ICES WGMHSA Report 2005

ICES Advisory Committee on fishery Management
ICES CM 2006/ACFM:08

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

6 - 15 September 2005

Vigo, Spain

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

Recommended format for purposes of citation:
ICES. 2006. Report of the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy (WGMHSA), 6 - 15 September 2005, Vigo, Spain. ICES CM 2006/ACFM:08. 615 pp.

Contents

0 Executive Summary

The Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy (**WGMHSA**) met in Vigo from 5-16 September, to assess and provide catch options for four different pelagic species widely distributed in the Northeast Atlantic Ocean. The WG reports on the status of all **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 definitions. This year a **benchmark** analytical assessment is available for Anchovy in Biscay and **update** analytical assessments are available for Northeast-Atlantic Mackerel and Sardine in VIIIc and IXa. Western Horse mackerel is in a benchmark year, so an **in-depth exploratory analysis** was carried out using several models (with different assumptions) as well as exploring the signals in the input data. Southern horse mackerel and Gulf of Cadiz anchovy assessments are still in a developmental stage, whilst no assessment was possible for North Sea horse mackerel.

Northeast-Atlantic (NEA) Mackerel. This species is distributed in the whole ICES area and currently supports one of the most valuable European fisheries (with more than 600 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 combined stock. The quality of sampling data remains good. There is an extensive exploration section examining the trade offs in assessing the NEA mackerel stock with the available data and model formulations. This year the issue of accuracy of the catch data has been addressed, and indicates that data on both the accuracy of landings and estimates of total discards is inadequate. The WG carried out an update assessment applying the same approach as accepted by ACFM last year. The assessment indicates that the declining trend of the stock has not continued, but that F in 2004 was above F_{pa} and outside the management agreement. The exploration exercise concludes that although the trend in SSB and F and the level of F can be estimated without bias from the existing data, that the true level of SSB cannot be estimated without knowledge of the level of unaccounted mortality.

Horse Mackerel. Following from the redefinition of the stock boundaries last year, much work had been carried out intersessionally, in compiling extended data series for western and southern horse mackerel. For North Sea horse mackerel effort was applied this year to try and understand why any attempted assessments performed so poorly. The data exploration 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. An in depth exploration was carried out for western horse mackerel. These analyses showed (with the available data i.e. no independent measure of stock size), that there had most likely been a change in fishing pattern in the mid 90’s, that the SSB followed the growth of the exceptional 1982 year class, and that in 2004 this is at a level around that in 1982. Although large uncertainty surrounds the estimates of stock parameters, the analyses were more stable and indicated strong recruitment of the 2001 year class which may have halted the declining trend of the stock. An exploratory analyses was conducted for southern horsemackerel. This analysis suffers from conflicting signals between surveys and as for western horse mackerel the absence of an SSB index. None the less the data exploration indicates a declining SSB since the late 90’s with stable F.

Sardine is assessed only in part of the distribution area: in VIIIc and IXa. Stock structure is currently under investigation. An update assessment was performed. This assessment showed a small decrease in the SSB due to the waning influence of the 2000 year class, but that the SSB is about average. The assessment also indicates a large incoming recruitment (2004 year class). However even at this level of SSB the stock is more dependent on incoming recruitment than in the 1980’s.

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. 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 and meetings to be conducted before the WG. In addition this year the WG attempted a benchmark for Biscay anchovy, an annual ICA assessment, as performed in previous years, plus a seasonal one are presented as exploratory assessments, while a Bayesian implementation of the biomass dynamic model is proposed as the final assessment. There was coherence in the signals in the catch and survey data and new implementation of the assessment model overcomes some of the shortcomings of the previous approach. The overall outcome is that SSB is below Blim and recruitment at age 1 has been low since 2002. Without a recruitment index little can be said about the prognosis for the stock until the next acoustic and DEPM surveys in late Spring 2006. The assessment of Anchovy in Cadiz is developed further this year with a standardisation of the CPUE index. This exploratory assessment now gives a coherent picture of the development of the stock.

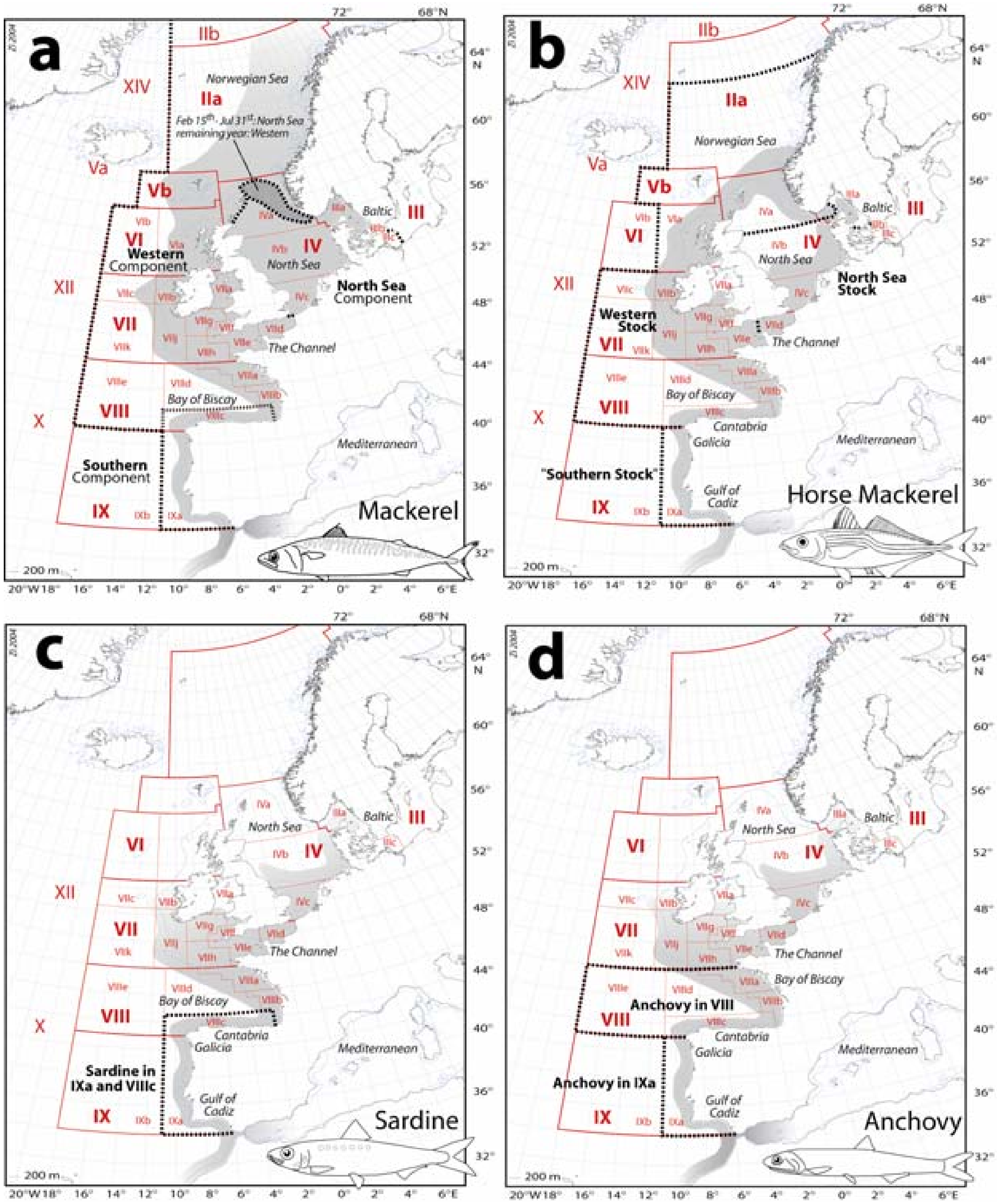


Figure 0.1: Distribution of the four species assessed by the ICES Mackerel, Horse Mackerel, Sardine and Anchovy WG: Stock and component definitions as used by the 2004 WG. Map source: GEBCO, polar projection, 200 m depth contour drawn. a: Northeast Atlantic Mackerel (with North Sea, Western and Southern 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 Vigo Spain from 6–15 September 2005 to address the following terms of reference, as decided by the 92nd Statutory Meeting:

a) assess the status of and provide management options for 2006 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 western horse mackerel 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) (1) based on input from e.g. WGRED incorporate (where appropriate) existing knowledge on important environmental drivers for stock productivity and management into assessment and prediction, and important impacts of fisheries on the ecosystem;
2) (2) for stocks where it is considered relevant, review limit reference points (and come forward with new ones where none exist) and develop proposals for management strategies including target reference points if management has not al-ready agreed strategies or target reference points (or HCRs) – following the guidelines from SGMAS (2005, 2006), AGLTA (2005) and AMAWGC (2004, 2005, and 2006);
3) (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) (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) (5) where misreporting is considered significant provide information on its distribution on fisheries and the methods used to obtain the information;
6) (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) (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) (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 structure of Sections 4 and 10 address term of reference b, with a greater consideration given to data and model exploration. All other assessments, with the exception of Sardine in VIIIc & IXa,, and NEA mackerel, which are considered as “Update” are either in a developmental or at an exploratory stage. 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. There is additional information on sardine in the Biscay area (outside the assessment area) given in Section 7. Specific attention has been given this year to explicit treatment of uncertainties in either the input data or the assessment assumptions.

1.2 Participants

Pablo Abaunza	Spain
Jose Mª Bellido	Spain
Sergei Belikov	Russia
Miguel Bernal	Spain
Leonie Dransfeld	Ireland
Erwan Duhamel	France
Guus Eltink	Netherlands
Leire Ibaibarriaga	Spain
Svein A. Iversen	Norway
Jan Arge Jacobsen (part time)	Faroe Islands
Ciarán Kelly (Chair)	Ireland
Sara Kraak	Netherlands
Jacques Massé	France
Alberto Murta	Portugal
Fernando Ramos	Spain
Beatriz Roel	UK (England and Wales)
Begoña Santos	Spain
Evgeny Shamrai	Russia
John Simmonds	Scotland
Alexandra Silva	Portugal
Dankert Skagen	Norway
Jens Ulleweit	Germany
Andres Uriarte	Spain
Dimitri Vasilyev	Russia
Begoña Villamor	Spain

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 2004 has decreased for mackerel (to 79%) and is below the longterm average, however the intensity of sampling with numbers measured and aged has increased in the last the last 12 years. The proportion of the sampled horse mackerel catch has again increased after the low sampling intensity in 1999. In 2004 the sampling level was 79% and this is still considered inadequate for some Divisions and periods (especially in the juvenile areas (see section 5.12). Sardines continue to be well sampled with samples now provided by Portugal, Spain and France. However 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 is similar to 2003 and continues at a high level. A short summary of the data, similar to that presented in recent Working Group is shown for each stock. Sampling programmes by EU countries have been partially funded under the new 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

*** Percentage related to Working Group catch**

In 2004, 79% of the total catch was covered by the sampling programmes. This is about the same level as last year, however sampling intensity has increased with higher numbers of samples and numbers of fish aged and measured than in 2003. Spain, Portugal and Russia carried out intensive programmes on their catches, as in 2003. Norway and Scotland also continued to sample their entire catch thoroughly. Denmark and Germany have increased their sampling coverage from 2003, with increases in their sample numbers and numbers of fish measured and aged. Ireland and England & Wales have also increased their sampling intensity in 2004, although the coverage was lower. France, the Faroe Islands, Northern Ireland, Belgium and Sweden did not sample any catches, although significant catches were only 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	4.82	0	0	0	0
Denmark	25665	98	18	1,607	1,607
UK (England & Wales)	21,807	9	32	4,074	1,821
Faroe Islands	13,029	0	0	0	0
France	20,266	0	0	0	0
Germany	23,244	76	66	35,908	2215
Ireland	61,102	59	51	8,506	3,523
Norway	157,363	93	228	25,971	1,105
Portugal	2,289	100	285	28,417	1,262
Russia	49,489	100	61	16,959	724
UK (Scotland)	141,989	91	155	24,240	5,177
Spain*	34,456	100	416	26,641	5,039
Sweden	4,437	0	0	0	0
The Netherlands	27,532	89	68	5,489	1,700
UK (Northern Ireland)	10,933	0	0	0	0
Total	593,606	79	1,380	177,812	24,173

*** Percentage based on Working Group catch**

The following text table shows sampling levels of mackerel by relating numbers measured and numbers aged relative to the size of the catch in each ICES division. Insufficient sampling was carried out in divisions IIIa, V, VIIc,d and VIIIa,d amounting to a total catch of 26,000t. Divisions IIId and VIIa,g,h,k were also not sampled, however these areas represent only minor catches of less than 500 t.

AREA	OFFICIAL CATCH	WG CATCH	NO SAMPLES	NO AGED	NO MEASURED	NO AGED/ 1000 TONNES**	NO MEASURED/ 1000 TONNES**
IIa	60,032	60,006	61	724	16,959	12	282
IIIa	1,369	1,369	1	100	100	73	73
IVa	267,951	294,129	349	5,952	48,296	22	180
Ivb	329	957	3	75	302	228	917
Ivc	1,024	784	3	75	240	73	234
Vb	2,853	2,480	0	0	0	0	0
Via	131,717	115,111	115	3,978	27,600	30	210
VIIa	6	6	0	0	0	0	0
VIIb	33,393	37,164	53	2,797	13,392	84	401
VIIc	1,143	1,470	0	0	0	0	0
VIId	9,241	9,697	16	400	1,681	43	182
VIIe	2,831	2,839	16	915	2,585	323	913
VIIf	225	225	21	1,355	2,145	6,012	9,517
VIIg	30	30	0	0	0	0	0
VIIh	129	389	0	0	0	0	0
VIIj	32,501	34,817	36	1,376	9,014	42	277
VIIk	41	41	0	0	0	0	0
VIIIa	8,275	9,817	4	100	328	12	40
VIIIb	3,872	3,873	72	1,281	3,985	331	1,029
VIIIc east	25,132	25,132	196	2,525	12,805	100	510
VIIIc west	3,474	3,474	80	769	4,733	221	1,362
VIIId	1,805	1,415	1	25	112	14	62
IXa central-south	2,289	2,289	285	1,262	28,417	551	12,417
IXa north	3,946	3,946	68	464	5,118	118	1,297
Total	593,607	611,461	1,380	24,173	177,812	41	300

**** 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

*** WG catches**

The overall sampling levels on horse mackerel increased until 2003, but decreased in 2004. The large numbers of samples and measured fish are due mainly to intensive length measurement programs in the southern areas. In 2004, 70 % of the horse mackerel measured were from Division IXa.

Countries that carried out comprehensive sampling programmes (>90%) in 2004 were Netherlands, Portugal, Spain and Norway. UK (England & Wales), France, Denmark and Sweden continue to take 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

The following table shows the most important horse mackerel catching countries and the summarised details of their sampling programme in 2004.

Country	Official catch t	% Catch covered by sampling programme *	Samples	Measured	Aged
Belgium	4	0	0	0	0
Denmark	20,267	0	0	0	0
UK (England & Wales)	10,251	0	0	0	0
Faroe Islands	3,849	0	0	0	0
France	10,590	0	0	0	0
Germany	22,742	59	57	17,953	2,255
Ireland	26,432	77	31	5,121	1,827
Norway	10,751	98	13	1,746	393
Portugal	11,875	100	964	133,534	1,582
Russia	5	0.0	0	0	0
UK (Scotland)	1,524	0.0	0	0	0
Spain*	28,147	98	527	43,097	3,413
Sweden	665	0.0	0	0	0
The Netherlands	67,289	93	80	11,615	2,000
Total *	216,361	68	1,672	213,066	11,470

*** WG catches**

In spite of the improvement the Working Group, once again, strongly recommends that all countries with relatively high horse mackerel catches should sample for age at an adequate level.

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	+	0			
Denmark	11,480	0	0	0	0
UK (England & Wales)	4,617	0	0	0	0
Faroes Islands	3,847	0	0	0	0
France	8,060	0	0	0	0
Germany	17,830	75	55	17,278	1,869
Ireland	26,431	78	31	5,121	1,827
Norway	10,751	98	13	1,746	393
Russia	5	0	0	0	
UK (Scotland)	1,523	0	0	0	0
Spain*	16,272	100	338	26,723	2,823
Sweden	568	0	0	0	0
The Netherlands	40,987	88	36	5,776	900
Total *	157,627	70	473	56,644	7,812

*** 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	4	0	0	0	0
Denmark	8,738	0	0	0	0
UK (England & Wales)	1,552	0	0	0	0
France	2,530	0	0	0	0
Germany	4,912	2	13	675	386
Ireland	1	0			
Norway	0	0			
Sweden	97	0			
The Netherlands	26,302	100	25	5,839	1,100
Total*	35,154	38	38	6,514	1,486

*** WG catches**

The horse mackerel sample intensity for the North Sea stock was the lowest since 1995 and considerably lower then last year (67%). There were no samples from any quarters in Division IVb, IIIa, and during the third quarter in Division VIId.

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	11,875	100	964	133,534	1,582
Spain*	11,706	97	189	16,374	590
Total *	23,681	99	1,153	149,908	2,172

*** WG catches**

In spite of the improvement the Working Group, once again, strongly recommends that all countries with relatively high horse mackerel catches should sample for age at an adequate level.

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

Division	WG Catch	Sampled Catch	N^{o} samples	N^{o} measured	N^{o} measured / 1000 tons*	N^{o} aged	N^{o} aged / 1000 tons*
IIa	47	0		0	0	0	0
IIIa	351	0		0	0	0	0
IVa	11841	10575	13	1746	147	393	33
IVb	2594	0	0	0	0	0	0
IVc	15754	2281	9	1178	75	225	14
VIIIa	5691	885	4	1144	201	100	18
VIIIb	1497	568	45	2447	1635	719	480
VIIIc E	7062	6967	175	12138	1719	1292	183
VIIIcW	8710	8710	118	12138	1394	812	93
VIIId	1166	694	1	438	376	25	21
VIIa	2	0	0	0	0	0	0
VIIb	17442	15326	24	5447	312	1032	59
VIIc	322	0	0	0	0	0	0
VIId	16455	11016	37	5336	324	1261	77
VIIe	10918	7092	18	3569	327	1122	103
VIIf	3	0	0	0	0	0	0
VIIg	161	0	0	0	0	0	0
VIIh	57897	38015	28	9203	159	329	6
VIIj	13122	5089	18	4308	328	369	28
VIIk	17	0	0	0	0	0	0
Via	21928	16016	29	4066	185	1619	74
IXa	23581	23255	1153	149908	6357	2,172	92
Sum	216561	146489	1672	213066	984	11,470	53

*** Values related to WG catch**

The working group is concerned about the low sampling intensity in several Divisions. As mentioned he coverage of the North Sea stock was particularly low this year.

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

The summarised details of individual sampling programmes in 2004 are shown below. These catches cover all areas where sardine is caught. Landings from the Netherlands are not included in this table. (VII, VIII and IXa.)

COUNTRY	OFFICIAL CATCH T	% CATCH COVERED BY SAMPLING PROGRAMME	SAMPLES	MEASURED	AGED
Spain	36,056	100	434	45,496	2,508
Portugal	55,831	100	498	66,722	6,760
France	13,856	100	41	2,990	1,491
UK (England &Wales)	2,390		0	0	0
Ireland	2,455		0	0	0
Germany	60		0	0	0
Total	110,648	98	973	115,208	10,759

The overall sampling levels for sardine are adequate for the stock area VIIIc and IXa. Length distributions and catch-at-age data for 2004 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 2004 are summarised below. The programmes are shown separately for Sub area VIII and for Division IX a. Sampling throughout Divisions VIIIa+b and VIIIc appear 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	22,117	97	304	22,436	6,553

The sampling programmes for France and Spain in Subarea VIII in 2004 are summarised below.

COUNTRY	DIVISION	OFFICIAL CATCH	% CATCH COVERED BY SAMPLING PROGRAMME	SAMPLES	MEASURED	AGED
France	VIII a, b	8,781	100	69	3,516	1,136
Spain*	VIII a	0	-	-	-	-
Spain*	VIII b	1,300	100	74	4,593	1,872
Spain*	VIII c	6,276	100	98	6,780	1,973
Total	VIII	16,356	100	241	14,889	4,981

∗ WG catches

The sampling programmes for the fisheries in Division IXa in 2004 are summarised below.

COUNTRY	DIVISION	OFFICIAL CATCH	% CATCH COVERED BY SAMPLING PROGRAMME	SAMPLES	MEASURED	AGED
Spain∗	IXa	5,187	100	63	7,547	1,572
Portugal	IXa	574	0	0	0	0
Total	IXa	5,761	90	63	7,547	1,572

∗ WG catches

No catches of anchovy from Portugal were sampled for length and age in Division IXa in 2004.

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 suggests substantial under reporting in the catches for which numerical information is not available for most countries (see section 2.2.1 for further discussion on accuracy of catch estimates for 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. The Spanish catches do not account for the anchovy catches made for live bait for the tuna fishery since 1999, this catch is assumed to be small (max 500t)

1.3.3 Discards

Mackerel

In 2004 three nations – the Netherlands, Germany and Scotland - provided discard data on mackerel to the working group. Age disaggregated data from the Scotish fishery in the first quarter in area VIIb and in the fourth quarter in area IVa as well as length disaggregated data from the German freezer trawlers in the first quarter in areas VIIb and VIIj, in the third quarter in IVa and in the fourth quarter in area VIIe were available. The Netherlands provided discard estimates for the areas IVc, VIa, VIId, VIIe, VIIh and VIIIa.

The highest mackerel catches (app. 290,000 tonnes) were taken in area IVa. Irish and Scottish vessels constitute a pelagic midwater fleet in this area. The Scottish catch comprised about 30% of that fleet component’s catch in Quarter 4. Other nations with considerable catches fishing in IVa include Norway, Denmark, England & Wales, Faroe Islands, Germany, and the Netherlands. With only two nations providing information on discards data are insufficient for this area.

The other areas of high mackerel catch are VIa (around 115,000 tonnes), VIIb (app. 37,000 tonnes), VIIj (app. 34,000 tonnes) and IIa (app. 60,000 tonnes). England & Wales, Faroe Islands, France, Germany, Ireland, the Netherlands, Scotland and Northern Ireland have substantial catches in VIa and VIIj, for which discard data were only available for one quarter in each area. VIIb catches of Scotland and Germany in the first quarter represent 26% of the total mackerel catch in this area. Norway and Russia have large catches in IIa, for which no discard information is available.

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 2004 the Netherlands and Germany provided discard data on horse mackerel to the working Group. Their horse mackerel catches represent app. 40% of the total catch in all areas.

Because of the potential importance of significant discards levels on the mackerel and horse mackerel 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.**

For the major areas covered by the mackerel and horse mackerel fishery and other fisheries quarterly discard sampling by fishing technique, by ICES Division (EU data regulation 1639/2001) is now a requirement. With only three countries providing discard data in 2004 this is still not done sufficiently.

Sardine

No observer programme has been conducted to collect more information on the importance of slipping but research on the effects of slipping on sardine survival has been carried out. However, at present the results are not available to the WG.

Anchovy

The most recent information from the Spanish anchovy fishery suggests that discarding is not a problem. There are no estimates of discards in the French anchovy fishery. It is not known if discarding in this fishery is a problem.

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

At the 2001 meeting the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine, and Anchovy it was recommended that institutes examine their otolith preparation technique for mackerel and that 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.

This recommendation was based on the analysis of the 2001 otolith exchange (EU-contract SAMFISH 2000/2001), which, however, only included age readers from Spain, Portugal, the Netherlands, England and Scotland. The age reading results were also examined by group of otoliths prepared by an institute in order to evaluate the different otolith processing techniques. The text table below shows the results based on the age readings of all readers reading all otoliths of all institutes:

Institute that prepared the otoliths	Percentage agreement to modal age	Precision CV (%)
RIVO	75.8	7.5
CEFAS	75.6	7.3
AZTI	66.7	14.8
IEO	66.6	10.2
IPIMAR	61.4	18.6
MARLAB	54.1	21.0

From the table above it is apparent that the otolith preparation method determines to a large extend the accuracy and precision of the age readings.

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.

The Working Group also recommends that a mackerel otolith exchange be carried out in 2006. It is proposed that this exchange be coordinated by Ireland. (EU countries should include work on this in their National Programmes regarding the data collection).

Horse mackerel

At last year 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.

Prior to a workshop on age reading horse mackerel in 2005 an otolith exchange will take place to detect and evaluate the problems in age reading. Netherlands will organize both the exchange and the workshop to try to solve the observed problems in age reading.

Anchovy

For the Bay of Biscay **anchovy**, two exchange 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 of the anchovy in IXa (Cadiz) have also taken place (Garcia 1998).

A workshop on age determination from otoliths for the anchovy took place in 2002. The major goal was to identify major difficulties in age determination and standardise anchovy otoliths ageing criteria for the Bay of Biscay and for division IXa (Uriarte 2002).

In 2005 an exchange programme of age reading for the Bay of Biscay anchovy has taken place, but its results are still in preparation. A workshop is devised to take place during 2006 to examine the results from exchange programme and to improve the consistency and accuracy of readers.

The working group endorses the workshop initiative (EU countries should include work on this in their National Programmes regarding the data collection).

Sardine

A workshop on sardine age reading took place in June 2005 to discuss the results of an exchange of otoliths carried out during 2004. The report of this workshop is being prepared.

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, but concluded that for the time being there are no valid proxies for fecundity and therefore it is not currently possible to derive an index to convert egg production into SSB of horse mackerel (ICES, 2005/G:09). A different method is therefore needed to provide a fishery independent index for this species.

Sardine

The need to revise maturity and weight at age estimates has been highlighted in the last WG meeting. Research on these issues is on course within the framework of Project "SARDYN", therefore new guidelines on how to proceed with the revision of maturity and stock weights at age is expected in the near future.

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.

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. This issue will have to be carefully considered in light of any future development by ICES of a standard platform to store all fisheries aggregated data.

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. 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

In 2005 ICES have developed a database for handling the collation and raising of catch data. The"ICES InterCatch database" is designed to store the national datasets and aggregate them into international data used in the assessment. In November 2005 the database will be tested by one of the WGMHSA species coordinators to ensure it meets the requirements of the working group.

1.4 Checklists for quality of assessments

As a step in the direction of systematic documentation of the assessment procedures and quality, checklists as suggested by the HAWG (ICES 2000) were made for some of the stocks since 2000 and updated again this year (Tables 1.4.1-1.4.5).

1.5 Comment on update and benchmark assessments

For this year, ICES had scheduled the horse mackerel stocks and the anchovy stocks for a benchmark assessment and the other stocks for an update assessment. In some of the update assessments and for various reasons, the WG decided to do more extensive studies than just to update the last year's assessment. A brief overview is given below; details are given in the respective sections.

NEA mackerel: Benchmark done in 2004. Next benchmark planned in 2007. Further exploartion of the effect of various model formulations is provided in the report.

North Sea horse mackerel*:* Update: The data are sparse and of variable quality. Attempts to design methods that make use of the best available data have been made for some years. This year, more complete survey data are available. The analysis of the data reveal that they are insufficient for an age based anlytical assessment. Length based assessments based on survey data may still be explored, but the necessary data were not available to the WG.

Western horse mackerel: Benchmark. The historic catch data are dominated by the very strong 1982 year class going through the fishery. Catch data was explored by means of user-defined and separable VPA's. Results from performing an assessment of the stock by means of a separable ADAPT like method, AMCI and ISVPA were compared. The interpretation and use in the assessment of the triennial Egg Survey time-series of egg estimates continues to be problematic.

Southern horse mackerel*:* Update.

The relative strength of each cohort in the research surveys and the catches were analysed to investigate where an analytical model could be used in the assessment of the stock.

A Separable VPA model was applied to check if the separability assumption could be made in the model of fishing mortality. The separability model provided an acceptable pattern of residuals and therefore an assessment assuming a strict separability model was applied using the AMCI program. Various exploratory runs were carried out to improve the fitting of the model to the data. The best fitting was achieve with the following assumptions:

a) the selectivity of the last three ages was constant

b) the fishing mortality effect of the last two years was also constant

c) the recruitment of the last two years was fixed as the geometric mean of the recruitments obtained in a preliminary assessment.

With the assessment results a short-term prediction and a yield per recruit analysis were carried out showing that the Fstatus quo is above Fmax and that at stable fishing effort SSB will continue to decrease slightly unless there is a strong recruitment entering in the population.

Sardine: Update assessment. Benchmark proposed 2006, when the results of SARDYN and the next DEPM-based SSB estimate are available.

Anchovy in VIIIc: Benchmark assessment. Extensive exploration of both the previous ICA assessment and new approaches are provided. The WG proposes the Bayesian biomass model asbasis for the advise, and as standard assessment tool for the future.

Anchovy IXa*:* Still, the data are too sparse to allow analytic assessments, but various model approaches are being explored.

1.6 The ICES stock handbook

The working group started to transfer "static" parts of the report into the stock handbook during this session. Due to time constraints, this task could not be completed. The information is therefore also kept in the report body for the interim year, but duplicate information will be removed intersessionally and during next year's WG session.

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 last years WG report.

1.8 Long term management strategies

ICES is developing alternative approaches to management that rely more on a fully developed management strategy framework rather than a reference point based precautionary domain described only in SSB and fishing mortality the framework is to replace the existing PA framework. To this end a Study Group on Management Strategies met for its first meeting in February 2005 to define a framework based on long-term considerations for management strategy evaluations in a Precautionary Approach context. A preliminary framework for evaluation of management strategies was described in the report, providing a description of the approach and operational guidelines for implementation of management strategy evaluations by ICES. Preliminary operational guidance for working groups in 2005 was provided to allow exploration and selection of options for management strategies including harvest control rules and targets. The report also contains a brief review of some of the existing software.

The SGMAS report is organized in sections. Section 2 describes the conceptual issues around management strategies including the role of the different parties in the fisheries system. Examples are given in Section 5 for a number of fisheries and stocks for which such strategies have been implemented and evaluated. Section 3 provides a general overview of the scope of the issues, the fisheries that require different management strategies, the differences in biological characteristics of exploited species that may call for different management strategies. Section 4 describes how long term management strategies could be developed including the role of the different parties in the process. In section 4.4 a detailed framework is presented for evaluation of management strategies. This framework is developed further in section 7 where simulation is described in detail. Section 5 provides seven examples of management strategies that are already in use. There are some specific types of management measures that present their own specific challenges for evaluators. Several of such types of management action are identified in section 6 and it is anticipated that additional types, as they present themselves in future, should be similarly analysed to identify special issues related to their evaluation. Section 7 draws heavily on the experience of the Methods WG (ICES 2004) and provides standards for simulation. Section 8 provides a brief review of the software currently available and indicates which are currently suitable for use in management strategy evaluations, in particular for HCR simulation and how they are documented.

It is recognized that presenting ideas as part of a dialog with managers is an important part of the development of HCRs and that it is unlikely that this will be available for many stocks immediately. In the absence of specific targets for management objectives, ICES will at least regard the Precautionary approach as an objective. In this respect, ICES will evaluate a management strategy to its own standards, which imply that the risk of SSB falling below B_{pa} should be low, i.e. less than 5-10% However, it is recognized that in earlier phases of the development of management strategies, information on the level of risk associated with alternative strategies will be of interest to managers, who may want to balance risk against potential gains.

For the WGMHMSA the challenges are diverse, with stocks with contrasting biology requiring diverse management strategies. Bay of Biscay anchovy; occupies differing areas at different ages, it is exploited as a single year class with the inevitable recruitment driven rapid fluctuations in the available resource, requiring early information on year class strength, and rapid management reaction in year. 2003. Roel et al 2003 proposed a two step TAC procedure for the anchovy of the Bay of Biscay in a working document to the WGMHSA in 2003. Petitgas et al (WD2005) propose the use of a matrix population model to evaluate management regimes for anchovy in Biscay, Ibaibarriaga at al (WD 2005) has extended the work presented by Roel (2003). Currently management has responded positively to these approaches but there is a need for further management and fishing industry consultation. See Section 10.10 for current details on these developments. NEA Mackerel which already has a management agreement for exploitation at low F has had long periods of relatively stable recruitment, and only an infrequent fishery independent measure of biomass though the Egg Surveys. Roel 2004 and Skagen 2004 & 2005 have both examined management on a three year cycle matching the availability of data on stock size. Currently there has been a little feedback from managers but the renegotiation of management agreements is necessarily complex and new agreements will take time. Western horse mackerel has historical evidence of widely differing recruiting years classes and the state of the stock is currently very uncertain, harvest control rules for this stock are discussed in section 5.11.

1.8.1 Answer to special request on Anchovy

Is the fishing mortality the main cause of the situation of the Anchovy stock or, rather can it be attributed to other factors? I consider appropriate to evaluate the effects of the fishing mortality on the sustainability of the stock.

ICES interprets the word “situation” in this question to refer to “very low recruitment” ICES considers that there is a direct link from recruitment to SSB through the growth and maturation of recruits (Figure 1.8.1.1). However the influence of the level of SSB on subsequent recruitment is not fully understood. The anchovy fishery in Biscay catches of between 30% and 80% of the SSB (Figure 1.8.1.2), but at low spawning biomass levels this percentage increases and fishing mortality makes up a significant proportion of the total mortality. In the last two years fishing mortality has increased as consequences of attempting to maintain previous levels of catches at low SSB. The low SSB is primarily a consequence of poor recruitment, but this is exacerbated by high fishing mortality. It is not possible to say if the low recruitment has been caused directly by the reduction of spawning biomass that fishing mortality induces.

ICES considers that low Spawning stock biomasses carry an increased risk of poor recruitment. ICES further considers that the biomass of anchovy in Biscay has been low since 2003 (below Bpa figure 1.8.1.1). However ICES is unable to say if the subsequent low recruitments have been the exclusive consequence of low SSB. Anchovy recruitment is presumed to be influenced by environmental effects, however the mechanism of the effect is still not fully understood. The environmental indices which we have at present were unable to predict the low recruitment of age 1 fish observed in 2003, 2004 and 2005.

In the long term, the average levels of fishing mortality on anchovy between 1990 and 2004 imply a mean reduction of the spawning biomass to about 63% of the one would have been without exploitation (Figure 1.8.1.3). A target fishing mortality which does not reduce the population beyond 50% of the unexploited state could be considered compatible with the application of the precautionary approach for the management in situations where the spawning biomass is within safe biological limits. So on average past levels of exploitation (as estimated by ICES) seemed to be sustainable notwithstanding the need for protection at low levels of biomasses.

ICES has repeatedly advised of the need to protect the stock at low levels of biomass in order to assure a minimum spawning biomass (or Blim) below which the risks of getting low recruitments and increasing fishing mortality would put the stock at the risk of depletion.

If since 2001 there were not fishing activity, do you consider anchovy recruitments should be maintained at the same levels?

If the catches are removed from the development of the stock for the past three years, the SSB would have been higher over the last years. With a hypothetical assumption of the same recruitment as seen under exploitation, the SSB would increase by about 140% (bringing it close to Blim). What this increase in SSB would have implied for the recruitments occurring during these years and subsequent spawning biomasses in not known. However ICES considers that an increase in biomass (from the very low levels observed for the past few years) will produce a higher likelihood of increased recruitment.

Situation of the stock is due to small recruitments, reduced SSB or other reasons?

In the third question ICES interprets the word "situation of the stock" to mean low abundance of the stock. ICES considers that for the Biscay anchovy stock the SSB is usually dominated by the recruits. In recent years there has been low recruitment and because of this the SSB has been low. ICES reiterates that the influence of the SSB level on subsequent recruitment is not fully understood, but that recruitment has a higher likelihood of being lower at very low stock sizes.

I will also propose to study the evolution of the rates of fishing mortality by the different fishing fleets exploiting this resource using the historical data.

The evolution of the rates of fishing mortality by the different fleets has been explored using a seasonal assessment. To provide this information has required the development of an ad-hoc approach, and the results must be considered as preliminary. The results of this exploration are given in Table 1.8.1.1. Details on the methodology behind this analysis are given in the WGMHSA 2005 report Section 10.

Note to ACFM fleet specific fishing mortality may be affected by the availability of the fish to the different fleets, this is not considersed here.

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

Last year WG provided a comprehensive update on work carried out by different ICES SGs in relation to ecological/environmental studies related to small pelagic species, as well as a short list of syntetic papers describing the state of the art of ecological/environmental knowledge in relation to small pelagics. Both SGRESP and SGSBSA were identified as important sources of information regarding these issues. SGRESP has met in Plymouth from 28th February to 2nd March and the last SGSBSA meeting took place between 11th-13th November 2004.

SGRESP report this year included an update of stock "identification cards". ID cards cover 11 small pelagic stocks in ICES areas, for which main features both related to the population dynamics and the main environmental variables affecting the population were summarised. Changes in anchovy and mackerel distribution using broad coverage surveys (IBTS, triannual surveys) were analysed. Although these data have gaps and surveys may not being aimed at the species of interest for SGRESP, sometimes they provide the only comprehensive broad scale data available. Potential spawning habitats of sardine and anchovy were characterised using CUFES data to estimate egg abundance and mesoscale environmental indexes. Possible northward migration of some small pelagic species like anchovy or sardine was also analysed, and a request for the collection of dataset that can be combined to provide broad coverage pictures was produced.

Last SGSBSA report mainly dealt with the preparation of the 2005 DEPM surveys to be carried out to evaluate sardine SSB in Iberian Peninsula waters, as well as anchovy SSB in the Bay of Biscay. Also, a detailed description of the state of the art of icthyoplanckton analysis methods and available software to help in the estimation of DEPM parameters was carried out in the SG. Although not directly related to environmental issues, software developed through this SG allows environmental characterisation of spawning areas to be performed easily, and provides modelling tools that allow to link egg production and DEPM parameters with both geographical and environmental variables. Also, data exploration to allow for spatial modelling of the different DEPM parameters led to an increased knowledge on variability of some of those parameters (e.g. spawning fraction or mean weight) in relation to environmental variables. SGSBSA reached its third and last meeting last year and ICES Living Resources Committee decided to extend its duration and scope by converting it into the Working Group on Acoustic and Egg survey for Sardine and Anchovy in ICES areas VIII and IV

(WGACEGGS), which is expected to deal with environmental properties affecting egg production and acoustic estimates of biomass and distribution.

Apart from the work of these SG, during next year, the GLOBEC project reaches its conclusion year, and synthesis of work carried out in its different packages is expected to become available. There are also other local projects that deal with the use of different models to link population dynamics and environmental variables (e.g. application of ECOPATH in Baltic Sea, Bay of Biscay and Cantabrian Sea).

The WG considers work on identification of main environmental forces affecting population dynamics a main milestone for the understanding of the mechanism linking population dynamics and environment. Thus, the WG values the work carried out in SGRESP and encourages the continuation of data collection and analysis of broad scale surveys . Also, the WG values the results from SGSBSA, in terms of revision of DEPM based estimates, in the understanding of the population dynamics with respect to geographical and environmental variables, and in providing tools to further extend the analysis of environmental effects on population variables. The WG expects contributions from WGACEGGS, GLOBEC and other regional scale projects to help understanding the links between population dynamics and environmental forces.

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 2004.

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
Ireland	YES	YES	YES	NO
Netherlands	YES	YES	YES	NO
Northern Ireland	YES	YES	NO	YES
Norway	YES	YES	YES	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	NO	NO	YES
England&Wales	YES	YES	NO	YES
Faroes	YES	NO	NO	YES
France	NO	-	-	YES
Germany	YES	YES	YES	NO
Ireland	YES	YES	YES	NO
Netherlands	YES	YES	YES	NO
Norway	YES	YES	YES	NO
Portugal	YES	YES	YES	NO
Russia	NO	-	-	NO
Scotland	YES	YES	NO	NO
Spain	YES	YES	YES	NO
Sweden	NO	-	-	YES

C. Sardine

Country	Data supplied	Data exchange sheet	Aged Samples	Problems
France	YES	YES	YES	NO
England&Wales	YES	YES	NO	YES
Ireland	YES	NO	NO	YES
Germany	YES	NO	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 X	Format W	Format D	Comments
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
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)
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
	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
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
	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

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 2004 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 as 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.

Table 1.4.1 (Cont'd)

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, Maturity-at-age, Size-at-age, age-specific reproductive in-formation	Catch at age: derived from national sampling programmes. Sampling programmes differ largely by country and sometimes by fishery. Sampling procedures applied are either separate length and age sampling or representative age sampling. 79% of the catch was sampled for length and age in 2004 (was 80% for2003). Total number of samples taken (2004): 1,380; total number of fish aged: 24,173; total number of fish measured: 177,812. Weight at age in the stock: Stock weights were available from national sampling programmes in 2004. 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: constant value since 1984 (start of data series). The 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: 87.3% / 9.9% / 2.8%). 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 (see above). As there was no new data there was no change in the maturity ogive in 2004.
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 (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.

Table 1.4.1 (Cont'd)

3. Assessment model

step	*Item*	*Considerations*
3.1	Age, size, length or sex-structured model	Current assessment model: ICA Exploratory analyses: AMCI & ISVPA
3.2	Spatially explicit or not	No
3.3	Key model parameters: natural mortality, vulnerability, fishing mortality, catchability	<u>Natural mortality</u>: fixed parameter over years and ages (M=0.15) based on tagging data. <u>Selection at age</u>: Reference age 5 for which selection is set at 1. Selection at final age set to 1.2. One period of 13 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. <u>Population in final year</u>: 13 parameters. <u>Population at final age for separable years</u>: 9 parameters. <u>Recruitment for survivors year</u>: Total number of parameters: 48 Total number of observations: 161 Number of observations per parameter: 3.4
	Recruitment	No recruitment relationship fitted.
3.4	Statistical formulation: - what process errors - what observation errors - what likelihood distr.	Model is in the form of a weighted sum of squares. 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 2001. In 2002 and 2003 it was treated as absolute. In 2004 and 2005 it was treated again as relative.
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.

Table 1.4.1 (Cont'd)

3.6	Retrospective evaluation	Currently retrospective analysis is carried out despite the fact it is not directly available within ICA and 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. In 2005 the WG started to evaluate the quality of the assessment by comparing the first estimates of SSB, F and 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 SSB, F and recruitment the changes.
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 (48 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

Table 1.4.1 (Cont'd)

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	<u>Stock weights at age</u>: average from last 3 years <u>Natural mortality at age</u>: average from last 3 years <u>Maturity at age</u>: average from last 3 years <u>Catch weights at age</u>: average from last 3 years <u>Proportion of M and F before spawning</u>: 0.4 <u>Fishing mortalities by age</u>: From ICA <u>Numbers at age</u>: 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 the 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

step	*Item*	*Considerations*
5.1	Age, size, sex or fleet-structured prediction model	Medium term predictions carried in 2004, but not in 2005, because the longer term view is better represented by yield per recruit of management simulations Age and fleet structured. *Software: STPR programme*
5.2	Spatially explicit or not	No
5.3	Key model parameters	Model parameters as in short term predictions. Exploitation pattern and numbers at age taken from short-term prediction input; CVs taken from ICA estimates in the previous year assessment. Expected Recruitments are based on the arithmetric mean computed from the time-series of estimated recruitments and a CV of 0.25.
5.4	Recruitment	An Ockham stock recruitment relationship is fitted, assuming recruitment independent of the SSB for SSB > 2 million t, and linearly decreasing with SSB below 2 million t.
5.5	Evaluation of uncertainty	Stochastic forward projections are based on the Baranov catch equation incorporating uncertainty in the starting population numbers and recruitment as noted in point 2, 5.3. Stochastic weights and maturities from historical data.
5.6	Evaluation of predictions	
5.7	Major Deficiencies	Intermediate year: general problem- whether to use status quo F or a TAC constraint for intermediate year

Table 1.8.1.1:

SUMMARY SEASONAL ASSESSMENT OF THE FISHEY OF ANCHOVY IN VIII

Year\ ages	Spawning Stock	Recruitment	Annual Catches	Catches Expected	Ratio Yield/SSB	Annual Average F (1-3+)	F (1-3+) Winter France	F (1-3+) Spring France	F (1-3+) 2nd half France	F (1-3+) Spring Spain	F (1-3+) 2nd half Spain
1987	41,845	7,656	15,309	15,197	0.366	0.490	0.000	0.075	0.082	0.277	0.056
1988	37,015	3,410	15,581	18,787	0.421	0.802	0.140	0.093	0.211	0.277	0.082
1989	18,039	17,884	10,614	10,415	0.588	0.628	0.060	0.051	0.034	0.384	0.099
1990	54,520	6,717	34,272	37,455	0.629	1.062	0.000	0.036	0.367	0.370	0.289
1991	23,131	25,986	19,635	21,904	0.849	1.074	0.215	0.101	0.193	0.522	0.042
1992	69,316	24,243	37,885	50,027	0.547	1.120	0.145	0.009	0.337	0.603	0.026
1993	84,895	11,404	40,392	38,108	0.476	0.695	0.106	0.012	0.283	0.260	0.034
1994	49,718	10,189	34,631	35,055	0.697	0.845	0.116	0.044	0.230	0.389	0.065
1995	39,734	14,304	30,116	31,959	0.758	1.048	0.075	0.058	0.248	0.644	0.022
1996	43,575	16,044	34,373	37,621	0.789	1.325	0.088	0.030	0.507	0.619	0.082
1997	42,009	29,653	22,339	21,437	0.532	0.605	0.083	0.020	0.242	0.194	0.066
1998	97,969	12,489	31,617	31,723	0.323	0.408	0.062	0.014	0.243	0.075	0.015
1999	71,888	22,533	27,258	26,775	0.379	0.387	0.057	0.010	0.148	0.127	0.045
2000	86,995	21,333	36,994	37,665	0.425	0.542	0.066	0.016	0.180	0.253	0.026
2001	88,705	3,945	40,149	38,048	0.453	0.494	0.015	0.011	0.198	0.233	0.036
2002	45,230	3,827	17,497	18,980	0.387	0.443	0.105	0.015	0.170	0.096	0.056
2003	21,727	6,838	10,595	10,462	0.488	0.675	0.002	0.056	0.515	0.093	0.008
2004	25,579	613	16,360	16,494	0.640	0.977	0.016	0.066	0.479	0.393	0.024
2005	8,322		1,152	1,352	0.138	0.128					
Average 1990-2004	56,333	14,008	28,941	30,248	0.558	0.780	0.077	0.033	0.289	0.325	0.056

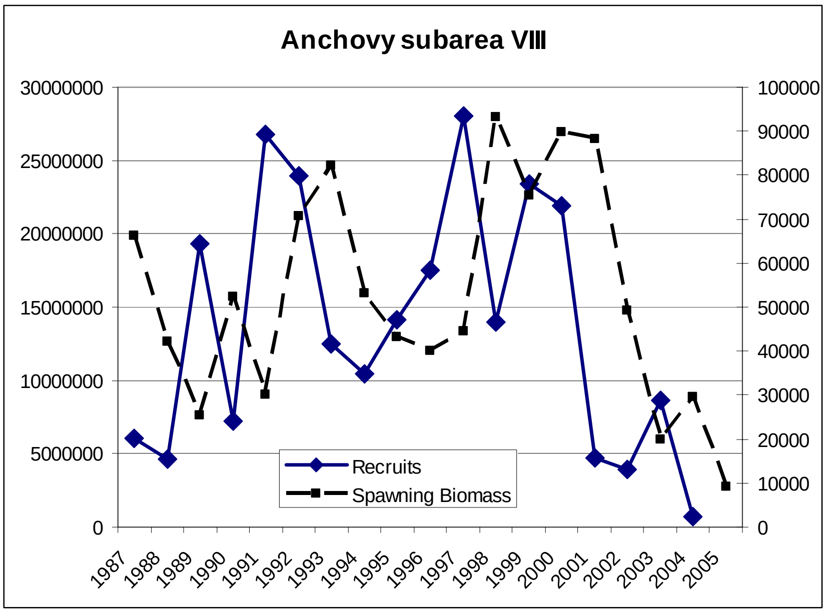


Figure 1.8.1.1: Series of Recruitments and Spawning Biomass of anchovy (according to a standard ICA assessment).

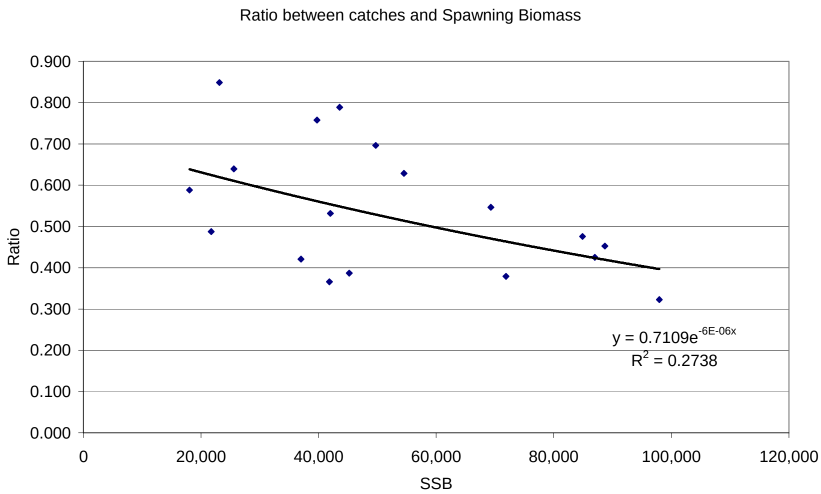


Figure 1.8.1.2: Ratio of annual catches to spawning biomass in relation to the spawning biomass estimates.

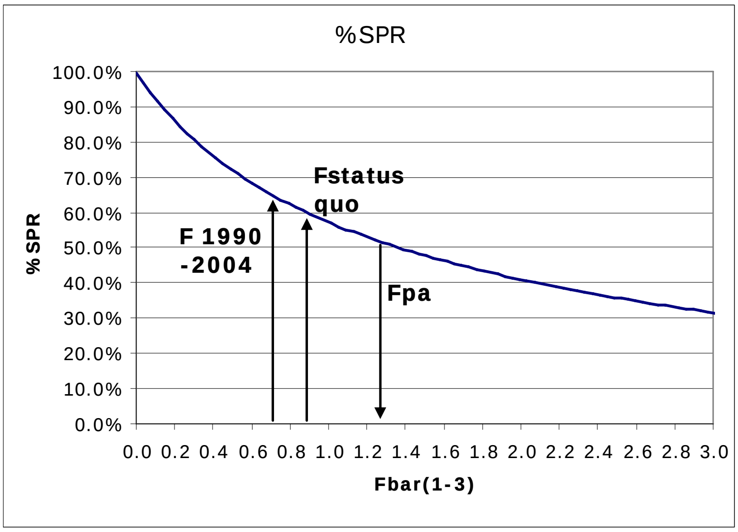


Figure 1.8.1.3: Analysis of spawning biomass per recruit for anchovy under different levels of exploitation.

2 Northeast Atlantic Mackerel

2.1 ICES advice applicable to 2004 and 2005

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 (Fig. 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 2004 and 2005 are given in the text table below.

Agreement	Areas and Divisions	TACs in 2004	TACs in 2005
Coastal states agreement (EU, Faroes, Norway)	IIa, IIIa, IV, Vb, VI, VII, VIII, XII, XIV	461,000	354,942
NEAFC agreement	International waters of IIa, IV, Vb, VI, VII, XII, XIV	36,998[1]	40,185
EU-NO agreement[2]	IIIa, IVa,b	1,865	1,865
EU autonomous[3]	VIIIc, IXa	32,305	24,873
Total		532,168	421,865

Stock components	ACFM advice 2004	ACFM advice 2005	Areas used for allocations	Prediction basis	Catch in 2004
North Sea	Lowest possible level	Lowest possible level	IIa, IIIa, IV, Vb, VI, VII, VIIIa,b,d,e, XII, XIV	Northern	576,621
Western	Reduce F below F_{pa} = 0.17	Reduce F in the range 0.15 – 0.20			
Southern			VIIIc, IXa	Southern[4]	34,840
	545	320-420			611,461

1) NEAFC agreement was 52,192 t including 15,194 t not fished by any party.
2) Quota to Sweden.
3) Includes 3,000 t of the Spanish quota that can be taken in Spanish waters VIIIb.
4) 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. 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 quota following additional management measures are advised as stated by ACFM (2004). These measures are mainly designed to afford maximum protection to the North Sea 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 2004

2.2.1 Catch Estimates

The total estimated catch in 2004 was 611,000 t which was similar to catches in 2003 (617,000t). The 2004 catch corresponds a TAC for the whole stock distribution area of 532,168 t; this was approximately 50,000 t lower than the 2003 TAC. The fishable TAC for 2003 was 582,509 t. The TAC set for 2004 covered all areas where mackerel is caught. The combined fishable TAC as best ascertained by the Working Group (Section 2.1) agreed for 2005 amounts to 421 865 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/ or slipping estimates are included. 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 info
Germany	Y		Y
Norway	Y (catches)		
UK	Y		Y
Ireland	Y		
Denmark	Y	Y (sale slips)	
Faroe	Y (catches)	y (coast guard)	
Netherlands	Y		Y
Spain		y	
Portugal	Y		
France	Y		
Russia	Y (catches)		
Sweden	Y		

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. In the Russian, Norwegian and Faroese fleets discarding is illegal, which means formally landings are equal to catches. 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 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 highest catches (about 294,000 t) were again taken in Division IVa. The catches taken from Div Vb and Sub area II (62,500 t) increased from last year by almost 10,000 t 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) increased by about 10,000 t to around 217,000 t which is at the same level as the mid to late nineties.

The total catch recorded from the North Sea (Sub-area IV and Division IIIa) (Table 2.2.1.3) in 2004 was about 297,000 t which is 34,000 t less than the catches in 2003.There had been a trend of increasing catches in this area since 1996, but this trend reversed in the last two years with a decline in catches since 2002. Misreporting of catches taken in this area into VIa has decreased by more than 50% of levels from previous years to 18,000 t. This component of the catch is highly variable and depends on the availability of mackerel to the fleet.

The catches taken in Divisions VIIIc and IXa in 2004 have increased by 9,000 t to 35,000 t. 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, but are still lower than in the years prior to the oil spill.

The total area misreported and unallocated catch during 2004 obtained by numerical methods by the WG was just less than 22,000 t, which is substantially lower than the 2003 value of 50,000 t. 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 other possible estimates for unrecorded catch).

The quarterly distributions of the catches since 1990 are shown in the text table below. The distribution of the catches in 2004 shows the highest proportion of catches in the 1th quarter (36%) and similar proportion of catches in quarter three and four. Over 60% of the total catch was taken in between the3rd and 4th quarter in IVa and the 1st quarter in VIa.

Percentage distribution of the total catches by quarter from 1990 – 2004.

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	34	9	30	27
2000	39	4	23	33
2001	38	7	25	30
2002	35	6	31	27
2003	34	5	24	37
2004	36	6	29	28

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, it should also be noted that these data may not indicate the location of the stock. Of the total catch, 36% 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. The proportion of the total catch taken in Quarter 2 was 6% with most catches taken in Sub-area VII. In Quarter 3 and Quarter 4 were 29% and 28% of the total catches respectively with most catches mainly taken from Division IVa. The main catches of mackerel in the south are taken in VIIIc (82%) and these are taken mostly in the first and second quarter. Catches increased since last year due to a resumption of the fishery after the "Prestige Oil spill" (see above). Catches from IXa comprise 18% of mackerel catches in the south and were evenly distributed over the first three quarters.

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 Norway, Scotland, Ireland, Russia, Netherlands and Spain. Significant catches were also taken by Denmark, Germany, France, England and Faroe Islands (combined catch 115,000 t); France and Faroes did not sample their catches in 2004.

The main catches taken in IVa were recorded by Norway (146,000 t), while substantial catches were also recorded by the United Kingdom (77,764 t) and Denmark (26,000 t). The Irish catch was slightly less at about 19,000 t. Discards were again reported this year and an age structure of the discarded catch was made available by Scotland (see section 2.2.2). The total catch estimated to have been taken from the Western areas (Table 2.2.1.4) was over 217,000t. This is about 10,000 t more than the catch taken in 2003. The main catches continue to be taken by United Kingdom (122,000 t) and Ireland (42,000 t). The Netherlands (21,000 t), Germany (19,000 t) and France (19,000 t) continue to have important fisheries in this area. The misreported catches from IVa are 18,000 t which is about half of the levels reported in 2003.

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 (see table 2.9.1.2). 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,b,d.e, and IV/III (Tab. 2.2.1.1). No data about discards are available for the areas I/II/Vb and VIIIc/IXa. In 2004 discard data for mackerel were provided by three nations: Scotland, the Netherlands and Germany. Discard figures amount to app. 10,000 tonnes as the sum given by the three countries and have not been raised to total catches.

Age disaggregated discard data from the Scottish fishery in the first quarter in area VIIb and in the fourth quarter in area IVa were available to the working group. In Div. IVa in the 4th quarter, 90% of the discard of app. 8,800 tonnes were 2 and 3 year old fish which mainly consisted of lengths between 29 and 34cm. In Div. VIIb in the 1st quarter discarding of app. 315 tonnes occurred. 50% of the discards consisted of 2 year old fish with lengths between 24 and 27cm. Germany provided length disaggregated discard data for the 1st quarter in area VIIb and VIIj, for the 3rd quarter in area IVa and for the 4th quarter in area VIIe. Discards in IVa and VIIe were by-catches in the herring and horse mackerel directed fishery. In Div. VIIb and VIIj in the 1st quarter, the discards of 550 tonnes consisted of fish with lengths between 24 and 32cm. The percentage length compositions of the discards for all areas are shown in table 2.4.2.1.

The observed age and length disaggregated discard data are indicating that small mackerel were increasingly discarded in the areas IVa and VIIb/j.

2.2.3 Fleet Composition in 2003

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 targeting 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 Species Mixing

Scomber sp.

As in previous years, there was both a Spanish and a Portuguese fishery 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 is similar during the whole period with the highest catches in the IXa South.

Table 2.2.4.1 shows the Spanish landings by sub-division in the period 1982-2004. The total Spanish landings of *S. japonicus* in 2004 were 3677 t, showing a decreasing trend since 1994 on. 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 882 t of *Scomber japonicus* in 2004. In the bottom trawl and acoustic surveys carried out in the Gulf of Cadiz in 2004, catches of *S. japonicus* making up on average 97.23 % and S. scombrus 2.82 % of the total catch in weight of both species (M. Millán, pers. comm), similar contributions to those recorded in 2003. From 1992 to 1997 the catch of *S. scombrus* in bottom trawl surveys 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. Due to the uncertainties in to the proportion of *S. scombrus* in landings, these catches 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) were 12,425 t, showing increase with respect to the 2003 (8030 t) catch level, with a similar level in comparison to the 1999 (13,877 t) and 2000 (10,520 t) catch levels, the highest ones since 1982. The distribution of the catches is similar during the whole period, catches being 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 for 67 % 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. There is no probably no miss identification of mackerel species in the Portuguese fishery in Division IXa.

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 (See Section 2.5.4 for a discussion on the size of the North Sea component).

Prior to 1995 catches from Divisions VIIIc and IXa were all considered belonging to the southern mackerel component 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 component to assess the Northeast Atlantic Mackerel stock.

The TAC for the Southern area applies to Divs.VIIIc and IXa. Since 1990, 3,000 t of this TAC, which has been around at 40,000 t, have been permitted to be taken from Div.VIIIb in Spanish waters. This area is included in the "Western management area”. These catches (3,000t) have always been included by the Working Group in the western component.

2.4 Biological Data

2.4.1 Catch in numbers at age

The 2004 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 611,460 t, which is the WG estimate of the total catches from the stock in 2004.

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 49,000t) while England & Wales provide aged data for only 9% of their catches. In addition there was insufficient samples to cover divisions IIIa, V, VIIc,d and VIIIa,d amounting to a total catch of 26,000t. Minor catches from Divisions IIId and VIIa,g,h,k with a total catch of >500t 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 2004 catches of NE Atlantic mackerel is mainly comprised of 1-7 year old fish. These age groups constitute 90 % of the total. Age 1 fish account for only 1% of the total catch numbers, which constitutes a substantial decrease from 2003 where the age 1 group contributed 11% to total catch numbers. This supports the assumption of a poor recruitment in 2003. Highest proportions of 1 year olds in 2004 were caught in the eastern Celtic Sea (VIIf, VIIg, VIIh) and west of Portugal (IXa).

Overall, 2 and 3 year old fish contributed most to the catches with 25% and 29% respectively, reflecting the strong recruitment in 2001 and 2002. The weight of five year and older fish are less represented in the catches in 2004 compared to 2003. The poor recruitment of the 2000 year class resulted in a low representation of the 4 year old fish in the 2004 catches (8%).

In the northern North Sea (IVa) where most of the catches of mackerel are taken, over 60% of the catches comprised 2 and 3 year old fish, while ages 4 to 7 comprised a further 30% of numbers in catch. While a high proportion of fish caught in 2003 in IVa were 1 year old fish (11%), this age group was almost absent in the catches in 2004 (0.4%).

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 distribution is dominated by fish in the age range 1 to 3 making up over 85% of the total catches. In the Bay of Biscay (VIIIe,b,d) the catch is primarily composed of ages 2 to 6 with a low numbers of 1 year olds. The contribution of 1 year old increased in the southern Biscayan waters (VIIIc) and IXa where ages 1 to 3 predominated the catches.

2.4.2 Length composition by fleet and country

Length distributions of the 2004 catches were provided by Denmark, 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 87% 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 2004 catches and discards are shown in Table 2.4.2.1. Further discussion on length distributions of discards samples is given in section 2.2.2.

2.4.3 Mean lengths at age and mean weights at age

Mean lengths

The mean lengths at age in the catch per quarter and ICES division for 2004 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 three year old fish was shorter than in the previous year. Some spatial patterns were also detectable with fish caught in the North Sea (IV) being above overall mean length at age for all age classes while fish in the western channel and Celtic Sea area (VIIe,h,f,g,j) were below mean length in all age classes.

Mean weights in the catch

The mean weights at age in the catch per quarter and ICES Division for NE Atlantic mackerel in 2004 are shown in Table 2.4.3.2.Compared to last year's data mean weights at age are lower for the one to three age classes. Spatial differences in mean weights were noticeable with heavier than average fish being caught in the North Sea (IV).

Mean weights in the stock

In this working group the mean weights at age are calculated the following: 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 of the North Sea, Western and Southern mackerel components based on the proportion of egg production in each area from the egg surveys. 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).

AGE	NORTH SEA	WESTERN COMPONENT	SOUTHERN COMPONENT	NEA MACKEREL
0	0.000	0.000	0.000	0.000
1	0.114	0.050	0.125	0.059
2	0.233	0.131	0.168	0.138
3	0.271	0.243	0.260	0.246
4	0.341	0.309	0.346	0.313
5	0.400	0.352	0.375	0.355
6	0.445	0.409	0.423	0.412
7	0.489	0.463	0.449	0.463
8	0.467	0.459	0.487	0.462
9	0.509*	0.509	0.497	0.508
10	0.606*	0.515	0.537	0.520
11	0.643*	0.532	0.558	0.538
12+	0.550*	0.592	0.584	0.590
Weighting of stock	**0.0275**	**0.8734**	**0.0991**	

***No age available for 9-12^{+}, mean of last three years**

The weighting is calculated as follows: For the western and southern areas egg production of the 2004 international egg survey is used from WGMEGS (2005/G:09). For the North Sea component the mean value of the egg production in 1996 and 1999 is used. The estimate from the 2002 egg survey was excluded in the weighting as the temporal coverage did not correspond to peak spawning. Figures will be revised when the full data set for the 2005 North Sea survey becomes available in from WGMEGS in 2006. For the Western component this year's working group uses stock weights based on Dutch and Irish mean weights at age from commercial catch data collected in Division 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 2004.

2.4.4 Maturity Ogive

The maturity ogive for NEA mackerel are the same as used in the 2004 working group and are given in the text table below. 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	0.59
3	1.00	0.90	0.70	0.88
4	1.00	0.97	1.00	0.97
5	1.00	0.97	1.00	0.97
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	**0.0275**	**0.8734**	**0.0991**	

[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.

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 meetings are held in the years before and after the surveys themselves, the WG works by correspondence in the survey years themselves. The WG met from 4 to 8 April 2005 in Bergen Norway, The main activity for this meeting was the reporting and analysis of the 2004 survey Triennial Mackerel and Horse Mackerel Egg Survey which was carried out from January to July 2004.. The working group has provided an extensive report (ICES 2005) the sections below present the major conclusions.

The 2004 surveys were carried out according to the plan laid out in the 2004 report of WGMEGS, and were modified and adapted by the survey coordinators during the surveys themselves. Within the periods chosen for the surveyed, the spatial and temporal coverage was generally good, although there were some periods where additional sampling would have been helpful – particularly the Cantabrian Sea and the western area south of 52oN in period 2, and across the western area in period 7. In general, sampling appeared to cover the bulk of the spatial range of both mackerel and horse mackerel spawning, and reached zero value samples along most of the edges of the distribution.

Total annual egg production for mackerel in the western area in 2004 was calculated as 1.2018 $\times 10^{15}$ with a standard error of 0.10947 $\times 10^{15}$. This can be compared to the 1.209 $\times 10^{15}$ in 2001. • Total annual egg production for mackerel in the southern area in 2004 was calculated as 0.126 $\times 10^{15}$ with a standard error of 0.0235 $\times 10^{15}$. This can be compared to the 0.283 $\times 10^{15}$ in 2001. The figures presented here are an update on the preliminary estimates presented at the WG in 2004 and there are no major changes.

Based on the total egg production, fecundity and atresia data given below, the analysis gave an estimate of western component spawning stock biomass for 2004 of 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

WGMEGS set up a detailed adult sampling scheme for fecundity in both species and for atresia in mackerel. Western mackerel fecundity samples were collected between 48°N and 53°N, the main area of spawning, during periods 3 and 4 – the start of spawning in this area. Southern samples were collected on the Cantabrian coast during period 1. Unlike previous years the samples were collected in triplicate from each fish and then divided between analysis groups, allowing a detailed examination of variation, within and between institutes and areas and times. The calculated potential fecundity for the western component was 1127 (se 27) eggs per gram female compared to 1097 (se 23) eggs per gram female reported in 2001. 2 | ICES WGMEGS Report 2005 The overall prevalence of atresia in the western component as a percentage of the population was 28% and the relative intensity was 33.5 eggs per gram. This reduced the potential fecundity by 7% giving a realised fecundity was 1052 eggs per g female. The overall prevalence of atresia in the southern component as a percentage of the population was 6% and the relative intensity was 105 eggs per gram. This reduced the potential fecundity by 5% giving a realised fecundity was 964 eggs per g female. The figures presented here are an update on the preliminary estimates presented at the WG in 2004 and there are no major changes.

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 surveys was good. 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. 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. As in 2000 the WG held an egg identification and staging workshop prior to the surveys. This meant that these aspects of the analysis were as consistent as possible across the participating institutes. The workshop was also expanded to include fecundity estimation and procedure. Both activities led to an improvement in the quality of the estimate. Some aspects of the area coverage were weaker than in previous years, notably in the Cantabrian Sea, and in the western area in the final period. This will have resulted in the estimate being very slightly negatively biased. It was discovered that there some small differences in the operation of the egg sampling procedure on the surveys themselves. In addition this year for the first time egg production was encountered in the north easren edge of the survey in the Celtic Sea. This small proportion of the total egg production was not completely cover in 2005 but the area was not covered in previous years either, its not possible to know if these surveys had underestimation also. These effects on the egg production estimates were small and were not believed to have had any significant impact on the final estimate (ICES WGMEGS Report 2005 G:05). Notwithstanding this the Survey Manual will be reviewed in 2006 and every effort will be made to harmonise sampling protocols.

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 40%.

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

During the period 6 June-3 July 2005 Netherlands and Norway carried out an egg survey in the North Sea to estimate the mackerel egg production and SSB. During this period the spawning area was covered four times. The last time the North Sea was covered several times during the spawning season was in 2002. The data were collected and handled according to ICES (2005/G:09). R/V "Tridens" and "Johan Hjort" carried out the survey with a Gulf 7 working in double oblique hauls from the surface to 5 m above the bottom or 20 m below the thermocline. The timing and the results of the surveys are given in Table 2.5.4.1. Except for the first and fourth coverage when the area was covered by one ship, "Johan Hjort " worked in the northern and "Tridens" worked in the southern area.

The eggs were sorted from each of the sampled stations. The age of stage 1A and 1B eggs were estimated according to the observed temperature in 5 m and the formula given in Lockwood et.al.(1981) and the number of eggs produced/day/m^2 was calculated for each statistical rectangle of 0.5° latitude * 0.5° longitude (Figures 2.5.4.1-4). The samples were obtained in the middle of each of the rectangles. The egg production was calculated for the total investigated area for each of the periods (Table 2.5.4.1).

The surveys did not cover the total spawning area and period. Some of the unsampled rectangles are given interpolated values (shadowed rectangles in Figure 2.5.4.1-4). The part of the interpolated egg production accounted for 10 and 13 % for the first and last coverages and 20% for the second and third coverages. The main spawning still takes place in the south western area but the production is more abundant further north and east than in 2002. Based on the four production estimates the spawning curve was drawn (Figure 2.5.4.5). The four estimates are considered minimum estimates since the sampling was not carried until zero values were obtained in all directions. By integrating the egg production curve over the "standard spawning time", 17 May-27 July, the total egg production was estimated at $155*10^{12}$ eggs compared with $147*10^{12}$ in 2002. By applying the weight fecundity relationship 1401 eggs/g/female (Adoff and Iversen, 1983) the SSB was estimated at 220,000 tons. There are no new fecundity data from the North Sea since 1982 (Iversen and Adoff, 1983). In 2004 the realized fecundity of western mackerel were 1052 eggs/g (ICES 2005/G:09). The realized fecundity of western mackerel has been about 30% lower during the surveys since 1998 than in the surveys until 1995. A similar fecundity in the North Sea in 2005 as in the western areas in 2004 would result in a SSB of about 290,000 tons. Ovaries were collected during the 2005North Sea survey to study fecundity and atresia. Results of this study will be reported to the WGMEGS in 2006. Table 2.5.4.2 gives the estimated egg production in the North Sea for the years with multiple surveys per season. The corresponding SSBs based on the standard fecundity (1401 eggs/g) are also given in the same table.

The estimated SSB in the North Sea has so far not been included in the SSB index from egg surveys to carry out the assessment of NEA mackerel. North Sea mackerel are exploited in the fishery but to what extent is not known. The 2002 estimate was considered rather uncertain since it might have been carried out too early to hit the maximum egg production. The years prior to 2002 the estimated SSB in the North Seas was less than 3% of the NEA stock. Since the SSB in the North Sea in the later years has increased to 7%, (though the percentage depends on the choice of fecundity) part of the NEA stock it should considered to be included. The present WG did not include the estimated SSB since no new data about the fecundity were available. It is also uncertain if the North Sea mackerel is exploited in the same way in the fishery as the southern and western components, see section 2.3.2.

The WG recommends WGMEGS to evaluate how to include the results from the North Sea mackerel egg surveys in the egg survey time series, taking into account both the timing of the survey and the precision of the surveys, particularly for the earlier surveys..

2.5.5 Bottom trawl survey CPUE for Southern component:

CPUE data is available for the southern component of the stock but because this component is not assessed separately this data is not used in an analytic assessment. There are two surveys 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-roper 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 borne 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 shows the numbers at age per half hour trawl from the Spanish bottom trawl surveys from 1984 to 2004 in September-October and the numbers at age per hour trawl from the Portuguese bottom trawl autumn surveys from 1986 to 2004. 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, the period from 1996 to 2000 and 2002 were those with the highest values of juvenile presence (0 and 1). The series of the Portuguese October survey shows a very high values of recruitment (age 0) in 1988, 1992, the period 1995 to 1999, 2001 and 2002.

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

Since 1981 there has been an irregular series of bottom trawl surveys carried out over the shelf area from southern Portugal to the North of Scotland. Surveys in this region have been conducted in both first, second and fourth quarters. An initial inspection of catch rates and survey coverage suggests that the 4^{th} quarter surveys for 0 group contain a more comprehensive coverage than the 1^{st} quarter surveys for 1 group and a longer time-series. Thus most of the effort has been expended on these fourth quarter surveys which have been examined to see if it is possible to establish a composite series that can be used predicatively to estimate 0 group abundance. The purpose of this is to improve the short term projections, which currently use geometric mean recruitment for as the basis for 0 and 1 group though the modified by observed f (see section 2.10). Table 2.5.6.1 illustrates the catch by survey, estimated as the sum of the mean catch per standard hour towed per ICES stat rectangle and Table 2.5.6.2 shows the number of ICES rectangles surveyed each year, which is an indicator of survey consistency. From Table 2.5.6.1 it is possible to see that catches from the Scottish area dominate the survey time series. There is missing data in many of the years and the survey is far from complete.

Data exploration by means of a linear model between surveys and ICA recruitment suggested a weak relationship between individual survey time series, the strongest being the intermittent French survey, however, this relationship is dominated by the year estimate in 2002. There was a clear need for a composite survey index but the different areas covered by different countries in different years provided a far from coherent series to work with. Preliminary examination of overlapping areas and years supported direct comparison of catch rates between France Ireland and England. The fishing gear used by Spain differs substantially from that used by Portugal and France and differences here were clear but a direct factor was not estimable directly from the survey data. It was not possible to check the significance of any 'country' factors due to the shortage of data to estimate all 7 country effects. Although there were 496 overlapping rectangles (7% of the data) only 83 give catch greater than zero for both countries and 170 were zero for both countries. This leads to considerable uncertainty in estimated country factors. Thus the current analysis uses the individual surveys without consideration of catch rates. In order to obtain a composite survey a multiplicative model (Patterson and Beverage 1995) with a year and country effect was fitted to the survey data given in Table 2.5.6.1. The year effect, the index, is given in this Table in the right hand column . The data is too sparse to give estimates for the period prior to 1985 and for the year 1996. The first two years used may also be poor as coverage and values are atypical. There are several ways to use this composite index of O group abundance.

1) The fitted time series may be used directly as an index of O group abundance (full model)
2) The fitted values can be used only where values are missing (missing model)
3) The fitted series may be used to select previously estimated recruitment based on the rank of the abundance selecting ranked recruitment from ICA estimates. (rank model)

The resulting three time series are shown in Figure 2.5.6.1a along with estimated recruitment from the ICA assessment (Section 2.9) The same series expressed as residual around the ICA recruitment in Figure 2.5.6.1b.

All methods show some trend with time, with surveys underestimating recruitment relative to later years. It should be remembered that the ICA recruitment is dependent on the validity of catch and conversely the surveys may be correct and there may be trends in unaccounted fishing mortality. Figure 2.5.6.2 illustrates the predictive capability for the three time series. Figure 2.5.6.3 illustrates the model fit and diagnostics for the for the fit to ICA recruitment. The ranking method appears to provide the best method for estimating recruitment, by scaling the observations to the range of observed values and reducing non linear effects.

The fit to this model is significant at the 90% level but the predictive power is rather poor. Its performance is only marginally better than an arithmetic mean (Figure 2.5.6.1), however, this study indicates that the arithmetic mean may be a better predictor of recruitment than the geometric mean currently used in the short term predictions (section 2.10) A preliminary examination of the recruitment estimated from catch data shows that this may be an even worse as a predictor of recruitment, though this is not presented here.

This preliminary analysis has shown that these surveys have some capability to estimate recruitment, and in particular more recent years may be more accurate. There may be more scope for a better method for combining the surveys, possibly by analysing data spatially rather than the quasi spatial country based analysis presented here. It is recommended that this be examined further intersessionally and the estimates of recruitment be considered as part of a mackerel assessment benchmark in the future.

2.5.7 Mortality estimates from tag recaptures.

A Working document by Skagen (WD 26) 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 20000) have been tagged with internal steel tags on the spawning grounds West of Ireland in May. Tags are recovered partly from fish meal factories, where they are extracted with magnets from the fish meal, partly from selected landing sites, where metal detectors are installed at the conveyor belts. With metal detectors on the conveyor belts the actual tagged fish are recovered, and they are aged routinely. Likewise, the catch that is screened will be known. For other tags, only the recapture year, and to some extent the area where they are caught will be known, in addition to the release information linked to the identification number on the tag.

Mortality between two releases can be estimated without knowing the amount screened by the Jolly-Seber method, which is to compare the recapture rate from the two. The material is disaggregated by age at release. All fish that is tagged is measured and is referred to age using age length keys. These age length keys are obtained by ageing fish that is too damaged to be tagged., to obtain age length keys. This year, estimates of total mortality were available using recaptures up to the end of 2004. The raw estimates are noisy, both due to uncertainty in ageing, to variations in mortality associated with tagging and to variance due to low numbers of recovered tags in each age-year category. Therefore, smoothed results are presented.

Figure 2.5.7.1 shows total mortalities smoothed by taking 3-years running means of averages over ages. Variances were estimated by bootstrapping, assuming that the number of tags recaptured from each age-release-recapture year stratum is Poisson distributed. The results are still too noisy to indicate recent trends, but the overall impression is that the mortality has been relatively stable at a level not higher than the range estimate by ICA (section 2.8). The results this year are very close to those arrived at last year, except for the very last year, which is bound to be highly uncertain due to the low number of tags recovered so shortly after the release.

The age profile of the mortality, taken as an average over all the years 1992 – 2001, is shown in Figure 2.5.7.2. It fits well with the ICA estimate of selection plus natural mortality, which was also estimated for the period from 1992 onwards in 2004.There is no strong indications that the selection at age increased towards old age and becomes lower again at the oldest true age, as it emerges form the ICA estimates, and the mortality at young age is slightly higher than estimated by ICA.

2.5.8 Biomass estimates from tag recaptures.

A working document by Antsalo & al (WD 1) describes estimates of stock biomass from tag recaptures. The material was the Norwegian tag recapture data described in Section 2.8.3.1, but using only the tags, which were recovered by metal detectors at landing sites, where both the age of the fish and the amount of fish screened were known. Biomass was estimated by the Peterson principle, assuming that the concentration of tags in the screened population is the same as the concentration of tags in the sea at tagging time. Since tagging takes place on the Western spawning grounds, the population that is tagged probably most closely represents the spawning stock in the Western area. This is work still in progress. Preliminary results for the biomass are shown in Figure 2.5.8.1. The absolute value of the biomass depends on what is assumed for mortality associated with the tagging process. This is not known precisely, but can realistically be assumed to be in the order of 30%. This mortality enters the calculations as a scaling factor, and several examples are given in the figure.

This study indicates that the spawning biomass has declined gradually over time, but that this trend may have been reversed at the end of the 1990ies. They also suggest that the biomass is larger and has fluctuated more than estimated by the ICA assessment. The present tag based estimate may include some immature fish, which may increase the level of the estimated SSB but not change the trends. The trend in spawning and total biomass estimated by ICA are more or less parallel, the latter being about one million tonnes larger. The team tagging mackerel has been largely the same in the whole period, and although it may vary somewhat from year to year, the tagging mortality is not likely to have changed markedly over time. Hence, there is some evidence in these results that the stock is larger than estimated by ICA.

2.5.9 Acoustic estimates of mackerel biomass

Section on errors

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. 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 (sA) to biomass and to obtain age distributions, large fish is 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. However, it is considered likely that the downward trend in biomass is real.

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 survey working document (Iglesias et al., 2005, WD to WGMHSA 2005). The results of the 2001 to 2005 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 in number of individuals has varied considerable from 2001 to 2005, 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) and a large fall in 2005 (409,493 t) with respect to 2003 and 2004 (907,814 t and 945,619 t respectively). The fall in abundance and biomass registered in 2005 may be partly because the dates on which the survey was carried out were the latest of the whole series (6-28 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, in 2004 and even more markedly in 2005, catches were mainly taken in March (57% in 2004 and 79% in 2005), while catches in April fell sharply (by 25% in 2004 and by 11% in 2005). This may suggest that in those last years mackerel began their post-spawning northward migration earlier than in previous years. 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 compared with previous years, since the survey was conducted on these dates.

The IPIMAR surveys have not so far been used to develop a biomass estimate for mackerel. This is due to the low mackerel abundance, the tendency to be mixed with other species, and 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 a biomass estimate.

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. This lack of aggregation into schools, combined with the low target strength value 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 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 2004 and from 1990 to 2004 respectively, for which mackerel is the target species from March to May. The Figure also shows the effort of the Aviles and A Coruna trawl fleets (Sub-division VIIIc East and VIIIc West) from 1983 to 2004. The effort of the Aviles trawl fleet is not available in 2004. The Spanish trawl fleet effort corresponds to the total annual effort of the fleet for which demersal species is the main target. The Vigo purse-seine fleet (Sub-division IXa North) from 1983 to 2004 for which mackerel is a by catch is also presented. In 2004, the effort of the Spanish fleets was lower due to the spatial and temporal closure during the first quarter imposed by the presence of oil in the water, due to the catastrophe of the *Prestige* oil spill. The effort of the hand-line fleet showed an increasing trend since 1994 to 2002. The effort for these fleets decreased in 2004 with respect 2002. The effort of the trawl fleets is rather stable during all period. The purse-seine fleet effort fluctuated during available period.

Portuguese Mackerel effort from the trawl fleet (Sub-division IXa Central-North, Central-South and South) during 1988 - 2001 is also included and as in Spain mackerel is a by catch. The effort for this fleet increased in 1998 with respect the previous years. Since 1999 to 2001, the effort decreased with respect 1998. Since 2002 the effort data is not 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 trend of the Spanish hand-line fleets shows an increasing trend since 1994 to 2001. In 2004, the CPUEs of the handline fleets , a fall was seen in yields by fishing trip in Santoña fleet. This trend was observed since 2002, particularly in the Santoña fleet, in which it was especially acute. The CPUE of the hand-line Santander fleet shows a decrease in 2002 and 2003, increasing in 2004 with respect 2003. The CPUE for the Aviles trawl fleet has increased since 1994, in particular in 2000 and 2002, but this figure is not reliable because catches of this fleet are estimated since 1994 onwards . For the A Coruña trawl fleet is rather stable during all period. The CPUE of the Portuguese trawl fleet shows a decrease from 1992 to 1998, increasing since 1999 to 2001. 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 shows 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 2003 – 2004

2.7.1 Distribution of commercial catches in 2004

The distribution of the mackerel catches taken in 2004 is shown by quarter and rectangle in Figures 2.7.1.1 – 4. These data are based on catches reported by Denmark, Faroe, 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 573,300 tonnes including Spanish WG data, the total working group catches were 611,460 tonnes. The main data missing from this series are from France and Belgium, who did not supply this data to the WG.

First Quarter 2004 (220,670 t)

There was still some evidence of mis-reporting between Divisions IVa and VIa, giving large catches just west of 4° W. However, this has reduced considerably from the previous year. The overall distribution of catches remained similar from 1995 to 2004, 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). Overall catches in VIIIc doubled compared to the previous year due to a limited fishery in 2003 following the prestige oil spill. The catch distribution is shown in Figure 2.7.1.1.

Second Quarter 2004 (36,830 t)

Catches in this quarter have fluctuated considerably in the last five years, with a steady decrease between 2000 and 2003 followed by an increase in 2004. The general distribution of catches was broadly similar to 2003, with the main catch area being along the western shelf edge between the southern Celtic Sea and the Hebrides. The catches taken in international waters east and north of the Faroe Islands is continuing to increase and doubled from 2003, probably representing an earlier start for this fishery, which occurs mainly in the third quarter. Catches in the Bay of Biscay, and Iberian Peninsula were broadly similar to 2003. The catch distribution is shown in Figure 2.7.1.2.

Third Quarter 2004 (179,713 t)

The general distribution of catches was similar to 2003, with the main catches being taken in international waters (II) and off the Norwegian coast (IVa). Catches increased in the international waters (II) from last year, but like in the previous two years the offshore catch was less concentrated along the south-eastern edge. This suggests that the fish distribution was more extended in a north-westerly direction than prior to 2001. Fishing off Norway was similar in extent to 2003 but also increased in scale (+30%). 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 2004 (174,248 t)

The general distribution of catches did not change between 2003and 2004. Most catches were taken in the area west of Norway across to Shetland. Catches west of Shetland increased in scale compared to 2003. There was some evidence of mis-reported catches west of 4°W, although this was small scale, and less than 2003. 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 only a quarter of those seen in 2003 indicating a reduced fishery in this area. Catches in the southern North Sea also declined further from 2003 catches. The catch distribution is shown in Figure 2.7.1.4.

2.7.2 Distribution of juvenile mackerel

Surveys in winter 2003/2004

Data is presented to this WG from 2004/2005 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 2004

Age 0 fish in quarter 4, 2004 (Fig 2.7.2.1)

- Catch rates were highest in the NW of Ireland, which is comparable to previous years. Rates increased from 2003 to 2004 and were more similar to the 2002 levels.
- In divisions VII and VIII catch rates were highest in the central Celtic Sea and close to the French coast.
- The hot spot in north Portugal, which had shown strong signs of recovery in 2001 after a long term decline, was almost absent in 2003 and 2004.

Age 1 fish in quarter 4, 2004 (Fig 2.7.2.2)

- In the Celtic Sea catch rates were low in most areas but appeared to be slightly higher than in 2003. In the Bay of Biscay high numbers were caught along the French coast.
- Catch rates off NW Ireland, NW Scotland and the Hebrides were similar to previous years with some reduced catches between 56ºN and 58ºN.

There was a very strong reduction in catch rates of age 0 fish in the 2000 surveys and this is now apparent in the commercial catches. Catch rates recovered in 2001 to close to normal levels, and increased further in 2002. This was backed up these strong year classes being seen in the catch. Catch rates in the surveys appeared lower in 2003 and early indication of the commercial catch is of a low year class. Catch rates in the 2004 surveys seem to have increased suggesting improved recruitment. 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 2005

Age 1 fish in quarter 1, 2005 (Fig 2.7.2.3)

- High catch rates were recorded off NW Ireland, NW of Scotland and off the Hebrides. Catches seem to have substantially increased from 2004 and are more similar to the levels noted in 2003.
- Good catch rates were also recorded between Shetland and the Norwegian coast, these did not occur in 2004.
- No data was available from the Celtic Sea in time for WGMHSA.

Age 2 fish in quarter 1, 2005 (Fig 2.7.2.4)

- Reasonable catch rates were recorded in NW Ireland/Hebrides area, broadly similar to 2004.

- In the North Sea only weak catch rates were encountered similar to levels in 2004.

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 encouraged to provide the mackerel recruit data for the WGMHSA before August of the year.

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 2004.

2.7.4 Aerial surveys

The annual Russian comprehensive aerial survey to map feeding mackerel with the Russian flight-laboratory An-26 “Arktika” was carried out in the Norwegian Sea during 15 July to 4 August 2005 between 62°-70°15’ N and 07° E – 06° W (WD Zabavnikov et. al. 2005).

The remote sensing equipment, which work in the optical, infrared and very high frequency electromagnetic wavelengths ranges were used as usual.

As usual the survey was targeted to map the distribution of mackerel, as well as the thermal and hydrodynamical status of the sea surface, locate of high bio-productivity and the distribution of sea mammals and birds.

Within the framework of aerial surveys, were carried out experimental research and joint works, as well as the surveys with the two Norwegian vessels (“Libas” and “Mogsterbas”) and two Russian research vessels (“Fridtjof Nansen” and “Persey-4”) that carried out trawl-acoustic surveys for mackerel. The researches were carried out under recommendations of PGAAM (ICES PGAAM 2005) and Joint Russian-Norwegian Program.

All vessels collected biological samples and investigated the distribution and abundance of mackerel by sonars, echo sounders and surface trawling.

Joint experimental research and works with Russian and Norwegian vessels was carried out as the same track as during in the same position.

In the research period Sea Surface Temperature (SST) varied from 8 ºC north of 70º N to 15 ºC in the Eastern Branch of the Norwegian Current. Spatial structure of SST field was non stability, had a great variability with many numbers of eddies and meanders. In comparing with July 2004 the SST data in the Norwegian Sea were less in the average on 0.8-1.5 °C (WD Zabavnikov et. al. 2005).

Pelagic fish schools (in the 75 % cases it was mackerel) were detected in the surface and subsurface layers (depth from 5 m to 30 m).

The final results will be presented to future planning survey group.

2.7.5 Acoustic surveys

Five 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. Acoustic surveys for mackerel are very sensitive to the target strength used. Further information on Norwegian and Scottish surveys can be found in the report meeting of the Planning Group on Aerial and Acoustic surveys of Mackerel in 2005 (ICES PGAAM 2005). The surveys were:

- An acoustic survey by the Institute of Marine Research, Bergen in October/November 2004. 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 1 o W - 4o 30' This survey was a continuation of surveys from 1996-2003, with the main purpose of finding distribution of Atlantic mackerel during fall annually, and to estimate abundance through acoustic methods.
- An acoustic survey by Fisheries Research Services, Aberdeen in October/November 2004. This was co-ordinated with the Norwegian survey. The survey also mainly covered the area between the Viking and Tampen Banks. This survey is the third carried out by the Marine Laboratory in the current series.
- An acoustic survey by IEO in ICES Divisions VIIIc and IXa in March and April 2005.
- 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 2004 was similar as in 1999 – 2003 (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 375 thousand tonnes in 2004 was the lower than in previous years (Table 2.7.5.1). Note that the ship covered only the Norwegian waters in 1999 and in 2002. There may be a potential problem of gear selectivity affecting the acoustic estimates. During these surveys the mackerel has been sampled with a small pelagic trawl (20 m opening) at a speed of 3-3.5 knots, and the age, length and weight has been measured for use in the biomass estimation. Slotte et al. (WD in PGAAM 2005) has 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 with 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.

1 n.mi. bottom depths recorded acoustically during all surveys 1999-2004 was used to make a 3D map of the bottom topography in the surveyed area, and the average depth of mackerel based on 1 n.mi. data from the same period was marked in the same map (Figure 2.7.5.2). This 3D perspective demonstrated that mackerel schools followed the bottom depth, and in fact they were found down to depths of 300 m and even deeper. The reason for this behaviour became more apparent when the horizontal and vertical distribution of schools was related to temperature (Figures 2.7.5.2-4). In 2003 and 2004 CTD stations were taken both inside and outside the mackerel distribution area, to study potential relations between environmental conditions and mackerel migration behaviour. From a 2D perspective it seemed like the mackerel these years avoided water colder than 9°C (Figure 2.7.5.3). When the depth of 9-10°C isoclines in 2003 and 2004 were and the related to the average depth of mackerel in a 3D perspective (Figure 2.7.5.4), the reason for the very deep mackerel school observations also became clearer. It seems like the mackerel follows this isocline. Due to the tongue of warm Atlantic water entering from the north along the western side of the Norwegian trench, this isocline is very deep. Detailed description see on in PGAAM report (ICES PGAAM 2005) and Korneliussen et. al. (Korneliussen et. al., 2005).

Norway will continue to survey the mackerel acoustically in the autumn of 2005.

Norway has surveyed the mackerel acoustically during the autumn for 6 years now. Following the PGAAM recommendations WGHMSA has demonstrated the use of the Norwegian e data as a relative index in the assessment , see Section 2.8.4

The FRS survey covered a similar area and found similar concentrations of mackerel to the IMR survey. The survey design was selected to cover the area in two levels of sampling intensity based on fish densities found in 2002 & 2003. Areas with highest intensity sampling had a transect spacing of 15 nautical miles and lower intensity areas a transect spacing of 30 nautical miles. The survey area was limited to the nearest whole ICES rectangle beyond the 200 m contour to the north and east; to the Scottish coast or the 0° line to the west; and to 59°N to the south. As expected, most of the mackerel were detected close to the border between EU and Norwegian waters, towards the east of the survey area around Viking Bank (Figure 2.7.5.5). Overall, the survey proved very satisfactory. Considerable numbers of large mackerel schools were detected, and most of these were successfully ground truthed with pelagic trawls. The mackerel were contained within the survey area.

There will be no Scottish acoustic survey for mackerel either in 2005 or in the foreseeable future. A monkfish trawl survey will now be conducting every autumn until 2008. There is no opportunity to collect date on mackerel during this trawl survey.

Last year a three year review of the Scottish surveys was presented to WGMHSA. The PGAAM recommended that WGHMSA consider the use of these data as a relative index in the assessment. So far, this has not been attempted, since the time series only covers 3 years.

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 results of these surveys since 1999 have been presented in the WGMHSA (ICES WGMHSA 2002, 2003, 2004 and 2005). The methodology for the estimation of mackerel biomass by acoustic methods in the study area has now been standardised and the different surveys previously presented to this WG re-evaluated. The results of the 2001 to 2005 surveys are presented in this study, leaving the re-evaluation of the 1999 and 2000 surveys pending. 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 all years, mackerel are distributed throughout the whole area surveyed (Figure 2.7.5.6), and the highest concentrations are found in Division VIIIc, coinciding with the main spawning ground in the Southern Area (ICES WGMHSA 2005). Biomass by length class (Figure 2.7.5.7) and at age (Figure 2.7.5.8) 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, and a weak year class in 2000 (age 1 in 2001).

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 a biomass estimate for mackerel. This is due to the low mackerel abundance, the tendency to be mixed with other species, and 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 a biomass estimate.

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 with other species and plankton. This lack of aggregation into schools, accessible to echo sounders combined with the low target strength value means that estimates of biomass are still very difficult to derive.

FUTURE of mackerel surveys Mackerel are widely distributed in the North-East Atlantic and caught from the Iberian Peninsula up to around 75° N and from the west off Faroese to Norway. The distribution of commercial catches is varying from year to year due to environmental factors, stock size, and quota limitations. The distribution of commercial catches by quarter that is described in detail annually in the WGMHSA reports indicative only of the wide area where mackerel are caught in the Northeast Atlantic, and the quarterly changes in the distribution of the fishery. Various surveys have verified that there is an even wider distribution of mackerel than that indicated by the commercial fisheries.

The assessment of the NEA mackerel stock based on the catch-at-age form the commercial catches and on a single fishery independent estimate of biomass, derived from the ICES Triennial Mackerel and Horse Mackerel Egg Surveys. This is only available once every three years and makes the assessment increasingly uncertain with elapsed time since the last survey.

At the same time, a number of different surveys have been carried out by a number of countries in recent years. All surveys have the potential to deliver information on the distribution and abundance of mackerel. However, the all surveys cover only part of the known distribution area and consequently have not been able to deliver a valid stock estimate or complete distribution map.

In September 2001 during WGMHSA meeting it was suggested to establish The Planning Group on Aerial and Acoustic Surveys for Mackerel (PGAAM) with main purposes to coordinate a number of surveys on pelagic species that can provide the information on the distribution and abundance of mackerel as well as to standardize the procedure of surveys.

The PGAAM met for four times and made their work as much as possible. The PGAAM met to coordinate vessels and airborne surveys in the Norwegian Sea, to coordinate Scottish and Norwegian acoustic surveys in the Viking Bank area, to coordinate Spanish, Portuguese and French acoustic surveys, and to utilize the findings of the EU SIMFAMI project to provide tools to identify mackerel echo-traces. Detailed results of the PGAAM are presented in the reports for the years 2002–2005; however there is still a lot of work to do in future.

Unfortunately the last two years only three nations took part in the PGAAM meetings and may assume that for the year 2006 only two will continue. Due to this the participants of the last PGAAM meeting has discussed this issues during the meeting. All of participants had agreed that the PGAAM duty have to be finalizing for the present time and the relevant references have to be pass to the PGNAPES and PGHERS as well for others from year 2006.

So far, it is probably premature to include the acoustic survey data in the assessments of the stock. Examples where this has been done in alternative assessments by ISVPA and AMCI are given in Section 2.8. Acoustic surveys are high priority only in few nations, and a comprehensive coverage is not within reach at present. There are also methodological problems still unsolved, for example related to inacessability to acoustics when the mackerel is spread instead of forming distinct schools, and to how target strength is influenced by behavior. A time series of at least 5-6 years will be needed before the data can be used to tune the assessment.

For the time being, the most important information from acoustic and aerial 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 behavior 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

In addition to the work carried out last year by the Working Group to provide a benchmark assessment, further work evaluating the data and the models has been required. Section 2.8.2 deals first with the evaluation of catch and survey data. Presenting differences between relative and absolute use of egg survey SSB index through the historic performance of the assessments by the WG (Section 2.8.2.1) and the evolution of the survey catchability coefficient (Q) evaluated by retrospective analysis (Section 2.8.2.2). The influence of unaccounted catch mortality (underestimated catches, discards, high grading, slipping and torn nets) on Q is presented in Section 2.8.2.3. Furthermore a possible explanation is given in Section 2.8.2.4 why Q is expected to be higher for NEA mackerel compared to Western mackerel. A visual presentation is given why an assessment with absolute SSB index achieves a trend in SSB and F that is biased in comparison to relative SSB index (Section 2.8.2.5).

The choices between a more precise but possibly biased result and an unbiased but more noisy estimate is evaluated through simulation. The use of ICA in the presence of biased catch and survey data was examined and the probability of obtaining a more accurate estimate of levels and trends in F and SSB, with different tuning methods is evaluated for specific levels of bias in Section 2.8.2.6.

Section 2.8.3 summarises inferences from fishery independent measures of the NEA mackerel stock. Further data exploration using trial runs with ISVPA and AMCI are presented in section 2.8.4.

Conclusions of this data modelling exploration are given in section 2.8.5.

2.8.2 Evaluation of catch and survey data

The question of whether to use the SSB index as absolute or relative seems to translate into:

A) the SSB calculated from the egg survey is the best estimator for the SSB but the catch may be underestimated, or

B) the catch data are correct and the SSB is overestimated by the egg survey index.

C) Both catch and survey data are biased by different amounts

It should not be a prejudgement that the survey data are biased. We should be objective by trying to evaluate whether the survey data, the catch or both are biased.

2.8.2.1 Observed differences between absolute and relative assessments

Figure 2.8.2.1 shows the differences by carrying out assessments in 2004 and 2005 with absolute and relative indices of egg survey SSB in relation to earlier years assessment of the WG. The difference in the ICA estimated SSB in 2005 from the relative and absolute assessments is over 1 million tonnes, which is associated with the higher Q of 1.36 in the 2005 assessment compared to the Q of 1.30 in the 2004 assessment. Next year this difference may be even larger.

2.8.2.2 How uncertain are estimates of catchability (Q)?

Eltink and Kraak (WD 07/05) presented a document in which the uncertainty of the estimates of catchability (Q) was explored by retrospective analyses. Three sets of retrospective analyses were carried out in which the relative tuning method was used to estimate the catchability:

1. NEA mackerel with all available 5 egg surveys included.
2. Western mackerel with all available 10 egg surveys included.
3. Western mackerel with only the last 5 egg surveys included.

The results are displayed in Figure 2.8.2.2. When all egg surveys are included in the Western mackerel assessment, the catchability is very stable in the most recent part of the retrospective analysis. In earlier parts, however, it fluctuates widely. This is probably due to the shorter time series of the egg survey. Indeed, the retrospective analysis of the NEA mackerel, with only 5 available egg surveys, also shows wide fluctuations of the catchability estimate. Similarly, when the time series of egg surveys for Western mackerel is artificially shortened to only the last 5, the catchability estimate fluctuates in a similar way but with slightly smaller amplitude and at a lower level compared to the NEA mackerel analysis (a possible cause why Q is at a higher level for NEA mackerel is explained below). These analyses suggest that short time series of egg surveys make estimation of catchability very uncertain. Therefore, time series of only 5 egg surveys may be too short for NEA mackerel to provide reliable and realistic estimates of Q, because the results of the retrospective runs indicated that Q might be within the range of 1.10 to 1.36.

2.8.2.3 How much should catches at age be raised to reduce catchability to 1?

ICA runs were carried with all catch numbers over the whole time series multiplied by a raising factor (WD 07/05). The result of this was that catchability (Q) estimates decreased linearly with the value of that raising factor. This implies that with a Q=1.36 catch at age data should be raised by a factor of 1.36 to result in a Q=1.

2.8.2.4 Why might catchability be higher for NEA mackerel than for western mackerel?

The catchability Q for the egg surveys has historically been lower for Western than for the NEA mackerel assessments, even though the western area contains the vast majority of both catch and eggs of NEA mackerel (figure 2.8.2.2). Possible explanations have been explored in WD 07/05.Q is determined by the SSBs from the egg surveys relative to the SSBs estimated from the population at age in the ICA assessment. Raising the catches at age indeed raised SSB from ICA and therefore did reduce Q (see above). Only changes in the adult part of the catches at age will affect SSB and therefore Q. Changes in the juvenile part of the catches at age will not affect SSB and Q. Adding relatively many juveniles (ages 0-2) from the Southern component to the Western component in order to compose the NEA mackerel catch in number at age is not expected to cause a change in Q. However, adding relatively low numbers of adult fish from the Southern component to the Western component is expected to lower SSB from ICA and therefore is expected to increase Q (WD 07/05). The text table below shows the ratios of mature catch weight to the SSB from the egg surveys. This ratio is low for the Southern component (adult fish leave the Southern area after spawning) and high for the Western component. This results in a somewhat lower ratio for NEA mackerel compared to Western component. This probably explains why there is an increase of Q to approximately a level of 1.2, when the Southern component catch in numbers at age are added to the Western component of which Q has been stable at 1.1.

		1992	**1995**	**1998**	**2001**	**2004**
Western	SSB from egg survey (A)	2930	2470	2950	2530	2470
Western	mature catch weight (B)	n.a.	n.a.	575	613	509
Western	ratio B/A	n.a.	n.a.	**0.195**	**0.242**	**0.206**
Southern	SSB from egg survey (C)	440	370	800	370	280
Southern	mature catch weight (D)	n.a.	n.a.	34	38	30
Southern	ratio D/C	n.a.	n.a.	**0.042**	**0.102**	**0.107**
NEA	SSB from egg survey (E)	3370	2840	3750	2900	2750
NEA	mature catch weight (F)	n.a.	n.a.	609	651	539
NEA	ratio F/E	n.a.	n.a.	**0.162**	**0.225**	**0.196**

n.a. = not available

2.8.2.5 Simple presentation of 4 different ways of assessing the NEA mackerel stock

To show the effects of bias and corrections of bias on an assessment using the index as relative or absolute, a simplified presentation showing 4 different possibilities of assessing a population with properties similar to the NEA mackerel stock. (WD 07/05) are given in Figure 2.8.2.3 (constant SSB over whole time series) and in Figure 2.8.2.4 (constant SSB over whole time series except a decline in the recent period):

1. SSB index relative
2. SSB index absolute
3. Egg survey SSB corrected for bias (assuming catch at age is not biased)
4. Catch at age corrected for bias (assuming egg survey SSB is not biased)

In Figure 2.8.2.3 the egg survey SSB is constant over the whole time period resulting in a constant SSB and F except in the case the SSB index is used as absolute. Treating the SSB index as absolute will raise the ICA SSB in the recent period towards the last egg survey SSB. This increase is realised by creating higher recruitment in the recent years and a declining trend in F in the recent years. Apparently, when Q > 1, tuning to an absolute SSB index causes an increasing trend in the estimated SSB and consequently a decreasing trend in F in the recent period, despite the fact that the actual SSB is constant over the whole period. This phenomenon of an increasing trend in SSB and decreasing trend in F in the recent period when Q>1 (or a decreasing trend in SSB and increasing trend in F in the recent period when Q<1) should be regarded as a bias caused by a tuning to an absolute index. This discrepancy in the trend in the recent period between relative and absolute assessments increases with the deviation of Q from 1.

In Figure 2.8.2.4 the egg survey SSB is constant over the biggest part of the time series but there is a decline in the recent period. This results in a decrease in SSB and an increase in F in the most recent period except in the case the SSB index is used as absolute. Treating the SSB index as absolute will force the ICA SSB in the recent period towards the last egg survey SSB, causing no change in SSB and therefore also no change over time in F in the recent years. Apparently, when Q > 1, tuning to an absolute SSB index results in a constant SSB and consequently a constant F, despite the fact that the actual SSB declined in the most recent years. This example in Figure 2.8.2.4 is given, because the decrease in egg survey SSB simulates the situation of last year's assessment, where the absolute assessment indicated constant F while the egg survey SSB decreased in the recent period.

An important conclusion from this is that when the SSB index is used as absolute the trend in F is not a good indicator of the actual trend in F in the recent years although the F and SSB in the last year might be correct in the case of bias in the catch at age data. Consequently this indicates that the 2004 WG should not have expected that the log catch ratio trends would correspond with the trend in F from the ICA run with the SSB index as absolute.

2.8.2.6 Mackerel Catch and Survey Bias simulations

The sections 2.8.2.1-4 describe the different results that are obtained using ICA with the available data for NE Atlantic mackerel. This section presents a study to evaluate how noise and bias in the input data translate to precision and bias in the assessment with ICA.based on WD 13/05 This has been done by simulation because without knowledge of the underlying truth it is not possible to establish where the correct choice lies or indeed if completely unbiased estimate are achievable. Two studies have addressed the question whether egg surveys perform better as relative or absolute measures of abundance within ICA assessments of NEA mackerel (Kolody and Patterson 1999, Simmonds 2003). In order to provide a better basis for the decision the use of ICA was examined through simulation studies reported in two working documents Kienzle and Simmonds 2004 and 2005. Fish populations with the basic characteristics of NE Atlantic Mackerel were simulated. The purpose of the simulation was to examine the performance of ICA as an assessment package under typical random variability in observations, stochastic variability in the stock and a differing of levels of bias in both the catch and the egg survey, which is used as an SSB tuning index.

2.8.2.6.1 Methods used for Mackerel Catch and Survey Bias simulations

Historic recruitment, mean and variance was estimated from the converged part of the VPA. The variability in the fishery and measured data was estimated as a year effect and a variance covariance matrix for estimated catch at age. Mean weights and fraction mature were assumed to vary randomly within the range observed. The full details are described in Kienzle and Simmonds 2004 only the main points are highlighted here. Natural mortality by year was taken with a mean of 0.15, the value used in the assessment, with an additional small stochastic component to give a range of M approximately from 0.1 to 0.2 using a normal distribution with a mean of 0.15 and a standard deviation of 0.1.

There is no independent measure of the variability in the fishery and the measurement error in the estimate of catch at age, the two sources of variability are compounded in the data. Two ways of simulating this observed combined variability were tested,

1) applying all the variability in the fishery with no measurement error, and
2) assuming a perfectly separable fishery with the covariance at age as measurement error.

The differences in the resulting precision and bias in the assessment between these two options were small, the first case gave slightly greater variability in fitting the assessments, probably because this violates the ICA model assumptions. As the differences were small it was not deemed necessary to split the observed variability into two components an implementation (fishery) variability and a measurement error. The 'worst case' variable fishery with no measurement error was selected.

Variability in the SSB index (the Mackerel Egg Survey) was obtained by parametric bootstrap of local sampling variability using a log normal distribution of observation errors. This was carried out only for the Western area survey where the data was already organized for this purpose (Simmonds et al 2003). The cumulative probability distribution by year is shown in Figure 2.8.2.5. The cumulative probability distribution of residuals for the western area obtained from an assessment using ICA with the use of the SSB survey as relative tuning. The magnitude of the residuals in the assessment is similar to the residuals obtained by the survey data analysis. Thus confirming that such a range of values is reasonably representative of the survey error. The simulations included options with the triennial Egg Survey being simulated in each of the possible three years preceding the assessment year.

Once the underlying properties of the population had been set the combination of the simulated stock model and an assessment by ICA was tested and it was shown that there was no error in the assessments (Kienzle and Simmonds 2004). Base line runs with stochastic variability in the stock and the measurement error were checked and found to give unbiased results.

Currently there are no good estimates of survey bias or catch bias that can be used to provide sufficiently accurate measures to allow for these to be tested specifically, the procedure chosen was to select a range of values that bracket the plausible range for testing. 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 discussed in detail in Section 2.5.3. This section concludes that the egg production might be underestimated by 40%. For the simulation the magnitude of the bias is expressed as a proportion of the simulated value; to full explore the influence of this factor a range values of bias from a factor of 1 (no bias) to a factor of 0.2 (80% bias) were tested in steps of 0.1.

The ICA assessment in 2004 accepted by ACFM shows that the Egg Survey is estimated with a Q of 1.3, suggesting either the survey overestimates rather than underestimates the stock, or that bias in the catches or at least unaccounted mortality from all sources exceeds bias in the Egg Survey by this factor. In contrast as discussed above WGMEGS indicate that underestimation of the SSB is the only possibility for the Egg survey and they provide a very approximate estimate of 40%, implying the Egg survey gives 60% of the true biomass. Taking these two values together this suggests the catches represent 0.6/1.3 = 0.46 of the fishing and unaccounted mortality. Taken at face value this suggests the reported catch underestimates the removals from the stock and that the total unaccounted mortality is 116% of reported catch (calculated as 54%/46%). This exceed the level of errors discussed in Section 2.2.1, however, the discussion presented there deals only with additional underreporting that can be considered numerically, and there is anecdotal evidence that this may not be comprehensive and thus not a complete estimate of the level of unrecorded catch. These calculations do not account for other sources of unaccounted mortality for example unaccounted natural mortality. It should be remembered that these factors used here are all poorly known. Thus for the simulations a range of values need to be tested and a similar range of bias to that applied for the Egg Survey was tested, again the notation is 1 (no bias) to .2 (80% bias).

The simulations were first carried out with catch or survey bias alone and then extended to include bias in both factors simultaneously.

The results of the simulation were evaluated through 6 parameters.

Error in terminal year SSB (TSSBE)	Terminal Estimated SSB- Simulated Terminal SSB
Error in terminal year F (TFE)	Terminal Estimated F - Simulated Terminal F
Error in historic SSB (HSSBE)	Year "1982" Estimated SSB- Simulated Year "1982" SSB
Error in historic F (HFE)	Year "1982" Estimated F - Simulated Year "1982" F
Error in SSB Trend	TSSBE – HSSBE
Error in F Trend	TFE - HFE

2.8.2.6.2 Results of Mackerel Catch and Survey Bias simulations

The results were of the simulations were first evaluated for situations with bias in only catch or survey independently. Figure 2.8.2.6 illustrates the results for estimates of terminal SSB and F in the presence of catch bias.

Figure 2.8.2.6 illustrates that the estimates of SSB are biased in both cases though with the absolute fit the bias is much less, but that F is also biased in the absolute fit but unbiased in the relative. However, from Figure 2.8.2.6 it can be clearly seen that the precision of the estimates using the relative index are more variable, showing that there is a trade-off between bias and precision. The way in which catch and survey biases create bias in the estimates of terminal, historic and trend estimates of SSB and F in the assessment are shown in Table 2.8.2.1. If the recorded catch is biased then ICA estimates of SSB and F will always show some bias though in some cases the bias may be small. However, in the case of either survey or catch bias in the data unbiased trends may be estimated with ICA using the Egg Survey as a relative index.

Analysis of these simulations was developed further to establish what level of bias in catch and survey would be required for either relative or absolute tuning to out-perform the other with respect to evaluation of trends in SSB and F. For each set of simulated data the error in the two assessments, relative and absolute, was estimated. Then from the full set of simulations the probability of which method would give the more accurate estimate of trend was estimated for the different levels of bias. Figure 2.8.2.7 illustrates the results for catch and survey bias independently. Trend in SSB and F are estimated more accurately more frequently by the absolute method if bias in either catch of survey is less than 0.85 (-15%). Conversely the relative method gives a higher probability of a more accurate estimate if the biases in either catch or survey is greater than 0.85 (-15%).

As discussed above, the information we have on survey and catch bias suggests that both are biased but unaccounted mortality may exceed the survey bias by a factor of 1.3. Different independent magnitudes of bias in both survey and catch were simulated simultaneously. The results show the absolute fit still gives biased results in SSB and F if catch is biased, but if the biases in the survey and the catch are equal the trends in SSB and F are correctly estimated with an absolute assessment. This is illustrated in Figure 2.8.2.8 which shows estimates of trend in SSB using box and whisker plots of estimated trend in SSB from "1982" to the present. In this figure bias in catches changes in the horizontal direction and bias in the survey changes vertically. The diagonal represents the case when both parameters are biased to the same extent. The diagonal shows than the trend is estimated correctly. The current situation is uncertain but the estimates of bias we do have suggest the panel 0.6-0.4 in row 5 column 3 (-40% survey and -60% catch bias) may be a one possible situation. If a relative fit is used the trend in both F and SSB is estimated without bias but with greater variability (see Figure 2.8.2.9 for the example of estimated SSB trend with the relative method).

For each set of simulated data with bias in both survey and catch the error in the assessment was estimated using both methods. Then from the full set the probability of which method would give the more accurate estimate of trend was estimated for different levels of bias in both parameters. Figure 2.8.2.10 illustrates the results for catch and survey bias together. The data to support the figure is insufficient to obtain precise results for every combination, as this would require far greater numbers if simulations, but the general conclusions are very similar to those when bias in catch or survey are examined independently. As illustrated in Figure 2.8.2.8 and 2.8.2.9 equal bias in each source of data allows the more accurate estimate of trend using the absolute method. Trend is more accurately estimated more frequently by the absolute method if bias in both catch and survey is less than 10% different. The relative method gives a higher probability of a more accurate estimate of the trend if the biases in both catch or survey is greater than 10% different.

These simulations provide a basis for deciding which method to use. They have been developed specifically for a single triennial SSB index used with ICA and the conclusions cannot necessarily be generalized to other situations. The simulations may slightly over estimate the variability due to the treatment of catch at age estimates, which have been used in a 'worse case' method, as discussed above. But they are also conditional on the choice of variability in M, greater variability will add to the variability in both methods of estimation, however, the conclusions are not heavily dependent on this variability. More importantly biases are assumed to be constant over time, this will not necessarily be the case though currently we have no way to estimate this. Strong trends in survey or catch bias will exacerbate the problems.

2.8.2.6.3 Conclusions from the Mackerel Catch and Survey Bias simulations

In the presence of catch bias advice on the correct levels of catch can only be given in a relative sense, projections should be treated as providing advice on change in catch not absolute levels. If the bias in the catch is more than -15% relative tuning gives a higher probability of obtaining more accurate estimate of F and trend but the estimates of SSB will be biased. If there is bias in both Egg Survey and catch the relative tuning will give a higher probability of obtaining more accurate estimates of F and trend if the difference in the bias is greater than about 10%. These results coupled with the information on Egg Survey bias (-40%) and the estimated Q in the relative assessment suggesting greater bias in the catch or other unaccounted mortality (54%) support the use of relative tuning, as this method will give a higher probability of obtaining the more accurate estimates of F and trends in F and SSB.

2.8.3 Summary of inferences from independent measurements of the stock

Fisheries 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 decrease trend over the period 1992 to 2004. The tagging data (Section2.5.7) 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 bee 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) indicates that the biomass is well above what is estimated in the analytic assessment (using the index as either absolute or relative) and that it has decreased throughout the 1990's 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.

2.8.4 Further data exploration

In this section on data exploration analyses with assessment tools other than ICA are presented.

2.8.4.1 Log catch ratio's

At last years 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 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.

2.8.4.2 ISVPA trial runs

ISVPA was used in the same settings as last year (age range from 0 till 12+; year range from 1972 till 2004; two selection patterns were fitted: 1972-1988 and 1989-2003; unbiased model description in terms of residuals in logarithmic catch-at-age was ensured).

As previously, three versions of the model with respect to catch-at-age were tested: the catch-controlled version, considering catch-at-age data as true and attributing residuals in catch-at-age to violations of selection pattern stability assumption; the effort-controlled version, considering selection pattern as stable and attributing residuals in catch-at-age to noise in catch-at-age data; the so called “mixed” version, which in current assessment gives equal weights to the above two assumptions. In the last year trial runs just the mixed version was shown to be more stable in comparison to the “marginal” versions (catch-controlled and effort-controlled).

As seen from Figure 2.8.4.2.1a,b,c, all versions are giving similar profiles of the respective loss function. They have a minimum even considering sum of squared residuals, while minimization of the median makes the position of the minimum clearer (Figure 2.8.4.2.1 c1).

As last year, in experiments the egg surveys were treated both as absolute or relative and, as in last year assessment, it gave strongly different results (see Figure 2.8.4.2.1 d,e).

Unlike previous assessments, this year two additional sources of auxiliary information were used: Norwegian autumn surveys (2000-2004) and Scottish surveys (2002-2004). Signal from Norwegian surveys (treated as relative) is in line with signals from catch-at-age and egg surveys, treated as relative (Figure 2.8.4.2.1f), while the signal from the Scottish surveys correspond to very high F, perhaps because this data set is too short (only 3 points).

For stock assessment the sources of information with meaningful signals were used: catch-at-age, egg surveys (treated as relative) and Norwegian surveys (also treated as relative)

Estimates of SSB, F(4-8) and R when different sources of information are used, are shown in Figure 2.8.4.2.2.

As it can be seen, the estimates, obtained when the three above mentioned sources were used in analysis, are very close to those, coming from each of the data source taken alone, especially to the result when catch-at-age data are used alone. Egg surveys data, treated as absolute SSB index, indicate sharp rise of SSB; Scottish surveys are marginal in indicating the stock decrease.

Estimated selection patterns for both periods are given on Figure 2.8.4.2.3.

Residuals for catch-at-age - Figure 2.8.4.2.4.

Retrospective runs - Figure 2.8.4.2.5.

The results of bootstrap are shown in Figure 2.8.4.2.6. What is interesting:

1) higher uncertainty in estimates of selection for age group 4;

2) for 1972-1988 uncertainty in selection pattern is higher than for second period - perhaps because of specific catch-at-age for first years

2.8.4.3 Exploratory analyses of the data with AMCI

AMCI was used to provide assessments with an alternative method to ICA. It was set up to imitate the ICA assessment except for the model of fishing mortality, which allowed for a gradual change in selection in all years, except for the first 4 years and the last year. Fishing mortality at oldest true age was not linked to any previous age. The fishing mortality of the plus age was set equal to that of the oldest true age. The plus group is modelled as a dynamic pool, and the fit to the catches at that age is included in the objective function. Weighting of individual data (age 0 and 1) and relative weighting of catch data and SSB data was close to what is used ion the ICA assessment. Egg survey data were taken as relative measurements of SSB.

In addition to a base run (named Notag in Figure 2.8.4.3.1) as outlined above, some additional runs were made:

- Including tag return data as described in previous WG reports (ICES 2001 ACFM06)
- In addition, including SSB estimates from the tag return data (see Section 2.8.3)
- In addition, including also SSB estimates from the Norwegian acoustic survey (see Section 2.8.3)
- Assume the egg survey estimate as an unbiased estimate of the SSB, and estimate natural mortality.

Each of the added SSB series was given the same weight in the objective function as the egg surveys.

The main results of these runs are shown in Figure 2.8.4.3.1. The results for the various options are not very different. However, the tag data induce a somewhat lower estimate of the fishing mortality, and a correspondingly higher estimate of the spawning biomass. The estimate of M scales the whole time series of SSB to the egg survey values, and uses the catches at reported and this reduces the fishing mortality correspondingly. The estimate of M was 0.234.

Altogether, including the additional data (log catch ratio's, AMCI and ISVPA) that are not routinely used in the assessment leads to a modest increase in the estimated SSB and a similar decrease in estimated fishing mortality.

2.8.5 Conclusions

This is a summary of the main conclusions from the preceding sections 2.8.1 to 2.8.4:

- Altogether, there is evidence from fishery-independent measurements that the stock is underestimated by the current analytic assessment, while there appears to be no conflict in the mortality estimates. The evidence from these sources for trends in biomass are to some extent conflicting (see also section 2.5).

- The time series of only 5 egg surveys appears too short for NEA mackerel to provide reliable and realistic estimates of Q, because the results of the retrospective runs indicated that Q might be within the range of 1.10 to 1.36 (this years assessment Q=1.36), (Section 2.8.2.2).
- Catchability (Q) for NEA mackerel becomes higher than for western mackerel, when the catch in numbers at age of the Southern component are added to the Western component for which Q has been stable at 1.1 in the recent period. This is probably caused by the lower ratio between adult catch weight and the egg survey SSB in NEA mackerel compared to Western mackerel, (Section 2.8.2.3)
- In the presence of catch bias advice on the correct levels of catch can only be given in a relative sense, projections should be treated as providing advice on change in catch not absolute levels (Section 2.8.2.6). If the bias in the catch is more than -15% relative tuning gives a higher probability of obtaining more accurate estimate of F and trend but the estimates of SSB will be biased. If there is bias in both Egg Survey and catch the relative tuning will give a higher probability of obtaining more accurate estimates of F and trend if the difference in the bias is greater than about 10%. These results coupled with the information on Egg Survey bias (-40%) and the estimated Q in the relative assessment suggesting greater bias in the catch or other unaccounted mortality (116%) support the use of relative tuning, and suggesting that this method will give a higher probability of obtaining the more accurate estimates of F and trend in F and SSB (Section 2.8.2.6).
- With additional data such as tags and acoustic surveys which are not routinely used in the assessment AMCI and ISVPA indicate slightly higher level in the estimated SSB and a corresponding decrease in estimated fishing mortality, but both show the same trends as ICA (Section 2.8.4).
- Because the assessment of NEA mackerel is based only on catch and a triennial SSB index it is borderline with respect to estimating the present state of the stock and exploitation. The assessment precision deteriorates with increasing time after each egg survey until a new egg survey data point becomes available.
- All the analytical assessments of the stock described here indicate the same trend (reverse in the trend of declining SSB) in the last three years.

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 to NEA mackerel. The changes in the inputs used in ICA this year relative to other years is given in Table 2.9.1.1. The only changes compared to last year are:

1. The period of separable constraint was increased from 12 to 13 years to include the SSB index time series over the period 1992-2004 and
2. the index of SSB from the egg surveys was used as relative index (the use of the SSB index as absolute by the Working Group was rejected by ACFM in October 2004).

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 are 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:

$$\sum_{a=0}^{a=11}\sum_{y=1992}^{y=2004}\lambda_a(\ln(C_{a,y}) - \ln(F_y.S_a.\overline{N}_{a,y}))^2 +$$

$$\sum_{y=1992}^{y=2004}\sum(\ln(EPB_y) - \ln(Q\sum_a N_{a,y}.O_{a,y}.W_{a,y}.\exp(-PF.F_y.S_a - PM.M))^2$$

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 1992–2004, 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 2.9.1.1–2.9.1.4 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 2.9.1.6 shows the catches from 1972 to 2004, the F(4-8) from 1977 to 2004, the recruitment from 1972-2004, the GM recruitment for 2004 and the SSB from 1980 to 2004 together with the egg survey SSB's from 1992 to 2004. 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 caution. Section 2.8 on the data exploration and modelling provides extensive information on the reliability of this assessment. It is important to note that section 2.8.5 summarizes the conclusions of sections 2.8.2 – 2.8.4.

According to the assessment, the NEA mackerel stock has been relatively stable in the earlier period up to 1992, but then decreased gradually (Figure 2.9.1.6).

The CV's of the stock number estimates for age 2-11 are in the range of 4% to 5%. The 2003 and 2004 year classes, for which there is little information in the data, have higher CV's. The CVs for these year classes were 12% and 39% respectively It must be stressed, however, that the variances estimated by ICA only express how well the parameters, including the present population numbers, can be estimated with the present data and model assumptions. These variances neither cover uncertainties in input data nor uncertainties with respect to model formulations and the validity of model assumptions. Therefore, the assessment is far less certain than reflected by these variance estimates.

The SSB, F(4-8) and recruitment estimates as obtained by previous Working Groups (1995-2004), are shown in Figure 2.9.2.1. Although the long-term trend in biomass is consistent, the levels of variability reflect switches between the use of SSB as a relative or an absolute index. The SSB estimates calculated at this Working Group meeting and last years accepted assessment by ACFM differed from the SSB estimates from the two earlier Working Groups and these differed again from the three earlier Working Groups, because the lower SSB estimates from the 2001 and 2004 egg surveys were included. From 1994 onwards the model tried to fit to the latest SSB estimates. During successive Working Group meetings the inclusion of new SSB estimates from egg surveys changes the perception of the stock, suggesting a more declining stock trajectory.

Figure 2.9.2.2 shows the retrospective analysis by ICA in which the egg survey SSB's were used as relative SSB index and in which the periods of separable constraint used were from 1992 up to final assessment year. It show large fluctuations in the recent trends of SSB dependent on the level of the last egg survey SSB’s. Confidence intervals of ± 30% are shown around the egg suvey SSB’s.

The approach taken to evaluate the quality of the assessments by the Working Group is by comparing the first estimates of recruitment, SSB and F(4-8) in a certain year with the second, third, fourth, etc. estimates for that same year from following WG meetings. Figures 2.9.2.3-5 show in the top panels the successive estimations of recruitment, SSB and F (taken from the ICES quality control diagram tables). It should be noted that the accepted assessment results from the 2004 ACFM meeting have been used being based on a relative SSB index. The SSB index from egg surveys has been used as an absolute SSB index from 1995 to 1997 and in 2002 and 2003. The SSB index has been used as a relative SSB index from 1999 to 2001 and in 2004 and 2005 (in 1998 no assessment was carried out). The lower panels show the maximum observed differences (%) between estimates from one assessment to the next (solid lines) as well as the median and 1st and 3rd quartiles. Over time there is a convergence, because these estimates become more reliable when they are based on more and more data. The main advantages of such a visual presentation are:

- The median (dotted line) indicates the accuracy of (i.e. the level of bias in) the successive estimates of SSB, F and recruitment.
- The maximum observed differences (%) indicate the likely interval of following estimates of SSB, F and recruitment. It indicates the improvement in precision when more data years are used for estimation.

The main conclusions on the quality of recent assessments from Figures 2.9.2.3-5 are:

- Systematic change: Historically assessed SSB is likely to have been revised downwards (median ranging from 0% to -3% change per year) and F is likely to be revised upwards (median ranging from +1% to +3% change per year); this systematic change seems rather constant when more data years are used for estimation; recruitment is revised downwards slightly (median ranging from 1% to -3% per year (excluding first estimation)).
- The maximum observed differences (%) indicate the likely interval of following estimates of SSB, F and recruitment. It indicates the improvement in precision over time.

- In general, estimates of SSB, F and recruitment become gradually more stable when more data years are used for estimation.

The WG feels strongly that the current use of the ICA model appears to be too sensitive to variability in the SSB estimates from egg surveys. The 95% confidence interval in the survey SSB estimates at around 30% is not exceptional for surveys in general and once incorporated in the assessment, uncertainty in the assessment from the egg surveys is around 22% one year after the Egg Survey (Simmonds et al 2003). In general, the most recent part of an assessment will be dominated by the information in the survey data, while the information from the catches dominate the estimates for the past. This problem is amplified by the three year interval between survey estimates becoming available. The model attempts to adapt to the calibrated value of the last survey estimate, which has the greatest influence, on the estimates for the most recent years. Therefore the noise in the last survey data will have a strong influence on the estimates for the next three years. Large corrections in the modelled SSB then appear when a new estimate becomes available that differs to any substantial degree from the previous one. In summary the fundamental problem is the sparsity of fishery independent data, specifically the three year cycle in the availability of egg survey SSB estimates, which, additionally is not age disaggregated. Possible ways to improve this situation are:

- More fishery independent data - e.g. more frequent egg surveys, or some other index
- Improved assessment modelling methodology -
- Design a management regime adapted to the uncertainty in the assessment process

2.10 Short term Catch predictions for 2005

Table 2.10.1 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 following assumptions were made regarding recruitment at age 0 and the abundance at age 1 in 2005:

Age 0 Traditionally the WG calculates the GM from the estimated 0-group (ICA), because no recruitment indices from surveys are available. Figure 2.10.1 shows the recruitment estimates of year classes 1972-2003 as obtained from this year's assessment. The value of 3672 million fish is calculated from the geometric mean of the North East Atlantic mackerel recruitments for the period 1972 - 2001, which value is used for the recruitment at age 0 for 2005 in the predictions. Figure 2.10.2 shows the GM recruitment estimates as estimated at the various WG meetings from 1995 - 2005. The GM recruitment estimate of this years WG meeting is near lowest of the GM recruitments as annually estimated during the WG meetings of 1995 - 2005.

Age 1 As in previous years the WG has taken the abundance at age 1 to be the geometric mean recruitment at age 0 (3672 million fish) brought forward 1 year by the total mortality at age 0 in that year (see Table 2.10.1), this corresponds to 3130.

Recruitment at age 0 in 2005 and 2006 was also assumed to be 3672 million fish.

The working group considers that estimates of 0 and 1 from the assessment should not be used in the prediction.Figure 2.9.2.3 shows the successive estimations of year class strength at age 0 in millions. At the annual WG meetings the recruitment strength at age 0 is estimated of all year classes (except for the youngest year class at age 0). The first estimation of a year class strength is based on the catches in numbers at age 1 and at age 0 the year before; the second estimation of the same year class is one year later and is then based on the catch in numbers at age 2, at age 1 the year before and at age 0 two years before; etc.. The lower panel of Figure 2.9.2.3 shows the maximum observed differences in percentage between year class estimates of recruits at age 0 from one assessment to the next. It indicates the improvement in the reliability in the successive estimates of year class strength. The spread indicates the precision of successive .estimates of recruitment; the median indicates the bias in the successive estimates of recruitment.

At 2003 Working Group meeting Norway had asked the Working Group to comment on the biological rationale for setting TACs by areas and to identify the implications for the TAC advice for the remaining part of the distribution area, considering a range of TAC options for the Southern area (ICES, 2004/ACFM:08). As a consequence, in 2004 catch options were not provided by fleet. The information provided then is regarded to be still relevant. Therefore, because at this year's Working Group meeting the catch predictions also this year are not carried for the so-called "Northern" and "Southern" areas .

The exploitation pattern used in the predictions was the mean of the separable ICA F's over the last three years 2001-2003, scaled to F in the final year.

Maturity at age was taken as an average of the values for the period 2002–2004.

Weight at age in the catch was taken as an average of the values for the period 2002–2004 for each area.

Weight at age in the stock was calculated from an average (2002–2004) of weights at age for the NEA mackerel stock.

The catch for 2005 is assumed to be 433 kt, which corresponds to the TAC of 422 kt in 2005 (see Section 2.1) plus an assumed amount of discards of 11 kt (see Section 1.3.3), this conforms to the same procedure as last year.

The catch predictions are carried out for a catch constraint. The actual catch and actual F obtained one year later for the same year can be compared to the catch and F of both prediction options to check, which of the two options fits best to the actual values. Figures 2.10.3 and 2.10.4 show these comparisons for respectively catch and fishing mortality. The catch constraint option fits best to the actual catches, when predicted catches are compared to recorded catches (Figure 2.10.3). However, when the predicted fishing mortalities are compared to the actual fishing mortalities (Figure 2.10.4), it is not evident anymore whether the Fsq option or the catch constraint option has a better fit. The predicted fishing mortalities from both options are closely related in most years. However, in a year of a greater TAC change (e.g. 1995 to 1996 from 645kt to 452kt) there is a large difference in the predicted catch and F between the Fsq and the catch constraint options. Especially in such case, which is directly comparable to the current situation, where the management changes in 2004 result in a TAC reduction of 27% from 2004 to 2005, it would be preferable to use a catch constraint option for the predictions.

Predictions were calculated by the MFDP program.

A detailed single fleet management option table is presented: Table 2.10.2 with *catch constraint* fishing (Catch = 433kt) in 2005 and F=0.17 in 2006 and 2007. Table 2.10.3 provides multi option for 2006 with a catch constraint of 433 kt in 2005 to give a range of F options from 0.0 up to 0.49.

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 years prediction indicates a reversal in the declining trend in SSB, this is partly due to the reduction in catch assumed for 2005 and partly due to increased recruitment.

The 2000 year class is now confirmed to be weak and will be 6 years old in the catches of 2006. The 2001 year class appears to be strong and 2002 is indicated to be even stronger. These year classes will be respectively 5 and 4 years old in the catches of 2006. However, indications are that the 2003 year class which will be 3 years old in 2006 is weak. The data from the catches 2001 to 2004 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

There were no special requests dealing with NEA mackerel.

2.12 Long Term Yield

2.12.1 Yield per Recruit

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

2.12.2 Production analysis.

The balance between production and removal of biomass by the stock can provide valuable information about the state and development of a stock, to some extent independent of analytic assessments. The biomass that potentially can be produced in a year is the number of fish (including recruits) multiplied with the increase in individual weight from one year and age to the next. Some of this potential production is spent on fish being removed due to fishing and to other causes. The difference will be the net production, i.e. the change in the biomass of the stock from one year to the next.

In the long term, a sustainable exploitation will imply that the removal – by the fishery and for other causes - does not exceed what is produced. This may be suggested as a basis for designing management strategies that are not dependent on annual assessments, but it may also be used to evaluate the effect of the current exploitation. The advantage of this kind of approach in evaluating performance properties of a management strategy is that most of the information that is needed is available, even if annual analytic assessments are unreliable. The exception may be the average recruitment to be expected. The average recruitment will serve as a scaling factor for productivity calculations, and it is in turn dependent on the scaling of the stock abundance by the absolute catch information in an assessment.

The mackerel assessment is marginal as a basis for conventional year - to - year management, both because of doubts about interpretation of data, because of the sparseness of other data than catch numbers at age, and because the information that can be used to scale the assessment (absolute catches and SSB estimates) are likely underestimates to an unknown extent. However, most of the information that is needed for evaluation of productivity is available:

- Weights at age and maturities at age: Measured
- Selection at age: Robust across most assessment assumptions, and in line with estimates from tag recaptures.
- Variability of recruitment: Even though the absolute values are uncertain, the weak and strong year classes are clearly identified in assessments, and their relative magnitude is not likely to be very wrong. In practise, the recruitments are well represented by a normal distribution with a CV in the order of 0.25 (WGMHSA 03 etc).

What is then missing are reliable estimates of natural mortality and of average recruitment. These will be interdependent to a large extent. Hence, estimates of recruitments will be linked to assumptions about natural mortality, both in assessments and predictions.

A working document by Skagen (WD#26) with preliminary studies along these lines was presented. ICA assessments of the mackerel stock with various additional assumptions was use to have a range of interpretations of the data. These included the standard assumptions with egg surveys as relative of SSB, one with egg surveys as absolute measure of SSB, one with an estimated level of natural mortality (=0.21), and one with an estimated underreporting factor for the catches (= 0.75). Both the latter were conditional on the assumption that the egg survey can be used to scale the assessment, i.e. that it is an unbiased measure of SSB. The data were those used by the WG in 2004. The results of all options indicated that the removal has exceeded the production for the last 10-15 years. Some large year classes provided a surplus that could be depleted gradually, but the net effect over time was a declining stock. In this perspective, the stock appears to be over-exploited, which is another (and more detailed) way of recognising that the stock has declined. Another finding was that the year to year changes in annual catches hardly were related to variations in productivity. Hence, the annual adjustments of TACs has not had any noticeable impact on the productivity of the stock.

Surplus production (net change in biomass from year to year +biomass caught) was not related to the stock biomass in any of these scenarios. Hence, classical surplus production models may not be adequate to evaluate the productivity of this stock.

Yield per recruit raised to the average recruitment can be used to evaluate productivity in a steady state, where the removal balances the production. In practical management, the variability in production also will have to be taken into account, both because the abundance of fish that will gain biomass through growth will vary, and to evaluate risks. The variability in production is due to variations in recruitment and, most often to a minor extent, variations in growth rate and natural mortality. Taking this into account will require simulations.

In last years report, some examples of possible tri-annual quota regimes were presented including testing robustness to under reporting (WGMHSA report 2004 section 2.12 WD Roel and Skagen). In the WD#26, some further studies are presented. In this WD, it is suggested that such simulations use stochastic input data obtained through a stochastic 'priming' projection with e.g. fixed fishing mortality, to avoid the influence of initial conditions derived from a possibly biased assessment. The input to such projections would then be only data for which there are direct measurements or robust estimates, apart form the scaling to absolute values through the average recruitment. A criterion for acceptance of a management regime, in addition to having a low risk of exceeding limits, might be that it maintains production at a near optimum level. Examples of simulations of harvest rules with tri-annual TACs are provided in the WD. 26.

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. Therefore the current biomass reference point may not be applicable to the current level of SSB estimated from the assessment.

2.14 Management considerations

Mackerel may be a good candidate for multi-annual management strategies, and it is suggested that the development of this kind of strategy for mackerel is initiated in dialogue with management and industry. This is further elaborated below.

The motive for developing revised 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 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 or three 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.

The mackerel is relatively long lived, and despite the uncertainty in the assessment, it is likely that with the current exploitation 25-30% of the stock in number and biomass is replaced each year. Studies of productivity (Section 2.12) indicate that the adjustments of quotas in the past have been largely unrelated to short term variations in production, and that the variations in stock productivity comes mostly from other causes than year-to-year adjustments of catches. If the exploitation can be maintained at a moderate level, setting quotas for several years ahead should therefore be feasible.

In last years report, some examples of possible tri-annual quota regimes were presented including testing robustness to under reporting (WD Roel in section 2.12 of 2004/ACFM:08 and Skagen WD20/04). Some further studies were presented to the WGMHSA this year. In particular, the relation between production and removal was explored (Section 2.8 and Skagen, WD 26/05). The underlying reasoning was that sustainable management should not allow more biomass to be removed in the long term than the stock produces. From 1992 onwards there is a declining trend in SSB indicating that the removals have exceeded the production.

In general, management strategies that aim at more stable quotas can include quotas set for several years ahead, either as table quotas or gradually changing quotas for the period. A crucial condition is however, that there are mechanisms in place to reduce the removal if the stock develops less favourable than expected. Simulation studies are needed to evaluate specific strategies with respect to performance and risk that the stock develops in an unacceptable way. Methods for such evaluation are available or under development as described in Sections 2.8, 5.11 (Western horse mackerel simulations, ICES 2005 (Report of the Study Group on Management Strategies, ICES 2005 /ACFM:09)

As described in Section 2.8, all information that is needed to evaluate the impact of the catches on the productivity of the stock, apart from the absolute level of average recruitment, which are either measured directly or are estimated from analytic assessments, are robust across a range of plausible interpretations of the data. It may also be feasible to use relevant information about the current state of the stock (e.g. egg survey estimates of SSB, potentially acoustic surveys) directly to advise on any modification the exploitation. Evaluations need to take the uncertainty in this information into account.

A prominent problem for the mackerel is that catches are underreported and regularily exceed the annual quotas (the overshoot of the TAC is likely to be important see Sections 2.2.1 and 2.8.2). When this is the case, the estimates of stock abundance and future catches become underestimates, because the catches are the only available information on the magnitude of the stock in absolute terms. This also applies to assumed recruitments in predictions and harvest rule simulations, as the recruitments also are scaled to the reported catches. Hence, future recommended catch levels that are derived from simulations are scaled by the catch levels as reported in the past, and tacitly assume that they will be overfished to the same extent as in the past. Furthermore, if overfishing increases, the stock may easily come out of control. Evaluations of management regimes will have to take this into account, and test robustness to overfishing and management regimes may have to rely on catch independent information to advise on any necessary reductions in exploitation if the real removal leads to depletion of the stock.

In summary, multi-annual management strategies can ameliorate 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.

Table 2.2.1.1 Catches of MACKEREL 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]	103,964		103,964	94,290		94,290	300,616		300,616	72,848	43,796	615,514	0	615,514
2000[2]	156,031	1	156,031	115,566	1,918	117,484	273,169	165	273,334	92,557	36,074	673,397	2084	675,481
2001[2]	117,997	83	117,997	142,890	1,081	143,971	314,802	24	314,826	67,097	43,198	685,984	1,188	687,172
2002[2]	113,862	12,931	126,793	102,484	2,260	104,744	363,310	8,583	371,893	73,929	49,576	703,161	23,774	726,935
2003	116,593	91	116,684	89,492		89,492	322,241	9,390	331,631	53,701	25,823	607,849	9,481	617,330
2004	114,871	240	115,111	99,922	1,862	101,784	288,370	8,870	297,240	62,486	34,840	600,488	10,972	611,461

***Preliminary.**

[1]For 1976–1985 only Division IIa. Sub-area I, and Division IIb included in 2000 only

[2] Data revised for Northern Ireleand

[§] Discards reported as part of unallocated catches

Table 2.2.1.2 Catch (t) of MACKEREL 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**	
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	
France	5	0	270							2	
Germany		1									
Iceland		92	925	357				53	122		
Ireland					100				495	471	
Latvia	389	233									
Lithuania						2,085					
Netherlands		561			661			569		34	
Norway	93,315	47,992	41,000	54,477	53,821	31,778	21,971	22,670	12,548	10,295	
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]											
Poland			22								
Sweden							8				
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	53701.15	62,486	

[2]Russia.

***Includes small bycatches in Sub area I & IIb**

**** Faroese catch revised from previously reported 7,628**

Table 2.2.1.3 Catch (t) of MACKEREL 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								
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	4,946	3,197	-272		-730
Discards	1,387	2,807	4,753		1,912	24	8,583	9390
Total	212,839	229,487	269,700	299,799	272,160	312,004	368,988	331,631
Country	2004							
Belgium	4.31							
Denmark	25,665							
Estonia								
Faroe Islands	11,705							
France	1,538							
Germany, Fed. Rep.	4,514							
Iceland								
Ireland	18,901							
Latvia								
Netherlands	6366							
Norway	147,069							
Sweden	4,437							
United Kingdom	50,474							
Russia								
Romania								
Misreported (IIa)								
Misreported (VIa)	18,480							
Unallocated	-783							
Discards	8,870							
Total	297,240							

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

Table 2.2.1.4 Catch (t) of MACKEREL 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	9,254	0	12,807	
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	192,486	266,367	255,408	225,389
Country	2003	2004							
Belgium		0.5							
Denmark	392								
Estonia									
Faroe Islands	2,260	674							
France	21,213	18,549							
Germany	19,202	18,730							
Ireland	49,715	41730							
Netherlands	23,640	21,132							
Norway									
Spain	735	2,081							
United Kingdom	130,762	122,311							
USSR									
Unallocated	4,573	7,632							
Misreported (IVa)	-46,407	-18,049							
Discards	91	2,102							
Grand Total	206,176	216,895							

[1]Faroese catches revised from 2,158

[2] Catches revised for Northern Ireland

Table 2.2.1..5 Catch (t) of MACKEREL in Divisions VIIIc and IXa, 1977–2004. 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
France[1]	226	177
Spain[1]	17,381	28,428
Portugal[2]	2,749	2,289
Spain[2]	5,646	3,946
Total[2]	8,213	6,234
TOTAL	25,820	34,840

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

Table 2.2.3.1. Pelagic fleet composition in 2004 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	Trawler	219-906	No	5
Faroe Islands	y	90	6468 kW	Trawler	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	24	413	Scottish Seine		No	1
Ireland	y	<20-40	200-900	Bottom Trawl Single	RSW/Dryhold	No	30
Ireland	y	<20	70	Midwater Trawl Single	Dryhold	No	1
Ireland	y	20-80	350-2500	Midwater Trawl Single	RSW	No	9
Ireland	y	>80	14440	Midwater Trawl Single	Freezer	No	1
Ireland	y	33.02	1119	Bottom Trawl Pair	RSW	No	1
Ireland	y	<20	<350	Midwater Trawl Pair	Dryhold	No	2
Ireland	y	20-80	300-3000	Midwater Trawl Pair	RSW	No	33
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 w/ice	No	247
Spain	y	19.5 - 31.3	220 – 800	Pair Bottom Trawl	Dry hold w/ice	No	74
Spain	y	6.5 – 27	16 – 650	Purse Seine	Dry hold w/ice	No	408
Spain	y	4 – 27	5 – 750	Artisanal: Hook	Dry hold w/ice	No	370
Spain	y	7 – 29	40 – 450	Artisanal: Gillnet	Dry hold w/ice	No	593
Spain	y	2 – 34	4 – 900	Artisanal: Others	Dry hold w/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	35-67	2394 – 9429	Single Midwater Trawl	RSW	Yes	

Table 2.2.4.1. Catches in tonnes of Scomber japonicus in Divisions VIIIb, VIIIc and IXa in the period 1982-2004

Country	Sub-Divisions	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Spain	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												
	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
Portugal	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	2803	1779
	Total Portugal	664	373	8059	9118	8184	8876	3816	6447	8568	10142	8981	7341
TOTAL	**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
	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
Spain	Division VIIIb	427	247	778	362	1218	632	344	426	99	157	40
	VIIIc East	1903	2558	2633	4416	1753	414	1279	1442	1130	1200	1482
	VIIIc west			47	610	12	3	626	54	379	1325	1260
	Total	1903	2558	2679	5026	1765	418	1905	1496	1509	2525	2741
	IXa North	7560	4705	5066	1727	412	104	531	1	54	33	6
	IXa South	1013	364	370	613	969	879	470	552	1512	948	882
	Total	8573	5068	5437	2340	1381	983	1001	553	1566	981	888
	Total Spain	10903	7872	8894	7729	4364	2033	3250	2475	3174	3663	3670
Portugal	IXa Central-North	378	913	785	521	481	296	146	60	177	476	242
	IXa Central-South	2474	1544	2224	2109	3414	10407	7450	2202	1380	3405	5990
	IXa South	1578	1427	1749	2778	2796	3173	2924	1966	3744	4149	6193
	Total Portugal	4430	3884	4759	5408	6690	13877	10520	4228	5301	8030	12425
TOTAL	**Division VIIIb**	427	247	778	362	1218	632	344	426	99	157	40
	VIIIc East	1903	2558	2633	4416	1753	414	1279	1442	1130	1200	1482
	VIIIc west			47	610	12	3	626	54	379	1325	1260
	Division VIIIc	1903	2558	2679	5026	1765	418	1905	1496	1509	2525	2741
	IXa North	7560	4705	5066	1727	412	104	531	1	54	33	6
	IXa Central-North	378	913	785	521	481	296	146	60	177	476	242
	IXa Central-South	2474	1544	2224	2109	3414	10407	7450	2202	1380	3405	5990
	IXa South	2591	1790	2120	3391	3764	4052	3395	2518	5256	5097	7075
	Division IXa	13003	8952	10195	7748	8071	14860	11521	4781	6867	9011	13313
	Total	15333	11756	13653	13137	11054	15909	13770	6703	8475	11693	16094

Table 2.4.1.1 Catch in numbers at age (000's) for NE Atlantic mackerel

For Quarters 1 to 4

Ages	IIa	IIIa	IIId	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	Ixa-central	Ixa-north	Total
				432.0	24.4	0.0		19.9		48.0	3.2	157.5	184.8	31.0	4.2	34.9			18.4	11.9	376.9	16.7		144.8	3581.9	5090.7
1	26.3	0.0	0.0	2822.9	132.8	306.5	47.2	2580.8	0.0	1165.8	12.9	1429.9	1397.7	154.7	22.7	159.9	10.0	0.0	84.3	558.6	2029.0	2453.0	0.2	3855.6	4692.3	23943.1
2	32159.5	1009.5	0.2	247249.5	971.1	760.3	427.1	36641.8	0.4	31240.4	1630.6	6265.9	4387.3	431.0	46.7	412.1	9940.7	11.7	3786.7	1771.2	5437.4	4775.3	1595.2	5607.6	5951.6	402510.6
3	44790.9	694.8	0.1	183332.7	593.4	3085.0	1401.4	77405.8	4.2	37055.1	1762.0	35267.7	8078.8	369.8	24.8	480.3	33078.4	37.5	15142.2	5301.3	19882.5	2553.7	2330.4	660.0	1882.5	475215.1
4	10831.5	548.1	0.0	59921.8	295.6	56.1	670.8	22572.7	1.6	9618.7	325.6	905.9	745.6	39.6	7.6	111.5	11057.1	12.1	4939.7	1301.4	7953.1	601.4	673.6	188.1	498.3	133877.2
5	19584.6	318.3	0.0	86851.4	214.6	82.4	1279.0	53625.8	3.4	19176.0	703.5	1307.7	613.4	41.2	10.3	120.2	16804.2	21.8	9336.5	2846.5	13035.3	1005.6	566.9	175.5	1144.5	228868.3
6	10219.2	116.0	0.0	45223.7	277.2	46.9	775.9	34607.4	2.5	11972.0	356.3	808.6	347.0	21.4	5.7	62.6	10207.9	13.8	637.0	709.9	10241.5	815.6	423.8	103.1	790.8	128785.5
7	5771.5	115.2		24552.7	13.3	72.8	523.1	24446.8	1.7	5030.9	174.3	1091.9	193.0	11.9	2.7	42.4	6205.6	7.0	554.6	600.6	7321.9	562.7	53.0	74.9	431.4	77855.6
8	4156.4	86.4		19385.2	9.3	3.1	358.7	17346.3	0.7	5045.7	153.4	836.0	86.3	9.2	2.4	29.2	4570.6	7.1	682.7	268.8	3166.1	255.5	54.1	43.9	135.2	56692.1
9	2251.2	0.2		11454.2	3.8	14.3	166.5	11216.9	0.4	2066.6	85.9	711.0	41.4	1.7	1.0	13.4	3321.9	4.1	407.7	257.9	2128.1	215.8	31.3	29.7	85.9	34510.8
10	1966.2	0.1		11882.3	3.6	1.4	228.3	10918.4	0.4	771.4	40.7	499.1	59.0	0.4	0.8	10.2	2074.7	2.9	273.3	120.6	758.2	68.5	22.0	11.1	22.9	29736.1
11	955.8	0.1		6267.7	2.3	0.5	62.0	4142.6	0.0	544.3	30.5	123.0	4.4	0.8	0.3	4.7	960.1	1.6	264.9	34.0	515.6	73.2	11.9	11.4	21.7	14033.2
12	793.0	0.1		4868.5	1.6	0.9	46.9	1899.1	0.0	241.9	16.6	298.9	8.0		0.1	1.2	433.2	0.8	4.7	47.6	271.3	26.1	6.3	2.9	14.1	8983.7
13	222.8	0.0		2042.7	0.7	0.4	20.0	689.6	0.0	62.7	0.8	183.8	13.0	0.8	0.1		28.0	0.1	0.3	5.1	60.7	15.0	0.4	4.3	6.8	3357.7
14	120.3	0.0		1336.2	0.3	0.4	15.1	767.3	0.0	89.8	3.7	107.3	3.9		0.0	0.3	226.3	0.3	1.6				2.1	1.9		2676.8
15	49.1			64.5	0.0	0.8	10.4	962.7	0.0	36.4	1.2	219.0	8.9		0.1	0.6	182.7	0.3	1.9		32.3	8.8	2.6	0.8	6.8	1589.8
SOP	60006.1	1369.3	0.1	293747.7	958.1	774.5	2500.8	114942.0	5.5	36820.5	1478.6	10567.4	2855.8	225.0	30.5	386.8	34019.2	41.6	9817.8	3872.8	25126.6	3473.2	1391.6	2288.6	3943.9	610695.6
Catch	60006.3	1369.0	0.1	294129.5	957.4	784.2	2479.7	115110.5	5.5	37163.9	1470.4	9697.0	2839.3	225.4	30.4	389.3	34817.2	41.1	9817.4	3872.6	25131.9	3473.7	1414.5	2288.5	3946.0	611460.7
SOP%	100%	100%	99%	100%	100%	101%	99%	100%	100%	101%	99%	92%	99%	100%	100%	101%	102%	99%	100%	100%	100%	100%	102%	100%	100%	100%

Quarter 1

Ages	IIa	IIIa	IIId	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	Ixa-central	Ixa-north	Total
										35.3	3.2			0.3	0.1											39.0
1				501.4			47.2	938.4	0.0	142.3	12.9	3.7	48.3	9.5	0.5	0.1	9.3	0.0	0.1	172.9	562.3	679.1	0.0	1153.2	1336.6	5617.8
2				9818.7	0.0	1.5	427.1	25857.7	0.2	25968.0	1630.6	609.1	2441.8	51.0	2.6	193.7	9613.0	11.7	1577.2	899.4	3083.1	2332.0	1409.3	1586.5	1701.8	89216.1
3				16032.3	0.1	3.2	1401.1	64520.2	0.6	30456.2	1761.7	1303.8	5745.4	30.4	5.8	419.2	31072.7	37.5	10037.3	3065.5	15395.4	1487.2	1950.3	297.1	1179.5	186202.3
4				7043.8	0.0	1.2	670.5	18680.6	0.2	7124.2	325.5	374.5	502.0	2.5	1.5	90.9	10024.4	12.1	2335.6	761.3	5981.4	437.0	553.7	76.2	338.0	55337.0
5				11113.7	0.0	1.6	1278.2	44828.5	0.4	14793.5	703.3	468.3	322.9	4.3	2.4	107.2	14457.8	21.8	5413.8	1750.0	9706.8	807.4	400.9	48.6	777.8	107009.0
6				5741.3	0.0	0.9	775.5	28853.5	0.3	9922.9	356.1	247.8	160.6	1.6	1.5	53.5	9126.6	13.8	77.4	565.2	7655.3	669.6	303.0	38.9	490.6	65055.7
7				4046.1	0.0	2.8	522.7	20595.3	0.2	4273.7	174.3	774.9	78.1	1.2	0.8	34.7	4969.3	7.0	39.1	505.1	5492.8	469.4	3.6	25.1	252.1	42268.1
8				2286.6		2.7	358.1	15261.7	0.2	4282.8	153.3	757.3	27.4	0.0	0.8	23.8	3850.4	7.1	39.9	215.4	2406.5	205.8	3.6	11.0	52.2	29946.6
9				999.0		2.0	166.1	9942.8	0.1	1678.3	85.9	553.6	20.0	0.5	0.4	12.2	2772.6	4.1	23.1	222.6	1634.4	177.4	2.1	9.8	30.4	18337.3
10				1645.0		1.2	228.1	9843.9	0.1	588.6	40.7	341.6	14.3	0.0	0.3	7.8	1733.4	2.9	16.2	102.4	578.1	54.7	1.5	3.8	4.7	15209.2
11				299.5		0.4	61.9	3859.0	0.0	470.8	30.5	123.0	4.4		0.2	4.2	829.5	1.6	8.8	20.5	409.6	62.5	0.8	3.9	2.4	6193.6
12				461.1		0.8	46.9	1814.0	0.0	241.9	16.6	220.2	8.0		0.1	1.2	409.8	0.8	4.7	44.7	215.4	22.2	0.4	1.2	1.2	3511.2
13				171.9		0.4	20.0	640.0	0.0	16.2	0.8	105.0	3.8		0.0		26.4	0.1	0.3	4.0	47.7	12.6	0.0	2.3	0.0	1051.4
14				204.8		0.4	15.1	714.2	0.0	81.5	3.7	107.3	3.9		0.0	0.2	131.8	0.3	1.6				0.1	0.5		1265.3
15				35.3		0.8	10.3	901.5	0.0	28.0	1.2	219.0	7.9		0.0	0.6	173.1	0.3	1.9		26.7	7.1	0.2	0.4	0.0	1414.3
SOP				21981.0	0.0	8.6	2499.1	97398.4	0.9	29967.8	1478.3	2557.2	1529.3	16.4	5.2	281.4	30249.3	41.6	4917.7	2502.1	18665.4	2112.4	1034.1	601.7	1565.6	219400.1
Catch				22080.7	0.0	8.7	2478.0	97431.9	0.9	30304.2	1470.2	2534.4	1530.6	16.5	5.0	283.3	31056.6	41.1	4914.5	2502.3	18671.7	2112.5	1059.8	601.7	1565.3	220669.7
SOP%	0%	0%	0%	100%	103%	101%	99%	100%	100%	101%	99%	99%	100%	100%	96%	101%	103%	99%	100%	100%	100%	100%	102%	100%	100%	101%

Table 2.4.1.1 (continued.)

Quarter 2

Ages	IIa	IIIa	IIId	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	Ixa-central	Ixa-north	Total
														0.1	3.3											3.3
1	0.0			0.7	83.8	0.3						0.2	0.0	55.9	14.9		0.6			19.0	508.2	102.0	0.2	398.9	1528.1	2712.8
2	631.7	104.9		891.7	838.7	363.0		331.8	0.1	502.6	0.0	3085.2	102.4	180.8	20.8	1.0	286.6		1250.7	191.3	1439.3	636.2	152.7	2231.2	2335.5	15578.0
3	1565.9	71.9		753.4	503.4	2759.0		5860.2	1.0	5892.2	0.3	23417.2	803.6	67.3	13.7	2.1	1814.8		1477.9	562.5	3944.7	624.2	343.2	237.1	331.9	51047.5
4	372.0	56.9		155.4	251.7	3.2		2351.1	0.4	2385.4	0.1	27.7	17.8	13.0	4.9	2.0	947.2		1591.3	193.7	1892.4	90.6	108.9	34.5	133.2	10633.4
5	691.2	33.0		271.3	167.9	3.3		5135.7	0.8	4297.2	0.2	26.9	30.0	15.0	6.6	3.2	2162.3		1932.5	317.0	3295.7	166.8	162.3	33.0	359.7	19111.5
6	591.6	12.0		202.9	251.6	0.1		3640.5	0.6	2030.7	0.1	0.7	16.2	7.7	3.5	1.0	989.8		454.5	141.2	2566.5	126.3	113.4	28.5	296.7	11476.1
7	388.2	12.0		130.6	0.1	0.1		2560.1	0.4	754.8	0.0	0.2	11.0	4.1	1.5	1.3	1147.4		454.5	93.6	1826.0	79.7	49.5	24.7	176.8	7716.8
8	200.2	9.0		50.8	0.0	0.0		1146.5	0.1	761.2	0.0		3.9	1.2	1.3	1.0	662.9		568.4	51.5	750.8	32.4	50.5	10.8	79.3	4381.7
9	89.2			27.3	0.0	0.0		722.4	0.1	387.7	0.0		0.5	1.0	0.4	0.7	507.9		341.1	34.2	487.4	26.4	29.2	11.6	53.1	2720.3
10	85.7			24.6	0.0	0.0		510.5	0.1	182.5	0.0		2.3	0.0	0.4	0.4	315.0		227.3	17.4	178.0	6.8	20.5	3.1	17.1	1591.5
11	47.9			2.4		0.0		86.9		73.4				0.6	0.1	0.3	119.7		227.3	12.7	105.4	8.5	11.1	2.4	19.0	717.4
12	22.3			1.9		0.0											20.4			2.9	55.7	2.9	5.9	0.6	12.8	125.4
13	21.7			0.7						46.5				0.8	0.1		1.4			1.1	12.7	1.4	0.4	0.7	6.7	94.1
14	16.0			0.3				21.6		8.4						0.1	88.2						2.0	0.9		137.4
15				0.0				21.6		8.4							8.5				5.4	0.7	2.4	0.1	6.7	53.7
SOP	2325.9	142.0		791.8	780.9	381.7		8074.7	1.2	5440.6	0.3	3237.0	141.4	67.5	16.4	4.8	3462.8		2846.5	496.9	5919.7	495.0	337.9	614.7	1223.1	36804.4
Catch	2326.0	142.0		790.4	780.4	385.6		8072.4	1.2	5442.6	0.3	3270.2	142.5	67.5	16.4	4.7	3454.6		2847.1	496.7	5920.0	495.1	334.2	614.8	1225.2	36830.0
SOP%	100%	100%	0%	100%	100%	101%	0%	100%	100%	100%	98%	101%	101%	100%	100%	100%	100%	0%	100%	100%	100%	100%	99%	100%	100%	100%

Quarter 3

Ages	IIa	IIIa	IIId	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	Ixa-central	Ixa-north	Total
				0.5	21.3					0.0		88.0	27.0	0.6	0.8	4.8					46.5	5.3		75.4	2451.9	2721.9
1	26.3			300.8	42.6	228.2				1.5		797.2	130.8	62.5	3.4	21.8				38.7	524.2	1363.5		1592.7	1791.4	6925.6
2	31527.2	754.0	0.1	89326.5	98.4	383.0	0.0	10.1	0.2	17.9		2043.5	448.6	181.9	5.1	30.5	0.9		353.8	199.9	335.4	1430.4	33.2	1234.9	1895.2	130310.8
3	43224.2	517.0	0.0	64053.9	58.3	154.4	0.3	183.6	2.7	15.2		10328.0	619.4	256.4	2.5	9.1	61.8		404.3	128.2	170.8	339.9	36.9	105.7	370.3	121043.0
4	10459.5	409.3	0.0	21137.3	28.7	39.4	0.3	71.0	1.0	2.4		292.9	79.9	22.3	0.8	3.6	43.8		267.0	10.1	25.4	56.0	11.1	69.8	26.2	33057.6
5	18893.1	237.0	0.0	32105.2	33.1	77.3	0.9	153.3	2.2	4.8		462.9	84.4	18.5	0.9	2.7	108.9		267.0	9.4	11.4	25.5	3.7	88.5	6.8	52597.3
6	9627.5	86.2		18945.2	19.3	19.9	0.5	110.4	1.6	2.7		315.0	49.8	10.9	0.6	1.4	43.9		101.0	2.8	9.0	15.1	7.4	34.2	3.2	29407.4
7	5383.3	86.2		10377.5	10.7	57.7	0.3	77.7	1.1	1.3		177.7	34.8	5.9	0.4	1.2	64.9		57.7	1.9	1.9	8.1		23.4	2.0	16375.5
8	3956.2	64.6		8265.6	7.6	0.3	0.5	30.1	0.4	1.0		44.0	8.6	7.2	0.3	1.0	32.7		72.2	2.0	4.5	9.0		20.7	3.1	12531.5
9	2161.9			3145.0	2.7	0.1	0.4	18.3	0.2	0.4		88.0	11.6		0.1	0.3	27.1		43.3	1.2	3.1	5.6		7.1	1.8	5518.2
10	1880.4			4365.1	2.9	0.1	0.2	14.1	0.2	0.2		88.0	6.7		0.1	0.4	16.3		28.9	0.8	1.1	2.4		3.6	0.7	6412.1
11	907.9			3337.4	2.0	0.1	0.1	1.1		0.0					0.1	0.2	5.5		28.9	0.8	0.2	1.0		4.4	0.2	4289.7
12	770.7			2307.2	1.4	0.1				0.0		44.0			0.0		0.1				0.1	0.3		1.0	0.0	3124.8
13	201.1			824.6	0.5	0.0				0.0		44.0	6.1								0.1	0.3		1.0	0.0	1077.6
14	104.4			328.0	0.2	0.0	0.0	0.3		0.0					0.0		5.4							0.4		438.6
15	49.1						0.0	0.3							0.0		0.0				0.1	0.3		0.2	0.0	50.0
SOP	57680.6	1021.2	0.0	113665.6	127.1	297.9	1.7	237.0	3.3	12.5		3734.7	322.8	126.2	3.5	15.5	164.1		481.3	71.5	211.3	674.1	19.9	770.4	1024.8	180657.9
Catch	57679.3	1021.0	0.0	113650.9	126.9	302.6	1.7	236.9	3.3	12.7		2802.4	310.2	126.5	3.5	15.8	164.4		482.1	71.4	211.4	674.0	20.5	770.4	1024.7	179712.6
SOP%	100%	100%	109%	100%	100%	102%	100%	100%	100%	102%	0%	75%	96%	100%	100%	102%	100%	0%	100%	100%	100%	100%	103%	100%	100%	99%

Table 2.4.1.1 (continued.)

Quarter 4

Ages	IIa	IIIa	IIId	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	Ixa-central	Ixa-north	Total
				431.6	3.1	0.0		19.9		12.7		69.5	157.8	30.0	0.1	30.2			18.4	11.9	330.4	11.4		69.4	1130.0	2326.4
1		0.0		2020.0	6.4	78.1		1642.4		1022.0		628.7	1218.6	26.9	3.9	138.0	0.1		84.2	328.0	434.3	308.4		710.7	36.1	8686.8
2	0.7	150.6	0.1	147212.6	34.0	12.8		10442.1	0.0	4752.0		528.0	1394.5	17.3	18.2	186.8	40.2		605.1	480.6	579.6	376.6		554.9	19.2	167405.7
3	0.8	105.8	0.1	102493.2	31.7	168.4		6841.7	0.1	691.6		218.6	910.3	15.7	2.7	49.9	129.2		3222.7	1545.0	371.6	102.4		20.1	0.7	116922.2
4	0.1	81.9	0.0	31585.3	15.1	12.3		1470.0	0.0	106.7		210.8	145.9	1.8	0.4	15.0	41.6		745.8	336.3	53.9	17.7		7.5	0.9	34849.1
5	0.3	48.4	0.0	43361.3	13.5	0.2		3508.3	0.1	80.5		349.5	176.1	3.5	0.3	7.1	75.2		1723.2	770.0	21.5	6.0		5.3	0.3	50150.5
6	0.1	17.9		20334.2	6.3	26.1		2003.0	0.0	15.8		245.0	120.4	1.1	0.1	6.7	47.6		4.1	0.8	10.7	4.7		1.4	0.3	22846.4
7	0.1	17.1		9998.4	2.5	12.2		1213.8	0.0	1.1		139.1	69.1	0.7	0.0	5.2	24.1		3.2		1.2	5.5		1.6	0.5	11495.3
8	0.1	12.8		8782.2	1.7	0.0		908.1	0.0	0.8		34.8	46.5	0.8	0.0	3.5	24.6		2.1		4.3	8.3		1.4	0.7	9832.4
9	0.1	0.2		7282.8	1.1	12.2		533.4	0.0	0.3		69.5	9.2	0.2	0.0	0.2	14.2		0.1		3.3	6.4		1.3	0.6	7935.0
10	0.1	0.1		5847.6	0.7	0.0		549.9	0.0	0.1		69.5	35.8	0.3		1.6	10.0		1.0		0.9	4.6		0.6	0.4	6523.3
11	0.0	0.1		2628.3	0.3	0.0		195.7		0.0				0.2			5.4				0.5	1.2		0.7	0.1	2832.5
12	0.0	0.1		2098.3	0.2	0.0		85.1		0.0		34.8					2.9				0.2	0.7		0.2	0.1	2222.4
13	0.0	0.0		1045.5	0.2			49.6				34.8	3.2				0.2				0.2	0.7		0.3	0.1	1134.7
14	0.0	0.0		803.1	0.1			31.2		0.0							1.0							0.1		835.5
15				29.2	0.0			39.4					0.9				1.2				0.2	0.7		0.2	0.1	71.7
SOP	1.0	206.1	0.1	157316.9	50.1	86.1		9235.5	0.1	1401.6		1038.8	862.6	14.9	5.4	85.2	143.3		1573.7	802.6	329.8	191.5		301.6	130.8	173782.1
Catch	1.00	206.00	0.07	157607.36	50.06	87.28		9369.30	0.10	1404.36		1090.08	855.97	14.87	5.41	85.52	141.57		1573.82	802.28	328.87	192.15		301.57	130.73	174248.38
SOP%	102%	100%	98%	100%	100%	101%	0%	101%	105%	100%	0%	105%	99%	100%	100%	100%	99%	0%	100%	100%	100%	100%	0%	100%	100%	100%

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

Zeros represent values <1%.

Ages	IIa	IIIa	IIId	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	IXa-central	IXa-north	Total
0					1%								1%	3%	3%	2%					1%			1%	19%	
1			3%		5%	7%	1%	1%		1%	0%	3%	9%	14%	18%	11%				4%	3%	18%		35%	24%	1%
2	24%	35%	48%	35%	38%	17%	7%	12%	3%	25%	31%	12%	27%	39%	36%	28%	10%	10%	10%	13%	7%	36%	28%	51%	31%	25%
3	33%	24%	30%	26%	23%	70%	23%	26%	28%	30%	33%	70%	50%	33%	19%	32%	33%	31%	42%	38%	27%	19%	40%	6%	10%	29%
4	8%	19%	9%	8%	12%	1%	11%	8%	10%	8%	6%	2%	5%	4%	6%	8%	11%	10%	14%	9%	11%	4%	12%	2%	3%	8%
5	15%	11%	6%	12%	8%	2%	21%	18%	22%	15%	13%	3%	4%	4%	8%	8%	17%	18%	26%	21%	18%	7%	10%	2%	6%	14%
6	8%	4%	3%	6%	11%	1%	13%	12%	16%	10%	7%	2%	2%	2%	4%	4%	10%	11%	2%	5%	14%	6%	7%	1%	4%	8%
7	4%	4%		3%	1%	2%	9%	8%	11%	4%	3%	2%	1%	1%	2%	3%	6%	6%	2%	4%	10%	4%	1%	1%	2%	5%
8	3%	3%		3%			6%	6%	4%	4%	3%	2%	1%	1%	2%	2%	5%	6%	2%	2%	4%	2%	1%		1%	3%
9	2%			2%			3%	4%	3%	2%	2%	1%			1%	1%	3%	3%	1%	2%	3%	2%	1%			2%
10	1%			2%			4%	4%	2%	1%	1%	1%			1%	1%	2%	2%	1%	1%	1%	1%				2%
11	1%			1%			1%	1%			1%						1%	1%	1%		1%	1%				1%
12	1%			1%			1%	1%				1%						1%								1%
13																										
14																										
15																										
	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 2.4.2.1. Percentage length compositon in catches by country and gear in 2004. Zeros represent values <1%.

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

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

Quarters 1-4

Ages	IIa	IIIa	IIId	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	Ixa-central	Ixa-north	Total
				22.4	20.0	22.1		21.0		29.1	32.0	22.0	19.6	19.9	19.6	19.6			19.6	25.5	23.4	24.4		24.4	22.6	22.6
1	27.9	30.3	28.6	29.1	29.2	29.6	24.9	25.3	23.7	26.8	23.8	27.0	27.0	26.6	27.2	27.2	22.4	23.0	27.2	26.3	26.7	27.6	23.0	27.9	27.5	27.4
2	31.5	33.8	30.9	32.3	32.9	28.2	28.9	29.1	30.8	28.0	27.7	26.4	28.3	28.6	29.7	29.1	28.5	28.3	27.6	28.4	28.7	28.7	27.4	29.7	29.0	31.1
3	34.2	36.2	33.6	34.6	35.3	27.0	34.0	33.5	34.4	33.0	32.6	27.8	29.2	30.8	33.0	32.8	33.4	33.6	32.5	32.5	33.0	31.6	31.4	32.5	33.0	33.3
4	34.9	37.4	35.1	36.3	36.5	35.5	36.0	35.7	35.4	35.2	35.2	35.9	31.2	33.1	34.5	34.5	34.7	35.0	34.5	34.5	36.1	36.8	34.2	34.8	36.9	35.7
5	36.0	39.7	35.7	36.8	37.5	36.0	36.3	36.2	36.4	35.7	35.8	36.9	32.6	33.7	35.2	35.8	36.1	35.8	35.1	35.2	37.1	37.8	36.5	35.9	37.3	36.4
6	37.6	41.5	36.5	38.3	38.5	36.8	37.9	37.7	38.3	38.0	37.6	39.7	34.0	34.7	36.5	37.6	37.8	37.2	38.5	38.5	38.6	39.2	38.6	36.9	38.4	38.0
7	38.9	42.0	38.4	39.0	39.8	37.8	38.8	38.8	38.4	39.1	38.9	39.7	35.4	34.7	37.0	38.5	39.2	38.6	39.2	39.8	39.4	39.9	38.6	37.7	38.8	39.0
8	39.6	42.5	37.8	39.8	40.5	40.1	39.6	39.4	40.2	39.1	39.2	40.2	39.0	35.5	38.6	39.4	39.2	38.9	41.2	40.8	40.4	41.2	38.9	38.9	40.6	39.6
9	40.3	40.2		39.9	40.9	36.9	40.7	40.1	40.9	40.8	40.4	39.7	37.4	37.5	39.7	41.2	40.2	39.6	41.1	41.3	40.6	41.1	39.6	39.9	41.3	40.1
10	41.1	40.4		40.4	41.8	41.3	40.1	40.4	41.3	40.2	40.0	42.6	37.0	37.0	39.4	40.3	40.4	39.0	42.3	42.1	41.7	42.4	39.0	41.2	42.5	40.5
11	41.4	41.3		41.1	41.1	40.6	41.1	40.8	40.9	40.4	40.5	40.5	40.5	35.4	39.7	41.2	40.1	39.9	42.4	42.8	42.3	42.9	39.9	42.6	42.9	41.0
12	42.1	42.6		41.7	41.8	43.3	41.1	41.9	42.3	41.7	41.7	44.0	43.4	42.0	41.5	42.0	41.5	41.5	41.5	42.6	42.3	42.8	41.5	42.9	43.1	41.9
13	42.2	42.9		42.4	42.7	44.4	39.6	41.5	42.0	41.4	45.1	45.4	40.2	37.5	40.3	42.5	42.5	42.5	42.5	37.9	44.6	44.4	42.5	43.8	43.7	42.4
14	43.5	42.8		42.3	42.4	42.4	42.3	42.4	43.5	42.4	41.9	42.4	42.4	44.5	42.2	44.5	43.1	42.2	42.2				42.2	44.7		42.5
15	45.3	46.0		44.7	45.9	40.7	43.5	43.2	43.4	43.0	42.5	40.7	40.8	43.3	41.6	43.3	41.8	41.6	41.6		44.1	45.8	41.6	46.6	43.7	42.8

Quarter 1

Ages	IIa	IIIa	IIId	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	Ixa-central	Ixa-north	Total
										32.0	32.0			19.6	19.6											31.9
1				25.1	24.2		24.9	23.7	23.7	23.8	23.8	20.5	20.5	23.4	27.1	21.5	22.4	23.0	23.0	22.8	26.2	25.6	23.0	24.5	26.3	25.0
2				28.9	29.2	30.3	28.9	28.9	28.7	27.6	27.7	30.0	27.5	27.0	28.6	28.5	28.5	28.3	28.0	28.3	28.7	28.1	27.3	29.2	29.1	28.3
3				33.3	33.1	32.6	34.0	33.4	33.5	32.9	32.6	32.3	29.1	31.4	33.2	32.9	33.3	33.6	32.7	32.6	33.0	32.2	31.1	32.4	33.8	33.0
4				35.2	34.5	35.2	36.0	35.8	35.8	35.5	35.2	34.9	30.1	33.2	34.5	34.4	34.6	35.0	33.5	34.7	36.0	36.8	34.1	34.5	36.7	35.3
5				35.8	36.5	36.2	36.3	36.2	36.3	35.9	35.8	36.0	31.1	33.4	35.4	35.7	36.0	35.8	34.2	35.4	37.0	37.9	36.6	35.4	36.9	36.0
6				37.9	37.6	37.0	37.9	37.6	37.6	38.2	37.6	36.9	33.1	32.1	36.8	37.9	37.8	37.2	37.2	38.8	38.6	39.2	39.0	36.5	37.9	37.9
7				38.3	37.4	38.4	38.8	38.8	38.9	39.4	38.9	38.2	35.9	32.6	38.2	39.1	39.2	38.6	38.6	40.0	39.4	39.9	38.6	37.4	37.9	38.9
8				39.5	39.1	40.1	39.6	39.3	39.4	39.3	39.2	40.1	40.1	41.2	38.9	39.0	39.1	38.9	38.9	40.9	40.4	41.4	38.9	38.5	40.0	39.4
9				40.2	38.1	38.9	40.7	40.0	40.1	41.0	40.4	38.9	38.9	36.5	39.6	41.1	40.0	39.6	39.6	41.4	40.7	41.2	39.6	39.7	40.7	40.1
10				39.0	39.9	41.3	40.1	40.3	40.6	40.0	40.0	41.3	40.4	39.5	39.0	40.3	40.4	39.0	39.0	42.2	41.7	42.5	39.0	41.1	41.8	40.3
11				41.5	41.5	40.5	41.1	40.7	40.9	40.4	40.5	40.5	40.5	41.2	39.9	41.2	40.1	39.9	39.9	43.0	42.3	42.9	39.9	42.2	42.5	40.8
12				40.7	40.5	43.4	41.1	41.9	42.3	41.7	41.7	43.4	43.4	42.0	41.5	42.0	41.5	41.5	41.5	42.7	42.4	42.8	41.5	42.5	42.5	41.8
13				38.7	38.7	44.5	39.6	41.5	42.0	45.2	45.1	44.5	44.5		42.5	42.5	42.5	42.5	42.5	38.1	44.7	44.5	42.5	43.5	44.3	41.6
14				40.6	41.5	42.4	42.3	42.2	43.5	41.9	41.9	42.4	42.4	44.5	42.2	44.5	42.3	42.2	42.2				42.2	44.5		41.9
15				43.7	43.7	40.7	43.5	43.1	43.4	42.5	42.5	40.7	40.7	43.3	41.6	43.3	41.8	41.6	41.6		44.2	46.2	41.6	46.3	44.3	42.6

Table 2.4.3.1 continued.

Quarter 2

Ages	IIa	IIIa	IIId	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	Ixa-central	Ixa-north	Total
				21.5	21.5	21.5								19.6	19.6											19.6
1	27.9			25.7	29.5	29.6						20.5	20.5	25.6	27.3		23.0			26.3	25.4	26.3	23.0	27.0	27.1	26.8
2	31.3	33.8		29.9	33.1	24.3		32.9	32.8	29.2	29.2	24.3	24.3	28.0	29.7	27.0	28.3		27.0	28.0	28.2	28.8	27.9	29.3	28.5	28.1
3	34.4	36.2		33.4	35.3	26.3		34.6	34.5	33.5	33.5	26.3	26.6	30.7	33.0	33.2	34.5		31.0	32.6	33.1	31.3	33.0	31.9	33.3	29.7
4	35.6	37.4		35.5	36.5	33.6		35.4	35.3	34.5	34.4	33.3	35.1	33.2	34.5	35.9	35.5		36.1	35.5	36.4	36.7	34.8	34.5	37.8	35.6
5	36.5	39.7		36.5	37.5	35.5		36.6	36.4	35.0	34.9	35.4	35.4	34.1	35.1	37.6	37.0		37.8	36.3	37.2	37.6	36.1	35.5	38.2	36.6
6	37.9	41.5		38.2	38.5	37.4		38.4	38.4	36.8	36.7	32.8	36.6	34.3	36.4	38.3	37.6		38.8	37.6	38.5	38.9	37.4	36.6	39.2	38.1
7	39.2	42.0		38.4	40.2	38.0		38.5	38.3	37.6	37.3	34.5	35.9	35.6	36.3	39.2	39.1		39.3	38.5	39.2	39.6	38.6	37.4	40.0	38.8
8	40.0	42.5		40.4	40.6	39.1		41.0	40.5	37.9	37.0		37.4	36.1	38.2	40.4	39.3		41.3	40.1	40.3	41.0	38.9	38.5	41.1	40.0
9	40.1			41.2	42.1	41.1		41.4	41.2	40.3	39.8		39.5	38.5	39.9	41.2	41.0		41.2	40.5	40.6	40.9	39.6	39.7	41.7	40.9
10	41.1			41.5	42.2	38.4		41.7	41.7	40.5	40.1		35.5	40.3	39.8	41.8	40.7		42.5	41.9	41.6	42.3	39.0	40.8	42.7	41.4
11	41.5			41.2	41.5	41.5		43.3		40.9	39.0			34.5	39.0	41.5	40.3		42.5	42.5	42.2	42.8	39.9	42.9	42.9	41.9
12	41.8			41.4	40.5	40.5											41.5			40.1	42.2	42.8	41.5	42.5	43.1	42.0
13	42.0			41.4	38.7	38.7		40.0		40.0	40.0			37.5	40.0		42.5			37.5	44.2	44.3	42.5	43.5	43.7	41.4
14	44.0			41.9	41.5	41.5		47.5		47.5				44.5		44.5	44.3						42.2	44.5		44.9
15				43.7	43.7	43.7		44.5		44.5							41.6				43.9	44.1	41.6	45.5	43.7	43.7

Quarter 3

Ages	IIa	IIIa	IIId	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	Ixa-central	Ixa-north	Total
				21.5	20.0	21.5				21.0		22.0	19.6	23.3	19.6	19.6					24.9	24.0		23.7	21.9	22.0
1	27.9		28.6	28.2	28.7	29.8				27.2		27.0	27.1	27.6	27.2	27.3	23.0			24.7	26.6	28.5		29.7	28.8	28.5
2	31.5	33.8	30.9	32.0	31.7	31.8	33.5	32.8	32.8	29.0		27.5	29.2	29.5	29.6	29.3	28.3		27.0	28.7	29.2	29.3	27.3	30.7	29.5	31.7
3	34.2	36.2	33.6	35.1	34.8	34.0	35.9	34.6	34.5	32.8		30.4	30.3	30.7	32.9	32.1	35.2		30.9	29.8	30.5	30.2	30.6	34.0	30.3	34.3
4	34.9	37.4	35.1	36.1	36.2	36.0	36.2	35.3	35.3	35.5		35.6	32.3	32.9	34.8	34.8	35.7		35.6	34.2	35.6	36.4	34.2	35.2	34.3	35.7
5	36.0	39.7	35.7	36.7	37.4	36.0	38.3	36.5	36.4	35.8		36.8	33.2	33.4	35.9	36.7	37.4		38.5	36.9	35.9	36.2	40.5	36.2	35.4	36.5
6	37.6	41.5	36.5	38.1	38.7	38.5	39.3	38.4	38.4	37.6		40.9	33.7	35.2	36.6	35.7	37.9		38.8	38.8	38.2	37.8	39.0	37.5	38.3	38.0
7	38.8	42.0	38.4	39.2	39.8	37.8	40.8	38.4	38.3	39.0		43.4	34.3	34.3	37.2	35.4	39.2		39.3	38.2	37.9	38.6		38.1	39.2	39.1
8	39.5	42.5	37.8	39.8	40.3	40.3	42.4	40.7	40.5	39.3		41.5	37.0	35.3	39.5	41.3	39.5		41.3	41.3	39.3	38.7		39.3	38.3	39.7
9	40.4			40.6	41.3	41.3	41.9	41.3	41.2	41.0		42.5	35.1	41.5	39.6	41.4	41.3		41.2	41.2	40.1	40.5		40.5	40.2	40.5
10	41.1			41.1	42.1	42.0	41.9	41.7	41.7	40.2		45.5	34.8	39.5	39.1	40.8	41.1		42.5	42.5	41.7	42.1		41.5	41.9	41.1
11	41.4			41.1	41.1	41.1	43.3	43.3		42.8					39.9	42.5	40.5		42.5	42.5	43.2	43.0		42.7	43.2	41.2
12	42.1			41.7	41.7	41.7				41.5		45.5			41.5		41.5				45.3	44.0		43.5	45.5	41.9
13	42.3			42.6	42.6	42.6				41.4		46.5	35.5		42.1		42.5				45.5	44.0		44.5	45.5	42.7
14	43.4			42.2	42.2	42.2	47.5	47.5		41.5					42.2		44.5							45.5		42.5
15	45.3						44.5	44.5							41.6		41.6				45.5	44.0		47.5	45.5	45.3

Table 2.4.3.1 continued.

Quarter 4

Ages	IIa	IIIa	IIId	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	Ixa-central	Ixa-north	Total
				22.4	20.0	22.1		21.0		21.0		22.0	19.6	19.8	21.0	19.6			19.6	25.5	23.1	24.5		25.2	24.1	23.1
1	27.8	30.3	28.6	30.2	28.8	28.8		26.3	23.7	27.2		27.0	27.2	27.4	27.2	27.3	23.0		27.3	28.3	28.8	28.6		29.8	26.7	28.1
2	32.5	33.8	30.9	32.7	32.6	31.5		29.5	28.7	29.9		30.8	29.5	29.2	29.9	29.7	28.3		28.3	28.6	30.1	29.6		30.7	27.0	32.3
3	34.5	36.1	33.6	34.6	35.3	32.2		33.3	33.5	32.3		34.4	31.5	31.6	32.3	32.3	33.6		32.6	32.4	31.0	30.5		33.8	31.7	34.4
4	36.7	37.4	35.1	36.6	36.9	34.5		35.8	35.8	34.4		38.5	34.2	34.7	34.4	34.6	35.0		33.5	33.5	34.8	36.3		35.1	37.8	36.5
5	36.9	39.6	35.7	37.2	38.3	37.4		36.2	36.3	34.5		38.4	34.5	34.5	34.5	36.5	35.8		34.2	34.2	35.4	36.3		36.1	37.3	37.0
6	37.8	41.4	36.5	38.6	39.9	35.5		37.6	37.6	35.4		41.1	35.1	35.9	35.4	35.1	37.2		35.1	35.5	38.4	38.4		37.5	38.7	38.5
7	37.9	41.9	38.4	39.2	39.7	37.5		39.0	38.9	39.1		43.5	35.5	36.8	37.9	34.8	38.6		34.8		38.5	39.5		38.3	39.7	39.2
8	39.4	42.5	37.8	40.0	41.2	40.9		39.5	39.4	39.5		41.5	38.9	35.9	38.6	41.3	38.9		41.3		39.0	40.3		39.3	40.5	39.9
9	39.8	40.2		39.6	40.1	36.5		40.2	40.1	41.1		42.5	36.7	35.5	39.1	41.5	39.6		41.5		40.3	41.2		40.5	41.2	39.6
10	40.4	40.4		40.2	40.4	42.1		40.4	40.6	40.2		45.5	36.2	36.8	38.4	39.5	39.0		39.5		42.2	41.9		41.5	41.9	40.3
11	41.3	41.3		41.1	41.2	40.9		40.9	40.9	43.5				37.5	39.9		39.9				42.9	43.0		42.8	43.0	41.1
12	42.6	42.6		41.8	42.4	42.9		42.3	42.3	41.5		45.5			41.5		41.5				43.5	43.5		43.5	43.5	41.9
13	42.9	42.9		42.8	42.9	46.1		41.3	42.0	43.5		46.5	43.8		42.8		42.5				43.5	43.5		44.5	43.5	42.9
14	42.8	42.8		42.8	42.8	43.5		43.5	43.5	41.5					42.2		42.2							45.5		42.9
15	46.0	46.0		46.0	46.0			43.4	43.4				41.5		41.6		41.6				43.5	43.5		47.1	43.5	44.4

Table 2.4.3.2. Mean weight (kg) at age for NEA mackerel.

Mean Weight at Age by Area (Kg)

Quarters 1-4

Ages	IIa	IIIa	IIId	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	Ixa-central	Ixa-north	Total
				0.086	0.062	0.078		0.060		0.189	0.235	0.076	0.049	0.056	0.049	0.049			0.049	0.112	0.088	0.110		0.113	0.086	0.086
1	0.200	0.262	0.187	0.209	0.213	0.212	0.116	0.124	0.102	0.141	0.083	0.141	0.143	0.145	0.145	0.145	0.065	0.072	0.145	0.133	0.140	0.166	0.072	0.174	0.160	0.160
2	0.322	0.347	0.265	0.305	0.310	0.193	0.186	0.190	0.216	0.151	0.144	0.147	0.158	0.181	0.198	0.174	0.156	0.160	0.132	0.152	0.172	0.180	0.129	0.206	0.185	0.266
3	0.421	0.456	0.340	0.394	0.380	0.143	0.328	0.303	0.292	0.266	0.261	0.161	0.170	0.228	0.269	0.266	0.279	0.287	0.238	0.241	0.260	0.239	0.227	0.274	0.269	0.326
4	0.445	0.506	0.375	0.457	0.421	0.398	0.399	0.375	0.319	0.333	0.341	0.379	0.215	0.283	0.308	0.316	0.312	0.329	0.283	0.287	0.344	0.372	0.284	0.341	0.369	0.403
5	0.485	0.616	0.402	0.482	0.484	0.444	0.414	0.395	0.348	0.336	0.358	0.435	0.250	0.295	0.327	0.368	0.366	0.355	0.317	0.320	0.373	0.397	0.366	0.380	0.379	0.423
6	0.568	0.698	0.436	0.551	0.539	0.411	0.472	0.449	0.403	0.440	0.432	0.553	0.281	0.326	0.368	0.450	0.438	0.402	0.397	0.421	0.422	0.440	0.400	0.410	0.412	0.490
7	0.602	0.723	0.480	0.580	0.653	0.475	0.514	0.495	0.412	0.498	0.489	0.553	0.334	0.324	0.393	0.491	0.487	0.458	0.440	0.466	0.449	0.463	0.458	0.439	0.427	0.525
8	0.642	0.745	0.472	0.621	0.692	0.575	0.553	0.528	0.481	0.496	0.503	0.569	0.473	0.350	0.445	0.514	0.490	0.471	0.506	0.503	0.485	0.515	0.471	0.496	0.487	0.560
9	0.665	0.659		0.620	0.700	0.406	0.600	0.555	0.504	0.563	0.560	0.537	0.426	0.405	0.491	0.634	0.527	0.498	0.529	0.524	0.496	0.511	0.498	0.526	0.513	0.577
10	0.720	0.650		0.637	0.745	0.597	0.574	0.571	0.524	0.533	0.540	0.639	0.412	0.367	0.496	0.575	0.543	0.475	0.515	0.552	0.536	0.566	0.475	0.588	0.559	0.603
11	0.747	0.723		0.689	0.709	0.559	0.610	0.593	0.599	0.559	0.566	0.529	0.529	0.335	0.495	0.636	0.527	0.510	0.559	0.580	0.557	0.575	0.510	0.662	0.569	0.638
12	0.765	0.743		0.707	0.739	0.652	0.612	0.649	0.671	0.623	0.627	0.717	0.645	0.704	0.580	0.704	0.590	0.580	0.580	0.580	0.558	0.573	0.580	0.676	0.577	0.685
13	0.760	0.736		0.729	0.763	0.637	0.540	0.634	0.659	0.566	0.814	0.758	0.509	0.411	0.494	0.623	0.623	0.623	0.623	0.402	0.657	0.640	0.623	0.711	0.604	0.705
14	0.859	0.707		0.708	0.745	0.605	0.672	0.668	0.741	0.643	0.632	0.601	0.601	0.590	0.637	0.799	0.624	0.637	0.637				0.637	0.754		0.689
15	1.069	0.775		0.748	0.772	0.595	0.729	0.710	0.731	0.642	0.662	0.595	0.587	0.783	0.582	0.783	0.601	0.582	0.582		0.631	0.713	0.582	0.886	0.604	0.690

Quarter 1

Ages	IIa	IIIa	IIId	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	Ixa-central	Ixa-north	Total
										0.235	0.235			0.049	0.049											0.233
1				0.117	0.105		0.116	0.102	0.102	0.083	0.083	0.056	0.056	0.088	0.142	0.053	0.064	0.072	0.072	0.090	0.130	0.124	0.072	0.114	0.134	0.117
2				0.183	0.199	0.198	0.186	0.186	0.180	0.140	0.144	0.193	0.137	0.133	0.167	0.153	0.156	0.160	0.129	0.150	0.170	0.162	0.127	0.193	0.182	0.163
3				0.308	0.309	0.262	0.328	0.305	0.306	0.265	0.261	0.252	0.161	0.208	0.275	0.267	0.278	0.287	0.243	0.245	0.261	0.247	0.220	0.268	0.282	0.280
4				0.371	0.359	0.329	0.399	0.382	0.379	0.346	0.341	0.320	0.180	0.246	0.314	0.316	0.311	0.329	0.252	0.294	0.341	0.367	0.277	0.323	0.361	0.348
5				0.397	0.439	0.388	0.414	0.400	0.400	0.343	0.358	0.380	0.200	0.250	0.340	0.365	0.365	0.355	0.294	0.326	0.372	0.398	0.365	0.351	0.366	0.377
6				0.482	0.487	0.363	0.472	0.454	0.453	0.455	0.432	0.358	0.239	0.226	0.385	0.467	0.442	0.402	0.402	0.429	0.423	0.441	0.399	0.385	0.395	0.449
7				0.493	0.477	0.475	0.514	0.506	0.507	0.517	0.489	0.468	0.340	0.233	0.437	0.521	0.497	0.458	0.458	0.475	0.450	0.464	0.458	0.415	0.399	0.495
8				0.549	0.556	0.562	0.553	0.530	0.531	0.512	0.503	0.562	0.562	0.531	0.472	0.513	0.497	0.471	0.471	0.510	0.486	0.515	0.471	0.454	0.463	0.521
9				0.581	0.517	0.487	0.601	0.558	0.564	0.579	0.560	0.487	0.487	0.323	0.498	0.640	0.530	0.498	0.498	0.527	0.497	0.507	0.498	0.498	0.487	0.548
10				0.529	0.591	0.584	0.574	0.574	0.585	0.544	0.540	0.584	0.540	0.551	0.476	0.585	0.552	0.475	0.475	0.559	0.537	0.555	0.475	0.557	0.525	0.564
11				0.626	0.626	0.529	0.610	0.591	0.599	0.563	0.566	0.529	0.529	0.646	0.510	0.646	0.530	0.510	0.510	0.593	0.558	0.572	0.510	0.606	0.553	0.579
12				0.602	0.581	0.645	0.612	0.648	0.671	0.623	0.627	0.645	0.645	0.704	0.580	0.704	0.590	0.580	0.580	0.586	0.560	0.566	0.580	0.619	0.553	0.626
13				0.495	0.495	0.629	0.540	0.634	0.659	0.820	0.816	0.629	0.629		0.623	0.623	0.623	0.623	0.623	0.407	0.662	0.633	0.623	0.665	0.626	0.612
14				0.582	0.627	0.601	0.672	0.662	0.741	0.632	0.632	0.601	0.601	0.884	0.637	0.884	0.648	0.637	0.637				0.637	0.714		0.640
15				0.726	0.726	0.595	0.729	0.713	0.731	0.662	0.662	0.595	0.595	0.783	0.582	0.783	0.602	0.582	0.582		0.634	0.716	0.582	0.810	0.626	0.678

Table 2.4.3.2 (Cont'd)

Quarter 2

Ages	IIa	IIIa	IIId	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	Ixa-central	Ixa-north	Total
				0.080	0.080	0.080								0.049	0.049											0.049
1	0.200			0.135	0.222	0.212						0.056	0.056	0.131	0.145		0.072			0.126	0.118	0.134	0.072	0.151	0.146	0.143
2	0.332	0.347		0.234	0.310	0.110		0.251	0.252	0.175	0.174	0.110	0.111	0.172	0.195	0.131	0.160		0.131	0.153	0.162	0.176	0.147	0.195	0.169	0.176
3	0.435	0.456		0.307	0.373	0.123		0.290	0.290	0.270	0.270	0.123	0.129	0.229	0.265	0.252	0.296		0.200	0.246	0.263	0.226	0.272	0.254	0.271	0.199
4	0.478	0.506		0.354	0.408	0.258		0.313	0.310	0.297	0.295	0.246	0.303	0.287	0.302	0.331	0.327		0.336	0.323	0.352	0.362	0.320	0.324	0.394	0.332
5	0.506	0.616		0.370	0.465	0.307		0.347	0.340	0.313	0.308	0.295	0.311	0.309	0.318	0.387	0.375		0.392	0.351	0.377	0.390	0.364	0.351	0.405	0.361
6	0.588	0.699		0.417	0.531	0.453		0.400	0.396	0.368	0.363	0.231	0.344	0.317	0.359	0.403	0.406		0.397	0.386	0.419	0.428	0.401	0.387	0.439	0.413
7	0.607	0.723		0.424	0.679	0.491		0.406	0.397	0.396	0.383	0.266	0.327	0.353	0.366	0.442	0.446		0.439	0.419	0.443	0.451	0.458	0.416	0.466	0.435
8	0.621	0.745		0.506	0.702	0.533		0.491	0.465	0.404	0.373		0.369	0.369	0.419	0.476	0.451		0.508	0.473	0.480	0.499	0.471	0.454	0.501	0.476
9	0.615			0.513	0.777	0.626		0.509	0.482	0.495	0.474		0.432	0.468	0.481	0.524	0.513		0.531	0.501	0.492	0.496	0.498	0.500	0.524	0.511
10	0.717			0.537	0.783	0.502		0.509	0.499	0.497	0.482		0.314	0.530	0.513	0.512	0.499		0.517	0.511	0.530	0.550	0.475	0.545	0.562	0.521
11	0.770			0.698	0.640	0.640		0.645		0.534	0.440			0.320	0.440	0.536	0.510		0.561	0.562	0.550	0.567	0.510	0.639	0.569	0.572
12	0.719			0.701	0.581	0.581											0.580			0.484	0.549	0.567	0.580	0.619	0.578	0.590
13	0.752			0.689	0.495	0.495		0.477		0.477	0.477			0.411	0.477		0.623			0.383	0.636	0.626	0.623	0.665	0.601	0.577
14	0.897			0.712	0.627	0.627		0.757		0.757				0.588		0.588	0.592						0.637	0.714		0.665
15				0.726	0.726	0.726		0.575		0.575							0.582				0.614	0.618	0.582	0.766	0.601	0.585

Quarter 3

Ages	IIa	IIIa	IIId	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	Ixa-central	Ixa-north	Total
				0.080	0.062	0.080				0.060		0.076	0.049	0.099	0.049	0.049					0.118	0.105		0.108	0.077	0.078
1	0.200		0.187	0.205	0.198	0.217				0.149		0.141	0.143	0.166	0.145	0.145	0.072			0.109	0.148	0.184		0.207	0.191	0.184
2	0.322	0.347	0.265	0.307	0.303	0.269	0.241	0.252	0.252	0.173		0.168	0.191	0.203	0.193	0.186	0.160		0.130	0.164	0.197	0.203	0.127	0.232	0.207	0.304
3	0.420	0.456	0.340	0.427	0.416	0.356	0.300	0.290	0.290	0.265		0.232	0.215	0.230	0.272	0.250	0.303		0.203	0.186	0.223	0.226	0.212	0.326	0.226	0.404
4	0.444	0.506	0.375	0.475	0.492	0.419	0.345	0.311	0.310	0.357		0.369	0.263	0.283	0.321	0.318	0.326		0.323	0.289	0.380	0.418	0.282	0.368	0.347	0.461
5	0.484	0.616	0.402	0.503	0.546	0.451	0.412	0.343	0.340	0.351		0.416	0.293	0.294	0.361	0.393	0.381		0.415	0.373	0.379	0.407	0.485	0.406	0.379	0.494
6	0.566	0.699	0.436	0.573	0.611	0.492	0.452	0.398	0.396	0.433		0.637	0.298	0.347	0.383	0.349	0.408		0.398	0.398	0.454	0.469	0.399	0.457	0.491	0.570
7	0.602	0.723	0.480	0.615	0.659	0.495	0.508	0.400	0.397	0.493		0.759	0.312	0.319	0.412	0.351	0.444		0.439	0.409	0.456	0.504		0.484	0.532	0.609
8	0.643	0.745	0.472	0.648	0.688	0.687	0.558	0.477	0.465	0.508		0.635	0.412	0.348	0.486	0.522	0.444		0.508	0.508	0.534	0.511		0.538	0.499	0.644
9	0.667			0.655	0.719	0.720	0.562	0.495	0.482	0.590		0.714	0.363	0.647	0.500	0.597	0.517		0.531	0.531	0.571	0.593		0.595	0.578	0.658
10	0.720			0.692	0.768	0.765	0.547	0.503	0.499	0.551		0.759	0.364	0.550	0.495	0.536	0.506		0.517	0.517	0.650	0.670		0.647	0.661	0.699
11	0.745			0.709	0.709	0.709	0.645	0.645		0.706					0.510	0.561	0.510		0.561	0.561	0.725	0.717		0.715	0.731	0.716
12	0.767			0.740	0.740	0.740				0.641		0.917			0.580		0.580				0.845	0.774		0.760	0.865	0.749
13	0.761			0.773	0.773	0.773				0.590		0.930	0.374		0.608		0.623				0.863	0.774		0.822	0.865	0.775
14	0.853			0.771	0.771	0.771	0.757	0.757		0.641					0.637		0.588							0.887		0.788
15	1.069						0.575	0.575							0.582		0.582				0.863	0.774		1.029	0.865	1.064

Table 2.4.3.2 (Cont'd)

Quarter 4

Ages	IIa	IIIa	IIId	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	Ixa-central	Ixa-north	Total
				0.086	0.062	0.078		0.060		0.060		0.076	0.049	0.055	0.060	0.049			0.049	0.112	0.084	0.112		0.118	0.106	0.092
1	0.228	0.262	0.187	0.232	0.200	0.197		0.136	0.102	0.149		0.141	0.147	0.146	0.149	0.145	0.072		0.145	0.158	0.169	0.187		0.210	0.148	0.173
2	0.318	0.347	0.265	0.313	0.327	0.224		0.198	0.180	0.208		0.228	0.190	0.177	0.208	0.196	0.160		0.141	0.152	0.194	0.210		0.232	0.154	0.299
3	0.391	0.455	0.340	0.387	0.430	0.265		0.301	0.306	0.275		0.337	0.232	0.224	0.275	0.258	0.287		0.242	0.237	0.214	0.234		0.319	0.268	0.373
4	0.472	0.506	0.375	0.466	0.503	0.371		0.387	0.379	0.338		0.512	0.301	0.295	0.337	0.315	0.329		0.251	0.252	0.335	0.417		0.366	0.475	0.454
5	0.495	0.614	0.402	0.490	0.569	0.495		0.400	0.400	0.341		0.545	0.309	0.291	0.339	0.393	0.355		0.292	0.292	0.349	0.413		0.399	0.449	0.473
6	0.539	0.695	0.436	0.551	0.635	0.351		0.458	0.453	0.370		0.644	0.323	0.329	0.364	0.341	0.402		0.341	0.322	0.459	0.494		0.457	0.506	0.542
7	0.553	0.720	0.480	0.580	0.628	0.381		0.515	0.507	0.499		0.764	0.338	0.350	0.425	0.337	0.458		0.337		0.498	0.546		0.490	0.551	0.574
8	0.607	0.744	0.472	0.616	0.708	0.640		0.540	0.531	0.519		0.635	0.441	0.327	0.456	0.532	0.471		0.532		0.523	0.584		0.535	0.592	0.608
9	0.640	0.659		0.611	0.652	0.389		0.569	0.564	0.601		0.714	0.374	0.314	0.475	0.647	0.498		0.647		0.580	0.626		0.595	0.626	0.609
10	0.650	0.650		0.627	0.645	0.655		0.579	0.585	0.558		0.759	0.375	0.354	0.451	0.550	0.475		0.550		0.676	0.660		0.647	0.660	0.623
11	0.723	0.723		0.671	0.709	0.620		0.599	0.599	0.757				0.371	0.510		0.510				0.710	0.720		0.719	0.720	0.666
12	0.743	0.743		0.693	0.731	0.755		0.671	0.671	0.641		0.917			0.580		0.580				0.745	0.745		0.760	0.745	0.695
13	0.736	0.736		0.734	0.735	0.908		0.639	0.659	0.761		0.930	0.623		0.623		0.623				0.745	0.745		0.822	0.745	0.735
14	0.707	0.707		0.714	0.708	0.806		0.741	0.741	0.641					0.637		0.637							0.887		0.715
15	0.775	0.775		0.775	0.775			0.731	0.731				0.515		0.566		0.582				0.745	0.745		0.997	0.745	0.744

Table 2.5.4.1. Mackerel egg surveys in the North Sea in 2005.

