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

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Executive Summary

The Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy (**MHSA**) met at ICES headquarters from 7 to 16 Sept 2004, 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 **full analytical assessment** is available for Northeast-Atlantic Mackerel (a benchmark assessment was performed this year) and Sardine in VIIIc and IXa (update assessment), while **exploratory or experimental assessments** have been conducted for most other stocks. **The** stock definitions of Horse Mackerel have been redefined this year.

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 catch and sampling data has increased over the last years. However, some species and area misreporting is known to occur. Information on discards is inadequate. The WG performed a benchmark assessment, thoroughly exploring input data and a variety of assessment models. The results indicate that the SSB for this stock has been stable over more than the last decade, and suggest that the stock can withstand the current fishing pressure. The WG spent a significant amount of time on the exploration of multi-annual management schemes with fixed TACs. The NEA Mackerel is considered an ideal example stock for such a management, as new independent information on stock size is available only every third year.

Horse Mackerel. The stock definitions for the three stocks of this species in the ICES area have been adapted this year following reviewed information from the recently finalised research project HOMSIR. Div. VIIIc now belongs to the distribution area of the Western stock, which made a number of updates of catch and survey data necessary. **Western Horse Mackerel** infrequently produces exceptionally strong year classes. A number of different models were developed by the group over the last years to accommodate this peculiarity. The input data is, however, considered to be poor: independent recruit estimates are not available, and the only fishery independent information (egg production) currently cannot be used as biomass estimate. For **North Sea Horse Mackerel**, very little information from catch and surveys is available. Data exploration for **Southern Horse Mackerel** (by means of XSA) indicates that the stock is stable and can withstand current fishing pressure. Part of the tuning data series are not available any more because of the amended stock definitions. The southern stock is targeted by a variety of fisheries, most of them are mixed pelagic or demersal fisheries.

Sardine is assessed only in part of the distribution area: in VIIIc and IXa. Stock structure is currently under investigation. An update assessment using the AMCI model was performed. This assessment showed this stock to be increasing due to good recruitment in 2000. Independent measures of stock size confirm this estimate (for VIIc and IXa) at probably greater than 400,000 t. Catch and survey data between areas show inconsistent signals, which may be due to migration of the adults. Catches outside the assessment area have been increased over the last years, and the WG started to collate data on these. Acoustic surveys for VIIa and VIIb indicate that the biomass in this area may be in the order of several hundred thousand tonnes.

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 0- and 1-yr old fish. Two surveys are performed in the distribution area of **Bay of Biscay-Anchovy** (Area VIII), which provide conflicting signals. Traditional assessment models (VPA's) and management schemes which set the TAC based on these might not be suitable for a species with such stock dynamics. The WG continued to explore different approaches for the assessment and management of these stocks.

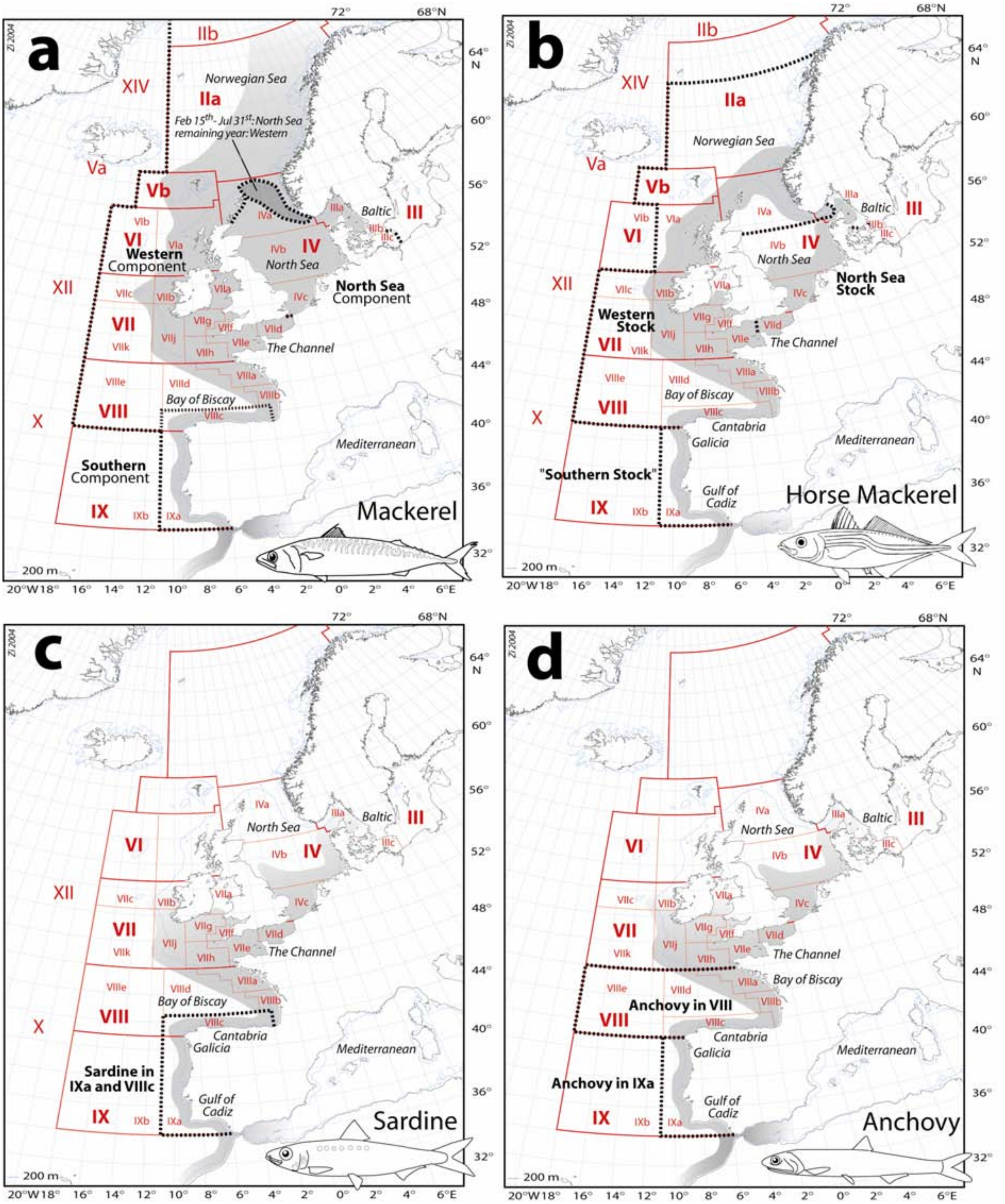


Figure 0.1: Distribution of the four species assessed by the ICES Mackerel, Horse Mackerel, Sardine and Anchovy WG: Stock and component definitions as used by the 2004 WG. Map source: GEBCO, polar projection, 200 m depth contour drawn. **a: Northeast Atlantic Mackerel** (with North Sea, Western and Southern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

Contents

1 Introduction

1.1 Terms of Reference

The **Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine, and Anchovy** [WGMHSA] met at ICES Headquarters from 7–16 September 2004 to address the following terms of reference, as decided by the 91st Statutory Meeting:

a) assess the status of and provide catch options for 2004 for the stocks of mackerel and horse mackerel (defining stocks as appropriate);
b) assess the status of and provide catch options for 2005 for the sardine stock in Divisions VIIIc and IXa;
c) assess the status of and provide catch options for 2005 for the anchovy stocks in Subarea VIII and Division IXa;
d) consider updated information on the stock structure of horse mackerel;
e) for sardine update information on the stock identification, composition, distribution and migration in relation to oceanographic effects;
f) finalise the evaluation of the harvest control rule for anchovy fishing;
g) provide specific information on possible deficiencies in the 2004 assessments including any major inadequacies in the data on catches, 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 from these deficiencies for the assessment of the status of the stocks and for the projection should be clarified;
h) comment on this meeting's assessments compared to the last assessment of the same stock, for stocks for which a full or update assessment is presented;
i) document fully the methods to be applied in subsequent update assessments and list factors that would warrant reconsideration of doing an update, and consider doing a benchmark ahead of schedule, for stocks for which benchmark assessments are done;
j) consider the report of the Study Group on the Bycatch of Salmon in Pelagic Trawl Fisheries with regard to the most appropriate methods for estimating salmon bycatch in pelagic fisheries.

Terms of reference a –g & i are addressed under the respective stocks. Where relevant, term of reference h is also addressed specifically for each stock. In addition, and overview of the input data and their shortcomings is given in Section 1.3, and an overview of the assessment methods in Section 1.4. Term of reference j is addressed in Section 2.2.4.

The present report is structured as in previous years. There is a new Section 1.8 which provides summary information on ecological factors affecting small pelagics. This information is intended to guide the reader to the relevant ICES groups or publications, rather than deal with the issues in depth. In the case of Sardine this issue is dealt with in more detail in Section 8.2, addressing term of reference e. In addition to the Terms of Reference, the WGMHSA was requested to perform a "Benchmark" assessment for NEA Mackerel . The structure of Section 2 reflects this with a greater consideration given to data and model exploration. All other assessments, with the exception of Sardine in VIIIc & IXa, which are considered as "Update" are either in a developmental or an exploratory stage.

1.2 Participants

Pablo Abaunza	Spain
Jose Mª Bellido	Spain
Sergei Belikov	Russia
Miguel Bernal	Spain
Mark Dickey-Collas	Netherlands
Leonie Dransfeld (part time)	Ireland
Erwan Duhamel	France
Guus Eltink	Netherlands
Emma Hatfield	UK (Scotland)
Leire Ibaibarriaga	Spain
Svein A. Iversen	Norway
Jan Arge Jacobsen (part time)	Faroe Islands
Ciarán Kelly (Chair)	Ireland
Marco Kienzle (part time)	UK (Scotland)

Marta Lopes	Portugal
Jacques Massé	France
Alberto Murta	Portugal
José de Oliveira	UK (England and Wales)
Fernando Ramos	Spain
David Reid (part time)	UK (Scotland)
Beatriz Roel	UK (England and Wales)
Eugeny Shamrai	Russia
Alexandra Silva	Portugal
Dankert Skagen	Norway
Aril Slotte (part time)	Norway
Per Sparre	Denmark
Andres Uriarte	Spain
Dimitri Vasilyev	Russia
Begoña Villamor	Spain
Christopher Zimmermann	Germany

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 levels have decreased for mackerel (to 80%) and are below the long term average. The proportion of the sampled horse mackerel catch has again increased after the low sampling intensity in 1999. In 2003 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. This year samples were provided by France. However samples should be obtained from all areas where sardines are caught. Anchovy sampling is similar to 2002 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	% 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	617330	80	1,212	148,501	19,779

In 2003 80% of the total catch was covered by the sampling programmes. This represents a decrease since last year. The number of samples and numbers of fish aged and measured have all decreased in 2003. Spain, Portugal and Russia carried out intensive programmes on their catches, as in 2002. Norway and Scotland also continued to sample their entire catch thoroughly. There have been marked decreases in the sampling levels for the Netherlands, Ireland, Germany and Denmark from 2002 to 2003. England & Wales' proportion of catch sampled increased from last year's 15% to 17% in 2003; however, the total number of samples taken and measured decreased. France, the Faroe Islands, Northern Ireland, Belgium, Iceland and Sweden did not sample any catches, although significant catches are only taken by the first three of those countries.

There were more areas than in previous years that were not adequately sampled. In general these areas were in the southern North Sea, the west of Ireland, the English Channel and north Biscay (with the exception of VIIId)

Less than 50% of the catch was sampled in IVc, VIIb,c,d, and VIIIa,b. Of these areas, significant catches of about 40,000t were insufficiently sampled in VIIb,d, and VIIIa.

No sampling of catches was carried out in IIb, IIIa, IVb, VIb, VIIa,g, and VIIIe. However these areas represent only minor catches of about 4,000 t in total.

Figures 1.3.1.1 & 1.3.1.2 illustrate sampling levels of mackerel by mapping the numbers measured and numbers aged relative to the size of the catch.

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	2	0	0	0	0
Denmark	27,621	88	14	867	854
UK (England & Wales)	24,451	17	27	3,133	1,449
Faroe Islands	14,014	0	0	0	0
France	22,906	0	0	0	0
Germany	24,059	45	36	19,293	821
Iceland	122	0	0	0	0
Ireland	67,355	64	15	2,964	1,121
Norway	163,406	100	186	25,050	1,864
Portugal	2,749	100	295	11,512	1,405
Russia	40,026	100	154	34,714	1,528
UK (Scotland)	146,131	100	163	25,911	5,211
Spain*	23,583	100	231	15,024	3,070
Sweden	4,450	0	0	0	0
The Netherlands	30,468	86	74	6,402	1,949
UK (Northern Ireland)	12,426	0	0	0	0
Total	603,770	80	1,212	148,501	19,779

∗WG 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	% 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

The overall sampling levels on horse mackerel appear to have increased in 2003, but the number of samples has decreased. The large numbers of samples and measured fish are due mainly to intensive length measurement programs in the southern areas. In 2003, 63 % of the horse mackerel measured were from Division IXa.

Countries that carried out comprehensive sampling programmes (>90%) in 2003 were Netherlands, Portugal, Spain and Norway. Sampling intensity from Ireland and Germany was slightly higher than last year, 71% and 63% respectively. 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 Group remain concerned about the low number of fish that are aged.

Figures 1.3.1.3 & 1.3.1.4 illustrate sampling levels of horse mackerel by mapping the numbers measured and numbers aged relative to the size of the catch.

The following table shows the most important horse mackerel catching countries and the summarised details of their sampling programme in 2003.

Country	Official catch t	% Catch covered by sampling programme	Samples	Measured	Aged
Belgium	5	0.0	0	0	0
Denmark	14,641	Not available	4	366	118
UK (England &Wales)	6,405	0.0	0	0	0
Faroe Islands	809	0.0	0	0	0
France	12,710	0.0	0	0	0
Germany	18,762	62	44	18,447	966
Ireland	36483	71	29	5,618	1,968
Norway	20,515	99	11	975	413
Portugal	11,241	100	939	130,736	1,412
Russia	2	0.0	0	0	0
UK (Scotland)	722	0.0	0	0	0
Spain*	32,228	100	384	26,270	2,551
Sweden	1,074	0.0	0	0	0
The Netherlands	71,445	98	85	18,151	2,125
Total	194,184	79	1,568	200,563	9,553

∗ 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	11,739	n.a.	4	366	118
UK (England & Wales)	4,440	0	0	0	0
Faroes Islands	59	0	0	0	0
France	10,383	0	0	0	0
Germany	15,826	71	31	14,648	856
Ireland	35,855	71	29	5,618	1,968
Norway	20,315	99	11	975	413
Russia	0				
UK (Scotland)	672	0	0	0	0
Spain*	24,588	100	257	15,913	2,379
Sweden	1,074	0	0	0	0
The Netherlands	47,327	97	60	14,509	1,500
Total	172,479	76	392	52,029	7,234

∗ 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	5	0	0	0	0
Denmark	2,902	0	0	0	0
UK (England & Wales)	1,965	0	0	0	0
France	2,326	0	0	0	0
Germany	2,936	19	13	3,799	110
Ireland	0				
Norway	0				
Sweden	0				
The Netherlands	24,118	100	25	3,642	625
Total	35,052	67	38	7,441	735

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	11,241	100	939	130,736	1412
Spain*	8,324	100	172	10,357	172
Total	19,565	100	1,111	141,093	1584

∗ 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.

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

The summarised details of individual sampling programmes in 2003 are shown below. These catches cover all areas where sardine is caught (VII, VIII and IXa.)

Country	Official catch t	% Catch covered by sampling programme	Samples	Measured	Aged
Spain	32,416	100	243	25,175	3,584
Portugal	66,528	100	513	67,917	7,045
France	21,518		71	6,668	1,403
UK (England &Wales)	4,929	0	0	0	0
Germany	16*	25	3	835	292
Total	125,407	57	830	100,595	12,324

∗ WG catches
* includes 4 tonnes of discards

The overall sampling levels for sardine are adequate for the stock area VIIIc and IXa. Length distributions and catch-at-age data in 2003 of Sardine by France in areas VIIIa,b were reported to the WG. Details are listed in section 7, where similar information is also reported for 2002. Catches of sardine in Area VII are not appropriately sampled. This is considered to be important given that catches in this area are increasing.

Anchovy

The sampling programmes carried out on anchovy in 2003 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 XIII+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

The sampling programmes for France and Spain in Sub-area VIII in 2003 are summarised below.

Country	Division	Official catch	% Catch covered by sampling programme	Samples	Measured	Aged
France	VIII a, b	7,593	99	73	5,506	1,638[1]
Spain∗	VIII a	0	-	-	-	-
Spain∗	VIII b	941	100	35	2,256	671
Spain∗	VIII c east	2,061	98	33	2,141	1,573
Total	VIII	10,595	99	141	9,903	3,882

∗ WG catches [1]1,099 from the scientific survey

The sampling programmes for the fisheries in Division IXa in 2003 are summarised below.

Country	Division	Official catch	% Catch covered by sampling programme	Samples	Measured	Aged
Spain∗	IXa	4,791	100	64	12,178	1,442
Portugal	IXa	478	0	0	0	0
Total	IXa	5,269	91	64	12,178	1,442

∗ WG catches

No catches from Portugal were sampled for length and age in Division IXa in 2003.

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.

For mackerel and horse mackerel it was concluded that in the southern areas the catch statistics appear to be satisfactory. In the northern areas it was concluded that since 1996 there has been a considerable improvement in the accuracy of the total landing figures, this continues to be the case. The reason for the improvement in catch statistics are given as: tighter enforcement of the management measures in respect of the national quota and increasing awareness of the importance of accurate catch figures for possible zonal attachment of some stocks. In 2003 the misreporting of catches from Division IVa into VIa is at the same level as last year. Underreporting of catches because of trans-shipping of catches at sea has decreased in recent years because most of the catches are now landed to factories ashore.

France now supplies catch data to this WG. However, no sampling of their catches of mackerel or horse mackerel was carried out. Catch data for sardine from Ireland was not available this year.

1.3.3 Discards

Mackerel

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 in numbers at age. The difference in prices has decreased since 1994 and the Working Group assumed that discarding may have 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. The level of discards is greatly influenced by the market price and by quotas.

One nation alone provided discard data for 2003: age disaggregated discard data from the Scottish fishery in the first quarter in areas IVa and VIa and in the fourth quarter in area IVa were available to the working group. The Scottish fleet is primarily composed of single pelagic trawlers. In Div. IVa in the 1st quarter, the discard of around 4,000 tonnes consisted mainly of 2 year old fish (the 2001 year class), while in the 4th quarter discards of around 5,000 tonnes mainly consisted of 1 year old fish (the 2002 year class). 75% of Quarter 1 discards in IVa were 2 year olds. Almost 90% of Quarter 4 discards were juvenile fish: 70% 1 year old and 19% 2 years old. Discards in VIa were minimal, around 90 tonnes, with a wide age range seen in the samples.

The Working Group highlights the possibility that discarding of small mackerel may be a problem in all areas, particularly if a strong year classes enters the fishery, as is believed to be the case for both the 2001 and 2002 year classes. Certainly the only discard information available, for IVa, shows a high discard of juvenile fish.

Irish, Northern Irish and Scottish vessels constitute a pelagic midwater trawl fleet in IVa. The Scottish catch comprised about 90% of that fleet component's catch in Q1 and around 70% in Q4. Its Q1 catch was 60% of the total mackerel catch in IVa; its Q4 catch was 33% of the IVa total. Other nations with considerable catches fishing in IVa include Denmark, England & Wales, Faroe Islands, Germany, Ireland, the Netherlands, Norway. No discard information was available from any of these countries in 2003.

The other areas of high catch are IIa (around 50,000 tonnes) and VIa (about 117,000 tonnes). Norway and Russia have large catches in IIa, for which no discard information is available. England & Wales, Faroe Islands, France, Germany, Ireland, the Netherlands and Northern Ireland have substantial catches in VIa, for which no discard information is available.

For the major areas covered by the mackerel fishery, quarterly discard sampling by fishing technique, by ICES Division (EU data regulation 1639_2001) is now a requirement. Clearly, this has not happened in 2003.

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.

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.**

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 are in progress.

Anchovy

There are no estimates of discards in the anchovy fishery.

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

The Netherlands and Germany will try to resolve their age-reading differences of juveniles (section 5.5.1) in 2004. Netherlands will carry out a horse mackerel otoliths exchange in 2005.

Anchovy

Since the beginning of the 90s, double anchovy otoliths reading were done by AZTI and ifremer. Within PELASSES project, workshops have been conducted to standardize the age readings of sardine and anchovy.

For **anchovy** it took place in S. Sebastian in January 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). An exchange of otoliths of the anchovy in IXa (Cadiz) have also taken place (Garcia 1998).

According to the discrepancies which appeared some year in Group 2 of Bay of Biscay anchovy, new exchanges of samples will be done between Spain and France on the 2 previous years otoliths in 2005 in order to check particular situations.

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. WD1996).

Sardine

The last sardine age reading workshop was carried out in 2002 within the framework of project PELASSES, and involved otolith samples collected within the area from the Celtic Sea to the Gulf of Cadiz (Soares et al., 2004).

There is an exchange of otoliths going on in 2004 and a workshop to discuss the results from this exchange is planned for 2005.

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.

Horse Mackerel

There is no new information on horse mackerel fecundity. Information on the spawning nature of horse mackerel is now urgently required. This is a consequence of discussions at WGMEGS (2003) whereby it is now uncertain if horse mackerel is a determinate spawner. In light of the recent findings, SSB indices from the survey are no longer considered as valid, and a different method will be needed to provide a fishery independent index for this species (this is further discussed in section 6.3.1).

Sardine

The exploratory analysis of input data highlighted the need to revise the estimates of maturity ogives and stock weights at age of the sardine stock (sections 8.4.3 and 8.7). Maturity and weight at age estimates from surveys are different from catch data estimates and may change considerably during the spawning season due to the seasonal cycle of maturation and fattening. There are gaps in the survey series and the data sets and methodology used to provide these estimates have not been consistent through time. There is also evidence of an increase in stock and catch weights at age in the last ten years while the proportion of mature 0-group fish has changed considerable along the time series. 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 is inadequate sampling of anchovy from the French fishery in quarter 1.

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 MHMSA WG

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 Figures 1.3.6.1-2 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 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. Sampling effort will be tabulated against official catches by species (as in this Section). Further, maps 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 (Figures 1.3.1.1 and 1.3.1.2).

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. 2004. 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 MHSA WG**, 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 2004 mackerel assessment the time series had to be truncated due to poor data in the earliest years.

Review of recommended progress and future developments. During the last four years WGMHSA has pressed for the urgent need for a database-based input application for the handling of commercial catch and catch at age data. WGMHSA stated that this should preferably be developed under the auspices of ICES and meet the requirements of more than the pelagic groups in the ICES environment. It was the WG's opinion that this database could solve not only the immediate data handling problems, but also most of the quality control issues at the data input level. The working group's view was recently supported by the newly established Study Group on Management of Integrated Data, which identified as a key issue for ICES the development of such a database (ICES CM 2004/ACE:05).

In spite of the considerable effort that has been expended by different WGs (especially WGMHSA and HAWG) since 1999 (e.g. Zimmermann et al WD 2000), and continuous announcements that an input database would be available for the WG's use within reasonable time, there has been to date no visible progress on this issue. Sufficient funding for the development has been available since 2002 (granted by the Norwegian government on the occasion of ICES' centennial).

The WG expresses its continued frustration with the current situation. This is that members of the group are forced to expend significant amounts of time on handling an outdated and error-prone data input system. The group feels that this problem could have been reasonably solved over the 4 yr time span.

As the WG regards this issue as being still a matter of highest priority, it continues to offer any possible support. It has also stipulated a number of times that an early involvement of species coordinators from a variety of WGs should be mandatory to assure that an appropriate database could be used for assessment purposes.

The WG recommends that each of its members raise the problem of the lack of an adequate database for the collation and handling of commercial catch and catch-at-age information (see section 1.3.6) with their ICES delegates and their ACFM members prior to the 2004 ICES ASC in Vigo.

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 has scheduled the NEA mackerel 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.

North Sea horse mackerel*:* 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, and at present attempts are made to use an ADAPT like algorithm. The analysis of the data are still to be considered exploratory, and so far, the results are not considered adequate for deriving TAC advise directly from the assessment.

Western horse mackerel: A separable ADAPT like model (SAD) has been used for assessment for some years, but was not accepted by ACFM last year. This year, the model has been rewritten and reformulated addressing ACFM concerns. The analysis is still considered exploratory. The input data for this stock have been revised because the stocks were redefined (see Sections 3.2 and 3.3).

Southern horse mackerel*:* The input data for this stock have been revised because the stocks were redefined (see Sections 3.2 and 3.3). XSA is still used to assess the stock, but the settings were changed. The assessment may still be regarded as exploratory.

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

Anchovy in VIIIc: At present, ICA is used to assess this stock. A biomass difference-delay type model has been developed over several years, and was further refined this year. It now estimates model parameters in a Bayesian framework, which also carries over to a Bayesian forecast. Some planned modifications could not be made in time for this meeting, and the runs with this model still should be considered as exploratory. ICA is not suited for this short lived species, and adjustments often have to be made to solve problems with the most recent data. For the futue, the new model is expected totake over as standard tool. The present ICA run was similar to that last year.

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

We recommend that in 2005 the WG should carry out in-depth exploratory assessments for western horse mackerel and anchovy Biscay.

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

In 2003, SGPRP and SGPA reviewed different reference points currently in place for a number of stocks in the ICES area, focussing on biomass reference points on the basis of stock-recruit relationships. For the stocks dealt with by WG MHSA, SGPRP concluded (ICES 2003/ACFM:15):

For Anchovy in Subarea VIII, ACFM subsequently revised the Blim from 18 000 tonnes to 21 000 tonnes. Both are based on the lowest observed biomass historically, and the change is due to the change in the estimate of this number in recent assessments. Bpa was revised from 36 000 tonnes to 33 000 tonnes, but changing the basis from a biomass that could sustain two successive years of poor recruitment to Blim*1.645. The reason for this change is not clear, but the justification for the former value was poorly substantiated.

For Western horse mackerel, the WG has suggested a Blim at Bloss. This was supported by SGPRP, but not implemented, since, lacking an accepted assessment, the corresponding biomass value is unknown. The WG suggests that the lowest observed SSB should be regarded as a Blim, even if the assessment at present only is considered reliable with respect to trends in the biomass.

For the other stocks, reference points either remain undefined, or are maintained at previous values.

For sardine, if the current assessment is accepted by ACFM, it may be relevant to consider reference points for this stock. So far, no preparatory work to establish reference points has been done, but this may be considered for next year.

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

The WG intends to provide indications of the sources of ecological processes affecting small pelagic species in this section. This year, the information relates mainly to ICES SGs dealing with these issues.

Since the last WG meeting, a meeting of the new ICES Study Group on Regional scale Ecology of Small Pelagics (SGRESP) took place in Nantes (23–26 February). Two SGRESP ToR's are of special relevance for this WG; ToR c) review existing relationships with physical and biological environmental indicators and ToR d) produce and deliver assessment Working Groups with integrated environmental and ecological information relevant to the evaluation and prediction processes.

In relation to the first ToR, examples of relationships between stock, recruitment and environmental indexes for different species/stocks were presented in SGRESP and its main conclusion was that although correlation between recruitment, stock and environmental indexes for different stocks was observed to “work” over a period of time, in most cases it shows a breakdown after new observations were included in the analysis. The SG hypothesised that this was due to a change in the relative importance of different parameters in different environmental conditions, and conclude that the incorporation of adult behaviour was essential to improve the understanding of this relationships.

In relation to deliverables to assessment WGs, the SG considered two different products; short-term recruitment prediction and medium-term interaction status between population and environment regime. Short-term recruitment prediction suffers the problems described above, and models to perform such prediction are still under development. In relation to the second product, the SGRESP concluded that in the future the SG could propose a list of indicators for diagnostic and health of stocks, relating to their spatial occupation, reproductive potential and demography. The intention would be to improve the understanding of long-term population dynamics and to devise qualitative/semi-quantitative indicators of stock state other than abundance at age.

Apart from the conclusions of the SGRESP, an update of the ToRs of next meeting of the SGSBSA, and some comments on the future of this SG (which reaches its last meeting) was provided to the WG. SGSBSA has dealt with methodological issues of DEPM, as well as with spatial stock structure and biological parameters in relation with environment on both sardine and anchovy. The future of the SG is still to be discussed by the SG members, although a proposal of converting it into a WG may arise from next SG meeting. Some of the proposed topics to be developed on a future WG include; a) comparison between acoustic and DEPM estimation of adult abundance and distribution, and thus stock structure and distribution in relation to oceanographic/environmental variables, b) spatial variability on biological parameters of the population such as fecundity, condition and mean weight of individuals, c) both DEPM and acoustic methodological issues and associated software.

Other sources of new environmental studies in relation to fisheries were pointed out to the group, such as the research work on Bay of Biscay oceanography and its relation to fisheries (Borges et al 2003, Chicharo et al 2003, Peliz et al 2002, 2003, 2004, Santos et al 2004, Lavín et al. *in press*) and a WD relating sardine recruitment off Portugal with NAO indices was also presented (Borges et al WD).

The WG believes that ecological studies on the relation between stock structure and environmental and biological variables are of great interest for small pelagic fisheries assessment and management. Stock/environment recruitment relationships can improve forward projections of stock abundances and help improving and designing management options. Nevertheless, in agreement with SGRESP, the WG believes that robust and reliable models of such relationships are not yet achieved and thus those relationships are not ready to be incorporated in the assessment/management of the species evaluated by the WG. Nevertheless, the WG encourages such ecological studies and regards SGRESP information on such issues as informative and relevant to the group.

The WG also values past SGSBSA inputs to the Group, and encourages its continuation as a WG.

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 2003.

A. Mackerel

Country	Data supplied	Data exchange sheet	Aged Samples	Problems
Belgium	NO	-	-	NO
Denmark	YES	YES	YES	NO
England	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
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	??	YES
England	YES	YES	NO	YES
Faroes	YES	NO	NO	NO
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	YES	YES	NO	YES
Ireland	NO	-	-	YES
Germany	YES	YES	YES	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	NO
Portugal	YES	-	NO	YES
Spain	YES	-	YES	NO

Table 1.3.6.2: Available disaggregated data for the WG MHSA per Sept. 2004
X: Multiple spreadsheets(usually xls); W: WG-data national input spreadsheets (xls);
D: Disfad and Alloc-outputs (ascii/txt)

Stock		Catchyear	Format			Comments
			X	**W**	**D**	
Horse Mackerel: Western and North Sea						
	HOM_NS+W	1991	X			Files from Svein Iversen, April 1999
		1992	X			Files from Svein Iversen, April 1999
		1993	X			Files from Svein Iversen, April 1999
		1994	X			Files from Svein Iversen, April 1999
		1995	X			Files from Svein Iversen, April 1999
		1996	X			Files from Svein Iversen, April 1999
		1997	X	W	D	Files from Svein Iversen, April 1999
		1998		W	D	Files provided by Pablo Abaunza Sept 1999
		1999		W	D	Files provided by Svein Iversen Sept 2000
		2000	X	W	D	Files provided by Svein Iversen Sept 2001
		2001	X	W	D	Files provided by Svein Iversen Sept 2002
		2002	X	W	D	Files provided by Svein Iversen Sept 2003
		2003	X	W	D	Files provided by Svein Iversen Sept 2004
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)
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
	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

Table 1.3.6.2 (Cont'd)

	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
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
	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

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 2003 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).
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 2001 year class.
	Acoustic surveys	Experimental surveys in 1999 to 2003 by Norway, Scotland, Spain, Portugal and France. 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
	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.

Table 1.4.1 (Cont'd)

2.3	Age, size and sex-structure: catch-at-age, weight-at-age, Maturity-at-age, Size-at-age, age-specific reproductive information	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. 80% of the catch was sampled for length and age in 2003 (was 87% for2002). Total number of samples taken (2003): 1,212; total number of fish aged: 19,779; total number of fish measured: 148,501. Weight at age in the stock: Stock weights were available from national sampling programmes in 2003. Western component: based on Dutch samples from March, April and May Div. VIIj. 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: 84.8% / 12.4% / 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 2003.
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.

3. Assessment model

step	*Item*	*Considerations*
3.1	Age, size, length or sex-structured model	Current assessment model: ICA Exploratory analyses: AMCI & ISVPA & spreadsheet version ICA
3.2	Spatially explicit or not	No
3.3	Key model parameters: natural mortality, vulnerability, fishing mortality, catchability	Natural mortality: fixed parameter over years and ages (M=0.15) based on tagging data. Selection at age: Reference age 5 for which selection is set at 1. Selection at final age set to 1.2. One period of 12 years of separable constraint (including the egg survey biomass estimates from 1992 onwards). The separable period is increased by one year for each new assessment, as it is based on a perceived change in fishing pattern from 1992 onwards. Population in final year: 13 parameters. Population at final age for separable years: 9 parameters. Recruitment for survivors year: Total number of parameters: 45 Total number of observations: 149 Number of observations per parameter: 3.3
	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. From 2004, the 1 group was also down-weighted to 0.1 based on observations of variable catch rates. The survey biomass estimate was treated as absolute up to 1998. From 1999 to 2001 it was treated as a relative index. In 2002, 2003 & 2004 it was again treated as absolute.
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 no retrospective analysis is carried out. Two reasons: because it is not directly available within ICA and because the assumptions concerning the separable period have been very variable over recent years. It is recognised that the retrospective analysis would be useful. 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.
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 (45 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 • simpler assessment models currently not evaluated • Assessment is over sensitive to recent survey SSBs

4. Prediction model(s) – SHORT TERM

step	*Item*	*Considerations*
4.1	Age, size, sex or fleet-structured prediction model	Age-structured model, by fleet and area fished.
4.2	Spatially explicit or not	Not
4.3	Key model (input) parameters	Stock weights at age: average from last 3 years Natural mortality at age: average from last 3 years Maturity at age: average from last 3 years Catch weights at age BY FLEET: average from last 3 years Proportion of M and F before spawning: 0.4 Fishing mortalities by age: From ICA Numbers at age: from ICA, final year in assessment; ages 2 to 12+ 0-group is GM recruitment whole period except last 3 years 1-group is GM recruitment applying mortality at age 0 Fishing mortalities by area (and age): The exploitation pattern used in the prediction was the separable ICA F's for the final year and then re-scaled according the ratio status quo F (last 3 years) and reference F ($F_{4\text{-}8}$). This exploitation pattern is subdivided into partial F's for each fleet using the average ratio of the fleet catch at each age for the last 3 years.
4.4	Recruitment	Geometric mean over whole period except last 3 years.

Table 1.4.1 (Cont'd)

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	SSB estimates from egg surveys are only available every 3 years. Assessment/Prediction mismatch: The prediction model contains more detail (by fleet) than the assessment model (not by fleet). 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 $F_{juvenile}$. Need to impose further constraints (eg maintain proportions of catches between fleets), to find unique solution. 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	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 arithmetic 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. 1.4.2. Checklist Southern Horse Mackerel Assessment

1. General

step	*Item*	*Considerations*
1.1	Stock definition	The results of EU funded HOMSIR project identified the western Iberian Peninsula as a distinct population from the rest of the Atlantic areas. Therefore, Division IXa is now considered as the distribution area for the Southern horse mackerel stock. Division VIIIc is considered to belong to the western horse mackerel stock. The HOMSIR project was unable to clarify the possible connection between fish from Divison IXa and North African horse mackerel.
1.2	Stock structure	
1.3	Single/multi-species	A single species assessment is carried out

2. Data

step	*Item*	*Considerations*
2.1	Removals: catch, discarding, fishery induced mortality	Catches are included in the assessment. Catch reports are quite good and mis-reported catches and discards are negligible. Mean catches during the assessment period are around 26,500 t. The missing of target species for the purse seiners, like anchovy and sardine, can produce an increase in the fishing mortality of the horse mackerel,, as it happened in 1998.
2.2	Indices of abundance	The following series of age disaggregated indices are available: two series of bottom trawl surveys from 1985 onwards. Another series of bottom trawl surveys from 1989 onwards. The relationship between the indices and abundance is considered to be linear. .
	Catch per unit effort	Information of catches, number of vessels and number of trips form the Portugues bottom trawl fleet is available from 1963 to 2000
	Gear surveys (trawl, longline)	Three series of Bottom trawl surveys are carried out in the distribution area (see Indices of abundance). Two of them cover the entire stock distribution area during the recruitment season (fourth quarter).
	Acoustic surveys	Information is available from acoustic surveys but not used in the assessment. Biomass estimates are considered to be underestimated, because the horse mackerel is also found close to the bottom blind area of the acoustic transducer.
	Egg surveys	Egg surveys are carried out on a triennial basis since 1995.but due to fecundity type uncertainties of horse mackerel the estimates are not considered for assessment purposes
	Larvae surveys	Some information from the egg surveys but not used in the assessment.
2.3	Age, size and sex-structure: catch-at-age, weight-at-age, Maturity-at-age, Size-at-age, age-specific reproductive information	Biological sampling of the catches is considered to be good. Catch at age matrix is available from 1991. Age assignment is validated until age 12. There is no significant trend in the weight at age in the catch along the assessment period. Weight at age in the stock is considered to be equal to mean weight at age in the catch due to large spawning season. Microscopic maturity ogive is available and it is considered constant during the assessment period
2.4	Tagging information	At the moment there is no available information from tagging
2.5	Environmental data	Environmental information is available from acoustic surveys and bottom trawl surveys. Satellite images can provide useful information on the dynamics of the aquatic systems based mainly in the estimation of the sea surface temperature.
2.6	Fishery information	Horse mackerel is mainly caught by purse seiners and bottom trawlers. The catches are relatively uniform over the year, although the second and third quarter show relatively higher catches.

Table 1.4.2 (cont'd). Checklist Southern Horse Mackerel Assessment

3. Assessment model

step	*Item*	*Considerations*
3.1	Age, size, length or sex-structured model	Age structured model (XSA)
3.2	spatially explicit or not	Not
3.3	key model parameters: natural mortality, vulnerability, fishing mortality, catchability	N = 0.15 Q = constant during the assessment period
	recruitment	Estimated from XSA
3.4	Statistical formulation: - what process errors - what observation errors - what likelihood distr.	
3.5	Evaluation of uncertainty: - asymptotic estimates of variance, - likelihood profile - bootstrapping - bayes posteriors	Exploratory assessment in 2004
3.6	Retrospective evaluation	Biased estimation of the fishing mortality and lack of agreement in SSB

4. Prediction model(s)

step	*Item*	*Considerations*
5.1	Age, size, sex or fleet-structured prediction model	
5.2	Spatially explicit or not	
5.3	Key model parameters	
5.4	Recruitment	
5.5	Evaluation of uncertainty	
5.6	Evaluation of predictions	

Table 1.4.3 Checklist for assessments of **Anchovy in Area VIII**

1. General

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

2. Data

step	*Item*	*Considerations*
2.1	Removals: catch, discarding, fishery induced mortality	Discards are not included but considered not relevant for the two fleets. The fishing statistics are considered accurate and the fishery is well known
2.2	Indices of abundance	Series of surveys for DEPM and acoustic since 1987 (with a gap in 1993). Acoustic surveys since 1983 (although not covering all the years)
	Catch per unit effort	There exists series of catch per unit effort for the French trawlers and Spanish purse seine fleets (although not standardized) and not used in assessment
	Gear surveys (trawl, longline)	Surveys use Pelagic trawls to sample the population mainly during the spawning period and in some cases (opportunistically) purse seining.
	Acoustic surveys	There are French acoustic survey indexes available since 1989 (which are used in the assessment), some previous indexes are available since 1983 but before the period of the assessment. In 2003 a series of acoustic surveys started on juveniles.
	Egg surveys	Daily Egg Production Method applied to estimate the SSB. Series since 1987-2003 with a gap in 1993. Estimates in 1996 & 1999 are based on regression models of previous DEPM SSB on P0 and SA or Total Egg production.
	Larvae surveys	Some sampling exists to know the larvae condition. And there are some experimental surveys on Juveniles in 1999 and 2000 (JUVESU project CT97-3374).
2.3	Age, size and sex-structure: catch-at-age, weight-at-age, Maturity-at-age, Size-at-age, age-specific reproductive information	Biological sampling of the catches has been generally sufficient, except for 2000 and 2001. An increase of the sampling effort seems useful to have a better knowledge of the age structure of the catches during the second semester in the North of the Bay of Biscay. Age reading is considered accurate and cross reading exchanges and workshops have taken place recently between Spain and France (Uriarte WD2002). Otoliths typology is made.
2.4	Tagging information	No tagging program
2.5	Environmental data	Much information exists, particularly on the temperature, water stratification, upwelling index, etc Motos et al. 1996, Borja et al. 1996, 98), (Allain et al. 2001). Currently a 3-Dymensional Hydrodynamic model is used to monitor the bay of Biscay environment affecting anchovy recruitment (Allain et al. 2001) .
2.6	Fishery information	Two main fisheries. A Spanish purse seine fishery operating mainly in Spring and a French one using mainly pelagic trawling and operating mainly in winter, summer and autumn. A small fleet of French purse seiners fishery operates in the South of the Bay of Biscay (Spring) and in the North (2^{nd} half of the year). See review in Uriarte *et al*. (1996).

Table 1.4.3 (Cont'd)

3. Assessment model

step	*Item*	*Considerations*
3.1	Age, size, length or sex-structured model	ICA is used with DEPM, Acoustic and age structure of the catches and the population. An alternative Biomass dynamic model was set up in 2002. In 2004 implemented in a Bayesian framework and is still under development.
3.2	Spatially explicit or not	No
3.3	Key model parameters: natural mortality, vulnerability, fishing mortality, catchability	Natural mortality is set fix at 1.2. It is considered variable. Catchability for the DEPM index is set to 1 because it is assumed to be an absolute indicator of Biomass. Catchability of the acoustic survey is estimated. Separability of the fishing mortality by ages is assumed and fishing pattern is estimated.
	Recruitment	No stock recruitment relationship is assumed.
3.4	Statistical formulation: - what process errors - what observation errors - what likelihood distr.	Accuracy of the data are not taken into account (No observation error). Only, a weighted factor allows to translate the validity of the information used into the tuning of the assessment. Log normal errors assumed. Maximum likelihood estimates.
3.5	Evaluation of uncertainty: - asymptotic estimates of variance, - likelihood profile – bootstrapping - bayes posteriors	Asymptotic estimates of variances, by the inverse of the Hessian matrix. No explicit bootstrapping evaluation of the uncertainty
3.6	Retrospective evaluation	Not done so far (2002)

4. Prediction model(s)

Step	*Item*	*Considerations*
4.1	Age, size, sex or fleet-structured prediction model	Deterministic age predictions models (too simplistic for this highly variable population) Based on CEFAS deterministic projections (MFDP). In 2004 stochastic projections based on the Bayesian biomass-based model has been explored.
4.2	Spatially explicit or not	No
4.3	Key model parameters	Recruitment at age 0 in the assessment year. Separable Fishing mortality, Catch constrain for the assessment year.
4.4	Recruitment	Geometric mean or more precautionary levels, according to the complementary information that might be available to the WG. Use of environmental indexes is on state of refinement for future use.
4.5	Evaluation of uncertainty	Short term sensitivity analysis was used in 1999.
4.6	Evaluation of predictions	Not properly.

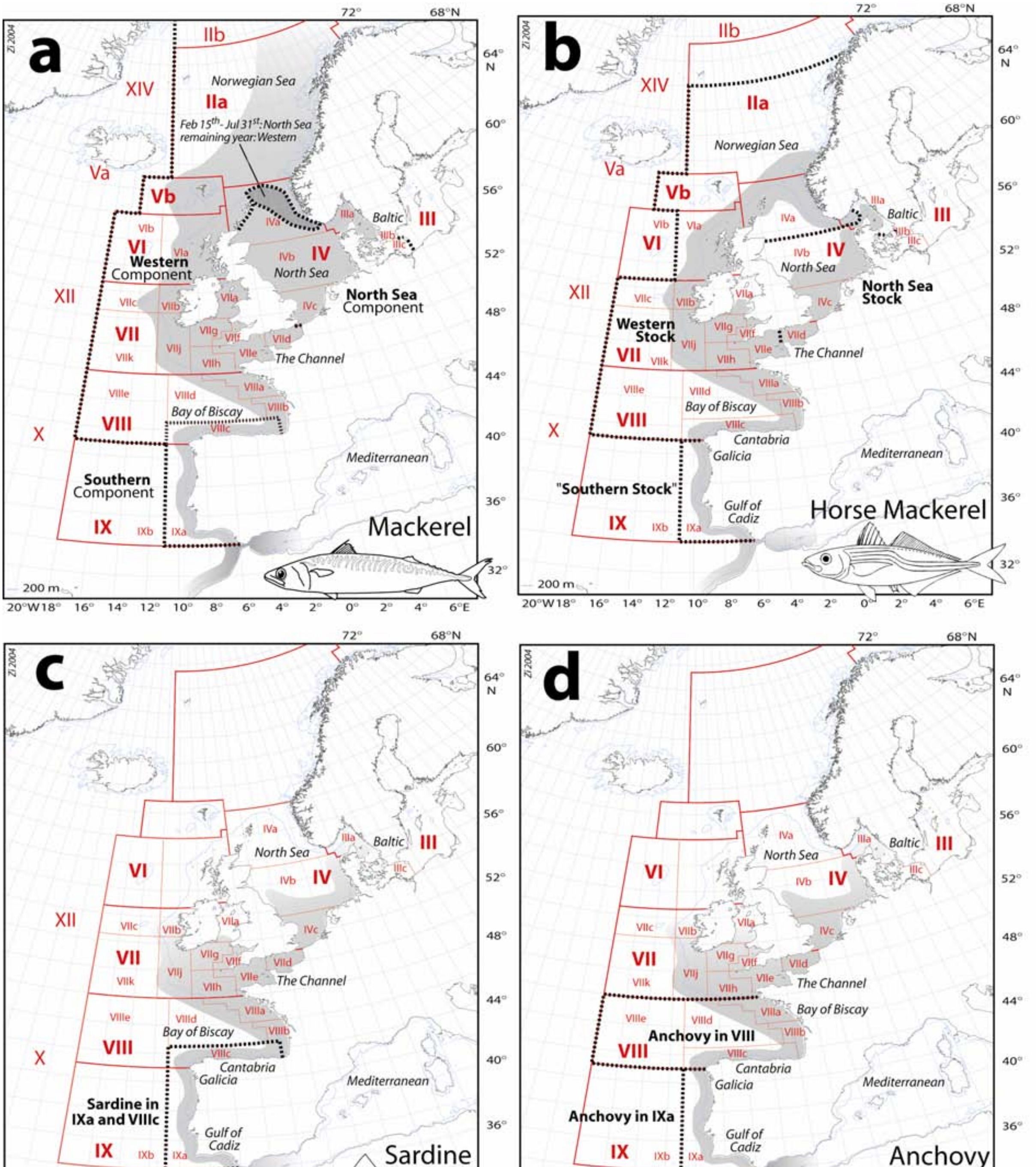


Fig 0.1: Distribution of the four species assessed by the ICES Mackerel, Horse Mackerel, Sardine and Anchovy WG: Stock and component definitions as used by the 2004 WG. Map source: GEBCO, polar projection, 200 m depth contour drawn. **a: Northeast Atlantic Mackerel** (with North Sea, Western and Southern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

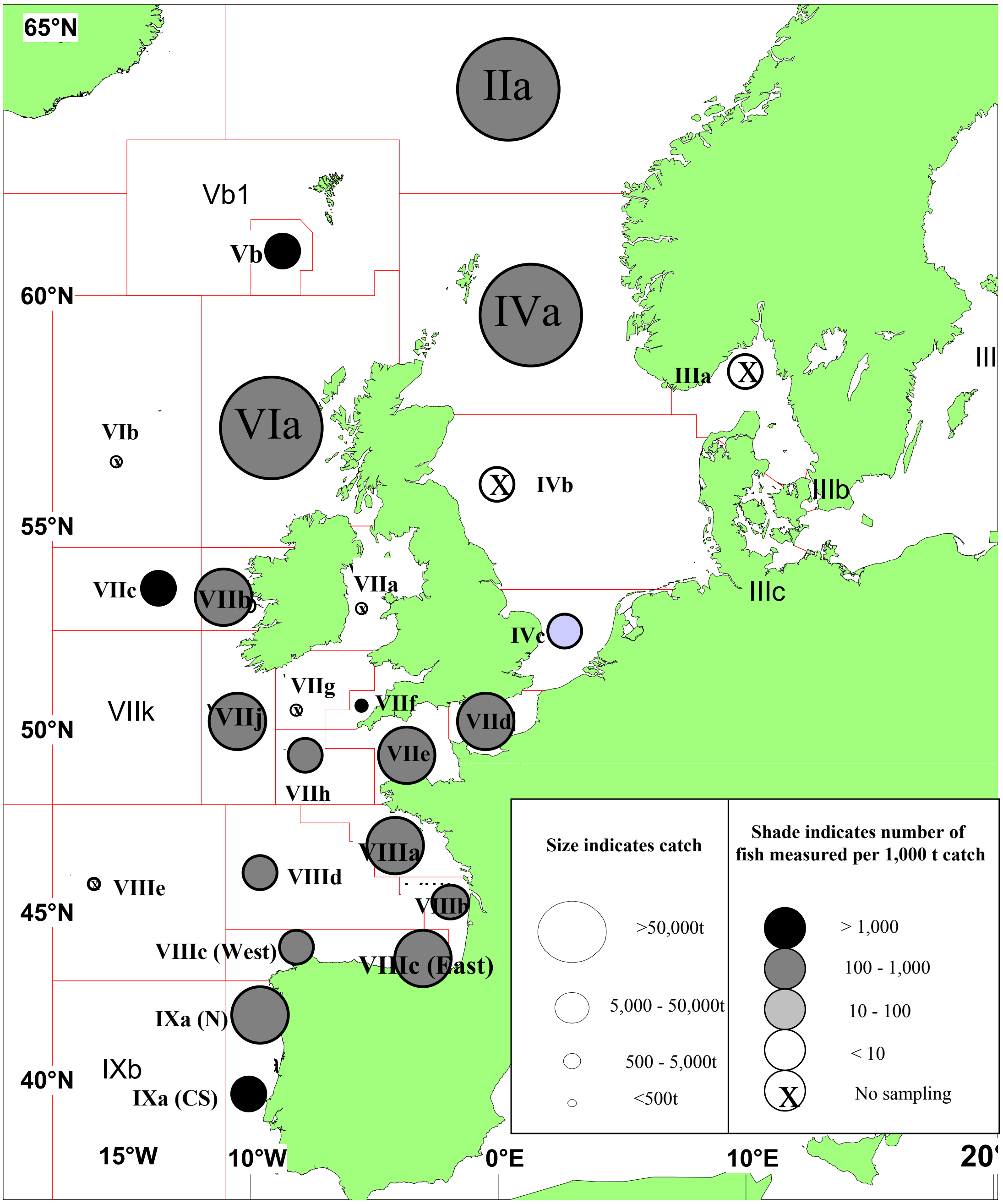


Figure 1.3.1.1. Sampling of mackerel for length in relation to tonnage landed by ICES sub-division. Circle size indicates catch tonnage and shading indicates sampling level.

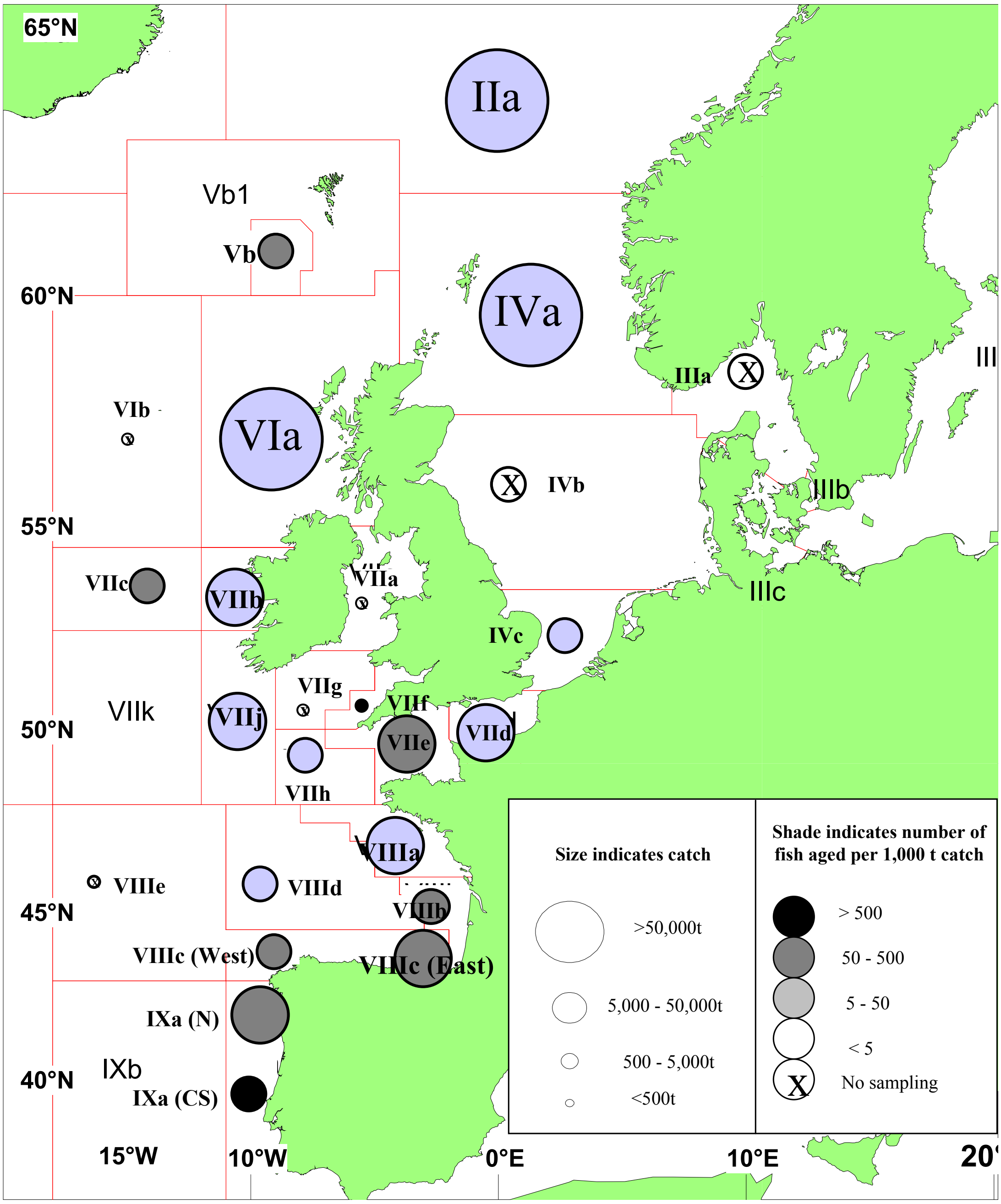


Figure 1.3.1.2. Sampling of mackerel for age in relation to tonnage landed by ICES sub-division. Circle size indicates catch tonnage and shading indicates sampling level.

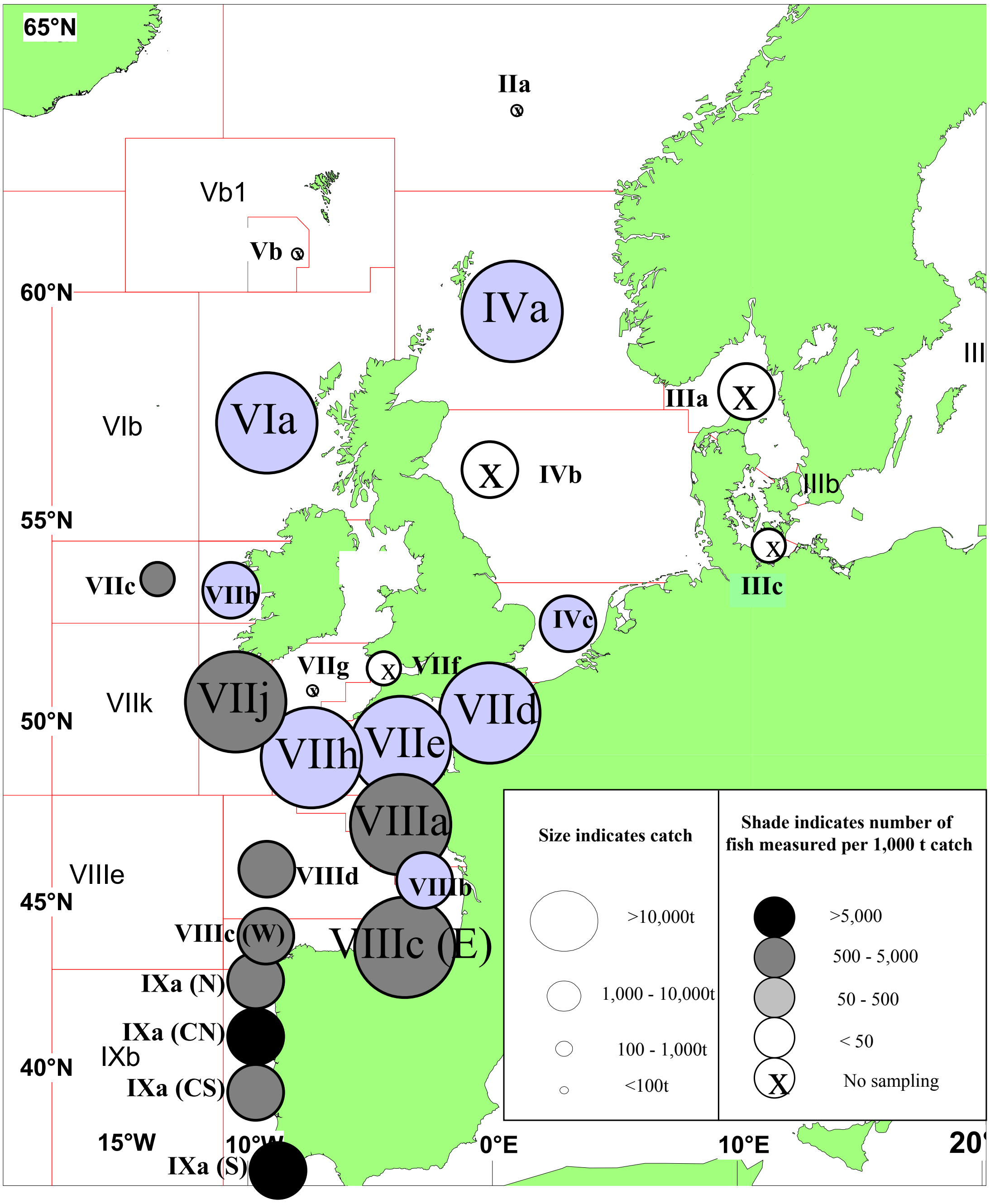


Figure 1.3.1.3. Sampling of horse mackerel for length in relation to tonnage landed by ICES sub-division. Circle size indicates catch tonnage and shading indicates sampling level.

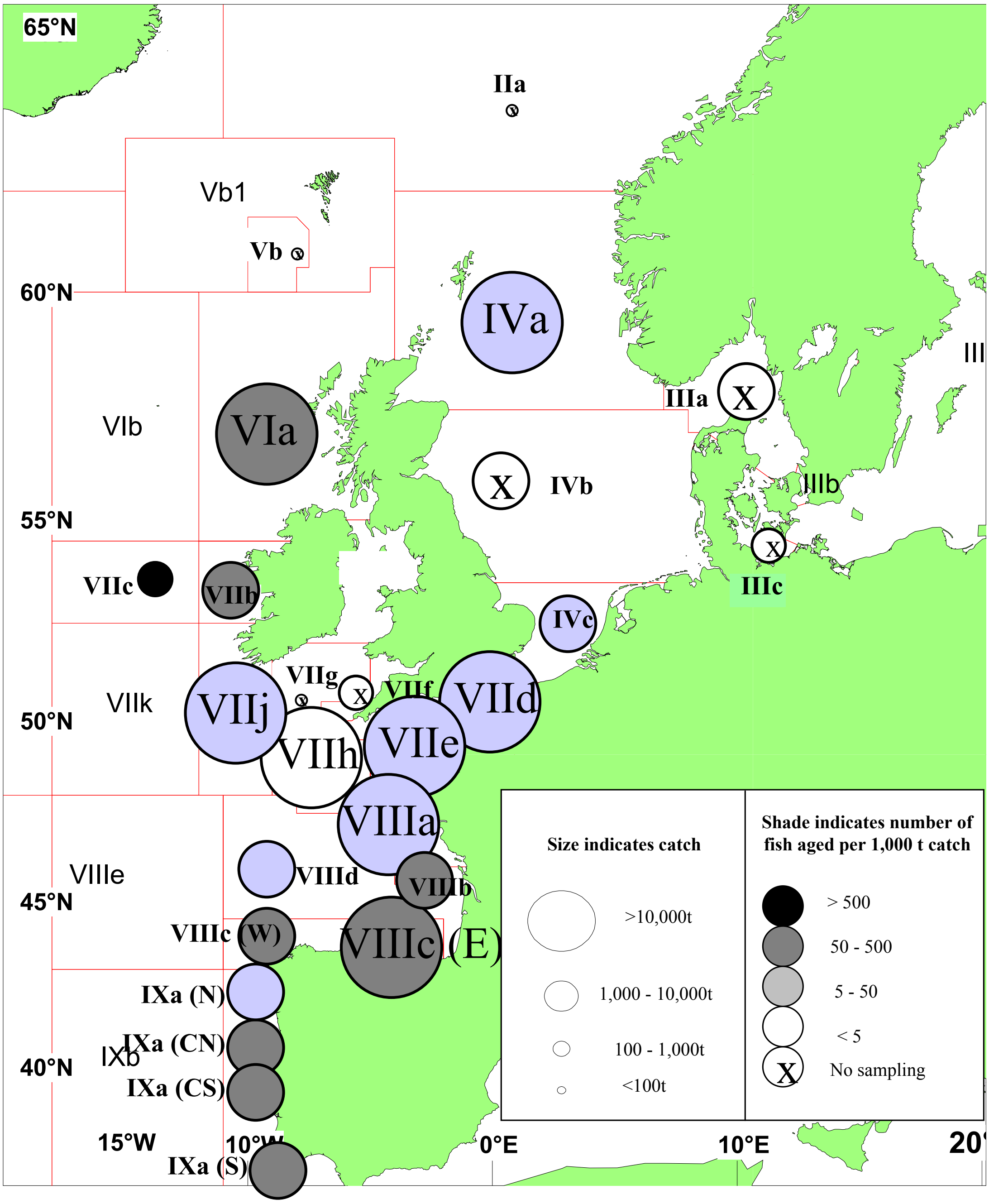


Figure 1.3.1.4. Sampling of horse mackerel for age in relation to tonnage landed by ICES sub-division. Circle size indicates catch tonnage and shading indicates sampling level.

2 Northeast Atlantic Mackerel

2.1 ICES advice applicable to 2003 and 2004

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 parts 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 2003 and 2004 are given in the text table below.

Agreement	Areas and Divisions	TACs in 2003	TACs in 2004
Coastal states agreement (EU, Faroes, Norway)	IIa, IIIa, IV, Vb, VI, VII, VIII, XII, XIV	500,000	461,000
NEAFC agreement	International waters of IIa, IV, Vb, VI, VII, XII, XIV	45,644[1)]	36,998[2)]
EU-NO agreement[3)]	IIIa, IVa,b	1,865	1,865
EU autonomous[4)]	VIIIc, IXa	35,000	32,305
Total		582,509	532,168

Stock components	ACFM advice 2003	ACFM advice 2004	Areas used for allocations	Prediction basis	Catch in 2003
North Sea	Lowest possible level	Lowest possible level	IIa, IIIa, IV, Vb, VI, VII, VIIIa,b,d,e, XII, XIV	Northern	591,507
Western	Reduce F below F_{pa} = 0.17	Reduce F below F_{pa} = 0.17			
Southern			VIIIc, IXa	Southern[5)]	25,823
					617,330

1) NEAFC agreement was 56,610 t including 10,966 t not fished by any party.
2) NEAFC agreement was 52,192 t including 15,194 t not fished by any party.
3) Quota to Sweden.
4) Includes 3,000 t of the Spanish quota that can be taken in Spanish waters VIIIb.
5) 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.
For the years 1999-2004 a fishing mortality not exceeding Fpa = 0.17 was recommended, which in 2005 corresponds to a catch around 489,000 t.

In addition to the TACs and the national quota the following are some of the more important additional management measures which have been in force since 1998. 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.

1. Prohibition of fishing in Division IVa from 15. February to 30. September, and of a directed mackerel fishery in Divisions IVb and IVc throughout the year;
2. Prohibition of a directed mackerel fishery in the “Mackerel Box”;
3. Minimum landing size of 30 cm for Sub-area IV, Division IIIa and 20 cm for Divisions VIIIc and IXa.

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

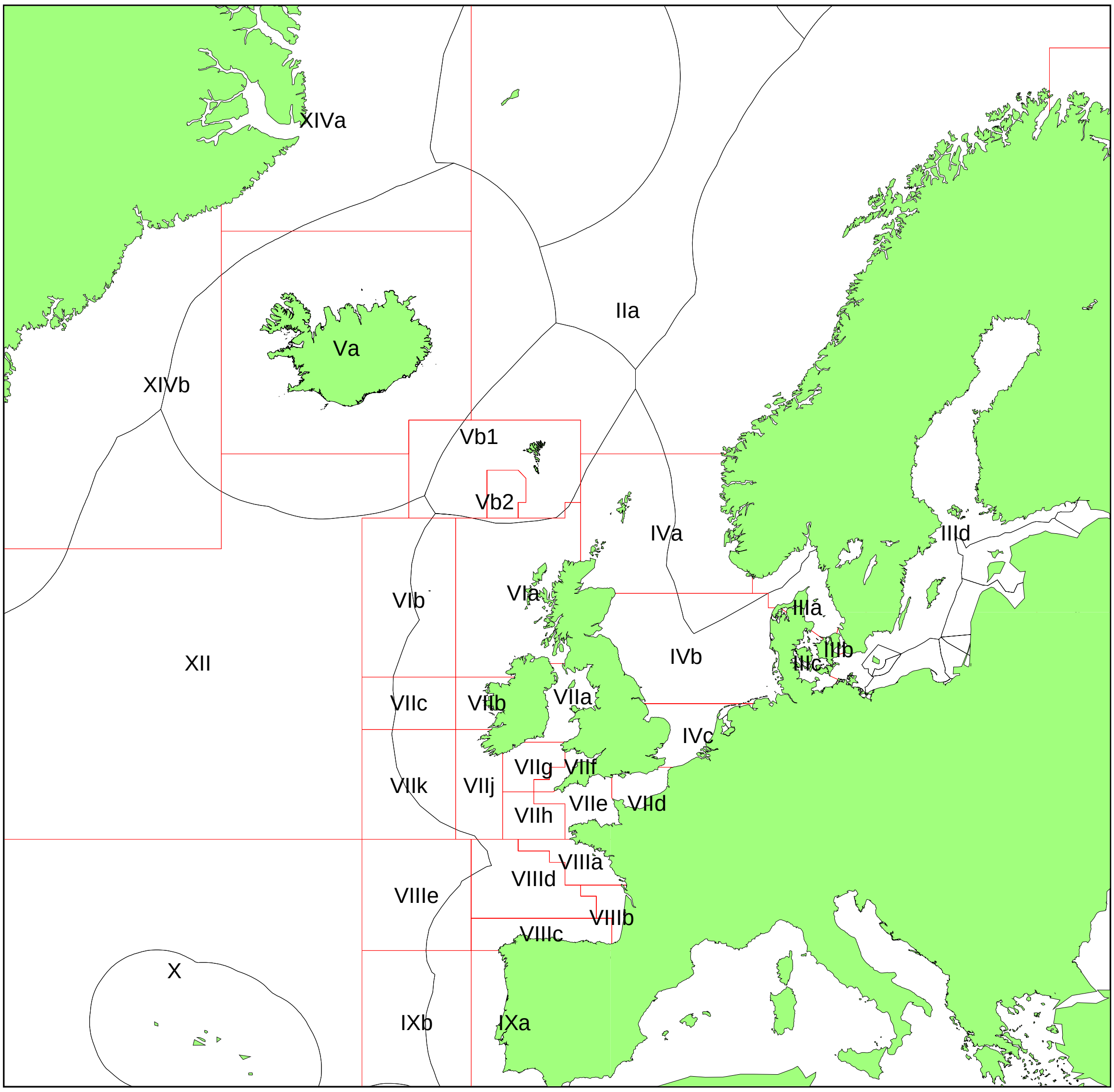


Figure 2.1.1. Map of approximate national zones and ICES Divisions and Subareas. Note that EU region is considered as one zone in this map.

2.2 The Fishery in 2003

2.2.1 Catch Estimates

The total estimated catch in 2003 was 617,000t, which was about 100,000t lower than the catch taken in 2002. The 2003 catch corresponds to a fishable TAC in 2003 for the whole stock distribution area of 582,509 t; this was some 100,000 t lower than the 2002 TAC. The fishable TAC for 2002 was 683,365 t. The TAC set for 2003 covered all areas where mackerel is caught. The combined fishable TAC as best ascertained by the Working Group (Section 2.1) agreed for 2004 amounts to 532,168 t.

The total catch estimated by the Working Group to have been taken from the various areas is shown in Table 2.2.1.1. Updates this year to these data are catches for UK (Northern Ireland) from 1999-2003, which had been previously mistakenly omitted. These catches were in the region of 5,000 t to 10,000 t per year. This table shows the development of the fisheries since 1969.

The highest catches (about 326,000 t) were again taken in Division IVa. The catches taken from Div Vb and Sub area II (54,000 t) were lower than in the mid to late nineties. The catch taken in the western area (Sub-area VI, VII and Divisions VIIIa,b,d,e) decreased by about 10,000 t to around 206,000 t which is at the same level as the mid to late nineties. As in last year (2002) a higher proportion of this area's catch was taken in the 3rd and 4th quarters.

The total catch recorded from Sub area II and Vb (Table 2.2.1.2) in 2003 was about 54,000t which about 20,000 t less than 2002. This is the lowest catch in this area since 1987.

The total catch recorded from the North Sea (Sub-area IV and Division IIIa) (Table 2.2.1.3) in 2002 was about 332,000t which is about 38,000t less than in 2002.There had been a trend of increasing catches in this area since 1996, but catches in this area in 2003 are reduced in line with the total catch reduction. Misreporting of catches taken in this area into VIa is at the same level as 2002. The reason for this misreporting is not clear and does not appear to be caused by the early closure of the North Sea area (14th February). The increasing trend in catches in this area in the 3rd quarter may be due to earlier targeting by the Norwegian fleet due to opportunities for blue whiting, and earlier targeting by the Scottish and Irish fleets, to avail of larger grade fish.

The catches taken in Divisions VIIIc and IXa were almost halved from just less than 50,000 t in 2002 to about 26,000 t in 2003. This decrease is due to the closure of the fishery in the first 2 quarters of 2003, due to the "Prestige" oil spill. When the fishery was reopened in quarter 3 mackerel were unavailable to the fleets.

The total area misreported catch during 2003 as best ascertained by the WG was just less than 50,000t, this is similar to the situation last year.

The quarterly distributions of the catches since 1990 are shown in the text table below. The distribution of the catches in 2003 shows the highest proportion of catches in the 4th & 1st quarters. The proportion of the catch taken in the 4th quarter was greater than the proportion of catch in the 1st quarter for the first time since 1993. Over 50% of the total catch was taken in between the 4th quarter in IVa and the 1st quarter in VIa.

Percentage distribution of the total catches by quarter from 1990 – 2003

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

The catches per quarter by Sub-area and Division are shown in Table 2.2.1.6. These catches are shown per statistical rectangle in Figs 2.8 1.1 to 2.8.1.4.and are discussed in more detail in Section 2.8. 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. 34% of the total catch 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 5%. 24% of the total catch was taken during Quarter 3; this represents a decrease in the fishery in IIa. The main catches in the second quarter were taken in Sub-area VII. During Quarter 4, 37% of the total catch was taken mainly from Division IVa. The main catches of mackerel in the south are taken in VIIIc (68%) and these are taken mostly in the first and second quarter. However, the magnitude of these catches was halved in 2003 due to the closure as a result of the "Prestige" oil spill (see above). Catches from IXa, that comprise 32% of mackerel catches in the south, were mainly taken in the third quarter.

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 113,332 t); France and Faroes did not sample their catches in 2003.

The main catches taken in IVa were recorded by Norway (151,000 t), while substantial catches were also recorded by the United Kingdom (52,000 t) and Denmark (27,000 t). The Irish catch was slightly less at about 17,000 t. Discards were again reported this year and an age structure of the discarded catch was made available by Scotland (see section 1.3.3). The new information on discarding indicates that it may be associated with the high abundance of juvenile fish (2001 and 2002 year classes) in the area (see section 1.3.3 and 2.8.2 for further discussions).

