model (i.e. those estimated directly) are: (1) Fishing mortality year effects for the final four years for which catch data are available; (2) Fishing mortality age effects (selectivities) for ages 1-10 (except for selectivity at age 7 which is set to 1); (3) scaling parameter for fishing mortality at age 10 relative to the average for ages 7-9 (ignoring the 1982 year-class where applicable); (4) fishing mortality on the 1982 year-class at age 10 in 1992; (5) catchability linking the egg production estimates and the SSB estimates from the model.
Catchabilities	The catchability parameter links the egg production estimates and the SSB estimates from the model.
Plus-group	A dynamic pool is assumed (plus group this year is the sum of last year's plus group and last year's oldest true age, both depleted by fishing and natural mortality). The plus group modelled in this manner allows the catch in the plus group to be estimated, and making

	the assumption that log-catches are normally distributed allows an additional component in the likelihood, fitting these estimated catches to the observed plus-group catch.
Objective function	The estimation is based on maximum likelihood. There are three components to the likelihood, corresponding to egg estimates, catches for the separable period, and catches for the plus-group. The variance of each component is estimated.
Variance estimates / uncertainty	Estimates of precision may be calculated by several methods, the simplest (based on the delta method) being used for results shown.
Program language	AD Model Builder (Otter Research Ltd)
References	Description in Working Group reports.

Table 5.6.2.: Western Horse Mackerel: Input to SAD

a) Catch in numbers (thousands)

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	0	0	0	0	0	0	876	0	0	20632	14887	46	3686	2702	10729	4860	744	14822	637	58685	13707	1843	21246	1260
1	3713	7903	0	1633	0	99	27369	0	20406	33560	229703	109152	60759	165382	19774	110145	91505	97561	78856	69430	461055	303721	140299	71508
2	21072	2269	241360	4901	0	493	6112	0	45036	89715	36331	94500	911713	470498	658727	465350	184443	83714	131112	246525	120106	585700	110976	170936
3	134743	32900	4439	602992	1548	0	2099	20766	138929	23034	80552	16738	115729	424563	860992	735919	488662	176919	52716	151707	164977	165666	474273	310085
4	11515	53508	36294	4463	676208	2950	4402	18282	61442	207751	56275	62714	53132	215468	186306	410638	360116	265820	71779	98454	126329	152117	76136	531221
5	13197	15345	149798	41822	8727	891660	18968	5308	33298	143072	256085	94711	44692	59035	85508	244328	219650	254516	150869	101344	64449	88944	103011	68559
6	11741	44539	22350	100376	65147	2061	941725	14500	10549	73730	127048	317337	38769	90832	51365	119062	157396	212225	170393	116952	69828	57445	69844	74392
7	8848	52673	38244	12644	109747	41564	12115	1276731	20607	25369	49020	144610	221970	35654	55229	127658	122583	187250	177995	234832	94429	45596	43981	61641
8	1651	17923	34020	16172	25712	90814	39913	12046	1384850	25584	19053	70717	106512	245230	53379	134488	81499	147328	133290	203823	130285	49476	31618	43454
9	414	3291	14756	6200	21179	11740	67869	59357	37011	1219646	23449	32693	40799	119117	57131	109962	68264	77691	61578	103968	85325	92758	49188	22304
10	1651	5505	4101	9224	15271	9549	9739	83125	70512	23987	1103480	4822	42302	99495	56962	109165	50555	35635	18010	36076	45798	50503	56109	27127
11+	81385	129139	58370	40976	56824	62776	76096	78951	226294	137131	152305	1309609	998180	1362342	729283	601196	389594	252044	168770	132706	150103	109994	63823	99898

Mean weight at age in the stock (kg)

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
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
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.07	0.05	0.05	0.05	0.085
3	0.08	0.08	0.077	0.081	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.066	0.095	0.08	0.09	0.11	0.087	0.074	0.109	0.11	0.104	0.095
4	0.207	0.171	0.122	0.148	0.105	0.105	0.105	0.105	0.105	0.121	0.105	0.105	0.105	0.119	0.118	0.112	0.108	0.12	0.108	0.082	0.12	0.142	0.114	0.110
5	0.232	0.227	0.155	0.14	0.134	0.126	0.126	0.103	0.127	0.137	0.133	0.153	0.147	0.096	0.129	0.124	0.129	0.13	0.148	0.1	0.135	0.139	0.127	0.141
6	0.269	0.257	0.201	0.193	0.169	0.15	0.141	0.131	0.135	0.143	0.151	0.166	0.185	0.152	0.148	0.162	0.142	0.16	0.17	0.121	0.146	0.161	0.142	0.163
7	0.28	0.276	0.223	0.236	0.195	0.171	0.143	0.159	0.124	0.144	0.15	0.173	0.169	0.166	0.172	0.169	0.151	0.17	0.173	0.131	0.153	0.169	0.157	0.182
8	0.292	0.27	0.253	0.242	0.242	0.218	0.217	0.127	0.154	0.15	0.158	0.172	0.191	0.178	0.183	0.184	0.162	0.18	0.193	0.142	0.177	0.169	0.168	0.197
9	0.305	0.243	0.246	0.289	0.292	0.254	0.274	0.21	0.174	0.182	0.16	0.17	0.191	0.187	0.185	0.188	0.174	0.19	0.202	0.161	0.206	0.176	0.166	0.181
10	0.369	0.39	0.338	0.247	0.262	0.281	0.305	0.252	0.282	0.189	0.182	0.206	0.19	0.197	0.202	0.208	0.191	0.21	0.257	0.187	0.216	0.176	0.178	0.209
11+	0.352	0.311	0.287	0.306	0.342	0.317	0.366	0.336	0.345	0.333	0.287	0.222	0.235	0.233	0.238	0.238	0.215	0.222	0.26	0.268	0.275	0.206	0.213	0.243

Table 5.6.3: Western Horse Mackerel: Input to SAD

Proportion of fish mature at start of the start of the year

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
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
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0.4	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
3	0.8	0.7	0.6	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
4	1	1	0.85	0.8	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
5	1	1	1	0.95	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11+	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table 5.6.4 The time series of egg production estimates for the western horse mackerel as reported in ICES (2002/G:06) and in Section 3.7.

Year	Egg Production
1983	513.125
1989	1762.125
1992	1712.125
1995	1264.5
1998	1135.7
2001	820.8
2004	889

Table 5.8.1. Western horse-mackerel. Input data for the assessment.

Scenario a) N at age as in the SADVF output								
Age	N 2006	CV of N	weights at age in the stock(03-4)			F	Maturity	weigh catch
0	3237877	0.44489	0	0	0	0	0	0.02
1	2714874	0.856438	0	0	0	0.026173	0	0.029
2	2498600	0.879132	0.05	0.05	0.085	0.038045	0.05	0.059
3	4232100	0.7919	0.11	0.104	0.095	0.061455	0.25	0.0847
4	3924200	0.720274	0.142	0.114	0.11	0.064452	0.7	0.107
5	6861200	0.646913	0.139	0.127	0.141	0.067399	0.95	0.157
6	953100	0.574252	0.161	0.142	0.163	0.073529	1	0.185
7	1106900	0.498283	0.169	0.157	0.182	0.086472	1	0.211
8	632310	0.426626	0.169	0.168	0.197	0.08846	1	0.215
9	361360	0.358313	0.176	0.166	0.181	0.083632	1	0.204
10	272080	0.305311	0.176	0.178	0.209	0.067918	1	0.238
11+	1846800	0.369699	0.206	0.213	0.243	0.067918	1	0.297

Scenario b) N at age corresponding to the 25th percentile

	N 25th pct
0	2272742
1	1157042
2	1026878
3	1986662
4	2030445
5	3887338
6	586395.6
7	737361.5
8	451570.8
9	274608.4
10	216423.8
11+	1389351

Table 5.8.2. Western horse mackerel. Scenario a) results from short-term predictions.

2006 Biomass	SSB	FMult	FBar	Landings
2969216	2094319	0.9091	0.0598	180000

2007 Biomass	SSB	FMult	FBar	Landings	2008 Biomass	SSB
2876589	2275829	0.0000	0.0000	0	2917238	2373690
.	2268462	0.1000	0.0066	20529	2897944	2348983
.	2261120	0.2000	0.0132	40918	2878785	2324536
.	2253801	0.3000	0.0197	61167	2859757	2300347
.	2246506	0.4000	0.0263	81278	2840861	2276413
.	2239236	0.5000	0.0329	101252	2822096	2252732
.	2231989	0.6000	0.0395	121089	2803460	2229299
.	2224765	0.7000	0.0460	140791	2784954	2206114
.	2217566	0.8000	0.0526	160359	2766574	2183173
.	2210389	0.9000	0.0592	179793	2748322	2160474
.	2203237	1.0000	0.0658	199094	2730196	2138014
.	2196107	1.1000	0.0723	218264	2712195	2115791
.	2189001	1.2000	0.0789	237303	2694318	2093801
.	2181919	1.3000	0.0855	256212	2676565	2072043
.	2174859	1.4000	0.0921	274993	2658934	2050515
.	2167822	1.5000	0.0986	293646	2641424	2029212
.	2160809	1.6000	0.1052	312171	2624035	2008134
.	2153818	1.7000	0.1118	330571	2606767	1987278
.	2146850	1.8000	0.1184	348845	2589617	1966642
.	2139905	1.9000	0.1249	366995	2572585	1946222
.	2132983	2.0000	0.1315	385021	2555671	1926018

Input units are thousands and kg - output in tonnes

Table 5.8.3. Western horse mackerel. Scenario b) results from short-term predictions.

2006 Biomass	SSB	FMult	FBar	Landings
1734446	1263800	1.5448	0.1016	180000

2007 Biomass	SSB	FMult	FBar	Landings	2008 Biomass	SSB
1565320	1287367	0.0000	0.0000	0	1635657	1305076
.	1283178	0.1000	0.0066	11644	1624955	1291418
.	1279003	0.2000	0.0132	23209	1614327	1277904
.	1274841	0.3000	0.0197	34694	1603772	1264533
.	1270693	0.4000	0.0263	46101	1593291	1251304
.	1266559	0.5000	0.0329	57430	1582882	1238215
.	1262439	0.6000	0.0395	68681	1572545	1225265
.	1258332	0.7000	0.0460	79855	1562280	1212452
.	1254239	0.8000	0.0526	90953	1552085	1199775
.	1250159	0.9000	0.0592	101975	1541961	1187233
.	1246092	1.0000	0.0658	112921	1531908	1174823
.	1242039	1.1000	0.0723	123793	1521923	1162545
.	1237999	1.2000	0.0789	134590	1512008	1150396
.	1233972	1.3000	0.0855	145314	1502162	1138376
.	1229959	1.4000	0.0921	155964	1492383	1126484
.	1225959	1.5000	0.0986	166542	1482672	1114717
.	1221972	1.6000	0.1052	177048	1473028	1103075
.	1217998	1.7000	0.1118	187481	1463450	1091557
.	1214037	1.8000	0.1184	197844	1453939	1080160
.	1210089	1.9000	0.1249	208136	1444493	1068883
.	1206154	2.0000	0.1315	218358	1435113	1057726

Input units are thousands and kg - output in tonnes

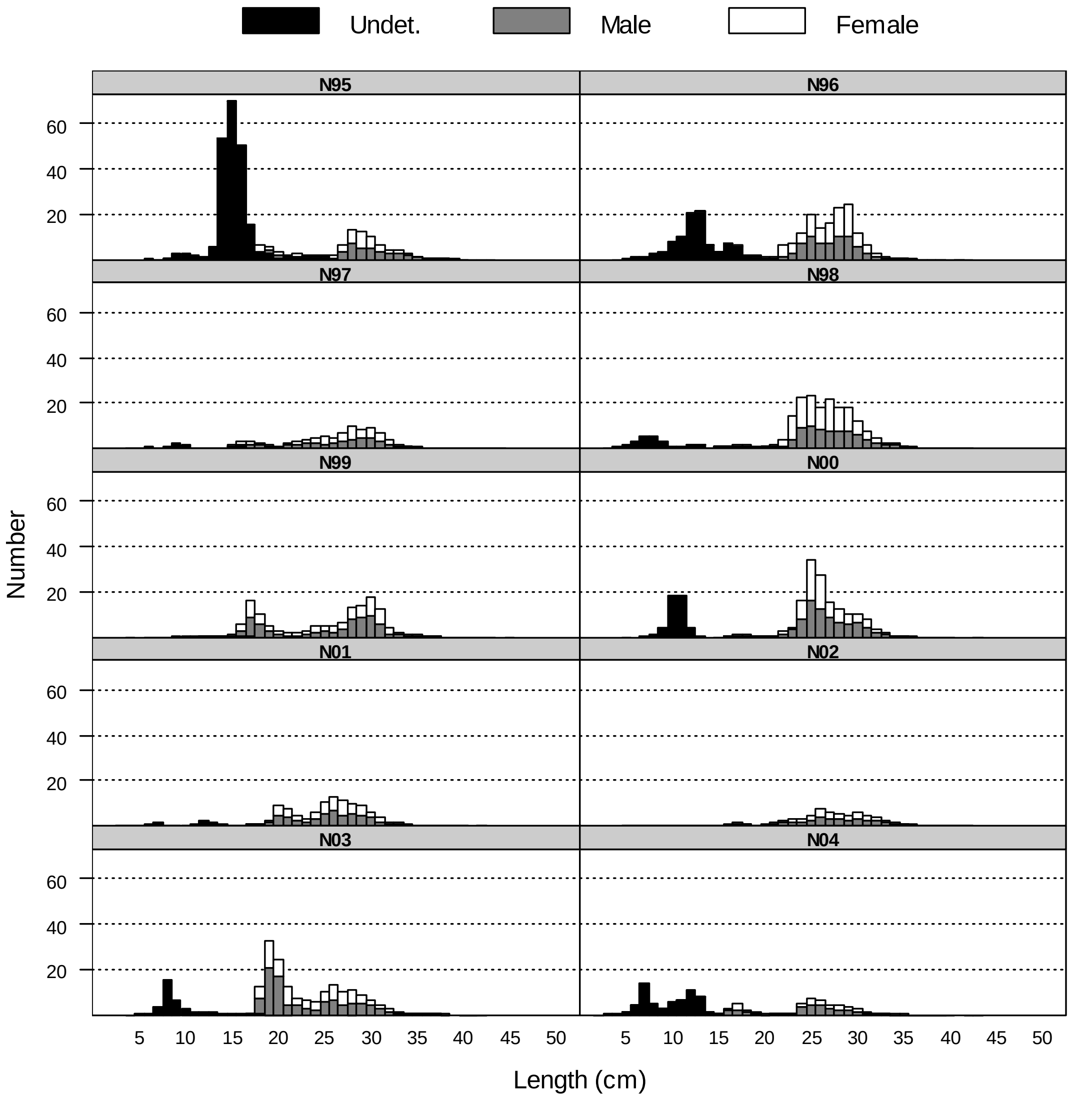


Figure 5.3.2.1. Mean stratified length distributions of horse mackerel in North Spanish Coast bottom trawl surveys (1995-2004)

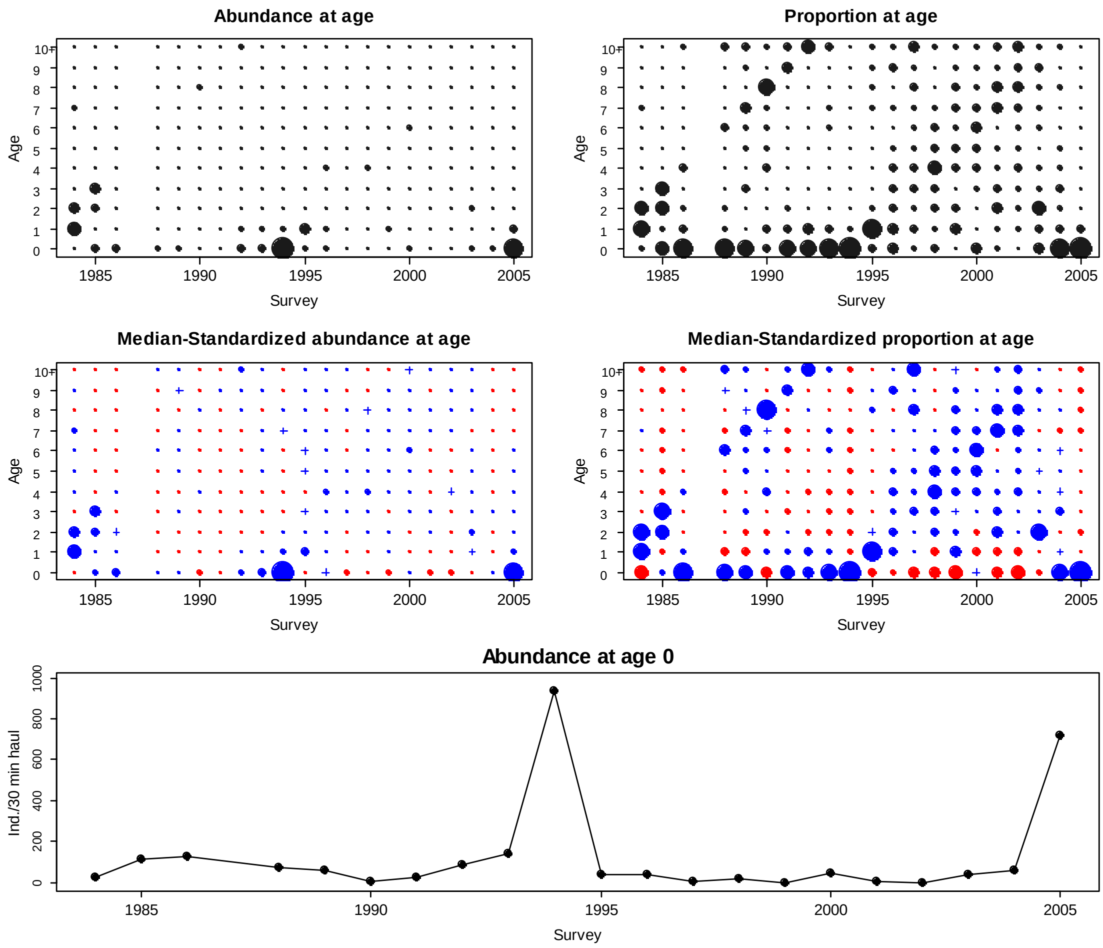


Figure 5.3.2.2. Bubbleplot of Horse mackerel abundances at age (0-8+), proportion at age and standardized abundances at age ((year-median years)/max (time series)) and proportion at age (No survey In 1987). (+ year with median value). Bottom graph: recruitment (age 0) time series.

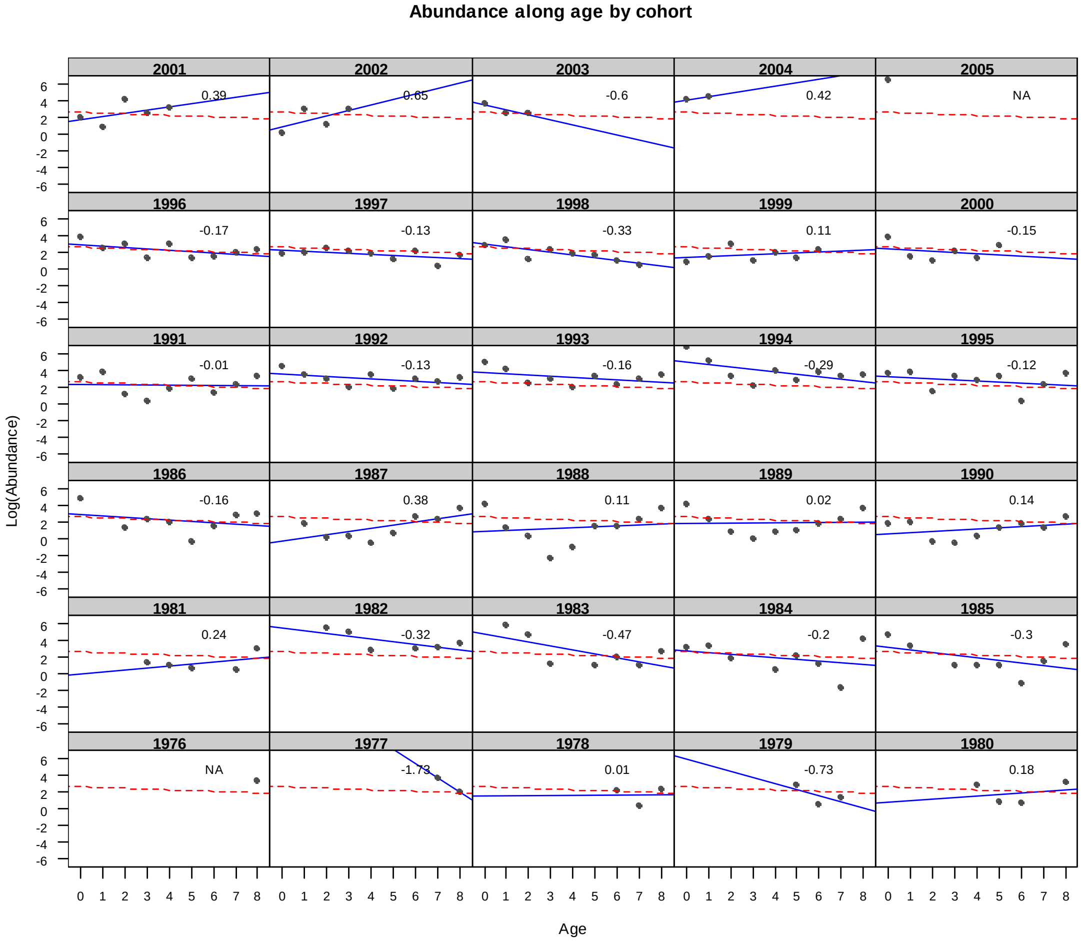


Figure 5.3.2.3. Horse mackerel abundance (No./30 min haul) evolution in logarithmic scale along each cohort sampled in North Spanish Coast surveys. Solid lines mark the linear regression fitted by cohort to the log(abundance)~age, the figure in the right corner of each panel corresponds to the slope. Dashed line marks the linear regression fitted to the overall time series.

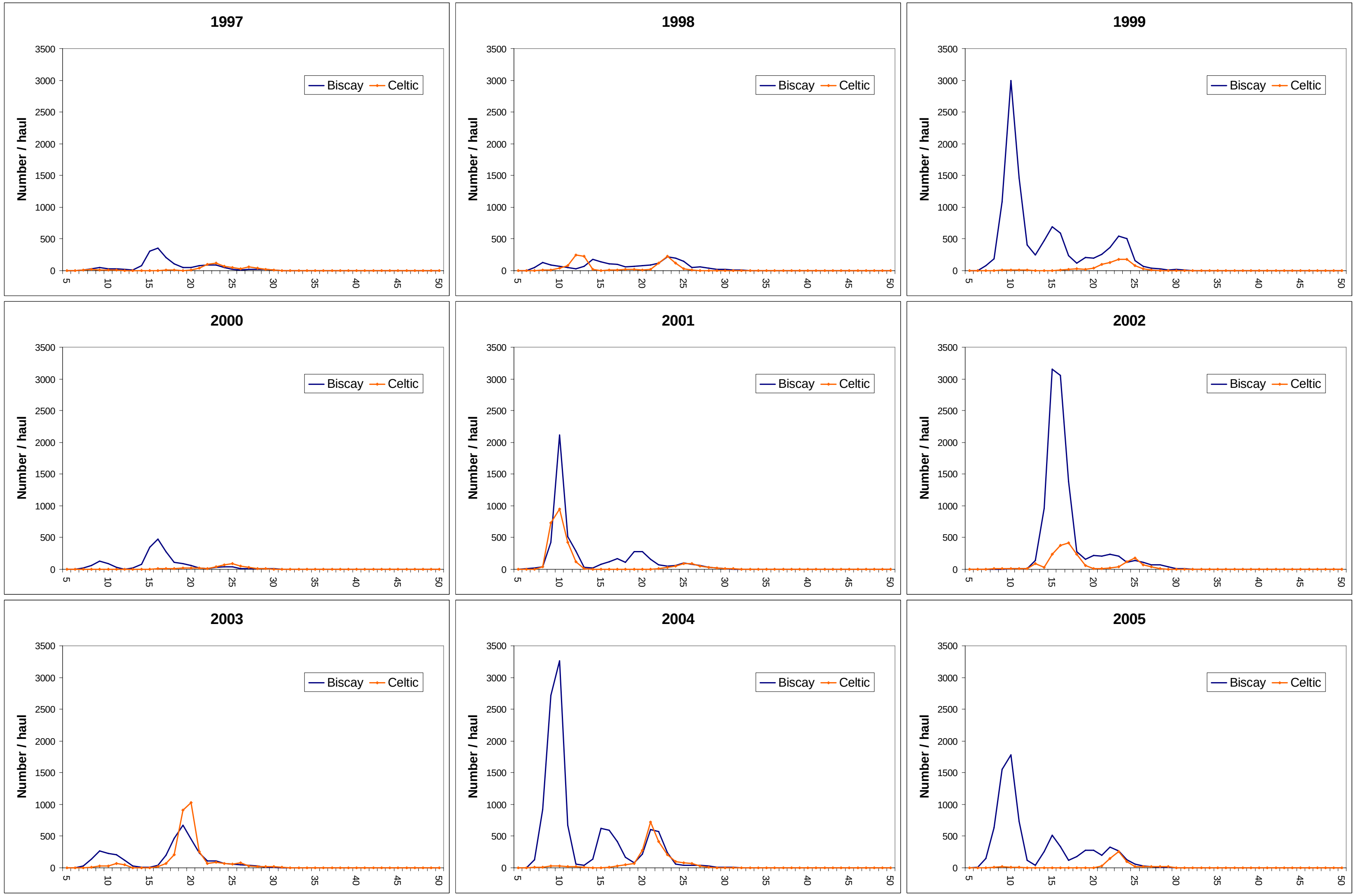


Figure. 5.3.2.4. Length distributions of horse mackerel by area from EVHOE bottom trawl surveys carried out in Bay of Biscay and Celtic Sea.

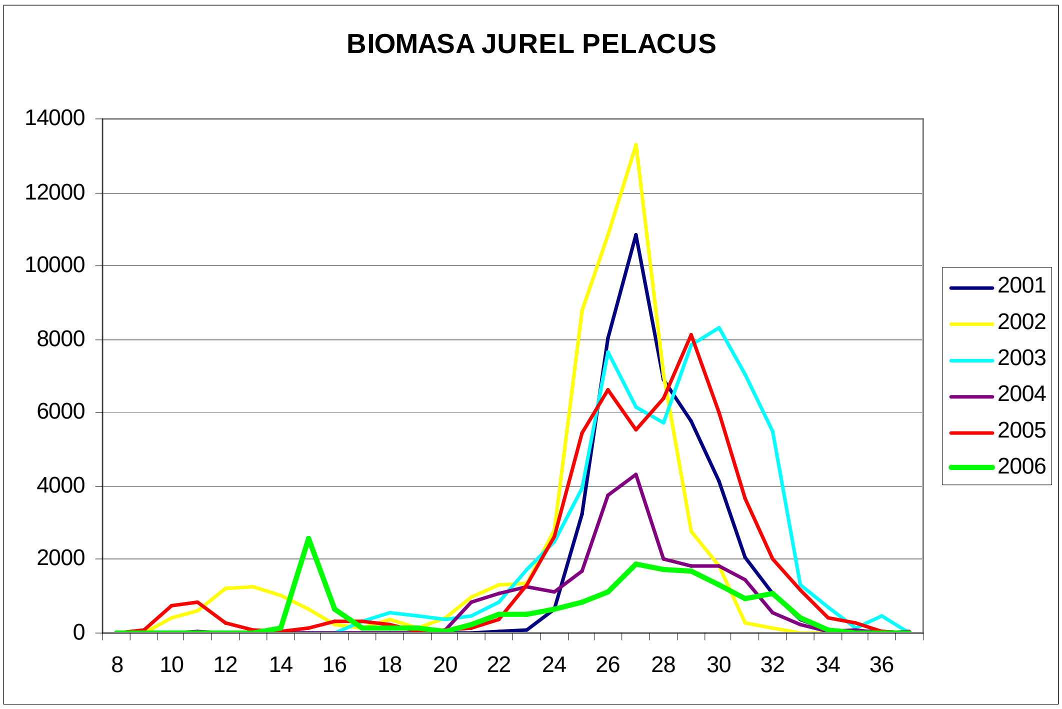


Figure 5.3.2.5. Horse mackerel biomass by length class, assessed at IEO-PELACUS surveys. In the y-axes: biomass in tonnes; in the x-axes: total length in cm.

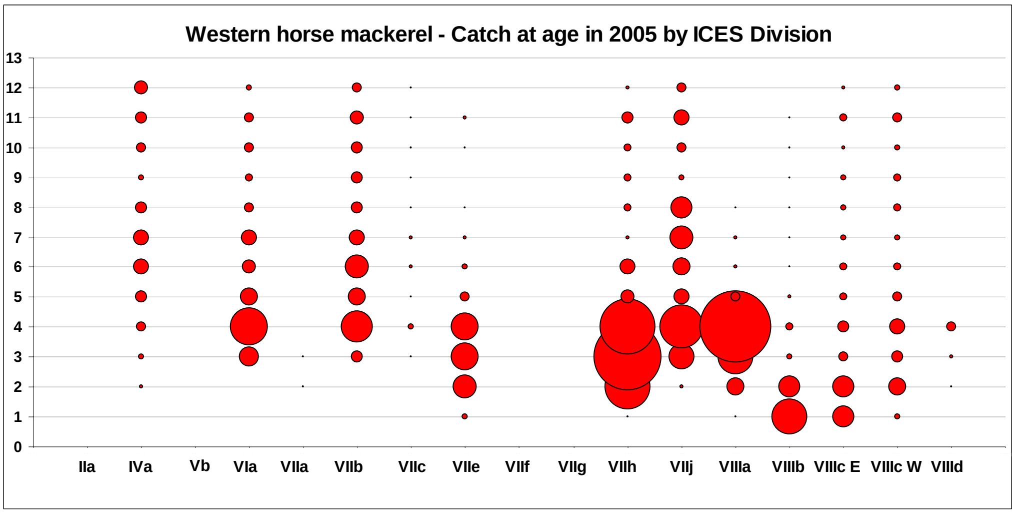


Figure 5.5.1.1 Western horse mackerel. Catch in numbers by yearclass and Divison in 2005.

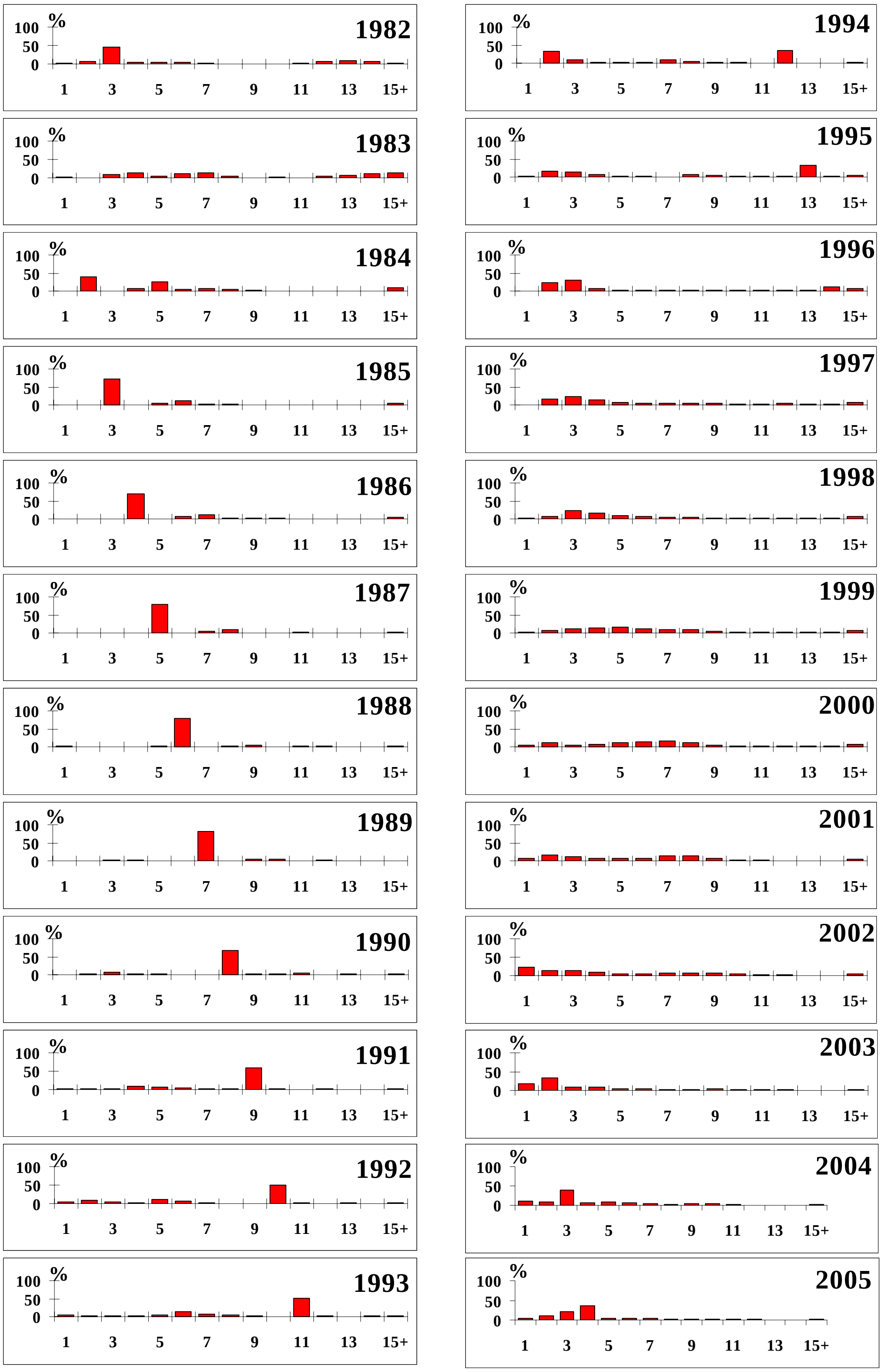
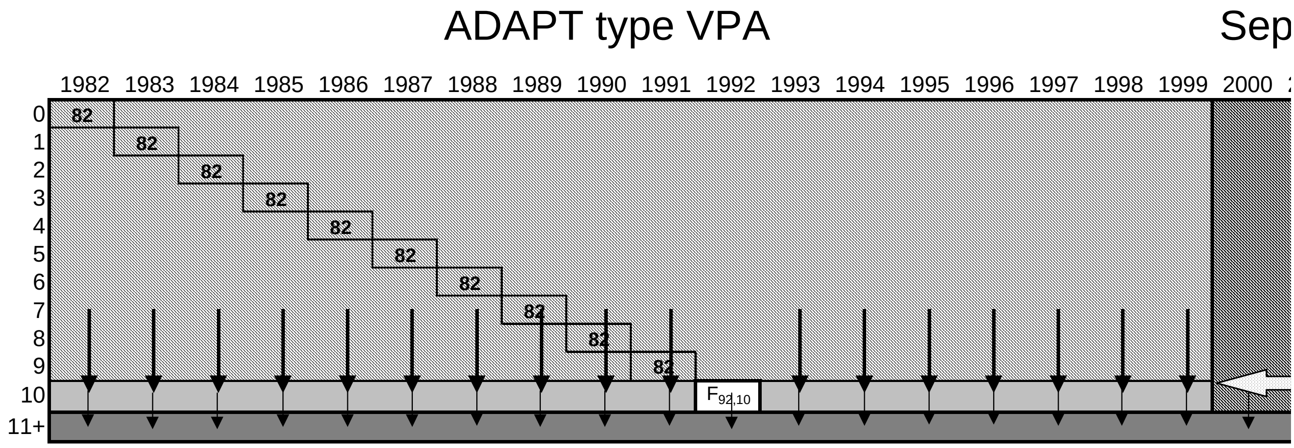


Figure 5.5.1.2 WESTERN HORSE MACKEREL. Age composition in the international catches during 1982-2005.



Model estimated parameters

1	F_y	Year effects in separable period fishing mortalities
2	S_a	Age effects in separable period fishing mortalities (with value at age 7 set to 1)
3	$F_{92,10}$	Fishing mortality on the 1982 year class at age 10 in 1992
4	F_{scal}	The scaling parameter which adjusts fishing mortality at age 10 relative to the avererage of ages 7 - 9
5	q_{egg}	Catchability of the estimated SSB relative to the western horse mackerel egg production time series

Figure 5.6.1. An illustration of the SAD model structure used for the assessment of the western horse mackerel stock and the "free" parameters estimated by maximum likelihood.

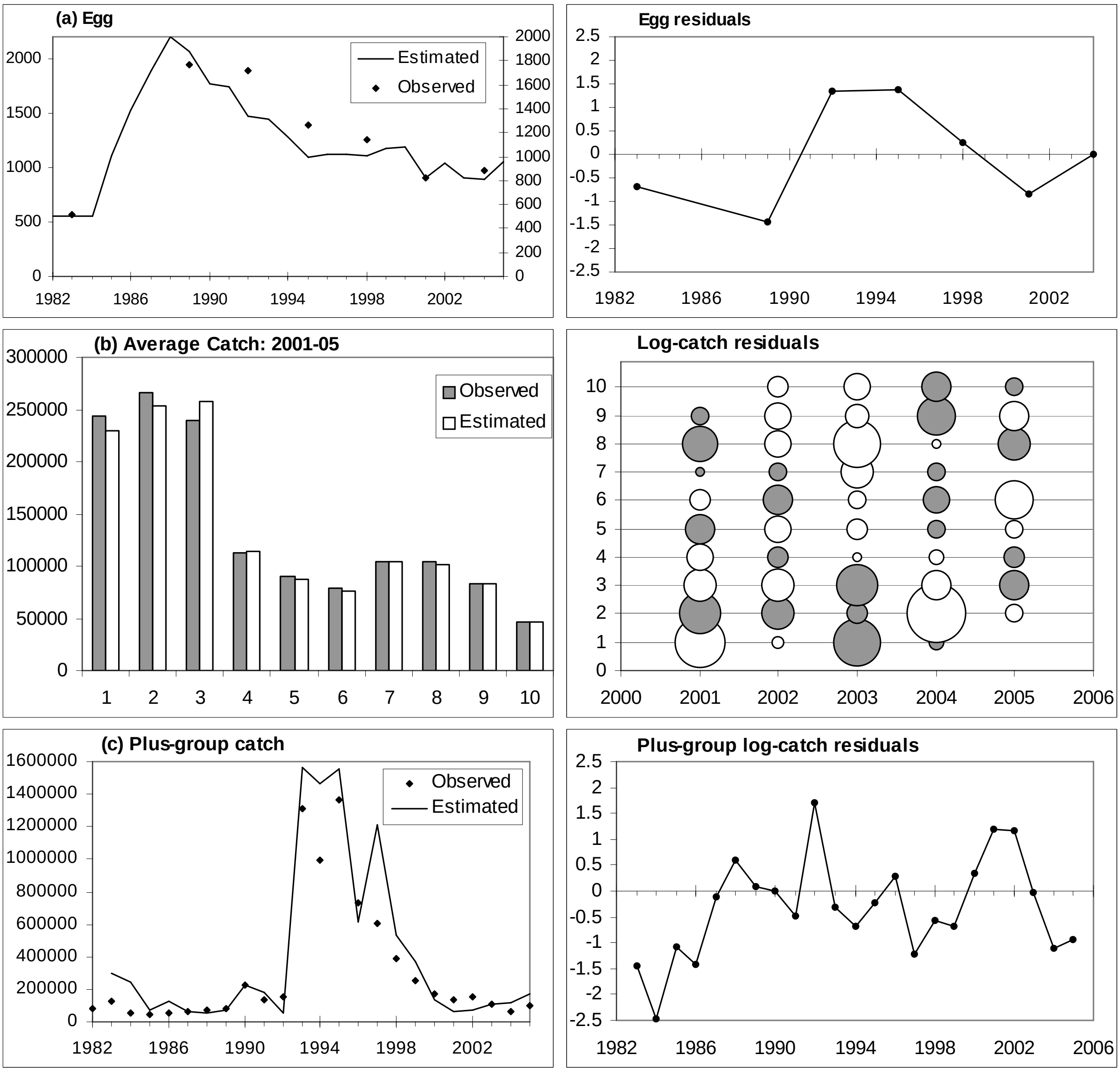


Figure 5.6.2.: Western horse-mackerel, same assessment procedure as last year (SPALY). Model fits to data for the three components of the likelihood corresponding to (a) the egg estimates, (b) the catches in the separable period, and (c) to the catches in the plus-group. The left-hand column shows the actual fit to the data (average catches are shown in (b) for ease of presentation), and the right-hand column normalised residuals, of the form: $(\ln X - \ln \hat{X})/\sigma$. In the residual plot for (b), the area of a bubble reflects the size of the residual (the largest bubble shown corresponds to an absolute residual value of 2.3).

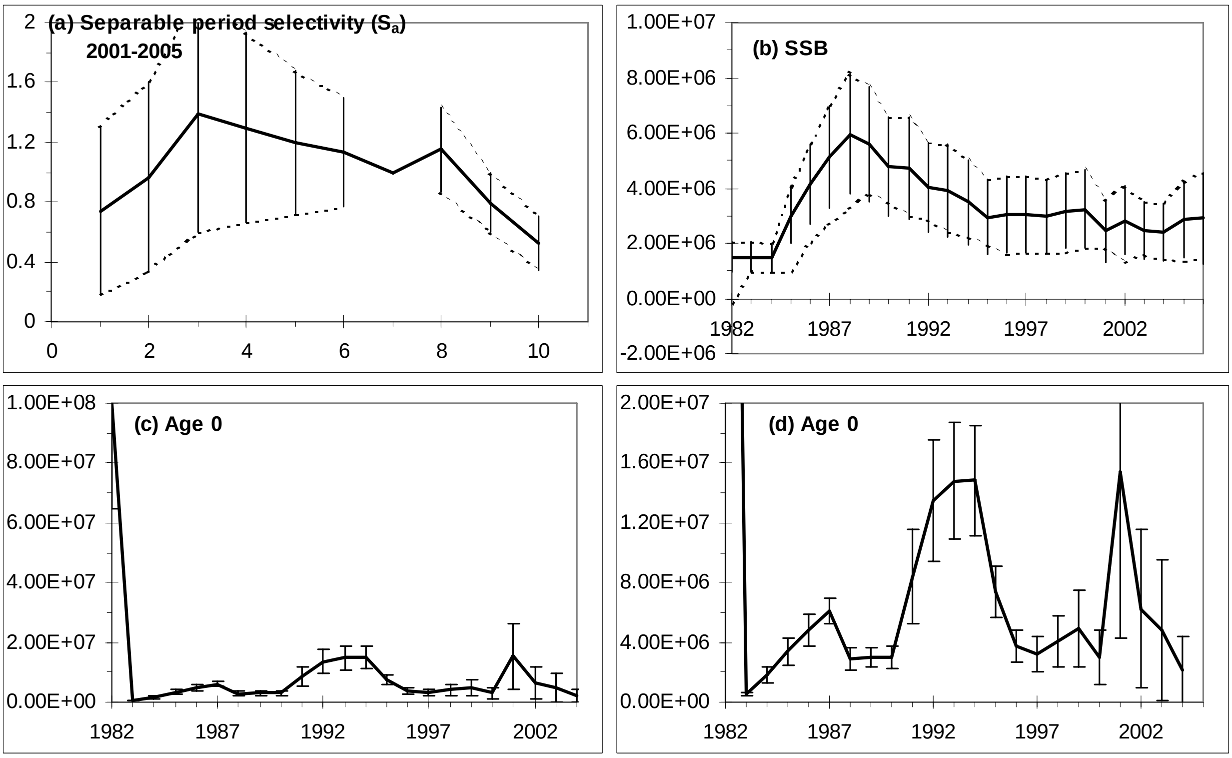


Figure 5.6.3.: Western horse-mackerel SPALY. Plots of (a) the selectivity pattern, (b) the SSB trajectory, (c) numbers at age 0, and (d) the same as (c) but scaled to capture more detail. The error bars are 2 standard deviations (indicating roughly 95% confidence bounds).

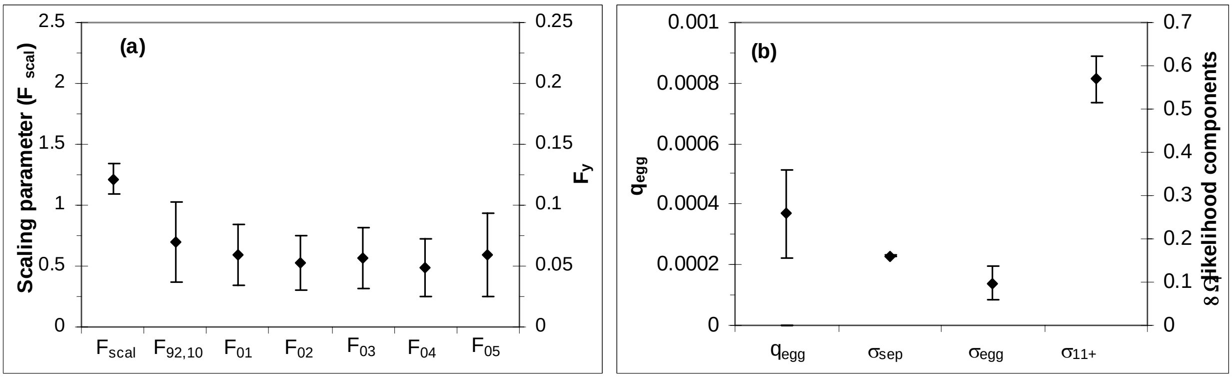


Figure 5.6.4. : Western horse-mackerel. Estimates for some key parameters, with (a) corresponding to fishing mortality parameters (the scaling parameter F_{scal}, fishing mortality at age 10 in 1992, $F_{92,10}$, and the fishing mortality year effects for the separable period, F_y), and (b) the catchability parameter q_{egg}, and estimates of variance, plotted as standard deviations, for the three components of the likelihood (σ_{sep}, σ_{egg} and σ_{11+}). The error bars are 2 standard deviations (indicating roughly 95% confidence bounds). (SPALY)

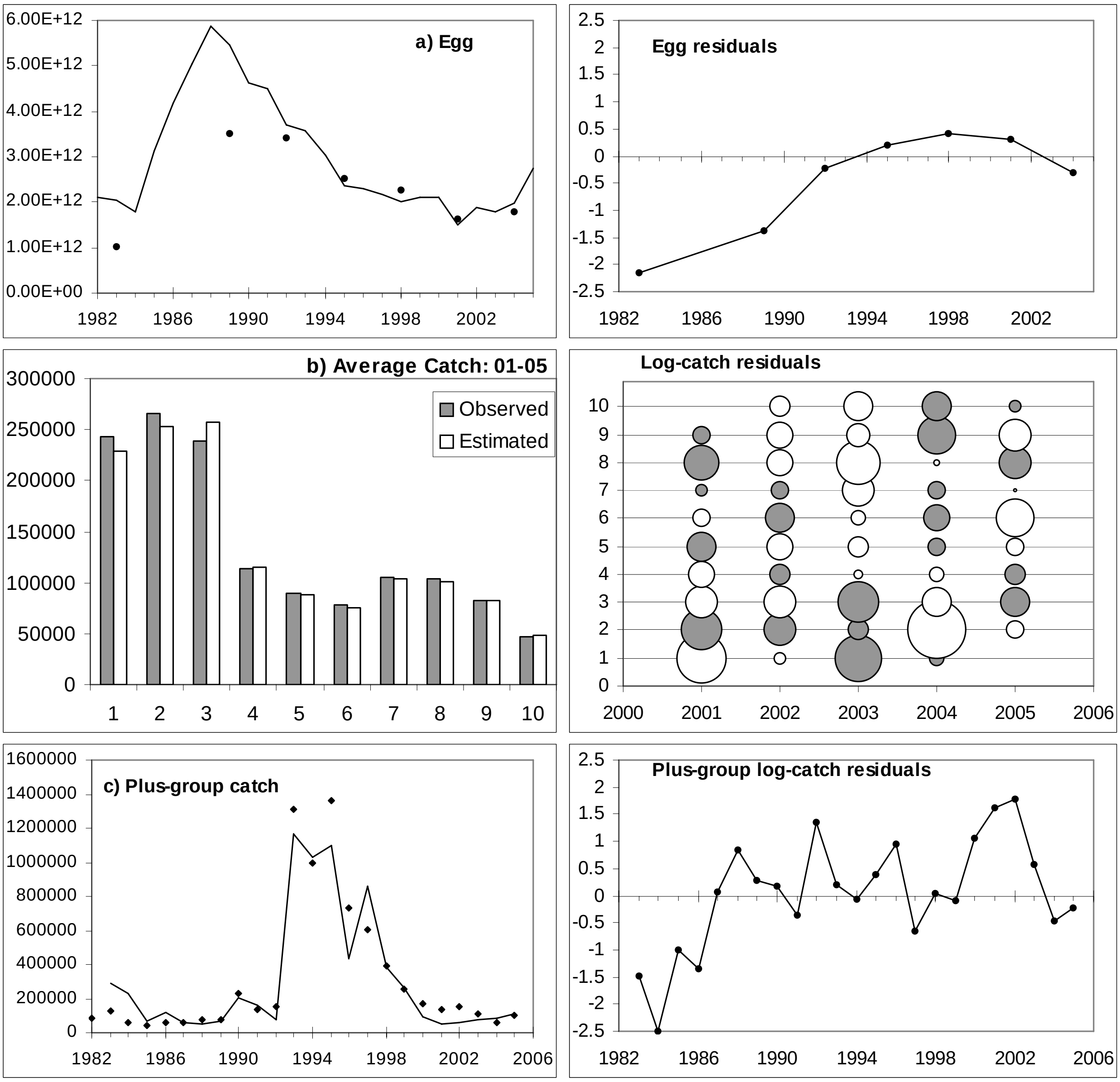


Figure 5.6.5.: Western horse-mackerel, variable fecundity model (sadVF). Model fits to data for the three components of the likelihood corresponding to (a) the egg estimates, (b) the catches in the separable period, and (c) to the catches in the plus-group. The left-hand column shows the actual fit to the data (average catches are shown in (b) for ease of presentation), and the right-hand column normalised residuals, of the form: $(\ln X - \ln \hat{X})/\sigma$. In the residual plot for (b), the area of a bubble reflects the size of the residual (the largest bubble shown corresponds to an absolute residual value of 2.3).

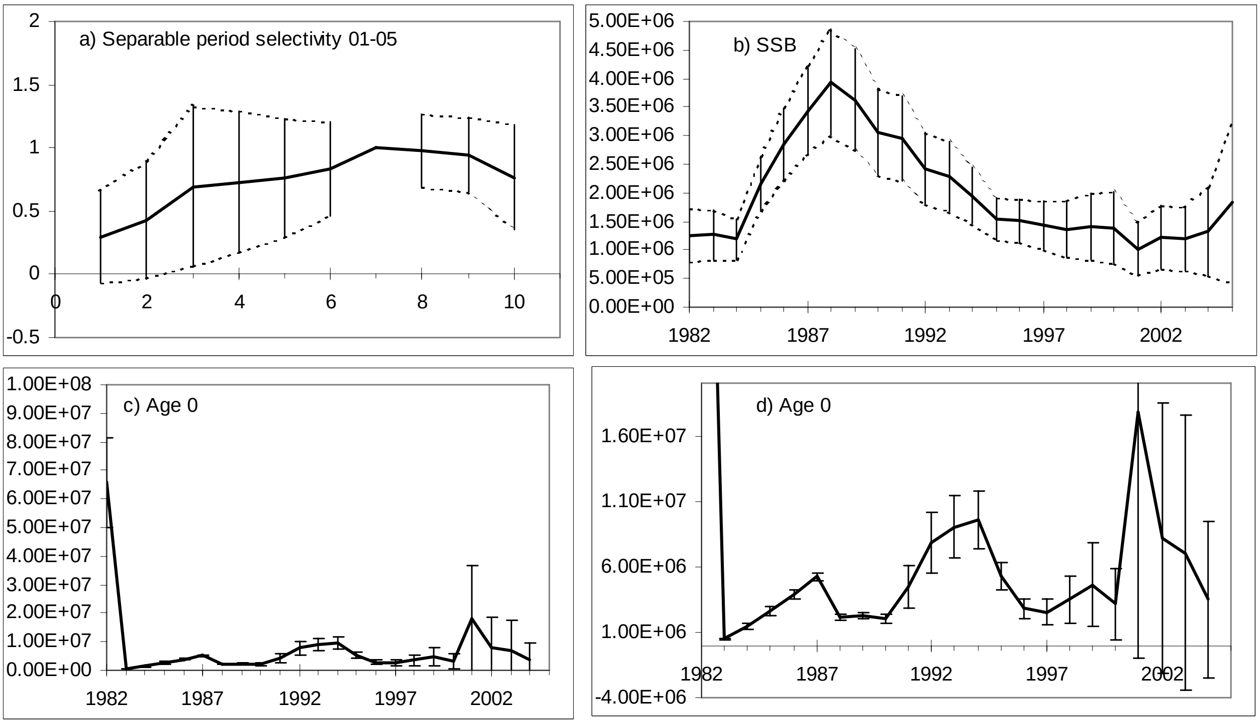


Figure 5.6.6: Western horse-mackerel sadVF. Plots of (a) the selectivity pattern, (b) the SSB trajectory, (c) numbers at age 0, and (d) the same as (c) but scaled to capture more detail. The error bars are 2 standard deviations (indicating roughly 95% confidence bounds).

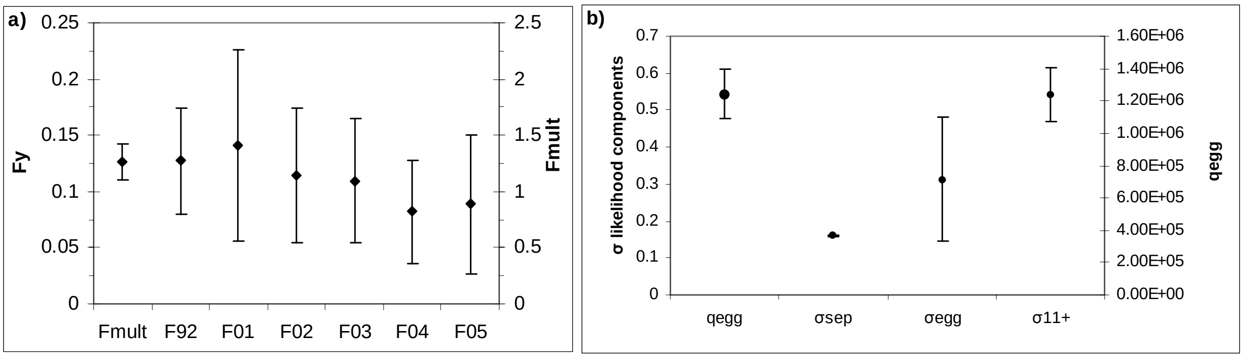


Figure 5.6.7: Western horse-mackerel. Estimates for some key parameters, with (a) corresponding to fishing mortality parameters (the scaling parameter F_{scal}, fishing mortality at age 10 in 1992, $F_{92,10}$, and the fishing mortality year effects for the separable period, F_y), and (b) the catchability parameter q_{egg}, and estimates of variance, plotted as standard deviations, for the three components of the likelihood (σ_{sep}, σ_{egg} and σ_{11+}). The error bars are 2 standard deviations (indicating roughly 95% confidence bounds). (sadVF)

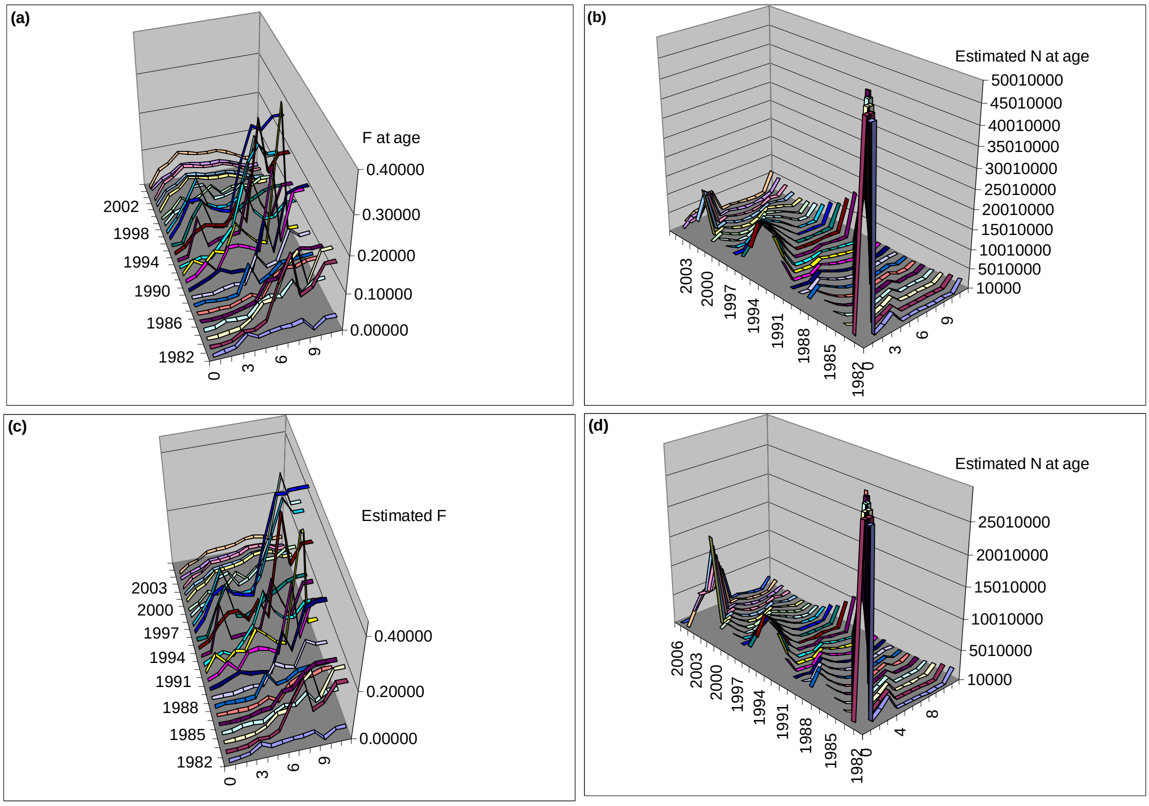


Figure 5.6.8: Western horse-mackerel estimated F and numbers at age from SPALY (a & b) and from sadVF (c & d).

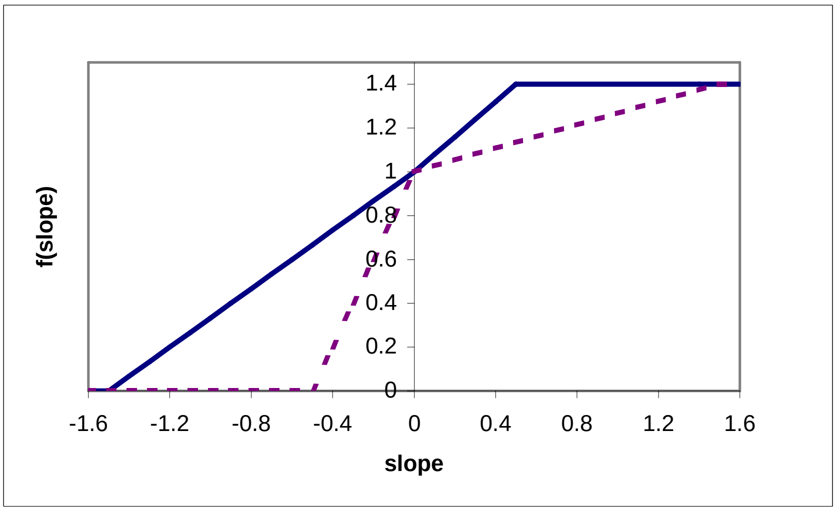


Figure 5.11.1. Western horse mackerel. Functions of the slope corresponding to the last 3 egg data points used to compute the TAC_y (slow or rapid decrease when the slope is <0).

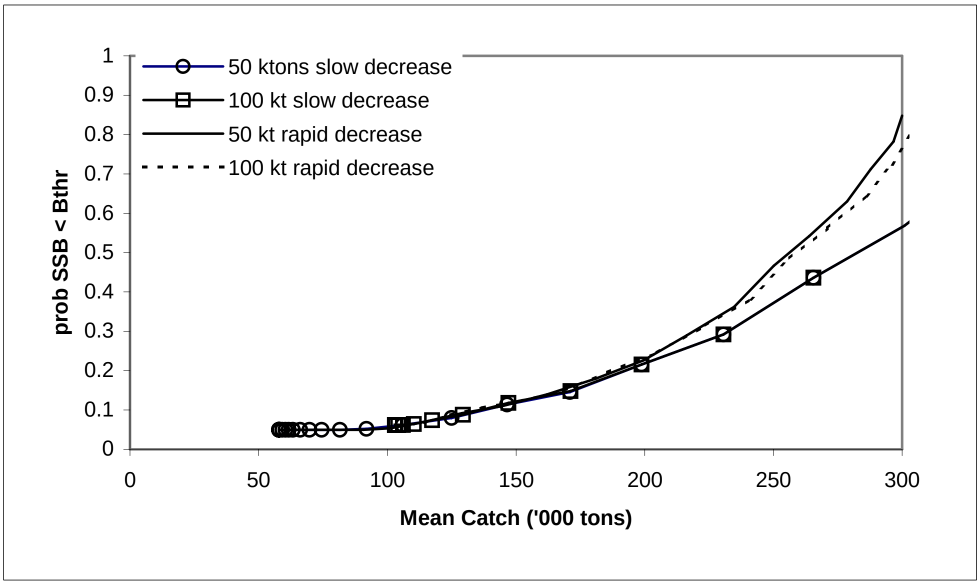


Figure 5.11.2. Western horse mackerel. Slope strategy a): Risk of SSB falling below Bthr for β values resulting in increasing average catch. Minimum TAC = 50 and 100 Ktons and slope functions resulting in slow or rapid reduction of the TAC when slope <0. Each succesive point on a curve (from bottom left) results from taking an increasing fraction of the stock biomass (increasing α or β). The HCRs compared result from combining the following options of minimum TAC and lower and upper limits for the values of the slope where the slope function flattens :

Minimum TAC	slope: low – upper limit
50 ktons	-0.5 – 1.5
100 ktons	-1.5 – 0.5

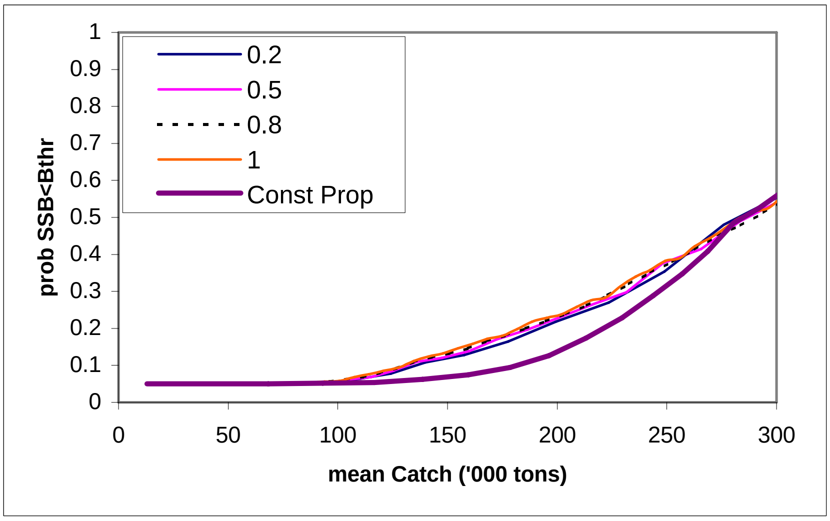
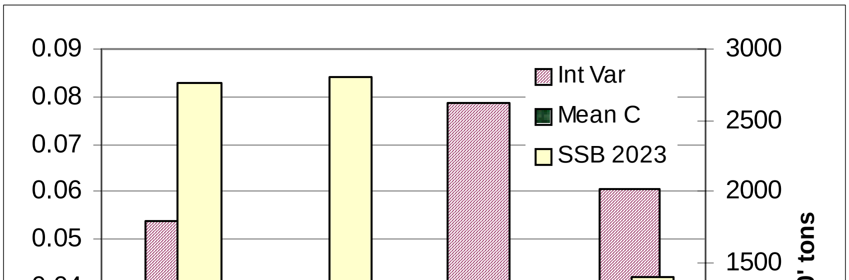


Figure 5.11.3. Western horse mackerel. Slope b) strategy and "constant proportion": Risk of SSB falling below B_{thr} for β values resulting in increasing average catch. Weights of the slope b) strategies = 0.2, 0.5, 0.8 and 1.



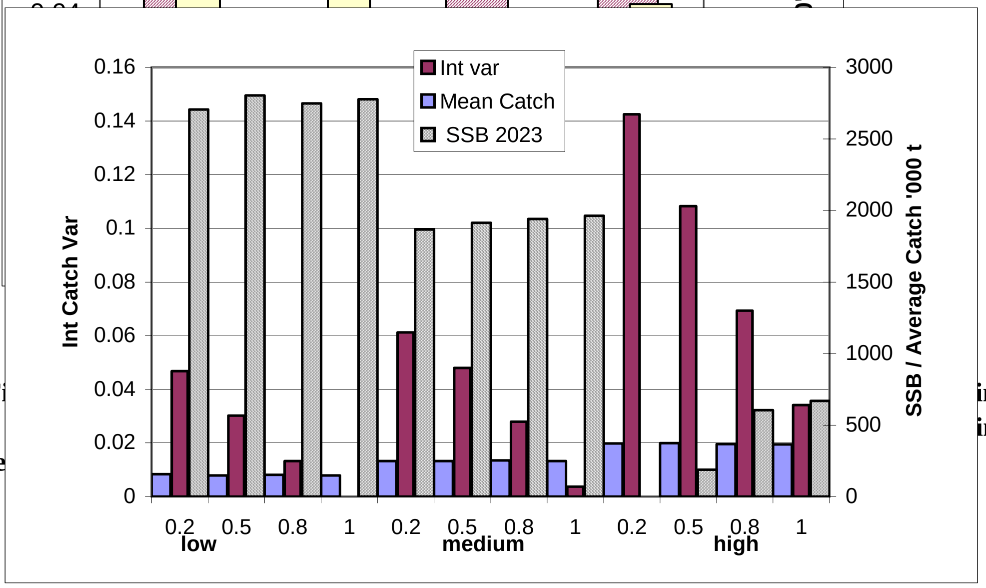


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Figure 5.11.5. Western horse mackerel. Comparison between slope b) strategies in terms of average catch, SSB in 1923 (left-axis) and inter-annual catch variability (right-axis) over 20-year projections. Scenarios of low, medium and high catch (150, 250 & 370 Ktons).

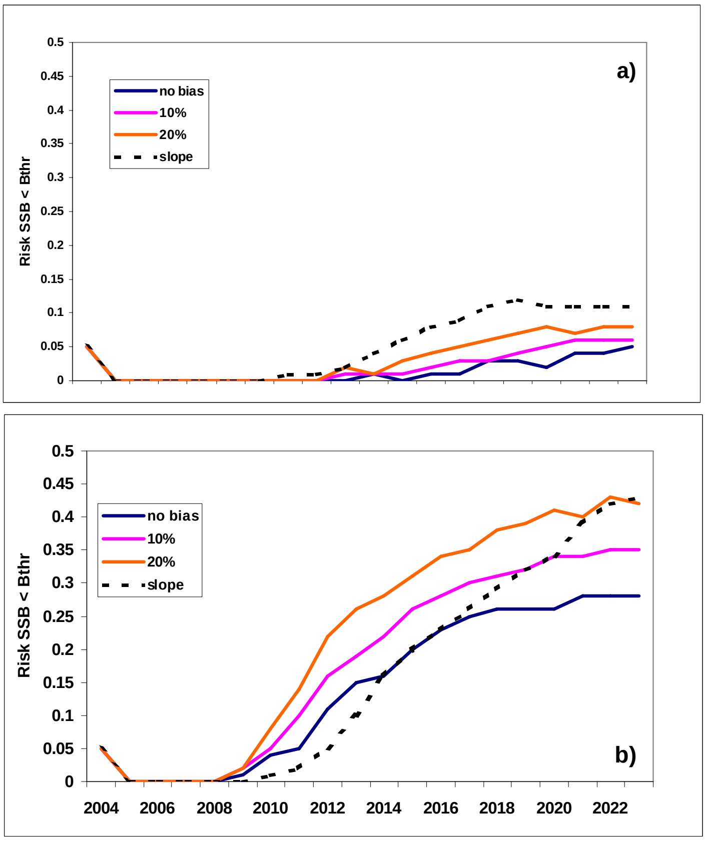


Figure 5.11.6. Western horse mackerel. Probability of SSB falling below B_{thr} (risk) for each projected year. a) average catch = 200 ktons and b) = 300 ktons

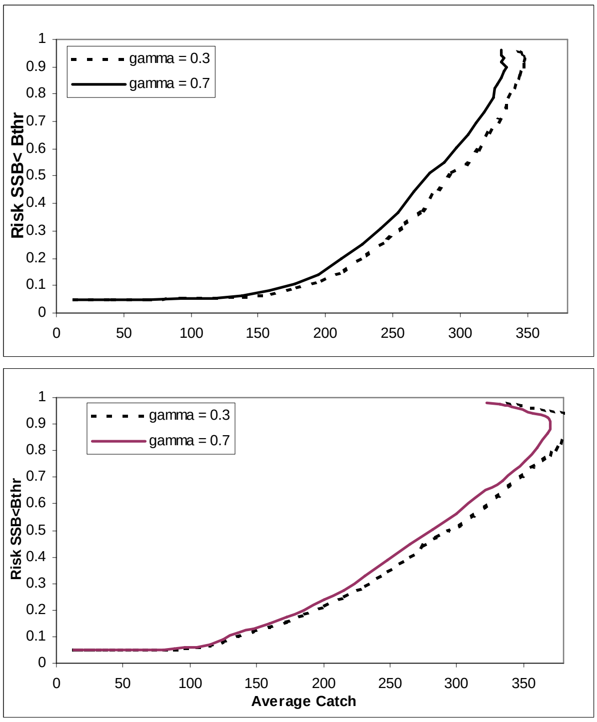


Figure 5.11.7. Western horse mackerel. Results in terms of risk and median catch for 20-year projections for a constant proportion (upper pannel) and slope (weight = 0.5, lower pannel) strategies. The parameter gamma reflects the proportion of the catch taken by the juvenile fishery

6 Southern Horse Mackerel (Division IXa)

6.1 ICES advice applicable to 2005 and 2006

In 2005 ICES considered that the state of the stock was unknown and that the previously proposed reference points will need to be reviewed as the stock boundaries have now been changed. Reference points should be revisited when a stable assessment is available.

Given the state of the stock and the likely decrease in spawning biomass, fishing effort must not increase and catches in 2006 should not exceed the recent average of 25, 000 t (2000-2004, excluding 2003 because of the "Prestige" accident).

The TAC for this stock should only apply to *Trachurus trachurus*.

6.2 The Fishery in 2005

Catches

The catches of horse mackerel in Division IXa (Subdivision IXa north, Subdivision IXa central-north, Subdivision IXa central-south and Subdivision IXa south) are allocated to the Southern Horse mackerel Stock. In the years before 2004 the catches from Subdivisions VIIIc west and VIIIc east, were also considered to belong to the southern horse mackerel stock. These catches were already removed in 2004 to obtain the historical series of stock catches (table 6.2.1 and figure 6.2.1). However, the definition of the Subdivisions was set quite recently (ICES, 1992) and some of the previous catch statistics came from an area that comprise more than one Subdivision. This is the case of the Galician coasts where the Subdivisions VIIIc West and Subdivision IXa North are located. Further work is necessary to collect the catches by port and to distribute them by Subdivision. At the moment we have collected the required information for the period 1991-2005, and it is expected to go back in time until 1939 (Portuguese catches are available since 1927) during the next years.

The Spanish catches in Subdivision IXa South (Gulf of Cadiz) are available since 2002. They will not be included in the assessment data until de time series is completed, to avoid a possible bias in the assessment results. On the other hand, the total catches from the Gulf of Cadiz are scarce and represent less than the 5% of the total catch (1.8 % in 2005). Therefore, their exclusion should not affect the reliability of the assessment. The Portuguese catches range from 51% of the total catch of the stock in 2004 and 1998 to 89% in 1992 (table 6.2.1). In 2005 the Portuguese catches were the 58% of the total catch. The catch time series during the assessment period shows a decreasing trend since the peak reached in 1998 until 2003, when the lowest level of the time series was reached (Fig. 6.2.1). This low catch level was mainly due to the markedly decrease (-21%) observed in Portuguese catches as compared to the catch reported in 2002. The Prestige oil spill had also an effect in the fishery activities in the Spanish area in 2003. The catches in 2005 represented a slight decrease of 3% compared with those obtained in 2004 mainly due to the drop of the Spanish catches in Subdivision IXa North, about 2,000 t less, partially compensated with the increment in the Portuguese catches (about 1,400 t more). In the assessment period the level of catches for this stock is about 26,000 (± 5,300) tonnes. The Spanish catches increased markedly from 1991 until 1998, whereas the Portuguese ones are more stable showing a smooth decreasing trend since the peak obtained in 1992 (with a secondary peak in 1998). Catches by Subdivision show a stable time series in Subdivisions IXa central-south and IXa south. In Subdivisions IXa central-north catches showed a decreasing trend whereas in Subdivision IXa north they incresead markedly until 1998 (an outstanding catches = 20,000 t) and since then the catches were always higher than 7,000 t (Figure 6.2.2). The catches from bottom trawlers are the majority in both countries (about 62%). The rest of the catches are taken by purse seiners (especially in the Spanish area) and by the artisanal fleet (more important in the Portuguese area).

Fishing fleets

The descriptions of the Portuguese fishing fleets operating in Division IXa and the Spanish fishing fleets operating in Division IXa (Southern stock) and Division VIIIc (Western stock) are shown in tables 6.2.2 and 6.2.3.

The Spanish bottom trawl fleet operating in ICES Divisions VIIIc (Western stock) and Subdivision IXa north (Southern stock), historically relatively homogeneous, has evolved in the last decade (approximately since 1995) to incorporate several new fishing strategies. A classification analysis for this fleet between the years 2002 and 2004, was made based on the species composition of the individual trips (Castro and Punzón 2005). The analysis resulted in the identification of five catch profiles in the bottom otter trawl fleet: 1) targeting horse mackerel (>70% in landings), 2) targeting mackerel (>73% in landings); 3) targeting blue whiting (>40% in landings); 4) targeting demersal species; and 5) a mixed "metier". In the bottom pair trawl fleet the classification analysis showed two métiers: 1) targeting blue whiting; and 2) targeting hake. These results should help in obtaining standardized and more coherent CPUE series from fishing fleets. The description of the Portuguese fishing fleets operating in Division IXa and the Spanish fishing fleets operating in Division IXa (Southern stock) and Division VIIIc (Western stock) are shown in tables 6.2.2 and 6.2.3.

6.3 Biological data:

6.3.1 Catch in numbers at age

The sampling scheme achieves a good coverage of the fishery (about 96% of the total catch). The number of fish aged seems also to be sufficient through the historical series. Catch in numbers at age have been obtained by applying a quarterly ALK to each of the catch length distribution estimated from the samples of each Subdivision. In the case of Subdivision IXa north the catch in number estimates before 2003 have changed. In previous years the age length key applied to the length distributions from Subdivision IXa north had included otoliths from Division VIIIc, which has been defined recently as part of the Western stock. Since 2003 the catch in numbers at age from Subdivision IXa north were estimated using age length keys which included only otoliths from Division IXa. In the time series of the catch in numbers at age, the 1994 yearclass showed high catches at age 11 and the 1996 yearclass appears to be conspicuous (table 6.3.1.1 and figure 6.3.1.1). In general, catches are dominated by juveniles and young adults (ages 0 to 4).

6.3.2 Mean length and mean weight-at-age

Table 6.3.2.1 and table 6.3.2.2 show the mean weight at age in the catch, and the mean length at age in catch respectively. They were calculated by applying the mean weighted by the catch over the mean weights at age or mean lengths at age obtained by Subdivision. The mean weight at age in the catch increased significantly in 2004 for the intermediate ages (3-9) when compared to the levels obtained in 2003 (Fig. 6.3.2.1). On contrary, in 2005 the mean weight at age of these intermediate ages decreased. In parallel the mean length at age showed a smooth increase trend for those ages since 2002 with a decrease in 2005 (table 6.3.2.2).

Mean weight at age in the stock: Taking in consideration that: the spawning season is very long, spawning is almost from September to June, and that the whole length range of the species has commercial interest in the Iberian Peninsula, with probably very scarce discards, there is no special reason to consider that the mean-weight in the catch is significantly different from the mean weight in the stock.

6.3.3 Maturity-at-age

For multiple spawners, such as horse mackerel, macroscopical analysis of the gonads cannot provide a correct and precise means to follow the development of both ovaries and testes. Histological analysis has to be included because it provides precise information on oocyte developmental stages and it can distinguish between immature gonads and regressing ones or those partly spawned (Abaunza et al. 2003a). The HOMSIR project (Abaunza et al., 2003b) provided microscopical maturity ogives from the different IXa subdivisions. The maturity ogive from Subdivision IXa south is adopted here as the maturity at age for all years of the southern stock, since it was based on a better sampling than in the others subdivisions. The percentage of mature female individuals per age group was adjusted to a logistic model with the following results (see the equation below and figure 6.3.3.1):

$Y = 1/(1 + \exp(-1 * ((-3.21055) + (2.3921)* X)))$

Where Y is the proportion of maturity individuals at age X. This maturity ogive is in accordance with the values of age at first maturity estimated by Arruda (1984) in Portuguese waters.

6.3.4 Natural mortality

Natural mortality is considered to be 0.15, which is the same value as the used in previous years. This level of natural mortality was adopted all horse mackerel stocks since 1992 (ICES 1992/Assess: 17).

6.4 Fishery Independent Information and CPUE Indices of Stock Size

6.4.1 Trawl surveys

There are currently 2 bottom-trawl survey series that can be used for tuning the assessment: the Portuguese and Spanish October surveys. These surveys cover Sub-divisions VIIIc East, VIIIc West, IXa North (Spain) and Sub-divisions IXa Central North, Central South and South (Portugal) from 20-750 m depth. The Spanish survey was disaggregated by subdivision in order to use the data from the subdivision IXa North which is part of the southern horse mackerel stock. The same sampling methodology was used in both surveys but there are differences in the gear design, as described in ICES (1991/G: 13). The Portuguese and the Spanish October survey indices are estimated by strata for the whole range of distribution of horse mackerel in the area, which has been consistently sampled over the years.

The CPUE matrices from these surveys are shown in Table 6.4.1.1. In the Spanish September/October survey, the ages from 1 to 5 are almost absent (except in 1993 and 2004), whereas in the Portuguese survey the oldest adults are not well represented. The total number per haul is dominated by the catch of the incoming year classes in the two time series of surveys.

6.4.2 Egg surveys

Recent work suggests that horse mackerel has indeterminate fecundity, which makes the Annual Egg Production Method (AEPM) unsuitable to estimate SSB for this species. For species with indeterminate fecundity, the Daily Egg Production Method (DEPM) should be used instead. The existence of different series of data from egg surveys covering the whole area of the southern horse mackerel stock, makes it possible to obtain egg production estimates using DEPM. A data series to calculate SSB estimates from the DEPM has been put together, both from horse mackerel and sardine DEPM surveys. SSB estimates from those data will be presented for review at the forthcoming WGACEGG meeting next November.

6.5 Effort and Catch per Unit Effort

Useful statistics of Portuguese bottom trawl fleet were collected to monitor the state of the stock with a historic perspective. The time series of number of vessels and number of trips from this fleet are now available from 1937 to 1998 and 1991 respectively. The time series of the specific catch from this fleet is available from 1963 to 1998. During the period 1969-1978 there were outstanding high catches which were not in relation with the small increase in effort, suggesting an increase in the abundance of horse mackerel in that period. However, the effort showed an increasing trend since 60’ until 1987 (figure 6.5.1). In the future, it is expected to use this information with appropriate models (e.g. biomass dynamic models) to examine the dynamics of this stock through a large time series.

Looking at the historical series of the catches from Portugal and Spain (available since 1930 until now), it can be observed periods with significant higher catches (figures 6.5.2 and 6.5.3). However, it is clear that the current catch level is not abnormally low when compared with the catches of the first half of the 20th century. Instead, the catches from 1962-1978, appear exceptionally high when looking to the whole time series. Many hypotheses have been proposed to explain this pattern (Murta and Abaunza, 2000) and some of them could be tested in the next future with the analysis of the catch and effort data from the Portuguese bottom trawl fleet available since 1963.

6.6 Recruitment forecast

No recruitment forecast was carried out.

6.7 State of the stock

6.7.1 Data exploration

The two bottom-trawl surveys series, available to use as tuning data in the assessment, were joined as suggested by last years' review group, by giving a weight to each data set, proportional to the respective area (80% to the Portuguese data and 20% to the Spanish one) and adding the values for each age and year. Figures 6.7.1.1, 6.7.1.2, 6.7.1.3 and 6.7.1.4 show the evolution of several yearclasses in each survey and also in the combined data set. The patterns in the Spanish survey (lack of decrease in the abundance of certain yearclasses) reveal the existence of migrations, probable coming in from the Portuguese area (Murta et al, in press). However, the combined data show a coherent decreasing pattern for each year class (Figure 6.7.1.3).

Last year, a separable model was set up with AMCI, using as auxiliary information the two bottom-trawl surveys with equal weight with estimated catchability at age estimated for each survey. Several exploratory runs were carried out to improve the fitting to the data, which showed that a stable assessment could only be achieved by setting the F effect of the last assessment year equal to that of the year before, and by setting the selectivity-at-age effects of ages 9, 10 and 11 equal to that of age 8. Moreover, the recruitment in the last year was always estimated at an unlikely high level. Given that this recruitment is the most uncertain estimate in the assessment, it was decided to fix it at the geometric mean of the recruitments obtained in a preliminary assessment trial. The same problem was observed with the recruitment of the year before (2003). As we considered that this recruitment was also poorly estimated, it was decided to also fix it at the same level.

This year, being this an "update" assessment, it was decided to repeat last year's assessment, with exactly the same options. The only differences were the update of the data for 2005 and the use of the combined surveys. The results obtained were significantly different from last year, and presented values that seemed unrealistic, such as extremely high SSB values and all

F values much lower that the assumed M (0.15). The fitted model estimated 81 parameters, being part of them highly correlated, as indicated by singularities in the Hessian matrix. Therefore, several options to reduce the number of estimated parameters were attempted by making stronger assumptions, such as fixing the year effects for catchability, fixing an average recruitment for the last 3 years, or fixing F for the last 2 ages. None of these options resulted in an assessment with acceptable parameters estimates. A possible explanation for this fact may be a lack of agreement between the CPUE matrix and the catch data, from the point of view of a separable model. In such a case, a VPA-based method may be more effective, as suggested by Walters and Martell (2004), given the agreement between the catch curves (Figure 6.7.1.5) and the decrease of year classes in survey data (Figure 6.7.1.3).

The "Extended Survivors Analysis" (XSA) (Darby and Flatman, 1994; Shepherd, 1999) has been the method used for the assessment of the southern horse mackerel stock since 1992, with the exception of last year, and was chosen to assess the stock again this year, with the new data arrangement (combined surveys). Preliminary runs made with XSA helped to define the best age range at which catchability is dependent of year-class strength. The assessment method was applied to ages 0 to 11+, with a high standard error (1.0) for the mean F to which survivors estimates were shrunk (hence a low shrinkage). The assessment input data are summarised in table 6.7.1.1.

6.7.2 Stock assessment

A final run with XSA was made according to the options taken during the data exploration. The report and diagnostics of this run are in Table 6.7.2.1. The method was allowed to run for 30 iterations because practical experience has shown that unreliable results can be obtained if the method is allowed to iterate for too long. The log-catchability residuals obtained (Table 6.7.2.1, Figure 6.7.2.1) were high in just a few ages and years (particularly 1998), but overall there was not any clear pattern that could indicate a strong deviation from the method's assumptions.

A retrospective analysis was made by removing sequentially the final years in the data set and repeating the run with the same options as the assessment run. The patterns obtained (Figure 6.7.2.2), both for F and SSB, do not show systematic under- or overestimation of these values in the final years. Nevertheless, the SSB retrospective trajectories show a high variability, especially for 1997, which may be due to the year effects in CPUE data. However, this hypothesis was not examined in detail.

The numbers-at-age matrix estimated from the assessment is represented in Figure 6.7.2.3. The strength of the 1982, 1991 and 1996 year classes is well marked in that figure. There is a pattern in some strong year classes, in which as the strength diminishes, the strength of a neighbouring year class seems to increase. This pattern is likely to be due to the influence of the year-effects, that can be seen in the combined surveys data (Figure 6.7.1.4), on the back-calculated VPA process.

The stock summary is shown in Table 6.7.2.2 and Figure 6.7.2.4. From these a pattern of relative stability is clear in the overall landings and fishing mortality in recent years, although the spawning stock biomass presents a declining trend. This may be due to the facts that there has not been a strong yearclass in recent years, and at the same time landings of older fish have been increasing in the sub-area IXa North. The recruitment seems to have an increasing trend, even without taking into account the less reliable estimates of the latest years.

6.7.3 Reliability of the assessment

The F and SSB trajectories of the present assessment were plotted along with those from the AMCI assessments from last year and this year (Figures 6.7.3.1 and 6.7.3.2). The overall SSB trends in the three assessments show a declining trend, although the absolute values are very different. Still, this year's AMCI exploratory assessment was the one that differed most from the others. The F trajectories show also disagreements between these assessments, especially in the latest years, both in terms of level and trends.

Given the difficulties in the conditioning of the models that were set up with AMCI, XSA seemed in this particular case a more robust alternative. Besides giving sensible estimates of F and SSB, the diagnostics from the XSA assessment do not indicate strong deviations from the method's assumptions. Still, this method seems to have difficulty in accommodating the year effects that are present in the tuning data. Given the improvements made in recent years in the basic data, motivated by the review of the stock distribution, this assessment is likely to give a more accurate view of the state of this stock than the previous ones.

6.8 Short-term catch predictions

No short-term catch predictions were carried out.

6.9 Management considerations

Independently of the exact level of SSB, it is clear that there is a declining trend during the whole time period covered by the assessment. Also, the restricting management measures for species caught with the same gears as horse mackerel, such as hake or sardine, do not seem to have produced a noticeable decrease in the horse mackerel catches. In fact, the development of new trawls especially designed for horse mackerel has led to a recent increase of the catches in sub-area IXa North. Since 1991 the catches in Subdivision IXa north increased markedly until 1998. The overall exploitation pattern therefore changed with a significant increase in the catches of old adults in that Subdivision. Since 1998 the catches in Subdivision IXa north were more stable but always higher than 7000 t. If the fishing mortality in that area starts to increase in the future, together with the lack of a strong recruitment, it may take the SSB to an even lower level than the present one, and may severely deplete the stock locally, or even in its whole distribution area.

Table 6.2.1. Time series of southern horse mackerel historical catches by country (in tonnes).

	Country		
Year	Portugal (Subdivisions: IX a central north; IXa central south and IXa south)	Spain (Subdivisions IXa North and IXa south*)	Total Catch
1991	17,497	4,275	21,772
1992	22,654	3,838	26,492
1993	25,747	6,198	31,945
1994	19,061	6,898	25,959
1995	17,698	7,449	25,147
1996	14,053	8,890	22,943
1997	16,736	10,906	27,642
1998	21,334	20,230	41,564
1999	14,420	13,313	27,733
2000	15,348	11,812	27,160
2001	13,760	11,152	24,910
2002	14,270	8,236 // (9,393)*	22,506 // (23,663)*
2003	11,242	7,645 // (8,324)*	18,887 // (19,566)*
2004	11,875	11,377 // (11,702)*	23,252 // (23,577)*
2005	13,307	9,388 // (9,804)*	22,695 // (23,111)*

(*) In parenthesis: the Spanish catches from Subdivision IXa south are also included. These catches are only available since 2002 and they will not be considered in the assessment data until the rest of the time series be completed.

Table 6.2.2.- Description of the Portuguese fishing fleets that catch horse mackerel in Division IXa (only trawlers and purse seiners). Note that horse mackerel is also caught in all polyvalent and most small scale fisheries.

Gear	Length	Storage	Number of boats
Trawl	10-20	Freezer	2
Trawl	20-30	Freezer	7
Trawl	30-40	Freezer	5
Trawl	0-10	Other	259
Trawl	10-20	Other	68
Trawl	20-30	Other	60
Trawl	30-40	Other	29
Purse seine	0-10	Other	79
Purse seine	10-20	Other	103
Purse seine	20-30	Other	79

Table 6.2.3.- Description of the Spanish fishing fleets that catch horse mackerel in Division IXa (sourthern horse mackerel stock) and in Division VIIIc (Western horse mackerel stock). It is indicated the range and the arithmetic mean (in parenthesis). Legends of gear type: Trawl 1 = Bottom trawl; Trawl 2 = Pair trawl; Artisanal 1 = Hook; Artisanal 2 = Gillnet; Artisanal 3 = Others artisanal. Data from official census.

Length Category	Engine power category	Gear	Storage	Discard estimates	Number of vessels
16 - 33 (28)	200 - 800 (442)	TRAWL	Dry hold with ice	NO	134
8 - 38 (22)	16 - 1100 (333)	PURSE SEINE	Dry hold with ice	NO	341
5 - 44 (20)	5 - 878 (250)	ARTISANAL 1	Dry hold with ice	NO	246
4 - 27 (15)	9 - 425 (131)	ARTISANAL 2	Dry hold with ice	NO	100
2 - 27 (6)	4 - 450 (29)	ARTISANAL 3	Dry hold with ice	NO	5513

Table 6.3.1.1 Catch in numbers at age from the Southern horse mackerel stock. Numbers in thousands.

	AGES															
YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1991	13914	72287	15701	7725	7182	10684	7133	8453	8333	19754	12079	9346	5765	4015	1763	522
1992	11966	102521	160026	43207	12516	10030	5615	7672	5633	4902	13783	4700	3409	1924	1213	1846
1993	5121	73007	154366	98963	34999	13410	13128	10972	6080	4317	3878	9537	1286	565	436	1741
1994	11943	54418	76970	95856	30476	8115	4567	3213	4646	3176	5534	2234	1579	1763	1266	3436
1995	6241	58241	28682	52856	28399	11225	4068	3124	2536	3496	2490	5251	6852	9705	3704	5677
1996	40207	12439	12449	27937	37498	11584	8353	5834	4148	10065	4481	4170	4808	3253	1109	4049
1997	3770	304637	115808	25895	17418	12323	7532	5259	4131	3393	2013	1957	1560	2065	2225	3042
1998	19023	54319	328147	84414	18308	11144	9281	21127	16389	7877	6562	3136	2624	3377	1849	4560
1999	39363	30615	26945	62894	42044	16994	16382	7464	4093	6772	3751	2874	3221	1429	847	3305
2000	9821	56973	31437	37675	35549	17438	20611	14007	7868	6323	4353	966	1497	1499	1261	2675
2001	107632	76414	28214	32098	27406	16641	14151	13436	8513	3488	4887	3062	1591	2053	272	1492
2002	17826	86185	95747	27782	12360	10982	9151	9996	8897	8910	5199	3103	1452	1673	1061	1071
2003	37403	5268	34426	33693	23880	13535	11363	10853	9847	7403	4994	1696	1485	491	69	2134
2004	6689	111702	51898	20474	10655	15629	12927	15350	10223	3582	5132	591	1508	214	438	2505
2005	27753	104789	46912	23480	18274	12407	11641	8217	8729	6514	4920	5062	2145	1417	1485	1700

Table 6.3.2.1. Southern horse mackerel. Mean wight at age in the catch

	AGES															
YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1991	0.026	0.036	0.073	0.101	0.122	0.153	0.170	0.179	0.210	0.217	0.221	0.215	0.256	0.296	0.398	0.374
1992	0.032	0.034	0.044	0.067	0.104	0.131	0.148	0.172	0.187	0.200	0.232	0.258	0.280	0.324	0.331	0.416
1993	0.023	0.029	0.038	0.066	0.089	0.130	0.166	0.208	0.243	0.243	0.253	0.269	0.319	0.341	0.369	0.413
1994	0.040	0.036	0.063	0.069	0.091	0.131	0.157	0.193	0.225	0.248	0.272	0.286	0.343	0.336	0.325	0.380
1995	0.036	0.035	0.060	0.083	0.097	0.124	0.164	0.168	0.200	0.222	0.230	0.255	0.284	0.292	0.331	0.391
1996	0.022	0.049	0.070	0.087	0.112	0.140	0.172	0.186	0.216	0.239	0.258	0.264	0.293	0.275	0.362	0.380
1997	0.028	0.031	0.051	0.073	0.112	0.138	0.166	0.200	0.236	0.264	0.255	0.288	0.324	0.332	0.348	0.443
1998	0.028	0.031	0.039	0.067	0.102	0.127	0.169	0.212	0.170	0.245	0.251	0.270	0.290	0.315	0.364	0.447
1999	0.022	0.040	0.060	0.084	0.108	0.140	0.163	0.191	0.217	0.249	0.271	0.284	0.300	0.321	0.397	0.474
2000	0.024	0.035	0.053	0.087	0.111	0.134	0.160	0.188	0.220	0.235	0.252	0.275	0.283	0.321	0.324	0.339
2001	0.024	0.029	0.067	0.083	0.087	0.131	0.157	0.183	0.199	0.232	0.241	0.281	0.279	0.306	0.330	0.428
2002	0.027	0.030	0.044	0.069	0.097	0.124	0.147	0.168	0.196	0.226	0.246	0.270	0.311	0.322	0.341	0.409
2003	0.022	0.033	0.045	0.063	0.088	0.124	0.146	0.179	0.204	0.235	0.254	0.280	0.299	0.318	0.440	0.344
2004	0.039	0.028	0.047	0.084	0.120	0.159	0.184	0.209	0.228	0.254	0.266	0.268	0.284	0.274	0.370	0.361
2005	0.019	0.026	0.043	0.072	0.115	0.148	0.167	0.183	0.220	0.241	0.253	0.281	0.284	0.309	0.286	0.412

Table 6.3.2.2. Southern horse mackerel mean length at age in the catch.

YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1991	13.31	13.57	20.56	23.62	25.14	26.93	28.13	28.37	29.58	29.67	30.17	29.67	31.50	31.83	36.12	35.68
1992	14.93	15.59	17.47	19.84	23.18	25.79	27.38	28.65	29.60	31.15	31.53	32.64	33.28	33.93	34.70	36.81
1993	13.96	15.54	17.41	18.89	21.28	28.23	29.56	31.09	31.70	31.66	32.05	32.45	34.08	34.72	35.81	37.18
1994	13.37	14.58	18.11	21.08	22.66	24.76	27.01	29.53	31.15	31.71	32.38	32.19	33.27	34.17	34.37	36.46
1995	16.04	15.44	19.88	21.77	23.12	24.49	28.64	26.54	30.14	30.90	31.61	32.61	33.95	33.99	35.23	36.94
1996	13.29	18.99	19.68	21.82	24.68	26.32	28.02	28.56	30.34	30.74	31.47	31.95	33.42	32.54	36.15	37.00
1997	13.36	15.81	18.89	20.72	24.27	26.30	27.62	29.46	31.15	32.40	31.88	33.05	34.64	34.82	35.45	38.54
1998	14.49	13.92	15.92	20.45	23.51	25.52	28.31	30.31	26.86	31.69	31.98	32.73	33.44	34.54	36.45	39.08
1999	13.41	16.39	18.97	22.27	24.48	26.20	27.51	28.98	30.29	31.70	32.69	33.26	33.88	34.74	37.31	39.59
2000	13.61	16.37	18.43	21.68	24.76	26.00	27.23	28.57	30.22	30.80	31.52	32.28	32.66	34.23	34.49	34.99
2001	14.11	15.62	20.24	21.85	22.46	25.44	27.36	28.73	29.59	30.85	31.18	32.98	32.84	33.99	34.73	38.23
2002	15.05	15.69	17.51	20.34	23.06	25.38	26.60	28.01	29.58	30.86	31.76	32.60	34.20	34.68	35.43	36.88
2003	13.00	15.72	18.75	20.70	23.14	26.08	26.73	29.19	30.00	31.21	31.96	32.90	33.55	33.93	38.86	35.31
2004	16.17	14.43	17.23	21.17	24.04	26.67	28.08	29.40	30.47	31.62	32.29	32.23	33.05	32.25	36.37	35.88
2005	12.50	13.93	16.62	20.08	23.54	25.92	27.12	28.09	30.02	31.14	31.64	32.79	32.58	33.55	32.59	37.22

Table 6.4.1.1. Sourthern horse mackerel. CPUE at age from bottom trawl surveys

Portuguese October Survey

YEAR	AGES 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1991	368.430	31.460	20.500	16.410	13.540	5.730	1.920	1.360	1.440	1.920	1.000	0.740	0.380	0.090	0.020	0.040
1992	225.530	686.050	159.250	38.330	24.190	13.010	8.210	6.160	4.540	3.850	6.970	2.160	1.370	0.390	0.220	0.070
1993	1505.320	268.640	338.760	167.840	34.350	5.500	3.550	3.420	0.790	1.290	0.860	2.240	0.580	0.380	0.090	0.080
1994	4.150	7.780	59.970	47.330	14.430	3.230	0.720	1.670	0.740	0.490	0.320	0.130	0.040	0.000	0.000	0.010
1995	12.360	33.940	88.960	125.380	41.330	10.760	1.790	0.750	0.320	0.230	0.170	0.420	0.450	0.640	0.230	0.170
1996*	1591.830	9.310	13.850	19.970	18.650	4.470	2.060	0.680	0.200	0.120	0.050	0.080	0.050	0.050	0.010	0.010
1997	1913.820	72.040	95.550	23.720	41.940	34.190	11.130	7.080	5.010	3.940	2.090	0.930	0.170	0.180	0.120	0.130
1998	39.940	50.810	90.790	71.330	2.720	2.810	1.860	1.070	0.540	0.290	0.140	0.020	0.000	0.000	0.000	0.000
1999*	185.070	24.980	42.110	47.770	4.280	1.420	0.750	0.190	0.050	0.080	0.020	0.000	0.000	0.010	0.000	0.000
2000	1.460	13.910	18.470	24.500	14.030	7.590	4.440	1.190	0.440	0.130	0.030	0.010	0.000	0.000	0.000	0.000
2001	903.470	43.370	5.650	25.550	98.920	9.140	10.270	13.990	7.490	3.340	1.840	0.320	0.180	0.180	0.010	0.000
2002 [1]	28.730	1.920	9.930	13.960	10.370	5.450	1.800	1.270	0.860	0.520	0.990	0.320	0.230	0.110	0.050	0.03
2003*	74.760	9.490	9.150	16.290	14.680	4.640	2.350	1.350	0.890	0.530	0.240	0.010	0.010	0.010	0.000	0
2004	119.300	38.380	206.490	20.350	7.490	4.750	2.800	6.300	5.050	0.550	0.080	0.000	0.000	0.000	0.000	0
2005	1924.500	22.200	56.400	8.200	7.200	30.700	22.500	6.400	2.300	0.550	0.220	0.180	0.130	0.020	0.080	0

Spanish October Survey (only Subdivision IXa North)

YEAR	AGES 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1991	0.146	0.000	0.000	0.000	0.000	0.000	0.000	0.017	0.878	1.860	0.782	0.829	2.734	1.438	1.699	1.812
1992	6.575	0.000	0.000	0.000	0.092	0.000	0.011	0.200	0.181	0.300	3.386	1.553	1.919	1.086	0.302	2.246
1993	92.068	1.652	5.164	3.945	0.354	0.000	1.152	5.175	5.724	8.721	5.228	10.801	2.235	1.646	0.415	0.958
1994	0.148	0.000	0.477	0.000	0.000	0.000	0.000	0.191	0.574	1.432	2.631	0.191	16.133	12.757	1.255	6.413
1995	0.092	0.000	0.000	0.001	0.000	0.003	0.018	0.018	0.339	0.175	0.761	2.534	3.967	8.751	2.450	2.203
1996	33.649	0.000	0.000	0.000	0.000	0.026	0.260	0.348	0.903	2.708	0.564	0.447	1.838	2.561	1.001	4.410
1997**	2.033	0.007	0.000	0.000	0.016	0.126	0.248	0.980	1.158	1.711	0.779	0.235	0.259	0.800	1.098	2.617
1998	0.976	0.000	0.000	0.000	0.000	0.000	0.134	0.926	0.540	0.253	0.146	0.043	0.078	0.126	0.041	0.163
1999	0.041	0.000	0.000	0.000	0.000	0.000	0.170	0.270	0.630	2.175	3.168	2.597	4.653	1.939	1.633	0.286
2000	0.478	0.000	0.000	0.000	0.000	0.005	0.374	2.792	3.686	3.241	0.721	0.578	0.427	0.537	0.294	0.719
2001	12.742	2.857	0.000	0.000	0.000	0.190	0.411	2.544	4.412	4.127	3.151	1.793	0.998	0.930	0.122	0.312
2002	0.143	0.000	0.000	0.000	0.000	0.000	0.594	1.240	7.291	7.091	8.949	10.386	3.540	4.463	1.336	2.295
2003	8.775	0.000	0.000	0.000	0.000	0.026	0.061	0.194	0.110	0.810	0.880	0.348	0.222	0.119	0.067	0.917
2004	89.967	1.191	2.500	16.218	5.390	4.599	1.710	1.306	0.653	0.290	0.797	0.100	0.350	0.044	0.056	0.070
2005	3520.441	0.045	0.000	0.000	0.348	0.409	0.259	0.252	0.515	0.479	0.140	0.637	0.288	0.194	0.099	0.045

* The surveys were carried out with a different vessel
** Since 1997 another stratification design was applied in the Spanish surveys
[1] In 2002 started a new series in which the duration of the trawling per haul has changed from one hour to thirty minutes

Table 6.7.1.1. Southern horse mackerel. Input parameters of the final XSA assessment.	
Assessment year	2006
First data year	1991
Final data year	2005
Age range in canum, weca, west, matprop	0-15
Plus group considered in the assessment	11
Natural mortality	0.15
Proportion of M and F before spawning	0.2
First age for calculation of reference F	1
Last age for calculation of reference F	11
Tuning indices	
CPUE at age from surveys	Two bottom trawl surveys (Portuguese and Spanish) combined in one
CPUE at age from commercial fleets	Not available
Model settings	
Time series weights	Tapered; Power = 3 over 20 years
Catchability dependent on stock size for ages	<2
Regression type	C
Minimum number of points used for regression	5
Catchability independent of age for ages	>8
Shrinkage	1.0 (= almost without shrinkage)
Minimum SE for population estimates derived from each fleet	0.3
Number of parameters	42
Number of observations	330

TABLE 6.7.2.1 - Southern horse mackerel. Output report and diagnostics of the XSA assessment

Lowestoft VPA Version 3.1
11/09/2006 17:28
Extended Survivors Analysis
Horse mackerel south
CPUE data from file hom9atunfin.dat

Catch data for 15 years. 1991 to 2005. Ages 0 to 11.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
IXa combined surveys	1991	2005	0	10	0	1

Time series weights :
Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :
Catchability dependent on stock size for ages < 2
Regression type = C
Minimum of 5 points used for regression
Survivor estimates not shrunk to the population mean
Catchability independent of age for ages >= 8

Terminal population estimation :
Survivor estimates shrunk towards the mean F
of the final 5 years or the 5 oldest ages.
S.E. of the mean to which the estimates are shrunk = 1.000
Minimum standard error for population
estimates derived from each fleet = .300
Prior weighting not applied

Tuning had not converged after 40 iterations

Total absolute residual between iterations
39 and 40 = .00847

Final year F values

Age	0	1	2	3	4	5	6	7	8	9
Iteration 39	0.035	0.1585	0.1641	0.3704	0.2596	0.1403	0.17	0.1168	0.1135	0.2035
Iteration 40	0.0349	0.1584	0.1636	0.3691	0.2569	0.1399	0.1688	0.1162	0.1128	0.2032

Age	10
Iteration 39	0.2803
Iteration 40	0.2797

Regression weights

0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	0.032	0.007	0.044	0.092	0.02	0.286	0.087	0.066	0.008	0.035
1	0.024	0.343	0.116	0.087	0.177	0.199	0.367	0.032	0.27	0.158
2	0.047	0.3	0.717	0.074	0.115	0.118	0.387	0.231	0.462	0.164
3	0.121	0.124	0.352	0.266	0.133	0.157	0.154	0.215	0.198	0.369
4	0.142	0.098	0.115	0.28	0.223	0.128	0.079	0.182	0.092	0.257
5	0.076	0.06	0.079	0.141	0.169	0.146	0.066	0.11	0.165	0.14
6	0.113	0.062	0.056	0.152	0.24	0.191	0.106	0.085	0.139	0.169
7	0.105	0.092	0.232	0.055	0.178	0.23	0.19	0.167	0.15	0.116
8	0.111	0.095	0.428	0.061	0.072	0.148	0.222	0.273	0.222	0.113
9	0.223	0.118	0.25	0.296	0.119	0.039	0.216	0.274	0.142	0.203
10	0.323	0.06	0.33	0.171	0.298	0.12	0.071	0.171	0.293	0.28

Table 6.7.2.1 Continued

XSA population numbers (Thousands)

YEAR	AGE 0	1	2	3	4	5	6	7	8	9
1996	1.36E+06	5.72E+05	2.91E+05	2.64E+05	3.05E+05	1.70E+05	8.41E+04	6.33E+04	4.27E+04	5.42E+04
1997	6.24E+05	1.13E+06	4.81E+05	2.39E+05	2.02E+05	2.28E+05	1.36E+05	6.46E+04	4.91E+04	3.29E+04
1998	4.79E+05	5.34E+05	6.91E+05	3.07E+05	1.82E+05	1.57E+05	1.85E+05	1.10E+05	5.08E+04	3.84E+04
1999	4.83E+05	3.95E+05	4.09E+05	2.91E+05	1.86E+05	1.39E+05	1.25E+05	1.50E+05	7.50E+04	2.85E+04
2000	5.40E+05	3.79E+05	3.11E+05	3.27E+05	1.92E+05	1.21E+05	1.04E+05	9.25E+04	1.23E+05	6.07E+04
2001	4.67E+05	4.56E+05	2.74E+05	2.39E+05	2.46E+05	1.32E+05	8.78E+04	7.05E+04	6.66E+04	9.82E+04
2002	2.30E+05	3.02E+05	3.22E+05	2.09E+05	1.76E+05	1.87E+05	9.82E+04	6.24E+04	4.82E+04	4.94E+04
2003	6.32E+05	1.81E+05	1.80E+05	1.88E+05	1.54E+05	1.40E+05	1.50E+05	7.60E+04	4.44E+04	3.33E+04
2004	9.03E+05	5.10E+05	1.51E+05	1.23E+05	1.31E+05	1.11E+05	1.08E+05	1.19E+05	5.54E+04	2.91E+04
2005	8.73E+05	7.71E+05	3.35E+05	8.20E+04	8.69E+04	1.02E+05	8.08E+04	8.07E+04	8.82E+04	3.82E+04
Estimated population abundance at 1st Jan 2006										
	0.00E+00	7.28E+05	5.67E+05	2.45E+05	4.90E+04	5.85E+04	7.69E+04	5.91E+04	6.21E+04	6.82E+04
Taper weighted geometric mean of the VPA populations:										
	5.97E+05	4.77E+05	3.34E+05	2.24E+05	1.72E+05	1.34E+05	1.03E+05	8.07E+04	6.01E+04	4.40E+04
Standard error of the weighted Log(VPA populations) :										
	0.4367	0.4694	0.4407	0.453	0.3179	0.2616	0.2965	0.3194	0.3568	0.4857

YEAR	AGE 10
1996	1.75E+04
1997	3.73E+04
1998	2.52E+04
1999	2.57E+04
2000	1.82E+04
2001	4.64E+04
2002	8.13E+04
2003	3.43E+04
2004	2.18E+04
2005	2.17E+04
Estimated population abundance at 1st Jan 2006	
	2.69E+04
Taper weighted geometric mean of the VPA populations:	
	3.37E+04
Standard error of the weighted Log(VPA populations) :	
	0.5893

Table 6.7.2.1 Continued

Log catchability residuals.
Fleet : IXa combined surveys

Age	1991	1992	1993	1994	1995
0	-0.12	-0.14	0.89	-0.69	-0.73
1	-0.29	0.5	0.31	-0.27	0.25
2	-0.19	1.41	1.96	0.32	1.03
3	-0.08	0.43	1.68	0.22	0.93
4	-0.13	0.75	0.87	0.01	0.67
5	0.4	0.64	0.16	-0.46	0.74
6	-0.18	1.23	0.02	-1.29	-0.38
7	-0.77	1.3	1.29	-0.21	-0.65
8	-0.27	0.54	0.73	-0.08	-1.45
9	-0.8	0.71	0.58	0.01	-0.78
10	-0.67	0.51	0.43	-0.47	-0.52

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	-0.08	0.76	-0.06	0.38	-1.08	0.88	-0.21	-0.09	-0.37	0.53
1	-0.6	-0.51	0.09	0.17	0.04	0.21	0.37	-0.47	0.05	0.18
2	-1.12	0.95	0.66	-0.04	-0.4	-1.46	-1.15	-1.5	1.01	0.65
3	-0.31	-0.09	0.79	0.43	-0.44	-0.08	-0.66	-0.27	-1	-0.06
4	-0.14	0.87	-1.74	-0.64	-0.18	1.47	-0.1	0.05	-0.78	-0.04
5	-0.49	1.18	-0.92	-1.45	0.35	0.4	-0.57	-0.36	-0.8	1.88
6	-0.4	0.92	-1.1	-1.68	0.39	1.31	-0.62	-0.77	0.16	2.19
7	-0.93	1.45	-0.72	-2.68	-0.22	2.07	-0.07	-0.37	-0.22	1.11
8	-0.99	1.43	-0.49	-2.2	-0.85	1.59	0.95	-0.16	0.96	0.07
9	-0.52	1.65	-0.93	-0.11	-0.5	0.48	0.93	-0.07	0.34	-0.33
10	-0.7	0.84	-1.13	0.24	-0.71	0.77	0.29	-0.61	-0.32	-0.7

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9	10
Mean Log q	-9.4083	-9.1291	-9.3717	-10.0662	-10.4408	-10.6412	-10.672	-10.672	-10.672
S.E(Log q)	1.0919	0.6515	0.8275	0.9466	1.1349	1.2631	1.1403	0.7301	0.6742

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	0.28	1.606	12.04	0.34	15	0.64	-8.77
1	0.31	3.022	12.1	0.66	15	0.35	-9.89

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.49	1.461	11.11	0.46	15	0.51	-9.41
3	0.59	1.729	10.44	0.65	15	0.35	-9.13
4	0.63	0.723	10.37	0.28	15	0.53	-9.37
5	2.56	-0.531	7.36	0.01	15	2.51	-10.07
6	-2.07	-1.308	13.84	0.02	15	2.28	-10.44
7	-0.76	-2.26	11.8	0.15	15	0.81	-10.64
8	5.56	-0.826	9.16	0	15	6.44	-10.67
9	0.94	0.129	10.62	0.34	15	0.72	-10.61
10	0.63	1.99	10.7	0.75	15	0.36	-10.87

Table 6.7.2.1 Continued

Terminal year survivor and F summaries :

Age 0 Catchability dependent on age and year class strength
Year class = 2005

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IXa combined surveys	1237846	0.709	0	0	1	0.658	0
P shrinkage mean	476569	0.47				0	0.053
F shrinkage mean	262753	1				0.342	0.093

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
728040	0.58	0.91	2	1.568	0.035

Age 1 Catchability dependent on age and year class strength
Year class = 2004

Fleet	Estimated S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IXa combined surveys	590613	0.335	0.236	0.71	2	0.884	0.152
P shrinkage mean	334375	0.44				0	0.255
F shrinkage mean	416926	1				0.116	0.21

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
567196	0.32	0.18	3	0.56	0.158

Age 2 Catchability constant w.r.t. time and dependent on age
Year class = 2003

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IXa combined surveys	265269	0.311	0.137	0.44	3	0.872	0.152
F shrinkage mean	144338	1				0.128	0.264

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
245408	0.3	0.16	4	0.545	0.164

Age 3 Catchability constant w.r.t. time and dependent on age
Year class = 2002

Fleet	Estimated S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IXa combined surveys	40564	0.332	0.22	0.66	4	0.821	0.43
F shrinkage mean	116309	1				0.179	0.172

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
48973	0.33	0.28	5	0.865	0.369

Age 4 Catchability constant w.r.t. time and dependent on age
Year class = 2001

Fleet	Estimated S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IXa combined surveys	52396	0.289	0.354	1.23	5	0.855	0.28
F shrinkage mean	111815	1				0.145	0.141

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
58468	0.29	0.32	6	1.118	0.257

Age 5 Catchability constant w.r.t. time and dependent on age
Year class = 2000

Fleet	Estimated S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IXa combined surveys	76233	0.283	0.388	1.37	6	0.873	0.141
F shrinkage mean	81877	1				0.127	0.132

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
76929	0.28	0.33	7	1.191	0.14

Table 6.7.2.1 Continued

Age 6 Catchability constant w.r.t. time and dependent on age
Year class = 1999

Fleet	Estimated S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IXa combined surveys	58194	0.268	0.334	1.25	7	0.875	0.17
F shrinkage mean	65591	1				0.125	0.152

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
59074	0.27	0.29	8	1.09	0.169

Age 7 Catchability constant w.r.t. time and dependent on age
Year class = 1998

Fleet	Estimated S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IXa combined surveys	66082	0.262	0.124	0.47	8	0.89	0.109
F shrinkage mean	37863	1				0.11	0.183

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
62142	0.26	0.13	9	0.493	0.116

Age 8 Catchability constant w.r.t. time and dependent on age
Year class = 1997

Fleet	Estimated S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IXa combined surveys	73162	0.264	0.21	0.79	9	0.887	0.105
F shrinkage mean	39189	1				0.113	0.188

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
68173	0.26	0.2	10	0.765	0.113

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 8
Year class = 1996

Fleet	Estimated S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IXa combined surveys	25371	0.326	0.162	0.5	10	0.825	0.214
F shrinkage mean	35167	1				0.175	0.159

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
26864	0.32	0.15	11	0.455	0.203

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 8
Year class = 1995

Fleet	Estimated S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
IXa combined surveys	12385	0.309	0.192	0.62	11	0.838	0.314
F shrinkage mean	28490	1				0.162	0.149

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
14180	0.31	0.2	12	0.641	0.28

Table 6.7.2.2 Southern horse mackerel. Summary table from XSA assessment (with SOP correction)

	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	SOPCOFAC	FBAR 2- 8
	Age 0						
1991	946195	248096	198299	21772	0.1098	0.8926	0.0876
1992	861828	245932	187843	26492	0.141	0.9577	0.1671
1993	530048	229254	185691	31945	0.172	1.0142	0.2595
1994	478602	218085	171028	25959	0.1518	1.001	0.1566
1995	671708	263334	214195	25147	0.1174	1.0005	0.0959
1996	1357942	232778	170848	22943	0.1343	1.0007	0.1021
1997	624033	267160	213355	27642	0.1296	0.9365	0.1187
1998	478929	214710	170829	41564	0.2433	0.9994	0.2827
1999	483008	222634	185207	27733	0.1497	1.0001	0.1469
2000	540392	206097	169333	27160	0.1604	1.038	0.1614
2001	467073	200221	167048	24910	0.1491	0.9998	0.1596
2002	229919	190716	165995	22506	0.1356	0.9999	0.1718
2003	632341	144332	117640	18887	0.1605	1.0001	0.1804
2004	903199	178197	124359	23252	0.187	1.0015	0.2038
2005	872695	163387	121836	23111	0.1897	1.0198	0.1896
Arith. Mean	671861	214996	170900	26068	.1554		.1656
0 Units	(Thousands	(Tonnes)	(Tonnes)	(Tonnes)			

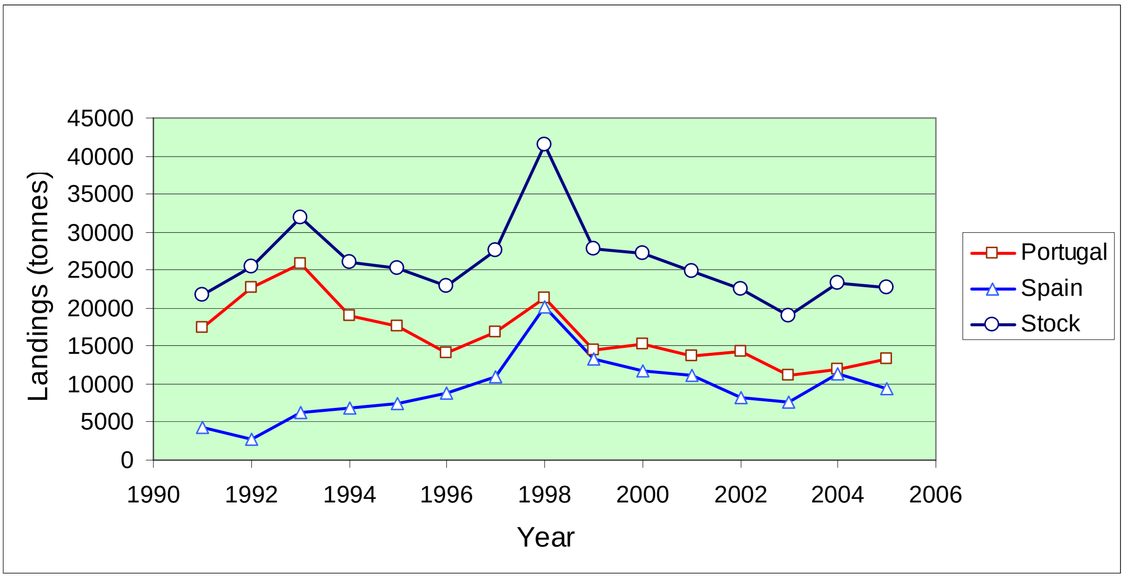


Figure 6.2.1. Time series of the total southern horse mackerel catches, with information of the catches by country, for the period 1991-2004 (not including catches from the Gulf of Cádiz).

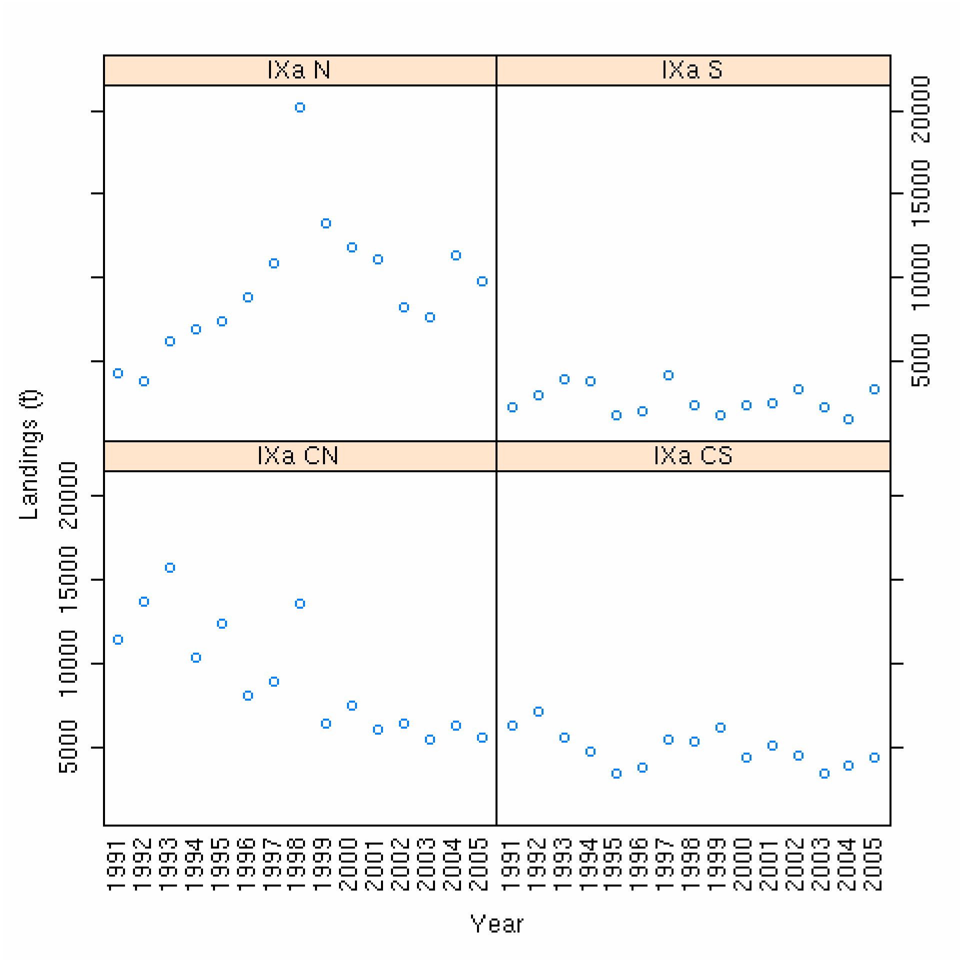


Figure 6.2.2. Historical series of Southern horse mackerel catches by Subdivisión. (Catches from the Gulf of Cadiz in Subdivision IXa south are not included).

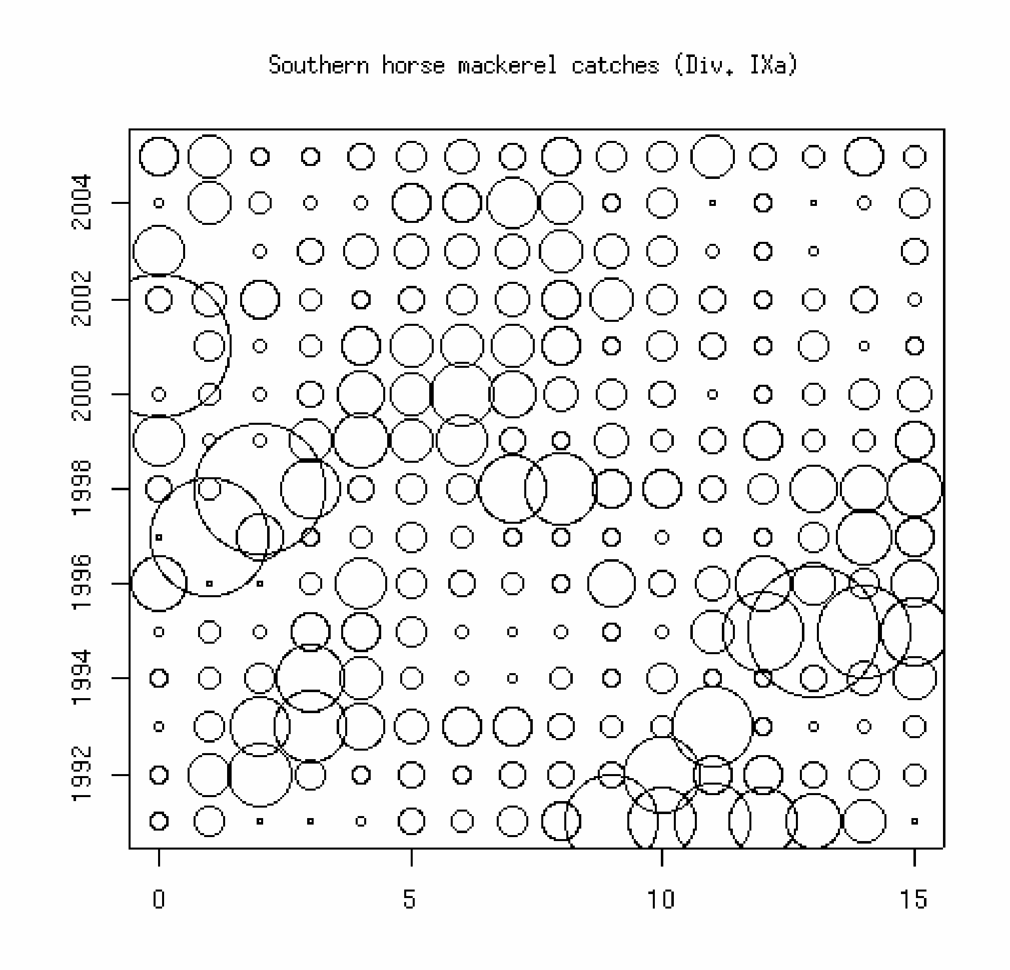


Figure 6.3.1.1. Southern horse mackerel (Division IXa). Bubble plot of proportions of catches by year in each age.

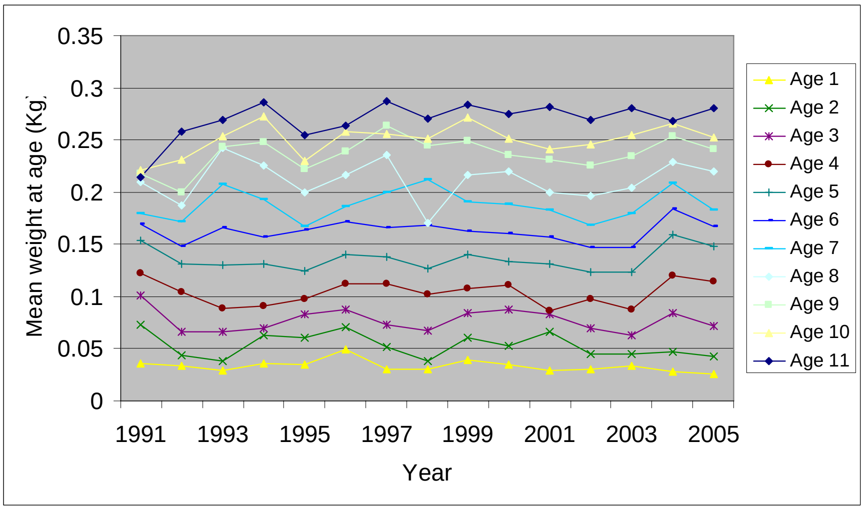


Figure 6.3.2.1. Time series of southern horse mackerel mean weight at age in the catch (from ages 1 to 11)

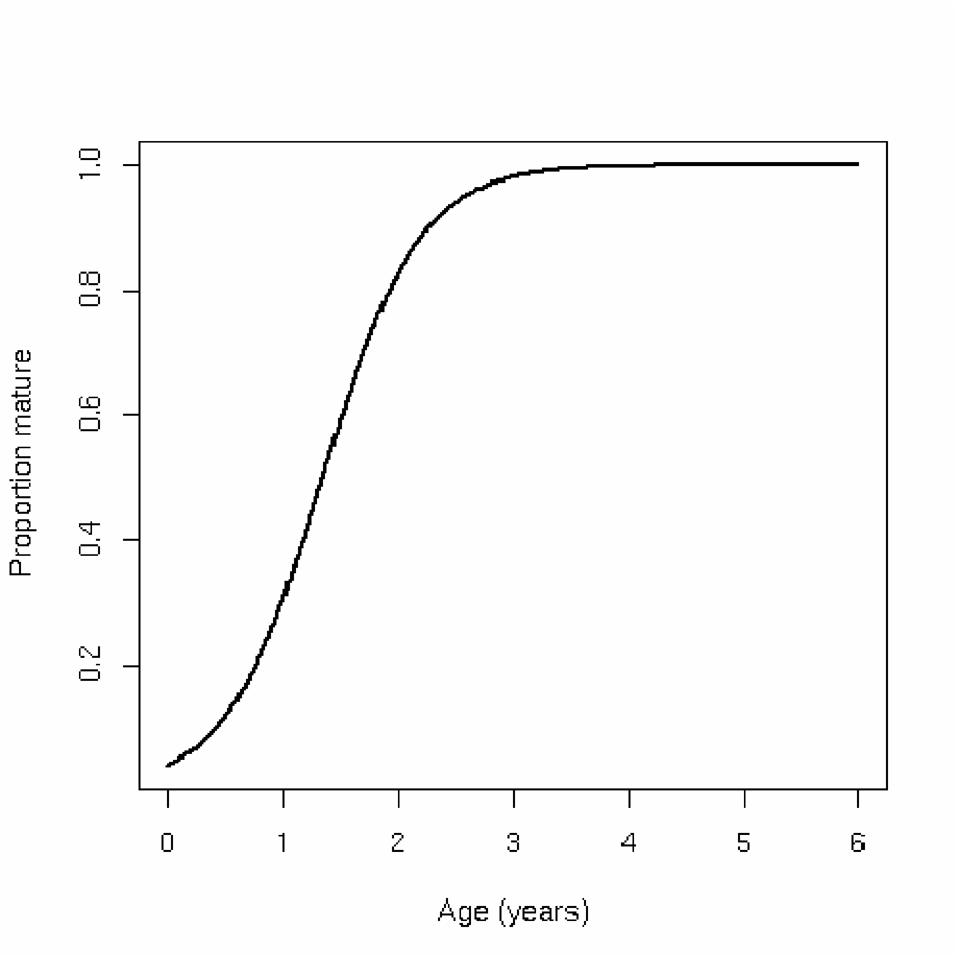


Figure 6.3.3.1. Maturity ogive adopted for southern horse mackerel stock during the assessment period.

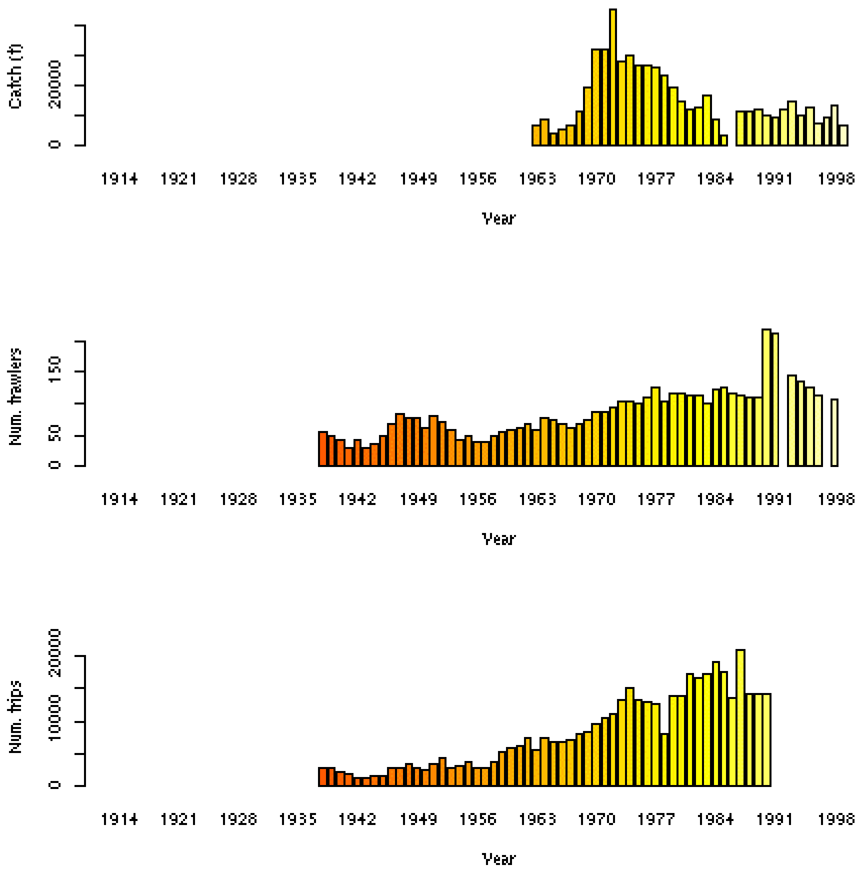


Figure 6.5.1. Southern horse mackerel. Time series of catch and effort from Portuguese bottom trawlers operating in Division IXa.