Coverage	1	2	3	4
”Tridens”	6-10.06	13-16.06	20-24.06	-
“Johan Hjort”	-	13-19.06	20-25.06	26.06-3.07
Midpoint of survey Julian day	8.06 159	15.06 166	22.06 173	30.06 181
Total daily egg prod. x 10^{-12}	3,48	4,12	4,20	2,44
Interpolated daily egg prod. x 10^{-12}	0.39	0.81	0.84	0.32

Table 2.5.4.2. Egg production estimates from egg surveys in the North Sea and corresponding SSB based on a standard fecundity of 1401 eggs/g/female.

Year	*Egg prod *10^{-12}*	*SSB*10^{-3} tons*
1980	60	86
1981	40	57
1982	126	180
1983	160	228
1984	78	111
1986	30	43
1988	25	36
1990	53	76
1996	77	110
1999	48	68
2002	147	210
2005	**155**	**220**

.

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

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	1.5899	6.9236	0.0735	0.0756	0.000	0.0279					
2004**	1	42.887	11.636	7.3348								

* DIFFERENT SHIP
** half hour trawl and different ship

Table 2.5.6.1 NE Atlantic Mackerel O group catch by county by year from Q4 bottom trwl surveys. Abundance (sum of average numbers caught per standardised 1 hour tow per ICES stat rectangle), and the composite index.

Year	Country							Sum	Composite Index
	England	France	Ireland	Netherlands	Portugal	Scotland	Spain		
1981			82.0					82.0	
1982	286.7		7.8					294.5	
1983	12.0		0.3				2.6	14.9	
1984	9877.8		79.8				34.5	9992.2	
1985	2336.9		151.8		11221.6	16.0	188.1	13914.3	0.582
1986	6.3		4.7		88.5	8.0	0.4	107.9	0.095
1987	1089.6	105.3	82.0	3128.0	17.0	566.0		4987.9	0.283
1988	1634.6	3581.5	526.5	23134.0	2597.1	3305.0	6.9	34785.5	0.925
1989		880.1		464.0	784.1	3840.0	28.6	5996.8	0.614
1990		1898.3	205.3	3272.0	29.5	24935.0	8.3	30348.4	0.706
1991			4.8	256.0	0.9	68714.0	3.4	68979.1	0.494
1992		7664.3	0.0	2440.0	2841.0	3113.0	79.1	16137.5	1.256
1993			692.5	4824.0	533.9	72088.0	5.0	78143.4	1.321
1994		1489.0	4585.2	2594.0	490.9	14811.0	21.1	23991.2	0.929
1995		1996.3	6313.9		7793.5	77498.0	140.4	93742.1	2.008
1996					5834.0		4721.0	10555.0	
1997		1040.7	8297.7		7149.0	4414.0	148.8	21050.3	1.105
1998		1053.3	546.5		2730.1	58740.9	9.0	63079.8	1.066
1999		8811.2	85.2		2263.7	71963.0	86.8	83209.9	1.666
2000		2584.6	669.6		281.7	506.7	1265.3	5307.9	0.680
2001			570.0		5246.0	3449.6	6.9	9272.5	0.992
2002		29185.8	5010.6		3509.8	41751.8	763.1	80221.1	2.273
2003			1262.8		45.2	7815.8	43.6	9167.5	1.006

Table 2.5.6.2 NE Atlantic Mackerel O group index coverage expressed as the number of rectangles surveyed per year.

Year	Country							Total
	En	Fr	Ir	Ne	Po	Sc	Sp	
1981			8					8
1982	21		3					24
1983	27		6				19	52
1984	36		3				14	53
1985	31		12		21	37	18	119
1986	20		9		20	17	18	84
1987	32	34	10	37	22	35		170
1988	35	34	12	37	21	41	20	200
1989		34		47	21	49	16	167
1990		67	13	45	22	42	18	207
1991			10	40	19	49	18	136
1992		66	3	34	16	38	18	175
1993			22	43	18	44	18	145
1994		47	22	48	20	33	19	189
1995		36	20		20	57	20	153
1996					19		20	39
1997		60	33		17	65	19	194
1998		62	32		20	55	20	189
1999		54	21		19	55	20	169
2000		45	28		19	61	20	173
2001			25		18	62	19	124
2002		64	64		19	61	19	227
2003			34		19	60	19	132

Table 2.5.9.1 Norwegian acoustic surveys in the Northern North Sea in Area, time, length, weight and total biomass of mackerel based on acoustic registrations 1999 –2004. Taken from Korneliussen & al, presented to the PGAAM in May 2005

YEAR	DATES	AREA	AVERAGE LENGTH [CM]	AVERAGE WEIGHT [GR.]	BIOMASS [X10^3 TONN]
1999	12. Oct. – 22. Oct	Norwegian waters north of 59^0 N	34.9	358	828
2000	15. Oct – 5. Nov	North of $57^0$30’ N	32.8	286	541
2001	8. Oct. – 25. Oct.	North of $57^0$30’ N	36.3	418	409
2002	15. Oct – 3. Nov	North of 59^0 N partly with RV ”Scotia”	33.3	295	535
2003	16. Oct – 6. Nov	59-62^0 N; 1^0 W – 4^0 E partly with “Scotia”	33.0	296	581
2004	18. Oct – 8. Nov	59-62^0 N; 1^0 W – 4^0 E with RV “Scotia”	34.1	322	375

Table 2.5.9.2- Spanish acoustic surveys from 2001 to 2005. 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	7,138	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	163.7	32,314	1,061	409,493

Table 2.5.9.3- Spanish acoustic surveys . Biomass (in number and weight), mean length and mean weight at age of mackerel from the acoustics surveys from 2001 to 2004 in ICES Sub-division IXa North and Division VIIIc.

	2001				2002				2003				2004			
AGE	Number (millions)	L (cm)	W (g)	Biomass t ('000)	Number (millions)	L (cm)	W (g)	Biomass t ('000)	Number (millions)	L (cm)	W (g)	Biomass t ('000)	Number (millions)	L (cm)	W (g)	Biomass 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	195.23	25.03	114.60	22.37
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	952.36	28.29	164.48	156.64
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	599.27	32.80	258.15	154.70
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	227.54	37.46	377.85	85.97
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	425.56	38.05	395.53	168.32
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	336.69	39.13	428.35	144.22
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	181.46	40.15	461.71	83.78
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	106.11	40.78	483.18	51.27
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	76.46	41.03	492.49	37.66
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	31.07	42.33	538.03	16.72
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	18.90	42.22	533.89	10.09
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	13.49	43.27	573.84	7.74
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	3.21	43.95	599.81	1.92
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	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	5.92	46.45	710.52	4.21
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	3173.25	33.80	298.00	945.62

Table 2.6.1 SOUTHERN MACKEREL. Effort data by fleets.

	SPAIN					PORTUGAL
	TRAWL		HOOCK (HAND-LINE)		PURSE SEINE	TRAWL
	AVILES (Subdiv.VIIIc East) (HP*fishing days*10^-2)	LA CORUÑA (Subdiv.VIIIc West) (Av. HP*fishing days*10^-2)	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	ANUAL	ANUAL	MARCH to MAY	MARCH to MAY	ANUAL	ANUAL
1983	12568	33999	-	-	20	-
1984	10815	32427	-	-	700	-
1985	9856	30255	-	-	215	-
1986	10845	26540	-	-	157	-
1987	8309	23122	-	-	92	-
1988	9047	28119	-	-	374	55178
1989	8063	29628	-	605	153	52514
1990	8492	29578	322	509	161	49968
1991	7677	26959	209	724	66	44061
1992	12693	26199	70	698	286	74666
1993	7635	29670	151	1216	-	47822
1994	9620	39590	130	1926	392	38719
1995	6146	41452	217	1696	677	42090
1996	4525	35728	560	2007	777	43633
1997	4699	35211	736	2095	304	42043
1998	5929	-	754	3022	631	86020
1999	6829	30232	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	-

- Not available

Table 2.6.2 SOUTHERN MACKEREL. CPUE series in commercial fisheries.

	SPAIN					PORTUGAL
	TRAWL		HOOCK (HAND-LINE)		PURSE SEINE	TRAWL
	AVILES (Subdiv.VIIIc East) (Kg/HP*fishing days*10^-2)	LA CORUÑA (Subdiv.VIIIc West) (Kg/Av. HP*fishing days*10^-2)	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	ANUAL	ANUAL	MARCH to MAY	MARCH to MAY	ANUAL	ANUAL
1983	14.2	34.2	-	-	1.3	-
1984	24.1	40.1	-	-	5.6	-
1985	17.6	38.1	-	-	4.2	-
1986	41.1	34.2	-	-	5.0	-
1987	13.0	36.5	-	-	2.1	-
1988	15.9	48.0	-	-	3.7	36.4
1989	19.0	43.0	-	1427.5	2.1	26.8
1990	82.7	59.0	739.6	1924.4	2.7	39.2
1991	68.2	54.6	632.9	1394.4	2.0	39.9
1992	35.1	19.7	905.6	856.4	3.9	21.2
1993	12.8	19.2	613.3	1790.9	-	16.9
1994	57.2	41.4	2388.5	1590.6	1.1	20.9
1995	94.9	34.0	3136.1	1987.9	0.3	24.5
1996	124.5	29.1	1165.7	1508.9	0.8	23.8
1997	133.2	35.7	2137.9	1867.8	1.7	18.5
1998	142.1	-	2361.5	2128.0	3.3	15.4
1999	136.4	42.9	2438.0	2084.7	3.6	23.9
2000	311.6	65.1	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	-

- Not available

Table 2.6.3 SOUTHERN MACKEREL. 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

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

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	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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	28119	0	6095	584	625	594	167	239	444	195	53	12	8	21	26	0	7
1989	29628	462	482	719	345	289	541	231	355	444	117	63	24	22	22	6	15
1990	29578	27	4535	939	175	235	370	624	184	409	405	145	45	69	5	9	5
1991	26959	1	39	454	573	839	551	445	504	165	165	266	53	4	10	11	23
1992	26199	1	154	102	298	251	355	128	61	84	25	32	38	14	6	0	2
1993	29670	0	307	440	118	528	188	265	98	41	33	21	11	3	4	2	3
1994	39590	0	237	1531	1085	821	1156	575	264	63	40	17	6	1	1	1	0
1995	41452	735	249	400	624	324	251	381	376	402	175	116	104	44	17	19	20
1996	35728	54	5865	104	562	695	148	77	127	65	59	27	20	8	1	2	2
1997	35211	13	626	1347	531	1234	493	136	140	114	88	49	32	25	6	3	6
1998	-	3	6745	2965	2547	641	678	451	144	80	72	49	36	38	13	8	18
1999	30232	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

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 2.7.5.1. Area, time, length, weight and total biomass based on acoustic registrations 1999 – 2004

YEAR	DATES	AREA	AVERAGE LENGTH [CM]	AVERAGE WEIGHT [GR.]	BIOMASS [x10^3 TONN]
1999	12. Oct. – 22. Oct	Norwegian waters north of 59°N	34.9	358	828
2000	15. Oct – 5. Nov	North of 57°30’ N	32.8	286	541
2001	8. Oct. – 25. Oct.	North of 57°30’ N	36.3	418	409
2002	15. Oct – 3. Nov	North of 59°N partly with RV ”Scotia”	33.3	295	535
2003	16. Oct – 6. Nov	59-62°N; 1°W – 4°E partly with “Scotia”	33.0	296	581
2004	18. Oct – 8. Nov	59-62°N; 1^0 W – 4°E with RV “Scotia”	34.1	322	375

Table 2.8.2.1 Summary of the influence of bias in either catch or SSB index from the Egg survey on parameters in the assessment. For SSB and F estimated for the terminal year, historically (“1982”) and the trend (Terminal –“1982”), estimated by ICA with the use of the Egg Survey as either a relative or absolute measure of abundance.

		SOURCE OF BIAS			
		Catch Bias		Survey Bias	
ICA Assessment Method	Parameter Estimated	SSB	F	SSB	F
Absolute Fit	Terminal	Small Bias	Biased	Biased	Biased
	Historic	Biased	Small Bias	Small Bias	Small Bias
	Trend	Biased	Biased	Biased	Biased
Relative Fit	Terminal	Biased	Unbiased	Unbiased	Unbiased
	Historic	Biased	Small Bias	Unbiased	Unbiased
	Trend	Unbiased	Unbiased	Unbiased	Unbiased

Table 2.9.1.1 Input parameters of the final ICA assessments of NEA-Mackerel for the years 1999-2005.

Assessment year	2005	2004	2003	2002	2001	2000	1999
First data year	1972	1972	1972	1972	1984	1984	1984
Final data year	2004	2003	2002	2001	2000	1999	1998
No of years for separable constraint ?	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(1992-2004)	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
Age range in canum, weca, west, matprop	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
Proportion of F and M before spawning	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
First age for calculation of reference F	4	4	4	4	4	4	4
Last age for calculation of reference F	8	8	8	8	8	8	8
Shrink the final populations	No	No	No	No	No	No	No

Tuning indices

SSB from egg surveys Years	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	WG: absolute index ACFM: relative index	absolute index	absolute index	relative index: linear	relative index: linear	relative index: linear

Model weighting

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	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
Stock recruitment relationship fitted?	No	No	No	No	No	No	No
Parameters to be estimated	48	45 (abs.) or 46 (rel.)	43	41	40	38	36
Number of observations	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 WG2005

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	70.38	14.27
1	119.85	144.39	99.35	73.56	102.29	40.12	212.19	174.65
2	168.88	186.48	229.77	131.87	134.79	153.64	67.11	245.94
3	333.37	238.43	264.57	215.69	256.96	219.84	344.72	82.02
4	279.18	378.88	323.19	252.68	351.02	277.92	329.96	265.17
5	177.67	246.78	361.94	270.26	266.00	287.69	246.12	210.97
6	96.30	135.06	207.62	231.74	218.51	214.36	221.74	166.94
7	119.83	84.38	118.39	150.94	158.56	179.81	142.70	121.63
8	55.81	66.50	72.75	82.46	96.65	111.13	111.24	85.24
9	59.80	39.45	47.35	47.69	47.29	66.36	75.25	68.50
10	25.80	26.73	24.39	28.89	28.28	38.61	40.81	41.64
11	18.35	13.95	16.55	16.06	17.04	19.00	20.16	23.15
12	30.65	24.97	22.93	30.93	30.68	38.05	37.51	28.78

x 10 ^ 6

AGE	2004
0	5.09
1	23.94
2	402.51
3	475.21
4	133.88
5	228.87
6	128.79
7	77.86
8	56.69
9	34.51
10	29.74
11	14.03
12	16.61

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

Weights at age in the catches (Kg)

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

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	0.15900	0.17000
2	0.22600	0.23000	0.22700	0.23500	0.22800	0.22300	0.25500	0.26900
3	0.31300	0.29500	0.31000	0.30700	0.30700	0.30600	0.30700	0.33700
4	0.37700	0.35900	0.35400	0.36100	0.36600	0.37700	0.36800	0.38800
5	0.42500	0.41500	0.40800	0.40500	0.42900	0.42600	0.42600	0.44000
6	0.48400	0.45300	0.45200	0.45300	0.46600	0.47600	0.46300	0.47800
7	0.51800	0.48100	0.46200	0.50100	0.50400	0.49800	0.51400	0.52500
8	0.55100	0.52400	0.51800	0.53700	0.53600	0.54200	0.53900	0.57600
9	0.57600	0.55300	0.55000	0.56900	0.56900	0.57900	0.58200	0.61700
10	0.59600	0.57700	0.57300	0.58700	0.58700	0.60700	0.60300	0.63700
11	0.60300	0.59100	0.59100	0.60800	0.59600	0.61200	0.63100	0.65400
12	0.67000	0.63600	0.63100	0.68800	0.64700	0.66700	0.66800	0.72000

Table 2.9.1.3 (Cont'd)

Weights at age in the catches (Kg)

AGE	2004
0	0.08600
1	0.16000
2	0.26600
3	0.32600
4	0.40200
5	0.42300
6	0.49000
7	0.52500
8	0.56000
9	0.57700
10	0.60300
11	0.63800
12	0.69000

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

Weights at age in the stock (Kg)

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

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

Table 2.9.1.4 (Cont'd)

AGE	2004
0	0.00000
1	0.05900
2	0.13800
3	0.24600
4	0.31300
5	0.35500
6	0.41200
7	0.46300
8	0.46200
9	0.50800
10	0.52000
11	0.53800
12	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

Natural Mortality (per year)

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

Table 2.9.1.5 (cont'd)

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

Proportion of fish spawning

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

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

Table 2.9.1.6 (Cont'd)

Proportion of fish spawning

AGE	2004
0	0.0000
1	0.0700
2	0.5900
3	0.8800
4	0.9700
5	0.9700
6	0.9900
7	1.0000
8	1.0000
9	1.0000
10	1.0000
11	1.0000
12	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
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	0.00522	0.00373	0.00761	0.00775	0.01338	0.00637	0.01134	0.02316
1	0.00679	0.02662	0.02798	0.01926	0.07324	0.04484	0.04306	0.14832
2	0.02556	0.01701	0.03265	0.02858	0.09369	0.10822	0.18659	0.09776
3	0.05000	0.06556	0.04242	0.07117	0.14648	0.10946	0.20003	0.29936
4	0.08930	0.13582	0.11339	0.08976	0.19722	0.12292	0.18092	0.24928
5	0.00000	0.14584	0.18965	0.16788	0.13840	0.10225	0.20019	0.23166
6	0.00000	0.15835	0.16341	0.15522	0.18940	0.10809	0.15725	0.25652
7	0.00000	0.17639	0.22937	0.36099	0.34812	0.21078	0.13051	0.26409
8	0.00000	0.18152	0.23605	0.20896	0.27997	0.34635	0.21313	0.17367
9	0.00000	0.19866	0.25834	0.22870	0.18854	0.20568	0.31185	0.32225
10	0.00000	0.18840	0.24500	0.21689	0.17880	0.13209	0.31754	0.41498
11	0.00000	0.17500	0.22757	0.20146	0.16609	0.12270	0.24023	0.45248
12	0.00000	0.17500	0.22757	0.20146	0.16609	0.12270	0.24023	0.45248

AGE	1980	1981	1982	1983	1984	1985	1986	1987
0	0.00628	0.00829	0.00575	0.00487	0.04259	0.02630	0.01556	0.00157
1	0.10280	0.06298	0.03719	0.02915	0.02498	0.04848	0.02224	0.01473
2	0.22592	0.16665	0.12587	0.14786	0.06368	0.01944	0.09546	0.07300
3	0.13053	0.19089	0.22066	0.16968	0.20918	0.05319	0.04279	0.20040
4	0.24651	0.08599	0.21630	0.25687	0.21305	0.19410	0.08690	0.07793
5	0.24441	0.20217	0.08817	0.21360	0.26041	0.19791	0.22741	0.13076
6	0.18970	0.24766	0.21772	0.08490	0.24124	0.25754	0.23524	0.22224
7	0.22211	0.21988	0.23810	0.20255	0.11952	0.22517	0.30176	0.25234
8	0.23280	0.28679	0.24868	0.22323	0.19708	0.13997	0.22350	0.32629
9	0.18618	0.25994	0.31830	0.19619	0.21487	0.21653	0.12871	0.27141
10	0.27284	0.30840	0.26229	0.27686	0.21556	0.24647	0.21522	0.26322
11	0.39782	0.34054	0.30573	0.28719	0.25694	0.22445	0.22117	0.24719
12	0.39782	0.34054	0.30573	0.28719	0.25694	0.22445	0.22117	0.24719

AGE	1988	1989	1990	1991	1992	1993	1994	1995
0	0.01749	0.01656	0.00809	0.00295	0.00901	0.01119	0.01150	0.01181
1	0.03833	0.02312	0.04257	0.02302	0.03108	0.03858	0.03964	0.04071
2	0.06092	0.09753	0.09284	0.07944	0.06718	0.08340	0.08569	0.08800
3	0.11303	0.11659	0.16982	0.11783	0.13154	0.16331	0.16781	0.17231
4	0.23463	0.13050	0.15539	0.21871	0.20363	0.25280	0.25977	0.26675
5	0.12904	0.23175	0.16418	0.19469	0.24538	0.30463	0.31303	0.32144
6	0.17335	0.11305	0.23867	0.18724	0.26644	0.33078	0.33989	0.34903
7	0.27117	0.15828	0.12951	0.27953	0.29679	0.36845	0.37860	0.38878
8	0.31616	0.22366	0.18673	0.21400	0.30542	0.37917	0.38962	0.40009
9	0.34507	0.27548	0.25306	0.23350	0.33427	0.41498	0.42642	0.43787
10	0.24297	0.32302	0.19674	0.32452	0.31700	0.39355	0.40440	0.41526
11	0.26724	0.24147	0.25901	0.25777	0.29446	0.36556	0.37563	0.38573
12	0.26724	0.24147	0.25901	0.25777	0.29446	0.36556	0.37563	0.38573

Fishing Mortality (per year)

AGE	1996	1997	1998	1999	2000	2001	2002	2003
0	0.00861	0.00829	0.00955	0.00930	0.01014	0.01153	0.01303	0.01175
1	0.02970	0.02857	0.03293	0.03208	0.03498	0.03974	0.04494	0.04053
2	0.06421	0.06176	0.07120	0.06934	0.07561	0.08591	0.09716	0.08761
3	0.12573	0.12094	0.13941	0.13578	0.14806	0.16822	0.19025	0.17156
4	0.19464	0.18722	0.21582	0.21019	0.22920	0.26041	0.29451	0.26557
5	0.23454	0.22561	0.26006	0.25329	0.27619	0.31380	0.35490	0.32003
6	0.25467	0.24498	0.28239	0.27503	0.29990	0.34073	0.38536	0.34749
7	0.28368	0.27288	0.31455	0.30635	0.33405	0.37954	0.42924	0.38707
8	0.29193	0.28082	0.32370	0.31526	0.34377	0.39058	0.44174	0.39833
9	0.31950	0.30734	0.35427	0.34503	0.37624	0.42747	0.48345	0.43595
10	0.30300	0.29147	0.33597	0.32722	0.35681	0.40539	0.45849	0.41344
11	0.28145	0.27073	0.31208	0.30394	0.33143	0.37656	0.42588	0.38403
12	0.28145	0.27073	0.31208	0.30394	0.33143	0.37656	0.42588	0.38403

Table 2.9.1.8 Cont'd

AGE	2004
0	0.01007
1	0.03472
2	0.07506
3	0.14698
4	0.22753
5	0.27418
6	0.29771
7	0.33161
8	0.34126
9	0.37349
10	0.35420
11	0.32901
12	0.32901

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	2214.2	4917.9	4157.5	5045.1	5063.9	1030.4	3305.0	5384.5
1	5566.5	1895.8	4217.2	3551.2	4308.8	4300.6	881.3	2812.6
2	2203.3	4758.7	1588.9	3529.6	2998.3	3446.7	3539.2	726.5
3	4290.9	1848.5	4026.8	1323.7	2952.4	2349.8	2662.4	2527.7
4	8196.4	3513.1	1490.1	3321.9	1061.0	2194.9	1812.8	1876.1
5	0.0	6452.0	2639.8	1145.0	2613.7	749.8	1670.6	1302.1
6	0.0	0.0	4799.7	1879.6	833.2	1958.9	582.6	1177.1
7	0.0	0.0	0.0	3508.3	1385.2	593.4	1513.3	428.5
8	0.0	0.0	0.0	0.0	2104.7	841.7	413.7	1143.1
9	0.0	0.0	0.0	0.0	0.0	1369.1	512.4	287.7
10	0.0	0.0	0.0	0.0	0.0	0.0	959.4	322.9
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	601.1
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

x 10 ^ 6

Population Abundance (1 January)

AGE	1980	1981	1982	1983	1984	1985	1986	1987
0	5693.0	7390.0	2098.1	1624.9	7416.1	3392.9	3486.6	5085.1
1	4528.4	4869.3	6308.1	1795.5	1391.8	6117.0	2844.5	2954.6
2	2087.1	3516.9	3935.3	5231.2	1501.0	1168.4	5015.8	2394.4
3	567.1	1433.1	2562.3	2986.5	3883.7	1212.2	986.3	3924.1
4	1612.8	428.4	1019.2	1768.7	2169.3	2711.8	989.3	813.3
5	1258.5	1084.9	338.3	706.6	1177.5	1508.9	1922.3	780.6
6	889.0	848.3	762.8	266.6	491.2	781.1	1065.5	1318.0
7	783.9	632.9	570.0	528.1	210.8	332.2	519.7	724.9
8	283.2	540.3	437.2	386.6	371.2	161.0	228.2	330.8
9	827.1	193.1	349.1	293.5	266.2	262.4	120.5	157.1
10	179.4	590.9	128.2	218.6	207.6	184.8	181.8	91.2
11	183.5	117.6	373.6	84.9	142.6	144.0	124.3	126.2
12	342.6	741.7	635.8	567.6	327.7	521.6	439.2	309.5

x 10 ^ 6

AGE	1988	1989	1990	1991	1992	1993	1994	1995
0	3578.9	4287.5	3239.5	3658.7	4421.5	5083.3	4481.6	3886.9
1	4369.9	3026.9	3629.7	2765.8	3139.8	3771.5	4326.6	3813.2
2	2505.9	3619.8	2545.8	2993.9	2326.3	2619.7	3123.3	3579.2
3	1915.8	2029.3	2826.1	1996.9	2380.1	1872.2	2074.4	2467.5
4	2764.2	1472.7	1554.4	2052.5	1527.7	1796.1	1368.6	1509.6
5	647.6	1881.6	1112.5	1145.4	1419.6	1072.6	1200.6	908.5
6	589.5	489.9	1284.5	812.6	811.4	956.0	680.8	755.6
7	908.3	426.7	376.6	870.8	580.0	535.0	591.1	417.1
8	484.7	596.1	313.5	284.7	566.8	371.0	318.6	348.4
9	205.4	304.1	410.3	223.9	197.9	359.4	218.5	185.7
10	103.1	125.2	198.7	274.2	152.6	121.9	204.3	122.8
11	60.3	69.6	78.0	140.5	170.6	95.6	70.8	117.3
12	263.1	179.2	131.3	250.3	286.9	238.8	197.0	133.1

x 10 ^ 6

AGE	1996	1997	1998	1999	2000	2001	2002	2003
0	3963.1	3194.1	3034.6	3389.6	1266.0	5600.2	8330.8	921.2
1	3306.2	3381.8	2726.5	2587.0	2890.5	1078.6	4764.9	7077.5
2	3151.2	2762.4	2828.8	2270.7	2156.4	2402.3	892.2	3920.9
3	2821.1	2543.6	2235.2	2267.4	1823.5	1720.9	1897.5	696.8
4	1787.6	2141.3	1939.9	1673.5	1703.8	1353.5	1251.8	1350.2
5	995.1	1266.5	1528.3	1345.5	1167.3	1166.1	897.9	802.6
6	567.0	677.4	869.9	1014.2	899.0	762.3	733.4	541.9
7	458.7	378.3	456.4	564.5	663.0	573.3	466.6	429.3
8	243.4	297.3	247.8	286.8	357.7	408.6	337.6	261.5
9	201.0	156.4	193.3	154.3	180.1	218.3	238.0	186.8
10	103.2	125.7	99.0	116.7	94.1	106.4	122.5	126.3
11	69.8	65.6	80.8	60.9	72.4	56.7	61.1	66.7
12	134.1	113.0	91.8	126.6	116.6	130.0	115.9	96.7

x 10 ^ 6

Table 2.9.1.9 (cont'd)

Population Abundance (1 January)

AGE	2004	2005
0	(547.1)	3232.9
1	783.6	466.2
2	5849.7	651.5
3	3091.7	4670.8
4	505.2	2297.3
5	891.1	346.4
6	501.6	583.1
7	329.5	320.6
8	250.9	203.6
9	151.1	153.5
10	104.0	89.5
11	71.9	62.8
12	63.5	83.9

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	0.2454	6	0.2181	0.2761	0.2311	0.2606	0.2458
2	1993	0.3046	5	0.2717	0.3415	0.2874	0.3229	0.3052
3	1994	0.3130	5	0.2793	0.3508	0.2954	0.3318	0.3136
4	1995	0.3214	5	0.2867	0.3604	0.3032	0.3407	0.3220
5	1996	0.2345	5	0.2086	0.2637	0.2209	0.2490	0.2350
6	1997	0.2256	5	0.2007	0.2536	0.2125	0.2395	0.2260
7	1998	0.2601	5	0.2314	0.2923	0.2450	0.2760	0.2605
8	1999	0.2533	6	0.2250	0.2851	0.2385	0.2690	0.2537
9	2000	0.2762	6	0.2447	0.3117	0.2597	0.2938	0.2767
10	2001	0.3138	6	0.2760	0.3568	0.2939	0.3350	0.3145
11	2002	0.3549	7	0.3074	0.4098	0.3298	0.3819	0.3559
12	2003	0.3200	8	0.2705	0.3786	0.2937	0.3487	0.3212
13	2004	0.2742	10	0.2242	0.3353	0.2474	0.3038	0.2756
Separable Model: Selection (S) by age								
14	0	0.0367	39	0.0169	0.0798	0.0247	0.0546	0.0397
15	1	0.1266	12	0.0982	0.1634	0.1112	0.1442	0.1277
16	2	0.2738	5	0.2446	0.3063	0.2585	0.2899	0.2742
17	3	0.5361	5	0.4804	0.5982	0.5069	0.5669	0.5369
18	4	0.8299	5	0.7457	0.9235	0.7858	0.8764	0.8311
	5	1.0000	Fixed : Reference Age					
19	6	1.0858	5	0.9809	1.2020	1.0310	1.1436	1.0873
20	7	1.2095	4	1.0972	1.3333	1.1508	1.2711	1.2110
21	8	1.2447	4	1.1343	1.3659	1.1871	1.3051	1.2461
22	9	1.3622	4	1.2464	1.4888	1.3019	1.4254	1.3636
23	10	1.2919	4	1.1793	1.4152	1.2332	1.3534	1.2933
	11	1.2000	Fixed : Last true age					
Separable model: Populations in year 2004								
24	0	547104	142	33564	8917946	131705	2272673	1508137
25	1	783647	43	332287	1848106	505842	1214020	862439
26	2	5849743	13	4494867	7613016	5113982	6691358	5902830
27	3	3091677	10	2531200	3776259	2791733	3423847	3107818
28	4	505222	10	411892	619699	455227	560708	507973
29	5	891108	9	739943	1073154	810477	979760	895124
30	6	501609	9	416947	603461	456461	551222	503845
31	7	329520	9	274028	396250	299931	362028	330982
32	8	250936	9	207698	303176	227855	276355	252107
33	9	151104	9	124291	183700	136770	166939	151856
34	10	103974	10	84461	127993	93513	115605	104560
35	11	71902	11	57549	89835	64181	80553	72368
Separable model: Populations at age								
36	1992	170579	14	128195	226976	147446	197341	172400
37	1993	95629	10	77084	118636	85669	106748	96209
38	1994	70794	9	58636	85473	64305	77938	71122
39	1995	117344	8	98611	139635	107380	128233	117807
40	1996	69778	8	59079	82413	64097	75961	70030
41	1997	65587	7	56135	76632	60581	71007	65794
42	1998	80823	7	69395	94134	74775	87361	81068
43	1999	60905	7	52421	70761	56417	65749	61083
44	2000	72421	7	62412	84035	67129	78131	72630
45	2001	56670	7	48726	65909	52467	61209	56839
46	2002	61062	8	51892	71854	56197	66349	61273
47	2003	66680	9	55153	80617	60526	73460	66994
SSB Index catchabilities								
INDEX1								
Linear model fitted. Slopes at age :								
48	1 Q	1.360	3	1.309	1.531	1.360	1.473	1.417

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	0.165	-0.998	-0.629	-1.055	0.184	0.386	0.825	0.832
1	-0.066	-0.034	-0.059	-0.550	0.288	0.490	0.191	-0.031
2	0.107	0.076	-0.074	0.196	-0.076	0.193	0.240	-0.070
3	0.267	0.016	0.029	-0.066	0.073	-0.122	-0.022	-0.216
4	0.017	0.064	-0.087	-0.180	-0.053	0.107	-0.081	-0.156
5	0.062	-0.072	0.002	-0.220	-0.087	0.035	0.104	-0.037
6	-0.125	0.017	0.011	-0.048	-0.210	-0.015	0.040	0.020
7	-0.198	-0.026	0.088	0.127	0.127	0.002	0.031	0.083
8	-0.004	-0.111	0.101	0.056	-0.029	-0.020	0.130	0.131
9	-0.024	0.063	0.122	0.118	0.154	0.022	-0.127	0.127
10	-0.054	0.047	-0.096	0.086	0.026	-0.102	-0.077	-0.050
11	0.010	0.062	-0.013	0.080	0.140	-0.038	-0.199	0.077

Age	2000	2001	2002	2003	2004
0	1.119	-0.828	-0.353	0.356	0.000
1	0.103	0.027	0.087	-0.402	-0.037
2	-0.080	-0.179	-0.135	-0.218	0.023
3	0.096	-0.120	0.119	-0.220	0.190
4	0.077	-0.039	0.103	-0.101	0.335
5	0.013	-0.018	-0.016	0.029	0.139
6	0.006	0.043	0.013	0.118	0.067
7	-0.102	0.062	-0.063	-0.056	-0.108
8	-0.004	-0.104	-0.012	0.061	-0.177
9	-0.108	-0.066	-0.125	0.106	-0.241
10	0.071	0.154	-0.031	0.042	0.028
11	-0.112	0.135	0.019	0.154	-0.292

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	*******	*******	*******	*******	-0.0667	*******	*******	-0.1279

	1996	1997	1998	1999	2000	2001	2002	2003
1	*******	*******	0.1935	*******	*******	-0.0174	*******	*******

	2004
1	0.0185

Table 2.9.1.10 (Cont'd)

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1992 to 2004	
Variance	0.0166
Skewness test stat.	-0.3964
Kurtosis test statistic	0.2864
Partial chi-square	0.1579
Significance in fit	0.0000
Degrees of freedom	**

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR INDEX1

Linear catchability relationship assumed

Variance	0.0736
Skewness test stat.	0.6932
Kurtosis test statistic	-0.2579
Partial chi-square	0.0197
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	8.8529	161	48	113	0.0783
Catches at age	8.7940	156	47	109	0.0807
SSB Indices					
INDEX1	0.0589	5	1	4	0.0147

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	3.2826	161	48	113	0.0290
Catches at age	1.8106	156	47	109	0.0166
SSB Indices					
INDEX1	1.4720	5	1	4	0.3680

Table 2.9.1.11 North East Atlantic Mackerel. Stock summary table

STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 4- 8	SoP (%)
1972	2214190	-------	-------	361204	------	------	99
1973	4917930	-------	-------	571011	------	------	100
1974	4157450	-------	-------	607632	------	------	100
1975	5045080	-------	-------	784070	------	------	99
1976	5063890	-------	-------	828239	------	------	99
1977	1030430	-------	-------	620276	0.1878	0.1781	100
1978	3305030	-------	-------	736832	0.2258	0.1764	100
1979	5384530	-------	-------	843227	0.3001	0.2350	100
1980	5693010	3453588	2360014	734951	0.3114	0.2271	100
1981	7389980	3606679	2412983	754438	0.3127	0.2085	100
1982	2098100	3518494	2313701	717267	0.3100	0.2018	100
1983	1624940	3605035	2577775	671588	0.2605	0.1962	99
1984	7416130	3345083	2569129	637606	0.2482	0.2063	99
1985	3392910	3555031	2541515	614371	0.2417	0.2029	100
1986	3486560	3516232	2520085	602200	0.2390	0.2150	99
1987	5085070	3350224	2485588	654991	0.2635	0.2019	99
1988	3578850	3416765	2490994	680492	0.2732	0.2249	100
1989	4287500	3470115	2543570	589509	0.2318	0.1714	100
1990	3239450	3225480	2386333	627511	0.2630	0.1749	100
1991	3658660	3525763	2649140	667886	0.2521	0.2188	98
1992	4421530	3613352	2648794	760351	0.2871	0.2635	99
1993	5083330	3507041	2469074	825036	0.3341	0.3272	100
1994	4481570	3317095	2259500	821395	0.3635	0.3362	100
1995	3886850	3450937	2373142	755776	0.3185	0.3452	99
1996	3963120	3195037	2322321	563612	0.2427	0.2519	100
1997	3194090	3274259	2368840	569613	0.2405	0.2423	99
1998	3034550	3110266	2272310	666682	0.2934	0.2793	100
1999	3389630	3176933	2324013	615512	0.2648	0.2720	100
2000	1265970	2970883	2151289	675479	0.3140	0.2966	100
2001	5600150	2904633	2169653	687173	0.3167	0.3370	99
2002	8330800	2644598	1779544	726935	0.4085	0.3812	99
2003	921230	2980098	1821410	617330	0.3389	0.3437	99
2004	(547100)	2770691	1984940	611461	0.3081	0.2945	100

No of years for separable analysis : 13
Age range in the analysis : 0 . . . 12
Year range in the analysis : 1972 . . . 2004
Number of indices of SSB : 1
Number of age-structured indices : 0

Parameters to estimate : 48
Number of observations : 161

Conventional single selection vector model to be fitted.

Table 2.10.1 North East Atlantic Mackerel. Prediction: INPUT DATA

2005 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	1.01E-02	0.073
1	3128800	0.15	0.07	0.4	0.4	7.03E-02	3.47E-02	0.163
2	651480	0.15	0.59	0.4	0.4	0.166667	7.51E-02	0.263333
3	4670800	0.15	0.88	0.4	0.4	0.252667	0.14698	0.323333
4	2297300	0.15	0.97	0.4	0.4	0.313333	0.227525	0.386
5	346360	0.15	0.97	0.4	0.4	0.363333	0.27418	0.429667
6	583060	0.15	0.99	0.4	0.4	0.423	0.297709	0.477
7	320570	0.15	1	0.4	0.4	0.448333	0.331612	0.521333
8	203570	0.15	1	0.4	0.4	0.466333	0.341264	0.558333
9	153540	0.15	1	0.4	0.4	0.530667	0.373491	0.592
10	89522	0.15	1	0.4	0.4	0.523	0.354205	0.614333
11	62799	0.15	1	0.4	0.4	0.556667	0.329012	0.641
12	83887	0.15	1	0.4	0.4	0.588333	0.329012	0.692667

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	3672928	0.15	0	0.4	0.4	0	1.01E-02	0.073
1	.	0.15	0.07	0.4	0.4	7.03E-02	3.47E-02	0.163
2	.	0.15	0.59	0.4	0.4	0.166667	7.51E-02	0.263333
3	.	0.15	0.88	0.4	0.4	0.252667	0.14698	0.323333
4	.	0.15	0.97	0.4	0.4	0.313333	0.227525	0.386
5	.	0.15	0.97	0.4	0.4	0.363333	0.27418	0.429667
6	.	0.15	0.99	0.4	0.4	0.423	0.297709	0.477
7	.	0.15	1	0.4	0.4	0.448333	0.331612	0.521333
8	.	0.15	1	0.4	0.4	0.466333	0.341264	0.558333
9	.	0.15	1	0.4	0.4	0.530667	0.373491	0.592
10	.	0.15	1	0.4	0.4	0.523	0.354205	0.614333
11	.	0.15	1	0.4	0.4	0.556667	0.329012	0.641
12	.	0.15	1	0.4	0.4	0.588333	0.329012	0.692667

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	1.01E-02	0.073
1	.	0.15	0.07	0.4	0.4	7.03E-02	3.47E-02	0.163
2	.	0.15	0.59	0.4	0.4	0.166667	7.51E-02	0.263333
3	.	0.15	0.88	0.4	0.4	0.252667	0.14698	0.323333
4	.	0.15	0.97	0.4	0.4	0.313333	0.227525	0.386
5	.	0.15	0.97	0.4	0.4	0.363333	0.27418	0.429667
6	.	0.15	0.99	0.4	0.4	0.423	0.297709	0.477
7	.	0.15	1	0.4	0.4	0.448333	0.331612	0.521333
8	.	0.15	1	0.4	0.4	0.466333	0.341264	0.558333
9	.	0.15	1	0.4	0.4	0.530667	0.373491	0.592
10	.	0.15	1	0.4	0.4	0.523	0.354205	0.614333
11	.	0.15	1	0.4	0.4	0.556667	0.329012	0.641
12	.	0.15	1	0.4	0.4	0.588333	0.329012	0.692667

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 433000 t in 2005, and F= F management target = 0.17 for 2006, 2007

Year:	2005	F multiplier:	0.6599	Fbar:	0.19				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST	SSB(ST)
0	0.0066	22593	1649	3672928	0	0	0	0	0
1	0.0229	65858	10735	3129700	220122	219079	15409	204438	14379
2	0.0495	29255	7704	651480	108580	384373	64062	354887	59148
3	0.097	401444	129800	4670800	1180155	4110304	1038537	3723624	940836
4	0.1502	297994	115026	2297300	719821	2228381	698226	1976274	619233
5	0.1809	53357	22926	346360	125844	335969	122069	294312	106934
6	0.1965	96816	46181	583060	246634	577229	244168	502528	212569
7	0.2188	58671	30587	320570	143722	320570	143722	276597	124008
8	0.2252	38228	21344	203570	94931	203570	94931	175199	81701
9	0.2465	31243	18496	153540	81479	153540	81479	131022	69529
10	0.2338	17379	10676	89522	46820	89522	46820	76783	40157
11	0.2171	11413	7316	62799	34958	62799	34958	54222	30184
12	0.2171	15245	10560	83887	49354	83887	49354	72430	42613
Total		1139497	433000	16265516	3052421	8769224	2633734	7842318	2341290

Year:	2006	F multiplier:	0.577	Fbar:	0.17				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST	SSB(ST)
0	0.0058	19762	1443	3672928	0	0	0	0	0
1	0.02	57858	9431	3140379	220873	219827	15461	205372	14445
2	0.0433	103677	27302	2632734	438789	1553313	258885	1437731	239622
3	0.0848	40335	13042	533635	134832	469599	118652	427501	108015
4	0.1313	417521	161163	3648557	1143214	3539100	1108918	3162490	990913
5	0.1582	231668	99540	1701619	618255	1650570	599707	1459130	530150
6	0.1718	36540	17430	248772	105230	246284	104178	216540	91596
7	0.1913	66840	34846	412328	184860	412328	184860	359704	161267
8	0.1969	36885	20594	221684	103379	221684	103379	192962	89984
9	0.2155	25250	14948	139881	74230	139881	74230	120855	64134
10	0.2044	17774	10919	103283	54017	103283	54017	89633	46878
11	0.1898	9816	6292	60991	33952	60991	33952	53239	29636
12	0.1898	16354	11328	101612	59782	101612	59782	88697	52183
Total		1080279	428276	16618402	3171414	8718472	2716022	7813853	2418825

Year:	2007	F multiplier:	0.577	Fbar:	0.17				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST	SSB(ST)
0	0.0058	19762	1443	3672928	0	0	0	0	0
1	0.02	57906	9439	3143003	221058	220010	15474	205544	14457
2	0.0433	104331	27474	2649336	441556	1563108	260518	1446798	241133
3	0.0848	164020	53033	2169971	548279	1909574	482486	1738387	439232
4	0.1313	48286	18639	421958	132213	409299	128247	365744	114600
5	0.1582	374943	161101	2753986	1000615	2671367	970597	2361530	858022
6	0.1718	183645	87599	1250293	528874	1237790	523585	1088300	460351
7	0.1913	29231	15239	180324	80845	180324	80845	157310	70527
8	0.1969	48765	27227	293089	136677	293089	136677	255115	118969
9	0.2155	28286	16746	156702	83156	156702	83156	135388	71846
10	0.2044	16702	10261	97056	50760	97056	50760	84229	44052
11	0.1898	11663	7476	72465	40339	72465	40339	63254	35212
12	0.1898	18630	12905	115755	68102	115755	68102	101042	59446
Total		1106171	448579	16976867	3332476	8926540	2840788	8002640	2527847

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 433kt in 2004**

2005				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
3052421	2341290	0.6599	0.1943	433000

2006					2007		% Change in 2006 landings
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**	
3171414	2557853	0	0	0	3707357	3015931	-100%
.	2545465	0.05	0.0147	39549	3672694	2969479	-91%
.	2533143	0.1	0.0294	78616	3638462	2923865	-82%
.	2520887	0.15	0.0442	117207	3604655	2879073	-73%
.	2508695	0.2	0.0589	155329	3571268	2835087	-64%
.	2496568	0.25	0.0736	192987	3538296	2791891	-55%
.	2484505	0.3	0.0883	230188	3505731	2749471	-47%
.	2472506	0.35	0.1031	266938	3473570	2707812	-38%
.	2460571	0.4	0.1178	303243	3441806	2666898	-30%
.	2448699	0.45	0.1325	339109	3410434	2626716	-22%
.	2436890	0.5	0.1472	374542	3379449	2587251	-14%
.	2425143	0.55	0.162	409549	3348846	2548490	-5%
.	2413458	0.6	0.1767	444133	3318618	2510419	3%
.	2401835	0.65	0.1914	478302	3288763	2473025	10%
.	2390274	0.7	0.2061	512060	3259273	2436295	18%
.	2378773	0.75	0.2208	545414	3230145	2400216	26%
.	2367334	0.8	0.2356	578368	3201373	2364775	34%
.	2355954	0.85	0.2503	610929	3172953	2329962	41%
.	2344635	0.9	0.265	643100	3144880	2295763	49%
.	2333376	0.95	0.2797	674888	3117149	2262167	56%
.	2322176	1	0.2945	706297	3089756	2229162	63%
.	2311035	1.05	0.3092	737333	3062696	2196738	70%
.	2299953	1.1	0.3239	768000	3035965	2164882	77%
.	2288929	1.15	0.3386	798304	3009558	2133585	84%
.	2277964	1.2	0.3533	828249	2983471	2102836	91%
.	2267056	1.25	0.3681	857839	2957699	2072624	98%
.	2256206	1.3	0.3828	887081	2932239	2042939	105%
.	2245413	1.35	0.3975	915977	2907086	2013771	112%
.	2234676	1.4	0.4122	944534	2882237	1985110	118%
.	2223997	1.45	0.427	972755	2857686	1956948	125%
.	2213373	1.5	0.4417	1000644	2833430	1929273	131%
.	2202805	1.55	0.4564	1028207	2809466	1902078	137%
.	2192293	1.6	0.4711	1055447	2785789	1875352	144%
.	2181836	1.65	0.4859	1082369	2762395	1849088	150%
.	2171435	1.7	0.5006	1108976	2739281	1823276	156%
.	2161087	1.75	0.5153	1135274	2716443	1797909	162%
.	2150795	1.8	0.53	1161266	2693877	1772977	168%
.	2140556	1.85	0.5447	1186956	2671579	1748472	174%
.	2130371	1.9	0.5595	1212348	2649547	1724387	180%
.	2120239	1.95	0.5742	1237446	2627777	1700714	186%
.	2110161	2	0.5889	1262254	2606264	1677445	192%

Input units are thousands and kg - output in tonnes

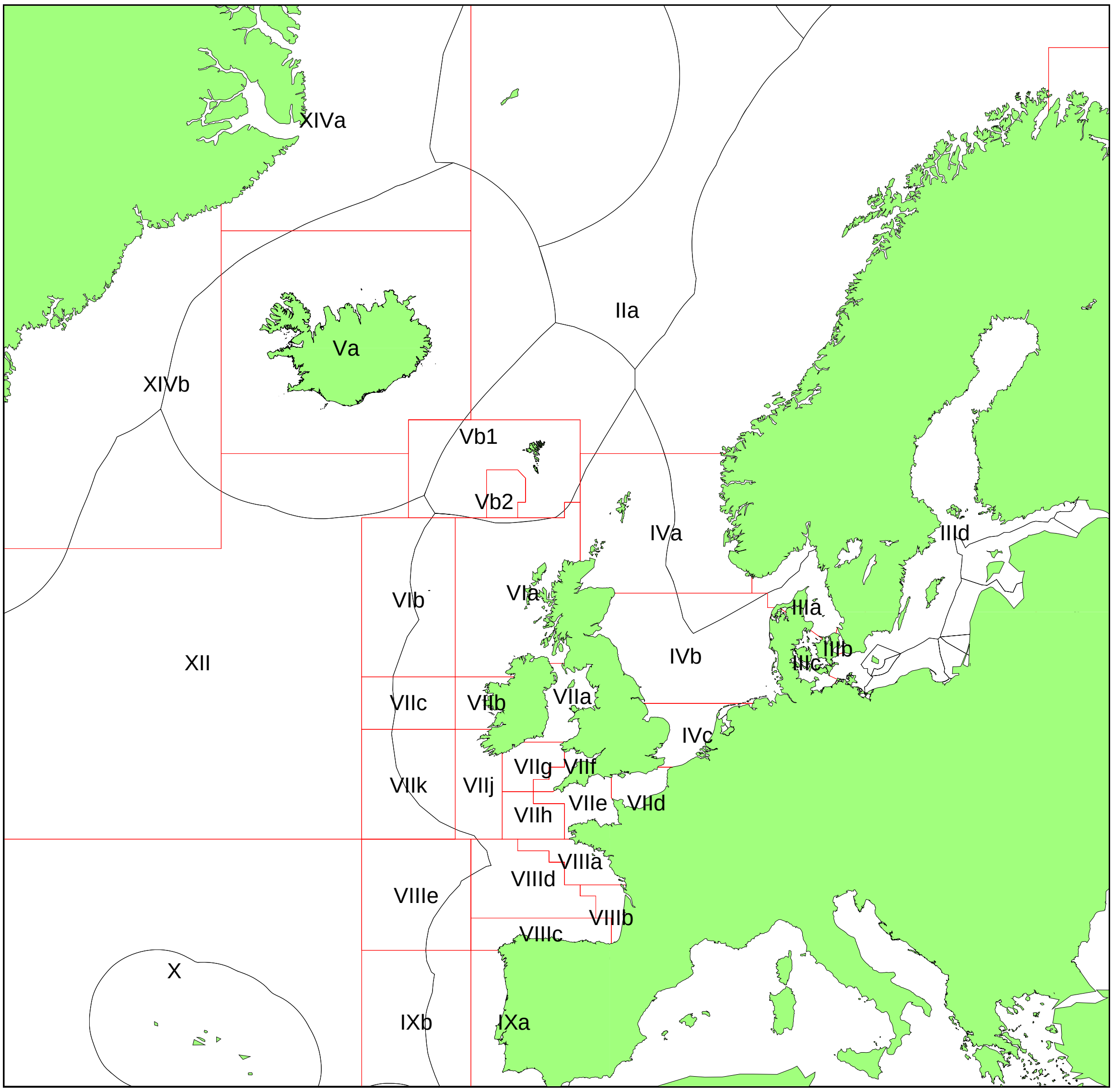


Figure 2.1.1. **Map of approximate national zones and ICES Divisions and Subareas. Note that EU region is considered as one zone in this map.**

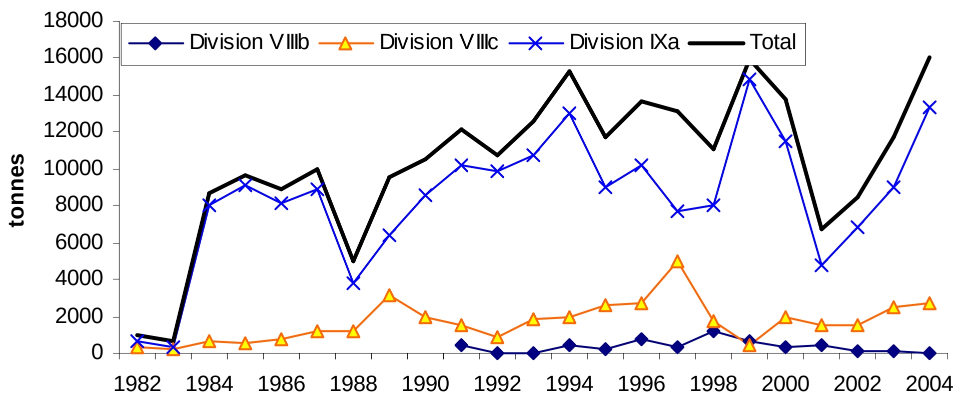


Figure 2.2.4.1 Annual landings of Scomber japonicus by ICES divisions since 1982 to 2004.

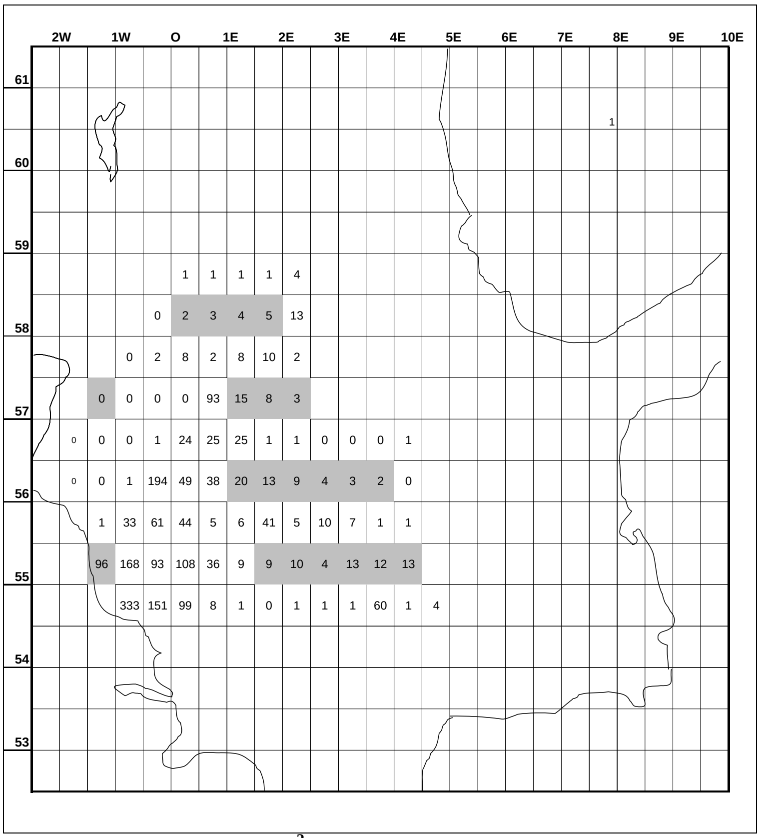


Figure 2.5.4.1 Daily egg production/m^2 during coverage 1 (shadowed rectangles = interpolated values)

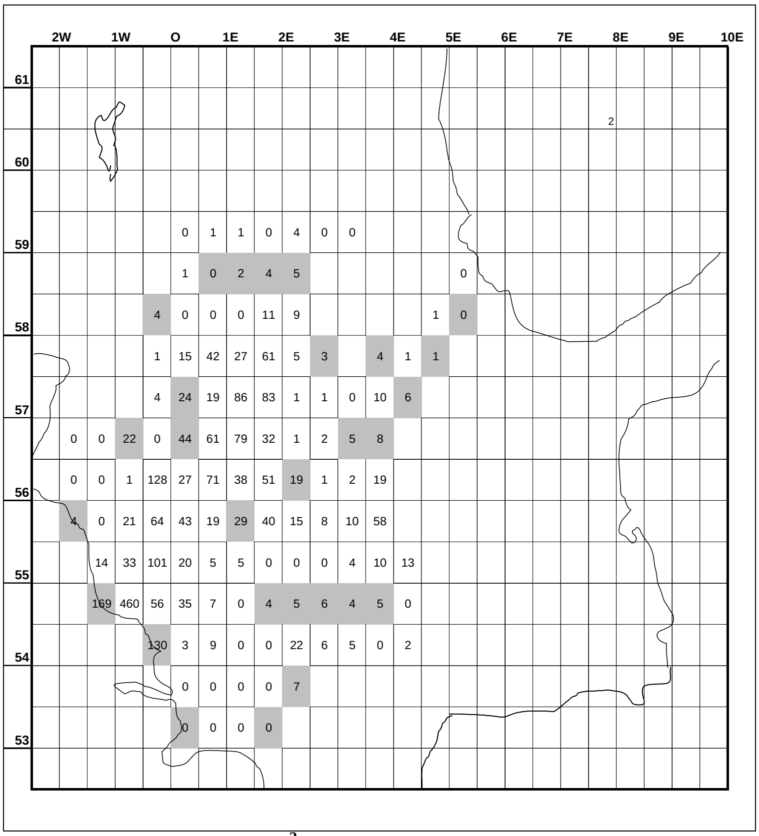


Figure 2.5.4.2 Daily egg production/m^2 during coverage 2 (shadowed rectangles = interpolated values)

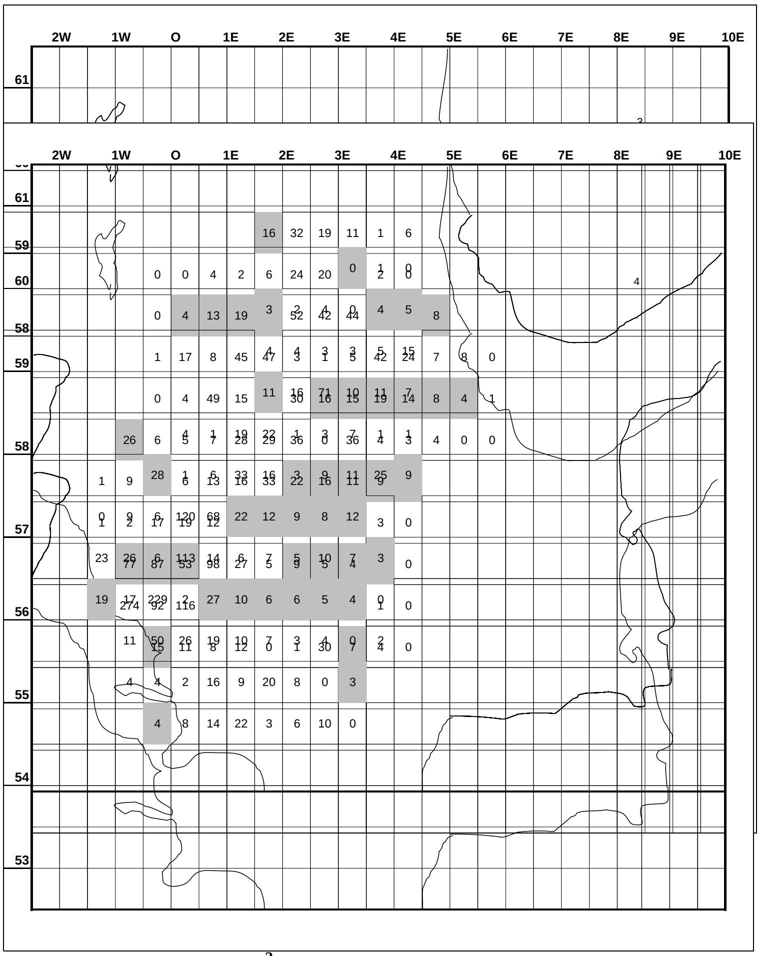


Figure 2.5.4.3 Daily egg production/m^2 during coverage 3 (shadowed rectangles = interpolated values)

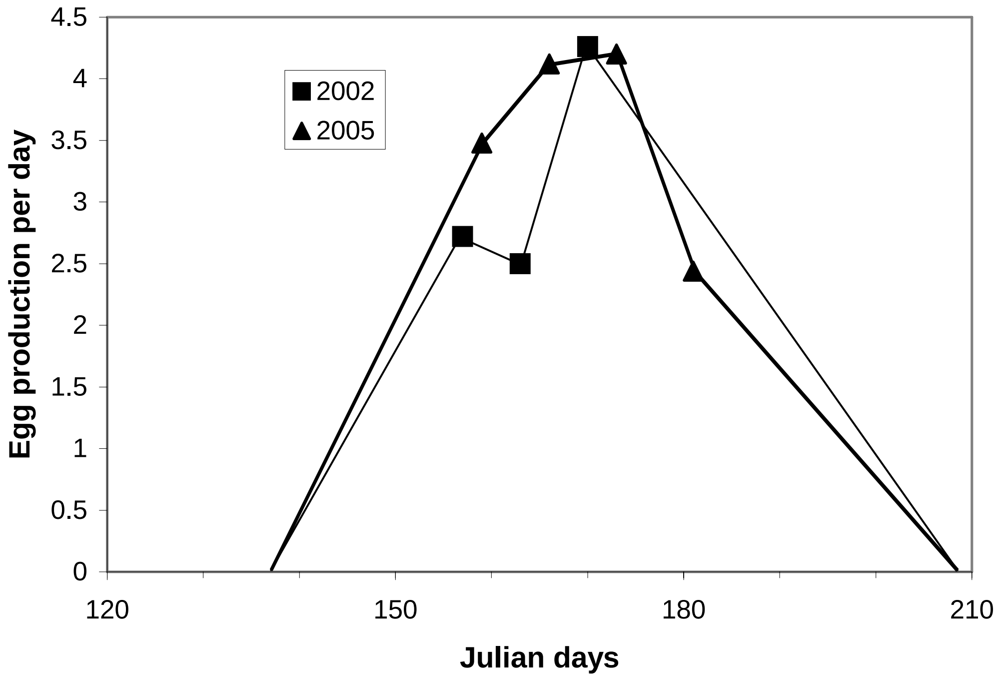


Figure 2.5.2.4 Daily egg production/m^2 during coverage 4 (shadowed rectangles = interpolated values)

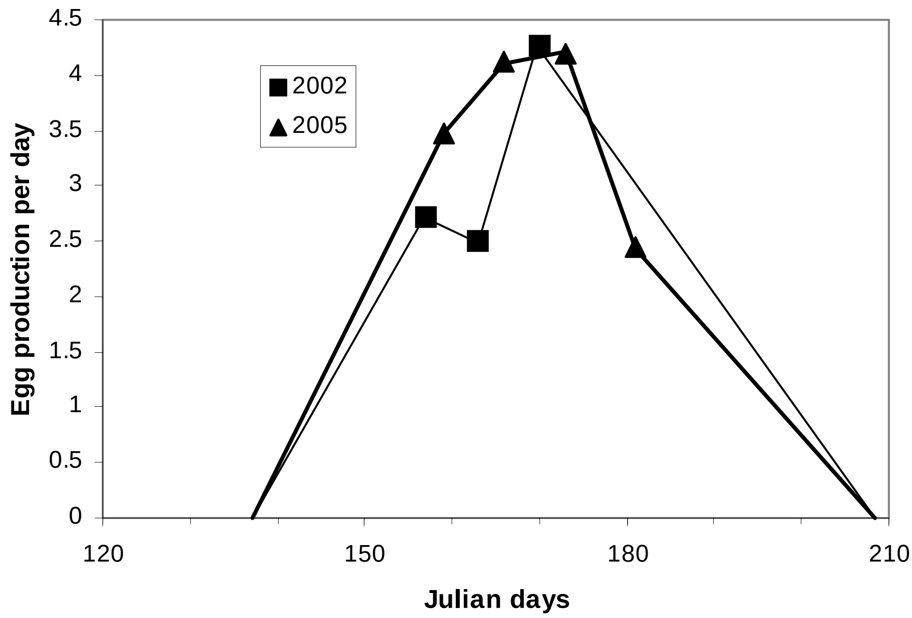


Figure 2.5.4.5 Egg production curve for North Sea mackerel in 2005 and 2002.

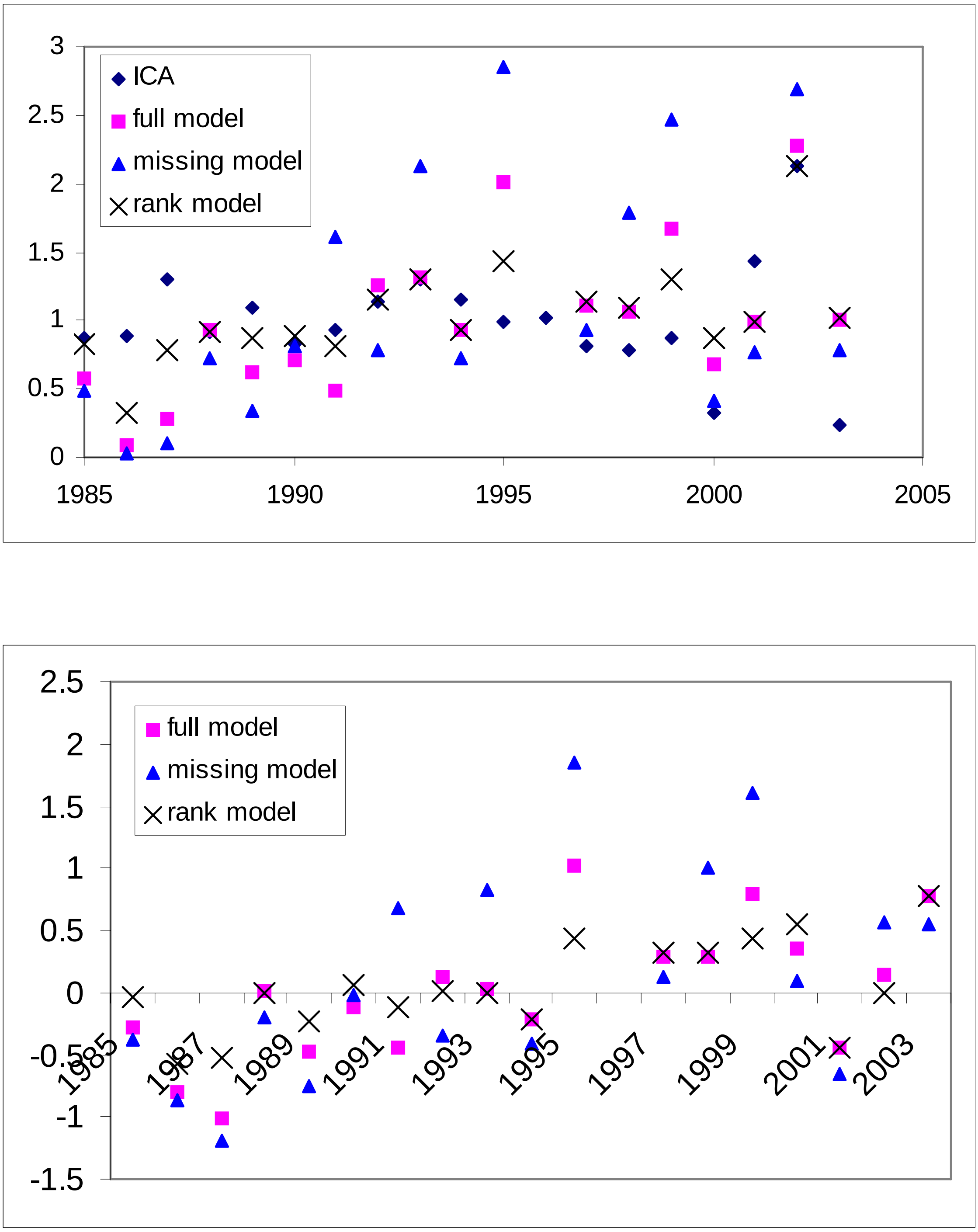


Figure 2.5.6.1 NE Atlantic mackerel O group recruitment estimated from composite model quarter 4 bottom trawl survey a) upper panel three data treatments (full model, missing data model and full model through ranked correlation) compared with ICA recruitment, b) lower panel residuals around ICA recruitment for three data treatments.

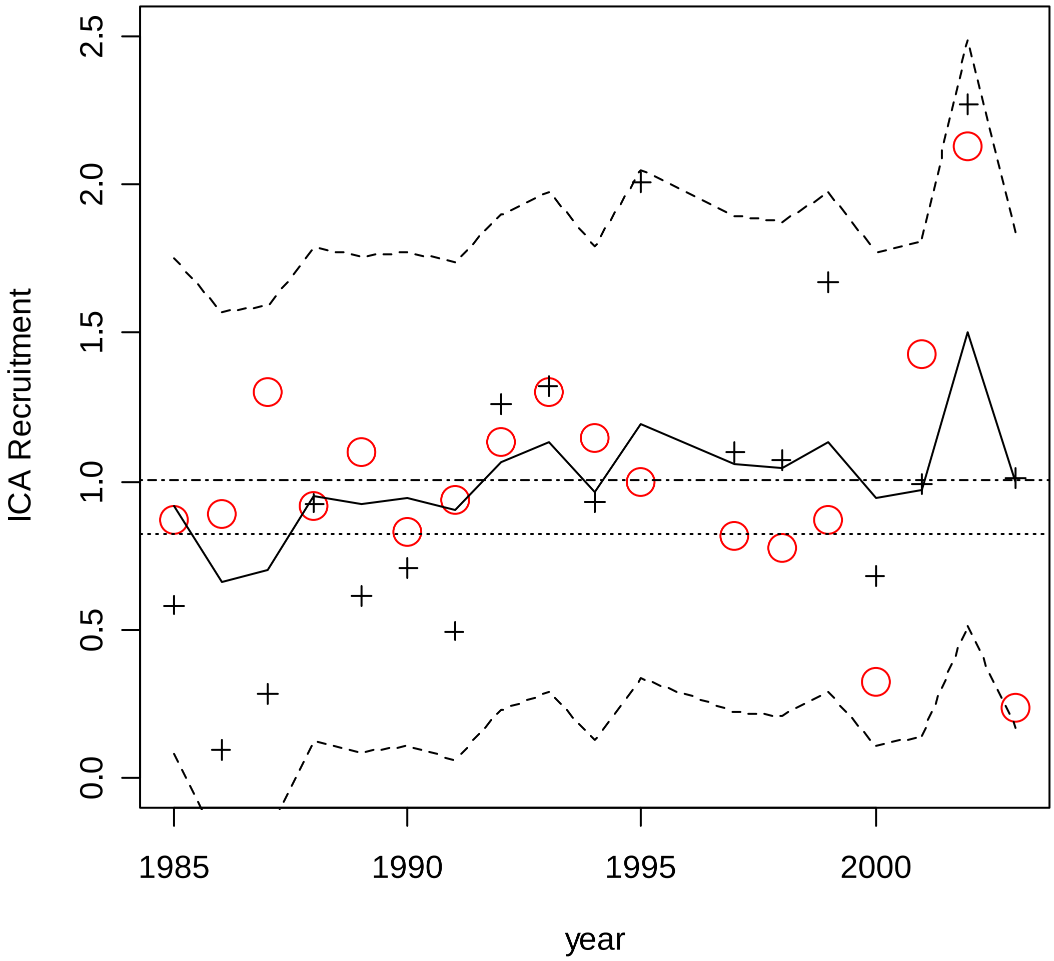


Figure 2.5.6.2 NE Atlantic mackerel predictions of O group recruitment by year (1985 to 2003) from a composite index from quarter 4 surveys (+), a rank model (solid line) with prediction intervals (dashed lines). These can be compared with ICA estimates (O), recent ICA estimates 2002 and 2003 are uncertain. Arithmetic mean (dashed) and geometric mean (dotted) values which is currently used for estimates of 0 group recruitment are shown as horizontal lines.

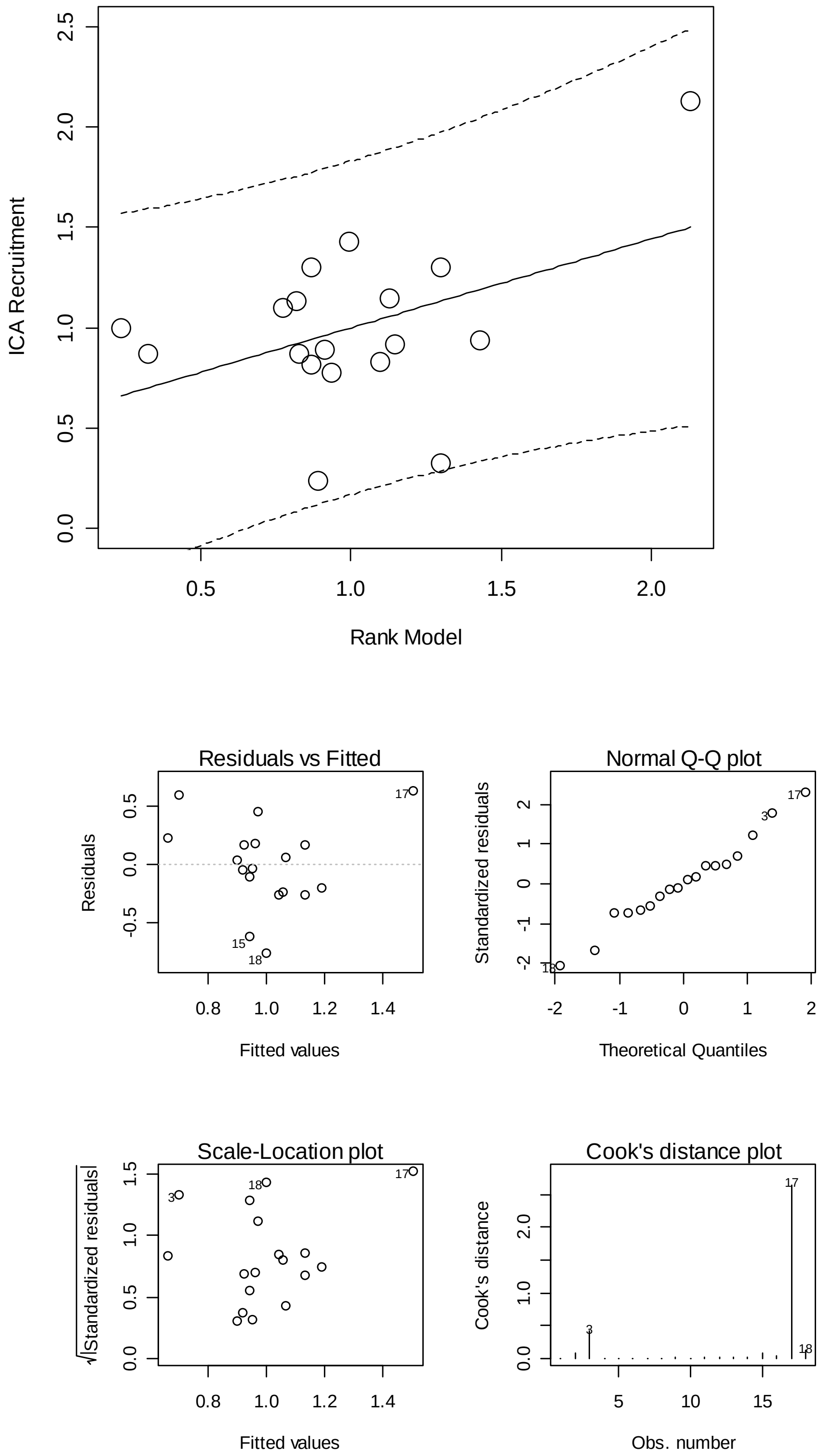


Figure 2.5.6.3 NE Atlantic Mackerel O group recruitment rank model a) the model fit with prediction intervals and b) model diagnostics

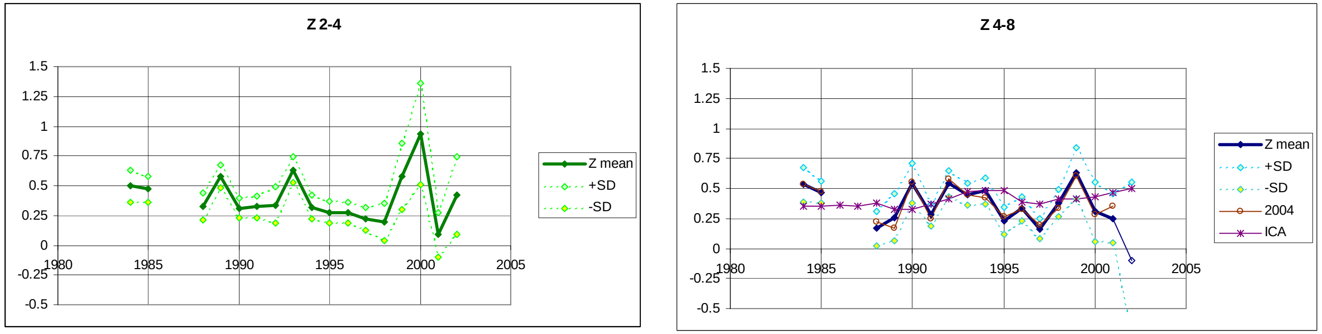


Figure 2.5.7.1 Mortality estimates (mean and SD) from bootstapped tag return data, assuming Poisson distribution of number of tags at age by recapture and release year. The estimate for 2002 cannot be regarded as reliable. Z4-8 as estimated in 2004 and as estimated in 2004 by ICA assuming egg surveys as relative measures of SSB are included for comparison. Taken from WD26

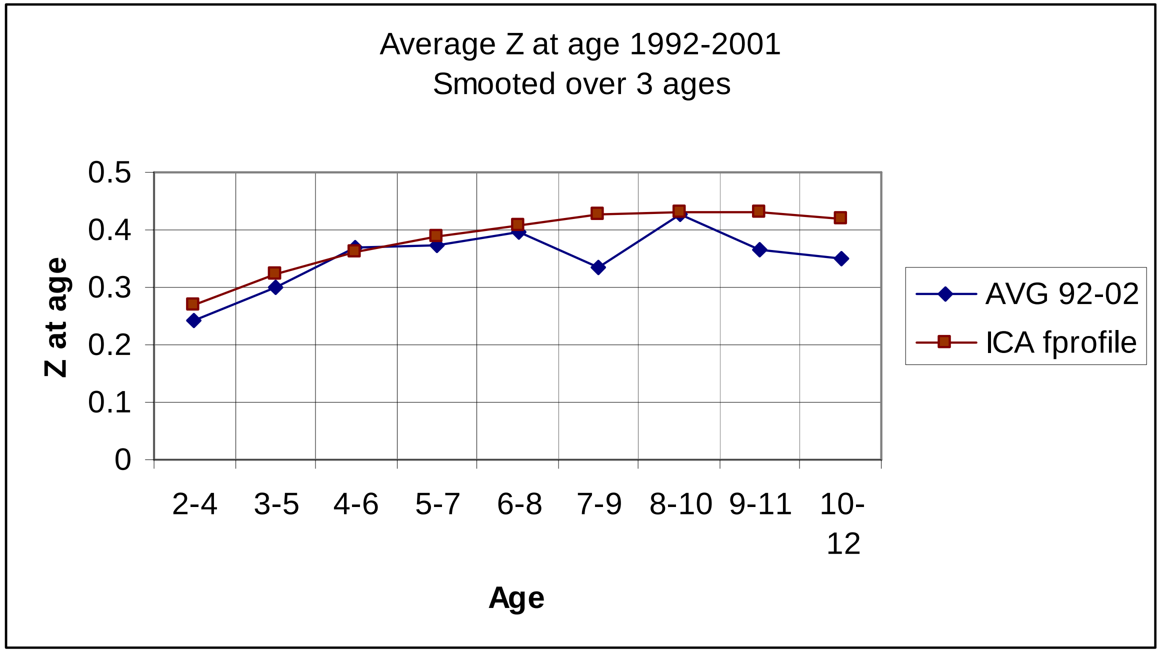


Figure 2.5.7.2 Overall age profile of Z from the tagging material. Comparable values if Z form the ICA in 2004, assuming egg survey as relative is included for comparison. Taken from WD26

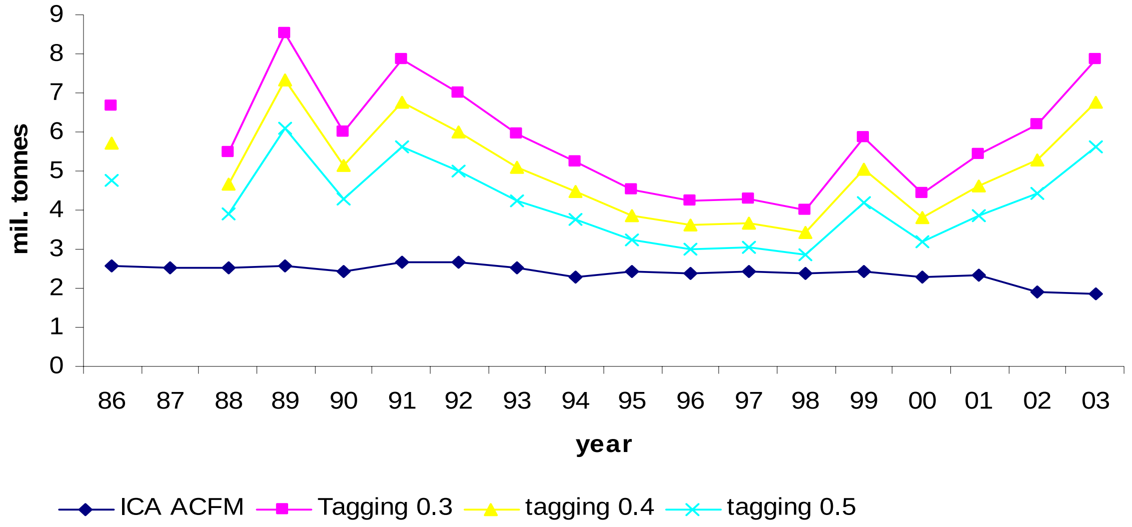
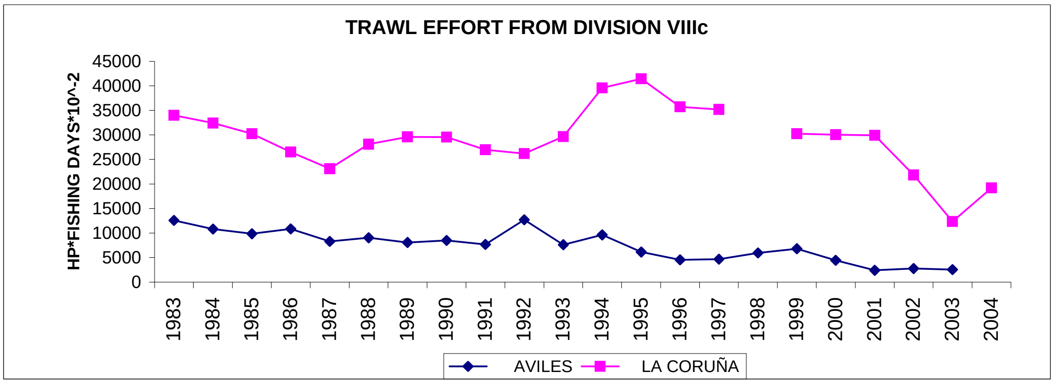
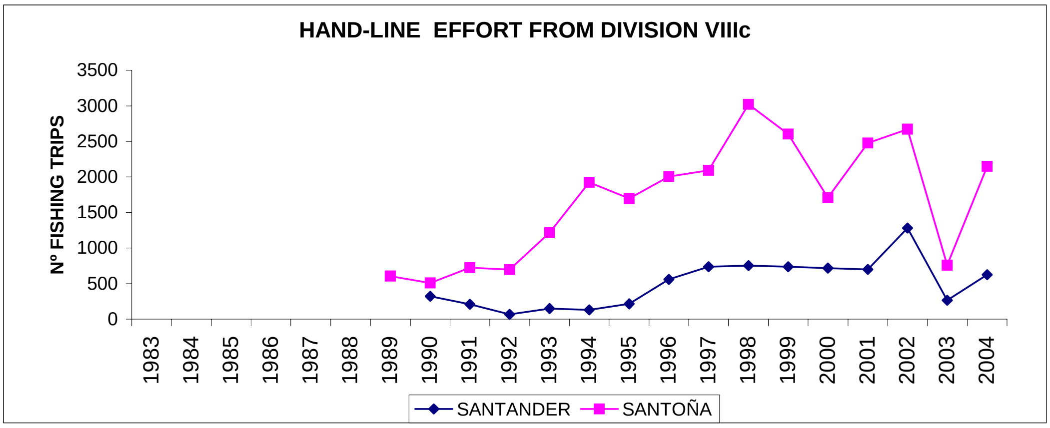
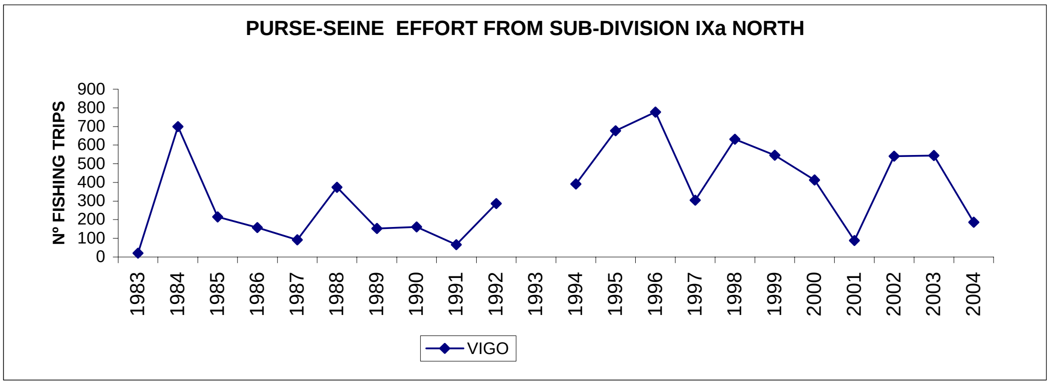


Figure 2.5.8.1 Spawning stock biomass estimated from the tagging study. Each line represents one assumption about tagging mortality. The spawning stock biomass estimate from the ICA assessment in 2004 is included for comparison.







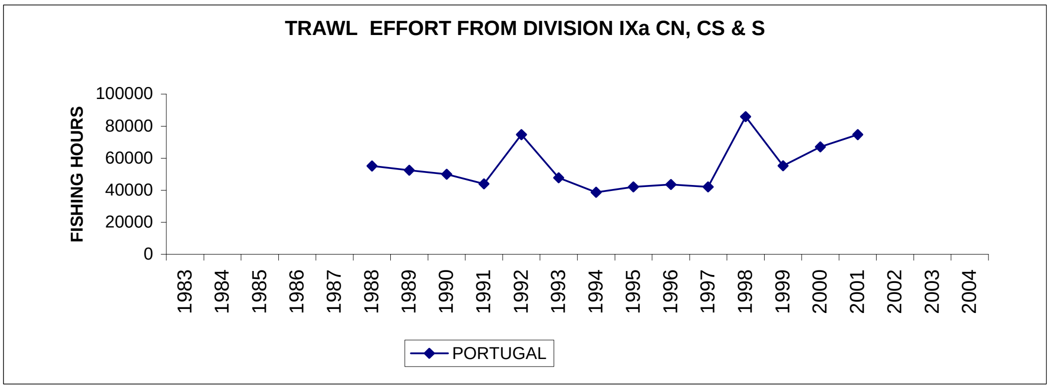


Figure 2.6.1. SOUTHERN MACKEREL. Effort data by fleets and area .

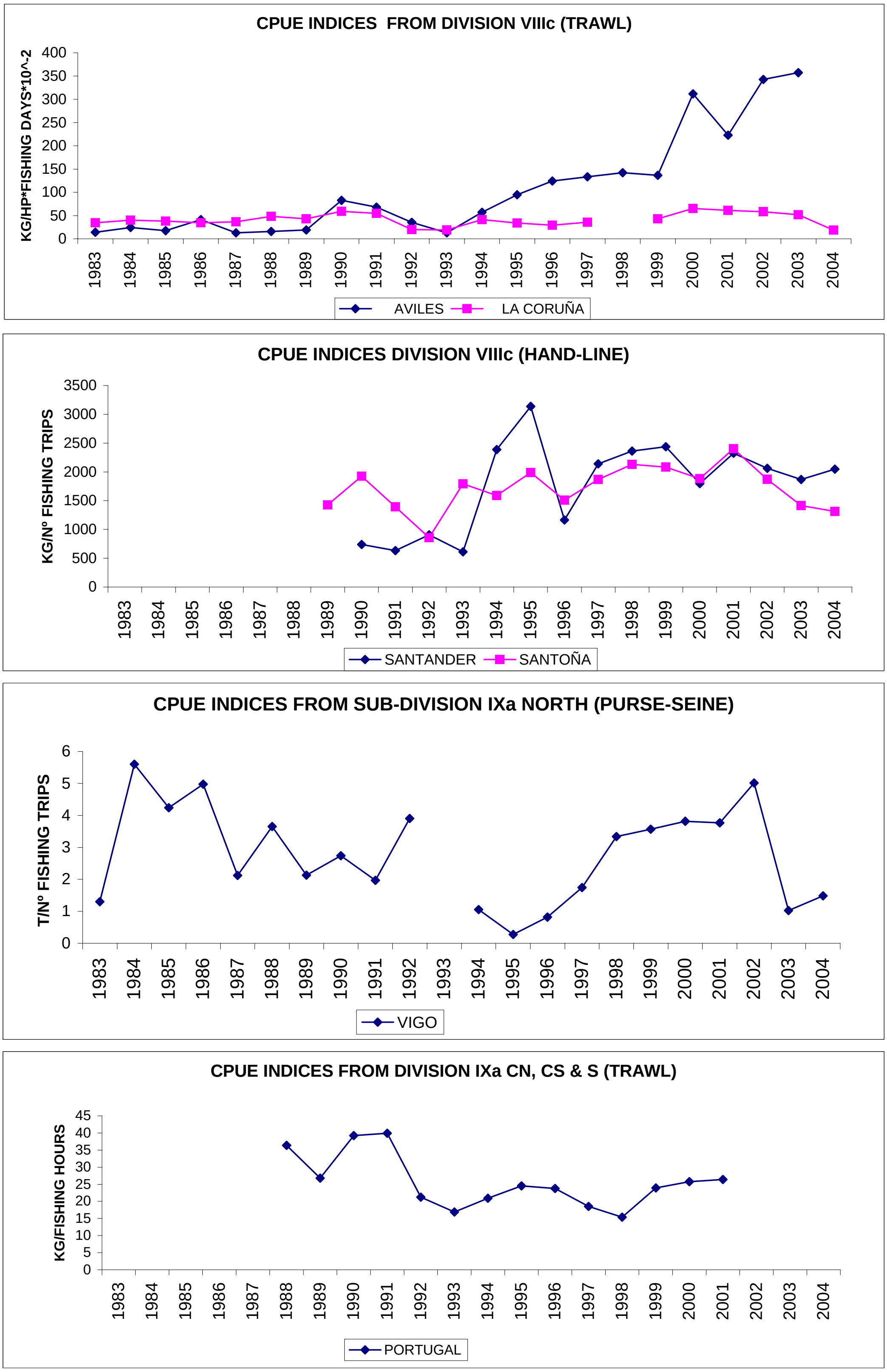


Figure 2.6.2. SOUTHERN MACKEREL. CPUE indices by fleets and area

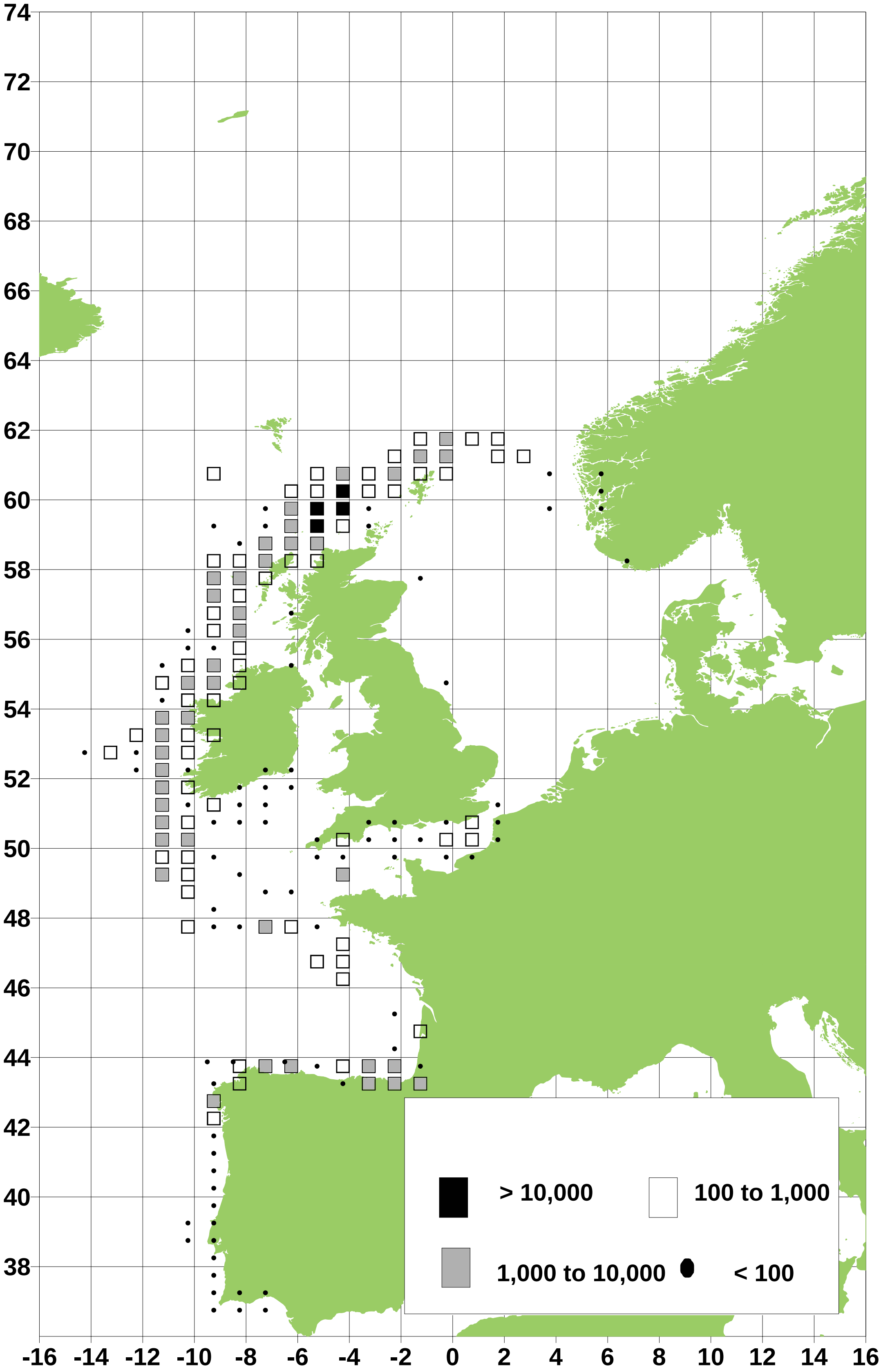


Figure 2.7.1.1 Mackerel commercial catches in quarter 1 2004.

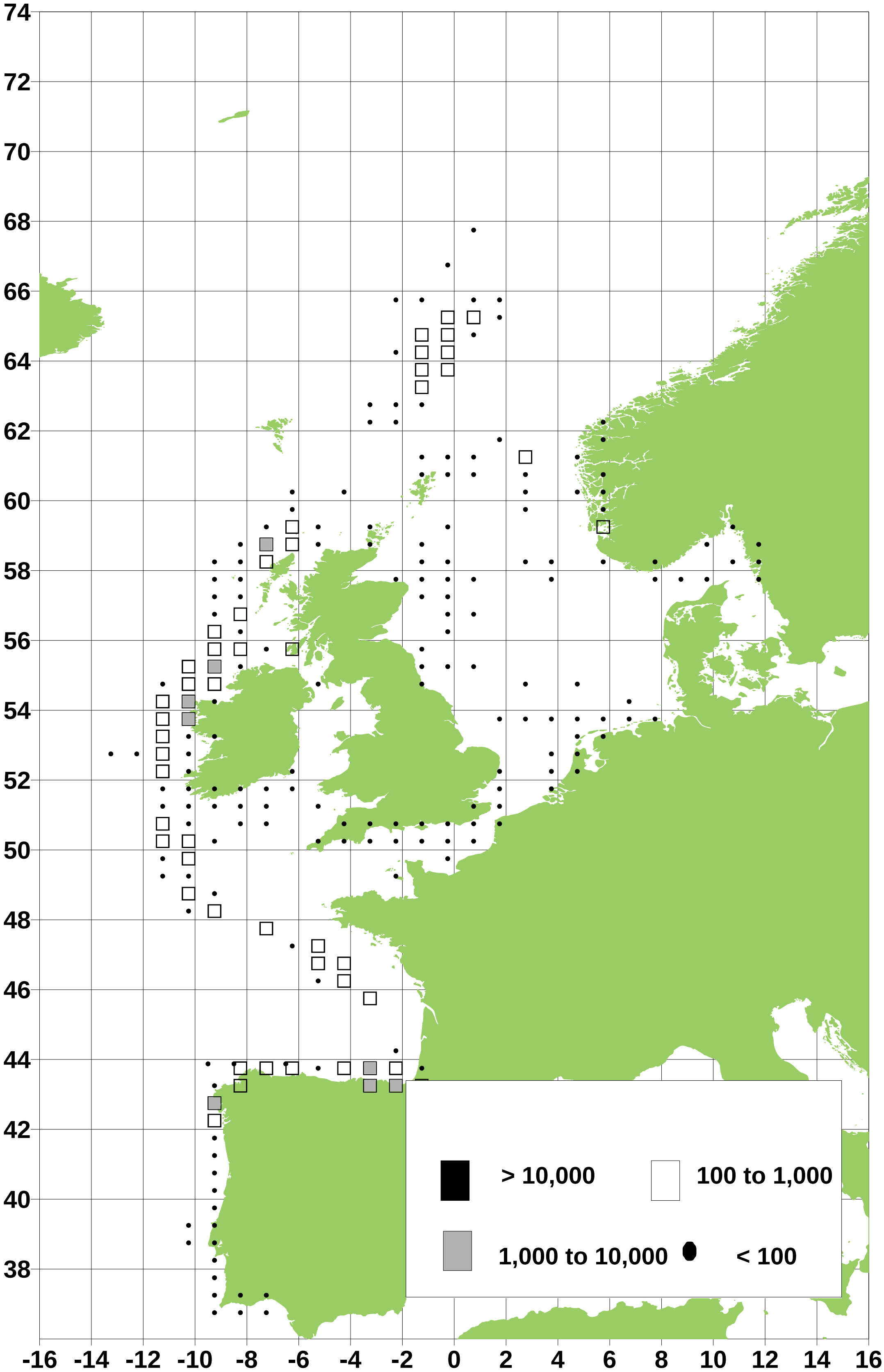


Figure 2.7.1.2 Mackerel commercial catches in quarter 2 2004.

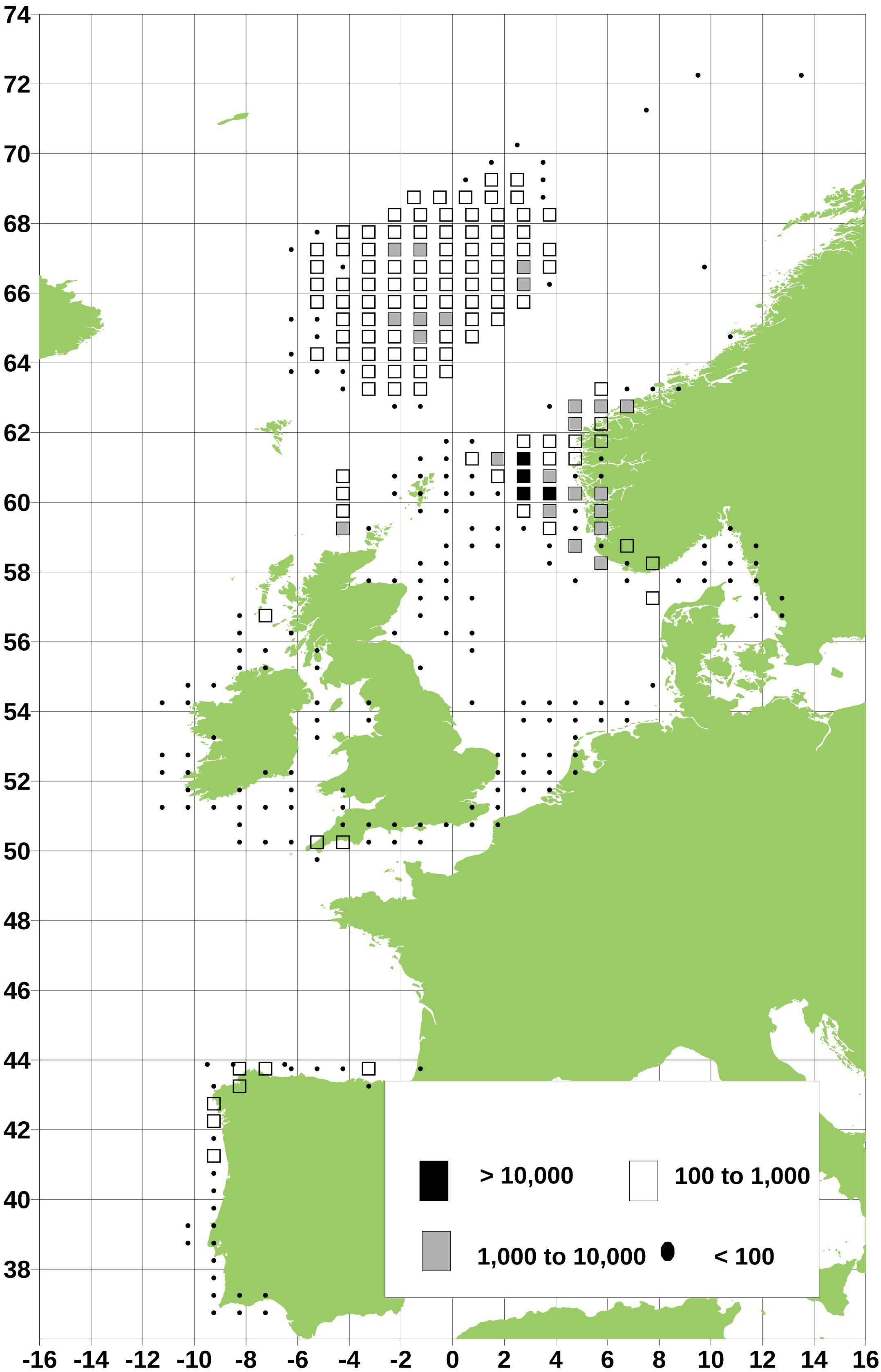


Figure 2.7.1.3 Mackerel commercial catches in quarter 3 2004.

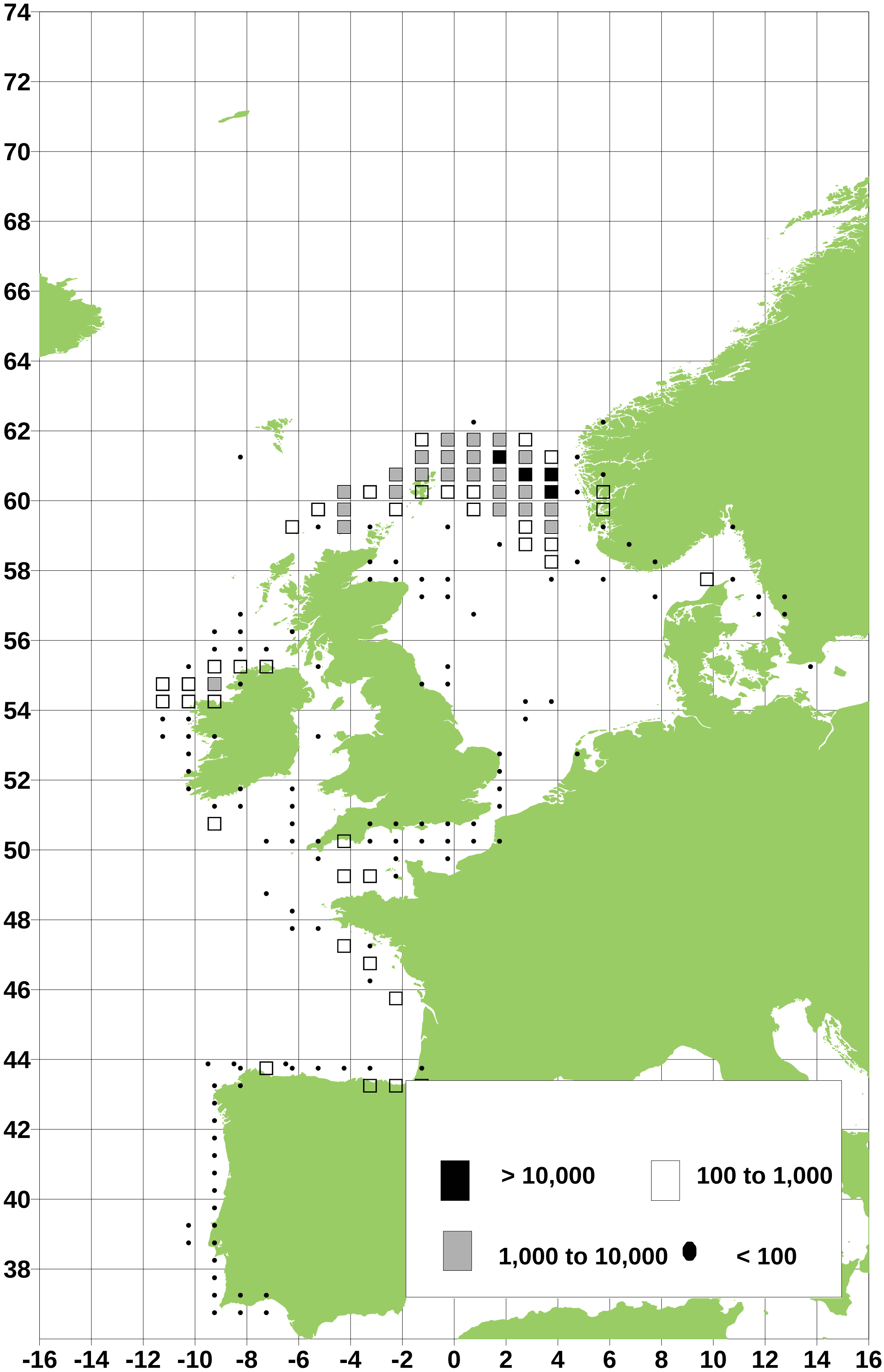


Figure 2.7.1.4 Mackerel commercial catches in quarter 4 2004.

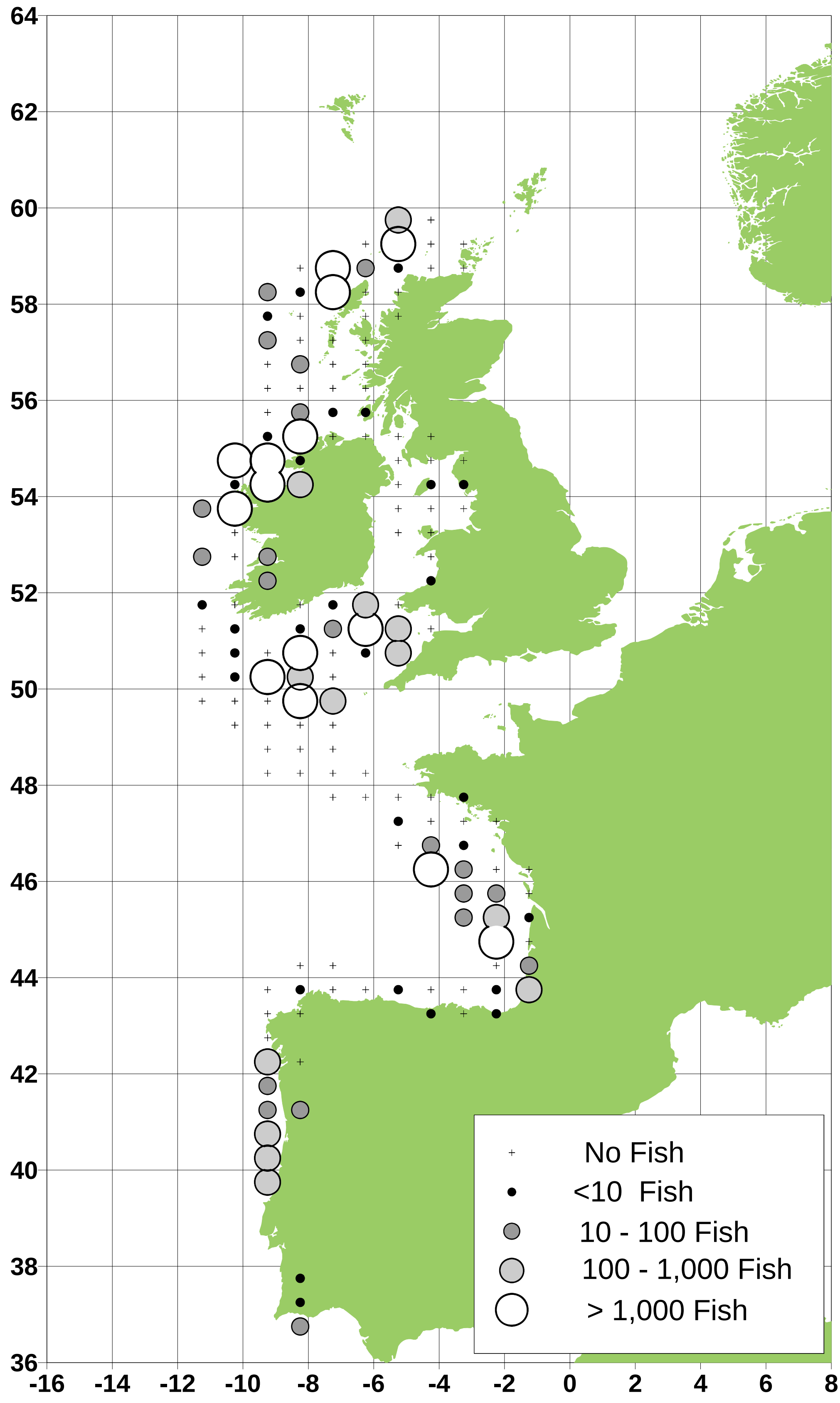


Figure 2.7.2.1. Distribution of mackerel recruits, 2004 year class age 0 in quarter 4, 2004.

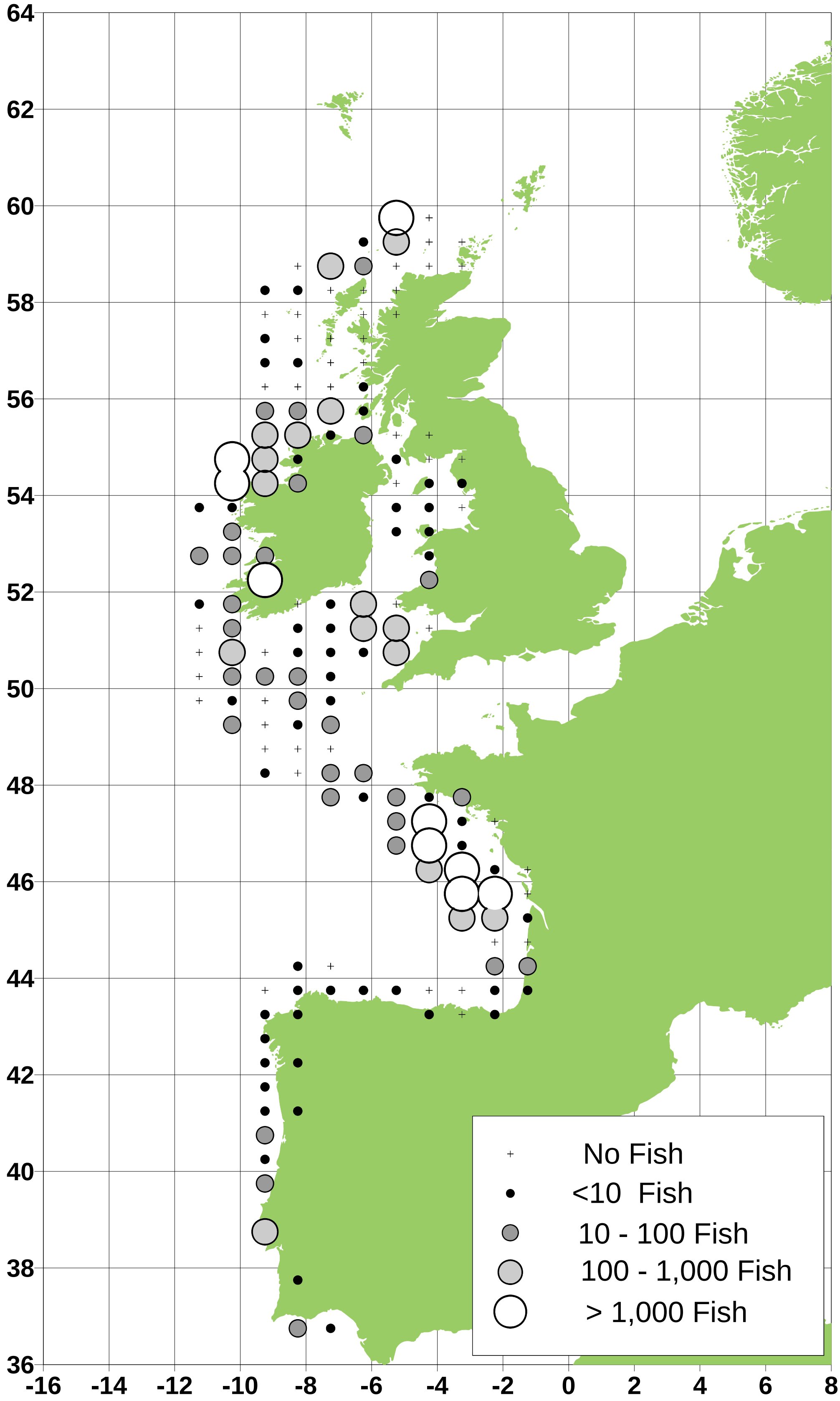


Figure 2.7.2.2. Distribution of mackerel recruits, 2003 year class age 1 in quarter 4, 2004.

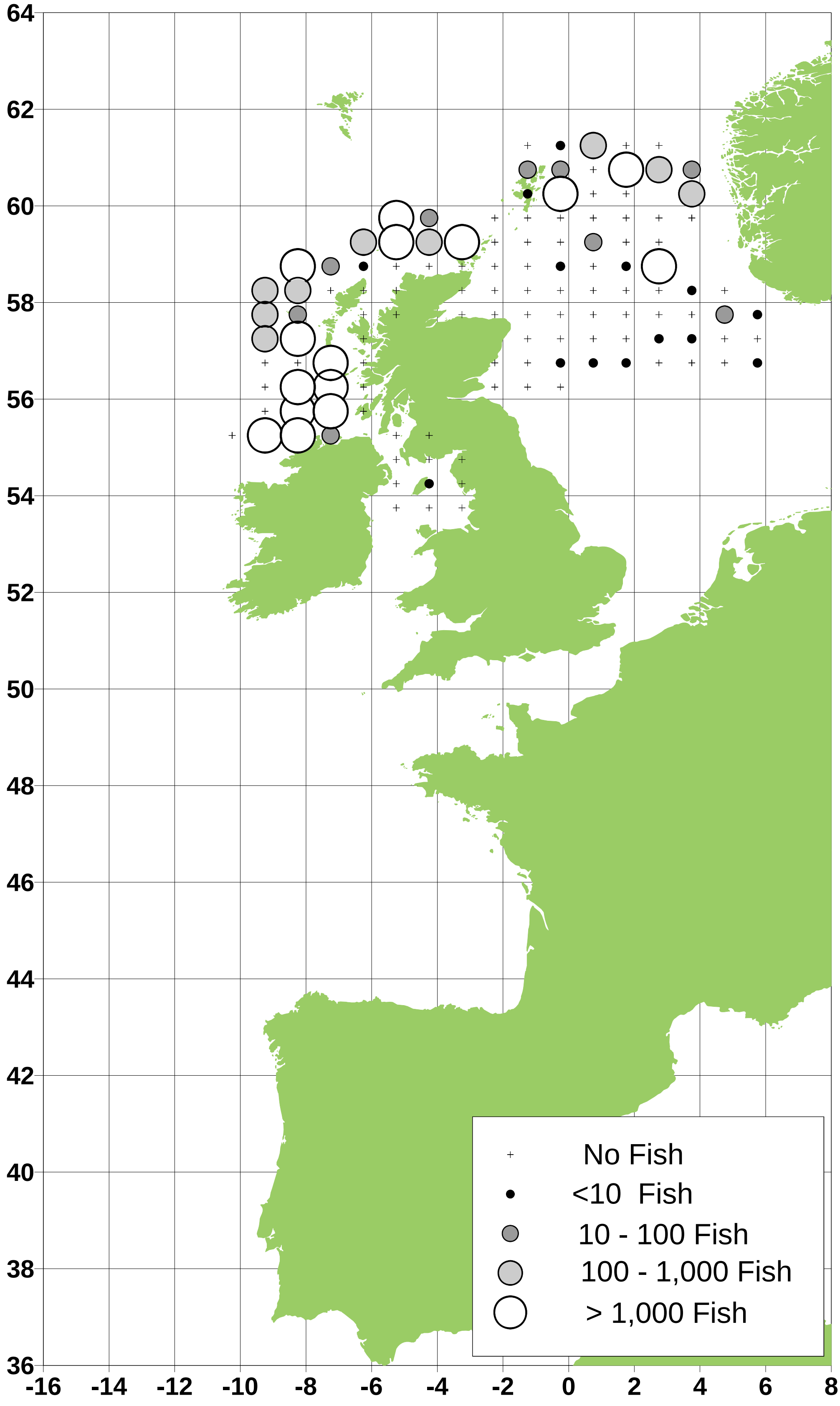


Figure 2.7.2.3. Distribution of mackerel recruits, 2004 year class age 1 in quarter 1, 2005.

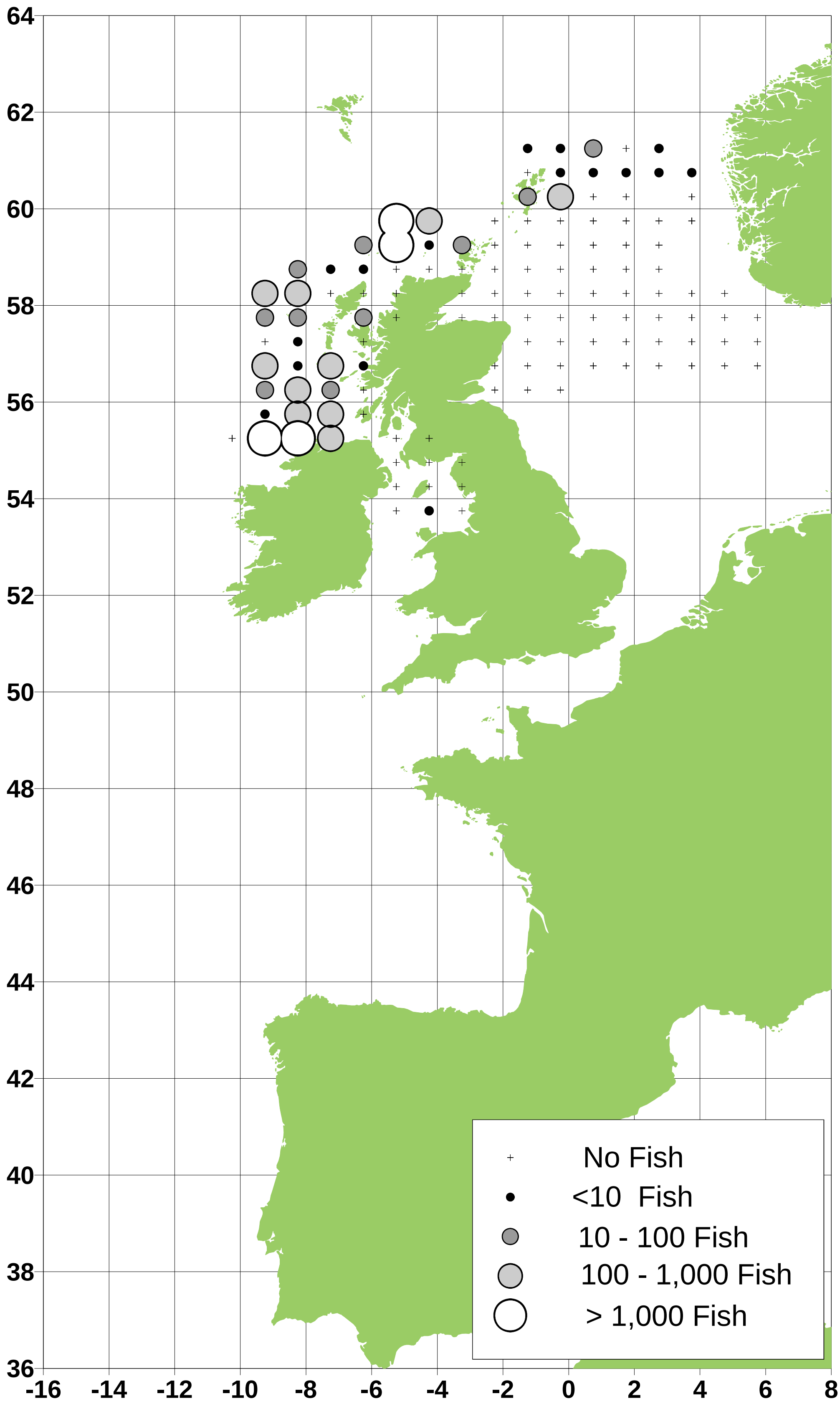


Figure 2.7.2.4. Distribution of mackerel recruits, 2003 year class age 2 in quarter 1, 2005.

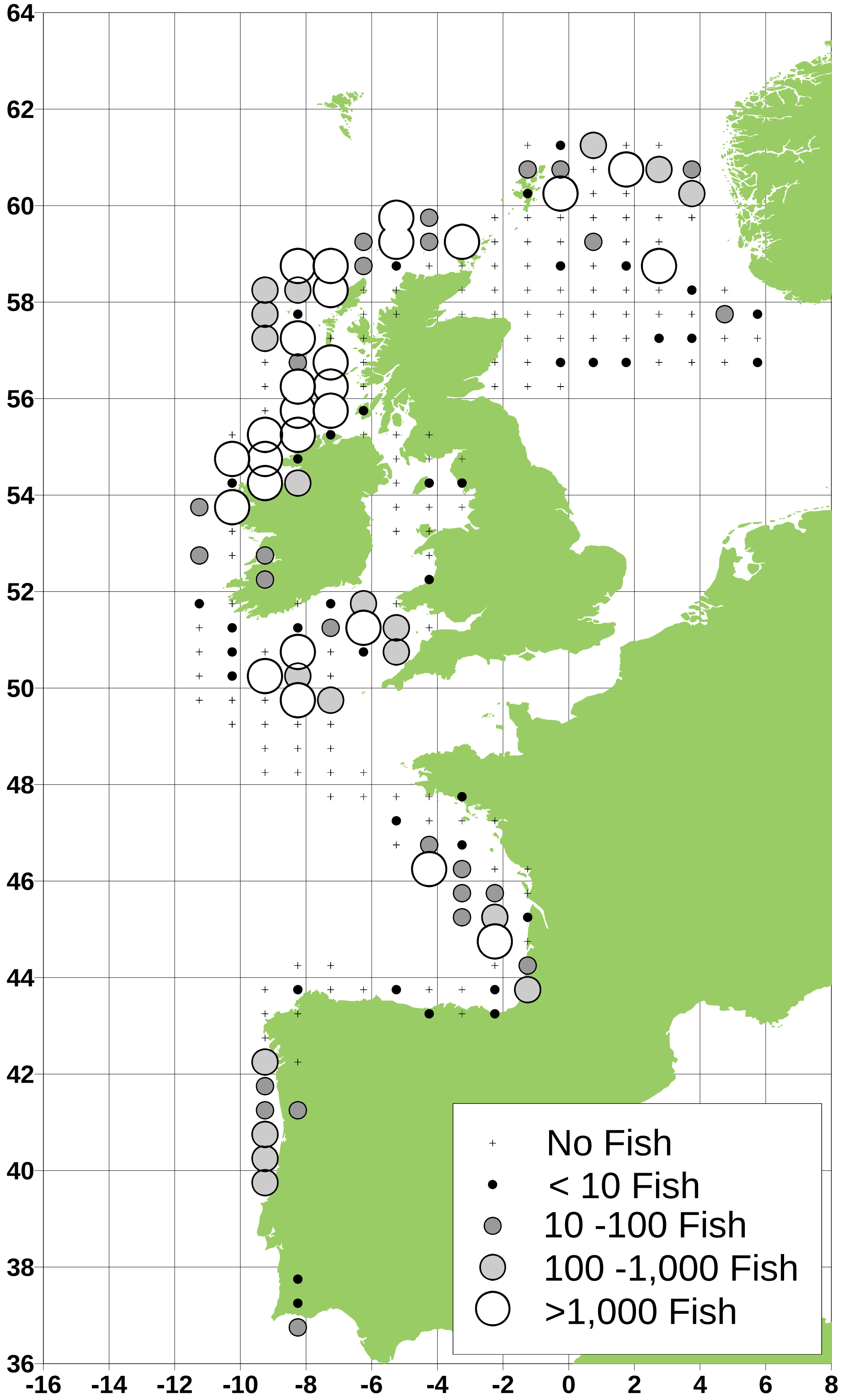


Figure. 2.7.2.5.Distribution of mackerel recruits. 2004 year class in 1st winter (2004/2005)

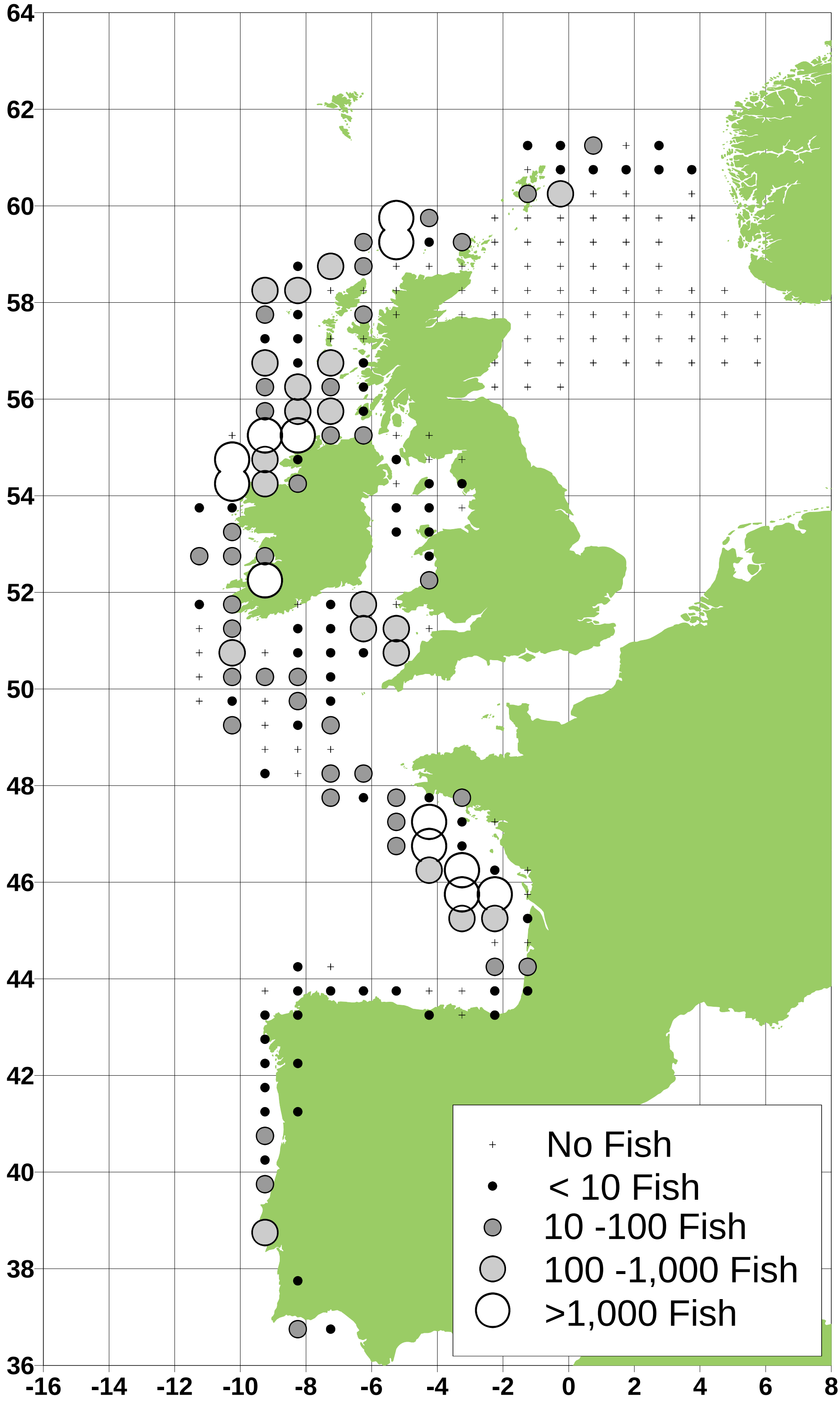


Figure. 2.7.2.6. Distribution of mackerel recruits. 2003 year class in 2nd winter (2004/2005)

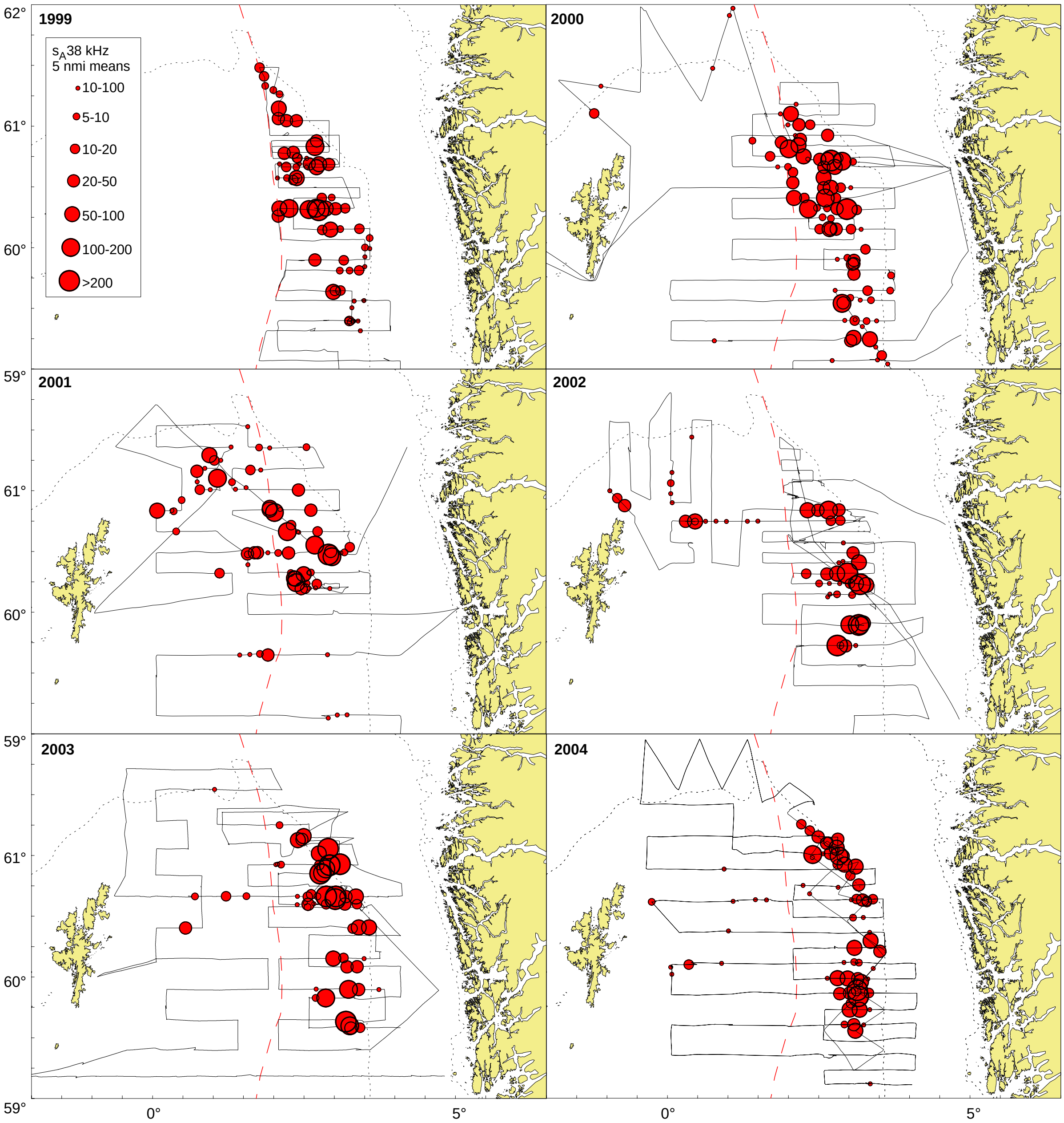


Figure 2.7.5.1. Distribution and density (in terms of s_A) of mackerel during October-November in the years 1999-2004. The size of the discs show the area density averaged over 5 n.mi. sailed distance.

.

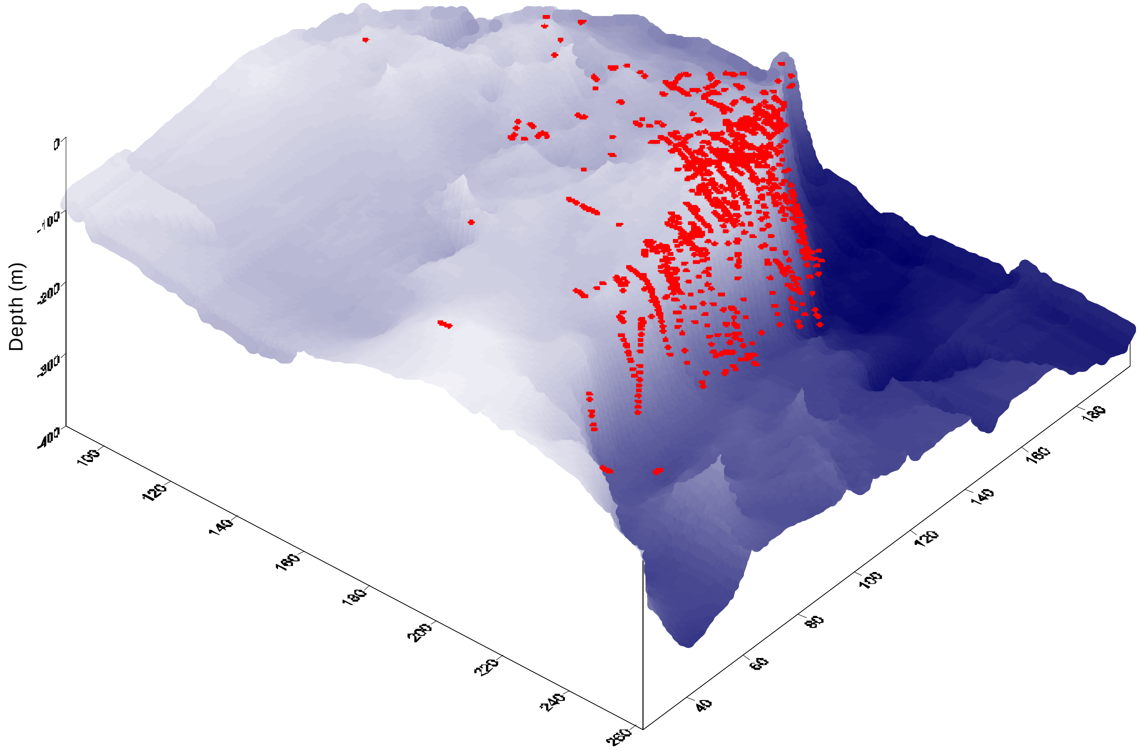


Figure 2.7.5.2. Bottom topography of the surveyed area based on 1 n.mi. bottom depths recorded acoustically during all surveys 1999-2004. The average depth of mackerel based on 1 n.mi. data from the same period is marked with red spots.

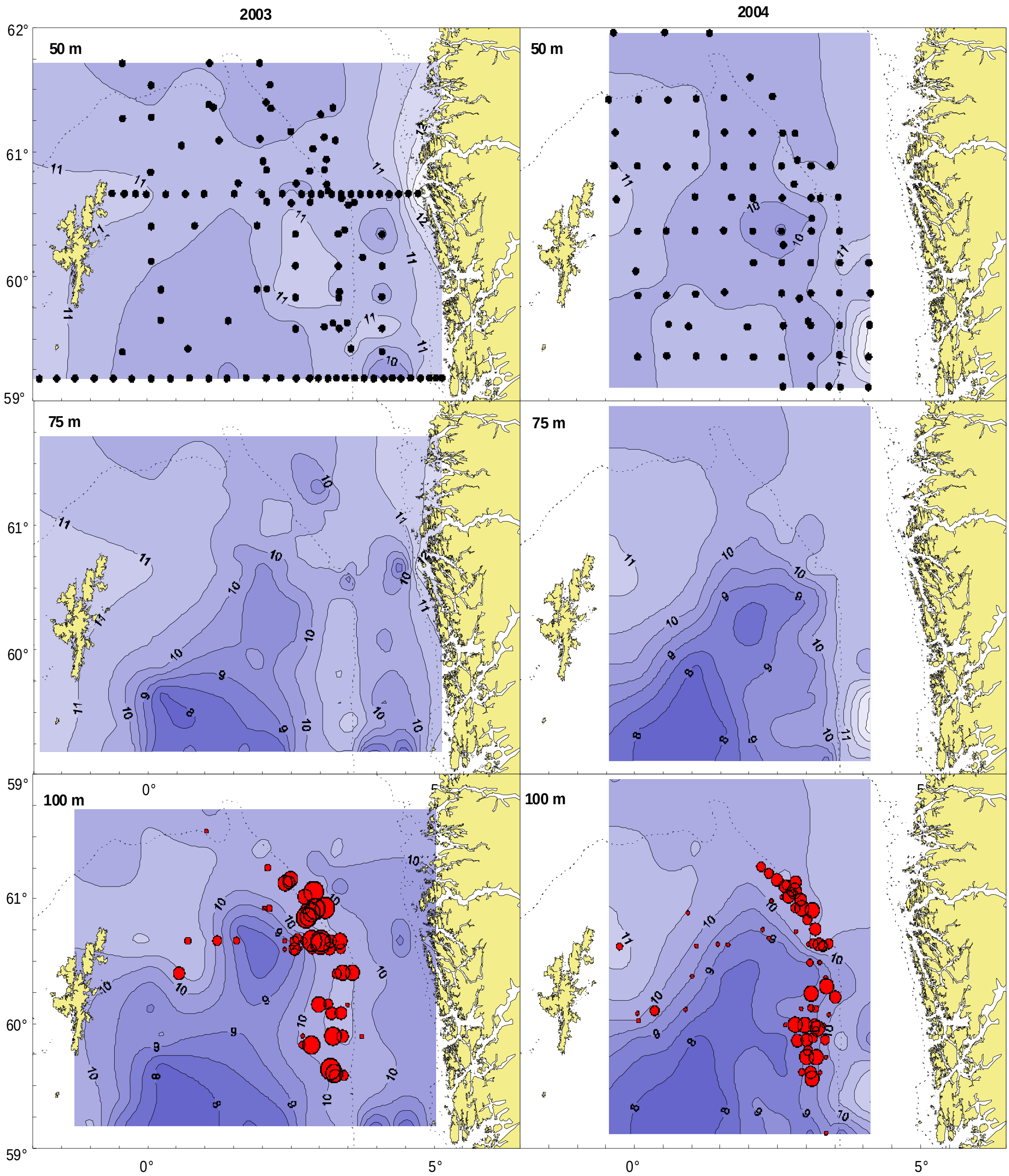


Figure 2.7.5.3. Temperature contour plots at various depths (50, 75 and 100 m) in the surveyed areas in 2003 and 2004. The belonging CTD-positions are given in the upper panel.

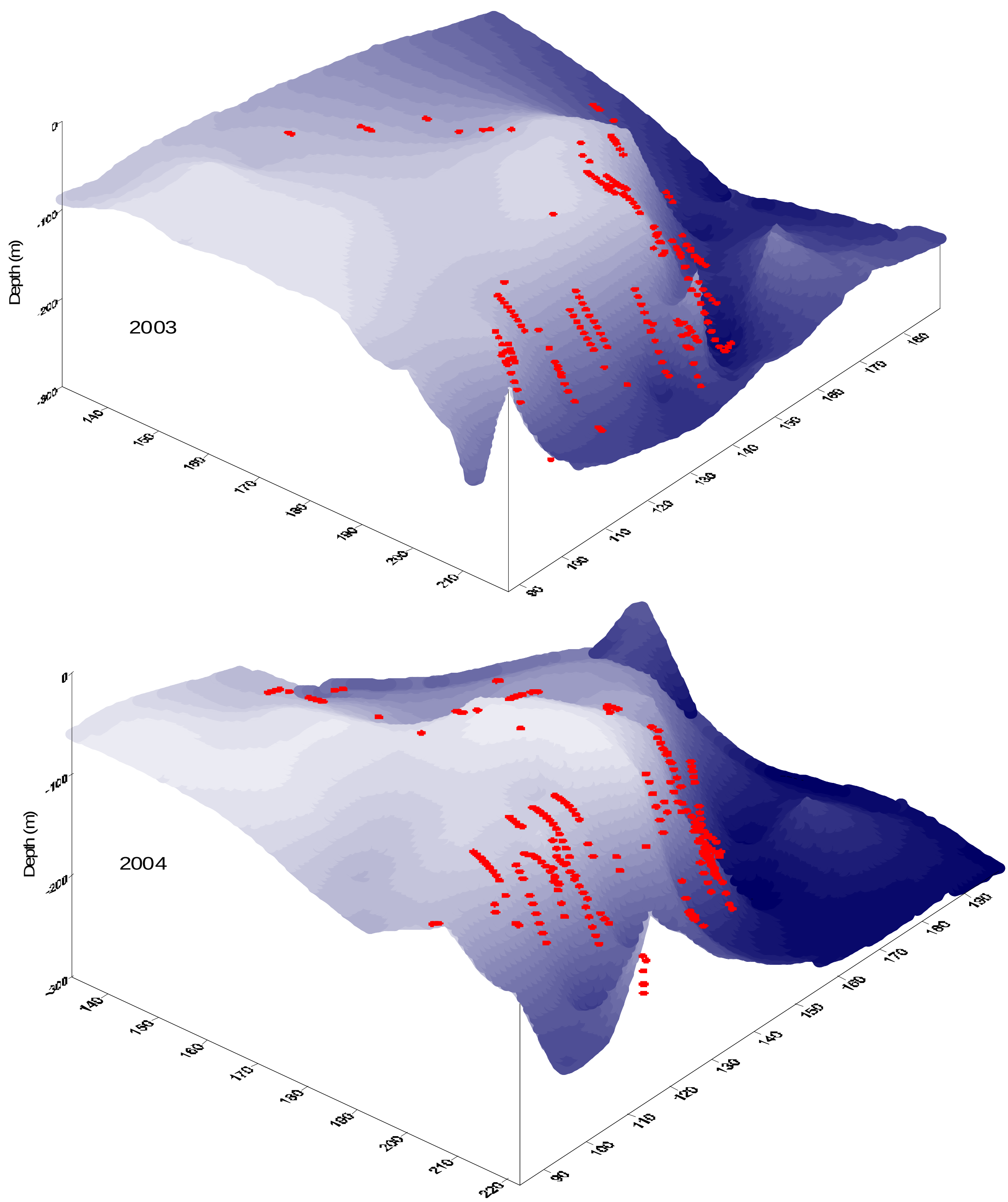


Figure 2.7.5.4. The depth of 9-10°C isoclines in 2003 and 2004, and the related the average depth of mackerel (red spots) based on 1 n.mi. acoustic data.

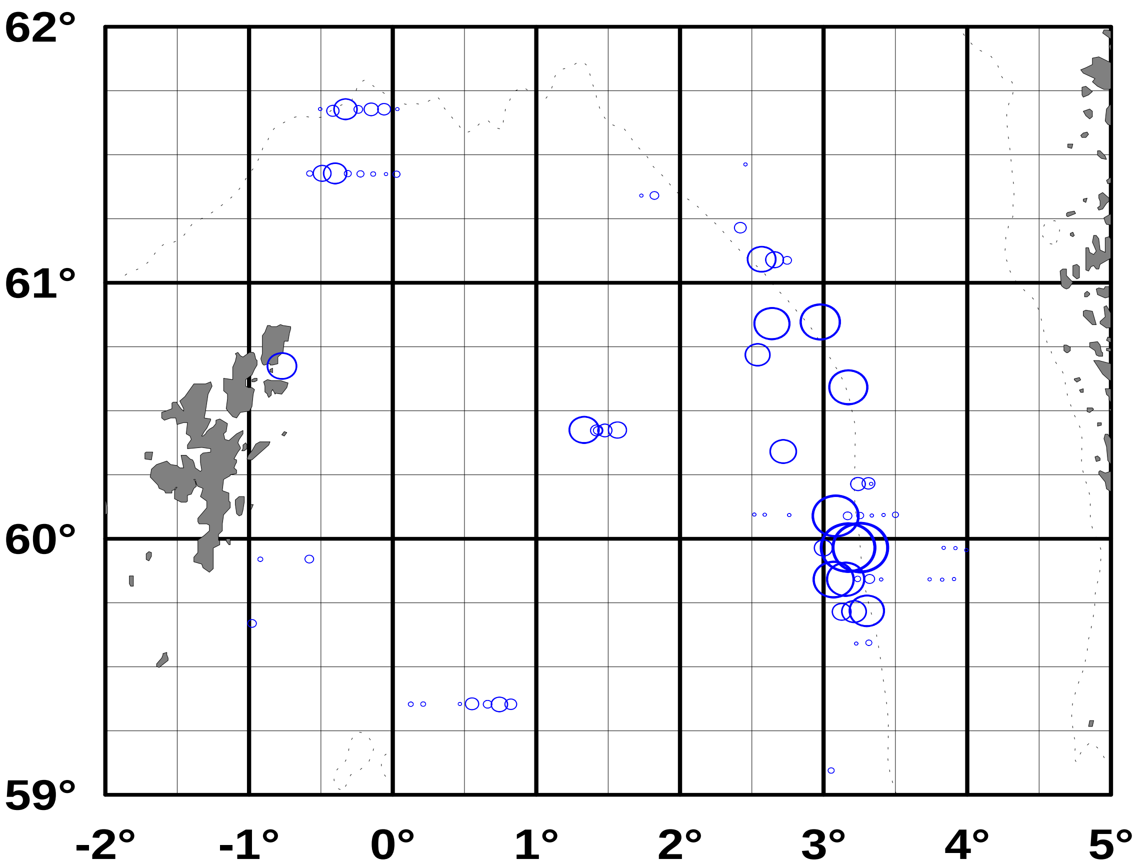


Figure 2.7.5.5. Map of the northern North Sea and a post plot of the distribution of mackerel. Circle size proportional to NASC attributed to mackerel in a 2.5 n.mi. EDSU, from the Scottish acoustic survey in October 2004; on a square root scale relative to a maximum value of 237 $m^2.nmi^{-2}$

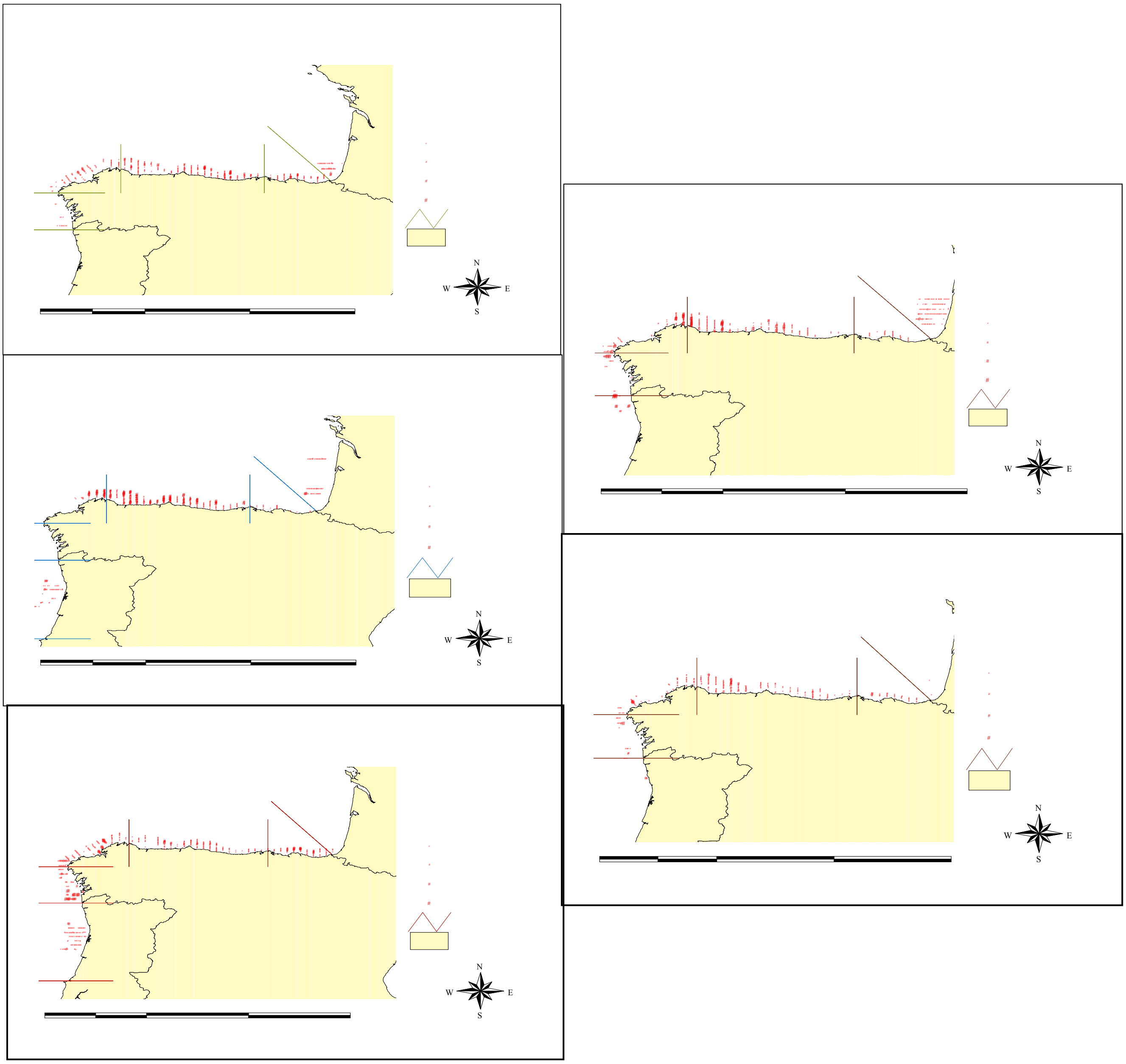


Figure 2.7.5.6 Mackerel distribution derived from backscattered energy (NASC). Spanish acoustic surveys PELACUS 2001-2005.

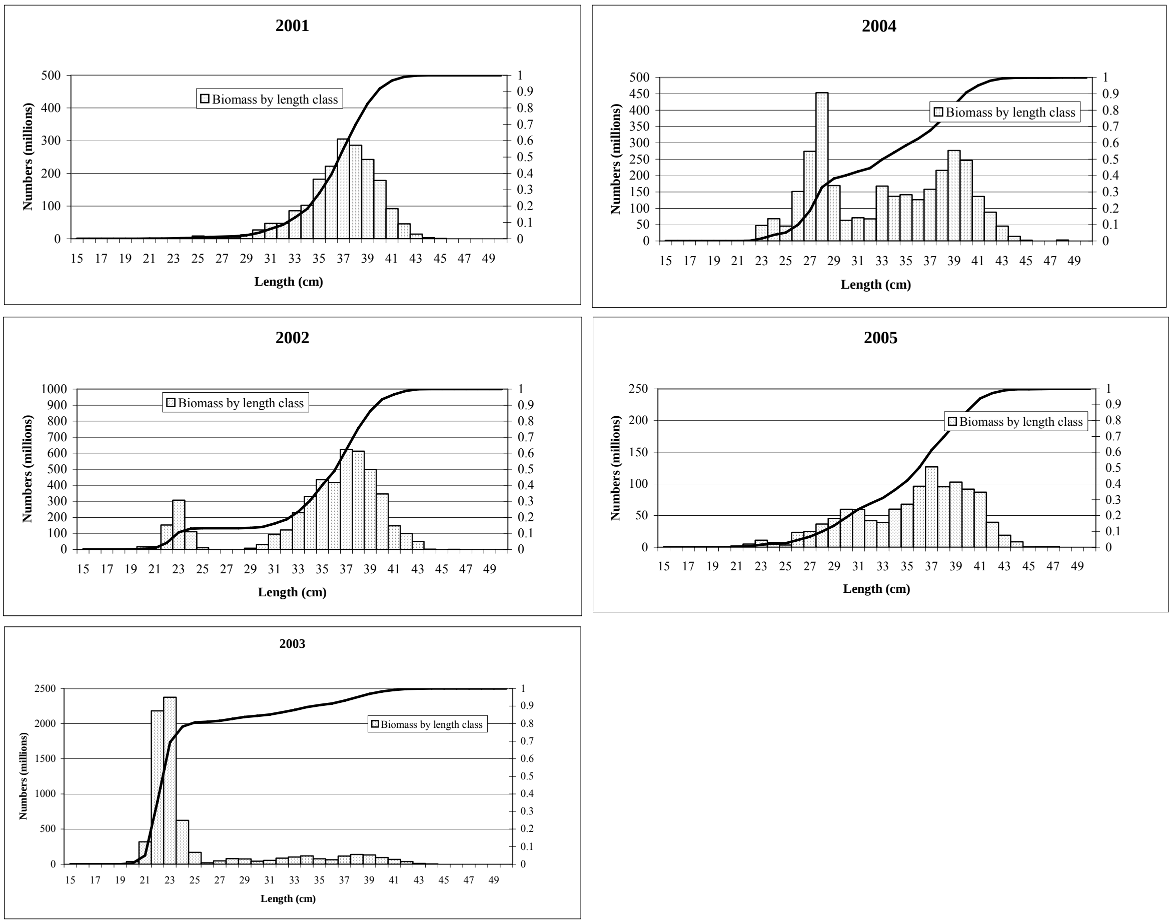


Figure 2.7.5.7 Mackerel length distribution for the Spanish acoustic survey from 2001 to 2005 in Sub-division IXa North and Division VIIIc (Spanish waters). The line denotes the cumulative frequency.

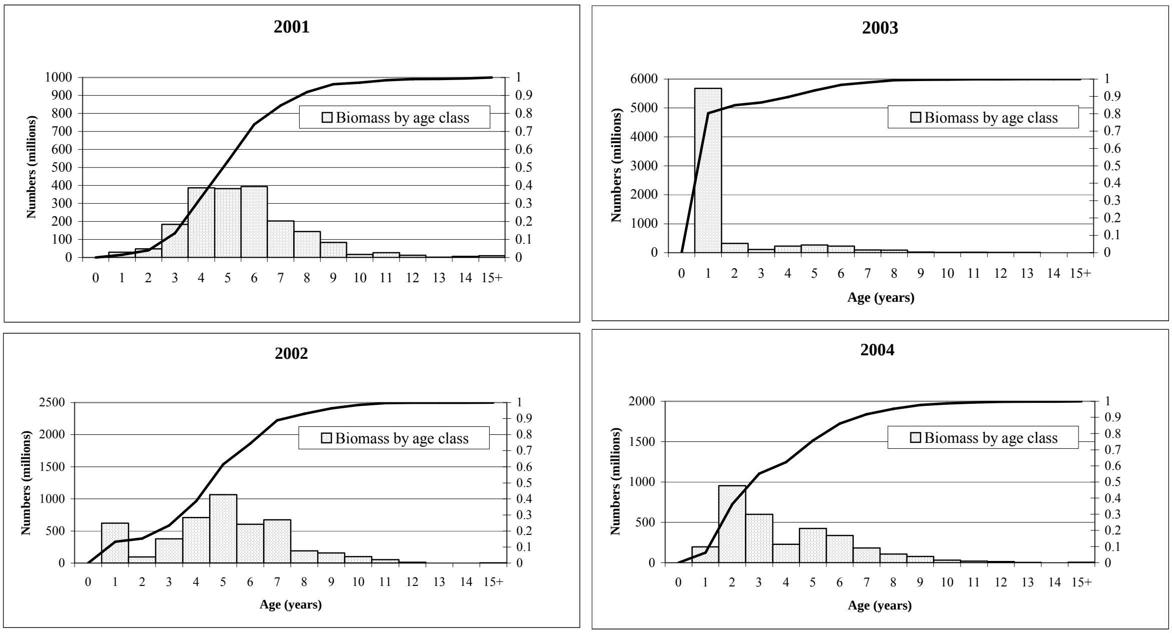


Figure 2.7.5.8 Mackerel age distribution for the Spanish acoustic survey from 2001 to 2004 in Sub-division IXa North and Division VIIIc (Spanish waters). The line denotes the cumulative frequency.

.

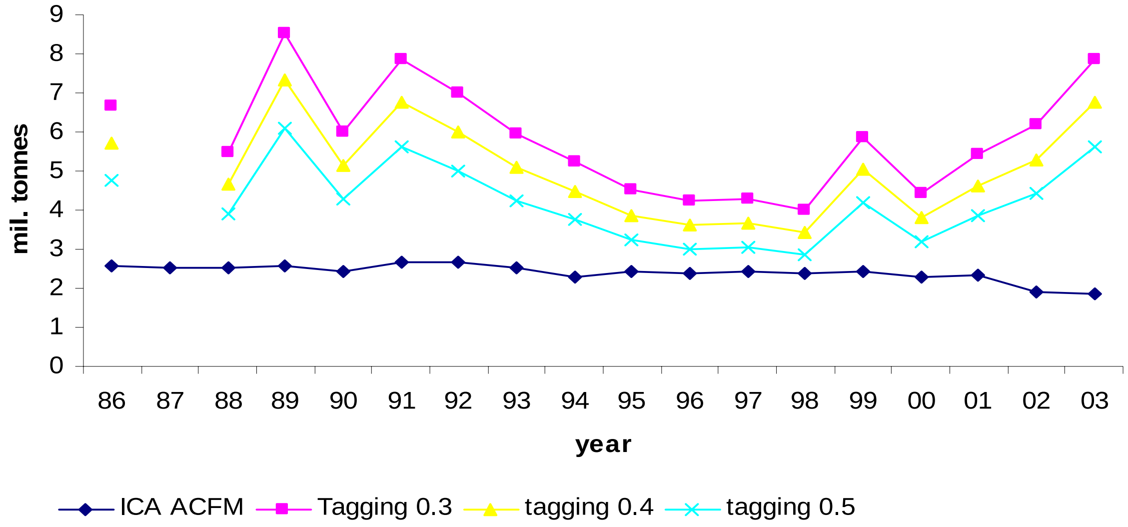


Figure 2.5.8.1 Spawning stock biomass estimated from the tagging study. Each line represents one assumption about tagging mortality. The spawning stock biomass estimate from the ICA assessment in 2004 is included for comparison.

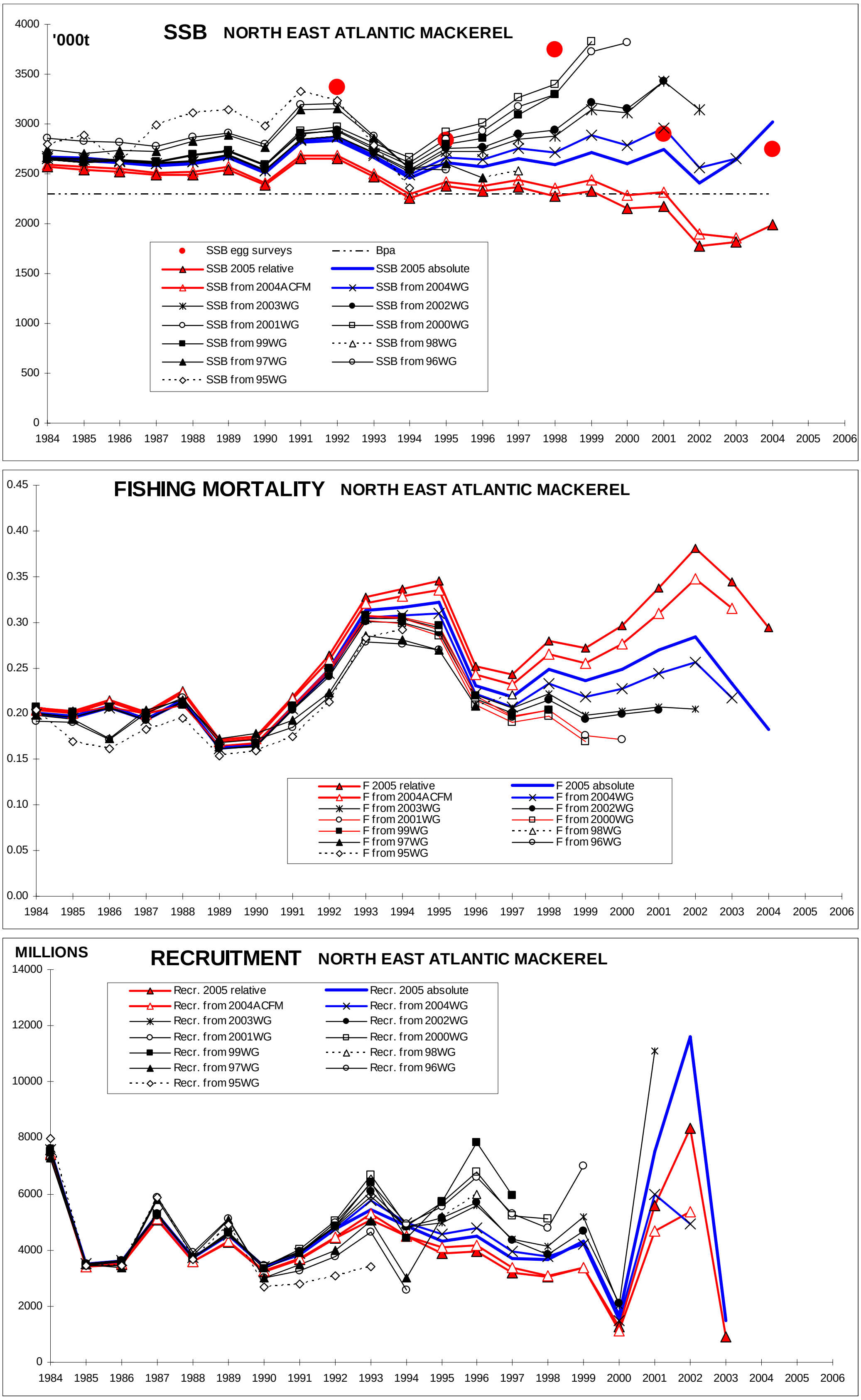


Figure 2.8.2.1 Comparison of SSB, F(4-8) and recruitment estimates (ICA) obtained at various assessment working group meetings. Biomass estimates from egg surveys in 1992, 1995, 1998, 2001 and 2004 are also shown. At the 1999 - 2001 working groups the 1992, 1995 and 1998 egg survey SSB's and at the 2002 and 2003 WG meetings the 1992, 1995, 1998 and 2001 egg survey SSB's were used. At the 2004 and 2005 WG meeting the 1992, 1995, 1998, 2001 and 2004 egg survey SSB's were used.
For 2004 and 2005 assessments using both relative and absolute SSB indices are shown to highlight the differences. (At the 1998 WG meeting the new assessment was rejected and in stead the 1997 assessment was projected one year forward).

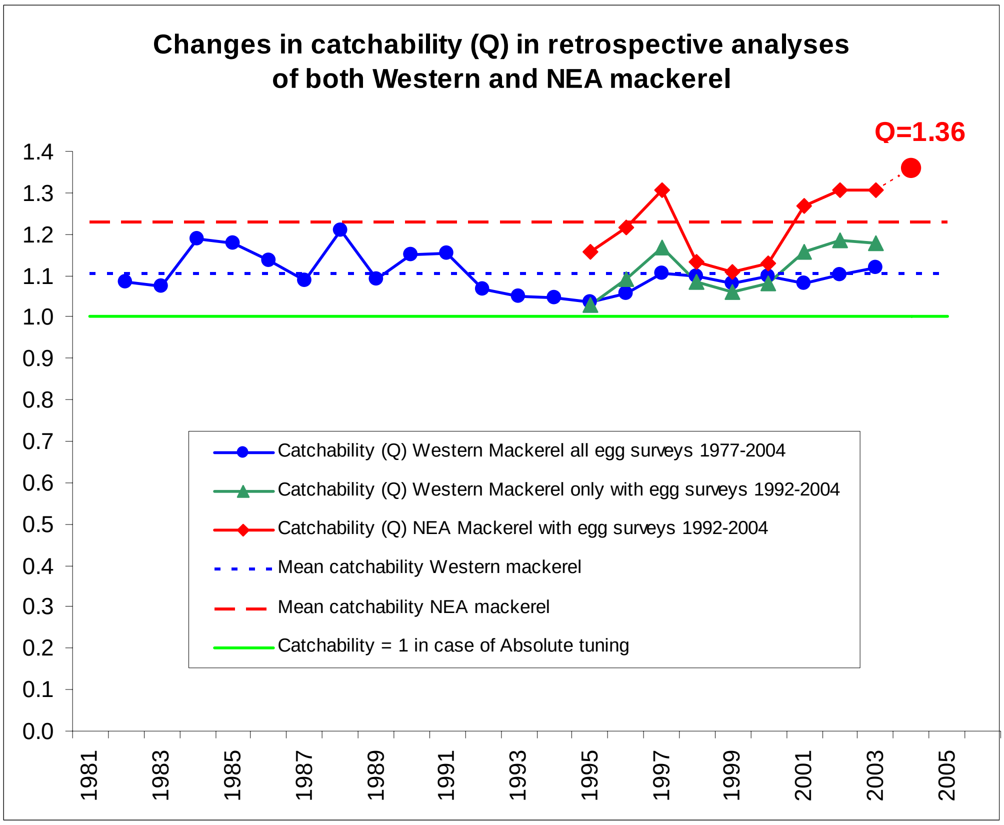


Figure 2.8.2.2 **Retrospective analyses of catchability in Western mackerel with all or only 5 egg surveys, and NEA mackerel with all available 5 egg surveys. The added Q=1.36 in 2004 is based on the assessment of this years WG.**

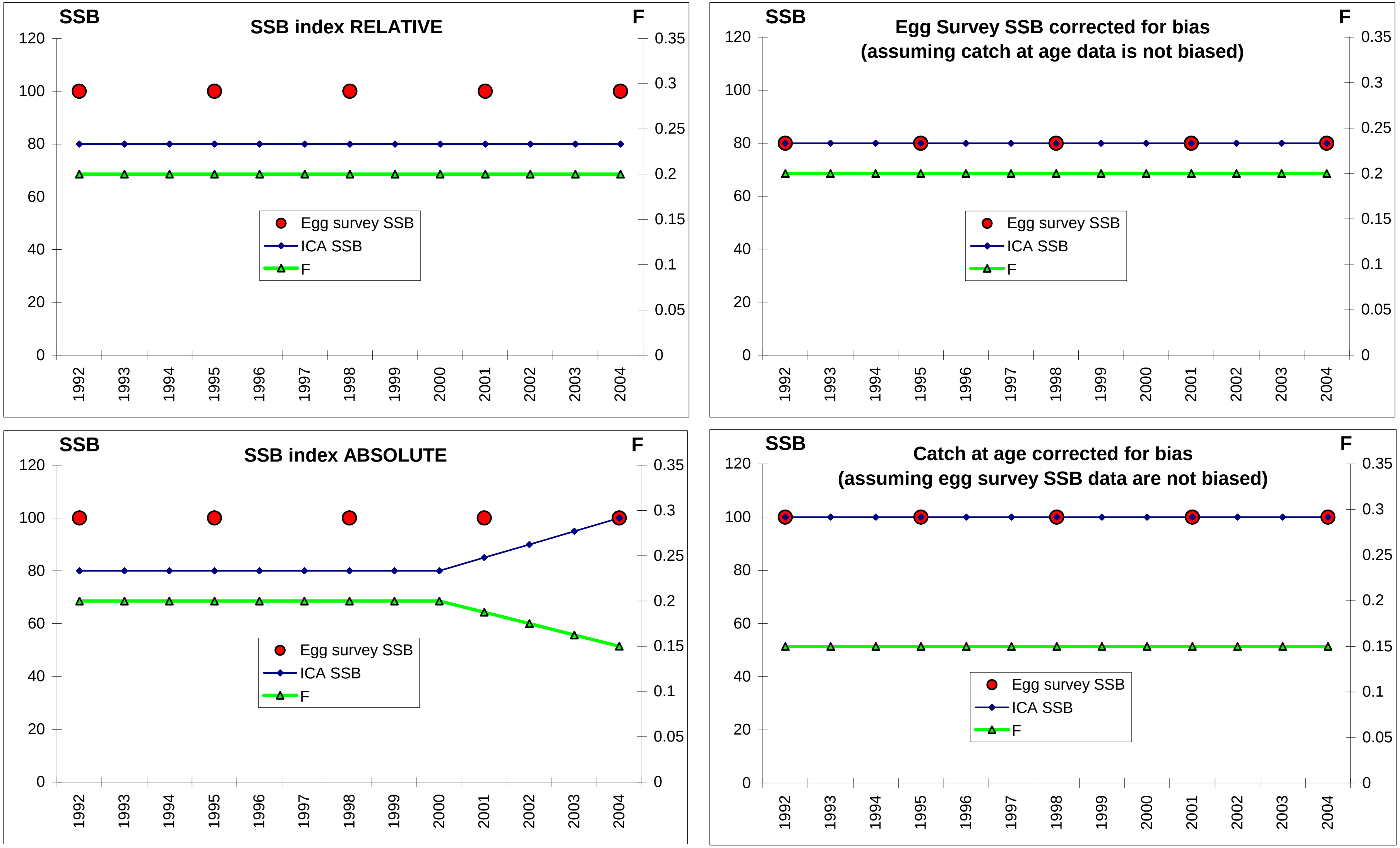


Figure 2.8.2.3 Simple presentations of the 4 different possibilities of assessing the NEA mackerel stock. All under the condition of constant egg survey SSB over whole time series.

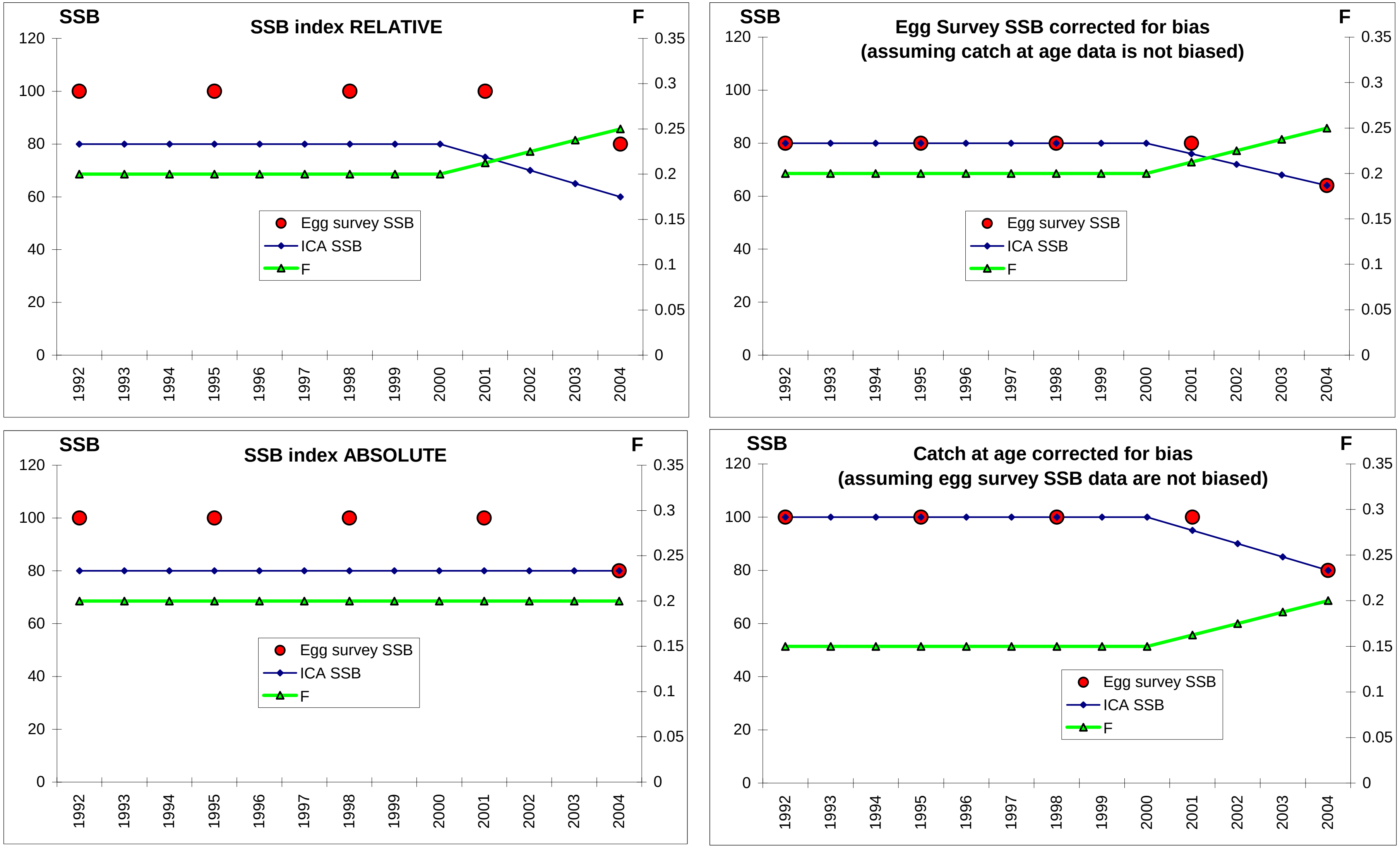


Figure 2.8.2.4 Simple presentations of the 4 different possibilities of assessing the NEA mackerel stock. All under the condition of constant egg survey SSB except that there is a decline in the recent period.

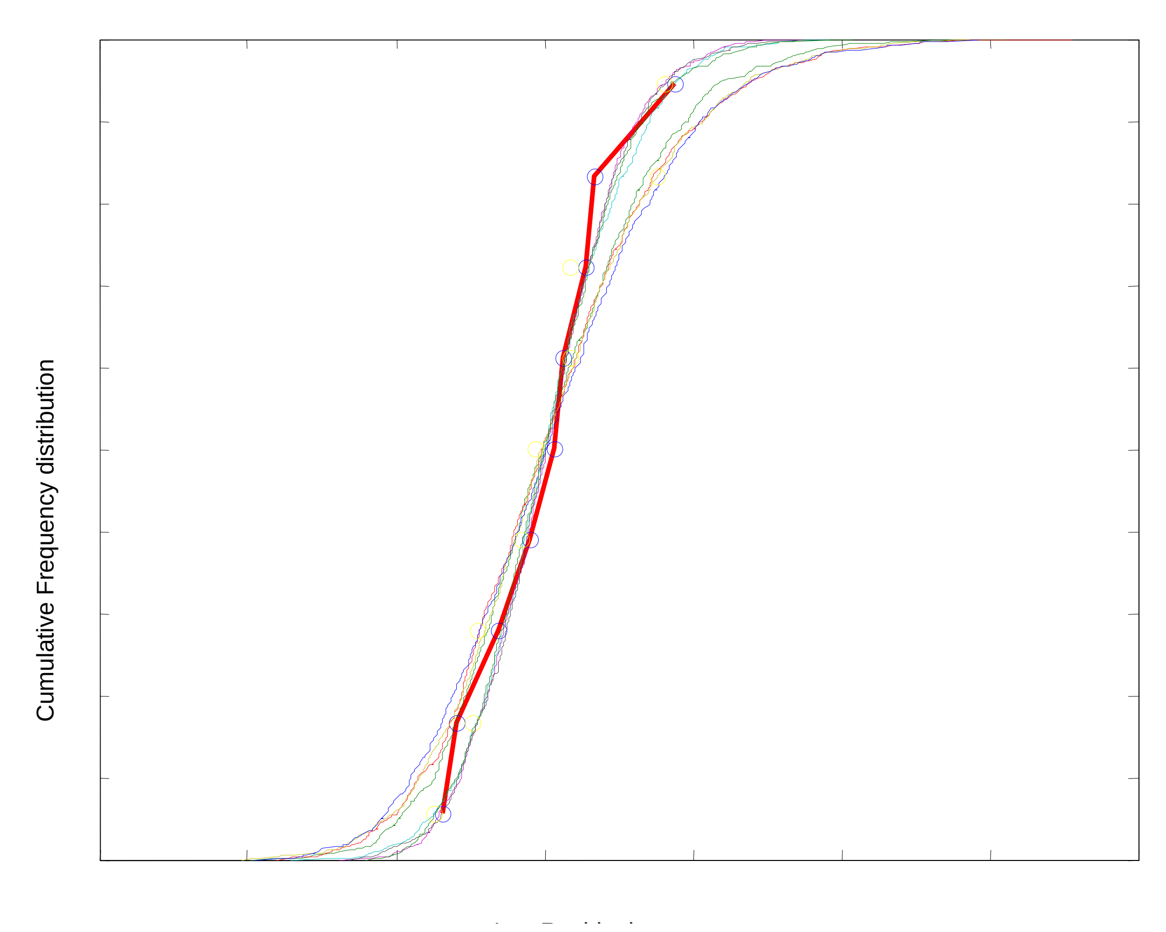


Figure 2.8.2.5 Cumulative probability distribution, by year, of SSB index (the Mackerel Egg Survey) obtained by parametric bootstrap of local sampling variability using a log normal distribution of observation errors, for Western Mackerel survey, (thin lines). Cumulative probability distribution of residuals in ICA assessment of western area obtained with SSB survey as tuning (thick line with circle symbols).

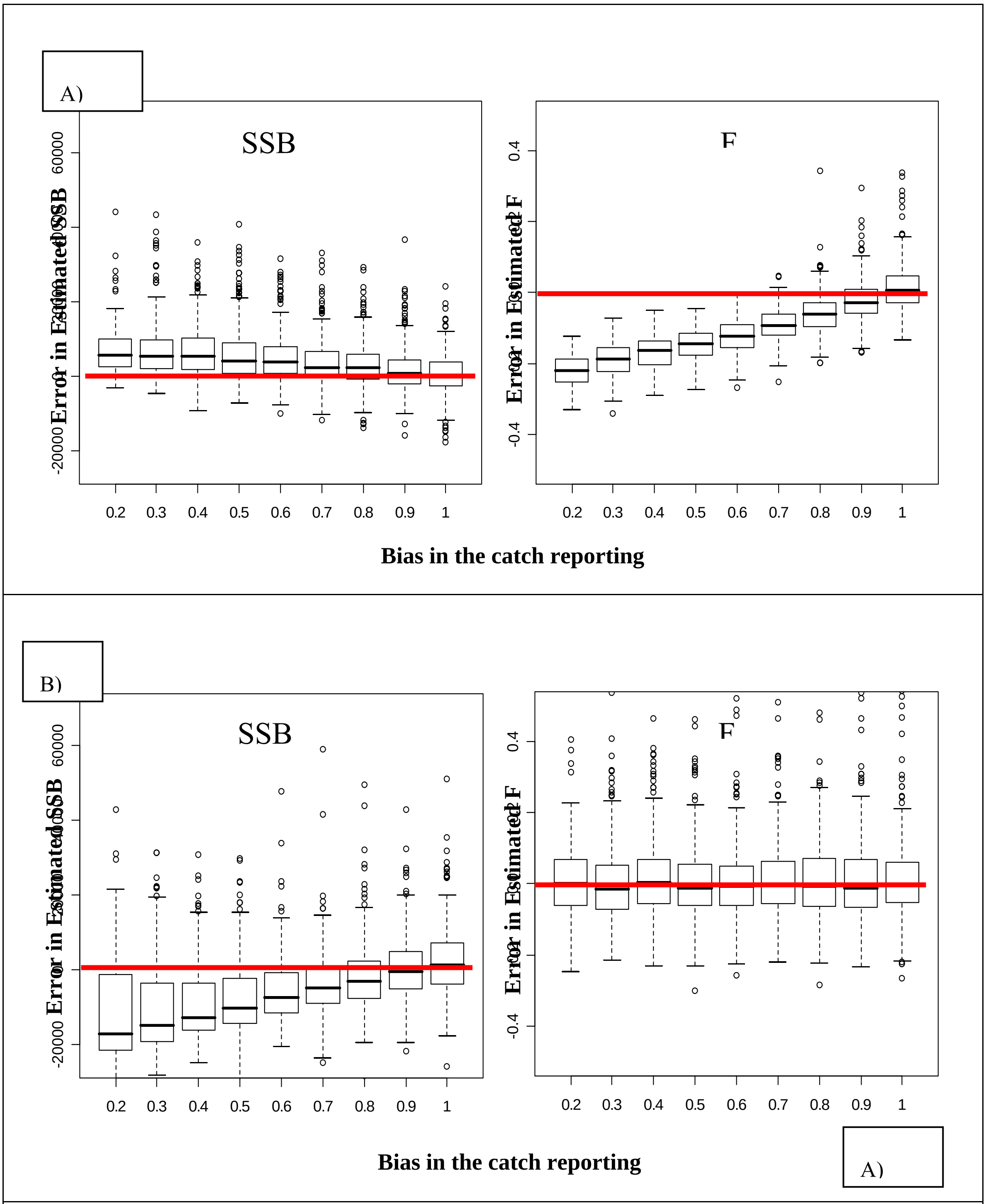


Figure 2.8.2.6 Estimates of Error in ICA estimates of terminal SSB and F (TSSBE and TTE) for varying catch bias with an unbiased Egg Survey used as an SSB series either A) absolute tuning or B) relative tuning

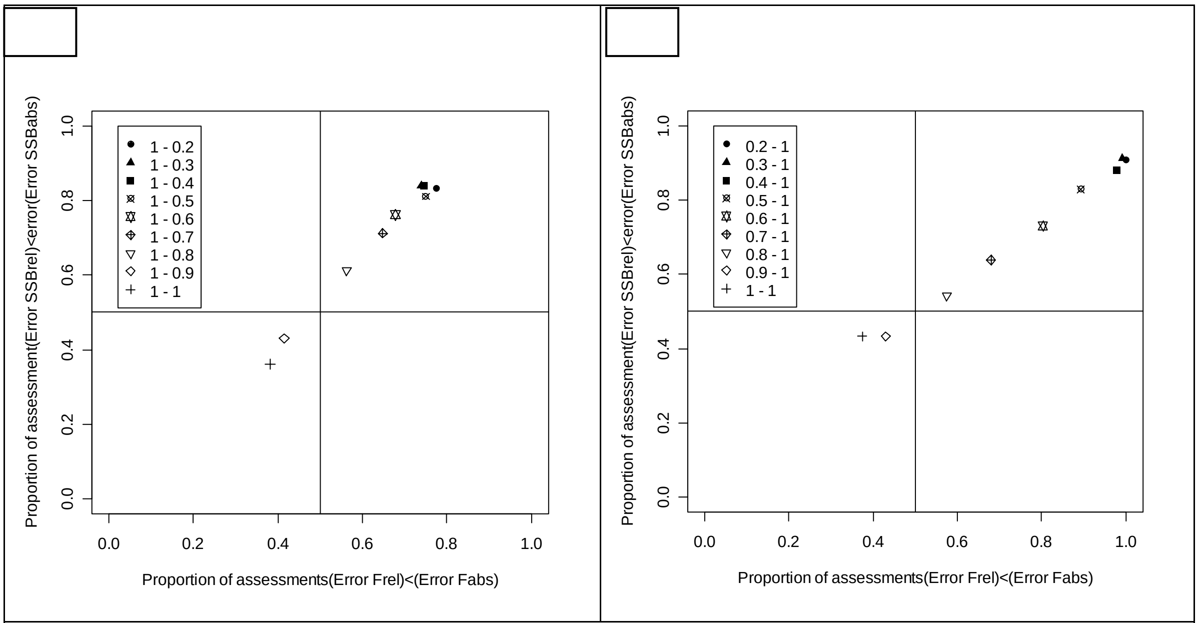


Figure 2.8.2.7 Proportion assessments with a more accurate estimate of either SSB or F trend in the presence of either A) catch bias and B) Survey bias. Trend is more accurately estimated more frequently by the absolute method if bias in either catch of survey is less than 0.85 (-15%). The relative method gives a higher probability of a the more accurate estimate if the biases in either catch or survey is greater than 0.85 (-15%).

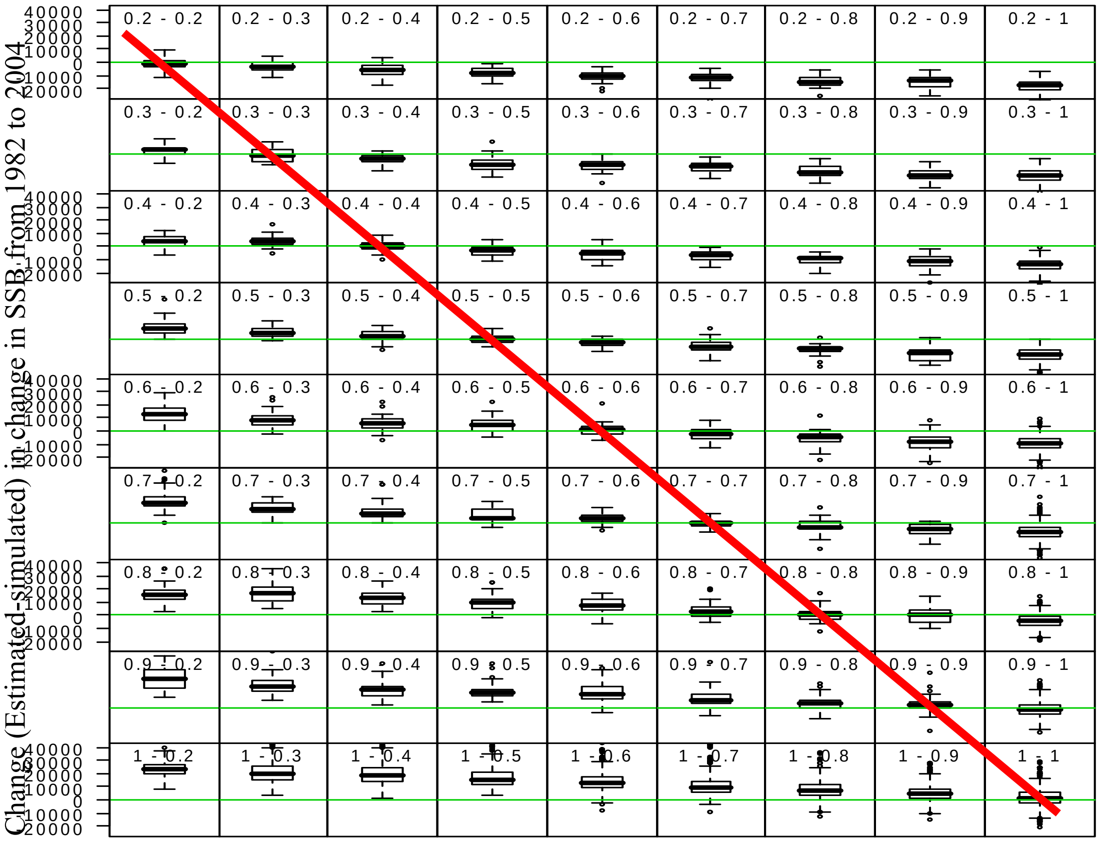


Figure 2.8.2.8 Box and whisker plots of estimated trend in SSB from "1982" to the present using ICA with an absolute fit with both catch and survey biased. Bias in catches changes on the horizontal direction and bias in the survey vertically and is given by the figures in the top of each panel. If the bias in both parameters is the same, the diagonal (shown by the red line), the trend is estimated correctly. The current situation is uncertain but the available estimates suggest the panel 0.6-0.4 (40% survey and 60% catch bias) may be a possibility.