The total catch estimated to have been taken from the Western areas (Table 2.2.1.4) was over 206,000t. This is about 20,000 t less than the catch taken in 2002. The misreported catches from IVa are about the same level as in 2002. The main catches continue to be taken by United Kingdom (131,000 t) and Ireland (50,000 t). The Netherlands (24,000 t), Germany (19,000 t) and France (21,000 t) continue to have important fisheries in this area.

2.2.2 Fleet Composition in 2003

In the Norwegian Sea (Sub-area II) catches are mainly taken by the Norwegian fleet (purse seiners >21 m) and Russian freezer trawlers. This fleet is composed of 58 freezer trawlers, targeting mackerel, blue whiting and herring. The Russian fleet is also the main fleet operating in Sub-division Vb off the Faroe Islands. 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 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 fished by the English fleet and French freezer trawlers. The Spanish fleet operates in the Bay of Biscay (VIII) and Division IX and consists of pelagic trawlers, purse-seiners between 10-32 m and a large artisanal fleet with vessels between 2 and 34 m.

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

*Preliminary.

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

[2] Data revised for Northern Ireland

[§] 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**
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	
France	5	0	270						
Germany		1							
Iceland		92	925	357				53	122
Ireland					100				495
Latvia	389	233							
Lithuania						2,085			
Netherlands		561			661			569	
Norway	93,315	47,992	41,000	54,477	53,821	31,778	21,971	22,670	12548
Russia	44,537	44,545	50,207	67,201	51,003	49,100*	41,566	45,811	40026
United Kingdom	194	48	938	199	662		54	665	510.15
USSR[2]									
Poland			22						
Sweden							8		
Misreported (IVa)	-18,647			-177	-40,011				
Misreported (VIa)					-100				
Misreported (unknown)								-570	
Discards									
Total	135,496	103,376	103,598	134,219	72,848	92,557	67,097	73,929	53701.15

[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 1990)								
Romania							2,903	
Misreported (IIa)							109,625	18,647
Misreported (VIa)	180,000	92,000	126,000	130,000	127,000	146,697	134,765	106,987
Unallocated	29,630	6,461	-3,400	16,758	13,566	-	-	983
Discards	29,776	2,190	4,300	7,200	2,980	2,720	1,150	730
Total	338,316	281,600	305,100	365,875	367,164	390,558	472,397	322,204

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

[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
Denmark	392
Estonia	
Faroe Islands	2,260
France	21,213
Germany	19,202
Ireland	49,715
Netherlands	23,640
Norway	
Spain	735
United Kingdom	130,762
USSR	
Unallocated	4,573
Misreported (IVa)	-46,407
Discards	91
Grand Total	206,176

[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, 1977–2001. 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	2003
France[1]														226
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	17,381
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	2,749
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	5,646
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	8,213
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	25,820

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

Table 2.2.2.1. Pelagic fleet composition, in 2003, of nations targeting mackerel.

Country	Details given	Length	Engine power	Gear	Storage	Discard estimates	No vessels
		(metres)					
Denmark	y	30-40	900-1500 HP	Trawl	Tank	No	35
Denmark	y	45-65	1000->	Purse seine	Tank	No	9
Faroe Islands	y	35-90	515-6468 kW	Trawler	100-1500	No	9
Faroe Islands	y	65-75	2208-8000 kW	Purse-seine/Trawl	1600-2600	No	7
France	n						
Germany	y	85-125	2400-4950KW	Single Midwater Trawl	Freezer		4
Ireland	n						
Netherlands	y	55	2890 hp	Pair Midwater Trawl	Freezer	No	2
Netherlands	y	88-140	4400-10455hp	Single Midwater Trawl	Freezer	No	13
Norway	y	≥21		Purse seiners			221
Norway	y	14-21		Purse seiners/fishnets			90
Norway	y	7-14		Purse seiners/trawlers			475
Norway	y	<7		Trawler			24
Portugal	y	10-40		Trawler	Freezer		14
Portugal	y	0-40		Trawler	Other		416
Portugal	y	0-30		Purse-seiner	Other		261
Russia	y	55-80	1000 to >5000hp	Single Midwater Trawl	Freezer	No	58
Spain	y	10 –31.3	110 - 800	Trawler 1	Dry hold with ice	No	321
Spain	y	6.5 - 27	16 - 650	Purse Seiner	Dry hold with ice	No	408
Spain	y	10 - 32	110 - 800	Artisanal (hooks)	Dry hold with ice	No	370
Spain	y	19.5 - 31.3	220 - 800	Artisanal (gillnets)	Dry hold with ice	No	593
Spain	y	6.5 - 27	16 - 650	Artisanal (other)	Dry hold with ice	No	4587
Sweden	n						
UK (England & Wales)	y	92.05	5053.5	Pair Midwater Trawl	Freezer		2
UK (England & Wales)	y	47.3	1992	Midwater Trawl	RSW		3
UK (Northern Ireland	n						
Scotland	y	35-67		Single Midwater Trawl	RSW	Yes	26

2.2.3 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 2.2.3.1 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 2.2.3.1).

Table 2.2.3.1 shows the Spanish landings by sub-division in the period 1982-2003. The total Spanish landings of *S. japonicus* in 2003 was 3663 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 Sub-division IXa South, the Gulf of Cadiz, there is a small Spanish fishery for mixed mackerel species which had a catch of 948 t of *Scomber japonicus* in 2003. In the bottom trawl surveys carried out in the Gulf of Cadiz in 2003, catches of *S. japonicus* making up 98.18 % and *S. scombrus* 1.82 % of the total catch in weight of both species (M. Millán, pers. comm), the same data that in 2002. 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. In 2002 and 2003 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 8030 t, showing increase increase with respect to the 2002 (5301 t) catch level, but a decrease in comparison to the 1999 (13,877 t) and 2000 (10520 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 2.2.3.1). 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.

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

Table 2.2.3.1: Catches in tonnes of Scomber japonicus in Divisions VIIIb, VIIIc and IXa in the period 1982-2003.

Country	**Sub-Divisions**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Spain	Division VIIIb	0	0	0	0	0	0	0	0	0	487	7	4	427	247	778	362	1218	632	344	426	99	157
	VIIIc East	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892	1903	2558	2633	4416	1753	414	1279	1442	1130	1200
	VIIIc west															47	610	12	3	626	54	379	1325
	Total	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892	1903	2558	2679	5026	1765	418	1905	1496	1509	2525
	IXa North												2557	7560	4705	5066	1727	412	104	531	1	54	33
	IXa South											895	800	1013	364	370	613	969	879	470	552	1512	948
	Total	0	0	0	0	0	0	0	0	0	0	895	3357	8573	5068	5437	2340	1381	983	1001	553	1566	981
	Total Spain	322	254	656	513	750	1150	1214	3091	1923	1989	1761	5253	10903	7872	8894	7729	4364	2033	3250	2475	3174	3663
Portugal	IXa Central-North	-	0	236	229	223	168	165	281	228	137	914	543	378	913	785	521	481	296	146	60	177	476
	IXa Central-South	-	244	3924	4777	3784	5299	838	2105	5792	6925	5264	5019	2474	1544	2224	2109	3414	10407	7450	2202	1380	3405
	IXa South	-	129	3899	4113	4177	3409	2813	4061	2547	3080	2803	1779	1578	1427	1749	2778	2796	3173	2924	1966	3744	4149
	Total Portugal	664	373	8059	9118	8184	8876	3816	6447	8568	10142	8981	7341	4430	3884	4759	5408	6690	13877	10520	4228	5301	8030
TOTAL	**Division VIIIb**										487	7	4	427	247	778	362	1218	632	344	426	99	157
	VIIIc East	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892	1903	2558	2633	4416	1753	414	1279	1442	1130	1200
	VIIIc west															47	610	12	3	626	54	379	1325
	Division VIIIc	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892	1903	2558	2679	5026	1765	418	1905	1496	1509	2525
	IXa North												2557	7560	4705	5066	1727	412	104	531	1	54	33
	IXa Central-North		0	236	229	223	168	165	281	228	137	914	543	378	913	785	521	481	296	146	60	177	476
	IXa Central-South		244	3924	4777	3784	5299	838	2105	5792	6925	5264	5019	2474	1544	2224	2109	3414	10407	7450	2202	1380	3405
	IXa South		129	3899	4113	4177	3409	2813	4061	2547	3080	3698	2579	2591	1790	2120	3391	3764	4052	3395	2518	5256	5097
	Division IXa	664	373	8059	9118	8184	8876	3816	6447	8568	10142	9876	10698	13003	8952	10195	7748	8071	14860	11521	4781	6867	9011
	Total	986	627	8715	9631	8934	10026	5030	9538	10491	12131	10742	12594	15333	11756	13653	13137	11054	15909	13770	6703	8475	11693

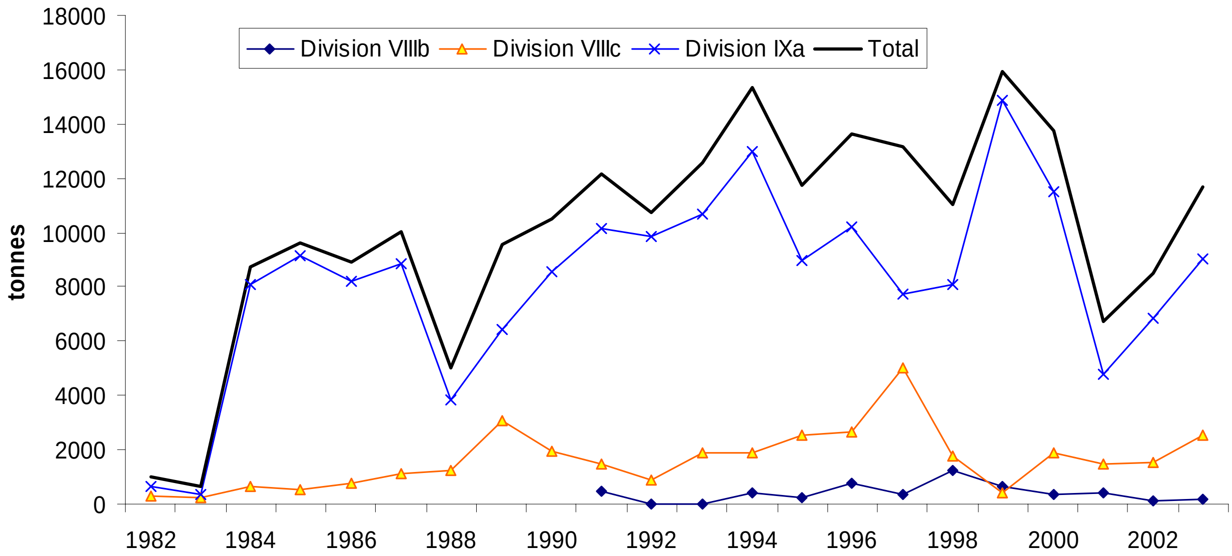


Figure 2.2.3.1: Annual landings of Scomber japonicus by ICES divisions since 1982 to 2003.

2.2.4 Salmon by-catch

WGMHSA considered the SGBYSAL report (ICES 2004/I:01) with regard to the most appropriate methods for estimating salmon by-catch in pelagic fisheries. The way towards a better quantification of salmon by-catch seems well described in the SGBYSAL report and the WGMHSA fully support their recommendations.

Two issues were considered by WGMHSA, firstly the request for disaggregated catch of mackerel, horse mackerel, and fleet data by week by ICES rectangle (Table 2.2.4.1) to be provided to SGBYSAL and secondly the possibilities of screening all mackerel and horse mackerel catches (commercial and scientific) for by-catch of salmon.

1) To properly facilitate the request from SGBYSAL for disaggregated catches the WGMHSA suggests that the request be directed to the official national delegates. This way the requested data might be obtained from the national resources dealing with catch statistics.

In the WGMHSA catch data (WG catches, not official catches) by quarter by rectangle for most of the countries catching mackerel is available are given in the WG reports. However disaggregated catches by week are not available within and the WGMHSA.

2a) The WGMHSA considered the current sampling scheme for mackerel and horse mackerel being inadequate to satisfactorily measure salmon by-catch in the fishery. Due to the apparently low by-catch rate of salmon in the mackerel and horse mackerel fishery, i.e. the infrequent incidence of a salmon being detected in the huge quantities of fish caught, other means of estimating salmon by-catch should be considered. As recommended by SGBYSAL observers on board commercial vessels might yield some results, but even with observers on board a proper sampling/screening of catches might be hampered when the catch is taken aboard, e.g. the high speed of pumping, without severe interference with the workflow on board.

In EU countries vessels are requested to sample for discards by observers, and the WG recommends that these could be made aware of the request to also screen the samples for salmon by-catch. Further, that the available data should be reported to SGBYSAL.

2b) All scientific catches of mackerel and horse mackerel are properly screened for all by-catches and reported to the respective institutes. SGBYSAL could obtain these results by contacting e.g. the PGHERS, PGNAPES, PGAAM, IBTS and other relevant WGs in addition to national institutes either directly or via an ICES request.

The SGBYSAL also mentioned that a technical modification of the fishing gear might reduce the by-catch of salmon by lowering the headline/rope depth from surface down to 5-10 m below during pelagic trawling in near the surface layer.

References

ICES 2004/I:01. Study Group on the Bycatch of Salmon in Pelagic Trawl Fisheries. ICES CM 2004/I:01, 65 pp.

Table 2.2.4.1 Nations fishing for mackerel (M) and horse mackerel (HM) in areas and periods of potential overlap with salmon. This table is a merged version of the tables in Annex 1 in a letter from the ICES General secretary dated 9. September 2004 to the WGMHSA (in the middle of the meeting) and Tables 3.2.1 in WGBYSAL (ICES 2004/I:01).

Weeks	12-36 (essentially Quarter 2-3)							
Divisions	IVb	VIa	VIIb	VIIc	VIIj,k	IVa	Vb	IIa
England		M	M	HM	M,HM	M		
Scotland		M	M		M	M		
Ireland		M	M	M	M,HM			
Germany		M			M	M		
France	M				M			
Netherlands	M			HM	M,HM			
Norway	M					M	HM	M,HM
Faroes							M,HM	M
Denmark	M	M		M	M	M		
Russia							M	M
Spain					M			
Portugal					M			

2.3 Stock Components

2.3.1 Biological evidence for stock components

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

2.3.2 Allocation of Catches to Component

Since 1987 all catches taken in the North Sea and Division IIIa have been assumed to belong to the Western stock. This assumption also applies to all the catches taken in the international waters. It has not been possible to calculate the total catch taken from the North Sea stock component separately but it has been assumed to be 10,000 t for a number of years. This is because of the very low stock size and because of the low catches taken from Divisions IVb,c. This figure was originally based on a comparison of the age compositions of the spawning stock calculated at the time of the North Sea egg surveys. This assumption has been continued for the catches taken in 2003. It should be pointed out that if the North Sea stock increases, this figure might need to be reviewed. An international egg survey carried out in the North Sea during June 1999 again provided a very low index of stock size in the area (<100,000t) (ICES 2002, G:06)). A new egg survey in the North Sea carried out during June 2002 and the SSB adopted at 210,000 t indicating an increase SSB from 70,000 t in 1999 (See Section 2.5.2).

Prior to 1995 catches from Divisions VIIIc and IXa were all considered belonging to the southern mackerel stock, although no separate assessment had been carried out on the stock. In 1995 a combined assessment was carried out in which all catches from all areas were combined, i.e. the catches from the southern stock were combined with those from the western stock. The same procedure was carried out by the 1997 - 2003 Working Groups and again by the present Working Group, - the new population unit again being called the Northeast Atlantic mackerel unit.

The TAC for the Southern area applies to Divs.VIIIc and IXa. Since 1990, 3,000t 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 and are therefore included in the provision of catch options for the Northern area.

2.4 Biological Data

2.4.1 Catch in numbers at age

The 2003 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 617,330t, which is the best estimate of the WG of total catches from the stock in 2003.

The percentage catch by numbers at age is given in Table 2.4.1.2. The age structure of the 2003 catches of NE Atlantic mackerel is mainly comprised of 1-9 year old fish. These age groups constitute 93 % of the total. Age 1 fish account for 11% of the catch numbers. Moreover 45% of age 1 fish were caught in IVa, with divisions VIIb and VIIe accounting for 7% each. Overall, the contribution of 3 year old fish to the catches was only 5% compared to 18% in 2002, reflecting the perception of poor recruitment of the 2000 year class.

In the northern North Sea (IVa) where most of the catches of mackerel are taken, 29% of the catches comprised 1 and 2 year old fish, while ages 4 to 7 comprised 50% of numbers in catch. In the southern North Sea and eastern English Channel (IVb,c and VIId) 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 6 with age 1 fish accounting for a large proportion (19%). In the western English Channel and northern Biscay (VIIe,f and VIIIa,b) the catch is primarily composed of ages 1 to 5. In southern Biscayan waters (VIIIc) ages 1 to 7 predominate and in IXa the catches are mainly composed of fish aged 0 to 2.

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 53,800t) while England & Wales provide aged data for only 17.5% of their catches. In addition there was insufficient samples to cover divisions VIIa,b,d and VIIIb amounting to a total catch of 43,250t. Minor catches from Divisions IIIa-d, IVb, VIb, VIIa,g, and VIIIe with a total catch of 4000t 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. The catches in numbers at age have been revised in the years 1999 to 2002 due to the inclusion of data from Northern Ireland. Updated numbers are shown in table 2.9.1.2.

2.4.2 Length composition by fleet and country

Length distributions of the 2003 catches by some of the fleets were provided by England & Wales, Netherlands, Norway, Portugal, Russia, Scotland, Spain and Germany. The length distributions were available from most of the fishing fleets and account for 82% 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 some fleets on the working group files. The length distributions by country and fleet for 2003 are shown in Table 2.4.2.1. These data may be useful in an examination of the spatial distribution of fisheries.

2.4.3 Mean lengths at age and mean weights at age

Mean lengths

The mean lengths at age per quarter and ICES division for 2003 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.

Mean weights

The mean weights at age in the catch per quarter and ICES Division for NE Atlantic mackerel in 2003 are shown in Table 2.4.3.2.Compared to last year's data mean weights at age are higher for every year class.

In this working group the mean weights at age are calculated the following:

The estimated weights for NE Atlantic mackerel and the Western, Southern and North Sea components given in Table 2.10.1.3 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 from the western and southern areas in 2001 and the North Sea in 2002 (ICES CM 2003 G:7). For the Western component this year's working group uses stock weights based on Dutch mean weights at age from commercial catch data from Division VIIj over the period March to May. In previous years stock weights for the Western component were based on mean weights at age in the catch from Irish and Dutch commercial catch data (from Division VIIb, & VIIj over the spawning period March to May), which was 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 2002 North Sea 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. The time series of weightings and mean weight at age are shown in table 2.4.4.1.

2.4.4 Maturity Ogive

The maturity ogive for NEA mackerel are the same as used in the 2003 working group and are given in Table 2.4.4.2.

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.

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

For Quarters 1 to 4

Ages	IIa	IIb	IIIa	IIIc	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	Ixa-Central	Ixa-north	Total
			0.1	0.0		2553.4	1.8			70.2											16.9	24.7	45.4	83.2	0.2		81.7	11388.4	14266.1
1	2198.9	0.1	58.5	0.3	0.0	78837.4	123.1	3015.4	390.0	1722.5	0.1	0.7	12452.9		7233.3	12692.5	88.3	7.9	9299.1	1387.7	7338.0	1666.6	2626.3	2926.2	2125.8	224.7	7078.8	21153.6	174648.7
2	10682.6	0.8	340.7	0.3	0.0	129546.4	348.7	1857.9	1704.7	24948.7	5.5	9.3	11519.2	36.0	13710.5	15102.7	317.3	13.9	1123.2	1205.9	9398.2	2787.0	5469.7	3133.6	6007.6	615.8	3051.1	3003.3	245940.4
3	5717.1	0.3	350.6	0.2		36164.5	264.4	426.1	515.8	15411.5	3.1	4.7	4483.7	227.8	3098.2	2788.0	63.2	8.1	216.4	1932.1	2817.3	1297.0	3117.9	866.4	990.9	90.6	582.5	585.2	82023.8
4	17344.9	0.6	841.2	0.4	0.0	129154.4	620.7	779.5	1180.9	58492.2	14.7	19.0	11785.5	713.1	3778.1	4332.4	91.2	27.0	622.2	13921.9	7266.7	2886.5	6798.4	2047.1	740.0	64.2	691.1	960.1	265173.9
5	13872.0	0.5	1039.2	0.3		98583.6	842.6	448.0	905.2	50840.5	12.8	15.6	6649.9	1050.1	3605.9	1455.2	24.2	33.1	360.1	12110.0	4392.0	1507.4	7267.5	1676.3	2829.4	264.6	582.5	604.3	210972.8
6	11180.3	0.4	1132.8	0.2		77650.9	950.0	268.7	628.7	38106.8	9.4	11.7	6737.8	838.2	1712.2	766.6	16.8	37.8	354.0	12998.1	2994.1	893.8	6722.0	1446.0	656.1	26.5	338.0	466.0	166943.9
7	9806.9	0.4	432.5	0.2		58344.2	310.8	124.3	499.4	27917.8	7.3	9.0	5284.2	800.9	725.8	240.5	4.4	39.8	230.3	7842.1	2449.4	776.3	3510.6	625.1	996.0	105.8	352.1	194.5	121630.5
8	7356.2	0.3	195.7	0.1		41235.9	130.4	62.9	430.5	21278.4	4.4	6.0	1743.4	549.1	532.4	205.6	5.0	9.3	160.5	2706.6	2216.6	578.1	3496.8	659.5	1267.4	105.8	107.3	198.9	85242.9
9	8101.9	0.4	168.7	0.1		32894.7	84.9	40.0	422.3	16561.9	4.1	5.3	1082.6	275.6	308.7	269.3	5.9	10.8	165.2	4435.8	1042.6	337.5	1096.3	274.2	701.5	52.9	70.9	89.3	68503.4
10	2988.2	0.1	79.5	0.0		21936.8	48.5	28.3	190.8	9834.5	2.8	3.4	1149.9	249.7	342.4	100.3	1.3	21.4	108.2	2989.0	382.8	101.8	574.6	155.5	249.0	26.5	29.0	47.4	41641.3
11	1900.8	0.1	32.6	0.0		11864.2	14.0	13.3	89.9	6804.5	2.1	2.5	339.2	116.1	101.0	59.5	0.1	4.2	45.7	719.9	201.1	68.9	358.0	77.9	249.0	26.5	33.8	21.8	23146.2
12	932.9	0.0	20.9	0.0		5975.8	10.0	44.3	29.1	3738.0	1.1	1.3	819.0		349.2	67.1	0.2	3.0	26.6	419.1	0.0	3.5	126.3	32.4			25.1	10.0	12634.7
13	539.2	0.0	38.7	0.0		4392.2	17.1	0.6	12.3	1494.6	0.5	0.6	127.8	55.6	8.3	20.1			8.3		0.1	3.7	30.3	20.6			3.8	6.4	6780.6
14	467.9		2.6			3157.9	0.1		10.6	1155.9	0.4	0.4	74.9					0.1	16.0	159.1	32.3	4.7	20.8	13.7			0.6	4.2	5122.3
15	371.7		2.7			2483.5	1.7	9.7	6.2	800.8	0.3	0.3	19.7		137.9	12.7	0.0		4.9	318.9		0.6	3.3	53.1				15.6	4243.5
SOP	50530.3	2.0	2071.1	1.1		327250.1	1474.0	1614.1	3170.1	116632.0	28.0	36.3	19621.3	2288.8	9091.8	8381.9	150.2	88.6	2493.2	27730.6	11065.3	3495.4	13567.2	3787.3	4352.7	396.8	2749.9	5436.3	617486.4
Catch	50529.0	2.0	2066.7	1.1	<1	326476.8	1469.0	1617.2	3170.2	116655.8	28.0	36.3	19612.7	2264.5	9110.8	8388.0	149.8	89.6	2494.3	28058.1	11027.2	3501.6	13749.6	3859.9	4361.7	397.6	2749.5	5463.8	617330.3
SOP%	100%	100%	100%	100%		100%	100%	100%	100%	100%	100%	100%	100%	99%	100%	100%	100%	101%	100%	101%	100%	100%	101%	102%	100%	100%	100%	101%	100%

Quarter 1

Ages	IIa	IIb	IIIa	IIIc	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	Ixa-Central	Ixa-north	Total
1						379.0				213.3	0.1	0.0					32.0				51.6	24.4	254.8	46.5	2114.2	224.7	1955.2	118.3	5413.9
2						18657.7	1.3	169.9	81.5	20258.9	5.5	0.9	2632.7	36.0	1015.8	2330.7	91.7		121.1	413.0	2893.4	1340.6	2844.4	217.7	5794.9	615.8	1030.3	529.4	61083.2
3			20.6			3315.6	18.9	147.3	37.9	12959.5	3.1	0.5	2581.3	227.8	880.2	986.8	4.6	4.7	107.8	1206.0	1601.7	851.0	2281.3	366.9	852.7	90.6	112.5	370.7	29029.5
4			120.1			19808.9	112.1	158.6	313.2	51907.7	14.7	2.2	7895.8	713.1	948.0	2111.5	6.0	21.8	420.2	12473.7	5270.0	2590.7	5364.4	1160.1	603.7	64.2	76.1	737.9	112894.3
5			519.9			22970.8	467.4	113.3	257.9	47303.9	12.8	1.8	4889.6	1050.1	677.0	410.0	1.9	30.9	285.6	11064.7	2066.6	1193.2	5162.7	1063.5	2489.9	264.6	97.4	382.7	102777.9
6			760.1			20306.5	679.6	90.6	148.8	34419.0	9.4	1.3	5318.1	838.2	541.6	229.6	1.8	36.2	274.7	11850.0	981.7	639.1	4686.1	932.9	249.0	26.5	50.4	260.9	83332.2
7			140.7			9113.6	127.4	68.0	129.8	24644.0	7.3	1.0	4402.3	800.9	406.2	164.8	0.4	39.2	200.2	7321.5	1085.1	601.0	2378.3	420.4	995.9	105.8	48.9	56.5	53259.2
8			20.6			8439.6	20.8	34.0	149.4	19647.2	4.4	0.7	1087.1	549.1	203.1	131.8	0.2	9.0	147.1	2503.0	775.1	405.2	2350.8	464.9	995.9	105.8	30.6	39.7	38115.0
9						6365.9	2.1	22.7	126.9	15360.9	4.1	0.6	436.3	275.6	135.4	44.9	1.4	10.2	127.1	3910.2	568.2	285.9	756.2	202.6	498.0	52.9	28.4	7.4	29223.9
10						4564.2	1.5		93.0	9006.4	2.8	0.4	704.5	249.7		15.5		20.9	70.5	2428.2	103.4	68.1	390.0	120.7	249.0	26.5	14.6	1.7	18131.3
11						2192.2	0.7	11.3	43.5	6560.9	2.1	0.3	166.0	116.1	67.7	15.2	0.1	4.1	44.0	684.8	103.4	56.5	246.2	54.6	249.0	26.5	27.4	0.3	10672.7
12						260.4	0.1	34.0	5.4	3380.4	1.1	0.2	729.9		203.1	53.4	0.2	3.0	26.6	409.2		2.9	86.6	24.2			23.3	0.0	5243.8
13						111.4	0.0		2.3	1435.0	0.5	0.1	95.3	55.6		18.7			8.3			3.1	21.7	16.5			3.5		1772.0
14						75.1	0.0		1.5	1119.4	0.4	0.1	1.1						3.8			0.9	15.1	10.3			0.6		1228.3
15						69.0	0.0		1.4	800.8	0.3	0.0	1.3						4.9	318.9		0.6	1.4	37.2					1235.8
SOP			301.6			41091.8	280.1	256.7	605.1	103645.3	28.0	4.1	11516.9	2288.8	1534.6	1483.2	21.6	79.3	798.9	24859.2	4436.5	2380.4	9099.4	1799.8	3734.0	396.8	553.2	607.7	211797.5
Catch			301.0			40430.0	278.0	257.9	605.2	103659.9	28.0	4.1	11541.1	2264.5	1541.4	1484.7	21.6	80.2	800.2	25187.2	4436.2	2380.1	9218.5	1848.9	3741.2	397.6	553.4	623.7	211684.4
SOP%	0%	0%	100%	0%	0%	98%	99%	100%	100%	100%	100%	100%	100%	99%	100%	100%	100%	101%	100%	101%	100%	100%	101%	103%	100%	100%	100%	103%	100%

Table 2.4.1.1 (continued.)

Quarter 2

Ages	IIa	IIb	IIIa	IIIc	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	Ixa-Central	Ixa-north	Total
1	51.9	0.1	7.2		0.0	16.8	14.5	86.9	308.9			0.6	1434.2		668.1	30.4	4.5	0.1	9.5			0.3	211.7	95.1			660.3	1120.1	4721.0
2	465.5	0.8	35.6		0.0	58.5	95.6	571.1	1416.4	2286.6		6.3	5562.5		4418.0	376.4	13.1	0.6	61.2	449.2	591.3	69.1	552.3	1108.6	203.5		940.1	532.7	19814.9
3	205.8	0.3	28.8			28.5	26.0	149.3	354.0	1274.1		3.0	1604.8		1156.1	105.0	0.7	0.5	53.3	694.7	381.1	50.5	278.5	336.3	135.5		90.8	74.6	7032.1
4	393.4	0.6	77.4		0.0	130.5	32.0	163.9	492.1	3861.7		12.0	3335.7		1275.7	157.1	0.9	1.0	103.0	1387.1	1320.4	173.2	1080.6	613.6	135.5		113.2	169.3	15029.9
5	285.9	0.5	54.5			95.4	34.1	179.9	315.1	1507.5		9.9	1721.5		1386.7	89.0	0.4	0.7	72.5	1030.5	1851.5	240.4	1930.5	468.9	339.0		106.3	188.5	11909.0
6	222.2	0.4	41.1			78.9	16.5	80.8	201.5	1876.4		7.4	1391.7		623.9	44.8	0.3	0.8	79.2	1132.6	1784.1	228.5	1942.6	400.2	406.9		65.8	193.3	10819.9
7	214.9	0.4	36.2			75.8	6.1	22.4	143.5	1842.9		5.7	860.7		173.3	15.4	0.0	0.3	30.0	504.1	1320.1	168.0	1107.8	170.2			53.7	131.1	6882.5
8	168.7	0.3	22.8			51.0	5.7	22.9	102.2	555.5		3.8	639.8		176.8	11.8	0.0	0.1	13.3	199.8	1420.4	169.2	1125.9	166.3	271.4		34.6	151.0	5313.5
9	215.8	0.4	23.3			49.6	3.6	11.7	100.3	199.9		3.4	633.7		90.3	4.7	0.2	0.4	38.1	521.4	412.0	51.6	337.0	64.8	203.5		24.9	81.9	3072.3
10	79.0	0.1	11.7			27.8	4.9	23.7	30.2	430.2		2.2	438.5		182.6	9.2	0.0	0.4	37.7	552.1	278.6	33.6	183.3	32.1			8.9	45.7	2412.7
11	42.5	0.1	7.5			22.4	0.9	2.0	13.3	60.4		1.6	168.4		15.4	0.6		0.0	1.7	33.4	97.3	12.4	111.1	21.8			5.9	21.5	640.0
12	21.7	0.0	4.4			11.8	1.8	10.3	4.9	194.6		0.8	85.8		79.1	3.5	0.0			8.7		0.6	39.5	7.7			1.8	10.0	486.9
13	10.5	0.0	4.7			7.0	0.2	0.6		17.8		0.4	31.5		4.6	0.8						0.6	8.6	4.0			0.3	6.4	97.8
14	0.0		1.1			3.6	0.0					0.3	73.4					0.1	12.2	159.1	32.3	3.7	5.7	3.4				4.2	299.1
15	0.0		1.2			4.0	1.6	9.7				0.2	17.9		74.6	3.0	0.0					0.0	1.8	15.8				15.6	145.5
SOP	1232.0	2.0	200.9		0.0	359.7	69.7	351.5	1428.0	5449.1		23.0	5626.7		2716.5	215.3	3.1	1.9	184.5	2558.9	3578.1	454.0	3368.3	956.2	614.2		435.9	623.9	30452.7
Catch	1232.0	2.0	200.6		0.0	359.2	69.3	352.8	1428.0	5456.3		23.0	5624.8		2726.1	214.3	3.2	1.9	184.3	2557.9	3579.2	454.2	3431.9	981.9	615.9		435.9	640.5	30575.1
SOP%	100%	100%	100%	0%	100%	100%	99%	100%	100%	100%	0%	100%	100%	0%	100%	100%	100%	100%	100%	100%	100%	100%	102%	103%	100%	0%	100%	103%	100%

Quarter 3

Ages	IIa	IIb	IIIa	IIIc	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	Ixa-Central	Ixa-north	Total
																											0.8	7800.8	7801.6
1	2146.8		43.7	0.0		3766.2	74.1	686.6	42.3	16.8		0.1	0.3		566.2	158.5	3.5	1.4	0.2	1.7	790.7	26.4	252.8	272.1	0.0		2874.1	18210.1	29934.6
2	10216.7		252.7	0.2		14750.5	158.4	366.7	91.0	138.4		2.1	1.4		3726.9	1417.5	12.6	6.6	0.4	8.6	3059.4	102.3	571.9	1330.4	0.1		736.9	1623.1	38574.8
3	5511.2		267.8	0.2		6960.6	153.4	108.4	61.8	40.7		1.2	0.3		973.6	349.9	2.5	1.4	0.1	1.8	167.8	5.6	94.4	138.0	0.0		278.6	117.0	15236.2
4	16951.0		565.5	0.4		30687.6	329.8	426.2	229.3	77.2		4.8	0.4		1066.6	430.1	3.7	2.0	0.1	2.6	87.5	2.9	181.6	267.5			415.2	45.8	51778.3
5	13585.9		402.1	0.3		21236.4	220.3	147.0	222.3	33.5		3.9	0.2		1173.0	336.8	1.3	0.8	0.1	1.1	75.2	2.5	91.8	139.8			325.2	28.4	38027.8
6	10957.9		277.5	0.2		17977.4	147.5	91.8	178.8	23.2		3.0	0.1		527.7	182.0	0.6	0.5	0.1	0.6	18.1	0.6	67.0	111.0			207.4	10.0	30783.0
7	9591.9		221.3	0.2		17613.3	111.2	32.5	148.5	16.3		2.3	0.0		146.3	60.3	0.3	0.2	0.0	0.3	10.3	0.3	17.7	32.8			229.4	5.7	28241.0
8	7187.4		131.2	0.1		11770.4	64.2	4.2	119.2	5.2		1.5	0.0		149.2	33.7	0.1	0.1		0.1	4.6	0.2	13.9	26.7			38.2	6.7	19556.8
9	7886.0		137.9	0.1		11676.1	66.7	4.0	140.7	0.7		1.4	0.0		76.4	15.3	0.1	0.1	0.0	0.1	2.0	0.1	3.1	6.8			15.7		20033.2
10	2909.1		59.8	0.0		6580.1	28.1	4.1	45.7	4.6		0.9	0.0		154.7	31.7	0.1	0.1		0.1	0.8	0.0	1.3	2.7			4.3		9828.1
11	1858.3		22.6	0.0		5444.5	8.5		22.8			0.6			13.0	2.0					0.4	0.0	0.7	1.5			0.4		7375.4
12	911.2		15.2	0.0		3094.5	6.1		9.8			0.3			67.0	10.2	0.0				0.0		0.2	0.5					4115.0
13	528.6		33.7	0.0		1870.0	16.9		7.6			0.1			3.7	0.6					0.1		0.1	0.1					2461.4
14	467.9		1.2			942.1			7.1			0.1									0.0		0.0	0.0					1418.4
15	371.7		1.3			1034.1			4.8			0.1			63.3	9.6	0.0						0.0	0.1					1485.0
SOP	49295.3		1362.4	1.0		87278.0	722.8	462.1	737.0	103.9		9.2	0.7		2292.7	785.9	5.6	3.1	0.3	4.0	638.6	21.3	286.6	512.1	0.0		1295.7	3554.6	149370.5
Catch	49296.0		1359.0	1.0		87247.0	720.9	463.3	737.0	103.8		9.2	0.7		2301.1	792.4	5.6	3.1	0.4	4.0	636.9	21.3	283.5	510.3	0.0		1295.8	3551.3	149343.5
SOP%	100%	0%	100%	100%	0%	100%	100%	100%	100%	100%	0%	100%	101%	0%	100%	101%	100%	100%	103%	100%	100%	100%	99%	100%	109%	0%	100%	100%	100%

Table 2.4.1.1 (continued.)

Quarter 4

Ages	IIa	IIb	IIIa	IIIc	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	Ixa-Central	Ixa-north	Total
			0.1	0.0		2553.4	1.8			70.2											16.9	24.7	45.4	83.2	0.2		81.0	3587.6	6464.6
1	0.2		7.6	0.3		74675.4	34.5	2241.9	38.9	1492.4			11018.4		5999.1	12503.7	48.3	6.4	9289.5	1386.0	6495.6	1615.5	1907.0	2512.6	11.6		1589.3	1705.2	134579.1
2	0.4		52.5	0.1		96079.7	93.3	750.3	115.8	2264.7			3322.5		4549.8	10978.0	199.9	6.7	940.5	335.1	2854.2	1275.0	1501.2	476.9	9.1		343.8	318.2	126467.6
3	0.1		33.4	0.0		25859.8	66.1	21.2	62.1	1137.3			297.3		88.3	1346.3	55.4	1.5	55.3	29.6	666.7	389.9	463.7	25.3	2.8		100.7	23.0	30725.9
4	0.4		78.2	0.0		78527.5	146.8	30.8	146.2	2645.7			553.5		487.7	1633.8	80.6	2.2	98.9	58.4	588.7	119.7	171.9	5.9	0.9		86.6	7.1	85471.5
5	0.3		62.7	0.0		54281.1	121.0	7.9	110.0	1995.6			38.6		369.1	619.4	20.6	0.7	1.9	13.6	398.7	71.4	82.6	4.1	0.5		53.6	4.7	58258.1
6	0.2		54.1			39288.1	106.5	5.4	99.7	1788.2			27.8		19.0	310.3	14.2	0.4	0.0	14.9	210.2	25.6	26.3	1.8	0.2		14.4	1.8	42008.9
7	0.2		34.3	0.0		31541.5	66.1	1.5	77.6	1414.6			21.2			0.1	3.8	0.1		16.2	34.0	7.0	6.8	1.7	0.1		20.1	1.2	33247.8
8	0.1		21.1			20974.9	39.7	1.8	59.7	1070.5			16.6		3.3	28.3	4.7	0.1		3.7	16.5	3.5	6.2	1.6	0.0		3.9	1.5	22257.7
9	0.1		7.5	0.0		14803.0	12.5	1.6	54.5	1000.5			12.7		6.6	204.4	4.2	0.1	0.0	4.2	60.4						1.8		16174.0
10	0.1		7.9			10764.6	13.9	0.4	21.9	393.3			6.9		5.1	43.9	1.1	0.0		8.6							1.2		11269.2
11	0.0		2.4			4205.1	4.0		10.2	183.3			4.9		4.9	41.7				1.7							0.1		4458.3
12	0.0		1.3			2609.1	2.0		9.1	163.0			3.3							1.3									2789.0
13	0.0		0.4			2403.8			2.3	41.8			1.0																2449.4
14	0.0		0.3			2137.1			2.0	36.5			0.5																2176.5
15	0.0		0.2			1376.4							0.5																1377.2
SOP	1.0		206.3			198513.3	401.5	543.8	400.0	7436.8			2477.5		2547.4	5897.3	119.8	4.4	1509.9	308.7	2412.6	639.6	813.9	519.1	4.6		464.3	649.2	225869.5
Catch	1.00		206.00	<1		198440.59	400.74	543.26	400.00	7435.85			2446.08		2542.20	5896.56	119.46	4.36	1509.39	309.00	2375.00	646.05	815.73	518.80	4.62		464.39	648.22	225727.38
SOP%	101%	0%	100%		0%	100%	100%	100%	100%	100%	0%	0%	99%	0%	100%	100%	100%	100%	100%	100%	98%	101%	100%	100%	101%	0%	100%	100%	100%

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

Zeros represent values <1%.

Ages	IIa	IIb	IIIa	IIIc	IIId	IVa	IVb	IVc	VIa	VIb	Vb	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	IXa-Central	IXa-North	Total
0			0%	2%		0%	0%		0%												0%	0%	0%	1%	0%		1%	29%	1%
1	2%	2%	1%	31%	33%	11%	3%	42%	1%	0%	6%	1%	19%		20%	33%	14%	4%	73%	2%	18%	13%	6%	21%	13%	14%	54%	55%	11%
2	11%	20%	7%	25%	33%	18%	9%	26%	9%	8%	24%	10%	18%	1%	38%	40%	51%	6%	9%	2%	23%	22%	13%	22%	36%	38%	23%	8%	16%
3	6%	9%	7%	22%		5%	7%	6%	6%	4%	7%	5%	7%	5%	9%	7%	10%	4%	2%	3%	7%	10%	8%	6%	6%	6%	4%	2%	5%
4	19%	17%	18%	43%	33%	18%	16%	11%	21%	21%	17%	21%	18%	15%	11%	11%	15%	12%	5%	22%	18%	22%	16%	15%	4%	4%	5%	2%	17%
5	15%	12%	22%	31%		13%	22%	6%	18%	19%	13%	17%	10%	21%	10%	4%	4%	15%	3%	19%	11%	12%	18%	12%	17%	16%	4%	2%	14%
6	12%	9%	24%	20%		11%	25%	4%	14%	14%	9%	13%	10%	17%	5%	2%	3%	17%	3%	21%	7%	7%	16%	10%	4%	2%	3%	1%	11%
7	10%	9%	9%	17%		8%	8%	2%	10%	11%	7%	10%	8%	16%	2%	1%	1%	18%	2%	12%	6%	6%	9%	4%	6%	7%	3%	1%	8%
8	8%	7%	4%	9%		6%	3%	1%	8%	6%	6%	7%	3%	11%	1%	1%	1%	4%	1%	4%	5%	4%	8%	5%	8%	7%	1%	1%	6%
9	9%	9%	4%	11%		4%	2%	1%	6%	6%	6%	6%	2%	6%	1%	1%	1%	5%	1%	7%	3%	3%	3%	2%	4%	3%	1%	0%	4%
10	3%	3%	2%	4%		3%	1%	0%	4%	4%	3%	4%	2%	5%	1%	0%	0%	10%	1%	5%	1%	1%	1%	1%	1%	2%	0%	0%	3%
11	2%	2%	1%	1%		2%	0%	0%	2%	3%	1%	3%	1%	2%	0%	0%	0%	2%	0%	1%	0%	1%	1%	1%	1%	2%	0%	0%	2%
12	1%	1%	0%	1%		1%	0%	1%	1%	2%	0%	1%	1%		1%	0%	0%	1%	0%	1%	0%	0%	0%	0%			0%	0%	1%
13	1%	1%	1%	3%		1%	0%	0%	1%	1%	0%	1%	0%	1%	0%	0%			0%		0%	0%	0%	0%			0%	0%	0%
14	1%		0%			0%	0%		0%	1%	0%	0%	0%					0%	0%	0%	0%	0%	0%	0%			0%	0%	0%
15	0%		0%			0%	0%	0%	0%	0%	0%	0%	0%		0%	0%	0%		0%	1%		0%	0%	0%				0%	0%

Table 2.4.2.1. Percentage length compositon in catches by country and gear in 2002. Zeros represent values <1%.

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

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

Quarters 1-4

Ages	IIa	IIb	IIIa	IIIc	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	IXa-Central	IXa-north	Total
			23.1	23.5		23.3	23.5			23.5											23.0	23.0	20.7	23.4	23.0		23.0	21.6	22.0
1	27.5	27.3	30.5	29.2	25.8	28.9	27.1	27.0	27.4	28.4	22.3	23.7	27.2		27.6	26.4	26.2	27.6	26.9	27.1	27.5	27.6	26.7	27.1	19.7	19.7	26.1	26.4	27.7
2	31.9	31.4	34.9	34.9	30.3	32.9	32.7	29.6	31.0	30.9	30.4	29.8	29.8	31.7	29.6	30.3	30.4	30.6	28.6	30.2	28.9	29.1	29.5	28.4	26.7	26.5	30.6	27.9	31.5
3	33.5	33.0	35.9	36.6	32.7	34.8	35.1	32.6	33.1	33.5	33.5	33.2	32.4	34.4	32.3	32.8	33.2	32.8	32.3	33.5	32.0	31.8	32.9	32.6	31.6	31.2	34.0	32.6	33.8
4	35.1	34.5	36.1	37.5	33.9	35.7	35.4	34.0	34.9	34.6	34.4	34.4	34.0	35.8	34.1	32.6	33.7	34.5	34.3	35.5	33.5	33.4	34.4	34.2	36.0	36.3	35.0	33.6	35.1
5	36.4	36.1	33.8	38.5	34.9	36.8	33.2	35.4	36.4	36.3	35.8	35.9	36.1	37.7	35.8	35.5	34.1	36.3	36.3	37.2	36.3	36.0	37.0	36.2	37.1	37.0	35.9	35.6	36.6
6	37.4	37.1	33.3	39.6	36.8	37.3	32.9	37.0	37.3	37.5	36.9	37.1	36.8	38.7	36.8	36.4	35.8	37.2	38.1	38.6	38.1	37.7	37.9	37.0	37.4	36.5	37.0	36.6	37.4
7	38.4	38.2	37.3	39.9	36.4	38.6	36.8	36.6	38.5	38.3	38.1	38.2	38.4	39.9	36.8	35.7	35.8	37.2	38.4	38.4	38.9	38.4	39.2	39.0	39.7	39.8	38.1	38.9	38.5
8	39.1	38.9	40.3	40.6	35.5	39.5	40.4	37.8	38.9	39.8	39.2	39.4	39.8	40.6	38.3	35.6	36.0	37.7	39.8	39.4	40.9	40.3	39.7	39.9	40.0	40.5	38.9	39.8	39.6
9	40.2	40.4	41.2	40.8	36.5	40.3	41.2	37.0	40.1	39.9	39.4	39.6	40.6	41.3	37.2	37.1	35.5	39.8	40.5	42.7	40.8	40.9	40.6	41.4	40.2	39.5	39.9	41.5	40.3
10	41.0	41.1	41.6	41.6	35.5	40.7	41.8	41.0	40.5	40.4	39.9	40.3	41.2	42.1	42.0	35.7	34.9	40.5	41.1	40.6	41.8	41.4	41.0	41.7	41.5	41.5	40.7	41.8	40.7
11	41.6	41.7	41.9	41.8		41.3	42.3	38.1	41.0	40.7	40.2	40.7	42.4	41.0	38.5	35.6	37.8	41.3	41.9	40.8	41.5	41.8	41.2	41.8	44.5	44.5	41.9	42.2	41.1
12	42.1	42.4	42.1	42.0		41.6	42.6	43.0	42.1	41.1	40.9	41.1	40.7		42.9	42.1	43.1	41.5	41.4	41.3	41.5	42.8	41.5	42.1	41.5		43.5	42.7	41.5
13	42.9	43.7	42.2	42.2		42.2	42.2	38.5	43.6	41.3	41.5	41.2	42.2	42.2	38.5	37.5	38.5		40.4		41.5	42.6	42.9	42.8	41.5		43.5	42.8	42.0
14	42.3		42.5			42.3	42.4	42.3	42.7	42.0	42.0	41.9	43.8					44.5	43.8	44.5	44.5	44.0	43.0	43.0	41.5		46.5	43.0	42.4
15	43.0		42.9			43.3	39.6	39.5	43.0	44.1	44.7	43.8	42.4		39.5	39.5	39.5		42.4	42.5		42.5	44.8	45.5				45.3	43.2

Quarter 1

Ages	IIa	IIb	IIIa	IIIc	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	IXa-Central	IXa-north	Total
1						28.4				22.3	22.3	22.3					23.9	23.9			20.5	21.3	21.3	23.2	19.7	19.7	22.0	23.2	21.5
2						30.0	31.0	30.3	31.0	30.4	30.4	30.2	30.1	31.7	30.3	28.5	28.2	28.1	30.0	30.5	28.3	28.5	29.4	30.9	26.5	26.5	30.1	29.8	29.6
3			23.5			32.1	23.8	32.9	33.9	33.2	33.5	33.2	32.5	34.4	32.9	31.4	32.0	32.7	32.7	33.0	31.5	31.8	32.7	33.2	31.2	31.2	33.4	32.4	32.7
4			28.3			34.2	28.6	34.4	35.0	34.4	34.4	34.4	34.2	35.8	34.4	32.2	31.7	34.7	34.6	35.5	33.1	33.3	34.2	34.6	36.3	36.3	34.5	33.4	34.4
5			29.2			34.1	29.3	35.4	36.5	36.2	35.8	35.9	36.4	37.7	35.4	34.2	32.1	36.4	36.4	37.3	36.0	36.0	36.8	36.4	37.0	37.0	35.5	34.8	35.8
6			30.2			33.4	30.3	37.6	36.8	37.4	36.9	37.1	36.6	38.7	37.6	36.5	34.6	37.2	37.8	38.5	38.0	37.6	37.7	37.1	36.5	36.5	36.5	35.2	36.4
7			31.8			36.6	31.9	36.7	38.1	38.2	38.1	38.1	38.4	39.9	36.7	35.7	36.7	37.2	38.3	38.4	38.0	38.1	39.2	39.1	39.8	39.8	37.5	36.3	38.0
8			38.5			38.6	38.5	37.5	38.4	39.7	39.2	39.3	39.8	40.6	37.5	34.3	37.5	37.7	39.8	39.4	40.0	39.9	39.7	40.1	40.5	40.5	38.5	36.5	39.4
9						39.6	39.5	37.0	39.5	39.8	39.4	39.6	41.8	41.3	37.0	36.2	34.7	39.9	40.8	43.1	41.0	40.9	40.6	41.6	39.5	39.5	39.7	36.2	40.3
10						40.1	40.1	35.5	40.1	40.3	39.9	40.3	41.5	42.1	35.5	35.5		40.5	41.2	40.6	42.0	41.3	41.0	41.8	41.5	41.5	40.5	38.7	40.4
11						40.9	40.9	37.5	40.9	40.7	40.2	40.6	42.8	41.0	37.5	37.5	37.5	41.3	41.9	40.8	42.5	42.1	41.3	41.8	44.5	44.5	41.9	40.0	40.9
12						40.5	40.5	43.2	40.5	41.1	40.9	41.2	40.6		43.2	42.1	43.2	41.5	41.4	41.3		42.6	41.6	42.1			43.5	41.4	41.1
13						42.3	42.3	37.5	42.3	41.2	41.5	41.2	42.8	42.2	37.5	37.5			40.4			42.5	42.9	42.7			43.5		41.4
14						42.3	42.3		42.3	41.9	42.0	41.9	41.5						41.5			42.4	43.1	42.9			46.5		42.0
15						42.1	42.1		42.1	44.1	44.7	44.1	42.4						42.4	42.5		42.5	44.5	45.4					43.6

Table 2.4.3.1 continued.

Quarter 2

Ages	IIa	IIb	IIIa	IIIc	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	IXa-Central	IXa-north	Total
1	27.3	27.3	29.6		25.8	27.8	22.3	22.2	27.2			23.1	27.5		22.2	22.7	23.9	23.9	23.9			23.8	24.7	25.8			24.1	24.5	25.2
2	31.4	31.4	34.6		30.3	33.7	28.8	28.6	30.8	33.2		29.7	29.7		28.6	29.1	28.2	29.8	29.6	30.8	28.4	28.5	28.6	29.0	29.8		29.9	27.3	29.8
3	33.0	33.0	36.5		32.7	35.5	32.3	32.1	32.5	34.9		33.1	32.8		32.1	32.0	31.9	34.7	34.7	34.7	32.3	32.6	34.2	32.2	34.0		33.4	32.8	33.3
4	34.5	34.5	37.0		33.9	36.3	34.4	34.1	34.4	36.0		34.4	33.7		34.0	33.2	31.8	34.9	34.8	34.9	34.6	34.8	35.8	33.7	34.5		34.5	34.3	34.8
5	36.1	36.1	38.1		34.9	37.4	36.2	36.0	35.9	37.6		35.9	35.5		36.0	35.3	33.3	35.9	35.9	36.0	36.9	36.9	37.7	36.2	37.5		35.4	37.3	36.6
6	37.1	37.1	39.1		36.8	38.5	36.8	36.5	36.8	38.1		37.1	37.7		36.5	36.0	34.5	39.1	39.1	39.0	38.3	38.2	38.4	37.2	38.0		36.5	38.4	38.0
7	38.2	38.2	39.5		36.4	38.8	37.6	37.1	38.1	37.5		38.2	38.2		37.0	35.8	37.1	39.2	39.2	38.9	39.8	39.6	39.4	38.9			37.5	40.0	38.6
8	38.9	38.9	40.1		35.5	39.5	38.9	38.8	38.8	39.4		39.4	39.7		38.8	37.0	38.9	40.1	40.1	39.9	41.4	41.3	39.8	39.6	38.3		38.5	40.6	40.1
9	40.4	40.4	40.8		36.5	40.3	38.6	37.4	40.0	39.6		39.6	39.7		37.3	37.0	34.7	39.6	39.6	39.7	41.2	41.1	40.6	41.0	41.8		39.6	42.0	40.2
10	41.1	41.1	41.3		35.5	40.9	41.8	42.1	40.8	41.7		40.3	40.7		42.1	40.7	42.1	41.0	41.0	41.0	41.7	41.6	41.0	41.3			40.5	41.9	41.3
11	41.7	41.7	41.8			41.7	41.3	41.5	41.4	40.6		40.7	42.0		41.5	41.5	41.5	42.5	42.5	42.2	40.5	40.6	41.0	41.8			41.7	42.2	41.4
12	42.4	42.4	41.9			41.9	42.5	42.5	41.7	40.5		41.1	41.5		42.5	42.0	42.6			41.5		43.7	41.2	41.9			43.5	42.7	41.4
13	43.7	43.7	42.0			41.9	40.7	38.5		43.5		41.2	40.3		38.5	37.7	38.5					43.3	42.8	43.2			43.5	42.8	41.9
14	42.6		42.6			42.6	42.5	42.3				41.9	43.9					44.5	44.5	44.5	44.5	44.4	43.0	43.3				43.0	44.3
15	42.8		42.8			42.8	39.6	39.5				43.6	42.4		39.5	39.5	39.5					42.5	45.0	45.5				45.3	41.3

Quarter 3

Ages	IIa	IIb	IIIa	IIIc	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	IXa-Central	IXa-north	Total
																											23.5	21.3	21.3
1	27.5		30.8	30.8		28.2	27.4	26.0	27.2	26.0		26.5	27.2		22.2	23.2	27.4	27.3	28.3	27.2	26.6	26.6	25.4	26.0	26.6		28.2	26.5	26.8
2	32.0		35.0	35.1		33.9	34.2	30.2	31.1	30.8		30.2	29.8		28.6	29.6	29.5	29.9	33.1	29.8	27.8	27.8	27.9	27.5	27.8		31.9	27.4	31.6
3	33.5		36.8	36.8		35.5	36.5	32.7	33.5	33.3		33.2	32.4		32.1	32.3	32.4	32.4	35.8	32.4	30.3	30.3	32.1	32.3	30.3		34.3	33.3	34.3
4	35.1		37.4	37.5		36.3	37.0	33.9	34.9	34.8		34.4	32.9		34.1	33.6	32.7	33.0	35.4	32.9	32.2	32.2	33.4	33.5	32.2		35.3	34.4	35.8
5	36.4		38.4	38.5		37.5	38.2	34.9	36.3	35.5		35.9	34.1		36.0	35.4	34.2	34.2	37.1	34.1	30.0	30.0	35.1	35.2	30.0		36.2	35.8	37.0
6	37.4		39.5	39.6		38.6	39.4	36.8	37.0	36.9		37.1	35.2		36.5	35.8	35.5	35.4	39.0	35.2	36.9	36.9	35.7	35.8	36.9		37.3	37.0	38.1
7	38.4		39.9	40.0		39.0	39.8	36.3	38.2	36.4		38.2	35.0		37.0	35.7	35.4	35.1	40.5	35.0	37.9	37.9	37.0	37.5	37.9		38.3	38.6	38.8
8	39.1		40.5	40.6		39.7	40.5	35.5	39.0	38.0		39.4	35.8		38.9	37.6	37.2	35.9		35.8	38.7	38.7	37.6	38.2	38.7		39.6	39.9	39.5
9	40.2		41.2	41.3		40.5	41.3	36.5	40.2	37.4		39.6	34.7		37.4	37.1	34.0	35.7	39.5	34.7	39.2	39.2	38.6	38.6	39.2		40.5		40.4
10	41.0		41.5	41.6		41.1	41.5	35.5	40.9	40.3		40.3	35.3		42.1	40.2	37.5	35.4		35.3	39.5	39.5	40.4	40.4	39.5		41.6		41.1
11	41.6		41.8	41.8		41.8	41.8		41.4	41.6		40.7			41.5	41.5	41.5				39.1	39.1	40.9	40.7	39.1		42.5		41.7
12	42.1		42.0	42.0		41.9	42.0		42.4	41.1		41.1			42.6	42.6	42.6				41.5	41.5	41.3	41.1	41.5				42.0
13	42.9		42.2	42.2		41.9	42.2		44.2	43.5		41.2			38.5	38.5	38.5				41.5	41.5	42.8	42.8	41.5				42.1
14	42.3		42.6			42.6			42.2			41.9									41.5	41.5	43.0	42.9	41.5				42.5
15	43.0		42.8			42.8			43.2			44.1			39.5	39.5	39.5						44.5	46.1					42.7

Table 2.4.3.1 continued.

Quarter 4

Ages	IIa	IIb	IIIa	IIIc	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	IXa-Central	IXa-north	Total
			23.1	23.5		23.3	23.5			23.5											23.0	23.0	20.7	23.4	23.0		23.0	22.4	22.8
1	29.6		29.0	29.0		28.9	28.5	27.5	29.7	29.3			27.1		28.7	26.5	27.8	27.7	26.9	27.1	27.7	27.7	27.8	27.4	27.7		28.1	27.2	28.2
2	33.6		34.3	34.3		33.4	34.4	29.9	32.9	33.0			29.8		31.1	30.8	31.6	31.3	28.3	29.0	30.8	29.9	30.4	28.5	29.9		31.6	28.6	32.7
3	34.6		36.0	32.5		34.9	36.1	33.3	35.7	35.6			29.4		32.7	34.0	33.3	32.9	29.3	29.5	33.3	32.0	33.0	32.4	32.0		34.3	32.5	34.7
4	35.5		37.1	35.5		35.9	37.3	33.9	36.5	36.5			32.4		33.7	32.8	33.9	33.7	32.2	32.6	34.6	34.0	34.0	35.0	34.0		35.0	34.4	35.8
5	37.4		38.1	37.5		37.6	38.2	34.3	38.0	38.0			36.1		35.5	36.5	34.3	35.2	35.5	36.3	36.0	33.6	34.4	36.5	33.6		36.1	36.4	37.6
6	38.4		39.9			38.8	40.0	36.0	39.2	39.2			37.6		35.1	36.7	36.0	36.4	38.5	37.2	37.2	35.0	35.6	37.9	35.0		37.1	37.6	38.7
7	38.4		40.6	37.5		39.0	40.9	35.7	40.4	40.4			38.3			33.5	35.7	35.7		37.2	33.9	36.1	38.1	38.1	36.1		38.5	38.9	39.1
8	39.2		41.3			39.8	41.6	35.9	40.4	40.4			40.0		38.5	38.5	35.9	35.9		37.7	36.3	37.2	38.7	38.7	37.2		39.7	40.0	39.8
9	40.5		41.6	34.5		40.5	41.6	35.8	41.2	41.0			40.4		39.5	37.3	35.8	36.1	36.5	39.9	36.5						40.5		40.5
10	40.5		42.1			40.8	42.5	34.5	40.8	40.8			41.3		31.5	31.5	34.5	34.5		40.5							41.6		40.7
11	40.2		43.2			40.7	44.0		40.4	40.4			42.0		34.5	34.5				41.3							42.5		40.7
12	40.9		43.5			41.3	44.5		43.0	43.0			41.5							41.5									41.4
13	42.3		42.5			42.4	43.1		43.0	43.0			40.5																42.4
14	42.1		42.1			42.2	42.2		45.0	45.0			41.5																42.3
15	43.5		43.9			43.7	44.7						42.4																43.7

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	IIb	IIIa	IIIc	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	IXa-Central	IXa-north	Total
			0.093	0.105		0.100	0.105			0.105											0.081	0.081	0.066	0.098	0.081		0.080	0.076	0.081
1	0.189	0.188	0.247	0.195	0.143	0.199	0.168	0.157	0.191	0.193	0.081	0.096	0.145		0.166	0.141	0.134	0.159	0.142	0.143	0.157	0.146	0.137	0.157	0.045	0.044	0.136	0.144	0.170
2	0.360	0.357	0.386	0.373	0.236	0.316	0.312	0.198	0.332	0.231	0.223	0.205	0.198	0.229	0.197	0.222	0.221	0.225	0.173	0.191	0.172	0.167	0.183	0.172	0.114	0.112	0.222	0.165	0.269
3	0.409	0.398	0.454	0.475	0.298	0.390	0.417	0.260	0.385	0.303	0.307	0.294	0.259	0.306	0.245	0.283	0.297	0.283	0.256	0.281	0.234	0.224	0.256	0.248	0.215	0.210	0.316	0.252	0.337
4	0.466	0.453	0.467	0.520	0.323	0.433	0.436	0.312	0.428	0.343	0.337	0.335	0.306	0.349	0.303	0.277	0.315	0.337	0.320	0.354	0.261	0.257	0.292	0.285	0.312	0.319	0.353	0.266	0.388
5	0.533	0.530	0.372	0.571	0.358	0.476	0.344	0.361	0.494	0.400	0.384	0.389	0.374	0.423	0.379	0.378	0.328	0.396	0.390	0.410	0.343	0.335	0.363	0.339	0.383	0.384	0.383	0.321	0.440
6	0.570	0.564	0.339	0.618	0.414	0.509	0.326	0.409	0.527	0.447	0.424	0.433	0.411	0.462	0.413	0.402	0.388	0.429	0.458	0.471	0.399	0.395	0.388	0.362	0.390	0.361	0.425	0.346	0.478
7	0.612	0.613	0.503	0.621	0.393	0.562	0.477	0.371	0.577	0.480	0.474	0.478	0.470	0.516	0.372	0.344	0.380	0.429	0.479	0.464	0.435	0.427	0.431	0.423	0.478	0.478	0.470	0.418	0.525
8	0.648	0.641	0.672	0.692	0.328	0.608	0.673	0.452	0.585	0.546	0.517	0.529	0.522	0.546	0.484	0.372	0.393	0.448	0.553	0.496	0.495	0.494	0.448	0.450	0.520	0.550	0.490	0.448	0.576
9	0.712	0.737	0.709	0.680	0.389	0.631	0.705	0.385	0.658	0.554	0.528	0.541	0.566	0.578	0.397	0.416	0.365	0.535	0.582	0.701	0.510	0.521	0.484	0.504	0.504	0.501	0.517	0.507	0.617
10	0.739	0.749	0.750	0.751	0.390	0.674	0.740	0.581	0.643	0.575	0.546	0.572	0.582	0.626	0.614	0.387	0.357	0.566	0.591	0.561	0.546	0.557	0.497	0.511	0.595	0.595	0.550	0.515	0.637
11	0.761	0.795	0.742	0.726		0.691	0.754	0.419	0.672	0.592	0.560	0.590	0.664	0.572	0.443	0.364	0.403	0.604	0.668	0.573	0.542	0.557	0.502	0.516	0.618	0.618	0.583	0.528	0.654
12	0.797	0.811	0.758	0.737		0.740	0.743	0.640	0.739	0.616	0.596	0.613	0.580		0.648	0.605	0.636	0.612	0.643	0.597	0.529	0.586	0.512	0.525	0.529		0.659	0.549	0.685
13	0.850	0.905	0.773	0.774		0.762	0.772	0.418	0.859	0.619	0.622	0.612	0.647	0.632	0.418	0.419	0.418		0.591		0.529	0.576	0.577	0.553	0.529		0.658	0.552	0.731
14	0.829		0.782			0.779	0.691	0.653	0.829	0.649	0.641	0.642	0.625					0.620	0.626	0.620	0.571	0.571	0.585	0.560	0.529		0.815	0.558	0.744
15	0.812		0.803			0.810	0.603	0.600	0.783	0.774	0.797	0.760	0.701		0.600	0.600	0.600		0.697	0.642		0.571	0.636	0.666				0.660	0.780

Quarter 1

Ages	IIa	IIb	IIIa	IIIc	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	IXa-Central	IXa-north	Total
1						0.190				0.081	0.081	0.081					0.092	0.092			0.048	0.060	0.063	0.082	0.044	0.044	0.075	0.083	0.070
2						0.213	0.241	0.190	0.241	0.216	0.223	0.213	0.205	0.229	0.190	0.161	0.157	0.157	0.205	0.202	0.142	0.147	0.178	0.202	0.112	0.112	0.203	0.179	0.193
3			0.084			0.271	0.092	0.242	0.320	0.292	0.307	0.293	0.258	0.306	0.242	0.223	0.236	0.281	0.277	0.274	0.207	0.217	0.250	0.252	0.210	0.210	0.281	0.233	0.267
4			0.159			0.333	0.168	0.284	0.360	0.335	0.337	0.334	0.309	0.349	0.284	0.247	0.229	0.344	0.339	0.359	0.246	0.253	0.286	0.287	0.319	0.319	0.312	0.257	0.324
5			0.174			0.334	0.177	0.316	0.416	0.395	0.384	0.388	0.377	0.423	0.316	0.295	0.240	0.400	0.405	0.417	0.337	0.336	0.359	0.337	0.384	0.384	0.341	0.293	0.375
6			0.195			0.307	0.197	0.392	0.429	0.441	0.424	0.433	0.403	0.462	0.392	0.368	0.308	0.429	0.463	0.474	0.421	0.402	0.383	0.359	0.361	0.361	0.375	0.303	0.401
7			0.228			0.414	0.233	0.352	0.477	0.477	0.474	0.477	0.469	0.516	0.352	0.335	0.352	0.429	0.484	0.465	0.424	0.423	0.429	0.423	0.478	0.478	0.409	0.334	0.457
8			0.486			0.498	0.487	0.422	0.492	0.544	0.517	0.527	0.506	0.546	0.422	0.314	0.422	0.448	0.559	0.498	0.510	0.498	0.448	0.453	0.550	0.550	0.445	0.339	0.520
9						0.541	0.540	0.369	0.540	0.548	0.528	0.541	0.604	0.578	0.369	0.351	0.309	0.540	0.614	0.731	0.533	0.526	0.486	0.510	0.501	0.501	0.490	0.334	0.568
10						0.567	0.567	0.345	0.567	0.573	0.546	0.571	0.589	0.626	0.345	0.345		0.568	0.627	0.569	0.636	0.579	0.500	0.513	0.595	0.595	0.523	0.405	0.571
11						0.604	0.604	0.388	0.604	0.592	0.560	0.588	0.654	0.572	0.388	0.388	0.388	0.604	0.670	0.571	0.594	0.572	0.508	0.515	0.618	0.618	0.583	0.447	0.590
12						0.572	0.572	0.631	0.572	0.612	0.596	0.612	0.571		0.631	0.590	0.631	0.612	0.643	0.596		0.578	0.518	0.526			0.659	0.498	0.602
13						0.664	0.664	0.419	0.664	0.614	0.622	0.612	0.668	0.632	0.419	0.419			0.591			0.570	0.580	0.549			0.658		0.618
14						0.653	0.653		0.653	0.642	0.641	0.642	0.645						0.645			0.569	0.589	0.555			0.815		0.641
15						0.640	0.640		0.640	0.774	0.797	0.772	0.701						0.697	0.642		0.571	0.622	0.664					0.729

Table 2.4.3.2 (Cont'd)

Quarter 2

Ages	IIa	IIb	IIIa	IIIc	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	IXa-Central	IXa-north	Total
1	0.188	0.188	0.228		0.143	0.186	0.082	0.080	0.187			0.087	0.154		0.080	0.087	0.092	0.092	0.092			0.091	0.101	0.114			0.102	0.098	0.120
2	0.357	0.357	0.379		0.236	0.353	0.177	0.172	0.338	0.277		0.200	0.198		0.172	0.182	0.158	0.178	0.176	0.190	0.155	0.159	0.163	0.166	0.166		0.200	0.138	0.208
3	0.398	0.398	0.471		0.298	0.426	0.255	0.244	0.382	0.328		0.292	0.277		0.244	0.248	0.237	0.298	0.297	0.298	0.245	0.251	0.286	0.229	0.245		0.281	0.244	0.287
4	0.453	0.453	0.508		0.323	0.471	0.329	0.310	0.449	0.372		0.336	0.307		0.309	0.289	0.238	0.311	0.310	0.314	0.286	0.293	0.324	0.266	0.281		0.312	0.281	0.332
5	0.530	0.530	0.560		0.358	0.521	0.403	0.392	0.522	0.417		0.389	0.365		0.392	0.365	0.301	0.332	0.332	0.339	0.342	0.346	0.379	0.333	0.378		0.341	0.365	0.380
6	0.564	0.564	0.610		0.414	0.578	0.441	0.424	0.554	0.432		0.433	0.441		0.424	0.393	0.324	0.440	0.440	0.439	0.383	0.385	0.401	0.361	0.407		0.375	0.398	0.421
7	0.613	0.613	0.622		0.393	0.588	0.444	0.397	0.606	0.410		0.478	0.471		0.396	0.363	0.397	0.444	0.444	0.442	0.448	0.444	0.434	0.415			0.409	0.450	0.446
8	0.641	0.641	0.675		0.328	0.634	0.533	0.524	0.629	0.477		0.529	0.548		0.523	0.442	0.524	0.481	0.481	0.477	0.489	0.486	0.448	0.436	0.410		0.445	0.471	0.490
9	0.737	0.737	0.699		0.389	0.666	0.500	0.415	0.719	0.517		0.541	0.540		0.415	0.405	0.310	0.477	0.476	0.482	0.495	0.495	0.478	0.487	0.512		0.488	0.523	0.529
10	0.749	0.749	0.743		0.390	0.715	0.621	0.619	0.732	0.559		0.572	0.570		0.619	0.565	0.620	0.524	0.524	0.528	0.514	0.512	0.489	0.496			0.523	0.519	0.557
11	0.795	0.795	0.744			0.734	0.627	0.591	0.765	0.566		0.590	0.673		0.591	0.591	0.591	0.613	0.613	0.611	0.488	0.492	0.488	0.515			0.572	0.529	0.595
12	0.811	0.811	0.776			0.784	0.673	0.670	0.750	0.567		0.613	0.656		0.671	0.646	0.671			0.612		0.625	0.499	0.519			0.658	0.549	0.617
13	0.905	0.905	0.769			0.763	0.618	0.418		0.715		0.612	0.587		0.418	0.419	0.418					0.610	0.569	0.567			0.658	0.552	0.651
14	0.785		0.785			0.783	0.722	0.653				0.642	0.625					0.620	0.620	0.620	0.571	0.571	0.574	0.572				0.558	0.616
15	0.801		0.801			0.800	0.603	0.600				0.754	0.701		0.600	0.600	0.600					0.571	0.645	0.667				0.660	0.634

Quarter 3

Ages	IIa	IIb	IIIa	IIIc	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	IXa-Central	IXa-north	Total
																											0.086	0.072	0.072
1	0.189		0.256	0.256		0.195	0.177	0.145	0.184	0.143		0.140	0.150		0.080	0.095	0.152	0.152	0.181	0.150	0.129	0.129	0.128	0.137	0.129		0.168	0.145	0.155
2	0.360		0.391	0.392		0.361	0.363	0.232	0.347	0.227		0.215	0.204		0.172	0.197	0.196	0.205	0.307	0.204	0.148	0.148	0.173	0.167	0.148		0.260	0.165	0.298
3	0.409		0.481	0.482		0.436	0.467	0.297	0.419	0.293		0.297	0.270		0.244	0.260	0.268	0.272	0.403	0.270	0.197	0.197	0.269	0.280	0.197		0.336	0.310	0.402
4	0.466		0.521	0.523		0.486	0.496	0.323	0.466	0.339		0.336	0.287		0.310	0.304	0.280	0.288	0.388	0.287	0.241	0.241	0.303	0.316	0.241		0.370	0.343	0.470
5	0.533		0.571	0.573		0.542	0.556	0.358	0.533	0.360		0.388	0.325		0.392	0.369	0.328	0.328	0.444	0.325	0.208	0.208	0.358	0.372	0.208		0.406	0.398	0.529
6	0.570		0.617	0.618		0.601	0.604	0.412	0.560	0.395		0.433	0.360		0.424	0.388	0.372	0.368	0.518	0.360	0.368	0.368	0.377	0.394	0.368		0.452	0.436	0.583
7	0.612		0.629	0.631		0.613	0.622	0.392	0.613	0.365		0.479	0.356		0.397	0.365	0.366	0.359	0.544	0.356	0.400	0.400	0.429	0.459	0.400		0.495	0.500	0.609
8	0.648		0.689	0.692		0.661	0.685	0.329	0.647	0.424		0.529	0.388		0.524	0.468	0.444	0.390		0.388	0.425	0.425	0.456	0.485	0.425		0.560	0.557	0.654
9	0.712		0.709	0.711		0.689	0.709	0.389	0.722	0.465		0.542	0.344		0.415	0.413	0.319	0.392	0.555	0.344	0.445	0.445	0.505	0.506	0.445		0.605		0.697
10	0.739		0.749	0.751		0.738	0.746	0.388	0.741	0.496		0.570	0.365		0.619	0.546	0.445	0.367		0.365	0.458	0.458	0.575	0.577	0.458		0.668		0.735
11	0.760		0.733	0.726		0.748	0.726		0.774	0.702		0.590			0.591	0.591	0.591				0.444	0.444	0.600	0.592	0.444		0.719		0.751
12	0.797		0.750	0.737		0.786	0.737		0.811	0.678		0.611			0.671	0.671	0.671				0.529	0.529	0.617	0.608	0.529				0.786
13	0.849		0.773	0.774		0.764	0.774		0.949	0.812		0.613			0.418	0.418	0.418				0.529	0.529	0.694	0.693	0.529				0.782
14	0.829		0.785			0.785			0.854			0.642									0.529	0.529	0.703	0.701	0.529				0.800
15	0.812		0.801			0.801			0.825			0.772			0.600	0.600	0.600						0.787	0.886					0.794

Table 2.4.3.2 (Cont'd)

Quarter 4

Ages	IIa	IIb	IIIa	IIIc	IIId	IVa	IVb	IVc	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	IXa-Central	IXa-north	Total
			0.093	0.105		0.100	0.105			0.105											0.081	0.081	0.066	0.098	0.081		0.080	0.085	0.091
1	0.225		0.210	0.188		0.199	0.182	0.164	0.234	0.210			0.144		0.184	0.142	0.165	0.162	0.142	0.143	0.161	0.148	0.153	0.163	0.148		0.166	0.159	0.179
2	0.344		0.365	0.317		0.329	0.367	0.204	0.316	0.316			0.191		0.242	0.240	0.255	0.248	0.168	0.179	0.233	0.190	0.203	0.187	0.190		0.252	0.189	0.306
3	0.407		0.452	0.292		0.393	0.457	0.304	0.412	0.410			0.180		0.284	0.336	0.304	0.295	0.176	0.183	0.302	0.237	0.266	0.284	0.237		0.333	0.288	0.382
4	0.444		0.515	0.412		0.438	0.528	0.324	0.443	0.443			0.257		0.307	0.307	0.324	0.317	0.250	0.264	0.346	0.283	0.295	0.365	0.283		0.361	0.344	0.432
5	0.528		0.573	0.523		0.510	0.583	0.336	0.512	0.513			0.389		0.408	0.441	0.336	0.371	0.353	0.397	0.403	0.273	0.311	0.424	0.273		0.402	0.423	0.508
6	0.577		0.729			0.572	0.749	0.400	0.562	0.562			0.457		0.371	0.436	0.400	0.416	0.508	0.429	0.437	0.309	0.355	0.468	0.309		0.442	0.460	0.570
7	0.576		0.688	0.435		0.576	0.705	0.384	0.620	0.617			0.490			0.308	0.384	0.384		0.429	0.313	0.343	0.467	0.475	0.343		0.503	0.509	0.577
8	0.646		0.749			0.624	0.771	0.390	0.619	0.619			0.565		0.495	0.495	0.390	0.390		0.448	0.389	0.374	0.494	0.504	0.374		0.561	0.564	0.623
9	0.632		0.746	0.312		0.624	0.766	0.387	0.658	0.650			0.591		0.540	0.431	0.387	0.388	0.389	0.538	0.389						0.605		0.623
10	0.691		0.765			0.680	0.788	0.341	0.640	0.640			0.639		0.250	0.250	0.341	0.341		0.568							0.668		0.677
11	0.666		0.816			0.661	0.868		0.614	0.614			0.675		0.341	0.341				0.604							0.719		0.656
12	0.714		0.789			0.702	0.832		0.754	0.754			0.649							0.612									0.706
13	0.764		0.766			0.764	0.772		0.753	0.753			0.597																0.764
14	0.792		0.766			0.781	0.692		0.875	0.875			0.645																0.783
15	0.820		0.828			0.825	0.849						0.701																0.825

Table 2.4.4.1 The calculation of the mean weights at age in the stock (WEST) of the NEA mackerel based on weighting by SSB's from egg surveys (1984-recent).
For 1972-1983 it is based on weighting by SSB,s from VPA (gradual change from 1972-1983).