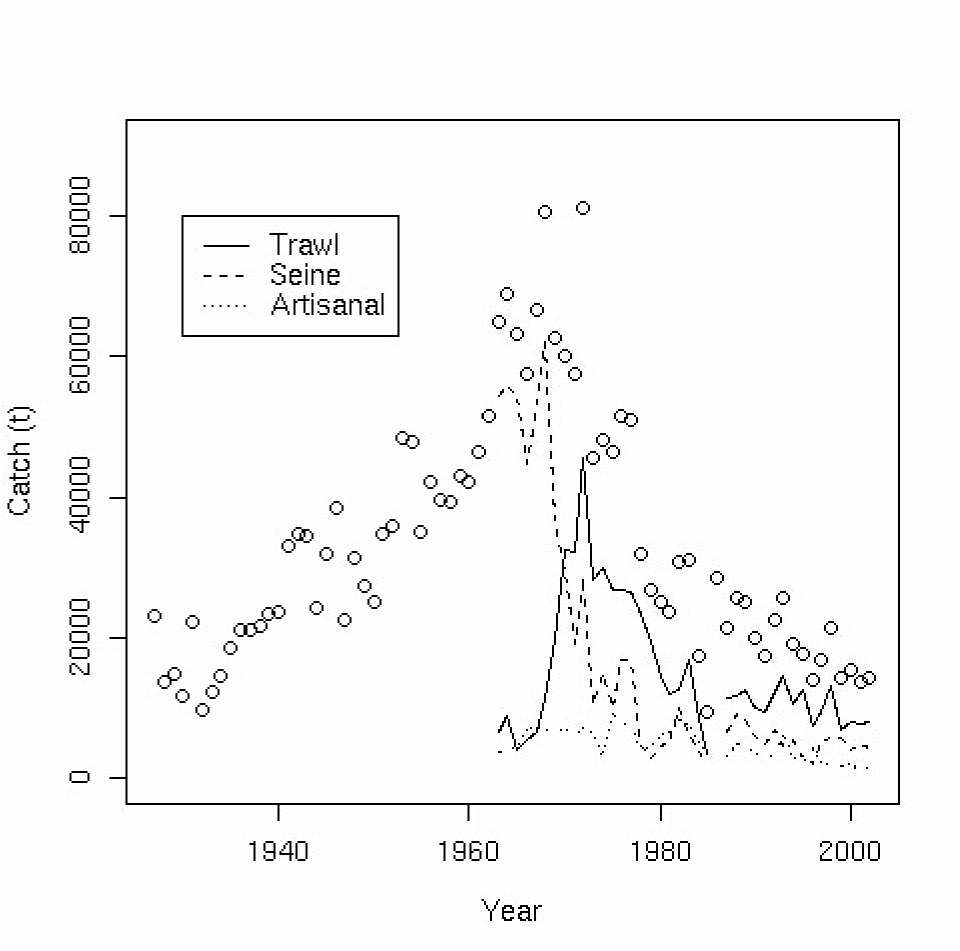


Figure 6.5.2. Southern horse mackerel. Time series of the Portuguese catches of horse mackerel in Division IXa: total and by fishing gear

Figure 6.5.3. Southern horse mackerel. Time series of the Spanish catches of horse mackerel in Division IXa (Southern stock) and in Division VIIIc (Western stock): total and by fishing gear.

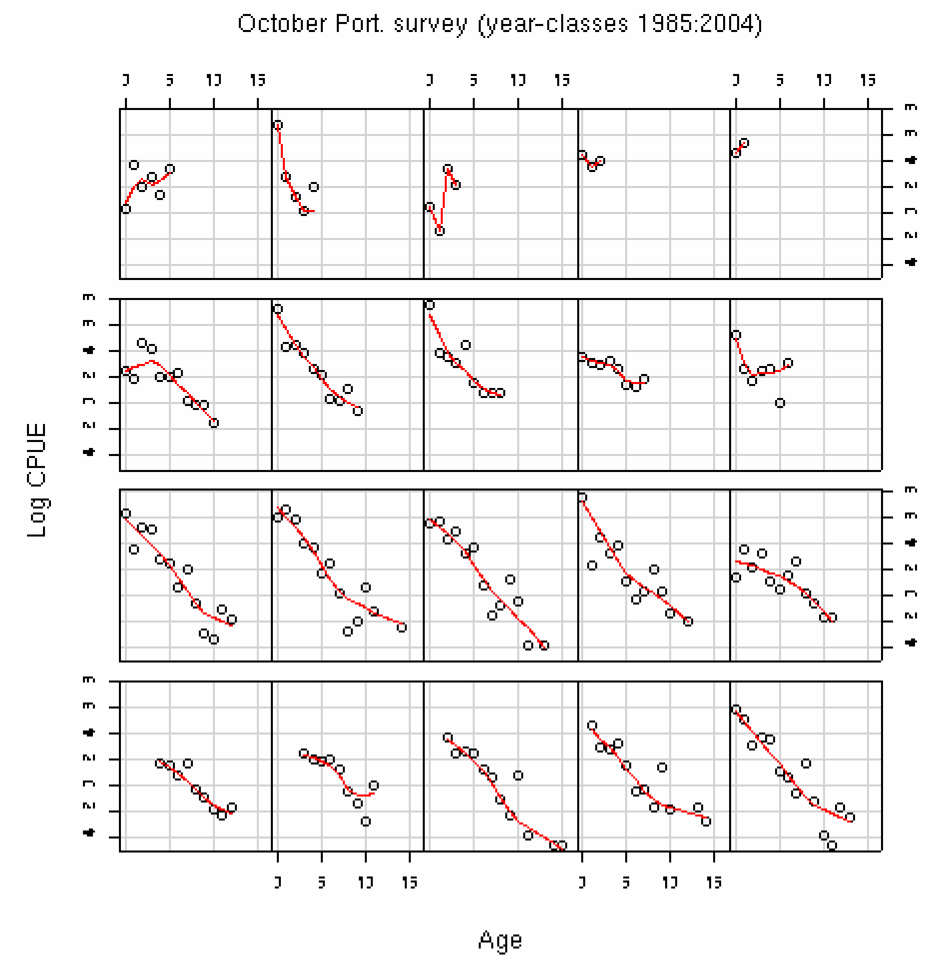


Figure 6.7.1.1. Southern horse mackerel. Evolution of the cohorts in the October Portuguese bottom trawl survey

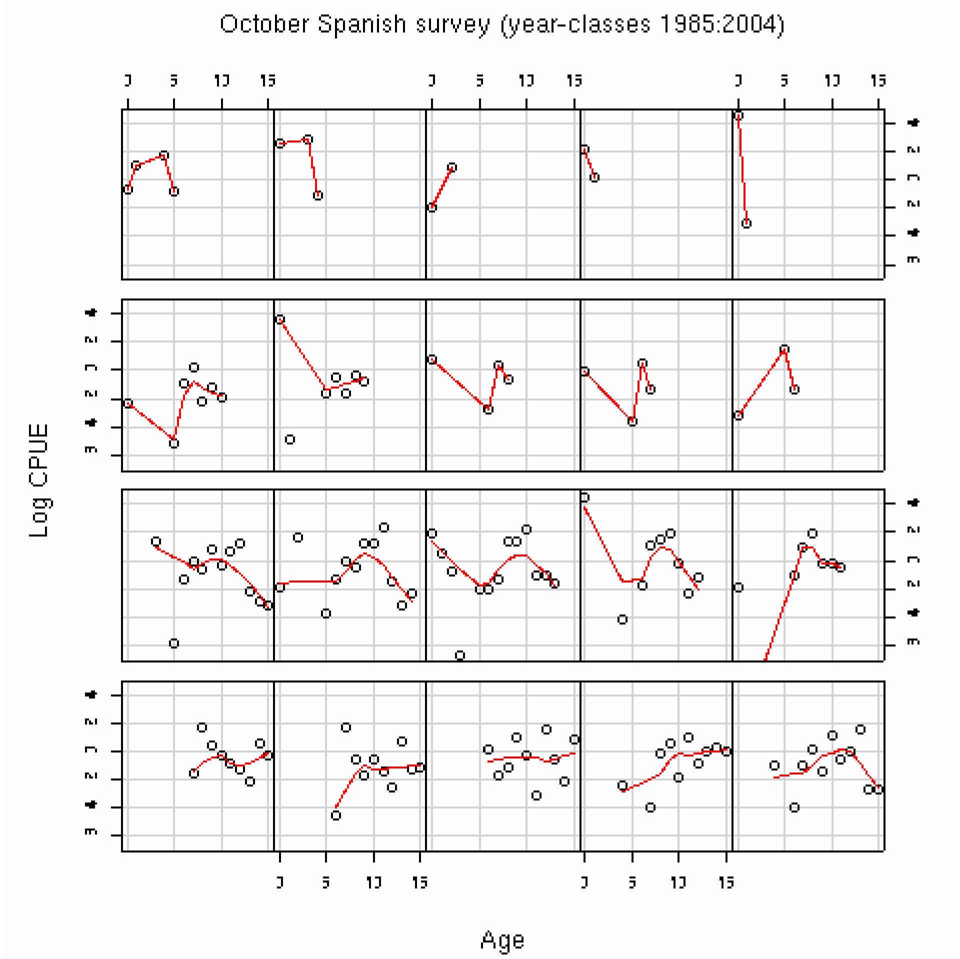


Figure 6.7.1.2. Southern horse mackerel. Evolution of the cohorts in the Sept/October Spanish survey.

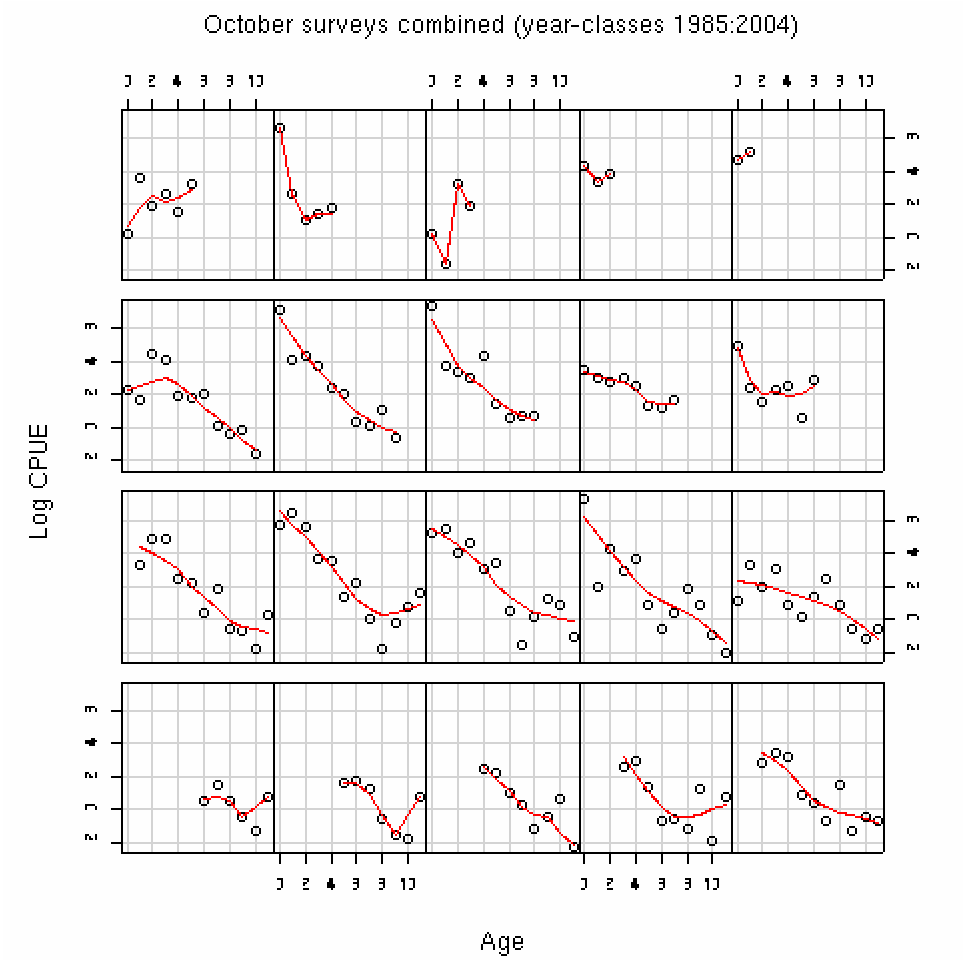


Figure 6.7.1.3. Southern horse mackerel. Evolution of the cohorts in the October surveys combined.

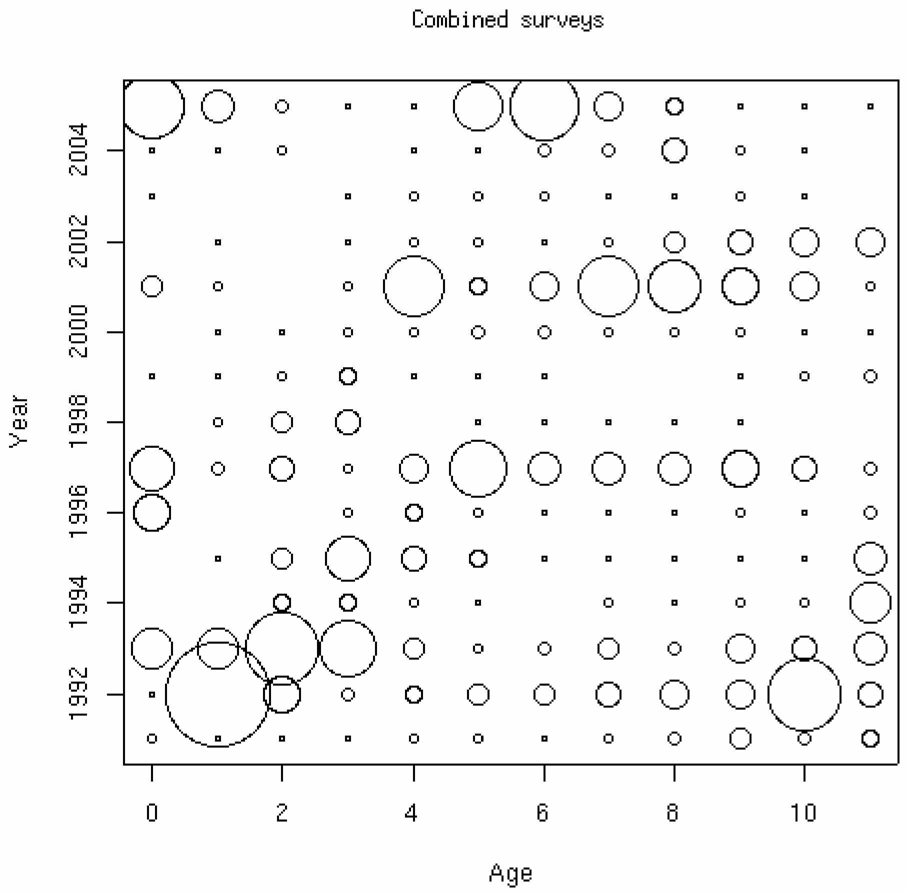


Figure 6.7.1.4. Southern horse mackerel. Bubleplot of the abundance indices from the combined survey

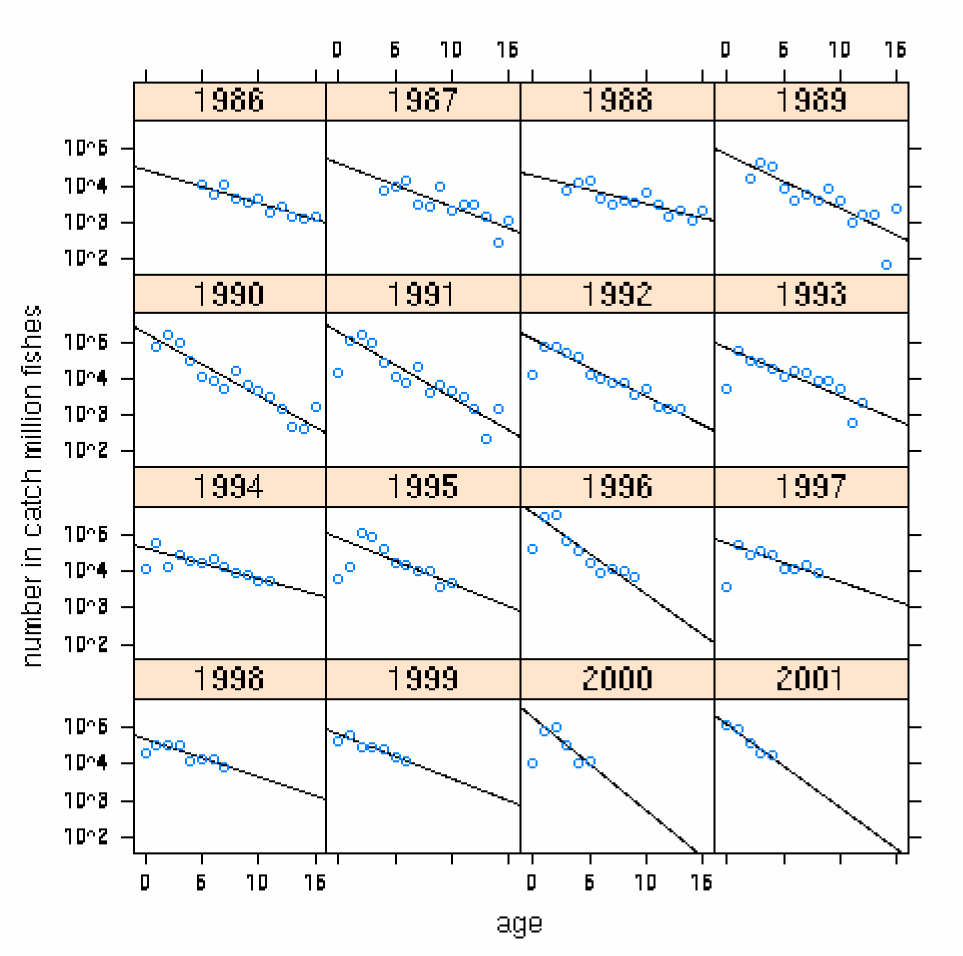


Figure 6.7.1.5. Southern horse mackerel. Catch curves by yearclass. For the fitting of the trend line, the age 0 was excluded.

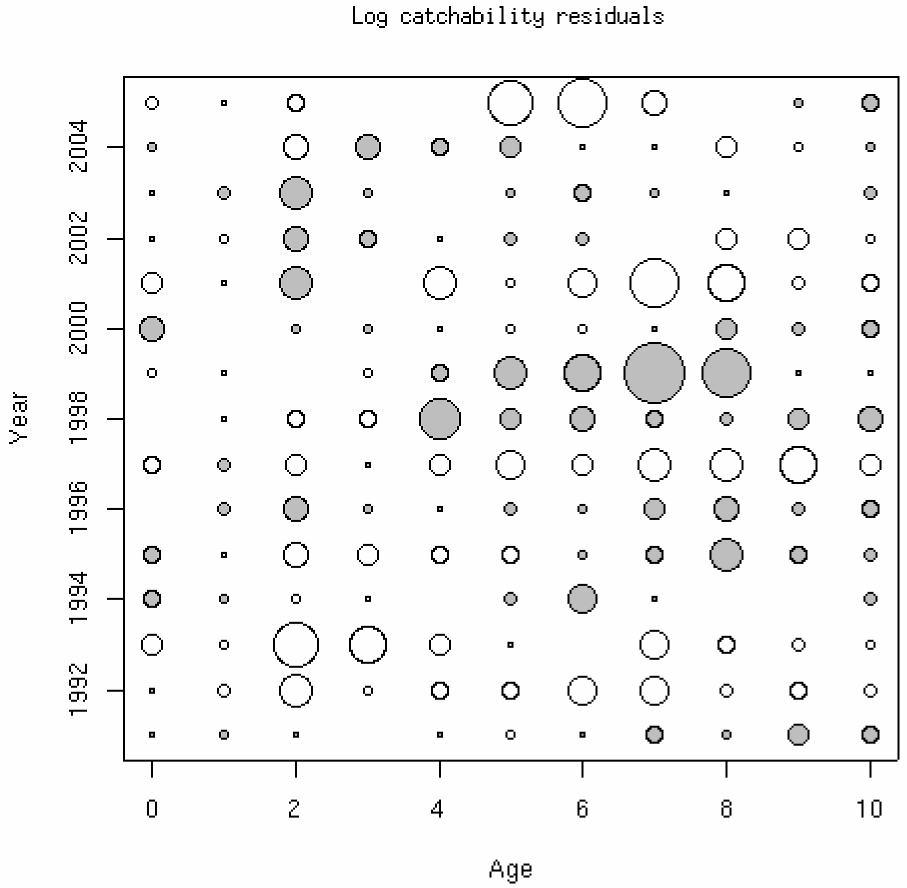
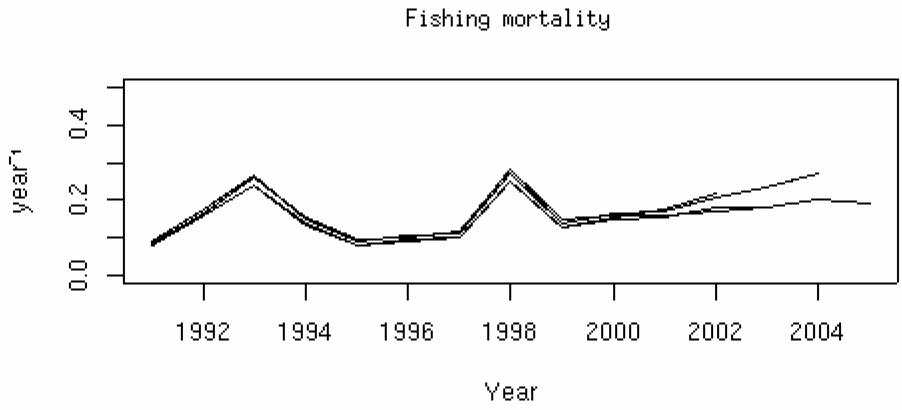


Figure 6.7.2.1. Southern horse mackerel. Log catchabilities residuals from the XSA assessment



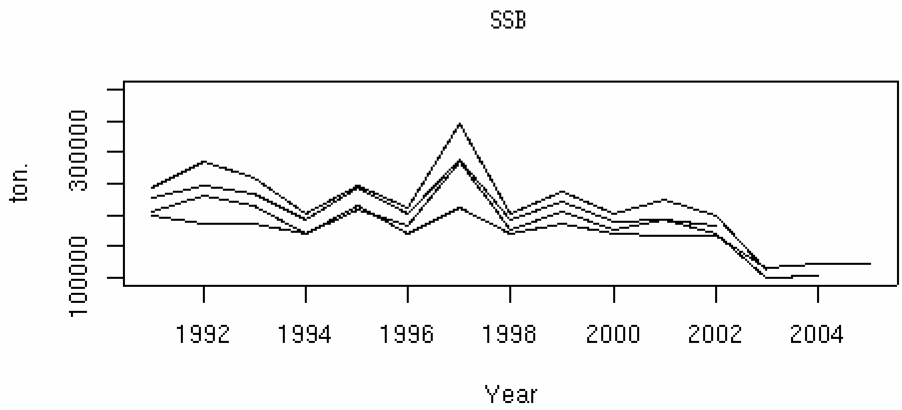


Figure 6.7.2.2. Southern horse mackerel. Fishing mortality and Spawning Stock Biomass retrospective patterns (four years considered: 2005-2002)

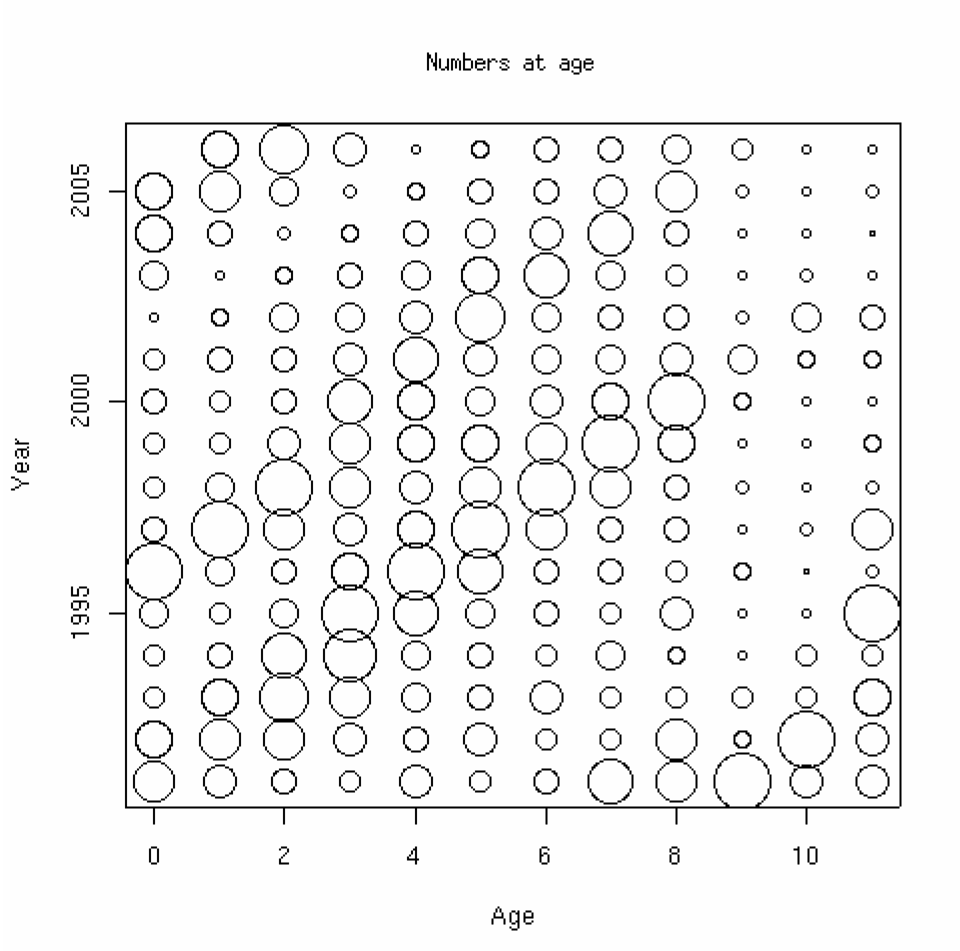


Figure 6.7.2.3. Southern horse mackerel. Bubleplot of numbers ata ge estimated from XSA assessment

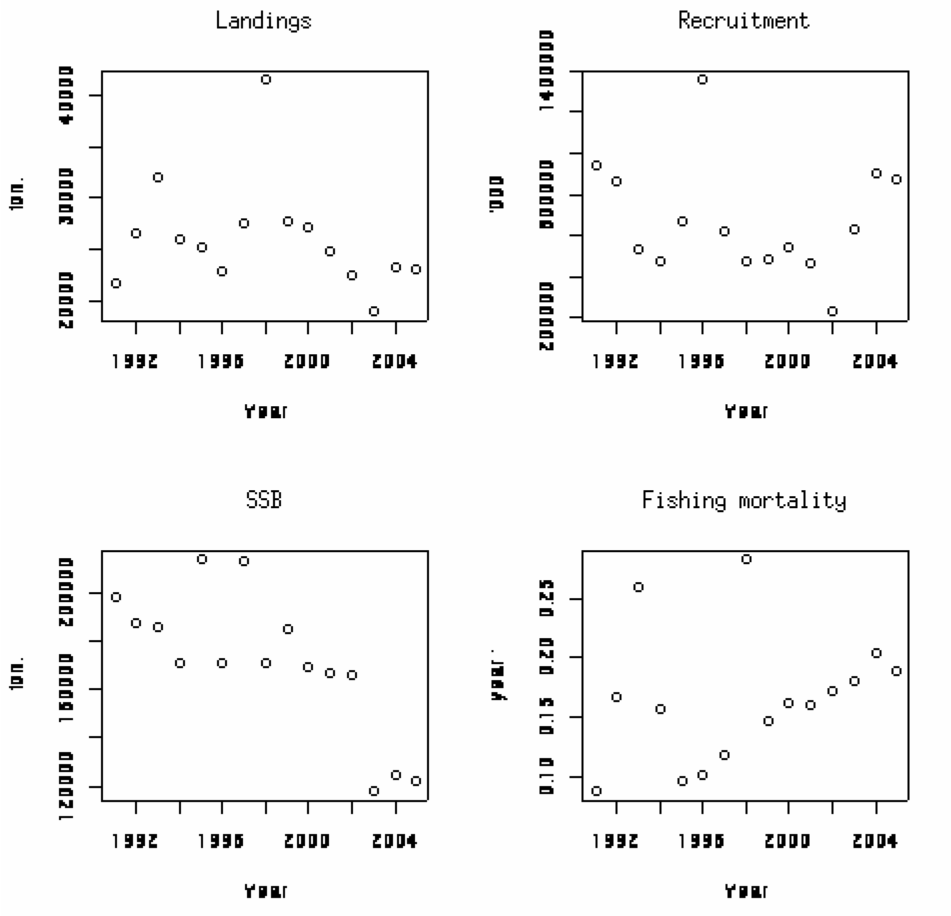


Figure 6.7.2.4. Southern horse mackerel. Summary plots from XSA assessment

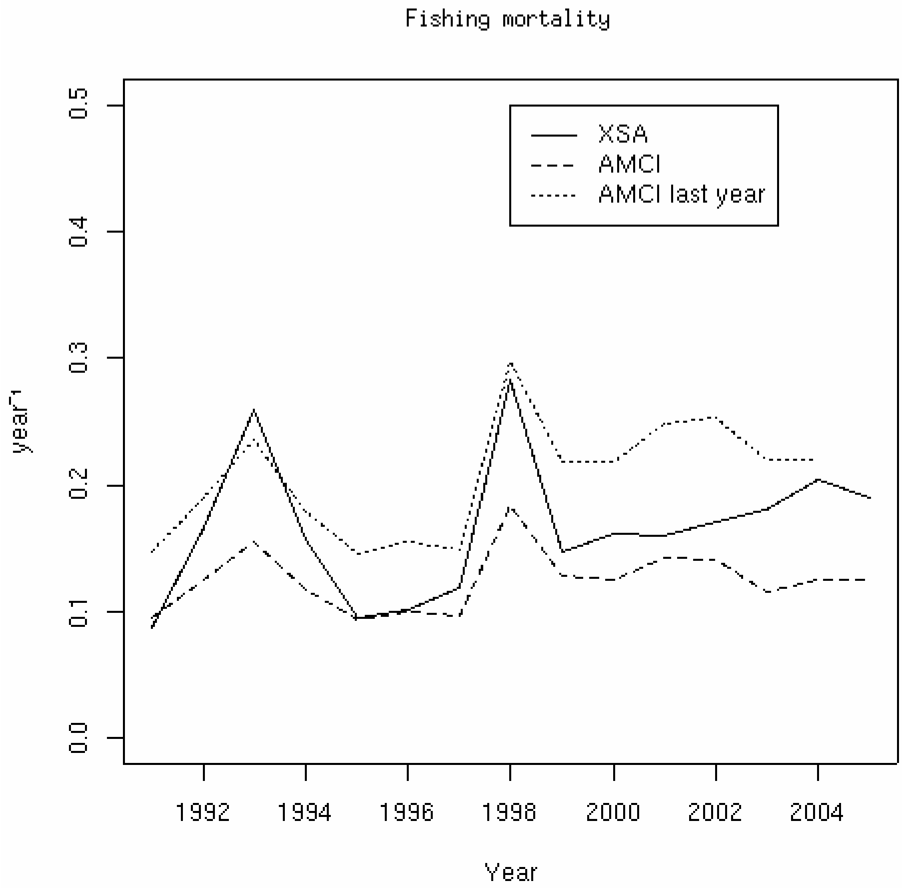


Figure 6.7.3.1. Southern horse mackerel. Fishing mortality estimates from XSA and AMCI assessments

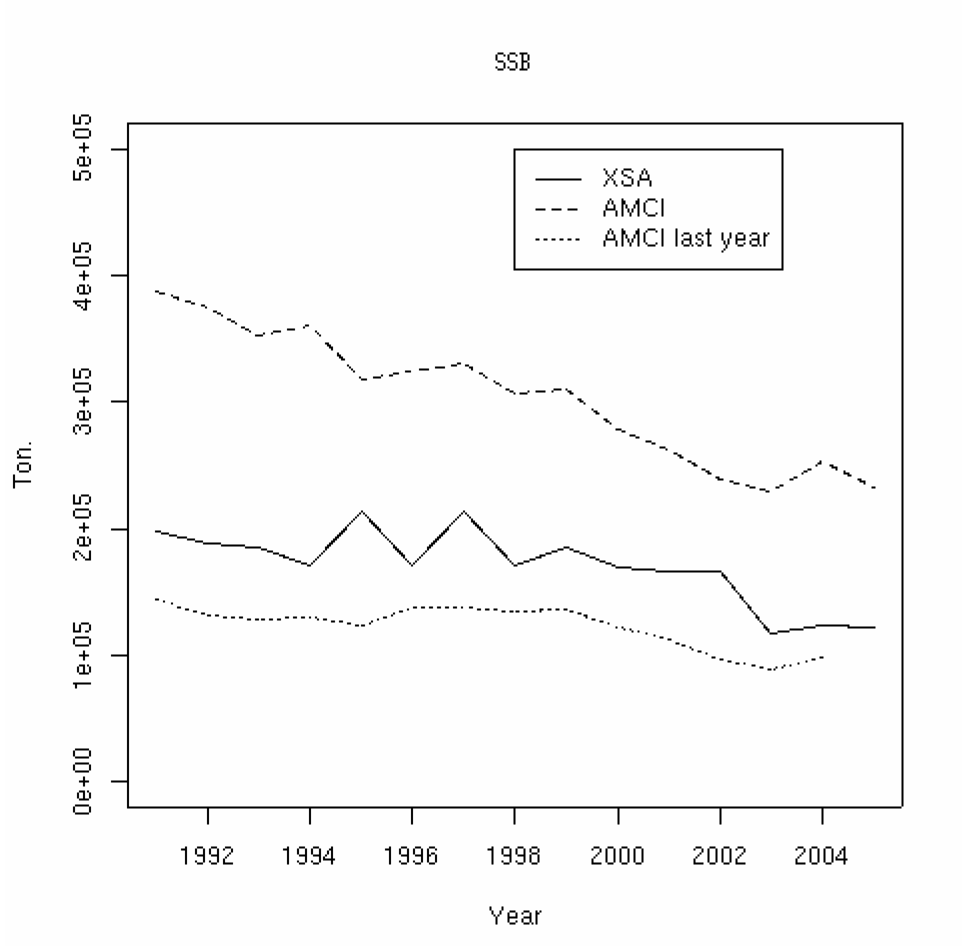


Figure 6.7.3.2. Southern horse mackerel. SSB estimates from XSA and AMCI assessments

7 Sardine general

7.1 The fisheries for sardine in the ICES area

Sardine 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) and the characteristics of the fishery, surveys and assessment of the species in the stock area are discussed in section 8. This section 7 lists the information available on sardine outside the stock area, both from fisheries and surveys. Estimates of sardine biomass from acoustic surveys off the French coast, as well as survey and catch data on age, length distribution and maturity for this species have been provided to the WG. The time series comprises data from 2000 onwards and was presented in 2004.

7.1.1 Catches for sardine in the ICES area

Commercial catch data for 2005 was provided by Portugal, Spain, France, Ireland, UK (England and Wales), Germany and The Netherlands (Table 7.1.1.1). Total reported catch was 138,351 t, divided as follows: 42% of the catches by Portugal, 29% by Spain and 19% by France. The remaining 10% catches are reported for division VIIa-j by Ireland, England and Wales, Germany and The Netherlands, in division VIIIabde and VIa by Ireland and in division VIIIa and IVc by The Netherlands. Catches in VIIIc and IXa amount to 70% of the total sardine catches. It should be noted that catches in both Spain and Portugal are regulated, while no regulations are in place for the remaining countries. In 2005, there is a 20% increase with respect to the total 2004 sardine catches in European waters (although this increase is in part due to the introduction of catches from The Netherlands for the first time), with increases of 3% in Portuguese, 12% in Spanish and 43% in French catches, respectively. Catches from Ireland were not provided for 2003, in 2004 Irish catches amounted to 2% of the total catches while in 2005 they amounted to 6% of the total catches.

7.2 Sardine in VIIIa and VIIIb

7.2.1 The fishery in 2005

An update of the French catch data series in Divisions VIIIa and VIIIb (from 1983) including 2005 catches was presented to this year´s WG (Table 7.2.1.1). Catches have increased along the series, with values ranging from 4,367 t in 1983 to 15,462 t in 2005 with some small fluctuations.

The main fishery takes place in the north part of the Bay of Biscay (VIIIa – 15,462 t). 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.

There are also important landings (about 10 700 t) taken in division VIId in the north of France, resulting from the catches of two single pelagic trawlers. However no biological data are collected on this fishery. Numbers by length-class for divisions VIIIa,b by quarter are shown in Table 7.2.1.2.

Both purse seiners and pelagic trawlers target sardine in French waters (WD Duhamel, 2006). Average vessel length is about 18m. Purse seiners operate mainly in coastal areas (<10 nautical miles) while trawlers are allowed to fish between 3 n miles from the coast up to 50 n miles offshore. Pair trawlers, when targeting sardine, operate close to their base harbour, as purse seiners do. The monthly distribution of landings per year is shown in Figure 7.2.1.1. Sardine catches appear to follow a seasonal pattern, with the highest landings recorded in summer. Almost all the catches were taken in south-west Brittany. Due to the autumn closure of the anchovy fishery in 2005, one third 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. September and October landings of sardine in 2005 reflect this decrease in effort.

The geographical distribution of sardine catches by the French fleet during 2002-05 is shown in Figure 7.2.1.2. 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 sardine, mainly during spring. Additionally, a smaller purse seine fleet targeting several species also operates in the Basque Country.

Figure 7.2.1.3. shows annual sardine landings by the different fleet components. Catches by purse seiners are increasing, driving the total landings increase while pair trawler catches are decreasing.

7.2.2 Fishery independent information: Acoustic surveys

Numbers at age for ICES subdivisions VIIIa and VIIIb estimated from the spring French acoustic surveys since 2000 have been made available to the WG. These data together with numbers at age estimated from both Spanish and Portuguese spring acoustic surveys for the same period for subdivisions VIIIc and IXa are shown in Figures 7.2.2.1-2. These figures show 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 stock numbers. Figures 7.2.2.1-2 show the evolution of the strong recruitments of 2000, 2001 and 2004 mainly located in the western area of the Iberian Peninsula. The figures also show evidence of an additional recruitment area in French waters and that the Gulf of Cádiz show the influence of different pulses of recruitment from those of the northwestern Iberian areas.

7.2.2.1 French Spring Acoustic survey 2006

A French acoustic survey (PELGAS) is routinely carried out each year in spring in the Bay of Biscay and information on sardine distribution and abundance is available, with a time series starting 2000 onwards. The 2006 survey (PELGAS06) took place from the 1 to 31 May on board the RV “Thalassa”. The objectives, methodology employed and sampling strategy are described in section 10.4.2.

During PELGAS06, sardine was present almost all over the area covered in the Bay of Biscay (Figure 7.2.2.1.1). Nevertheless, it should be noted that the north west area was not surveyed this year due to bad weather conditions at the end of the survey. Sardine usually appeared as small dense schools in mid-water or sub-surface in the offshore area, often mixed with mackerel and sometimes with horse mackerel. In coastal areas, sardine was usually observed as small echoes, mixed with anchovy in the south part of the Bay and alone in the northern area. This year, a strong abundance of sardine was observed in the Loire river plume but sardine was not present in the Gironde area.

During PELGAS06 age 2 sardines where predominant in all areas. Small sardine (age 1) was not so abundant although this could be explained, at least in part, since the R/V Thalassa is not able to fish in shallow waters (<20 m) where probably small fish are mainly concentrated. It should be noted that the lack of surface hauls carried out during last year survey has been solved this year by the use of the gear with a special setting that allows it now to fish efficiently at the surface. Successful catches have been taken during the survey showing that echo-traces at the surface were well identified.

The estimated sardine biomass in PELGAS06 is listed below together with the values obtained in previous years for comparison:

	Year						
	2000	**2001**	**2002**	**2003[1]**	**2004**	**2005**	**2006**
Biomass (tonnes)	286391	214200	301023		323021	49521	229071

[1]No sardine abundance was estimated for the 2003 cruise.

Length distributions of sardine in numbers of fish as observed during PELGAS06 for divisions VIIIa and VIIIb are shown in Figure 7.2.2.1.2. The length and age distributions for the whole time series (all 7 years combined) are shown in Figures 7.2.2.1.3 and Figure 7.2.2.1.4., respectively.

The variability of the survey estimates (sardine was abundant in 2000, occasional in 2001 and abundant again in 2002) throw some doubts on whether the abundance estimates from the spring acoustic surveys in this area are adequate indexes of the overall abundance of sardine in French waters or are only representative of the presence of sardine at the time of the survey. Migration patterns and migration intensity from the area northwards or southwards is still unknown, and should help defining the validity of these acoustic surveys as a potential index of the abundance of sardine in French waters.

Both Spanish and French spring acoustic surveys are carried out on board the same R/V (Thalassa) using the same echo-sounder and gears. The Spanish survey (PELACUS) is carried out in April each year while PELGAS is carried out in May (except in 2003 where PELGAS took place in June). Sampling strategies of both surveys have been standardised during the PELASSES project and are still coordinated in the frame of WGACEGG. Therefore, there is not a strong reason to assume that these surveys have different catchabilities.

7.3 Stock identification, distribution and migration in relation to oceanographic effects: Results from the SARDYN project

A considerable volume of new information compiled within the project *Sardine dynamics and stock structure in the northeastern Atlantic* (SARDYN) is now available through the project final report. Although most of the studies carried out within the project focused on the area occupied by the currently defined stock unit (ICES Divisions VIIIc and IXa, Iberian waters), relationships with adjacent areas and in some cases across most of the distribution range of the species were described.

From the results of SARDYN, 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 (see distribution of distinct stocks in Figure 7.3.2). Although genetic similarity can be maintained through interchange of a low number of individuals, the existence of other evidence, such as the 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 this area suggest considerable mixing between ICES Division VIIIa and b and the actual assessed stock area (ICES areas VIIIc and IXa). Additional data from French waters available to this WG in recent years supports this hypothesis by showing a connection between strong year-classes observed in east Cantabrian Sea and southern French waters. The predominance of large fish in the former area and of juvenile fish in the latter area suggests that emigration to the Cantabrian area is the most likely hypothesis. This immigration into Spanish waters was supported by assessment trials carried out in SARDYN. The large abundance of sardine in French waters, as indicated by acoustic surveys carried out annually since 2000 (see section 7.2.2.1), indicates that the dynamics of sardine in ICES divisions VIIIc and, to some extent in IXa, may be influenced by that of sardine in French waters, at least by those distributed in the southern part of these waters.

Genetic results from the SARDYN project also provide indication that sardine populations mix across the southern stock limit (Gulf of Cadiz). Similarity of morphometric characters and life history properties among the Gulf of Cadiz, southwest Mediterranean and northern Morocco populations corroborate this hypothesis. Some indication that transport of sardine eggs and larvae between southern Iberia and northern Morocco shelf may be important came from a particle tracking study carried out in SARDYN. However, available data on population demography and dynamics which could support this hypothesis from areas adjacent to the southern boundary is much more limited in time and space (only a few samples collected in recent years from a few locations are available). Since existing information suggest that no large sardine populations are distributed in these areas, bias from assuming the same border in the future is lower than in the case of the northern border.

Considering areas VIIIc and IXa, genetic results from SARDYN show that there are no completely isolated sardine populations. Nevertheless, different evidence analyzed in SARDYN pointed out to a spatial structure of the population. 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, provide some support to population sub-structuring across Iberian waters. Persistent spatial differences in growth and spawning temperature tolerance and existence of a persistent gap in the spawning area corroborate the hypothesis of spatial heterogeneity of sardine populations. From the above information, 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.

7.4 Future of assessment and management of sardine outside the main stock area.

During this year´s meeting, the conclusions of the EU project SARDYN have provided a large amount of information on sardine stock dynamics and migration, as well as new assessment exploratory tools and models. Also, age disaggregated acoustic biomass estimates and catches from ICES Divisions VIIIa and VIIIb have been updated, and a review of fleet composition for these areas has been presented. Altogether, a series of estimates of acoustic numbers-at-age (since 2000) and catches at age (since 2002) for this area is now available to the WG. This new framework allows for different future procedures in the assessment of sardine, both strictly within the Iberian Peninsula waters, and outside them. Various options are now open to discussion for the next year´s sardine assessment: a) inclusion of data on migration between the current stock area and northern waters (ICES Divisions VIIIa and VIIIb) would require both migration intensity estimates and tests of robustness of current models to leakage; b) relationship between the abundance within the stock area and the surrounding waters (especially to the north) are likely to require estimates of biomass outside the stock area. This will imply biomass estimates, and if necessary, assessment of the population in ICES Division VIIIa and VIIIb; c) even if not conclusive within SARDYN, the use of area disaggregated assessment procedures within the actual stock distribution may be a solution worth pursuing if a requirement for local or regional management exist; d) the actual relationship between the current stock and southern areas (Morocco) remains unclear, although this area is believed to have less influence than the northern border as the biomass level in northern Morocco is not considered to be as high as the one in ICES Division VIIIa and VIIIb.

In the actual situation, migration across the northern stock border can only be addressed by indirect methods, as attempts to produce direct estimates have so far not being successful. Also, full assessment of sardine in areas VIIIa and VIIIb will require the development of specific assessment models different to those used in the stock area, as AMCI requires a large series of age disaggregated catches, not available for this area. Thus, addressing the future of assessment of sardine within and outside the actual stock area will require additional efforts both on data gathering, exploratory analysis and development of methodology.

Apart from the actual monospecific assessment currently carried out in relation to sardine, different projects related to the understanding and assessment of the whole pelagic community have been conducted within Iberian waters and especially in the Bay of Biscay. These projects are expected to provide in the medium term estimates of the ecosystem productivity, as well as on the pelagic fish community composition and distribution. This information is expected to improve the actual way assessment is carried out, both by influencing the information used in the actual assessment and by providing new ways of understanding population dynamics, especially in the framework of heterogeneous and competing small pelagic communities.

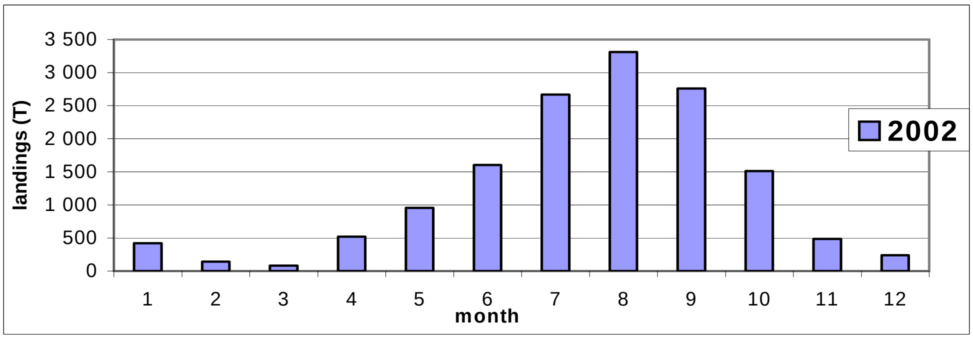
Table 7.1.1.1: Sardine-general: commercial catch data from the ICES area, available to the Working Group. Unit Tonnes. [1]Catches from The Netherlands are preliminary values

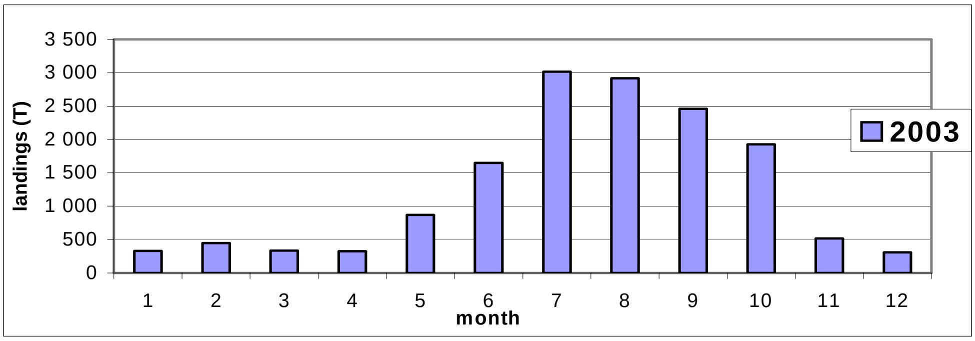
Divisions	Netherlands[1]	Germany	UK (Engl&Wal)	Ireland	France	Spain	Portugal	Total
IVc	22				83			105
VIa				12				12
VIIa			16	688				704
VIIb				186				186
VIIc								0
VIId	1966	16	7		10772			12761
VIIe	198	2	3230	1765				5195
VIIf			204					204
VIIg				471				471
VIIh	44	134		92				271
VIIi		6						6
VIIj				359	8			367
VIIIa	1	64		700	15462			16226
VIIIb				3363		898		4261
VIIIc						19800		19800
VIIId				188				188
VIIIe				50				50
IXaN						11663		11663
IXaCN							25 696	25696
IXaCS							24 619	24619
IXaS-Alg							7 175	7175
IXaS-Cad						8391		8391
Total	2232	221	3457	7875	26324	40753	57490	138351

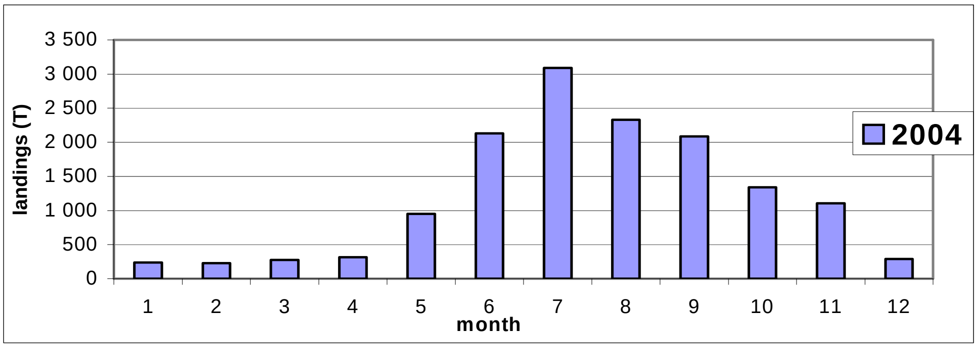
Table 7.2.1.1: Sardine-general: French landings in ICES Divisions VIIIa+VIIIb (1983-2005)

Year	Catch (tonnes)
1983	4,367
1984	4,844
1985	6,059
1986	7,411
1987	5,972
1988	6,994
1989	6,219
1990	9,764
1991	13,965
1992	10,231
1993	9,837
1994	9,724
1995	11,258
1996	9,554
1997	12,088
1998	10,772
1999	14,361
2000	11,939
2001	11,285
2002	13,849
2003	15,494
2004	13,855
2005	15,462

Table 7.2.1.2: Sardine-general: Catch length distributions from areas VIIIa,b (thousands)					
Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4	All year
6					
6.5					
7					
7.5					
8					
8.5				62	62
9				124	124
9.5				31	31
10					
10.5					
11	84	390	129	26	629
11.5	151	701	233	46	1 132
12	268	1 247	414	82	2 012
12.5	285	1 325	440	88	2 137
13	369	1 715	569	113	2 766
13.5	302	1 403	465	93	2 263
14	153	882	319	46	1 400
14.5	61	596	273	16	946
15	65	2 115	735	13	2 929
15.5	85	3 861	1 173	5	5 123
16	257	6 195	2 397	20	8 869
16.5	304	3 450	3 610	31	7 395
17	328	1 765	3 744	27	5 863
17.5	200	1 136	2 500	59	3 895
18	144	741	4 609	80	5 573
18.5	131	1 466	10 361	270	12 227
19	97	1 249	9 032	486	10 865
19.5	93	1 465	7 808	648	10 014
20	152	3 817	8 545	592	13 106
20.5	204	4 153	12 248	535	17 140
21	224	5 956	18 813	615	25 608
21.5	300	7 632	18 947	812	27 692
22	476	5 392	10 971	1 097	17 937
22.5	497	3 312	5 928	1 642	11 380
23	611	2 020	2 577	1 611	6 820
23.5	484	1 750	260	1 022	3 516
24	399	523	715	589	2 226
24.5	280	60	86	186	612
25	159	30		93	282
25.5	31	30		62	123
26	28			31	59
26.5	48				48
27					
27.5				31	31
28					
28.5					
29					
29.5					
30					
30.5					
31				31	31
TOTAL numbers	7 271	66 377	127 904	11 316	212 867
Official Catch (t)	540	4 307	9 553	1 062	**15 462**







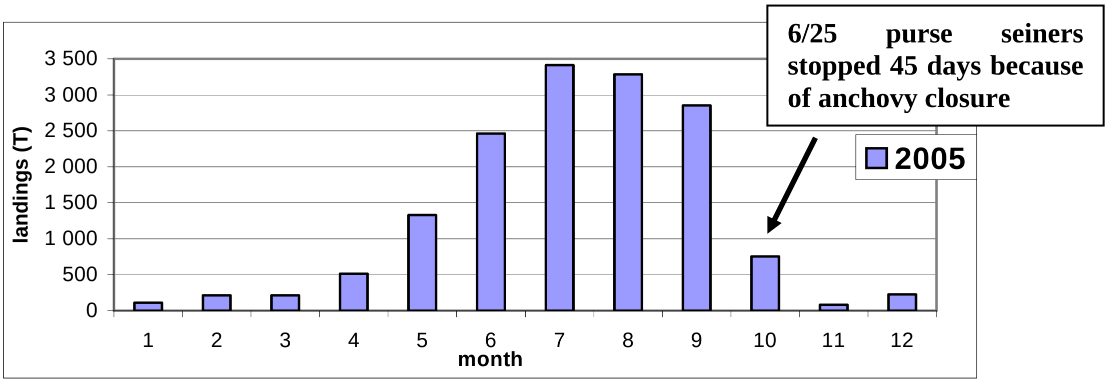


Figure 7.2.1.1. Monthly distribution of French sardine landings for 2002-05.

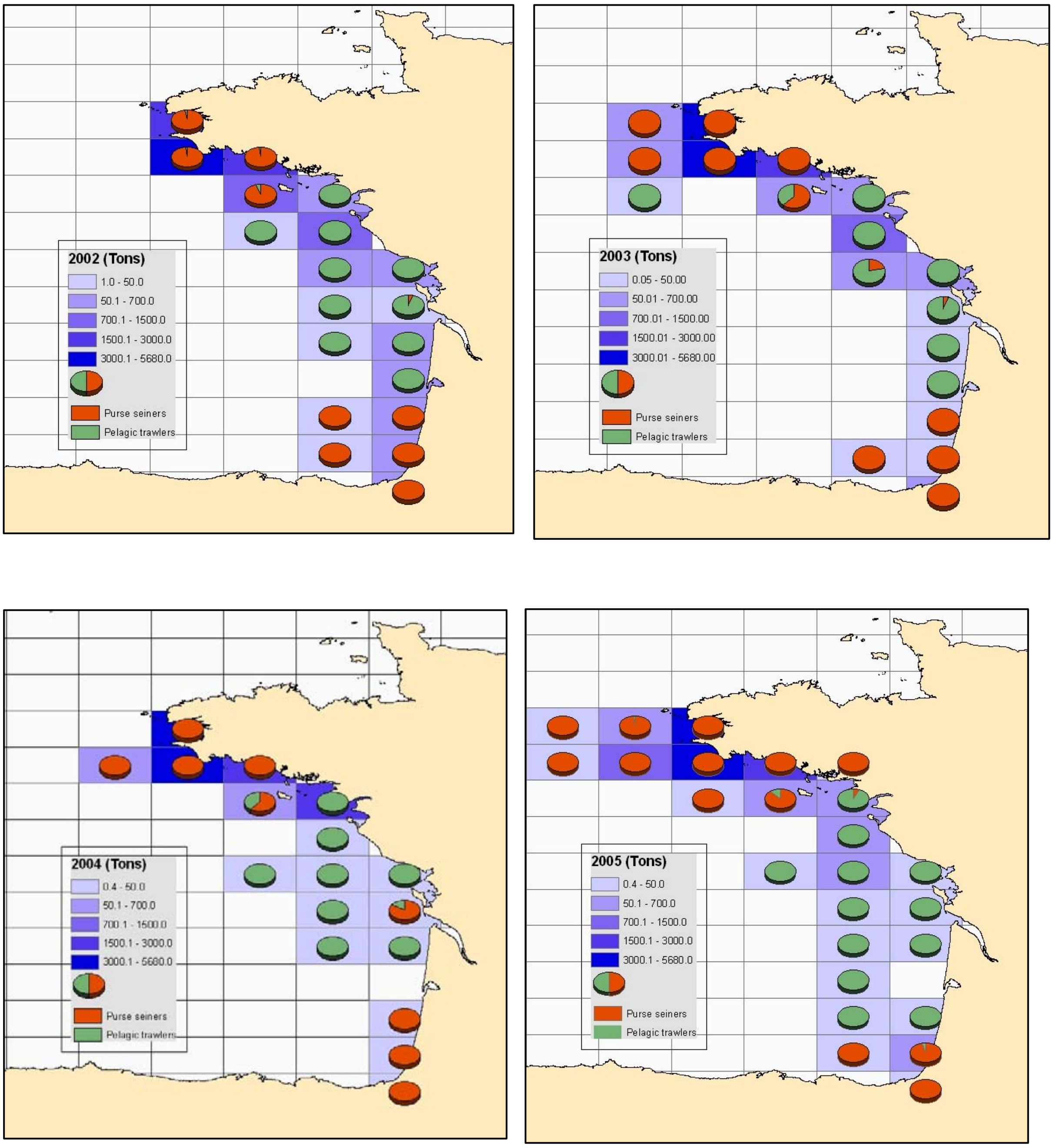


Figure 7.2.1.2. Geographical distribution of sardine catches by the French fleet during 2002-05.

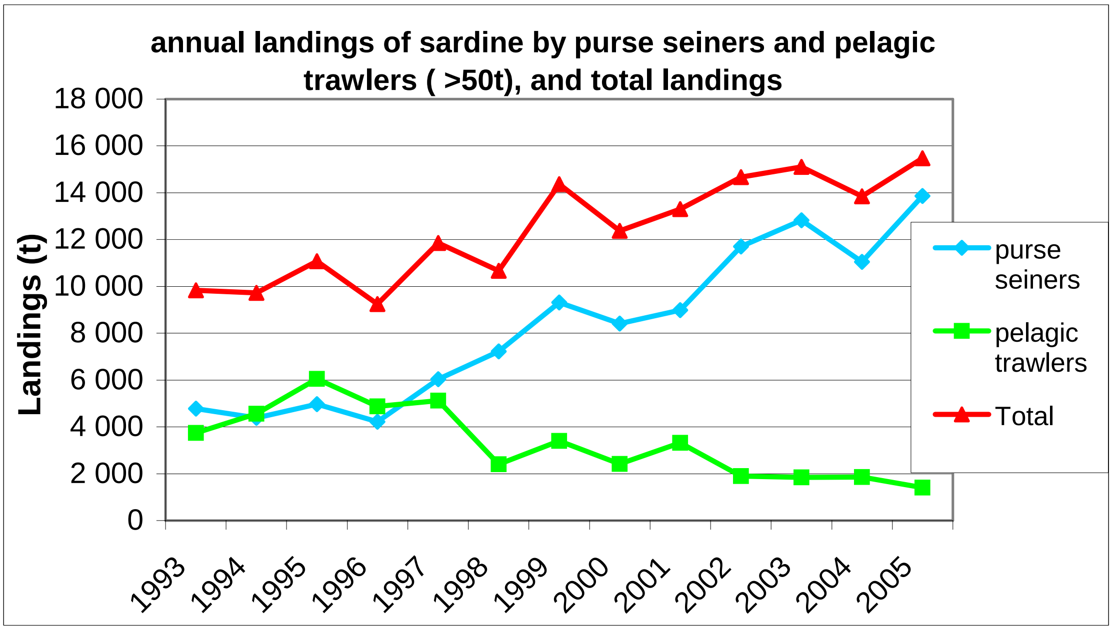


Figure 7.2.1.3. Annual sardine landings by the different French fleet components.

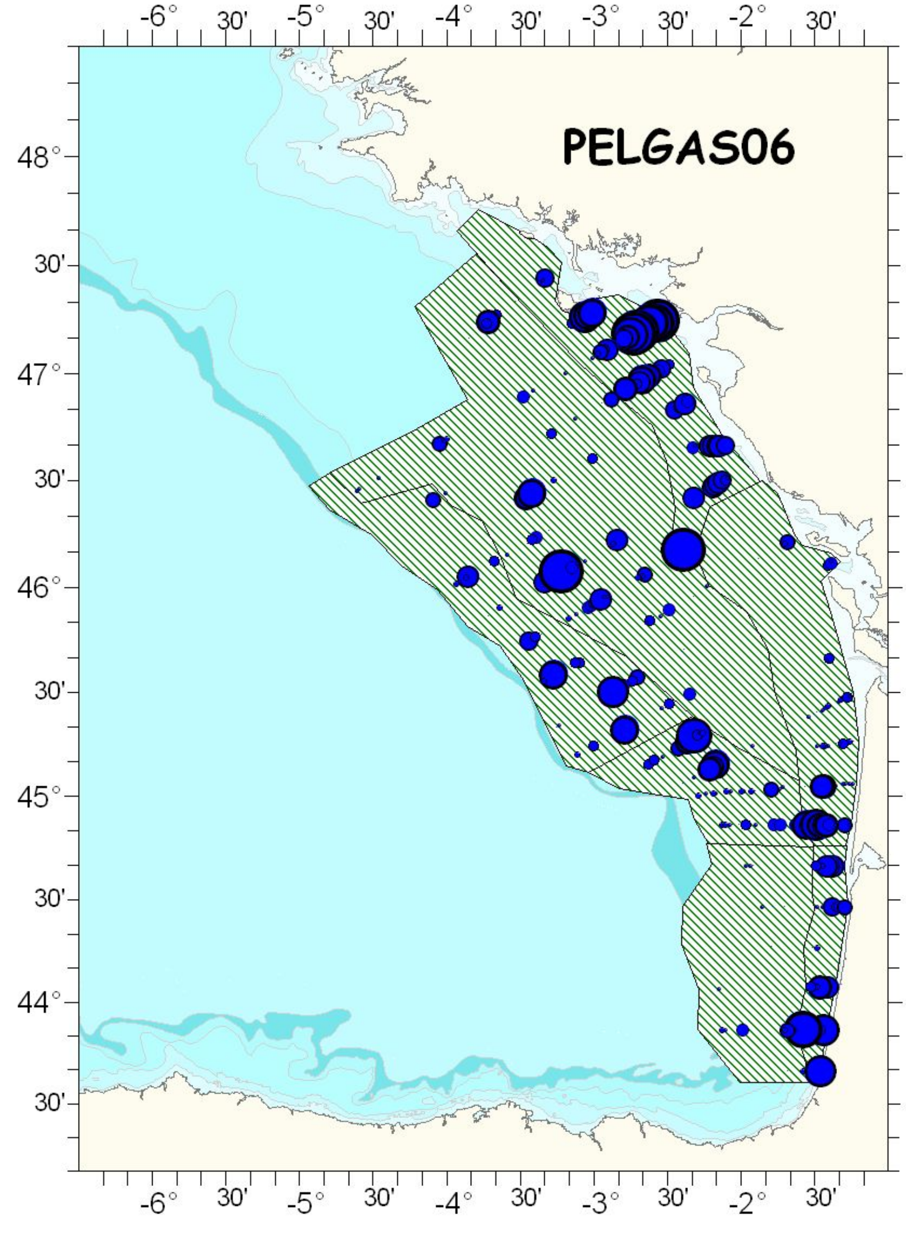


Figure 7.2.2.1.1. Distribution of sardine as observed during the acoustic survey PELGAS06 (shaded area represents the area surveyed by the cruise). Sardine is predominant in the central offshore area, mainly close to the surface and all along the coast except in front of Loire river plume. The north west area was not surveyed this year.

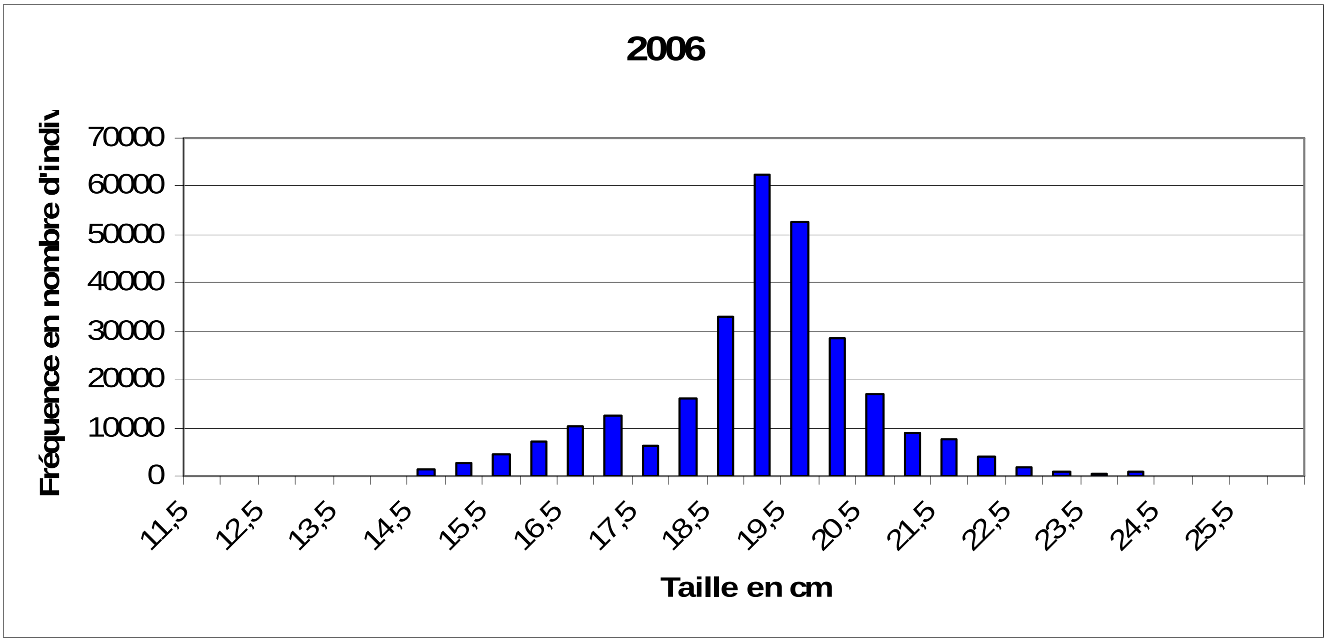


Figure 7.2.2.1.2. Length distribution of sardine in numbers of fish as observed during the acoustic survey PELGAS06 for divisions VIIIa and VIIIb.

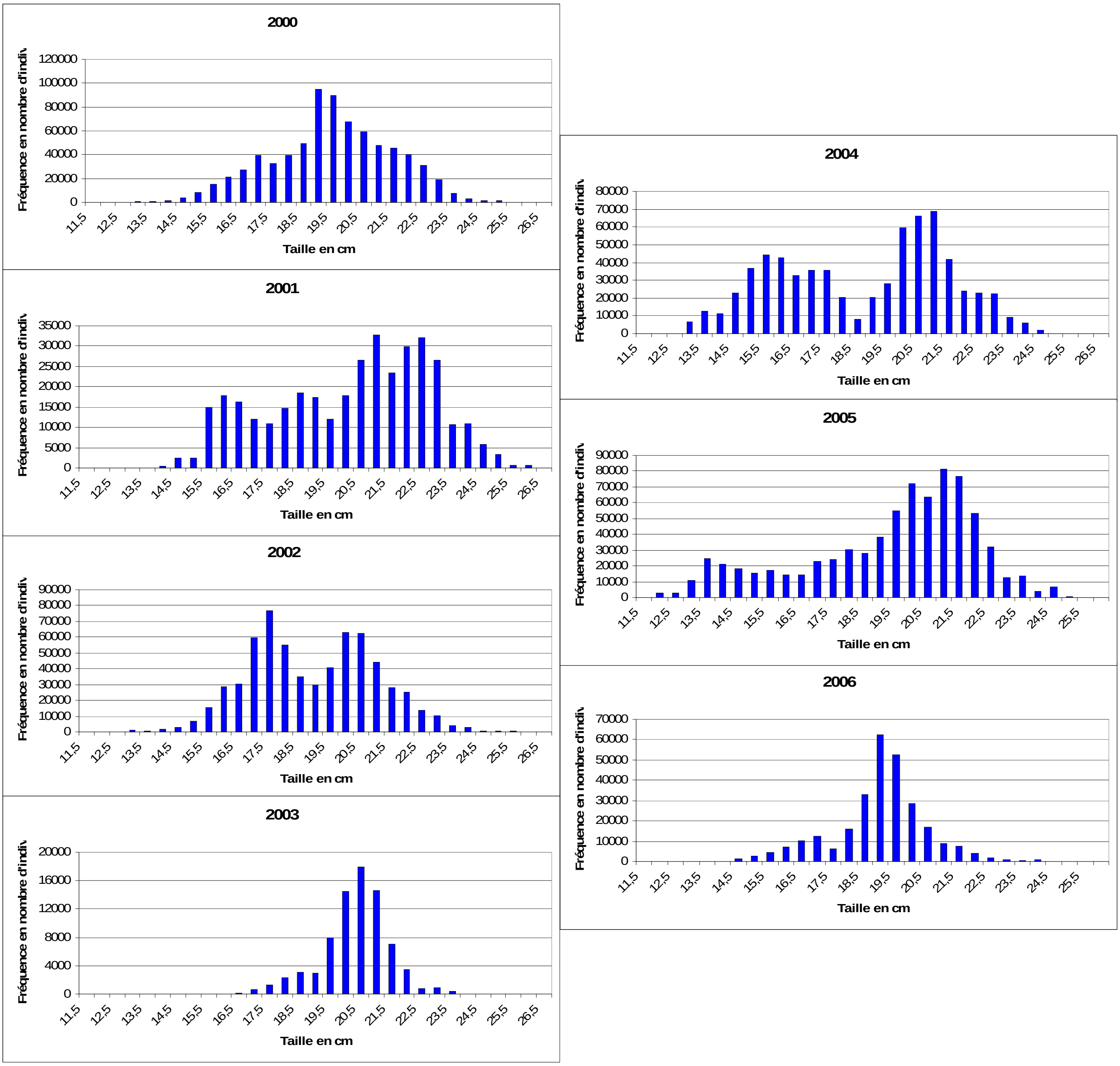


Figure 7.2.2.1.3. Length distribution of sardine in numbers of fish as observed during the acoustic surveys PELGAS 2000 – 2006 for divisions VIIIa and VIIIb.

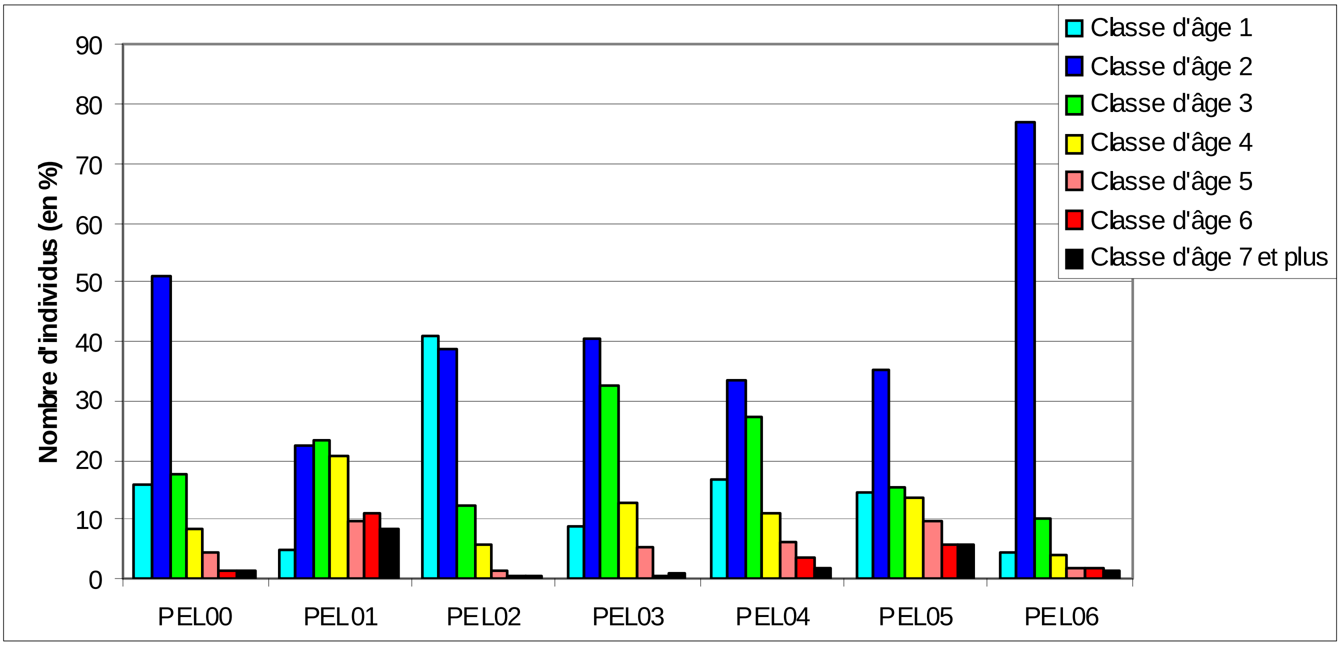


Figure 7.2.2.1.4. Age distribution of sardine in numbers of fish as observed during the acoustic surveys PELGAS 2000 – 2006 for divisions VIIIa and VIIIb.

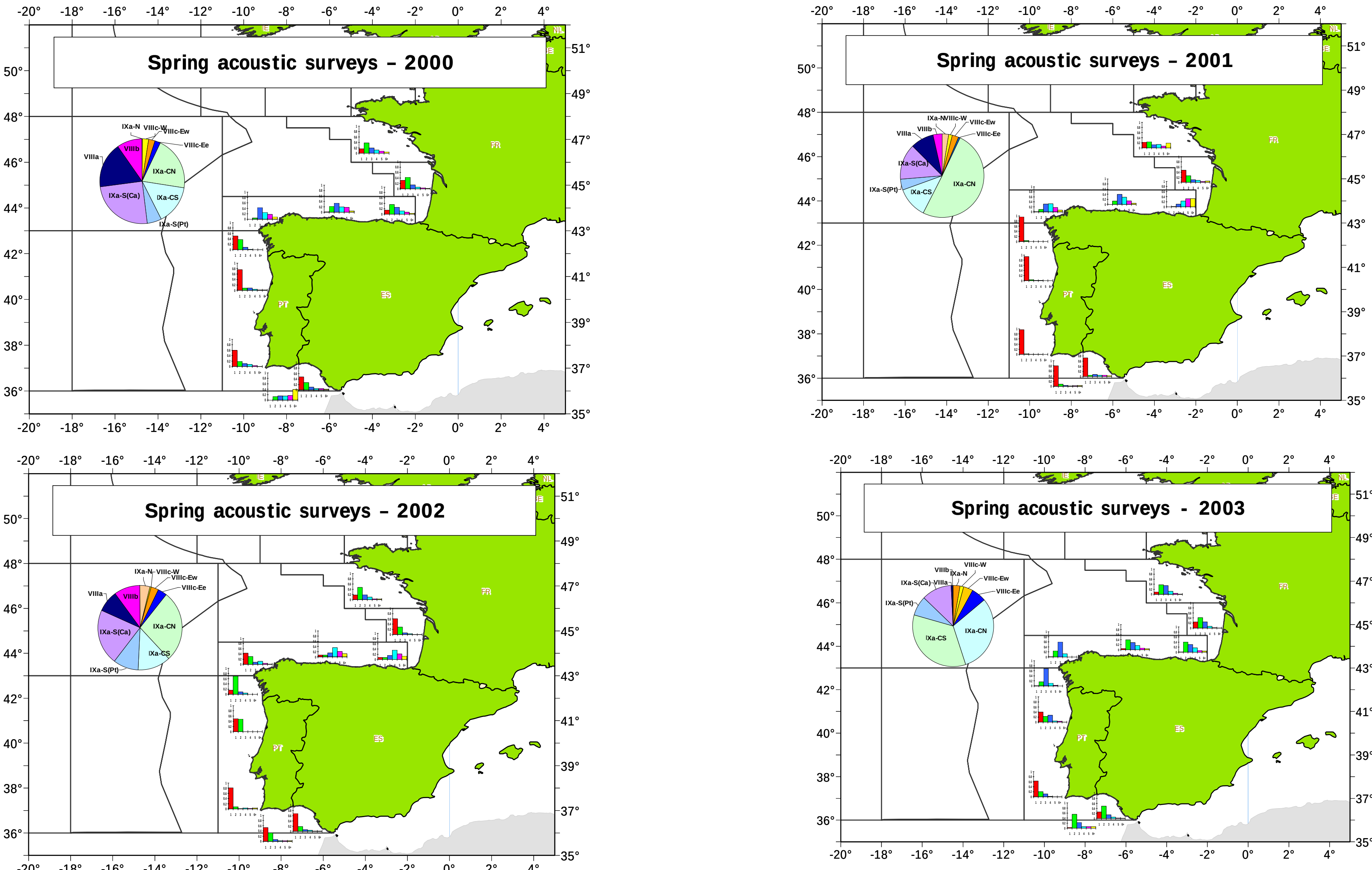


Figure 7.2.2.1: Sardine age frequency distribution by subarea showing the importance of each age class in each subarea in relation to the total sardine population in that subarea. Abundance data (thousands of fish) estimated by the spring surveys carried out by France, Spain and Portugal (2000-2003). Age categories are: 1, 2, 3,…and 6+. The pie chart represents the contribution of each subarea to the total stock numbers.

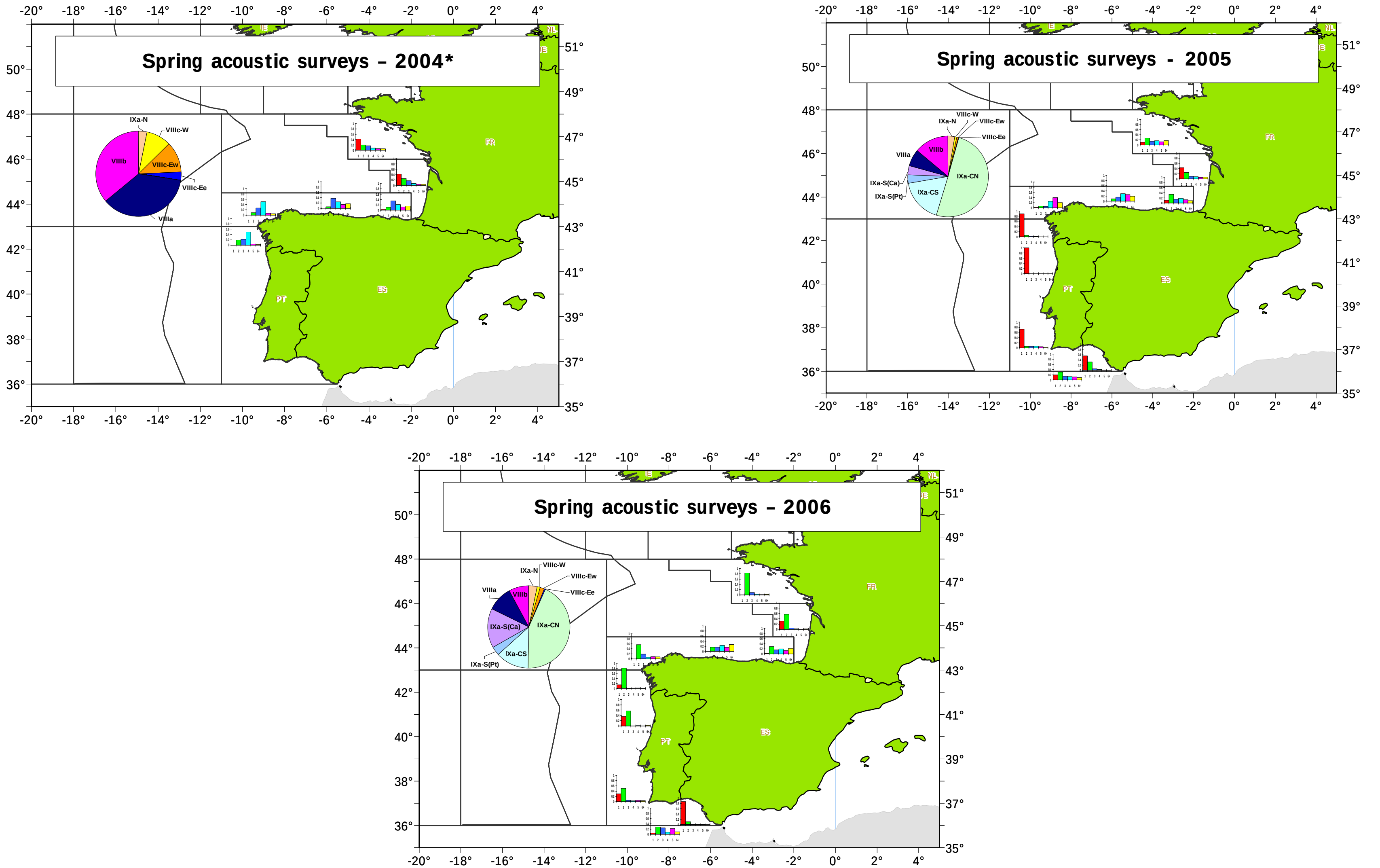


Figure 7.2.2.2: Sardine age frequency distribution by subarea showing the importance of each age class in each subarea in relation to the total sardine population in that subarea. Abundance data (thousands of fish) estimated by the spring surveys carried out by France, Spain and Portugal (2004-2006). Age categories are: 1, 2, 3,…and 6+. The pie chart represents the contribution of each subarea to the total stock numbers.*No Portuguese survey was carried out in spring 2004.

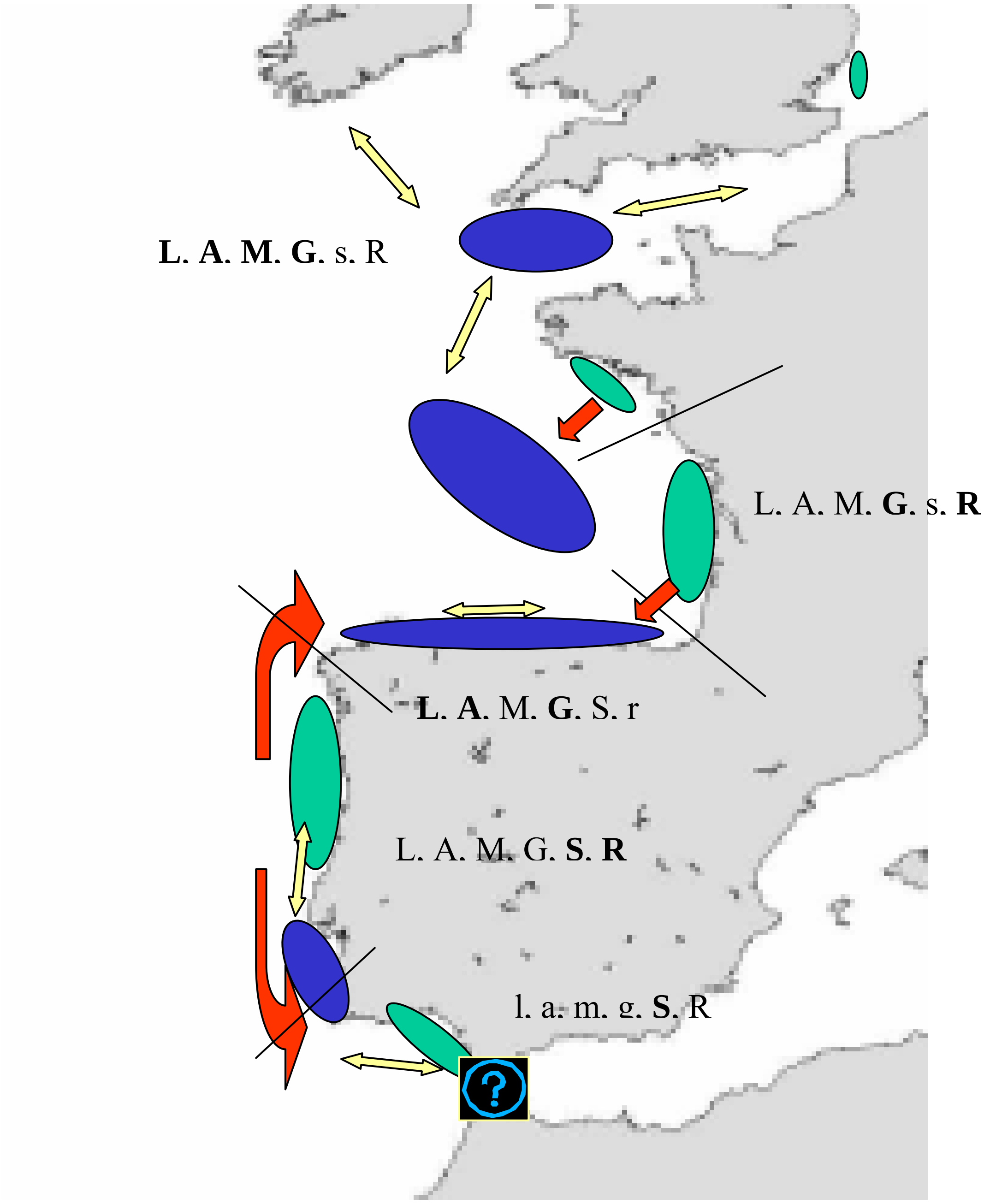


Figure 7.3.1. Schematic diagram of sardine life history dynamics based on information collected under SARDYN and revision of literature. Green areas indicate recruitment zones/areas dominated by young fish, while blue areas indicate areas dominated by older fish. Yellow arrows indicate haphazard movements (usually smaller-scale and seasonal) and red arrows indicate persistent directional movements (usually larger-scale and along life). Question marks indicate unknown rates of movement. Solid black lines indicate regions for which comparative information on life history properties (Longevity; maximum Age; length at first Maturation; Growth; duration of Spawning season and Recruitment strength respectively) is provided. Small letter indicates below average value of local life history parameter, capital letter indicates average level and bold capital letter indicates above average local value.

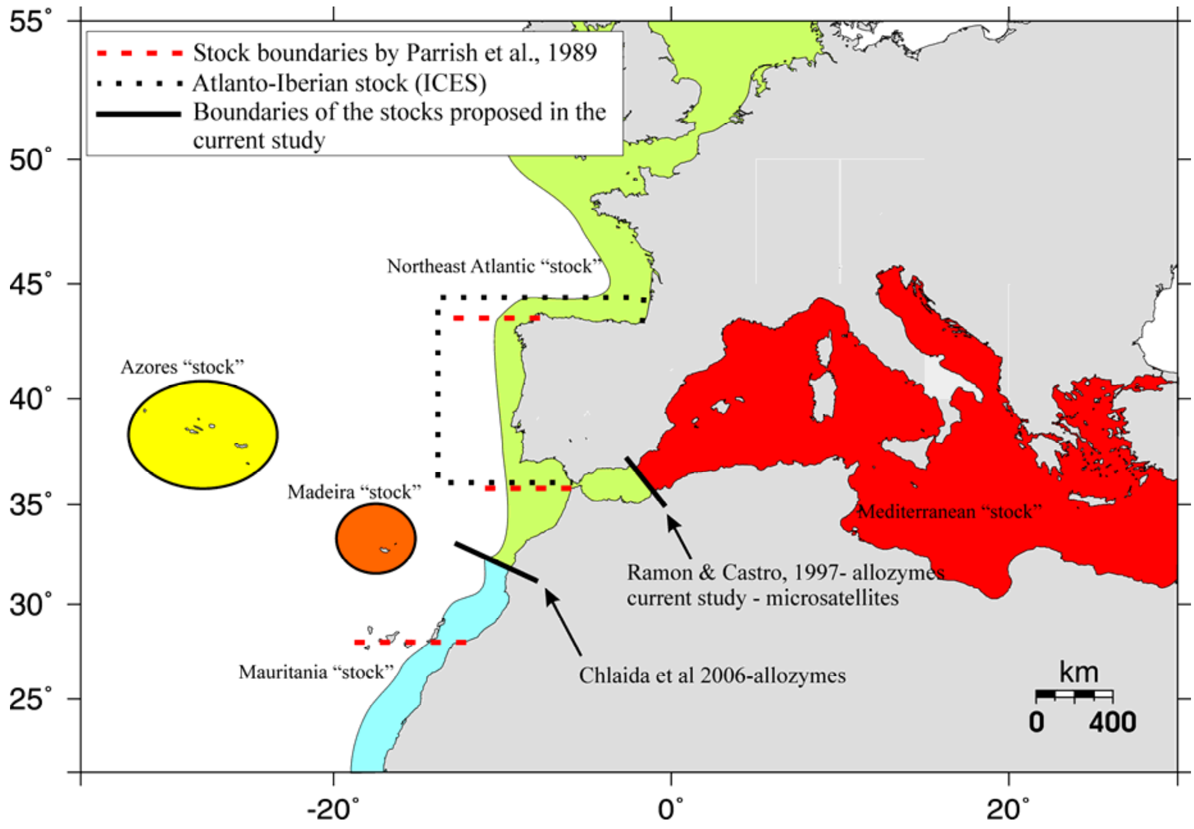


Figure 7.3.2. Schematic diagram of sardine "population" structure prior and after SARDYN.

8 Sardine in VIIIc and IXa

8.1 ACFM Advice Applicable to 2005

ICES recommends that fishing mortality should not increase above the level in 2002-4 of 0.22, corresponding to a catch of less than 96 000 t in 2006. Fishing mortality in 2006 should not increase because, even through the SSB is considered to be at a satisfactory level, the abundance of sardine in some areas of the stock continues to be low when compared to the mid-1980s. The SSB is expected to increase from 2005 onwards due to the strong 2004 recruitment but the absolute value of this recruitment has to be confirmed.

The 2004 year class is mainly distributed off northwest Iberia and its impact on other areas depends on dispersal. In addition, the 2000 year-class appears to have been depleted faster than strong year classes from the 1980s. The implication of this is that the stock is now more dependent on the strength of the incoming recruitment.

8.2 The fishery in 2005

Management measures implemented in each country since 1997 continued to be enforced in 2005.

Regarding Spain, the minimum landing size for the species is 11 cm. According to Spanish regulations, a maximum daily catch of 7 000 kg of sardine bigger than 15 cm is allowed as well as a maximum daily catch of 500 kg of juvenile sardines (between 11 and 15 cm). Effort is also regulated via a limitation in the number of fishing days allowed per week (5).

In the southern Spanish area (Cadiz), additional regulations have continued to be applied to the pelagic fishery. These measures include a closure of the fishery (which took place in 2005 between the 17th November to the 31st December). Additionally, there is a maximum daily sardine catch limit of 3 tons per boat.

In Portugal, a closure of the purse-seine fishery took place in the northern Portuguese coast (north of the 39º42" north) from the 1st of February to the 31st of March in 2004. A yearly quota has not been implemented in 2005 but the producers organisations had agreed to keep the same level of catches than in 2004.

As estimated by the Working Group, sardine landings in 2005 shows a minor increase with those of 2004 (Tables 8.2.1 and 8.2.2, Figure 8.2.1). Total 2005 landings in divisions VIIIc and IXa were 97 345 t, i.e. an increase of 6% with respect to 2004 values (91 886 t). The bulk of the landings (99%) were made by purse-seiners. Regarding countries, 39 855 t were landed in Spain, which represent an increase of 11% from 2004 (36 055 t). Almost all ICES subdivisions in Spanish waters showed an increase in catches, with the exception of IXaS Cadiz (with catches 9% smaller than in 2004). Portugal landings were 57 490 t, which represent an increase of 3% with respect to last year (55 831 t in 2004). This increase in landings took place only in subdivision IXaCS while a decrease was apparent in the rest of Portugal.

The historical time series may provide further insights when catch data is considered at a broader temporal scale, for instance landings of the last decade (1995-2005). Values for area VIIIc are rather stable, in a range between 15,000 to 19,800 t, with a decrease in 1999 and 2000, but increasing to reach in 2005 slightly higher values than those reported for 1995. Values for IXa North also present a sharp decrease in 1998-2000, increasing slowly but continuously afterwards. IXa Central North values have been quite stable for the past few years but a decrease in landings has taken place on the past 2 years. The same could be said for IXa Central South, which remains relatively stable, although with some fluctuations. The southern part of stock shows opposite trends: while fishery catches in Algarve decreased to a level equivalent to a third of the values in the middle 90s, Gulf of Cádiz catches have been increasing gradually (although a small decrease in landings took place in 2005).

Table 8.2.1 summarises the quarterly landings and their relative distribution by ICES Subdivision. Most of the catches (58%) were landed in the second semester (mainly in the third quarter) while 52% of the landings took place off the western Portuguese coast (IXaCN and IXaCS). These values are slightly lower than those reported for previous years. There is an apparent increase in landings in the northern areas of the stock (VIIIc and IXaN), with catches reaching up to 32% of the total stock landings in 2005 (comparing with 29% of the total stock landings in 2004 and 23% in 2003). The southern areas accounts for 16% of the total values in 2005, similar to previous years (although with small decreases in both Algarve and Gulf of Cádiz landings).

8.2.1 Fleet Composition in 2005

Details about the vessels operated by both Spain and Portugal targeting sardine are given in table 8.2.1.1. In northern Spanish waters, sardine is taken by purse seiners (n = 341) ranging in size from 8 to 38 m (mean vessel length = 22 m). Vessel engine power ranges widely between 16 to 1100 (mean = 333). In the Gulf of Cadiz, purse seiners taking sardine are generally targeting anchovy (n = 99) and range in size from 5.8 to 21.6 m (horse power between 22 to 500). In Portuguese waters, sardine is taken by purse seiners (n = 107) ranging in size from 10.5 to 27 m (mean vessel length = 21 m). Vessel engine power ranges between 71 to 447 (mean = 254). It should be noted that data from Portugal excludes those vessel with catches in 2005 below 1 t.

8.3 Fishery independent information

Figures 8.3.1 and 8.3.2 show the time series of fishery independent information for the sardine stock.

8.3.1 DEPM – based SSB estimates

DEPM surveys were carried out in winter 2005 by both Spain and Portugal. The methodology used and results obtained, as well as a revision of the DEPM-based SSB estimates time series was provided as a WD to this WG (WD Stratoudakis & Bernal, 2006). Preliminary results of this survey have already been presented in WGACEGG, where improvements in the estimation methods to be used were discussed.

The 2005 DEPM survey for sardine off the Iberian peninsula was executed following the same methodology as in 2002. Survey coverage in both surveys (Table 8.3.1.1) is considered to be good, given the sampling objectives stated in SGSBSA (ICES 2005) and WGACEGG (ICES 2006). Progressive introduction of survey semi-adaptative rules using CUFES as a secondary sampler have lead to a slight decrease in the number of CalVET stations along the time series, while adult sampling have been progressively increasing in order to improve the precision of the adult parameters estimates. Changes in the 2005 estimation procedure in relation to previous years are the adoption of the proposed multinomial ageing method in the Portuguese survey and that post-stratification was not considered necessary for estimation in northern Spain (WD Stratodakis and Bernal). The estimation of egg production in northern Spain adopts the definition of a positive stratum, while it is not used in Portuguese survey, leading to a slightly larger (but more conservative) coefficient of variance in the later.

Together with the 2005 estimates of egg production and adult fecundity, a review of the full DEPM time series have been presented to this WG. This review includes new estimates of spawning frequency in the Portuguese 1997 survey, based on recovered data, which lead to the first DEPM-based SSB estimate provided to this WG. Also, a small correction for an adult haul with a species misidentification error in 2002, which only produced a 3% change in biomass in relation to the original estimate. Tables 8.3.1.2 and 8.3.1.3 provide respectively the estimates of the different parameters required for DEPM for all the years in the DEPM time series (1997, 1999, 2002 and 2005) for the two national surveys (Spanish survey referring to northern Spain, Portuguese survey referring to Portugal and the Gulf of Cádiz). Estimates are provided as global estimates for each survey and by sub-strata for all the Portuguese surveys, while in the Spanish survey, sub-strata estimates are only provided in 2002. This is due to low sampling size preventing poststratification in the early part of the database, and to the fact that in 2005 it was not considered appropriate to postsitratify after the examination of the spatial distribution of adult parameters and egg densities. In all cases, when stratification was considered, the most appropriate final SSB estimate was consider the one obtained by addition of the estimates of all sub-strata, instead of the global estimate (for rationale see Stratoudakis and Fryer, 2000).

In relation to the 2005 estimates, the most relevant fact is a low estimate of spawning fraction in northern Spain, the smaller of the time series in northern Spain. Although variable, spawning fraction in northern Spain have been historically higher than those found in the Portuguese survey, while in 2005 spawning fraction is at a similar level in both surveys, even lower in the Spanish one. This leads to a large increase in SSB in northern Iberia while in western and southern Iberia there is a decrease in SSB, mainly caused by an increase in spawning fraction. Egg distribution and modeled egg production are shown in Figure 8.3.1.1. Egg production in 2005 is concentrated in Cádiz, in front of Lisbon and in the coastal areas of northern Iberia, while north Portugal and south Galicia show low densities of eggs forming offshore patches.

Table 8.3.1.4 provides a comparison of the different DEPM-based SSB estimates (with or without poststratification) and highlights the SSB estimates provided for assessment, which corresponds with the traditional poststratified estimate. For all years in which model-based spatial explicit DEPM is available, results are comparable (1999 being the most different one). Also, acoustic estimates of SSB for the same years are provided in the same table, and shown in Figure 8.3.1.2. Acoustic and DEPM SSB estimates in the last decade show a similar trend, with acoustics providing larger estimates, although within the DEPM-based estimates confidence limits. In 2005, the DEPM provides for the first time a larger estimate than the acoustic one, mainly due to the increase of SSB estimates by the DEPM in the northern Iberia waters.

Apart from the review of egg production presented to this year WG, an analysis of spawning areas of sardine in the Iberian Peninsula, using all available ichthyoplanckton data was carried out within SARDYN (Bernal et al. *in press*). This analysis covered the period from 1985 to 2005 and concluded that the extension of spawning area in the Iberian Peninsula sardine is not directly related to the biomass of the stock. Nevertheless, a change in the use of the shelf for spawning can be detected in the middle 90’s (Figure 8.3.1.3). Before the shift, around 60% of the shelf was consistently used for spawning, while after this shift, this percentage decreased to 40% of the shelf. The study described spawning dynamics by defining four main spawning nucleus, in Armorican shelf, the north Iberian coast, west Iberia and South Iberia, each covering a variable extension. After the middle 90’s, the northwest corner of Iberia is nearly devoided of eggs, and the north part of the Portuguese waters show patchy and sometimes offshore distribution of eggs. Spawning areas off the north Iberian coast are concentrated to a narrow coastal strip, while spawning in the south Iberia nucleus is intense. The 2005 DEPM survey fits well with this general picture, while a gradual increase in spawning in the north west corner can be observed.

8.3.2 Acoustic surveys

The methodology used in the Portuguese and Spanish acoustic surveys was standardized within the framework of the Planning Group for Pelagic Acoustic Surveys in ICES Divisions IX and VIII (ICES CM 1999/G:13). Surveys are undertaken within the framework of the EU DG XIV project “Data Directive”.

8.3.2.1 Portuguese November 2005 and April 2006 Acoustic Surveys

During 2005/2006, two acoustic surveys were carried to estimate sardine and anchovy abundance in IXa (WD Marques & Morais, 2006). The November 2005 survey (SAR05NOV) aims to cover the early spawning and recruitment season while the April 2006 survey (SAR06APR) aims to cover the late spawning season. Borth surveys took place onboard the RV “Noruega” and followed the standard methodology adopted by the Planning Group for Acoustic Surveys in ICES Sub-Areas VIII and IX (ICES 1986, 1998).

Due to bad weather, the November 2005 survey did not cover the Gulf of Cadiz area (only 60 out of the planned 69 transects could be surveyed) (Figure 8.3.2.1.1). A total of 29 trawls hauls were performed and sardine was present in 20 of those, being predominant in the subdivision Central North where it presented a broad distribution area, extending from the coast to the 100 m depth contour line. In subdivision Central South sardine was scarce, being almost absent between Cape Espichel and Cape S. Vicente. In Algarve only a few sardine schools were detected, mainly close to the coast. Total sardine biomass estimated in the survey area was 504 thousand tonnes corresponding to 17 800 million individuals (Table 8.3.2.1.1). Comparing 2004 values with previous estimates, the abundance value for the subdivision Central North (458 thousand tonnes; 16 600 million individuals) is the second largest ever found for this area while the abundance estimated for subdivision Central South (34 thousand tonnes, 863 million individuals) is one of the lowest in the series. For Algarve the estimated value is also very low (12 thousand tonnes, 333 million individuals). Subdivision Central North was dominated by juveniles from 2005 (age 0) and also confirms the strong 2004 recruitment (age I). Subdivision Central South had a multimodal age structure with both juveniles (46% of the total abundance located mainly in front of Lisbon) and adults. In the Algarve, 66% of the very low estimated abundance was represented by juveniles.

The April 2006 survey (SAR06APR) also took place onboard the RV “Noruega” and covered the following areas: sub-divisions Central North, Central South, South Algarve and South Cadiz (Portuguese waters and Gulf of Cadiz). All the 69 planned acoustic transects were carried out together with 40 fishing stations (with sardine being present in 32 of those) (Figure 8.3.2.1.2). As usual, sardine was mainly distributed in subdivision Central North (from Caminha to Cape Espichel) where it presented a wide spatial distribution (from near the coast to ca 80 m depth), being more abundant between Porto and Figueira da Foz. In subdivision Central South, sardine was scarce while off Algarve the main sardine concentrations were found in the Western part (between Sagres and Portimão), being almost absent in the remaining Algarve area. In the Cadiz Bay sardine was regularly distributed from shore to around 60 m depth.

Total estimated sardine biomass was 637 thousand tonnes corresponding to 16.5 billion individuals (Table 8.3.2.1.2). These values represent an increase of 13% in biomass but a decrease of 35% in numbers compared with the values estimated by last year spring survey (Figures 8.3.1. and 8.3.2). More than half the total estimated biomass and abundance (58% in both cases) was located in subdivision Central North. The strong 2004 cohort is apparent in all areas with the exception of Cadiz, where age 1 fish (2005 cohort) represented 87% of the total abundance in number and 82% of the total biomass estimated for that area.

8.3.2.2 Spanish April 2006 Acoustic Survey

The Spanish Spring Acoustic Surveys time series comprises data from 1986 onwards, with three gaps in 1989, 1994 and 1995.

The Spanish acoustic survey (PELACUS 0406) took place from the 1st to the 28th of April 2006 on-board the R/V “Thalassa”, covering Spanish waters in Divisions VIIIc and IXa North as well as the northern part of Portugal and a small area of the southern French shelf. During the cruise, in addition to standard acoustic transects, sampling was also carried out for the characterisation of the egg, plankton and primary production distribution.

The survey covered a total of 60 acoustic tracks (53 in Spanish waters, 5 in Portuguese and 2 in French waters, see Figure 8.3.2.2.1a). Different from previous years, fishing stations during PELACUS 0406 were sampled only by the R/V Thalassa (pelagic trawls) since this time the chartered purse-seiner did not accompany the Thalassa.

A total of 61 fishing stations were sampled during the cruise, 54 of them in Spain (two of which were deemed invalid, see Figure 8.3.2.2.1b). In Spanish waters, the highest sardine density was found in ICES Subdivision IXa North, followed by VIIIc East and VIIIc West (see Figure 8.3.2.2.1c).

Table 8.3.2.2 shows sardine 2006 acoustic estimates by areas and ages. The abundance estimated in 2006 in the North Spanish area is 1484 million individuals, very close to the 2005 value (1471 millions). Regarding biomass, the 2006 survey estimated a total of 93000 tonnes (an increase of 37% with respect to the 2005 figure of 68000 tonnes).

For the total Spanish surveyed area, age 2 fish (the strong 2004 cohort) represented 58% of the total abundance in number and 47% of the total biomass. Age 1 accounted for almost 8% of the total abundance but less than 5% of the total biomass. Age classes 3 to 5 all individually contribute more than 10% of overall stock biomass.

Figure 8.3.2.2.2 shows the sardine age distribution by area. Over 50% of fish (by number) are present in area IXa North, mainly due to the huge importance of the age 2 group in this area (81% in abundance and 80% in biomass). Age 2 is also the most abundant age group in area VIIIc West, representing 57% of the abundance in number and 51% in biomass. In area VIIIc East west, age 4 is the most important age group (23% in abundance and 23% in biomass) while age group 2 is the most important in area VIIIc East east (28% in abundance and 23% in biomass).

Historically, sardine abundance in numbers shows a high inter-annual variability since 1986 and up to 1993 (Figure 8.3.1). An important decrease is apparent from 1996 to 1999, followed by an important recovery in 2000, due to the strong 2000 recruitment. An increasing trend is noted since then until 2003, which is the highest value of the time series. Both 2004 and 2005 show a decrease in abundance while 2006 value is very similar to 2005. The reduction of the strong 2000 year class is also apparent together with the appearance of the strong 2004 year class.

As referred in previous reports, the age structure has changed from “old fish” dominated to “young fish” dominated from the 1980s to the 1990s. These numbers reflects that sardine population is highly dominated by young fish from good year-classes which support the fishery.

8.4 Biological data

Biological data were provided by both Spain and Portugal. In Spain, samples for age length keys were pooled on a half year basis for each Sub-Division while length/weight relationships were calculated for each quarter. Age length key and length/weight relationship from Cádiz area (IXaS-Cadiz) have also been used. In Portugal, both age length keys and length/weight relationships were compiled on a quarterly and Sub-Division basis.

8.4.1 Catch numbers at length and age

Tables 8.4.1.1a,b,c,d show the quarterly length distributions of landings from each Sub-Division. Annual length distributions are generally bimodal in Spain with the exception of IXaN where a single mode at 15.5 cm was observed. For Portugal, single modes were observed for IXaCN at 16 cm, for IXaCS at 19.5 cm and for IXaS-Algarve at 19 cm respectively. In Spain there is a general decrease in the length distributions from VIIIcE to IXaN as usual, however some small individuals (<15 cm) were also landed in 2005 in both VIIIcE and VIIIcW.

Catch at age numbers were derived from length distributions and age length keys by country using the same basis than section 8.4.

Table 8.4.1.2 shows the catch-at-age in numbers for each quarter and Sub-Division. In Table 8.4.1.3, the relative contribution of each age group in each Sub-Division is shown as well as their relative contribution to the catches. In the area from Galicia (VIIIc West and IXa North) to southwest Portugal (IXaCS) and Gulf of Cadiz, catches are dominated by the strong 2004 year class (1-group in 2005). The 2004 year class however is not apparent in IXaS-Algarve, where age 2 fish (2003 year class) dominate the catches although there is also evidence of the strong 2001 recruitment. In the VIIIc East Sub-Division not a single age class dominated the catches.

0-group catches are mainly concentrated in sub-division IXaCN (north Portuguese waters) which has been an important recruitment area in recent years. Older fish (age groups 5 and 6+) concentrate in the Bay of Biscay/Cantabrian area (VIIIcE) and southwest Portugal (IXaCS).

8.4.2 Mean length and mean weight at age

Mean length and mean weight at age by quarter and Sub-Division are shown in Tables 8.4.2.1 and 8.4.2.2.

8.4.3 Maturity and stock weights at age

A revision of the maturity ogives and stock weights for the period 1996-2005 has been presented to the WG (WD2006 Silva et al). For this revision, biological samples from Portuguese and Spanish spring acoustic surveys were used to estimate maturity and weight length for the northern, western and southern stock areas. Predicted values from these models are raised to population numbers using length frequency distributions (from acoustic estimation) and age-length-keys, separately for each year and area. These are combined to produce annual stock values using population numbers-at-age assuming equal catchability of the two surveys. New biological parameters presented were considered reliable since they are based on large samples collected across the stock area using a consistent procedure which takes into account recent knowledge about spatial and temporal variations in sardine biology. New estimates are generally within the range of variation of those previously used but some change on the stock SSB estimated by the assessment is seen for 1996-1998 and 2003.

The maturity ogive and stock weights for 2005 (see below) were calculated according to the above procedure and are within the range of values observed in the data series.

AGE	0	1	2	3	5	5	6+
% mature fish	0	19.8	85.7	96.6	98.7	99.2	99.3

AGE	0	1	2	3	5	5	6+
Weight, kg	0	0.019	0.044	0.059	0.068	0.073	0.078

8.4.4 Natural mortality

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

8.5 Effort and catch per unit effort

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

8.6 Recruitment forecasting and Environmental effects

No new information on recruitment forecasting has been presented to the WG. Current knowledge on recruitment environment relationships for sardine is still at an early stage, and the WG encourages further research along these lines in order to understand environmental effects on stock dynamics.

8.7 Data and model exploration

This year, due to the benchmark assessment of sardine, a large amount of exploration was done, both on the assessment data and on the models used. Extensive data and model exploration was done through the SARDYN project, and some extra revision of the assessment input data was carried out after SARDYN and before the WG meeting. Revised data presented to this group include a revision of the maturity ogives (WD Silva et al 2006) and of the DEPM-based SSB estimates (WD Stratoudakis et al. 2006). Stock assessment model exploration from SARDYN focus on the use of two different area disaggregated models; an expansion of the currently used AMCI model and a new Bayesian area disaggregated state-space model. Both models required detailed information on migration between the areas defined in the model, which to some extent was expected to be provided from the tagging experiment of SARDYN. However, low recapture rates prevent any estimate of migration. Thus the structure of the different area dissagregated models explored included either a heavily constrained migration model, leaving a limited number of parameters to be estimated, or expert guessestimates of migration parameters. These were needed in order to overcome the overparameterisation expected if the usual assessment parameters plus migration rates are to be estimated by the same data routinely used in assessment, but dissagregated by area.

The objective of this section of the report is therefore to further analyse the results of SARDYN, and to try to use the available data and the required model exploration to test the basic underliying assumptions within both the current assessment models and a set of plausible alternatives, and to sugest the model that better describe the sardine fishery, as well as to list the different assumptions used in the process and evaluate, in the best possible way, their validity.

Although data and model exploration for choosing this year’s sardine assessment model have been carried out in a iteratively fashion (i.e. models with different structures were tested and then the likelihood of the assumptions implied in each model run was evaluated by closer look at the basic available data), the rest of this section is separated between data and model exploration, to improve readibility. Also, the model exploration has been separated into two sections, area dissagregated model exploration and single area model exploration. Each model section has two subsections that list the main different approaches used. Finally, a summary of the main results and conclusions from all the data and model exploratory sections is included.

8.7.1 Data exploration

Sardine catch and survey data were explored to extract information on mortality signals and year-class strength and to evaluate the consistency between the different sources of information. Figure 8.7.1.1 shows the plots of log-numbers at age for year-classes represented in the catches. Catch data suggests strong recruitments in 1978-1980, 1983, 1987, 1991 and 2001. In general, cohorts are fully recruited to the fishery at ages 1 or 2 and their gradual depletion is clear from these data. The exception are those year-classes from the first half of the 1990s, which show comparatively poor representation in the catches up to age 2 suggesting either a lower availability to the fishery or a lower selection.

Log-numbers at age of year-classes observed by the Spanish and Portuguese spring surveys are shown in Figure 8.7.1.2 and 8.7.1.3. These suveys cover the northern (VIIIc and IxaN) and the west and south (IXaCN to IXaS-Cadiz) parts of stock area. While the depletion of year-classes in the west and south areas is clear, in the northern area the abundance of most year-classes either remains stable or increases with age at least during the first years of life. The complementary picture provided by these surveys suggests that cohorts observed in the northern stock area recruit outside this area, possibly to some extent in the west Iberian waters.

Regression lines were fitted to the log-numbers at ages 2-5 (age range used to estimate F) for each year-class. The slopes of these lines varied between –0.18 and -0.79 for 1976-2000 year-classes showing higher values for the earlier cohorts and lower values for the 1990 cohorts mentioned above (Figure 8.7.1.4). The mean value of these estimates, - 0.56 is broadly consistent with the average estimate of mortality across the period in recent assessments of this stock (average F2-5= 0.31 and M=0.33 across all ages). Depletion of year-classes in the Portuguese spring surveys is comparable to that observed from catch data (mean= - 0.61 and range=0.34-0.84) and suggests and increasing trend since 1995 (Figure 8.7.1.4). The data from the Portuguese November survey (covering the Portuguese waters since 1984) shows extensive gaps. Data for the most complete year-classes in this survey suggest a similar mortality signal to that provided by the Portuguese March survey (Figure 8.7.1.5).

The relationship between catchabilities of the Portuguese and Spanish acoustic surveys was explored using data from acoustic and DEPM surveys. The rationale for this exploration was the following: the total SSB estimated by DEPM can be split to provide the proportion of sardine biomass in the northern and western+southern Iberia. If the spatial distribution of sardine biomass given by the Spanish and Portuguese acoustic surveys is comparable to that obtained from the DEPM surveys, there is some support to the hypothesis of equal catchability in the Spanish and Portuguese acoustic surveys. Therefore, the proportion of sardine biomass off the west and south Iberia was calculated for each year in both acoustic and DEPM surveys assuming (i) that the acoustic surveys have equal catchability (corresponding biomasses were simply summed) and (ii) that the catchability of the Spanish survey is half of that of the Portuguese survey. The results show a good agreement between DEPM and acoustic surveys in 1997 and 1999 with both indicating around 95% of sardine in the west and south Iberia, slightly less agreement in 2002 (10% difference) and different values in 2005 due mainly to the larger SSB of sardine in the Spanish waters provided by the DEPM (Figure 8.7.1.6). It is also clear that the area proportions in the two types of surveys have better agreement when the acoustic catchabilities are assumed equal (SSBs for each area simply summed) than when the catchability of the Spanish survey is assumed to be half of the Portuguese survey. The WG agreed that these results provide some support to the hypothesis of comparable catchabilities in the two surveys although it also acknowledged the need of additional data to confirm them.

If the Spanish and Portuguese spring acoustic surveys are combined in an assessment model to provide an index of the overall stock, it is not coherent to include also the Portuguese November survey which covers only part of the stock area. However, this survey covers the main recruitment area for the stock and may be alternatively used as an index of recruitment to the stock. To explore the use of this survey as a recruitment index, the number of recruits (at age 0) from these survey was compared to estimates of recruitment provided by the assessment model using the assumptions of the spaly run without this survey series. It was observed that the absolute numbers of age 0 fish from the two sourcs are uncorrelated however, there is a good relationship in qualitative terms (when the two data series are ranked, Figure 8.7.1.7). It is also apparent that the relationship is different for the years 1984 – 1997 and 1998 – 2005. This change may have several possible explanations such as changes in survey catchability and changes in the spatial distribution of recruitment which need further study. Therefore, the WG agreed that this survey should be used in the future both to complement the estimates of recruitment strength provided by the spring survey and to provide indications of the recruitment level for predictions.

8.7.2 Model exploration: area disaggregated models

In previous WGMHSA meetings, the spatial structure of sardine stock and the differences in the signals of the fishery independent surveys carried out in different parts of the stock (i.e. off the north Iberian coast and off the west and south Iberian coast) have raised important doubts on the validity of the different indices and the assessment models used. Also, there were doubts on the stock boundaries and the integrity of the current stock unit, and thus the assessment was not considered to be completely reliable. These issues have been addressed through the SARDYN project from different perspectives (see section 7). In terms of assessment, two different area disaggregated models were developed to test different hypotheses on migration and ultimately to improve the assessment by addressing spatial heterogeneity of the sardine population in the Iberian Peninsula and adjacent waters; a) an extension of AMCI which include a migration model (WD Skagen) and b) a Bayesian state-space model (Cunninghan and Roel 2006) .

8.7.2.1 AMCI area disaggregated model

As part of the SARDYN project, the AMCI model was extended with a migration model of the Markov chain type, i.e. at exact time step, fish have a certain probability to move from one area to another (Skagen 2006). The probabilities are expressed as entries in a probability matrix, as shown below for the 3-area model that was implemented for the Iberian sardine.

$$
\begin{array}{cc}
 & \textbf{From} \\
 & \begin{array}{ccc} N & \quad W \quad & S \end{array} \\
\textbf{To} & \\
\begin{array}{c} N \\ W \\ S \end{array} & \begin{pmatrix} 1 & \rho_{NW} & 0 \\ 0 & 1-\rho_{NW}-\rho_{SW} & 0 \\ 0 & \rho_{SW} & 1 \end{pmatrix}
\end{array}
$$

Here, the ρ_{NW} is the probability, for a fish present in area W, to move to area N in the next time step, and similar for the other coefficients. Coefficients are assumed to be equal for all ages within each year class, starting at age 1, to represent equal migration rates over year classes. That gives 4 parameters to estimate for each year class minus two migration coefficients and the initial fraction in each area.

An additional finding was that the migration coefficients varied over time, indicating a more Southward migration trend in the late 1990’s. No correlation was found between migration parameters and year class strength.

AMCI was run with 3 areas (North, West and South coast of Iberia, one fishing fleet for each area and the March and November surveys split by area. For the Western area, the Spanish and Portuguese March survey indices for that area were added together on equal terms. The model was run with data for the years 1990 to 2002, for which such data were available at the time.

The experience with this model was that it required quite strong constraints on selection and catchability at age to converge. The run chosen as a reference run modelled the selection at age as a logistic function for each area, the catchabilities as logistic functions except for the Spanish survey on the North coast, all selections and catchabilities being assumed constant over time. These constraints are far more restrictive than those used in the ordinary sardine assessments.

Even though the 3-area model gave overall results comparable with the one area models, and in gross terms, with the ICES 2004 assessment, the estimates of local fishing mortalities were extremely high, in particular in the Northern area in some years. This indicates that the migration model was too rigid to cover local short term variations in abundance.

8.7.2.2 Area disaggregated Bayesian space – state model

A Bayesian state-space model was developed as part of the SARDYN project, explicitly accounting for the assumed migratory characteristics of the population by allowing stock- and age-dependent movement between model divisions at the beginning of each quarter of the year (Cunningham and Roel 2006). The distribution of the sardine and the harvest rate was assumed to be uniform within each of 6 model divisions, while some model parameters (e.g. catch weights-at-age) differ between model divisions. Sardine was modelled to spawn at the beginning of the first quarter in more southerly divisions and at the beginning of the second quarter along the Cantabrian coast, while recruitment to the population was modelled to occur at the beginning of the third quarter. Catch was modelled to be taken at discrete times during the year using a harvest rate that wass year-, quarter- and model division-dependent. Thus the rate of fishing mortality, F, was not be explicitly modelled. Rather the catch from each stock was modelled to be proportional to the abundance of each stock’s age group in each division, by quarter. Data enabled a 6+ group to be modelled prior to 1990, increasing annually such that a 12+ group was modelled from 1996 onwards.

The model was fitted to annual catch-at-age data for earlier years and quarterly catch-at-age data for latter years, to DEPM estimates of spawner biomass and to acoustic estimates of relative biomass and numbers-at-age by area.

One key difference between the modelling approach used with AMCI (described in section 8.7.2.1) and that used with this model was the treatment of migration within the model. In the Bayesian state-space model, migration matrices denoting the proportion of fish from one area moving into another area at the beginning of each quarter of the year were fixed using input from scientists closely working with the stock. Briefly, little movement of the 0-group and 1-year-olds was assumed, with some diffusion to neighbouring areas. No directional movement of the 2+ adults was assumed during the spawning season, with a northerly movement from ICES division IXa(central-north) to IXa(north) at the beginning of the third quarter and some southerly movement from IXa(north) down to IXa(central-south), IXa(south-algarve) and

IXa(south-cadiz). These fixed migration matrices were able to result in some good fits of the model to the observed data, in particular to the proportions-at-age by division.

This model was updated at the WG to take account of data that are available up to the end of 2005. Only results at the posterior mode (not full posterior distributions) could be obtained during the time available. This model run differed from the base case used for the SARDYN project in two areas:

i) Potential immigration from ICES division VIIIb into ICES division VIIIc(east) or emigration from VIIIc(east) to VIIIb was modelled by estimating an error term to account for the average immigration/emigration over time. These multiplicative errors were applied to the model calculated numbers-at-age in division VIIIc(east) at the beginning of the year (see Cunningham and Roel 2006 for equations). The same error term was used for all years, with a separate error for age 1 and ages 2+. Prior information from the SARDYN project suggested a net immigration into the Iberian sardine stock for age 1 and a net emigration for ages 2+. Thus the prior distributions used were $\varepsilon_{imm} \sim N\left(0.1, \sigma_R^2\right)$ and $\varepsilon_{em} \sim N\left(-0.05, \sigma_R^2\right)$, with $\sigma_R^2 = 0.453$.

ii) The migration matrices for all yearclasses were assumed to be the same, i.e. good recruitment yearclasses were not assumed to move in a manner substantially differently to that of normal/weak yearclasses.

These two above changes were made to the base case for two reasons. Firstly results demonstrated as part of the SARDYN project showed both alternatives resulted in improved fits of the model to the data compared to the base case hypothesis, while secondly one of the key reasons for WGMHSA wanting an update of this model was to further investigate the extent to which the sardine in ICES division VIIIc(east) and VIIIb mix, given that the latter area is currently not included in the sardine assessments carried out by the WGMHSA.

The model predicted trajectories of SSB, estimated fishing mortality[1] on ages 2 to 5 and recruitment are given in Figure 8.7.2.2.1.

In previous results, the model suggested that immigration from VIIIb to VIIIc(east) was likely for 1-year-olds, while there was little movement of the 2+ adults between these divisions, slightly biased towards immigration into VIIIc(east) (Cunningham and Roel 2006). The updated model again estimated likely emigration from VIIIb to VIIIc(east) for 1-year-olds (posterior mode of $\varepsilon_{imm} = 0.4$) and also estimated likely immigration (at a smaller rate) into VIIIc(east) for 2+ adults (posterior mode of $\varepsilon_{em} = 0.17$). The proportion of the total stock biomass resulting from immigration into the assessed area was estimated to range between 1 and 4% (Figure 8.7.2.2.2). The effect of this immigration on the stock distribution throughout ICES division VIIIc(east) was much greater contributing, on average, 19% of the biomass in VIIIc(east).

8.7.3 Model exploration: single area models

This section addresses problems and explorations with AMCI using two different approaches: a) as it has been used in recent years, i.e. with one area and making use of the 3 regional acoustic surveys as indexes of the full stock area, and b) combining the Spanish and Portuguese march acoustic surveys in order to produce a single acoustic based index of abundance by age along the Iberian Peninsula. The first option reflects the current state of the art in the assessment of Iberian sardine, while the second options reflects an alternative way of

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1 Instantaneous fishing mortality is not a parameter directly estimated within the model, but rather catches are based on an estimated harvest rate in each year, quarter and division. However, an estimate of fishing mortality for comparative purposes was obtained by solving a non-linear equation relating the harvest rate and instantaneous fishing mortality through alternative catch equations.

dealing with migration across areas within the Iberian sardine stock, different to that presented in section 8.7.2 above and suggested as an alternative by previous WG (ICES 2005).

8.7.3.1 Single area AMCI with three independent acoustic indexes

The experience accumulated in this WG with the current assessment model since its adoption in 2003 have provided some insight on the main problems that need to be addressed:

- For the 6+ group, the fishing mortalities were far lower than for the oldest true ages (ages 4 and 5), and the stock numbers correspondingly higher.
- There is concern about the use of the DEPM estimates as absolute measures of SSB
- There is some retrospective pattern, where estimates of F increase while SSB estimates decrease for each new data year.

These problems may be related and have some common background. A series of exploratory runs were made to get some understanding of the source of these problems, and to find ways to condition the model properly. Some of these are outlined in Table 8.7.3.1.1 and the main results are shown in Table 8.7.3.1.2. The main inferences from this exploration are listed below.

The way AMCI has been set up in recent years (the SPALY options), there is no structuring of neither the selection at age nor of the catchabilities at age. Hence, as such the model is likely to be over-parameterised, unless there are very clear and consistent signals in the data. Overparametrisation has been overcome in previous assessment of this stock by anchoring the biomass to the DEPM survey estimates. Attempting to take the DEPM as relative measure of the spawning biomass with the remaining SPALY options, failed. It lead to a progressive increase in stock abundance and decrease in fishing mortality over time, and the model did not converge. (Figure 8.7.3.1.1). It is commonly observed that an overparameterised model will tend to deviate towards either very large or very small numbers. Apparently, the fit to the data improves by moving in that direction. This may not necessarily be a real signal in the data, rather it may just reflect that the noise in the data deviate from the underlying hypothesis that it is uncorrelated and independent.

In order to explore further the background for this tendency for an overparameterised model to drift towards increasing trend in stock abundance, this trend was mimicked by fixing the 2005 DEPM catchability at 0.2, in order to allow the model to converge, treating the other DEPM data as relative. This gave a converging model fit, with a population growing progressively over time, which could be compared with the spaly run. With this forcing, the fit improved to the catches and in particular to the Spanish March survey, while the fit to both the Portuguese surveys became slightly worse. The gains and losses in terms of the objective function are shown in Figures 8.7.3.1.2a-d. These figures show which data terms (squared residuals) in the objective function either gain (dark) or loose (light grey) by letting the stock expand towards recent years. The improvement to the fit to the Spanish survey was due in particular to improved fit to the years 1996 – 1999. This coincides with a trend in the residuals from negative in the 1990’s to positive in the later years which is consistent with the hypothesis of a shift in the migration between the Portuguese and Spanish waters studied within the SARDYN project. Hence, the current assumption that the relative distribution between the areas covered by the Spanish and Portuguese surveys has been stable, may be violated and the Spanish survey may have given an implicit signal that the stock is growing over time. Even though this signal should be overruled by other information, it will have some influence on the final estimate, in particular if the model assumptions are not very restrictive. Since the influence of this signal may change as new information becomes available, this is also a potential cause for retrospective bias.

It is not satisfactory to be dependent on using the DEPM survey as absolute in order to get a firm estimate of the stock, for at least two reasons. First, one can always question the unbiasedness of a survey, even with an egg survey where all sources of bias presumably are accounted for. Secondly, and more importantly, the abundance in the past will mainly be scaled by the catch information and the assumption about natural mortality, while the present will largely be scaled by the DEPM level.

Hence, one would like the assessment to be sufficiently constrained to avoid overparametrisation even without using the DEPM data, or at least using it as a relative index.

One way to overcome this problem is to assume some structure in the selections at age, catchabilities at age or both. The common procedure in some other assessments is to assume a flat selection or catchability from some age onwards. This may be problematic with respect to the 6+ group, since there always have been less catches from that group that one might expect from the catches at younger age. Instead, one may consider to use the trajectory of the 6+ group as a diagnostic. If the selection and catchability for age 6 is let free, and the observations from that group is heavily down-weighted, one will get estimates of F and numbers for the 6+ group, without any influence of that group on the other results. If this leads to unduly high or low input to the pool, the Fs for the 6+ group will deviate progressively from the other ages.

Several attempts were made to link the mortality or the catchability of the 6+ group to that of younger ages, e.g. by taking the 6+ mortality as an average of the Fs at previous ages. Although this led to some stabilisation of the assessment, the fit to the catches became considerably poorer. Such experiments were done both with the DEPM estimates as relative estimates of SSB, and without using estimates of the SSB. Some of the more promising examples are shown in Table 8.7.3.1.2.

It was also attempted to estimate the natural mortality for the 6+ group as a separate parameter assuming that F6+ = F5, recognizing that the natural mortality covers all disappearance from the stock not accounted for in the catch numbers. It was observed that the estimate largely was determined by the trend in the input to the 6+ group, large amounts into the 6+ group pool led to high estimates of M and vice versa. With no constraints on the 6+ group mortality or catchability, the model again led to very high estimates of recent abundance.

A more promising approach was to assume the selection as well as the catchabilities equal for ages 4 and 5. This is a likely assumption according to the biology and the fishery of the stock. The results for the relative and absolute assumptions for the DEPM were quite similar (Figure 8.7.3.1.3). Estimates of the stock could also be obtained without using the DEPM data, leading to a somewhat higher terminal fishing mortality. However, a low weight to the 6+ group increased the estimate of the terminal fishing mortality and decreased the estimate of recent biomass.

Hence, to assume the selection as well as the catchabilities equal for ages 4 and 5 stabilised the model sufficiently to allow stable estimates of the stock even without the DEPM survey, and led to quite similar estimates when using the DEPM survey as abolute or relative. This may be regarded as the minimum stabilising measure that would be needed to assess the stock with the data that have been used up to now.

However, even if this problem is apparently solved, the 6+ group problem remains, as is illustrated by the effect of downweighting the data at that age. Furthermore, there still is a retrospective bias.

8.7.3.2 Single area AMCI with combined spring acoustic surveys

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, and because there may be migration between the Iberian stock area and the adjacent areas. This would in particular influence the Spanish survey, which normally covers a minor part of the stock and may be influenced by migration between the Spanish and the French Biscay coasts.

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 SARDYN project (Cunningham and Roel, 2006) that the Spanish survey may have a higher local catchability than the Portuguese survey. A joint survey data series was made as a weighted sum of the two spring surveys. Results from the exploration of survey data (see section 8.7.1) provided some indication of similar catchabilities but were based on a limited number of years. 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 Figure 8.7.3.1.4. Therefore, the stock was assessed with a joint spring survey derived by just adding the Spanish and the Portuguese results .

The November survey was not used in this set of analyses, since this covers only parts of the area (see section 8.7.1).

First, a SPALY-like run using only the merged March survey was made. The results from this run were quite similar to those obtained with 3 surveys. Attempting to repeat this run with the DEPM data as relative failed, as it did for the 3-survey case. Setting the selection and catchability at age 5 equal to that at age 4 again led to a stable assessment, with results quite close to the SPALY-like run, both with the DEPM as relative and absolute. A comparison of the main results is shown in Figure 8.7.3.1.5.

Hence, also with a single joint survey setting fishing mortalities and catchabilities at age 5 equal to those at age 4 was sufficient to obtain a stable assessment, both with the DEPM as relative and absolute. The retrospective problem still persists, but to a lesser extent than with 3 surveys (Figure 8.7.3.1.6). The F at age 6+ is considerably lower than at age 5, and reflects that the estimate of abundance for the 6+ group is out of proportion with the catches. However, as noted above, this does not necessarily indicate an overestimate of the 6+ group.

8.7.4 Conclusions from data and model exploration

Structural uncertainties of sardine assessment outlined in previous years were approached by exploring area-based models (within SARDYN project), merging data from surveys covering parts of the stock area and reducing the number of parameters to estimate in order to reduce the risk the model overparametrisation. Also, these explorations were extended during the WG, in order to include new available data on DEPM and catches and also to test specific hypothesis about the inmigration from areas north to the stock.

The WGMHSA considers that area-based assessment of sardine is currently limited by the lack of data on migrations. The independent information about migrations and area distribution was too sparse to obtain detailed estimates of local area abundance, and of local fishing mortality, and thus this approach also required very strong constraints on selections and catchabiliy, or alternatively, assumed migration parameters. However, the developed models are valuable tools to explore hypothesis on migration and promising for the study of sardine dynamics at a regional level. The structure of the Bayesian model allowed for test of the influence of areas north of the stock to the adjacent stock areas and to the whole stock, and provided important information on the likely impact of this inmigration on the stock assessment. Although most of the migration assumptions were consistent across the different experts consulted, these results are conditional on them and thus robustness and sensitivity test to those assumptions would be desirable.

As an alternative, the WG has consider advantageous to tune the assessment to one survey covering the whole stock distribution area, rather than using 3 local surveys under the assumption that the relative proportion of the stock in these areas is stable. Doubts about the scaling of the two spring surveys still persist and this issue needs to be further explored. However, this scaling appears to have only minor impact on the final result.

Furthermore, the WG prefers using the DEPM as relative, in order to avoid possible conflicts between the scaling of the populations in the past (from VPA and assumed mortality values) and those arising from using the DEPM as absolute in recent years.

Several solutions were explored to overcome overparametrisation arising from estimation of DEPM catchabilities and decreasing observations by joining surveys. Assuming equal selection and catchability for ages 4 and 5 is in accordance with the perceived behaviour of the fishery and the survey. Fishes of ages 4 and 5 have similar lengths and are believed to share similar habitats, and thus no indications of important differences in their catchabilities or selectivities exist. This options seems sufficient to avoid overparametrisation of the model when surveys are merged and the DEPM is taken as relative. It is reassuring that the results using the DEPM as absolute or relative are well in accordance with each other.