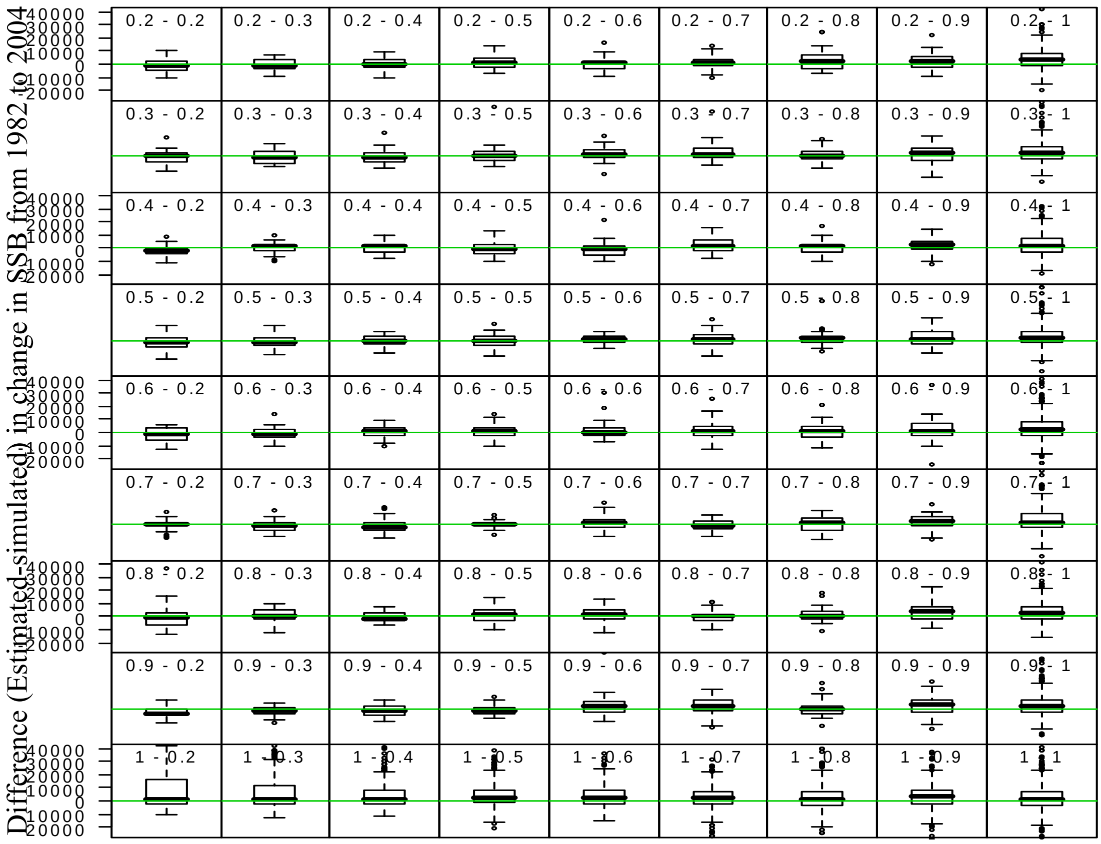


Figure 2.8.2.9 Box and whisker plots of estimated trend in SSB from "1982" to the present using ICA with an relative fit with both catch and survey biased. Bias in catches changes on the horizontal direction and bias in the survey vertically and is given by the figures in the top of each panel. Trend is estimated as unbiased but less precisely than for the absolute fit, see figure 2.??.4

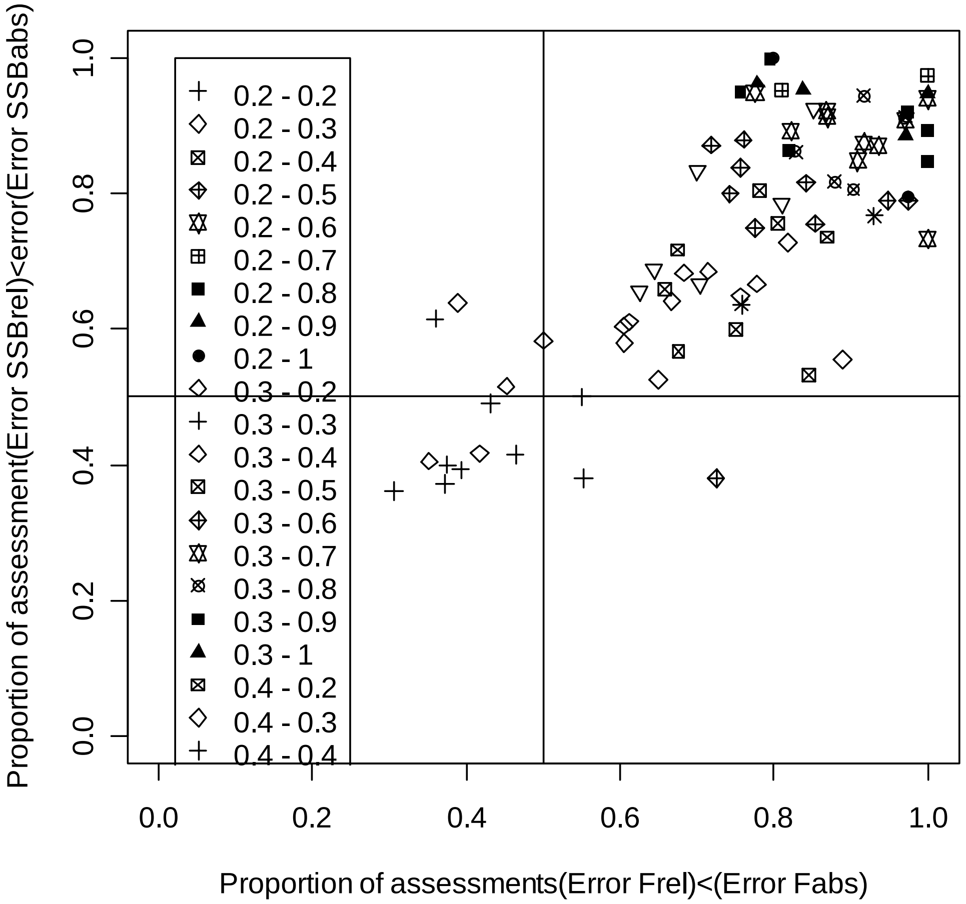
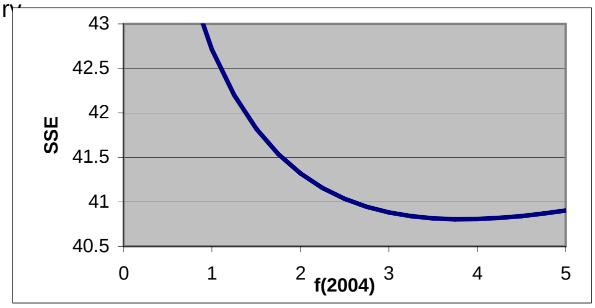
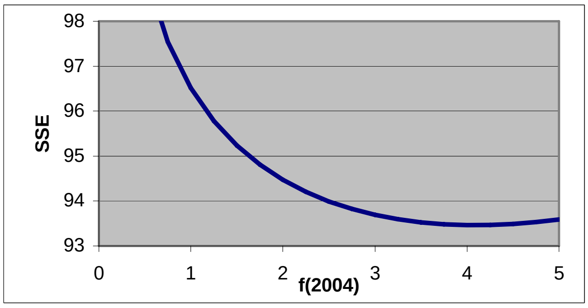


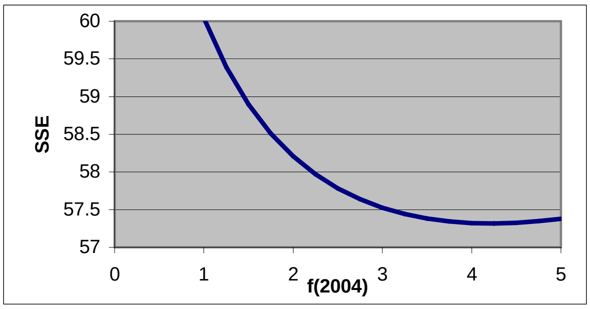
Figure 2.8.2.10 Proportion assessments with a more accurate estimate of either SSB or F trend in the presence of both catch bias and survey bias. The same symbol is used for the same magnitude of difference in bias between catch and survey, see truncated legend. (+ represents equal bias, diamond 10%, crossed square 20% difference etc. Trend is more accurately estimated more frequently by the absolute method if the difference in bias in either catch of survey is less than 10%. The relative method gives a higher probability of a the more accurate estimate if the biases in both catch or survey is different by greater than 10%.



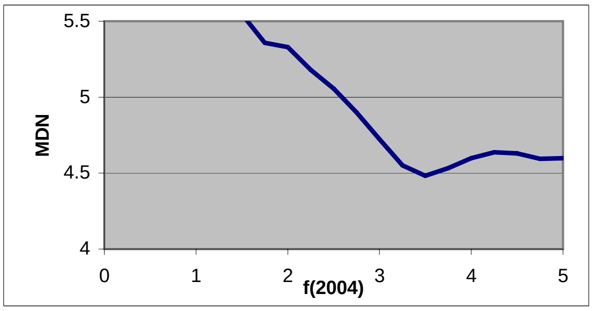
a. Catch-controlled version, catch-at-age alone



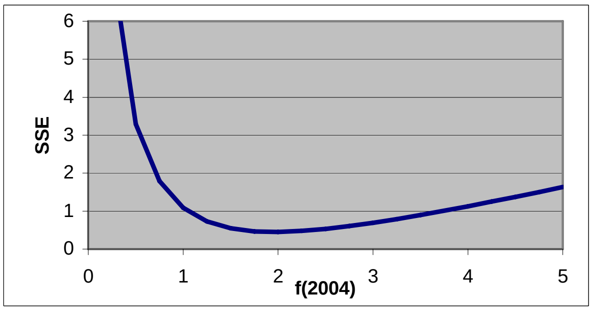
b. Effort-controlled version, catch-at-age alone



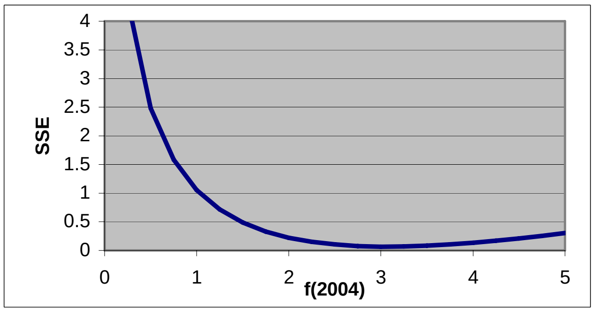
c. Mixed version, catch-at-age alone



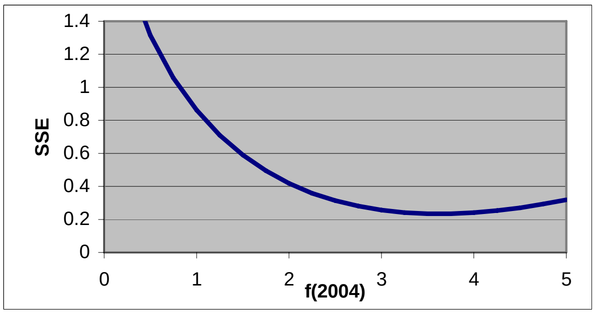
c1. Mixed version, catch-at-age alone, minimization of MDN



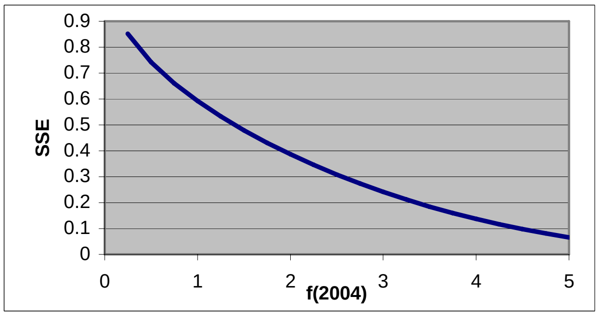
d.Egg surveys, as absolute



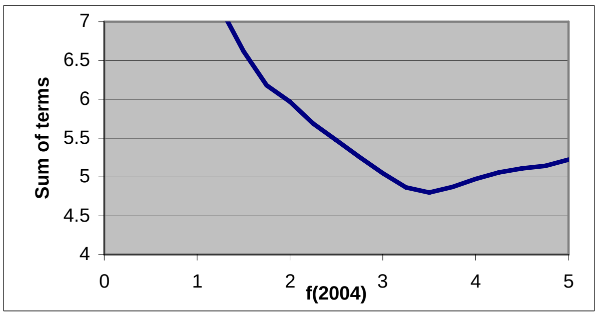
e. Egg surveys as relative



f. Norwegian surveys (relative)



g. Scottish surveys (relative)



h. Sum of signals from catch-at-age (as MDN) + egg surveys + Norwegian surveys

Figure 2.8.4.2.1 Profiles of components of the ISVPA loss function.

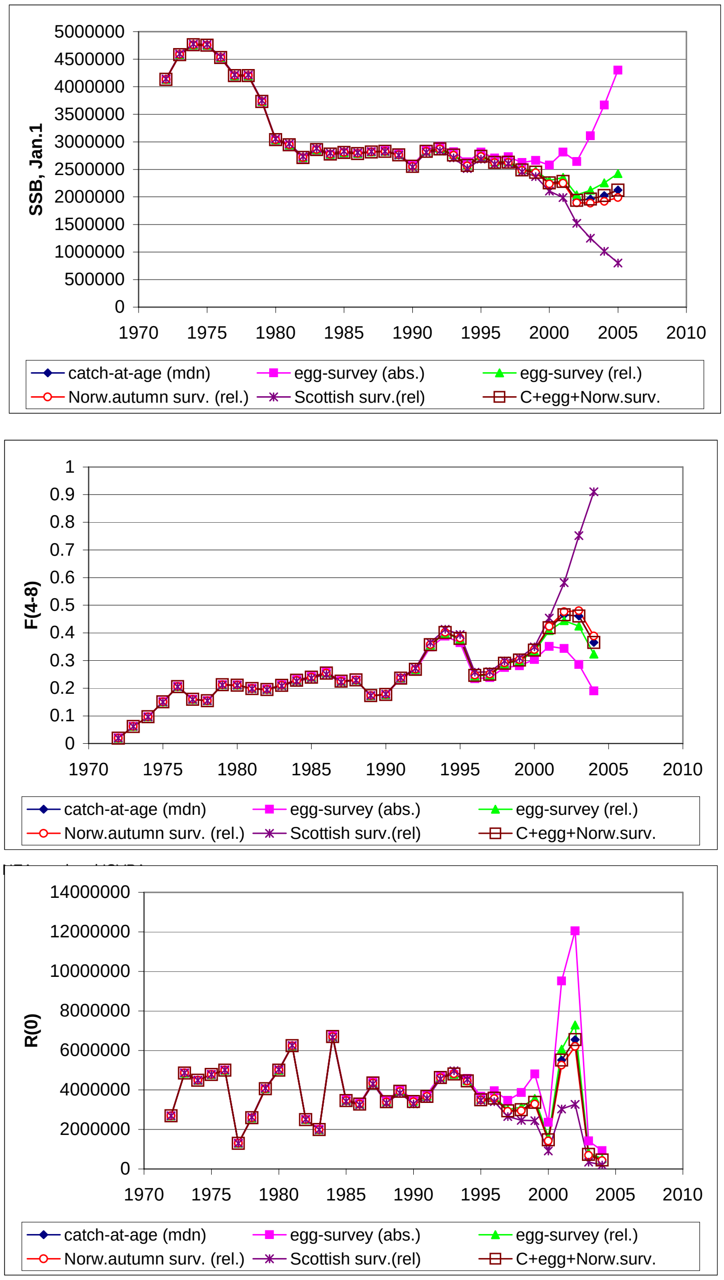


Figure 2.8.4.2.2 ISVPA. Estimates of SSB, F and R for different sources of information used

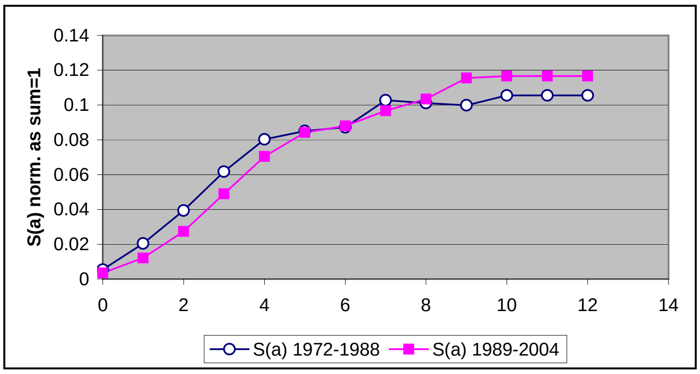


Figure 2.8.4.2.3 ISVPA. NEA mackerel. Estimated selection patterns

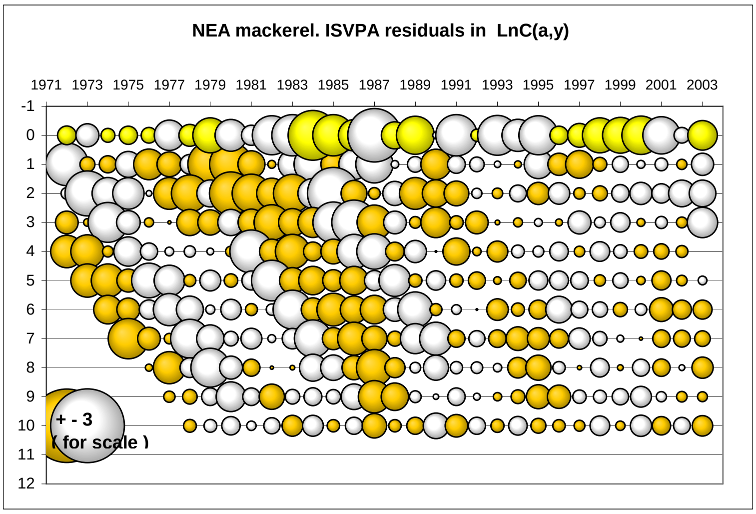


Figure 2.8.4.2.4 NEAM. ISVPA. Residual in logarithmic catch-at-age

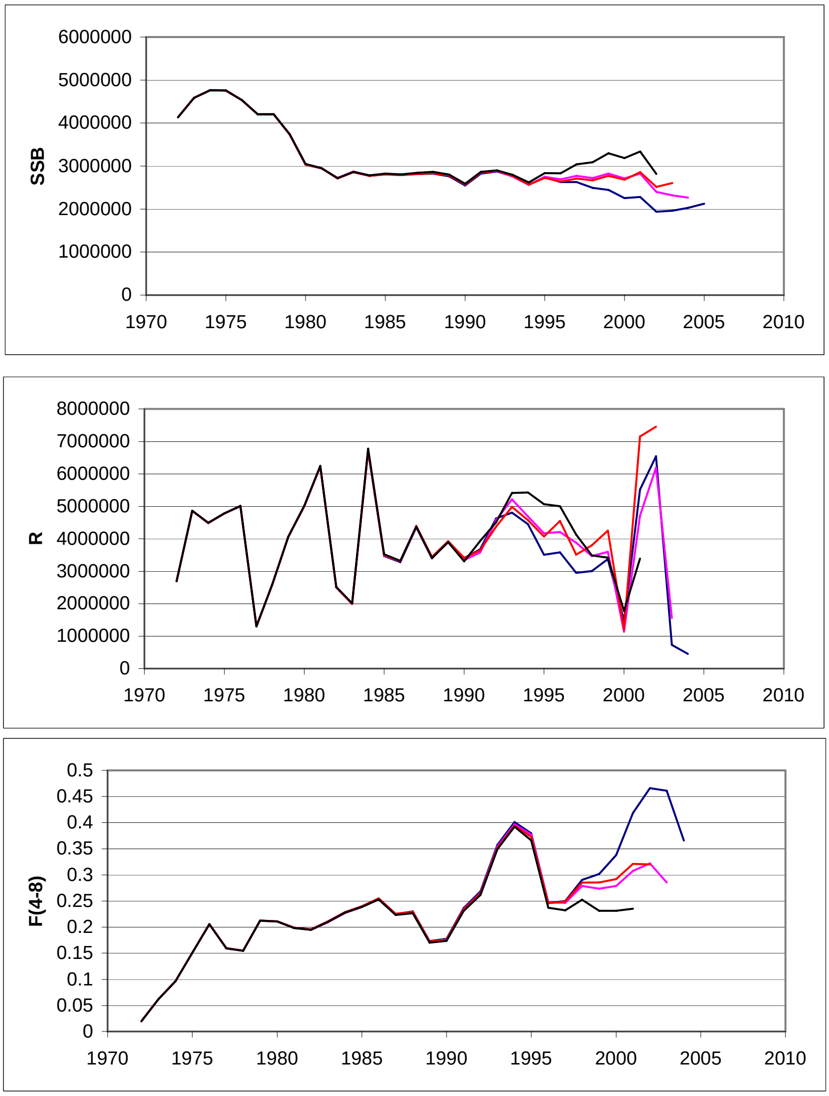


Figure 2.8.4.2.5 NEAM. ISVPA. Retrospective runs

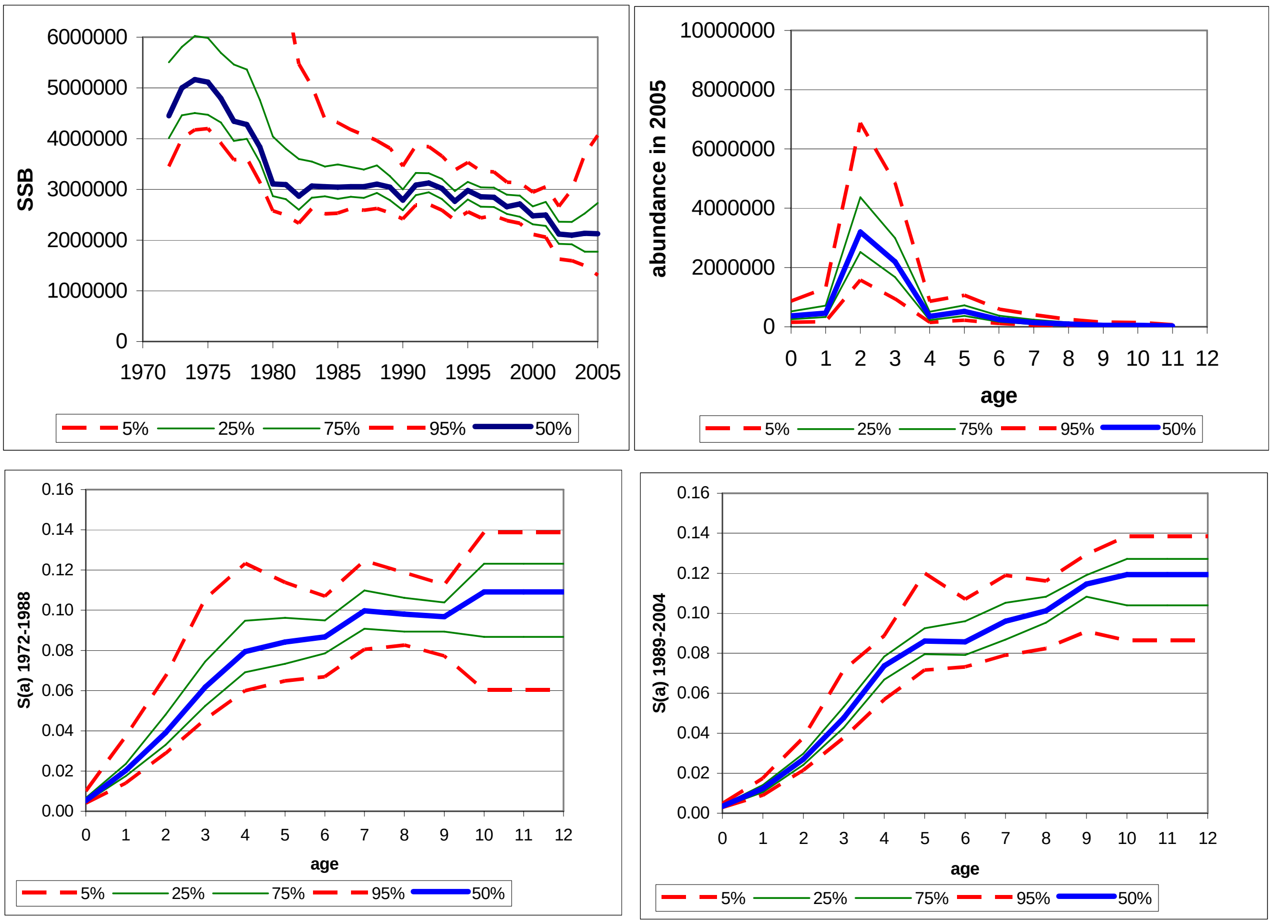
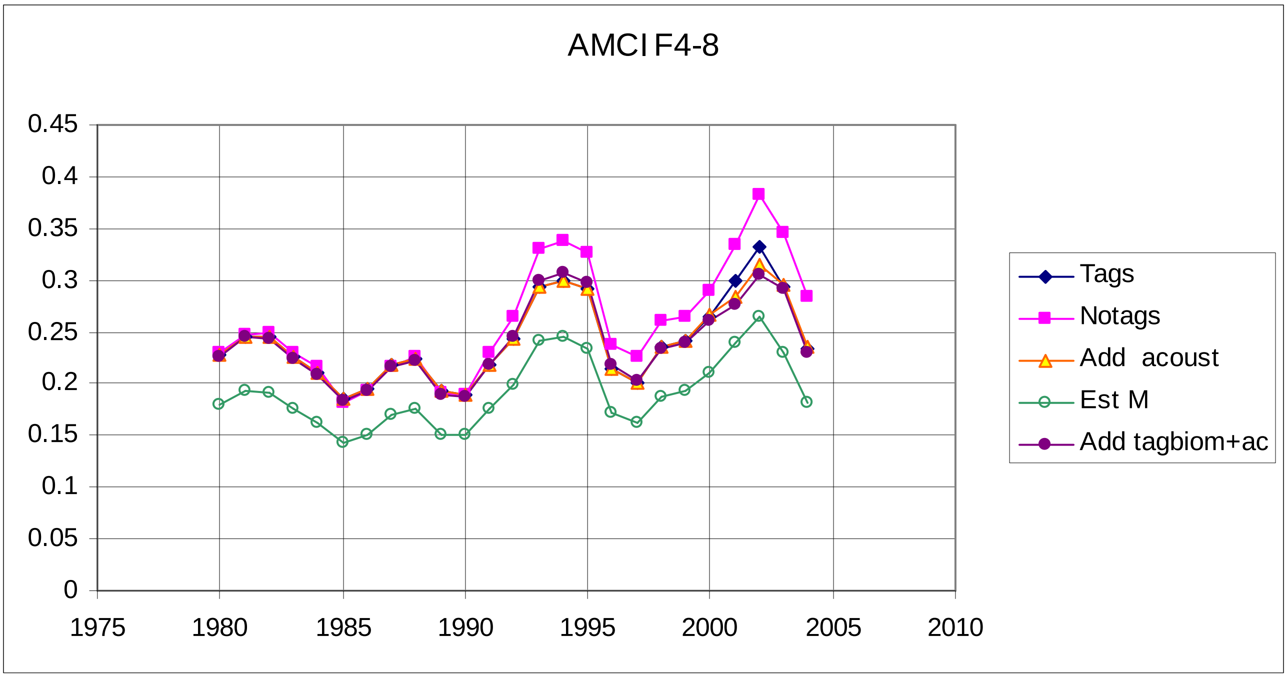


Figure 2.8.4.2.6 NEAM. ISVPA. Bootstrap



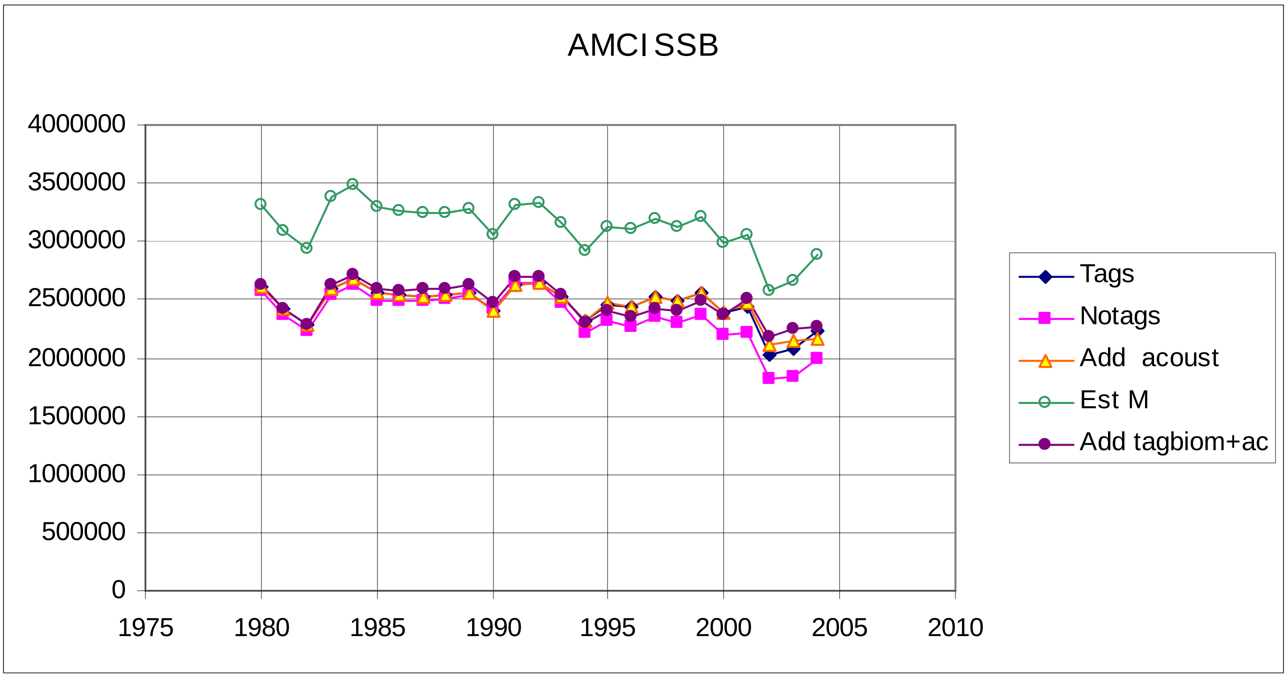


Figure 2.8.4.3.1 Fishing mortalities and SSBs for NEA mackerel estimated with various options by the AMCI software.

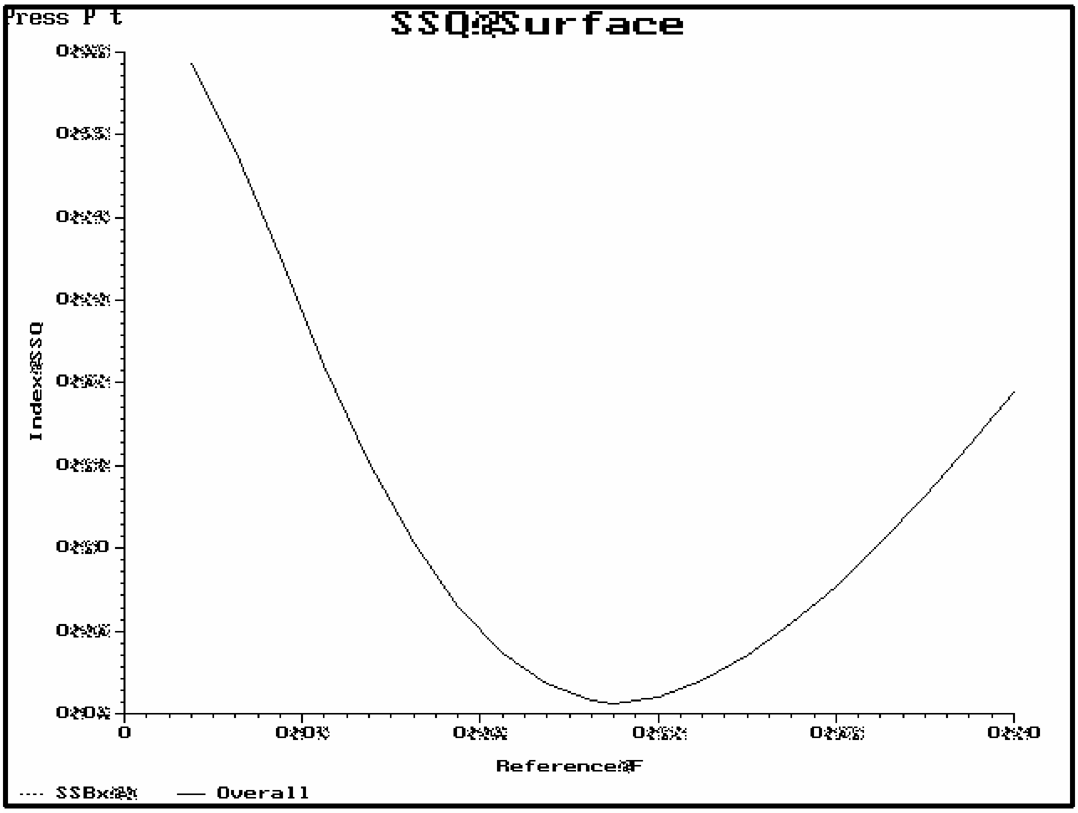


Figure 2.9.1.1 The sum of squares surface for the ICA separable VPA fit to the North East Atlantic mackerel egg survey biomass estimates (period of separable constraint 1992-2004).

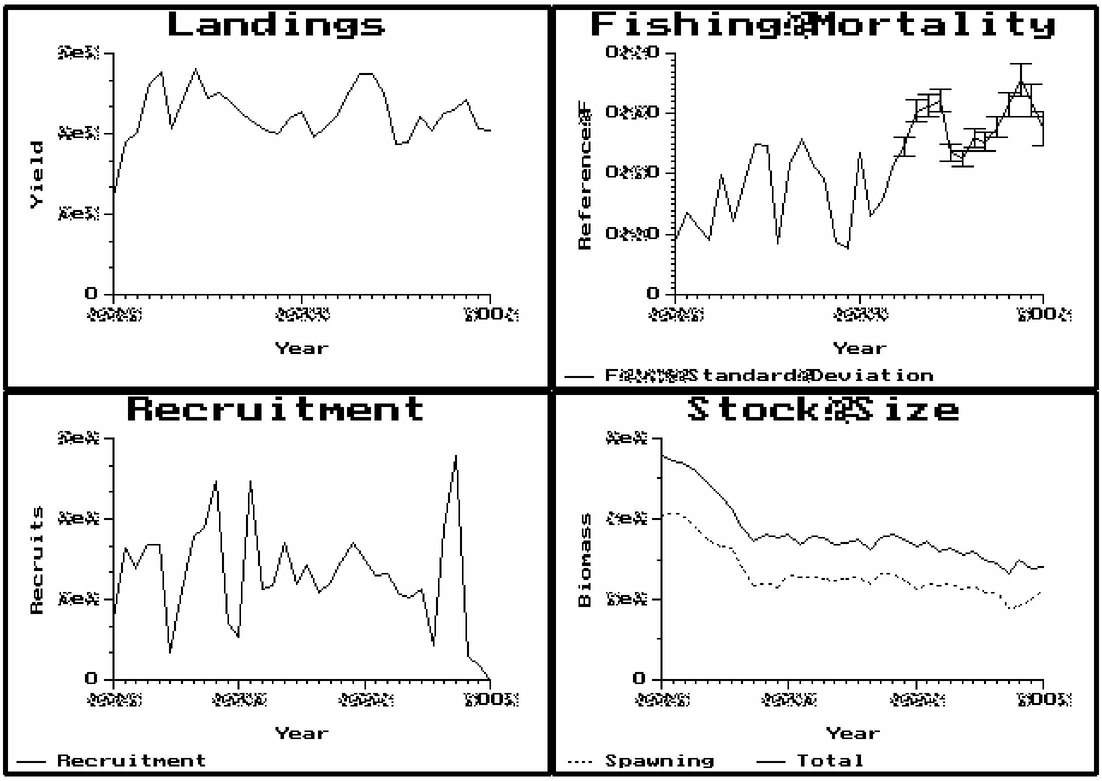


Figure 2.9.1.2 The long term trends in stock parameters for North East Atlantic mackerel. SSB estimates from egg surveys covering the range 1992-2004 are used in the biomass index.

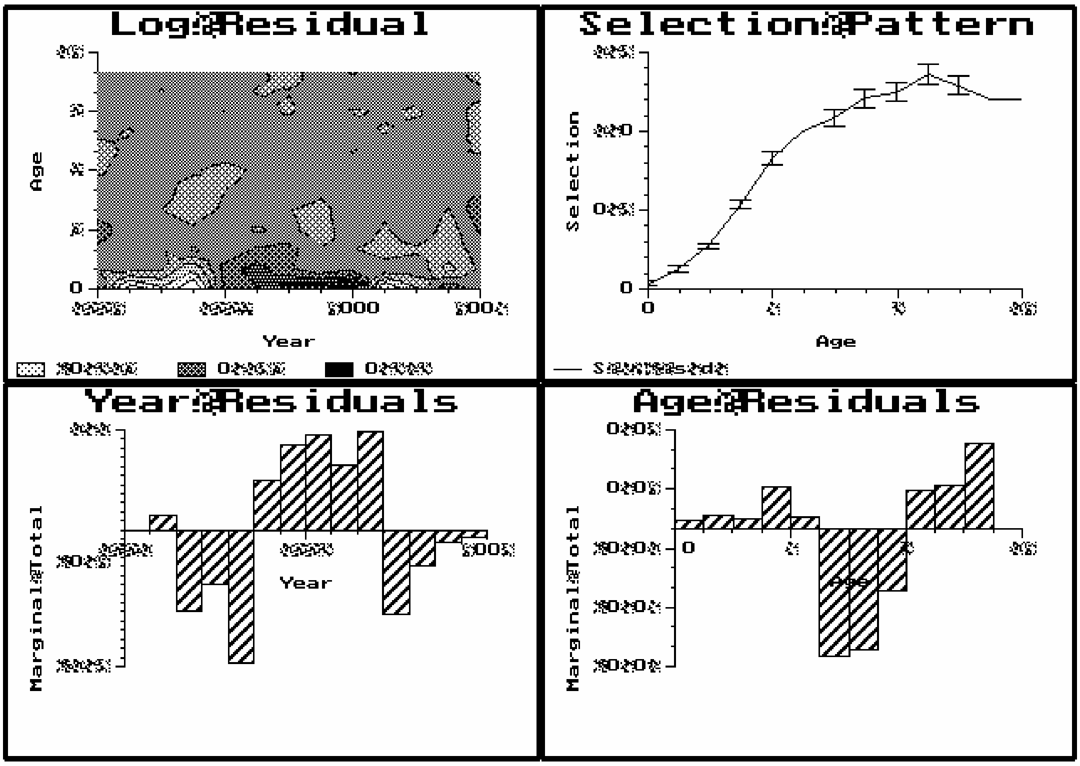


Figure 2.9.1.3 The catch at age residuals and ages fitted by ICA to the North East Atlantic Mackerel data. SSB estimates from egg surveys covering the range 1992-2004 are used in the biomass index and there is only one period of separable constraint (1992-2004).

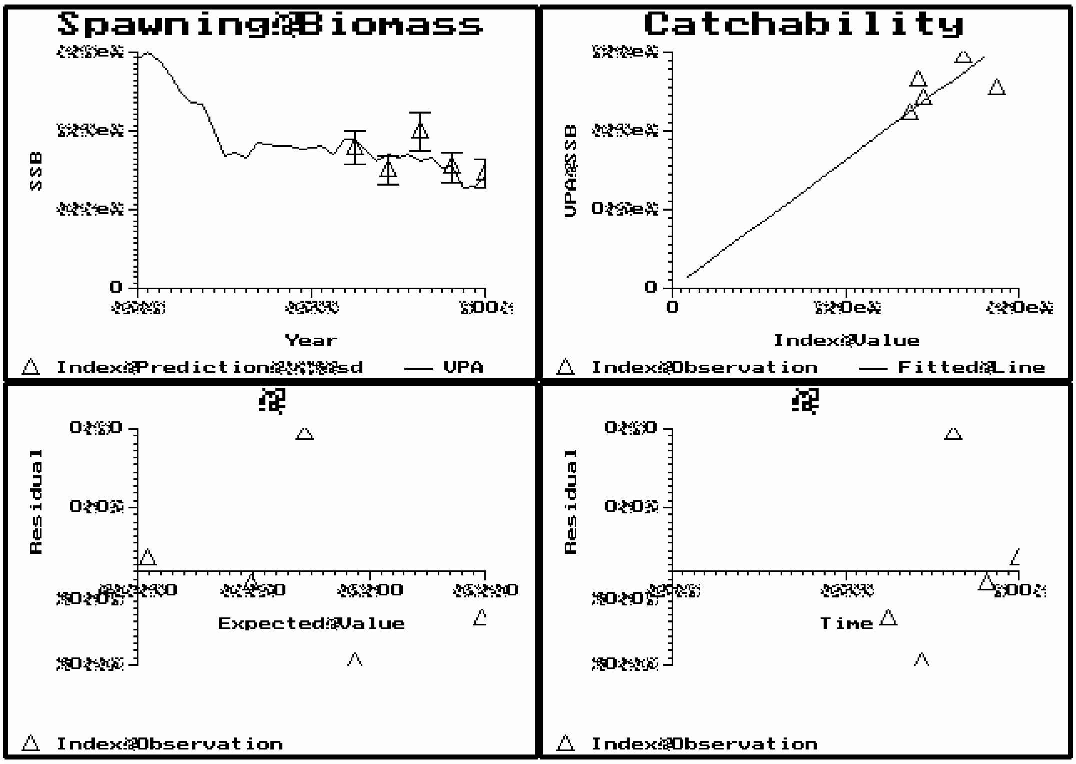


Figure 2.9.1.4 The diagnostics for the egg production index as fitted by ICA to the North East Atlantic Mackerel. SSB estimates from egg surveys covering the range 1992-2004 in the biomass index and there is only one period of separable constraint (1992-2004).

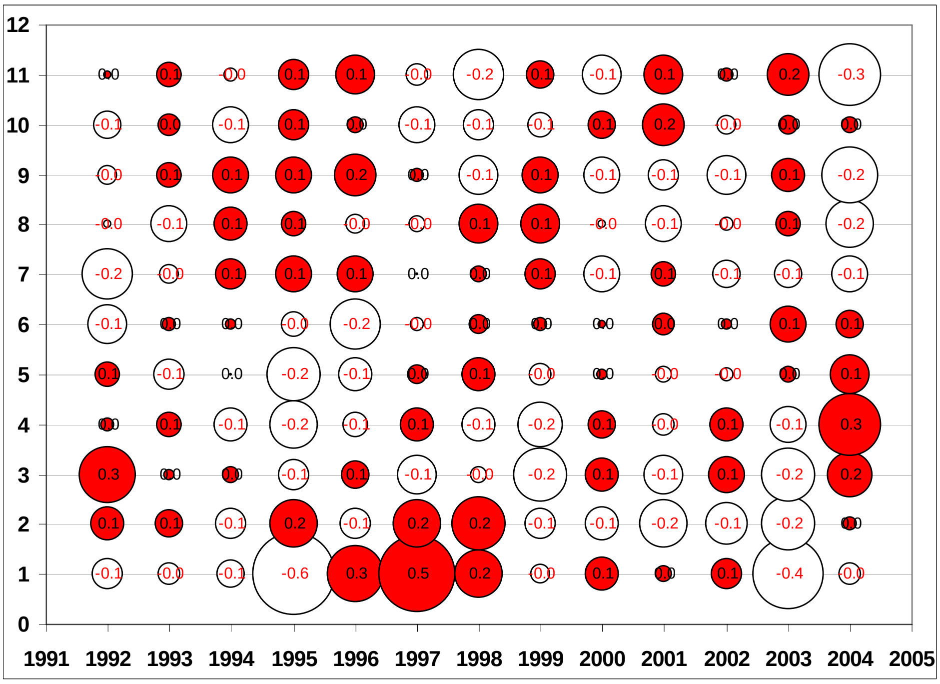


Figure 2.9.1.5 The catch at age residuals and ages fitted by ICA to the North East Atlantic Mackerel data covering the period of separable constraint.

(run 2) Residuals at age 0 and 1 are downweighted resp. 0.01 and 0.1.

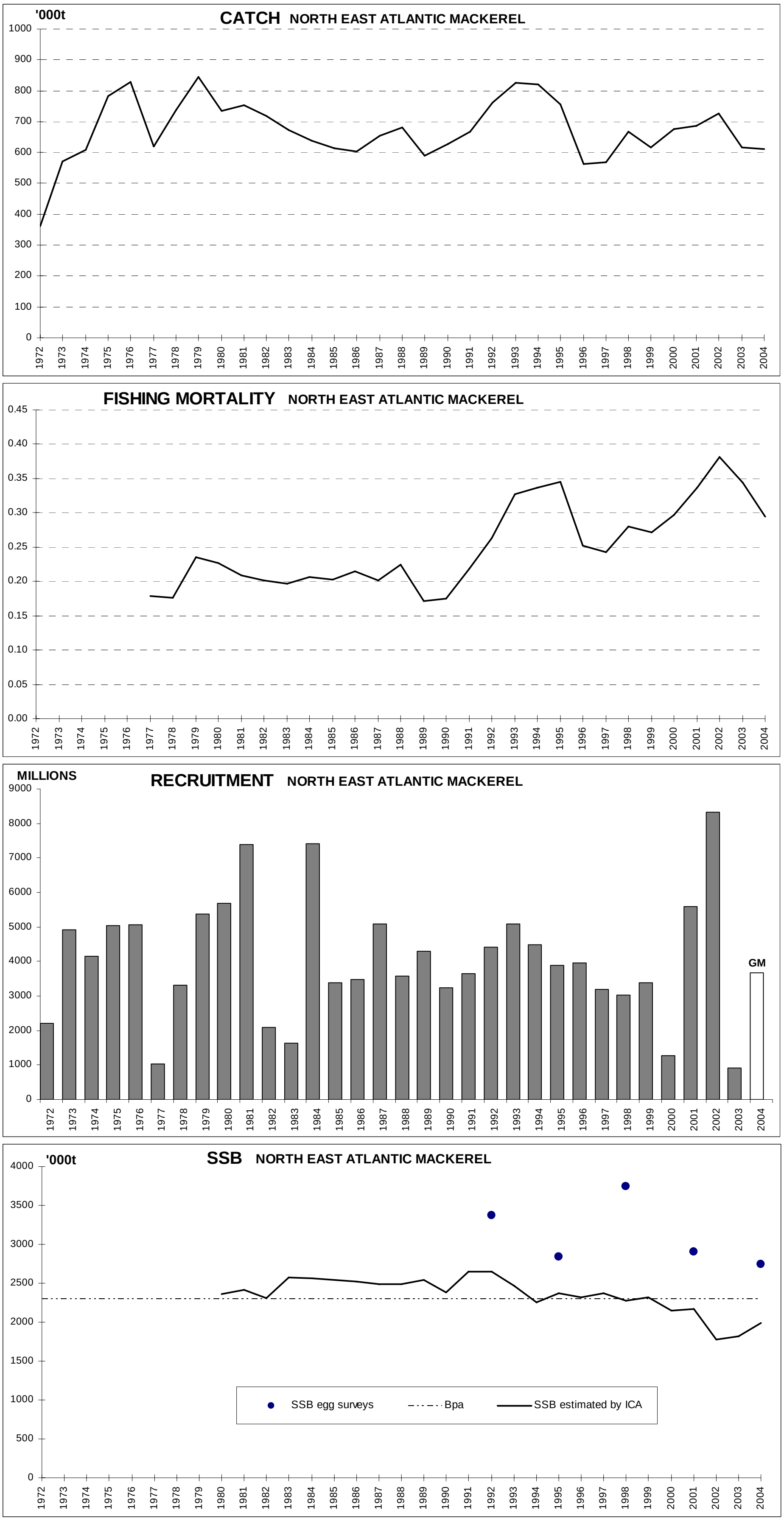


Figure 2.9.1.6 **Catch, SSB, F and recruitment for North East Atlantic Mackerel (ICA) for the period 1972-2004. Biomass estimates from egg surveys in 1992, 1995, 1998, 2001 and 2004 are used for the assessment.**

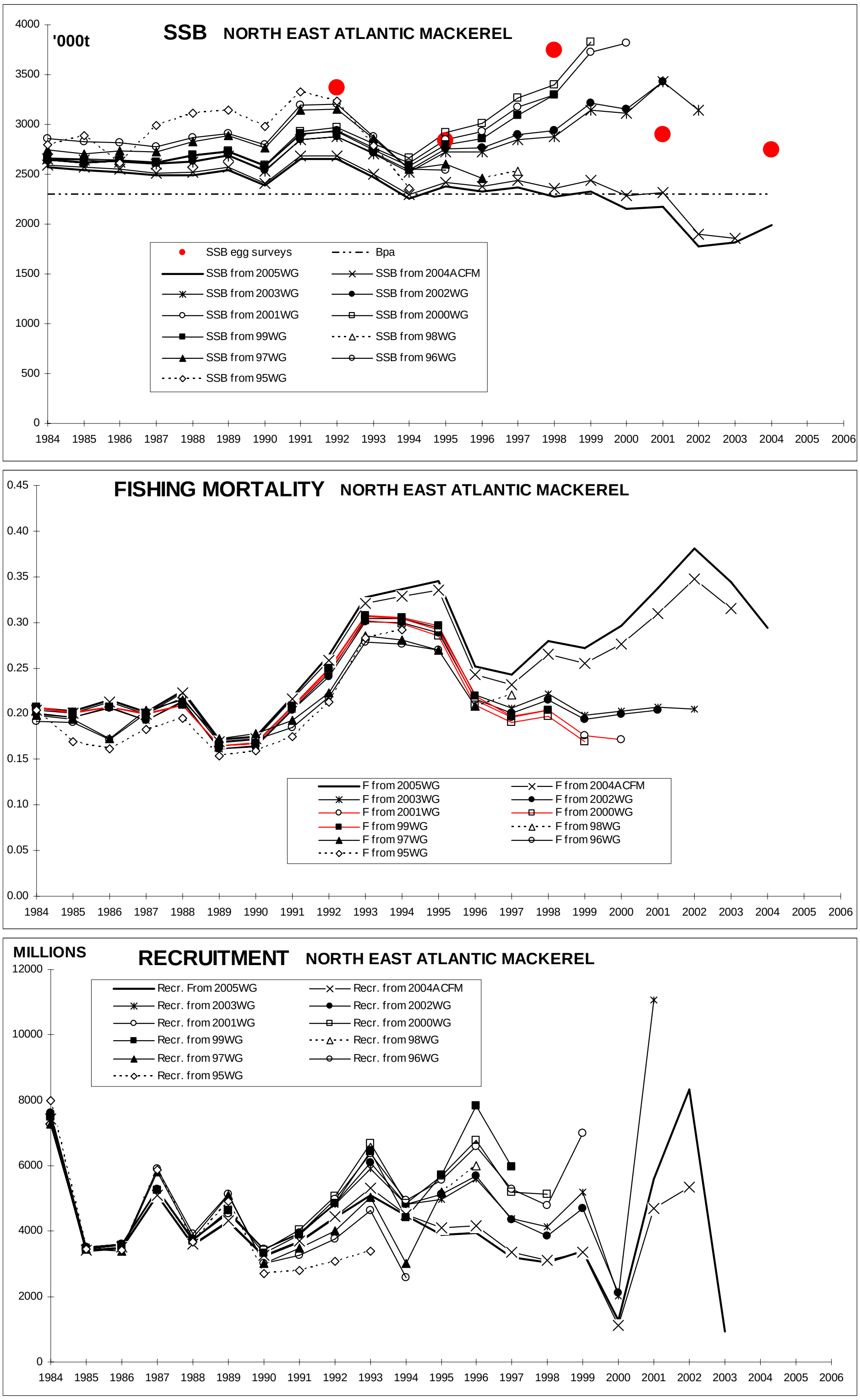


Figure 2.9.2.1 **Comparison of SSB, F(4-8) and recruitment estimates (ICA) obtained at various assessment working group meetings. Biomass estimates from egg surveys in 1992, 1995, 1998, 2001 and 2004 are also shown. At the 1999 - 2001 working groups the 1992, 1995 and 1998 egg survey SSB's and at the 2002 and 2003 WG meetings the 1992, 1995, 1998 and 2001 egg survey SSB's were used. At the 2004 and 2005 WG meeting the 1992, 1995, 1998, 2001 and 2004 egg survey SSB's were used. After the 2004WG meeting ACFM rejected the absolute assessment of the WG; therefore, the relative assessment of ACFM is shown.**
(At the 1998 WG meeting the new assessment was rejected and in stead the 1997 assessment was projected one year forward).

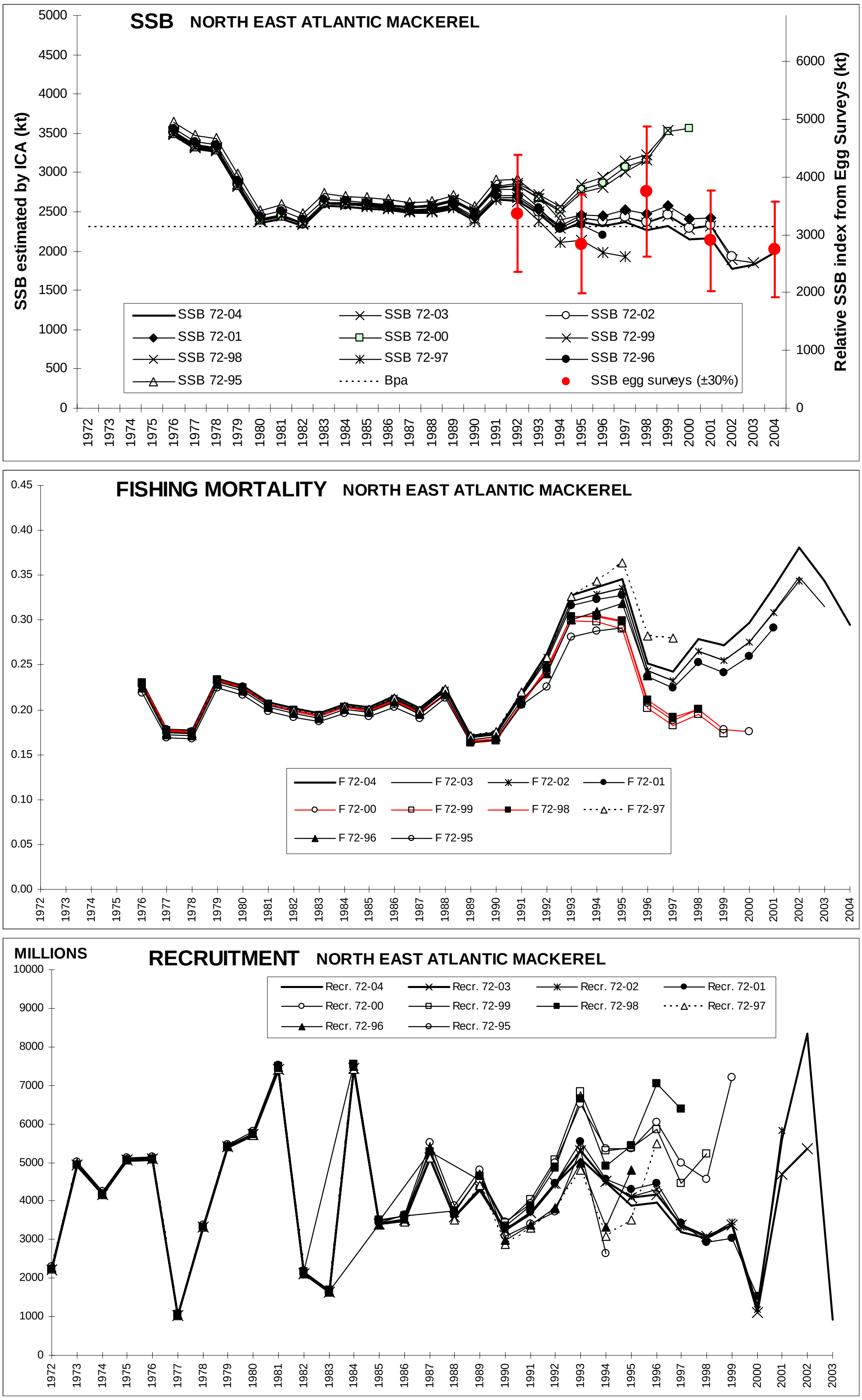


Figure 2.9.2.2 Retrospective analysis by ICA. Egg survey SSB's are used as RELATIVE SSB index. Periods of separable constraint used were from 1992 up to final assessment year.

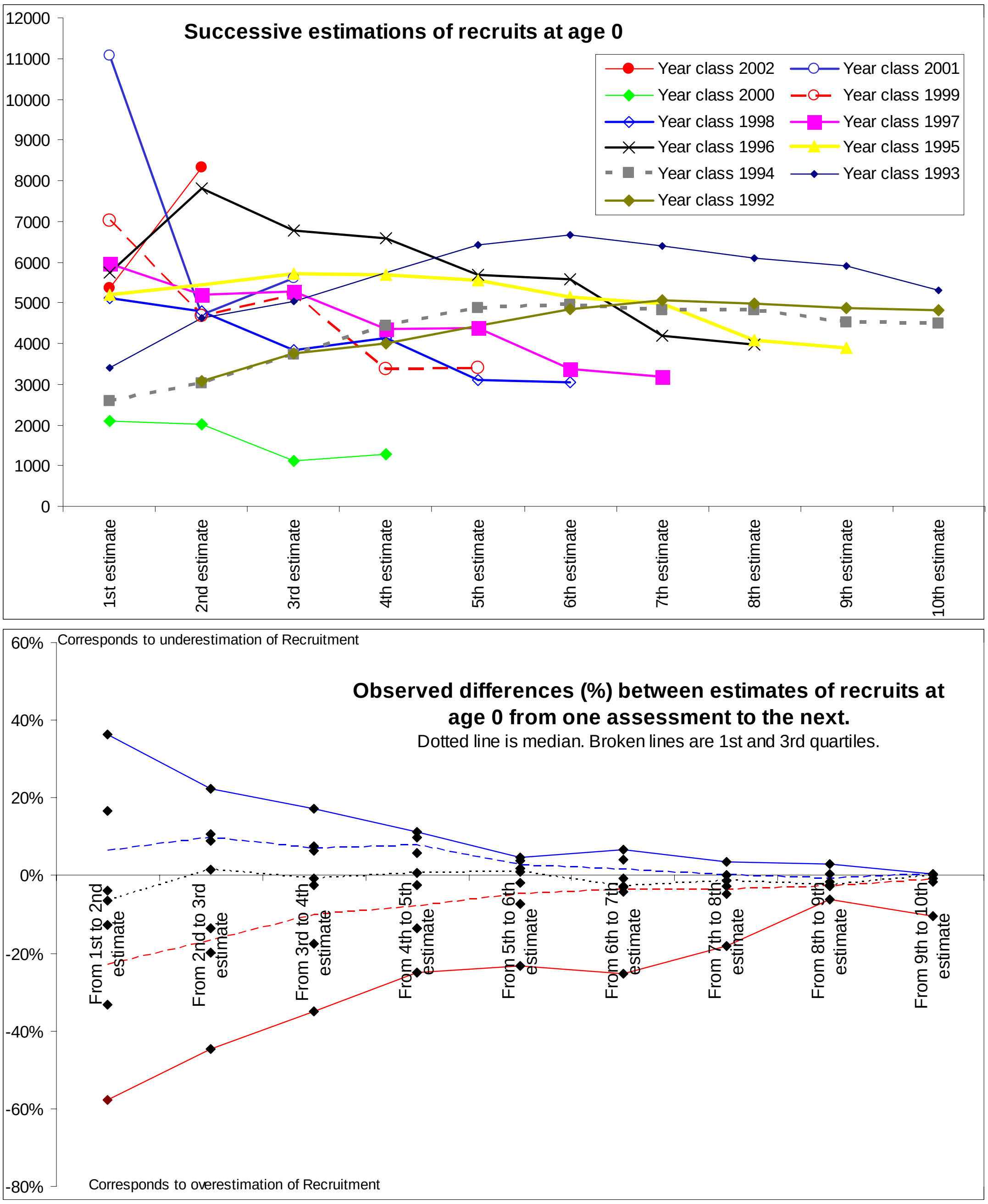


Figure 2.9.2.3 At the annual WG meetings the recruitment strength at age 0 is estimated of all year classes of NEA mackerel (except last year). The first estimation of a year class strength is based on the catch in numbers at age 1 and at age 0 the year before; the second estimation of same year class is one year later and is then based on the catch in numbers of 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.

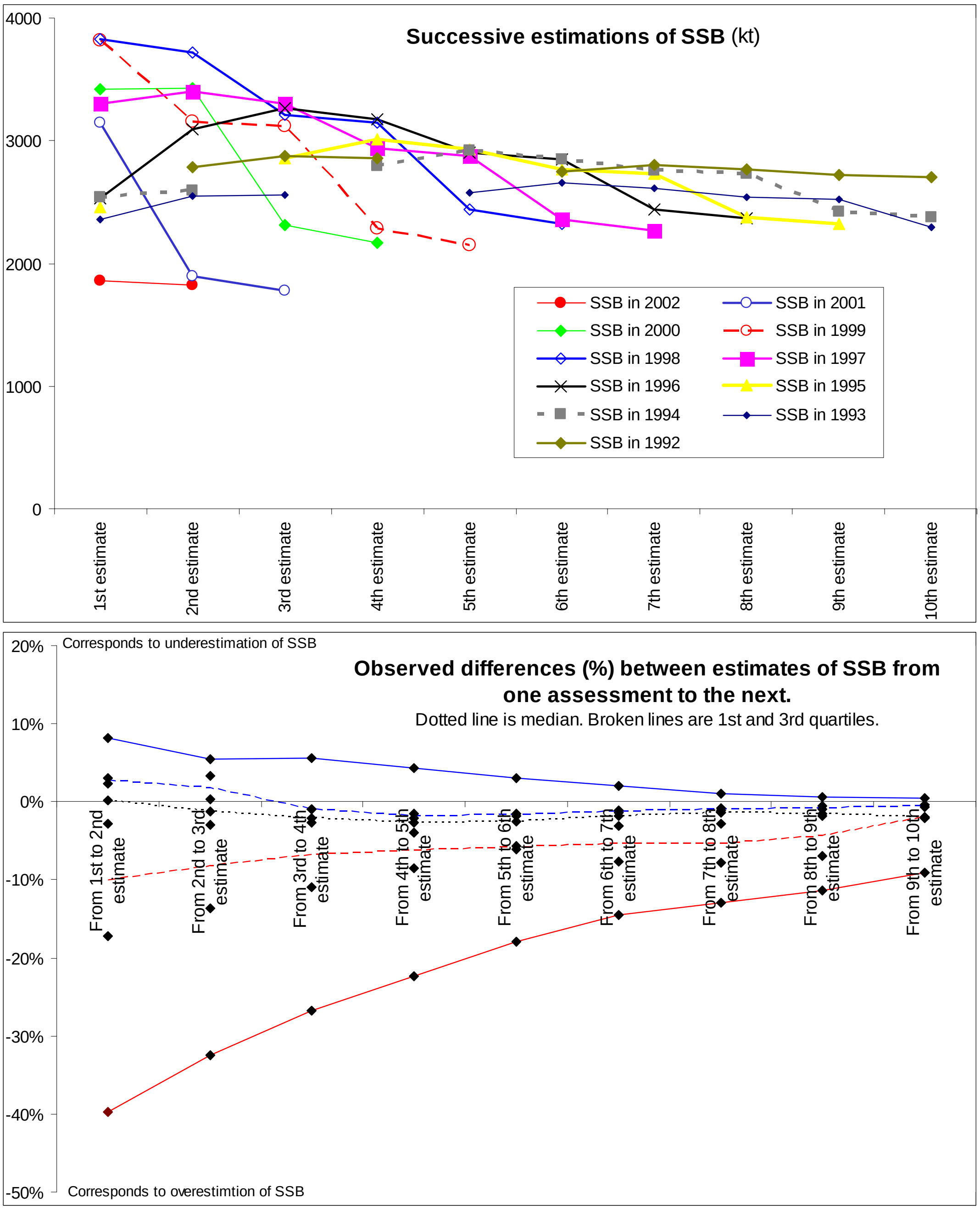


Figure 2.9.2.4 At the annual WG meetings the SSB (kt) is estimated for all years of the assessment period of NEA mackerel. The first estimation of SSB in a certain year is based on the assessment of the WG meeting one year later. The second estimation of SSB in that same year is based on the assessment of the WG meeting two years later. The third estimation of SSB in that same year is based on the assessment of the WG meeting three years later. The fourth estimation of SSB in that same year is based on the assessment of the WG meeting four years later. Etc.. The maximum observed differences (%) between SSB estimates 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 SSB; the median indicates the bias in the successive estimates of SSB. Data are obtained from the ICES quality control tables.

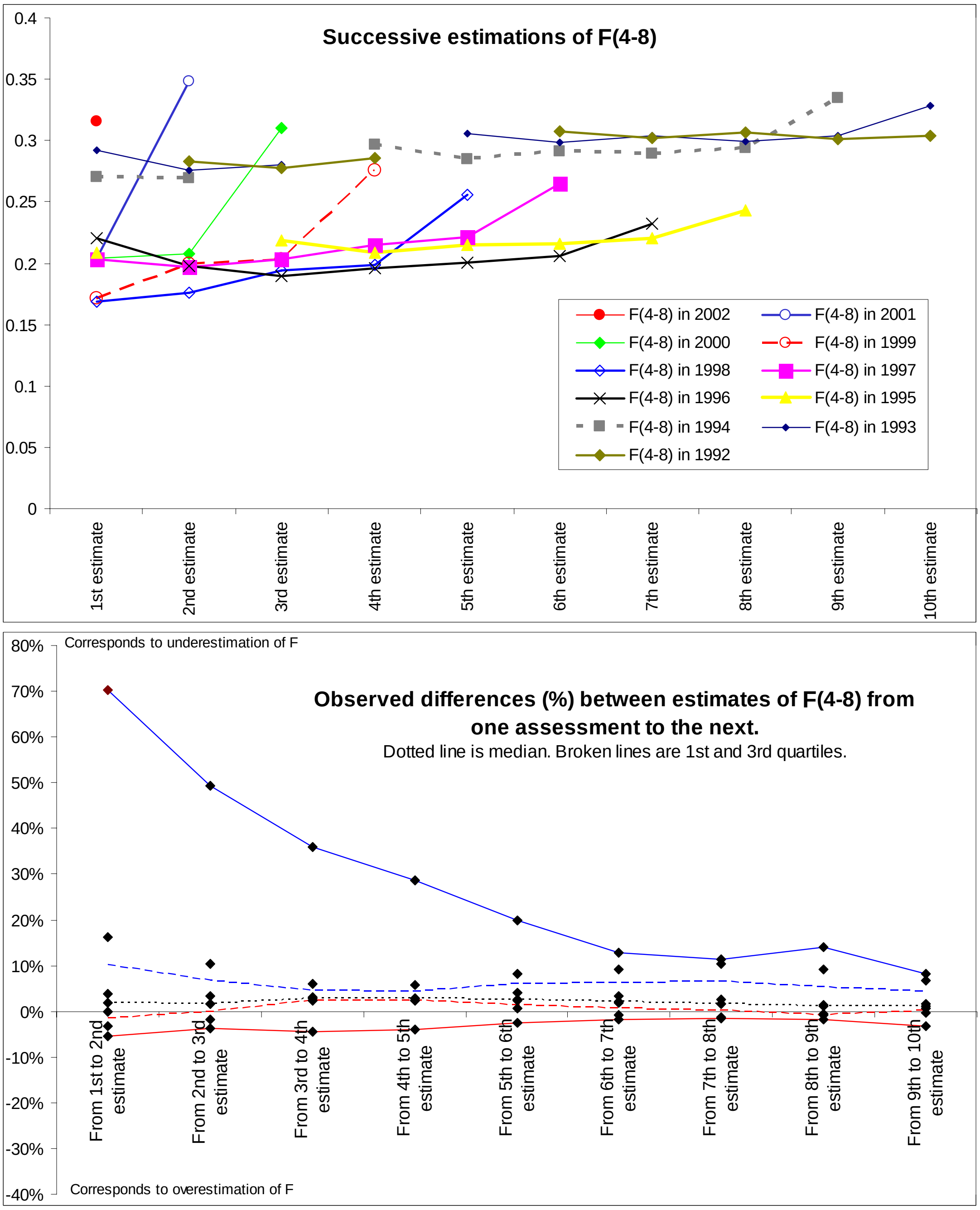


Figure 2.9.2.5 At the annual WG meetings the F(4-8) is estimated for all years of the assessment period of NEA mackerel. The first estimation of F(4-8) in a certain year is based on the assessment of the WG meeting one year later. The second estimation of F(4-8) in that same year is based on the assessment of the WG meeting two years later. The third estimation of F(4-8) in that same year is based on the assessment of the WG meeting three years later. The fourth estimation of F(4-8) in that same year is based on the assessment of the WG meeting three years later. Etc.. The maximum observed differences (%) between F(4-8) estimates 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 F(4-8); the median indicates the bias in the successive estimates of F(4-8). Data are obtained from the ICES quality control tables.

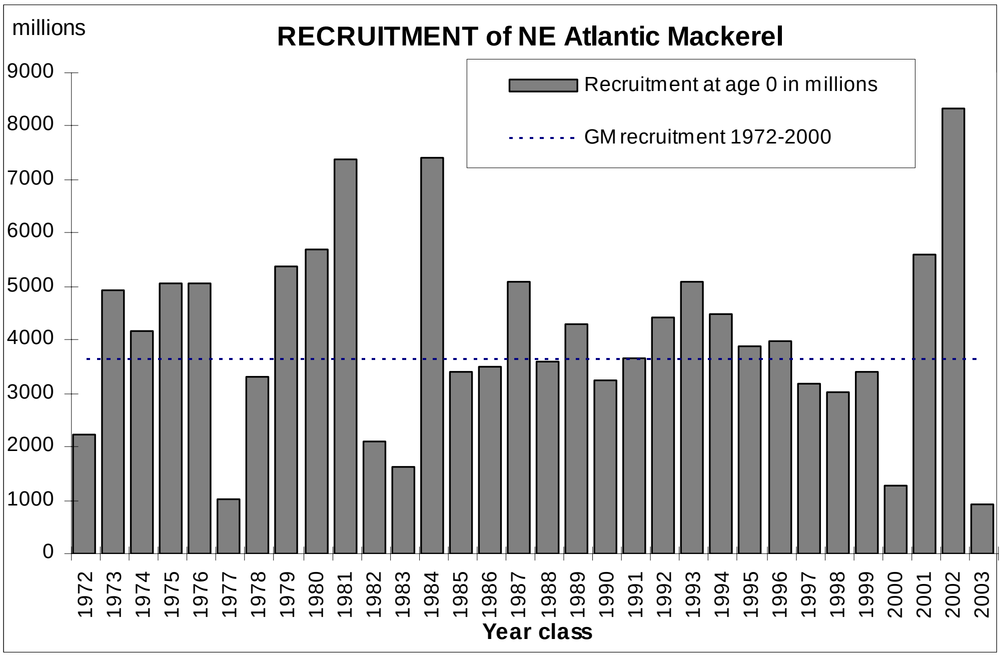


Figure 2.10.1 Recruitment estimates of NEA mackerel from ICA.

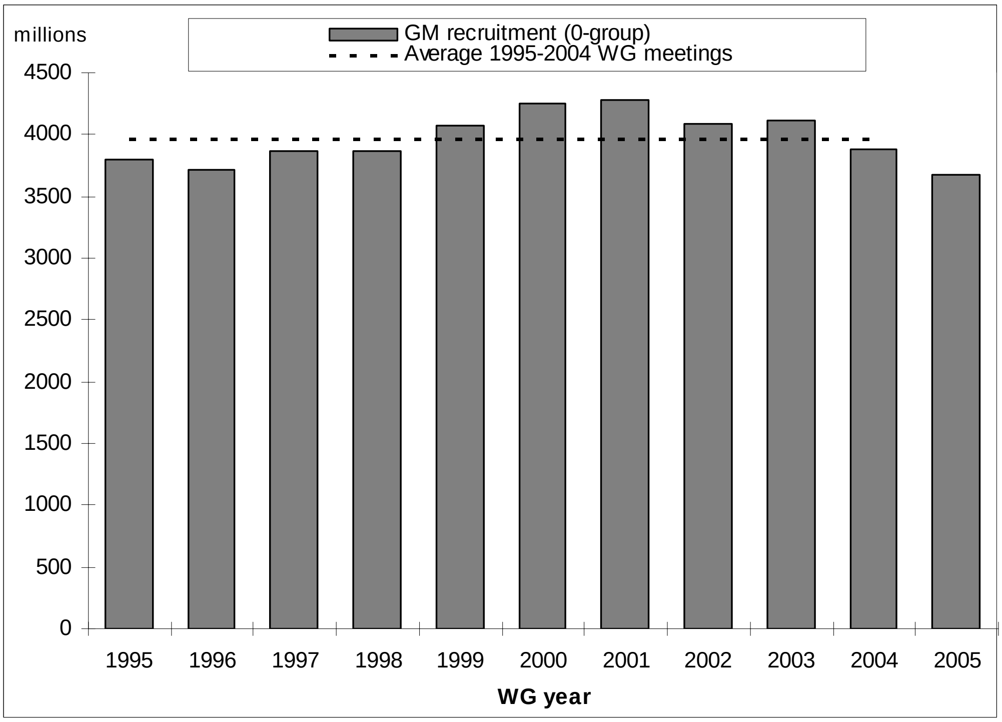


Figure 2.10.2 Annual GM recruitment (0-group) estimates of NEA mackerel as used for the short-term predictions at the various WG meetings from 1995 - 2005. Broken line is the average during the period 1995-2005.

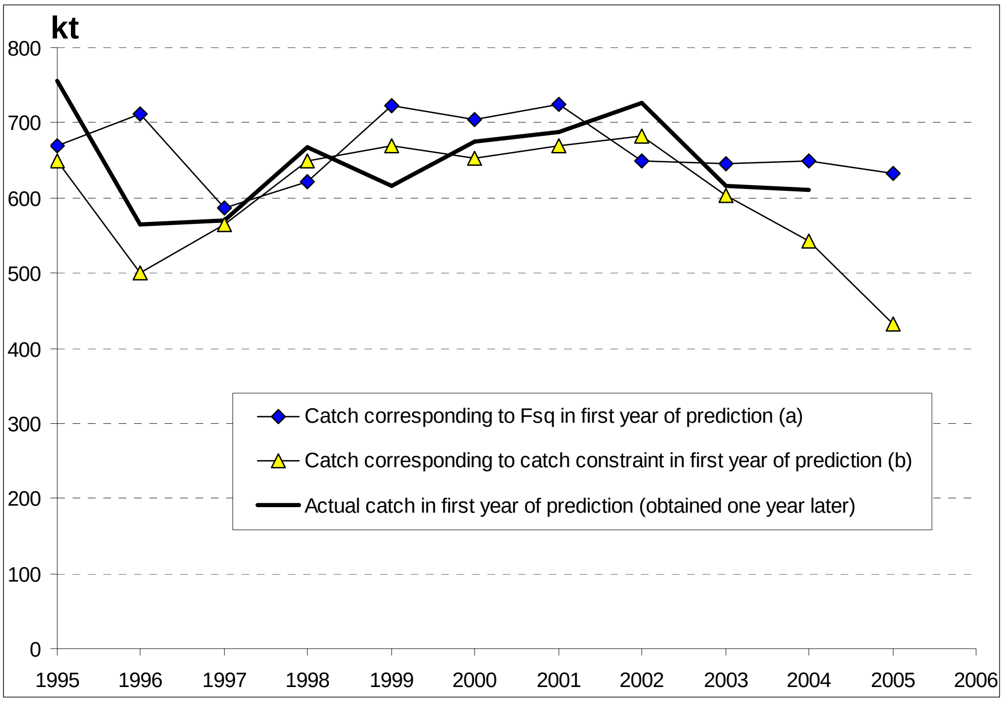


Figure 2.10.3 The catch predictions are carried out for two options: a) a catch corresponding Fsq and b) a catch contstra The actual catch obtained one year after the predictions can be compared to catches of both options to chec which of the two options fits best to it.

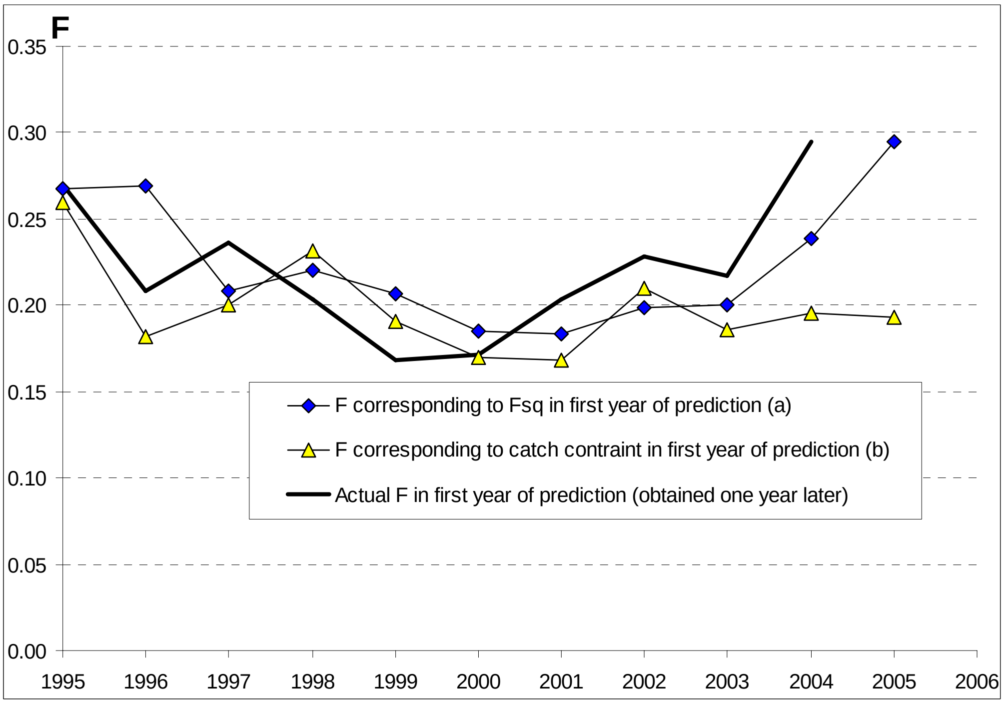


Figure 2.10.4 The catch predictions are carried out for two options: a) a catch corresponding Fsq and b) a catch contstra The actual F obtained one year after the predictions can be compared to F's of both options to check which the options fits best to it.

3 Horse Mackerel

3.1 Fisheries in 2004

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 2004 was 216,361 tons which is 25,500 tons less than in 2003.This is 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. The fishery has changed since the catches were mostly used for meal and oil in eearlier years 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 2004 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 93 % of the total catches.

The geographical distribution of the catches was similar to previous years. In 2004 about 117,100 tons of horse mackerel was caught in the juvenile area (Divisions VIIa,d,e,f,g,h, VIIIa,b,d and IXa). About 42 % of this catch in numbers was from 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 west of Ireland and Norway in the north eastern part of the North Sea.

First quarter: 64,200 tons. This is 8,200 tons less than in 2003. The fishery was mainly carried out west of Ireland, in the Channel and along the Spanish and Portuguese coast (Figure 3.1.1.a).

Second quarter: 22,000 tons. This is 1,000 tons less than in 2003. As usual, rather low catches were taken during the second quarter. 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: 30,200 tons. This is 3,400 tons more than in 2002. As usual the catches were distributed over a relatively larger parts of the distribution area. Small catches are taken in the northern North Sea and in the Norwegian Sea (Figure 3.1.1.c).

Fourth quarter: 99,900 tons. This is 38,300 tons less than in 2003 and the catches were distributed similar to the third quarter but now including relatively large catches in the northern part of the North Sea (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). Since little information from research has been available until recently (HOMSIR, QLK5-Ct1999-01438), this separation was based on the observed egg distributions and the temporal and spatial distribution of the fishery. Western horse mackerel are thought broadly to have similar migration patterns as NEA mackerel. Based on the results from an EU funded project (HOMSIR, QLK5-Ct1999-01 438) the WG last year decided to include Division VIIIc as 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. 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 zero or close to zero. In 2004 these catches were low and represent either 1% of the North Sea stock or 0.3% of the western stock. The Working Group allocated IVa catches to the western stock and Div IIIa catches to the North Sea stock.

North Sea stock: Divisions IIIa (eastern part), IVb,c and VIId. The catches from the two first quarters from Divisions IVa (134 tons) were allocated to the western 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 country have provided data on discards and the amount of discards given in Table 3.3.1 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.

3.5 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. In Divisions VIIIa,b and Subdivision VIIIc East, the decrease observed in *T. mediterraneus* catches comparing with the 2003 catches was about 56%, reaching in 2004 the the lowest figure of the time series. In Sub-divisions VIIIc West, IXa North and IXa South there are no landings of this species. Since 2000 to 2002 there were small catches of *T.mediterraneus* 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 1986-2004 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:

As usual England and Wales, Germany, Ireland, Netherlands, Norway, Portugal and Spain provided length distribution data for parts or for the total of their catches in 2004. These length distributions cover 83 % 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) is primarily responsible for the planning and analysis of the ICES Triennial mackerel and horse mackerel egg surveys. The working group reported the following conclusions (ICES, 2005/G:09):

The 2004 surveys were carried out according to the plan laid out in the 2003 and 2004 reports of WGMEGS (ICES, 2003/G:07 and ICES, 2004/G:10), and were modified and adapted by the survey coordinators during the surveys themselves. Within the periods chosen for the survey, the spatial and temporal coverage was generally good, although there were some periods where additional sampling would have been helpful – particularly the Cantabrian Sea and the western area south of 52°N in period 2, and across the western area in period 7. In general, sampling appeared to cover the bulk of the spatial range of horse mackerel spawning, and reached zero samples along most of the edges of the distribution.

Egg production

Total annual egg production for horse mackerel in the western area in 2004 was calculated as 0.678×10^{15} with a standard error of 0.150×10^{15}. This can be compared to the 0.684×10^{15} in 2001.

Total annual egg production for horse mackerel in the southern area in 2004 was calculated as 0.248×10^{15} with a standard error of 0.121×10^{15}. This can be compared to the 0.171×10^{15} in

2001. Recent work has indicated that the geographical split between southern and western horse mackerel should change, placing Division VIIIc in the western area. New time series of egg production were calculated based on this change up to and including 2004, and included in the report.

Fecundity

Horse mackerel fecundity remained difficult to determine in the early part of spawning it was calculated at 215 eggs per gram female rising to a maximum of 1152 eggs per g female by the time of peak spawning. It is not possible currently to use this estimate to provide a realistic estimate of the spawning biomass

Estimation of Spawning Stock Biomass

WGMEGS identified two candidate proxies for fecundity in horse mackerel that may have had value in providing a biomass estimate. These were feeding state and lipid content. In order to assess energy intake the stomach content of the horse mackerel was monitored throughout the spawning season. However, results showed no evidence of feeding during spawning and there was no sign of regurgitation, indicating that this could not be used as a proxy. Large numbers of fish were collected and frozen for analysis of total lipid content. The results of this analysis showed a considerable variation in both fecundity and lipid content during the spawning season. These results suggest that it is not currently possible to derive an index to convert egg production into SSB of horse mackerel.

Table 3.1.1 Catches (t) of HORSE MACKEREL 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[1]
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

[1]Preliminary.

Table 3.1.2 Quarterly catches of HORSE MACKEREL by Division and Sub-division in 2004.

Division	1Q	2Q	3Q	4Q	TOTAL
IIa+Vb	0	0	26	21	47
IIIa	302	1	10	38	351
IVa	111	23	118	11,589	11,841
IVbc	9,371	1,456	1,975	5,546	18,348
VIId	4,579	230	774	10,872	16,455
VIa,b	2,772	78	11,785	7,293	21,928
VIIa–c,e–k	34,166	7,532	2,114	55,872	99,684
VIIIa,b,d,e	4,812	2,562	528	452	8,354
VIIIc	2,508	2,768	6,374	4,122	15,772
IXa	5,642	7,407	6,486	4,046	23,581
Sum	64,263	22,057	30,190	99,851	216,361

Table 3.3.1 Landings and discards of HORSE MACKEREL (t) by year and Division, for the North Sea, Western, and Southern horse mackerel. (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

[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 Landings (t) of *Trachurus mediterraneus* in Divisions VIIIab, VIIIc and IXa and Sub-area VII in the period 1989-2004 and *Trachurus picturatus* in División IXa, Subarea X and in CECAF Division 34.1.1 in the period 1986-2004.

	Divisions	Sub-Divisions	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
T. mediterraneus	**VII**		**-**	**-**	**-**	0	0	0	0	0	0	0	0	0	0	0	59	1	1	0	0
	VIIIab		**-**	**-**	**-**	23	298	2122	1123	649	1573	2271	1175	557	740	1100	988	525	525	340	53
	VIIIc	VIIIc East	-	-	-	3903	2943	5020	4804	5576	3344	4585	3443	3264	3755	1592	808	1293	1198	1699	841
		VIIIc west	-	-	-	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
	IXa	IXa North	-	-	-	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
		Total	-	-	-	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**
T. picturatus	**IXa**		367	181	2370	2394	2012	1700	1035	1028	1045	728	1009	834.01	526	320	464	420	663	773	508
	X Azorean Area		3331	3020	3079	2866	2510	1274	1255	1732	1778	1822	1715	1920	1473	690	563	1089	5000	1509	1244.2
	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
	TOTAL		**5704**	**4734**	**7136**	**6824**	**6385**	**4135**	**3082**	**3290**	**3120**	**2756**	**3117**	**3516**	**2657**	**1354**	**1672**	**1894**	**6021**	**2854**	**2405**

(-) Not available

Table 3.6.1 Length distributions (%) of HORSE MACKEREL catches by fleet and country in 2004 (0.0=<0.05%)

	E&W	Neth	Germany						Norway	Spain			Portugal			Ireland	
	P. trawl	P.trawl	Trawl						P.seine	P.seine	D.trawl	Artisanal	Trawl	P. Seine	Artisanal		Trawl
cm	VIIe	All	VIa	VIIb	VIId	VIIe	VIIh	VIIj	IVa	All	All	All	All	All	All	VIa	VIIb
5																	
6																	
7																	
8										0.0			0.0				
9										0.0			0.1				
10										0.1			0.3	1.0	0.1		
11										1.3			0.9	6.4	1.4		
12										4.9	0.0		4.1	7.3	11.0		
13										10.7	0.0		12.6	9.0	14.5		
14										9.8	0.0		15.4	7.0	7.1		
15										10.9	0.2		13.9	3.8	2.9		
16		0.1								13.7	0.1		11.7	4.0	2.1		
17	1.2	0.2				0.7	0.0			9.4	0.7		10.0	7.9	2.8		
18	0.1	2.5			5.6	1.6	0.5			5.2	3.3		7.4	14.2	2.7		
19	1.4	4.4			16.0	3.3	1.5			4.1	5.5		5.2	9.5	1.9		
20	0.2	4.1			13.0	6.1	11.6	0.0		2.9	5.1	0.1	3.7	5.3	0.7		
21	2.5	11.3			17.1	15.1	23.5	0.1		2.7	1.4	0.0	1.4	4.1	0.8	0.1	
22	3.6	14.8		0.1	15.5	24.8	21.9	0.2	0.1	2.5	1.3	0.1	0.9	2.9	0.8	0.8	2.7
23	1.2	16.5		0.2	15.6	18.9	13.2	0.8		2.3	1.0	0.7	1.0	2.5	1.4	9.1	17.4
24	3.7	9.5		0.9	8.6	10.9	10.1	3.0		2.6	1.4	1.1	1.5	3.1	2.8	23.4	21.6
25	9.6	9.1		4.3	4.2	8.1	7.4	15.4		2.6	1.3	0.9	2.0	4.8	4.0	24.3	12.4
26	18.0	6.9		7.4	2.5	5.6	5.3	23.7	0.2	2.6	2.3	1.6	1.9	4.6	5.5	17.3	13.5
27	21.5	6.3	3.1	10.1	1.5	3.4	3.3	16.6	0.2	3.2	4.8	5.9	1.6	1.9	6.8	14.7	13.1
28	15.6	4.2	8.8	11.5	0.2	0.9	1.5	13.9	0.5	2.6	8.6	6.2	1.6	0.5	8.0	7.2	7.8
29	9.5	3.5	18.2	9.8	0.3	0.5	0.3	10.6	1.5	2.1	13.0	10.1	1.1	0.2	7.4	2.4	3.5
30	6.0	1.9	17.0	9.8		0.1	0.0	7.0	4.4	1.3	12.9	11.7	0.7	0.1	5.9	0.7	1.7
31	4.7	1.5	11.3	10.3				2.9	6.4	0.9	11.5	9.5	0.4	0.0	3.5	0.0	0.8
32		0.5	6.9	11.1				2.4	11.3	0.5	8.2	10.3	0.2	0.0	2.0	0.0	0.8
33		0.8	6.9	7.8				1.3	14.1	0.3	5.0	11.6	0.1		1.3		0.6
34		0.7	13.2	5.9				0.8	16.3	0.2	4.7	9.0	0.1		0.9		0.6
35	1.2	0.6	5.7	4.2				0.5	14.1	0.1	3.0	9.0			0.6		0.4
36		0.2	3.8	2.7				0.4	13.9	0.2	1.8	3.5			0.5		0.6
37		0.3	3.1	1.7				0.1	11.8	0.1	1.5	3.8			0.3		0.3
38		0.1	1.9	1.0				0.1	2.5	0.1	0.7	2.6			0.1		0.1
39				0.6					2.0	0.0	0.4	1.1			0.1		0.4
40		0.0		0.3					0.5	0.0	0.2	0.4			0.0		0.1
41				0.1					0.2	0.0	0.1	0.2			0.0		0.3
42+				0.1						0.0	0.1	0.5			0.0		1.2

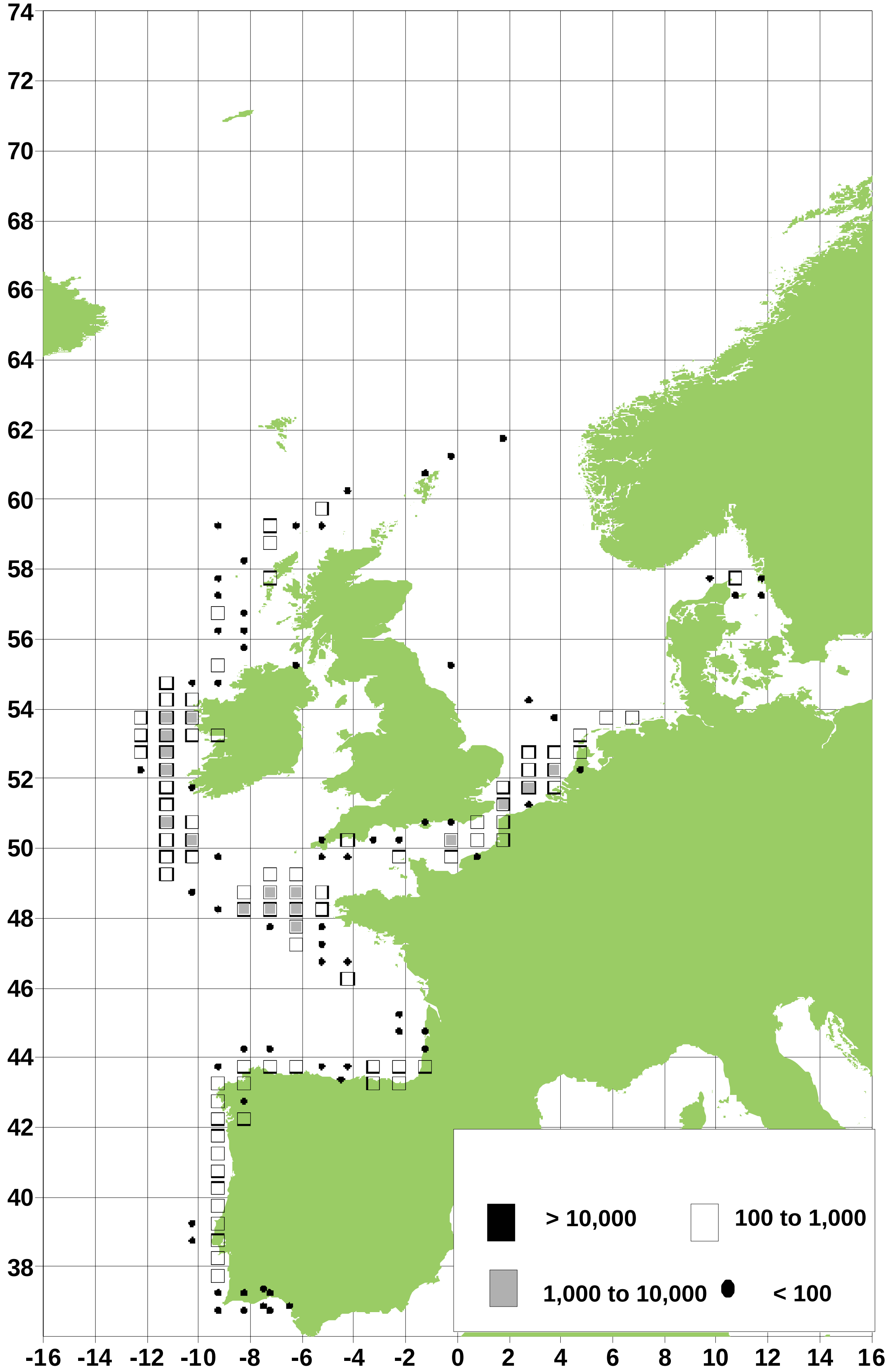


Figure 3.1.1a Horse Mackerel commercial catches in quarter 1 2004.

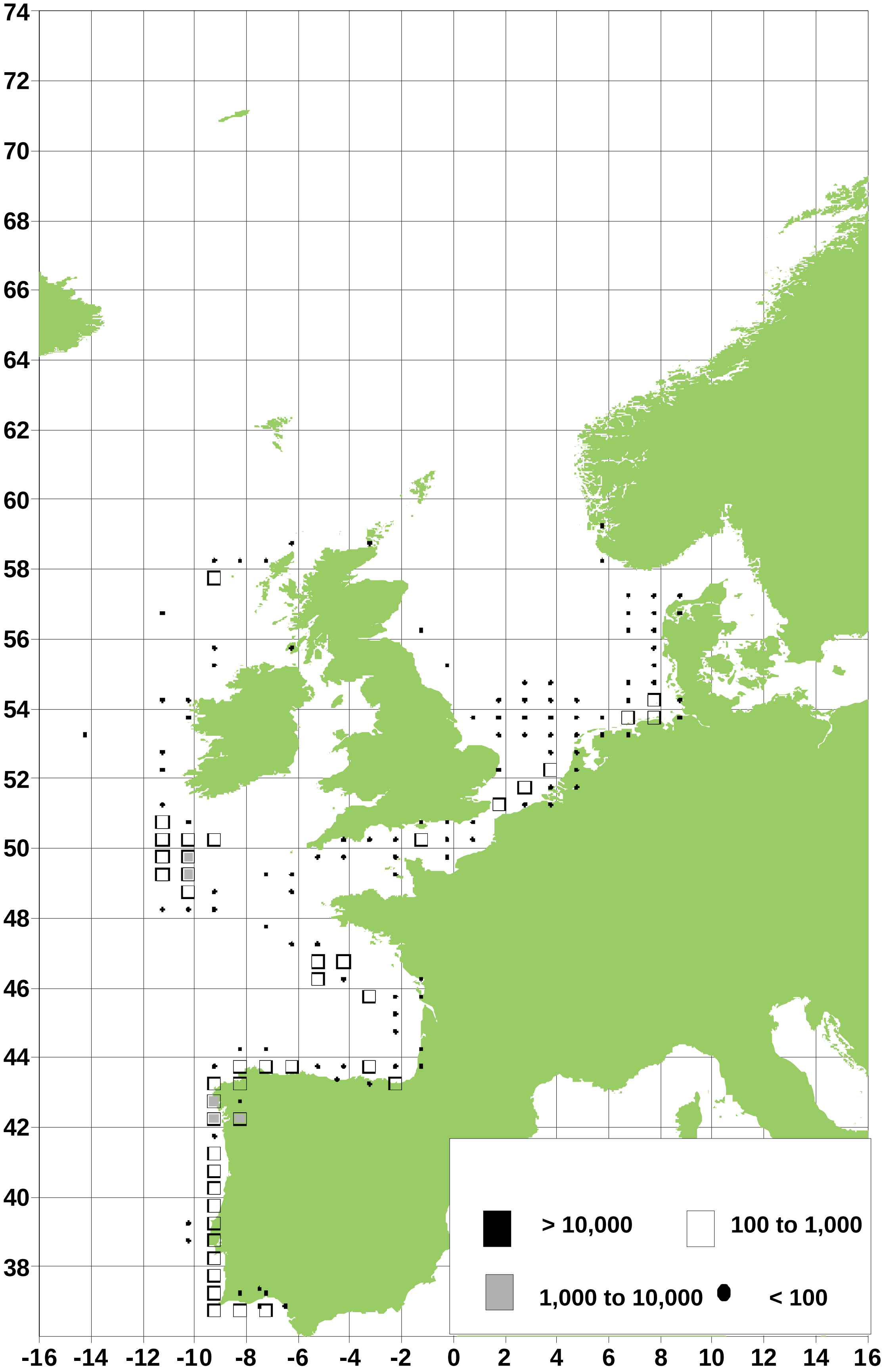


Figure 3.1.1b Horse mackerel commercial catches in quarter 2 2004.

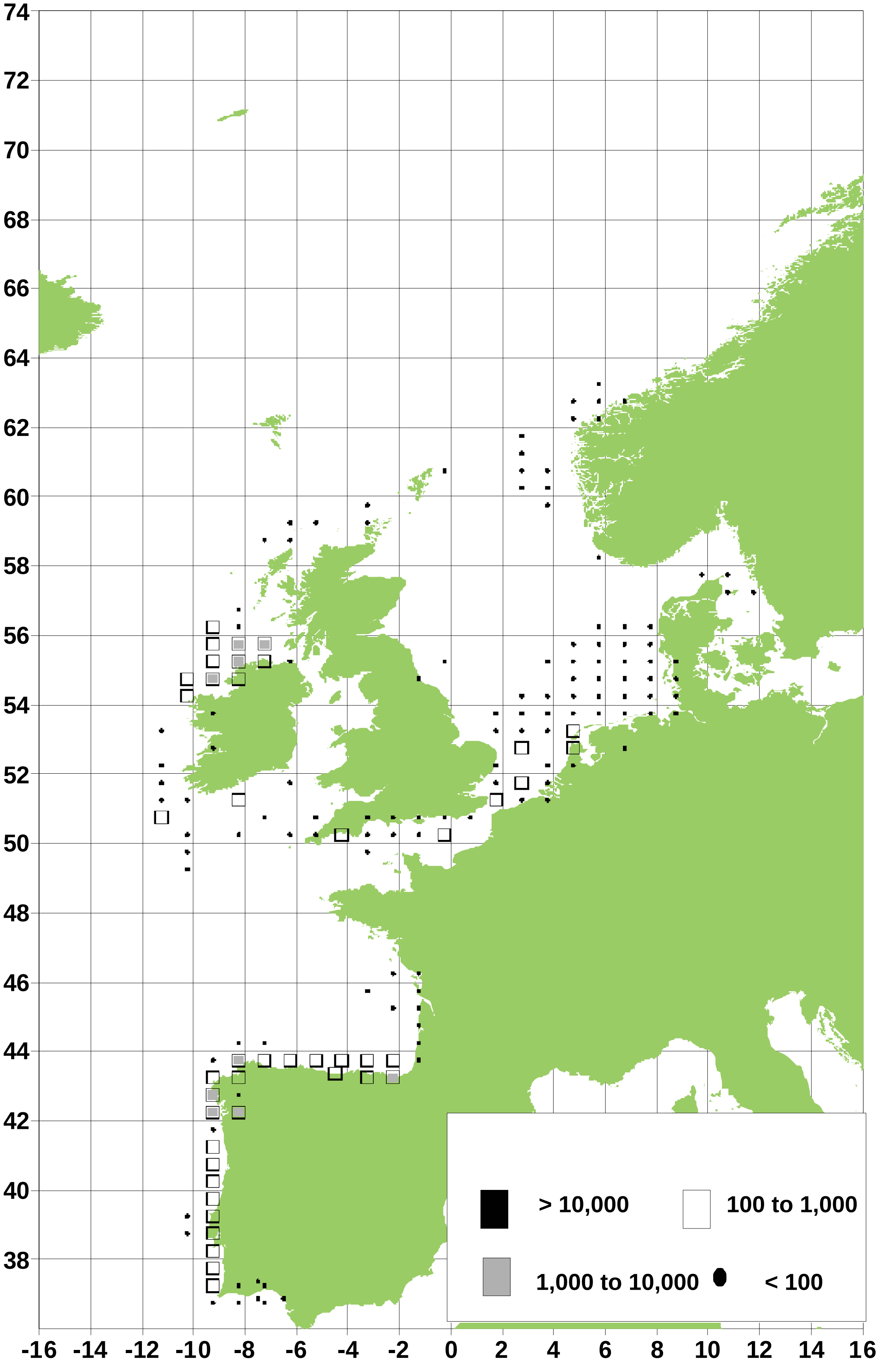


Figure 3.1.1.c Mackerel commercial catches in quarter 3 2004.

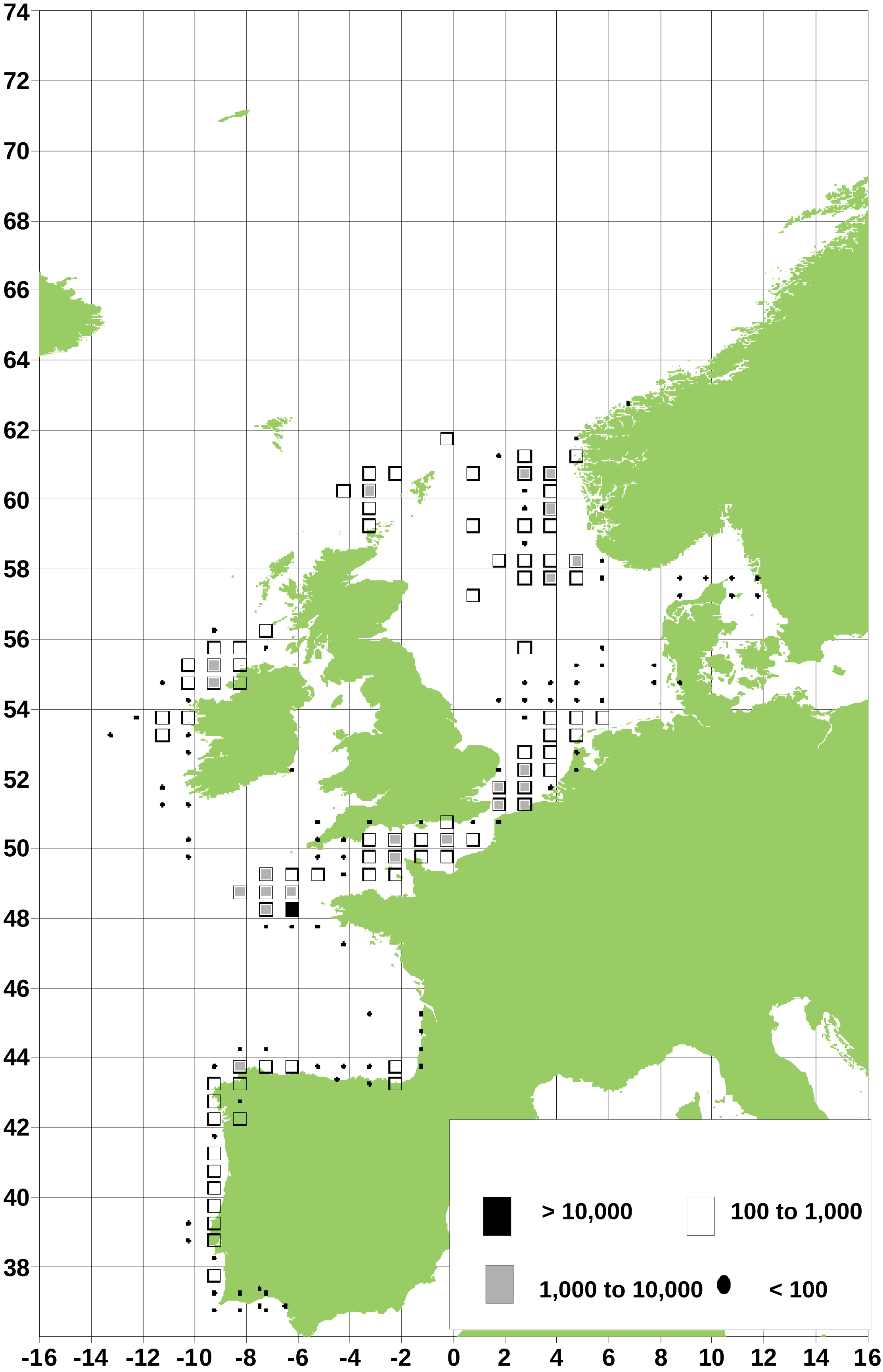


Figure 3.1.1d Horse mackerel commercial catches in quarter 4 2004.

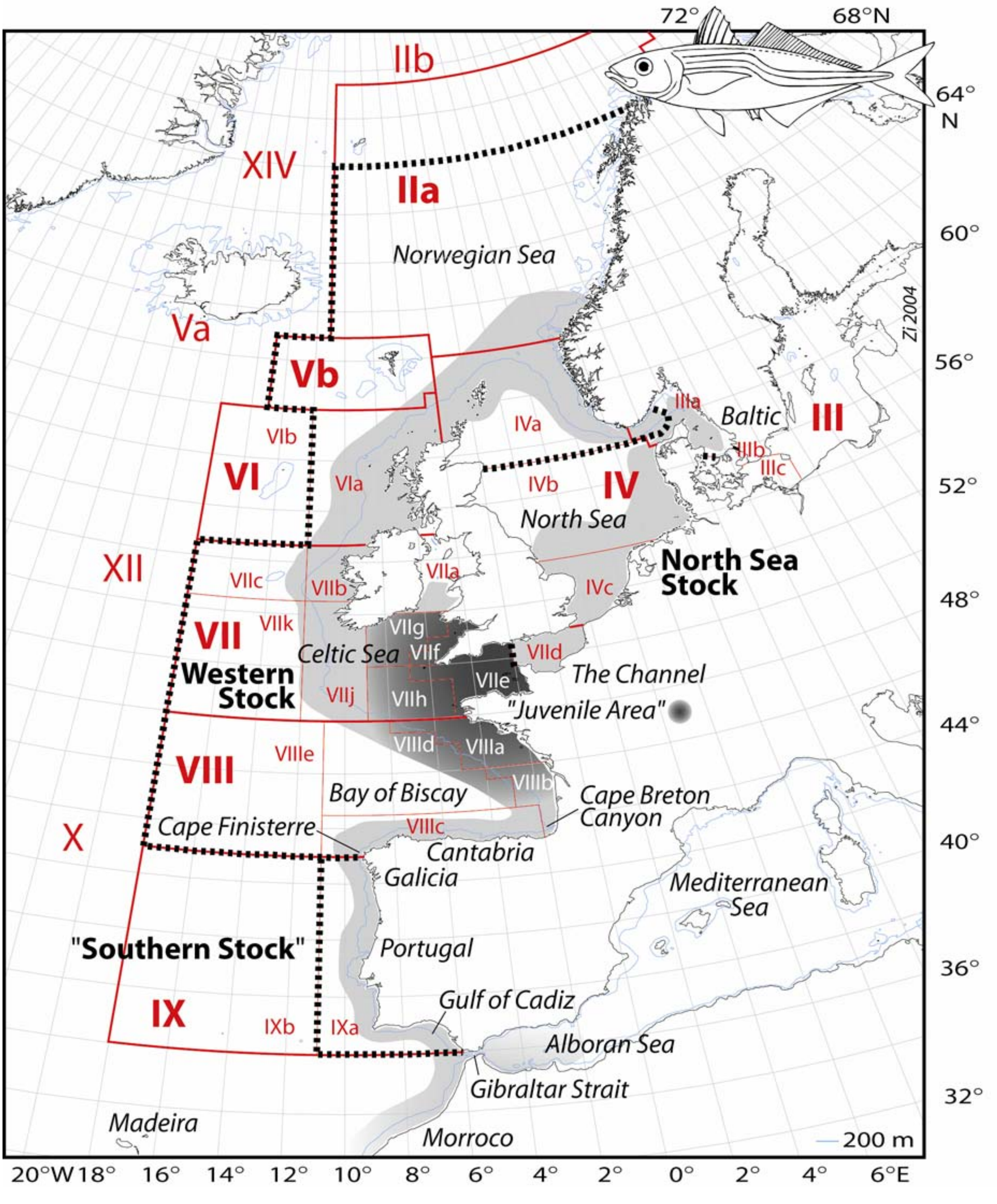


Figure 3.2.1: Distribution of Horse Mackerel in the Northeast-Atlantic: Stock definitions as used by the 2004 WG MHSA. Note that the "Juvenile Area" is currently only defined for the Western Stock distribution area – juveniles do also occur in other areas (like in Div. VIId). Map source: GEBCO, polar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

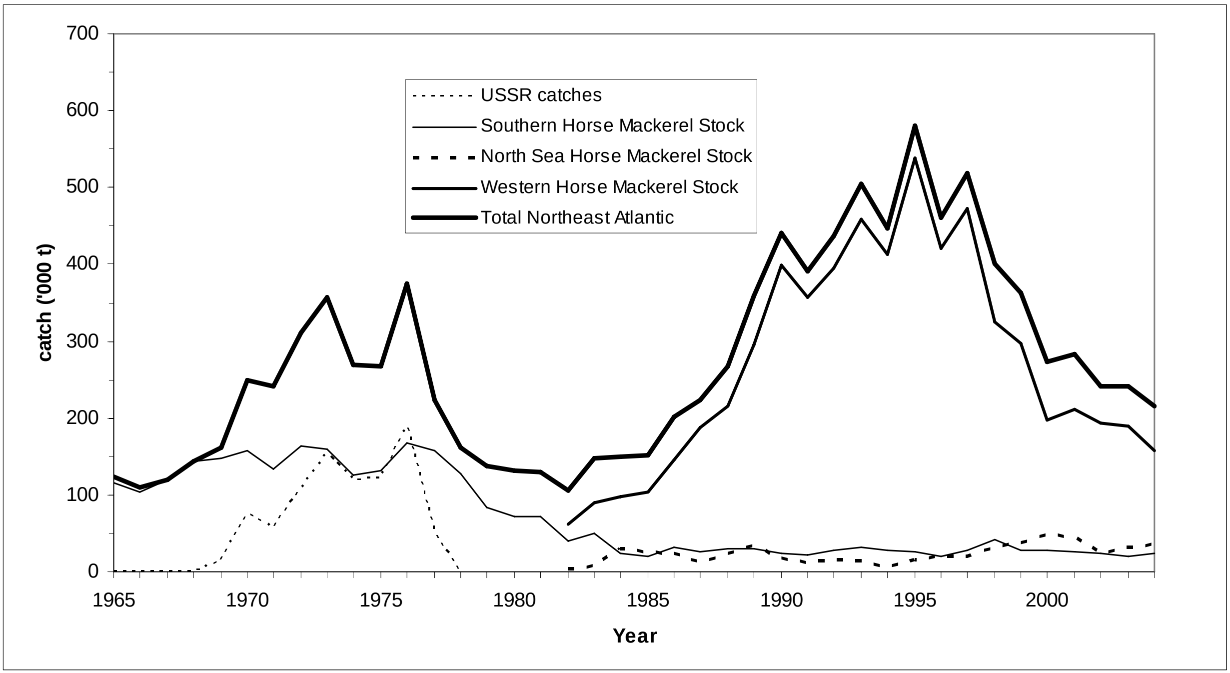


Figure 3.3.1 Total catches of horse mackerel in the northeast Atlantic during the period 1965 - 2004. The catches taken by the USSR and catches taken from the southern, western and North Sea horse mackerel stocks are shown in relation to the total catches in the northeast Atlantic. Caches from Div. VIIIc 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 2004 and 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 2004 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 4.3.1 shows the catches of this stock from 1982–2004. 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 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 (see section 3.7). 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

Estimates of total age composition of the catches are available since 1985 based on Dutch samples (table 4.4.1.1). In 1995 and 1996 a certain number of commercial catches were converted into age distributions by research vessel samples, and may not be representative for the commercial fleet.

Catch in numbers at age by quarter and annual values for 2004 were calculated according to Dutch samples collected in Division IVc and from Dutch and German samples from 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 2004. 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 cover 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.

At present the sampling intensity is rather low and the quality of the catch at age data may be questionable. If a dependable analytical assessment is to be done in the future the sampling needs to be improved. From 1995 the proportion of the catch taken for human consumption has been high (around 70% in 1995 and 96). The Dutch samples after 1996 covered all their catches, and as this catch is the largest part, the coverage has been around 70 % in recent years. In 2004 the coverage was only 38 % and as shown in the text table below the lowest on record (see section 1.3).

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
% of landings covered	62	55	57	66	77	71	50	60	67	38
Samples from	RV	RV+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 2004. The annual average values are shown in Table 4.4.1.1.

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 2004, 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 nor 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 2004, 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 (only sub-areas IVb and IVc) by year for each of these three groups separately (Figure 4.5.2.1).

After inspection of Figure 4.5.2.1., it was decided to select a subset of ICES rectangles in which hauls were taken in each of the years 1995-2004 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. It was decided that indices based on this subset of rectangles would be representative for the development of the stock for exploration; these indices are shown in Figure 4.5.2.2. 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. 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 4.5.2.3. 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

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. It is needed that survey data become available to the Working Group that give information on the migration from sub-area VIId.

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 1995-2004 was 31 000 tons.

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

Table 4.4.1.1 Catch in numbers at age (millions), weight at age (kg) and length at age (cm) for the North Sea horse mackerel stock 1995-2004

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

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

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

Table 4.4.1.2 North Sea Horse Mackerel catch in numbers (1000) at age by quarter and area in 2004

1Q

Ages	IIIa	IVb	IVc	VIId	Total
0	0.0	0.0	0.0	0.0	0.0
1	0.3	691.6	0.0	6.3	698.2
2	7.1	724.1	369.0	87.6	1187.7
3	41.9	2018.0	737.2	687.3	3484.3
4	35.2	248.6	2581.1	344.2	3209.2
5	205.6	531.2	6267.4	3060.0	10064.2
6	224.1	337.1	5530.4	3490.7	9582.3
7	145.5	163.6	2212.2	2430.4	4951.7
8	26.1	76.3	1106.3	350.5	1559.1
9	87.2	116.5	2581.3	1307.7	4092.7
10	114.5	210.7	4792.0	1550.1	6667.4
11	64.0	83.4	1843.2	965.6	2956.2
12	49.8	96.9	2211.9	657.8	3016.3
13	89.1	162.2	3685.8	1210.1	5147.2
14	10.7	46.8	1105.9	66.1	1229.5
15+	148.0	93.4	1843.0	2520.9	4605.3

2Q

Ages	IIIa	IVb	IVc	VIId	Total
0	0.0	0.0	0.0	0.0	0.0
1	0.9	782.0	672.6	0.0	1455.5
2	0.9	782.3	310.7	534.2	1628.1
3	2.6	2149.0	540.7	1927.6	4619.8
4	0.3	271.8	237.8	0.0	509.9
5	0.6	561.8	492.8	0.0	1055.3
6	0.4	341.2	301.9	0.0	643.5
7	0.2	161.5	142.3	0.0	304.0
8	0.1	80.8	71.1	0.0	152.0
9	0.1	115.4	103.2	0.0	218.8
10	0.3	214.3	191.7	0.0	406.3
11	0.1	82.4	73.7	0.0	156.3
12	0.1	98.9	88.5	0.0	187.5
13	0.2	164.9	147.4	0.0	312.5
14	0.1	49.5	44.2	0.0	93.8
15+	0.1	82.4	73.7	0.0	156.3

3Q

Ages	IIIa	IVb	IVc	VIId	Total
0	0.0	0.0	0.0	0.0	0.0
1	26.3	1197.8	3984.4	455.1	5663.5
2	11.6	527.0	1755.3	837.0	3130.9
3	20.0	910.3	3034.6	1761.9	5726.8
4	5.3	239.5	798.7	360.1	1403.6
5	9.5	431.2	1436.6	673.6	2550.8
6	3.2	143.7	478.8	379.4	1005.1
7	2.1	95.8	319.0	148.4	565.2
8	1.1	47.9	159.4	45.4	253.7
9	0.0	0.0	0.4	56.3	56.7
10	0.0	0.0	0.0	96.1	96.1
11	0.0	0.0	0.1	81.5	81.6
12	0.0	0.0	0.0	12.1	12.1
13	0.0	0.0	0.0	36.3	36.3
14	0.0	0.0	0.0	21.2	21.2
15+	0.0	0.0	0.0	142.0	142.0

4Q

Ages	IIIa	IVb	IVc	VIId	Total
0	0.0	0.0	0.0	0.0	0.0
1	24.3	287.2	2047.0	5474.9	7833.4
2	34.6	408.9	2615.6	8531.7	11590.9
3	58.0	685.0	4150.9	15653.6	20547.4
4	20.4	241.2	3127.6	5996.7	9385.9
5	35.7	421.2	2615.7	11025.4	14098.0
6	20.6	242.6	2047.2	6631.1	8941.4
7	9.0	106.4	2047.0	2599.3	4761.7
8	3.1	36.2	1023.7	795.1	1858.1
9	2.8	33.2	0.4	960.9	997.3
10	6.4	75.6	2047.2	1655.0	3784.1
11	5.3	62.2	1535.4	1427.1	3030.0
12	1.4	16.6	1023.7	211.3	1253.0
13	1.8	21.4	0.0	635.9	659.1
14	1.5	17.2	511.9	370.6	901.1
15+	7.9	93.2	1024.5	2487.4	3612.9

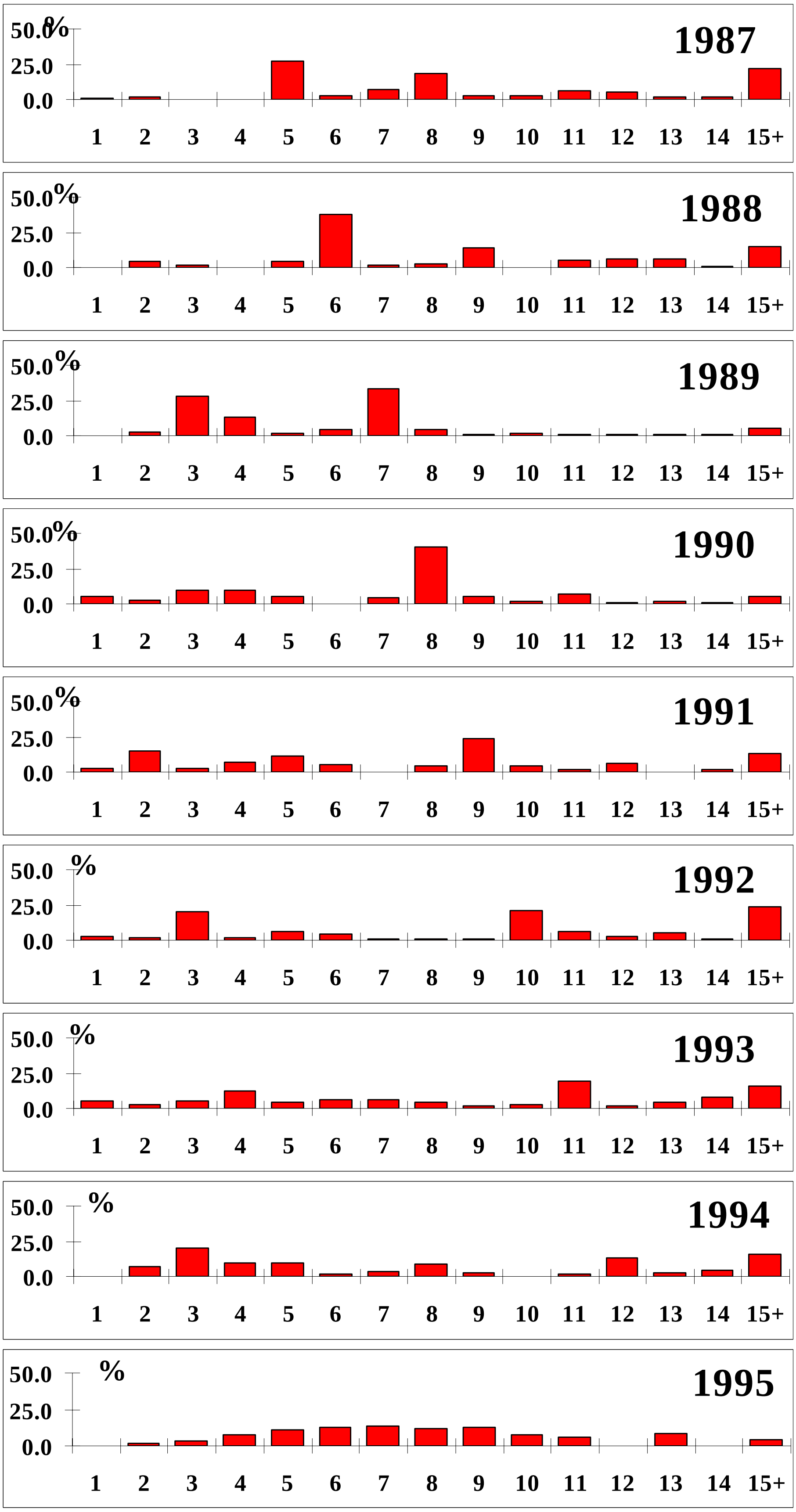
2004

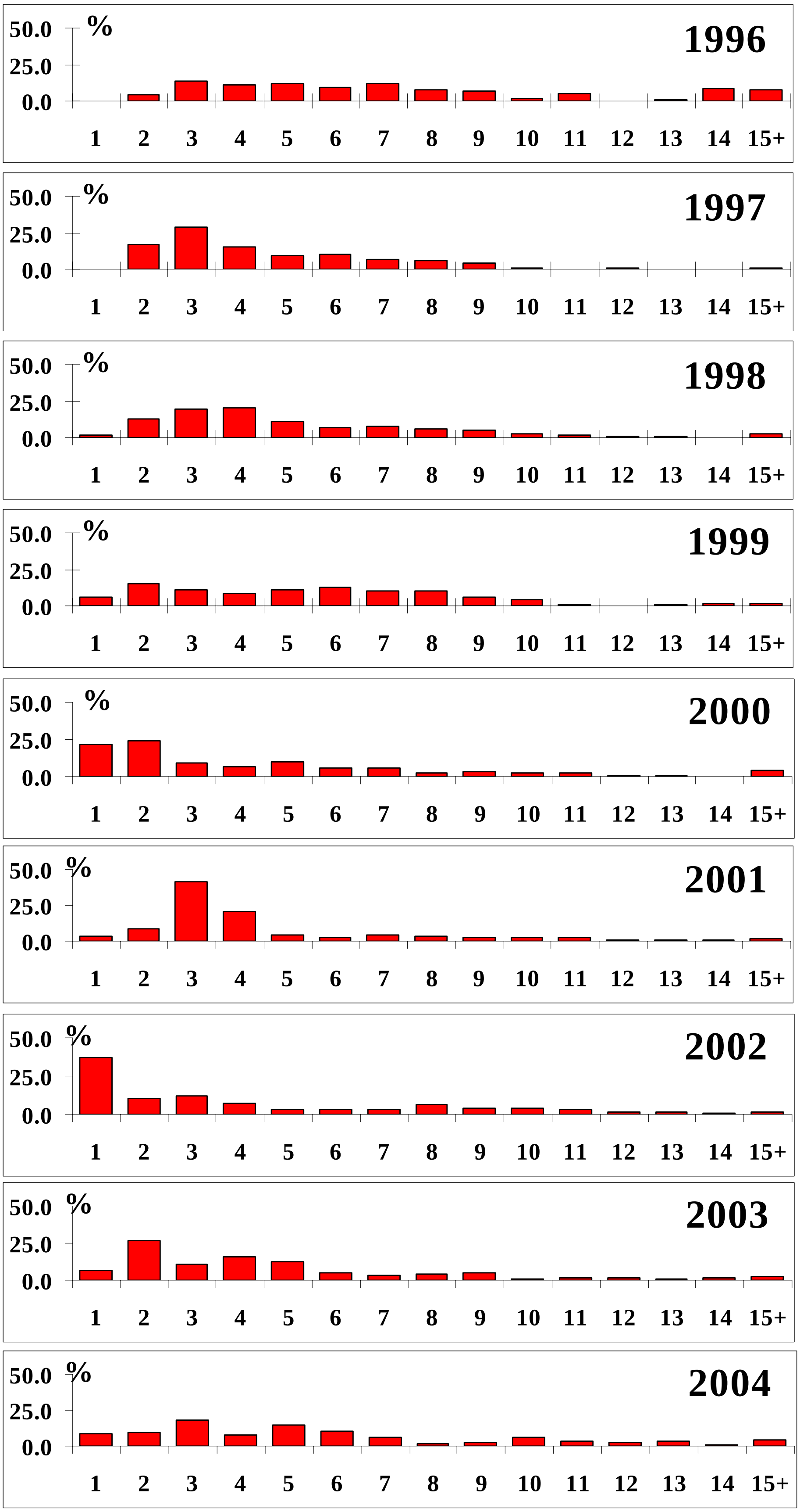
Ages	IIIa	IVb	IVc	VIId	Total
0	0.0	0.0	0.0	0.0	0.0
1	51.8	2958.6	6704.0	5936.3	15650.6
2	54.2	2442.3	5050.6	9990.5	17537.5
3	122.4	5762.2	8463.3	20030.4	34378.3
4	61.2	1001.2	6745.2	6701.0	14508.6
5	251.4	1945.4	10812.5	14759.0	27768.3
6	248.2	1064.6	8358.3	10501.1	20172.2
7	156.8	527.4	4720.4	5178.0	10582.6
8	30.3	241.1	2360.5	1191.1	3822.9
9	90.2	265.2	2685.3	2324.9	5365.5
10	121.2	500.7	7030.9	3301.2	10954.0
11	69.4	228.1	3452.4	2474.1	6224.0
12	51.3	212.4	3324.0	881.1	4468.8
13	91.1	348.5	3833.2	1882.3	6155.0
14	12.2	113.4	1662.1	457.8	2245.5
15+	156.0	269.0	2941.2	5150.2	8516.5
	1567.4	17880.0	78143.9	90759.0	188350.2

Table 4.4.2.1 North Sea Horse Mackerel mean weight (Kg) and length (cm) in catch at age by quarter and area in 2004

1Q			Kg					Cm		
Ages	IIIa	IVb	IVc	VIId	Total	IIIa	IVb	IVc	VIId	Total
0										
1	0.060	0.080	0.086	0.060	0.080	19.50	19.74	22.50	19.50	19.74
2	0.102	0.102	0.100	0.102	0.101	22.50	22.31	22.50	22.50	22.38
3	0.107	0.111	0.103	0.108	0.109	23.83	23.52	24.00	23.79	23.68
4	0.150	0.154	0.150	0.150	0.150	25.12	25.33	25.50	25.03	25.43
5	0.175	0.171	0.166	0.176	0.170	26.93	26.45	26.62	27.00	26.73
6	0.194	0.201	0.199	0.193	0.197	27.62	27.34	27.18	27.72	27.39
7	0.217	0.246	0.217	0.217	0.218	28.92	28.84	28.33	29.05	28.72
8	0.239	0.223	0.222	0.243	0.227	30.02	29.15	28.83	30.28	29.19
9	0.245	0.239	0.238	0.246	0.241	30.34	29.97	29.93	30.43	30.10
10	0.280	0.271	0.270	0.282	0.273	31.34	30.91	30.88	31.44	31.02
11	0.320	0.279	0.275	0.330	0.294	32.90	31.45	31.30	33.25	31.98
12	0.294	0.256	0.253	0.303	0.265	32.13	30.60	30.50	32.50	30.97
13	0.312	0.297	0.296	0.315	0.301	32.45	31.75	31.70	32.61	31.93
14	0.314	0.347	0.348	0.307	0.345	32.41	33.15	33.17	32.24	33.11
15+	0.378	0.385	0.387	0.375	0.380	34.40	34.48	34.50	34.38	34.43
2Q										
Ages	IIIa	IVb	IVc	VIId	Total	IIIa	IVb	IVc	VIId	Total
0										
1	0.080	0.080	0.080		0.080	19.74	19.74	19.74		19.74
2	0.102	0.102	0.105	0.093	0.100	22.31	22.31	22.38	22.05	22.24
3	0.111	0.111	0.115	0.094	0.104	23.52	23.53	23.88	22.27	23.04
4	0.154	0.154	0.154		0.154	25.33	25.32	25.33		25.33
5	0.170	0.170	0.170		0.170	26.43	26.42	26.43		26.42
6	0.201	0.201	0.201		0.201	27.32	27.32	27.32		27.32
7	0.250	0.250	0.250		0.250	28.83	28.84	28.83		28.84
8	0.222	0.222	0.222		0.222	29.12	29.12	29.12		29.12
9	0.238	0.238	0.238		0.238	29.93	29.93	29.93		29.93
10	0.270	0.270	0.270		0.270	30.88	30.88	30.88		30.88
11	0.275	0.275	0.275		0.275	31.30	31.30	31.30		31.30
12	0.253	0.253	0.253		0.253	30.50	30.50	30.50		30.50
13	0.296	0.296	0.296		0.296	31.70	31.70	31.70		31.70
14	0.348	0.348	0.348		0.348	33.17	33.17	33.17		33.17
15+	0.387	0.387	0.387		0.387	34.50	34.50	34.50		34.50
3Q										
Ages	IIIa	IVb	IVc	VIId	Total	IIIa	IVb	IVc	VIId	Total
0										
1	0.080	0.080	0.080	0.074	0.080	19.74	19.74	19.74	19.90	19.75
2	0.111	0.111	0.111	0.104	0.109	22.23	22.23	22.23	22.15	22.21
3	0.132	0.132	0.132	0.121	0.128	23.71	23.71	23.71	23.57	23.67
4	0.159	0.159	0.159	0.147	0.156	25.10	25.10	25.10	25.21	25.13
5	0.176	0.176	0.176	0.175	0.176	26.17	26.17	26.17	26.65	26.30
6	0.204	0.204	0.204	0.196	0.201	27.50	27.50	27.50	27.63	27.55
7	0.293	0.293	0.293	0.226	0.275	29.50	29.50	29.50	29.23	29.43
8	0.223	0.223	0.223	0.228	0.224	29.50	29.50	29.50	28.84	29.38
9			0.169	0.309	0.308			26.97	31.57	31.54
10				0.339	0.339				33.03	33.03
11			0.187	0.282	0.281			27.99	30.79	30.79
12				0.409	0.409				34.50	34.50
13				0.313	0.313				32.49	32.49
14				0.381	0.381				34.50	34.50
15+				0.395	0.395				34.56	34.56
4Q										
Ages	IIIa	IVb	IVc	VIId	Total	IIIa	IVb	IVc	VIId	Total
0										
1	0.073	0.073	0.070	0.074	0.073	19.89	19.89	19.75	19.89	19.86
2	0.104	0.104	0.098	0.106	0.104	22.13	22.13	21.90	22.20	22.13
3	0.123	0.123	0.114	0.125	0.123	23.66	23.66	23.12	23.77	23.63
4	0.146	0.146	0.135	0.148	0.144	25.18	25.18	25.00	25.22	25.15
5	0.175	0.175	0.177	0.178	0.178	26.59	26.59	26.10	26.75	26.62
6	0.198	0.198	0.212	0.196	0.199	27.67	27.67	28.00	27.53	27.65
7	0.226	0.226	0.224	0.226	0.225	29.14	29.14	28.50	29.23	28.91
8	0.229	0.229	0.236	0.228	0.233	28.92	28.92	29.50	28.84	29.21
9	0.309	0.309	0.246	0.322	0.322	31.57	31.57	31.25	31.99	31.98
10	0.335	0.335	0.303	0.351	0.325	32.84	32.84	31.25	33.40	32.22
11	0.288	0.288	0.337	0.282	0.310	31.07	31.07	33.17	30.79	32.00
12	0.407	0.407	0.388	0.409	0.392	34.44	34.44	34.00	34.50	34.09
13	0.313	0.313		0.313	0.313	32.49	32.49		32.49	32.49
14	0.370	0.370	0.286	0.381	0.327	34.15	34.15	31.50	34.50	32.79
15	0.409	0.409	0.510	0.395	0.428	34.85	34.85	37.00	34.56	35.26
2004										
Ages	IIIa	IVb	IVc	VIId	Total	IIIa	IVb	IVc	VIId	Total
0										
1	0.077	0.079	0.077	0.074	0.076	19.81	19.75	19.74	19.89	19.80
2	0.105	0.105	0.103	0.105	0.104	22.20	22.26	22.09	22.19	22.17
3	0.119	0.116	0.120	0.121	0.120	23.72	23.57	23.46	23.61	23.56
4	0.149	0.153	0.144	0.148	0.147	25.14	25.24	25.22	25.21	25.22
5	0.175	0.173	0.170	0.178	0.174	26.85	26.41	26.43	26.80	26.63
6	0.194	0.201	0.203	0.195	0.198	27.62	27.43	27.40	27.60	27.51
7	0.218	0.252	0.226	0.222	0.225	28.94	29.02	28.50	29.15	28.85
8	0.238	0.224	0.228	0.233	0.229	29.89	29.18	29.17	29.27	29.21
9	0.247	0.247	0.238	0.279	0.256	30.38	30.15	29.93	31.10	30.46
10	0.283	0.280	0.280	0.318	0.291	31.41	31.19	30.99	32.47	31.45
11	0.318	0.280	0.303	0.301	0.301	32.76	31.29	32.13	31.75	31.96
12	0.297	0.266	0.295	0.330	0.300	32.19	30.85	31.58	33.00	31.83
13	0.312	0.298	0.296	0.314	0.302	32.44	31.77	31.70	32.57	31.98
14	0.321	0.351	0.329	0.370	0.338	32.62	33.31	32.66	34.17	33.00
15+	0.379	0.394	0.430	0.386	0.401	34.42	34.61	35.37	34.47	34.79
	0.225	0.147	0.201	0.181	0.187	28.65	24.51	27.19	26.38	26.56

Figure 4.4.1.1. The age composition of the NORTH SEA HORSE MACKEREL based on commercial and research vessel samples 1987-2004.




1996
1997
1998
1999
2000
2001
2002
2003
2004
%
50.0
25.0
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15+

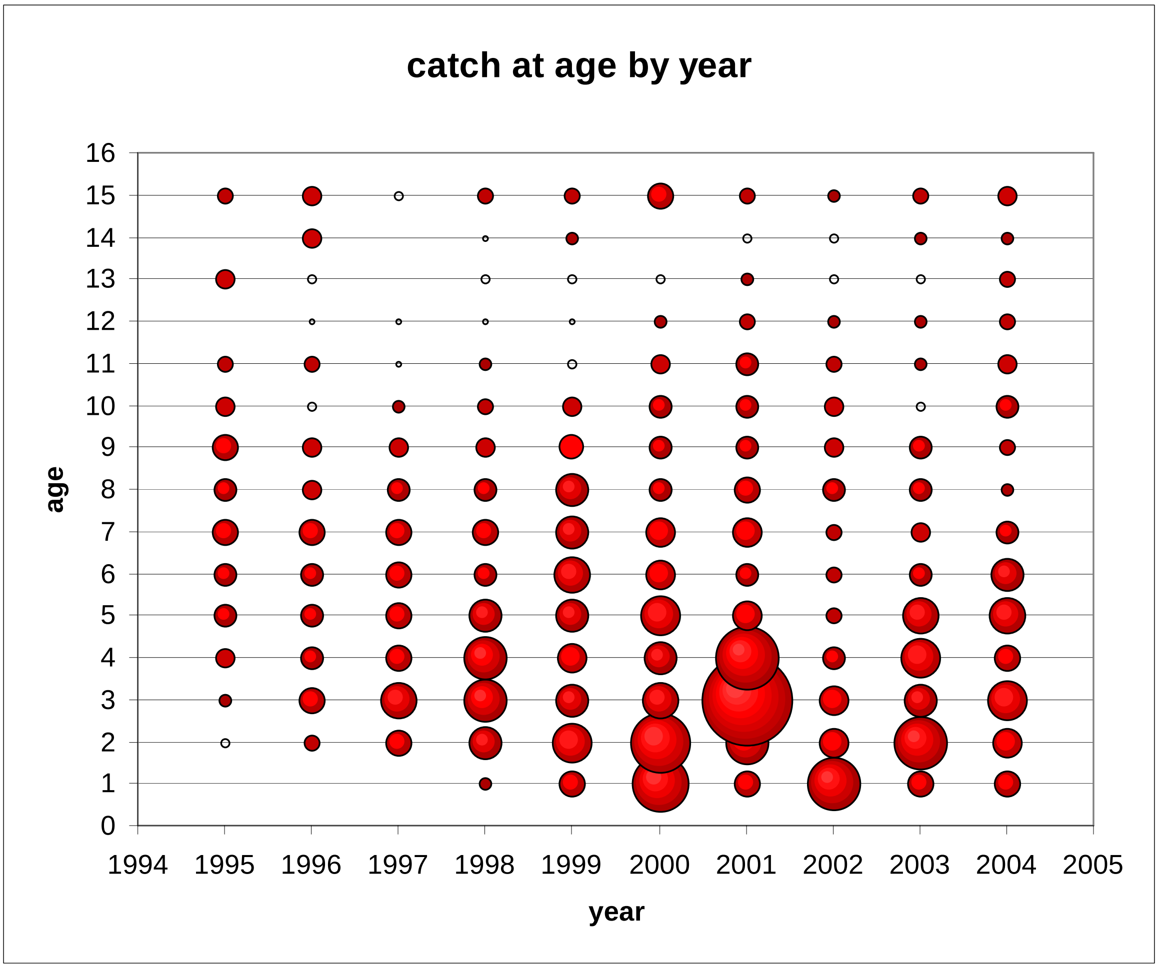


Figure 4.5.1.1. The catch-at-age of North Sea horse mackerel; note that the age composition for 1995 and 1996 was partly based on research vessel samples and may not be representative.

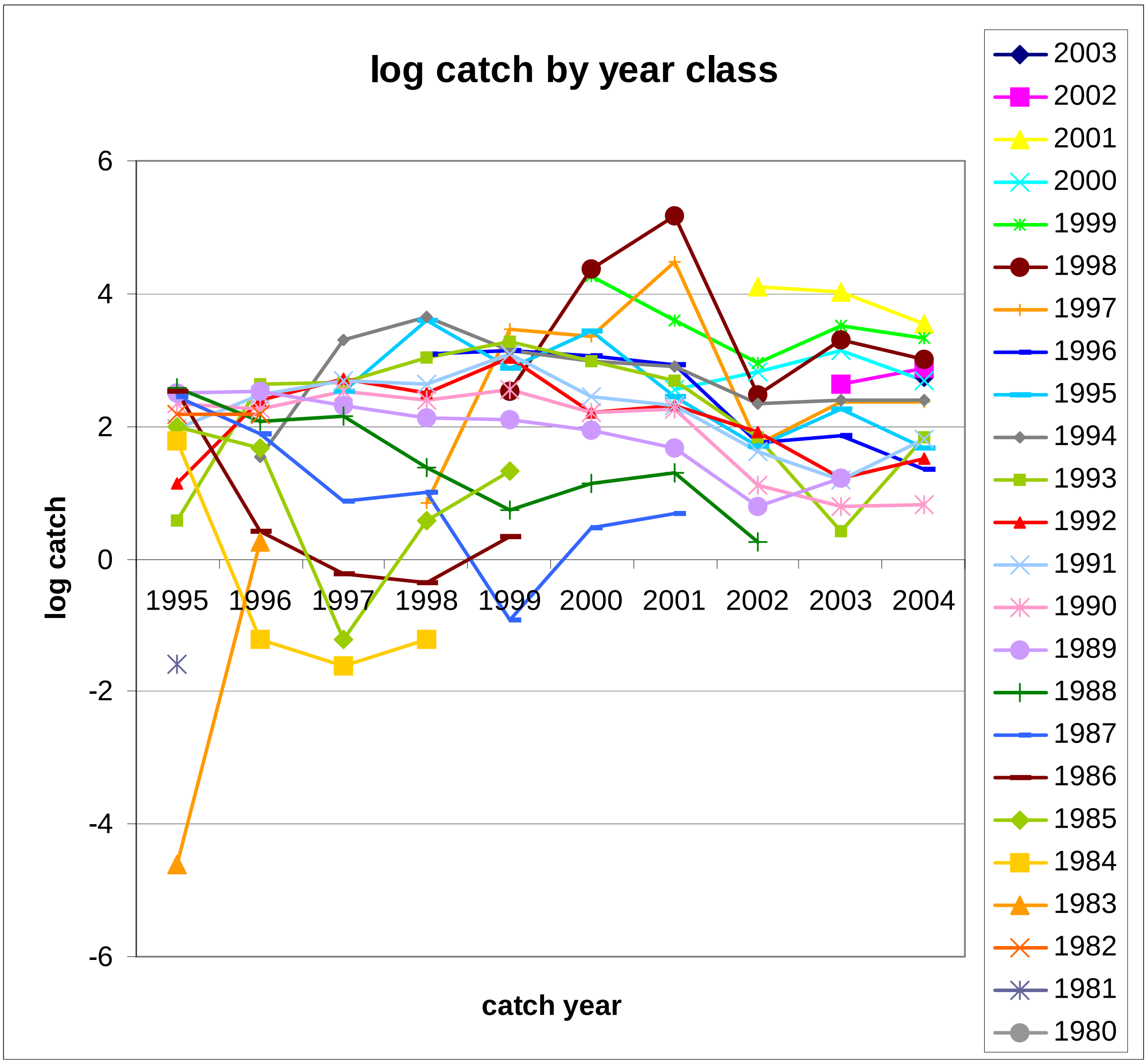


Figure 4.5.1.2. Log catch ratios of North Sea horse mackerel by year class.

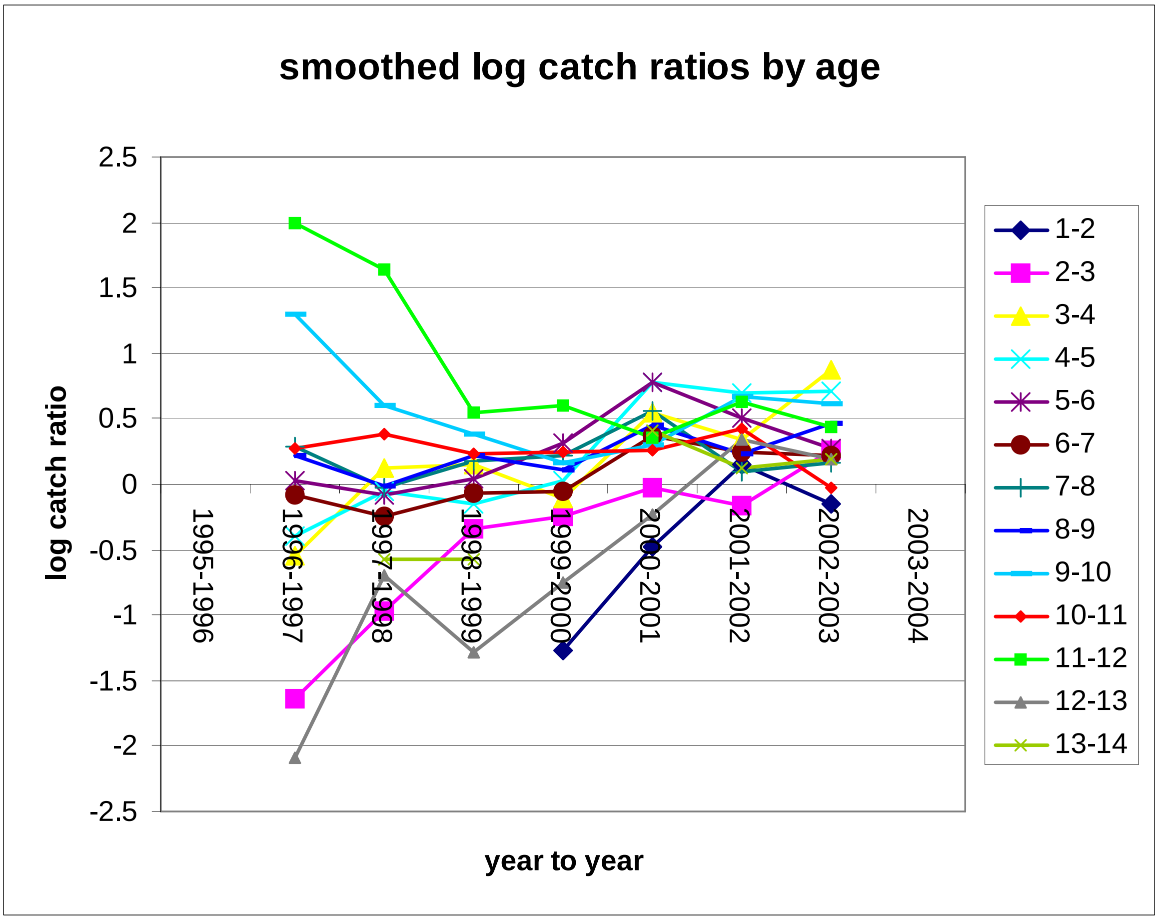


Figure 4.5.1.3. Smoothed (running average over 3 years) log catch ratios of North Sea horse mackerel.

Figure 4.5.2.1. 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 right corner of each panel is the index (mean catch rate in numbers/hour) based on the shaded rectangles.

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42		0	0	0	0	1	26	0	0	4	32	
41	0	0	0	0	0	0	0				8	
40		0	0	0	0	0	0	0	2			
39			0	0	0			80	0	8		
38			0	0		6			0		4	
37									64	160	80	
36								4				
35					2		104	6528				
34		1995					4	2				
33		0-14 cm				2	368	124		index	525	
32					4		22					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42		0	0	0	0	0	0	0	0			
41	0	0	0	0	0	0	0	0				
40		0	0	0	0	0	0		0	0		
39		0	0	0	0			0	0		118	6321
38			0	0	0		0				3264	8977
37				0						21290	7980	48
36				0	0			126		3739	1680	
35				0	0		22	138				
34		1996					4	59				
33		0-14 cm				4		4071		index	2747	
32						2	76					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42		0	0	0	0	0	0	1	0			
41	0	0	0	0	0	0	0	0	0	8	128	
40		0	0	0	0	0	0	0	8	5891	77722	
39			0	0		0	560		3740	1428	1956	
38			0	0	0		2	27460	16774	7390	40968	
37				0	0		754	50556	24288	1154	17378	0
36				2	2	6	12396	4256	490	1914		
35						2	40	948				
34		1997				24		29462				
33		0-14 cm								index	16003	
32							1436					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42	0	0	0	0	0	0	0	0		2	120	
41	0	0	0	0	0	0	0	0	8	24	931	
40		0	0	0	0	0			0	180	104	
39			0		0			0	14	618	4103	
38				0					56	262	4931	
37					0	0	3	66	1936	2429	47111	
36				0	27	50	6	4	89	40		
35						206	264	286				
34		1998				10	218	46				
33		0-14 cm				57	128	680		index	2683	
32					6		26					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42	0	0	0	0	0	0	0	0	2	106	578	
41	0	0	0	0	0	0	0	4	6	422	2308	
40		0	0	0	0	0			4	3443	34	
39			0	0	0	792		6	8	1487	1506	116
38			0	0	0	150	2	12	64	25330	5932	204
37				0	0	133	38	403	1915	3368	2021	586
36				0	6	214	26	1724	15653	7462		
35				8		1044	596	664				
34		1999				4	11	479				
33		0-14 cm				260	1148	1936		index	2737	
32					18	8	64					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42	0	0	0	0	0	0	0	0	0	0	130	
41	0	0	0	0	0	0	0	0		50	12	
40		0	0	0	0	0					42	
39			0	0	0	0	0	0	4	392	4	220
38			0	0	0	0	0		28	43	147	768
37				0	0		0	0	39	13692	13018	0
36				0	0	0			15	148		
35				0	0	112	6114	14726				
34		2000						138				
33		0-14 cm					587			index	3084	
32					0	186	3152					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42	0	0	0		0	0	0	0	0	4	0	
41	0	0	0	0	0	0	0	0	0	4	8	
40		0	0	0	0	0				14	214	
39			0	0	0	0		0	0	104	42	
38			0	0	0				8	1810	12	438
37				0	0	0		0	40	4059	89547	0
36				0	0	0			22245	148464		
35					0	16	115	1936				
34		2001				6	26	93514				
33		0-14 cm					267			index	12883	
32					0	1233	42487					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42									6			
41									62	62	129	
40										1027	690	
39								34	2	9769	9625	
38						8		16	431	4126	4	
37								10984	13493	43851	27215	
36							4	2	12			
35					16	2216	1052	12908				
34		2002					508	2335				
33		0-14 cm				126		268		index	6303	
32					2	50	7837					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42		0		0	0	0	0	2	0	2	18	
41	0	0	0	0	0		0	0	0	0	3941	
40		0	0	0	0	0	0	0	2	0	18178	
39			0	0	0		113	11	24	45	21747	
38			0	0	2	309	12	58	46	41	36	
37				0	0	1	481	13855	13562	6352	8979	
36				0	1	636	31	151	3178	2		
35				0	0	602	12080	11426				
34		2003				183	468	2252				
33		0-14 cm				12	702	890		index	3882	
32					0	873	50					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42		0	0	0	0	0	0	0	0	0	6	
41	0	0	0	0	0	0	0	0	17	9	1264	
40		0	0	0	0	0	0		0	2		
39			0	0	0		7	4	136	963	192	
38			0	0			0	2			4	
37				0	0	0	0	12	48	266	2955	
36					0	18						
35				0	0	6	1992	1418				
34		2004				0	2	562				
33		0-14 cm				58	2402	38		index	604	
32					0	128	52					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42												
41												
40												
39												
38			2							20		
37							4					
36							327	36	5557			
35								512				
34		1995				4	227	4130				
33		14-23 cm				1116	512	96		index	1584	
32						6316	256					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42	2											
41												
40												
39						5					24	
38								7	832	381	18	
37				2		5		35	1144	907	292	25
36						4	174	945	1265	1366	2755	
35						2	2	266				
34		1996				2	356	6475				
33		14-23 cm				218	2159	26357		index	758	
32						414	22					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42												
41											2	
40										20		
39											2	
38									100	247	755	
37											2	
36					8		116	4	336			
35							2	1760				
34		1997						728				
33		14-23 cm			280		416			index	384	
32						691	204					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42												
41												
40										4	4	
39							5			45		
38								2		8		
37								2	2	6	30	
36							54	64	698	1800		
35							3					
34		1998				12		2357				
33		14-23 cm				2454	4	77		index	339	
32						430	271					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42												
41												
40										2	8	
39											24	
38											32	
37									262	18	79	
36							35		110	2996		
35					3			476				
34		1999						6511				
33		14-23 cm					1896	64		index	735	
32						116	4					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42												
41											2	
40										27		
39						4					4	
38								4	13	2	68	
37									2	8675	1209	
36							2		26	25524		
35					2		8	408				
34		2000				28	2	12534				
33		14-23 cm				2	9575	55928		index	1888	
32						2502	793					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42												
41												
40										47	350	
39										2	59	2
38									6	364	4	
37									2	877	308	
36								4	126	1388		
35						12	474					
34		2001					20	13497				
33		14-23 cm				11272	14097			index	2217	
32						575	90					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42												
41											16	
40										36	2232	
39												
38						16	2	410	2		12	
37											40	
36							324	13	6303	27920		
35												
34		2002				836	34	116941				
33		14-23 cm				4290	55768	32		index	11906	
32						83	3176					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42		2	4	1								
41			1	1		3						
40			1	3							13	
39						1	4		1		187	
38			1			1		1	53	1006	314	
37								2	3649	1431	432	
36							977	7	2037	314		
35								108				
34		2003						3653				
33		14-23 cm					2380			index	997	
32						627	265					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42	16										12	
41											5	
40											82	
39									15	1	1	
38									230	316	2	
37					7				4	4	1	
36									548	2378		
35						92						
34		2004					28	2038				
33		14-23 cm				8	60	2		index	254	
32						650	6					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42	1	2										
41			12			3		1				
40					125			3610	22	3762	16	
39						383	54	2				
38			164	1	40	8	4	1651		104	1294	
37							28	4	38	34	30	
36					82	564	1197	362	8581			
35					2	18		3136				
34		1995				594	643	4517				
33		23+ cm				13144	2240	2688		index	2567	
32					52	8336	4205					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42	2	6	23				2		2	36		
41												
40				2	1		62	1026	2	48	20	
39					261	56	125	4	28	569	5670	70
38			6			861	30	451	4052	1818	174	
37				90	31	107	1644	1120	556	2712	7991	603
36				5	4	2016	2847	1356	830	1196	1091	
35						45	1197	2005				
34		1996			60	190	2815	2043				
33		23+ cm			18	1877	1173	6771		index	1642	
32					60	846	2670					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42	1		6		1					2		
41										18	170	
40			6				622	77		592	36	
39			2		5		2	4	10	16	46	
38			20		6	2	16	199	4257	1248	2806	
37						2	6	14	8	116	232	
36				4	31		650	157	487	394		
35					84	8	34	4000				
34		1997			280	55	705	1052				
33		23+ cm			64	44	1232	2992		index	818	
32					10	498	1181					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42			110		6				4	34		
41						2			12		15	
40							2631	33	4	290	283	
39						25	667	30	137	2202	1196	
38			20		8	16	21	132	651	118	14	
37				4	8	7	561	24	166	372	804	1831
36				4		24	626	513	489	2614		
35					4		135	440				
34		1998				93	2	632				
33		23+ cm				28	6	180		index	426	
32						807	968					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42			2							22	65	
41											715	
40				2			12	248		57	531	
39						39	60	24		2	1189	
38			2			36	4	250	2	6	1454	
37							16		7115	115	1220	
36						40	484	76	261	1054		
35				8	3			2136				
34		1999				18		793				
33		23+ cm				220	86	46		index	764	
32					4	359	89					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42		2	2				2		2	144	637	
41								468	276	6	435	
40			2			591	179	430	63	2294	893	
39					40	4	36	20	40	108	90	
38				2	26	124	6	458	1890	172	2074	
37				2		8	2	42	95	2686	4001	
36						14	3693	64	173	739		
35								1394				
34		2000				209	4	513				
33		23+ cm				6	508	1712		index	992	
32					2	375	161					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42		2		4						73	16	
41			14						12	96	105	
40			4			2	209	241	22	1441	1962	
39			2		44	216	253	94	148	26	160	122
38						52	2	1674	298	720	220	82
37					2		31	132	6	270	628	
36							26	60	797	474		
35						12	282					
34		2001				40	56	491				
33		23+ cm				8566	1068			index	832	
32					18	128	238					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42										14	4	
41											120	
40			2					211	12	864	5621	
39					572	112	63	2	154	279	6	
38					56	182	10	1630	173	22	155	
37					12		8	2	25	18	91	
36				4			1028	84	4188	687		
35						8						
34		2002				2613	120	1739				
33		23+ cm				506	2606	38		index	994	
32						16	78					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42	2		1		1				1	39		
41		1				1			22	4	2	
40							17	124			57	
39			2			46	125	1	3	1	654	
38					1	2		2	235	855	466	
37						1	1	4	167	273	183	
36				1			3382	36	429	416		
35								76				
34		2003				1	3	639				
33		23+ cm					853			index	443	
32					2	124	1072					

	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8
42	4										978	
41											107	
40								96		14	404	
39				1		692	1		53	11	62	
38					2	32			3288	1426	32	
37						2	3	5	36	48	21	
36				4			62	6	4014	3484		
35						4	12					
34		2004					2	38				
33		23+ cm								index	504	
32						8	136					

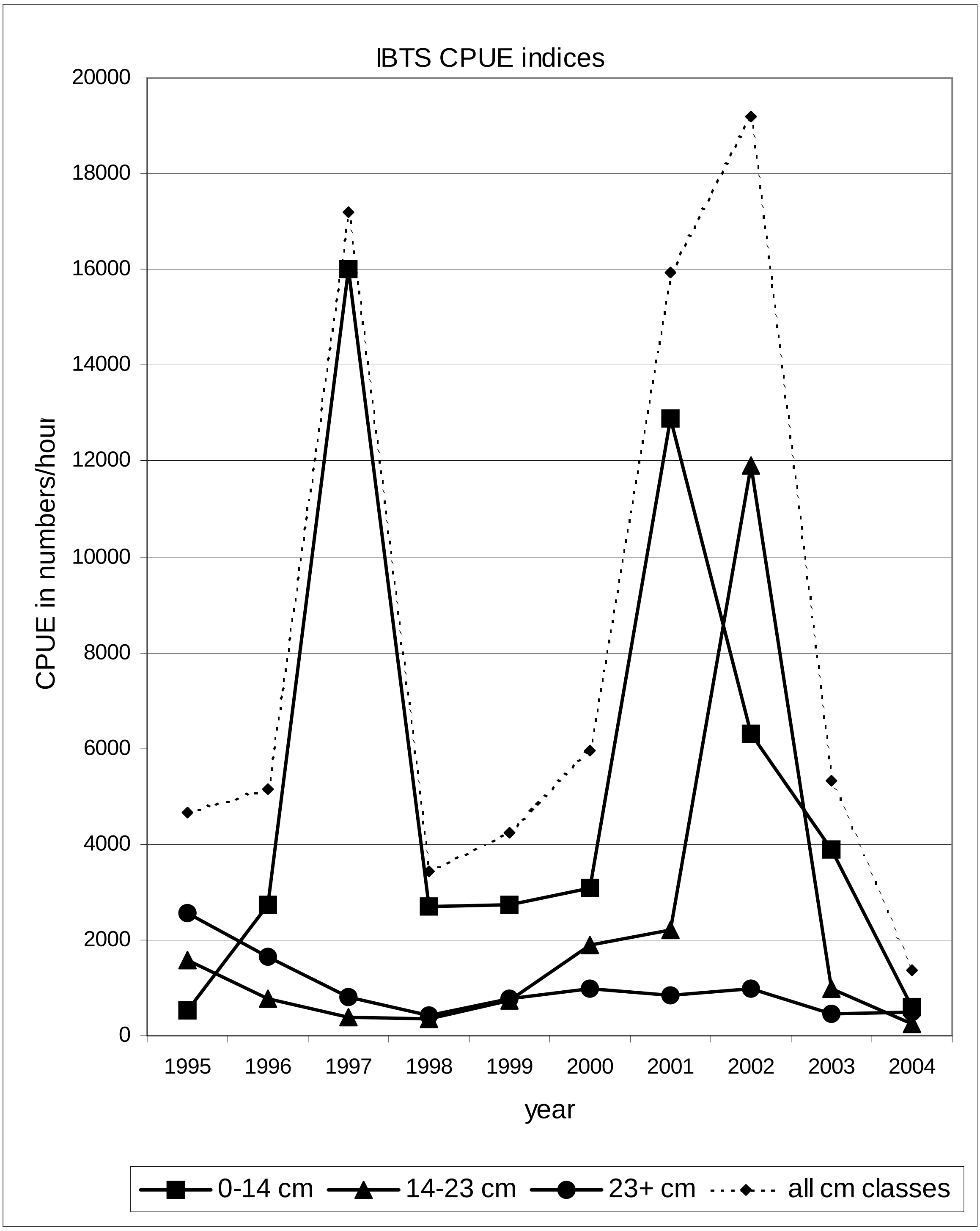


Figure 4.5.2.2. Indices are mean IBTS catch rates of horse mackerel in quarter 3 by year, in ICES rectangles shaded in Figure 4.5.2.1, for fish <14 cm, for fish ≥14 cm and <23 cm, and for fish ≥23 cm.

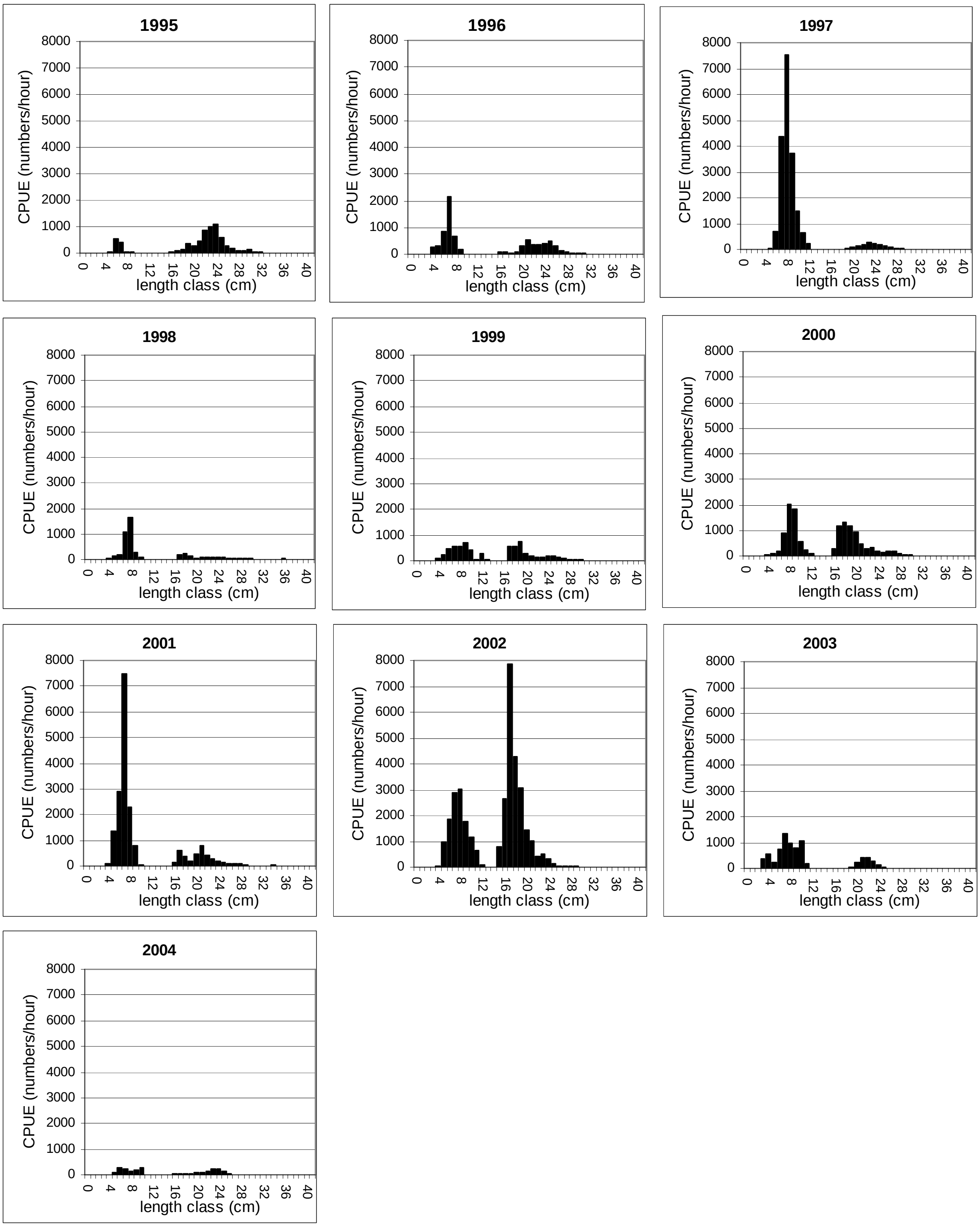


Figure 4.5.2.3. Length frequency distributions. Mean IBTS catch rates of horse mackerel in quarter 3 by year, in ICES rectangles shaded in Figure 4.5.2.1.

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 2003 and 2004

Until 2005 ICES has given advice for the western stock without including Divison VIIIc. ICES advised that catches in 2004 be limited to less than 130,000 t. ICES repeated this advice for 2005 and included the average catch in VIIIc during 200-2003 of 20,000 tons resulting in catch limit of 150,000 tons.

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. One TAC is set for Division Vb, Sub areas VI and VII, Divisions VIIIa,b,d,e which cover parts of the western and North Sea stock distribution areas. This TAC has been reduced every year since 1998 from 320,000 tons to 137,000 tons in 2003-2005. Another TAC is set for EU waters in Division IIa and Subarea IV covering parts of the Western and North Sea stock areas. This TAC is 42,727 tons for 2005. The last TAC applies to Division VIIIc and Subarea IX . This TAC includes the area of the southern stock and parts of the western stock. This TAC is 55,000 tons for 2005.

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 2004 were about 157,700 tons, including about 16,000 tons from Division VIIIc. Division VIIIc was not included in the advice for 2004 and that means that the advised TAC was overfished by 9 % by excluding the catches in Division VIIIc. The Fishery in 2004 of the Western Stock

The fishery for western horse mackerel is carried out in Divisions IIa, IIIa (western part) IVa, VIa, VIIa–c,e–k and VIIIa-e. The national catches taken by the countries fishing in these areas are shown in Tables 5.2.1–5.2.5, while 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 2004 was 157,700 tons (Table 3.3.1) which is 32,500 tons less than in 2003. Once again large catches of westen horse mackerel was caught in the juvenile area (Divisions VIIa,e,f,g,h and VIIIa,b,d). In 2004 about 77,000 tons were caught in this area and 53% of the catch in numbers was from the 2001 yearclass.

5.2 The Fishery in 2003 of the Western Stock

The fishery for western horse mackerel is carried out in Divisions IIa, IIIa (western part) IVa, VIa, VIIa–c,e–k and VIIIa-e. The national catches taken by the countries fishing in these areas are shown in Tables 5.2.1–5.2.5, while 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 2004 was 157,700 tons (Table 3.3.1) which is 32,500 tons less than in 2003.

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. In 2003 and 2004 the catches dropped to 24 and 47 tons respectively.

Sub-area 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 2004 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 1987-2004. These fluctuations are mainly due to the availability of western horse mackerel for the Norwegian fleet in October –November (see section 5.3.3).

Sub-area VI

The catches in this area increased from 21,000 tons 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 2004 the total catch was about 21,900 tons which is 1,300 tons less than in 2003.

Sub-area 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 99,000 tons in 2004. This is about 3,000 tons less than the catch in 2003 and is the lowest catch since 1988 (Table 3.3.1).

Sub-area 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 tons, except for the record high catch in 2001 of 75,000 tons. In 2004 the catches dropped to 24,000 tons which is the second lowest since 1980.

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: 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 a fishery independent information of this stock. The surveys cover the whole Division VIIIc and the Subdivision IXa North. Table 5.3.2.1 shows the total number at age per haul including the Subdivision IXa north which is defined as southern stock area. In the future the age matrix will be amended to correspond with Division VIIIc only.

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: Horse Mackerel data coming from the French acoustic PELGAS surveys are available as an independent information about the western stock of horse mackerel. This survey is covering each spring divisions VIIIa and VIIIb. Table 5.3.2.2 shows the length distributions of horse mackerel (in percentage) from 2000 to 2005. Real numbers at length estimates will be provided in the future, but actually only the length distribution in percentage are available.

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, 2002 and 2003 the predicted and actual catches were similar. The modelled influx for 2005 is higher than that for 2004 and indicates an catch level of about 45,000 tons horse mackerel in NEZ (Iversen et al WD 2005). This is four times more than the catch in 2004.

5.4 Effort and catch per unit of effort.

Information on effort and cath 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 is exploiting the western stock. The effort in this fleet has decreased substantially since 2001 being in 2004 at the same low lebel reached in 2003 (table 5.4.1). The catch per unit effort (see table below, expressed in Kg/HP * day * 10^{-2}) shows some variability from year to year. In the period 1987-1993 the yields were well above the mean. In 2004 the increasing trend observed in CPUE since 2000 has changed, reaching the lowest CPUE value of the whole time series.

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
CPUE	90.4	136	118	131	177	147	173	146	145	163	201

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
CPUE	137	124	157	117	------	122	108	115	122	147	62

The rich 1982 year class is nicely shown in the CPUE at age matrix (table 5.4.1).

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 77,100 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

5.6.1 Trends and patterns in basic data

The catch at age matrix (Fig. 5.6.1.1) exhibits clear year-class effects, the strong 1982 year-class is very obvious, the 1992 year-class also appears strong and more recently there is some indication of a strong 2001 year-class which becomes apparent in the age 1 catch. The 1982 year class enters the plus group in 1993 and dominates the plus group in the period 1993-1996. The catch at age suggests that there has been a change in fishing patterns in the early 90s the fishery directing more effort towards the juvenile component in the stock. Given this change of patterns in the fishery, the age composition of the catch suggests a good representation of older ages in the stock.

In the early part of the time-series selection increases gradually over the whole age range while in the late part of the time-series they are almost fully recruited at ages 3-4 (Fig. 5.6.1.2). In the case of the 1982 strong year-class the curve is flat after age 4 indicating that the fishery was targeting that year class once fully recruited. Moderately noisy log-catch ratios (Fig 5.6.1.3) smoothed with a three-year running average to show the main trends are shown in Figure 5.6.1.4. There is a pattern of the catch ratios being negative in the early years while the opposite seems to happen in recent years. This could be the result of comparatively lower total mortality combined with recruitment to the fishery taking place at older ages until the strong 1982 year-class virtually disappeared from the fishery. Further, catch ratios of age 7 and older run in parallel one above each other in recent years suggesting that total mortality increases with age probably as a result of increasing selection.

Catch curves for four five-year periods from 1986 to 2001 where each point is computed as the average number are shown in Figures 5.6.1.5 and 5.6.1.6. Examination of the slope suggests similar total mortality in the most recent two periods while 1982-86 looks quite flat probably as a result of a more gradual recruitment with age. The slope in the log-catch- at-age by period is consistent for recent years. However, given a declining catch in recent years, Z may be lower than the one estimated by the slope.

The exploration of western horse mackerel catch data suggest that there have been substantial changes in selectivity during the period considered for the assessment both caused by changes in fishing patterns and the sporadic appearance of strong year classes, 1982 in particular. Therefore, if separable models are used in the assessment this should only apply to the most recent period when the 1982 year-class has practically disappeared and fishing patterns have stabilised.

A time-series of egg estimates resulting from including VIIIc in the stock distribution area and, the old time-series without VIIIc are shown in Figure 5.6.1.7. Egg estimates for VIIIc are only available for the most recent four years of egg data so the WG was faced with the decision of shortening the time-series or finding a way to correct 1983, 1989 and 1992. There is a small difference between the two series (1995-2004), which is showing a slight upwards trend. The group decided to add the average difference to the first three data points (as opposed to assuming the difference was getting narrower with time: time-series New 1) to extend the series backwards to 1983 (time-series New 2). The basis for the decision was that the additional uncertainty derived from adding a constant was likely to be smaller than the one that would result if the strong signal from the complete time-series of egg estimates was ignored. The egg time-series together with an estimate of the mature fraction of the catch in weight are shown in figure 5.6.1.8. The trend in the mature fraction of the catch in weight matches the trends in the egg estimates. The year 1995 is an outlier in the catch-eggs ratio series (Fig. 5.6.1.9) caused by a very large commercial catch consisting of a mixture of horse-mackerel and mackerel. The ratio (Fig. 5.6.1.10) seems to have declined in 1994 suggesting a switch of the exploitation pattern towards juveniles. Otherwise, the relative ratio is consistent with approximately 15 – 20% of the survey estimate being removed by the fishery.

5.6.2 Models used for exploration

In an effort to investigate the sensitivity of the recently used assessment model to assumptions, an effort was made this year to explore the fitting of several models to the data.

5.6.2.1 Seperable VPA

A user-defined Cohort analysis and Separable VPA (Darby and Flatman, 1998) was used for exploring the catch at age data and determining terminal fishing mortalities to be used in an assessment. The methods are 'user-defined' in the sense that the user must supply values for the terminal F's of a VPA or Cohort analysis. Separable VPA determines values of fishing mortality from a matrix of catch-at-age data, on the assumption that the exploitation pattern is constant. The choice as to which solution to take as the final run may be guided by fishery independent information such as SSB estimates from egg surveys or biomass data from acoustic surveys.

Estimates of SSB from the used-defined Cohort analysis are shown in Fig. 5.6.2.1.1 together with the egg estimates from the triennial Egg survey. The trends resulting from fixing the terminal fishing mortalities (terminal Fs) for values of 0.2, 0.15 and 0.1 follow the trend shown by the Egg survey quite well but the VPA appears unstable showing little convergence as a result of low mortality. The separable VPA was run for the catch data corresponding to the period 1994 to date. The choice of the initial separable year was influenced by information on changes in fishing patterns resulting in more effort directed to the juvenile component of the stock. The historic estimates of F and the estimated selection pattern are highly dependent on the choice of terminal F and selection (Fig. 5.6.2.1.2 & 5.6.2.1.3). The estimated selectivity patterns suggests an increase in selections towards age 8 and a relative decrease in selection from age 9 to age 10. This is likely to be the effect of the choice of selection at oldest age.

5.6.2.2 SAD

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 the time, three assessment methods were compared (ICES CM2001/ACFM:06), and the Working Group and ACFM considered the SAD model to provide the most realistic representation of the dynamics of the western horse mackerel stock. At last year's meeting, exploratory work on the 2004 SAD model set within a more rigorous statistical framework than previous approaches, was carried out. This was to deal with some of the concerns expressed by ACFM in the Technical Minutes of the 2003 Working Group report (ICES CM 2004/ACFM:08), which led to the rejection of 2003 SAD assessment.

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). The main features of western horse mackerel that require the use of a uniquely-developed assessment tool are the dominance of a very strong 1982 year class in the catches for many years, a change in the selection pattern towards increasing exploitation of younger fish in recent years, and the lack of age-disaggregated information for model calibration. A further problem is that horse mackerel is no longer thought to be a determinate spawner (WGMEGS 2005) so that the time-series of egg production estimates is treated as an index of spawner biomass with a constant but unknown fecundity, estimated within the SAD assessment.

Figure 5.6.2.2.1 presents an illustration of the model structure and the “free” parameters estimated by maximum likelihood (i.e. those estimated directly), and Table 5.6.2.2.1. summarises it’s main features. The variances in the objective function are estimated by closed form solution. The age structure of the assessment, 0 to 11+, aggregates the 1982 year class within the plus group for the years 1993-2003, removing its influence on the selection pattern estimated for the cohorts currently dominating the catches. The separable model is fitted to the catch data for the years 2000-2003. The separable model estimates of the 2000 population abundance at age initiate a historic VPA for the cohorts exploited in that year. Apart from 1992, population abundance at the oldest true age for the years 1999 and earlier is derived from the catch-at-age data at the oldest true age and the average (un-weighted) fishing mortality-at-ages 7-9, in the same year (omitting the 1982 year class where applicable), multiplied by a scaling parameter (F_{scal}). This scaling parameter is estimated.

The plus group is modelled as a dynamic pool (plus group this year is the sum of the plus group last year and the oldest true age last year, both depleted by fishing and natural mortality). The fishing mortality on the plus group is taken to be equal to that on the oldest true age. The scaling parameter F_{scal} allows the model to increase selection at the oldest true age and for the plus group, compared to the mid-range ages, allowing for directed fishing of older, larger fish. In order to model the directed fishing of the dominant 1982 year-class, fishing mortality on this year-class at age 10 in 1992 ($F_{92,10}$) was also estimated as a parameter in the model. The plus-group modelled as a dynamic pool allows the estimation of a plus-group catch, and assuming the plus-group catches are log-normally distributed, allows the inclusion of an additional component to the likelihood, fitting estimated plus-group catches to their corresponding observed quantities.

The negative log-likelihood (-ln$L$) to be minimised is as follows:

$$-\ln L = \tfrac{1}{2}\sum_{y\in Y_{egg}}\left\{\frac{\left(\ln Egg_y - \ln(q_{egg}\hat{SSB}_y)\right)^2}{\sigma_{egg}^2} + \ln\left[2\pi\sigma_{egg}^2\right]\right\}$$

$$+\tfrac{1}{2}\sum_{y=2000}^{2004}\sum_{a=1}^{10}\left\{\frac{\left(\ln C_{y,a} - \ln\hat{C}_{y,a}\right)^2}{\sigma_{sep}^2} + \ln\left[2\pi\sigma_{sep}^2\right]\right\}$$

$$+\tfrac{1}{2}\sum_{y=1983}^{2004}\left\{\frac{\left(\ln C_{y,11+} - \ln\hat{C}_{y,11+}\right)^2}{\sigma_{11+}^2} + \ln\left[2\pi\sigma_{11+}^2\right]\right\}$$

where:

Egg_y	egg production estimate in year y;
$\hat{SSB}_y$	SSB model estimate in year y;
q_{egg}	catchability parameter linking the egg production estimates and the SSB model estimates;
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) catchability (q_{egg}) linking the egg production estimates and the SSB model estimates.

Input data for the model were as presented in Tables 5.6.2.2.2 and 5.6.2.2.3. 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 5.6.2.2.4 presents the Egg production estimates taken from ICES (2002:G06) and Section 5.1.1.

The application of maximum likelihood estimation provides a more rigorous statistical framework for the estimation of parameters. The inclusion of a dynamic pool approach to model the plus-group allows additional information to be used in the likelihood (the dynamic pool allows estimate of plus-group catches). It also results in a smoother SSB trajectory, avoiding sudden changes in SSB caused purely by variable catches in the plus-group.

Results

Plots of the model fits to data for the three components of the likelihood, together with plots of normalised residuals, are shown in Figure 5.6.2.2.2. The model provides reasonable fits to the data, and the residual plots appear free of systematic patterns apart from the early part of plus-group residuals in Figure 5.6.2.2.2(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. 5.6.2.2.2 (c)) 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.

Figure 5.6.2.2.3 shows the selectivity pattern for the separable period, and the SSB and age 0 trajectories, with error-bars reflecting 95% confidence bounds. CVs are in the range 10-41% for the selectivity parameters which are more imprecise for the young ages, 19-23% for the SSB estimates, and 7-46% for the age 0 estimates where the CVs increase substantially for the estimates corresponding to recent years. Point estimates and 95% confidence bounds for other key parameter estimates are given in Figure 5.6.2.2.4.

A run with SAD for a scenario where the selectivity for ages 9 and 10 was fixed equal to age 8 (s9&10=8) was performed to test the sensitivity of the results to that assumption. Results are shown in Figures 5.6.2.2.5 to 5.6.2.2.7. 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. 5.6.2.2.5) and less precise estimates of key parameters (Fig. 5.6.2.2.7) in the s9&10=8 scenario. As the selectivity pattern for older ages is kept flat the model interprets the low catch in older ages as the result of low numbers in the stock scaling the SSB down. The wider confidence intervals in model parameters are the result of not allowing the model to estimate selectivity for the older ages; basically by doing so the model is taken away from the ‘true’ minimum parameters’ space.

Fishing mortalities at age and observed catch at age are shown in Figure 5.6.2.2.8. They highlight the dominance of the 1982 year-class and the apparent shift in selectivity towards younger ages in recent years.

Discussion

Although SAD appears to provide reasonable fits to the egg production estimates and catches in both the separable period and plus-group, there are concerns about the generally low values estimated for fishing mortality, which result in high SSB estimates. Justification for the concerns about low fishing mortality estimates are based on qualitative information from the fishery, which suggests that these low levels of fishing mortality may not be realistic for the western horse mackerel stock.

The decrease in SSB level from SPALY (Same Procedure as Last Year)compared to s9&s10=s8 scenario is partly caused by the very different selectivity pattern in these two models (Figure 5.6.2.2.3(a) and 5.6.2.2.6(a)), and may indicate the need to include additional information (for example on the scaling parameter F_{scal}, the egg catchability parameter q_{egg}, or the levels of fishing mortality to be expected) to allow further evaluation of the scale of the model. Nevertheless, the overall trends in SSB remain similar, as shown in Figures 5.6.2.2.3(b) and 5.6.2.2.6(b).

The CVs corresponding to the egg production estimates were briefly considered and the WG concluded that they probably did not reflect the precision of the surveys. So, although the model was adapted to take into account those CVs this version was not run by WG.

Aspects that warrant further investigation/exploration are:

- the availability of additional information that would allow further evaluation of the scale the model;
- an estimate of variability in fecundity for horse mackerel stocks.

5.6.2.3 ISVPA

ISVPA was used to compare signals coming from catch-at-age data and from data on egg production. A further description of ISVPA can be found in SGAMHBW.(#ref) Historical changes in selection pattern were investigated as well by splitting the whole period of separable constraint into two parts.

Since selection pattern for this stock was expected to be strongly unstable because of extremely abundant 1982 year class, the catch-controlled version of the model (attributing the model residuals to violations of separability assumption) was used. By the same reason the stabilizing condition of ”unbiasedness”(zero year- and age sums of residuals) was imposed not on residuals in logarithmic catch-at-age, but on separable representation of fishing mortality.

Two cases concerning the year of change in selection pattern were tested:

1) 1) s(1): 1982-1991; s(2): 1992-2004, as it was done in ISVPA runs for WHM in 2002;

2) 2) s(1): 1982-2000; s(2):2001-2004, what makes the second period to be closer to period of separable constrain in SAD.

In both cases the results derived from catch-at-age alone and from tuning on egg production (as relative index of SSB) are rather close to each other (see figures 5.6.2.3.1 - 5.6.2.3.4), but if the year of change in selection is chosen as 2001, they almost coincide.

Figure 5.6.2.3.4 compares results obtained from catch-at-age alone; egg-surveys alone, and using both sources .

Comparison of results for the two years of change in selection pattern (using catch-at-age + egg surveys together) is given on figure 5.6.2.3.5.

Figure 5.6.2.3.6compares the ISVPA-derived estimates of selection patterns for the two cases of years of change in selection. In the second case selection patterns look smoother.

If one was to look at the dependence of the model loss function on the year of change in selection (figure 5.6.2.3.6), case 1) may be a better choice.

Figure 5.6.2.3.7- shows plots of residuals.

5.6.2.4 AMCI

AMCI was used to explore the signals in the catch data for Western horse mackerel. Using catch data alone in a separable model, with fixed or slowly varying selection should in principle not be sufficient to estimate all parameters, and any optimum of the objective function will be heavily influenced by the way noise appears in the data. However, the remaining parameters may be estimated if the terminal fishing mortality is specified. Therefore, AMCI was run with specified values for terminal F1-10.

Catch numbers at age from age 0 to 11+ for the period 1982 – 2004 were analysed. In order to reduce the number of parameters for which there is poor information in the data, the following assumptions were made:

- Fixed selection for the first 3 years, with flat selection at ages 9,10 and 11.
- Selection in 2004 equal to that in 2003.
- Slowly changing selection was applied for the other years, with gain factor 0.1, except for the years 1993 – 95, where a slightly higher gain of 0.2 was used because a fishery in the juvenile areas developed in those years. Selection at age 11 was kept equal to that at age 10.
- Recruitment was estimated for all years except in 2004, where a fixed value was used.
- Natural mortality was assumed constant at 0.15 for all ages.
- AMCI estimates the 11+ group as a dynamic pool, and includes it in the objective function. Hence, part of the model fit is that the plus group is fed from the younger age in such a way that catches generated from the modelled plus group fit with those observed at that age.

The objective function to be minimised to obtain parameter estimates was a combination of

- a sum of squared log catch residuals
- a sum of squares of residual of the annual total catches
- a sum of squared log (Catch(a,y)/Catch(a+1,y+1))

This choice of objective function was made to get a firmer estimate of the mortalities and biomasses. It reflects both the fit of the total catches and the fit of the mortality model to the specific mortality signal in the data, in addition to the general fit to the individual catch at age observations.

The observations at age 0 were downweighted by a factor of 0.01, as the information in these data about year class strength is considered poor. The outstanding 1982 year class was also downweighted by a factor of 0.01 at ages 0-10. This was done to concentrate the assessment on other year classes. In practise this means that the 1982 year class was estimated by applying fishing mortalities that were essentially derived from all the other year classes to the catches at age of the 1982 year class.

Parameters were estimated assuming a terminal F of 0.10 and 0.15. Furthermore, the objective function was calculated for a wider range of terminal F.

The value of the optimum objective function was virtually the same for a range of terminal F-values, demonstrating that there is not enough information to estimate this parameter (Figure 5.6.2.4.1). The model fit is not quite satisfactory, however, in the sense that there are some clusters of catch residuals remaining (Figure 5.6.2.4.2). Exploring various alternative objective functions indicated a discrepancy between total catch and catch numbers at age. Attempting to fit the model by using only the sum of squared log residuals as objective function led to a gross discrepancy between modelled and observed yields. Hence, there may be observations in the catch at age data that has undue influence on the model fit. Perturbation of the terminal F indicated that some of the catches at age 1 were the most influential, but this was not explored further. The results for terminal F = 0.10 and 0.15 are shown in Figure 5.6.2.4.3.

Even though the data for the 1982 year class were heavily downweighted, the residuals of this year class are not outstanding. This indicates that the exploitation also for this year class can be inferred from the other year classes. The

The selection at age also was virtually independent on the choice of terminal F An example of the selections is shown in Figure 5.6.2.4.4. Two distinct patterns were found, one for the early and one for the late period. The shift took place around 1993. This fits well with the development of a fishery in areas dominated by juveniles in that period. Attempting to fit the model by using only the sum of squared log residuals as objective function led to a gross discrepancy between modelled and observed yields.

Stock numbers at age, derived with a terminal F of 0.1 are shown in Figure 5.6.2.4.5. The 1982 year-class stands out clearly, and does also lift the 11+ group for several years.

Some inferences can be made form this data exploration with AMCI:

- The model, when applied only to catch data is overparameterised, and only estimates conditional on assumed terminal fishing mortalities can be provided.
- Even then, there are individual catch data that have an undue influence on the results. This can be ameliorated by including a fit to the total annual catch and to the log catch ratios in the objective function.
- Under these conditions, estimates of selection at age, as well as to the development and magnitude of the stock in the past are robust to assumptions about terminal fishing mortality.
- The selection at age changed markedly around 1993, in accordance with the development in the fishery at the time.
- Recruitment, apart from the extreme 1982 year class has fluctuated, with a period of better recruitments in the mid 1990ies and another after 2000. The 2001 year class appears to be the strongest since 1982.
- The present level of exploitation remains unknown.

Conclusion

The exploratory analysis described above has examined the stock trajectory through VPA, ISVPA, AMCI and SAD models. All analyses conclude that the fishery has changed through history with major changes in the early 1990s and further changes in the last few years as the fishery has changed to take more juveniles and less adults.

The VPA analysis gives an unstable estimate of the historical perception of the stock, this is thought to be the result of the large numbers in the +group in the catch number matrix, however, the consequences are that the VPA is not informative for the stock history. The separable VPA is not well suited for the whole time series of data for western horse mackerel, because of the changing fishery, but gives a similar perception of the stock trends in recent years compared to other models. AMCI has been used in a similar fashion to the VPA with a specified terminal F but using a smoothly changing separable model and estimated catches. This model gives a more stable estimate of historic biomass but provides uncertain estimates of SSB in the first few years of the assessment. This is because there is little information to estimate the numbers at age in the first years. AMCI captures the general conclusion of a rising biomass in the mid 1980s with a decline to the present which is well supported, but the exact levels of SSB in 1982, the maximum SSB in the late 1980s and the current SSB are rather different from other models, giving a more extreme range of stock size. AMCI estimates the abundance of the 1982 year class as higher than the other models and SSB in 2000 as lower. While AMCI is not fitted analytically the model provides indications that a fitted model would favour a low F of 0.1 or lower. The estimated SSB in 2004 with a terminal F=0.1 are similar to the estimates of biomass for 1982 both at approximately 1.4 Mt. Suggesting that the stock today is at a comparable level to 1982.

Both ISVPA and SAD models have been used with minimisation of both catch and egg surveys to give estimated population trajectories. The WGMEGS has evaluated how to transform the horse mackerel egg survey to an SSB index and they indicate that results of biological studies suggest that it is not currently possible to derive an index to convert egg production into SSB in this species. However, WGMEGS has considered this aspect without evaluating the precision required. The stock trajectory given by AMCI matches closely with the egg survey data in 1982 / 1990 but then gives a factor of 0.25 between estimated SSB and the egg survey in 2001. In contrast the SAD model is fitted closely to the egg survey index and follows the general trajectory in SSB implied by this survey estimating an average conversion factor from SSB to egg survey of 0.36 (q_{egg}; CV 20%). Knowledge of the magnitude of the variability in fecundity is necessary to evaluate the use of the egg survey as a proxy for SSB in the current assessment framework. Unless this magnitude is large (a factor of 4) the WG considered it appropriate to use the egg index as a proxy of SSB.

Both ISVPA and SAD models support the view that the stock is lightly exploited with an F between 0.03 and 0.15, and these F levels are reproduced by all the fitted runs. The major difference between the different models is the detailed perception of the current biomass relative to historical biomass. All the models give the rise in SSB due to the 1982 year class, followed by the decline to the present. The major important difference in perception is the difference in biomass now from that in 1982. This is important in a management context because SSB in 1982 is taken as Bpa for western horse mackerel. ISVPA estimates the 2004 SSB as comparable or slightly lower than the 1982 biomass. The SAD model, which follows the egg survey, estimates the current SSB as above the 1982 biomass, (1Mt and 600,000t respectively).

In conclusion it is not possible to provide an analytic assessment of the state of the stock, perceptions from the data exploration are:-

F is low in the range 0.05 to 0.15

SSB in 2004 is comparable or above SSB in 1982

The magnitude of the 2001 year class appears relatively large however there is considerable uncertainty about the estimate of its size.

The 2001 WG and ACFM viewed SAD as providing a realistic representation of the dynamics of the western horse mackerel and the model has been refined since then to provide a more rigorous statistical framework. However, the problems related to the interpretation of the egg survey data, the only time-series available apart from the catch data, pose a fundamental question to the results from any stock assessment model. The different models give a very different perception of the magnitude of the stock in 2000. Without more information on the relationship between the egg abundance and the SSB, these differences cannot be resolved. This leads to a large uncertainty in the current level of biomass.

5.7 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

Giving the uncertainty of the absolute levels of SSB, F and R, and in the absence of a full analytical assessment, no catch predictions have been carried out this year. A detailed analysis of the influence of a distribution of the catch to the juvenile and the adult area was presented in 2003 report (ICES 2004/ACFM:08). As this analysis was presented in relative terms in last year's ACFM report, it is still considered valid.

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 highly uncertain. As this affects also the historic perception of the stock, a definition of reference points is currently not possible. The stock is characterised by infrequent, extremely large recruitments.

Biomass reference points. As only a short time series of data is available, it is not possible to quantify stock-recruit relationships. 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 1983 for B_{lim}. However, the method used to estimate the SSB in 1982 (from 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.

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

A simulation study to evaluate simple stock assessment and management for this stock was presented in response to a request from the Study Group on *ad hoc* Long-Term Advice which met on 12-13 April 2005. This worked performed by Roel & J. De Oliveira. was presented to the WG for discussion. A brief description of the methodology and a summary of the main results follow.

Simulation framework

Operating model

This will be based on the parameters estimated in the last assessment. There is a scaling problem in the estimated numbers-at-age by the SAD assessment. The problem is likely to be solved if fecundity could be estimated, for example by introducing a Bayes-like approach to estimate fecundity incorporating a prior for fecundity based on existing information for other horse mackerel stocks and/or stocks with similar dynamics. Weight of the stock and of the catch, age-at-maturity and natural mortality were based on historical data.

Fishery model

Both fisheries, the one that catches primarily juveniles and the one that catches adults, need to be regulated. Therefore, the behaviour of both fleets will be taken into account in the operating model.

Stock assessment

Estimates of egg abundance and SSB will be based on the numbers-at-age generated by the operating model and on estimates of fecundity.

Harvest control rule

Given the recent development of a fishery on juveniles (consisting of fish 1–3 years old) and the impact that fishing mortality on such ages is likely to have on the sustainability of the stock, separate harvest rules applying to the juvenile area and to the adult area need to be considered. In the absence of a recruitment index, the juvenile fishery can only be regulated by a fixed catch or by limiting effort. Effort control on a shoaling species such as horse mackerel would be difficult to implement successfully, so it may need to be combined with area closures. However, testing area closure approaches will require developing an operating model that takes spatial distribution into account or modelling availability, both beyond the scope of this study. Therefore, we only propose harvest rules that result in a TAC as a form of managing the fishery.

The WGMHSA (ICES 2003) examined the selectivity patterns in the juvenile and adult area fleets (Fig. 1) showing that the proportion of juveniles caught in the juvenile area is much larger compared to the adult area. Given this reality the TAC will be computed for two components: one applied in the juvenile area (referred to as $TAC_{j)}$ and the other to the adult area (TAC_{ad}).