Revision because from 1984-1994 ratio western/southern 85:15 was used and did not include North Sea SSB (WG1995)

WEIGHTING FACTORS

For 1984 up to 1997 the same SSB ratio's are used as estimated from the 1995 Egg surveys

Ratio's from 1995 onwards see Overview egg survey SSB's Table 6 (WD2002)

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
North Sea	0.2541	0.2487	0.2211	0.2047	0.2010	0.1774	0.1361	0.1251	0.1164	0.0860	0.0799	0.0743	0.0372	0.0372	0.0372	0.0372	0.0372	0.0372	0.0372	0.0372	0.0372	0.0372	0.0372	0.0372	0.0372	0.0372	0.0178	0.0178	0.0178	0.0275	0.0275	0.0275		
Western	0.6181	0.6235	0.6511	0.6675	0.6712	0.6948	0.7361	0.7471	0.7558	0.7862	0.7923	0.7979	0.8350	0.8350	0.8350	0.8350	0.8350	0.8350	0.8350	0.8350	0.8350	0.8350	0.8350	0.8350	0.8350	0.8350	0.7727	0.7727	0.7727	0.8481	0.8481	0.8481		
Southern	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.2095	0.2095	0.2095	0.1244	0.1244	0.1244		

The ratio's between North Sea and western from 1972-1983 reflect the SSB's from VPA
(western SSB from ICES CM 2002/ACFM:06 and North Sea SSB from ICES CM 1984/Assess:8)

Unit: kg

NORTH SEA MACKEREL (ICES fisheries assessment data base 1972-1983)

From 1984 onwards a constant data set has been used

Data for 2001 from 2002 egg survey (Iversen & Eltink WD2002)

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
1	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.138	0.138	0.138	0.138	0.138	0.138	0.138	0.138	0.138	0.138	0.138	0.138	0.138	0.138	0.138	0.138	0.138	0.120	0.120	0.120		
2	0.275	0.275	0.275	0.275	0.275	0.275	0.275	0.275	0.275	0.275	0.275	0.275	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.230	0.209	0.209	0.209		
3	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.295	0.295	0.295		
4	0.477	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.357	0.357	0.357	0.357	0.357	0.357	0.357	0.357	0.357	0.357	0.357	0.357	0.357	0.357	0.357	0.357	0.357	0.342	0.342	0.342		
5		0.497	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.438	0.438	0.438	0.438	0.438	0.438	0.438	0.438	0.438	0.438	0.438	0.438	0.438	0.438	0.438	0.438	0.438	0.364	0.364	0.364		
6			0.543	0.495	0.495	0.495	0.495	0.495	0.495	0.495	0.495	0.495	0.464	0.464	0.464	0.464	0.464	0.464	0.464	0.464	0.464	0.464	0.464	0.464	0.464	0.464	0.464	0.464	0.464	0.437	0.437	0.437		
7				0.572	0.525	0.525	0.525	0.525	0.525	0.525	0.525	0.525	0.418	0.418	0.418	0.418	0.418	0.418	0.418	0.418	0.418	0.418	0.418	0.418	0.418	0.418	0.418	0.418	0.418	0.444	0.444	0.444		
8					0.570	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.471	0.471	0.471	0.471	0.471	0.471	0.471	0.471	0.471	0.471	0.471	0.471	0.471	0.471	0.471	0.471	0.471	0.429	0.429	0.429		
9						0.587	0.565	0.565	0.565	0.565	0.565	0.565	0.529	0.529	0.529	0.529	0.529	0.529	0.529	0.529	0.529	0.529	0.529	0.529	0.529	0.529	0.529	0.529	0.529	0.509	0.509	0.509		
10							0.615	0.590	0.590	0.590	0.590	0.590	0.545	0.545	0.545	0.545	0.545	0.545	0.545	0.545	0.545	0.545	0.545	0.545	0.545	0.545	0.545	0.545	0.545	0.606	0.606	0.606		
11								0.634	0.610	0.610	0.610	0.610	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.550	0.643	0.643	0.643		
12+									0.647	0.636	0.646	0.648	0.665	0.665	0.665	0.665	0.665	0.665	0.665	0.665	0.665	0.665	0.665	0.665	0.665	0.665	0.665	0.665	0.665	0.550	0.550	0.550		

From 1988-2000 the stock weight of the 15+ group weight estimated from average over 12-15+group

WESTERN MACKEREL Data are taken from WEST file (2001WG)

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	not av.	0.000		
1	0.113	0.113	0.113	0.113	0.113	0.113	0.095	0.095	0.095	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	not av.	0.070		
2	0.131	0.131	0.131	0.131	0.131	0.131	0.150	0.150	0.150	0.172	0.108	0.156	0.187	0.150	0.164	0.139	0.146	0.176	0.128	0.149	0.216	0.193	0.175	0.151	0.122	0.187	0.139	0.195	0.187	0.158	not av.	0.181		
3	0.201	0.201	0.201	0.201	0.201	0.201	0.215	0.215	0.215	0.241	0.202	0.220	0.246	0.292	0.261	0.233	0.233	0.238	0.213	0.227	0.257	0.264	0.230	0.259	0.244	0.216	0.217	0.237	0.236	0.237	not av.	0.276		
4	0.380	0.251	0.251	0.251	0.251	0.251	0.275	0.275	0.275	0.300	0.260	0.261	0.283	0.300	0.290	0.268	0.302	0.299	0.280	0.307	0.309	0.311	0.289	0.316	0.314	0.290	0.277	0.301	0.282	0.345	not av.	0.320		
5		0.410	0.264	0.264	0.264	0.264	0.320	0.320	0.320	0.300	0.379	0.322	0.305	0.328	0.345	0.363	0.327	0.342	0.331	0.356	0.359	0.357	0.353	0.392	0.356	0.357	0.339	0.350	0.350	0.392	not av.	0.373		
6			0.440	0.316	0.316	0.316	0.355	0.355	0.355	0.359	0.329	0.360	0.379	0.366	0.337	0.371	0.434	0.363	0.365	0.408	0.400	0.416	0.407	0.445	0.443	0.398	0.407	0.401	0.385	0.452	not av.	0.456		
7				0.470	0.380	0.380	0.380	0.380	0.380	0.401	0.388	0.384	0.429	0.421	0.395	0.392	0.455	0.419	0.405	0.431	0.424	0.458	0.468	0.493	0.464	0.446	0.434	0.432	0.427	0.461	not av.	0.449		
8					0.490	0.412	0.400	0.400	0.400	0.412	0.417	0.420	0.421	0.440	0.467	0.402	0.436	0.468	0.393	0.506	0.464	0.464	0.464	0.506	0.505	0.480	0.473	0.446	0.448	0.506	not av.	0.481		
9						0.511	0.420	0.420	0.420	0.427	0.425	0.497	0.465	0.448	0.441	0.459	0.460	0.441	0.420	0.547	0.489	0.480	0.472	0.546	0.576	0.520	0.515	0.491	0.494	0.535	not av.	0.602		
10							0.485	0.485	0.485	0.413	0.460	0.453	0.515	0.554	0.451	0.483	0.528	0.451	0.514	0.574	0.523	0.512	0.550	0.502	0.580	0.539	0.567	0.503	0.489	0.586	not av.	0.530		
11								0.485	0.485	0.509	0.513	0.550	0.497	0.579	0.472	0.442	0.606	0.496	0.514	0.574	0.556	0.597	0.612	0.627	0.624	0.530	0.535	0.452	0.539	0.610	not av.	0.613		
12+									0.485	0.509	0.513	0.550	0.549	0.599	0.568	0.547	0.645	0.585	0.514	0.574	0.582	0.561	0.568	0.633	0.638	0.579	0.588	0.574	0.543	0.589	not av.	0.620		

SOUTHERN MACKEREL (1972-1983 Data from Uriarte&Villamor&Martins, WD2000)

Revised set 1984-2001 according WD 2002

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
1	0.128	0.128	0.128	0.128	0.128	0.128	0.128	0.128	0.128	0.128	0.128	0.128	0.137	0.164	0.107	0.116	0.069	0.098	0.081	0.093	0.116	0.111	0.122	0.134	0.095	0.100	0.099	0.118	0.085	0.127	0.117	0.094		
2	0.213	0.213	0.213	0.213	0.213	0.213	0.213	0.213	0.213	0.213	0.213	0.213	0.230	0.241	0.260	0.183	0.204	0.168	0.178	0.174	0.183	0.211	0.179	0.229	0.173	0.165	0.178	0.185	0.172	0.196	0.206	0.176		
3	0.271	0.271	0.271	0.271	0.271	0.271	0.271	0.271	0.271	0.271	0.271	0.271	0.281	0.296	0.294	0.268	0.237	0.264	0.253	0.226	0.253	0.277	0.257	0.309	0.278	0.281	0.235	0.255	0.227	0.259	0.233	0.245		
4	0.426	0.322	0.322	0.322	0.322	0.322	0.322	0.322	0.322	0.322	0.322	0.322	0.356	0.332	0.378	0.386	0.277	0.340	0.310	0.295	0.303	0.326	0.360	0.381	0.325	0.319	0.310	0.294	0.307	0.320	0.293	0.283		
5		0.459	0.376	0.376	0.376	0.376	0.376	0.376	0.376	0.376	0.376	0.376	0.415	0.401	0.404	0.425	0.314	0.390	0.365	0.340	0.360	0.361	0.388	0.422	0.410	0.363	0.344	0.357	0.344	0.382	0.335	0.353		
6			0.489	0.416	0.416	0.416	0.416	0.416	0.416	0.416	0.416	0.416	0.465	0.476	0.410	0.459	0.337	0.468	0.401	0.403	0.395	0.403	0.433	0.460	0.447	0.413	0.367	0.370	0.401	0.404	0.392	0.378		
7				0.515	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.491	0.492	0.554	0.534	0.387	0.497	0.475	0.439	0.424	0.441	0.468	0.496	0.463	0.447	0.398	0.391	0.421	0.445	0.428	0.423		
8					0.536	0.490	0.490	0.490	0.490	0.490	0.490	0.490	0.567	0.578	0.510	0.594	0.392	0.510	0.494	0.484	0.448	0.466	0.511	0.529	0.483	0.469	0.439	0.415	0.439	0.470	0.457	0.441		
9						0.552	0.505	0.505	0.505	0.505	0.505	0.505	0.559	0.581	0.429	0.621	0.403	0.542	0.525	0.505	0.465	0.495	0.541	0.554	0.502	0.506	0.450	0.459	0.450	0.491	0.489	0.478		
10							0.570	0.530	0.530	0.530	0.530	0.530	0.546	0.595	0.554	0.592	0.476	0.542	0.507	0.521	0.508	0.492	0.551	0.582	0.536	0.525	0.481	0.478	0.498	0.502	0.504	0.489		
11								0.584	0.553	0.553	0.553	0.553	0.582	0.590	0.649	0.629	0.490	0.591	0.574	0.517	0.524	0.514	0.600	0.588	0.541	0.541	0.480	0.504	0.505	0.545	0.514	0.492		
12+									0.594	0.594	0.594	0.594	0.520	0.643	0.591	0.529	0.536	0.643	0.584	0.700	0.562	0.656	0.664	0.674	0.584	0.597	0.545	0.523	0.538	0.570	0.645	0.551		

NEA MACKEREL

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
1	0.132	0.132	0.130	0.129	0.128	0.127	0.111	0.110	0.109	0.087	0.086	0.086	0.081	0.085	0.077	0.078	0.072	0.076	0.074	0.075	0.078	0.078	0.079	0.081	0.076	0.076	0.077	0.081	0.074	0.078	0.078	0.074		
2	0.178	0.177	0.173	0.171	0.170	0.167	0.175	0.174	0.173	0.186	0.135	0.172	0.194	0.165	0.179	0.148	0.156	0.177	0.138	0.155	0.212	0.197	0.178	0.164	0.133	0.186	0.149	0.194	0.185	0.164	0.181	0.181		
3	0.243	0.242	0.238	0.236	0.236	0.233	0.238	0.237	0.236	0.252	0.221	0.235	0.253	0.293	0.267	0.240	0.237	0.244	0.222	0.230	0.259	0.268	0.237	0.267	0.251	0.228	0.223	0.242	0.235	0.241	0.240	0.273		
4	0.411	0.301	0.296	0.294	0.293	0.289	0.300	0.299	0.297	0.313	0.280	0.280	0.295	0.306	0.304	0.286	0.301	0.306	0.287	0.307	0.310	0.315	0.301	0.326	0.317	0.296	0.285	0.301	0.289	0.342	0.310	0.316		
5	0.000	0.438	0.322	0.318	0.318	0.313	0.346	0.345	0.343	0.323	0.385	0.339	0.324	0.341	0.356	0.374	0.329	0.352	0.339	0.357	0.362	0.360	0.361	0.398	0.366	0.361	0.342	0.353	0.350	0.390	0.364	0.371		
6	0.000	0.000	0.469	0.365	0.365	0.361	0.382	0.380	0.379	0.378	0.353	0.377	0.393	0.384	0.351	0.386	0.423	0.380	0.373	0.409	0.402	0.416	0.413	0.448	0.444	0.402	0.400	0.396	0.390	0.446	0.410	0.446		
7	0.000	0.000	0.000	0.497	0.419	0.416	0.410	0.408	0.407	0.419	0.408	0.404	0.436	0.430	0.416	0.411	0.445	0.429	0.414	0.432	0.424	0.454	0.466	0.491	0.462	0.445	0.426	0.423	0.426	0.459	0.436	0.446		
8	0.000	0.000	0.000	0.000	0.512	0.446	0.432	0.430	0.429	0.434	0.437	0.439	0.441	0.459	0.473	0.429	0.432	0.474	0.409	0.502	0.462	0.465	0.470	0.508	0.501	0.478	0.466	0.440	0.447	0.499	0.462	0.475		
9	0.000	0.000	0.000	0.000	0.000	0.530	0.451	0.449	0.448	0.449	0.446	0.503	0.479	0.468	0.443	0.482	0.455	0.457	0.437	0.541	0.487	0.484	0.483	0.546	0.565	0.519	0.502	0.485	0.485	0.529	0.500	0.584		
10	0.000	0.000	0.000	0.000	0.000	0.000	0.514	0.504	0.503	0.443	0.479	0.473	0.520	0.559	0.468	0.499	0.522	0.466	0.514	0.566	0.522	0.511	0.550	0.514	0.573	0.537	0.549	0.498	0.492	0.576	0.522	0.527		
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.516	0.508	0.523	0.526	0.555	0.510	0.579	0.497	0.470	0.589	0.510	0.523	0.566	0.552	0.585	0.608	0.619	0.611	0.532	0.524	0.465	0.532	0.603	0.533	0.599		
12+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.518	0.531	0.534	0.563	0.550	0.607	0.575	0.549	0.632	0.595	0.529	0.594	0.583	0.577	0.584	0.639	0.632	0.585	0.580	0.565	0.544	0.586	0.565	0.610		

mean of
3 years

Table 2.4.4.2 The calculation of the proportions mature at age in the stock (MATPROP) of the NEA mackerel based on weighting by SSB's from egg surveys (1984-recent). For 1972-1983 it is based on weighting by SSB,s from VPA (gradual change from 1972-1983).

WEIGHTING FACTORS

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
North Sea	0.2541	0.2487	0.2211	0.2047	0.2010	0.1774	0.1361	0.1251	0.1164	0.0860	0.0799	0.0743	0.0372	0.0372	0.0372	0.0372	0.0372	0.0372	0.0372	0.0372	0.0372	0.0372	0.0372	0.0372	0.0372	0.0372	0.0178	0.0178	0.0178	0.0275	0.0275	0.0275	0.0000	0.0000
Western	0.6181	0.6235	0.6511	0.6675	0.6712	0.6948	0.7361	0.7471	0.7558	0.7862	0.7923	0.7979	0.8350	0.8350	0.8350	0.8350	0.8350	0.8350	0.8350	0.8350	0.8350	0.8350	0.8350	0.8350	0.8350	0.8350	0.7727	0.7727	0.7727	0.8481	0.8481	0.8481	0.0000	0.0000
Southern	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.1278	0.2095	0.2095	0.2095	0.1244	0.1244	0.1244	0.0000	0.0000

NORTH SEA MACKEREL (ICES fisheries assessment data base kept constant 1972-recent)

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
2	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37		
3	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
11	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
12+	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		

WESTERN MACK (Data from ICES 2001 WG)

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
1	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08		
2	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60		
3	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90		
4	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97		
5	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97		
6	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99		
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
11	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
12+	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		

SOUTHERN MACKEREL Data set 1972-1997 revised to be the same as 1998-2001, because these were based on histology

Revised from 1998 onwards (WG1999 section 2.4.4)

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
1	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02		
2	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54		
3	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70		
4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
11	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
12+	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		

NEA MACKEREL

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
1	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07		
2	0.53	0.54	0.54	0.55	0.55	0.55	0.56	0.56	0.57	0.57	0.57	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.59	0.59	0.59		
3	0.90	0.90	0.90	0.89	0.89	0.89	0.89	0.89	0.89	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.86	0.86	0.86	0.88	0.88	0.88		
4	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.98	0.98	0.98	0.97	0.97	0.97		
5	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.98	0.98	0.98	0.97	0.97	0.97		
6	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99		
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
11	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
12+	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		

2.5 Fishery-independent Information

2.5.1 Egg survey estimates of spawning biomass in 2004

2.5.1.1 Description

The ICES Triennial Mackerel and Horse Mackerel Egg Survey was carried out from January to July 2004. It is planned to present the results of the survey at the WGMEGS in Bergen, Norway in April 2005. However, it was agreed at the WGMEGS meeting in Lisbon 1-4 April 2003 that the WG should aim to provide an estimate of NEA mackerel biomass and western horse mackerel egg production in time for the meeting of the WGMHSA in Copenhagen, September 2004 (ICES CM 2003/G:07). This required a complete work up of the data from the egg survey itself as well as the histological data on mackerel fecundity and atresia. It should be noted that this data has not previously been available within the year of the survey. It has routinely been reported to a meeting of WGMEGS for analysis in the following year, and then on to WGMHSA in that year. The production of useable estimates for both species required considerable commitment from the members of WGMEGS. WGMHSA were both aware and appreciative of this.

The survey was carried out over seven non-contiguous periods – see table below

Period	Dates
1	15 to 26 January (southern area only)
2	19 February to 2 March (southern area only)
3	20 March to 18 April (7 March to 10 April – southern area)
4	21 April to 10 May (12 April to 16 May – southern area)
5	11 May to 8 June (21 to 27 May – southern area)
6	9 to 27 June
7	4 to 15 July

Data analysis for Annual egg Production

The analysis protocols followed those described in the report of WGMEGS (ICES 2000/G:01). Egg counts were converted to stage 1 egg production m^{-2}, using data on the volume of water filtered and on the sampled depth. These values were then converted to egg production $m^{-2}.day^{-1}$ using the development equations and water temperature at 20m depth. Arithmetic means were used where more than one sample per rectangle per period was collected. Daily egg production values were interpolated into unsampled rectangles according to the rules set down in the above report.

Plots of distribution of egg production from the southern area are not shown. Plots of the distribution of egg production for the western area are presented in Figures 2.5.1.1. a-e. The western area survey coverage was from periods 3 - 7. In general the coverage in periods 3 – 6 was very good. There was a greatly reduced need for rectangle interpolation than in 2001. The edges of the egg distribution were also generally well defined with zero samples along the borders. However, the survey did have a small number of aspects where there were minor problems.

- In period 5, the area between 46 and 47°N was not fully covered, and some egg production was probably missed along the shelf break.
- In period 6, there was an unusually strong egg production in the inner part of the Celtic Sea, and the eastern border of this was not identified. Again, it is likely that some egg production was missed.
- In period 7, it proved impossible to obtain sufficient vessel resources to cover the whole area. As a result the areas north of 55°N, and south of 48°30'N were not surveyed, and some egg production was probably missed.

This information will be presented in more detail following the meeting of WGMEGS in April 2005.

Egg production for each survey period was then calculated by raising each value to the rectangle area, summing across the whole period, and raising to the number of days in each period. Egg production in the unsampled periods was then calculated by simple linear interpolation from the adjacent periods. The observed and interpolated periods were then assembled to produce separate western and southern area egg production curves or histograms. The Total Annual Egg Production (TAEP) was then calculated by integration of the histograms. The egg production curves for the two areas are presented in figs 2.5.1.2 & 2.5.1.3. The TAEP for the western area was 1.202 $*10^{15}$. This can be compared with a value of 1.21 $*10^{15}$ in 2001. TAEP in the southern area was 0.121 $*10^{15}$. This can be compared with a 2001 value of 0.28 $*10^{15}$.

Conversion of TAEP to biomass

The TAEP was converted to an SSB estimate using information on female fecundity, sex ratio & Pre-SSB to SSB correction. Sex ratio is taken to be 50:50 and the Pre-SSB conversion factor is taken as 1.08. The realised female fecundity used in the estimate was based on potential fecundity from samples taken prior to the start of the spawning season and from estimates of atresia from ovary samples taken in periods 4 - 7 in the western area.

Fecundity and atresia estimation

During the planning stages WGMEGS set out to collect and analyse 600 fecundity samples, 500 in the western area and 100 in the southern area. The western samples were to be split between FRS, CEFAS & IMR and the southern samples analysed by IEO. Up to the date of the WGMHSA, it was possible to analyse 338 samples in total (294 western and 44 southern samples). For various reasons, the southern samples were also split between the four institutes. The splits allowed comparisons between samples sources and between analysis institutes. These will be reported fully by WGMEGS, however, in general there was good agreement between analysts and samples. The samples analysed to date and their source are presented below. For comparison, in 2001 there were 187 samples for analysis in the western area, and 82 in the south.

Institute	CEFAS Endeavour	Walther Herwig III	Southern samples	Total
CEFAS	83	15	12	110
FRS	44	66	12	122
IMR	13	40	9	62
IEO	0	0	44	44

A total of 321 fish were collected for atresia analysis in the western area from trawling in periods 4-7. Of these 194 fish have been analysed. No atresia data are available as yet for the southern area. The total number of fish analysed for atresia in 2001 was 290.

Based on these analyses it was possible to determine a potential fecundity in the western area of 1193 eggs.g^{-1}.Female, and 1013 in the south. Atresia in the west was calculated at a prevalence of 0.386 and intensity of 33 eggs.g^{-1}. With no atresia data available for the southern area, and the low number of fecundity data, it was decided to pool the results from both areas. This provided a realised fecundity value of 1090 eggs.g^{-1} female, for use in making the biomass conversion for both areas. The realised fecundity value is similar to the value from the 2001survey.

Biomass estimates for the western and southern areas.

The SSB estimate for the western area was around 2.4 million tonnes, a drop of 6% from 2001. The SSB estimate for the southern area was about 240,000 tonnes, a drop of approximately 36% from 2001. The combined biomass estimate for the North East Atlantic mackerel from the 2004 egg survey was some 2.6 million tonnes, down by around 9.5% from the 2001 estimate (2.9 million tonnes).

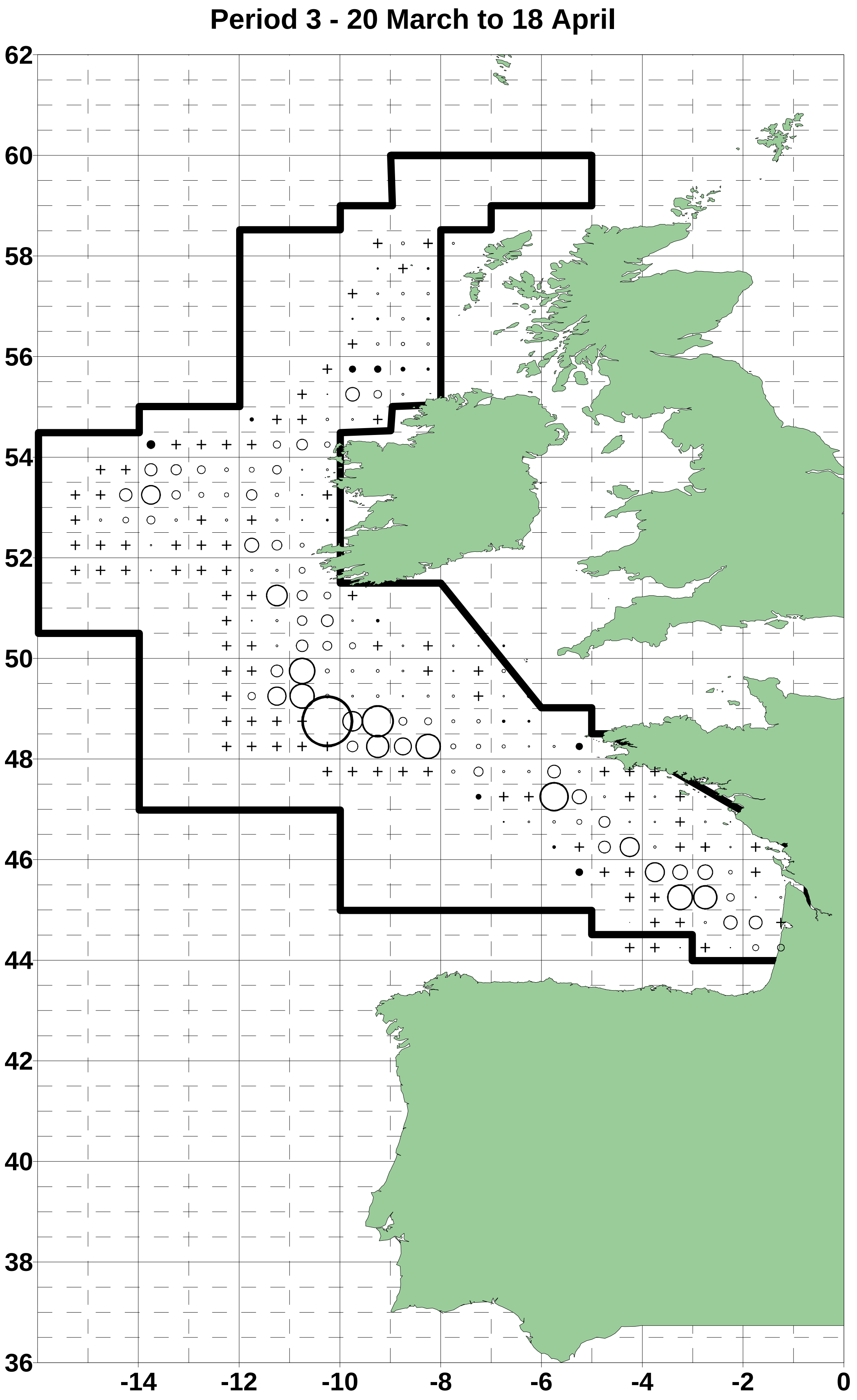


Figure 2.5.1.1.a. Mackerel daily egg production values from Period 3. Open circles represent observed data, and filled circles represent interpolated data. All circles are square root scaled to a max of 800 eggs.m^{-2}.d^{-1}.

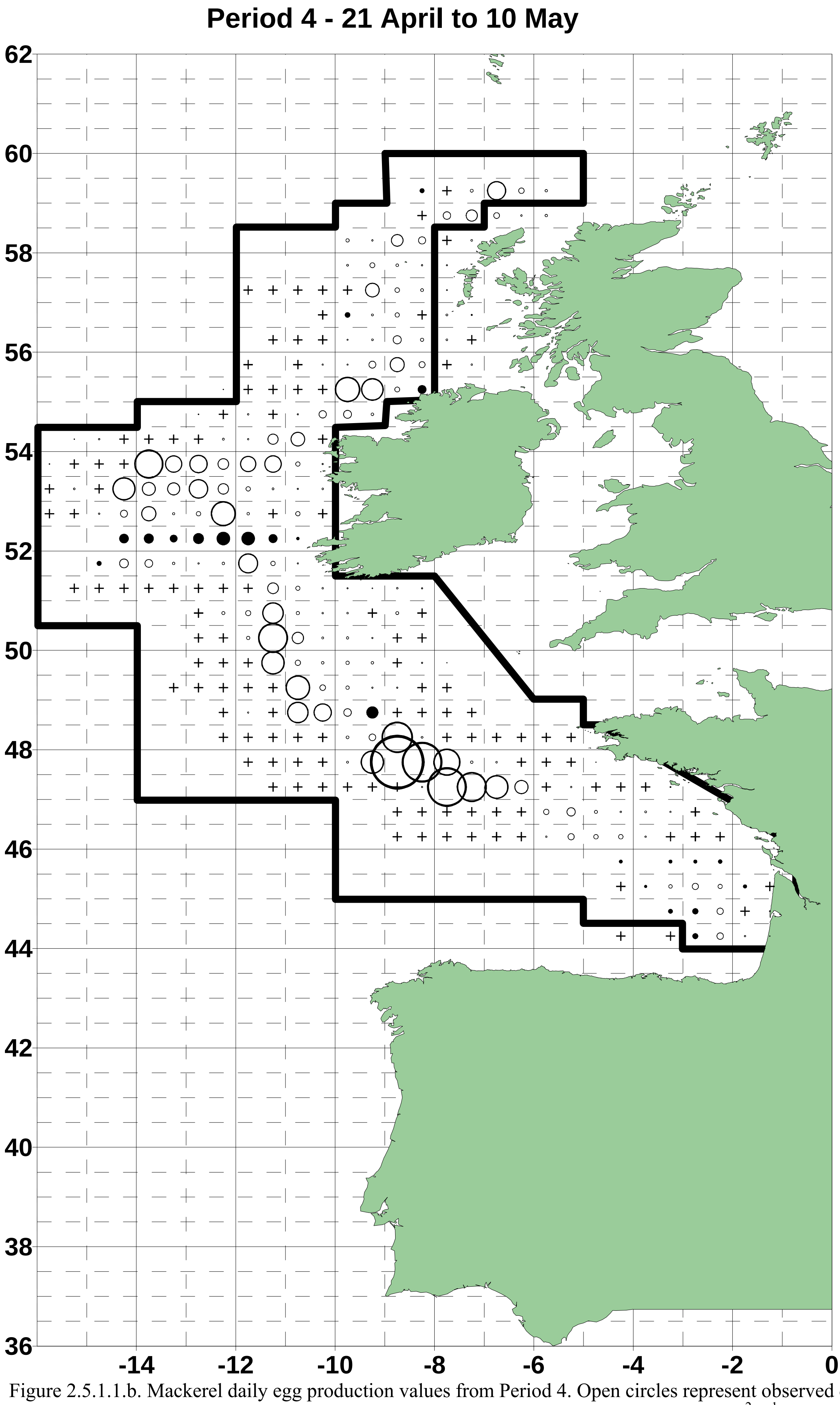


Figure 2.5.1.1.b. Mackerel daily egg production values from Period 4. Open circles represent observed data, and filled circles represent interpolated data. All circles are square root scaled to a max of 800 eggs.m^{-2}.d^{-1}.

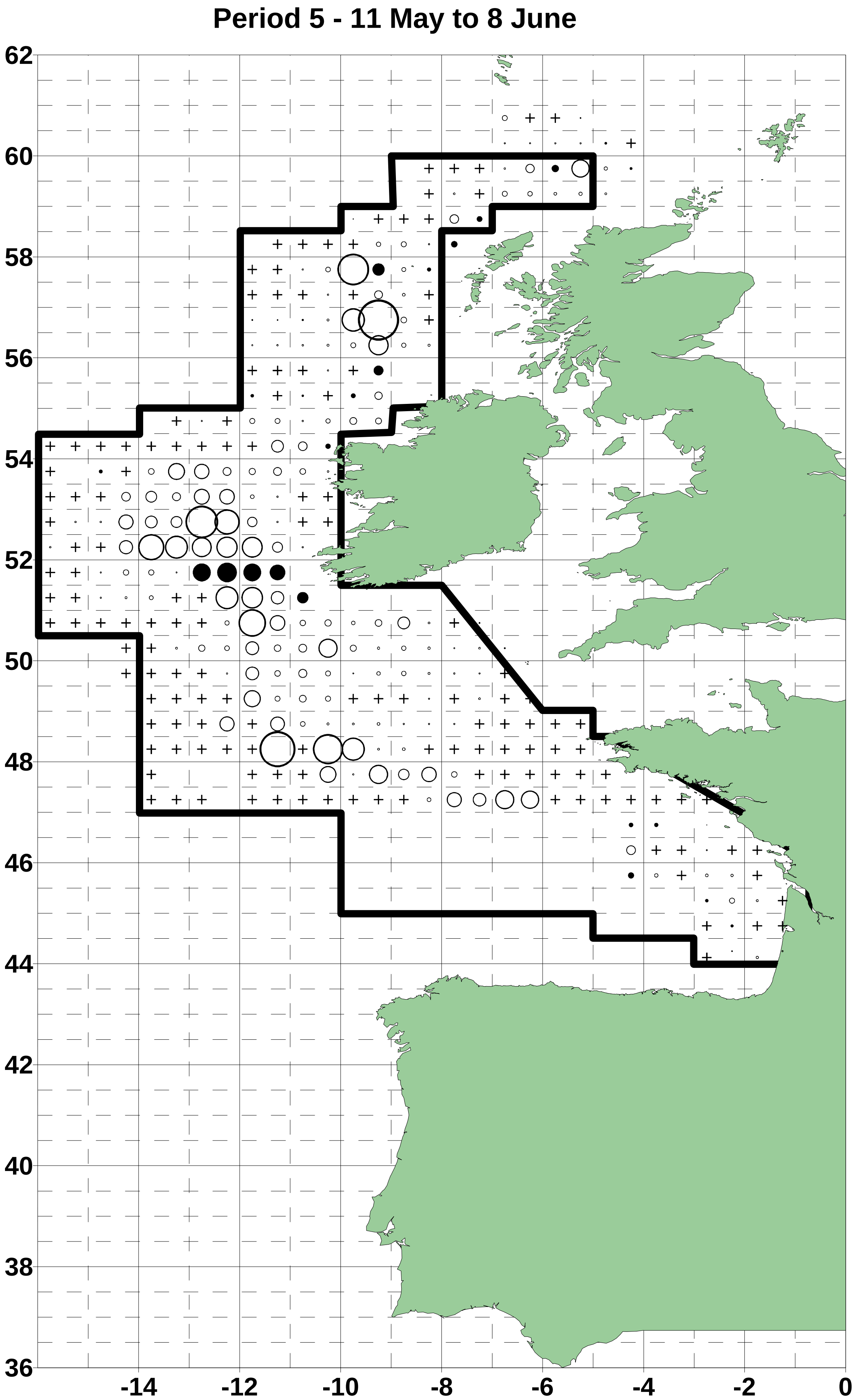


Figure 2.5.1.1.c. Mackerel daily egg production values from Period 5. Open circles represent observed data, and filled circles represent interpolated data. All circles are square root scaled to a max of 800 eggs.m^{-2}.d^{-1}.

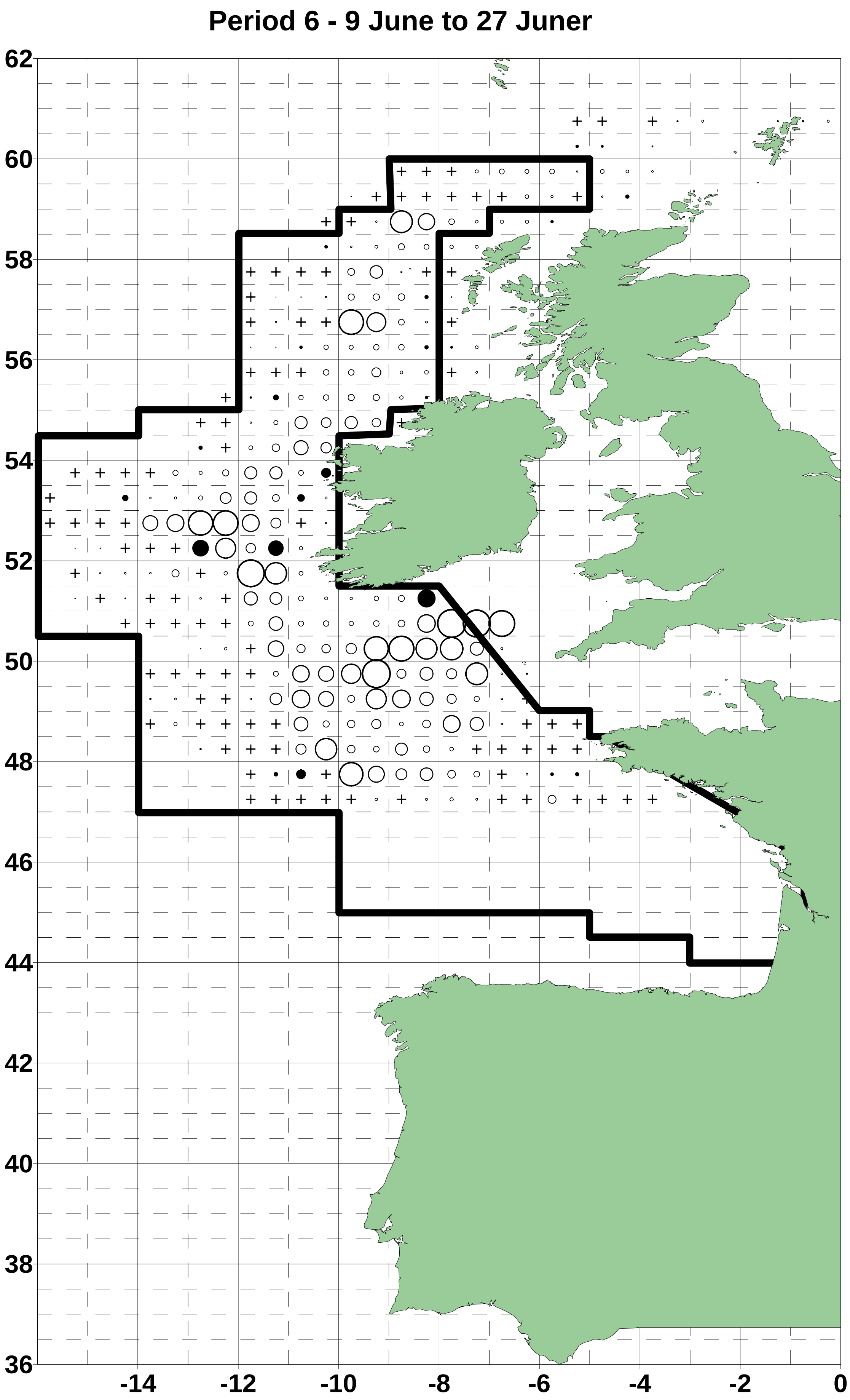


Figure 2.5.1.1.d. Mackerel daily egg production values from Period 6. Open circles represent observed data, and filled circles represent interpolated data. All circles are square root scaled to a max of 800 eggs.m^{-2}.d^{-1}.

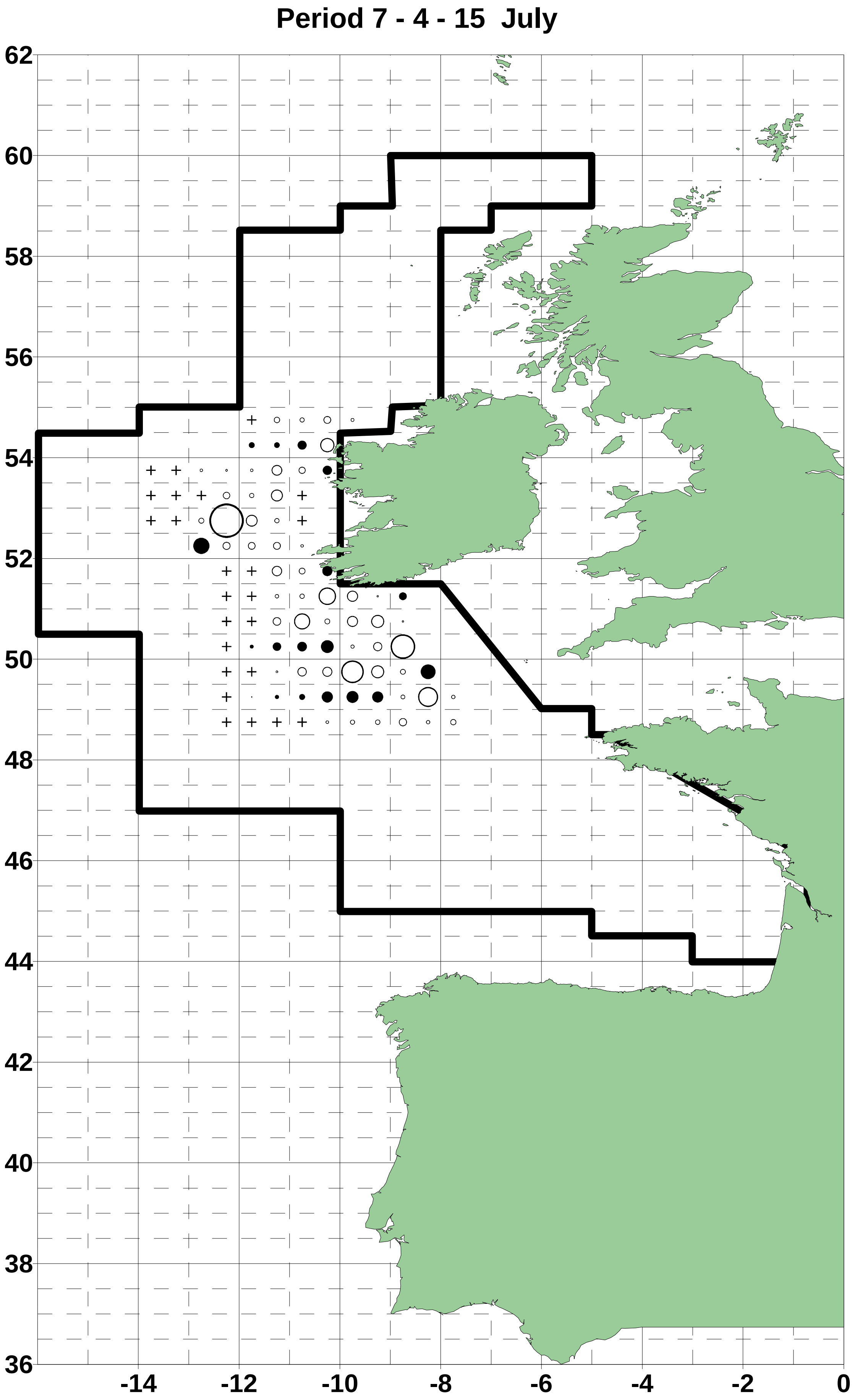


Figure 2.5.1.1.e. Mackerel daily egg production values from Period 7. Open circles represent observed data, and filled circles represent interpolated data. All circles are square root scaled to a max of 800 eggs.m^{-2}.d^{-1}.

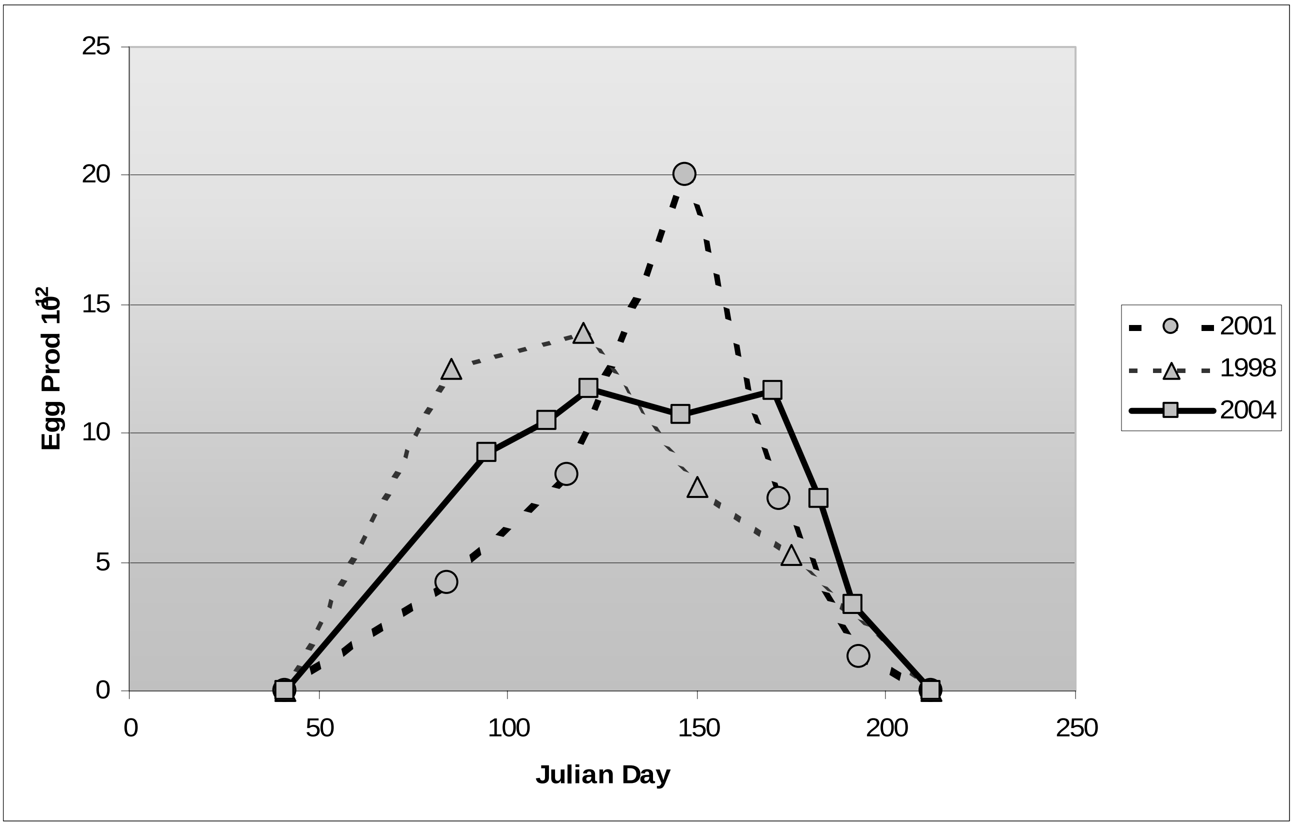


Figure 2.5.1.2. Egg production curve for the 2004 egg survey in the western area. The results for the 2001 and 1998 surveys are shown for comparison.

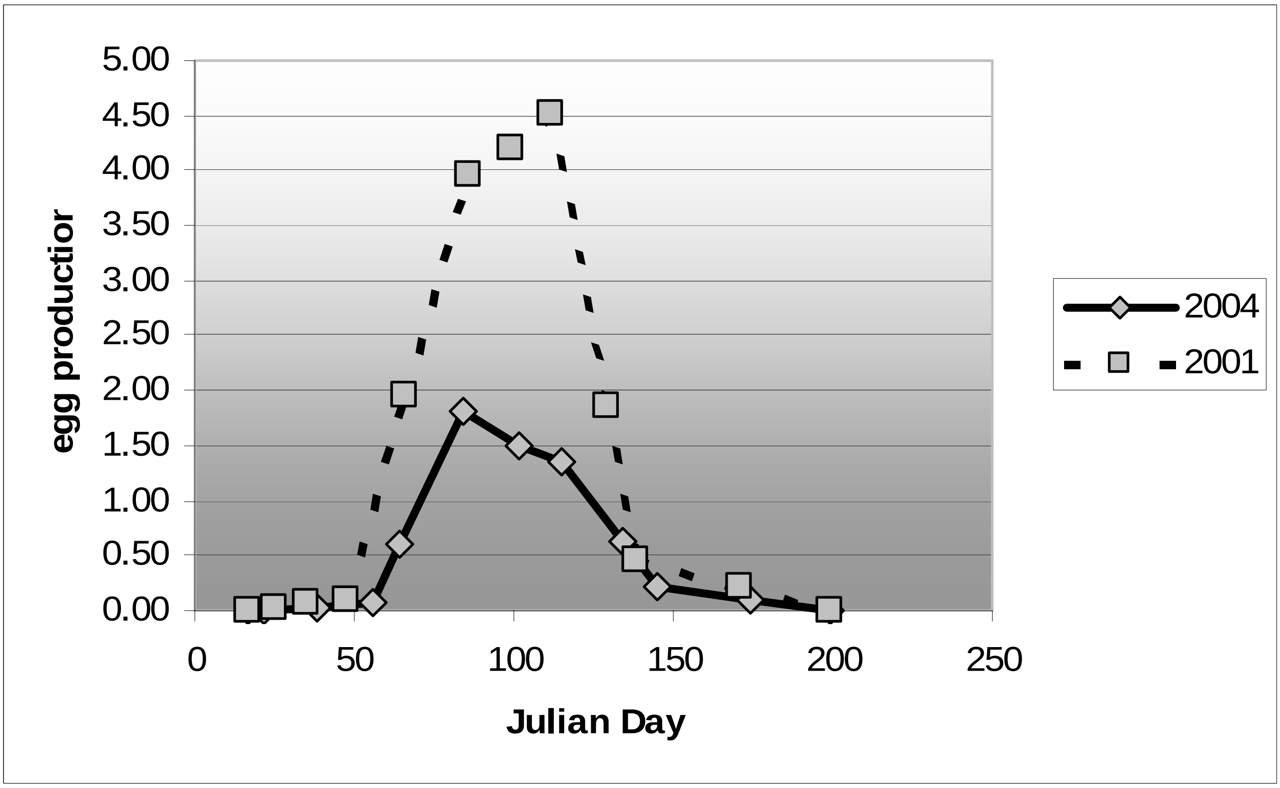


Figure 2.5.1.3. Egg production curve for the 2004 egg survey in the southern area. The results for the 2001 survey are shown for comparison.

2.5.2 Previous Egg survey estimate in the North Sea

The last North Sea egg survey was carried out in 2002. Based on this survey the SSB was estimated at 210,000 tons, which is considered an uncertain estimate due the restricted survey time and the application of a standard fecundity.

It is recommended to carry out a new egg survey in the North Sea in 2005. As in 2002 the Netherlands and Norway are planning to participate in the 2005 survey.

2.5.3 Examination of changes to potential fecundity in mackerel in the western area

One of the key elements in the production of a biomass estimate for mackerel (*Scomber scombrus*) from the Triennial mackerel and horse mackerel egg survey is the potential fecundity estimate. From 1983 onwards the value was relatively constant between 1457 and 1608 egg g^{-1} female. In 1998 this dropped dramatically to 1206, and again in 2001 to 1097 (see Figure 2.5.3.1). The drop in 1998 coincided with a relatively low egg production of $1.49 * 10^{15}$ (cf. 1995 $1.94 * 10^{15}$). This resulted in a biomass estimate for the western area in 1995 of 2.47 million tonnes and in 1998 of 2.95 million tonnes. The combination of a drop in egg production but a rise in biomass caused some disquiet at the time. This led to an intensified fecundity sampling programme in 2001, and again in 2004.

Reports presented in 2003 (Slotte WD & Reid WD) suggested that there may be links between potential fecundity in mackerel and condition factor – particularly during the feeding season in the Norwegian Sea in the autumn of the preceding year.

It has not been possible to carry out much further work on this link, however, the time series on condition factor has been updated (Slotte WD 2004). The key finding was that condition factor has improved over the last 3 years and is now higher than in 2001 (Fig 2.5.3.2.). At the same time, the potential fecundity (i.e. before correction for atresia) in the western spawning component has gone from 1097 eggs.g^{-1}.female in 2001 to 1193 eggs.g^{-1}.female in 2004. While this does not confirm a causative link, it is interesting and suggests that this link should be investigated further.

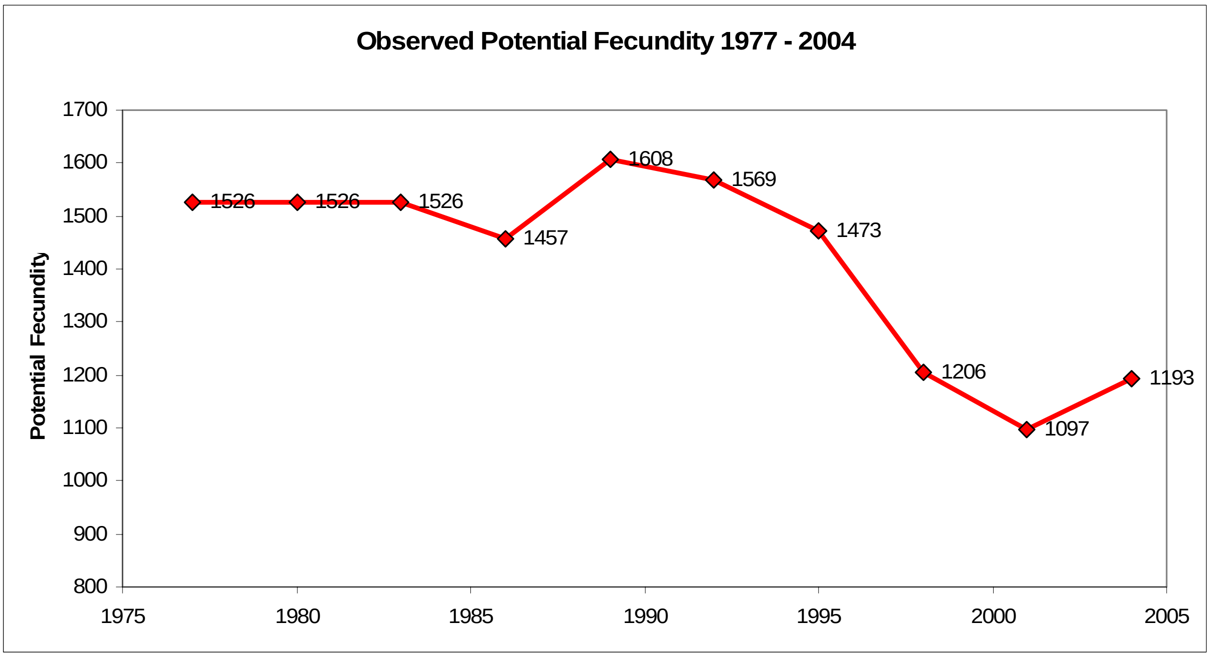


Figure 2.5.3.1. Potential fecundity of the western mackerel stock measured from 1977 to 2004.

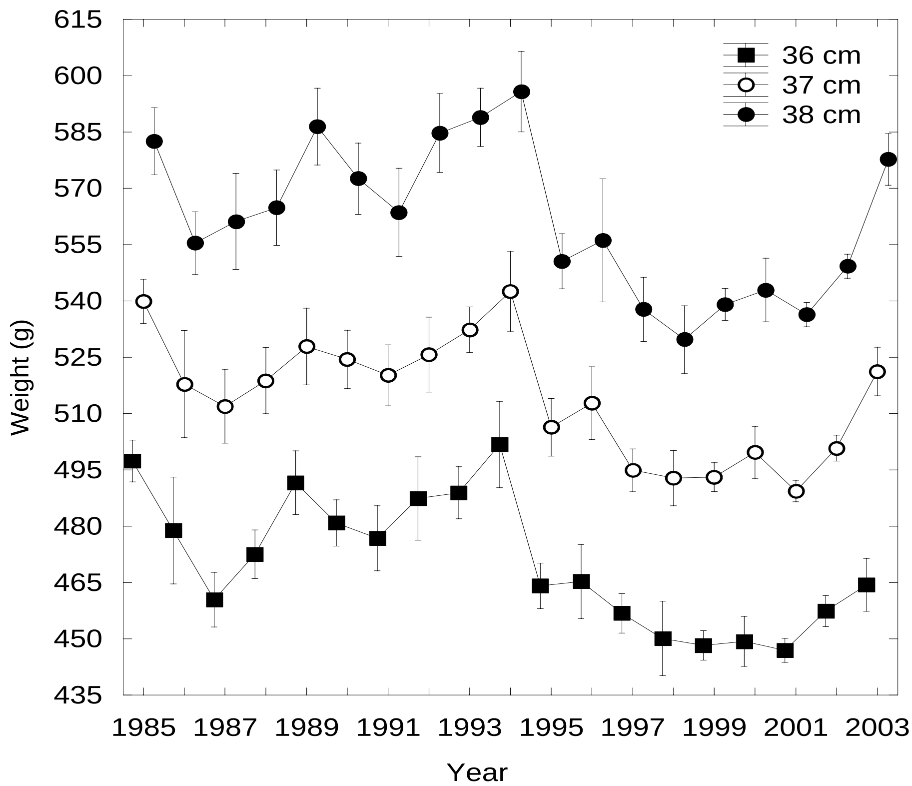


Figure 2.5.3.2. Condition factor in 3 size classes of mackerel collected in the Norwegian Sea in the autumn, 1985 – 2003.

2.5.4 Mortality estimates from tagging data

Estimates of total mortality derived from tag recaptures have been presented to the WG for several years, and were updated this year. The material is the Norwegian tagging experiments, in which about 20 000 mackerel have been tagged on the western spawning grounds in May each year. Total mortality is derived from the proportional representation of release years in the recaptured tags. A detailed description of the method is given in Skagen (2003) and in last years WG report (WGMHSA 2003).

Figure 2.5.4. shows the total mortality derived from the updated material, together with the mortalities presented last year. Bootstrap estimates of the uncertainty are also included. These estimates account for sampling uncertainty, but not for uncertainty in the variation in mortality associated with the tag release process. It is concluded that the total mortality is in the order of 0.3 – 0.4, with no strong trends in recent years.

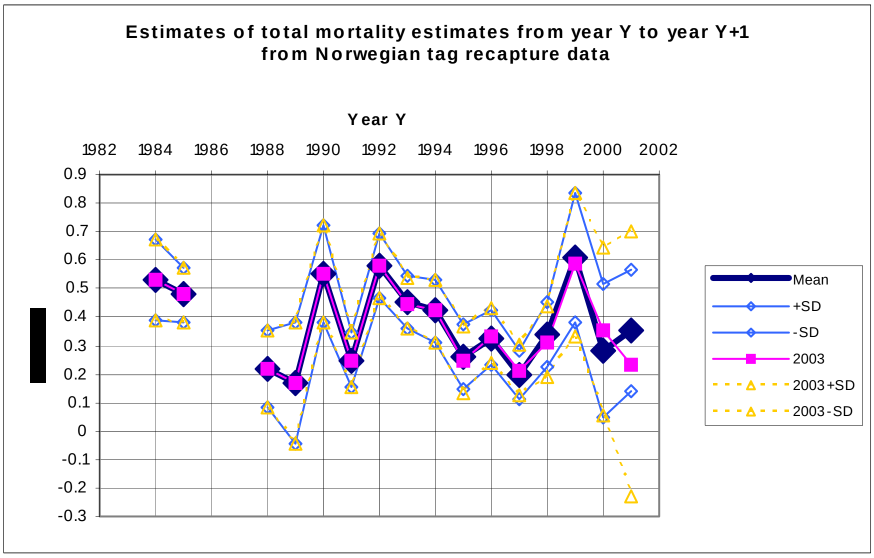


Figure 2.5.4 Estimates of total mortality for ages 4-8 according to tag recaptures as estimated in 2004 and in 2003. Uncertainties obtained by bootstrap of the recapture data are indicated for both estimates.

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 Santona and Santander (Sub-division VIIIc East) from 1989 to 2003 and from 1990 to 2003 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 2003. 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 2003 for which mackerel is a by catch is also presented. In 2003, 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 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. In 2002 and 2003 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 2003, the CPUEs of the handline fleets of Santoña and Santander, a fall was seen in yields by fishing trip in both fleets. This trend was also observed in 2002, particularly in the Santoña fleet, in which it was especially acute. 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 more information see Section 7.5). 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.

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.

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	-

- 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	-

- Not available

Table 2.6.3. SOUTHERN MACKEREL. CPUE at age from fleets.

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

Year	Effort	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8	age 9	age 10	age 11	age 12	age 13	age 14	age 15+
										Catch							
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

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

Year	Effort	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8	age 9	age 10	age 11	age 12	age 13	age 14	age 15+
										Catch							
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

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

Year	Effort	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8	age 9	age 10	age 11	age 12	age 13	age 14	age 15+
										Catch							
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

Table 2.6.3. (Cont'd)

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

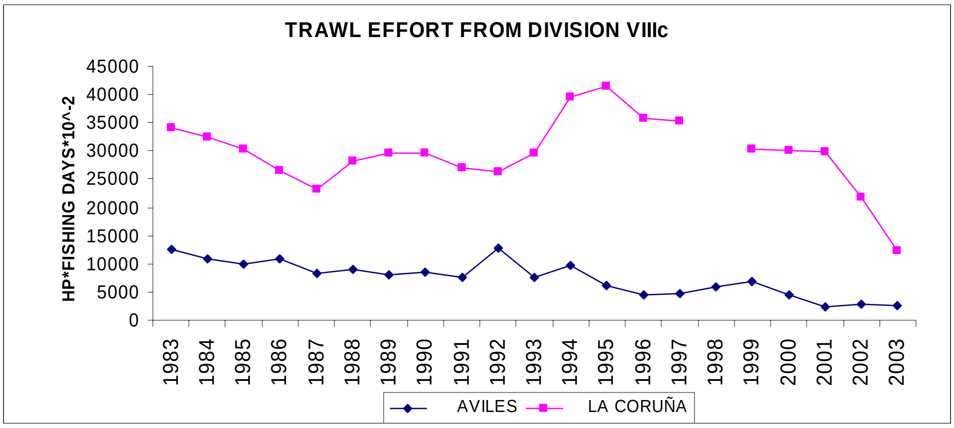
		Catch															
Year	**Effort**	**age 0**	**age 1**	**age 2**	**age 3**	**age 4**	**age 5**	**age 6**	**age 7**	**age 8**	**age 9**	**age 10**	**age 11**	**age 12**	**age 13**	**age 14**	**age 15+**
1988	28119	0	6095	584	625	594	167	239	444	195	53	12	8	21	26	0	7
1989	29628	462	482	719	345	289	541	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

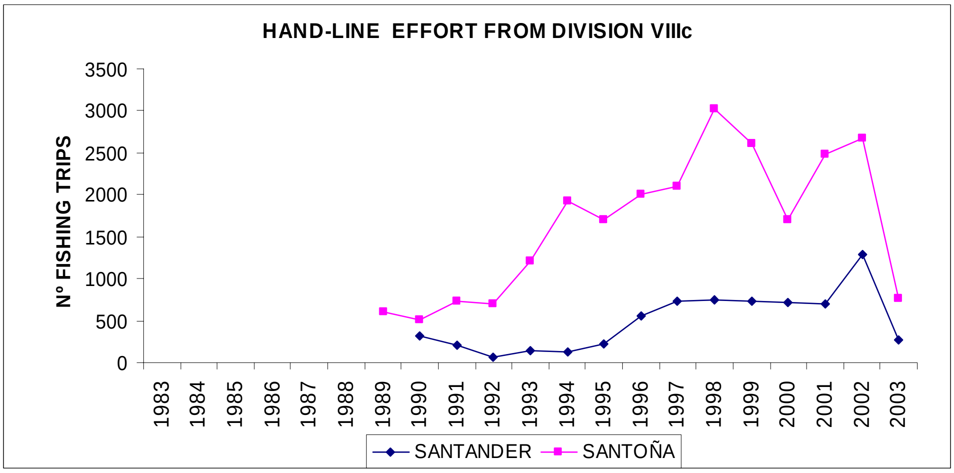
IXa trawl fleet (Portugal) (Catch thousands)

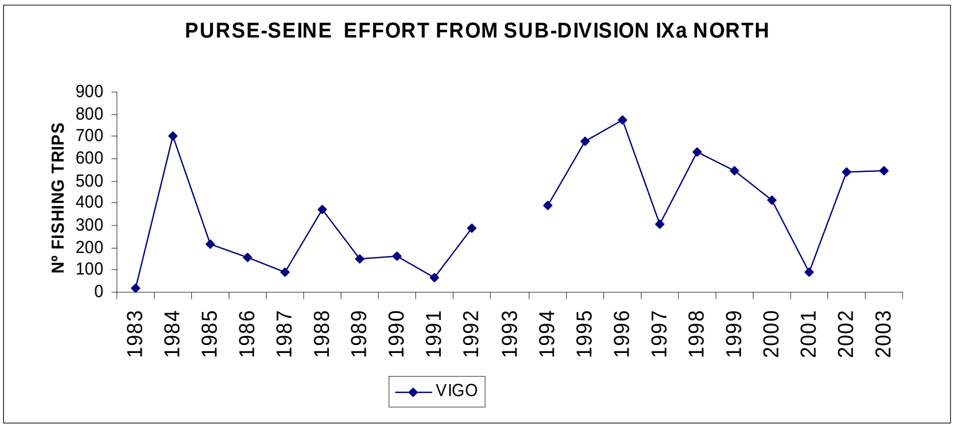
		Catch															
Year	**Effort**	**age 0**	**age 1**	**age 2**	**age 3**	**age 4**	**age 5**	**age 6**	**age 7**	**age 8**	**age 9**	**age 10**	**age 11**	**age 12**	**age 13**	**age 14**	**age 15+**
1988	55178	8076	4510	536	457	76	14	3	0	1	5	0	0	0	0	0	0
1989	52514	6092	6468	1080	572	185	51	15	4	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	0	0	0
2001*	74684	3030	5539	1665	382	195	149	65	42	24	3	2	0	0	0	0	0
2002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2003	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(-) Not available

* preliminary







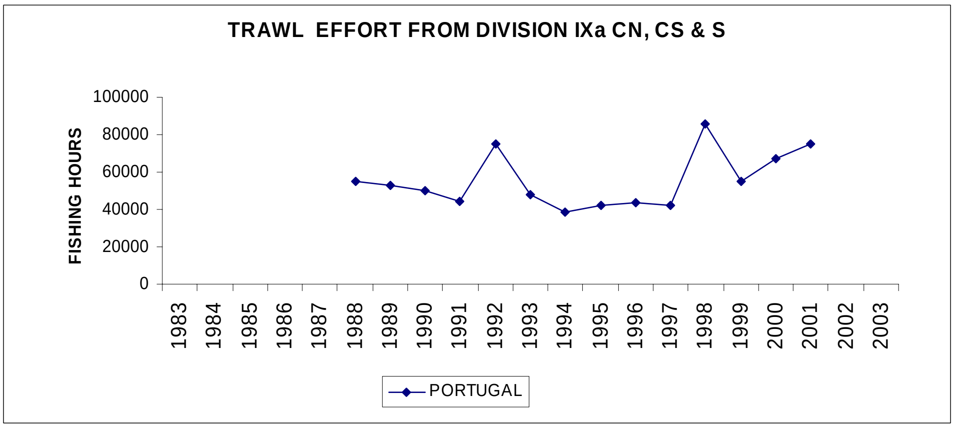


Figure 2.6.1 : SOUTHERN MACKEREL. Effort data by fleets and area

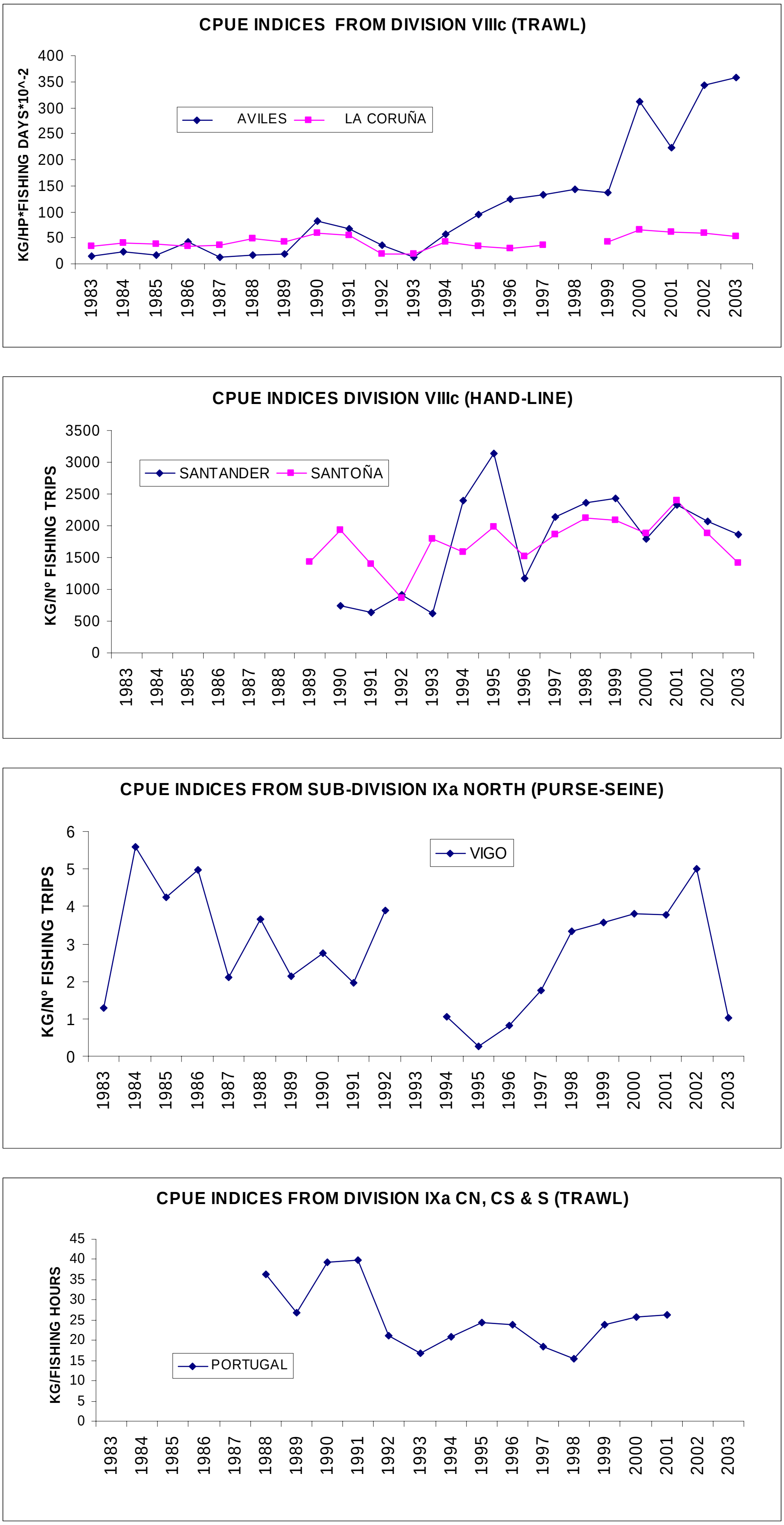


Figure 2.6.2 : SOUTHERN MACKEREL. CPUE indices by fleets and area

2.7 Distribution of mackerel in 2003 - 2004

2.7.1 Distribution of commercial catches in 2003

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 Portugal, Spain, Netherlands, Germany, Norway, Russia, Faroes, UK, Ireland, Denmark and Sweden. 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 574,200 tonnes including Spanish WG data, the total working group catches were 617,330 tonnes. The main data missing from this series are from France, Belgium, Iceland & Northern Ireland, who did not supply this data to the WG.