Most of the options tested to tight the standard AMCI model as used last year provided a similar result in terms of the general trend and overall level of biomass and mortality. For the time being, the WGMHSA presents an assessment with a single joint survey fleet, using the DEPM as relative and assuming F5=F4 and Q5=Q4 as the final run. It should be noted, however, that the time to explore the properties of this formulation of the assessment model was limited, and further analysis should be done intersessionally. A better understanding of the relative performance of the Spanish and Portuguese surveys is needed, as well as a better understanding of the stock structure, in particular the linkage between the sardine in Iberian and in neighbouring waters.

8.8 State of the stock

8.8.1 Stock assessment.

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

The following data were used:

- Catch numbers at age: 1978-2005
- 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 2006.
- DEPM estimates of spawning biomass, covering VIIIc and IXa, for the years 1997, 1999, 2002 and 2005

The model was conditioned as follows:

- Selection at age in the fishery at age 4 equal to age 5
- Survey catchability at age 4 equal to age 5
- DEPM survey as a relative index of SSB

- Selection at age was allowed 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.

The following model parameters were estimated:

- Initial numbers in 1978 and recruitments each year except in 2006. Recruitment in 2006 was assumed at $9*10^9$
- Initial selection at age in the fishery, for all ages, but assumed equal for ages 4 and 5.
- 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 downweighed 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, and the set of DEPM observations, each are given the same weight as each year of catch numbers at age.

Input data and results are given in Table 8.8.1.1a-f, and the main results as Figure 8.8.1.1. Residuals are shown in Figure 8.8.1.2 and 8.8.1.3. Fishing mortalities at age are shown in Figure 8.8.1.4, and the catchabilites at age 8.8.1.5

Coefficients of variance of the estimated parameters, as derived from the Hessian matrix, are given in Table 8.8.1.2. Corelations between parameter estimates as derived from the Hessian were all below 0.1 in absolute value, with the exception of the estimates of initial selection at age in the fishery, which had mutual correlations from 0.1 to 0.55. 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 were made by resampling the residuals of all data around the model values. The main results from 100 replicas are shown in Figure 8.8.1.6 and 8.8.1.7.

8.8.2 Reliability of the assessment

For this benchmark assessments, input data have been revised (Sections 8.3 and 8.4), and one year of survey and catch data and 2 new years of DEPM data have been added.

Combining the March surveys has been discussed for years, but has been postponed because it was uncertain to what extent they were comparable. The analyses with the Bayesian state space model indicate that the catchability by the Spanish survey may be higher, and this requires further research. The justification for merging the surveys now can be summarised as follows:

- The time series of surveys conducted in both areas is now long enough to enable the use of a combined survey.
- The final results were not sensitive to combining the surveys with a plausible range of scaling factors.
- There were indications that the fraction of the stock in each area has changed over the years, in particular since 2000. A crucial assumption when using the surveys separate is that these fraction remain constant.

In comparison with other more restrictive assessment models, all indications in the sardine assessment seem to require a model which can account with gradual changes on catchability and selectivity. Those were the original motives for preferring AMCI instead of the original assessment models using ICA. The current choice of conditioning the AMCI model was the result of extensive exploration of the model performance (Section 8.7), aiming at constraining the model with plausible assumptions taking knowledge about the stock and fishery into account, and avoiding more constraints than necessary.

Some unresolved problems remain:

- There is evidence of some leakage between the assessment area and neighbouring areas (see e.g. Section 8.7.2).
- The fishing mortality of the 6+ group is far below that of the younger ages. There may be a biological reason for this, but at present it is not clear to what exten that result is realistic.
- The retrospective deviation was reduced by using a joint survey fleet, but some deviation still remains (Figure 8.8.2.1.)
- There is a trend in the residuals for the survey, in particular for the older ages.
- The bootstrap distribution of Fs and SSBs is asymmetrical, and the fit to the bootstrap data, where the residuals are randomly distributed around the model values, is better than in the primary model fit. That may indicate clustering of the noise in the data, the effect of which has not been fully explored.

The trends obtained by two models with very different model structures, like AMCI and the Bayesian space-state model used in this year model exploration provide a general similar trend. Nevertheless, some differences in the levels can be observed and require further investigation

Notwithstanding the problems highlighted above, it is reassuring that the results obtained with a large range of plausible model structures using AMCI show similar trends and a range of levels well within the confidence intervals of an usual fish assessment. Also, the biomass estimates derived when treating the DEPM data as relative are close to the actual DEPM observation.

8.9 Catch predictions

8.9.1 Divisions VIIIc and IXa

A deterministic short-term prediction was carried out using results from the final AMCI assessment. Estimates of age 1 in 2006 were recalculated to avoid possible upward bias (see section 8.7). Information about the 2005 recruitment does not indicate a high recruitment, but indicates an average or even low recruitment. Sardine recruitments show a cycle of very large and low recruitments. A slight general decreasing trend is apparent in the time series, when comparing the 80’s and 90’s to the most recent decade. Therefore the input to the forecast was selected as the average values of the non-high recruitments of the last 10 years excluding the values from 2005 and 2006.

In order to account for cyclical recruitment. Input recruitment for 2005 was calculated as the geometric mean of the recruitments for the last 10 years of the time series (1994-2003) after excluding the value from 2000, $R_{GM(94-04)}$ = 4332 millions individuals. For 2006 and 2007 recruitment was set equal to the geometric mean of 1994-2004. Numbers at age 1 at 1st January 2006 were calculated as geometric mean at 0 group with the fishing mortality rate F_{age0} for 2005.

As in previous years weights at age in the stock and in the catch were calculated as the arithmetic mean value of the three last years (2003-2005). The maturity ogive and the exploitation pattern corresponded to the 2005 values. 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. F_{sq} was the average F(2003-05) unscaled.

Input values and results are shown in Tables 8.9.1.1 and 8.9.1.2. The predicted landings with Fsq (0.21) for 2006 are 116 thousand tonnes. Predicted SSB for 2006 is 545 thousand tons. If fishing mortality remains at the Fsq level (0.21), the predicted yield in 2007 (114 thousand tonnes) is above the catch level in recent years. Predicted SSB for 2007 is 506 thousand tons, which means an increase of 31% with respect to the estimated 2005 SSB and is due to the strong 2004 year class.

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

8.10 Short term risk analysis

This stock does not have reference points and short term risk analysis is not applicable.

8.11 Medium term projections

See section 8.12 below

8.12 Long term yield

The WG considers that long term yield or other estimates based on equilibrium assumptions for the sardine stock are unreliable. This is due to the fact that the dynamics of sardine is strongly dependent on recruitment strength and that recruitment shows large interannual variations. There is currently no reliable method to predict recruitment on the short or long term. This type of dynamics indicates that the management of this stock should not be based in long-term yield.

8.13 Uncertainty in the assessment

The main sources of uncertainty of the current sardine assessment have been highlighted in section 8.7. and 8.8 and discussed in section 8.8.2.

8.14 Reference points for management purposes

The Study Group on the Precautionary Approach to Fisheries Management (ICES 1998/ACFM:10) did not consider any reference points for sardine. Since the assessment was revised this year and some problems still remain, reference points were not considered.

8.15 Harvest control rules

No harvest control rules were proposed for sardine by the Study Group on the Precautionary Approach to Fisheries Management (ICES 1998/ACFM:10).

8.16 Management considerations

At present the Spawning Stock Biomass of this stock is at an intermediate level (386,000 tonnes in 2005), and has remained stable since 2002. It decreased as the strong 2000 cohort was depleted. The 2002 and 2003 year classes were weak, and the 2004 year class is not as strong as previously estimated. Fishing mortality has been decreasing since 1998 and remained stable since 2002.

Management measures undertaken by Spain and Portugal to reduce the fishing effort and the overall catches may have contributed to this decrease. Short term catch predictions indicate that catches in 2006 will increase if fishing mortality is maintained and SSB will increase due to the strong 2004 year class. The fraction of the stock that is found at the Northern Iberian coast appears to have increased in recent years, although the indications are not quite unequivocal.

Both the 2000 year class and the 2004 year class appears to have been depleted faster than strong year classes from the 1980s and have not led to a similar rise in the spawning biomass as previous large year classes did. The implication of this is that the buffer biomass is removed from the stock and therefore the stock will become more dependent on the strength of the recruitment than in the 1980’s

If regional or local management is considered important, the tools and insight on migration acquired through the SARDYN project may prove an important source for developing such advise.

Table 8.2.1: Sardine in VIIIc and IXa. Quaterly distribution of sardine landings (t) in 2005 by ICES Sub-Division. Above absolute values; below, relative numbers.

VIIIc-E	2010	1865	1686	3820	**9382**
VIIIc-W	768	3470	4553	1628	**10418**
IXa-N	1414	3647	4501	2101	**11663**
IXa-CN	2686	7038	6666	9307	**25696**
IXa-CS	4678	5564	9435	4942	**24619**
IXa-S (A)	1925	2257	1877	1117	**7175**
IXa-S (C)	2363	1620	3168	1240	**8391**
Total	**15843**	**25461**	**31886**	**24155**	**97345**

Sub-Div	**1st**	**2nd**	**3rd**	**4th**	**Total**
VIIIc-E	2.06	1.92	1.73	3.92	**9.64**
VIIIc-W	0.79	3.56	4.68	1.67	**10.70**
IXa-N	1.45	3.75	4.62	2.16	**11.98**
IXa-CN	2.76	7.23	6.85	9.56	**26.40**
IXa-CS	4.81	5.72	9.69	5.08	**25.29**
IXa-S (A)	1.98	2.32	1.93	1.15	**7.37**
IXa-S (C)	2.43	1.66	3.25	1.27	**8.62**
Total	**16.27**	**26.16**	**32.76**	**24.81**	

Table 8.2.1.1. Spanish and Portuguese composition of the fleet catching sardine in 2005. 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)	16 – 1100 (333)	Purse seine	Dry hold with ice	No	341
Spain (Gulf of Cadiz)	yes	5.8 – 21.6	22 – 500	Purse seine	Dry hold with ice	No	99[1]
Portugal	yes	10.5 – 27 (21)	71 – 447 (254)	Purse seine	Dry hold with ice	No	107[2]

[1]Preliminary estimate. [2]Excludes vessels with catches in 2005 below 1 t.

Table 8.2.2: Sardine in VIIIc and IXa. Iberian Sardine Landings (tonnes) by sub-area and total for the period 1940-2005.

	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	26864	21590	7377	9176	**91886**	**73580**	**55831**	**26879**	**36055**
2005	19800	11663	25696	24619	7175	8391	**97345**	**77545**	**57490**	**31464**	**39855**

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

Table 8.3.1.1: Level of sardine DEPM sampling off Iberia: number of ichthyoplankton (total) and fishing stations (with sardine) by year and stratum.

Variable	Year	South	W Port	Galicia	W Cant	E Cant	Total
Eggs	1997	139	245	188	175	141	888
	1999	151	274	141	189	60	815
	2002	156	328	129	109	75	797
	2005	158	250	165	122	77	772
Adults	1997	10	16	-	3	6	35
	1999	11	29	1	-	6	47
	2002	32	42	7	11	10	102
	2005	21	42	17	14	7	101

Table 8.3.1.2: DEPM parameter estimates and sardine spawning biomass for the Spanish surveys (northern Spain) over 1997-2005, using traditional estimation. Post-stratification was not possible in 1997 and 1999 due to limited presence of sardine in Galicia and western Cantabria, while it was not considered necessary in 2005.

Year	Variable	GAL	W CANT	E CANT	Total
1997	Egg production				0.72 (82)
	Female weight				70.1 (6)
	Batch fecundity				26.5 (5)
	Spawning fraction				0.18 (15)
	Sex ratio				0.52 (11)
	Spawning biomass				**20.7 (84)**
1999	Egg production				0.34 (44)
	Female weight				66.3 (41)
	Batch fecundity				21.8 (12)
	Spawning fraction				0.14 (26)
	Sex ratio				0.55 (45)
	Spawning biomass				**13.4 (77)**
2002	Egg production	0	0.66 (32)	0.20 (31)	
	Female weight	67.6 (11)	78.6 (8)	77.7 (6)	
	Batch fecundity	23.6 (13)	27.7 (8)	26.9 (6)	
	Spawning fraction	0.243 (38)	0.075 (14)	0.125 (20)	
	Sex ratio	0.519 (7)	0.604 (14)	0.494 (22)	
	Spawning biomass	**0**	**41.3 (39)**	**9.4 (44)**	**50.7 (33)**
2005	Egg production				2.1 (23)
	Female weight				78.6 (5)
	Batch fecundity				32.3 (4)
	Spawning fraction				0.063 (16)
	Sex ratio				0.525 (6)
	Spawning biomass				**154.5 (29)**

Table 8.3.1.3: DEPM parameter estimates and sardine spawning biomass for the Portuguese surveys (Portugal and Gulf of Cádiz) over 1997-2005, using traditional estimation, with and without post-stratification into western and southern area.

Year	Variable	W PORT	SOUTH	Total (Strata sum)	Total (no Strata)
1997	Egg production	1.10 (34)	3.24 (39)		4.72 (32)
	Female weight	48.5 (7)	43.1 (7)		46.6 (5)
	Batch fecundity	18.0 (6)	16.1 (6)		17.4 (5)
	Spawning fraction	0.060 (25)	0.061 (24)		0.060 (17)
	Sex ratio	0.659 (4)	0.576 (6)		0.609 (4)
	Spawning biomass	**75.0 (44)**	**246.9 (47)**	**321.9 (37)**	**345.2 (37)**
1999	Egg production	2.07 (30)	3.15 (34)		5.00 (35)
	Female weight	45.8 (6)	42.1 (6)		44.8 (5)
	Batch fecundity	18.6 (6)	17.6 (6)		18.4 (5)
	Spawning fraction	0.133 (19)	0.070 (32)		0.113 (17)
	Sex ratio	0.681 (5)	0.540 (7)		0.602 (5)
	Spawning biomass	**56.3 (37)**	**199.3 (48)**	**255.6 (38)**	**179.0 (40)**
2002	Egg production	1.32 (24)	0.89 (36)		1.69 (24)
	Female weight	45.1 (5)	40.0 (5)		42.5 (4)
	Batch fecundity	14.5 (7)	12.6 (6)		13.5 (5)
	Spawning fraction	0.024 (27)	0.038 (31)		0.030 (21)
	Sex ratio	0.608 (3)	0.612 (5)		0.610 (3)
	Spawning biomass	**281.4 (37)**	**121.5 (48)**	**402.9 (31)**	**302.8 (33)**
2005	Egg production	3.04 (34)	1.21 (39)		3.76 (27)
	Female weight	45.4 (6)	46.4 (7)		45.7 (5)
	Batch fecundity	18.9 (7)	18.6 (8)		18.8 (5)
	Spawning fraction	0.060 (15)	0.122 (15)		0.079 (11)
	Sex ratio	0.564 (6)	0.512 (13)		0.545 (6)
	Spawning biomass	**215.8 (39)**	**48.3 (45)**	**264.1 (33)**	**212.3 (31)**

Table 8.3.1.4: Sardine spawning biomass estimates (thousand tones, CV in brackets when available) by stratum, country and overall for the period 1997-2005, based on post-stratified traditional DEPM estimates (PS-trad), GAM-based DEPM estimates (GAM) and spring acoustic survey estimates (Acoustics). GAM estimate is not available for the 1997 DEPM survey. In DEPM estimates of SSB, western Galicia is included in the North stratum, but the impact should be very small because the area contributes very little biomass to the total. DEPM PS-trad estimates are those provided to the assessment group and are highlighted in bold

Year	Method	West	South	West+South	North	Total
1997	DEPM PS-trad	75.0	246.9	321.9	20.7	**342.6**
		(44)	(47)	(37)	(84)	**(35)**
	DEPM GAM	-	-	-	-	-
	Acoustics	273.1	197.1	470.2	40.7	510.7
1999	DEPM PS-trad	56.3	199.3	255.6	13.4	**269.0**
		(37)	(48)	(38)	(77)	**(37)**
	DEPM GAM	47.0	241.6	288.6	27.9	316.5
	Acoustics	184.9	219.6	404.5	38.0	442.5
2002	DEPM PS-trad	281.4	121.5	402.9	50.7	**453.6**
		(37)	(48)	(31)	(33)	**(28)**
	DEPM GAM	291.2	99.8	391.0	51.4	442.4
	Acoustics	273.4	226.5	499.9	143.4	643.3
2005	DEPM PS-trad	215.8	48.3	264.1	154.5	**418.6**
		(39)	(45)	(33)	(29)	**(23)**
	DEPM GAM	208.5	73.4	281.9	157.0	438.9
	Acoustics	178.3	86.3	264.6	46.1	310.7

Table 8.3.2.1.1: Sardine in VIIIc and IXa. Sardine Assessment from the 2005 Portuguese autumn acoustic survey. Number in thousand fish and Biomass in tonnes.

AREA		0	1	2	3	4	5	6+	Total
Oc. Norte	Biomass	149774	305070	1143	645	615	819	0	458066
	%	33	67	0	0	0	0	0	
	Mean Weight	20.1	33.4	59.7	69.6	73.8	70.9		
	No fish	7452078	9122140	19148	9272	8341	11555	0	16622534
	%	45	55	0	0	0	0	0	
	Mean Length	14.1	16.4	19.4	20.2	20.6	20.3		
Oc. Sul	Biomass	4390	5159	4441	8038	7550	3939	721	34238
	%	13	15	13	23	22	12	2	
	Mean Weight	11	48.3	65.6	66.5	70.7	74.1	91.0	
	No fish	399349	106833	67737	120819	106764	53162	7911	862575
	%	46	12	8	14	12	6	1	
	Mean Length	11.4	18.4	20.2	20.3	20.7	21.0	22.4	
Algarve	Biomass	5264	572	1417	662	1331	797	1968	12011
	%	44	5	12	6	11	7	16	
	Mean Weight	24.0	43.8	51.5	56.3	59.2	65.9	73.5	
	No fish	219647	13073	27508	11748	22494	12108	26747	333325
	%	66	4	8	4	7	4	8	
	Mean Length	14.4	17.8	18.9	19.5	19.9	20.6	21.5	
Total	Biomass	159428	310801	7001	9345	9496	5555	2689	504315
Portugal	%	32	62	1	2	2	1	1	
	Mean Weight	20.0	33.7	61.8	66.0	69.3	72.5	78.2	
	No fish	8071074	9242046	114393	141839	137599	76825	34658	17818434
	%	45	52	1	1	1	0	0	
	Mean Length	14.0	16.4	19.8	20.2	20.6	20.8	21.7	

Table 8.3.2.1.2: Sardine in VIIIc and IXa. Sardine Assessment from the 2006 Portuguese spring acoustic survey. Number in thousand fish and Biomass in tonnes.

AREA		1	2	3	4	5	6+	Total
Oc. Norte	Biomass	109413	222131	3126	8688	8428	18020	369806
	%	30	60	1	2	2	5	
	Mean Weight	31.5	40.9	58.3	61.0	61.9	64.6	
	No fish	3472528	5430794	53664	142404	136243	278778	9514411
	%	36	57	1	1	1	3	
	Mean Length	16.2	17.7	19.8	20.1	20.2	20.5	
Oc. Sul	Biomass	34944	68862	9746	6351	10087	8451	138441
	%	25	50	7	5	7	6	
	Mean Weight	40.1	47.5	56.0	64.2	67.9	74.1	
	No fish	871626	1448580	173967	98980	148560	114013	2855726
	%	31	51	6	3	5	4	
	Mean Length	17.3	18.4	19.6	20.6	21	21.7	
Algarve	Biomass	1605	10081	9751	3950	10130	4677	40194
	%	4	25	24	10	25	12	
	Mean Weight	40.8	49.2	54.7	61.3	63.3	68	
	No fish	39348	204905	178424	64443	160147	68772	716039
	%	5	29	25	9	22	10	
	Mean Length	17.4	18.6	19.3	20.1	20.3	20.8	
Cadiz	Biomass	73142	11844	1686	608	1356	308	88944
	%	82	13	2	1	2	0	
	Mean Weight	24.7	32.9	45.2	47.8	52.5	51.8	
	No fish	2957108	360025	37323	12703	25815	5956	3398930
	%	87	11	1	0	1	0	
	Mean Length	14.9	16.4	18.3	18.7	19.3	19.2	
Total	Biomass	145962	301074	22623	18989	28645	31148	548441
Portugal	%	27	55	4	3	5	6	
	Mean Weight	33.7	42.7	55.8	62.1	64.5	67.7	
	No fish	4383502	7084279	406055	305827	444950	461563	13086176
	%	33	54	3	2	3	4	
	Mean Length	16.4	17.9	19.5	20.3	20.5	20.8	
Total	Biomass	219104	312918	24309	19597	30001	31456	637385
	%	34	49	4	3	5	5	
	Mean Weight	30.1	42.2	54.9	61.6	63.8	67.5	
	No fish	7340610	7444304	443378	318530	470765	467519	16485106
	%	45	45	3	2	3	3	
	Mean Length	15.8	17.8	19.4	20.2	20.4	20.8	

Table 8.3.2.2. Sardine in VIIIc and IXa. New corrected estimates of the 2006 Spanish Spring Acoustic Survey

Number of fish in thousands and biomass AGE

AREA VIIIcE east	1	2	3	4	5	6	7	8	9	TOTAL
Biomass (Tonnes)	73	1830	1224	1643	1188	1048	585	284	134	8009
% Biomass	0.9	22.9	15.3	20.5	14.8	13.1	7.3	3.5	1.7	100
Abundance (Numbers in '000)	1543	26971	15065	18344	12840	10825	5663	2648	1300	95199
% Abundance	1.6	28.3	15.8	19.3	13.5	11.4	5.9	2.8	1.4	100
Medium Weight (gr)	47.1	67.9	81.2	89.6	92.5	96.8	103.4	107.3	102.8	71.7
Medium Length (cm)	18.0	20.5	21.9	22.6	22.9	23.3	23.8	24.1	23.7	18.3
AREA VIIIcE west	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**TOTAL**
Biomass (Tonnes)	12	4054	4588	6901	4940	4434	2659	1234	585	29408
% Biomass	0.0	13.8	15.6	23.5	16.8	15.1	9.0	4.2	2.0	100
Abundance (Numbers in '000)	238	54971	54986	76762	53161	45661	25549	11532	5700	328561
% Abundance	0.1	16.7	16.7	23.4	16.2	13.9	7.8	3.5	1.7	100
Medium Weight (gr)	52.4	73.7	83.4	89.9	92.9	97.1	104.1	107.0	102.7	73.0
Medium Length (cm)	18.8	21.1	22.1	22.7	22.9	23.3	23.9	24.1	23.7	18.4
AREA VIIIcW	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**TOTAL**
Biomass (Tonnes)	0	11540	4321	1723	2585	1631	794	45	45	22685
% Biomass	0.0	50.9	19.0	7.6	11.4	7.2	3.5	0.2	0.2	100
Abundance (Numbers in '000)	0	173625	58388	19802	28451	17439	8326	383	383	306796
% Abundance	0.0	56.6	19.0	6.5	9.3	5.7	2.7	0.1	0.1	100
Medium Weight (gr)	0.0	66.5	74.0	87.0	90.9	93.5	95.4	117.5	117.5	67.5
Medium Length (cm)	0.0	20.4	21.1	22.4	22.7	23.0	23.1	24.9	24.9	16.6
AREA IXaN	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**TOTAL**
Biomass (Tonnes)	4075	26755	426	739	981	357	0	0	0	33334
% Biomass	12.2	80.3	1.3	2.2	2.9	1.1	0.0	0.0	0.0	100
Abundance (Numbers in '000)	112169	609343	5431	9713	12441	4005	0	0	0	753102
% Abundance	14.9	80.9	0.7	1.3	1.7	0.5	0.0	0.0	0.0	100
Medium Weight (gr)	36.3	43.9	78.5	76.1	78.8	89.2	0.0	0.0	0.0	36.6
Medium Length (cm)	16.5	17.6	21.6	21.4	21.6	22.6	0.0	0.0	0.0	11.0
TOTAL SPAIN	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**TOTAL**
Biomass (Tonnes)	4160	44180	10560	11006	9693	7471	4039	1563	764	93436
% Biomass	4.5	47.3	11.3	11.8	10.4	8.0	4.3	1.7	0.8	100
Abundance (Numbers in '000)	113950	864910	133870	124621	106892	77930	39538	14563	7383	1483658
% Abundance	7.7	58.3	9.0	8.4	7.2	5.3	2.7	1.0	0.5	100
Medium Weight (gr)	36.5	51.1	78.9	88.3	90.7	95.8	102.1	107.3	103.4	83.8
Medium Length (cm)	16.5	18.5	21.6	22.5	22.7	23.2	23.7	24.1	23.8	21.8

Table 8.4.1.1

Length	VIIIc E	VIIIc W	IXa N	IXa CN	IXa CS	IXa S	IXa S (Ca)	Total
				Total				
	0.04403285	0.052352613	0.52521236(					
7	0	0	0	3.24259E-06	0	0	0	19.114941
7.5	0	0	0	6.48517E-06	0	0	0	133.804586
8	0	0	0	1.94555E-05	0	0	0	238.879186
8.5	0	0	0	8.04288E-05	0	0	0	204.729883
9	0	0	5.66044E-05	0.000208874	0	0	0	95.207777
9.5	0	0	0.001495776	0.000577637	0	0	0.000222603	206.249867
10	0	0	0.004784462	0.001465585	0	0	0.000667823	1291.262588
10.5	0	0	0.021728576	0.003474876	4.9468E-05	0	0.002639622	5022.542281
11	0	0	0.022217157	0.010351649	0.000276351	8.89169E-05	0.004378033	16233.53492
11.5	0.000114116	0	0.0289353	0.018292586	0.000359242	7.33236E-05	0.009844926	35486.24087
12	0.000491359	0	0.045311375	0.028350174	0.001133133	0.000428991	0.015981757	77382.0347
12.5	0.002253297	0.000906258	0.072696069	0.03495052	0.001761388	0.000266751	0.04404108	80720.89579
13	0.002490512	0.0039236	0.062366697	0.059244977	0.003591673	0.000829891	0.090303612	93788.048
13.5	0.00486638	0.009029356	0.071717266	0.061444397	0.006150169	0.000758773	0.091060944	83244.76715
14	0.007975621	0.015294839	0.041350687	0.067000736	0.012243499	0.001562513	0.061574423	70894.70747
14.5	0.011523572	0.009294186	0.056890686	0.060398661	0.011909945	0.001392577	0.060767548	59804.28395
15	0.014317994	0.013904374	0.097214095	0.069925278	0.011849428	0.00246695	0.048805418	46914.95389
15.5	0.014457372	0.010278053	0.137544761	0.078466614	0.013539868	0.002191033	0.050734024	40154.63595
16	0.009323099	0.015140727	0.136267487	0.106984194	0.020780368	0.004571458	0.080527742	33372.16012
16.5	0.005932554	0.024351938	0.117358771	0.083883557	0.024338558	0.004530692	0.136532364	32845.56793
17	0.006588007	0.082711	0.079443109	0.072402113	0.045246654	0.018569885	0.162701218	41476.82077
17.5	0.006777887	0.126791684	0.063109885	0.046917336	0.070849456	0.029970159	0.108988888	61363.59754
18	0.010693931	0.169510137	0.049255248	0.036035382	0.101934538	0.090285139	0.079940542	90113.48193
18.5	0.019289862	0.074339147	0.04678681	0.025720102	0.117638197	0.145100855	0.041049258	113130.8491
19	0.025157318	0.051902896	0.061541026	0.028658188	0.143848453	0.200508273	0.037214529	157101.4758
19.5	0.028090858	0.037969666	0.061604333	0.02631835	0.16678542	0.157022429	0.024313721	159057.1192
20	0.037812828	0.050637004	0.074668149	0.025959821	0.165340499	0.146716545	0.024653041	156708.335
20.5	0.050187679	0.060939238	0.056763919	0.017053556	0.13369797	0.0765249	0.006941545	116603.6337
21	0.082300766	0.10321671	0.048880265	0.009478508	0.089393417	0.049852124	0.004066791	95559.13999
21.5	0.110059442	0.105904993	0.036415751	0.0037842	0.04975559	0.010287607	0.001110076	65072.97338
22	0.114476897	0.092889766	0.019974655	0.001606497	0.020905631	0.00515522	0.00041355	46643.87485
22.5	0.107982162	0.060220039	0.009831948	0.000634654	0.008029497	0.00102223	0	26162.95498
23	0.067574576	0.032870872	0.00241692	0.000301427	0.00298677	0.000210149	0	13734.18787
23.5	0.035551211	0.01540898	0.000586976	0.000225771	0.000735775	2.04514E-05	0	5491.74528
24	0.014593647	0.006403467	9.32409E-05	5.20124E-05	0.000223309	8.68731E-06	0	1672.566609
24.5	0.004216369	0.00274482	4.16742E-05	3.45356E-05	0	0	0	777.198382
25	0.001081269	0.000392788	9.71442E-05	0	0	0	0	149.564
25.5	4.75383E-05	0.000182692	0	0	0	0	0	56.331
26	6.83281E-05	0	0	0	0	0	0	7.845
26.5	6.27985E-05	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	19.639
27.5	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0
28.5	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0
Total	144493.896	130268.646	163962.428	738386.4527	333723.0302	121381.8673	196740.635	1828956.955

Table 8.4.1.1a: Sardine in VIIIc and IXa: Sardine length composition (thousands) by ICES Sub-Division in the first quarter 2005.

				First 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				92				92
9.5				184				184
10				874				874
10.5			142	1 236	17		81	1 476
11			310	2 062	92			2 464
11.5	10		1508	3 116	120		170	4 924
12	33		3239	6 717	378		1 070	11 437
12.5	245		4109	6 354	588		5004	16 299
13	299		2132	4 974	1 153		12034	20 593
13.5	623		1853	3 613	1 726		10058	17 874
14	955		876	1 739	2 284	5	6161	12 020
14.5	1 124		791	1 233	1 481	49	4695	4 679
15	989		516	1 102	1 265	46	1821	3 918
15.5	435		373	645	1 060	62	2510	2 573
16	175	1	322	551	1 238	302	2897	2 589
16.5	30		158	281	990	345	3472	1 806
17	3		147	992	1 446	1684	4956	4 272
17.5	8		220	1 764	3 445	2127	3704	7 564
18	56		228	2 722	6 703	4373	5515	14 082
18.5	108	23	391	4 391	10 641	3939	2514	19 493
19	240	24	1456	7 244	13 677	4836	3262	27 479
19.5	436	36	1687	7 936	15 606	4213	2203	29 914
20	954	119	2427	6 053	13 027	5947	3083	28 528
20.5	1 726	521	2342	5 297	9 665	3409	611	22 960
21	3 149	1 651	2328	2 152	5 141	2682	475	17 104
21.5	4 201	1 995	2089	1 082	2 207	405	218	11 979
22	4 195	2 259	1556	500	978	299	81	9 788
22.5	3 989	1 547	657	98	253	18		6 562
23	2 217	790	28	96		8		3 139
23.5	967	391	15	29	7	2		1 412
24	437	73	1					511
24.5	126	44						171
25	41							41
25.5								
26	10							10
26.5	4							
27								
27.5								
28								
28.5								
29								
Total	27 786	9 476	31 903	75 130	95 188	34 751	76 597	308 809
Mean L	20.7	22.1	16.8	16.5	19.	19.4	15.7	17.9
sd	3.03	0.86	3.97	3.61	2.03	1.25	2.46	3.43
Catch	**2 010**	**768**	**1 414**	**2686**	**4678**	**1925**	**2 363**	**15 843**

Table 8.4.1.1b: Sardine in VIIIc and IXa: Sardine length composition (thousands) by ICES Sub-Division in the second quarter 2005.

				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				40				40
9				26				26
9.5				121				121
10				40				40
10.5								
11			33					33
11.5	6		66	153				225
12	35		2 042	3575				5 652
12.5	76		4 477	12709				17 262
13	41		4 959	30661	45			35 706
13.5	46		4 936	36308	326			41 617
14	138		1 755	41433	1 802		457	45 584
14.5	513		3 822	35635	2 494		3212	45 675
15	1 065		10 786	31749	2 632	17	5268	51 516
15.5	1 646	179	15 750	24803	3 197	5	4455	50 036
16	1 168	420	13 327	15862	3 806	30	1762	36 376
16.5	815	2 408	8 266	7214	2 984	31	5669	27 387
17	882	7 465	3 534	4031	3 975	338	7989	28 215
17.5	621	8 709	1 737	1858	4 651	1143	5599	24 317
18	586	6 246	1 163	1595	6 146	5000	3438	24 174
18.5	524	2 601	1 779	1754	7 122	8805	1598	24 182
19	312	1 473	3 601	3859	9 816	10511	620	30 190
19.5	467	1 303	3 307	3305	12 324	6322	372	27 399
20	681	2 809	3 321	5289	12 307	3608	372	28 387
20.5	1 225	3 270	1 917	1982	9 917	1341	124	19 776
21	2 048	4 646	1 033	1294	6 923	528	124	16 597
21.5	2 525	4 576	422	336	4 294	99		12 252
22	3 274	4 015	113	140	2 302	47		9 891
22.5	3 187	3 260	25	13	947	33		7 464
23	2 152	1 033		8	411			3 604
23.5	1 108	417	2	66	216			1 809
24	375	52		0	59	1		487
24.5	177	8						185
25	15	23						38
25.5	1							1
26								
26.5								
27								
27.5								
28								
28.5								
29								
Total	25 708	54 913	92 174	265 860	98 695	37 858	41 058	616 267
Mean L	20.3	19.5	16.1	15.0	19.1	19.2	16.8	16.8
sd	2.92	2.06	2.16	1.79	2.04	0.79	1.31	2.74
Catch	**1 865**	**3470**	**3 647**	**7038**	**5564**	**2257**	**1 620**	**25 461**

Table 8.4.1.1c: Sardine in VIIIc and IXa: Sardine length composition (thousands) by ICES Sub-Division in the third quarter 2005.

				Third Quarter				
Length	**VIIIc E**	**VIIIc W**	**IXa N**	**IXa CN**	**IXa CS**	**IXa S**	**IXa S (Ca)**	**Total**
7				2				2
7.5				5				5
8				14				14
8.5				19				19
9			9	36				45
9.5			245	95				340
10			761	61				822
10.5			3 215	350				3 564
11			2 931	1881		11		4 823
11.5			2 301	4283		7	191	6 782
12	3		1 140	5184		50	191	6 568
12.5	5		1 778	3835		32	381	6 031
13	20	1	1 757	2385		101	165	4 430
13.5	34	1	2 488	1669		92	394	4 679
14	59	1	1 780	2008		152	191	4 191
14.5	27	3	1 828	3512		109	502	5 981
15	15	6	2 519	9233	57	173	880	12 885
15.5	8	29	4 742	13793	52	136	1574	20 335
16	4	128	7 730	21138	345	75	9397	38 817
16.5	12	419	9 917	17394	1 283	39	15799	44 863
17	62	2982	8 542	18114	3 013	143	18240	51 096
17.5	331	7630	7 059	13406	7 210	204	10294	46 133
18	877	15428	4 346	9887	10 896	1254	5501	48 189
18.5	1 998	6262	2 722	5472	12 198	4017	2537	35 205
19	2 512	3010	2 259	5218	15 301	7302	2043	37 646
19.5	1 511	1597	3 066	4625	18 616	6164	1667	37 246
20	751	1942	4 761	5270	21 982	4126	845	39 677
20.5	546	2736	3 738	3373	18 775	1479	587	31 233
21	652	5938	3 096	2145	13 357	752	179	26 118
21.5	1 206	6321	2 004	425	7 910	182		18 046
22	1 875	4861	722	191	2 795	50		10 494
22.5	2 487	2219	310	127	1 149	23		6 316
23	2 050	1409	138	53	491	7		4 148
23.5	1 393	521	22		21			1 957
24	530	186			16			732
24.5	202	90						291
25	52							52
25.5	6	1						8
26								
26.5								
27								
27.5								
28								
28.5								
29								
Total	19 226	63 721	87 927	155 203	135 468	26 681	71 558	559 784
Mean L	21.1	19.7	16.8	16.6	19.9	19.4	17.2	18.1
sd	2.06	1.86	2.97	2.25	1.29	1.22	1.19	2.53
Catch	**1 686**	**4553**	**4 501**	**6666**	**9435**	**1877**	**3 168**	**31 886**

Table 8.4.1.1c: Sardine in VIIIc and IXa: Sardine length composition (thousands) by ICES Sub-Division in the third quarter 2005.

				Third Quarter				
Length	**VIIIc E**	**VIIIc W**	**IXa N**	**IXa CN**	**IXa CS**	**IXa S**	**IXa S (Ca)**	**Total**
7				2				2
7.5				5				5
8				14				14
8.5				19				19
9			9	36				45
9.5			245	95				340
10			761	61				822
10.5			3 215	350				3 564
11			2 931	1881		11		4 823
11.5			2 301	4283		7	191	6 782
12	3		1 140	5184		50	191	6 568
12.5	5		1 778	3835		32	381	6 031
13	20	1	1 757	2385		101	165	4 430
13.5	34	1	2 488	1669		92	394	4 679
14	59	1	1 780	2008		152	191	4 191
14.5	27	3	1 828	3512		109	502	5 981
15	15	6	2 519	9233	57	173	880	12 885
15.5	8	29	4 742	13793	52	136	1574	20 335
16	4	128	7 730	21138	345	75	9397	38 817
16.5	12	419	9 917	17394	1 283	39	15799	44 863
17	62	2982	8 542	18114	3 013	143	18240	51 096
17.5	331	7630	7 059	13406	7 210	204	10294	46 133
18	877	15428	4 346	9887	10 896	1254	5501	48 189
18.5	1 998	6262	2 722	5472	12 198	4017	2537	35 205
19	2 512	3010	2 259	5218	15 301	7302	2043	37 646
19.5	1 511	1597	3 066	4625	18 616	6164	1667	37 246
20	751	1942	4 761	5270	21 982	4126	845	39 677
20.5	546	2736	3 738	3373	18 775	1479	587	31 233
21	652	5938	3 096	2145	13 357	752	179	26 118
21.5	1 206	6321	2 004	425	7 910	182		18 046
22	1 875	4861	722	191	2 795	50		10 494
22.5	2 487	2219	310	127	1 149	23		6 316
23	2 050	1409	138	53	491	7		4 148
23.5	1 393	521	22		21			1 957
24	530	186			16			732
24.5	202	90						291
25	52							52
25.5	6	1						8
26								
26.5								
27								
27.5								
28								
28.5								
29								
Total	19 226	63 721	87 927	155 203	135 468	26 681	71 558	559 784
Mean L	21.1	19.7	16.8	16.6	19.9	19.4	17.2	18.1
sd	2.06	1.86	2.97	2.25	1.29	1.22	1.19	2.53
Catch	**1 686**	**4553**	**4 501**	**6666**	**9435**	**1877**	**3 168**	**31 886**

Table 8.4.1.1d: Sardine in VIIIc and IXa: Sardine length composition (thousands) by ICES Sub-Division in the fourth quarter 2005.

				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				27			44	71
10			23	107			131	262
10.5			206	980			438	1 624
11			369	3701			861	4 931
11.5			870	5954		2	1 577	8 402
12			1 008	5458		2	1 883	8 351
12.5		118	1 556	2909			3280	7 863
13		510	1 378	5725			5567	13 180
13.5		1 175	2 481	3780			7463	14 899
14		1 991	2 369	4292		32	5306	13 991
14.5		1 208	2 886	4218		11	3547	11 870
15		1 805	2 118	9547		64	1633	15 168
15.5		1 131	1 686	18699	210	63	1442	23 231
16		1 423	964	41444	1 546	149	1786	47 311
16.5		345	902	37049	2 865	135	1922	43 217
17	4	327	803	30324	6 666	89	825	39 038
17.5	20	179	1 332	17615	8 338	164	1846	29 494
18	26	408	2 339	12404	10 273	332	1273	27 055
18.5	158	799	2 779	7374	9 297	852	1428	22 687
19	571	2 254	2 774	4840	9 211	1689	1397	22 736
19.5	1 645	2 010	2 041	3568	9 115	2360	541	21 280
20	3 078	1 727	1 733	2556	7 862	4127	551	21 633
20.5	3 755	1 412	1 310	1940	6 262	3060	44	17 783
21	6 043	1 211	1 557	1408	4 412	2089	22	16 742
21.5	7 971	904	1 456	951	2 194	563		14 040
22	7 197	965	883	355	902	230		10 532
22.5	5 940	819	620	231	331	50		7 991
23	3 345	1 050	230	65	94	10		4 795
23.5	1 669	678	58	72	1			2 477
24	767	523	14	38				1 343
24.5	104	216	7	26				352
25	48	28	16					92
25.5		22						22
26								
26.5	5							5
27								
27.5								
28								
28.5								
29								
Total	42 348	25 237	38 768	227 657	79 578	16 073	44 805	474 466
Mean L	21.8	18.6	17.1	16.4	19.1	20.1	14.7	17.5
sd	1.11	3.26	3.14	2.01	1.42	1.15	2.2	2.82
Catch	**3 820**	**1628**	**2 101**	**9307**	**4942**	**1117**	**1 240**	**24 155**

Table 8.4.1.2: Sardine in VIIIc and IXa: Catch in numbers (thousands) at age by quarter and by SubDivision in 2005

							First Quarter	
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0								0
1	4896	12	16326	35494	15712.05	709	44437	117586
2	1516	425	818	5942	14136.66	9506	23952	56296
3	4770	1520	2829	8687	25573.26	5603	7821	56803
4	7134	3676	7427	11263	16471.82	11691	387	58051
5	5125	3111	3881	12625	18341.57	4448		47532
6	2570	602	621	922	3301.811	1613		9630
7	974	80		128	947.4622	647		2776
8	536	49		69	494.0884	462		1610
9	265				159.1983	27		451
10					50.56165	45		96
Total	27786	9476	31903	75130	95188	34751	76597	350831
Catch (Tons)	2010	768	1414	2686	4678	1925	2363	15843

							Second Quarter	
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0								0
1	6010	14509	67222	244652	27463	2173	16005	378035
2	3284	16172	9849	4165	17902	13878	22714	87964
3	3444	7239	5157	5305	19076	5437	2277	47935
4	5235	8945	6442	4642	13001	10232	62	48560
5	3968	6698	3436	6795	15778	1669		38344
6	2208	1238	67	180	2362	2006		8062
7	828	73		47	1911	1440		4299
8	469	40			164	505		1178
9	263			75	1036	408		1782
10						108		108
Total	25708	54913	92174	265860	98695	37858	41058	616267
Catch (Tons)	1865	3470	3647	7038	5564	2257	1620	25461

							Third Quarter	
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	189	43	28631	29206	789	1020	2874	62751
1	7008	40341	41082	101174	42363	3224	38799	273990
2	1796	6685	6992	9581	29672	7120	22287	84133
3	2786	5360	4741	5554	31437	8641	4976	63497
4	2567	6987	4836	8498	23522	4467	829	51707
5	2430	3448	1376	1073	4317	1499	598	14741
6	1475	598	235	15	2377	418	598	5715
7	807	222	30	102	727	125	598	2612
8	167	36	2		263	168		637
9								0
10								0
Total	19226	63721	87927	155203	135468	26681	71558	559784
Catch (Tons)	1686	4553	4501	6666	9435	1877	3168	31886

							Fourth Quarter	
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	0	7937	15921	54283	3653	537.9749	24141	106474
1	4910	9342	12778	154885	38702	1642.086	13656	235914
2	7757	1643	3262	5907	10811	3613.58	4826	37820
3	12367	1661	2719	5015	11839	3818.864	1001	38422
4	8367	2297	2769	3873	10017	4978.116	393	32695
5	4910	1456	1036	3482	3890	973.9197	263	16011
6	2655	529	205	211	271	314.601	263	4448
7	1229	253	65		394	116.8546	263	2321
8	153	119	13			76.97626		362
9								0
10								0
Total	42348	25237	38768	227657	79578	16073	44805	474466
Catch (Tons)	3820	1628	2101	9307	4942	1117	1240	24155

							Whole Year	
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	189	7979	44553	83489	4442	1557	27015	169225
1	22823	64204	137408	536204	124241	7748	112897	1005525
2	14352	24926	20922	25595	72521	34118	73779	266213
3	23368	15780	15445	24562	87926	23500	16075	206656
4	23303	21906	21475	28277	63013	31369	1670	191013
5	16433	14713	9730	23975	42327	8590	861	116628
6	8908	2966	1129	1327	8312	4352	861	27855
7	3838	629	95	276	3979	2329	861	12007
8	1325	244	15	69	922	1212		3787
9	528			75	1196	435		2233
10					51	153		204
Total	115069	153347	250772	723849	408929	115363	234018	2001348
Catch (Tons)	9382	10418	11663	25696	24619	7175	8391	97345

Table 8.4.1.3: Sardine in VIIIc and IXa. Relative distribution of sardine catches. Upper pannel, relative contribution of each group within each Sub-Division. Lower pannel, relative contribution of each Sub-Division within each Age Group.

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	Xa-S (Ca)	Total
0	0%	5%	18%	12%	1%	1%	12%	8%
1	20%	42%	55%	74%	30%	7%	48%	50%
2	12%	16%	8%	4%	18%	30%	32%	13%
3	20%	10%	6%	3%	22%	20%	7%	10%
4	20%	14%	9%	4%	15%	27%	1%	10%
5	14%	10%	4%	3%	10%	7%	0%	6%
6+	13%	3%	0%	0%	4%	7%	1%	2%
	100%	100%	100%	100%	100%	100%	100%	100%

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	Xa-S (Ca)	Total
0	0%	5%	26%	49%	3%	1%	16%	100%
1	2%	6%	14%	53%	12%	1%	11%	100%
2	5%	9%	8%	10%	27%	13%	28%	100%
3	11%	8%	7%	12%	43%	11%	8%	100%
4	12%	11%	11%	15%	33%	16%	1%	100%
5	14%	13%	8%	21%	36%	7%	1%	100%
6+	32%	8%	3%	4%	31%	18%	4%	100%

Table 8.4.2.1: Sardine VIIIc and IXa: Sardine Mean length (cm) at age by quarter and by Subdivision in 2005.

First Quarter

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	
0								
1	14.6	18.5	13.1	13.0	15.3	16.7	14.1	13.8
2	20.1	21.3	18.1	18.4	18.5	18.2	17.3	18.0
3	21.4	21.7	20.0	19.4	19.4	19.2	19.7	19.7
4	22.0	22.1	21.0	19.8	20.1	20.0	21.5	20.5
5	22.4	22.3	21.0	20.4	20.4	20.3		20.8
6	22.8	22.3	22.3	21.0	20.8	20.8		21.6
7	23.3	24.0		21.3	21.6	20.7		22.0
8	23.1	24.2		22.6	21.4	20.5		21.8
9	24.0				22.4	21.8		23.3
10					22.8	22.5		22.6

Second Quarter

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
0								
1	15.9	17.6	15.2	14.6	16.5	18.3	15.9	15.0
2	18.6	18.2	17.1	18.2	18.9	18.8	17.2	18.1
3	21.4	20.8	19.5	19.7	19.8	19.2	19.0	19.9
4	22.1	21.8	20.1	20.0	20.5	19.4	21.3	20.6
5	22.5	22.0	20.2	20.3	20.8	20.0		21.0
6	22.9	22.1	22.0	21.3	21.7	19.9		21.6
7	23.4	24.0		20.8	21.5	20.0		21.4
8	23.3	24.3			22.3	20.8		22.1
9	24.0			23.6	23.0	20.0		22.5
10						21.4		21.4

Third Quarter

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
0	14.4	15.4	13.4	13.2	16.6	14.7	14.5	13.4
1	19.1	18.7	17.5	16.9	18.5	18.8	16.9	17.6
2	20.8	19.8	19.4	19.2	19.9	19.2	17.8	19.2
3	22.0	21.8	20.8	19.9	20.6	19.7	18.0	20.4
4	22.4	21.9	21.0	20.4	20.8	20.0	19.6	20.9
5	23.1	22.4	21.3	20.5	21.2	20.1	19.9	21.6
6	23.4	23.0	21.8	22.3	21.7	20.8	19.9	22.0
7	23.5	23.4	23.0	22.3	21.1	21.3	19.9	21.8
8	24.8	24.5	23.8		21.6	20.7		22.4
9								
10								

Fourth Quarter

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
0		14.6	13.9	13.9	16.6	16.2	13.3	13.9
1	20.2	19.0	18.1	16.9	18.2	19.1	15.3	17.3
2	21.2	20.2	19.8	19.0	19.5	19.7	18.3	19.7
3	21.9	21.6	21.0	19.4	20.2	20.4	18.7	20.7
4	22.1	22.3	21.3	20.6	20.7	20.6	19.4	21.2
5	22.8	22.8	21.6	20.4	20.9	21.0	19.7	21.6
6	23.0	23.8	22.2	22.3	21.7	20.8	19.7	22.6
7	23.3	24.0	23.2		22.0	21.6	19.7	22.7
8	24.7	24.7	24.3			21.1		23.9
9								
10								

Whole Year

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
0	14.4	14.6	13.6	13.6	16.6	15.2	13.4	13.7
1	17.5	18.5	15.9	15.6	17.6	18.6	15.5	16.1
2	20.5	18.8	18.3	18.8	19.3	18.8	17.5	18.6
3	21.7	21.3	20.3	19.6	20.0	19.6	19.0	20.2
4	22.1	21.9	20.8	20.1	20.6	19.9	20.0	20.7
5	22.6	22.2	20.8	20.3	20.7	20.3	19.8	21.1
6	23.0	22.6	22.1	21.3	21.4	20.4	19.8	21.8
7	23.3	23.8	23.2	21.6	21.5	20.3	19.8	21.9
8	23.5	24.5	24.2	22.6	21.6	20.7		22.2
9	24.0			23.6	22.9	20.1		22.7
10					22.8	21.7		22.0

Table 8.4.2.2: Sardine VIIIc and Ixa: Sardine Mean weight (kg) at age by quarter and by SubDivision in 2005.

							First Quarter	
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0								
1	0.023	0.047	0.016	0.015	0.026	0.035	0.022	0.020
2	0.064	0.072	0.044	0.043	0.044	0.045	0.039	0.043
3	0.076	0.076	0.059	0.052	0.051	0.053	0.056	0.055
4	0.082	0.081	0.069	0.055	0.057	0.060	0.073	0.064
5	0.087	0.083	0.069	0.060	0.059	0.063		0.065
6	0.092	0.084	0.083	0.066	0.063	0.068		0.074
7	0.098	0.105		0.068	0.070	0.067		0.080
8	0.096	0.108		0.083	0.068	0.065		0.078
9	0.106				0.078	0.078		0.095
10					0.082	0.087		0.084

							Second Quarter	
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0								
1	0.032	0.045	0.029	0.024	0.036	0.054	0.033	0.027
2	0.053	0.050	0.041	0.046	0.053	0.057	0.041	0.048
3	0.080	0.074	0.061	0.059	0.061	0.059	0.055	0.064
4	0.089	0.085	0.067	0.062	0.068	0.061	0.076	0.071
5	0.094	0.088	0.068	0.065	0.071	0.065		0.075
6	0.099	0.089	0.087	0.076	0.080	0.064		0.083
7	0.106	0.115		0.071	0.078	0.065		0.080
8	0.104	0.118			0.086	0.071		0.088
9	0.114			0.104	0.096	0.065		0.092
10						0.076		0.076

							Third Quarter	
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	0.028	0.034	0.024	0.021	0.042	0.037	0.027	0.023
1	0.064	0.061	0.050	0.043	0.057	0.065	0.041	0.049
2	0.082	0.071	0.068	0.064	0.070	0.068	0.048	0.064
3	0.096	0.093	0.082	0.071	0.076	0.073	0.051	0.076
4	0.102	0.096	0.084	0.076	0.079	0.075	0.064	0.082
5	0.111	0.101	0.088	0.077	0.083	0.077	0.068	0.091
6	0.115	0.110	0.093	0.099	0.089	0.083	0.068	0.095
7	0.117	0.115	0.110	0.100	0.082	0.087	0.068	0.093
8	0.136	0.132	0.120		0.088	0.082		0.102
9								
10								

							Fourth Quarter	
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0		0.027	0.024	0.023	0.040	0.037	0.019	0.023
1	0.070	0.065	0.055	0.043	0.053	0.060	0.030	0.046
2	0.081	0.077	0.072	0.064	0.065	0.066	0.050	0.068
3	0.089	0.095	0.087	0.069	0.073	0.073	0.053	0.079
4	0.093	0.105	0.091	0.084	0.079	0.074	0.060	0.085
5	0.105	0.112	0.096	0.081	0.081	0.079	0.062	0.092
6	0.109	0.130	0.103	0.111	0.091	0.076	0.062	0.105
7	0.114	0.132	0.119		0.095	0.086	0.062	0.106
8	0.142	0.144	0.138			0.080		0.129
9								
10								

							Whole Year	
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	0.028	0.027	0.024	0.022	0.040	0.037	0.020	0.023
1	0.048	0.058	0.036	0.032	0.047	0.058	0.031	0.037
2	0.073	0.058	0.055	0.056	0.060	0.057	0.043	0.055
3	0.086	0.083	0.072	0.061	0.065	0.065	0.054	0.068
4	0.090	0.090	0.075	0.066	0.071	0.065	0.066	0.074
5	0.098	0.093	0.074	0.065	0.068	0.068	0.066	0.075
6	0.103	0.099	0.089	0.075	0.076	0.068	0.066	0.086
7	0.109	0.121	0.116	0.080	0.079	0.068	0.066	0.088
8	0.109	0.131	0.136	0.083	0.077	0.071		0.090
9	0.110			0.104	0.094	0.066		0.093
10					0.082	0.079		0.080

Table 8.7.3.1.1: Sardine: Summary of assumptions from exploratory runs using AMCI with three independent acoustic indexes.

Run name	DEPM	**Constrains on selection**	**Constraints on catchabilites**	**Weighting of 6+ group**
SPALY	Absolute	No	No	Full weight
SPALY - rel	Relative	No	No	Full weight
SPALY - rel F6=F5	Relative	F6 = F5		
SPALY - rel F6=F4-5	Relative	F6 = Average(F4,F5)	No	Full weight
SPALY - rel Downw. 6+	Relative		No	0.0001
QDEPM = 0.2 in 2005	Relative Q for 2005 fixed at 0.2	No	No	Full weight
QDEPM = 1.0 in 2005	Relative Q for 2005 fixed at 0.1.0	No	No	Full weight
4=5 – abs fullw6	Absolute	F4=F5	Q4=Q5	Full weight
4=5 – rel fullw6	Relative	F4=F5	Q4=Q5	Full weight
4=5 – Abs downw6	Absolute	F4=F5	Q4=Q5	0.0001
4=5 – rel downw6	Relative	F4=F5	Q4=Q5	0.0001
4=5 No SSB	Not used	F4=F5	Q4=Q5	0.0001
4=5 Ac and total catch **	Not used	F4=F5	Not used	0.0001
Retro04 4=5 - Abs fullw6	Absolute	F4=F5	Q4=Q5	Full weight
Retro04 4=5 - rel fullw6	Relative	F4=F5	Q4=Q5	Full weight
Retro04 4=5 Abs-downw6	Absolute	F4=F5	Q4=Q5	0.0001
Retro04 4=5 – rel downw6	Relative	F4=F5	Q4=Q5	0.0001

Table 8.7.3.1.2. Sardine: Summary of results from exploratory runs using AMCI with three independent acoustic indexes.

Run name	Obj.f catch	Obj. f. Sp. spring	Obj. f. Pt. spring	Obj. f. Pt. nov	Obj.f. DEPM	Obj.f. total	F4-8 2005	F5 2005	F6 2005	SSB 2005	Q SSB
SPALY	1.43	0.75	0.37	0.30	0.022	2.87	0.237	0.25	0.087	401	1*
SPALY - rel	1.39	0.68	0.39	0.34	0.014	2.81	0.054	0.044	0.011	1729	0.24
SPALY - rel F6=F5	1.68	0.79	0.38	0.29	0.012	3.16	0.373	0.515	0.515*	379	1.44
SPALY - rel F6=F4-5	1.69	0.78	0.37	0.30	0.013	3.16	0.375	0.517	0.474*	377	1.44
SPALY - rel Downw. 6+	0.94	0.72	0.38	0.33	0.021	2.41	0.051	0.042	0.010	2331	0.22
QDEPM = 0.2 in 2005	1.38	0.68	0.39	0.35	0.014	2.81	0.045	0.037	0.009	2074	0.20 (excl 2005)
QDEPM = 1.0 in 2005	1.41	0.74	0.37	0.30	0.022	2.85	0.199	0.200	0.058	473	0.74 (excl 2005)
4=5 – abs fullw6	1.41	0.78	0.38	0.33	0.015	2.91	0.223	0.253	0.083	426	1*
4=5 – rel fullw6	1.41	0.77	0.38	0.33	0.014	2.91	0.223	0.253	0.083	426	0.92
4=5 – Abs downw6	1.39	0.71	0.18	0.30	0.024	2.60	0.274	0.352	0.098	361	1*
4=5 – rel downw6	1.38	0.72	0.18	0.29	0.025	2.60	0.291	0.336	0.108	342	1.05
4=5 No SSB	1.37	0.75	0.17	0.27	-	2.47	0.376	0.437	0.127	272	-
4=5 Ac and total catch **	-	0.60	0.16	0.27	-	1.03	0.077	0.077	0.023	1017	-
Retro04 4=5 - Abs fullw6	1.34	0.78	0.42	0.26	0.009	2.80	0.231	0.268	0.106	499	1*
Retro04 4=5 - rel fullw6	1.34	0.74	0.43	0.27	0.004	2.78	0.155	0.173	0.057	734	0.69
Retro04 4=5 Abs-downw6	1.32	0.72	0.21	0.23	0.009	2.49	0.271	0.315	0.112	438	1*
Retro04 4=5 – rel downw6	1.32	0.70	0.22	0.24	0.005	2.49	0.214	0.244	0.078	546	0.82

**   means value fixed at or linked to that level*

*** means poorly converged*

Table 8.8.1.1a

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	11911.8	14002.9	15204.2	9645.2	7039.0	20364.3	8644.9	6601.9
1	7714.4	9464.8	11177.1	12322.4	7656.0	5683.3	16521.5	7082.8
2	3776.7	4248.7	5263.3	6624.4	7044.3	4524.2	3475.5	10007.8
3	1280.3	1843.2	2100.8	2819.0	3320.9	3604.9	2441.5	1951.2
4	654.3	645.2	933.3	1179.9	1491.0	1796.7	2004.1	1375.5
5	199.7	346.6	334.5	533.2	649.0	825.5	1027.6	1171.4
6	89.2	155.6	265.5	350.6	492.9	637.6	838.1	1093.2

	1986	1987	1988	1989	1990	1991	1992	1993
0	5502.2	9227.1	5930.1	5899.5	5578.2	12868.3	10722.2	4752.4
1	5418.7	4473.0	7315.3	4679.1	4674.1	4418.2	10238.6	8620.6
2	4403.4	3262.3	2709.5	4415.4	2811.1	2765.1	2768.8	6520.4
3	5646.7	2345.8	1750.7	1453.7	2340.8	1460.7	1587.8	1628.6
4	1102.9	3073.5	1266.5	929.6	750.0	1146.3	783.6	877.1
5	805.0	597.8	1687.3	684.2	491.3	365.2	621.3	433.3
6	1347.8	1230.3	1057.2	1530.8	1248.6	940.6	769.7	822.3

	1994	1995	1996	1997	1998	1999	2000	2001
0	4599.9	3878.2	4894.1	3747.1	3802.3	3624.6	9792.2	6266.1
1	3834.2	3790.9	3209.7	4029.7	3052.0	3029.7	2902.2	7864.2
2	5468.6	2581.5	2551.7	2173.1	2635.5	1947.9	1922.4	1833.3
3	3751.5	3443.2	1620.4	1594.2	1282.1	1496.2	1126.4	1115.2
4	847.3	2143.4	1924.8	879.5	802.6	609.7	751.5	573.0
5	460.4	482.5	1201.8	1041.2	423.2	363.6	289.7	362.2
6	727.9	733.6	744.4	1134.3	1225.3	962.8	790.4	648.6

	2002	2003	2004	2005	2006
0	3587.8	3009.5	14654.2	5307.2	9000.0
1	5095.5	2936.5	2443.5	11888.9	4330.6
2	5002.4	3260.8	1862.4	1551.1	7671.1
3	1105.1	3050.2	1969.8	1114.1	950.5
4	610.3	626.0	1714.8	1091.0	638.5
5	298.6	331.9	338.8	912.7	604.0
6	614.4	569.7	553.6	539.8	860.5

Table 8.8.1.1b

Total yearly fishing mortalities at age

	1978	1979	1980	1981	1982	1983	1984	1985
0	0.0650	0.0604	0.0451	0.0660	0.0489	0.0441	0.0343	0.0325
1	0.2665	0.2568	0.1931	0.2292	0.1961	0.1618	0.1713	0.1453
2	0.3874	0.3743	0.2944	0.3605	0.3399	0.2868	0.2473	0.2423
3	0.3553	0.3506	0.2469	0.3069	0.2843	0.2571	0.2438	0.2405
4	0.3055	0.3270	0.2298	0.2678	0.2612	0.2287	0.2070	0.2057
5	0.3055	0.3270	0.2298	0.2678	0.2612	0.2287	0.2070	0.2057
6	0.2528	0.2652	0.1795	0.2331	0.2417	0.2254	0.2015	0.1712
Fref	0.3384	0.3447	0.2502	0.3007	0.2866	0.2503	0.2262	0.2236

	1986	1987	1988	1989	1990	1991	1992	1993
0	0.0421	0.0672	0.0719	0.0678	0.0681	0.0636	0.0532	0.0497
1	0.1774	0.1713	0.1749	0.1795	0.1950	0.1373	0.1212	0.1251
2	0.2997	0.2925	0.2927	0.3046	0.3247	0.2247	0.2007	0.2228
3	0.2782	0.2864	0.3030	0.3317	0.3840	0.2928	0.2634	0.3234
4	0.2825	0.2697	0.2857	0.3077	0.3898	0.2825	0.2625	0.3146
5	0.2825	0.2697	0.2857	0.3077	0.3898	0.2825	0.2625	0.3146
6	0.1991	0.1934	0.2048	0.2158	0.2467	0.1678	0.1447	0.1665

Table 8.8.1.b cont.

Fref	0.2858	0.2796	0.2918	0.3129	0.3720	0.2706	0.2473	0.2938

	1994	1995	1996	1997	1998	1999	2000	2001
0	0.0284	0.0242	0.0293	0.0402	0.0621	0.0573	0.0543	0.0418
1	0.0656	0.0658	0.0600	0.0946	0.1191	0.1249	0.1294	0.1224
2	0.1326	0.1357	0.1404	0.1977	0.2361	0.2177	0.2145	0.1762
3	0.2297	0.2516	0.2810	0.3562	0.4133	0.3587	0.3459	0.2729
4	0.2330	0.2486	0.2844	0.4015	0.4619	0.4139	0.3999	0.3218
5	0.2330	0.2486	0.2844	0.4015	0.4619	0.4139	0.3999	0.3218
6	0.1045	0.1071	0.1001	0.1186	0.1331	0.1140	0.1103	0.0910
Fref	0.2071	0.2211	0.2476	0.3392	0.3933	0.3510	0.3401	0.2732

	2002	2003	2004	2005	2006
0	0.0353	0.0434	0.0441	0.0384	0.0384
1	0.1164	0.1254	0.1244	0.1082	0.1082
2	0.1647	0.1740	0.1838	0.1598	0.1598
3	0.2383	0.2459	0.2608	0.2267	0.2267
4	0.2791	0.2841	0.3007	0.2613	0.2613
5	0.2791	0.2841	0.3007	0.2613	0.2613
6	0.0812	0.0908	0.1018	0.0885	0.0885
Fref	0.2403	0.2470	0.2615	0.2273	0.2273

Table 8.8.1.1c

YEARLY CATCH NUMBERS BY FLEET 1
IN AREA 1
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Modelled catches by year, fleet 1 area 1

	1978	1979	1980	1981	1982	1983	1984	1985
0	691213.2	757561.9	619469.8	568244.9	310350.1	811488.2	269200.3	194905.2
1	1548316.3	1841036.8	1682269.2	2166218.7	1170693.0	728991.6	2228395.4	821651.2
2	1044090.4	1142211.1	1151428.2	1722652.2	1743360.3	967871.6	652862.6	1846346.7
3	329318.4	468896.7	394496.3	640095.7	705790.1	700956.7	452583.2	357418.9
4	147947.5	154575.0	164271.3	237979.4	294106.3	314925.5	321089.3	219157.1
5	45161.9	83027.7	58868.5	107543.6	128010.2	144702.0	164647.0	186641.4
6	17094.5	31098.0	37375.9	62501.3	90718.8	110170.0	130938.3	147456.5

	1986	1987	1988	1989	1990	1991	1992	1993
0	209397.2	553161.8	379911.4	357296.8	339429.0	731978.2	512518.5	212836.2
1	756785.2	604931.8	1008344.1	661096.2	713297.4	487602.2	1005012.7	873352.5
2	979646.7	710413.7	590703.0	996848.6	671693.1	478455.6	432534.7	1120254.1
3	1178110.6	501504.5	392876.3	352509.1	642380.1	318055.7	315331.3	386383.8
4	232863.3	623314.6	270124.5	211451.5	208171.3	241892.4	155049.0	203194.8
5	169965.2	121225.9	359891.3	155630.2	136359.4	77059.8	122940.7	100371.8
6	209030.4	185784.2	168156.2	255289.5	234954.8	124901.3	89123.8	108474.1

	1994	1995	1996	1997	1998	1999	2000	2001
0	119193.6	85690.3	130744.9	136362.9	211530.8	186317.7	477659.1	236954.5
1	210060.1	208370.6	161533.8	313611.6	294978.2	305547.0	302378.8	776250.0
2	583940.9	281661.6	287480.9	335614.2	477401.3	327877.7	319243.8	254271.3
3	659503.5	656204.6	340471.9	411142.7	374054.7	388220.0	283443.9	228797.1
4	150755.5	404177.6	408567.7	250054.6	255732.5	177732.7	212995.8	135290.3
5	81916.7	90991.2	255101.1	296024.3	134842.4	105995.6	82127.8	85512.6
6	62053.8	64058.0	61083.5	109520.6	131848.1	89552.8	71203.4	48596.6

	2002	2003	2004	2005	2006
0	115044.2	117892.7	583987.3	184349.5	312620.2
1	479217.2	296188.2	245017.9	1044071.4	380312.4
2	651416.1	446612.7	268218.7	196329.8	970934.2
3	201061.1	570609.5	388163.1	193795.7	165337.3
4	127425.5	132787.6	382061.1	215054.5	125853.6
5	62347.7	70394.6	75473.9	179904.1	119051.8
6	41205.4	42481.6	45976.6	39208.1	62503.4

Table 8.8.1.1 c cont

Observed catches by year, fleet 1 area 1

	1978	1979	1980	1981	1982	1983	1984	1985
0	869437.0	674489.0	856671.0	1025961.0	62000.0	1070000.0	118000.0	268000.0
1	2296646.0	1535557.0	2037400.0	1934838.0	795000.0	577000.0	3312000.0	564000.0
2	946698.0	956132.0	1561971.0	1733725.0	1869000.0	857000.0	487000.0	2371000.0
3	295360.0	431466.0	378785.0	679001.0	709000.0	803000.0	502000.0	469000.0
4	136661.0	189107.0	156922.0	195304.0	353000.0	324000.0	301000.0	294000.0
5	41744.0	93185.0	47302.0	104545.0	131000.0	141000.0	179000.0	201000.0
6	16468.0	36038.0	30006.0	76466.0	129000.0	139000.0	117000.0	103000.0

Observed catches by year, fleet 1 area 1

	1986	1987	1988	1989	1990	1991	1992	1993
0	304000.0	1437000.0	521000.0	248000.0	258000.0	1580579.0	498265.0	87808.0
1	755000.0	543000.0	990000.0	566000.0	602000.0	477368.0	1001856.0	566221.0
2	1027000.0	667000.0	535000.0	909000.0	517000.0	436081.0	451367.0	1081818.0
3	919000.0	569000.0	439000.0	389000.0	707000.0	406886.0	340313.0	521458.0
4	333000.0	535000.0	304000.0	221000.0	295000.0	265762.0	186234.0	257209.0
5	196000.0	154000.0	292000.0	200000.0	151000.0	74726.0	110932.0	113871.0
6	167000.0	171000.0	189000.0	245000.0	248000.0	105186.0	80579.0	120282.0

Observed catches by year, fleet 1 area 1

	1994	1995	1996	1997	1998	1999	2000	2001
0	120797.0	30512.0	277053.0	208570.0	449115.0	246016.0	489836.0	219973.0
1	60194.0	189147.0	101267.0	548594.0	366176.0	475225.0	354822.0	1172301.0
2	542163.0	280715.0	347690.0	453324.0	501585.0	361509.0	313972.0	256133.0
3	1094442.0	829707.0	514741.0	391118.0	352485.0	339691.0	255523.0	195897.0
4	272466.0	472880.0	652711.0	337282.0	233672.0	177170.0	194156.0	126389.0
5	112635.0	70208.0	197235.0	225170.0	178735.0	105518.0	97693.0	75145.0
6	72091.0	64485.0	46607.0	70268.0	105884.0	72541.0	64373.0	49547.0

Observed catches by year, fleet 1 area 1

	2002	2003	2004	2005	2006
0	106882.0	198412.0	589910.0	169229.0	0.0
1	587354.0	318695.0	180522.0	1005530.0	0.0
2	753897.0	446285.0	263521.0	266213.0	0.0
3	181381.0	518289.0	386715.0	206657.0	0.0
4	112166.0	114035.0	377848.0	191013.0	0.0
5	55650.0	61276.0	78396.0	116628.0	0.0
6	40219.0	51172.0	55312.0	46087.0	0.0

Table 8.8.1.c cont

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	-0.82	0.32
1	0.39	-0.18	0.19	-0.11	-0.39	-0.23	0.40	-0.38
2	-0.10	-0.18	0.30	0.01	0.07	-0.12	-0.29	0.25
3	-0.11	-0.08	-0.04	0.06	0.00	0.14	0.10	0.27
4	-0.08	0.20	-0.05	-0.20	0.18	0.03	-0.06	0.29
5	-0.08	0.12	-0.22	-0.03	0.02	-0.03	0.08	0.07
6	-0.04	0.15	-0.22	0.20	0.35	0.23	-0.11	-0.36

Residuals: log (Obs/mod), fleet 1 area 1

	1986	1987	1988	1989	1990	1991	1992	1993
0	0.37	0.95	0.32	-0.37	-0.27	0.77	-0.03	-0.89
1	0.00	-0.11	-0.02	-0.16	-0.17	-0.02	0.00	-0.43
2	0.05	-0.06	-0.10	-0.09	-0.26	-0.09	0.04	-0.03
3	-0.25	0.13	0.11	0.10	0.10	0.25	0.08	0.30
4	0.36	-0.15	0.12	0.04	0.35	0.09	0.18	0.24
5	0.14	0.24	-0.21	0.25	0.10	-0.03	-0.10	0.13
6	-0.22	-0.08	0.12	-0.04	0.05	-0.17	-0.10	0.10

Residuals: log (Obs/mod), fleet 1 area 1

	1994	1995	1996	1997	1998	1999	2000	2001
0	0.01	-1.03	0.75	0.42	0.75	0.28	0.03	-0.07
1	-1.25	-0.10	-0.47	0.56	0.22	0.44	0.16	0.41
2	-0.07	0.00	0.19	0.30	0.05	0.10	-0.02	0.01
3	0.51	0.23	0.41	-0.05	-0.06	-0.13	-0.10	-0.16
4	0.59	0.16	0.47	0.30	-0.09	0.00	-0.09	-0.07
5	0.32	-0.26	-0.26	-0.27	0.28	0.00	0.17	-0.13
6	0.15	0.01	-0.27	-0.44	-0.22	-0.21	-0.10	0.02

Residuals: log (Obs/mod), fleet 1 area 1

	2002	2003	2004	2005	2006
0	-0.07	0.52	0.01	-0.09	0.00
1	0.20	0.07	-0.31	-0.04	0.00
2	0.15	0.00	-0.02	0.30	0.00
3	-0.10	-0.10	0.00	0.06	0.00
4	-0.13	-0.15	-0.01	-0.12	0.00
5	-0.11	-0.14	0.04	-0.43	0.00
6	-0.02	0.19	0.18	0.16	0.00

Table 8.8.1.d

RESULTS FOR SURVEY FLEET 1
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Modelled surveys indices by year, fleet 1

	1978	1979	1980	1981	1982	1983	1984	1985
0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
1	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
2	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
3	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
4	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
5	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
6	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0

	1986	1987	1988	1989	1990	1991	1992	1993
0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
1	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
2	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
3	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
4	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
5	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
6	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0

	1994	1995	1996	1997	1998	1999	2000	2001
0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
1	-1.0	-1.0	5160224.8	6449847.5	4869919.6	4833350.4	4627973.9	12557682.8
2	-1.0	-1.0	2930348.8	2477298.0	2989906.1	2215696.9	2187923.9	2097109.4
3	-1.0	-1.0	1668936.3	1625908.7	1298585.5	1525258.5	1150074.9	1148833.1
4	-1.0	-1.0	2547001.9	1148005.5	1040073.6	794533.2	980906.3	754914.2
5	-1.0	-1.0	1590294.5	1359053.1	548409.0	473840.9	378221.7	477157.0
6	-1.0	-1.0	336676.5	511482.8	551372.5	434439.9	356883.0	293685.8

	2002	2003	2004	2005	2006
0	-1.0	-1.0	-1.0	-1.0	-1.0
1	8143923.1	4688220.3	3900563.2	19018027.3	6927486.7
2	5732441.6	3732718.3	2129221.5	1778790.7	8796872.3
3	1143307.3	3152952.4	2032512.0	1154404.3	984883.4
4	808031.6	828352.4	2264503.8	1447583.9	847150.8
5	395359.7	439133.8	447339.4	1210977.9	801366.2
6	278645.6	258081.3	250466.8	244646.3	390001.2

Table 8.8.1.d cont'd

Observed surveys indices by year, fleet 1

	1978	1979	1980	1981	1982	1983	1984	1985
0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
1	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
2	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
3	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
4	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
5	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
6	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0

	1986	1987	1988	1989	1990	1991	1992	1993
0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
1	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
2	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
3	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
4	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
5	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
6	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0

	1994	1995	1996	1997	1998	1999	2000	2001
0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
1	-1.0	-1.0	1635624.0	6400640.0	2146029.0	5926268.0	6673110.0	19659943.0
2	-1.0	-1.0	2136446.0	3501235.0	4118108.0	2712998.0	2455735.0	1037373.0
3	-1.0	-1.0	2505075.0	1677442.0	2271278.0	1595295.0	1657118.0	701978.0
4	-1.0	-1.0	3256833.0	1383544.0	1467734.0	968748.0	998930.0	480259.0
5	-1.0	-1.0	600318.0	1425779.0	1205597.0	624070.0	720824.0	374475.0
6	-1.0	-1.0	36743.0	263797.0	1005403.0	533150.0	681348.0	249742.0

	2002	2003	2004	2005	2006
0	-1.0	-1.0	-1.0	-1.0	-1.0
1	13040557.0	5884533.0	-1.0	22921588.0	7454560.0
2	6998075.0	4584129.0	-1.0	1302100.0	8309214.0
3	1164108.0	3567936.0	-1.0	685187.0	577248.0
4	1130977.0	1008979.0	-1.0	763181.0	443151.0
5	565547.0	570302.0	-1.0	652746.0	577657.0
6	442031.0	338076.0	-1.0	369282.0	606933.0

Survey residuals by year, fleet 1

	1978	1979	1980	1981	1982	1983	1984	1985
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	1986	1987	1988	1989	1990	1991	1992	1993
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	1994	1995	1996	1997	1998	1999	2000	2001
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	-1.15	-0.01	-0.82	0.20	0.37	0.45
2	0.00	0.00	-0.32	0.35	0.32	0.20	0.12	-0.70
3	0.00	0.00	0.41	0.03	0.56	0.04	0.37	-0.49
4	0.00	0.00	0.25	0.19	0.34	0.20	0.02	-0.45
5	0.00	0.00	-0.97	0.05	0.79	0.28	0.64	-0.24
6	0.00	0.00	-2.22	-0.66	0.60	0.20	0.65	-0.16

	2002	2003	2004	2005	2006
0	0.00	0.00	0.00	0.00	0.00
1	0.47	0.23	0.00	0.19	0.07
2	0.20	0.21	0.00	-0.31	-0.06
3	0.02	0.12	0.00	-0.52	-0.53
4	0.34	0.20	0.00	-0.64	-0.65
5	0.36	0.26	0.00	-0.62	-0.33
6	0.46	0.27	0.00	0.41	0.44

Table 8.8.1.e

SPAWNING STOCK BIOMASS

Year	Modelled Total		Expected By fleet	Observed/q By fleet
1978	312916.38	1	312916.38	-1.00
1979	385055.10	1	385055.10	-1.00
1980	477452.10	1	477452.10	-1.00
1981	598132.89	1	598132.89	-1.00
1982	633092.72	1	633092.72	-1.00
1983	589597.78	1	589597.78	-1.00
1984	644851.04	1	644851.04	-1.00
1985	751168.24	1	751168.24	-1.00
1986	700034.13	1	700034.13	-1.00
1987	593780.04	1	593780.04	-1.00
1988	517222.60	1	517222.60	-1.00
1989	434912.54	1	434912.54	-1.00
1990	395411.99	1	395411.99	-1.00
1991	400432.57	1	400432.57	-1.00
1992	517832.45	1	517832.45	-1.00
1993	575590.83	1	575590.83	-1.00
1994	581125.50	1	581125.50	-1.00
1995	635601.45	1	635601.45	-1.00
1996	430626.90	1	430626.90	-1.00
1997	380181.83	1	380181.83	356251.91
1998	325520.90	1	325520.90	-1.00
1999	322432.56	1	322432.56	279719.10
2000	255373.40	1	255373.40	-1.00
2001	287494.46	1	287494.46	-1.00
2002	400358.81	1	400358.81	471675.04
2003	395069.56	1	395069.56	-1.00
2004	388468.12	1	388468.12	-1.00
2005	416877.05	1	416877.05	435280.36
2006	560683.89	1	560683.89	-1.00

Table 8.8.1.f

SUMMARY TABLE

Year	Recruits age 0	SSB	F 2 - 5	Catch SOP
1978	11911834	312916	0.3384	173761
1979	14002879	385055	0.3447	162454
1980	15204172	477452	0.2502	204861
1981	9645170	598132	0.3007	242574
1982	7038955	633092	0.2866	214148
1983	20364294	589597	0.2503	176636
1984	8644894	644851	0.2262	215114
1985	6601853	751168	0.2236	219928
1986	5502223	700034	0.2858	192838
1987	9227069	593780	0.2796	176283
1988	5930086	517222	0.2918	157273
1989	5899532	434912	0.3129	146539
1990	5578189	395411	0.3720	142966
1991	12868263	400432	0.2706	132785
1992	10722179	517832	0.2473	131196
1993	4752417	575590	0.2938	144949
1994	4599935	581125	0.2071	138725
1995	3878171	635601	0.2211	126755
1996	4894125	430626	0.2476	115179
1997	3747052	380181	0.3392	117250
1998	3802261	325520	0.3933	112033
1999	3624569	322432	0.3510	95793
2000	9792156	255373	0.3401	87272
2001	6266125	287494	0.2732	102903
2002	3587836	400358	0.2403	101741
2003	3009522	395069	0.2470	99113
2004	14654240	388468	0.2615	98464
2005	5307222	416877	0.2273	97282
2006	9000000	560683	0.2273	0

Table 8.8.1.2. Coefficient of variation of estimated parameters from the inverse Hessian

	Parameter		Param. value	CV
1	Initial number 1978 age1		7714946.1795	0.0422
2	Initial number 1978 age2		3776992.8778	0.0439
3	Initial number 1978 age3		1280416.5809	0.0788
4	Initial number 1978 age4		654337.2769	0.0817
5	Initial number 1978 age5		199740.5927	0.1537
6	Initial number 1978 age6		89229.7040	0.2633
7	Recruitment age0 1978		11911834.9845	0.0704
8	Recruitment age0 1979		14003797.4699	0.0591
9	Recruitment age0 1980		15205168.6739	0.0771
10	Recruitment age0 1981		9645802.8550	0.0838
11	Recruitment age0 1982		7039416.5164	0.1031
12	Recruitment age0 1983		20364294.2632	0.0636
13	Recruitment age0 1984		8645461.3905	0.0428
14	Recruitment age0 1985		6601853.4093	0.0771
15	Recruitment age0 1986		5502223.4532	0.0546
16	Recruitment age0 1987		9227673.8734	0.0623
17	Recruitment age0 1988		5930475.3120	0.0449
18	Recruitment age0 1989		5899918.6840	0.0355
19	Recruitment age0 1990		5578555.1228	0.0476
20	Recruitment age0 1991		12869950.8278	0.0483
21	Recruitment age0 1992		10722882.0991	0.0447
22	Recruitment age0 1993		4752728.9026	0.0597
23	Recruitment age0 1994		4600538.0384	0.0313
24	Recruitment age0 1995		3878425.5028	0.0543
25	Recruitment age0 1996		4894446.1415	0.0539
26	Recruitment age0 1997		3747297.7622	0.0678
27	Recruitment age0 1998		3802760.3930	0.0323
28	Recruitment age0 1999		3625044.1726	0.0692
29	Recruitment age0 2000		9793439.7218	0.1098
30	Recruitment age0 2001		6266947.3443	0.1088
31	Recruitment age0 2002		3588307.0216	0.1005
32	Recruitment age0 2003		3009916.9776	0.0955
33	Recruitment age0 2004		14656161.9275	0.1827
34	Recruitment age0 2005		5308266.4746	0.3579
35	F-select year 1978	age 0	0.4394	0.4112
36	F-select year 1978	age 1	0.9014	0.1768
37	F-select year 1978	age 2	1.3103	0.0699
38	F-select year 1978	age 3	1.2019	0.1981
39	F-select year 1978	age 4	1.0334	0.1618
40	F-select year 1978	age 6	0.8551	0.2519
41	F year 1978		0.3384	0.0545
42	F year 1979		0.3447	0.0500
43	F year 1980		0.2502	0.0379
44	F year 1981		0.3007	0.0426
45	F year 1982		0.2866	0.0499
46	F year 1983		0.2503	0.0346
47	F year 1984		0.2262	0.1069
48	F year 1985		0.2235	0.0576
49	F year 1986		0.2857	0.0635
50	F year 1987		0.2795	0.0974
51	F year 1988		0.2917	0.0640
52	F year 1989		0.3129	0.0365
53	F year 1990		0.3720	0.0317
54	F year 1991		0.2706	0.0513
55	F year 1992		0.2473	0.0615
56	F year 1993		0.2938	0.0549
57	F year 1994		0.2070	0.1023
58	F year 1995		0.2211	0.0528
59	F year 1996		0.2475	0.0308
60	F year 1997		0.3392	0.0870
61	F year 1998		0.3932	0.1084
62	F year 1999		0.3510	0.0522
63	F year 2000		0.3400	0.1122
64	F year 2001		0.2731	0.1122
65	F year 2002		0.2402	0.0363
66	F year 2003		0.2470	0.0564
67	F year 2004		0.2614	0.1162
68	F year 2005		0.2272	0.0359
69	Sp. March Acoustic	age 1	1.6895	0.0957
70	Sp. March Acoustic	age 2	1.2190	0.1055
71	Sp. March Acoustic	age 3	1.1100	0.2328
72	Sp. March Acoustic	age 4	1.4263	0.0427
73	Sp. March Acoustic	age 6	0.4776	0.1010
74	Q for ssb year 1988		0.9615	0.0994

Table 8.9.1.2. Sardine short term prediction with management option table

2006 Biomass	SSB	FMult	FBar	Landings
726256	545459	1.0000	0.2109	116275

2007 Biomass	SSB	FMult	FBar	Landings	2008 Biomass	SSB
657158	529987	0.0000	0.0000	0	677421	546841
.	527566	0.1000	0.0211	12324	666993	535127
.	525157	0.2000	0.0422	24436	656756	523690
.	522760	0.3000	0.0633	36340	646705	512524
.	520374	0.4000	0.0844	48041	636838	501621
.	518001	0.5000	0.1055	59541	627150	490975
.	515639	0.6000	0.1266	70846	617638	480580
.	513289	0.7000	0.1476	81958	608298	470430
.	510950	0.8000	0.1687	92882	599127	460517
.	508623	0.9000	0.1898	103621	590121	450837
.	506308	1.0000	0.2109	114178	581278	441384
.	504004	1.1000	0.2320	124557	572594	432151
.	501712	1.2000	0.2531	134762	564067	423134
.	499430	1.3000	0.2742	144795	555692	414327
.	497161	1.4000	0.2953	154660	547467	405725
.	494902	1.5000	0.3164	164360	539389	397322
.	492654	1.6000	0.3375	173899	531456	389115
.	490418	1.7000	0.3586	183279	523663	381097
.	488193	1.8000	0.3797	192504	516010	373265
.	485979	1.9000	0.4007	201575	508492	365613
.	483775	2.0000	0.4218	210497	501107	358137

Input units are thousands and kg - output in tonnes

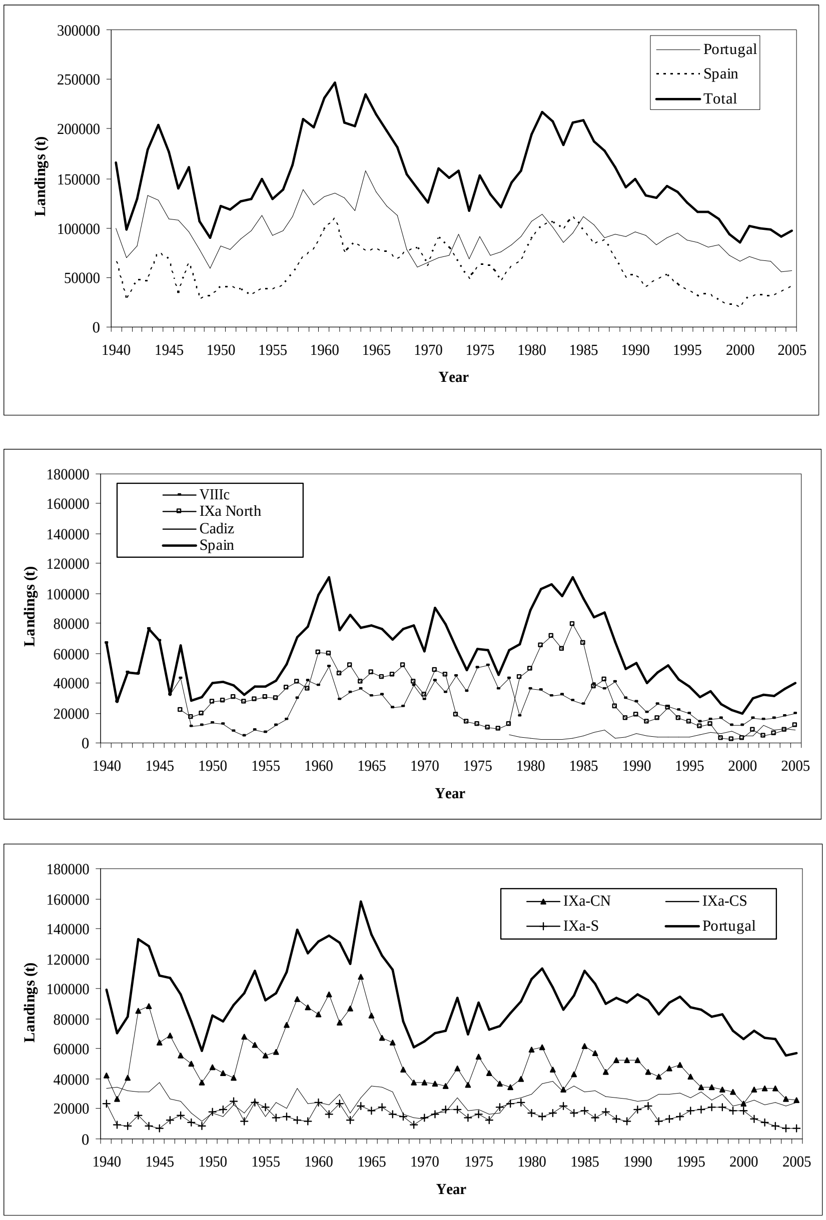


Figure 8.2.1: Sardine in VIIIc and IXa: Annual landings of sardine, by country (upper pannel) and by ICES Sub-Division and country

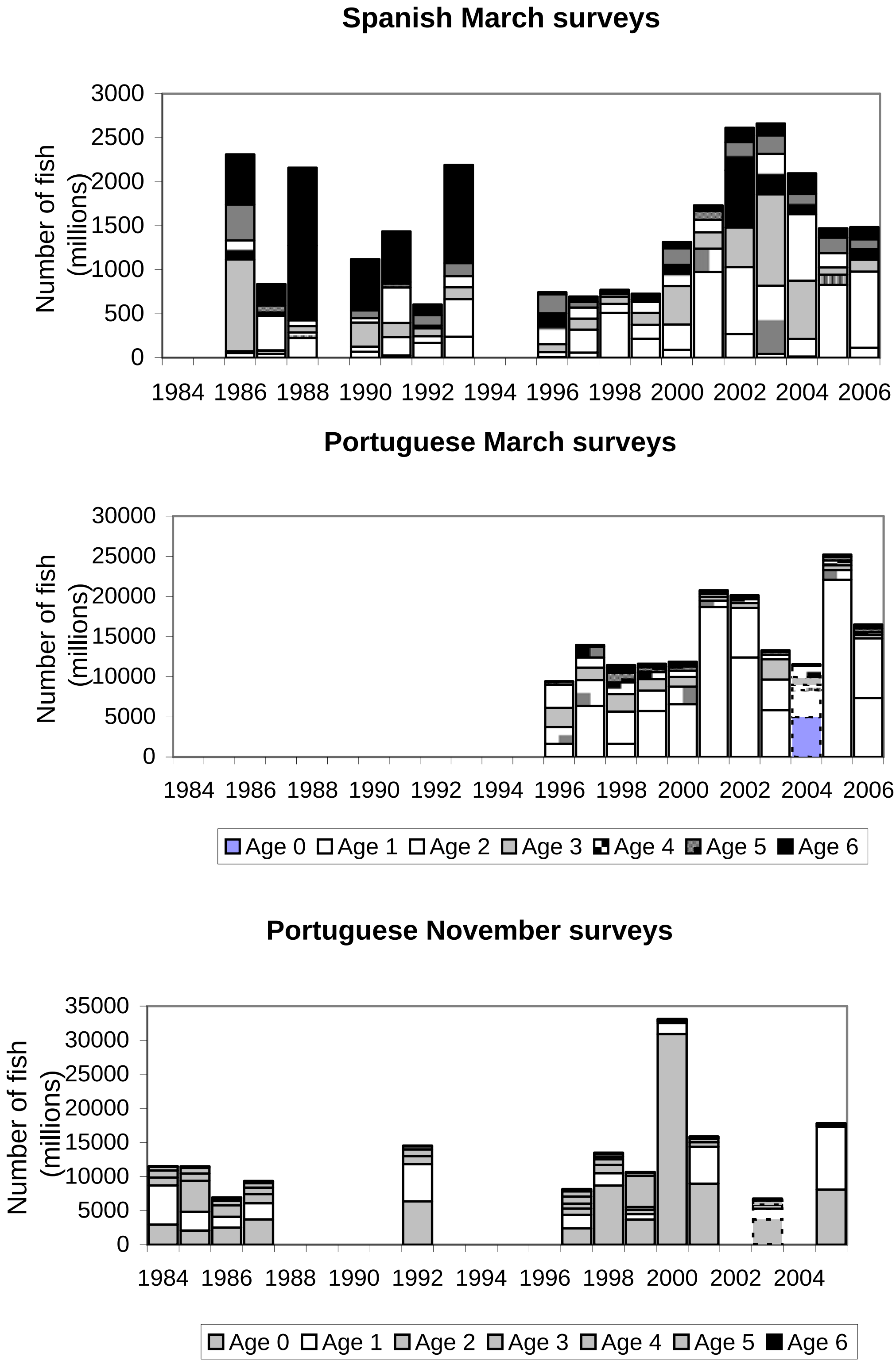


Figure 8.3.1 – Sardine in VIIIc and IXa: Total abundance and age structure (numbers) of sardine estimated in the acoustic surveys. The Spanish March survey series covers area VIIIc and IXa-N (Galicia), the Portuguese March surveys covers the Portuguese area and the Gulf of Cadiz (Subdivisions IXa-CN, IXa-CS, IXa-S-Algarve and IXa-S-Cadiz) and the Portuguese November survey covers only the Portuguese waters. Estimates from Portuguese acoustic surveys in November 2003 and June 2004 are considered as indications of the population abundance and are not included in assessment.

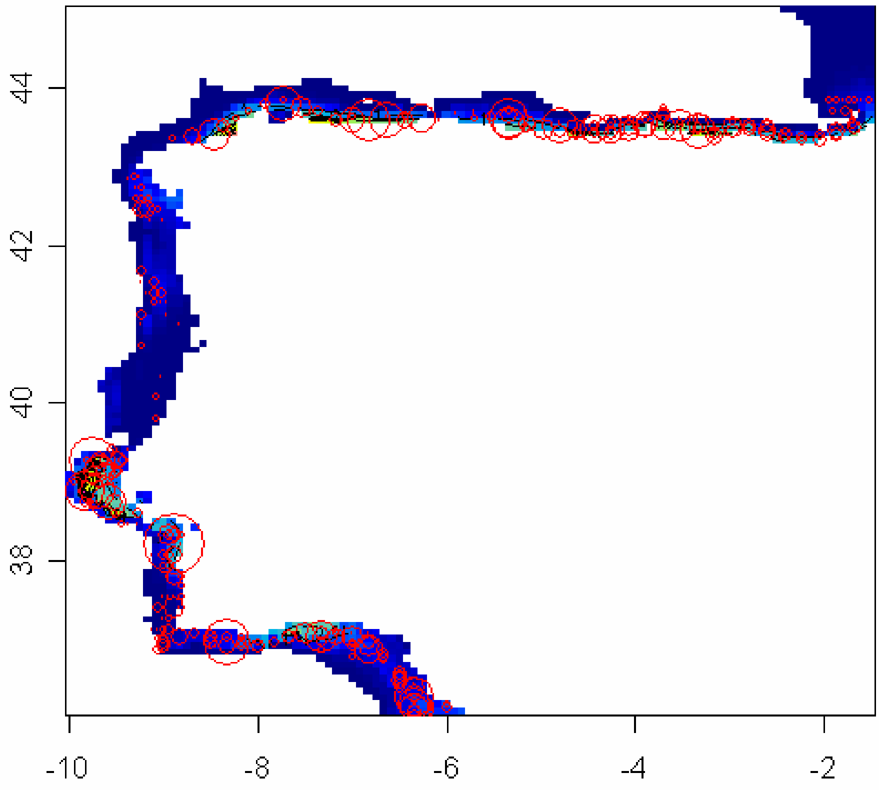


Figure 8.3.1.1: Observed egg densities (red points, diameter proportional to egg density) and modelled egg productions (colour image, dark blue lower egg production, red higher egg production) for the combined Spanish and Portuguese DEPM survey.

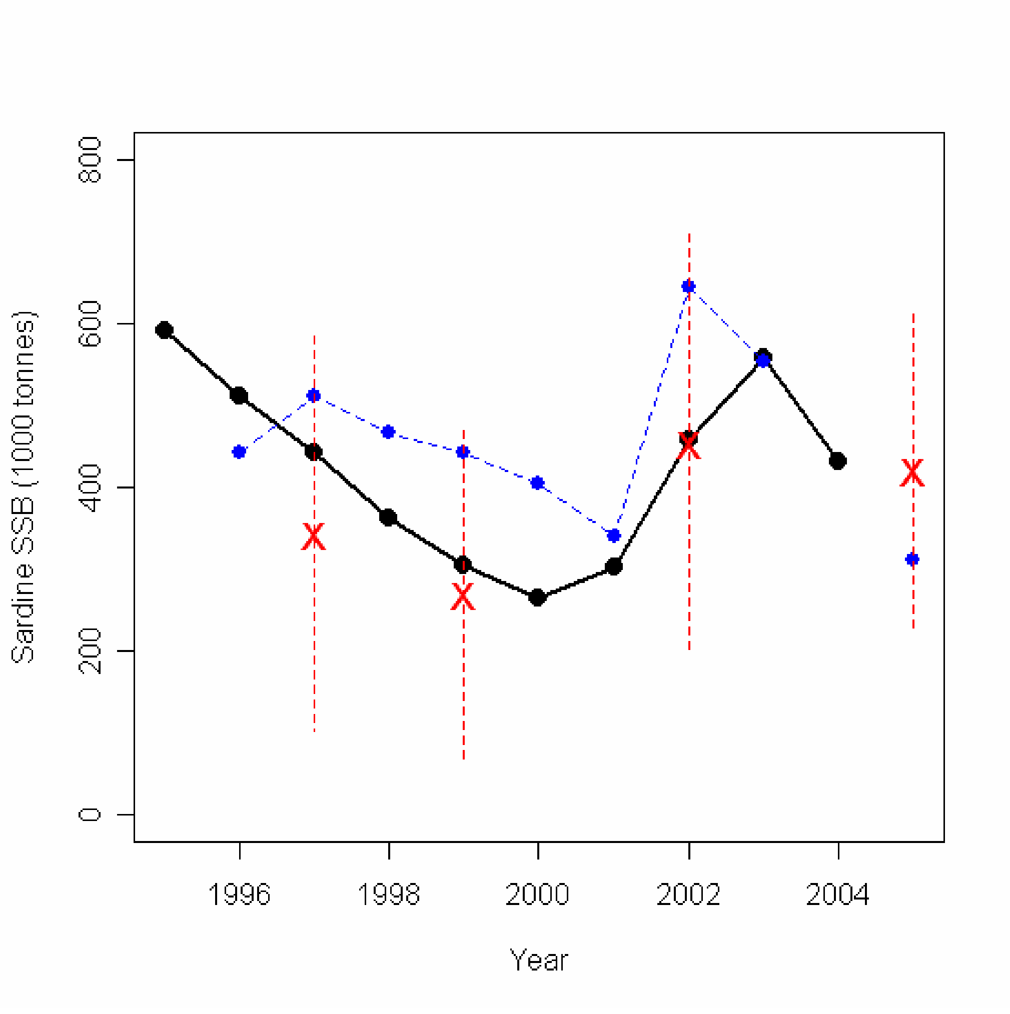


Figure 8.3.1.2: Comparision between acoustic (blue points) and DEPM based (red crosses) SSB estimates for the last decade. Vertical red lines represent the different DEPM estimates confidence intervals, while the black solid line represent the 2005 AMCI assessment estimate. No acoustic data is available in 2004, and thus the blue line is broken for that year.

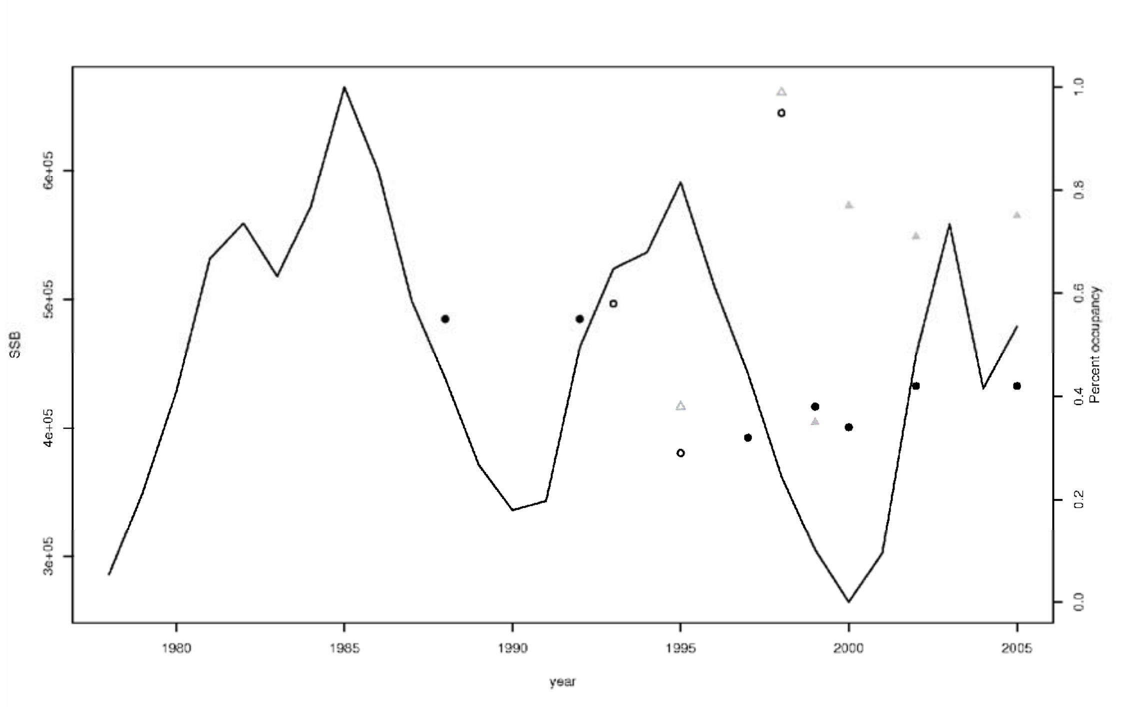


Figure 8.3.1.3: Comparison between the time series of sardine SSB within the ICES stock unit (solid continuous line, scale on the left in tonnes), the percentage of shelf occupied by eggs within the same limits (circles, scale on the right), and the degree of shelf occupied with eggs in the Armorican shelf (triangles, scale on the right). Solid symbols indicate "non-bongo" based surveys, while open symbols indicate bongo-based surveys, consider to be of lower precision for the estimation of spawning area extension, as they have low number of stations within the shelf.

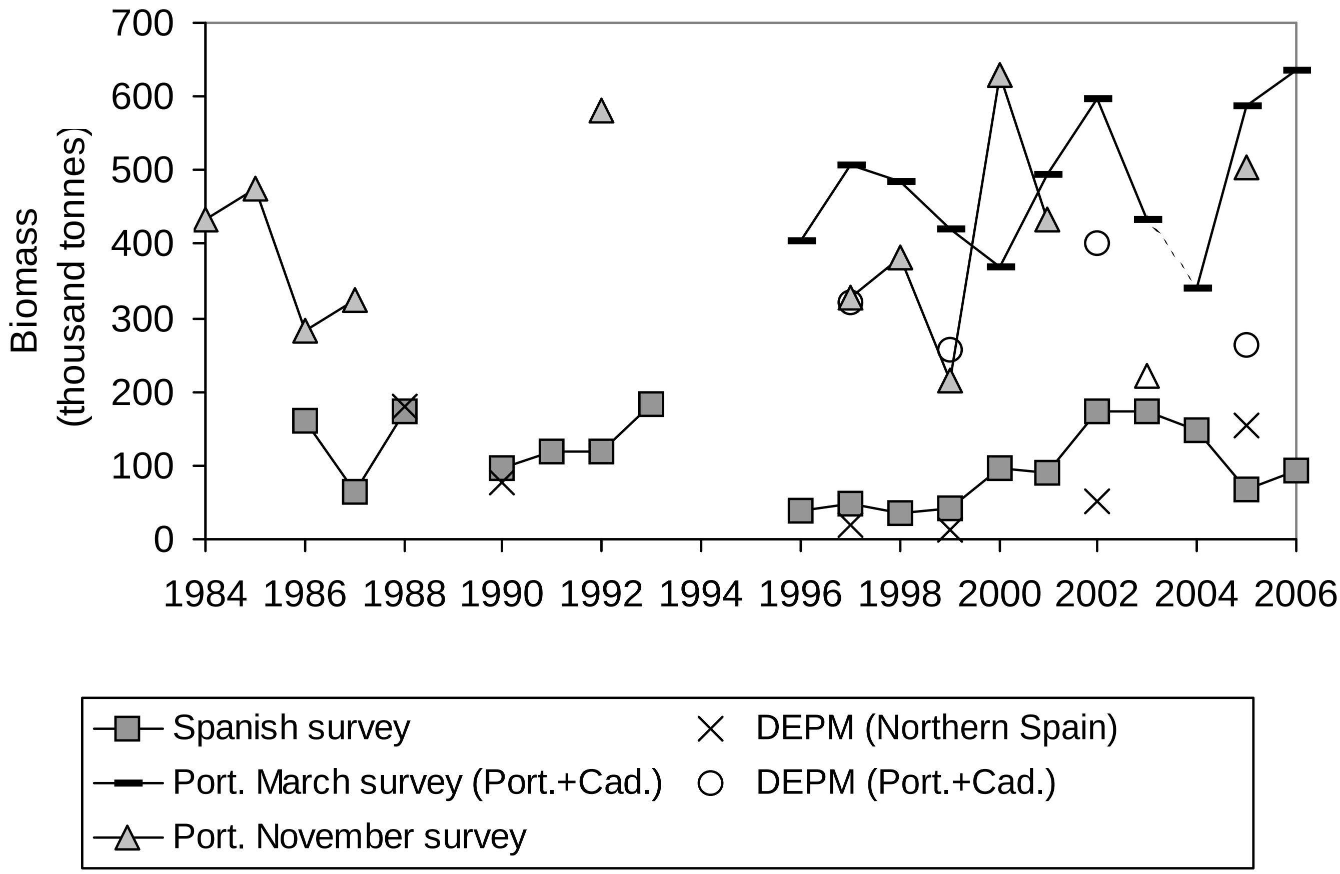


Figure 8.3.2 - Sardine in VIIIc and IXa: Total sardine biomass (thousand tonnes) estimated in the different series of acoustic surveys and SSB estimates from the DEPM series covering the northern area and the west and southern area of the stock.

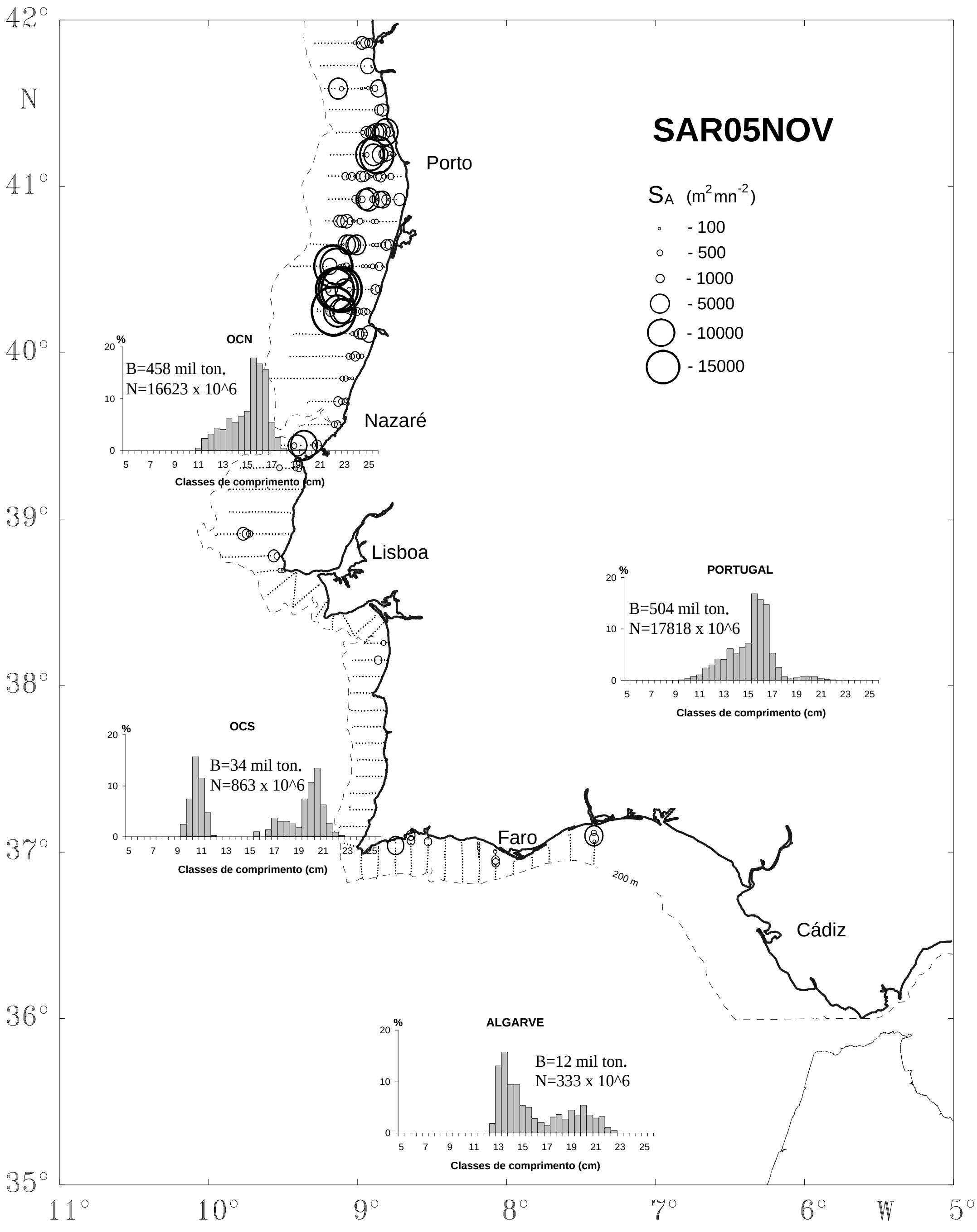


Figure 8.3.2.1.1 Sardine in VIIIc and IXa: Portuguese autumn acoustic survey in 2005. Acoustic energy by nautical mile and abundance and length structure by area. Circle area is proportional to the acoustic energy (S_A m^2/nm^2).

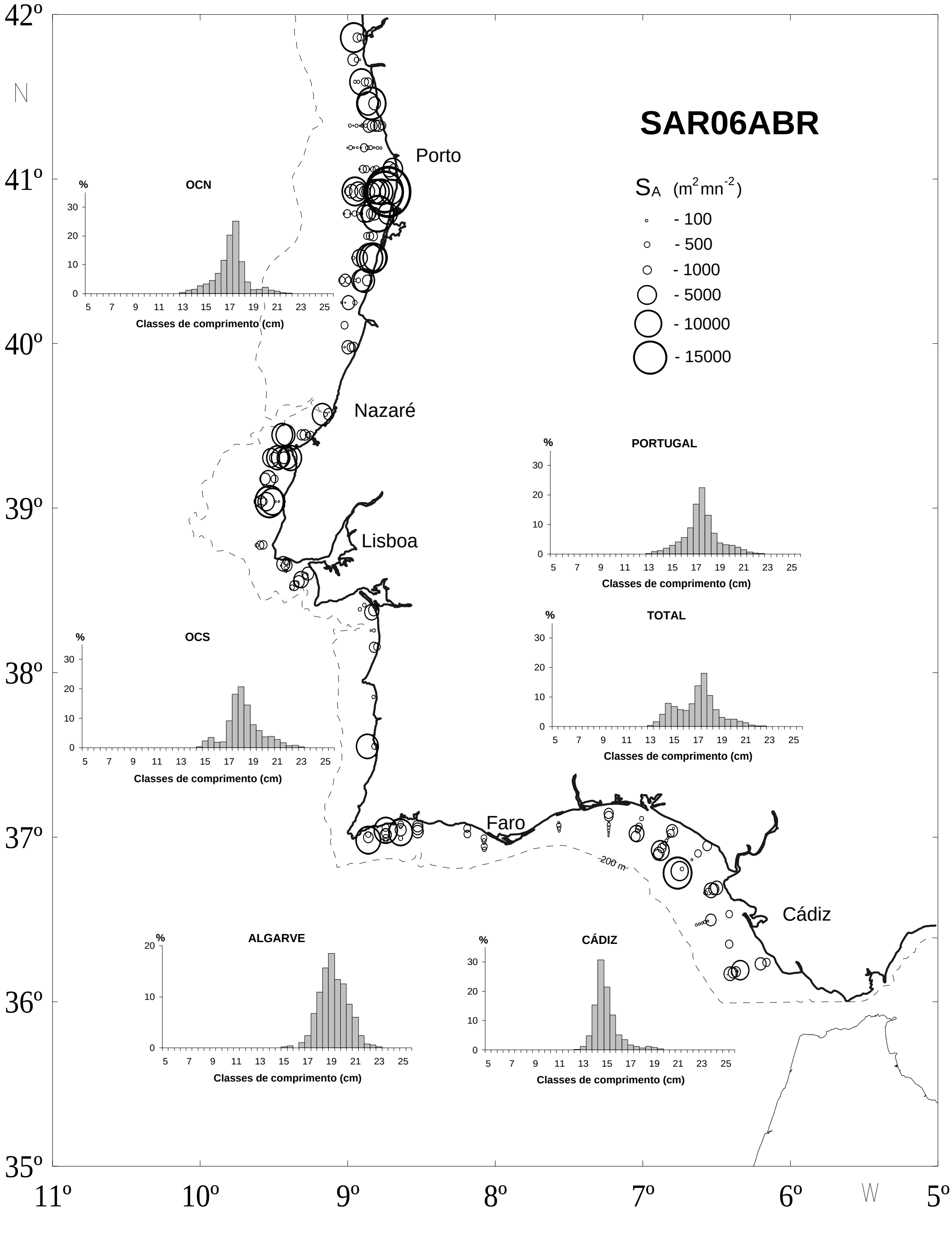
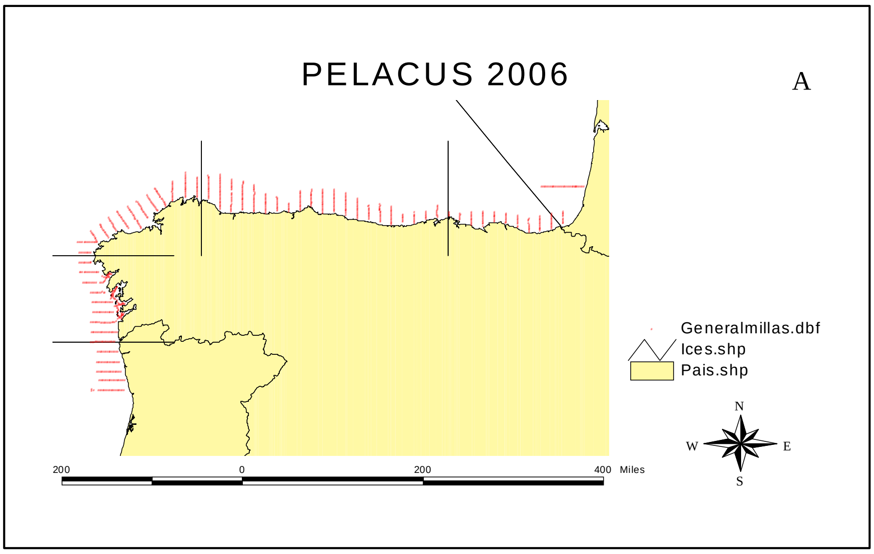


Figure 8.3.2.1.2 Sardine in VIIIc and IXa: Portuguese spring acoustic survey in 2006. Acoustic energy by nautical mile and abundance and length structure by area. Circle area is proportional to the acoustic energy (S_A m^2/nm^2).



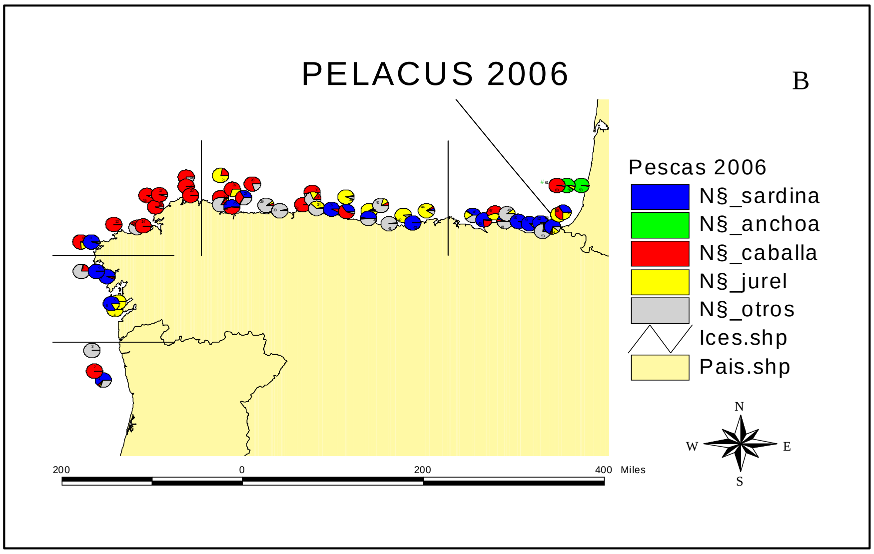


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Figure 8.3.2.2.1. Spanish acoustic survey in 2006: a) cruise tracks, b) fishing stations and c) sardine acoustic energy and length structure by area.

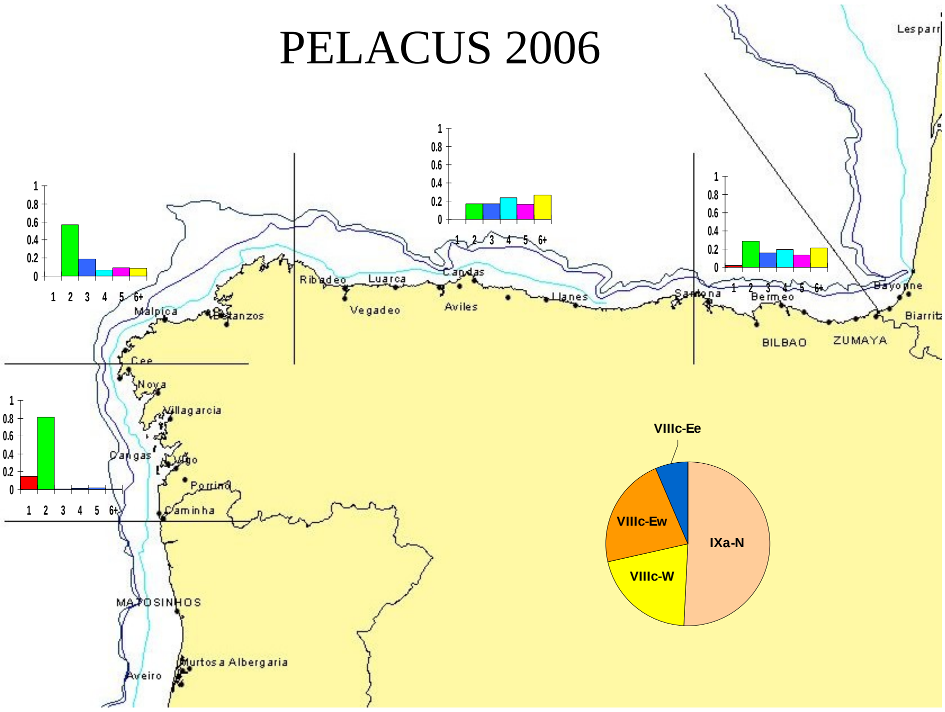


Figure 8.3.2.2.2. Spanish acoustic survey in 2006: sardine relative abundance at age in each subarea (i.e. the proportion of all age classes within subarea sum to 1). The pie chart shows the contribution of each subarea to the total stock numbers..

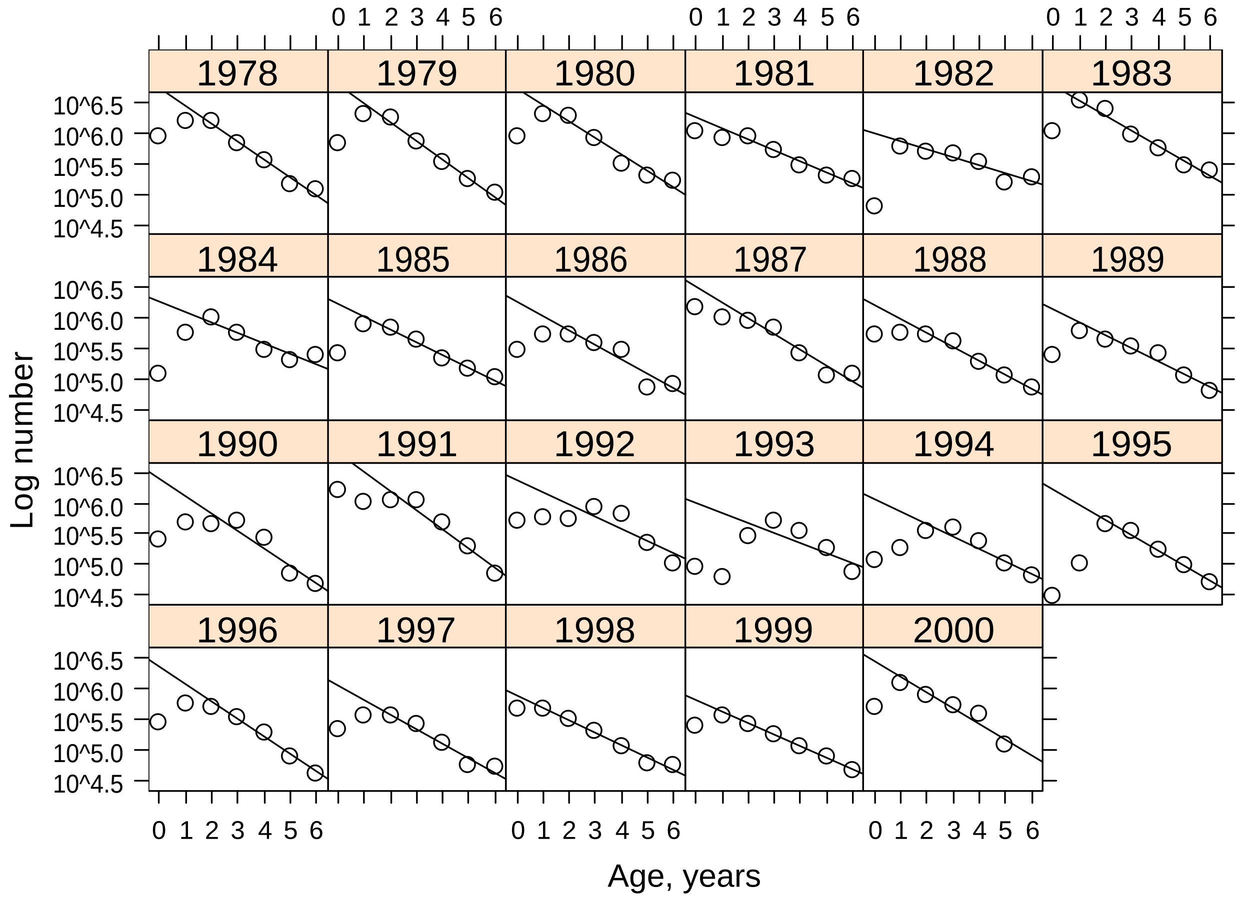


Figure 8.7.1.1. Sardine: Log-numbers at age in the catches by year-class. Lines represent linear regressions fit to data for ages 2-5.

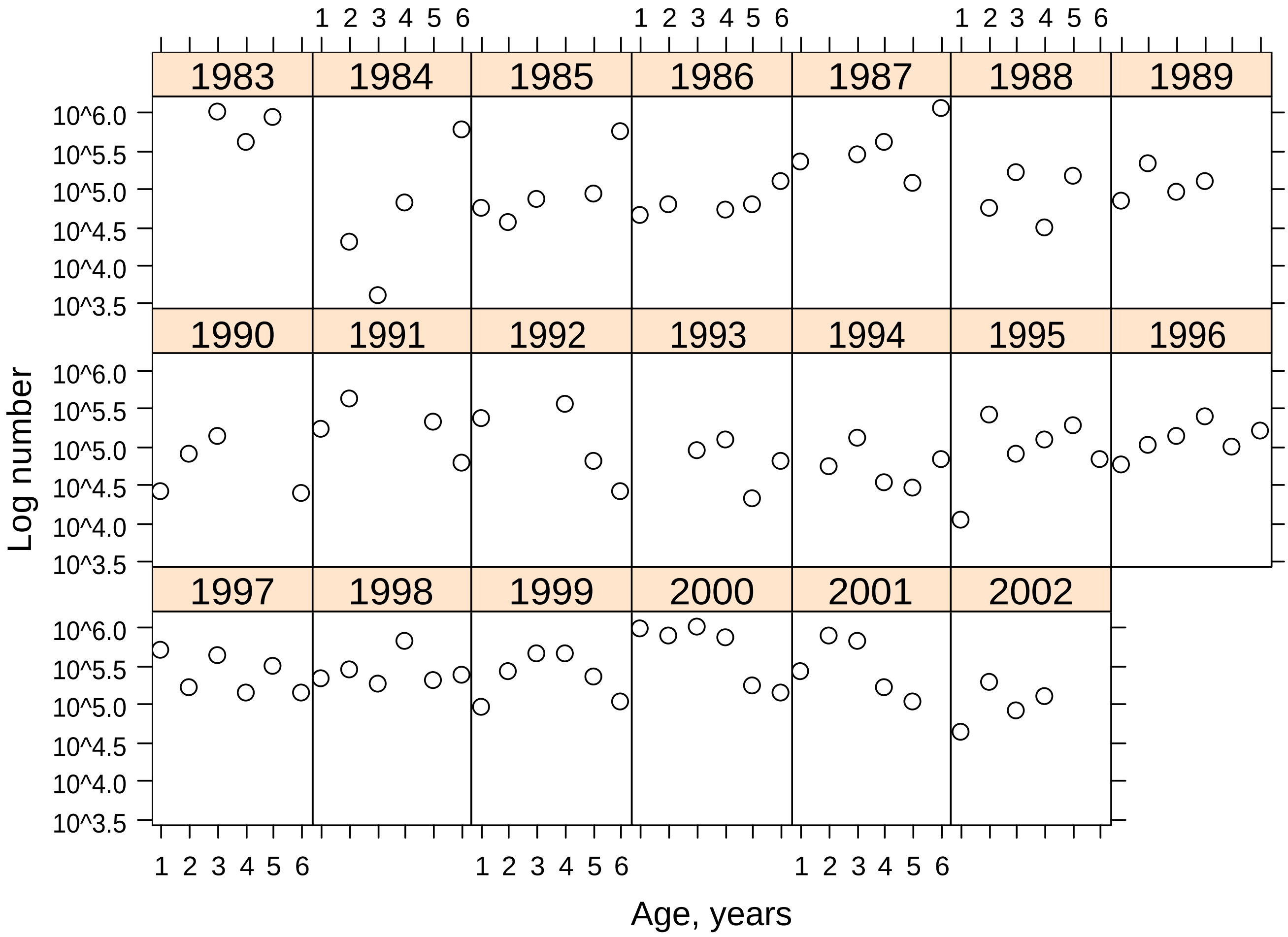


Figure 8.7.1.2. Sardine: Log-numbers at age in the Spanish spring acoustic survey by year-class.

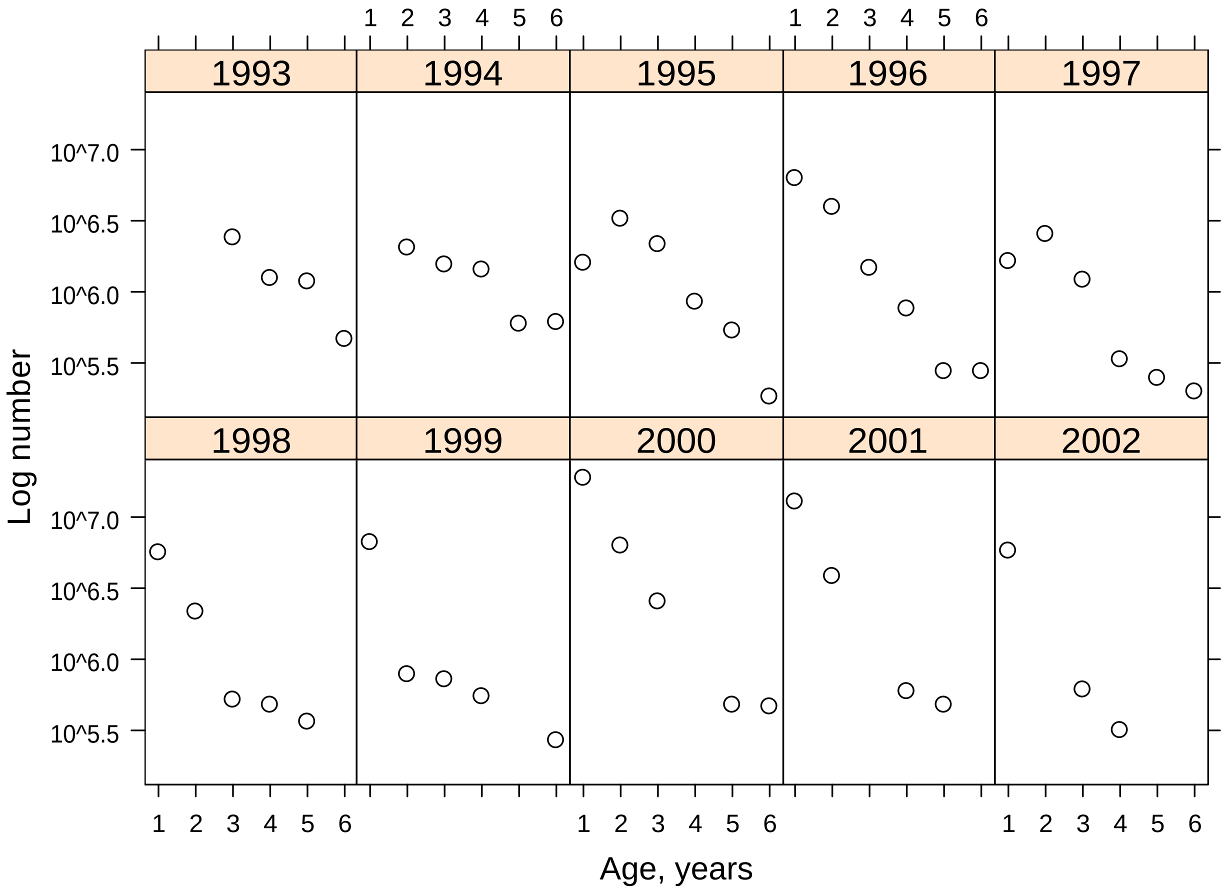


Figure 8.7.1.3. Sardine: Log-numbers at age in the Portuguese spring acoustic survey by year-class.

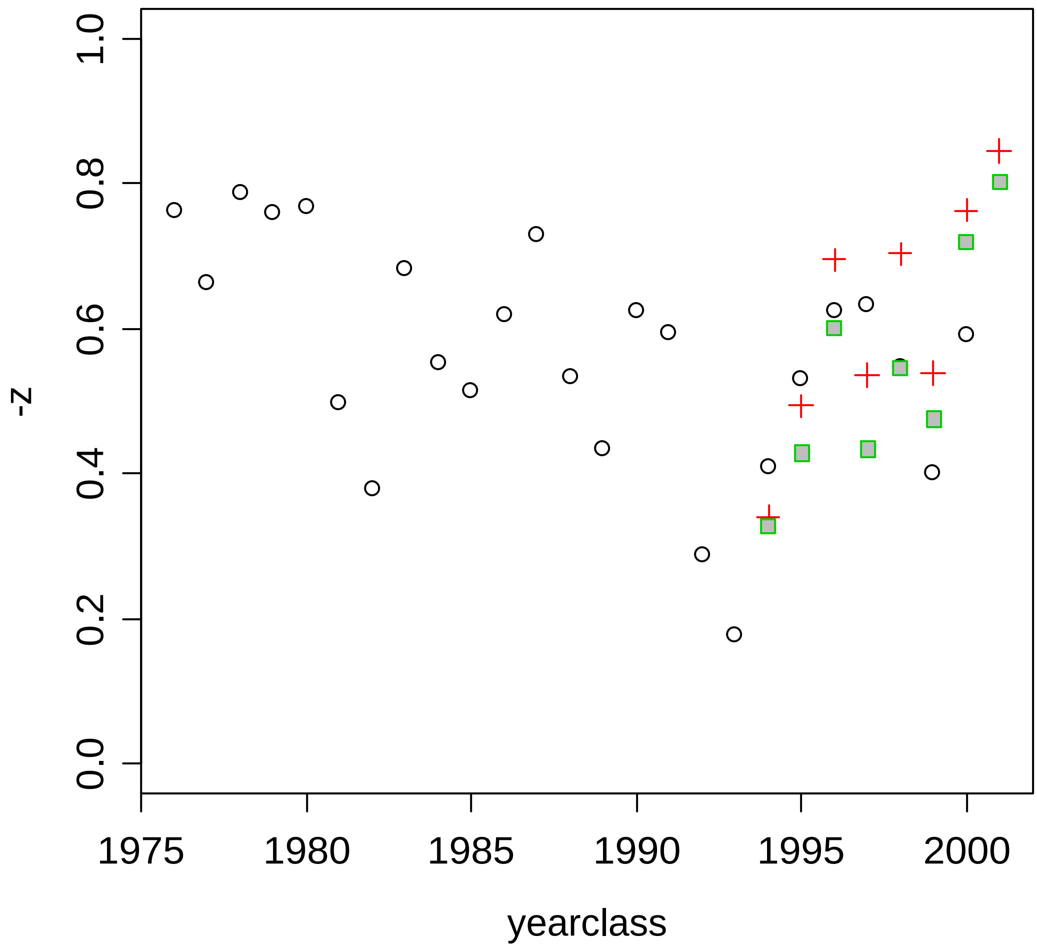


Figure 8.7.1.4. Sardine: Slope of the regression lines fitted to the log-numbers at age by year-class from catch data (circles), Portuguese spring survey (crosses) and combined Portuguese and Spanish spring surveys (squares).