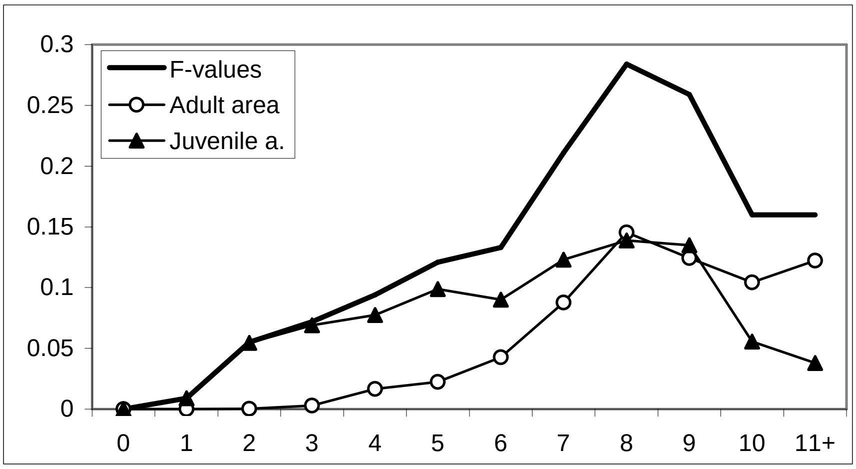


Fig. 1. Fishing mortality patterns in the juvenile and adult areas.

Another question is whether an annual or rather a multi-annual TAC is more appropriate in this case. At present, the TAC could be adjusted every year. Conversely, an assessment could be provided every third year when the egg survey results become available, in which case a multi-annual three-year TAC could be considered. Some arguments in favour of multi-annual TACs for northeast Atlantic mackerel also apply to western horse mackerel:

- the assessment data, apart from catches in numbers at age, are restricted to one point estimate of the SSB every third year;
- the SSB data are noisy, the noise carrying over to the assessment of recent years' stock abundance;
- if variability in recruitment is not particularly great (extraordinary year classes are not taken into account) and there are no clear changes in weight and maturity over time, then those could also be arguments in favour of multi-annual TACs.

Implementation error model

We propose to model the mismatch between TAC area and the area where the stock's catch is taken as implementation error. Examination of trends in TAC overshoot suggests that, when a strong year class was present in the fishery, the EU TAC was largely exceeded as it was limiting the fishery. In recent years, as the strong 1982 year class has virtually disappeared from the fishery, total catches have been close to or slightly below the EU TAC, likely related to stock availability. For the purpose of this simulation testing exercise, the overshoot will be a function of the EU TAC, with random variation added (Figure 2).

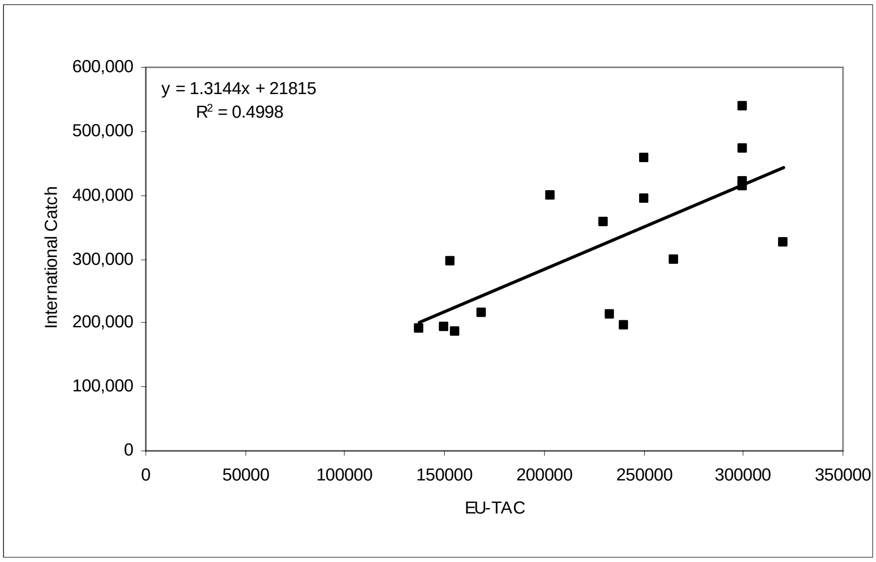


Fig. 2: International catch against EU TAC (tons) for the period 1987 – 2003 and linear regression used to model the overshoot.

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.

Frequency $< B_{threshold}$: average over 1000 simulations of the number of times SSB fell below the biomass reference point during the 20-year projection period.

Mean catch: median value over 1000 simulations of the average of 20 years of annual catch.

End SSB: median values over 1000 simulations of the biomass at the end of the 20-year projection period.

Median interannual catch variability: median value over 1000 simulations of the average 20-year interannual catch variability (*ICV*):

$$ICV = \{\sum_{y=a}^{z} \mathrm{abs}[(C_{y-1}-C_y)/C_{y-1}]\}/(z-a),$$

where *abs* denotes the absolute value, and *a* and z the first and last years in the projections, respectively.

Performance statistics could also be presented for the short and medium-term if so required.

Stochasticity

See comments under operating model and formulation in the Appendix.

Choice of simulation period

Given the spasmodic nature of recruitment, the simulation period needs to be sufficiently long on average for at least two 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 two types of three-year TAC strategies:

1)The TAC consists of a juvenile and an adult component. The juvenile component is a fraction (β) of the juvenile biomass and the adult component is computed as a fraction (α) of the estimated SSB.

$$\boldsymbol{TAC_{,y} = \beta\ Juv_y + \alpha\ \ SSB_y}$$

Results are presented for two cases: a) the juveniles are estimated based on geometric mean recruitment for 1983 – 2002 (base case) and b) the juvenile component is computed as a proportion of an index of juvenile abundance with a CV assumed = 0.25.

2) The TAC is adjusted according to the trend in the last 3 egg survey data:

$$TAC_y = TAC_{y-1}(1 + f(slope))$$

The function of the slope which, takes values between 0 and 1.4, is illustrated in Figure 3.

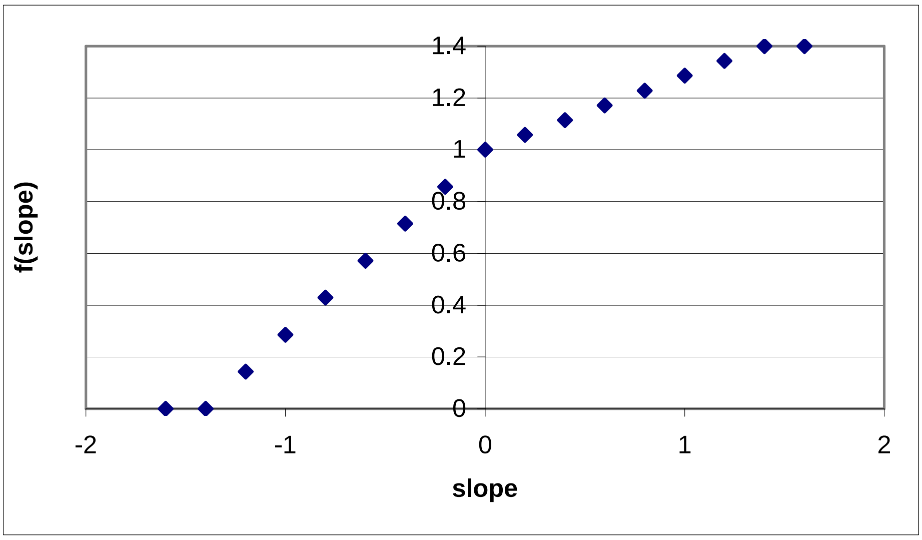


Fig. 3 Slope of the last 3 years egg data used to estimate the TAC_y.

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. Results from this strategy are presented for a range of TACs in 2007.

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.

The effects of overshooting the TAC were tested for the base case scenario.

Results and discussion

Median of the average 20 year-projections catch and associated risk are presented for the b ase case and for the case where a juveniles index is available (Figure 4). The various plots correspond to scenarios where the total TAC is computed by taking increasing fractions of the juveniles and of the estimated SSB. Each point on a curve corresponds to one median catch over 500 simulation and associated risk which result from taking a fraction (α) of the SSB, so as α increases so does the catch until it becomes too large for the available biomass and the curve starts curling to the left as a result. In all cases taking a larger component of the TAC in the juvenile area is a more risk prone exploitation strategy. Comparison between the two columns in Figure 4, without and with a juvenile index, suggests that if a juvenile index was available the risk associated with a higher TAC will increase at a slower rate compared to using the geometric mean to predict juvenile abundance. However, if the juvenile fraction was too high then it would result in no advantage.

Results from applying the slope strategy are shown in Figure 5. Each curve corresponds a different fraction of the TAC taken by the juvenile area fleet. For any particular curve the median catch increases as the first applied TAC (2007) increases by 50 thousand tons. This strategy is also sensitive to the fraction of the TAC taken by the juvenile area fleet.

Median catch, spawning stock biomass at the end of the projection period and inter-annual catch variability are compared in Figure 6 for a selection of all the strategies tested. All the scenarios selected result in a risk of SSB < Bpa laying between 0.25 and 0.3. Comparison under those conditions suggests that the slope strategy is more conservative and results in less inter-annual catch variability than the constant proportion strategy. In the case of the constant proportion strategies there seems to be a trade-off between juveniles fraction in the TAC and inter-annual catch variability. This is because the scenarios compared have similar risks and similar median catch but the TACs are computed using different α values. Inter-annual catch variability increases when α increases.

The effect of TAC overshoot on catch and associated risk compared to the base case for juvenile components of the TAC of 0.2 and 0.4 and fractions taken by the juvenile fishery = 0.3, 0.5 and 0.7 is shown on Figure 7. Under the assumptions made in this study, overshoot of the TAC at levels similar to the ones seen in the recent past results in substantial increase in associated risk for a similar outcome in terms of catches. However, results in absolute terms are dependent on the biomass level which is still uncertain.

The WG considered the approach and results from the simulation study as a step forward in evaluating harvest control rules (HCR) to manage this stock. A number of suggestions were made:

- alternative graphic presentation of results from different strategies in terms of yield and associated risk, the catch curves seem to be difficult to interpret;
- 20-year predictions appear to be short to see the results from strategies tested given the life-span of the stock, levels of correlation in recruitment considered and the multi-annual nature of the TAC;
- Presentation of average catch for comparison with median catch and of fishing mortalities associated with the application of the various HCRs.
- Test sensitivity of the results to alternative formulations to generate recruitment, i.e. by random sampling with replacement from the assessment historic estimates of recruitment;
- Consider other forms of risk in addition of probability of SSB falling at least once below Bpa.

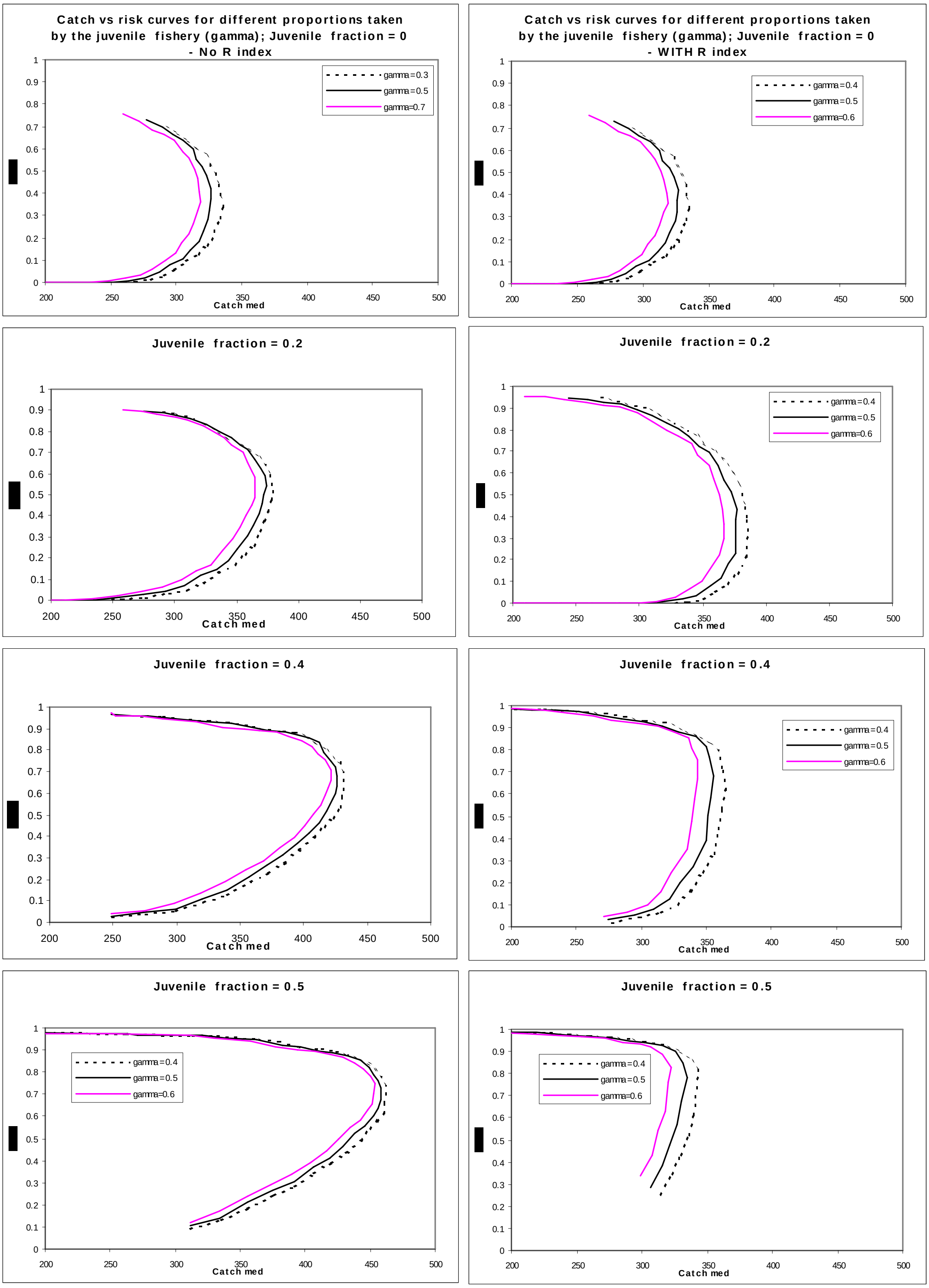


Figure 4: Results in terms of risk and median catch for 20-year projections for a constant proportion strategy without a juvenile index (left column) and with a juvenile index (right). The parameter gamma reflects the proportion of the catch taken by the juvenile fishery.

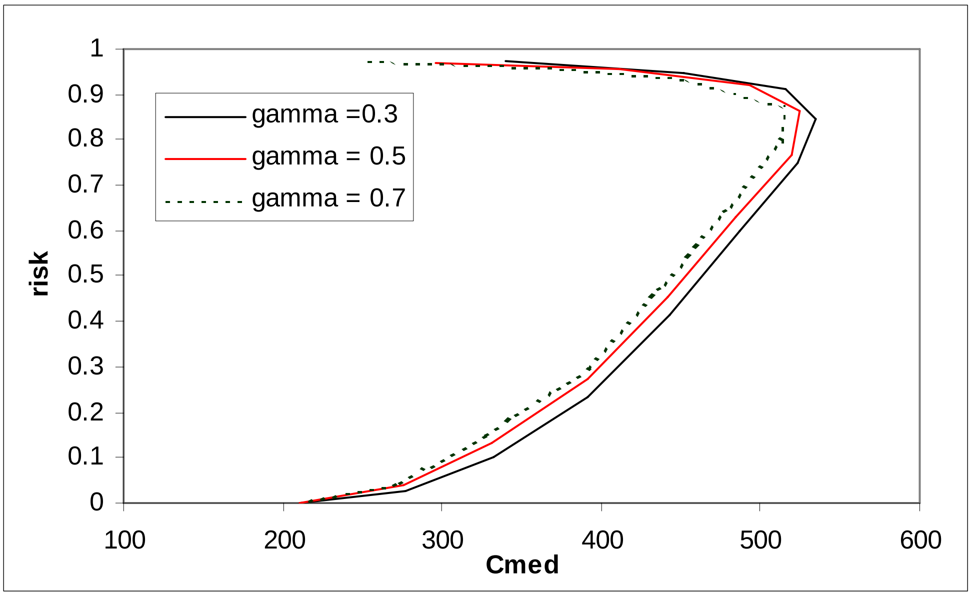


Fig. 5: Results in terms of risk and median catch for 20-year projections for a slope strategy. The parameter gamma reflects the proportion of the catch taken by the juvenile fishery

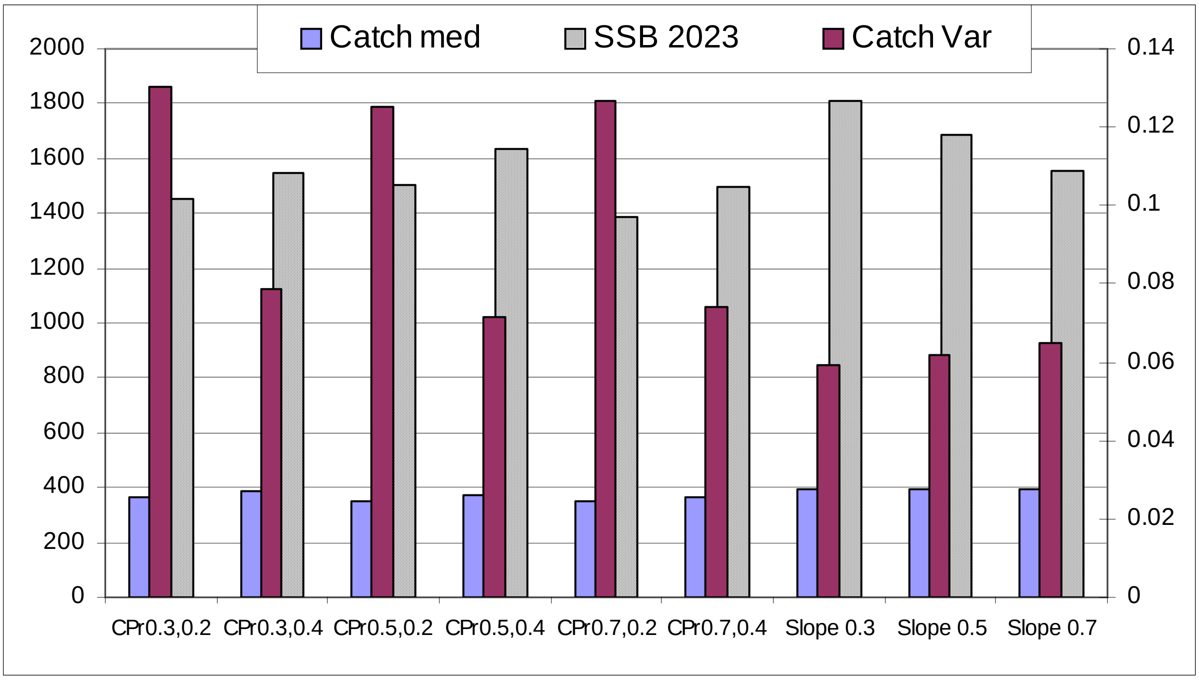


Fig. 6: Comparison between constant proportion and slope strategies for TAC fractions taken by the juvenile area fishery = 0.3, 0.5 and 0.7 in terms of median catch, SSB in 1923 (left-axis) and inter-annual catch variability (right-axis) over 20-year projections.

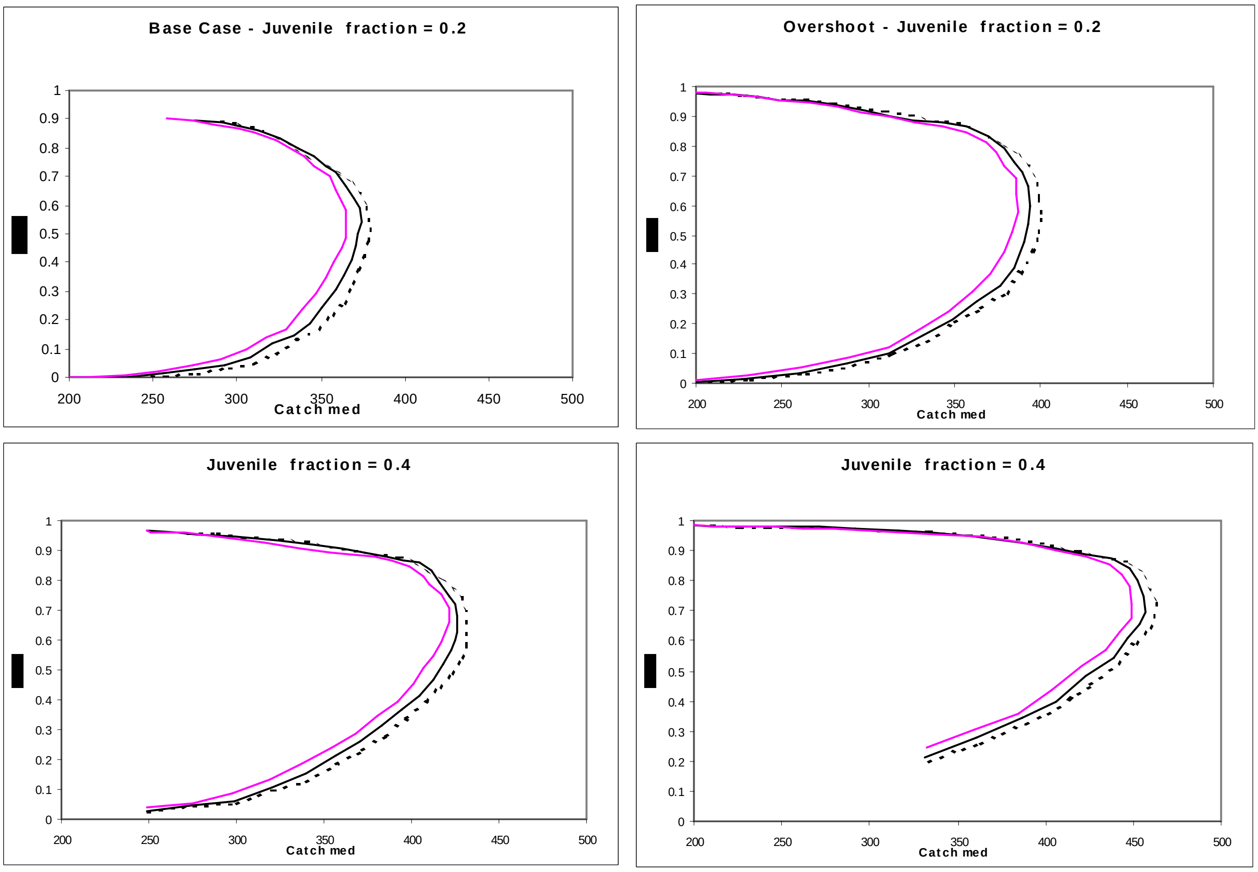


Fig. 7: Effect of TAC overshoot on catch and associated risk (right panels) compared to the base case (left panels) for juvenile components of the TAC of 0.2 and 0.4 and fractions taken by the juvenile fishery = 0.3, 0.5 and 0.7.

APPENDIX (from De Oliveira *et al*.)

5.12 Spawning stock biomass:

The spawning stock biomass in the underlying model, referred to as the "true" spawning stock biomass, is calculated as follows:

$$SSB_y^{true} = \sum_{a=1}^{11+} N_{y,a} Q_a w_a^{stock} e^{-p_F\, s_a\, F_y\, -\, p_M\, M_a} \qquad y = 2002,...,2021 \qquad \text{A1}$$

where

$N_{y,a}$	is the number of fish aged a in year y;
Q_a	is the proportion of mature fish aged a;
w_a^{stock}	is the mean weight of fish aged a in the stock;
s_a	is the selectivity at age a;
F_y	is the fishing mortality in year y;
M_a	is the natural mortality at age a;
p_F	is the proportion of fishing mortality that occurs before spawning;

and

p_M	is the proportion of natural mortality that occurs before spawning.

5.13 Recruitment

Recruitment is generated using a combination of the Ricker stock-recruit function with parameters a and b estimated from a fit to stock-recruit estimates derived from the SAD model (ICES, 2004), and a process that allows the influx of very large recruitment with a frequency of roughly one in 20 years (equation A2). The recruitment variation and serial correlation parameters, σ_R and ρ_{ser} (equations A2 and A3), are derived from this fit.

$$N_{y,0} = \begin{cases} a\, SSB_y^{true}\; e^{-b\, SSB_y^{true}}\; e^{\sigma_R\, \zeta_y - \frac{1}{2}\sigma_R^2} & \text{for } \psi \geq 0.05 \\ 45\, \text{billion fish} & \text{for } \psi < 0.05 \end{cases} \qquad \text{A2}$$

where y = 2002,...,2021, ψ is independently drawn form a U[0; 1] distribution, and

$$\zeta_y = \rho_{ser}\, \zeta_{y-1} + \sqrt{1-\rho_{ser}^2}\; \xi_y$$

$$\xi_y \sim N[0;1]$$

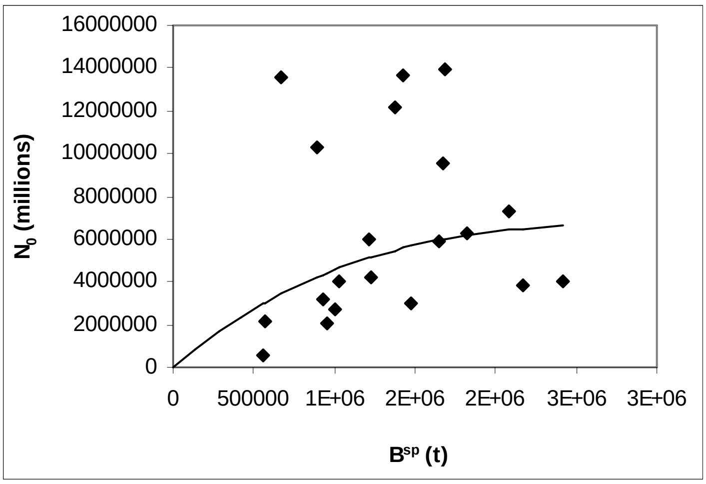


Figure a1. Ricker fit to 1983 – 2002 stock and recruitment data (2004 assessment results).

A cumulative probability distribution of the recruitment values used in the simulations and of the historic time-series (excluding 1982 year-class) is shown in figure ??. Simulated values of recruitment, based on the Ricker curve, larger the 95th percentile of the distribution were omitted in the simulations.

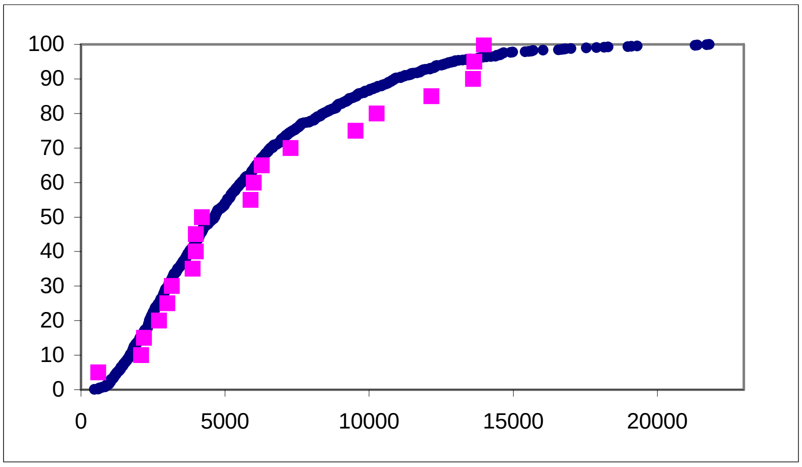


Figure a2. Cumulative distribution of simulated recruitment and of the historic data.

5.14 Numbers-at-age

An age-structured deterministic underlying model is used, and is based on a separable assumption with regard to fishing mortality and selectivity, and assumes a plus group at age 11. Uncertainty in the starting numbers at age will be taken into account.

$$\left.\begin{array}{ll} N_{y+1,a+1} = N_{y,a}\ e^{-s_a F_y - M_a} & a = 0,...,9 \\ N_{y+1,11+} = N_{y,10}\ e^{-s_{10} F_y - M_{10}} + N_{y,11+}\ e^{-s_{11+} F_y - M_{11+}} & \end{array}\right\} \quad y = 2002,...,2021 \qquad \text{A4}$$

5.15 Calculating the fishing mortality and catch

The fishing mortality that results from applying C_y is calculated by solving for F_y from the following:

$$C_y = \sum_{a=0}^{11+} N_{y,a}\ w_a^{catch}\ \frac{s_a F_y}{s_a F_y + M_a}(1 - e^{-s_a F_y - M_a}) \qquad \text{A5}$$

An upper limit is placed on catching efficiency. To achieve this, F_y is restricted to be ≤ 20, which results in $\frac{s_a F_y}{s_a F_y + M_a}(1 - e^{-s_a F_y - M_a}) \leq 0.98$ for any age group, given the values used for s_a and M_a. If no implementation error is considered (i.e. no mismatch between TAC and catch is modelled), then as long as $F_y < 20$, it follows that $C_y = TAC_y$. However, when F_y is restricted to a value of 20, this is no longer the case and C_y is calculated by solving equation A5 (with $F_y = 20$) after replacing TAC_y with C_y. If implementation error is considered, then generally $C_y \neq TAC_y$, even when $F_y < 20$.

5.15.1 Generating egg abundance observations

In order to generate egg abundance observations, the “true” egg abundance needs to be obtained from the “true” spawning stock biomass (equation A1). It is modelled on the basis of the relationship between egg abundance and spawning stock biomass estimated from the SAD model (ICES, 2003). To incorporate different components of variance into this relationship, the total variance can be apportioned into a "process" error component (λ_{egg}) linking true egg abundance to true spawning stock biomass (where fecundity plays a role), and an "observation" error component (cv_{egg}) linking observed egg abundance to true egg abundance through the sampling CV of egg abundance estimates.

EGG^{true} is derived from SSB^{true} with process error, as follows:

$$EGG_y^{true} = \frac{1}{q} SSB_y^{true} \ e^{\lambda_{egg}\eta_y} \qquad \text{A6}$$

where $\eta_y \sim N[0;1]$. In equation A6, 1/q is the constant of proportionality linking egg abundance to spawning stock biomass, and λ^2_{egg} represents the process error component of the total variance of the egg abundance versus spawning stock biomass relationship (in log-terms), which could in part be due to variability in fecundity. The observed egg abundance is generated from EGG^{true}, with observation error as follows:

$$EGG_y^{obs} = EGG_y^{true} \ e^{cv_{egg}\ \omega_y} \qquad \text{A7}$$

where $\omega_y \sim N[0; 1]$, and cv_{egg} represents the sampling CV related to observed egg abundance estimates.

5.16 Management considerations

The SSB of Western Horse Mackerel has been dominated by an outstanding 1982 year-class that reached a maximum in 1988. This year class has been gradually fished out and since then no other outstanding year classes have appeared, while the spawning biomass has slowly declined. There are strong indications that the 2001 year class might be strong. As there are no recruitment indices available, the strength of this year class can only be determined once this year class becomes mature and appear in the spawning area. Therefore, fishing should be kept at a low level in the next years. However, such a decision should be kept under review and modified as evidence of the strength of the 2001 year class becomes available. Major catches of juvenile horse mackerel may be an early sign of the strength of this year class, and if this occurs it will necessitate rapid management decisions. As the fishery has increasingly targeted juvenile horse mackerel (see below), separating these factors might be difficult. 60 % of the total international catch now consists of one to three year old fish. The WG expresses concern that catches of juvenile fish are high at a time when the recruitment appears to be low, and the spawning stock size seems to decline.

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 50% in 2004. In 2004 53% of catch in numbers in this area was from the 2001 year class.

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.

The TAC had been overshot considerably between 1988 and 1997. Since 1998 the total catches have been close to or below the TAC, which is however set only for a fraction of the distribution area.

Table 5.2.1 Landings (t) of HORSE MACKEREL 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[1]
Faroe Islands	-
Denmark	-
France	-
Germany	-
Norway	42
Russia	
UK (England + Wales)	-
Estonia	-
Total	42

[1]Preliminary.

[2]Included in Subarea IV.

[3]Includes catches in Division Vb.

Table 5.2.2 Landings (t) of HORSE MACKEREL in Subarea IV and Division IIIa by country.

(Data submitted by Working Group members).

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

Continued

COUNTRY	1998	1999	2000	2001	2002	2003	2004[1]
Belgium	19	21	19	19	1,004	5	4
Denmark	2,048	8,006	4,409	2,288	1,393	3,774	8,735
Estonia	22	-	-				
Faroe Islands	28	908	24	-	699	809	
France	379	60	49	48	-	392	174
Germany	4,620	4,071	3,115	230	2,671	3,048	4,905
Ireland	-	404	103	375	72	93	379
Netherlands	3,811	3,610	3,382	4,685	6,612	17,354	21,418
Norway	13,129	44,344	1,246	7,948	35,368	20,493	10,709
Russia	-	-	2	-	-	-	
Sweden	3,411	1,957	1,141	119	575	1,074	665
UK (Engl. + Wales)	2	11	15	317	1,191	1,192	2,552
UK (Scotland)	3,041	1,658	3,465	3,161	255	1	1
Unallocated + discards	737	-325	14613	649	-149	-14,009	-19,103
Total	31,247	64,725	31583	19,839	49,691	34,226	30,435

[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 Landings (t) of HORSE MACKEREL 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[1]
Denmark	-	-	-	-	-	-	-
Faroe Islands	-	-	-	-	-	-	-
France	221	25,007	-	428	55	209	172
Germany	414	1,031	209	265	149	1,337	1,413
Ireland	21,608	31,736	15,843	20,162	12,341	20,915	15,702
Netherlands	885	1,139	687	600	450	847	3,701
Spain	-	-	-	-	-	-	-
UK (Engl. + Wales)	10	344	41	91	-	46	5
UK (N.Ireland)	1,132	-	-			453	
UK (Scotland)	10,447	4,544	1,839	3,111	1,192		377
Unallocated +disc.	98	1,507	2,038	-21	3	-553	559
Total	34,815	65,308	20,657	24,636	14,190	23,254	21,929

[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 Landings (t) of HORSE MACKEREL 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[1]
Faroe Islands	-	-	550	-	-	-	-
Belgium	18	-	-	-	1	-	+
Denmark	25,492	19,223	13,946	20,574	10,094	10,867	11,529
France	24,223	-	20,401	11,049	6,466	7,199	8,083
Germany	25,414	15,247	9,692	8,320	10,812	13,873	16,352
Ireland	51,720	25,843	32,999	30,192	23,366	13,533	8,470
Netherlands	91,946	56,223	50,120	46,196	37,605	48.222	41,123
Spain	-	-	50	7	0	1	27
UK (Engl. + Wales)	12,832	8,885	2,972	8,901	5,525	4,186	7,178
UK (N.Ireland)	-	-	-	-	-		
UK (Scotland)	5,095	4,994	5,152	1,757	1,461	268	1,146
Unallocated + discards	12,706	31,239	1,884	11,046	2,576	24,897	18,485
Total	249,446	161,654	137,766	138,042	97,906	123,046	112,393

[1]**Provisional.**

[2]**Includes Subarea VI.**

Table 5.2.5 Landings (t) of HORSE MACKEREL 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[1]
Denmark	1,728	4,818	2,584	582	-	-	
France	1,844	74	7	5,316	13,676	-	2,161
Germany	3,268	3,197	3,760	3,645	2,249	4,908	72
Ireland	-	-	6,485	1,483	704	504	1,882
Netherlands	6,604	22,479	11,768	36,106	12,538	1,314	1,047
Russia	-	-	-	-	-	6,620	
Spain	23,599	24,190	24,154	23,531	22,110	24,598	16,245
UK (Engl. + Wales)	9	29	112	1,092	157	982	516
UK (Scotland)	-	-	249	-	-	-	
Unallocated + discards	1,884	-8658	5,093	4,365	1,705	2,785	2,202
Total	38,936	46,129	54,212	76,120	54,560	41,711	24,125

[1]Preliminary.

[2]Included in Subarea VII.

Table 5.3.2.1.- Catch in number at age per haul from Spanish September/October surveys operating in Division VIIIc and Subdivision IXa North

	AGES															
YEAR	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15+**
1985	182.630	84.360	322.510	467.600	7.090	6.500	4.710	4.050	4.840	5.390	3.580	0.880	0.840	0.260	0.770	5.010
1986	289.420	44.600	12.640	7.000	41.810	4.920	5.150	11.110	4.680	7.200	8.540	3.050	1.310	0.800	0.980	3.840
1987	217.665	64.153	20.035	8.053	18.482	16.448	5.100	7.979	5.662	5.879	4.712	4.630	1.470	1.389	4.147	0.001
1988	145.910	14.650	14.220	9.000	5.130	8.170	54.990	5.050	5.730	6.850	4.800	2.600	7.030	1.650	2.410	17.550
1989	115.000	6.540	1.900	21.300	4.680	17.500	15.620	65.040	7.680	10.470	26.160	0.570	0.410	4.770	0.400	5.440
1990	26.620	17.790	2.730	2.680	15.920	5.680	7.630	6.090	73.350	3.050	4.730	0.860	0.810	0.600	0.770	1.670
1991	48.470	15.370	5.100	0.150	1.440	1.820	0.710	0.640	2.170	28.900	6.420	6.520	2.220	1.070	2.780	0.640
1992	85.470	44.810	0.740	1.050	0.350	2.080	4.470	4.360	5.730	5.090	47.600	5.060	1.620	0.600	0.180	3.550
1993	138.619	31.848	3.447	0.630	2.199	4.546	13.762	17.072	4.513	4.422	3.881	22.057	0.235	0.041	0.228	0.256
1994	937.761	64.849	20.936	1.332	1.510	2.535	4.887	9.632	11.578	2.473	1.530	0.911	4.512	0.361	0.194	0.433
1995	38.308	172.564	12.492	6.941	5.806	3.845	6.311	9.659	14.481	11.868	3.503	1.930	0.340	8.609	0.101	0.049
1996	43.288	47.240	26.844	19.573	35.014	19.058	6.602	11.004	2.733	21.892	7.012	1.079	1.723	0.033	3.657	0.078
***1997**	6.652	11.099	4.819	8.647	7.559	6.257	3.849	4.066	12.489	4.112	10.678	8.052	0.498	0.345	0.100	2.648
***1998**	22.701	7.359	20.453	26.250	54.153	28.340	19.392	11.049	4.552	2.623	0.897	2.132	2.238	0.491	0.259	2.493
***1999**	2.378	33.265	12.158	3.444	18.065	16.289	9.945	13.734	12.261	9.046	4.559	1.069	1.335	0.079	0.060	0.113
***2000**	45.982	4.200	2.943	8.474	18.432	28.615	47.078	20.507	6.944	7.450	1.426	0.479	0.940	0.928	4.315	1.102
***2001**	6.882	4.541	19.285	10.482	6.002	3.646	1.280	27.886	17.310	3.502	5.678	3.387	0.511	0.616	0.215	0.484
***2002**	1.223	2.387	2.866	2.699	6.375	3.139	4.383	9.674	12.774	8.072	4.316	2.428	0.704	1.086	1.743	0.163
***2003**	38.806	20.117	68.039	9.052	7.726	5.461	8.168	7.654	8.355	16.503	7.214	2.849	1.301	0.073	0.182	1.836
***2004**	59.134	11.430	3.220	11.149	3.467	3.645	2.851	1.431	3.331	2.689	1.912	0.015	0.553	0.071	0.161	0.889

* Since 1997 a new stratification was applied. Data from years 1985 -1996 will be revised according to this new stratification.

Table 5.3.2.2.- Length distribution of Horse Mackerel from French pelagic survey PELGAS (spring)

Length_cm	PEL00	PEL01	PEL02	PEL03	PEL04	PEL05
8	0	0	0	0	0	0.05
9	0.08	0	0.11	0	0.18	2.15
10	0.45	0	0.84	0	5.17	13.05
11	5.69	0.24	5.70	0.00	22.16	16.63
12	28.82	1.75	20.21	0.02	21.85	5.13
13	33.54	7.45	35.02	1.81	15.99	0.68
14	8.35	9.92	16.68	0.84	9.44	0.09
15	5.97	7.99	6.90	1.65	3.38	0.33
16	2.40	1.13	0.48	17.68	0.31	1.58
17	1.24	7.87	0.40	29.88	0.66	2.84
18	0.04	16.69	0.34	24.53	1.83	4.02
19	0.02	14.36	0.12	10.85	8.44	4.39
20	0.07	6.76	1.21	5.21	7.59	4.31
21	0.30	5.82	3.72	1.31	1.51	12.93
22	0.53	4.61	3.71	0.49	0.40	16.29
23	1.69	2.97	1.83	0.29	0.22	6.23
24	3.69	3.47	0.83	0.52	0.12	2.70
25	3.44	3.21	0.59	0.84	0.22	0.93
26	1.33	2.05	0.50	1.14	0.18	1.85
27	0.62	0.68	0.26	1.03	0.08	1.86
28	0.49	0.43	0.19	0.78	0.12	0.63
29	0.40	0.24	0.20	0.40	0.03	0.58
30	0.18	0.05	0.06	0.38	0.06	0.28
31	0.24	0.14	0.03	0.19	0.04	0.14
32	0.12	0.10	0.03	0.06	0.01	0.07
33	0.08	0.62	0.02	0.03	0.01	0.08
34	0.05	0.69	0.02	0.04	0.00	0.07
35	0.04	0.46	0.01	0.01	0.00	0.04
36	0.02	0.27	0.01	0.01	0.00	0.04
37	0	0.03	0.00	0.02	0	0.03
38	0.03	0.00	0	0.01	0	0.02
39	0	0.00	0.00	0.00	0	0
40	0.04	0.01	0	0	0	0
41	0	0.00	0.00	0	0.00	0
42	0.03	0	0	0	0	0
43	0	0.00	0	0	0	0
total	100	100	100	100	100	100

Table 5.4.1. Horse mackerel in Division VIIIc. CPUE at age from A Coruña bottom trawl fleet (Subdivision VIIIc West).

Effort unit: Fishing trips/100 * mean HP

		AGES															
YEAR	**Effort**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15+**
1985	30255	3	12	134	399	19	42	39	25	27	43	22	8	3	1	3	27
1986	26540	3	79	58	118	400	40	31	22	15	15	41	16	6	10	2	33
1987	23122	1	33	113	92	143	672	76	61	13	22	20	16	8	2	1	13
1988	28119	5	167	258	58	58	51	408	40	29	22	11	11	16	4	2	9
1989	29628	23	152	48	115	56	57	38	299	40	103	78	6	2	23	2	16
1990	29578	1	84	128	37	71	17	27	39	394	21	27	5	6	6	7	15
1991	26959	1	1	41	2	20	39	27	65	49	376	37	17	12	2	9	5
1992	26199	0	191	60	10	9	54	99	48	46	51	361	12	6	3	0	8
1993	29670	0	34	467	39	51	95	87	210	56	79	16	209	1	0	1	1
1994	26393	2	79	270	12	8	20	92	146	165	34	18	4	45	1	0	1
1995	28000	0	7	122	84	37	25	36	64	129	102	33	12	2	47	1	1
1996	23818	0	1	29	14	65	89	51	62	41	125	108	36	15	14	59	3
1997	23668	0	2	3	2	6	13	14	32	52	49	86	80	34	18	6	40
1998	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1999	20154	0	0	2	5	35	46	65	99	118	65	37	23	17	5	3	14
2000	20048	0	0	3	6	15	49	87	96	71	55	22	34	26	17	20	26
2001	19958	0	0	0	1	7	17	41	90	87	97	69	45	32	15	19	14
2002	14549	0	0	0	1	3	2	12	21	52	64	61	62	26	39	27	90
2003	12346	0	0	2	4	13	19	53	43	65	137	67	49	27	4	18	94
2004	12799	0	0	1	25	8	6	8	23	18	20	63	46	15	12	9	43

Table 5.5.1.1 Western Horse Mackerel catch in numbers (1000) at age by quarter and area in 2004

1Q

Ages	IIa	IVa	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc E	VIIIc W	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	30.5	877.3	0.0	5.5	0.4	0.0	0.0	0.0	0.0	0.0	0.0	8472.0	617.8	830.8	3314.6	0.0	14149.0
2	0.0	213.5	6141.5	0.0	27.4	2.0	76.5	0.1	0.0	392.8	0.0	0.1	8001.4	913.9	399.5	646.9	15.4	16831.1
3	0.0	76.3	2193.3	0.0	1587.0	77.5	50.9	0.0	0.0	519.6	90.6	4.3	12237.4	3996.7	2361.6	1143.8	20.4	24359.3
4	0.0	46.8	1335.8	0.0	4664.2	123.8	127.7	0.1	0.0	3747.2	2091.4	6.9	1411.9	129.5	404.2	565.2	147.0	14801.6
5	0.0	11.0	214.3	0.0	13182.9	337.1	306.3	0.2	0.0	14170.7	5987.1	18.7	3294.8	209.9	242.3	341.0	555.8	38872.0
6	0.0	43.6	1065.6	0.0	12450.7	300.7	535.8	0.4	0.0	10452.0	4380.4	16.6	2824.2	173.9	207.1	353.8	410.0	33214.6
7	0.0	26.5	629.6	0.0	5506.4	123.3	408.4	0.3	0.0	7115.6	3551.0	6.8	941.2	62.1	366.4	619.6	279.1	19636.4
8	0.0	19.4	453.6	0.0	6787.1	128.9	204.2	0.1	0.0	5387.9	2641.6	7.1	1411.9	90.6	195.3	419.6	211.3	17958.6
9	0.0	14.3	316.1	0.0	13945.5	167.3	229.8	0.2	0.0	7435.1	4096.9	9.3	2353.5	155.3	259.0	560.2	291.6	29833.9
10	0.0	41.9	851.6	0.0	9056.7	175.9	204.2	0.1	0.0	8956.9	4117.7	9.7	2353.5	151.9	794.0	1515.7	351.3	28581.1
11	0.0	25.4	570.0	0.0	9179.6	122.2	102.1	0.1	0.0	3677.7	1554.1	6.8	2353.5	152.0	516.6	1103.1	144.3	19507.2
12	0.0	8.2	177.9	0.0	1303.1	29.6	127.7	0.1	0.0	1122.4	163.7	1.6	0.0	2.2	213.9	332.9	44.0	3527.3
13	0.0	23.5	609.6	0.0	4856.5	54.1	127.7	0.1	0.0	993.5	342.3	3.0	941.2	57.3	105.8	262.5	39.0	8416.1
14	0.0	2.0	39.7	0.0	1756.7	14.5	25.6	0.0	0.0	477.0	121.2	0.8	0.0	0.2	61.8	195.7	18.7	2714.1
15+	0.0	63.1	1588.0	0.0	4049.1	65.7	25.6	0.0	0.0	1616.9	633.1	3.6	470.6	29.6	191.9	872.7	63.4	9673.5

2Q

Ages	IIa	IVa	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc E	VIIIc W	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	6.4	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2636.1	1710.9	35725.7	0.1	0.0	40081.6
2	0.0	55.0	69.0	0.0	0.0	0.0	34.7	0.3	0.0	2.7	0.0	0.0	2489.6	1224.9	895.4	155.8	0.1	4927.6
3	0.0	45.8	220.2	0.0	0.0	0.0	69.5	0.7	0.0	5.5	0.0	0.0	3807.7	3413.5	1396.6	2902.4	13596.2	25457.9
4	0.0	18.2	72.3	0.0	5.5	0.8	34.7	0.3	0.0	6.6	473.2	0.0	439.3	249.3	206.0	726.1	0.2	2232.7
5	0.0	10.6	84.1	0.0	88.6	12.8	139.1	1.3	0.0	72.9	7569.9	0.0	1025.2	444.2	104.7	355.4	2.0	9910.6
6	0.0	8.2	33.0	0.0	132.9	19.2	243.3	2.3	0.0	112.1	11354.8	0.0	878.7	369.8	103.4	295.9	3.1	13556.7
7	0.0	3.6	7.1	0.0	72.0	10.4	34.7	0.3	0.0	53.0	6150.6	0.0	292.9	127.6	284.9	462.0	1.5	7500.6
8	0.0	1.7	7.1	0.0	60.9	8.8	69.5	0.7	0.0	48.1	5204.2	0.0	439.3	188.7	176.5	274.2	1.3	6481.0
9	0.0	2.7	7.9	0.0	66.5	9.6	0.0	0.0	0.0	46.4	5677.4	0.0	732.3	316.9	200.7	426.3	1.3	7488.0
10	0.0	0.9	9.2	0.0	49.9	7.2	0.0	0.0	0.0	34.8	4258.2	0.0	732.3	314.9	698.6	1126.0	1.0	7232.8
11	0.0	2.3	4.1	0.0	49.9	7.2	34.7	0.3	0.0	37.6	4258.2	0.0	732.3	316.1	503.2	798.8	1.0	6745.6
12	0.0	0.4	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	188.7	248.3	0.0	441.6
13	0.0	3.4	1.7	0.0	11.1	1.6	34.7	0.3	0.0	10.5	946.1	0.0	292.9	122.6	112.1	168.0	0.3	1705.3
14	0.0	0.0	0.1	0.0	0.0	0.0	34.7	0.3	0.0	2.7	0.0	0.0	0.0	0.7	65.4	111.5	0.1	215.5
15+	0.0	8.1	4.5	0.0	16.6	2.4	104.2	1.0	0.0	19.8	1419.3	0.0	146.4	62.3	296.2	475.1	0.6	2556.5

Table 5.5.1.1 (Cont'd)

3Q Ages	IIa	IVa	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc E	VIIIc W	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	331.3	7438.0	8393.7	0.0	16163.0
1	0.0	0.0	0.0	0.0	0.0	0.0	302.6	0.3	89.4	0.0	0.0	0.0	496.8	3204.4	18771.5	33911.0	0.0	56775.9
2	0.1	85.6	8558.8	0.0	494.4	0.0	588.0	0.5	173.7	0.0	1090.2	0.0	469.2	590.0	740.1	1681.5	0.0	14472.1
3	0.3	355.2	35498.4	0.0	1420.3	0.0	1573.6	1.4	464.9	0.1	3131.8	0.0	717.6	635.1	4173.6	1515.8	0.0	49488.1
4	0.6	113.8	11372.8	0.0	413.0	0.0	392.5	0.4	116.0	0.0	910.7	0.0	82.8	66.2	1116.9	216.8	0.0	14802.3
5	2.5	138.6	13850.6	0.0	503.2	0.0	762.7	0.7	225.3	0.0	1109.5	0.0	193.2	154.3	648.5	83.1	0.0	17672.2
6	5.2	49.8	4976.7	0.0	156.8	0.0	253.8	0.2	75.0	0.0	345.8	0.0	165.6	132.3	972.3	112.1	0.0	7245.7
7	2.8	8.9	884.3	0.0	48.9	0.0	110.4	0.1	32.6	0.0	107.8	0.0	55.2	44.1	505.1	129.6	0.0	1929.7
8	2.8	9.7	967.2	0.0	0.0	0.0	44.9	0.0	13.3	0.0	0.0	0.0	82.8	66.1	775.7	232.5	0.0	2195.0
9	2.5	11.7	1169.2	0.0	88.2	0.0	42.8	0.0	12.6	0.0	194.4	0.0	138.0	110.3	1604.9	291.3	0.0	3665.8
10	5.5	11.3	1125.5	0.0	0.0	0.0	22.3	0.0	6.6	0.0	0.0	0.0	138.0	110.3	2471.2	584.2	0.0	4474.7
11	3.0	4.2	414.8	0.0	26.3	0.0	7.3	0.0	2.2	0.0	58.0	0.0	138.0	110.3	1897.8	395.0	0.0	3056.8
12	12.5	1.1	114.0	0.0	0.0	0.0	3.4	0.0	1.0	0.0	0.0	0.0	0.0	0.0	338.5	151.9	0.0	622.4
13	2.4	0.0	0.0	0.0	0.0	0.0	27.5	0.0	8.1	0.0	0.0	0.0	55.2	44.1	218.2	123.3	0.0	478.8
14	1.4	0.0	0.0	0.0	0.0	0.0	7.3	0.0	2.2	0.0	0.0	0.0	0.0	0.0	101.1	73.8	0.0	185.8
15+	10.4	0.0	0.0	0.0	0.0	0.0	25.4	0.0	7.5	0.0	0.0	0.0	27.6	22.1	621.6	741.6	0.0	1456.2

4Q Ages	IIa	IVa	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc E	VIIIc W	VIIId	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	1966.1	0.0	0.0	36.0	3.3	2657.1	420.4	0.0	5082.8
1	0.0	23.0	0.0	0.0	0.0	0.0	5258.2	0.1	0.0	7197.5	0.0	0.0	35.5	1153.0	9557.0	6068.3	0.0	29292.5
2	0.1	60.3	5891.3	1.6	0.0	0.0	8745.1	0.3	0.0	57583.0	0.0	0.0	187.8	527.8	790.7	957.3	0.0	74745.2
3	0.3	153.4	31324.9	8.6	22.0	0.0	23131.1	4.2	0.0	310579.7	0.0	0.0	2554.6	231.1	2695.3	4262.8	0.0	374968.0
4	0.6	318.9	6321.1	1.7	110.0	0.0	7948.7	0.2	0.0	28252.1	0.0	0.0	132.1	4.3	372.3	837.6	0.0	44299.7
5	2.5	1398.4	3551.7	1.0	44.0	0.0	16523.8	0.2	0.0	14268.1	0.0	0.0	116.7	3.0	156.5	489.9	0.0	36555.8
6	5.2	2869.2	1246.4	0.3	88.0	0.0	4636.7	0.1	0.0	6143.8	0.0	0.0	64.3	1.6	166.4	604.9	0.0	15826.9
7	2.8	1534.3	794.6	0.2	0.0	0.0	2513.2	0.1	0.0	9504.3	0.0	0.0	77.7	1.8	125.7	359.8	0.0	14914.5
8	2.8	1560.6	264.6	0.1	88.0	0.0	783.3	0.0	0.0	1308.7	0.0	0.0	23.9	0.9	229.3	720.6	0.0	4983.1
9	2.5	1372.1	775.0	0.2	175.9	0.1	1110.5	0.1	0.0	3314.8	0.1	0.0	60.6	1.9	342.1	1044.0	0.0	8199.9
10	5.5	3015.0	72.6	0.0	88.0	0.0	345.4	0.2	0.0	9969.9	0.0	0.0	134.2	3.2	521.4	1665.3	0.0	15820.7
11	3.0	1642.8	222.0	0.1	88.0	0.0	0.0	0.1	0.0	1786.6	0.0	0.0	32.7	1.4	388.1	1259.2	0.0	5423.9
12	12.5	6915.5	81.1	0.0	88.0	0.0	87.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	101.7	340.2	0.0	7626.3
13	2.4	1320.6	0.0	0.0	0.0	0.0	522.8	0.0	0.0	0.0	0.0	0.0	0.0	1.1	63.4	222.6	0.0	2132.9
14	1.4	769.4	0.0	0.0	66.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	43.0	143.3	0.0	1023.5
15+	10.4	5738.4	0.0	0.0	483.8	0.2	87.2	0.0	0.0	0.0	0.2	0.0	0.0	0.7	287.7	1039.7	0.0	7648.2

Table 5.5.1.1 (Cont'd)

2004 Ages	IIa	IVa	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc E	VIIIc W	VIIId	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	1966.1	0.0	0.0	36.0	334.6	10095.0	8814.1	0.0	21245.8
1	0.1	59.9	879.8	0.0	5.5	0.4	5560.8	0.3	89.4	7197.5	0.0	0.0	11640.3	6686.1	64884.9	43294.0	0.0	140299.0
2	0.2	414.4	20660.7	1.6	521.8	2.0	9444.3	1.2	173.7	57978.5	1090.2	0.1	11148.0	3256.6	2825.6	3441.6	15.5	110975.9
3	0.6	630.6	69236.7	8.6	3029.3	77.5	24825.2	6.4	464.9	311104.8	3222.4	4.3	19317.2	8276.3	10627.0	9824.9	13616.6	474273.3
4	1.2	497.7	19102.1	1.7	5192.7	124.7	8503.6	1.0	116.0	32006.0	3475.4	6.9	2066.0	449.4	2099.3	2345.7	147.2	76136.4
5	5.1	1558.6	17700.8	1.0	13818.7	349.8	17731.9	2.4	225.3	28511.6	14666.5	18.7	4629.8	811.4	1152.0	1269.4	557.8	103010.8
6	10.4	2970.8	7321.6	0.3	12828.4	319.9	5669.6	3.0	75.0	16707.8	16081.1	16.6	3932.8	677.6	1449.2	1366.6	413.1	69843.9
7	5.6	1573.3	2315.6	0.2	5627.3	133.7	3066.7	0.8	32.6	16673.0	9809.5	6.8	1367.0	235.7	1282.1	1570.9	280.6	43981.2
8	5.7	1591.4	1692.6	0.1	6936.0	137.7	1101.9	0.9	13.3	6744.7	7845.8	7.1	1957.9	346.4	1376.8	1646.9	212.7	31617.7
9	5.0	1400.9	2268.3	0.2	14276.1	176.9	1383.1	0.3	12.6	10796.3	9968.7	9.3	3284.4	584.4	2406.6	2321.8	292.9	49187.7
10	10.9	3069.0	2058.9	0.0	9194.5	183.1	571.9	0.4	6.6	18961.7	8375.9	9.7	3358.1	580.2	4485.1	4891.2	352.3	56109.4
11	6.0	1674.7	1210.9	0.1	9343.7	129.4	144.1	0.5	2.2	5501.9	5870.3	6.8	3256.5	579.7	3305.6	3556.0	145.3	34733.4
12	25.1	6925.2	374.2	0.0	1391.1	29.6	218.3	0.1	1.0	1122.4	163.7	1.6	0.0	5.3	842.8	1073.3	44.0	12217.7
13	4.8	1347.6	611.4	0.0	4867.6	55.7	712.7	0.4	8.1	1004.0	1288.3	3.0	1289.3	225.0	499.6	776.4	39.3	12733.0
14	2.8	771.4	39.8	0.0	1822.7	14.6	67.6	0.4	2.2	479.7	121.3	0.8	0.0	1.3	271.3	524.3	18.8	4138.8
15+	20.8	5809.6	1592.5	0.0	4549.5	68.3	242.4	1.0	7.5	1636.8	2052.6	3.6	644.7	114.7	1397.4	3129.1	64.0	21334.4
	104.0	30295.1	147065.8	13.8	93404.7	1803.2	79244.1	19.1	1230.4	518392.6	84031.5	95.3	67927.8	23164.7	109000.3	89846.0	16199.8	1261838.2

Table 5.5.2.1 Western Horse Mackerel mean weight in catch (Kg) at age by quarter and area in 2004

1Q Ages	IIa	IVa	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc E	VIIIc W	VIIId	Total
0																		
1		0.063	0.063		0.086	0.086						0.086	0.054	0.052	0.018	0.023		0.045
2		0.084	0.084		0.096	0.096	0.095	0.095		0.095		0.096	0.060	0.054	0.062	0.052	0.095	0.070
3		0.094	0.094		0.126	0.127	0.106	0.106		0.098	0.095	0.127	0.053	0.053	0.083	0.108	0.098	0.069
4		0.135	0.114		0.135	0.136	0.133	0.133		0.137	0.127	0.136	0.105	0.094	0.111	0.132	0.137	0.128
5		0.205	0.205		0.145	0.147	0.175	0.175		0.154	0.144	0.147	0.116	0.114	0.143	0.139	0.154	0.146
6		0.187	0.186		0.158	0.164	0.190	0.190		0.163	0.152	0.164	0.114	0.115	0.147	0.152	0.163	0.156
7		0.218	0.218		0.171	0.176	0.215	0.215		0.173	0.159	0.176	0.167	0.166	0.168	0.182	0.173	0.172
8		0.213	0.215		0.188	0.187	0.232	0.232		0.183	0.166	0.187	0.115	0.118	0.190	0.206	0.183	0.179
9		0.269	0.266		0.171	0.178	0.235	0.235		0.195	0.175	0.178	0.134	0.137	0.168	0.189	0.195	0.177
10		0.252	0.277		0.196	0.197	0.248	0.248		0.197	0.179	0.197	0.142	0.145	0.175	0.201	0.197	0.192
11		0.283	0.279		0.207	0.196	0.239	0.239		0.223	0.221	0.196	0.128	0.131	0.191	0.209	0.223	0.203
12		0.379	0.353		0.234	0.220	0.206	0.206		0.241	0.255	0.220		0.200	0.214	0.217	0.241	0.240
13		0.334	0.335		0.260	0.231	0.258	0.258		0.214	0.170	0.231	0.135	0.135	0.252	0.221	0.214	0.240
14		0.417	0.417		0.410	0.260	0.246	0.246		0.270	0.280	0.260	0.000	0.226	0.289	0.233	0.270	0.361
15+		0.379	0.380		0.253	0.268	0.225	0.225		0.278	0.296	0.268	0.158	0.161	0.279	0.242	0.278	0.276

2Q Ages	IIa	IVa	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc E	VIIIc W	VIIId	Total
0																		
1		0.063	0.063										0.054	0.042	0.020	0.055		0.023
2		0.095	0.110				0.091	0.091		0.091			0.060	0.059	0.037	0.105	0.091	0.058
3		0.106	0.134				0.099	0.099		0.099			0.053	0.056	0.077	0.105	0.051	0.061
4		0.131	0.154		0.099	0.099	0.125	0.125		0.104	0.099		0.105	0.096	0.104	0.122	0.104	0.110
5		0.169	0.169		0.126	0.126	0.152	0.152		0.131	0.126		0.116	0.115	0.146	0.132	0.131	0.126
6		0.170	0.179		0.141	0.141	0.184	0.184		0.150	0.141		0.114	0.114	0.156	0.144	0.150	0.140
7		0.197	0.197		0.152	0.152	0.222	0.222		0.166	0.152		0.167	0.167	0.176	0.180	0.166	0.156
8		0.201	0.193		0.163	0.163	0.235	0.235		0.177	0.163		0.115	0.117	0.205	0.206	0.177	0.162
9		0.233	0.199		0.161	0.161				0.161	0.161		0.134	0.136	0.192	0.176	0.161	0.159
10		0.230	0.220		0.154	0.154				0.154	0.154		0.142	0.144	0.193	0.195	0.154	0.163
11		0.249	0.240		0.164	0.164	0.253	0.253		0.182	0.164		0.128	0.130	0.207	0.204	0.182	0.167
12		0.417	0.287											0.216	0.225	0.220		0.223
13		0.335	0.335		0.149	0.149	0.290	0.290		0.177	0.149		0.135	0.135	0.219	0.224	0.177	0.161
14			0.417				0.325	0.325		0.325				0.236	0.243	0.242	0.325	0.257
15+		0.382	0.380		0.236	0.236	0.380	0.380		0.265	0.236		0.158	0.160	0.253	0.251	0.265	0.241

Table 5.5.2.1 (Cont'd)

3Q Ages	IIa	IVa	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc E	VIIIc W	VIIId	Total
0										0.073				0.022	0.029	0.033		0.031
1	0.120						0.066	0.066	0.066	0.068			0.054	0.035	0.037	0.048		0.044
2	0.202	0.128	0.128		0.112		0.096	0.096	0.096	0.077	0.112		0.060	0.061	0.093	0.071		0.111
3	0.228	0.136	0.136		0.125		0.114	0.114	0.114	0.094	0.125		0.053	0.055	0.120	0.100		0.129
4	0.256	0.159	0.159		0.157		0.137	0.137	0.137	0.126	0.157		0.105	0.105	0.137	0.115		0.155
5	0.290	0.168	0.168		0.169		0.152	0.152	0.152	0.133	0.169		0.116	0.116	0.153	0.184		0.166
6	0.325	0.177	0.177		0.173		0.179	0.179	0.179	0.146	0.173		0.114	0.114	0.158	0.190		0.172
7	0.329	0.182	0.182		0.174		0.194	0.194	0.194	0.145	0.174		0.167	0.167	0.179	0.226		0.184
8	0.385	0.183	0.183				0.248	0.248	0.248	0.151			0.115	0.115	0.175	0.258		0.186
9	0.368	0.181	0.181		0.169		0.191	0.191	0.191	0.163	0.169		0.134	0.134	0.171	0.206		0.175
10	0.390	0.176	0.176				0.200	0.200	0.200	0.150			0.142	0.142	0.174	0.254		0.183
11	0.399	0.185	0.185		0.187		0.253	0.253	0.253	0.158	0.187		0.128	0.128	0.169	0.223		0.176
12	0.455	0.184	0.184				0.222	0.222	0.222						0.193	0.256		0.212
13	0.445						0.255	0.255	0.255				0.135	0.135	0.189	0.267		0.204
14	0.446						0.325	0.325	0.325						0.216	0.262		0.241
15+	0.454						0.256	0.256	0.256				0.158	0.158	0.212	0.335		0.275

4Q Ages	IIa	IVa	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc E	VIIIc W	VIIId	Total
0								0.073		0.073			0.073	0.035	0.029	0.037		0.047
1	0.120	0.120					0.065	0.068		0.068			0.068	0.042	0.043	0.060		0.057
2	0.202	0.202	0.131	0.131			0.096	0.077		0.090			0.077	0.063	0.082	0.092		0.094
3	0.228	0.228	0.134	0.134	0.132	0.132	0.117	0.094		0.093	0.132		0.094	0.080	0.100	0.125		0.099
4	0.256	0.256	0.163	0.163	0.181	0.181	0.142	0.126		0.128	0.181		0.126	0.123	0.115	0.138		0.137
5	0.290	0.290	0.177	0.177	0.212	0.212	0.160	0.133		0.138	0.212		0.133	0.133	0.154	0.160		0.158
6	0.325	0.325	0.193	0.193	0.201	0.201	0.182	0.146		0.143	0.201		0.146	0.145	0.171	0.171		0.193
7	0.329	0.329	0.177	0.177			0.203	0.145		0.150			0.145	0.143	0.194	0.203		0.181
8	0.385	0.385	0.207	0.207	0.224	0.224	0.250	0.151		0.151	0.224		0.151	0.148	0.185	0.202		0.253
9	0.368	0.368	0.188	0.188	0.246	0.246	0.191	0.163		0.163	0.246		0.163	0.162	0.186	0.190		0.210
10	0.390	0.390	0.209	0.209	0.211	0.211	0.215	0.150		0.148	0.211		0.150	0.153	0.196	0.206		0.204
11	0.399	0.399	0.220	0.220	0.296	0.296		0.158		0.158	0.296		0.158	0.193	0.189	0.196		0.247
12	0.455	0.455	0.229	0.229	0.345	0.345	0.222				0.345			0.216	0.214	0.232		0.435
13	0.445	0.445					0.250							0.304	0.223	0.241		0.369
14	0.446	0.446			0.410	0.410					0.410			0.319	0.228	0.251		0.407
15+	0.454	0.454			0.549	0.549	0.240				0.549			0.309	0.251	0.288		0.427

Table 5.5.2.1 (Cont'd)

2004 Ages	IIa	IVa	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc E	VIIIc W	VIIId	Total
0								0.073		0.073			0.073	0.023	0.029	0.033		0.035
1	0.120	0.085	0.063		0.086	0.086	0.065	0.067	0.066	0.068		0.086	0.054	0.039	0.028	0.048		0.041
2	0.202	0.112	0.116	0.131	0.111	0.096	0.096	0.090	0.096	0.090	0.112	0.096	0.060	0.059	0.068	0.075	0.095	0.091
3	0.228	0.151	0.134	0.134	0.125	0.127	0.116	0.099	0.114	0.093	0.124	0.127	0.058	0.055	0.101	0.114	0.051	0.098
4	0.256	0.218	0.157	0.163	0.137	0.135	0.142	0.130	0.137	0.129	0.131	0.136	0.106	0.097	0.125	0.130	0.137	0.138
5	0.290	0.278	0.170	0.177	0.146	0.146	0.160	0.152	0.152	0.146	0.137	0.147	0.116	0.115	0.150	0.148	0.154	0.152
6	0.325	0.320	0.181	0.193	0.158	0.163	0.182	0.183	0.179	0.156	0.145	0.164	0.115	0.114	0.158	0.162	0.163	0.163
7	0.329	0.326	0.190	0.177	0.171	0.174	0.204	0.204	0.194	0.160	0.155	0.176	0.166	0.166	0.177	0.190	0.173	0.173
8	0.385	0.382	0.195	0.207	0.189	0.186	0.246	0.231	0.248	0.177	0.164	0.187	0.115	0.117	0.183	0.212	0.183	0.188
9	0.368	0.365	0.195	0.188	0.172	0.177	0.198	0.204	0.191	0.185	0.167	0.178	0.135	0.136	0.175	0.189	0.194	0.179
10	0.390	0.387	0.219	0.209	0.196	0.195	0.226	0.187	0.200	0.171	0.166	0.197	0.142	0.144	0.179	0.208	0.197	0.191
11	0.399	0.397	0.236	0.220	0.208	0.194	0.243	0.240	0.253	0.202	0.179	0.196	0.128	0.130	0.181	0.205	0.223	0.201
12	0.455	0.455	0.274	0.229	0.241	0.220	0.213	0.207	0.222	0.241	0.255	0.220		0.209	0.208	0.228	0.241	0.360
13	0.445	0.442	0.335		0.260	0.228	0.254	0.282	0.255	0.214	0.155	0.231	0.135	0.136	0.214	0.235	0.214	0.250
14	0.446	0.446	0.417		0.410	0.260	0.295	0.321	0.325	0.271	0.280	0.260		0.261	0.241	0.244	0.271	0.361
15+	0.454	0.453	0.380		0.284	0.267	0.300	0.375	0.256	0.278	0.254	0.268	0.158	0.161	0.238	0.281	0.278	0.326
	0.404	0.391	0.149	0.144	0.185	0.173	0.137	0.160	0.128	0.110	0.155	0.174	0.084	0.065	0.064	0.097	0.072	0.124

Table 5.5.2.2 Western Horse Mackerel mean length in catch (Cm) at age by quarter and area in 2004

1Q

Ages	IIa	IVa	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc E	VIIIc W	VIIId	Total
0																		
1		20.50	20.50		22.50	22.50						22.50	19.61	19.25	12.98	13.50		17.83
2		22.57	22.57		23.32	23.32	22.50	22.50		22.50		23.32	20.56	19.61	20.03	18.11	22.50	21.22
3		23.50	23.50		25.50	25.59	23.50	23.50		23.11	22.95	25.59	19.73	19.35	21.97	23.57	23.11	20.91
4		25.90	24.87		25.77	26.02	24.50	24.50		25.64	25.23	26.02	24.50	23.46	24.01	25.27	25.64	25.36
5		29.34	29.34		26.53	26.81	26.67	26.67		26.64	26.43	26.81	25.79	25.61	26.31	25.81	26.64	26.50
6		28.70	28.64		27.37	27.74	27.60	27.60		27.27	27.06	27.74	25.50	25.53	26.55	26.54	27.27	27.16
7		30.21	30.22		27.88	28.30	28.75	28.75		27.77	27.53	28.30	28.00	27.97	27.74	28.30	27.77	27.89
8		30.03	30.09		28.89	29.01	30.00	30.00		28.44	27.86	29.01	25.83	25.97	28.73	29.55	28.44	28.40
9		31.92	31.87		28.25	28.56	30.17	30.17		29.16	28.62	28.56	26.30	26.47	27.62	28.55	29.16	28.43
10		31.74	32.59		29.42	29.50	30.88	30.88		29.23	28.62	29.50	26.90	27.06	28.04	29.25	29.23	29.09
11		32.83	32.64		29.76	29.45	31.25	31.25		30.49	30.33	29.45	26.30	26.46	28.77	29.68	30.49	29.57
12		35.43	34.71		30.53	30.52	29.50	29.50		31.49	32.28	30.52		30.00	29.77	30.09	31.49	31.03
13		34.10	34.01		32.26	30.96	31.30	31.30		29.65	28.00	30.96	27.00	27.02	31.36	30.33	29.65	31.18
14		36.85	36.85		35.80	32.53	31.50	31.50		32.66	33.13	32.53		31.50	32.86	30.84	32.66	34.64
15+		35.65	35.65		31.65	32.78	30.50	30.50		32.79	33.55	32.78	28.50	28.64	32.61	31.28	32.79	32.49

2Q

Ages	IIa	IVa	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc E	VIIIc W	VIIId	Total
0																		
1		20.50	20.50										19.61	17.45	13.74	18.63		14.28
2		22.83	23.40				22.50	22.50		22.50			20.56	20.34	16.74	23.43	22.50	19.98
3		23.76	24.49				23.50	23.50		23.50			19.73	19.77	21.71	23.42	19.38	20.14
4		25.41	25.95		24.50	24.50	24.50	24.50		24.50	24.50		24.50	23.61	23.62	24.59	24.50	24.40
5		26.98	26.72		25.88	25.88	26.50	26.50		26.00	25.88		25.79	25.65	26.68	25.31	26.00	25.87
6		27.66	27.43		27.08	27.08	27.79	27.79		27.22	27.08		25.50	25.51	27.30	26.06	27.22	26.93
7		28.98	28.62		27.50	27.50	28.50	28.50		27.70	27.50		28.00	27.98	28.43	28.20	27.70	27.61
8		29.75	28.35		28.50	28.50	30.00	30.00		28.80	28.50		25.83	25.91	29.81	29.52	28.80	28.34
9		29.99	28.34		28.42	28.42				28.42	28.42		26.30	26.39	29.18	27.76	28.42	28.11
10		31.00	29.50		27.94	27.94				27.94	27.94		26.90	27.00	29.28	28.92	27.94	28.08
11		31.15	30.54		28.28	28.28	30.50	30.50		28.72	28.28		26.30	26.40	29.93	29.34	28.72	28.24
12		36.50	31.90											30.79	30.64	30.14		30.37
13		33.88	34.01		28.00	28.00	31.00	31.00		28.60	28.00		27.00	27.02	30.52	30.38	28.60	28.24
14			36.85				33.50	33.50		33.50				31.94	31.48	31.15	33.50	31.67
15+		35.66	35.65		32.50	32.50	34.50	34.50		32.90	32.50		28.50	28.59	32.09	31.60	32.90	32.06

Table 5.5.2.2 (Cont'd)

3Q Ages	IIa	IVa	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc E	VIIIc W	VIIId	Total
0										20.50				14.35	15.51	15.38		15.42
1	22.00						20.10	20.10	20.10	19.89			19.61	16.64	16.71	17.70		17.35
2	26.50	24.00	24.00		23.21		22.37	22.37	22.37	20.87	23.21		20.56	20.44	22.96	20.36		23.10
3	27.90	24.55	24.55		24.14		23.74	23.74	23.74	22.62	24.14		19.73	19.88	25.10	22.93		24.35
4	29.30	26.08	26.08		26.28		25.07	25.07	25.07	24.94	26.28		24.50	24.50	26.28	23.94		26.03
5	30.50	26.68	26.68		26.98		25.82	25.82	25.82	25.55	26.98		25.79	25.79	27.24	28.36		26.67
6	31.80	27.17	27.17		27.25		27.20	27.20	27.20	26.25	27.25		25.50	25.50	27.53	28.74		27.18
7	32.10	27.49	27.49		27.20		27.90	27.90	27.90	26.27	27.20		28.00	28.00	28.65	30.54		28.04
8	33.50	27.53	27.53				29.97	29.97	29.97	26.68			25.83	25.83	28.46	31.72		28.26
9	33.30	27.39	27.39		26.97		28.24	28.24	28.24	27.38	26.97		26.30	26.30	28.26	29.60		27.86
10	33.70	27.15	27.15				28.18	28.18	28.18	26.59			26.90	26.90	28.39	31.56		28.41
11	33.70	27.65	27.65		27.99		30.50	30.50	30.50	27.07	27.99		26.30	26.30	28.14	30.33		28.21
12	35.70	27.52	27.52				30.50	30.50	30.50						29.36	31.88		29.77
13	35.30						30.11	30.11	30.11				27.00	27.00	29.22	32.40		29.67
14	35.50						33.50	33.50	33.50						30.55	32.18		31.38
15+	35.70						31.83	31.83	31.83				28.50	28.50	30.31	34.83		32.63

4Q Ages	IIa	IVa	VIa	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc E	VIIIc W	VIIId	Total
0								20.50		20.50			20.50	15.91	15.27	16.07		17.40
1	22.00	22.00					19.91	19.89		19.21			19.89	17.55	17.66	19.09		18.74
2	26.50	26.50	24.34	24.34			22.23	20.87		22.09			20.87	20.33	22.08	22.10		22.27
3	27.90	27.90	24.55	24.55	26.00	26.00	23.82	22.62		22.62	26.00		22.62	21.90	23.55	24.87		22.89
4	29.30	29.30	26.40	26.40	28.60	28.60	25.21	24.94		24.69	28.60		24.94	24.99	24.60	25.71		25.09
5	30.50	30.50	27.19	27.19	30.00	30.00	26.02	25.55		25.52	30.00		25.55	25.66	27.02	26.99		26.13
6	31.80	31.80	28.08	28.08	29.50	29.50	27.10	26.25		25.95	29.50		26.25	26.28	28.06	27.71		27.63
7	32.10	32.10	27.17	27.17			28.23	26.27		26.40			26.27	26.22	29.38	29.40		27.43
8	33.50	33.50	28.84	28.84	30.50	30.50	29.97	26.68		26.68	30.50		26.68	26.80	28.75	29.15		29.97
9	33.30	33.30	27.81	27.81	31.25	31.25	28.24	27.38		27.38	31.25		27.38	27.59	28.95	28.76		28.85
10	33.70	33.70	29.00	29.00	30.00	30.00	28.73	26.59		26.36	30.00		26.59	26.79	29.37	29.48		28.28
11	33.70	33.70	29.46	29.46	33.25	33.25		27.07		27.07	33.25		27.07	29.20	29.07	28.99		29.87
12	35.70	35.70	30.00	30.00	34.75	34.75	30.50				34.75			30.98	30.36	30.76		35.28
13	35.30	35.30					30.00							34.85	30.80	31.17		33.44
14	35.50	35.50			36.67	36.67					36.67			35.45	31.10	31.68		34.86
15+	35.70	35.70			39.68	39.68	31.50				39.68			35.04	31.89	33.03		35.40

Table 5.5.2.2 (Cont'd)

2004																		
Ages	**IIa**	**IVa**	**VIa**	**VIIa**	**VIIb**	**VIIc**	**VIIe**	**VIIf**	**VIIg**	**VIIh**	**VIIj**	**VIIk**	**VIIIa**	**VIIIb**	**VIIIc E**	**VIIIc W**	**VIIId**	**Total**
0																		15.89
1	22.00	21.08	20.50	0.00	22.50	22.50	19.92	20.06	20.10	19.21	0.00	22.50	19.61	17.24	15.16	17.58	0.00	16.81
2	26.50	23.47	23.67	24.34	23.22	23.32	22.24	22.03	22.37	22.09	23.21	23.32	20.57	20.15	20.33	20.56	22.50	22.12
3	27.90	25.18	24.52	24.55	24.87	25.59	23.81	22.97	23.74	22.62	24.11	25.59	20.11	19.63	23.57	23.99	19.39	22.79
4	29.30	28.10	26.10	26.40	25.87	26.01	25.19	24.80	25.07	24.80	25.41	26.02	24.53	23.71	25.28	25.09	25.64	25.31
5	30.50	30.13	26.81	27.19	26.55	26.78	26.03	26.24	25.82	26.08	26.19	26.81	25.78	25.66	26.96	26.29	26.64	26.34
6	31.80	31.67	27.54	28.08	27.38	27.70	27.18	27.67	27.20	26.78	27.08	27.74	25.51	25.52	27.43	27.13	27.27	27.23
7	32.10	32.04	28.13	27.17	27.87	28.23	28.29	28.16	27.90	26.99	27.51	28.30	27.90	27.97	28.41	28.71	27.77	27.70
8	33.50	33.42	28.42	28.84	28.91	28.98	29.98	29.85	29.97	28.10	28.28	29.01	25.84	25.92	28.72	29.68	28.44	28.63
9	33.30	33.23	28.16	27.81	28.28	28.56	28.56	28.94	28.24	28.61	28.47	28.56	26.32	26.40	28.37	28.63	29.15	28.41
10	33.70	33.65	29.48	29.00	29.42	29.44	29.48	28.19	28.18	27.72	28.28	29.50	26.89	27.00	28.58	29.53	29.23	28.67
11	33.70	33.67	30.34	29.46	29.78	29.39	31.03	30.20	30.50	29.37	28.82	29.45	26.31	26.40	28.62	29.43	30.48	29.24
12	35.70	35.70	31.49	30.00	30.80	30.53	29.91	29.54	30.50	31.49	32.28	30.52		30.47	29.87	30.57	31.49	33.59
13	35.30	35.28	34.01		32.25	30.87	30.29	31.01	30.11	29.64	28.00	30.96	27.00	27.05	30.17	30.91	29.64	31.11
14	35.50	35.50	36.85		35.83	32.53	32.74	33.41	33.50	32.67	33.13	32.53		32.99	31.39	31.32	32.67	34.39
15+	35.70	35.70	35.65		32.51	32.78	32.72	34.38	31.83	32.80	32.83	32.78	28.50	28.63	31.33	32.75	32.80	33.49
	34.14	33.71	25.46	25.18	28.51	28.20	24.74	25.95	24.37	23.56	27.43	28.23	22.39	20.02	17.20	19.83	20.78	24.02

Table 5.6.2.2.1 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 5.6.2.2.2: 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
0	0	0	0	0	0	0	876	0	0	20632	14887	46	3686	2702	10729	4860	744	14822	637	58685	13707	1843	21246
1	3713	7903	0	1633	0	99	27369	0	20406	33560	229703	109152	60759	165382	19774	110145	91505	97561	78856	69430	461055	303721	140299
2	21072	2269	241360	4901	0	493	6112	0	45036	89715	36331	94500	911713	470498	658727	465350	184443	83714	131112	246525	120106	585700	110976
3	134743	32900	4439	602992	1548	0	2099	20766	138929	23034	80552	16738	115729	424563	860992	735919	488662	176919	52716	151707	164977	165666	474273
4	11515	53508	36294	4463	676208	2950	4402	18282	61442	207751	56275	62714	53132	215468	186306	410638	360116	265820	71779	98454	126329	152117	76136
5	13197	15345	149798	41822	8727	891660	18968	5308	33298	143072	256085	94711	44692	59035	85508	244328	219650	254516	150869	101344	64449	88944	103011
6	11741	44539	22350	100376	65147	2061	941725	14500	10549	73730	127048	317337	38769	90832	51365	119062	157396	212225	170393	116952	69828	57445	69844
7	8848	52673	38244	12644	109747	41564	12115	1276731	20607	25369	49020	144610	221970	35654	55229	127658	122583	187250	177995	234832	94429	45596	43981
8	1651	17923	34020	16172	25712	90814	39913	12046	1384850	25584	19053	70717	106512	245230	53379	134488	81499	147328	133290	203823	130285	49476	31618
9	414	3291	14756	6200	21179	11740	67869	59357	37011	1219646	23449	32693	40799	119117	57131	109962	68264	77691	61578	103968	85325	92758	49188
10	1651	5505	4101	9224	15271	9549	9739	83125	70512	23987	1103480	4822	42302	99495	56962	109165	50555	35635	18010	36076	45798	50503	56109
11+	81385	129139	58370	40976	56824	62776	76096	78951	226294	137131	152305	1309609	998180	1362342	729283	601196	389594	252044	168770	132706	150103	109994	63823

b. Proportion of fish mature at start of 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
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
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
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
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
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
6	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
8	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
10	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

Table 5.6.2.2.3: Western Horse Mackerel: Input to SAD

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
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
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
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
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
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
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
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
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
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
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
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

Table 5.6.2.2.4 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

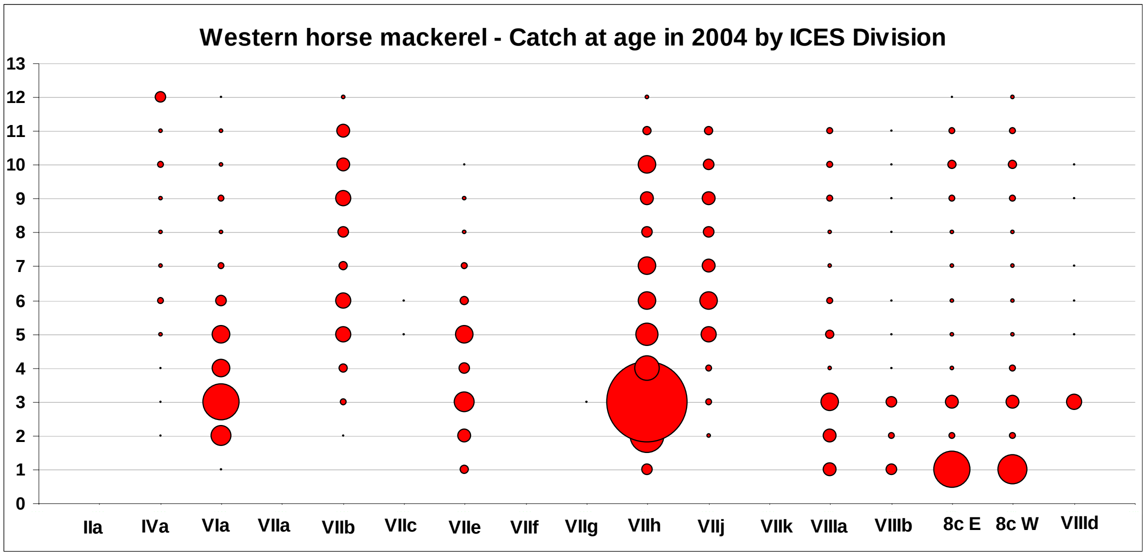


Figure 5.5.1.1 Catch in numbers by yearclass and Divison of western horse mackerel in 2004.

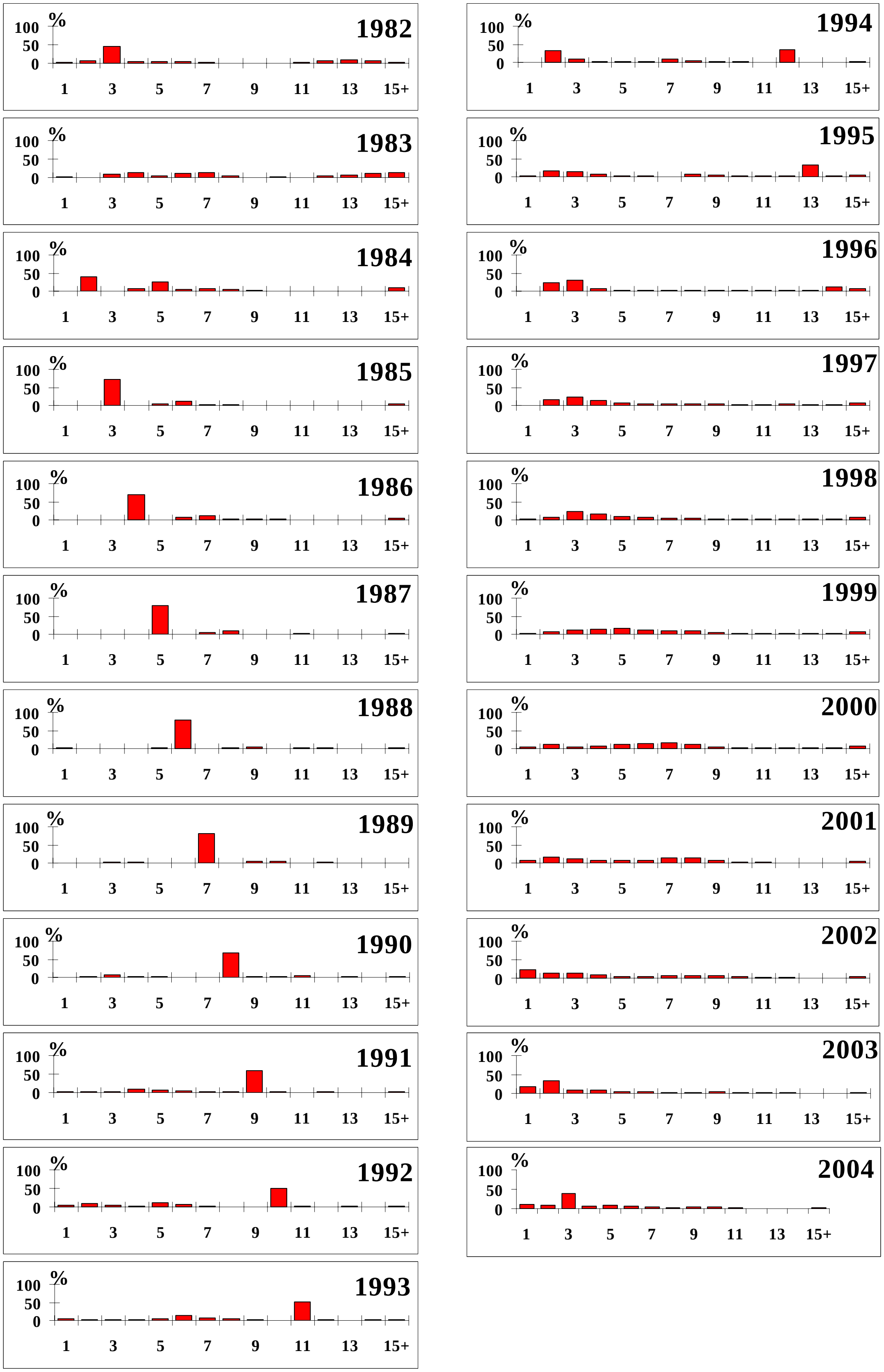


Figure 5.5.1.2 The age composition of the WESTERN HORSE MACKEREL in the international catches during 1982-2004.

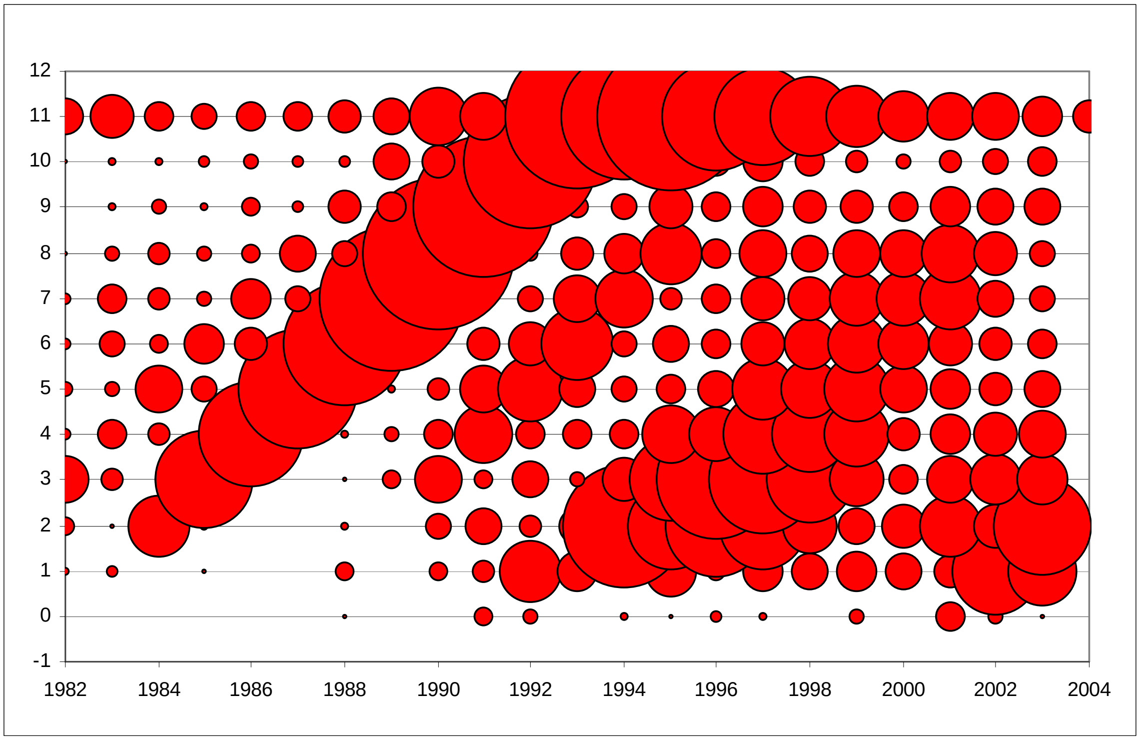


Fig. 5.6.1.1 Numbers at age in the catch for the period 1982 - 2004, ages 0 to 11+.

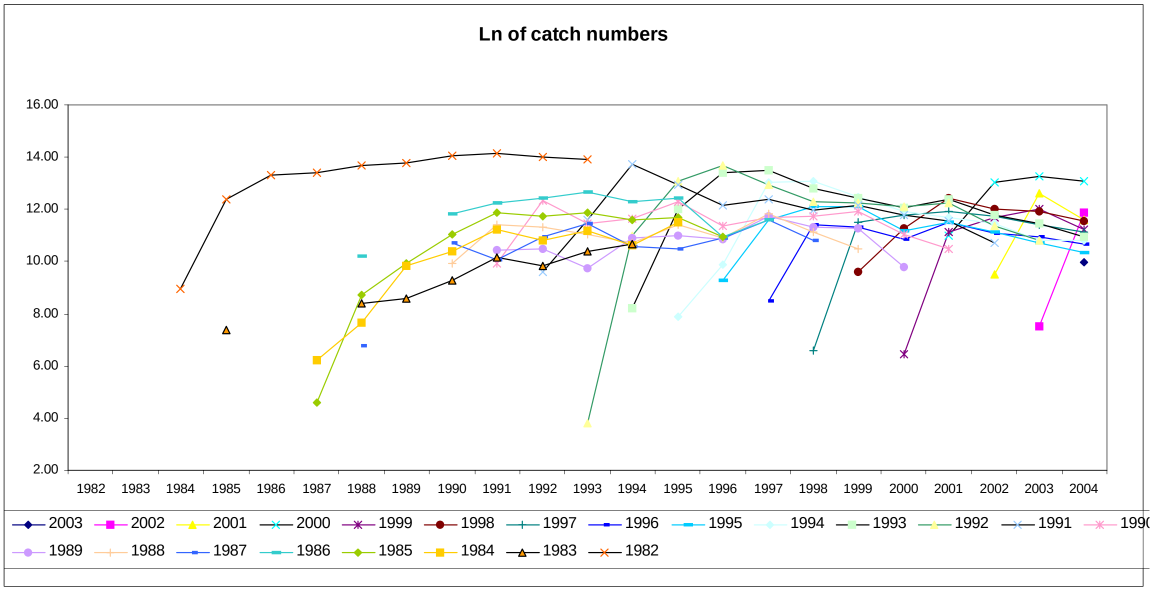


Fig. 5.6.1.2: Western Horse Mackerel log-transformed numbers at age in the age by cohort.

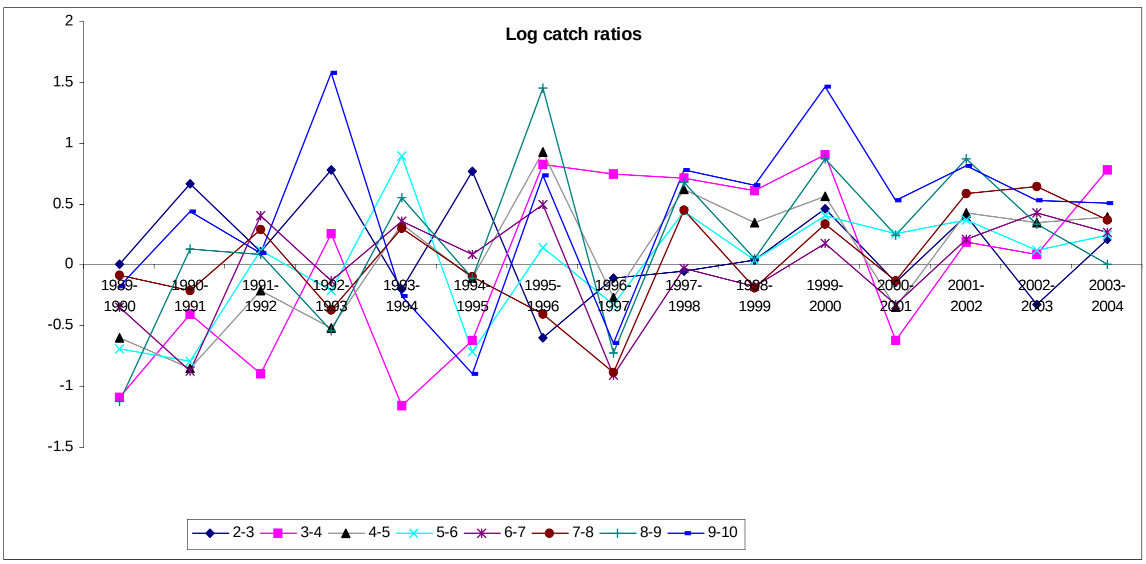


Fig. 5.6.1.3: Western Horse Mackerel log-catch ratios.

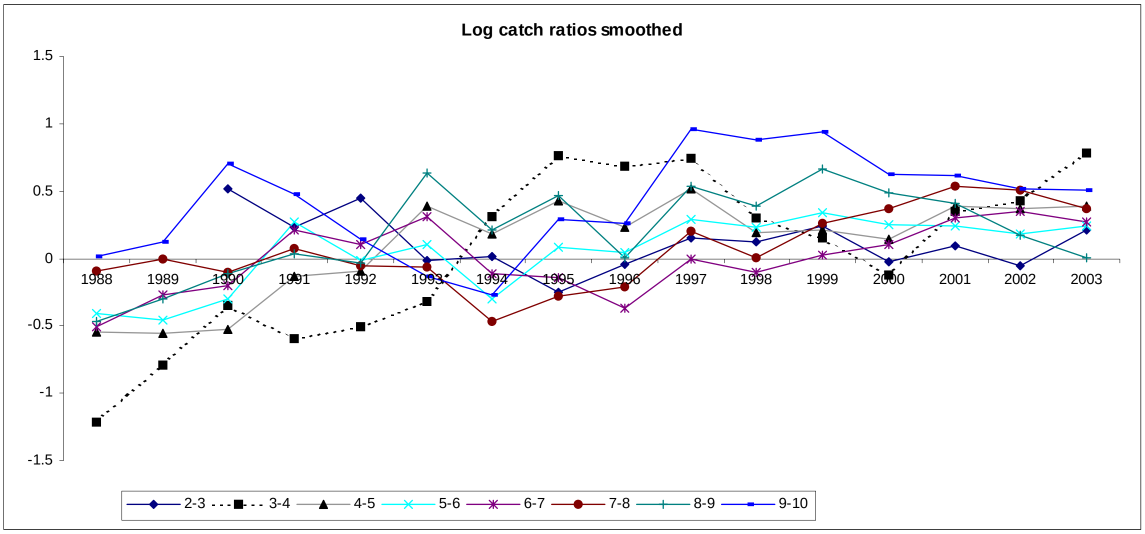


Fig. 5.6.1.4: Western Horse Mackerel three-year averages log-catch ratios.

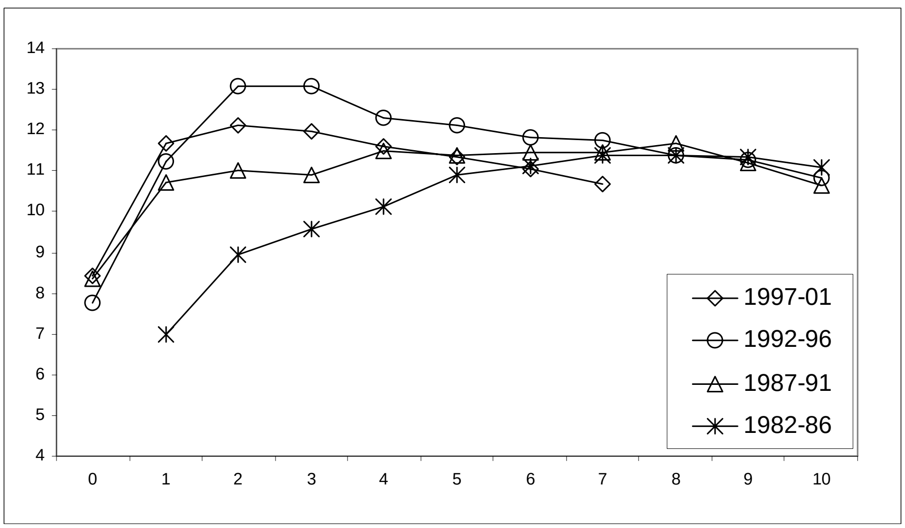


Fig. 5.6.1.5: Western Horse Mackerel catch curves for 4 different periods. Each individual point in the curve corresponds to the average numbers at age during the period.

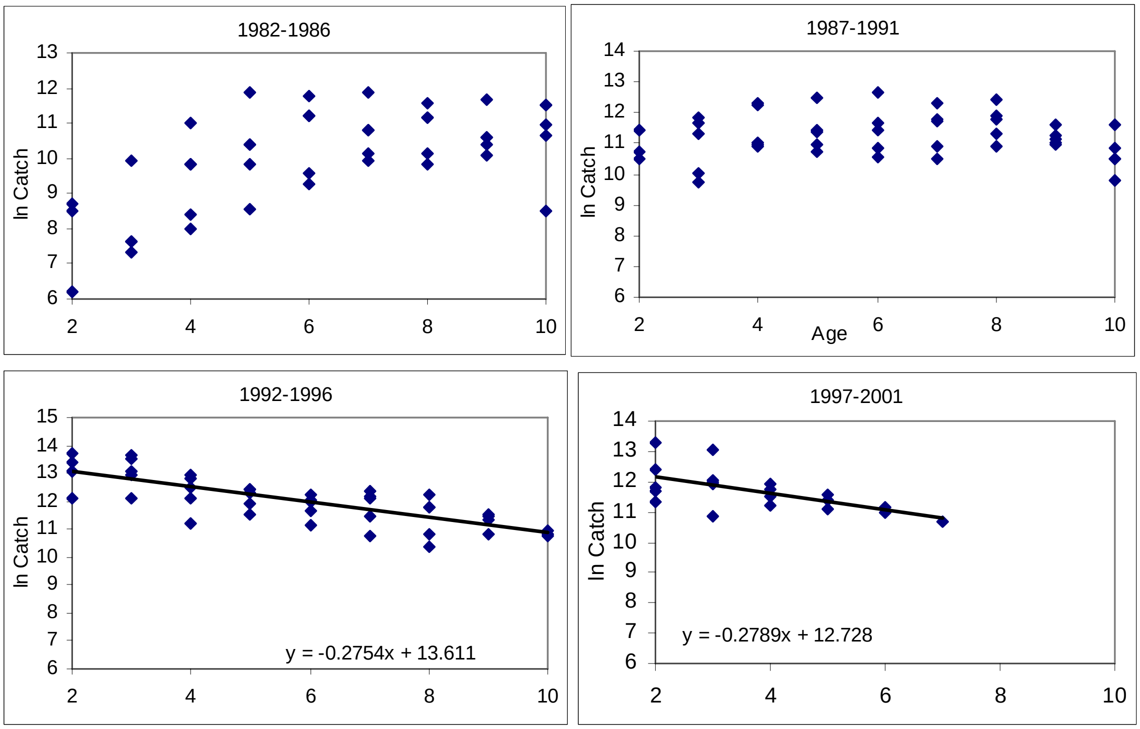


Fig. 5.6.1.6: Western horse mackerel. Log-transformed catch numbers at age for 5-year periods. The slope is an estimate of total mortality (Z).

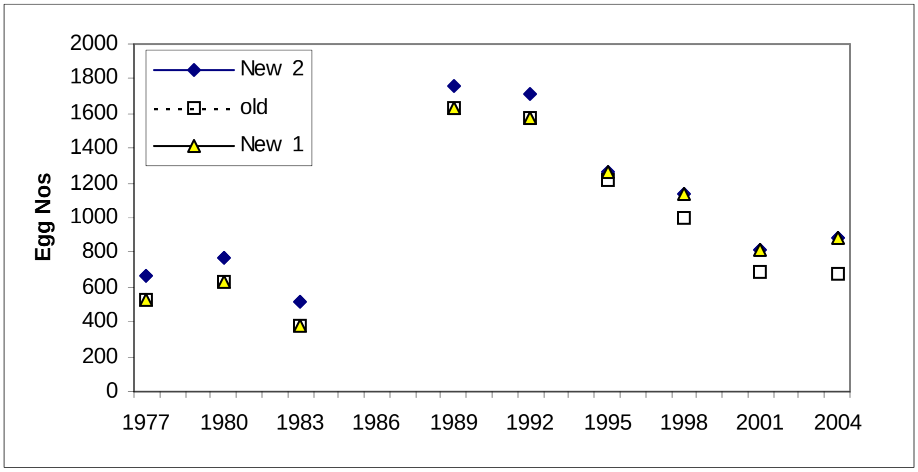


Fig. 5.6.1.7: Egg survey estimates without VIIIc data (old) and including it in the last 4 data points. New 2 results from adding the mean difference between new and old in the last 4 data points.

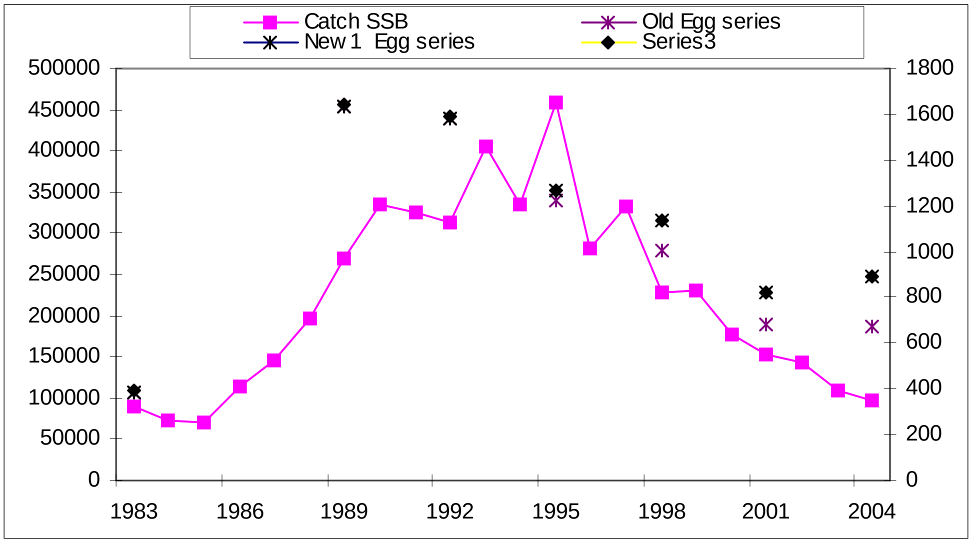


Fig. 5.6.1.8. SSB fraction of the catch (left y-axis) and Egg series (right y-axis).

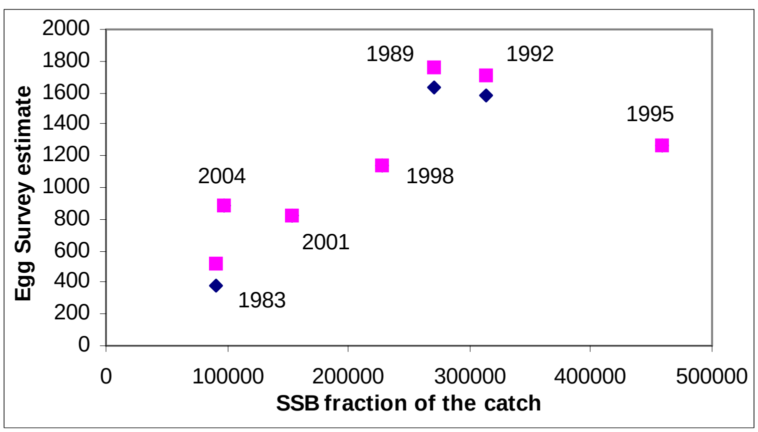


Fig. 5.6.1.9: Egg survey estimates against mature fraction of the catch for the corresponding years.

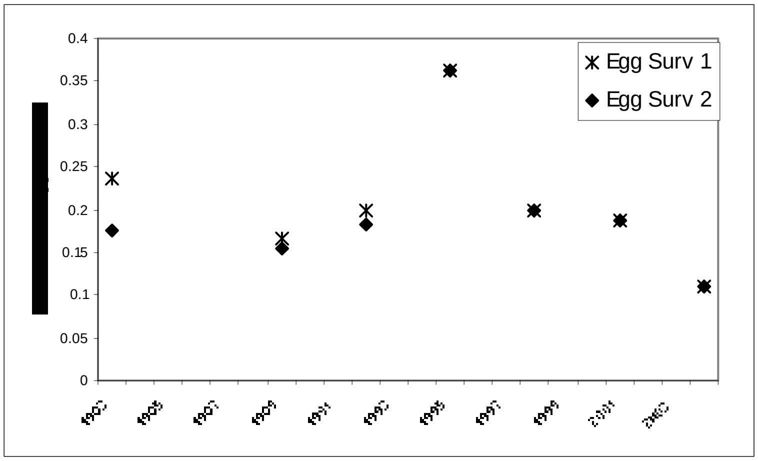


Fig. 5.6.1.10: Ratio of mature fraction of the catch over survey Egg estimate over time.

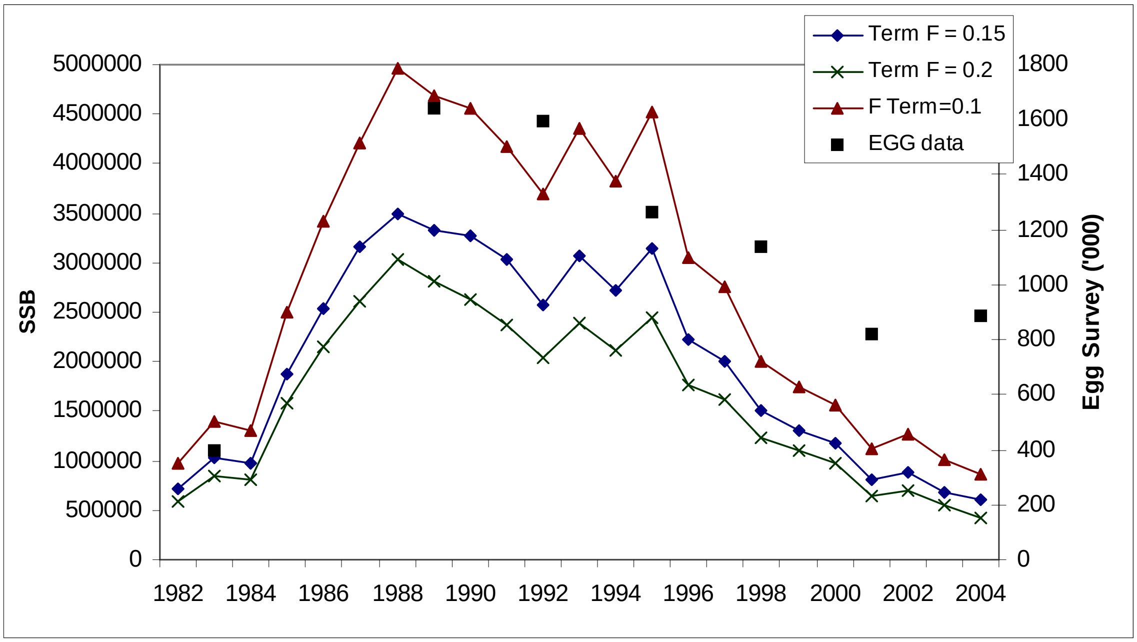


Figure 5.6.2.1.1: Western horse-mackerel. User-defined VPA SSB estimates for terminal F = 0.1, 0.15 & 0.2 and egg estimates (upper panel); estimates of annual F for terminal F= 0.1 and 0.2

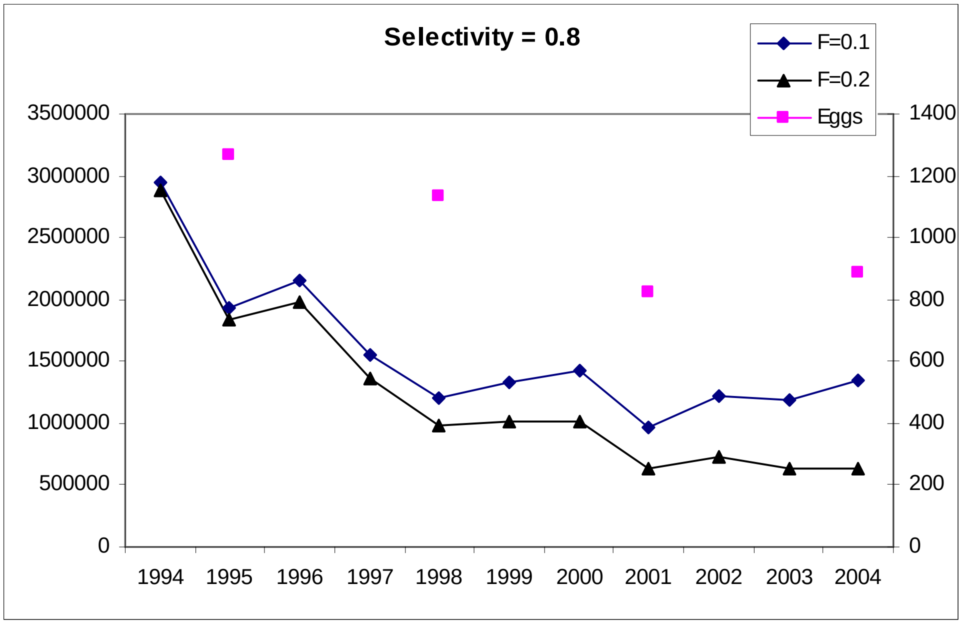


Figure 5.6.2.1.2: Western horse mackerel, estimates of SSB from the separable VPA with terminal Fs = 0.1 and 0.2 and Egg numbers from the triennial survey.

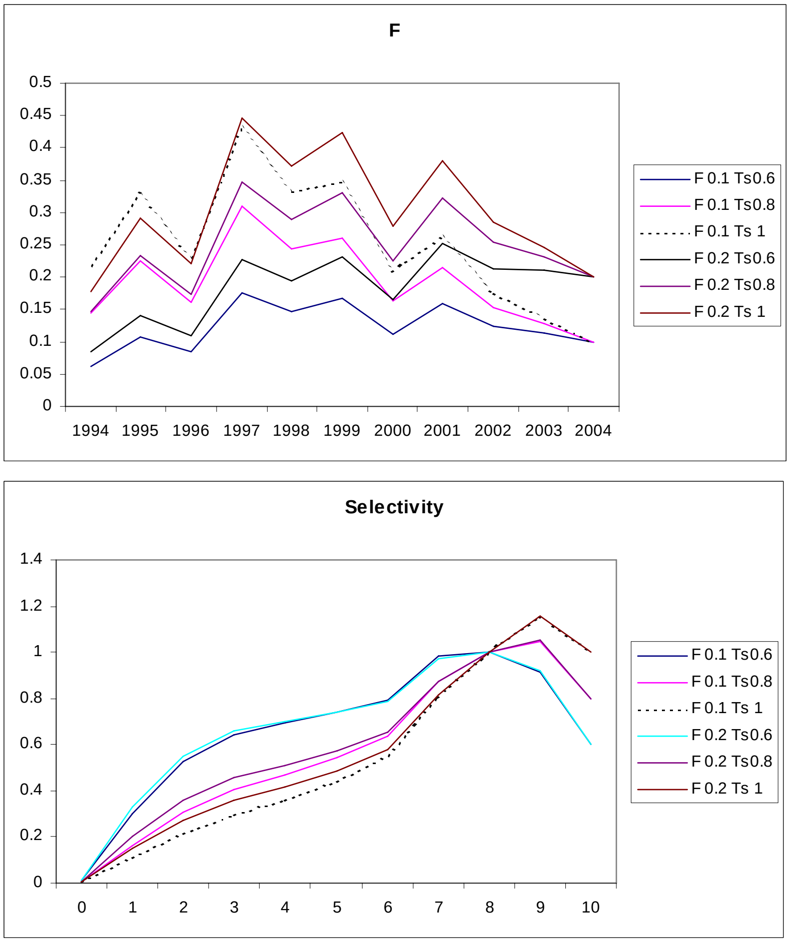
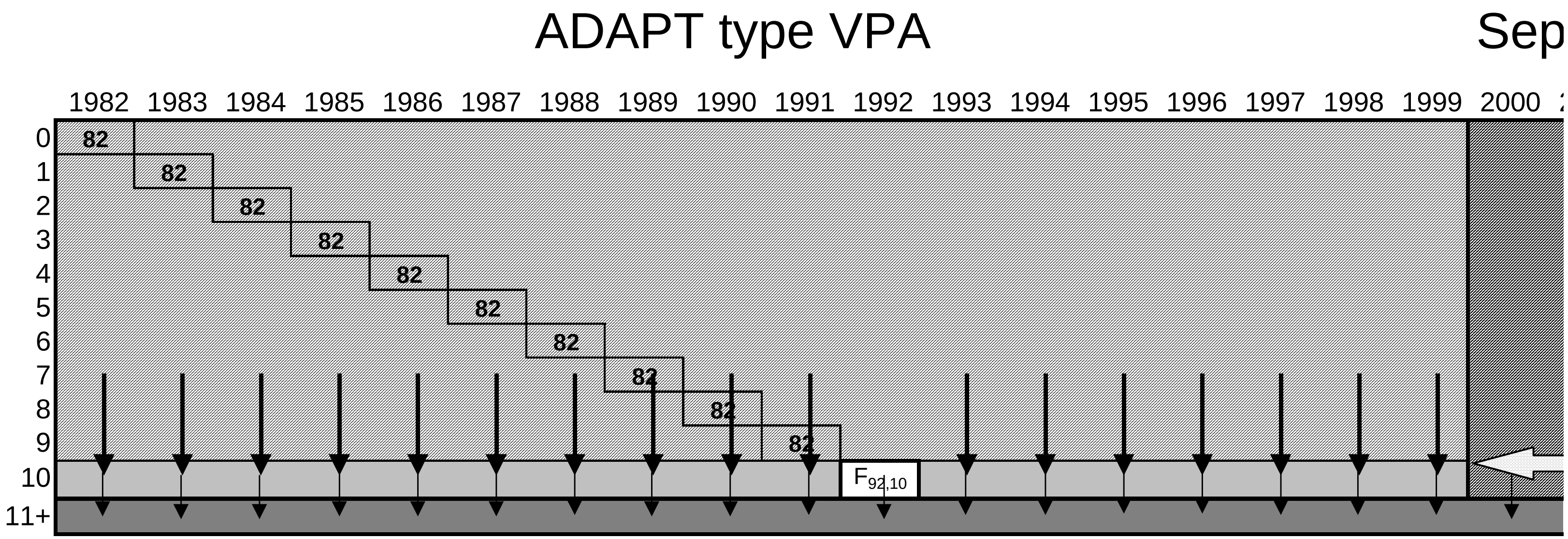


Fig. 5.6.2.1.3: Western horse mackerel, estimates of F from the separable VPA for terminal Fs = 0.1 and 0.2 and selectivity at the oldest true age equal to 0.6, 0.8 and 1; s8 = 1.



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 5.6.2.2.1: 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.

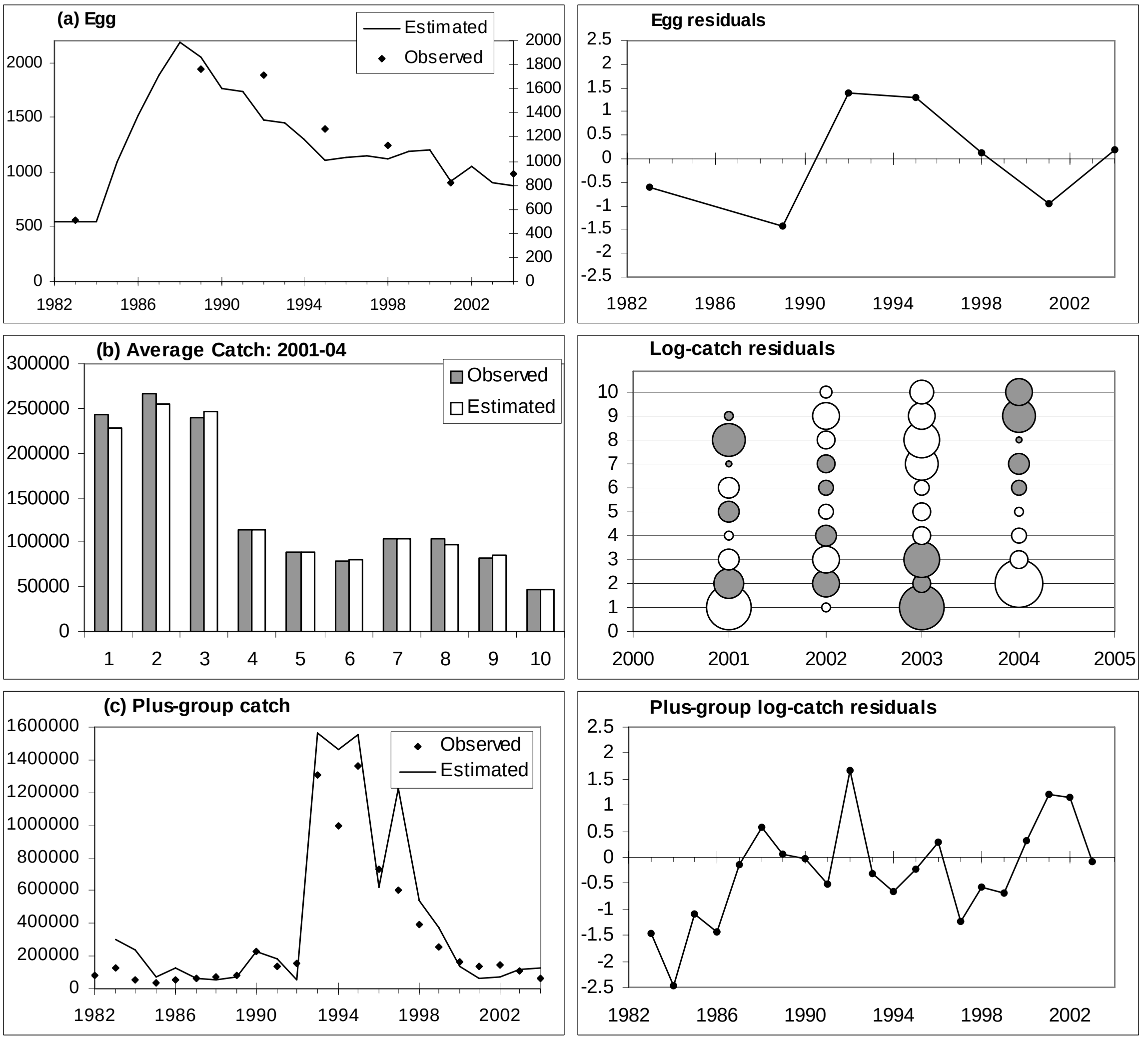


Figure 5.6.2.2.2: Western horse-mackerel, same assessment procedure as last year (SPALY). Model fits to data for the three components of the likelihood corresponding to (a) the egg estimates, (b) the catches in the separable period, and (c) to the catches in the plus-group. The left-hand column shows 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).

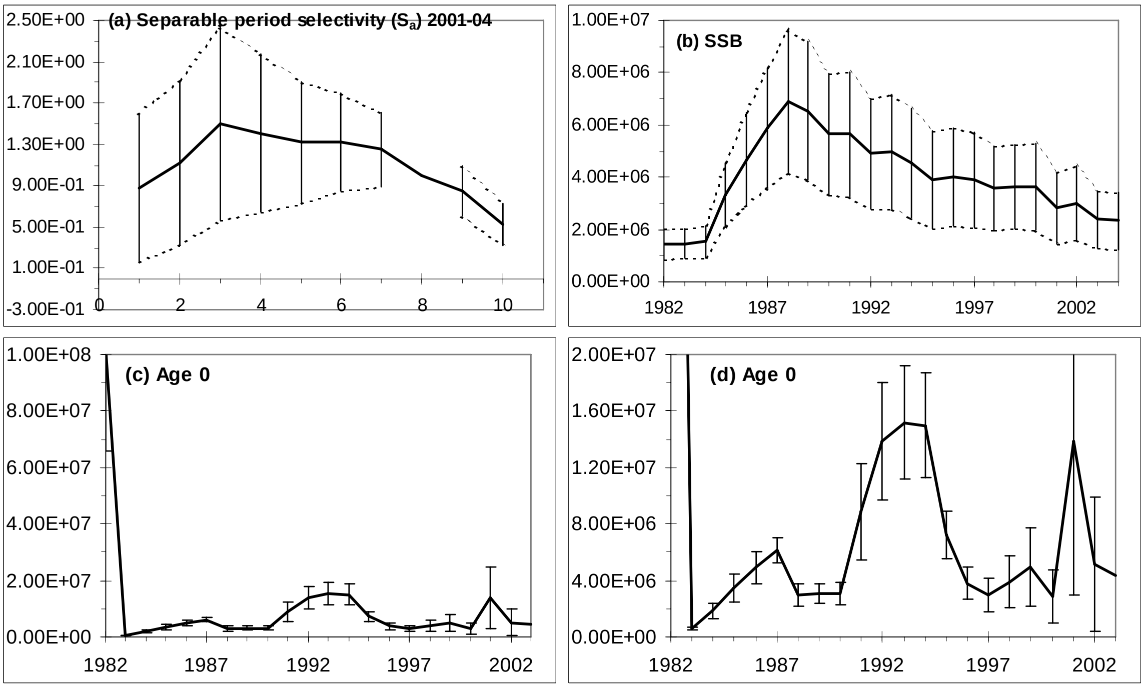


Figure 5.6.2.2.3: Western horse-mackerel SPALY. Plots of (a) the selectivity pattern, (b) the SSB trajectory, (c) numbers at age 0, and (d) the same as (c) but scaled to capture more detail. The error bars are 2 standard deviations (indicating roughly 95% confidence bounds).

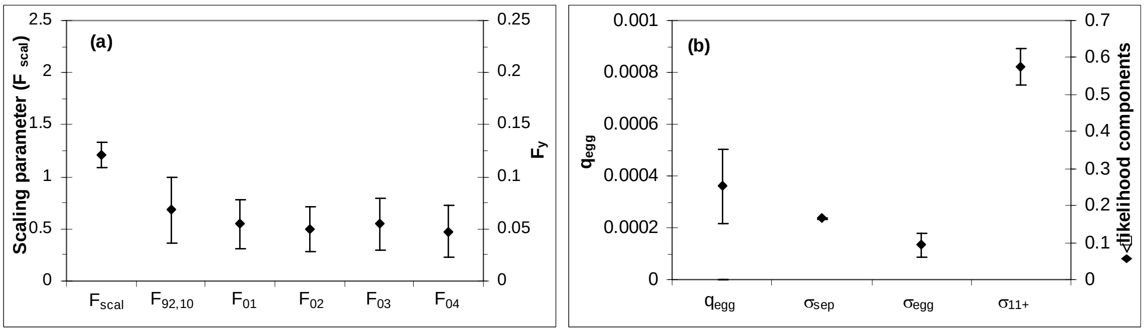


Figure 5.6.2.2.4: Estimates for some key parameters, with (a) corresponding to fishing mortality parameters (the scaling parameter F_{scal}, fishing mortality at age 10 in 1992, $F_{92,10}$, and the fishing mortality year effects for the separable period, F_y), and (b) the catchability parameter q_{egg}, 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)

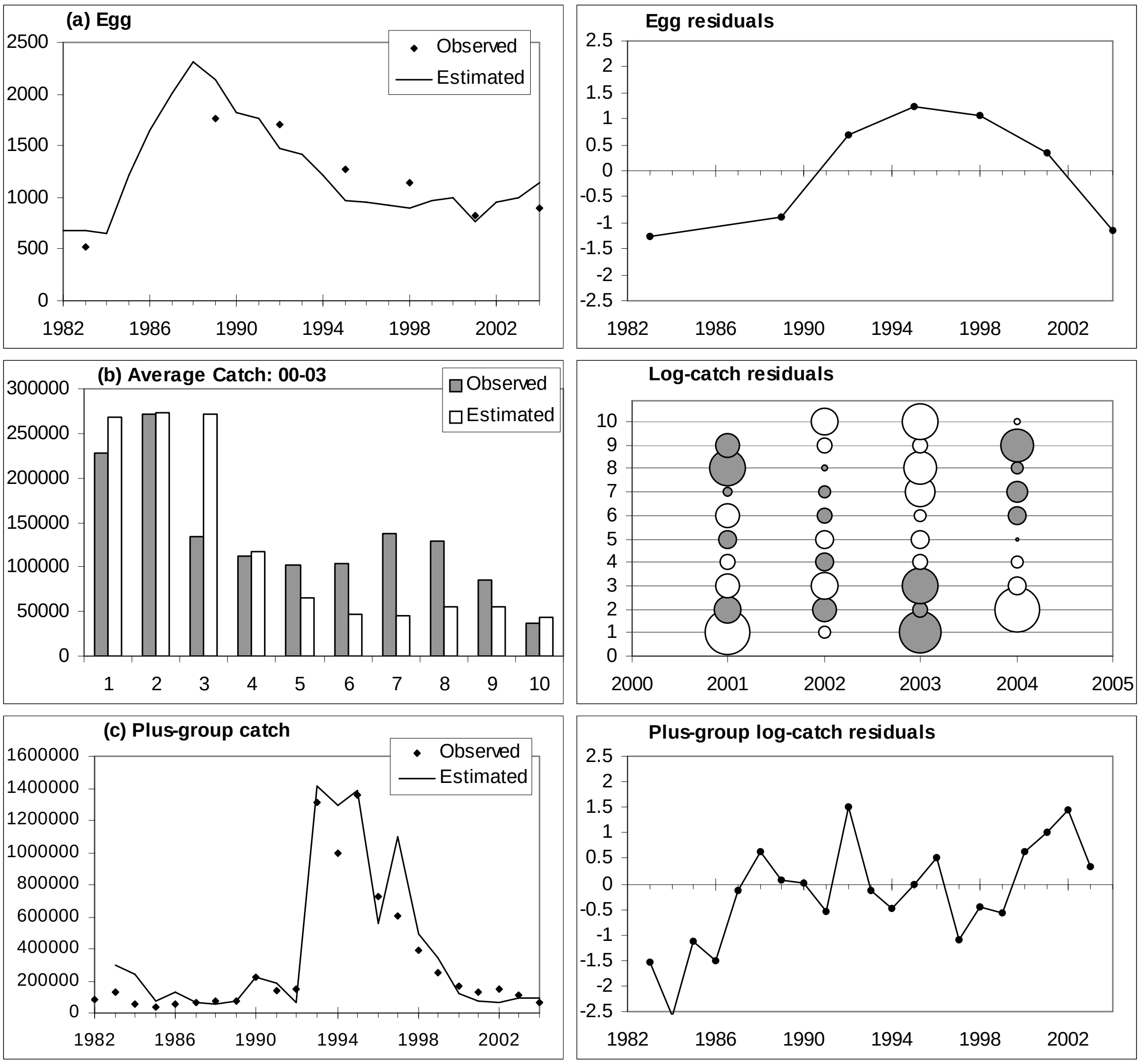


Figure 5.6.2.2.5: Western horse-mackerel, selectivity pattern for ages 9 & 10 = selectivity at age 8. Model fits to data for the three components of the likelihood corresponding to (a) the egg estimates, (b) the catches in the separable period, and (c) to the catches in the plus-group. The left-hand 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).

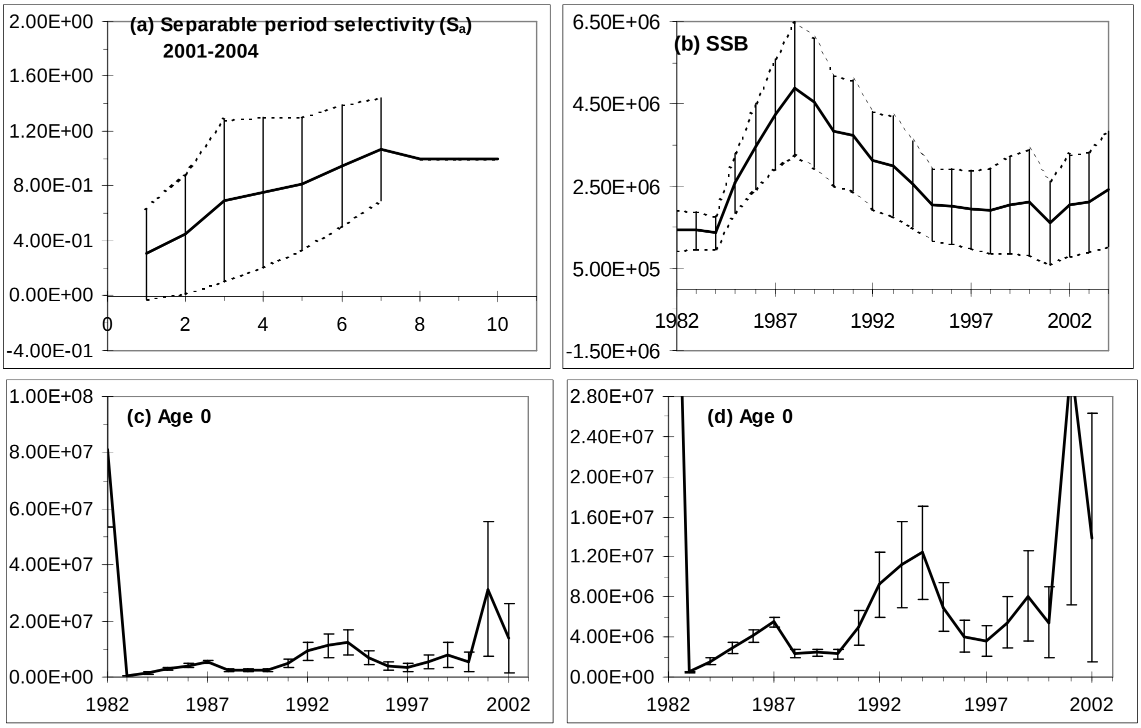


Figure 5.6.2.2.6: Western horse-mackerel, selectivity pattern for ages 9 & 10 = selectivity at age 8. Plots of (a) the selectivity pattern, (b) the SSB trajectory, (c) numbers at age 0, and (d) the same as (c) but scaled to capture more detail. The error bars are 2 standard deviations (indicating roughly 95% confidence bounds).

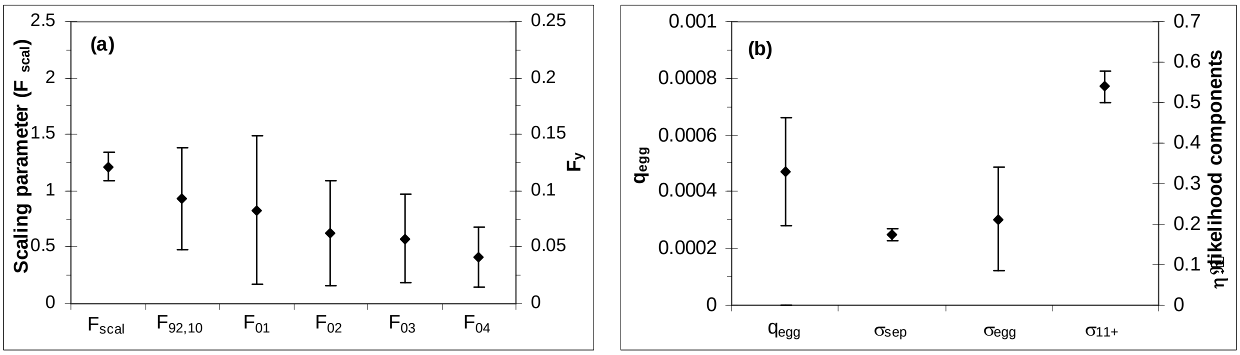


Figure 5.6.2.2.7 Western horse-mackerel, selectivity pattern for ages 9 & 10 = selectivity at age 8. Estimates for some key parameters, with (a) corresponding to fishing mortality parameters (the scaling parameter F_{scal}, fishing mortality at age 10 in 1992, $F_{92,10}$, and the fishing mortality year 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).

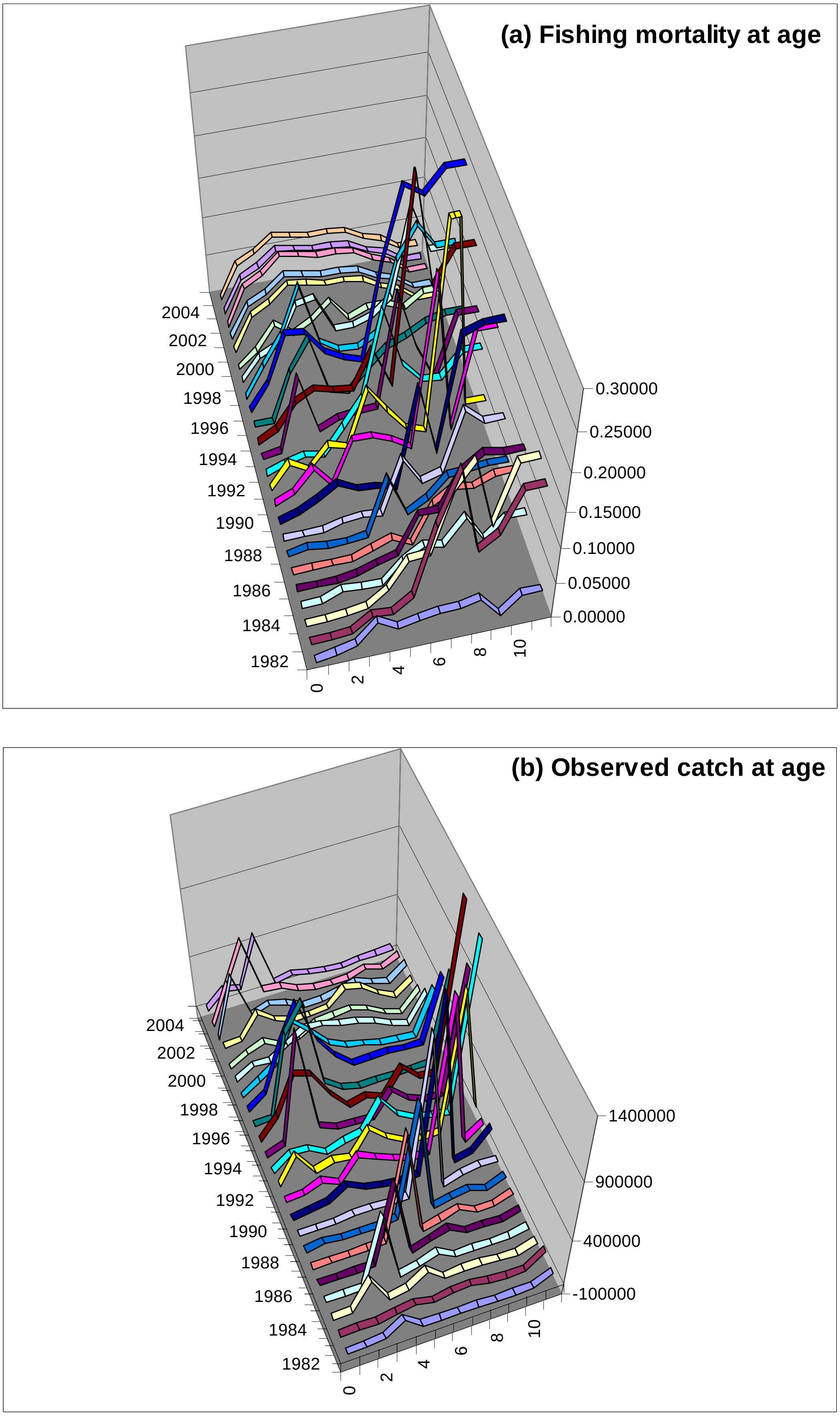
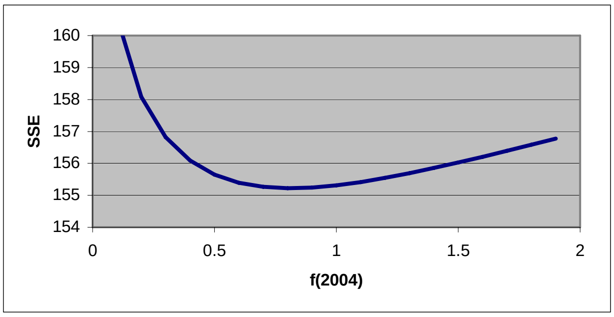
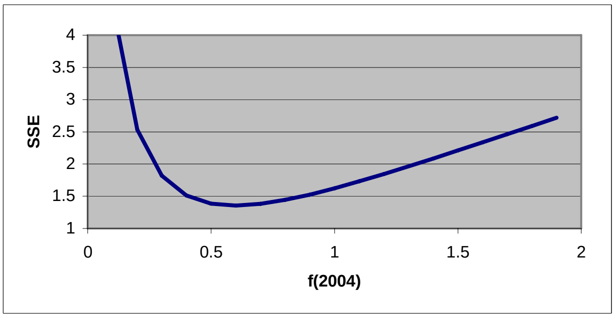


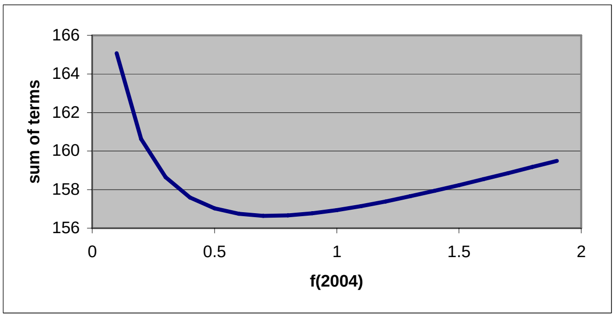
Figure 5.6.2.2.8. Three-dimensional plots of (a) estimated fishing mortality-at-age and (b) observed catch-at-age.



WHM ISVPA. signal from catch-at-age

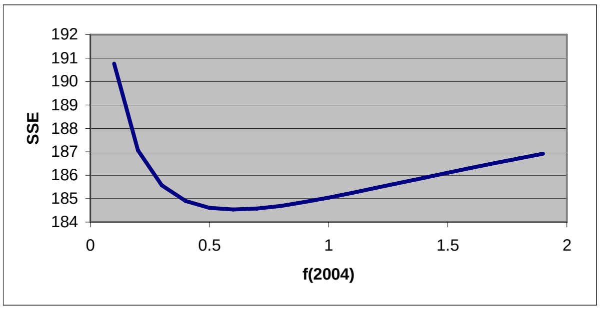


WHM ISVPA. signal from egg production (as relative SSB index)

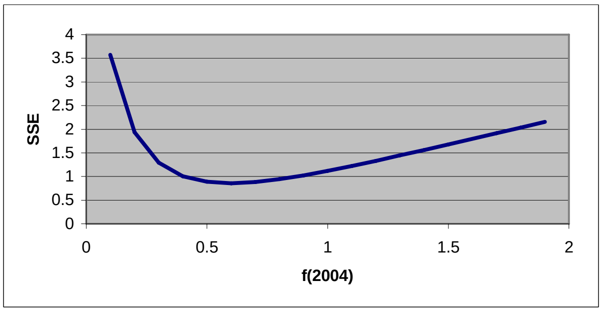


Profile of total loss function

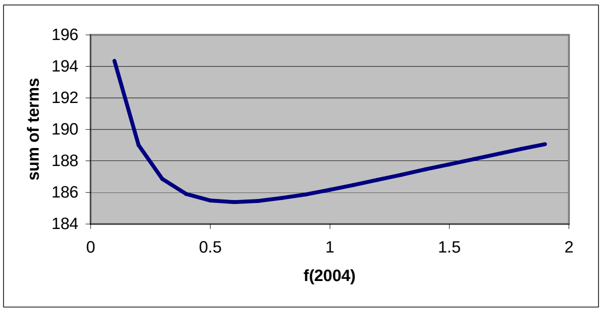
Figure 5.6.2.3.1. WHM. ISVPA. Profiles of components of the model loss function (S1:1982-1991; S2:1992-2004)



WHM ISVPA. signal from catch-at-age

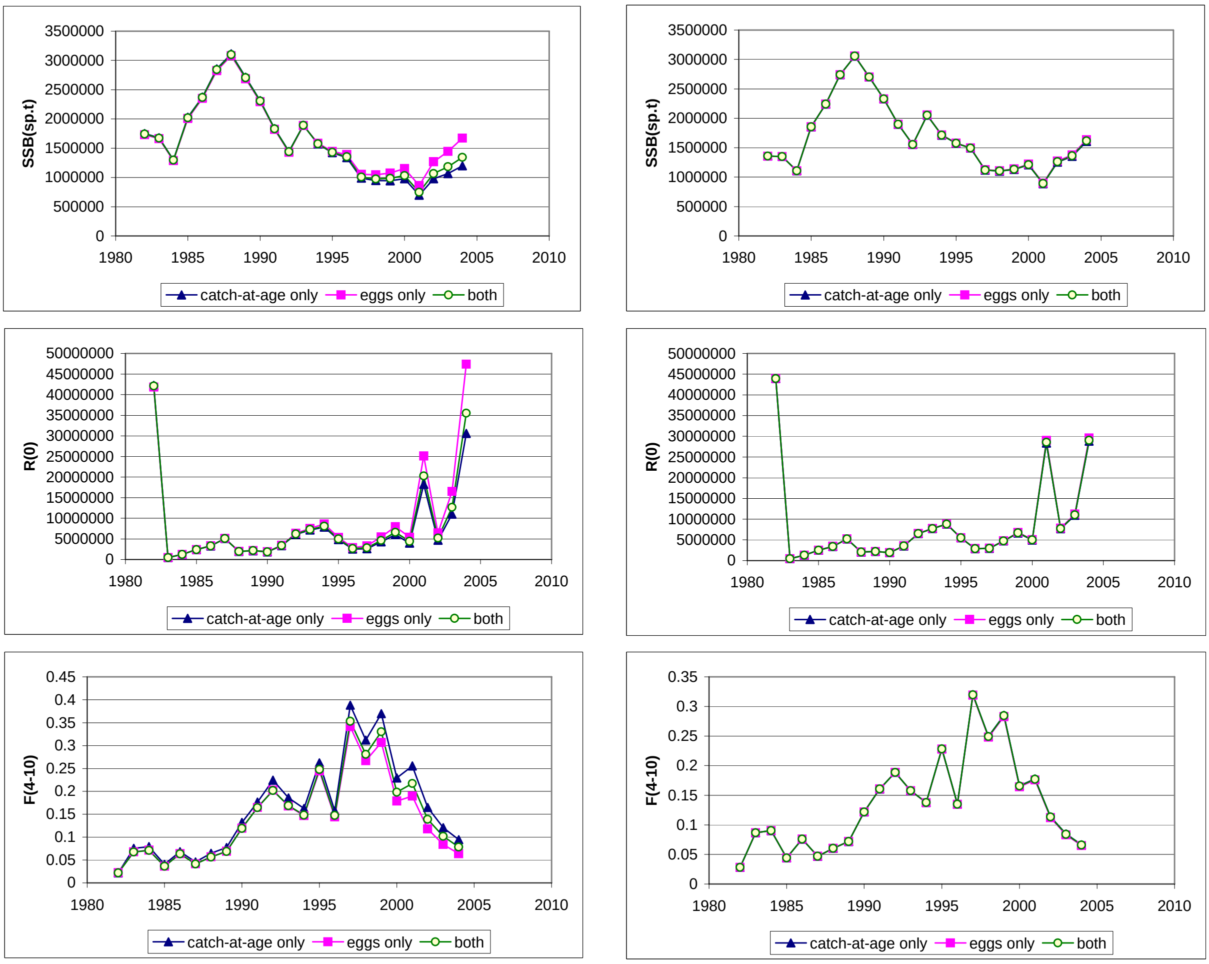


WHM ISVPA. signal from egg production (as relative SSB index)



Profile of total loss function

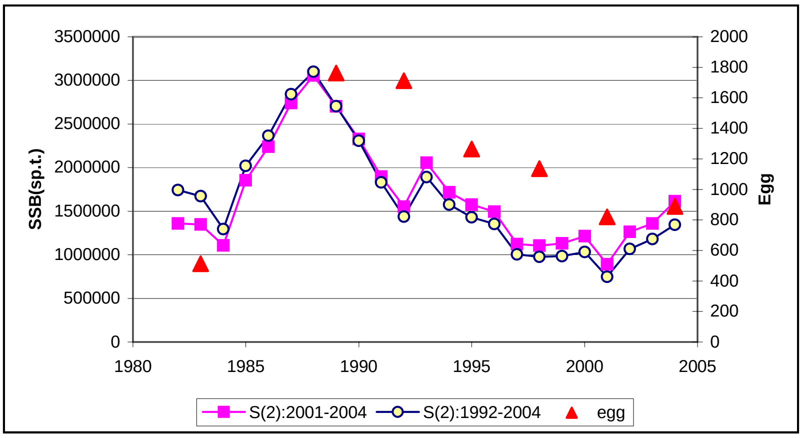
Figure 5.6.2.3.2. WHM. ISVPA. Profiles of components of the model loss function (S1:1982-2000; S2:2001-2004)

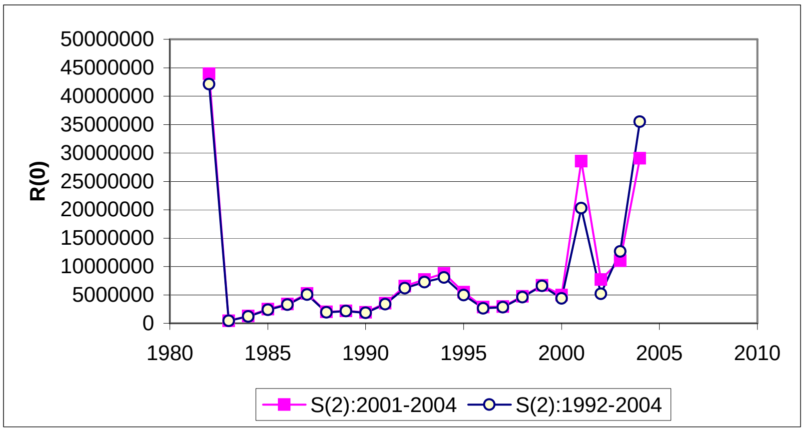


s(1): 1982-1991; s(2):1992-2004

s(1): 1982-2000; s(2):2001-2004

Figure 5.6.2.3.3 ISVPA results (for years of change in selection pattern - 1992 or 2001)





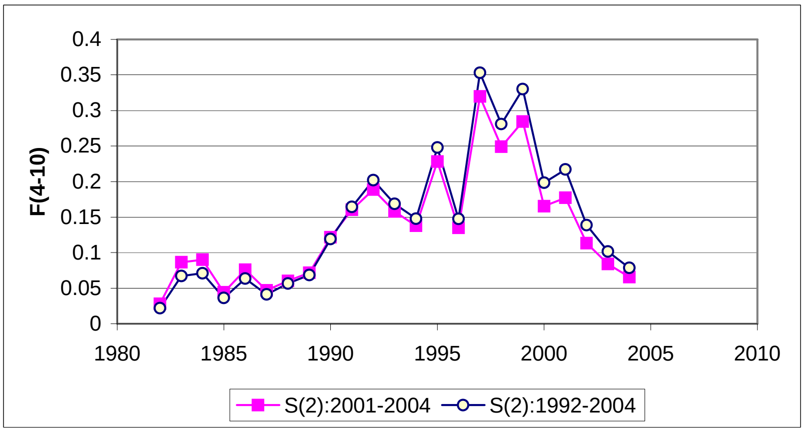


Figure 5.6.2.3.4. The ISVPA results for the year of change in selection pattern chosen as 1992 or 2001

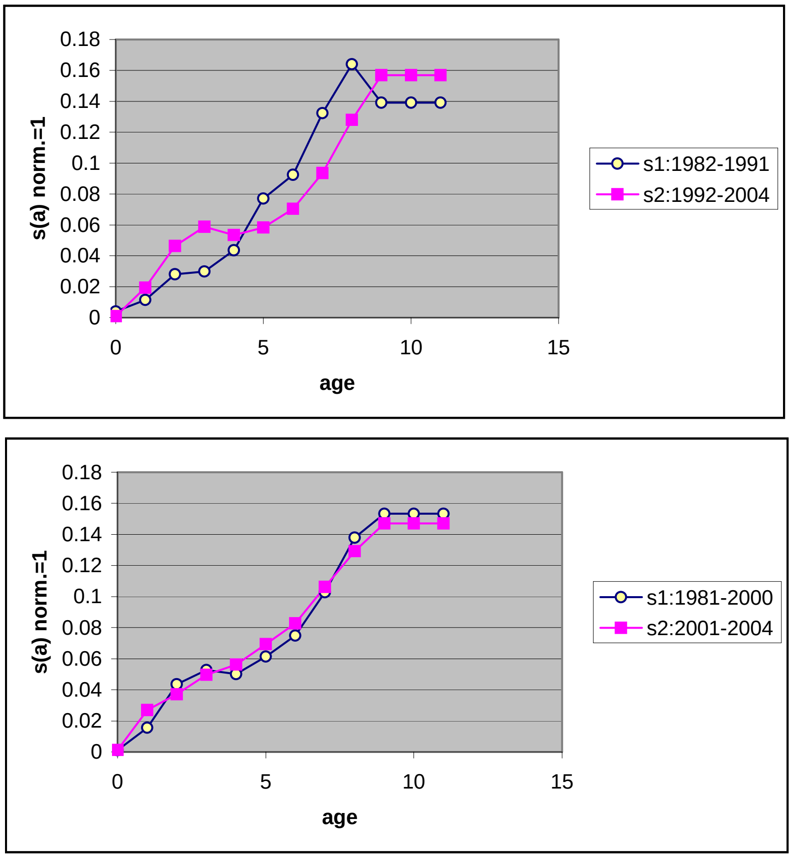


Figure 5.6.2.3.5. Estimated selection patterns for different choices of the year of change in selection

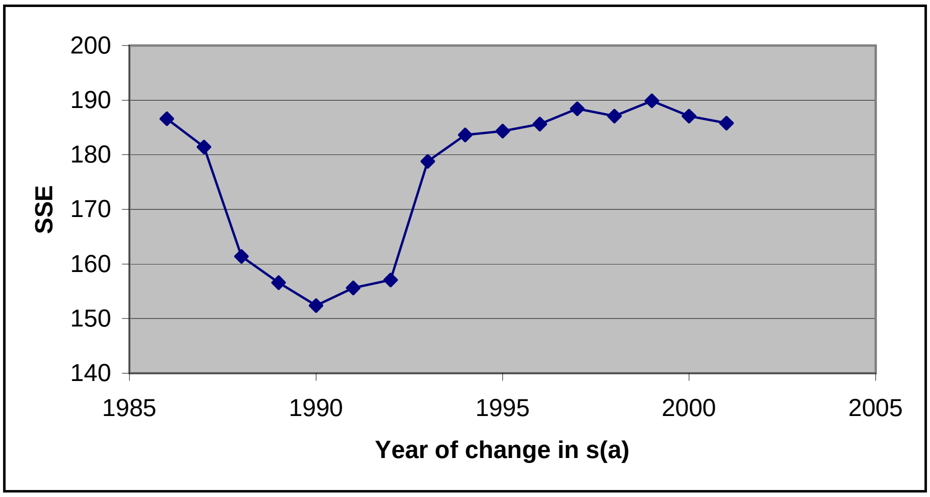
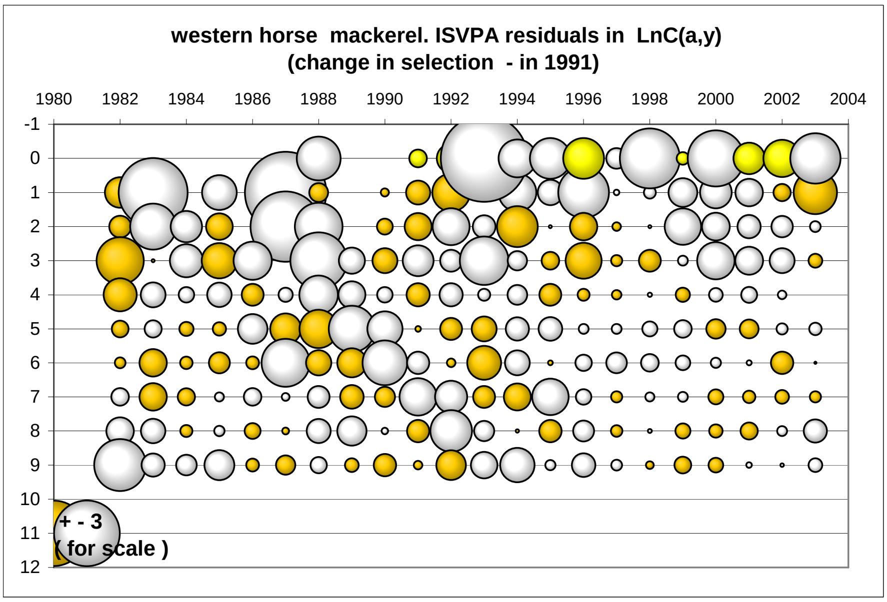


Figure 5.6.2.3.6. ISVPA loss function with respect to the year of change in selection pattern



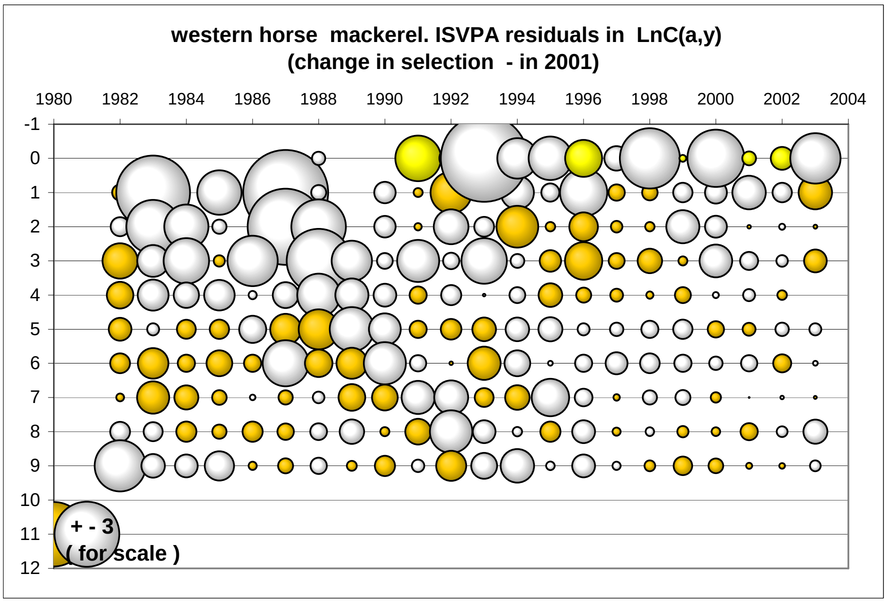


Figure 5.6.2.3.7. ISVPA. Residuals in logarithmic catch-at-age

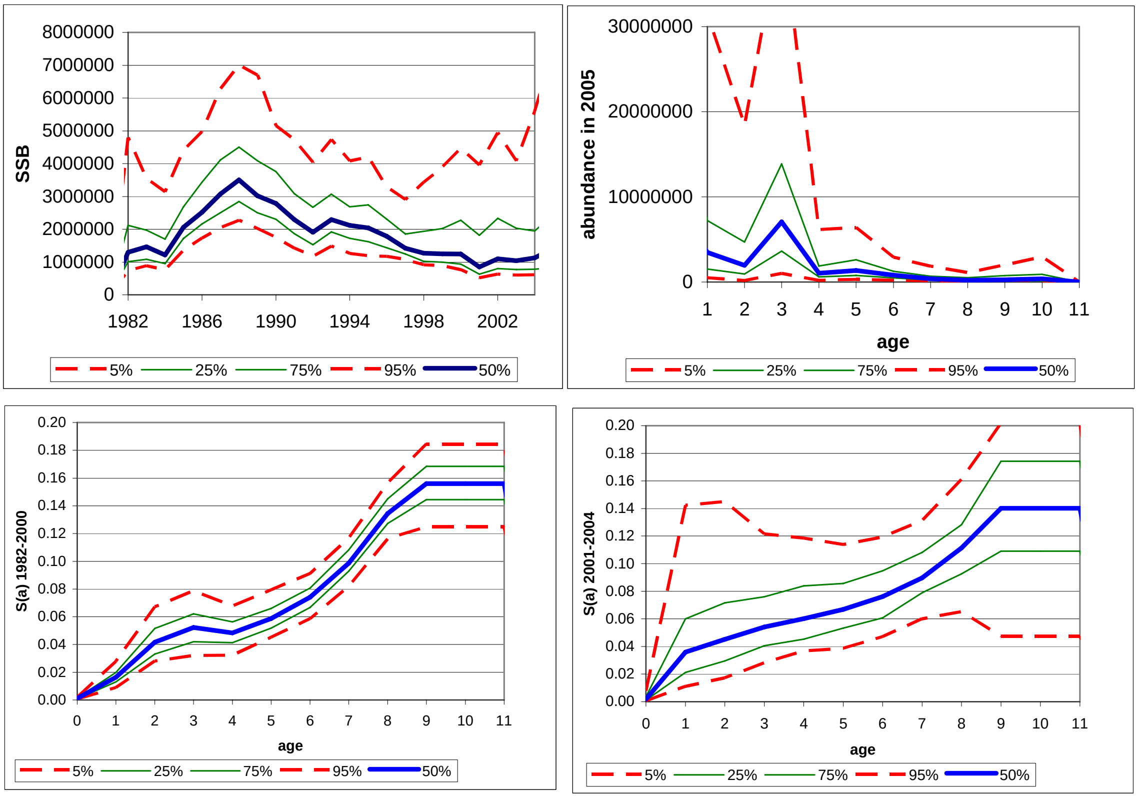


Figure 5.6.2.3.8 ISVPA bootstrap (for change in selection in 2001)

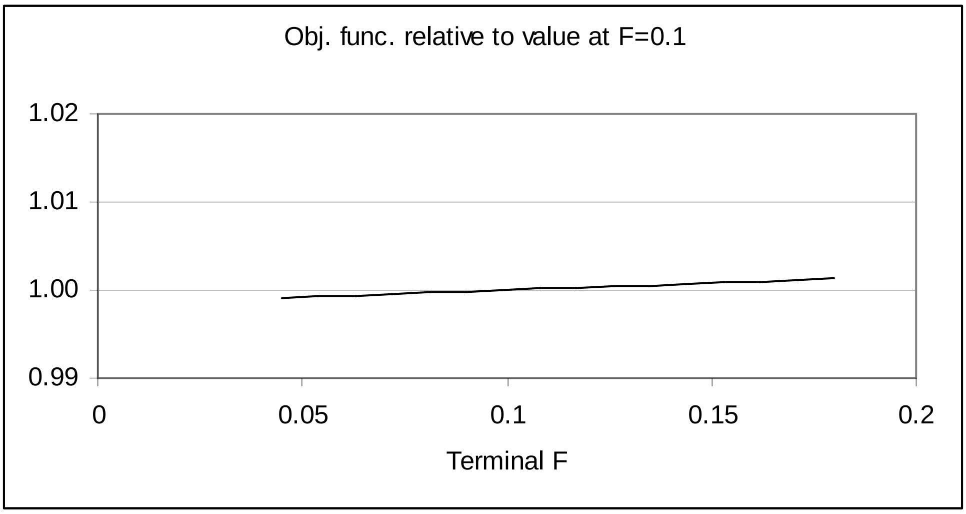


Figure 5.6.2.4.1 Fit of AMCI to catch at age data for Western horse mackerel. Objective function at a range of values for terminal F. The plot shows the values relative to that at Fterm=0.1

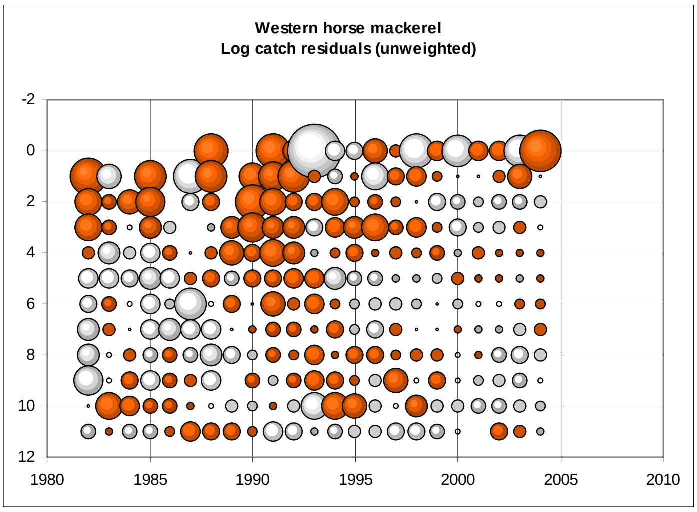
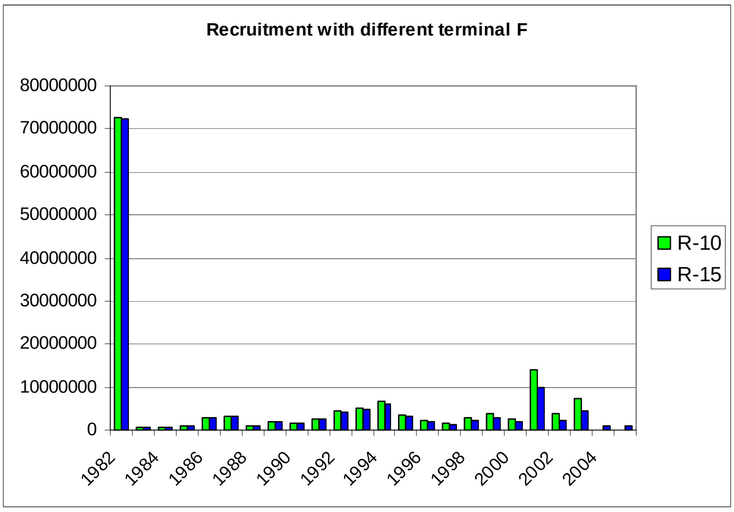
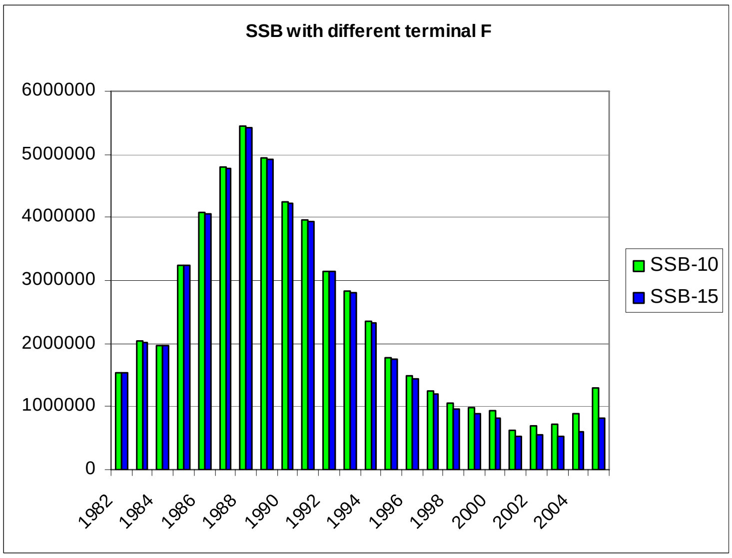


Figure 5.6.2.4.2 Log catch residuals by fitting AMCI to catch numbers at age for Western horse mackerel. Example with terminal F set at 0.1.





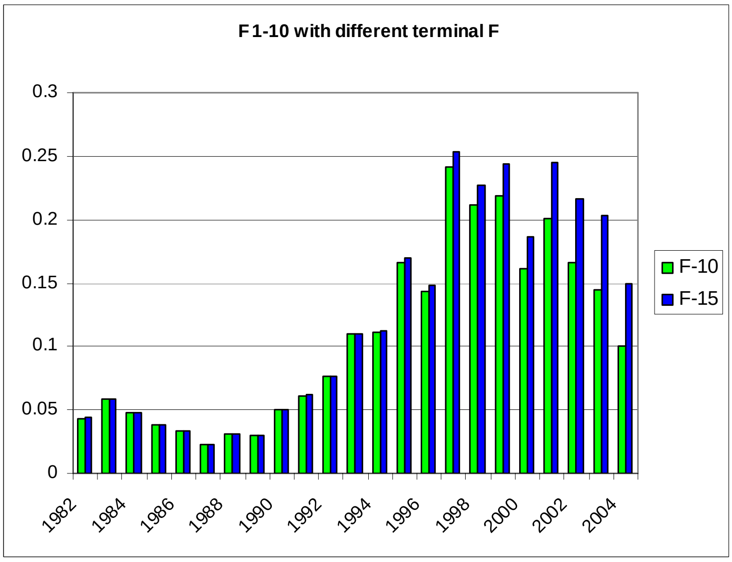


Figure 5.6.2.4.3. AMCI on Western horse mackerel data. Comparison of main interest parameters at two choices of terminal F

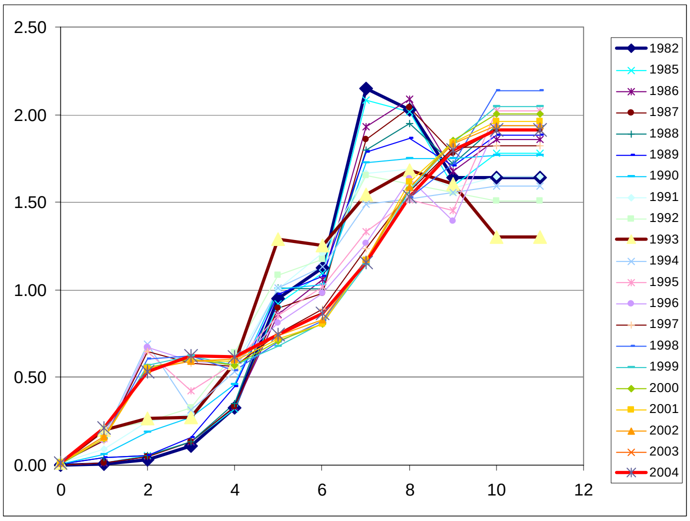


Figure 5.6.2.4.4. Selection at age by fitting AMCI to catch numbers at age for Western horse mackerel., allowing for a gradual change in selection over time. The years 1982, 1993 and 2004 are emphasied, as typical representatives for the early period, the transition and the late period. Example with terminal F set at 0.1.

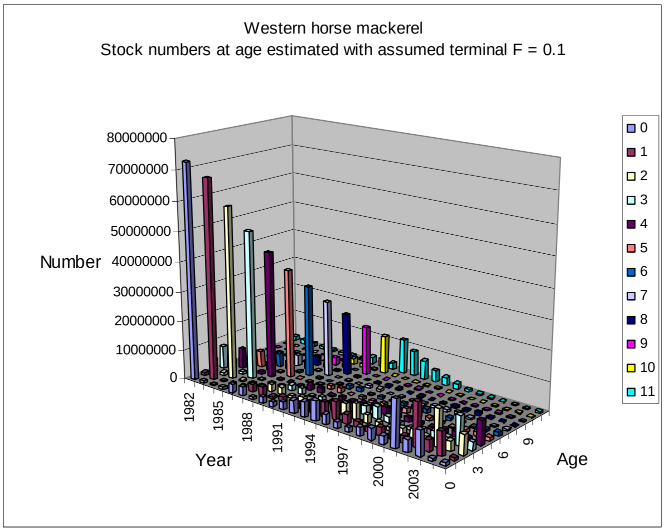


Figure 5.6.2.4.5. Stock numbers of Wesstern horse mackerel estimated with AMCI, assuming a terminal F of 0.1

6 Southern Horse Mackerel (Division IXa)

6.1 ICES advice applicable to 2003 and 2004

In 2004 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.

Given the apparently stable state of the stock and exploitation pattern, fishing effort must not increase and catches in 2005 should not exceed the recent average of 25, 000 t (2000-2002). In calculating the average of recent catches the year 2003 has been left out as this year was abnormal due to the "Prestige" oil spill.

The TAC for this stock should only apply to *Trachurus trachurus*.

6.2 The Fishery in 2003

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 last year 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 1991-2004, 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 has decreased through the short time period available from the 5% of the total catch in 2002 to the 1.4 % in 2004. 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). 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 2004 represented an increase of 23% compared with those obtained in 2003. In the assessment period the level of catches for this stock is about 26,200 (± 5,400) 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). The catches from bottom trawlers are the majority in both countries (65%). 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 & Punzón, WD 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 is believed to achieve 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 Sub-division. 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 1996 yearclass appears to be conspicuous (table 6.3.1.1 and figure 6.3.1.1). It is also noticeable the catches of age 1 in 2004. 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 in 2004 for the intermediate ages (3-9) when compared to the levels obtained in 2003 (Fig. 6.3.2.1). The mean length at age also showed an smooth increase trend for those ages since 2002. (table 6.3.2.2).

<u>Mean weight at age in the stock:</u> Taking in consideration that: the spawning season is very long, spawning almost from September to June, and that the 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 3 bottom-trawl survey series that can be used for tuning the assessment: the Portuguese July and October surveys and the Spanish October survey. The two October 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 October and July survey indices 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 series of the Portuguese July surveys stopped in 2001 and a new winter series has started in February 2005.

Indices from the Portuguese surveys were, until 200l, based on a 48 strata in which fixed bottom trawl stations were allocated. This design led to a increase of the noise in the data because some strata were difficult to sample. A revision of those indeces was carried out in 2004, using a new post-stratification design similar to the one used in the Spanish survey. Nine strata were defined according to depth and latitude, reflecting oceanographic and fish distribution features (Gomes et al., 2001). The new indices give a more coherent pattern and less noisy estimates of fish abundance.

In 2002 the haul duration in the Portuguese October bottom-trawl surveys was reduced from 1 hour (as used from 1990 to 2002) to 30 minutes. An experimental survey was carried out to investigate if this change in haul duration could have a significant effect on the abundance indices of the different length classes. The results from the experimental survey showed no significant differences of overall catch in numbers/hour between hauls of different duration. However, the test for differences in the length distributions using generalised linear models with continuation-ratio logits (Rindorf and Lewy, 2001) showed a significant effect due to the duration of hauls. It can be seen in Figure 6.4.1.1 that the difference is due to larger length classes (> 30 cm) being present in 60 minute hauls but not in 30 minute ones, which could be explained by the "catch by exhaustion" hypothesis (Wardle, 1986). Given that fish larger than 30 cm are usually scarce in Portuguese bottom-trawl surveys, whatever the haul duration, it is likely that this change in catchability may just cause a negligible bias.

In 1996, 1999, 2003 and 2004, the October Portuguese surveys were carried out with N.I. "Capricórnio" instead of N.I. "Noruega". These vessels use different gears and may have different catchabilities. Therefore, in the Spring of 2005 an experimental survey was done to compare the estimates obtained with these two vessels. A conversion factor between vessels is not available yet, so the abundance estimates for those years may have to be revised next year. Also the sampling design of Spanish October survey was changed in 1997. The strata used until 1997 (30m-100m, 101m-200m, 201m-500m) were changed from that year to the present (70m-120m, 121m-200m, 201m-500m). A comparison of the indices obtained with these two stratifications was made using the data from 1997 to the present, showing that although the trends remained the same, the absolute values changed slightly. The calculation of abundance indices with the new stratification backwards in time from 1997 is not made yet, and is expected to be available next year.

The CPUE matrices from these surveys are shown in Table 6.4.1.1. It could be observed the year effect, especially in 1993 in which the yield was high for all ages in the three bottom trawl surveys. In the Spanish September/October survey, the ages from 1 to 5 are almost absent (except in 1993 and 2004), whereas in the Portuguese surveys the oldest adults are not well represented. The total number per haul is dominated by the catch of the incoming year classes in the three time series of surveys (figs. 6.4.1.2 and 6.4.1.3). The two CPUE series from the October surveys are used in data exploration (see section 6.7.1).

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. These data series correspond to samples collected in AEPM cruises for horse mackerel in 1998, 2001 and 2004, and DEPM cruises for sardine in 1999 and 2002. This series, combined with the adult fecundity estimates, will allow the construction of a series of SSB estimates.

In the AEPM surveys (1998, 2001 and 2004) double oblique tows are made using a plankton Bongo net, while in the sardine surveys (1999 and 2002) a vertical double plankton net CalVET (California Vertical Egg Tow) was used. It was therefore necessary to standardize the data obtained with these different sampling devices. Total egg production for each survey was calculated as the product between egg production per unit area and the total area of spawning, taking as estimator of the proportion of the area where egg production occurred, the proportion of sampling stations with one or more eggs.

The calculation of the daily egg production per unit area was based on the method described by Lasker (1985). From the estimates of egg number at age per unit area, the following exponential model was fitted:

$N_t = P_0 \exp(-Z\ t)$

where N_t is the egg number per unit area, sampled at age t (in days), P_0 is the daily egg production and Z the instantaneous rate of daily egg mortality. Thus, it is assumed that the egg production and mortality rate are constant across stations. Because of lack of information in the data, it was not possible to obtain different estimates of mortality rate for each survey. So, it was adopted a further assumption that egg mortality rate was the same in all surveys. Egg abundance values with less than 12 hours of age were not included in the fitting of the model, as they were much scarcer than what would be expected by the exponential model.

The ageing of the eggs was based on the embryonic development stages and on the sea average temperature at the moment each sample was collected. The embryonic development stages were subdivided into 11 easily identifiable stages, each one lasting much less than 24 hours (Vendrell et al, 2002). The stage description and its duration were based on the development of artificially fertilised eggs in incubation experiments. The Kimura and Chikuni (1987) method was then used to estimate egg abundance at age, from the estimates of egg abundance in each stage and the stage distribution at each age given by the incubation experiments.

Figure 6.4.2.1 shows the total egg production and confidence intervals for the 5 egg surveys analysed. The calculations of the adult parameters, for the time period corresponding to each of those egg surveys, is expected to be finished by 2006. Therefore, a series of SSB estimates from the DEPM is expected to be available next year. See also section 3.7

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 especific 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 20^{th} century. Instead, the catches from 1962-1978, appear exceptionally high when looking to the whole time series. Many hypothesis 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. See Section 6.7.3.

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, reveal marked year-effects (Figures 6.4.1.2 and 6.4.1.3) possibly related to changes in catchability have most probably a natural cause and not a methodological one, given the accordance in patterns between the Portuguese and Spanish surveys, that are carried out independently with different vessels and fishing gears.

The evolution of the year-classes in the population can be clearly followed in the Portuguese October survey (Figure 6.7.1.2a). The Spanish October survey presents a pattern different from the Portuguese ones, with the abundance of most year-classes increasing with age (Figure 6.7.1.2b). This is related to migrations in the stock area, along the life of each year-class. In these ontogenic migrations, according to the October surveys data, the large fish tend to be distributed in the northern part of the stock, which results in a too steep decrease of each yearclass given by the Portuguese survey, and an apparent negative mortality given by the Spanish survey. By looking at the combined indices from these surveys, which seem to have similar catchabilities (see section 6.4.1), it would be possible to see that the decline of each cohort roughly matches the corresponding catch curve (Figure 6.7.1.1). This observation takes us to believe that an analytical assessment of the stock could be done using the catch and survey data.

As an initial approach, a simple separable VPA was carried out with the Lowestoft fisheries assessment package, with different selectivity reference ages, terminal F and terminal S, in order to check if a separable model of fishing mortality could be used. The different options taken for the separable VPA did not change significantly the pattern of the residuals. As an example we show in Figures 6.7.1.3 and 6.7.1.4 the selectivity at age and the corresponding pattern of catch residuals for a terminal F=0.2, terminal S=1 and age 2 as the reference age.

Given the acceptable residual pattern being produced by the separable VPA analysis, a separable model was set up with AMCI (D. Skagen, IMR Norway), 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 consider that this recruitment is also poorly estimated it was decided to also fix it at the same level. This option is a conservative one since there are signals in the catches showing that the 2003 yearclass could be a strong one. The objective function minimised the sum of the log sum of squares of the residuals of the catches and of the surveys abundance indeces.

The catch residuals from that assessment are shown in Figure 6.7.1.5, and the catchability residuals of the surveys are shown in Figures 6.7.1.6(a and b). The pattern of the catch residuals do not show clear trends along ages or years. As for the catchability residuals, the patterns obtained show a higher variability and for certain years (e.g. 1999 in the Portuguese survey or 1993 in the Spanish one) there is a clear trend from young to old ages. Given the characteristics of the survey data, this was to be expected, and it can be explained by the difficulty of accommodating divergent information coming from different sources. The contradictory trends in the surveys carried out in the Portuguese and Spanish areas of the stock are due to ontogenic migrations. Given that these surveys are sampling different age classes of the same population, the indices could be seen as complementary, Further exploration of this assessment model should elaborate on whether a merging of the surveys is appropriate examine the benefits of such merging. Further exploration should examine the sensitivity of this assessment to the input data, and to model assumptions.

6.7.2 Stock assessment

The estimates of fishing mortality rates and numbers at age from and the exploratory assessment are shown in Tables 6.7.2.1 and 6.7.2.2. Table 6.7.2.3 has the stock summary, and Figure 6.7.2.1 shows the contour plot of the estimated numbers at age. That figure clearly shows the strength of the 1996 yearclass and to a certain extent a good recruitment in 2001. It also shows a decreasing trend of the adults in the population over the years.

Figure 6.7.2.2 shows the stock summary. The highest recruitment in the series took place in 1996, and since then a series of medium and low recruitments are partially responsible for the decreasing trend in SSB since 1999. The catches have been also decreasing, especially in 2003 in the Spanish area due to the "Prestige" oil spill, and therefore the fishing mortality level seems stable in the last decade.

6.7.3 Reliability of the assessment

Any assessment carried out with the current data set is more reliable than the previous ones, given that the biology and structure of the horse mackerel populations is clearer now than in previous years. The main weakness of this assessment, as seen from the exploratory analyses, is the difficulty in estimating the recruitment of the last years. Especially because those recruitments appear to have a big influence in the fitting of the model to the whole dataset. This difficulty is probably related to the big fluctuation in the catches in the recent past, due to the 2003 oil spill in the Spanish coast.

6.8 Short-term catch predictions

Data input and results of short term catch predictions are shown in tables 6.8.1-3, and figure 6.8.1. Recruitment for predictions was estimated as the geometric mean of recruitments from 1991 to 2002. At $F_{status\ quo}$ level, which corresponds to landings of about 21000 tonnes in 2005 and 2006, the SSB is expected to smoothly decrease through the prediction period.

6.9 Long term yield

Yield per recruit analysis shows that the $F_{status\ quo}$ (F = 0.23) is well above the estimated F_{max} (F = 0.18) (Table 6.9.1 and figure 6.8.1). $F_{0.1}$ is estimated to be the 44% of the $F_{status\ quo}$ ($F_{0.1}$ = 0.1).

6.10 Reference points for management purposes

No reference points were defined for this stock.

6.11 Harvest control rules

No harvest control rules have been defined for this stock

6.12 Management considerations.

The fishery for horse mackerel is carried out essentially by the same purse seiners that fish sardine and the same trawlers that target hake and other demersal species. Therefore, the fishing mortality of horse mackerel is in fact controlled by the restrictions imposed to the sardine and demersal mixed fisheries. Given the depleted state of Iberian hake and other stocks, it is likely that a probable future reduction in fishing effort may limit the exploitation of the southern horse mackerel stock.

The fluctuations of the SSB of this stock are strongly dependent on the recruitment. There are strong indications that SSB has been decreasing in the last decade. Therefore there is the possibility that a period with low recruitments may bring the SSB below an acceptable level. The F status quo (as estimated in the exploratory assessment) is well above F max and a restriction of fishing effort should be applied to keep the stock in a healthy condition until new strong recruitment may increase the SSB to a higher level.

The southern horse mackerel stock delimitation has been recently revised according to the conclusions of the HOMSIR project (QLK5-CT1999-01438). However, the southern boundary of the southern stock could not be delimited due to the lack of samples from the north coast of Morocco. However extra samples were recently collected from that area and started to be analysed and compared to other results from the project HOMSIR. Preliminary results regarding the parasite fauna of those samples indicated that the Moroccan coast may be part of a different stock unit than the Iberian, Mediterranean or Mauritanian ones (MacDonald, pers comm., University of Aberdeen), as suggested previously by other authors.

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)*

(*) In parenthesis: the Spanish catches from Subdivision IXa south are also included. These catches are only available for 2002, 2003 and 2004 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).

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	Discards	Number of vessels
10 - 40 (24)	110 - 800 (415)	TRAWL 1	Dry hold with ice		247
19.5 - 40 (24.9)	220 - 800 (495)	TRAWL 2	Dry hold with ice		88
6.5 - 40 (20)	16 - 600 (250)	PURSE SEINE	Dry hold with ice		412
4 - 27 (12.6)	5 - 750 (138)	ARTISANAL 1	Dry hold with ice		370
7 - 29 (14)	40 - 450 (170)	ARTISANAL 2	Dry hold with ice		593
2 - 34 (9)	4 - 900 (62)	ARTISANAL 3	Dry hold with ice		4587

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

Table 6.3.2.1. Southern horse mackerel. Mean wight at age in the catch.

YEAR	AGES 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

Table 6.3.2.2. Southern horse mackerel. Mean length at age.

YEAR	AGES 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

Table 6.4.1.1. Southern horse mackerel. CPUE at age from 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

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

July Portuguese Survey

YEAR	AGES 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1991	36.959	29.995	8.894	3.267	3.723	4.385	3.147	2.953	2.987	6.169	3.828	2.981	1.793	0.812	0.260	0.334
1992	293.437	922.089	30.372	13.328	7.647	5.426	4.244	3.750	3.189	3.749	8.569	3.131	2.234	0.724	0.290	0.101
1993	8.529	188.439	303.711	101.404	19.742	41.708	83.385	48.772	8.984	5.286	0.341	0.861	0.045	0.015	0.001	0.000
1994*																
1995	28.856	32.139	13.539	42.402	36.483	11.385	2.931	1.633	0.752	0.358	0.214	0.326	0.277	0.295	0.159	0.119
1996*																
1997	58.076	362.460	96.818	9.945	12.425	4.641	4.235	1.158	0.292	0.157	0.120	0.516	0.024	0.016	0.017	0.006
1998	86.829	178.183	74.747	45.480	11.541	4.930	2.994	1.573	0.887	0.476	0.331	0.060	0.019	0.007	0.000	0.000
1999*																
2000	31.740	22.709	5.601	8.179	5.585	6.154	9.641	5.914	2.690	1.317	0.345	0.148	0.121	0.090	0.000	0.000
2001	2.300	3.642	12.555	7.727	7.066	8.238	9.822	9.108	3.702	1.336	0.827	0.367	0.222	0.204	0.015	0.017

***** 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 6.7.2.1. Matrix of fishing mortalities from AMCI assessment model

Year	Age 0	1	2	3	4	5	6	7	8	9	10	11+
1991	0.026	0.116	0.171	0.169	0.136	0.109	0.113	0.139	0.172	0.172	0.172	0.172
1992	0.034	0.150	0.221	0.218	0.176	0.141	0.146	0.180	0.222	0.222	0.222	0.222
1993	0.042	0.186	0.274	0.270	0.218	0.175	0.180	0.223	0.275	0.275	0.275	0.275
1994	0.032	0.142	0.209	0.206	0.166	0.133	0.137	0.170	0.210	0.210	0.210	0.210
1995	0.026	0.115	0.169	0.167	0.135	0.108	0.112	0.138	0.171	0.171	0.171	0.171
1996	0.028	0.122	0.180	0.177	0.143	0.115	0.118	0.147	0.181	0.181	0.181	0.181
1997	0.027	0.117	0.173	0.171	0.138	0.110	0.114	0.141	0.174	0.174	0.174	0.174
1998	0.053	0.235	0.347	0.342	0.276	0.221	0.228	0.283	0.349	0.349	0.349	0.349
1999	0.039	0.172	0.254	0.250	0.202	0.162	0.167	0.207	0.255	0.255	0.255	0.255
2000	0.039	0.173	0.255	0.251	0.203	0.163	0.168	0.208	0.257	0.257	0.257	0.257
2001	0.044	0.196	0.289	0.284	0.230	0.184	0.190	0.235	0.290	0.290	0.290	0.290
2002	0.045	0.199	0.294	0.290	0.234	0.188	0.193	0.240	0.296	0.296	0.296	0.296
2003	0.039	0.174	0.257	0.253	0.204	0.164	0.169	0.209	0.258	0.258	0.258	0.258
2004	0.039	0.174	0.257	0.253	0.204	0.164	0.169	0.209	0.258	0.258	0.258	0.258

Table 6.7.2.2. Matrix of stock numbers from AMCI assessment model.

Year	Age 0	1	2	3	4	5	6	7	8	9	10	11+
1991	615887	545822	222000	109902	96431	84170	58910	55172	41480	107426	64085	113292
1992	519453	556611	418338	161045	79919	72443	64952	45307	41308	30060	77850	128543
1993	411880	465864	412336	288630	111459	57690	54140	48331	32563	28462	20712	142211
1994	421139	366433	333049	269954	189695	77171	41695	38920	33283	21284	18604	106490
1995	456253	378409	273740	232645	189127	138287	58131	31279	28255	23220	14849	87272
1996	937125	412436	290323	198878	169426	142251	106816	44752	23448	20507	16853	74118
1997	400497	845774	314200	208739	143355	126381	109148	81670	33264	16841	14729	65336
1998	346499	361841	647365	227480	151496	107525	97402	83835	61048	24058	12180	57907
1999	403756	304841	246195	394017	139134	98979	74176	66737	54399	37080	14612	42570
2000	369102	360295	220875	164400	264055	97858	72444	54021	46704	36271	24723	38126
2001	499230	329312	260849	147321	110049	185549	71571	52719	37769	31103	24155	41856
2002	187332	443127	233047	168237	95404	75291	132826	50945	35864	24318	20026	42501
2003	538325	166144	312461	149509	108379	64996	53715	94217	34507	22967	15573	40043
2004	538325	480153	120130	208011	99892	76041	47479	39041	65770	22936	15266	36967

Table 6.7.2.3. Stock catches and Summary of the results from the AMCI model

Year	Recruits Age 0 (thousands)	SSB (tonnes)	F (1-10)	Catch (tonnes)
1991	615887	144924	0.147	24397
1992	519452	131389	0.190	27670
1993	411880	128195	0.235	31499
1994	421138	129514	0.179	25935
1995	456253	123141	0.146	25129
1996	937124	137471	0.155	22933
1997	400496	138325	0.149	29517
1998	346499	133991	0.298	41596
1999	403755	135732	0.218	27729
2000	369101	122889	0.219	26170
2001	499229	112230	0.248	24916
2002	187331	96561	0.252	22510
2003	538325	89528	0.221	18887
2004	538325	99085	0.221	23214

Table 6.8.1.- Input data for predictions.

MFDP version 1a
Run: hom9ast1.run
Time and date: 11:05 15/09/05
Fbar age range: 1-10

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	434988	0.15	0.0388	0.08	0.08	0.029	0.041	0.029
1	489695	0.15	0.3061	0.08	0.08	0.030	0.183	0.030
2	347174	0.15	0.8283	0.08	0.08	0.046	0.269	0.046
3	79973	0.15	0.9814	0.08	0.08	0.072	0.265	0.072
4	138979	0.15	0.9983	0.08	0.08	0.102	0.214	0.102
5	70087	0.15	0.9998	0.08	0.08	0.135	0.172	0.135
6	55547	0.15	1	0.08	0.08	0.159	0.177	0.159
7	34508	0.15	1	0.08	0.08	0.185	0.219	0.185
8	27253	0.15	1	0.08	0.08	0.209	0.271	0.209
9	43717	0.15	1	0.08	0.08	0.238	0.271	0.238
10	15246	0.15	1	0.08	0.08	0.255	0.271	0.255
11	34719	0.15	1	0.08	0.08	0.318	0.271	0.318

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	434988	0.15	0.0388	0.08	0.08	0.029	0.041	0.029
1	.	0.15	0.3061	0.08	0.08	0.030	0.183	0.030
2	.	0.15	0.8283	0.08	0.08	0.046	0.269	0.046
3	.	0.15	0.9814	0.08	0.08	0.072	0.265	0.072
4	.	0.15	0.9983	0.08	0.08	0.102	0.214	0.102
5	.	0.15	0.9998	0.08	0.08	0.135	0.172	0.135
6	.	0.15	1	0.08	0.08	0.159	0.177	0.159
7	.	0.15	1	0.08	0.08	0.185	0.219	0.185
8	.	0.15	1	0.08	0.08	0.209	0.271	0.209
9	.	0.15	1	0.08	0.08	0.238	0.271	0.238
10	.	0.15	1	0.08	0.08	0.255	0.271	0.255
11	.	0.15	1	0.08	0.08	0.318	0.271	0.318

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	434988	0.15	0.0388	0.08	0.08	0.029	0.041	0.029
1	.	0.15	0.3061	0.08	0.08	0.030	0.183	0.030
2	.	0.15	0.8283	0.08	0.08	0.046	0.269	0.046
3	.	0.15	0.9814	0.08	0.08	0.072	0.265	0.072
4	.	0.15	0.9983	0.08	0.08	0.102	0.214	0.102
5	.	0.15	0.9998	0.08	0.08	0.135	0.172	0.135
6	.	0.15	1	0.08	0.08	0.159	0.177	0.159
7	.	0.15	1	0.08	0.08	0.185	0.219	0.185
8	.	0.15	1	0.08	0.08	0.209	0.271	0.209
9	.	0.15	1	0.08	0.08	0.238	0.271	0.238
10	.	0.15	1	0.08	0.08	0.255	0.271	0.255
11	.	0.15	1	0.08	0.08	0.318	0.271	0.318

Input units are thousands and kg - output in tonnes

Table 6.8.2. Catch forecast management option table

MFDP version 1a
Run: hom9ast1.run
TestProjection index file horsemackerel9a
Time and date: 11:05 15/09/05
Fbar age range: 1-10

2005				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
119168	90846	1.0000	0.2313	20831

2006					2007	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
117102	93034	0.0000	0.0000	0	140306	115848
.	92858	0.1000	0.0231	2292	137564	113012
.	92683	0.2000	0.0463	4531	134887	110248
.	92508	0.3000	0.0694	6720	132273	107556
.	92333	0.4000	0.0925	8858	129720	104932
.	92159	0.5000	0.1156	10948	127228	102376
.	91985	0.6000	0.1388	12990	124794	99886
.	91811	0.7000	0.1619	14986	122417	97459
.	91638	0.8000	0.1850	16937	120096	95094
.	91465	0.9000	0.2081	18843	117829	92790
.	91292	1.0000	0.2313	20706	115615	90545
.	91120	1.1000	0.2544	22528	113453	88357
.	90948	1.2000	0.2775	24308	111342	86226
.	90777	1.3000	0.3006	26048	109279	84148
.	90605	1.4000	0.3238	27749	107265	82124
.	90434	1.5000	0.3469	29411	105298	80151
.	90264	1.6000	0.3700	31037	103376	78228
.	90093	1.7000	0.3931	32625	101499	76354
.	89923	1.8000	0.4163	34179	99666	74528
.	89754	1.9000	0.4394	35698	97875	72748
.	89585	2.0000	0.4625	37183	96126	71014

Input units are thousands and kg - output in tonnes

Table 6.8.3. Single option prediction detailled tables.