First Quarter 2003 (211,684 t)

There was still some evidence of mis-reporting between Divisions IVa and VIa, giving large catches just west of 4^{o} W. However, this may be reduced slightly from previous years. Otherwise, the general distribution of catches remained similar from 1995 to 2003, with the bulk of the catches along the western shelf edge between Shetland and the Celtic Sea, but mainly in the north of this area. Again, this suggests that the pattern and timing of the pre-spawning migration has remained relatively constant. There was also some evidence of more fishing in the western Channel and SW of Brittany. Total catch from the northern Spanish coast was reduced in this quarter as a result of the fishery closure due to the "*Prestige*" oil spill. The catch distribution is shown in Figure 2.7.1.1.

Second Quarter 2003 (30,575 t)

Catches in this quarter have fluctuated considerably in the last five years, but seem to have steadily decreased in the last three years. The general distribution of catches was broadly similar to 2002, with the main catch area being along the western shelf edge between the Hebrides and the Celtic Sea. The catches taken in international waters east and north of the Faroe Islands were greater than in 2002, probably representing an earlier start for this fishery, which occurs mainly in the third quarter. There was no repetition of the catches immediately north of the Faroes seen in 2002. Total catch from the northern Spanish coast was again reduced in this quarter as a result of the fishery closure due to the "*Prestige*" oil spill. Catches in the Bay of Biscay, and Iberian Peninsula were broadly similar to 2002. The catch distribution is shown in Figure 2.7.1.2.

Third Quarter 2003 (149,343 t)

The general distribution of catches was similar to 2002, with the main catches being taken in international waters and off the Norwegian coast. Unlike 2001 & 2002 the catch in international waters (IIa) was less concentrated along the south-eastern edge. This may possibly suggest that the fish distribution was more extended in a north-westerly direction than in previous years. Surveys suggest that this distribution extends further north and east to the Norwegian coast. Fishing off Norway appeared similar in scale and extent to 2002. There was some evidence of more fishing in the Skagerrak than in previous years, and also off Cornwall. The 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 2003 (225,727 t)

The general distribution of catches was broadly similar to 2002. The main catches were taken in the area west of Norway across to Shetland. Unlike 2002 the catches west of Shetland were weak. There was some evidence of mis-reported catches west of 4^{o}W, although this was small scale, and less than 2002. The apparent mis-reporting into Faroese waters was reduced. 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 2002. The pattern of catches seen in the English Channel were as in 2002 following an increase in 1999 and following years. As in quarter 3 there was some evidence of more fishing in the Skagerrak, and a reduced fishing the southern North Sea. 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 2003/2004. This compared to previous years below.

Fourth Quarter 2003

Age 0 fish in quarter 4 2003 (Fig 2.7.2.1)

- Catch rates in the key NW Ireland area were very low in 2000, and recovered in 2001 and in 2002. In 2003, catch rates were reasonable but not high, broadly similar to 2001, but less than 2002.
- No survey data were available to the WG this year for the southern Celtic Sea or central and northern Biscay.
- The hot spot in north Portugal which had been declining up to 2000 and appeared to have recovered in 2001 and 2002 was almost absent in 2003
- In the Celtic Sea there were low catches in most areas, definitely reduced from 2002.
- Catch rates off the Hebrides and NW of Scotland were similar to 2001 and 2002
- Survey data were again available this year for the northern North Sea from Norway. As in 2002, these showed no catch at age 0. It should be noted that these were carried out at the end of September and beginning of October and may be too early to catch young of the year spawned to the west in the spring and summer.

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 appeared to be even better in 2002. The picture in 2003 is weaker again, and probably can be taken as representing an average 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.

Reasonable catches of age 1 fish (Fig 2.7.2.2.) were taken across most of the area, particularly in NW Ireland and the Hebrides. Catches in Portugal seemed similar to 2002. This is broadly similar to the pattern in the years prior to the weak year class of 2000.

First quarter 2004

Age 1 fish in quarter 1 2004 (Fig 2.7.2.3)

- High catch rates were recorded off NW Ireland although much less was seen off the Hebrides. In 2003 this area showed widespread and substantial catch rates. The pattern in 2004 is more similar to the period prior to the weak 2000 year class.
- Again, good and well distributed catch rates were recorded in most parts of the Celtic Sea, although possibly more patchy than in 2003. As in the NW Ireland area the pattern was similar to earlier years before 2000.
- There was little evidence of many recruits in the north part of the North Sea, however, data were not available for the key area east of the meridian.

Age 2 fish in quarter 1 2003 (Fig 2.7.2.4)

- Reasonable catch rates were recorded in NW Ireland/Hebrides area, broadly similar to 2003 although slightly weaker. These catch rates were generally similar to previous good years
- Good catch rates were recorded in the Celtic Sea and in the Cornish box area, although again these were less than in 2003, when very large catches were recorded. These data should be treated with some caution as the catches were split into age using length and not otolith readings.

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. The picture from these distributions (figures 2.7.2.5 & 6) largely confirms that seen from the individual quarters of broadly good catch rates, somewhat reduced from 2002/03.

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. There have also been recent modifications in the design of the English GOV (here used in the Celtic Sea in Q1 2004). It is not known how these may affect pelagic catch rates.

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 where the local conditions allow, it should be noted that fishing with GOV is very difficult in the western English Channel. This new data is available courtesy of the Irish Marine Institute and CEFAS, although the CEFAS data was not available in time for this WG. New data from Norwegian bottom trawl surveys in the northern North Sea in September/October were available again this year. Although these are timed a little early for the purposes of mackerel recruit surveys, they should prove valuable

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 2001, much earlier than it would have shown up in the catches. Early warning of such recruitment failures would seem critical for a 3 year assessment/management cycle for this species. 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 by August of the year.

2.7.3 Distribution and migration of adult mackerel

This information has not been updated this year.

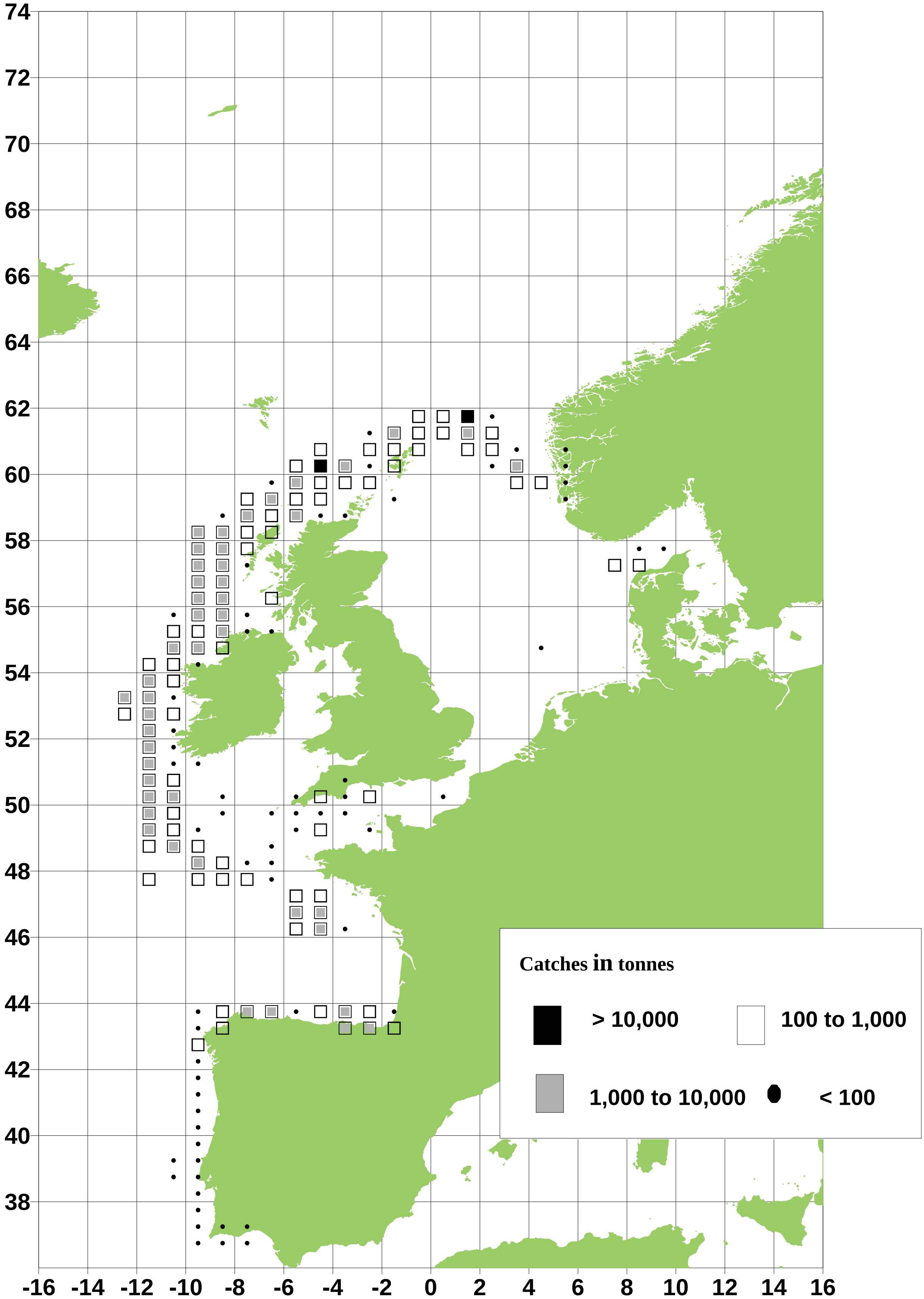


Figure 2.7.1.1 Mackerel commercial catches in quarter 1 2003.

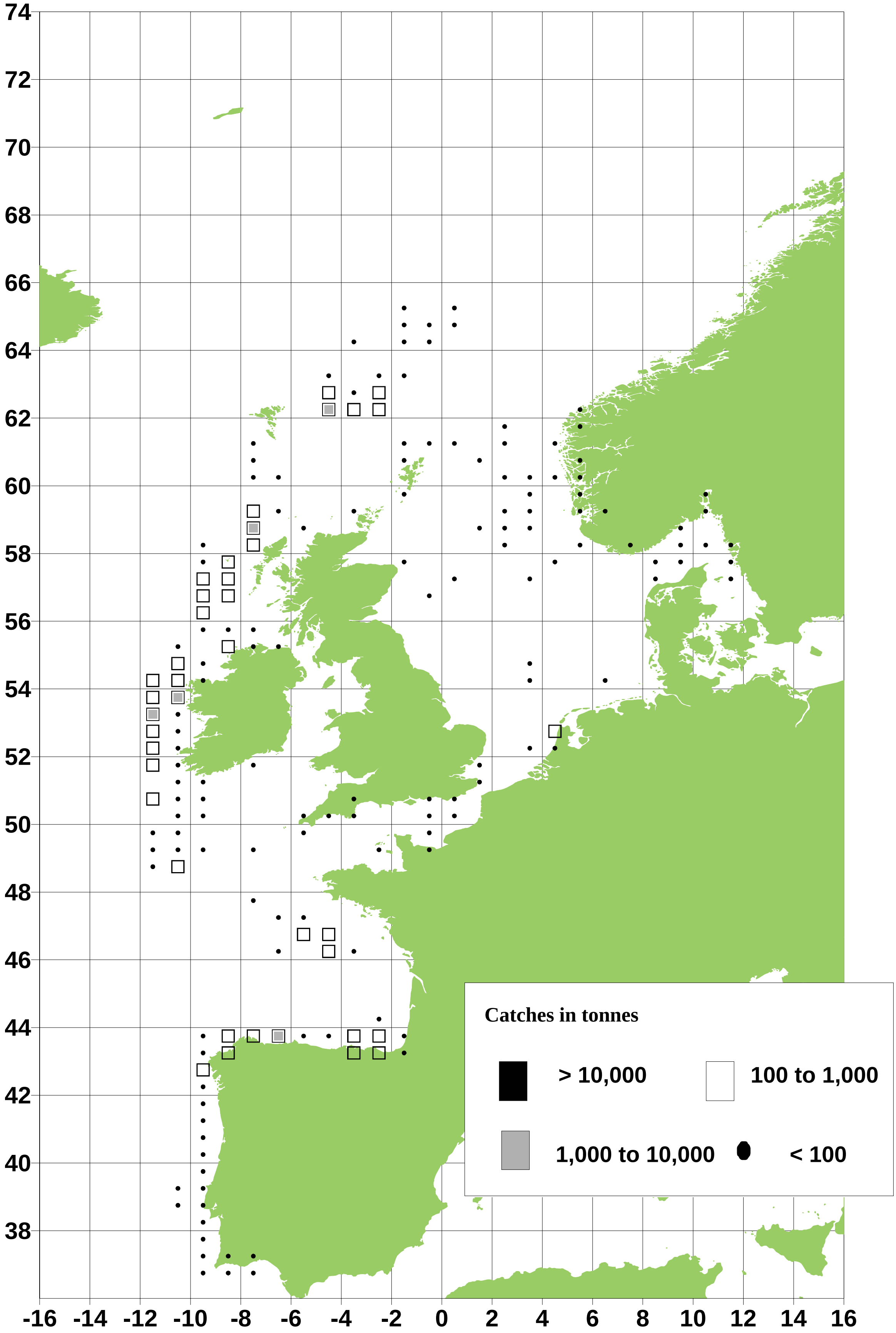


Figure 2.7.1.2 Mackerel commercial catches in quarter 2 2003.

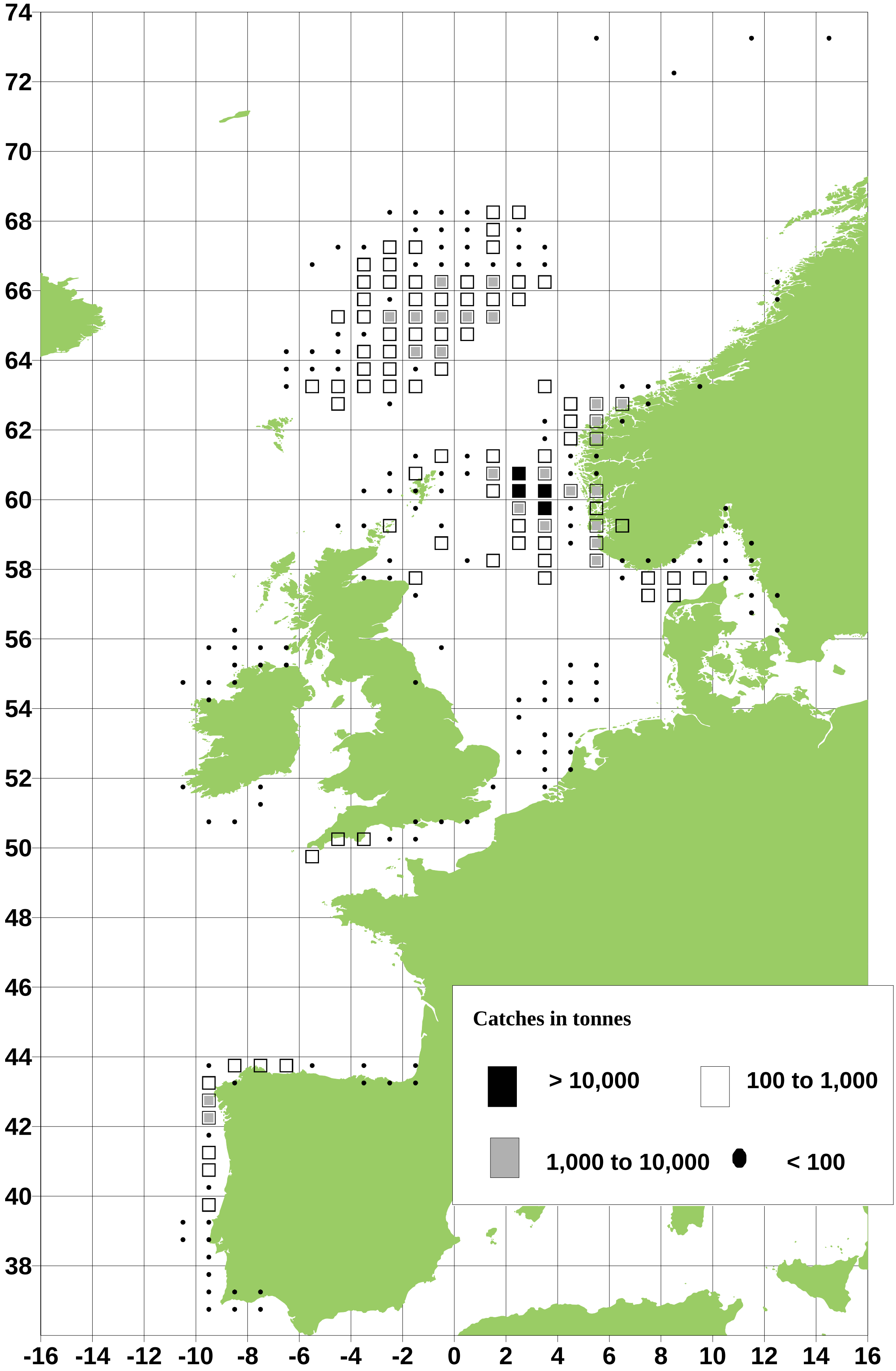


Figure 2.7.1.3 Mackerel commercial catches in quarter 3 2003.

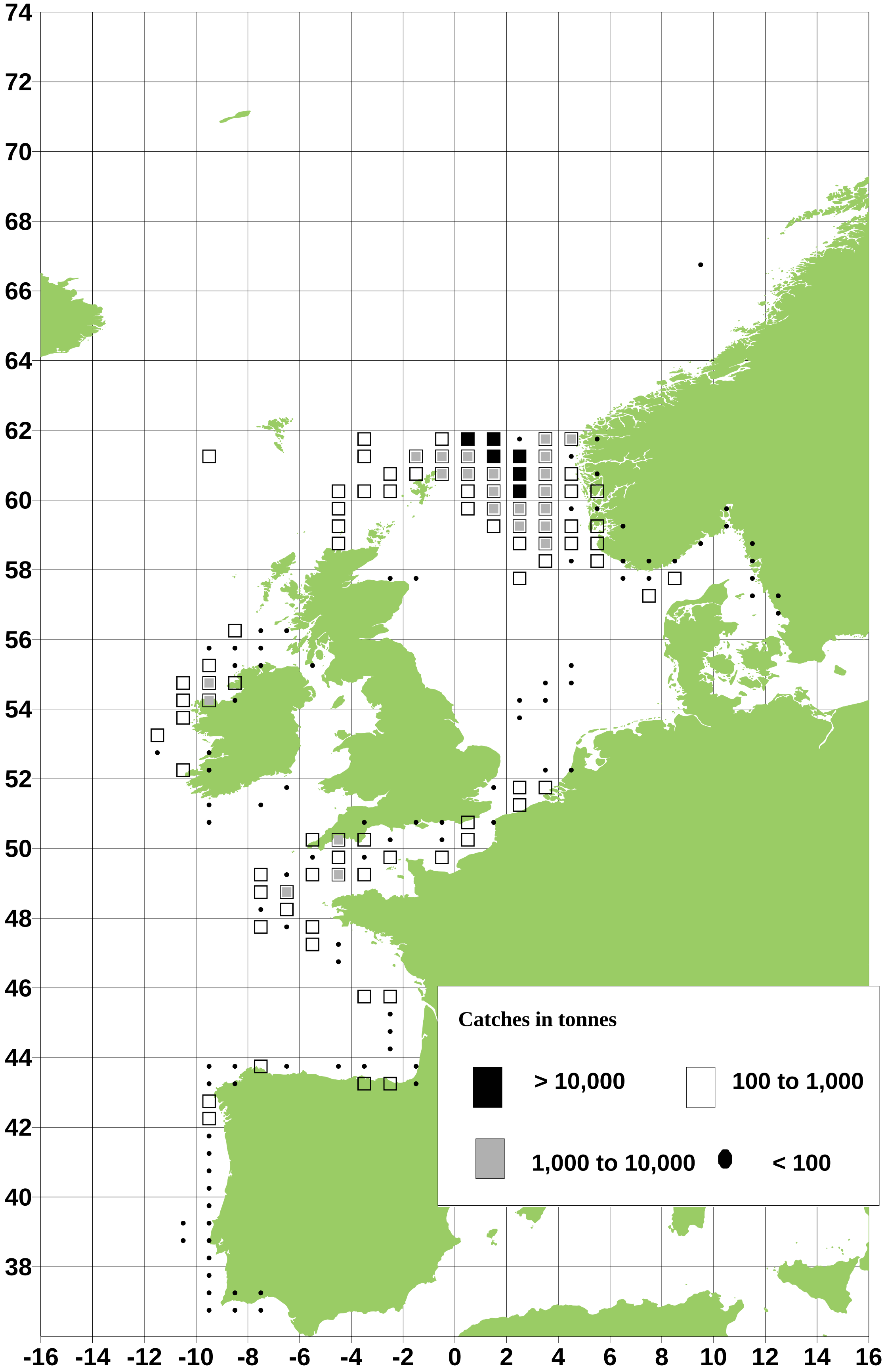


Figure 2.7.1.4 Mackerel commercial catches in quarter 4 2003.

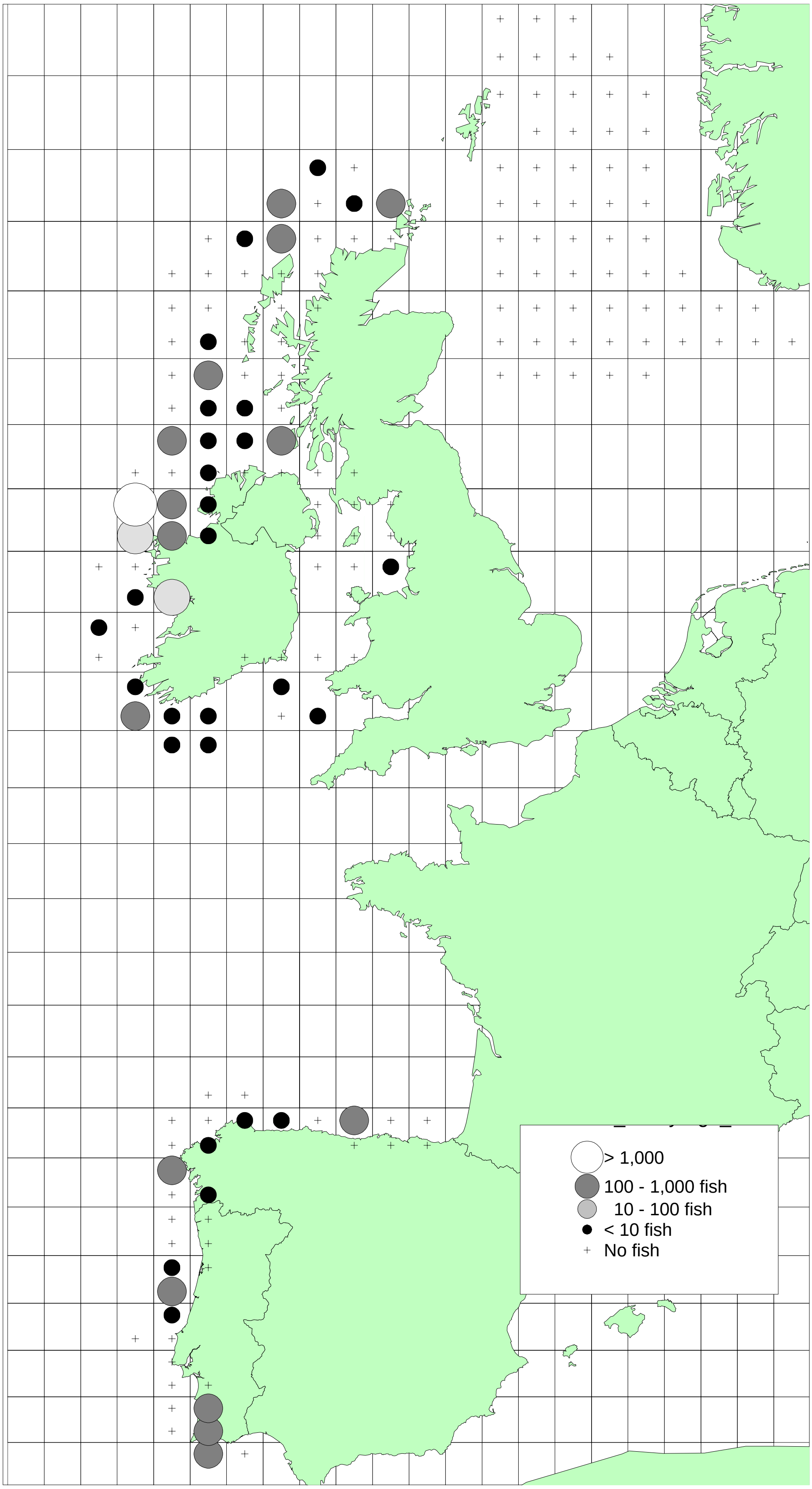


Figure 2.7.2.1. Distribution of mackerel recruits, 2003 year class age 0 in quarter 4, 2003.

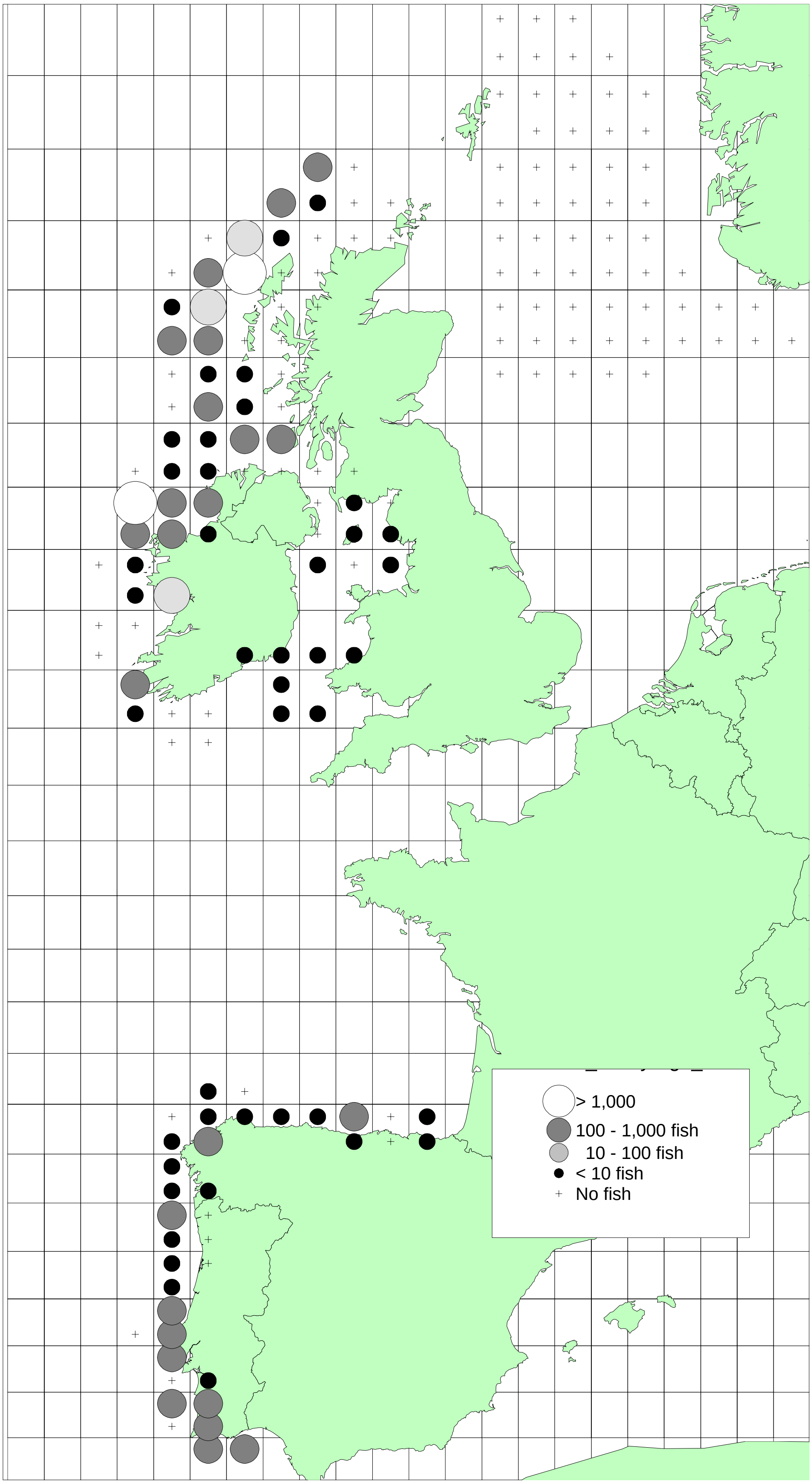


Figure 2.7.2.2. Distribution of mackerel recruits, 2002 year class age 1 in quarter 4, 2003.

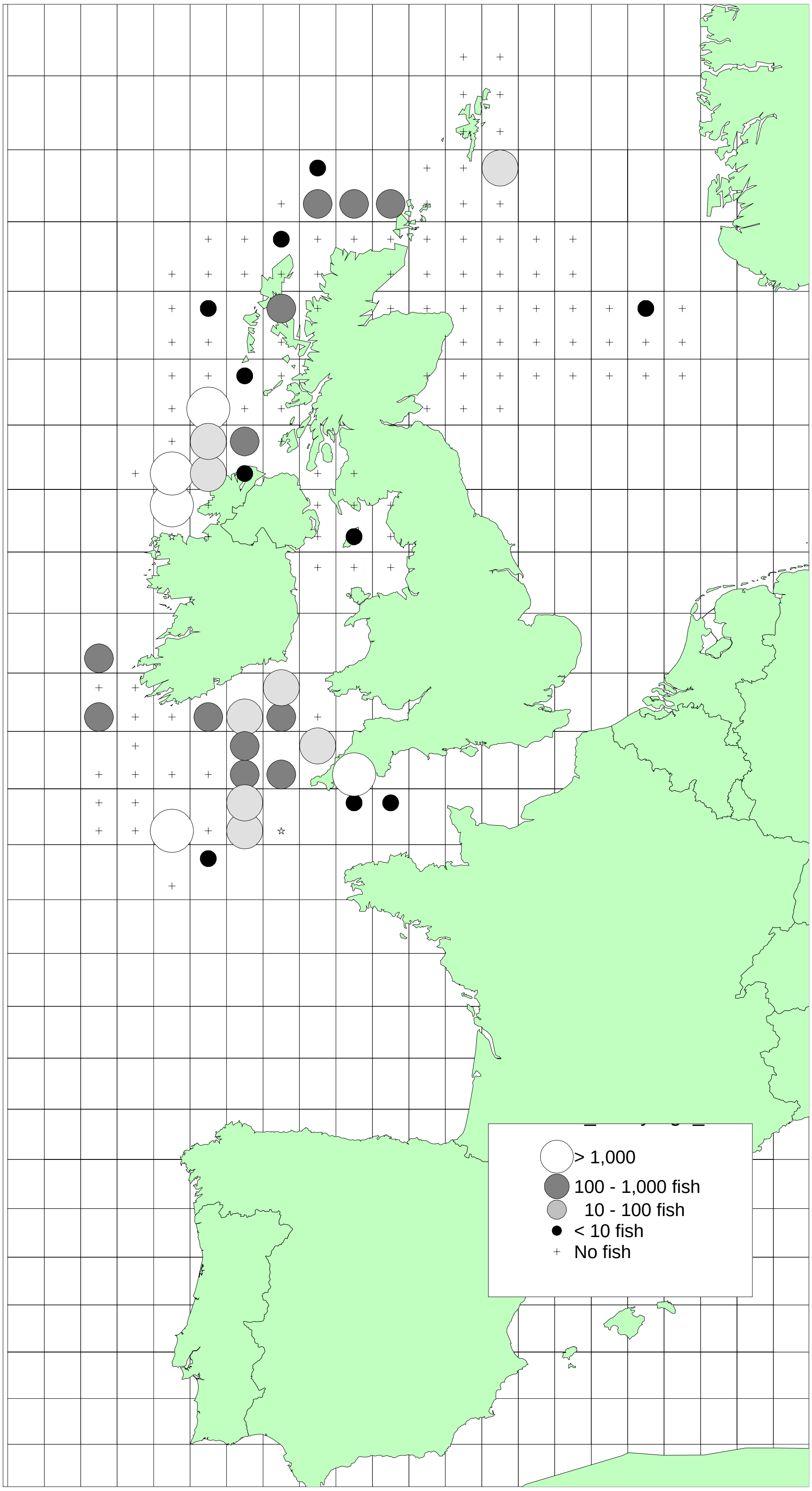


Figure 2.7.2.3. Distribution of mackerel recruits, 2003 year class age 1 in quarter 1, 2004.

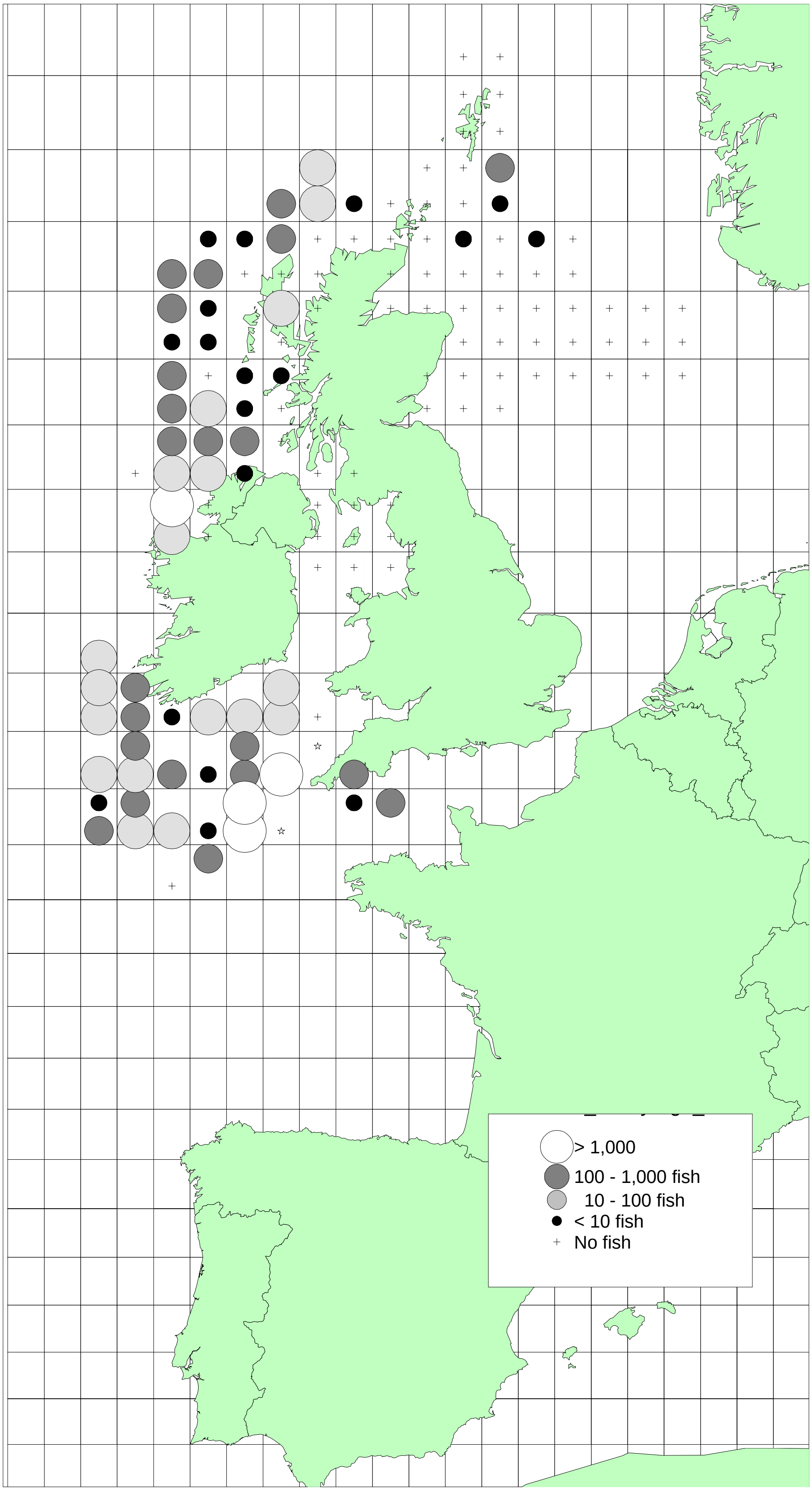


Figure 2.7.2.4. Distribution of mackerel recruits, 2002 year class age 2 in quarter 1, 2004.

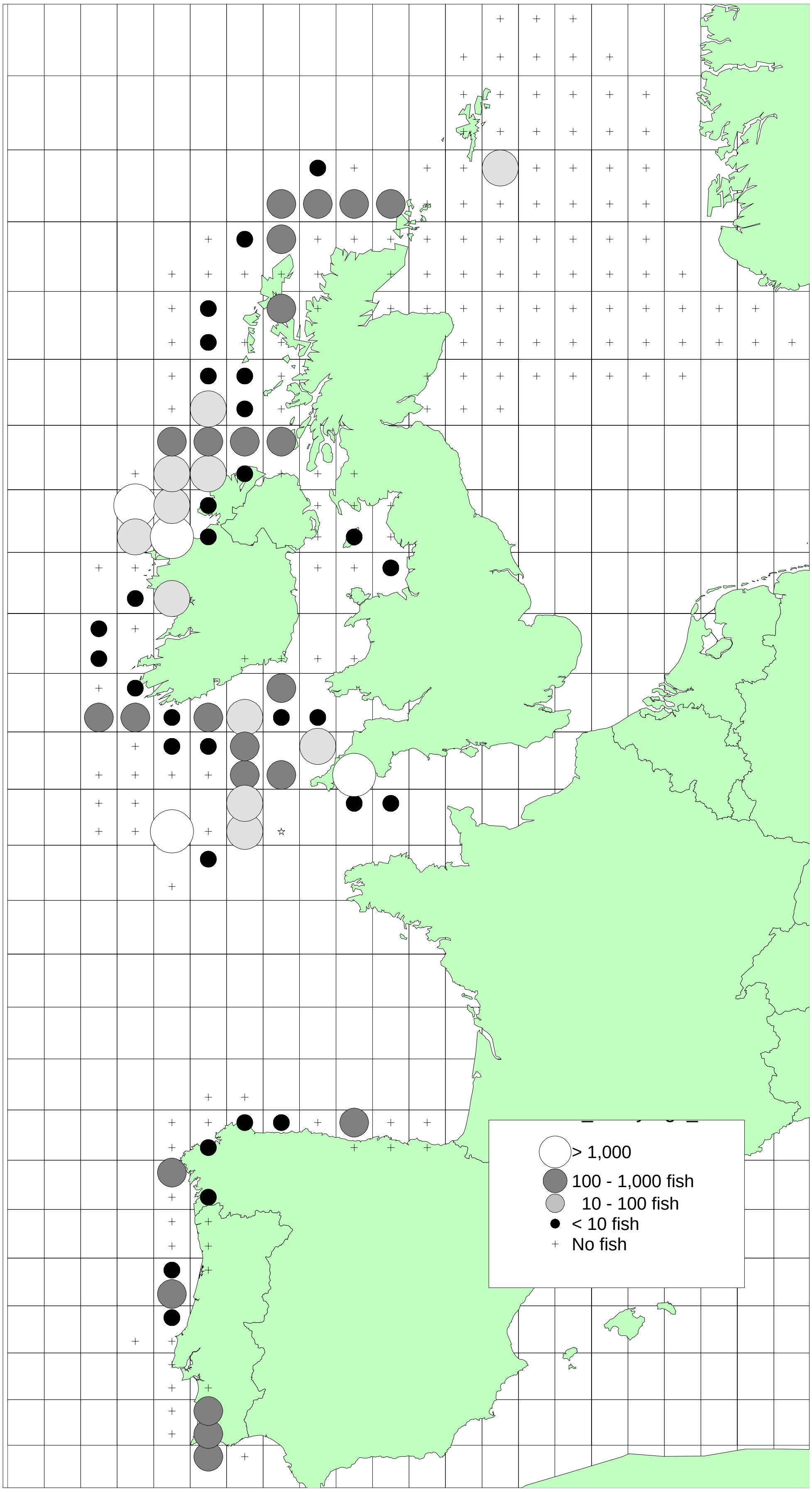


Figure. 2.7.2.5.Combination of Q4 2003 & Q1 2004 showing distribution of mackerel recruits.
2003 year class in 1st winter (2003/2004)

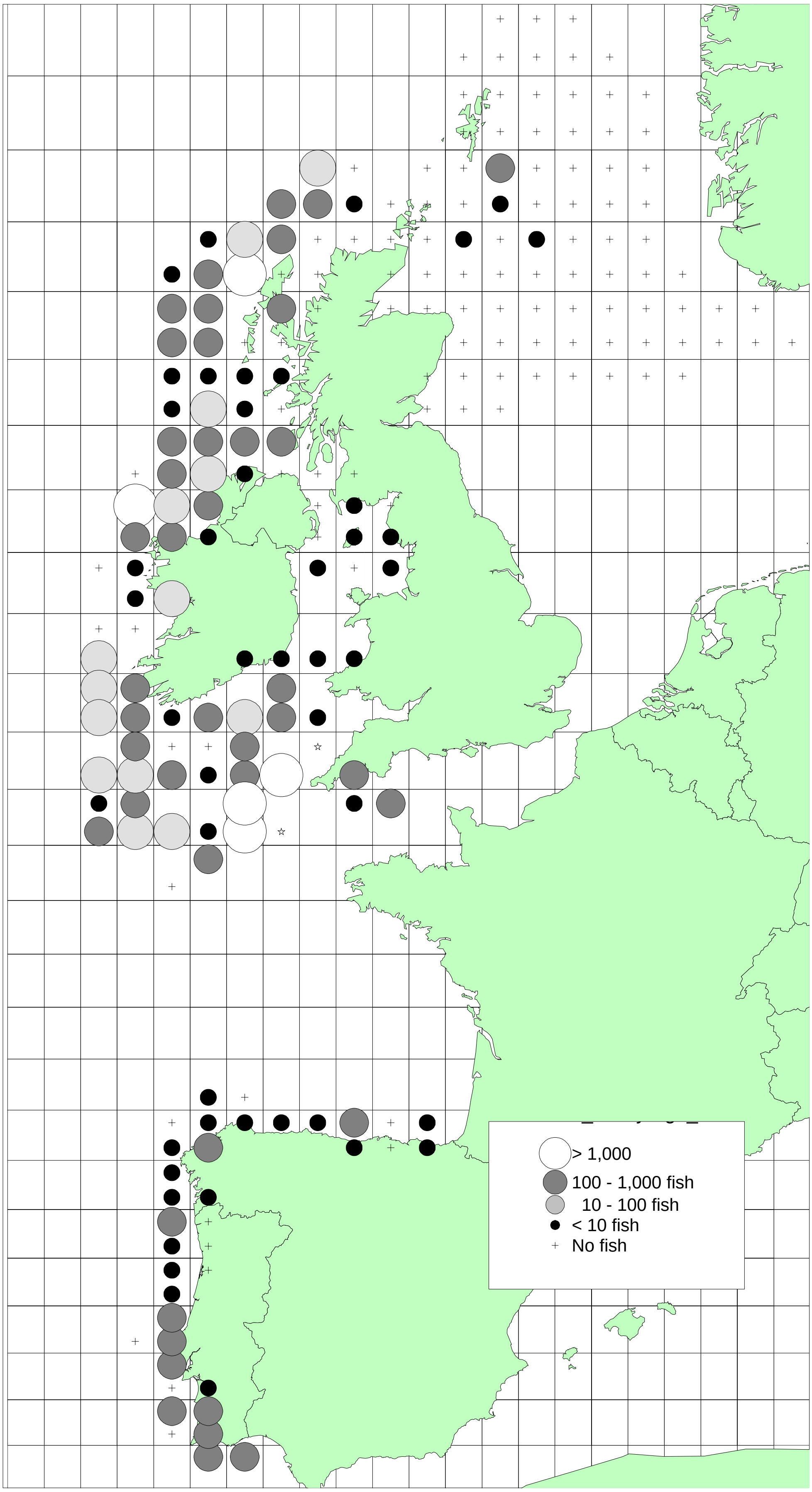


Figure. 2.7.2.6. Combination of Q4 2003 & Q1 2004 showing d istribution of mackerel recruits. 2002 year class in 2nd winter (2003/2004)

2.7.4 Aerial surveys

A new Russian comprehensive aerial survey to map feeding mackerel with the Russian flight-laboratory An-26 "Arktika" was carried out in the Norwegian Sea during 11 July to 1 August 2004 between 62º45'-70ºN and 12ºW-10ºE (WD Shamray et. al. 2004).

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.

The Russian aircraft was equipped with several different remote-sensing sensors (IR-radiometer, synthetic aperture radar, LIDAR, digital photo- and video cameras). It has to be mentioned that post-processing procedure for LIDAR data have been improved considerably and can be used for calculating the geometrical size of schools.

A new experimental work started this year. A new Norwegian LIDAR system was installed in the Russian aircraft while Russian was taken off and used in joint Russian-Norwegian investigations during 20-24 July.

Within the framework of aerial surveys, experimental and calibration works were conducted with a Russian research vessel and two Norwegian vessels surveying mackerel.

Russian research vessel "Persey-4" carried out acoustic small-scale survey in the central Norwegian Sea and Faroese EEZ area with CTD and pelagic trawl stations in July-August.

During 15-30 July two Norwegian commercial purse seiners, "Libas" and "Endre Dyrøy" carried out a mackerel trawl survey at prefixed stations. Both vessels trawled the surface layer (the upper 40 m) at each station for 30 n. miles.

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

The aircraft and the vessels met at five events for calibration purposes. This was to compare/validate LIDAR and the other remote observations with the observations made by the different vessels. A good correlation between vessels data and aircraft data were observed in all cases.

These investigations were carried out according to recommendations of the Planning Group on Aerial and Acoustic Surveys for Mackerel (Anon. 2004) and Russian-Norwegian Program for joint investigations in the Norwegian Sea.

Due to the technical reasons it is not possible to provide final results at this WGMHSA meeting. The final results will be given to this Working group and PGAAM next year.

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 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 these surveys can be found in the Planning Group on Aerial and Acoustic surveys of Mackerel (PGAAM) The surveys were:

- An acoustic survey by the Institute of Marine Research, Bergen in October/November 2003. This mainly covered the area between the Viking and Tampen Banks (north/central IVa) but scouting surveys covered a wider area (approx. 59 º - 61º 30' N and 2 º W - 4º 30' E). This was a slightly wider scouting area coverage than in 2002. The course tracks and the acoustic registrations are shown in Figure 2.7.5.1 for 2003 as well as for the previous years.
- An acoustic survey by Fisheries Research Services, Aberdeen in October 2003. This was co-ordinated with the Norwegian survey. The survey also mainly covered the area between the Viking and Tampen Banks but scouting surveys covered a wider area (approx. 59 º 30' - 61º 45' N and 1 - 4º E). This was a smaller scouting coverage than in 2002.
- An acoustic survey by IEO in ICES Divisions VIIIb and VIIIc and Sub-divisions IXa North and Ixa Central North, in March and April 2004.
- Portuguese acoustic surveys by IPIMAR in March and November.
- French acoustic surveys by IFREMER in April/May

The IMR survey showed that there were substantial concentrations of mackerel spread across the platform up to 30 nm from the shelf break between the Viking and Tampen Banks (approx 60ºN 3ºE to 61º30N 2ºE). In 2003, the hydrographic conditions were unusual, as the marked thermocline usually present at 50-60 m depth was absent, and warm water was found through the whole water column (Figure 2.7.5.1). Accordingly, mackerel was registered at far greater depths than in previous years. In the western part of the Norwegian trench, mackerel was found close to the bottom, in an area that was known as an overwintering area for the North Sea stock in the 1960s. Table 2.7.5.1 shows the yearly abundance estimates. Mean length and weight in the samples used in the estimates are also given. These lengths and weights are considerably lower than in samples from the purse seine fishery that takes place in the same area during the survey period, and points to sampling as an important and unresolved problem. There are also doubts about the target strength used. The present value (20logL – 84.9 at 38 kHz) is that currently agreed in the PGAAM. The provisional biomass estimate was 581,000 tonnes for the whole survey. This is in line with the results from 2002.

The FRS survey covered a similar area and found similar concentrations of mackerel to the IMR survey. Details are available in the survey working document (Fernandes 2004, WD to WGMHSA 2004). The same target strength value is used in the Scottish and Norwegian surveys. It is felt that the estimate in both surveys is likely to be an underestimate due to the target strength function used and to the conservative nature of the identification algorithms currently employed. The provisional biomass estimate was 660,600 tonnes. The survey data were analysed together with that part of the Norwegian survey which occurred at the same time. The combined cruise tracks and NASC values are presented in Figure 2.7.5.3. The combined biomass estimate was 545,900 tonnes.

The IEO survey was primarily targeted on sardine and anchovy, however, substantial amounts of mackerel were observed and quantified. The survey took place in March and April 2004 in Sub-division IXa Central North, Sub-division IXa North and Divisions VIIIb and VIIIc. The TS/L relationship used was the same as in the North Sea and as recommended by PGAAM. This was a further change from the value of –86 dB used for the 2002 and 2003 surveys. Total biomass was estimated at 1.1 million tonnes.

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 very difficult to derive.

Table 2.7.5.1. Acoustic estimates of mackerel 1999-2003 from Norwegian surveys in the North Sea , October – November each year

Year	Date	L [cm]	W [g]	Biomass [x10^3 tonn]
1999	12.– 22.10	34.9	358	828
2000	15.10– 5.11	32.8	286	541
2001	8.-25.10	36.3	418	409
2002	15.10 – 3.11	33.3	295	535
2003	16.10 – 6.11	33.0	296	581

Table 2.7.5.2. Results of the combined Scottish and Norwegian mackerel acoustic survey 18-20 October 2003. Numbers are in millions of fish, length in cm, weight in g and biomass in thousands of tonnes.

Age	Number	Mean length	Mean weight	Biomass
1	529.36	28.07	234.36	124.06
2	394.60	32.37	377.38	148.92
3	105.21	33.84	437.70	46.05
4	216.30	34.33	460.67	99.64
5	88.80	35.34	508.50	45.16
6	47.24	36.58	569.57	26.91
7	22.04	37.64	625.57	13.79
8	23.87	37.88	643.33	15.36
9	9.87	39.38	724.76	7.15
10	8.53	39.69	746.09	6.36
11	5.21	40.76	812.61	4.23
12	5.97	40.97	827.37	4.94
13	0.74	40.00	761.18	0.57
14	1.98	41.32	854.92	1.69
15	0.83	41.39	855.13	0.71
16	0.37	44.00	1,049.16	0.39
Total	1,460.93	31.87	373.68	545.92

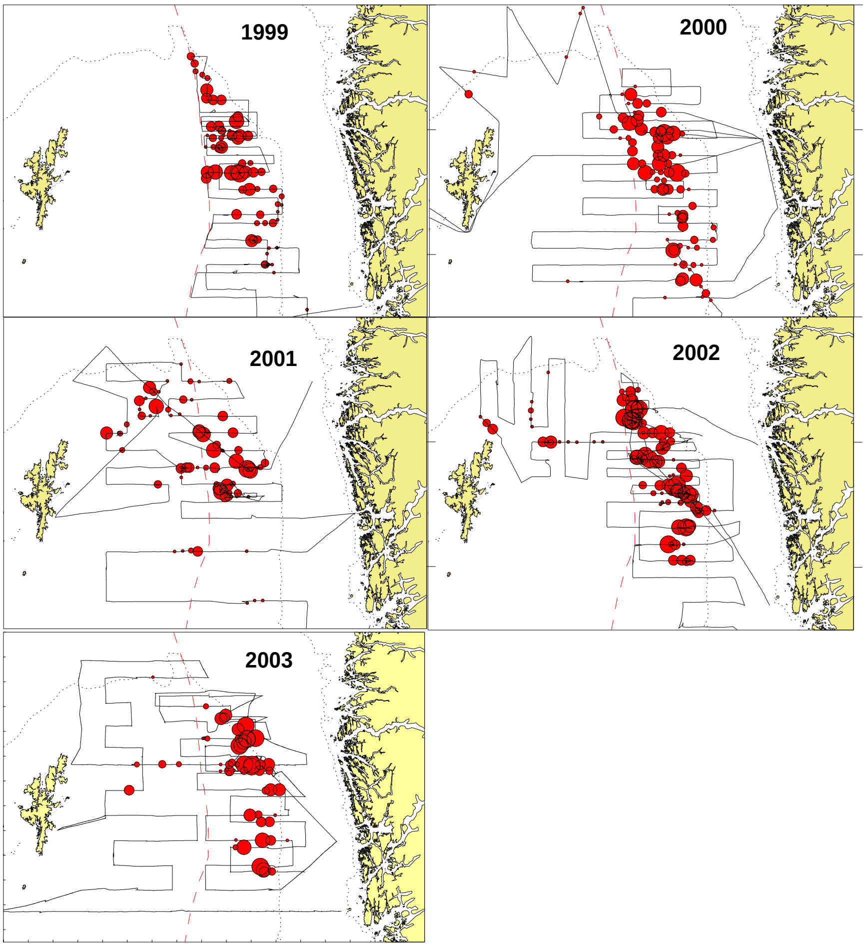


Figure 2.7.5.1. Acoustic registrations of mackerel in Norwegian surveys in October-November 1999 – 2003.

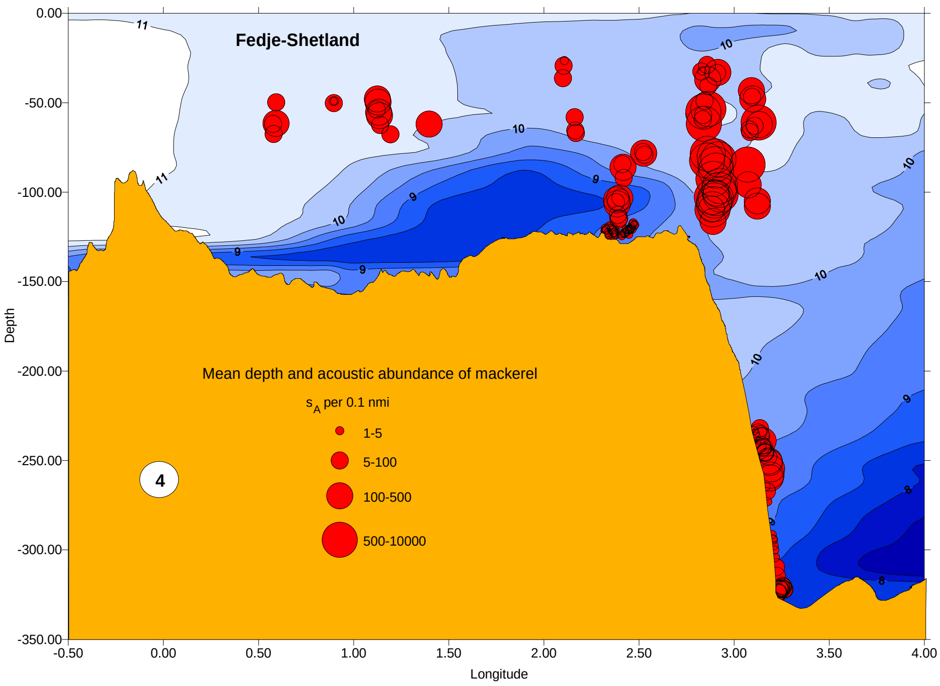


Figure 2.7.5.2. Distribution in the water column of water temperature and acoustic mackerel registrations along the Faroe- Shetland hydrographic section (E-W at 60°45'N)

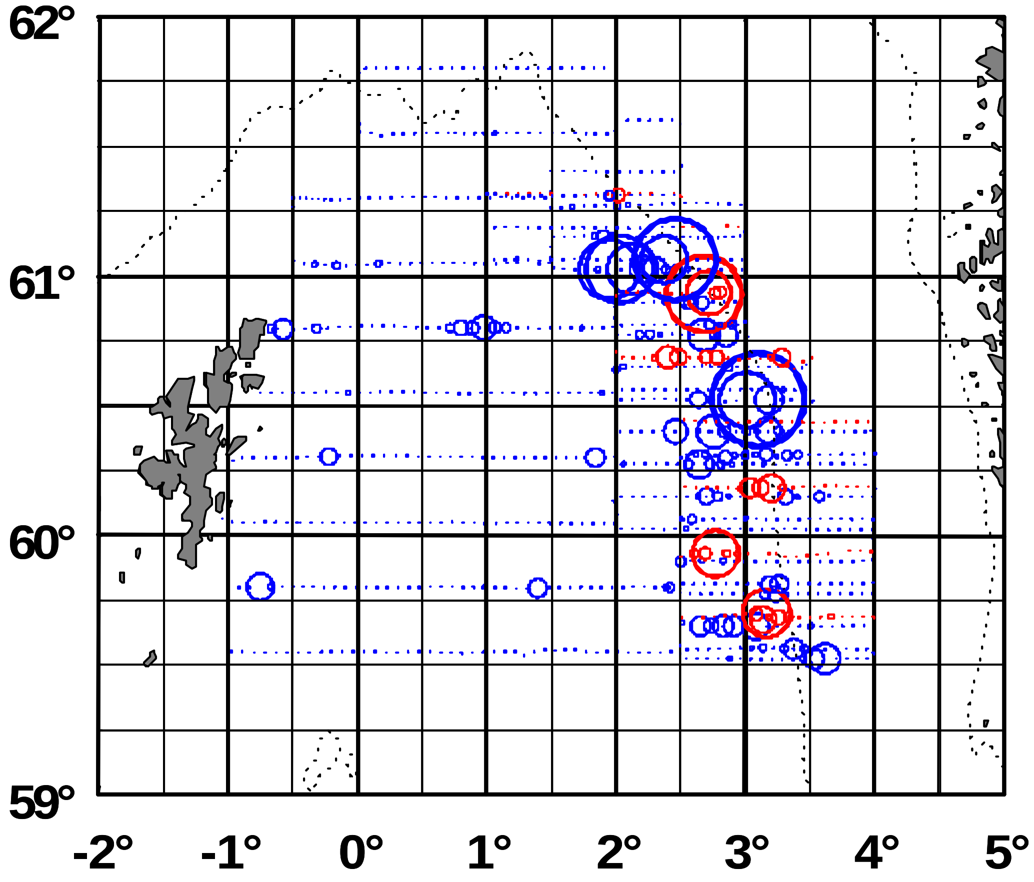


Figure 2.7.5.3. Map of the northern North Sea and a post plot of the distribution of mackerel. Circle size proportional to NASC attributed to mackerel, from the combined acoustic survey 18-20 October 2003: red circles = *G.O. Sars*; blue circles = *Scotia*; on a square root scale relative to a maximum value of 964 $m^2.nmi^{-2}$.

2.8 Data and Model Exploration

Various characteristics of the data and model fitting were examined using ICA, AMCI and ISVPA. The exploration was intensified this year to conform to the requirement for a "benchmark" assessment.

2.8.1 Trends and patterns in basic data

The catch at age matrix exhibits clear year class effects, the poor 1982, 1983 and 2000 year classes are obvious at all ages of those cohorts (Figure 2.8.1.1), as are the strong 1981 and 1984 year classes. The presence of at least 12 ages is maintained throughout the series, suggesting stability in the age profile. Recruitment is relatively consistent and the level of exploitation has been stable. There is little evidence for an increase in exploitation (assuming no increase in effort and no strong basin effect), except on later ages between 1996 and 2000. A basin effect is when a population density remains the same as the population declines by restricting its geographic distribution, with certain fishery behaviour this will allow the catches to appear stable when in fact the stock is declining. The age range is broadening in the very last years, which may suggest targeting older age, or alternatively, a better preservation of those cohorts, i.e. a low mortality (Figure 2.8.1.1).

The survey time series also appears consistent although the latest survey SSB estimate is the lowest in the series (Figure 2.8.1.2a). The relative ratio of the catch of mature fish to the SSB survey-estimates is also consistent (Figure 2.8.1.2b) with approximately 15 to 20% of the survey-estimated SSB removed by the fishery in the five survey years. Both the estimates of catch and SSB will be biased. However if the bias does not vary greatly between years or shows no trend, the ratio can indicate that the catches of mature fish are stable in relation to the reproductive portion of the stock. This provides some evidence to reject an escalating mortality. It also suggests that the level of noise in both sets of data is not that great (Figure 2.8.1.2).

The dome shape of the catch curves suggest increasing selection at age (Figure 2.8.1.3a) with full recruitment to the fishery at approximately age 3 or 4. Although earlier on in the series the year classes 1968 to 1972 are fully recruited at ages 5 or 6. This is thought to be due to the shift in the behaviour of the fishery from exploiting older fish in the North Sea to younger fish in the western waters in the 1970s. However the exploitation appears consistent from the mid eighties year classes onwards. This is emphasized by the log catch ratios (ln[catch of one year class/catch of the same year class a year later], Figure 2.8.1.3.b) which are smoothed with a 3 year running average to show the main trends (Figure 2.8.1.3.c). The ratio between ages 0 and 1 is very variable and shows little stability. This is also seen, but to a lesser extent, for the ratio between age 1 and age 2. This suggests that the fishery's exploitation of these age groups is highly variable between years and it confirms the comments above about age 1 in the raw catch at age matrix (Figure 2.8.1.1). Full exploitation occurs in the ratio between ages 4 and 5. The higher exploitation of the older ages between 1995 and 1999 is also apparent with an increase in the ratio between these years (Figure 2.8.1.3c), and interestingly is coincident with the pattern in fish condition (section 2.5.3.2 in WGMHSA 2003 and section 2.5.3 in this report). There is some instability between the ratios of the older ages, with the smoothed lines from the older ages often crossing. The average of the log catch ratios for separate 5 year periods (Figure 2.8.1.4) confirms the increasing selection at older ages and as the general exploitation patterns do not appear to change greatly, separable models can be used to assess this stock.

The rate of decline in numbers in the catch has changed over the time series (Figure 2.8.1.5). This rate of decline can be taken as a proxy for total mortality providing that fishing mortality is stable. The suggested total mortality rose for the year classes 1985 to 1994, as also described above. Z changed from approximately 0.3 to 0.4 and then back to 0.3 in the cohorts from the end of the 1990s. There is some evidence that some less abundant year classes (see graph for 1975-1979, Figure 2.8.1.5) had a lower total mortality rate. These data also suggest that the mortality rate does change with age, with a lower rate between 4 and 7 and then an increase in the later ages, as the linear decay model does not appear to fully fit the data. This would support the choice in assessment models of a higher terminal selection on the older ages. A re-estimation of decline rate of each cohort for each cohort by maximum likelihood method (Kienzle, 2004a) again suggests no major trend in z, but as predicted by Kienzle (2004a) the values are higher (0.3-0.45, Figure 2.8.1.6.) than the biased linear regression described above.

The estimates of total mortality (Z) from tagging exercises by Norway (section 2.5.4) also suggest total mortality rates in the order of 0.3 – 0.4 on the fully recruited ages, although with considerable noise.

The exploration of the basic data has shown that this stock can be assessed with separable models, such as ICA, AMCI and ISVPA. The signals in the catch and survey suggest that the stock has been exploited at similar rates throughout the time series (except in the late 1990s) and that the age profile is still diverse. Total mortality was also higher during the late 1990s. Year classes can be easily tracked as they age, but the signals from the age 0 and age 1 fish are weaker than in the older fish. There appears to be more noise in these younger age groups, and this suggests that their exploitation is variable between years. The fish appear to be fully recruited to the fishery between ages 3 and 4.

2.8.2 Models used for exploration

Separable models (exploration tools) were used for further data and model exploration. This was justified by their use in former WGs and by the findings of the basic analysis (section 2.8.1). The settings were generally similar to those used to explore data in previous WGs and attempts were made to ensure that similar assumptions were made in all, to allow comparability. The four tools were ICA, ICA in a spreadsheet, ISVPA and AMCI. ICA is a separable model attached to a VPA.

The general settings used for ICA are described in table 2.9.1.1 from 2003. The ICA spreadsheet version was developed to give more insight into the fitting of the model solutions and to use “Excel Solver” as the minimisation process. It was written by Dankert Skagen and has been tested alongside the traditional Fortran ICA and found to give comparable results. The settings for the ICA spreadsheet were the same as that for ICA.

ISVPA is a totally separable model, that offers a range of minimising methods and the ability to estimate F on catch at age alone. ISVPA has been reviewed by the methods WG in 2003 (ref D:03) and the SGAMHBW in 2004 (Report of the Study Group on Assessment Methods Applicable to Assessment of Norwegian Spring-Spawning Herring and Blue Whiting Stocks (SGAMHBW) ICES CM 2004/ACFM:14), and the version used in this exercise was that presented to the methods WG WGMG (2004), except for some extensions (Table 2.8.2.1). It has been run alongside the ICA estimates of Northeast Atlantic mackerel for the last few years. The ISVPA settings are given in Table 2.8.2.1. Importantly it is run assuming two periods of separable constraint (1972-1988 and 1989-2003) representing a perceived change in fishing behaviour in the late 1980s. The overall loss function of the model was composed of the sum of squared residuals (or their absolute median deviation, AMD) in logarithmic catch-at-age and the sum of squared residuals between logarithms of model-derived and observed SSB values from egg surveys. These two components were used in overall loss function with equal weights when brought to equal scale. In (terminal+1) year the same fishing pattern as in terminal year was assumed, this was created to enable the 2004 egg survey to be incorporated. The condition of unbiased residuals in logarithmic catch-at-age was applied. Three versions of the model were used: catch-controlled, effort controlled and mixed (with equal weights). Catch-controlled version of the model considers catch-at-age data as true and attributes residuals in catch-at-age to violations of selection pattern stability assumption. To the contrary, effort-controlled version assumes selection pattern as stable and attributes residuals in catch-at-age to noise in catch-at-age data. In general case results of these assumptions can be strongly different.

AMCI is also a separable model but it offers a range of options about the separability assumption. It also allows for the inclusion of information from tagging studies. It is more adaptable than ICA or ISVPA, but in this instance, settings were used to make it comparable with the other three tools. The gain factor for change in the selection was 0.1 at all ages, requiring a rather consistent signal to make substantial changes in the selection. The selection was assumed constant in the first 4 years and it was assumed equal in 2002, 2003 and 2004. Fishing mortality in 2004 was set equal to that in 2003. Fishing mortality for the plus group was set equal to that at oldest true age. SSB indices from 1992 onwards were included as either relative (with constant catchability) or absolute measures of SSB. The objective function was a sum of squared log residuals of both catch at age and survey biomass data. The survey data were given a weight of 1.5, which corresponds approximately to the weighting of 5 used in ICA. Catches at age were down weighted to 0.01 for age 0 and 0.1 at age 1. Tag data were not used.

2.8.3 Sensitivity

2.8.3.1 Weightings

To test the sensitivity of the model fits, the weighting factors on the ages and surveys were investigated, particularly in light of the findings of the basic data exploration (section 2.8.1). It was felt that it was appropriate to adjust the weight on age 0 and 1 as the catch data were noisy and did not contain a clear signal (Figure 2.8.1.3). Various runs were carried out in ICA with a range of weighting factors in the separable model on the earliest ages (Table 2.8.3.1). Changing the weighting factors on ages 0, 1 and 2 made no difference to estimates of SSB (using a relative index of SSB surveys) but increased the terminal SSB by either 3 or 7% (using an absolute index of SSB surveys, Table 2.8.3.1). The fit of the model improved when the age 1 catch was down weighted (Table 2.8.3.1) and this combined with the clear evidence from the basic analysis (section 2.8.1) lead the WG to agree that age 1 fish should be down weighted in the assessment, along with the age 0 fish. A weighting of 0.01 for age 0 and 0.1 for age 1 was recommended.

The use of ISVPA enabled the signal from the survey to be compared with that in the catch at age data alone (Figure 2.8.3.1). The catch at age data suggest that the stock is increasing in recent years, whilst the use of the survey as an absolute index suggests that the population is stable. The addition of the survey strongly diminishes the uncertainty in the ISVPA assessment (Figure 2.8.3.2).

In previous assessments the survey weighting was found to have a large impact on the outcome of the model. ICA was used to investigate the sensitivity of the model to a weighting for the SSB survey of 0.1, 1, 5, 10. It was found that a weighting of between 1 to 10 had virtually no effect on the fitting of the model or on the outcome of the model (Figure 2.8.3.3). In the same way, if the survey was treated as a relative index, the determination of the catchability coefficient q might be affected by one of the survey years more than the others, hence ICA was used to test the influence of each survey. The model was fitted five times to the catch and survey, but with a survey year removed each time (Figure 2.8.3.4). It was clear that the determination of q was not greatly effected by any one survey in particular (Table 2.8.3.1). It was concluded not to down weight any individual survey points.

2.8.3.2 Outliers

Since outliers in the data may strongly influence the results of assessment, their detection and their effect should be investigated. There are several approaches to detect and perhaps diminish the influence of outliers on the results and model fits. A method was developed within ISVPA to detect outliers and then investigate their influence on the assessment (table 2.8.3.2).

This method applied to northeast Atlantic mackerel catch-at-age data revealed that in total only 8 points were possible candidates for outliers, that is about 2% of all catch-at-age data points (giving in the model non-zero residuals). Five of them belong to age group 0, and one to each age group 1, 2 and 3 (Table 2.8.3.3). This conforms to the previous observations in the basic data exploration. Reducing the influence of the outliers in the catch at age matrix does not change solution if only the signal from the survey is considered, but unsurprisingly their reduction does change the impression of the SSB considerably when the solution is based on the signal from catch-at-age data alone (Figure 2.8.3.5). Their impact on the residuals is also shown (Figure 2.8.3.6). However it is important to mention that the signal from catch-at-age in this investigation was taken by non-robust sum of squared residuals in logarithmic catches. The use of the AMD (absolute median deviations) in the minimization process in ISVPA also tends to avoid the impact of outliers compared to minimisation of the standard errors of the squared residuals. Both methods gave very similar results, and these were in fact similar to the ICA and AMCI, again suggesting that outliers have a small impact on the assessment. The WG felt that considering this information and that in section 2.8.1, the impact of the outliers in the catch at age matrix was minimal and hence no corrective action was taken.