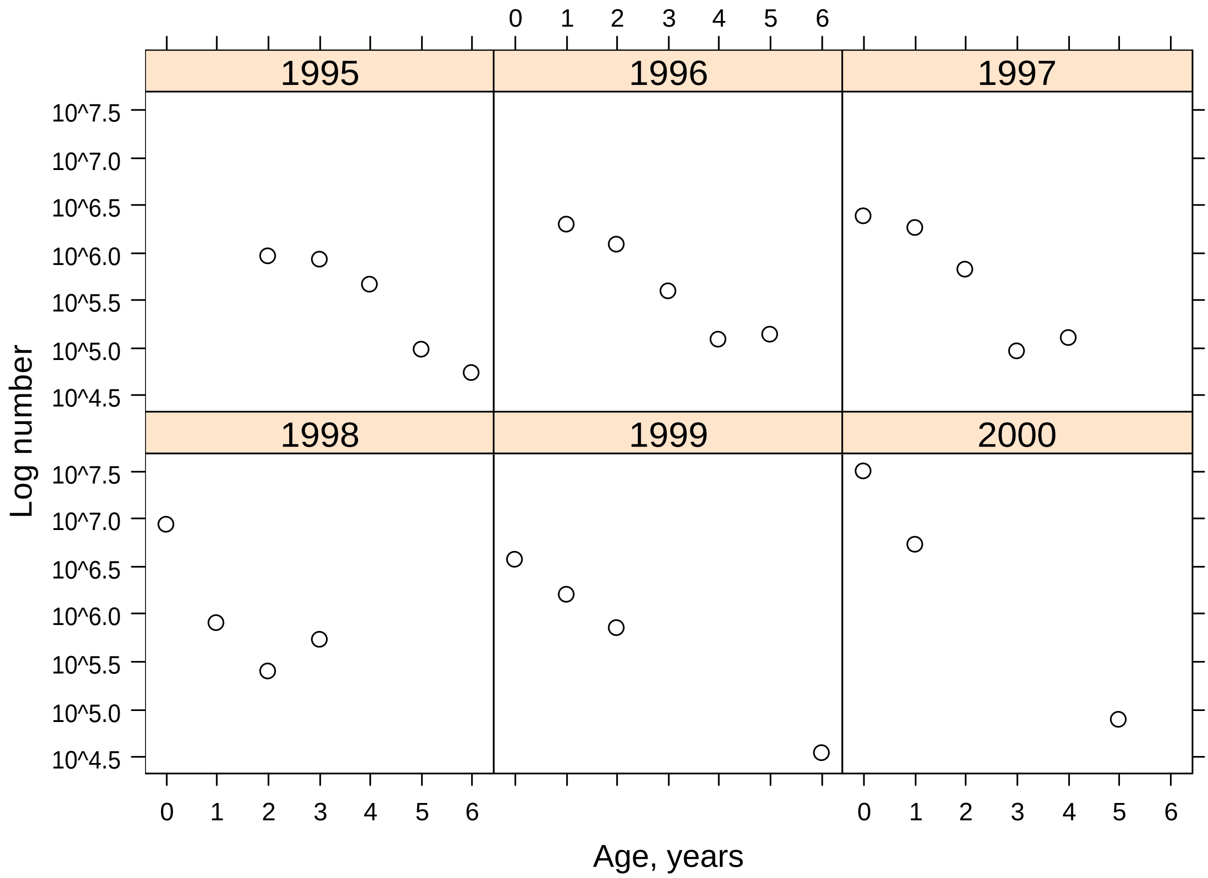


Figure 8.7.1.5. Sardine: Log-numbers at age in the Portuguese November acoustic survey by year-class.

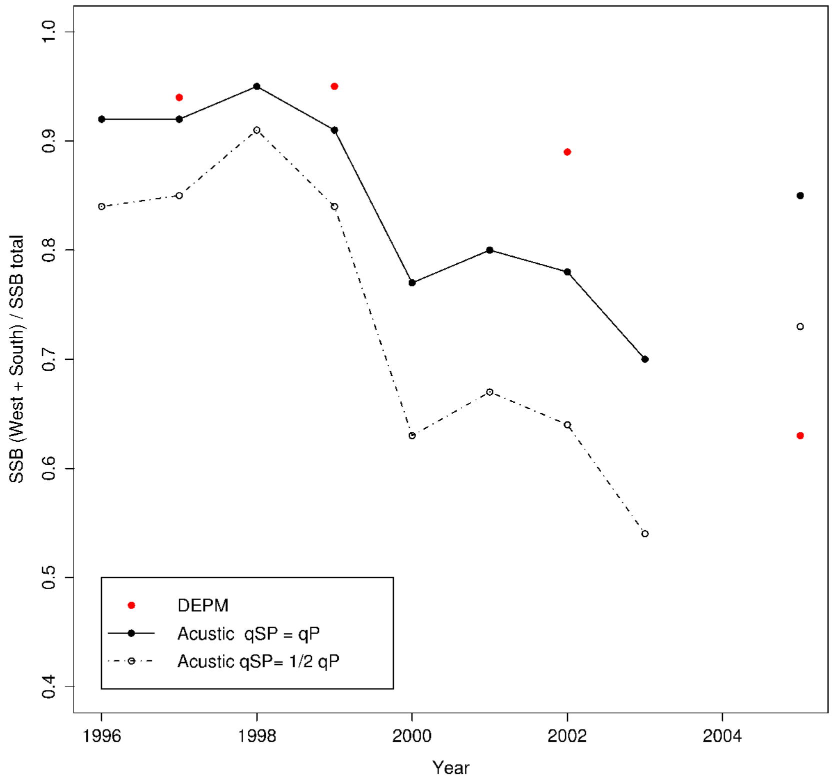


Figure 8.7.1.6. Sardine: Proportion of sardine biomass in the west+south stock areas obatined from the DEPM survey (symbols) and from the acoustic surveys assuming equal catchability of the Spanish and Portuguese surveys (solid line) and catchability in the Spanish surveys half of that in Portuguese surveys (dashed line).

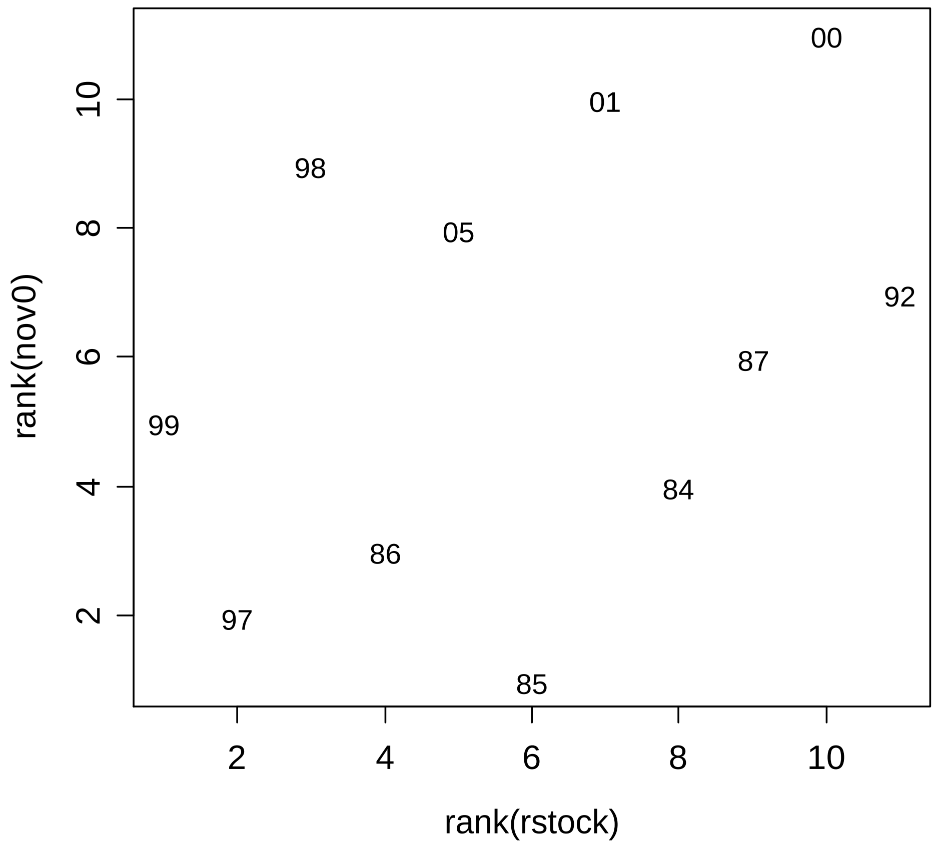


Figure 8.7.1.7. Sardine: Scatterplot of the rank of number of recruits (age 0) estimated by the Portuguese November survey and the rank of the recruitment estimated by the assessment model.

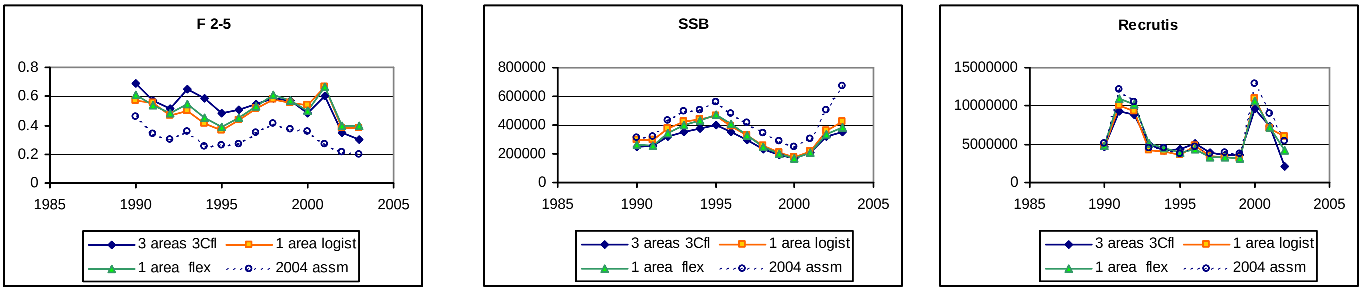


Figure 8.7.2.1. Sardine: Fishing mortality, SSB and Recruitment with a three area AMCI model (Run 4 = 3 areas 3 catch fleets) and to one area model (Run 5: logistic curve for selection and catchability and 6: flexible selection and catchability). For comparison, the results of the ICES assessment in 2004 is also shown. From Skagen, 2006.

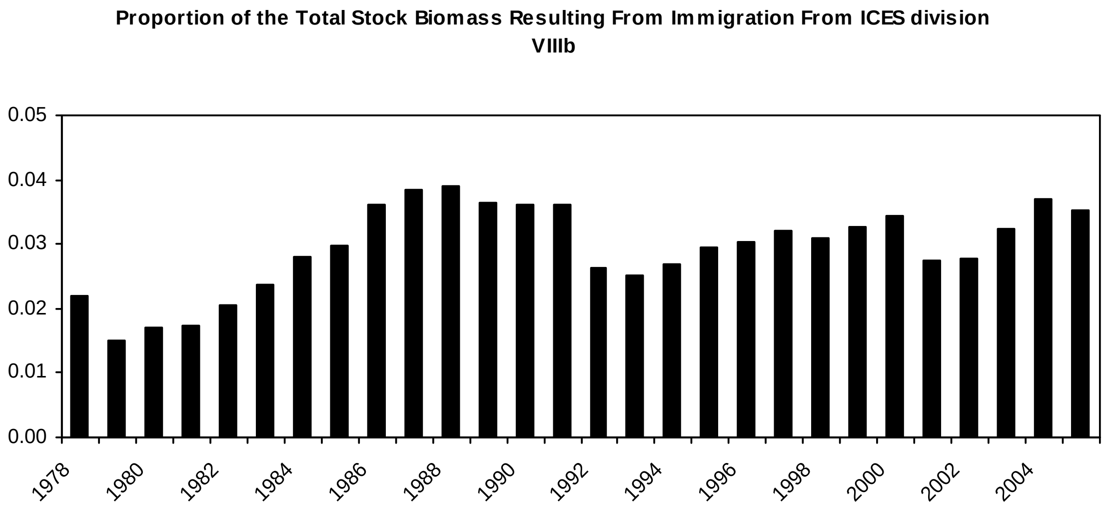


Figure 8.7.2.2.2. Proportion of the total stock biomass resulting from immigration from ICES division VIIIb into VIIIc(east).

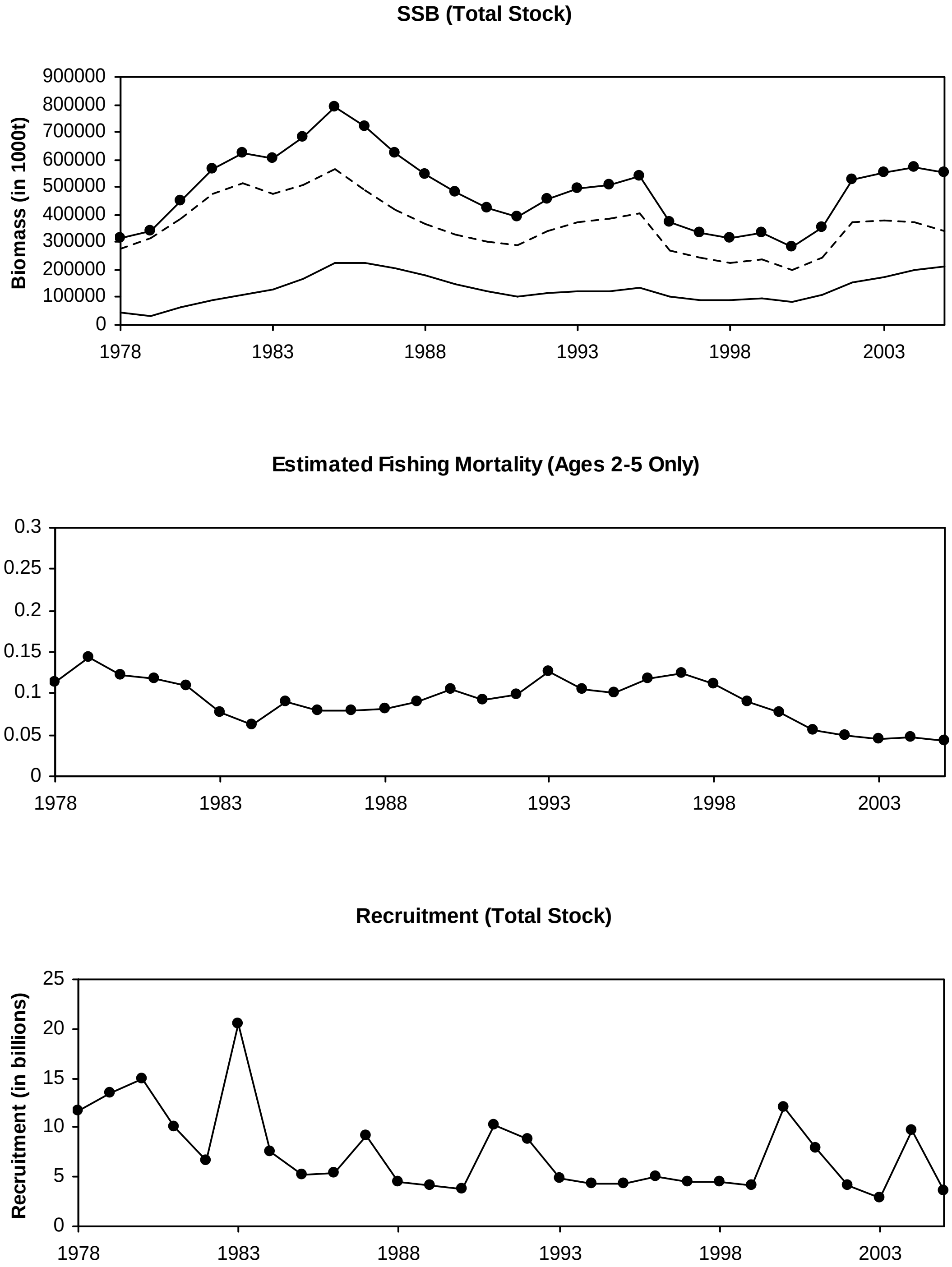


Figure 8.7.2.2.1. Sardine: Model predicted SSB for the total assessed stock and the portion of the stock in Spanish (solid line) and Portuguese (dashed line) waters (upper panel); Estimated fishing mortality on ages 2-5 (middle panel); and recruitment to the total assessed stock (lower panel).

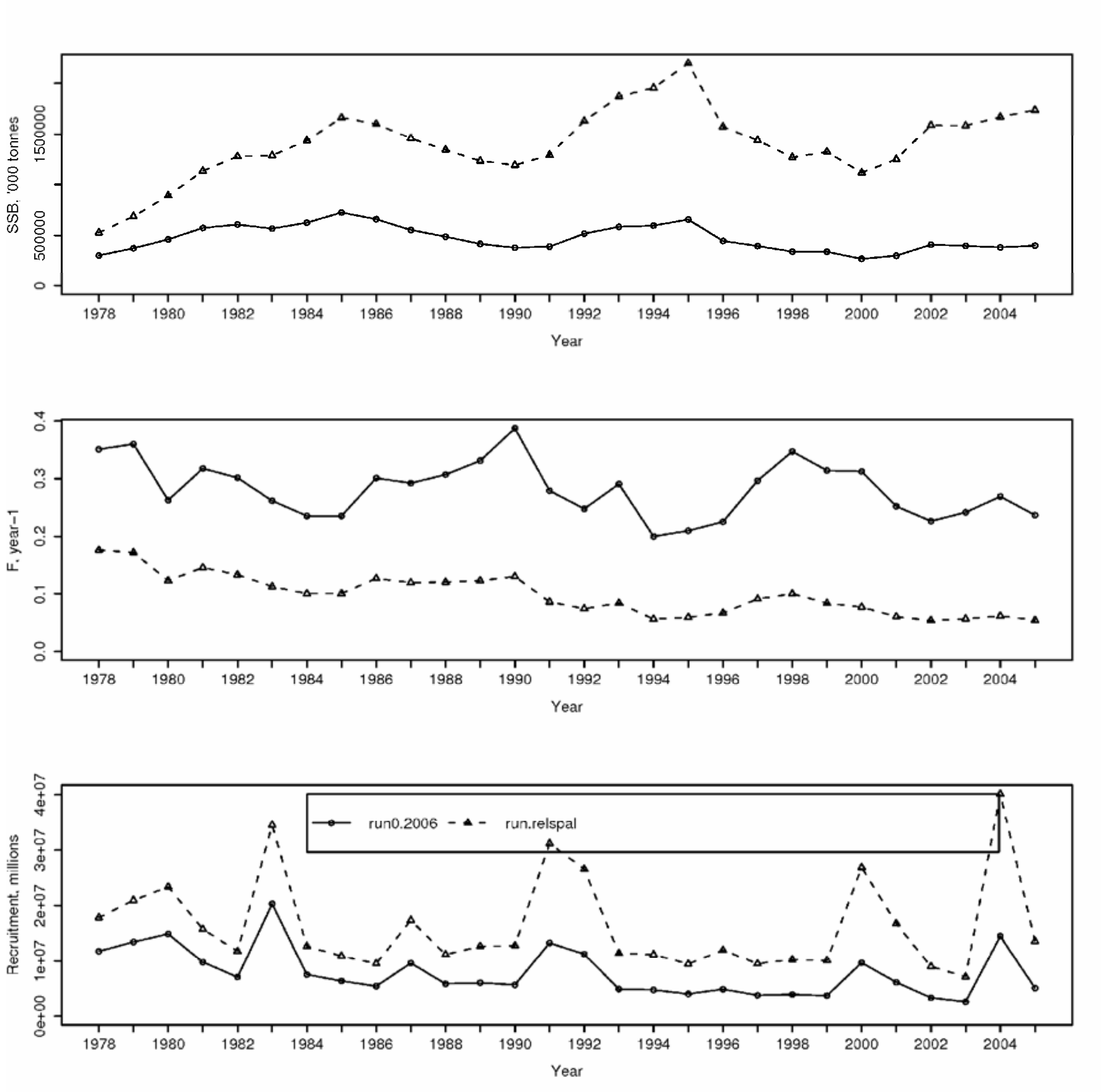


Figure 8.7.3.1.1. Sardine: Comparison of SPALY run for 2006 assessment with a similar run using DEPM estimates as relative. The run with DEPM relative was not fully converged.

Figure 8.7.3.1.2a: Spanish March survey (all surveys and catches in the same scale).

Relative change in square residuals between a run forced to SSB in 2005 equal to the DEPM estimate and one forcing the SSB in 2005 equal to 5 times the DEPM estimate. Dark grey indicates data where the model fit improves by the high stock alternative, light grey are data where the fit gets poorer.

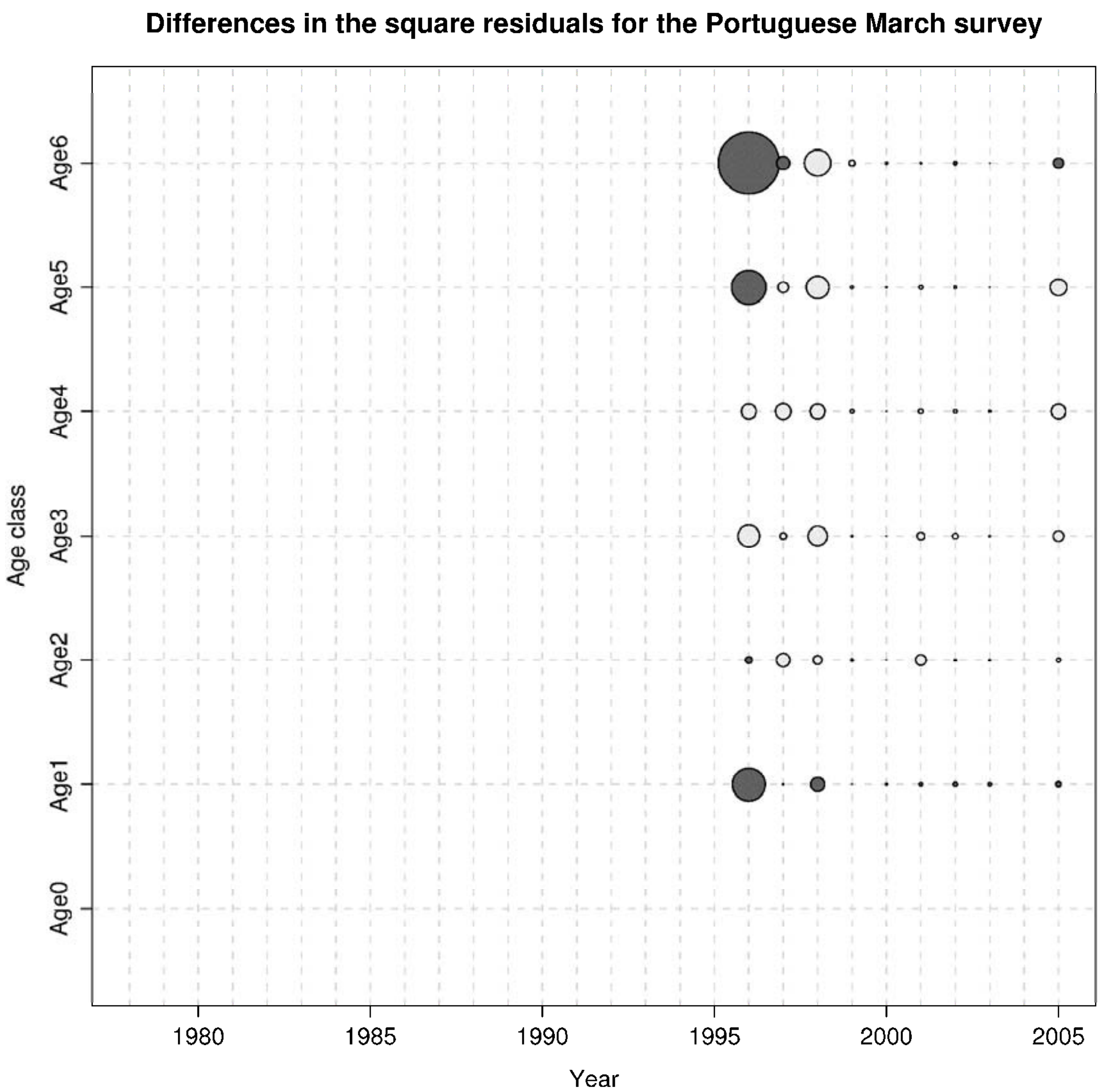


Figure 8.7.3.1.2b: Portuguese March survey Relative change in square residuals between runs as in Figure 8.7.3.1.2a:

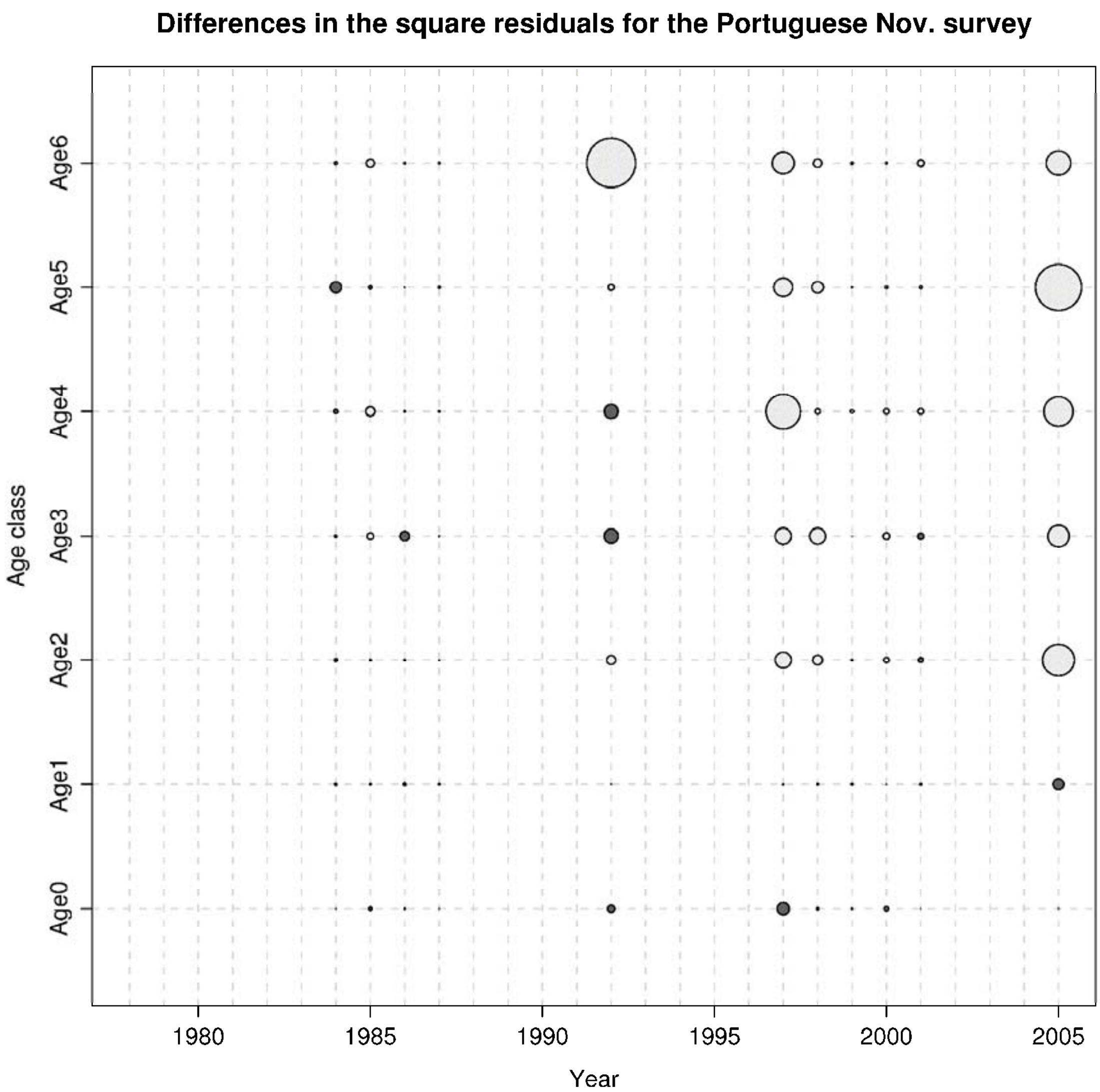


Figure 8.7.3.1.2c: Portuguese November survey Relative change in square residuals between runs as in Figure 8.7.3.1.2a:

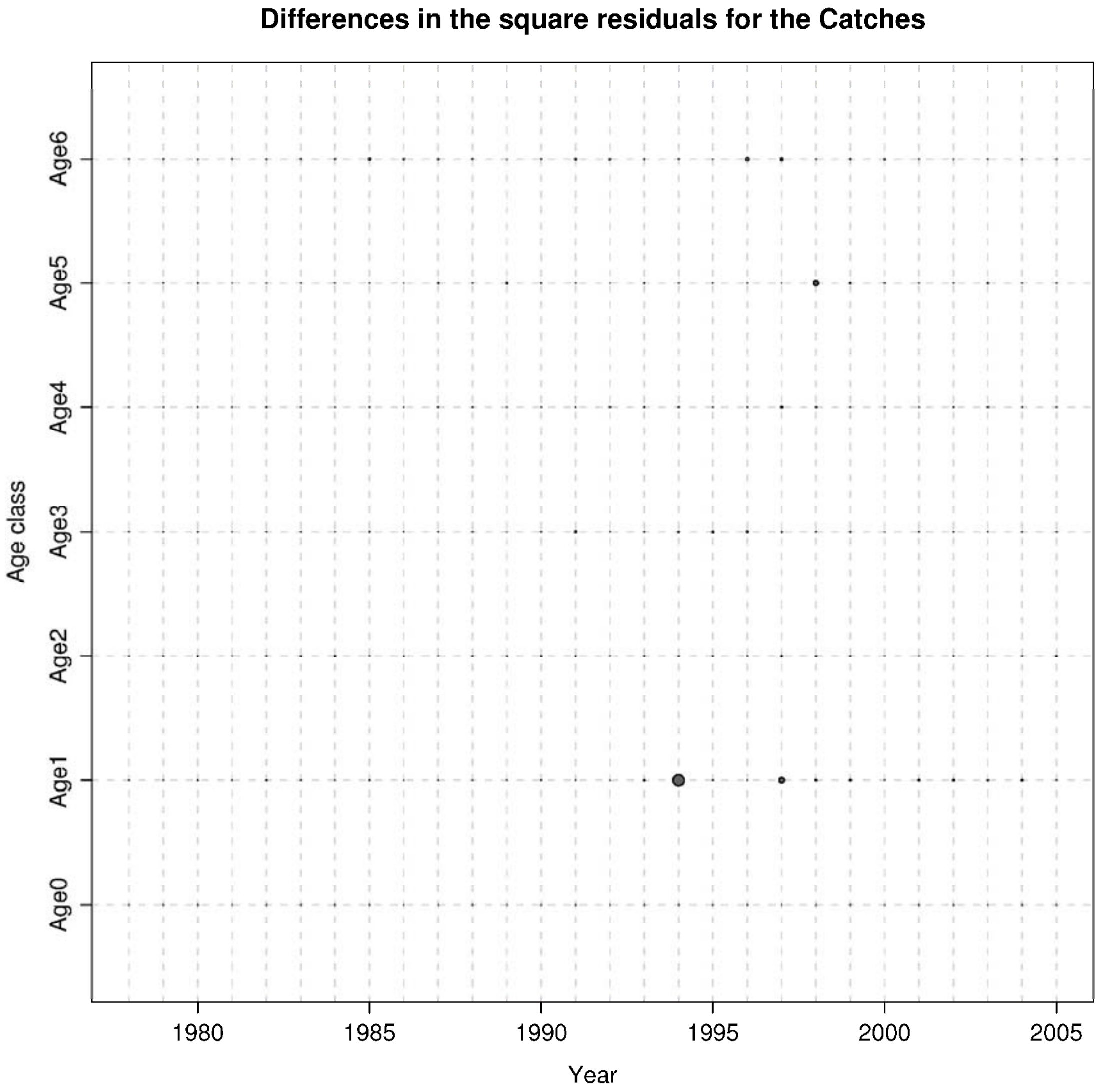


Figure 8.7.3.1.2d: Catch numbers at age. Relative change in square residuals between runs as in Figure 8.7.3.1.2a:

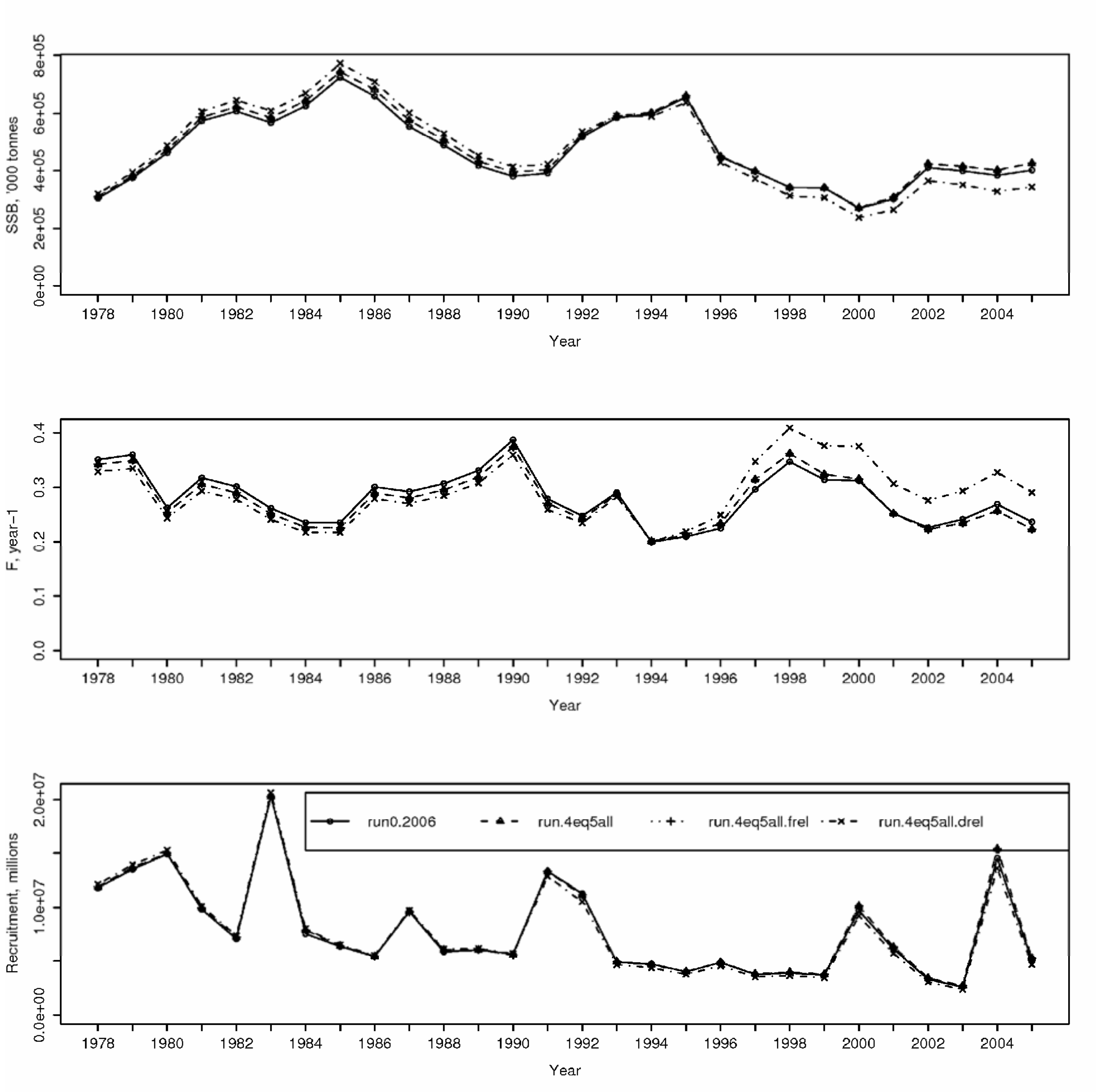


Figure 8.7.3.1.3. Comparison of runs with the constraints F4 = F5 and q4=q5 for all acoustic surveys.

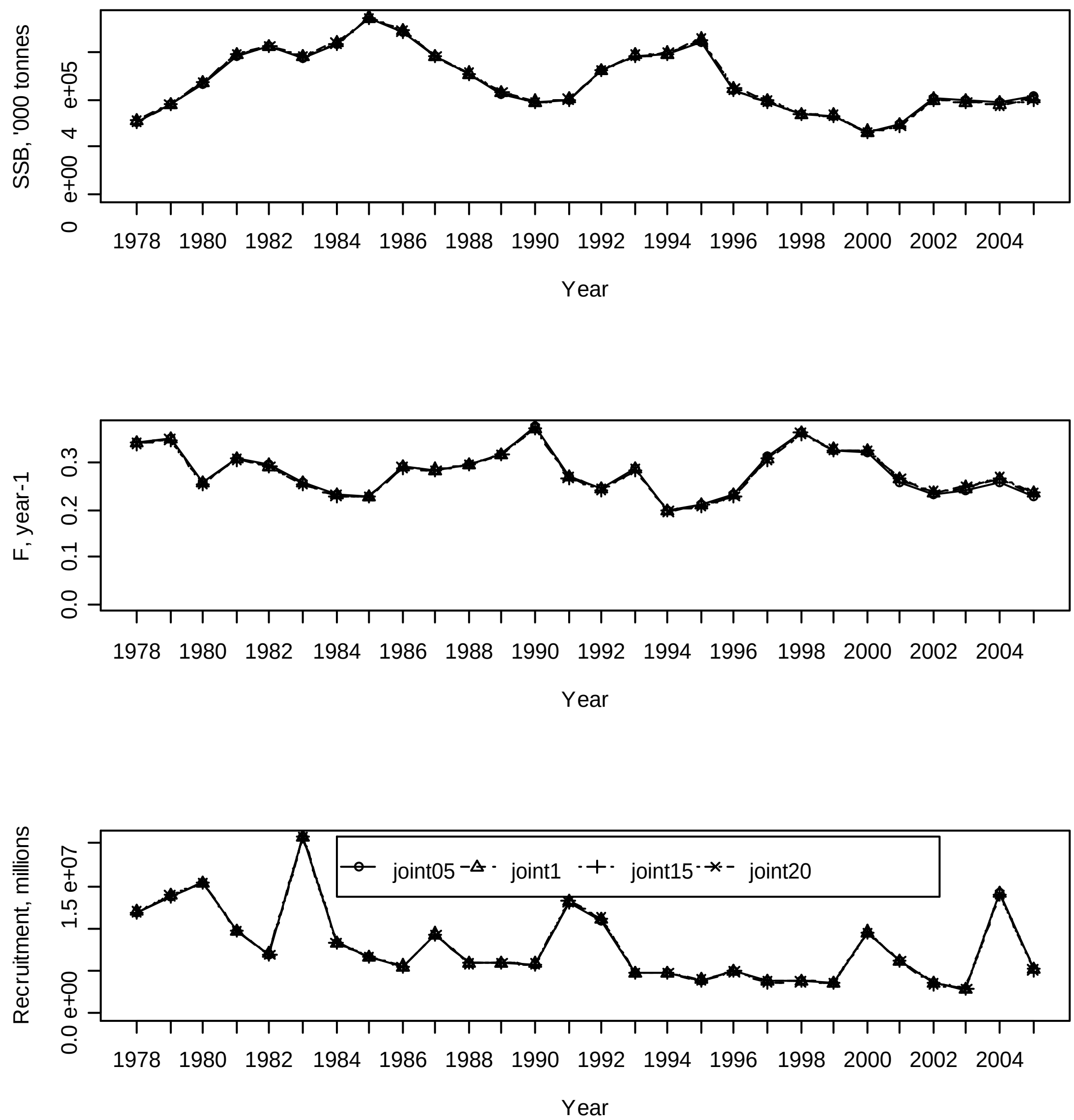


Figure 8.7.3.1.4. Sardine: Summary plots for AMCI runs using pooled data from Spanish and Portuguese spring surveys with different weights. Data from the Portuguese surveys were multiplied by 0.5, 1.0, 1.5 and 2.0 before summing with data from the Spanish surveys.

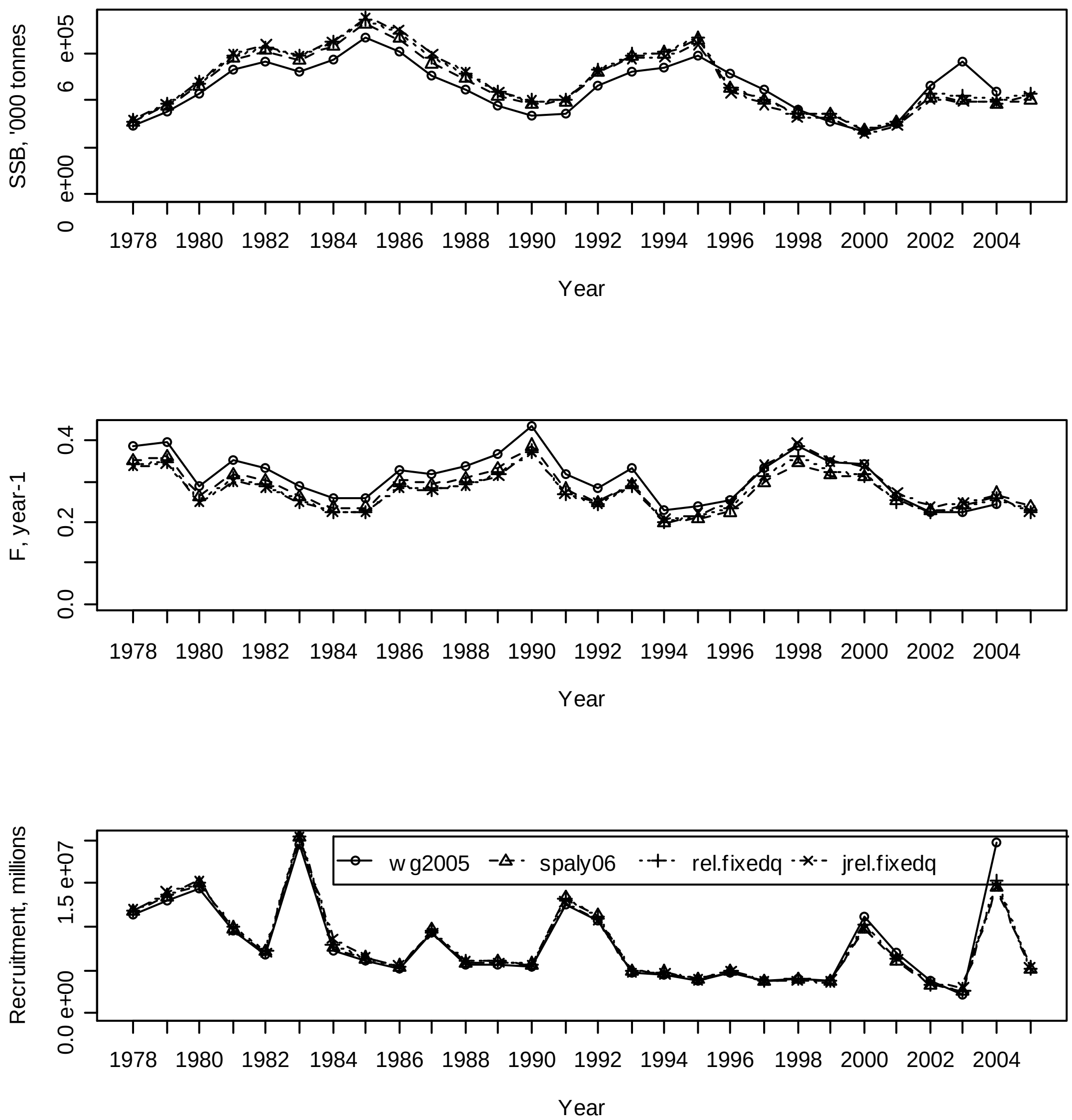


Figure 8.7.3.1.5. Sardine: Summary plots comparing the spaly 2006 AMCI run with runs using DEPM as relative and either the joint spring acoustic surveys (jrel.fixedq) or the three acoustic surveys as independent indices. The 2005 assessment is shown for comparison.

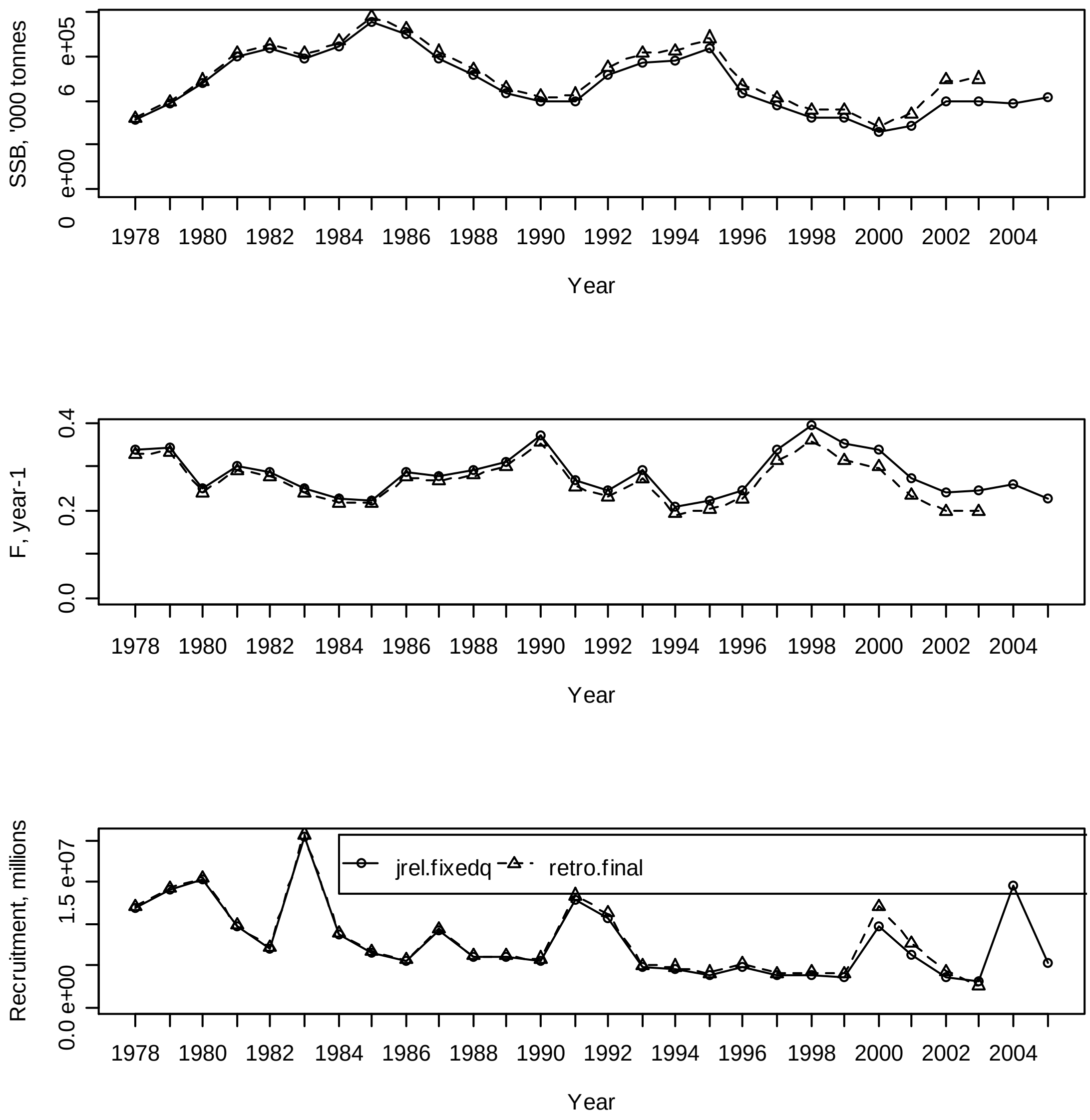


Figure 8.7.3.1.6. One year retrospective plot for the assessment of sardine using joined acoustic surveys, equal selection and catchability for ages 4-5 and DEPM as relative.

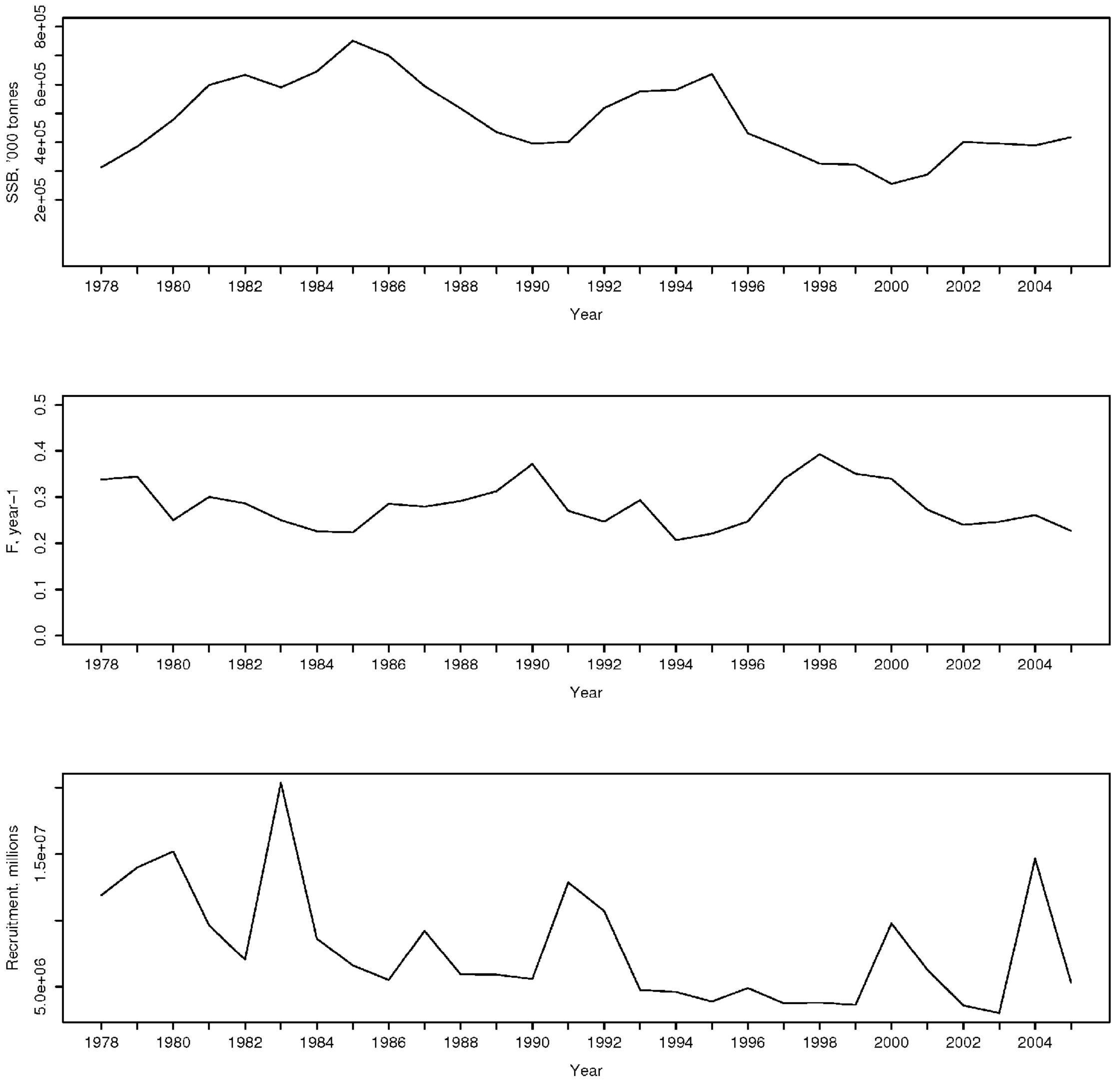


Figure 8.8.1.1: Sardine VIIIc and IXa: SSB (top), F (middle) and recruitment (bottom) trajectories from the sardine AMCI final assessment.

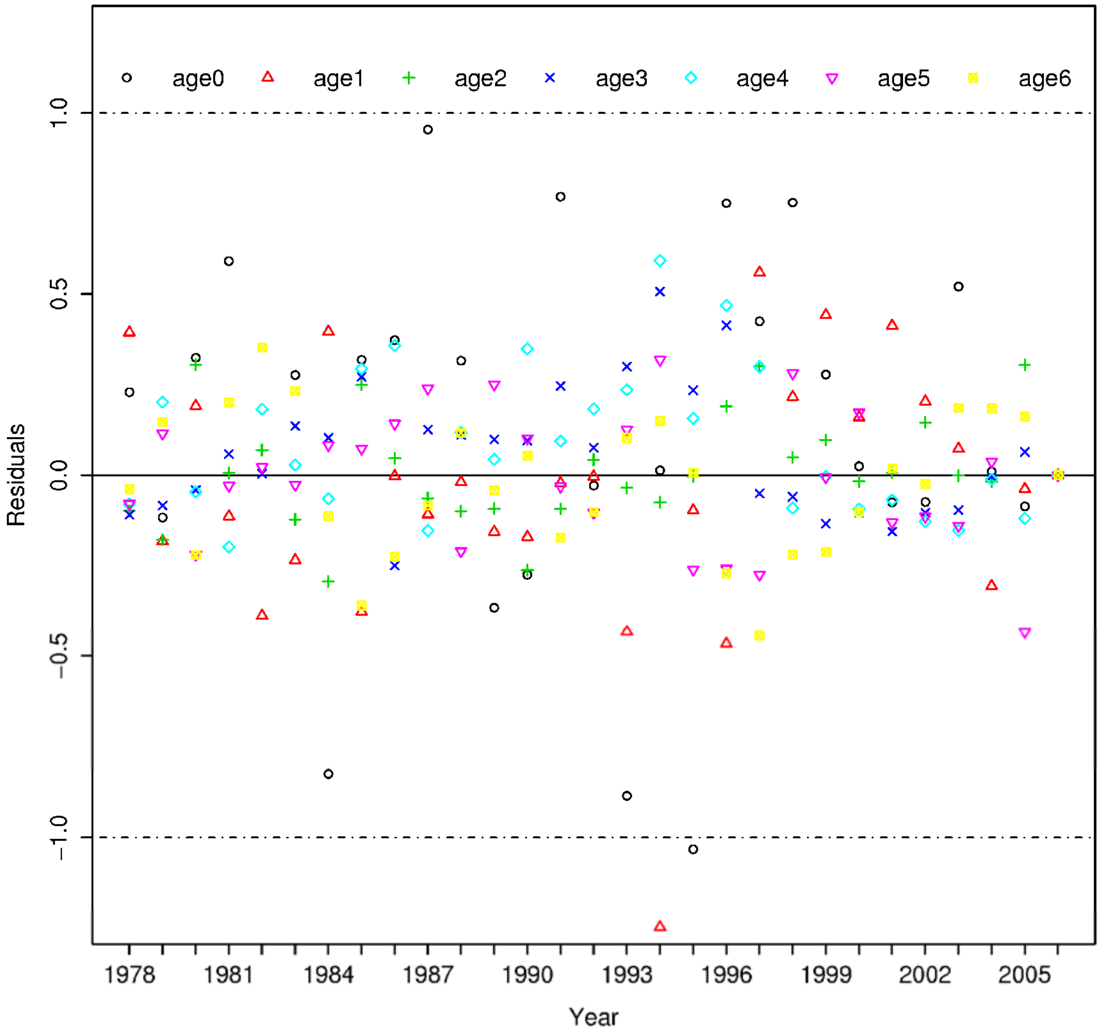


Figure 8.8.1.2: Sardine VIIIc and IXa: Catch residuals for the final assessment model.

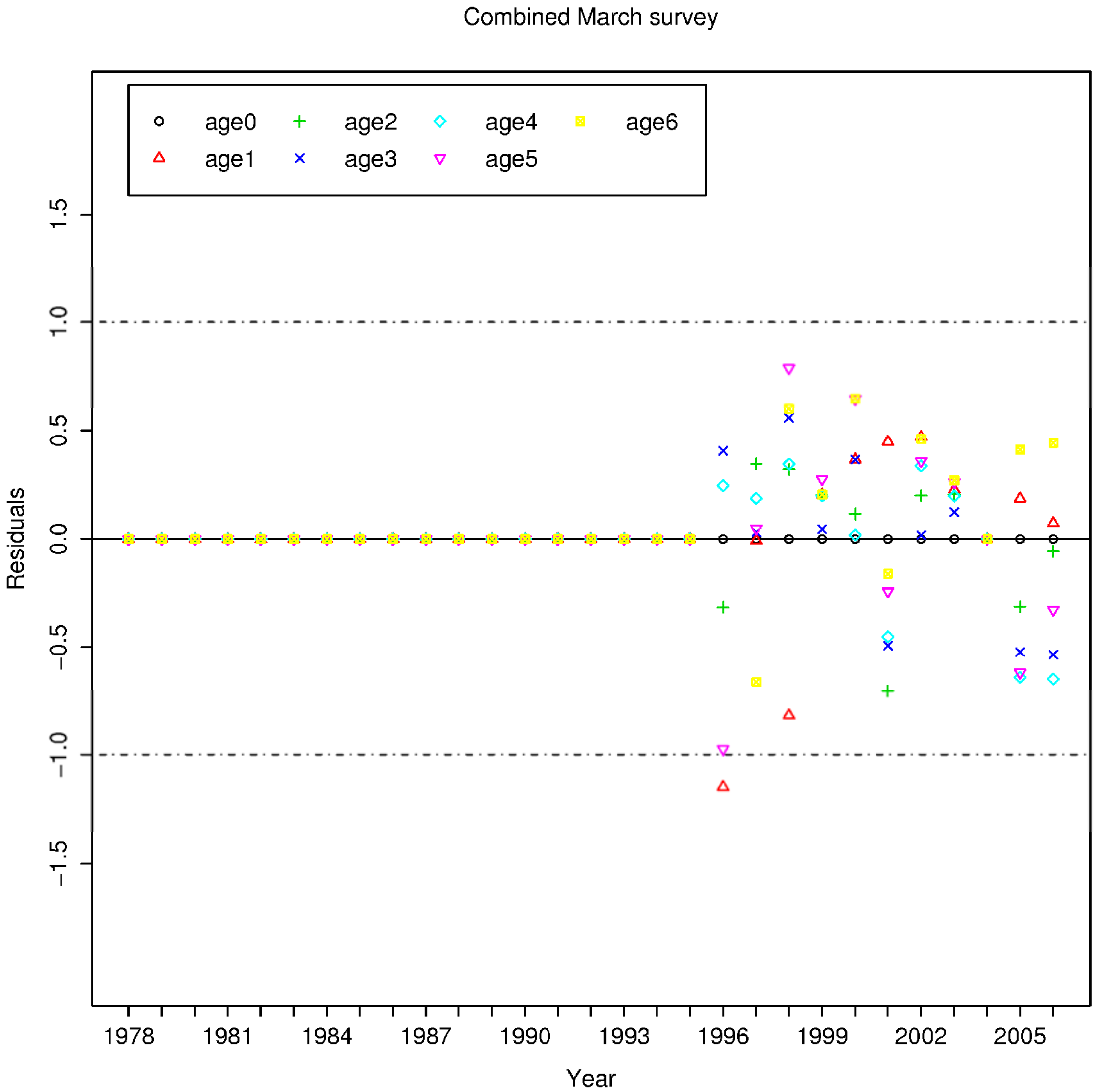


Figure 8.8.1.3: Sardine VIIIc and IXa: Survey residuals (for the combined march Iberian acoustic survey) for the final assessment model

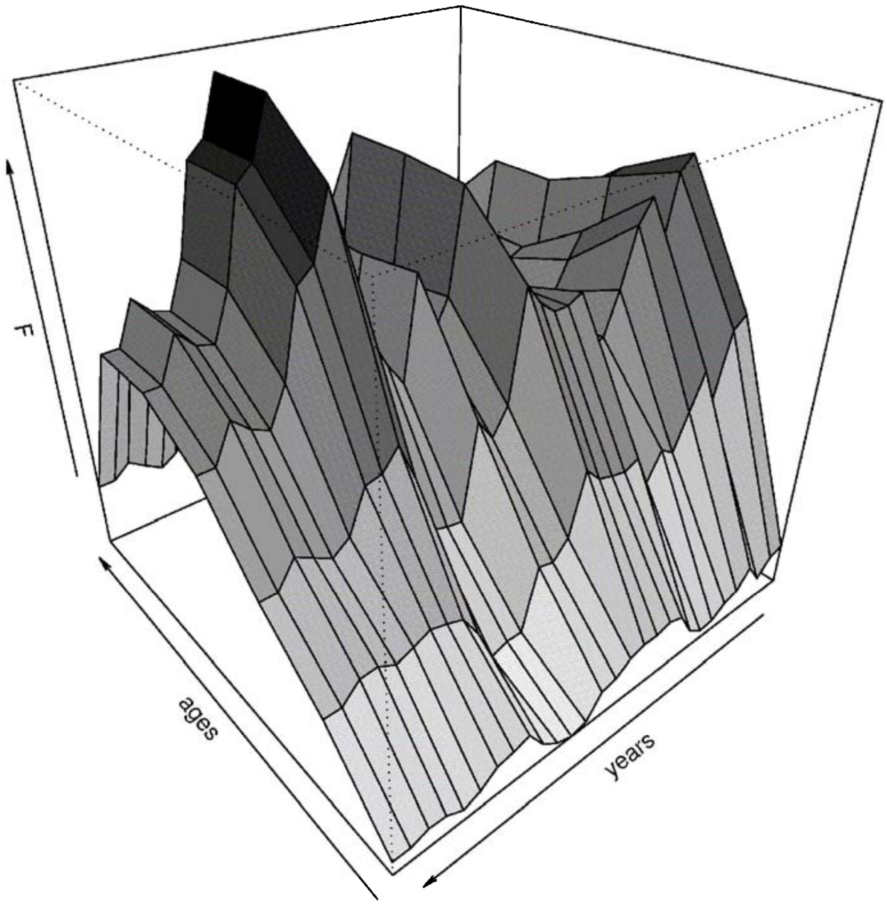


Figure 8.8.1.4: Sardine VIIIc and IXa: Year and age specific fishing mortalities estimated by the final assessment model.

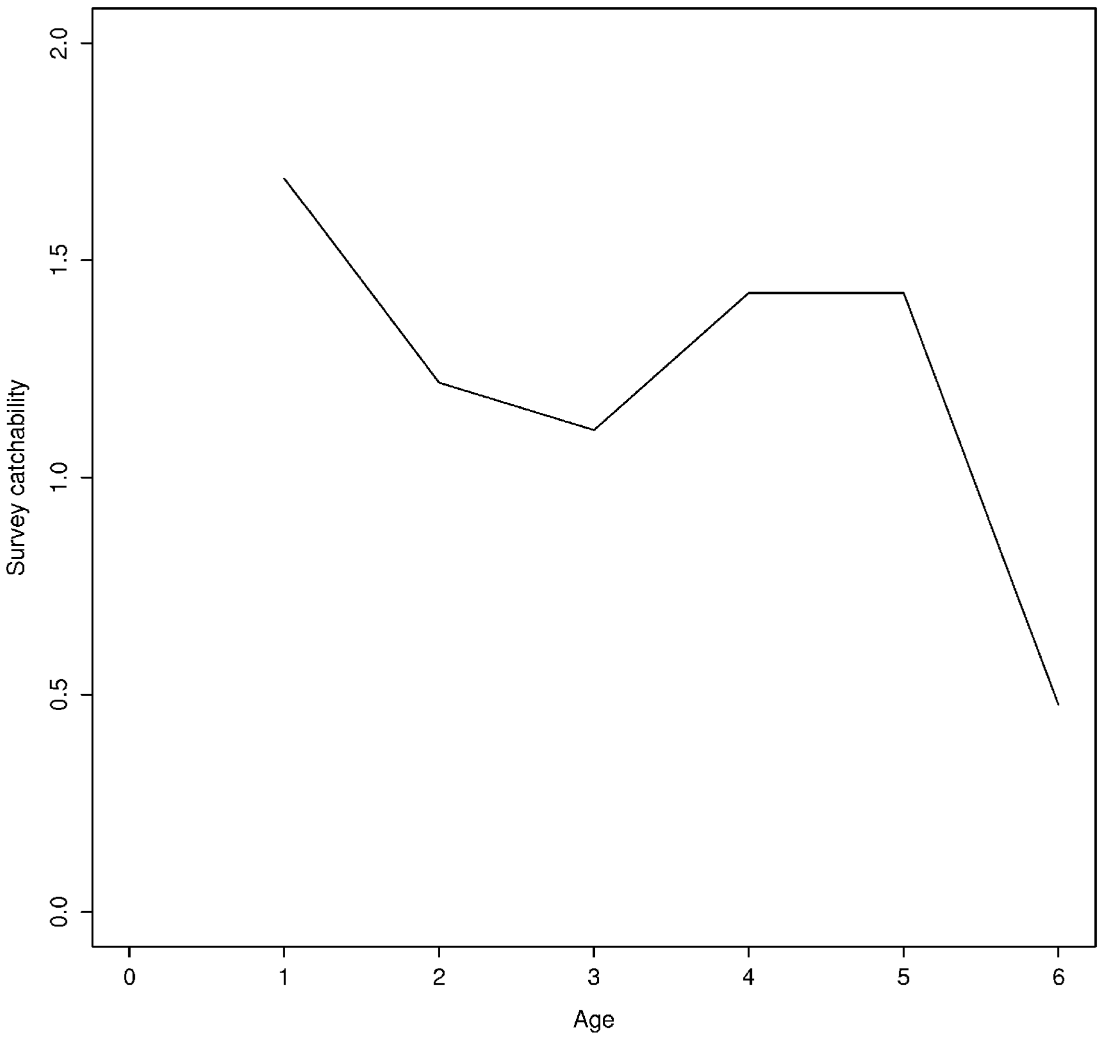


Figure 8.8.1.5: Sardine VIIIc and IXa: Survey catchability for ages 1 to 6+ in the final assessment model

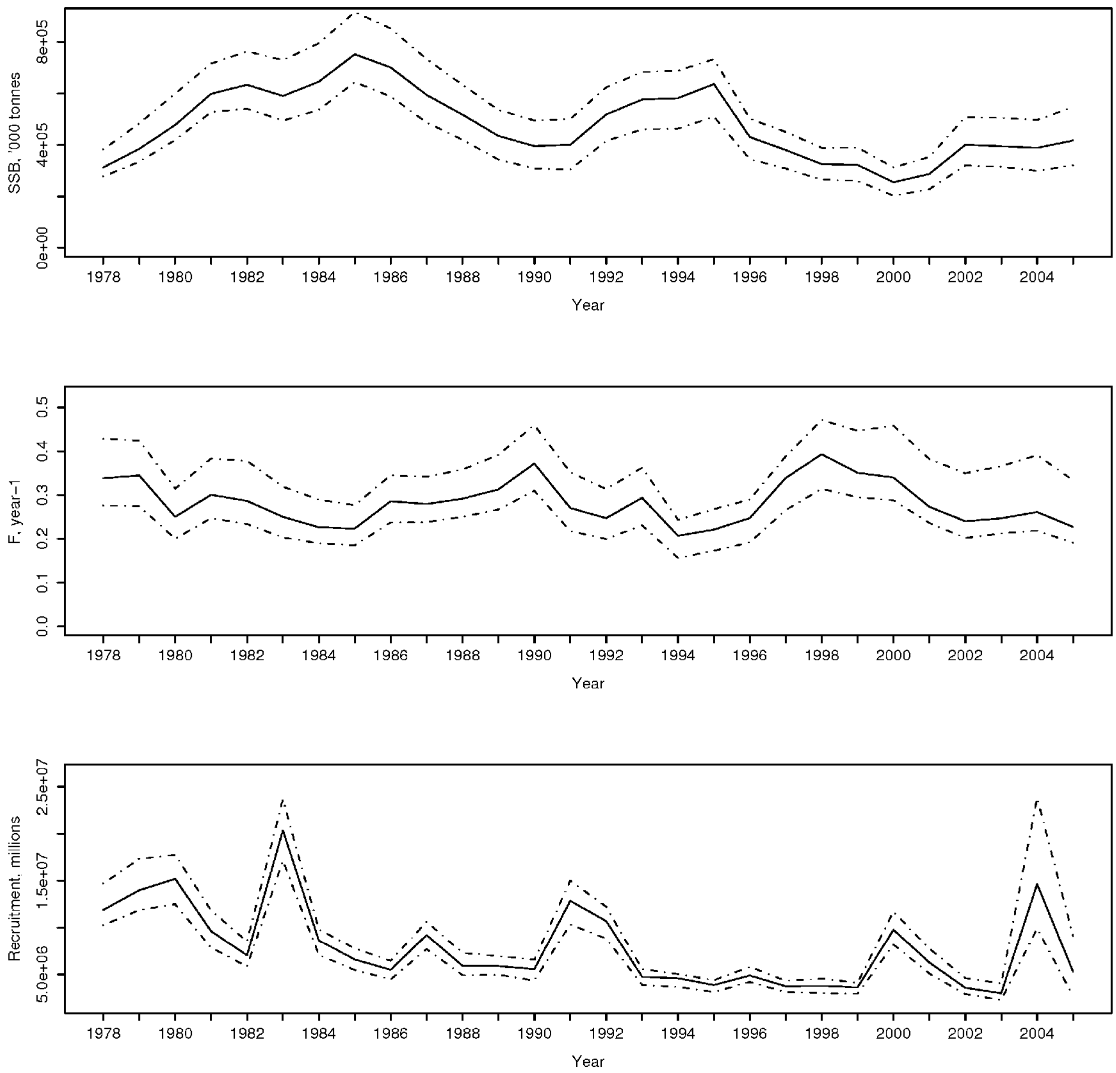


Figure 8.8.1.6: Sardine VIIIc and IXa: Bootstrap trajectories of SSB, recruitment and F for the final assessment model. Dotted lines represent the 90% limits

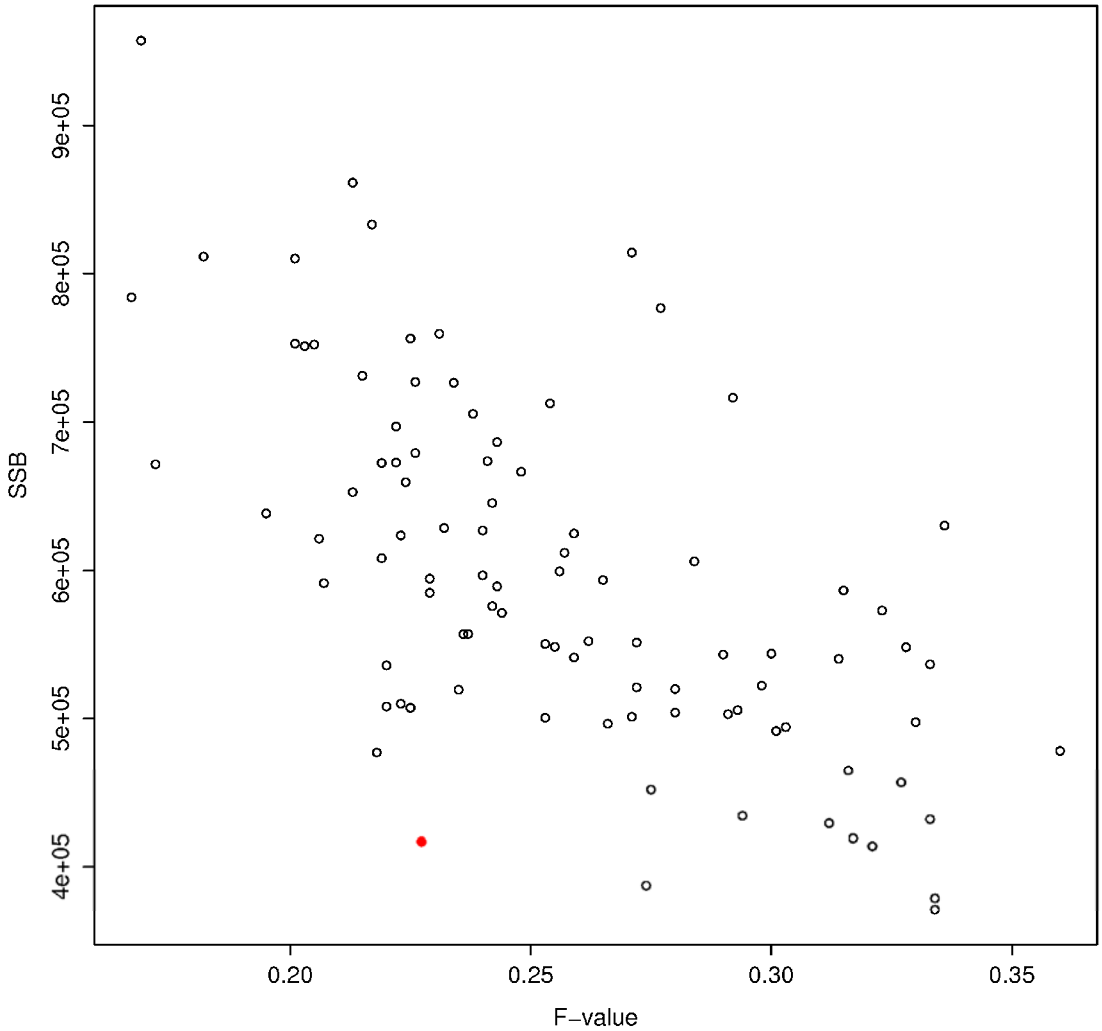


Figure 8.8.1.7: Sardine VIIIc and IXa: Relationship between bootstrap estimates of F and SSB for the final assessment model. Red point on the bottom of the figure represent the 2005 F point estimate.

9 Anchovy – General

9.1 Stock Units

The WG reviewed the basis for the discrimination of the stocks in Sub-area VIII and Division IXa. No detailed study has been made to discriminate sub-populations along the whole European Atlantic distribution of the anchovy. Morphological studies have shown large variability among samples of anchovies coming from different areas, from the central part of the Bay of Biscay to the West of Galicia (Prouzet and Metuzals, 1994; Junquera, 1993). These authors explained that the variability is reflecting the different environments in the recruitment zones where the development of larvae and juveniles took place. They suggested that the population may be structured into sub-populations or groups with a certain degree of reproductive isolation. In the light of information like the well defined spawning areas of the anchovy at the South-east corner of the Bay of Biscay (Motos *et al*., 1996) and the complementary seasonality of the fisheries along the coasts of the Bay of Biscay (showing a general migration pattern; Prouzet *et al.,* 1994), the WG considers that the anchovy in this area has to be dealt with as a single management unit for assessment purposes. Recent genetic studies carried out on samples collected during 2001 and 2002 French acoustic surveys seem to show that two well separate types of fish exist but that they are both present all over the distribution area of the species in the Bay of Biscay. This is totally in agreement with the idea to deal with this population as a single management unit for assessment purposes at the stage of the art.

Some observations made in 2000 during the PELASSES survey in winter suggest the presence of anchovy in the Celtic Sea (Carrera, 2000). So far, these observations not affect our perception of one stock in the Bay of Biscay area. Anchovy found in the Celtic sea area is probably linked to the population of anchovy found in the Channel in spring by the professional fisheries.

Junquera (1993) suggested that anchovy in the Central and Western part of Division VIIIc may be more closely related to the anchovy found off the Western Galician coasts than with the anchovy at the South-east corner of the Bay of Biscay (where the major fishery takes place). Morphological studies, as mentioned previously, are influenced by environmental conditions and further investigations, especially on genetic characteristics, are necessary in order to be more certain. The WG considers that for assessment and management purposes the anchovy population along the Atlantic Iberian coasts (Division IXa) should be dealt with as a management unit independent of the one in the Bay of Biscay

In Division IXa, the differences found between areas in length distributions, mean length- and mean weight at age, and maturity-length ogives, which were estimated from both fishery data and acoustic surveys, support the view that the populations inhabiting IXa may be not entirely homogeneus, showing different biological characteristics and dynamics (ICES 2001/ACFM:06). The recent catch distribution of anchovy along Division IXa confirms that anchovy fishery is mainly concentrated in the Spanish waters of the Gulf of Cadiz (more than 80% of total landings), which is also corroborated by direct estimates of the stock biomass (about 90% of total biomass). Such data seem to suggest the existence of an anchovy stable population in the Gulf of Cadiz which may be relatively independent of the remaining populations in Division IXa. These others populations seem to be latent ones, which only develop when suitable environmental conditions take place, as occurred in 1995. (See section 11 and Ramos *et al*., 2001)

Recent studies on anchovy catches between North of Morocco, the Gulf of Cadiz and South of Portugal (Silva and Chlaida, WD 2003) show parallel changes of the catches in the period

1963-2000. There is a need for further studies on the dynamic on the anchovy in IXa and its possible connection with anchovies from other areas.

9.2 Distribution of the Anchovy Fisheries

The observations collected by the members of the Working group allowed defining the principal areas of fishing according to quarters. **Table 9.2.1** shows the distribution of catches of anchovy by quarters for the period 1991-2005.

In Subarea VIII during the first quarter in 2005, the very scarce landings were caught around the Gironde estuary from 45ºN up to 47ºN by the French fleet. During the second quarter, the main landings were caught in the Southern part of the Bay of Biscay (south of 45°N), mainly in Sub-area VIIIb. The Spanish Spring fishery in 2005 suffered a complete failure. Due to the results of the Spring acoustic and eggs surveys, EU decided to close the fishery at the beginning of July. For this reason, there are no catches in subarea VIII during third and fourth quarters. In 2006, the Spanish fishery has obtained the same result and the fishery is actually closed.

Anchovy fishery in Division IXa in 2005 was again located in the Gulf of Cadiz area (Spanish part of the Sub-division IXa South) throughout the year as observed in recent years. Highest landings this year from this Division occurred during the first and second quarters, which were mainly caught by the Spanish fleets fishing in the Gulf of Cadiz. Spanish catches from the Subdivision IXa North were negligible. Portuguese anchovy landings from Division IXa in 2005 were relatively low as compared with the Spanish ones. Most of the Portuguese anchovy was caught in the Sub-division IXa Central North during the second half of the year.

Changes in anchovy distribution: In the Bay of Biscay, the stock is seen to have nearly disappeared from the Spanish coast and lost spawning grounds. Anchovy distribution expanded in northern waters since 1994 with no particular change in the southern limit. The means by which anchovy is expanding in the North Sea was questioned. Some indices coming from many bottom surveys (from 1990 to 2005) are describing the expansion of anchovy in the North Sea. There are also two hypotheses: good recruitment in micro local northern populations or vagrancy of adults from southern populations attempting to establish new life cycles in the North. (Report of SGRESP, ICES CM 2005/G: 06).

Table 9.2.1: Catch (t) distribution of ANCHOVY fisheries by quarters in the period 1991-2005

Q 1	DIVISION IXa				SUB-AREA VIII					
Year	IXa South	IXa CS	IXa CN	IXa North	VIIIc West	VIIIc Central	VIIIc East	VIIIb	VIIIa	VIIId
1991	1049	2	6	1	126	0	36	2797	1259	-
1992	1125	0	26	0	0	187	756	3666	958	-
1993	767	0	3	1	0	69	1605	4147	1143	-
1994	690	0	0	0	0	5	62	4601	786	27
1995	185	1	203	12	0	0	35		2380	
1996	41	0	1289	11	116	61	9	2345	0	-
1997	908	6.0	164	2	12	43	58	1548	925	-
1998	1782	109	424	192		472		4725	0	
1999	1638	65	91	76		65		4008	0	0
2000	416	61	41	0		88		4003	0	0
2001	1052	13	27	0		598		1406	0	0
2002	1775	80	6	3		14		3947	350	0
2003	1027	46	0	0		0		37	4	0
2004	1384	34	22	0		0		283	35	
2005	1383	4	21	1		2		413	0	0

Q 2	DIVISION IXa				SUB-AREA VIII					
Year	IXa South	IXa CS	IXa CN	IXa North	VIIIc West	VIIIc Central	VIIIc East	VIIIb	VIIIa	VIIId
1991	3692	0	10	14	90	295	5848	3923	650	-
1992	1368	0	10	0	11	457	17532	2538	275	-
1993	921	0	6	0	25	24	10157	6230	658	-
1994	2055	0	0	0	1	79	11326	6090	163	75
1995	80	7	1989	1233	23	36	14843		6153	
1996	807	1	227	6	1	404	9366	8723	0	-
1997	1110	2	49	4	0	81	4375	3065	598	-
1998	2175	0	191	51		2215		5505	0	
1999	1995	0	4	7		7138		4169	0	0
2000	668	0	5	1		14690		3755	0	0
2001	3233	3	30	4		13462		7629	0	0
2002	2964	2	14	1		3312		2118	90	0
2003	2539	2	37	2		2007		2022	4	0
2004	1976	17	45	1		6010		2743	66	0
2005	2252	2	39	0		99		613	0	0

Q 3	DIVISION IXa				SUB-AREA VIII					
Year	IXa South	IXa CS	IXa CN	IXa North	VIIIc West	VIIIc Central	VIIIc East	VIIIb	VIIIa	VIIId
1991	703	0	0	0	24	15	145	386	1744	-
1992	499	0	4	27	192	390	632	191	4108	-
1993	167	0	0	0	1	8	1206	1228	6902	-
1994	210	8	29	1	61	6	1358	2341	3703	15
1995	148	52	1817	4043	1	10	55		3620	
1996	586	0	189	22	134	146	1362	171	6930	-
1997	2007	0	44	2	202	3	735	4189	2651	-
1998	2877	12	49	5		1579		205	11671	0
1999	1617	0	139	318		949		351	5750	0
2000	673	0	0	7		1238		211	8804	0
2001	3278	3	107	13		1314		249	8788	0
2002	2705	6	200	11		381		3181	2223	0
2003	984	0	52	9		46		159	3988	0
2004	1553	0	11	1		266		2514	3019	
2005	705	0	10	0		0		0	0	0

Q 4	DIVISION IXa				SUB-AREA VIII					
Year	IXa South	IXa CS	IXa CN	IXa North	VIIIc West	VIIIc Central	VIIIc East	VIIIb	VIIIa	VIIId
1991	274	0	171	0	205	692	148	91	805	-
1992	4	1	96	6	8	18	204	27	5533	-
1993	105	1	13	0	0	0	574	1005	5106	-
1994	80	0	198	116	6	13	895	341	2520	14
1995	157	271	2716	42	398	148	18		2080	
1996	398	12	1002	5	21	12	158	204	4016	-
1997	589	0	353	54	93	83	530	1225	1354	-
1998	2710	32	231	123		27		1	5217	0
1999	692	30	723	12		98		0	4266	0
2000	603	0	25	2		98		266	3843	0
2001	1091	0	234	11		36		624	6042	0
2002	817	2	213	5		5		1041	845	0
2003	416	19	122	11		7		4	2317	0
2004	703	88	5	1		4		187	1181	
2005	82	1	13	3		0		0	0	0

TOTAL	DIVISION IXa				SUB-AREA VIII					
Year	IXa South	IXa CS	IXa CN	IXa North	VIIIc West	VIIIc Central	VIIIc East	VIIIb	VIIIa	VIIId
1991	5717	3	187	15	445	1003	6177	7197	4458	-
1992	2996	1	136	33	211	1053	19122	6422	10874	-
1993	1960	1	22	1	26	101	13542	12609	13809	-
1994	3035	8	227	117	68	103	13641	13373	7172	130
1995	571	331	6725	5329	421	194	14951		14233	
1996	1831	13	2707	44	272	623	10895	11442	10946	-
1997	4614	8	610	62	307	210	5698	10027	5528	-
1998	9543	153	894	371		4294		10436	16888	0
1999	5942	96	957	413		8249		8529	10016	0
2000	2360	61	71	10		16113		8235	12647	0
2001	8655	19	397	27		15410		9908	14831	0
2002	8262	90	433	21		3713		10288	3508	0
2003	4968	67	211	23		2061		2222	6312	0
2004	5617	139	83	4		6280		5727	4300	0
2005	4423	6	82	4		101		1026	0	0

Not available

10 Anchovy - Subarea VIII

10.1 ACFM Advice and STECF recommendations applicable to 2005 and 2006

The EU set the 2005 TAC for Bay of Biscay anchovy at 30 000 tonnes, with no provision for in-year adjustment.

After the low population level pointed out by the spring surveys in 2005, the European Commission decided to close the anchovy fishery in the Bay of Biscay from 3rd of July to 3rd of October, and to plan a STECF meeting as soon as possible to assess the stock according to new available information (mainly spring surveys) and give an advice on management measures to be considered in the near future. This STECF subgroup recommended that *the Biscay anchovy fishery should remain closed until reliable estimates of the 2006 SSB and 2005 year class become available based on the results from the spring 2006 acoustic and DEPM surveys. This implies closure of the fishery until at least July 2006. Minimum values of recruitment predicted to provide an SSB above current Blim and current Bpa are provided. The subgroup emphasises that any recovery is entirely dependent on good incoming recruitment.*

ICES advice from ACFM in October 2005 corroborated the STECF advice and stated that *the fishery should remain closed and should, at the earliest, be considered for opening if the acoustic and egg surveys in May-June 2006 demonstrate a strong 2005 year class.*

In September 2005 the European Commission extended the ban on anchovy fishing until the end of 2005.

In November 2005 STECF agreed with the ICES' advice and reiterated its July 2005 recommendations that *there should be a zero TAC for at least the first half of 2006 and that the fishery for anchovy in the Bay of Biscay be reopened in 2006 only if the results of the 2006 Spring surveys indicate that the Spawning Stock Biomass in 2006 is above Blim (21 000 t).* The EU Council in December established for 2006 a *provisional TAC of 5,000 t, which may not be fished before the 1st of March, and required a ban on fishing activities if STECF advises that the spawning stock size in 2006 is less than 28 000 t.*

In June 2006, the STECF assessed the Spawning Stock Biomass on the basis of the spring acoustic and DEPM surveys to be below Blim (21 000 tonnes) and recommended that *the Biscay anchovy fishery should remain closed until reliable estimates of the 2007 SSB and 2006 year class become available based on the results from the spring 2007 acoustic and DEPM surveys. This implies a closure of the fishery until at least July 2007. Minimum levels of recruitment needed to provide an SSB above current Blim and current Bpa in the absence of fishing are provided in the report. The subgroup emphasises that any recovery is entirely dependent on good incoming recruitment.*

The closure of the anchovy fishery until the end of 2006 was established by the European Commission on 20th July 2006 stating that *as the anchovy spawning stock biomass at spawning time in 2006 is below the threshold of 28 000 tonnes, the fishery has to be prohibited for the remainder of 2006.*

10.2 The fishery in 2005 and 2006

10.2.1 Catches for 2005 and first half of 2006

Introduction: Two fleets operate on anchovy in the Bay of Biscay: Spanish purse seines and French fleet constituted of purse seiners and pelagic trawlers. The pattern of each fishery has not changed in recent years (Table 10.2.1.1). The seasonal fisheries by countries are well described in the MHSAWG report (ICES 2004), and, in general (1992-2004), most of Spanish landings (85 %) are usually caught in divisions VIIIc and VIIIb in spring, while 35 % of the French landings are caught in divisions VIIIb in first semester and 65% in summer and autumn in division VIIIa (Table 10.2.1.2).

Spanish purse seine fleet: The Spanish fleet is composed of purse seines (of about 200 boats) that operate mainly in spring at the south-eastern corner of the Bay of Biscay (in Divisions VIIIc and b), when usually more than 80 % of the Spanish annual catches (Table 10.2.1.2). The major part of this fleet goes for tuna fishing in summer time and by then they use small anchovies as live bait for its fishing. These catches are not landed but the observations collected from logbooks and fisherman interview (up to 1999) indicate that they are supposed to be less than 5 % of the total Spanish catches. Since 1999, a part of the Spanish fleet goes to fish in the VIIIa during summer and autumn and lands significant amounts of fish as in 2001, but there was no catch in 2003 and 2004(Table 10.2.1.3).

French fleet: the main catches are produced by pair trawlers. The French fishery starts normally at the beginning of the year in the centre of the bay of Biscay. Progressively, the fishery is moving towards the south of the bay of Biscay (generally in April). After a voluntary break of the pelagic fishery (bilateral agreement) in April and May, the fishery moves north, and reaches sometimes the northern part of VIIIa in August or September. Later, the fishery moves to the centre of the bay. The major fishing areas are the north of the VIIIb in the first half of the year and VIIIa, mainly, during the second half. Area VIIIc is prohibited to the French pelagic fleet. A part of pelagic trawlers are opportunistic: looking at annual catches vessel by vessel, a high number of them can catch a small amount of anchovy at least once a year. Therefore, a good proportion of them are polyvalent and a threshold of 50 tons per year has been decided to separate target trawlers to occasional one. Therefore, the number of vessels that fish anchovy with a pelagic trawl can be very variable from year to year. (Duhamel E. et al, WD 2004). 2005 was an abnormal year: because of a particularly low level of biomass and a closure of the fishery at 1st july. So, the threshold separating target trawlers to occasional ones have been decreased to 10 tons of catches per boat during 1st semester.

French purse seiners are also opportunistic and they always operate around their home harbour, in coastal waters. Catches of anchovy by purse seiners are not regular because their real target species is sardine. The some French purse seiners located in the Basque country fish mainly in spring in VIIIb and the Brittanish one fish occasionally anchovy during autumn in the north of the Bay of Biscay.

Catches in 2005 (Table 10.2.1.2): In 2005 international catches of the first half of the year amounted about 1127 t, which represents only 12.3% of 2004 catches for the same period. Both French and Spanish fisheries landed far less anchovy than usual. This was particularly true for the Spanish fishery: By 12 May, (when usually about 40% of annual Spanish catches are already achieved) only about 176 t had been caught (i.e. about 1% of a normal year). This was a complete crash of the commercial fishery. Subsequently the fishery stopped and claimed for financial aids, along with a ban of the international fishery. The French fleet was also at a low level: with 952 tons, catches in first semester which represent only 45% of the 2004 landings for the same period (which in addition was just about half of a commercial year). So French catches during the first half of 2005 were about 21% of those taken over the same period in a normal year.

Due to the failure of the fishery and subsequent closure in July 2005, the catches made during the first half of the year accounted for the total annual catches.

Catches in the first half of 2006: The Fishery was open in March. The Spring Spanish fishery on anchovy caught up to the end of June 2006 about 972 tonnes (8% of average catches since 1987). These are the second worse catches of the whole series (with the sole exception being last year, 2005) (Table 10.2.1.2 and Figure 10.2.1.1). Monitoring of the activities of commercial purse seiners during May 2006 was performed by AZTI through incorporation of observers on board 4 fishing vessels of the Basque Country (Cotano & Uriarte 2006). They reported low rate of catches in comparison to years prior to 2005. The areas covered by these vessels are the typical areas of searching of the purse seine fleet, ranges from 45º20' N to the southern part of the Bay of Biscay and the regions between about the coast and beyond the shelf edge.

The French landings in the first half of 2006 amounted to 450 tonnes which are about at the same level than last year for the same period. which is about 10% of a normal year. They were landed mostly by the pelagic trawlers in June (since they are not allowed to fish in April and May). French purse seiners tried to catch anchovy between march and june but their very low catches may be due to a particular problem in catchability and accessibility.

The 2005 and 2006 anchovy catches are so far below any catch taken in previous years that they clearly constitute a fishery 'crash' since 2004. This drastic drop observed in 2005 and 2006 is related to the very low biomass level and partly, for the French fleet in particular, to the closure of the fishery between july 2005 and march 2006. In addition, acoustic survey suggest that anchovy seems to be more scattered at the surface than before (see section 10.4.2), so that the likely scarcity of surface schools might produce some catchability problems particularly for the purse seines.

After the new failure of the fishery and the review of the survey's SSB estimates, the fishery was closed in July 20th.

10.2.2 Discards

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

10.2.3 Schooling behaviour and catchability

In addition to the former uncertainties, the catchability of the fleets deserves also increasing studying. This is relevant for the study of fishing fleet dynamics and their relation to actual fishing mortality.

A better understanding of the dynamics of the fleets and their catchability patterns and seasonality could be used to better assess the effects of different management options and harvest control rules. On the other hand, understanding the catchability of the different fleets in relation to fish abundance and fish behavior could serve to clarify the differential degree of failure of catches for the different components of the anchovy fishery. On the one hand, the catchability of purse seine was shown to be more noisy than that of pelagic trawlers during the 2004 pelagic Working Group (ICES, 2005), On the other hand, the recent failure of catches seems to have been more intense for the Spanish purse seine fleet than for the French pelagic trawlers, a reason of which might come from the aggregation pattern of anchovy in schools: for the last 20 years anchovy has been generally well distributed as small schools of medium density and aligned between 15 and 30 m above the bottom in the bay of Biscay during the day, rising and schooling at the surface at night particularly during the spawning season (Massé, 1996), when purse seiners usually took advantage to catch it. However since the beginning of the XXI century, anchovy schools seem to appear more often at surface as very small schools or de-segregated along the surface both during the night and the day and they seem not to form school anymore at night (see chapter 10.4.2..). It would be certainly worth further studying the catchability phenomena of the fleets in relation to changes in fishing aggregation behavior, changes in abundance levels of biomass and their likely interaction.

10.3 Biological data

10.3.1 Catch in numbers at Age

In 2005 the age composition for both countries was based on routine sampling of catches for length and for grade compositions and on biological samples collected from surveys and market sampling:. Table 10.3.1.1 provides the age compositions by quarters and by countries in2005. In Spanish and French catches age 2 was predominant during the 1st semester 2005. We have to precise that fishery was closed at 1st july. A predominance of two years old anchovy is uncommun, and it shows a failure in the last recruitment. In 2005, age 2 represents 77% of spanish catches (but very few landings), and 68% of french ones.

Table 10.3.1.2 records the age composition of the international catches since 1987, on a half-yearly basis. 1-year-old anchovies have usually predominate largely in the catches during both halves of most of the years. However 2 years old anchovies are predominant in international catches during the first half of 1999, 2002 and 2005. Figure 10.3.1.1 shows the Spanish and French catch at age compositions of the first half of the year since 1987. The Spanish age composition during the first half of several recent years (2002, 2003 and 2005) are predominated by the age 2. In the French fishery the age group 1 usually contributes to 62% of the landings of the first half of the year, with a few exceptions (1991, 1999, and 2002). In the first half of 2005, the age groups 1 to 3 contribute to 16%, 67% and 16%, respectively. During the years when 2 years old predominated the catches, their level was low for both countries. This is typical of the occurrence of weak year classes and reduction of spawning biomass.

During the first half of 2006 there is no age composition of the French catches, but the analysis of the few Spanish catches reveal a preponderance of the 1 year olds (reaching about 60 %). In a historic perspective, the Spanish spring catches in 2006 indicate a remarkable proportion of age 1 in comparison with previous years (Figure 10.3.1.1), similar to the one detected in 2004, 2000 or 1998 when age 1 seemed to dominate the anchovy population at sea. However the low raise of catches in comparison with 2005 and the still remarkable occurrence of ages 2 and 3 suggest that the recovery of this population is still modest.

The catches of anchovy corresponding to the Spanish live bait fishery have not been provided since 2000. The Table 10.3.1.3 gives the data available for the period 1987 – 1999. These are traditionally catches of small anchovy mainly of 0 and 1 year old groups amounting about 5 hundred tonnes or less. Fishermen reported that they could hardly catch any juvenile anchovies for live bait tuna fishing in summer-autumn 2004. A similar observation in 2001 was followed by the failure of recruitment in 2002.In 2005, because of the ban on the fishery, live bait catches of anchovy were not allowed in bay of biscay. So, spanish vessels went to the Galician coast to catch small anchovy (very low catches), and sardine.

10.3.2 Mean Length at age and mean Weight at Age

Table 10.3.2.1 shows the distribution of length catches and the variation of mean length and weight by quarters in 2005 .

For the first quarter, in 2005 the only fishery was the French one (Figure 10.3.2.1), with a mode 15 cm). As usual, very low Spanish catches occurred.

For the second quarter, the french fishery is also the main one and showed a unimodal distribution with a mean length of 15.13 cm (mostly age 2). On average, the anchovies landed by the French fleet are smaller than those caught by the Spanish one in the second quarter (Figure 10.3.2.1). In fact, spanish catches are very low (only 171 tons), this year representing the lowest catches since landings are studied.

Because of the closure of the fishery, no catch were reported during the third and the fourth quarter.

The series of mean weight at age in the fishery by half year, from 1987 to 2005, is shown in Table 10.3.2.2. The French mean weights at age in the catches are based on biological samplings from scientific survey and commercial catches.

Spanish mean weights at age were calculated from routine biological sampling of commercial catches. The series of annual mean weight at age in the fishery is shown with the inputs to the explorative ICA assessment in Table 10.7.1.1a.These annual values for the fishery represent the weighted averages of the half-year values per country, according to their respective catches in numbers at age.

The values of mean weight at age for the stock appear with the inputs to the explorative ICA assessment in Table 10.7.1.1a. These values are the ones estimated for the spawners during the DEPM surveys of 1990-2004. For the years 1993, 1996, 1999 and 2000, when no estimate of mean weight at age for the stock existed, the average of the rest of the years is taken.

10.3.3 Maturity at Age

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

10.3.4 Natural Mortality

For the purpose of the assessment applied in the WG, a constant natural mortality of 1.2 is used. However, the natural mortality for this stock is high and probably variable. Natural mortality estimates after Prouzet et al, 1999 suggest that this parameter could vary from 0.5 to 3. From the results obtained, M (natural mortality) can vary widely among years and it seems that the assumption of a constant M used for the current management procedure is a strong simplification of the actual population dynamic.

Last year a seasonal separable VPA for the different fisheries operating on anchovy was carried out, by which essays of estimating a pattern of natural mortality value were essayed. However, as with other analytical models, natural mortality is confounded with catchability and fishing mortality and recruitment. Without some independent measure it is difficult to estimate M with the current model formulation and with the available data. Therefore, at the end the conclusion from such analysis was that by the moment, the simplest approach is to stay with the assumption of constant natural mortality of 1.2 for ages and years, which is a solution as good as any other so far attempted and is around the minimum WSSQ obtained for a set of model fittings for a range of natural mortality values. The catchability of the adult sampling for the surveys or the potential for a changing in natural mortality across age or between years for this population are issues that deserve further independent analysis.

10.4 Fishery-Independent Information

10.4.1 Egg surveys

Egg surveys to estimate the spawning stock biomass (SSB) of the Bay of Biscay anchovy through the Daily Egg Production Method (DEPM) have been implemented from 1987 to 2006, with a gap in 1993 (Table 10.4.1.1).

Daily Egg Production Method on anchovy in 2006 (DEPM2006)

The Daily Egg Production Method (DEPM) survey called BIOMAN06 to estimate the Spawning Stock Biomass (SSB) and population at age of anchovy in the Bay of Biscay was carried out in May 2006 (between 4 and 24 of May) by AZTI-Tecnalia within the frame of the Spanish Fishery Monitoring National Programme contracted with the European Commission and co-founded by the Basque Government (Santos et al. WD2006). preliminary SSB estimate presented at STECF in June (14-16) 2006 at Ispra (Italy) was 16,820 tonnes with a C.V. 25%. This was based on the total egg production (P_{tot}) and a Daily Fecundity (DF) obtained from a linear regression model between DF and sea surface temperature (SST). Here present the results of the complete application of the DEPM to the anchovy including all the adult parameters defining the daily fecundity (DF) (Santos et al. WD2006).

Sampling strategy was similar to previous years. The text table below summarises the different surveys contributing to sample for the application of the DEPM during May 2006:

Description of egg and adult samples obtained for the implementation of the DEPM

Parameters to estimate	Survey	Vessel	Date	Samples	Selected samples
Total egg production & Spawning area	Bioman 06	Vizconde de Eza	4-24 May	405	404 egg samples
Daily fecundity & Numbers at age	Bioman 06 Commercial fleet Pelgas 06	Vizconde de Eza Purse seines “Thalassa”	4 - 24 May 4 - 24 May 1 - 31 May	4 29 14	3 adult samp. 23 adult samp. 11 adult samp.

The area covered was the southeast of the Bay of Biscay, from 43º20’ to 46º40’N and from 1º10’ to 4º20´W, which corresponds to the main spawning area of anchovy. The total area sampled was 59,991 km^2. The map of egg abundance and the positive spawning area for 2005 is shown in **Figure 10.4.1.1.** (number of eggs per 0.1 m^2) with the limits of the spawning area (24,614 km^2). Up to 45ºN anchovy eggs were spread as far as the 200m iso-line. There were less abundance of eggs between the coast and the 100m iso-line and more between the 100 and 200m iso-lines. In the area of influence of the Gironde River the eggs were distributed between the coast and the 100m iso-line. The eggs were found well near the coast and near the 100m iso-line. In a general view and comparing with the historical series the abundance was low.

The eggs were staged in the laboratory and transformed into daily cohort abundances using the Bayesian ageing method. Daily egg production (P0) and mortality (Z) rates were estimated by fitting an exponential mortality model as a weighted non-linear regression model with weights given by the number of standard area units represented by each station:

$$E[P] = P_0\ e^{-Z\ age}$$

where *P* denotes the egg abundance by cohort in each station and *age* is the corresponding mean age. This regression was fitted for the entire set of egg abundances at age for all sampled stations in the positive area (**Figure 10.4.1.2**). No stratification was considered for the P0 estimate. The estimated parameters with the correspondent variance and coefficient of variation are shown in the table below:

	Bayesian ageing + N linear reg	
	Value	**CV**
P_0	4.3265	0.17
Z	0.266	0.40
Ptot	1.065 E+12	0.17

The total egg production estimate was computed as the product of the daily egg production and the effective positive area of spawning, resulting in 1.065*E12 eggs per day with a coefficient of variation of 17%. This egg production is among the lowest egg productions of the historical series of estimates in the Bay of Biscay, but certainly higher than in 2005 (**see Table 10.4.1)**

Adult samples to estimate the Daily Fecundity were obtained from 3 different sources: samples taken directly during DEPM survey on board R/V Vizconde de Eza, opportunistic samples from the commercial fleet and samples from the French acoustic survey conducted by IFREMER on board R/V Thalassa (Figure 2). From a total of 47 samples 37 were selected according to its coincidence in time and space with the sampling of eggs (**Figure 10.4.1.3**). Processing of adult samples and examination of gonads for the estimation of the parameters of Daily specific fecundity (sex ratio, mean weight of mature females, Batch fecundity and spawning frequency) followed the standards of the DEPM as applied in previous years (Lasker 1985, Santiago and Sanz 1992, Motos 1994, Motos 1996).

For the purposes of producing population at age estimates, an Age Length Key (ALK) of a total of 1,462 otoliths readings was built up from 30 anchovy samples taken on board R/V Vizconde de Eza and purse seines. To estimate the population at age a total of 37 samples were selected and 4 regions were defined: Garonne, Arcachon, Adour and Outer region. 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 numbers (see details in Santos et al WD2006).

According to a lower mean weight and younger age composition of anchovies close to shore than those in the outer shelf regions (**Figure 10.4.1.4**), a search for any difference in any of the daily fecundity parameters was made (Santos et al. WD2006): no difference was found either in the Batch fecundity or the daily spawning fraction. In any case weighting factors for the samples by regions were applied to estimate the Daily Fecundity of the population: Weighting factors were allocated according to the amount of samples in by regions respective to the relative egg abundance, so that a weighted average of the individual parameters per sample across both regions (as a pool) was made (Santos et al. op.cit).

The adult parameter estimates along with the spawning biomass (SSB) and population at age estimate, appear in **Table 10.4.1.2**. The SSB estimate for 2006 turned out to be about 21400 tones and, following the DEPM, it was computed as the quotient between the total egg production and the daily fecundity estimates. By applying the delta method to the quotient of total egg production by Daily Fecundity (DF) a CV of 19% was deduced for the above SSB estimate.

The preliminary SSB estimate presented at STECF in June (14-16) 2006 at Ispra (Italy) was 16,820 tonnes with a C.V. 25%. This was based on the total egg production (Ptot= 1.08 *E+22) and a Daily Fecundity (DF) obtained from a linear regression model between DF and sea surface temperature (SST) (DF inferred at 64.071 eggs/day and gram of anchovy). The current estimate of SSB (= 21,436 t) obtained through the complete application of the DEPM on adults results in an increase of 27%, mainly due to the new estimate of Daily Fecundity (at about 50.14 eggs/day and gram of anchovy), at 78% of former inference which explains basically the different SSB estimates.

From a historical point of view the current final biomass estimate is among the lowest of the whole series (along with the 1989, 1991, 2003, 2004 and 2005). Certainly, this estimate (21,426) reflect some recovery in comparison with the 2005 DEPM SSB estimate of 8.033 t, but this recovery seems not to be sufficient as to clearly overpass the threshold biomass limit of 21,000 t (Blim) (set by ICES at 21,000 tones) (**Figure 10.4.1.5**). The low DEPM estimates of SSB are due to the low egg abundances recorded during these years (**Figure 10.4.1.6).**

Age composition of the population (**Figure 10.4.1.7**) shows that the partial recovery of the biomass is due to some recovery of the recruitment (although being in absolute still low). However, an inconsistency appears in the amount of age 2 which has been estimated in this year, because it is larger than the one years old estimated in 2005. This similar to the acoustic observation and the integrated assessment will have to deal with it.

This is the fifth consecutive recruitment failure in the anchovy population. The current survey confirms that this anchovy population is passing a period of low productivity since 2002. This result supports the vision that the failure of the fishery is being largely due to the decrease of the SSB level.

10.4.2 Acoustic surveys

PELGAS06 survey

The French acoustic survey estimates available from 1983 to date are shown in Table 10.4.2.1. In 1993, 1994 and 1995, the survey was targeted only on anchovy ecological observations and mainly close to the Gironde estuary, the Gironde being one of the major spawning areas for anchovy in the Bay of Biscay. In 1997, 1998 the surveys were broadened in scope to provide acoustic abundance indices for anchovy as well as the ecological work (Anon. 1993/ Assess:7).

In 2000 and 2001 a series of co-ordinated acoustic surveys were planned covering the whole continental shelf of south-western part of Europe (from Gibraltar to the English Channel). These were carried out within the frame of the EU Study Project PELASSES. The main objective of these cruises was the abundance estimation using the echo-integration method of the pelagic fish species present off the Portuguese, Spanish and French coast. Surveys were conducted in spring, using two research vessels: R/V Noruega for the southern area (from Gibraltar to Miño river – south Galicia) and R/V Thalassa for the northern area (North Spain and France) and combining two different survey methodologies: acoustics and CUFES. Since 2002, France continued regular spring surveys, using the same method as in the PELASSES project. These also followed the same transect layout in the overall area.

The 2006 acoustic survey PELGAS06 (Massé & al. WD 2006) was carried out in the bay of Biscay from 1st May to 31st May on board the French research vessel Thalassa. The objective was the same than since 2000, to study the abundance and distribution of pelagic fish in the Bay of Biscay and to study the pelagic ecosystem as a whole. The target species were mainly anchovy and sardine but were considered in a multi-specific context.

To assess an optimum horizontal and vertical description of the pelagic ecosystem in the area, two types of actions were combined: i) Continuous acquisition by storing acoustic data (from five different frequencies : 18, 38, 70, 120 & 200 kHz) and pumping sea-water under the surface, in order to evaluate the distribution of fish eggs using CUFES system, and ii) discrete sampling at stations (by trawls, plankton nets, CTD). Concurrently, a visual counting and identification of cetaceans and of birds (from board) was carried out in order to characterise the higher level predators of the pelagic ecosystem.

A total of 1355 prospected nautical miles were usable for assessment purposes and 56 pelagic hauls were carried out for identification of echo-traces (figure 10.4.2.1).

As the previous years, after echogram scrutiny, the global area has been splitted into strata where coherent communities were observed (species associations) in order to minimise the variability due to the variable mixing of species (ICES 2005). Allocation to species was therefore done using the standard method (Massé,J, WD2001) and biomass were estimated for anchovy, sardine sprat and horse mackerel. The global biomass estimates for each species are presented in the table below :

Anchovy	30 649
Sardine	229 071
Sprat	29 990
Horse-mackerel	155 782

Despite bad weather after the call (17 may) the Pelgas06 survey had already cover the whole potential area for anchovy distribution and the first coverage was therefore sufficient to carry out its biomass assessment by acoustic in suitable conditions. For anchovy, biomass were gathered into 2 well separated areas according to their specific length distribution (figure 10.4.2.2).

The biomass observed in spring 2006 is globally still low, quite similar to the 2004 one but nevertheless higher than in 2005. The spatial distribution of anchovy was characterised according to two main regions: the Adour and Gironde, which have been collected together into the "coastal area", while the Fer à cheval called "offshore area". In the Adour region (from the Spanish coast to 44°40N), anchovy were observed in a smaller area than in previous years and very close to the coast, mixed with sardine and mackerel. In the Gironde region (from 45°N to 46°20N) higher concentrations of small anchovy were observed, compared to last year and also close to the coast. Here, they were mixed with sardine in the southern part of the region, and with sprat in the northern part. Anchovy from the Gironde (9 to 13cm) region were the smallest. 75% of these coastal fish were estimated to be 1 year old, and 20% 2 years old. However, due to the minimum water depth required by the vessel to fish (20-25m), the inshore limit of anchovy distribution could not be defined and an underestimation of young fish, therefore, likely. The anchovy observed offshore in the Fer à Cheval region were much larger, with a mean length of 17cm (about 20-25 individuals per kilo). 14% of these fish were 1 year old and 62% 2 years old.

Globally it must be noted that during PELGAS06 survey the aggregation pattern was more similar to the 5 past years surveys than to the previous one. At least offshore, during the last surveys, anchovy appear more and more often close to the surface as very small schools or even scattered in opposition to 80s and 90s surveys when they were used to gather in small schools aligned 15 to 20 m above the bottom (Massé, 1996). This visible change in anchovy behaviour is associated to some changes in horse mackerel behaviour too and was confirmed by commercial fishermen. Because of this new aggregation pattern, S_A values were processed well separated according to their vertical distribution and attributed to species according to separate hauls. It should be noted that the lack of surface hauls possible during the previous years is now no longer an issue. A special setting (different doors and 'Dyneema' cables) of the usual gear now permits the gear to fish efficiently even at the very surface. Successful catches at several times during the survey showing that echo-traces at the surface were well identified.

A biomass estimate in tons and in number has been processed for each area at age group (table 10.4.2.2.), using length distributions at each closest haul. According to the very different length structure between the 2 separate areas of distribution : coastal and offshore fish (Figure 10.4.2.3)., two different age/length keys (Massé & al. WD 2006) have been settled and applied separately. Mean weight at age for 2006 are gathered in table 10.4.2.3.

The number of 1 year old anchovy was estimated at a level of 1 353.10^6 millions fish. Though the combination of the two observations 1) of eggs (CUFES) and 2) acoustics and pelagic trawl hauls, shows that the main abundance of anchovy was inshore (mainly closed to the Gironde) which is a more classical situation than last year; The offshore group was scattered in very small schools at the surface and constituted by very big anchovy. Globally the majority was small anchovy (74% one year old) and close to the shore. Although they were small a good proportion was attributed to age 2 up to an abnormal amount compare to the number of age 1 estimated last year. Nevertheless, despite a better age distribution equilibrium, the abundance of anchovy was very low.

During this survey, more than acoustic transects and pelagic trawl hauls, 888 CUFES samples were collected and counted, 44 vertical and 38 oblique plankton hauls and 82 CTD were carried out.

The eggs provided by CUFES were sorted and counted during the survey and two spawning areas were therefore localised (figure 10.4.2.6). CUFES data are considered here for distribution purposes and can't be considered for a quantitative estimate. The spawning areas were localised in the south of the Bay of Biscay (Adour), in front of Gironde and offshore along the "Fer à cheval" area. The distribution of eggs was in good agreement with the adult distribution, except in front of the Gironde where the eggs seemed to appear mainly offshore with CUFES and the adults were mainly inshore.

Hydrological conditions observed during PELGAS06 are similar to classic years with a beginning of warming up suggested by surface temperatures, an upwelling along the southern coast (Landes) and moderate river flows (figure 10.4.2.7.).

Because of bad weather, the last ten days were mostly used to prospect once more the southern area (where climate conditions were better) on three studies areas (figure 10.4.2.8.) : the Gironde, the "Fer à cheval" and Adour. The main objective was to study the nyctemeral behaviour of anchovy, the coherence between the eggs distribution and the adults one and to collect data on eggs density. The last experiments were carried out in order to validate a vertical model of distribution which could be usable in the future to validate CUFES data for a quantitative use. This second coverage of the southern area confirms the presence of anchovy in "Adour" area very close to the coast, which were suggested by the presence of eggs during the first part of the survey, but not in evidence according to the two hauls carried out too offshore

Conclusion : The anchovy biomass from the Pelgas06 survey has been estimated at 30.649 t. The number of 1 year old anchovy was estimated at 1,353 million fish, indicating a higher recruitment than in 2005. The global population observed in the Bay of Biscay was composed of 74% of age 1, 20% of age 2 and 6% of age 3. However, the following questionable point arises from the results obtained which should be noted: the number of age 2 were estimated at 390 million fish in 2006, whereas in 2005 age 1s were estimated at 107 million of fish. The higher number of age 2s in 2006 than there were age 1s in 2005 requires further data exploration and explanation. For instance, the interpretation of otolith patterns should be discussed with experts during the next otolith workshop in November, while hypotheses of a possible serious under-estimate of age 1s last year due to the effects of migration and/or catchability should also be investigated.

PELGAS series

These spring acoustic surveys are yearly carried out in the Bay of Biscay since 2000 applying the same surveying and sampling strategy. Looking at the series, 2 kinds of results may be considered. On the one hand the adult distributions (figure 10.4.2.4) compared for the same series which shows the drastic decrease in both the distribution area and in abundance in 2005 with a slight increase in 2006. It can be noticed that small anchovies are well present in front of the Gironde which is the normal situation. On the other hand, the age compositions in numbers along the same series (figure 10.4.2.5) shows the same decrease and particularly the lack of age 1 in 2005 but an increase in 2006 and a more normal age distribution with 74% of age 1. The recruitment is nevertheless of the same order than the

The number of eggs collected by CUFES during the survey (figure 10.4.2.9) was similar to the one observed the previous years (except 2001 where eggs numbers were extremely high).

Biomass estimates by acoustic survey since 1983 are shown in Figure 10.4.2.10. with the exception of 1985-1988. During this period, estimated biomasses have fluctuated between circa 18,000 tonnes to more than 130,000 tonnes.

10.4.3 Surveys on juvenile anchovy

10.4.3.1 JUVENA Surveys on juvenile anchovy

The JUVENA survey series (Acoustic surveying of anchovy juveniles) aims at estimating the abundance of anchovy juveniles in autumn in the Bay of Biscay. The long term objective of the project is to be able to assess the strength of the anchovy recruitment entering the fishery the next year so as to help on the provision of scientific advice to managers. The surveys take place annually since 2003 (Boyra and Uriarte, WD 2006) using acoustics, purse seine hauls 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.

So far, three surveys have been conducted (Boyra et al 2004, 2005 and WD2006 see text table below). They took place from mid-September to the beginning of October, covering the area from the coast to 5º W and 46º N onboard commercial purse-seines chartered specifically for surveying, although spatial coverage was enlarged to the north in 2005 and again further to the North in 2006 to assure full coverage of the whole juvenile distribution (despite the bulk of the juveniles seem to be South of 46ºN).

JUVENA SURVEYS SERIES

SURVEY	VESSEL	GEAR	PERIOD	Area in Bay of Biscay
JUVENA 2003	Divino Jesús de Praga	Purse seine	17 September - 15 October	South 46ºN East 5ºW
JUVENA 2004	Nuevo Erreinezubi	Purse seine	19 September - 20 October	South 46ºN East 5ºW
JUVENA 2005	Gure Aita José Mater Bi	Purse seine Purse seine	12 September - 07 October	South 47ºN East 5ºW
JUVENA 2006 (just taking place)	Itxas Lagunak Enma Bardan	Purse seine Pelagic trawling	12 September - 19 October	South 48ºN East 5º30'W

Acoustic data were recorded with a 38 and 120 KHz Simrad EY60 split-beam, scientific echo sounder system (Kongsberg Simrad AS, Norway), calibrated using standard procedures (Foote et al. 1987). The water column was sampled with acoustics up to depths of 100 m. A threshold of -70 dB was applied for data collection. Acoustic back-scattered energy by surface unit (SA, MacLennan et al. 2002) was recorded for each geo-referenced nautical mile (1852 m). In addition, continuous sea surface temperature and salinity measurements and CTD casts every 10 nm were conducted.

Fish identity and population size structure was obtained from fishing hauls and echo-trace characteristics. The hauls were grouped by strata of homogeneous species and size composition. Inside each of these homogeneous strata, the echo-integrated acoustic energy was separated by the contribution of each species according to the composition of the hauls. 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). Afterwards, the energy corresponding to each species-size was transformed into biomass using their corresponding conversion factor. The scattering cross section of anchovies according to their size was estimated using the parameters for anchovy detailed in Diner & Marchand (1995) (see further details in Boyra & Uriarte WD2006).

JUVENA 2005

Sampling coverage: The survey took place between the 12th of September and the 8th of October, a week earlier than the two previous years. The sampling comprised about 2750 nautical miles, 1750 of which corresponded to effective diurnal acoustic sampling (**Fig. 10.4.3.1.1a**). The second vessel, provided more fishing power and flexibility for the sampling strategy, and total of 85 fishing hauls were obtained between both vessels (**Fig. 10.4.3.1.1b**). The surveyed area, reaching on the coastal area up to the 47ºN, is wider than the one covered in previous years and it seems to have covered most of the whole juvenile anchovy distribution, since the last two northernmost tracks were empty of anchovy juveniles. The western limits were as well successfully covered.

Spatial distribution of anchovy: In 2005 (as in 2003), anchovy was distributed in two different areas at the time of the survey: the first one was the region bounded by the 2º30’ and 4º West and to the South of 45º30 (**Fig. 10.4.3.1.2**). Here, all anchovy were juveniles, found mostly pure, without mixing with other species (with the exception of occasional jellyfish) and was located in general in oceanic waters, off the continental shelf. This area contained the majority of anchovy juveniles in the entire surveyed area. The other important area for anchovy was located in the vicinity of the Garonne river plume. Here, the anchovy population was composed of both juveniles and adults, mixed with several other species (especially sardine, but also mackerel, horse mackerel, sprat and big jellyfish). The coastal juveniles (found in the Garonne area) were on average bigger than the oceanic ones. Separation between juveniles and adults was achieved through the collection of otoliths to anchovy samples per hauls, and construction of an Age Length Key for the stratum.

The live bait tuna fleet reported anchovy detections made from the beginning of August to the start of the JUVENA cruise. In agreement with the results of the cruise, all the anchovy schools reported were seen off the continental shelf and to the South of the 45º30’.

The positive area for anchovy in 2005 which served to estimate the acoustic abundance is shown in (**Fig. 10.4.3.1.2b)**. The acoustic estimate of anchovy juveniles in 2005 and in comparison with previous years are shown in **Table. 10.4.3.1.1**.

The coverage of the survey JUVENA 2005 can be considered satisfactory, as we have succeeded in covering a large extent of the foreseen tracks. The covered area was higher than the previous years thanks to the availability of the supporting second vessel, which provided more fishing power and flexibility for the sampling strategy, and a reasonably good weather conditions during the survey. The Western and Northern limits of the anchovy juvenile distribution were well established.

Comparison between different years

The spatial distribution of anchovy in the last years is shown in **Figure 10.4.3.1.3**. In 2003, anchovy was mostly located at the Cantabrian Sea and Southern French Coast. In this area, anchovy shoals (over 99% of them composed by juveniles) were spread over a narrow strip parallel to the shelf edge, about five miles off shore from it. Inside this strip, the shoals were quite dense and of good size (typically, about 40 to 50 m of diameter). The western limit of the juvenile distribution along the Cantabrian Sea was 5º W. In the northern coastal area the anchovy was less abundant and anchovy detections were made close to shore at the plume of the Garonne River. Here, half of the collected individuals were juveniles of about 10 cm in length and the rest 1 year old adults.

The coverage of the anchovy juveniles in 2003 south of 46ºN was successful, with the sole exception of a single transect at 3ºW where the anchovy juveniles still appeared close to the end of that radial. For all other transects, the acoustic track largely overpasses, by at least 3 nm, the end of the juvenile distribution. The neat distribution pattern of anchovy juveniles parallel to the shelf edge and the concurrent information provided by tuna skippers looking for juveniles for live bait purposes, suggest that the area to the north of the region covered by the transects along the Spanish coasts was empty of juveniles in 2003. For this reason the coverage seem to be sufficient in 2003, in spite of the fact that the surveying at 3 W do not allow discarding the extension of juveniles to the north in that area.

In 2004, anchovy detections were scarce in the surveyed area, more than 95% of it located in the Northern part of the French Coast. Of this, the population found in the Garonne plume consisted mainly in 1 year old adults whereas the population found in the southern part of the Garonne, were 11 cm long juveniles. In the Cantabrian Sea, the small amount of anchovy found, were juveniles of about 6 cm in length.

If we compare the three years, it is clear that the 2004 presented the least amount of juveniles in the series (being thus congruent with the subsequent crisis of the stock and collapse of the fishery during year 2005). In comparison with year 2004, years 2003 and 2005 show larger occupied areas and increased amount of anchovy juveniles (**Table. 10.4.3.1.1**). In fact, the abundance estimated for year 2004 was two orders of magnitude less than the abundances found in 2003 and 2005. When comparing between the latter two, the estimated biomass of juveniles in 2005 exceeded in about 40 % the 2003 one.

Comparability of results

The coverage of the sampling area was satisfactory all the years, covering the foreseen minimum standard area for inter-annual comparisons (that is south of 46ºN and East of 5ºW). The western coverage was completed every year. Concerning the Northern coverage, in order to estimate the amount of the anchovy juveniles that could have occurred in regions to the north of 46ºN, the 2005 coverage was extended to the North (up to 47º near the coast), finding negligible amounts of anchovy juveniles out of the standard area. This result is consistent with the observations made by JUVEGA surveys in 2003 and 2005, in which the anchovy detected to the North of the 46º was mainly composed of adults (Petitgas et al., 2004, Petitgas, 2005). A table providing comparisons of the three survey just to the south of 46ºN, could be provided for assuring comparability of results (but is not now available for this WG).

Doubts about the potential missing of juvenile anchovies in the offshore regions off the Cantabrian shelf during the first 2 years of surveys, have been raised particularly after comparison with the 2005 juvenile distribution. However this is not likely. The survey was adaptative and in case of having appeared juveniles, acoustic surveying would have been pursued to the north till reaching their limits in those years as well. In addition the survey is made with frequent contacts with skippers looking for juvenile anchovy as live bait, that in both years were re-assuring about the lack of detections to the north of the areas we had surveyed. The track where the northern limit was not achieved in JUVENA 2003, seems not to be a major problem for the concomitant information of skippers for tuna and for the neat pattern of the juvenile distribution, parallel to the shelf edge in all the area. Therefore, the error that it might induce is most likely to be minor, although a more significant error can not be discarded.

For the years with higher abundance of juveniles (2003 and 2005), the largest fraction of those juveniles (above 90%) was invariantly in offshore oceanic regions of the South of the Bay of Biscay (South of 461N), forming mostly pure schools of anchovy juveniles close to surface during day time, well fishable by purse seining. This spatial distribution of juveniles endorses the conclusions obtained from JUVESU project (Uriarte, 2002), concerning the suitability of the acoustic surveys for anchovy juveniles. The reason is the mostly mono-specific distribution of juvenile anchovy in offshore grounds and it's epipelagic distribution (but below the blind zone of transducers), therefore well identifiable, detectable and fishable.

Some potential problems of this survey are discussed:

Bad weather conditions may make the juveniles to sink or disperse, thus making them less visible to the equipment. In order to overcome the noise due to that behaviour of juveniles, it's always been included (as a contrasting information) reports of juvenile detections by live bait tuna fishing boats, which can ultimately point out if a failure in the detections of juveniles have occurred during JUVENA surveys. There was no indication of those failures in the past (nor in 2005).

The doubts about the fraction of juvenile than can be located North of 46º has been overcame by extending the limits of the coverage of JUVENA surveys. Anyway, according to our data and the feedback from the live bait tuna, this fraction seems to be very low.

The potential problem of only using a purse seine has also been overcomed for 2006, since a pelagic trawling will be incorporated (in addition to purse seining) to the JUVENA survey.

Relationship between JUVENA juvenile index and assessment of 1 y.o. recruits.

Figure 10.4.3.1.4 present the series of juvenile acoustic abundance indices in autumn each year in comparison with the assessment of the population at age 1 at the beginning of the following year (as resulting from the ICA assessment presented in section 10.7.2 and for the Bayesian biomass model in section 10.8. By the time being, the results were encouraging since the huge drop in juveniles abundance estimates recorded by JUVENA surveys in 2004 matched well with the drop in the recruitment of age 1 to the adult population occurring in 2005. On the other hand a recovery of the recruitment at age 1 in 2006 as suggested from the JUVENA 2005 index has certainly occurred, as revealed the assessments in conformity with the spring surveys estimates of the population in this year. However that recovery was not as intense as the relative index would suggest. The coefficient of correlation between the assessments at age 1 and the JUVENA estimates are 0.88 and 0.92 for the two respective models (ICA and Bayesian), besides of not being statistically significant yet given the low amount of observations (3).

In summary, in the first three years of cruises, the project has succeeded in predicting the failure of the recruitment (at age 1) in 2005 and the partial recovery in 2006 (as reported by surveys in May 2006). These encouraging results suggest that the current definition of JUVENA survey might in future contribute to forecasting the strength of anchovy year classes. These series of campaigns, however, in order to become quantitatively useful, will need some additional years of observations so that proper calibration of its juvenile biomass estimates can be made with next year's biomass estimates of 1 year old recruiting the adult population.

The JUVENA survey in 2006:

In 2006 the JUVENA survey will be sponsored by the Basque and Spanish Governments (Viceconsejería de Pesca and the MAPA respectively), and will operate with two vessels (Text table above), both equipped with acoustic devices, a purse seine and a pelagic trawler. The area has been expanded to cover the whole Bay of Biscay, south of 48ºN and east of 5ºW (**Figure 10.4.3.1.5**). This will produce the fourth estimation of juveniles in the series which will allow further testing of the predictive capacity of this acoustic abundance index.

10.4.3.2 French Acoustic survey JUVAGA for Juveniles

The cruise JUVAGA05 (Juveniles Anchois Gascogne 2005) was focused on juveniles of anchovy in the Bay of Biscay and took place between the 5th and 17th October 2005. It was part of a series of IFREMER research cruises initiated in 2003 and planned every 2 years on board RV Thalassa, the objectives of which are: (1) the validation of an IBM larvae drift growth and survival model, designed to provide an early index of juvenile abundance; (2) the understanding of the mechanisms governing juveniles recruitment to the adult stock; (3) the hydro-plankton characteristics of juvenile habitats; and (4) the characterization of the conditions in which juveniles can be reliably observed and evaluated at sea with acoustic methodology

Method

The cruise used acoustic methodology with pelagic trawl hauls and hydro-plankton stations. The strategy was to visit particular areas for a few days (Figure 1a-b). In each area once juveniles were located their schooling behaviour, during a day-night cycle as well as their behavioural relationship with adults, were observed. In each area, juvenile habitats were characterized in terms of hydrology, plankton and fish community.

The following operations were undertaken: (1) Acoustic backscattering was digitally recorded continuously along the cruise track at 4 frequencies: 38, 120, 70, 200 kHz; (2) Pelagic trawling was performed with a mid-water trawl with 20m of vertical opening and 52m of horizontal opening. Trawling was performed depending on echo-traces between 07:00 and 22:30 local time, at surface, near bottom or in mid-water;

(4) Combined CTD / LOPC casts (Laser optical particular counter) were shot after each trawl haul and also along transects to describe physical structures; (5) Triple WP2 vertical hauls were performed after each trawl haul. The triple WP2 was mounted with 2 nets of 200□ mesh-size and 1 net of 50□ mesh-size.

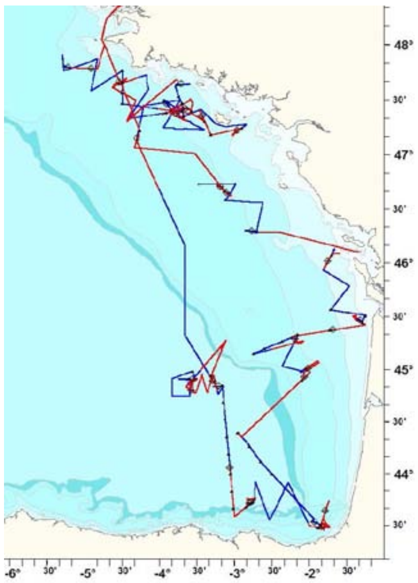


Figure 1a: Cruise track by day (red) and night (blue) with trawl hauls (circles with cross) and ctd/lopc casts (black triangles).

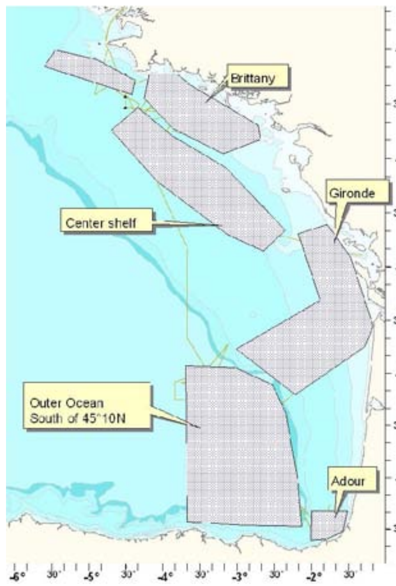


Figure 1b: Areas which were investigated

Results

Spatial distribution of anchovy juveniles (age 0)

Age-0 anchovy displayed a large length range, from 3.5cm to 14.5cm with two length modes at approx. 5cm and 10cm. The outer ocean area off the shelf South of 45°10N (45°10N – 43°35N, 2°W - 3°40W) comprised small age-0 anchovy only with length ranging from 4cm to 9cm. These juveniles were independent of the adult stock (i.e., still not recruited to the stock). Echotraces of these small age-0 anchovies were typically subsurface aggregations (0-30m) by day and night.

In coastal areas (Adour, Gironde and Brittany) age-0 anchovy had always a length greater than 8cm and was observed mixed with the adult anchovy age-1+. These juveniles displayed a day/night schooling behaviour as the adult fish. They were recruited to the adult stock age-1+.

On the shelf centre (around isobath 100m), age-0 anchovy was not encountered, meaning that nearly all the age-0 fish had already been recruited to the adult stock.

In the Northern border of the Brittany area (North of 47°40N and West of 4°W, following the isobath 100m), large anchovy were observed (length > 16cm) alone, not mixed with juveniles. These fish could represent a different component of the stock, with a different behaviour.