MFDP version 1a
Run: hom9ast1.run
Time and date: 11:05 15/09/05
Fbar age range: 1-10

Year: 2005 F multiplier: 1 Fbar: 0.2313

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0.0412	16331	480	434988	12774	16878	496	16621	488
1	0.1826	76085	2319	489695	14927	149896	4569	145959	4449
2	0.2692	76348	3483	347174	15837	287564	13118	278080	12685
3	0.2654	17370	1249	79973	5749	78485	5642	75920	5457
4	0.2142	24947	2533	138979	14110	138743	14086	134759	13682
5	0.1719	10302	1395	70087	9492	70072	9490	68291	9249
6	0.1772	8395	1335	55547	8835	55547	8835	54112	8606
7	0.2195	6332	1174	34508	6399	34508	6399	33503	6213
8	0.2708	6025	1262	27253	5709	27253	5709	26351	5520
9	0.2708	9664	2301	43717	10410	43717	10410	42269	10065
10	0.2708	3370	861	15246	3893	15246	3893	14741	3764
11	0.2708	7675	2439	34719	11033	34719	11033	33570	10667
Total		262846	20831	1771885	119168	952628	93679	924176	90846

Year: 2006 F multiplier: 1 Fbar: 0.2313

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0.0412	16331	480	434988	12774	16878	496	16621	488
1	0.1826	55820	1702	359269	10951	109972	3352	107084	3264
2	0.2692	77217	3522	351124	16018	290836	13267	281244	12830
3	0.2654	49583	3564	228287	16410	224041	16105	216718	15578
4	0.2142	9475	962	52787	5359	52697	5350	51184	5197
5	0.1719	14194	1922	96559	13077	96540	13074	94085	12742
6	0.1772	7677	1221	50796	8079	50796	8079	49483	7870
7	0.2195	7349	1363	40046	7426	40046	7426	38879	7210
8	0.2708	5272	1104	23848	4996	23848	4996	23059	4830
9	0.2708	3955	942	17892	4260	17892	4260	17299	4119
10	0.2708	6345	1620	28700	7329	28700	7329	27750	7086
11	0.2708	7251	2304	32802	10423	32802	10423	31716	10078
Total		260469	20706	1717096	117102	985046	94157	955122	91292

Year: 2007 F multiplier: 1 Fbar: 0.2313

Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0.0412	16331	480	434988	12774	16878	496	16621	488
1	0.1826	55820	1702	359269	10951	109972	3352	107084	3264
2	0.2692	56651	2584	257605	11751	213374	9734	206337	9413
3	0.2654	50147	3605	230885	16597	226590	16288	219183	15755
4	0.2142	27048	2746	150683	15299	150427	15273	146108	14834
5	0.1719	5391	730	36675	4967	36668	4966	35735	4840
6	0.1772	10577	1682	69982	11130	69982	11130	68173	10843
7	0.2195	6720	1246	36620	6791	36620	6791	35554	6593
8	0.2708	6118	1282	27675	5797	27675	5797	26759	5605
9	0.2708	3461	824	15656	3728	15656	3728	15138	3605
10	0.2708	2597	663	11746	2999	11746	2999	11357	2900
11	0.2708	8926	2836	40376	12830	40376	12830	39039	12405
Total		249787	20380	1672159	115615	955963	93384	927089	90545

Input units are thousands and kg - output in tonnes

Table 6.9.1. Yield per recruit results

MFYPR version 2a
Run: hom9apr1.run
Time and date: 11:14 15/09/05
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	7.1792	1.0044	5.4806	0.9512	5.4153	0.9399
0.1000	0.0231	0.1193	0.0176	6.3858	0.8054	4.6932	0.7525	4.6285	0.7420
0.2000	0.0463	0.2088	0.0282	5.7905	0.6643	4.1037	0.6116	4.0395	0.6019
0.3000	0.0694	0.2789	0.0346	5.3252	0.5601	3.6441	0.5076	3.5805	0.4986
0.4000	0.0925	0.3353	0.0385	4.9504	0.4806	3.2749	0.4284	3.2118	0.4201
0.5000	0.1156	0.3819	0.0407	4.6412	0.4186	2.9712	0.3666	2.9087	0.3588
0.6000	0.1388	0.4212	0.0420	4.3814	0.3691	2.7168	0.3173	2.6548	0.3100
0.7000	0.1619	0.4547	0.0425	4.1597	0.3290	2.5005	0.2774	2.4390	0.2705
0.8000	0.1850	0.4836	0.0426	3.9681	0.2959	2.3142	0.2446	2.2532	0.2381
0.9000	0.2081	0.5089	0.0424	3.8009	0.2684	2.1522	0.2173	2.0916	0.2112
1.0000	0.2313	0.5313	0.0421	3.6536	0.2453	2.0099	0.1944	1.9498	0.1886
1.1000	0.2544	0.5511	0.0416	3.5229	0.2256	1.8842	0.1749	1.8245	0.1693
1.2000	0.2775	0.5689	0.0410	3.4060	0.2087	1.7722	0.1582	1.7130	0.1529
1.3000	0.3006	0.5848	0.0404	3.3009	0.1941	1.6720	0.1438	1.6132	0.1388
1.4000	0.3238	0.5993	0.0398	3.2060	0.1815	1.5818	0.1313	1.5234	0.1265
1.5000	0.3469	0.6125	0.0392	3.1197	0.1704	1.5002	0.1204	1.4422	0.1158
1.6000	0.3700	0.6245	0.0386	3.0411	0.1606	1.4262	0.1108	1.3686	0.1064
1.7000	0.3931	0.6355	0.0380	2.9691	0.1520	1.3587	0.1024	1.3015	0.0981
1.8000	0.4163	0.6456	0.0375	2.9029	0.1443	1.2970	0.0949	1.2401	0.0907
1.9000	0.4394	0.6550	0.0369	2.8419	0.1374	1.2404	0.0882	1.1839	0.0842
2.0000	0.4625	0.6637	0.0364	2.7854	0.1313	1.1883	0.0822	1.1321	0.0783

Reference point	F multiplier	Absolute F
Fbar(1-10)	1.0000	0.2313
FMax	0.7819	0.1808
F0.1	0.4484	0.1037
F35%SPR	0.5585	0.1292

Weights in kilograms

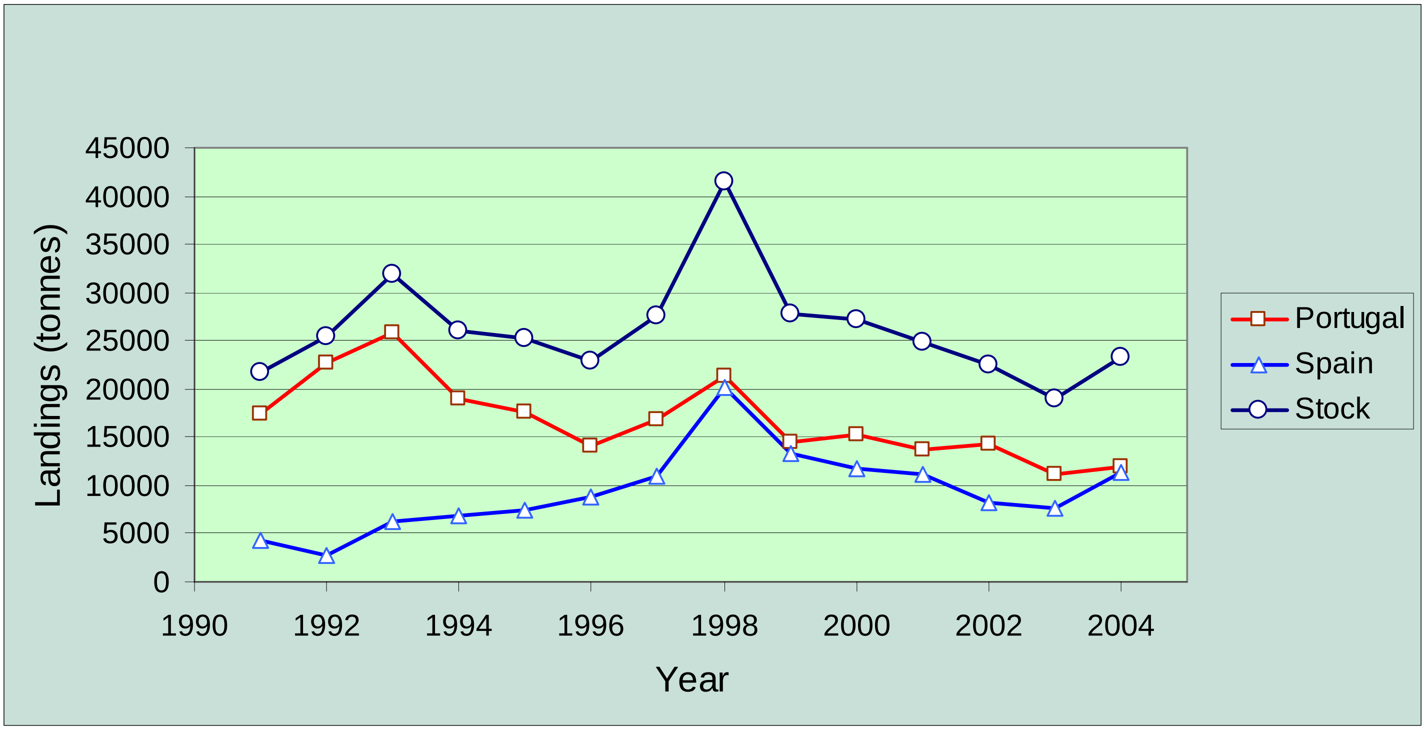


Figure 6.2.1. Time series of the total southern horse mackerel catches, with information of the catches by country, for the period 1991-2004 (not including catches from the Gulf of Cádiz).

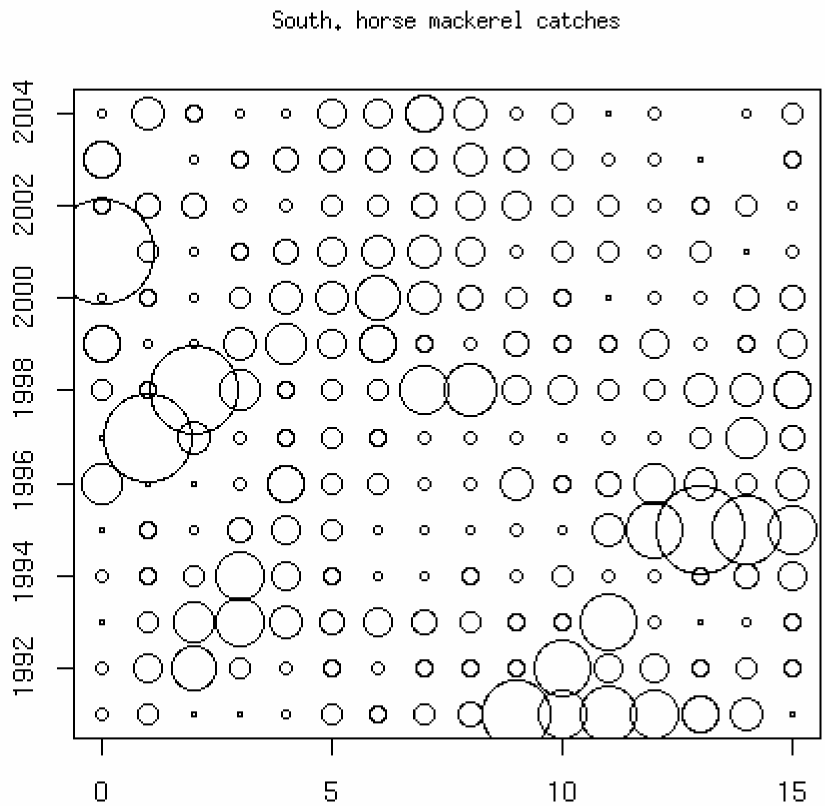


Figure 6.3.1.1 Proportion of catches by year in each age, from souther hors mackerel stock commercial catches.

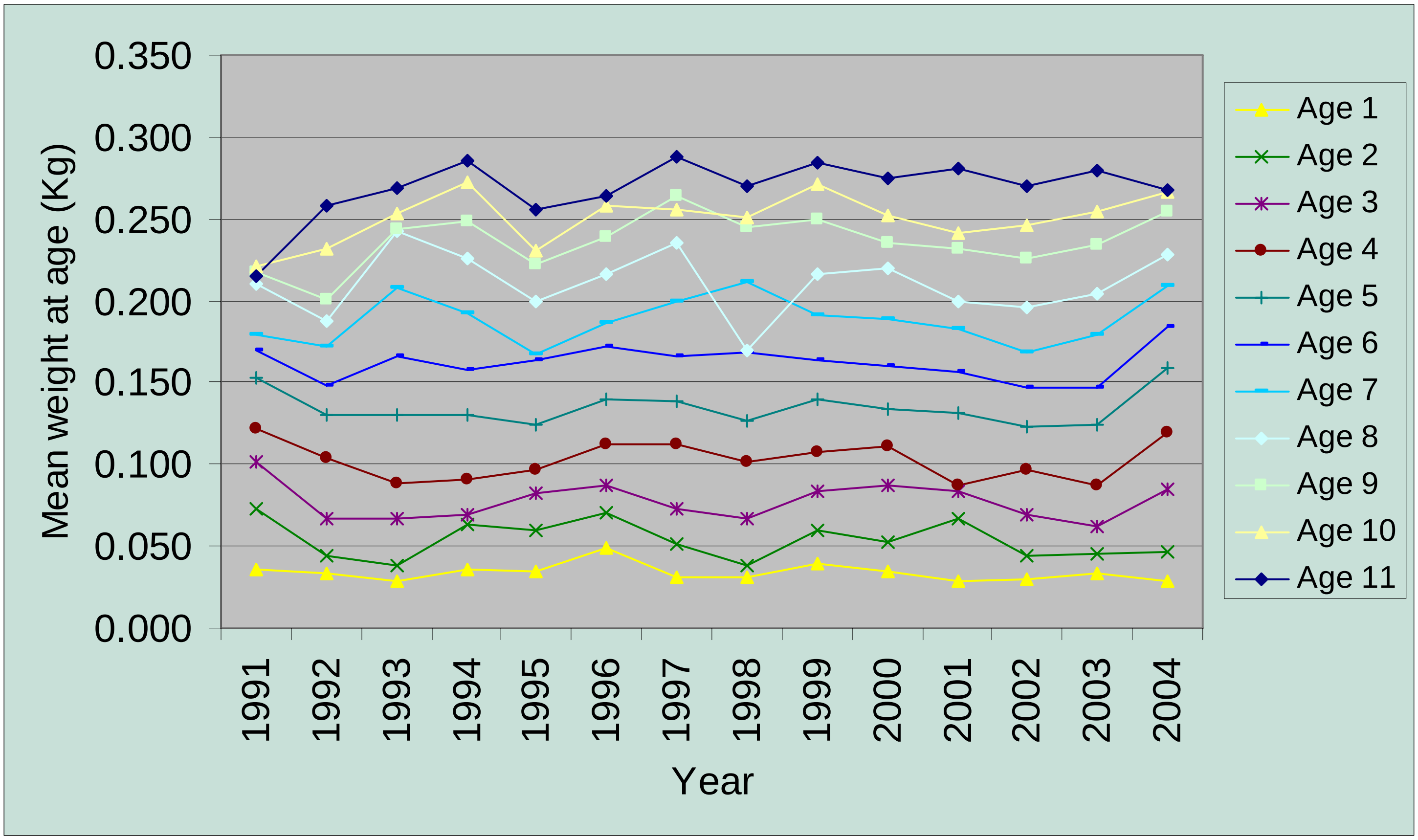


Figure 6.3.2.1. Time series of the southern horse mackerel mean weight at age in the catch.

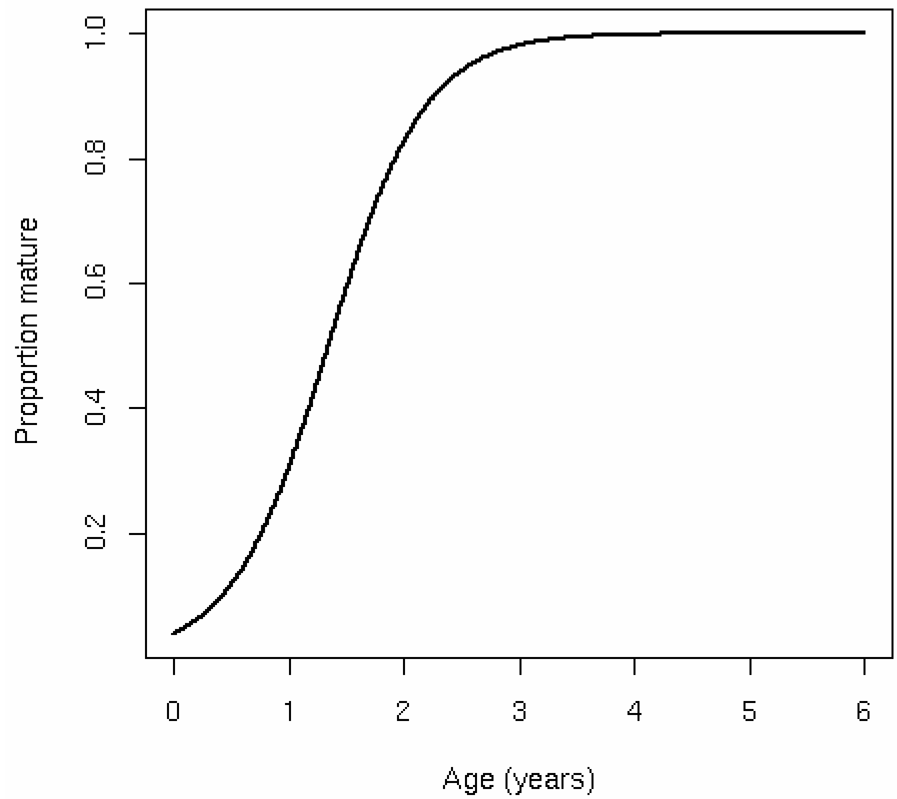


Figure 6.3.3.1. Maturity ogive adopted for southern horse mackerel stock during the assessment period.

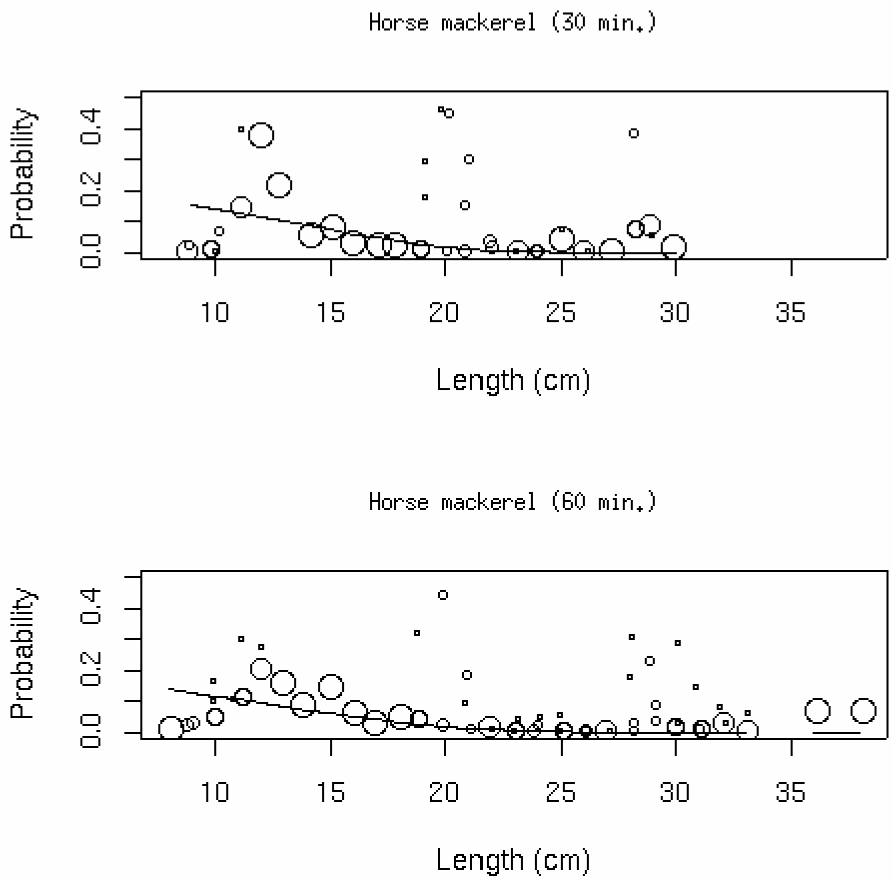


Figure 6.4.1.1. Comparison of horse mackerel length distributions from different haul duration (30' and 60') carried out in the october Portuguese bottom trawl survey.

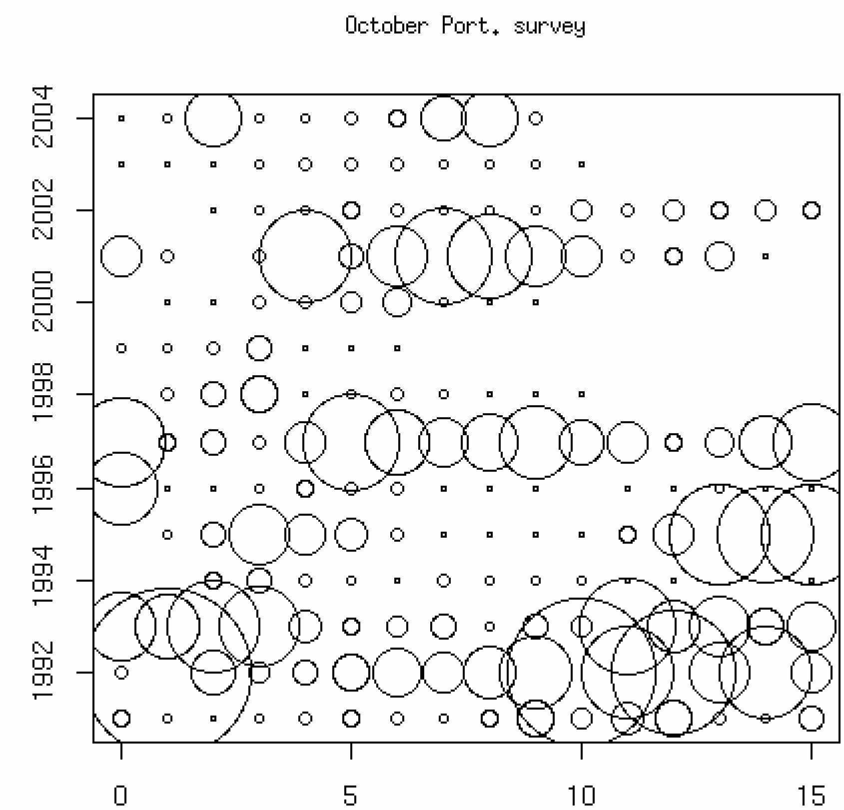


Figure. 6.4.1.2. Proportion of catches by year in each age, from October Portuguese bottrom trawl survey.

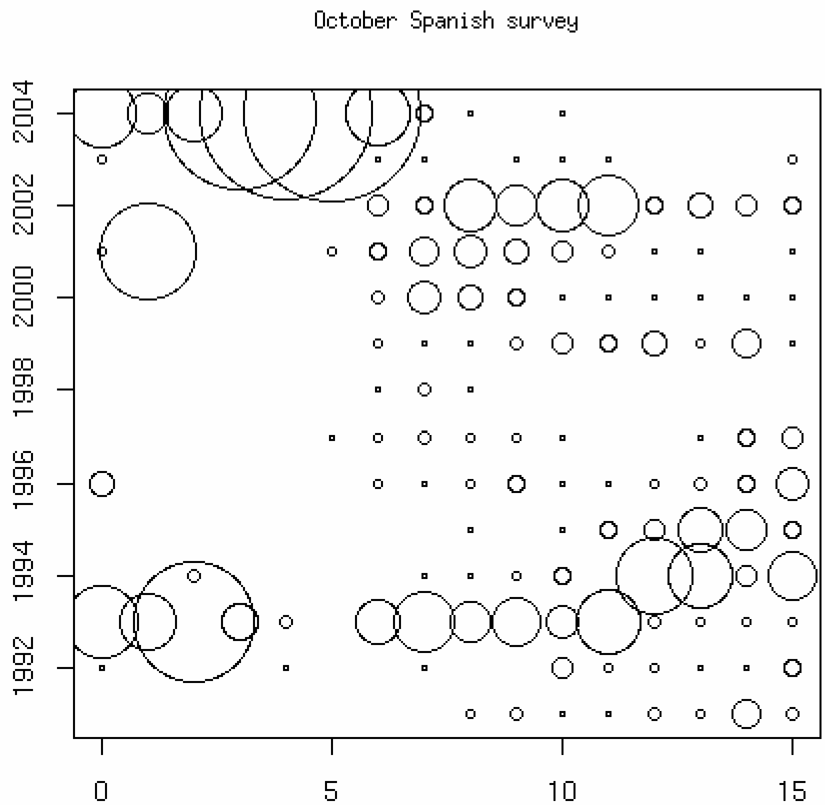


Figure 6.4.1.3. Proportion of catches by year in each age, from September-October Spanish bottrom trawl survey

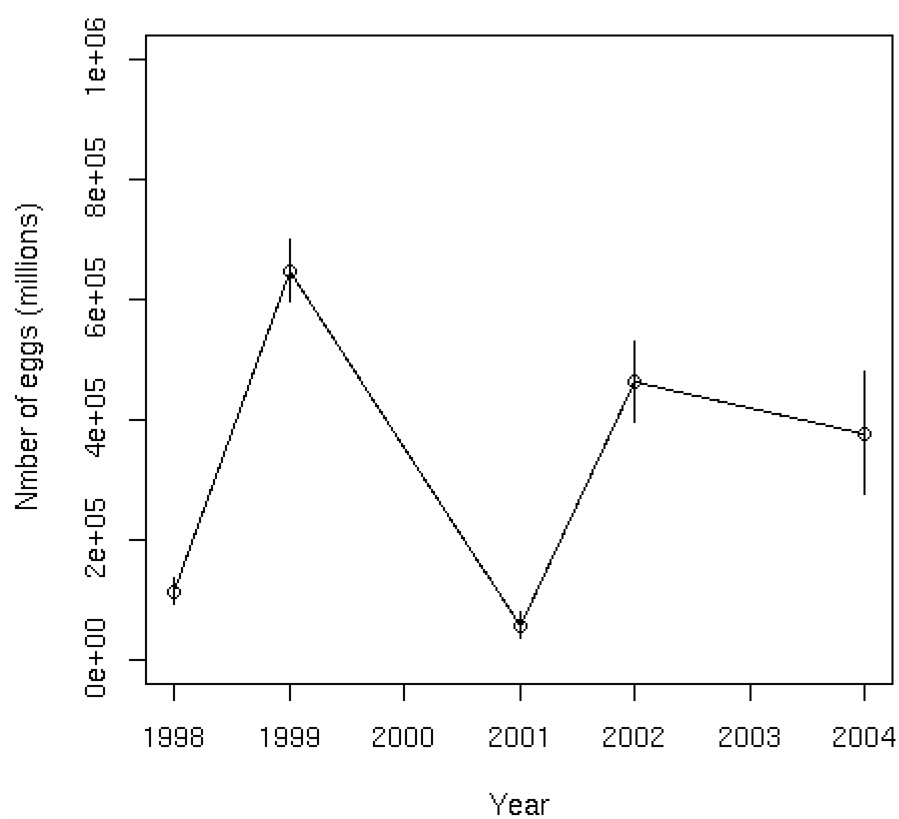


Figure 6.4.2.1. Time series of the horse mackerel egg production in Division IXa.

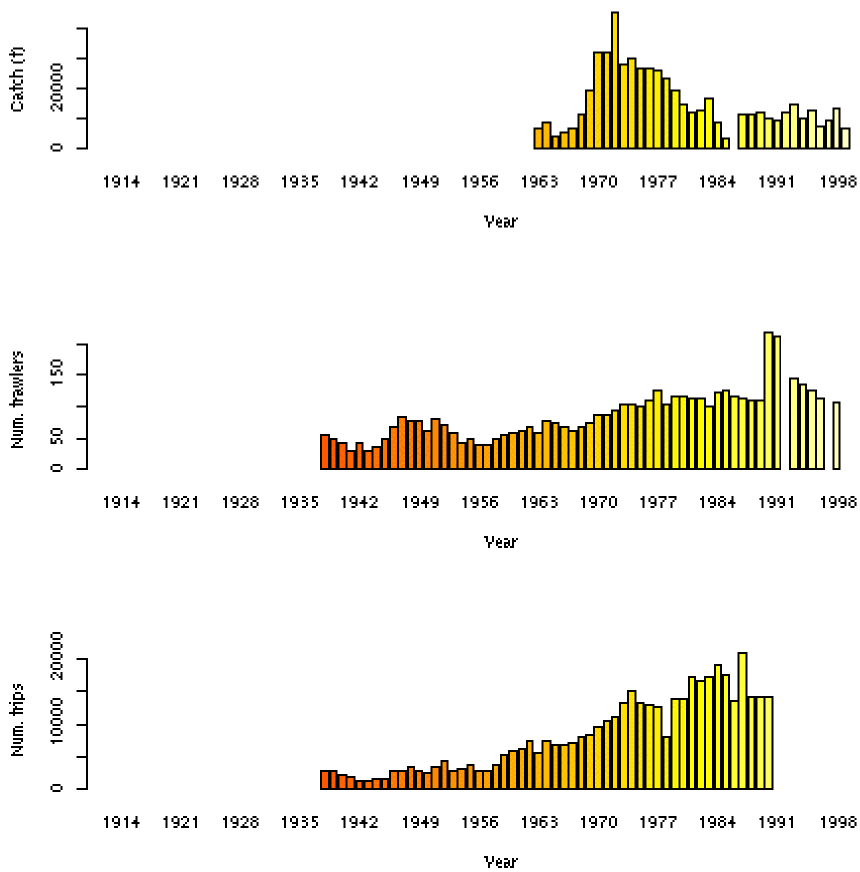


Figure 6.5.1. Time series of catch and effort from Portuguese bottom trawlers operating in Division IXa (Southern stock).

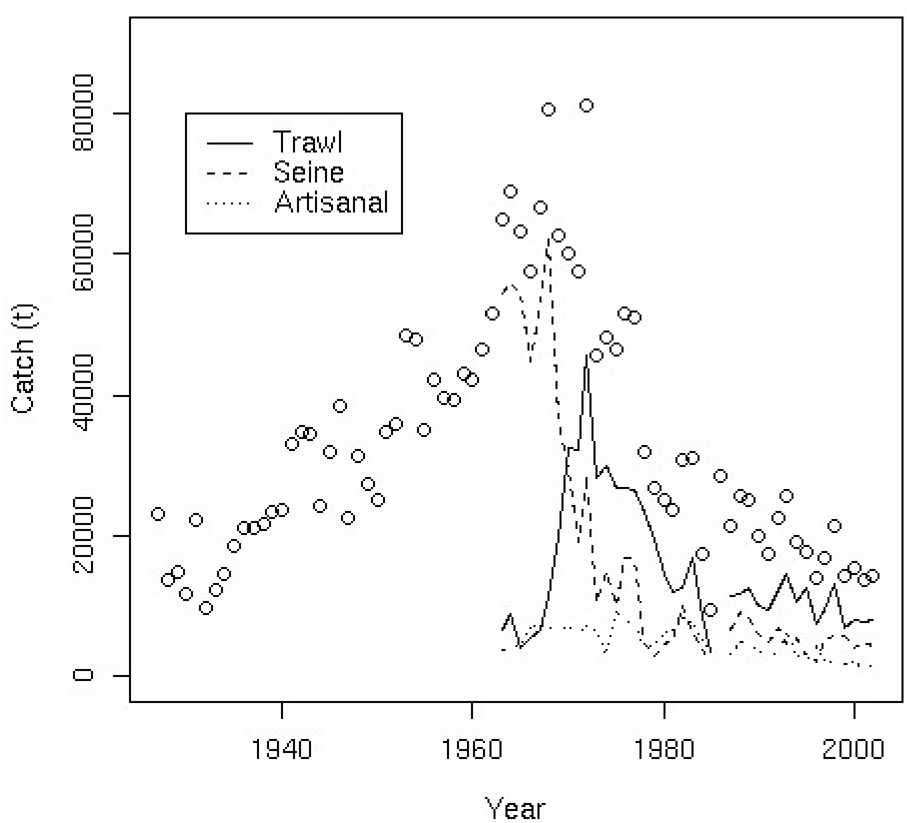


Figure 6.5.2. Time series of the Portuguese catches of horse mackerel in Division IXa: total and by fishing gear

Figure 6.5.3. 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.

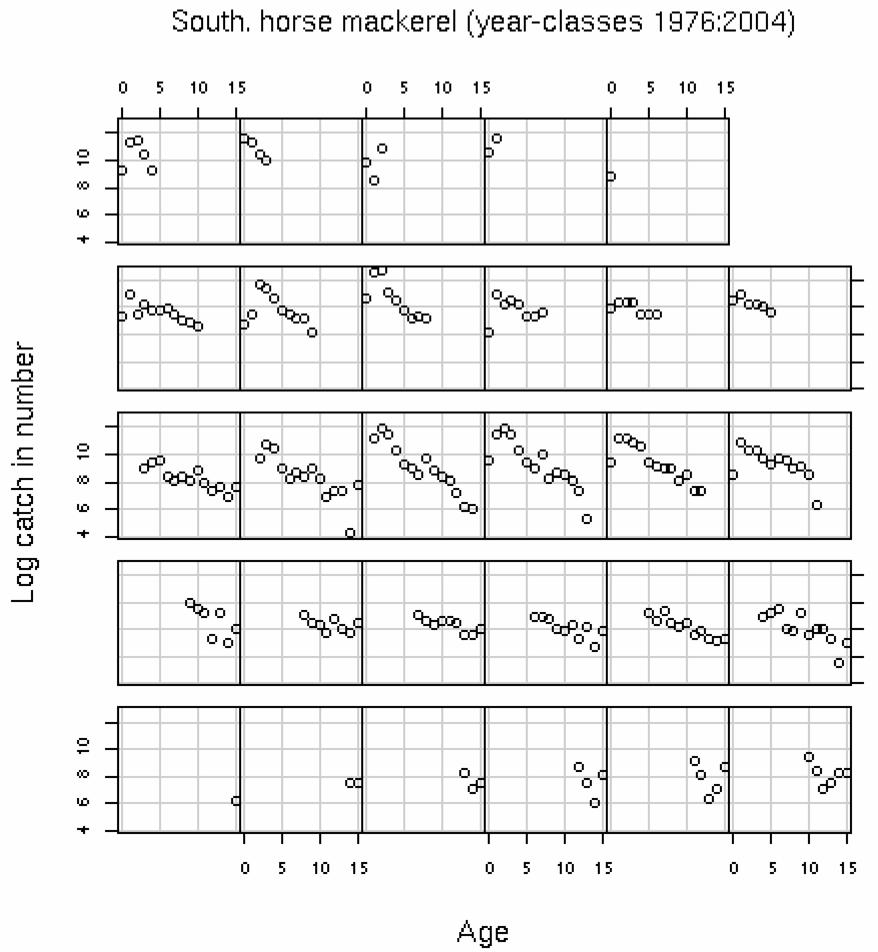
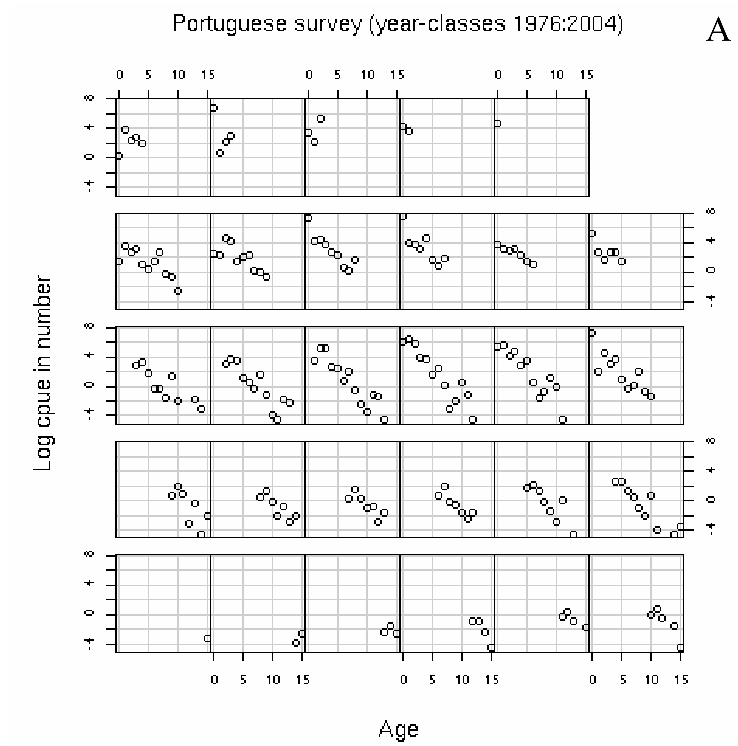


Figure 6.7.1.1. Logarithm of the catch in numbers of each year class in the Southern horse mackerel catches.



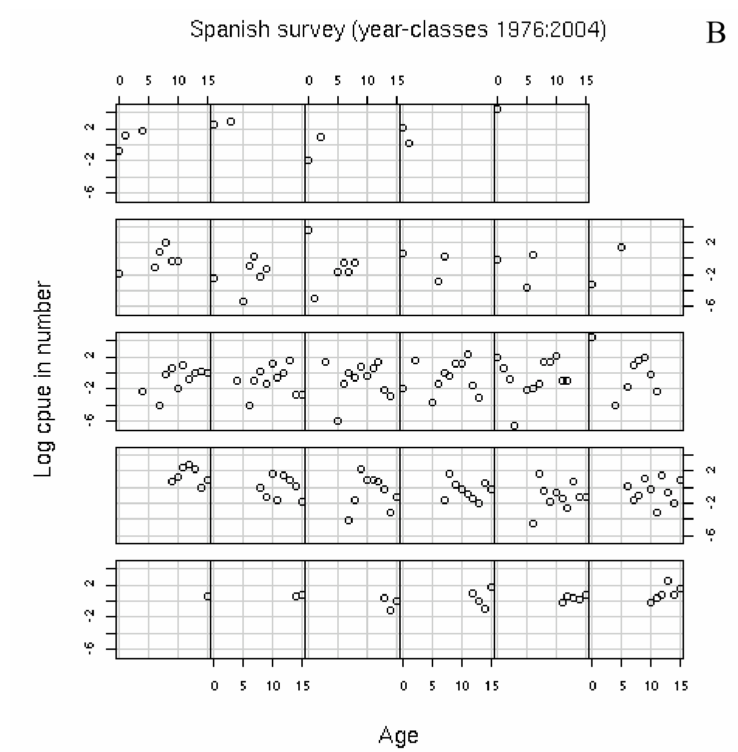


Figure 6.7.1.2 (a,b). Logarithm of the catch in numbers of each yearclass in the October Portuguese bottom trawl survey (upper panel, a) and in the Sept-October Spanish bottom trawl survey (b).

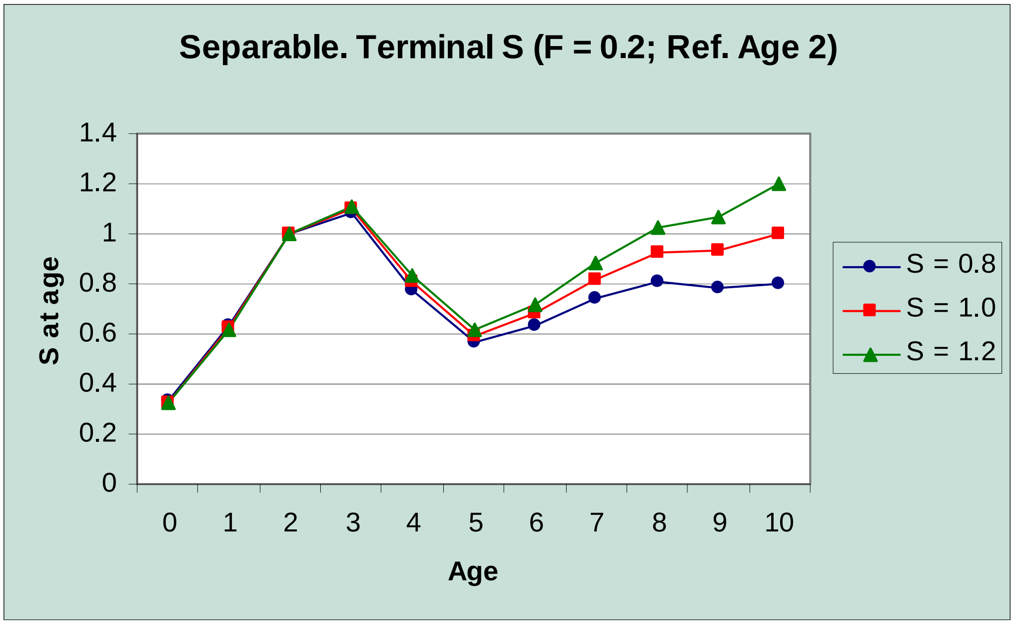


Figure 6.7.1.3. Southern horse mackerel selection pattern from separable analysis for different terminal S.

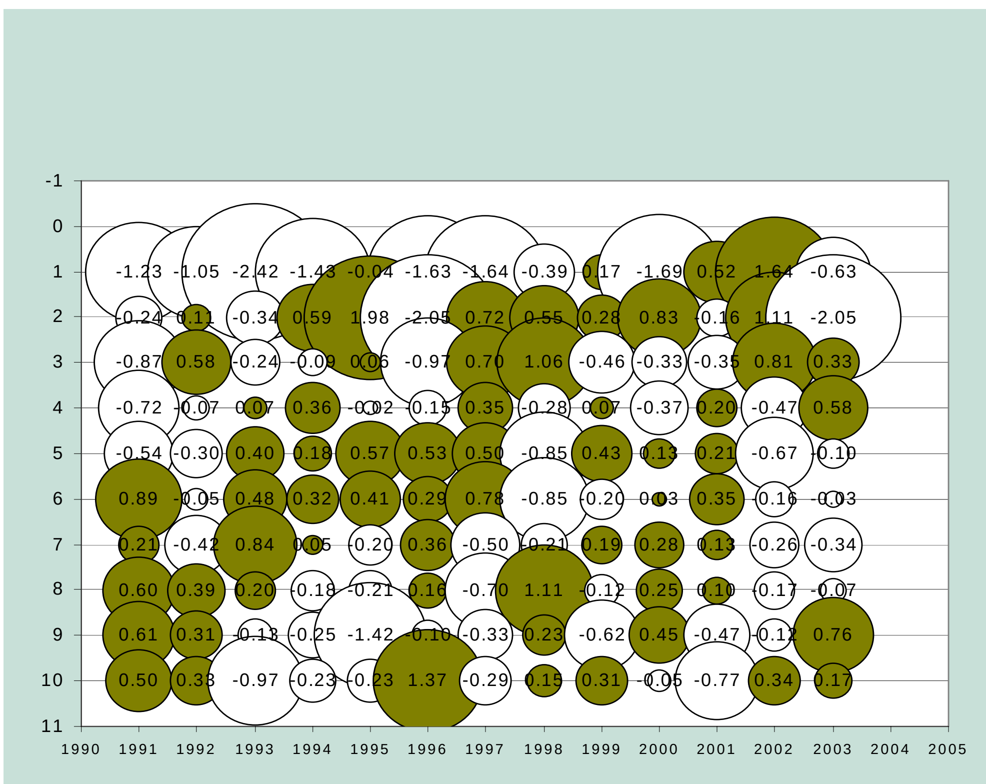


Figure 6.7.1.4. Pattern of residuals from separable analysis. Terminal F = 0.2 and terminal S = 1.

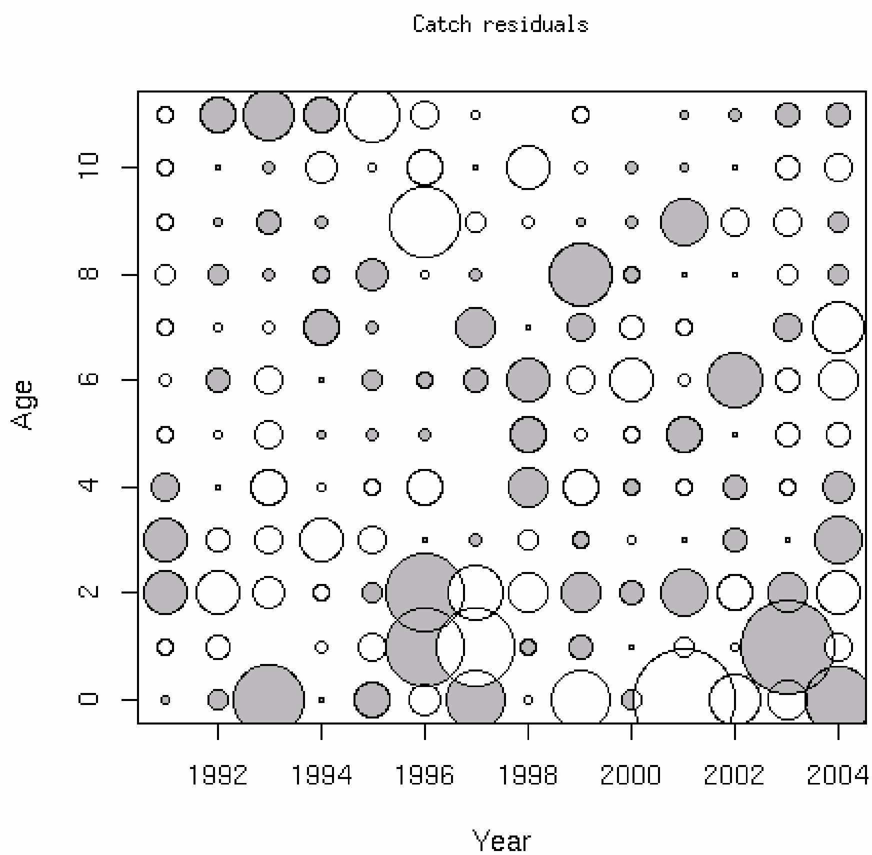
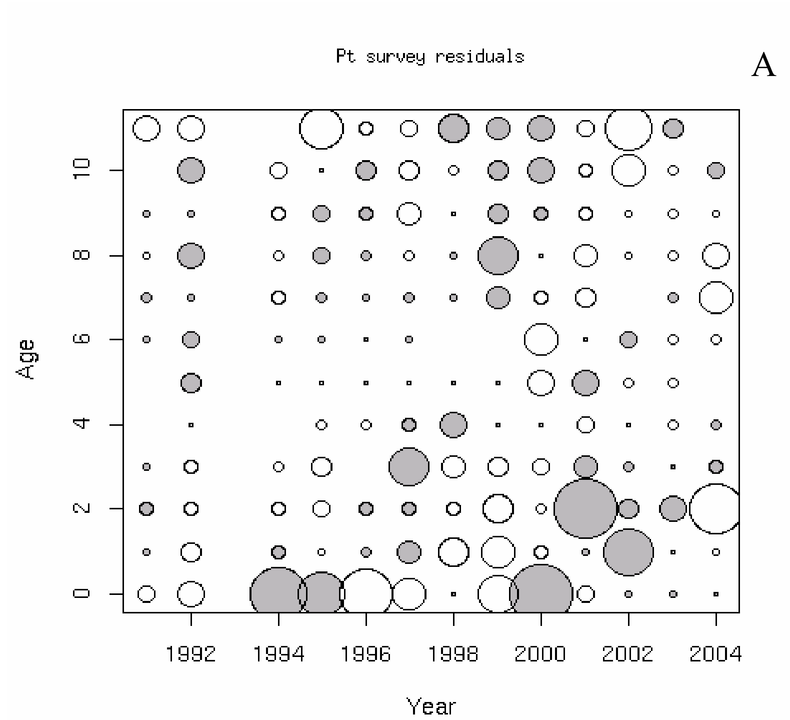


Figure 6.7.1.5. Pattern of catch residuals from AMCI assessment model



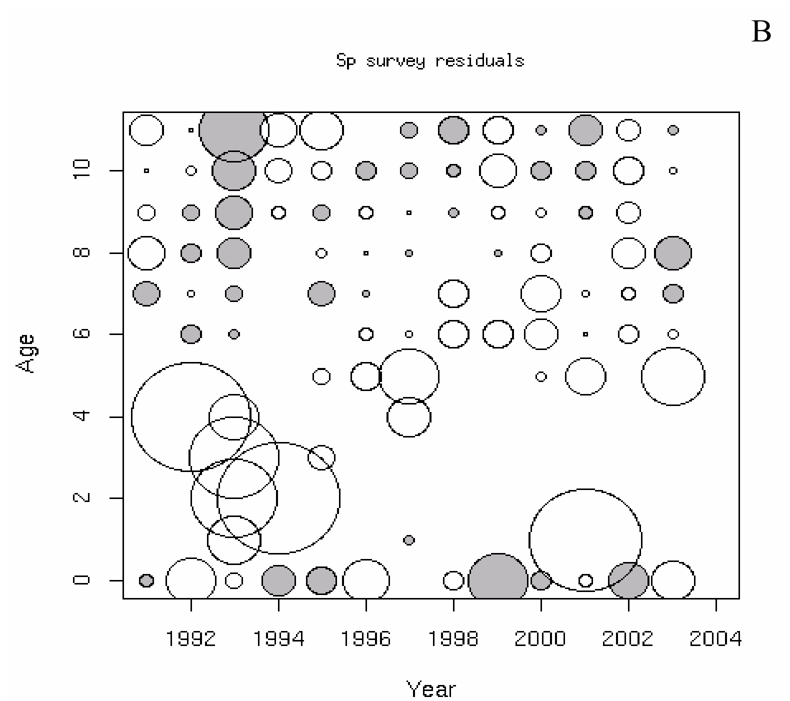


Figure 6.7.1.6(a.b). Catchability residuals from the October Portuguese bottom trawl survey (upper panel = a) and Spanish Sept-October bottom trawl survey (b).

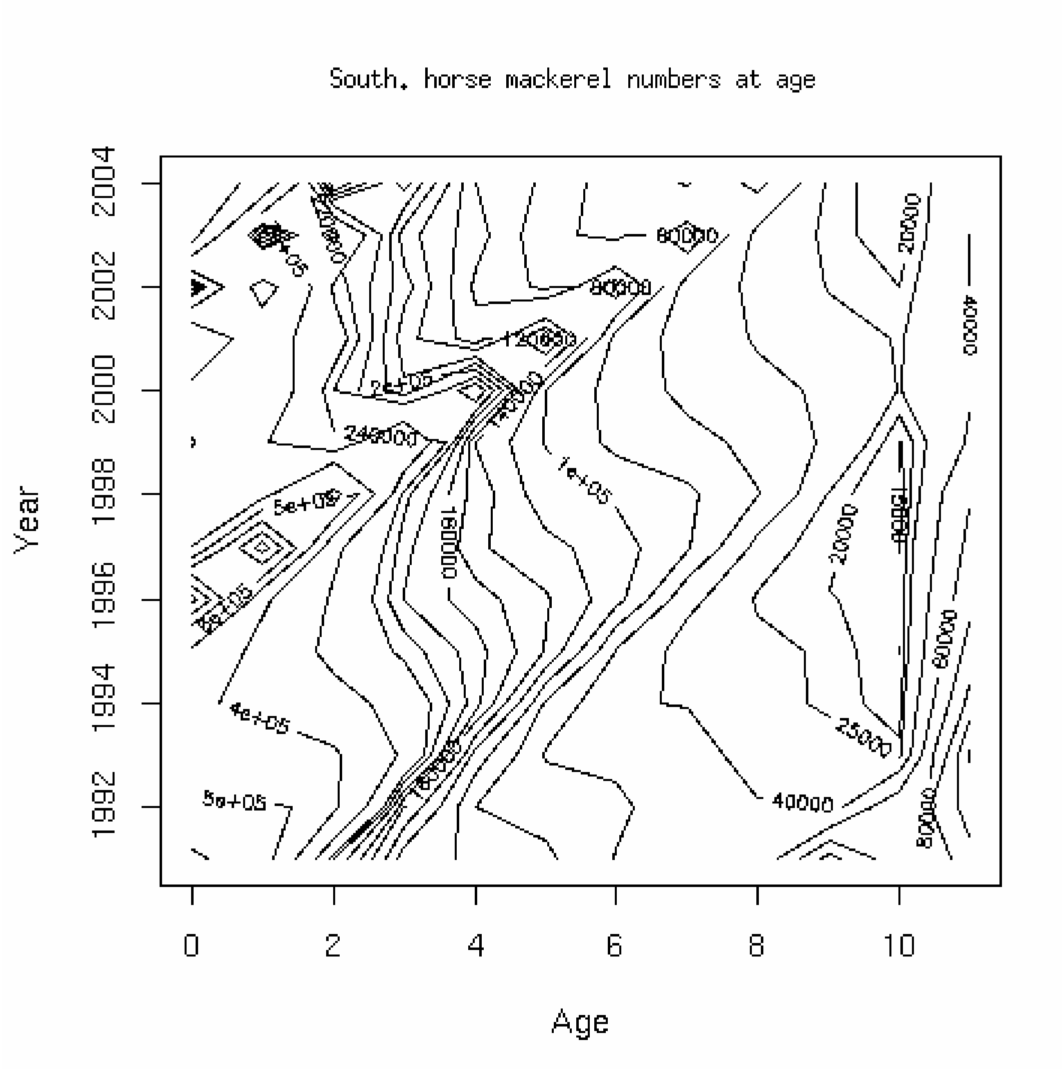
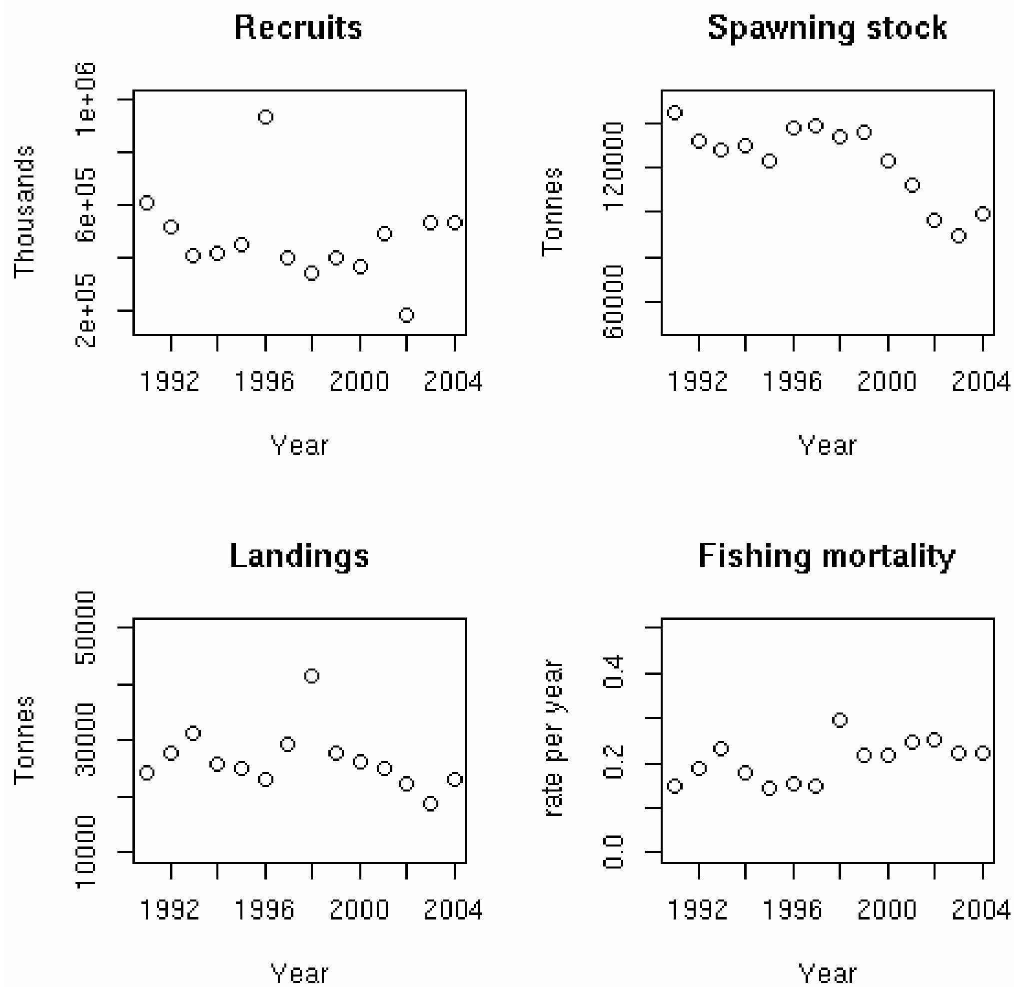


Figure 6.7.2.1. Contour plot of stock numbers at age from the AMCI assessment model.



Figures 6.7.2.2. Summary results from AMCI assessment model.

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 last year WG. Given the quality of the data presented and the high sardine biomass in the area, a dedicated section to catch and survey data in areas VIIIa and VIIIb is now included in this year's WG report.

7.1.1 Catches for sardine in the ICES area

Commercial catch data for 2004 was provided by Portugal, Spain, France, Ireland, UK (England and Wales) and Germany (Table 7.1.1.1). Total reported catch was 110 833 t, divided as follows: 48% of the catches by Portugal, 31% by Spain and 16% by France. The remaining 5% catches are reported for division VIIa-j by Ireland, England and Wales and Germany and in division VIIIab by Ireland. Catches in the VIIIc and IXa amount to 80% 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. There is a small 8% reduction of total 2003 sardine catches in European waters, with a 16 % reduction in Portuguese catches and a small 12% increase in Spanish waters. Catches from Ireland were not provided for 2003 and 2004 Irish catches amount to 2% of the total catches.

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

7.2.1 Catch data in areas VIIIa and VIIIb

An update of the French catch data series in Divisions VIIIa and VIIIb (from 1983) including 2004 catches was presented to this year WG (Table 7.2.1.1). Catches have increased along the series, with values ranging from 4 367 t in 1983 to 15 494 t in 2003 with a small decrease of landings between 2003 and 2004 (from 15 500 to 13 855 t).

The main fishery takes place in the north part of the Bay of Biscay (VIIIa – 13 850 t). A total of 82% of the catches are taken by purse seiners while the remaining 18% is reported by pelagic trawlers (mainly pair trawlers). A substantial part of the French catches originates in division VIIh (about 3 700 t in 2004), but these catches have been assigned to division VIIIa due to their very limited location at the boundary between VIIIa and VIIe.

There are also important landings (about 4 600 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.

7.2.2 Acoustic survey in areas VIIIa and VIIIb

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 2005 survey (PELGAS05) took place from the 3 May to 1 June on board the RV “Thalassa”. The objectives, methodology employed and sampling strategy are described in section 10.4.2.

During PELGAS05, sardine was present all over the Bay of Biscay (Figure 7.2.2.1). It appeared usually as small dense schools in mid-water, mostly between the coast and 100m depth, often mixed with sprat (*Sprattus sprattus*), except in front of the Loire river plume. In more offshore areas and mainly in the centre of the Bay of Biscay, sardine was sometimes observed as small echoes, mixed with mackerel and horse mackerel in a layer between the bottom and 50m above, but mainly as small echotraces between the surface and 30m below, mixed with mackerel. In the northern offshore area, sardine was mainly observed at the surface and always mixed in the catches with mackerel. It should be noted that for this last area, a reduced number of fishing stations were sampled at the surface and therefore the corresponding estimated biomass must be taken with caution.

The calculated biomass for each strata is listed below:

Adour	**Gironde**	**offshore**	**North coastal**	**North offshore**	Total
41 358 t	88 520 t	154 052 t	12 573 t	133 018 t	**429 521 t**

Length distributions and age distributions have been calculated for areas VIIIa and VIIIb in 2005 and are shown in Figure 7.2.2.2 and Figure 7.2.2.3. The length distribution for the whole time series (all 6 years combined) is shown in Figure 7.2.2.4.

Survey data from 2000 to 2004 were used to analyse whether sardine show a preferential distribution in relation to bottom depth and/or latitude. For this analysis, four strata were considered; north or south of latitude 46°N (separating VIIIa and VIIIb) and bottom depths deeper or shallower than 110m. Sardine length distributions are plotted as the proportion of small (< 18.5 cm) or big (larger than 18.5 cm) fish on the samples over the years (Figure 7.2.2.5.). This division was chosen to take into account the bimodal structure of sardine length distributions (usually with a “valley” at 18.5 cm fish length). Age distributions for the same geographic strata are shown in Figure 7.2.2.6. Small fish (mainly 1 year old) are generally found close to the coast and preferentially in the southern part. The year 2003 is different to the others but this year was totally atypical for all species and sardine was rather absent of the Bay of Biscay at the time of the survey.

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.

7.3 Stock identification, distribution and migration in relation to oceanographic effects

As stated in last year WG report, identification of the limits of the stock, as well as estimates of migration intensity across the stock boundaries and between stock units are important unresolved issues for the understanding of the sardine population in the ICES area. Results from the ongoing project SARDYN, as well as work carried out by SGRESP and objectives of the newly created WGACEGGS are expected to provide new information.

During this year WG, a presentation of ongoing results in identification of sardine main spawning areas along the North East Atlantic area, as well as changes of spawning distribution and intensity in the time series was presented. Final results from this ongoing work are to be presented in WGACEGGS and in the final report of SARDYN, and thus it is expected that they will be available for next year sardine benchmark assessment. An example of spawning areas distribution based on egg presence probability for two years, as well as mean egg probability fields from all analysed surveys are shown in Figures 7.3.3.1 and 7.3.3.2, and an analysis of spawning preferences in relation to distance along the 100m contour depth is shown in Figure 7.3.3.3 Figure 7.3.3.1a shows the spawning situation from late 1980's - early 1990's, when spawning along the northern Iberian coast, as well as along most of Portuguese western coast was intense, while Figure 7.3.3.1b shows the spawning situation from early 00's, when spawning in the North-West Iberian corner disappeared and spawning in both the southern limit and the northern limit (and northwards) of the stock was intense. Discontinuities in spawning grounds are consistently found in the time series near the Spanish-Portuguese northern frontier. This is shown both in the low mean probabilities of egg presence in the region (Figure 7.3.3.2) and in the significant spawning avoidance of that area, shown in the spawning preference analysis in relation to distance along the 100m contour depth (Figure 7.3.3.3). On the other hand, spawning grounds does not show a continuous discontinuity through the limits of areas VIIIc and VIIIb, suggesting that the degree of mixing between fish in those areas may be large.

Collection and analysis of data performed within the SARDYN project, as well as in the SGRESP are also expected to provide results in relation to stock identification, distribution and migration for next year benchmark assessment.

7.4 Future of assessment and management of sardine outside the main stock area.

The amount and quality of the data from Divisions VIIIa and VIIIb has largely improved in the last couple of years. Estimates from the acoustic survey have confirmed the existence of an area of large sardine biomass level, subject to increasing catch levels. This biomass and the possible scenario of continuous increasing catches in the area make assessment of this sardine population component possible. Nevertheless, various issues should be taken into account before a routine assessment can be performed. First, as stated in section 7.3 above, the migration intensity between Divisions VIIIa and VIIIb and the actually assessed stock is unknown. Different assessment scenarios should then be considered; an independent assessment from the actual stock area, with corrections for migration intensity across the southern (and maybe northern) border, or a combined assessment with the actual stock. In the latter case, additional difficulties on how to use survey series and biological data series with different temporal coverage (for the areas inside or outside the actual assessed stock) would need to be considered. Standardisation of biological data acquisition should also be ensured. Standardisation of survey data acquisition and analysis has been attempted through different projects (e.g. PELASSES) and will be monitored by WGACEGGS. Different assessment methods and/or different areas from those defined by ICES (coastal and oceanic components) may be considered.

The decision on whether this component of sardine in ICES areas should be assessed does not directly depend on this WG. Nevertheless, in anticipation of such a request the WG recommends that data from areas VIIIa and VIIIb continue to be collected in a way that could be used for an assessment. In order to do that, a complete description of the fishery would be required, as well as an evaluation of the characteristics of the population (distribution, age/length composition, possible migration patterns) from the survey and catch data. Also, results of the SARDYN project may improve the range of assessment models available for this species, as well as the knowledge on sardine migration patterns and distribution.

Table 7.1.1.1: Sardine-general: commercial catch data from the ICES area, available to the Working Group. Unit Tonnes

Divisions	Germany	UK (Engl&Wal)	Ireland	France	Spain	Portugal	Total
IVc							0
VIIa			445				445
VIIb			173				173
VIIc							0
VIId	1	84*		4605			4606
VIIe	10	2128	128	3697			5963
VIIf							0
VIIg			279				279
VIIh	49	22					71
VIIi							0
VIIj			18				18
VIIIa			535	10115			10650
VIIIb			877	43	342		1262
VIIIc					18306		18306
IXaN					8573		8573
IXaCN						26 864	26864
IXaCS						21 590	21590
IXaS-Alg						7 377	7377
IXaS-Cad					9176		9176
Total	60	2150	2455	18460	36397	55831	115353

* about 5% of these catches from France were carried out along the divisions IVb and IVc.

Table 7.2.1.1: Sardine-general: French landings in ICES Divisions VIIIa+VIIIb (1983-2004)

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	15494
2004	13855

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
3.5					
4					
4.5					
5					
5.5					
6					
6.5					
7					
7.5					
8					
8.5					
9					
9.5					
10	2	86			88
10.5	7	257	172	64	500
11	26	1 028	401	150	1 605
11.5	48	1 884	803	300	3 035
12	37	2 250	1 491	375	4 154
12.5	35	4 305	3 086	716	8 142
13	24	6 970	4 543	568	12 106
13.5	35	6 945	4 382	433	11 795
14	10	5 992	3 753	316	10 071
14.5	9	4 561	2 643	296	7 509
15	4	3 177	1 882	283	5 347
15.5	4	1 655	818	206	2 683
16	4	1 543	864	136	2 546
16.5	6	2 014	1 074	128	3 223
17	43	1 599	1 734	284	3 660
17.5	136	692	1 197	755	2 780
18	422	601	914	3 004	4 941
18.5	957	506	254	4 715	6 432
19	1 511	1 997	552	4 164	8 224
19.5	1 721	3 466	1 117	3 175	9 480
20	1 128	4 479	5 710	2 524	13 841
20.5	669	4 961	15 456	1 740	22 826
21	516	4 357	25 107	2 453	32 432
21.5	535	3 254	13 853	2 866	20 509
22	593	2 071	5 970	2 495	11 129
22.5	382	913	1 952	1 212	4 459
23	249	848	1 987	699	3 782
23.5	287	440	1 485	342	2 555
24	153	369	167	114	804
24.5	38	138		114	291
25	57	130			187
25.5		23			23
26	19				19
26.5					
27					
27.5					
28					
28.5					
29					
29.5					
30					
30.5					
31					
TOTAL numbers	9 668	73 512	103 368	34 627	221 174

Official Catch (t)	722	3 386	7 312	2 436	**13 856**

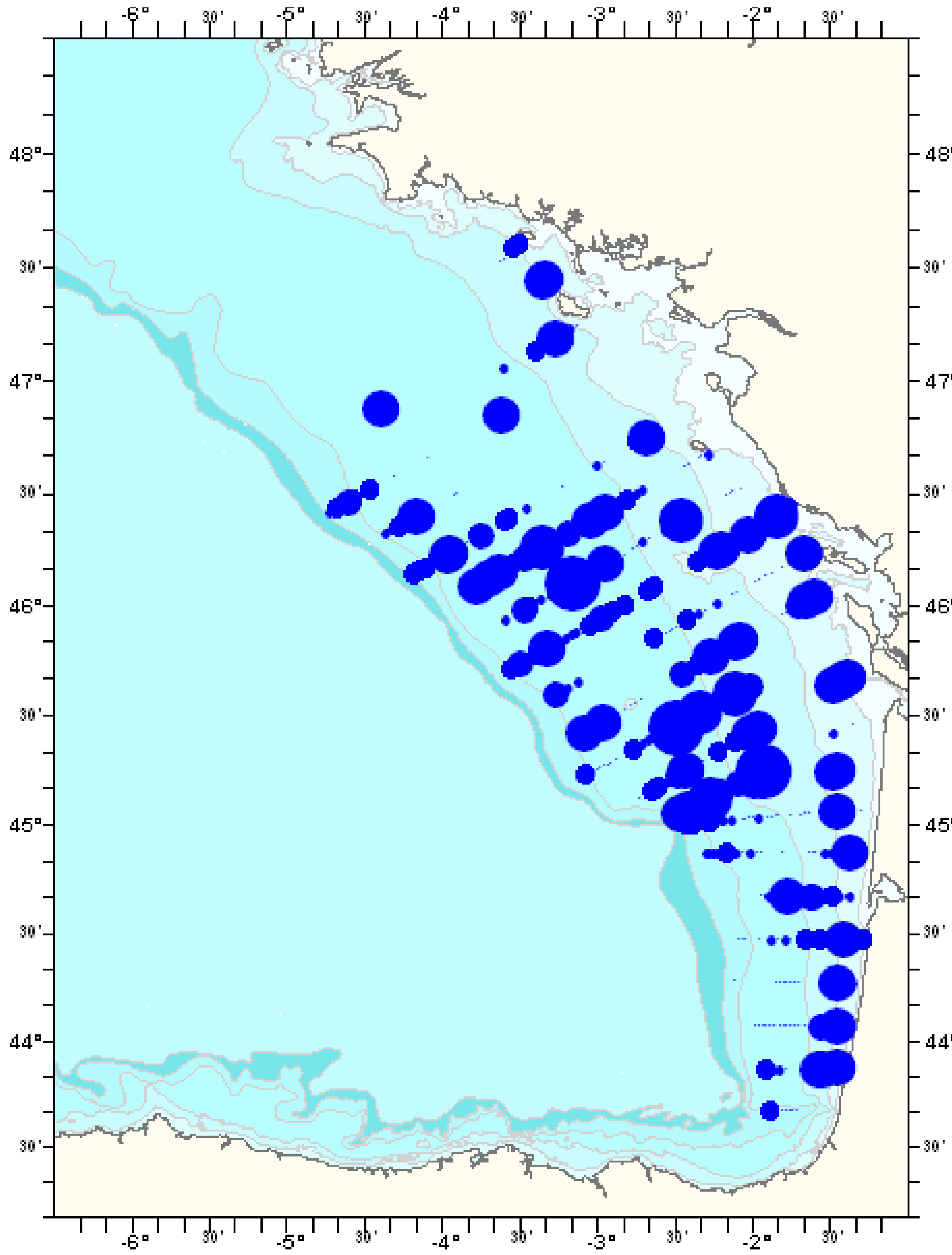


Figure 7.2.2.1: Distribution of sardine as observed during the acoustic survey PELGAS05. Sardine is predominant in the central offshore area, mainly close to the surface and all along the coast except in front of Loire river plume. The north west area was not surveyed this year.

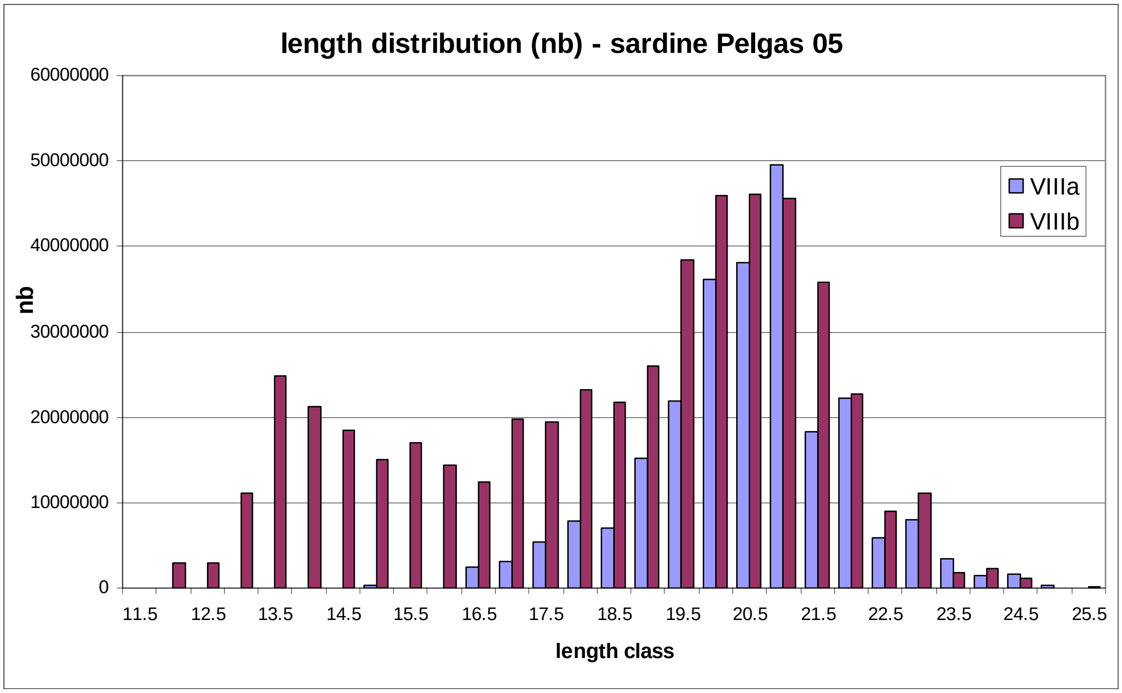


Figure 7.2.2.2: Length distribution of sardine in numbers of fish as observed during the acoustic survey PELGAS05 separated for divisions VIIIa and VIIIb.

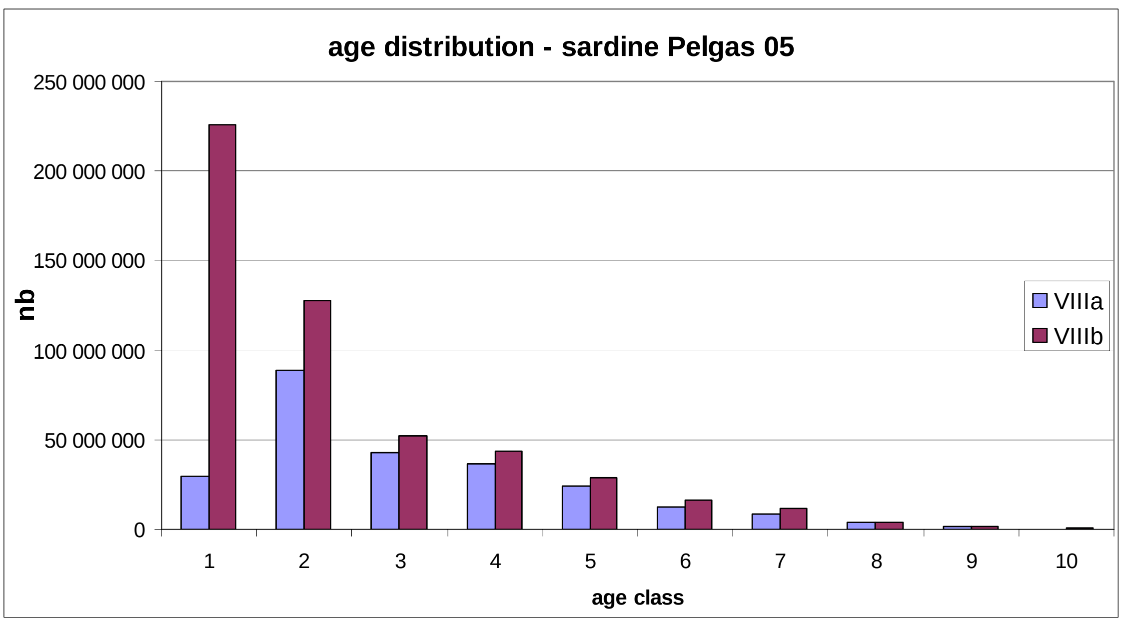


Figure 7.2.2.3: Age distribution of sardine in numbers of fish as observed during the acoustic survey PELGAS05 separated for divisions VIIIa and VIIIb.

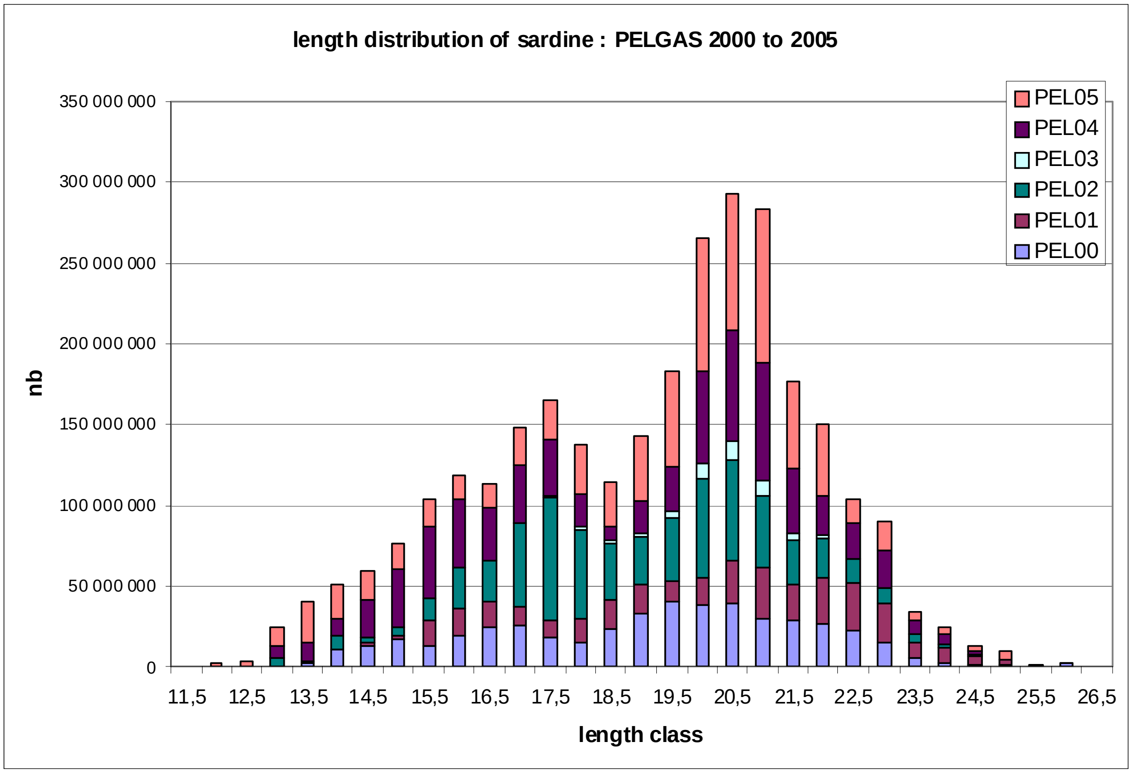


Figure 7.2.2.4: Cumulated length distribution in numbers of fish observed in the Bay of Biscay during acoustic surveys PELGAS 2000 – 2005.

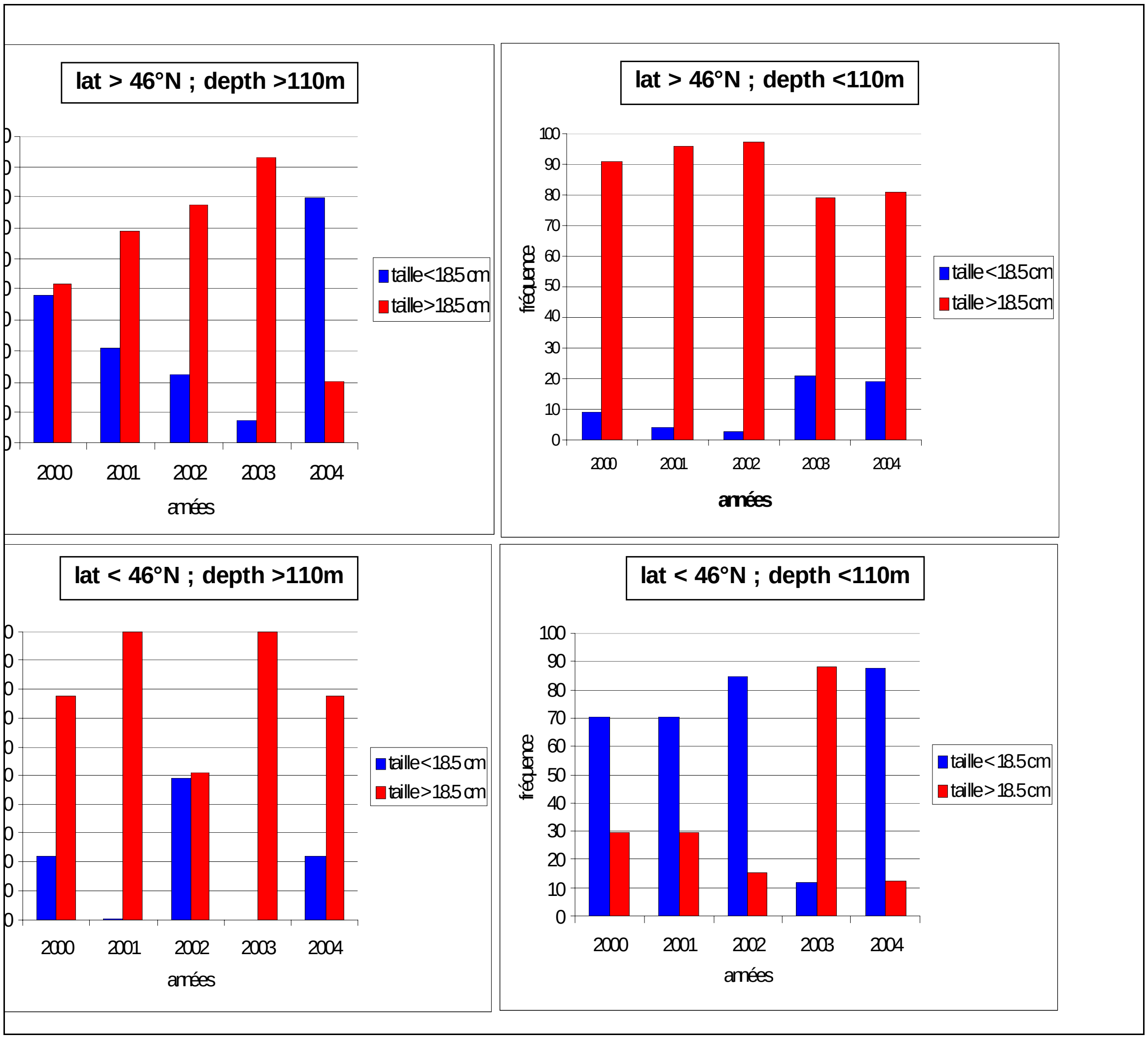


Figure 7.2.2.5: Proportions of small and big sardines (size limit at 18.5 cm) as observed in the Bay of Biscay during acoustic surveys PELGAS 2000 – 2004.(top figures are North of 46°N and left figures are depth>110m).

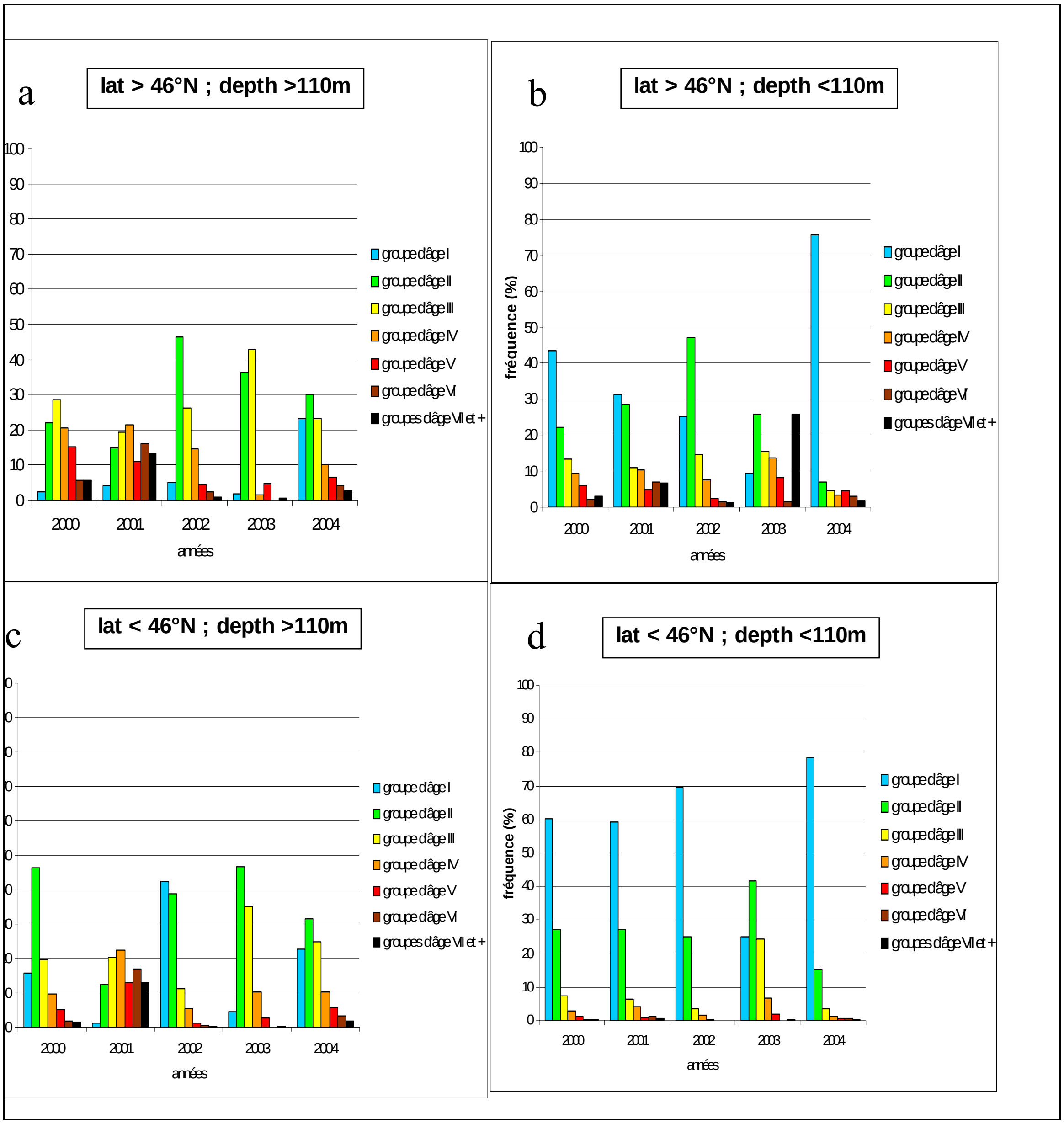
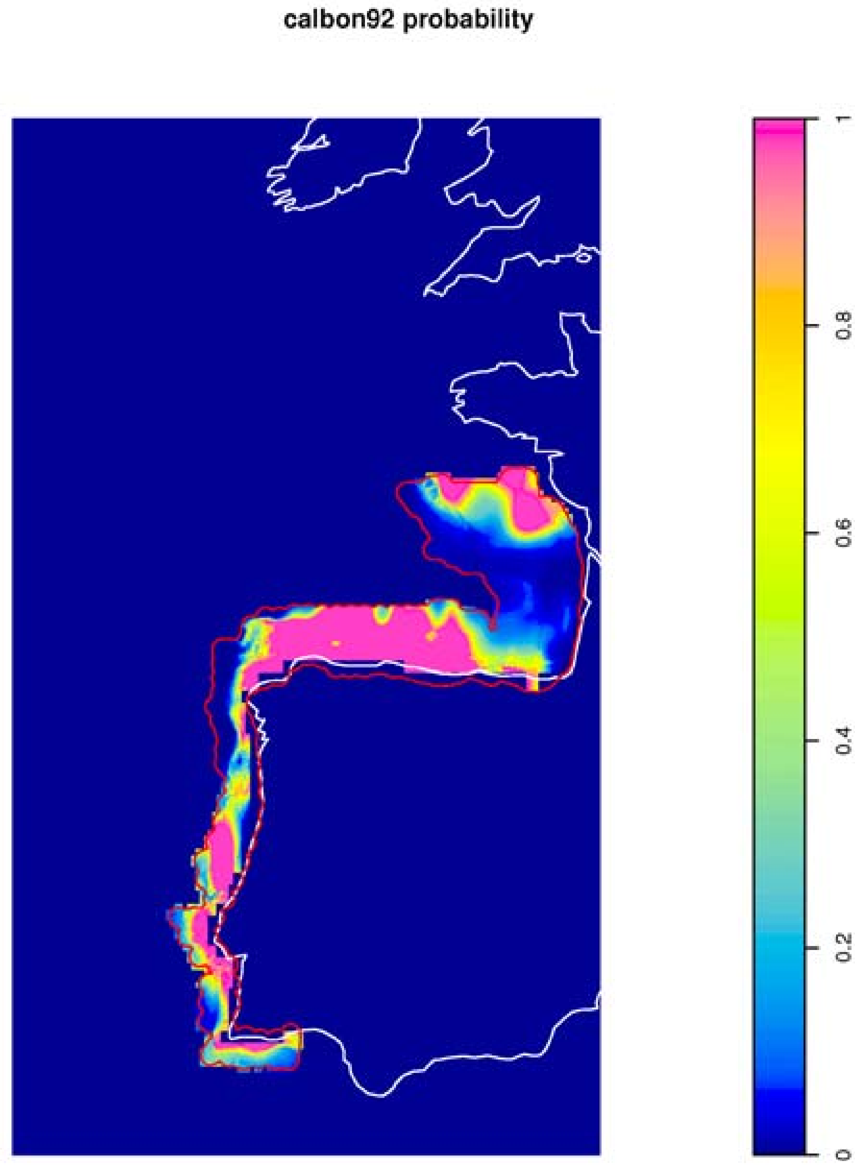
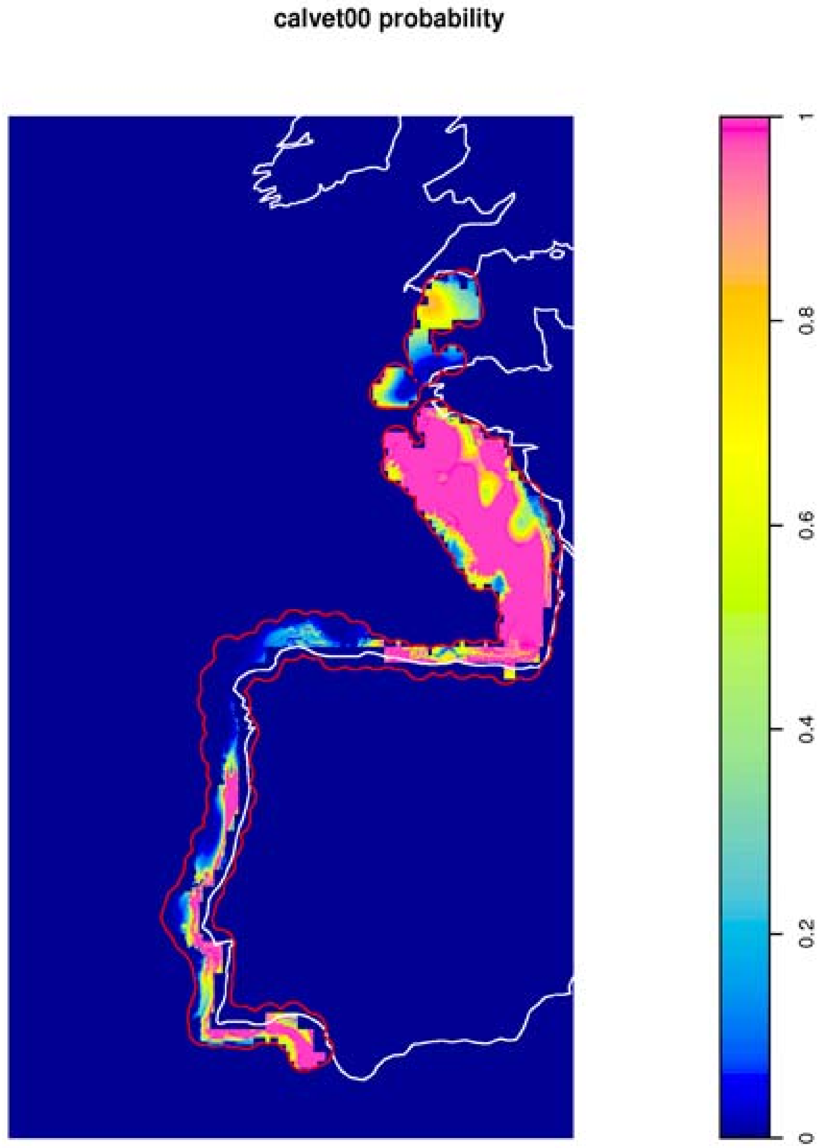


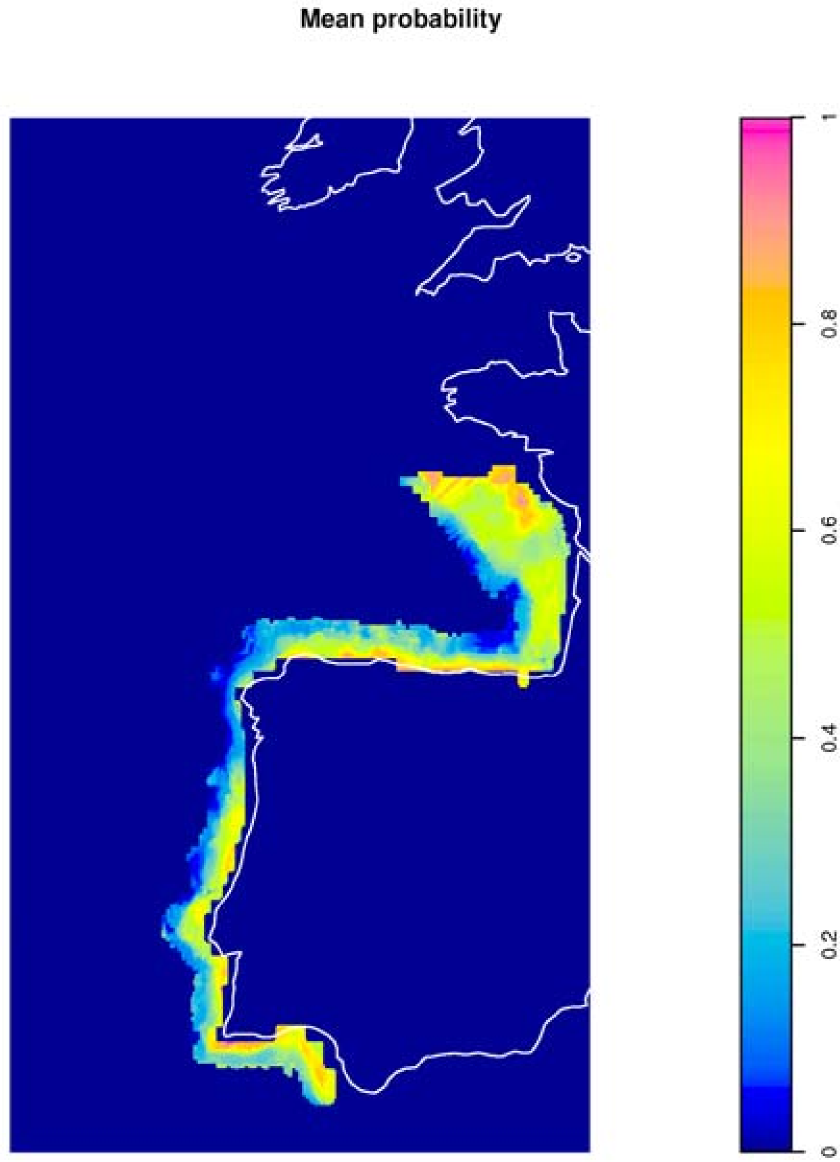
Figure 7.2.2.6: Age distribution of sardines as observed in the Bay of Biscay during acoustic surveys PELGAS 2000 – 2004. (Top figures are North of 46°N and left figures are depth>110m).



Figures 7.3.3.1 a): An example of spawning distribution around the Iberian Peninsula and northwards in late 1980's-early 1990's. Figure represent modeled probabilities of egg presence in color scale within the surveyed limits (red line).



Figures 7.3.3.1 b): An example of spawning distribution around the Iberian Peninsula and northwards in early 2000's. Figure represent modeled probabilities of egg presence in color scale within the surveyed limits (red line).



Figures 7.3.3.2: Main spawning grounds around the Iberian Peninsula and northwards from the analysis of the ichthyoplanckton historical series. Figure represent mean modeled probabilities of egg presence through the historical series in color scale, for areas covered at least 4 times in the historical series.

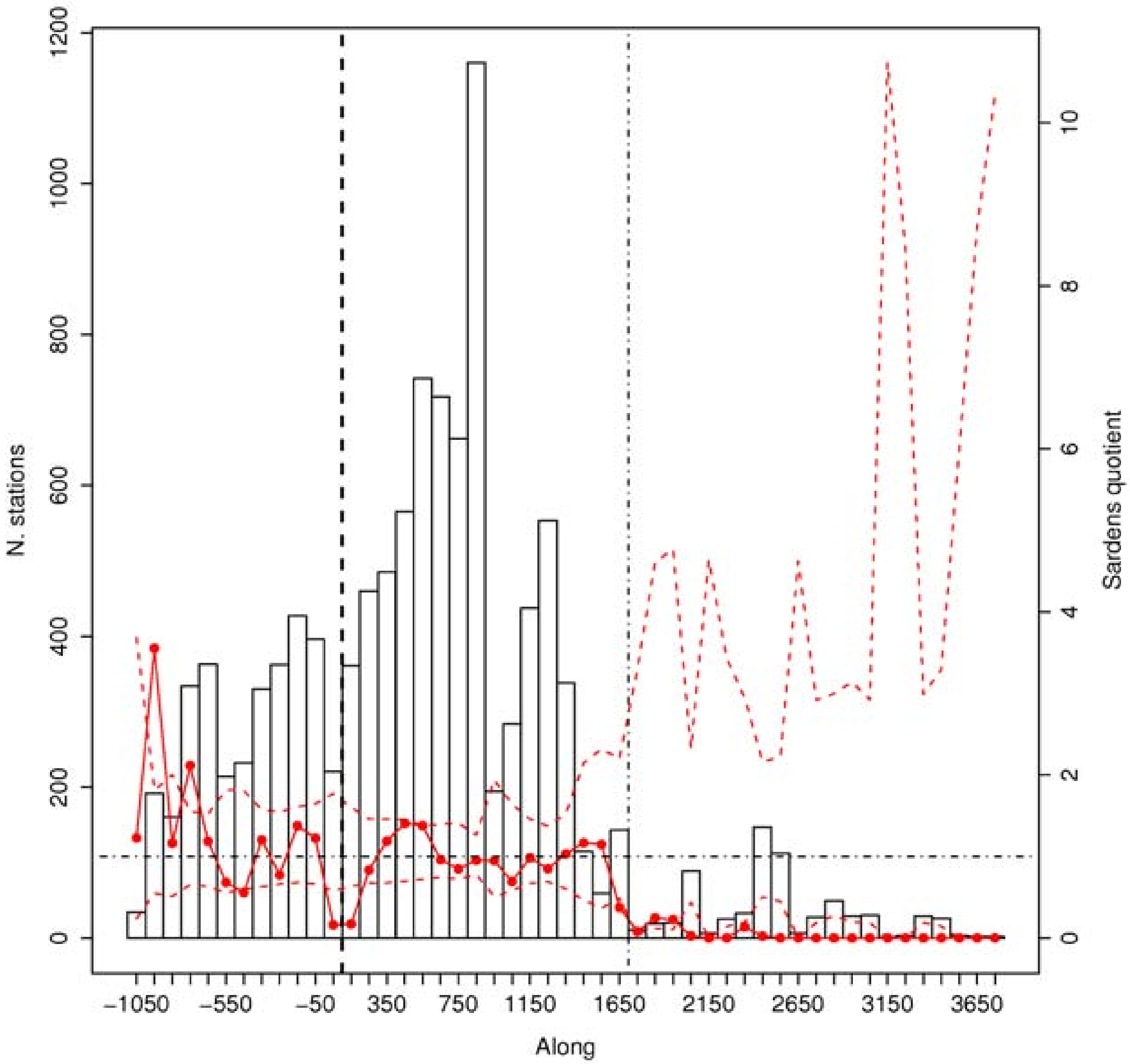


Figure 7.3.3.3: Analysis of spawning preferences with respect to position relative to the 100m contour depth line. x-axys represent distance along the 100m contour line, with negative values being positions to the south of the Spanish-Portuguese Northern border. Histogram represents the number of stations found in each along-distance bin. Solid red line represent the preference quotient (percentage of eggs within a bin divided by percentage of stations in the bin; values above 1 mean preference) and red broken line represent confidence interval of the null hypothesis of evenly distributed eggs (quotient values above the upper confidence interval means significant preference, values below the lower confidence interval means significant avoidance). Vertical dashed black lines shows a significant avoidance area within the main stock area, near the Northern Portuguese-Spanish border (line to the left), and the northern limit of the sardine spawning distribution (around the English Channel, line to the right). Numbers of observations northern to this limit are very low, decreasing the power of the analysis for northern areas.

8 Sardine in VIIIc and IXa

8.1 ACFM Advice Applicable to 2004

ICES recommends that fishing mortality should not increase above the level in 2002-3 of 0.20, corresponding to a catch of less than 106 000 t in 2005. Fishing mortality in 2005 should not increase since the short term forecast indicates that the SSB is expected to decrease from 2004 onwards, unless a new strong year class enters the stock.

The stock biomass is increasing from one of the lowest observed levels, due to the contribution of the strong 2000 year class. Historically, the current level of F has been sustainable. In spite of the overall apparent good situation of the stock, the abundance of sardine in some areas continues to be low when compared to the mid-1980s. There is uncertainty on the outer limits of the stock and scarce knowledge on movements and migrations of fish between areas. The stock size is strongly dependent on incoming year classes, and the 2002 and 2003 recruitments are estimated to be around the lowest of the series.

8.2 The fishery in 2004

Management measures implemented in each country since 1997 continued to be enforced in 2004.

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), new additional regulations have been applied to the pelagic fishery. These measures include a closure of the fishery (which took place in 2004 between the 17 November to the 31 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 and the yearly quota for the Producers Organization was limited to 80 thousand tons. In mid-spring, fishermen from the northern Portuguese coast started to report the occurrence of large quantities of juvenile sardine (8-10 cm) in the area that caused severe clogging of the nets and complicated the fishing operation. As a result, fishing activity decreased in the area to avoid damage to the fishing gear. This situation was closely followed by IPIMAR both by intensifying sampling and carrying out short surveys on board the commercial vessels across the area. Although there were periods when fishermen could find places with larger, commercially valuable sardine, high proportion of juveniles continued to be present during the summer in the area. In November, there was a second crisis in the fishery with a new entrance of 8-10 cm fish in the area. Thus in 2004, fishing effort possibly decreased in the northern Portuguese coast and slipping may have occurred.

As estimated by the Working Group, sardine landings in 2004 shows a minor reduction with those of 2003 (Tables 8.2.1 and 8.2.2, Figure 8.2.1). Total 2004 landings in divisions VIIIc and IXa were 91 886 t, i.e. a decrease of 6% with respect to 2003 values (97 831 t). The bulk of the landings (99%) were made by purse-seiners. Regarding countries, 36 055 t were landed in Spain, which represent an increase of 15% from 2003 (31 303 t). All ICES subdivisions in Spanish waters showed an increase in catches, which was more evident in IXa North (with catches 34% higher than in 2003). Portugal landings were 55 831 t, which represent a decrease of 16% with respect to last year (66 528 t in 2003). All ICES subdivisions in

Portuguese waters show reduction in catches, mainly in IXa Central North with a decrease of 20% which was partly due to the decline in fishing effort as mentioned before.

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 (1995-2004). Values for area VIIIc are rather stable, in a range between 15,000 to 19,000 t, with a decrease in 1999 and 2000, but increasing to reach in 2004 similar values than those reported for 1995. Values for IXa North also present a sharp decrease in 1999-2000, increasing slowly but continuously afterwards,. IXa Central North values have been quite stable for the past few years with the exception of the decrease in landings observed in 2004. 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 are increasing gradually.

Table 8.2.1 summarises the quarterly landings and their relative distribution by ICES Subdivision. Most of the catches (65%) were landed in the second semester (mainly in the third quarter) while 55% 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 30% of the total stock landings in 2004. The southern areas accounts for 18% of the total values, similar to previous years (although with a decrease in Algarve landings been compensated by an increase in Gulf of Cádiz landings).

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. Results from these surveys are expected to be available for the 2006 WGMHSA meeting.

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”. In November 2004 no acoustic survey was carried out by Portugal due to the non-availability of the RV “Noruega”. A Portuguese survey is planned for November this year.

8.3.2.1 Portuguese Acoustic Survey 2005

An acoustic survey was carried out from the 8 April to 10 May 2005 onboard the RV “Noruega” covering the Portuguese waters and the Gulf of Cadiz (ICES division IXa, sub-divisions Central North, Central South, South Algarve and South Cadiz) (WD Marques et al., 2005). Overall sampling coverage was good. The 69 planned acoustic transects were successfully carried out and 41 fishing stations (32 with pelagic gear and 9 with bottom trawl gear) were sampled under good weather conditions. Some aspects of the distribution of sardine across the area are worth noting since they have not been observed in recent surveys (Figure 8.3.2.1). There was an apparent wider offshore extension to the sardine distribution (down to 80-100 m depth), namely off the northern and off the southern Portuguese coast, and higher abundance in the southwest waters and lower abundance in the Gulf of Cadiz than traditionally. Total sardine biomass estimated in the survey area was 587 thousand tonnes corresponding to 25 229 million individuals (Table 8.3.2.1). These estimates indicate an increase of 36% in biomass and of 90% in numbers compared to the values for the 2003 spring survey (Figures 8.3.1 and 8.3.2). Most of the biomass of sardine was located off the northern (49%) and southwest (34%) Portuguese waters while an unprecedented low abundance of sardine was observed in the Gulf of Cadiz (40 thousand tones corresponding to 7% of the total). This increase in sardine abundance is mainly due to the presence of large numbers of age 1 individuals (2004 recruitment). These fish comprise 73% of the sardine observed off southwest Portugal and nearly the whole population of the northern area. In south Portuguese waters, juvenile abundance was low as usual, while in the Gulf of Cadiz area a small number of very small juveniles (5-7.5 cm) were observed near the Guadalquivir estuary. The strong 2000 cohort (mainly distributed off the northern area) was not noticeable in this survey, which may be partly due to the outstanding number of juveniles present in the area. There is no clear evidence of other strong cohorts across the whole survey area.

8.3.2.2 Spanish April 2005 Acoustic Survey

The Spanish Spring Acoustic Surveys time series comprises data from 1986 onwards, with three gaps in 1989, 1994 and 1995.

The estimates of sardine abundance from the spring survey PELACUS 2004 (included in last years assessment) were corrected this year. The former estimates were calculated based on a greater weight of the information gathered from fishing stations carried out by the purse-seiner than in previous surveys. This gave higher values for sardine presence and an overestimation of the sardine abundance and biomass. Also, a more precise allocation to fishing stations to echograms has been carried out.

Table 8.3.2.2 shows the corrected 2004 sardine acoustic estimates by areas and ages. The new estimates reduce in a 34% both the total acoustic biomass (149 thousand tons versus 226 thousand tons) and the total abundance in number (2096 million individuals versus 3170 million individuals) estimated previously. Although the reduction was more important in age 1 estimates, the sardine age structure for year 2004 remains quite similar after the values have been corrected, with 3 and 4 years-old being the most important age groups. It should be highlighted the low recruitment detected in the 2004 survey, which accounted for less than 1% of the total abundance in the sampled areas in 2004. The input files for the assessment were corrected using the new estimates of the 2004 Spanish survey and the model was run using the same assumptions as last year. This effect on assessment due to this correction was a 4% lower SSB and 40% lower R (Table 8.3.2.3).

The Spanish acoustic survey (PELACUS 0405) took place from the 1st of April to the 1st of May 2005 on-board the RV “Thalassa”, covering Spanish waters in Divisions VIIIc and IXa North as well as the northern part of Portugal and a rather small area of the southern French shelf. During the cruise, in addition to standard acoustic transects, sampling is also carried out for the characterisation of the egg, planckton and primary production distribution.

The survey covered a total of 61 acoustic tracks, from which 54 took place in Spanish waters. As in previous years, fishing stations were sampled by both the RV “Thalassa” (pelagic trawls) and by a chartered purse-seiner. Information gathered from the purse-seiner is particularly useful in Subdivision IXa North (Rias Bajas), where the topography difficults the use of trawl nets.

A total of 72 fishing stations were sampled during the cruise, 66 of them in Spain (49 by the RV “Thalassa” and 17 by the purse-seiner, see Figure 8.3.2.2a). Higher sardine density in Spanish waters was found in IXa North, followed by VIIIc West while low sardine presence was found in ICES Subdivion VIIIc East (see Figure 8.3.2.2b).

Table 8.3.2.2 shows sardine 2005 acoustic estimates by areas and ages. The abundance estimated in 2005 in the North Spanish area is 1 471 millions of individuals, which represent s a decrease of 30% with respect to the 2004 value (2 097 millions). Regarding biomass, the 2005 survey estimated a total of 68 thousand tonnes (a decrease of 55% with respect to the 2004 figure of 149 thousand tonnes).

For the total surveyed area, age 1 represents 56% of the total abundance in number and 26% of the total biomass. The second most abundant age group is age 5, which corresponds to the 2000 strong year class (12% of the total abundance in number and 23% of the total biomass). Age 4 is also important, accounting for 11% of the total abundance. This three age groups comprise the 80% of the abundance in number of the total survey and the 68% of the total biomass.

Figure 8.3.2.3 shows the sardine age distribution by areas. The 62% of the total abundance in numbers correspond to area IXa North, mainly due to the huge importance of the age 1 group in this area IXa North (90% in abundance and 80% in biomass). Age 5 is the most abundant age group in area VIIIc West, representing 41% of the abundance in number of that area.

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 a reduction of the strong 2000 year class is also apparent.

It is important to note that the age structure is quite variable along the time series. Two main periods can be distinguished: i) from the beginning of the series to middle of the 90s, when abundance was dominated by older fish, with age groups 5 and 6+ with representing about half of the total estimated numbers and ii) from middle of the 90's onwards, where abundance was dominated by young fish, ages 1 to 3 (older age groups 5 and 6+ represented only less than 15% of the total estimated population during this period). These numbers reflects that sardine population is highly dominated by some age groups, corresponding to high pulses of recruitment. These strong year classes are also the main support of 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 both countries with the exception of Cadiz in south Spain where a single mode at 18 cm was observed. For Portugal, single modes were observed for IXaCS and IXaS-Algarve at 19.5 and 19 cm respectively. There is a general decrease in the length distributions from the northern areas (VIIIc and IXaN) to the western and southern areas of the stock as usual, however small individuals (10-15 cm) were landed in 2004 in IXaN (south Galicia) and in VIIIcE (Bay of Biscay/Cantabria).

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 north Portugal (IXaCN), catches continue to be dominated by the strong 2000 year class (4-group in 2004). In the southern area, southwest Portugal and Algarve (IXaCS and IXaS-Algarve) the age structure supports previous indications of a strong 2001 recruitment. In IXaS-Cadiz there is no evidence of particularly strong cohorts while in the VIIIc East Sub.Division there seems to be an indication of a strong recruitment in 2004.

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

The maturity ogive and stock weights at age for sardine are usually based on survey biological data collected close to the peak spawning season. Two estimates are produced, one for the northern Spanish waters based on data from the spring acoustic survey and other for the Portuguese and Gulf of Cadiz waters based on the November acoustic survey (on the year before, ages shifted 1 year). These estimates are combined using the population numbers at age estimated in the corresponding surveys. The use of surveys in different seasons is justified by the difference in the spawning season on the two areas: spawning starts earlier in the Portuguese waters than in northern Spain.

In 2004, maturity and weight estimates for the northern Spanish waters were based on data collected during the annual Spanish spring acoustic survey as usual. The Portuguese November 2003 survey did not cover the Cadiz area. The population numbers at age provided in the Portuguese November 2003 and Spanish spring survey of 2004, considered the best available measure of the sardine proportion distributed in each area, were used as weighting factors to combine estimates from the two areas.

The 2004 maturity ogive and stock weights at age for sardine (tables below) are within the range of values observed in the data series although more similar to the values in years where survey data were also used for the estimation (e.g. 2002 and 2001):

AGE	0	1	2	3	5	5	6+
% mature fish	0	48.9	93.6	97.4	98.3	98.5	100

AGE	0	1	2	3	5	5	6+
Weight, kg	0	0.020	0.045	0.061	0.069	0.076	0.073

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 exploration

This year the assessment required for the species by ACFM is an updated assessment, and thus no comprehensive exploration of data was carried out. However, an exploratory analysis of area-disaggregated data and an area-based assessment using AMCI was presented to the working group (WD Skagen, #), as part of ongoing work within the project SARDYN (Q5RS – 2002 – 000818). The use of local surveys to estimate the state of the whole stock has been considered problematic for sardine assessment, and it has been claimed that an area-disaggregated assessment model is therefore needed. AMCI has now been extended to include a migration model, and preliminary results using this method are summarised below.

Sardine catch and survey data by ICES subdivision were used first to explore a possible formulation of a migration model, and then as input to the extended version of AMCI. Experiments with possible formulations led to a Markov chain type migration model. The migration model now implemented in AMCI has parameters ρ between each origin area and destination area, for each year, season and age. The model for the relative distributions *P* for each destination area is:

$$P_{dest} = \Sigma_{all\ origins} (N_{origin} * \rho_{o,d}) / \Sigma_{all\ destinations} N_{dest}$$

For sardine, three areas were used: North (Division VIIIc), West (Subdivisions IXaN, IXaCN, IXaCS) and South (IXa-S-Algarve and IXa-S-Cadiz). The transition parameters ρ were assumed to be equal for all ages within each year class. Likewise, only migration from West to North and from West to South was considered. The program is formulated in such a way that net migration in the opposite direction can be expressed by negative values of ρ. This gives 4 parameters to be estimated for each year class: $\rho_{N,W}$, $\rho_{S,W}$ and the initial fraction in area N and area S at age 1.

AMCI runs were carried out for several combinations of survey fleets, and for either one or 3 fishing fleets. It should be noted that some of the input data may differ slightly from those used by the WGMHSA. This has not been controlled extensively. Some results are presented in Figure 8.7.1.

These preliminary analyses indicate that the introduction of 3 areas does not lead to drastic changes in the perception of the state of the stock, although there are differences that deserve further scrutiny. Further exploration of both the migration model and the assumptions applied in AMCI is needed before more definitive conclusions can be drawn. So far, the way the surveys are used seems more important for the result than the area disaggregation. In particular, the weight given to the November survey has a large impact, mainly in the area disaggregated case. Including this survey leads to higher estimates of fishing mortality and lower estimates of SSB.

The 2005 assessment of sardine includes catch-at-age data for 1978 - 2004, acoustic survey data 1984 - 2005 (with gaps in the different countries/surveys) and DEPM-based estimates of biomass in 1999 (269 000 tonnes) and 2002 (442 600 tonnes). Data from the different sources were plotted to provide a perspective of stock history and its evolution in 2004, namely the progress of year classes and recruitment strength. As discussed in section 8.2, sardine catches in 2004 (91 886 thousand tonnes) declined slightly compared to 2003 values, due to lower catches in Portuguese waters (see Figure 8.2.1). The occurrence of small juveniles mixed with adults off the northern Portuguese coast during the second half of the year can explain partly this decline. Figure 8.7.2 shows catch in numbers by age classes for the whole stock area. The 2004 catch at age distribution suggests that the 2004 recruitment is considerably higher than those of 2001-2003 while providing still some signal of the strong 2000 year class. The 2005 Spanish acoustic survey shows a 50% decline of the biomass compared to the 2004 value due to the depletion of the strong 2000 year class and the almost no compensation from recent recruitments (see also section 8.3.2). On the other hand, the 2005 Portuguese spring survey shows one of the highest observed levels of biomass corresponding to an increase of 36% compared to the 2003 estimate (previous survey). Both surveys provide evidence of a strong 2004 year class, while the opposite trends observed from these surveys essentially reflect that this year class is mainly distributed off the Portuguese area (see section 8.3.1). Figure 8.7.3 shows the evolution of abundance by age classes in the Spanish and Portuguese March surveys and the Portuguese November survey. Contrary to the catch at age data, there is little signal of the strong 2000 year class both in the Portuguese and in the Spanish waters suggesting a rapid disappearance of this cohort from the stock. In addition, data from the 2005 surveys confirm previous indications that sardine recruitments were low during 2002-2003.

8.8 State of Stock

8.8.1 Stock assessment

Sardine stock assessment is carried out using the AMCI software (Skagen, 2004; ICES 2004). The final assessment selected for this year is essentially an update of last year assessment regarding both the input data and the model assumptions:

		2004 ASSESSMENT	**2005 ASSESSMENT**
INPUT DATA	Catch at age	1978-2003, Divisions VIIIc+Ixa	1978-2004, Divisions
	Acoustic surveys	Spanish March, VIIIc+IXaN, 1986-2004 Portuguese March, Port. Waters + Cadiz, 1996-2003* Portuguese November survey, Port. Waters, 1984-2001*	Spanish March, VIIIc+IXaN, 1986-2005[1] Portuguese March, Port. Waters + Cadiz, 1996-2005 Portuguese November survey, Port. Waters, 1984-2001 *
	DEPM survey	VIIIc+IXa, Winter, 1999,2002	VIIIc+IXa, Winter, 1999,2002
	Maturity at age	Combined VIIIc+Ixa	Combined VIIIc+IXa
	Stock weights at	Combined VIIIc+Ixa	Combined VIIIc+IXa
	Natural mortality	0.33, all ages, all years	0.33, all ages, all years
MODEL STRUCTURE	Selectivity model	Smooth model of selectivity across all ages and through the time series (AMCI gain set to 0.2).	Smooth model of selectivity across all ages and through the time series (AMCI gain set to 0.2).
	Catchability for acoustic surveys	Fixed catchability split in two periods, 1984-1992 and 1993-2003	Fixed catchability split in two periods, 1984-1992 and 1993-2004
	Weighting	Downweight 0 group in catches (weight of 0.1) Equal weights for surveys and equivalent to catch data.	Downweight 0 group in catches (weight of 0.1) Equal weights for surveys and equivalent to catch data.
	Precision estimates	Non-parametric bootstrap of residuals for catch and survey data, lognormal parametric bootstrap (CV=0.3) on DEPM estimates.	Non-parametric bootstrap of residuals for catch and survey data, lognormal parametric bootstrap (CV=0.3) on DEPM estimates.

*** - No new data available, see section 8.3.2.1**

[1] – 2004 survey corrected, 2005 survey added

Table 8.8.1.1 shows the input data used for the assessment and Table 8.8.1.2 the output of the assessment. Figure 8.8.1.1 shows the evolution of recruitment, SSB and F for the time series. Overall, both the absolute values and the historical trends in sardine recruitment, SSB and fishing mortality estimated in the current assessment are similar to those obtained in the last assessment. Recruitment for 2004 (19,927 million individuals) is estimated as the highest in the time series and previous indication of low 2002-2003 recruitments is also supported. Survey data from both Spanish and Portuguese areas in 2005 suggest that the 2004 recruitment is comparable to the 2000 recruitment (as observed by 2002 surveys). Catch data from both areas and anedoctal information from the fishermen support the existence of a strong 2004 year class. In spite of the evidence that the 2004 recruitment is strong, there is still little information about its absolute value and thus the current estimate has a high uncertainty (CV=47%). Fishing mortality shows a decreasing trend since 1998 and remains at a low level in recent years ($F_{(2\text{-}5)}$=0.23). The SSB is estimated to be 431 thousand tonnes in 2004, showing a 23% decline compared to 2003 which reflects the depletion of the strong 2000 recruitment and the absence of good recruitments since then. The 2004 level of biomass is however close to the median value of the time series. Figure 8.8.1.2 shows the catch residuals and Figure 8.8.1.3 the survey residuals. Catch residuals are higher at age 0 but are not expected to affect the assessment since the 0-group is heavily downweighted in the model (weight=0.1). There are small year and year class effects on survey residuals. In some of the cases, these effects show opposite signals in Spanish and Portuguese surveys providing some support to the hypothesis of migrations between areas (Figure 8.8.1.3). As both indexes enter the model as independent series for the whole stock, these trends probably cancel each other out. Both the selection pattern of the fishery and survey catchability estimated in the current assessment are comparable to those from last year assessment (Table 8.8.1.2).

Bootstrap estimates of variance of the different estimates (SSB, F and recruitment) were obtained using same assumptions as last year (see summary table at the beginning of section 8.8.1). Figure 8.8.1.4 shows the mean trajectories of recruitment, SSB and F-values trajectories for 999 bootstrap runs, as well as the 90% confidence intervals and the estimated standard deviation. Mean trajectory is computed by taking the mean yearly value of either recruitment, SSB or mortality for all bootstrap runs. Estimated coefficient of variance (CV) of the SSB and F estimates are 18%, same as last year assessment and the estimate CV of Recruitment is 14%, one percent lower than last year.

8.8.2 Reliability of the assessment

The perception of the state of the stock provided by the assessment has been stable in recent years. The current assessment is considered to adequately describe the stock dynamics in recent years although there is still some uncertainty about the relationship in the relative population level and exploitation between 1980s and the present. The retrospective analysis provides limited information on the biases in the assessment (because of the short time series of indices) however, the available years show consistent stock estimates across the time series (Figure 8.8.2.1). There is evidence that the 2000 strong recruitment was considerably overestimated when there was still little information on its strength. The retrospective analysis shows a positive bias in SSB and a negative bias in F in 2004. This is a consequence of the 2000 recruitment overestimation.

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 2005 were recalculated to avoid the influence of the 2004 recruitment estimated by the model, which has a high uncertainty and possibly upward bias (see sections 8.8.2 and 8.13) There is evidence from survey data that the 2004 recruitment has a level similar to the strong 2000 recruitment and thus, its estimate was replaced by the value of age 0 in 2000. Hence, numbers at age 1 at 1st January 2005 were calculated with the fishing mortality rate F_{age0} for 2004.

Input recruitment for 2005-2007 was calculated as the geometric mean of the recruitments for the time series (1988-2003), $R_{GM(88\text{-}03)}$ = 5225 millions individuals.

Weights at age in the stock and in the catch were calculated as the arithmetic mean value of the three last years (2002-2004). The maturity ogive and the exploitation pattern corresponded to the 2004 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(2002-04) unscaled.

Input values and results are shown in Tables 8.9.1.1 and 8.9.1.2. The predicted landings with Fsq (0.22) for 2005 are 103 thousand tonnes. Predicted SSB for 2005 is 405 thousand tons. If fishing mortality remains at the Fsq level (0.22), the predicted yield in 2006 (96 thousand tonnes) remains close to the catch level in recent years. Predicted SSB for 2006 is 485 thousand tons, which means an increase of 13% with respect to the estimated 2004 SSB and is directed by the importance of the just incoming 2004 year class which absolute level is still not known.

It should be pointed out that the outcome of short term deterministic predictions have a high uncertainty due to the use of guess estimates of recruitment, possible bias in the assessment and projection of current levels of fishing mortality. The discrepancy between the observed and predicted landings in 2004 (18%) illustrates this uncertainty.

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 extensively described in recent reports (ICES 2003, 2004, 2005). The main sources of uncertainty in the assessment regard the definition of the stock unit, migration patterns within the stock area and across stock boundaries and the relationship between stock dynamics in the 1980s and 1990s.

The relationship between sardine populations across the southern stock boundary is still unknown while there is growing evidence that the stock extends to the French waters, both from the distribution of eggs and adults, and from the age distribution of catches and survey samples (see section 7). Changes in stock distribution and migration may have occurred as perceived by survey and catch data from the Spanish and Portuguese areas while there is also evidence of geographical differences in exploitation patterns. An exploration of area disaggregated data and preliminary results from an area-based model have mainly highlighted the sensitivity of the assessment to the tuning indices (see section 8.7). The need to revise biological data included in the assessment has been also pointed out in last years report. The ongoing "SARDYN" project is expected to provide information about these topics and thus a revision of the stock unit, a comprehensive analysis of biological data and further exploration of area-based modelling is anticipated for the 2006 benchmark assessment.

The 2004 recruitment is estimated as the highest of the time series but its absolute magnitude is uncertain (Figure 8.8.1.4). However there is evidence of its strength and in the survey it appears at similar levels to the 2000 year class. It should be noted that the 2000 year class initially was overestimated by the assessment and this may also be the case for the 2004 year class. In addition, there is clear information that the 2004 recruits are restricted to the western Iberian waters, mainly the northern Portuguese coast as was also the case for the 2000 strong cohort. Its abundance in some of the stock areas (Cantabrian waters and southern Portuguese waters) is low, indicating that the impact on the different areas is dependent on its dispersal.

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.

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 considered high (431 thousand tonnes in 2004) but it decreased slightly in relation to the 2003 SSB. This decline reflects the depletion of the strong 2000 cohort and the low recruitments which entered the stock more recently (2002-2003). Fishing mortality shows a decreasing trend since 1998 and a stable level since 2002. Management measures undertaken by Spain and Portugal to reduce the fishing effort and the overall catches may have contributed to this decrease. There is evidence that the 2004 year class is strong and in the catch forecasts its strength has been assumed at the level of the 2000 yearclass. Short term catch predictions indicate that catches in 2006 will remain stable if fishing mortality is maintained and SSB will increase due to the strong 2004 yearclass.

However, it should also be taken into account that the abundance of sardine in some areas of the stock continues to be low when compared to the mid 1980's. The 2000 year class recruited off northwest Portugal had a large contribution to increase the abundance within western Iberian and north Galician areas but apparently a limited impact on east Cantabria and south Portugal were catches show a declining trend. 0 group sardine in 2004 are also restricted to the northwestern Iberia and its impact on other areas depends on dispersal. In addition, the 2000 yearclass appears to have been depleted faster than strong year classes from the 1980s. 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 1980s.

Sub-Div	1st	2nd	3rd	4th	Total
VIIIc-E	2006	1136	2087	4292	**9522**
VIIIc-W	1374	2285	2947	2178	**8784**
IXa-N	1044	1334	3762	2433	**8573**
IXa-CN	1441	4924	11940	8560	**26864**
IXa-CS	4474	4392	6683	6041	**21590**
IXa-S (A)	1513	2028	1949	1887	**7377**
IXa-S (C)	2302	1779	3878	1217	**9176**
Total	**14154**	**17878**	**33246**	**26608**	**91886**

Sub-Div	1st	2nd	3rd	4th	Total
VIIIc-E	2.18	1.24	2.27	4.67	**10.36**
VIIIc-W	1.50	2.49	3.21	2.37	**9.56**
IXa-N	1.14	1.45	4.09	2.65	**9.33**
IXa-CN	1.57	5.36	12.99	9.32	**29.24**
IXa-CS	4.87	4.78	7.27	6.57	**23.50**
IXa-S (A)	1.65	2.21	2.12	2.05	**8.03**
IXa-S (C)	2.51	1.94	4.22	1.32	**9.99**
Total	**15.40**	**19.46**	**36.18**	**28.96**	

Table 8.2.1: Sardine in VIIIc and IXa. Quaterly distribution of sardine landings (t) in 2004 by ICES Sub-Division. Above absolute values; below, relative numbers.

Table 8.3.2.1: Sardine in VIIIc and IXa. Sardine Assessment from the 2005 Portuguese spring acoustic survey. Number in thousand fish and Biomass in tonnes.

AREA		**1**	**2**	**3**	**4**	**5**	**6+**	**Total**	
Oc. Norte	**Biomass**	284664	1604	119	0	0	0	**286387**	48.7544411
	%	99	1	0	0	0	0		
	Mean Weight	16.9	42.0	40.4					
	No fish	16868108	38231	2937	0	0		**16909276**	
	%	100	0	0	0	0	0		
	Mean Length	13.5	17.9	17.8					
Oc. Sul	**Biomass**	101862	18559	21195	25564	21278	10726	**199184**	33.9090273
	%	51	9	11	13	11	5		
	Mean Weight	23.6	47.4	58.2	63.9	67.2	73.0		
	No fish	4308259	391425	364084	400218	316598	146944	**5927528**	
	%	73	7	6	7	5	2		
	Mean Length	14.7	18.5	19.8	20.4	20.8	21.3		
Algarve	**Biomass**	9594	17745	9330	9489	8690	7439	**62287**	10.6037211
	%	15	28	15	15	14			
	Mean Weight	41.7	49.8	55.4	60.7	63.5	67.9		
	No fish	230133	356138	168285	156312	136785	109600	**1157253**	
	%	20	31	15	14	12			
	Mean Length	17.4	18.5	19.2	19.8	20.2	20.6		
Cadiz	**Biomass**	16696	15699	3083	2324	1279	468	**39549**	6.73281047
	%	42	40	8	6	3			
	Mean Weight	24.2	39.4	45.3	52.3	59.8	58.3		
	No fish	689070	398294	68071	44467	21384	8023	**1229309**	
	%	56	32	6	4	2			
	Mean Length	14.3	17.6	18.4	19.3	20.3	20.1		
Total	**Biomass**	396120	37908	30644	35053	29968	18165	**547858**	
Portugal	**%**	72	7	6	6	5	3		
	Mean Weight	19.2	48.3	57.3	63.0	66.1	70.9		
	No fish	21406500	785794	535306	556530	453383	256544	**23994057**	
	%	89	3	2	2	2	1		
	Mean Length	13.8	18.5	19.6	20.2	20.6	21.0		
Total	**Biomass**	412816	53607	33727	37377	31247	18633	**587407**	
	%	70	9	6	6	5	3		
	Mean Weight	19.4	45.3	55.9	62.2	65.8	70.5		
	No fish	22095570	1184088	603377	600997	474767	264567	**25223366**	
	%	88	5	2	2	2	1		
	Mean Length	13.8	18.2	19.5	20.2	20.6	21.0		

Table 8.3.2.2. Sardine in VIIIc and IXa. New corrected estimates of the 2004 Spanish Spring Acoustic Survey
Number of fish in thousands and biomass in tons.

AREA VIIIcE east											
AGE	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**TOTAL**
Biomass (Tonnes)	413	5013	30160	21205	13221	10335	3833	1444	374	374	86372
% Biomass	1.7	9.3	33.9	22.4	14.0	11.4	4.5	1.7	0.5	0.5	100
Abundance (Numbers in '000)	6859	28708	87331	52089	30463	23747	9073	3414	989	989	243662
% Abundance	2.8	11.8	35.8	21.4	12.5	9.7	3.7	1.4	0.4	0.4	100.0
Medium Weight (gr)	43.5	56.7	68.3	75.5	81.0	84.0	88.0	88.8	95.9	95.9	70.7
Medium Length (cm)	17.9	19.7	21.1	21.9	22.5	22.8	23.2	23.3	23.9	23.9	20.0
AREA VIIIcE west											
AGE	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**TOTAL**
Biomass (Tonnes)	115	3386	24198	17275	10754	8340	3035	1141	279	279	68802
% Biomass	0.2	4.9	35.2	25.1	15.6	12.1	4.4	1.7	0	0	100
Abundance (Numbers in '000)	2227	52591	343794	228373	133963	100841	35284	13106	2937	2937	916052
% Abundance	0.2	5.7	37.5	24.9	14.6	11.0	3.9	1.4	0.3	0.3	100.0
Medium Weight (gr)	51.4	64.4	70.4	75.6	80.3	82.7	86.0	87.1	95.0	95.0	71.6
Medium Length (cm)	19.1	20.7	21.4	21.9	22.4	22.7	23.0	23.1	23.8	23.8	20.2
AREA VIIIcW											
AGE	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**TOTAL**
Biomass (Tonnes)	0	2815	10849	21587	3723	2000	689	43	0	0	41706
% Biomass	0	6.7	26.0	51.8	8.9	4.8	1.7	0.1	0	0	100
Abundance (Numbers in '000)	0	49424	159583	302548	46458	23724	7405	454	0	0	589595
% Abundance	0	8.4	27.1	51.3	7.9	4.0	1.3	0.1	0	0	100
Medium Weight (gr)	0	57.0	68.0	71.3	80.1	84.3	93.1	93.8	0	0	49.8
Medium Length (cm)	0	19.8	21.1	21.5	22.4	22.8	23.7	23.8	0	0	14.1
AREA IXaN											
AGE	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**TOTAL**
Biomass (Tonnes)	240	3453	4395	10801	1304	420	373	177	0	0	21163
% Biomass	1.1	16.3	20.8	51.0	6.2	2.0	1.8	0.8	0	0	100
Abundance (Numbers in '000)	5296	65787	73998	171861	18062	5240	4878	2386	0	0	347509
% Abundance	1.5	18.9	21.3	49.5	5.2	1.5	1.4	0.7	0	0	100
Medium Weight (gr)	45.3	52.5	59.4	62.8	72.2	80.2	76.5	74.2	0	0	47.6
Medium Length (cm)	18.2	19.2	20.1	20.5	21.6	22.4	22.0	21.8	0	0	15.1
TOTAL SPAIN											
AGE	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**TOTAL**
Biomass (Tonnes)	653	11281	45404	53593	18248	12756	4895	1664	374	374	149242
% Biomass	0.4	7.6	30.4	35.9	12.2	8.5	3.3	1.1	0.3	0.3	100
Abundance (Numbers in '000)	14383	196511	664706	754871	228946	153552	56639	19360	3926	3926	2096818
% Abundance	0.7	9.4	31.7	36.0	10.9	7.3	2.7	0.9	0.2	0.2	100.0
Medium Weight (gr)	45.4	57.4	68.3	71.0	79.7	83.1	86.4	86.0	95.2	95.2	76.8
Medium Length (cm)	18.2	19.8	21.1	21.4	22.4	22.7	23.0	23.0	23.9	23.9	21.9

Table 8.3.2.3: Sardine VIIIc and IXa: Summary table for the 2004 sardine assessment, after correcting the 2004 Spanish spring acoustic survey.

Year	Recruits	SSB	F (2-5)
1978	11164144	279492	0.40
1979	12715851	341116	0.41
1980	14115806	416654	0.30
1981	9353556	516906	0.36
1982	6739802	542449	0.35
1983	19240709	500913	0.30
1984	7129418	553962	0.27
1985	6035787	645075	0.27
1986	5131785	580667	0.34
1987	9148897	480565	0.33
1988	5494978	421813	0.35
1989	5584885	356217	0.38
1990	5147444	321700	0.45
1991	12248967	327666	0.33
1992	10521532	443393	0.30
1993	4579495	502178	0.35
1994	4455186	514977	0.24
1995	3814159	566783	0.25
1996	4699535	489108	0.26
1997	3690480	424203	0.34
1998	3853797	347995	0.40
1999	3734380	293149	0.36
2000	12560640	254091	0.35
2001	8653799	300865	0.27
2002	4977263	492628	0.22
2003	2970326	644625	0.21

Table 8.3.2.4:	Sardine in VIIIc and IXa. Sardine acoustic estimates of the 2005 Spanish Spring Acoustic Survey										
	Number of fish in thousands and biomass in tons.										
AREA VIIIcE east											
AGE	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**TOTAL**
Biomass (Tonnes)	348	1496	843	1180	918	498	133	84	16	0	5517
% Biomass	6.3	27.1	15.3	21.4	16.6	9.0	2.4	1.5	0.3	0.0	100
Abundance (Numbers in '000)	8464	26961	11468	14301	10301	5302	1253	769	122	0	78942
% Abundance	10.7	34.2	14.5	18.1	13.0	6.7	1.6	1.0	0.2	0.0	100.0
Medium Weight (gr)	41.1	55.5	73.5	82.5	89.1	94.0	106.1	109.6	132.6	0.0	71.3
Medium Length (cm)	17.4	19.1	21.0	21.8	22.3	22.7	23.6	23.8	25.3	0.0	17.9
AREA VIIIcE west											
AGE	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**TOTAL**
Biomass (Tonnes)	27	1295	2696	5368	5079	2721	832	461	53	0	18533
% Biomass	0.1	7.0	14.5	29.0	27.4	14.7	4.5	2.5	0	0	100
Abundance (Numbers in '000)	709	19481	33924	63097	55799	28962	7968	4337	416	0	214694
% Abundance	0.3	9.1	15.8	29.4	26.0	13.5	3.7	2.0	0.2	0.0	100.0
Medium Weight (gr)	38.6	66.5	79.5	85.1	91.0	93.9	104.4	106.3	127.0	0.0	72.0
Medium Length (cm)	17.1	20.3	21.5	22.0	22.5	22.7	23.5	23.6	25.0	0.0	18.0
AREA VIIIcW											
AGE	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**TOTAL**
Biomass (Tonnes)	179	1022	1165	5502	9262	3414	2041	0	0	0	22584
% Biomass	1	4.5	5.2	24.4	41.0	15.1	9.0	0.0	0	0	100
Abundance (Numbers in '000)	5196	18617	16323	68047	107703	35623	19964	0	0	0	271472
% Abundance	2	6.9	6.0	25.1	39.7	13.1	7.4	0.0	0	0	100
Medium Weight (gr)	34	54.9	71.4	80.9	86.0	95.8	102.2	0.0	0	0	47.8
Medium Length (cm)	17	19.1	20.8	21.6	22.1	22.9	23.3	0.0	0	0	13.3
AREA IXaN											
AGE	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**TOTAL**
Biomass (Tonnes)	16999	1969	1185	1069	287	0	0	0	0	0	21508
% Biomass	79.0	9.2	5.5	5.0	1.3	0.0	0.0	0.0	0	0	100
Abundance (Numbers in '000)	811649	52953	20094	16739	4175	0	0	0	0	0	905610
% Abundance	89.6	5.8	2.2	1.8	0.5	0.0	0.0	0.0	0	0	100
Medium Weight (gr)	20.9	37.2	59.0	63.9	68.8	0.0	0.0	0.0	0	0	22.7
Medium Length (cm)	14.0	16.7	19.6	20.1	20.6	0.0	0.0	0.0	0	0	8.3
TOTAL SPAIN											
AGE	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**TOTAL**
Biomass (Tonnes)	17552	5782	5889	13119	15546	6632	3006	545	69	0	68142
% Biomass	25.8	8.5	8.6	19.3	22.8	9.7	4.4	0.8	0.1	0.0	100
Abundance (Numbers in '000)	826018	118012	81810	162184	177979	69886	29185	5105	538	0	1470717
% Abundance	56.2	8.0	5.6	11.0	12.1	4.8	2.0	0.3	0.0	0.0	100.0
Medium Weight (gr)	21.2	49.0	72.0	80.9	87.4	94.9	103.0	106.8	128.3	0.0	82.6
Medium Length (cm)	14.1	18.2	20.8	21.6	22.2	22.8	23.4	23.7	25.1	0.0	21.3

Table 8.4.1.1a: Sardine in VIIIc and IXa: Sardine length composition (thousands) by ICES Sub-Division in the first quarter 2004.

				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								
9.5								
10								
10.5								
11	163							163
11.5	244	7						251
12	244	55				7		307
12.5	326	89					116	531
13	814	115			66	2	324	1 322
13.5	1 059	271		46	87	15	1551	3 030
14	169	136		126	104	57	3245	3 838
14.5		192	2	211	162	58	2564	625
15	85	174	5	507	409	185	1959	1 365
15.5	72	92	18	734	683	301	1912	1 900
16	174	132	50	665	760	748	732	2 530
16.5	277	82	79	1 253	1 194	681	1889	3 565
17	268	164	132	2 845	2 293	947	2392	6 649
17.5	139	310	312	4 634	4 197	817	4641	10 408
18	94	239	679	5 236	7 949	2018	6692	16 216
18.5	57	356	1 055	3 835	12 397	2944	6118	20 645
19	201	553	1 660	3 914	16 391	4123	5658	26 843
19.5	568	481	2 172	2 179	15 051	3749	4008	24 200
20	1 821	713	2 679	1 673	10 115	4689	4519	21 691
20.5	2 829	2 232	2 540	733	6 238	2733	1778	17 305
21	4 538	3 086	1 996	388	3 010	1529	1007	14 546
21.5	4 602	3 710	1 316	247	1 055	742	290	11 673
22	3 668	3 088	860	95	688	355		8 754
22.5	2 801	1 844	375	52	116	86		5 274
23	1 836	626	209	3	87	34		2 795
23.5	800	337	76	34	10			1 257
24	325	64						389
24.5	131	17						148
25	46							46
25.5	4							4
26								
26.5								
27	6							
27.5								
28								
28.5								
29								
Total	28 361	19 168	16 215	29 412	83 064	26 819	51 396	208 269
Mean L	20.7	20.9	20.3	18.4	19.3	19.4	17.9	19.5
sd	2.96	2.17	1.29	1.37	1.23	1.45	2.06	2.07
Catch	**2 006**	**1374**	**1 044**	**1441**	**4474**	**1513**	**2 302**	**14 154**

Table 8.4.1.1a: Sardine in VIIIc and IXa: Sardine length composition (thousands) by ICES Sub-Division in the first quarter 2004.

				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								
9.5								
10								
10.5								
11	163							163
11.5	244	7						251
12	244	55				7		307
12.5	326	89					116	531
13	814	115			66	2	324	1 322
13.5	1 059	271		46	87	15	1551	3 030
14	169	136		126	104	57	3245	3 838
14.5		192	2	211	162	58	2564	625
15	85	174	5	507	409	185	1959	1 365
15.5	72	92	18	734	683	301	1912	1 900
16	174	132	50	665	760	748	732	2 530
16.5	277	82	79	1 253	1 194	681	1889	3 565
17	268	164	132	2 845	2 293	947	2392	6 649
17.5	139	310	312	4 634	4 197	817	4641	10 408
18	94	239	679	5 236	7 949	2018	6692	16 216
18.5	57	356	1 055	3 835	12 397	2944	6118	20 645
19	201	553	1 660	3 914	16 391	4123	5658	26 843
19.5	568	481	2 172	2 179	15 051	3749	4008	24 200
20	1 821	713	2 679	1 673	10 115	4689	4519	21 691
20.5	2 829	2 232	2 540	733	6 238	2733	1778	17 305
21	4 538	3 086	1 996	388	3 010	1529	1007	14 546
21.5	4 602	3 710	1 316	247	1 055	742	290	11 673
22	3 668	3 088	860	95	688	355		8 754
22.5	2 801	1 844	375	52	116	86		5 274
23	1 836	626	209	3	87	34		2 795
23.5	800	337	76	34	10			1 257
24	325	64						389
24.5	131	17						148
25	46							46
25.5	4							4
26								
26.5								
27	6							
27.5								
28								
28.5								
29								
Total	28 361	19 168	16 215	29 412	83 064	26 819	51 396	208 269
Mean L	20.7	20.9	20.3	18.4	19.3	19.4	17.9	19.5
sd	2.96	2.17	1.29	1.37	1.23	1.45	2.06	2.07
Catch	**2 006**	**1374**	**1 044**	**1441**	**4474**	**1513**	**2 302**	**14 154**

Table 8.4.1.1b: Sardine in VIIIc and IXa: Sardine length composition (thousands) by ICES Sub-Division in the second quarter 2004.								
				Second Quarter				
Length	**VIIIc E**	**VIIIc W**	**IXa N**	**IXa CN**	**IXa CS**	**IXa S**	**IXa S (Ca)**	**Total**
7								
7.5								
8				44				44
8.5				44				44
9				45				45
9.5				52				52
10		16		239				255
10.5		127		29				156
11	17	465	4	233				719
11.5	176	1 129	13	224				1 542
12	231	1 303	22		28			1 584
12.5	71	573	17	0	96		46	804
13	8	287	11		249		0	556
13.5		48	6		596		23	672
14		25	1		615		77	718
14.5		134		121	704	26	542	1 526
15		243		345	703	63	1677	3 031
15.5		259		639	1 048	65	2872	4 883
16	2	276	7	1796	1 327	247	4077	7 731
16.5	5	330	37	3434	1 206	196	6070	11 277
17	9	266	169	5753	1 119	815	6155	14 287
17.5	13	272	83	6829	2 032	2309	7908	19 445
18	12	278	795	8789	4 118	5327	5266	24 585
18.5	70	258	812	11695	7 351	6832	2317	29 335
19	19	275	3 635	16141	11 501	7724	1531	40 827
19.5	147	919	2 747	13993	12 459	4774	703	35 741
20	659	2 078	3 242	9993	10 485	3195	309	29 961
20.5	795	4 444	3 094	4541	6 679	1060	271	20 885
21	1 321	6 356	2 766	2301	4 048	763	46	17 602
21.5	1 823	4 596	1 086	778	2 055	308	99	10 747
22	2 564	3 706	657	176	742	162	50	8 057
22.5	2 281	1 800	124	89	274	51		4 619
23	1 622	1 114	58	0	76	9		2 879
23.5	768	318		16	7			1 109
24	246	186			8			440
24.5	126	45						170
25	6	11						16
25.5	5	6						11
26	2							2
26.5								
27			13					13
27.5								
28								
28.5								
29								
Total	12 997	32 143	19 403	88 340	69 524	33 927	40 039	296 373
Mean L	21.8	20.	20.2	18.9	19.3	19.1	17.3	19.1
sd	2.22	3.32	1.18	1.51	1.65	1.01	1.19	2.01
Catch	**1 136**	**2285**	**1 334**	**4924**	**4392**	**2028**	**1 779**	**17 878**

Table 8.4.1.1c: Sardine in VIIIc and IXa: Sardine length composition (thousands) by ICES Sub-Division in the third quarter 2004.

				Third Quarter				
Length	**VIIIc E**	**VIIIc W**	**IXa N**	**IXa CN**	**IXa CS**	**IXa S**	**IXa S (Ca)**	**Total**
7				19				19
7.5				134				134
8				195				195
8.5				161				161
9				50				50
9.5			65	88				154
10			380	569				948
10.5			843	2612				3 455
11	13		2 610	6484	129	68		9 304
11.5	97		5 848	12158	287	34		18 424
12	252		13 105	21972	239	477	134	36 179
12.5	148		4 251	27467	334	682	136	33 018
13	72		3 033	39642	511	2387	402	46 047
13.5	890		640	35015	537	1504	197	38 783
14	4 004	29	323	28455	806	1809	536	35 963
14.5	8 124	114	190	22436	1 089	814	1231	33 997
15	9 710	472	253	9876	719	619	3320	24 970
15.5	4 831	713	61	4638	643	48	4624	15 558
16	1 255	305	26	673	253	278	5371	8 161
16.5	220	96	26	870	301	204	4908	6 625
17	1		84	2439	626	639	7812	11 600
17.5	1	103	81	4618	1 786	1123	11515	19 225
18	1	455	547	8518	4 035	3007	12984	29 548
18.5	1	943	1 117	13172	8 381	3690	12527	39 831
19	2	1 138	3 172	25375	12 593	5450	8407	56 138
19.5	29	1 380	6 502	27805	15 866	3949	3917	59 448
20	124	3 611	12 159	22849	15 801	4205	1502	60 252
20.5	282	7 221	9 412	9777	12 156	1222	304	40 374
21	869	7 048	6 788	5109	8 636	810	210	29 470
21.5	2 086	7 142	2 190	1552	4 841	162		17 973
22	2 481	3 840	1 386	523	2 184	54		10 468
22.5	2 704	1 322	295	224	944	5		5 494
23	1 843	464	137	52	367		105	2 968
23.5	1 188	5	22	1	39			1 256
24	441	25	9					475
24.5	180	34	22	1				237
25	63							63
25.5	1							1
26	6							6
26.5								
27								
27.5								
28								
28.5								
29								
Total	41 919	36 460	75 575	335 532	94 106	33 242	80 140	696 974
Mean L	17.2	20.8	17.	15.7	19.7	17.9	17.8	17.1
sd	3.52	1.52	4.12	3.15	1.77	2.60	1.43	3.35
Catch	**2 087**	**2947**	**3 762**	**11940**	**6683**	**1949**	**3 878**	**33 246**

Table 8.4.1.1d: Sardine in VIIIc and IXa: Sardine length composition (thousands) by ICES Sub-Division in the fourth quarter 2004.

				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								
10				87				87
10.5				1412				1 412
11	3		28	6017				6 048
11.5	24	10	21	15215				15 269
12	269	48	1 038	37958				39 313
12.5	203	280	2 415	43256		6	207	46 368
13	220	397	5 576	38740		13	917	45 863
13.5	346	335	6 838	32109		14	1117	40 760
14	1 319	453	6 715	20931	77	53	827	30 376
14.5	3 519	952	4 906	10878	177	66	593	21 091
15	4 876	2 564	2 160	5071	663	105	152	15 589
15.5	4 011	7 062	894	1957	1 398	129	448	15 901
16	1 951	9 097	376	524	1 583	390	297	14 218
16.5	1 044	5 436	273	124	1 448	370	794	9 489
17	457	2 042	92	633	1 305	718	1302	6 550
17.5	105	312	40	1827	2 234	660	2465	7 643
18	13	222	63	3606	3 757	1334	4076	13 073
18.5	2	65	119	3973	7 563	1391	4089	17 202
19	121	87	441	8424	12 287	3000	3276	27 635
19.5	212	183	1 118	14057	14 358	3168	2564	35 660
20	1 999	136	2 246	14547	13 980	6061	1316	40 286
20.5	4 560	877	3 745	10422	11 335	4737	586	36 262
21	8 926	1 385	3 810	8041	6 897	3738	137	32 934
21.5	8 578	2 971	4 356	3124	4 566	796		24 390
22	8 778	3 128	3 099	1511	2 309	539		19 364
22.5	5 267	2 539	1 627	450	827	66		10 776
23	2 959	1 339	432	142	182	39		5 093
23.5	1 182	410	167	65	44			1 869
24	186	107	36	0	39			368
24.5	76	60	85					222
25	5		18					23
25.5	4		36					40
26								
26.5								
27								
27.5								
28								
28.5								
29								
Total	61 217	42 497	52 770	285 102	87 029	27 394	25 165	581 175
Mean L	19.9	17.9	17.	14.8	19.8	19.9	17.9	16.9
sd	3.12	2.95	3.73	3.17	1.46	1.36	1.98	3.63
Catch	**4 292**	**2178**	**2 433**	**8560**	**6041**	**1887**	**1 217**	**26 608**

Table 8.4.1.2: Sardine in VIIIc and IXa: Catch in numbers (thousands) at age by quarter and by SubDivision in 2004

							First	Quarter
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0								0
1	3690	1661	547	2475	4534.94	3213	14480	30601
2	2104	1398	2675	10123	16250.16	793	11530	44872
3	7140	2510	3771	6244	29304.38	11457	15892	76319
4	5336	9004	7446	9903	24741.23	7684	6861	70976
5	5567	2485	1121	316	5382.937	2196	1931	18998
6	2674	1023	406	241	1576.55	935	702	7558
7	1252	505	249	90	864.8129	470		3431
8	512	582		18	184.608	71		1368
9	86				202.6528			289
10				3	21.81776			25
Total	28361	19168	16215	29412	83064	26819	51396	254436
Catch (Tons)	2006	1374	1044	1441	4474	1513	2302	14154

							Second	Quarter
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0				910				910
1	522	5579	792	16318	8694	2237	13709	47851
2	563	1583	3171	19997	14112	4495	15183	59105
3	2870	4038	4888	15571	21397	17021	8792	74577
4	2540	14364	8972	33103	19567	6000	1969	86514
5	3384	3686	1116	1826	3066	1137	295	14510
6	1771	1361	319	495	1657	1915	92	7610
7	934	729	145	120	558	364		2849
8	378	804			272	759		2212
9	34				200			234
10								0
Total	12997	32143	19403	88340	69524	33927	40039	296373
Catch (Tons)	1136	2285	1334	4924	4392	2028	1779	17878

							Third	Quarter
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	28232	1559	31585	212308	5421	8444	2997	290546
1	1105	1839	362	13185	5809	2274	32030	56605
2	1099	2435	3187	26624	17567	5109	28129	84150
3	3930	8260	15124	34785	36923	10250	14420	123693
4	3316	17318	18901	45814	19253	3838	1826	110266
5	1940	4311	4682	1983	4984	1630	311	19842
6	1393	544	1385	731	2609	1369	427	8459
7	902	194	349	30	837	122		2434
8				56	506			561
9				16	113	206		334
10					84			84
Total	41919	36460	75575	335531	94106	33242	80140	696974
Catch (Tons)	2087	2947	3762	11940	6683	1949	3878	33246

							Fourth	Quarter
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	15516	20277	30335	212915	4622	738.2755	3279	287683
1	2046	9013	1030	5209	9250	3583.321	5722	35854
2	7560	244	494	12880	21740	3369.186	8621	54907
3	17295	2416	4588	19338	21101	11929.19	5917	82584
4	9041	6227	9434	31548	20709	5420.529	1039	83419
5	5437	3015	3417	2500	5671	1190.524	243	21473
6	2678	799	2444	476	1833	1010.828	344	9585
7	1644	506	1028	236	1357	152.274		4924
8					603			603
9					122			122
10					23			23
Total	61217	42497	52770	285102	87029	27394	25165	581175
Catch (Tons)	4292	2178	2433	8560	6041	1887	1217	26608

							Whole	Year
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	43749	21836	61920	426134	10042	9183	6276	579139
1	7365	18091	2732	37186	28288	11307	65941	170910
2	11325	5660	9527	69624	69669	13766	63462	243033
3	31235	17225	28371	75939	108725	50657	45020	357172
4	20233	46912	44752	120368	84271	22942	11696	351174
5	16328	13497	10335	6625	19104	6154	2780	74823
6	8516	3728	4554	1944	7676	5230	1566	33213
7	4733	1934	1771	475	3617	1108		13638
8	890	1386		74	1566	830		4745
9	120			16	637	206		978
10				3	129			132
Total	144494	130269	163962	738386	333723	121382	196741	1828957
Catch (Tons)	9522	8784	8573	26864	21590	7377	9176	91886

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	IXa-S (Ca)	Total
0	30%	17%	38%	58%	3%	8%	3%	32%
1	5%	14%	2%	5%	8%	9%	34%	9%
2	8%	4%	6%	9%	21%	11%	32%	13%
3	22%	13%	17%	10%	33%	42%	23%	20%
4	14%	36%	27%	16%	25%	19%	6%	19%
5	11%	10%	6%	1%	6%	5%	1%	4%
6+	10%	5%	4%	0%	4%	6%	1%	3%
	100%	100%	100%	100%	100%	100%	100%	100%

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
0	8%	4%	11%	74%	2%	2%	1%	100%
1	4%	11%	2%	22%	17%	7%	39%	100%
2	5%	2%	4%	29%	29%	6%	26%	100%
3	9%	5%	8%	21%	30%	14%	13%	100%
4	6%	13%	13%	34%	24%	7%	3%	100%
5	22%	18%	14%	9%	26%	8%	4%	100%
6+	27%	13%	12%	5%	26%	14%	3%	100%

Table 8.4.2.1: Sardine VIIIc and IXa: Sardine Mean length (cm) at age by quarter and by Subdivision in 2004.

							First	Quarter
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0								
1	13.7	15.1	18.7	15.8	16.3	16.6	15.1	15.4
2	19.9	19.5	19.1	17.7	18.3	18.6	18.2	18.3
3	21.2	21.0	20.0	18.6	19.4	19.3	19.0	19.5
4	21.8	21.6	20.7	19.4	19.9	20.2	19.5	20.2
5	22.2	22.0	21.6	20.7	20.4	20.6	20.3	21.2
6	22.5	22.4	22.1	21.0	21.3	20.9	20.7	21.8
7	22.9	22.4	22.5	22.3	21.4	20.7		22.1
8	23.0	22.4		21.2	21.8	22.5		22.5
9	23.9				21.3			22.1
10				22.8	22.4			22.4

							Second	Quarter
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0				10.6				10.6
1	12.3	13.3	18.5	17.2	16.0	17.4	16.3	16.2
2	20.3	19.8	19.3	18.7	19.0	18.3	17.5	18.5
3	21.5	21.0	19.9	19.2	19.7	19.0	18.2	19.4
4	22.1	21.4	20.5	19.8	20.2	19.7	19.0	20.3
5	22.5	21.8	21.4	20.4	20.6	19.9	20.3	21.3
6	22.7	22.3	21.8	20.9	20.4	20.1	21.2	21.3
7	23.0	22.3	22.3	21.4	21.1	19.9		22.0
8	23.2	22.4			21.3	21.5		22.1
9	23.9				21.9			22.2
10								

							Third	Quarter
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	15.0	15.6	12.3	13.4	14.2	13.7	14.5	13.5
1	16.0	18.4	17.6	17.9	18.1	17.9	16.9	17.3
2	20.1	19.7	19.5	19.2	19.2	18.6	18.3	18.9
3	22.2	21.1	20.2	19.7	20.1	19.4	18.9	19.9
4	22.7	21.3	20.6	20.0	20.6	19.8	19.3	20.5
5	22.9	21.8	20.9	20.8	21.2	20.3	21.2	21.3
6	23.1	22.3	21.8	20.9	21.7	20.6	20.9	21.7
7	23.2	23.1	22.5	22.4	21.5	20.8		22.4
8				21.3	21.9			21.9
9				22.4	21.8	20.3		20.9
10					22.3			22.3

							Fourth	Quarter
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	15.1	15.7	13.9	13.1	15.9	15.9	13.8	13.5
1	16.6	16.8	16.4	17.5	18.1	18.0	17.3	17.4
2	20.5	19.8	19.5	19.5	19.4	19.4	18.6	19.4
3	21.7	21.8	20.7	20.1	20.2	20.3	19.2	20.5
4	22.2	22.0	21.3	20.4	20.5	20.8	19.7	20.9
5	22.1	22.5	21.7	21.0	21.3	21.1	20.7	21.7
6	22.6	22.9	22.1	21.8	21.8	20.9	20.6	22.1
7	22.8	23.2	22.7	22.2	21.7	22.6		22.5
8					21.9			21.9
9					22.3			22.3
10					23.3			23.3

							Whole	Year
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	15.0	15.7	13.1	13.2	15.0	13.9	14.1	13.5
1	14.8	15.7	17.6	17.4	17.1	17.4	16.5	16.7
2	20.4	19.7	19.3	18.9	19.0	18.7	18.1	18.8
3	21.6	21.2	20.2	19.6	19.8	19.4	18.8	19.9
4	22.1	21.5	20.8	20.0	20.3	20.1	19.4	20.5
5	22.3	22.0	21.3	20.8	20.9	20.5	20.4	21.4
6	22.7	22.5	22.0	21.1	21.4	20.5	20.8	21.7
7	22.9	22.6	22.6	22.0	21.5	20.7		22.2
8	23.1	22.4		21.2	21.8	21.6		22.2
9	23.9			22.4	21.8	20.3		21.7
10				22.8	22.4			22.5

Table 8.4.2.2: Sardine VIIIc and Ixa: Sardine Mean weight (kg) at age by quarter and by SubDivision in 2004

							First	Quarter
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0								
1	0.020	0.027	0.050	0.031	0.033	0.035	0.026	0.028
2	0.061	0.057	0.053	0.044	0.046	0.049	0.046	0.047
3	0.072	0.071	0.061	0.050	0.054	0.055	0.052	0.056
4	0.079	0.077	0.068	0.057	0.058	0.063	0.057	0.063
5	0.084	0.081	0.077	0.070	0.063	0.067	0.063	0.073
6	0.087	0.086	0.082	0.073	0.072	0.070	0.067	0.079
7	0.091	0.085	0.086	0.086	0.073	0.068		0.082
8	0.093	0.086		0.075	0.077	0.087		0.088
9	0.105				0.073			0.082
10				0.091	0.084			0.084

							Second	Quarter
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0				0.010				0.010
1	0.017	0.022	0.054	0.041	0.034	0.046	0.037	0.037
2	0.070	0.066	0.060	0.053	0.058	0.053	0.045	0.053
3	0.082	0.077	0.066	0.057	0.066	0.059	0.051	0.062
4	0.089	0.081	0.072	0.064	0.072	0.065	0.057	0.070
5	0.094	0.086	0.081	0.069	0.077	0.067	0.069	0.082
6	0.096	0.092	0.086	0.075	0.075	0.069	0.078	0.082
7	0.100	0.092	0.091	0.080	0.083	0.066		0.089
8	0.103	0.092			0.086	0.083		0.090
9	0.112				0.095			0.098
10								

							Third	Quarter
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	0.027	0.031	0.014	0.020	0.025	0.027	0.025	0.021
1	0.034	0.054	0.046	0.047	0.053	0.056	0.041	0.045
2	0.074	0.066	0.064	0.059	0.064	0.062	0.053	0.059
3	0.098	0.083	0.072	0.064	0.074	0.070	0.058	0.070
4	0.104	0.086	0.077	0.067	0.080	0.075	0.062	0.075
5	0.108	0.092	0.081	0.075	0.087	0.080	0.084	0.087
6	0.112	0.099	0.092	0.076	0.095	0.082	0.081	0.093
7	0.113	0.111	0.102	0.093	0.091	0.084		0.102
8				0.080	0.097			0.095
9				0.094	0.095	0.079		0.085
10					0.102			0.102

							Fourth	Quarter
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	0.027	0.031	0.021	0.017	0.034	0.036	0.020	0.020
1	0.037	0.038	0.035	0.044	0.052	0.051	0.043	0.044
2	0.073	0.064	0.061	0.062	0.064	0.063	0.053	0.063
3	0.086	0.087	0.074	0.069	0.073	0.072	0.058	0.074
4	0.092	0.089	0.081	0.072	0.077	0.077	0.063	0.078
5	0.091	0.096	0.086	0.080	0.087	0.080	0.073	0.088
6	0.098	0.102	0.091	0.089	0.094	0.078	0.072	0.092
7	0.100	0.106	0.098	0.094	0.093	0.098		0.098
8					0.096			0.096
9					0.102			0.102
10					0.116			0.116

							Whole	Year
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	0.027	0.031	0.018	0.019	0.029	0.028	0.023	0.020
1	0.026	0.033	0.045	0.043	0.043	0.046	0.037	0.039
2	0.071	0.064	0.059	0.056	0.059	0.059	0.050	0.056
3	0.084	0.080	0.070	0.063	0.067	0.063	0.054	0.066
4	0.090	0.083	0.075	0.067	0.071	0.069	0.058	0.072
5	0.091	0.089	0.082	0.075	0.079	0.073	0.067	0.083
6	0.096	0.093	0.090	0.078	0.086	0.074	0.073	0.087
7	0.100	0.096	0.097	0.089	0.086	0.073		0.093
8	0.097	0.090		0.079	0.092	0.083		0.091
9	0.107			0.094	0.089	0.079		0.089
10				0.091	0.101			0.101

Table 8.8.1.1a: Sardine VIIIc and IXa: Input to the AMCI assessment model: Catch data per year and age class (thousand individuals).

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
0	869437	674489	856671	1025961	62000	1070000	118000	268000	304000	1437000
1	2296646	1535557	2037400	1934838	795000	577000	3312000	564000	755000	543000
2	946698	956132	1561971	1733725	1869000	857000	487000	2371000	1027000	667000
3	295360	431466	378785	679001	709000	803000	502000	469000	919000	569000
4	136661	189107	156922	195304	353000	324000	301000	294000	333000	535000
5	41744	93185	47302	104545	131000	141000	179000	201000	196000	154000
6+	16468	36038	30006	76466	129000	139000	117000	103000	167000	171000

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	521000	248000	258000	1580579	498265	87808	120797	30512	277053	208570
1	990000	566000	602000	477368	1001856	566221	60194	189147	101267	548594
2	535000	909000	517000	436081	451367	1081818	542163	280715	347690	453324
3	439000	389000	707000	406886	340313	521458	1094442	829707	514741	391118
4	304000	221000	295000	265762	186234	257209	272466	472880	652711	337282
5	292000	200000	151000	74726	110932	113871	112635	70208	197235	225170
6+	189000	245000	248000	105186	80579	120282	72091	64485	46607	70268

Age	1998	1999	2000	2001	2002	2003	2004
0	449115	246016	489836	219973	106882	198412	579139
1	366176	475225	354822	1172301	587354	318695	170910
2	501585	361509	313972	256133	753897	446285	243033
3	352485	339691	255523	195897	181381	518289	357172
4	233672	177170	194156	126389	112166	114035	351174
5	178735	105518	97693	75145	55650	61276	74823
6+	105884	72541	64373	49547	40219	51172	52705

Table 8.8.1.1b: Sardine VIIIc and IXa:Input to the AMCI assessment model: Survey data, Spanish March survey.

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
0										
1									55067	44000
2									20551	36000
3									1040674	4000
4									215284	398000
5									408836	118000
6+									571684	245000

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0										
1	224056		69072	25415	167959	238561			10639	56495
2	63832		56015	208127	77477	427333			54249	263095
3	73627		272946	163708	88392	135919			90547	125658
4	64156		53317	400984	30956	126078			350825	123331
5	848302		87541	62373	116886	145795			213842	65713
6+	885665		582299	574261	122791	1117949			24779	61002

Age	1998	1999	2000	2001	2002	2003	2004	2005
0								
1	509838	214525	91656	975603	270396	42375	14383	826018
2	103126	160375	285808	262883	760203	773772	196511	118012
3	80396	134618	435440	186538	448599	1041239	664706	81810
4	33762	124313	242249	142929	651658	459583	754871	162184
5	20590	28357	188879	98945	318591	209138	228946	177979
6+	25410	64013	68124	66062	163290	136528	237402	104715

Table 8.8.1.1.c: Sardine VIIIc and IXa: Input to the AMCI assessment model: Survey data, Portuguese March survey.

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0										
1									1624985	6344145
2									2082197	3238140
3									2414528	1551784
4									2906008	1260213
5									386476	1360066
6+									11964	202795

Age	1998	1999	2000	2001	2002	2003	2004	2005
0								
1	1636191	5711743	6581454	18684340	12770161	5842158		22095570
2	4014982	2552623	2169927	774490	6237872	3810357		1184088
3	2190882	1460677	1221678	515440	715509	2526697		603377
4	1433972	844435	756681	337330	479319	549396		600997
5	1185007	595713	531945	275530	246956	361164		474767
6+	979993	469137	613224	183680	278741	201548		264567

Table 8.8.1.1.d: Sardine VIIIc and IXa: Input to the AMCI assessment model: Survey data, Portuguese November survey.

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
0							2956621	2063177	2493102	3714540
1							5733231	2743525	1611895	2379377
2							1152160	4548240	1669563	1343695
3							1036826	1083437	658385	928682
4							528343	839215	322912	665600
5							76423	143789	127266	236473
6+							40140	69987	49634	79903

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0					6349072					2424702
1					5480539					1961202
2					1157103					906448
3					1002580					728899
4					437424					1040594
5					108224					771805
6+					18772					322421

Age	1998	1999	2000	2001
0	8680376	3696787	30871080	9202582
1	1809393	798000	1615890	5433385
2	1214608	646000	246620	721533
3	823316	391121	89920	537225
4	396247	459342	121900	126483
5	367120	382447	93970	135808
6+	220416	164649	66460	53374

Table 8.8.1.1e: Sardine VIIIc and IXa: Input to the AMCI assessment model: Mean weight in the Catches (kg)

Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6+
1978	0.017	0.034	0.052	0.06	0.068	0.072	0.1
1979	0.017	0.034	0.052	0.06	0.068	0.072	0.1
1980	0.017	0.034	0.052	0.06	0.068	0.072	0.1
1981	0.017	0.034	0.052	0.06	0.068	0.072	0.1
1982	0.017	0.034	0.052	0.06	0.068	0.072	0.1
1983	0.017	0.034	0.052	0.06	0.068	0.072	0.1
1984	0.017	0.034	0.052	0.06	0.068	0.072	0.1
1985	0.017	0.034	0.052	0.06	0.068	0.072	0.1
1986	0.017	0.034	0.052	0.06	0.068	0.072	0.1
1987	0.017	0.034	0.052	0.06	0.068	0.072	0.1
1988	0.017	0.034	0.052	0.06	0.068	0.072	0.1
1989	0.013	0.035	0.052	0.059	0.066	0.071	0.1
1990	0.024	0.032	0.047	0.057	0.061	0.067	0.1
1991	0.02	0.031	0.058	0.063	0.073	0.074	0.1
1992	0.018	0.045	0.055	0.066	0.07	0.079	0.1
1993	0.017	0.037	0.051	0.058	0.066	0.071	0.1
1994	0.02	0.036	0.058	0.062	0.07	0.076	0.1
1995	0.025	0.047	0.059	0.066	0.071	0.082	0.1
1996	0.019	0.038	0.051	0.058	0.061	0.071	0.1
1997	0.022	0.033	0.052	0.062	0.069	0.073	0.1
1998	0.024	0.04	0.055	0.061	0.064	0.067	0.1
1999	0.025	0.042	0.056	0.065	0.07	0.073	0.1
2000	0.025	0.037	0.056	0.066	0.071	0.074	0.1
2001	0.023	0.042	0.059	0.067	0.075	0.079	0.1
2002	0.028	0.045	0.057	0.069	0.075	0.079	0.1
2003	0.024	0.044	0.059	0.067	0.079	0.084	0.1
2004	0.02	0.039	0.056	0.066	0.072	0.083	0.1

Table 8.8.1.1f: Sardine VIIIc and IXa: Input to the AMCI assessment model: Mean weight in the Stock (kg)

Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6+
1978	0	0.015	0.038	0.050	0.064	0.067	0.100
1979	0	0.015	0.038	0.050	0.064	0.067	0.100
1980	0	0.015	0.038	0.050	0.064	0.067	0.100
1981	0	0.015	0.038	0.050	0.064	0.067	0.100
1982	0	0.015	0.038	0.050	0.064	0.067	0.100
1983	0	0.015	0.038	0.050	0.064	0.067	0.100
1984	0	0.015	0.038	0.050	0.064	0.067	0.100
1985	0	0.015	0.038	0.050	0.064	0.067	0.100
1986	0	0.015	0.038	0.050	0.064	0.067	0.100
1987	0	0.015	0.038	0.050	0.064	0.067	0.100
1988	0	0.015	0.038	0.050	0.064	0.067	0.100
1989	0	0.015	0.038	0.050	0.064	0.067	0.100
1990	0	0.015	0.038	0.050	0.064	0.067	0.100
1991	0	0.019	0.042	0.050	0.064	0.071	0.100
1992	0	0.027	0.036	0.050	0.062	0.069	0.100
1993	0	0.022	0.045	0.057	0.064	0.073	0.100
1994	0	0.031	0.040	0.049	0.060	0.067	0.100
1995	0	0.029	0.050	0.062	0.072	0.079	0.100
1996	0	0.036	0.047	0.061	0.069	0.075	0.100
1997	0	0.025	0.050	0.058	0.068	0.074	0.100
1998	0	0.023	0.041	0.053	0.061	0.067	0.100
1999	0	0.020	0.039	0.054	0.062	0.068	0.100
2000	0	0.017	0.043	0.059	0.064	0.067	0.100
2001	0	0.017	0.042	0.058	0.075	0.080	0.100
2002	0	0.020	0.044	0.060	0.071	0.078	0.100
2003	0	0.027	0.054	0.064	0.075	0.082	0.100
2004	0	0.020	0.045	0.061	0.069	0.076	0.100

Table 8.8.1.1g: Sardine VIIIc and IXa: Input to the AMCI assessment model: Maturity ogive.

Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6+
1978	0	0.650	0.950	1.000	1.000	1.000	1.000
1979	0	0.650	0.950	1.000	1.000	1.000	1.000
1980	0	0.650	0.950	1.000	1.000	1.000	1.000
1981	0	0.650	0.950	1.000	1.000	1.000	1.000
1982	0	0.650	0.950	1.000	1.000	1.000	1.000
1983	0	0.650	0.950	1.000	1.000	1.000	1.000
1984	0	0.650	0.950	1.000	1.000	1.000	1.000
1985	0	0.650	0.950	1.000	1.000	1.000	1.000
1986	0	0.650	0.950	1.000	1.000	1.000	1.000
1987	0	0.650	0.950	1.000	1.000	1.000	1.000
1988	0	0.650	0.950	1.000	1.000	1.000	1.000
1989	0	0.230	0.830	0.910	0.920	0.940	0.977
1990	0	0.600	0.810	0.880	0.890	0.940	0.987
1991	0	0.740	0.910	0.960	0.970	1.000	1.000
1992	0	0.790	0.910	0.950	0.980	1.000	1.000
1993	0	0.470	0.930	0.940	0.970	0.990	1.000
1994	0	0.800	0.890	0.960	0.960	0.970	1.000
1995	0	0.730	0.980	0.970	0.990	1.000	1.000
1996	0	0.830	0.890	0.920	0.960	1.000	1.000
1997	0	0.727	0.918	0.950	0.972	0.993	1.000
1998	0	0.720	0.924	0.956	0.987	0.995	1.000
1999	0	0.619	0.911	0.987	0.995	1.000	1.000
2000	0	0.257	0.910	0.947	0.950	1.000	1.000
2001	0	0.391	0.902	0.962	0.989	1.000	1.000
2002	0	0.496	0.936	0.964	0.985	0.987	1.000
2003	0	0.500	0.964	0.988	0.997	0.999	1.000
2004	0	0.489	0.936	0.974	0.983	0.985	1.000

Table 8.8.1.1h: Sardine VIIIc and IXa: Input to the AMCI assessment model: SSB (thousand tons) from DEPM surveys.

Year	SSB
1999	269.0
2000	
2001	
2002	442.6

Table 8.8.1.2a: Sardine VIIIc and IXa:Recruitment (thousands), SSB (tons) and F ($year^{-1}$) estimates from the AMCI assessment model.

Year	Recruitment	SSB	F(2-5)
1978	11326329	285706	0.39
1979	12912546	349642	0.40
1980	14320703	428173	0.29
1981	9470404	531521	0.35
1982	6823526	559084	0.33
1983	19485728	517864	0.29
1984	7251385	571914	0.26
1985	6118733	665000	0.26
1986	5208636	600561	0.33
1987	9259239	499086	0.32
1988	5589434	438466	0.34
1989	5700706	371302	0.36
1990	5289988	336277	0.43
1991	12535520	343527	0.32
1992	10707869	462669	0.28
1993	4668418	523766	0.33
1994	4544285	536496	0.23
1995	3862658	590844	0.24
1996	4723358	510392	0.25
1997	3689068	442467	0.33
1998	3901944	362380	0.39
1999	3730510	304988	0.35
2000	11190992	264419	0.34
2001	7055308	302489	0.26
2002	3690099	456962	0.22
2003	2253893	558465	0.22
2004	19927058	430846	0.23

Table 8.8.1.2b: Sardine VIIIc and IXa:Fishing mortality (year^{-1}) at age and year estimates from the AMCI assessment model.

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
0	0.07	0.06	0.05	0.07	0.05	0.05	0.04	0.04	0.05	0.07
1	0.28	0.27	0.21	0.25	0.21	0.17	0.18	0.16	0.20	0.18
2	0.42	0.41	0.33	0.40	0.38	0.32	0.27	0.27	0.34	0.32
3	0.39	0.39	0.28	0.35	0.33	0.29	0.27	0.27	0.32	0.33
4	0.37	0.39	0.28	0.32	0.32	0.28	0.25	0.25	0.34	0.31
5	0.36	0.39	0.27	0.33	0.31	0.27	0.26	0.25	0.32	0.33
6+	0.33	0.35	0.24	0.31	0.33	0.31	0.28	0.24	0.28	0.27

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	0.07	0.07	0.07	0.07	0.05	0.05	0.03	0.02	0.03	0.04
1	0.19	0.19	0.21	0.15	0.13	0.13	0.07	0.07	0.06	0.10
2	0.33	0.33	0.35	0.25	0.22	0.24	0.14	0.14	0.15	0.20
3	0.35	0.38	0.43	0.34	0.30	0.36	0.26	0.28	0.30	0.37
4	0.35	0.37	0.47	0.34	0.32	0.37	0.28	0.29	0.32	0.44
5	0.33	0.39	0.47	0.34	0.30	0.35	0.24	0.25	0.24	0.30
6+	0.29	0.30	0.35	0.25	0.22	0.25	0.16	0.16	0.15	0.17

Age	1998	1999	2000	2001	2002	2003	2004
0	0.06	0.05	0.05	0.04	0.03	0.04	0.05
1	0.12	0.12	0.12	0.11	0.10	0.11	0.11
2	0.23	0.22	0.21	0.17	0.15	0.15	0.15
3	0.41	0.36	0.34	0.26	0.22	0.22	0.22
4	0.49	0.43	0.41	0.32	0.27	0.26	0.27
5	0.41	0.38	0.40	0.31	0.26	0.26	0.27
6+	0.17	0.15	0.14	0.11	0.09	0.10	0.10

Table 8.8.1.2c: Sardine VIIIc and IXa: Stock numbers (thousands) at age (1st January) in the population estimates from the AMCI assessment model.

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
0	11326330	12912546	14320704	9470405	6823527	19485728	7251385	6118734	5208637	9259239
1	7278842	8965671	10260660	11562250	7491684	5494824	15775220	5932242	5009344	4219878
2	3471979	3962219	4907518	5982177	6491784	4360302	3322668	9471792	3635450	2958878
3	1198522	1642860	1889481	2544935	2883058	3194966	2285746	1829001	5210519	1855000
4	571490	583420	797089	1025416	1292520	1495750	1710582	1251406	1000324	2726475
5	172411	284354	282828	432866	533311	677376	814846	960493	702138	512950
6+	70995	122924	200453	268305	364891	468743	617513	790297	985071	899000

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	5589435	5700706	5289989	12535521	10707869	4668419	4544286	3862658	4723358	3689069
1	7343564	4402553	4516673	4184450	9950069	8597272	3763477	3743264	3195337	3885633
2	2530283	4383453	2623569	2640633	2593573	6285776	5417937	2525525	2511515	2159752
3	1543493	1313919	2272107	1323021	1480619	1496428	3551813	3379222	1570674	1558602
4	963199	781114	649125	1058249	679171	789763	748294	1978282	1843329	834480
5	1439965	489866	389123	290567	539913	356004	391380	408597	1063344	960327
6+	761718	1156535	855986	606280	487402	570077	499051	526962	552383	944822

Age	1998	1999	2000	2001	2002	2003	2004
0	3901945	3730510	11190992	7055309	3690100	2253894	19927058
1	3003021	3118114	2994693	9024941	5764539	3033944	1828534
2	2536573	1920640	1984392	1901081	5808255	3745789	1955133
3	1269029	1444069	1112410	1157289	1157994	3606925	2316324
4	771920	602917	723279	566615	640860	668399	2085443
5	385926	341564	281520	344368	295937	353436	369334
6+	1085500	840176	689828	568581	549000	523988	536747

Table 8.8.1.2d: Sardine VIIIc and IXa: Catchability estimates from the AMCI assessment model by survey and period.

Age	Spanish March acoustic survey		Portuguese March acoustic survey	Portuguese November acoustic survey	
	1986-1993	1996-2005	1996-2005	1984-1992	1997-2001
0				0.459	1.467
1	0.016	0.031	1.490	0.605	0.634
2	0.027	0.099	1.096	0.638	0.444
3	0.061	0.155	0.940	0.605	0.481
4	0.136	0.262	1.095	0.592	0.714
5	0.347	0.263	1.130	0.277	0.991
6+	0.719	0.121	0.362	0.091	0.224

Table 8.8.1.2e: Sardine VIIIc and IXa: Residuals (tonnes) for the DEPM survey estimates of SSB from the AMCI assessment model by survey and period.

Year	Obs-Exp
1999	-35988
2002	-14363

Table 8.9.1.1. Sardine (VIIIc and Ixa). Input data for the deterministic short term prediction.

MFDP version 1a
Run: change2
Time and date: 20:51 13/09/2005
Fbar age range: 2-5

				2005				
	Stock	Natural	Maturity	Prop. of F	Prop. of M	Weight	Exploit.	Weight
Age	Size	mortality	ogive	bef. spaw	bef. spaw	in stock	pattern	in catch
0	5225233	0.33	0.00	0.25	0.25	0.000	0.040	0.024
1	9069428	0.33	0.49	0.25	0.25	0.022	0.108	0.043
2	1175274	0.33	0.94	0.25	0.25	0.048	0.150	0.057
3	1204683	0.33	0.97	0.25	0.25	0.062	0.220	0.067
4	1332309	0.33	0.98	0.25	0.25	0.072	0.266	0.075
5	1145137	0.33	0.99	0.25	0.25	0.079	0.262	0.082
6	551761	0.33	1.00	0.25	0.25	0.100	0.098	0.100

				2006				
	Stock	Natural	Maturity	Prop. of F	Prop. of M	Weight	Exploit.	Weight
Age	Size	mortality	ogive	bef. spaw	bef. spaw	in stock	pattern	in catch
0	5225233	0.33	0.00	0.25	0.25	0.000	0.040	0.024
1	.	0.33	0.49	0.25	0.25	0.022	0.108	0.043
2	.	0.33	0.94	0.25	0.25	0.048	0.150	0.057
3	.	0.33	0.97	0.25	0.25	0.062	0.220	0.067
4	.	0.33	0.98	0.25	0.25	0.072	0.266	0.075
5	.	0.33	0.99	0.25	0.25	0.079	0.262	0.082
6	.	0.33	1.00	0.25	0.25	0.100	0.098	0.100

				2007				
	Stock	Natural	Maturity	Prop. of F	Prop. of M	Weight	Exploit.	Weight
Age	Size	mortality	ogive	bef. spaw	bef. spaw	in stock	pattern	in catch
0	5225233	0.33	0.00	0.25	0.25	0.000	0.040	0.024
1	.	0.33	0.49	0.25	0.25	0.022	0.108	0.043
2	.	0.33	0.94	0.25	0.25	0.048	0.150	0.057
3	.	0.33	0.97	0.25	0.25	0.062	0.220	0.067
4	.	0.33	0.98	0.25	0.25	0.072	0.266	0.075
5	.	0.33	0.99	0.25	0.25	0.079	0.262	0.082
6	.	0.33	1.00	0.25	0.25	0.100	0.098	0.100

Input units are thousands and kg - output in tonnes

Table 8.9.1.2. Sardine short term prediction with management option table.

MFDP version 1a
Run: change2
Sardine (VIIIc+IXa), 2005 WG
Time and date: 20:51 13/09/2005
Fbar age range: 2-5

Basis for 2005: Fsq = F(2002-04) unscaled; Recruitment 2005 to 2007: GM 1988-2003 = 5225 millions

2005					2006					2007	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
573603	405310	1	0.225	102770	611402	505960	0.0	0.000	0	668100	561085
					.	503874	0.1	0.023	10335	658656	550266
					.	501797	0.2	0.045	20506	649372	539680
					.	499730	0.3	0.067	30516	640245	529323
					.	497672	0.4	0.090	40369	631272	519189
					.	495624	0.5	0.112	50066	622451	509272
					.	493585	0.6	0.135	59611	613778	499568
					.	491556	0.7	0.157	69008	605251	490071
					.	489536	0.8	0.180	78257	596866	480777
					.	487526	0.9	0.202	87363	588622	471681
					.	485524	1.0	0.225	96327	580514	462778
					.	483532	1.1	0.247	105153	572542	454064
					.	481549	1.2	0.270	113843	564701	445535
					.	479575	1.3	0.292	122399	556990	437185
					.	477610	1.4	0.315	130824	549407	429012
					.	475654	1.5	0.337	139121	541948	421011
					.	473707	1.6	0.360	147291	534611	413177
					.	471769	1.7	0.382	155336	527395	405508
					.	469840	1.8	0.404	163260	520297	398000
					.	467920	1.9	0.427	171064	513314	390648
					.	466008	2.0	0.449	178751	506445	383449

Input units are thousands and kg - output in tonnes

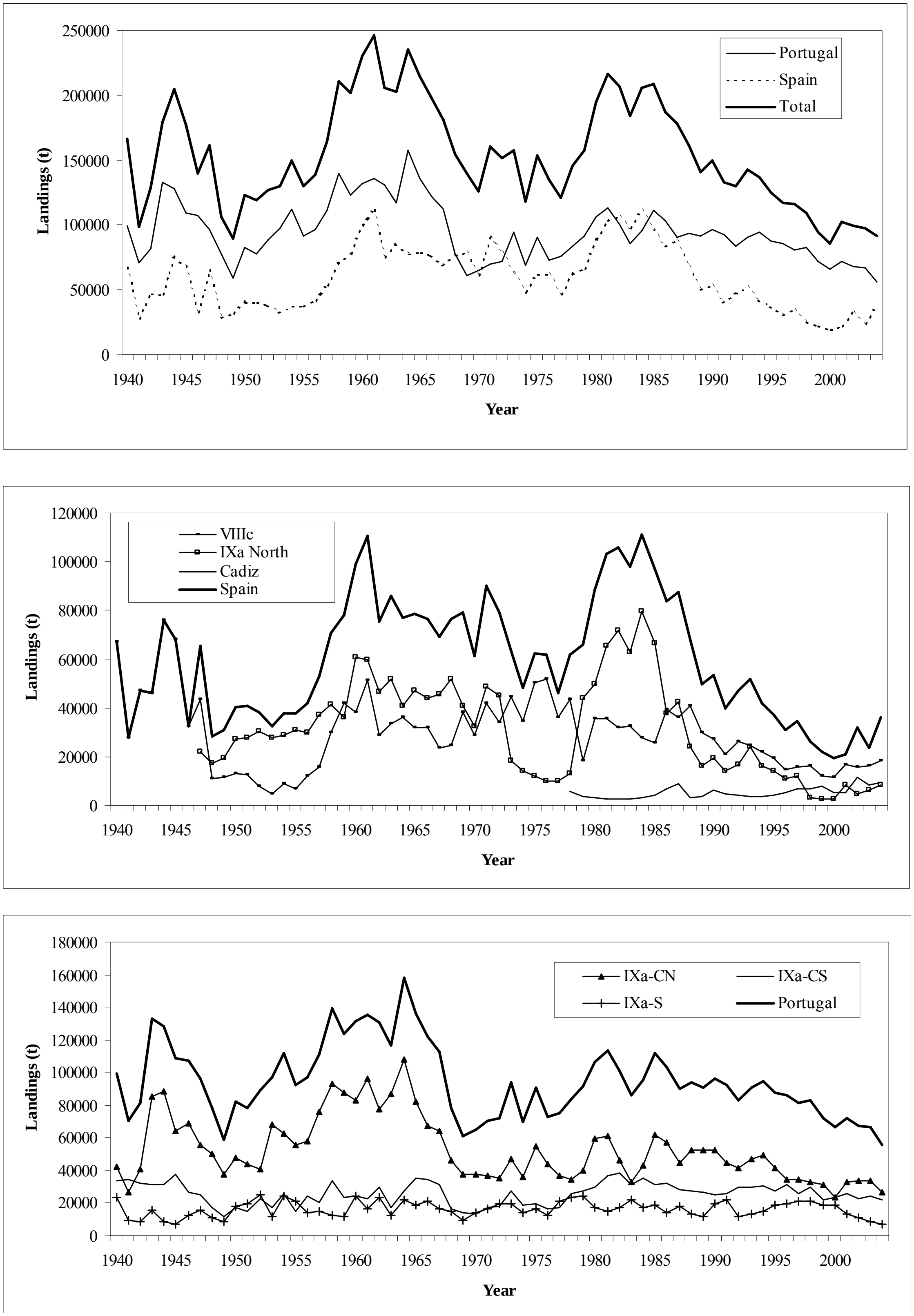


Figure 8.2.1: Sardine in VIIIc and IXa: Annual landings of sardine, by country (upper pannel) and by ICES Sub-Division and country

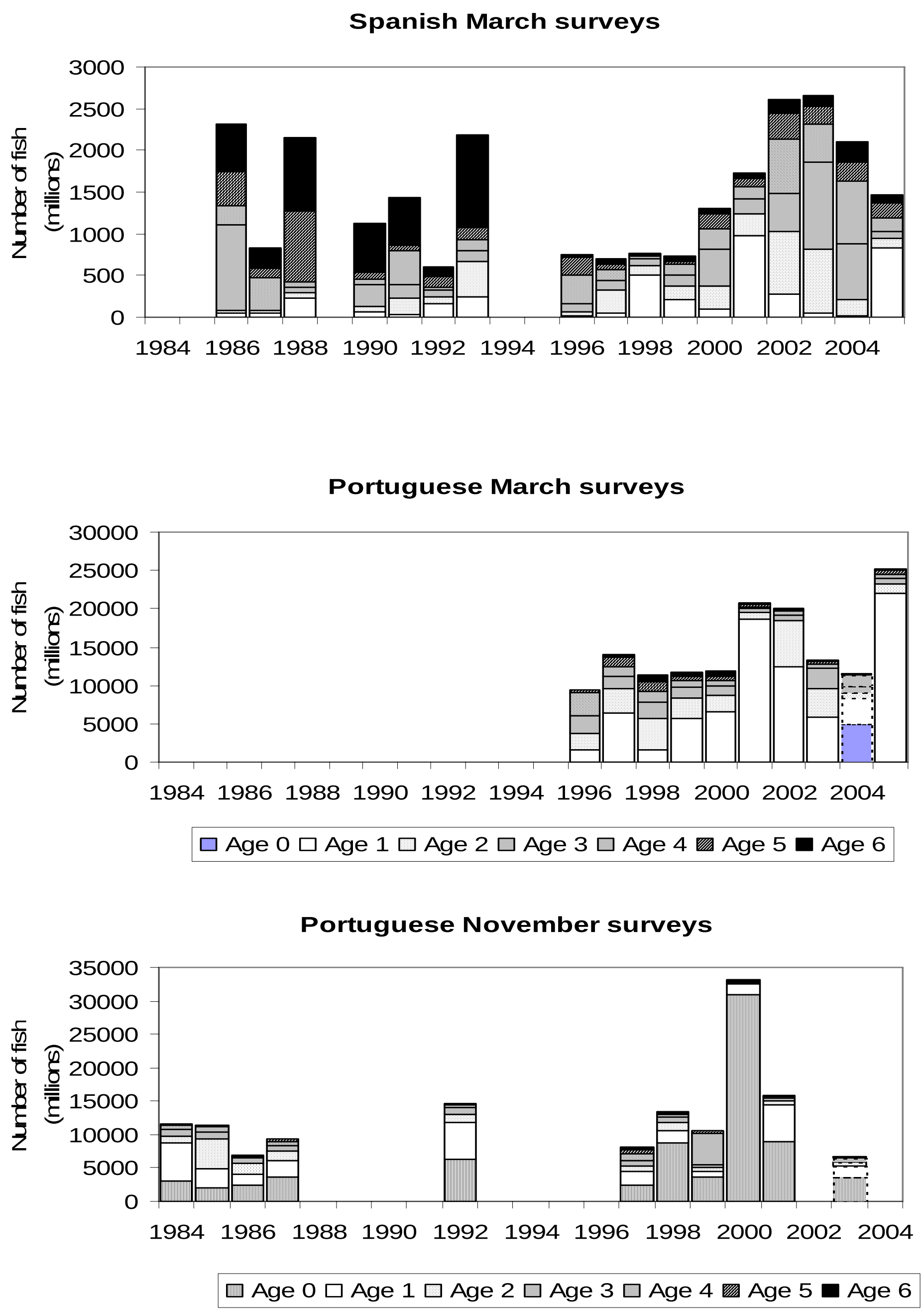


Figure 8.3.1 – Sardine in VIIIc and IXa: Total abundance and age structure (numbers) of sardine estimated in the acoustic surveys. The Spanish March survey series covers area VIIIc and IXa-N (Galicia), the Portuguese March surveys covers the Portuguese area and the Gulf of Cadiz (Subdivisions IXa-CN, Ixa-CS, IXa-S-Algarve and IXa-S-Cadiz) and the Portuguese No«vember survey covers only the Portuguese waters. Estimates from Portuguese acoustic surveys in November 2003 and March 2004 are considered as indications of the population abundance and are not included in assessment.

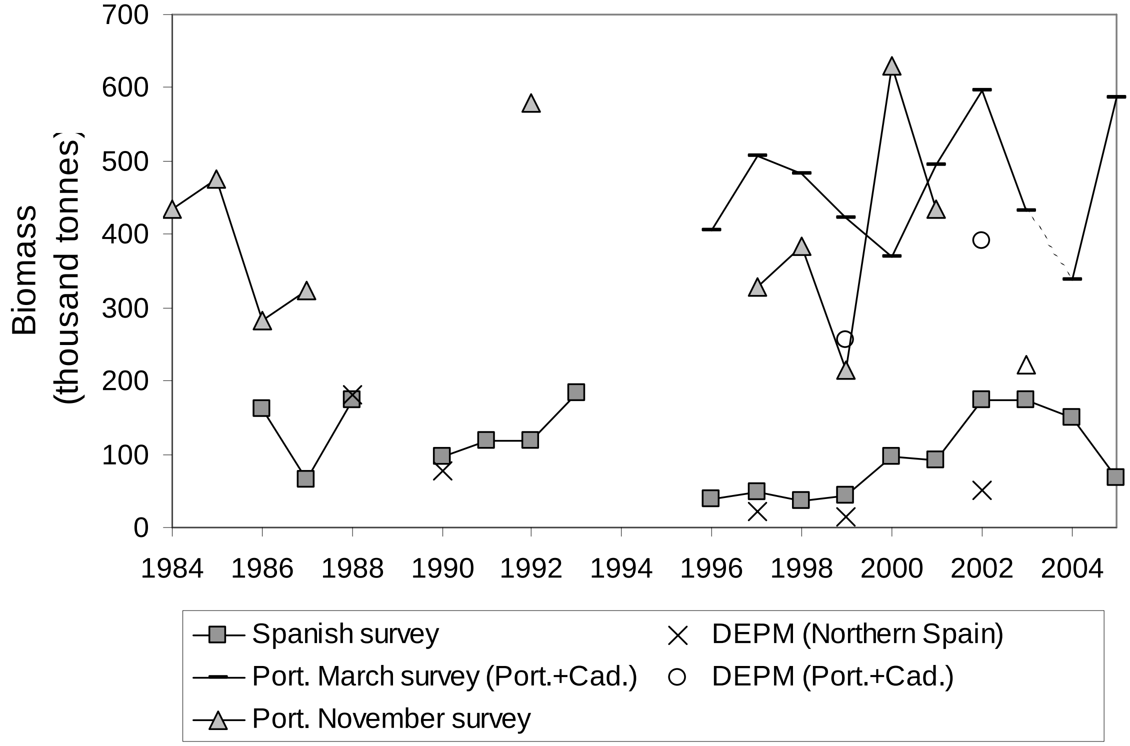


Figure 8.3.2 - Sardine in VIIIc and IXa: Total sardine biomass (thousand tonnes) estimated in the different series of acoustic surveys and SSB estimates from the DEPM series covering the northern area and the west and southern area of the stock.