2.8.3.3 Robustness of Parameter estimates

This exploration of parameter estimate robustness concentrates on the estimation of terminal fishing mortality, which is a key parameter in the assessment. As described in section 2.8.2, in ISVPA the catch-controlled version of the model considers catch-at-age data as true whereas the effort-controlled version assumes a selection pattern and attributes residuals in catch-at-age to noise in catch-at-age data. These assumptions can result in very different perceptions of a stock. However fitting the catch and survey data to both types of model assumptions results in very similar perceptions of the stock (Figure 2.8.3.7), and similar profiles of respective loss functions (Figure 2.8.3.8). This may infer that the level of errors in catch-at-age and level of violations in selection pattern stability assumption are more or less similar and each of them shows no major peculiarities that could give rise to strong deviations in the results. The level of noise in catch-at-age data is sufficiently low (Figure 2.8.3.8), and allows a reasonable minimum to be detected from the catch-at-age data alone using traditional (and not robust) sum of squared residuals as a measure of closeness of fit.

Profiles of the objective function for a range of terminal fishing mortalities with AMCI are shown in Figure 2.8.3.9). When the egg survey is taken as absolute, the terminal fishing mortality indicated by the survey is slightly lower than that indicated by the catch data. With the egg survey as relative, the fit is less precise.

The robustness of the estimate of the fishing mortality in the last year was examined for ICA using the spreadsheet version (Figure 2.8.3.10). As the selection at oldest age (terminal selection) also has to be stated in ICA, the impact of that parameter on the goodness of fit was also explored. The figure shows the optimal sum of squares when the terminal F and terminal selection were fixed. Taking the survey data as absolute, the fit to the catches becomes slightly better at lower Fs with a high terminal selection, while the best fit was at F between 0.2 and 0.25 with a lower terminal selection. The fit to the survey data is marginally better at terminal F (at reference age) around 0.25. With the survey as relative, the best fit to the catches is at terminal F around 0.3, while the fit to the survey is slightly better at very high fishing mortalities. Altogether, ICA can fit almost equally well to a wide range of terminal fishing mortalities, both with respect to fit to the surveys and to the catches. The fit at various values of terminal selection does not seem to be a good guidance for the choice of this parameter, which is somewhat dependent on the choice of terminal selection.

ICA provides variances of the parameter estimates according to the goodness of fit. The consequence of these variances for the assessment as a whole is shown in Figure 2.8.3.11. The uncertainty in the early period appears to be smaller. This is because ICA here performs a VPA that is less influenced by the model parameters and more directly relying on the assumption that the catches in this period are exact.

2.8.4 Uncertainty and Bias

2.8.4.1 Structural Uncertainty

As noted in Section 2.8.1, a separable model, as has been used in the past for this stock, seems to be adequate. Within this group of models, ICA, AMCI and ISVPA have been explored. These models differ with respect to some structural assumptions. The implication of these assumptions are discussed here.

Selection at age.

AMCI, ICA and ISVPA assume constant selections at age, with ICA limiting this to the separable part of the model. All allow for two different periods during the separable period. AMCI also allows for a gradual change in selection, and would pick up more permanent changes. The residuals do not show any strong patterns in any of the models, except for ISVPA in the earliest years, confirming of relatively strong signals in the catch data (section 2.8.1).

ISVPA and AMCI estimate the selection at oldest true age (terminal selection). ISVPA does so under the assumption that it is equal to the selection at the penultimate true age. ICA requires that the selection at oldest true age is specified. There are no objective criteria on which to base this choice in ICA. The log catch curves along the cohorts (Section 8.2.1.) are slightly dome shaped, suggesting that the terminal selection should be somewhat above 1.0. The effect of the terminal selection of the model fit was explored on the spreadsheet version of ICA. Taking the egg survey biomass as an absolute measure of SSB, the best fit was obtained with a selection of 0.63, and taking it as a relative measure, the best fit was at 1.60 (see also Figure 2.8.2.9). The estimate by AMCI in recent years is around 1.4 in both cases. ISVPA estimates a selection at oldest age relative to age 5 is 1.48 in the last separable period, with egg survey estimates as absolute. Hence, there is little information to allow an evidence based decision and thus it is difficult to comment on whether the previously used value of 1.2 is appropriate.

The implications of the choice of terminal selection in ICA are twofold. First it reduces the fitted stock numbers at oldest age in the separable period, which leads to a modest reduction in the SSB estimate. Secondly, for the years prior to the separable period, ICA calculates the stock numbers and fishing mortalities from the catches in a VPA procedure. The starting numbers for the cohorts at oldest true age are calculated assuming an F at oldest age which is derived from the selection in the separable period. Hence, the historical SSB estimates are quite sensitive to the choice of terminal selection in ICA. Figure 2.8.4.1 shows some trajectories of historical SSBs under various assumptions about terminal selection. In both AMCI and ICA there is no VPA in recent years. Hence, the results back in time will be sensitive to recent catch data through the estimates of selections at age.

AMCI uses a dynamic pool model for the plus group, while ICA and ISVPA derive the stock numbers from the catches assuming that the F at the plus age is equal to the F at oldest true age. Moreover, AMCI includes the plus group in the objective function. The impact of these differences have not been explored in depth, but since the SSB estimates in the early period are rather similar with the three models, this is probably not a serious problem for the assessment of this stock.

Similarly the choice of reference age in the separable model should not really impact the assessment, if the selectivity is properly replicated by the model. It was shown in section 2.8.1 that full recruitment was at ages 3 or 4, hence the choice of 5 in the previous WG assessments seems appropriate (as the reference age should be after full recruitment). ICA was used to confirm that there was little difference in the perception of the state of the stock, or in the model fit by using 4 or 5 (Figure 2.8.4.2). Since the terminal selection of 1.2 was maintained, the relationship of terminal S to the reference age became slightly different when moved to age 4, thus causing the slight differences in the SSB estimates back in time.

Use of the SSB estimate from egg surveys.

Whether the survey data should be used as absolute or as relative indices has been debated by this Working Group several times in the past. Using the egg survey data as relative seems more satisfactory from a theoretical point of view (Simmonds et al., 2003; Kienzle 2004b). All examples where these options have been compared show that the choice can have severe implications on the results, both in ICA, ISVPA and AMCI. The difference appears e.g. in Figure 2.8.4.3 for ICA, 2.8.4.5 for ISVPA and 2.8.4.6 for AMCI. The egg surveys in principle give an absolute measure of the biomass, although probably are biased due to mortality from hatching to capture (about 3-6 hours of mortality) and it is probable that the survey coverage never is quite complete. These two factors would cause an underestimate. The variance of these surveys is not formally estimated routinely. Previous studies indicate a CV in the order of at least 30%. A range of survey SSB estimates in 2001 and 2004 were used to show the possibilities of variation of 30% in the survey on the assessment results (Figure 2.8.4.3) in ICA, this was done manually. The way the survey data influence the final estimate of abundance and mortality is different when it is used as relative or absolute. The last years in the stock numbers matrix are the easiest to adjust without large change in the residuals, because the recruitments and the fishing mortalities are confounded. With the survey as absolute, it is least costly, in terms of increasing the objective function, to hit the SSB in the last survey year. It is far more costly to adapt to all survey years. Therefore with absolute, the model will fit to the survey data mostly by getting close to the last survey point. Using the surveys as relative implies that the SSB in the last survey year is adjusted by the catchability. Hence, the value for the last year is not fixed, rather, the best fit will be where the trend in survey indices can be reproduced. The trend in the survey data is slightly downwards since 1998. The population matrix can be adapted to that trend by assuming relatively low recruitment and fitting to the catches with relatively high fishing mortalities. Thus, the trend in the recent survey data will to a large extent determine the recruitments and fishing mortalities in the most recent years. This is the case with all separable models, when there are no age-structured survey data. The analytic assessment to which the survey data are applied is to some extent a relative measure of abundance. In particular, the natural mortality has a scaling effect on the stock abundance estimates. Furthermore, underreporting of catches will in general lead to underestimation of the stock abundance.

The undue impact of the SSB survey data can be illustrated by the impact of noise in the data on the assessment. Bootstrap runs were made with AMCI where the egg survey data were drawn from a lognormal distribution with mean at the model value and a CV of 30 %. Figure 2.8.4.4 shows that the spread in the SSB and F estimates for 2003 is clearly larger with the relative option. Given the variance of the SSB estimates and the few data points, it seems clear that impact on the assessment of the recent trend in point estimates of the survey SSBs is out of proportion with the precision of the survey data.

With only triennial SSB estimates as supporting information, a separable model is close to being over-parameterised. The various methods use different approaches to reduce the parameter space to what can be estimated. ICA estimates the population conditional on a choice of selection at oldest age. In AMCI, various options can be used, in the present case the selection at oldest age is set equal to that at penultimate age. ISVPA has constraints on row sums and column sums in the matrix of deviations from the separable model, somewhat dependent on the version.

The robustness of the parameter estimates (Section 2.8.3.3.) give an indication of over-parametrisation. For the case where the egg surveys are taken as relative measures of the SSB in particular, both ICA and AMCI are close to being over-parameterised.

The Working Group is hesitant to accept that the survey has a considerable overestimate, with a catchability near 1.3 when it is treated as a relative SSB measure. Also, the way the population is adjusted to these data, by low recruitment estimates and rapidly increasing fishing mortality in recent years is in conflict with the stable catch data, the stable age composition in the catches, the lack of evidence for a basin effect, the indications that at least the 2001, and probably also the 2002 year classes are well above average and the lack of indications of an escalating mortality in the tagging data. All these factors point in the direction that the model outcome when using the egg survey data as relative, is not realistic. The WG decided to use the egg survey data as absolute measures of SSB in the assessment, because using them as relative gave results that were in conflict with all other evidence.

2.8.4.2 Data Uncertainty

The only data available for assessing the NEA mackerel stock is catch numbers at age and the egg survey data. The latter have been discussed above. The catch data are relatively well sampled, although some fleet segments are lacking. Previous otolith exchange studies have indicated some but not severe problems with ageing (see section 1.3.4). The most recent otolith exchange indicated that these mainly relate to differences in the otolith processing techniques. The precision of the age readings showed that precision was in the range of 7% to 20% (CV). The effect of age reading errors on the assessment regarding precision (CV of 5%, 10% and 15%) is described in ICES (1999/G:16 addendum).

The most severe problem with catch data is probably discarding and underreporting. In this stock, estimates of discarding is only included for parts of the fishery, and is clearly underestimated for the stock as a whole. Underreporting is known to have taken place, and may have been quite severe in some periods. In general, underreporting will lead to underestimate of stock abundance and SSB, but may also induce bias in the assessment (Mohn, 1999, Methods WG CM 2002/D:01). The fishing mortality may be approximately correct only if the age composition of the discards is similar to the landed catch and the proportion discarded does not vary between years.

Last year the WG was shown that the precision of the estimation of weight at age in the Dutch catch was high (CV<5%), and the precision in the raising of numbers at age was acceptable in comparison to other similar stocks (CV<30%, Dickey-Collas and Eltink, 2003). No overall estimates of the total international catch were carried out, and hence neither was the implications of these precision levels on the quality of the stock assessment. Further work on the catch and survey data was carried out at this WG.

A common way of evaluating the impact of noise in the data on the assessment is by bootstrap with noisy data. This was done with AMCI and ISVPA. With AMCI, a non-parametric bootstrap around the model values drawing noise randomly from the residuals at each age was done. The results are shown in Figure 2.8.4.6. Again, the variation in the estimates for the last year are larger if the egg surveys are treated as relative (CV on SSB in 2003 at 10% for absolute and 16% for relative). The ISVPA bootstraps investigated the role of survey and catch at age data noise, and were referred to in section 2.8.3. They show a much better fit when the signals from both survey and catch at age are combined (Figure 2.8.3.3).

In the bootstrap, errors are drawn randomly, while in the real data, the errors may be clustered. The impact of this clustering is not clear, but it has been suggested as a potential cause of retrospective bias. If there is such clustering, one may expect that the SSQ in the bootstrap runs generally to be lower than in the assessment itself. To some extent this was the case in the AMCI bootstrap runs, where the average value of the objective function was about 20% below the value in the basic run for both options for the egg survey. Apart from the role of undeclared catches (whether due to discards or unofficial landings) there is little evidence to suggest that uncertainty in the current data sets will cause problems for the assessment. There are still many probable sources of unquantified bias in these data sets, and further work must be carried out to address and quantify their impact on the assessment.

2.8.5 Retrospective patterns

Retrospective stability of estimates could serve as a rough illustration of uncertainty in current results and can be used for choice of better (while perhaps, only from point of view of historical stability) model settings.

As it can be seen from figure 2.8.5.1 (first row), ISVPA catch-controlled version - derived estimates are rather historically unstable, which is caused by unstable signals both from surveys (second row, Figure 2.8.5.1), and from catch-at-age (third row). Since signals from surveys are much stronger, the overall solution follows mostly signals from surveys.

In ISVPA, almost nothing can be done with stability of signals from surveys by changing the settings in the cohort part of the model, but the signal from catch-at-age data themselves can be made apparently more stable (see fourth row Figure 2.8.5.1) by implementation of more robust measure of closeness of the model fit to catch-at-age data. The retrospective pattern of catch-at-age only - based solution becomes additionally more stable by changing the error model. It appears that the implementation of "mixed" version of the model (in equal proportion attributing residuals to errors in catch-at-age and to separable representation of fishing mortality, instead of "catch-controlled", assuming that catch-at-age data are true) helps to mutually suppress influence of errors in catch-at-age and in separable representation on the solutions (Figure 2.8.5.1, fifth row).

This argument cannot be explored in ICA or AMCI, however it is clear that as shown by ISVPA, the surveys play an important role in the cause of the retrospective variability (Figure 2.8.5.2 for ICA and 2.8.5.3 for AMCI). While overall level of noise (magnitude of residuals) for NEA mackerel catch-at-data is rather low, the stability in the stock dynamics for at least last 20 years makes the estimates of parameters of separable part of the model very sensitive to the low noise in the dynamics and the influence of the surveys. In particular, there tend to be clusters of retrospective patterns due to the dominating influence of the last survey. In addition, the recruitment estimates are unstable until the year classes are fully recruited to the fishery, since the selection at ages 0 and 1 in particular often deviate considerably from the common selection pattern.

2.8.6 Choice of Assessment Model

A separable model seems to be adequate for the NEA mackerel stock assessment. Such a relatively rigid model for the mortalities is probably necessary given the shortage of supplementary data. The most serious problem in the assessment of NEA mackerel appears to be the paucity supplementary data (i.e. surveys). The egg survey data, and the way they are used, then dominate the final outcome beyond what is justified by the precision in these data. The three models considered here are similar to a large extent, and the results are remarkably consistent. Thus, for the assessment of the NEA mackerel stock, one method appears to be as good as the other. The WG decided to continue to use ICA as its primary assessment tool to be consistent with previous practise and because most members of the WG are familiar with ICA. Both ISVPA and AMCI have features that may be useful in future advice, notably bootstrap facilities for estimating uncertainty. They also provide different choices with respect to model assumptions, and thus allow the user to select how to constrain the parameter space to a greater extent than ICA. Therefore, a change to AMCI, ISVPA, or some other implementation of separable models may become relevant in the future.

2.8.7 Dealing with early period of varying plus groups.

The catch at age matrix for NE Atlantic mackerel has an unusual set of increasing plus groups at the beginning of the series (1972-1979). The impact of these data on the assessment was unknown and so further analysis was carried out. Preliminary analysis by Eltink (2004) suggest that substituting these values with simulated data from 1977 to 1979, has little effect on the perception of the current state of the stock, and the increasing series of plus groups had no impact on the estimation of recruits.

In ISVPA these plus groups are dealt with inherently in the model. Although residuals in catch-at-age for early period of fishery are considerably higher, which is reflected by higher residuals for the whole period of first selection pattern of the model (1972-1988), the influence of data for 1972-1979 on the solution for later years is negligible (Figure 2.8.6.1a). Components of the model loss function also reveal distinct minima for shorter time interval (1980-2003), as well as for the whole period (1972-2003, Figure 2.8.6.1b, compared to Figure 2.8.3.8). Hence within ISVPA there is no clear reason, other than questions about the quality of the data to reject the data during the early part of the time series.

ICA treats this succession of plus groups as an ordinary cohort, which may be adequate, provided that the selection is relatively flat within the "moving" plus group. However this is not the case. An additional problem is that the weights at age in the plus group may be inadequate. To what extent catch data for the missing ages can be collated from achieved material is unclear, but attempts to do should be encouraged, in order to understand better the dynamics of the stock in a period where it was less exploited. ICA also prints fishing mortalities for the ages above the plus age, but these values are just the selection at age in the separable period, raised to the mortality level in the ages that are represented in the catch matrix. These values are not used in the calculations.

The working group decided that for the time being, estimates of SSB and average F prior to 1980, as well as the F (4-8) prior to 1977 should be removed or shaded, to indicate that these are to some extent artificial data. The recruitments back to 1972 should be reliable, because these all belong to cohorts for which there are real data.

Table 2.8.2.1. Northeast Atlantic mackerel. Settings for ISVPA model runs.

Model	**ISVPA**
Version	**2004.3**
Model type	A separable model is applied to one or two periods, determined by the user. The separable model covers the whole assessment period
Selection	The selection at oldest age is equal to that of previous age; selections are normalized by their sum to 1. For the plus group the same mortality as for the oldest true age.
Estimated parameters	
Catchabilities	The catchabilities by ages and fleets can be estimated or assumed equal to 1. Catchabilities are derived analytically as exponents of the average logarithmic residuals between the catch-derived and the survey-derived estimates of abundance.
Plus group	The plus group is not modelled, but the abundance is derived from the catch assuming the same mortality as for the oldest true age.
SSB surveys	Considered as absolute or relative. If considered as relative, coefficient of proportionality is derived analytically as exponent of the average logarithmic residuals between the catch-derived and the survey estimates of SSB.
Surveys in year (terminal + 1)	Can be taken into account (in assumption that fishing pattern in the year (terminal+1) is equal to that of terminal year)
Objective function	The objective function is a weighted sum of terms (weights may be given by user). For the catch-at-age part of the model, the respective term is: • sum of squared residuals in logarithmic catches, or • median of distribution of squared residuals in logarithmic catches MDN(M, fn), or • absolute median deviation AMD(M, fn). For SSB surveys it is sum of squared residuals between logarithms of SSB from cohort part and from surveys. For age- structured surveys it is SS, or MDN, or AMD for logarithms of N(a,y) or for logarithms of proportions-at-age, or for logarithms of weighted (by abundance) proportions-at-age.
Variance estimates/ uncertainty	For estimation of uncertainty parametric conditional bootstrap with respect to catch-at-age, (assuming that errors in catch-at-age data are log-normally distributed, standard deviation is estimated in basic run), combined with adding noising to indexes (assuming that errors in indexes are log-normally distributed with specified values of standard deviation) is used.
Other issues	Three error models are available for the catch-at-age part of the model: • errors attributed to the catch-at-age data. This is a strictly separable model ("effort-controlled version") • errors attributed to the separable model of fishing mortality. This is effectively a VPA but uses the separable model to arrive at terminal fishing mortalities ("catch-controlled version") • errors attributed to both ("mixed version"). For each age and year, F is calculated from the separable model and from the VPA type approach (using Pope's approximation). The final estimate is an average between the two where the weighting is decided by the user or by the squared residual in that point. Four options are available for constraining the residuals on the catches: 1. Each row-sum and column-sum of the deviations between fishing mortalities derived from the separable model and derived from the VPA-type (effort controlled) model are forced to be zero. This is called "unbiased separabilization" 2. As option 1, but applied to logarithmic catch residuals. 3. As option 1, but the deviations are weighted by the selection-at-age. 4. No constraints on column-sums or row-sums of residuals.
Program language	Visual Basic
References	Kizner Z.I. and D.A.Vasilyev. 1997. Instantaneous Separable VPA (ISVPA). ICES Journal of Marine Science, 54 , N 3: 399-411 Vasilyev, D.A. (2001). Cohort models and analysis of commercial bioresources at information supply deficit. VNIRO Publishing: Moscow. Vasilyev D. 2003. Is it possible to diminish the impact of unaccounted time trends in age structured surveys' catchability on the results of stock assessment by means of separable cohort models ? ICES CM 2003/X:03. 13 pp. Vasilyev, D. 2004. Description of the ISVPA (version 2004.3)

Table 2.8.3.1. Northeast Atlantic mackerel. Sensitivity of down weighting ages 0, 1 and 2 in the catch. Coefficients of Variation of the estimation of parameters in the separable model.

		Relative SSB index			Absolute SSB index		
	weighting of age 0	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
	weighting of age 1	**1**	**0.1**	**0.1**	**1**	**0.1**	**0.1**
	weighting of age 2	**1**	**1**	**0.5**	**1**	**1**	**0.5**
	0	42	36	35	48	43	42
	1	6	11	11	7	14	13
	2	6	5	6	7	6	7
	3	6	5	5	6	6	6
Separable model:	4	5	5	4	6	5	5
Selection (S) by age	5	fixed ref age					
	6	5	4	4	6	5	5
	7	5	4	4	6	5	5
	8	5	4	4	5	5	5
	9	4	4	4	5	5	4
	10	5	4	4	5	5	5
	11						
	Average 3-11	5.0	4.3	4.1	5.6	5.1	5.0
	0	146	126	123	169	149	146
	1	14	29	29	16	38	38
	2	10	12	14	11	13	16
	3	10	11	11	10	11	12
Separable model:	4	8	9	9	9	9	9
Populations in year 2003	5	8	8	8	8	8	8
	6	8	8	8	8	8	8
	7	8	8	8	8	7	7
	8	8	8	8	8	7	7
	9	9	9	9	8	7	7
	10	10	9	9	8	8	8
	11	10	10	10	9	8	8
	Average 3-11	8.8	8.9	8.9	8.4	8.1	8.2
	1992	15	13	12	17	15	15
	1993	11	9	9	13	11	11
	1994	10	8	8	11	10	10
	1995	9	8	7	10	9	9
Separable model:	1996	8	7	7	10	9	8
Populations at age	1997	8	7	7	9	8	8
	1998	8	7	7	9	8	8
	1999	8	7	7	9	8	7
	2000	8	7	7	8	7	7
	2001	8	7	7	8	7	7
	2002	9	8	8	8	8	8
	Mean	9.3	8.0	7.8	10.2	9.1	8.9
ICA estimated SSB in 2003 (kt)		1866	1855	1864	2573	2648	2658
Percentage difference compared to run 1		-	-1%	0%	-	3%	3%
Variance (unweighted statistics)	Total for the model	0.0771	0.0802	0.0797	0.0775	0.0845	0.0836
	Catch at age	0.0797	0.0829	0.0824	0.0798	0.0874	0.0863
	SSB index	0.0144	0.0132	0.0134	0.0330	0.0283	0.0282

Continued

Table 2.8.3.1. Northeast Atlantic mackerel. Estimates of catchability coefficients (q) of ICA model fits with all SSB survey estimates and with each survey removed.

Survey removed	q
None	1.31
1992	1.34
1995	1.38
1998	1.21
2001	1.32
2004	1.28

Table 2.8.3.2. Northeast Atlantic mackerel. The method used to incorporated the detection and reduction of the influence of outliers into ISVPA and as used in exploratory data analysis in the mackerel data sets.

Development of method for determining outliers within ISVPA

Besides the implementation of more robust loss functions and additional model assumptions, the most traditional approach is censoring of the data by searching for "apparently bad" observations and then excluding them from the parameter estimation procedure (or use with lower statistical weights). This kind of preliminary correction could be made on the basis of statistical properties of the data by means of some statistical procedures, e.g. kriging (see, for example, Vasilyev et al., 2000). More traditional are approaches are based on the residuals derived from an initial model run using all data. For example, is the well-known procedure of "gradual improvement" of estimates, known as α-winsorization (Huber, 1981), and can be ascribed as follows:

Assume that observations y_i are used for estimation of parameters of a model by means of least squares method and model-derived ("theoretical") values $\hat{y}_i$ and residuals $r_i = y_i - \hat{y}_i$ are estimated. If to denote the standard error of residuals as S, then the procedure of widsorization may be represented as substitution of observations y_i by "pseudo-observations" y_i * :

$$y_i^* = y_i, \qquad \text{if } |r_i| \le \alpha S;$$
$$y_i^* = \hat{y}_i - \alpha S, \qquad \text{if } r_i < -\alpha S;$$
$$y_i^* = \hat{y}_i + \alpha S, \qquad \text{if } r_i > \alpha S.$$

Parameter α serves as a "regulator of robustness" and usually taken within the diapason from 1 to 2. After that, using pseudo-observations y_i^*, the parameters of the model are estimated again. The sequence is repeated till convergence.

But it is easy to see that in this procedure the result is influenced by the result obtained using the initial data. Moreover, the distribution obtained after such a procedure is not necessarily closer to a normal one; it also may happen that some new outliers have appeared in new positions. It is also can be seen that initial solution should be itself "good" enough not to measure residuals from absolutely unreasonable estimates. Thus, in fact, this approach does not help to get rid of problem of "robustization" of the model itself, especially in the procedure of its parameters estimation. Besides, the measure of scale, determining the level which tells what is an outlier and what is not, also should be robust. From this point of view more promising looks the procedure based on more robust procedure based on modified "X84 rule" by P.Huber (Hampel et al., 1986). According to this rule all points with residuals higher than 5.2 absolute median deviations are to be excluded. Since it is problematic to exclude points from catch-at-age matrix, the proposed modification consists in changing these points into "theoretical" ones, estimated in the initial model run:

$$y_{a,y}^* = y_{a,y}, \qquad \text{if } |r_{a,y}| \le 5.2^*\text{AMD};$$
$$y_{a,y}^* = \hat{y}_{a,y}, \qquad \text{if } |r_{a,y}| > 5.2^*\text{AMD}, \qquad (2)$$

where AMD = median$\{|r_{a,y} - \text{median}\{r_{a,y}\}|\}$

This procedure has been tested on simulated data at it showed high efficiency in improvement of the assessment results for noisy data and, unlike traditional winsorisation procedure, in most cases requires only one iteration. (see Vasilyev D., 2004).

References

Hampel, F. R., Ronchetti, E. M., Rousseeuw, P. J. and Stahel, W. A.. 1986. Robust Statistics. The approach based on Influence Function. John Wiley & Sons, NY.

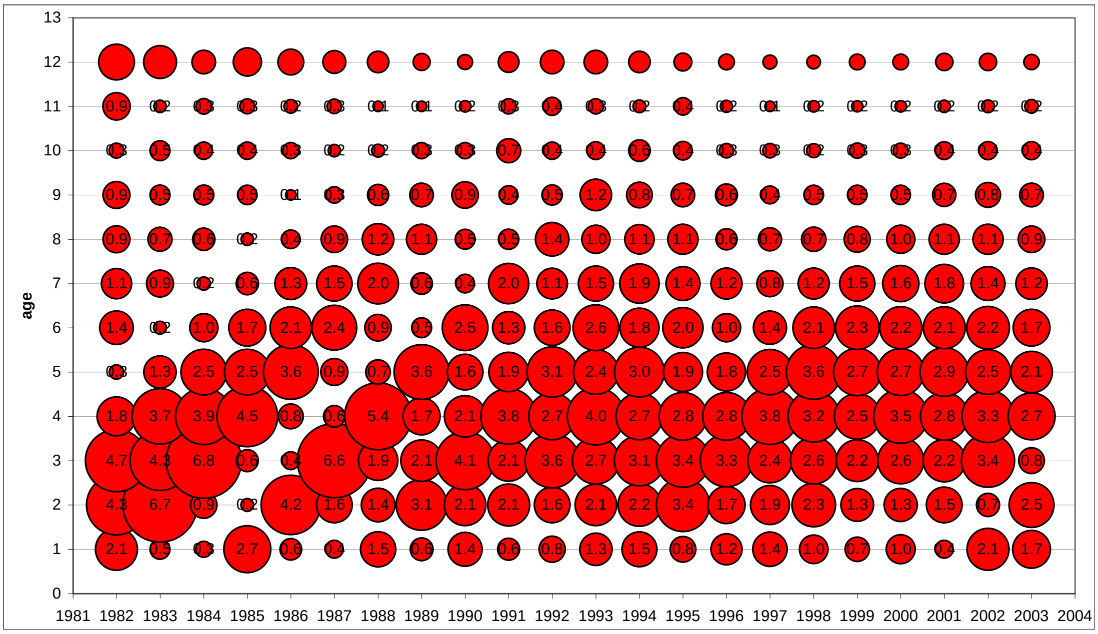
Huber, P. J. 1981. Robust statistics. John Wiley & Sons, NY

Vasilyev D.2004. Winsorization: does it help in cohort models? ICES ASC 2004. ICES CM 2004/K:45

Table 2.8.3.3. Northeast Atlantic mackerel. Candidates for outliers in catch-at-age according to “X84 rule” by P.Huber (Hampel et al., 1986) for exploratory ISVPA run.

Data	% of detected outliers with respect to all data points	age (and year) of outliers
Catch-at-age	2.2	0 (1984, 1985, 1987, 1995, 2000) 1 (1979) 2 (1985) 3 (1986)

According to this rule all point with residuals higher than 5.2 absolute median deviations are excluded (in this model they were substituted by “theoretical” values).



2.8

Figure 2.8.1.1. Northeast Atlantic Mackerel. Catch in numbers (x10^8) at age of mackerel from 1982 to 2003. Area of bubbles denotes size of catches.

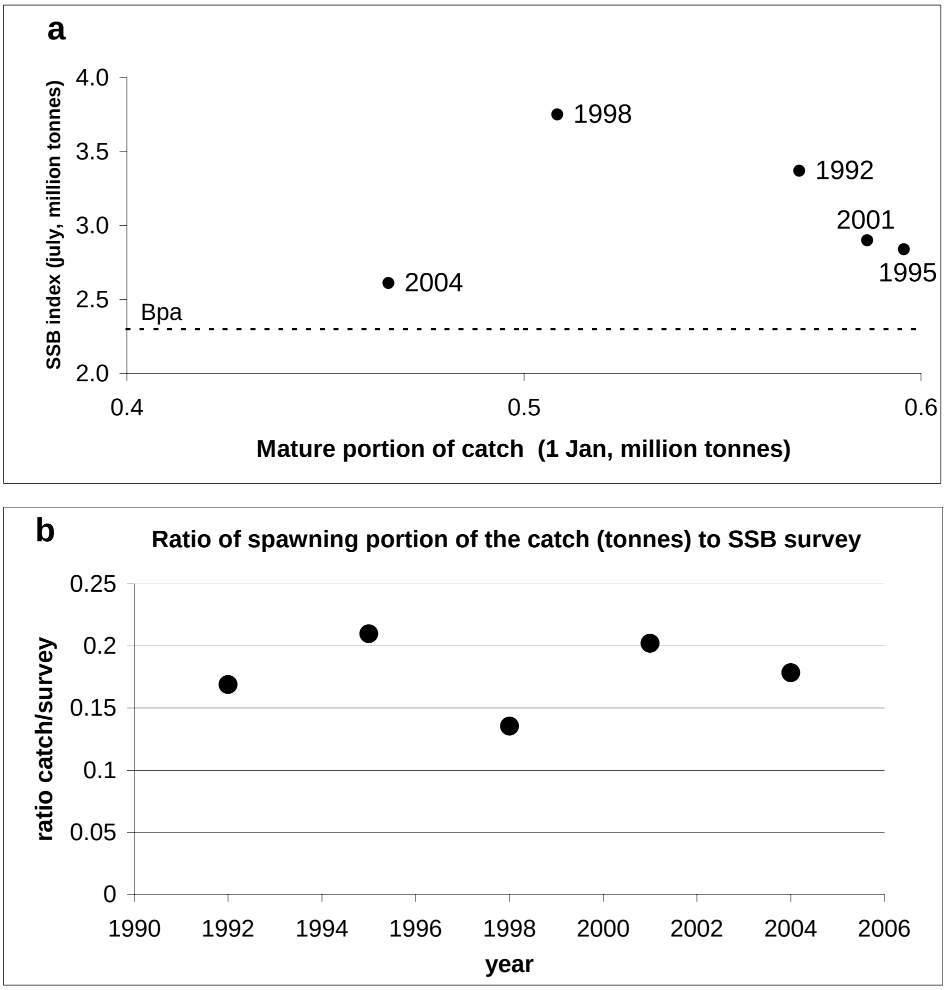


Figure 2.8.1.2. Northeast Atlantic Mackerel. Survey estimates compared to the catch. Ratio of mature fish in the catch to SSB from egg surveys.

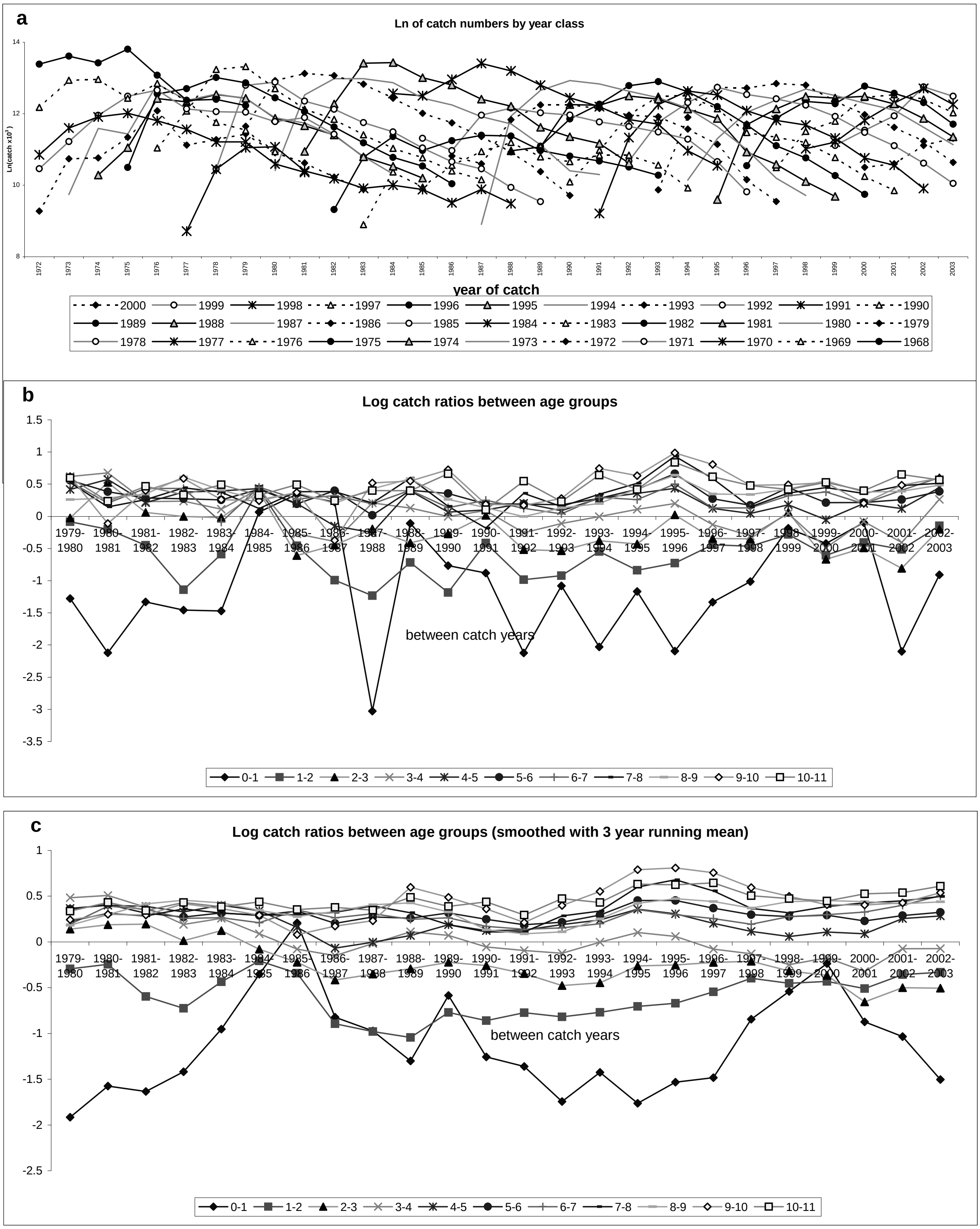


Figure 2.8.1.3. Northeast Atlantic Mackerel. Logged catch of year classes (cohorts) by year and logged catch ratios between cohorts and years (as raw data and smoothed by running 3 year mean).

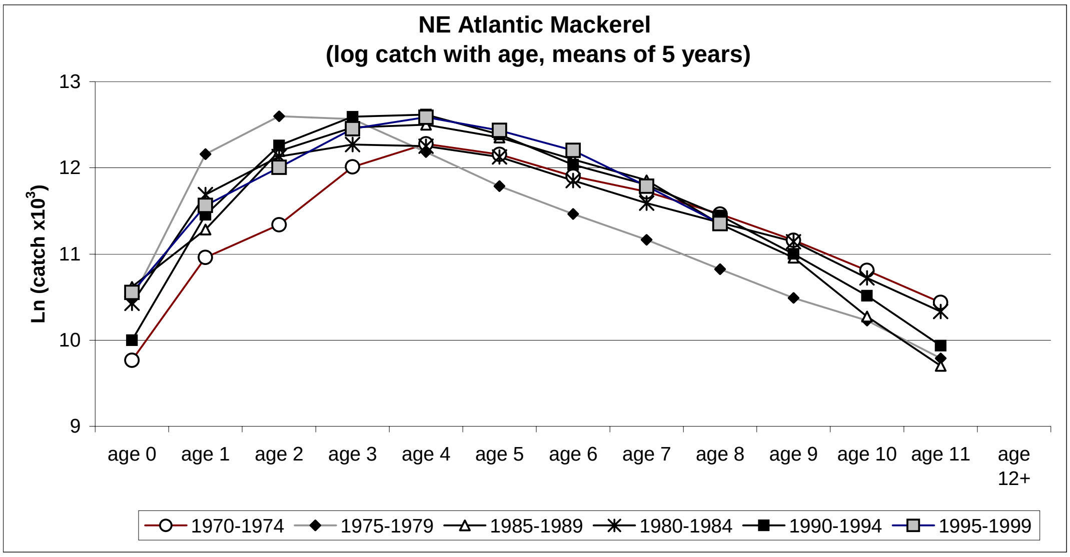


Figure 2.8.1.4. Northeast Atlantic Mackerel. Mean log catch by age, of sets of 5 successive year classes from yearclass 1970 to year class 1999.

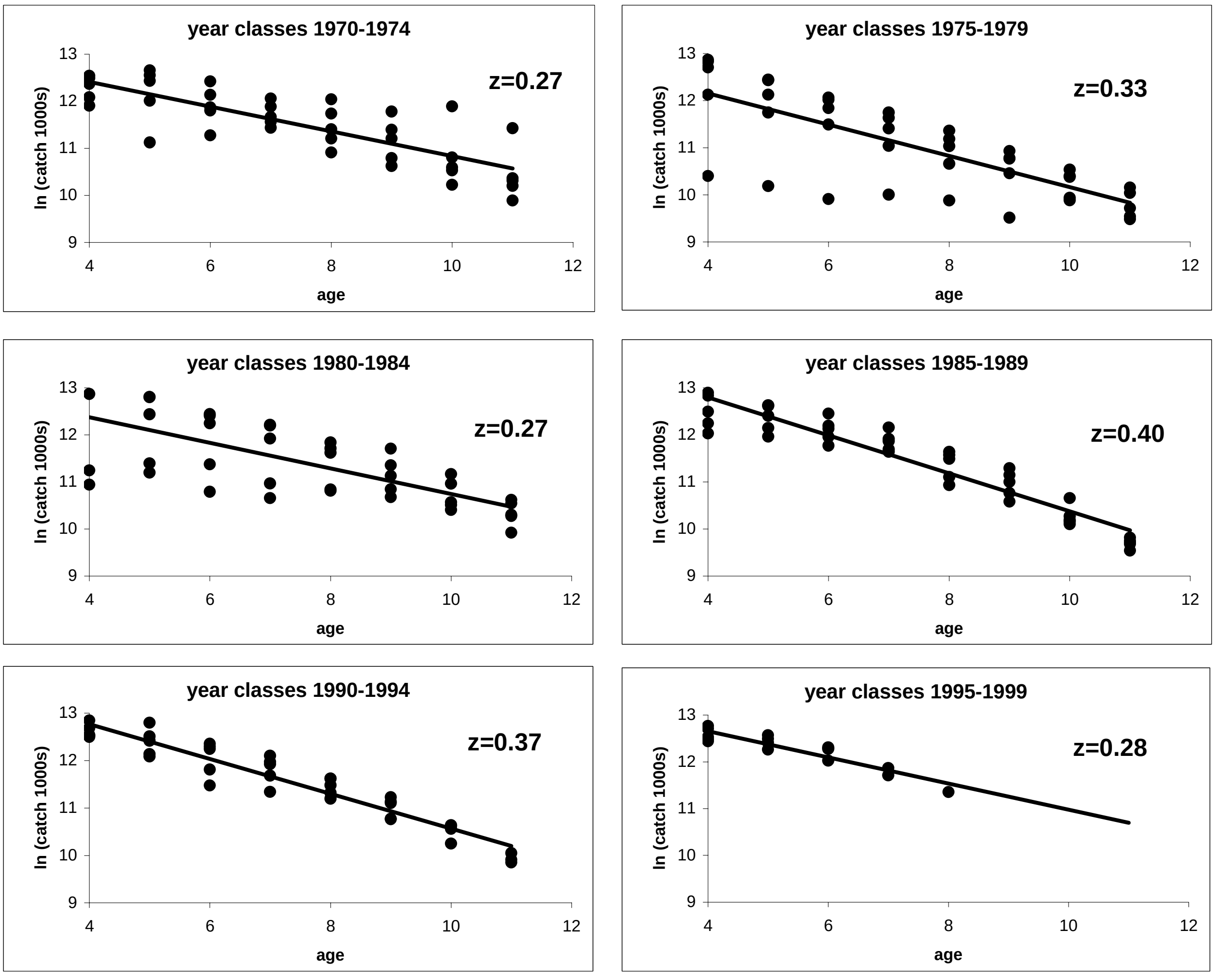


Figure 2.8.1.5. Northeast Atlantic Mackerel. Estimates of decline in slope (as proxy for total mortality, z) from ln catch data by grouped year classes, from age 4 onwards. Year classes grouped into 5 successive years sets.

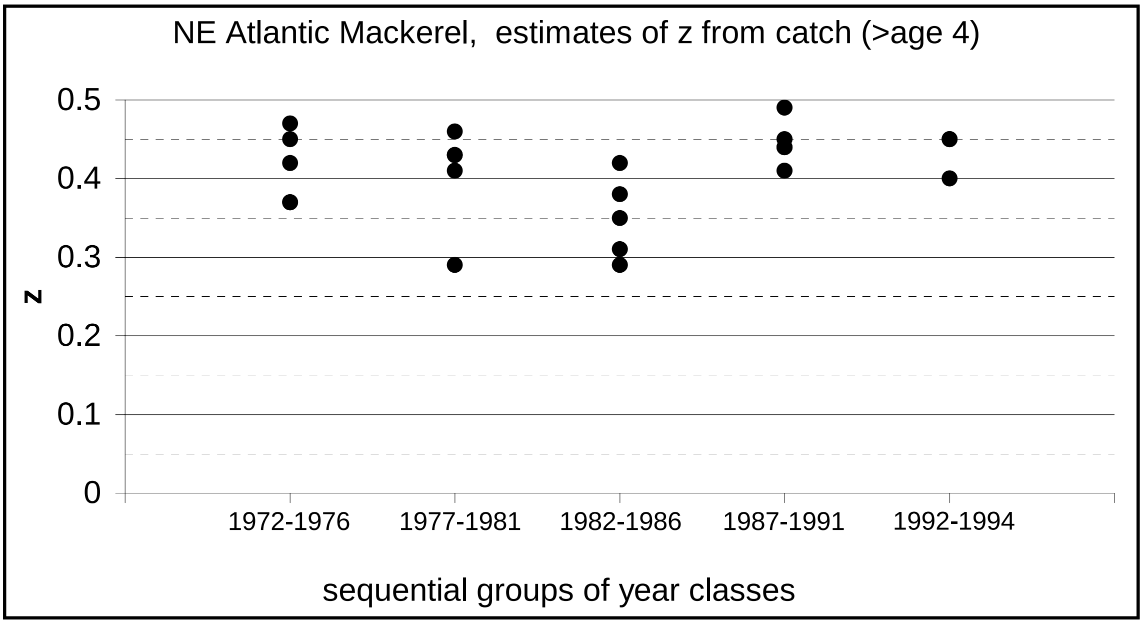


Figure 2.8.1.6. Northeast Atlantic Mackerel. Estimates of slopes in the catch data by maximum likelihood method (Kienzle, 2004). Data from age 4 to age 11, by year class, grouped to account for noise in the time series.

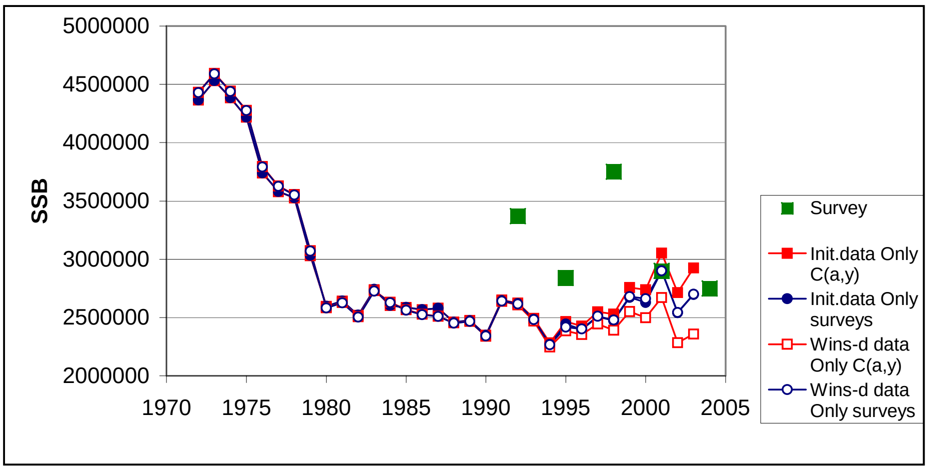
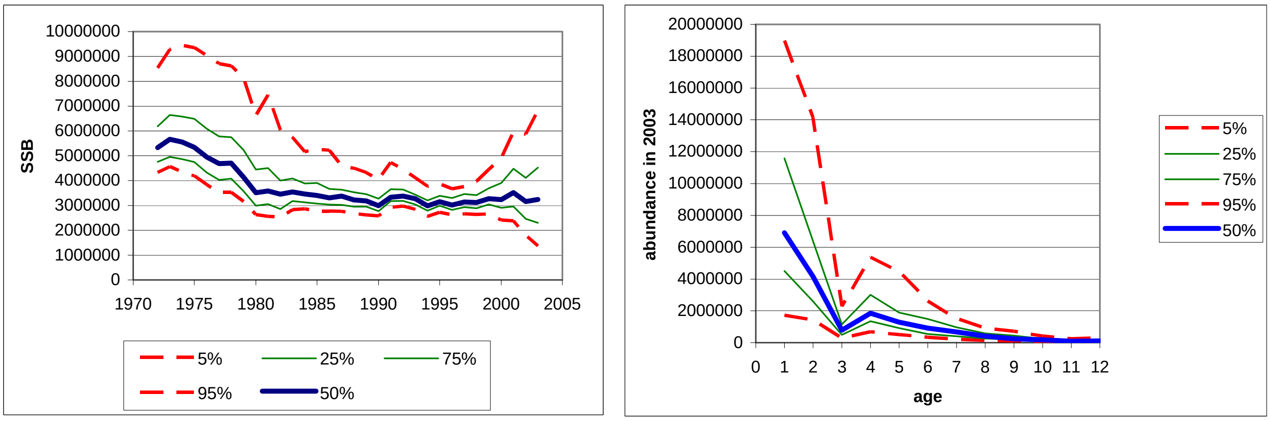
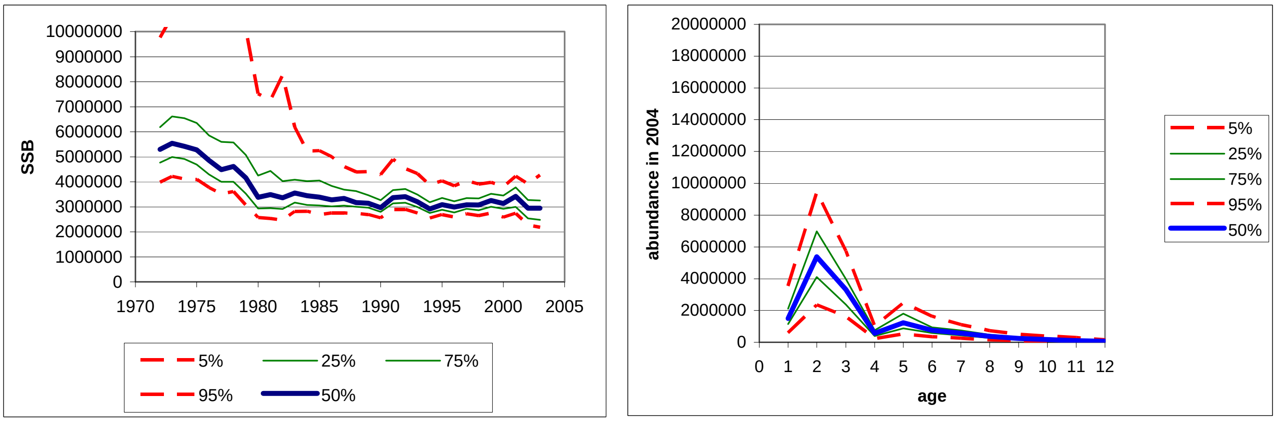


Figure 2.8.3.1. Northeast Atlantic Mackerel. The impact of the survey. Assessment results from the catch at age matrix only, compared to that of the catch at age and survey combined. ISVPA (catch-controlled).



Without survey (2004)



With survey (2004)

Figure 2.8.3.2. Northeast Atlantic Mackerel. The effect of including the survey. Model uncertainty from ISVPA (catch-controlled). Bootstrap results.

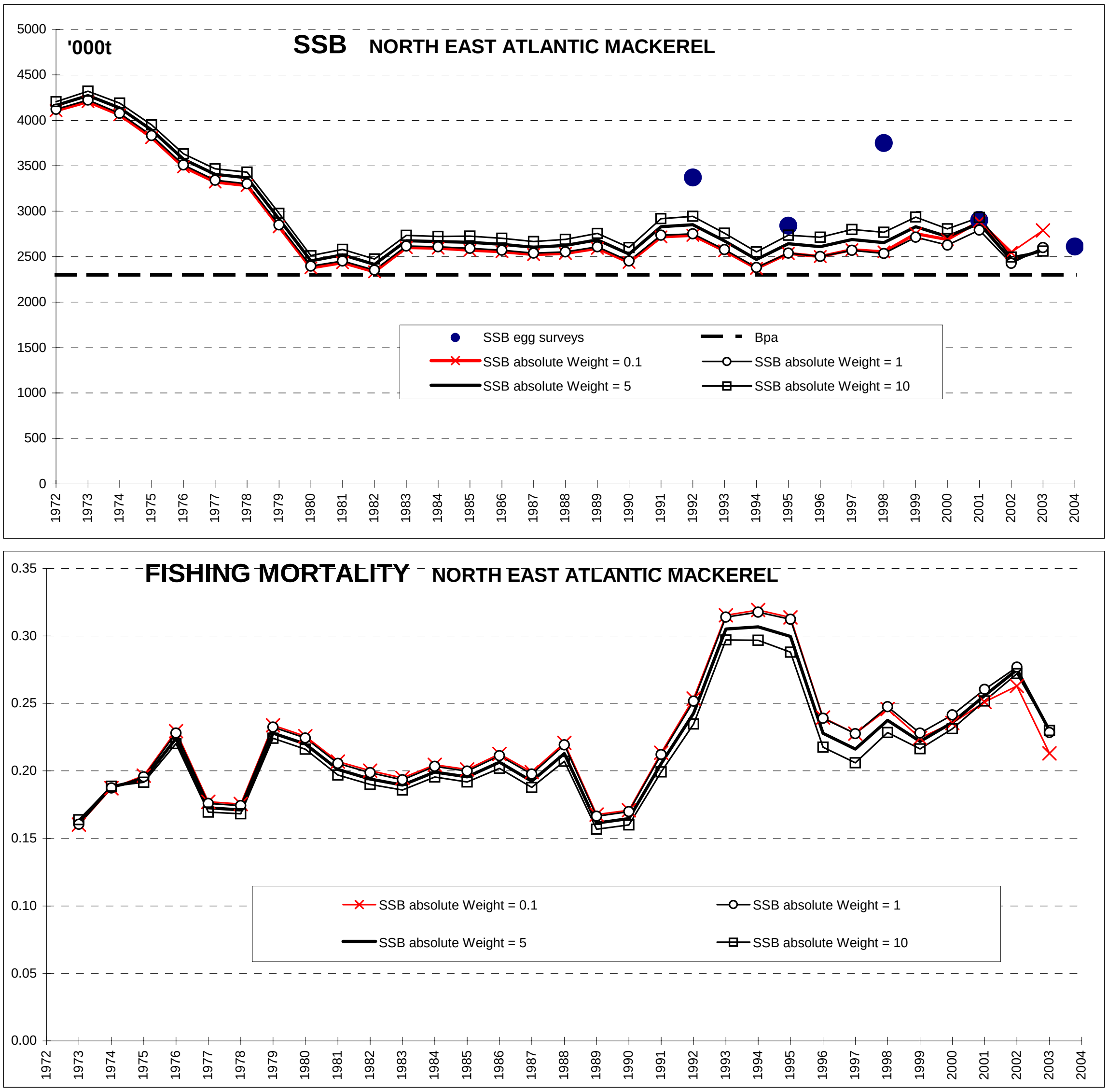


Figure 2.8.3.3. Northeast Atlantic Mackerel. Sensitivity of weighting of survey SSB index (ICA model, survey SSB as **absolute**).

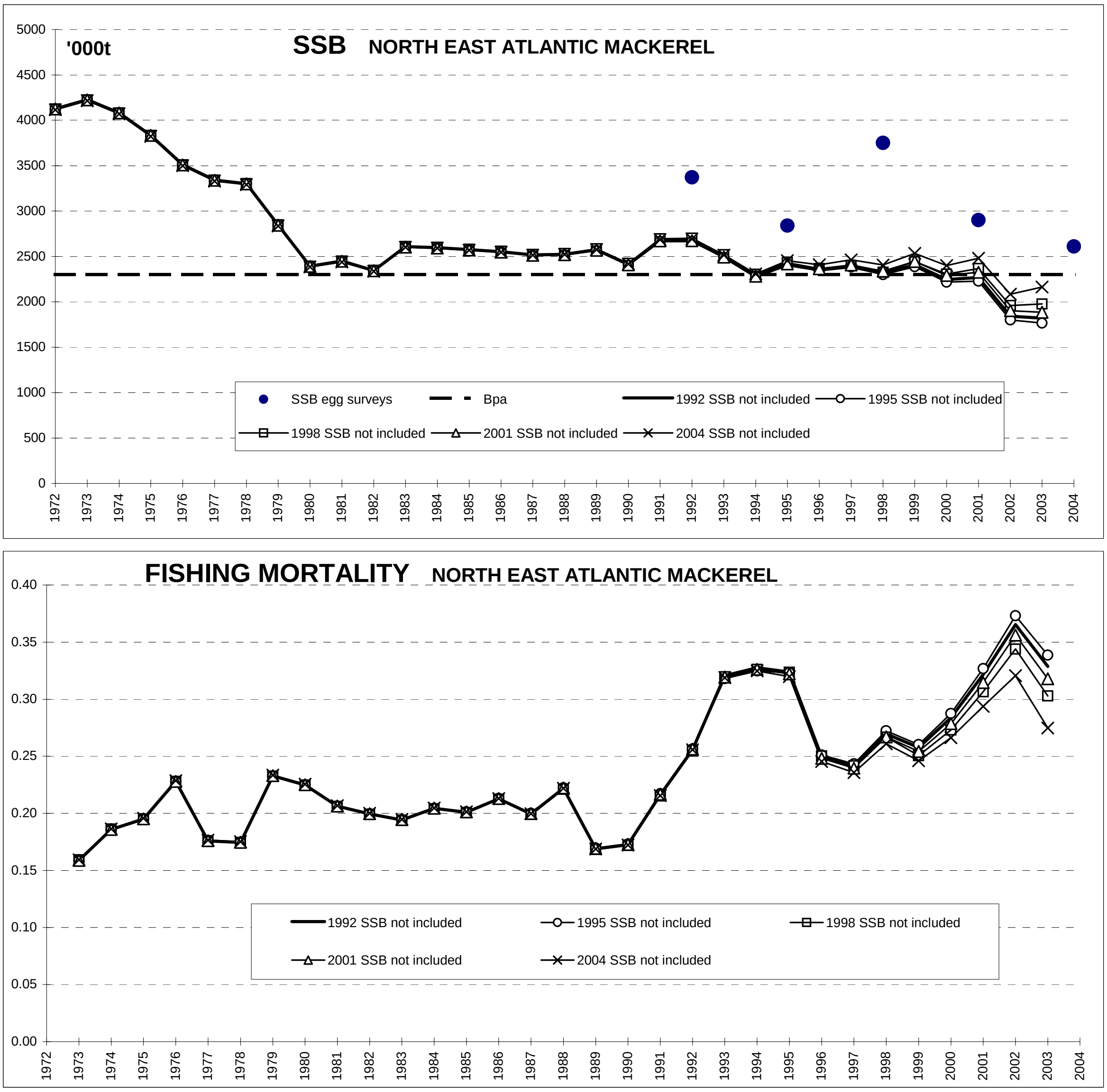


Figure 2.8.3.4. Northeast Atlantic Mackerel. Sensitivity of the removal of one survey at a time (ICA model, survey SSB as **relative**). See table 2.8.3.2 for estimates of catchability coefficient q.

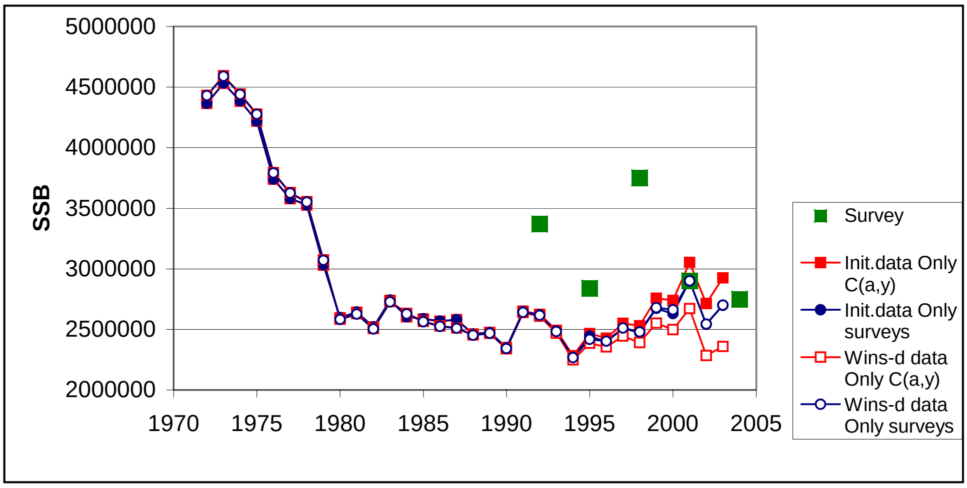
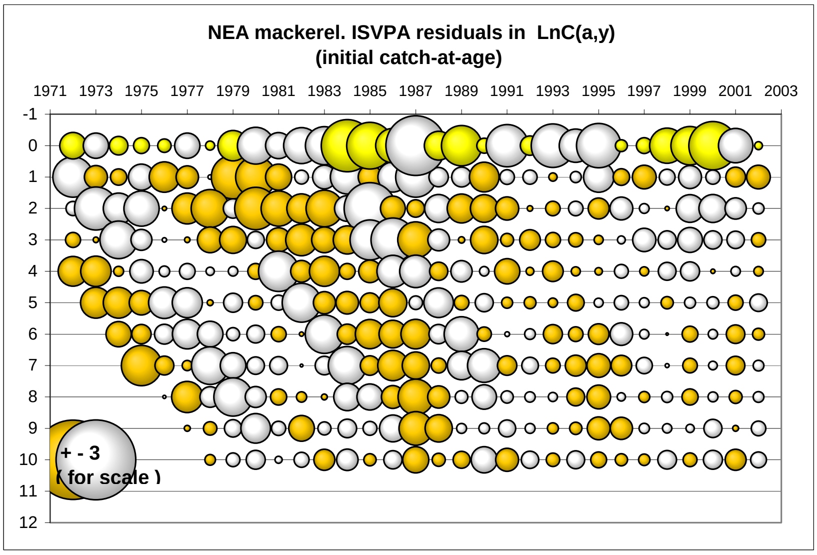


Figure 2.8.3.5. Northeast Atlantic Mackerel. The impact of outliers on the assessment of SSB (ISVPA). Estimates of SSB when signals from catch-at-age or SSB alone are used, with outliers replaced by modeled values.



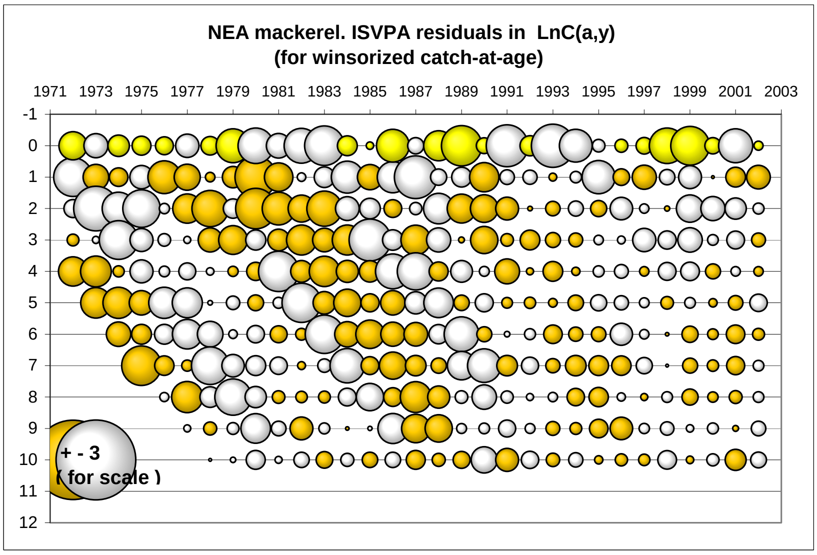


Figure 2.8.3.6. Northeast Atlantic Mackerel. Impact of outliers. ISVPA. Residuals in logarithmic catch-at-age for initial and winsorised catch-at-age data.

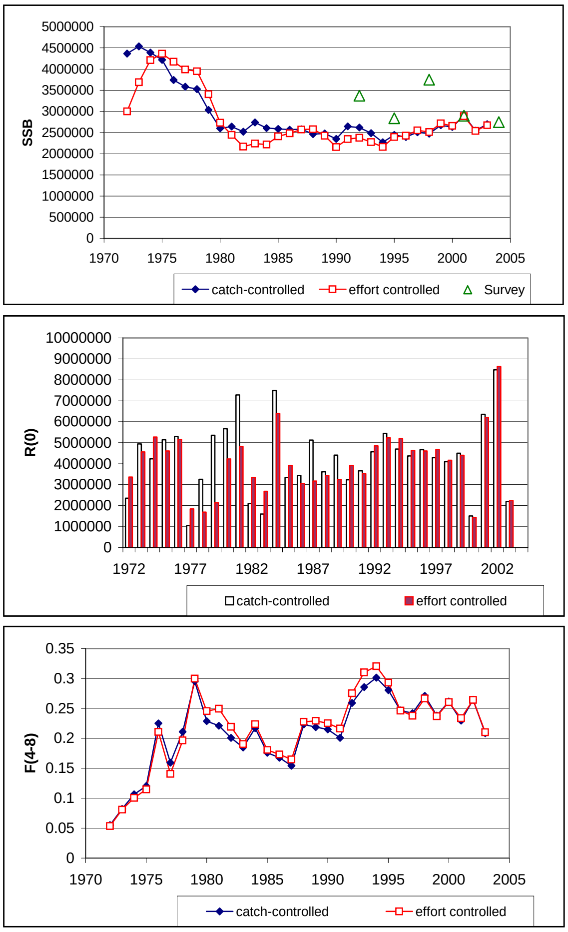
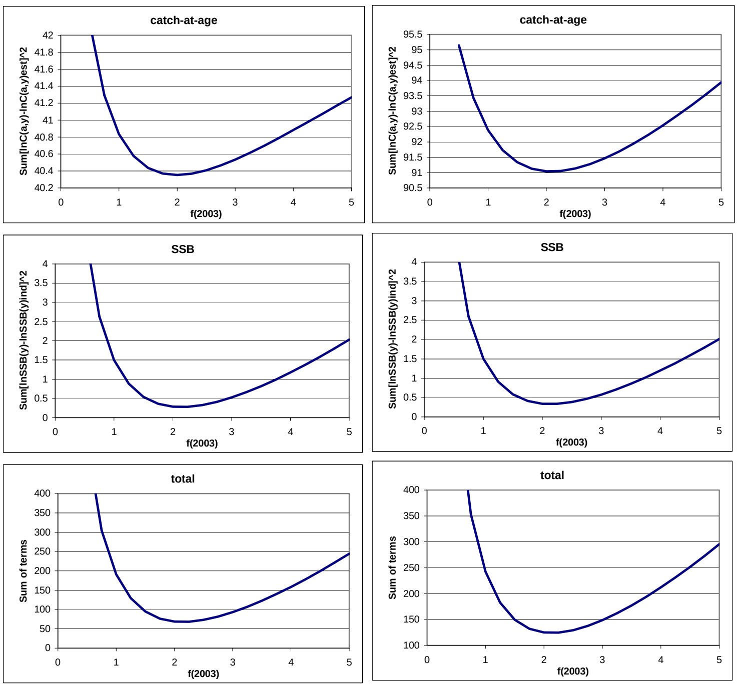


Figure 2.8.3.7. Northeast Atlantic Mackerel. The robustness of parameter estimates, ISVPA. Outputs of stock dynamics from two differing model assumptions in ISVPA; catch controlled and effort controlled.



NEAM ISVPA (catch-controlled version) NEAM ISVPA (effort-controlled version)

Figure 2.8.3.8. Northeast Atlantic Mackerel. The robustness of parameter estimates, ISVPA. Profiles of ISVPA loss function for NEA mackerel for catch controlled and effort controlled assumptions.

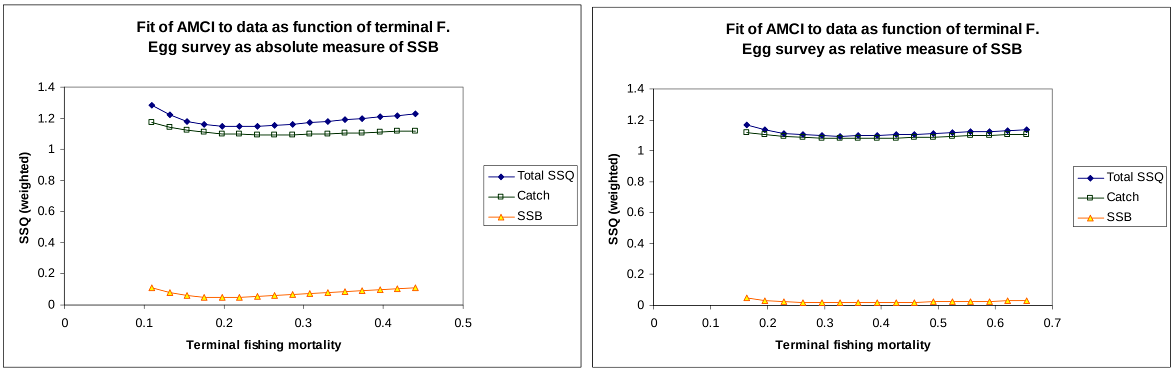
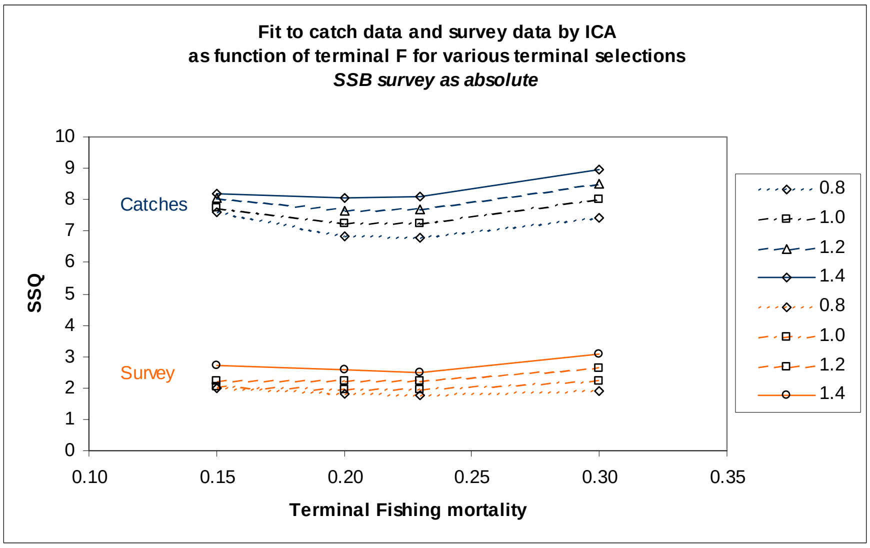


Figure 2.8.3.9. Northeast Atlantic Mackerel. Probability profiles by AMCI for the fit to the catches, surveys and the total objective function. left Egg survey as absolute, right: Egg survey as relative.



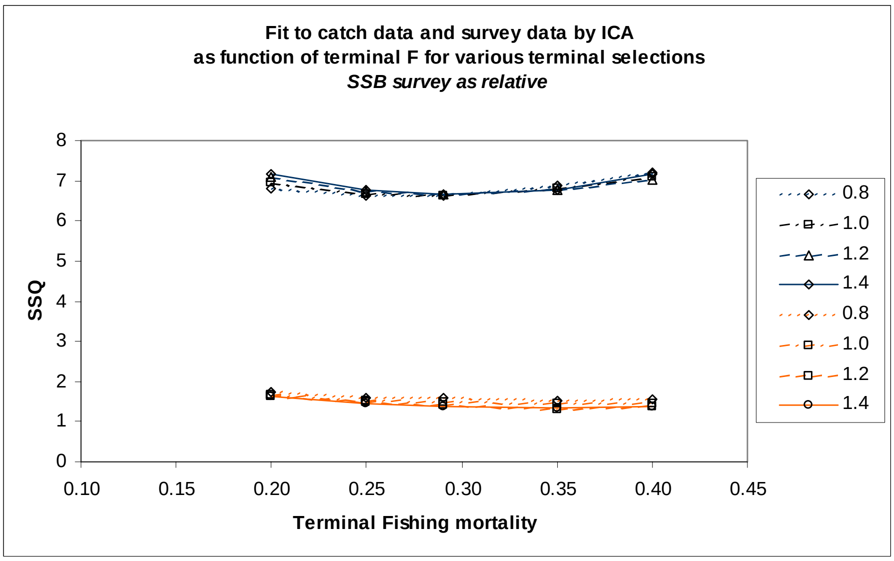


Figure 2.8.3.10 Northeast Atlantic mackerel. ICA. Probability profiles for fit to catch and survey data as function of terminal fishing mortalities for a range of terminal selections. Upper: Using survey as absolute. Lower: Using survey as relative.