Schooling behaviour of anchovy juveniles and adults

Trawl hauls were repeated by day and night in areas of anchovy presence to characterize their day-night schooling behaviour.

Small age-0 anchovies alone. Small age-0 anchovy (4-8cm) off-shelf South of 45°10N made characteristic subsurface aggregation/schools/layers between 0-30m. Such echotraces at night also contained Euphausidae and Myctophidae making dense layers.

Large age-0 anchovies mixed with age-1+ of similar size. Large age-0 (>8cm) in coastal waters made bottom schools during day time and were dispersed at surface (0-25m) during night time. They were mixed with adults age-1+ in the trawl catches.

Large age-1+ anchovies alone. The core adult population (including the newly recruited juveniles) displayed a length range from 10cm to 15cm. But larger fish were observed alone with length greater than 16cm, North of 47°40N and West of 4°W and following the isobath 100m, possibly associated with the tidal mixing front of the Iroise. These large anchovies were not mixed with the core population and showed particular schooling behaviour. They typically formed day time anchovy schools near the bottom but were also totally diffuse near the surface during day time.

A qualitative note on age-0 abundance

A large range in age-0 length was observed, meaning that different spawning periods have been successful in providing off-spring.

Perspectives - Sampling strategy and technical issues

Issue on fish echo-traces distinction at night

During day time the fish were gathered in surface schools, whereas during night time they were spread among a dense layer of plankton (Euphausidae and Myctophidae). Figure 2 presents echograms of juvenile anchovy during day time (2a) and night (2b) observed at the same geographical position. The layers of plankton send back high acoustic energy among which the fish acoustic response is not distinguishable, and so not quantifiable.

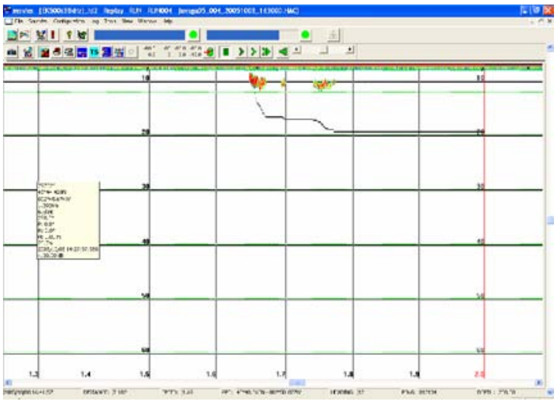


Figure 2a: Juvenile anchovy school during day time. Acoustic energy (Sa) = 830m2/mn2.

Catch = 32kg of anchovy (mean size = 6.4cm)

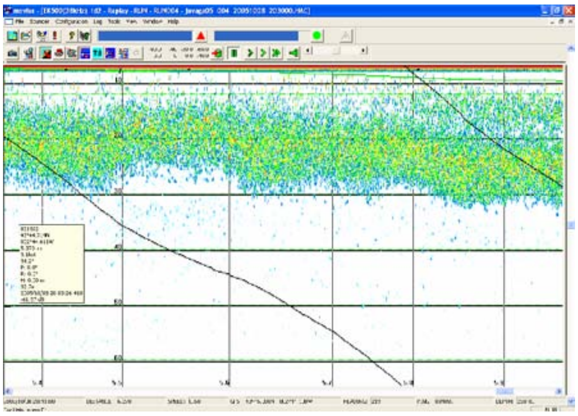


Figure 2b: Juvenile anchovy during night time mixed with dense plankton layer. Acoustic energy (Sa) = 10 163m2/mn2

Catch = 33kg of anchovy (mean size = 5.4cm)

Reliable estimates of juvenile anchovy in autumn

In addition to information on juvenile anchovies, the survey collected valuable information on the Bay of Biscay ecosystem as a whole during autumn (fish, physics, plankton). There is a need for maintaining an adaptive sampling strategy to characterize meso-scale structures (eddies, river plumes, fronts) and currents (advection). In addition, it is necessary to resolve plankton sampling vertically to define food quality in distinct vertical layers as well as distinguishing juvenile fish from plankton echo-traces by their ground-truth identification. For future autumn cruises the possibility should be evaluated of deploying more comprehensive hydro-plankton equipment, together with the CTD/LOPC (e.g., fluorometer, water sampling bottles, oxygen probe) and zooplankton vertical multi-net samplers. Also, stomach content should be sampled systematically to define juvenile anchovy food preferences. Large areas where juvenile anchovy is potentially present (e.g., Landes shelf, West of 3°W) have not been visited at all. A one month period would be necessary for a full investigative cruise. The JUVAGA05 cruise thus identified some important processes for which more comprehensive investigations are required.

It is, therefore, crucial to continue these studies in order to understand the mechanisms which lead juveniles to join the adults in order to adequately relate juvenile abundance in autumn to recruitment in the following spring.

10.4.3.3 Spanish experimental surveys for Adults and Juveniles using commercial fishing vessels

Due to the critical situation of the anchovy resource in 2005, the Spanish Fishery Administration allowed fishermen's associations to carry out experimental surveys with the aim of obtaining some new or useful information on anchovy distribution in the Bay of Biscay. This survey called, "Centinela" (Sentinel in English), was carried out in December 2005 and was designed by the IEO (Abaunza & Villamor, 2005).

The objectives were:

To know the anchovy and other pelagic fish distribution in late autumn in the Bay of Biscay.

If possible, to obtain a qualitative information of the relative density of anchovy.

To get information on anchovy demographic structure in late autumn.

Five commercial fishing vessels (purse seiners) participated in the survey and five observers were also onboard. They followed a sampling grid consisting initially of 34 transects covering the shelf along the Bay of Biscay from 4ºW at the Spanish coast up to 48º N at the French coast. The method was to use the vessel's echosounders to explore the area and to make opportunistic fishing hauls to identify the shoals and to collect biological information. In addition, the same transects were made by day and by night (by different vessels) with the aim of having more opportunities to fish anchovy with the purse seine. Anchovy is usually distributed at the surface by night.

In fact 31 transects were actually done (see Figure 10.4.3.3.1) but due to the bad weather only 10 fishing hauls were done. Therefore, the major part of the echosounder's interpretation was based on the experience of the skippers.

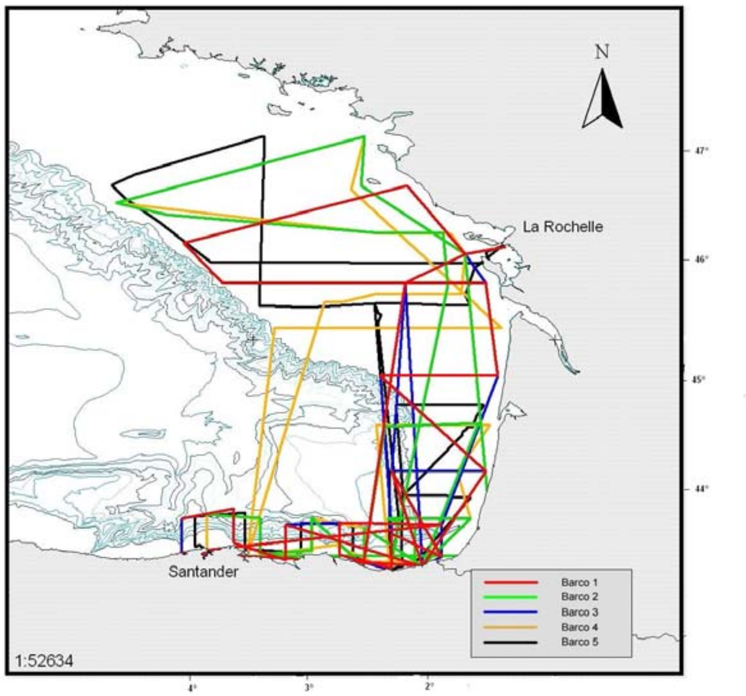


Figure 10.4.3.3.1. Study area showing the tracks of the five commercial fishing vessels

Main results:

a) Anchovy shoals were scarce, the majority appearing in the Gironde area corresponding to a bathymetric range of between 50 and 150m. There were also some indications of anchovy presence at 46º N and at 125-200 m depth but there were no fishing hauls to confirm these observations (see figure 2). Positive anchovy catches (apart from one testimonial fishing haul = 1 kg of anchovy) were mixed catches, mainly with sprat, sardine and Alosa sp., in which anchovy was never the most abundant species.

b) There were sardine shoals along the whole study. Horse mackerel and mackerel also occurred with some regularity. The species composition of the catches in the Gironde area showed the highest diversity of pelagic fishes.

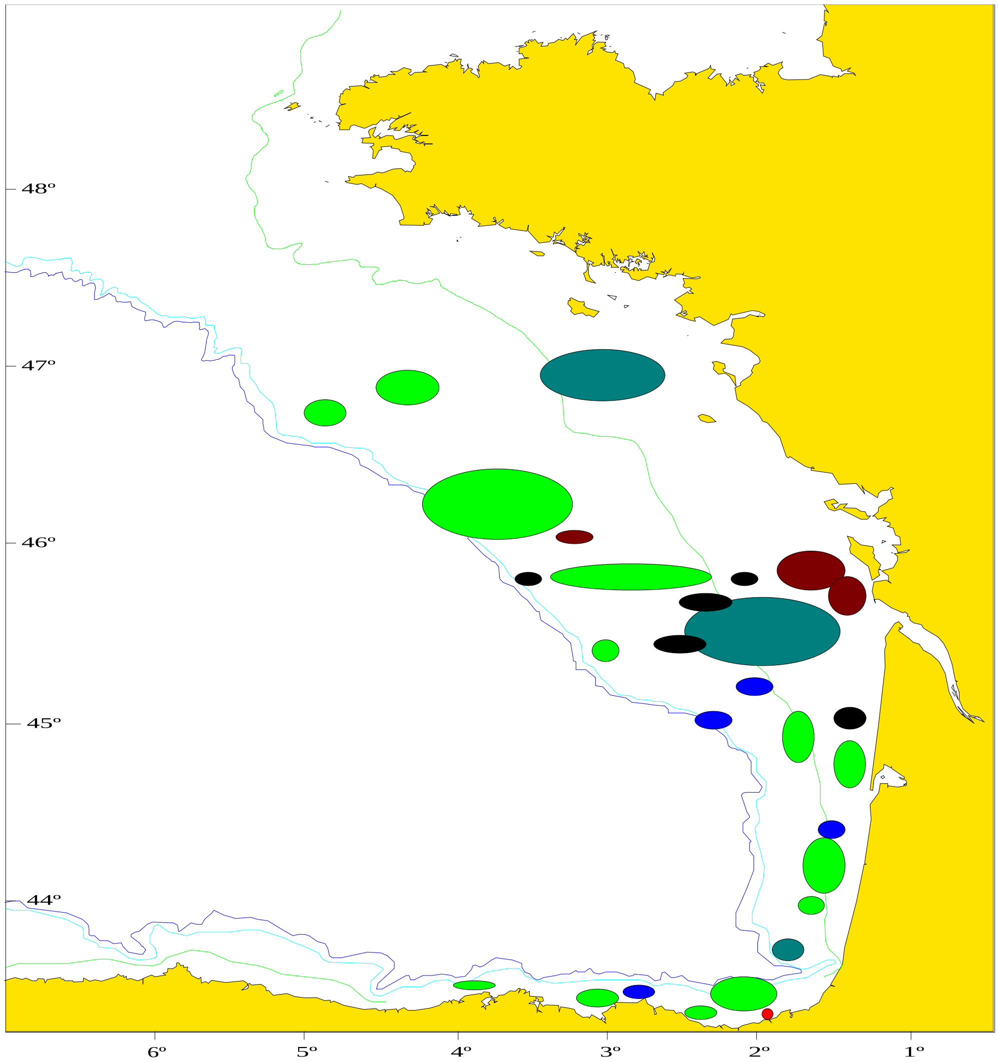


Figure 10.4.3.3.2. Distribution of the fish shoals observed in the "Sentinel survey". Key. Red = anchovy. Red with lines = mixture of species with anchovy presence (sardine, sprat, Alosa sp., anchovy etc). Green = sardine. Dark blue = horse mackerel. Light blue with lines = Mixture of species (sardine, horse mackerel, and mackerel). Black = Unidentified shoals. [Note: this figure represents qualitative information only. The major part of the identification criteria was based on the experience of the skippers (few fishing hauls).

c) Demographic structure: the length range of anchovies in the catches was 6 – 15 cm, with the mode in 12.5 cm. Eighty-four percent of sampled specimens were below 13.5 cm (Figure 10.4.3.3.3). This length range corresponds with ages 0, 1 and a few age 2 (Figure 10.4.3.3.4). The specimens collected in the Garona area showed that age 1 was reached at a smaller length than the anchovy sampled in the northern coast of Spain. This causes the strange pattern in the proportion of ages in total sampled specimens (Figure 10.4.3.3.4.)

Regarding the pelagic species sampled in the survey: sardine, horse mackerel, mackerel, sprat and Alosa sp., the majority of the catches were composed by juveniles, apart from sardine in which the two segments of the population, adults and new recruits, was evident.

The mixed catches in the Garona area (anchovy, sprat and *Alosa sp*.) showed that all these species had almost the same length structure, between 11 – 13 cm.

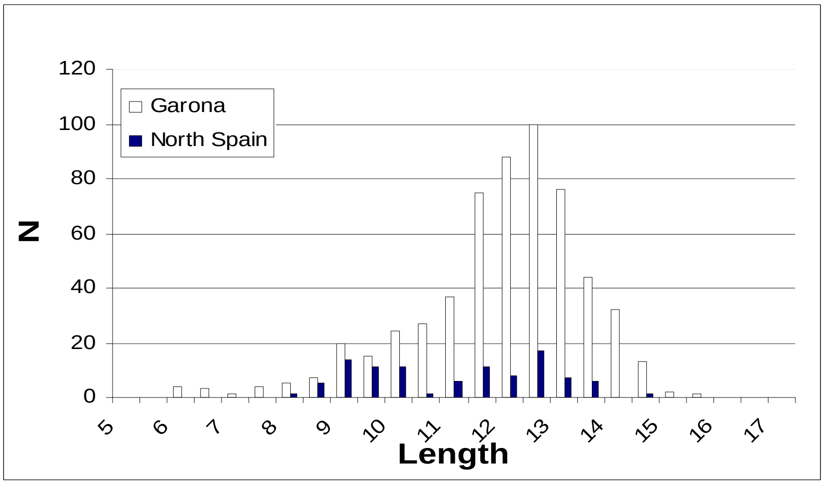


Figure 10.4.3.3.3. Anchovy length distribution by area

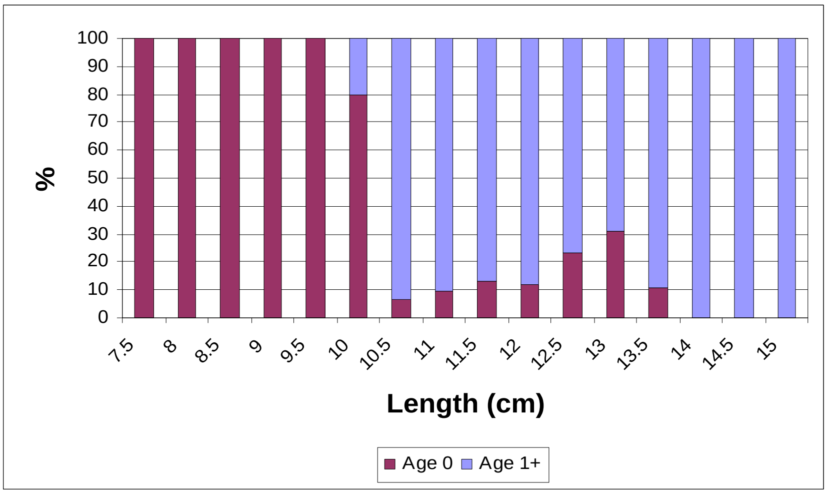


Figure 10.4.3.3.4. Percentage of anchovy ages in the catches.

10.4.3.4 French Commercial fishing vessels' survey in autumn 2005 for juveniles

This survey was organised at the request of French commercial fishermen and took place between 25 and 30th September 2005. The objective was to try to have an indication of juveniles of anchovy abundance by surveying the Bay of Biscay using 8 commercial fishing vessels (ie. 4 pelagic pair-trawlers) from the 2 main pelagic harbours (La Turballe and St Gilles Croix de vie).

The survey protocol was drawn up by IFREMER where samples and data were also processed. One of the vessels was equipped with a SIMRAD ES60 which made it possible to store HAC files and analyse them visually. The others only took pictures of their echo-sounder screens when the characteristics of the echo-traces lead them to fishing operations.

After fishing (see species compositions on Figure 10.4.3.4.1.) a sample of fish was measured and the resulting mean lengths are presented in Figure 10.4.3.4.2. The behaviour of those juveniles appeared that they were more visible at night than during day, but mixed with plankton. They were generally close to the surface and mainly offshore.

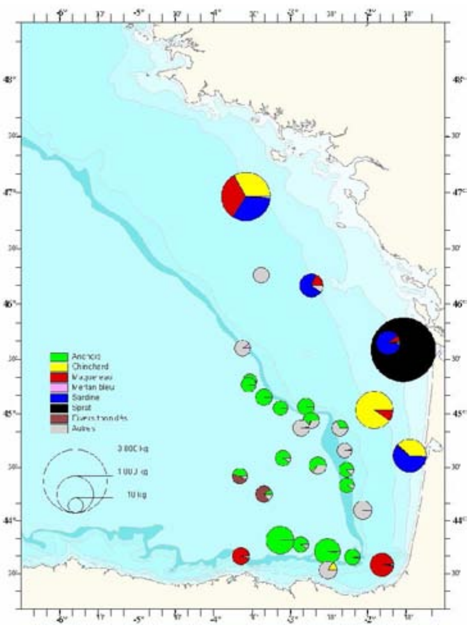


Figure 10.4.3.4.1.: Catch compositions of pelagic hauls during the commercial survey (anchovy in green)

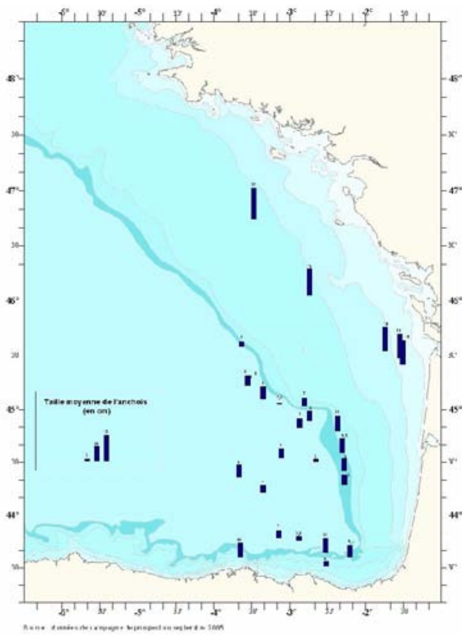
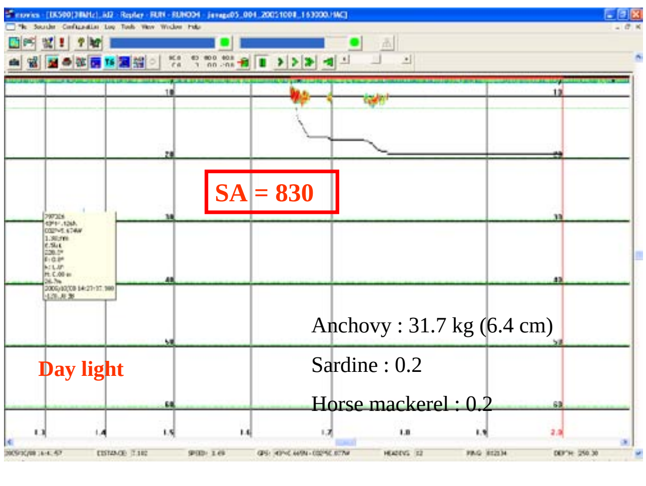


Figure 10.4.3.4.2.: Mean length of anchovy in the hauls

Commercial fishermen did most of the prospection by night and some transects were doubled by day. As the JUVAGA survey covered part of these area (see chapter 10.4.3.2.) it was possible to compare some of the commercial fishermen acoustic observations to JUVAGA's ones. Echo-traces were especially scrutinised between day and night in juveniles areas. Figure 10.4.3.4.3. shows how juveniles may be mixed with plankton at night preventing any quantification of juveniles out of daylight.



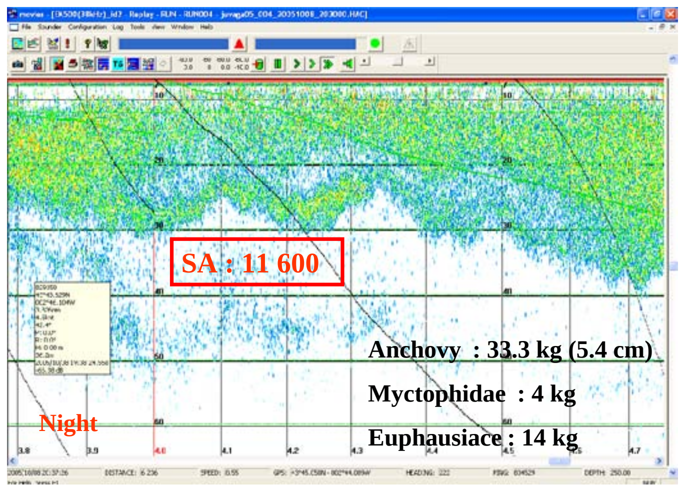


Figure 10.4.3.4.3 – juveniles of anchovy echo-traces observed by day (left) and by night (right) and corresponding catches. The S_A values are very different compared to similar catches of juveniles. A big amount of Myctophidae and Euphosiace are present at night despite the big size of mesh.

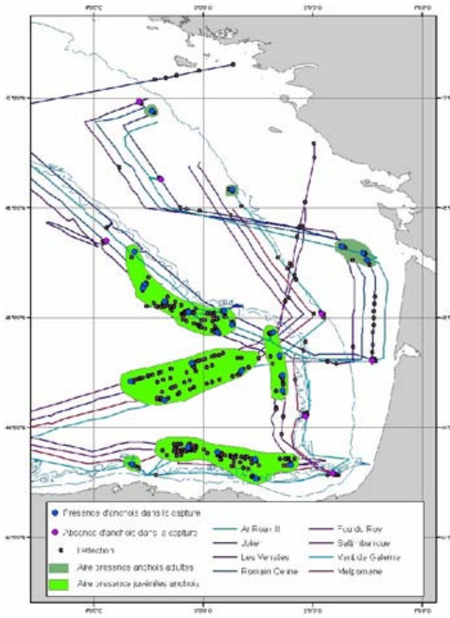


Figure 10.4.3.4.4.: Tracks of commercial pelagic vessels and positive areas of juveniles of anchovy presence

As a conclusion, this survey permitted a rather good identification of positive areas where juvenile anchovies were present (Figures 10.4.3.4.4.) in a short time of surveying. Nevertheless, as vessels were not equipped with suitable echo-sounders (except one) and therefore no quantification could be done.

10.5 Effort and Catch per Unit Effort

The evolution of the fishing fleets during recent years is shown in Table 10.5.1. For the French fleet, this table shows the number of vessels that have caught anchovy each year, and not the total number of vessels. The number of French pelagic trawlers involved in the anchovy fishery (more than 50 tons per vessel and per year) is variable: it depends on the biomass of fish available (e.g. 1992-1994 when biomass and vessel numbers increased). Since 1995 the number of pelagic trawlers is more stable (about 50). The total number of French purse seines are slightly increasing since 2000 (33 in 2000; 41 estimated in 2004), but it doesn't produce real increase in term of catches as their real target is still sardine. The number of Spanish purse seines is decreasing since 1997 (267 in 1997, 211 in 2004 and 197 in 2005).

The fishing effort developed by the two countries is nowadays similar although the fishing pattern is different, mainly since 1992 when the Pelagic French Fleet stopped fishing in spring during the spawning season of anchovy in the Bay of Biscay. In the nineties, the effort may have been at the level that existed in this fishery at the beginning of the 1980’s (Anon. 1996/Assess:7), but the stop of the French pelagic fleet in spring allows to prevent a catch of a too large number of fish before their first spawning. Because of the ban on the anchovy fishery at 1st july 2005, it has been necessary to decrease the threshold of 50 tons per years to 10 Tons to calculate the catch per vessel.

10.6 Recruitment forecasting and environment

Two environmental recruitment index have been considered during the last 10 years : i) Borja 1998 which is an upwelling index and ii) Allain et al. 2001 which is a combination of upwelling and stratification breakdown. Both were considered as not usable for the present assessment as they failed for several years. Nevertheless the necessity to have an efficient index of recruitment in the future they were considered by ICES for further revision. The state of each index may be expressed as following:

AZTI upwelling index

The series of Borja's et al. (1996, 1998) upwelling index are presented in Figure 10.6.1 in comparison with the ICA assessment presented in the exploratory analysis (section 10.7.2) and with standard Biomass based model (section of assessment 10.8). The index was positively related to the strength of next coming recruitment provided by ICA over the period (1987-1998), however afterwards it failed to predict the strong years classes of 1999 and 2000 and became not significant (in statistical terms). The succession of weak classes in recent years at low levels of this upwelling index has rendered it again statistically significant (at Alpha of 10%, with a Probability of being due to random of 0.02 for the ICA series of recruitment and of 0.08 for the Biomass based model), but with a coefficient of determination of past recruitments of only 29% or 16.3% respectively. The poor predictable performance of this index over the past decade renders it useless in quantitative terms for the forecast of year class strength and therefore it will not be used.

IN 2005 and 2006 this index raised up to 626 and 667, which imply an increase of about 40% and 50% in comparison with the average value of this index between 1998 and 2004 (453), but they are still below the historical average value of 716 (since 1986). Certainly the recruitment at age 1 in 2005 raised up slightly but was still insufficient, according to the assessment presented afterwards, to rebuild the stock well above Blim. Therefore from the perspective of this upwelling index series, no signal for a better recruitment at age 1 in 2007 can be attired, although in now way it excludes that possibility. NO use of this index can be made so far given its little coefficient of determination.

Since 1998 all the values of the upwelling index have been below the historical average (Figure 10.6.1). High values of this index seem to favour the recruitment success for anchovy and lower does not. Does this means that some environmental changes have occurred in the Bay of Biscay as to induce an environmental regime shift? At the beginning of this period (in 1999 and 2000) two big recruitments still happened with anchovy, but subsequently all of them have been in the lower range of recruitments. The possibility of a strong affection of the recruitment by this index alone is not sustainable, other factor as the levels of biomasses may play a relevant role as well.

IFREMER anchovy recruitment index

The IFREMER anchovy recruitment index (Allain et al., 2001) is based on a multi-linear regression of anchovy abundance on 2 environmental indices: upwelling and stratification breakdown. The anchovy abundance considered is the abundance at age 1 on January 1 of year y, as estimated by the ICES WG. The environmental indices are extracted from the hydrodynamic model of IFREMER for the French part of the continental shelf of Biscay (Lazure and Jégou, 1998). The period considered for constructing the environmental indices is March 1 to July 31 of year y-1.

Two different models (ICES 2004) are considered (Petitgas et al. 2005 WD), one (Model 1) which is fitted using the age-1 series 1987-1998 (ICES 1999) and the environmental parameter series 1986-2001 and the other one (Model2) by fitting the model using the age-1 series 1987-2002 (ICES 2005) and the environmental parameter series 1986-2001.

. Both Models well predicted the low year class 2002, but failed in the period 2004-2005 (ICES 2005) where it didn't predict low recruitment, particularly in 2005.

The fact that this recruitment index failed since 2002seems to show that the stock may now respond differently to a similar environment than previously. ICES (2005b) stressed the role of population structure and life history in the recruitment processes, meaning that larval survival is not always the key in stocks at low abundance. ICES (2005c) envisaged different processes other than larval survival potentially affecting recruitment, in particular the adult stock reproductive potential, the adult stock space-time spawning distribution and the adult stock spatial occupation at the timing of the incorporation of juveniles to the adult stock.

To revisit the series of Allain et al. (2001 and subsequent WDs), containing the upwelling value for the Landes area and the SBD break stratification index, that series was fitted by a multiple regression linear model to the observed recruitment at age 1 estimates from the Biomass Bayesian Model (section of assessment 10.8) (Figure 10.6.2) and to the ICA numbers at age 1 estimates(in exploratory analysis section 10.7.2). The series related well to the strength of next coming recruitment provided by ICA over the period (1987-2002), however the most recent failures of recruitment were not well explained by the model. The fitted multiple regression model is still statistically at Alpha of 10%, with a Probability of being due to random of 0.03 for the ICA series of recruitment and of 0.07 for the Biomass based model), but with a coefficient of determination of past recruitment of only 27% or 19% respectively (R-squared -adjusted for d.f.-).

The poor coefficient of determination of this index over the recent past years renders it useless in quantitative terms for the forecast of year class strength. Therefore, for the present W.G., the authors considered that these indices were not enough reliable to be used for management considerations for the time being until outstanding investigation will provide new indications and did not give any index for 2006..

The strong message is that spawning dynamics in relation to environment has changed since 2002. Though no signs of potential change have been identified in the environment (temperature, river discharges, wind regimes: Planque, WD 2005), meaning that changes may be in the spawning stock or in the critical period of early life mortality.

10.7 Data exploration and model of assessment

Bay of Biscay anchovy has been assessed in the last years using ICA (Integrated Catch-at-age Analysis) along with a Bayesian Biomass-based Model (BBM), the latter being adopted as the assessment of reference in 2005 (ICES 2006). Last year a benchmark assessment for anchovy was carried out based on the results from BBM. This year the WG continues the in-depth exploratory analysis for this stock, but without conducting a new benchmark assessment.

In this section the in-depth exploratory analysis is presented before the final assessment of this stock is adopted, paying particular attention to the sensitivity of the assessment to the assumptions on the DEPM surveys catchability (assuming acoustic surveys as relative). Attention is also paid to the sensitivity of BBM to the amount of information reflected in the priors.

10.7.1 General analysis of input data

The input data for the assessment of the anchovy stock consist of total biomass and numbers at age from the research surveys conducted in spring, namely, egg and acoustic surveys (see section 10.4) and of catch information from the different fleets exploiting the stock that are described in section 10.2. In addition, the age composition and the mean weights at age of the catches derived from the biological sampling of the catches are used. For BBM only the spawning stock biomass along with the proportion at age 1 (in mass) estimates from the surveys are considered. The catches are only treated as removed biomass (i.e. catch is not included in the observation equations).

Figure 10.7.1.1 compares the historical series of spawning biomass from the DEPM and acoustic surveys. Except in some of the years, like 1994, 1998 or 2004, in which there are some discrepancies, the trends in biomass from the DEPM and acoustic surveys are similar. In particular, in the last years a parallel trend but with larger biomass estimates from the acoustic surveys is apparent. The agreement between both surveys is higher when estimating the proportion of age 1 over total biomass (**Figure 10.7.1.2**). Numbers at age from both surveys are also compared in **Figure 10.7.1.3**. For the first time in both historical series the estimated numbers at age 2 in 2006 are larger than the number of individuals at age 1 estimated last year.

A bubble plot of catch at age is shown in **Figure 10.7.1.4**. Most of the catches correspond to age 1 and to a lesser extent to age 2 classes, while the older age groups are almost non-existent. Therefore there is little amount of information available on the evolution of the cohorts from the catches at age.

10.7.2 Sensitivity of ICA to input data

The assessment of the anchovy stock performed up to 2005 using ICA is based on fitting a separable selection model for fishing mortality, assuming a constant natural mortality of 1.2, with the auxiliary information provided by the direct estimates of biomass and population in numbers at age. The acoustic and egg surveys performed by France and Spain have allowed such analysis and for the current year new estimates of biomass in 2006 are again available from both methods.

In this section the assessment with ICA, as performed in past years, is presented again and attention is paid to the sensitivity of this assessment to the use of DEPM as a relative or absolute index. The same settings as those for the model produced in last year's ICA assessment were adopted, just including the new data available (**Table 10.7.2.1a**): the catches at age in 2005 and the new estimates from both the DEPM and acoustic surveys in 2006 (sections 10.4.1 and 10.4.2). The separable model of fishing mortality is applied over a period of 15 years (1991-2005), where the first four years (1987-90) will be subject to a VPA based estimate (due to the maximum number of 15 years allowed for the separable constraint in ICA software). Catches for ages 0 and 4 are down-weighted to 0.01 in the assessment because they represent about 3% for age 0 and less than 1% for age 4 of the total catch. Age 3 is down-weighted to 0.1 because it also represents a small percentage in the catch around 3% and its down-weighting results in an improvement in the fitting of the separable model to ages 1 and 2 (ICES CM2002/ACFM: 06). The standard assessment similar to the one run in previous years is achieved by a non-linear minimisation of the following objective function (case of DEPM being used as an absolute estimator of SSB):

$$\sum_{a=0}^{a=4}\sum_{y=1991}^{y=2005}\lambda_{a,y}\left(Ln(C_{a,y})-Ln(F_y\cdot S_a.\overline{N}_{a,y})\right)^2$$

$$+\lambda_{DEPM}\sum_{y=1991}^{y=2006}\left[Ln(SSB_{DEPM})-Ln\left(\sum_{a=1}^{5}N_{a,y}\cdot O_a\cdot W_{a,y}\cdot\exp(-P_F F_Y\cdot S_a-P_M.M)\right)\right]^2$$

$$+\sum_{y=1991}^{2006}\sum_{a=1}^{3+}\lambda_{DEPM,a}\left[Ln(SP_{DEPM,a,y})-Ln(N_{a,y}\cdot\exp(-P_F\cdot F_y\cdot S_a-P_M\cdot M))\right]^2$$

$$+\lambda_{acoustics}\sum_{y=1991}^{2006}\left[Ln(SSB_{acoustic})-Ln\left(Q_{acoustic}\sum_{a=1}^{5}N_{a,y}\cdot W_{a,y}\cdot\exp(-P_F F_Y\cdot S_a-P_M.M)\right)\right]^2+$$

$$+\sum_{y=1991}^{2006}\sum_{a=1}^{2+}\lambda_{acoustics,a}\left[Ln(SP_{acoustic})-Ln(Q_{a,y}\cdot N_{a,y}\cdot\exp(-P_F\cdot F_Y\cdot S_a-P_M\cdot M))\right]^2$$

with the following constraints: S2 =1, S5 = S4 = 0.79, for reaching the interim year 2006 F2006 = F2005, weight at age in the stock in 2005 are ad hoc estimated values in the DEPM survey and $\overline{N}$ average exploited abundance over the year

N: population abundance on the first of January

O: maturity ogive, percentage of maturity

M: natural Mortality

FY: annual fishing mortality for the separable model

Sa: selection at age for the separable model

PF and PM: respectively proportion of F and M occurring until mid spawning time

Ca,Y: catches at age a the year Y

Qa and Qa,Y: catchability coefficients for the acoustic survey

SSBDEPM and SSBacoust: SSB estimates from DEPM and acoustics methods

SPDEPM and SPacoust: Spawning population at age from DEPM and acoustics

$\lambda_{a,Y}$: weighting factor for the catches at age

(set respectively for ages 0 to 5 at 0.01, 1, 1, 0.1, 0.01, 0.01)

λDEPM and λacoustics: weighting factor for the indices and/or ages (*a priori* 0.5)

The standard ICA assessment uses the DEPM indices as absolute estimators of the population abundance with age structure comprising age classes 1, 2 and 3plus, the latter being usually less than 5% of the population, while the acoustic index is relative and aggregates the 2 and 3 plus age classes into a unique 2plus group. For the cases when DEPM is used as a relative estimator of SSB and population at age abundance then catchability factors should be included in the above minimization function in parallel to the way the acoustic catchability appears, being additional parameters to be estimated in the assessment.

A summary of the results from an assessment similar to the ICA run last year in the exploratory assessment is presented in Table 10.7.2.1b and **Figure 10.7.2.1**. This assessment is very consistent with the one from last year (**Figure 10.7.2.2**). Minor differences in the first years of the series (1987-90) concerning SSB and F can be observed probably due to the fact that the separable model does not reach that period and hence population and F estimates are just VPA estimates.

The sensitivity of this ICA assessment to the use of DEPM as absolute or relative is shown in **Figure 10.7.2.3**. The use of surveys as relative indices drops down the absolute level of R and SSB, increasing the fishing mortality. This reduction of SSB and recruitments is due to the fact that the absolute level of the population is now relying heavily on the level of catches at age. Using the surveys as relative leads to smaller residuals for almost all input data, but particularly to the catches at age and to the age structured DEPM index (**Table 10.7.2.2**). This accommodation to the data is achieved through the estimation of catchability coefficients for the DEPM. However the estimates achieved of catchabilities for both surveys in these type of assessments are different between ages, suggesting that the surveys show higher catchability for older ages than for younger ones (doubling them, see **Table 10.7.1.1b**). This result however is contrary to the perception of the performance of the surveys (of a more uniform catchability across ages). This changes the assessment to a virtual population estimate, scaled to the level of catches, just tuned to relative trend series (from surveys). For a short living species as anchovy no convergence properties exist for a VPA estimate and therefore there is no reason to believe that those population estimates are better to any other possible population. From all these, it follows that a relative fitting of all indices probably lead to an over parameterisation of the ICA model, making a bad use of the age structured indices and scaling the population levels just to the VPA catch levels (which is inadequate for short living species).

In the assessment, the DEPM and acoustic indices were used both as aggregated indices of biomass and as aged structured indices as discussed in previous years (ICES CM1999, 2001, 2003 and 2004), despite the inherent interdependency and correlation of the aggregate and disaggregate form of the indices. This is made in order to gain age structure information. The years with age structure information are not all the same for acoustic and the DEPM and therefore they complement each other. In addition, while introducing these tuning indices they are down weighted in ad hoc manner by 0.5 so that the double use of them has less influence in the minimization.

As a summary of the sensitivity analysis with ICA, the current estimates with the standard setting of the assessment confirm past year estimation of the stock well below Blim (SSB2005 is estimated now about 11,800 t well below the Blim level set by ICES at 21,000 t). It also indicates some recovery in 2006 to a level around Blim (to about 21,600 t in ICA). The use of the surveys as relative simply changes the scale of the assessment but not the relative trends and therefore it still suggest that SSB in 2006 is around the lowest levels of the past series of SSB. Moving to a relative assessment would imply a changes of the reference points used for advice on management (as Blim), but in no way would change the perception provided by ICA of a relative low level of biomass in 2006 at around the lowest historical levels.

10.7.3 Bayesian biomass-based model

In 2002 (ICES 2003) a biomass delay-difference model (Schnute, 1987), based on the model applied to squid by Roel & Butterworth (2000), was attempted for the first time for modelling the Bay of Biscay anchovy population dynamics as an alternative to ICA. The model seeks to estimate recruitment at age 1 at the beginning of the year accounting for the signals of the inter-annual biomass variations obtained from the direct surveys (DEPM and acoustics) and the level of total catches produced each year. In 2002 and 2003 the model was fitted using least squares (ICES 2003 and 2004). In 2004 the model was further developed (ICES 2005) and it was implemented in the framework of Bayesian state-space models. The results from this model were encouraging as the model was able to track the trends in the population in close agreement with ICA but being more appropriate than ICA for a short living species like anchovy. However, the model still presented some drawbacks (ICES 2004). For example, the age 1 and total biomass indices were assumed to be independent in the observation equations, while in reality they are highly correlated, and the assumption of equal variance for all the indices in the observation equations might be too simplistic. Last year an improved biomass-based model overcoming these difficulties was presented. The model incorporated the following modifications:

- Changing the observation equations for the age 1 biomass by observation equations for the age 1 proportions in order to avoid correlation.
- Allowing different variances for DEPM and acoustics indices.
- Including process errors in the state equations. This is a natural extension of the current state equations that are derived as solutions of deterministic differential equations by solving the stochastic version of this equation.

The working group considered that the improved biomass-based model (see section 10.8.1 for a detailed description) was more appropriate than ICA to assess the state of the Bay of Biscay anchovy stock. On the one hand, the standard ICA assessment relies heavily on the surveys, and the catch at age data does not provide much additional information on the development of the cohorts due to the short lifespan of the species. Moreover, ICA might be over parameterized. On the other hand, the Bayesian framework allows directly inferring uncertainties of the estimates, including additional information through the prior distribution and projecting stochastically future states of the population. Therefore, the working group presented the benchmark assessment for the Bay of Biscay anchovy stock based on the improved Bayesian biomass-based model (referred in what follows as BBM).

For this year's assessment, input data for BBM are given in **Table 10.8.1.1**.

Figure 10.7.3.1 shows the spawning stock biomass resulting from the update of last year's benchmark assessment including the new data. The consistency between last year's and the current assessment is very high.

Two sets of prior distributions (same as last year) have been considered in order to analyze the sensitivity of posterior inference to prior assumptions.

- For the first set of prior distributions, the Normal distributions of survey catchabilities ($\log(q_{depm})$ and $\log(q_{ac})$) are taken to have mean 0 (corresponding to absolute abundance indices) and precision (inverse of the variance) equal to 5, resulting in a prior 95 % central credible interval of (0.42, 2.4). The prior distribution of the precision of the biomass observation equations for the surveys, ψ_{depm} and ψ_{ac}, are taken as a Gamma distribution with mean 10. This corresponds to a coefficient of variation around 32.5 % for the spawning stock biomass estimates given by the DEPM and acoustics surveys. Similarly the prior distribution for the parameters defining the variance of the proportion in biomass of age 1 in the DEPM and acoustic surveys, ξ_{depm} and ξ_{ac} respectively, are taken as a Normal distribution with mean 4.68, in agreement with the variance of the age 1 proportion from the surveys. After an examination of the real series of DEPM and acoustic total biomass indices, the initial total biomass B0 is taken as a Normal distribution with mean and variance equal to the midpoint and the squared range of the observed series, respectively. Similarly, the prior distribution of recruitment is taken as a Log-Normal distribution with mean given by the midpoint of observed DEPM and acoustics age 1 biomass estimates, after accounting for the catches taken during the first period. Finally, the precision proportionality factor for the process errors ω_1 was assumed to be Gamma distributed with mean 10.
- The parameters of the second set of priors were specified so as to keep the same prior mean as in the first set, but have a larger variance in order to be less informative.

Table 10.7.3.1 summarises the hyper-parameter values for the two sets of prior distributions, together with the corresponding 95 % central credible intervals, and **Figure**

10.7.3.2 compares both sets of prior density functions. Note that the second set of priors provides very wide prior credible intervals (see **Table 10.7.3.1**), minimizing its influence on the final results.

In addition, two different models have been explored depending on whether the DEPM surveys are absolute or relative (i.e. whether the catchability of the DEPM survey is fixed to 1 or has to be estimated):

- DEPM as relative and acoustics as relative
- DEPM as absolute (q_{depm}=1) and acoustics as relative

From a Bayesian perspective, assuming that the DEPM surveys are absolute can be interpreted as having a very informative prior distribution on the catchability parameter of the DEPM surveys.

Figure 10.7.3.3 shows the sensitivity of the posterior distributions of recruitment to the choice of different priors when both surveys are taken as relative and when DEPM is taken as absolute and acoustics as relative indices. In general, the posterior medians of the recruitment series are similar for both sets of prior distributions, but the second set of priors leads to wider posterior credible intervals. The working group considered that given the small difference on the assessment for the two sets of priors, the first set of priors is more realistic and uninformative enough, supporting the use of first set of priors as done in last year's benchmark assessment.

Figure 10.7.3.4 compares the posterior distribution of spawning stock biomass when the DEPM surveys are taken as relative and when they are taken as absolute for each set of prior distributions. Due to the misidentification issues explained below, considering the DEPM surveys as relative slightly raises the biomass, decreases the catchability of the surveys and gives wider credible intervals indicating an increase in the uncertainty. However, the medians from any of the models are within the credible intervals of the other model. In addition, the differences on the historical trends between both models (absolute and relative) are small and mainly correspond to years when there is no data available for some of the indices. For these years with missing data the posterior credible intervals are also wider, reflecting the lack of knowledge. When analysing the ratio of the spawning stock spawning biomass with respect to the spawning stock biomass in 1989, which sets B_{lim} for this stock as B_{loss} from the assessment in 2003 (ACFM 2003), the perception of the current state of the stock does not change depending on the assumption on the catchability of the DEPM surveys (**Figure 10.7.3.5**). For any of the two models, the median of the ratio for 2006 is around 1.

Posterior joint distributions of the parameters of q_{ac} and q_{depm}, of B_0 and q_{depm}, of $\log(R_1)$ and q_{depm} and of $\varepsilon_1(0_{(y)}, h_{1(y)})$ and ω_1 for the second set of priors when DEPM and acoustics are both taken as relative biomass indices are shown in **Figure 10.7.3.6**. This illustrates the parameter confounding issue as it has been pointed out in previous years (ICES 1004 and 2005). On the one hand, the incorporation of process errors leads to posterior correlation between the process errors ε_1 and ω_1. On the other hand, the catchability parameters q_{depm} and q_{ac} are positively correlated between them, whereas they are both negatively correlated with the initial biomass B_0 and the recruitments R_y. This means that the larger the catchability parameters for biomass are, the smaller the recruitment will be. Thus, when considering both surveys as relative, the prior distributions would lead the posterior inference. Furthermore, the posterior correlation, and subsequently the confounding between the parameters, would increase for the less informative prior distributions. This explains the larger biomass levels obtained when the DEPM and acoustics are considered as relative compared to the case when the DEPM biomass catchability parameter is fixed to 1 (**Figure 10.7.3.4**). Contrary to BBM, when setting DEPM as relative the ICA assessment resulted in a drop of SSB estimates. In ICA taking DEPM as relative eliminates the scaling effect of this survey and reduces the population results to a catch scaled separable VPA (with no convergence properties for this short living species), whereas in BBM the catches are only taken as an offset and the prior distributions become the main source of information to set the actual level of the population. The usual practice by this working group regarding the Bay of Biscay anchovy stock in order to address the misidentification between the parameters has been to fix the catchability of the DEPM surveys to 1, assuming that the DEPM biomass estimates are absolute. This is based on the assumption that in the DEPM the spawning stock biomass is derived by estimating all the biological parameters with no bias. For these reasons the working group decided to keep the assumption of taking the DEPM as absolute, which scale the assessment assuring at the same time consistency with previous practices on the catchability assumption for the assessment of this stock and hence comparability both in relative and absolute terms with former results. However, the working group considers that there are less restrictive alternatives that could be explored in the near future. These encompass comparative studies between the catchabilities of DEPM and acoustics surveys that would allow taking both surveys as relative incorporating these results into the assessment via the prior distributions.

The performance of BBM using the first set of priors with the DEPM as an absolute index and acoustics as relative has been compared with the standard ICA assessment. **Figure 10.7.3.7** shows the posterior median of biomass series with the corresponding 95% credible intervals. DEPM and acoustics spawning stock biomass estimates are also included for comparison. BBM and ICA show similar trends in the historical evolution of the stock. In general, ICA biomass estimates are within the 95% posterior credible intervals from BBM, although it tends to point out slightly smaller biomasses. In 2006 both models result in very similar biomass levels. The working group considers that BBM is more appropriate than ICA to assess the state of the anchovy stock, given the statistically more appropriate way of dealing with the information contained in the surveys, which is the information driving the assessment (SSB and proportion of age 1 biomass estimates from the surveys are independent).

10.8 State of the stock

10.8.1 Stock assessment

This year the final assessment for the Bay of Biscay anchovy population is an update of last year benchmark assessment based on the Bayesian biomass-based model (BBM).

Let $B(s_{(y)}, a)$ and $C(s_{(y)}, a)$ denote population biomass (in tonnes) and catch (in tonnes) of the a age class at time s of year y respectively. At the beginning of the year y, the total biomass is the new recruitment, $R_y = B(0_{(y)},1)$, plus the biomass surviving from previous year:

$$B(0_{(y)},1+) = R_y + B(f_{1(y-1)},1+) \exp\{-f_{2(y-1)}\, g\} - C(f_{1(y-1)}+h_{2(y-1)},1+) \exp\{-(f_{2(y-1)} - h_{2(y-1)})g\}$$

For the beginning of the second period in year y the age 1 and total biomasses are those surviving from the beginning of the year and accounting for the catch taken in the first period:

$$\begin{aligned} B(f_{1(y)},1) \;&=\; R_y \exp\{-f_{1(y)}\, g\} \exp\{\varepsilon_1(0_{(y)}, h_{1(y)}) + \varepsilon_1(h_{1(y)}, f_{1(y)})\} \\ &\quad - C(h_{1(y)},1) \exp\{-(f_{1(y)} - h_{1(y)})\, g\} \exp\{\varepsilon_1(h_{1(y)}, f_{1(y)})\} \\ B(f_{1(y)},1+) \;&=\; B(0_{(y)},1+) \exp\{-f_{1(y)}\, g\} - C(h_{1(y)},1+) \exp\{-(f_{1(y)} - h_{1(y)})\, g\} \end{aligned}$$

The parameter g is a biomass decreasing rate accounting for growth (G) and natural mortality (M) rates. In particular, $g = M - G = 1.2 - 0.52 = 0.68$. $f_{1(y)}$ and $f_{2(y)}$ are fractions of the year corresponding to each period ($f_{1(y)} = f_1 = 0.375$ and $f_{2(y)} = 1-f_{1(y)} = 1- f_1 = 0.625$ assuming that the periods are the same all the years and surveys are conducted 15th May) and $h_{1(y)}$ and $h_{2(y)}$ are fractions within each period corresponding to the elapsed time from the beginning of the period to the date when catches are taken on average. The dynamics of biomass at age 1 in the first period of the year incorporates log-normal process errors through three new parameters in the model. On the one hand, $\varepsilon_1(0_{(y)}, h_{1(y)})$ and $\varepsilon_1(h_{1(y)}, f_{1(y)})$, that denote respectively the process error associated to the age 1 biomass change in the first period from the beginning of the year $0_{(y)}$ to the time the catches are taken $h_{1(y)}$ and from there to the end of the first period $f_{1(y)}$. These are normally distributed with mean 0 and variance proportional to the elapsed time interval:

$$\varepsilon_1(0_{(y)}, h_{1(y)}) \sim \text{Normal (mean} = 0\text{, var} = (h_{1(y)} - 0_{(y)}) / \omega_1)$$

and

$$\varepsilon_1(h_{1(y)}, f_{1(y)}) \sim \text{Normal (mean} = 0\text{, var} = (f_{1(y)} - h_{1(y)}) / \omega_1).$$

On the other hand, the parameter ω_1 defines the precision of the process error.

The observation equations for the total biomass are the same as in the initial biomass-based model (ICES 2004) but now the variances are allowed to be different for DEPM and acoustic indices. In order to avoid the correlation between the observation equations of age 1 and total biomass the observation equation for age 1 biomass is replaced by the observation equation for the age 1 biomass proportion which is a beta distribution with mean given by the age 1 biomass proportion in the population and variance proportional to the product between the age 1 and age 2+ biomass proportions. This is analogous to the mean and variance of a binomial distribution but allows more flexibility. On top of it, it is on agreement with the experimental variance function of the age 1 biomass proportions from the DEPM.

The observation equations are

$$P_{depm}(f_{1(y)}) \sim \text{Beta}(\exp(\xi_{depm}) P(f_{1(y)}), \exp(\xi_{depm}) (1-P(f_{1(y)})))$$

$$\log(B_{depm}(f_{1(y)}, 1+)) \sim N(\log(q_{depm}) + \log(B(f_{1(y)}, 1+)), 1/\psi_{depm})$$

$$P_{ac}(f_{1(y)}) \sim \text{Beta}(\exp(\xi_{ac}) P(f_{1(y)}), \exp(\xi_{ac}) (1-P(f_{1(y)})))$$

$$\log(B_{ac}(f_{1(y)}, 1+)) \sim N(\log(q_{ac}) + \log(B(f_{1(y)}, 1+)), 1/\psi_{ac}),$$

where all are assumed to be independent from each other. The parameters ξ_{depm} and ξ_{ac} define the variance of the observation equations for the age 1 biomass proportion of DEPM and acoustic indices, respectively.

The parameters to estimate are $\log(q_{depm})$, $\log(q_{ac})$, ψ_{depm}, ψ_{ac}, ξ_{depm}, ξ_{ac}, B_0, R_y for all years y, the state errors $\varepsilon_1(.,.)$ for all the time intervals and ω_1. The prior distributions considered are

$$\log(q_{depm}) \sim N(\mu_{qdepm}, 1/\psi_{qdepm})$$

$$\log(q_{ac}) \sim N(\mu_{qac}, 1/\psi_{qac})$$

$$\psi_{depm} \sim \text{Gamma}(a_{\psi depm}, b_{\psi depm})$$

$$\psi_{ac} \sim \text{Gamma}(a_{\psi ac}, b_{\psi ac})$$

$$\xi_{depm} \sim N(\mu_{\xi depm}, 1/\psi_{\xi depm})$$

$$\xi_{ac} \sim N(\mu_{\xi ac}, 1/\psi_{\xi ac})$$

$$B_0 \sim N(\mu_0, 1/\psi_0)$$

$$\text{Log}(R_y) \sim N(\mu_r, 1/\psi_r)$$

$$\omega_1 \sim \text{Gamma}(a_{w1}, b_{w1})$$

In order to avoid as much as possible problems in the MCMC algorithm due to the misidentification problems between R_y and $\varepsilon_1(0_{(y)}, h_{1(y)})$, a centered parameterization is considered:

R_y and $\varepsilon_1(0_{(y)}, h_{1(y)})$ => $R_y^* = R_y \exp(\varepsilon_1(0_{(y)}, h_{1(y)}))$ and $\varepsilon_1(0_{(y)}, h_{1(y)})$.

In addition, the parameters involved in the state equations have to be such that the biomass of each of the age classes is positive, which basically means that the recruitment entering the population is large enough to support the catches taken:

$B(s_{(y)},1) \geq 0$ at any time s for all y

$B(s_{(y)},2+) = B(f_{1(y)},1+) - B(f_{1(y)},1) \geq 0$ at any time s for all y

Sampling from the joint posterior distribution is carried out using Markov Chain Monte Carlo (MCMC) techniques (Gilks et al 1996). MCMC is implemented sampling the parameters one by one. On the one hand, $\log(q_{depm})$, $\log(q_{ac})$, ψ_{qdepm}, ψ_{qac} and $\omega_1$are sampled directly from their posterior conditional distributions using Gibbs sampling. B_0 and R_y , $\varepsilon_1(0_{(y)}, h_{1(y)})$ and $\varepsilon_1(h_{1(y)}, f_{1(y)})$ for all y had non standard posterior conditional distributions and are sampled using Metropolis-Hastings within Gibbs sampling. In order to find appropriate proposal distributions, first the mode of the target is found by numerical methods. In case the mode is lower than the lower bound, an exponential distribution with the same first derivative of the log posterior probability at the lower bound is chosen as proposal distribution. Otherwise, the proposal distribution is a normal distribution with the same first and second derivatives of the log posterior probability at the mode. All this is implemented in a program in Fortran.

The data used for BBM is detailed in **Table 10.8.1.1**.

From the set of models and assumptions explored in the previous section, the final result is the one corresponding to DEPM as absolute with the first set of priors (see **Table 10.7.3.1**). **Figures 10.8.1.1** and **10.8.1.2** compare prior and posterior distributions of the parameters. Summary statistics (median and 95% posterior intervals) of the posterior distributions of recruitment (in tonnes), spawning stock biomass and harvest rates are shown in **Table 10.8.1.2** and **Figure 10.8.1.3**. The largest credible intervals correspond to the period in which some data is missing. In general recruitment is highly variable from year to year. However, in the last four years it has been kept at very low levels, with recruitment in 2005 the lowest of the historical series (posterior median of around 4,600 tonnes and 95 % credibility interval between 2,800 and 7,900 tonnes). In 2006 recruitment has increased slightly (posterior median of 19,419 tonnes), however it is still among the lowest of the historical series together with 1989, 2002 and 2005.

Median and 95% posterior credible intervals of the ratio of spawning stock biomass with respect to 1989 spawning stock biomass, in which B_{lim} is based (ACFM 2003), are given in **Table 10.8.1.2**. Median of the ratio for 2006 is 1.12 (with a 95% interval between 0.6 and 2) indicating that the current level of the population is similar to 1989.

Figure 10.8.1.4 shows the posterior distribution of current level of spawning stock biomass in 2006. Current state of the population is summarized in **Table 10.8.1.3**. The estimated level of biomass in 2006 is 22,300 tones and the 95% credible interval is (14,600; 35,500) tonnes. The probability of SSB being below B_{lim} (21,000 tonnes), B_{pa} (33,000 tonnes) and the biomass threshold level of 28,000 tonnes set by STECF in November 2005, are respectively 40%, 95% and 83%.

10.8.2 Reliability of the assessment and uncertainty of the estimation

The Bayesian biomass-based model forms a simple but powerful tool to assess the Bay of Biscay anchovy stock. The observation equations of the model refer just to the age 1 and total biomass indices from the research surveys (DEPM and acoustics). Therefore, the results are completely driven by the surveys, and the reliability of the current assessment depends on the reliability of the surveys themselves. Furthermore, the assessment is scaled by the assumption of absolute catchability of DEPM surveys. However, Section 10.7.3 explains how the current perception of the population in relative terms (regarding B_{lim}) is insensitive to the use of the DEPM survey as absolute or relative. Therefore, for future assessments the working group could explore further considering the DEPM biomass surveys as relative. The working group emphasizes the importance of the continuity of the series of estimates from direct surveys, both in terms of total biomass and disaggregated by age in order to be able to assess the stock efficiently. In this model catch data are just accounted for in the development of the dynamics of the population. This basically means that the population has to be large enough to support the observed catches. However, it is necessary to continue the collection of total landings and catch at age data. This will allow on the one hand further work on BBM exploring the possibility of incorporating catch data in the observation equations in order to evaluate whether additional information can be extracted from the catch data, and on the other hand, the use of age disaggregated models as exploratory tools on the international seasonal fisheries.

The Bayesian state-space model framework provides a statistically well founded basis to BBM. This allows directly to infer the uncertainties of the estimates from the posterior distribution, including additional information through the prior distribution and projecting future states of the population.

It is important to note that this model relies on the assumption that both the natural mortality and growth are constant across ages and from year to year. In terms of growth it is well known that the growth from age 1 to age 2 is larger than from the older year classes. Thus it might be worth studying the effect of different growth and natural mortality parameters for age 1 and age 2+ groups. However, the exploratory analysis presented last year suggests that this assumption might not have a major impact on the final outcome. Supporting biological information is also required to clarify the dynamics of the population.

Finally, the working group notes that changing the assessment model entails changes in both the methodology used for projecting the population forward and establishing catch options and in the terminology the assessment and consequent advice is given. Concepts such as fishing mortality or selectivity at age are not used in the model. Alternatively, harvest rates, defined as the ratio between total annual catches and spawning stock biomass, are introduced. The state of the stock is given in terms of spawning biomass, recruitment is understood as biomass at age 1 at the beginning of the year and management options may be given in terms of catches. On the other hand, due to the Bayesian framework, all the results are given in stochastic terms and deterministic points estimates are replaced by summary statistics of the posterior distributions of the parameters, such as medians and 95% intervals. See **Table 10.8.1.3** and **Figure 10.8.1.4** summarising recruitment, SSB, harvest rates and SSB in relation with SSB in 1989. The estimated level of biomass in 2006 is 22,300 tonnes and the 95% credible interval is (14,600, 35,500) tonnes. The probability of SSB being below B_{lim} (21,000 tonnes), B_{pa} (33,000 tonnes) and the biomass threshold level of 28,000 tonnes set by STECF in November 2005, are respectively 40%, 95% and 83%.

10.8.3 Reference points for management purposes

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

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

Technical basis:

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

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

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

Since 2002, due to a successive series of low recruitments, the Bay of Biscay anchovy spawning stock biomass has been around the precautionary reference points: B_{pa} and B_{lim}. In 2005, the population level was estimated as the lowest in the historical series, being the biomass far below B_{lim}, and in 2006, the biomass has been estimated just around B_{lim}. In addition, in these last two years the Spanish spring fishery has collapsed and immediate action has been taken by managers to close the fishery for the second half of the year. At the current levels of biomass, the possibility of a reduction of the chances of good recruitments cannot be discounted (**Figure 10.8.3.1**) and therefore, the current level of B_{lim} set by ICES seems to be appropriate and should not be revised by the historical minimum biomass recorded in 2005.

On the other hand, the good recruitment leading to the recovery of the population from the low biomass level in 1989 might have been favoured by good upwelling conditions in the bay of Biscay in that year (Borja et. 1998). However the recent evolution of the population in the absence of particularly favourable environmental conditions, suggests that for low spawning biomasses, around B_{lim}, the chances of successful recruitment and recovery of the stock can be diminished, supporting the definition of current B_{lim}.

According to BBM the SSB in 1989 is now estimated at about 19,700 t., close to the current B_{lim} definition. Thus, the new assessment model does not change our perception of the stock and subsequently, the current B_{lim} (set at 21,000 t) is still valid. However, since the reference points are based on the current assessment assumptions on catchability of surveys, natural mortality, etc. Any major future change on these assumptions as for instance the survey catchability explored in section 10.7 would imply a revision of the absolute levels of the reference points. However, this would not change the historical perspective of relative changes of biomass. **Figure 10.7.3.5** shows that whatever the catchability of the DEPM surveys is, the current level of SSB in 2006 is around the biomass estimated in 1989 that served as a basis for defining B_{lim}.

Further work using the Bayesian framework would allow to define the precautionary reference points in probabilistic terms, based for instance in the ratios between the most recent biomass estimates over some past period of biomass.

10.9 Catch predictions for 2007

The predictive capacity of the stock projection is severely compromised in the absence of a recruitment index. This situation is reflected in the poor performance of the stock and catch projections in the past. Without a reliable recruitment index the WG is not in a position to carry out catch predictions for 2007.

10.10 Harvest Control Rules

From 1979 to 2004 the anchovy stock has been managed by annual TACs which have been set at a fixed level independent of the advice. In 2005 and 2006, annual TAC of 30,000 and 5,000 tonnes respectively were set. However, due to the low biomass level pointed out by the spring surveys (DEPM and acoustics) the EU decided to close the fishery for the second half of the year in both 2005 and 2006. This annual TAC based management strategy seems to be not adequate for a short lived species like anchovy in which the population is mainly dominated by the incoming year class. Since 2002 the total annual catches have been well below the fixed annual TAC, with a failure of the Spanish purse seine fishery in 2005 and 2006. Therefore, when the recruitment level is low, a management regime based on fixed annual TACs which does not account for variability in recruitment does not have any regulation effect. Furthermore, it could lead to an over exploitation of the oldest part of the population that in the case of low recruitment will be the main age class of the population.

In 2003 the working group tested by simulation a management regime consisting of an initial annual TAC, which is revised in the middle of the year, after the survey estimates of biomass become available.

In 2005 the working group further explored harvest control rules for the Bay of Biscay anchovy stock alternative to the annual fixed TAC and carried out two new simulation exercises. The first one was based on Leslie matrices and the second one was a continuation of the work started in 2003 based on the Bayesian biomass-based model. Both approaches considered new management measures such as the closure of a certain area or the temporal closure during different periods. The actual effects of these management measures are difficult to quantify due to all the uncertainties on the population dynamics and fishery changes. These exercises were presented only for illustrative purposes and the results should not be used as a basis for any management decision. Nevertheless, in both cases the importance of the new incoming year class strength and the availability of a recruitment index to help to establish adequate exploitation levels became apparent.

Recruitment indices for the Bay of Biscay anchovy have continuously been provided on environmental conditions during the early life stages (eggs, larvae, etc.). In 1999 they were used for projection of the population. However, the performance of these models to predict recruitment has been quite poor in the recent years (section 10.6) and therefore they have not been further used for prediction. There is still a lack of understanding of the process linking recruitment to environmental indices. Further work in this area is still required.

Additionally, a series of autumn acoustic surveys aiming at estimating the juvenile abundance of the population started in 2003. The results of these 3 surveys seem to be promising as the low level of juveniles observed in 2004 fit to the lack of recruitment (at age 1) in 2005. However, the time series is still too short to properly evaluate the performance of such a relationship between the juvenile abundance in autumn and next year’s recruitment at age 1 for forecast purposes (section 10.4.3.1).

Further work on testing harvest control rules could be directed to evaluate the effect of the bias and uncertainty of the recruitment indices.

For the time being, only spring surveys (acoustic and DEPM) are able to quantify the level of recruitment. Therefore, until a reliable recruitment index (prior to the management advice) is available, the working group considers that the mid-year revision of management advice using the recruitment estimates from the spring surveys is the most effective strategy.

Given the current state of the population, the working group considers that appropriate management strategies for the Bay of Biscay anchovy stock are urgently required and should be generated through collaboration between managers, stake holders and scientists.

10.11 Management Measures and Considerations

For the last two years the spawning biomass of anchovy has been at the lowest historical levels, after continuous weak recruitments since 2002. The current assessment confirms that the spawning biomass in 2005 was around 14,800 t, well below Blim (of 21,000 tonnes). In addition the 2006 spawning biomass (SSB) has been estimated at 22,300 tonnes which is around Blim. Furthermore, the probabilities of the spawning stock biomass in this year of being below B_{lim} and B_{pa} are 40% and 95% respectively. Although the 2005 year class is higher than that estimated for the 2004 year class, it is assessed to be still below the 25th percentile in the historical series of recruitment.

At these low levels of biomass the Spanish purse seine spring fishery has collapsed, producing the lowest catches since records began (for example, in 2006 the catches were about 8% of average catches since 1987). French catches by pelagic trawl were also poor (at about 20% of a normal year in 2005) but not as disastrous as those of the Spanish purse seines. There may have been some change in catchability (anchovy behaviour) that, in addition to the low levels of biomass, might have particularly and negatively affected the purse seine fishery.

A comprehensive long-term management plan is lacking for this stock. Alternative management measures to output control (TAC) need to be further investigated to maintain the longer term viability of the stock (closed seasons, closed areas, minimum size, etc.).

In order to improve the management of this fishery, three key approaches must be followed:

a) to monitor the evolution of the population until recovery (Surveys on adult population): it is essential to continue to carry out the spring surveys, acoustics and DEPM, which are the only reliable information on SSB and actual recruitment entering the population for the time being. The spring acoustic and DEPM surveys provide the main tuning indices to the current assessment.

b) To monitor the strength of recruitment before it enters the fishery (Recruitment surveys): Because anchovy is a short lived species the population and the fishery depend on the recruitment at age 1 occurring every year. The lack of an anchovy recruitment index before it enters the fishery has prevented a forecast of the population and the provision of catch options to managers. To overcome the current situation managers should endorse the continuation of the acoustic recruitment surveys on juveniles in September-October every year, aiming at estimating their abundance as potential predictors of incoming recruitment to the fishery. This should preferably be made in the frame of coordinated surveys between research institutes and their countries. In this way, the series of juvenile abundance indices from the acoustic surveys on juveniles, started in 2003, could complete their testing period (of at least 5 years), so that their predictive performance of incoming recruitment at age 1 to the fishery (as produced by the spring surveys next years) can be evaluated.

c) To study the ecological process of recruitment: To manage this stock it is necessary to understand the mechanisms which drive the population from SSB to eggs, larvae, juveniles and finally recruitment (which is the key population component). There's no usable stock/recruitment relationship which would allow one to predict the level of the next recruitment. To better understand the role of SSB in the next recruitment, it is necessary to understand as well the role of the ecosystem community and the environment on the recruitment process via ecological studies and research surveys, modelling, etc.: ecological spring surveys (the actual acoustic surveys supply information on a lot of environmental parameters at spawning time), autumn surveys (to know the level of juveniles), any other studies which can explain the mechanisms of survival from eggs to recruits (climate conditions, larval drift, change in behaviour from juvenile to adult stages, …)

For the time being there's no way to know if the juveniles observed in autumn 2006 surveys will survive as to produce a good or bad recruitment. Thus, it is not possible to predict recruitment in 2007 (as 1 group) which should comprise a significant proportion of the SSB in 2007. At the current low levels of biomass, it is uncertain how long it will be before a new strong recruitment may appear. Therefore, given the current stock situation, maximum protection of the spawning population is required. The WG recommends that the fishery should remain closed and should only be considered for opening after reliable assessment of the recruitment and SSB in 2007 become available, based on the results from the spring 2007 acoustic and DEPM surveys. This implies a closure of the fishery until at least July 2007. The working group emphasises that any recovery is entirely dependent on good incoming recruitment. If the fishery is re-opened in 2007 contrary to advice, technical measures should be taken to minimise the disruption to spawning. Such technical measures can include effort reduction and/or seasonal or area closures.

Table 10.2.1.1: Bay of Biscay Anchovy. Annual catches (in tonnes) (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	n/a	1,128
2006(Up 1st July)	458	972	n/a	1,430
AVERAGE (1990-04)	6,394	26,337	318	32,824

Table 10.2.1.2. Bay of Biscay Anchovy. Monthly catches by country (Sub-area VIII) (without live bait catches)

COUNTRY: FRANCE Units: t. 1000 **Half year basis**

YEAR\ MONTH	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL	1st half	2nd half
1987	0	0	0	1,113	1,560	268	148	582	679	355	107	87	4,899	2,941	1,958
1988	0	0	14	872	1,386	776	291	1,156	2,002	326	0	0	6,822	3,048	3,775
1989	704	71	11	331	648	11	43	56	70	273	9	28	2,255	1,776	479
1990	0	0	16	1,331	1,511	127	269	1,905	3,275	1,447	636	82	10,598	2,985	7,613
1991	1,318	2,135	603	808	1,622	195	124	419	1,587	557	54	285	9,708	6,682	3,026
1992	2,062	1,480	942	783	57	11	335	1,202	2,786	3,165	2,395	0	15,217	5,334	9,883
1993	1,636	1,805	1,537	91	343	1,439	1,315	2,640	4,057	3,277	2,727	47	20,914	6,851	14,062
1994	1,972	1,908	1,442	172	770	1,730	663	2,125	3,276	2,652	223	0	16,934	7,994	8,939
1995	620	958	807	260	844	1,669	389	1,089	2,150	1,231	855	22	10,892	5,157	5,735
1996	1,084	630	614	206	150	1,568	1,243	2,377	3,352	2,666	1,349	0	15,238	4,251	10,987
1997	2,235	687	24	36	90	1,108	1,579	1,815	1,680	2,050	718		12,022	4,180	7,842
1998	1,523	2,128	783	0	237	1,427	2,425	4,995	4,250	2,637	2,477	103	22,987	6,099	16,888
1999	2,080	1,333	574	55	68	948	1,015	922	3,138	1,923	1,592	0	13,649	5,058	8,591
2000	2,200	948	825	5	58	1,412	2,190	2,720	3,629	2,649	1,127	0	17,765	5,449	12,316
2001	717	517	143	46	47	1,311	1,078	3,401	4,309	2,795	2,732	0	17,097	2,782	14,316
2002	1,435	2,561	1,560	1	30	758	350	979	1,957	771	578	0	10,978	6,345	4,633
2003	39	2	0	32	123	1,031	284	2,284	1,478	1,319	983	19	7,593	1,226	6,367
2004	210	106	3	13	145	1,625	853	1,995	2,464	555	813	0	8,781	2,102	6,679
2005	363	15	33	0	16	525	0	0	0	0	0	0	952	952	0
2006	1		28		3	425							458	458	0
Average 87-05	1,063	910	523	324	511	918	768	1,719	2,428	1,613	1,020	38	11,834	4,459	8,005
in percentage	9.0%	7.7%	4.4%	2.7%	4.3%	7.8%	6.5%	14.5%	20.5%	13.6%	8.6%	0.3%	100%	36%	64%
Average 92-05	1,298	1,077	663	121	213	1,183	980	2,039	2,752	1,978	1,326	15	13,645	4,833	9,788
in percentage	9.5%	7.9%	4.9%	0.9%	1.6%	8.7%	7.2%	14.9%	20.2%	14.5%	9.7%	0.1%	100%	33%	67%

COUNTRY: SPAIN 1000

YEAR\ MONTH	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL	1st half	2nd half
1987	0	0	454	4,133	3,677	514	81	54	28	457	202	265	9,864	8,778	1,086
1988	6	0	28	786	2,931	3,204	292	98	421	118	136	246	8,266	6,955	1,311
1989	2	2	25	258	4,295	795	90	510	116	198	1,610	273	8,173	5,377	2,796
1990	79	6	2,085	1,328	9,947	2,957	1,202	3,227	2,278	123	16	10	23,258	16,401	6,857
1991	100	40	23	1,228	5,291	1,663	91	60	34	265	184	596	9,573	8,343	1,230
1992	360	384	340	3,458	13,068	3,437	384	286	505	63	94	89	22,468	21,047	1,421
1993	102	59	1,825	3,169	7,564	4,488	795	340	198	65	546	23	19,173	17,207	1,966
1994	0	9	149	5,569	3,991	5,501	1,133	181	106	643	198	74	17,554	15,219	2,335
1995	0	0	35	5,707	11,485	1,094	50	9	6	152	48	365	18,951	18,322	629
1996	48	17	138	1,628	9,613	5,329	1,206	298	266	152	225	17	18,937	16,774	2,164
1997	43	1	81	2,746	2,672	877	316	585	1,898	331	203	185	9,939	6,420	3,519
1998	35	235	493	371	4,602	1,083	1,518	44	47	3	22	1	8,455	6,818	1,637
1999	8	26	52	4,626	4,214	1,396	1,037	26	911	207	615	27	13,144	10,323	2,822
2000	18	0	99	1,952	11,864	3,153	958	342	413	346	83	0	19,230	17,087	2,143
2001	243	48	337	2,203	14,381	3,102	1,436	1	126	1,055	120	1	23,052	20,314	2,738
2002	1	0	13	914	2,476	1,340	323	56	1,013	381	1	0	6,519	4,745	1,774
2003	0	0	0	1,709	767	373	10	12	124	4	3	0	3,002	2,848	154
2004	0	0	0	2,364	3,102	1,616	50	22	423	1	1	2	7,580	7,081	498
2005	0	2	2	4	167	0	0	0	0	0	0	0	7,580	176	0
2006	0	0	4	118	602	248							7,580	972	0
Average 87-04	55	44	325	2,324	6,111	2,108	577	324	469	240	227	114	12,919	10,967	1,952
in percentage	0.4%	0.3%	2.5%	18.0%	47.3%	16.3%	4.5%	2.5%	3.6%	1.9%	1.8%	0.9%	100%	85%	15%
Average 92-04	61	56	255	2,601	6,426	2,342	658	157	431	243	154	56	13,441	12,631	1,831
in percentage	0.5%	0.4%	1.9%	19.4%	47.8%	17.4%	4.9%	1.2%	3.2%	1.8%	1.1%	0.4%	100%	87%	13%

Total

COUNTRY: FRANCE + SPAIN

Average 92-05	1,360	1,133	918	2,723	6,639	3,525	1,638	2,196	3,183	2,221	1,481	71	27,087	7,262	1,159
in percentage	5.0%	4.2%	3.4%	10.1%	24.5%	13.0%	6.0%	8.1%	11.8%	8.2%	5.5%	0.3%	100%	60%	40%

Table 10.2.1.3: Bay of Biscay Anchovy. Catches in the Bay of Biscay by country and divisions in 2005 (without live bait catches)

		QUARTERS				CATCH (t)	
COUNTRIES	DIVISIONS	1	2	3	4	ANNUAL	%
SPAIN	VIIIa	0	0	0	0	0	0.0%
	VIIIb	2	72	0	0	75	42.6%
	VIIIc	2	99	0	0	101	57.4%
	TOTAL	5	171	0	0	176	100
	%	2.6%	97.4%	0.0%	0.0%	100.0%	
FRANCE	VIIIa	0	0	0	0	0	0.0%
	VIIIb	411	541	0	0	952	100.0%
	VIIIc	0	0	0	0	0	0.0%
	TOTAL	411	541	0	0	952	100.0%
	%	43.2%	56.8%	0.0%	0.0%	100.0%	952
INTERNATIONAL	VIIIa	0	0	0	0	0	0.0%
	VIIIb	413	613	0	0	1026	91.1%
	VIIIc	2	99	0	0	101	8.9%
	TOTAL	415	712	0	0	1127	100.0%
	%	36.8%	63.2%	0.0%	0.0%	100.0%	

The separation of Spanish catches during the second half of the year between VIIIa and VIIIb are only approximate estimations

Table 10.3.1.1: Bay of Biscay Anchovy. Catch at age in thousands for 2005 by country, division and quarter (without the catches from the live bait tuna fishing boats)

2005 units: thousands

	QUARTERS	1	2	3	4	Annual total
	AGE	VIIIbc	VIIIbc	VIIIabc	VIIIabc	VIIIabc
SPAIN	0	0	0	0	0	0
	1	181	915	0	0	1.096
	2	71	4.560	0	0	4.631
	3	4	262	0	0	266
	4	0	16	0	0	16
	TOTAL(n)	256	5.753	0	0	6.009
	W MED.	17,93	29,97	0,00	0,00	29,46
	CATCH. (t)	4,5	171,0	0,0	0,0	175,5
	SOP	4,6	172,6	0,0	0,0	177,2
	VAR. %	101,88%	100,93%	0,00%	0,00%	100,96%

	QUARTERS	1	2	3	4	Annual total
	AGE	VIIIab	VIIIab	VIIIab	VIIIab	VIIIab
FRANCE	0	0	0	0	0	0
	1	2.779	3.943	0	0	6.722
	2	12.618	15.663	0	0	28.281
	3	3.045	3.625	0	0	6.669
	4	262	308	0	0	570
	TOTAL(n)	18.703	23.538	0	0	42.242
	W MED.	23,66	23,07	0,00	0,00	23,33
	CATCH. (t)	410,7	541,0	0,0	0,0	951,7
	SOP	442,5	543,0	0,0	0,0	985,5
	VAR. %	107,74%	100,36%	0,00%	0,00%	103,54%

	QUARTERS	1	2	3	4	Annual total
	AGE	VIIIabc	VIIIabc	VIIIabc	VIIIabc	VIIIabc
TOTAL Sub-area VIII	0	0	0	0	0	0
	1	2.960	4.858	0	0	7.818
	2	12.689	20.223	0	0	32.911
	3	3.049	3.886	0	0	6.935
	4	262	325	0	0	586
	TOTAL(n)	18.959	29.291	0	0	48.250
	W MED.	23,58	24,42	0,00	0,00	24,09
	CATCH. (t)	415,2	712,0	0,0	0,0	1.127,2
	SOP	447,1	715,5	0,0	0,0	1.162,7
	VAR. %	107,67%	100,50%	0,00%	0,00%	103,14%

Table 10.3.1.2 . 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.

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	
Periods		1st half	2nd half	1st half	2nd half	1st half	2nd half
Age	0	0	7.530	0	11.184	0	0
	1	50.327	133.083	254.504	252.887	7.818	0
	2	44.546	87.142	85.679	20.072	32.911	0
	3	34.133	11.459	12.444	1.153	6.935	0
	4	887	1.152	4.598	16	586	0
	5	0	0	0	0	0	0
Total #		129.893	240.366	357.225	285.312	48.250	0
Internat Catches		4.074	6.521	9.183	7.177	1.127	0
Var. SOP		100%	100%	100%	100%	103%	0%
Annual Catch			10.595		16.360		1.127

Table 10.3.1.2 . (Cont. 2) Bay of Biscay Anchovy.

FRANCE

YEAR	1987		1988		1989		1990		1991		1992		1993		1994	
Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
Age 0	0	2.688	0	8.419	0	5.282	0	4.985	0	5.111	0	25.313	0	0	0	912
1	84.280	79.925	107.540	142.634	42.336	13.919	127.949	283.669	113.191	95.177	250.495	367.980	215.836	535.182	237.560	308.598
2	38.162	5.747	31.012	10.644	30.976	1.290	12.216	32.795	171.293	10.866	61.916	25.530	173.043	80.073	178.415	29.896
3	4.026	0	2.245	0	9.863	0	36	0	26.522	0	6.893	0	4.369	0	17.045	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total #	126.468	88.360	140.797	161.697	83.175	20.492	140.200	321.449	311.007	111.154	319.303	418.823	393.248	615.255	433.020	339.406
Catch France	2.941	1.958	3.048	3.775	1.776	479	2.985	7.613	6.682	3.027	5.334	9.883	6.851	14.062	7.994	8.939
Var. SOP	100,4%	101,0%	99,0%	102,5%	102,6%	97,8%	99,2%	98,7%	101,3%	98,6%	100,5%	99,8%	101,6%	99,4%	100,3%	100,4%
Annual Catch		4.899		6.822		2.255		10.598		9.708		15.217		20.914		16.934

YEAR	1995		1996		1997		1998		1999		2000		2001		2002	
Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd haf
Age 0	0	18.670	0	56.936	0	41.832	0	0	0	25.300	0	4.859	0	1	0	29
1	154.437	171.470	140.882	383.401	175.109	316.877	226.107	540.293	85.656	156.115	170.418	325.413	82.210	453.527	71.864	89.243
2	75.914	20.438	70.085	40.753	63.327	30.579	87.683	113.710	148.628	105.260	69.121	56.072	47.334	54.630	118.518	54.507
3	19.311	0	16.631	0	3.653	0	1.594	3.389	7.710	0	33.603	16.528	844	4.631	24.184	1.005
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	76	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total #	249.662	210.578	227.598	481.089	242.089	389.288	315.384	657.392	241.994	286.676	273.142	402.873	130.388	512.789	214641	144783
Catch France	5.157	5.735	4.251	10.987	4.284	7.546	6.099	16.888	5.058	8.591	5.449	12.316	2.782	14.316	6.357	4.631
Var. SOP	99,4%	97,9%	102,8%	99,8%	100,0%	103,9%	102,5%	94,3%	101,7%	103,4%	99,8%	97,0%	100,5%	101,3%	95%	102%
Annual Catch		10.892		15.238		11.830		22.987		13.649		17.765		17.097		10.988

YEAR	2003		2004		2005	
Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half
Age 0	0	7.481	0	11.069	0	0
1	38.567	128.188	70.651	233.893	6722	0
2	11.981	86.074	14.091	19.590	28281	0
3	5.324	11.187	4.983	1.130	6669	0
4	453	1.152	258	0	570	0
5	0				0	0
Total #	56.325	234.082	89.982	265.683	42.242	0
Catch France	1.226	6.367	2.102	6.679	952	0
Var. SOP	100%	100%	100%	100%	104%	0%
Annual Catch		7.593		8.781		952

Table 10.3.1.2 . (Cont) Bay of Biscay Anchovy.

SPAIN

YEAR	1987		1988		1989		1990		1991		1992		1993		1994	
Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
Age 0	0	35.452	0	141.918	0	174.803	0	11.999	0	81.536	0	13.121	0	63.499	0	59.022
1	134.390	40.172	210.641	47.480	110.276	13.165	719.678	234.021	210.686	21.113	751.056	72.154	578.219	75.865	257.050	47.065
2	119.503	7.787	61.609	2.690	92.707	9.481	47.266	43.204	139.327	1.715	131.221	5.916	266.612	11.904	315.022	24.971
3	27.336	1.664	7.710	596	8.232	1.986	8.139	4.999	2.657	61	10.067	1	967	0	44.622	1.325
4	14.831	58	1.356	0	54	0	0	0	0	0	0	0	0	0	0	0
5	8.920	0	99	0	0	0	0	0	0	0	0	0	0	0	0	0
Total #	304.980	85.134	281.414	192.684	211.270	199.435	775.083	294.222	352.670	104.425	892.344	91.192	845.798	151.268	616.694	132.383
Catch Spain	8.777	1.632	6.955	1.804	5.377	2.981	16.401	7.273	8.343	1.583	21.047	1.621	17.206	2.272	15.219	2.478
Var. SOP	100,7%	99,7%	97,9%	100,6%	97,1%	99,5%	100,9%	99,5%	94,7%	98,2%	99,3%	100,5%	100,8%	100,2%	101,3%	99,6%
Annual Catch		10.409		8.759		8.358		23.674		9.926		22.669		19.479		17.697

YEAR	1995		1996		1997		1998		1999		2000		2001		2002	
Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd haf
Age 0	0	31.101	0	52.238	0	91.400	0	4.075	0	29.057	0	439	0	748	0	239
1	367.924	17.611	542.127	72.763	296.261	123.011	217.711	57.847	134.411	87.191	389.515	71.547	378.136	54.151	31.347	40.149
2	206.387	1.333	163.010	12.403	74.856	9.435	41.171	9.515	231.384	37.644	199.233	8.640	327.090	43.487	98.700	22.621
3	57.214	90	14.461	499	1.927	195	4.002	9	10.051	525	50.834	2.085	18.854	464	13.702	2.041
4	4.096	7	2.213	42	0	0	155	0	108	0	0	0	4.948	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total #	635.621	50.142	721.810	137.945	373.044	224.041	263.039	71.445	375.954	154.416	639.583	82.711	729.029	98.851	143748,2	65049,3
Catch Spain	18.322	902	16.774	2.361	6.420	3.897	6.818	1.812	10.323	3.287	17.087	2.143	20.314	2.738	4.745	1.774
Var. SOP	102,1%	100,1%	99,5%	100,4%	99,5%	98,7%	98,9%	99,8%	102,1%	101,7%	101,1%	100,7%	102,1%	101,7%	101%	101%
Annual Catch		19.224		19.135		10.317		8.630		13.610		19.230		23.052		6.519

YEAR	2003		2004		2005	
Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half
Age 0	0	49	0	115	0	0
1	11.761	4.895	183.853	18.994	1096	0
2	32.566	1.068	71.589	482	4631	0
3	28.809	272	7.461	23	266	0
4	434	0	4.340	16	16	0
5	0	0			0	0
Total #	73.569	6.285	267.243	19.630	6.009	0
Catch Spain	2.848	154	7.081	498	176	0
Var. SOP	100%	101%	101%	101%	101%	0%
Annual Catch		3.002		7.580		176

Table 10.3.1.3: Bay of Biscay Anchovy. Spanish half - yearly catches (2nd semester) by age in ('000) of Bay of Biscay anchovy from the live bait tuna fishing boats. (From Anon., 1996 and Uriarte et al., WD 1997). Since 1999 onwards are not being estimated.

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	10 020	97 581	6 114	11 999	12 716	2 167	3 557	7 872	10 154	8 102	33 078	1 032	17 230	n/a
1	24 675	17 353	6 320	21 540	13 736	14 268	20 160	5 753	10 885	6 100	8 238	15 136	20 784	n/a
2	1 461	203	1 496	139	0	0		477	209	522	58	0	810	n/a
3	912	3	0	0	0	0		0	0	0	0	0	0	n/a
Total	37 068	115 140	13 930	33 677	26 452	16 435	23 717	14 102	21 248	14 724	41 375	16 169	38 825	n/a
Catch (t)	546	493	185	416	353	200	306	143.2	273.2	197.5	378	175.5	465.13	n/a
meanW (g)	14.7	4.3	13.3	12.4	13.3	12.1	12.9	10.2	15.8	13.4	9.14	10.85	11.98	n/a
AGE	2001	2002	2003	2004	2005									
0	n/a	n/a	n/a	n/a	n/a									
1	n/a	n/a	n/a	n/a	n/a									
2	n/a	n/a	n/a	n/a	n/a									
3	n/a	n/a	n/a	n/a	n/a									
Total	n/a	n/a	n/a	n/a	n/a									
Catch (t)	n/a	n/a	n/a	n/a	n/a									
meanW (g)	n/a	n/a	n/a	n/a	n/a									

Table 10.3.2.1: Bay of Biscay Anchovy. Length distribution ('000) in Division VIIIa,b,c by country and quarters in 2005.

	QUARTER 1		QUARTER 2		QUARTER 3		QUARTER 4	
Length (half cm)	France VIIIab	Spain VIIIbc	France VIIIab	Spain VIIIbc	France VIIIab	Spain VIIIabc	France VIIIab	Spain VIIIabc
3,5								
4								
4,5								
5								
5,5								
6								
6,5								
7								
7,5								
8								
8,5								
9								
9,5								
10			9					
10,5			43					
11			148					
11,5	10	18	307					
12	39	64	271					
12,5	149	43	225					
13	502	18	542	15				
13,5	939	3	1.018	82				
14	2.215	19	2.449	154				
14,5	2.691	33	3.384	368				
15	3.358	13	4.455	732				
15,5	2.700	14	3.951	945				
16	2.093	10	2.342	781				
16,5	1.863	10	2.084	1.128				
17	1.006	6	1.020	811				
17,5	675	4	804	508				
18	285	3	255	147				
18,5	153	1	216	36				
19	26		15	49				
19,5								
20								
20,5								
21								
21,5								
22								
22,5								
23								
23,5								
24								
24,5								
25								
25,5								
26								
Number('000)	18.703	255	23.538	5.756	0	0	0	0
Catch (t)	411	5	541	171				
Mean Length(cm)	15,26	13,55	15,13	16,06				
Mean weight(g)	21,96		22,98	29,71				

Table 10.3.2.2: 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	
Sources:	WG data		WG data		WG data	
Periods	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
1	21,0	25,4	21,7	24,9	19,3	0,0
2	36,2	29,5	35,7	33,5	24,5	0,0
3	40,3	36,4	39,3	40,7	27,6	0,0
4	36,9	37,9	44,0	42,8	24,5	0,0
5	0,0	0,0	0,0	0,0	0,0	0,0
Total	31,4	27,1	26,0	25,2	24,1	0,0
SOP	4.078	6.524	9.271	7.181	1.162	0
mean weight 3+	40,3	36,4	0,0	0,0	0,0	0,0

TABLE 10.4.1.1 Bay of Biscay anchovy: Time series of SSB estimates from the Daily Egg Production Method
(From ICES2001/ACFM06 updated for the 2001 from Uriarte et a. Working Document 2002) and for 2002 from Santos& Uriarte Working Document 2002 (preliminary estimate))

YEAR		1987	1988	1989(*)	1989(*)	1990	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Period of year		2 - 7 June	21 - 28 May	10 - 21 May	14-24 June	4 - 15 May	29 May- 15 June	16May-07Jun	16May-13Jun	No survey	17 May-3June.	11 - 25 May	18 - 30 May	9 - 21 May	18 May - 8 June	22 May - 5 June	2 May - 20 May	14 May - 8 June	6-21 May	22May-9Jun	2 - 22 May	8 - 28 May	4 - 24 May
Julian Mid Day		155	145	136	171	130	158	148	151		146	138	144	135	149	149	131	147	134				
Positive area (km2)		23,850	45,384	17,546	27,917	59,757	69,471	24,264	67,796		48,735	31,189	28,448	50,133	73,131	51,019	37,883	72,022	35,980	42,535	23,124	27,863	24,614
Surveyed area (km2)		34,934	59,840	37,930	-	79,759	-	84,032	92,782		60,330	51,698	34,294	59,587	83,156	61,533	63,192	92,376	56,176	70,041	53,285	61,619	53,991
Po (Egg per 0.05 m^2)(En Area +)		4.60	5.52	2.08	1.50	3.78	5.21	2.55	4.27		3.93	4.98	4.87	2.69	3.83	3.65	3.45	5.89	3.28	2.53	1.82	0.79	2.16
Total Daily egg production		2.20	5.01	0.73	0.83	5.02	7.24	1.24	5.81		3.83	3.09	2.77	2.70	5.6	3.72	2.61	8.48	2.34	2.15	0.842	0.44	1.065
(* Exp(-12))	C.V.	0.39	0.24	0.4	-	0.15	-	0.06	0.14		0.14	0.07	0.16	0.07	0.05	0.09	0.19	0.087	0.127	0.28	0.115	0.16	0.17
SSB (t)		**29,365**	**63,500**	**11,861**	**10,058**	**97,239**	**77,254**	**19,276**	**90,720**	**--**	**60,062**	**54,700**	**39,545**	**51,176**	**101,976**	**69,074**	**44,973**	**124,132**	**30697**	**23962**	**19,498**	**8,002**	**21,436**
	C.V.	0.48	0.31	0.41	-	0.17	-	0.14	0.20		0.17	0.09	0.16	0.10	0.09	0.15	0.15	0.20	0.13	0.28	0.15	0.19	0.19
TOTAL #		1129	2675	470		5843		965.6	5797	--	2954	2644		3737.7	6282.4			6047.6	1,038.7	1296	979.9	292.3	1,203.8
(millions)	C.V.							0.14	0.25		0.19	0.11		0.16	0.13			0.23	0.1451	0.29	0.2	0.2	0.2513118
No/age:	1	**656.0**	**2,349.0**	**246.0**		**5,613.0**		**670.5**	**5,571.0**		**2,030.0**	**2,257.0**		**3,242.6**	**5,466.7**			**4,362.2**	**283.6**	**1,042.0**	**837.0**	**95.1**	**998.2**
	C.V.							0.16	0.26		0.23	0.13		0.17	0.15			0.27	0.30	0.30	0.23	0.26	0.29
(millions)	2	**331.0**	**258.0**	**206.0**		**190.0**		**290.3**	**209.3**		**874.0**	**329.0**		**482.1**	**759.5**			**1,562.0**	**621.3**	**179.6**	**114.9**	**188.8**	**156.5**
	C.V.							0.17	0.22		0.19	0.23		0.10	0.14			0.22	0.13	0.34	0.19	0.19	0.24
	3+	**142.0**	**68.0**	**18.0**		**40.0**		**4.8**	**16.7**		**49.3**	**58.0**		**13.1**	**56.3**			**123.5**	**133.8**	**74.0**	**28.0**	**8.4**	**49.7**
	C.V.							0.42	0.51		0.30	0.30		0.27	0.36			0.37	0.14	0.38	0.26	0.37	0.24

(*) Likely subestimate according to authors (Motos &Santiago,1989)

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

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

Table 10.4.1.2: Bay of Biscay anchovy: Summary results of the DEPM application to the Bay of Biscay anchovy in 2006. DEP is total Daily Egg Production in the area, R' sex ratio in weight, S spawning fraction, F batch fecundity, Wf mean weight of mature females, Wt mean weight of anchovies, DF is daily Fecundity and SSB is spawning biomass, Pa 1, 2 and 3 are proportions at age in the population, Nage1, 2 and 3 are the population in numbers at age.

Parameter	estimate	S.e.	CV
DEP	**1,06E+12**	**1,78E+11**	**0,1674**
R'	0,537	0,0073	0,0136
S	0,263	0,0150	0,0572
F	9.046	1.054	0,1165
Wf	25,5	2,08	0,0818
DF	**50,14**	**4,56**	**0,0910**
BIOMASS	**21.436**	**4.084**	**0,1905**
Wt	18,17	2,20	0,1209
POPULATION	**1.204**	**303**	**0,2513**
Pa 1	0,82	0,0466	0,0567
Pa 2	0,14	0,0362	0,2677
Pa 3	0,04	0,0116	0,2697
Nage 1	998,2	290	0,2907
Nage 2	156,5	38	0,2414
Nage 3	49,7	12	0,2377

Table 10.4.2.1: Bay of Biscay Anchovy. Evaluation of Anchovy abundance index from French acoustic surveys in the Bay of Biscay.

YEAR	1983	1984	1989 (2)	1990	1991	1992	1994	1997	1998	2000	2001	2002	2003	2004	2005	2006
DATE	20/4-25/4	30/4-13/5	23/4-2/5	12/4-25/4	6/4-29/4	13/4-30/4	15/5-27/5	6/5-22/5	20/5-7/6	18/04 - 14/05	27/04 - 6/06	6/05 - 6/06	27/5 - 25/6	27/4 - 25/5	3/05 - 31/05	1/05 - 31/05
Surveyed area	3,267	3,743	5,112	3,418 (3)	3388 (3)	2440(3)	2300(3)	1726(3)	9,400	19,838	21,300	10,667	12,917	12,225	16,354	17,204
									5600 (3)							
Biomass (t)	50,000	38,500	15,500	60-110,000 (4)	64,000	89,000	35,000	63,000	57,000	98,484	137,200 (5)	97,051	29,428	46,018	16,446	30,649
Nb (10**(-6))	2,600	2,000	805	4,300-7,500 (4)	3,173	9,342	*na*	3351	*na*		7892 (6)	3569	1451	2678	631	1862
Nb of age 1 (1(	1,800 (1)	600	400	4,100-7,500 (4)	1,873	9,072	*na*	2481	*na*		6163 (6)	831	983	2290	128	1353
Nb of age 2 (1(	800*	1400*	405*	0 -200 (4)*	1300*	270*	*na*	870*	*na*		1728* (6)	2738*	468	249	401	390
*(age 2+ when *)*																
Nb of age 3+ group(10**(-6))														139	102	118
Anchovy mear	19.2	19.3	19.3	*na*	20.2	9.5	*na*	18.8	*na*		16.8 (6)	27.2	20.28	18.02	31.14	16.5

(1) Rough estimation
(2) Assumption of overestimate
(3) Positive area
(4) uncertainty due to technical problems
(*) area where anchovy shools have been detected
(5) For the assessment performed in the WG of year 2001 the value used for 2001 biomass was 132800t becouse the definitive figure from the survey arrived too late to the WG
(6) based on the biomass estimate of areas 2, 4, 6 and 7 (13 2600 t)

Table 10.4.2.2: Bay of Biscay Anchovy. Biomass estimate by age group in tons and in numbers in the Bay of Biscay in 2006 from French acoustic surveys PELGAS06.

Biomass in tons	G 1	G 2	G 3	G 4+	Total	%
Coastal	15 570	4 521	1 534	10	21 634	70.6
Offshore	1 116	5 712	2 124	63	9 015	29.4
total	**16 686**	**10 233**	**3 658**	**73**	**30 649**	
%	*60.4 %*	*28.5 %*	*10.9 %*	*0.2 %*		

Biomass in numbers (10^6)	G 1	G 2	G 3	G 4+	Total	%
Coastal	1 314 114	267 296	72 893	225	1 654 528	88.9
Offshore	39 114	122 881	43 754	1 357	207 106	11.1
total	**1 353 228**	**390 177**	**116 647**	**1 582**	**1 861 634**	
%	*74.2 %*	*19.6 %*	*6.2 %*	*0.1 %*		

Table 10.4.2.3: Bay of Biscay Anchovy. Mean weights at age for the the Bay of Biscay in 2006 from French acoustic surveys PELGAS06.

mean weight / age (g)	G 1	G 2	G 3	G 4	Global
coastal area	11.8	16.9	21.0	42.5	13.1
offshore	28.5	46.5	48.5	46.6	43.5
global	12.3	26.2	31.4	46.0	16.5

Table 10.4.3.1.1: Bay of Biscay anchovy: Synthesis of the JUVENA acoustic abundance estimates of adult and juvenile anchovy in the Bay of Biscay since 2003.

Region	<NASC> (m2/nmi2)	Area (nmi2)	Size juve (mm)	Size adult (mm)	Weight juve (g)	Weight adult (g)	Abund juve (index)	Abund adult (index)
					2003			
Oceanic	40.5	2,910.4	79.7		3.0		96,476.8	0.0
Garonne	44.4	737.8	109.5	139.7	7.8	16.6	6,238.5	14,944.3
Total		3,648.2					102,715.3	14,944.3
					2004			
Oceanic	0.9	499.8	59.9		1.2		213.7	0.0
Garonne	30.4	2,026.4	106.6	132.8	7.5	15.5	1,929.1	3,881.5
Total		2,526.2					2,142.9	3,881.5
					2005			
Oceanic	72.1	5,394.8	65.7		1.7	0.0	140,754.9	0.0
Garonne	32.6	1,927.5	102.9	119.7	7.5	11.1	6,450.0	13,630.8
Total		7,322.3					147,204.9	13,630.8

Table 10.5.1: Bay of Biscay Anchovy. Evolution of the French and Spanish fleets in Subarea VIII (from Working Group members). Units: Numbers of boats.

	France				Spain	
Year	**P. seiner**	**P. trawl**		**Total**	**P. seiner**	**Total**
1960	-	-			571	571
1972	-	-			492	492
1976	-	-			354	354
1980	-	-			293	293
1984	-	-			306	306
1987	-	-			282	282
1988	-	-			278	278
1989	18	6	(1,2)	24	215	239
1990	25	48	(1,2)	73	266	339
1991	19	53	(1,2)	72	250	322
1992	21	85	(1,2)	106	244	350
1993	34	108	(1,2)	142	253	395
1994	34	77	(1,2)	111	257	368
1995	33	44	(1,2)	77	257	334
1996	30	60	(1,2)	90	251	341
1997	27	52	(1,2)	79	267	346
1998	29	44	(1,2,3)	73	266	339
1999	30	49	(1,2)	79	250	329
2000	32	57	(1,2)	89	238	327
2001	34	60	(1,2)	94	220	314
2002	32	47	(1,2)	79	215	294
2003	19	47	(1,2)	66	208	274
2004	31	54	(1,2)	85	201	286
2005	8	41	(1,2,4)	49	196	245

(1) Only purse seiners having catched anchovy at least once a year but fishing sardine most of the time
(2) only trawlers that targeted anchovy (annual catch > 50 t)
(3) doubtful in term of separation between gears because of misreporting
(4) because of the closure of the fishery (1st july), the threshold was decreased to 10t to select the vessels which really targeted anchovy before the closure

Table 10.6.1: Bay of Biscay anchovy: Series of Upwelling indexes from Borja et al. (1996,98 Updated for this WG) and two-covariate model Allain et al. (1999) & Petitgas et al (WD2004)

	Pers.Comm.			
	Borja's et al. (1996,98)	**Petitgas et al. (WD2003)**		**Assessment 06**
Year	Upwelling	UPW	SBD	Age_1 Serie
1986	617.5	20.49	0	17,792
1987	508.4	47.25	1	42,775
1988	473.2	35.88	1	12,477
1989	970.9	45.45	0	88,486
1990	905.9	50.00	1	26,114
1991	1,076.3	110.74	0	131,313
1992	1,128.8	47.16	0	90,846
1993	570.9	53.03	0	48,784
1994	905.0	29.20	0	59,735
1995	1,204.0	74.99	0	63,810
1996	973.0	50.17	0	51,365
1997	1,230.5	100.04	0	80,902
1998	461.0	58.49	0	73,906
1999	402.0	32.68	0	117,257
2000	391.0	65.32	0	86,392
2001	418.0	57.93	1	11,969
2002	642.0	65.32	0	25,340
2003	424.0	57.93	0	38,192
2004	435.0	60.81	0	4,645
2005	626.0	55.83	0	19,412
2006	667.0	n.a.	n.a.	

TABLE 10.7.2.1a: Bay of Biscay anchovy: Input data for ICA.

Anchovy in subarea VIII (Bay of Biscay a

Catch in Number

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	38.1	150.3	180.1	17.0	86.6	38.4	63.5	59.9	49.8	109.2	133.2	4.1	54.4	5.3	0.7
1	338.8	508.3	179.7	1365.3	440.2	1441.7	1405.1	850.3	711.4	1139.2	911.3	1042.0	463.4	956.9	968.0
2	171.2	106.0	134.5	135.5	323.2	224.6	531.6	548.3	304.1	286.3	178.2	252.1	522.9	333.1	472.5
3	33.0	10.6	20.1	13.2	29.2	17.0	5.3	63.0	76.6	31.6	5.8	9.0	18.3	103.0	24.8
4	14.9	1.4	1.0	1.0	1.0	1.0	1.0	1.0	4.1	2.3	1.0	1.0	1.1	1.0	4.9
5	8.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

x 10 ^ 6

Catch in Number

AGE	2002	2003	2004	2005
0	0.3	7.5	11.2	0.8
1	232.6	183.4	507.4	7.8
2	294.3	131.7	105.8	32.9
3	40.9	45.6	13.6	6.9
4	1.0	2.0	4.6	1.0
5	1.0	1.0	1.0	1.0

x 10 ^ 6

Predicted Catch in Number

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	51.4	49.8	20.0	18.3	26.9	48.4	33.8	11.6	19.1	23.7	5.0	4.0	10.7	1.9	1.6
1	491.4	1926.3	1394.1	782.6	715.2	1267.2	792.0	908.3	454.4	957.5	889.0	181.0	209.0	535.5	9.4
2	341.3	189.9	572.4	611.9	328.9	325.3	206.4	282.2	499.3	307.5	467.6	422.4	119.1	116.6	33.8
3	4.0	31.6	12.9	65.0	64.3	36.1	10.1	20.7	47.7	104.1	43.5	64.5	82.5	18.0	1.6
4	0.8	0.4	2.3	1.6	7.3	7.7	1.2	1.0	3.5	10.1	15.1	6.1	13.0	13.2	0.3

x 10 ^ 6

Weights at age in the catches (Kg)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	.011700	.005100	.012700	.007400	.014400	.012600	.012300	.014700	.015100	.011900	.011600	.010200	.015700	.019300	.014300
1	.021300	.021900	.020300	.021800	.020300	.020600	.017800	.020300	.023700	.019900	.017200	.022900	.022300	.024400	.025200
2	.032100	.030300	.029000	.028100	.025400	.030600	.027400	.026900	.032200	.031100	.027600	.026000	.030800	.029900	.031600
3	.037700	.035000	.031000	.043300	.028200	.037700	.030500	.030700	.036400	.040100	.031900	.030700	.034800	.033600	.036800
4	.041000	.037600	.027100	.040500	.040500	.040500	.040500	.040500	.037300	.046000	.040500	.031900	.055900	.040500	.040700
5	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000

Weights at age in the catches (Kg)

AGE	2002	2003	2004	2005
0	.009500	.015400	.015500	.015500
1	.027100	.024200	.023300	.019300
2	.032100	.031800	.035300	.024500
3	.042300	.039300	.039400	.027600
4	.045600	.037400	.044000	.025000
5	.042000	.042000	.042000	.042000

Weights at age in the stock (Kg)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	.013000	.013000	.013000	.010000	.015000	.012000	.012000	.015000	.012000	.012000	.012000	.012000	.012000	.012000	.012000
1	.021700	.022600	.021000	.016200	.016800	.015400	.016000	.017100	.019000	.016000	.011900	.014600	.016000	.016800	.016000
2	.033000	.029800	.029000	.029500	.028000	.031700	.028900	.025800	.031100	.028900	.026600	.029900	.028900	.028500	.028900
3	.038000	.034100	.033000	.034600	.034000	.031700	.034500	.032300	.034100	.034500	.037400	.036900	.034500	.034800	.034500
4	.041000	.042500	.040500	.040500	.040500	.040500	.040500	.040500	.040500	.040500	.040500	.040500	.040500	.040500	.040500
5	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000

Table 10.7.2.1a (Cont'd)

Weights at age in the stock (Kg)

AGE	2002	2003	2004	2005
0	.012000	.012000	.012000	.012000
1	.022300	.015900	.017800	.021700
2	.033200	.029000	.034300	.029500
3	.035900	.034400	.034400	.044300
4	.040500	.040500	.040500	.044300
5	.042000	.042000	.042000	.042000

Natural Mortality (per year)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000
1	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000
2	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000
3	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000
4	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000
5	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000

Natural Mortality (per year)

AGE	2002	2003	2004	2005
0	1.2000	1.2000	1.2000	1.2000
1	1.2000	1.2000	1.2000	1.2000
2	1.2000	1.2000	1.2000	1.2000
3	1.2000	1.2000	1.2000	1.2000
4	1.2000	1.2000	1.2000	1.2000
5	1.2000	1.2000	1.2000	1.2000

Proportion of fish spawning

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Proportion of fish spawning

AGE	2002	2003	2004	2005
0	0.0000	0.0000	0.0000	0.0000
1	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000

Table 10.7.2.1a (Cont'd)

INDICES OF SPAWNING BIOMASS

DEPM

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	29.36	63.50	16.72	97.24	19.28	90.72	*******	60.06	54.70	39.55	51.18	101.98	69.07	44.97	124.13

x 10 ^ 3

DEPM

	2002	2003	2004	2005	2006
1	30.70	23.96	19.50	8.00	21.44

x 10 ^ 3

Acoustic

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	*******	*******	15.50	*******	64.00	89.00	*******	35.00	*******	*******	63.00	57.00	*******	98.48	137.20

x 10 ^ 3

Acoustic

	2002	2003	2004	2005	2006
1	97.05	29.43	46.02	15.60	30.65

x 10 ^ 3

AGE-STRUCTURED INDICES

DEPM SUVEYS (Ages 1 to 3+)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	656.0	2349.0	346.9	5613.0	670.5	5571.0	*******	2030.1	2257.0	*******	3242.6	5466.7	*******	*******	4362.2
2	331.0	258.0	290.5	190.0	290.3	209.3	*******	874.3	329.0	*******	482.1	759.5	*******	*******	1562.0
3	142.0	68.0	25.4	40.0	4.8	16.7	*******	49.3	58.0	*******	13.1	56.3	*******	*******	123.5

x 10 ^ 3

DEPM SUVEYS (Ages 1 to 3+)

AGE	2002	2003	2004	2005	2006
1	283.6	1042.0	837.0	95.1	998.2
2	621.3	179.6	114.9	188.8	156.5
3	133.8	74.0	28.0	8.4	49.7

x 10 ^ 3

ACOUSTIC SURVEYS (ages 1 to 2+)

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	400.0	*******	1873.0	9072.0	*******	*******	*******	*******	2481.0	*******	*******	*******	6163.0	831.0	983.2
2	405.0	*******	1300.0	270.0	*******	*******	*******	*******	870.0	*******	*******	*******	1728.0	2738.0	467.8

x 10 ^ 3

ACOUSTIC SURVEYS (ages 1 to 2+)

AGE	2004	2005	2006
1	2645.0	127.6	1353.2
2	145.0	503.1	508.4

x 10 ^ 3

Weighting factors for the catches in number

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	0.0001	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
4	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100

Table 10.7.2.1b: Bay of Biscay anchovy: Summary results of an update annual assessment using Integrated Catch at age analysis (ICA) in 2006 with the same settings as in past year (2005 ICES CM2006).

Output Generated by ICA Version 1.4

Anchovy in subarea VIII (Bay of Biscay a

Fishing Mortality (per year)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.0108	0.0707	0.0194	0.0041	0.0033	0.0036	0.0028	0.0030	0.0033	0.0048	0.0021	0.0014	0.0015	0.0019	0.0019
1	0.4571	0.6059	0.3332	0.6261	0.4686	0.5042	0.3889	0.4240	0.4691	0.6751	0.2939	0.2028	0.2042	0.2685	0.2639
2	1.4270	0.8666	1.1865	1.9706	1.1660	1.2546	0.9677	1.0550	1.1672	1.6799	0.7314	0.5045	0.5082	0.6681	0.6568
3	1.6293	1.1051	1.6675	1.3210	1.0578	1.1382	0.8779	0.9571	1.0589	1.5241	0.6635	0.4577	0.4611	0.6061	0.5959
4	1.1482	0.9460	1.0148	1.3126	0.9212	0.9911	0.7645	0.8335	0.9221	1.3271	0.5778	0.3986	0.4015	0.5278	0.5189
5	1.1482	0.9460	1.0148	1.3126	0.9212	0.9911	0.7645	0.8335	0.9221	1.3271	0.5778	0.3986	0.4015	0.5278	0.5189

Fishing Mortality (per year)

AGE	2002	2003	2004	2005
0	0.0018	0.0025	0.0036	0.0004
1	0.2483	0.3497	0.5039	0.0615
2	0.6178	0.8703	1.2540	0.1531
3	0.5605	0.7895	1.1376	0.1389
4	0.4881	0.6875	0.9906	0.1209
5	0.4881	0.6875	0.9906	0.1209

Population Abundance (1 January)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	6085.	3757.	16067.	7188.	26513.	23849.	12431.	10443.	13848.	17318.	27727.	13769.	22622.	21338.	4590.
1	1518.	1813.	1054.	4746.	2156.	7959.	7157.	3734.	3136.	4157.	5191.	8334.	4141.	6804.	6415.
2	340.	289.	298.	228.	764.	407.	1448.	1461.	736.	591.	637.	1165.	2049.	1017.	1567.
3	61.	25.	37.	27.	10.	72.	35.	166.	153.	69.	33.	92.	212.	371.	157.
4	34.	4.	2.	2.	2.	1.	7.	4.	19.	16.	5.	5.	18.	40.	61.
5	20.	3.	2.	2.	3.	2.	3.	3.	3.	2.	4.	5.	5.	4.	4.

x 10 ^ 6

Population Abundance (1 January)

AGE	2002	2003	2004	2005	2006
0	3910.	7367.	900.	6101.	9305.
1	1380.	1175.	2213.	270.	1837.
2	1484.	324.	250.	403.	77.
3	245.	241.	41.	21.	104.
4	26.	42.	33.	4.	6.
5	4.	3.	2.	15.	5.

x 10 ^ 6

Weighting factors for the catches in number

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	0.0001	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
4	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100

Predicted SSB Index Values

DEPM

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	23197.	24848.	16265.	40534.	27934.	69836.	999990.	52585.	43214.	39035.	43868.	91734.	74132.	87001.	85175.

DEPM

	2002	2003	2004	2005	2006
1	47421.	19339.	25027.	11833.	21668.

Table 10.7.2.1b (Cont'd)

Acoustic

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	*******	*******	21.24	*******	36.48	91.21	*******	68.68	*******	*******	57.30	119.81	*******	113.63	111.25

x 10 ^ 3

Acoustic

	2002	2003	2004	2005	2006
1	61.94	25.26	32.69	15.45	28.30

x 10 ^ 3

Predicted Age-Structured Index Values

DEPM SUVEYS (Ages 1 to 3+) Predicted

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	690.8	768.9	509.0	1993.7	976.1	3542.5	*******	1726.4	1419.2	*******	2553.2	4280.2	*******	*******	3200.1
2	97.5	108.5	95.9	50.5	248.4	126.7	*******	500.6	239.1	*******	254.7	518.6	*******	*******	648.6
3	33.5	10.4	11.1	9.5	5.0	24.9	*******	62.2	60.4	*******	17.2	46.8	*******	*******	95.7

x 10 ^ 3

DEPM SUVEYS (Ages 1 to 3+) Predicted

AGE	2002	2003	2004	2005	2006
1	693.5	563.0	985.3	148.4	1008.9
2	625.7	121.3	77.8	211.8	40.2
3	119.6	112.1	26.0	21.4	60.8

x 10 ^ 3

ACOUSTIC SURVEYS (ages 1 to 2+) Predicted

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	751.1	*******	1477.1	5395.9	*******	*******	*******	*******	3740.6	*******	*******	*******	4662.5	1007.5	833.4
2	323.6	*******	757.6	458.9	*******	*******	*******	*******	749.6	*******	*******	*******	2021.5	2010.1	655.1

x 10 ^ 3

ACOUSTIC SURVEYS (ages 1 to 2+) Predicted

AGE	2004	2005	2006
1	1500.7	208.2	1415.9
2	312.8	578.0	250.1

x 10 ^ 3

Fitted Selection Pattern

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.0076	0.0815	0.0163	0.0021	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029
1	0.3203	0.6992	0.2809	0.3177	0.4019	0.4019	0.4019	0.4019	0.4019	0.4019	0.4019	0.4019	0.4019	0.4019	0.4019
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.1418	1.2752	1.4054	0.6704	0.9072	0.9072	0.9072	0.9072	0.9072	0.9072	0.9072	0.9072	0.9072	0.9072	0.9072
4	0.8046	1.0916	0.8553	0.6661	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900
5	0.8046	1.0916	0.8553	0.6661	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900

Fitted Selection Pattern

AGE	2002	2003	2004	2005
0	0.0029	0.0029	0.0029	0.0029
1	0.4019	0.4019	0.4019	0.4019
2	1.0000	1.0000	1.0000	1.0000
3	0.9072	0.9072	0.9072	0.9072
4	0.7900	0.7900	0.7900	0.7900
5	0.7900	0.7900	0.7900	0.7900

Table 10.7.2.1b (Cont'd)

STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 1- 3	SoP (%)
1987	6084550	127786	23196	15308	0.6599	1.1711	99
1988	3756930	99536	24848	15581	0.6270	0.8592	100
1989	16067340	241068	16265	10614	0.6526	1.0624	100
1990	7188420	156609	40533	34272	0.8455	1.3059	99
1991	26513210	455850	27934	19634	0.7029	0.8975	101
1992	23848520	424056	69836	37885	0.5425	0.9657	100
1993	12430880	307143	81349	40293	0.4953	0.7448	99
1994	10442950	263837	52584	34631	0.6586	0.8120	99
1995	13848030	254758	43213	30115	0.6969	0.8984	99
1996	17318260	294523	39035	34373	0.8806	1.2930	100
1997	27727060	413035	43867	22337	0.5092	0.5629	99
1998	13769360	325579	91734	31617	0.3447	0.3883	102
1999	22621930	405186	74131	27259	0.3677	0.3912	97
2000	21337640	414055	87000	36994	0.4252	0.5142	100
2001	4589510	211042	85174	40564	0.4762	0.5055	100
2002	3909610	136964	47420	17507	0.3692	0.4755	99
2003	7367030	126624	19338	10595	0.5479	0.6698	99
2004	900170	61606	25027	16361	0.6537	0.9652	99
2005	6101280	92710	11832	1127	0.0952	0.1178	91

No of years for separable analysis : 15
Age range in the analysis : 0 . . . 5
Year range in the analysis : 1987 . . . 2005
Number of indices of SSB : 2
Number of age-structured indices : 2

Parameters to estimate : 40
Number of observations : 175

Conventional single selection vector model to be fitted.

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1991	1.1660	21	0.7592	1.7908	0.9368	1.4514	1.1943
2	1992	1.2546	23	0.7889	1.9953	0.9901	1.5897	1.2902
3	1993	0.9677	23	0.6077	1.5410	0.7632	1.2269	0.9953
4	1994	1.0550	22	0.6803	1.6362	0.8434	1.3198	1.0818
5	1995	1.1672	24	0.7281	1.8712	0.9175	1.4850	1.2016
6	1996	1.6799	19	1.1411	2.4732	1.3791	2.0464	1.7129
7	1997	0.7314	24	0.4551	1.1753	0.5742	0.9316	0.7531
8	1998	0.5045	27	0.2962	0.8594	0.3845	0.6621	0.5235
9	1999	0.5082	27	0.2938	0.8791	0.3843	0.6722	0.5285
10	2000	0.6681	25	0.4087	1.0920	0.5199	0.8584	0.6894
11	2001	0.6568	23	0.4139	1.0423	0.5189	0.8313	0.6753
12	2002	0.6178	23	0.3906	0.9773	0.4889	0.7807	0.6350
13	2003	0.8703	22	0.5545	1.3659	0.6915	1.0953	0.8936
14	2004	1.2540	21	0.8158	1.9275	1.0070	1.5615	1.2845
15	2005	0.1531	25	0.0928	0.2526	0.1186	0.1976	0.1582
Separable Model: Selection (S) by age								
16	0	0.0029	81	0.0006	0.0142	0.0013	0.0065	0.0040
17	1	0.4019	11	0.3210	0.5031	0.3583	0.4507	0.4045
	2	1.0000		Fixed : Reference Age				
18	3	0.9072	28	0.5175	1.5904	0.6813	1.2081	0.9452
	4	0.7900		Fixed : Last true age				
Separable model: Populations in year 2005								
19	0	6101285	27	3546802	10495564	4626208	8046694	6339488
20	1	270154	23	169315	431051	212855	342879	277940
21	2	402768	17	287581	564093	339168	478295	408761
22	3	21449	32	11365	40479	15512	29657	22605
23	4	3948	43	1684	9253	2556	6097	4339
Separable model: Populations at age								
24	1991	2200	306	5	901957	102	47375	244438
25	1992	998	108	119	8328	338	2946	1793
26	1993	6921	47	2731	17538	4307	11122	7745
27	1994	4370	45	1780	10726	2764	6909	4853
28	1995	19163	40	8675	42331	12789	28712	20795
29	1996	16006	44	6705	38206	10268	24950	17663
30	1997	4525	57	1452	14095	2534	8079	5353
31	1998	5144	42	2216	11943	3347	7906	5642
32	1999	17607	32	9379	33050	12768	24278	18539
33	2000	40252	33	21013	77103	28891	56080	42527
34	2001	61005	36	29555	125923	42149	88298	65321
35	2002	26063	37	12590	53954	17981	37779	27922
36	2003	42073	29	23444	75506	31219	56700	43988
37	2004	32949	30	17951	60477	24170	44917	34569

SSB Index catchabilities
DEPM
Absolute estimator. No fitted catchability.
Acoustic
Linear model fitted. Slopes at age :

38	2	Q	1.306	13	1.147	1.951	1.306	1.713	1.509

Table 10.7.2.1b (Cont'd)

Age-structured index catchabilities

DEPM SUVEYS (Ages 1 to 3+)

Absolute estimator. No fitted catchability.

ACOUSTIC SURVEYS (ages 1 to 2+)

```
Linear model fitted. Slopes at age :
  39   1  Q  1.111      17 .9404     1.860     1.111     1.574     1.343
  40   2  Q  1.930      17 1.627     3.273     1.930     2.758     2.344
```

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	0.521	-0.260	1.154	1.184	0.616	0.814	1.373	-1.043	1.044	-1.500	-1.902	-2.712	-0.349	1.784	-0.730
1	-0.110	-0.290	0.008	0.083	-0.005	-0.106	0.140	0.137	0.020	-0.001	0.085	0.251	-0.130	-0.054	-0.189
2	-0.055	0.168	-0.074	-0.110	-0.078	-0.128	-0.147	-0.113	0.046	0.080	0.010	-0.361	0.101	-0.097	-0.026
3	1.986	-0.618	-0.890	-0.032	0.175	-0.132	-0.547	-0.831	-0.958	-0.011	-0.561	-0.455	-0.594	-0.280	1.441
4	0.172	0.913	-0.840	-0.443	-0.581	-1.213	-0.201	-0.023	-1.184	-2.314	-1.117	-1.815	-1.853	-1.054	1.328

SPAWNING BIOMASS INDEX RESIDUALS

DEPM

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.2358	0.9383	0.0278	0.8750	-0.3710	0.2616	*******	0.1330	0.2357	0.0130	0.1541	0.1058	-0.0707	-0.6599	0.3766

DEPM

	2002	2003	2004	2005	2006
1	-0.4349	0.2144	-0.2497	-0.3912	-0.0108

Acoustic

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	*******	*******	-0.3152	*******	0.5620	-0.0246	*******	-0.6741	*******	*******	0.0949	-0.7429	*******	-0.1431	0.2097

Acoustic

	2002	2003	2004	2005	2006
1	0.4491	0.1528	0.3420	0.0095	0.0797

AGE-STRUCTURED INDEX RESIDUALS

DEPM SUVEYS (Ages 1 to 3+)

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	-0.052	1.117	-0.383	1.035	-0.376	0.453	*******	0.162	0.464	*******	0.239	0.245	*******	*******	0.310
2	1.222	0.867	1.108	1.326	0.156	0.502	*******	0.558	0.319	*******	0.638	0.382	*******	*******	0.879
3	1.444	1.874	0.827	1.434	-0.046	-0.398	*******	-0.233	-0.040	*******	-0.274	0.185	*******	*******	0.255

DEPM SUVEYS (Ages 1 to 3+)

Age	2002	2003	2004	2005	2006
1	-0.894	0.616	-0.163	-0.445	-0.011
2	-0.007	0.393	0.390	-0.115	1.358
3	0.112	-0.416	0.074	-0.940	-0.201

ACOUSTIC SURVEYS (ages 1 to 2+)

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	-0.6301	*******	0.2375	0.5196	*******	*******	*******	*******	-0.4106	*******	*******	*******	0.2790	-0.1926	0.1653
2	0.2243	*******	0.5400	-0.5305	*******	*******	*******	*******	0.1489	*******	*******	*******	-0.1569	0.3090	-0.3367

Table 10.7.2.1b (Cont'd)

```
        ACOUSTIC SURVEYS (ages 1 to 2+)
        ------------------------------
------+-----------------------
Age   |    2004    2005    2006
------+-----------------------
  1   |  0.5667 -0.4895 -0.0453
  2   | -0.7688 -0.1389  0.7095
------+-----------------------


 PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)
 -----------------------------------------------------

 Separable model fitted from 1991  to 2005
 Variance                            0.0428
Skewness test stat.                 -1.6745
Kurtosis test statistic              0.5281
Partial chi-square                   0.1649
Significance in fit                  0.0000
Degrees of freedom                       38

 PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES
 -----------------------------------------------


   DISTRIBUTION STATISTICS FOR   DEPM

 Index used as absolute measure of abundance
 Last age is a plus-group

 Variance                            0.0803
Skewness test stat.                  1.6228
Kurtosis test statistic              0.3608
Partial chi-square                   0.1452
Significance in fit                  0.0000
Number of observations                   19
Degrees of freedom                       19
Weight in the analysis               0.5000

   DISTRIBUTION STATISTICS FOR   Acoustic


 Linear catchability relationship assumed
 Last age is a plus-group

 Variance                            0.0768
Skewness test stat.                 -0.9078
Kurtosis test statistic             -0.3001
Partial chi-square                   0.0835
Significance in fit                  0.0000
Number of observations                   13
Degrees of freedom                       12
Weight in the analysis               0.5000

 PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES
 ------------------------------------------------------------


   DISTRIBUTION STATISTICS FOR DEPM SUVEYS (Ages 1 to 3+)

 Index used as absolute measure of abundance

 Age                          1         2         3
 Variance                0.0973    0.1960    0.2050
Skewness test stat.      1.3413    2.2907    2.5647
Kurtosis test statisti  -0.2510   -0.7087    0.5478
Partial chi-square       0.1130    0.2742    0.3411
Significance in fit      0.0000    0.0000    0.0000
Number of observations       16        16        16
Degrees of freedom           16        16        16
Weight in the analysis   0.3333    0.3333    0.3333

   DISTRIBUTION STATISTICS FOR ACOUSTIC SURVEYS (ages 1 to 2+)

 Linear catchability relationship assumed

 Age                          1         2
 Variance                0.0665    0.0830
Skewness test stat.     -0.1660   -0.1300
Kurtosis test statisti  -0.8460   -0.6475
Partial chi-square       0.0427    0.0578
Significance in fit      0.0000    0.0000
Number of observations       10        10
Degrees of freedom            9         9
Weight in the analysis   0.3750    0.3750

 ANALYSIS OF VARIANCE
--------------------------

 Unweighted Statistics


Variance
                                       SSQ     Data    Parameters d.f. Variance
Total for model                    89.5067      175          40  135   0.6630
Catches at age                     57.1021       75          37   38   1.5027

SSB Indices
  DEPM                              3.0496       19           0   19   0.1605
  Acoustic                          1.8441       13           1   12   0.1537

 Aged Indices
DEPM SUVEYS (Ages 1 to 3+)         23.9210       48           0   48   0.4984
```

Table 10.7.2.1b (Cont'd)

	SSQ	Data	Parameters	d.f.	Variance
ACOUSTIC SURVEYS (ages 1 to 2+)	3.5900	20	2	18	0.1994

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	6.0109	175	40	135	0.0445
Catches at age	1.6248	75	37	38	0.0428
SSB Indices					
DEPM	0.7624	19	0	19	0.0401
Acoustic	0.4610	13	1	12	0.0384
Aged Indices					
DEPM SUVEYS (Ages 1 to 3+)	2.6579	48	0	48	0.0554
ACOUSTIC SURVEYS (ages 1 to 2+)	0.5048	20	2	18	0.0280

Table 10.7.2.2: Bay of Biscay anchovy: Comparison of fitting achieved for two different catchability models.

Weighted Statistics	**Standard ICA assessment (DEPM absolute and Acoustic Relative)**				
Variance	SSQ	Data	Parameters	d.f.	Variance
Total for model	6.0109	175	40	135	0.0445
	1.6248	75	37	38	0.0428
Catches at age					
SSB Indices	0.7624	19	0	19	0.0401
DEPM	0.461	13	1	12	0.0384
Acoustic					
Aged Indices	2.6579	48	0	48	0.0554
DEPM SUVEYS (Ages 1 to 3+)					
ACOUSTIC SURVEYS (ages 1 to 2+)	0.5048	20	2	18	0.028

Weighted Statistics	**Relative ICA assessment (DEPM and Acoustic as Relative)**				
Variance	SSQ	Data	Parameters	d.f.	Variance
Total for model	4.2223	175	44	131	0.0322
	1.6195	75	37	38	0.0426
Catches at age					
SSB Indices	0.4902	19	1	18	0.0272
DEPM	0.5917	13	1	12	0.0493
Acoustic					
Aged Indices	1.0162	48	3	45	0.0226
DEPM SUVEYS (Ages 1 to 3+)					
ACOUSTIC SURVEYS (ages 1 to 2+)	0.5046	20	2	18	0.028

Table 10.7.3.1: Bay of Biscay anchovy: Specification of the two sets of prior distributions used for BBM with the correspondent 95% confidence intervals

Parameter	PRIORS 1			PRIORS 2		
	Distribution	95 % C.I.		Distribution	95 % C.I.	
Log(qdepm)	N(mu=0, prec=5)	0.416	2.403	N(mu=0, prec=0.5)	0.063	15.988
Log(qac)	N(mu=0, prec=5)	0.416	2.403	N(mu=0, prec=0.5)	0.063	15.988
ψdepm	Gamma(a=5, b=0.5)	3.247	20.483	Gamma(a=0.1, b=0.01)	0	97.79
ψac	Gamma(a=5, b=0.5)	3.247	20.483	Gamma(a=0.1, b=0.01)	0	97.79
ξdepm	N(mu=4.68, pre=0.3)	1.102	8.258	N(mu=4.68, pre=0.2)	0.297	9.063
ξac	N(mu=4.68, pre=0.3)	1.102	8.258	N(mu=4.68, pre=0.2)	0.297	9.063
B0	N(mu=78000, prec=6.5 E-11)	- 165 104	321 104	N(mu=78000, prec=1 E-11)	- 541 795	697 795
Ry	LN(mu=10.5, prec=1)	5 116	257 806	LN(mu=10.5, prec=0.1)	74	17 857 789
ω_1	Gamma(a=10, b=1)	4.795	17.085	Gamma(a=1, b=0.1)	0.253	36.889

Table 10.8.1.1: Bay of Biscay anchovy: Input data for BBM.

			CATCH DATA			DEPM		ACOUSTICS	
Year	h1	h2	C(y,1,1)	C(y,1,1+)	C(y,2,1+)	B(y,1)	B(y,1+)	B(y,1)	B(y,1+)
1987	0.3068	0.1940	2711	8318	6543	14235	29365		
1988	0.3253	0.1774	2602	3864	10954	53087	63500		
1989	0.2820	0.2328	1723	3876	4442	7282	16720		
1990	0.3070	0.2057	9314	10573	23574	90650	97239		
1991	0.2347	0.1984	3903	10191	8196	11271	19276	28322	64000
1992	0.2542	0.2184	11933	16366	21026	85571	90720	84439	89000
1993	0.2368	0.2378	6414	14177	25431				
1994	0.2331	0.2050	3795	13602	20150	34674	60062		35000
1995	0.2917	0.1751	5718	14550	14815	42906	54700		
1996	0.2756	0.1978	4570	9246	23833		39545		
1997	0.2078	0.2624	4323	7235	13256	38536	51176	38498	63000
1998	0.1992	0.2567	5898	7988	23588	80357	101976		57000
1999	0.2304	0.2626	2067	10895	15511		69074		
2000	0.2569	0.1999	6298	12010	24882		44973		98484
2001	0.2984	0.2195	5481	11468	28671	73198	124132	90928	137200
2002	0.1833	0.2389	1962	7738	9754	6352	30697	17723	97051
2003	0.2997	0.2795	625	2379	8101	16575	23962	15732	29430
2004	0.2989	0.2126	2754	4623	11657	14649	19498	37124	46018
2005	0.1138	0.0741	102	790	372	2063	8002	2405	15603
2006	0.3271		287	598		15280	21436	16686	30649

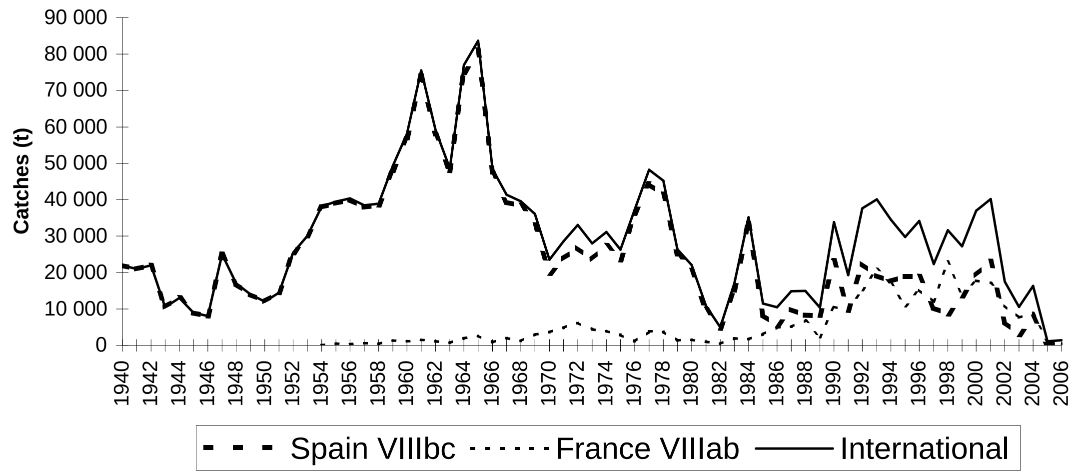
Table 10.8.1.2: Bay of Biscay anchovy: Median and 95 % credible intervals for recruitment (in tonnes), spawning stock biomass, harvest rates (Catch/SSB) and the ratio of SSB with respect to SSB in 1989 as resulted from BBM.