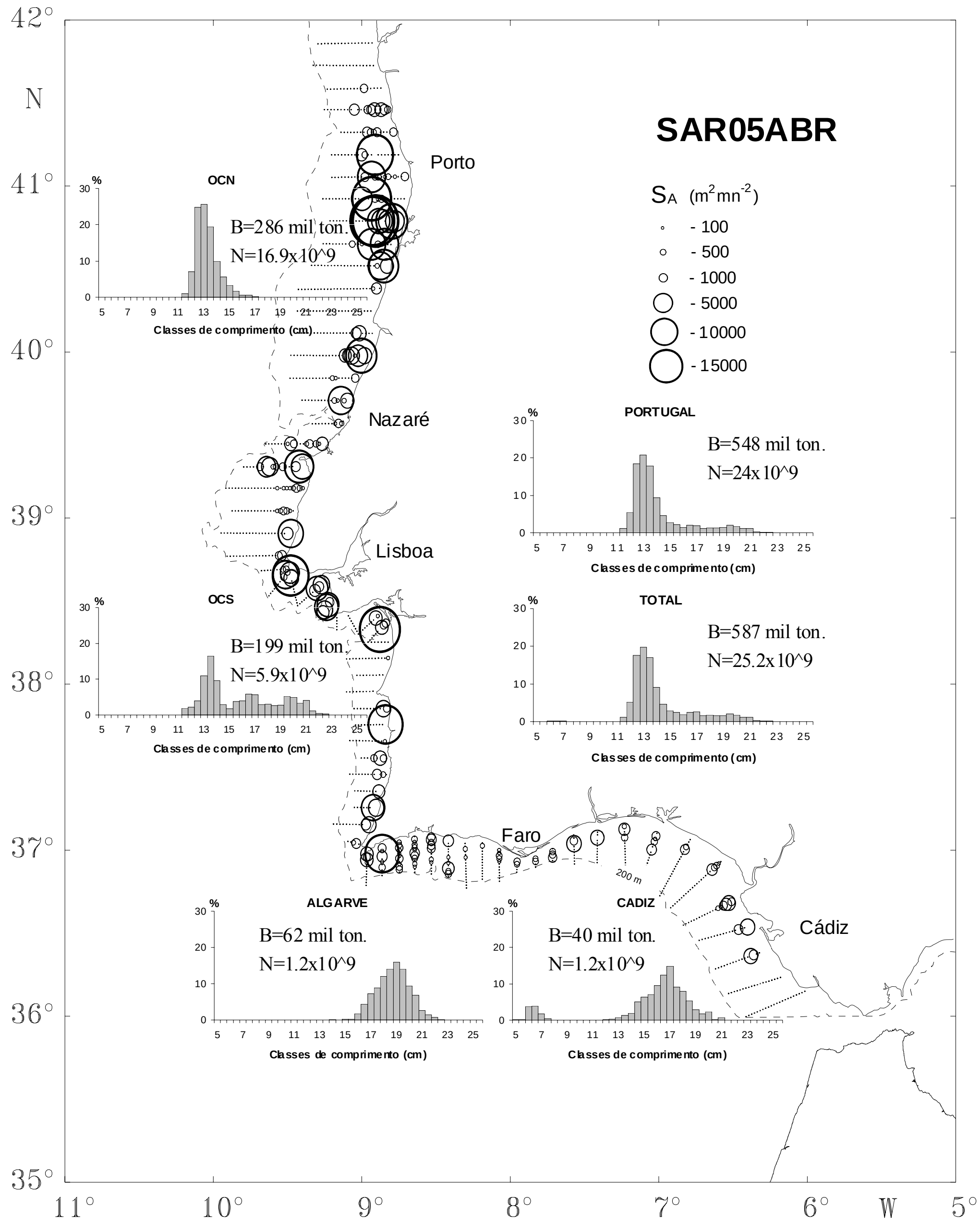
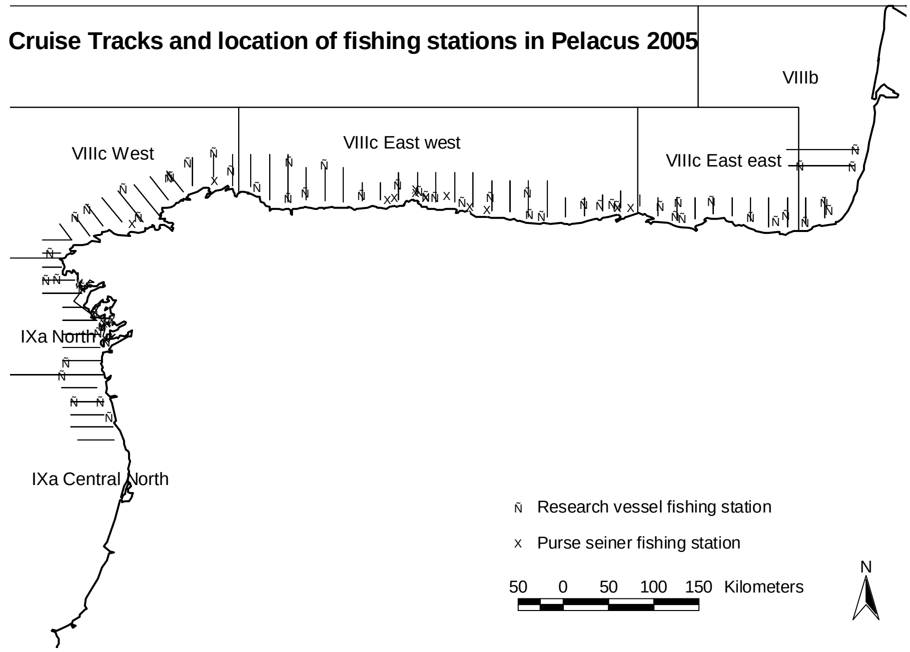
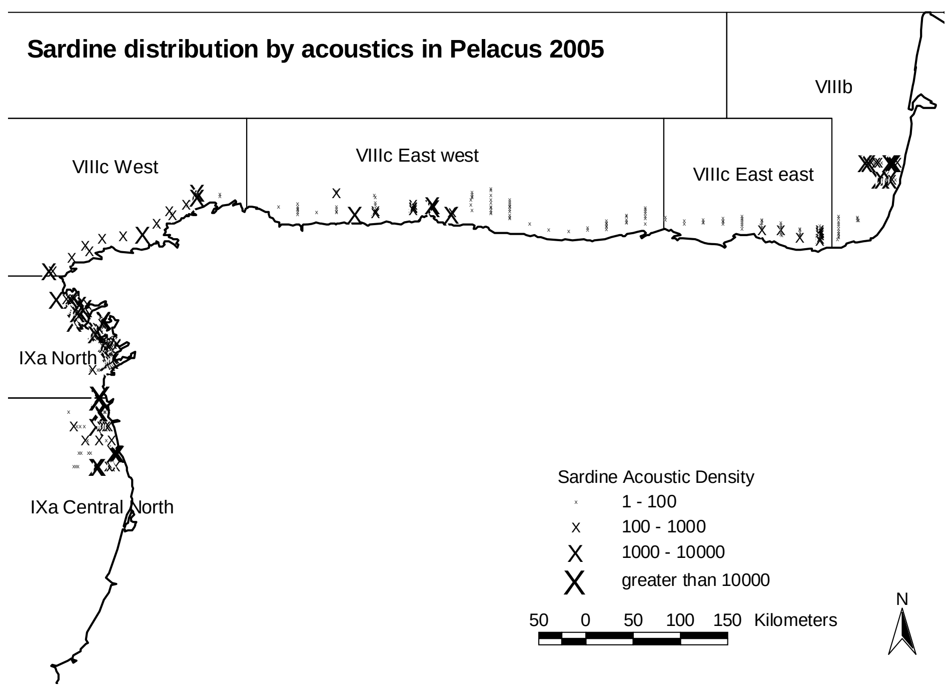


Figure 8.3.2.1 Sardine in VIIIc and Ixa: Portuguese spring acoustic survey in 2005. Acoustic energy by nautical mile and abundance and length structure by area. Circle area is proportional to the acoustic energy (S_A m^2/nm^2).



(a)



(b)

Figure 8.3.2.2. Cruise tracks, fishing stations and sardine distribution as observed in the Spanish acoustic survey in 2005.

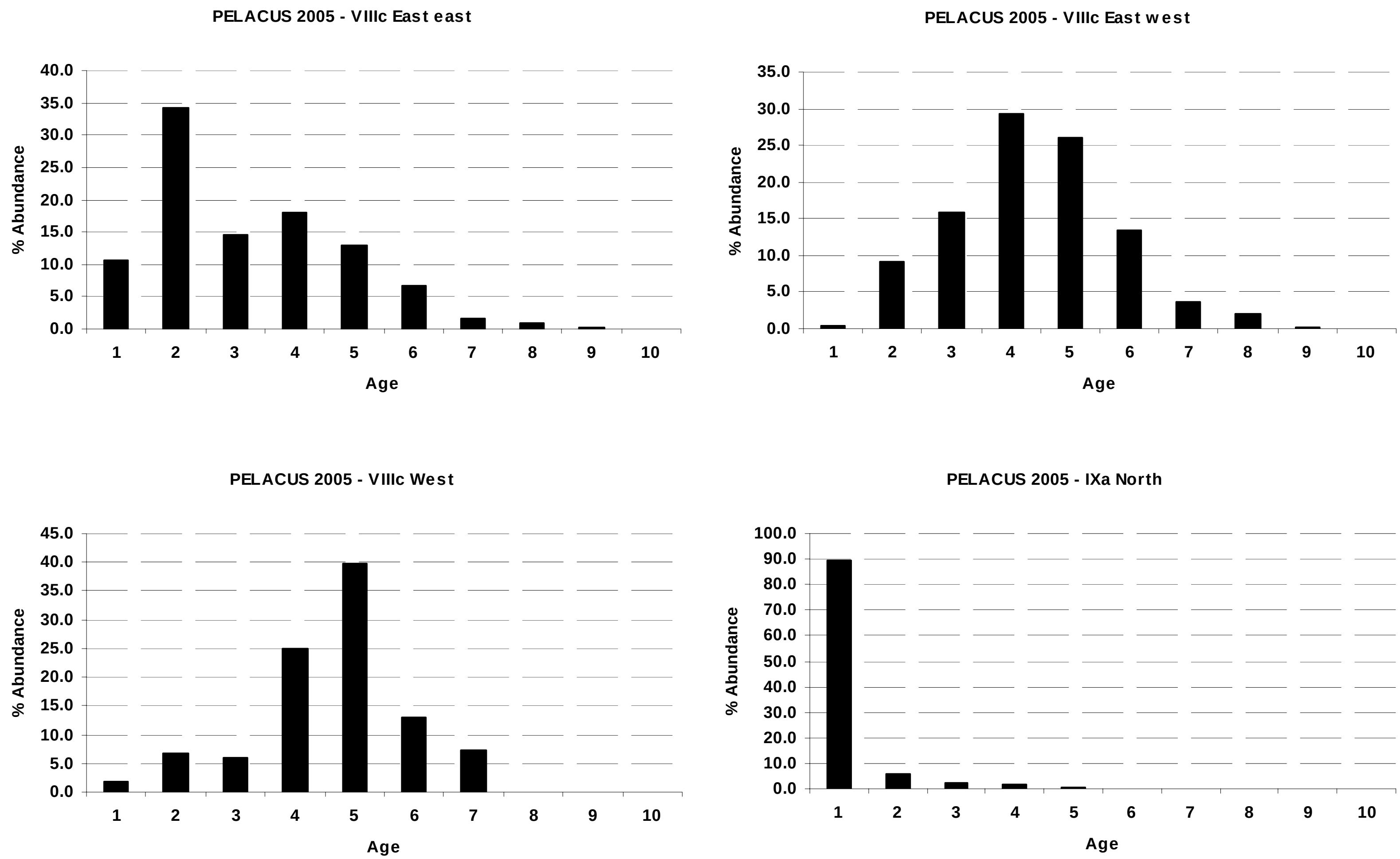


Figure 8.3.2.3: Sardine relative abundance at age (percentage by area) as estimated in Spanish acoustic survey (PELACUS 2005).

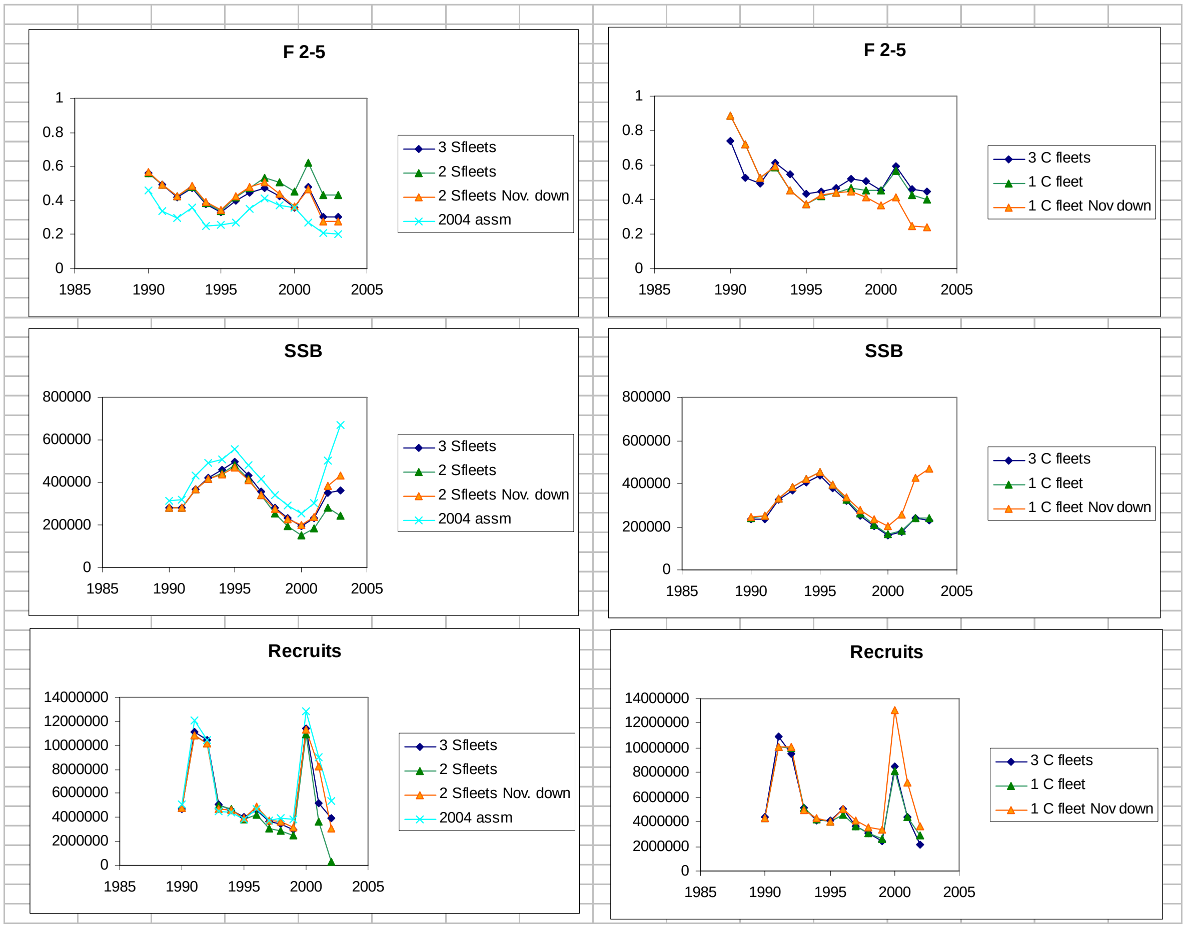


Figure 8.7.1: Sardine in VIIIc and IXa: Time course of Fishing mortality, SSB and Recruitment estimated with the AMCI model. Left: One area. Results are for using either 3 survey fleets (Spanish March, Portuguese March and Portuguese November) or 2 survey fleets (merging the Spanish and Portuguese March surveys. *Right: 3 areas with migration. For the 3 area case, results are shown for either one uniform fishing fleet or for one separate fleet for each area. All three survey fleets were used.For both one and 3 areas runs are also shown where the Portuguese Novembers survey is downweighted. To the left is included the results of the ICES assessment in 2004.*

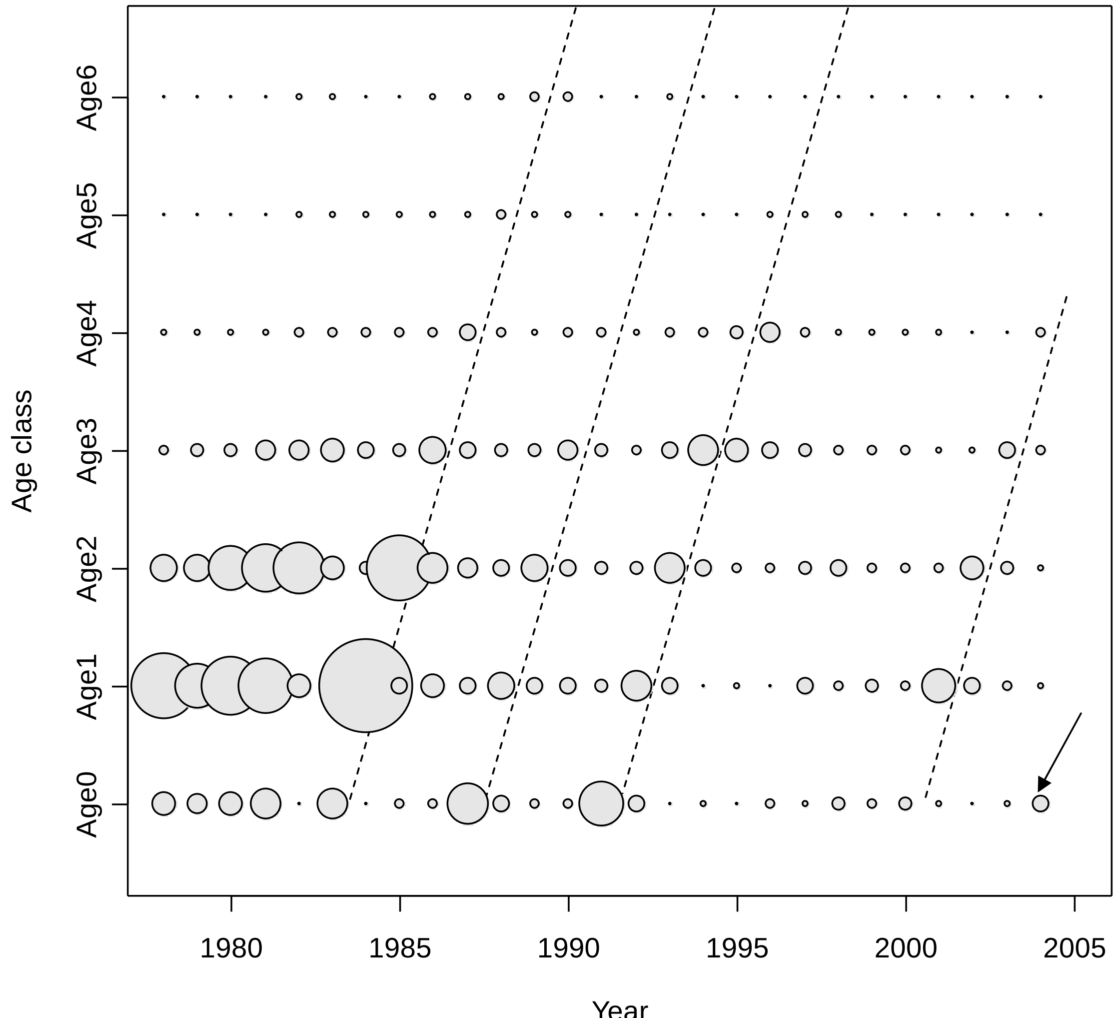


Figure 8.7.2: Sardine VIIIc and IXa: Assessment input data (I) Catch at age for the whole stock 1978-2004. Bubble size proportional to catch numbers for each age and year. Dashed lines highlight strong year classes.

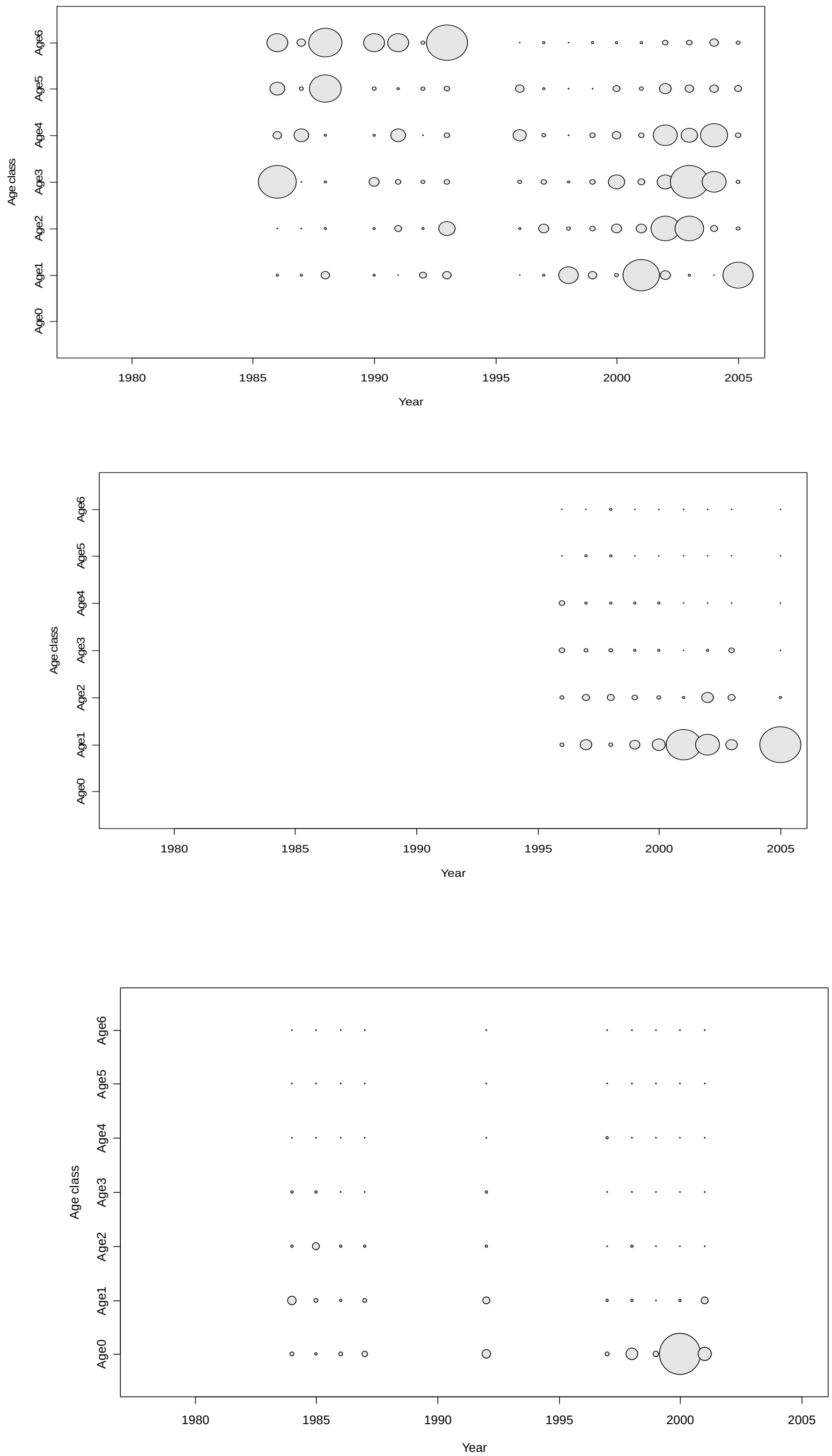


Figure 8.7.3: Sardine VIIIc and IXa: Assessment input data (V): Survey abundances in the Spanish March acoustic survey (top), Portuguese March acoustic survey (middle) and Portuguese November survey (bottom). Bubble size proportional to estimated abundance.

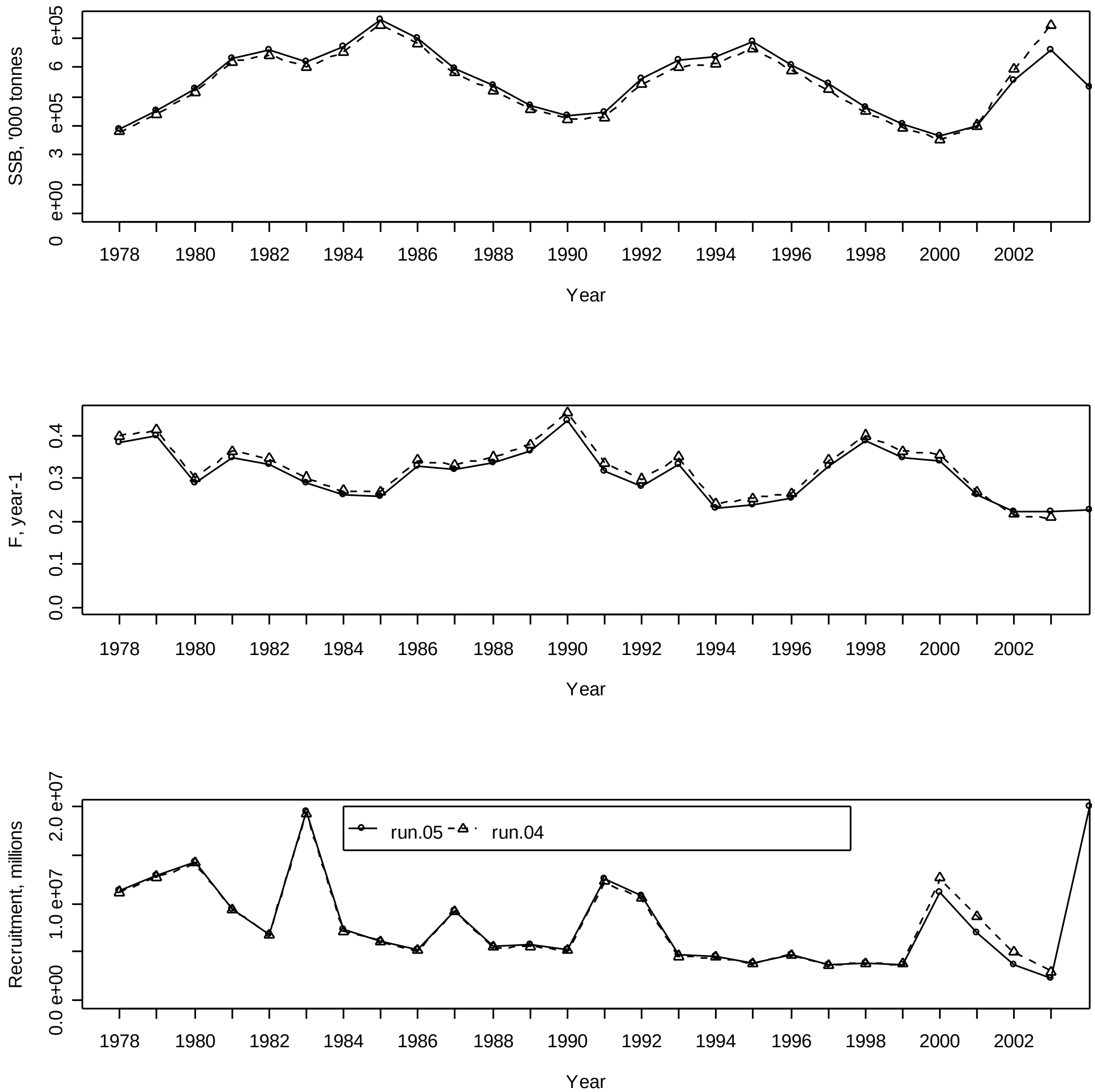


Figure 8.8.1.1. Sardine VIIIc and IXa: Comparison of assessments WG2004 (dotted lines and triangles) and WG2005 (black line and circles). SSB (top), F (middle) and recruitment (bottom) trajectories from the sardine AMCI assessment.

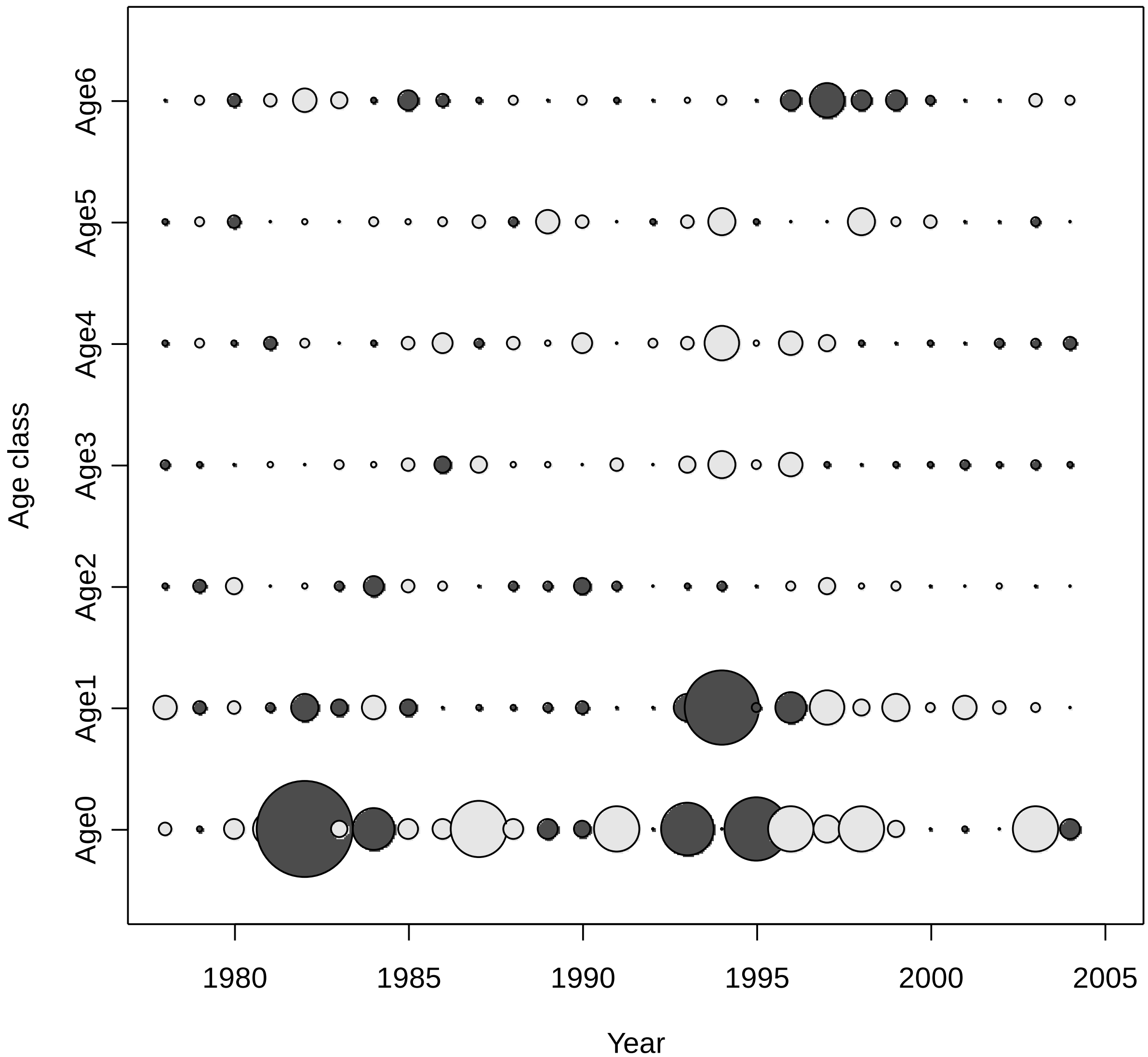


Figure 8.8.1.2: Sardine VIIIc and IXa: Catch residuals in the assessment model. Bubble size proportional to residual absolute level; black bubbles represent negative residuals, white bubbles represent positive residuals. Absolute values vary between –1.6 and 0.90.

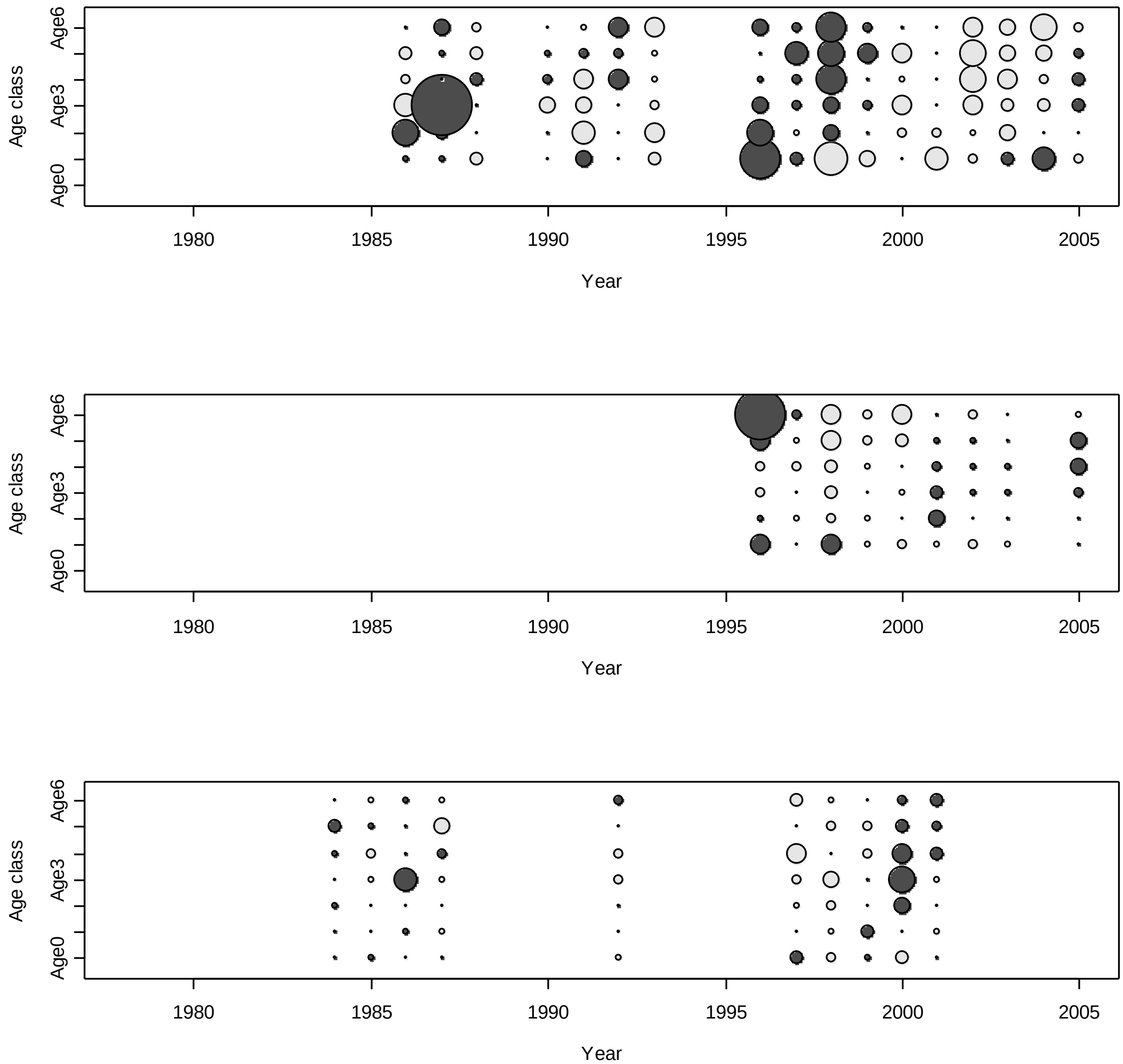


Figure 8.8.1.3. Sardine VIIIc and IXa: Survey residuals for the three different acoustic surveys used in the analysis. Top panel: Spanish March acoustic survey, middle panel: Portuguese March acoustic survey, bottom panel: Portuguese November survey. Bubble size proportional to residual absolute level; black bubbles represent negative residual, white bubbles represent positive residuals. Residual values are on the range [–3.3,+3.3] and all graphs use the same scale.

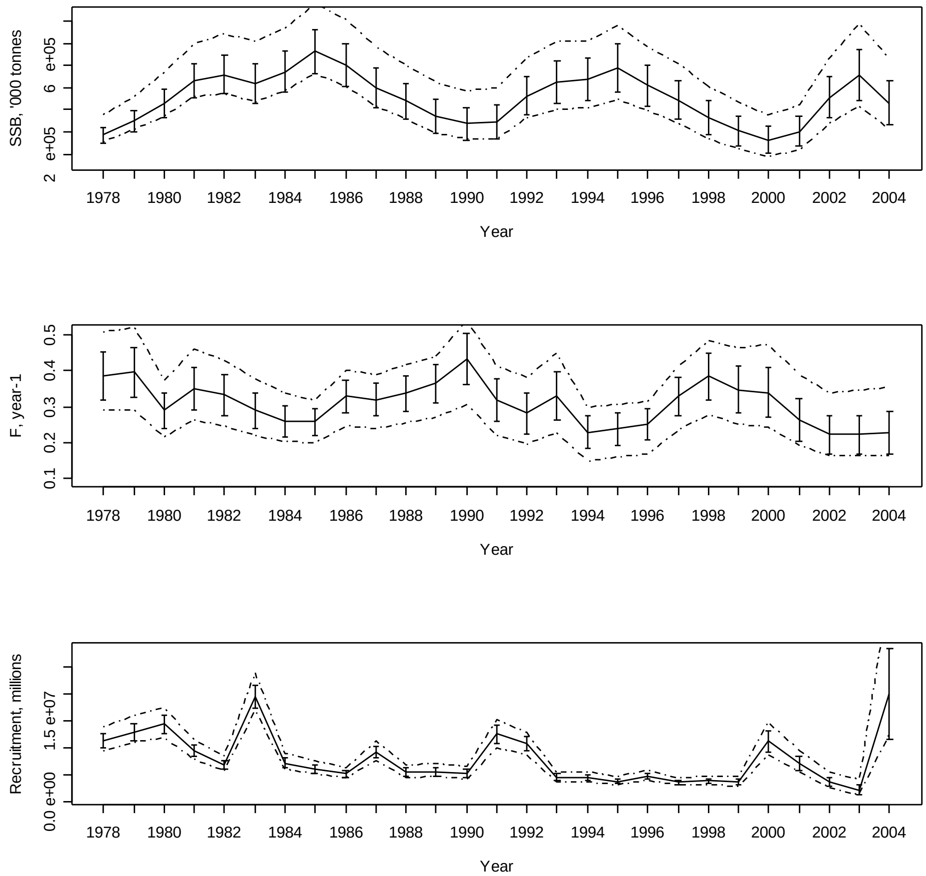


Figure 8.8.1.4: Sardine VIIIc and IXa: Bootstrap trajectories of SSB, recruitment and F for the assessment model. Dotted lines represent the 90% limits and vertical lines represent the mean plus and min us the standard deviation of the bootstrap runs for any given year.

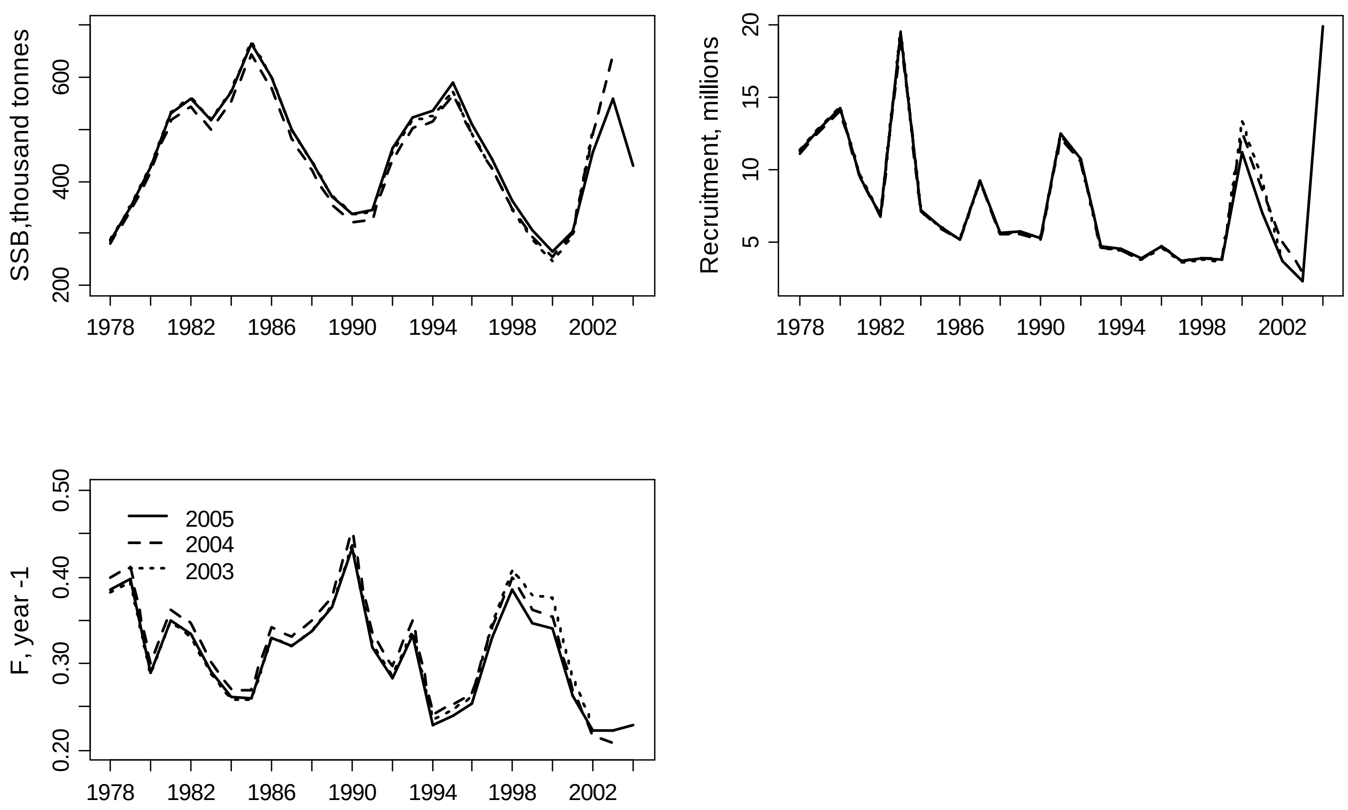


Figure 8.8.2.1: Sardine in VIIIc and IXa: Summary plots from the retrospective analysis of the sardine assessment .

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 enterely 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 1991-2004.

In Subarea VIII. during the first quarter in 2004 , the very scarce landings were caught around the Gironde estuary from 45□N up to 47□N by the French fleet. During the second quarter, the main landings (predominantly Spanish) were caught in the Southern part of the Bay of Biscay (south of 45°N.), mainly in Sub-areas VIIIb and VIIIc. During the third and fourth quarter in 2004, the main fishery was located in the Center (VIIIb) and in the North (VIIIa) and the main production corresponded to the French fleets in the North. The Spanish Spring fishery in 2005 has suffered a complete failure: By 12 May, (when usually about 40% of annual Spanish catches are already achieved) about 200 t had only be caught (i.e. about 1% of a normal year). The French landings (952 tons), during the first and second quarter of 2005, are the lowest value of the recorded series, two times less than the 2004 value.

Anchovy fishery in Division IXa in 2004 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, second and third 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 2004 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 and in the South (Algarve area) during the third quarter.

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 2004) 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 1991-2004.

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	

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	44	1		6010		2743	66	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	1473	0	10	1		266		2514	3019	

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	

10 Anchovy - Subarea VIII

10.1 ACFM Advice and STECF recommendations applicable to 2004

ICES advice from ACFM in November 2004 stated "*A preliminary TAC for 2005 should be set to 5 000 t. A catch of this size will, even in the case of poor recruitment, allow the SSB to rebuild in 2005. The TAC could be re-evaluated in the middle of the year 2005, based on the development of the fishery and on the results from the acoustic and egg surveys in May-June 2005.*"

The EU set the 2005 TAC for Bay of Biscay anchovy at 30,000 tonnes, with no provision for in-year adjustment.

ICES also advised that:

"*Measures to protect juveniles, allowing a larger part of the recruiting year class to spawn, should be considered as supplements to quota regulations. Such measures could include closures of key nursery areas and economic incentives to reduce the catch of small fish. In 1999 ICES advised on the closure of such an area (ICES Cooperative Research Report No.236, 1999) with the following boundaries:*

- from the French coast north along longitude 1°35'W to latitude 44°45'N
- west to longitude 1°45'W
- north to latitude 46°00'N
- and east to the French mainland."

This measure was not adopted.

In May 2005 ICES ACFM had become aware that indications from the anchovy fishery and from surveys in the first half of 2005 suggested a strong reduction of recruitment into this stock by the 2004 year class. Combined with a low stock level at the last assessment in 2004 and the recent low recruitment levels, ICES felt that immediate management action was required and recommended for the Biscay anchovy stock that:

"*Although based on preliminary information, ICES considers that strong management measures are urgently required, in order to protect the remaining stock, i.e. that the fishery be closed immediately, and remain closed until there is reliable fishery independent evidence of a strong year class recruiting to the stock.*"

The European Commission finally decided to close the anchovy fishery in the Bay of Biscay from 3rd of July to 3rd of October of the current year, 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 took place in Brussels from 11th to 14th July.

The STECF sub group conclusions are:

1. *The interpretation of the survey and fisheries information presented qualitatively in the ICES advice, May 2005, was substantiated by the more detailed evaluation performed at the*

meeting. The subgroup evaluation confirmed the ICES interpretation that the Biscay anchovy stock is well below Blim and with the strength of the 2004 year class far lower than any previous level.

2. With the current stock situation, maximum protection of the remaining spawning population is required. No alternative management measures short of closure should be considered at this time. Options of a closed area to protect juveniles and to close fishing during spawning were preliminarily explored by simulation. The results suggest that such measures provided less protection to the whole stock than a complete closure.

3. The subgroup recommends 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.

4. Alternative management measures are still required to maintain the longer term viability of the stock. These should only be considered after the stock has recovered to biologically safe levels, and would need to be scientifically evaluated prior to adoption.

5. The spring acoustic and DEPM surveys provide the main tuning indices to the current assessment and should be maintained. 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 distribution area of the juvenile anchovy and should include pelagic trawling as well as purse seine fishing. All nations and/or institutes involved in the fishery should be encouraged to collaborate in these surveys and the subgroup recommends that co-ordination should be under ICES WGACEGG. The subgroup encourages development of any other research surveys that could provide additional information on the recruitment process in this stock.

10.2 The fishery in 2004

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 10.5.1).

Spanish purse seine fleet: The Spanish fleet is composed of purse seines (211 boats) that operate mainly in spring. This spring fishery operates at the south-eastern corner of the Bay of Biscay in Divisions VIIIc and b and accounts for more than 80 % of the Spanish annual catches.

Until 1995, the Spanish purse seines were allowed to catch anchovy in Sub-division VIIIb only during the spring season and under a system of fishing licences (Anon. 1988), while Division VIIIa was closed to them for the whole year. Since 1996 this fleet was allowed to catch anchovy throughout the year in Subarea VIII under the same system of fishing licences legislation.

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: Each year, the main anchovy catches are taken 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. Therefor, 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)

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.

If the last two years total catches are similar (8781 T in 2004, 7593 T in 2003), the purse seiners catches increase while pelagic trawlers are decrease. This can be explain by the fact that more purse seiners targeted anchovy in 2004, resulting in an increase of their mean catches. At the same time, the pelagic trawlers number increased also(54 in 2004, 47 in 2003) but their mean catches decreased (134 tons by vessel in 2004, 143 in 2003).

10.2.1 Catches for 2004 and first half of 2005

In 2004 a total of 16 361 tonnes were caught in Subarea VIII (Table 10.2.1.1 and Figure 10.2.1.1). This is a 54.4% increase compared to the level of 2003 catches, and a small decrease (6.5%) compared to 2002. As usual, the main Spanish fishery took place in the second quarter (94.9% of their catches) and the French catches in the second semester (76.1%) (Table 10.2.1.3).

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).

In 2005 international catches of the first half of the year amounted about 1152 t, which represents only 12.5% of 2004 catches for the same period. (Table 10.2.1.1). Both fisheries have landed less anchovy than usual. It is particularly true for the Spanish fishery: By 12 May, (when usually about 40% of annual Spanish catches are already achieved) about 200 t had only be caught (i.e. about 1% of a normal year). This is a complete crash of the commercial fishery. Since then commercial fishery has stopped and claim for financial aids for a ban of the commercial fishery. This drastic drop observed in 2005 indicated a great decrease in the abundance of the anchovy. The fact that this level of the catches is the lowest of the time series could indicate that, in addition to the low abundance level of anchovy, a problem with the accessibility to the purse seine could be present. Also for the French fleet at a lower level : with 952 tons, catches in first semester represent 45% of the landings 2004 for the same period. Generally, French fishery is more constant than the Spanish one during the first semester, and previous failures in Spanish catches (e.g. 1996 and 1997) could be already explained by such catchability phenomenon where schools were not available to purse seiners on the contrary of French pelagic trawlers. (Petitgas and Massé; WD 2004). For these two fleets, 2005 is representing the weakest catches of anchovy in the time series.

It must be noticed that the Spanish fleet is essentially purse seiners and French pelagic trawlers. Therefore, more than an evident decrease of the biomass, a catchability factor probably affects more the Spanish fleet than the French one as schools seem to be less often available at the surface.

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 Spanish commercial purse seine vessel fishing surveys in 2005

This year, given the difficulties of the Cantabrian fleet to catch anchovy in April and May, two surveys (PROA05-I and PROA05-II) were carried out by the commercial fleet, with the support of the Basque Government and under the technical coordination of AZTI-Tecnalia. The main objective of the surveys was the localization of anchovy concentrations of commercial interest for the purse-seine fleet.

The first survey took place between 12-16 May and aimed at covering the northern area of the French shelf (at North of 45º15'N) and the oceanic area (to the West of the 2ºW) where the commercial fleet didn’t track before. Seven purse seines, with an observer on board each, covered in parallel and situated between 5 and 10 nm apart, the 100 m depth isoline up to 47ºN, and then went back following the 200 m depth isoline (Figure 10.2.3.1). In the northern areas the vessels did not detect any anchovy patches. Most of the detections and fishing hauls corresponded to sardine and horse mackerel (Figure 10.2.3.2). On the other hand the oceanic area from the 45ºN to the Cantabrian shelf, among 2º30'W up to the 3º30W, were empty of any detections. The conclusion was that no commercial fishing concentrations of anchovy were available in the surveyed areas to the North or West from the areas were they had been fishing up to then (Figure 10.2.3.2).

Given that the commercial fishing activities of the Cantabrian fleet stopped on 12th May, the second survey, conducted between 20 May and 3 June, aimed at determining the presence of concentrations of anchovy in the areas where the fleet usually works at those dates, namely, in the Southern area of the French shelf (south of 45ºN) and around the shelf edge to the West of 2ºW. Four purse seines, with an observer on board each of them, started prospecting northward through the French shelf until reaching the 45º10'N. Then, a westward trip was done reaching 3º30'W (Figure 10.2.3.3). In the areas at South of 45º10'N main detections corresponded to horse mackerel and mackerel, but only very small quantities of fishable anchovy were detected by the purse seines (maximum catch of 25 kg). On the other hand, along the Cantabrian western area no anchovy concentration was found (Figure 10.2.3.4).

Besides the fact that the sampling strategy could be improved for any future survey by covering different areas at different times of the day, so as to assure that they all are covered by day and night, the main conclusion from these surveys was that no profitable anchovy concentration were available for the purse seine fleet in the surveyed areas, either outside or inside the traditional fishing grounds. This all reveals above all a weak abundance of the resource, but in addition some catchability problems may have also occurred, never observed before, perhaps related to a too disperse distribution of anchovies, given that the French pelagic trawling boats could still obtain some catches at the beginning of June (although clearly smaller than in previous years).

10.3 Biological data

10.3.1 Catch in numbers at Age

Table 10.3.1.1 provides the age compositions by quarters and by countries in 2004. In 2004 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: Both half of the years had length and biological samples. In 2004 in Spanish and French catches age 1 was predominant all over the year (71 % and 86% respectively).

Table 10.3.1.2 records the age composition of the international catches since 1987, on a half-yearly basis. 1-year-old anchovies predominate largely in the catches during both halves of most of the years (except for the years 1991, 1994 and 1999 and 2002). For the last years age 2 has shown a high relative abundance compared to age 1, in 2002 age 2 predominated in the catches of both countries and in 2003 this is still the case for the Spanish fishery. Despite that age 1 predominated the French catches in 2003, the relative importance of age 2 in the second semester was remarkable as well and rather similar to the 2002 case. In both years the total catches (tonnes) were low for both countries and in general the age composition is typical of the occurrence of weak year classes, otherwise age 1 would have largely sustained all catches. In 2004 age 1 have again predominated the catches of both countries, although catches were still rather low in comparison with the catches of years previous to 2002.

A few catches of immature, 0 ages group, appear during the second half of the year. The estimates of the catches at age on annual basis since 1987 are presented along with the inputs to the assessment in Table 10.7.2.1a.

During the first half of 2005 (Table 10.3.1.2) age 2 predominated in the catches of both countries, while usually is age 1 the one predominating. The lack of young fish is even clearer when looking at the age composition.

Figure 10.3.1.1 shows the Spanish and French catch at age compositions of the first half of the year from 1987 to 2005. The Spanish age composition in 2002, 2003 and 2005 is different compared to the rest of the historical series. In these years, age 2 predominated in the catches of the first half of the year, while usually is age 1 the one predominating. In the period 1987-2004, the age group 1 contributes to 62% in average to the French landings of the first half of the year. In some years, age 2 predominates (1991, 1999, and 2002). In the first half of 2005, the age groups 1 to 3 contribute to 16, 67 and 16%, respectively.

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.

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 2004.

For the first quarter, in 2004 the only fishery was the French one (Figure 10.3.2.1). No catches of the Spanish fishery were recorded in this year although catches in this quarter are usually low.

For the second quarter, the Spanish fishery is the main one and showed a unimodal distribution with a mean length of 15.4 cm (mostly age 1). 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).

For the third quarter, the main fishery is the French one. The French anchovy catches had a length distribution with two modes, one about 14 cm and the other about 16 cm. The mean length of the French landing was 15.0 cm. The Spanish had one modal and the mean length was 15.1 cm (Figure 10.3.2.1).

For the fourth quarter, the size distribution of the French landings had two modes, one about 14.5 cm and the other about 17 cm (Figure 10.3.2.1.). The catches of the Spanish fleet were negligible in this quarter. The mean length of the French and Spanish landing was 16.13 cm and 16.45 cm respectively.

The series of mean weight at age in the fishery by half year, from 1987 to 2004, 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 assessment in Table 10.7.2.1a.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 assessment in Table 10.7.2.1a. 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. The current WG presents an exercise (see section 10.7.1 and Uriarte, WD 2005) that allows for exploring some alternative assumptions in the natural mortality, along with changes in natural mortality regarding the age classes.

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 2004, with a gap in 1993 (Table 10.4.1.1).

DEPM2004

In September 2004, as the Daily Fecundity was not yet available for the 2004 survey, the working group used a preliminary estimate of biomass based on an assumption of Daily fecundity based on past estimates of this parameter. That preliminary estimate pointed out a biomass of about 18,113 tones with a CV of around 20% (Santos and Uriarte WD2004, ICES CM2005/ACFM08). The Daily Fecundity was based on assuming a spawning frequency of about 0.235 which corresponded with past estimates from surveys with temperatures below 16ºC.

Nowadays, after the estimation of the Daily Fecundity parameters, the Biomass arising from the 2004 DEPM application is reported at about 19,500 t(Santos et al. WD2005). This implies an increase of about 8% due to a just a bit lower estimate of spawning frequency than believed (being now estimated at 0.215). The text table below summarise the updated results of Spawning Biomass and population at age estimates from that survey:

Parameter	Estimate	s.e.	CV
DEP	8.4E+11	9.69E+10	0.1150
R'	0.5388	0.0045	0.0084
S	0.2147	0.0135	0.0631
F	9589.8	1145.4	0.1194
Wf	25.42	1.9867	0.0782
BIOMASA	19,498	2863.992	0.1469
Wt	20.17	1.91	0.0947
POBLACION	979.9	197.5	0.2016
Pa 1	0.8496	0.0349	0.0411
Pa 2	0.1213	0.0306	0.2521
Pa 3	0.0291	0.0075	0.2588
Nage 1	837.0	193.0	0.2306
Nage 2	114.9	22.2	0.1935
Nage 3	28.0	7.3	0.2623

DEPM2005

In 2005 a new DEPM survey took place between 8 and 28 of May on board the Spanish R/V Vizconde de Eza (Santos et al. WD2005). Sampling strategy was similar to previous years. The total area sampled was 61,619 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 (27,863 km^2). The anchovy eggs were concentrated in the area of Arcachon at 44º30'-50'N and 2ºW, between the depth lines of 100 and 200m and at costal areas in the Gironde area. Egg abundance was low across the whole area and the numbers of eggs found at the stations with maximum number of eggs were 1/3 of last year's. As a result, the total egg abundance estimate (1.33 10^{12} eggs) is almost the lowest of the DEPM series, being half of the total egg abundance found in 2004. The only exception is 1989, in which only a fraction of the total spawning area was surveyed[1].

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 + N linear reg		
	Value	**Variance**	**CV**
P_0	1.5822	6.1649	0.16
Z	0.1969	1.35E-05	0.45

The total egg production estimate was computed as the product of the daily egg production and the effective positive area of spawning, resulting in 0.440*E12 eggs per day with a coefficient of variation of 16%. This is the lowest egg production of the historical series of estimates in the Bay of Biscay.

Adult samples for estimating both the daily fecundity and the age composition of the population were obtained from 3 different sources: samples taken directly during the egg

1 This is because the 1989 survey could not entered the 12 nm of the French coastal area. This was already admitted when providing the final SSB estimate for that year (Santiago and Motos 1989) and for that reason the input to the assessment made in the MHSAWG of ICES is for that year always raised up by 1 SD (ICES 2005)

survey on board R/V Vizconde de Eza, samples from the commercial fleet (opportunistic or from the PROA surveys) and samples from the French acoustic survey conducted by IFREMER on board R/V THALASSA. From a total of 38 samples 20 have 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, age determination in the otoliths of 20 anchovy samples taken on board R/V Vizconde de Eza, R/V Thalassa and purse seines were available. When no set of otoliths was available an age length key based on 579 otoliths was applied. 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.

According to a lower mean weight and younger age composition of anchovies in the region close to the GIronde river (from 45º08'N to the North) in comparison with the characteristics of anchovies detected in the remainder southern region, a search for any difference in any of the daily fecundity parameters was made (Santos et al. WD2005). Batch fecundity changed among these two areas being higher in the northern than the southern region (Figure 10.4.1.4). No other adult parameter changed by areas. This information was taken into account to calculate weighting factors for the samples by regions: Weighting factors were allocated according to the amount of samples in the two regions (Garonne and Southern regions) respective to the relative egg abundance and daily fecundity in those areas, 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 SSB estimate for 2005 was about 8000 tones and, following the DEPM, 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% of deduced for the above SSB estimate. The following text table summarized the results by parameters. Table 10.4.1.2 show the individual parameters and a summary of the results overall region.

From a historical point of view, the current biomass estimate is the lowest in the time series, well below Blim (set by ICES at 21,000 tones) (Figure 10.4.1.5). Age composition of the population (Figure 10.4.1.6) shows that the abundances by age classes in 2005 were very low, only comparable to the levels found in 1989. However, in 2005 the 2 year old class was more abundant than the 1 year old, indicating a failure of recruitment. This age structure was only found in another year, 2002, in the whole time series. Distribution maps of the egg abundance over the past 8 years are shown in Figure 10.4.1.7. The egg distributions in the last 4 years occupy a smaller area, being concentrated in the southeast corner of the Bay of Biscay and decreasing mainly in the northern area. In 2005 there was an overall decrease of egg abundance (the maximum number of eggs per station was 1/3 the last year's). In particular, the egg abundance decrease over the Gironde area, which is one of the most relevant spawning areas of 1 year old anchovies, indicating again a recruitment failure this year. Certainly, the egg spatial distribution and the age composition of the population demonstrate that the current low biomass levels are due to a failure of recruitment.

10.4.2 Acoustic surveys

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 2005 acoustic survey PELGAS05 was carried out in the bay of Biscay from 3 May to 1 June 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) 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 2300 nautical miles were prospected during the survey and 41 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 for five separated areas (figure 10.4.2.2) :

- "Adour": the southern area from the French coast to the shelf break with anchovy, horse mackerel and sardine (in minor importance).
- "Gironde": closed to the coast in front of the Gironde where mainly sprat, sardine and anchovy (in minor importance) was seen,
- "Offshore": off the Gironde area until the shelf break characterised by more surface echotraces where horse mackerel, mackerel and sardine were predominant,
- "North offshore": where depth was above 100m and few echotraces appeared attributed to sardine and mackerel.

- "North coast": coastal area in front of Loire river plume where pelagic echotraces were mainly represented by sardine and sprat

The biomass estimates for each species at each strata are presented in the table below.

	Adour	**Gironde**	**Offshore**	**North coastal**	**North offshore**	**Total**
anchovy	**10 660**	**4 787**	**156**			**15 603**
sardine	**41 358**	**88 520**	**154 052**	**12 573**	**133 018**	**429 521**
sprat		**56 596**		**32 330**		**88 926**
horse mackerel	**22 310**		**15 116**	**26 470**	**119 366**	**183 262**

Using length distributions at each closest haul and the age/length key settled for the survey, a biomass estimate in number has been processed for anchovy for each area at age group (Figure 10.4.2.3).

in numbers ($x10^6$)	*area (nm²)*	G 1	G 2	G 3+	Total
North coastal	*2 226*	55.3	107.4	17.9	180.6
North offshore	*4 176*	2.5	4.8	0.8	8.2
South of Arcachon	*2 456*	49.8	256.0	77.7	383.4
total	*8 858*	107.6	368.2	96.3	572.2
%		*18.8*	*64.4*	*16.8*	*100*

in tons	*area (nm²)*	G 1	G 2	G 3+	Total
North coastal	*2 226*	909	2 098	384	3 391
North offshore	*4 176*	44	91	16	151
South of Arcachon	*2 456*	1 142	7 302	2 671	11 115
total	*8 858*	2 095	9 492	3 070	14 657
%		*14.3*	*64.8*	*20.9*	*100*

The number of 1 year old anchovy was estimated at a level of 108.10^6 millions fish. Though the combination of the two observations 1) of eggs (CUFES) and 2) acoustics and pelagic trawl hauls, shows that the Gironde spawners were certainly very close to the coast and might be under-estimated, the abundance of anchovy was very low and the predominance of big fish confirmed a very low level of recruitment.

Mean weight at age for 2005 are as below:

mean weight	**G1**	**G2**	**G3+**
Gironde	**16.43**	**19.54**	**21.48**
Offshore	**17.21**	**19.01**	**19.69**
Adour	**22.95**	**28.52**	**34.38**

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 show a drastic decrease in both the distribution area and in abundance in 2005. 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.

During this survey, more than acoustic transects and pelagic trawl hauls, 955 CUFES samples were collected and counted, 53 vertical plankton hauls and 79 vertical profiles with 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. On the one hand, the spawning area localised in the south of the Bay of Biscay (Adour) seemed to be well linked with the adult’s distribution. On the other hand, the eggs presence in front of Gironde was broader than the few adults that were seen by acoustics. Keeping in mind that CUFES can't be used for quantitative purposes, the eggs distribution observed with this system from 2000 to 2005 (figure 10.4.2.7), seems to reveal similar number of eggs from one year to the other (except 2001 where eggs numbers were extremely high) but changes in positive areas.

According to this, the survey was interrupted before the end of the whole coverage and the last week was therefore devoted exclusively to anchovy in the southern area with two objectives : i) to check the adults distribution in the southern area and have more samples in the Gironde coastal area and ii) to study the vertical distribution of eggs, validate a vertical model and therefore study the hypothetical validity of CUFES samples in a quantitative point of view.

The new coverage of this area is shown in figure 10.4.2.8. The mix of anchovy and horse mackerel observed during the first week of May was still present in the same echotraces structure that previous one. A new pelagic haul was carried out and showed the same proportions of species and length distributions.

A dense acoustic and CUFES covering of the Gironde area was then carried out. It showed the same presence of eggs and fish echoes. Hauls revealed the presence of some small anchovies when they occurred close to the coast, confirming the fact that the adults of anchovy producing the eggs were probably very close to the coast and may be difficult to be observed by acoustics with a vessel like Thalassa. Many plankton net hauls combined to dense CUFES samples (1 nm instead of 3 nm) were carried out in this area. A gradual distribution of eggs was observed according to the stage of eggs proving that the broad distribution was due to the drift of eggs from the coast to offshore and that these eggs were mainly produced very close to the coast. The drift was due to Garonne river plume. This area (depth < 25 m) is of course badly surveyed by acoustics for security reasons and spawners in this area might be under-estimated.

The hydrological observations done during the survey showed surface temperatures rather similar to previous years but well visible up-wellings along the Landes coast. The river plumes are narrow and rather cold at the surface, showing a recent flow of fresh water and well correlated to the dry winter which preceded. Nevertheless, temperatures at 40 m depth were very cold (< 11°), even 2° below the colder one registered since 2000.

10.4.3 Surveys on Juvenile anchovy

JUVENA acoustic surveys aims at estimating the abundance of the anchovy juvenile population and their growth condition at the end of the summer in the Bay of Biscay in order to be able to assess the strength of the recruitment entering the fishery the next year, so that assistance to the formulation of the scientific advise for management can be provided.

Two JUVENA surveys have been conducted in 2003 and 2004 (Boyra et al WD2005). They took place from mid September to the beginning of October covering the area from Spanish coast to 5º W and up to 46º N onboard the commercial purse-seines (Divino Jesús de Praga in 2003 and Nuevo Erreñezubi in 2004). Acoustic data were recorded with a 38 and 120 KHz Simrad EY60 split-beam, scientific echo sounder system (Kongsberg Simrad AS, Kongsberg, 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).

Fish identity and population size structure was obtained from purse seining 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 specie-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 Dinner & Marchand (1995). Separation between adults and juveniles for anchovy is achieved by examination of otoliths taken from every sample. In addition, continuous sea surface temperature and salinity measurements and CTD casts every 10 nm were conducted.

In 2003, anchovy was mostly located at the Cantabrian Sea (Figure 10.4.3.1)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. Acoustic estimation provided for anchovy from this area will refer only to juveniles (after removing the part of energy corresponding to adult anchovy).

In 2004, very little anchovy was found in the surveyed area, more than 95% of it being located in the Northern part of the French Coast (Figure 10.4.3.2). Of this, the population found in the Garonne plume consisted mainly in 1 year old adults while the population found in the southern part of the Garonne, was mostly composed of 11 cm long juveniles. In the Cantabrian Sea, the small amount of anchovy found corresponded to juveniles of about 6 cm in length.

The anchovy juvenile abundance estimates for 2003 and 2004 are shown Table 10.4.3.1. These biomass estimates are still pending of an exhaustive checking of the method and a sensibility analysis to the parameters used in the data processing. In addition, given the experimental nature of this survey, the biomass estimates should not be taken as absolute biomass values but as relative ones. However, results indicate a large reduction in total anchovy abundance in 2004 (to 1/20 of the previous year). The larger differences were observed in the Southern area of the bay of Biscay (Cantabrian and Landes areas) which were almost empty of juvenile detections. Thus, is not only the abundance, but the positive area for juveniles what is drastically decreased for the year 2004.

JUVENA surveys are still in a preliminary stage: Only two surveys have been conducted in the series. By the time being, the results were encouraging since the huge drop in juveniles abundance estimates recorded by JUVENA surveys in 2004 matches quite well with the drop in recruitment to the adult population of age 1 occurring in 2005, as recorded by the spring surveys (Acoustic and DEPM May 2005 see former sections). The strength of this survey is that it is implemented during September and early October when juveniles are usually found in the upper layers of water as pure schools, being therefore well detectable with acoustics and well fishable with purse seine, with little risk of species misidentification. The experimental surveys carried out by AZTI and IFREMER within JUVESU project (FAIR CT97-3374, Uriarte editor 2002) in 1998 and 1999; provide additional contrasting background on the abundances and spatial distribution of juveniles. In those years juveniles were well detected in the Cantabrian regions and in front of the Garonne area (Figure 10.4.3.3) and this gives support to the impression of a big failure of recruitment in 2004 according to the absence of detections in most of these areas during JUVENA2004. JUVESU project served to establish the current JUVENA survey design. Furthermore, it is expected that a quantitative index can be obtained from the 1999 survey. This would enlarge the series of juvenile's acoustic estimates to three years (1999, 2003 and 2004).

The drawbacks of JUVENA surveys are that the surveyed area, south of 46ºN, cover the area where the bulk of recruitment is presumed to occur (Uriarte et al. 2001) but does not cover the whole distribution of the juveniles. Detections of juveniles have been made further north by JUVEGA survey (Petitgas et al. 2004) in 2003. The limits of the area surveyed in JUVENA 2005 will be expanded further north.

Comparisons between JUVENA and JUVAGA surveys in 2003 (op. cit.) suggested that bad weather conditions can make the juveniles to sink or disperse, thus making them less visible to the equipment. However in JUVESU survey in 1998 after a strong storm such phenomena did not occur and juveniles were still detectable in subsequent days. In order to overcome some noisy results due to that behaviour of juveniles, the inclusion (as a contrasting information) of juvenile detections reported by live bait tuna fishing boats can be studied; this can ultimately point out if a failure in the detections of juveniles have occurred during the survey.

During autumn (second half of October) anchovy juveniles at some stage disappear from the surface layers of waters, recruiting either to more coastal area and/or to deeper waters and mixing then with other species. If a part of the population by the time of the survey is being carried out has already sank to bottom then purse seine fishing will not allow identification of those juveniles and therefore the survey results will in those cases be biased. For that the inclusion of pelagic trawling would be convenient.

So far these surveys are not used for the assessment of the population or for forecasting the recruitment. A minimum of about 4 surveys are required to start assessing its performance in assessing the strength of recruiting year classes.

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.

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 and further reflections were done. 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 standard ICA assessment presented in the exploratory analysis (section 10.7.2). The index was positively related to the strength of next coming recruitment 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 rended it again statistically significant (P=0.02 of being due to chance up to 2004) but with a coefficient of determination of past recruitments of only 25%. 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 this index has raised up to 626, which imply an increase of about 40% in comparison with the average value of this index since 1998, but it is still below the historical average value of 757 (since 1986). Whether this will be translated into a better recruitment at age 1 in 2005 is totally uncertain.

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.

Those recruitment indices are in fact related to potential larval survival during spring. It seems that Model 1 well predicted the low year class 2002, but that both Models failed in the period 2003-2005 (Figure 10.6.2) where it didn't predict low recruitment, particularly in 2005. This may suggest that recruitment dynamics may have changed.

Nevertheless, an index has been calculated for 2006. Conditions for larval survival during spring 2004 are comparable to average conditions for the period 1986-2001 and the model predicts an average recruitment value around 5000 millions of age-1 fish (see table below).

	Abundance (ICES 1999)	Adjusted Model 1	Predicted Model 1	Abundance (ICES 2005)	Adjusted Model 2	Predicted Model 2
1987	1941	3269		1747	3521	
1988	2223	2066		2287	1854	
1989	1286	1363		1015	1363	
1990	5702	4811		5763	4598	
1991	2156	2236		2163	1973	
1992	8251	8846		7939	7418	
1993	7688	4917		7149	4672	
1994	4155	5280		3794	4926	
1995	3127	3807		3752	3897	
1996	4329	6637		3130	5874	
1997	6380	5103		4247	4802	
1998	9282	8185		5208	6956	
1999			5617	8422	5162	
2000			4022	4170	4047	
2001			5167	6974	4847	
2002			1780	1379	1654	
2003			6039	(1182)		5456
2004			5583	(2276)		5137
2005			5761	(200)		5262
2006			5453			5047

The fact that this recruitment index failed since 2002 seems 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.

For this reason, an analysis of climatic processes that happened in the Bay of Biscay during the past year has been done to see if another climatic event may have affect the anchovy recruitment in 2005 .

The climatic situation (Planque et al. 2005 WD) since September 2004 is described using indices of river hydrology, sea temperature and wind. The analysis covers all seasons but a specific focus was given on winter conditions. It has been also compared to long series which were available. The conclusions are:

- The river flows for the three main rivers have been low to average for the past 12 months and cumulated flow (since January 2005) is low for the Gironde and Adour. One noticeable flow event happened in late April-early May in all three rivers, but it was not sufficient to bring up cumulated flows. The last 12 months can be classified as a dry period but not extremely dry. (Figure 10.6.3).
- Temperature anomalies along the southern part of the Bay of Biscay coast have been negative during winter (December-March). Cold winters have been observed for the last four years (2001-2005) with 2005 being the coldest year. At Oleron station, it is noticeable that part of the last winter has been cold with negative SST anomalies from January through to March with significant minimum values in January (-3.6°C, ttest $p<0.05$). Over the winter period (December-March) the cumulated anomaly has been significantly lower that average (-1.7°C, ttest $p<0.05$). (Figure 10.6.4). At Cap Ferret station, it is noticeable that the last winter has been generally cold with negative SST anomalies from November through to April with significant minimum values in March (-1.9°C, ttest $p<0.01$). Over the winter period (December-March) the cumulated anomaly has been significantly lower that average (-1.1°C, ttest $p<0.05$). (Figure 10.6.5).
- The wind tension odograph for 2004-2005 shows that winds have been strong with a dominant northerly component during January and February 2005. The similarities between annual odographs and average odograph over the period of study show that the wind pattern at Chassiron during the last 12 months do not appear to be exceptional except for the winter northerly wind which may be noticeable (Figure 10.6.6)..

It must be also noticed that the hydrological conditions observed during PELGAS05 also show an atypical situation with bottom sea temperature 2°c below the average of temperatures observed since the last 6 years at the same season.

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) In addition, in the last three years a biomass-based model has been explored as an alternative to ICA (ICES 2004). This year a benchmark assessment is required for this anchovy stock. In this section an in-depth exploratory analysis is conducted before the final assessment of this stock is adopted. In the first sub section the input data for the assessment is analyzed and signals of mortality coming from the different data sources are compared. In the second section standard ICA assessment for this stock is explored in detail. Then, in sub section 3, a seasonal assessment of the different fisheries that allow the comparison between different operating fleets is presented and compared with respect to ICA. Sensitivity of the assessment to the constant natural mortality assumption is studied in sub section 4. Finally, an improved version of the biomass based model is introduced in sub section 5.

10.7.1 General analysis of input data

The input data entering into the assessment of the anchovy stock consist on total biomass and numbers at age from the research surveys conducted in spring, namely, egg and acoustic surveys (see section 10.4) and on 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 are derived from the biological sampling of the catches.

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 or 1998, in which there are some discrepancies, the trends in biomass from the DEPM and acoustic surveys are similar. In particular, in the last 6 years a parallel trend but with larger biomass estimates from the acoustic surveys is apparent. The agreement between both surveys is higher when estimating biomass at age 1 (Figure 10.7.1.2). The larger discrepancy is found in 2004. Numbers at age groups 1 and 2+ from both surveys are also compared in Figure 10.7.1.3.

Historical series of total landings are shown in Figure 10.7.1.4. Besides the year to year fluctuations, it can be seen that the level of total landings is higher in the 90's and that in the last three years has decreased to the same levels as those at the beginning of the series. Most of the catches correspond to age 1 and to a lesser extent to age 2 classes, see Figure 10.7.1.5, while the older age groups are almost non-existent.

Figure 10.7.1.6 shows the evolution of the cohort from catch-at-age data for age groups 1 to 5+. Note that surviving individuals of age classes 3 and older are very few, indicating the small amount of information is available on the evolution of the cohorts.

Total mortality is studied from the age structure observed in each of the different data sources. Numbers at age from acoustics in some of the years of the historical series is only available for the age classes 1 and 2+, therefore they are not included in this analysis. Figure 10.7.1.7 compares the cohort curves in log scale from the catch at age and the numbers at age from DEPM. The slopes of these curves are the log ratios between different age classes and provide ad-hoc estimates of total mortality, accounting for different effects as fishing mortality, natural mortality, catchability of the fleets or availability of the surveys. Log-ratios for each age class from catch at age and DEPM numbers at age are shown in Figure 10.7.1.8. It can be seen that in general:

- Log-ratio values are high, up to 4.
- Log-ratio values are very variable from year to year.
- There is some apparent trend in catch at age log ratios. This affects similarly all the age classes, suggesting that it might be due to natural mortality changes driven by environmental conditions.
- Average log ratios increase with age for both catch at age and DEPM numbers at age. However, when comparing average log ratios between both the average mortality estimates from age 2 to 3 are similar (around 2.5), whereas from age 1 to 2 DEPM indicates a higher mortality (above 1.6 for DEPM and around 1 for catch-at-age).

10.7.2 Sensitivity of ICA to input data

The assessment of the anchovy stock performed up to 2004 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 2005 are again available from both methods. The sensitivity of the assessment to the natural mortality is tested in section 10.7.1.4

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 information contained in each of the survey input data.

For such analysis, different Runs of ICA were made based on the partial and/or different use of surveys as follows:

- OnlyAcoustics (Absolute)
- OnlyAcoustics (Linear)
- OnlyDEPM (Absolute)
- OnlyDEPM (Relative)
- OnlySSBindices (DEPM absol and Acoustics Relative)
- BothSurveys (Relatives)
- BothSurveys (Absolutes)
- DEPMabsolute_AcousticRelative (Standard assessment in past years)

The reason for using ICA for this sensitivity analysis instead of the Biomass model was that this is made faster with ICA that with the Bayesian Biomass model.

The same settings as those for the model produced in the last year ICA assessment were adopted, just including the new data available (Table 10.7.2.1a): the catches at age in 2004, the revision of the spawning biomass and population at age estimates of the DEPM in 2004 and the new estimates from both the DEPM and acoustic surveys in 2005 (sections 10.4.1 and 10.4.2). Appropriate weighting factors for the ages in the catches in the estimation process for the assessment were analysed in detail in 2000 (ICES CM2001/ACFM:06). It was shown that the fitting to the separable model could be improved by down weighting ages 0 and 3, which can be considered marginal ages in terms of their percentage in the catch. Therefore, the WG has adopted the same weighting factors for this year‘s assessment i.e., down weighting ages 0 and 3 to 0.01 and 0.1 respectively. In addition, catch at age 3 in 1991 was found to be an outlier and is strongly down-weighted to 0.0001.

The separable model of fishing mortality is applied over a period of 15 years (1990-2004), where the first three years (1987-89) 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).

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):

$$
\begin{aligned}
&\sum_{a=0}^{a=4}\sum_{y=1990}^{y=2004}\lambda_{a,y}\left(Ln\left(C_{a,y}\right)-Ln\left(F_y \cdot S_a .\overline{N}_{a,y}\right)\right)^2 \\
&+\lambda_{DEPM}\sum_{y=1987}^{y=2005}\left[Ln\left(SSB_{DEPM}\right)-Ln\left(\sum_{a=1}^{5}N_{a,y}\cdot O_a \cdot W_{a,y}\cdot \exp\left(-P_F F_Y \cdot S_a - P_M .M\right)\right)\right]^2 \\
&+\sum_{y=1987}^{2005}\sum_{a=1}^{3+}\lambda_{DEPM,a}\left[Ln\left(SP_{DEPM,a,y}\right)-Ln\left(N_{a,y}\cdot \exp\left(-P_F \cdot F_y \cdot S_a - P_M \cdot M\right)\right)\right]^2 \\
&+\lambda_{acoustics}\sum_{y=1989}^{2005}\left[Ln\left(SSB_{acoustic}\right)-Ln\left(Q_{acoustic}\sum_{a=1}^{5}N_{a,y}\cdot W_{a,y}\cdot \exp\left(-P_F F_Y \cdot S_a - P_M .M\right)\right)\right]^2 + \\
&+\sum_{y=1989}^{2005}\sum_{a=1}^{2+}\lambda_{acoustics,a}\left[Ln\left(SP_{acoustic}\right)-Ln\left(Q_{a,y}\cdot N_{a,y}\cdot \exp\left(-P_F \cdot F_Y \cdot S_a - P_M \cdot M\right)\right)\right]^2
\end{aligned}
$$

with constraints on:

S2 =1, S5 = S4 = 0.79

and for reaching the interim year 2005 F2005 = F2004 and 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 to 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 indices 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 catchabilty factors should be included in the above minimization function in parallel to the way the acoustic catchability appear, being additional parameters to be estimated in the assessment.

When no age structured index is used the terms for population at age minimization between age disaggregated data and modelled population disappear.

A summary of the results from an assessment similar to the standard one adopted last year are 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 shows minor differences in the two first years of the series (1987-88) concerning SSB and F can be observed probably due to the fact that the separable model does not reach that period and population and F estimates are just VPA estimates.

The sensitivity of this ICA assessment to the information provided by each survey and the model of catchability of these suveys can be seen in Figure 10.7.2.3. In comparison with the standard ICA assessment, some differences appear in the absolute levels of the assessment particularly when the acoustic survey is used alone either as absolute or relative index of abundance. In the former case SSB values and recruitment are higher than the standard ICA assessment, with a reduction in the estimation of fishing mortality. This is due that on average biomass and population at age estimates in acoustics surveys are higher than in DEPM surveys particularly in the last 10 years (Figure 10.7.1.1). When the acoustic or the DEPM surveys are used as relative indices each one at a time alone it makes the SSB and recruitments to drops down since the absolute levels of the assessment is then more heavily relying on the level of catches at age (see below). The same effect is observed when the assessment is tuned to both surveys together (either as relative or absolute at a time) (Figure 10.7.2.4). The use of surveys as relative indices drops down the absolute level of R and SSB, increasing a bit the fishing mortality, while the absolute level of survey indices increases a bit these results for the reasons explained before. However, the use of both indices together minimize these effect compared when each one is used at a time to tune the assessment. Given the fact that the general trend of the assessments arising from the use of each survey alone is very parallel, the minor difference arising from the relative or absolute catchability models of the indices when used together gives confidence to the results of the assessment (similar relative tendencies and close absolute levels).

Using the surveys as relative leads to reduction of the fitting 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 surveys. However the estimates achieved of catchabilities for both surveys in these type of assessments are different between ages (Table 10.7.2.3), suggesting that the surveys show higher catchability for older ages than for younger ones. This result however is contrary to the perception of the performance of the surveys (see section 10.4.3). This reduces the assessment to a virtual population estimate tuned, 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). Therefore the WG believes that this outcome is unrealistic and actual catchability levels need to be assumed for the surveys in order to scale the assessment and obtain fishing selectivities at age etc. With this purpose, the standard ICA assessment for anchovy has always been based on the consideration of the DEPM surveys as absolute estimators of Biomass. Any other assessment shown above was rather similar regardless DEPM alone or both indices are taken as absolute estimators. The WG decided to continue to consider the standard ICA assessment the one based on DEPM as an absolute index to which all assessed parameters will be scaled.

In this analysis of sensitivity, 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. Figure 10.7.2.4 show that the sole use of the aggregate indices induced little effects on the relative tendencies and absolute levels of the stock.

As a summary of the sensitivity analysis, the effects of using separately or at the same time the estimates from these surveys and of their catchability models on the most recent estimates of SSB, recruitment and fishing mortality levels are shown in Figure 10.7.2.5, 6 and 7. In all cases the assessments point out a drop of SSB well below B_{lim} (of 21 000 tones) in 2005, along with a low recruitment at age 0 and high fishing mortality in 2004. The current update assessment points out the failure of recruitments for the last four years and an increase of fishing mortality in 2004 followed by a drop of SSB below B_{lim} in 2005.

10.7.3 Seasonal assessment of anchovy fisheries

In the Integrated Catch at age analysis, the assumption of constant fishing pattern may not be fully appropriate since two major fleets (Spanish purse seines and French pelagic trawlers – see section 10.7.1.3) exploit anchovy making use of different gears, in different areas and fishing seasons and may indicate different fishing patterns. Therefore, differences in the proportion of each fleet’s contribution to annual catches would imply changes on the average fishing pattern. In recent years tendencies of fishing fleets sizes (number of boats) and catchability problems have induced changes of the relative catches by fleet. These considerations about the two fleets suggest that data from the two fisheries should be better considered as separate when running a separable model. On the other hand, answering the demand of the Spanish Government about the evolution of the fishing mortalities by the fleets requires such type of analysis.

In this section we present a separable forward VPA model of several seasonal fisheries operating on anchovy in the Bay of Biscay (Uriarte WD2005) which essentially is a seasonal ICA assessment. The assessment fits Catches at age of five different fisheries operating over three periods of the year, as follows in the text table below (were the average catches in absolute and relative terms of these seasonal fisheries are shown):

1990-2004 Averages	France Catch	Spain Catch	Internation Catch	France %	Spain %	International %	Relative Weighting factors France	Spain
March	3080	0	3080	11%		11%	0.24	
June	1753	12597	14349	6%	44%	50%	0.14	1.00
2ndSemeste	9192	2320	11511	32%	8%	40%	0.73	0.18
Total	14025	14916	28941	48%	52%	100%		

The major fisheries are the Spring Spanish fishery and the 2nd half of the year French fishery which account for about 44% and 32% of the annual international catches. To the right of the above text table, weighting factors for the seasonal fisheries proportional to those catches, as used in the assessment, are presented. The fisheries can operate in parallel as for the Spanish and French parallel fisheries during the spring and 2nd half of the year.

Catches are modelled up to age 3+ (older ages are negligible) except for the French fishery of the 2nd half of the year for which a plus group is made from age 2+; this is made so because up to 1997 null or few catches of 3 years old anchovies were reported, whereas afterwards they have been reported in non negligible quantities (therefore a plus group was made on 2).

The modelled population is tuned to the Acoustic and DEPM spawning biomass and population at age estimates in the same manner as for the ICA annual assessment presented above.

Inputs

Catches in numbers and mean weights at age are taken from the fisheries as reported to this working group (by year and quarters, since 1998). Earlier catches were taken from (Prouzet et al. 1999 and Uriarte et al. WD 1997) (Tables10.7.3.1 and 10.7.3.2).

Tunning indices were the DEPM and the Acoustic biomass indices up to 2005 (Table 10.4.1.1 and Table 10.4.2.1). As for the standard assessment, DEPM was used as absolute estimator of SSB and population at age and Acoustic as a relative estimator of both SSB and population at age. Both numbers at age and SSB indices are used for the fitting.

Inputs of seasonal Catches at age and populations at age estimates from surveys are assumed to have lognormal errors. Minimizations are made on log residuals.

Operating Model

Population at age: Usual survival exponential model (Ricker 1975) and catch equation (Baranov 1918). Separability model for fishing mortality defines for each age, year and period-fishery of the year

$$F_{a,y,p} = F_{ref,y,p}.S_{a,p}$$

Where $F_{ref,y,p}$ is the fishing mortality in year y and period-fishery p for the age of reference, which in this study is age 2 ($F_{ref,y,p} = F_{2,y,p}$) for all the season fisheries.

$S_{a,p}$ is the selectivity for each age typical of every seasonal fishery and relative to the age of reference (age 2, which has a fixed selectivity value of 1).

Natural mortality is set fixed for all years and ages at M=1.2. For each season Natural Mortality is proportional to its duration in months (m). So that for a seasonal fishery *e* lasting *m* months Natural Mortality will be:

$$M_e = \frac{M}{12} \cdot m_e$$

Where suffix corresponding to year is omitted given it is assumed constant for the whole time series.

A total of 128 parameters are fitted: starting population -N1-N5- (5 params), Recruitments at age 0 (18 years), Selectivities at age (11 params), fishery fishing mortalities at age 2 by ages (92 params = 5*18+3(2005seasons)-1) and two catchability parameters (acoustic population estimates at age 1 and 2) (Table 10.7.3.3)

Fitting

Fitting the model is achieved by minimization the objective function: a sum of squared log residuals is defined for the tuning survey indices of biomass and population at age estimates and for the catches at age and catches in tonnes of the different seasonal fisheries defined above.

$$WSSQTotal =$$
$$SSQCapt_{age} + SSQCapt_{weight} + SSQDEPM_{age} + SSQDEPM_{weight} + SSQAc._{age} + SSQAc._{weight}$$

Where residuals to the catches at age ($SSQCapt_{age}$) were:

$$\sum_{a=1}^{3+}\sum_{1987}^{2005}\sum_{p=1}^{3}\lambda_{a,y,p} \cdot \left(Ln(C_{a,y,p} / \hat{C}_{a,y,p})\right)^2 + \sum_{a=0}^{3+}\sum_{1987}^{2004}\lambda_{a,y,4} \cdot \left(Ln(C_{a,y,4} / \hat{C}_{a,y,4})\right)^2$$
$$+ \sum_{a=0}^{2+}\sum_{1987}^{2004}\lambda_{a,y,5} \cdot \left(Ln(C_{a,y,5} / \hat{C}_{a,y,5})\right)^2$$

With p referring to the following fisheries:

p	Fishery
1	Winter Frech Fishery
2	Spring-French
3	Spring-Spanish
4	2nd Half of the year-Spain
5	2nd Half of the year-France

The sum of squares to the catches in tonnes ($SSQCapt_{weight}$) are just based on the comparison of SOPs from modelled catches at age with the actual catches in weight. In this way this additional fitting terms act more as a penalty from deviation of cumulative catches, so that errors across ages in the fitting are somehow force to partly balance in order to still match total catches.

Fitting to the DEPM and acoustic population at age estimates is made parallel to the fitting performed for ICA on annual basis (section 10.7.2).

A small difference from the annual ICA is that fitting to the relative acoustic SSB indices do not require a catchability parameter, because only the population at age estimates derived from these surveys are used for catchability analysis. Modelled SSB as estimated by a survey is just the product of the modelled numbers at age estimates for the surveys by the weights at age estimates for the surveys. This implies that only 9 out of the 12 acoustic estimates are used for tuning of catchabilities (because the other 3 cruises have no age structured information).

The minimization is made in a workbook named ASANES2004.xls. Notice that the data for fisheries of the first half of 2005 and the DEPM and acoustic surveys in 2005 are included.

Weighting factors: Fishery weighting factors (λ) were assumed and set proportional to the catches they actually produced (see above) and Weighting factors for the catches at age were set common for all fisheries as follows:

Specifications of weights on the catches at age by Fisheries

	Relative weights at age:				INPUT **General Weighting factor for the fishery**
Seasons / Ages	**0**	**1**	**2**	**3+**	Relative to Spring Weighting factors
Winter Frech Fishery	0	1	1	0.5	0.24
Spring-French	0	1	1	0.5	0.14
Spring-Spanish	0	1	1	0.5	1
2nd Half of the year-France	0.02	1	1	0	0.73
2nd Half of the year-Spain	0.02	1	1	0.5	0.18

Seasons	Duración/Duration	
Winter	2.67	0.2225
Spring	3.33	0.2775
Semestre 2	6	0.5
Total (::12)	12	

Weighting factors for the catches at age 0 were set equal to 0.02 since this catches are very small and noisy and are not considered to be separable (this is they are not targeted by the fleets and they are just occasionally taken separated from other ages). For ages 1 and 2 weights are 1. And the difference with the weighting factors at age used for annual ICA assessment was that of age 3+ for which here was set equal to 0.5 instead of 0.1; this is made in order to achieve a better fit the selectivity at this age. Sensitivity to this assumption was tested (see results).

Weighting factors for the DEPM and acoustic were set equal to those used in ICA (=0.5 for each age).

Potential correlation among ages in catches or the surveys are accounted for by correcting the weighting factors as in the ICA implementation (Patterson and Melvin, 1996)

Fitting performance

No coefficient of variation of parameter estimates is provided. Anova tables of residuals by sources of information (fisheries, tuning indices etc) and tables and figures of the fitting population and parameters as well as for the tuning of the indices and catches by fisheries are provided in a companion workbook (name: ASANES2004Complement.xls).

Given that this is the first time this type of assessment of the seasonal fisheries is made and that the current model is run in an ad hoc workbook (not in properly tested software) the results should be considered preliminary, although consistency with annual ICA runs gives credibility to the results.

Results

Table 10.7.3.4 summarizes the results of fitting the model. Figure 10.7.3.1 shows a high consistency between the annual and seasonal ICA assessments of this fishery (up to 2005), regardless of the weighting factor applied to age 3+. Figure 10.7.3.2 show the selectivity at age of the different fisheries: The winter French fishery and the spring Spanish fishery are the ones targeting more heavily old fishes. The French fishery in the second half of the year is the less selective one. The levels of fishing mortality by fleets (averages across ages 1 to 3+) since 1987 are shown in Figure 10.7.3.3. As expected the Spring Spanish fishery and the second half of the year fishery are the most relevant ones. They both show some decrease of fishing mortality levels between 1998 and 2001, probably linked to the high SSB levels, but an increase in the last two years at the recent low levels of biomass. The interannual variability in the fleet specific fishing mortalities in the last 3 years (where the highest discrepancies occur) reflect availability of the fish to the fisheries in those years.

Anova of the fitting results to the different sources of data and to different fishing fleets are presented in Table 10.7.3.5 and 4 respectively. For weighted sum of squares, international catches in tonnes are matched by the model with a CV of 16% as the addition of the modelled catches of the different fisheries. Other sources of information have higher values of CV between 30-50%. Despite the large marginal negative residuals (unweighted) of the catches at age fitted by the separable model (particularly for age 3), residuals to the catches at age have no major tendencies according to Figure 10.7.3.4. Fitting for the different fishing fleets by ages are shown in Figures 10.7.3.5, 6, 7, 8 and 9. The fitting is rather satisfactory for the major ages classes in the fishery (ages 1 and 2). However, catches at age 3+ have been badly fitted for the French second quarter and for Spanish second half of the year fisheries, in both cases probably due to single large individual residuals which bias the whole fitting for these fisheries (see the workbook). Individual down-weighting of these residuals would probably improve the fitting of the selectivities at age 3+ for these fleets. In addition catches at age 0 are badly fitted given their low weight in the analysis.

Concerning the tuning of surveys, the seasonal model has the same problems as the annual ICA assessment Figures 10.7.3.10 & 11: Observed population at age 2 is higher than expected according to the DEPM estimates (taken as absolute). This leads to overall positive residuals for age 2 and contributes to the high residuals on the SSB estimates. Catchability at age 2 in acoustics is about double than for age 1 (Table 10.7.3.4), leading to the same conclusion (higher than expected abundance of age 2 in comparison with age 1).

This analysis is shown to be coherent with the annual ICA assessment but the persistence of some clear bias in the fitting of age 3+ of some fisheries suggest that the fitting can be still improved, therefore the current results should be taken as preliminary.

10.7.4 Sensitivity of assessment to natural mortality assumption

The assumption of constant natural mortality, fixed in the assessment to 1.2, may not be correct for this stock since it is suspected to be highly variable (Prouzet et al. 1999). In addition, the results of the annual and seasonal ICA assessments shown above indicate that surveys estimate higher than expected anchovies at age 2 according to the model of this population, but age 3 (in DEPM surveys) is well fitted. In section 10.7.5 the analysis of total mortality both in catches at age and from the DEPM survey suggest Z could be higher between 2/3 than ½. These findings lead to questioning if a lower than assumed level of natural mortality could allow a better fitting to the catches and tuning indices.

This section used the separable ICA modelling presented above to make such a search. Here Natural mortality is set fixed for all years and ages, but searching for a multiplying factor (MEa) for age 2 onwards is also allowed:

$$\boldsymbol{M_a = M_1 \cdot ME_a}$$

The basic assumption for estimating natural mortality is based on the absolute level of biomass and population at age estimates provided by the DEPM.

A systematic search of a constant natural mortality (fixed across ages or changing for ages 2 and older) is presented for an assessment with a heavier weighting of DEPM and acoustics surveys indices than for the catches at age (so that each survey index receive 10 as weighting factor). Results are judged in terms of the weighted sum of squared residual obtained for each pre selected level of natural mortality. When searching for a pattern of natural mortality for age 1 and older, M1 was fixed and MEa was dealt as a new parameter to optimise. Finally a “best” natural mortality pattern at age from surveys is selected to adjust again the seasonal fisheries and the population with the original weighting factors. A brief discussion follows.

Figure 10.7.4.1 shows that for a constant natural mortality modelling of this anchovy a M of 1.2 or 1.3 produce minimum WSSQ. The higher the M the lower the average fishing mortality estimated over the time series.

Figure 10.7.4.2 shows that for a changing pattern of natural mortality at age modelling this anchovy with lower natural mortality at age 1 than for age 2 produce minimum WSSQ. The fitting to the DEPM survey is more sensitive to the choice of natural mortality at age, fitting better to a lower level of M at age 1. Catches in tonnes point out a bit in the contrary direction. However catches at age seem to be equally fitted at any choice of natural mortality at age. A compromise seems to be found at about 0.8 for M1 and 1.5 for M2.

A new seasonal separable model was run similar to the one presented in section 10.7.3 (with the same weighting factor) but natural mortality pattern at age as suggested by surveys (M0=M1=0.8 and M2=M3+=1.5). Figure 10.7.4.3 shows the high consistency between the annual and seasonal ICA assessments based on M=1.2 with the seasonal assessment based on a changing pattern of M by age. It is remarkable that the natural mortality pattern does not change the levels of fishing mortality (averages between ages 1-3) achieved. Small changes in selectivity at age by fisheries and in trends of fishing mortality throughout the times series were observed (not shown here). The ANOVA table shows that total WSSQ amounts to 45.03 (slightly below the WSSQ value of 45.83 achieved for a constant M of 1.2). The small reduction in WSSQ is basically due to DEPM age population at age fitting, while the fitting to catches at age is very similar. However an analysis of the fitting achieved of the DEPM (Figure 10.7.4.4) and of acoustic surveys indicate still an estimate higher than expected population at age 2 estimates in the DEPM, and a higher catchability at age 2 than at age 1 of the acoustic surveys (Q1= 1.38 and Q2= 1.90). This implies that despite the better fitted attained, the change in natural mortality has not solved the problems of fitting to the surveys and the separable model.

Given the accommodation of catches at age to any pattern of natural mortality at age and the similar results concerning fishing average mortality etc, this analysis shows that the basis for changing the natural mortality mostly rely on the information provided by surveys. Given the fact that for many years adult sampling of the DEPM has been heavily based on the one obtained in the parallel acoustic survey, the common problems shown in the age structured indices from these two surveys are not complete independent signals pointing towards the same direction, but part of the same input split in two surveys. The fact that average fishing does not change indicates that the ratio between catches and the SSB estimates provided by the surveys is determining this value and this ratio does not depend on the natural mortality at age pattern. This points out again the over parametrization of the analytical assessment of anchovy in these ICA type assessments and the undetermination of the solution unless some parameters are fixed. Changing partially M has not yet solved this problem. And the idea of largely changing natural mortality from year to year can also be affecting this result. 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 that the one carried out here, so as to understand the reason of this noisy fitting. The conclusion from this analysis is that for the moment being 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.

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.

10.7.5 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.

In this section, last year Bayesian biomass-based model is revisited and a new model trying to overcome the main drawbacks of this model is presented. The results from the improved model are compared with the initial biomass-based model and with the standard ICA assessment.

Biomass changes in time are due to either growth, recruitment, natural mortality or fishing mortality processes (Hilborn, 1992). In the biomass-based model, catch and recruitment are assumed to be instantaneous processes happening at specific time points, whereas growth and natural mortality are continuous processes in time. In particular, the model considers two different seasons. The first period goes from the 1st January to the date when research surveys are conducted, and allows obtaining intermediate population biomass estimates. The second period just takes the surviving total biomass to the beginning of the next year, when the new recruitment at age 1 enters into the population.

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. The population dynamics are then described through the following deterministic state equations. 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:

$$B(f_{1(y)},1) = R_y \exp\{-f_{1(y)}\,g\} - C(h_{1(y)},1)\exp\{-(f_{1(y)} - h_{1(y)})\,g\}$$

$$B(f_{1(y)},1+) = B(0_{(y)},1+)\exp\{-f_{1(y)}\,g\} - C(h_{1(y)},1+)\exp\{-(f_{1(y)} - h_{1(y)})\,g\}$$

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. In the initial biomass based model the state equations are deterministic, i.e. no process errors are considered so far. Note that, applying above equations recursively the total biomass at the beginning of the second period, $B(f_{1(y)}, 1+)$, can be expressed as a function of an initial biomass, $B_0 = B(f_{1(1986)}, 1+)$ and all the previous recruitments, R_k for $k \le y$.

In order to use the maximum available information to estimate the recruitments, the model makes use of total biomass and biomass at age 1 estimates from the direct surveys (DEPM and acoustic). In the initial biomass based model DEPM and acoustics age 1 and total biomass indices are assumed to follow log normal distributions all independent from each other and with the same variance:

$$\log(B_{depm}(f_{1(y)}, 1)) \sim N(\log(q_{depm}) + \log(B(f_{1(y)}, 1)), 1/\psi)$$

$$\log(B_{depm}(f_{1(y)}, 1+)) \sim N(\log(q_{depm}) + \log(B(f_{1(y)}, 1+)), 1/\psi)$$

$$\log(B_{ac}(f_{1(y)}, 1)) \sim N(\log(q_{ac}) + \log(B(f_{1(y)}, 1)), 1/\psi)$$

$$\log(B_{ac}(f_{1(y)}, 1+)) \sim N(\log(q_{ac}) + \log(B(f_{1(y)}, 1+)), 1/\psi) ,$$

where q_{depm} and q_{ac} are the catchability coefficients for the DEPM and acoustic surveys.

The results from this model presented last year 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, some problems regarding this model were also pointed out (ICES 2004). For example, the age 1 and total biomass indices are assumed to be independent in the observation equations, while in reality they are highly correlated. In addition, the assumption of equal variance for all the indices in the observation equations might be too simplistic. This year an improved biomass-based model trying to solve these difficulties has been presented (Ibaibarriaga et al working document 2005). The model incorporates 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 model is described extensively in the next section. As in the initial biomass-based model inference is conducted using Markov Chain Monte Carlo (MCMC) techniques. The parameters are sampled one by one, i.e. Gibbs sampling. In case the conditional posterior is of a non-standard form, Metropolis-Hastings within Gibbs sampling is used.

Input data for this model is shown in Table 10.7.5.1.

Four different models have been considered depending on whether the DEPM and acoustic surveys are absolute or relative (i.e. whether the catchabilities of the DEPM and acoustic surveys are fixed to 1or have to be estimated):

- Both surveys as relative
- DEPM as absolute (q_{depm}=1)
- Acoustic as absolute (q_{ac}=1)
- Both surveys as absolute (q_{depm}=1 and q_{ac}=1)

For each case, several runs have been conducted each with a different set of prior distributions.

- Priors 1 for all the parameters
- Priors 2 for all the parameters

Both sets of prior distributions have the same mean but the second set of priors is less informative having larger variances. Table 10.7.5.2 shows the parameters of the two set of prior distributions with the corresponding mean and 95% confidence intervals.

Figures 10.7.5.1, 10.7.5.2, 10.7.5.3 and 10.7.5.4 show the posterior medians for each of these models when both surveys are taken as relative, when either DEPM or acoustics are considered as absolute respectively and when both surveys are taken as absolute indices. In general, the posterior medians of recruitment series are similar for both set of prior distributions, but the second set of priors leads to wider credibility intervals. Figures 10.7.5.5 and 10.7.5.6 show the posterior medians for each set of prior distributions respectively. In this case it can be seen that the differences between different models (absolute and relative) are small and correspond to years when there is no data available for some of the indices. 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 case with priors 2 for all the parameters and DEPM and acoustics as relative indices are shown in Figure 10.7.5.7. This illustrates the parameter confounding issue as already pointed out in last year with the addition of the misidentification introduced by the process errors for recruitment.

The performance of the improved model has been compared with the initial biomass-based model and with the standard ICA assessment. The assumptions for the biomass based models are taken as in ICA with the DEPM as an absolute index and acoustics as relative. The first set of prior distribution has been taken. Figures 10.7.5.8 and 10.7.5.9 shows the posterior median of recruitment and biomass series with the corresponding 95 % credibility intervals.

The improved biomass model gives similar and consistent results compared to ICA. This supports the idea that the standard ICA assessment relies heavily on the surveys, and that the catch at age data does not provide much additional information on the development of the cohorts. Moreover, ICA might be over parameterized for a short living species like anchovy. On the other hand, the biomass based model has been further developed, avoiding some of the initial problems as correlation between age 1 and total biomass indices or the too simplistic assumption of equal variance for all the surveys. In addition, it makes a better use of the survey information, avoiding the double use of the survey estimates as spawning biomass and numbers at age and it is constructed on a statistically well founded framework. Therefore, the working group considers that the improved biomass based model is more appropriate than ICA to assess the state of the anchovy stock. However, this doesn't preclude the future use of age structured models like ICA or the seasonal model presented in this section for exploratory analysis.

10.8 State of the stock

10.8.1 Stock assessment

This year the final assessment for the anchovy population is based on the improved biomass-based model introduced in the previous section.

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:

$$B(f_{1(y)},1) = R_y \exp\{-f_{1(y)}\, g\} \exp\{\varepsilon_1(0_{(y)}, h_{1(y)}) + \varepsilon_1(h_{1(y)}, f_{1(y)})\}$$

$$- C(h_{1(y)},1) \exp\{-(f_{1(y)} - h_{1(y)})\, g\} \exp\{\varepsilon_1(h_{1(y)}, f_{1(y)})\}$$

$$B(f_{1(y)},1+) = B(0_{(y)},1+) \exp\{-f_{1(y)}\, g\} - C(h_{1(y)},1+) \exp\{-(f_{1(y)} - h_{1(y)})\, g\}$$

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. Note that in comparison with the last year biomass-based model (ICES 2004) in which the state equations were deterministic, in this model log normal error are considered for the dynamics of biomass at age 1 in the first period of the year. This introduces 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:

$$\varepsilon_1(0_{(y)}, h_{1(y)}) \sim \text{Normal}\ (\text{mean} = 0,\ \text{var} = (h_{1(y)} - 0_{(y)}) / \omega_1)$$

and

$$\varepsilon_1(h_{1(y)}, f_{1(y)}) \sim \text{Normal}\ (\text{mean} = 0,\ \text{var} = (f_{1(y)} - h_{1(y)}) / \omega_1).$$

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 last year 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

$$P_{depm}\ (f_{1(y)}) \sim \text{Beta}(\ \exp(\xi_{depm})\ P(f_{1(y)})\ ,\ \exp(\xi_{depm})\ (1\text{-}P(f_{1(y)}))\ )$$

$$\log(B_{depm}\ (f_{1(y)}\ ,1+)) \sim N(\ \log(q_{depm}) + \log(B(f_{1(y)}\ ,1+)),\ 1/\ \psi_{\ depm})$$

$$P_{ac}\ (f_{1(y)}) \sim \text{Beta}(\ \exp(\xi_{ac})\ P(f_{1(y)})\ ,\ \exp(\xi_{ac})\ (1\text{-}P(f_{1(y)}))\ )$$

$$\log(B_{ac}\ (f_{1(y)}\ ,1+)) \sim N(\ \log(q_{ac}) + \log(B(f_{1(y)}\ ,1+)),\ 1/\ \psi_{\ ac})\ ,$$

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}, $\xi_{depm,}$ $\xi_{ac,}$ B_0, R_y for all years y, the state errors $\varepsilon_1(.,\ .)$ and $\varepsilon_2(.,\ .)$ for all the time intervals and ω_1 and ω_2. 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.

$$R_y \text{ and } \varepsilon_1(0_{(y)},\ h_{1(y)}) \quad \Rightarrow \quad R_y^* = R_y \exp(\varepsilon_1(0_{(y)},\ h_{1(y)})) \text{ and } \varepsilon_1(0_{(y)},\ h_{1(y)})$$

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.

From the set of models and assumptions explored in the previous section, the final result (table 10.8.1.1) is the one corresponding to DEPM as absolute with the first set of priors (see Table 10.7.5.2). Figures 10.8.1.1 and 10.8.1.2 compare prior and posterior distributions of the parameters. The posterior median with 95 % credibility intervals for recruitment historical series is presented in Figure 10.8.1.3. The largest credibility 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, being this year recruitment the lowest of the historical series (posterior median of around 3 800 tones and 95 % credibility interval between 2000 and 7400 tones). The next lowest recruitment is found in 2002 with 11 800 tones.

Figure 10.8.1.4 shows the posterior distribution of current level of spawning biomass in 2005. The estimated level of biomass in 2005 is 12 900 tones and the 95% credibility interval is (7 600, 22 300) tones. This biomass level is the lowest of the historical level and it is well below the current B_{lim} (B_{lim} = 21 000 tones). Note that even the upper limit of the credibility interval is very close to B_{lim}.

10.8.2 Reliability of the assessment and uncertainty of the estimation

The biomass dynamic 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. 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 the biomass-based model 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 this model. This allows directly inferring the uncertainties of the estimates from the posterior distribution, including additional information through the prior distribution and projecting future states of the population.

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 in section 10.7 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 reminds 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. The state of the stock will be 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.

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:**
Blim is 21 000 t, the lowest observed biomass in 2003 assessment.	**B**pa=33 000 t.
There is no biological basis for defining.	be established between 1.0-1.2.

Technical basis:

Bloss = **B**lim = 21 000 t.	**B**loss *1.645.
	Fpa= 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

Precautionary reference points were not revised by the WG this year. At present the SSB is at the lowest observed level, and the stock dynamics are not well understood in this situation. The perception of the historical development of the stock is consistent with the old and new assessment model. Therefore the reference points may not need to be changed. .However the bayesian framework allows defining limits in probabilistic terms.

Given the short life span of this species, the working group considers B_{pa} as poor guidance for management of the population. If harvest control rules are implemented the current B_{pa} could be defined in the context of its use in the HCR.

10.9 Catch predictions for 2006

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 2006.

10.10 Harvest Control Rules

The anchovy stock has been managed by annual TACs which has been set independent at a fixed level independent of the advice (from 1979 to 2004). However, this management strategy seems to be not adequate for a short living 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, indicating that when the recruitment level is low, a management regime based on such annual TAC's 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 estimate of biomass becomes available. However, even if the exercise was considered a progress, it was not taken into further discussion.

This year two new simulation exercises for testing harvest control rules for the Bay of Biscay anchovy stock have been presented in the working group. The first one is based on Leslie matrices and the second one is a continuation of the work started in 2003 based on the biomass-based dynamic model. Both approaches consider new management measures such as the closure of a certain area or the temporal closure along different periods. The results of these exercises are presented for illustration purposes only and should not be used as a basis for any management decisions.

The working group considers that this type of tools can be useful for testing harvest control rules alternative to the annual fixed TAC. However, it is not the role of the WG to propose a concrete harvest control rule. The WG recommends that further discussion and work between managers, stake holders and scientists is promoted to develop appropriate management strategies for the Bay of Biscay anchovy stock.

10.10.1 Harvest control rules based on a Leslie matrix model

The long-term and short-term effects of alternative management measures for anchovy stock dynamics was explored using a preliminary simple Leslie matrix model (Petitgas et al. WD.2005). Such measures include temporal and spatial closure of the fishery.

The model

The standard Leslie model is

$$x(t) = A\,x(t-1)$$

where A is the time invariant transition matrix, x(t)=[x1(t), x2(2), x3(t)] are numbers at age.

The long term equilibrium is determined by the transition matrix

$$A = \lambda x$$

where λ is the population growth rate and x is the stable population age structure. λ is determined by the first eigenvalue of A.

For anchovy

$$A = \begin{bmatrix} Fe1 & Fe2 & Fe3 \\ S1 & 0 & 0 \\ 0 & S2 & 0 \end{bmatrix}$$

The parameters are given in Table 10.01.1.1 where S is the survival at age: S=exp(-(M+F)) and M and F are the annual natural and fishing mortality. Fe is the fertility at age: Fe=Fb*sd*sf*We*Se*Su*S0=fec*Su*S0; Fb=batch fecundity (nb of eggs spawned per batch per gramme of female); sd=spawning duration (days) ; sf=spawning fraction (percent of females spawning per day); We: weight at age, Se=sex ratio, S0=survival from egg to age 1 ; Su=survival to next year at spawning time; Su=exp(-(M+F)*(sb+sd/2)/12).

Evaluation of alternative management measures

Five alternative measures were explored:

- complete closure of the fishery,
- closing fishing during the spawning season,
- halving of annual catches,
- no fishing during spawning season, spatial fishery closure (box) covering part of the observed juvenile distribution and
- a combination of the previous two measures.

The box corresponds to the area (Figure 10.10.1.1) in which the mean length of anchovy in spring is less than 13.5 cm (grade of 60), based on the series of acoustic surveys (1985-2002) (Petitgas et al, 2002). The closure during the spawning period means than no catches of anchovy are allowed from May to mid August.

In the model, all measures were parameterised by a reduction in the value of fishing mortality, which assumed to be the same for all ages. The assumed effects of each of these measures on F and survival at age 0 are shown in Table 10.10.1.2.

Long-term population growth rate

The population growth rate was calculated by analysis of the properties of the time invariant transition matrix of the model. The population growth rate corresponds to the first eigenvalue of the transition matrix.

As a baseline for comparison, the population growth rate for the status quo fishing mortality was calculated. Input parameters are given in Table 10.10.1.1. Population growth rate at status quo was estimated as 1.01, showing that in the long term the modelled anchovy population was just viable, as its growth rate was just above 1. The long-term stable age structure is found to be 81% age 1, 16% age 2 and 3% age 3.

Long-term effects on population growth rate were similar for most management measures, but most important for complete closure of fishery (population growth rate 1.37). The combination measure (reducing fishing mortality on ages 0 and 1 by a spatial fishing closure, i.e. a closed box, and no fishing at all during the spawning period) was second best (1.30). The stable age structures were very similar to the age structure under the status quo situation.

Short-term effects of management measures

To evaluate short-term effects of the alternative management measures, estimated population abundance in spring 2005 from the PELGAS survey was used as a starting point and projections were carried out for 2006. In addition to the five management scenarios plus the status quo, three levels of recruitment were tested: low, medium and high.

The results showed that the assumed recruitment primarily determines the projected population in 2006 (Table 10.10.1.3). Not surprisingly, medium levels of recruitment are required to permit the population to increase. The greatest increase is predicted for a closure of the fishery (F=0) and population growth is somewhat less for all other scenarios, with the combination measure being second best.

From this exercise, the main conclusions are the following:

- Rebuilding the stock in 2006 depends on the recruitment scenario.
- Obviously none of the explored measures provide better results that the complete closure of the fishery.

Though this study has to be considered as a preliminary exploration (assumed linear relationship between SSB and recruitment), such an approach with improved stock recruitment dynamics could be developed to scrutinise potential effect of various management measures that could be considered for a better conservation of the stock than with a single TAC measure.

10.10.2 Harvest control rules based on the biomass-based model

This simulation exercise (Ibaibarriaga et al WD 2005) follows the work done in the WGMHSA in 2003.

The population dynamics is based on the biomass based model used in the WGMHSA (2004) and described briefly in section 10.7. The model considers three periods: the first one from the 1st January to the 15th May, when the peak of the spawning and both DEPM (Daily Egg Production Method) and acoustic surveys take place. The second period goes from the 15th May to mid-year, when the implementation of a revised management strategy based on the results from the surveys could start. The last period is from the 1st of July to the end of the year. Catch is assumed to be taken instantaneously in the middle of each period.

Initial states (recruitment and biomass at age 2+ at the beginning of the first year of simulations) of the population are taken from the recruitment and biomass at the beginning of year 2005 resulting from the biomass model in STECF 2005. The initial TAC is taken as 1200 tones, the total catches taken this year until the fishery was closed. The recruitment at age 1 entering the population every year is randomly sampled from the Ricker stock-recruitment model fitted to 1987-2005 recruitment at age 1 and total biomass resulting from the biomass model in STECF 2005. The population is projected forward for 20 years, 1000 times for each management strategy studied.

The management strategies considered are a combination of the measures enumerated below:

- Fixed TAC of 33 000 tones.
- Update the TAC every year as a proportion γ' of the spawning stock biomass estimate $S\hat{S}B$ for that year as illustrated in Figure 10.10.2.1:

$$TAC = \gamma' S\hat{S}B = \begin{cases} 0 & \text{if } S\hat{S}B \le B_{\lim} \\ \gamma \dfrac{S\hat{S}B - B_{\lim}}{B_{pa} - B_{\lim}} S\hat{S}B & \text{if } B_{pa} \le S\hat{S}B \le B_{\lim} \\ \gamma\, S\hat{S}B & \text{if } S\hat{S}B \ge B_{pa} \end{cases}$$

- $S\hat{S}B$ is the sum of the recruitment entering the population and the projection forward from the previous year biomass estimate taking into account growth and mortality. In the case a survey on recruitment is available the recruitment estimate at the beginning of the year is sampled from the error distribution of the survey assumed to be log-normally distributed with mean given by true population recruitment and coefficient of variation of 25 %. Otherwise, an average recruitment scenario of 55 000 tones is assumed.
- Revise the TAC at mid-year using the most recent biomass estimates $S\hat{S}B$ from the surveys. The survey biomass estimates are assumed to be log-normally distributed with mean the true biomass and coefficient of variation of 25 %.
- Close an area for a certain period in order to protect a certain fraction of the population. Only the part of the population outside the box would be exploitable at each period. The closure area considered in this exercise encloses the French coast and the Garonne river plume. The proportions for each age group considered to be within the area for each period are given in the following table:

	1 January - 30 June	1 July – 31 December
Age 1	75 %	20 %
Age 2+	15 %	5 %

- Close the fishery when the biomass estimate from the spring survey is below B_{lim}. Note that this follows naturally from the definition of the TAC when the TAC is revised at mid-year.
- Cap the TAC at certain value.

All the TAC is taken unless the population cannot sustain the catch, in which case a maximum proportion of the available population $\gamma_{\max} = 0.8$ is taken. The fraction of the TAC taken in each period is assumed to be the average fraction according to the historical series.

The performance statistics computed for each simulation are:

- Descriptive statistics of the spawning biomass
- Descriptive statistics of the catch taken
- Descriptive statistics of the recommended TAC established at the beginning of the year
- Descriptive statistics of the recommended TAC after revision at mid-year
- Probability of falling below B_{lim}
- Probability of falling below B_{pa}
- Average frequency for which total catches are 0

It is a decision of managers to define management targets for the stock and to decide on the management strategies to be evaluated. According to that different performance statistics can be looked at for each management strategy.

The different combinations of management measures presented here and the possible range of values for each of them are very large. So, here only an example is shown for illustration. Table 10.10.2.1 shows the probability of SSB of falling below B_{lim} (B_{lim} = 21 000 tones) for updatable TAC at which the proportion of the biomass defining the TAC is $\gamma = 0.5$, $\gamma = 0.75$ and $\gamma = 1$, without and with TAC capped at 33000 tones respectively, in comparison with the fixed TAC at 33000 tones without and with the fishery closure in case SSB is below B_{lim}. The first column contains the name representing each harvest control rule (HCR), the following columns indicate the management measures adopted for each case and the rest of columns contain the risk statistic for each case. In general terms that the stock will fall below B_{lim}

- The higher γ, the higher the risk
- A capped TAC reduces the risk
- An index of recruitment decreases the risk
- The closure of an area doesn’t have a big effect in terms of risk
- The TAC revision at mid-year has little impact on the risk.

10.11 Management Measures and Considerations

The results of the assessment show that SSB is below B_{lim} and that recruitment has been low since 2002.The recruitment in 2005 (as 1 group biomass) is estimated to be the lowest in the series. It is not possible to predict recruitment in 2006 (as 1 group) which should compose a significant proportion of the SSB in 2006. Given this situation the fishery should remain closed and should only be considered for opening after a reliable estimate of the 2005 recruitment and SSB in 2006 can be obtained. The most reliable information on recruitment will come from the spring survey in 2006.

The lack of a recruitment index before it enters the fishery has prevented for all these year the provision of a population and catch for the anchovy fishery in the Bay of Biscay. To overcome the current situation managers should endorse the continuation of acoustic recruitment surveys on juveniles in September-October of each year, in the frame of coordinated research between research institutes and countries. In this way, the series of results from the acoustic surveys on juveniles would be properly tested in relation to the recruits at age 1 to the fishery and the spring surveys next years, so that its predictive performance of in coming recruitment can be evaluated.

Continuation of the studies on the potential influence of environment on the recruitment process should also be encouraged.

Table 10.2.1.1 Annual catches (in tonnes) of Bay of Biscay anchovy (Subarea VIII)
As estimated by the Working Group members.

COUNTRY	FRANCE	SPAIN	SPAIN	INTERNATIONAL
YEAR	**VIIIab**	**VIIIbc, Landings**	**Live Bait Catches**	**VIII**
1960	1,085	57,000	n/a	58,085
1961	1,494	74,000	n/a	75,494
1962	1,123	58,000	n/a	59,123
1963	652	48,000	n/a	48,652
1964	1,973	75,000	n/a	76,973
1965	2,615	81,000	n/a	83,615
1966	839	47,519	n/a	48,358
1967	1,812	39,363	n/a	41,175
1968	1,190	38,429	n/a	39,619
1969	2,991	33,092	n/a	36,083
1970	3,665	19,820	n/a	23,485
1971	4,825	23,787	n/a	28,612
1972	6,150	26,917	n/a	33,067
1973	4,395	23,614	n/a	28,009
1974	3,835	27,282	n/a	31,117
1975	2,913	23,389	n/a	26,302
1976	1,095	36,166	n/a	37,261
1977	3,807	44,384	n/a	48,191
1978	3,683	41,536	n/a	45,219
1979	1,349	25,000	n/a	26,349
1980	1,564	20,538	n/a	22,102
1981	1,021	9,794	n/a	10,815
1982	381	4,610	n/a	4,991
1983	1,911	12,242	n/a	14,153
1984	1,711	33,468	n/a	35,179
1985	3,005	8,481	n/a	11,486
1986	2,311	5,612	n/a	7,923
1987	4,899	9,863	546	15,308
1988	6,822	8,266	493	15,581
1989	2,255	8,174	185	10,614
1990	10,598	23,258	416	34,272
1991	9,708	9,573	353	19,634
1992	15,217	22,468	200	37,885
1993	20,914	19,173	306	40,393
1994	16,934	17,554	143	34,631
1995	10,892	18,950	273	30,115
1996	15,238	18,937	198	34,373
1997	12,020	9,939	378	22,337
1998	22,987	8,455	176	31,617
1999	13,649	13,145	465	27,259
2000	17,765	19,230	n/a	36,994
2001	17,097	23,052	n/a	40,149
2002	10,988	6,519	n/a	17,507
2003	7,593	3,002	n/a	10,595
2004	8,781	7,580	n/a	16,361
2005(1st half)	952	200	n/a	1,152
AVERAGE	6,394	26,337	318	32,824
(1990-04)				

Table 10.2.1.2.	Monthly catches of the Bay of Biscay anchovy by country (Sub-area VIII) (without live bait catches)												
COUNTRY:											Units: t.	1000	
FRANCE													
YEAR\ MONTH	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**TOTAL**
1987	0	0	0	1,113	1,560	268	148	582	679	355	107	87	4,899
1988	0	0	14	872	1,386	776	291	1,156	2,002	326	0	0	6,822
1989	704	71	11	331	648	11	43	56	70	273	9	28	2,255
1990	0	0	16	1,331	1,511	127	269	1,905	3,275	1,447	636	82	10,598
1991	1,318	2,135	603	808	1,622	195	124	419	1,587	557	54	285	9,708
1992	2,062	1,480	942	783	57	11	335	1,202	2,786	3,165	2,395	0	15,217
1993	1,636	1,805	1,537	91	343	1,439	1,315	2,640	4,057	3,277	2,727	47	20,914
1994	1,972	1,908	1,442	172	770	1,730	663	2,125	3,276	2,652	223	0	16,934
1995	620	958	807	260	844	1,669	389	1,089	2,150	1,231	855	22	10,892
1996	1,084	630	614	206	150	1,568	1,243	2,377	3,352	2,666	1,349	0	15,238
1997	2,235	687	24	36	90	1,108	1,579	1,815	1,680	2,050	718		12,022
1998	1,523	2,128	783	0	237	1,427	2,425	4,995	4,250	2,637	2,477	103	22,987
1999	2,080	1,333	574	55	68	948	1,015	922	3,138	1,923	1,592	0	13,649
2000	2,200	948	825	5	58	1,412	2,190	2,720	3,629	2,649	1,127	0	17,765
2001	717	517	143	46	47	1,311	1,078	3,401	4,309	2,795	2,732	0	17,097
2002	1,435	2,561	1,560	1	30	758	350	979	1,957	771	578	0	10,978
2003	39	2	0	32	123	1,031	284	2,284	1,478	1,319	983	19	7,593
2004	210	106	3	13	145	1,625	853	1,995	2,464	555	813	0	8,781
2005 (prelim)	363	15	33	0	16	525							
Average 87-04	1,102	959	550	342	538	967	811	1,814	2,563	1,703	1,076	40	12,466
in percentage	8.8%	7.7%	4.4%	2.7%	4.3%	7.8%	6.5%	14.6%	20.6%	13.7%	8.6%	0.3%	100%
Average 92-04	1,370	1,159	712	131	228	1,234	1,055	2,196	2,964	2,130	1,428	16	14,622
in percentage	9.4%	7.9%	4.9%	0.9%	1.6%	8.4%	7.2%	15.0%	20.3%	14.6%	9.8%	0.1%	100%
COUNTRY:		1000											
SPAIN													
YEAR\ MONTH	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**TOTAL**
1987	0	0	454	4,133	3,677	514	81	54	28	457	202	265	9,864
1988	6	0	28	786	2,931	3,204	292	98	421	118	136	246	8,266
1989	2	2	25	258	4,295	795	90	510	116	198	1,610	273	8,173
1990	79	6	2,085	1,328	9,947	2,957	1,202	3,227	2,278	123	16	10	23,258
1991	100	40	23	1,228	5,291	1,663	91	60	34	265	184	596	9,573
1992	360	384	340	3,458	13,068	3,437	384	286	505	63	94	89	22,468
1993	102	59	1,825	3,169	7,564	4,488	795	340	198	65	546	23	19,173
1994	0	9	149	5,569	3,991	5,501	1,133	181	106	643	198	74	17,554
1995	0	0	35	5,707	11,485	1,094	50	9	6	152	48	365	18,951
1996	48	17	138	1,628	9,613	5,329	1,206	298	266	152	225	17	18,937
1997	43	1	81	2,746	2,672	877	316	585	1,898	331	203	185	9,939
1998	35	235	493	371	4,602	1,083	1,518	44	47	3	22	1	8,455
1999	8	26	52	4,626	4,214	1,396	1,037	26	911	207	615	27	13,144
2000	18	0	99	1,952	11,864	3,153	958	342	413	346	83	0	19,230
2001	243	48	337	2,203	14,381	3,102	1,436	1	126	1,055	120	1	23,052
2002	1	0	13	914	2,476	1,340	323	56	1,013	381	1	0	6,519
2003	0	0	0	1,709	767	373	10	12	124	4	3	0	3,002
2004	0	0	0	2,364	3,102	1,616	50	22	423	1	1	2	7,580
Average 87-04	58	46	343	2,453	6,441	2,329	609	342	495	254	239	121	13,730
in percentage	0.4%	0.3%	2.5%	17.9%	46.9%	17.0%	4.4%	2.5%	3.6%	1.8%	1.7%	0.9%	100%
			3.3%			81.7%			10.5%			4.5%	
Average 92-04	66	60	274	2,801	6,908	2,522	709	169	464	262	166	60	14,462
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%
	Total												
COUNTRY:	**FRANCE + SPAIN**												
Average 92-02	1,436	1,219	986	2,932	7,135	3,756	1,764	2,365	3,428	2,392	1,595	76	29,083
in percentage	4.9%	4.2%	3.4%	10.1%	24.5%	12.9%	6.1%	8.1%	11.8%	8.2%	5.5%	0.3%	100%

Table 10.2.1.3: ANCHOVY catches in the Bay of Biscay by country and divisions in 2004 (without live bait catches)

		QUARTERS				CATCH (t)	
COUNTRIES	DIVISIONS	1	2	3	4	ANNUAL	%
SPAIN	VIIIa	0	0	0	0	0	0.0%
	VIIIb	0	1072	228	0	1300	17.2%
	VIIIc	0	6010	266	4	6280	82.8%
	TOTAL	0	7081	495	4	7580	100
	%	0.0%	93.4%	6.5%	0.0%	100.0%	
FRANCE	VIIIa	35	66	3026	1181	4307	49.1%
	VIIIb	283	1672	2285	187	4427	50.4%
	VIIIc	0	46	0	0	46	0.5%
	TOTAL	318	1783	5311	1368	8780	100.0%
	%	3.6%	20.3%	60.5%	15.6%	100.0%	8780
NTERNATIONAL	VIIIa	35	66	3026	1181	4307	26.3%
	VIIIb	283	2743	2514	187	5727	35.0%
	VIIIc	0	6056	266	4	6325	38.7%
	TOTAL	318	8865	5806	1372	16360	100.0%
	%	1.9%	54.2%	35.5%	8.4%	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: ANCHOVY catch at age in thousands for 2004 by country, division and quarter(without the catches from the live bait tuna fishing boats).

	QUARTERS	1	2	3	4	Annual total
	AGE	VIIIbc	VIIIbc	VIIIabc	VIIIabc	VIIIabc
SPAIN	0	0	0	115	0	115
	1	0	183,853	18,881	113	202,847
	2	0	71,589	482	0	72,071
	3	0	7,461	23	0	7,484
	4	0	4,340	16	0	4,356
	TOTAL(n)	0	267,243	19,516	113	286,873
	W MED.	0.00	26.83	25.56	32.95	26.74
	CATCH. (t)	0.0	7081.5	494.5	3.7	7,579.7
	SOP	0.0	7169.7	498.8	3.7	7,672.3
	VAR. %	0.00%	101.25%	100.87%	99.83%	101.22%

	QUARTERS	1	2	3	4	Annual total
	AGE	VIIIab	VIIIab	VIIIab	VIIIab	VIIIab
FRANCE	0			10,172	897	11,069
	1	10,423	60,228	194,622	39,271	304,544
	2	2,625	11,465	13,484	6,107	33,681
	3	970	4,013	801	329	6,113
	4	53	204			258
	TOTAL(n)	14,072	75,910	219,079	46,604	355,665
	W MED.	22.60	23.50	24.24	29.35	24.69
	CATCH. (t)	318.0	1783.6	5311.0	1367.9	8,780.5
	SOP	318.0	1783.6	5311.0	1367.9	8,780.5
	VAR. %	100.00%	100.00%	100.00%	100.00%	100.00%

	QUARTERS	1	2	3	4	Annual total
	AGE	VIIIabc	VIIIabc	VIIIabc	VIIIabc	VIIIabc
TOTAL Sub-area VIII	0	0	0	10,287	897	11,184
	1	10,423	244,081	213,503	39,384	507,391
	2	2,625	83,054	13,966	6,107	105,751
	3	970	11,474	824	329	13,597
	4	53	4,545	16	0	4,614
	TOTAL(n)	14,072	343,154	238,595	46,717	642,538
	W MED.	22.60	26.09	24.35	29.36	25.61
	CATCH. (t)	318.0	8865.0	5805.5	1371.7	16,360.2
	SOP	318.0	8953.3	5809.8	1371.7	16,452.8
	VAR. %	100.00%	101.00%	100.07%	100.00%	100.57%

Table 10.3.1.2: Catches at age of anchovy of the fishery in the Bay of Biscay on half year basis as reported up to 1998 to ICES WGs and updated since then.

INTERNATIONAL

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
Age 0	0	7,530	0	11,184	0
1	50,327	133,083	254,504	252,887	7,973
2	44,546	87,142	85,679	20,072	32,848
3	34,133	11,459	12,444	1,153	7,263
4	887	1,152	4,598	16	585
5	0	0	0	0	0
Total #	129,893	240,366	357,225	285,312	48,669
Internat Catches	4,074	6,521	9,183	7,177	1,152
Var. SOP	100%	100%	100%	100%	
Annual Catch		10,595		16,360	

Table 10.3.1.2: (Cont. 2)

FRANCE

YEAR	1987		1988		1989		1990		1991		1992		1993		1994		1995	
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	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	0	18,670
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	154,437	171,470
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	75,914	20,438
3	4,026	0	2,245	0	9,863	0	36	0	26,522	0	6,893	0	4,369	0	17,045	0	19,311	0
4	0	0	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	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	249,662	210,578
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	5,157	5,735
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%	99.4%	97.9%
Annual Catch		4,899		6,822		2,255		10,598		9,708		15,217		20,914		16,934		10,892

YEAR	1996		1997		1998		1999		2000		2001		2002		2003		2004		2005
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 haf	1st half	2nd half	1st half	2nd half	1st half
Age 0	0	56,936	0	41,832	0	0	0	25,300	0	4,859	0	1	0	29	0	7,481	0	11,069	0
1	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	38,567	128,188	70,651	233,893	6,722
2	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	11,981	86,074	14,091	19,590	28,281
3	16,631	0	3,653	0	1,594	3,389	7,710	0	33,603	16,528	844	4,631	24,184	1,005	5,324	11,187	4,983	1,130	6,669
4	0	0	0	0	0	0	0	0	0	0	0	0	76	0	453	1,152	258	0	570
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				0
Total #	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	56,325	234,082	89,982	265,683	42,242
Catch France	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	1,226	6,367	2,102	6,679	952
Var. SOP	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%	100%	100%	100%	100%	
Annual Catch		15,238		11,830		22,987		13,649		17,765		17,097		10,988		7,593		8,781	

Table 10.3.1.2: (Cont)

SPAIN

YEAR	1987		1988		1989		1990		1991		1992		1993		1994		1995	
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	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	0	31,101
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	367,924	17,611
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	206,387	1,333
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	57,214	90
4	14,831	58	1,356	0	54	0	0	0	0	0	0	0	0	0	0	0	4,096	7
5	8,920	0	99	0	0	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	635,621	50,142
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	18,322	902
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%	102.1%	100.1%
Annual Catch		10,409		8,759		8,358		23,674		9,926		22,669		19,479		17,697		19,224

YEAR	1996		1997		1998		1999		2000		2001		2002		2003		2004		2005
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 haf	1st half	2nd half	1st half	2nd half	1st half
Age 0	0	52,238	0	91,400	0	4,075	0	29,057	0	439	0	748	0	239	0	49	0	115	0
1	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	11,761	4,895	183,853	18,994	1,251
2	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	32,566	1,068	71,589	482	4,567
3	14,461	499	1,927	195	4,002	9	10,051	525	50,834	2,085	18,854	464	13,702	2,041	28,809	272	7,461	23	594
4	2,213	42	0	0	155	0	108	0	0	0	4,948	0	0	0	434	0	4,340	16	15
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0
Total #	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	73,569	6,285	267,243	19,630	6,428
Catch Spain	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	2,848	154	7,081	498	200
Var. SOP	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%	100%	101%	101%	101%	
Annual Catch		19,135		10,317		8,630		13,610		19,230		23,052		6,519		3,002		7,580	

Table 10.3.1.3: Spanish half - yearly catches of anchovy (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	2001
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	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	n/a
2	1,461	203	1,496	139	0	0		477	209	522	58	0	810	n/a	n/a
3	912	3	0	0	0	0		0	0	0	0	0	0	n/a	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	n/a
Catch (t)	546	493	185	416	353	200	306	143.2	273.2	197.5	378	175.5	465.126	n/a	n/a
mean W (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	n/a

AGE	2002	2003	2004
0	n/a	n/a	n/a
1	n/a	n/a	n/a
2	n/a	n/a	n/a
3	n/a	n/a	n/a
Total	n/a	n/a	n/a
Catch (t)	n/a	n/a	n/a
mean W (g)	n/a	n/a	n/a

Table 10.3.2.1: Length distribution ('000) of anchovy in Division VIIIa,b,c by country and quarters in 2004.

	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	7		38					
10.5	14		162	152	1			
11	89		942	671	4			
11.5	553		4,359	1,884	13	2	2	
12	1,113		7,376	3,875	64	6	6	
12.5	1,144		7,223	10,017	3,335	443	109	
13	1,288		5,089	13,411	1,784	1,120	436	
13.5	1,457		4,527	23,002	10,708	1,175	1,440	
14	955		5,152	26,239	50,851	2,199	3,105	
14.5	851		6,860	23,887	48,806	1,936	5,228	
15	924		6,766	27,202	28,347	2,898	3,302	2
15.5	891		8,262	22,509	11,784	2,994	3,872	20
16	1,406		6,872	24,366	22,882	3,226	5,064	34
16.5	1,250		4,023	22,893	14,220	1,781	6,280	17
17	899		3,716	25,024	14,432	983	6,995	24
17.5	644		2,747	15,681	7,897	373	5,575	8
18	334		776	15,415	1,907	204	2,906	7
18.5	50		558	6,093	1,608	82	1,500	2
19	193		150	3,770		47	611	
19.5	9		313	941	439	29	173	
20				181		18		
20.5				14				
21				17				
21.5								
22								
22.5								
23								
23.5								
24								
24.5								
25								
25.5								
26								
Number('000)	14,072	0	75,910	267,243	219,079	19,516	46,604	113
Catch (t)	318		1,784	7,081	5,311	495	1,368	4
Mean Length(cm)	14.60		14.37	15.38	15.04	15.17	16.13	16.45
Mean weight(g)	22.60		23.50	26.50	24.24	25.34	29.35	33.00

Table 10.3.2.2: Mean weight at age in the international catches of anchovy 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)		WG data		WG data		WG data		WG data		WG data	
Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	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	
Sources:	WG data		WG data	
Periods	1st half	2nd half	1st half	2nd half
Age 0	0.0	15.4	0.0	15.5
1	21.0	25.4	21.7	24.9
2	36.2	29.5	35.7	33.5
3	40.3	36.4	39.3	40.7
4	36.9	37.9	44.0	42.8
5	0.0	0.0	0.0	0.0
Total	31.4	27.1	26.0	25.2
SOP	4,078	6,524	9,271	7,181
mean weight 3+	40.3	36.4	39.4	40.9

TABLE 10.4.1.1	Daily Egg Production Method.: Egg surveys on the Bay of Biscay anchovy.																					
		(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
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
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
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
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
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
(* 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
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**
	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
TOTAL #		1129	2675	470		5843		965.6	5797	--	2954	2644		3737.7	6282.4			6047.6	1,038.7	1296	979.9	292.3
(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
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**
	C.V.							0.16	0.26		0.23	0.13		0.17	0.15			0.27	0.30	0.30	0.23	0.26
(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**
	C.V.							0.17	0.22		0.19	0.23		0.10	0.14			0.22	0.13	0.34	0.19	0.19
	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**
	C.V.							0.42	0.51		0.30	0.30		0.27	0.36			0.37	0.14	0.38	0.26	0.37

(*) Likely subestimate according to authors (Motos &Santiago,1989)

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

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

Table 10.4.1.2: Summary results of the DEPM application to the Bay of Biscay anchovyy in 2005. 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 feamales, 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	STAND.ERROR	CV
DEP	4.4E+11	6.9E+10	0.1570
R'	0.5505	0.0046	0.0084
S	0.2621	0.0095	0.0363
F	12172.0	1419.7	0.1166
Wf	31.51	1.9306	0.0613
SSB	8,002	1495.31	0.1869
Wt	27.46	1.48	0.0539
Population	292.3	57.1	0.1955
Pa 1	0.3237	0.0422	0.1304
Pa 2	0.6472	0.0376	0.0581
Pa 3	0.0291	0.0107	0.3656
Nage 1	95.1	24.5	0.2574
Nage 2	188.8	36.7	0.1942
Nage 3	8.4	3.1	0.3681

Table 10.4.2.1: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**
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	8/04 - 14/0	27/04 - 6/0	6/05 - 6/06	27/5 - 25/6	27/4 - 25/5	3/05 - 31/05
Surveyed area	3,267	3,743	5,112	3,418 (3)	3388 (3)	2440(3)	2300(3)	1726(3)	9,400	6,781	21,300	10,667	12,917	9,996	8,858
									5600 (3)						
Biomass (t)	50,000	38,500	15,500	)-110,000 (	64,000	89,000	35,000	63,000	57,000	98,484	137,200 (5	97,051	29,428	46,018	16,446
Number (10(-6))**	2,600	2,000	805	300-7,500 (	3,173	9,342	*na*	3351	*na*		7892 (6)	3569	1451	2678	572
Number of 1-group(10(-6))**	1,800 (1)	600	400	100-7,500 (	1,873	9,072	*na*	2481	*na*		6163 (6)	831	983	2465	108
Number of age 2-group(10(-6)**	800	1,400	405	0 -200 (4)	1,300	270	*na*	870	*na*		1728 (6)	2738	468	145	465
Anchovy mean weight	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

(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 10.4.3.1: Estimates of acoustic abundance of anchovy juveniles by different strata and years. Values are given in metric tones.

	2003	2004
West Cantabrian (West of -3º30)	49.535,94	0,00
West Cantabrian and Landes (South of 45º)	158.758,20	488,82
North West (around shelf break)	988,76	0,00
Garonne area	30.947,01	12.461,98
Total	**240.219,41**	**12.950,8**

Table 10.5.1: Evolution of the French and Spanish fleets for ANCHOVY 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	211	296

(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

TABLE 10.7.2.1a. 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
0	0.3	7.5	11.2
1	232.6	183.4	507.4
2	294.3	131.7	105.8
3	40.9	45.6	13.6
4	1.0	2.0	4.6
5	1.0	1.0	1.0

x 10 ^ 6

Predicted Catch in Number

AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0	17.9	59.0	53.2	21.2	19.4	29.1	51.1	35.7	12.3	20.8	25.2	5.3	4.2	13.1	1.3
1	1512.6	523.5	1945.0	1392.7	783.7	714.3	1277.4	788.3	909.5	454.8	965.8	883.7	179.3	209.6	560.4
2	150.6	454.6	184.7	571.6	611.1	329.1	321.1	208.8	281.3	497.1	303.4	470.8	423.0	120.4	108.3
3	12.7	10.5	39.9	13.4	70.2	69.2	38.1	10.9	22.9	51.6	111.1	46.8	71.7	91.7	18.1
4	35.0	0.8	0.8	2.5	1.4	7.0	7.2	1.1	1.0	3.5	9.8	14.5	6.0	13.3	12.0

x 10 ^ 6

TABLE 10.7.2.1. Input data for ICA. Continued.

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
0	.009500	.015400	.015500
1	.027100	.024200	.023300
2	.032100	.031800	.035300
3	.042300	.039300	.039400
4	.045600	.037400	.044000
5	.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. Input data for ICA. Continued.

Weights at age in the stock (Kg)

AGE	2002	2003	2004
0	.012000	.012000	.012000
1	.022300	.015900	.017800
2	.033200	.029000	.034300
3	.035900	.034400	.034400
4	.040500	.040500	.040500
5	.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
0	1.2000	1.2000	1.2000
1	1.2000	1.2000	1.2000
2	1.2000	1.2000	1.2000
3	1.2000	1.2000	1.2000
4	1.2000	1.2000	1.2000
5	1.2000	1.2000	1.2000

TABLE 10.7.2.1a. Input data for ICA. Continued.

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
0	0.0000	0.0000	0.0000
1	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000

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
1	30.70	23.96	19.50	8.00

x 10 ^ 3

TABLE 10.7.2.1a. Input data for ICA. Continued.

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
1	97.05	29.43	46.02	15.60

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
1	283.6	1042.0	837.0	95.1
2	621.3	179.6	114.9	188.8
3	133.8	74.0	28.0	8.4

x 10 ^ 3

TABLE 10.7.2.1a. Input data for ICA. Continued.

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
1	2645.0	127.6
2	145.0	503.1

x 10 ^ 3

Fishing Mortality (per year)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.0109	0.0573	0.0161	0.0042	0.0038	0.0038	0.0029	0.0032	0.0035	0.0050	0.0022	0.0015	0.0015	0.0020	0.0019
1	0.1353	0.6147	0.2608	0.5615	0.4999	0.5037	0.3858	0.4218	0.4683	0.6642	0.2891	0.2004	0.2016	0.2612	0.2551
2	1.2836	0.1626	1.2258	1.3833	1.2315	1.2409	0.9505	1.0390	1.1537	1.6363	0.7123	0.4936	0.4967	0.6434	0.6284
3	1.4356	0.8182	0.1184	1.3699	1.2196	1.2289	0.9413	1.0290	1.1426	1.6205	0.7054	0.4889	0.4919	0.6372	0.6224
4	0.8075	0.6591	0.5235	1.0928	0.9729	0.9803	0.7509	0.8208	0.9114	1.2927	0.5627	0.3900	0.3924	0.5083	0.4965
5	0.8075	0.6591	0.5235	1.0928	0.9729	0.9803	0.7509	0.8208	0.9114	1.2927	0.5627	0.3900	0.3924	0.5083	0.4965

Fishing Mortality (per year)

AGE	2002	2003	2004
0	0.0018	0.0026	0.0033
1	0.2407	0.3454	0.4402
2	0.5930	0.8509	1.0844
3	0.5872	0.8427	1.0739
4	0.4684	0.6722	0.8567
5	0.4684	0.6722	0.8567

TABLE 10.7.2.1a. Input data for ICA. Continued.

Population Abundance (1 January)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	6017.	4608.	19330.	7262.	26801.	23990.	12504.	10445.	14137.	17494.	28068.	13948.	23393.	21874.	4677.
1	4538.	1793.	1311.	5729.	2178.	8042.	7198.	3755.	3136.	4243.	5243.	8435.	4195.	7035.	6575.
2	361.	1194.	292.	304.	984.	398.	1464.	1474.	742.	591.	658.	1183.	2079.	1033.	1632.
3	65.	30.	306.	26.	23.	87.	35.	170.	157.	70.	35.	97.	217.	381.	163.
4	43.	5.	4.	82.	2.	2.	8.	4.	18.	15.	4.	5.	18.	40.	61.
5	26.	3.	4.	2.	3.	3.	3.	3.	3.	2.	4.	5.	5.	4.	4.

x 10 ^ 6

Population Abundance (1 January)

AGE	2002	2003	2004	2005
0	3964.	8623.	696.	9926.
1	1406.	1192.	2590.	209.
2	1535.	333.	254.	502.
3	262.	255.	43.	26.
4	26.	44.	33.	4.
5	4.	3.	3.	5.

x 10 ^ 6

Weighting factors for the catches in number

AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
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	0.1000	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
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: Summary results of an update annual assessment of anchovy using Integrated Catch at age analysis (ICA) in 2005 with the same settings as in past year (2004 ICES CM2005).

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	0.0109	0.0573	0.0161	0.0042	0.0038	0.0038	0.0029	0.0032	0.0035	0.0050	0.0022	0.0015	0.0015	0.0020	0.0019
1	0.1353	0.6147	0.2608	0.5615	0.4999	0.5037	0.3858	0.4218	0.4683	0.6642	0.2891	0.2004	0.2016	0.2612	0.2551
2	1.2836	0.1626	1.2258	1.3833	1.2315	1.2409	0.9505	1.0390	1.1537	1.6363	0.7123	0.4936	0.4967	0.6434	0.6284
3	1.4356	0.8182	0.1184	1.3699	1.2196	1.2289	0.9413	1.0290	1.1426	1.6205	0.7054	0.4889	0.4919	0.6372	0.6224
4	0.8075	0.6591	0.5235	1.0928	0.9729	0.9803	0.7509	0.8208	0.9114	1.2927	0.5627	0.3900	0.3924	0.5083	0.4965
5	0.8075	0.6591	0.5235	1.0928	0.9729	0.9803	0.7509	0.8208	0.9114	1.2927	0.5627	0.3900	0.3924	0.5083	0.4965

Fishing Mortality (per year)

AGE	2002	2003	2004
0	0.0018	0.0026	0.0033
1	0.2407	0.3454	0.4402
2	0.5930	0.8509	1.0844
3	0.5872	0.8427	1.0739
4	0.4684	0.6722	0.8567
5	0.4684	0.6722	0.8567

Table 10.7.2.1b: Summary results of an update annual assessment of anchovy using Integrated Catch at age analysis (ICA) in 2005 with the same settings as in past year (2004 ICES CM2005) Continued.

Population Abundance (1 January)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	6017.	4608.	19330.	7262.	26801.	23990.	12504.	10445.	14137.	17494.	28068.	13948.	23393.	21874.	4677.
1	4538.	1793.	1311.	5729.	2178.	8042.	7198.	3755.	3136.	4243.	5243.	8435.	4195.	7035.	6575.
2	361.	1194.	292.	304.	984.	398.	1464.	1474.	742.	591.	658.	1183.	2079.	1033.	1632.
3	65.	30.	306.	26.	23.	87.	35.	170.	157.	70.	35.	97.	217.	381.	163.
4	43.	5.	4.	82.	2.	2.	8.	4.	18.	15.	4.	5.	18.	40.	61.
5	26.	3.	4.	2.	3.	3.	3.	3.	3.	2.	4.	5.	5.	4.	4.

x 10 ^ 6

Population Abundance (1 January)

AGE	2002	2003	2004	2005
0	3964.	8623.	696.	9926.
1	1406.	1192.	2590.	209.
2	1535.	333.	254.	502.
3	262.	255.	43.	26.
4	26.	44.	33.	4.
5	4.	3.	3.	5.

x 10 ^ 6

Table 10.7.2.1b: Summary results of an update annual assessment of anchovy using Integrated Catch at age analysis (ICA) in 2005 with the same settings as in past year (2004 ICES CM2005) Continued.

Predicted SSB Index Values

DEPM

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	66229.	42096.	25423.	52298.	30225.	70602.	999990.	53047.	43316.	39927.	44617.	93099.	75334.	89883.	88142.

DEPM

	2002	2003	2004	2005
1	49191.	19836.	29526.	9199.

Acoustic

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	*******	*******	31.33	*******	37.24	87.00	*******	65.36	*******	*******	54.98	114.71	*******	110.75	108.61

x 10 ^ 3

Acoustic

	2002	2003	2004	2005
1	60.61	24.44	36.38	11.34

x 10 ^ 3

Table 10.7.2.1b: Summary results of an update annual assessment of anchovy using Integrated Catch at age analysis (ICA) in 2005 with the same settings as in past year (2004 ICES CM2005) Continued.

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	2406.6	757.0	654.9	2481.5	971.3	3580.1	*******	1738.1	1419.8	*******	2584.4	4337.4	*******	*******	3294.1
2	111.1	625.0	92.2	89.2	310.1	124.8	*******	508.9	242.5	*******	265.2	529.0	*******	*******	684.7
3	45.0	14.9	166.9	35.9	8.9	28.9	*******	61.8	59.3	*******	17.5	48.4	*******	*******	97.8

x 10 ^ 3

DEPM SUVEYS (Ages 1 to 3+) Predicted

AGE	2002	2003	2004	2005
1	709.2	572.0	1188.5	95.9
2	654.8	125.7	85.9	169.7
3	126.1	116.2	28.0	12.2

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	944.3	*******	1463.9	5399.4	*******	*******	*******	*******	3746.1	*******	*******	*******	4744.8	1018.8	837.8
2	560.9	*******	783.7	378.1	*******	*******	*******	*******	630.8	*******	*******	*******	1718.3	1704.4	552.2

x 10 ^ 3

Table 10.7.2.1b: Summary results of an update annual assessment of anchovy using Integrated Catch at age analysis (ICA) in 2005 with the same settings as in past year (2004 ICES CM2005) Continued.

ACOUSTIC SURVEYS (ages 1 to 2+) Predicted

AGE	2004	2005
1	1771.6	142.9
2	271.0	434.7

x 10 ^ 3

Fitted Selection Pattern

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.0085	0.3524	0.0131	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031
1	0.1054	3.7803	0.2127	0.4059	0.4059	0.4059	0.4059	0.4059	0.4059	0.4059	0.4059	0.4059	0.4059	0.4059	0.4059
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	1.1184	5.0314	0.0966	0.9903	0.9903	0.9903	0.9903	0.9903	0.9903	0.9903	0.9903	0.9903	0.9903	0.9903	0.9903
4	0.6291	4.0535	0.4270	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900
5	0.6291	4.0535	0.4270	0.7900	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
0	0.0031	0.0031	0.0031
1	0.4059	0.4059	0.4059
2	1.0000	1.0000	1.0000
3	0.9903	0.9903	0.9903
4	0.7900	0.7900	0.7900
5	0.7900	0.7900	0.7900

Table 10.7.2.1b: Summary results of an update annual assessment of anchovy using Integrated Catch at age analysis (ICA) in 2005 with the same settings as in past year (2004 ICES CM2005) Continued.

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	6016810	193926	66228	15308	0.2311	0.9515	99
1988	4608420	137365	42095	15581	0.3701	0.5318	100
1989	19330460	297704	25423	10614	0.4175	0.5350	100
1990	7261820	178707	52298	34272	0.6553	1.1049	99
1991	26801030	467128	30224	19634	0.6496	0.9837	101
1992	23990200	427271	70602	37885	0.5366	0.9912	100
1993	12504440	309154	82103	40293	0.4908	0.7592	99
1994	10445260	264711	53047	34631	0.6528	0.8299	99
1995	14137350	258513	43315	30115	0.6952	0.9215	99
1996	17494330	298041	39927	34373	0.8609	1.3070	100
1997	28068180	418328	44617	22337	0.5006	0.5689	99
1998	13947780	329901	93098	31617	0.3396	0.3943	102
1999	23393350	416370	75333	27259	0.3618	0.3967	97
2000	21873820	425167	89883	36994	0.4116	0.5139	100
2001	4677090	216765	88142	40564	0.4602	0.5020	100
2002	3963950	140534	49190	17507	0.3559	0.4736	99
2003	8622950	142781	19836	10595	0.5341	0.6797	99
2004	695980	66106	29526	16361	0.5541	0.8662	99
2005			9200				

No of years for separable analysis : 15
Age range in the analysis : 0 . . . 5
Year range in the analysis : 1987 . . . 2004
Number of indices of SSB : 2
Number of age-structured indices : 2

Parameters to estimate : 40
Number of observations : 168

Conventional single selection vector model to be fitted.

Table 10.7.2.1b: Summary results of an update annual assessment of anchovy using Integrated Catch at age analysis (ICA) in 2005 with the same settings as in past year (2004 ICES CM2005) Continued.

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	1990	1.3833	21	0.9059	2.1123	1.1146	1.7167	1.4159
2	1991	1.2315	20	0.8221	1.8447	1.0020	1.5135	1.2579
3	1992	1.2409	23	0.7872	1.9562	0.9838	1.5653	1.2748
4	1993	0.9505	23	0.6007	1.5041	0.7521	1.2013	0.9769
5	1994	1.0390	22	0.6751	1.5993	0.8338	1.2947	1.0645
6	1995	1.1537	23	0.7265	1.8321	0.9112	1.4607	1.1863
7	1996	1.6363	19	1.1161	2.3990	1.3461	1.9890	1.6678
8	1997	0.7123	23	0.4472	1.1344	0.5617	0.9032	0.7326
9	1998	0.4936	26	0.2930	0.8315	0.3783	0.6441	0.5114
10	1999	0.4967	27	0.2900	0.8504	0.3775	0.6535	0.5157
11	2000	0.6434	24	0.3967	1.0435	0.5027	0.8234	0.6633
12	2001	0.6284	23	0.3986	0.9907	0.4982	0.7927	0.6456
13	2002	0.5930	23	0.3774	0.9317	0.4709	0.7467	0.6089
14	2003	0.8509	22	0.5456	1.3271	0.6783	1.0675	0.8731
15	2004	1.0844	18	0.7498	1.5683	0.8984	1.3090	1.1038
Separable Model: Selection (S) by age								
16	0	0.0031	79	0.0006	0.0147	0.0014	0.0068	0.0042
17	1	0.4059	11	0.3252	0.5068	0.3625	0.4546	0.4085
	2	1.0000	Fixed : Reference Age					
18	3	0.9903	28	0.5692	1.7232	0.7466	1.3137	1.0307
	4	0.7900	Fixed : Last true age					
Separable model: Populations in year 2004								
19	0	695979	36	340287	1423466	483115	1002634	743937
20	1	2590403	17	1852092	3623030	2182871	3074018	2628631
21	2	254104	18	178316	362101	212095	304432	258286
22	3	42812	27	25009	73288	32543	56323	44453
23	4	33124	30	18192	60311	24398	44970	34708

Table 10.7.2.1b: Summary results of an update annual assessment of anchovy using Integrated Catch at age analysis (ICA) in 2005 with the same settings as in past year (2004 ICES CM2005) Continued.

Separable model: Populations at age

24	1990	81772	73	19358	345420	39206	170554	107140
25	1991	1974	104	257	15170	697	5588	3392
26	1992	2042	46	822	5071	1284	3248	2274
27	1993	7623	45	3147	18464	4854	11972	8440
28	1994	4070	45	1672	9907	2585	6408	4511
29	1995	18340	40	8327	40391	12259	27437	19890
30	1996	15090	44	6298	36155	9662	23567	16667
31	1997	4198	58	1339	13162	2343	7520	4976
32	1998	5157	41	2264	11746	3389	7849	5633
33	1999	17950	31	9662	33346	13087	24621	18869
34	2000	40043	32	21057	76146	28848	55582	42255
35	2001	60702	36	29697	124078	42149	87421	64877
36	2002	26421	36	12965	53843	18374	37992	28222
37	2003	43895	29	24743	77874	32764	58809	45814

SSB Index catchabilities

DEPM

Absolute estimator. No fitted catchability.

Acoustic

Linear model fitted. Slopes at age :

38	2	Q	1.232	13	1.080	1.851	1.232	1.622	1.427

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	1.100	18	.9256	1.876	1.100	1.578	1.339
40	2	Q	1.567	18	1.316	2.689	1.567	2.257	1.912

Table 10.7.2.1b: Summary results of an update annual assessment of anchovy using Integrated Catch at age analysis (ICA) in 2005 with the same settings as in past year (2004 ICES CM2005) Continued.

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0	-0.054	0.384	-0.326	1.095	1.128	0.536	0.759	1.316	-1.106	0.962	-1.558	-1.948	-2.756	-0.555	2.116
1	-0.102	-0.173	-0.299	0.009	0.082	-0.004	-0.115	0.145	0.136	0.019	-0.009	0.091	0.260	-0.133	-0.099
2	-0.105	-0.341	0.196	-0.073	-0.108	-0.079	-0.115	-0.158	-0.110	0.051	0.093	0.004	-0.363	0.090	-0.024
3	0.038	1.018	-0.854	-0.931	-0.108	0.101	-0.187	-0.638	-0.936	-1.037	-0.076	-0.635	-0.561	-0.699	-0.288
4	-3.556	0.243	0.205	-0.923	-0.361	-0.529	-1.138	-0.105	-0.007	-1.183	-2.278	-1.076	-1.795	-1.878	-0.959

SPAWNING BIOMASS INDEX RESIDUALS

DEPM

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	-0.8133	0.4111	-0.4188	0.6202	-0.4498	0.2507	*******	0.1242	0.2334	-0.0096	0.1371	0.0911	-0.0867	-0.6924	0.3424

DEPM

	2002	2003	2004	2005
1	-0.4715	0.1890	-0.4150	-0.1395

Table 10.7.2.1b: Summary results of an update annual assessment of anchovy using Integrated Catch at age analysis (ICA) in 2005 with the same settings as in past year (2004 ICES CM2005) Continued.

Acoustic

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	*******	*******	-0.7036	*******	0.5414	0.0228	*******	-0.6246	*******	*******	0.1362	-0.6994	*******	-0.1174	0.2337

Acoustic

	2002	2003	2004	2005
1	0.4707	0.1857	0.2350	0.3195

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	-1.300	1.132	-0.636	0.816	-0.371	0.442	*******	0.155	0.464	*******	0.227	0.231	*******	*******	0.281
2	1.092	-0.885	1.147	0.757	-0.066	0.517	*******	0.541	0.305	*******	0.598	0.362	*******	*******	0.825
3	1.149	1.520	-1.884	0.108	-0.615	-0.549	*******	-0.225	-0.022	*******	-0.289	0.151	*******	*******	0.234

Table 10.7.2.1b: Summary results of an update annual assessment of anchovy using Integrated Catch at age analysis (ICA) in 2005 with the same settings as in past year (2004 ICES CM2005) Continued.

DEPM SUVEYS (Ages 1 to 3+)

Age	2002	2003	2004	2005
1	-0.917	0.600	-0.351	-0.008
2	-0.052	0.357	0.292	0.107
3	0.059	-0.451	-0.002	-0.375

ACOUSTIC SURVEYS (ages 1 to 2+)

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	-0.8590	*******	0.2464	0.5189	*******	*******	*******	*******	-0.4121	*******	*******	*******	0.2615	-0.2038	0.1601
2	-0.3256	*******	0.5062	-0.3367	*******	*******	*******	*******	0.3215	*******	*******	*******	0.0056	0.4740	-0.1658

ACOUSTIC SURVEYS (ages 1 to 2+)

Age	2004	2005
1	0.4008	-0.1129
2	-0.6254	0.1461

Table 10.7.2.1b: Summary results of an update annual assessment of anchovy using Integrated Catch at age analysis (ICA) in 2005 with the same settings as in past year (2004 ICES CM2005) Continued.

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

 Separable model fitted from 1990  to 2004
 Variance                                 0.0469
Skewness test stat.                      -4.3062
Kurtosis test statistic                  -0.3014
Partial chi-square                        0.1660
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                                 0.0780
Skewness test stat.                      -1.2900
Kurtosis test statistic                  -0.5841
Partial chi-square                        0.1292
Significance in fit                       0.0000
Number of observations                        18
Degrees of freedom                            18
Weight in the analysis                    0.5000
```

Table 10.7.2.1b: Summary results of an update annual assessment of anchovy using Integrated Catch at age analysis (ICA) in 2005 with the same settings as in past year (2004 ICES CM2005) Continued.

```
   DISTRIBUTION STATISTICS FOR   Acoustic



 Linear catchability relationship assumed
 Last age is a plus-group

 Variance                           0.0986
Skewness test stat.                -0.9289
Kurtosis test statistic            -0.6960
Partial chi-square                  0.1001
Significance in fit                 0.0000
Number of observations                  12
Degrees of freedom                      11
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                0.1360    0.1315    0.1873
Skewness test stat.     -0.3517    1.6043   -0.5546
Kurtosis test statisti  -0.4498   -0.7147    0.9624
Partial chi-square       0.1451    0.1627    0.2611
Significance in fit      0.0000    0.0000    0.0000
Number of observations       15        15        15
Degrees of freedom           15        15        15
Weight in the analysis   0.3333    0.3333    0.3333
```

Table 10.7.2.1b: Summary results of an update annual assessment of anchovy using Integrated Catch at age analysis (ICA) in 2005 with the same settings as in past year (2004 ICES CM2005) Continued.

DISTRIBUTION STATISTICS FOR ACOUSTIC SURVEYS (ages 1 to 2+)

Linear catchability relationship assumed

Age	1	2
Variance	0.0725	0.0583
Skewness test stat.	-0.9029	-0.1306
Kurtosis test statisti	-0.2646	-0.7499
Partial chi-square	0.0405	0.0353
Significance in fit	0.0000	0.0000
Number of observations	9	9
Degrees of freedom	8	8
Weight in the analysis	0.3750	0.3750

Table 10.7.2.1b: Summary results of an update annual assessment of anchovy using Integrated Catch at age analysis (ICA) in 2005 with the same settings as in past year (2004 ICES CM2005) Continued.

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

 Unweighted Statistics


Variance
                                       SSQ     Data    Parameters d.f. Variance
Total for model                        92.0631     168          40  128   0.7192
Catches at age                         63.8334      75          37   38   1.6798

SSB Indices
  DEPM                                  2.8067      18           0   18   0.1559
  Acoustic                              2.1684      12           1   11   0.1971

 Aged Indices
DEPM SUVEYS (Ages 1 to 3+)             20.4645      45           0   45   0.4548

ACOUSTIC SURVEYS (ages 1 to 2+)         2.7901      18           2   16   0.1744


 Weighted Statistics


Variance
                                       SSQ     Data    Parameters d.f. Variance
Total for model                         5.6934     168          40  128   0.0445
Catches at age                          1.7834      75          37   38   0.0469

SSB Indices
  DEPM                                  0.7017      18           0   18   0.0390
  Acoustic                              0.5421      12           1   11   0.0493

 Aged Indices
DEPM SUVEYS (Ages 1 to 3+)              2.2738      45           0   45   0.0505

ACOUSTIC SURVEYS (ages 1 to 2+)         0.3924      18           2   16   0.0245
```

Table 10.7.2.2						
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	5.6934	168	40	128	0.0445	
Catches at age	1.7834	75	37	38	0.0469	
SSB Indices						
DEPM	0.7017	18	0	18	0.039	
Acoustic	0.5421	12	1	11	0.0493	
Aged Indices						
DEPM SUVEYS (Ages 1 to 3+)	2.2738	45	0	45	0.0505	
ACOUSTIC SURVEYS (ages 1 to 2+)	0.3924	18	2	16	0.0245	
Weighted Statistics	**Relative ICA assessment (DEPM and Acoustic as Relative)**					
Variance	SSQ	Data	Parameters	d.f.	Variance	
Total for model	5.0047	168	44	124	0.0404	
Catches at age	1.4559	75	37	38	0.0383	
SSB Indices						
DEPM	0.6707	18	1	17	0.0395	
Acoustic	0.5803	12	1	11	0.0528	
Aged Indices						
DEPM SUVEYS (Ages 1 to 3+)	1.9077	45	3	42	0.0454	
ACOUSTIC SURVEYS (ages 1 to 2+)	0.39	18	2	16	0.0244	

Table 10.7.2.3															
Fitting of catchability parameters for the DEPM or acoustic surveys used alone (A) or together (B)															
A- Catchability of DEPM and acoustic when each survey tuned independently the catches at age.															
Annual Fitting	**M= 1.2**							**M= 1.2**							
ICA annual assessment (DEPM alone)								**ICA annual assessment (Acoustic alone)**							
Model	**Fitted Catchability Parameters**					**Biomass**		**Model**	**Fitted Catchability Parameters**						
Relative Index	**DEPM**	**Age 1**	**Age 2**	**Age 3+**	Q=	1.1600		**Relative Index**	**Acoustic**	**Age 1**	**Age 2 +**		**Biomass**		
	Q=	1.2270	1.9980	1.3740	K=	1			Q=	1.2150	1.9630	Q=	1.4730		
	K=	1.0000	1.0000	1.0000					K=	1.0000	1.0000	K=	1		
A- Catchability of acoustic when bothh surveys tuned the assessent (under the assumption of DEPM as abosolute index of abundance)															
M= 1.2															
Standard ICA annual assessment (DEPM absolute and Acoustic Relative)								**Standard ICA annual assessment (DEPM absolute and Acoustic Relative)**							
Model	**Assumed Catchability Parameters**							**Model**	**Fitted Catchability Parameters**						
Absolute	**DEPM**	**Age 1**	**Age 2**	**Age 3+**		**Biomass**		**Relative**	**Acoustic**	**Age 1**	**Age 2 +**		**Biomass**		
	Q=	1.0000	1.0000	1.0000	Q=	1.0000			Q=	1.1000	1.5670	Q=	1.2320		
	K=	1.0000	1.0000	1.0000	K=	1.0000			K=	1.0000	1.0000	K=	1		

Table 10.7.3.1: Mean weight at age in the catch of anchovy in the Bay of Biscay

		FRANCE						SPAIN					
		Weight at age for the catches to be tunned											
Year\ ages	**Season**	**W0**	**W1**	**W2**	**W3+**	**Total**	**Year\ ages**	**Season**	**W0**	**W1**	**W2**	**W3+**	**Total**
1987	**Winter**	0.0	20.4	29.4	35.4	23.4	**1987**	**Winter**					
	Spring	0.0	20.3	28.7	35.4	23.4		**Spring**	0.0	21.4	33.0	39.6	29.0
	Semestre 2	13.0	22.3	27.2	27.2	22.4		**Semestre 2**	11.6	21.0	39.3	39.2	19.1
1988	**Winter**	0.0	17.7	23.8	34.0	23.5	**1988**	**Winter**					
	Spring	0.0	19.8	26.1	34.0	21.4		**Spring**	0.0	21.3	32.4	35.2	24.2
	Semestre 2	12.1	24.3	29.0	29.0	23.9		**Semestre 2**	4.7	21.7	35.7	44.5	9.4
1989	**Winter**	0.0	12.0	22.0	31.7	19.0	**1989**	**Winter**					
	Spring	0.0	20.6	30.0	31.7	24.8		**Spring**	0.0	20.6	29.3	27.3	24.7
	Semestre 2	17.0	24.5	29.6	29.6	22.9		**Semestre 2**	12.6	25.3	36.0	42.7	14.9
1990	**Winter**	0.0	15.1	20.5	29.0	18.3	**1990**	**Winter**					
	Spring	0.0	20.6	26.7	29.0	21.1		**Spring**	0.0	20.6	29.0	44.9	21.4
	Semestre 2	11.0	23.3	26.1	26.1	23.4		**Semestre 2**	5.9	24.4	28.9	40.8	24.6
1991	**Winter**	0.0	16.9	21.5	27.6	21.1	**1991**	**Winter**					
	Spring	0.0	20.1	25.9	27.6	22.9		**Spring**	0.0	18.5	28.1	34.4	22.4
	Semestre 2	15.6	27.1	30.0	30.0	26.8		**Semestre 2**	14.3	16.4	22.4	39.0	14.9
1992	**Winter**	0.0	12.6	27.4	27.9	16.0	**1992**	**Winter**					
	Spring	0.0	21.9	28.8	27.9	22.8		**Spring**	0.0	21.5	32.6	44.5	23.4
	Semestre 2	12.3	23.9	29.8	29.8	23.6		**Semestre 2**	13.0	18.2	24.4	27.4	17.9
1993	**Winter**	0.0	12.5	23.1	27.6	19.7	**1993**	**Winter**					
	Spring	0.0	13.5	26.0	27.6	13.9		**Spring**	0.0	16.4	29.5	43.3	20.5
	Semestre 2	0.0	21.7	29.8	29.8	22.7		**Semestre 2**	12.3	15.5	26.6	0.0	15.0
1994	**Winter**	0.0	13.7	22.5	27.3	19.8	**1994**	**Winter**					
	Spring	0.0	15.5	23.5	27.3	16.4		**Spring**	0.0	18.7	29.2	32.0	25.0
	Semestre 2	11.6	26.1	30.3	30.3	26.4		**Semestre 2**	14.7	19.6	25.4	30.0	18.6
1995	**Winter**	0.0	13.7	23.4	31.4	21.9	**1995**	**Winter**					
	Spring	0.0	18.2	27.6	31.4	19.5		**Spring**	0.0	24.8	35.2	38.1	29.4
	Semestre 2	13.5	27.6	31.1	31.1	26.7		**Semestre 2**	16.1	20.1	33.4	35.9	18.0
1996	**Winter**	0.0	13.5	22.8	30.5	20.6	**1996**	**Winter**					
	Spring	0.0	16.7	25.8	30.5	17.7		**Spring**	0.0	19.9	31.9	41.0	23.1
	Semestre 2	12.7	23.9	27.3	27.3	22.9		**Semestre 2**	11.2	19.3	29.0	36.0	17.2
1997	**Winter**	0.0	16.4	25.7	26.8	20.9	**1997**	**Winter**					
	Spring	0.0	14.1	21.1	28.0	14.7		**Spring**	0.0	14.1	28.6	41.7	17.1
	Semestre 2	13.4	20.0	31.0	31.0	20.1		**Semestre 2**	10.8	21.1	27.4	29.7	17.2
1998	**Winter**	0.0	19.5	20.4	22.7	19.8	**1998**	**Winter**					
	Spring	0.0	19.5	21.2	24.2	19.9		**Spring**	0.0	24.2	32.3	35.3	25.6
	Semestre 2	0.0	23.6	27.1	27.1	24.2		**Semestre 2**	10.2	24.7	35.3	52.1	25.3
1999	**Winter**	0.0	14.0	24.3	27.1	21.6	**1999**	**Winter**					
	Spring	0.0	15.6	27.2	27.1	20.1		**Spring**	0.0	18.6	33.0	40.7	28.0
	Semestre 2	21.8	30.2	34.3	34.3	31.0		**Semestre 2**	10.0	21.3	31.0	38.9	21.5
2000	**Winter**	0.0	16.3	22.3	26.8	19.6	**2000**	**Winter**					
	Spring	0.0	19.0	28.5	26.8	20.7		**Spring**	0.0	23.6	31.2	36.8	27.0
	Semestre 2	19.8	28.7	34.6	34.6	29.7		**Semestre 2**	14.0	25.8	28.2	28.2	26.1
2001	**Winter**	0.0	18.9	28.6	30.0	21.2	**2001**	**Winter**					
	Spring	0.0	17.8	25.5	30.0	21.7		**Spring**	0.0	23.6	32.5	37.4	28.1
	Semestre 2	20.4	27.8	32.0	32.0	28.3		**Semestre 2**	14.3	25.2	30.9	44.7	27.7
2002	**Winter**	0.0	24.8	28.2	45.7	29.1	**2002**	**Winter**					
	Spring	0.0	28.2	30.3	44.4	31.0		**Spring**	0.0	24.4	35.4	38.0	33.2
	Semestre 2	7.9	30.9	33.8	33.8	32.0		**Semestre 2**	9.7	24.2	33.1	31.7	27.5
2003	**Winter**	0.0	15.5	21.6	26.2	17.0	**2003**	**Winter**					
	Spring	0.0	18.6	27.5	32.7	22.0		**Spring**	0.0	29.4	39.5	41.7	38.8
	Semestre 2	15.3	25.5	30.4	30.4	27.2		**Semestre 2**	19.9	23.5	27.3	38.9	24.8
2004	**Winter**	0.0	18.5	33.4	36.2	22.6	**2004**	**Winter**					
	Spring	0.0	20.2	35.8	37.3	23.5		**Spring**	0.0	22.4	35.8	42.1	26.8
	Semestre 2	15.5	24.8	33.8	33.8	25.1		**Semestre 2**	13.1	25.4	35.4	42.1	25.6
2005	**Winter**	0.0	19.5	25.8	31.9	27.8	**2005**	**Winter**					
	Spring	0.0	19.5	25.8	31.9	29.3		**Spring**	0.0	27.1	31.5	36.6	31.1
	Semestre 2	13.2	24.0	29.0	29.0	23.8		**Semestre 2**	11.5	20.6	30.3	34.8	17.7
2006	**Winter**	0.0	19.5	25.8	31.9	27.8	**2006**	**Winter**					
	Spring	0.0	19.5	25.8	31.9	29.3		**Spring**	0	20	31	38	24
	Semestre 2	13.2	24.0	29.0	29.0	23.8		**Semestre 2**	11	21	30	35	18
2007	**Winter**	0.0	19.5	25.8	31.9	27.8	**2007**	**Winter**					
	Spring	0.0	19.5	25.8	31.9	29.3		**Spring**	0	20	31	38	24
	Semestre 2	13.2	24.0	29.0	29.0	23.8		**Semestre 2**	11	21	30	35	18

Table 10.7.3.2: Catch in numbers

COUNTRY	FRANCE					SPAIN					INTERNATIONAL BAY OF BISCAY (Subarea VIII)				
	âge 0	âge 1	âge2	âge3 et +	Total	âge 0	âge 1	âge 2	âge3 et +	Total	âge 0	âge 1	âge 2	âge3 et +	Total
Mar-87	0.000	0.000	0.000	0.000	0.000						0.000	0.000	0.000	0.000	0.000
Jun-87	0.000	84.280	38.162	4.026	126.468	0.000	134.390	119.503	51.087	304.980	0.000	218.670	157.665	55.113	431.448
2nd Sem.8	2.688	79.925	5.747	0.000	88.360	35.452	40.172	7.787	1.722	85.134	38.140	120.098	13.534	1.722	173.494
Mar-88	0.000	0.183	0.331	0.091	0.604						0.000	0.183	0.331	0.091	0.604
Jun-88	0.000	107.357	30.681	2.154	140.192	0.000	210.641	61.609	9.165	281.414	0.000	317.998	92.289	11.319	421.607
2nd Sem.8	8.419	142.634	10.644	0.000	161.697	141.918	47.480	2.690	0.596	192.684	150.338	190.113	13.334	0.596	354.381
Mar-89	0.000	19.455	15.543	7.228	42.226						0.000	19.455	15.543	7.228	42.226
Jun-89	0.000	22.881	15.433	2.635	40.949	0.000	110.276	92.707	8.286	211.270	0.000	133.157	108.140	10.922	252.219
2nd Sem.8	5.282	13.919	1.290	0.000	20.492	174.803	13.165	9.481	1.986	199.435	180.085	27.085	10.771	1.986	219.927
Mar-90	0.000	0.402	0.463	0.030	0.895						0.000	0.402	0.463	0.030	0.895
Jun-90	0.000	127.547	11.753	0.005	139.305	0.000	719.678	47.266	8.139	775.083	0.000	847.225	59.019	8.144	914.388
2nd Sem.9	4.985	283.669	32.795	0.000	321.449	11.999	234.021	43.204	4.999	294.222	16.984	517.690	75.999	4.999	615.671
Mar-91	0.000	51.210	117.938	25.884	195.032						0.000	51.210	117.938	25.884	195.032
Jun-91	0.000	61.981	53.355	0.639	115.975	0.000	210.686	139.327	2.657	352.670	0.000	272.667	192.682	3.296	468.645
2nd Sem.9	5.111	95.367	10.866	0.000	111.344	81.536	21.113	1.715	0.061	104.425	86.647	116.480	12.581	0.061	215.769
Mar-92	0.000	217.904	57.196	6.880	281.980						0.000	217.904	57.196	6.880	281.980
Jun-92	0.000	32.590	4.720	0.014	37.324	0.000	751.056	131.221	10.067	892.344	0.000	783.646	135.941	10.081	929.668
2nd Sem.9	25.313	367.980	25.530	0.000	418.823	13.121	72.154	5.916	0.001	91.193	38.434	440.134	31.446	0.001	510.015
Mar-93	0.000	85.572	167.904	4.369	257.845						0.000	85.572	167.904	4.369	257.845
Jun-93	0.000	130.264	5.139	0.000	135.402	0.000	578.219	266.612	0.967	845.798	0.000	708.483	271.751	0.967	981.200
2nd Sem.9	0.000	535.157	80.073	0.000	615.231	63.499	75.866	11.904	0.000	151.268	63.499	611.023	91.977	0.000	766.499
Mar-94	0.000	90.969	161.726	16.766	269.461						0.000	90.969	161.726	16.766	269.461
Jun-94	0.000	146.590	16.689	0.279	163.559	0.000	257.050	315.022	44.622	616.694	0.000	403.640	331.711	44.901	780.253
2nd Sem.9	0.832	308.678	29.896	0.000	339.406	59.022	47.065	24.971	1.325	132.383	59.854	355.743	54.868	1.325	471.789
Mar-95	0.000	32.357	56.652	19.212	108.220						0.000	32.357	56.652	19.212	108.220
Jun-95	0.000	122.080	19.263	0.099	141.442	0.000	367.924	206.387	61.310	635.621	0.000	490.004	225.650	61.409	777.063
2nd Sem.9	18.670	171.451	20.441	0.000	210.562	31.101	17.611	1.333	0.097	50.142	49.771	189.062	21.774	0.097	260.704
Mar-96	0.000	41.655	58.143	16.630	116.428						0.000	41.655	58.143	16.630	116.428
Jun-96	0.000	99.227	11.942	0.001	111.170	0.000	542.127	163.010	16.674	721.810	0.000	641.354	174.952	16.675	832.980
2nd Sem.9	56.936	383.401	40.753	0.000	481.089	52.238	72.763	12.403	0.541	137.945	109.173	456.164	53.156	0.541	619.034
Mar-97	0.000	62.004	52.327	3.652	117.983						0.000	62.004	52.327	3.652	117.983
Jun-97	0.000	113.105	11.000	0.001	124.106	0.000	296.261	74.856	1.927	373.044	0.000	409.366	85.856	1.928	497.150
2nd Sem.9	41.832	316.877	30.579	0.000	389.288	91.400	123.011	9.435	0.195	224.041	133.232	439.888	40.014	0.195	613.329
Mar-98	0.000	164.392	68.533	1.028	233.954						0.000	164.392	68.533	1.028	233.954
Jun-98	0.000	61.715	19.150	0.565	81.430	0.000	217.711	41.171	4.157	263.039	0.000	279.426	60.321	4.722	344.469
2nd Sem.9	0.000	540.293	117.099	0.000	657.392	4.075	57.847	9.515	0.009	71.445	4.075	598.139	126.614	0.009	728.837
Mar-99	0.000	51.345	127.443	7.710	186.498						0.000	51.345	127.443	7.710	186.498
Jun-99	0.000	34.311	21.185	0.000	55.496	0.000	134.411	231.384	10.159	375.954	0.000	168.723	252.569	10.159	431.450
2nd Sem.9	25.300	156.115	105.260	0.000	286.676	30.057	87.191	37.644	0.525	155.416	55.357	243.306	142.904	0.525	442.092
Mar-00	0.000	112.983	59.407	29.696	202.087						0.000	112.983	59.407	29.696	202.087
Jun-00	0.000	57.435	9.714	3.907	71.055	0.000	389.515	199.233	50.834	639.583	0.000	446.950	208.947	54.741	710.638
2nd Sem.0	4.859	325.413	72.601	0.000	402.873	0.439	71.547	8.640	2.085	82.711	5.298	396.961	81.240	2.085	485.584
Mar-01	0.000	49.620	14.738	0.844	65.202						0.000	49.620	14.738	0.844	65.202
Jun-01	0.000	32.590	32.597	0.000	65.186	0.000	378.136	327.090	23.803	729.029	0.000	410.726	359.687	23.803	794.215
2nd Sem.0	0.001	453.527	59.261	0.000	512.789	0.748	54.151	43.487	0.464	98.851	0.749	507.678	102.748	0.464	611.639
Mar-02	0.000	61.384	103.967	21.358	186.709						0.000	61.384	103.967	21.358	186.709
Jun-02	0.000	10.480	14.551	2.902	27.933	0.000	31.347	98.700	13.702	143.748	0.000	41.827	113.251	16.604	171.681
2nd Sem.0	0.029	89.243	55.512	0.000	144.783	0.239	40.149	22.621	2.041	65.049	0.267	129.392	78.133	2.041	209.832
Mar-03	0.000	1.908	0.348	0.133	2.389						0.000	1.908	0.348	0.133	2.389
Jun-03	0.000	36.659	11.633	5.644	53.936	0.000	11.761	32.566	29.243	73.569	0.000	48.420	44.198	34.887	127.505
2nd Sem.0	7.481	128.188	98.413	0.000	234.082	0.049	4.895	1.068	0.272	6.284	7.530	133.083	99.481	0.272	240.366
Mar-04	0.000	10.423	2.625	1.023	14.072						0.000	10.423	2.625	1.023	14.072
Jun-04	0.000	60.228	11.465	4.217	75.910	0.000	183.853	71.589	11.802	267.243	0.000	244.081	83.054	16.019	343.154
2nd Sem.0	11.069	233.893	20.721	0.000	265.683	0.115	18.994	0.482	0.038	19.630	11.184	252.887	21.203	0.038	285.312
Mar-05	0.000	2.779	12.618	3.306	18.703						0.000	2.779	12.618	3.306	18.703
Jun-05	0.000	3.943	15.663	3.933	23.538	0.000	1.251	4.567	0.609	6.428	0.000	5.194	20.230	4.542	29.966
2nd Sem.05															
Averages 1990-2004															
March	0.000	68.942	69.961	10.348	149.250						0.000	68.942	69.961	10.348	149.250
June	0.000	75.120	16.944	1.218	93.282	0.000	337.982	156.362	19.337	513.682	0.000	413.102	173.306	20.556	606.964
2ndSemes	13.494	292.617	53.320	0.000	359.431	29.309	66.559	15.622	0.843	112.334	42.804	359.175	68.943	0.843	471.765

Table 10.7.3.3 Parameters of the separable Model

	Population		Selectivity	Mortality at age 2 by year and fisheries		
Years	**Parameters**		**Parameters**	**Parameters**	**Parameters**	
Y-22	N5_1987		Winter Sel_1	Winter.F2_1988	SpainSpring.F2_1987	
Y-21	N4_1987		Winter Sel_3	Winter.F2_1989	SpainSpring.F2_1988	
Y-20	N3_1987		France Spring Sel_1	Winter.F2_1990	SpainSpring.F2_1989	
Y-19	N2_1987		France Spring Sel_3	Winter.F2_1991	SpainSpring.F2_1990	
Y-18	N1_1987		Spain Spring Sel_1	Winter.F2_1992	SpainSpring.F2_1991	
Y-17	R0_1987		Spain Spring Sel_3	Winter.F2_1993	SpainSpring.F2_1992	
Y-16	R0_1988		Spain.2nhalf.Sel_0	Winter.F2_1994	SpainSpring.F2_1993	
Y-15	R0_1989		Spain.2nhalf.Sel_1	Winter.F2_1995	SpainSpring.F2_1994	
Y-14	R0_1990		Spain.2nhalf.Sel_3	Winter.F2_1996	SpainSpring.F2_1995	
Y-13	R0_1991		France.2nhalf.Sel_0	Winter.F2_1997	SpainSpring.F2_1996	
Y-12	R0_1992		France.2nhalf.Sel_1	Winter.F2_1998	SpainSpring.F2_1997	
Y-11	R0_1993	Subtotal	11	Winter.F2_1999	SpainSpring.F2_1998	
Y-10	R0_1994			Winter.F2_2000	SpainSpring.F2_1999	
Y-9	R0_1995			Winter.F2_2001	SpainSpring.F2_2000	
Y-8	R0_1996			Winter.F2_2002	SpainSpring.F2_2001	
Y-7	R0_1997			Winter.F2_2003	SpainSpring.F2_2002	
Y-6	R0_1998	**Mortality at age 2 by year and fisheries**		Winter.F2_2004	SpainSpring.F2_2003	
Y-5	R0_1999		**Parameters**	Winter.F2_2005	SpainSpring.F2_2004	
Y-4	R0_2000		France2ndhalf.F2_1987	FranceSpring.F2_1987	SpainSpring.F2_2005	
Y-3	R0_2001		France2ndhalf.F2_1988	FranceSpring.F2_1988	Spain2ndhalf.F2_1987	
Y-2	R0_2002		France2ndhalf.F2_1989	FranceSpring.F2_1989	Spain2ndhalf.F2_1988	
Y-1	R0_2003		France2ndhalf.F2_1990	FranceSpring.F2_1990	Spain2ndhalf.F2_1989	
Y	R0_2004		France2ndhalf.F2_1991	FranceSpring.F2_1991	Spain2ndhalf.F2_1990	
Subtotal	23		France2ndhalf.F2_1992	FranceSpring.F2_1992	Spain2ndhalf.F2_1991	
			France2ndhalf.F2_1993	FranceSpring.F2_1993	Spain2ndhalf.F2_1992	
			France2ndhalf.F2_1994	FranceSpring.F2_1994	Spain2ndhalf.F2_1993	
			France2ndhalf.F2_1995	FranceSpring.F2_1995	Spain2ndhalf.F2_1994	
			France2ndhalf.F2_1996	FranceSpring.F2_1996	Spain2ndhalf.F2_1995	
			France2ndhalf.F2_1997	FranceSpring.F2_1997	Spain2ndhalf.F2_1996	
			France2ndhalf.F2_1998	FranceSpring.F2_1998	Spain2ndhalf.F2_1997	
			France2ndhalf.F2_1999	FranceSpring.F2_1999	Spain2ndhalf.F2_1998	
Acoustic Catchability at age 1			France2ndhalf.F2_2000	FranceSpring.F2_2000	Spain2ndhalf.F2_1999	
Acoustic Catchability at age 2+			France2ndhalf.F2_2001	FranceSpring.F2_2001	Spain2ndhalf.F2_2000	
Subtotal	2		France2ndhalf.F2_2002	FranceSpring.F2_2002	Spain2ndhalf.F2_2001	
			France2ndhalf.F2_2003	FranceSpring.F2_2003	Spain2ndhalf.F2_2002	
			France2ndhalf.F2_2004	FranceSpring.F2_2004	Spain2ndhalf.F2_2003	
				FranceSpring.F2_2005	Spain2ndhalf.F2_2004	
		Subtotal	18	37	37	92
				TOTAL	**128**	

Table 10.7.3.4

Standard Seasonal Assessment output M=1.2 constant

Recruiting Population		SELECTIVITIES AT AGE						Fitted Catchability Parameters		
		Fisheries	**Age 0**	**Age 1**	**Age 2**	**Age 3**				
Age 3+, 1987	284	**Winter**	0.0000	0.2410	1.0000	1.3279		**Acoustic**	Age 1	Age 2 +
Age 5 , 1987	1	**Spring Spain**	0.0000	0.2610	1.0000	0.6365		Q=	1.3398	2.1796
Age 4 , 1987	273	**Spring France**	0.0000	0.5674	1.0000	0.0469		K=	1.0000	1.0000
Age 3 , 1987	11	**Spain 2nd**	0.0870	0.6295	1.0000	0.1412				
Age 2 , 1987	559	**France 2n**	0.0018	0.8510	1.0000	1.00	Plusgroup			
Age 1 , 1987	2,065									

Year\ ages	Spawning Stock	Recruitment	Annual Catches	Catches Expected	Ratio Yield/SSB	Annual Average F (1-3+)	F (1-3+) Winter France	F (1-3+) Spring France	F (1-3+) 2nd half France	F (1-3+) Spring Spain	F (1-3+) 2nd half Spain
1987	41,845	7,656	15,309	15,197	0.366	0.490	0.000	0.075	0.082	0.277	0.056
1988	37,015	3,410	15,581	18,787	0.421	0.802	0.140	0.093	0.211	0.277	0.082
1989	18,039	17,884	10,614	10,415	0.588	0.628	0.060	0.051	0.034	0.384	0.099
1990	54,520	6,717	34,272	37,455	0.629	1.062	0.000	0.036	0.367	0.370	0.289
1991	23,131	25,986	19,635	21,904	0.849	1.074	0.215	0.101	0.193	0.522	0.042
1992	69,316	24,243	37,885	50,027	0.547	1.120	0.145	0.009	0.337	0.603	0.026
1993	84,895	11,404	40,392	38,108	0.476	0.695	0.106	0.012	0.283	0.260	0.034
1994	49,718	10,189	34,631	35,055	0.697	0.845	0.116	0.044	0.230	0.389	0.065
1995	39,734	14,304	30,116	31,959	0.758	1.048	0.075	0.058	0.248	0.644	0.022
1996	43,575	16,044	34,373	37,621	0.789	1.325	0.088	0.030	0.507	0.619	0.082
1997	42,009	29,653	22,339	21,437	0.532	0.605	0.083	0.020	0.242	0.194	0.066
1998	97,969	12,489	31,617	31,723	0.323	0.408	0.062	0.014	0.243	0.075	0.015
1999	71,888	22,533	27,258	26,775	0.379	0.387	0.057	0.010	0.148	0.127	0.045
2000	86,995	21,333	36,994	37,665	0.425	0.542	0.066	0.016	0.180	0.253	0.026
2001	88,705	3,945	40,149	38,048	0.453	0.494	0.015	0.011	0.198	0.233	0.036
2002	45,230	3,827	17,497	18,980	0.387	0.443	0.105	0.015	0.170	0.096	0.056
2003	21,727	6,838	10,595	10,462	0.488	0.675	0.002	0.056	0.515	0.093	0.008
2004	25,579	613	16,360	16,494	0.640	0.977	0.016	0.066	0.479	0.393	0.024
2005	8,322		1,152	1,352	0.138	0.128					
Average 1990-2004	56,333	14,008	28,941	30,248	0.558	0.780	0.077	0.033	0.289	0.325	0.056

Table 10.7.3.5

A- Standard Seasonal Assessment output M=1.2 constant

ANOVA TABLE WEIGHTED STATISTICS

FUNCTIONS OF MINIMIZATION

Weighted SSQ of ...	Availability Contribution Nº of years	WSSQ	Observa	Params.	d.f.	Variance	CV
Catches (t)	18	2.1523	90	0	90	0.0239	15.6%
Catches (Cages)	18	32.1960	288	124	164	0.1963	46.6%
DEPM SSB (t)	18	1.7743	18	0	18	0.0986	32.2%
DEPM SPages (1-3+)	15	5.0173	45	0	45	0.1115	34.3%
Acoustic SSB (t)	12	2.6370	12	0	12	0.2198	49.6%
Acoust. SPages (1-2+)	9	2.0502	18	2	16	0.1281	37.0%
TOTAL	18	45.8272	471	126	345	0.1328	37.7%

ANOVA TABLE UNWEIGHTED STATISTICS

Unweighted SSQ of ...

	Nº of years	USSQ	Data	Params.	d.f.	Variance	CV
Catches (t)	18	2.152	90	0	90	0.0239	16%
Catches (Cages)	18	510.384	288	124	164	3.1121	463%
DEPM SSB (t)	18	1.774	18	0	18	0.0986	32%
DEPM SPages (1-3+)	15	7.861	45	0	45	0.1747	44%
Acoustic SSB (t)	12	2.637	12	0	12	0.2198	50%
Acoust. SPages (1-2+)	9	2.734	18	2	16	0.1708	43%
TOTAL	18	527.543	471	126	345	1.5291	190%

B- Seasonal Assessment ANOVA tables
for a Natural mortality at age pattern M1=0.8 and M2+=1.5

Weighted SSQ of ...	Contribution Nº of years	WSSQ	Observa	Params.	d.f.	Variance	CV
Catches (t)	18	2.2463	90	0	90	0.0250	15.9%
Catches (Cages)	18	32.3152	288	124	164	0.1970	46.7%
DEPM SSB (t)	18	1.9967	18	0	18	0.1109	34.3%
DEPM SPages (1-3+)	15	3.7796	45	0	45	0.0840	29.6%
Acoustic SSB (t)	12	2.7199	12	0	12	0.2267	50.4%
Acoust. SPages (1-2+)	9	1.9697	18	2	16	0.1231	36.2%
M Variance Constraint	0	0.0000	0	2.00	0	0.0000	0.0%
TOTAL	18	45.0274	471	128	345	0.1305	37.3%

ANOVA TABLE UNWEIGHTED STATISTICS

Unweighted SSQ of ...