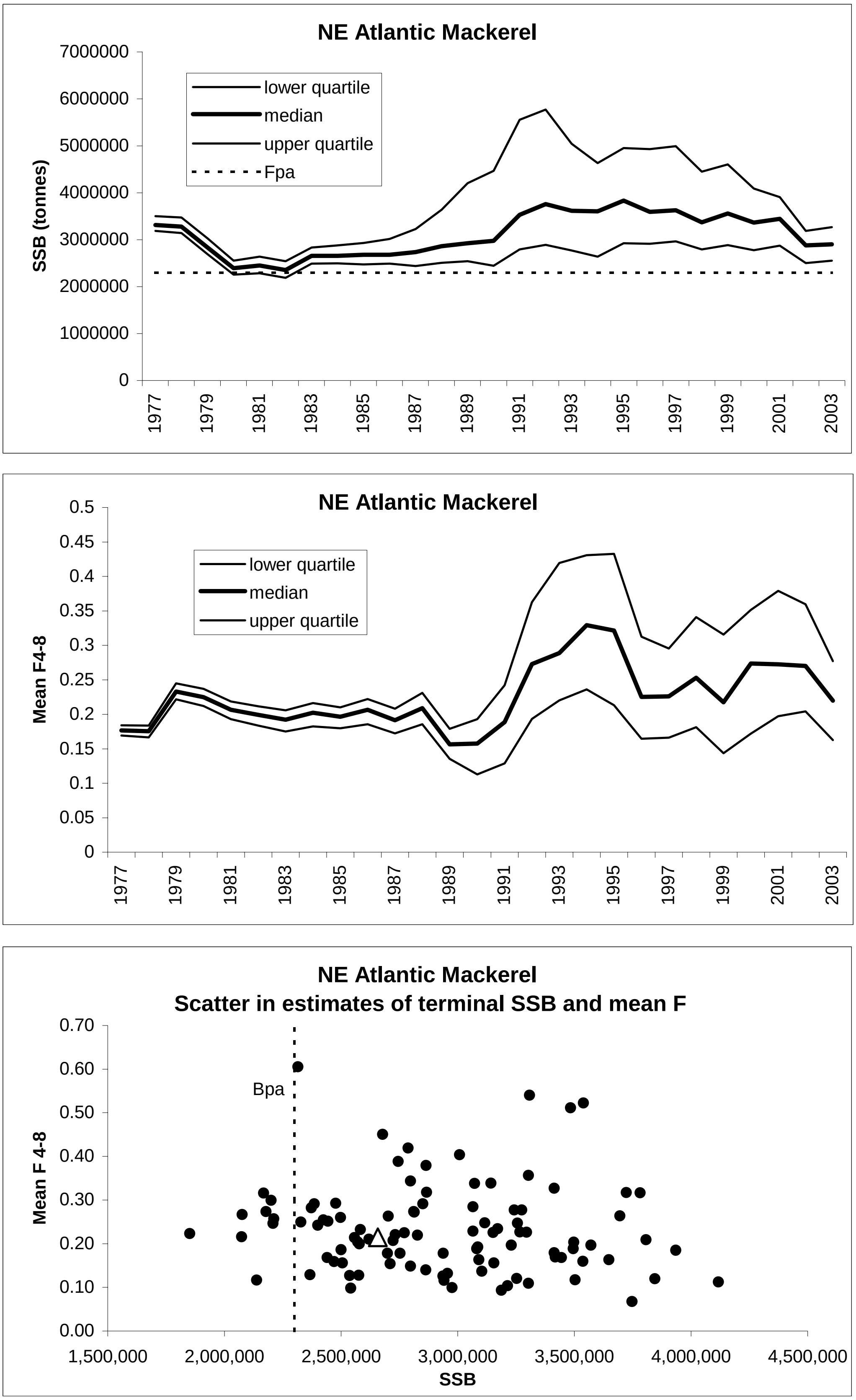


Figure 2.8.3.11 Northeast Atlantic Mackerel. Historic uncertainty estimates from ICA (resampling of the covariance matrix) showing estimated modelled uncertainty in parameters, with 100 samples. Lowest graph shows estimates for final year, with triangle denoting the central point estimate. The separable period began in 1992, thus the apparent jump in variability is caused by the move from the VPA modelled estimates to the separable model.

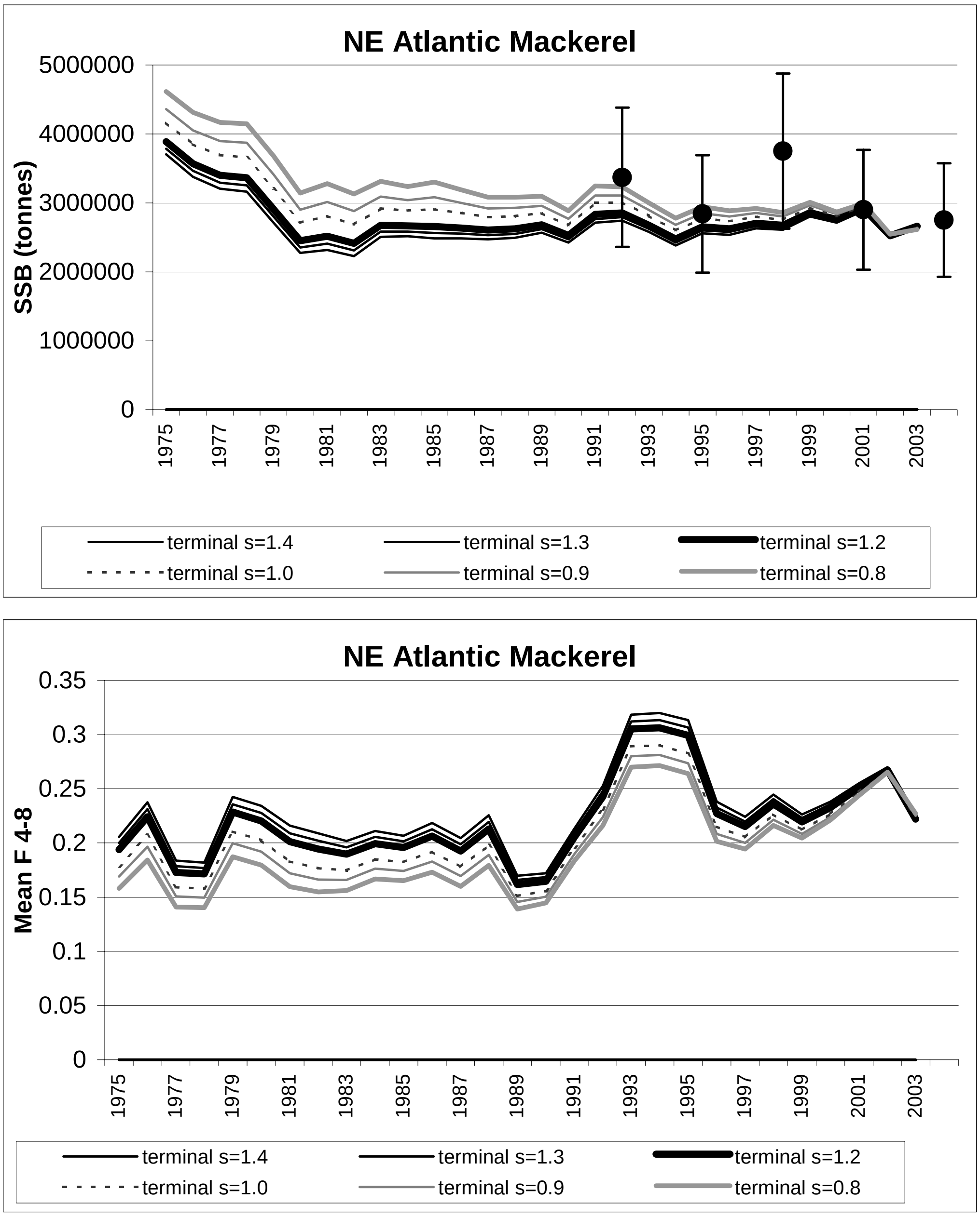


Figure 2.8.4.1. Northeast Atlantic Mackerel. Impact of choice of selection for last true age (terminal selection) in ICA. Survey used as absolute.

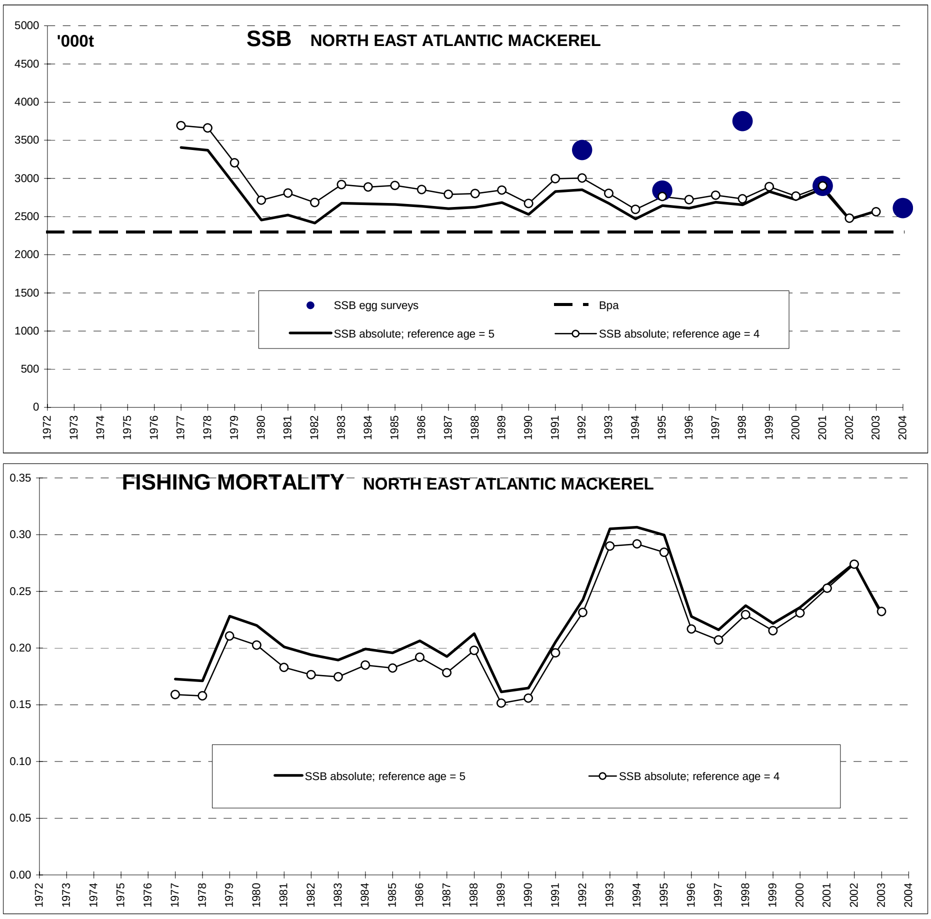


Figure 2.8.4.2. Northeast Atlantic Mackerel. Impact of choice of selection of reference age (age 4 or 5) for separable model in ICA. Survey used as absolute.

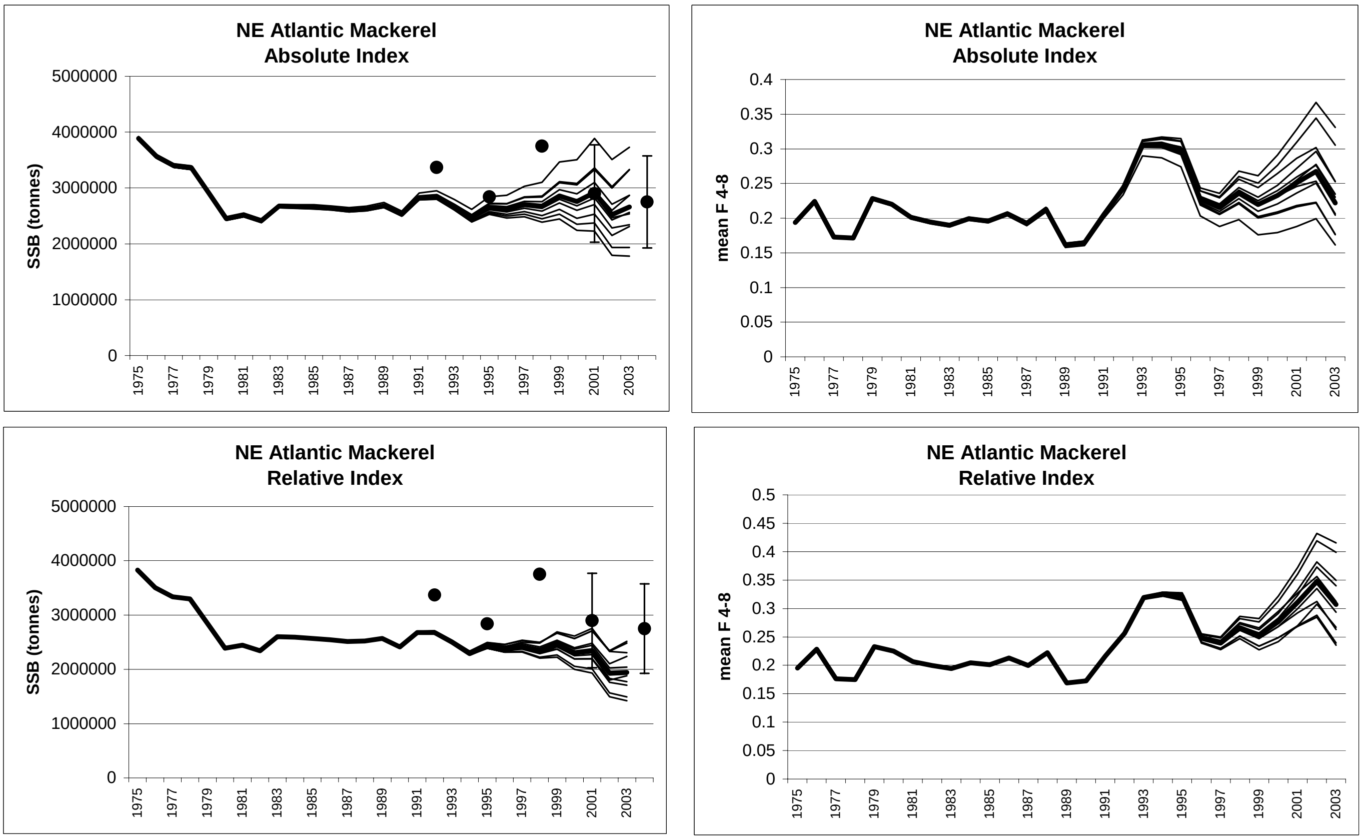


Figure 2.8.4.3. Northeast Atlantic Mackerel. ICA. Results from 12 re-samplings of the last two egg survey SSB estimates (from log normal distribution about the mean with CV of 30%). Dark line denotes the deterministic SSB estimates.

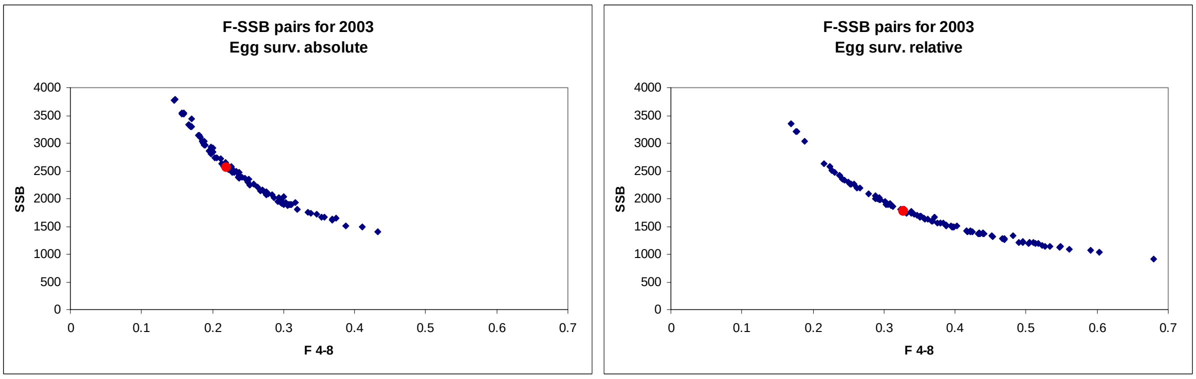


Figure 2.8.4.4 Northeast Atlantic Mackerel. SSB and Fishing mortality pairs in 2003 from bootstrap runs with AMCI. Parametric bootstrap with log-normal noise (CV = 0.3) in the SSB survey data only, with no noise in the catch numbers at age. Left: Egg survey as absolute. Right: Egg survey as relative

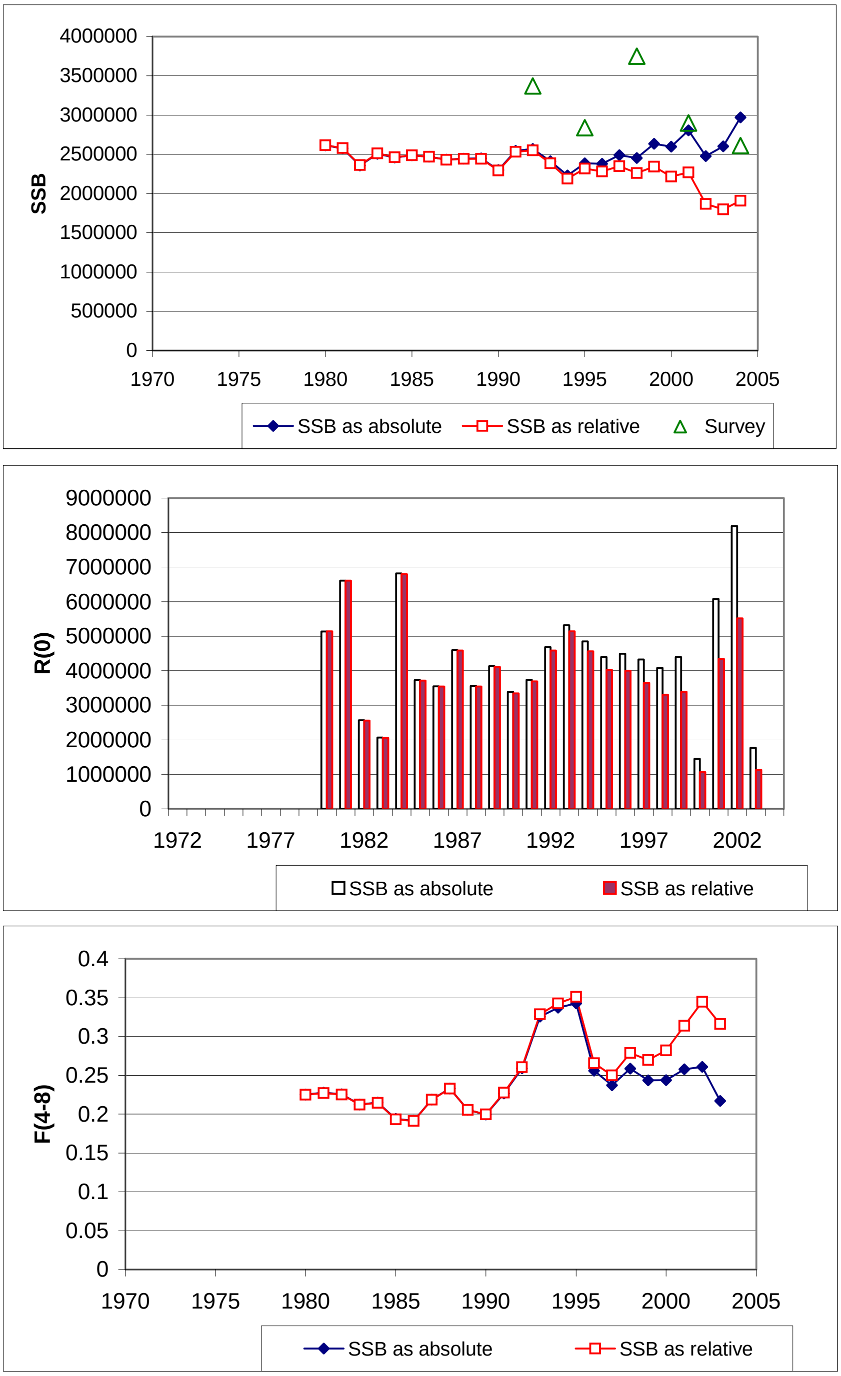


Figure 2.8.4.5 Northeast Atlantic Mackerel. ISVPA (mixed version). Comparison of results when SSB index is treated as absolute or relative (signals from surveys only).

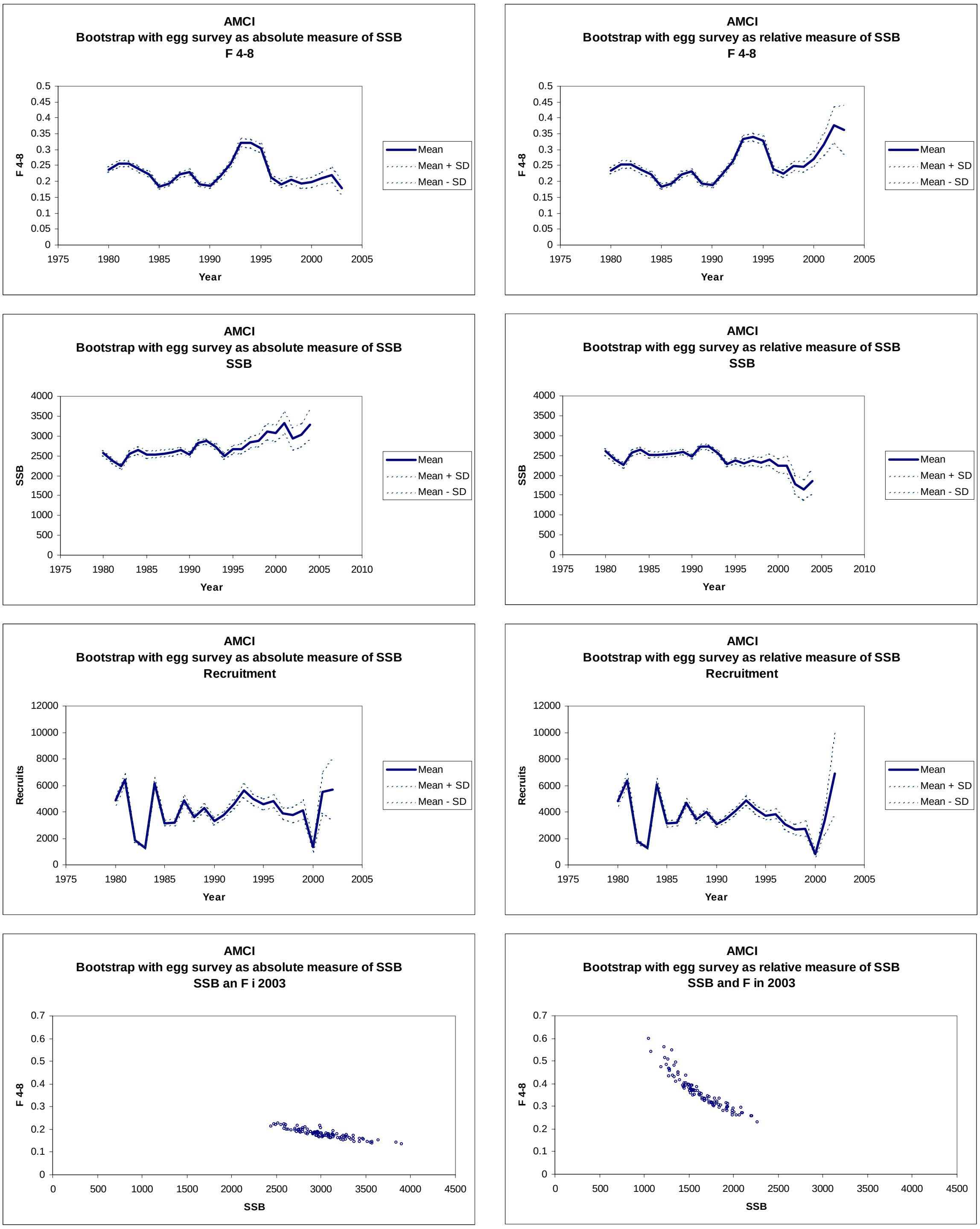
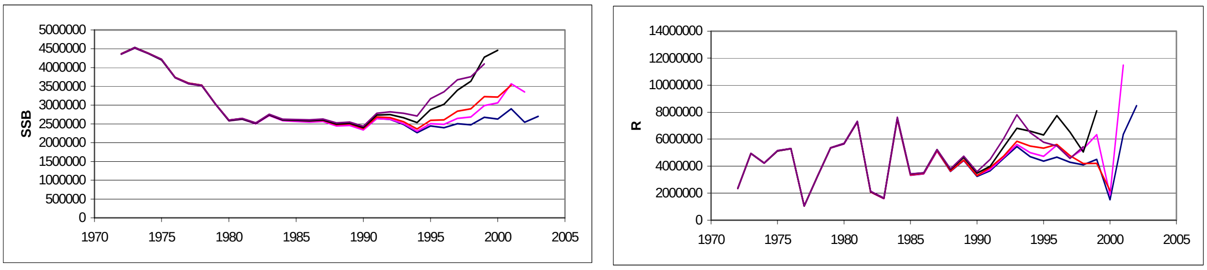
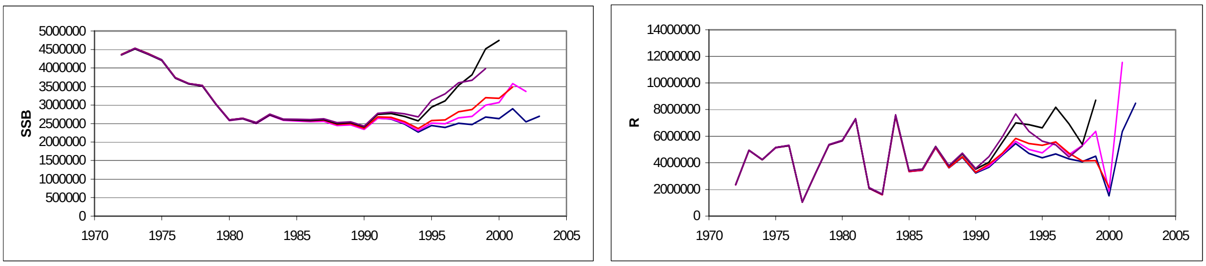


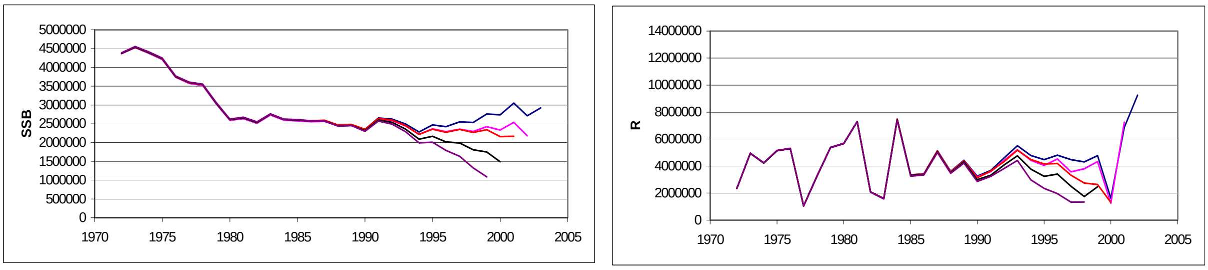
Figure 2.8.4.6 Northeast Atlantic Mackerel.. Results of non-parametric bootstraps with AMCI on catches at age and SSB survey data. Left: Taking the egg survey estimate of SSB as absolute; Right:Taking the egg survey estimate of SSB as relative.



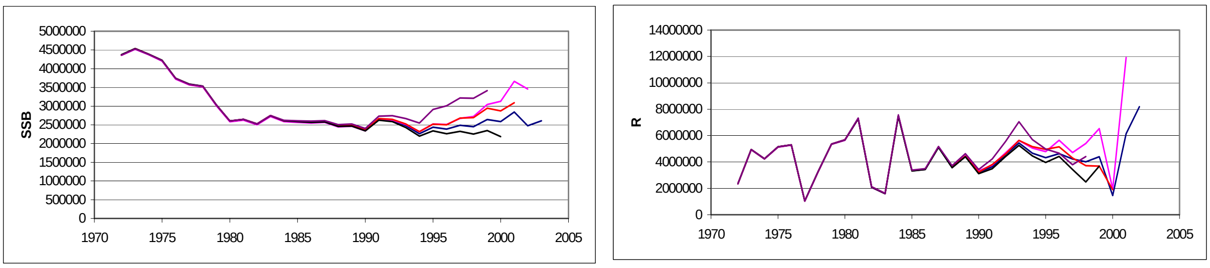
signal from catch-at-age + surveys



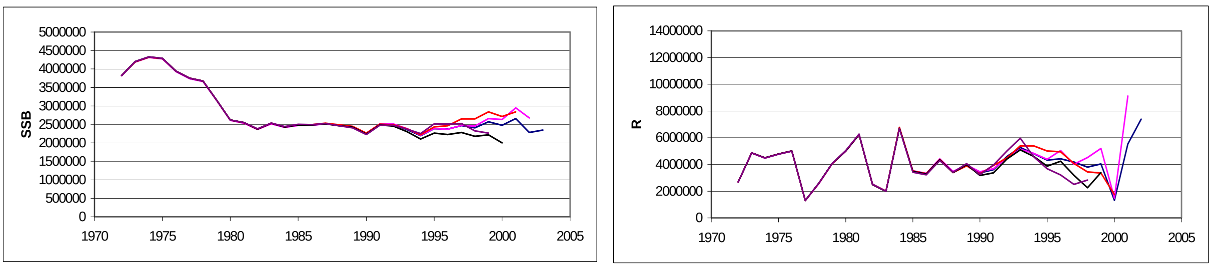
signal from surveys only



signal from catch-at-age only, minimization of SSE



signal from catch-at-age only, minimization of AMD



signal from catch-at-age only, minimization of AMD, "mixed (50%)" version of ISVPA

Figure 2.8.5.1. Northeast Atlantic Mackerel. ISVPA. Analysis of the retrospective stability.

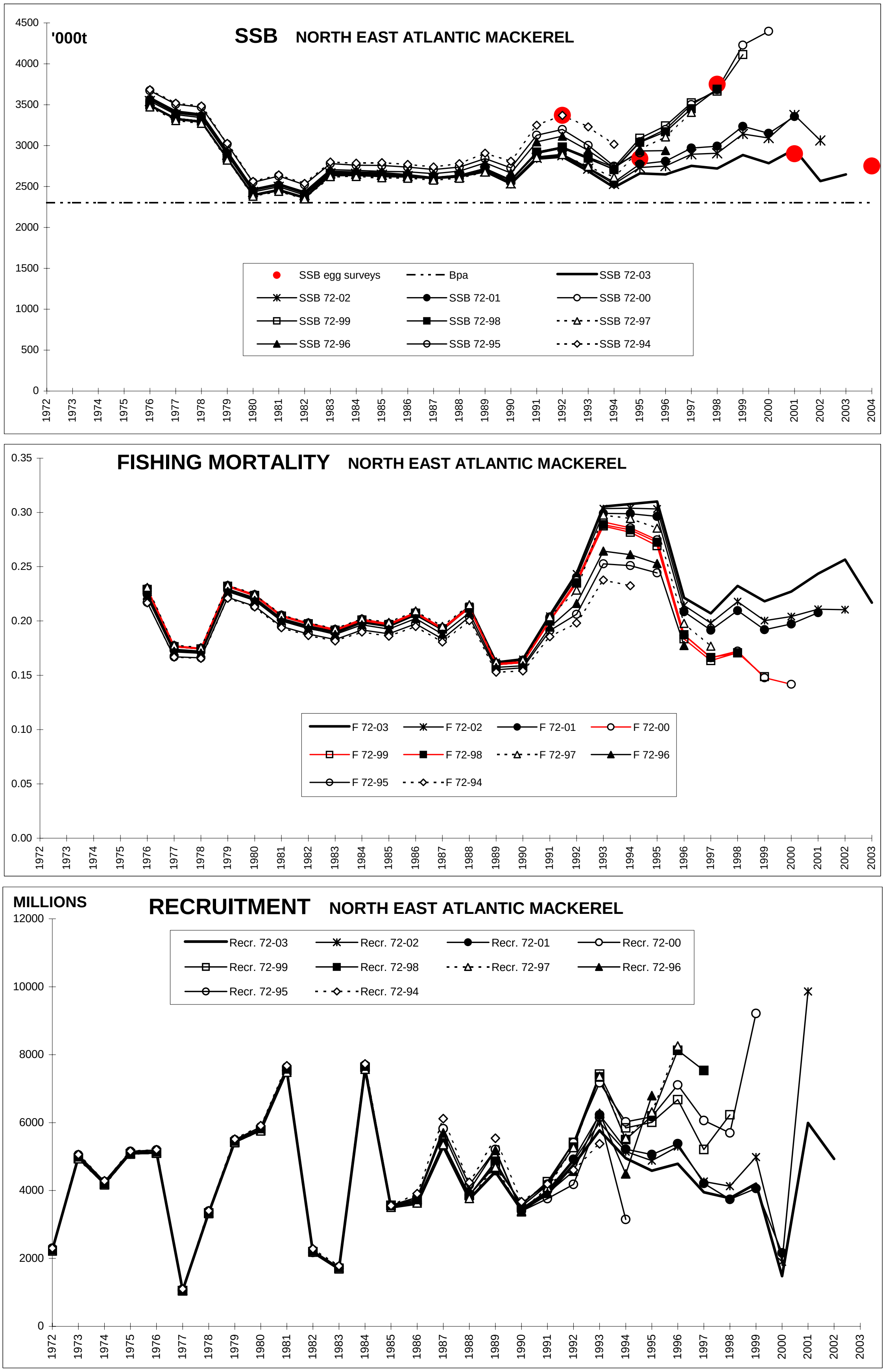
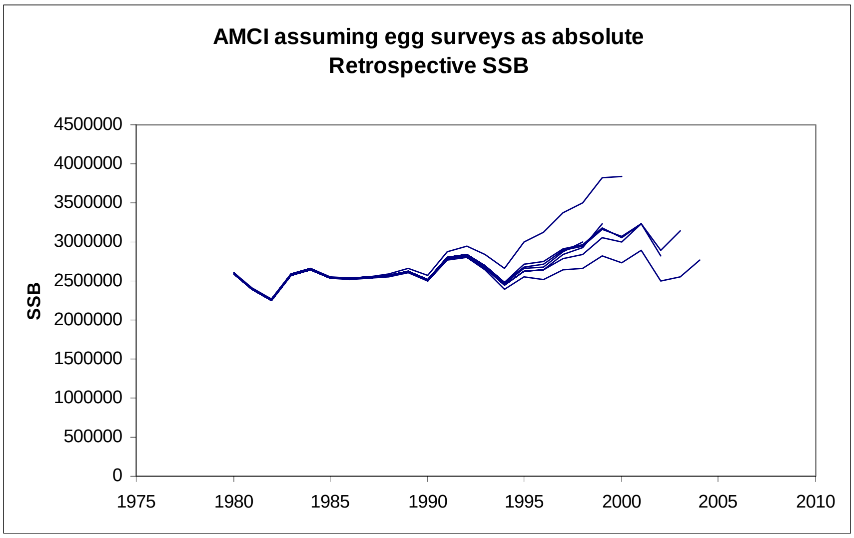
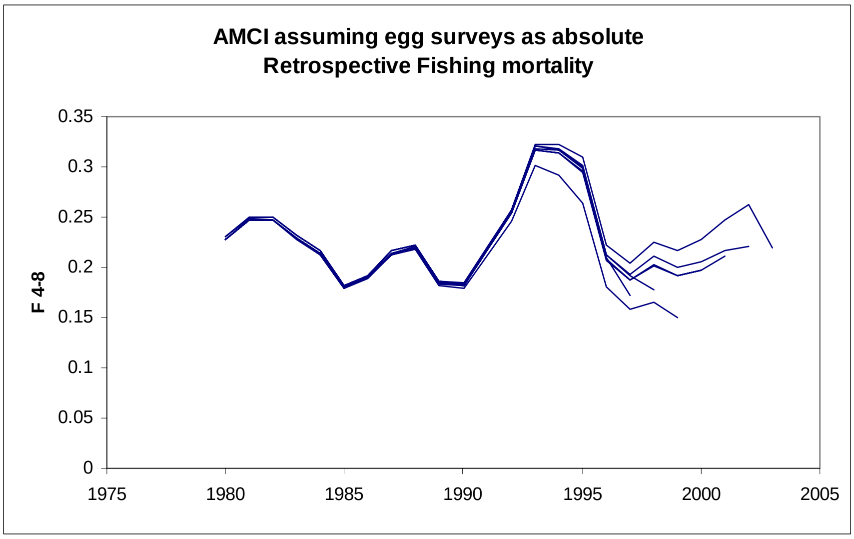


Figure 2.8.5.2. Northeast Atlantic Mackerel. Retrospective analysis by ICA. Egg survey SSB's are used as absolute SSB index. Periods of separable constraint used were from 1992 up to final assessment year.





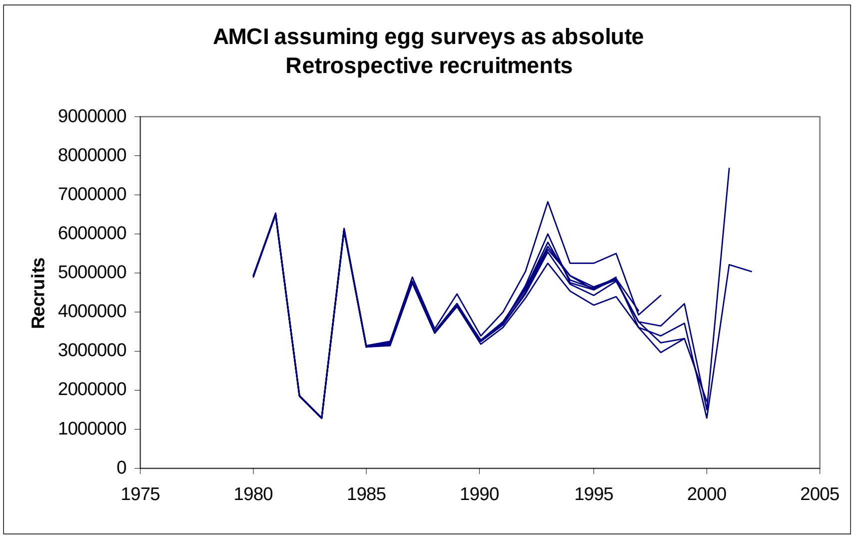


Figure 2.8.5.3. NE Atlantic mackerel. Retrospective patterns with AMCI, taking egg surveys as absolute.

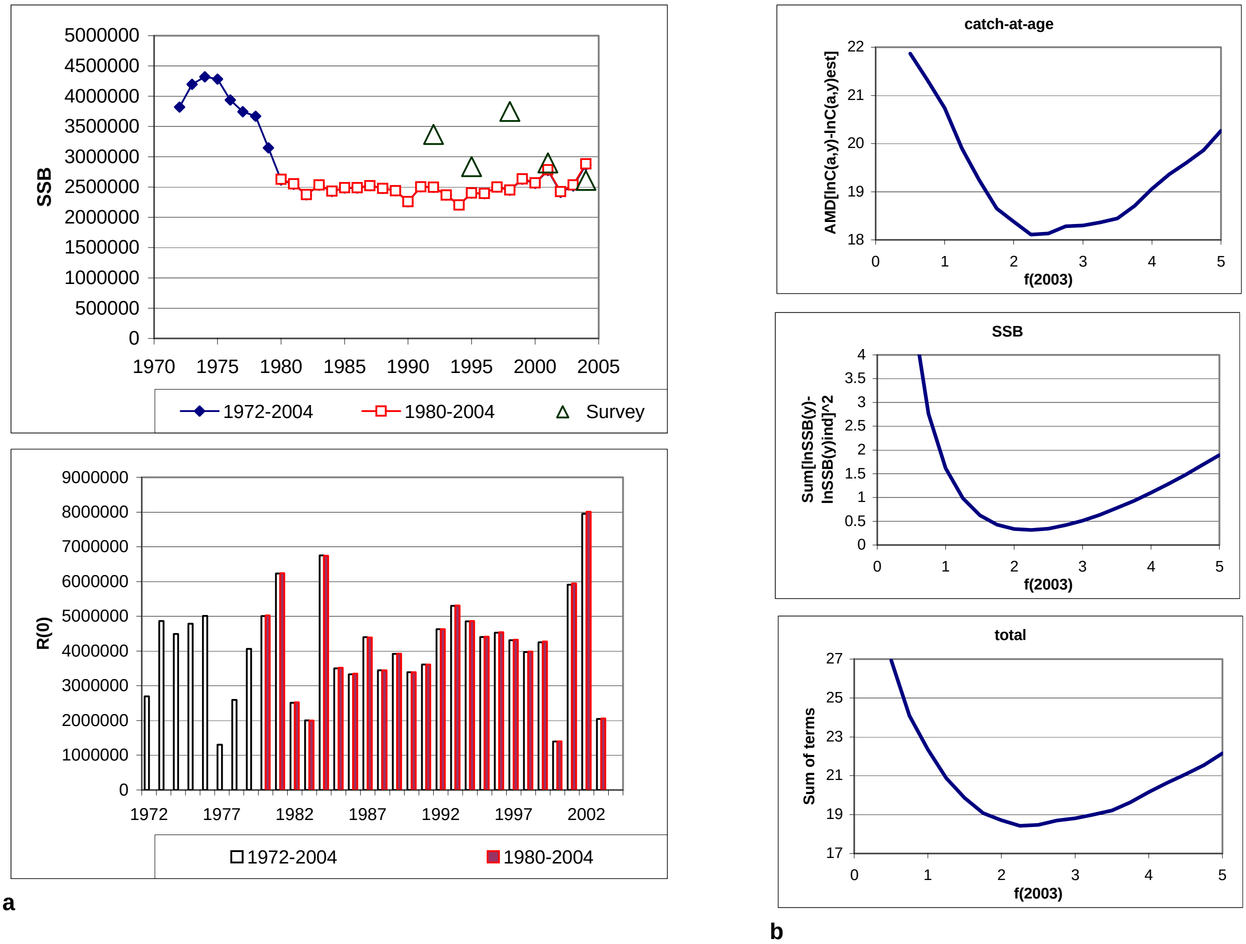


Figure 2.8.7.1. Northeast Atlantic Mackerel. ISVPA. . Comparison of estimates obtained for 1972-2004 and 1980-2004 (**a**) and components of the model loss function for 1980-2004 (**b**) (mixed (50%) version of the model with minimization of AMD for residuals in logarithmic catch-at-age, and SSE - for logarithmic SSB)

2.9 State of the stock

2.9.1 Stock Assessment

Tables 2.9.1.2-7 show the input data to the assessment. The possible inputs for ICA have extensively been discussed in section 2.8. 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:

The period of separable constraint was increased from 11 to 12 years to include the SSB index time series over the period 1992-2004.

In addition to the traditional down weighting of age group 0 to 0.01 the age group 1 has been down weighted to 0.1 (see section 2.8.3.1).

The Working Group decided to use a weighting of 5 for the SSB index and used the index series as an absolute index of abundance after consideration of section 2.8.

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:

$$\sum_{a=0}^{a=11}\sum_{y=1992}^{y=2003}\lambda_a(\ln(C_{a,y}) - \ln(F_y.S_a.\overline{N}_{a,y}))^2 +$$

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

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 1992–2002, 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. The selection at age (F relative to F(4-8) as estimated by ICA is shown in Figure 2.9.1.6.

Figure 2.9.1.7 shows the catches from 1972 to 2003, the F(4-8) from 1977 to 2003, the recruitment from 1972-2002, the GM recruitment for 2003 and the SSB from 1980 to 2003 together with the egg survey SSB's from 1992 to 2004. In section 2.8 is explained why different year ranges have been used.

2.9.2 Reliability of the Assessment and Uncertainty estimation

Section 2.8 on the data exploration provides extensive information on the reliability of the assessment.

It is recognised that poor sampling of some parts of the fishery, may lead to unknown errors in the catch at age data. In 2003 the proportion of the total catch sampled was 80% of the total catch, which is lower than in 2002 (87%). Total number of samples taken in 2003: 1,212; total number of fish aged: 19,779; total number of fish measured: 148,501. On average the overall sampling level has been just below the level according EU Regulation 1639/2001. It should be noted that Divisions IVbc, VIIbch and VIIIab have relatively been undersampled. (see Section 1.3).

The variances estimated by ICA express how well the parameters, including the present population numbers, can be estimated with the present data and model assumptions. The CV's of the stock number estimates for age 2-11 are in the range of 7% to 13% in the 2003 assessment compared to the range of 8-14% in the 2002 assessment. The 2002 and 2003 year classes, for which there is little information in the data, have higher CV's. In the 2001 WG meeting this CV range was again 7% to 13%.

Figure 2.10.3 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 (see section 2.10).

The SSB, F(4-8) and recruitment estimates as obtained by previous Working Groups (1995-2003), 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 differed from the last two 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 median stock trajectory.

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 variability 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 20%. A problem appears to lie mainly in the three year interval between survey estimates becoming available. The model attempts to fit to the last survey estimate, which has the greatest influence. Large corrections in the modelled SSB then have to be made when a new estimate becomes available that differs to any substantial degree from the previous one. Now the new SSB estimate of 2004 lies in the same trajectory as the SSB estimate of 2001. It could be suggested that the model is actually attempting to fit to the noise in the survey data rather than the signal. Examination of the full egg survey time series in the western area suggests that the stock is relatively stable. (Figure 2.9.1.7 shows that the SSB of the NEA mackerel remained rather constant from 1980 onwards).

In summary the fundamental problem is the sparcity 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

The management regime needs to take into account the problems in providing an accurate assessment of the state of the stock. This implies a moderate fishing mortality allowing a buffer stock, which is sufficiently large to sustain year-to-year variations in recruitment and extraction. In a strategy like this, the long term yield would be nearly independent of the fishing mortality over a wide range of fishing mortalities. So such moderate fishing mortalities can be applied without any significant loss in long term yield (see Figure 2.9.3.2 and Table 2.9.3.2). The current management regime is appropriate to this approach and should be continued. However, managers should understand that fluctuations in SSB estimates are likely and that any management regime should be robust to such fluctuations on at least a three-year cycle. As such it is suggested that a multi-annual management regime could be advised for NEA mackerel.

Table 2.9.1.1 Input parameters of the final ICA assessments of NEA-Mackerel for the years 1999-2004.

Assessment year	**2004**	**2003**	**2002**	**2001**	**2000**	**1999**
First data year	1972	1972	1972	1984	1984	1984
Final data year	2003	2002	2001	2000	1999	1998
No of years for separable constraint ?	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(1992-2003)	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
Age range in canum, weca, west, matprop	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
Proportion of F and M before spawning	0.40	0.40	0.40	0.40	0.40	0.40
Reference age for separable constraint	5	5	5	5	5	5
First age for calculation of reference F	4	4	4	4	4	4
Last age for calculation of reference F	8	8	8	8	8	8
Shrink the final populations	No	No	No	No	No	No

Tuning indices

SSB from egg surveys — Years	1992 + 1995 + 1998 + 2001 + 2004	1992 + 1995 + 1998 + 2001	1992 + 1995 + 1998 + 2001	1992 + 1995 + 1998	1992 + 1995 + 1998	1992 + 1995 + 1998
Abundance index	absolute 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	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
Stock recruitment relationship fitted?	No	No	No	No	No	No
Parameters to be estimated	45	43	41	40	38	36
Number of observations	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 WG2004

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		814.52	424.46	164.67	314.26	67.76	282.16	250.75
6			673.32	251.42	133.82	186.62	78.88	248.10
7				991.63	379.79	105.00	172.21	92.66
8					478.93	229.80	73.93	169.60
9						236.97	127.97	73.90
10							243.33	102.36
11								204.29
12								

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)

Catch in Number

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

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		0.44800	0.39200	0.34800	0.34600	0.35200	0.34500	0.34800
6			0.48100	0.43000	0.40600	0.40700	0.40300	0.40100
7				0.48800	0.44300	0.44600	0.42100	0.41600
8					0.51800	0.54600	0.51800	0.50600
9						0.53700	0.53600	0.51300
10							0.52900	0.53700
11								0.52200
12								

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

Table 2.9.1.3 (Cont'd)

Weights at age in the catches (Kg)

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

Weights at age in the catches (Kg)

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 2.9.1.4 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		0.43800	0.32200	0.31800	0.31800	0.31300	0.34600	0.34500
6			0.46900	0.36500	0.36500	0.36100	0.38200	0.38000
7				0.49700	0.41900	0.41600	0.41000	0.40800
8					0.51200	0.44600	0.43200	0.43000
9						0.53000	0.45100	0.44900
10							0.51400	0.50400
11								0.51600
12								

Table 2.9.1.4 (Cont'd)

Weights at age in the stock (Kg)

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

Weights at age in the stock (Kg)

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 2.9.1.5 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

Natural Mortality (per year)

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

Natural Mortality (per year)

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

Table 2.9.1.5 (Cont'd)

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 2.9.1.6 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

Table 2.9.1.6 (Cont'd)

Proportion of fish spawning

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

Proportion of fish spawning

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 2.9.1.7 North East Atlantic Mackerel. Biomass estimates from egg surveys

INDICES OF SPAWNING BIOMASS

INDEX1

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

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

x 10 ^ 3

Table 2.9.1.7 (Cont'd)

INDEX1

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

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

	2004
1	2610.0

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	0.00513	0.00368	0.00748	0.00765	0.01321	0.00617	0.01121	0.02295
1	0.00660	0.02613	0.02759	0.01891	0.07230	0.04426	0.04166	0.14644
2	0.02507	0.01654	0.03203	0.02817	0.09193	0.10671	0.18387	0.09435
3	0.04930	0.06425	0.04121	0.06974	0.14419	0.10720	0.19679	0.29381
4	0.08746	0.13373	0.11092	0.08704	0.19273	0.12073	0.17661	0.24424
5	0.00000	0.14246	0.18622	0.16369	0.13372	0.09956	0.19600	0.22491
6	0.00000	0.16413	0.15901	0.15190	0.18377	0.10397	0.15255	0.24981
7	0.00000	0.18253	0.23861	0.34845	0.33860	0.20319	0.12493	0.25442
8	0.00000	0.18502	0.24187	0.21260	0.26678	0.33312	0.20371	0.16509
9	0.00000	0.19853	0.25952	0.22812	0.18635	0.19349	0.29558	0.30391
10	0.00000	0.17629	0.23045	0.20257	0.16548	0.12320	0.29354	0.38454
11	0.00000	0.17095	0.22347	0.19643	0.16046	0.11947	0.23520	0.40395
12	0.00000	0.17095	0.22347	0.19643	0.16046	0.11947	0.23520	0.40395

Fishing Mortality (per year)

AGE	1980	1981	1982	1983	1984	1985	1986	1987
0	0.00618	0.00814	0.00554	0.00469	0.04166	0.02548	0.01500	0.00151
1	0.10176	0.06199	0.03649	0.02806	0.02402	0.04737	0.02153	0.01420
2	0.22247	0.16474	0.12369	0.14483	0.06120	0.01867	0.09312	0.07056
3	0.12546	0.18731	0.21760	0.16630	0.20408	0.05099	0.04105	0.19472
4	0.24055	0.08229	0.21136	0.25236	0.20793	0.18835	0.08307	0.07458
5	0.23812	0.19610	0.08404	0.20759	0.25452	0.19211	0.21915	0.12438
6	0.18292	0.23958	0.20971	0.08058	0.23278	0.25005	0.22673	0.21223
7	0.21479	0.21031	0.22829	0.19345	0.11282	0.21530	0.29026	0.24081
8	0.22199	0.27472	0.23517	0.21177	0.18638	0.13111	0.21138	0.30953
9	0.17528	0.24471	0.30045	0.18307	0.20132	0.20225	0.11948	0.25284
10	0.25236	0.28566	0.24270	0.25638	0.19812	0.22722	0.19789	0.24062
11	0.35566	0.30673	0.27590	0.25963	0.23269	0.20227	0.19980	0.22264
12	0.35566	0.30673	0.27590	0.25963	0.23269	0.20227	0.19980	0.22264

Table 2.9.1.8 (Cont'd)

Fishing Mortality (per year)

AGE	1988	1989	1990	1991	1992	1993	1994	1995
0	0.01672	0.01562	0.00766	0.00277	0.00895	0.01121	0.01128	0.01137
1	0.03680	0.02208	0.04008	0.02176	0.03241	0.04060	0.04089	0.04120
2	0.05863	0.09338	0.08842	0.07453	0.06614	0.08284	0.08342	0.08407
3	0.10889	0.11181	0.16161	0.11163	0.12669	0.15870	0.15981	0.16105
4	0.22643	0.12514	0.14814	0.20600	0.19215	0.24069	0.24237	0.24426
5	0.12291	0.22161	0.15642	0.18397	0.21711	0.27195	0.27385	0.27598
6	0.16357	0.10702	0.22563	0.17678	0.25013	0.31332	0.31551	0.31796
7	0.25575	0.14785	0.12178	0.26006	0.27818	0.34845	0.35089	0.35362
8	0.29726	0.20764	0.17229	0.19899	0.28198	0.35321	0.35568	0.35845
9	0.32080	0.25382	0.23051	0.21163	0.30256	0.37899	0.38164	0.38461
10	0.22191	0.29220	0.17757	0.28705	0.26867	0.33654	0.33890	0.34154
11	0.23811	0.21545	0.22703	0.22703	0.26053	0.32634	0.32862	0.33118
12	0.23811	0.21545	0.22703	0.22703	0.26053	0.32634	0.32862	0.33118

Fishing Mortality (per year)

AGE	1996	1997	1998	1999	2000	2001	2002	2003
0	0.00812	0.00760	0.00852	0.00800	0.00833	0.00893	0.00941	0.00796
1	0.02942	0.02753	0.03088	0.02900	0.03018	0.03237	0.03410	0.02883
2	0.06004	0.05617	0.06300	0.05916	0.06159	0.06605	0.06957	0.05883
3	0.11501	0.10759	0.12068	0.11333	0.11797	0.12653	0.13328	0.11269
4	0.17443	0.16318	0.18303	0.17188	0.17892	0.19191	0.20213	0.17090
5	0.19708	0.18438	0.20680	0.19421	0.20216	0.21683	0.22839	0.19310
6	0.22706	0.21242	0.23826	0.22375	0.23291	0.24982	0.26313	0.22248
7	0.25252	0.23624	0.26498	0.24884	0.25903	0.27783	0.29263	0.24742
8	0.25597	0.23947	0.26859	0.25224	0.26257	0.28162	0.29663	0.25080
9	0.27465	0.25695	0.28820	0.27065	0.28173	0.30218	0.31828	0.26911
10	0.24389	0.22817	0.25592	0.24034	0.25018	0.26833	0.28264	0.23897
11	0.23650	0.22125	0.24816	0.23305	0.24259	0.26020	0.27407	0.23172
12	0.23650	0.22125	0.24816	0.23305	0.24259	0.26020	0.27407	0.23172

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	2255.0	4986.5	4231.3	5107.5	5128.4	1064.2	3344.1	5435.3
1	5722.4	1931.0	4276.1	3614.8	4362.5	4356.1	910.3	2846.2
2	2245.6	4892.9	1619.2	3580.4	3053.0	3493.0	3587.0	751.5
3	4350.6	1885.0	4142.3	1349.7	2996.0	2396.9	2702.1	2568.8
4	8361.8	3564.5	1521.4	3421.4	1083.4	2232.5	1853.4	1910.3
5	0.0	6594.4	2683.9	1172.0	2699.3	769.1	1703.0	1337.0
6	0.0	0.0	4922.2	1917.6	856.5	2032.5	599.2	1204.9
7	0.0	0.0	0.0	3613.7	1417.9	613.4	1576.7	442.8
8	0.0	0.0	0.0	0.0	2195.2	869.8	430.9	1197.7
9	0.0	0.0	0.0	0.0	0.0	1447.0	536.6	302.5
10	0.0	0.0	0.0	0.0	0.0	0.0	1026.4	343.6
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	658.7
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

x 10 ^ 6

Table 2.9.1.9 (Cont'd)

Population Abundance (1 January)

AGE	1980	1981	1982	1983	1984	1985	1986	1987
0	5780.7	7527.1	2177.7	1689.1	7578.7	3500.8	3614.9	5292.3
1	4572.1	4944.8	6426.1	1864.0	1447.1	6256.9	2937.3	3065.1
2	2116.0	3554.5	4000.2	5332.8	1560.0	1215.9	5136.2	2474.3
3	588.6	1458.0	2594.7	3042.4	3971.1	1263.0	1027.2	4027.7
4	1648.1	446.9	1040.6	1796.6	2217.4	2787.0	1033.0	848.6
5	1287.9	1115.3	354.3	725.0	1201.4	1550.3	1987.0	818.3
6	919.0	873.6	789.0	280.3	507.0	801.7	1101.1	1373.6
7	807.8	658.7	591.7	550.6	222.6	345.8	537.4	755.5
8	295.5	560.9	459.4	405.4	390.6	171.2	240.0	346.0
9	874.0	203.7	366.8	312.6	282.3	279.0	129.2	167.2
10	192.1	631.3	137.3	233.8	224.0	198.7	196.2	98.7
11	201.4	128.5	408.3	92.7	155.7	158.2	136.2	138.5
12	375.9	810.7	694.9	619.8	357.8	572.8	481.3	339.7

x 10 ^ 6

Population Abundance (1 January)

AGE	1988	1989	1990	1991	1992	1993	1994	1995
0	3743.0	4543.4	3422.7	3889.1	4753.7	5770.6	4952.3	4582.3
1	4548.2	3168.2	3850.0	2923.5	3338.1	4055.1	4911.5	4214.6
2	2601.0	3773.3	2667.4	3183.5	2462.1	2781.5	3351.4	4058.0
3	1984.6	2111.2	2958.2	2101.6	2543.3	1983.5	2203.7	2653.7
4	2853.3	1531.9	1624.9	2166.2	1617.8	1928.5	1456.7	1616.6
5	677.9	1958.3	1163.4	1206.0	1517.3	1149.0	1304.8	983.9
6	621.9	516.0	1350.5	856.4	863.6	1051.1	753.5	854.0
7	956.2	454.5	399.0	927.6	617.7	578.8	661.4	473.0
8	511.1	637.3	337.4	304.1	615.5	402.5	351.6	400.8
9	218.5	326.8	445.7	244.5	214.5	399.6	243.4	212.0
10	111.8	136.5	218.2	304.6	170.3	136.4	235.5	143.0
11	66.8	77.0	87.7	157.3	196.8	112.0	83.9	144.4
12	291.3	198.4	147.5	280.1	319.2	262.8	220.4	151.2

x 10 ^ 6

Population Abundance (1 January)

AGE	1996	1997	1998	1999	2000	2001	2002	2003
0	4784.8	3947.2	3775.5	4201.6	1474.8	5989.3	4932.0	(1745.8)
1	3899.4	4085.0	3371.7	3222.1	3587.6	1258.9	5109.2	4205.2
2	3481.1	3259.0	3420.5	2813.8	2694.0	2996.0	1049.0	4250.1
3	3211.1	2821.7	2651.8	2764.3	2282.7	2180.3	2413.9	842.2
4	1944.3	2463.5	2180.9	2023.0	2124.4	1746.1	1653.5	1818.4
5	1089.9	1405.6	1801.1	1563.1	1466.2	1528.9	1240.5	1162.7
6	642.6	770.3	1006.1	1260.6	1107.9	1031.0	1059.4	849.7
7	534.9	440.8	536.1	682.4	867.5	755.5	691.2	700.9
8	285.9	357.6	299.6	354.0	457.9	576.3	492.5	444.0
9	241.0	190.5	242.3	197.1	236.8	303.1	374.3	315.1
10	124.2	157.6	126.8	156.3	129.4	153.8	192.9	234.3
11	87.5	83.8	108.0	84.5	105.8	86.7	101.2	125.1
12	156.2	135.1	112.0	159.7	152.9	178.2	167.9	149.4

x 10 ^ 6

Table 2.9.1.9 (Cont'd)

Population Abundance (1 January)

AGE	2004
0	(3867.1)
1	(1490.8)
2	3516.6
3	3449.1
4	647.6
5	1319.2
6	825.0
7	585.5
8	471.0
9	297.4
10	207.2
11	158.8
12	187.4

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	0.2171	6	0.1914	0.2463	0.2036	0.2315	0.2176
2	1993	0.2719	6	0.2403	0.3078	0.2553	0.2897	0.2725
3	1994	0.2739	6	0.2421	0.3098	0.2572	0.2916	0.2744
4	1995	0.2760	6	0.2437	0.3125	0.2590	0.2940	0.2765
5	1996	0.1971	6	0.1736	0.2238	0.1847	0.2103	0.1975
6	1997	0.1844	6	0.1625	0.2092	0.1729	0.1966	0.1848
7	1998	0.2068	6	0.1823	0.2346	0.1939	0.2206	0.2072
8	1999	0.1942	6	0.1709	0.2207	0.1819	0.2073	0.1946
9	2000	0.2022	6	0.1776	0.2302	0.1892	0.2160	0.2026
10	2001	0.2168	6	0.1895	0.2481	0.2024	0.2323	0.2173
11	2002	0.2284	7	0.1973	0.2644	0.2119	0.2461	0.2290
12	2003	0.1931	7	0.1660	0.2246	0.1788	0.2086	0.1937
Separable Model: Selection (S) by age								
13	0	0.0412	43	0.0176	0.0967	0.0267	0.0637	0.0453
14	1	0.1493	14	0.1133	0.1968	0.1297	0.1719	0.1508
15	2	0.3046	6	0.2688	0.3452	0.2858	0.3247	0.3053
16	3	0.5836	6	0.5172	0.6584	0.5487	0.6206	0.5847
17	4	0.8850	5	0.7882	0.9938	0.8342	0.9390	0.8866
	5	1.0000	Fixed : Reference Age					
18	6	1.1521	5	1.0328	1.2852	1.0896	1.2182	1.1539
19	7	1.2813	5	1.1535	1.4233	1.2144	1.3519	1.2831
20	8	1.2988	5	1.1739	1.4370	1.2335	1.3676	1.3005
21	9	1.3936	5	1.2628	1.5380	1.3252	1.4655	1.3954
22	10	1.2375	5	1.1172	1.3708	1.1746	1.3038	1.2392
	11	1.2000	Fixed : Last true age					
Separable model: Populations in year 2003								
23	0	1745841	149	92327	33012662	389618	7822939	5376148
24	1	4205241	38	1967537	8987911	2854243	6195707	4533161
25	2	4250086	13	3273496	5518023	3720041	4855653	4287959
26	3	842196	11	669724	1059084	749271	946645	847971
27	4	1818401	9	1510134	2189596	1653977	1999172	1826586
28	5	1162733	8	983173	1375086	1067362	1266626	1166999
29	6	849676	8	725893	994567	784089	920749	852422
30	7	700879	7	601745	816344	648413	757589	703003
31	8	443996	7	381080	517300	410696	479996	445347
32	9	315094	7	269796	367996	291105	341059	316083
33	10	234319	8	199483	275239	215845	254374	235110
34	11	125131	8	105813	147975	114870	136307	125589

Table 2.9.1.10 (Cont'd)

Separable model: Populations at age

35	1992	196770	15	145613	265899	168750	229441	199105
36	1993	112031	11	89154	140778	99707	125877	112794
37	1994	83861	10	68613	102499	75700	92903	84302
38	1995	144408	9	120063	173689	131426	158672	145050
39	1996	87476	9	73222	104505	79887	95786	87837
40	1997	83789	8	70916	98998	76953	91231	84093
41	1998	107998	8	91912	126900	99467	117261	108365
42	1999	84497	8	72209	98877	77987	91552	84769
43	2000	105792	7	90861	123176	97890	114331	106111
44	2001	86734	7	74548	100912	80286	93699	86993
45	2002	101194	8	86483	118408	93400	109639	101520

SSB Index catchabilities

INDEX1

Absolute estimator. No fitted catchability.

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1992	1993	1994	1995	1996	1997	1998	1999
0	0.100	-1.127	-0.710	-1.182	0.055	0.261	0.720	0.768
1	-0.168	-0.157	-0.216	-0.662	0.132	0.337	0.042	-0.151
2	0.065	0.023	-0.119	0.114	-0.110	0.120	0.169	-0.130
3	0.235	-0.015	0.014	-0.077	0.027	-0.116	-0.058	-0.245
4	0.013	0.036	-0.088	-0.171	-0.037	0.093	-0.049	-0.163
5	0.105	-0.043	0.034	-0.168	-0.021	0.114	0.144	0.051
6	-0.132	-0.031	-0.027	-0.092	-0.233	-0.016	0.044	-0.015
7	-0.205	-0.058	0.039	0.080	0.075	-0.023	0.018	0.075
8	-0.018	-0.134	0.078	0.007	-0.075	-0.064	0.101	0.115
9	-0.019	0.032	0.105	0.091	0.103	-0.019	-0.177	0.091
10	-0.021	0.065	-0.091	0.095	0.030	-0.114	-0.090	-0.074
11	-0.026	-0.001	-0.071	0.000	0.067	-0.104	-0.290	-0.018

Separable Model Residuals

Age	2000	2001	2002	2003
0	1.163	-0.642	0.495	0.105
1	0.032	0.074	0.288	0.453
2	-0.104	-0.147	0.024	0.086
3	0.084	-0.092	0.207	-0.017
4	0.080	-0.021	0.158	-0.003
5	0.063	0.036	0.043	0.104
6	0.019	0.010	-0.029	0.056
7	-0.151	0.052	-0.136	-0.163
8	-0.019	-0.171	-0.058	-0.074
9	-0.136	-0.105	-0.234	-0.011
10	0.058	0.135	-0.081	-0.108
11	-0.220	0.026	-0.114	-0.041

Table 2.9.1.10 (Cont'd)

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	*******	*******	*******	*******	0.1630	*******	*******	0.0660

	1996	1997	1998	1999	2000	2001	2002	2003
1	*******	*******	0.3216	*******	*******	-0.0187	*******	*******

	2004
1	-0.0825

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1992 to 2003	
Variance	0.0146
Skewness test stat.	-3.3803
Kurtosis test statistic	-0.1781
Partial chi-square	0.1253
Significance in fit	0.0000
Degrees of freedom	99

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR INDEX1

Index used as absolute measure of abundance

Variance	0.1415
Skewness test stat.	1.4307
Kurtosis test statistic	-0.0625
Partial chi-square	0.0477
Significance in fit	0.0000
Number of observations	5
Degrees of freedom	5
Weight in the analysis	5.0000

Table 2.9.1.10 (Cont'd)

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	8.7919	149	45	104	0.0845
Catches at age	8.6504	144	45	99	0.0874
SSB Indices					
INDEX1	0.1415	5	0	5	0.0283

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	4.9822	149	45	104	0.0479
Catches at age	1.4449	144	45	99	0.0146
SSB Indices					
INDEX1	3.5373	5	0	5	0.7075

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	2255040	-------	-------	361204	------	------	99
1973	4986450	-------	-------	571011	------	------	100
1974	4231330	-------	-------	607632	------	------	100
1975	5107500	-------	-------	784070	------	------	99
1976	5128350	-------	-------	828239	------	------	99
1977	1064160	-------	-------	620276	0.1816	0.1721	100
1978	3344100	-------	-------	736832	0.2181	0.1708	100
1979	5435320	-------	-------	843227	0.2884	0.2277	100
1980	5780710	3569843	2462383	734951	0.2985	0.2197	100
1981	7527140	3737536	2526474	754438	0.2986	0.2006	100
1982	2177730	3647194	2421549	717267	0.2962	0.1937	100
1983	1689140	3729136	2680889	671588	0.2505	0.1892	99
1984	7578710	3464452	2670444	637606	0.2388	0.1989	99
1985	3500770	3699987	2662229	614371	0.2308	0.1954	100
1986	3614930	3658313	2637226	602200	0.2283	0.2061	99
1987	5292260	3491269	2603090	654991	0.2516	0.1923	99
1988	3743030	3576048	2621639	680492	0.2596	0.2132	100
1989	4543430	3645303	2685362	589509	0.2195	0.1619	100
1990	3422730	3408226	2533517	627511	0.2477	0.1648	100
1991	3889120	3755323	2839864	667886	0.2352	0.2052	98
1992	4753680	3873314	2863010	760351	0.2656	0.2439	99
1993	5770590	3784465	2687832	825036	0.3070	0.3055	100
1994	4952280	3627713	2488419	821395	0.3301	0.3077	100
1995	4582300	3827831	2658632	755776	0.2843	0.3101	99
1996	4784800	3615810	2647167	563612	0.2129	0.2214	100
1997	3947190	3780480	2752211	569613	0.2070	0.2071	99
1998	3775540	3681389	2718817	666682	0.2452	0.2323	100
1999	4201630	3883142	2884656	615512	0.2134	0.2182	100
2000	1474820	3751751	2786105	675479	0.2424	0.2271	100
2001	5989280	3808246	2954820	687173	0.2326	0.2436	99
2002	4931980	3532037	2565201	726935	0.2834	0.2566	99
2003	(1745840)	3692410	2648356	617330	0.2331	0.2169	99

No of years for separable analysis : 12
Age range in the analysis : 0 . . . 12
Year range in the analysis : 1972 . . . 2003
Number of indices of SSB : 1
Number of age-structured indices : 0

Parameters to estimate : 45
Number of observations : 149

Conventional single selection vector model to be fitted.

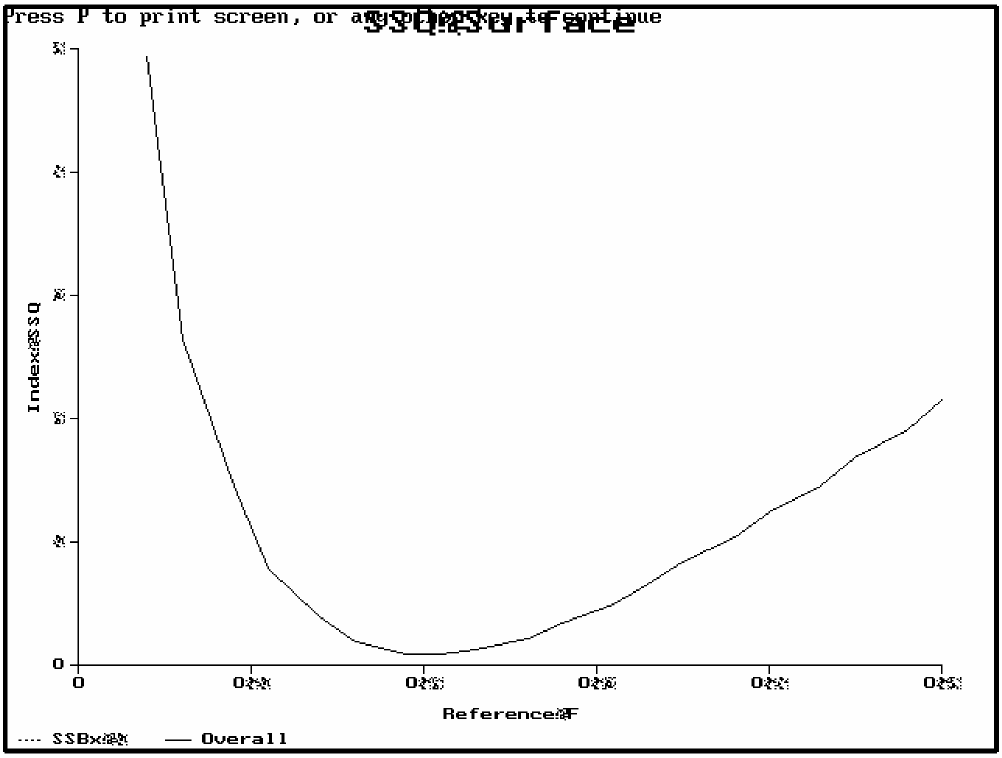


Figure 2.9.1.1 The sum of squares surface for the ICA separable VPA fit to the North East Atlantic mackerel egg survey biomass estimates (period of separable constraint 1992-2003).

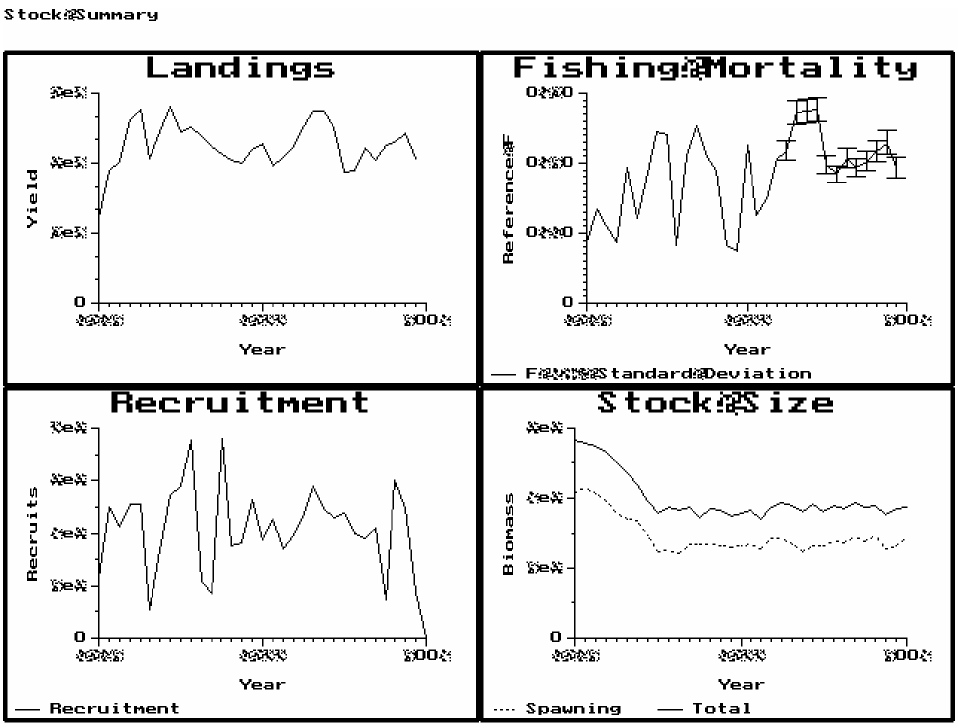


Figure 2.9.1.2 The long term trends in stock parameters for North East Atlantic mackerel.
SSB estimates from egg surveys covering the range 1992-2004 are used in the biomass index.