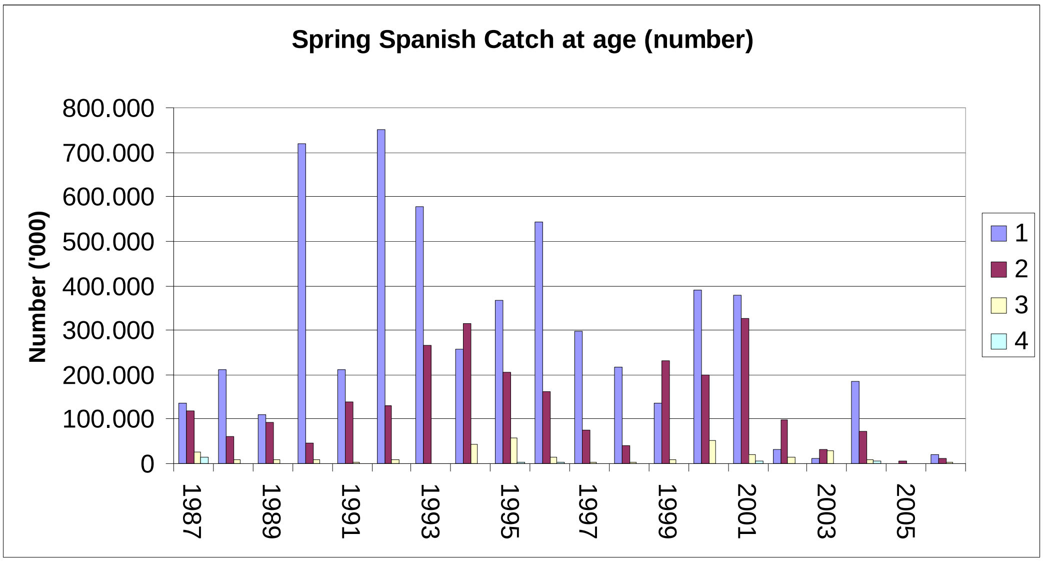
	R (tonnes)			SSB (tonnes)			Harvest rate			SSB/SSB_{1989}		
Year	2.50%	Median	97.50%	2.50%	Median	97.50%	2.50%	Median	97.50%	2.50%	Median	97.50%
1987	13346	**17792**	30320	17763	**23144**	35211	0.422	**0.642**	0.837	0.722	**1.211**	1.671
1988	33839	**42775**	61886	32076	**38446**	55168	0.269	**0.385**	0.462	1.489	**1.984**	2.326
1989	8966	**12477**	21956	14437	**19690**	32968	0.252	**0.422**	0.576	1.000	**1.000**	1.000
1990	74054	**88486**	110425	59233	**67847**	84696	0.403	**0.503**	0.576	2.173	**3.471**	4.768
1991	18919	**26114**	37605	24461	**31971**	46529	0.395	**0.575**	0.752	0.962	**1.633**	2.457
1992	81038	**131313**	221314	59927	**101234**	177168	0.211	**0.369**	0.624	2.511	**5.067**	9.614
1993	40639	**90846**	131725	80226	**99112**	122273	0.324	**0.400**	0.494	2.796	**5.078**	7.258
1994	34576	**48784**	67547	49383	**61027**	80629	0.419	**0.553**	0.683	1.730	**3.129**	4.745
1995	35096	**59735**	110564	29194	**52977**	98123	0.299	**0.554**	1.006	1.229	**2.637**	5.363
1996	33477	**63810**	92032	50687	**60646**	79303	0.417	**0.545**	0.653	1.867	**3.100**	4.492
1997	36082	**51365**	73223	37776	**51771**	73135	0.280	**0.396**	0.542	1.416	**2.620**	4.177
1998	51986	**80902**	131337	48531	**76004**	121470	0.260	**0.415**	0.651	1.945	**3.819**	6.883
1999	22807	**73906**	183245	36690	**74218**	158818	0.166	**0.356**	0.720	1.611	**3.696**	8.630
2000	61331	**117257**	157007	89026	**113625**	131337	0.281	**0.325**	0.414	3.118	**5.732**	8.181
2001	70037	**86392**	114116	90370	**100397**	118952	0.337	**0.400**	0.444	3.142	**5.134**	7.159
2002	8802	**11969**	18116	30872	**36712**	48091	0.364	**0.476**	0.567	1.166	**1.873**	2.718
2003	17861	**25340**	33499	24903	**30727**	39262	0.267	**0.341**	0.421	0.898	**1.566**	2.305
2004	29353	**38192**	53840	29015	**36600**	50757	0.321	**0.445**	0.561	1.105	**1.851**	2.863
2005	2767	**4645**	7929	9970	**14826**	23429	0.050	**0.078**	0.117	0.415	**0.739**	1.297
2006	11513	**19412**	32684	14583	**22304**	35542				0.576	**1.122**	2.008

Table 10.8.1.3: Bay of Biscay anchovy: Summary table of the current state of the stock from the Bayesian biomass-based model.

R_{2006}	**Median**	19 412
	95 % C.I.	(11 513, 32 684)
SSB_{2006}	**Median**	22 304
	95 % C.I.	(14 582, 35 542)
$P(SSB_{2006} < 21\,000)$		0.401
$P(SSB_{2006} < 28\,000)$		0.837
$P(SSB_{2006} < 33\,000)$		0.951

Figure 10.2.1.1: Bay of Biscay anchovy: Historical evolution of the fishery since 1940





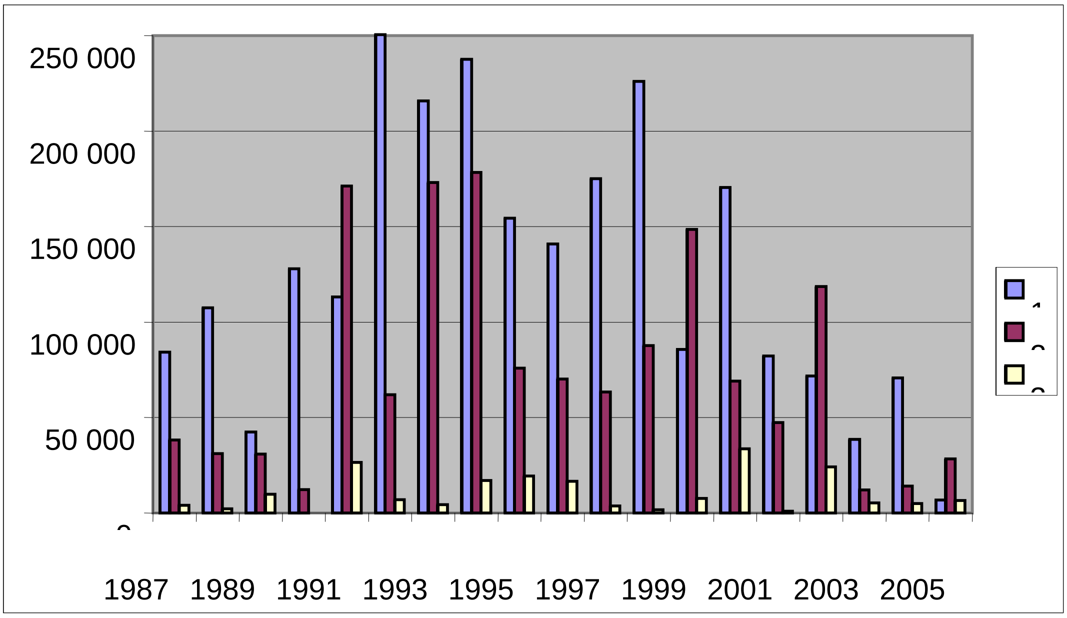


Figure 10.3.1.1: Bay of Biscay Anchovy. Spanish (upper panel) and French (bottom panel) catch at age compositions of the first half of the year from 1987 to 2006 (for Spain) and from 1987 to 2005 for France.

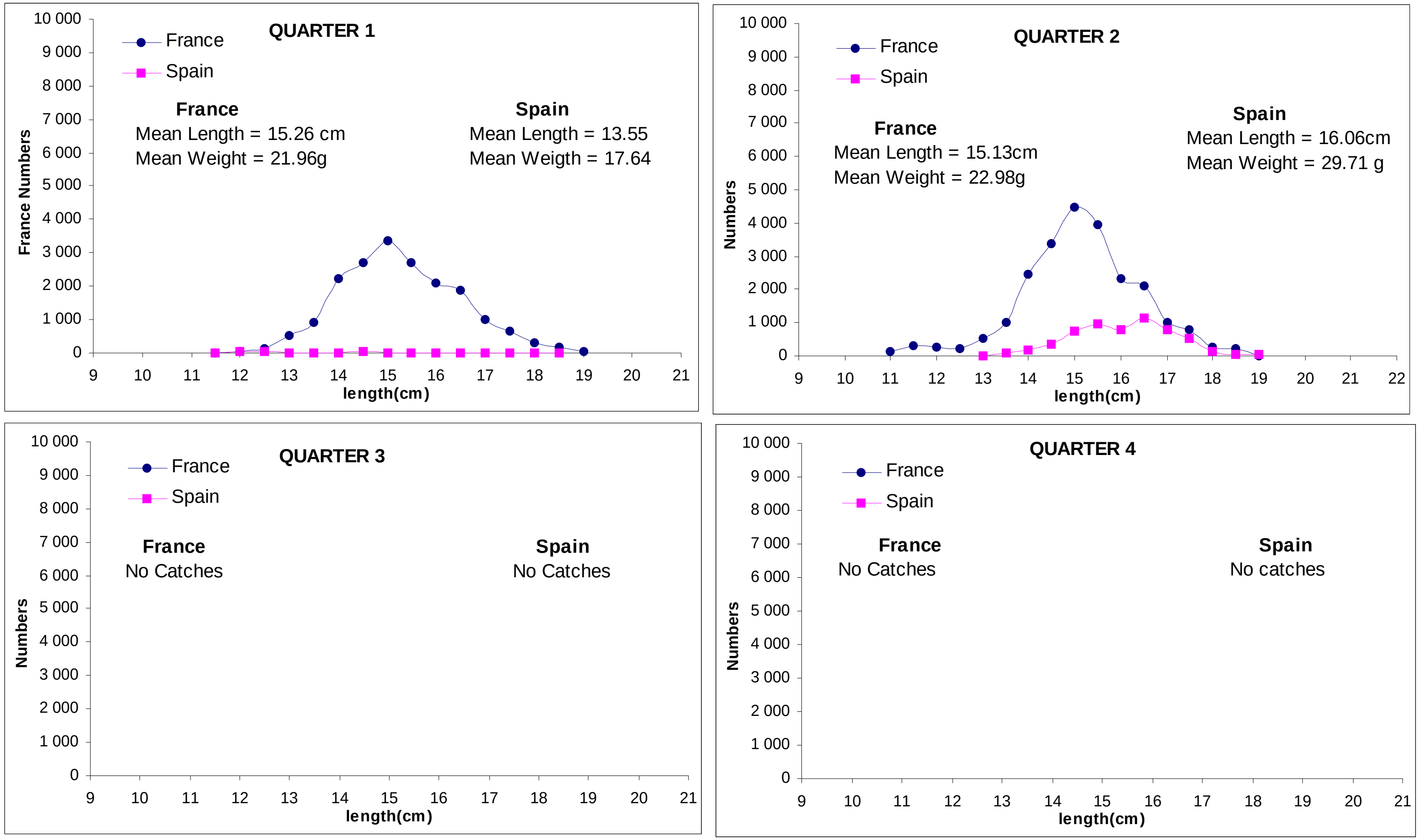


Figure 10.3.2.1. Bay of Biscay Anchovy. Length distribution of catches by country in 2005 by quarter

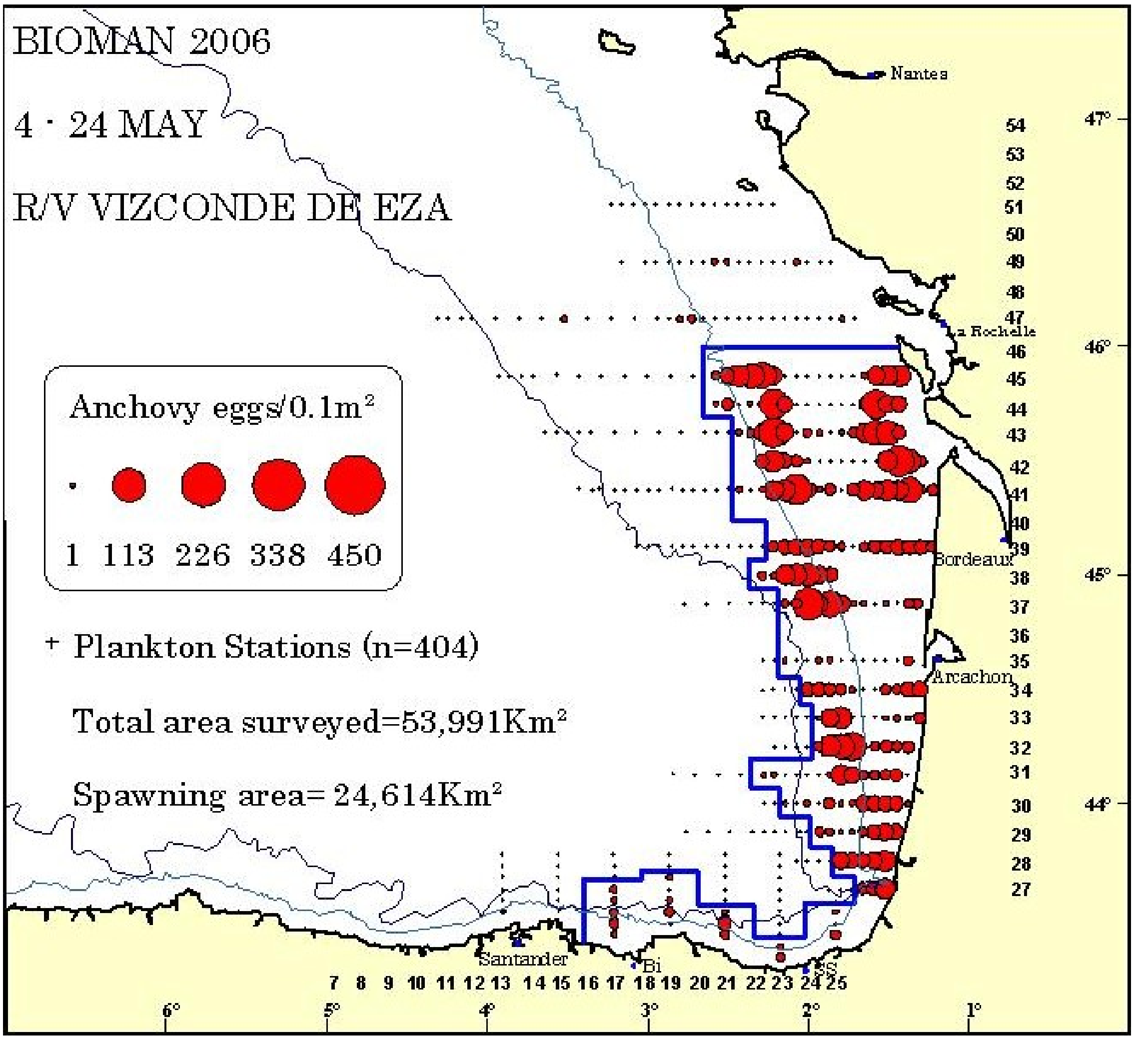


Figure 10.4.1.1: Bay of Biscay anchovy: Egg distribution (egg/0.1m^2) and abundance found during BIOMAN 2005. Solid line encloses the positive spawning area.

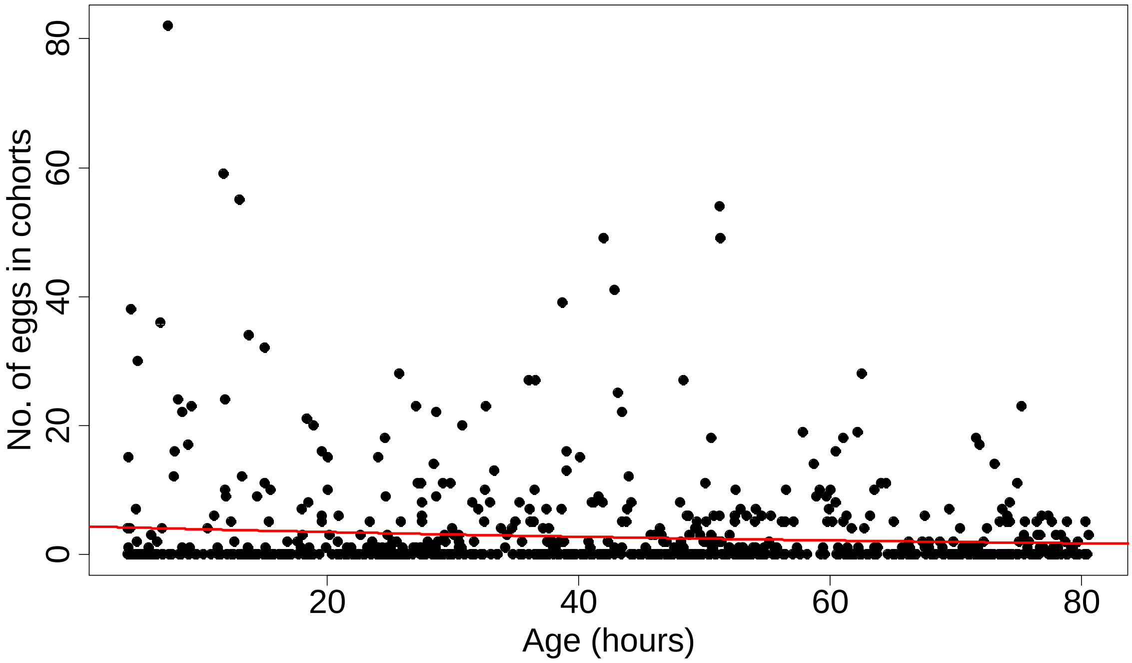


Figure 10.4.1.2: Bay of Biscay anchovy: Exponential mortality model of eggs fitted using non linear regression.

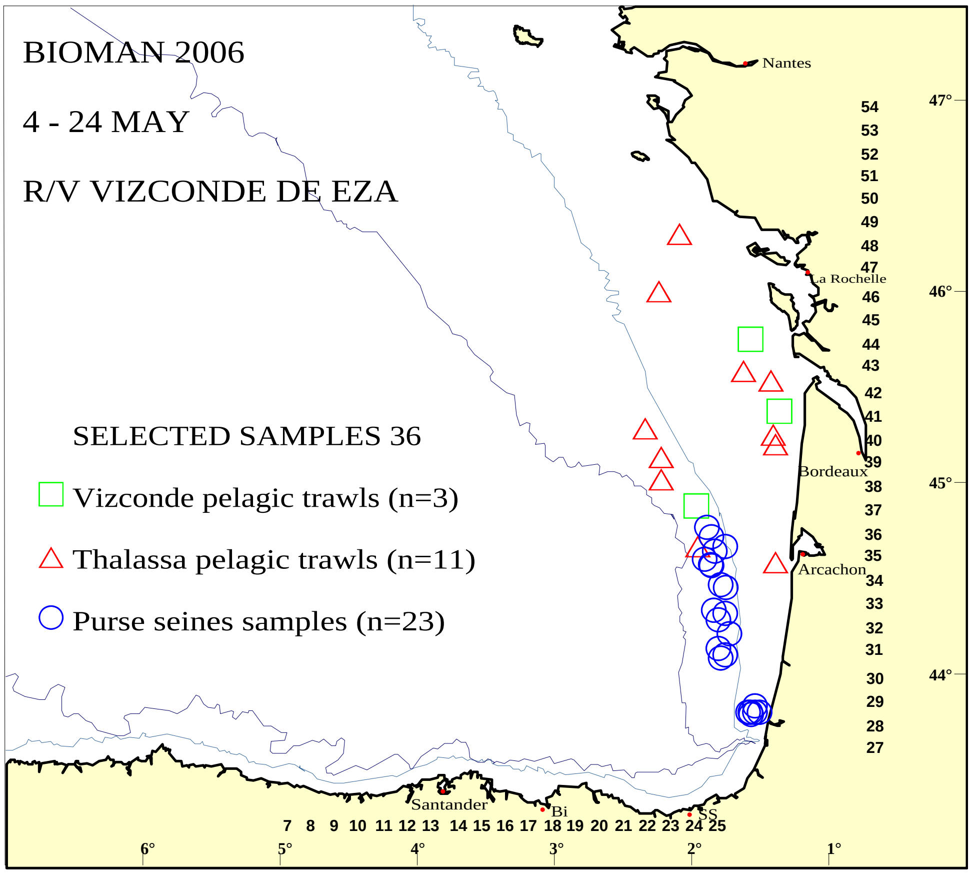


Figure 10.4.1.3: Bay of Biscay anchovy: Adult samples selected for the estimation of the spawning stock biomass.

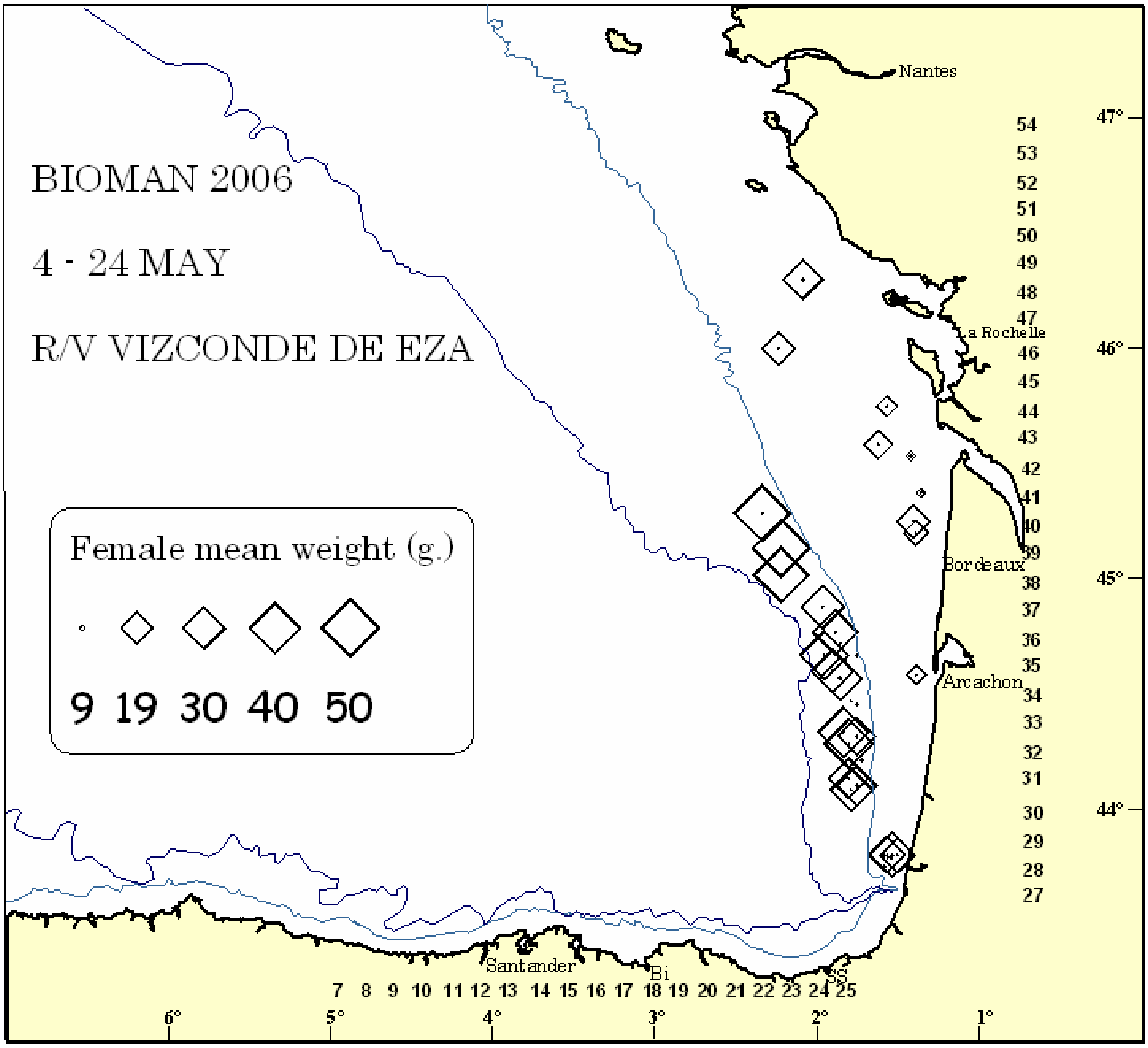


Figure 10.4.1.4: Bay of Biscay anchovy: Mean weight for the samples selected in BIOMAN 2006 for the estimation of the Daily fecundity and age composition at age.

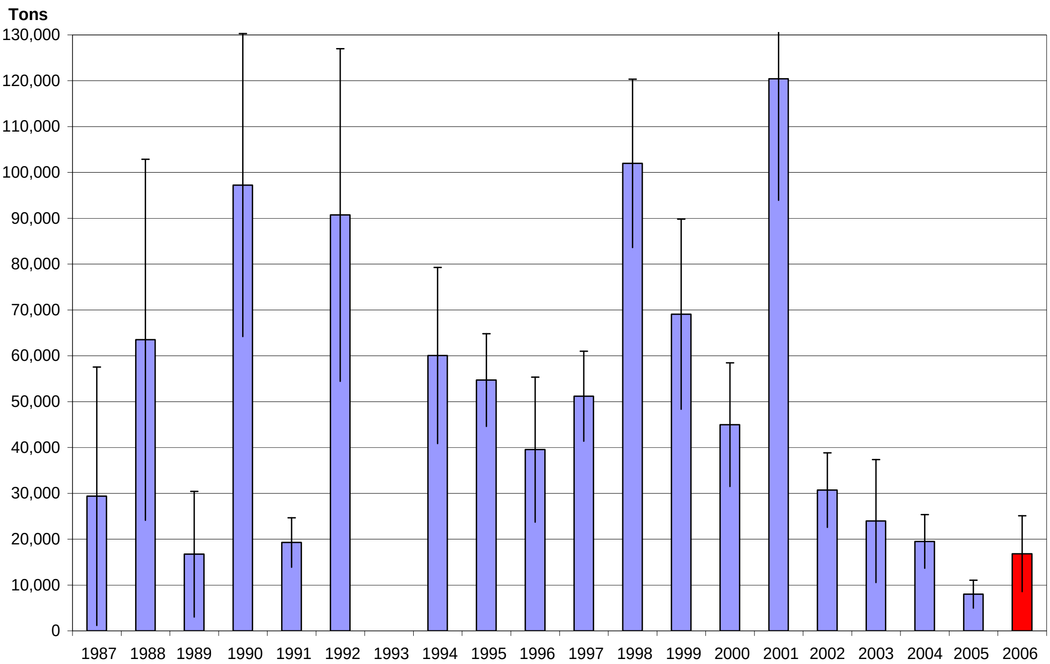


Figure 10.4.1.5: Bay of Biscay anchovy: Historical Series of Biomass estimates (tonnes) obtained from the Egg surveys applying the DEPM since 1987. Most of them are full DEPM estimates, except in 1996, 1999 and 2000, when no adult samples existed and then the SSSB was deduced indirectly from the relationship of biomass with the spawning area and P_0.

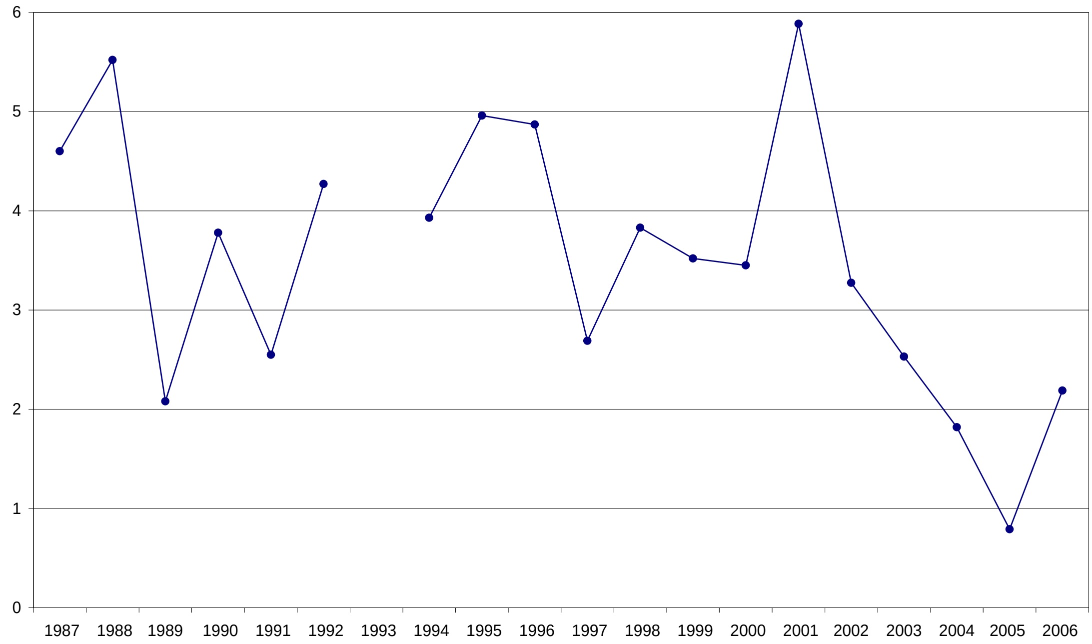


Figure 10.4.1.6: Bay of Biscay anchovy: Historical series of Total daily Egg production estimates obtained from the DEPM surveys since 1987.

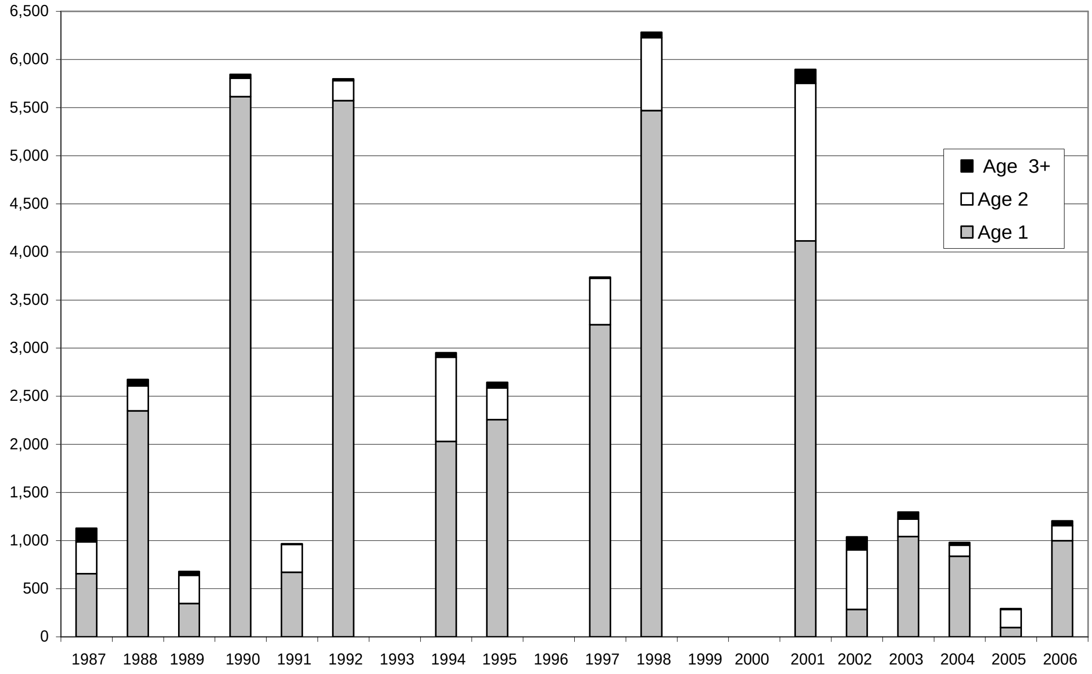


Figure 10.4.1.7: Bay of Biscay anchovy: Historical series of population at age estimates obtained from the DEPM surveys since 1987.

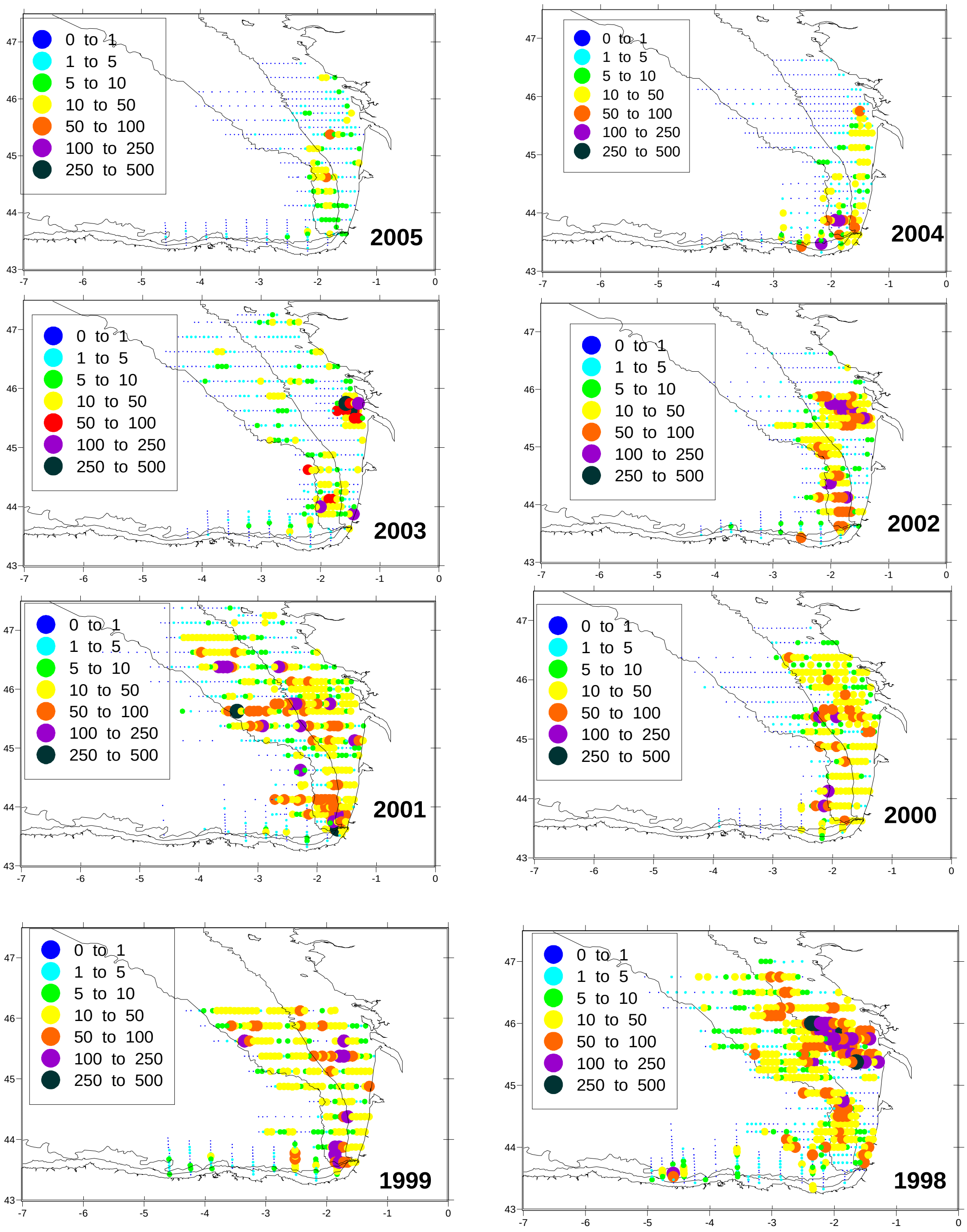


Figure 10.4.1.8: Bay of Biscay anchovy: Egg distribution maps from applications of the DEPM since 1998.

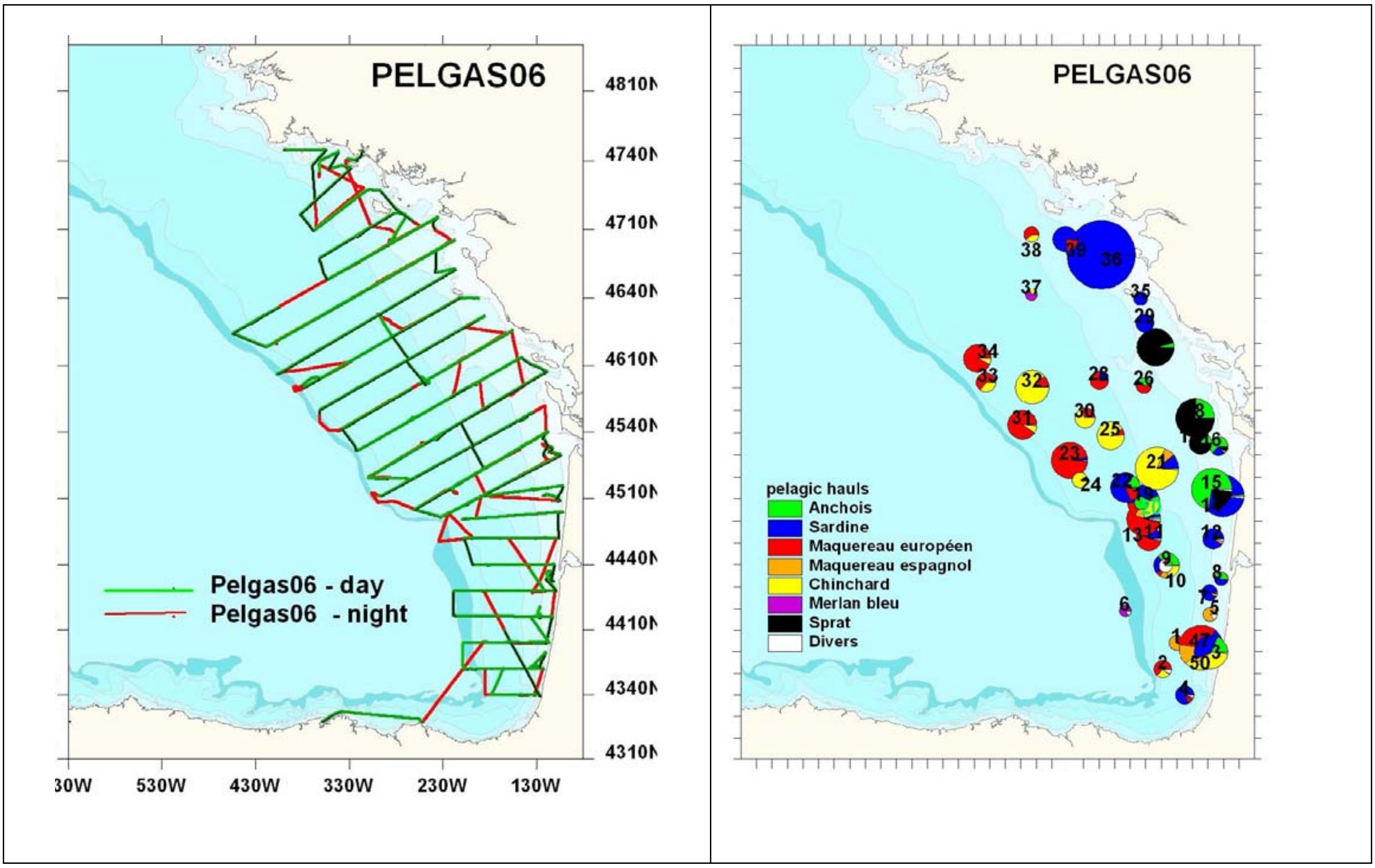


Figure 10.4.2.1: Bay of Biscay Anchovy. Prospected transects by acoustics and species compositions of catches obtained from identification hauls into during PELGAS06.

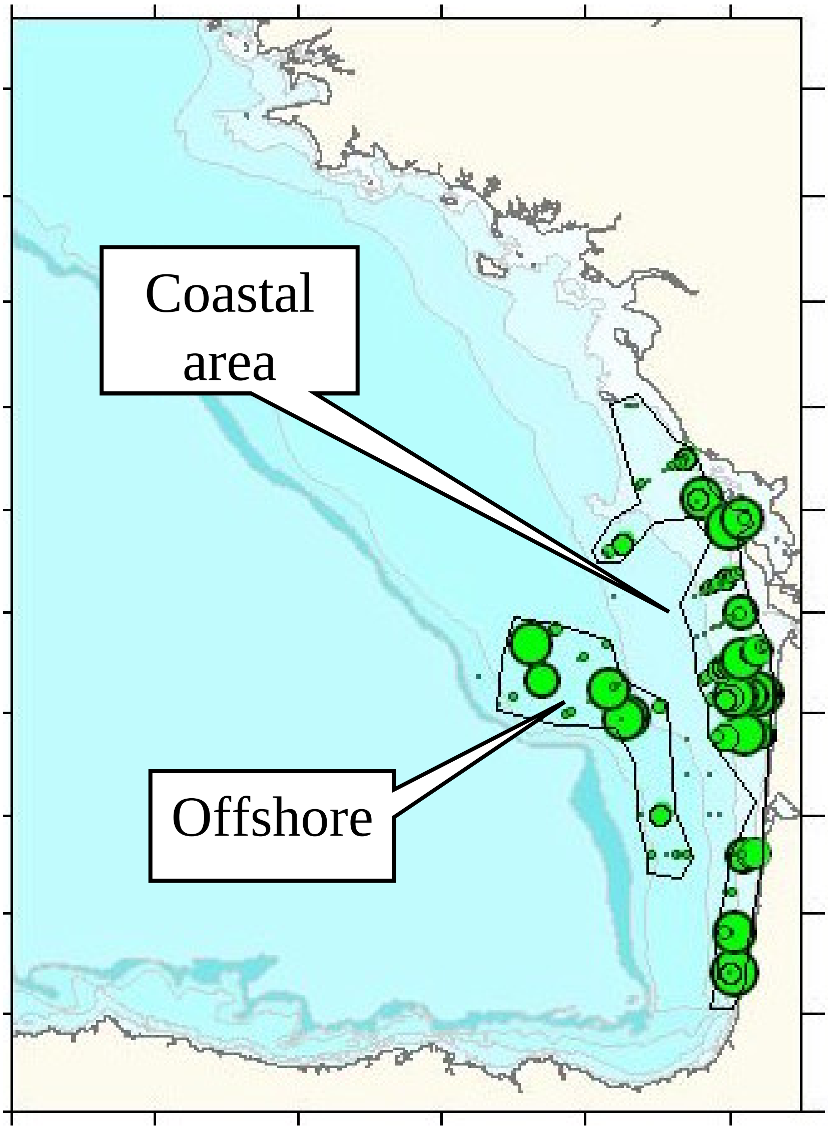


Figure 10.4.2.2: Bay of Biscay Anchovy. Area considered for biomass estimates from acoustics during PELGAS06 survey

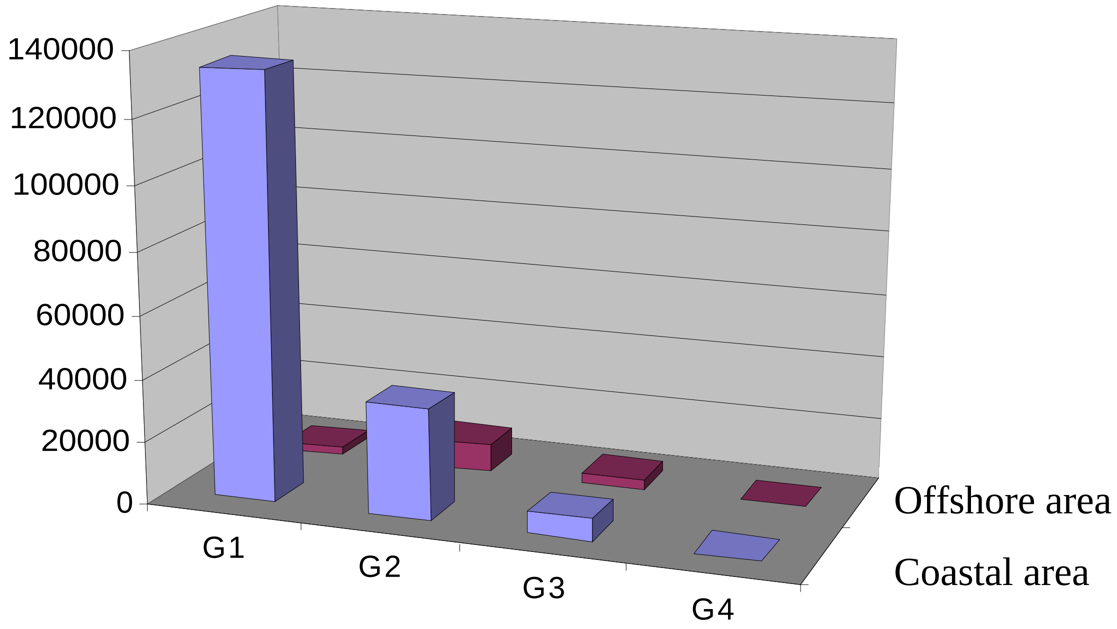
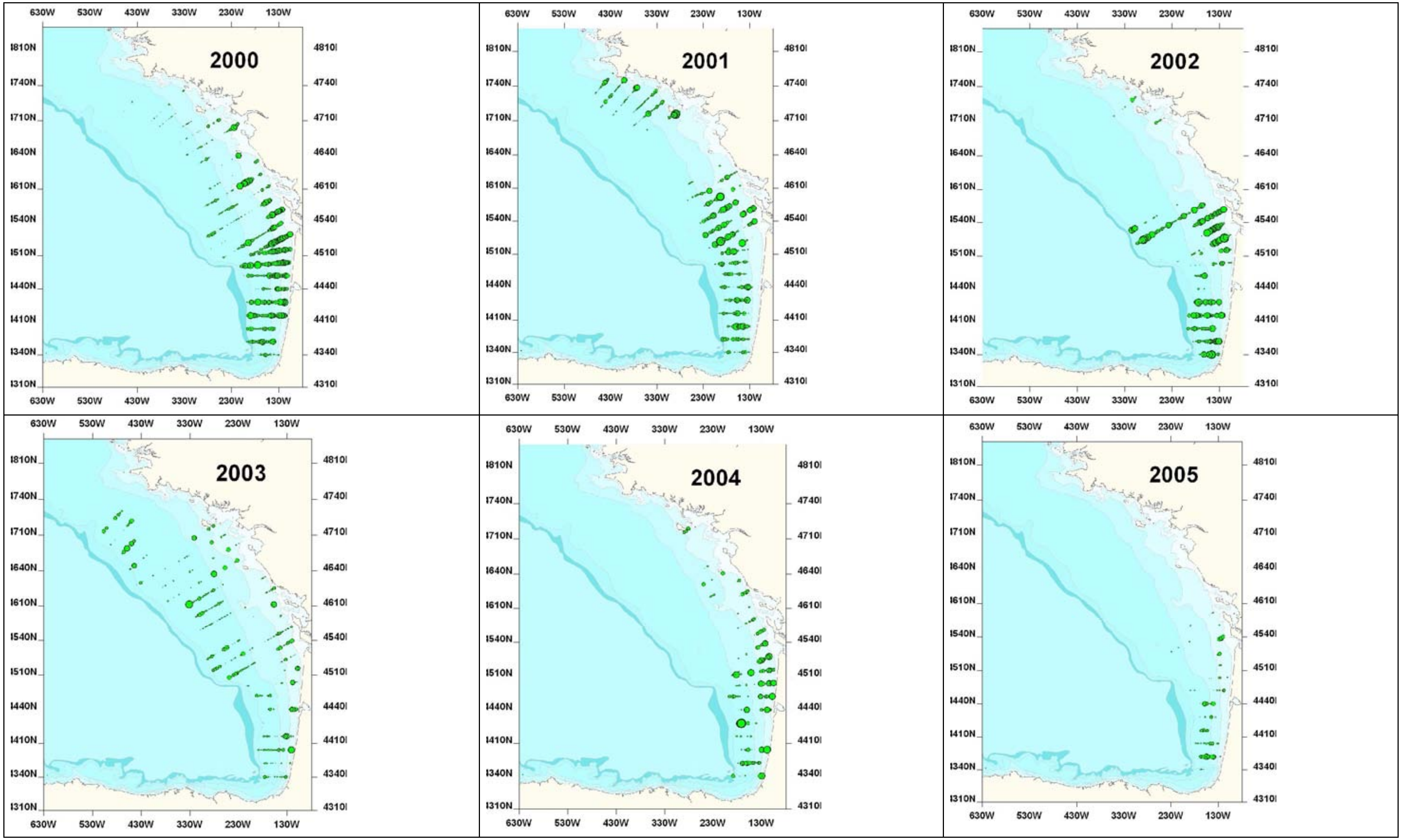


Figure 10.4.2.3: Bay of Biscay Anchovy. Number of anchovy per age group during PELGAS06 (numbers used in this figure are sum of numbers per nm² at each ESDU, they are proportional to abundance estimate)


2000
2001
2002
2003
2004
2005

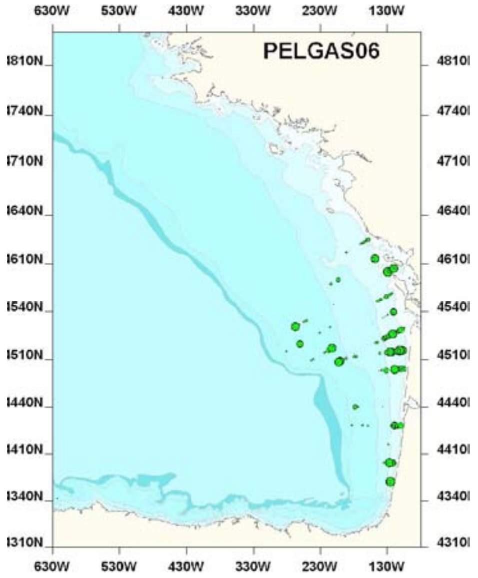


Figure 10.4.2.4: Bay of Biscay Anchovy. Abundance and distribution of anchovy as observed during acoustic surveys from 2000 to 2006

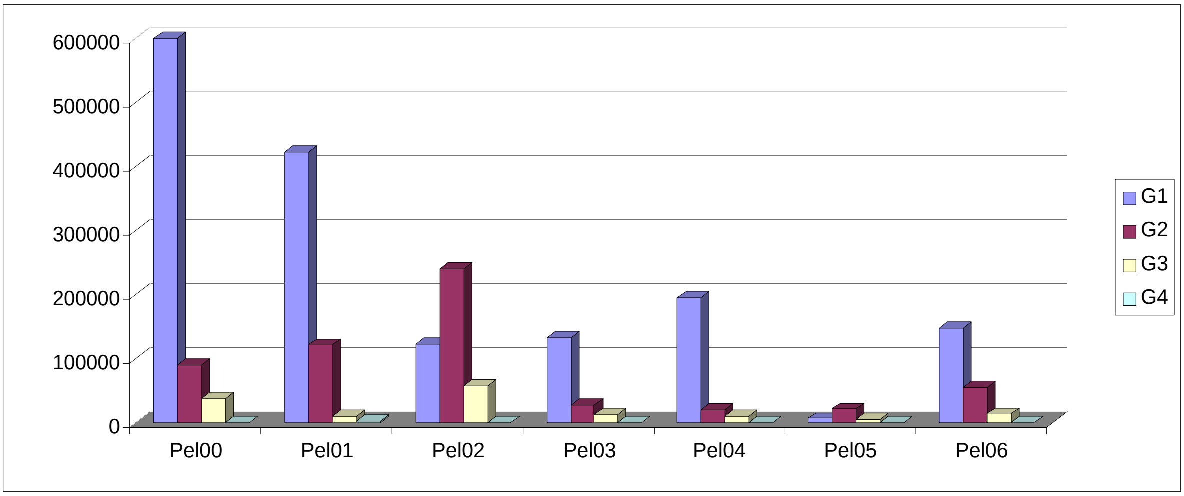


Figure 10.4.2.5 – Bay of Biscay Anchovy. Age composition as observed during acoustic surveys from 2000 to 2006. (numbers used in this figure are sum of numbers per nm² at each ESDU, they are well proportional to abundance estimate)

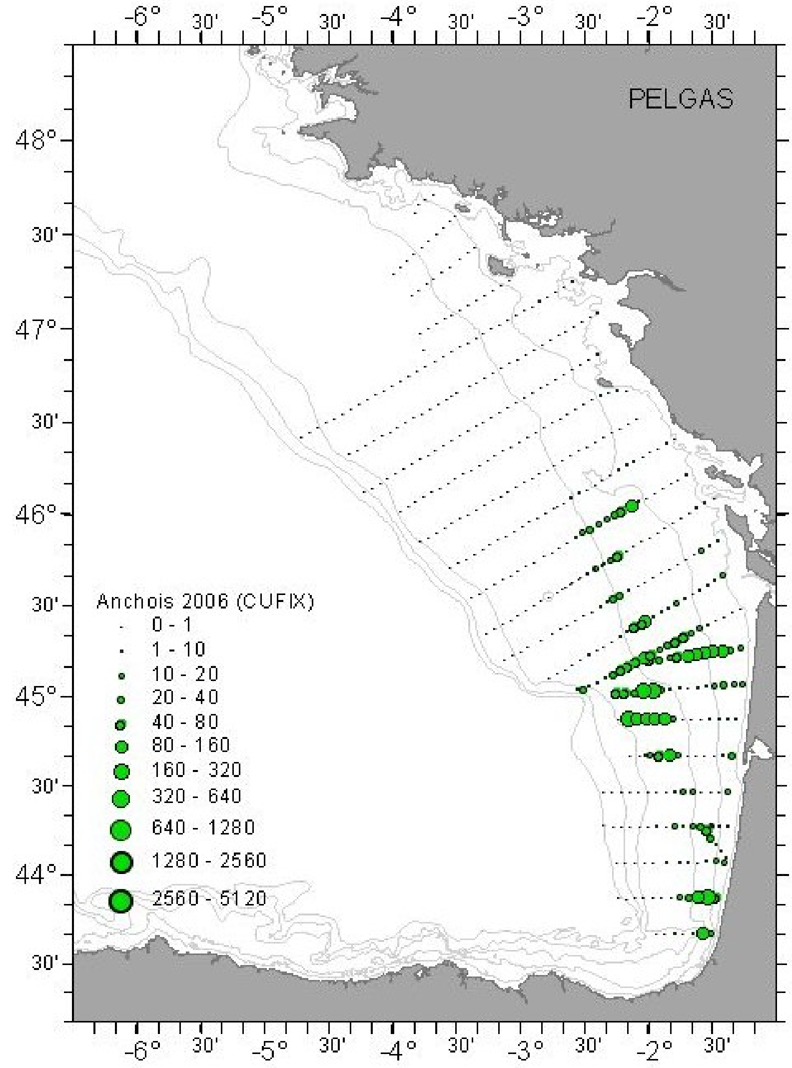


Figure 10.4.2.6: Bay of Biscay Anchovy. Anchovy eggs distribution as observed by CUFES during PELGAS06 survey

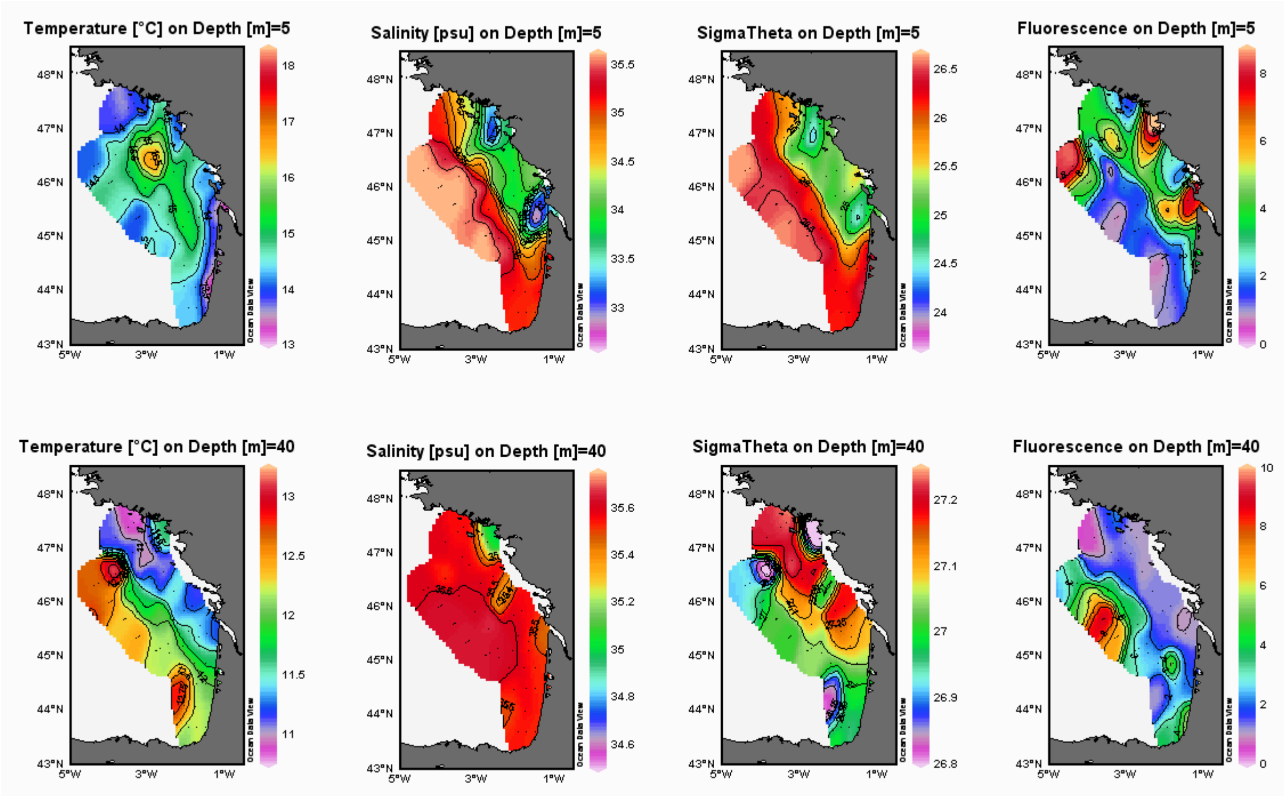


Figure 10.4.2.7. –Bay of Biscay Anchovy. Temperatures, salinity, densities and fluorescence observed during PELGAS06 at the surface (top) and at 40 m depth (bottom)

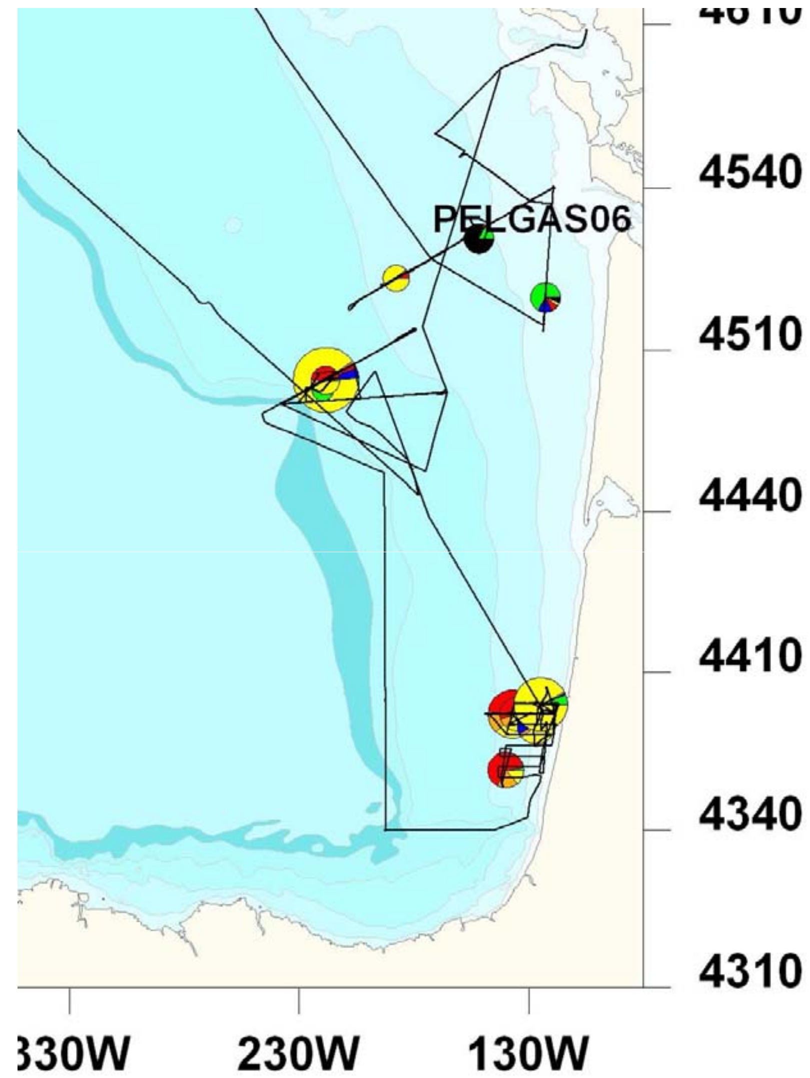


Figure 10.4.2.8: Bay of Biscay Anchovy. Area prospected during the last week of the PELGAS06 survey. Colours in pies are similar to figure 10.4.2.1. (green : anchovy – blue : sardine – yellow : horse mackerel – red : mackerel).

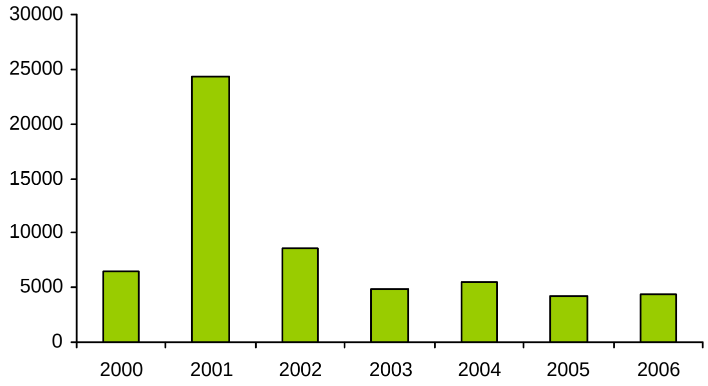


Figure 10.4.2.9. Bay of Biscay Anchovy.: Number of eggs observed during PELGAS surveys from 2000 to 2006

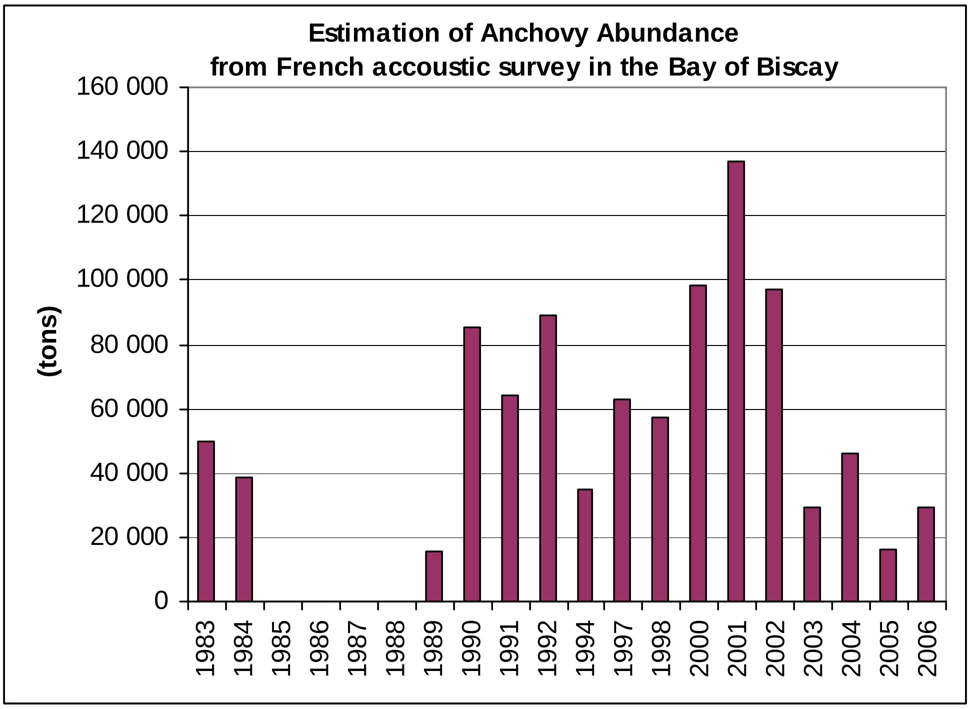


Figure 10.4.2.10. Bay of Biscay Anchovy. Biomass estimates by acoustic survey since 1983

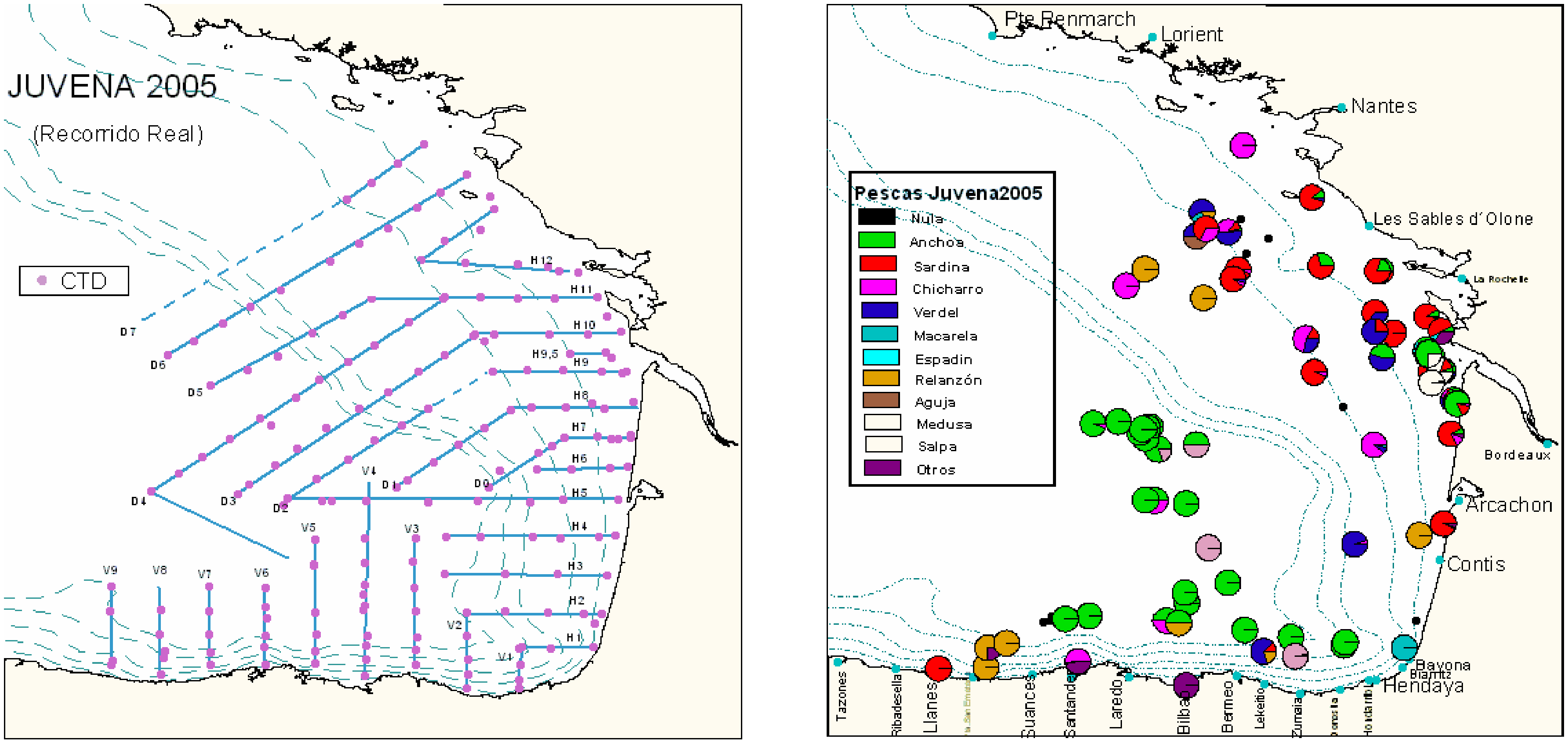


Figure 10.4.3.1.1: Bay of Biscay anchovy: JUVENA 2005 survey: left panel: Actual transects and CTD stations (The dashed lines refers to a transects covered by the commercial second vessel, which lack acoustic registration). Right panel: Species composition of the hauls: Green colour refers to anchovy.

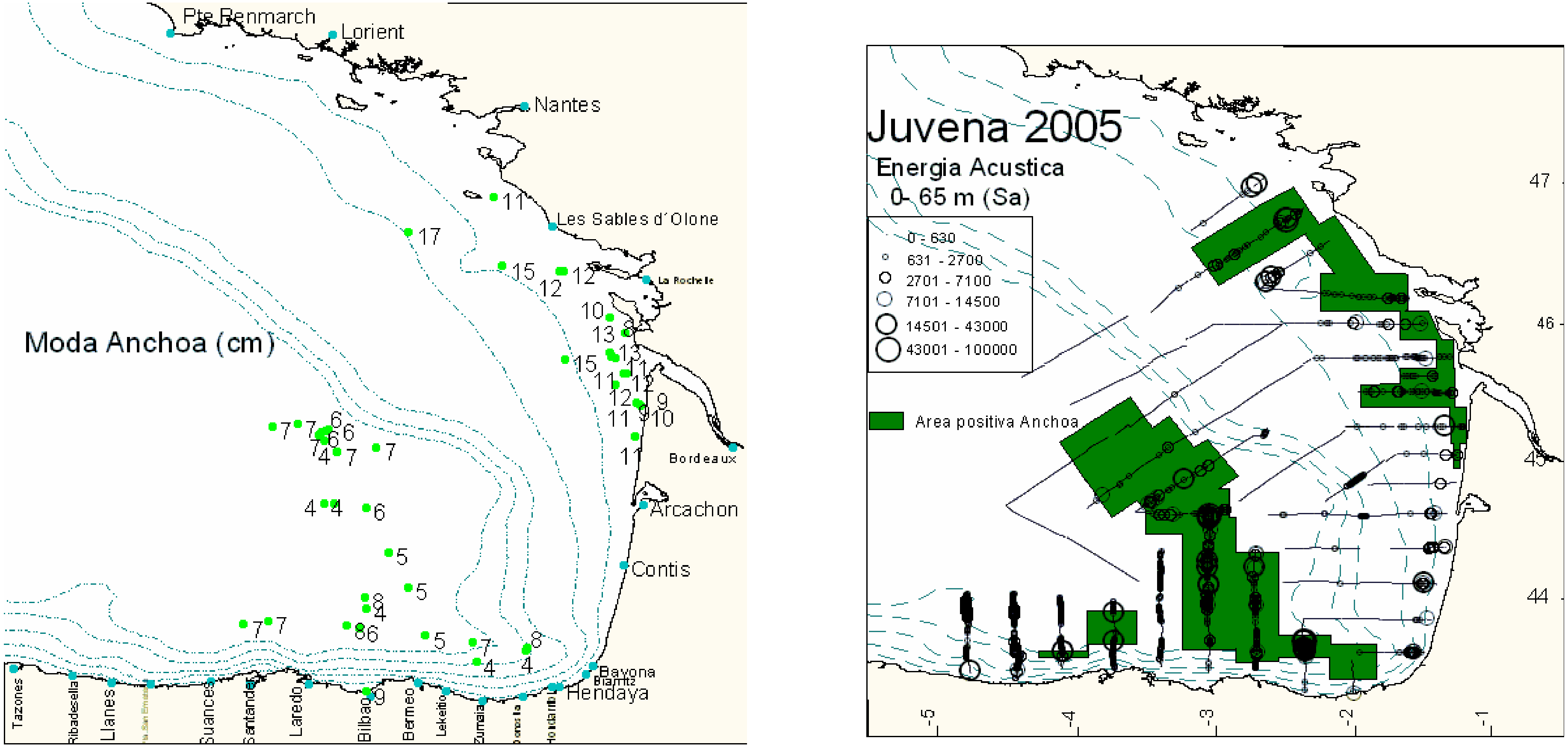


Figure 10.4.3.1.2: Bay of Biscay anchovy: JUVENA 2005 survey: left panel: Positive hauls for anchovy and Standard length in cm (mode) of the captured anchovy in each haul. Right panel: Positive area for anchovy, found during 2005 survey (green rectangles). The black rings represent the acoustic energy echo-integrated from 0 to 65 m depth.

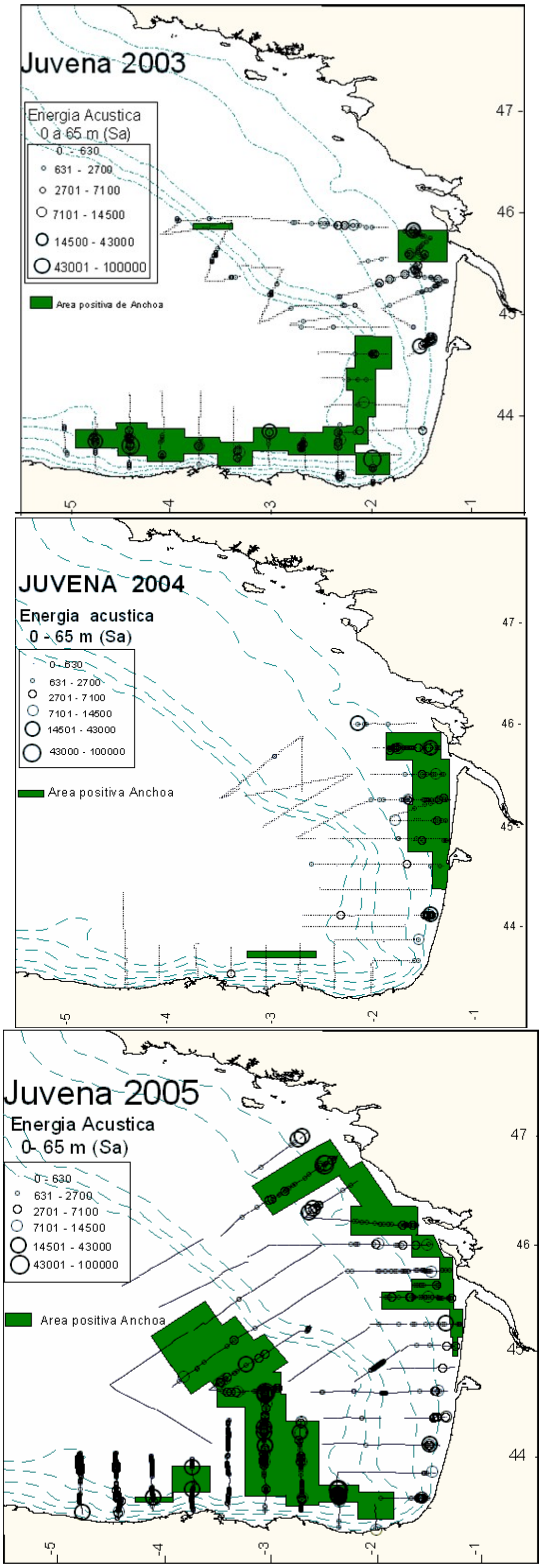


Figure 10.4.3.1.3: Bay of Biscay anchovy: JUVENA series of surveys on juveniles. Tracks, Acoustic energy and positive areas of anchovy detections (Shadow areas correspond to the positive area of anchovy). In coastal areas not all anchovy detections were based on juveniles.

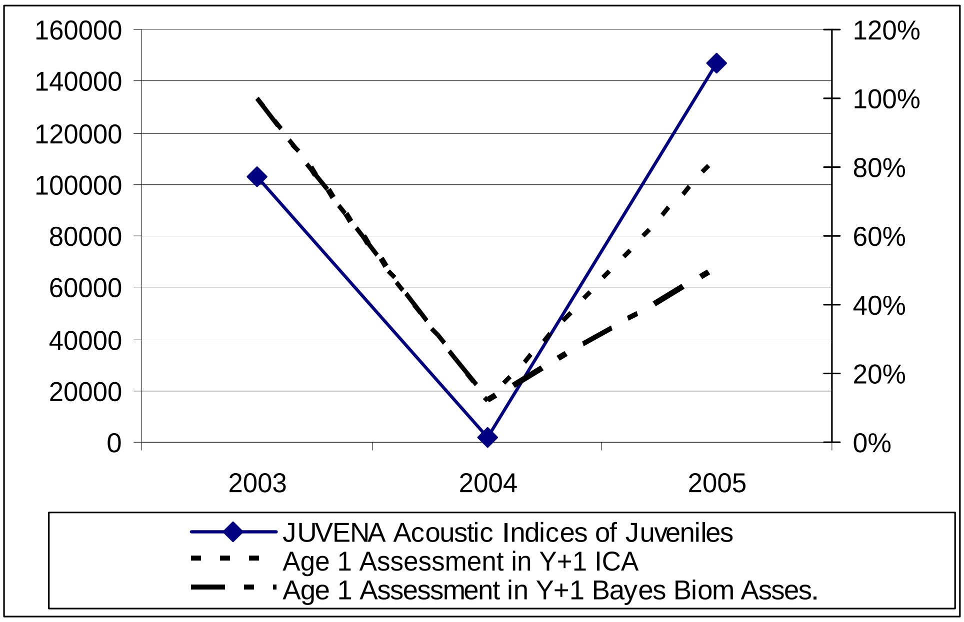


Figure 10.4.3.1.4: Bay of Biscay anchovy: JUVENA series of acoustic index of anchovy juveniles in comparison with the ICA and Bayesian biomass assessment of the population at age 1 (in numbers and biomass, respectively for each model).

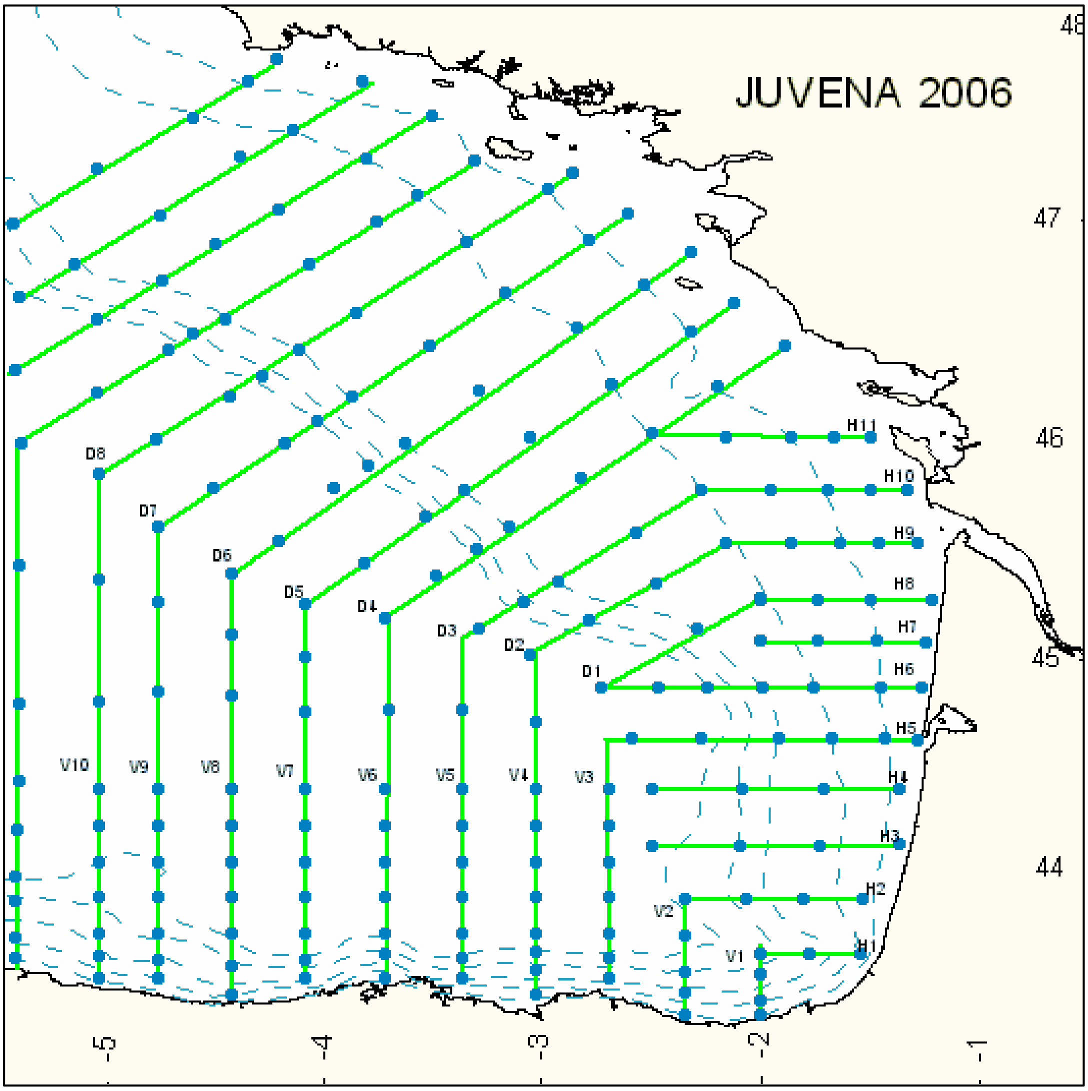


Figure 10.4.3.1.5: Bay of Biscay anchovy: JUVENA survey in 2006 aiming at estimating an acoustic index of anchovy juveniles in the bay of Biscay.

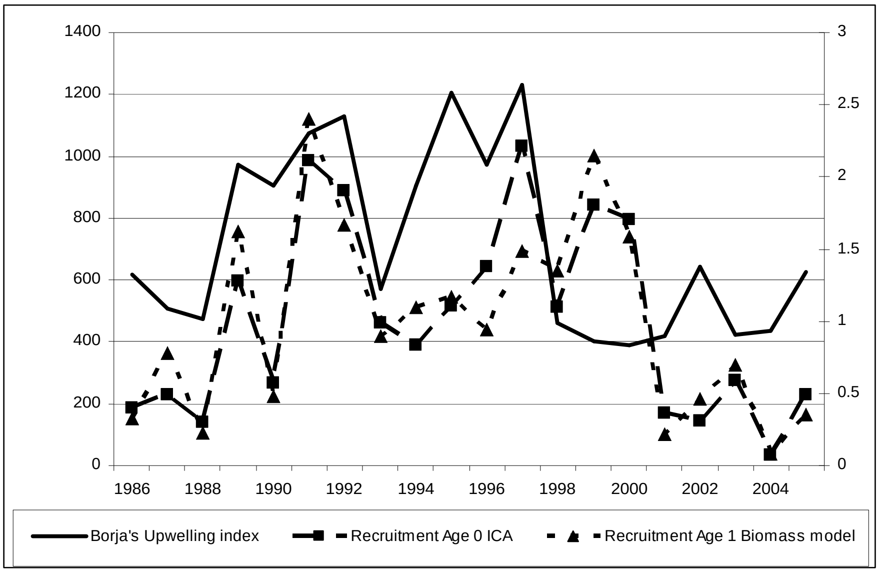


Figure 10.6.1: Bay of Biscay anchovy: Borja's et al. upwelling index (1996 & 1998) and recruitment of anchovy.

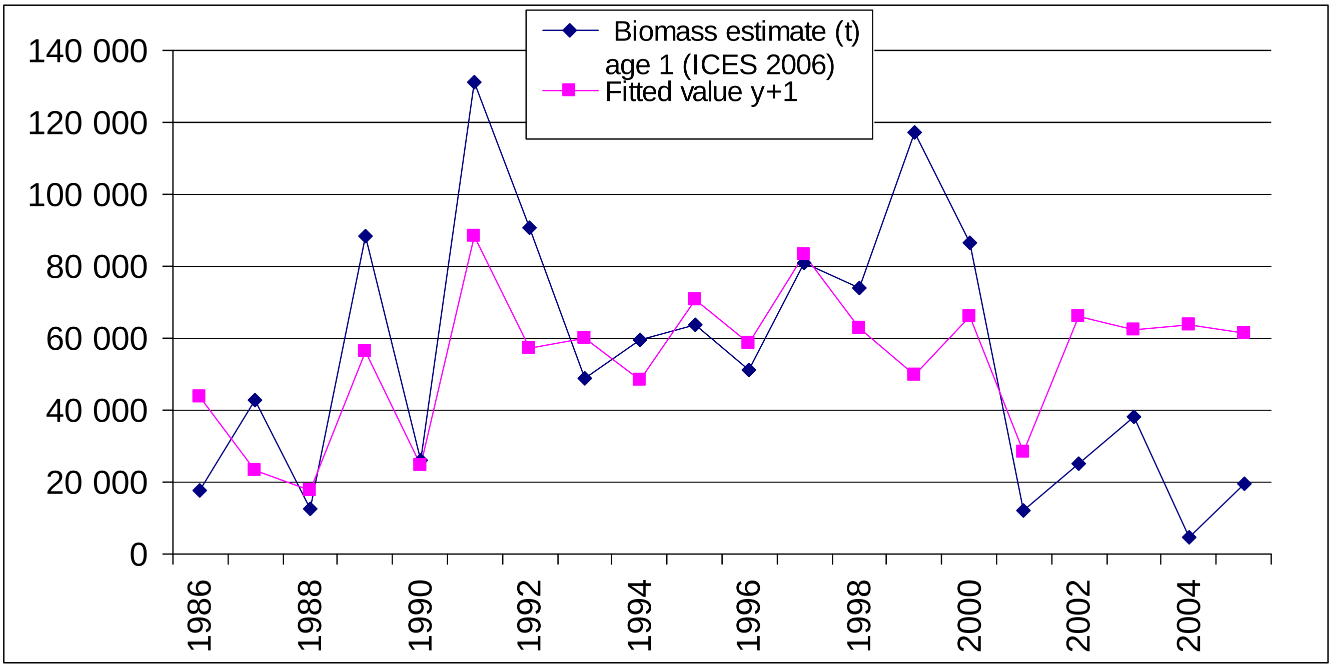


Figure 10.6.2. Bay of Biscay Anchovy. Retrospective model fitted values based on multiple regression of Upweelling index and SDB (Allains et al.) on Biomass based estimates of age 1

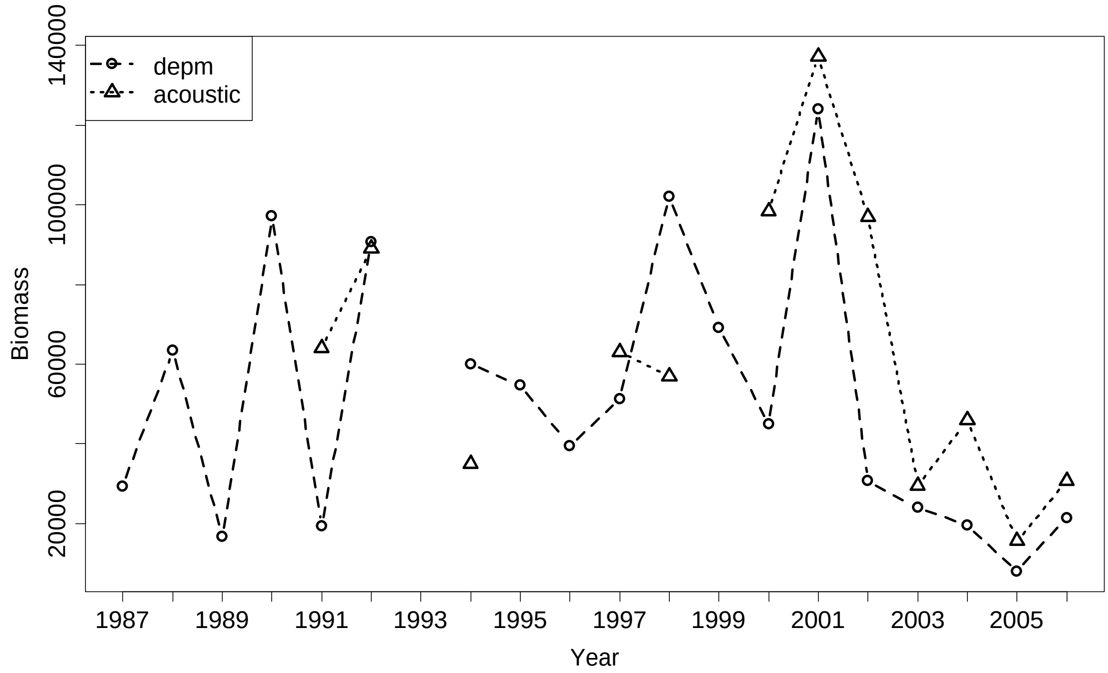


Figure 10.7.1.1: Bay of Biscay anchovy: Historical series of spawning stock biomass estimates from DEPM (solid line and circles) and acoustics (dotted line and triangles).

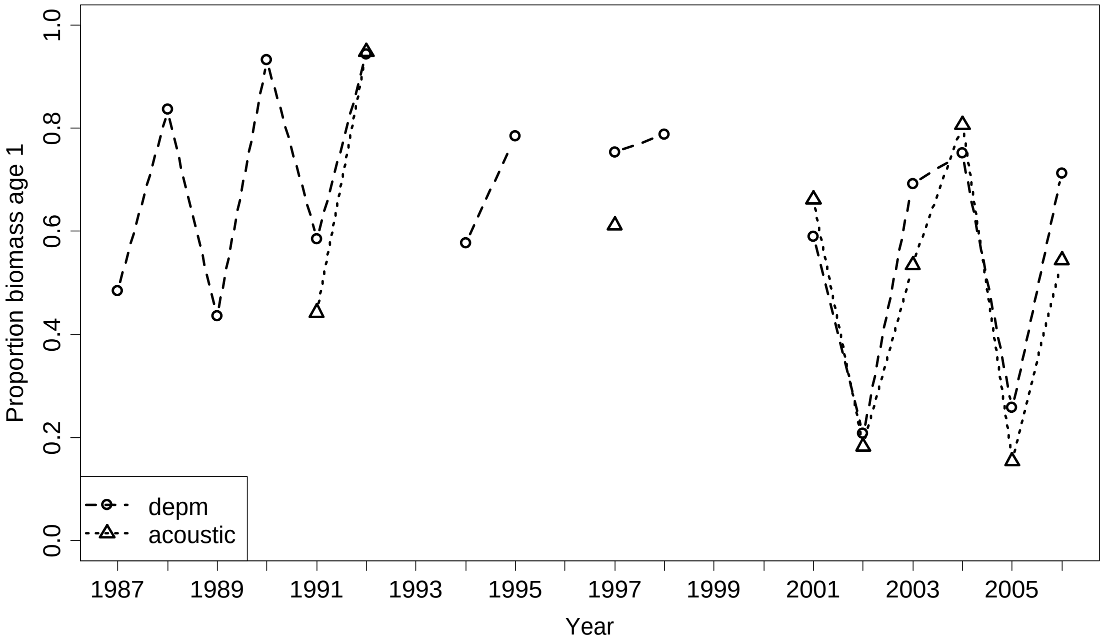


Figure 10.7.1.2: Bay of Biscay anchovy: Historical series of age 1 biomass proportion estimates from DEPM (solid line and circles) and acoustics (dotted line and triangles).

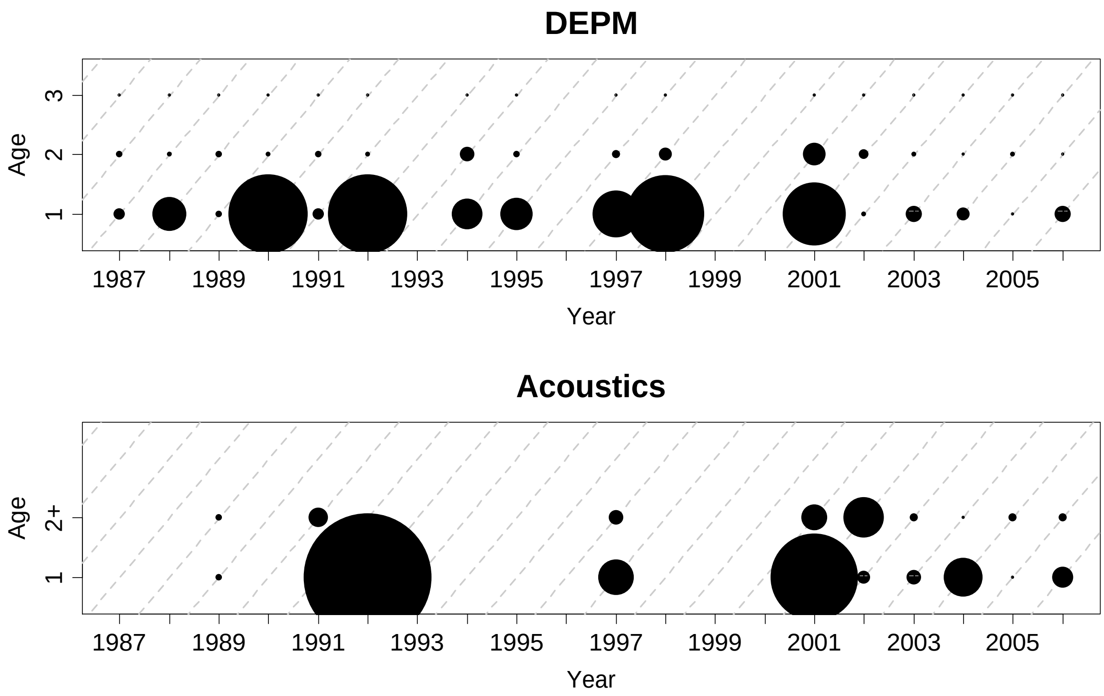


Figure 10.7.1.3: Bay of Biscay anchovy: Bubble plots of the numbers at age estimates from DEPM (top panel) and acoustics (bottom panel).

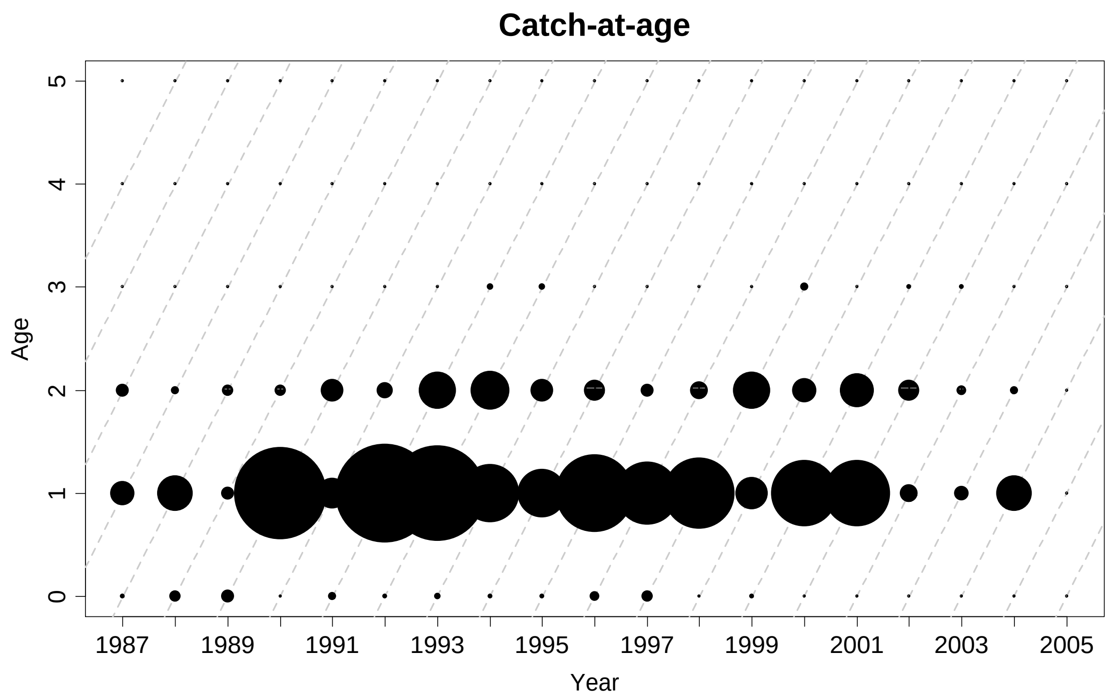


Figure 10.7.1.4: Bay of Biscay anchovy: Bubble plot of the catch at age data.

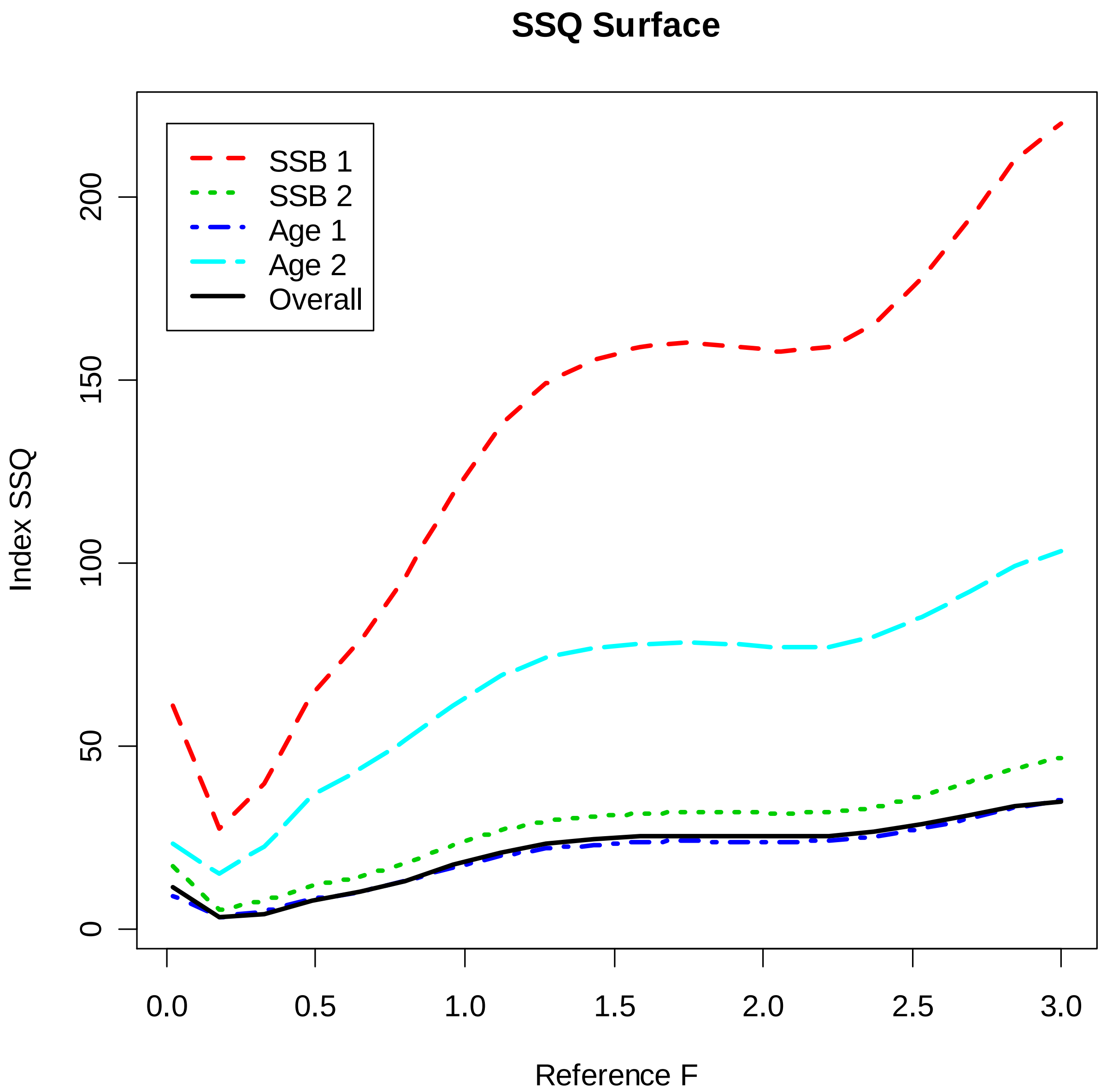


Figure 10.7.2.1.a: Bay of Biscay anchovy: The sum of squares profile for the ICA separable VPA fit from 1991 to 2006 (for 15 years of separable constraint).

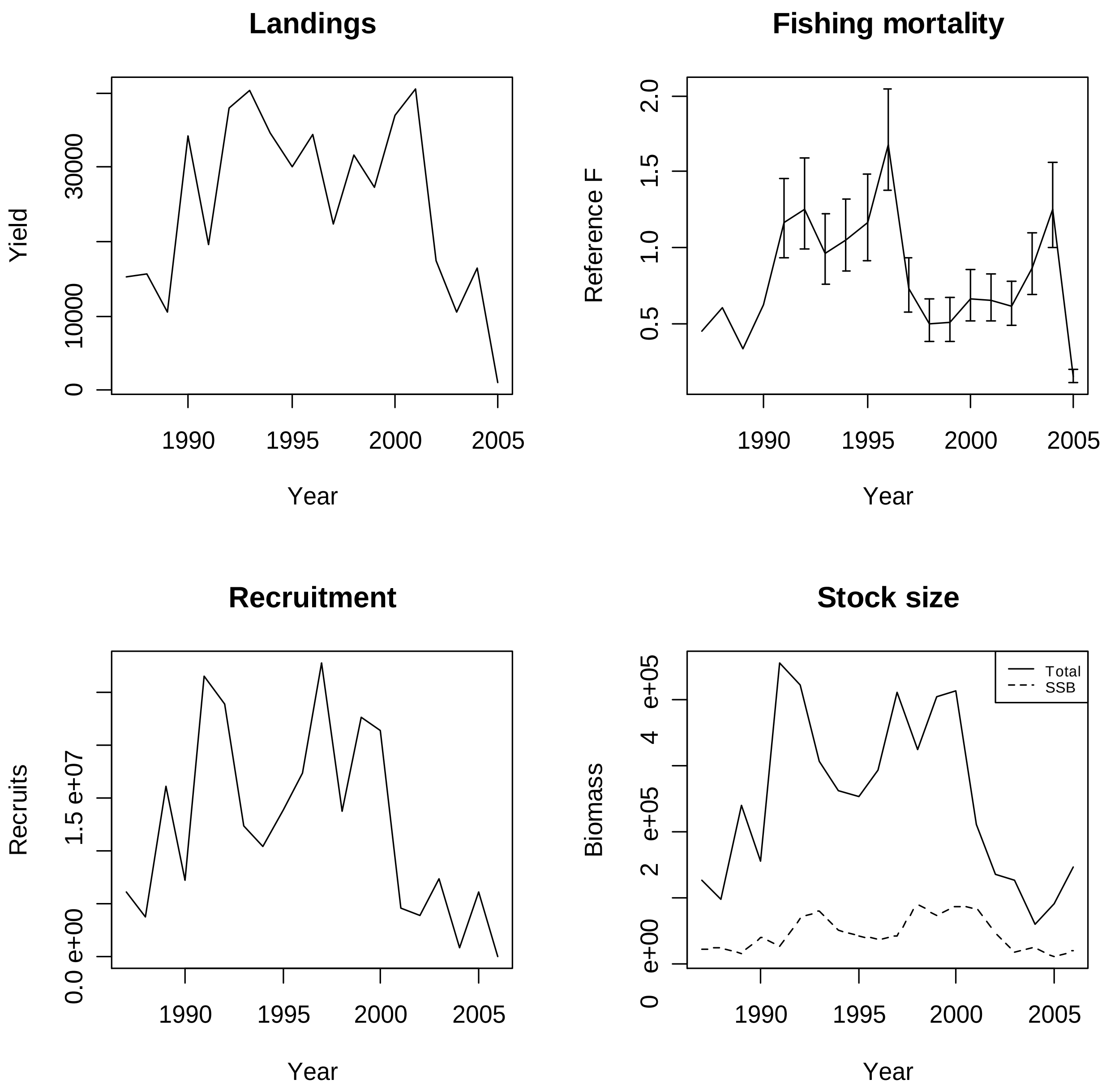


Figure10.7.2.1.b: Bay of Biscay anchovy: The long term trends in stock parameters for 1987-2005.

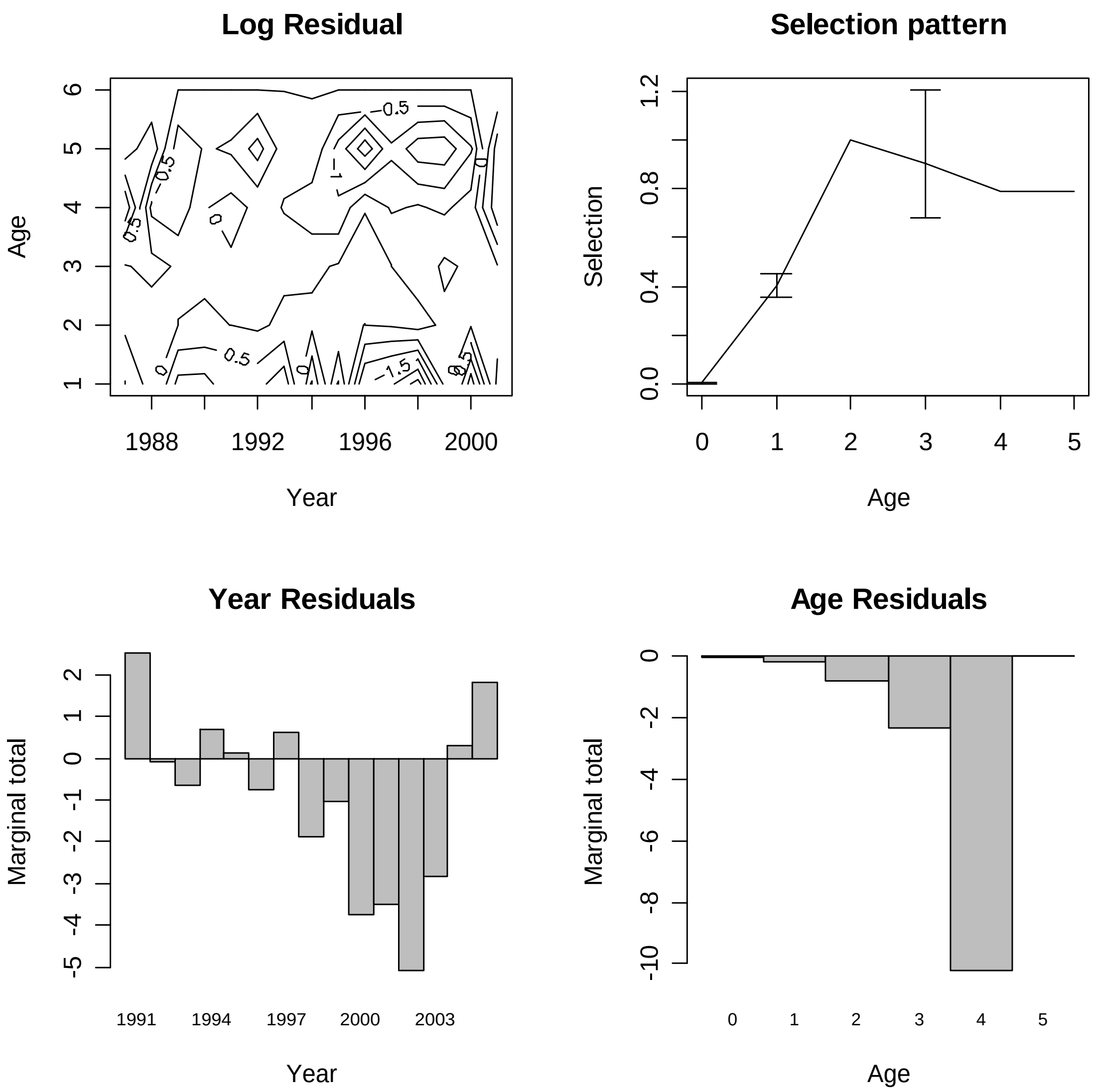


Figure10.7.2.1c: Bay of Biscay anchovy: Catch at age residuals and ages fitted by ICA from 1991 to 2005.

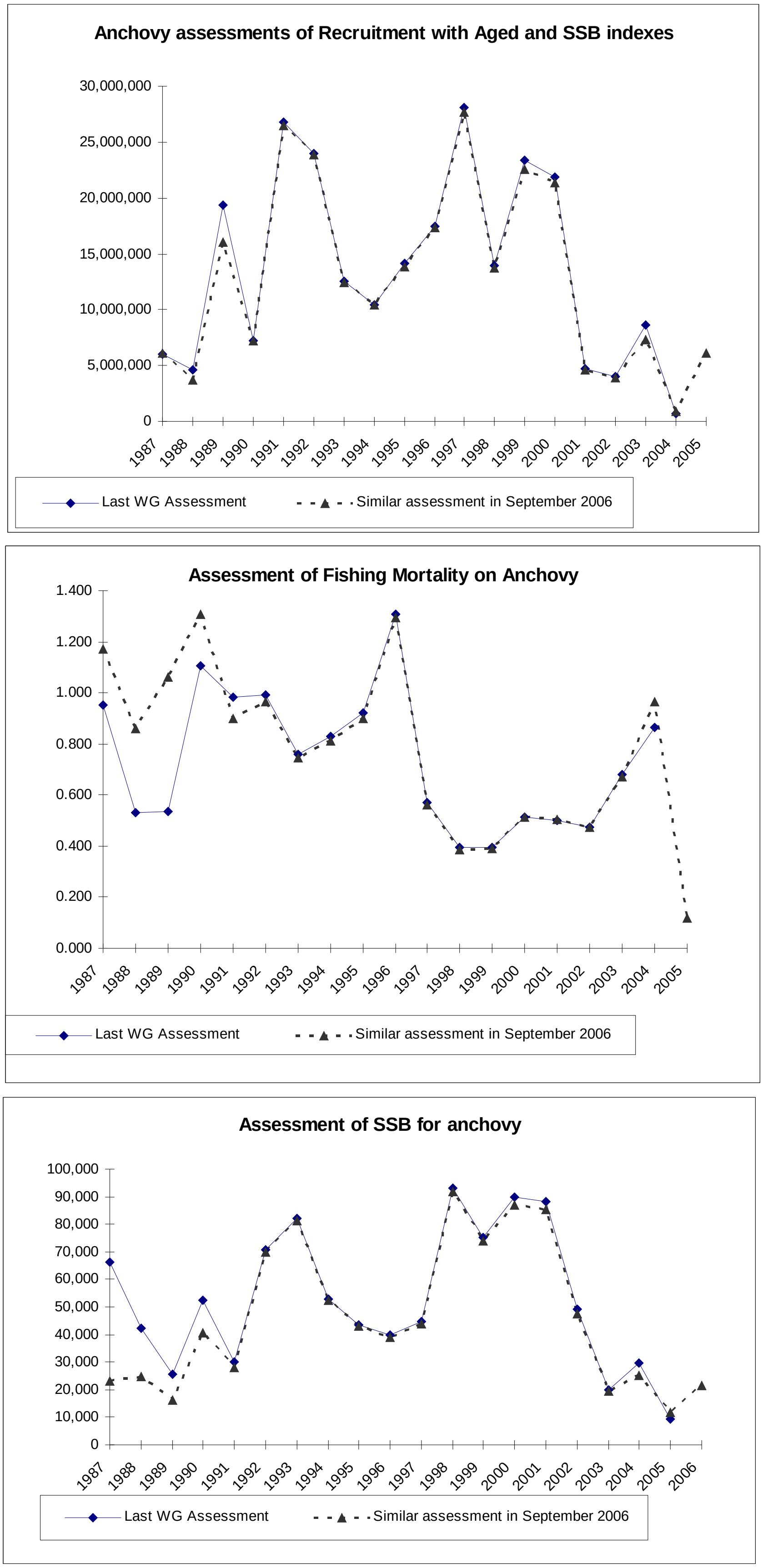
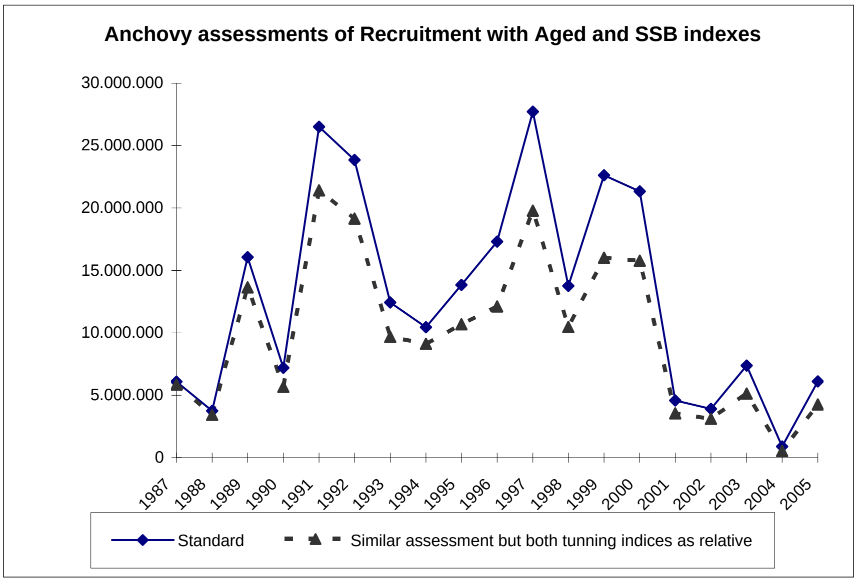
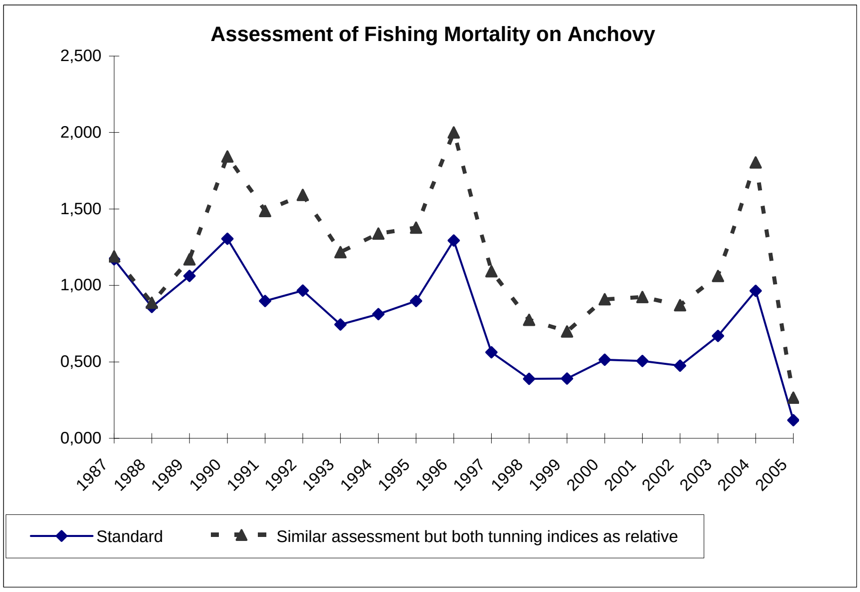


Figure 10.7.2.2: Bay of Biscay anchovy: Comparison of last year's ICA exploratory assessment with September 2006 update including new survey estimates in 2006 (DEPM+Acoustic).





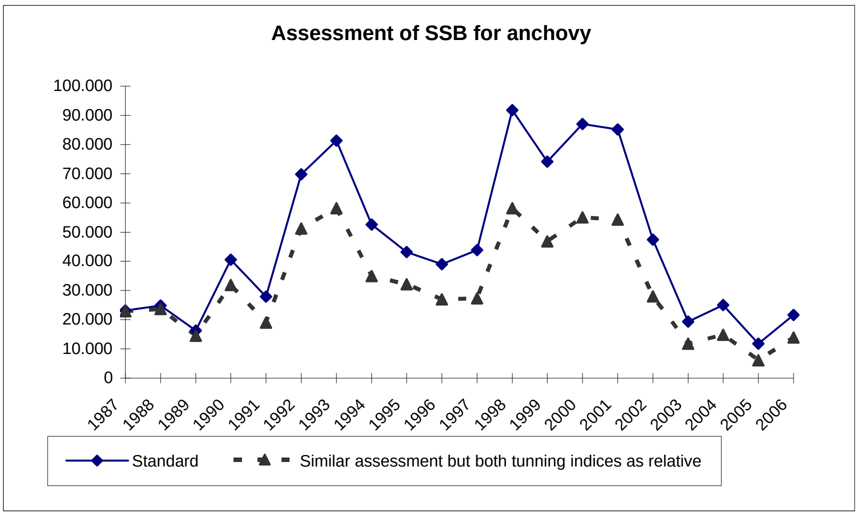


Figure 10.7.2.3: Bay of Biscay anchovy: Sensitivity to the ICA Assessment to catchability of DEPM surveys. The standard procedure adopts DEPM as absolute index of biomass.

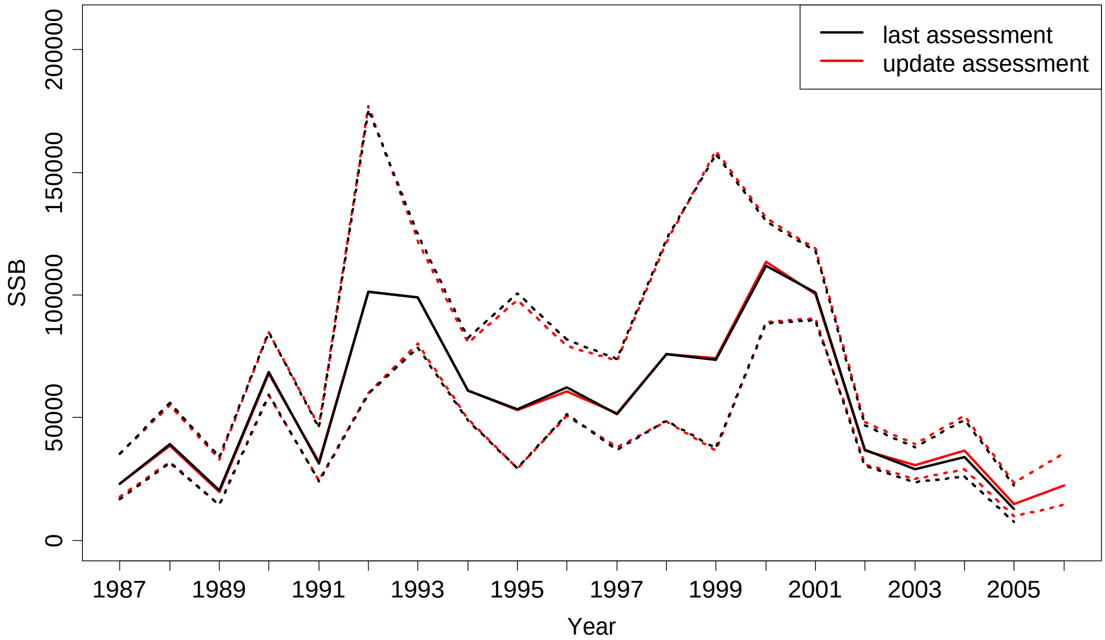


Figure 10.7.3.1: Bay of Biscay anchovy: Comparison of spawning stock biomass posterior median (solid lines) and corresponding 95 % credible intervals (dashed lines) for last year benchmark assessment (black) and the updated assessment (red) using BBM.

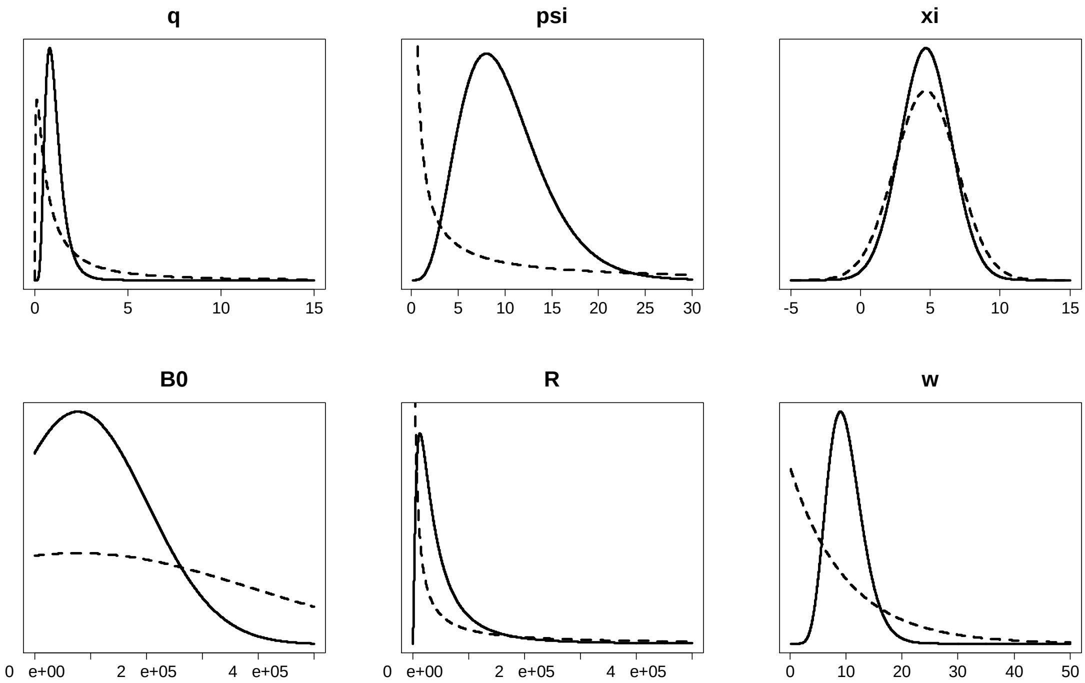


Figure 10.7.3.2: Bay of Biscay anchovy: First and second set of prior density functions, solid and dashed lines respectively, for the parameters of BBM.

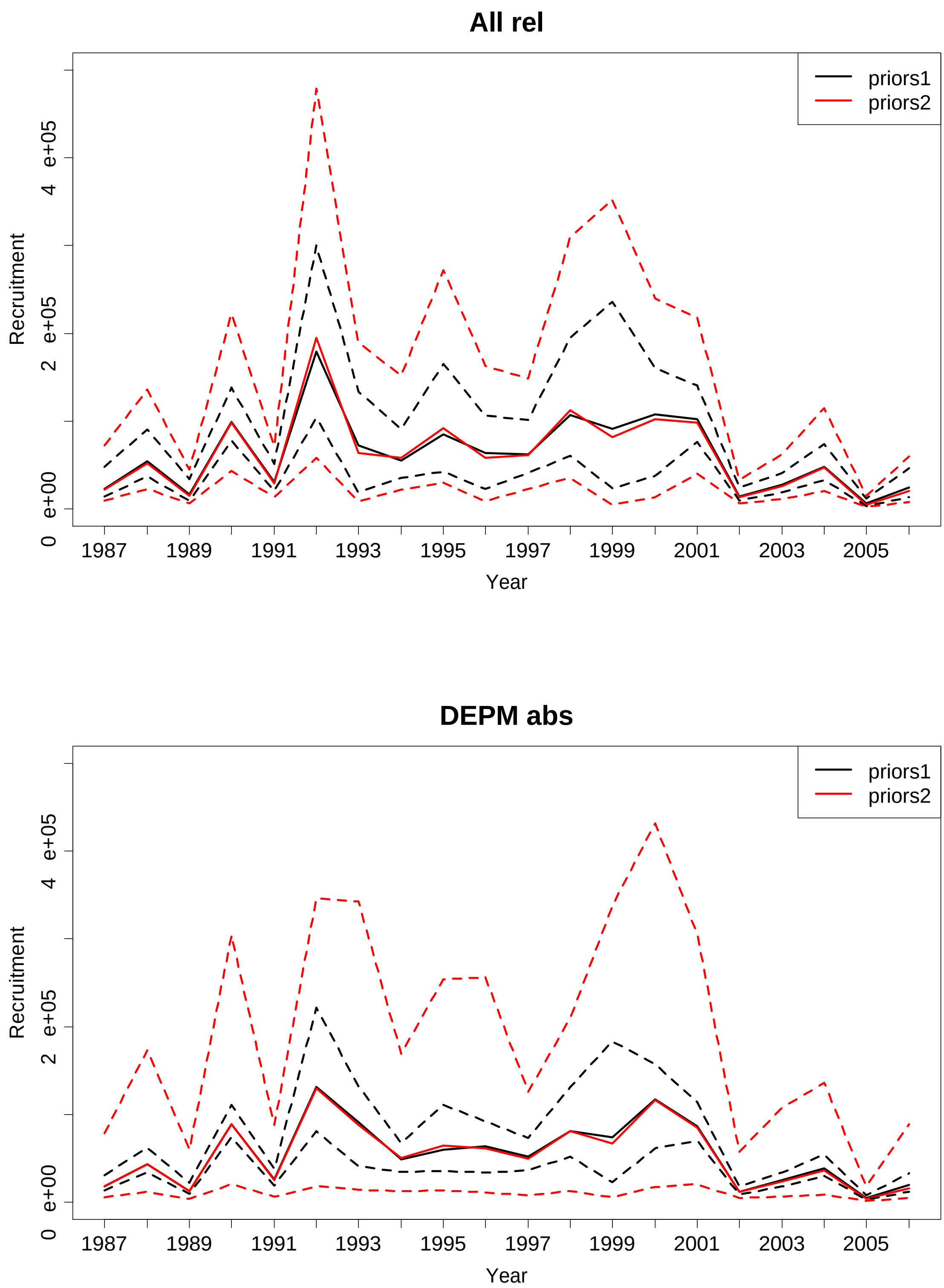
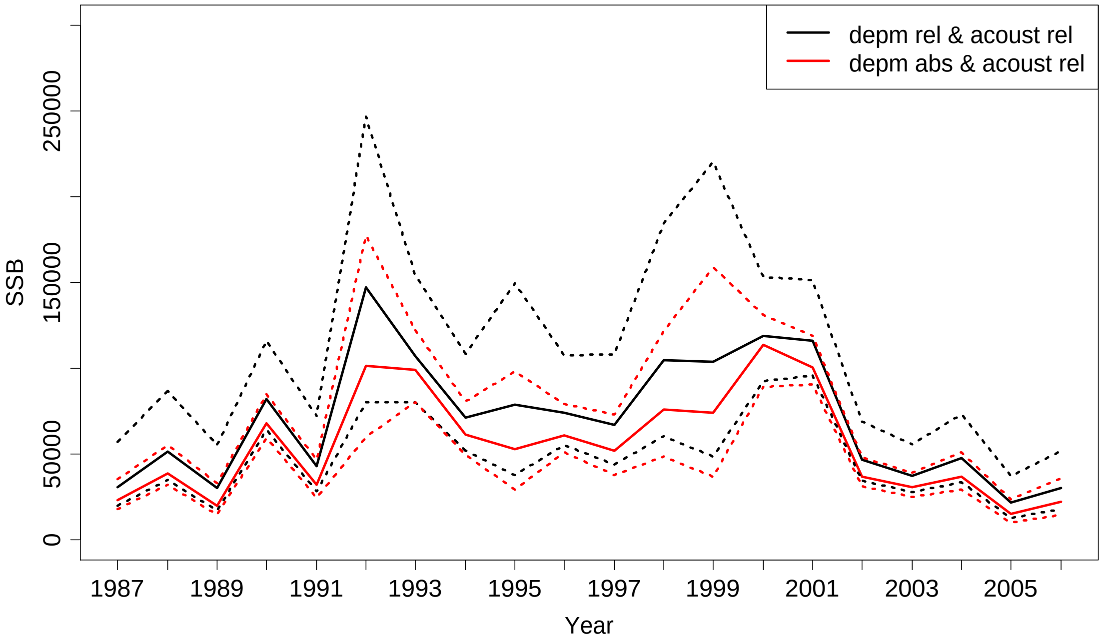


Figure 10.7.3.3: Bay of Biscay anchovy: Comparison of recruitment (in tonnes) posterior median (solid lines) and corresponding 95 % credible intervals (dashed lines) resulting from BBM for the two set of priors when the DEPM is considered as relative (on the top pannel) and as absolute (on the bottom).



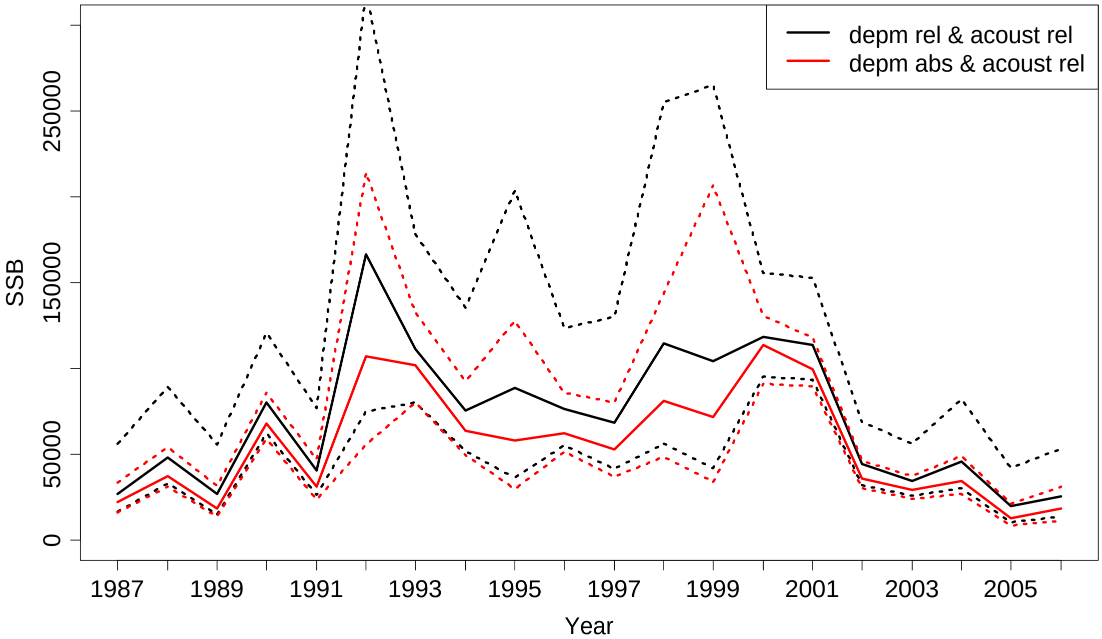


Figure 10.7.3.4: Bay of Biscay anchovy: Comparison of anchovy spawning biomass (in tonnes) for the posterior median (solid lines) and corresponding 95 % credible intervals (dashed lines) resulting from BBM for different catchability assumptions of the DEPM surveys for the first (on the top) and the second set of priors (on the bottom).