	Nº of years	USSQ	Data	Params.	d.f.	Variance	CV
Catches (t)	18	2.246	90	0	90	0.0250	16%
Catches (Cages)	18	507.753	288	124	164	3.0961	459%
DEPM SSB (t)	18	1.997	18	0	18	0.1109	34%
DEPM SPages (1-3+)	15	6.010	45	0	45	0.1335	38%
Acoustic SSB (t)	12	2.720	12	0	12	0.2267	50%
Acoust. SPages (1-2+)	9	2.626	18	2	16	0.1641	42%
M Variance Constraint	2	0.000	0	2	0	0.0000	0%
TOTAL	18	523.352	471	128	345	1.5170	189%

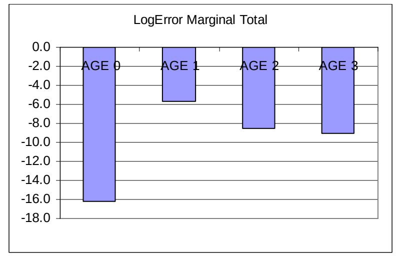
Table 10.7.3.6

ANALYSIS OF WSSQ OF CATCHES AT AGE 1987-2004 for the Separable seasonal model

FISHERY	# Years	WSSQ AGE 0	WSSQ AGE 1	WSSQ AGE 2	WSSQ AGE 3	WSSQ TOTAL	Observat.	Aprox. Params.	d.f.	Weighted Variance	CV%	Ponder.	Variance 2	CV%
France Quarter 1	16	0	1.21	0.26	1.71	**3.18**	48	22.6	25.4	0.12	36.5%	0.20	0.62	93.1%
France Quarter 2	19	0	0.40	0.57	12.91	**13.88**	57	26.8	30.2	0.46	76.4%	0.12	3.94	710.5%
Spain Quarter 2	19	0	1.41	0.88	1.78	**4.06**	57	26.8	30.2	0.13	37.9%	0.79	0.17	43.1%
France 2nd Semester	18	2.31	0.94	2.66	0.00	**5.91**	54	21.3	32.7	0.18	44.5%	0.46	0.39	68.9%
Spain 2nd Semester	18	0.27	0.43	1.36	3.12	**5.17**	72	26.6	45.4	0.11	34.7%	0.11	1.06	137.7%
TOTAL WSSQ	**90**	**2.58**	**4.39**	**5.72**	**19.50**	**32.20**	**288**	**124**	**164**	**0.1963**	**46.6%**	**0.33**	**0.60**	**90.8%**

Log error Marginal total USSQ	**-16.25**	**-5.72**	**-8.54**	**-9.04**	**-39.54**

Fitting Statistics					**TOTALES**	
Observ.	36	90	90	72	**288**	
Parámetros (Aprox.)	2	50	50	21	**124.0**	Ver aquí abajo
DF	33.7	39.8	39.8	50.8	**164.0**	
Total USSQ	240.93	13.22	19.15	237.08	510.38	
UnweightedVariance	7.16	0.33	0.48	4.67	3.11	
Logarithmic CV	3583%	63%	79%	1028%	463%	
Total WSSQ	**2.58**	**4.39**	**5.72**	**19.50**	**32.2**	
WVariance	0.0767	0.1103	0.1438	0.3842	0.1963	
Poderac.media	0.0086	0.4441	0.4441	0.1914	0.3265	
Variance 2	8.9272	0.2483	0.3237	2.0077	0.6013	
Logarithmic CV	8680%	53%	62%	254%	91%	



Descomposición y atribución de parámetros por edades

Weighted observations	0.31	39.97	39.97	13.78	94.03	
Frequency	0.00	0.43	0.43	0.15	1.00	
Sudivision of Parameters	2.34	50.21	50.21	21.24	124.00	
Selectivities at age % Fy	Se=2	Se=5	Se=5	Se=4		
	2	5	5	4	16	There are only 4 Sel in age 3+ becouse of Frech 2half of the year fishery with plus group in age 2+
Initial Population	0	1	1	2	4	Is 0 for age 1 becouse is R1 and 2 to age 4 becouse of the plus group in 3+ (as 3 and 4 pooled)
Common paramters	Fy	Y*Seasons - Seasons (+1)			86	Selectivity at age 2 is substracted for all fisheries (but +1 is conditional to estimating F in year Y)
	Ry			Y	18	
	Nat Mor			Y+1	0	NatMor is allocated to all age structured indices (Maximum of Y years plus factor for 2+)
				Common Subtotal	104	
Total amount of Parameters allocated to CAGEs					124	

Table 10.7.5.1: Input data for the biomass-based model for the Bay of Biscay anchovy

			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	0.1197		89	703		2063	8002	2405	15603

Table 10.7.5.2: Specification of the tw o sets of prior distributions used for the improved biomass-based model w ith 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)	-165104	321104	N(mu=78000, prec=1 E-11)	-541795	697795
Ry	LN(mu=10.5, prec=1)	5116	257806	LN(mu=10.5, prec=0.1)	74	17857789
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. Historical series of 95 % credibility intervals and posterior medians for recruitment and SSB from the biomass based model

	Recruitment			SSB		
Year	low	median	up	low	median	up
1987	13298	18224	32626	16907	23208	35324
1988	33817	43570	63909	31680	39231	56257
1989	8725	12838	22556	14327	20394	33803
1990	73982	88576	110552	59500	68717	84844
1991	18135	25185	36432	24127	31476	45886
1992	81527	131088	220001	59775	101462	175749
1993	41076	90579	134635	78647	99185	124787
1994	33920	48916	69108	48669	61158	82540
1995	35075	60176	113011	29468	53579	100854
1996	33992	65471	95995	51342	62292	81903
1997	34502	50365	73369	37041	51624	73932
1998	51440	80899	134006	48883	76009	122878
1999	22705	73058	181592	37433	73699	157438
2000	60103	116017	155383	88428	111779	130016
2001	70128	88378	113124	89793	101110	117848
2002	8615	11779	17600	30427	37023	46884
2003	16559	23323	32387	23598	29125	37955
2004	26777	36054	52003	25946	34093	49009
2005	1973	3788	7341	7658	12903	22352

Table 10.10.1.1: Parameter values used for anchovy status quo Leslie matrix model.

Parameter	Value	Source
M	1.2 all ages	ICES working group WGMHSA 2004
F	0.4 all ages	WGMHSA 2004
Fb	600	Motos 1996
Sd	3.5	
Sf	0.25 per day	Motos 1996
We	16, 28, 36 ages	Average 2000-2005 Pelgas
Se	0.5	
Sb	4.75	
S0	1.33 10-5	Motos 1996

Table 10.10.1.2: Multipliers s for juvenile survival rates used for short term one-year ahead predictions for 2006 under different recruitment scenarios. S0* = s S0; S0 as in Table 10.10.1.1. Management scenarios as in table 10.10.1.3.

		Management scenario					
		Status quo	No fishing	Closed during	50% catch	Closed box for	Closed box and closed
Recruitment scenario	low	0.02	0.021	0.02	0.02	0.021	0.021
	mean	1	1.05	1	1	1.03	1.03
	high	1.98	2.08	1.98	1.98	2.04	2.04
Fishing mortality		0.4	0	0.28	0.17	F1=0.18, F2&F3=0.4	F1=0.13,F2&F3=0.28

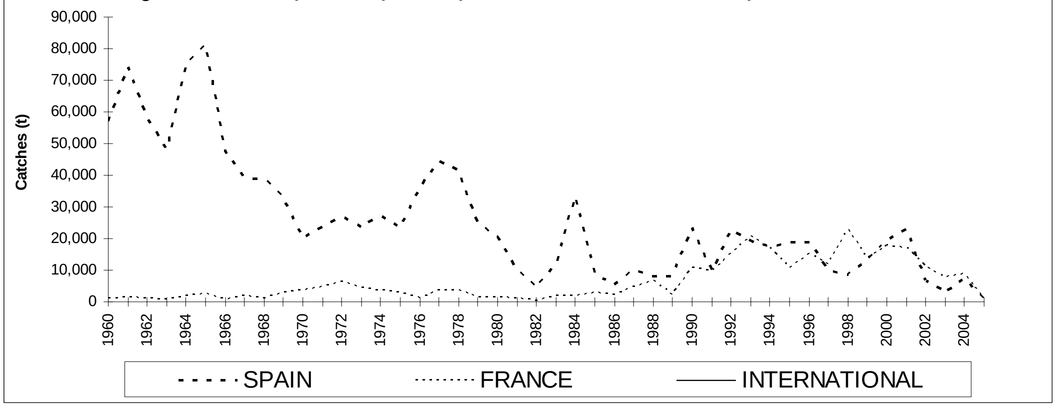
Table 10.10.1.3: Predicted relative population abundance in spring 2006 starting from observed population abundance in spring 2005 (Pelgas acoustic survey): age 1= 19, age 2= 64, age 3= 17.
See tables 10.10.1.1 and 10.10.1.2 for parameter values.

	Recruitement				
Management	low	mean	high		
Scenario		Age 1		Age 2	Age 3
Status quo	2	119	236	4	13
No fishing	3	155	308	6	19
Closed during spawning	3	148	293	4	15
50% catch	3	135	267	5	16
Closed box for juveniles	2	125	247	5	13
Closed box and closed during spawning	3	153	302	5	15

Table 10.10.2.1: Risk in terms of probability of SSB of falling below Blim for different management strategies

HCR	Management measures					no TAC cap			TAC cap = 33000		
	fixed TAC	survey rec	box	revision	closure	γ=0.5	γ=0.75	γ=1	γ=0.5	γ=0.75	γ=1
1	yes	no	no	no	no	0.192	0.197	0.197	0.193	0.196	0.193
2	yes	no	no	no	yes	0.195	0.187	0.19	0.192	0.197	0.194
3	no	no	no	no	yes	0.116	0.194	0.26	0.119	0.169	0.193
4	no	no	1st sem	no	yes	0.111	0.182	0.212	0.109	0.16	0.162
5	no	no	2nd sem	no	yes	0.112	0.185	0.249	0.108	0.17	0.185
6	no	no	all year	no	yes	0.113	0.181	0.211	0.109	0.148	0.166
7	no	yes	no	no	yes	0.058	0.103	0.133	0.048	0.063	0.076
8	no	yes	1st sem	no	yes	0.056	0.098	0.127	0.05	0.068	0.079
9	no	yes	2nd sem	no	yes	0.054	0.096	0.11	0.046	0.068	0.076
10	no	yes	all year	no	yes	0.055	0.087	0.107	0.051	0.068	0.075
11	no	no	no	yes	yes	0.123	0.224	0.284	0.102	0.155	0.177
12	no	no	1st sem	yes	yes	0.122	0.204	0.23	0.1	0.141	0.148
13	no	no	2nd sem	yes	yes	0.118	0.202	0.261	0.104	0.153	0.165
14	no	no	all year	yes	yes	0.12	0.184	0.213	0.099	0.135	0.147
15	no	yes	no	yes	yes	0.062	0.101	0.128	0.051	0.07	0.078
16	no	yes	1st sem	yes	yes	0.062	0.1	0.126	0.052	0.072	0.082
17	no	yes	2nd sem	yes	yes	0.059	0.089	0.108	0.047	0.066	0.079
18	no	yes	all year	yes	yes	0.061	0.087	0.106	0.052	0.065	0.074

Figure 10.2.1.1: Bay of Biscay anchovy: Historical evolution of the fishery since 1940



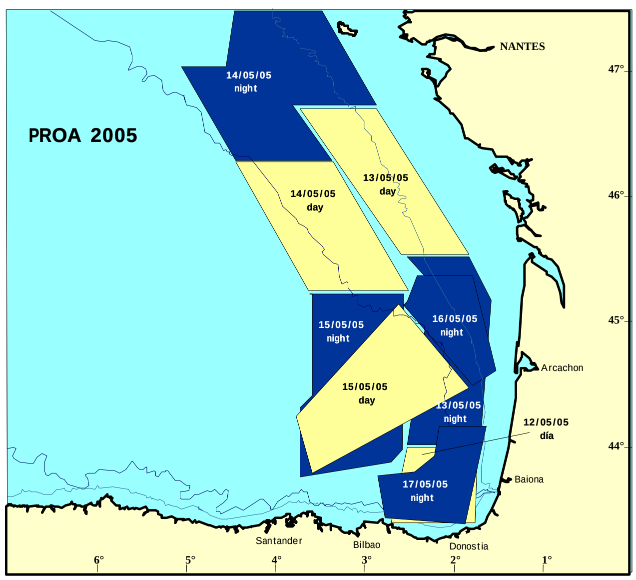


Figure 10.2.3.1: Spatio-temporal summary of the areas prospected during PROA05-I survey.

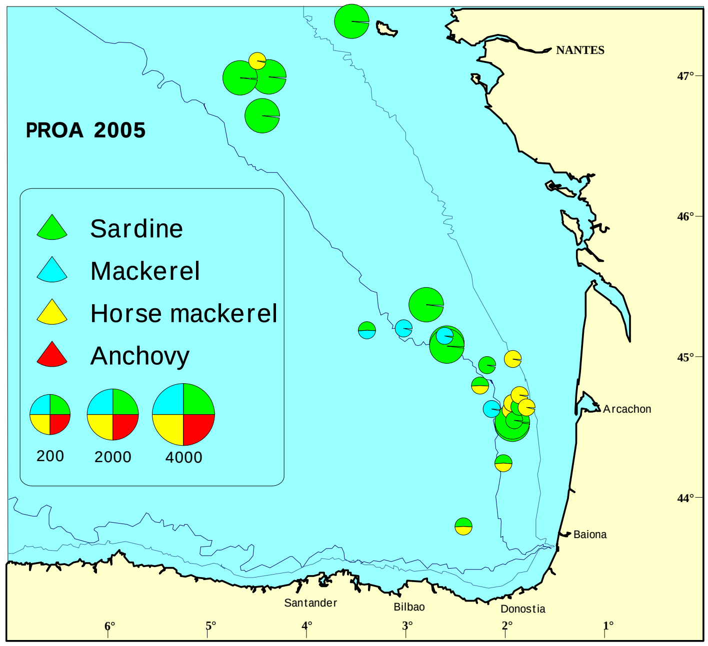


Figure 10.2.3.2: Species composition of the hauls during PROA05-I.

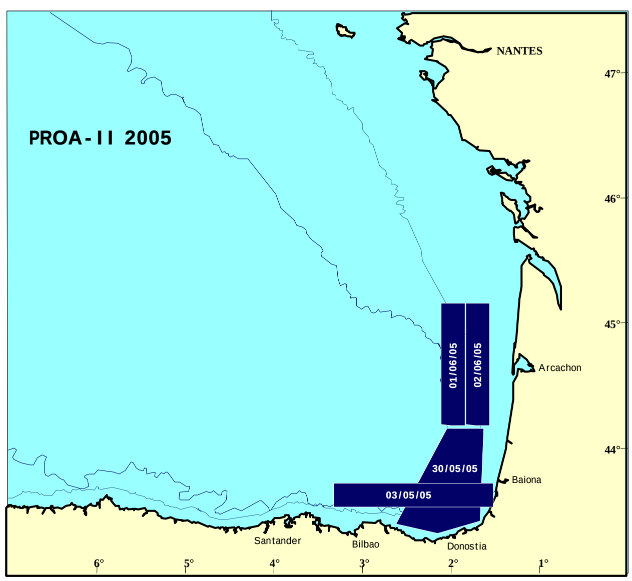


Figure 10.2.3.3: Spatio-temporal summary of the areas prospected during PROA05-II.

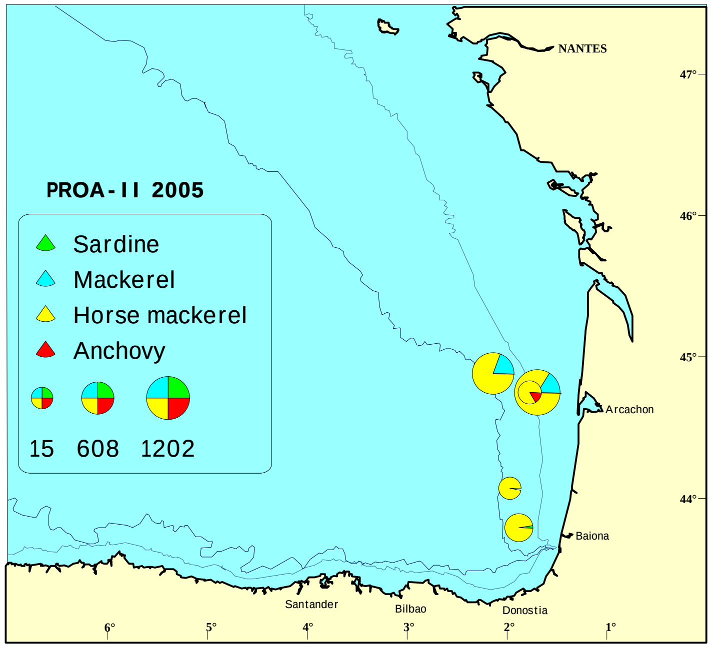
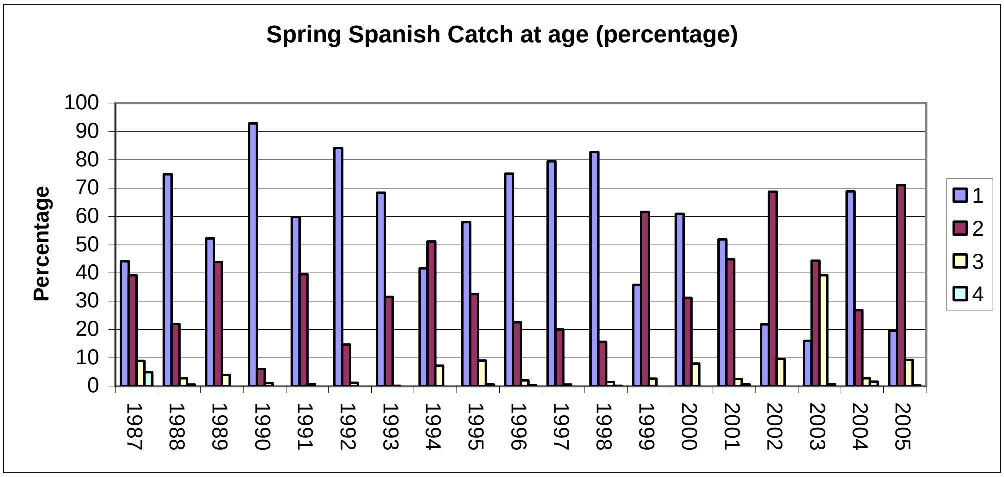


Figure 10.2.3.4: Species composition of the hauls during PROA05-II.



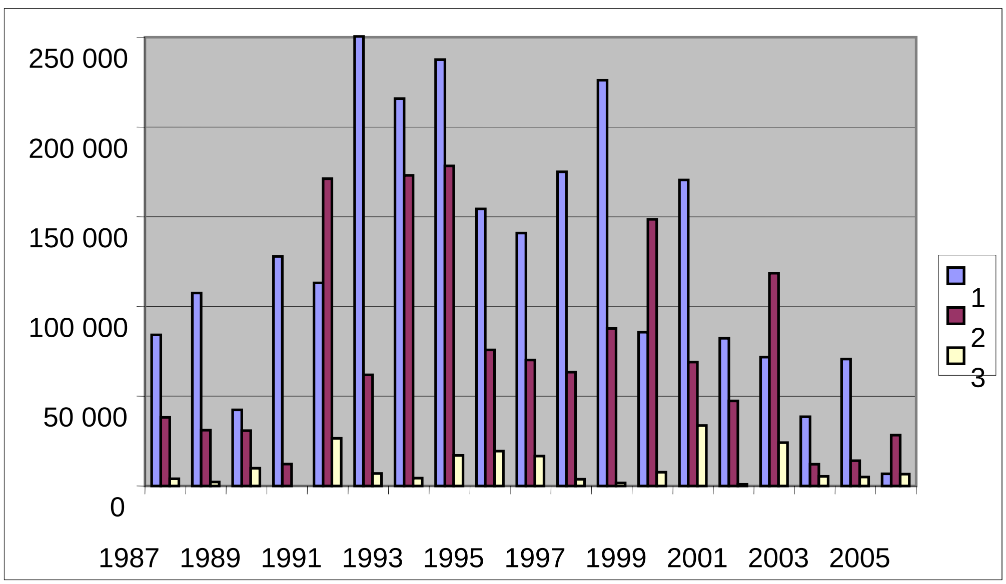


Figure 10.3.1.1: Spanish (upper panel) and French (bottom panel) catch at age compositions of the first half of the year from 1987 to 2005.

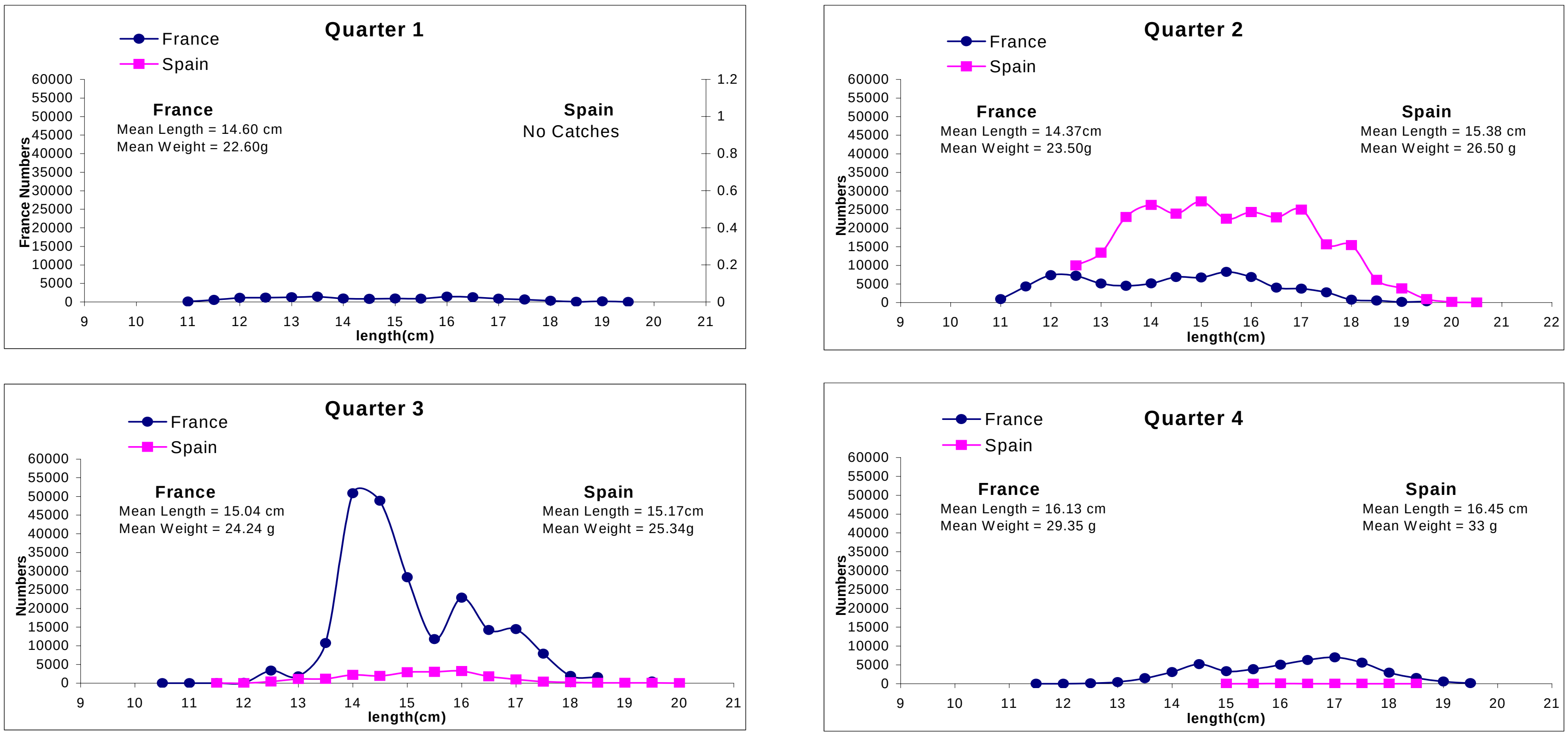


Figure 10.3.2.1. Length distribution of Anchovy catches by country in 2004 by quarter.

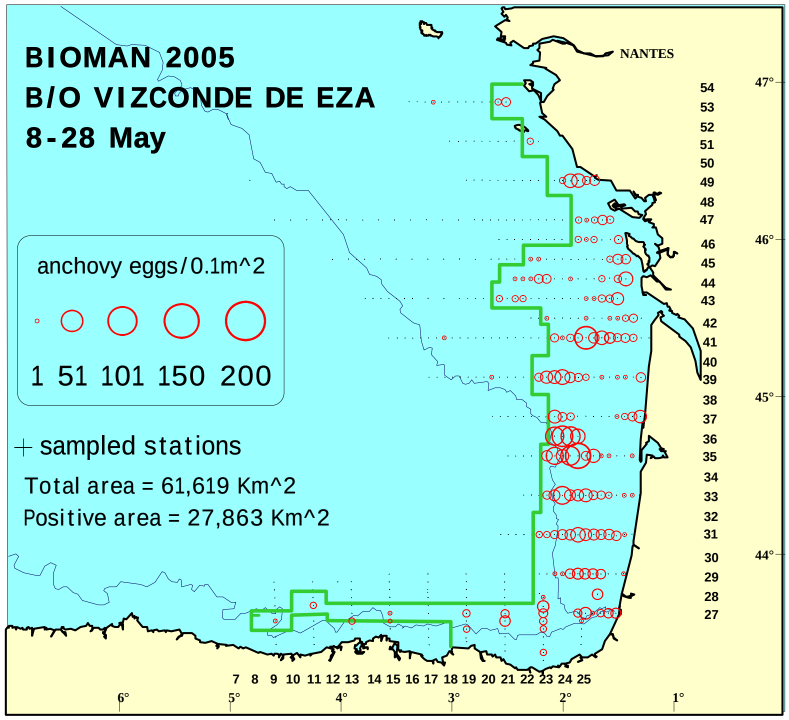


Figure 10.4.1.1: Anchovy eggs distribution (egg/0.1m^2) and abundance found during BIOMAN 2005. Solid line encloses the positive spawning area.

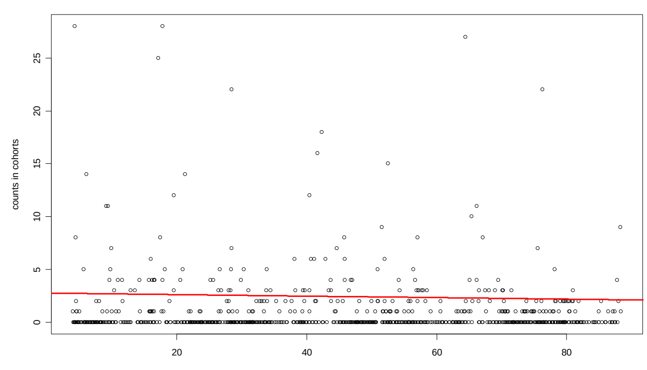


Figure 10.4.1.2: Exponential mortality model of anchovy eggs fitted using non linear regression.

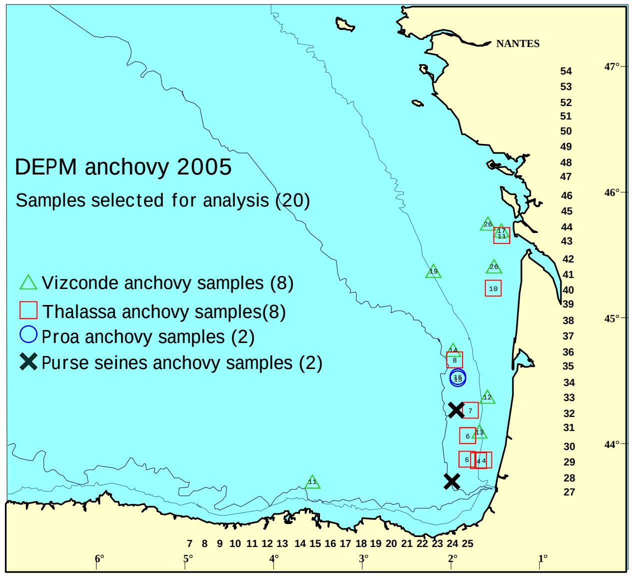


Figure 10.4.1.3: Anchovy adult samples selected for the estimation of the spawning biomass of anchovy.

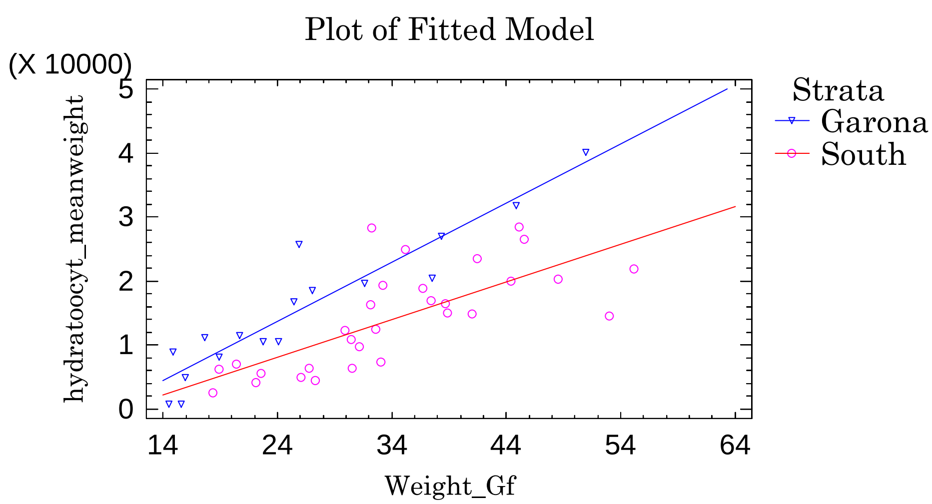


Figure 10.4.1.4: Anchovy Batch fecundity regression lines per regions from the DEPM survey BIOMAN 2005.

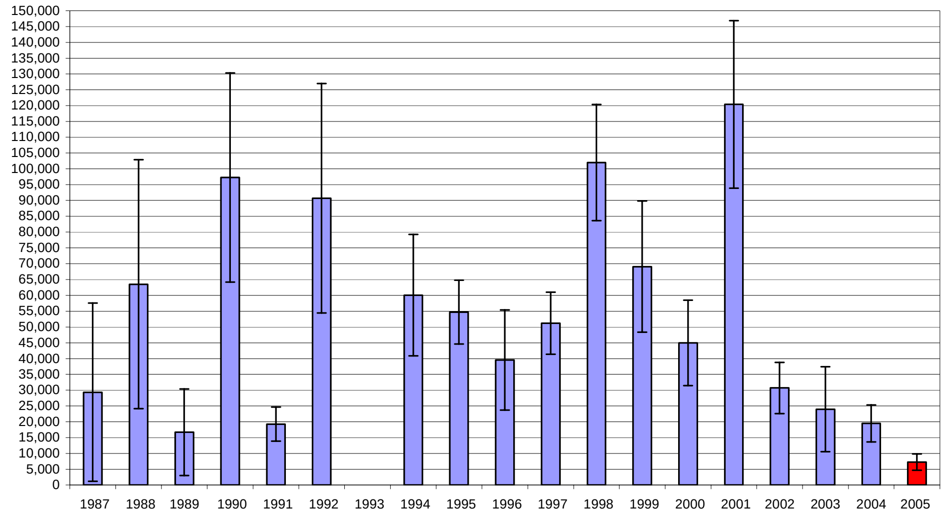


Figure 10.4.1.5: Series of Biomass estimates (tonnes) obtained from the Egg surveys since 1987. Most of them are full DEPM estimates, except in 1996, 1999 and 2000, which were deduced indirectly from the relationship of biomass with the spawning area and P_0.

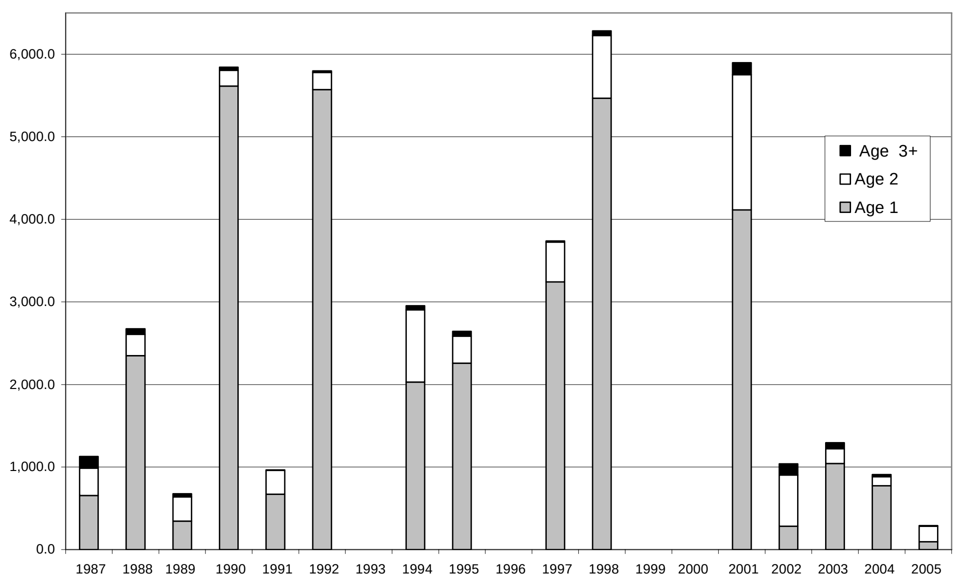


Figure 10.4.1.6: Historical series of population at age estimates obtained from the surveys since 1987

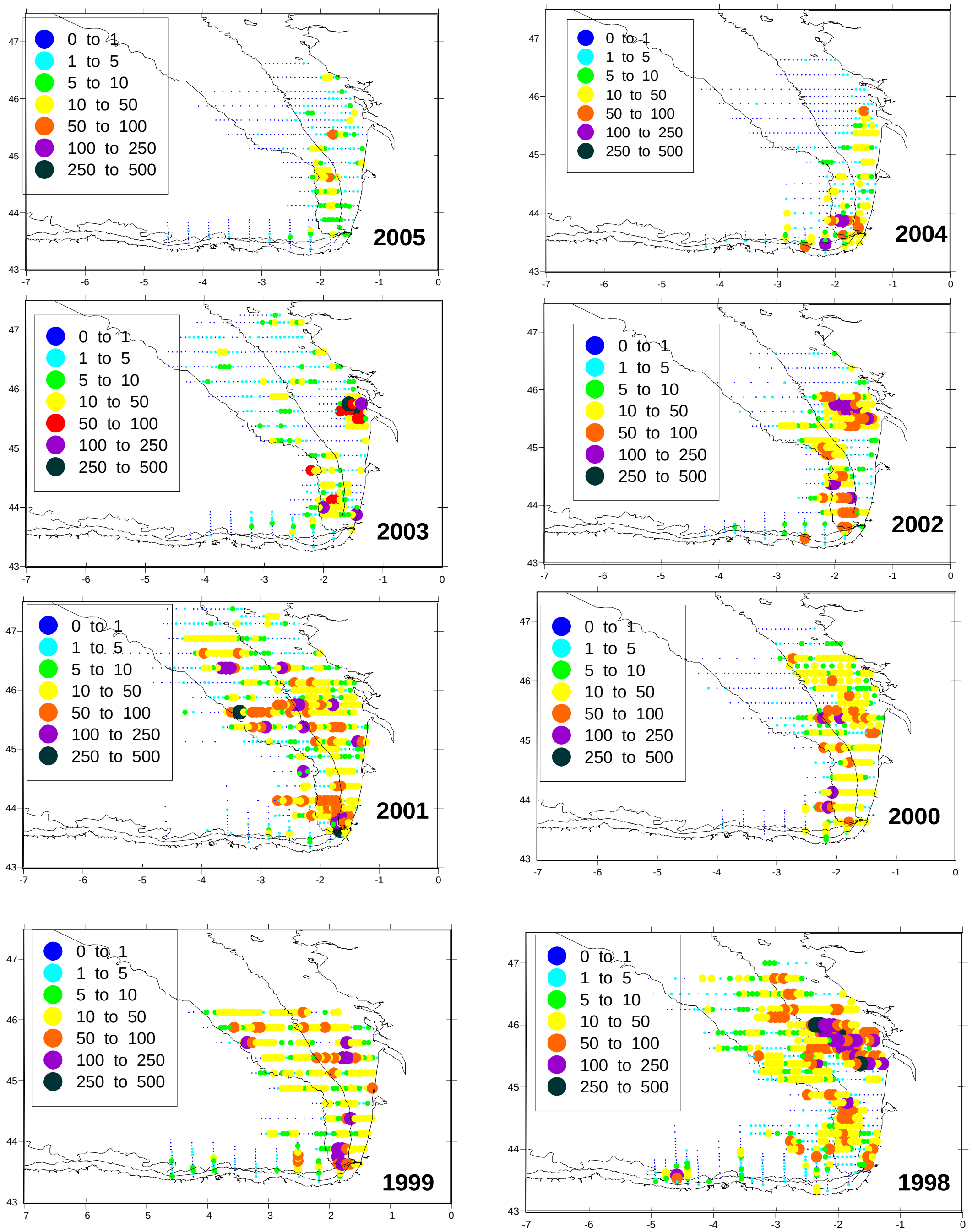


Figure 10.4.1.7: Egg distribution maps from applications of the DEPM since 1998.

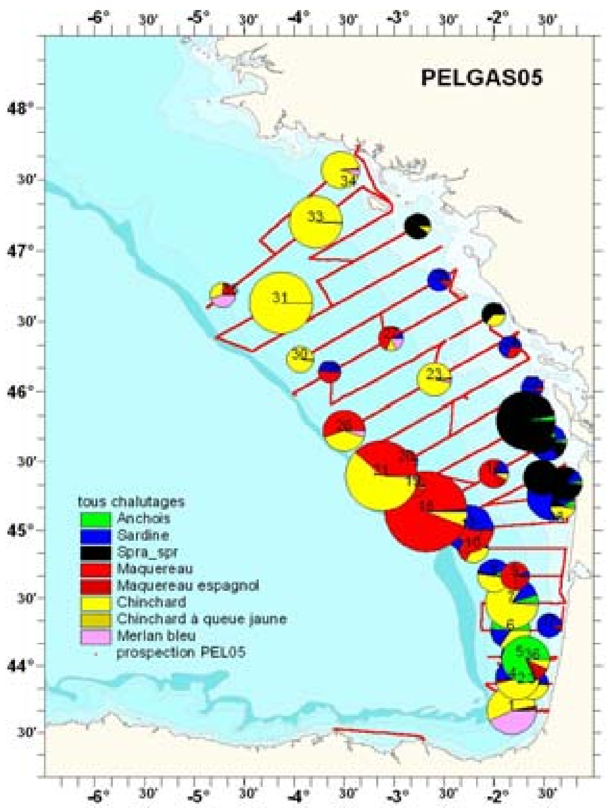


Figure 10.4.2.1: Prospected transects by acoustics and species compositions of catches obtained from identification hauls into during PELGAS05.

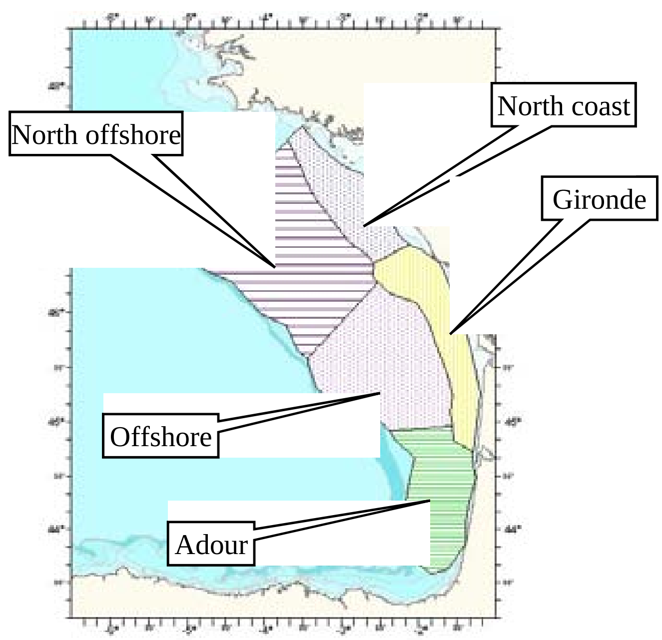


Figure 10.4.2.2: Area considered for biomass estimates from acoustics during PELGAS05 survey.

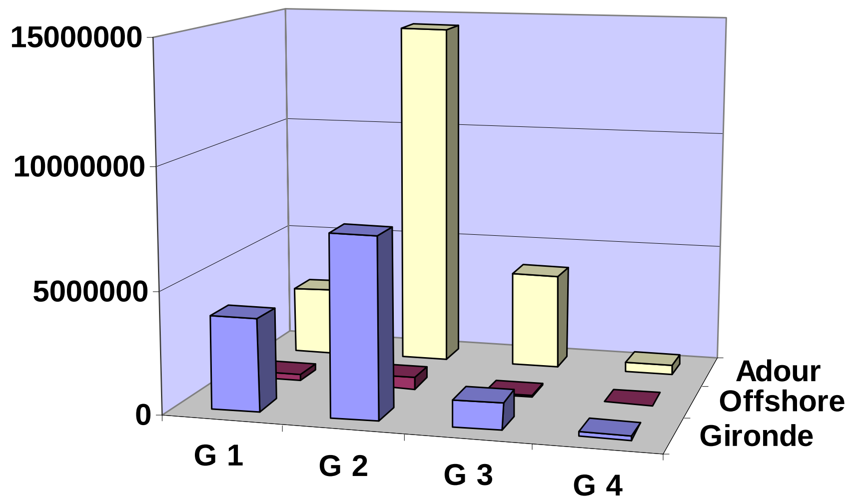


Figure 10.4.2.3: Number of anchovy per age group during PELGAS05 (numbers used in this figure are sum of numbers per nm² at each ESDU, they are proportional to abundance estimate).

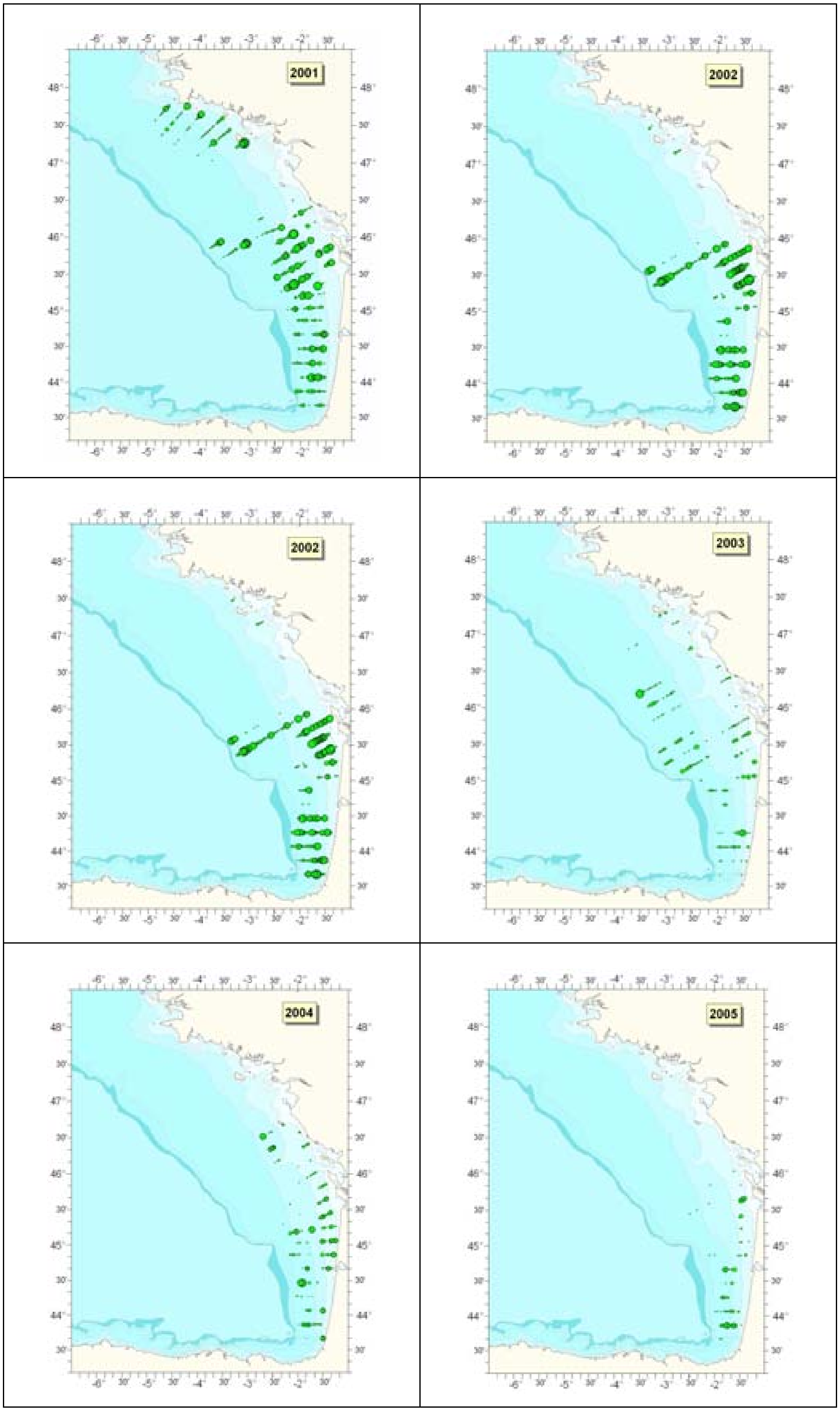


Figure 10.4.2.4: Abundance and distribution of anchovy as observed during acoustic surveys from 2000 to 2005

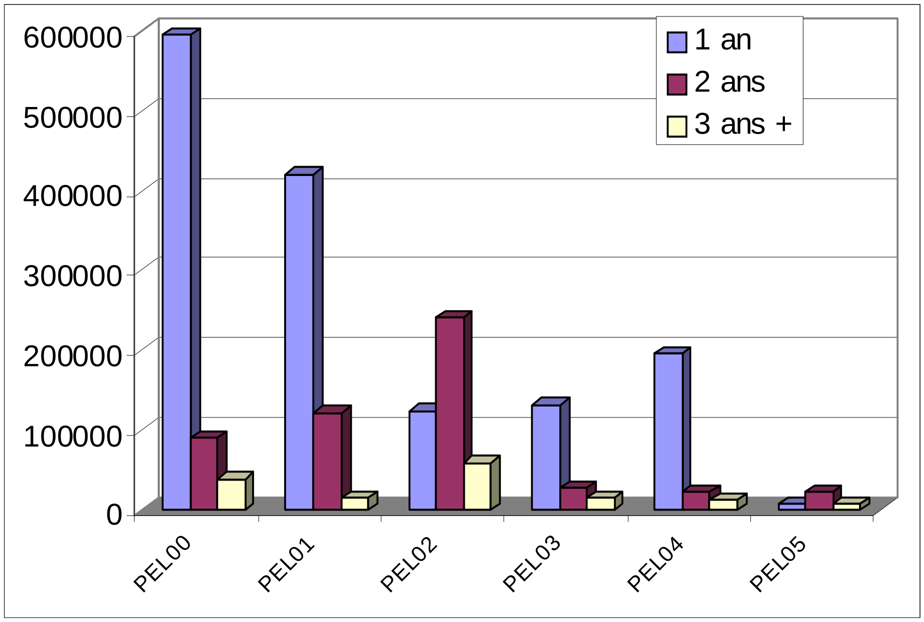


Figure 10.4.2.5 – Age composition of anchovy as observed during acoustic surveys from 2000 to 2005. (*numbers used in this figure are sum of numbers per nm² at each ESDU, they are well proportional to abundance estimate)*

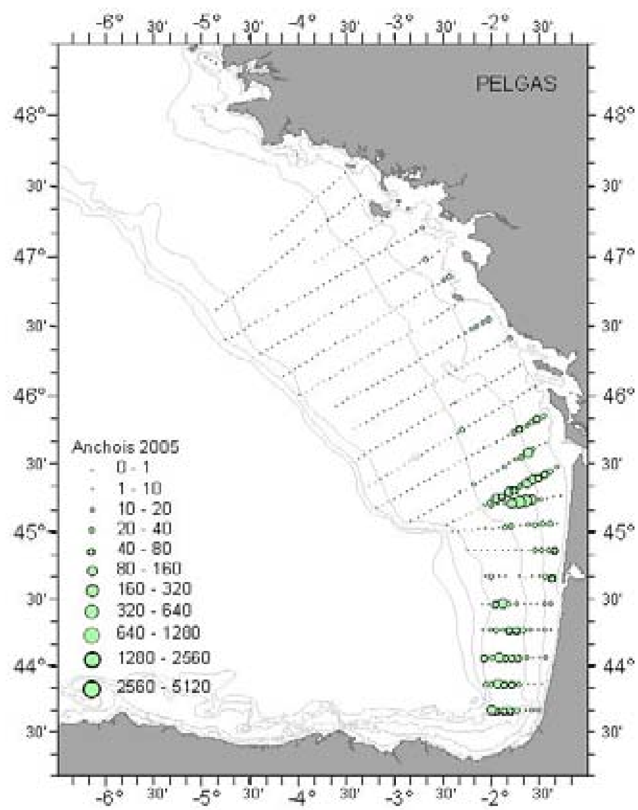


Figure 10.4.2.6: Anchovy eggs distribution as observed by CUFES during PELGAS05 survey.

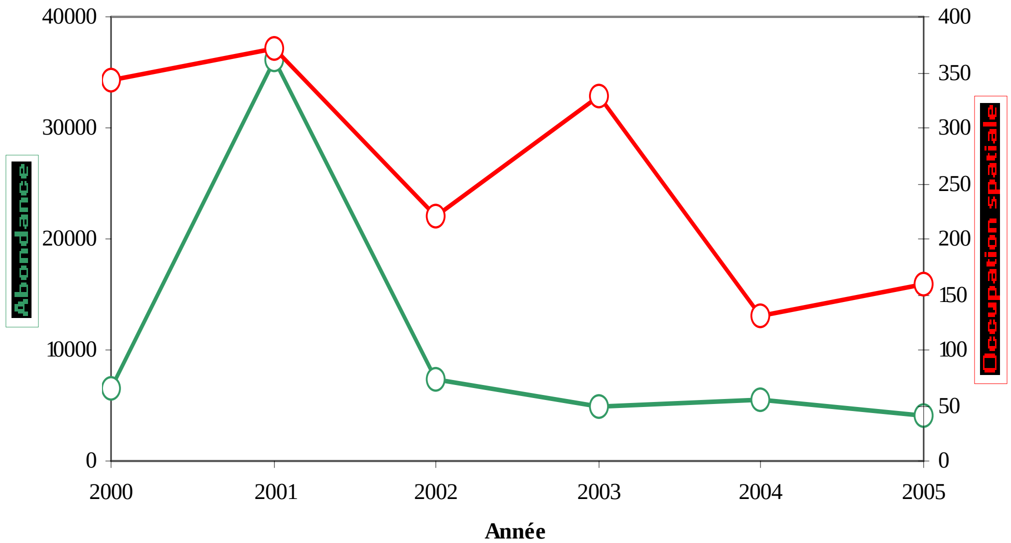


Figure 10.4.2.7: Number of eggs and positive areas observed during PELGAS surveys from 2000 to 2005.

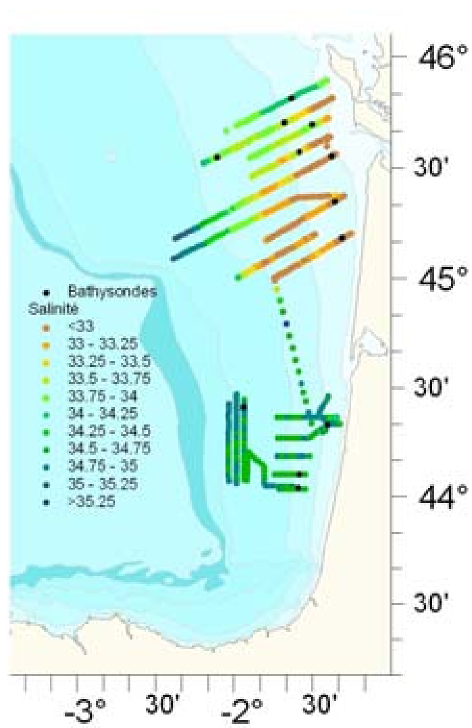


Figure 10.4.2.8: Area prospected during the last week of the PELGAS05 survey. Colours are proportional to salinity to show the influence of river plume in front of the Gironde.

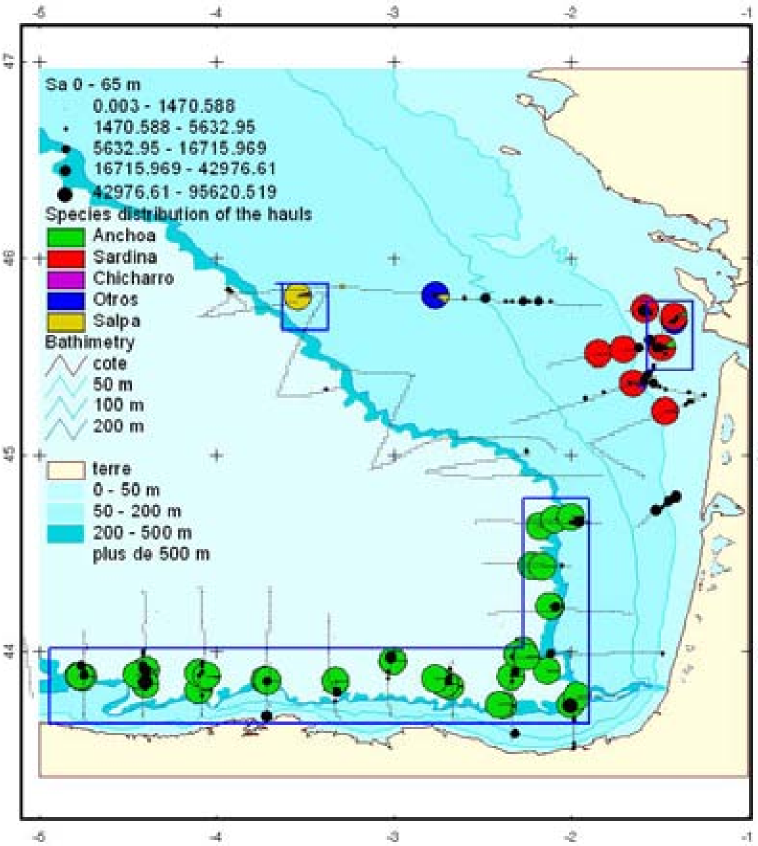


Figure 10.4.3.1: Spatial distribution of acoustic energy (echo-integrated between 5 and 65 m depth) and species composition in JUVENA 2003.

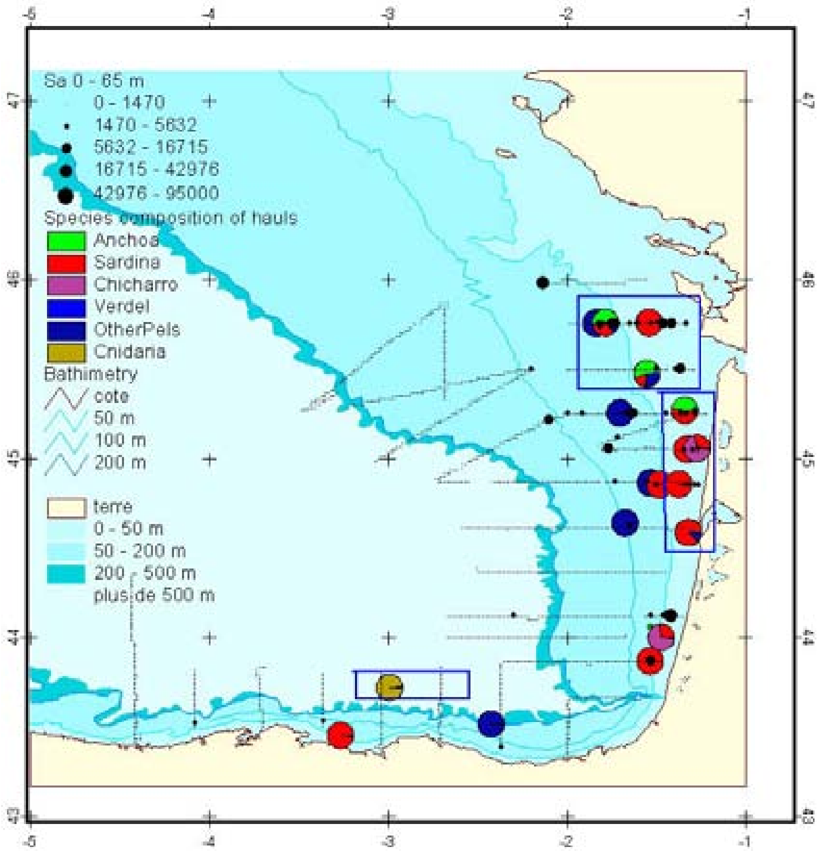


Figure 10.4.3.2: Spatial distribution of acoustic energy (echo-integrated between 5 and 65 m depth) and species composition in JUVENA 2004

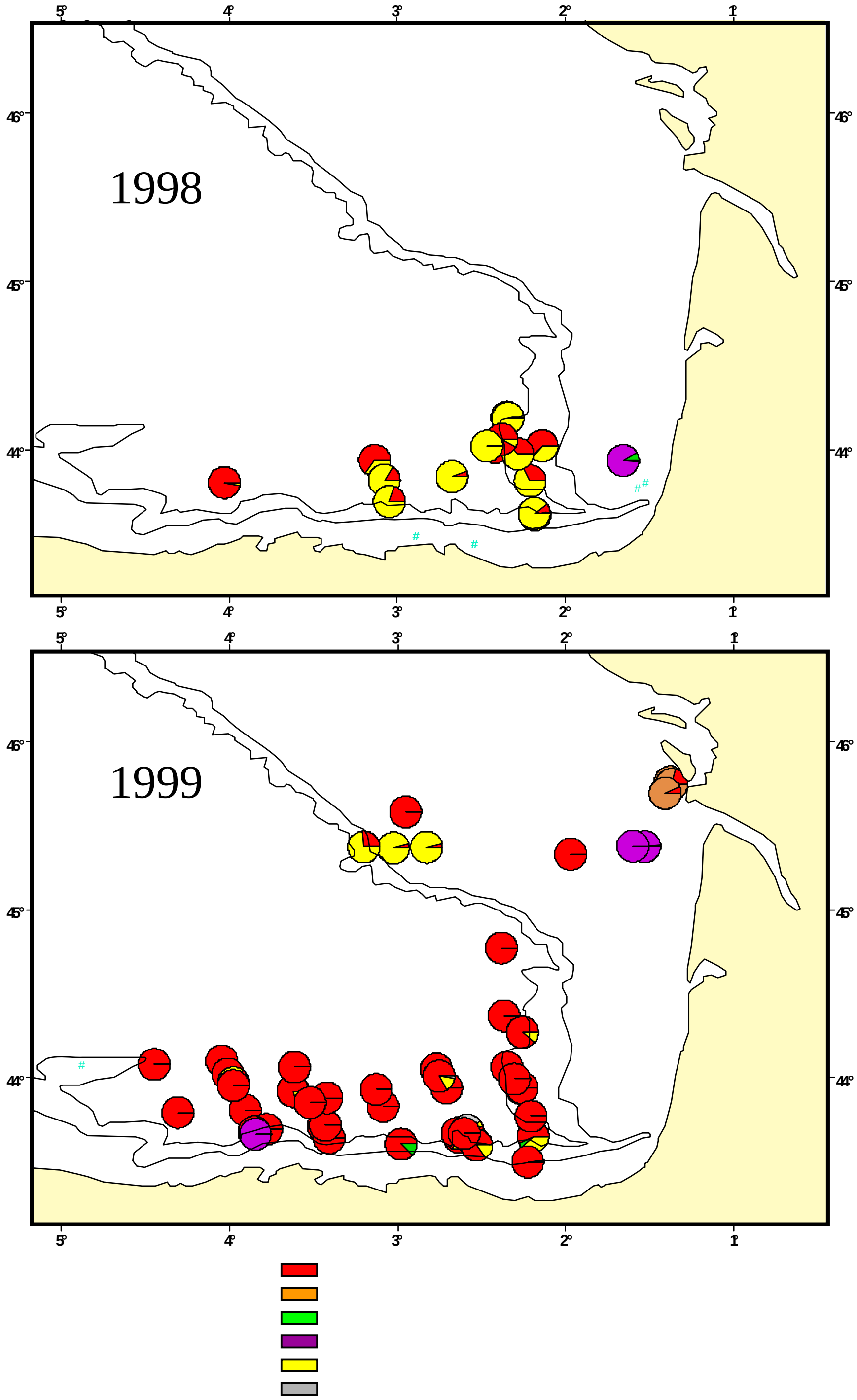
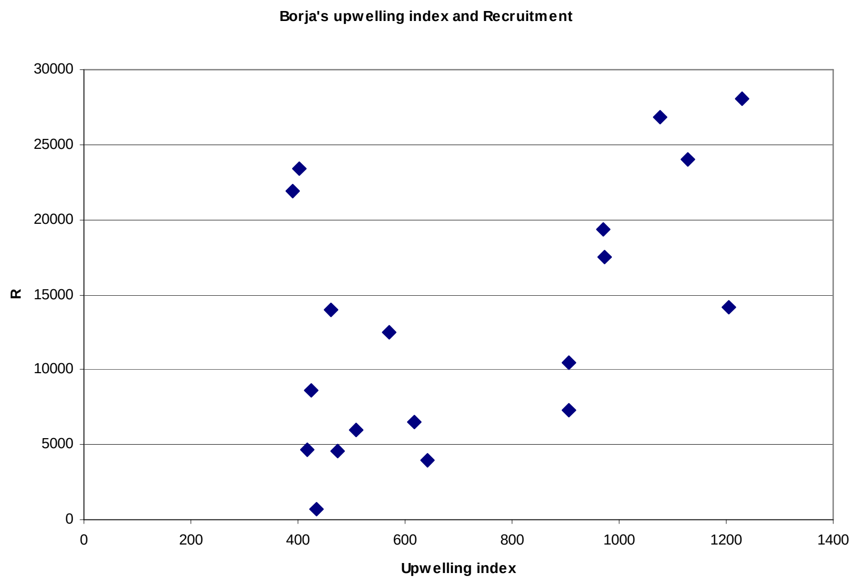
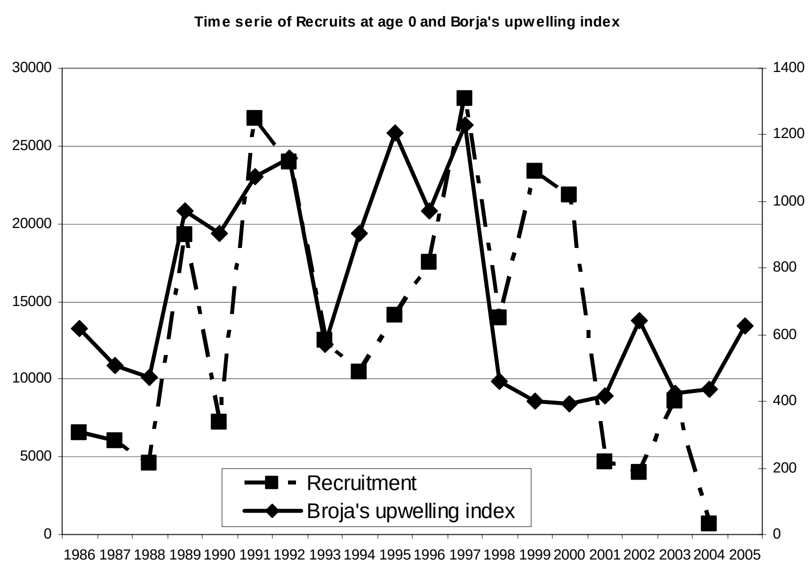


Figure 10.4.3.3: Spatial distribution of the different species captured in JUVESU 1998 and 1999 (in 1998 only the southern region was covered) (From Uriarte et al. 2001).

Figure 10.6.1
Borja's et al. upwelling index (1996 & 1998) and recruitment of anchovy at age in the same year





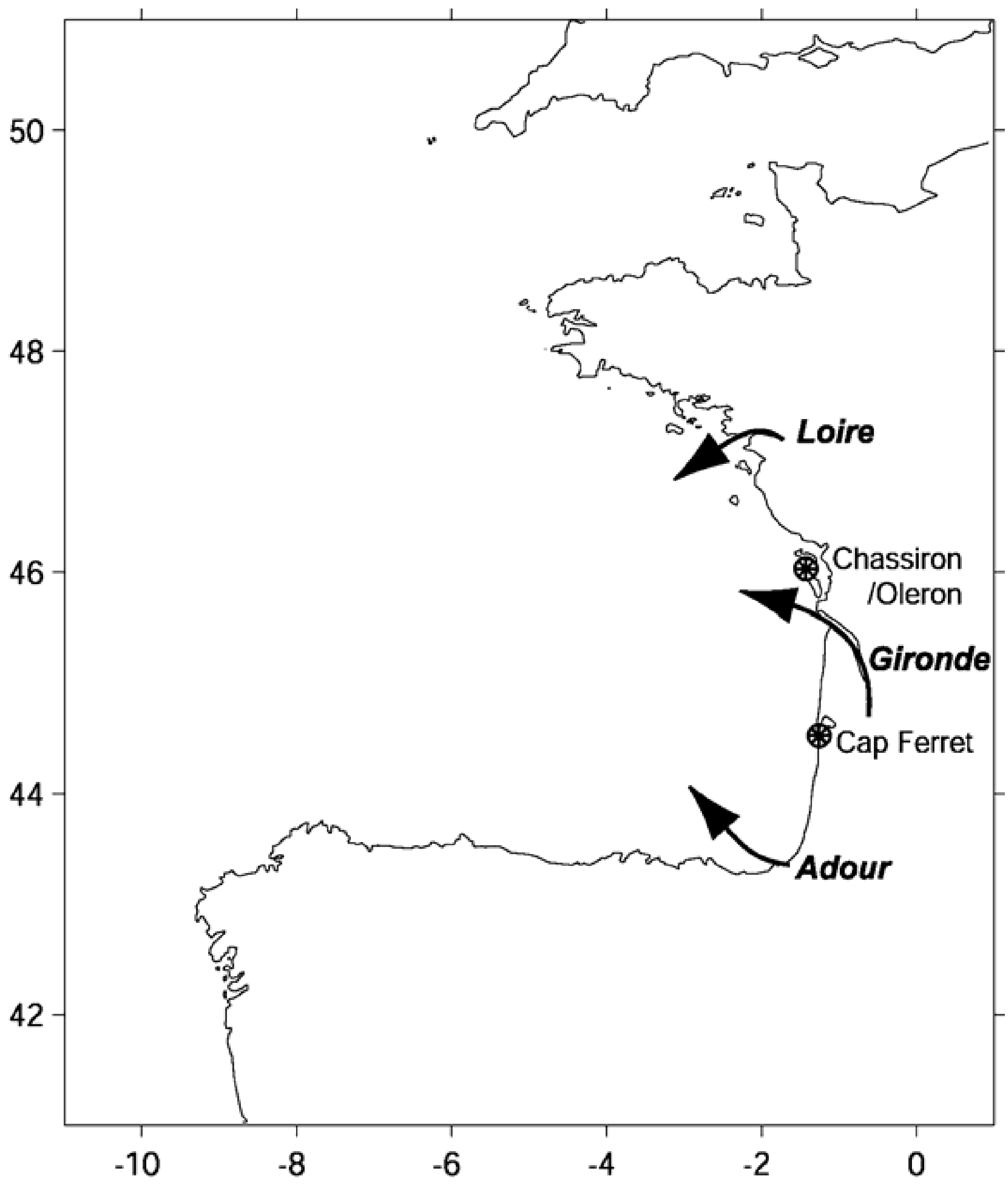


Figure 10.6.2: Localisation of measurement stations for river flows, sea temperatures and wind speed and direction since September 2004 and along time series.

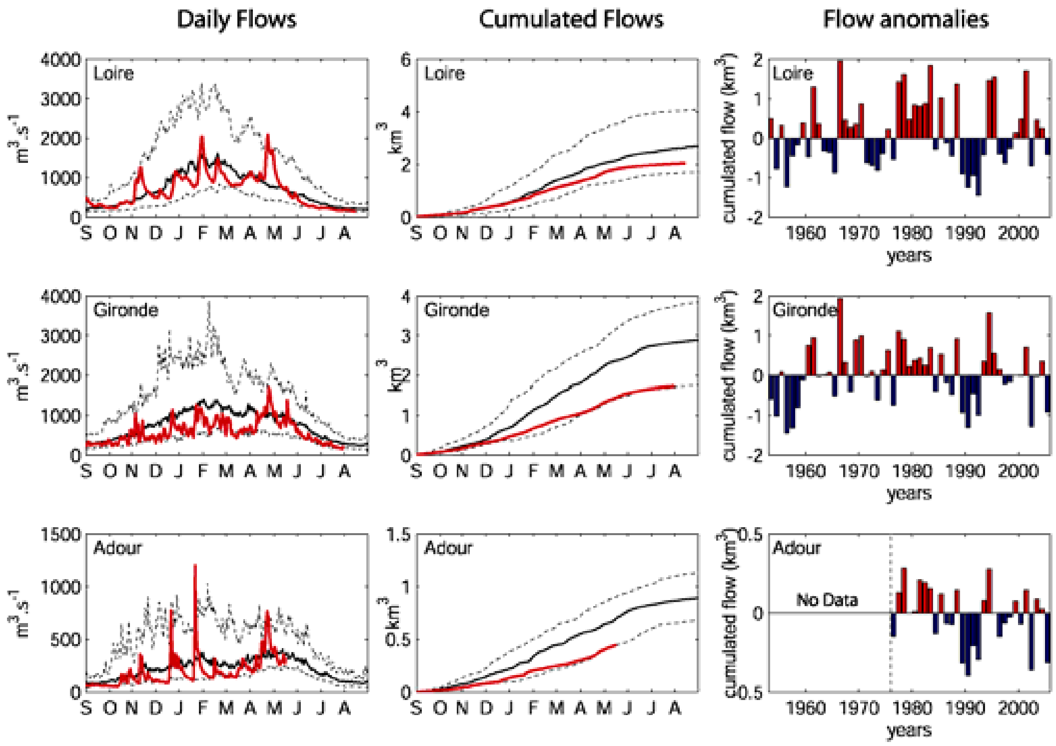


Figure 10.6.3: Daily flow (left), cumulated flow (centre) and flow anomalies (right) for the three main French rivers along the southern part of the Bay of Biscay. Red lines show the flow for the period September 2004 to present (limited to data availability). Black lines show median flows over the period 1952-2005. Dotted lines show the envelop containing 75% of the flow values for the period 1952-2005.

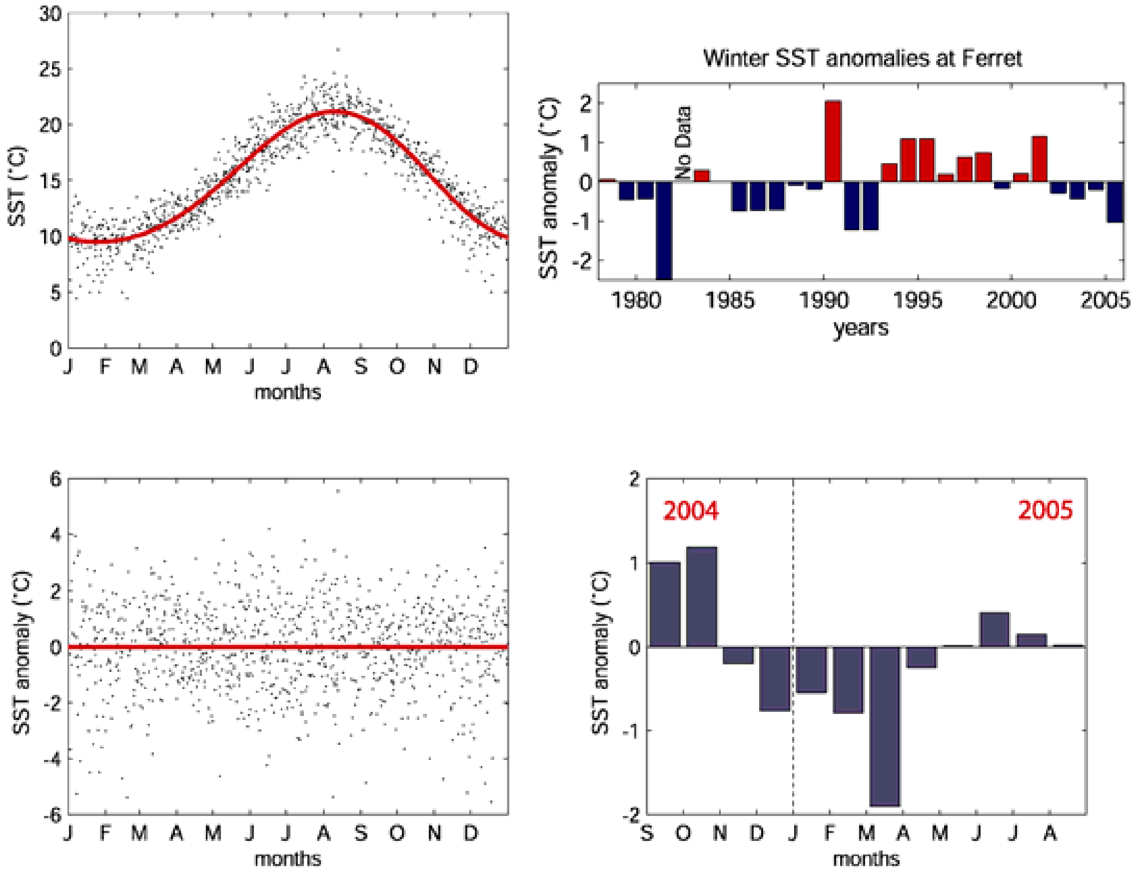


Figure 10.6.4: Seasonal and interannual variability in sea surface temperature (SST) at Cap Ferret (bay of Arcachon). Seasonal variations (top left) were modelled by fitting a polynomial function (order 7) to the data. Their is no seasonal trend left in the resulting SST anomalies (bottom left). Interannual variability in SST anomalies (top right) show a long term drift from lower temperatures in the 1980s to higher temperatures in the 1990s and 2000s.

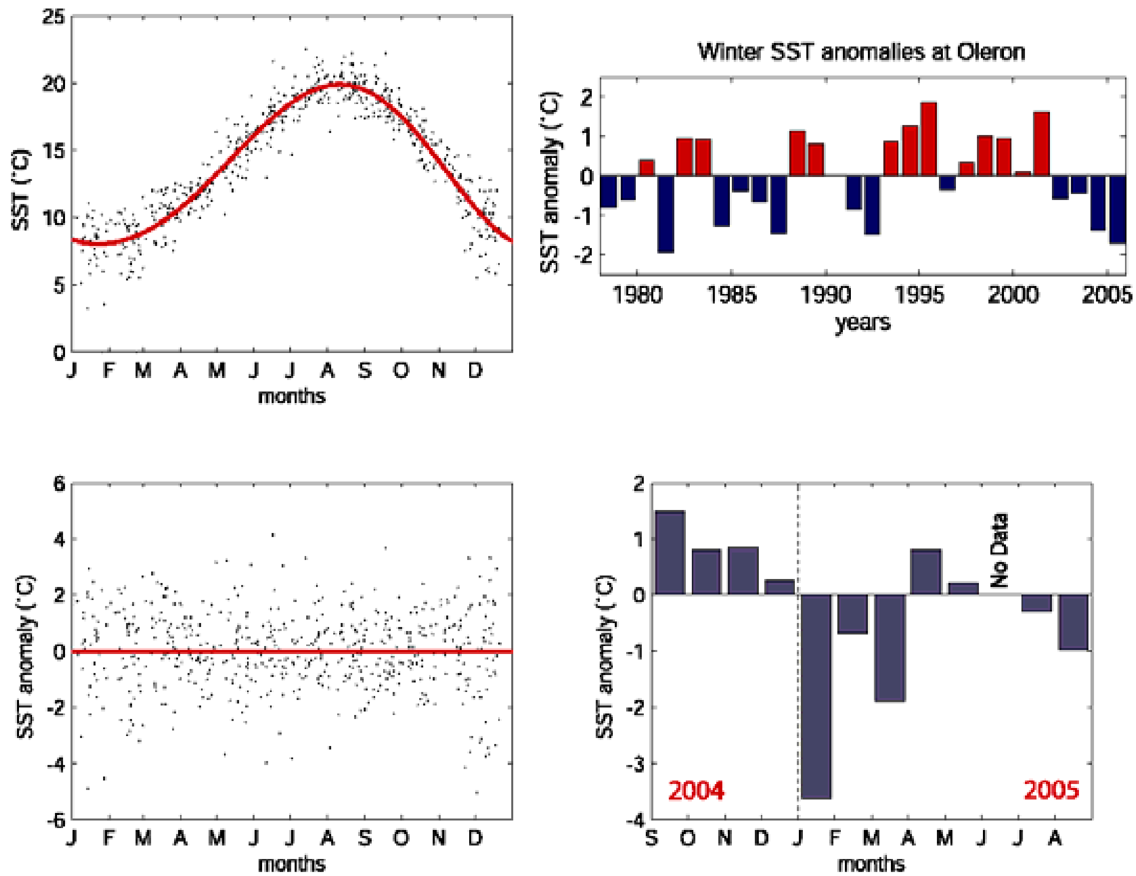


Figure 10.6.5: Seasonal and interannual variability in sea surface temperature (SST) off Boyardville (Oléron Basin). Seasonal variations (top left) were modelled by fitting a polynomial function (order 7) to the data. There is no seasonal trend left in the resulting SST anomalies (bottom left). Interannual variability in SST anomalies (top right) show a long term drift from lower temperatures in the 1980s to higher temperatures in the late 1990s and 2000s.

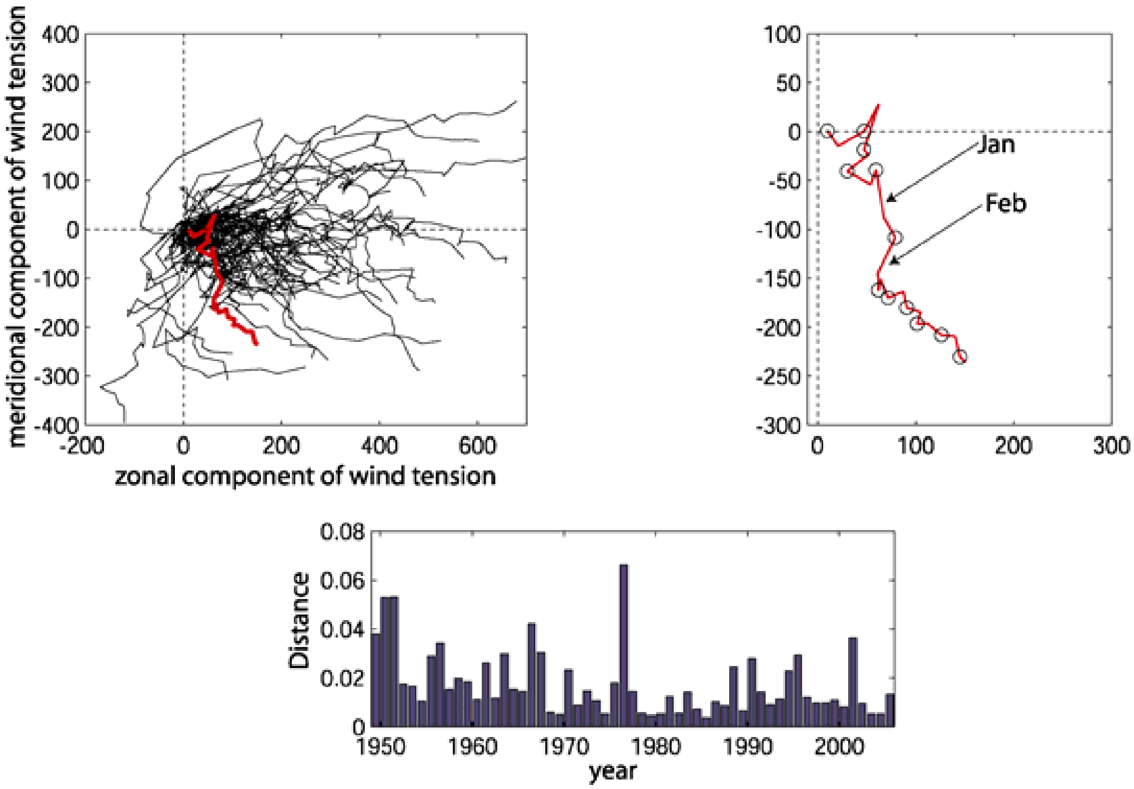


Figure 10.6.6: Wind speed and direction monitored every 3 hours at the meteorological station of Chassiron. Wind tension calculated for the period September (of the preceeding year) to August. Odographs for all years (1949-2005, top left) are shown in thin black lines and 2004-2005 in heavy red. The odographs are calculated as the sum of wind tension vectors (m2/s2) averaged for 15 days periods. A detailed view of the wind tension odograph for 2004-2005 (top right). The similarities between annual odographs and average odograph over the period of study are shown in the bottom panel (the higher the value, the lower the similarity).

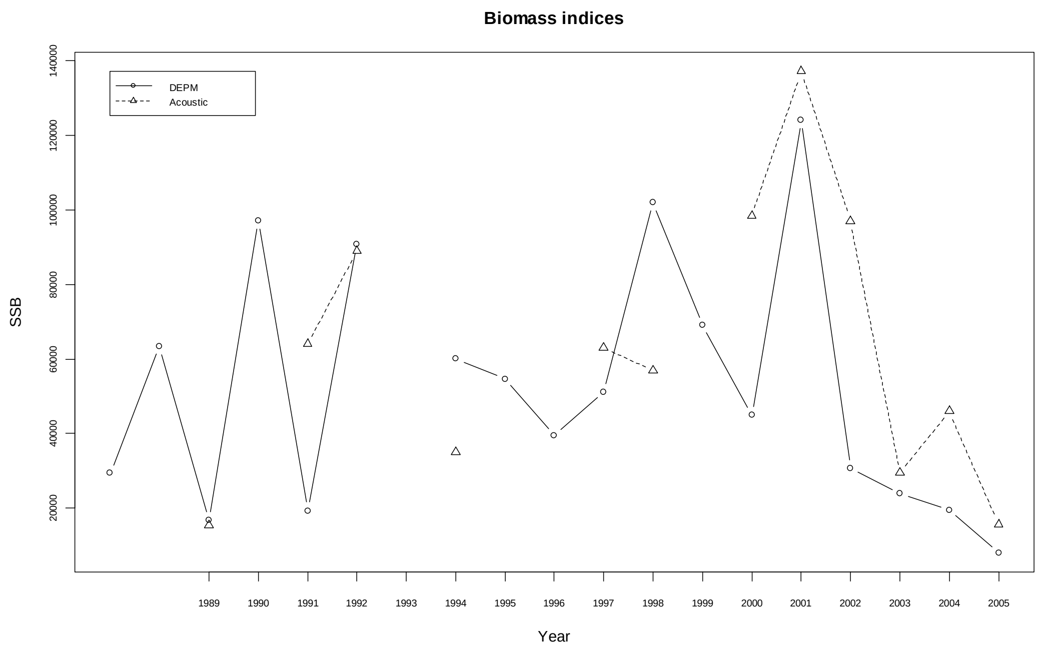


Figure 10.7.1.1: Historical series of biomass estimates from DEPM (solid line and circles) and acoustic (dotted line and triangles) methods.

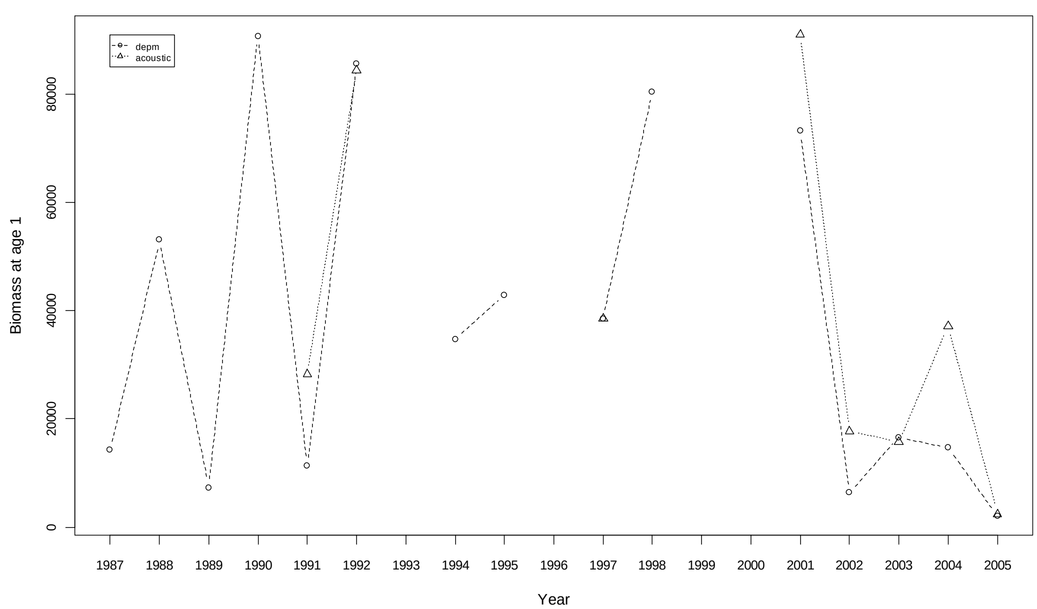


Figure 10.7.1.2: Historical series of biomass at age 1 estimates from DEPM (solid line and circles) and acoustic (dotted line and triangles) methods.

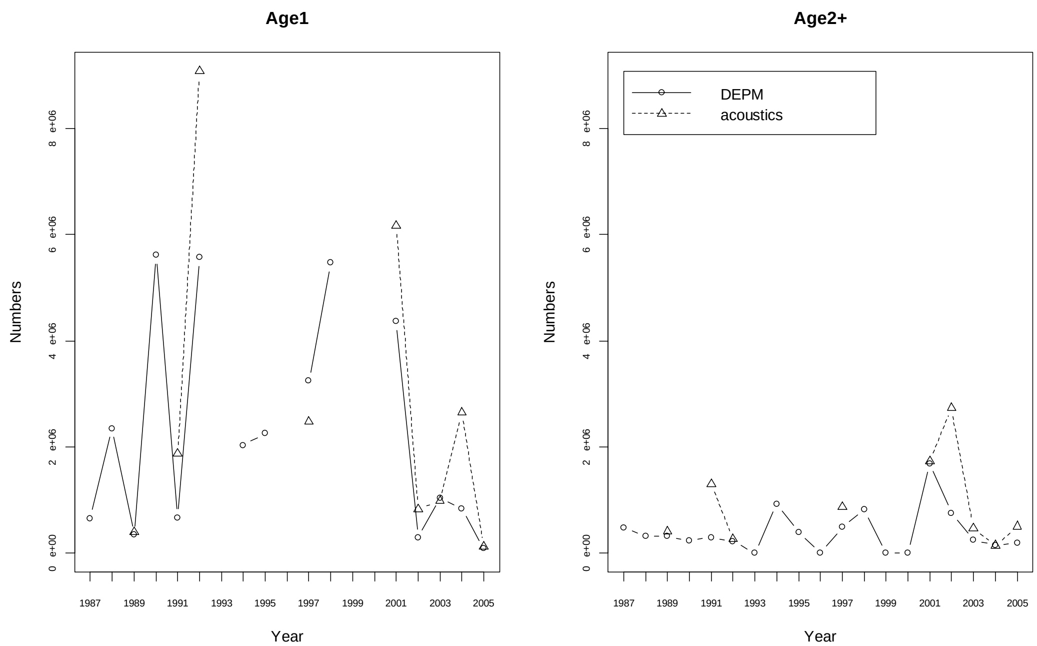


Figure 10.7.1.3: Historical series of numbers at age estimates from DEPM (solid line and circles) and acoustic (dotted line and triangles) methods for age 1 on the left and for age 2+ on the right panel respectively.

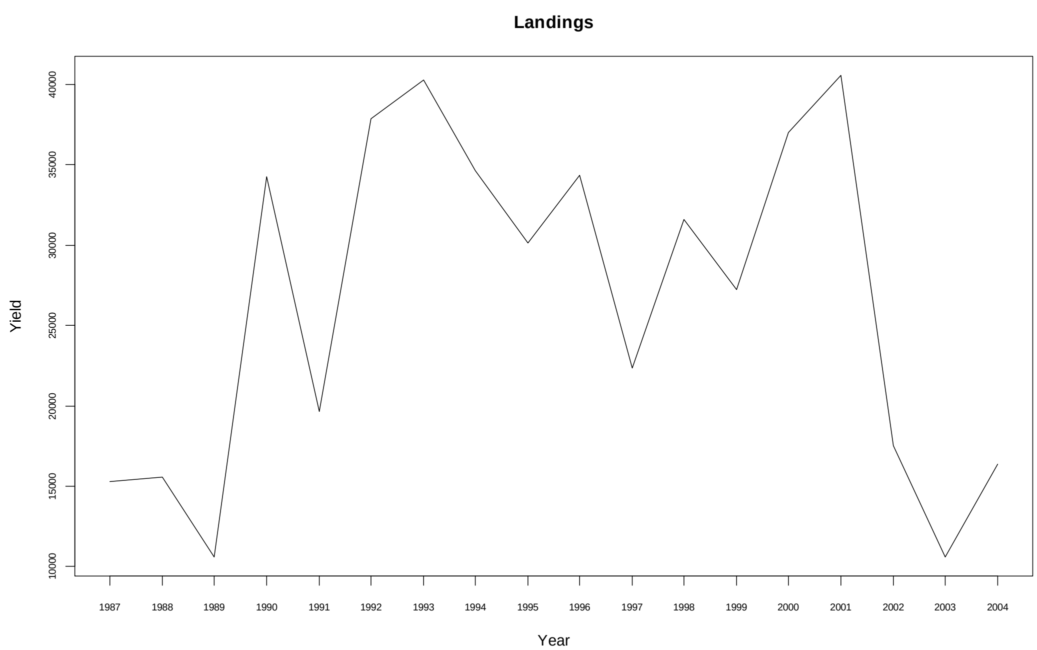


Figure 10.7.1.4: Historical series of total landings for the Bay of Biscay anchovy.

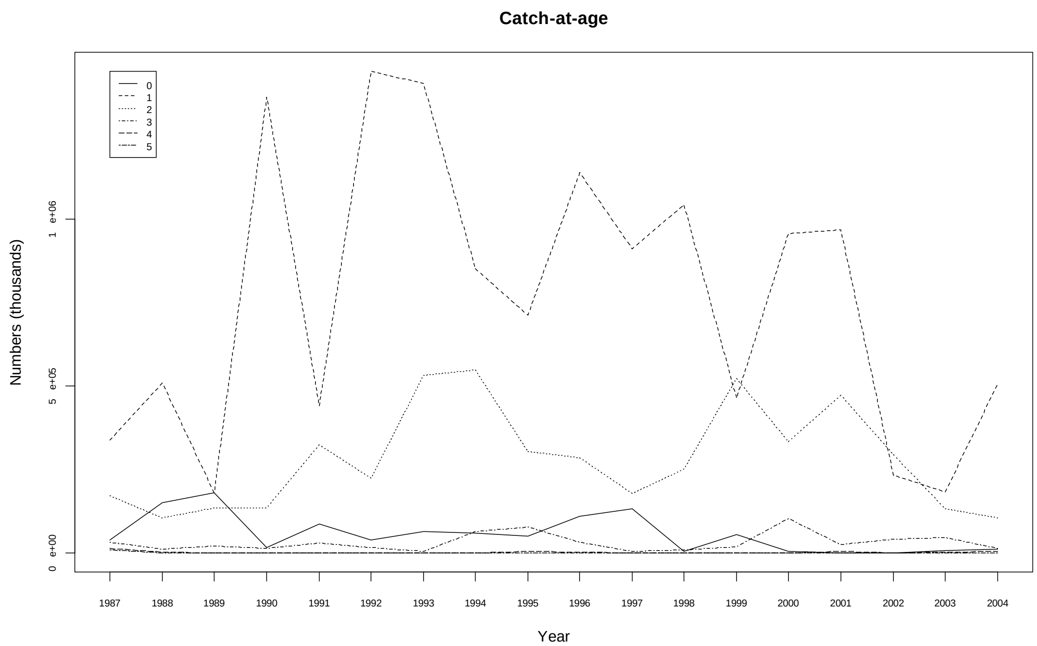


Figure 10.7.1.5: Historical series of catch at age data for the Bay of Biscay anchovy.

Figure 10.7.1.6: Bubble plot of the catch at age for the Bay of Biscay anchovy population.

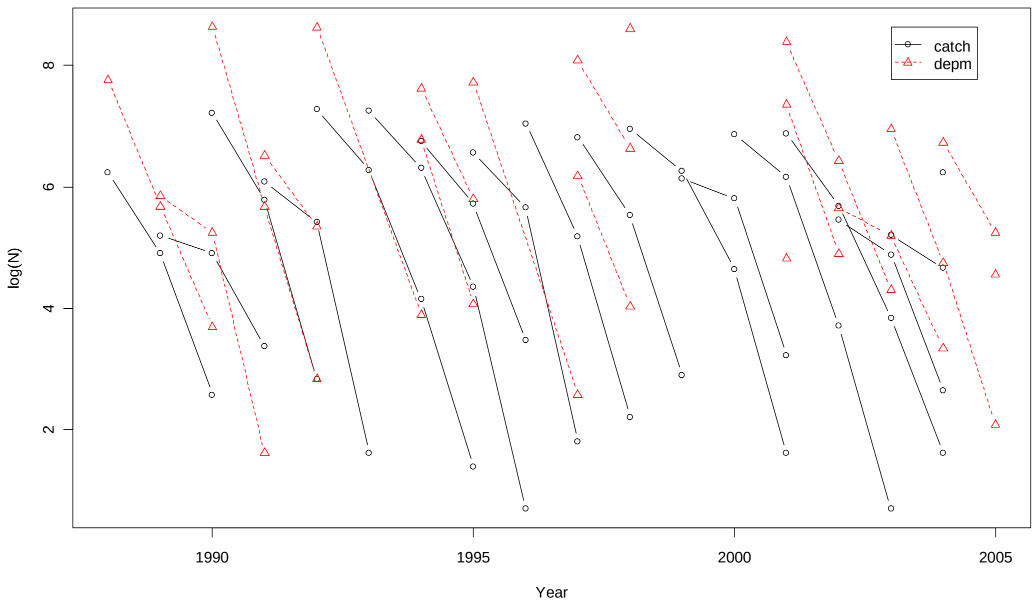


Figure 10.7.1.7: Cohort curves in log scale from catch at age (in black) and DEPM numbers at age (in red).

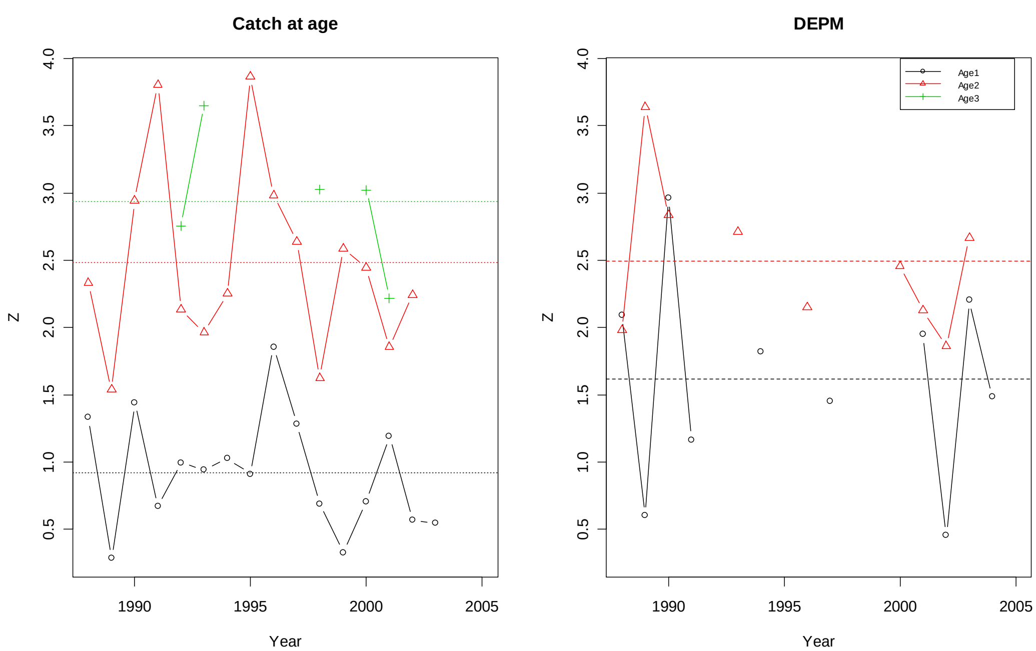


Figure 10.7.1.8: Log-ratio for each age class from catch at age data on the left and from DEPM numbers at age on the right panel. Horizontal dashed lines represent the average log-ratio for each age class.

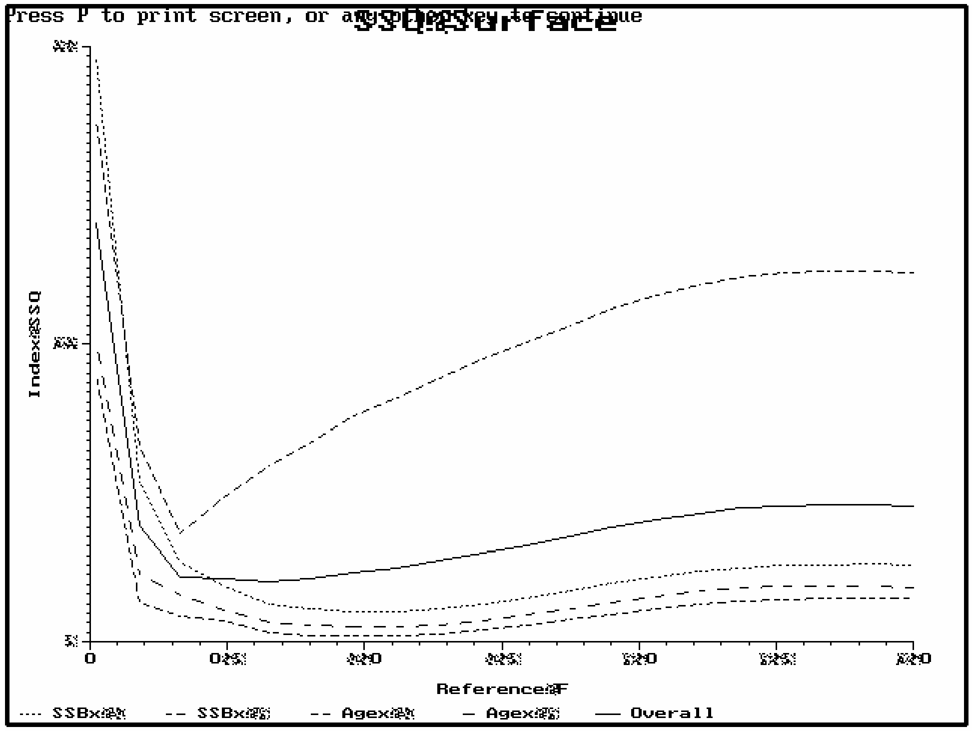


Figure 10.7.2.1.a: The sum of squares surface for the ICA separable VPA fit to the Bay of Biscay anchovy 19872005 (for 15 years of separable constraint).

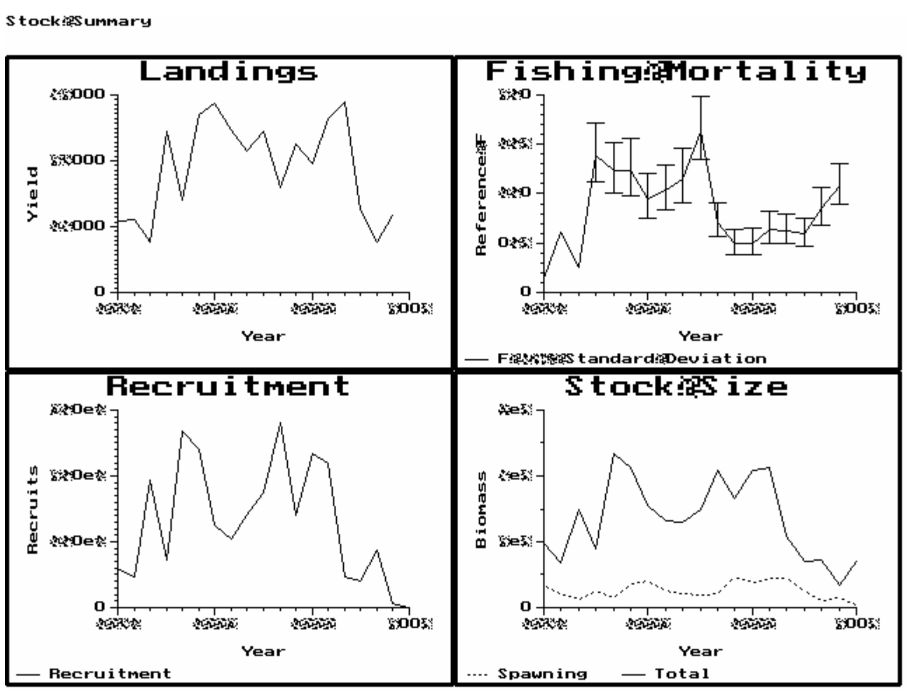


Figure10.7.2.1.b: The long term trends in stock parameters for the Bay of Biscay anchovy 1987-2005

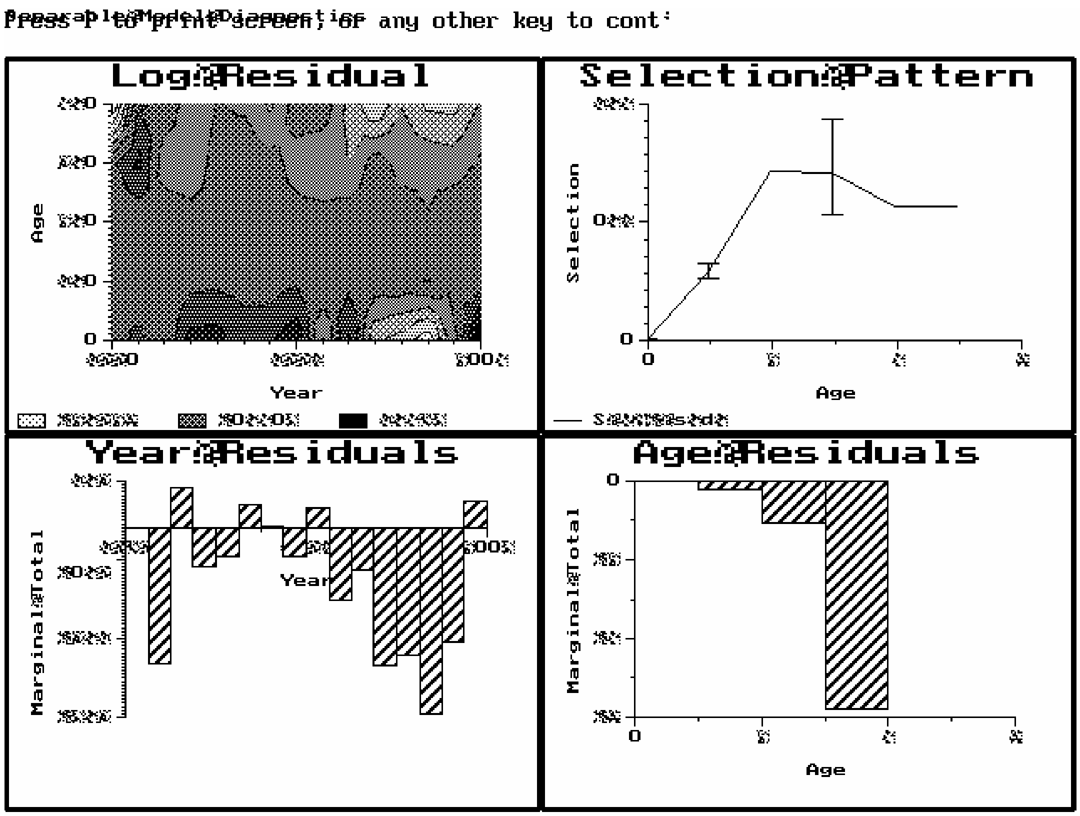
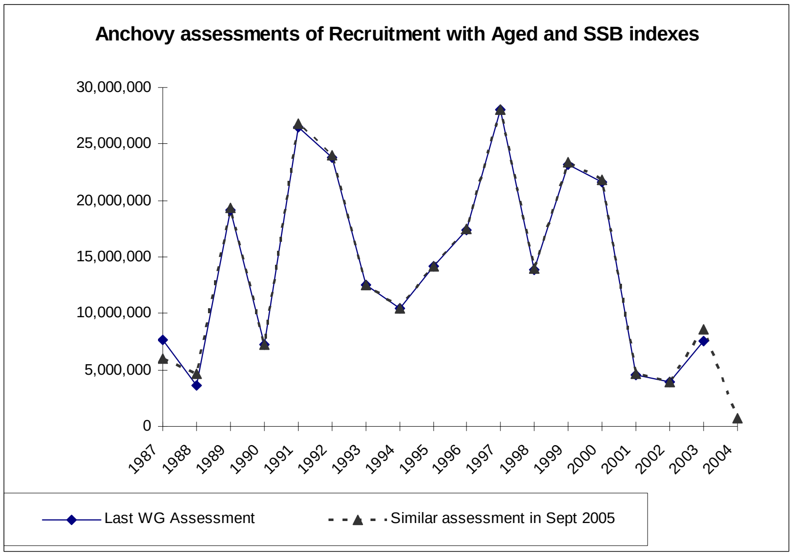
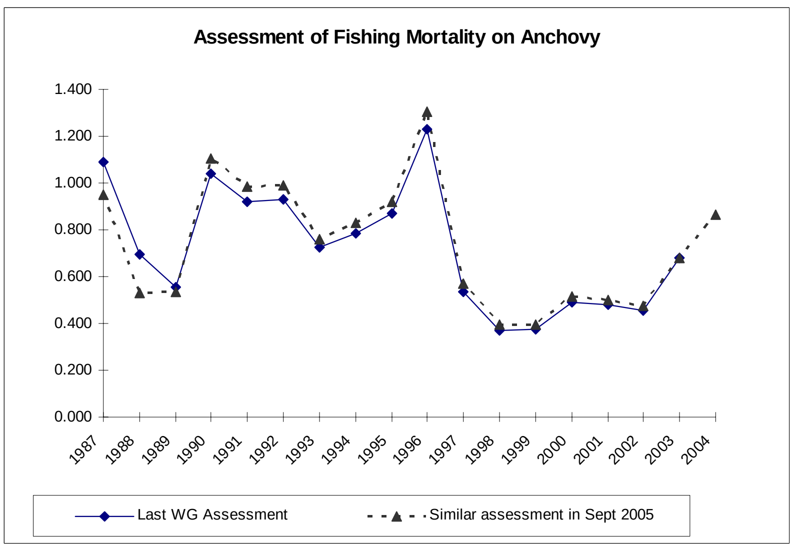


Figure10.7.2.1c: The catch at age residuals and ages fitted by ICA to the Bay of Biscay anchovy 1987-2005





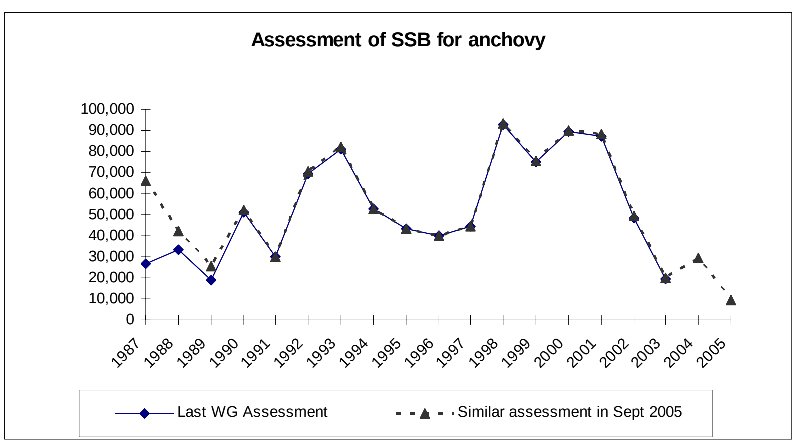
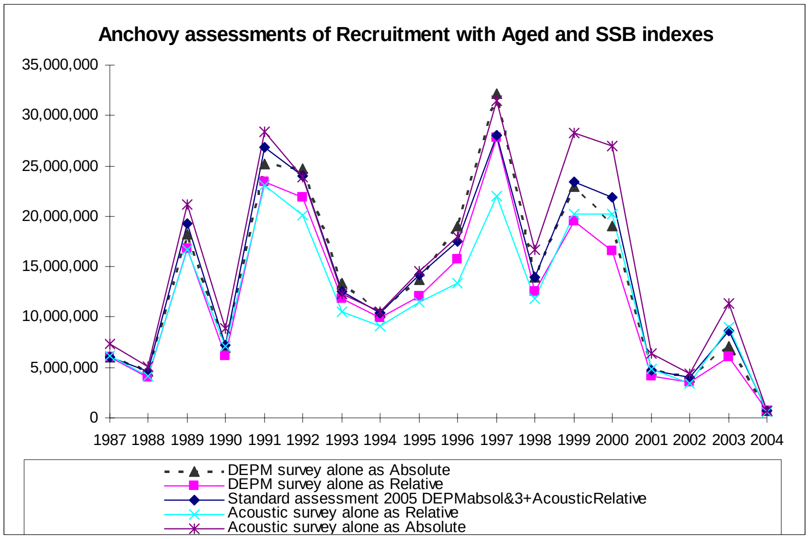
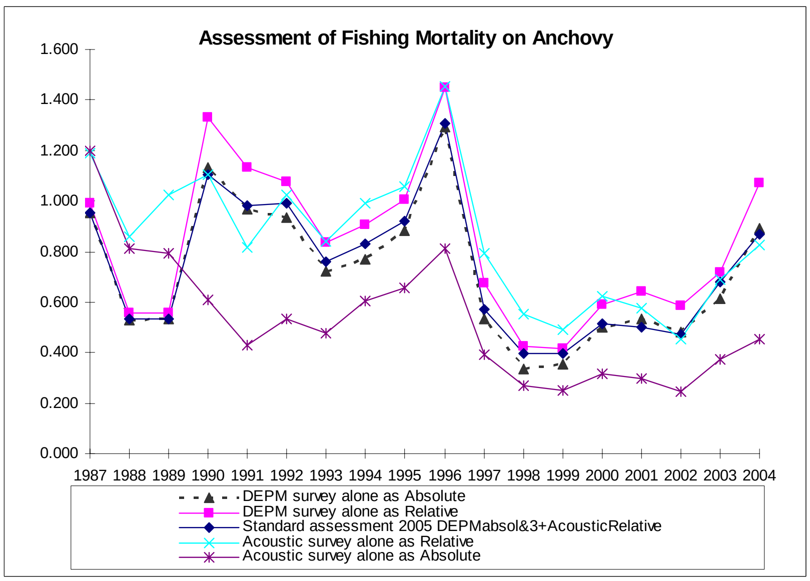


Figure 10.7.2.2: Comparison of last year ICA assessment with an update of it in September 2005 concerning anchovy in Subarea VIIII including new survey estimates in 2004 (DEPM) and 2005 (DEPM+Acoustic).





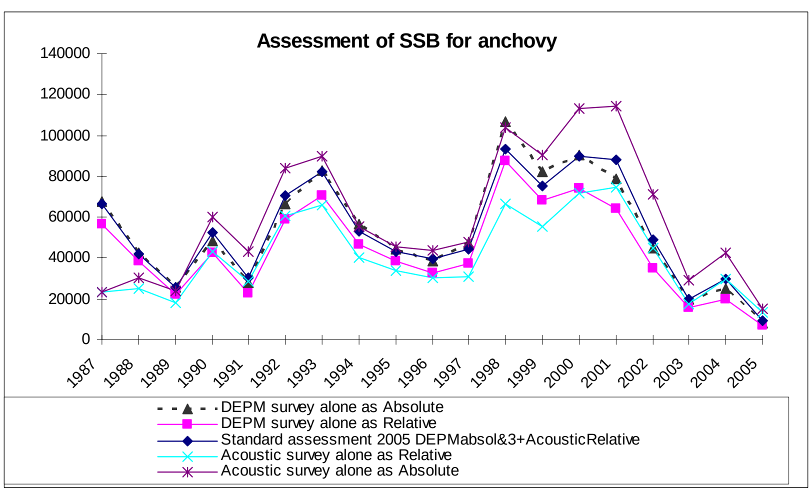


Figure 10.7.2.3: Annual ICA Assessment of Anchovy in 2005. Sensitivity analysis concerning different signals the tuning surveys used alone.

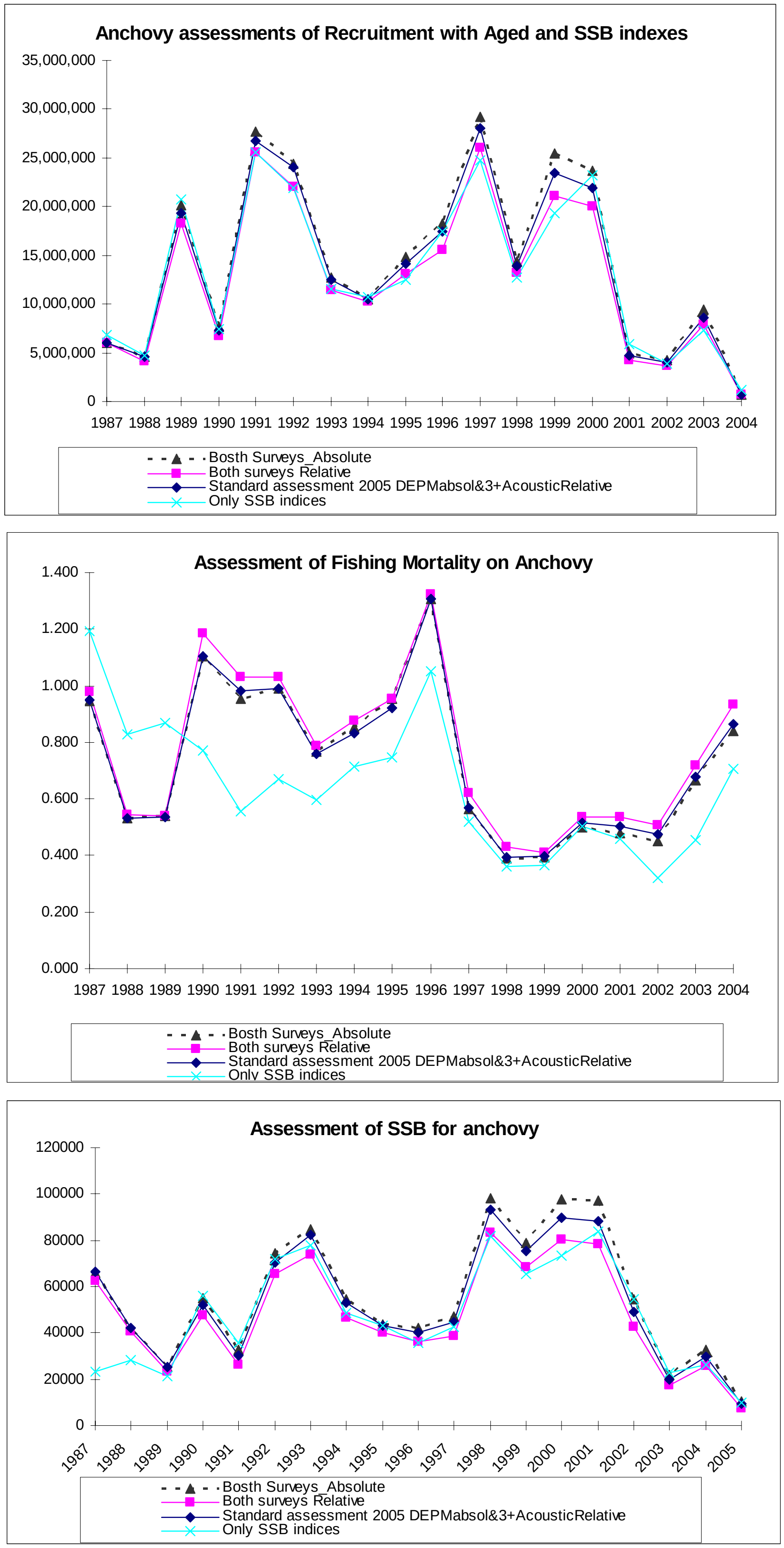


Figure 10.7.2.4: ICA Assessment of Anchovy in September 2005: sensitivity to catchability of surveys.

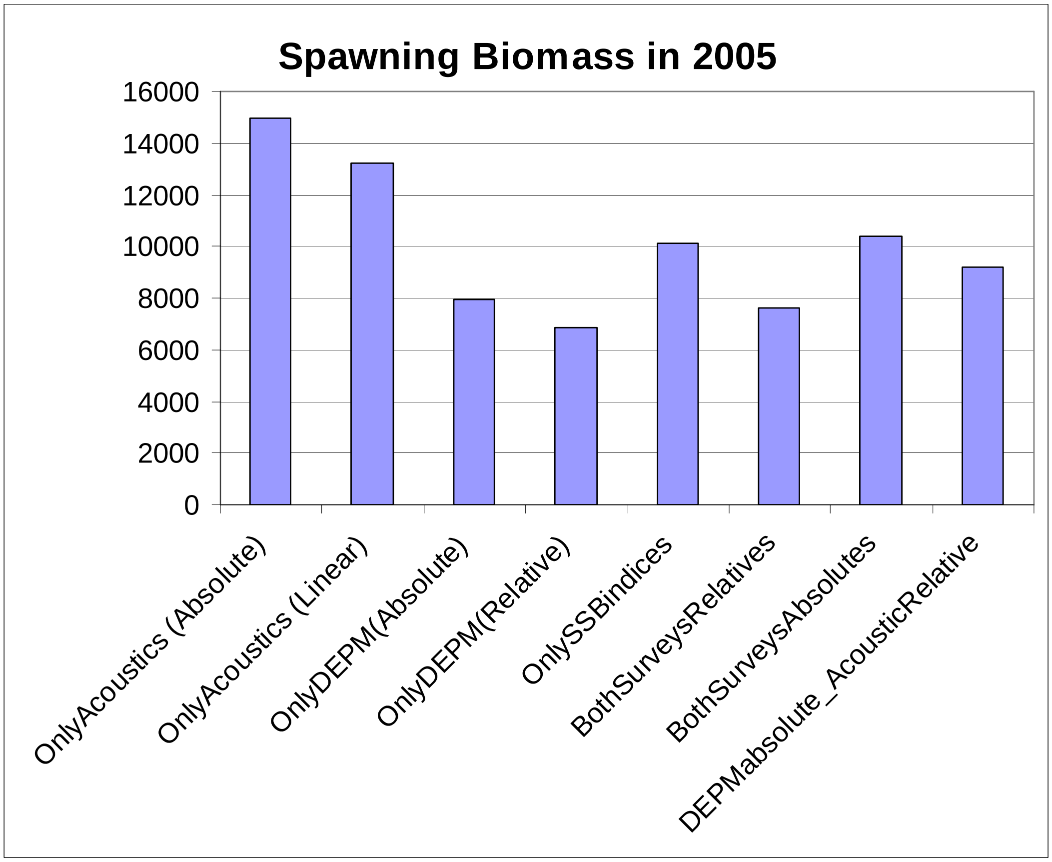


Figure 10.7.2.5: Sensitivity of the standard ICA assessent's estimate of SSB in 2005 to different use of the survey indices.

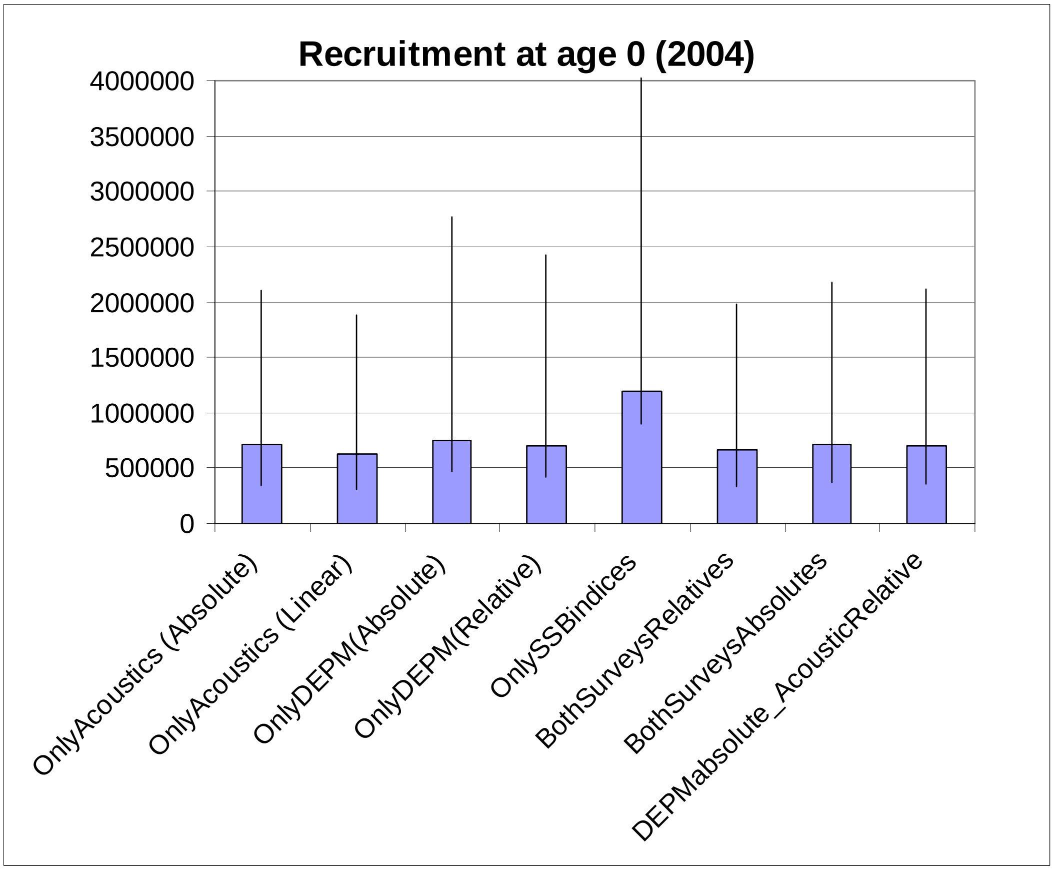


Figure 10.7.2.6: Sensitivity of the standard ICA assessent's estimate of recruitment in 2004 to different use of the survey indices.

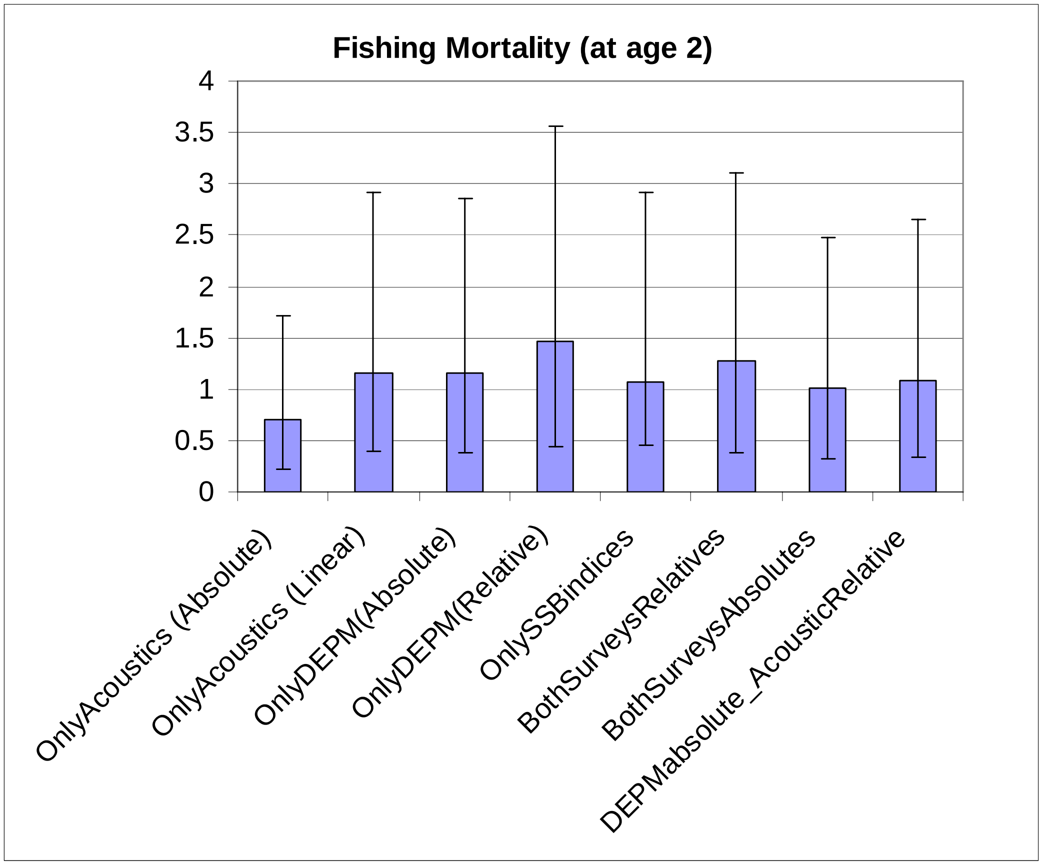


Figure 10.7.2.7: Sensitivity of the standard ICA assessent's estimate of Fishing mortality at age 2 in 2004 to different use of the survey indices.

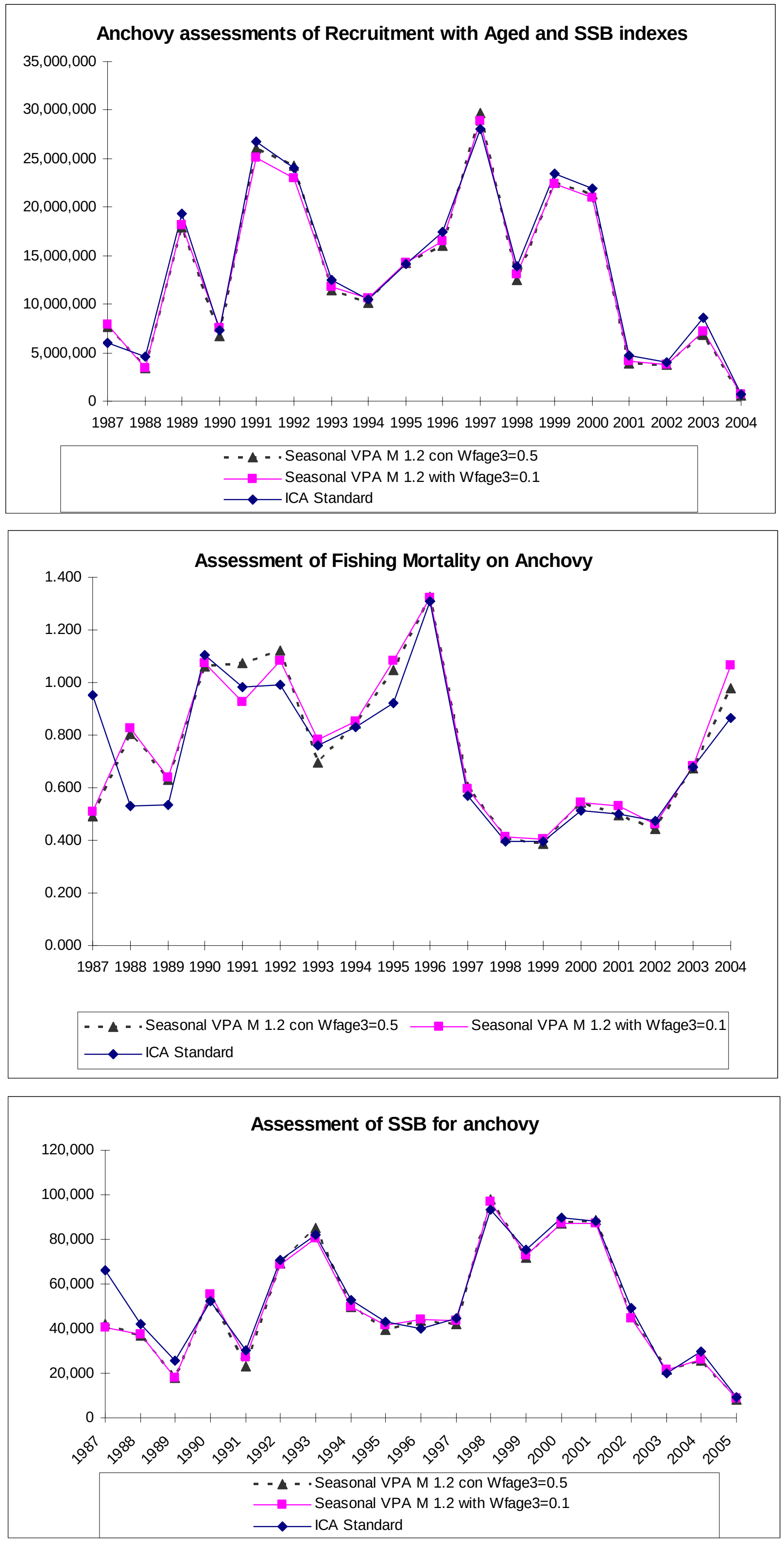


Figure 10.7.3.1: Comparison of Assessment for the Bay of Biscay anchovy sensitivity to annual or seasonal modeling.

Figure 10.7.3.2: Fishing selectivities of the anchovy fishing fleets

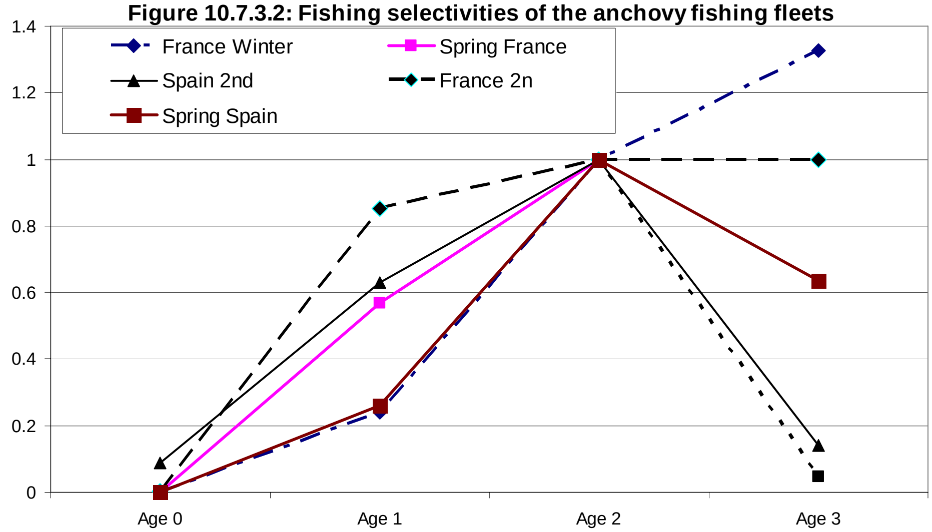


Figure 10.7.3.3: Series of partial Fishing Mortalities F(1-3+) on anchovy by fleets

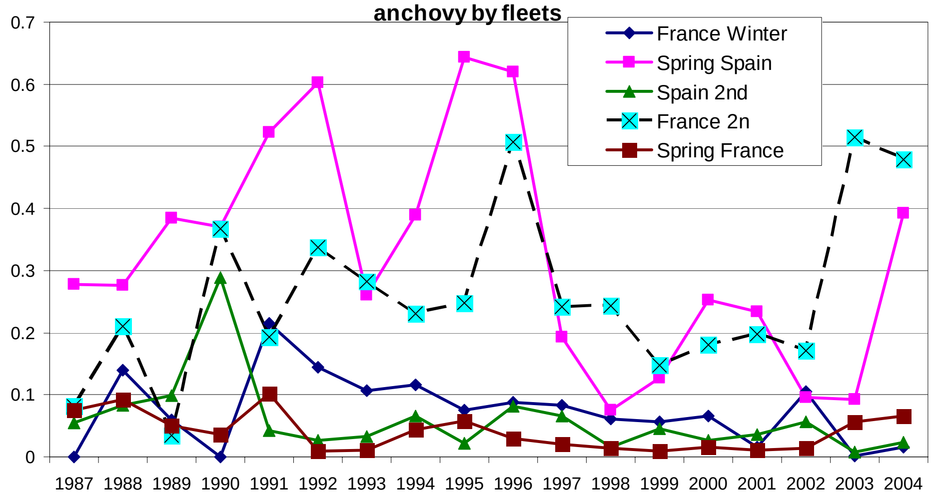


Figure 10.7.3.4 Fitting of the individual catches at age of the all the seasonal fleets on anchovy in the Bay of Biscay

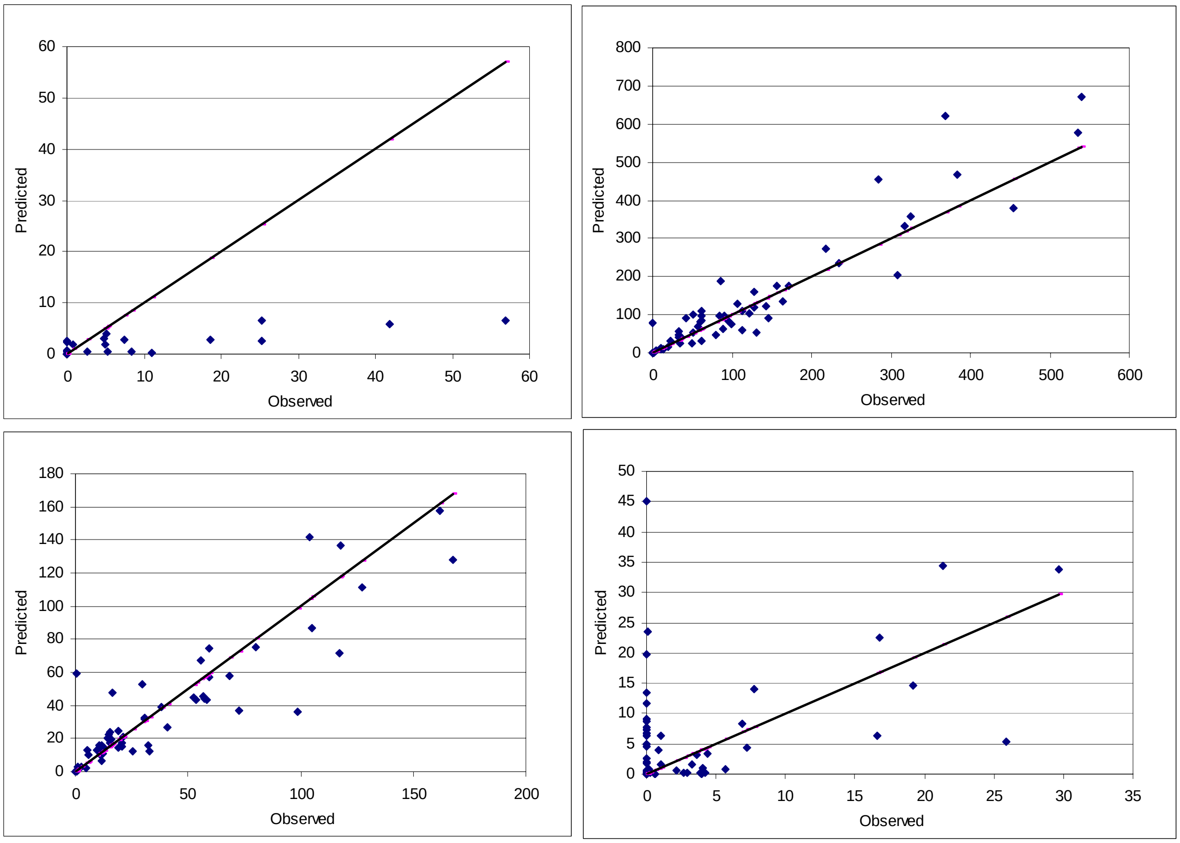
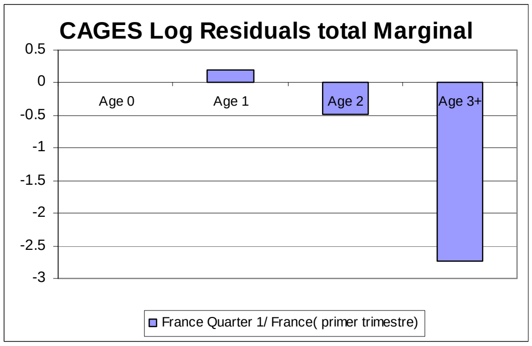
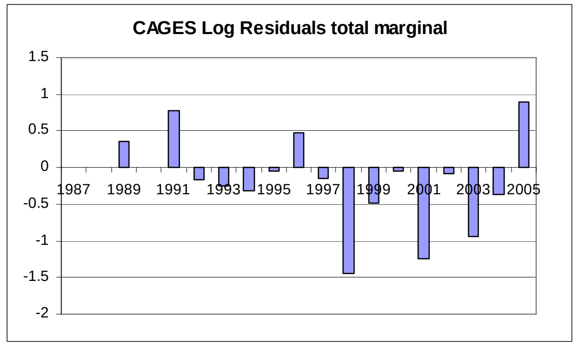
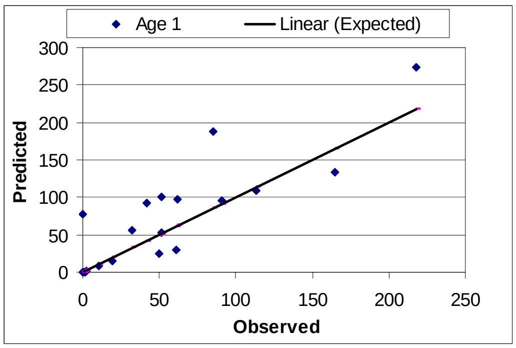


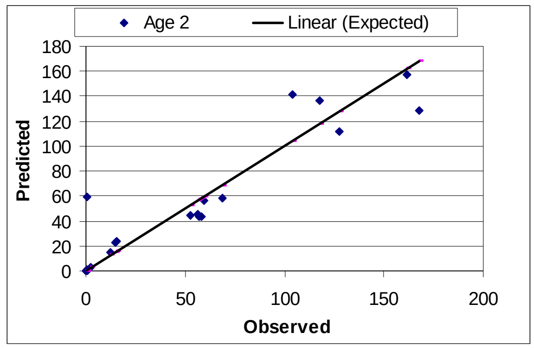
Figure 10.7.3.5

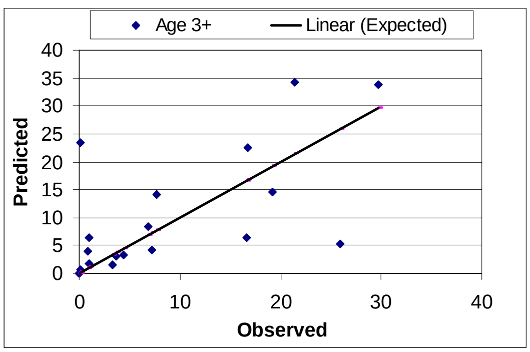
France Quarter 1











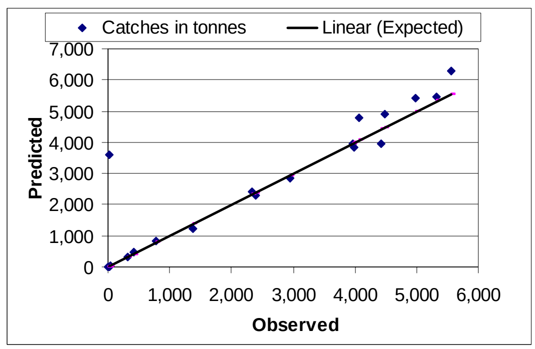


Figure 10.7.3.7
France 2nd Half of the Year

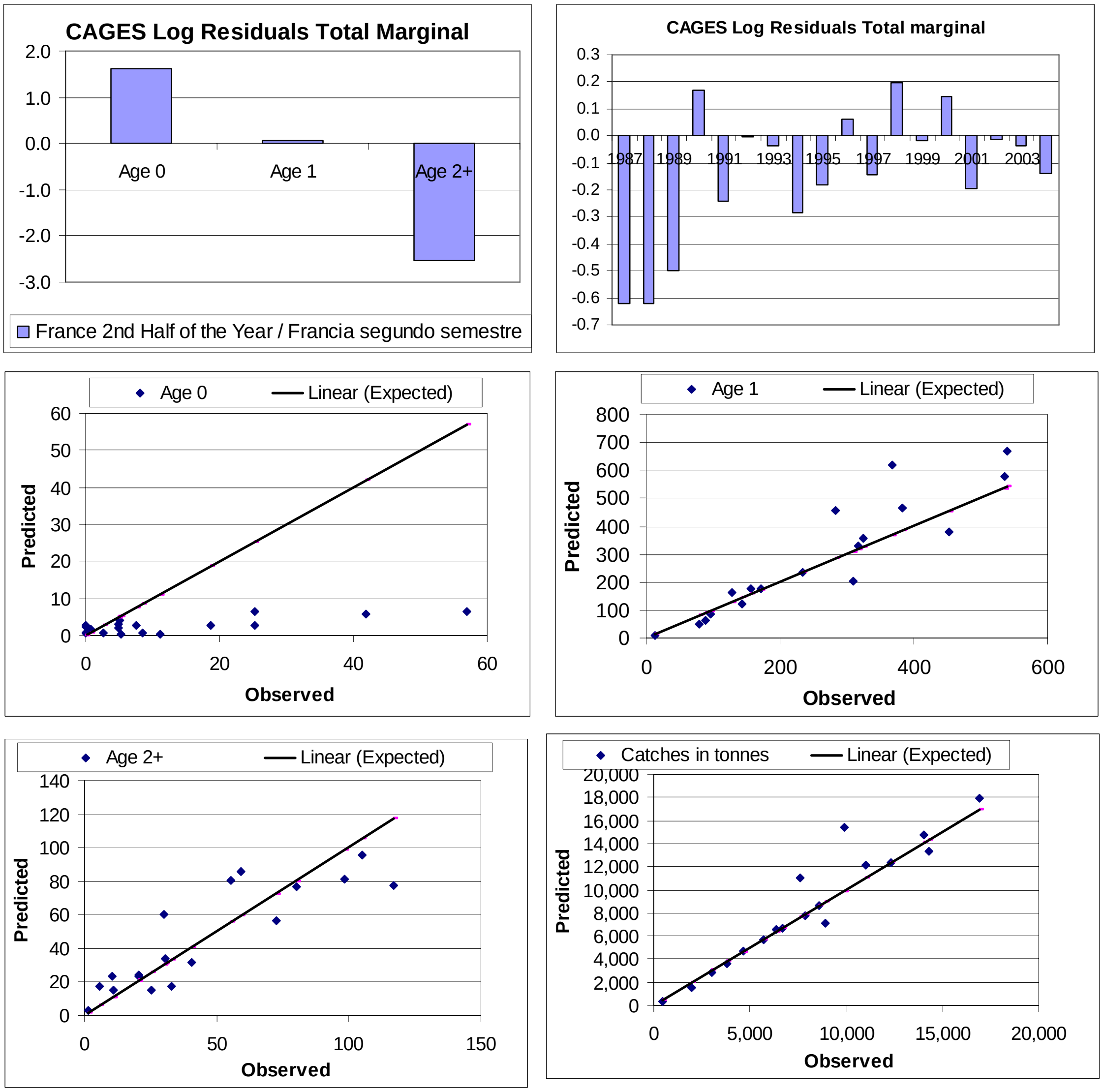


Figure 10.7.3.8
Spain Quarter 2

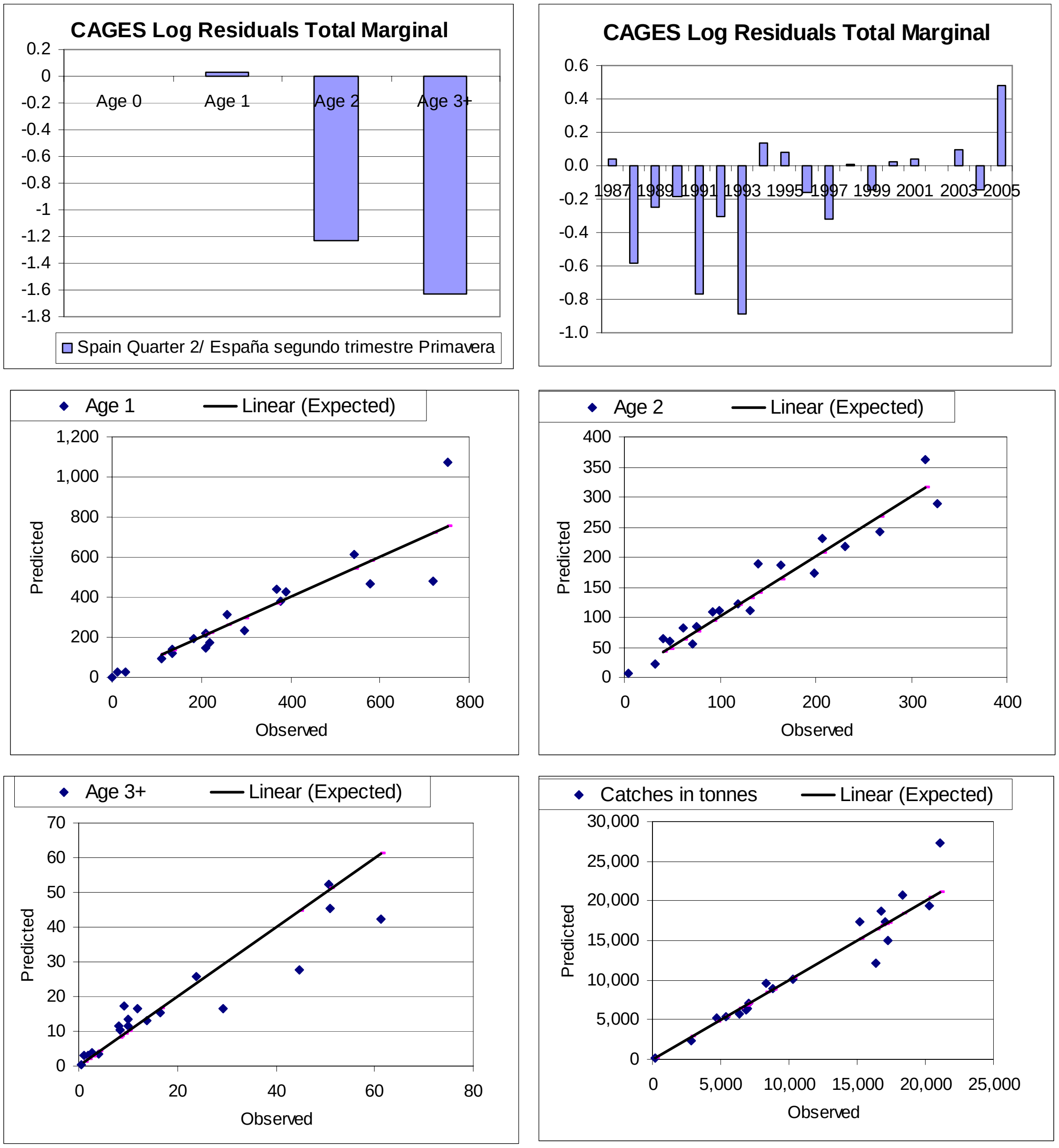


Figure 10.7.3.9
Spain 2nd Half of the Year

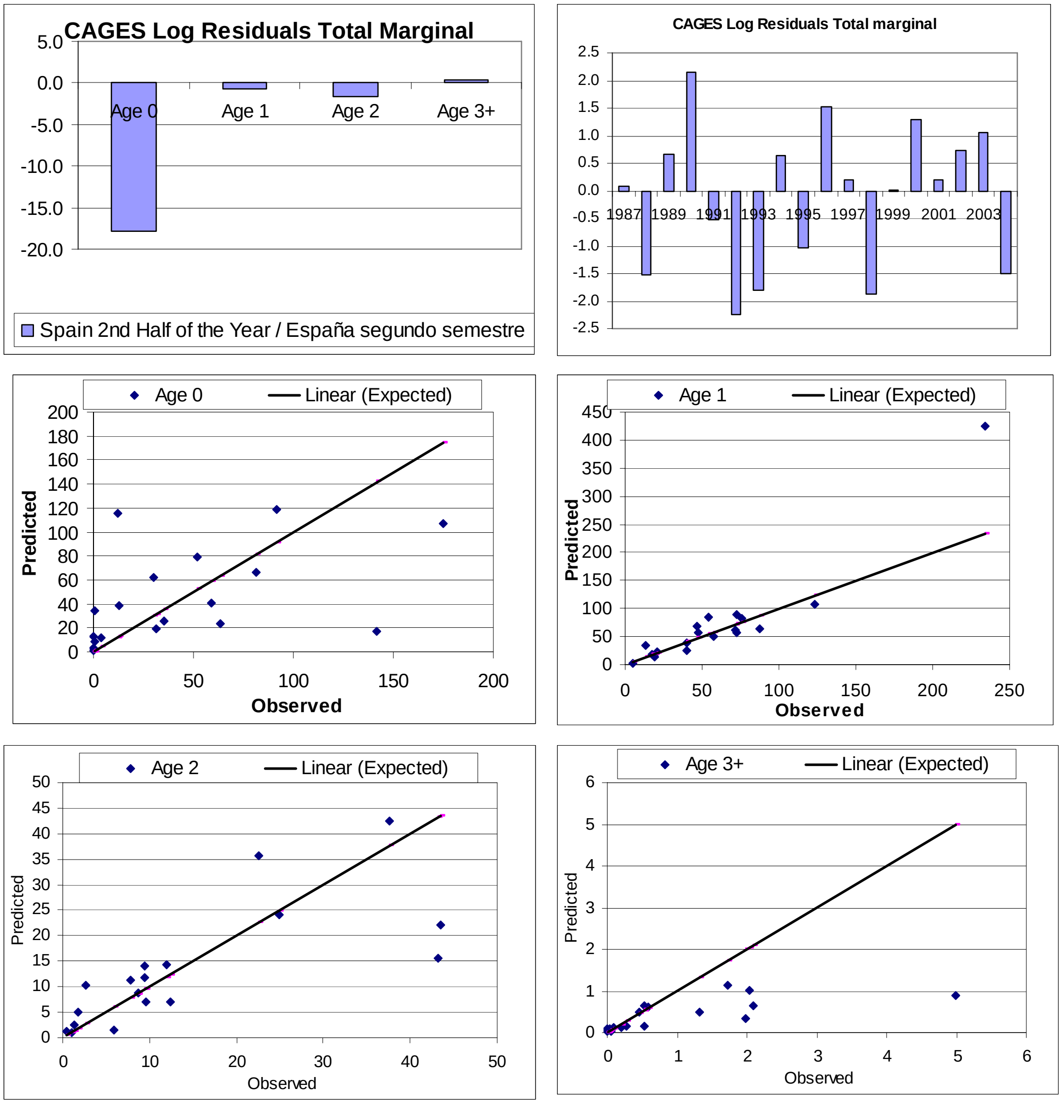


Figure 10.7.3.10
DEPM Population Estimates

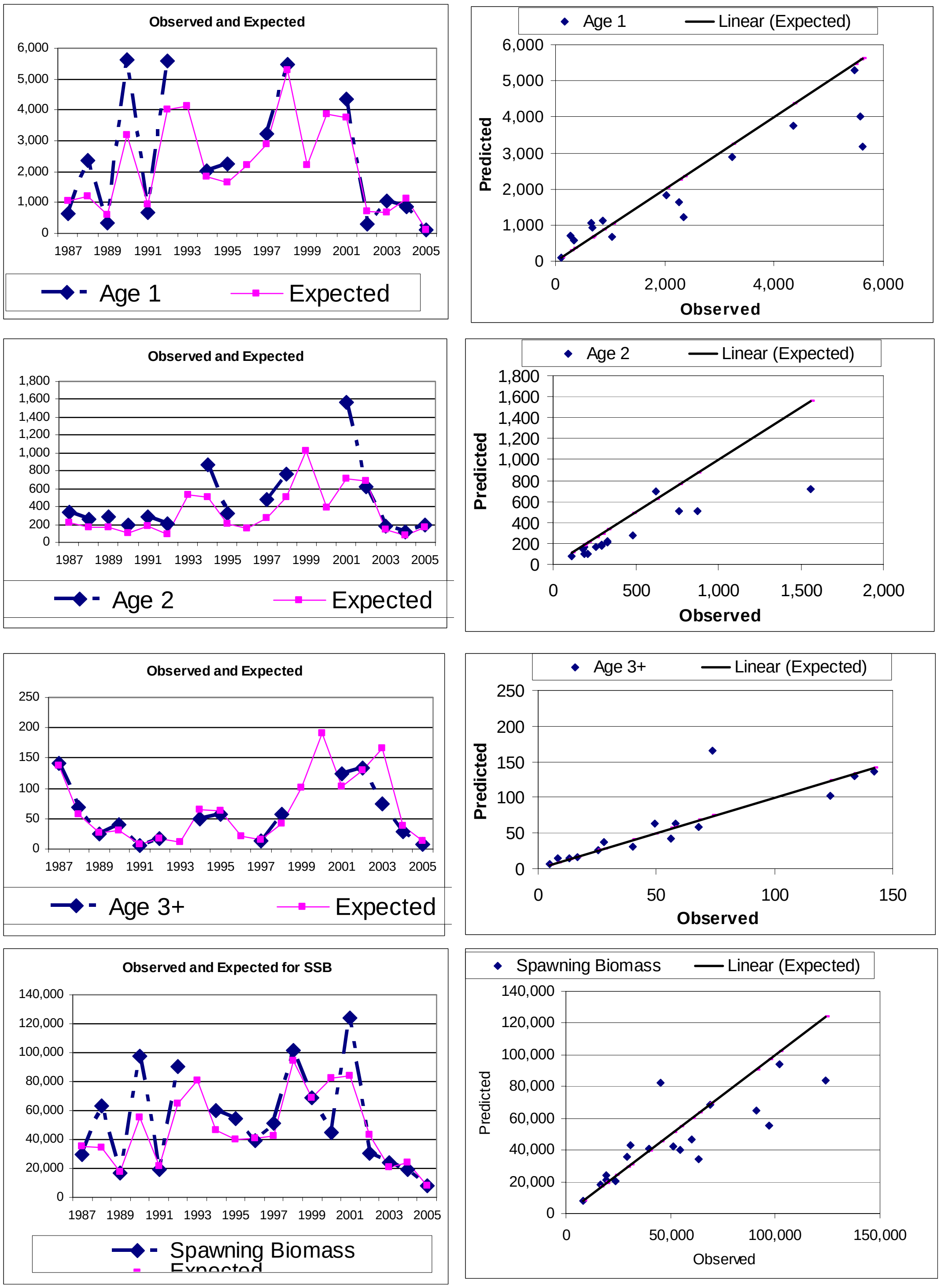


Figure 10.7.3.11
DEPM Population Estimates

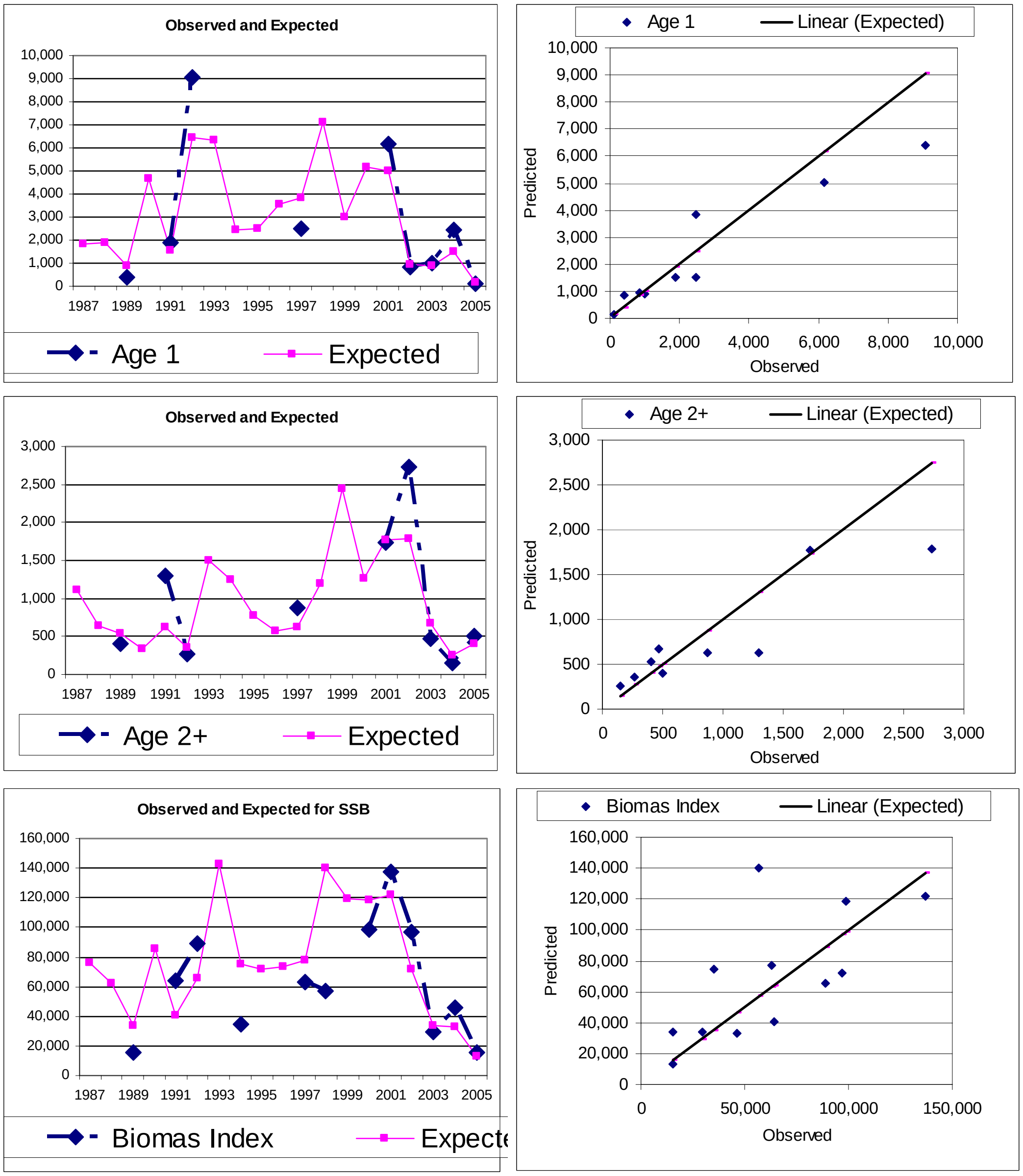


Figure 10.7.4.1:
A-Weighted sum of squares from fitting of a seasonal separable model to the anchovy fisheries according to Natural Mortality
B- Respective average time series of annual fishing mortality at age 2

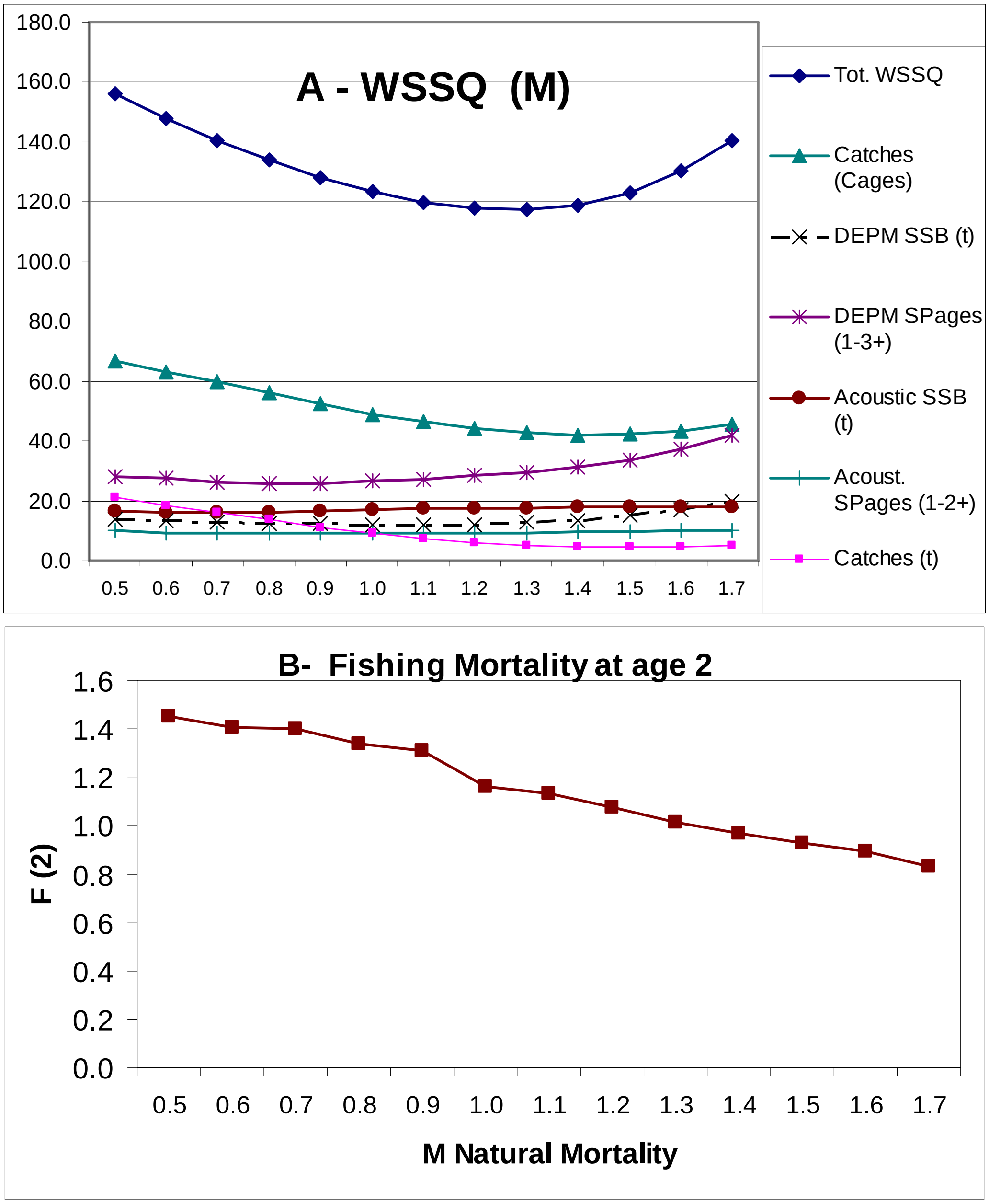
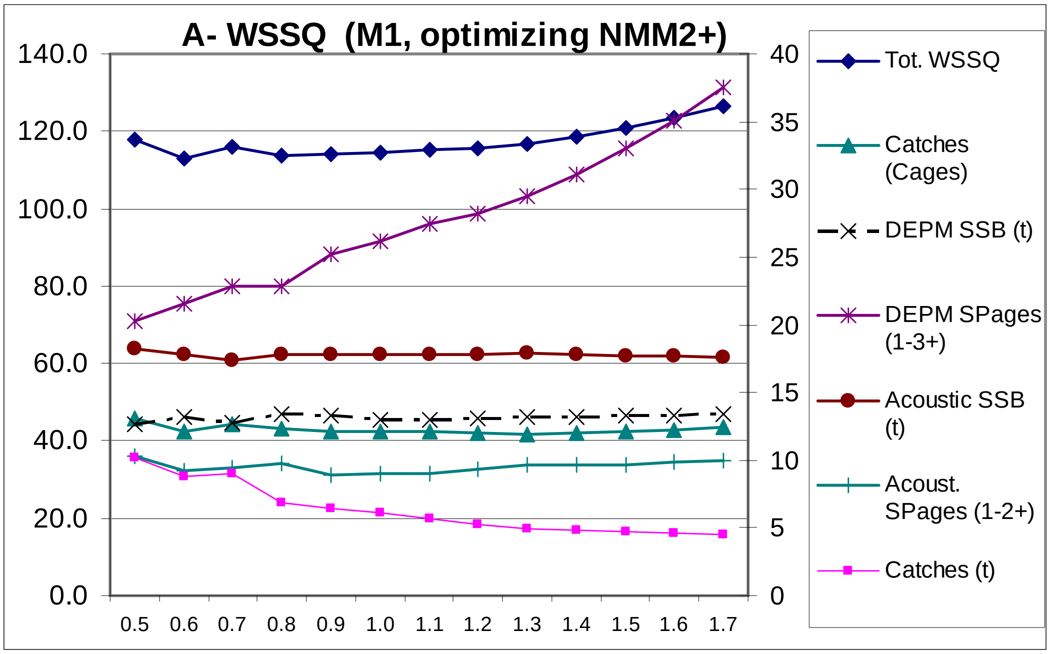
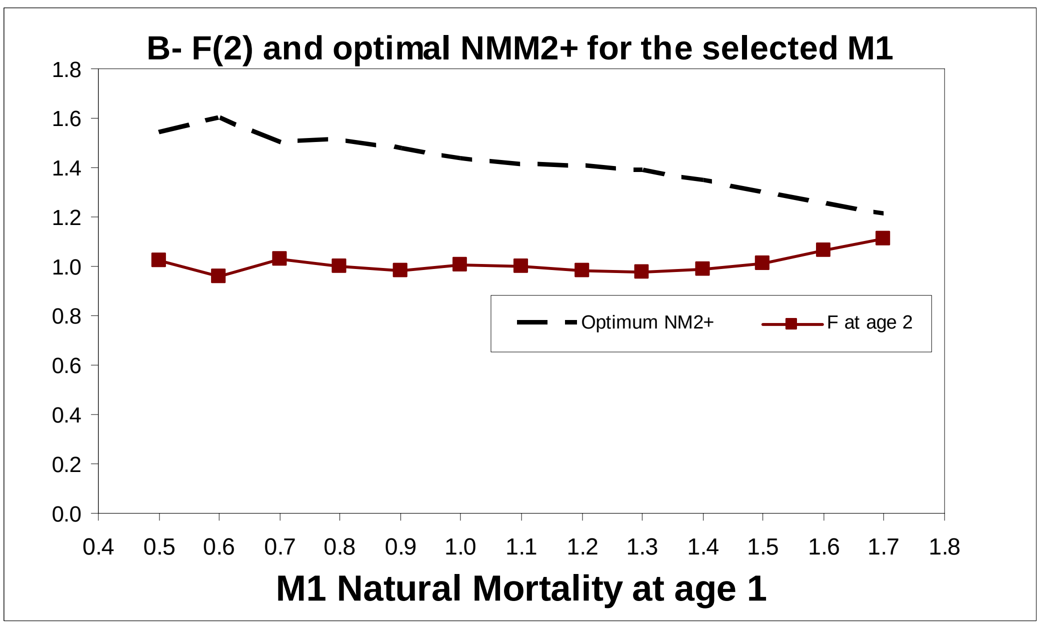


Figure 10.7.4.2:

A-Weighted sum of squares (WSSQ) from fitting of a seasonal separable model to the anchovy fisheries according to pattern of Natural Mortality at age. Natural mortality at age 1 (M1) in X axis and WSSQ in Y axis

B- Respective fitted natural mortality at ages 2 and olders and average time series of annual fishing mortality at age 2





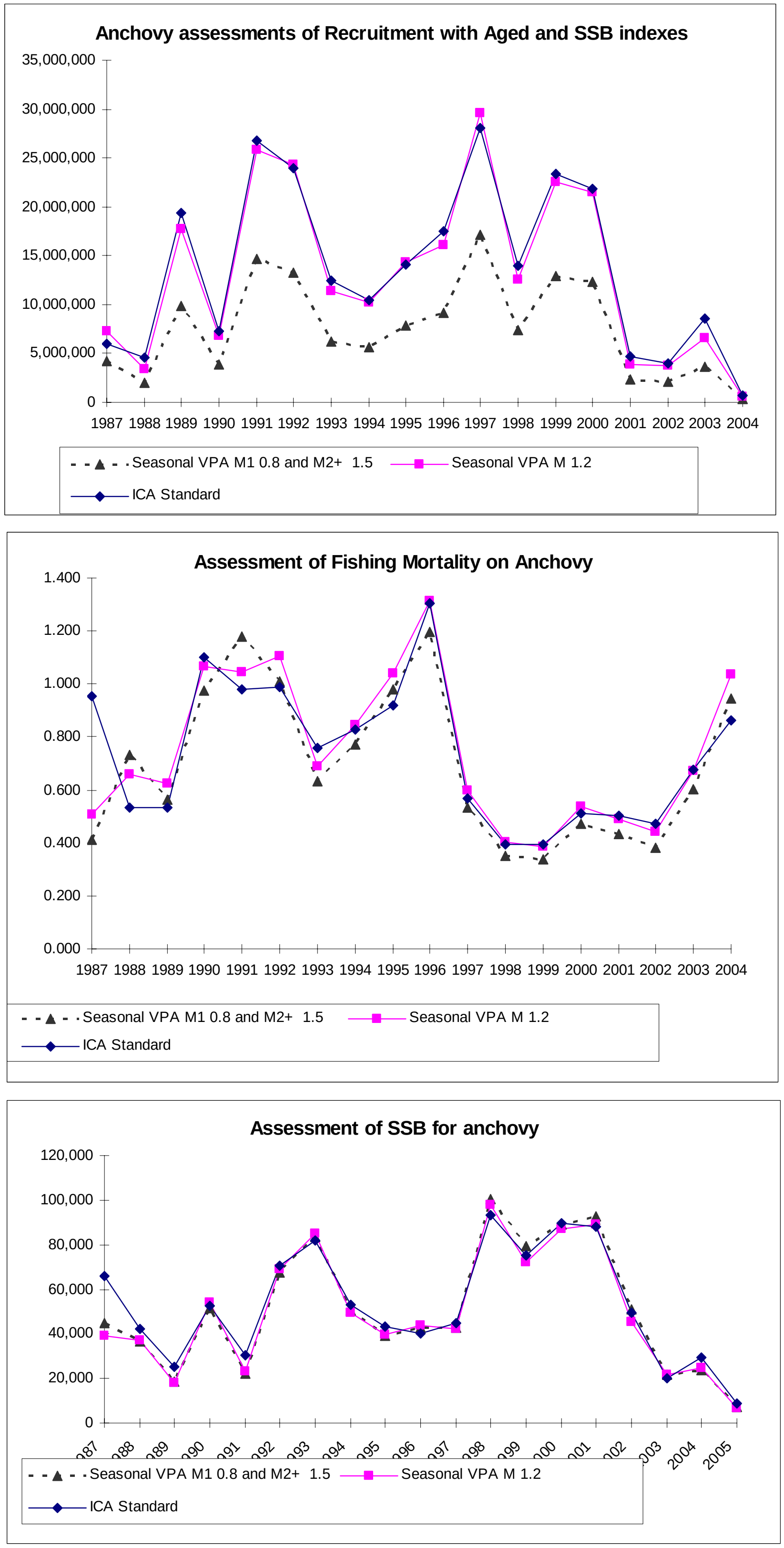
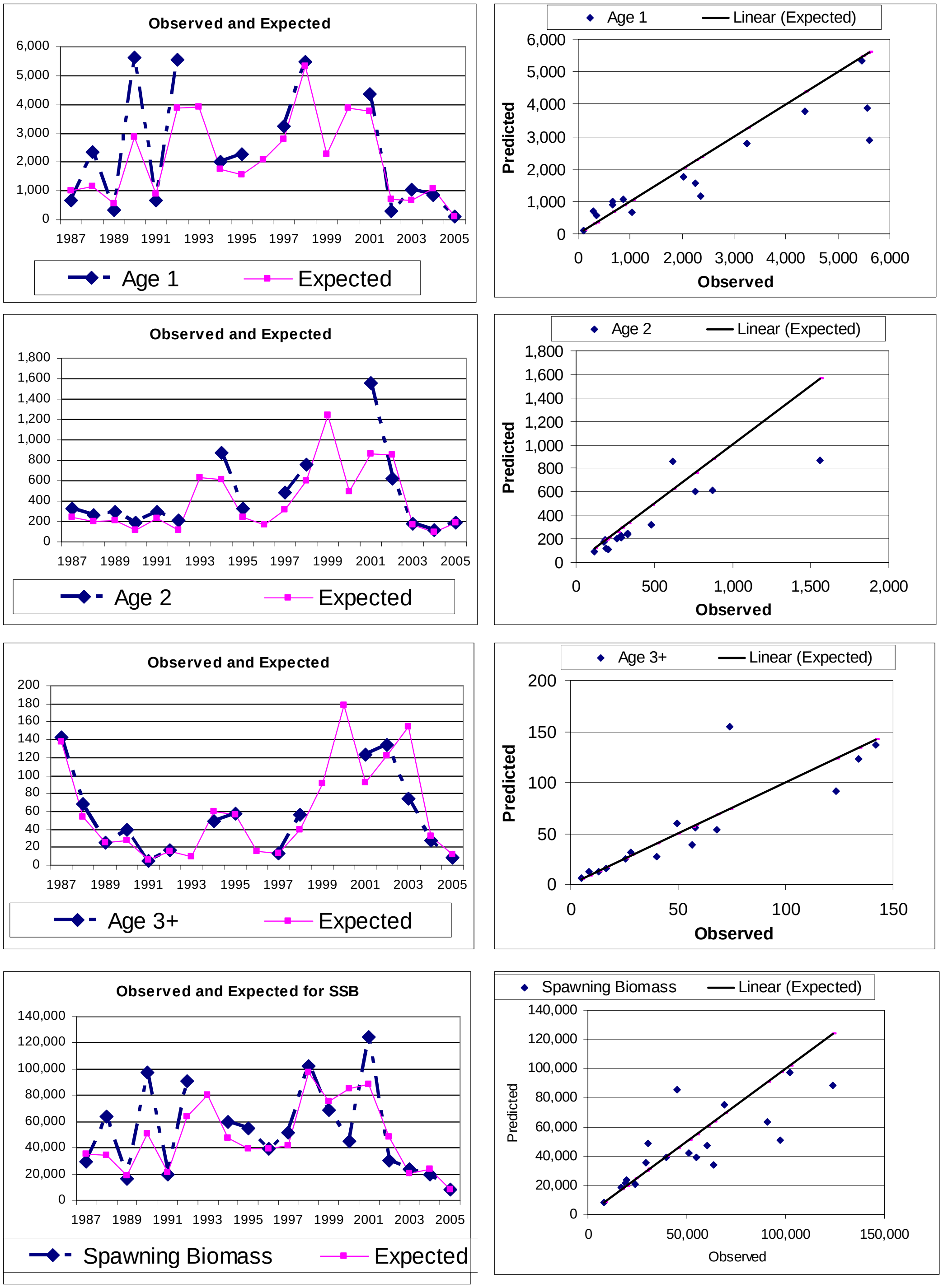


Figure 10.7.4.3: Comparison of Assessment for the Bay of Biscay anchovy concerning different units of time for the assessment and pattern of natural mortality at age

Figure 10.7.4.4

FITTING TO A SEPARABLE SEASONAL ASSESSMENT MODEL WITH M1=0.8 AND M2+=1.5

DEPM Population Estimates



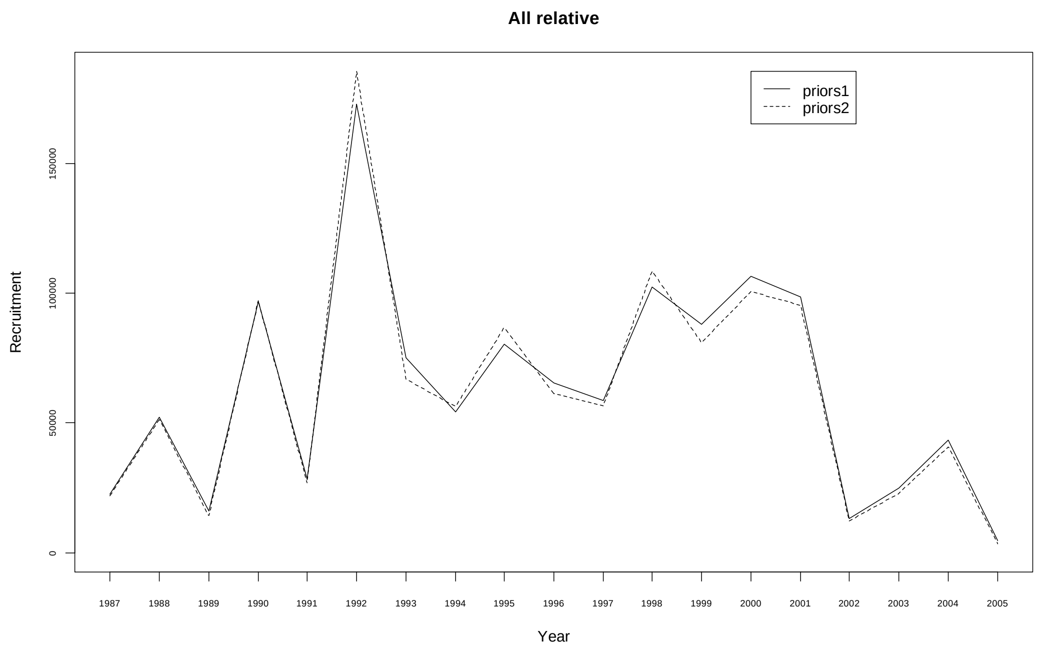


Figure 10.7.5.1: Comparison of posterior medians of recruitment from the improved biomass based model when DEPM and acoustic biomass indices are taken as relative for the two set of priors.

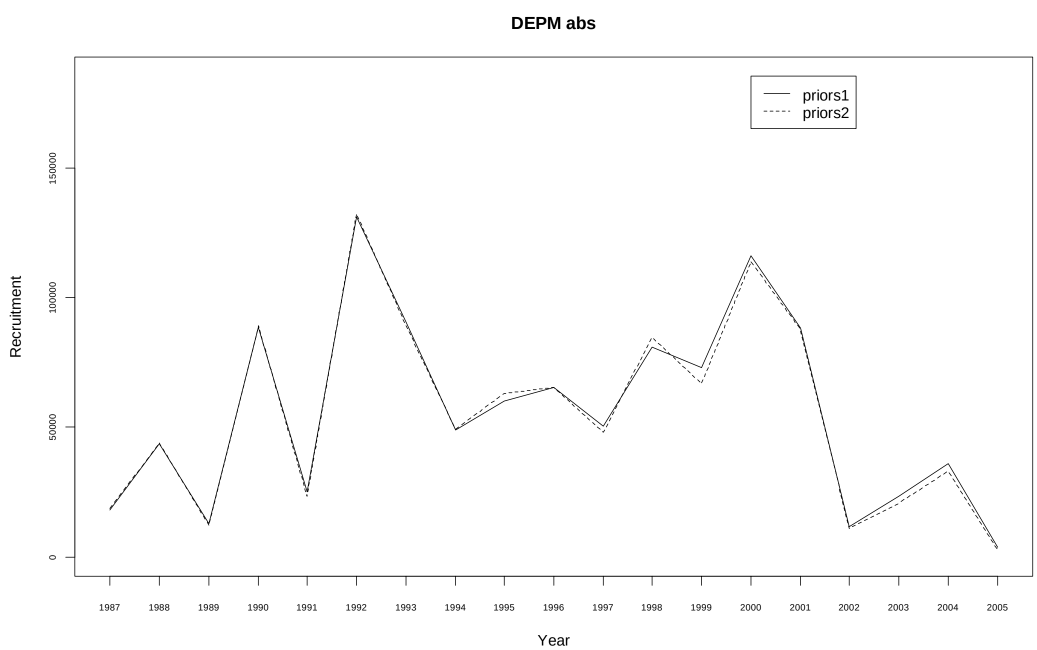


Figure 10.7.5.2: Comparison of posterior medians of recruitment from the improved biomass based model when DEPM biomass index is taken as absolute ($q_{depm} = 1$) for the two set of priors.

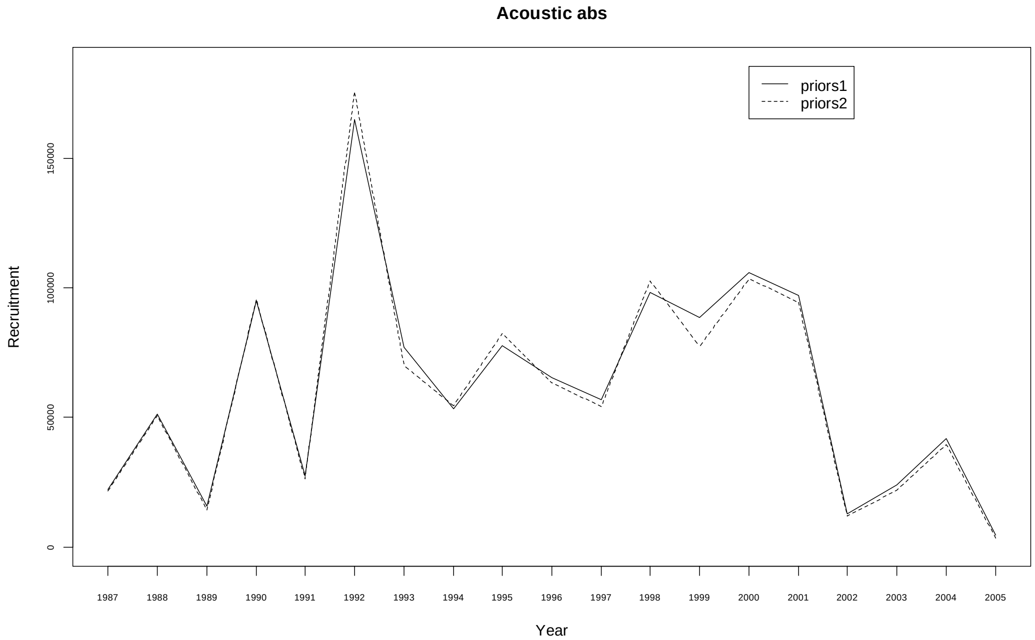


Figure 10.7.5.3: Comparison of posterior medians of recruitment from the improved biomass based model when acoustic biomass index is taken as absolute ($q_{ac} = 1$) for the two set of priors.

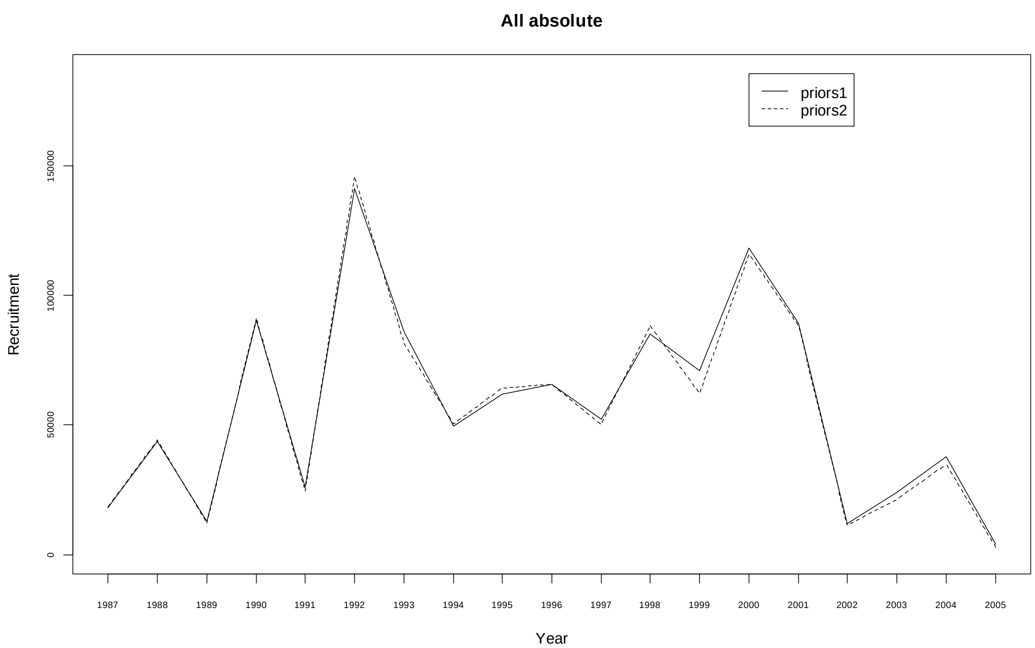


Figure 10.7.5.4: Comparison of posterior medians of recruitment from the improved biomass based model when both DEPM and acoustic biomass indices are taken as absolute ($q_{depm} = 1$ and $q_{ac} = 1$) for the two set of priors.

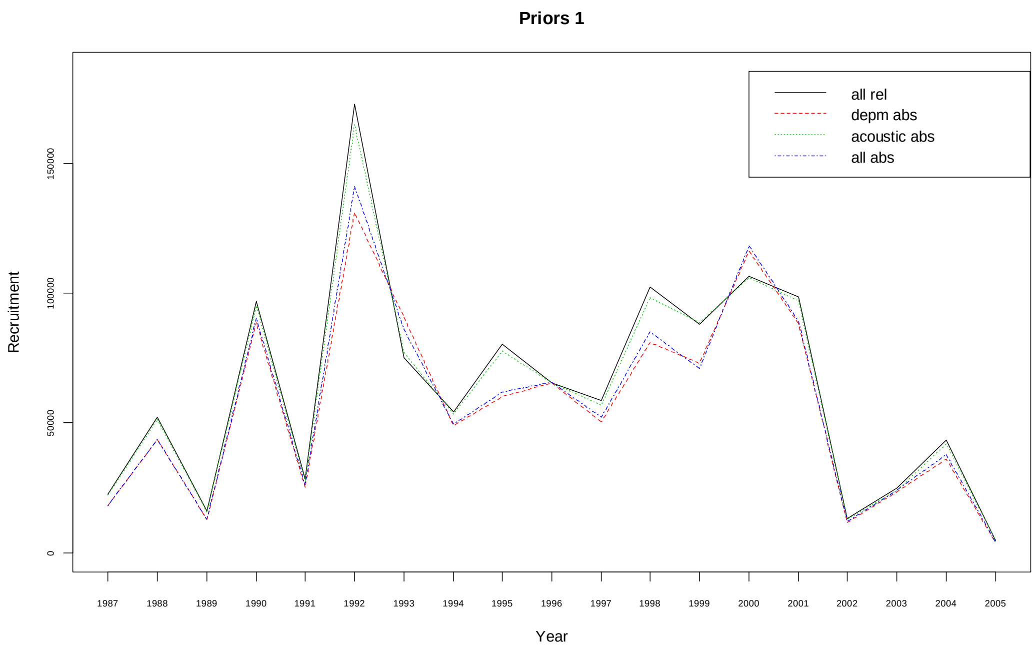


Figure 10.7.5.5: Comparison of posterior medians of recruitment from the improved biomass based model with the first set of priors for different catchability assumptions for DEPM and acoustic biomass indices.

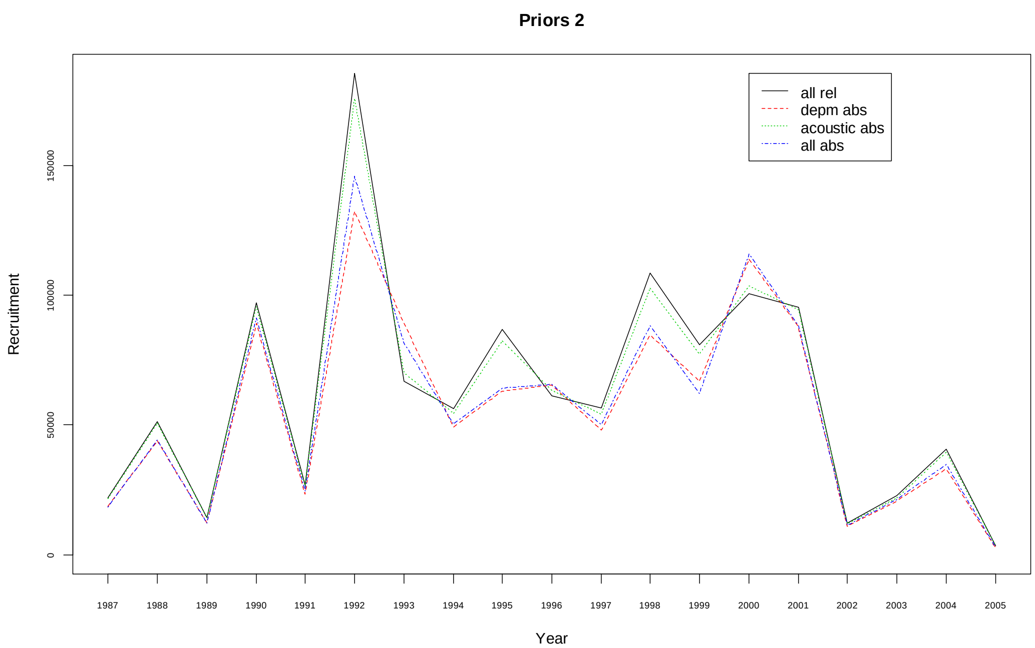


Figure 10.7.5.6: Comparison of posterior medians of recruitment from the improved biomass based model with the second set of priors for different catchability assumptions for DEPM and acoustic biomass indices.

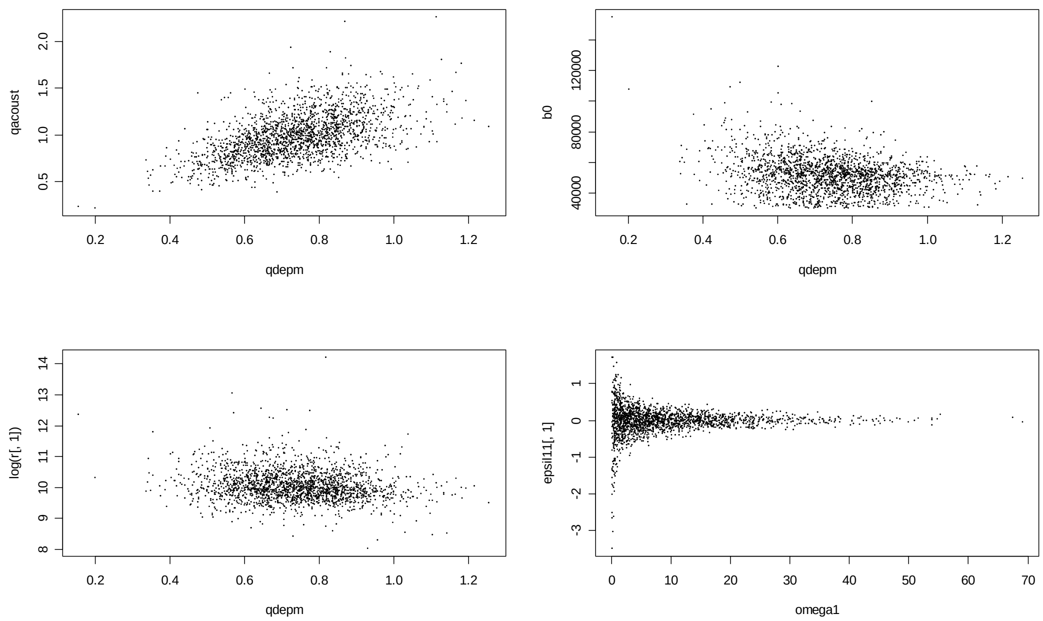


Figure 10.7.5.7: Posterior correlation between some of the parameters in the improved biomass based model. From left to right and from top to bottom, q_{ac} vs q_{depm}, B_0 vs q_{depm}, $\log(R_1)$ vs q_{depm} and $\varepsilon_1(0_{(y)}, h_{1(y)})$ vs ω_1.

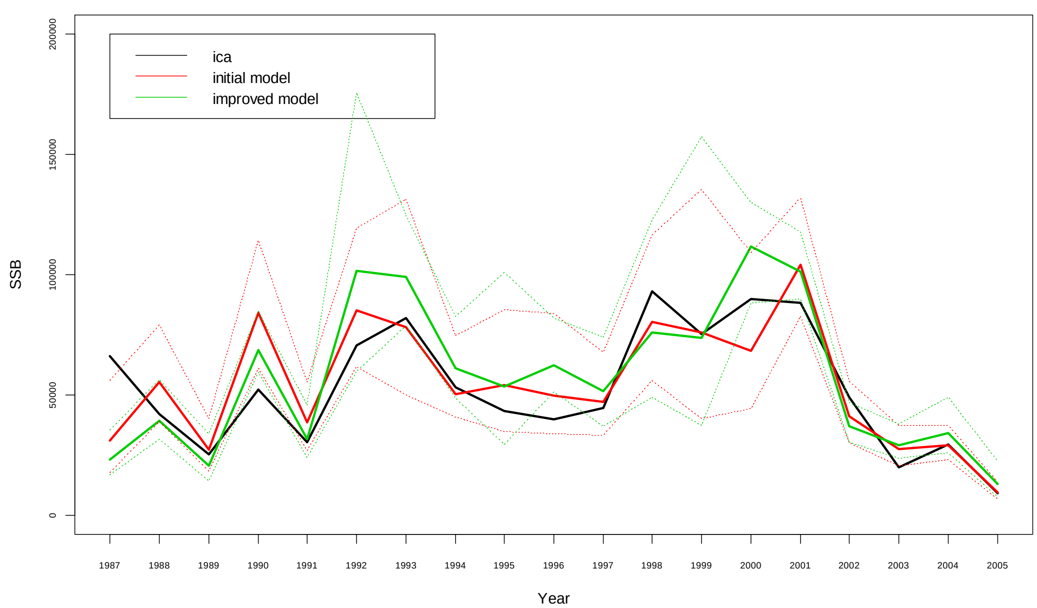


Figure 10.7.5.8: Posterior median (solid line) of spawning biomass with corresponding 95% credibility intervals (dotted line) for the initial model in red and for the improved model in green. Estimates from the ICA model are in black.