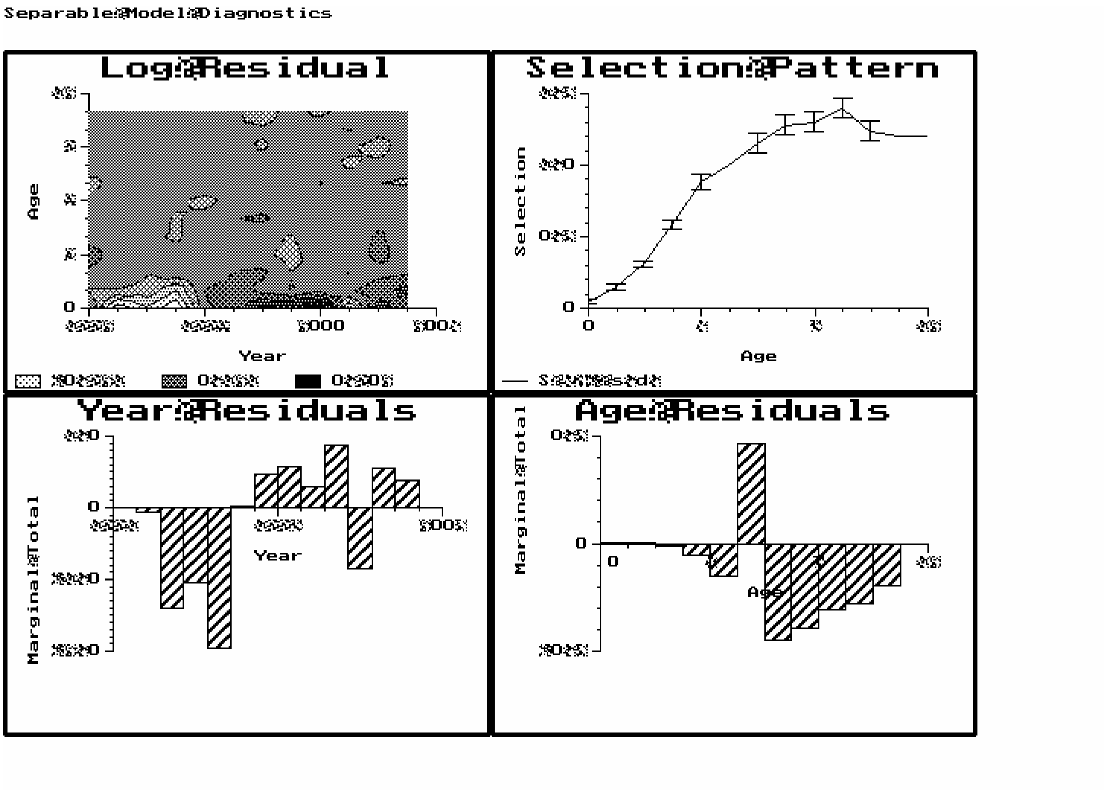


Figure 2.9.1.3 The catch at age residuals and ages fitted by ICA to the North East Atlantic Mackerel data. SSB estimates from egg surveys covering the range 1992-2004 are used in the biomass index and there is only one period of separable constraint (1992-2003).

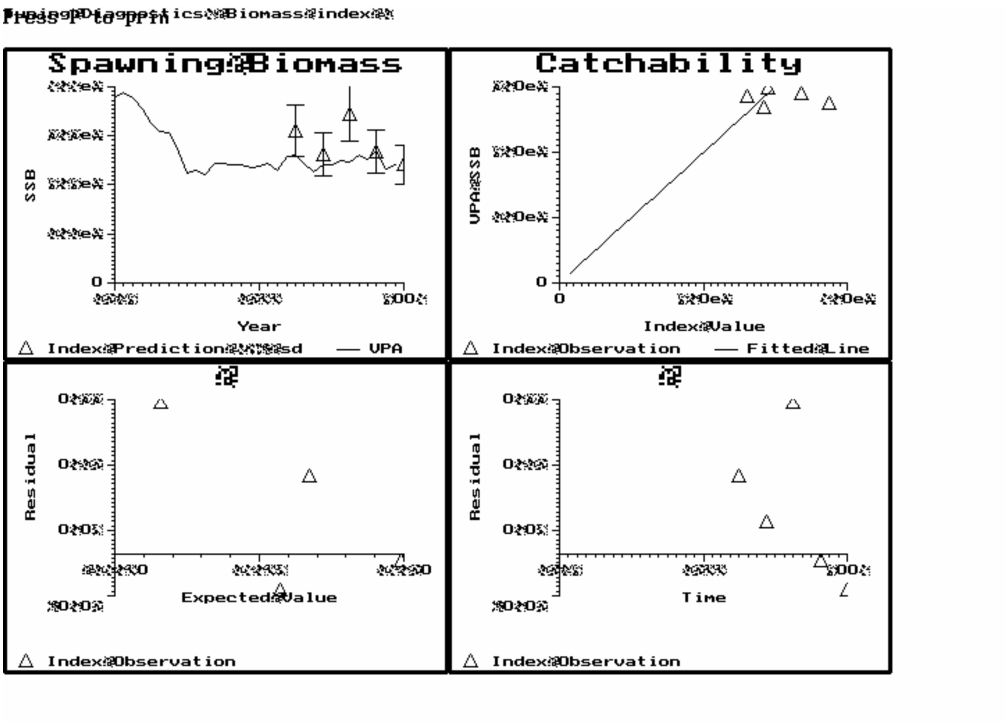


Figure 2.9.1.4 The diagnostics for the egg production index as fitted by ICA to the North East Atlantic Mackerel. SSB estimates from egg surveys covering the range 1992-2004 in the biomass index and there is only one period of separable constraint (1992-2003).

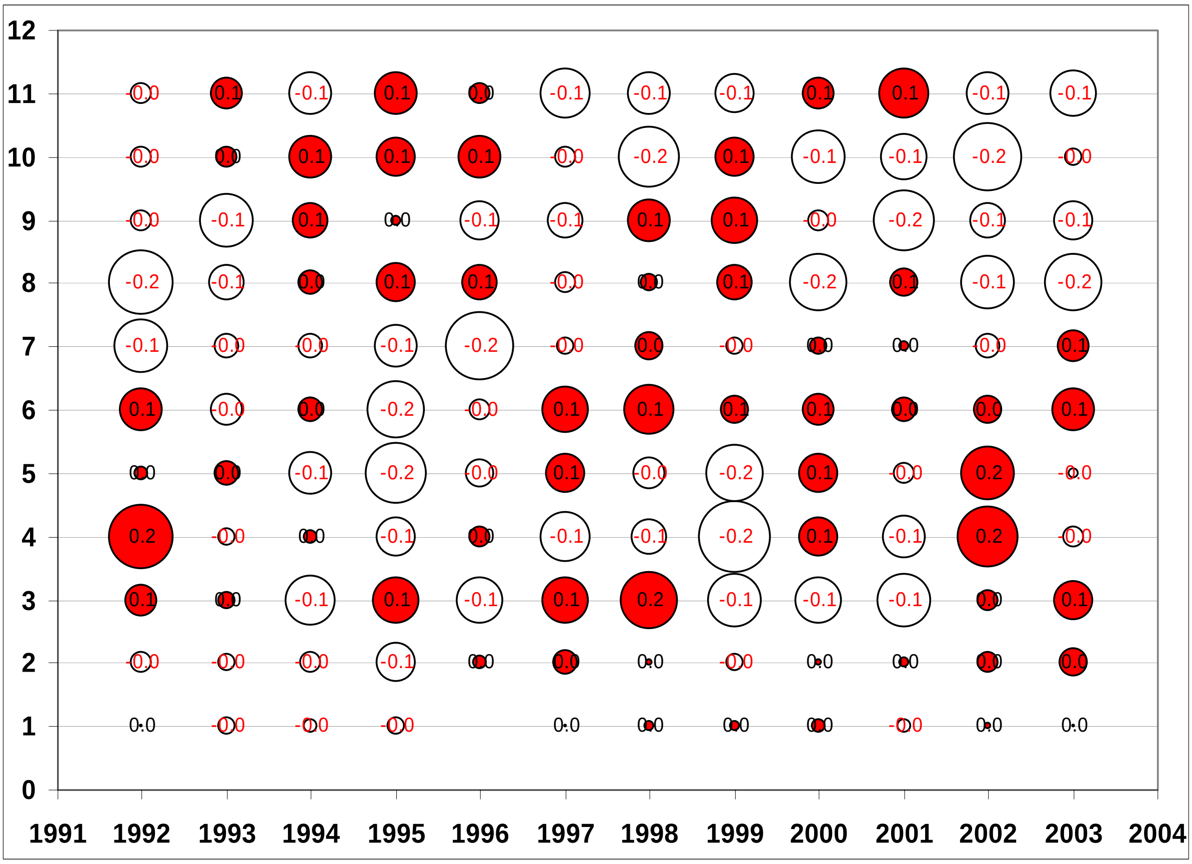


Figure 2.9.1.5 The catch at age residuals and ages fitted by ICA to the North East Atlantic Mackerel data covering the period of separable constraint.

(run 13) Residuals at age 0 and 1 are downweighted resp. 0.01 and 0.1.

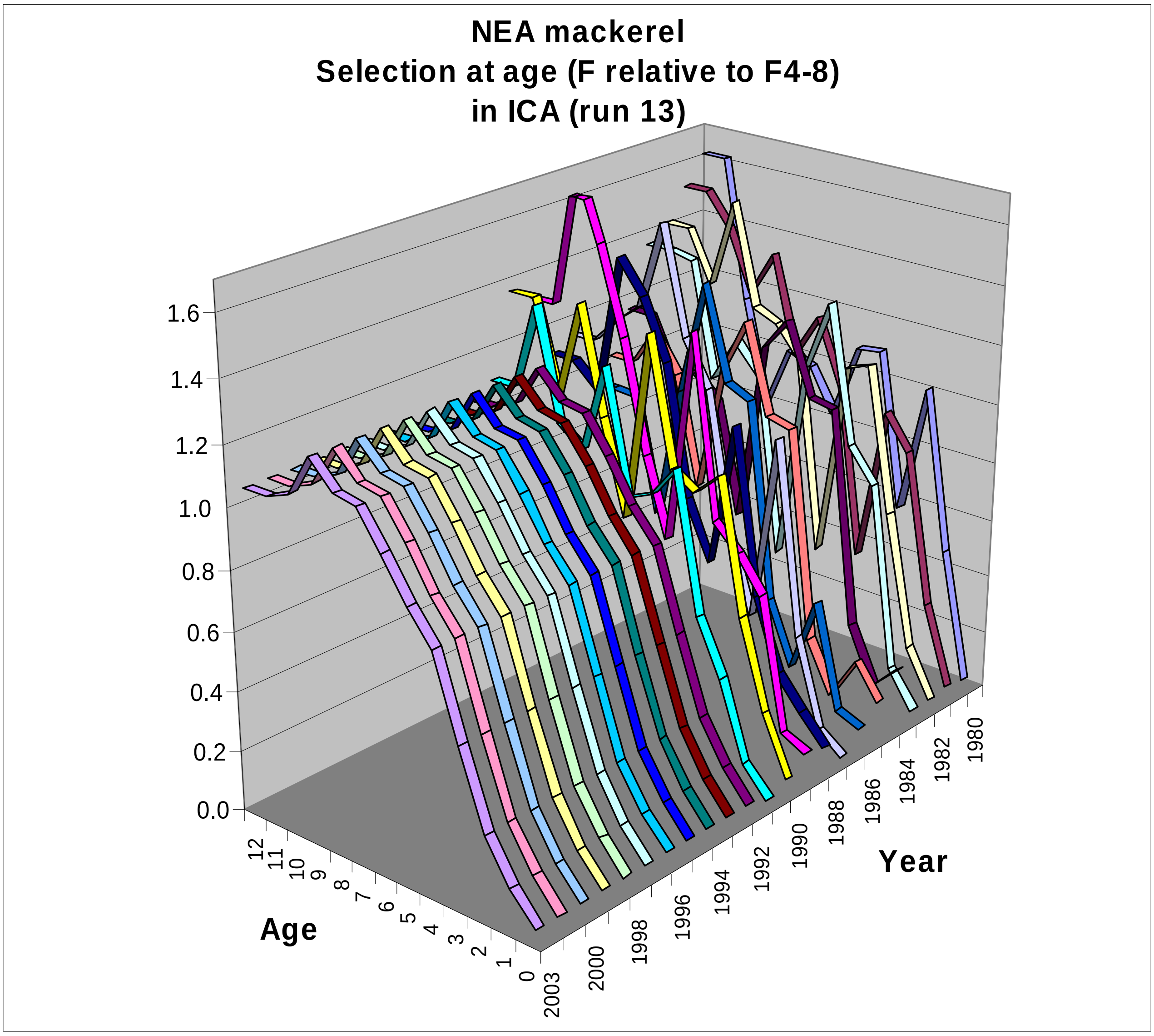


Figure 2.9.1.6 **NEA mackerel** Selection at age (F at age relative to F4-8)

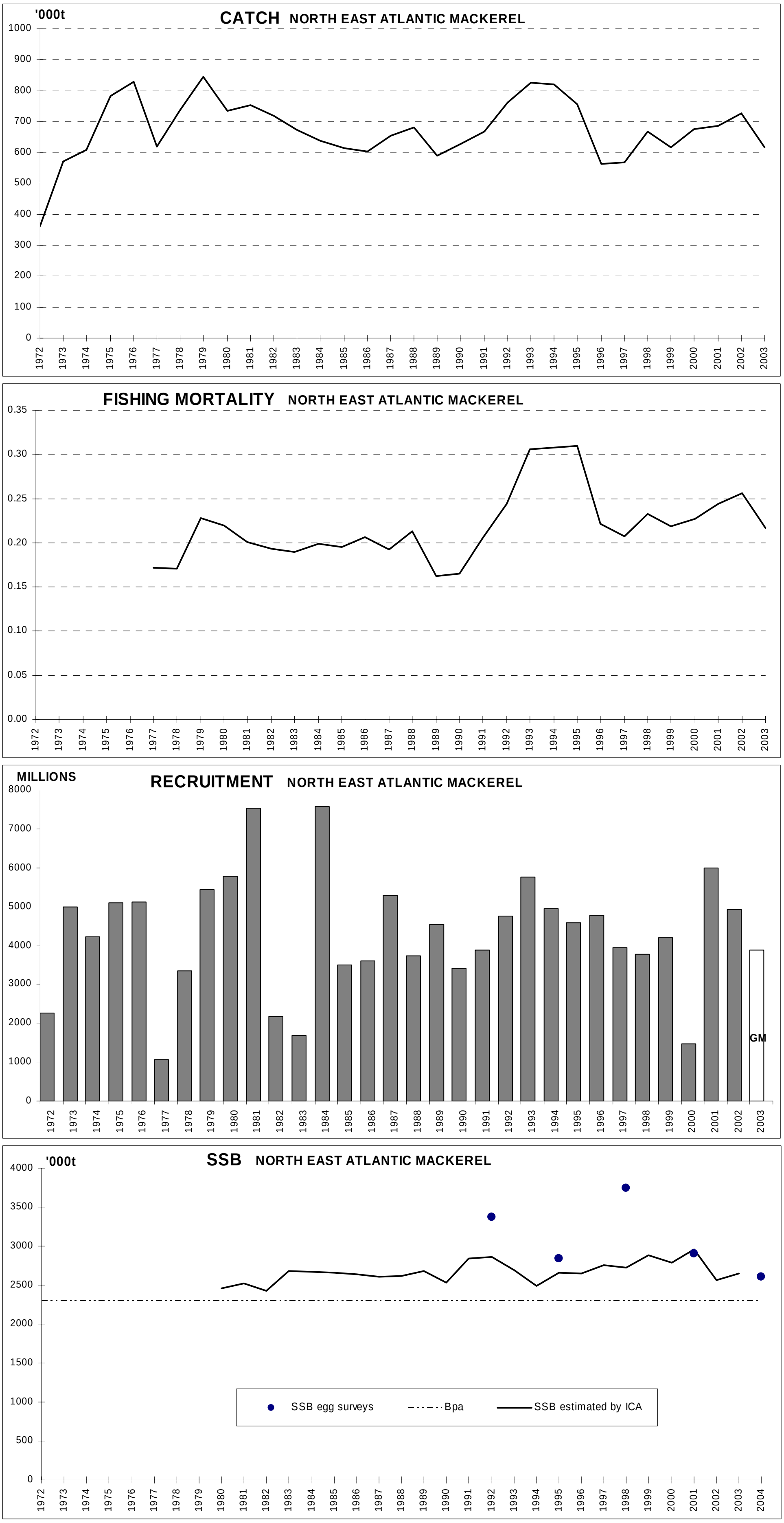


Figure 2.9.1.7 Catch, SSB, F and recruitment for North East Atlantic Mackerel (ICA) for the period 1972-2003. Biomass estimates from egg surveys in 1992, 1995, 1998, 2001 and 2004 are used for the assessment.

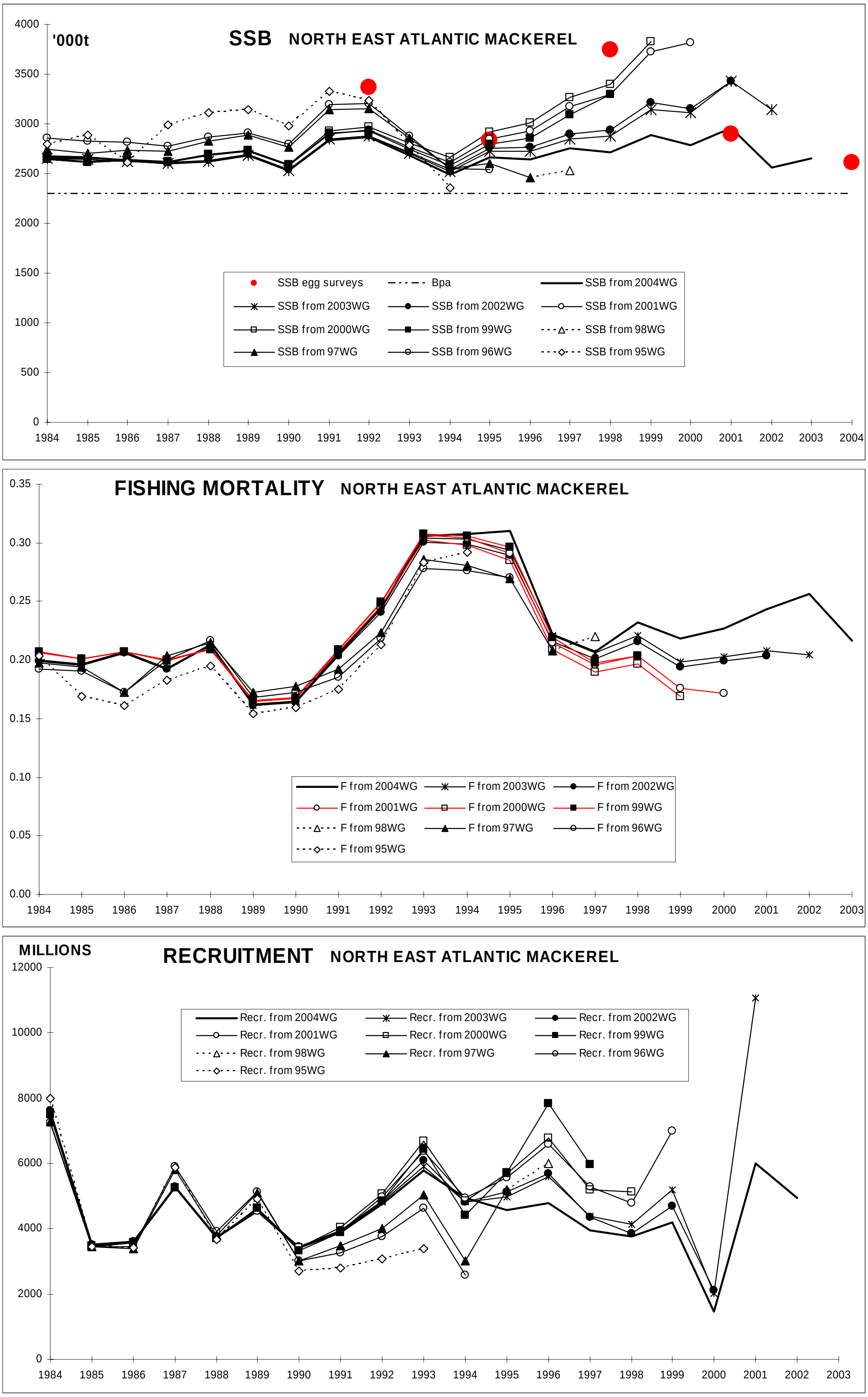


Figure 2.9.2.1 **Comparison of SSB, F(4-8) and recruitment estimates (ICA) obtained at various assessment working group meetings. Biomass estimates from egg surveys in 1992, 1995, 1998, 2001 and 2004 are also shown. At the 1999 - 2001 working groups the 1992, 1995 and 1998 egg survey SSB's and at the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

2.9.3 Reference Points

In the 1997 Working Group Report (ICES 1998/ACFM:6) an extensive and detailed analysis on potential candidates for reference points for the precautionary approach were given. The reference points suggested by SGPAFM were largely based on this analysis and are in line with the suggestions from the 1997 Working Group, and were consequently adopted in the 1998 Working Group Report (ICES 1999/ACFM:6). These values have been used by ACFM since 1998. The WG ran the PA programme to calculate various precautionary reference points of spawning stock biomass and fishing mortality. The input to the PA is the .sum and the .sen files from ICA. However, these need extensive modifications before any use.

The stock numbers in the .sen file are from the last years with data (2002), and not the stock sizes at the end of the current year, i.e. 2003, where the recruitment at age 0 in 2003 was replaced with the GM estimate (1972-2000), and recruitment at age 1 from ICA in 2003, which was only based on catches as 0-group, was replaced by the GM estimate of 0-group in 2003 multiplied by the ratio of age 0 in 2002 and age 1 in 2003 (sec. 2.10). Furthermore the selection-pattern from the ICA output has to be changed to the mean F at age for the last three years, as well as three year averages of stock and catch weights (same as used for prediction, Table 2.10.2). At the end of the new input file, some additional values have to be added manually (Human consumption multipliers, recruitments and natural mortality multipliers, all set to 1). In addition the CV for age 0 (2003 year class) was taken from the GM estimate while the CVs for older ages were the same as for the stock size number from 2003 (ICA output).

The .sum file also need changes, the recruitment at age 0 in 2003 was replaced with the GM estimate (1972-2000). The analysis was limited to cover the years 1977-2003 due to incomplete average F(2-8) values in the beginning of the period (1972-1976, including 0s in the average). Table 2.9.3.1 give a list of input parameters to the PA run.

The results are shown in Table 2.9.3.2 and Figs 2.9.3.1-5. The stock-recruitment plot is shown in Fig. 2.9.3.6. $F_{0.1}$ was estimated to be 0.19 in the present assessment, the same as in the previous four years. F_{max} is poorly defined at a combined reference F of about 0.68. However, for pelagic species F_{max} is generally estimated to be at levels of F well beyond sustainable levels and should not be used as a fishing mortality target. A combined yield per recruit and spawning stock per recruit plot is shown in Fig. 2.9.3.2 with some reference points indicated, however refer to Table 2.9.3.2 for actual vales of the indicated reference points.

The Working Group noted that recent updates have not significantly changed the basis for the present references points. The WG also noted that the lowest observed SSB was 2.42 million tonnes, slightly higher than the current B_{pa} of 2.3 million tonnes (Table 2.9.3.2).

References

ICES 1998/ACFM:6. Report of the Working Group on the assessment of mackerel, horse mackerel, sardine and anchovy. ICES CM 1998/ACFM:6, 383 pp.

ICES 1999/ACFM:6. Report of the Working Group on the assessment of mackerel, horse mackerel, sardine and anchovy. ICES CM 1999/ACFM:6, 468 pp.

Table 2.9.3.1 NEA mackerel. Input variables to the PA software.

Age	N	M	CWt	SWt	Mat	F	FPreSpwn	MPreSpwn	NCV
0	3883000	0.15	0.06747	0	0	0.00796	0.4	0.4	0.42406
1	3315830	0.15	0.167	0.07682	0.07	0.02883			0.38752
2	3516600	0.15	0.249	0.1753	0.59	0.05882			0.1332
3	3449100	0.15	0.31667	0.25131	0.88	0.11269			0.11691
4	647600	0.15	0.37767	0.32271	0.97	0.1709			0.09478
5	1319200	0.15	0.43067	0.37513	0.97	0.1931			0.08558
6	825000	0.15	0.47233	0.43399	0.99	0.22248			0.08033
7	585500	0.15	0.51233	0.44678	1	0.24742			0.07781
8	471000	0.15	0.55233	0.4788	1	0.2508			0.07796
9	297400	0.15	0.59267	0.53752	1	0.26911			0.07919
10	207200	0.15	0.61567	0.54175	1	0.23897			0.08212
11	158800	0.15	0.63233	0.57833	1	0.23172			0.08555
12	187400	0.15	0.685	0.58685	1	0.23172			0.08555

FbarMinAge	4
FbarMaxAge	8
M year CV	0.1

Table 2.9.3.2 NEA mackerel. Calculated references points for NEA mackerel based on the 1977-2000 recruitment time series.

Reference point	Deterministic	Median	75th percentile	95th percentile	Hist SSB < ref pt %
MedianRecruits	4202000	4202000	4582000	4785000	
MBAL	2300000				0.00
Bloss	2422000				
SSB90%R90%Surv	2637819	2652462	2700138	2840307	33.33
SPR%ofVirgin	35.52	35.42	37.13	39.01	
VirginSPR	1.99	2.00	2.20	2.53	
SPRloss	0.50	0.50	0.53	0.62	

	Deterministic	Median	25th percentile	5th percentile	Hist F > ref pt %
FBar	0.22	0.22	0.22	0.22	44.44
Fmax	0.68	0.68	0.61	0.54	0.00
F0.1	0.19	0.19	0.18	0.16	85.19
Flow	0.06	0.04	0.02	0.00	100.00
Fmed	0.23	0.26	0.23	0.19	25.93
Fhigh	0.40	0.41	0.37	0.34	0.00
F35%SPR	0.22	0.22	0.21	0.19	33.33
Floss	0.35	0.36	0.32	0.26	0.00

For estimation of Gloss and Floss:
A LOWESS smoother with a span of 1 was used.
Stock recruit data were log-transformed
A point representing the origin was included in the stock recruit data.
For estimation of the stock recruitment relationship used in equilibrium calculations:
A LOWESS smoother with a span of 1 was used.
Stock recruit data were log-transformed
A point representing the origin was included in the stock recruit data.

NEA Mackerel Mackerel NEA (sen file)

Steady state selection provided as input
FBar averaged from age 4 to 8

FishLab DLL used
FLVB32.DLL built on Jun 14 1999 at 11:53:37
PASoft 4 October 1999

14-09-2004 11:34:15

Number of iterations = 100
Random number seed = -99
Stock recruitment data Monte Carloed using residuals from the equilibrium LOWESS fit

Data source:
D:\Fisk\Mac04\MHSAWG04\Jan Arge\PA\ica2004.sen
D:\Fisk\Mac04\MHSAWG04\Jan Arge\PA\ica2004.sum

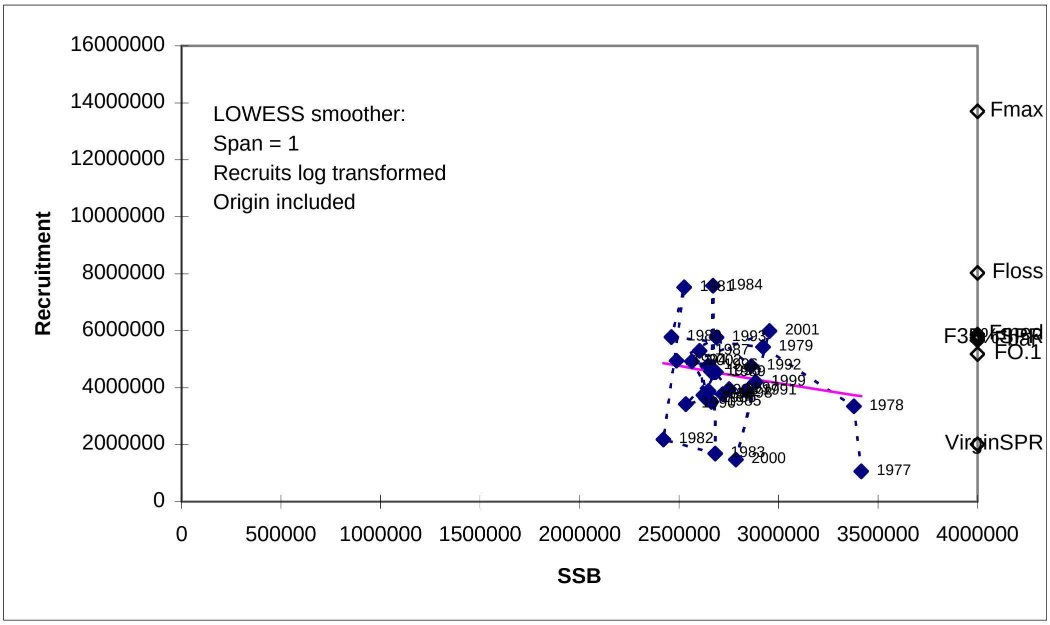


Figure 2.9.3.1 NEA mackerel. Stock-recruitment plot with a LOWESS smoother as a possible stock recruitment relationship. Some reference points are also indicated (PA output).

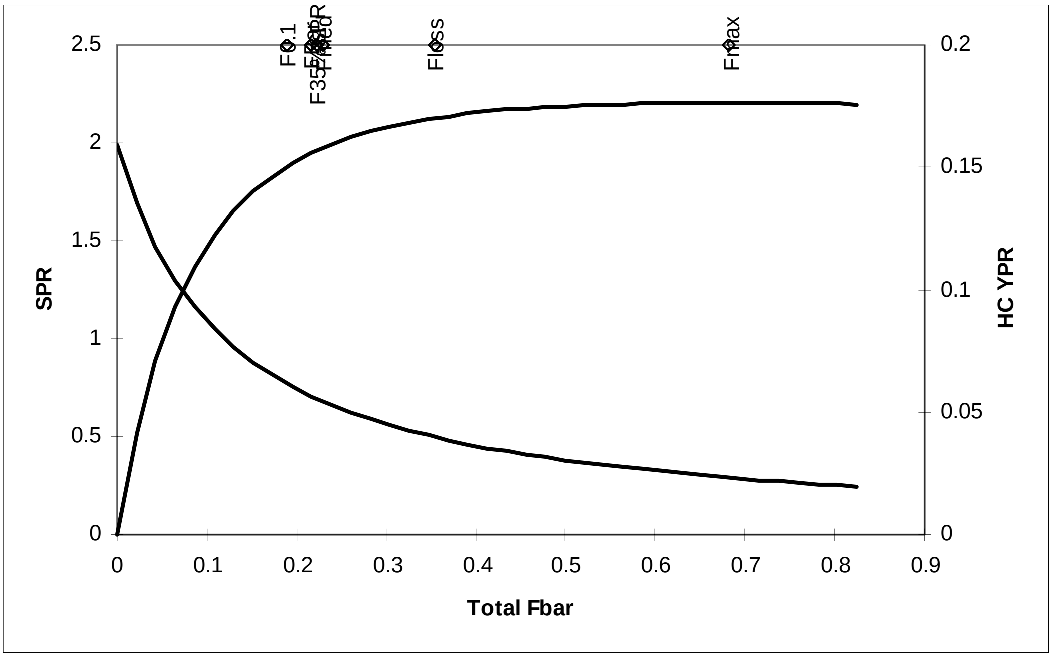


Figure 2.9.3.2 NEA mackerel. Plot of YPR and SPR curves with some reference points indicated (see Table 2.9.3.2).

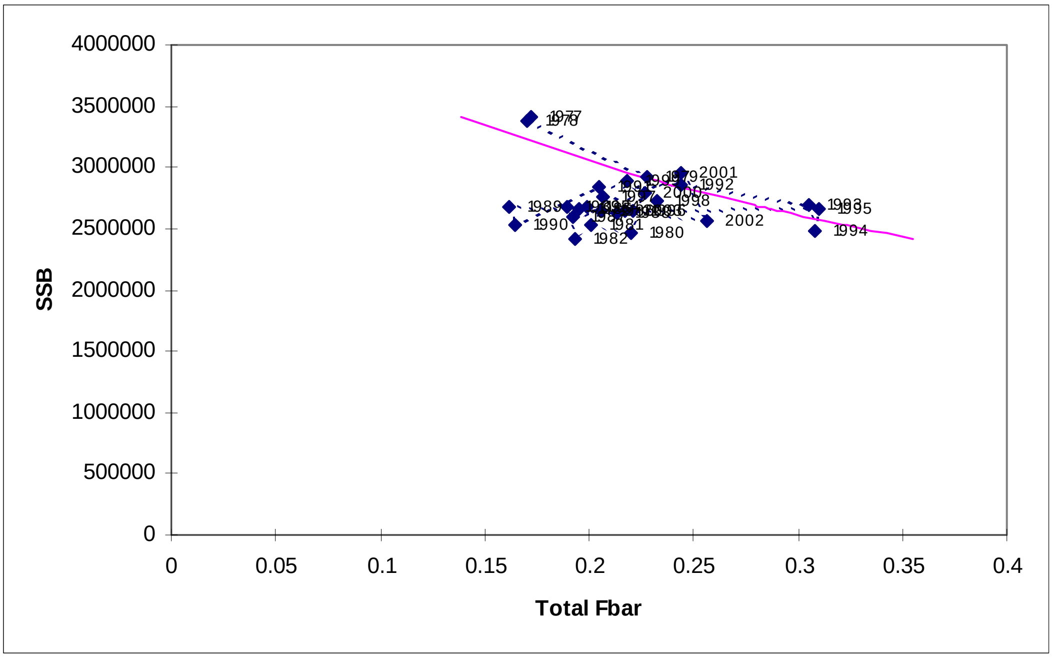


Figure 2.9.3.3 NEA mackerel. Plot of historical SSB against Fbar with an equilibrium curve based on the LOWESS stock recruitment relationship.

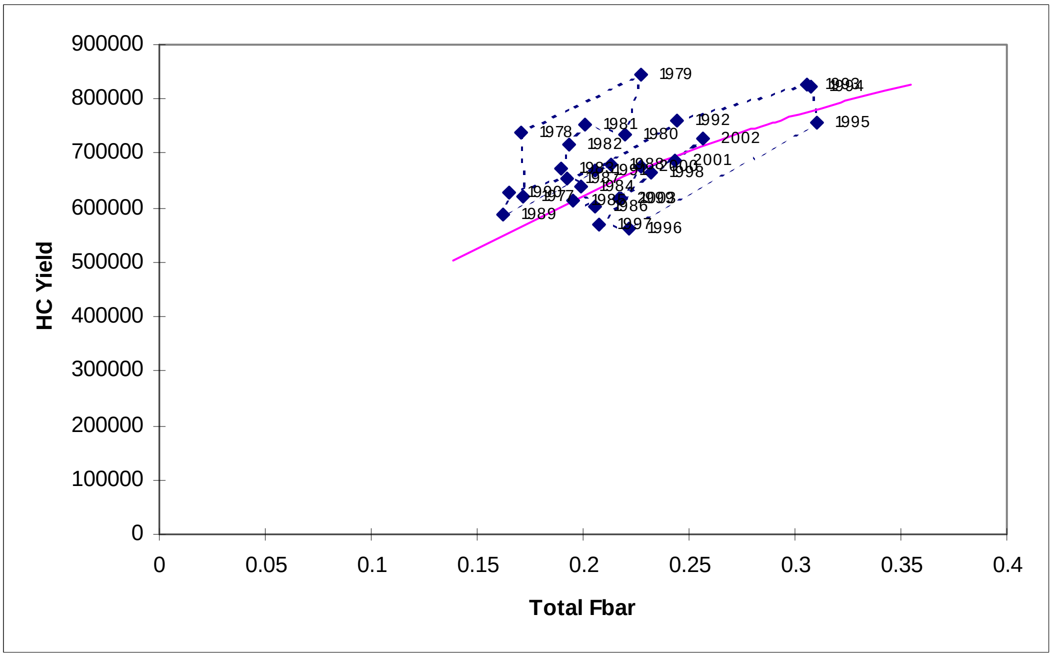


Figure 2.9.3.4 NEA mackerel. Plot of historical yield against Fbar with an equilibrium curve based on the LOWESS stock recruitment relationship.

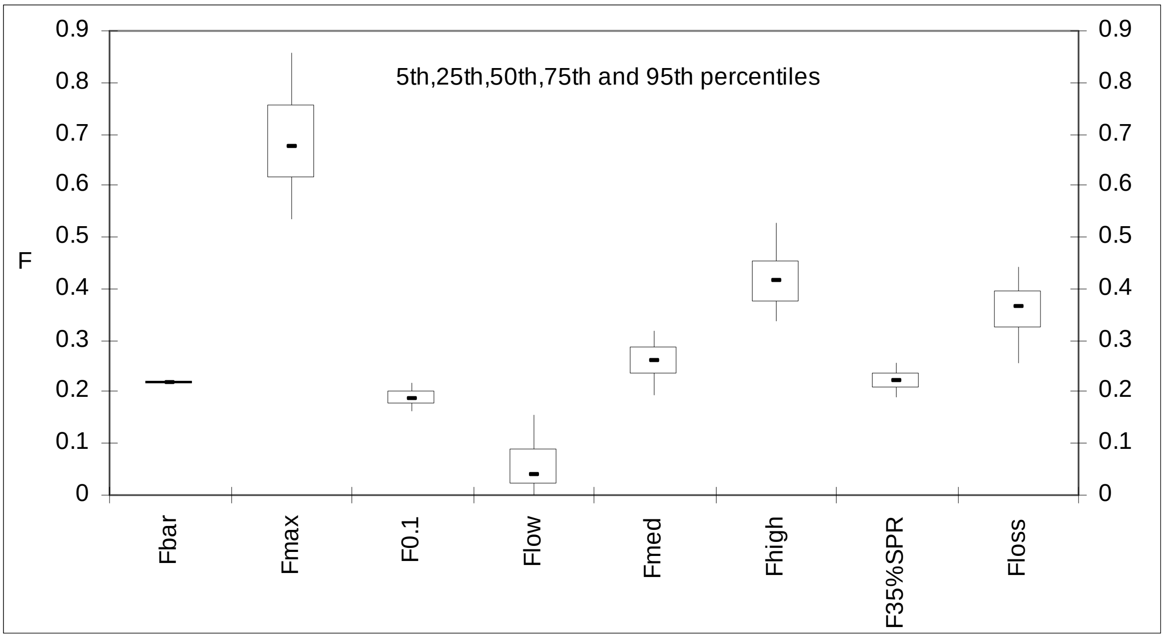


Figure 2.9.3.5 NEA mackerel. Various Reference points and their uncertainties calculated.

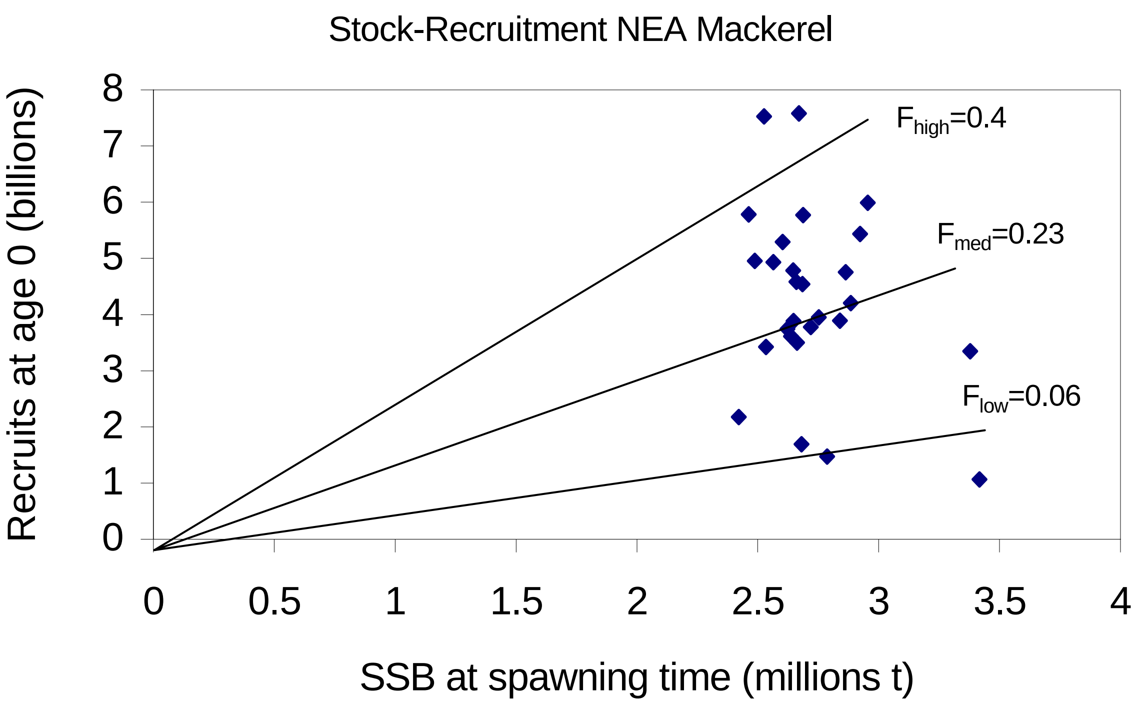


Figure 2.9.3.6 NEA mackerel. Stock-recruitment plot, indicating F_{high}, F_{med} and F_{low} (drawn by hand but values from Table 2.9.3.2).

2.10 Catch predictions for 2005

Table 2.10.1 presents the calculations for the input values for the catch forecasts and Table 2.10.2 lists the input data for the 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 2004:

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 1972-2002 as obtained from this year's assessment. The value of 3883 million fish is calculated from the geometric mean of the North East Atlantic mackerel recruitments for the period 1972-2000, which value is used for the recruitment at age 0 for 2004 in de predictions. Figure 2.10.2 shows the GM recruitment estimates as estimated at the various WG meetings from 1995 -2004. The GM recruitment estimate of this years WG meeting is just below the average of the GM recruitments as annually estimated during the WG meetings of 1995-2004.

Age 1 Traditionally the WG has taken the abundance at age 1 to be the geometric mean recruitment (3883 million fish) brought forward 1 year by the total mortality at age 0 in that year (see Table 2.10.1). See also section 2.7.2 in which the possible strength of the 2003 year class is discussed.

Recruitment at age 0 in 2005 and 2006 was also assumed to be 3883 million fish.

Figure 2.10.3 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 2.10.3 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 time series is not long enough to calculate the confidence intervals, because up to now there are only 7 estimates per 1st, 2nd, 3rd, etc. estimation available.

Traditionally catch forecasts have been calculated for the provision of area based TACs. Two "fleets" had been defined:

1) "Northern" area corresponding to the exploitation of the western area, including the North Sea and Division I, IIa and IIIa; "Northern" area reflects all areas except Divisions VIIIc and IXa;
2) "Southern" area including Div. VIIIc and IXa.

In 2003 the catches in the southern area have decreased drastically due to the oil spill disaster caused by MV "Prestige" off the northwest coast of Spain. Therefore, the WG decided not to subdivide the exploitation pattern for NEA mackerel into partial F's for each fleet using the average ratio of the fleet catch at each age for the years 2001–2003, because this would affect the predicted catches for 2005. The predictions were carried out for the whole management area of the NEA mackerel. At last years Working Group meeting Norway has 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). The information provided then is regarded to be still relevant, because at this year's Working Group meeting the catch predictions are not carried for the so-called "Northern" and "Southern" areas as in earlier years.

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

Maturity at age was taken as an average of the values for the period 2001–2003.

Weight at age in the catch was taken as an average of the values for the period 2001–2003 for each area.

Weight at age in the stock was calculated from an average (2001–2003) of weights at age for the NEA mackerel stock.

The catch for 2004 is assumed to be 542 kt, which corresponds to the TAC of 532 kt in 2004 (see Section 2.1) plus an assumed amount of discards of 10 kt (see Section 1.3.3), which is the same procedure as last year.

Predictions were calculated by the MFDP program.

Two one area management option tables are presented: Table 2.10.3 with *status quo* fishing mortality (Fsq = 0.24) in 2004 and Table 2.10.4 with a catch constraint of 542 kt in 2004. Both are then followed by range of F's from 0.0 up to 0.43.

The single option summary tables are not presented in this year WG report, because the aim was to provide a multi-annual TAC advice (see section 2.12).

The SSB in this years assessment appears to be lower and the F(4-8) to be higher than last years because of the effect of the 2004 survey (see Figure 2.9.2.1). The 2000 year class appears to be weak and will be 5 years old in the catches of 2005. The 2001 year class appears to be strong and 2002 is indicated to be strong as well. These year classes will be respectively 4 and 3 years old in the catches of 2005.

The catch predictions are carried out for two options: a) a catch corresponding Fsq and b) 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 2.10.4 and 2.10.5 show these comparisons for respectively catch and fishing mortality. The catch constraint option fits best to the actual catches, when predicted catches are compared actual catches (Figure 2.10.4). However, when the predicted fishing mortalities are compared to the actual fishing mortalities (Figure 2.10.5), 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 strong 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 it would be preferable to use a catch constraint option for the predictions. In most years the actual observed fishing mortalities are fluctuating more than the predicted fishing mortalities from both options. These fluctuations are likely to be due to up- and downward revisions once every three years when new SSB values from egg surveys become available for tuning the assessment. Predictions with a Fsq option should be carried out in the case of consistent year to year underestimations of the fishing mortality. This is, however, not the case.

Table 2.10.1 CALCULATION OF INPUTS FOR SHORT-TERM PREDICTIONS FOR NEA MACKEREL

UNIT: millions

Year class	AGE	Stock in numbers at 1st January 2004	
2004	0	3883	<--- GM over period 1972-2000
2003	1	3315.8	<--- corrected 1-year olds ===============||
2002	2	3516.6	<-- from ICA
2001	3	3449.1	<-- from ICA
2000	4	647.6	<-- from ICA
1999	5	1319.2	<-- from ICA
1998	6	825.0	<-- from ICA
1997	7	585.5	<-- from ICA
1996	8	471.0	<-- from ICA
1995	9	297.4	<-- from ICA
1994	10	207.2	<-- from ICA
1993	11	158.8	<-- from ICA
	12+	187.4	<-- from ICA

GM recruitment 1972-2000 (ICA) = 3883

CALCULATION OF RECRUITMENT AT AGE 1	
Numbers at age **1** in 2004	1490.8
Numberst age **0** in 2003	1745.8
CORRECTED **1**-YEAR OLDS	3316

(N_age_1_in_2004 / N_age_0_in 2003) x GM recruitment

Rescaling factor to correspond to F(2003): **0.907542**

AGE	F's of WG2004 (from ICA) 2001	2002	2003	Mean F(4-8) 2001-2003	AGE	Rescaled F-values
0	0.00893	0.00941	0.00796	0.00877	0	0.00796
1	0.03237	0.0341	0.02883	0.03177	1	0.02883
2	0.06605	0.06957	0.05883	0.06482	2	0.05882
3	0.12653	0.13328	0.11269	0.12417	3	0.11269
4	0.19191	0.20213	0.17090	0.18831	4	0.17090
5	0.21683	0.22839	0.19310	0.21277	5	0.19310
6	0.24982	0.26313	0.22248	0.24514	6	0.22248
7	0.27783	0.29263	0.24742	0.27263	7	0.24742
8	0.28162	0.29663	0.25080	0.27635	8	0.25080
9	0.30218	0.31828	0.26911	0.29652	9	0.26911
10	0.26833	0.28264	0.23897	0.26331	10	0.23897
11	0.2602	0.27407	0.23172	0.25533	11	0.23172
12+	0.2602	0.27407	0.23172	0.25533	12+	0.23172
	0.2436	**0.2566**	**0.2169**	**0.2390**	Mean F(4-8)	**0.2169**

Proportion of F and M before spawing

F	M
0.4	0.4

NEA

AGE	Proportion MATURE	2001	2002	2003
0	0.00	0.00	0.00	0.00
1	0.07	0.07	0.07	0.07
2	0.59	0.59	0.59	0.59
3	0.88	0.88	0.88	0.88
4	0.97	0.97	0.97	0.97
5	0.97	0.97	0.97	0.97
6	0.99	0.99	0.99	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

NEA

AGE	NEA Mean weight at age in the STOCK	2001	2002	2003
0	0.000	0.000	0.000	0.000
1	0.077	0.078	0.078	0.074
2	0.175	0.164	0.181	0.181
3	0.251	0.241	0.240	0.273
4	0.323	0.342	0.310	0.316
5	0.375	0.390	0.364	0.371
6	0.434	0.446	0.410	0.446
7	0.447	0.459	0.436	0.446
8	0.479	0.499	0.462	0.475
9	0.538	0.529	0.500	0.584
10	0.542	0.576	0.522	0.527
11	0.578	0.603	0.533	0.599
12+	0.587	0.586	0.565	0.610

NEA

AGE	NEA Mean weight at age in the CATCH	2001	2002	2003
0	0.067	0.069	0.052	0.081
1	0.167	0.172	0.159	0.170
2	0.249	0.223	0.255	0.269
3	0.317	0.306	0.307	0.337
4	0.378	0.377	0.368	0.388
5	0.431	0.426	0.426	0.440
6	0.472	0.476	0.463	0.478
7	0.512	0.498	0.514	0.525
8	0.552	0.542	0.539	0.576
9	0.593	0.579	0.582	0.617
10	0.616	0.607	0.603	0.637
11	0.632	0.612	0.631	0.654
12+	0.685	0.667	0.668	0.720

Table 2.10.2 North East Atlantic Mackerel. Prediction: INPUT DATA

2004

Age	Exploit. pattern	Weight in catch	Stock size	Natural mortality	Maturity ogive	Prop. of F bef. spaw.	Prop. of M bef. spaw.	Weight in the stock
0	0.0080	0.067	**3883.0**	0.15	0.00	0.4	0.4	0.000
1	0.0288	0.167	**3315.8**	0.15	0.07	0.4	0.4	0.077
2	0.0588	0.249	3516.6	0.15	0.59	0.4	0.4	0.175
3	0.1127	0.317	3449.1	0.15	0.88	0.4	0.4	0.251
4	0.1709	0.378	647.6	0.15	0.97	0.4	0.4	0.323
5	0.1931	0.431	1319.2	0.15	0.97	0.4	0.4	0.375
6	0.2225	0.472	825.0	0.15	0.99	0.4	0.4	0.434
7	0.2474	0.512	585.5	0.15	1.00	0.4	0.4	0.447
8	0.2508	0.552	471.0	0.15	1.00	0.4	0.4	0.479
9	0.2691	0.593	297.4	0.15	1.00	0.4	0.4	0.538
10	0.2390	0.616	207.2	0.15	1.00	0.4	0.4	0.542
11	0.2317	0.632	158.8	0.15	1.00	0.4	0.4	0.578
12+	0.2317	0.685	187.4	0.15	1.00	0.4	0.4	0.587
UNIT:		(kg)	(millions)					(kg)

2005

Age	Exploit. pattern	Weight in catch	Recruit-ment	Natural mortality	Maturity ogive	Prop. of F bef. spaw.	Prop. of M bef. spaw.	Weight in the stock
0	0.0080	0.067	3883.0	0.15	0.00	0.4	0.4	0.000
1	0.0288	0.167	-	0.15	0.07	0.4	0.4	0.077
2	0.0588	0.249	**-**	0.15	0.59	0.4	0.4	0.175
3	0.1127	0.317	**-**	0.15	0.88	0.4	0.4	0.251
4	0.1709	0.378	**-**	0.15	0.97	0.4	0.4	0.323
5	0.1931	0.431	**-**	0.15	0.97	0.4	0.4	0.375
6	0.2225	0.472	**-**	0.15	0.99	0.4	0.4	0.434
7	0.2474	0.512	**-**	0.15	1.00	0.4	0.4	0.447
8	0.2508	0.552	**-**	0.15	1.00	0.4	0.4	0.479
9	0.2691	0.593	**-**	0.15	1.00	0.4	0.4	0.538
10	0.2390	0.616	**-**	0.15	1.00	0.4	0.4	0.542
11	0.2317	0.632	**-**	0.15	1.00	0.4	0.4	0.578
12+	0.2317	0.685	**-**	0.15	1.00	0.4	0.4	0.587
UNIT:		(kg)	(millions)					(kg)

2006

Age	Exploit. pattern	Weight in catch	Recruit-ment	Natural mortality	Maturity ogive	Prop. of F bef. spaw.	Prop. of M bef. spaw.	Weight in the stock
0	0.0080	0.067	3883.0	0.15	0.00	0.4	0.4	0.000
1	0.0288	0.167	-	0.15	0.07	0.4	0.4	0.077
2	0.0588	0.249	**-**	0.15	0.59	0.4	0.4	0.175
3	0.1127	0.317	**-**	0.15	0.88	0.4	0.4	0.251
4	0.1709	0.378	**-**	0.15	0.97	0.4	0.4	0.323
5	0.1931	0.431	**-**	0.15	0.97	0.4	0.4	0.375
6	0.2225	0.472	**-**	0.15	0.99	0.4	0.4	0.434
7	0.2474	0.512	**-**	0.15	1.00	0.4	0.4	0.447
8	0.2508	0.552	**-**	0.15	1.00	0.4	0.4	0.479
9	0.2691	0.593	**-**	0.15	1.00	0.4	0.4	0.538
10	0.2390	0.616	**-**	0.15	1.00	0.4	0.4	0.542
11	0.2317	0.632	**-**	0.15	1.00	0.4	0.4	0.578
12+	0.2317	0.685	**-**	0.15	1.00	0.4	0.4	0.587
UNIT:		(kg)	(millions)					(kg)

Table 2.10.3 **NORTH EAST ATLANTIC MACKEREL.**

One area management option table.

OPTION: **Fsq in 2004**

MFDP version 1a
Run: fstat_1
Mackerel NE Atlantic Mark test
Time and date: 16:55 13/09/2004
Fbar age range: 4-8

2004				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
3760	2740	1	0.239	650

2005					2006	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
3785	3042	0	0	0	4345	3559
.	3030	0.05	0.012	37	4312	3514
.	3018	0.1	0.0239	73	4279	3471
.	3006	0.15	0.0359	109	4247	3428
.	2994	0.2	0.0478	145	4215	3385
.	2983	0.25	0.0598	180	4183	3343
.	2971	0.3	0.0717	215	4151	3302
.	2959	0.35	0.0837	249	4120	3262
.	2948	0.4	0.0956	284	4090	3222
.	2936	0.45	0.1076	317	4059	3182
.	2925	0.5	0.1195	351	4029	3143
.	2914	0.55	0.1315	384	3999	3105
.	2902	0.6	0.1434	417	3970	3067
.	2891	0.65	0.1554	450	3941	3030
.	2880	0.7	0.1673	482	3912	2993
.	2868	0.75	0.1793	514	3883	2957
.	2857	0.8	0.1912	545	3855	2922
.	2846	0.85	0.2032	577	3827	2886
.	2835	0.9	0.2151	608	3799	2852
.	2824	0.95	0.2271	638	3771	2818
.	2813	1	0.239	669	3744	2784
.	2802	1.05	0.251	699	3717	2751
.	2791	1.1	0.2629	728	3690	2718
.	2781	1.15	0.2749	758	3664	2686
.	2770	1.2	0.2868	787	3638	2654
.	2759	1.25	0.2988	816	3612	2623
.	2748	1.3	0.3108	845	3586	2592
.	2738	1.35	0.3227	873	3561	2562
.	2727	1.4	0.3347	901	3536	2532
.	2717	1.45	0.3466	929	3511	2502
.	2706	1.5	0.3586	956	3486	2473
.	2696	1.55	0.3705	984	3462	2445
.	2685	1.6	0.3825	1011	3437	2416
.	2675	1.65	0.3944	1037	3413	2388
.	2665	1.7	0.4064	1064	3390	2361
.	2654	1.75	0.4183	1090	3366	2334
.	2644	1.8	0.4303	1116	3343	2307
.	2634	1.85	0.4422	1142	3320	2281
.	2624	1.9	0.4542	1167	3297	2255
.	2614	1.95	0.4661	1193	3275	2229
.	2604	2	0.4781	1218	3252	2204

Input units are thousands and kg - output in tonnes

Table 2.10.4 **NORTH EAST ATLANTIC MACKEREL.**

One area management option table.

OPTION: **Catch constraint 542kt in 2004**

MFDP version 1a
Run: catch_1
Mackerel NE Atlantic Mark test
Time and date: 17:15 13/09/2004
Fbar age range: 4-8

2004				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
3760	2778	0.9027	0.1958	542

2005					2006	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
3882	3130	0	0	0	4438	3645
	3119	0.05	0.0108	34	4407	3604
	3108	0.1	0.0217	68	4376	3563
	3097	0.15	0.0325	102	4346	3522
	3086	0.2	0.0434	136	4316	3482
	3075	0.25	0.0542	169	4286	3443
	3064	0.3	0.0651	202	4257	3404
	3053	0.35	0.0759	234	4227	3366
	3042	0.4	0.0868	267	4199	3328
	3031	0.45	0.0976	298	4170	3291
	3020	0.5	0.1085	330	4141	3254
	3010	0.55	0.1193	362	4113	3217
	2999	0.6	0.1302	393	4085	3182
	2988	0.65	0.141	423	4058	3146
	2978	0.7	0.1519	454	4030	3111
	2967	0.75	0.1627	484	4003	3077
	2956	0.8	0.1736	514	3976	3043
	2946	0.85	0.1844	544	3949	3009
	2936	0.9	0.1952	573	3923	2976
	2925	0.95	0.2061	603	3897	2944
	2915	1	0.2169	632	3871	2911
	2915	1	0.2169	632	3871	2911
	2904	1.05	0.2278	660	3845	2879
	2894	1.1	0.2386	689	3820	2848
	2884	1.15	0.2495	717	3795	2817
	2874	1.2	0.2603	745	3770	2786
	2864	1.25	0.2712	772	3745	2756
	2853	1.3	0.282	800	3720	2726
	2843	1.35	0.2929	827	3696	2697
	2833	1.4	0.3037	854	3672	2668
	2823	1.45	0.3146	880	3648	2639
	2813	1.5	0.3254	907	3624	2611
	2803	1.55	0.3363	933	3601	2583
	2794	1.6	0.3471	959	3577	2556
	2784	1.65	0.358	985	3554	2528
	2774	1.7	0.3688	1010	3532	2502
	2764	1.75	0.3796	1036	3509	2475
	2754	1.8	0.3905	1061	3486	2449
	2745	1.85	0.4013	1086	3464	2423
	2735	1.9	0.4122	1110	3442	2398
	2726	1.95	0.423	1135	3420	2372
	2716	2	0.4339	1159	3399	2348

Input units are thousands and kg - output in tonnes

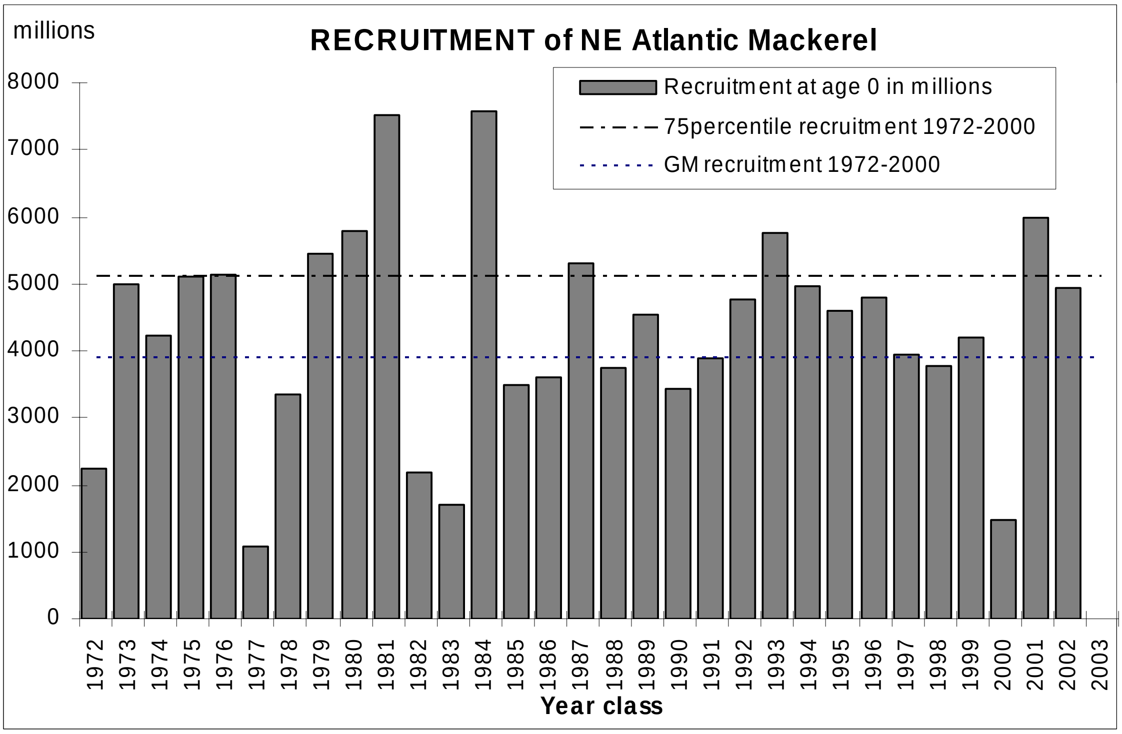


Figure 2.10.1 Recruitment estimates of NEA mackerel from ICA.

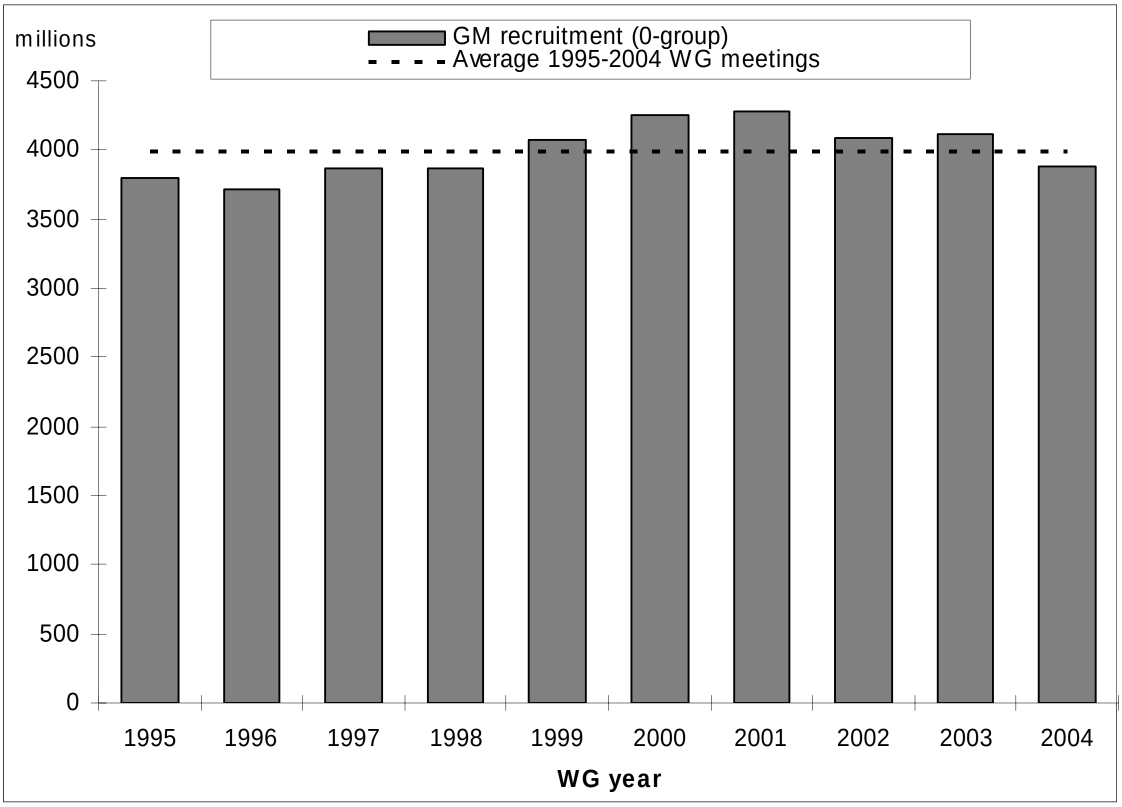


Figure 2.10.2 Annual GM recruitment (0-group) estimates of NEA mackerel as used for the short-term predictions at the various WG meetings from 1995 - 2004.
Broken line is the average during the period 1995-2004.

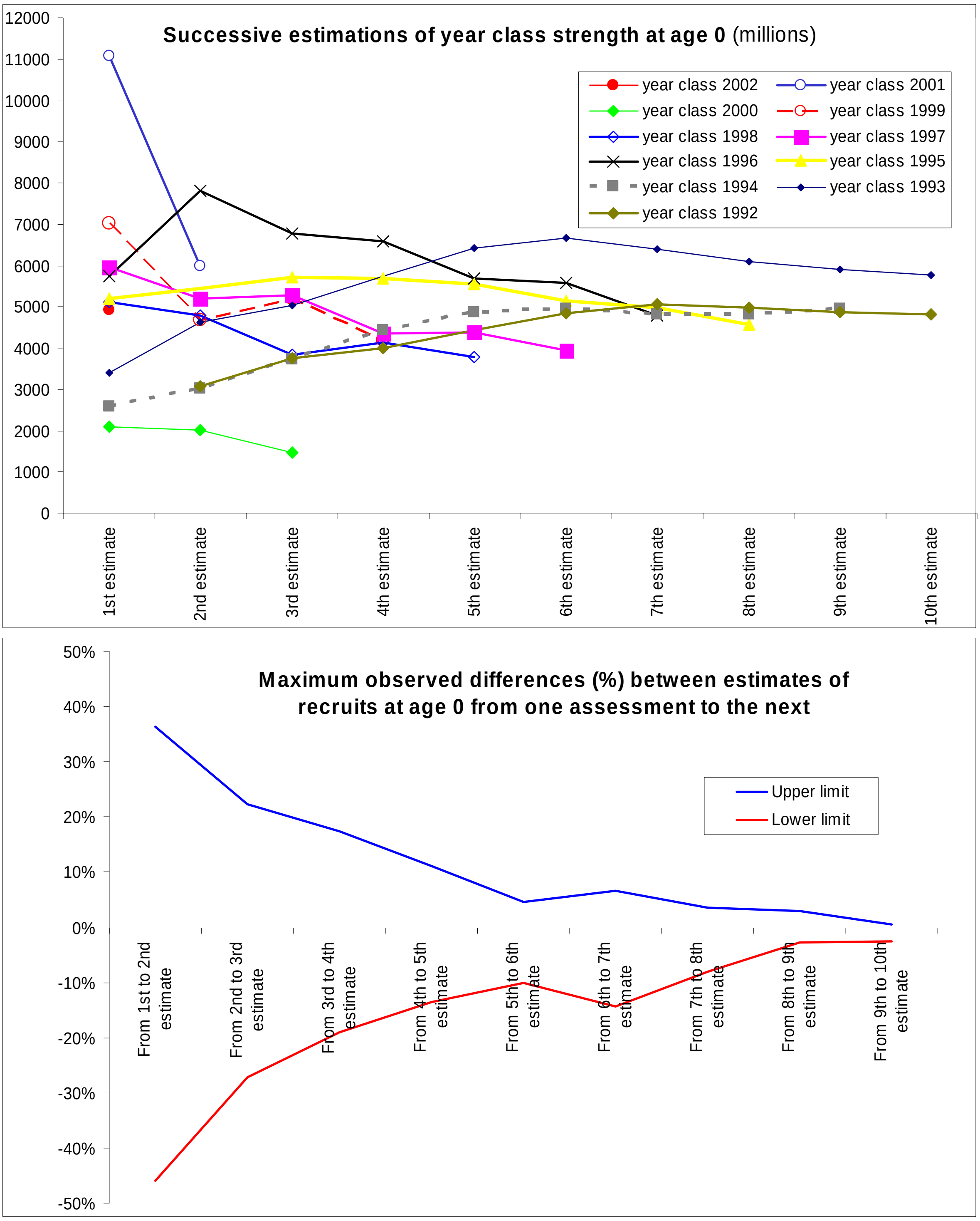


Figure 2.10.3 At the annual WG meetings the recruitment strength at age 0 is estimated of all year classes of NEA mackerel (except age 0). The first estimation of a year class strength is based on the catch in numbers at age 1 and at age 0 the year before; the second estimation of same year class is 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 (lower panel). It shows the improvement in the reliability in the successive estimates of year class strength.
The confidence intervals could not be calculated, because of only 7 observations per 1st, 2nd, 3rd, etc. estimation.

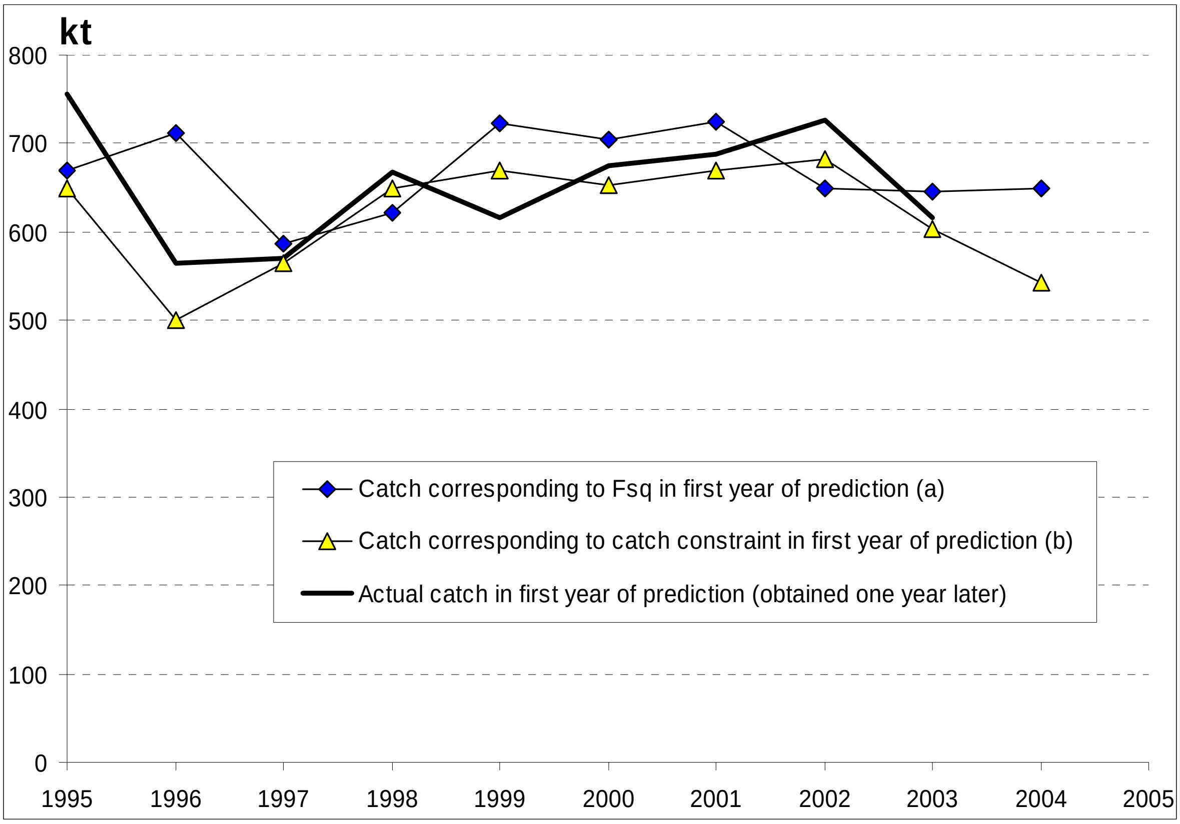


Figure 2.10.4 The catch predictions are carried out for two options: a) a catch corresponding Fsq and b) a catch contstra The actual catch obtained one year after the predictions can be compared to catches of both options to chec which of the two options fits best to it.