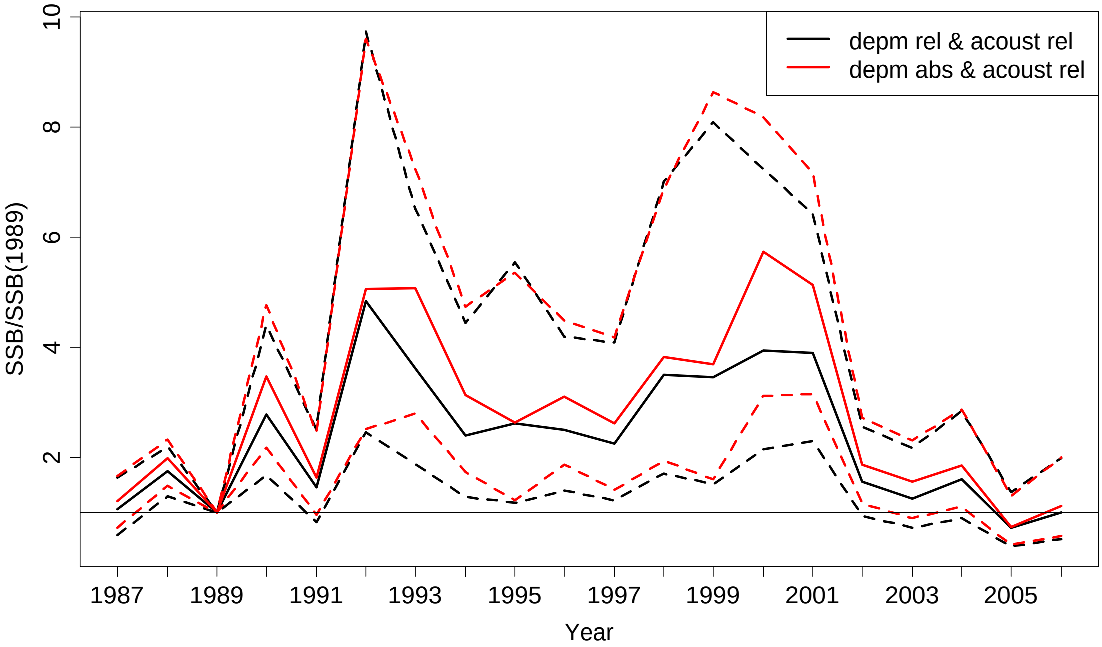


Figure 10.7.3.5: Bay of Biscay anchovy: Median (solid line) and 95% credible intervals (dashed lines) of the ratio of spawning stock biomass with respect to spawning stock biomass in 1989 when the DEPM is considered as relative (black) and absolute (red). The horizontal solid line represents a ratio of 1.

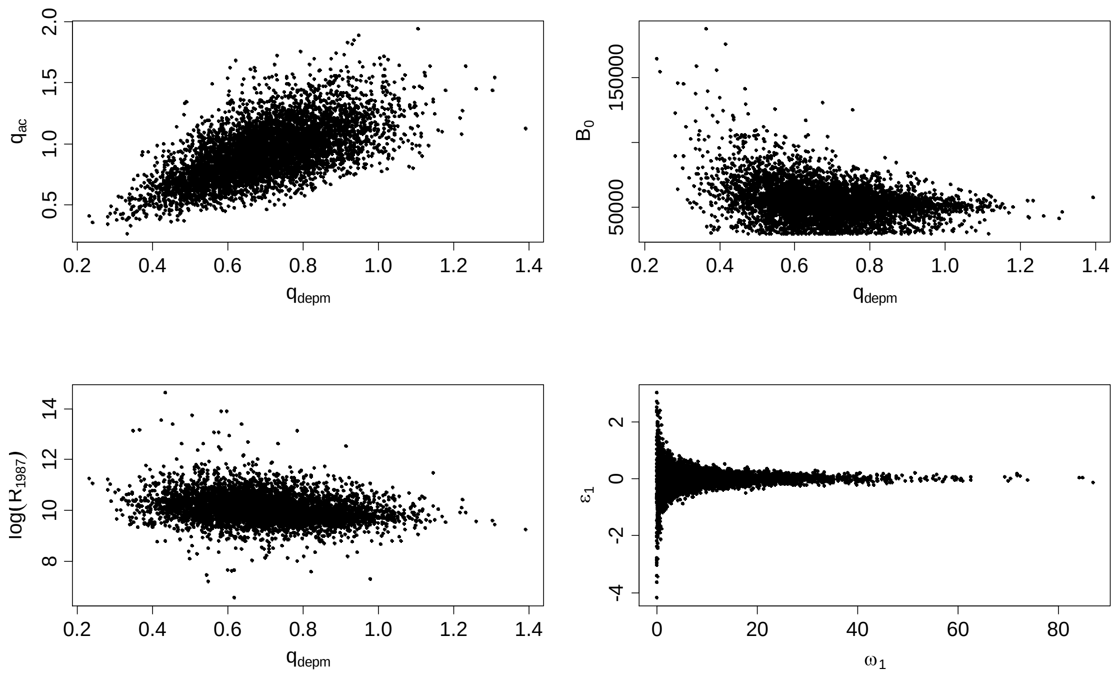


Figure 10.7.3.6: Bay of Biscay anchovy: Posterior correlation between some of the parameters in BBM. From left to right and from top to bottom q_{ac} vs q_{depm}, B_0 vs q_{depm}, $\log(R_{1987})$ vs q_{depm} and $\varepsilon_1(0_{(1987)},h_{1(1987)})$ vs ω_1.

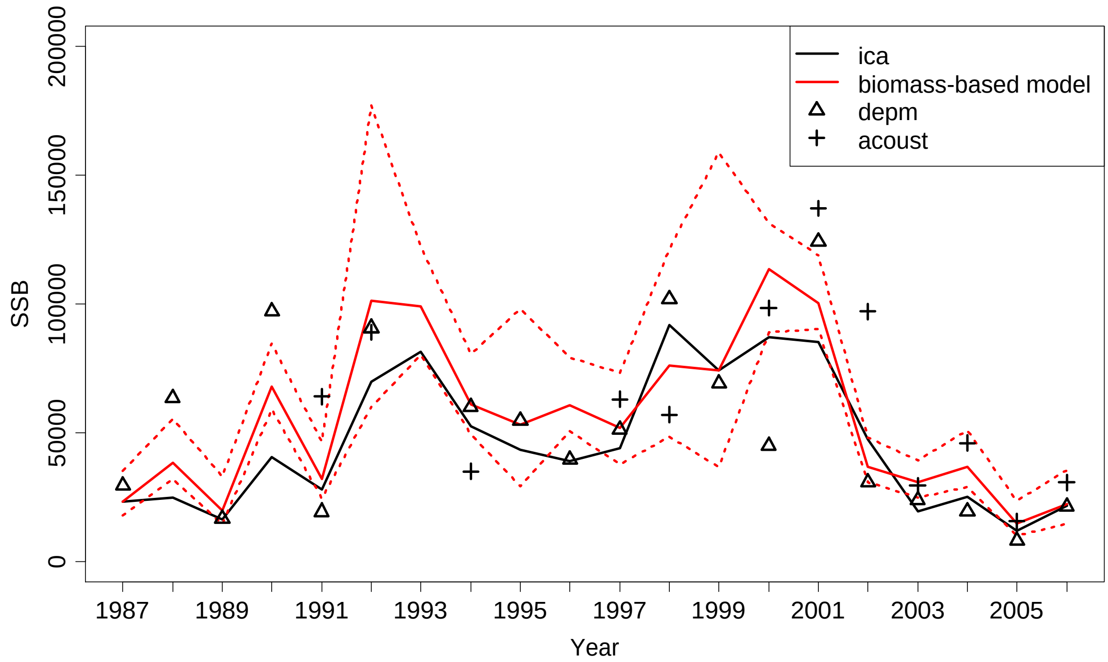


Figure 10.7.3.7: Bay of Biscay anchovy: Posterior median (solid lines) and corresponding 95 % credible intervals (dashed lines) for spawning stock biomass when the DEPM is taken as absolute and the first set of priors are used from BBM (red). The solid black line represents the spawning stock biomass from ICA and the points represent the estimates from the DEPM and Acoustics methods.

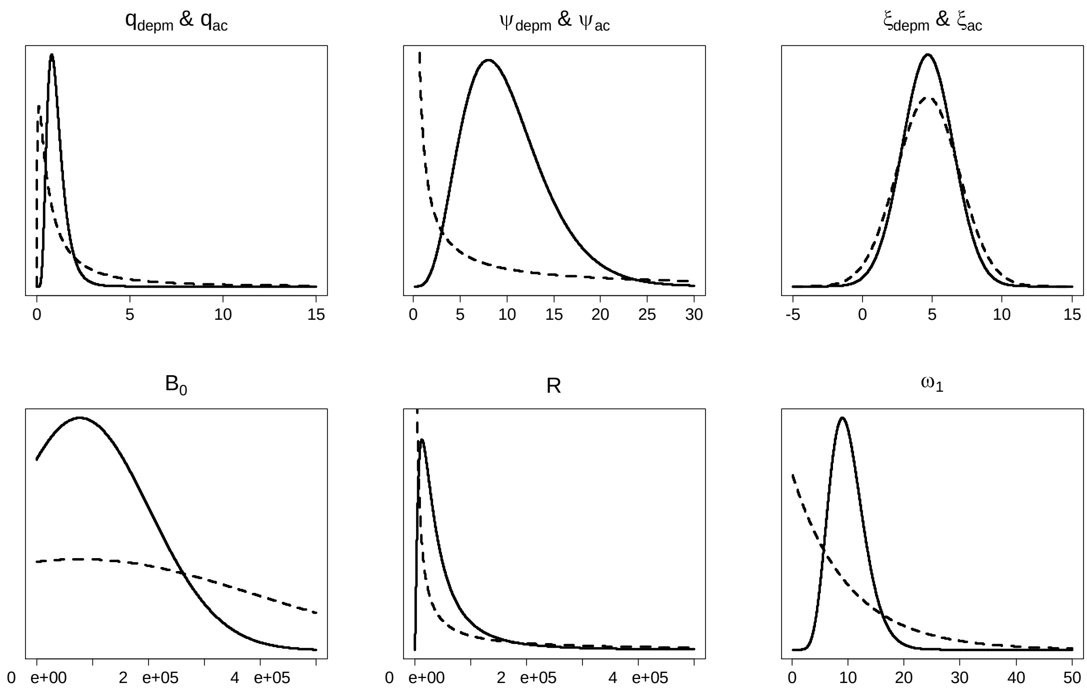


Figure 10.8.1.1: Bay of Biscay anchovy: Comparison between the prior (dotted line) and posterior distribution (solid line) for some of the parameters of BBM.

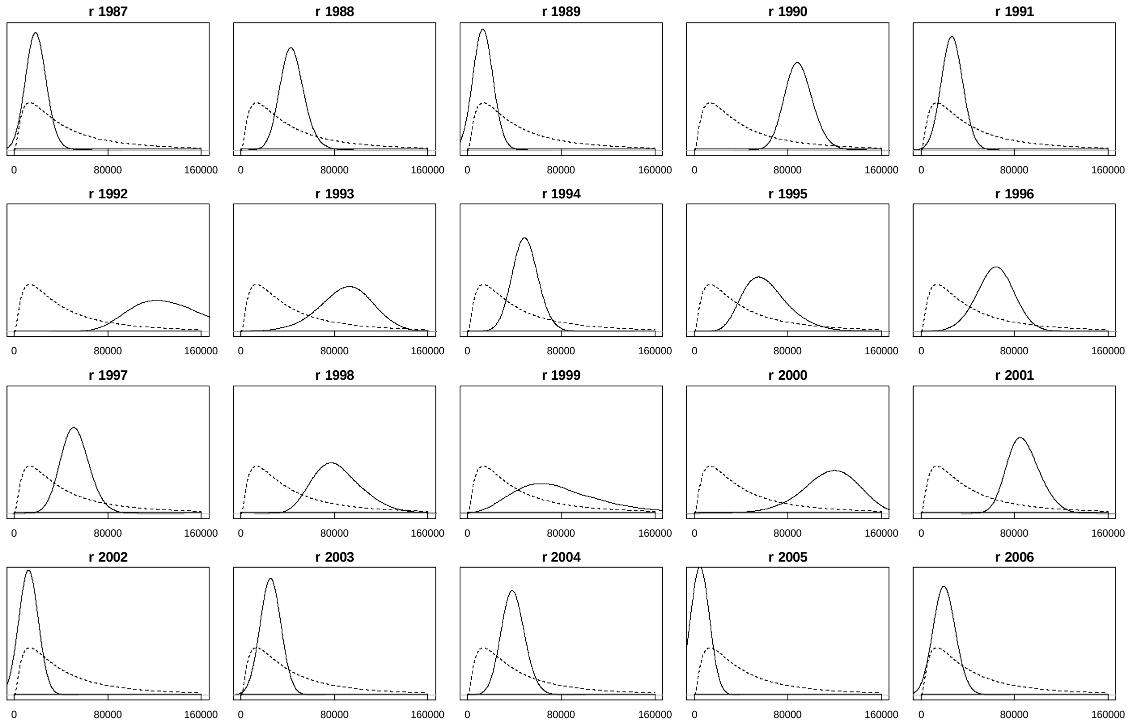


Figure 10.8.1.2: Bay of Biscay anchovy: Comparison between the prior (dotted line) and posterior distribution (solid line) for each of the recruitments in the historical series from BBM.

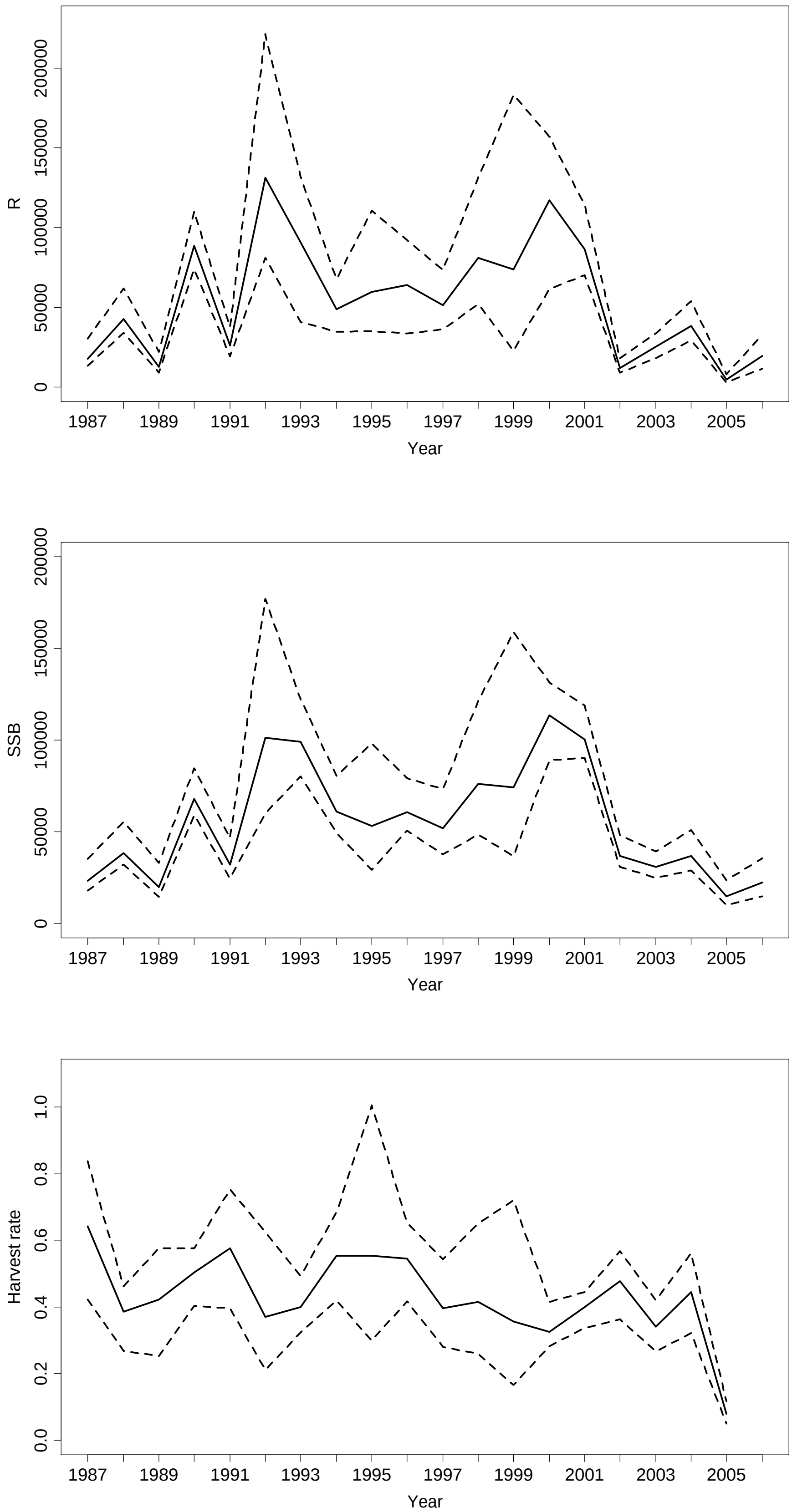


Figure 10.8.1.3: Bay of Biscay anchovy: Posterior median (solid line) and 95% credible intervals (dotted lines) for the recruitment series (in tones), the spawning stock biomass and the harvest rates (Catch/SSB) from BBM

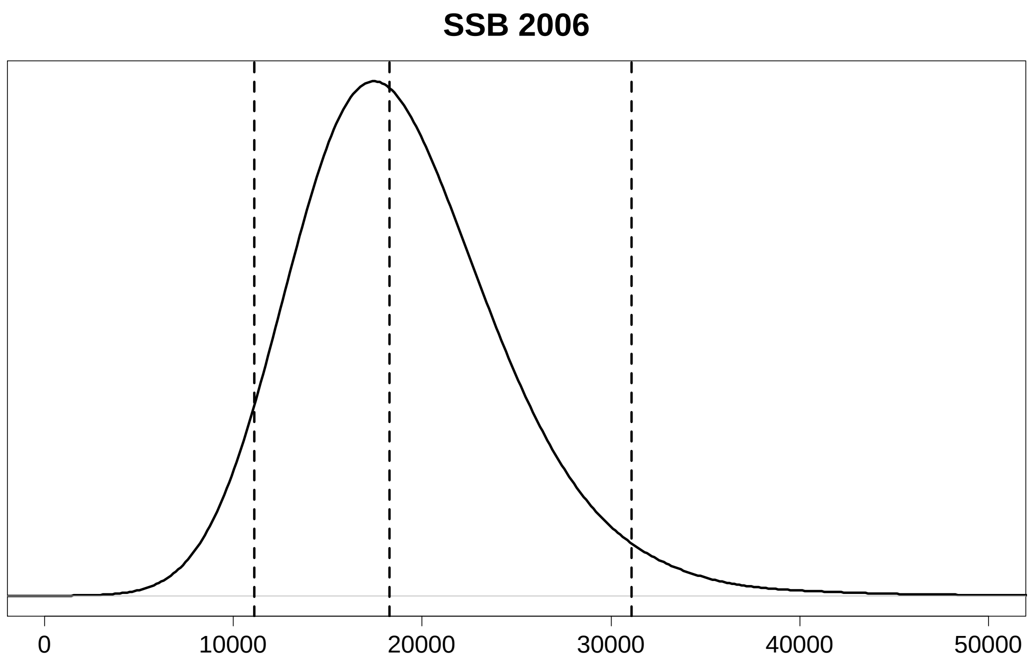


Figure 10.8.1.4: Bay of Biscay anchovy: Posterior distribution of spawning biomass in 2005 from BBM. Vertical dashed lines correspond to posterior median and 95% credible intervals.

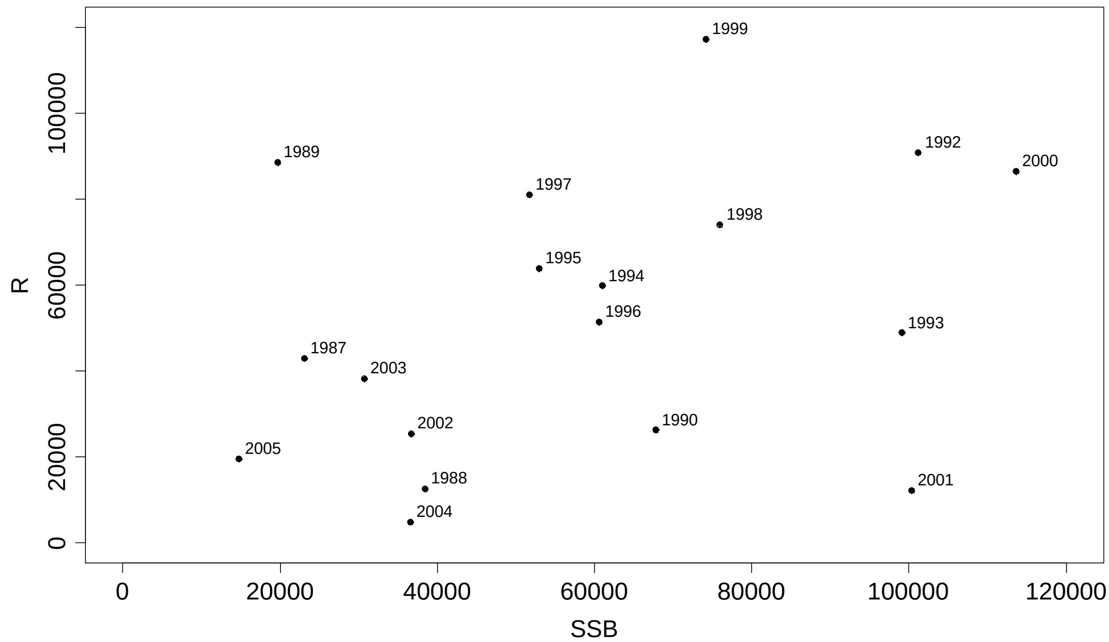


Figure 10.8.3.1: Bay of Biscay anchovy: Scatter plot of the medians of recruitment (in tonnes) and spawning stock biomass as resulted from the Bayesian biomass-based model.

11 Anchovy in Division IXa

11.1 ACFM Advice Applicable to 2005 and 2006

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 the provision of explicit management objectives for this stock and the estimation of appropriate reference points.

Accordingly, ICES advice in relation to the exploitation boundaries of this stock stated that catches in 2006 should be restricted to 4,700 t (mean catches from the period 1988-2002, excluding 1995, 1998, 2001, and 2002), 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 that stock.

The agreed TAC for anchovy from 2002 to 2005 (for Sub-areas IX and X and CECAF 34.1.1) was of 8,000 t. Anchovy catches in Division IXa in 2005 were 4,515 t, which represented 22.7% and 14,3% decreases in relation to the levels recorded in 2004 (5,844 t) and 2003 (5,269 t), respectively, and about the half of the most recent maxima recorded in 2001 (9,098 t) and 2002 (8,806 t). For 2006 this TAC has been agreed again in 8,000 t, with national catch quotas being established in 3,826 t for Spain and 4,174 t for Portugal.

11.2 The Fishery in 2005

11.2.1 Landings in Division IXa

Corrected official data for Portuguese landings in 2004 has been provided by IPIMAR to this working group after detection of relatively small errors (an 83 t difference) in the previous provision of official landings. Such correction, however, doesn't involve any change in the figures of the relative importance of landings by sub-division given the last year.

Anchovy total landings in 2005 were 4,515 t, which represented a relatively important decrease (23%) with regard to 2004 landings (5,844 t). Such a decrease is even greater, of approximately a 50% decrease, in relation to the landings recorded in 2001 (9,098 t) and 2002 (8,806 t), respectively (**Table 11.2.1.1**, **Figure 11.2.1.1**). This decreasing trend in catches was observed in all Sub-divisions but in the northernmost ones (the Spanish IXa North and the Portuguese IXa Central-North), where catch levels (very low) were similar to the ones recorded the last year.

As usual, the anchovy fishery in 2005 was mainly harvested by purse seine fleets (99% of total catches). Portuguese and Spanish purse-seine landings accounted for 49% and almost the whole of their respective national total catches (**Table 11.2.1.2**). However, unlike the Spanish Gulf of Cadiz fleet, the remaining purse-seine fleets in the Division only target on anchovy when its abundance is high. The Portuguese artisanal anchovy fishing in 2005, although contributed in a remarkable way to their national landings (45%), also suffered the decreased trend in catch levels experienced by the whole anchovy fishery, with only 57 t. Landings from this fishery as well as from the trawl ones (both Spanish and Portuguese) were still small in relation to the whole anchovy fishery in the Division.

11.2.2 Landings by Sub-division

The anchovy fishery was mainly located in 2005 in the Sub-division IXa South (4,423 t, *i.e.*, 98% of total catch in the whole Division, **Table 11.2.2.1**, **Figure 11.2.1.1**). As observed in recent years, the bulk (99%) of these catches was fished in the Spanish Gulf of Cadiz (4,385 t against 38 t landed in the Algarve). Excepting catches from these areas, the relative importance of the remaining Sub-divisions was negligible.

The Spanish fishery in 2005 followed the same distribution pattern described for recent years, with almost the whole anchovy being fished in the Gulf of Cadiz waters (again, only 4 t in Sub-division IXa North, *i.e.*, southern Galician waters). However, as also happened in 2004, the Gulf of Cadiz purse-seine fishery was closed in 2005 from November the 17th to December the 31st, as one of the management measures included within the "*Plan, to be implemented urgently, for the conservation and sustainable management of the purse-seine fishery in the Gulf of Cadiz National Fishing Ground*". This Fishing Plan was implemented in 2004 in October the 30th and both the 2004 and 2005 fishery closures (about 45 days) were accompanied by a subsidized tie-up scheme for the purse-seine fleet. A more detailed description of this Plan is given in **Section 11.10**. The effects of such a closed season on purse-seine landings in the fourth quarter in 2004 and 2005 in comparison with preceding years are shown in **Figure 11.2.2.1**. The years included in this figure are those ones when the whole purse-seine fleet has been exerting its greatest fishing capacity. As evidenced by the recent trend in autumn landings, the 2004 closed season does not seem to affect seriously to the catch levels both in this season and in the total annual landings. In fact, the relative importance of autumn landings in 2004 is even greater (12%) than in preceding years (10% in 2002, 9% in 2003). This was not the case in 2005, since landings in the fourth quarter were the lowest ones in the recent analysed series both in absolute and relative terms. Impacts of this management measure in the fishing effort will be discussed in **Section 11.5**.

As described in the last year's report, the Portuguese anchovy fishery in 2004 showed a shift in its usual distribution pattern exhibited since 1998. So, although from this year up to 2003 the fishery was concentrated in the IXa Central-North and IXa South, in 2004 the fishery seemed to experience a southward displacement, with relatively scanty catches in IXa Central-North to somewhat higher levels in their southernmost national fishing grounds. In 2005, the fishery exhibited again the usual aforementioned pattern for the 1998-2003 period. Historically, each of these three Sub-divisions has shown alternate periods of relatively high and low landings, anchovy fishery being located either in the IXa South (before 1984) or in the IXa Central-North (after 1984), (see **Table 11.2.1.1** and Pestana, 1996).

Seasonal distribution of catches by country and Sub-divisions in 2004 (corrected data) and 2005 is shown in **Table 11.2.2.1**. In 2005, although with a different intensity, anchovy catches were recorded throughout the year in all Sub-divisions. In the northernmost Sub-divisions catches occurred mainly in the second quarter, those ones from Portuguese waters of the IXa Central-South and South in the first quarter, whereas anchovy fishery season in IXa South occurred throughout spring-summer months.

11.2.3 Discards

No information on anchovy discarding in the Division IXa has been available till 2005. The Spanish National Sampling Scheme, adopted by the European Regulation (EC) Nº 1639/2001 of July 2001, is the Minimum Program of the European Commission. According to Appendix XII of this Regulation (modified in Nº 1581/2004), anchovy is included in the species list to be considered within the Division IXa (especifically in the Gulf of Cadiz) for discards. Moreover, discards' length distribution must be estimated if discards represent more than 10% of the total catch in weight or more than 20% of the catches in number, both on a yearly base. Age-structured estimates only must be computed when discards occur for length ranges that are not represented in the landings. According to this, several "pilot surveys" for estimating discards in the Gulf of Cadiz Spanish fisheries (trawl, purse-seine and artisanal) were conducted in 2005 by an onboard observer's programme along a five-month period covering the whole study area. Preliminary results from these "pilot surveys" are reported in Pérez *et al*. (2005). This discard sampling programme was carried out based on stratified random sampling per Fishing Activity unit (*i.e*., métier) which comprises species, area, gear and target species. The sampling level for 2005 in number of fishing trips and allocation during the sampled period is given in the text table below:

FISHERY UNIT	QUARTER	TRIPS	SAMPLED HAULS	TOTAL HAULS	FISHING TRIP DAYS
Bottom otter trawl	1st,2nd	20	46	46	20
Artisanal	1st,2nd	4	4	4	4
Purse-Seine	2nd	6	13	13	6

Six purse-seine trips were carried out during May and June with a total of 13 hauls with an average duration of 1.5 hours each at an average depth of 53.2 metres. Sampled vessels belong to the Barbate's fleet, with lengths ranging between 16 and 24 metres with an average power of 267HP and an average crew of 15 people. The net sizes were between 500m in length and 60m height. Anchovy was the target species of all the sampled trips. Preliminary results presented here are not raised to total annual landings and correspond to average estimates per trip. For the total of sampled trips, anchovy accounted as an average about 62% of the total catch in weight. Anchovy discarding represented 10.1% in numbers and 10.7% in weight of the total catch. Such ratios should be, however, considered with caution given the extremely high CV associated to the estimates (CV= 157.2 for discarded catch in weight). On the other hand, discarded anchovies were of a commercial and legal size, comprised between 10 and 15 cm size classes (mode at 12.5 cm), and no reasons for discarding anchovy is given by the authors of this study.

Anchovy catches in sampled trips from the bottom otter-trawl fleet were negligible and therefore the resulting ratios are meaningless.

There is no information about the continuity of this sampling programme in the next years.

11.2.4 Fleet composition

Details about purse-seine vessels operated by Spain in the Gulf of Cadiz targeting anchovy are given in **Table 11.2.4.1**. The evolution of the number of vessels composing each of the fleet types exploiting this fishery through the historical series is not yet available. The only available information on this aspect is the total number of vessels (single- and multi-purpose purse-seiners pooled) fishing in 2003 (127 vessels), 2004 (129 vessels) and 2005 (99 vessels).

11.3 Fishery-Independent Information

11.3.1 Acoustic Surveys

A summary list of the 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
Portuguese Surveys	Q1				Mar		Mar	Mar	Feb			
	Q2									Jun	Apr	Apr
	Q3											
	Q4			Nov		Nov	Nov		Nov		Nov	
Spanish Surveys	Q1							Feb				
	Q2	Jun								Jun		Jun
	Q3											
	Q4											

The Portuguese surveys series (SAR series) correspond to those routinely performed off the Portuguese continental shelf and Gulf of Cadiz, during March (sardine late spawning season) and November (early spawning and recruitment season), and mainly aimed at the acoustic estimation of the sardine abundance in Division IXa. Anchovy estimates from these surveys started to be available from the November 1998 survey. Spanish acoustic surveys in the Division has been sporadically conducted from 1993 to 2003 in Gulf of Cadiz waters. A consistent yearly series of late-spring acoustic surveys (ECOCÁDIZ series), aimed at the anchovy abundance estimation in the Subdivision IXa South (Algarve and Gulf of Cadiz) started in 2004. However, this new series may show, as occurred in 2005, some gaps in those years coinciding (same dates and surveyed area) with the conduction of the (initially triennial) anchovy DEPM survey because of the available ship time. As for the text table, acoustic estimates from surveys on a black background are those ones used as tuning series in the exploratory assessment of anchovy in Sub-division IXa South (Algarve and Gulf of Cadiz, see **Section 11.7**). Surveys on a white background were carried out but not provided any anchovy acoustic estimate because of its very low presence and/or for an incomplete geographical coverage (some areas uncovered). 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. Results from the acoustic surveys in 2005 were presented and discussed in the last year's report (ICES, 2005 b). A summarised description of results from the surveys conducted in the first half in 2006 is given below.

Portuguese Surveys

Two Portuguese acoustic surveys have been carried out during the intersession time: one survey in November 2005 (SAR05NOV) and the other one in April 2006 (SAR06ABR). Results on anchovy distribution and abundance during these surveys has been provided to this WG (Marques and Morais, WD 06/06). Surveys are carried out with the R/V 'Noruega' and the surveyed area usually includes the waters of the Portuguese continental shelf and those of the Spanish Gulf of Cadiz (Sub-divisions IXa Central-North, Central-South, and South), between 20 and 200 m depth.

Unfortunately, due to the bad weather in the November 2005 survey, the Spanish Gulf of Cadiz area was not covered and no anchovy estimate was given since the species was almost absent along the remaining surveyed area.

In April 2006 the anchovy total estimated biomass was 24.1 thousand tonnes (2,246 millions fish), which is near the average value for entire time series (26.2 thousand tonnes), and it was entirely located in the Sub-division IXa south. Like in previous years, the area with the highest anchovy abundance was the Gulf of Cadiz, accounting for 81% of the total estimated biomass (**Table 11.3.1.1**, **Figures 11.3.1.1** and **11.3.1.2**). The Portuguese coast presented some differences concerning to the last surveys. No anchovy schools were found in the coast in front of Lisbon and the acoustic estimates for Algarve were the highest of the time series (4.5 thousand tonnes).

The length composition obtained for Algarve and Cadiz presented some similarities. Both areas presented a unimodal length distribution (modal length: 12.5 cm – Algarve; 11 cm – Cádiz) and a similar range (10.5 - 16 cm – Algarve; 9.5 -16 cm – Cadiz), (**Figure 11.3.1.3**). However, Algarve presented a higher number of larger individuals. In this area anchovies with lengths between 12 and 13.5 cm represented 78% of the total abundance (**Figure 11.3.1.4**).

Spanish Surveys

Spanish acoustic surveys aimed at sardine have been conducted in Sub-division IXa North and Division VIIIc since 1983. 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 *et al*., 1999; Carrera, 1999, 2001). This situation still continues in the most recent years (surveys in the 2003-2005 period, see Porteiro *et al*., 2005).

Results from the spring acoustic survey in June 2004 (BOCADEVA 0604), aimed at the acoustic estimation of the anchovy SSB in Subdivision IXa South, were presented that year to this WG (ICES, 2005 b). The total estimated biomass for anchovy in that survey was 13.2 thousand tonnes (894.4 million fish), Spanish waters accounting for the 86.4% of this total biomass (11.4 thousand tonnes), (**Table 11.3.1.2**). Such estimates were the lowest ones ever recorded for the Subdivision when they are compared with the estimates derived from the Portuguese surveys series. However, some doubts arose in the last years' working groups about the consistency of the Spanish survey estimates (possible acoustic undersampling of shallow waters).

No acoustic survey was carried out in 2005 since the available ship-time was invested on the conduction of the anchovy DEPM survey (see **Section 11.3.2**).

The last Spanish acoustic survey in the Subdivision IXa south was carried out in June 2006 (ECOCÁDIZ 0606) and their results have been provided by IEO to this working group (Ramos *et al*., WD 08/06). As compared with the 2004 survey, the present one has included some important improvements in its design, related basically to the sampling coverage and intensity. Firstly, this survey has substantially increased the available ship-time, from one to two weeks. Such an improvement has involved the possibility of increasing noticeably the number of valid fishing stations (from 13 in 2004 to 34 in this year) and, therefore, to achieve a more complete coverage of the species composition of the pelagic fish assemblage over the shelf (**Figure 11.3.1.5**). Moreover, the acoustic transects has been extended up to the 20-m depth isobath, instead of the 30-m depth isobath as established in the 2004 pilot survey, increasing the sampling coverage of coastal waters. Acoustic estimates and inferences on the species' distribution are, under this new sampling scheme, much more reliable than those derived from the previous acoustic survey. Notwithstanding the above, a relatively large coastal area shallower than 20-m depth comprised between the Guadalquivir and Guadiana rivers is still uncovered by the acoustic (and fishing stations) sampling, not only by the Spanish survey but also by the Portuguese one.

In June 2006 anchovy was mainly distributed in the Spanish waters off the Gulf, with the highest densities occurring in the central part of the sampled area, mainly between 20 and 50 m depth, although an isolated nucleus of high density at 130 m depth in front of the Huelva coast was also observed. In the Portuguese waters the species was restricted to the westernmost shelf although showing very low densities. Anchovy was absent between Cape Santa Maria and Tavira (**Figures 11.3.1.5** and **11.3.1.6**).

Anchovy total biomass in the Subdivision was estimated at 27.8 thousand tonnes (2,487 million fish), values very close to the ones estimated short before in the Portuguese survey. The Spanish Gulf of Cadiz contributed with the 93.4% (25.9 thousand tonnes) of the total biomass and 95.8% of the total abundance (2,384 million fish).

Size- and age-based estimates suggest an east-west size (-age) gradient, with the largest (and oldest) anchovies being more abundant in the westernmost limit of their distribution, and a recruitment area located in shallow waters close to the Guadalquivir river (**Table 11.3.1.3**, **Figures 11.3.1.7** and **11.3.1.8**).

Some comments on recent trends in acoustic estimates from Subdivision IXa South

For comparative purposes, **Figure 11.3.1.9** shows the updated series of anchovy acoustic estimates from Subdivision IXa South available from the Portuguese surveys together with the estimates from the 2004 and 2006 late-spring Spanish surveys. The depicted data series shows several gaps which make difficult to follow any clear trend, mainly in the last years. As stated in the last year WG, the picture of an alarming decreasing trend just in 2004-2005 should initially be considered with caution for causes either related to the undersampling of coastal waters (2004 Spanish survey), problems in echo-traces discrimination because of the mixing of target species with plankton (2005 Portuguese survey), or the differences found in the population structure (and an additional mortality) between March and June surveys which makes difficult the between-surveys comparison. Notwithstanding the above, the April 2005 estimates, which are more susceptible of being compared with the remaining 'March' data points, seem to reflect (although bearing in mind the problems in the echo-traces discrimination) a worrying decreased trend in the recent population levels. Such a perception changes when the 2006 estimates are taken into consideration since they are indicating some recovery of the population levels.

11.3.2 Egg Surveys

Spanish Surveys

Results from a pilot DEPM survey for anchovy in Subdivision IXa South performed during June 2004 (coupled to an acoustic survey, see previous Section) were reported both to the 2004 SGSBSA and WGMHSA (Anon., 2005; ICES, 2004; Jiménez *et al*., 2004, Millán *et al*., 2004). A full-scale DEPM survey for anchovy in the same surveyed area was then carried out in June 2005 (BOCADEVA 0605) taking into consideration the Study Group recommendations on the increase of sampling coverage. The agreed egg and adult sampling strategies were identical to those adopted in the Bay of Biscay. This survey was performed between 10th and 22nd June 2005 with the R/V *Cornide de Saavedra*. A summary of the methodological aspects of this survey was reported in the last year WGMHSA report (ICES, 2005 b). Preliminary results from this survey were presented to the 2005 WGACEGG (ICES 2006, Jiménez *et al*., 2005 a, 2005 b; Millán *et al*., 2005). However, no SSB estimate is still available to the working group because of technical problems with the estimation of the spawning fraction which has recently been solved.

An internal IEO Workshop on methods standardisation, data exploratory analysis and (spatial) modelling of egg and adult parameters from recent IEO DEPM surveys under R environment (see Bernal *et al*., 2004) was held in June this year. Results from this workshop relative to the 2005 survey parameter estimates will be presented and discussed in November during the 2006 WGACEGG.

Given the absence of anchovy DEPM-based studies in the area, the WG recognises the progress that is being made in this research field. The WG also considers the 2005 survey as a very positive development and encourages to go forward in this direction.

11.4 Biological Data

11.4.1 Catch Numbers at Age

Catch-at-age data from the whole Division IXa in 2005 are only available from the Spanish Gulf of Cadiz fishery (Sub-division IXa South). Data from the Spanish fishery in Sub-division IXa North are not available since commercial landings were negligible.

The age composition of the Gulf of Cadiz anchovy landings from 1988 to 2005 is presented in **Table 11.4.1.1** and **Figure 11.4.1.1**. 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 (excepting 1997, 1999, and the 2001-2003 period, with contributions oscillating between 2% and 7%). Likewise, age-3 anchovies only occurred in the first quarter in 1992 but their importance in the total annual catch that year was insignificant.

The relative importance of 0- and 1-age groups in the fishery has experienced some changes through the series and it shows relatively opposite trends. Thus, 1 year-old anchovies constituted almost the whole of anchovy landed in the period 1988-1994 (with percentages higher than 80%). Between 1995 and 1997 the contribution of this age group decreased down to between 25% (1996) and 50% (1995), whereas since 1998 onwards the relative importance of 1 year-old anchovies was increased again, although up to percentages between 60-75% till 2001, and higher than 80% thereafter. The contribution of the 0-age group was relatively low in the 1988-1994 catches, although it was considerably increased in the 1995-1997 period (percentages between 50 and 75%). Since then, this age group firstly showed a decreased but relatively stable annual contribution during the 1998-2001 period (22-37%), then, in 2002 and 2003, it evidenced a considerable lesser importance in the fishery (9% in 2002 and 15% in 2003), which was slightly increased in 2004 (21%), but decreased again in 2005 (7%).

Total catch in the Gulf of Cadiz in 2005 was estimated at 524 million fish, which represents a 3% overall increase compared to the previous year (507 millions), but it is still at a lower level than the recent maxima recorded in 2001 (723 millions) and 2002 (800 millions). The aforementioned slight increase was mainly caused by the 21% and 35% increases observed in landings of 1 and 2 olds respectively in relation to those estimated in the previous year, but negatively compensated by the 36% decrease of the 0-age group fish.

Landings of the 0 age-group anchovies are restricted to the second half of the year (mainly during the fourth quarter), whereas 1 and 2 year-old catches are present throughout the year . However, in 2005, catches of 0 year olds in the fourth quarter were drastically reduced and those of 2 year fish completely absent (**Table 11.4.1.1**).

11.4.2 Mean Length- and Mean Weight at Age

Length Distributions by Fleet

Annual length composition of anchovy landings in Division IXa are routinely provided by Spain for the Sub-division IXa South, this series dating back to 1988. Length distributions for the Spanish fishery in Sub-division IXa North are only available for the 1995-1999 period. Portugal has not provided length distributions of landings in Division IXa.

Gulf of Cadiz anchovy quarterly length distributions in 2005 are shown in **Table 11.4.2.1** and **Figure 11.4.2.1**. **Table 11.4.2.2** shows annual length distributions since 1988. **Figure 11.4.2.2** compares annual length distributions in Sub-divisions IXa South and IXa North since 1995. Note that, with the exception of 1998, the fish caught in the North are larger than 12.5 cm.

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, a situation that was repeated in 2005 (**Table 11.4.2.1**, **Figure 11.4.2.1**).

Mean length and weight in the annual catch (10.6 cm and 7.9 g) are the lowest recorded in the last five years (**Table 11.4.2.2**, **Figures 11.4.2.1** and **11.4.2.2**).

Mean Length- and Mean Weight at Age in Landings

Mean length- and mean weight-at-age data are only available for Gulf of Cadiz anchovy catches (**Tables 11.4.2.3** and **11.4.2.4**). 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 (Anon., 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.

Seasonally, 0 age-group anchovies off the Gulf of Cadiz are larger (and usually also heavier) in the fourth quarter. However, in 2004 and 2005 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.

11.4.3 Maturity at Age

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

Annual maturity ogives for Gulf of Cadiz anchovy are shown in **Table 11.4.3**. 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.

11.4.4 Natural Mortality

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, see **Section 11.6**).

11.5 Effort and Catch per Unit Effort

Data availability and standardisation

The annual series of both nominal fishing effort (number of fishing trips) and CPUE indices of anchovy in Division IXa are available for the Gulf of Cadiz 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 on sardine (see **Section 11.2** and **Table 11.2.2.1**).

Regarding the Gulf of Cadiz anchovy fishery, data on annual values of effort (fishing trips targeting on anchovy) and CPUE by fleet type have routinely been provided to this WG. A total of 8 fleets were initially differentiated according to their respective home-ports (Barbate, Sanlúcar, Punta Umbría and Isla Cristina) and degree of dedication to the purse-seine fishing (single- and multi-purpose fleets). Such data were however provided without a proper standardisation that considered the relative fishing power of the above fleets preventing from the appreciation of overall trends in effort and CPUE.

The lack of a consistent series of a biomass index to tune the anchovy exploratory assessments (no DEPM-based SSB estimates, gaps in the series of acoustic estimates) led in the last years to tentatively adopt the CPUE index as the only available alternative. Standardised effort and CPUE data were presented for the first time to this WG in 2003, but only considering the Barbate single-purpose fleet. This choice was based on the representativity and importance of this fleet in the Gulf of Cadiz anchovy purse-seine fishery. Alternatively, the series of nominal effort and CPUE from all of the fleets exploiting the fishery were also standardised and provided to the WG 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 (métiers). A comparative analysis of the former (one fleet) and new (all fleets) standardised CPUE series was presented in the last year WG report. Results from this comparative analysis showed the overall CPUE series as the more recommendable one for its tentative use as a fishery-based tuning index since it offers a complete and weighted view of the fishing capacity of the whole fleet. Following this suggestion, the overall CPUE standardised series will be the only one tested this year during the exploratory assessment in order to evaluate its effects in the model outputs.

The standardisation procedure was performed by fitting quarterly log-transformed CPUE's from fleet types composing the fishery to a GLM (without interaction) with the form (Robson, 1966; Gavaris, 1980):

$$LnCPUE_{(ft_i,\, quarter_i)} = \mathrm{int}\, ercept + quarter + fleettype$$

Reference fleet (métier or fleet type) and period used in the standardisation were the Barbate's single-purpose high-tonnage fleet and the first quarter in 1988 respectively. The updated series (1988-2005) of nominal effort and CPUE from all of the fleets exploiting the fishery have been standardised and provided to the WG this year. Parameter estimates resulting from the generalised linear modelling used for CPUE standardisation are shown in **Table 11.5.1**. Goodness of fit of this model as assessed by ANOVA and model graphical diagnosis (residuals plots and profile plots of estimated marginal means of the dependent variable) are shown in **Table 11.5.2** and **Figure 11.5.1**. The model as implemented shows a relatively acceptable fit to observed data, explaining 60% of the total variance (adjusted R^2= 0.60). Predicted versus observed data and residuals plots corroborate the appropiateness of the chosen model. Profile plots of marginal means run parallel indicating that interaction between factors may not be relevant. Notwithstanding, the WG recommends that the effects of a possible year effect (*i.e.*, interaction) be also considered in the model implementation and the results of this exploratory analysis be presented to the next year WG.

Annual and half-year standardised CPUE series for the whole fleet were computed from the quotient between the sum of raw quarterly catches and that of standardised quarterly efforts within the respective time period. The resulting estimates are shown in **Tables 11.5.3** and **11.5.4**.

Recent trends in effort and CPUE: overall estimates and by fleet type

Standardised series of overall annual effort and CPUE and the historical series of landings are shown together in **Figure 11.5.2**. Landings associated to the sampled fishing effort are also included in the figure in order to appreciate the sampling coverage of the fishing effort. An almost complete coverage of the whole fleet is evidenced since 1999 on, whereas some gaps in the information on effort occur in preceding years, mainly in the 1988-1993 period. Therefore any interpretation about trends during the above period it should be taken with caution.

The description of the recent dynamics of the Spanish fleets in the Gulf of Cadiz has been summarised in previous WG reports, although based on not-standardised values. Nevertheless, the standardisation provides a similar perception that the one described previously. Thus, the fleets' behaviour in 2000 and 2001 was mainly driven by a drastic reduction of the fishing effort exerted by the heavy-tonnage vessels belonging to the Barbate's single-purpose purse-seine fleet. This fleet segment (the main responsible for anchovy exploitation in both the Moroccan and Gulf of Cadiz fishing grounds in previous years) accepted a subsidised tie-up scheme in those years because the EU-Morocco Fishery Agreement was not renewed. The void left by these vessels in the fishing grounds was rapidly seized by fleets with a lighter tonnage and lower fishing capacity, that experienced remarkable increases in their exerted fishing efforts (**Figure 11.5.3**). Since 2002 onwards Barbate's heavy-tonnage purse-seiners are fishing again in the Gulf of Cadiz gradually increasing their effort levels. This last trend is accompanied by a progressive decrease in the effort by smaller vessels. Overall, such shifts in the fleet dynamics does not seem to affect to the total fishing effort since the annual values are maintained at quite high levels since 1997. In 2005, however, the possible combination of a fishing closure in the fourth quarter and the reduction of the number of active vessels fishing anchovy (from 127-129 vessels in 2003-2004 to only 99 vessels in 2005) led a marked decrease in fishing effort. Such a decreasing trend seems to have affected to all the fleet segments.

As for the CPUE is concerned, the high yields estimated in 2001 and 2002 showed a remarkable decrease in 2003 and 2004, and a new increase in 2005, a general trend that it is also observed in each of the fleet types but the multipurpose one, which still mantains the aforementioned decreased trend observed in recent years.

The Gulf of Cadiz purse-seine fishery closure in autumn 2004-2005: analysis of changes in standardised effort and CPUE before and after the closed seasons

Figure 11.5.4 shows the quarterly purse-seine landings and quarterly estimates of standardised effort and CPUE for the 2002-2005 period. The fishery closure during the last 45 days in 2004 caused a 35% decrease in the standardised overall effort exerted during the fourth quarter in that year (683 fishing trips) in comparison to the estimated for the same quarter in 2002 (1,056 trips) and 2003 (1,047 trips). Such a decrease also affected to the contribution of this quarter (9.9%) to the total fishing effort in 2004 (6,919 fishing trips). In 2002 (total annual effort of 7,970 trips) and 2003 (6,830 trips) the relative importance of their respective fourth quarter in terms of fishing activity was 13.3% and 15.3%. However, as it is shown by the annual values during these years, the overall decrease in fishing effort in 2004 was almost negligible in relation to the effort levels recorded the previous year.

As compared to the effects of the 2004 fishing closure, in 2005, the effort exerted in the fourth quarter (251 fishing trips) experienced a stronger decrease (76%) in relation to the effort exerted in the same quarters in years not affected by closed seasons (2002 and 2003). The contribution of this quarter to the total annual effort in 2005 (4,739 fishing trips) was only 5%. Unlike 2004, annual effort was noticeably affected by such a disminution of the effort levels in the fourth quarter, although other additional causes than the fishing closure (*e.g.*, reduction in the number of active vessels and, possibly the decrease of effective fishing days because of bad weather as well) should also be taken into consideration to explain this trend.

As noted in **Subsection 11.2.2** (see also **Figure 11.2.2.1**), the effects of the 2004 closure in landings were not so evident at a seasonal scale, since the relative importance of autumn landings in 2004 was even greater (12%) than in preceding years (10% in 2002, 9% in 2003). In absolute terms the fourth quarter catches in 2004 (633 t) were either at the same level than its counterpart in 2002 (780 t) or even higher than in 2003 (412 t). As a consequence, the autumn CPUE in 2004 (0.916 t/fishing day) was higher than in preceding years in spite of the closure (0.747 t/fishing day in 2002, 0.395 t/fishing day in 2003). However, this was not the case in 2005, when landings in the fourth quarter were the lowest ones in the recent analysed series both in absolute (77 t) and relative terms (2%). The low effort levels together with even more disminished catches in the fourth quarter resulted in a relatively low autumn CPUE (0.307 t/fishing day) in 2005.

11.6 Recruitment Forecasting

Recruitment forecasts of anchovy in Division IXa are not available. By analogy with the anchovy stock in Sub-area VIII, recruitment may be driven by environmental factors and may be highly variable as a result.

As described in **Section 11.3**, anchovy population estimates in the Sub-division 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 November (as age-0 recruits in the year) or March surveys (as age-1 fish in the next year) may be derived after the application of Spanish age-length keys. However, such keys are based on commercial samples from purse-seine catches and therefore they may result in a biased picture of the population structure because of a different catchability. Since 2005 otolith collections from these surveys are being provided by IPIMAR to IEO in order to derive their corresponding age-length keys. Age reading is in progress and is expected that disaggregated acoustic estimates be provided to this WG in a mid term. 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 in shallow waters), the series of point estimates is at present scattered and scarce.

No progress has been carried out in relation to the updating of the anchovy pre-recruitment index series presented to this WG three years ago (see Ramos *et al*., 2003). This index, although highly provisional, summarised the incorporation of pre-recruits into the Guadalquivir River estuary, one of the main anchovy nursery areas in the Division. At present, previous and new raw data needed for the computation of the annual estimates (since 1997) are being explored in detail and the method of estimation is under revision. The WG encourages the continuation of their provision in next years.

So far, no information is available to this WG about the influence of the environment on the anchovy recruitment in Division IXa and particularly in the Gulf of Cadiz area. Environmental indices, such as those described in **Section 10.6** for Anchovy in VIII c, have not been yet provided for the Sub-division IXa South, but it is expected that in medium-term they may be available to this WG allowing thus to understand their possible relationships with the anchovy recruitment in the area.

11.7 Data Exploration

Data availability and some fishery (recent catch trajectories) and biological evidence have justified in previous years a separate data exploration of anchovy in Sub-division IXa South (Algarve and Gulf of Cadiz) (Ramos *et al*., 2001; Anon., 2002).

11.7.1 Data exploration with the ad hoc separable model

An *ad hoc* seasonal separable model implemented and run on a spreadsheet has been used in the last years for data exploration of anchovy catch-at-age data in IXa South since 1995 onwards. Data in this model are analysed by half-year-periods, those from the Algarvian anchovy being previously compiled by applying Gulf of Cadiz ALKs (**Table 11.7.1**; **Figure 11.7.1**). Weights at age in the catches are estimated as usual, whereas weights at age in the stock correspond to yearly estimates calculated as the weighted mean weights-at-age in the catches for the second and third quarters.

The separable model has been fitted this year to the updated half-year catch-at-age data till 2005 and to two aggregated-biomass indices: an annual standardised CPUE series from the whole Spanish purse-seine fleet covering the same period, and the available acoustic estimates of anchovy biomass from Portuguese surveys since 1998 (**Table 11.7.1**; **Figure 11.7.2**). Catches at age are assumed to be linked by the usual 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. Parameters estimated are selectivity at age for both half-year-periods in relation to the reference age (age 1), recruitment, survey catchability (Q1) and CPUE catchability (Q2) 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, the CPUE and the acoustics biomass data. F values for 1995 are computed as an average of the Fs in subsequent years.

The absence of acoustic estimates in the second half-year (from the November SAR surveys) since 2002 onwards (**Figure 11.7.2**) resulted in the exploratory runs performed last years in noisy signals for the recruitment and population biomass in these years since the model was only tuned in such periods by the CPUE index or directly driven by catches. In order to obtain a somewhat more stable model performance, the WG members considered the last year as the most suitable option that of setting the F value for the second half-year in the last year in the assessment. In a first approach, this value was computed as the product between the F in the first half-year in that year and the average ratio of half-year F's in the preceding years.

Since the suitability of using a purse-seine CPUE as a biomass tuning index has been previously questioned by the WG members, three different runs have initially been performed this year:

- **RUN 0**: full assessment with the last year's settings and new input data for 2005. Overall CPUE and acoustic biomass tuning indices (both as relative ones). F in the 2nd half-year in 2005 estimated as a ratio of the F estimated in the 1st half using the average ratio of seasonal Fs in previous years. **RUN 1**: alternative run with the overall CPUE series as the only tunning (relative) index.
- **RUN 2**: alternative run with Acoustic estimates of biomass as the only tuning (relative) index.

Further, the alternative approach followed last year aiming to improve the stability in the model performance in the last years (without direct estimates) by including the additional information provided by the acoustic estimate available one year ahead of the assessment's last year, was also followed this year. In this case was considered the inclusion of the April 2006 acoustic estimate. No information is available on the fishery for the first half year in 2006 (when the above survey was performed). Thus, under this second approach, catches at age for the first half in 2006 were assumed to be the same ones that in 2005. Moreover, weights at age in the stock for 2006 were set as the average of the estimates in the 3 last years in the assessment (2003-2005). Finally, F in the first half year in 2006 was also set as the average of its Fs counterparts for the same period of years. Log-residuals of both catch at age and CPUE index in 2006 were excluded from the minimisation routine whereas the residuals from the 2006 biomass acoustic estimate were included in the model fitting. According to these settings, two additional runs were performed:

- **RUN 3**: as RUN 0 but including the new settings.
- **RUN 4**: as RUN 2 with new settings.

Finally, a third alternative approach was also considered in order to improve the model stability by setting the F value in the second-half year in the last year in the assessment (2005) as the product between the F in the first half-year in that year and the ratio of half-year F's in the preceding year (2004). The occurrence of a fishing closure in both 2004 and 2005 was the main criterion to select the 2004 ratio of semestral F for shrinking the F value in the second semester of the assessment's last year . Under this last approach the following additional runs were performed:

- **RUN 5**: as RUN 0 but changing the former assumptions of the F in the 2nd half-year in 2005 by the new ones. **RUN 6**: as RUN 1 with new settings on F in the 2nd half-year in 2005.
- **RUN 7**: as RUN 2 with new settings on F in the 2nd half-year in 2005.
- **RUN 8**: as RUN 3 with new settings on F in the 2nd half-year in 2005.
- **RUN 9**: as RUN 4 with new settings on F in the 2nd half-year in 2005.

Figure 11.7.3 show the trends exhibited by the main model outputs from all the runs, including the last year's accepted run, excepting those ones considering "extra year" information on acoustic estimates (RUN 3 and RUN 4). **Figure 11.7.4** compares the trends of the main model outputs for all the performed runs with updated data.

Without any additional information on the population levels one year ahead of the assessment, using tuning indices as relative ones drops down in the assessment's last year the absolute leves of recruitment and population biomass, increasing the fishing mortality. This effect is much more marked when only surveys are considered as the only tuning index. At this point it must be reminded the gaps of information existing in the Portuguese acoustic surveys series, mainly in the second semester in the year (their November surveys), and the greater length and consistency of the CPUE series, which, furthermore, excepting in 2005, follows to the trajectory of catches. As stated previously for the Biscay anchovy (see **Section 10.7**), such decreases in these model outputs are explained by the fact that the absolute level of the population is relying heavily on the level of catches at age. In this context, the assessment is reduced to a virtual population estimate, scaled to the level of catches, just tuned to relative trend series (either from surveys, or from CPUE series, or from both). For a short living species as anchovy no convergence properties exist for a VPA estimate and scaling the population levels just to the VPA catch levels is inadequate.

Runs including extra information one year ahead of the assessment's last year on population levels yielded an opposite trend to the one described above, with decreased levels of fishing mortality in the last semester of the assessment (which coincides with the observed in the fishery), and increases in the absolute levels of recruitment and average population biomass. These last two model outputs showed even higher increases when the model includes both tuning indices. Last year, the inclusion of this extra information was only considered for the purposes of the exploration of the model performance, and finally this approach was considered as a not very formal one since included artficial information on catch at age structure for the first half-year in the year ahead of the assessment's last year. This same considerations has also been posed in this WG. Nonetheless, in **Figure 11.7.5** are represented the size composition and age structure (after applying Spanish age-length keys) of the estimated abundance in the April 2005 and 2006 Portuguese surveys. Dissagregated age estimates in the April 2005 survey indicate not only a recovery of the population in relation to the previous year, but also the possibility of a relatively good recruitment in 2005 from the abundance of age 1 fish in the population the next year.

Notwithstanding the above, and aiming to follow a consistent line with previous exploratory assessments the WG considered more convenient to accept as final run the RUN 5 as the best compromise, since that this run includes the information actually comparable for both tuning indices and the assumptions on F in the assessment's last year seem to be more adequate to explain what has happened in the fishery in the past two years (fishery closures). Table **11.7.2** and Figure **11.7.6** show a summary of the outputs from this run.

As stated in previous WG reports catches in the year 2000 were low as only a small fraction of the Barbate purse-seine fleet operated in that year (**Figure 11.7.1**). Because of the few vessels contributing to the CPUE estimate in that year the use of this index as an descriptor of the resource abundance may contain additional uncertainty (even using the overall CPUE series), and fitting the model to both the CPUE and the acoustic survey time-series seemed sensible. In fact, the model does not fit the catch at age and the CPUE data reasonably well regardless of the run considered (**Figure 11.7.6**).

The acoustic estimates of biomass, the average biomass and the biomass at the time of the acoustic survey as estimated by the model show that the fit to the acoustic data was poor (**Figure 11.7.6**). This is likely to be related to the fact that the two biomass indices show conflicting trends. Thus, acoustic estimates show, excepting April 2005 (14 thousand tonnes), a relative stable trend in population biomass (between 25 and 30 thousand tonnes), whereas the fishery-based index evidences somewhat higher fluctuations. However, as previously cited, the CPUE time-series has more data points than the acoustic one so, the former will be more powerful in any regression. Furthermore, the point estimate of the acoustic survey catchability coefficient (Q1 between 4 and 5 according to the run considered; 4.5 for RUN 5 **Table 11.7.2**) seemed high, which resulted in an acoustic estimate of biomass much higher than the one estimated by the assessment model.

Residuals from the model fit to the catch at age data are plotted in **Figure 11.7.6**, suggesting that they broadly conform to assumptions of normality.

According to the model, fishing mortality seemed to have been increasing until 1999 and then gone down in 2000, increasing again in recent years excepting in 2005 when a new decrease is observed (**Figure 11.7.6**). Given the catch data and the level of natural mortality adopted, the estimated selectivity for age 2 ($S_{2,1st\ S}$ = 1.3 and $S_{2,2nd\ S}$ = 1.5) is in agreement with the perception of the impact of the fishery on the stock.

Figure 11.7.7 compares the main model outputs obtained in the last year's WG with the ones estimated this year.

11.7.2 Quality and reliability of the assessment

The suitability of the seasonal model itself and the biomass tuning indices used in the assessment has been discussed in previous WG and the same statements has been drawn this year. Thus, the model, as currently implemented, assesses the population biomass mainly according to catch levels. However, it must also be stated that the approach herein presented is the one that is possible to be carried out for the time being with the available data. It was also noticed that there is no reliable information about the true levels of both the stock, F and Catch/SSB ratios. So, the stock trajectory resulting from these exploratory runs is therefore a picture of a relative trend and therefore the assessment must be properly scaled.

For the above reasons, the Working Group has stressed in last years the necessity of the inclusion in the model of an absolute scaling factor of the biomass population. In this context, the Working Group recognises the progresses that are starting to be carried out in the direct surveying of the anchovy in Sub-division IXa South with the realisation of an Spanish Egg (DEPM) survey in 2005 and encourages the provision of the resulting SSB estimate to the next WG.

Although the assessment presented here is only considered for the purpose of data exploration, the results suggest that the capacity in the fishery prior to 2000 and since this year onwards may result in relatively high fishing mortality even if the stock is at an average biomass level as, for example, in 1997-1999 (**Figure 11.7.5**). Moreover, by analogy with the anchovy stock in Sub-area VIII, this stock may fluctuate widely due to variations in recruitment largely driven by environmental factors.

11.8 Reference Points for Management Purposes

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

11.9 Harvest Control Rules

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

11.10 Management Considerations

In Portugal a closure of the purse-seine fishery took place during 2003 and 2004 in the northern part (north of the 39º 42” North) of the Portuguese coast from the 1st of February to 31 of March.

The regulatory measures in place for the Spanish anchovy purse-seine fishing in the Division were the same as for the previous years and are summarised 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 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 (Sub-division IXa South) the Spanish purse-seine fleet was performing a voluntary closure of three months (December to February) until 1997. In 2004 two complementary sets of management measures affecting directly to the fishery have been implemented. The first one was the new “*Plan, to be implemented urgently, for the conservation and sustainable management of the purse-seine fishery in the Gulf of Cadiz National Fishing Ground*”. This plan was in force during 12 months since October the 30th and included a fishery closure of 45 days between 17th of November to the 31st of December which was accompanied by a subsidized tie-up scheme for the purse-seine fleet. 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 (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). This plan has also been implemented in 2005 with the same dates as in 2004 for the fishery closure.

As described in **Section 11.5** the fishery closure in autumn 2004 did not cause a serious impact in the fishery in terms of overall annual effort (6919 fishing days), at least when this level is compared with the one recorded the previous year (6830 fishing days). The same was also observed in landings. The only remarkable effect of such a closure was the decreased contribution of the effort exerted in autumn 2004 as compared to the exerted in the same season in previous years (a 35% decrease). Therefore, such a measure seems to have halted the possibility of recording annual effort levels close to the historical maxima in 1998, 2001 and 2002. Conversely, in 2005, both fishing effort and landings in fourth quarter experienced remarkable decreases both in absolute and relative terms in relation not only to their counterparts in previous years (including 2004), but also in relation to the total annual values. So, the fishing effort exerted in the 2005 fourth quarter (251 fishing days) represented only 5% of the total annual effort (4,739 fishing days). In this case, although the fishing closure in the last 45 days in the year may be one of the main responsibles for such decreased trend other additional causes occurring short before the closure (*e.g.*, reduction in the number of active vessels and, possibly the decrease of effective fishing days because of bad weather as well) should also be taken into consideration.

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

Given that the catch are comprised almost entirely of a single age group (age 1), in order to advise on sustainable harvest levels 2 years ahead of the most recent catch data an estimate of incoming recruitment is required. Currently the March survey tracks the population best, if this were to be used as an estimate of 1 age group strength, a within year setting of the harvest level would be required.

11.11 Recommendations for intersessional work

The WG recommends that a more detailed retrospective and updated information on the number of vessels by fleet type targeting anchovy in the whole Division be compiled as far as possible not only for the Spanish fleet but also for thePortuguese one.

The WG recommends that the implementation of the GLM used for the standardisation of the Spanish purse-seine fleets' CPUE be intersessionally explored in depth and the results of this exploratory analysis be presented to the next year WG.

The Working Group appreciates the progress in the direct surveying of anchovy in Division IXa by Acoustics and DEPM, mainly with the new Spanish late spring surveys in the Subdivision IXa South in 2005 and 2006, and recommends its continuation within a routine either annual (Acoustics) or triennial (DEPM) survey series. The Working Group recommends that the acoustic surveying of the Division IXa by Spain and Portugal achieves proper standardisation, including the complementary use of different working frequencies in next surveys for a better echo-traces discrimination. Regarding the DEPM survey in 2005 the WG recommends that a priority should be given to the histological analysis of adult samples in order to provide the corresponding anchovy SSB estimate to the next year WG.

The Working Group recommends to continue with the provision of all the information available on anchovy (including information on age structure by Sub-division if available) from the Portuguese acoustic surveys conducted in Division IXa. Regarding these surveys and although they are are not directly aimed at the estimation of anchovy abundance, the WG considers them as a very valuable source of information for this species and encourages their continuation both in their conduction (as routinely planned) and the provision of seasonal (late winter-early spring and autumn) estimates.

The Working Group recommends that previous and new age determinations of the Gulf of Cadiz anchovy according to the recommendations proposed in the 2002 Workshop on Anchovy otoliths and endorsed by this Working Group be provided to the next year meeting if possible.

The Working Group recommends to recover all the information available on the anchovy fishery and biology (including information on age structure by Sub-division if available) off Portuguese waters.

Table 11.2.1.1. Anchovy in Division IXa. Portuguese and Spanish annual landings (tonnes), (from Pestana, 1989 and 1996, and WG 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

(-) Not available

(0) Less than 1 tonne

Table 11.2.1.2. Anchovy in Division IXa. Catches (tonnes) by gear and country in 1988-2005 (corrected data for Portuguese landings in 2004).

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

* Portuguese catches not differentiated by gear

Table 11.2.2.1. Anchovy in Division IXa. Quarterly anchovy catches (tonnes) by country and Sub-division in 2004 (corrected data for Portuguese landings) and 2005.

COUNTRY	SUBDIVISIONS	QUARTER 1 C(t)	QUARTER 1 %	QUARTER 2 C(t)	QUARTER 2 %	QUARTER 3 C(t)	QUARTER 3 %	QUARTER 4 C(t)	QUARTER 4 %	ANUAL (2004) C (t)	ANUAL (2004) %
SPAIN	IXa North	0.5	14.0	1	32.6	1	29.8	1	23.6	4	0.1
	IXa South	1382	26.7	1975	38.1	1192	23.0	634	12.2	5183	99.9
	TOTAL	1382	26.6	1976	38.1	1193	23.0	635	12.2	5187	100.0
PORTUGAL	IXa Central North	22	26.1	45	54.3	11	13.3	5	6.4	83	12.7
	IXa Central South	34	24.1	17	12.4	0.3	0.2	88	63.4	139	21.2
	IXa South	3	0.6	1	0.3	362	83.3	69	15.8	434	66.1
	TOTAL	58	8.8	64	9.7	373	56.8	162	24.7	657	100.0
TOTAL	IXa North	0.5	14.0	1	32.6	1	29.8	1	23.6	4	0.1
	IXa Central North	22	26.1	45	54.3	11	13.3	5	6.4	83	1.4
	IXa Central South	34	24.1	17	12.4	0.3	0.2	88	63.4	139	2.4
	IXa South	1384	24.6	1976	35.2	1553	27.7	703	12.5	5617	96.1
	TOTAL	1440	24.6	2040	34.9	1566	26.8	798	13.6	5844	100.0

COUNTRY	SUBDIVISIONS	QUARTER 1 C(t)	QUARTER 1 %	QUARTER 2 C(t)	QUARTER 2 %	QUARTER 3 C(t)	QUARTER 3 %	QUARTER 4 C(t)	QUARTER 4 %	ANUAL (2005) C (t)	ANUAL (2005) %
SPAIN	IXa North	1	28.5	0.3	7.0	0.3	5.8	3	58.7	4	0.1
	IXa South	1361	31.0	2241	51.1	705	16.1	77	1.8	4385	99.9
	TOTAL	1362	31.0	2242	51.1	706	16.1	80	1.8	4389	100.0
PORTUGAL	IXa Central North	21	25.1	39	47.4	10	12.0	13	15.6	82	65.0
	IXa Central South	4	59.7	2	28.1	0.0	0.2	1	12.0	6	4.9
	IXa South	22	58.1	11	29.3	0	0.0	5	12.5	38	30.0
	TOTAL	46	36.7	52	41.0	10	7.8	18	14.5	126	100.0
TOTAL	IXa North	1.2	28.5	0	7.0	0	5.8	3	58.7	4	0.1
	IXa Central North	21	25.1	39	47.4	10	12.0	13	15.6	82	1.8
	IXa Central South	4	59.7	2	28.1	0.0	0.2	1	12.0	6	0.1
	IXa South	1383	31.3	2252	50.9	705	16.0	82	1.8	4423	98.0
	TOTAL	1408	31.2	2293	50.8	716	15.8	98	2.2	4515	100.0

Table 11.2.4.1. Anchovy in Division IXa. Spanish purse-seine fleet composition targeting Gulf of Cadiz anchovy in 2004 and 2005. 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 purse-seiners). Length criteria refers to length between perpendiculars. Storage: catches are dry hold with ice (fishing trip equals to fishing day). No discard estimates.

2004	Engine (HP)				
Length (m)	0-50	51-100	101-200	201-500	Total
<10	11	8	20	0	39
11-15	3	14	38	12	67
16-20	0	0	3	18	21
>20	0	0	0	2	2
Total	14	22	61	32	129

2005	Engine (HP)				
Length (m)	0-50	51-100	101-200	201-500	Total
<10	6	5	14	0	25
11-15	2	12	22	15	51
16-20	0	0	3	18	21
>20	0	0	0	2	2
Total	8	17	39	35	99

Table 11.3.1.1. Anchovy in Division IXa. Estimated abundance (millions) and biomass (tonnes) in Division IXa from Portuguese acoustic surveys by area and total.

		Portugal				Spain	TOTAL
Survey	Estimate	Central-North	Central-South	South (Algarve)	Total	South (Cadiz)	
November 1998	Number	30	122	50	203	2346	2549
	Biomass	313	1951	603	2867	30092	32959
March 1999	Number	22	15	*	37	2079	2116
	Biomass	190	406	*	596	24763	25359
November 2000	Number	4	20	*	23	4970	4994
	Biomass	98	241	*	339	33909	34248
March 2001	Number	25	13	285	324	2415	2738
	Biomass	281	87	2561	2929	22352	25281
November 2001	Number	35	94	-	129	3322	3451
	Biomass	1028	2276	-	3304	25578	28882
March 2002	Number	22	156	92	270	3731 **	4001 **
	Biomass	472	1070	1706	3248	19629 **	22877 **
February 2003	Number	0	14	*	14	2314	2328
	Biomass	0	112	*	112	24565	24677
April 2005	Number	0	59	0	59	1306	1364
	Biomass	0	1062	0	1062	14041	15103
April 2006	Number	-	-	319	319	1928	2246
	Biomass	-	-	4490	4490	19592	24082

* Due to the distribution observed during the survey, the last transect (near the border with Spain) that normally belongs to sub-area Algarve was included in Cadiz.

** Corrected estimates after detection of errors in the S_A values attributed to the Cadiz area (Marques & Morais, WD 2003)

Table 11.3.1.2. Anchovy in Division IXa. Estimated abundance (millions) and biomass (tonnes) in Sub-division IXa South from Spanish acoustic surveys by area and total.

					Observations		
Survey	Estimate	Portugal	Spain	TOTAL	R/V	Sampling grid	Sampled depth range
June 1993	Number	-	462	-	Cornide	Zig-zag	20-500 m
	Biomass	-	6569	-			
February 2002 **	Number	-	18202	-	Cornide	Parallel	20-200 m
	Biomass	-	212935	-			
June 2004 *	Number	91	804	894	Cornide	Parallel	30-200 m
	Biomass	1793	11376	13168			
June 2006	Number	103	2384	2487	Cornide	Parallel	20-200 m
	Biomass	1844	25924	27769			

* Preliminary estimates. Probably underestimated because of problems of sampling coverage.
** Estimates under revision.

Table 11.3.1.3. Anchovy in Division IXa. Age structure of the anchovy estimated abundance (millions) and biomass (tonnes) in Sub-division IXa South from June 2006 Spanish acoustic survey by area and total.

Age class	ALGARVE	CÁDIZ	TOTAL
	Number	Number	Number
0	0	0	0
I	93597	2359828	2453424
II	9562	24235	33797
III	91	0	91
TOTAL	103250	2384062	2487313

Age class	ALGARVE	CÁDIZ	TOTAL
	Weight	Weight	Weight
0	0	0	0
I	1609	25400	27010
II	231	524	755
III	4	0	4
TOTAL	1844	25924	27769

Table 11.4.1.1. Anchovy in Division IXa. Spanish catch in numbers ('000) at age of Gulf of Cadiz anchovy (Sub-division IXa-South, 1988-2005) on a quarterly(Q), half-year (HY) and annual basis. Data for 1994 and second half in 1995 estimated from an iterated ALK by applying the Kimura and Chikuni's (1987) algorithm .

1988	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	13204	55286	0	68490	68490
	1	89197	188073	87183	18794	277269	105976	383245
	2	0	0	1928	0	0	1928	1928
	3	0	0	0	0	0	0	0
	Total (n)	89197	188073	102315	74080	277269	176394	453663
	Catch (t)	730	1815	1164	553	2545	1718	4263
	SOP	728	1810	1164	552	2537	1716	4253
	VAR.%	100	100	100	100	100	100	100
1989	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0	0	0	2652	7981	0	10633	10633
	1	199286	302223	69570	3471	501509	73042	574551
	2	0	0	5747	0	0	5747	5747
	3	0	0	0	0	0	0	0
	Total (n)	199286	302223	77969	11452	501509	89421	590930
	Catch (t)	1314	2579	1327	110	3892	1437	5330
	SOP	1311	2563	1322	110	3874	1432	5306
	VAR.%	100	101	100	100	100	100	100
1990	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0	0	0	18313	316191	0	334504	334504
	1	341850	206863	99526	5373	548713	104900	653612
	2	185	0	929	0	185	929	1114
	3	0	0	0	0	0	0	0
	Total (n)	342035	206863	118768	321565	548897	440333	989230
	Catch (t)	2273	1544	1169	740	3816	1909	5726
	SOP	2271	1543	1166	739	3814	1905	5719
	VAR.%	100	100	100	100	100	100	100
1991	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0	0	0	11537	45411	0	56948	56948
	1	351314	334722	36156	1189	686036	37345	723381
	2	0	4053	1591	376	4053	1968	6021
	3	0	0	0	0	0	0	0
	Total (n)	351314	338775	49284	46977	690089	96261	786350
	Catch (t)	1049	3673	701	273	4722	975	5697
	SOP	1035	3638	696	271	4672	968	5640
	VAR.%	101	101	101	101	101	101	101
1992	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0	0	0	2415	0	0	2415	2415
	1	159677	147523	42707	86	307200	42793	349993
	2	182	0	861	41	182	902	1084
	3	63	0	0	0	63	0	63
	Total (n)	159922	147523	45983	127	307445	46110	353555
	Catch (t)	1125	1367	499	4	2492	503	2995
	SOP	1120	1364	498	4	2484	502	2986
	VAR.%	100	100	100	100	100	100	100
1993	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0	0	0	13797	23517	0	37314	37314
	1	73104	81486	12120	2025	154590	14145	168735
	2	576	649	0	12	1225	12	1237
	3	0	0	0	0	0	0	0
	Total (n)	73680	82135	25917	25555	155815	51472	207287
	Catch (t)	767	921	167	105	1688	272	1960
	SOP	761	914	166	105	1675	271	1946
	VAR.%	101	101	100	100	101	100	101

1994	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	1794	960	0	2755	2755
	1	130013	217610	5150	3512	347622	8662	356285
	2	1	31	4576	691	32	5267	5299
	3	0	0	0	0	0	0	0
	Total (n)	130014	217641	11521	5163	347655	16684	364339
	Catch (t)	690	2055	210	80	2745	290	3035
	SOP	687	2045	210	80	2732	290	3022
	VAR.%	100	100	100	101	100	100	100
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

Table 11.4.1.1. (cont.)

2000	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	41028	77780	0	118808	118808
	1	75141	65947	46460	9949	141088	56409	197497
	2	638	2670	523	14	3307	537	3844
	3	0	0	0	0	0	0	0
	Total (n)	75779	68617	88011	87743	144395	175755	320150
	Catch (t)	329	660	655	537	989	1193	2182
	SOP	327	659	666	535	986	1201	2187
	VAR.%	101	100	98	100	100	99	100
2001	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0	0	0	30987	127140	0	158126	158126
	1	98687	227388	177264	37992	326075	215256	541331
	2	4155	14028	4535	624	18183	5159	23342
	3	0	0	0	0	0	0	0
	Total (n)	102842	241416	212785	165756	344258	378541	722800
	Catch (t)	924	3031	3195	1066	3955	4261	8216
	SOP	908	3014	3145	1065	3922	4210	8132
	VAR.%	102	101	102	100	101	101	101
2002	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0	0	0	45129	29271	0	74399	74399
	1	218090	304295	149120	36565	522385	185685	708070
	2	2004	6083	8808	620	8087	9428	17515
	3	0	0	0	0	0	0	0
	Total (n)	220094	310378	203057	66456	530471	269512	799984
	Catch (t)	1700	2814	2566	789	4515	3355	7870
	SOP	1617	2778	2524	818	3937	3342	7737
	VAR.%	105	101	102	96	115	100	102
2003	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0	0	0	26034	45813	0	71847	71847
	1	96135	229184	49058	7028	325320	56087	381407
	2	10041	2587	481	0	12628	481	13109
	3	0	0	0	0	0	0	0
	Total (n)	106176	231772	75574	52841	337948	128415	466363
	Catch (t)	1025	2533	798	413	3557	1211	4768
	SOP	1031	2398	759	378	3430	1137	4567
	VAR.%	99	106	105	109	96	94	104
2004	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0			31680	74278	0	105958	105958
	1	157200	165738	69542	6383	322937	75924	398862
	2	388	1419	248	534	1808	782	2590
	3	0	0	0	0	0	0	0
	Total (n)	157588	167157	101470	81195	324745	182665	507410
	Catch (t)	1382	1975	1192	634	3357	1826	5183
	SOP	1284	1844	1194	593	3129	1788	4916
	VAR.%	108	107	100	107	107	102	105
2005	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0			24163	13743		37906	37906
	1	195482	249404	36999	371	444886	37370	482256
	2	2716	445	334	0	3161	334	3495
	3	0	0	0	0	0	0	0
	Total (n)	198198	249848	61496	14114	448046	75610	523656
	Catch (t)	1361	2241	705	77	3602	783	4385
	SOP	1302	2098	665	67	3401	732	4132
	VAR.%	105	107	106	115	106	107	106

Table 11.4.2.1. Anchovy in Division IXa. Length distribution ('000) of Anchovy in Division IXa by country and Sub-divisions in 2005.

	QUARTER 1			QUARTER 2			QUARTER 3			QUARTER 4			TOTAL		
Length (cm)	SPAIN IXa North	PORTUGAL IXa CN,CS,S	SPAIN IXa South	SPAIN IXa North	PORTUGAL IXa CN,CS,S	SPAIN IXa South	SPAIN IXa North	PORTUGAL IXa CN,CS,S	SPAIN IXa South	SPAIN IXa North	PORTUGAL IXa CN,CS,S	SPAIN IXa South	SPAIN IXa North	PORTUGAL IXa CN,CS,S	SPAIN IXa South
3.5	-	-		-	-		-	-		-	-		-	-	
4	-	-		-	-		-	-	16	-	-		-	-	16
4.5	-	-		-	-		-	-	130	-	-		-	-	130
5	-	-		-	-		-	-	146	-	-		-	-	146
5.5	-	-		-	-		-	-	81	-	-		-	-	81
6	-	-	48	-	-		-	-	374	-	-	24	-	-	445
6.5	-	-	143	-	-	127	-	-	370	-	-	94	-	-	734
7	-	-	149	-	-	94	-	-	643	-	-	227	-	-	1112
7.5	-	-	1372	-	-	323	-	-	708	-	-	639	-	-	3041
8	-	-	10203	-	-	646	-	-	3141	-	-	975	-	-	14965
8.5	-	-	30494	-	-	2227	-	-	3760	-	-	1103	-	-	37584
9	-	-	32661	-	-	3778	-	-	5624	-	-	2763	-	-	44826
9.5	-	-	20531	-	-	11553	-	-	3917	-	-	3457	-	-	39459
10	-	-	18906	-	-	39603	-	-	3599	-	-	2173	-	-	64282
10.5	-	-	20563	-	-	91058	-	-	2344	-	-	1152	-	-	115117
11	-	-	13736	-	-	44291	-	-	2179	-	-	757	-	-	60964
11.5	-	-	12080	-	-	15216	-	-	2470	-	-	354	-	-	30119
12	-	-	12997	-	-	22808	-	-	4438	-	-	250	-	-	40492
12.5	-	-	8515	-	-	5400	-	-	7098	-	-	68	-	-	21081
13	-	-	6332	-	-	4634	-	-	8516	-	-	40	-	-	19523
13.5	-	-	5513	-	-	4081	-	-	6248	-	-	28	-	-	15870
14	-	-	3127	-	-	3353	-	-	3602	-	-	0	-	-	10081
14.5	-	-	531	-	-	367	-	-	1341	-	-	4	-	-	2243
15	-	-	296	-	-	60	-	-	474	-	-	4	-	-	835
15.5	-	-		-	-	230	-	-	77	-	-		-	-	306
16	-	-		-	-		-	-	201	-	-		-	-	201
16.5	-	-		-	-		-	-		-	-		-	-	
17	-	-		-	-		-	-		-	-		-	-	
17.5	-	-		-	-		-	-		-	-		-	-	
18	-	-		-	-		-	-		-	-		-	-	
18.5	-	-		-	-		-	-		-	-		-	-	
19	-	-		-	-		-	-		-	-		-	-	
19.5	-	-		-	-		-	-		-	-		-	-	
20	-	-		-	-		-	-		-	-		-	-	
20.5	-	-		-	-		-	-		-	-		-	-	
21	-	-		-	-		-	-		-	-		-	-	
21.5	-	-		-	-		-	-		-	-		-	-	
22	-	-		-	-		-	-		-	-		-	-	
Total N	-	-	198198	-	-	249848	-	-	61496	-	-	14114	-	-	523656
Catch (T)	1	46	1361	0.3	52	2241	0.3	10	705	3	18	77	4	126	4385
L avg (cm)	-	-	10.2	-	-	10.8	-	-	11.3	-	-	9.4	-	-	10.6
W avg (g)	-	-	6.6	-	-	8.4	-	-	10.8	-	-	4.8	-	-	7.9

Table 11.4.2.2: Anchovy in Division IXa. Annual Length distributions ('000) available from 1988 to 2005.

	1988	1989	1990	1991	1992	1993	1994	1995		1996		1997		1998		1999		2000	2001	2002	2003	2004	2005
Length	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN
(cm)	IXa South	IXa South	IXa South	IXa South	IXa South	IXa South	IXa South	IXa North	IXa South	IXa North	IXa South	IXa North	IXa South	IXa North	IXa South	IXa North	IXa South	IXa South	IXa South	IXa South	IXa South	IXa South	IXa South
3.5											1349								266	77			
4			4281	172	2	49					12677						1831	114	200	275	36		16
4.5			18371	3937	29	707					67819		1333		4656		17055	856	1649	1463	116	25	130
5	65		32251	54991	90	1832					160894		11492		25825		41100	5006	5489	3871	218	54	146
5.5	86		46584	80537	369	3247					129791		38722		57086		36181	9391	9301	8742	653	213	81
6			45810	43303	983	5031					52812		53185		82442		19366	12961	11832	13779	1763	396	445
6.5		1185	44454	28102	2685	6463	6092				33640		50275		76694		20421	11446	15051	17768	3132	759	734
7	226	3906	37065	17847	4094	6169	13330				32469		62492		68074		17749	11754	15911	14238	4800	1745	1112
7.5	347	5609	34614	20448	7178	7507	20415		402		19088		42120		43197		19089	20386	10684	14800	5389	2358	3041
8	1871	15959	32562	20037	15632	8325	26136		402		8949		45120		32964		20835	19704	16989	14137	10074	3613	14965
8.5	7892	36001	43081	17916	22442	7748	24497		454		11776		36200		47796		15724	18590	19426	18211	17371	5683	37584
9	13492	31905	53016	19745	16924	7820	22586		2799		12007		20009	156	78561		14937	19435	22924	29985	23525	15726	44826
9.5	26090	36222	88097	34408	23280	8612	16520		9153		6844		13611	367	106350		17487	27397	29620	66330	33446	35970	39459
10	42791	69717	115050	40656	37450	7320	26383		10743		4887		8951	754	132106		23530	34049	35897	67732	43164	57645	64282
10.5	60760	82715	108001	59678	38310	9199	30570		13282		7156		12231	1486	150718		31482	26203	43145	60360	48805	61361	115117
11	73499	82718	86757	67113	39426	8500	31536		8408		17343		22647	2047	158806		33604	21814	50672	66572	50797	64192	60964
11.5	61624	64599	72875	63013	36883	10154	37310		7340		21738		27353	1477	133585		40004	18846	59031	65752	44753	60307	30119
12	66239	50823	50592	65983	39500	24246	29363	74	5279		17855		39131	1267	99586		55614	18734	66873	79576	43017	62435	40492
12.5	42651	42791	34023	54033	33181	33555	33560	711	4502		11544		45267	1178	76285		66384	14738	68648	61848	38544	46567	21081
13	26053	20237	19022	45191	19867	27543	17543	3049	2299	8	6450	374	46852	2737	44979		52625	11841	59942	54683	33673	43285	19523
13.5	9415	11846	12683	21333	7003	13059	9602	3381	1957	12	4468	997	38183	2403	25038	92	38719	9197	50964	54884	21756	22454	15870
14	4954	8397	5779	13684	3785	5710	6493	14998	1205	258	3880	2004	19127	3038	11847	246	22962	6860	39385	32016	18802	14336	10081
14.5	561	3048	1671	4097	2293	2793	5495	25944	194	335	1990	422	11268	2813	5712	497	13247	3713	23375	26055	8870	5367	2243
15	6102	2147	817	2391	521	1082	4217	46371	219	375	790	48	6370	1976	2080	1075	6811	2812	16035	14275	7415	1720	835
15.5	2985	1757	402	1194	1045	525	1054	42244	8	226	703	40	3764	890	579	1160	2422	983	9402	6655	3418	762	306
16	2995	4975	370	1943	271	75	977	44171		227	159	33	2224	560	138	1658	889	294	8305	3936	1609	107	201
16.5	2621	7842	489	2406	225	17	443	14369		151		10	296	330		2430	246	4	5034	946	721	329	
17	252	4584	275	1767	75		216	8378		104		10		438		2221		97	3065	784	493		
17.5	109	1325	133	595	12			778		94		13		311		1717			2731	234			
18		621	95	75				236		24						1045			38				
18.5			10							21						397							
19										1						317			38				
19.5																138							
20																							
20.5																							
21																							
21.5																							
22																							
Total N	453679	590930	989230	786595	353555	207287	364339	204705	68647	1835	649078	3951	658223	24231	1465102	12993	630315	327225	701921	799984	466363	507410	523656
Catch (T)	4263	5330	5726	5697	2995	1960	3035	5329	571	44	1780	63	4600	371	8977	413	5587	2182	8216	7870	4768	5183	4385
L avg (cm)	11.3	11.0	9.3	9.6	10.7	10.9	10.5	15.6	10.9	15.6	6.6	14.2	9.4	13.4	9.7	16.8	10.1	9.8	11.4	11.1	11.2	11.3	10.6
W avg (g)	9.4	9.0	5.8	7.2	8.4	9.4	8.3	26.0	8.3	23.7	2.6	16.1	7.0	15.3	6.3	31.8	8.1	6.8	11.3	9.7	9.8	9.7	7.9

Table 11.4.2.3. Anchovy in Division IXa. Mean length (TL, in cm) at age in the Spanish catches of Gulf of Cadiz anchovy (Sub-division IXa-South, 1988-2005) on a quarterly (Q), half-year (HY) and annual basis. Data for 1994 and second half in 1995 estimated from an iterated ALK by applying the Kimura and Chikuni's (1987) algorithm.

1988	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			9.4	10.2		10.0	10.0
	1	10.9	11.4	12.3	12.2	11.3	12.3	11.6
	2			16.4			16.4	16.4
	3							
	Total	10.9	11.4	12.0	10.7	11.3	11.5	11.3
1989	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0			9.1	10.9		10.5	10.5
	1	10.1	10.8	13.3	13.3	10.5	13.3	10.9
	2			16.9			16.9	16.9
	3							
	Total	10.1	10.8	13.4	11.6	10.5	13.2	11.0
1990	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0			9.4	6.9		7.1	7.1
	1	10.1	10.4	11.8	11.5	10.2	11.8	10.5
	2	15.2		16.9		15.2	16.9	16.6
	3							
	Total	10.1	10.4	11.5	7.0	10.2	8.2	9.3
1991	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0			10.7	9.4		9.7	9.7
	1	7.2	11.5	13.1	16.1	9.3	13.2	9.5
	2		14.9	17.1	17.1	14.9	17.1	15.6
	3							
	Total	7.2	11.5	12.7	9.7	9.3	11.2	9.6
1992	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0			9.5			9.5	9.5
	1	10.0	11.1	12.0	15.9	10.5	12.0	10.7
	2	16.3		15.7	16.7	16.3	15.7	15.8
	3	16.9				16.9		16.9
	Total	10.0	11.1	12.0	16.2	10.5	12.0	10.7
1993	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0			6.3	7.7		7.2	7.2
	1	11.5	11.7	12.2	13.8	11.6	12.4	11.7
	2	14.7	14.9		16.5	14.8	16.5	14.8
	3							
	Total	11.5	11.8	9.1	8.2	11.6	8.6	10.9

1994	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			9.2	9.2		9.2	9.2
	1	9.3	11.0	13.3	13.9	10.4	13.5	10.5
	2	12.8	14.3	15.3	15.4	14.3	15.3	15.3
	3							
	Total	9.3	11.0	13.4	13.2	10.4	13.4	10.5
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

Table 11.4.2.4. Anchovy in Division IXa. Mean weight (in kg) at age in the Spanish catches of Gulf of Cadiz anchovy (Sub-division IXa-South, 1988-2005) on a quarterly (Q), half-year (HY) and annual basis. Data for 1994 and second half in 1995 estimated from an iterated ALK by applying the Kimura and Chikuni's (1987) algorithm.

1988	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.005	0.006		0.006	0.006
	1	0.008	0.010	0.012	0.011	0.009	0.012	0.010
	2			0.028			0.028	0.028
	3							
	Total	0.008	0.010	0.011	0.007	0.009	0.010	0.009

1989	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.004	0.008		0.007	0.007
	1	0.007	0.008	0.016	0.014	0.008	0.016	0.009
	2			0.034			0.034	0.034
	3							
	Total	0.007	0.008	0.017	0.010	0.008	0.016	0.009

1990	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.005	0.002		0.002	0.002
	1	0.007	0.007	0.010	0.009	0.007	0.010	0.008
	2	0.023		0.032		0.023	0.032	0.031
	3							
	Total	0.007	0.007	0.010	0.002	0.007	0.004	0.006

1991	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.008	0.005		0.006	0.006
	1	0.003	0.011	0.015	0.027	0.007	0.016	0.007
	2		0.024	0.036	0.033	0.024	0.035	0.028
	3							
	Total	0.003	0.011	0.014	0.006	0.007	0.010	0.007

1992	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.005			0.005	0.005
	1	0.007	0.009	0.011	0.029	0.008	0.011	0.008
	2	0.027		0.024	0.033	0.027	0.024	0.025
	3	0.030				0.030		0.030
	Total	0.007	0.009	0.011	0.030	0.008	0.011	0.008

1993	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.002	0.003		0.003	0.003
	1	0.010	0.011	0.012	0.016	0.011	0.012	0.011
	2	0.021	0.021		0.028	0.021	0.028	0.021
	3							
	Total	0.010	0.011	0.006	0.004	0.011	0.005	0.009

1994	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.005	0.005		0.005	0.005
	1	0.005	0.009	0.017	0.017	0.008	0.017	0.008
	2	0.013	0.020	0.025	0.023	0.020	0.025	0.025
	3							
	Total	0.005	0.009	0.018	0.015	0.008	0.017	0.008

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

Table 11.4.3. Anchovy in Division IXa. Maturity ogives (ratio of mature fish at age) for Gulf of Cadiz anchovy (Sub-division IXa South).

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

Table 11.5.1. Anchovy in Division IXa. Parameter estimates of the GLM used for standardisation of CPUE data for Spanish fleets in Sub-division IXa-South (Gulf of Cadiz).

GLM Parameter Estimates
Dependent Variable: LNCPUE
Fleet type of reference= Barbate's high-tonnage single-purpose fleet (FLEETTYPE=11)
Quarter of reference= 1st quarter 1988 (QUARTER=72)

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval		Partial Eta-Squared	Noncentrality Parameter	Observed Power (a)
					Lower Bound	Upper Bound			
Intercept	0.070	0.687	0.101	0.919	-1.282	1.421	0.000	0.101	0.051
[QUARTER=1]	0.131	0.758	0.173	0.863	-1.361	1.624	0.000	0.173	0.053
[QUARTER=2]	0.266	0.748	0.355	0.723	-1.207	1.738	0.000	0.355	0.064
[QUARTER=3]	0.837	0.748	1.119	0.264	-0.636	2.310	0.005	1.119	0.200
[QUARTER=4]	0.687	0.748	0.918	0.359	-0.786	2.160	0.003	0.918	0.150
[QUARTER=5]	0.487	0.740	0.657	0.512	-0.971	1.944	0.002	0.657	0.100
[QUARTER=6]	0.240	0.730	0.329	0.743	-1.197	1.677	0.000	0.329	0.062
[QUARTER=7]	0.381	0.740	0.515	0.607	-1.076	1.838	0.001	0.515	0.081
[QUARTER=8]	0.212	0.741	0.286	0.775	-1.247	1.670	0.000	0.286	0.059
[QUARTER=9]	-0.327	0.740	-0.442	0.659	-1.784	1.130	0.001	0.442	0.073
[QUARTER=10]	-0.144	0.740	-0.195	0.845	-1.601	1.313	0.000	0.195	0.054
[QUARTER=11]	0.701	0.740	0.948	0.344	-0.756	2.159	0.003	0.948	0.157
[QUARTER=12]	0.367	0.748	0.491	0.624	-1.105	1.840	0.001	0.491	0.078
[QUARTER=13]	0.216	0.741	0.292	0.771	-1.242	1.674	0.000	0.292	0.060
[QUARTER=14]	0.829	0.735	1.128	0.260	-0.618	2.277	0.005	1.128	0.203
[QUARTER=15]	0.519	0.735	0.707	0.480	-0.928	1.967	0.002	0.707	0.108
[QUARTER=16]	0.829	0.731	1.135	0.258	-0.610	2.268	0.005	1.135	0.204
[QUARTER=17]	0.741	0.735	1.009	0.314	-0.706	2.189	0.004	1.009	0.171
[QUARTER=18]	1.448	0.731	1.982	0.049	0.009	2.887	0.014	1.982	0.506
[QUARTER=19]	1.443	0.727	1.986	0.048	0.012	2.874	0.014	1.986	0.507
[QUARTER=20]	1.174	0.735	1.597	0.111	-0.273	2.621	0.009	1.597	0.356
[QUARTER=21]	0.485	0.740	0.656	0.513	-0.972	1.943	0.002	0.656	0.100
[QUARTER=22]	-0.049	0.748	-0.065	0.948	-1.522	1.424	0.000	0.065	0.050
[QUARTER=23]	0.063	0.761	0.082	0.935	-1.436	1.562	0.000	0.082	0.051
[QUARTER=24]	0.054	0.761	0.071	0.944	-1.445	1.553	0.000	0.071	0.051
[QUARTER=25]	-0.070	0.734	-0.095	0.924	-1.516	1.376	0.000	0.095	0.051
[QUARTER=26]	-0.146	0.734	-0.199	0.843	-1.592	1.300	0.000	0.199	0.055
[QUARTER=27]	0.074	0.734	0.101	0.920	-1.372	1.520	0.000	0.101	0.051
[QUARTER=28]	-0.049	0.734	-0.066	0.947	-1.495	1.397	0.000	0.066	0.051
[QUARTER=29]	0.246	0.758	0.324	0.746	-1.246	1.737	0.000	0.324	0.062
[QUARTER=30]	0.134	0.758	0.176	0.860	-1.358	1.625	0.000	0.176	0.054
[QUARTER=31]	0.221	0.758	0.291	0.771	-1.271	1.712	0.000	0.291	0.060
[QUARTER=32]	0.518	0.758	0.684	0.494	-0.973	2.010	0.002	0.684	0.105
[QUARTER=33]	-0.157	0.747	-0.211	0.833	-1.628	1.313	0.000	0.211	0.055
[QUARTER=34]	-0.021	0.747	-0.028	0.978	-1.491	1.449	0.000	0.028	0.050
[QUARTER=35]	-0.499	0.747	-0.668	0.505	-1.969	0.972	0.002	0.668	0.102
[QUARTER=36]	-0.973	0.757	-1.286	0.200	-2.463	0.517	0.006	1.286	0.249
[QUARTER=37]	-0.676	0.757	-0.893	0.373	-2.167	0.815	0.003	0.893	0.144
[QUARTER=38]	-0.282	0.757	-0.372	0.710	-1.773	1.209	0.001	0.372	0.066
[QUARTER=39]	-0.585	0.757	-0.772	0.441	-2.076	0.906	0.002	0.772	0.120
[QUARTER=40]	-0.709	0.775	-0.914	0.361	-2.236	0.818	0.003	0.914	0.149
[QUARTER=41]	-1.212	0.775	-1.563	0.119	-2.738	0.315	0.009	1.563	0.344
[QUARTER=42]	-1.039	0.775	-1.340	0.181	-2.566	0.488	0.007	1.340	0.267
[QUARTER=43]	-0.962	0.757	-1.271	0.205	-2.453	0.529	0.006	1.271	0.245
[QUARTER=44]	-1.458	0.773	-1.886	0.060	-2.979	0.064	0.013	1.886	0.468
[QUARTER=45]	-0.498	0.757	-0.658	0.511	-1.989	0.993	0.002	0.658	0.101
[QUARTER=46]	-0.089	0.757	-0.118	0.906	-1.580	1.402	0.000	0.118	0.052
[QUARTER=47]	0.084	0.773	0.109	0.914	-1.437	1.605	0.000	0.109	0.051
[QUARTER=48]	0.444	0.798	0.557	0.578	-1.126	2.014	0.001	0.557	0.086
[QUARTER=49]	-0.742	0.844	-0.880	0.380	-2.404	0.919	0.003	0.880	0.142
[QUARTER=50]	-1.248	0.971	-1.285	0.200	-3.159	0.664	0.006	1.285	0.249
[QUARTER=51]	-0.269	0.797	-0.337	0.737	-1.838	1.301	0.000	0.337	0.063
[QUARTER=52]	-0.491	0.845	-0.580	0.562	-2.155	1.173	0.001	0.580	0.089
[QUARTER=53]	-0.470	0.844	-0.558	0.578	-2.132	1.191	0.001	0.558	0.086
[QUARTER=54]	-0.865	0.971	-0.891	0.374	-2.777	1.046	0.003	0.891	0.144
[QUARTER=55]	-0.456	0.797	-0.571	0.568	-2.025	1.114	0.001	0.571	0.088
[QUARTER=56]	-0.152	0.797	-0.191	0.849	-1.722	1.417	0.000	0.191	0.054
[QUARTER=57]	-0.116	0.844	-0.138	0.891	-1.777	1.545	0.000	0.138	0.052
[QUARTER=58]	0.071	0.844	0.084	0.933	-1.591	1.732	0.000	0.084	0.051
[QUARTER=59]	0.057	0.845	0.068	0.946	-1.607	1.721	0.000	0.068	0.051
[QUARTER=60]	0.140	0.845	0.166	0.868	-1.524	1.804	0.000	0.166	0.053
[QUARTER=61]	-0.817	0.797	-1.024	0.307	-2.386	0.753	0.004	1.024	0.175
[QUARTER=62]	0.006	0.844	0.007	0.995	-1.655	1.667	0.000	0.007	0.050
[QUARTER=63]	-0.046	0.797	-0.057	0.954	-1.615	1.524	0.000	0.057	0.050
[QUARTER=64]	0.409	0.797	0.514	0.608	-1.160	1.979	0.001	0.514	0.080
[QUARTER=65]	-1.091	0.844	-1.293	0.197	-2.753	0.570	0.006	1.293	0.252
[QUARTER=66]	0.360	0.844	0.426	0.670	-1.302	2.021	0.001	0.426	0.071
[QUARTER=67]	0.393	0.845	0.465	0.642	-1.271	2.057	0.001	0.465	0.075
[QUARTER=68]	0.431	0.845	0.510	0.610	-1.233	2.095	0.001	0.510	0.080
[QUARTER=69]	-0.330	0.971	-0.340	0.734	-2.242	1.582	0.000	0.340	0.063
[QUARTER=70]	0.137	0.797	0.172	0.863	-1.432	1.707	0.000	0.172	0.053
[QUARTER=71]	-0.626	0.797	-0.785	0.433	-2.196	0.943	0.002	0.785	0.123
[QUARTER=72]	0 (b)	.	.	.	.	.	.	.	.
[FLEETTYPE=1]	-2.131	0.171	-12.497	0.000	-2.467	-1.795	0.368	12.497	1.000
[FLEETTYPE=2]	-2.035	0.219	-9.300	0.000	-2.466	-1.604	0.244	9.300	1.000
[FLEETTYPE=3]	-0.825	0.169	-4.883	0.000	-1.158	-0.492	0.082	4.883	0.998
[FLEETTYPE=4]	-1.547	0.137	-11.281	0.000	-1.817	-1.277	0.322	11.281	1.000
[FLEETTYPE=5]	-1.537	0.138	-11.124	0.000	-1.809	-1.265	0.316	11.124	1.000
[FLEETTYPE=6]	-1.628	0.168	-9.689	0.000	-1.958	-1.297	0.259	9.689	1.000
[FLEETTYPE=7]	-1.847	0.160	-11.535	0.000	-2.162	-1.531	0.332	11.535	1.000
[FLEETTYPE=8]	-0.905	0.153	-5.919	0.000	-1.206	-0.604	0.116	5.919	1.000
[FLEETTYPE=9]	-1.019	0.201	-5.059	0.000	-1.416	-0.623	0.087	5.059	0.999
[FLEETTYPE=10]	-0.802	0.275	-2.916	0.004	-1.344	-0.261	0.031	2.916	0.828
[FLEETTYPE=11]	0 (b)	.	.	.	.	.	.	.	.

a Computed using alfa = ,05
b A 0 value has been assigned to the parameter because is redundant.

FLEETTYPE CODE	Description of the metiérs
1	Isla Cristina's Multi-purpose
2	Punta Umbría's Multi-purpose
3	Sanlucar de Barrameda's Multi-purpose
4	Barbate's Multi-purpose
5	Isla Cristina's Light-tonnage Single-purpose
6	Punta Umbría's Light-tonnage Single-purpose
7	Sanlucar de Barrameda's Light-tonnage Single-purpose
8	Barbate's Light-tonnage Single-purpose
9	Isla Cristina's High-tonnage Single-purpose
10	Mediterranean High-tonnage Single-purpose
11	Barbate's High-tonnage Single-purpose

Table 11.5.2. Anchovy in Division IXa. ANOVA results of the GLM used for standardisation of CPUE data for Spanish fleets in Sub-division IXa-South (Gulf of Cadiz).

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

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta-Squared	Noncentrality parameter	Observed power (a)
Corrected Mo	283.911	81	3.505	7.434	3.068E-36	0.692	602.164	1.000
Intercept	233.566	1	233.566	495.385	7.293E-63	0.649	495.385	1.000
QUARTER	107.542	71	1.515	3.213	4.476E-12	0.460	228.092	1.000
FLEETTYPE	141.937	10	14.194	30.104	1.763E-38	0.529	301.043	1.000
Error	126.358	268	0.471					
Total	749.414	350						
Corrected Tot	410.269	349						

a Computed using alfa = ,05
b R Squared = ,692 (Adjusted R Squared = ,599)

Table 11.5.3. Anchovy in Division IXa. Effort data (no. of standardised fishing trips fishing anchovy) for Spanish fleets in Sub-division IXa-South (Gulf of Cadiz) (SP: single purpose; MP: multi purpose; HT: heavy GRT; LT: light GRT). Color intensities denote increasing problems in sampling coverage of fishing effort.

FLEET	SUB-DIVISION IXa SOUTH (Gulf of Cadiz) – PURSE SEINE – BARBATE			SANLÚCAR		P.UMBRÍA		I. CRISTINA			MEDIT.	SUBTOTAL	SUBTOTAL	TOTAL	TOTAL	OVERALL
	(SP-HT)	(SP-LT)	(MP)	(SP-LT)	(MP)	(SP-LT)	(MP)	(SP-HT)	(SP-LT)	(MP)	(SP-HT)	SP-HT	SP-LT	SP	MP	EFFORT
Year	No. fishing trips															
1988	5250	-	31	-	300	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	5250	?	5250	330	**5581**
1989	3306	-	66	-	322	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	3306	?	3306	388	**3693**
1990	4640	-	105	-	1635	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	4640	?	4640	1740	**6380**
1991	4507	-	64	-	759	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	4507	?	4507	823	**5330**
1992	4065	-	117	-	492	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	4064	?	4064	609	**4674**
1993	1998	-	10	-	189	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	1998	?	1998	199	**2197**
1994	1703	-	108	-	699	*n.a.*	*n.a.*	0	151	32	-	1703	151	1854	839	**2693**
1995	674	-	30	-	451	*n.a.*	*n.a.*	0	18	12	-	674	18	692	492	**1184**
1996	1250	-	188	-	1329	*n.a.*	*n.a.*	0	86	132	-	1250	86	1336	1648	**2985**
1997	5019	22	192	-	1172	*n.a.*	*n.a.*	0	50	16	-	5019	72	5091	1380	**6470**
1998	4588	54	0	2603	0	*n.a.*	*n.a.*	0	151	39	-	4588	2808	7396	39	**7435**
1999	3394	80	9	3604	0	484	648	0	205	320	-	3394	4373	7767	977	**8744**
2000	35	2075	0.4	2624	0	1155	134	0	856	0	-	35	6709	6744	134	**6878**
2001	160	1421	135	597	0	3082	12	147	1995	6	295	603	7095	7698	154	**7852**
2002	2489	684	38	758	0	3113	6	9	660	0	117	2615	5216	7831	45	**7876**
2003	2115	445	12	2128	0	1407	0	63	652	0	0	2178	4633	6811	12	**6823**
2004	2362	577	3	875	0	1876	30	141	952	7	0	2504	4280	6784	40	**6824**
2005	1344	477	0	819	0	1367	0	134	598	0	0	1479	3260	4739	0	**4739**

Table 11.5.4. Anchovy in Division IXa. Standardised CPUE data (Tonnes/fishing trip) for Spanish fleets in Sub-division IXa-South (Gulf of Cadiz). (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	CPUE
Year	Tonnes/fishing trip															
1988	0.790	-	0.255	-	0.295	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	0.790	?	0.790	0.291	**0.760**
1989	1.521	-	0.316	-	0.686	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	1.521	?	1.521	0.623	**1.427**
1990	1.124	-	0.251	-	0.259	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	1.124	?	1.124	0.259	**0.888**
1991	1.159	-	0.211	-	0.521	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	1.159	?	1.159	0.497	**1.057**
1992	0.695	-	0.172	-	0.355	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	0.695	?	0.695	0.320	**0.646**
1993	0.687	-	0.135	-	0.306	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	0.687	?	0.687	0.297	**0.652**
1994	1.266	-	0.167	-	0.512	*n.a.*	*n.a.*	0	0.265	0.154	-	1.266	0.265	1.184	0.454	**0.957**
1995	0.295	-	0.076	-	0.139	*n.a.*	*n.a.*	0	0.064	0.036	-	0.295	0.064	0.290	0.133	**0.224**
1996	0.634	-	0.149	-	0.308	*n.a.*	*n.a.*	0	0.121	0.065	-	0.634	0.121	0.601	0.270	**0.418**
1997	0.693	0.319	0.183	-	0.427	*n.a.*	*n.a.*	0	0.160	0.103	-	0.693	0.209	0.686	0.389	**0.623**
1998	1.467	0.648	0	0.190	0	*n.a.*	*n.a.*	0	0.285	0.151	-	1.467	0.204	0.987	0.151	**0.983**
1999	1.110	0.453	0.215	0.145	0	0.194	0.132	0	0.216	0.121	-	1.110	0.159	0.575	0.129	**0.525**
2000	1.806	0.486	0.377	0.174	0	0.261	0.180	0	0.261	0	-	1.806	0.297	0.304	0.180	**0.302**
2001	3.770	1.672	0.990	0.556	0	0.728	0.595	1.478	0.858	0.549	1.857	2.273	0.939	1.044	0.941	**1.042**
2002	2.129	0.911	0.512	0.298	0	0.401	0.322	0.788	0.462	0	0.994	2.074	0.460	0.999	0.484	**0.996**
2003	1.618	0.620	0.219	0.179	0	0.286	0	0.645	0.353	0	0	1.590	0.278	0.698	0.219	**0.697**
2004	1.568	0.619	0.340	0.213	0	0.283	0.209	0.522	0.322	0.188	0	1.509	0.323	0.761	0.214	**0.757**
2005	2.085	0.872	0	0.307	0	0.406	0	0.764	0.433	0	0	1.965	0.454	0.925	0	**0.925**

Table 11.7.1. Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz) . Input values from the seasonal separable assessment model.

Anchovy IXa-South (Algarve+Gulf of Cadiz)
Years: 1995-2005
Fleets: All

Half-year Catch in number (in millions) at age (1995-2005)

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

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	
0	7.03	1.06	2.57	2.65	3.19	3.14	6.21	3.32	5.98	6.64	4.94	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	0.6
2	22.55	19.98	20.90	20.45	19.99	23.82	31.76	26.29	26.79	21.87	22.62	0.6

Acoustic Biomass estimates (tonnes) in Sub-division IXa South (Algarve+Gulf of Cadiz) (Portuguese surveys)

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

Anchovy standardised annual CPUE (kg/fishing trip) of the Spanish purse-seine fleet

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
All fleets	224	418	623	983	525	302	1042	996	697	757	925

Exploratory runs with the seasonal separable model

	CPUE	Portuguese Ac. Surv.	F assumptions	Wage stock
RUN0	All fleets	1998-2005	FHY2 in the last assessment year as the 1996-2004 average ratio of half year Fs (= AvgFratio)	-
RUN1	All fleets	-		
RUN2	-	1998-2005		
RUN3	All fleets	1998-2006	AvgFratio for FHY2-2005. FHY1-2006 :averageFHY1 in 3 last years (03-05).	Wage stock in 2006 as the average in 03-05
RUN4	-	1998-2006		
RUN5	All fleets	1998-2005	FHY2 in the last assessment year as the 2004 ratio of half year Fs (=2004Fratio).	-
RUN6	All fleets	-		
RUN7	-	1998-2005		
RUN8	All fleets	1998-2006	2004Fratio for FHY2-2005.FHY1-2006:average FHY1 in 3 last years (03-	Wage stock in 2006 as the average in 03-05
RUN9	-	1998-2006		

Table 11.7.2. Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz) . Outputs from the seasonal separable assessment model. RUN5 with F in the second-half in 2005 set as the ratio between F half-year values in 2004

Fishing Mortality per half-year period

	1995		1996		1997		1998		1999		2000		2001		2002		2003		2004		2005	
AGE	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
0	0.0000	0.1406	0.0000	0.0728	0.0000	0.1793	0.0000	0.1465	0.0000	0.2150	0.0000	0.0650	0.0000	0.1328	0.0000	0.1698	0.0000	0.1523	0.0000	0.1580	0.0000	0.1143
1	0.9411	1.5839	0.3635	0.8207	0.7055	2.0197	0.8857	1.6509	1.5124	2.4222	0.6853	0.7320	0.7004	1.4966	0.6029	1.9130	1.6424	1.7157	1.3424	1.7805	0.9706	1.2875
2	1.2102	2.3758	0.4674	1.2311	0.9072	3.0295	1.1390	2.4763	1.9449	3.6333	0.8813	1.0980	0.9007	2.2449	0.7753	2.8695	2.1120	2.5736	1.7262	2.6708	1.2482	1.9312

Population abundance (millions)

	1995		1996		1997		1998		1999		2000		2001		2002		2003		2004		2005	
AGE	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
0	0	716	0	1889	0	3560	0	2403	0	1005	0	1867	0	1660	0	1284	0	1002	0	1289	0	739
1	99	21	341	130	964	261	1633	370	1139	138	445	123	960	262	798	240	595	63	472	68	604	126
2	1	0	2	1	31	7	19	3	39	3	7	2	32	7	32	8	19	1	6	1	6	1

Predicted Biomass Index values

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
CPUE Index(kg/fishing day)	415	247	990	835	556	638	1209	578	613	792	453

	Nov. 98	Mar. 99	Nov. 99	Mar. 00	Nov. 00	Mar. 01	Nov. 01	Mar. 02	Nov. 02	Feb. 03	Nov. 03	Mar. 04	Nov. 04	Apr. 05	Nov. 05
Acoustic Index (tonnes)	20290	34227	-	-	19342	40249	32668	27802	-	21064	-	-	-	11676	-

Fitted Selection Pattern

	1995		1996		1997		1998		1999		2000		2001		2002		2003		2004		2005	
AGE	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
0	0.0000	0.0888	0.0000	0.0888	0.0000	0.0888	0.0000	0.0888	0.0000	0.0888	0.0000	0.0888	0.0000	0.0888	0.0000	0.0888	0.0000	0.0888	0.0000	0.0888	0.0000	0.0888
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.2859	1.5000	1.2859	1.5000	1.2859	1.5000	1.2859	1.5000	1.2859	1.5000	1.2859	1.5000	1.2859	1.5000	1.2859	1.5000	1.2859	1.5000	1.2859	1.5000	1.2859	1.5000

Catchability indices

	Q
CPUE	0.1082
Acoustic Survey	4.5246

Table 11.7.2.(cont'd) Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz) . Outputs for the seasonal separable assessment model. RUN5 with F in the second-half in 2005 set as the ratio between F half-year values in 2004.

Average population Biomass (tonnes)

1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
3837	2281	9155	7719	5137	5896	11174	5346	5665	7323	4191

Residuals about the model fit

Separable model residuals

	1995		1996		1997		1998		1999		2000		2001		2002		2003		2004		2005	
AGE	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
0		-0.723		1.598		-0.278		0.630		-0.158		0.379		0.035		-0.669		-0.114		-0.162		-0.444
1	-0.581	-0.602	0.590	-1.054	-0.687	-0.740	-0.041	0.343	-0.529	0.040	-0.060	0.168	-0.058	0.299	0.672	0.152	-0.153	0.552	0.145	0.706	0.418	-0.665
2	-1.084		0.269	0.959	0.789	0.785	0.158	-0.533	0.164	0.026	0.129	-0.377	0.262	-0.017	-0.465	0.422	-0.071	-0.471	-0.836	0.631	-0.105	-0.729

Biomass index residuals

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
CPUE Index (kg/fishing day)	-0.615	0.528	-0.463	0.163	-0.057	-0.747	-0.148	0.544	0.129	-0.045	0.714

	Nov. 98	Mar. 99	Nov. 99	Mar. 00	Nov. 00	Mar. 01	Nov. 01	Mar. 02	Nov. 02	Feb. 03	Nov. 03	Mar. 04	Nov. 04	Apr. 05	Nov. 05
Acoustic Index (tonnes)	0.414	-0.324	-	-	0.561	-0.480	-0.245	-0.265	-	0.154	-	-	-	0.1844	-

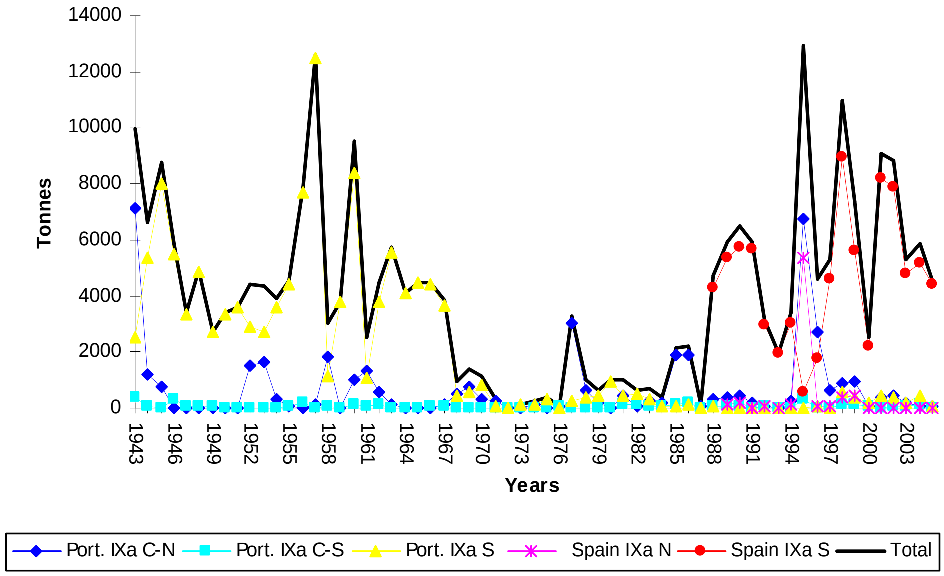


Figure 11.2.1.1. Historical series of Portuguese and Spanish anchovy landings in Division IXa (1943-2005).

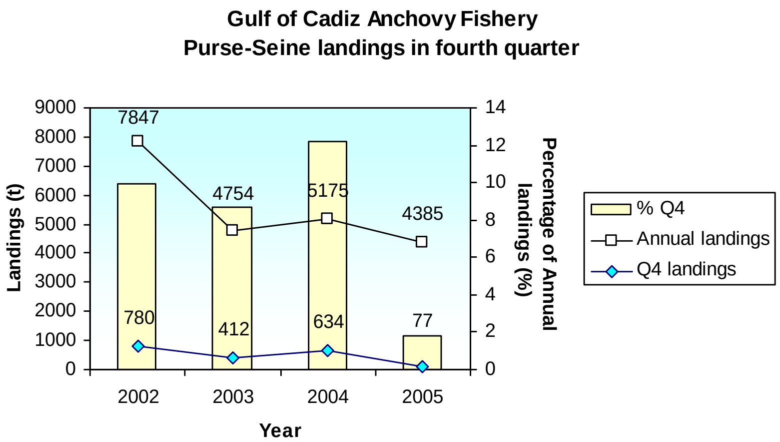


Figure 11.2.2.1 Gulf of Cadiz Anchovy (Subdivision IXa South): comparison of annual purse-seine landings with catches landed in the fourth quarter to assess the effects of the closed season in the fourth quarter in 2004 and 2005. Bar chart represents the relative importance of landings in the fourth quarter in relation to the annual landings.

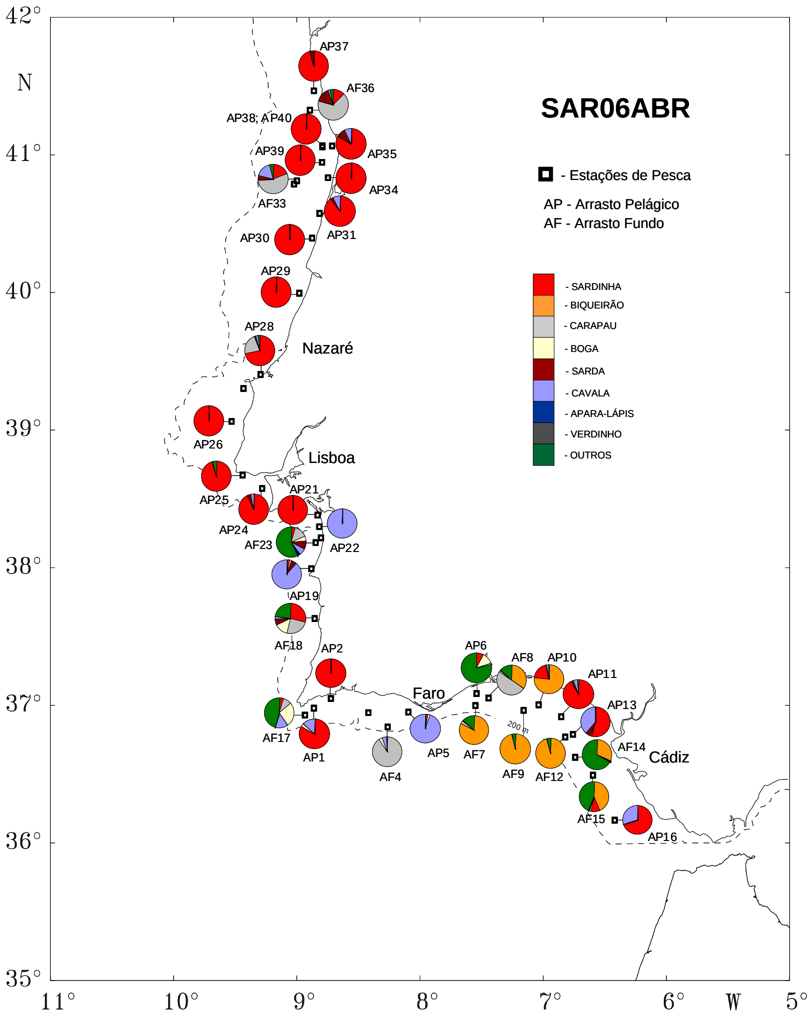


Figure 11.3.1.1. Anchovy in Division IXa. Fishing trawl location and haul species composition (AP-Pelagic trawl; AF- Bottom trawl) in April 2006 Portuguese acoustic survey.

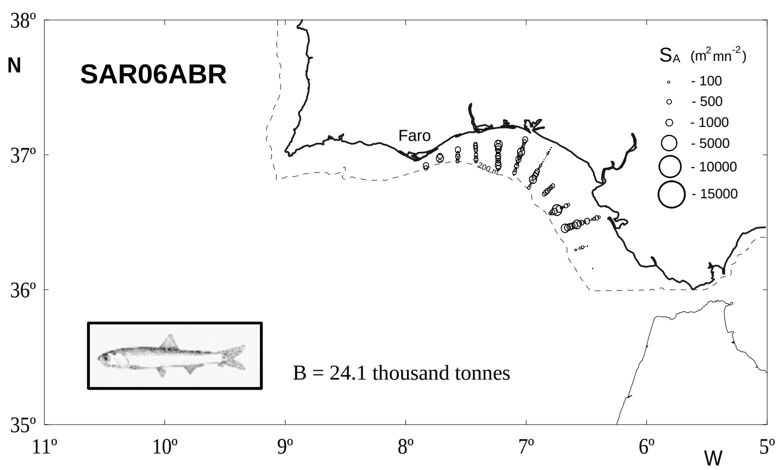


Figure 11.3.1.2. Anchovy in Division IXa. Acoustic energy distribution per nautical mile during the April 2006 Portuguese survey. Circle diameter is propocional to the acoustic energy (S_A).

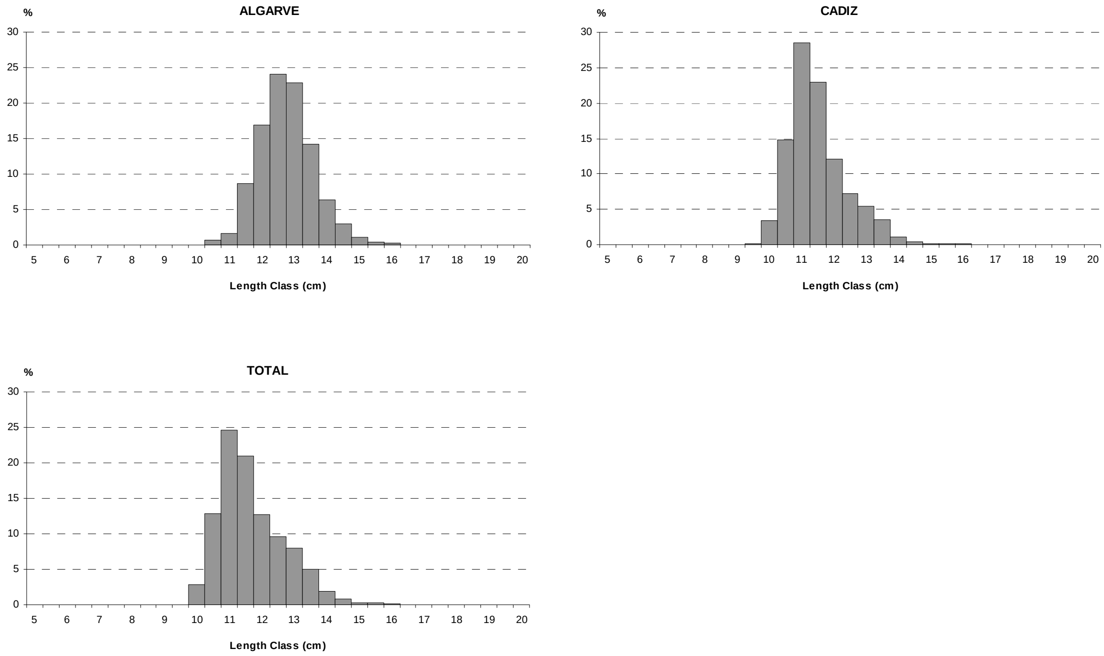


Figure 11.3.1.3. Anchovy in Division IXa. Distribution of length class frequency (%) by region and total area during the April 2006 acoustic Portuguese survey.

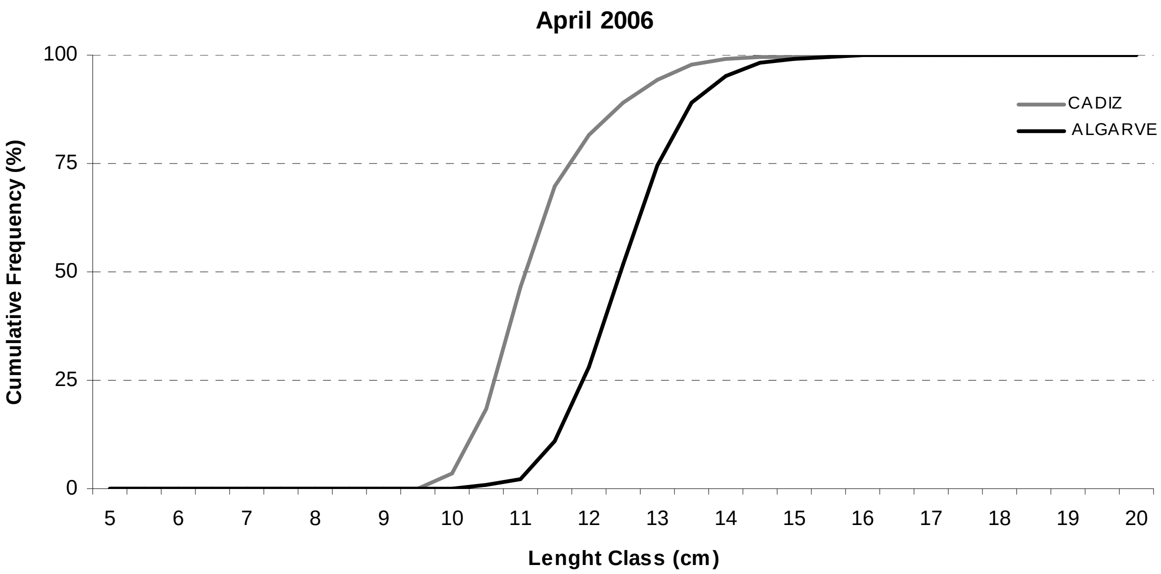


Figure 11.3.1.4. Anchovy in Division IXa. Cumulative frequency (%) by length class and region during the April 2006 acoustic Portuguese survey.

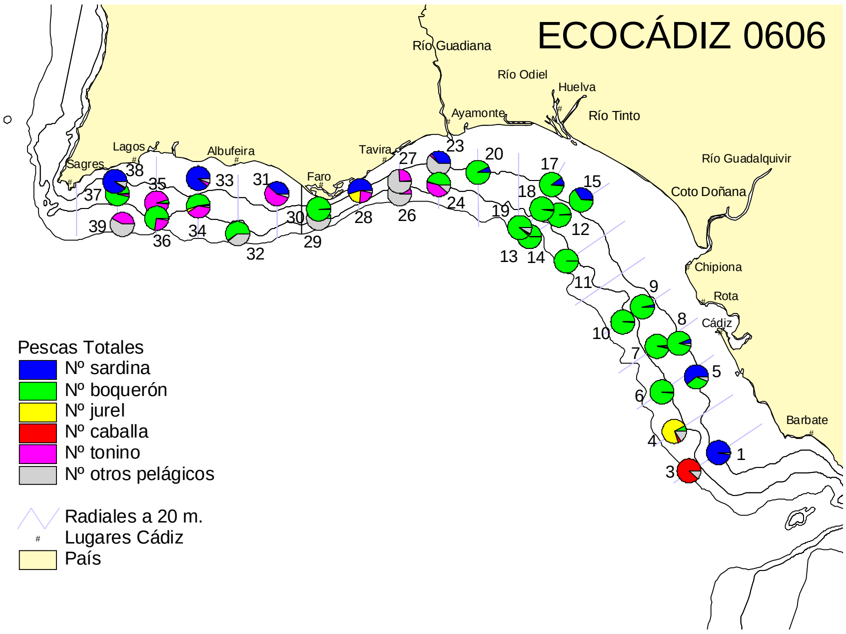


Figure 11.3.1.5. Anchovy in Division IXa. Fishing trawl location and haul species composition in June 2006 Spanish acoustic survey in Sub-division IXa South.

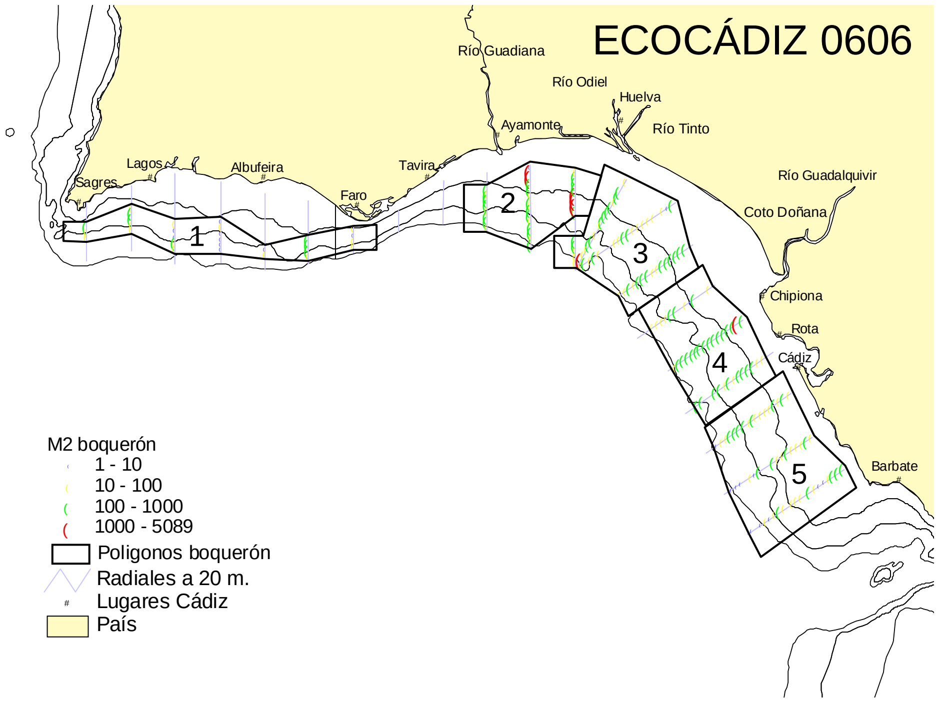


Figure 11.3.1.6. Anchovy in Division IXa. Acoustic energy distribution per nautical mile during the June 2006 Spanish survey in the Sub-division IXa South. Circle diameter and colour are proportional to the acoustic energy (S_A). Homogeneous size-based post-strata used in the biomass/abundance estimates are also shown.