Figure 10.7.5.9: Posterior median (solid line) of recruitment (in tones) with corresponding 95% credibility intervals (dotted line) for the initial model in red and for the improved model in green. Estimates from the ICA model are in black.

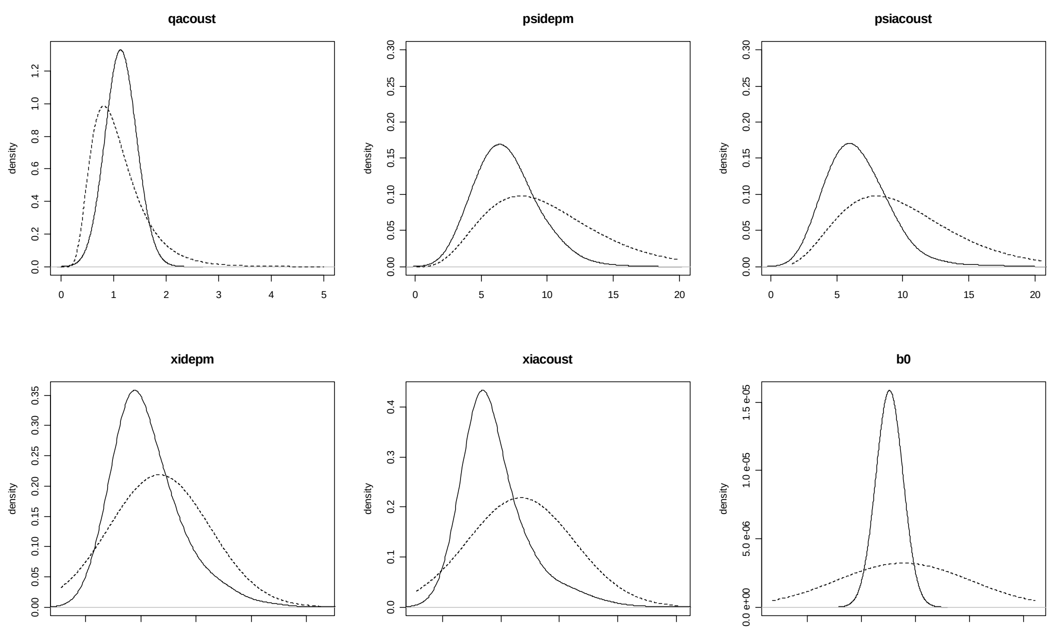


Figure 10.8.1.1: Comparison between the prior (dotted line) and posterior distribution (solid line) for some of the parameters of the improved biomass-based model.

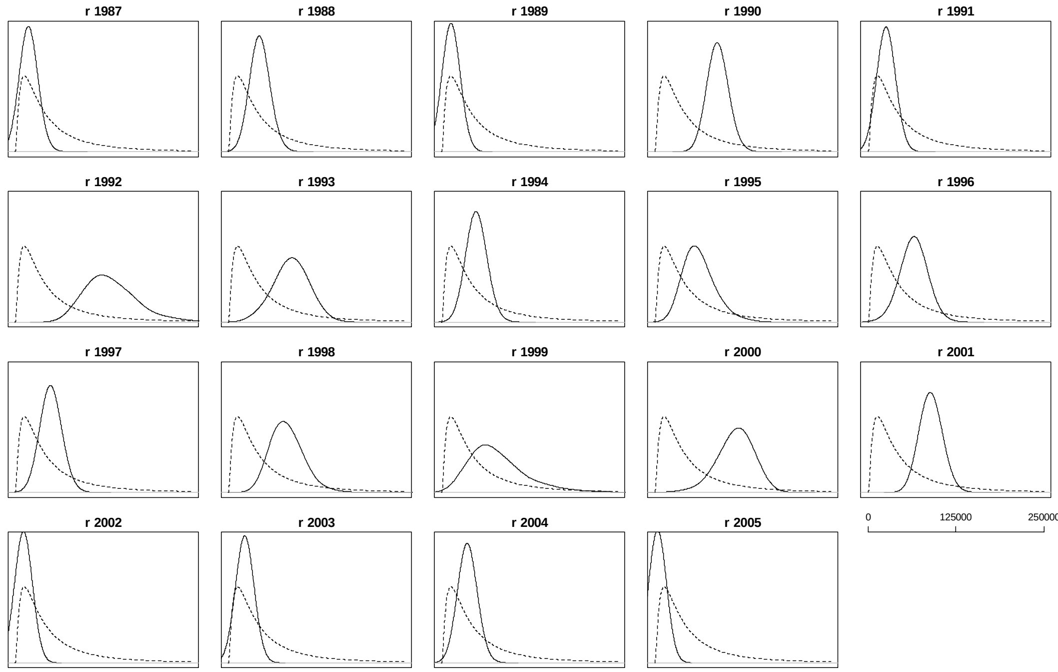


Figure 10.8.1.2: Comparison between the prior (dotted line) and posterior distribution (solid line) for each of the recruitments in the historical series from the improved biomass-based model.

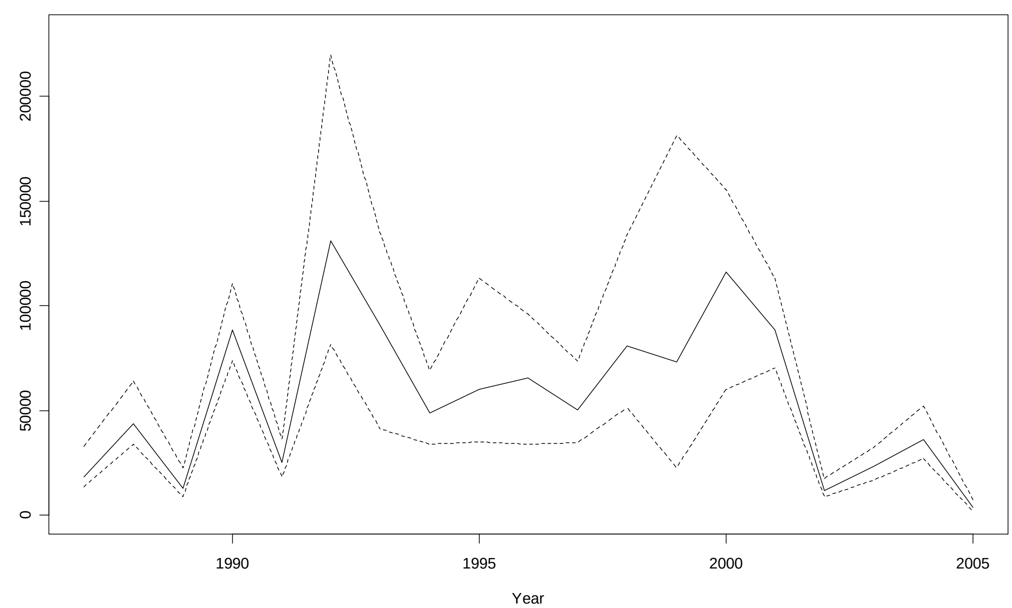


Figure 10.8.1.3: Posterior median (solid line) and 95% credibility intervals (dotted lines) for the recruitment series from the improved biomass-based model.

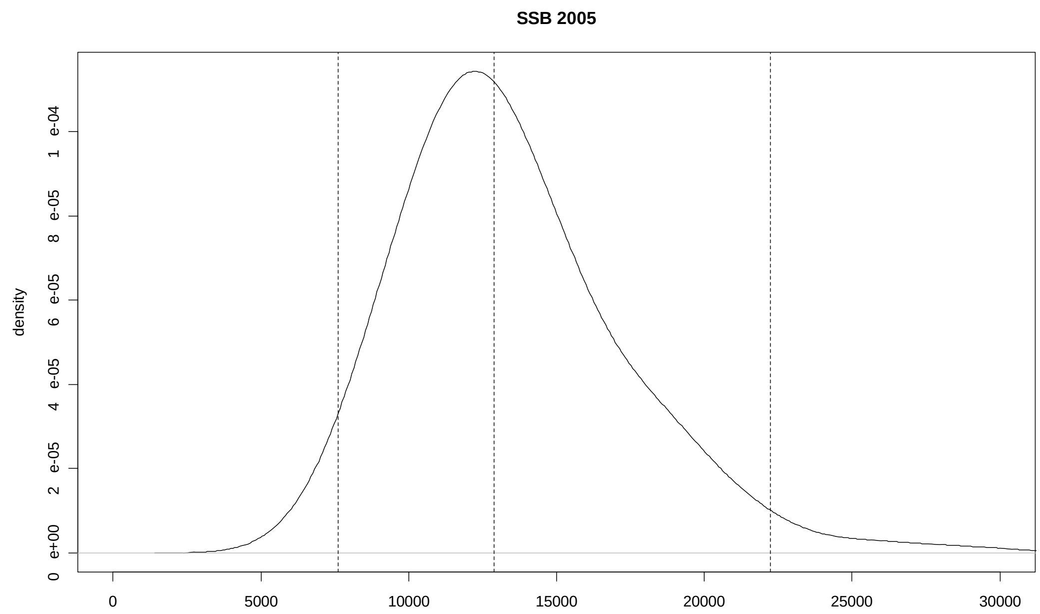


Figure 10.8.1.4: Posterior distribution of spawning biomass in 2005 from the improved biomass-based model. Vertical dashed lines correspond to posterior median and 95% credibility intervals.

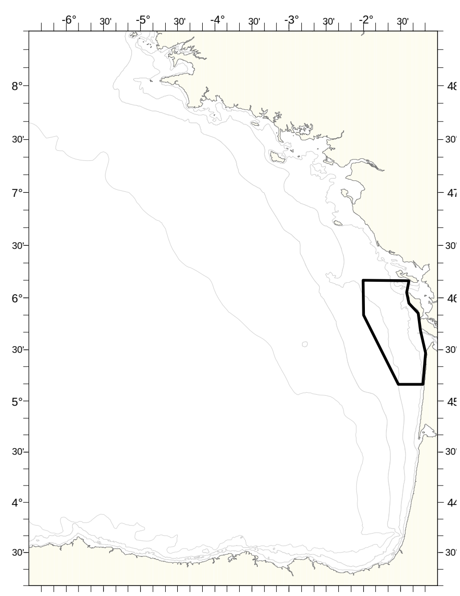


Figure 10.10.1.1: Box taken into consideration for the Leslie matrix model. The area corresponds to the one in which the mean length of anchovy in spring is less than 13.5 cm, based on the series of acoustic surveys (1985-2002).

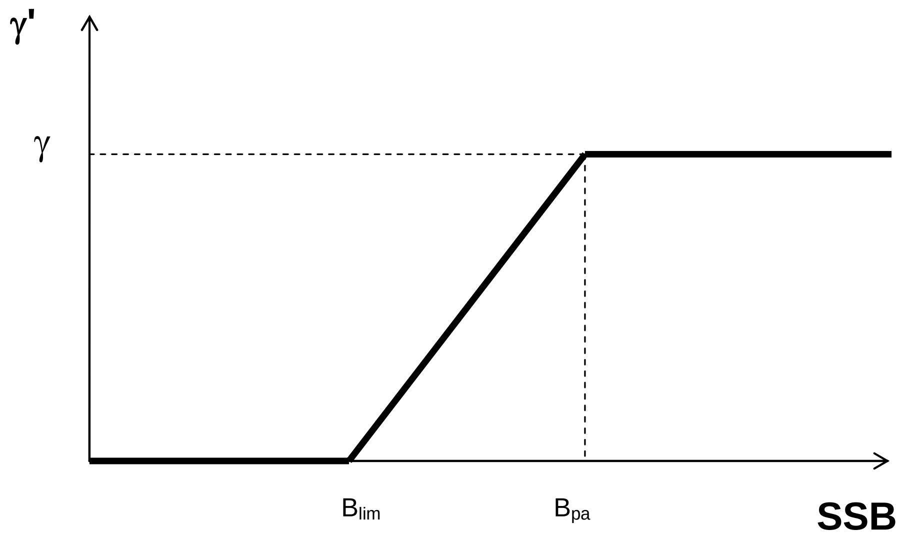


Figure 10.10.2.1: Parameter γ’ that defines the TAC depending on the SSB estimate.

11 Anchovy in Division IXa

11.1 ACFM Advice Applicable to 2004 and 2005

ICES advice from ACFM recommendations in October 2004 (ICES, 2004) 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 2005 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 2004 (for Subareas IX and X and CECAF 34.1.1) was of 8,000 t. Anchovy catches in Division IXa in 2004 were 5,761 t, at a level similar to that recorded in 2003 (5,269 t), but still lower that those landed in 2002 (8,806 t). For 2005 this TAC has been agreed in 6,400 t.

11.2 The Fishery in 2004

11.2.1 Landings in Division IXa

Anchovy total landings in 2004 were 5,761 t, which represented a slight increase (9%) with regard to 2003 landings (5,269 t), but still accounting for approximately a 36% decrease in relation to the landings recorded in 2001 (9,098 t) and 2002 (8,806 t), (**Table 11.2.1.1**, **Figure 11.2.1.1**). The above slightly increasing 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 the opposite trend was observed.

As usual, the anchovy fishery in 2004 was mainly harvested by purse seine fleets (97% of total catches). Portuguese and Spanish purse-seine landings accounted for 68% 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 2004 (182 t, 32% of the Portuguese anchovy total landings) was maintained at the same level that in 2003 (184 t), both years experiencing a relative increase in catches when compared with the ones recorded in preceding years. However, 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 2004 in the Sub-division IXa South (5,537 t, *i.e.*, 96% of total catch in the whole Division, **Table 11.2.2.1**, **Figure 11.2.1.1**). As observed in recent years, the bulk of these catches was fished in the Spanish Gulf of Cadiz (5,183 t against 354 t landed in the Algarve). Excepting catches from these areas and those ones from the Portuguese IXa Central-South (139 t, but only 2% of total catch), the relative importance of the remaining Sub-divisions was negligible.

The Spanish fishery in 2004 followed the same distribution pattern described for recent years, with almost the whole anchovy being fished in the Gulf of Cadiz waters (only 4 t in Sub-division IXa North, *i.e.*, southern Galician waters). It is noteworthy, however, that the Gulf of Cadiz purse-seine fishery was closed 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 October the 30th and the fishery closure (about 45 days) was 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 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). Impacts of this management measure in the fishing effort will be discussed in **Section 11.5**.

The Portuguese anchovy fishery in 2004 showed a shift in its usual distribution pattern exhibited since 1998. 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 (81 t, 14% of total Portuguese catches). Landings in IXa Central-South were 139 t (24%), and in IXa South (Algarve) 354 t (62%). 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 is shown in **Table 11.2.2.1**. 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 half in the year, those ones from Portuguese waters of the IXa Central-South in the fourth quarter, whereas anchovy fishery season in IXa South occurred throughout spring-summer months.

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
Portuguese Surveys	Q1				Mar		Mar	Mar	Feb		
	Q2									Jun	Apr
	Q3										
	Q4			Nov		Nov	Nov		Nov		
Spanish Surveys	Q1							Feb			
	Q2	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 acoustic estimation of 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 series of late-spring acoustic surveys, aimed at the anchovy abundance estimation in the Subdivision IXa South (Algarve and Gulf of Cadiz), is expected to be yearly performed since 2004 on. This new series may show however 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 2004 were presented and discussed in the last year's report (Anon., 2005 a). A detailed description of results from the surveys conducted in the first half in 2005 is given below.

Portuguese Surveys

The March/November acoustic survey series was interrupted in 2004 by the conduction of only one survey in the second quarter. So, the acoustic survey originally planned to take place in March 2004 was delayed until June due to ship engine problems (Anon., 2005 a). In this survey the Gulf of Cadiz was not sampled because of the lack of survey time. Moreover, no anchovy acoustic estimate was provided for the remaining surveyed area due to the species' low occurrence in trawls and the low acoustic energy attributed to anchovy. In addition, no survey was carried out in the fourth quarter in 2004.

A new Portuguese acoustic survey was carried out in April 2005 with the R/V 'Noruega'. Results on anchovy distribution and abundance during this survey has been provided to this WG (Marques *et al*., WD 13/05). The surveyed area included 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 (**Figures 11.3.1.1** and **11.3.1.2**). Anchovy biomass for the whole surveyed area was estimated at 15,103 t (1,364 million fish), (**Table 11.3.1.1**). These biomass and abundance estimates are the lowest ones ever recorded from Division IXa through the historical series. Although Gulf of Cadiz anchovy accounted for the 93% (14,041 t) of the estimated total biomass, the estimates from this area (and hence for the whole area) were affected by the occurrence of anchovy within plankton layers. This fact made very difficult the anchovy-plankton discrimination and the subsequent allocation of the acoustic energy to this species (even after using –50 or –55 dB thresholds) and therefore the resulting estimates should be considered with caution.

In the remaining areas only small concentrations were detected in front of Lisbon (IXa Central-South), northernmost waters being devoid of anchovy (**Figure 11.3.1.2**).

The population size composition for each Subarea is presented in **Figures 11.3.1.3** and **11.3.1.4**. Anchovy size in the OCS Subarea (Sub-division IXa Central-South) ranged between 12 and 17 cm, showing a right skewed distribution with a mode at 13 cm. Sizes of Gulf of Cadiz anchovy ranged between 9 and 15 cm, with a distribution showing two modal classes, the smaller mode at 10.5 cm and the larger one at 13 cm.

Although these surveys are not directly aimed at the estimation of anchovy abundance, the WG considers the annual series of these surveys 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. Regarding the problems caused by plankton in the discrimination of fish echotraces in the Gulf of Cadiz, the WG recommends the complementary use of the 38 and 120 KHz working frequencies in next surveys.

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*., WD 20/05).

Results from the spring acoustic survey in June 2004, aimed at the acoustic estimation of the anchovy SSB in Subdivision IXa South, were presented in the last year's report (Anon., 2005 a). The total estimated biomass for anchovy in that survey was 13,168 tonnes (894,4 million fish), Spanish waters accounting for the 86.4% of this total biomass (11,376 tonnes), (**Table 11.3.1.2**). As shown the last year, such estimates were the lowest ones ever recorded for the Subdivision when compared with the estimates derived from the Portuguese surveys series. However, some doubts arose in the last year's WG about the consistency of the Spanish survey estimates (possible acoustic undersampling of shallow waters).

No acoustic survey has been carried out in 2005 since the ship time available this year was invested on the conduction of the anchovy DEPM survey (see below). The next acoustic survey is foreseen to be conducted in 2006.

The WG recognises the progress made to consolidate a routine Spanish annual acoustic survey series for anchovy in Subdivision IXa South as a positive development and encourages its continuation. The WG recommends that next surveys be performed making every effort to increase the acoustic sampling coverage at depths below 30 m and using the same complementary working frequencies previously recommended for the Portuguese surveys.

Some comments on recent trends in acoustic estimates from Subdivision IXa South

For comparative purposes, **Figure 11.3.1.5** shows the available series of anchovy acoustic estimates from Subdivision IXa South obtained in Portuguese surveys together with the estimates from the 2004 spring Spanish survey. The depicted data series shows several gaps which makes difficult to follow any clear trend, mainly in the last years. Furthermore, the picture of an alarming decreasing trend just in 2004-2005 should be initially considered with caution for several causes. Firstly, the estimates themselves in such years seem to be affected by problems related either to the sampling coverage (2004 Spanish survey) or to the echo-traces discrimination (2005 Portuguese survey). Secondly, the survey season for the 2004 Spanish survey (June) entailed a 3 months delay relative to the usual March Portuguese survey series. Such a delay makes hardly comparable the June 2004 estimates with those ones from the March surveys because of an additional 3-months mortality affecting the population estimates and a probable different population structure. In this last case, recruits in the 'March' surveys constitute a relatively important proportion of the sampled population, a relative importance that diminishes in late spring, when spawners configure the bulk of the population (**Figure 11.3.1.6**). 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.

11.3.2 Egg Surveys

Spanish Surveys

Preliminary results from the pilot DEPM survey for anchovy in Subdivision IXa South performed during June 2004 (coupled to an acoustic survey, see previous Section) were reported to the last year's ICES SGSBSA (Anon., 2005 b, Jiménez *et al*., 2004, Millán *et al*., 2004). Thus, anchovy spawning area was delimited through CUFES sampling according to a semi-adaptive sampling scheme, with the adaptive rule of enlarging the transects in case of anchovy egg presence at the end of each transect, until finding two consecutive negative stations. All transects but the most easterly ones closest to the Strait of Gibraltar, registered positive stations for anchovy eggs (**Figure 11.3.2.1**). Delimitation of the survey area and estimation of the area represented by each sampling station was carried out using the R package *Geofun* (Bernal *et al*., 2004). Positive area was continuous and spawning area was quantified by adding up the area represented by the stations included in the positive area. The obtained results were: a total sampling surface area of 9,345 km^2, and a total spawning area surface of 4952 km^2 (positive area).

Anchovy spawning habitat in the surveyed area was characterised in this survey from the relationships between egg abundance and physical parameters (depth, temperature and salinity). Relationships were established through single parameter quotient analyses (SPQ) and showed that: 90% of eggs were fished below the 100 m depth isobath, most of the eggs were sampled in a range of temperature of 19.8-22.0 ºC and in areas with salinities between 35.9 and 36.4$‰_0$ (Anon., 2005 b). However, this analysis will require of a large data series from future surveys in order to obtain a more detailed description of the anchovy spawning habitat in the area.

A CUFES-PAIROVET calibration exercise was also performed in this survey in 7 selected transects spreading throughout the whole sampling area (upper panel in **Figure 11.3.2.1**). A clear linear relationship between CUFES and PAIROVET observed egg densities was found with the form:

$$\text{CUFES}_{\text{egg density}}\ (\text{eggs/m}^3) = 0.81236 + (0.31576 * \text{PAIROVET}_{\text{egg density}}\ (\text{egg/m}^2))$$

$$\text{Adjusted } R^2 = 0.90;\ DF = 22$$

Additionally, an exploratory analysis of anchovy adult-DEPM parameters was attempted from biological samples collected during the survey (from pelagic trawls for echo-traces identification). Given the pilot nature of the survey, the sampling intensity for covering these issues was lower than that usually adopted in full-scale DEPM surveys. So far, results from this exploratory analysis are only available for sex ratio (R=0.566; CV=36%; n=476) and mean female weight (W=17.64 g; CV=42%; n=237), the low number of both positive fishing stations and sampled fish per haul being the probable causes for the above high CVs. Histological analysis of adult samples is still in progress hence batch fecundity (F) and spawning fraction (S) estimates and their precision have not been explored yet.

In the light of the results from the 2004 pilot survey, a full-scale DEPM survey for anchovy in the same surveyed area in June 2005 was designed, after discussion, in the 2004 ICES SGSBSA (Anon., 2005 b). The survey plan took into consideration the Study Group recommendations on the increase of the inshore coverage at depths below 30 m as well as the necessity of increasing the number of independent adult samples. 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*. Egg sampling was based on a total of 119 PAIROVET-CTD stations (made every 3 nm) and 109 CUFES ones (collected every 2.8 nm) which were carried out throughout 21 transects (normal to the coast line and spaced by 8 nm). These transects were extended inshore as much as possible. Additionally, an *ad hoc* sampling grid (10 stations) was designed for anchovy larvae sampling with Bongo-90 net in order to obtain the anchovy larvae size composition and age structure throughout the nursery ground located in the surroundings of the Guadalquivir river mouth (**Figure 11.3.2.2**). As for the adults sampling, a total of 31 pelagic trawls (12 in Portuguese waters, 19 in Spanish ones) and 4 commercial purse-seine hauls were performed during the survey. The biological sampling provided a collection of 1094 ovaries (778 non hydrated and 316 hydrated).

Results from this survey are not yet available. Thus, egg samples, although preliminary processed onboard, are pending of the finalization of a more complete sorting and staging in laboratory. A working document including a comparative analysis of the results from the egg sampling in 2004 and 2005 surveys is expected to be presented in late October this year to the recently created ICES WGACEGGS. The 2005-survey adult samples are starting to be histologically processed in laboratory. The accumulation of adult samples from two consecutive surveys (2004 and 2005) may however entail some delay in the provision of results from the histological analysis of samples.

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. Regarding this last survey 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.

11.4 Biological Data

11.4.1 Catch Numbers at Age

Catch-at-age data from the whole Division IXa in 2004 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 2004 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 60-89%. 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%).

Total catch in the Gulf of Cadiz in 2004 was estimated at 507 million fish, which represents a 9% overall increase compared to the previous year (466 million), but it is still at a lower level than the recent maxima recorded in 2001 (723 million) and 2002 (800 million). The aforementioned increase was mainly caused by the 47% increase observed in the 0-age group landings in relation to those estimated in the previous year. The 1-age group was mantained at about the same level that in 2003, whereas age 2 fish showed a marked decrease.

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 (**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 2004 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 2004 (**Table 11.4.2.1**, **Figure 11.4.2.1**).

Mean length and weight in the annual catch (11.3 cm and 9.7 g) were similar to those estimated since 2001 and they are within the highest annual estimates in the whole series (**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. 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 Subarea 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 have been usually 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 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. The standardisation was performed by fitting quarterly log-transformed CPUE's from fleet types composing the above fleet (high tonnage fleet: since 1988; medium-light tonnage fleet: since 1997) to a GLM (without interaction) with the form (Robson, 1966; Gavaris, 1980):

$$LnCPUE_{(ft_i,\, quarter_i)} = intercept + quarter + fleettype \quad 1)$$

Reference fleet and period used in the standardisation were the high tonnage fleet and the first quarter in 1988 respectively. 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. Following this same approach, the series of nominal effort and CPUE from all of the fleets exploiting the fishery have been standardised and provided to the WG this year. For this purpose, vessels from single-purpose fleets have also been differentiated according to their tonnage in heavy- (≥30 GRT) and light- (<30 GRT) tonnage vessels, rendering a total of 11 fleet types (métiers). The resulting estimates are shown in **Tables 11.5.1** and **11.5.2**. Unfortunately, the evolution of the number of vessels composing these fleets through the 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) and 2004 (129 vessels). The WG recommends that a more detailed retrospective and updated information on the number of vessels by fleet type be compiled as far as possible.

Recent trends in annual effort and CPUE: overall estimates and by fleet type

Standardised series of overall effort and CPUE and the historical series of landings are shown together in **Figure 11.5.1**. 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 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 11.5.2**). 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. As for the CPUE is concerned, the high yields estimated in 2001 and 2002 showed a remarkable decrease in 2003 and 2004, a general trend that it is also observed in each of the fleet types.

Comparison between one-fleet-based and overall standardised CPUE series

2) Both annual and half-yearly standardised CPUE series for the whole purse-seine fleet (new estimates) and the Barbate's single-purpose one (former approach) are shown in **Figure 11.5.3** for comparison. On an annual basis, both series show rather similar trends, although CPUE estimates for the whole fleet are lower than those of the Barbate fleet as a consequence of the smoothing effect caused by the inclusion in the overall estimates of fleets with lower relative fishing powers than the Barbate fleet. This same effect is also observed for the half-yearly series, the Barbate fleet CPUE showing however more marked fluctuations in the most recent years and even in some seasons an opposite trend to that exhibited by the whole fleet (e.g. the historical maximum in the first half in 2002). Such differences seem to be more related to the aforementioned particular dynamics of the Barbate fleet after its re-incorporation to the fishery in 2002 than to actual changes in the resource abundance. For these reasons, the overall CPUE series shows 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. Nonetheless, both series will be tested during the exploratory assessment in order to evaluate their effects in the model outputs.

The Gulf of Cadiz purse-seine fishery closure in autumn 2004: analysis of changes in standardised effort and CPUE before and after the closure

Figure 11.5.4 shows the quarterly purse-seine landings and quarterly estimates of effort and CPUE for the 2002-2004 period, as calculated in this year WG. 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 (676 fishing trips) in comparison to the estimated for the same quarter in 2002 (1045 trips) and 2003 (1043 trips). Such a decrease also affected to the contribution of this quarter (9.9%) to the total fishing effort in 2004 (6824 fishing trips). In 2002 (total annual effort of 7876 trips) and 2003 (6823 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 noted in **Subsection 11.2.2** (see also **Figure 11.2.2.1**), the effects of this closure in landings were not so evident at a seasonal scale, the relative importance of autumn landings in 2004 being 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).

11.6 Recruitment Forecasting

Recruitment forecasts of anchovy in Division IXa are not available. By analogy with the anchovy stock in Subarea 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. Otolith collections from these surveys have recently been 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 two years ago (see Ramos *et al*., 2003). This index, although highly provisional, summarises 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 was fitted the last year to half-year catch-at-age data and to two aggregated-biomass indices: an annual standardised CPUE from the Barbate single-purpose purse-seine fleet, and acoustic estimates of biomass from Portuguese surveys (**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 in both 2002 and 2003 (**Figure 11.7.2**) resulted in the first exploratory runs performed last year in noisy signals for the recruitment and population biomass in these last two 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 as the most suitable option that of setting the F value for the second half-year in the last year in the assessment. 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. This situation also occurs for the second half-year in 2004 and, therefore, the same considerations about the F setting for the second half-year in 2004 were also taken into account.

The model has been fitted this year to catch-at-age data from the period 1995 to 2004. The acoustic estimates of biomass include those ones from the years 1998 to 2003 (no available estimates for 2004). The former CPUE-based tuning index from the Barbate fleet also covered the same period. Alternatively, the model has been fitted using as fishery-based tuning index the standardised overall CPUE series presented to the WG this year.

Since the suitability of using a purse-seine CPUE as a biomass tuning index has been previously questioned by the WG members, five different runs have initially been performed this year:

- **RUN 0**: an initial run with the last year's settings and new input data for 2004. Barbate CPUE and Acoustic biomass tuning indices (both as relative ones).
- **RUN 1**: as RUN 0, but replacing the former CPUE series by the overall CPUE one.
- **RUN 2**: an alternative run with the Barbate CPUE series as the only tunning (relative) index.
- **RUN 3**: as RUN 2, but replacing the one-fleet-based CPUE series by the overall CPUE one.
- **RUN 4**: an alternative run with Acoustic estimates of biomass as the only tuning (relative) index.

Further, an alternative approach was followed aiming to improve the stability in the model performance in the last years (without direct estimates) by including the additional information provided by the April 2005 acoustic estimate (one year ahead of the assessment's last year). No information is available on the fishery for the first half year in 2005 (when the above survey was performed). Thus, under this approach, catches at age for the first half in 2005 were assumed to be the same ones that in 2004. Moreover, weights at age in the stock for 2005 were set as the average of the estimates in the 3 last years in the assessment (2002-2004). Finally, F in the first half year in 2005 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 2005 were excluded from the minimisation routine whereas the residuals from the 2005 biomass acoustic estimate were included in the model fitting. According to these settings, three additional runs were performed:

- **RUN 5**: as RUN 0 but including the new settings.
- **RUN 6**: as RUN 1 with new settings.
- **RUN 7**: as RUN 4 with new settings.

Figure 11.7.3 and **11.7.4** show the trends exhibited by the main model outputs from runs under the 2 different approaches evidencing, however, rather similar trajectories regardless the tuning indices and settings used. For this reason, outputs from **RUN 1** (including the new overall CPUE series) are summarised in **Table 11.7.2** and **Figure 11.7.5** and commented below in order to analyse the behaviour of both tuning indices.

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 11.7.5**).

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 11.7.5**). This is likely to be related to the fact that the two biomass indices show conflicting trends. Thus, acoustic estimates show a relative stable trend in population biomass (between 25 and 30 thousand tonnes) whereas the fishery-based index evidences somewhat higher fluctuations. However, 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 about 4 regardless the run considered; **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 11.7.5**, 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 the last years (**Figure 11.7.5**). The model estimates for 2002 and 2003 low CPUE levels in the period which, linked to a low estimate of average biomass, results in a comparatively high fishing mortality. Given the catch data and the level of natural mortality adopted, the estimated selectivity for age 2 ($S_{2,1st\ S}$ = 1.4 and $S_{2,2nd\ S}$ = 1.5) is in agreement with the perception of the impact of the fishery on the stock.

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.

Regarding acoustic surveying of this population and from the problems posed in **Sections 11.3** and **11.6**, the Working Group also encourages that steps in improving both the sampling coverage and the standardisation of the acoustic surveying by Portugal and Spain be pursued in the short term.

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 Subarea 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, although the exact dates for the fishery closure in 2005 have not been decided yet.

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 (6824 fishing days), at least when this level is compared with the one recorded the previous year (6823 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.

The second management action in 2004 was the creation the 15 July 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.

Table 11.2.1.1. Portuguese and Spanish annual landings (tonnes) of anchovy in Division IXa (from Pestana, 1989 and 1996, and Working Group 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	81	139	354	574	4	5183	5187	5761

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

Table 11.2.1.2. Anchovy catches (tonnes) by gear and country in Division IXa in 1988-2004.

Country/Gear	1988*	1989*	1990*	1991*	1992	1993	1994	1995*	1996	1997	1998	1999	2000	2001	2002	2003	2004
SPAIN	4263	5454	6131	5711	3028	1961	3153	5900	1823	4664	9349	6000	2191	8244	7891	4791	5187
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
Purse seine IXa South	4263	5336	5911	5696	2995	1630	2884	496	1556	4410	7830	4594	2078	8180	7847	4754	5177
Trawl IXa South						330	152	75	224	190	1148	993	104	36	23	14	6
PORTUGAL	458	496	541	210	275	23	237	7056	2771	632	1613	1408	310	855	915	478	574
Trawl					4	9	1		56	46	37	43	6	16	13	7	5
Purse seine	458	496	541	210	270	14	233	7056	2621	579	1541	1346	297	806	888	287	388
Artisanal					1	1	3		94	7	35	20	7	32	13	184	182
Total	4721	5950	6672	5921	3303	1984	3390	12956	4594	5295	10962	7409	2502	9098	8806	5269	5761

* Portuguese catches not differentiated by gear

Table 11.2.2.1. Quarterly anchovy catches (tonnes) in Division IXa by country and Subdivision in 2004.

COUNTRY	SUBDIVISIONS	QUARTER 1		QUARTER 2		QUARTER 3		QUARTER 4		ANUAL	
		C(t)	%	C(t)	%	C(t)	%	C(t)	%	C (t)	%
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	26.7	44	53.9	10	12.9	5	6.5	81	14.1
	IXa Central South	34	24.0	17	12.4	0.3	0.2	88	63.4	139	24.3
	IXa South	3	0.8	1	0.2	282	79.6	69	19.4	354	61.6
	TOTAL	58	10.1	62	10.7	293	50.9	162	28.3	574	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	26.7	44	53.9	10	12.9	5	6.5	81	1.4
	IXa Central South	34	24.0	17	12.4	0.3	0.2	88	63.4	139	2.4
	IXa South	1384	25.0	1976	35.7	1473	26.6	703	12.7	5537	96.1
	TOTAL	1440	25.0	2038	35.4	1485	25.8	798	13.8	5761	100.0

Table 11.3.1.1. Anchovy 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

* 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 estimated abundance (millions) and biomass (tonnes) in Subdivision IXa South from Spanis acoustic surveys by area and total.

					Observations		
Survey	Estimate	Portugal	Spain	TOTAL	R/V	Sampling grid	Sampled depth range
June 2004 *	Number	91	804	894	Cornide	Parallel	30-200 m
	Biomass	1793	11376	13168			
February 2002 **	Number	-	18202	-	Cornide	Parallel	20-200 m
	Biomass	-	212935	-			
June 1993	Number	-	462	-	Cornide	Zig-zag	20-500 m
	Biomass	-	6569	-			

* Preliminary estimates. Probably underestimated because of problems of sampling coverage.

** Estimates under revision.

Table 11.4.1.1. Spanish catch in numbers ('000) at age of Gulf of Cadiz anchovy (Sub-division IXa-South, 1988-2004) 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

Table 11.4.2.1. Length distribution ('000) of Anchovy in Division IXa by country and Sub-divisions in 2004.

	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	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
4	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
4.5	-	-	0	-	-	0	-	-	25	-	-	0	-	-	25
5	-	-	0	-	-	28	-	-	25	-	-	0	-	-	54
5.5	-	-	0	-	-	107	-	-	82	-	-	24	-	-	213
6	-	-	0	-	-	92	-	-	253	-	-	52	-	-	396
6.5	-	-	0	-	-	206	-	-	426	-	-	127	-	-	759
7	-	-	0	-	-	350	-	-	1079	-	-	316	-	-	1745
7.5	-	-	2	-	-	593	-	-	1249	-	-	513	-	-	2358
8	-	-	569	-	-	1186	-	-	917	-	-	941	-	-	3613
8.5	-	-	1311	-	-	2331	-	-	1161	-	-	880	-	-	5683
9	-	-	6323	-	-	1823	-	-	1602	-	-	5978	-	-	15726
9.5	-	-	11751	-	-	3749	-	-	3166	-	-	17305	-	-	35970
10	-	-	23497	-	-	9265	-	-	5544	-	-	19340	-	-	57645
10.5	-	-	28091	-	-	10619	-	-	9914	-	-	12737	-	-	61361
11	-	-	31538	-	-	17036	-	-	7688	-	-	7930	-	-	64192
11.5	-	-	21373	-	-	24272	-	-	10093	-	-	4569	-	-	60307
12	-	-	17871	-	-	30068	-	-	11649	-	-	2846	-	-	62435
12.5	-	-	8798	-	-	23247	-	-	12283	-	-	2239	-	-	46567
13	-	-	3617	-	-	23888	-	-	13912	-	-	1868	-	-	43285
13.5	-	-	1168	-	-	10136	-	-	10196	-	-	953	-	-	22454
14	-	-	939	-	-	5521	-	-	6749	-	-	1127	-	-	14336
14.5	-	-	493	-	-	1854	-	-	2526	-	-	495	-	-	5367
15	-	-	4	-	-	659	-	-	682	-	-	374	-	-	1720
15.5	-	-	0	-	-	62	-	-	126	-	-	574	-	-	762
16	-	-	0	-	-	65	-	-	36	-	-	5	-	-	107
16.5	-	-	243	-	-	0	-	-	86	-	-	0	-	-	329
17	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
17.5	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
18	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
18.5	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
19	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
19.5	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
20	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
20.5	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
21	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
21.5	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
22	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
Total N	-	-	157588	-	-	167157	-	-	101470	-	-	81195	-	-	507410
Catch (T)	0.5	58	1382	1	62	1975	1	293	1192	1	162	634	4	574	5183
L avg (cm)	-	-	10.9	-	-	11.8	-	-	11.8	-	-	10.4	-	-	11.3
W avg (g)	-	-	8.2	-	-	11.0	-	-	11.8	-	-	7.3	-	-	9.7

Table 11.4.2.2: Annual Length distribution ('000) of Anchovy in Division IXa from 1988 to 2004.

	1988	1989	1990	1991	1992	1993	1994	1995		1996	
Length	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
3.5											1349
4			4281	172	2	49					12677
4.5			18371	3937	29	707					67819
5	65		32251	54991	90	1832					160894
5.5	86		46584	80537	369	3247					129791
6			45810	43303	983	5031					52812
6.5		1185	44454	28102	2685	6463	6092				33640
7	226	3906	37065	17847	4094	6169	13330				32469
7.5	347	5609	34614	20448	7178	7507	20415		402		19088
8	1871	15959	32562	20037	15632	8325	26136		402		8949
8.5	7892	36001	43081	17916	22442	7748	24497		454		11776
9	13492	31905	53016	19745	16924	7820	22586		2799		12007
9.5	26090	36222	88097	34408	23280	8612	16520		9153		6844
10	42791	69717	115050	40656	37450	7320	26383		10743		4887
10.5	60760	82715	108001	59678	38310	9199	30570		13282		7156
11	73499	82718	86757	67113	39426	8500	31536		8408		17343
11.5	61624	64599	72875	63013	36883	10154	37310		7340		21738
12	66239	50823	50592	65983	39500	24246	29363	74	5279		17855
12.5	42651	42791	34023	54033	33181	33555	33560	711	4502		11544
13	26053	20237	19022	45191	19867	27543	17543	3049	2299	8	6450
13.5	9415	11846	12683	21333	7003	13059	9602	3381	1957	12	4468
14	4954	8397	5779	13684	3785	5710	6493	14998	1205	258	3880
14.5	561	3048	1671	4097	2293	2793	5495	25944	194	335	1990
15	6102	2147	817	2391	521	1082	4217	46371	219	375	790
15.5	2985	1757	402	1194	1045	525	1054	42244	8	226	703
16	2995	4975	370	1943	271	75	977	44171		227	159
16.5	2621	7842	489	2406	225	17	443	14369		151	
17	252	4584	275	1767	75		216	8378		104	
17.5	109	1325	133	595	12			778		94	
18		621	95	75				236		24	
18.5			10							21	
19										1	
19.5											
20											
20.5											
21											
21.5											
22											
Total N	453679	590930	989230	786595	353555	207287	364339	204705	68647	1835	649078
Catch (T)	4263	5330	5726	5697	2995	1960	3035	5329	571	44	1780
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
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

	1997		1998		1999		2000	2001	2002	2003	2004
Length	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN
(cm)	IXa North	IXa South	IXa North	IXa South	IXa North	IXa South	IXa South	IXa South	IXa South	IXa South	IXa South
3.5								266	77		
4						1831	114	200	275	36	
4.5		1333		4656		17055	856	1649	1463	116	25
5		11492		25825		41100	5006	5489	3871	218	54
5.5		38722		57086		36181	9391	9301	8742	653	213
6		53185		82442		19366	12961	11832	13779	1763	396
6.5		50275		76694		20421	11446	15051	17768	3132	759
7		62492		68074		17749	11754	15911	14238	4800	1745
7.5		42120		43197		19089	20386	10684	14800	5389	2358
8		45120		32964		20835	19704	16989	14137	10074	3613
8.5		36200		47796		15724	18590	19426	18211	17371	5683
9		20009	156	78561		14937	19435	22924	29985	23525	15726
9.5		13611	367	106350		17487	27397	29620	66330	33446	35970
10		8951	754	132106		23530	34049	35897	67732	43164	57645
10.5		12231	1486	150718		31482	26203	43145	60360	48805	61361
11		22647	2047	158806		33604	21814	50672	66572	50797	64192
11.5		27353	1477	133585		40004	18846	59031	65752	44753	60307
12		39131	1267	99586		55614	18734	66873	79576	43017	62435
12.5		45267	1178	76285		66384	14738	68648	61848	38544	46567
13	374	46852	2737	44979		52625	11841	59942	54683	33673	43285
13.5	997	38183	2403	25038	92	38719	9197	50964	54884	21756	22454
14	2004	19127	3038	11847	246	22962	6860	39385	32016	18802	14336
14.5	422	11268	2813	5712	497	13247	3713	23375	26055	8870	5367
15	48	6370	1976	2080	1075	6811	2812	16035	14275	7415	1720
15.5	40	3764	890	579	1160	2422	983	9402	6655	3418	762
16	33	2224	560	138	1658	889	294	8305	3936	1609	107
16.5	10	296	330		2430	246	4	5034	946	721	329
17	10		438		2221		97	3065	784	493	
17.5	13		311		1717			2731	234		
18					1045			38			
18.5					397						
19					317			38			
19.5					138						
20											
20.5											
21											
21.5											
22											
Total N	3951	658223	24231	1465102	12993	630315	327225	701921	799984	466363	507410
Catch (T)	63	4600	371	8977	413	5587	2182	8216	7870	4768	5183
L avg (cm)	14.2	9.4	13.4	9.7	16.8	10.1	9.8	11.4	11.1	11.2	11.3
W avg (g)	16.1	7.0	15.3	6.3	31.8	8.1	6.8	11.3	9.7	9.8	9.7

Table 11.4.2.3. Mean length (TL, in cm) at age in the Spanish catches of Gulf of Cadiz anchovy (Sub-division IXa-South, 1988-2004) 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 11.4.2.3. (cont.)

2000	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			7.7	9.5		8.9	8.9
	1	8.2	10.9	11.9	12.5	9.4	12.0	10.2
	2	14.1	15.0	15.4	16.1	14.9	15.5	15.0
	3							
	Total	8.2	11.1	10.0	9.8	9.6	9.9	9.8
2001	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0			9.9	8.4		8.7	8.7
	1	10.7	11.4	13.2	13.0	11.2	13.1	12.0
	2	15.5	16.2	16.3	16.2	16.0	16.3	16.1
	3							
	Total	10.9	11.7	12.8	9.5	11.4	11.3	11.4
2002	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0			7.9	10.2		8.8	8.8
	1	10.7	10.6	12.8	13.6	10.6	12.9	11.2
	2	15.0	15.1	15.6	15.7	15.1	15.6	15.4
	3							
	Total	10.7	10.7	11.8	12.1	10.7	11.9	11.1
2003	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0			9.6	10.1		9.9	9.9
	1	10.8	11.3	12.1	12.6	11.1	12.2	11.3
	2	15.1	15.4	16.5		15.1	16.5	15.2
	3							
	Total	11.2	11.3	11.3	10.4	11.3	10.9	11.2
2004	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0			9.9	10.1		10.0	10.0
	1	10.9	11.8	12.7	13.3	11.4	12.8	11.6
	2	15.8	14.5	15.9	15.2	14.8	15.4	15.0
	3							
	Total	10.9	11.8	11.8	10.4	11.4	11.2	11.3

Table 11.4.2.4. Mean weight (in kg) at age in the Spanish catches of Gulf of Cadiz anchovy (Sub-division IXa-South, 1988-2004) 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 11.4.2.4.(cont.)

2000	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.003	0.005		0.005	0.005
	1	0.004	0.009	0.011	0.012	0.006	0.011	0.008
	2	0.018	0.024	0.025	0.027	0.023	0.025	0.023
	3							
	Total	0.004	0.010	0.008	0.006	0.007	0.007	0.007
2001	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0			0.006	0.004		0.005	0.005
	1	0.008	0.011	0.016	0.014	0.010	0.015	0.012
	2	0.025	0.032	0.031	0.028	0.030	0.031	0.030
	3							
	Total	0.009	0.012	0.015	0.006	0.011	0.011	0.011
2002	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0			0.003	0.007		0.005	0.005
	1	0.007	0.009	0.014	0.016	0.008	0.015	0.010
	2	0.019	0.025	0.027	0.026	0.024	0.027	0.025
	3							
	Total	0.007	0.009	0.012	0.012	0.008	0.012	0.010
2003	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0			0.006	0.006		0.006	0.006
	1	0.008	0.010	0.012	0.012	0.010	0.012	0.010
	2	0.022	0.026	0.030		0.023	0.030	0.023
	3							
	Total	0.010	0.010	0.010	0.007	0.010	0.009	0.010
2004	**AGE**	**Q1**	**Q2**	**Q3**	**Q4**	**HY1**	**HY2**	**ANNUAL**
	0			0.007	0.007		0.007	0.007
	1	0.008	0.011	0.014	0.015	0.010	0.014	0.010
	2	0.026	0.021	0.028	0.023	0.022	0.024	0.023
	3							
	Total	0.008	0.011	0.012	0.007	0.010	0.010	0.010

Table 11.4.3. 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

Table 11.5.1. 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.

	SUB-DIVISION IXa SOUTH (Gulf of Cadiz)															
	PURSE SEINE															
FLEET	BARBATE			SANLÚCAR		P.UMBRÍA		I. CRISTINA			MEDIT.	SUBTOTAL	SUBTOTAL	TOTAL	TOTAL	OVERALL
	(SP-HT)	(SP-LT)	(MP)	(SP-LT)	(MP)	(SP-LT)	(MP)	(SP-HT)	(SP-LT)	(MP)	(SP-HT)	SP-HT	SP-LT	SP	MP	EFFORT
Year	No. fishing trips															
1988	5250	-	31	-	300	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	5250	?	5250	330	**5581**
1989	3306	-	66	-	322	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	3306	?	3306	388	**3693**
1990	4640	-	105	-	1635	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	4640	?	4640	1740	**6380**
1991	4507	-	64	-	759	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	4507	?	4507	823	**5330**
1992	4065	-	117	-	492	*n.a.*	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	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**

Table 11.5.2. 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	EFFORT
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**

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+Golfo de Cádiz)
Years: 1995-2004
Fleets: All

Half-year Catch in number (in millions) at age (1995-2004)

	1995		1996		1997		1998		1999		2000		2001		2002		2003		2004	
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
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	121.50
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	323.32	93.06
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	0.90

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	
0	7.03	1.06	2.57	2.65	3.19	3.14	6.21	3.32	5.98	6.64	0.6
1	10.72	6.26	11.06	7.40	12.84	9.96	13.29	10.50	10.57	12.01	0.6
2	22.55	19.98	20.90	20.45	19.99	23.82	31.76	26.29	26.79	21.87	0.6

Acoustic Biomass estimates (tonnes) in Sub-division IXa South (Algarve+Gulf of Cadiz) (Portuguese surveys)

Nov. 1998	Mar. 1999	Nov. 1999	Mar. 2000	Nov. 2000	Mar. 2001	Nov. 2001	Mar. 2002	Nov. 2002	Feb. 2003	Nov. 2003
30695	24763	-	-	33909	24913	25580	21335	-	24565	-

Anchovy standardised annual CPUE (kg/fishing trip) of the Spanish purse-seine fleet

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Barbate single-purpose	377	509	954	1751	1294	812	1784	2012	1402	1336
All fleets	224	418	623	983	525	302	1042	996	697	757

Exploratory runs with the seasonal separable model

	CPUE	Portuguese Ac. Surv.	F assumptions	Wage stock
RUN0	Barbate fleet	1998-2003	F in 2nd half year in last assessment year as 1996 - 2003 average ratio of half year Fs	-
RUN1	All fleets	1998-2003		
RUN2	Barbate fleet	-		
RUN3	All fleets	-		
RUN4	-	1998-2003		
RUN5	Barbate fleet	1998-2005	F in 2005 1st half year as the average F in the 3 last years (02-04)	Wage stock in 2005 as the average in 02-04
RUN6	All fleets	1998-2005		
RUN7	-	1998-2005		

Table 11.7.2. Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz) . Outputs from the seasonal separable assessment model. RUN1 with F in the second-half in 2004 set as the average ratio between F half-year values of preceding years.

Fishing Mortality per half-year period

	1995		1996		1997		1998		1999		2000		2001		2002		2003		2004	
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
0	0.0000	0.1434	0.0000	0.0772	0.0000	0.1823	0.0000	0.1559	0.0000	0.2269	0.0000	0.0657	0.0000	0.1406	0.0000	0.1816	0.0000	0.1581	0.0000	0.1021
1	0.8433	1.5040	0.3564	0.8097	0.6958	1.9125	0.9035	1.6352	1.4703	2.3796	0.6774	0.6892	0.6991	1.4745	0.5979	1.9054	1.6462	1.6582	0.5435	1.0714
2	1.1394	2.2560	0.4816	1.2145	0.9400	2.8688	1.2207	2.4528	1.9864	3.5694	0.9152	1.0338	0.9444	2.2117	0.8077	2.8581	2.2240	2.4874	0.7343	1.6071

Population abundance (millions)

	1995		1996		1997		1998		1999		2000		2001		2002		2003		2004	
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
0	0	755	0	1796	0	3724	0	2355	0	1025	0	1972	0	1758	0	1151	0	1304	0	1533
1	91	21	359	138	913	250	1703	379	1106	139	449	125	1014	276	838	253	527	56	611	195
2	1	0	3	1	34	7	20	3	41	3	7	2	34	7	35	8	21	1	6	2

Predicted Biomass Index values

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
CPUE Index(kg/fishing day)	381	214	890	735	487	586	1121	489	644	930

	Nov. 98	Mar. 99	Nov. 99	Mar. 00	Nov. 00	Mar. 01	Nov. 01	Mar. 02	Nov. 02	Feb. 03	Nov. 03
Acoustic Index (tonnes)	19184	32499	-	-	19637	40888	33190	28201	-	18170	-

Fitted Selection Pattern

	1995		1996		1997		1998		1999		2000		2001		2002		2003		2004	
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
0	0.0000	0.0953	0.0000	0.0953	0.0000	0.0953	0.0000	0.0953	0.0000	0.0953	0.0000	0.0953	0.0000	0.0953	0.0000	0.0953	0.0000	0.0953	0.0000	0.0953
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
2	1.3510	1.5000	1.3510	1.5000	1.3510	1.5000	1.3510	1.5000	1.3510	1.5000	1.3510	1.5000	1.3510	1.5000	1.3510	1.5000	1.3510	1.5000	1.3510	1.5000

Catchability indices

	Q
CPUE	0.0949
Acoustic Survey	4.3552

Table 11.7.2.(cont'd) Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz) . Outputs for the seasonal separable assessment model. RUN1 with F in the second-half in 2004 set as the average ratio between F half-year values of preceding years.

Average population Biomass (tonnes)

1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
4017	2256	9380	7749	5137	6176	11816	5154	6783	9802

Residuals about the model fit

Separable model residuals

	1995		1996		1997		1998		1999		2000		2001		2002		2003		2004	
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
0		-0.795		1.592		-0.339		0.592		-0.226		0.313		-0.075		-0.622		-0.412		0.077
1	-0.427	-0.593	0.557	-1.102	-0.622	-0.673	-0.096	0.323	-0.485	0.033	-0.059	0.196	-0.111	0.251	0.630	0.099	-0.033	0.693	0.491	-0.085
2	-1.049		0.149	0.886	0.698	0.763	0.056	-0.511	0.116	0.031	0.049	-0.361	0.173	-0.027	-0.572	0.378	-0.151	-0.411	-0.266	-0.101

Biomass index residuals

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
CPUE Index (kg/fishing day)	-0.530	0.671	-0.357	0.290	0.074	-0.663	-0.073	0.712	0.079	-0.205

	Nov. 98	Mar. 99	Nov. 99	Mar. 00	Nov. 00	Mar. 01	Nov. 01	Mar. 02	Nov. 02	Feb. 03	Nov. 03
Acoustic Index (tonnes)	0.470	-0.272	-	-	0.546	-0.495	-0.260	-0.279	-	0.302	-

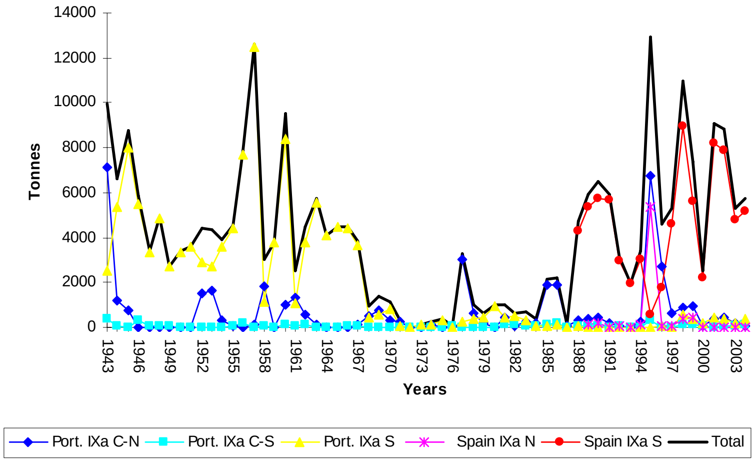


Figure 11.2.1.1. Historical series of Portuguese and Spanish anchovy landings in Division IXa (1943-2004).

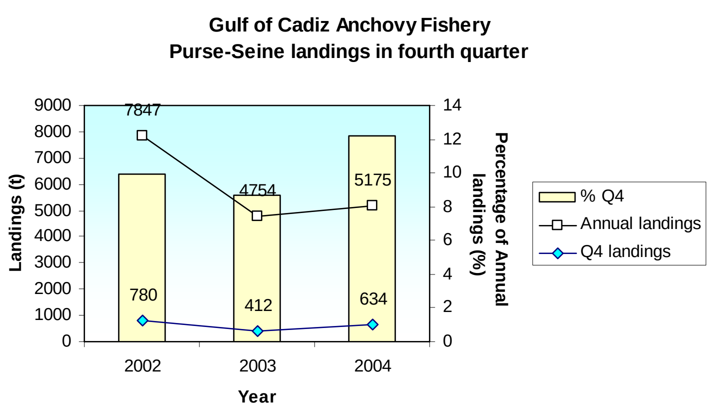


Figure 11.2.2.1 Gulf of Cadiz Anchovy (Subdivision IXa South): comparison of annual purse-seine landings with catches landed in the fourth quarter to assess the effects of the closed season in the fourth quarter in 2004. Bar chart represents the relative importance of landings in the fourth quarter in relation to the annual landings.

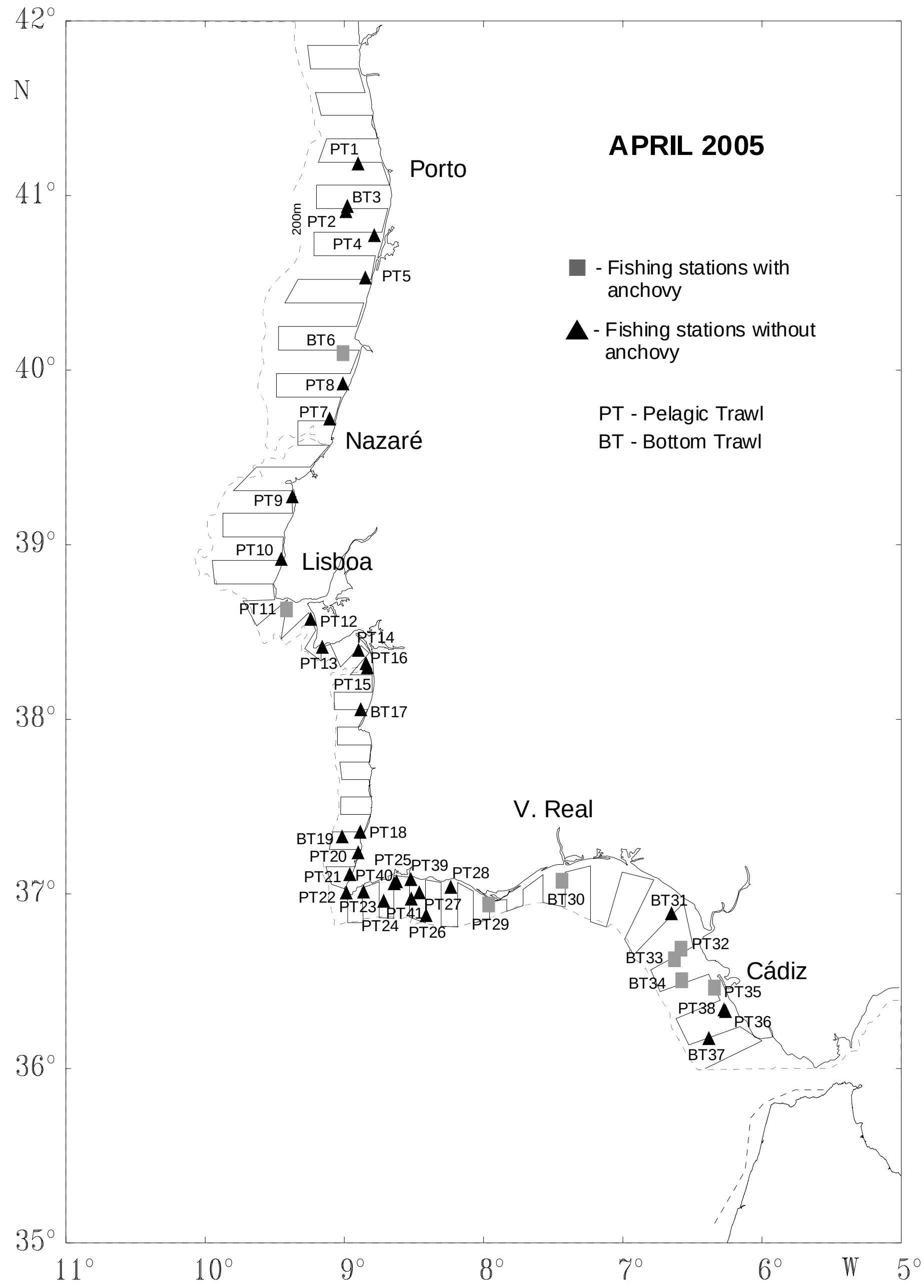


Figure 11.3.1.1. Survey track design and location of trawl stations (with and without anchovy) in April 2005 Portuguese acoustic survey.

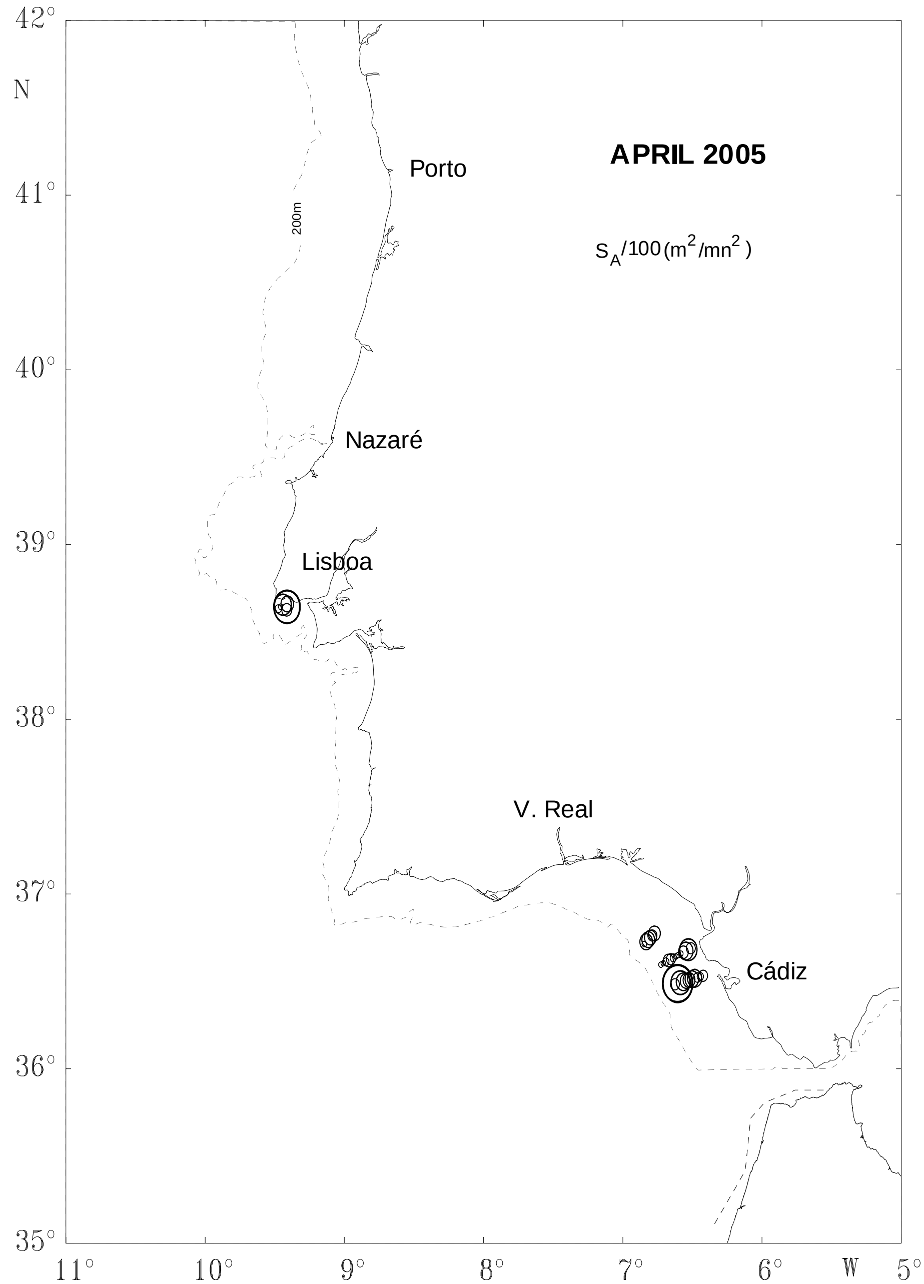


Figure 11.3.1.2. Anchovy in Division IXa: acoustic energy distribution per nautical mile during the April 2005 Portuguese survey. Circle diameter is propocional to the square root of the acoustic energy (S_A).

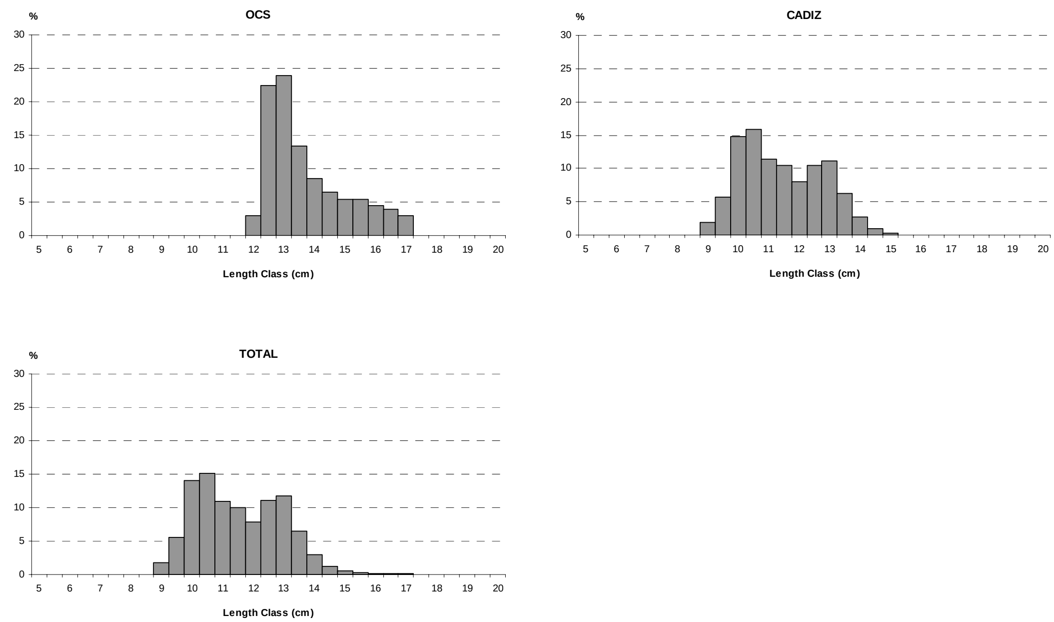


Figure 11.3.1.3. Anchovy in Division IXa: Distribution of length class frequency (%) by region and total area during the April 2005 acoustic Portuguese survey.

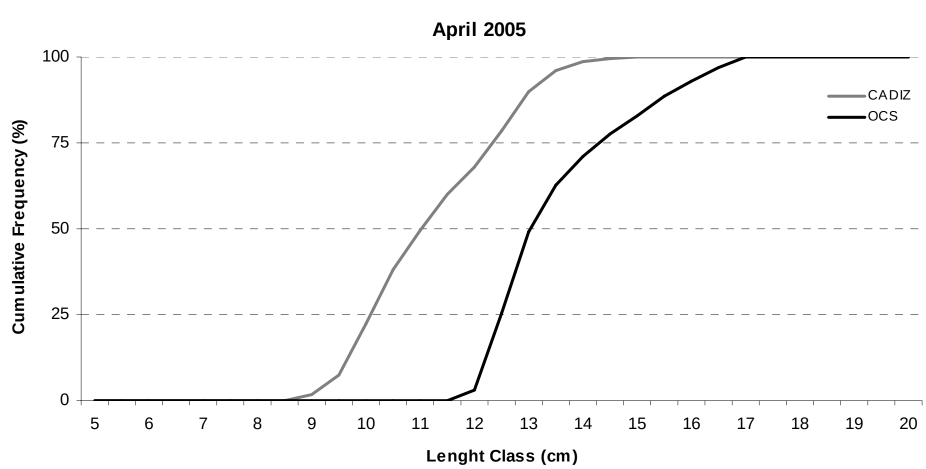


Figure 11.3.1.4. Anchovy in Division IXa: cumulative frequency (%) by length class and region during the April 2005 acoustic Portuguese survey.

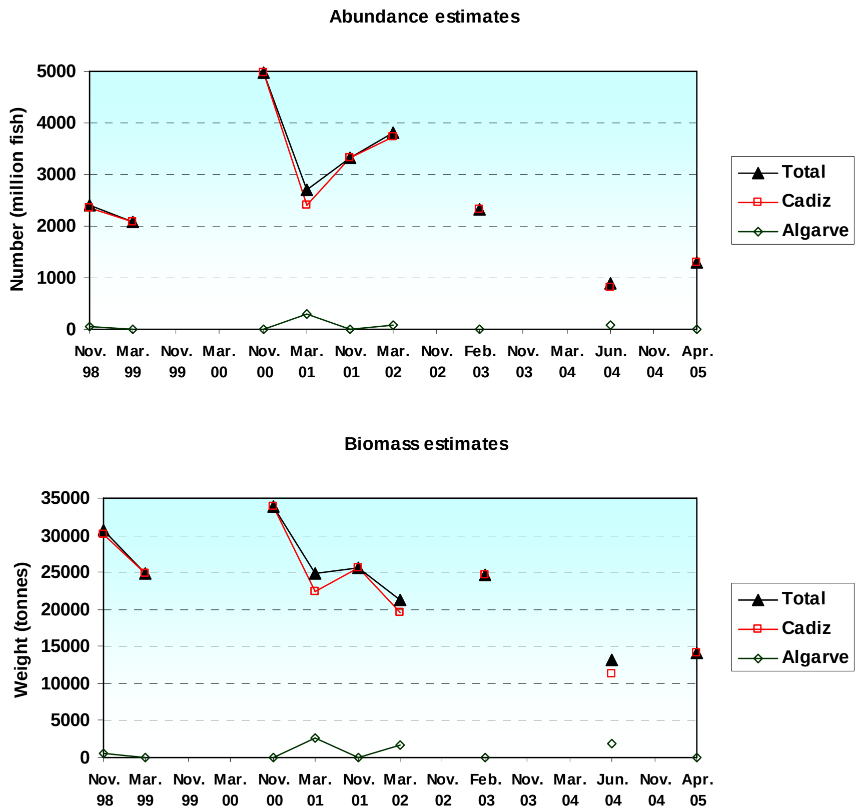


Figure 11.3.1.5. Anchovy in Subdivision IXa South: Portuguese historical series of acoustic estimates. Data for June 2004 correspond to the Spanish acoustic survey.

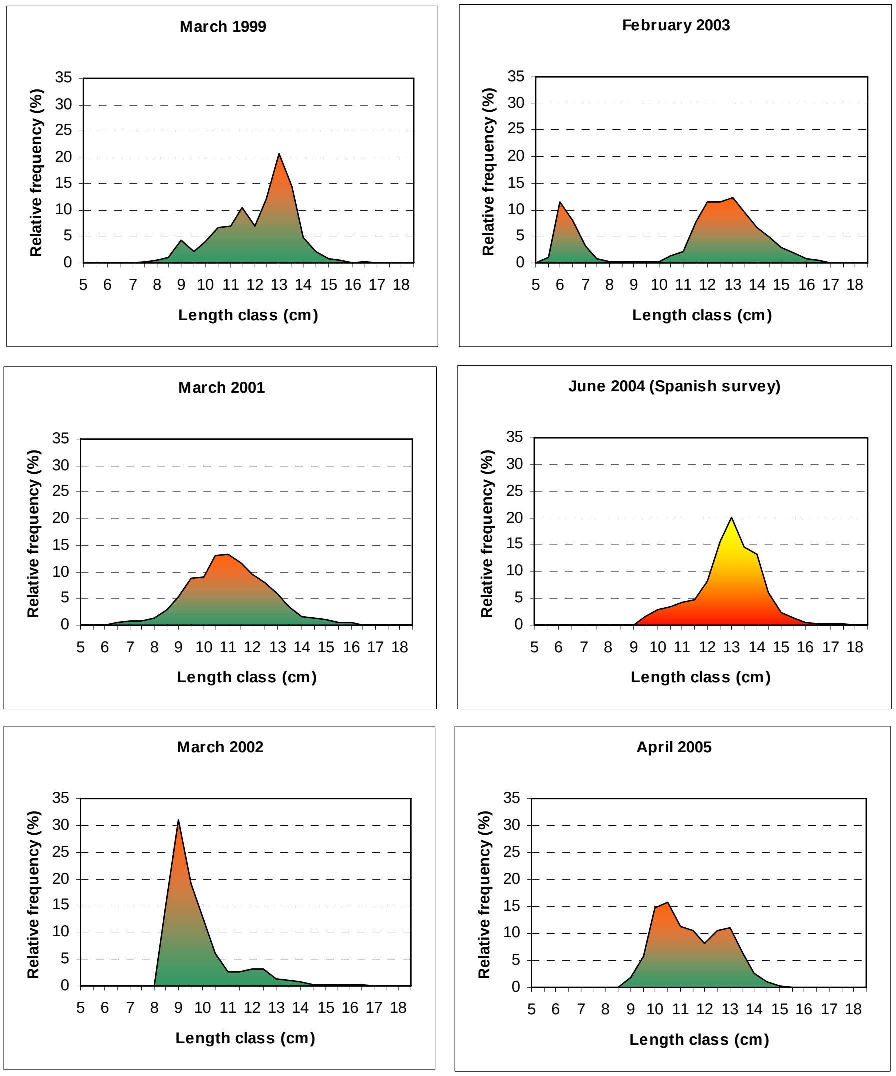


Figure 11.3.1.6. Anchovy in Subdivision IXa South: size composition of the estimated population abundance in the acoustic surveys conducted in the first half in the year. Portuguese 'March' surveys series and Spanish June 2004 survey.

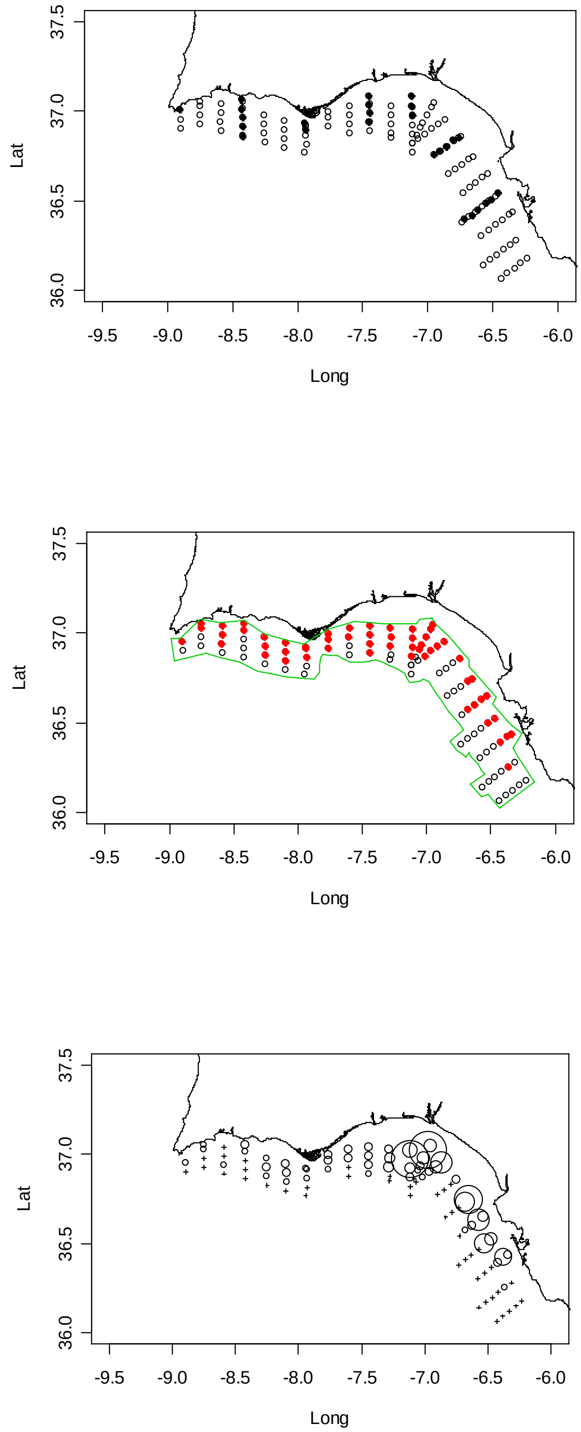


Figure 11.3.2.1. *BOCADEVA 0604* anchovy egg survey. Upper panel: (○) CUFES and (●) PAIROVET stations. Middle panel: (-) Sampling area delimitation and (●) CUFES stations with presence of anchovy eggs. Lower panel: abundance of anchovy eggs (nº/m^3).

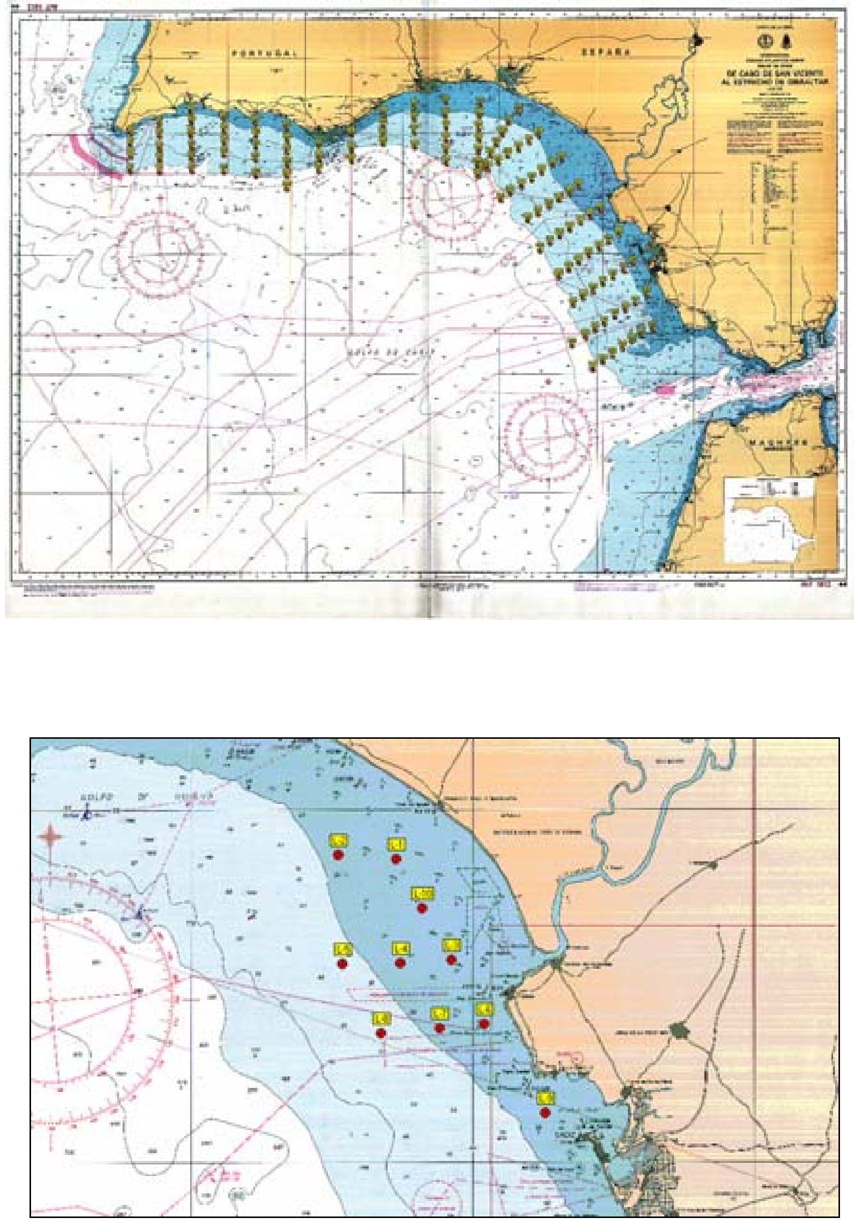


Figure 11.3.2.2. *BOCADEVA 0605* anchovy DEPM survey. Upper panel: sampling grid of PAIROVET-CTD stations. Bottom panel: *ad hoc* sampling grid of Bongo-90 stations (anchovy larvae sampling).

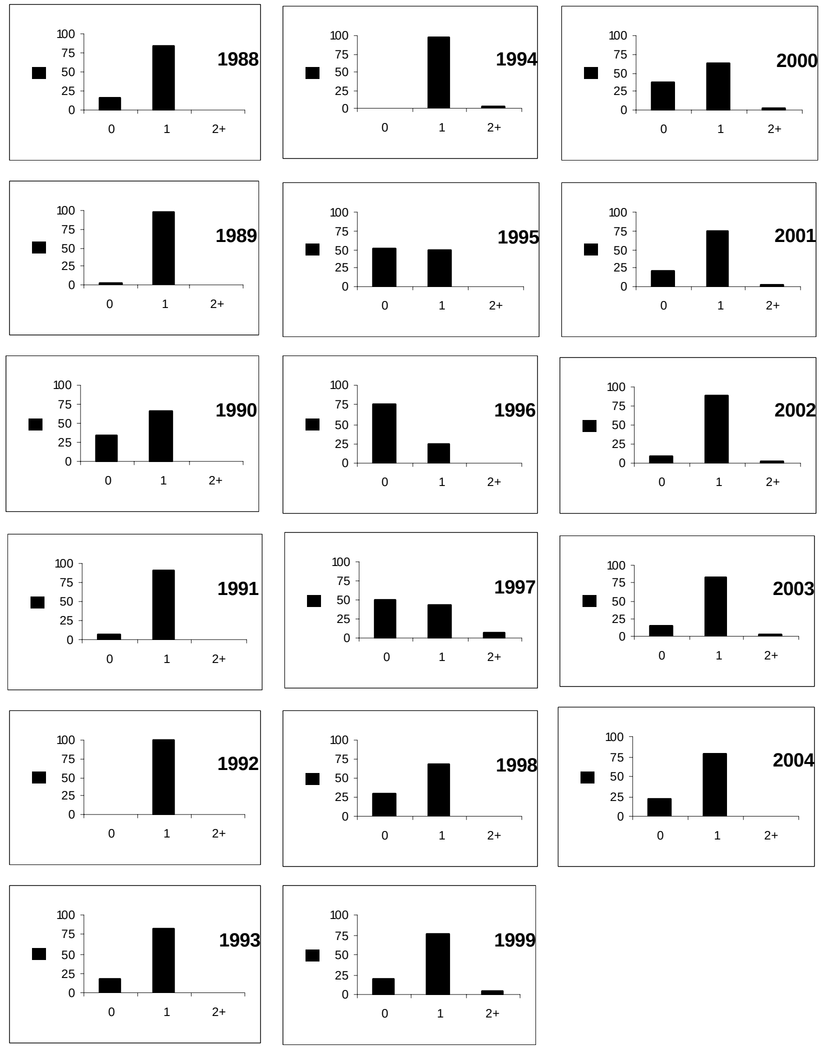


Figure 11.4.1.1. Age composition of Spanish catches of Gulf of Cadiz anchovy (Sub-division IXa-South; 1988-2004). Data for 1994 and second half in 1995 estimated from an iterated ALK by applying the Kimura and Chikuni's (1987) algorithm.

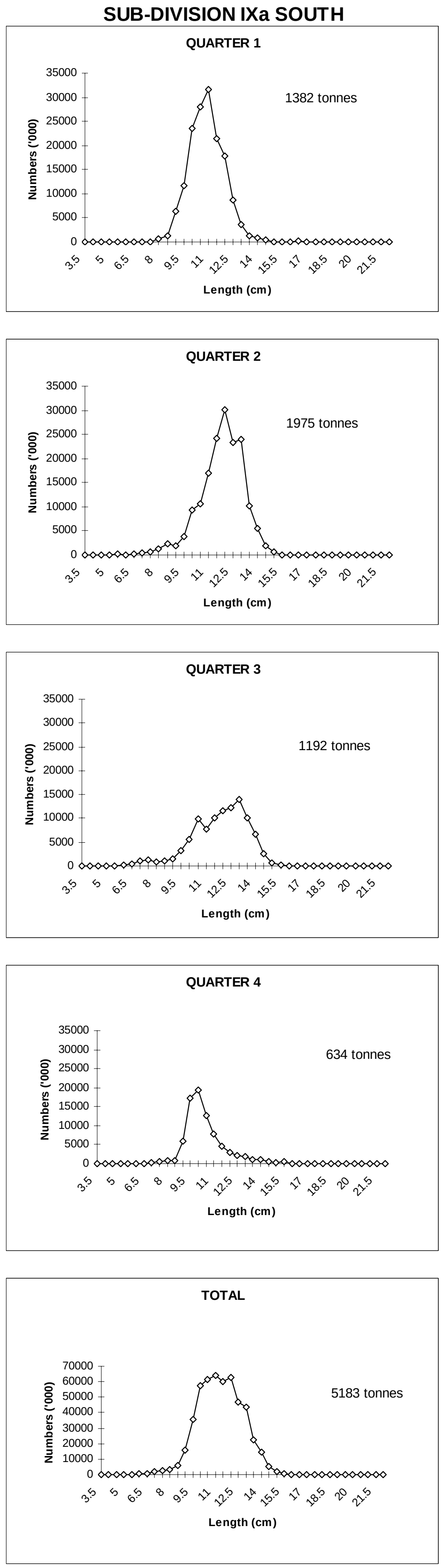


Figure 11.4.2.1: Length distribution ('000) of anchovy landings in Subdivision IXa South (Gulf of Cadiz) by quarter in 2004. Without data for Subdivision IXa North (Western Galicia).

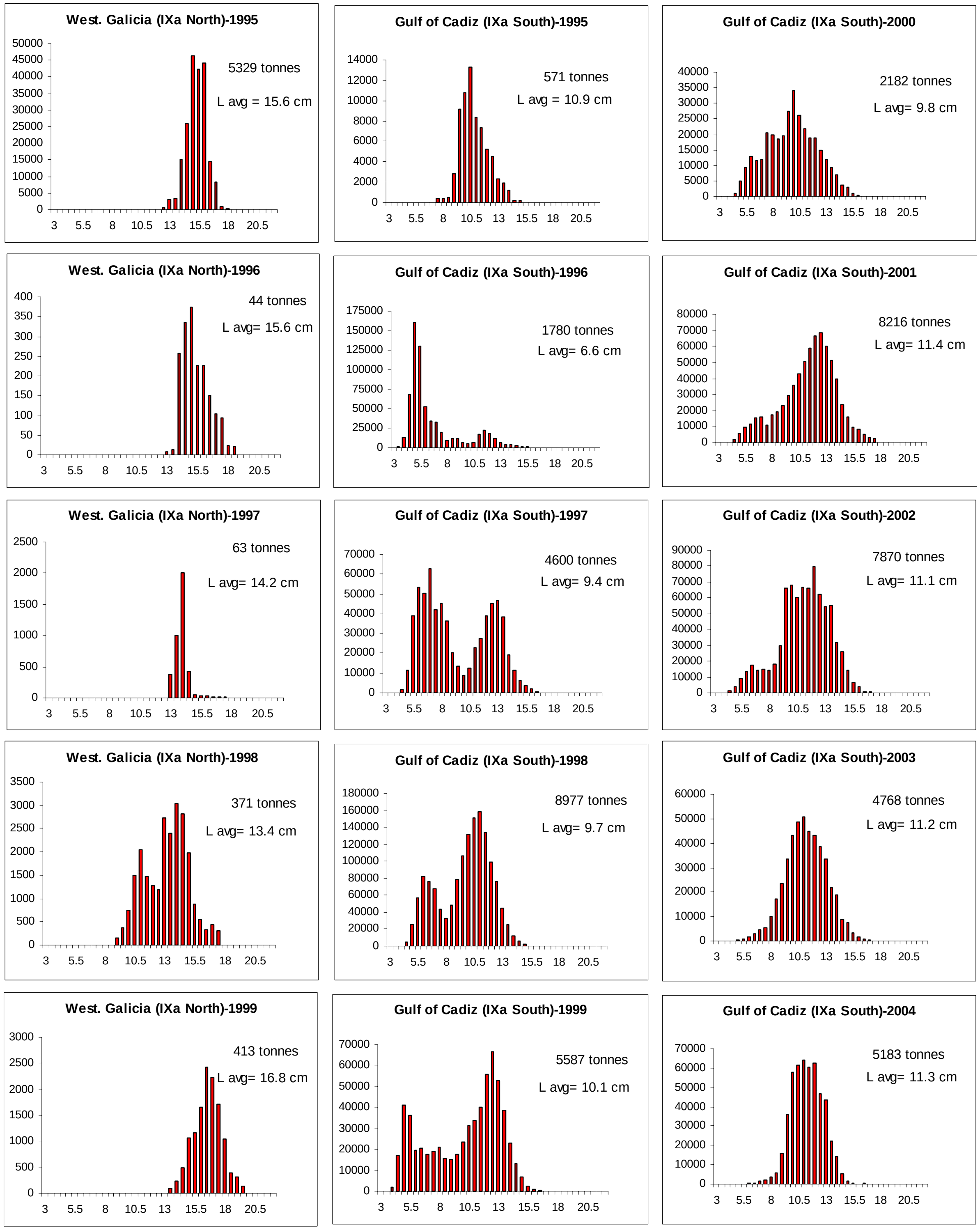


Figure 11.4.2.2. Length distribution ('000) of anchovy in Sub-divisions IXa South and IXa North (1995-2004).

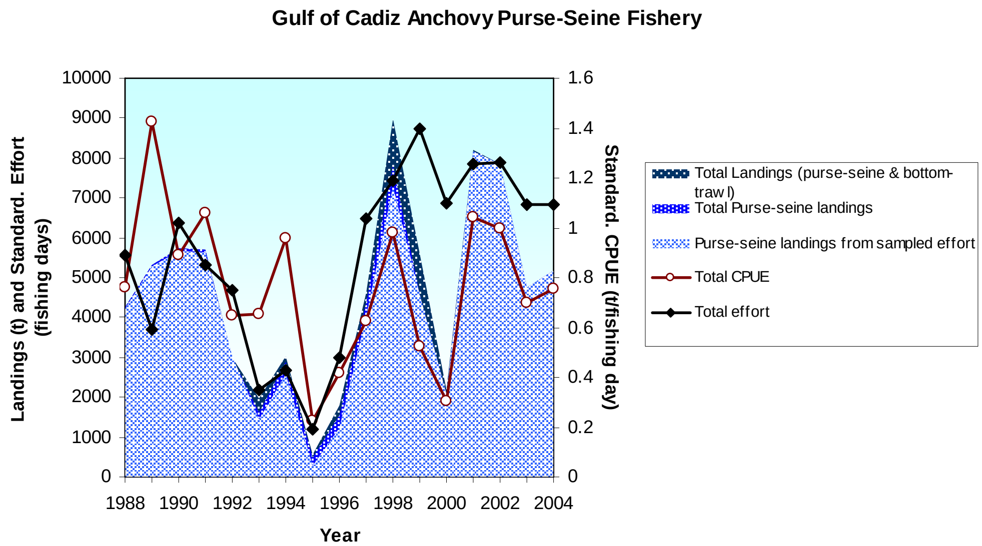


Figure 11.5.1. Gulf of Cadiz anchovy purse-seine fishery. Trends in annual landings, overall effort and CPUE. Landings are differentiated in total (purse-seine and bottom trawl fleets), purse-seine landings, and purse-seine landings corresponding to the sampled fishing effort.

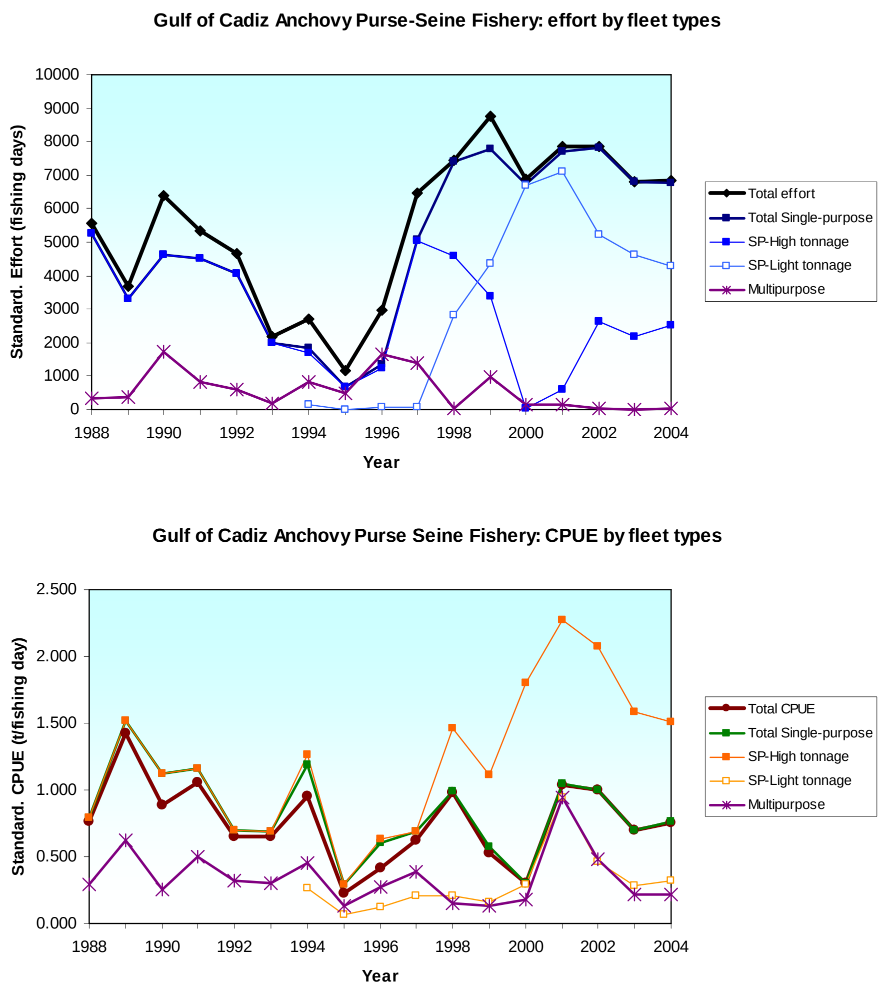
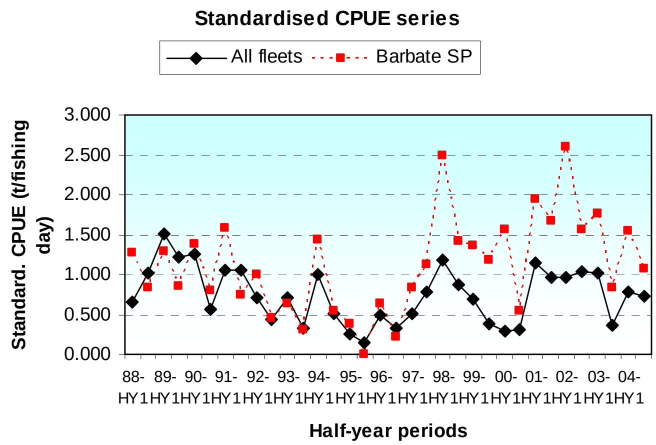


Figure 11.5.2. Gulf of Cadiz anchovy purse-seine fishery. Trends in annual series of effort (upper panel) and CPUE (bottom panel) by fleet type. Single-purpose fleet is also differentiated in heavy and light GRT vessels.



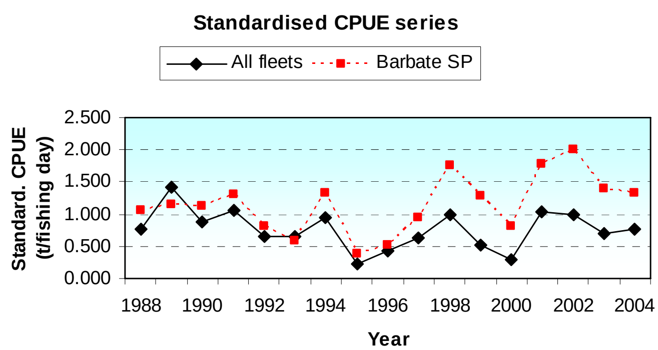


Figure 11.5.3. Gulf of Cadiz anchovy purse-seine fishery. Comparison of trends in standardised CPUE series from the Barbate single-purpose purse-seine fleet and the whole fleet. Upper panel: half-year series, bottom panel: annual series.

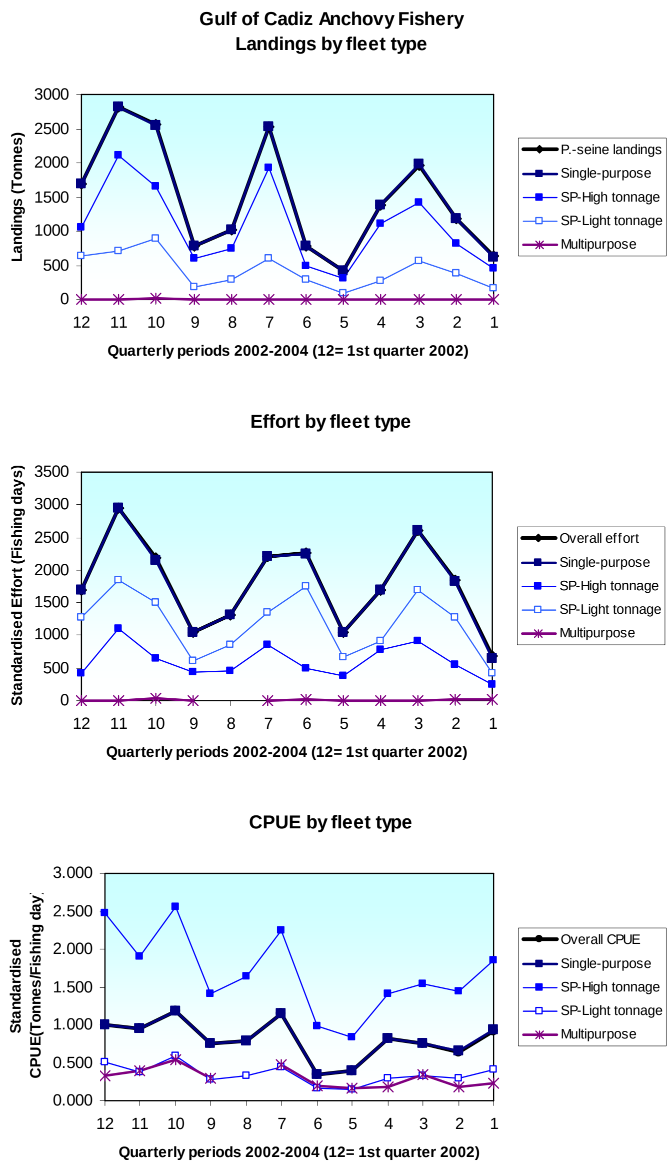
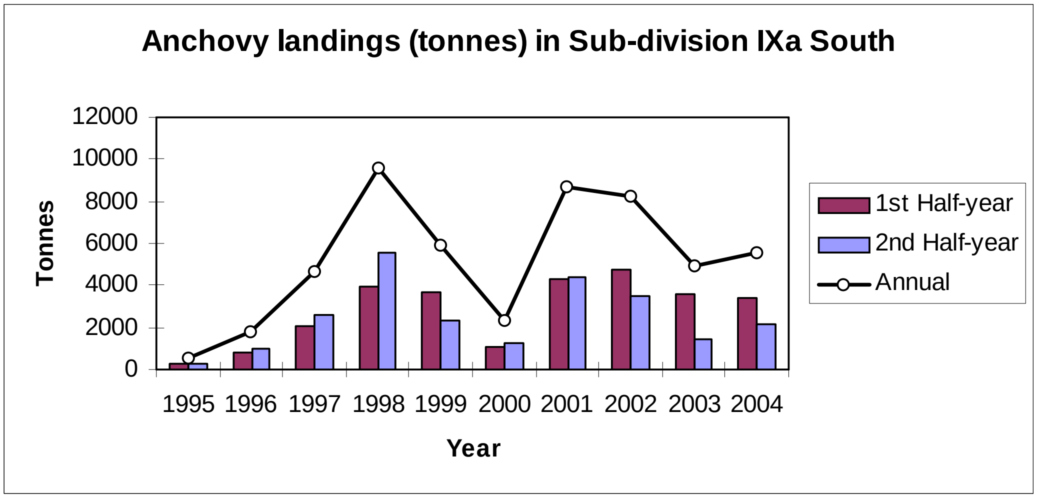


Figure 11.5.4. Gulf of Cadiz anchovy purse-seine fishery. Trends in quarterly series of landings (upper panel), effort (middle panel) and CPUE (bottom panel) by fleet type during the 2002-2004 period. A purse-seine fishery closure was implemented during the fourth quarter in 2004 (17th November-31st December). Single-purpose fleet is also differentiated in heavy and light GRT vessels.



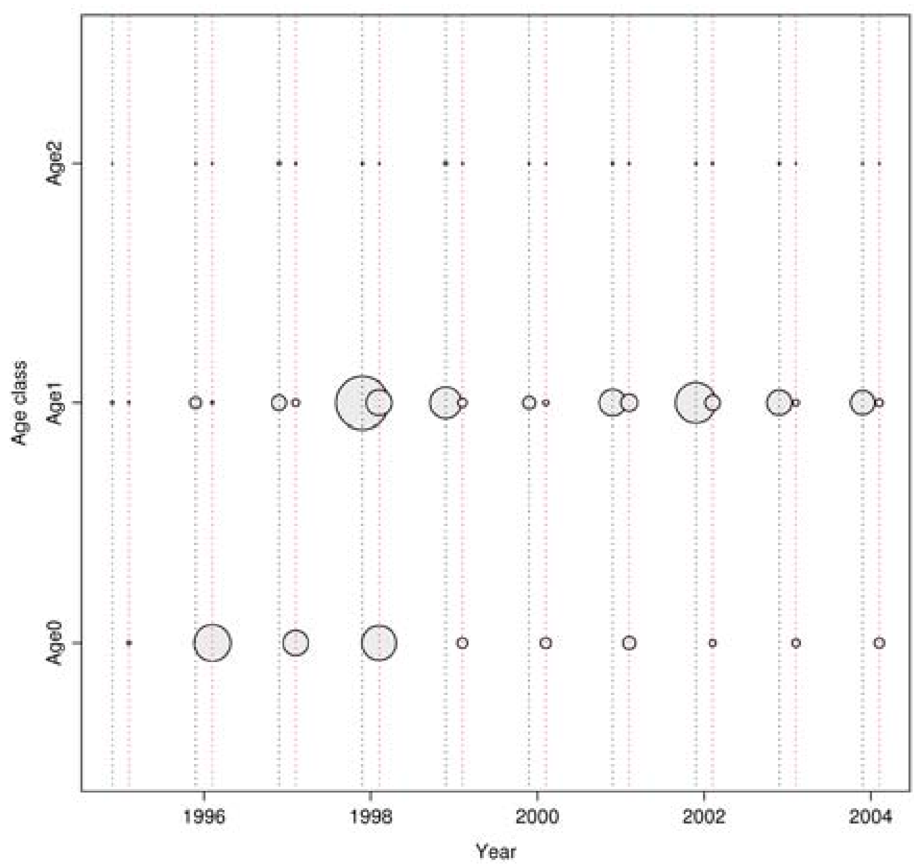
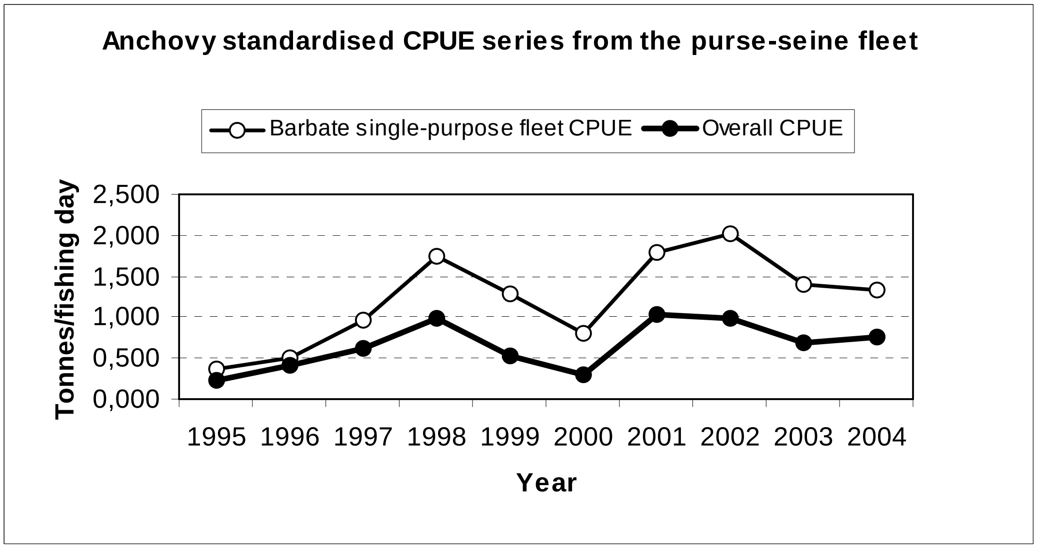


Figure 11.7.1. Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz). Trends in landings (upper panel, on an annual and half-year basis) and half-year catch-at-age numbers.



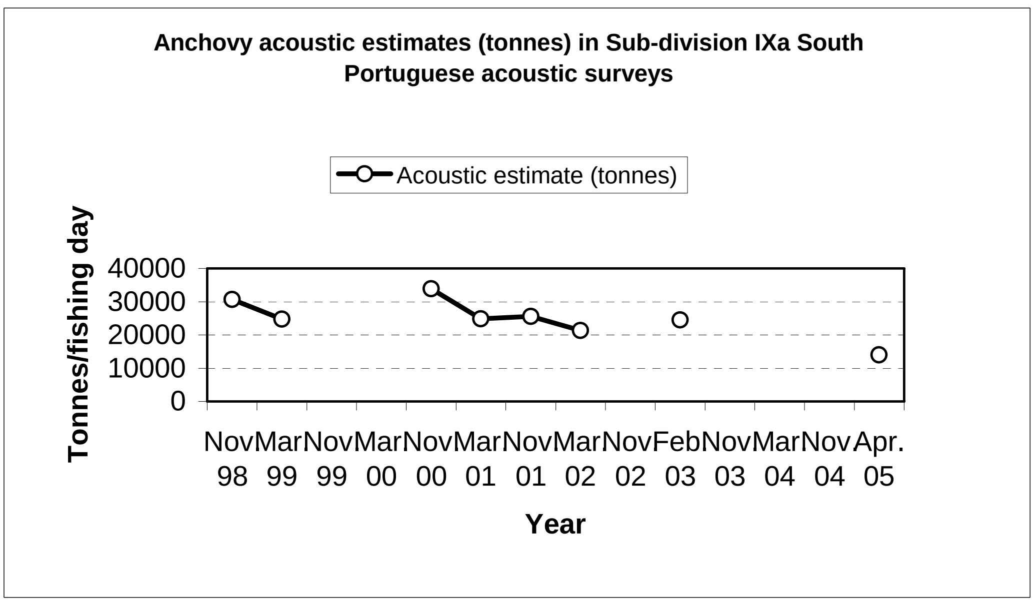


Figure 11.7.2. Anchovy in Sub-division IXa South(Algarve+Gulf of Cadiz). Trends in tuning indices (aggregated biomass) used in data exploration: standardised CPUE (upper panel) and Portuguese Acoustic Surveys estimates (bottom panel).

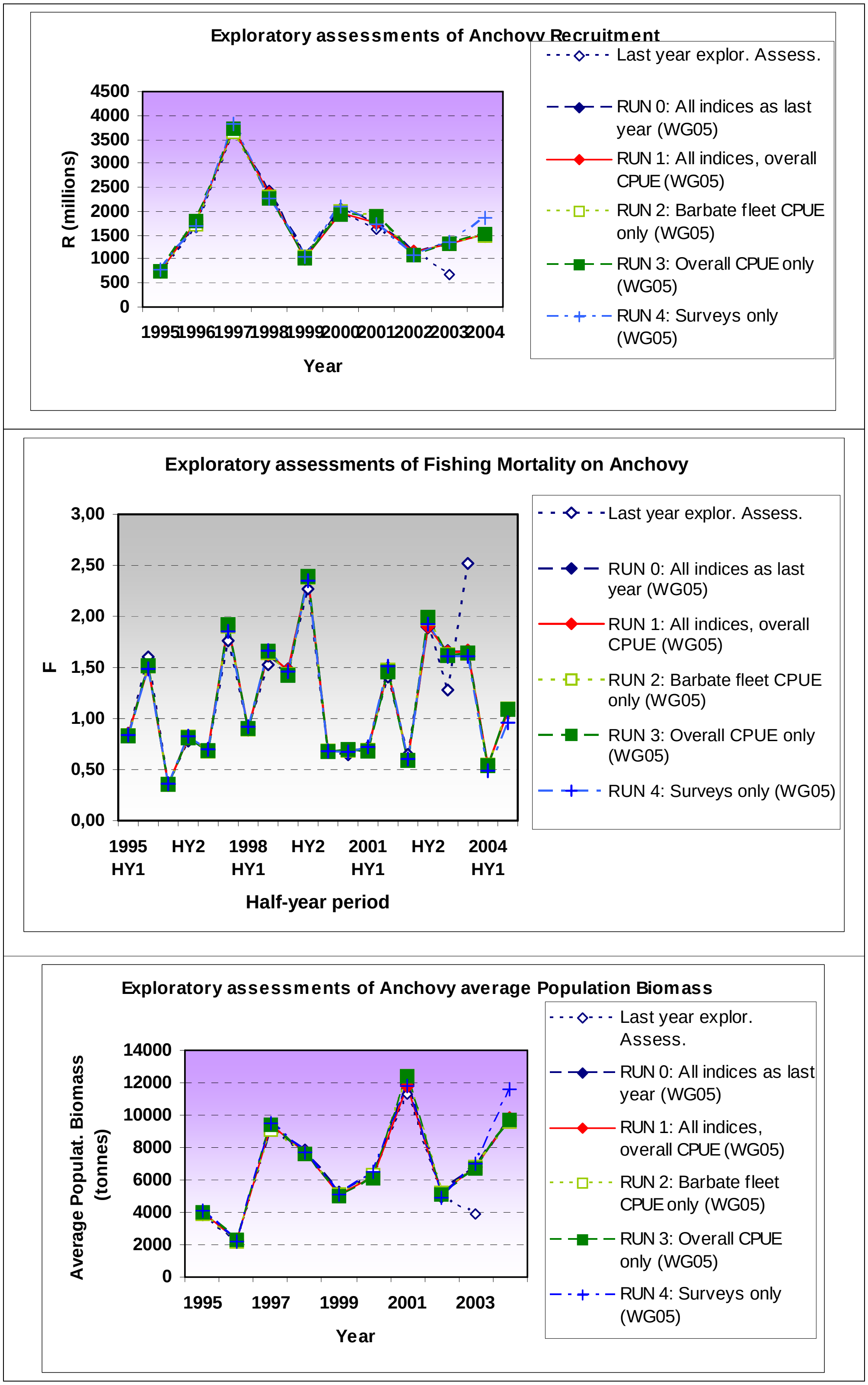
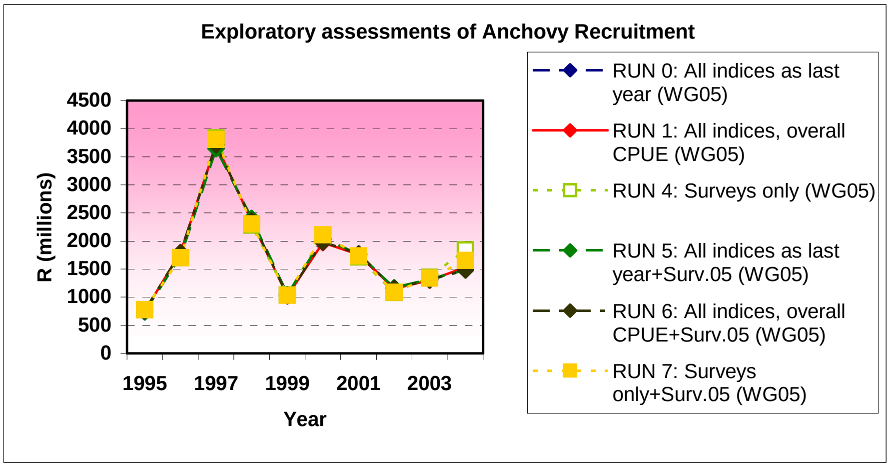
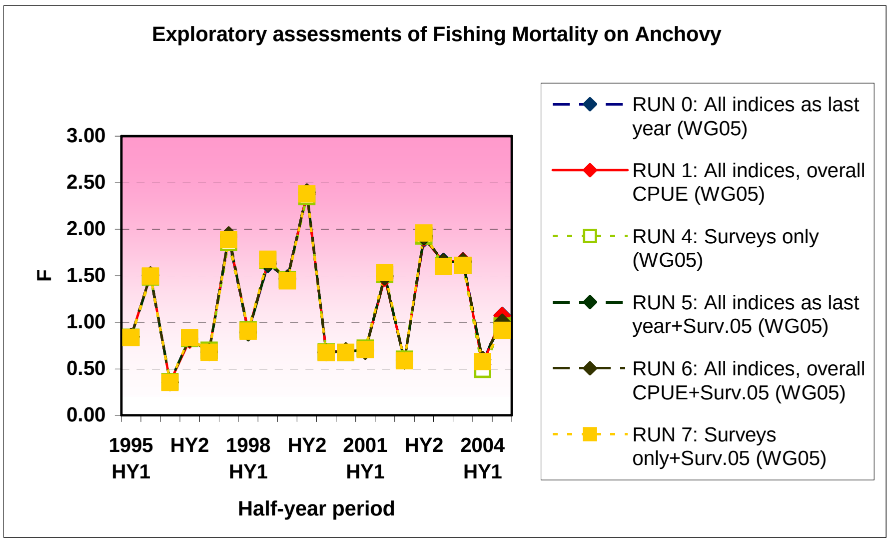


Figure 11.7.3. Anchovy in Sub-division IXa South(Algarve+Gulf of Cadiz). Comparison of last year's exploratory assessment with the new input data in 2005. Settings as last year (F in the second-half in the last assessment year as the average ratio between F half-year values of preceding years).





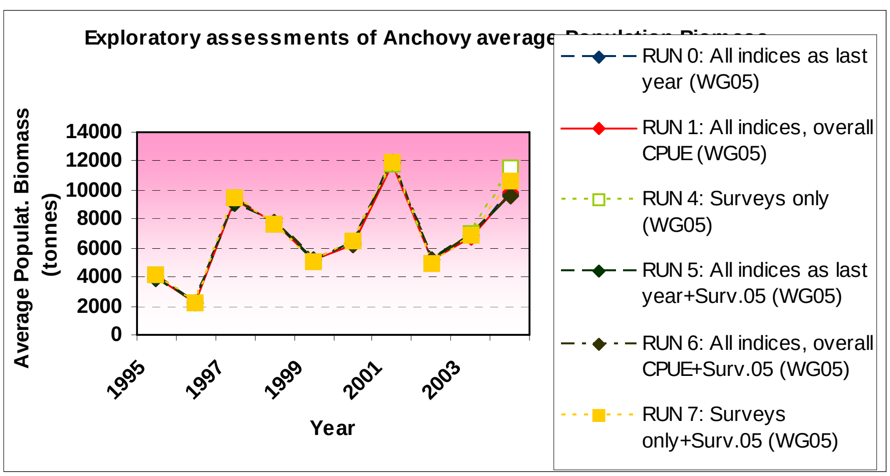


Figure 11.7.4. Anchovy in Sub-division IXa South(Algarve+Gulf of Cadiz). Comparison of exploratory runs performed with the last year's settings and those ones including the April 2005 acoustic estimate and assumptions on the catch at age, weight at age in the stock and F in the first half-year in 2005.

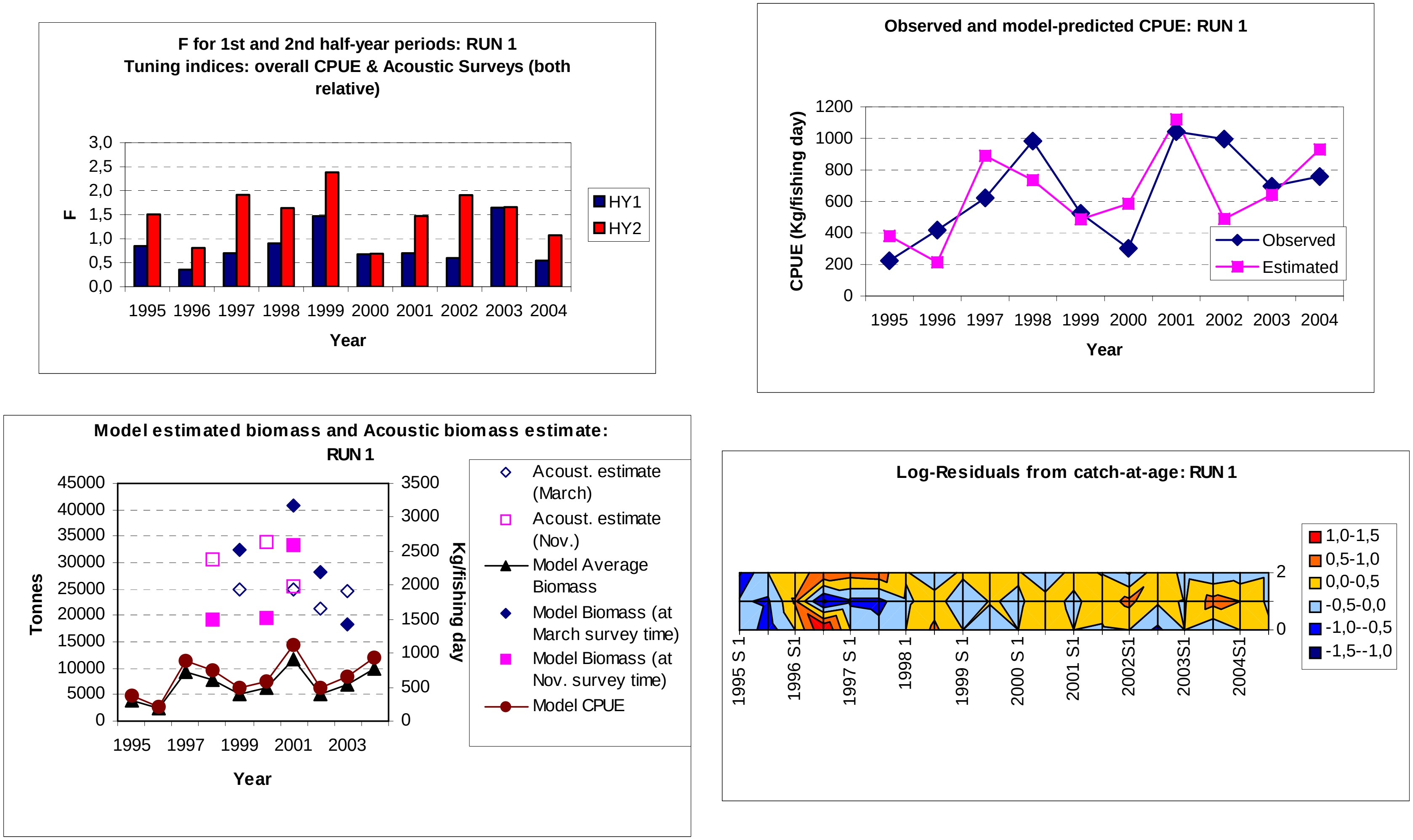


Figure 11.7.5: Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz). Results from data exploration RUN1 with the *ad-hoc* seasonal separable model: estimated fishing mortalities (F) by the separable model (top left), observed and model predicted CPUE for the whole purse-seine fleet (top right), model estimated biomass and acoustic biomass estimates (bottom left), and Log-residuals from catch-at-age data (bottom right).

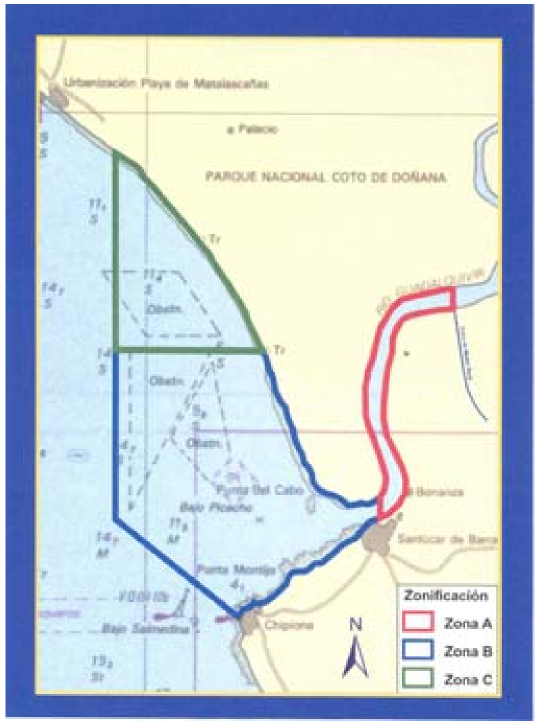


Figure 11.10.1: Limits of the Fishing Reserve off the Guadalquivir River mouth.

12 Recommendations

Mackerel

The WGMHSA recommends WGMEGS to evaluate how to include the results from the North Sea mackerel egg surveys in the NE Atlantic Egg Survey time series, taking into account both the timing of the surveys and the precision of the surveys, in particularly for the earlier surveys in the North Sea. Consideration should be given to whether the distribution of the combined estimates is more or less precise than the current NEA survey and how much of the probability density functions is overlapping.

Horse mackerel

For Western horse mackerel knowledge of the magnitude of the variability in fecundity is necessary to evaluate the use of the egg survey as a proxy for SSB in the current assessment framework. Currently inclusion or exclusion of this survey can give rise to a factor of 4 difference of perception. The WGMEGS should give an estimate of precision for the relationship between the estimates egg abundance and its relationship to SSB in the context of resolving a factor of 4.

Sardine

The WGMHSA recommends that biological data regarding maturity and weights at age is revised based on results from ongoing studies on the seasonal cycle of maturation and fattening.

The WGMHSA recommends, under the auspices of WGACEGGS, to continue monitoring the comparability of Spanish and Portuguese acoustic surveys, as well as the possibility of merging them and compare them with DEPM based estimates of sardine population distribution. It will also be desirable to compare these surveys with the French acoustic surveys.

The WGMHSA recommends that data from areas VIIIa and VIIIb continue to be collected in a way that could be used for an eventual assessment.

Giving that next year a benchmarck assessment is required, the WGMHSA recommends that state-of-the-art assessment models for sardine are thoroughly tested under different possible scenarios outlined by EU projects like SARDYN**.**

Anchovy

The WGMHSA recommends continuing the spring surveys PELGAS (acoustic) and BIOMAN (DEPM) Up to now these surveys are considered to be the only consistent series of biomass estimate independent of the fishery. These surveys provide for the time being the most reliable knowledge about recruitment abundance in the current year. They are therefore essential, especially at low level of biomass as to day.

The WGMHSA recommends the continuity of acoustic surveys on juveniles in autumn (JUVENA, JUVAGA) in order to get a significant series which could be correlated to spring direct assessments (DEPM and Acoustics) and developing the understanding the mechanism of recruitment. It recommends to IFREMER, IEO and AZTI to collaborate in order to increase their effort by coordinating their respective surveys on pre-recruits or by doing a common one.

Otoliths exchanges have been carried out during 2005 and a workshop is planned in 2006. The WGMHSA recommends that the workshop will take place next year and continuing these exchanges of otoliths for anchovy between France and Spain.

The WGMHSA recommends that further discussion and work between managers, stake holders and scientists is promoted to develop appropriate management strategies (alternative to the annual fixed TAC) for the Bay of Biscay anchovy stock considering that there was already several available tools at the present WG.

The WGMHSA recommends the continuity of the studies on natural mortality and the catchability of surveys and the accessibility to fisheries. .

Anchovy IXa

The WGMHSA 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 2004 and 2005, and recommends its continuation within a routine either annual (Acoustics) or triennial (DEPM) survey series. Nonetheless, the Working Group recommends that steps in improving the acoustic survey design in the Gulf of Cadiz area be pursued in the short-term, in order to understand the true magnitude of the uncovered population (mainly in the shallowest waters).

The WGMHSAp 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 WGMHSA 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 WGMHSA 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 WGMHSA 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.

The WGMHSA recommends to recover all the information available on the anchovy fishery and biology (including information on age structure by Sub-division if available) off

13 References

Allain G., Petitgas P. and Lazure P. 2001. The influence of mesoscale ocean processes on anchovy (I) recruitment in the Bay of Biscay estimated with a three-dimensional hydrodynamic model. Fisheries Oceanography 10: 151–163.

Arruda, L.M. 1984. Sexual maturation and growth of *Trachurus trachurus* (L.) along the Portuguese coast. Inv. Pesq., 48: 419–430.

Bernal, M., Stratoudakis, Y., Ibaibarriaga, L., 2004.Using R to obtain estimates of fish Daily Egg Production (v. 0.0.2). Working Document presented to the ICES Study Group on the Estimation of Spawning Stock Biomass of Sardine and Anchovy. ICES CM 2005/G:02.

Cárdenas L., Hernández, C.E., Poulin, E., Magoulas, A., Kornfield, I., Ojeda, F.P. 2005. Origin, diversification, and historical biogeography of the genus Trachurus (I). Molecular Phylogenetics and Evolution, 35: 496–507.

Carrera, P. 1999. Acoustic survey JUVESU 0899: preliminary results. Working Document presented to the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2000/ACFM:05.

Carrera, P. 2001. Acoustic abundance estimates from the multidisciplinary survey PELACUS 0401. Working Document presented to the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2002/ACFM:06.

Carrera, P., Villamor, B., Abaunza, P. 1999. Report of the acoustic survey PELACUS 0399: results on sardine, mackerel, horse mackerel and anchovy. Working Document presented to the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES, CM 2000/ACFM:05.

Darby, C. D. and Flatman, S. 1994. Virtual population analysis: version 3.1. User guide. Information technology series N 1. 85pp.

Darby, C.D. and Flatman. S. 1998. Virtual Population Analysis:version 3.1 (Windows/DOS) user guide.

De Oliveira, J. A. A., Roel, B. A. and Dickey-Collas, M. 2005. In press. Investigating the use of proxies for fecundity to improve management advice for western horse mackerel Trachurus trachurus. ICES Journal of Mar. Sci.

Diner, N., Marchand, P. 1995. "Acoustique et pêche maritime." Editions IFREMER, Brest, France: 147pp.

Duhamel E., Biseau A. and Massé J. 2004. The French anchovy fishery. Working Document to the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2005/ACFM:08.

Foote, K. G., Knudsen, H. P., Vestnes, G., MacLennan, D. N., Simmonds, E. J. 1987. "Calibration of acoustic instruments for fish density estimation: a practical guide." ICES Coop. Res. Rep. 144: 57pp.

Gavaris, S., 1980. Use of a multiplicative model to estimate catch rate and effort from commercial data. Can. J. Fish. Aquat. Sci., 37: 2272–2275.

Gilks, W.R., Richardson, S. and Spiegelhalter, D.J. (editors). 1996. Markov Chain Monte Carlo in practice. Chapman and Hall.

ICES. 1991. Report of the Study Group on Coordination of Bottom Trawl Surveys in Subareas VI, VII, VIII and Division IXa. ICES CM 1991/G: 13

ICES. 1993. Report of the Working Group on Long-Term Management Measures. ICES CM 1993/Assess:7.

ICES. 1993. Report of the Working Group on the assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 1993/Assess:19.

ICES. 1996. Report of the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 1996/Assess:7.

ICES. 1998. Report of the Study Group on the Precautionary Approach to Fisheries Management (ICES 1998/ACFM:10.

ICES. 1999. Report of the Planning Group for Pelagic Acoustic Surveys in ICES Divisions IX and VIII. ICES CM 1999/G:13.

ICES. 2000. Report of the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES, C.M. 2000/ACFM:05.

ICES. 2001. Report of the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES, C.M. 2001/ACFM:06.

ICES. 2002. Report of the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2003/ACFM:06.

ICES. 2002. Report of the Working Group on Mackerel and Horse Mackerel Egg Surveys. ICES CM 2002/G:06, Ref. D.

ICES. 2003. Report of the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2004/ACFM:07.

ICES. 2004. Report of the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2005/ACFM:08.

ICES. 2004. Report of the ICES Advisory Committee on Fishery Management and Advisory Committee on Ecosystems. *ICES Advice*. Volume 1, Number 2. 1554 pp.

ICES. 2004. Report of the Advisory Committee on Fishery Management and Advisory Committee on Ecosystems, 2004. ICES Advice, 1(2). 1544 pp.

ICES. 2005. Report of the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2006/ACFM:08.

ICES. 2005. Report of the Study Group on Management Strategies, ICES 2005/ACFM:09.

ICES. 2005. Report of the Study Group on the Estimation of Spawning Stock Biomass of Sardine and Anchovy. ICES, C.M. 2005/G:02.

ICES. 2005. Report of the Study Group on regional scale ecology of small pelagic fish (SGRESP). ICES Living Resources Committee ICES CM 2005/G:06 Ref. ACFM, ACE.

ICES. 2005. Report of the Working Group on mackerel and horse mackerel egg surveys. ICES CM 2005/ G:09.

ICES. 2005. Report of the Report of the Planning Group on Aerial and Acoustic Surveys for Mackerel. ICES CM 2005/G:13, REF. ACFM, B.

Iversen, S.A. and Adoff, G.R. 1983. Fecundity observations on mackerel from the Norwegian coast. ICES CM 1983/H:45, 6pp.

Jiménez, M.P., Bernal M., Romero Z., 2004. BOCADEVA-0604 egg survey preliminary results. Working Document presented to the ICES Study Group on the Estimation of Spawning Stock Biomass of Sardine and Anchovy. ICES CM 2005/G:0.2.

Kienzle, M. and Simmonds, J. 2004. Simulating the dynamic of a fishery to discriminate between different stock assessment options Application to the NEA mackerel. Working Document to the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2005/ACFM:08.

Kimura, D.K., Chikuni, S. 1987. Mixtures of empirical distributions: an iterative application of the age-length key. Biometrics, 43: 23–35.

Kolody, D. and Patterson, K. 1999. Evaluation of NE Atlantic mackerel Stock Assessment Models on the Basis of Simulated Long-Term Management Performance. Working Document to the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 1999/ACFM:06.

Korneliussen et. al., R. J., Skagen, D. W., Slotte, A. 2004. Cruise summary report/Institute of Marine Research/ISSN 1503–6294/Nr. 3 – 2005. (Bergen, Norway). Working Dokument to the ICES Planning Group on Aerial and Acoustic Surveys for Mackerel. ICES CM 2005/G:13, REF. ACFM, B.

Lasker, R. ed. 1985. An egg production method for estimating spawning biomass of pelagic fish: application to the northern anchovy, *Engraulis mordax*. U.S. Dep. Comm., NOAA Tech.Rep. NMFS 36. 99 pp.

Lazure P. and Jegou A.-M. 1998. 3D modelling for seasonal evolution of Loire and Gironde plumes on Biscay Bay continental shelf. Oceanologica Acta 21: 165–177.

Lockwood, S.J., Nichols, J.H. and Dawson, W.A. 1981. The Estimation of a Mackerel (*Scomber scombrus* L.) Spawning Stock Size by Plankton Survey. J.Plank.Res., 3:217–233.

MacLennan, D. N., Fernandes, P. G., Dalen J. 2002. "A consistent approach to definitions and symbols in fisheries acoustics." ICES J. Mar Sci. 59: 365–369.

Massé, J. 2001. Report of the acoustic survey PEL2001. Working Document presented to the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2002/ACFM:06.

Marques, V. and Morais, A. 2003. Abundance estimation and distribution of sardine (Sardina pilchardus) and anchovy (*Engraulis encrasicolus*) off the Portuguese continental waters and Gulf of Cadiz (November 2002/February 2003). Working Document presented to the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2004/ACFM:08.

Millán, M. 1999. Reproductive characteristics and condition status of anchovy (Engraulis encrasicolus, L.) from the Bay of Cadiz (S.W. Spain). Fish. Res., 41: 73–86.

Millán, M., Vila Y., Ramos F., 2004. Sampling of anchovy DEPM-adult parameters during the BOCADEVA 0604 Spanish pilot survey (June 2004, ICES Subdivisión IXa South): a progress report. Working Document presented to the ICES Study Group on the Estimation of Spawning Stock Biomass of Sardine and Anchovy. ICES CM 2005/G:02.

Motos, l. 1994. Estimación de la biomasa desovante de la población de anchoa del golfo de Vizcaya, engraulis encrasicolus, a partir de su producción de huevos. Bases metodológicas y aplicación. Memoria presentada para defensa de la Tesis Doctoral. Universidad del País Vasco, 1994.

Motos, L. 1996. Reproductive biology and fecundity of the Bay of Biscay anchovy population (Engraulis encrasicolus, L.). Scientia Marina, 60: 195–207.

Patterson, K.R. and D.S. Beveridge 1995: Report of the Herring Larvae Surveys in the North Sea and Adjacent Waters in 1993/1994. ICES CM 1995/H:22

Patterson, K. R. and Melvin, G. D. 1996. Integrated catch at age analysis version 1.2. Scottish Fisheries Research Report, 56. Aberdeen: FRS.

Pestana, G. 1996. Anchovy in Portuguese waters (IXa): landings and length distribution in surveys. Working Document for the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 1996/Assess:7.

Petitgas P. and Massé J. 2004. On the quality of the assessment of Bay of Biscay anchovy in recent years and its implications. Working document to the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2005/ACFM:08.

Petitgas, P., Allain, G. and Lazure, P. 2002. A recruitment index for anchovy in 2003 in Biscay. Working document to the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2003/ACFM:06

Petitgas, P., Massé, J. and Vaz, S. 2003. Biological basis for the management of the anchovy in Biscay based on the analysis of the spring acoustic surveys. Working document to the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2004/ACFM:07.

Petitgas P. and Lazure P. 2004. A recruitment index for anchovy in Biscay for 2005. Working document to the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2004/ACFM:08

Petitgas P. and Massé J. 2004. On the quality of the assessment of bay of Biscay anchovy in recent years and its implications. Working document to the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2004/ACFM:08

Prouzet P., Uriarte, A., Villamor, B., Artzrouni, M., Gavart, O., Albert, E. and Biritxinaga, E. 1999. Estimations de la mortalite par peche (F) et naturelle (M) a partir des methodes directes d'evaluation de l'abondance chez les petits pelagiques – Precision de ces estimateurs. Rapport final contrat UE – DG XIV 95/018, 67 pages.

Ramos F., Uriarte A., Millán M. and Villamor B., 2001. Trial analytical assessment for anchovy (*Engraulis encrasicolus*, L.) in ICES Subdivision IXa-South. Working Document presented to the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2002/ACFM:06.

Rindorf, A. and Lewy, P. 2001. Analyses of length and age distributions using continuation-ratio logits. Canadian Journal of Fisheries and Aquatic Sciences. 58: 1141–1152.

Robson, D.S., 1966. Estimation of the relative fishing power of individual ships. ICNAF Research Bulletin, 3:5–14.

Roel, B. A. and Butterworth, D. S. 2000. Assessment of the South African squid Loligo vulgaris reynaudii - is disturbance of aggregations by the recent jig fishery having a negative impact on recruitment? Fish. Res.,

Saila, S.B., Recksiek, C.W., Prager, M.H. 1988. BASIC Fishery Science Program (DAFS, 18). Elsevier, New York, 230 pp.

Santos M. and Uriarte A. 2004. Estimates of the Spawning Stock Biomass of the Bay of Biscay anchovy (*Engraulis encrasicolus*, L.) in 2004. Working document to the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2005/ACFM:08.

Schnute, J. 1987. A general fishery model for a size-structured fish population. Can. J. Fish. Aquat. Sci. 44:924–940.

SESITS, 1999. Evaluation of Demersal Resources of Southwestern Europe fro Standardised Groundfish Surveys. Final Report of SESITS Project to CEC (DG XIV Study contract 96–029), 195 pp.

Simmonds, J. 2003. The use of Egg Surveys as relative or absolute measures of abundance within ICA assessments of NEA mackerel. Working Document to the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2004/ACFF:06.

Simmonds, J., Beare, D. and Reid, D. G. 2003. Sensitivity of the current ICA assessment of western mackerel and short term prediction to the sampling error in the egg survey parameters. ICES CM 2003/X:10

Skagen, D. W. 2004. AMCI – version 2.3. Model description, instructions for installation and running file formats. ICES CM 2004/?????

Slotte, A., Iversen, S. A. and Skagen, D. 2005. Size and condition of mackerel in research vessel trawl hauls versus commercial purse seine catches: implications for acoustic biomass estimation. Working Document to the ICES Planning Group on Aerial and Acoustic Surveys for Mackerel. ICES CM 2005/G:13, REF. ACFM, B.

Vendrell, C., Farinha, A. and Cunha, E. 2002. Horse mackerel egg staging for Daily Egg Production Method. Working document, ICES working group on the assessment of Mackerel, Horse-mackerel, sardine and anchovy. Copenhagen, 10–19 September 2002.

Vasilyev D. 200? ISVPA

Wardle, C.S. 1986. Fish behaviour and fishing gear. In: T.J. Pitcher (Editor), The Behaviour of Teleost Fishes. Croom Helm, London, pp. 463–495.

NOT RECOGNIZED but referred in the report

(Murta and Abaunza, in prep.).

Santiago and Motos 1989

Santiago and Sanz 1992

14 Abstracts of Working Documents

WD 01/05

Antsalo, M., Slotte, A. and Skagen, D. W.

Abundance estimate of the Western spawning stock component of the Northeast Atlantic Mackerel based on the Norwegian tagging data.

Document available from: Maria Antsalo, Institute of Marine Research, P.O Box 1870 Nordnes, 5817 Bergen, Norway.

E-mail: maria.antsalo@imr.no

The Institute of Marine Research (IMR) in Bergen has used internal steel tags for tagging mackerel since 1966. The tagging has been carried out in the spawning area west of Ireland, where an average of 20 000 fish have been tagged each year. Since 1986 commercial catches of mackerel have been screened through metal detectors connected to conveyor belt systems located in four factories in Norway. Each year a total of 10.000-40.000 tons of mackerel are screened and the recaptured tagged fish are identified and sent to IMR for data collection. In the present study we utilize the detector based tagging data to estimate the year class abundance of western mackerel in the period 1986-2003, by using a model based on the Petersen's formula and by adding a tagging mortality estimate. These estimates of abundance are compared with the results from the ICA model runs in the assessment of the stock.

WD 02/05

Bernal, M., Villamor, B., Abaunza, P., Bellido, J. M., and Porteiro, C.

Some thoughts on the anchovy fisheries decline. Individual fecundity versus population fecundity and larval mortality.

Document available from: Miguel Bernal, Instituto Español de Oceangrafia Puerto Perquero s/m, 29640 Fuengirola, Spain.

E-mail: miguel.bernal@ma.ieo.es

Anchovy is a small pelagic fish that forms large and valuable fisheries in different regions of the world. Some of its main characteristics include a short life, large individual fecundity, and large population variations, due to variable recruitment pulses. Both the large individual fecundity and the large variations in recruitment suggest an environmental control on early life stages survival. Nevertheless, despite the large individual fecundity, anchovy fisheries have suffered the best documented collapses around the world and recovery of these fisheries have been long, and in some cases not even achieved.

Documented collapses are always accompanied by a reduction of spawning areas, gathering of the schools, periods of recruitment variability even larger than usual, and finally continuous failures in recruitment. After one or two years of recruitment failure (no matter the reason), the breeding stock is reduced by fishing to levels producing so few eggs that one or several years of good larval survival cannot rebuild the stock

Recovery after collapse is very slow, and the fact that overfishing has been one of the causes of the collapse is a well founded hypothesis in fisheries literature.

Combined with data on reduced spawning habitats and concentration of schools, the following hypothesis can be proposed: *Reduction in spawning area and concentration of the population decrease the possibility of occupying suitable spawning grounds, and thus decrease the ability of sustaining a given population size. A gradual reduction in spawning areas can be* *happening in the population for periods larger than the fish life cycle, and this may explain a continuous decreasing trend (although with high variability) as well as a population collapse***.**

WD 03/05

Boyra, G., Arregi, I., Cotano, U., Alvarez, P. and Uriarte, A.

Acoustic surveying of anchovy Juveniles in the Bay of Biscay: JUVENA 2003 and 2004: preliminary biomass estimates.

Document available from: Guillermo Boyra, AZTI, Instituto Tecnológico Pesquero y Alimentario, San Sebastián, País Vasco, España.

E-mail: gborja@azti.es

The project JUVENA aims at estimating the abundance of the anchovy juvenile population and their growth condition at the end of the summer in the Bay of Biscay. The long term objective of the project is to be able to assess the strength of the recruitment entering the fishery the next year. The surveys take place annually using acoustics, purse seine hauls for species identification and biological sampling and hydrological recordings, that consist in continuous surface hydrographical registration plus CTD casts. This project is funded by the Department of Agriculture and Fisheries of the Basque Government, seeking for improving the scientific advice for management of this population. After two years of campaigns, the spatial distribution of anchovy juveniles in both years will be presented, along with the preliminary biomass estimates. Such estimates have to be taken with caution, due to the experimental character of these surveys, and regarded as a relative acoustic index of abundance, used to compare abundances between consecutive years. In 2003, anchovy was mostly located at the Cantabrian Sea. In this area, anchovy shoals 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. 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 and the rest 1 year old adults. In 2004, very little anchovy was found 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 and the population found in the southern part of the Garonne, were juveniles. In the Cantabrian Sea, the small amount of anchovy found, were juveniles. The quantitative estimates of biomass reveal a drastic reduction in the abundance of anchovy juveniles from 2003 to 2004 of about 95%.

WD 04/05

Castro, J. and Punzon, A.

Pelagic métiers of the Northern Spanish coastal bottom trawl fleet.

Document available from: Jose Castro, Instituto Español de Oceanografía; P.O. BOX 1552; 36280; Vigo, Spain.

E-mail: jose.castro@vi.ieo.es

A non-hierarchical cluster analysis was used to classify the Spanish bottom trawl fleet operating in the ICES Divisions VIIIc (Cantabrian Sea and Northern Galician waters) and IXa North (Southern Galician waters) between 2002 and 2004. A classification of individual trips based on the species composition of landings was made separately for the bottom otter trawl and the bottom pair trawl fleets. Five catch profiles were identified in the bottom otter trawl fleet: 1) targeting horse mackerel, 2) targeting mackerel; 3) targeting blue whiting; 4) targeting demersal species (hake, megrim, monk and Nephrops); and 5) a “mixed” métier. The bottom pair trawl fleet showed two métiers: 1) targeting blue whiting; and 2) targeting hake.

WD 05/05

Clarke, M. and Kelly, C.

Assessing the NEA Mackerel stock considering misreported catches.

Document available from: Maurice Clarke Marine Institue, GTP, Parkmore, Galway, Ireland

E-mail:

The assessment carried out at ICES WGMHSA was not accepted by ACFM as a basis for management advice for 2005. This rejection was based on the treatment of the egg survey estimates of SSB. It was the view of ACFM that the egg survey index should be used as a relative index in the assessment, as this provided a better model fit, and the development of the stock was more clearly seen to follow the trend in the egg survey.

In the relative case, the egg survey is considered not to provide an accurate estimate of the SSB. Instead, the SSB estimated in the assessment model is related to the egg survey estimate by the catchability. In the absolute case, the SSB estimate from the survey is considered to be accurate. Thus, the model assumes a catchability of 1.0. This formulation of the model has less parameters to find solutions for, but requires a prior assumption to be made about the accuracy of the egg survey SSB estimates.

The debate about relative versus absolute treatment of the egg survey estimates extended from ACFM to STECF. Scientists were divided on this matter and there were good arguments in both directions. The debate centred on the accuracy of the egg survey estimates. It is argued in this paper that the debate should shift towards the accuracy of the catch at age data.

No recent attempt has been made in ICES or elsewhere to investigate the effect of misreported catches on the estimates of stock size. This paper takes a simplistic approach to this problem by assuming that catches since 1987 should be scaled up by 40% to account for misreporting in the fishery for the entire northeast Atlantic mackerel stock. The year 1987 is used as a starting point as this was the beginning of the period where large mackerel fetched a premium price, and the fishery became much more valuable.

WD 06/05

Cotano, U. and Uriarte, A.

Surveys for Localization of Anchovy Concentrations of commercial interest in the Bay of Biscay.

Document available from: U. Cotano, AZTI-Tecnalia, Instituto Tecnológico Pesquero y Alimentario, Pasaia, SPAIN.

E-mail: ucotano@pas.azti.es

Up to May of 2005, Cantabrian Spanish fleet had hardly obtained anchovy captures. With the recent records of repeated failures on recruitment in the three previous years, it was suspected that low captures obtained during April and May of this year could be again due to a failure of the annual recruitment and anchovy abundance, at least in the south-eastern areas of the Bay of Biscay where habitually the Spanish purse seiner commercial fleet carry out their fishing activities. Such critical situation forced to fishermen to carry out a Survey for Localization of Anchovy Concentrations of commercial interest for the purse seiner fleet in the Bay of Biscay. This survey would be carried out with the participation of commercial fleet with supporting of the Basque Government, tracking the north half of the Bay of Biscay, as well as the western areas, to determine if there could be outstanding concentrations of anchovy for commercial fishing. In this initiative AZTI-Tecnalia Foundation was commended to carry out the technical support and coordination.

Two main objectives were established in this project:

- To determine the presence of concentrations of anchovy economically important in the northern area of the French shelf (North of 45ºN).
- To determine the presence of concentrations of anchovy economically important in the oceanic area located at West of the 2ºW.

These areas had not been previously tracked by the commercial fleet. Among the vessels involved in this survey, only the "Berriz Irigoien" of Getaria port had arrived at 45ºN during the previous days, although it did not found any important patch of anchovy.

WD 07/05

Eltink, G. and Kraak, S.

Should NEA mackerel be assessed with the egg survey as a relative or an absolute index for SSB?

Document available from: Guus Eltink, RIVO, P.O. box 68, 1970 AB IJmuiden, Netherlands.

E-mail: a.t.g.w.eltink@rivo.wag-ur.nl

In September 2004 the WGMHSA carried out the final assessment of NEA mackerel with the egg survey used as an absolute index for SSB. Subsequently, ACFM rejected this assessment in October 2004 and replaced it with an assessment using the egg survey as a relative index.

In this Working Document we present some further analyses whose results bear relevance to the choice for a relative or an absolute index. The conclusions are:

1. We recommend that more attention be paid to the possibility that the catch data may be underestimates. It seems more likely that the catch data are underestimates than that the egg survey overestimates the SSB.
2. The NEA egg survey time series seems too short to result in reliable estimates of catchability (Q). The range of Q was from 1.1 to 1.3 indicating an average level of around 1.2.
3. Catchability (Q) becomes on average 1.2 for NEA mackerel, when the catch in numbers at age of the Southern component are added to the Western component for which Q has been stable at 1.1. This is probably caused by the lower ratio between adult catch weight and the egg survey SSB in NEA mackerel compared to Western mackerel.
4. Trends in SSB and F in the recent period differ between absolute and relative assessments when Q deviates from 1. The phenomenon of an increasing trend in SSB and a decreasing trend in F in the recent period when Q>1 (or a decreasing trend in SSB and an increasing trend in F in the recent period when Q<1) should be regarded as a bias caused by a tuning to an absolute index. This discrepancy in trend in the recent period between relative and absolute assessments increases with the deviation of Q from 1.
5. When the SSB index is used as absolute the trend in F is biased and is therefore not a good indicator of the actual trend in F. In principle it is more appropriate to use the ICA run with the SSB index as relative to obtain information on the trend in F in the most recent years.
6. There still remains a discrepancy that is difficult to explain: The increasing trend in F from the assessment with the SSB index as relative (as accepted by ACFM) and no trend in F from the information of the log-catch ratios.
7. Inclusion of discard data and unallocated landings would increase the catch in numbers at age and therefore reduce the catchability (Q). It would reduce the discrepancy between the assessments with an absolute and a relative SSB index.
8. We suggest that in the future the WG report should include an evaluation of the quality of the assessments by the WG by comparing the first estimates of recruitment, SSB and F (4-

8) in a certain year with the second, third, fourth, etc. estimates from following WG meetings to indicate changes in accuracy and precision over time.

WD 08/05

Ibaibarriaga, L., Fernandes, C. and Uriarte, A.

New biomass based model for the Bay of Biscay anchovy.

Document available from: Leire Ibaibarriaga, AZTI, Herrera Kaia Portualde z/g, 20110 Pasaia, Gipuzkoa, Basque Country, Spain

E-mail: libaibarriaga@pas.azti.es

The bay of Biscay anchovy is assessed yearly in the WGMHSA using the ICA method. However, as an alternative a biomass delay-difference based on the model applied to squid, has been attempted in the last two years. This model aims at estimating the recruitment biomass at age 1 at the beginning of the year using the information obtained from the DEPM and acoustic surveys and accounting for the level of catches produced each year. The results from this model have shown a good agreement with those obtained by ICA. However, some drawbacks of this model have been already pointed out such as the correlation between the observation equations of age 1 and total biomass or the equal variance assumption for all the biomass indices.

In this working document a new Bayesian state-space model that tries to overcome these difficulties is presented and is applied to 1987-2004 data set. Markov chain Monte Carlo (MCMC) methods are used to conduct inference with this model. Resulting posterior distributions are compared with the posterior distributions from the initial biomass based model and with the estimates obtained by ICA in the last year working group.

WD 09/05

Ibaibarriaga, L., Uriarte, A. and Roel, B.

More on harvest control rules for Bay of Biscay anchovy.

Document available from: Leire Ibaibarriaga, AZTI, Herrera Kaia Portualde z/g, 20110 Pasaia, Gipuzkoa, Basque Country, Spain

E-mail: libaibarriaga@pas.azti.es

The Bay of Biscay anchovy is a short living species. The year to year fluctuations in the population are due to recruitment success that is strongly dependent on the environmental conditions. At present, after consecutive failures in recruitment the population is at the lowest level of the historical series. The Spanish purse seines fleet stopped the fishing activities in spring due to the impossibility to find any profitable catch. The catches by the French fleet, composed by pelagic trawlers, were also much lower than any previous year. The spring research surveys, acoustic survey and ichthyoplankton survey for the DEPM, confirmed the low biomass level. Under this situation the EC decided to close the fishery for three months, until the end of September, when a new decision will be adopted.

The stock is managed by annual TAC fixed at 33000 tones. However, the current ICES management advice for this stock is based on a two stage TAC approach. A preliminary precautionary TAC is set at the beginning of the year aiming at keeping the stock above Blim for any recruitment scenario and is revised at the middle of the year according to the first semester catches and the direct spring survey estimates. Exploration and evaluation of harvest control rules for anchovy has been requested to the WGMHSA. In the 2003 WGMHSA a simulation exercise for the two stages TAC procedure was presented.

This working document revisits that work and explores additional management measures such as the closure of specific areas to protect a fraction of the population and the closure of the fishery when the population is below some specific reference point.

WD 10/05

Iglesias, M., Miquel, J., Villamor, B., Porteiro, C. and Carrera, P.

Spanish Acoustic surveys in Division VIIIc and Sub-division IXa North: Results on Mackerel from 2001 to 2005.

Document available from: Magdalena Iglesias, Instituto Español de Oceanografía. P.O. Box 2609, 11006 Cádiz, Spain.

E-mail: magdalena.iglesias@ba.ieo.es

Mackerel is widely distributed in the Northeast Atlantic and makes long-distance seasonal migrations. Spawning takes place in spring near the shelf-break from Portugal to Shetland, as well as in the North Sea.

Mackerel are abundant in the southern area (Division VIIIc and IXa) in spring, when they come to the area to spawn. 87% of the annual catch is taken in the first half of the year, mainly in Division VIIIc. After spawning, they migrate towards northern. The Cantabrian Sea (Division VIIIc) contains the largest spawning ground of the Southern component of mackerel and spawning in this area takes place in spring, from February to June, reaching a peak in April.

A Spanish acoustic survey (PELACUS) has been carried out each spring since 1986 in north western and north Atlantic waters off the Iberian Peninsula. The PELACUS surveys are among the IEO's planned activities as an objective 1 within the National Plan of Basic Data, dealing with estimation by direct methods of the pelagic resources of the North and Northwest of Spain. They were also the main activity of the IEO within the frame of the PELASSES and SARDYN projects. The main goal of these projects was the combination of different direct assessment methods (acoustic and sampling techniques) in order to improve abundance estimates and general knowledge of the ecosystem provided by extensive sampling techniques. Although mainly aimed at the estimation of the sardine (*Sardina pilchardus*) in Spanish waters in the spawning period, data of other pelagic species such as mackerel (*Scomber scombrus*), anchovy (*Engraulis encrasicolus*) and horse mackerel (*Trachurus trachurus*) were also collected due to the multispecificity of the area. Another series of activities has also been carried out within the SIMFAMI project, in which one of the target species was mackerel and whose objective was the discrimination of this species from plankton by notification using different frequencies.

Since 1999 the stock abundance of mackerel has been estimated off Galicia and in the Cantabrian Sea (Sub-division IXa North and Division VIIIc). The aims of the survey were to provide an abundance estimate for mackerel in this area, to map the distribution of this species and to provide information for the purpose of research into the acoustic identification of mackerel. The results of these surveys have been presented for the WGMHSA in 2002-2005. The methodology for the estimation of mackerel biomass by acoustic methods in the study area has now been standardised and the different surveys previously presented to this WG re-evaluated.

WD 11/05

Iversen, S. A., Skogen, M. and Svendsen, E.

A prediction of the Norwegian catch level of horse mackerel in 2005.

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 of the later years been the major nation fishing for horse mackerel in the North Sea and Norwegian Sea. This fishery is carried out by purse seiners mainly in the Norwegian economical zone of the northern part of the North Sea and in the southern part of the Norwegian Sea and not regulated by any measures. 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 catches have increased significantly since 1987 when the extremely rich 1982 year class recruited.

The modelled influx has been used to predict the catch level since 1997. The predicted catches fit fairly well with the actual ones except for 2000 (predicted a rather high catch while the actual catch was the lowest since 1987). The modelled influx for 2005 is higher than that for 2004 and indicates an availability/catch level of horse mackerel in NEZ more than caught in 2004.

WD 12/05

Kienzle, M. and Simmonds, J.

Investigating the implication of fitting ICA using the egg survey as an absolute or relative measurement of the SSB

Document available from: Marco Kienzle, FRS Marine Laboratory PO Box 101, Victoria Road, Aberdeen, AB11, Scotland, UK

E-mail: m.kienzle@marlab.ac.uk

Last year we presented, in front of this working group (WG), the results of a fishery dynamic simulation investigating the effect on our perception of the status of the North East Atlantic mackerel stock of using the spawning stock biomass (SSB) survey index as an absolute or a relative measurement of the abundance of the spawners [Kienzle and Simmonds, 2005]. This study concluded that (a) the outcome of ICA depends on whether the SSB index is fitted as an absolute or a relative measurement of the size of the spawning stock biomass (b) absolute fitting should only be considered if there is evidence that the egg survey provides an un-biased estimation of the SSB.

Following the comments from our colleagues at the WG and some modifications we wished to

make, we improved the programs used to generate the simulated sets of data. This year, we present the results of an investigation of the influence of under-reporting of catches on the perception of the stock as well as their interaction with a biased index of the SSB.

WD 13/05

Marques, V., Morais, A., Silva, A.

Sardine acoustic survey carried out in April 2005 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 survey carried out during April 2005 with 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. All the 69 planned acoustic tracks were performed. In order to identify species and collect biological samples, 41 trawl stations were made.

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” supported this survey.

WD 14/05

Massé, J., Beillois, P., Duhamel, E.

Direct assessment of anchovy by the PELGAS05 acoustic survey.

Document available from: Jacques Masse, Laboratoire ECOHAL, IFREMER, BP 21105, 44311 Nantes Cedex 01, France.

E-mail: Jacques.Masse@ifremer.fr

An acoustic survey was carried out in the Bay of Biscay on board the French research vessel Thalassa. The objective of PELGAS05 survey was to study the abundance and distribution of pelagic fish in the Bay of Biscay. The target species were mainly sardine and anchovy but had to be 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".

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

The strategy was the identical to previous surveys (2000 to 2004): acoustic data were collected along systematic parallel transects perpendicular to the French coast only during the day because of anchovy behaviour in this area.

A total of 2300 nautical miles were prospected during the survey and are usable for evaluation. A total of 41 pelagic hauls were carried out for identification of echo-traces.

WD 15/05

Massé, J., Duhamel, E. Delaunay, D.

Sardine series in PELGAS surveys: PELGAS 2000 to 2005.

Document available from: Jacques Masse, Laboratoire ECOHAL, IFREMER, BP 21105, 44311 Nantes Cedex 01, France.

E-mail: Jacques.Masse@ifremer.fr

The acoustic survey PELGAS takes place each year in spring on the French research vessel Thalassa. The objective of PELGAS surveys is to study the abundance and the distribution of pelagic fish in the Bay of Biscay. This document presents the length distribution of sardine each year. For biological data from 2000 to 2004, a distinction is made between four areas:

North offshore (ICES VIIIa), North coast (VIIIa), South offshore (VIIIb), and South coast (VIIIb). For each area, this document presents the age and length composition, and the sexual maturity.

WD 16/05

Petigas, P., Trenkel, V. and Masse, J.

Use of a matrix population model to evaluate management regimes for anchovy in the Bay of Biscay.

Document available from: Pierre Petitgas, IFREMER, BP 21105, F- 44311, Nantes, France.

E-mail: Pierre.Petitgas@ifremer.fr

The interest in the matrix population formalism is that it allows combining information on survival and fertility in a biologically meaningful way and evaluating the sensitivity of population growth to changes in the vital rates as well as in management scenarios. The methodology also allows separating the long-term and short-term effects of management measures. A simple 3x3 age-structured matrix population model was considered that used the values of vital rates commonly accepted in the literature and by ICES WGMHSA. With these values of vital rates and current fishing mortality, the population was close to a stable state. Different scenarios for management measures and natural variation in the vital rates were formulated and their effects compared quantitatively. Management scenarios were: closing the fishery during spawning time only, reducing catches over the entire year, closing a box in front of Gironde that contains 50% of age-1 and age-0 fish, closing a box in front of Gironde in addition to closing the fishery during spawning. The management regime that increased the most population growth was the one that protected spawning. Closing the Gironde box or reducing the annual catches by 50% had a similar effect in increasing population growth rate. Because the closure of the Gironde box strategically targeted the protection the spawning of age-1 fish and the survival of age-0, increase in population growth rate was obtained with a lesser reduction of fishing mortality than by halving annual catches globally. The sensitivity of population growth rate to variations in the vital rates was important and similar in all management regimes meaning that the inter-annual variability in the population is expected to stay the same as is currently. The recruitment variability being the major driver of population variability, short-term measures had merely no effect in rebuilding the stock in 2006 from its 2005 situation. Closing the fishery during spawning time performed slightly better than other measures.

WD 17/05

Petitgas, P. and Lazure, P.

A recruitment index for anchovy in Biscay for 2006.

Document available from: Pierre Petitgas, IFREMER, BP 21105, F- 44311, Nantes, France.

E-mail: Pierre.Petitgas@ifremer.fr

The IFREMER anchovy recruitment index 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. The period considered for constructing the environmental indices is March 1 to July 31 of year y-1. The regression model was constructed using the recruit series (age-1 fish) given in ICES for the period 1987-1998. Coefficients of the model were updated by fitting the model using the recruit series given in ICES for the period 1987-2002. The updated model is very close to the previous one with similar noise, meaning that recruitment dynamics in the period 1999-2002 was similar to that of previous years. In contrast, in the period 2003-2005 the model has failed to predict recruitment failures, suggesting that recruitment dynamics may have changed.

For predicting anchovy abundance at age-1 in 2006, upwelling and stratification breakdown indices for the period March-July 2005 were estimated from the hydrodynamic model outputs, and the regression model was used in extrapolation mode. The prediction for 2006 is that of an average recruitment level. The recruitment index is in fact an index related to potential larval survival during spring. But it seems that since this low year class 2002, the population has changed recruitment dynamics.

WD 18/05

Petitgas, P., Massé, J. and Trenkel, V.

Possible IFREMER's operational products on 0-group and timing for their delivery.

Document available from: Pierre Petitgas, IFREMER, BP 21105, F- 44311, Nantes, France.

E-mail: Pierre.Petitgas@ifremer.fr

Since 2001, in early September IFREMER delivers to WGMHSA a recruitment index based on a correlation between recruitment (ICES series) and two spring hydro-climate indices, an index of upwelling and an index of water-column stratification breakdown. The hydro-climate indices are estimated in the period 1 March – 31 July and on the area of the French shelf south of 46°30N. They are estimated by running the IFREMER's MARS3D ocean circulation model for the Bay of Biscay. This recruitment index corresponds in fact to an environmental index describing potential larval survival in the spring period and South of 46°30N. Perhaps an index of spawning behaviour would be needed to convert potential survival into realised survival.

The index was produced by regression in the period 1987-1998 with an R2 of 0.75 and used in projection mode since 2001. In the period 2001-2004, it predicted once a low recruitment that was subsequently observed the next spring. In 2004, it predicted medium recruitment for 2005. A gale in July 2004 was close to breaking stratification breakdown but did not. Should the threshold used in forming the index be modified? Perhaps also, the atypical 2004/2005 winter conditions were critical when they usually are not. Perhaps also, unaccounted fishing mortality on the 0-group was larger in 2004 than for other years.

A larval drift and survival model was developed that estimates the probability of realised survival at 100 days post-hatch in the period 1 March – 31 September and for the entire bay of Biscay. The model uses IFREMER's MARS3D circulation model for the Bay of Biscay for estimating larval drift. Larval survival is conditioned to growth which is a function of temperature and water-column stratification along the drift trajectories. The larvae are seeded in the model according to a space-time spawning model. This model has been calibrated on survey data for the year 1999 and validated with ICES recruitment series on the years 1997-1999. At present, the model is still in a validation phase for larval drift trajectories and larval growth. The intention is to implement this model in operational mode for delivering a 0-group index in early December.

WD 19/05

Planque, B., Jégou, A., Prou, J., Auby, I.

Climatic situation over the Bay of Biscay during the period 09/2004-08/2005 in relation to anchovy population.

Document available from: Benjamin Planque, IFREMER, BP 21105, F- 44311, Nantes, France.

E-mail: benjamin.planque@ifremer.fr

The present document provides summary information of key climatic processes that happened in the Bay of Biscay during the past year. The climatic situation is described using indices of river hydrology, sea temperature and wind. The analysis covers all seasons but a specific focus is given on winter conditions.

- River flows for the three main rivers have generally been low to average. Cumulated flow for the past 12 months is low but not extreme. The year 2004/2005 can be classified as a dry period.
- Temperature anomalies along the southern part of the Bay of Biscay coast have been negative during winter (December-March). Cold winters have been observed for the last four years (2001-2005) with 2005 being the coldest year.
- The wind pattern is not exceptional but it is marked by strong northerly winds during January and February 2005

WD 20/05

Porteiro, C., Batle, J. M., Iglesias, M., Bellido, J. M. and Villamor, B.

Presence of anchovy in acoustic research surveys PELACUS 2001-2005.

Document available from: Carmela Porteiro, Instituto Español de Oceanografía. Centro Oceanográfico de Vigo. PO Box 1552, Vigo, Spain.

E-mail: carmela.porteiro@vi.ieo.es

The research survey PELACUS started at the 80s, particularly since 1983, and from 1986 onwards is a spring survey. Although it changed its name from time to time it has always been the northern Spanish acoustic research survey. Its main aim is the assessment of pelagic resources by acoustics tools across the northwest and northern Spanish waters. This survey is mainly targeted at sardine, although other pelagic resources are also taken into account, such as horse mackerel, mackerel and anchovy.

The sampling area comprises the northern part of Portugal (ICES area IXa Central North), in the vicinity of Porto and extends to the southern Atlantic French waters (ICES area VIIIb), in the vicinity of Arcachon. Depths are from 30 to 200 m.

The acoustic device is an echosounder EK-500, working at frequencies of 12, 38 and 120 KHz. This echosounder was replaced in 2005 by a new echosounder EK-60, working at frequencies of 18, 38, 70 and 120 KHz. Fish samples were collected by a pelagic trawling gear, with 24 m of vertical opening.

An auxiliary purse-seiner is also chartered to help in shoal identification in coastal waters. This fishery boat is mainly used when the research vessel cannot fish because of the bathymetry, particularly in the Rias Bajas area, in Galicia.

The presence of anchovy was rather occasional in PELACUS and no assessment is routinely produced because of the poor presence of this species on fishing samples as well as echograms. Also it has to be considered that this survey is mostly targeted to sardine and both the distribution area and the main season of abundance of anchovy are not totally covered by this survey.

Hence the research surveys PELACUS are considered NOT GOOD INDICATORS on anchovy distribution and abundance and conclusions regarding anchovy from this survey should be taken with caution.

WD 21/05

Roel, B.

Testing harvest control rules for Horse Mackerel: a Scoping Document.

Document available from: Beatri, CEFAS, Lowestoft Laboratory, Pakefield Road, Lowestoft, Suffolk NR33 0HT, United Kingdom

E-mail: b.a.roel@cefas.co.uk

In response to the joint EU-Norway request concerning western horse mackerel:

"*Advise on appropriate management systems including management strategies, objectives and ecosystem considerations for western horse mackerel, anglerfish, sandeels and Norway pout*."

The WGMHSA submitted a document to the Study Group on *ad hoc* Long-Term Advice which met on 12-13 April 2005. An evaluation of simple stock assessment approaches and management was requested. Carl O'Brien of CEFAS, present at the meeting, proposed that a scoping document identifying options be prepared by CEFAS to be presented for discussion at the May 2005 meeting of ACFM. A new simulation studies are presented on this paper.

WD 22/05

Santos, M., Ibaibarriaga, L., Alvarez, P., Uriarte, A.

Estimates of the Spawning Stock Biomass of the Bay of Biscay anchovy (Engraulis encrasicholus, L.) applying the DEPM.

Document available from: Maria Santos, AZTI, Instituto Tecnológico Pesquero y Alimentario, San Sebastián, País Vasco, España.

E-mail: msantos@pas.azti.es

A survey to estimate the Biomass and population at age of anchovy in the Bay of Biscay (BIOMAN05) was carried out in May 2005 by AZTI 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 carried out by the IFREMER collaborating with this survey to supply some 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 2005 to EC & ICES for the assessment of this species. This document presents final estimates of the spawning stock biomass and numbers at age in May 2005 of the Bay of Biscay anchovy according to the results of BIOMAN05 survey. These estimates are base on full application of the DEPM after the whole adult samples were processed. The preliminary estimate presented at STECF in July (11-14) 2005 at Brussels. This was based on the total egg production and DF obtained from the linear regression model between DF and sea surface temperature (SST). The final biomass estimated, computed through the complete application of the DEPM in the total area was higher. Preliminary results of this survey were presented in a working document remitted to ACFM meeting celebrated from May 26 to June 2 at ICES Copenhagen.

WD 23/05

Santos, M., Uriarte, A.

Final Estimates of the Spawning Stock Biomass of the Bay of Biscay anchovy (Engraulis encrasicolus, L.) in 2004.

Document available from: Maria Santos, AZTI, Instituto Tecnológico Pesquero y Alimentario, San Sebastián, País Vasco, España.

E-mail: msantos@pas.azti.es

An application of the Daily Egg Production Method to estimate the Biomass and population at age of anchovy in the Bay of Biscay was carried out in 2004 by AZTI within the frame of the Spanish Fishery Monitoring National Programme contracted with the European Commission and co-financed by the Basque government. The survey covered southeast of the Bay of Biscay in May 2004 to estimate the adult anchovy Biomass.

A preliminary estimate of the SSB was already presented to WGMHSA in September 2004. However the estimate of the spawning frequency was not available and for the Biomass estimations several options of spawning frequency according to the past series of this parameter and the temperatures during those surveys were presented.

This document describes the final estimates of anchovy stock in the Bay of Biscay in 2004 obtained using the complete DEPM, including all adult parameter estimates for producing the spawning biomass and population in numbers at age.

WD 24/05

Skagen, D. W.

Mortality of NEA mackerel estimated from tag recaptures.

Document available from: Dankert W. Skagen, Institute of Marine Research, P.O Box 1870 Nordnes, 5817 Bergen, Norway

E-mail: dankert@imr.no

IMR has tagged mackerel on the spawning grounds from South-West of Ireland to Rona most years since 1969. In the last decades, approximately 20 000 fish have been tagged each year, except in some years when fewer tags were released due to poor working conditions. Internal steel tags inserted in the belly are used. The fish is caught by hand-line and the tagging technique is highly standardised with great care taken to avoid damage of the skin. Every fish that is tagged is length measured. Fish that look damaged are taken aside and used for biological examination, including ageing.

This study concentrates on estimates of total mortality that can be derived by comparing how tags from subsequent releases are represented in the material of recaptured tags. Such estimates have been presented to the WG regularly, and this is an update where all tags recaptured until the end of 2004 are included.

Mortality estimates were made by age. Because all tagged fish was measured at release time, and good age-length keys were available from each tag release, the age distribution associated with each recaptured fish could be established. Some fish were aged when recaptured. For this year's estimates, we have used the measured age for all those fish that were actually aged. Admittedly, this ageing may be inaccurate. There is no way to control this, but fish that apparently would have had negative or zero age at the time they were tagged were given age according to the age-length key. The same data set is used in the AMCI assessment method as an indicator of mortality, but in a slightly different way.

WD 25/05

Skagen, D. W.

Assessment of the Iberian Sardine stock with an area-disaggregated assessment method.

Document available from: Dankert W. Skagen, Institute of Marine Research, P.O Box 1870 Nordnes, 5817 Bergen, Norway

E-mail: dankert@imr.no

The assessment of the Iberian sardine stock was considered problematic for a number of years, and one important reason was thought to be the lack of universal survey information. Survey series that exist both from Spain and Portugal cover only national waters. Sardine may migrate to new areas as it grows older. Taking local survey data to represent the state of the whole stock then becomes misleading. Recognising these problems, it has been advocated on several occasions to assess the stock with an area-disaggregated model, where each survey could be related to the stock abundance in the specific survey area. Such models have not been readily available. The assessment tool AMCI, which has been used on a single area basis for routine assessment of Iberian sardine in the recent years has now been extended to include a migration model and assess the stock in multiple areas. This communication reports on studies to decide on a migration model, the extensions of AMCI and some early results.

The current view is that there are at least 3 West African stocks, separated by gaps in the distribution. The northernmost is in Northern Morocco, and it is not clear to what extent it extends to the southern coasts of Iberia, i.e. the Gulf of Cadiz and Algarve. The Gulf of Cadiz and Algarve are included in the Iberian area at present.

The SARDYN project was initiated to address the problems of stock identity and migration for Iberian Sardine. One of the goals was to design an assessment tool that took the insight in stock identity and migration that had been gained into account. The presentation here considers one of the approaches towards this goal, namely to use a conventional age structured statistical assessment model with area disaggregating and a simple migration model to relate the local surveys to the stock abundance in the respective areas. This was done by extending the currently used assessment software.

WD 26/05

Skagen, D. W.

Management of mackerel without annual assessment.

Document available from: Dankert W. Skagen, Institute of Marine Research, P.O Box 1870 Nordnes, 5817 Bergen, Norway

E-mail: dankert@imr.no

The annual assessments of mackerel have always been uncertain, and on some occasions, the WG has just projected the stock forwards with reported catches after having given up doing a full assessment. The main reason is the paucity of data, in particular that the only data to supplement the catch numbers at age are triennial SSB estimates from egg surveys. A separable model can be fitted almost equally well to a range of recent biomasses, by adjusting the fishing mortality accordingly. This allows the model to fit almost precisely to the last egg survey. The estimate of stock abundance in the past reflects what is needed to account for the catches as reported, taking an assumed natural mortality into account. Hence, the model will adapt to the assumed biomass at present and to the catches in the past.

Two important lessons can be learned from this: One is that the estimate of the present state of the stock is almost totally dependent on how the egg survey is interpreted. The other is that a good deal important information still can be extracted from the data.

So where it is impossible to produce a reliable assessment for the most recent years, it may be wiser to explore ways to advise on management without annually updates of the analytical assessment. This WD is an attempt to prepare some ground for this kind of advisory strategy.

WD 27/05

Ulleweit, J. and Zimmermann, C.

Spatial Distribution of the German Pelagic Freezer Trawler Fleet´s Activity in 2003 and 2004 obtained by VMS.

Document available from: Jens Ulleweit, Federal Research Centre for Fisheries Institute for Sea Fisheries, Palmaille 9, D-22627 Hamburg, Germany.

E-mail: jens.ulleweit@ish.bfa-fisch.de

The fishing activity of the German pelagic fleet depends on the accessibility of the different target species, the quota regulation and the market price. This document gives a description of the activity of the pelagic freezer trawlers throughout the years 2003 and 2004, using data of the satellite based vessel monitoring system (for spatial and temporal distribution), combined with logbook data (for information on total catch and species composition).

WD 28/05

Ulleweit, J., Panten, K., Zimmermann, C.

Catch and discard in the German mackerel and horse mackerel directed fishery.

Document available from: Jens Ulleweit, Federal Research Centre for Fisheries Institute for Sea Fisheries, Palmaille 9, D-22627 Hamburg, Germany.

E-mail: jens.ulleweit@ish.bfa-fisch.de

Within the EU-funded National Data Collection Program 9 German pelagic freezer trawler cruises directed on mackerel and horse mackerel were investigated by biological observers in 2003 and 2004. The data obtained were used for calculating discard rates of mackerel, horse mackerel and other species. In 2003 no discarding was observed, in 2004 discards of horse mackerel and mackerel were found. Discard rates depended on the target species: Discards in the mackerel fishery varied between 0% and 9% of the mackerel catch. Higher mackerel discard rates were found in the horse mackerel fishery. Other species discarded were herring, argentine, blue whiting and boar fish.

Only in the mackerel directed fishery discards were representing a considerable part of the total catch with more than 100t. Besides the disposing of unwanted by-catch the observed discarding practice can also be explained by high-grading. Length distributions and age compositions show differences between 2003 and 2004 which are indicating that more young fish was caught in 2004 in ICES-divisions VIIb and j.

WD 29/05

Uriarte, A.

Assessment of the Bay of Biscay anchovy by means of a seasonal separable VPA.

Document available from: Andrés Uriarte, AZTI, Herrera kaia, Portualde z/g, 20110 PASAIA, Gipuzkoa, País Vasco, España.

E-mail: auriarte@pas.azti.es

Since 1995 ICES carries out annual assessment of the Bay of Biscay anchovy by means of fitting a separable model of fishing mortality using the ICA. For all these years the assessment has remained almost unchanged concerning the auxiliary information and the use made of it for tuning purposes. Some of the problems which arise in the past years assessments are:

a) The assessment of these years shows the large marginal negative residuals for the separable model of the catches at age which is more pronounced in the recent years and for the poor represented age groups which deserve more analysis

b) The assessment has always assumed a constant natural mortality of 1.2, which is about the average value estimated earlier at the ICES working group.

c) Numbers at age 2 in the surveys seem to be overestimated in comparison with modelled population at age.

d) Over-parametrization of the ICA implementation for a short living species like anchovy, since a minimum of 5 classes at age are required for the model to run.

e) The different and individual fisheries which operate all year around are not dealt separately in the assessment.

The current WD presents an alternative evaluation of the Bay of Biscay anchovy including the seasonal assessment of the population and the fisheries operating all year around. At the same time allows for exploring some alternative assumptions in the natural mortality, along with other minor changes regarding the age classes.

WD 30/05

Zabavnikov,V., Shamray,E., Lisovsky, A. and Belikov, S.

The Russian annual aerial survey on mackerel in the Norwegian Sea during summer 2005.

Document available from: Vladimir Zabavnikov, Knipovich Polar Research Institute of Marine Fisheries and Oceanography (PINRO), 6 Knipovich Street, 183763, Murmansk, Russia.

Email: inter@pinro.ru

A Russian comprehensive aerial survey to map feeding mackerel was carried out in the Norwegian Sea during 15 July to 1 August 2005. Within the framework of aerial surveys, were carried out experimental research and joint works, as well as the surveys with the two Norwegian vessels (“Libas” and “Mogsterbas”) and two Russian research vessels (“Fridtjof Nansen” and “Persey-4”) that carried out trawl-acoustic surveys for mackerel. The researches were carried out under recommendations of PGAAM and Joint Russian-Norwegian Program and with Russian commercial vessels fishing mackerel.

This Working Document presents a short review of the aerial survey in the summer 2005.

ANNEX 1

Technical Minutes of the Review Group of the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy (WGMHSA)

Copenhagen, October 4-6, 2005

The Review Group met in Copenhagen, on October 4-6, 2005, and was attended by Hoskuldur Bjornsson, Hans-Peter Cornus, Ciaran Kelly (WG Chair), Denis Rivard (Chair).

General

The Review Group noted that a number of methods had been used to explore the dynamics of many of the stocks and that more than one method was found useful and often served to gain confidence in the assessment results. These assessments are typically data poor due to the limited number of fishery-independent observations that are available. The tendency has thus been to compensate for this relative lack of data by building relatively strong assumptions into the assessment models so as to avoid overparameterisation. The lack of convergence in the optimization process and the poor determination of survey catchabilities between successive evaluations are indications that these "systems" are still overparameterised. As such, many of the results obtained are considered solely as an indication of trends.

Exploration with Bayesian approaches were noted and could provide a framework to deal with the underlying assumptions in a statistical way (using priors). However, such priors should be given due consideration 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 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. Such models should be investigated for these stocks.

It was also noted that the current tendency in ICES is to look at projections in a long term context. For pelagic species, it is particularly important to look at forecasts in relation to environmental conditions.

Guidelines are needed from ACFM to guide Working Groups on the use of survey data as absolute or relative values in assessments. It is disconcerting to see that some survey estimates are still being used as absolute in some analytical assessments without due testing or consideration of the impact this may have in the results. Also, Working Groups should use a standard table for describing the model setup, including a section on the parameters being estimated and the objective function.

If AMCI model is used, diagnostics should be provided in addition to residual plots. The Review Group also suggests that catch curves should be presented in a more readable format/manner and that models like the Shephard-Nicholson model be used routinely to get and idea on CV in the data.

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:

- Catches 2004: 611461t including discards of 10972 t is the WG estimate of catches. Official catches 593606t.
- TAC 421865 t (see page 36).
- Despite the data sampling regulation for EU-member states only few discard information was reported to the Working Group.
- There are indications of substantial high-grading in some fisheries.
- Insufficient sampling in Divisions IIa, VIIc,d, VIIIa,d and Sub-area V.
- 90% of catch in numbers in 2004 comprised of age groups 1 to 7, with age groups 2 and 3 accounting for 55%.
- Year classes 2001 and 2002 are confirmed to be above average whereas year class 2000 appears to be weak.
- The 2002 year class is the strongest on record (30 years). As there are no recruitment indices available the size of this year class is only determined from catch at age data using separable model. This year class will have considerable weight in the landings and SSB in coming years.
- Catch curves from landings are not provided.
- The lack of tuning data is what bothers most. 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.
- B_{pa} is estimated from data on SSB at January 1st but predictions use spawning stock at spawning time. This mismatch needs to be taken care of in the next benchmark assessment.

Information relevant for the assessment

The Working Group reviewed and commented on information relevant for assessment purposes:

- WGMEGS Egg survey estimates of spawning biomass in 2004
- Fecundity and atresia
- 2005 mackerel egg survey in the North Sea
- Bottom trawl survey CPUE for Southern component
- Preliminary analysis of Quarter 4 Western Bottom Trawl Surveys as recruit index
- Mortality and biomass estimates from tag recaptures
- Acoustic survey in the North Sea
- Acoustic estimates of mackerel in the Iberian peninsula and Bay of Biscay
- Effort and CPUE
- Distribution of adult and juvenile mackerel from fishery data and surveys

The Working Group proceeded, as done last year, to use the Mackerel egg survey as the only fishery independent data in the assessment. The change in SSB estimates from that update for SSB in 2004 is minor.

The Review Group proposed in 2004 that the Working Group take a closer look at the methods used to estimate Z from the tagging. The Working Group responded by presenting investigations using the Jolly-Seber Method based on the Norwegian tagging program which covers more than 30 years. Although the resultant overall mortality is in the range of what is indicated by the assessment, a number of questions are still pending with respect to the use of this method for mortality and population estimation, e.g.:

- How are the missing returns due to discarded fish affecting the results?
- Were the return data corrected by fishing effort and what would be the impact of variable effort over time?

- What is the effect of the use of a restricted tagging area (North Sea) and specific fisheries?
- Also, the spatial aspect of the tag recovery procedure needs to be investigated, as the magnets detecting tags are only located in Norway.

The Review Group proposes that the Working Group should investigate further these tagging issues for the next benchmark assessment.

The Review Group complimented the Working Group for doing a thorough exploration of "data and models". Within others, simulations were conducted to examine the performance of ICA using the "absolute fit" or the "relative fit" under differing assumptions of variation in the observations, stock and differing levels of bias in both the catch and egg survey:

- Population properties from converged VPA, with stochasticity added
- Bias in the egg survey and/or catch data tested over the range 1-0.2 (meaning no bias to 80% bias)
- Output from the simulations examined through 6 parameters

The results are presented in the fig. below:

		Source of Bias			
		Catch Bias		Survey Bias	
ICA Assessment Method	Parameter	**SSB**	**F**	**SSB**	**F**
Absolute Fit	Terminal	Small Bias	Biased	Biased	Biased
	Historic	Biased	Small Bias	Small Bias	Small Bias
	Trend	Biased	Biased	Biased	Biased
Relative Fit	Terminal	Biased	Unbiased	Unbiased	Unbiased
	Historic	Biased	Small Bias	Unbiased	Unbiased
	Trend	Unbiased	Unbiased	Unbiased	Unbiased

In conclusion, in the presence of bias in the fishery data, advice on catch can only be given in a relative sense. As the management of this stock is based on fishing mortality the Egg survey SSB is best used as relative index in the assessment.

By taking into account all information and investigations, the Working Group concluded to conduct the 2005 assessment with the same settings as used in the assessment in 2004 except for:

- The period of separable constraint was increased from 12 to 13 years to include the SSB index time series over the period 1992 – 2004
- the index of SSB from the egg surveys was used as relative index (the use of SSB index as absolute by the Working Group was rejected by ACFM in October 2004)

Methods used for estimation:

- ICA
- Recruitment: no information in any model on tuning those. Recruitment arises from separability assumption and observed catches.

A number of issues related to treating the SSB index as relative were discussed. In particular:

- The trend in the model SSB now matches the survey.
- The residual pattern from the 2004 catches is opposite to 2003, possibly indicating a change in selection pattern. This needs to be investigated.
- The presence of a strong retrospective pattern.
- B_{pa} has to be reviewed.

The biases potentially arising from misreporting were also discussed this year. It was noted that misreporting could be considerable but there is no estimate available. In that context, it should be noted that the forecasts provided in the ICES advice have been provided in terms of landings (excluding discards) for 2006. This was done to avoid confusion regarding the actual level of discard that is accounted for in forecasts due to the inclusion of historical info on discards (which is not believed to capture the scale of the problem). To do so, the catch forecasts were adjusted by a factor of 97.6%, based on the observed percentage of discards to ACFM catch in recent years (2002-2004). This quick fix was believed to be necessary to avoid misinterpretation of the forecasts. As such, the "Catch for 2006" column was relabeled "Landings for 2006". A better approach would have been to use the approach used by other Working Groups to include a "discard" column in the forecast table. However, this is meaningful only when the there is sufficient information on the actual level of discards so that the scale of the problem is believed to be properly captured in the assessment. This does not appear to be the case here.

In summary:

- The assessment now uses the mackerel egg survey tuning series as a relative index of abundance.
- Treating the surveys as relative makes the estimated fishing mortality less sensitive to bias.
- Current use of ICA model appears to be too sensitive to variability in the SSB estimates from egg surveys. Retrospective patterns experiences considerable changes every 3 years when new egg survey estimates are available. This might be caused by relatively few data points (5 surveys).
- Trends from assessment in accordance with information from other sources.

Horse mackerel

Catches from the North Sea stock constitute a substantial part of the total catch. This, in connection with uncertainties with respect to the division between stocks in the channel, makes estimates of landings from each stock uncertain.

The fisheries for western horse mackerel are limited by TAC, while those for North Sea horse mackerel are in practice not limited by TAC.

Catch by country have not been not provided. This Table needs to be updated annually.

Western horse mackerel (benchmark assessment) .

Catch-at-age models predict a larger decrease in the spawning stock when the 1982 year class was disappearing than the egg surveys do. Tuning with the egg surveys leads to very low estimated fishing mortality. The problem is likely caused by the use of too high M (0.15). Development of the very large 1982 year class indicates that M for this stock is low (except possibly for natural mortality on the recruits) and the data could even be sufficient to estimate M. Lower M would lead to higher estimated F as the estimate of Z would be unchanged. The value of M should be investigated in future assessments.

There are convergence problems and such problems are not unexpected as fishing mortality and total annual mortalities are likely very low.

The lack of recruitment index is a concern, in particular when the fisheries could be targeting the younger age groups. As the fisheries only remove a small fraction of the total stock every year, this lack of information does not cause a risk to the stock. Nevertheless, having a recruitment index would be beneficial on the long term. Are there any existing surveys that go back to the period when the 1982 year class was recruiting and can those provide a satisfactory index of recruitment?

Egg surveys cover a period with reasonable contrast in spawning stock so they are quite useful, even though they can not be used as absolute index.

The very big 1982 year class causes problems in assessment, in particular in the backward calculations involving the plus-group. The 1982 year class was very big as a plus group (12+) and a model formulation specially designed for this situation, like the SAD model, would be the most reasonable approach.

Work on Harvest Control Rules (HCR) indicates that changing the selection pattern so as to target more the juveniles might lead to increased yield from this stock (Section 5.11). The analysis in 5.11 indicates that, for a given catch, increasing the proportion of the juvenile catch leads to a reduced risk of the stock falling below B_{lim}. With the price of juveniles being higher than that of adults, there is little danger of high grading in the juvenile fishery. The same things could probably apply to the yield per recruit analysis.

Appropriate statistical methods to make inferences about the frequency of huge year classes from one occurrence need to be developed.

Southern Horse Mackerel (update assessment).

Catch curves need to be improved and year class labels put on them. To illustrate, an R-routine is provided in Annex.

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).

Zeros in the surveys seem to be treated as missing values (which they are not except in years when the survey was not conducted).

Survey indices look very noisy for use in an analytical assessment. The AMCI assessment was also unstable until some major restrictions on the freedom of the model had been done. The Review Group considers it is premature to use these preliminary assessments as the basis for providing advice. The Working Group is invited to continue its work and exploration in this area.

While a yield per recruit has been provided, the results depend upon the selection pattern estimated. As such, prior to proposing reference points arising from the yield per recruit analysis, a more stable assessment should be obtained.

The catch Table 6.2.1 does not match the data provided on Table 3.3.1 for the Southern stock. These tables need to be reconciled.

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.

There is no clear tracing of cohorts possible in the catch-at-age matrix. There is, however, some signal/information that is not fully exploited in the assessment and this needs to be explored further in future years. It is noted that the selection pattern changes over time and that this complicates the interpretation of catch data.

Catch curves appear to be unreliable and cannot be used for mortality estimation. Some even show negative mortalities.

Abundance indices from the IBTS Survey reveal highly variable distributions from year to year. 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 (benchmark assessment).

Bayesian approach. The *priors* on catchability in acoustic and DEPM survey are likely too informative leading to a relatively good agreement between treating the indices as relative and absolute that may be spurious. It must be considered that there is not much information to estimate certain parameters from the data so the priors could potentially be dominating. The reviewers believe that the Bayesian approach offers potential as a way forward for the assessment of this stock. The method should include forecasts that provide information on all population metrics that are typically presented in traditional forecasts. Also, additional thoughts should be given on how the method can be used for providing advice in the context of current, or future, management regimes. For instance, if the method depends on the availability of specific surveys for providing catch advice, then the timing of assessments, or of the management process, is a key aspect that needs consideration. Other observations:

- The 2004 year class is so small that the priors on recruitment could have a major effect on the estimate. While this is unlikely to change the perception that the stock is below B_{lim}, it should be addressed.
- The timing of different events within the year is important (M before spawning and catch before spawning) and seems to be taken care of in the biomass model.
- When using such models, the user should start with non-informative *priors*. Informative priors should be brought in only after due consideration, if they are needed to put more structure or "stiffness" in the model. If informative priors are retained, they need to be clearly identified and coupled with an analysis of their influence on the results (possible biases, scaling, etc.).

Mortality is very high (both fishing and natural). Further discussions seem to indicate that this in not related to a physiological phenomenon such as the high spawning mortality like for capelin but the reasons for such high mortality seem elusive (predation, food supply, etc.).

The B_{lim} value of 21 000 t and B_{pa} value of 33 000 t do not fit F_{pa} of 1.0 – 1.2. If the stock is just above B_{pa}, the fishery will drive the spawning stock below B_{lim} even though only part of the fishery is before spawning. Then there is no room left for error in assessment that the difference between B_{pa} and B_{lim} is supposed to cover. As such, F_{pa} needs to be revisited and this should be done in any case as we move towards a new approach for the assessment.

There is no way to predict recruitment reliably and, as there is usually only one age group dominating the fishery, the TAC can not be determined until recruitment has been estimated. To be able to determine TAC in time, recruitment survey measuring age 0 in quarter 4 need to be continued and compared to surveys in quarter 1, landings and results from DEPM to see if it can be used to predict recruitment reliably.

An assessment done in September has and will not have any value for predicting TAC for next year.

Anchovy in subarea IX (update assessment).

The Review Group notes that progress has been made in the investigation of possible approaches for the assessment of this stock and that the model formulation and assessment approach are under active investigation. In particular, a lot of work has been done with exploratory runs and *ad hoc* tuning.

The GLM model was used for estimating standardized CPUE, but more information would be needed on the exact form of the model, residuals and statistics for a better appreciation of the results.

The Review Group noted that there is a discrepancy between the results from CPUE and acoustics in the last year, the standardized CPUE indicating better state of the stock than acoustics.

Sardines in VIIIc and IXa (update assessment).

The AMCI assessment uses 3 acoustic surveys and one DEPM survey with 2 data points. One of the surveys stops in 2001 and its use in the assessment is questionable. The surveys that are currently conducted are the Spanish acoustic survey in March and the Portuguese acoustic survey in March. The surveys cover different part of the distribution area of the stock during the same time so they should be added, possibly by multiplying one of them by an estimated weighting factor.

Some observations on the indices and the tuning:

- The Portuguese March survey was not conducted in 2004 so last year the most recent data point was missing.
- The Portuguese survey measures much more age 1 fish than the Spanish survey but for older fish the order of magnitude is similar.
- Both surveys indicate that the 2004 year class is large, as do the catches in 2004.
- Treating the DEPM survey estimates as absolute is questionable and residuals from the DEPM should be shown with other residuals (they were omitted in the summary graphs). The model should also be run without the DEPM indices to see how much effect they have on the estimated spawning stock (see below). When more points are available and added to the tuning, the index should be used as a relative measure of abundance.
- Residuals of age 0 in the catches are rather large. It was noted that these had been down weighted (by a factor of 0.1) for the catch data). The same applies to less degree to age 1.
- More work should be done in looking at the sensitivity of the assessment results to increased weighting of different data. More diagnostics need to be produced, not only residuals.

Acoustic measurements in the bay of Biscay indicate that this sardine stock may be of the same order of magnitude as the stock in VIIIc and IXa. This makes it important to clarify the relationship between those stocks.

As noted above, the AMCI model provided by the Working Group as the final run used the egg survey estimates as absolute (with the other fishery independent surveys used as relative indices). While this was used in the advice, the next benchmark assessment should treat the egg surveys as relative indices. ACFM carried out exploratory runs to see the effect of removing the egg survey from the tuning, as well as the effect of treating these survey estimates as relative. For the AMCI model to converge, additional structure was needed in the form of assumptions on the selection pattern for the plus-group (taken as the average of ages 4-5). These are less stringent assumptions than assuming that the egg surveys provide an absolute estimate of SSB. The results led to a SSB estimate in the range of 360,000-370,000 for 2004 (compared to 430,000 t) and to a fishing mortality estimate of around 0.27, as compared to 0.23 in the WG run). The impact on catch forecasts was not evaluated but is likely to be much less given that the forecasts are done on the basis of status quo fishing mortality. Nevertheless, this should be addressed in future assessments of this stock.

As reference points are not defined for this stock and as the assessment methodology is still maturing, the Working Group should have a look again at defining reference points in the next benchmark assessment. Accordingly, Yield-per-recruit had not been provided and should be carried out in the benchmark assessment.

Appendix

R or Splus script to plot catch curves as the Review Group recommends.

```
 #Function to plot lines with certain slope on a plot.  Different scaling if used on a
zplot <-
function(z = 1, col = 30, n = 10, trellis = T)
{
		par(err = -1)
		# convert to 10 log
		x1 <- par()$usr[1:2]
		y <- par()$usr[3:4]
		y <- 10^y
		mx <- min(x1) - diff(x1) * 5
		x1 <- seq(mx, x1[2], length = n * 6)
		dx <- diff(x1)[1]
		x1 <- matrix(x1, length(x1), length(x1))
		for(i in 2:nrow(x1))
			x1[, i] <- x1[, i - 1] + dx
		y1 <- matrix(max(y), nrow(x1), nrow(x1))
		for(i in 2:nrow(y1))
			y1[i,  ] <- y1[i - 1,  ] * exp( - z * dx)
		if(trellis)
			for(i in 1:ncol(x1))
				lines(x1[, i], log10(y1[, i]), col = col)
		else for(i in 1:ncol(x1))
				lines(x1[, i], (y1[, i]), col = col)
}
# Script for plotting catch curves
# assumes a dataframe with the names of the columns year, age, yearclass and ObsCno
# Uses the function zplot
  tmp3 <- tmp[!is.na(match(tmp$yearclass,c(1976,1985:1999))),]
    print(xyplot(ObsCno~age
|factor(yearclass),data=tmp3,scales=list(cex=0.9,y=list(log=T,exp=F,alternating=F)),
    ylab=list("number in catch million
fishes",cex=1.2),xlab=list("age",cex=1.2),par.strip.text=list(cex=1.3),as.table=T,layout=c(4,4),
    panel = function(x, y)
    {
      pltgrid(T,T,col=30)
      zplot(z=0.6,col=50)
      lines(x,y,lwd=2)
    }
  ))
```