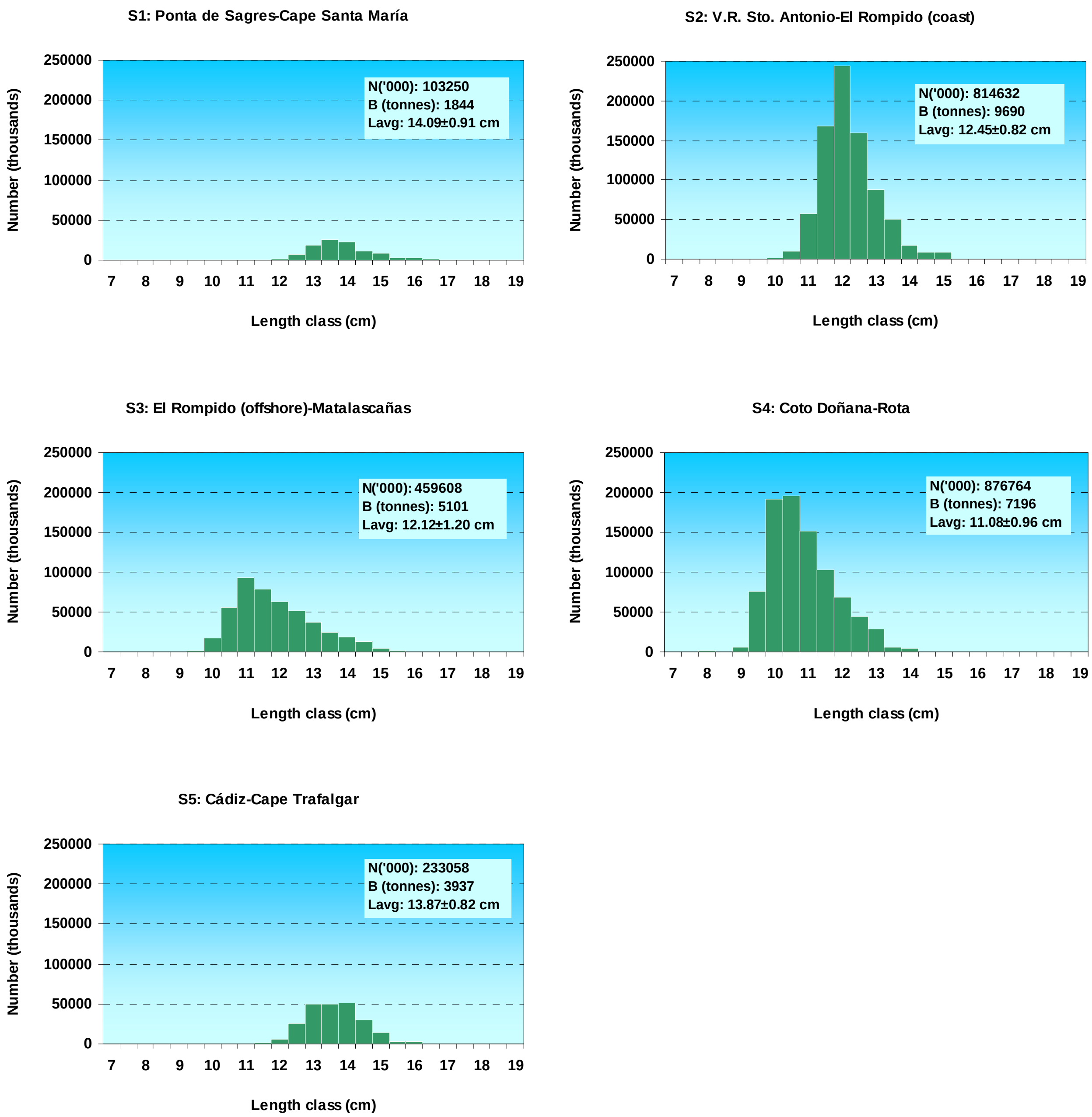


Figure 11.3.1.7. Anchovy in Division IXa. Estimated abundances by length class by sector during the June 2006 acoustic Spanish survey in Sub-division IXa South.

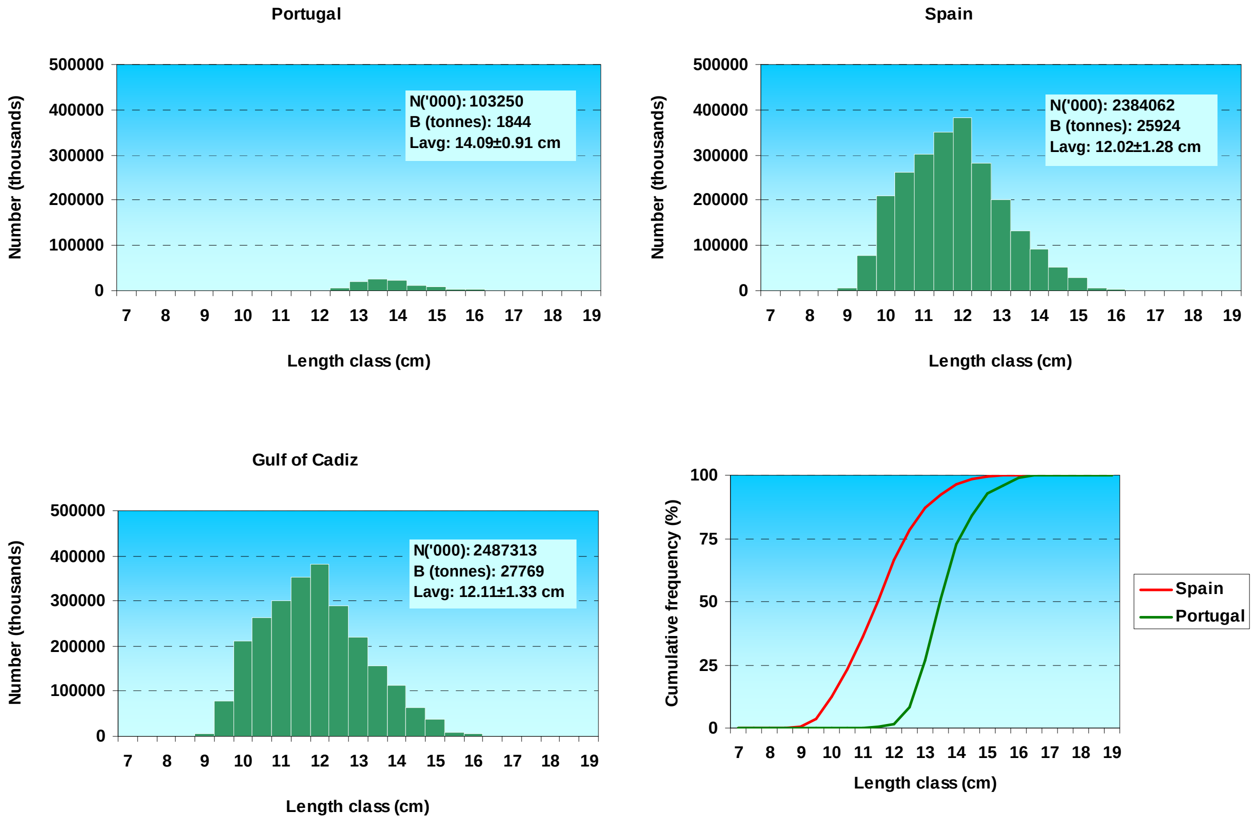
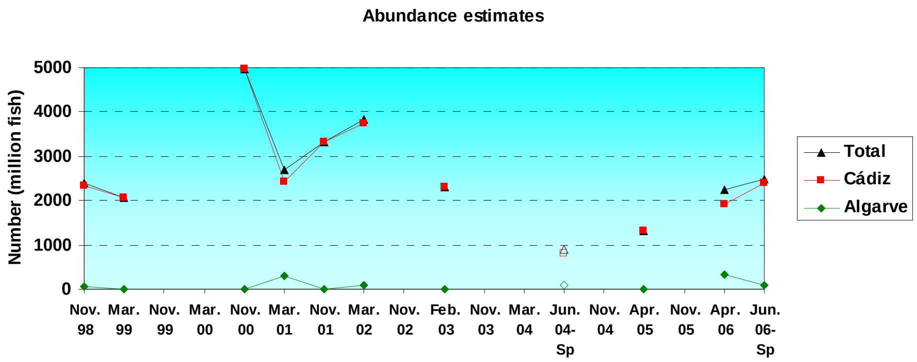


Figure 11.3.1.8. Anchovy in Division IXa. Estimated abundances by length class by region and total area during the June 2006 acoustic Spanish survey in Sub-division IXa South. Bottom right: cumulative frequency (%) by length class and region.



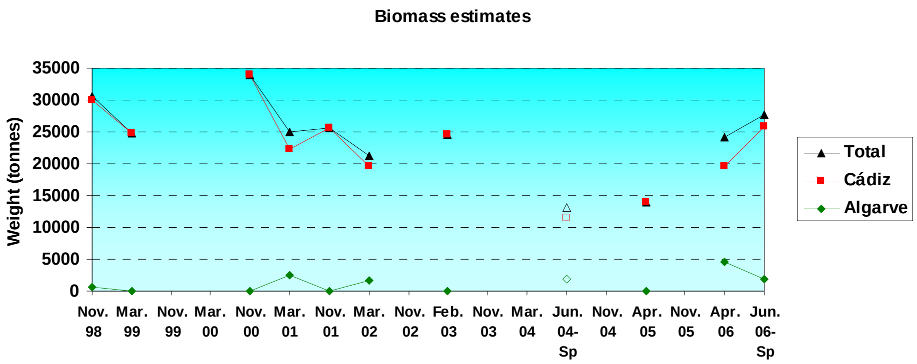


Figure 11.3.1.9. Anchovy in Division IXa. Portuguese historical series of acoustic estimates in Sub-division IXa South. Data for June 2004 and 2006 correspond to the Spanish acoustic surveys.

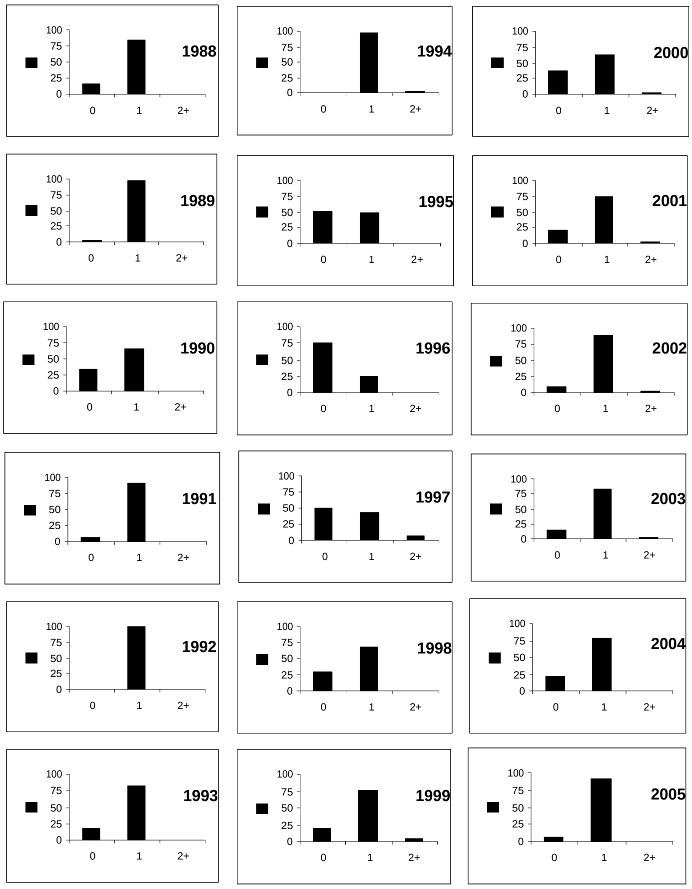


Figure 11.4.1.1. Anchovy in Division IXa. Age composition of Spanish catches of Gulf of Cadiz anchovy (Sub-division IXa-South, 1988-2005). Data for 1994 and second half in 1995 estimated from an iterated ALK by applying the Kimura and Chikuni's (1987) algorithm.

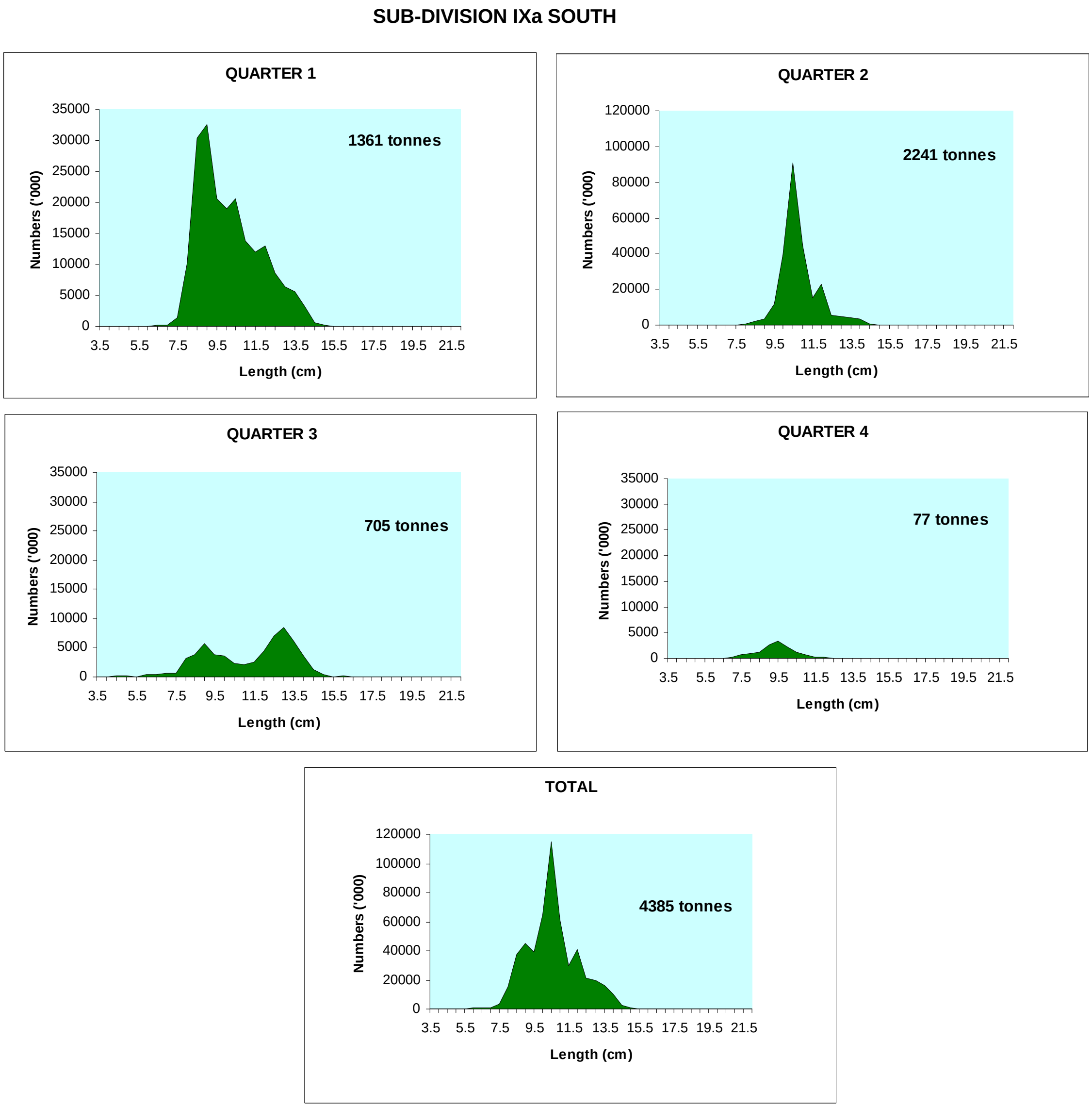


Figure 11.4.2.1. Anchovy in Division IXa. Length distribution ('000) of the Spanish quarterly and annual landings of anchovy in Sub-division IXa South (Gulf of Cadiz) in 2005. Note different scale in the y axis for 2nd quarter and total annual. Without data for Sub-division IXa North (Western Galicia).

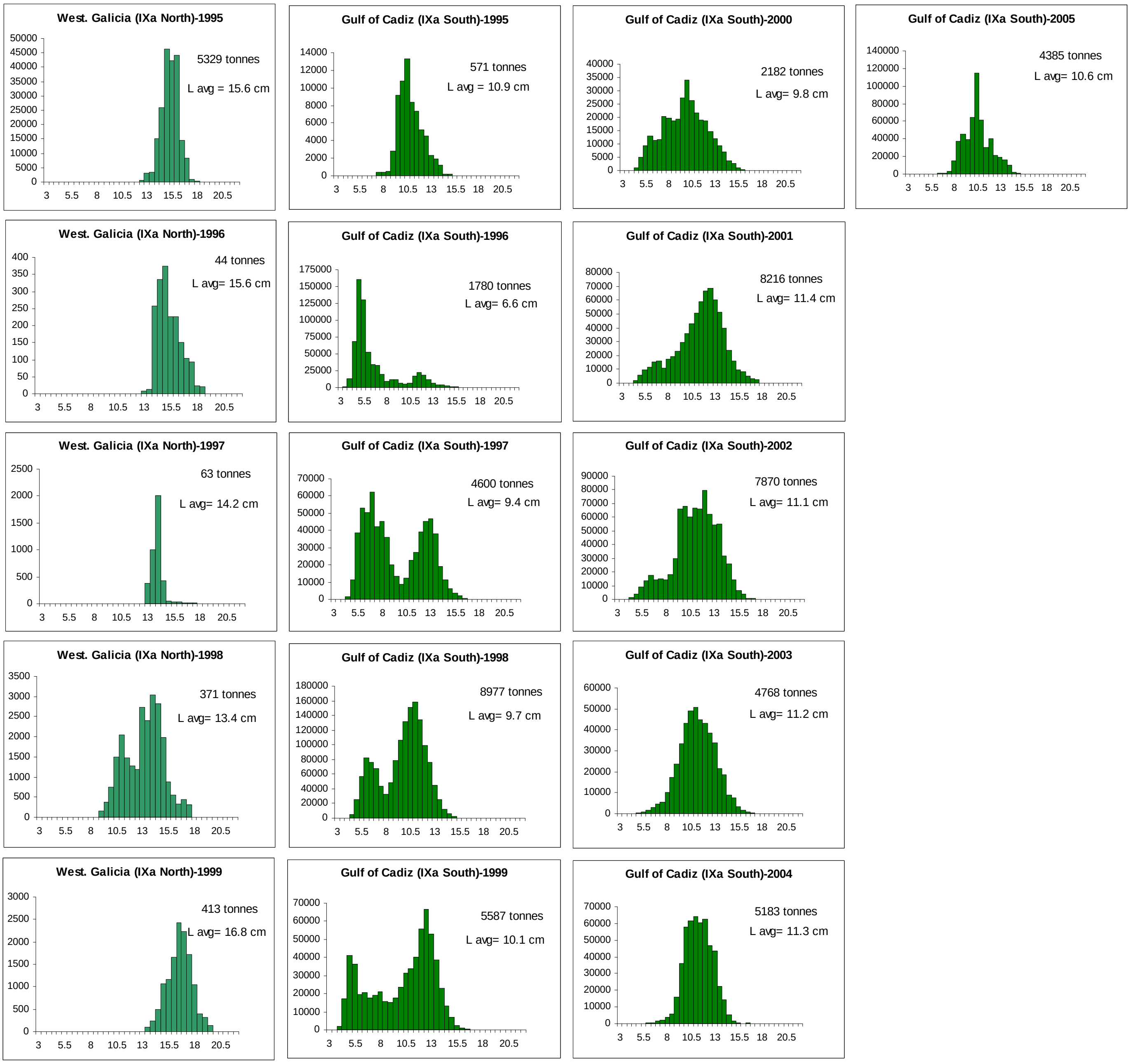
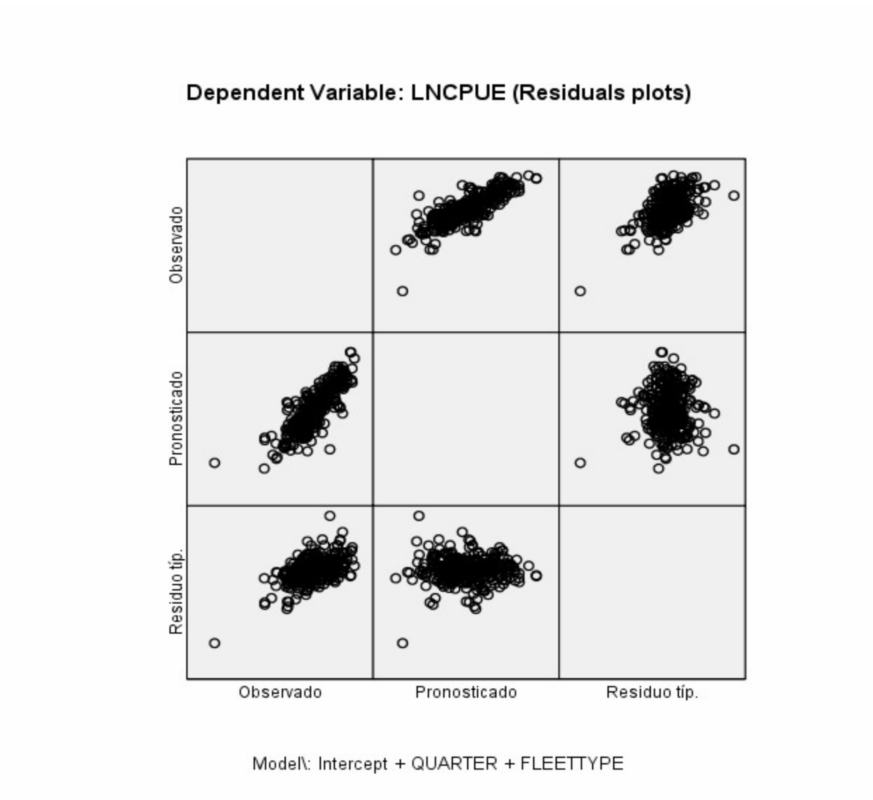


Figure 11.4.2.2. Anchovy in Division IXa. Length distribution ('000) of anchovy in Sub-divisions IXa South and IXa North (1995-2005).



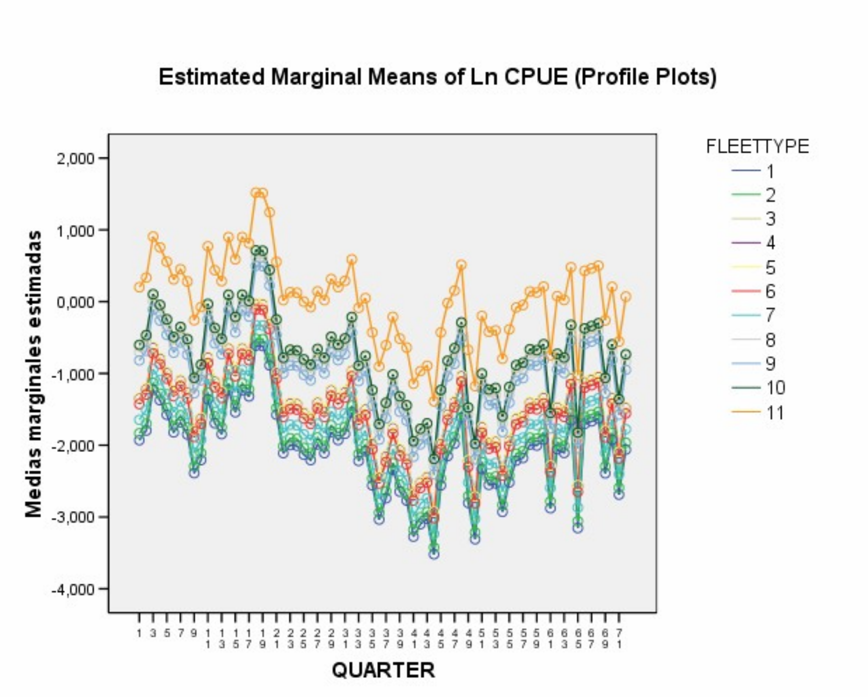


Figure 11.5.1. Anchovy in Division IXa. Residual and Profile plots for the GLM used for standardisation of CPUE data for Spanish fleets in Sub-division IXa-South (Gulf of Cadiz).

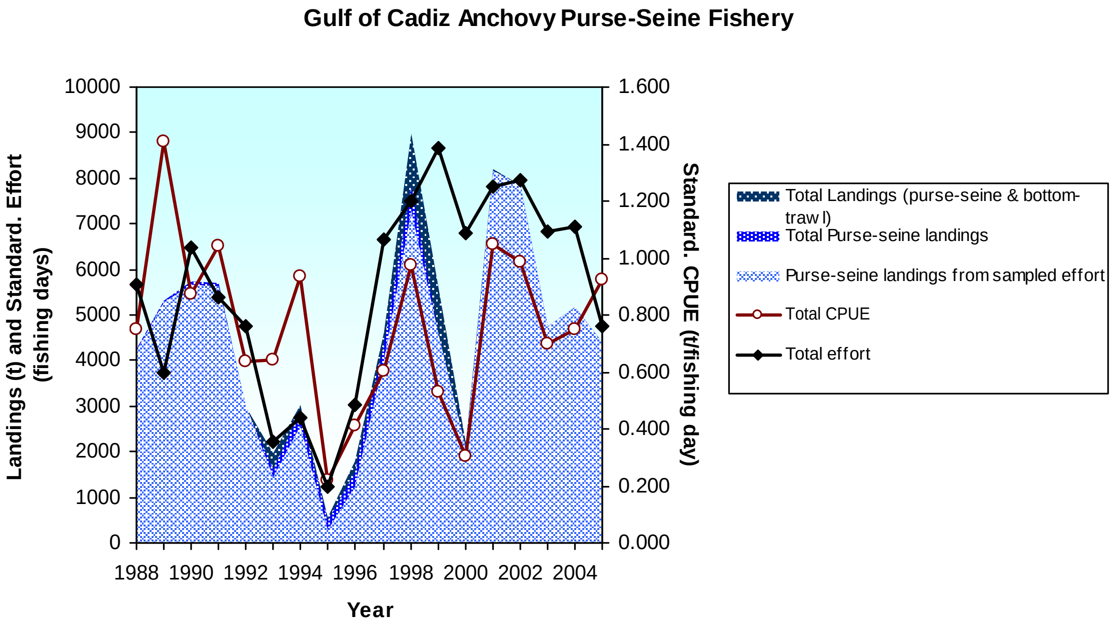
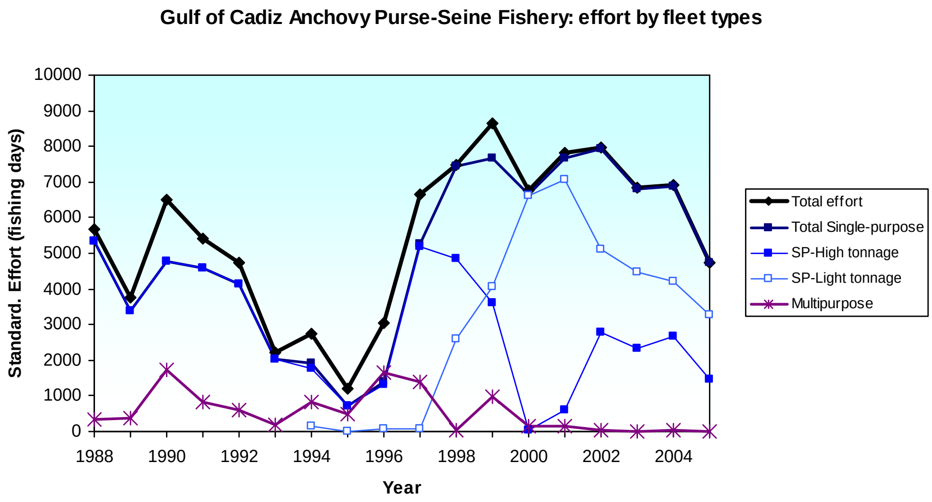


Figure 11.5.2. Anchovy in Division IXa. Gulf of Cadiz anchovy purse-seine fishery. Trends in annual landings, overall effort and CPUE. Landings are differentiated in total (purse-seine and bottom trawl fleets), purse-seine landings, and purse-seine landings corresponding to the sampled fishing effort.



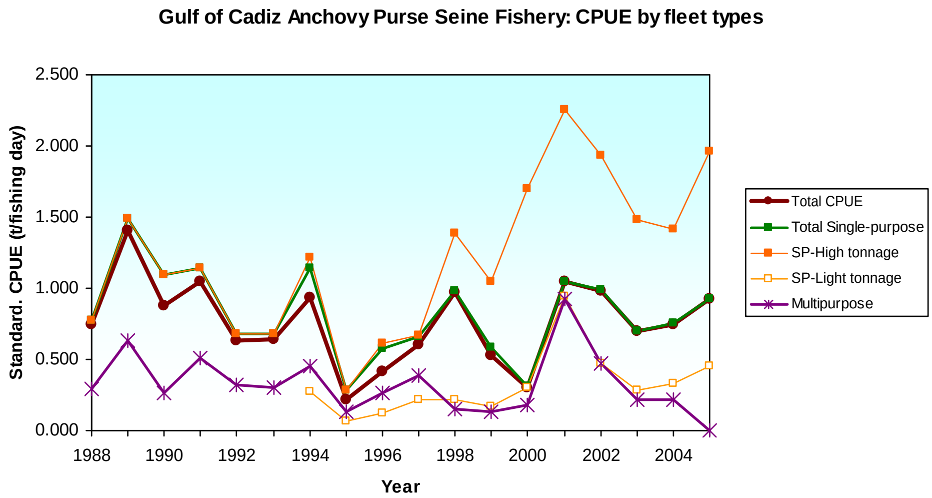


Figure 11.5.3. Anchovy in Division IXa. Gulf of Cadiz anchovy purse-seine fishery. Trends in annual series of effort (upper panel) and CPUE (bottom panel) by fleet type. Single-purpose fleet is also differentiated in heavy and light GRT vessels.

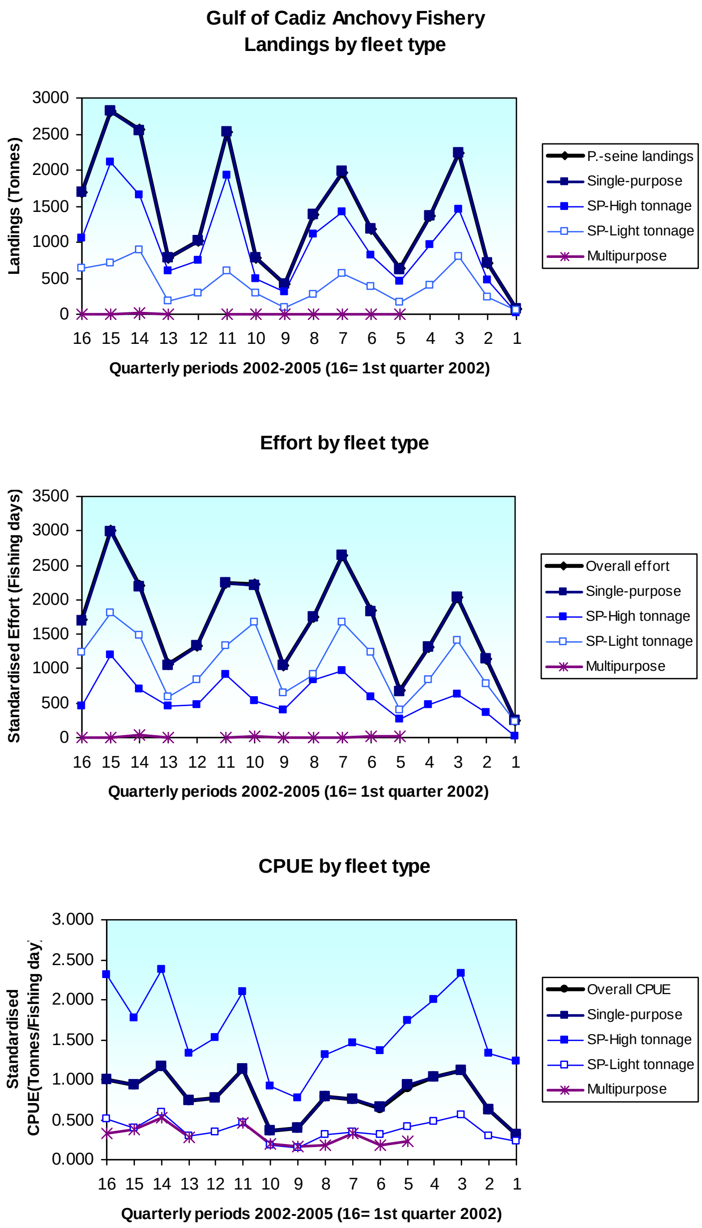
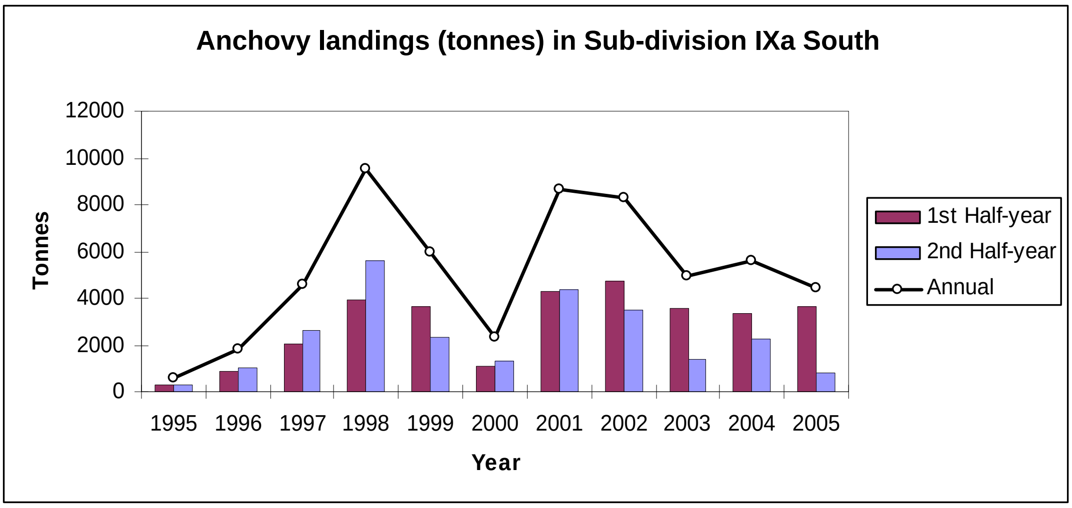


Figure 11.5.4. Anchovy in Division IXa. Gulf of Cadiz anchovy purse-seine fishery. Trends in quarterly series of landings (upper panel), effort (middle panel) and CPUE (bottom panel) by fleet type during the 2002-2005 period. A purse-seine fishery closure was implemented during the fourth quarter in 2004 and 2005 (17th November-31st December) . Single-purpose fleet is also differentiated in heavy and light GRT vessels.



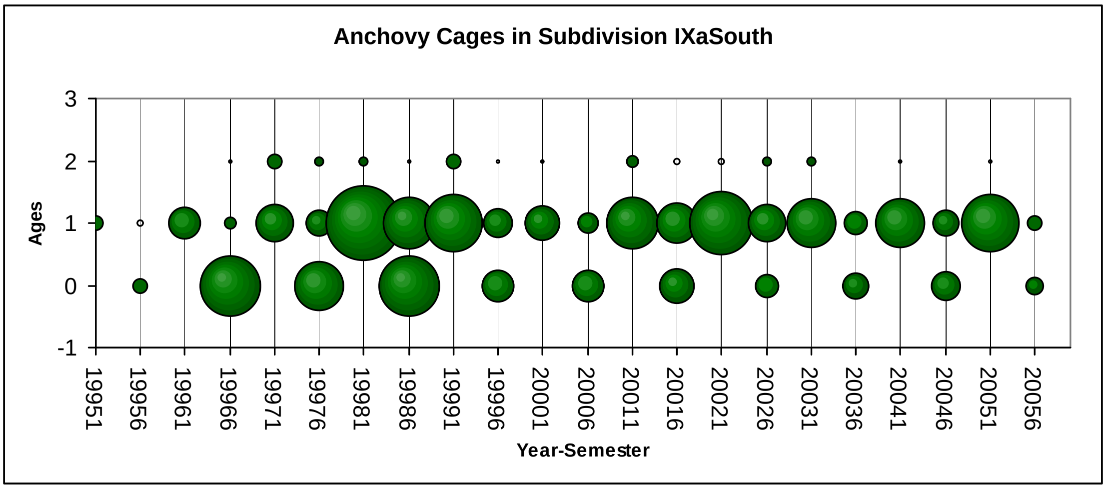
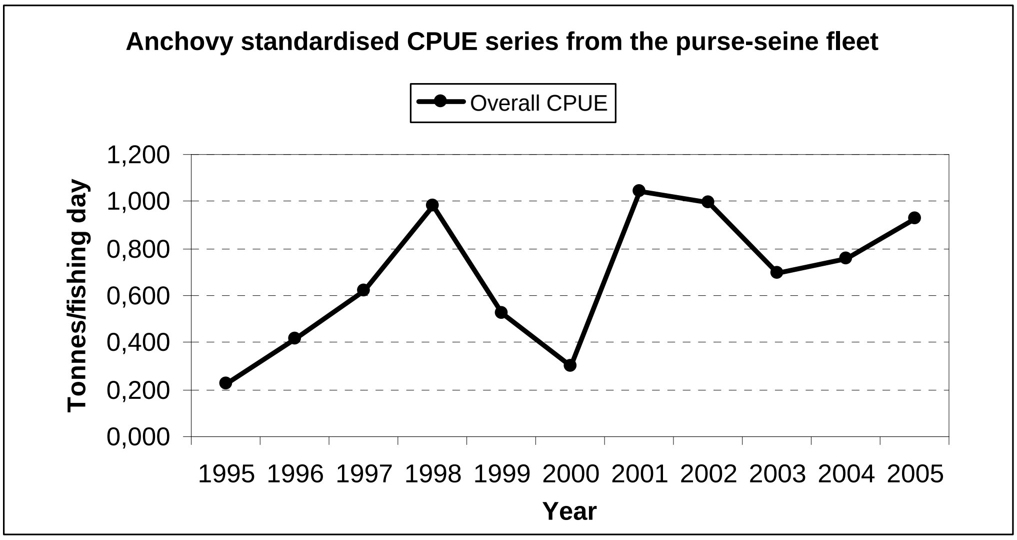


Figure 11.7.1. Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz). Trends in landings (upper panel, on an annual and half-year basis) and half-year catch-at-age numbers.



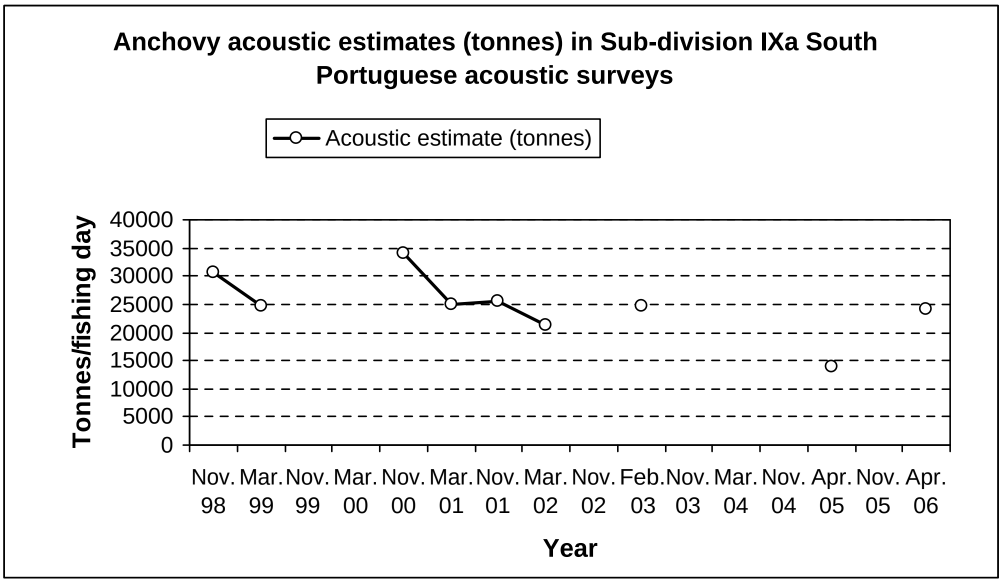
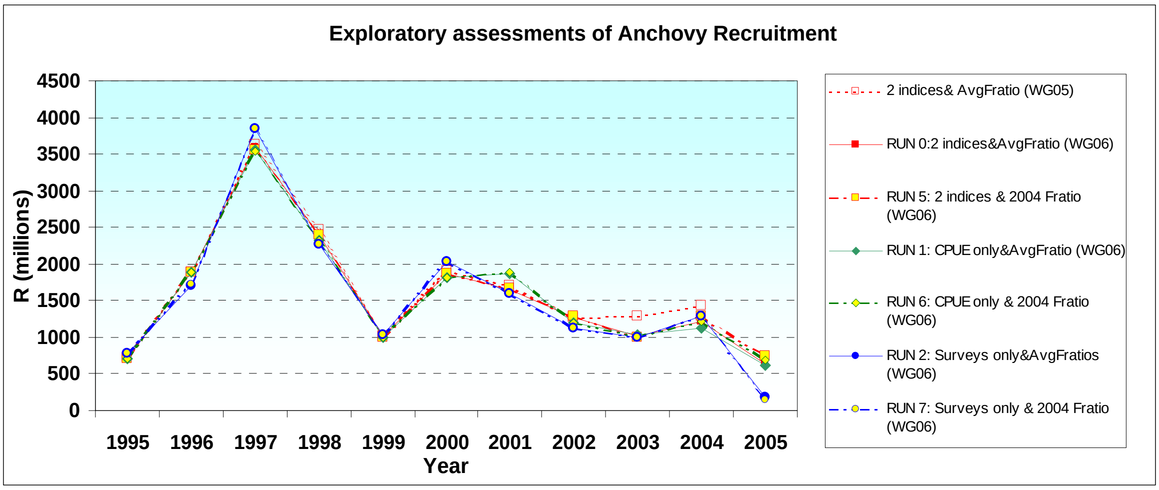
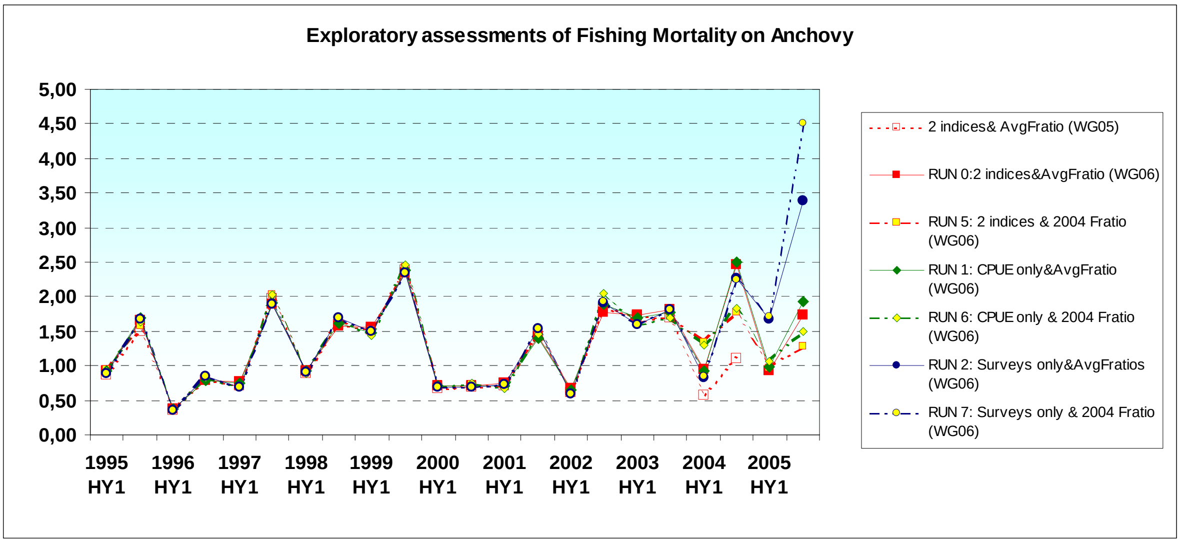


Figure 11.7.2. Anchovy in Sub-division IXa South(Algarve+Gulf of Cadiz). Trends in tuning indices (aggregated biomass) used in data exploration: standardised CPUE (upper panel) and Portuguese Acoustic Surveys estimates (bottom panel).





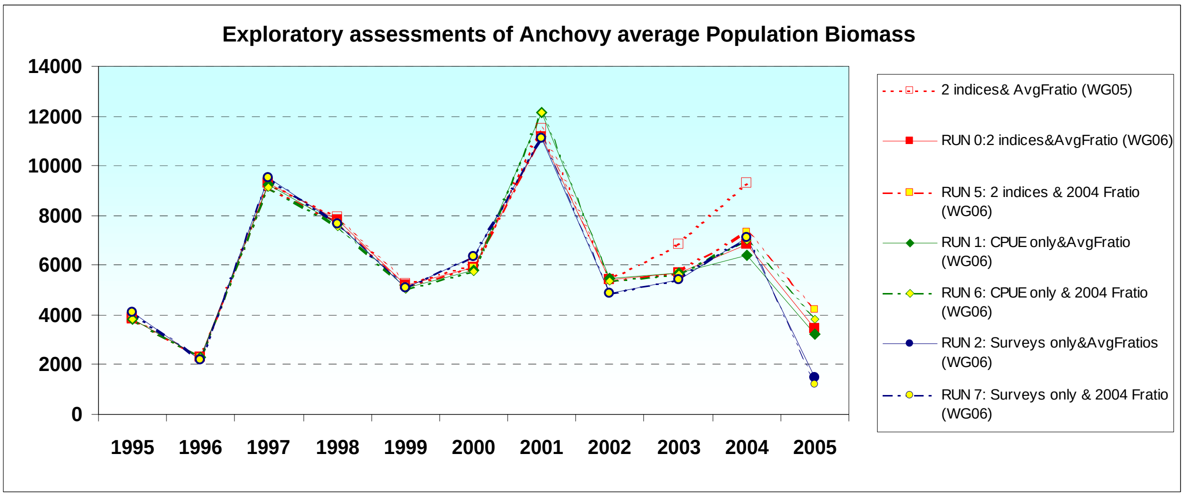
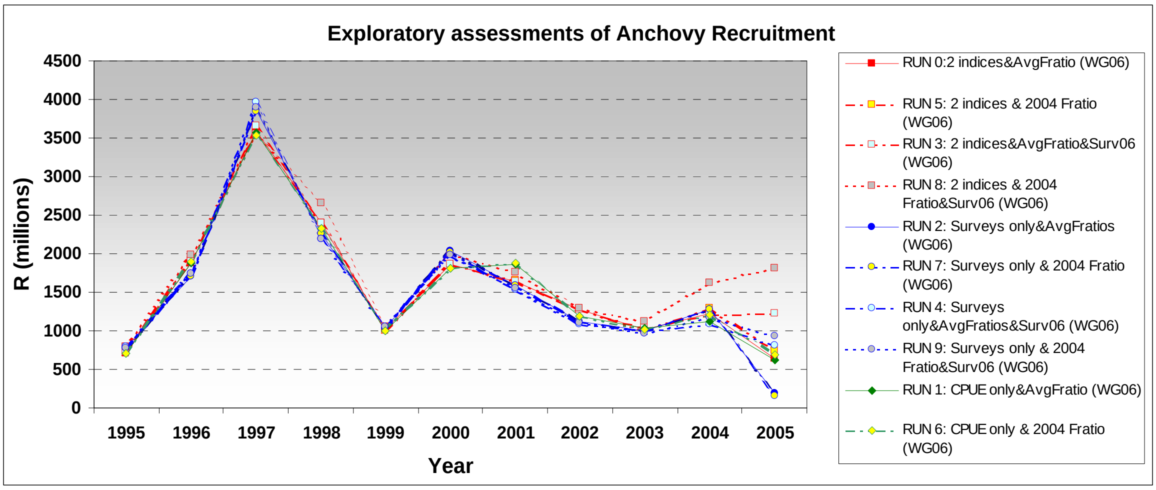
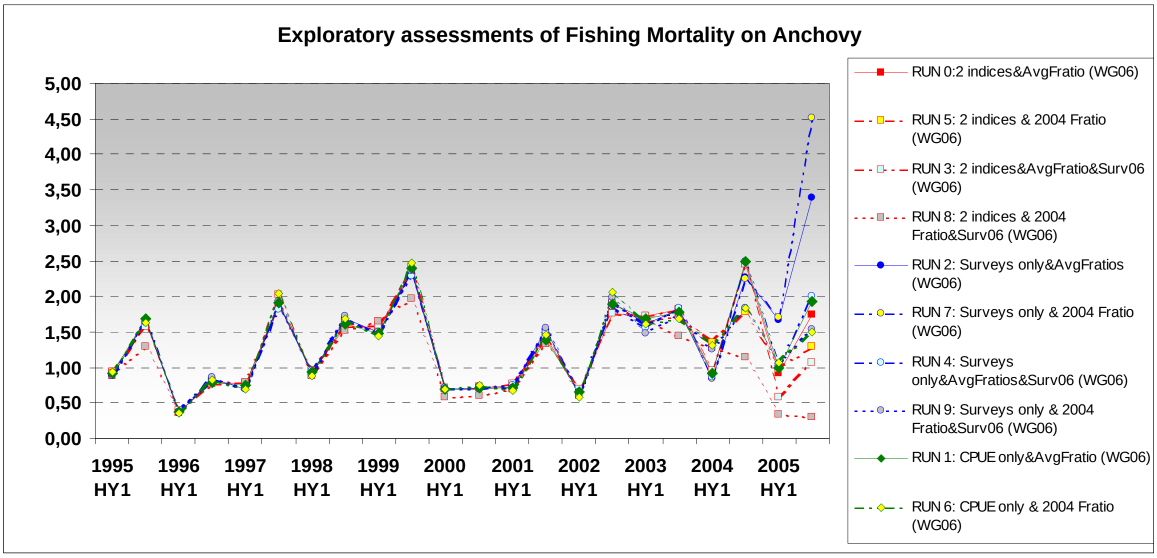


Figure 11.7.3. Anchovy in Sub-division IXa South(Algarve+Gulf of Cadiz). Comparison of last year's exploratory assessment (WG05) with the new input data in 2005 (WG06). AvgFratio: F settings as last year (F in the second-half in the last assessment year as the average ratio between F half-year values of preceding years); 2004Fratio: alternative setting for F (F in the second-half in the last assessment year as the average ratio between F half-year values in 2004).





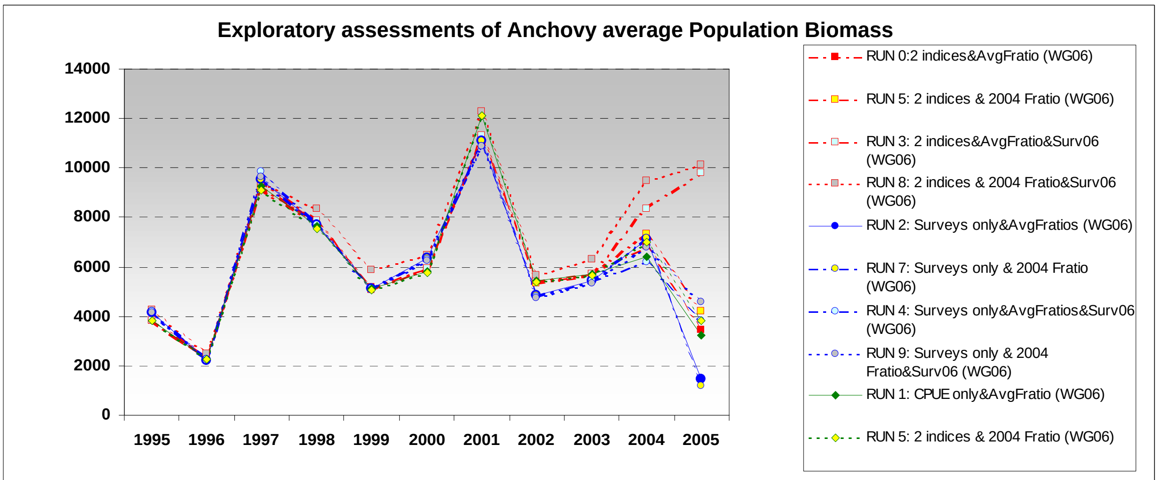
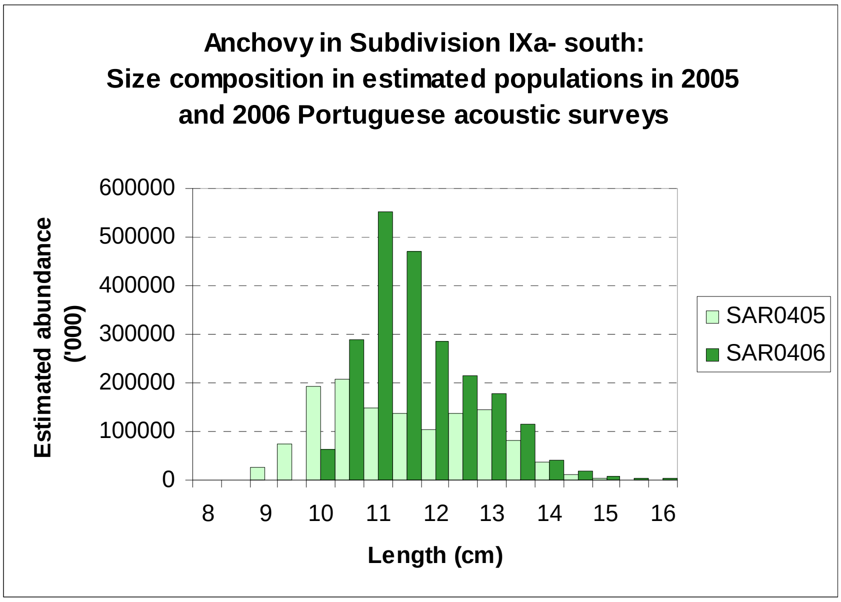


Figure 11.7.4. Anchovy in Sub-division IXa South(Algarve+Gulf of Cadiz). Comparison of exploratory runs performed with different settings of the F value in the second semester in the assessment's last year and those ones including the April 2006 acoustic estimate and assumptions on the catch at age, weight at age in the stock and F in the first semester in 2006.



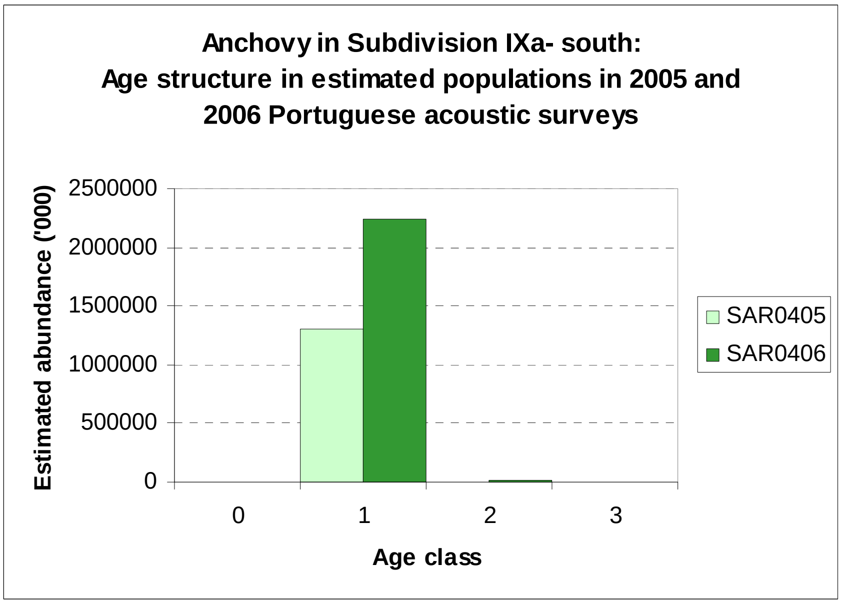


Figure 11.7.5. Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz). Size composition and age structure of anchovy in the April 2005 and 2006 Portuguese acoustic surveys.

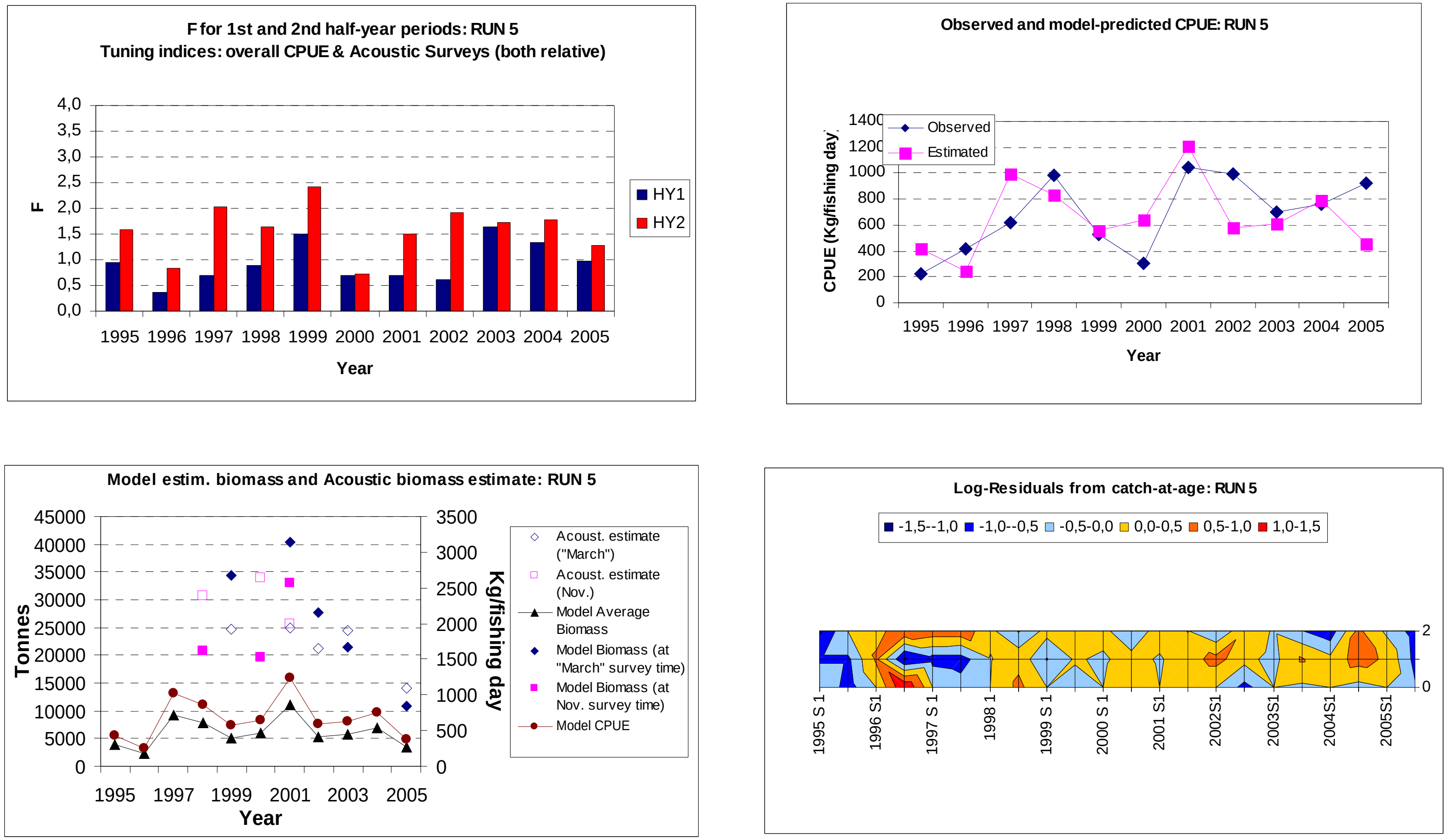
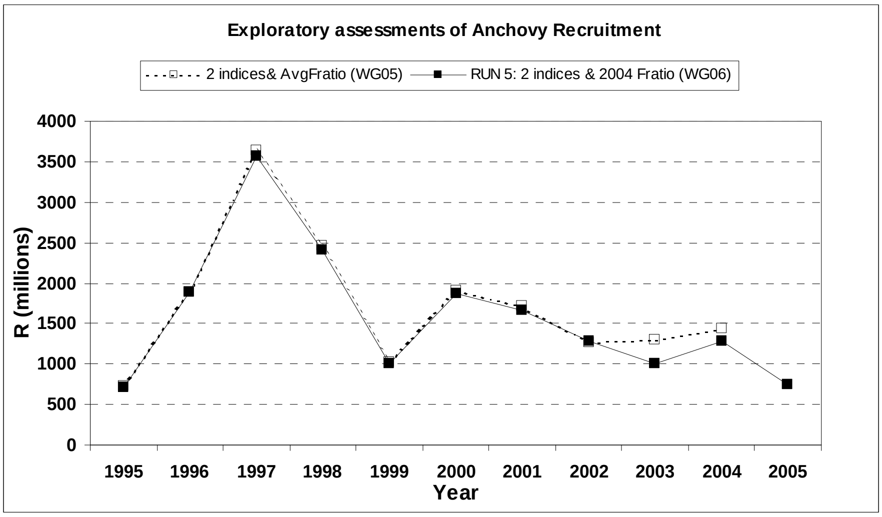
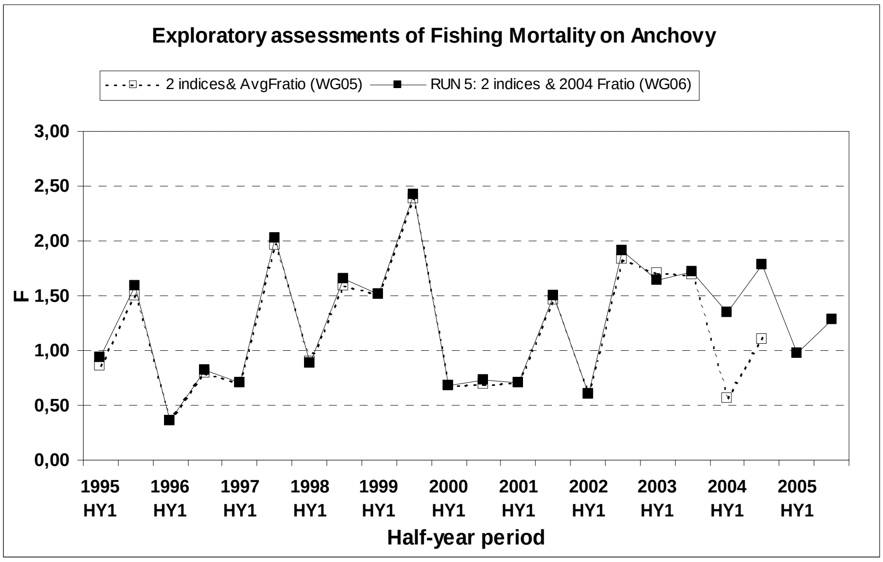


Figure 11.7.6. Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz). Results from data exploration RUN 5 with the ad-hoc seasonal separable model: estimated fishing mortalities (F) by the separable model (top left), observed and model predicted CPUE for the whole purse-seine fleet (top right), model estimated biomass and acoustic biomass estimates (bottom left), and Log-residuals from catch-at-age data (bottom right).





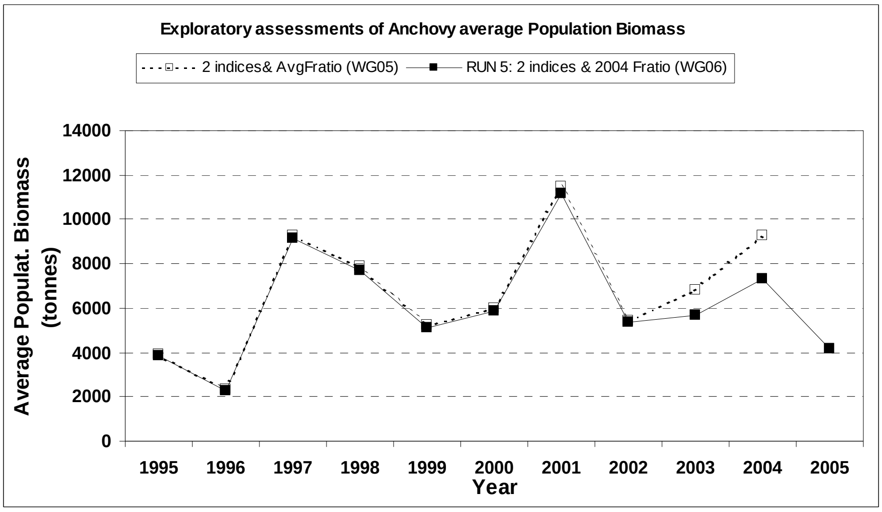


Figure 11.7.7. Anchovy in Sub-division IXa South(Algarve+Gulf of Cadiz). Comparison of accepted exploratory runs performed in the last year's WG and in the present one.

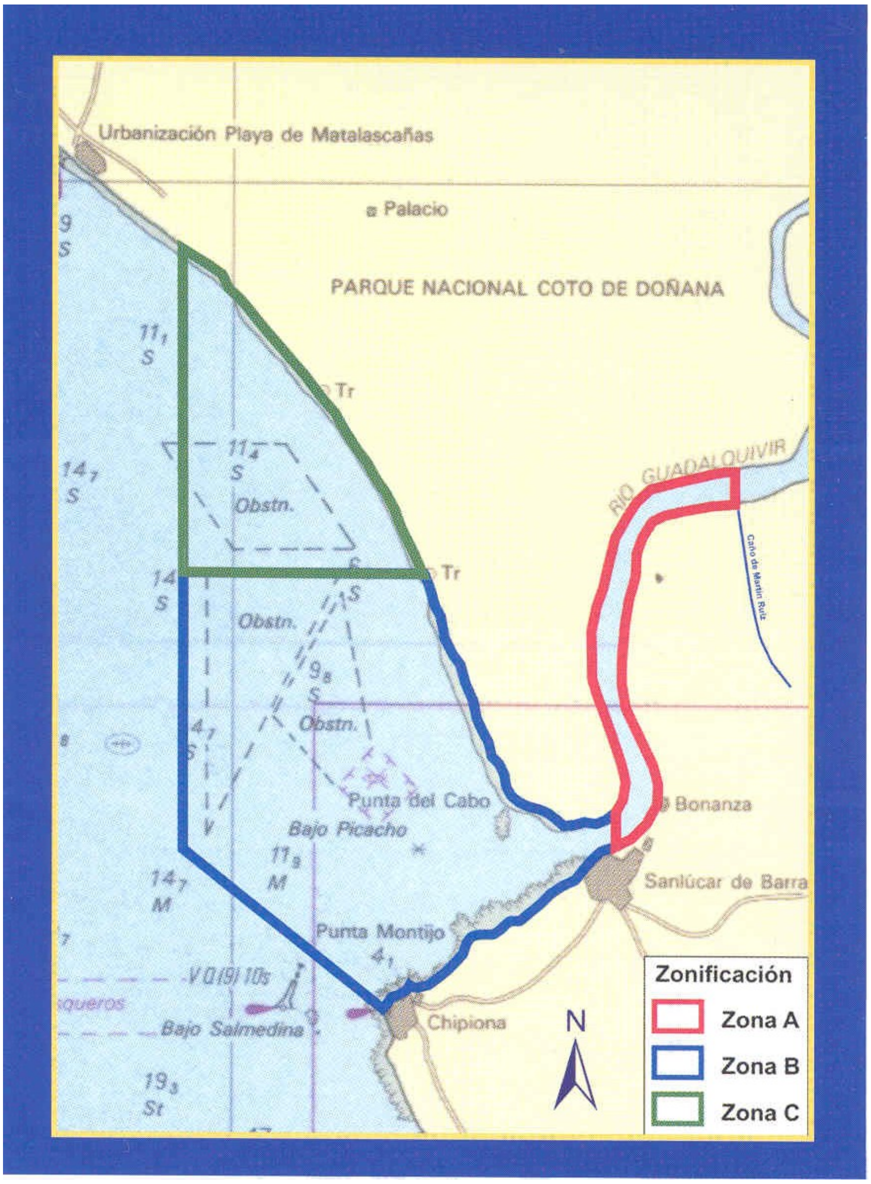


Figure 11.10.1. Anchovy in Division IXa. Limits of the Fishing Reserve off the Guadalquivir river mouth (Spanish Gulf of Cadiz. Sub-division IXa South).

12 Recommendations

1) The Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine, and Anchovy recommends for improved coordination between assessment working groups and the ecological/oceanographic working groups, with clearly defined deliverables. In particular, with the development of tools and the analysis for

a) the detection and enumeration of environmental variability and changes in productivity;

b) highlighting vulnerabilities of ecosystems to overexploitation and impact on trophic diversity.

2) The Working Group again recommends that observers should be placed on board vessels in those areas in which discarding may be a problem, because of the potential importance of significant discards levels on pelagic species assessments. Existing observer programmes should be continued.

North East Atlantic Mackerel

3) The Working Group again recommends that institutes examine their otolith preparation technique for mackerel before a new mackerel otolith exchange be carried out to evaluate the otolith processing techniques of all institutes that are providing age data to this Working Group.

4) All nations carrying out bottom trawl surveys in the western area or the northern North Sea are requested to provide the mackerel recruit data for Q4 surveys by the end of January 2007 and for Q1 surveys by the end of May 2007, to John Simmonds, together with their best estimates of their full survey time series.

Western Horse mackerel

5) The Working Group strongly recommends that The Netherlands samples the significant catches of horse mackerel taken by foreign flagged freezer trawlers landing into the Netherlands.

Sardine

6) The Working Group recommends that an intercalibration exercise should take place between the Spanish and Portuguese spring surveys to check the comparability of both population estimates.

7) The Working Group recommends that the Portuguese November acoustic survey should continue to be carried out since preliminary exploration during the WG has highlighted its usefulness as an indicator of recruitment strength for the stock. The WGMHSA also recommends that all possible efforts to cover the Spanish waters of the Gulf of Cadiz are made since Gulf of Cadiz seems to be an important recruitment area (at least in some years) with different recruitment dynamics than the northern area.

8) The Working Group recommends that data from areas VIIIa and VIIIb continue to be collected and to start the continuous collection of data from areas further north. The WGMHSA also recommends the coordination of that both acoustic and DEPM surveys carried out by Portugal, Spain and France in areas IXa, VIIIc, VIIIb and VIIIa continues to take place in order to cover the broader possible distribution of sardine.

9) The Working Group recommends further examination of the models developed in the SARDYN project, including the problems uncovered during the benchmark assessment process.

Anchovy Bay of Biscay

10) The WG recommends that the workshop on anchovy age determination taking place in the autumn of 2006 should, in particular, address the abnormal abundance of 2-ring fish observed in the 2006 spring surveys to determine whether it is the result of incorrect age determination.

11) The WG recommends that the spring acoustic and DEPM surveys should be maintained since they provide the main tuning indices to the current assessment.

12) The WG recommends that the acoustic and fishing surveys should continue to be carried out in the period of September/October every year to provide an index of abundance of recruits. The survey(s) should cover the known distributional areas of the juvenile anchovy and should include pelagic trawling as well as purse seine fishing.

13) The WG recommends the continuity of the ecological studies and research surveys to understand the role of SSB, as well that of ecosystem community and the environment on the recruitment process.

14) The WG also recommends that further understanding of the catchability and observation error of surveys should be pursued with ICES WGACEGGS.

Anchovy IXa

15) The Working Group recommends that the intersectional work outlined in Section 11.11 should be carried out. A special priority must however be given to:

- the exploratory analysis and model implementation of the GLM utilized for the standardisation of the Spanish purse-seine fleets' CPUE.
- the histological analysis of adult samples from the 2005 DEPM Spanish survey in order to provide the corresponding anchovy SSB estimate to the next year WG.
- the continuation of direct surveying of the anchovy in the Division either by annual (Acoustics) or triennial (DEPM) survey series.
- the recovery of all the information available on the anchovy fishery and biology (including information on age structure by Sub-division if available) off Portuguese and Spanish waters.

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14 Abstracts of Working Documents

WD 01/06

Bernal, M. Stratoudakis, Y. Coombs, S. Angelico, M.M. A Lago de Lanzós, Porteiro, C. Sagarminaga, Y. Santos, M. Uriarte, A. Cunha, E. Valdés, L. and Borchers, D.

Sardine spawning off the European Atlantic coast: spawning areas and temporal variability.

Document available from: Miguel Bernal, IEO, Centro Costero de Cádiz, Centro Andaluz de Ciencia y Tecnología Marina, Poligono del Río San Pedro s/n, 11519 Puerto Real, Cádiz, Spain..

E-mail: miguel.bernal@cd.ieo.es

Data on the occurrence of sardine (*Sardina pilchardus*) eggs from 42 national ichthyoplankton surveys along the European Atlantic coast were collated in order to describe the spawning habitat and spawning distribution of sardine in recent decades (1985-2005). A modification of existing spawning habitat characterisation techniques and a newly developed method to compare the probability of egg presence across surveys carried out with different sampling gears were used. Results showed that sardine spawning off the Atlantic European coast is mainly restricted to the shelf area, with the main geographical range being between the Strait of Gibraltar (the southern limit of data available for this analysis) and the middle part of the Armorican shelf (latitude around 47.5º North), and along a temperature range of 12 to 17º C. Spawning grounds within these limits show a nearly continuous geographical distribution, covering a large proportion of the shelf of the Iberian peninsula and adjacent waters, except for 1) a persistent gap at the north west corner of the Iberian peninsula, 2) a small secondary break at the Spanish – French border in the inner part of the Bay of Biscay and 3) at the south west corner of the peninsula where there is a narrowing of the shelf width. These discontinuities were used to separate spawning into four nuclei and to describe the changes in spawning distribution in the time series. The relative importance of each nucleus and the degree of separation between adjacent nuclei varies between years, with the exception of the permanent gap at the north west corner of the Iberian peninsula, which is persistent throughout the time series. Year to year changes in the proportion of the potential spawning habitat in which spawning actually occurred, changed from around 60% before the mid 1990s to around 40% thereafter, and did not show any relationship with spawning stock biomass. Evolution of potential habitat occupation over the Armorican shelf shows larger variability than that observed in the Iberian peninsula, with percentages of occupation ranging from around 30% up to nearly 80% of the shelf in recent years (within the limitations of the relatively sparse data for this region).

WD 02/06

Boyra, G. and Uriarte, A.

Acoustic surveying of anchovy Juveniles in the Bay of Biscay: JUVENA 2005 survey results and 2003-2005 biomass estimates.

Document available from: Andrés Uriarte, AZTI, Herrera kaia, Portualde z/g, 20110 PASAIA, Gipuzkoa, País Vasco, España.

E-mail: auriarte@pas.azti.es

The project JUVENA (Acoustic surveying of anchovy juveniles) aims at estimating the abundance of anchovy juveniles in Autumn in the Bay of Biscay. The long term objective of the project is to be able to assess the strength of the anchovy recruitment entering the fishery the next year so as to help on the provision of scientific advice to managers. The surveys take place annually since 2003 using acoustics, purse seine hauls 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. This project is funded by the Department of Agriculture and Fisheries of the Basque Government, as well as the Spanish Ministry of Agriculture, Fisheries and Food, seeking for improving the scientific advice for management of this population.

This document presents the results of the 2005 survey, as well as a comparison of anchovy juvenile abundance and spatial distribution during the three years of campaigns, including preliminary discussion about the ability of the surveys to forecast the recruitment magnitude each year. However, notice that the short series of JUVENA surveys precludes so far any categorical conclusion or quantitative use of their results.

WD 03/06

Cunningham, C.L. and Roel, B.A.

The Assessment of Iberian Sardine: A Bayesian State-Space Model Incorporating Migration and Spatially-Disaggregated Data

Document available from: Carryn Cunningham, Marine Resource Assessment and Management Group, Department of Mathematics and Applied Mathematics, University of Cape Town, Private Bag X3, Rondebosch, 7701, South Africa.

E-mail: c.l.cunningham@telkomsa.net

A number of questions cloud the accurate assessment of the Iberian sardine (*Sardina pilchardus*). These include the direction and degree of migration within the assessed area (ICES divisions IXa and VIIIc), immigration from /emigration to adjacent areas outside that considered by the assessment models and the potential for multiple stocks within the assessed area. The *Sardine Dynamics and Stock Structure in the North-East Atlantic* (SARDYN) EU-project has sought to provide further research to answer some of these questions. As part of the SARDYN project, a Bayesian state-space model for the Iberian sardine has been developed as a first step to testing these uncertainties.

Combining spatially explicit data together with expert advice this model is able to explicitly incorporate the migration of the sardine between areas. Some of the implications of the results from this work include the following: i) immigration into the Iberian sardine population from the North-east (ICES division VIIIb) is likely; ii) the migration pattern of good yearclasses may not be distinct (especially w.r.t a greater northerly flux) from that of normal/weak yearclasses and iii) either sardine of age 7+ appear to leave Portuguese waters or there may be a tendency to underestimate the age of older year-classes. This model was also able to test an alternative hypothesis in which two separate stocks were assumed to span the modelled area. Comparing the marginal posterior probabilities suggested that the single stock hypothesis is much more likely than the two stock hypothesis. This is in agreement with results from other contributions to the SARDYN project.

WD 04/06

Duhamel, E.

The French sardine fishery.

Document available from: Erwan Duhamel, IFREMER, Lab. Fisheries Research, 8 rue François Toullec 56100 Lorient, France.

E-mail: erwan.duhamel@ifremer.fr

Since 1999, two database are available. The first one called 'log-books' is made of all the information available in the EU log-books. The second one ('Sales') is a record of all the information from the auctions. This includes all the landings of all species from all vessels (since the sale is recorded). It does not provide any information on effort, gear or area.

Before 1999, only one database was available which was a merge of the two sources of data. In the earlier years, vessels without log-books were generally merged in a common vessel. This was the case in 1998 for lot of vessels operating in the Bay of Biscay.

This fishery is not so opportunist compared to the anchovy one. Few catches may even be taken by bottom trawlers. The purse seine is the main gear for sardine, but to define a clear target fishing fleet, it is necessary to analyse the catches boat by boat along a year to separate regular to occasional vessels.

Pelagic trawlers are targeting less and less sardine, year after year. In an assessment approach, it would be necessary to define an estimation of fishing effort, but it will be very difficult.

WD 05/06

Iversen, S. A. Skogen, M. and Svendsen, E.

A prediction of the Norwegian catch level of horse mackerel in 2006.

Document available from: Svein A. Iversen, Institute of Marine Research, P.O Box 1870 Nordnes, 5817 Bergen, Norway.

E-mail: svein.iversen@imr.no

Norway has in most years since 1987 been the major nation fishing for horse mackerel in the northern North Sea and Norwegian Sea, and the fishery is carried out by purse seiners in the Norwegian economical zone (NEZ). The fishery is usually carried out in October and is considered to exploit the western stock. The purse seine fleet adapts its effort in this fishery according to the actual availability of horse mackerel. This means that in years with low availability of horse mackerel the fleet will leave the fishery. The Norwegian fleet exploits mainly the 5+ group and the fishery started in 1987 when the 1982 year class was five years old.

The modelled influx of Atlantic water to the North Sea during the first quarter correlates well with the Norwegian catches of horse mackerel in NEZ later in the year. An exception is 2000 when there was no obvious correlation. The correlation has been used locally to predict the catch levels in NEZ since 1996.

WD 06/06

Marques, M. and Morais, A.

Sardine acoustic surveys carried out in November 2005 and April 2006 off the Portuguese Continental Waters and Gulf of Cadiz, onboard RV "Noruega".

Document available from: Vítor Marques Instituto Nacional de Investigação Agrária e das Pescas (INIAP-IPIMAR), Av. Brasília, 1449-006, Lisboa, Portugal.

E-mail: vmarques@ipimar.pt

This paper presents the main results of the Portuguese acoustic surveys carried out during November 2005 and April 2006 onboard R. V. "Noruega". The objectives of the survey were to estimate the spatial distribution and the abundance of sardine (*Sardina pilchardus*) and anchovy (*Engraulis encrasicolus*) by length classes and by age groups, in the surveyed area. Due to bad weather in the November 2005 survey the Cadiz area was not covered (a total of 60 transects were surveyed). In the April 2006 survey all the 69 planned acoustic tracks were performed. A Continuous Underway Fish Eggs Sampler (CUFES) was also used to monitor the sardine egg abundance and to collect some hydrographical parameters (surface temperature, salinity and fluorescence). The Portuguese "PNAB-EU Data Collection Regulation" partially supports both surveys.

WD 07/06

Massé, J., Méhault, S., Beillois, P., Duhamel, E., Planque, B., Petitgas, P., Biseau, A.

Direct assessment of anchovy by the PELGAS06 acoustic survey

Document available from: Jacques Massé, IFREMER, lab. Fisheries Ecology, BP 21105, F-44311, Nantes, France.

E-mail: Jacques.Masse@ifremer.fr

An acoustic survey was carried out in the bay of Biscay from May 1st to May 30th on board the French research vessel Thalassa. The objective of PELGAS06 survey was to study the abundance and distribution of pelagic fish in the Bay of Biscay. The target species were mainly anchovy and sardine and were considered in a multi-specific context. The results have to be used during ICES working groups in charge of the assessment of sardine, anchovy, mackerel and horse mackerel and in the frame of the Ifremer fisheries ecology program "resources variability".

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

1) Continuous acquisition by storing **acoustic** data from five different frequencies and pumping sea-water under the surface, in order to evaluate the number of fish eggs using **CUFES** system (Continuous Under-water Fish Eggs Sampler)), and

2) discrete sampling at **stations** (by trawls, plankton nets, CTD).

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

Concurrently, a visual counting and identification of cetaceans and of birds (from board) was carried out in order to characterise the higher level predators of the pelagic ecosystem.

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

WD 08/06

Ramos, F., Miquel, J., Millán, M., Iglesias, M., Oñate, D., and Díaz, N.

Results on the acoustic assessment and distribution of the main pelagic fish species in the ICES Subdivision IXa South during the ECOCÁDIZ 0606 Spanish survey (June 2006).

Document available from: Fernando Ramos, Instituto Español de Oceanografía (IEO), Estación de Biología Pesquera de Cádiz, Apdo. 2609, 11006 Cadiz, Spain.

E-mail: fernando.ramos@cd.ieo.es

The working document reports the main results from a Spanish acoustic survey conducted between 18th June and 1st July 2006 in the Portuguese and Spanish shelf waters (20-200 m isobaths) off the Gulf of Cadiz with the R/V "*Cornide de Saavedra*". The survey season was coincident with the anchovy (*Engraulis encrasicolus*) peak spawning to achieve an acoustic estimate of the anchovy SSB in the study area. Abundance and biomass estimates are given for anchovy (by length and age classes), sardine (*Sardina pilchardus*) and Chub mackerel (*Scomber japonicus*) (both by length classes), the only commercially important species that were susceptible of being acoustically assessed from their occurrence and abundance levels in the study area. The distribution of these species is also shown from the mapping of their back-scattering energies. Anchovy was distributed all over the study area but in the shelf fringe between Cape Santa María and the Guadiana river mouth, and with the densest concentrations being recorded, as usual, in the Spanish waters. The total biomass estimated for anchovy was 27.8 thousand tonnes (2487.3 x 10^6 individuals). Sardine showed an almost uninterrupted distribution, although higher densities occurred in both extremes of the sampled area. Again, the Cape Santa María's shelf area seemed to play a role of "barrier" in the sardine distribution, but in a weaker way than in the anchovy distribution. The total biomass estimated for sardine was 123.9 thousand tonnes (2874.1 x 10^6 individuals). Chub mackerel was mainly distributed in Algarvian waters, with relatively small and scattered nuclei of density in the Spanish waters. The highest densities surprisingly occurred in the sourroundings of the Cape Santa María, just where anchovy was absent and sardine was relatively scarce. The Chub mackerel total biomass was estimated at 30.0 thousand tonnes (456.2 x 10^6 individuals).

WD 09/06

Rihan, D. & Graham, N.

Working Document from ICES-FAO Working Group on Fishing Technology & Fish Behaviour to WGMHSA.

Document available from: Dominic Rihan, BIM (Bord Iascaigh Mhara), P.O.Box 12, Crofton Road, Dum Laoghaire, Ireland.

E-mail: rihan@bim.ie

This report is based on the WGFTFB annual questionnaire, which is sent to WG member each year. Information relating to fleet activities, such as changes between métiers, technological creep, reactions to legislative constraints etc is gathered each year. The objective is to provide information that may be of use to assessment working groups, in relation to fisheries based management plans and to 'flag' issues that may affect commercial CPUE. The information is largely qualitative and is based on the personal experiences and observations of gear technologists across Europe. During the annual WGFTFB meeting, the information is collated and a report detailing the various issues produced. As well as the production of this general report, issues specific to particular assessment groups are raised in separate 'regional' report.

This document outlines a number of technical issues relating to fishing technology that may impact on fishing mortality and also more general ecological impacts. These include recent changes in commercial fleet behaviour that may influence commercial CPUE estimates, identification of recent technological advances (creep); selectivity issues; sources of unaccounted fish mortality not perhaps previously considered; ecosystem effects in pelagic; and also pelagic survey trawl design.

It should be noted that the information contained in this report does not cover fully all fleets engaged in pelagic fisheries for mackerel, horse mackerel, sardine and anchovy; information was obtained from Ireland, Scotland, Netherlands, Norway, France and Spain.

WD 10/06

Roel, B. A. and De Oliveira, J. A. A.

Harvest Control Rules for Western horse mackerel (*Trachurus trachurus* L.) given paucity of fishery-independent data

Document available from: Beatriz A. Roel, CEFAS, Lowestoft Laboratory, Pakefield Road, Lowestoft, Suffolk NR33 0HT, United Kingdom.

E-mail: b.a.roel@cefas.co.uk

The western horse mackerel is a widely distributed EU stock characterised by spasmodic recruitment. At present, the strength of a year class cannot be confirmed before it is 5 years old, when it is fully recruited to the fishery. The only fishery-independent information available is an estimate of egg abundance made every third year. The state of the stock is considered uncertain and there is no agreed management plan. Following EU and ICES requests, a set of Harvest Control Rules (HCRs) that take into account the fact that the fishery has expanded in recent years to take a large proportion of juvenile fish was tested by simulation. The proposed HCRs are either based on the results from a full assessment (constant proportion strategy) or simply on the egg estimate used as an indicator of the state of the stock (slope strategy). Biological risk is compared for scenarios where: 1) uncertainty regarding the stock dynamics and implementation of management measures is large (current situation); 2) variable fractions of the TAC are taken in the juvenile and adult areas and 3) there is implementation error. Results suggest that taking a larger component of the TAC in the juvenile area increases the risk for the stock. Comparison of the constant proportion and slope strategies suggests that the constant proportion is more conservative provided that the assessment is unbiased or the bias is low. Given the paucity of fishery independent data a strategy resulting in practically constant catch may be appropriate for this stock.

WD 11/06

Santos, M., Ibaibarriaga, L., Uriarte, A.

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

Document available from: Maria Santos, Instituto Español de Oceangrafia Puerto Perquero s/m, 29640 Fuengirola, Spain.

E-mail: msantos@pas.azti.es

The Daily Egg Production Method (DEPM) survey called BIOMAN06 to estimate the Spawning Stock Biomass (SSB) and population at age of anchovy in the Bay of Biscay was carried out in May 2006 by AZTI-Tecnalia (Instituto Tecnológico Pesquero y Alimentario, Pasajes). This survey was carried out within the frame of the Spanish Fishery Monitoring National Programme contracted with the European Commission and co-founded by the Basque Government.

In addition, an acoustic survey was conducted by the Institute Français de Recherche pour l'Exploration de la Mer (IFREMER, Nantes) collaborating with this survey to supply part of the adult samples required to estimate the adult fecundity parameters for the application of the DEPM.

Within this international context the current survey intend to provide biomass and population at age estimates of the anchovy in the Bay of Biscay on this year 2006 to ICES for the assessment of this species.

The preliminary SSB estimate presented at STECF in June (14-16) 2006 at Ispra (Italy) was 16,820 tonnes with a C.V. 25%. This was based on the total egg production (P_{tot}) and a Daily Fecundity (DF) obtained from a linear regression model between DF and sea surface temperature (SST).

Preliminary results of this survey were remitted as well to the Basque government, IEO and IFREMER scientists, the Spanish General Secretariat for Marine Fisheries and other interested parties.

This document presents final estimates of the SSB and numbers at age in May 2006 of the Bay of Biscay anchovy according to the results of BIOMAN06 survey. These estimates are base on full application of the DEPM after the whole adult samples were processed. The final biomass estimated was 21,436 tonnes. C.V. 19%

WD 12/06

Silva, A. Bernal, M. And Santos B.

Revision of maturity ogives and stock weights for the Iberian sardine stock.

Document available from: Alexandra Silva, IPIMAR – DRM, Instituto de Investigaçao das Pescas e do Mar, Av. Brasília, 1400 Lisboa, Portugal.

E-mail: asilva@ipimar.pt

This document presents revised estimates of annual maturity ogives and weight-at-age for the Iberian sardine stock in 1996-2005, describes changes in SSB due to this revision and discusses the possibility of revising biological data for earlier assessment years. Biological samples from Portuguese and Spanish acoustic surveys spanning the whole stock area in the period 1996-2005 are used to estimate these parameters. Logistic and power models are fitted to maturity-at-length and weight-at-length, respectively. Predicted values from these models are raised to population numbers using length frequency distributions (from acoustic estimation) and age-length-keys, separately for each year and region (north, west and south Iberia). These are combined to produce annual stock values using population numbers-at-age assuming equal catchability of the two surveys. Sardine maturity and weight-at-age present considerable geographical variation, with heavier and earlier maturing individuals off the northern region. The revised stock maturity ogives are generally similar to those currently used in assessment. On the other hand, currently used weights-at-age calculated from catch samples collected off the Portuguese coast are higher than the ones obtained in this revision. Thus revised SSB estimates for 1996-1998 and 2003 are considerably lower than former estimates. New biological parameters presented here are considered reliable since they are based on large samples collected across the stock area with comparable methods and estimated with a consistent procedure which takes into account recent knowledge about spatial and temporal variations in sardine biology. This approach can be pursued in the future however revisions of biological parameters for earlier assessment years are limited due to data sparseness.

WD 13/06

Simmonds, J.

Missing biomass in estimates of NE Atlantic mackerel stock.

Document available from: John Simmonds, Fisheries Research Services, Marine Laboratory, P.O. Box 101, 375 Victoria Road, Aberdeen AB11 9DB, United Kingdom.

E-mail: j.simmonds@marlab.ac.uk

In 2004 the assessment for mackerel was changed to reflect greater uncertainty in the size of the stock. This resulted from preliminary analysis of the mackerel egg survey data that indicated that the egg survey may be estimating fewer eggs than the number spawned due to initial egg mortality of about 40%. In addition, when fitted to the index, the assessment indicated a further 30% difference between the population based on reported catches and the state of the stock.

Three estimates of underreporting of Scottish catches amounting to 9% of the total catch of mackerel are used to explore the sensitivity of the assessment. The values of mean F4-8 in the terminal year are relatively insensitive to the changes, lying in all cases between 0.28 and 0.3. The magnitude of the changes in the historic stock size depends directly on the extent of underreporting, the higher stock coming from the greater underreporting factors. Recent history is very similar for all scenarios. The stock is always shown to be at its lowest in 2002,

and shows similar changes in the last two years in all cases. However, because the underreporting can revise both current and historic estimates the scenarios were examined for changes in SSB relative to 1983, the year when the stock was previously at its lowest point. It is SSB in that year (or approximately that year) that provides the B_{loss} value used for B_{pa}. In all cases the SSB in the terminal year lies at between 0.84 and 0.92 of the SSB in the 'Bpa year'. Thus the 2005 WG conclusion that the stock was below Bpa in 2004 holds under all scenarios.

Two methods to estimate the potential extent of missing landings were investigated. An intrinsic error method used probability distributions of estimates of mackerel egg mortality and egg abundance, fecundity and atresia to estimate amplitude distributions of SSB. These are fitted in the ICA model using the assessment WG settings and a range of Natural Mortality (M). Secondly the assessment model was recoded in a Bayesian framework using WINBUGS. The factors for missing catch, and the values for M were estimated separately and together. Both analyses give broadly similar results. There are strong indications of missing biomass from the assessment of NE Atlantic mackerel. Consideration of both M and missing catch could be responsible for the differences. In all the cases there is evidence of significant underreporting of catch. The estimated amounts of missing catch from the Scottish fishery at 9% do not seem to be sufficient to reconcile the differences indicated by the Mackerel Egg Survey. Median estimates of missing catch factors vary between 1.4 and 2.3 and depend on M assumed. There is little information from the model fit on the appropriate M to choose, but what information there is supports the lower values of M and higher values for Missing Catch Factors. This supports the view that at least since 1992, the date of the first survey, catches have probably exceeded reported catches substantially and by much more than the 9% estimated from Scottish Catches.

WD 14/06

Skagen, D. W.

Stock identity and migrations of the Iberian Sardine stock, and implications for assessment with an area-disaggregated extension of the AMCI assessment method.

Document available from: Dankert W. Skagen, Institute of Marine Research, P.O Box 1870 Nordnes, 5817 Bergen, Norway

E-mail: dankert.skagen@imr.no

This document includes:

- An overview of evidence for stock identity and migrations, where it is argued that the Iberian sardine may realistically be assessed and managed as a stock unit, although there is strong indications of some communication with adjacent areas which may comprise different stock units.

- Analysis of catch and survey data by area, confirming the previous common view that sardine migrates along the Atlantic coast of Iberia both Northwards and Southwards as it ages. The migration pattern appears to vary over time.

- A brief description of the AMCI assessment method in general, and the incorporation of a migration model in particular.

- Trial assessments with various formulations of AMCI for single and multiple areas.

It is concluded that attempts to include area disaggregation and migration in the assessment of the stock were only partially successful. The major trends in abundance and exploitation are in accordance with those found by single area assessments, but estimates of local abundance and exploitation are heavily influenced by the rather firm assumptions that have to be made to avoid over-parametrisation of the model. From an assessment perspective, merging the March surveys to give a comprehensive coverage of the area and assessing the stock in a single area framework emerges as the most promising approach.

WD 15/06

Skagen, D. W.

Estimating mortality of NEA mackerel from tag recaptures with the Jolly-Seber method

Document available from: Dankert W. Skagen, Institute of Marine Research, P.O Box 1870 Nordnes, 5817 Bergen, Norway.

E-mail: dankert.skagen@imr.no

Norwegian tagging data were used to obtain estimates of total mortality. The data have been revised this year and calculations refined by bootstrapping some of the sources of uncertainty. The total mortality for the ages 4 to 8 appears to have fluctuated mostly between 0.3 and 0.4.

WD 16/06

Stratoudakis, Y. and Bernal, M.

Sardine spawning biomass estimates from Iberian DEPM surveys, 1997-2005.

Document available from: Yorgos Stratoudakis, INIAP/IPIMAR, Avenida de Brasilia, s/n, Lisboa, 1449-006, Portugal.

E-mail: yorgos@ipimar.pt

Following the WD presented in the 2003 WGMHSA (Stratoudakis and Bernal 2003), the methodological considerations reported in the last SGSBSA and the first WGACEGGS reports, the results of the EU project SARDYN, the revision of the 1997 Portuguese histological data and the completion of the laboratory analysis of the 2005 DEPM survey samples, this WD provides revised DEPM estimates of sardine spawning biomass (SSB) to be used in the 2006 benchmark assessment of the Atlanto-Iberian stock. The revision is restricted to the period 1997-2005, since reliable estimates for 1988 and 1990 can only be provided for sub-areas of the stock (Stratoudakis and Bernal 2003). This document briefly reports on:

- estimation for the 2005 DEPM survey;
- revision of the Portuguese 1997 and 2002 estimates;
- results of recent work (mainly within SARDYN) with relevance to sardine DEPM estimation in the Iberian peninsula;
- comparisons with GAM-based DEPM estimation and with SSB estimates from spring acoustic surveys;

and provides sardine SSB estimates for 1997, 1999, 2002 and 2005 to be used in the 2006 sardine assessment. Estimates for these years are also provided separately for the northern, western and southern stock area to facilitate inclusion in area-based assessment trials. Finally, it should be noted that although many IEO and IPIMAR scientists have contributed to data provision and estimation, this document is the exclusive responsibility of the authors and the estimates provided here have not been yet presented and discussed in the WGACEGGS.

Without some modifications in calendar, it is anticipated that this problem will remain in the future (next benchmark assessment in September 2009 will use the 2008 DEPM results that will be obtained in summer 2009 but will only become available to WGACCEGS for scrutiny in the late autumn of 2009).

WD 17/06

Velasco, F. and Abaunza, P.

Spanish bottom trawl surveys in Cantabrian Sea and Galician waters (North of Spain). Overview of horse mackerel historical series.

Document available from: Paublo Abaunza, Instituto Español de Oceanografía, Apdo. 240, 39080, Santander, Spain.

E-mail: pablo.abaunza@st.ieo.es

Data from bottom trawl surveys carried out in autumn in the Cantabrian Sea and Galician coasts (North of Spain) are analysed in relation with horse mackerel species. The surveys provided valuable information on horse mackerel dynamics. In this sense, the length distributions showed a gap in length range 18-23 cm which could be related with the particular exploitation pattern of this species. Juveniles are more abundant in the eastern part of the Cantabrian Sea although the depth strata < 120 m, in which the young horse mackerel is also distributed, are very poor sampled in the Galician coasts. The recruitment in 1994 appeared to be strong one in the data series. The evolution of the cohorts through the matrix data showed poor information on mortality. This could be due to a possible migration with other areas, especially with the French continental shelf. Therefore the survey will benefit from the information of other bottom trawl surveys carried out in adjacent areas. Taking in consideration that the South of Galicia (Subdivision IXa North) is belonging to another stock unit in future works the data will be also analysed separately.

Annex 1: List of Participants

WORKING GROUP ON THE ASSESSMENT OF

MACKEREL, HORSE MACKEREL, SARDINE AND ANCHOVY

Galway Ireland, 5 September–14 September 2006

NAME	ADDRESS	TELEPHONE	FAX	E-MAIL
Ciaran Kelly (Chair)	Marine Institute Fisheries Science Services Galway Technology Park Galway Ireland	+353 91 387 200	+353 91 387 ???	Ciaran.kelly@marine.ie
Pablo Abaunza	Instituto Español de Oceanografia Apdo. 240 39080 Santander Spain	+34 942 29 10 60	+34 942 27 50 72	pablo.abaunza @st.ieo.es
Sergei Belikov	PINRO 6, Knipovich Street Murmansk, 183763 Russia	+7 8152 47 34 24	+47 78 91 05 18	belikov@pinro.ru
Miguel Bernal	Instituto Español de Oceangrafia Puerto Perquero s/m 29640 Fuengirola Spain	+34 952 471 907	+34 952 463 808	miguel.bernal@ cd.ieo.es
Lisa Borges	IMARES Institute for Marine Research and Ecosystem Studies Haringkade 1 P.O. Box 68 NL-1970 AB IJmuiden Netherlands$	+31 255564684	+31 31 255564644	lisa.borges@wur.nl
Mariella Canales Andrades				mcanales@ifop.cl
Mark Dickey-Collas	RIVO P.O. Box 68 1970 AB IJmuiden Netherlands	+31 255 564 685	+31 255 564 644	mark.dickeycollas@wur.nl
Leonie Dransfeld	The Marine Institute Marine Fisheries Services Galway Technology Park Galway Ireland	+353 91 730 400	+353 91 730 470	leonie.dransfeld@marine.ie
Erwan Duhamel	IFREMER 8, rue François Toullec F-56100 Lorient France$	+33 297 873 837	+33 2 9797 3836	Erwan.Duhamel@ifremer.fr
Emma Hatfield	Marine Laboratory P.O. Box 101 Victoria Road AB11 9DB Aberdeen Scotland	+44 1224 295434	+44 1224 295511	e.hatfield@marlab.ac.uk
Leire Ibaibarriaga	AZTI Herrera Kaia Portualde z/g 20110 Pasaia Gipuzkoa, Basque Country Spain	+34 943 00 48 00	+34 943 00 48 01	libaibarriaga@ pas.azti.es

NAME	ADDRESS	TELEPHONE	FAX	E-MAIL
Svein A. Iversen	Institute of Marine Research P.O. Box 1870 Nordnes 5817 Bergen Norway	+47 55 23 84 07	+47 55 23 86 87	Svein.iversen@imr.no
Jan Arge Jacobsen	Fiskirannsóknarstovan P.O. Box 3051, Noatún FO-110 Tórshavn Faroe Islands	+298 353900	+298 353901	janarge@frs.fo
Jacques Massé	IFREMER rue de l'Ile d'Yeu B.P. 21105 F-44311 Nantes Cédex 03 France	+33 2 40 374 169	+33 2 40 374 075	Jacques.masse@ifremer.fr
Alberto Murta	IPIMAR – DRM Instituto de Investigaçao das Pescas e do Mar Av. Brasília 1449-006 Lisboa Portugal	+351 21 302 7120	+351 21 3015948	amurta@ipimar.pt
Fernando Ramos	Instituto Español de Oceanografía Apdo. 2609 11006 Cadiz Spain	+34 956 26 16 33	+34 956 26 35 56	fernando.ramos@ cd.ieo.es
David Reid	Marine Laboratory P.O. Box 101 Victoria Road AB11 9DB Aberdeen Scotland	+44 1224 295363	+44 1224 295511	reiddg@marlab.ac.uk
Beatriz Roel	CEFAS Lowestoft Laboratory Pakefield Road Lowestoft, Suffolk NR33 0HT United Kingdom	+44 1502 52 4358	+44 1502 513865	b.a.roel@cefas.co.uk
Begoña Santos	Inst. Español de Oceanografía Centro Oceanográfico de Vigo Cabo Estay – Canido Apdo 1552 E-36280 Vigo Spain	+34 986492111		m.b.santos@vi.ieo.es
Evgeny Shamray	PINRO 6, Knipovich Street Murmansk, 183763 Russia	+7 8152 47 49 63	+47 78 91 05 18	shamray@pinro.ru
Alexandra Silva	IPIMAR – DRM Instituto de Investigaçao das Pescas e do Mar Av. Brasília 1400 Lisboa Portugal	+351 21 302 7095	+351 1 3025948	asilva@ipimar.pt
John Simmonds	Fisheries Research Services Marine Laboratory P.O. Box 101 375 Victoria Road Aberdeen AB11 9DB United Kingdom	+44 1224 295366	+44 1224 295511	j.simmonds@marlab.ac.uk
Dankert W. Skagen	Institute of Marine Research P.O. Box 1870 Nordnes 5817 Bergen Norway	+47 55 23 84 19	+47 55 23 86 87	Dankert.skagen@imr.no

NAME	ADDRESS	TELEPHONE	FAX	E-MAIL
Per Sparre	Danish Institute for Fishery Research Charlottenlund Slot DK-2920 Charlottenlund Denmark	+45 33 96 3455	+45 33 96 3333	pjs@dfu.min.dk
Jens Ulleweit	Institut für Seefischerei Palmaille 9 22757 Hamburg Germany$			jens.ulleweit@ish.bfa-fisch.de
Andrés Uriarte	AZTI Herrera Kaia Portualde z/g 20110 Pasaia Gipuzkoa, Basque Country Spain	+34 943 00 48 00	+34 943 00 48 01	auriarte@pas.azti.es
Dmitri Vasilyev	VNIRO 17 Verkhne Krasnoselskaya 107140 Moscow Russia	007 095 264 9965	007 095 264 9187	dvasilyev@vniro.ru
Begoña Villamor	Instituto Español de Oceanografía Apdo. 240 39080 Santander Spain	+34 942 29 10 60	+34 942 27 50 72	begona.villamor @st.ieo.es

Annex 2: Technical Minutes of the Review Group of the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy (WGMHSA)

Copenhagen, October 2-4, 2006

The Review Group met in ICES Headquarters, on October 2-4, 2006, and was attended by Steve Cadrin, Frans van Beek, Asgeir Aglen, Ciaran Kelly (WG Chair), and Denis Rivard (Chair).

General

On the general lay out of the report, it was noted that the Checklists on each stock were very useful for first time reviewers as they provided at a glance an appreciation of the information available and the assessment procedures attempted. The review group encourages the working group to continue to use theses checklists and keep them up to date. It was noted, however, that some of the checklists had not been updated in time for the review. The geographic representation of the data was found to be excellent and a necessary precursor to more complex spatial analyses. As said by one reviewer, "It is nice to "see" where everything is laid out as these are complex species and complex datasets covering a broad area".

Also, the Review Group suggested last year that Working Groups use a standard table for describing the model setup, including a section on the parameters being estimated and the objective function. Such tables have been provided in the Working Group Report to summarize the main features of the tuning models. Also, the graphical representation of the surveys provided in Section 11.3.1 (summary list of the acoustic surveys) was found useful by providing a temporal representation of the surveys. A broader use of such representation would help the reading of the report.

The assessments of these pelagic stocks are typically data poor due to the limited number of fishery-independent observations that are available. The Review Group noted that the current developments in methodology applied by the Working Group illustrate a maturation of the "minds" in dealing with such situations. Accordingly, the treatment of indices as relative (vs absolute) is well explained in the report, in particular in relation to overparameterisation. Despite this maturation, it remains that these systems remain overparameterized and that , as such, many of the results obtained are considered solely as an indication of trends.

The use of Bayesian approaches was noted and seen as a welcome addition to the suite of techniques for assessing these stocks. In some cases, it appears that the Bayesian approach could become the principal approach for the assessment. The approach provides a framework to deal with the underlying assumptions in a statistical way (using priors) and the Review group reiterated the need to give due consideration to the priors in the assessments as they may drive the results in cases where data are limited (as is often the case for the stocks under consideration). The priors are necessary and useful in systems that are potentially overparameterized as help to delimitate the space of feasible options.

The Review Group reiterates the observation made last year that the best way to reduce the effects of overparemeterisation is to develop reliable indices of abundance (or biomass) and recruitment for each stock. Efforts should be directed towards the development of such indices. The Review Group notes that the WG is aware of this need and has identified such requirement in various places in their report.

Another way is to simplify the models by reducing the number of parameters to those essential to capture the dynamics of population in response to fishing. It was noted that the Working Group is obviously aware of this, as illustrated with the formulation of the assessment model for many stocks.

While improvements are made in the assessment methods, the Review Group believes that there is not enough consideration given to the development of abundance and recruitment indices. We also need to have a look at existing surveys with a critical mind so as to focus our energies on surveys which contribute directly to the assessment procedure. A more concerted approach is needed here, most likely through coordination development of a greater awareness of the assessment process as a “system” whereby information on stocks flows into the advice.

Some technical observations:

- In Section One on catch sampling: it is unclear how the percentage of catch covered by the sampling program is calculated. % of catch covered by the sampling programme: 48% for 29000 t and 91% for 25579 t. It is noted that the explanation for this could be quite complex and takes its root in the way misreported catches are handled.
- There are sampling deficiencies in some fisheries:
  - Horse mackerel (UK, Faroes, France) landed in Netherlands (recommendation)
  - Sardines (UK, Ireland, Netherlands)
- The under-reported catch of mackerel & horse mackerel in northern & western areas (1.3.2) requires attention.

Northeast Atlantic Mackerel (update assessment)

Northeast Atlantic Mackerel is assessed as one stock, and the results are split thereafter into management areas.

General observations on data:

The Working Group reviewed and commented on information relevant for assessment purposes:

- The information on biological characteristics for each stock component is confusing. The Review Group plotted the data by component as a visual inspection of the data by component. The corresponding Figures are provided at the end of this Section. Similar representation could be used in future years.
- There is a 120kt overshoot of the TAC in 2005!
- Substantial underreported catch (Scottish observer data indicates 30% under-reporting in 2001-2005; 9% of total catch). It is disconcerting that despite the data sampling regulation for EU-member states only few discard information was reported to the Working Group. Effect of putative missing catch on the interpretation of the assessment was explored (i.e. 9%).
- Figure captions for 2.8.7.7. and 2.8.7.8 are switched (7 is bootstrap and 8 is retrospective)
- Interesting quote from the report: *“Use of the assessment data directly is clearly the worst decision and has been correctly rejected by the WG.”*
- There is not enough information in the assessment to estimate M or unaccounted catch. Estimating the missing catch factor by assuming values of M implicitly assumes an age structure of the missing catch. The values of unaccounted catch in the WG should not be considered to be reliable.
- The Jolly-Seber fractional tag recapture method addresses some of the 2005 RG’s concerns (discarded fish, variable effort), but not all (restricted area – not representative of stock). The concern is that tagging juveniles & adults is not where the major fishery occurs.
- The changes in maturity ogives are not relevant and could be artificial; it might be better to keep those constant and the Working Group should investigate this further.
- The review group appreciates the exploration of data done to estimate unreported landings; however, the tables in report are unclear to period or year to which estimates apply. The exercise of estimating missing catch; supports statement that present estimates of F are robust.

Information relevant for the assessment

The Working Group proceeded, as done last year, to use the Mackerel egg survey as the only fishery independent data in the assessment.

Methods used for estimation:

- With respect to recruitment, there is no information in any model on tuning those. Recruitment arises from separability assumption and observed catches.
- A TISVPA (triple separable, age and cohort effect on mortality) model was used in data exploration.
- The Working Group also used also a Bayesian Implementation of ICA. It seems that the Bayesian ICA implementation of promising for the next benchmark assessment.
- It was observed that the trend in SSB from assessments is not in agreement with acoustic survey; it was noted that these surveys as local and do not cover the entire stock area. Also, the acoustic techniques are complicated for mackerel as the estimation of target strength is complicated by the species composition. Because mackerel has no swim bladder, TS is in doubt. The Review Group questioned the utility of these surveys as an indication of stock abundance, as did the Working Group.

While this is an update year, it was noted that there are large CVs for SSB in last year and related estimates. CV on SSB is 44% and on F is 51%. Accordingly, caution is required in using these results. The Review Group discussed the limitations of an assessment dependent on a single survey series updated every three years. Having surveys every year or every other year would reduce the uncertainties associated with the estimates. Another approach would be a multi-year management regime taking into account the paucity of the data for this stock. Accordingly, we note that the WG recommends exploring three avenues: better or more frequent indices, improved assessment modeling technology or designing a management regime adapted to the uncertainty in the assessment process.

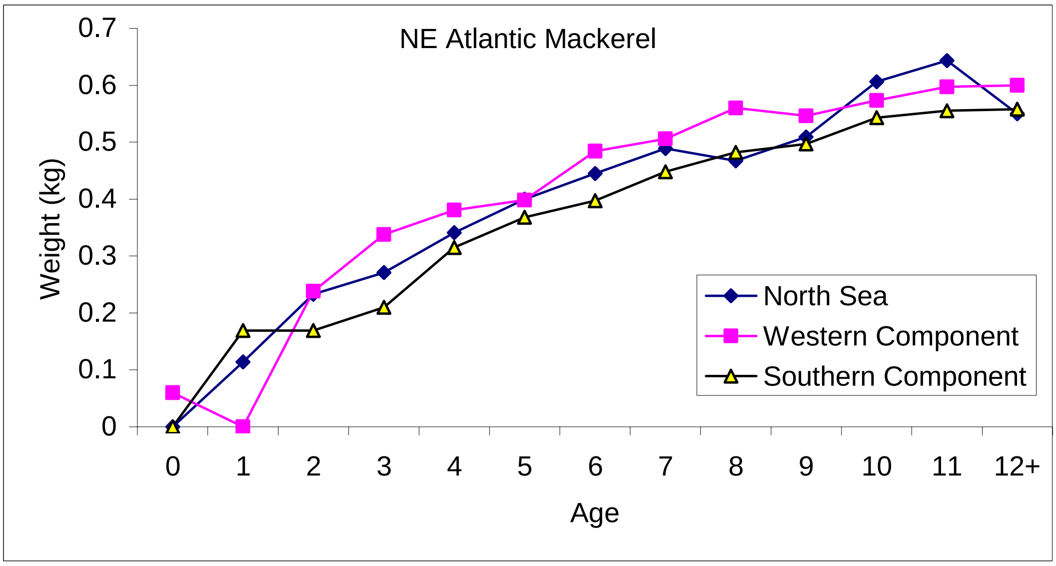
It would be useful to have, in the Working group report, a section of recruitment estimates summarizing the conclusions of the available information. Currently, that information is spread out in the survey section. It would also be useful, in a situation like this year where the estimates of SSB have a large coefficient of variation, to express results in terms of the risks related to a given level of catch.

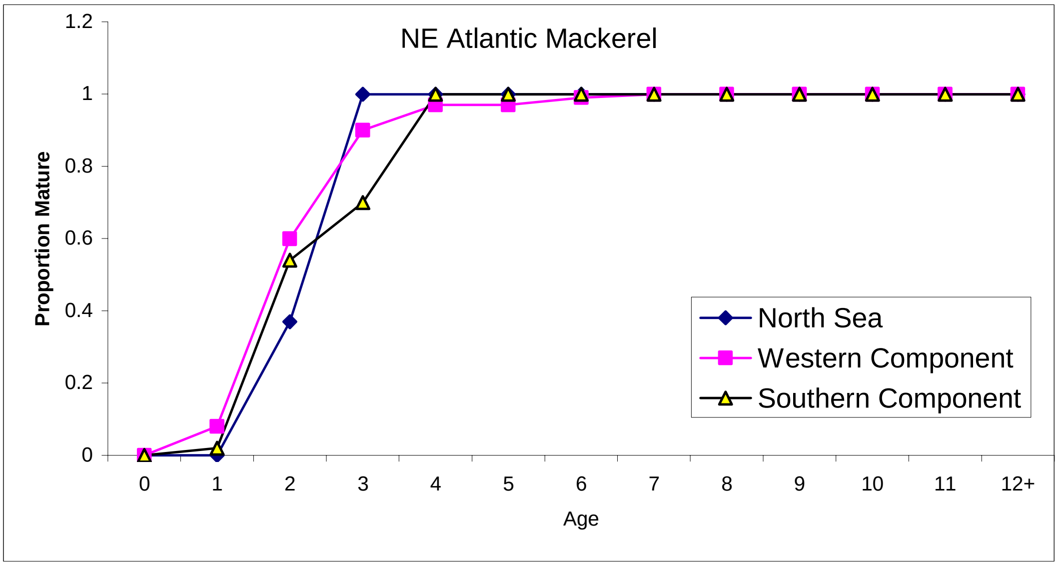
The biases potentially arising from misreporting were also discussed this year. It was noted that misreporting could be considerable but current estimates are unlikely to represent the full dimension of the problem. Additional observations on the assessment results:

- Year classes 2001 and 2002 are confirmed to be above average (very strong) whereas year class 2000 appears to be weak.
- The information on the size of the 2004 and 2005 year classes is inconclusive. Existing surveys have potential for estimating recruitment but this need to be investigated further.
- The lack of tuning data is cause for concern, in particular because the last index from the egg survey was three years ago. With only five observations and little contrast in SSB egg production, estimates have limited precision and assessments are highly dependent upon new survey estimates when they are added (every three year). In absence of indices of recruitment, it is unclear how well recruitment is determined. And given that the last observation was 3 years ago, the precision of the estimates arising from the assessment is poor.

The Working Group looked at the effect of underreporting through simulations. The results suggest that the reported catches could be underestimated by a factor of 60% to 140%: While the WG warns that this is extremely exploratory, their conclusions are that missing catch are a more probable explanation for model misspecification than a biased estimate of M. The Review Group noted that the purpose of this study is not to generate an actual estimate of missing catches but to get a general indication of where model misspecification could occur.

The graphical representations produced by the Review Groups for NEA mackerel biological data by stock component are given below:





In summary, this year's assessment is an update of last year's assessment. This assessment is based on catch numbers-at-age for the period 1972–2005 and egg survey estimates of SSB from 1992, 1995, 1998, 2001, and 2004. Exploratory assessments using different assessment models gave comparable results. The estimate of total mortality in the past is in line with estimates from tag recapture studies. The results are sensitive to the way the surveys are used in the models.

The Review Group supports the views of the WG on the current use of the ICA model which is very sensitive to variability in the SSB estimates from egg surveys. It may be difficult to improve on this situation without more fishery independent data, e.g. more frequent surveys or some other complementary index.

Horse mackerel

Catches from the North Sea stock constitute a substantial part of the total catch. There are uncertainties with respect to the division between stocks in the channel which affect the attribution of landings to each stock.

The fisheries for western horse mackerel are limited by TAC, while those for North Sea horse mackerel are in practice not limited by TAC.

Western horse mackerel (update assessment) .

The Review Group noted that there are Sampling deficiencies by nation (1.3.1) UK, Faroes, France landed in Netherlands (recommendation).

The Review Group notes that exploratory analyses led to the use of a model with variable fecundity, not SPALY. There were new developments in the SAD model (Separable ADAPT) in an attempt to scale the assessment. The Review Group expressed concern with some of the diagnostics, in particular trends in residuals and high CVs of certain estimates.

Some notes on the exploratory analyses:

- Revised stock boundary (now includes Cantabarian coast)
- 1982 year-class dominant and persisted (indicating low M)
- Difficult to use egg survey as a SSB index, because horse mackerel is an indeterminate spawner.
- Exploratory SAD – separable ADAPT developed in 2005
- Newly developed SADvf allows for annually varying fecundity. The problem with SAD is that the relationship between SSB and egg production may not be constant for two reasons: 1) demographic changes in which larger fish produce greater eggs per gram, and 2) random environmental variation. SADvf allows for random variation in eggs per gram, but deviations from the egg survey are consistent with the demographic factor (e.g., eggs per gram was low when the dominant 1982 yearclass was young and increased as that yearclass grew). SADvf has some advantageous properties (e.g., more realistic biomass, F and selectivity estimates), but does not fit the data as well and has less precise estimates. The WG suggests that a more demographically structured approach, in which eggs per gram increases with age (as determined with observed fecundity data; e.g., Eltink 1991), may be more biologically realistic and less prone to spurious annual variations:

The SAD model estimate of relative egg production ($\hat{E}$) was fit to the observed egg survey index (*E*) as the product of a constant survey catchability (*q*) and the model estimate of SSB $\left(\sum_{a=0}^{a=15+} N_{a,t} w_{a,t} m_{a,t}\right)$:

(SAD) $$\hat{E}_t = \left(q_t \sum_{a=0}^{a=15+} N_{a,t} w_{a,t} m_{a,t}\right) + \varepsilon_t \, .$$

This allows for random annual variation, including both survey measurement error and environmental variation. An alternative revision to SAD (SADDLE?: <u>S</u>eparable <u>AD</u>apt with <u>D</u>emographically <u>L</u>imited <u>E</u>gg production) is to explicitly model increasing egg production (eggs per gram) by size:

(SADDLE?) $$\hat{E}_t = \left(q_t \sum_{a=0}^{a=15+} N_{a,t} w_{a,t} m_{a,t} \alpha w^{\beta}\right) + \varepsilon_t$$

In which egg production increases by factor α, which accounts for increased eggs per gram with increasing size (*w*), either linearly (β=1) or curvilinearly (β≠1). The parameters α and β would be determined by field observations of eggs per gram by body weight .

- The RG encourages the further development and evaluation of harvest control rules.
- Given the different fishery selectivities estimated by SAD and SADvf, the WG should make sure that HCR evaluations are consistent with the selectivity indicated by the stock assessment model.
- The RG encourages further exploration for the catch at age data using TISVPA. In addition to the separability assumptions to age and year, a cohort factor is estimated. In this stock, the strong 82 year class and the directed fishery on the year class has been a problem in the assessment.

- The WG presents a HCR for western horse mackerel based on the trend in the results of the triannual egg survey. The reviewers consider the HCR promising but regret that the documentation and analyses of the HCR were poorly presented in the report.
- 2005 RG recommended investigation of M, which should be done at the next benchmark assessment of this stock.

Southern Horse Mackerel (exploratory assessment).

This assessment is in an exploratory stage, although the text at some places refers to it as an update. The Review Group notes that the SPALY assessment did not work and that the Working Group returned to XSA model to determine stock trends.

- In the data exploration, a number of bubble plots are shown. Those would be more readable by a more standardized layout, and clear legends (like normalized by age or not in Figure 6.7.2.3). Figure 6.7.1.3 and other related figures, are inconsistent in presentation. Neither are they labeled by year class. This needs to be improved in future assessments. Discussed the southern boundary in relation to stock definition. Some presence in the south likely.
- The bubble plots of catch at age normalized by age do not show a clear pattern of cohorts moving through the fishery. This is likely caused by between year differences in selection pattern (some fleets focus on young fish, others on old). This suggests that models assuming strong separability are not appropriate.
- The bubble plots on surveys reflect year effects plus possible aging problems.
- The layout of the mortality signal plots should also be more consistent. (catches start with oldest year-class in upper left, surveys start with youngest in upper right).
- Last year, the Review Group commented that the two surveys used for tuning take place in different regions at approximately the same time. Therefore, using them as two independent measures of stock size is questionable. They should rather be added (most likely by multiplying one of the surveys with an estimated weighting factor).
- The Working Group has followed the proposal from last years review and combined the two bottom trawl surveys. The surveys have been weighted according to the size of the covered areas. The plotted mortality signals for this combined survey are more reasonable than the one from the Spanish survey alone. There is, however, indication of a shift from the 1998 year-class onward (as it is in the Portuguese survey).
- A separate table for the combined survey would be helpful.
- The AMCI analysis shows that the constraints used the previous year were not appropriate with the new input data, and no real stable assessment was achieved by using AMCI. There appear to be a conflict between the separable constrain and overparameterisation.
- Some year effects appear to be present and are the overriding signal. No signal along cohorts. Difficult to do tuning in such a case.
- The XSA run shows poor diagnostics (negative slopes for some age groups). The matrices of XSA-results (population numbers and F at age) are not included in the report.
- In essence, the XSA did not converge either and indication that results are unreliable. This is recognized in the WG report. Accordingly, the results are indicative of SSB trends at best.

The conclusion from the Review group is that there is no reliable analytical assessment. These are considered to be indicative of trends only and, accordingly, catch forecasts are not provided. More information on the fishing fleet would be valuable to explore whether the shifts in exploitation at age are associated with changes in effort for the fleets fishing young fish relative to the fleets fishing older fish.

North Sea Horse Mackerel (update assessment).

It was noted that the sampling for catch at age is very poor, especially in earlier years. Sampling needs to be improved and sampling deficiencies by nation (1.3.1) UK, Faroes, France landed in Netherlands.

Specific observations by the Review Group are as follows:

- Figure 4.5.2.2.b difficult to interpret. The information is better illustrated by Figure 4.5.2.2.a.
- Uncertainties in stock boundary near the channel and associated uncertainties in catch monitoring.
- The Review Group discussed stock unit definition. What would be gain by assessing this area as part of the Western stock, in particular in relation to age structure and age dynamics. Perhaps we should also consider using this in a joint assessment for western horse mackerel.
- Stock units are incompatible with management units. Excerpt from the 2004 WG report: "*Parasites and body morphometrics indicated that horse mackerel in the North Sea could constitute a stock well differentiated from the rest of adjacent Atlantic areas.*" This was based on the absence of myxosporean parasites in all North Sea samples and frequent myxosporean infestation in western area samples (Campbell 2005). However, there were no HOMSIR samples from the English Channel.
- Large 1982 year class (similar to western)
- Not limited by TAC (because VIId catches are taken from the western TAC – and VIId catches are increasing) so catch>TAC.
- The catch at age matrix confirms earlier findings on lack of consistency as there is no clear tracing of cohorts.
- Catch curves appear to be unreliable and cannot be used for mortality estimation. Some even show negative mortalities.
- Needs a survey for an improved assessment. Abundance indices from the IBTS Survey reveal highly variable distributions from year to year. The Review Group noted that IBTS data do not extend to VIId where a significant portion of the fishery takes place. The Working Group should investigate IBTS data in detail for assessment purposes and also for migration "features" with the aim of obtaining an index of abundance that is informative for this stock.

Anchovy in subarea VIII (update assessment).

There was no basis for management units given in the WG report. The WG chair noted that there is large spatial discontinuity between Bay of Biscay and the Gulf of Cadiz.

The Review Group noted that fleets went looking for fish in 2006 and could not find them.

- An assessment model for short lived species like anchovy only describes the stock history. Since the fishery is based on the incoming year-class, the assessment cannot give reasonable predictions further than about half a year after the last input observation. To provide advice for management, an assessment should concentrate on the estimation of the most relevant year classes in the management year.
- The acoustic survey of the 2004 cohort had greater abundance at age-2 (2006) than age-1 (2005). The RG interprets this peculiarity as the result of a noisy survey.
- The RG suggested that M may be estimated by MSVPA. The WG chair responded that the principle predators in this area are large pelagic species that are not monitored by age-based assessments and the utility of MSVPA in that case in unclear.
- DEPM was used as an absolute index (which is inconsistent with sardine decision), but catchability (q) was >1 when q was estimated, and estimates that assume q=1 have lower variance. DEPM is essentially a model of eggs and adult fecundity, including a combination of measurement error and estimation error. Therefore a q>1

result could be from estimation error. For northeast Atlantic mackerel, the same pattern (q>1) was explained as from unaccounted mortality. The WG chair felt that assuming M is constant may be the cause of this pattern. The RG suggests using the DEPM index as relative in the next assessment.

- Correlated parameters are difficult to estimate well, but their correlation should be expected from their structure (e.g., q's, N's, F's) and are not statistically invalid. The issue though is that, as illustrated by the high CVs, the precision of the parameter estimates is poor.
- 2005 RG thought that priors of q's were overly informative. – this year, 2 sets of priors were assumed: uninformative & informative.
- The RG agrees that there is no way to predict recruitment, and projections would not be reliable.
- The RG noted that recruitment has been very low for the last 5 years.
- 2005 RG recommended that Fpa be revised because it was somewhat inconsistent with B_{lim} and did not allow for enough uncertainty. The RG recommends that F_{msy} be evaluated by the delay-difference model for comparison with F50% and as a candidate as a PA reference point. Next benchmark should evaluate reference points. Including the trigger point of 21000 t below which they are not going to consider reopening.

The Review Group discussed management aspects in relation to the life span of the species and the availability of the survey information. In that context, only in season management makes sense.

Anchovy in subarea IXa (exploratory assessment).

Getting information on fleet dynamics historically would be useful to interpret the fishery data in relation to stock dynamics. There is no information provided on fleet dynamics and effort.

An assessment model only describes the stock history. Since the fishery is based on the incoming year-class the assessment cannot give reasonable predictions further than about half a year after the last input observation.

With respect to the data, CPUE series have been standardized in a reasonable manner. It is not clear whether searching time is included. The Review Group is concerned that purse seine cpue may not be a relevant stock indicator as is commonly the case for fleets fishing on schooling fish.

The Review Group is also concerned with the conflicting signal from acoustic survey and cpue in 2005 and first half year of 2006.

A number of exploratory runs are presented based on an *ad hoc* half-year separable model. The results are very sensitive to the choice of input data for the most recent year, illustrating the conflicts in the signals arising from the data series. RG could not determine which run was best because it was difficult to justify the many permutations of selecting surveys, observations and model conditioning.

In essence, the estimates of biomass are driven by the assumptions on how the F is calculated in the final semester in 2005 and by which data points are considered in the estimation. In particular the model results are driven by assumptions on F in 2005 in 2nd half of the year and by selection of points. Results are unstable.

There is a proposal by WG to use the recruitment index from the March survey for an in-season determination of TAC. CPUE and modeled historic biomass are both driven by catches. For this stock M could be high and variable, which means that catches may not very well reflect the stock size. Within season recruitment observations seem to be the logical approach for advice to the fishery.

Figure 11.7.6 is confusing and should be split in 2 figures.

Could a delay-difference model be useful (as for Bay of Biscay anchovy)? Such an approach should be tried in the future as it may not have all the sensitivities between all the different indices. The RG notes that there is some hope for developing a DEPM index for tuning and the Working Group is encouraged to do so by the RG.

It appears in reading the report that WG believes that CPUE is a better indication of abundance. The RG has some concerns with this. Acoustic surveys may provide as good an index of abundance. The RG expressed concern with CPUE. As this is essentially a one age group fishery, it should be the focus of assessment and management. This points to the need for a survey that picks up recruitment. It also points to the need for within year management.

Sardines in VIIIc and IXa (benchmark assessment).

Some observations on the indices and the tuning:

- A late correction was made to figures and tables of the WG report, including an additional 8% of Portuguese catch and revised maturity ogives. It was noted that the correct figures were used in the final assessment presented in the report.
- 2005 RG thought it was important to clarify relationships with the Bay of Biscay stock, a clear summary of SARDYN project is needed in WG text (but figures 7.3.1 [not cited in text] and 7.3.2 are good summaries)
- In summary, the current stock definition is justified (VIIIc and IXa) . The northern boundary with Bay of Biscay sardine is based on longevity, maximum age, spawning season and recruitment patterns. The southern boundary is based on genetic and morphometric variation. There is some movement of recruits from Bay of Biscay (VIIIb) to the Cantabarian Shelf (VIIIc), but annual movement rates appear to vary.
- DEPM need to be described (as in anchovy section)
- DEPM is essentially a model of eggs and adult fecundity, including a combination of measurement error and estimation error. Therefore a $q>1$ result could be from estimation error. Should DEPM estimation be incorporated into the stock assessment model? This may be a job for WGACEGG.
- $M=0.33$, based on what? (reference missing)
- Merging Spanish and Portuguese surveys assumes equal catchability, but q of the Spanish survey may be greater.
- An exploratory AMCI model incorporated movement of recruits from west to north or south, assuming 3 areas and a simple migration model where migration parameters were estimated together with population parameters. The outcome of the AMCI exercise was that it required strong constraints, both in the form of the migration model and on the mortality model, in order for the estimation procedure to converge at all. In essence, migration and mortality parameters are confounded in the estimation.
- The WG also used an area disaggregated Bayesian space state model. The Bayesian state-space model used expert advice on migration and did not attempt to estimate parameters for the migration. As such, the results are conditional on the assumptions about migration. The RG encourages the continued development of spatially-explicit models. The RG is concerned, however, that the expert opinion of the movement between areas could be driving the results and should be complemented in future years with actual measurements or observations.
- The stock assessment is based on AMCI (without movement) with three independent acoustic indices.
- The low selection estimated for age 6+ appears to be odd.
- In order to use the DEPM as a relative index, the number of parameters needed to be reduced (combined surveys, equal selectivity & catchability of ages 4 and 5). The RG agrees that the revised model is better than the 2005 model that used the DEPM as an absolute index.
- Modeling decisions are well justified (8.7.4)
- SARDYN identified wind-driven advection as a factor for recruitment patterns. The RG recommends that the WG consider advection to explain historical recruitment and perhaps as a recruitment indicator.

- 2005 RG recommended that reference points should be developed in the next benchmark assessment. We encourage development of reference points for consideration as PA reference points that are consistent with this assessment.
- F decreased since 1998 – effort controls appear to be effective.
- Strong 2000 & 2004 year-classes, but being targeted.
- Table 8.4.1.1 has no caption to describe columns (proportions and totals).
- AMCI produces non-standard tables & figures. In the future standard tables should be provided by the WG.
- Transition matrix wrong on page 324. Weight at age matrix missing.
- The Section Advice for 2005 is missing; the advice described is for 2006.
- The first paragraph in fisheries applies to management.