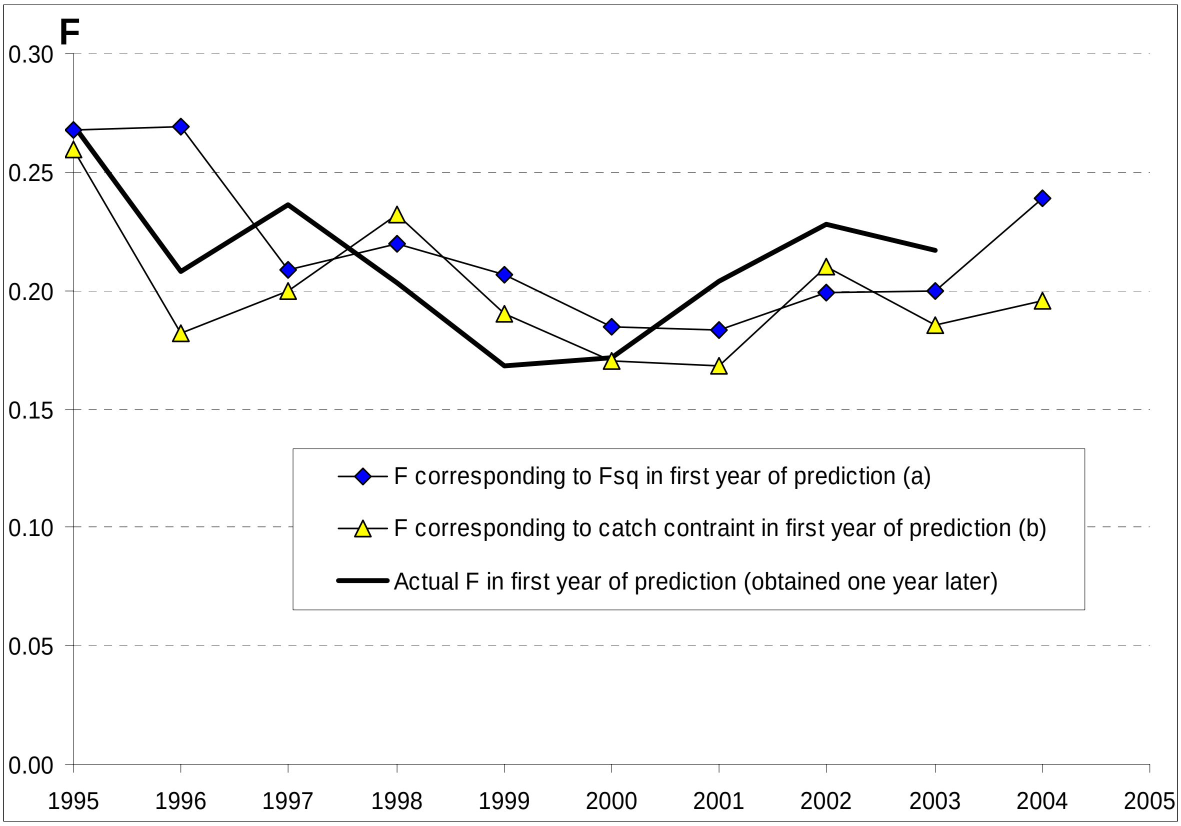


Figure 2.10.5 The catch predictions are carried out for two options: a) a catch corresponding Fsq and b) a catch contstra The actual F obtained one year after the predictions can be compared to F's of both options to check which the options fits best to it.

2.11 Triennial TAC advise

As an alternative to the standard annual TAC advise, the WG proposes to advise on a TAC valid for 3 year ahead, i.e. for the period 2005-2007 (Cfr. Sections 2.9.2 and 2.12, and ICES 1999). The WG suggests to use deterministic projections 3 years ahead to derive a proposed TAC, and to use stochastic predictions to evaluate the risk to SSB associated with the proposed TAC.

The following procedures were used:

1. Derive a proposed TAC by:

   Either
   Make a deterministic projection 3 years ahead, with a fixed F and then
   take the average of the predicted catches for the 3 years as a proposed TAC

   or

   Do deterministic short term predictions with fixed catch, to find the highest catch that keeps the F below a given value in any of the 3 years.

2. Use a medium term stochastic programme to evaluate the risk to SSB in the period 2005- 2008 associated with the proposed TAC.

The deterministic projections were done with the MFDP software, with input data as for the short term prediction (Section 2.10). Two options were explored: F = Fpa, leading to a proposed TAC of 512 000 tonnes, and a TAC of 570 000 tonnes, which was the highest TAC not leading to F>0.2 in any of the years. The rationale for the latter option was the current management agreement, which aims at maintaining F between 0.15 and 0.2. The detailed output from these predictions are given in Tables 2.11.1 and 2.11.2.

The stochastic predictions were made with the STPR software (Skagen, 1997, Patterson & al, 1997, Patterson & al, 2000, WGMHSA 2003).

Stochastic values for the initial stock numbers were obtained by taking the numbers at the start of 2004 used in the short term prediction, with a log-normal noise term according to the variance-covariance matrix produced by the ICA assessment. The variance of the youngest ages were substitued with the variances in the recruitment function, as these numbers are assumed because they are poorly estimated by ICA. An 'Ockhams razor' recruitment function was used, assuming recruitment (mean = 4226 thousands) independent of the SSB for SSB > 2.3 million tonnes, and linearly decreasing for SSB below that threshold. A normally distributed noise function was added to the recruitments from this stock-recruit relationship, with a CV of 0.4, to give a distribution of future recruitments (at high levels of SSB) comparable with the historic recruitments (Figure 2.12.1).

Future weights and maturities were drawn from the hiostorical weights and maturities.

The two fixed catch regime was simulated. For the intermediate year 2004, Fsq was assumed. However, to avoid depletion of the stock in extreme cases it was assumed that F = 0.05 would be applied if SSB < 1.5 million tonnes. The catch options considered did not result in that situation.

Figure 2.12.2 shows the projected SSB (fractals 5% – 95%) from 1000 bootstrap realisations under catch constraint equal to 512 and 570 thousand tons. It could be worth noting that in these simulations the SSB corresponding to the 50^{th} fractal is below the deterministic projections SSB for the corresponding year. The results from STPR can be interpreted as conservative, with respect to biomass. Hence, the risk that SSB will be below 2.3 million tonnes is slightly overestimated..

The text table below shows the risk that the SSB will be below 2.3 million tonnes in each of the years.

	2004	2005	2006	2007	2008
Catch = 512 000 t	2.6	1.1	1.3	2.8	2.4
Catch = 570 000 t	2.6	1.3	2.8	5.4	6.7

The simulations indicate that the risk to SSB with either of the proposed catch options is acceptable.

It must be stressed that the proposed TACs include all catch. Implementation error has not been considered in the catculations. If the TAC is overfished, in any of the years then the risk to SSB is underestimated in the table above. If the TAC is overfished, it is propsed that furter TACs are revised according to the estimates of the state of the stock then prevailing.

Other harvest control rules than the one that is implicit in the present procedure are discussed in Section 2.12.

Reference:

ICES (1999)
Report of the Study Group on Multiannual Assessment Procedures
ICES CM 1999/ACFM:11

2.12 Harvest control rules and future advisory framework.

North East Atlantic mackerel is suggested as a candidate for advise valid for more than one year ahead. This suggestion is motivated both by properties of the stock, the characteristics of the assessment and the request by managers and industry for stable and predictable conditions.

Even though the SSB is assessed to be lower than in previous years, it is still considered to be in a good condition. There are indications that the mortality is quite stable and of two strong incoming year classes. Moreover, the range of ages in the catches is wide. All this implies that the stock has a considerable buffering capacity.

The stock assessment is problematic because the only data in addition to the catch numbers at age are the triennual SSB estimates from the egg surveys. Such additional data are necessary to assess the present state of the stock, and the 3-year cycle in the survey data leads to a 3-year cycle in the perception of the current state of the stock. Hence, an advise for 3 years ahead would probably not be more misleading than annual advise for each of the years.

Within management, there is a growing interest in developing harvest control rules (HCRs) instead of using annual catch estimates based on a precautionary fishing mortality applied to the current estimate of the state of the stock. Although a harvest rule may simply be to apply a fixed F to the current stock estimate, the concept allows a much wider range of options to accommodate managers objectives. Stabilisation of catches is a common example of such objectives.

The WG now calculates catch options applicable for a 3-year period. The present calculations rely on this year's assessment, and transmits error in this assessment into the derived catch options. An alternative type of harvest control rule, which relies less on the last assessments, was explored to some extent. This approach includes a fixed TAC to be applied, together with a protection rule to reduce the TAC if the stock appears to be below some trigger biomass level. A protection rule is necessary in order to avoid a rapid depletion once the stock becomes too small to sustain the standard catch. The advantage of such a rule is that it relies mostly on information about the productivity of the stock to set the TAC level, which is largely determined by average recruitment, recruitment variation, growth, maturity and selection at age in the fishery, all parameters that can be derived from the more stable parts of the assessment or directly from biological information. However, this approach will still rely on regular monitoring of the stock, e.g. by analytic assessments at the time of implementing the protection rule.

Two working documents were presented, where various aspects of harvest control rules for NEA mackerel were studied by simulation.

WD by B. A. Roel

Management options were evaluated by means of a simulation framework that incorporates uncertainties in initial population numbers, weight-at-age and future recruitment and includes bias in the stock assessment model, based on forward projections of the stock numbers-at-age as estimated by WG 2003 (Roel 2004). The simulation framework consists of three main components: (1) an operating model representing the stock dynamics and the assessment process, (2) management options to be investigated, and (3) a selection of performance statistics.

Operating model

Stock numbers-at-age are projected forward, given future catches provided by the management option being tested and parameters such as natural mortality-at-age and maturity ogive, as adopted in the ICA routine assessment. Uncertainty in natural mortality and maturity-at-age is not taken into account in the current framework. The projection period is 20 years. Although ICES (2002) has indicated that 10 years was the longest period for which projections are sensible, that is not long enough to fully evaluate 3 years of fixed TAC strategies. Furthermore, initial conditions in 10-year projections are likely to be too influential. Starting numbers for projections are sampled from a log-normal distribution, with mean equal to the estimated stock numbers-at-age at the start of the year in 2003 and variance based on the ICA standard errors (s.e.) of the population estimates. In subsequent years, recruitment at age 0 is generated from an Ockham stock and recruitment (S–R) model with log-normal error with CV = 0.25. Parameters for the Ockham model are 2300 kt for the threshold and geometric mean recruitment which was based on estimates of recruitment (R) at 0 year of age for the period 1972–2000 (Fig. 2.12.1).

In the framework, the assessment is simulated, rather than actually performed, by introducing bias and uncertainty in the numbers-at-age generated by the operating model. A positive bias has been present in consecutive estimates of population numbers-at-age for this stock. A three-year cycle in the assessment uncertainty was highlighted by Simmonds *et al.* 2003. The approach suggested by Skagen (2003) to generate a perceived SSB was adopted in the simulation framework. Based on the simulated assessment, the perceived numbers-at-age at the start of year y are given by

$$N'_{y,a} = N_{y,a} k_y \cdot e^{\xi_{y,a}} ,$$

where $\xi_{y,a}$, a normally distributed random variable with mean zero and $\sigma = 0.15$, 0.2 and 0.25 for the years 1 to 3 in relation to the survey, is a measure of uncertainty in the population numbers-at-age [denoted $\xi_{y,a} \sim N(0,\sigma^2)$] and

$k_y = 1.0 + \varphi_y$ where $\varphi_y \sim N(0,\sigma^2 = 0.16)$ drawn every survey year and left constant during the subsequent two years, introduces bias in the assessment.

In the absence of a full simulation of the assessment, it is difficult to decide upon a realistic level of uncertainty in the perceived population numbers-at-age. This value is likely to capture the uncertainty resulting from fitting the model to data, but observation errors such as those arising from landing statistics and insufficient biological sampling, may not be accounted for.

Estimates of SSB and R since 1972 suggest uncertain *R* for *SSB* below approximately 2300 kt (B_{pa}). A value of 1500 kt was treated as B_{lim}, indicating drastic management action if *SSB* was estimated to be below this point.

Scenarios

A scenario related to compliance was formulated to evaluate the performance of the management options under those conditions. An outline of the scenarios and the conditions that characterize them is presented in the Table below:
NEA mackerel scenarios in the operating model and management options explored by simulation.

a) Stock

SSB	Wgt-at-age	R - SSB
AS IN WG 2003	NO trend	OCKHAM

b) Bias and error in the assessment simulated as in Skagen 2003

c) Management Options

Annual Revision F strategy (= 0.17; 0.2)
Multi-Annual (revised every 3 ys)

F strategy	fixed TAC
0.17	600
0.2	700

With and without overshoot

Annual revision. TAC is set annually, based on keeping $F=F_{pa}$. Constraint: if predicted *SSB* at the start of the forthcoming season (based on the assessment) $SSB^p_y<B_{pa}$, *F* is then reduced until $SSB^p_y \geq B_{pa}$.

Multi-annual, no constraints (3-year, F= 0.17, 0.20). TAC is set based on $F=F_{pa}$ and remains fixed for a period of either three or five years. At the end of the period, the stock is re-assessed and a new TAC is computed and implemented. Constraint as in the above.

Fixed (low/high). TAC is set at a fixed level of either 600 or 700 kt for a 20-year period. SSB is evaluated every three years and if it is below SSB trigger = 2300 kt, the TAC is reduced in proportion to the ratio SSB_y/ SSB trigger.

TAC overshoot. The scenarios above are simulated for the case where the catch is equal to the TAC and for the case where the TAC is overshot. The last situation was simulated on the basis of the overshoot level observed in this fishery.

Performance statistics

Risk SSB<B_{pa} or <B_{lim}): probability of the SSB falling at least once within the simulation period below one of the biomass reference points.

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

Mean SSB, lowest SSB: median values over 1000 simulations of the average of 20 years of SSB, and of the lowest biomass during the 20-year projection period.

Average <SSB trigger. Number of times, on average over 1000 simulations, fixed TAC was reduced after the assessment.

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

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

where *abs* denotes absolute value, *a* is the first year in the projections, and *z* is the last one.

Results

Comparison between the performance of annual revision strategy and the multi-annual strategies in terms of median values and 90th and 10th percentiles of yields and *SSB* suggests the following (see Tables 2.12.1.1-2 and Fig 2.12.2):

- The fixed TAC strategy 600 kt provides stability at low risk, while fixed = 700 kt appears too risky (p(SSB<Bpa) = 0.48);
- The multi-annual F-based compares favourably with the annual F-based with similar level of catches.
- The multi-annual F-based strategy (F =0.17) results in similar risks and average catch than the fixed TAC.
- A fixed TAC of 700 kt results in high risk of falling below Bpa, non-zero risk of falling below Blim and on reductions of the TAC more than once (on average) during the projection period.
- In the presence of TAC overshoot fixed TAC = 600 kt has an associated risk of SSB < Bpa of about 43% while multi-annual Fpa based has a risk just over 10%.
- The results may be dependent on the starting values and assumptions about recruitment, although those were not tested.

WD by Skagen (Appendix 2??)

This study concentrated on a harvest rule with a permanent TAC and a protection rule. This was implemented here as:

If $SSB \geq SSB_{trigger}$: $TAC = TAC_{standard}$
if $SSB < SSB_{trigger}$: $TAC = TACs_{tandard} * SSB/SSB_{trigger}$

The study considered the trade-off between standard TAC and trigger SSB in terms of risk and long term average catch, under conditions where the decision to adjust the TAC is made only every 3rd year, and based on the SSB 2 years prior to the decision year. The estimate of the SSB was considered to be a noisy representation of the real biomass. The purpose was to study to what extent the harvest rule still would be satisfactory, given the delay and error that may be typical for the assessment and management of NEA mackerel.

Simulations were carried out with a stochastic projection model. The stock was projected forwards for 30 years starting with stochastic initial numbers, and applying stochastic recruitments. Removals from the stock were according to the harvest control rule as outlined above, with no implementation error. Hence, the simulations considered the real removals, and not how these removals correspond to formal TACs. Selection at age, weights and maturities at age and natural mortality were kept constant, taken from the input data to the short term prediction by the MHSA WG in 2003. Recruitment was modelled as normally distributed, with a mean according to the 'Ockhams razor' model, and a variance adapted to give a cumulated distribution similar to the distribution of historical recruitments. The SSB on which decisions to adjust the catch were based, were given a normally distributed error with av CV of 30%, which may be in line with the uncertainty of the egg survey estimates of SSB. The initial numbers were obtained by running the projection for 100 years with fixed F of 0.20. This gave an average SSB at 3 million tonnes in the starting year.

Table 2.12.3 shows the probability in percent that SSB is below 1.5 million tonnes in year 30, as a function of trigger biomass and standard TAC. SSB < 1.5 million tonnes can be taken as an indication that the stock is about to be depleted with no probability of recovery under the rule applied.

The main result of this is that a high standard TAC requires action to be taken at a high level of biomass, if not there will be a considerable risk that the stock will collapse. Standard TACs in the order of 600 000 tonnes will require a trigger point at about 2.7 million tonnes to eliminate the risk of stock collapse with the present conditioning of the model.

Figures 2.12.3 show the performance of the rule in terms of stability and need to reduce the TAC. This example is for a trigger SSB of 2.5 million tonnes, trigger values of 2.3 and 2.8 gave similar results, with probabilities and average change increasing slightly with the level of the trigger biomass. .The left panels show the probability that the TAC has to be reduced in each 3 year period. Not surprisingly, if the standard TAC is high, it is more likely that it has to be reduced, and the probability of that happening increases over time. The right hand panels show the average magnitude of the changes that have to be made. With standard catches in the order of 600 000 tonnes, there is a 10 – 20% probability that the TAC has to be reduced in any year, and the reduction will on average be in the order of 5-10%, with a small probability that it is substantially higher.

Figure 2.12.4 shows the time course of the average biomass and the average catch. SSB will rise slightly at low standard TACs, and decrease at high standard TACs. The average catch almost independent of the standards TAC, except when a very low standard TAC is applied. Hence, a high level of the standard catch gives a regime that adapts more to stock abundance at the expense of stability, but without any noticeable gain in actual yield.

The conclusion from this study is that a harvest control rule with a fixed TAC combined with a protection rule can work under the conditions typical for mackerel. The delay in decision to reduce TAC does not seem to be a major obstacle. It should be noted that the assumptions made, in particular the stock-recruit relation, probably are conservative. It must also be emphasised that implementation errors are not considered, so that the numbers referred to as TACs here represent the real removal from the stock.

WG conclusions

The overall conclusion by the group was that multiannual advise may perform well, and at least as well as annual advise regimes. The choice of harvest rules has implications for the year to year variability of the catches, and the risk of the stock becoming unacceptably small, but with the input parameters used here for recruitments, weights and selection at age in the fishery, a long term yield of about 600 000 tonnes is what can be expected. Fixed TAC regimes need some kind of protection rules, which need to be evaluated through simulation. Depending on the protection rule, fixed F regimes may carry less risk than fixed catch regimes.

The WG considers that the studies support the proposal this year to advise on a TAC valid for 3 years ahead.. In a longer time perspective, harvest rules as outlined here are promising, and should be developed further in dialogue with managers. The software presented, or extensions and refinements of these, should be adequate tools for evaluation of such harvest rules. It needs to be stressed that the catches used in the simulations represent the real uptake of the stock. Exceeding the quotas obviously leads to increased risks and so far actions to be taken if the TAC was exceeded have not been evaluated.

		Catch	Inter-A V	SSB	LowstSSB	Risk Bpa	Risk<1.5	Av N Fall <Bpa	Av Num below trig
Annual	pct 50	592	0.24	3281	3331	0.026	0	0.041	
F 0.17	pct 10	538	0.12	3017	2789				
	pct 90	649	2.14	3588	3975				
TriAnn	pct 50	593	0.1	3306	3369	0.024	0	0.05	
F strat	pct 10	527	0.05	3028	2838				
F 0.17	pct 90	645	2.4	3625	4116				
TriAnn	pct 50	600	600	600	600	0.035	0	0.089	0.604
Fixed C	pct 10	575	575	575	575				
600 t	pct 90	600	0.03	3666	4031				
Annual	pct 50	626	1.17	3072	3076	0.155	0	0.343	
F 0.2	pct 10	565	0.14	2823	2523				
	pct 90	687	2.76	3378	3756				
TriAnn	pct 50	622	0.19	3116	3120	0.17	0	0.396	
F strat	pct 10	538	0.05	2852	2567				
F 0.2	pct 90	681	2.56	3461	4011				
TriAnn	pct 50	675	0.02	2760	2643	**0.485**	0.021	2.637	1.662
Fixed C	pct 10	636	0	2414	2023				
700 t	pct 90	700	0.06	3151	3278				

Table 2.12.1 : Performance statistics for the TAC with no overshoot scenario.

		Catch	Inter-A V	SSB	LowstSSB	Risk Bpa	Risk<1.5	Av N Fall <Bpa	Av Num below trig
Annual	pct 50	618	0.93	3126	3176	0.082	0	0.18	
F 0.17	pct 10	561	0.11	2863	2618				
	pct 90	670	2.13	3437	3794				
TriAnn	pct 50	615	0.15	3147	3193	0.115	0	0.249	
F strat	pct 10	539	0.07	2843	2662				
F 0.17	pct 90	668	1.73	3528	4052				
TriAnn	pct 50	661	0.06	2865	2780	0.337	0.012	1.615	1.28
Fixed C	pct 10	631	0.05	2517	2166				
600 t	pct 90	676	0.09	3263	3457				
Annual	pct 50	641	1.08	2967	2966	0.274	0.001	0.736	0
F 0.2	pct 10	577	0.12	2704	2424				
	pct 90	699	2.48	3287	3649				
TriAnn	pct 50	630	0.89	3029	3058	0.304	0.002	0.841	0
F strat	pct 10	543	0.08	2730	2442				
F 0.2	pct 90	695	1.67	3425	4030				
TriAnn	pct 50	706	0.07	2498	2150	**0.794**	0.186	6.87	2.556
Fixed C	pct 10	655	0.05	2049	1305				
700 t	pct 90	738	0.11	2904	2889				

Table 2.12.2 Performance statistics for the scenario where there is overshoot of the TAC.

Trigger biomass											
Std. TAC	**2.0**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**2.8**	**2.9**	**3.0**
550	0.4	0.1	0.1	0	0	0	0	0	0	0	0
575	1.0	0.6	0.4	0.1	0	0	0	0	0	0	0
600	2.8	2.0	1.3	0.8	0.5	0.2	0.1	0	0	0	0
625	6.5	5.2	3.5	2.6	1.2	0.8	0.5	0.3	0.2	0	0
650	13.2	9.8	7.8	6.0	4.3	2.9	1.9	0.9	0.7	0.5	0.4
675	23.7	19.3	14.4	11.7	8.9	6.5	4.4	3.1	1.1	0.9	0.6
700	37.5	32.1	26.1	20.7	16.0	11.5	8.4	6.3	4.0	2.6	1.3

Table 2.12.3. Risk (per cent in 1000 iterations) that SSB < 1.5 million tonnes in year 30, representing 'trapping' of the stock towards collapse, as a function of standard TAC and trigger biomass.

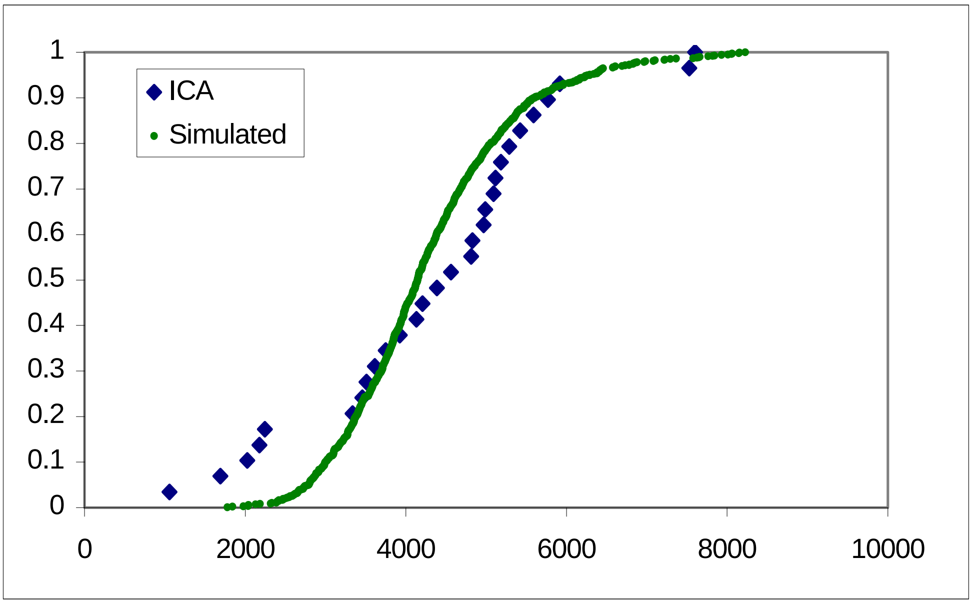


Figure. 2.12.1 ICA estimated and 1000 simulated recruitment values in the last year of the projections

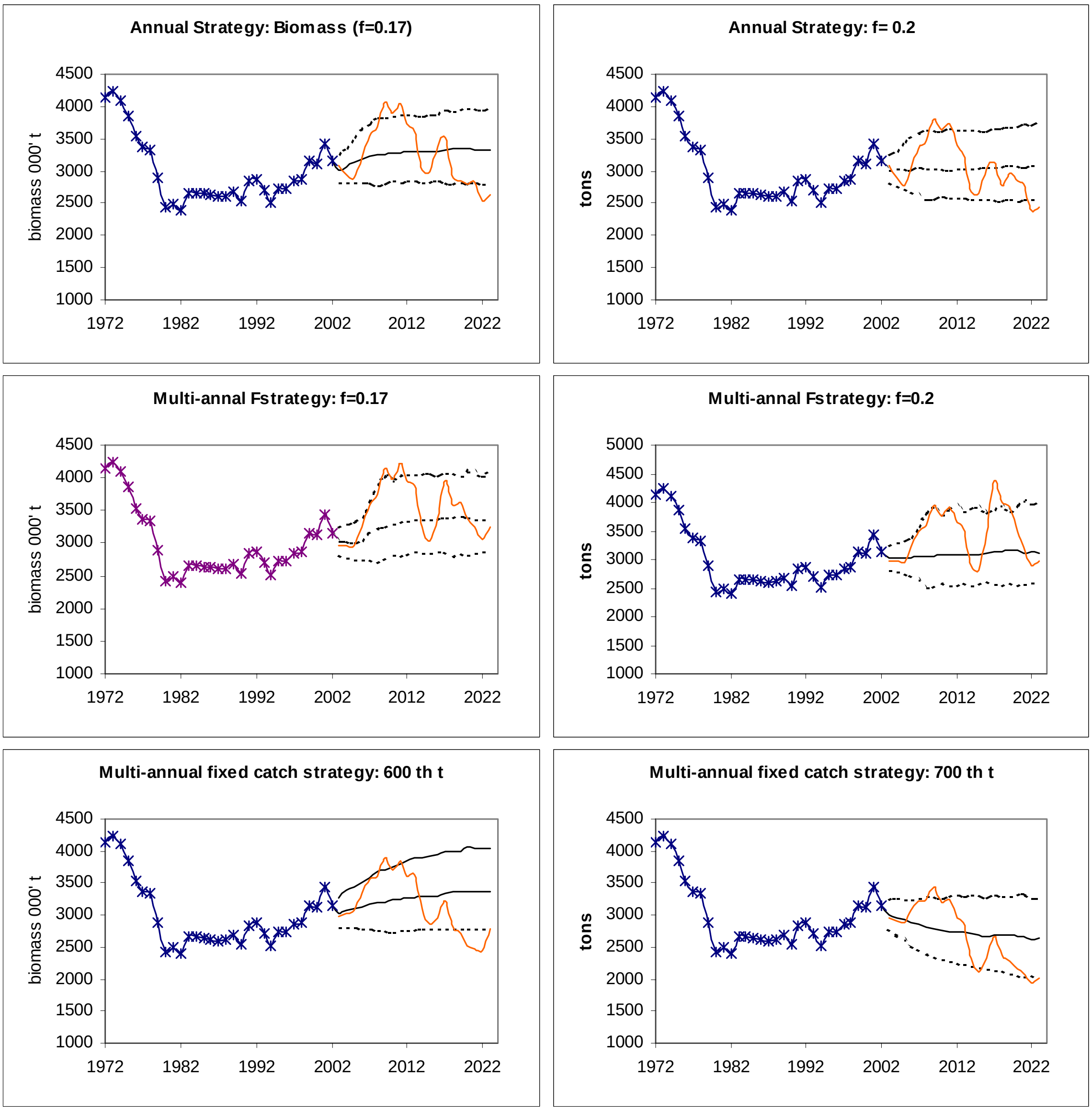
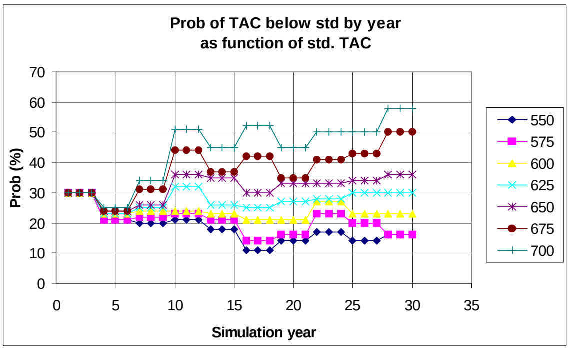


Figure 2.12.2 Spawning stock biomass projected forward 20 years, median, 10th and 90th percentiles, and deterministic trajectory for the strategies considered.



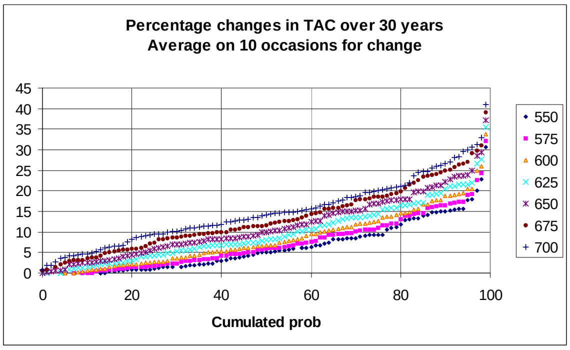
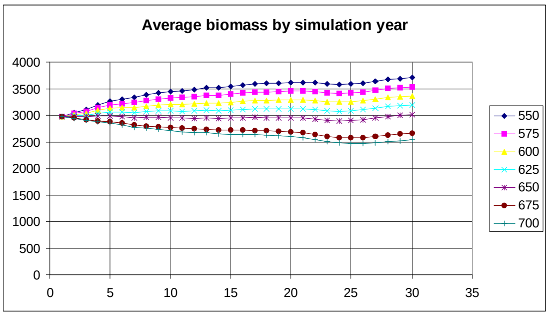


Figure 2.12.3 Performance of the harvest rule with fixed TAC as indicated, but with a reduction in TAC at estimated **SSB<2.5** million tonnes.
Left: The likelihood in each time period that the protective rule is in effect, and that the TAC is below the standard..
Right: The percentage change that on average has to be made each time the TAC is revised



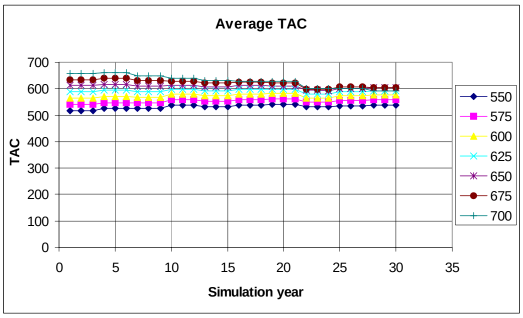


Figure 2.12.4 Performance of the harvest rule with fixed TAC as indicated, but with a reduction in TAC at estimated **SSB<2.5** million tonnes.
Left: Average spawning biomass.
Right: Average realised catch.

2.13 Special requests

For this years Working Group meeting there is no special request.

2.14 Management Measures and Considerations

The perception of the NEA mackerel stock has changed slightly. The SSB decreased since the previous assessment, but the mackerel stock still appears to have remained stable from 1980 onwards and is still in a healthy state.

In 1999 Norway, Faroes and EU have agreed on: "For 1999 and subsequent years, the parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality in the range of 0.15 – 0.20 for appropriate age groups as defined by ICES, unless future scientific advice requires modification of the fishing mortality rate." The Working Group sees no reason to deviate from the strategy to maintain a fishing mortality of 0.17. Medium and long-term predictions made in previous Working Groups have indicated that a long-term harvesting strategy with a fixed F near F0.1 would be optimal with respect to long-term yield and low risk. ACFM has recommended F=0.17 as Fpa.

The North Sea spawning component still needs the maximum possible protection although the indications from the egg survey in the 2002 stock show some signs of recovery.

Even though information on discards has improved since 2002, still, little is known about discards in the mackerel fishery.

The assessment model is considered as unreliable at estimating the most recent year classes prior to their appearance in the fishery. Given this, and the high sensitivity of the model to the most recent SSB estimate leading to fluctuations in the stock assessment, a management regime is needed which is capable of incorporating this uncertainty in the advice. Specifically the regime should consider the possibility that poor year classes are not recognised until several years later, and that the recent perceptions of the stock is subject to variability and allow for this uncertainty in the advice. See Sec-tion 2.8 and 2.9.2 for a more detailed discussion of the reliability of the assessment and its implications for management.

The management regime needs to take into account the problems in providing an accurate assessment of the state of the stock. This implies a moderate fishing mortality allowing a buffer stock, which is sufficiently large to sustain year-to-year variations in recruitment and extraction. In a strategy like this, the long term yield would be nearly independent of the fishing mortality over a wide range of fishing mortalities. So such moderate fishing mortalities can be applied without any significant loss in long term yield. The current management regime is appropriate to this approach and should be continued. However, managers should understand that fluctuations in SSB estimates are likely and that any management regime should be robust to such fluctuations on at least a three-year cycle. As such it is suggested that a multi-annual management regime could be advised for the NEA mackerel (see section 2.11).

If a triennial TAC is set for 2005-2007, it must be stressed that the proposed TAC's include all catch. Implementation error has not been considered in the calculations. If the TAC is overfished in any of years then it increases the risk that SSB will fall below 2.3 million tonnes. If the TAC is overfished, it is proposed that further TAC's are revised according to the estimates of the state of the stock then prevailing.

The Working Group made a start in the development of a Harvest Control Rule (HCR) based on a triennial advice given in a year when the SSB from a new egg survey becomes available (see section 2.12). However, further development along that line is best done in a dialogue with managers and fishing industry, and ICES is prepared to enter such a dialogue.

3 Horse Mackerel

3.1 Fisheries in 2003

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 2003 was 241,800 tons which is 500 tons more than in 2002. Ireland, Denmark, Scotland, England and Wales, 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 quarterly catches of horse mackerel by Division and Sub-division in 2003 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, Ireland, Germany, Netherlands, Norway, Portugal and Spain representing 93 % of the total catches. About 103,000 tons of horse mackerel was caught in the juvenile area (Divisions VIIa,e,f,g,h and VIIIa,b,d). About 42% of this catch in numbers was from the 2001 year class (see section 5.4.1).

First quarter: 56,000 tons. This is around 6,200 tons less than in 2002. The catches this quarter (Figure 3.1.1.a) are mainly distributed in the western and southern areas as in previous years. About 500 tons were taken in northern part of Division IVa. These catches might represent western fish migrating back to the spawning area.

Second quarter: 20,900 tons. This is about 18,000 tons less than in 2002. As usual, rather low catches were taken during the second quarter and the catches are distributed as in previous years (Figure 3.1.1.b). Most of the catches were taken in the southern part of the western area and in the southern area.

Third quarter: 26,800 tons. This is about 1,600 tons less than in 2002. As in previous years the catches were spread over large parts of the distribution area (Figure 3.1.1.c).

Fourth quarter: 138,200 tons. This is about 14,000 tons more than in 2002 and the distribution of the catches were mainly as in previous years (Figure 3.1.1.d). The Norwegian fishery in the North Sea has since 1987 mainly been carried out during this quarter and the catches have varied between 2,000 and 128,000 tons. In 2003 Norway caught 20,500 tons which was about 15,000 tons less than in 2002.

During this quarter in 2002 a record high numbers of juvenile horse mackerel (particularly the 2001 year class) were caught in the juvenile distribution area (Divisions VIIa,e,f,g,h and VIIIa,b,d).

3.2 Stock Units

For many years the Working Group has considered 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 to have broadly similar migration patterns as NEA mackerel.

A study of stock structure of horse mackerel from an holistic point of view within the western, the southern, the North Sea and the Mediterranean areas has just been carried out in a EU funded project (HOMSIR, QLK5-Ct1999-01438). The project included various genetic approaches (multilocus allozyme electrophoresis, mitochondrial DNA analysis, microsatellite DNA analysis and single stranded conformation polymorphysm SSCP analysis), the use of parasites as biological tags, body morphometrics, otolith shape analysis and the comparative study of life history traits (growth, reproduction and distribution). The project finished in June 2003 and some of the main results from this project that could be of interest for this Working Group were (Abaunza et al., 2004):

- *A major separation of horse mackerel populations between the Atlantic Ocean and the Mediterranean Sea exists.*
- *However, the horse mackerel from the Alboran Sea (the most western Mediterranean Sea) and from the Atlantic Ocean (near to Strait of Gibraltar) could be partially connected.*
- *Horse mackerel from the west Iberian Atlantic coast can be distinguished from the rest of the Atlantic areas.*
- *In the Atlantic Ocean, the northern boundary of the so called "southern stock" ought to be revised, and accordingly, the southern boundary of the so called "western stock".*

The body morphometrics and the otolith shape analysis joined the northwest of the Iberian Peninsula (North Galicia) to the areas located more to the North in the Atlantic Ocean, Bay of Biscay and Celtic Sea. On the other hand, the genetic results from SSCP associates the northwest of Iberian Peninsula to the Portuguese sampling sites. These differences between the techniques suggest that North Galicia may correspond to a transition area between two possible stock units. Therefore, it is proposed to move the actual boundary of the "Southern" and "Western" stocks from Cape Breton Canyon (southeast of Bay of Biscay) to the northwest of Iberian Peninsula (Galician coasts) and specifically to Cape Finisterre at 43º N latitude, which could be considered also as a boundary for certain hydrographic features like the influence of North-Atlantic Central Water (Fraga et al., 1982).

- *The southern boundary of the so called "southern stock" is more uncertain*. The finding of parasites typically distributed in tropical areas in Portuguese coasts suggest migrations of *T. trachurus* from West Africa into European waters. The similarities found in otolith shape analysis between the Portuguese coast and the very far southwards coast of Mauritania, open the question of the connexion between the Portuguese sampling sites and the Northwest African coasts as was also suggested by Murta (2000). Given that the only area sampled in the African coast is very far southwards (coast of Mauritania), data from the Moroccan coast is needed to allow a definitive delimitation of the southern boundary of this stock.
- *Parasites and body morphometrics indicated that horse mackerel in the North Sea could constitute a stock well differentiated from the rest of adjacent Atlantic areas.*
- *Horse mackerel in western european coasts, from the northwest of Spain to Norway, seems to be a unique stock*. This definition is very similar to the current so called "western stock", excepting that from the results of this project it is also included the north coast of the Iberian Peninsula. Nor the SSCP results neither the parasite composition showed any contradiction with this definition. Anisakid parasites species composition are homogeneus through this area. otolith shape analysis and body morphometrics include the sampling sites from this area in the same cluster showing a great similarity in their morphometric characters.
- *However, the population structure in the western european coasts could be more complicate and more research is needed to clarify the migration patterns within the Northeast Atlantic Ocean.* This is especially relevant to the boundary areas between the North Sea Stock and the Western stock (Northern North Sea and English Channel).
- *Horse mackerel from the Mauritanian coasts is differentiated mainly by the high growth rates and high batch fecundity*

Therefore, in many ways the project results support the Working Group's perception of stock units. Based on findings in this project the working group decided to include Division VIIIc as part of the distribution area of the western horse mackerel stock. 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 as in previous years allocated to the three stocks as follows:

Western stock: Divisions IIa, IIIa (western part), Vb, IVa, VIa, VIIa–c,e–k and VIIIa-e. As mentioned before based on the results of the HOMSIR project Divison VIIIc is also considered as part of the distribution area of this stock. 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 2003 these catches were low and represent either 2% of the North Sea stock or 0.4% of the western stock. The Working Group allocated these catches to the North Sea stock.

The present TAC set by EU applies only to EU waters of the Divisions VIa, VIIa–c,e–k, VIIIa,b,d,e and the western part of Division IVa,. A TAC set for the western stock should to apply to the total distribution area including Division VIIIc and the second half of the year for Divisons IVa and IIIa (western part)..

North Sea stock: Divisions IIIa (eastern part), IVb,c and VIId. The catches from the two first quarters from Divisions IVa and IIIa were allocated to the North Sea stock.

Southern stock: Division IXa. All catches from these areas are allocated to the southern stock. As mentioned before based on the HOMSIR results Division VIIIc is now 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. The WGMHSA revised Figure 3.3.1 this year in a way that it now shows how much of the catches taken in Division IIIa and IVa that have been allocated to North Sea and western horse mackerel respectively.

3.4 Estimates of discards

Over the years only one country have provided data about discard 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. 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 *Trachurus* genus, *T. trachurus*, *T. mediterraneus* and *T. picturatus* are found together and are commercially exploited in NE Atlantic waters. Studies on genetic differentiation showed three clear groups corresponding to each species of *Trachurus* with no intermediate principal component scores, excluding the possibility of hybrids between species (Soriano, M. and Sanjuan, WD 1997).

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 total catch of *T. mediterraneus* was 2039 t in 2003, showing a slight increase with respect to the 2002 (1724 t) catch level, the lowest ones since 1982. In Sub-divisions VIIIc West, IXa North and IXa South there are no catches 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, mainly in autumn, when the *T. trachurus* catches were lowest. *T. mediterraneus* catches were lowest in spring.

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 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 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 catches of *T. mediterraneus* and *T. trachurus* appear separately, except for some small categories, in which the separation is made on the basis of samplings carried out in ports and information reported by fishermen. In the ports of Cantabria and Asturias the separation of the catch of the two species is not registered in all the ports, for which reason the total separation of the catch is made based on the monthly percentages of the ports in which these catches are separated and based on samplings made in the 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 1986-2003 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.

As information is available on the amounts and distribution of catches of T. *mediterraneus* and *T. picturatus* for at least 15 years (ICES 1990/Assess:24, ICES 1991/Assess:22, ICES 1992/Assess:17, ICES 1993/Assess: 19, ICES 1995/ Assess:2, ICES 1996/Assess:7, ICES 1997/Assess:3, ICES 1998/ Assess:6, ICES 1999/ ACFM:6, ICES 2000/ACFM:5; ICES 2001/ACFM:06; ICES 2002/ACFM:06; ICES 2003/ACFM:06; ICES CM 2004/ACFM: 08), and as the evaluations and assessments are 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*. in general, as is the case at present . It would then be appropriate to set TACs for the other species as well.

3.6 Length Distribution by Fleet and by Country:

As usual England and Wales, Netherlands, Norway, Germany, Ireland, Portugal and Spain provided length distribution data for parts or for the total of their catches in 2003. These length distributions cover 85 % of the total landings and are shown in Table 3.6.1.

3.7 Egg surveys

3.7.1 Description

The ICES Triennial Mackerel and Horse Mackerel Egg Survey was carried out from January to July 2004. It is planned to present the results of the survey at the WGMEGS in Bergen, Norway in April 2005. However, it was agreed at the WGMEGS meeting in Lisbon 1-4 April 2003 that the WG should aim to provide an estimate of western horse mackerel egg production in time for the meeting of the WGMHSA in Copenhagen, September 2004 (ICES CM 2003/G:07).

Details of the survey and the analysis methods are presented in section 2.5.1.

Details of egg production presented here refer to the old western stock area (not including VIIIc). These surveys run from period 3 to period 7. In the future the egg production for the western stock will have to include VIIIc. This will entail a revision of the historical data series.

Data analysis for Annual egg Production

Plots of the distribution of horse mackerel egg production for the western area are presented in Figures 3.7.1.1. a-e. In general the coverage in periods 3 – 6 was very good. There was a greatly reduced need for rectangle interpolation than in 2001. The edges of the egg distribution were also generally well defined with zero samples along the borders. However, the survey did have a small number of aspects where there were minor problems.

- In period 5, the area between 46 and 47°N was not fully covered, and some egg production was probably missed along the shelf break.
- In period 6, there was probably some egg production missed south of 47°N.
- In period 7, it proved impossible to obtain sufficient vessel resources to cover the whole area. As a result the areas north of 55°N, and south of 48°30'N were not surveyed, and some egg production was probably missed. Additionally, there was a single large interpolated value north of 52°N.

Much of the Total Annual Egg Production (TAEP) was driven by a small number of large observations in periods 5, 6 and 7. The egg production in these rectangles was up to four times that seen in previous surveys of this stock.

Egg production for each survey period was then calculated by raising each value to the rectangle area, summing across the whole period, and raising to the number of days in each period. Egg production in the unsampled periods were then calculated by simple linear interpolation from the adjacent periods. The observed and interpolated periods were then assembled to produce separate western and southern area egg production curves or histograms. The TAEP was then calculated by integration of the histograms. The egg production curve is presented in fig 3.7.1.2. The TAEP for the western area was $0.67783 * 10^{15}$. This can be compared with a value of $0.684 * 10^{15}$ in 2001.

Following the 2001 egg survey it was agreed that as horse mackerel was probably an indeterminate spawner, it was not possible to use fecundity data to convert this value to biomass. For the time being the TAEP will be used as an index of abundance in the assessment.

This information will be presented in more detail following the meeting of WGMEGS in April 2005.

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[1]
II + Vb	2,538	2,557	1,169	60	1,324	24
IV + IIIa	31,295	58,746	31,583	19,839	49,691	34,226
VI	35,073	40,381	20,657	24,636	14,190	23,254
VII	250,656	186,604	137,716	138,790	97,906	123,046
VIII	38,562	47,012	54,211	75,120	54,560	41,711
IX	41,574	27,733	27,160	24,912	23,665	19,570
Total	399,698	363,033	272,496	283,357	241,335	241,831

[1]Preliminary.

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

Division	1Q	2Q	3Q	4Q	TOTAL
IIa+Vb	2	0	22	0	0
IIIa	48	0	139	1,835	2,022
IVa	520	103	71	21,201	21,895
IVbc	2,2236	548	1,553	5,972	10,309
VIId	7,317	830	129	12,823	21,098
VIa,b	6,140	208	4,861	12,045	23,254
VIIa–c,e–k	22,907	2,642	4,260	72,139	101,948
VIIIa,b,d,e	11,054	5,700	2,873	2,105	21,732
VIIIc	1,644	6,211	7,155	4,969	19,979
IXa	4,081	4,667	5,735	5,086	19,570
Sum	55,949	20,909	26,799	138,174	241,831

Table 3.3.1 Landings and discards (only limited data) of HORSE MACKEREL (t) by year for the North Sea, Western and Southern horse mackerel stocks, by Divisions. (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

[1]Divisions IIIa and IVb,c combined
[2]Norwegian catches in IVb included in Western horse mackerel
[3] Includes Norwegian catches in IVb (1,426t)
[4]Includes 1937 t from Vb.
[5]Includes 132 t from Vb
[6]Includes 250 t from Vb

Table 3.5.1 Catches (t) of Trachurus mediterraneus in Divisions VIIIab, VIIIc and IXa and Sub-area VII in the period 1989-2003 and Trachurus picturatus in División IXa, Subarea X and in CECAF Division 34.1.1 in the period 1986-2003.

	Divisions	Sub-Divisions	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
T. mediterraneus	**VII**		-	-	-	0	0	0	0	0	0	0	0	0	0	0	59	1	1	0
	VIIIab		-	-	-	23	298	2122	1123	649	1573	2271	1175	557	740	1100	988	525	525	340
	VIIIc	VIIIc East	-	-	-	3903	2943	5020	4804	5576	3344	4585	3443	3264	3755	1592	808	1293	1198	1699
		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
	IXa	IXa North	-	-	-	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
		Total	-	-	-	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**
T. picturatus	**IXa**		367	181	2370	2394	2012	1700	1035	1028	1045	728	1009	834.01	526	320	464	420	663	773
	X Azorean Area		3331	3020	3079	2866	2510	1274	1255	1732	1778	1822	1715	1920	1473	690	563	1089	5000	1509
	34.1.1 Madeira's area		2006	1533	1687	1564	1863	1161	792	530	297	206	393	762	657	344	646	385	358	572
	TOTAL		**5704**	**4734**	**7136**	**6824**	**6385**	**4135**	**3082**	**3290**	**3120**	**2756**	**3117**	**3516**	**2657**	**1354**	**1672**	**1894**	**6021**	**2854**

(-) Not available

Table 3.6.1 Length distributions (%) of HORSE MACKEREL catches by fleet and country in 2003 (0.0=<0.05%)

	E&W	Neth	Germany						Norway	Spain				Portugal			Ireland
	P. trawl	P.trawl	Trawl						P.seine	P.seine	D.trawl	Gill net	Hook	Trawl	P. Seine	Artisanal	Trawl
cm	Div. VIIe	All	Div VIIb	Div VIIc	Div VIId	Div VIIe	Div VIIh	Div VIIj	Div IVa	All	All	All	All	All	All	All	All
5																	
6															1.8		
7															7.0		
8															3.2		
9														0.0	3.0	0.1	
10										0.1				0.3	3.3	0.9	
11										0.7				0.7	3.6	2.5	
12						0.0				2.7				1.8	5.2	6.6	
13						0.0				3.4	1.2	0.0		4.8	7.3	4.4	
14						0.1				2.5	3.4	0.1		6.8	9.4	3.1	
15		0.1				0.2				1.8	15.9	0.1		8.1	16.7	3.6	
16		0.6			0.0	0.3				4.2	19.4	0.1		6.6	13.3	2.7	
17		1.5			0.0	1.5	0.0			7.7	6.8	0.1		7.8	11.7	1.2	
18	0.1	3.3			0.2	6.8				11.8	2.6	0.1		6.0	5.1	0.8	
19		5.1			2.5	14.2	1.3			13.3	0.7	0.0		5.7	2.0	0.6	0.0
20	1.3	9.9			6.3	17.4	9.0			11.1	0.5	0.1		5.4	2.6	0.8	0.2
21	4.1	6.5			15.4	14.9	20.8			9.3	0.7	0.1		6.2	3.3	3.2	0.3
22	5.4	7.3			27.5	15.3	24.8			6.2	0.5	0.4		7.0	1.2	3.1	0.5
23	10.8	12.4			24.9	14.7	20.3	0.1		2.5	0.7	4.1	2.6	6.2	0.2	3.7	0.7
24	11.2	11.2			10.7	6.8	9.1	0.1		2.3	0.6	12.1	2.2	5.4	0.0	4.3	4.4
25	11.2	11.4	0.6	1.1	5.1	3.6	5.7	1.1		2.1	1.6	12.8	3.4	4.3	0.0	5.3	17.4
26	10.1	7.7	3.1	5.6	3.5	2.2	4.2	5.7		2.7	3.7	13.7	3.8	3.6	0.0	9.2	23.0
27	10.2	5.6	8.4	10.1	1.8	1.0	2.7	12.5	0.4	3.6	4.2	13.9	5.9	4.2	0.0	12.2	17.0
28	9.1	4.0	12.5	19.4	0.9	0.7	1.5	20.4	1.7	2.8	4.9	9.1	6.5	3.3		11.3	13.4
29	8.6	3.7	14.5	18.7	0.5	0.3	0.4	17.3	1.4	2.7	6.8	5.7	16.8	2.4		8.0	9.9
30	5.7	2.6	15.0	14.1	0.1	0.1	0.0	13.8	2.2	2.2	6.4	5.7	22.8	1.7		4.3	5.6
31	4.3	2.5	15.6	13.0	0.2			8.9	5.4	1.7	6.1	5.1	17.0	0.8		2.6	3.5
32	3.8	2.4	13.7	8.2	0.1			7.6	5.5	1.1	4.6	4.3	10.5	0.4		1.5	1.4
33	2.0	0.6	6.6	4.5	0.0			5.1	9.4	0.6	3.0	4.2	5.5	0.3		1.3	0.7
34	1.0	0.4	3.5	3.3	0.0			2.9	14.8	0.3	2.1	3.4	0.6	0.2		0.9	0.5
35	0.7	0.3	0.0	1.4				1.3	20.3	0.3	1.7	3.1	0.9	0.1		0.7	0.5
36	0.2	0.4	2.9	0.5				1.1	18.0	0.2	0.9	1.0	0.4	0.0		0.5	0.4
37	0.1	0.2	2.4		0.02			0.8	12.6	0.1	0.6	0.4	0.2	0.0		0.4	0.3
38		0.0	0.7					0.7	5.7	0.1	0.2	0.1	0.5	0.0		0.2	0.2
39	0.1	0.0	0.6					0.2	1.3	0.1	0.1	0.2	0.0	0.0		0.1	0.1
40		0.0						0.1	1.0	0.0	0.1	0.2	0.3	0.0		0.1	0.1
41		0.0						0.0	0.1	0.0	0.0			0.0		0.0	
42+		0.0						0.2	0.1		0.0			0.0		0.0	
Sum	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

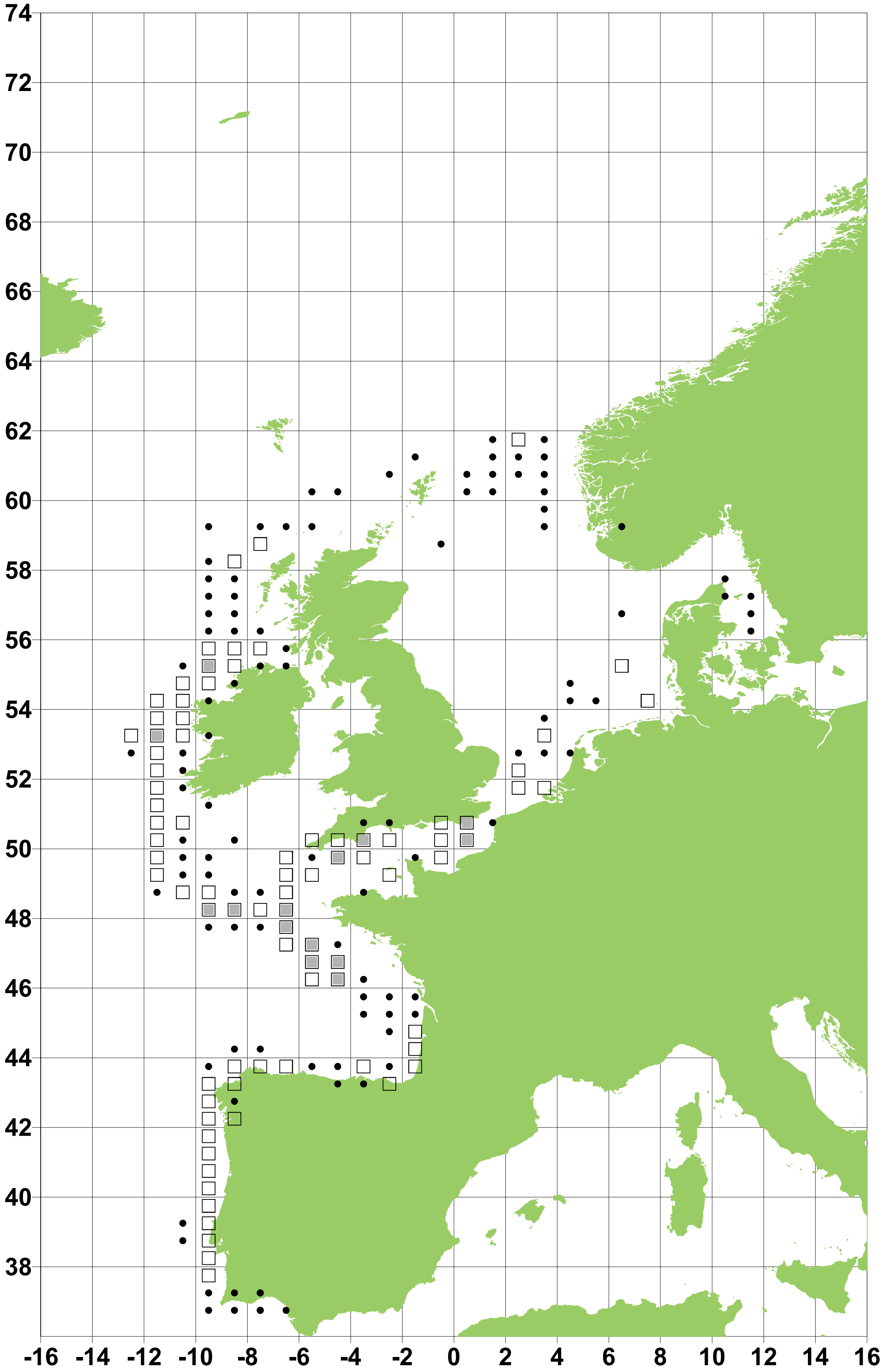


Figure 3.1.1.a Horse mackerel commercial catches in quarter 1 2003.

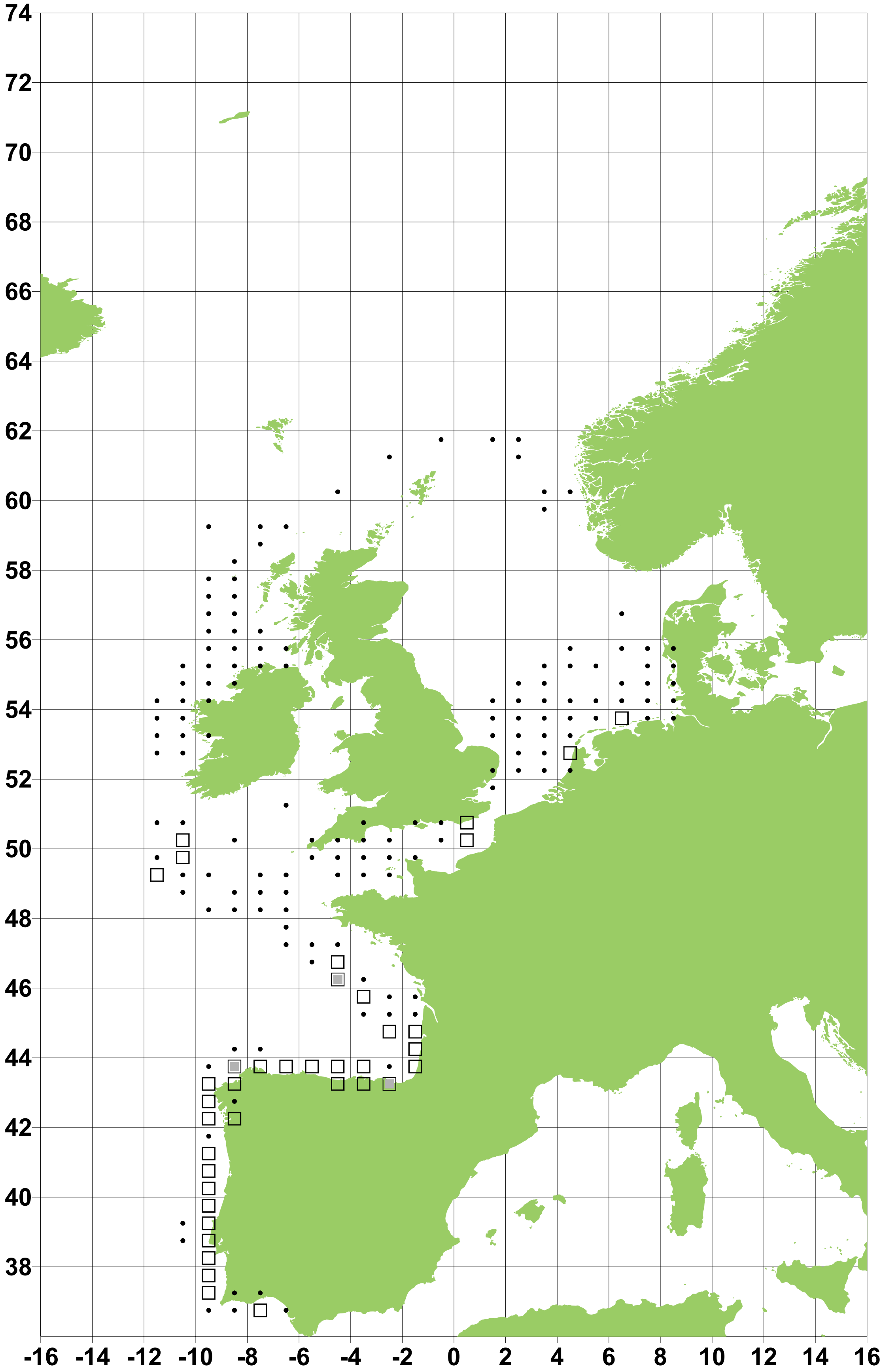


Figure 3.1.1.b Horse mackerel commercial catches in quarter 2 2003.

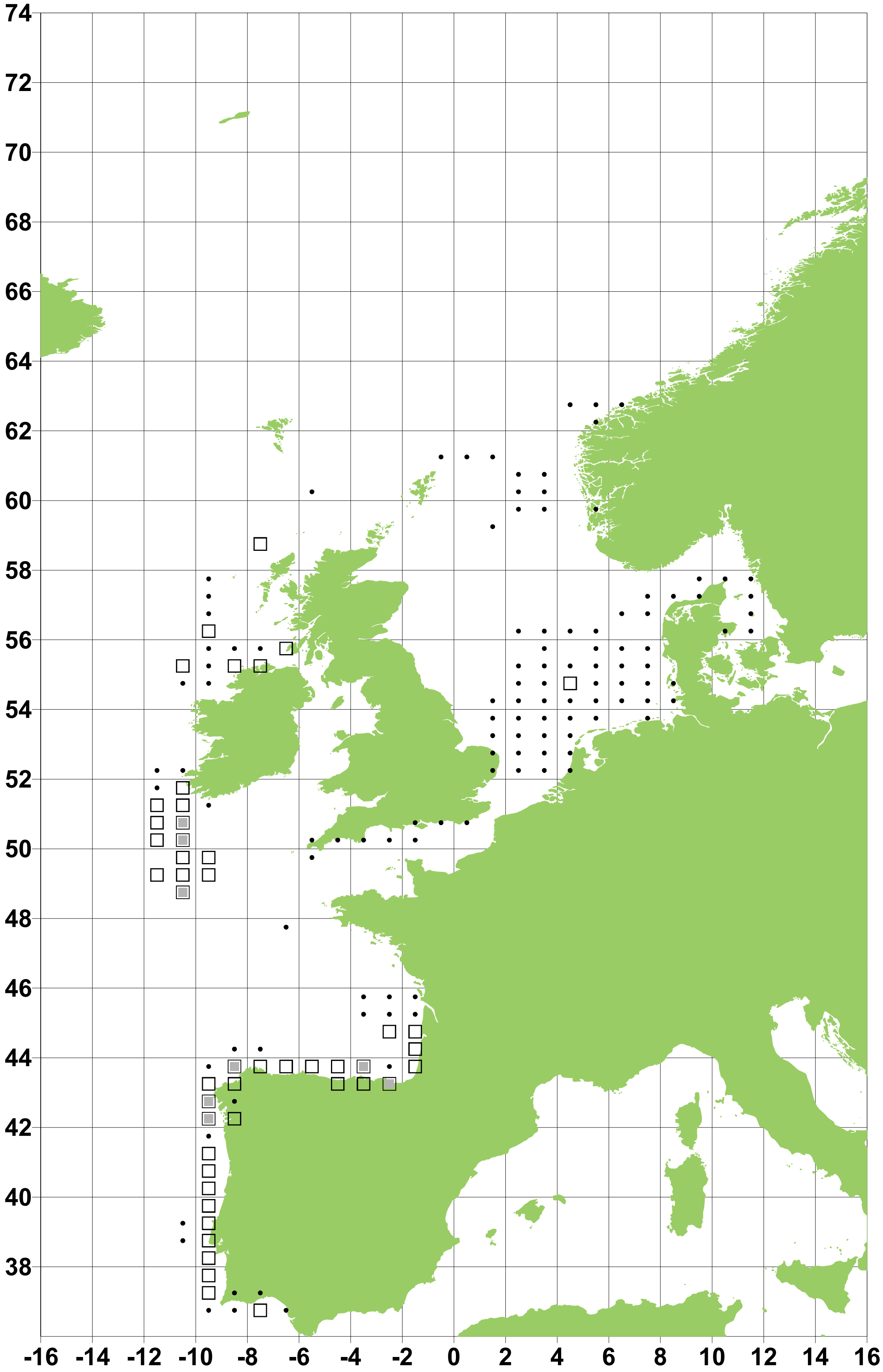


Figure 3.1.1.c Horse mackerel commercial catches in quarter 3 2003.

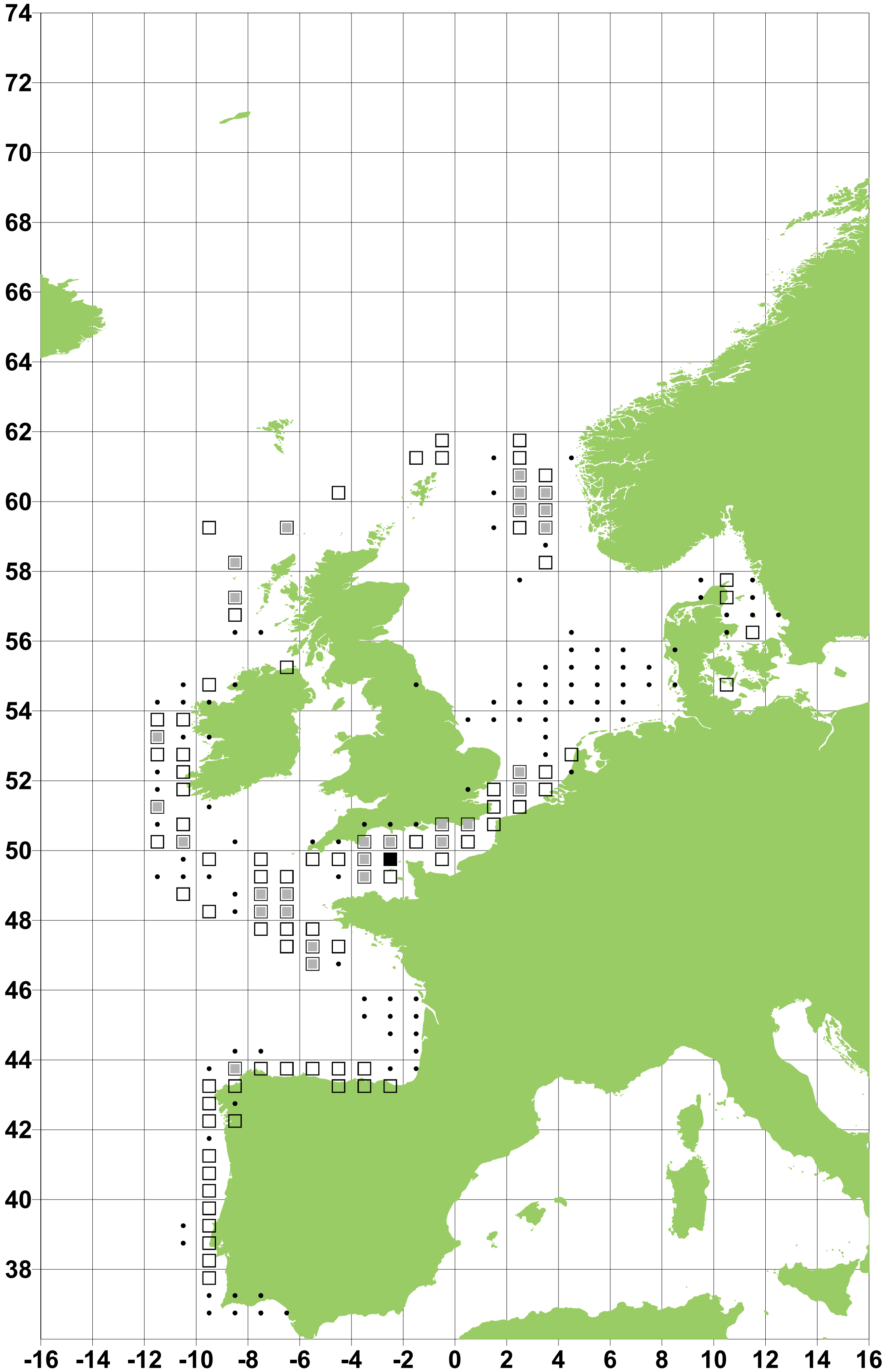


Figure 3.1.1.d Horse mackerel commercial catches in quarter 4 2003.

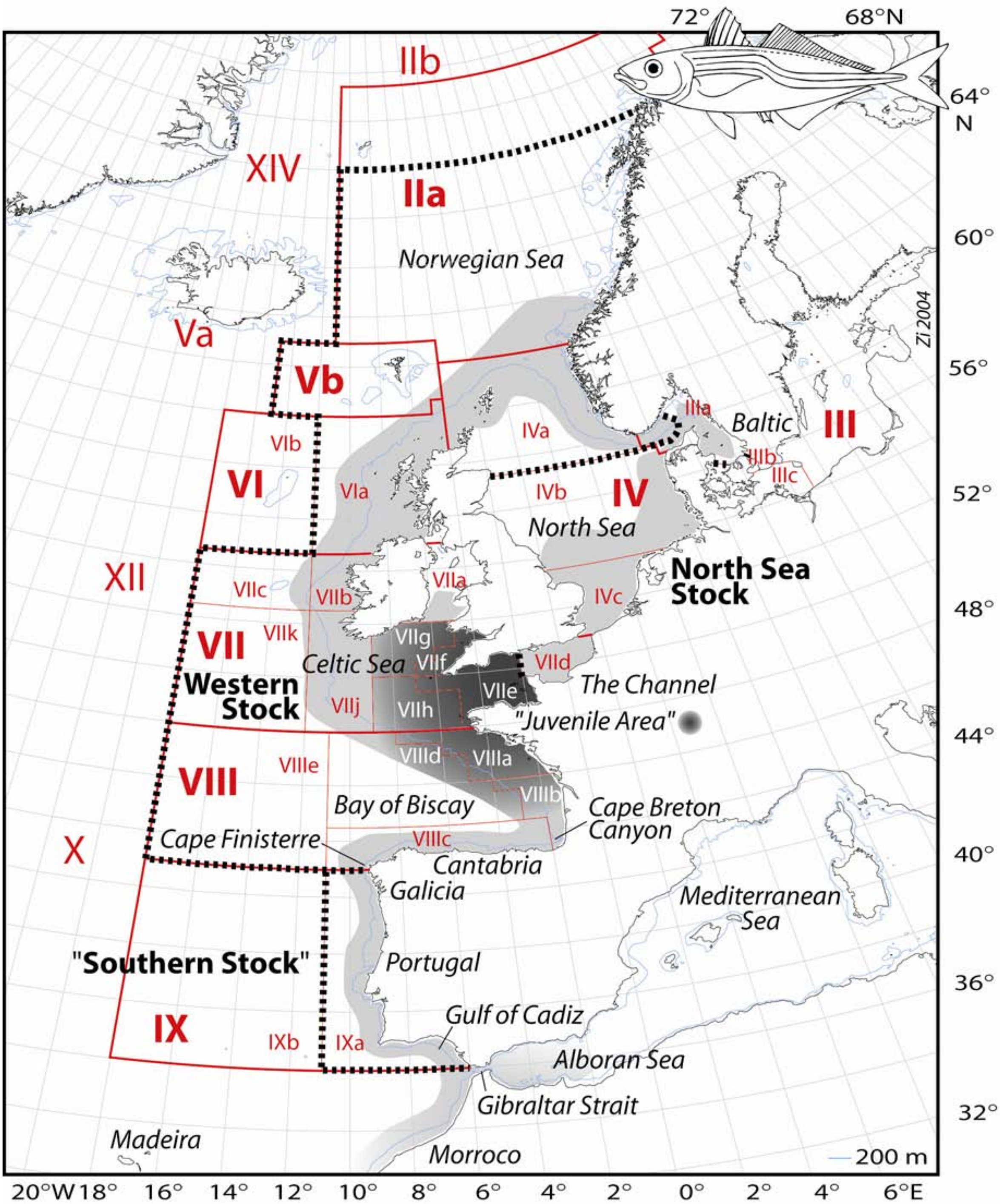


Figure 3.2.1: Distribution of **Horse Mackerel** in the Northeast-Atlantic: Stock definitions as used by the 2004 WG MHSA. Note that the "Juvenile Area" is currently only defined for the Western Stock distribution area – juveniles do also occur in other areas (like in Div. VIId). Map source: GEBCO, polar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

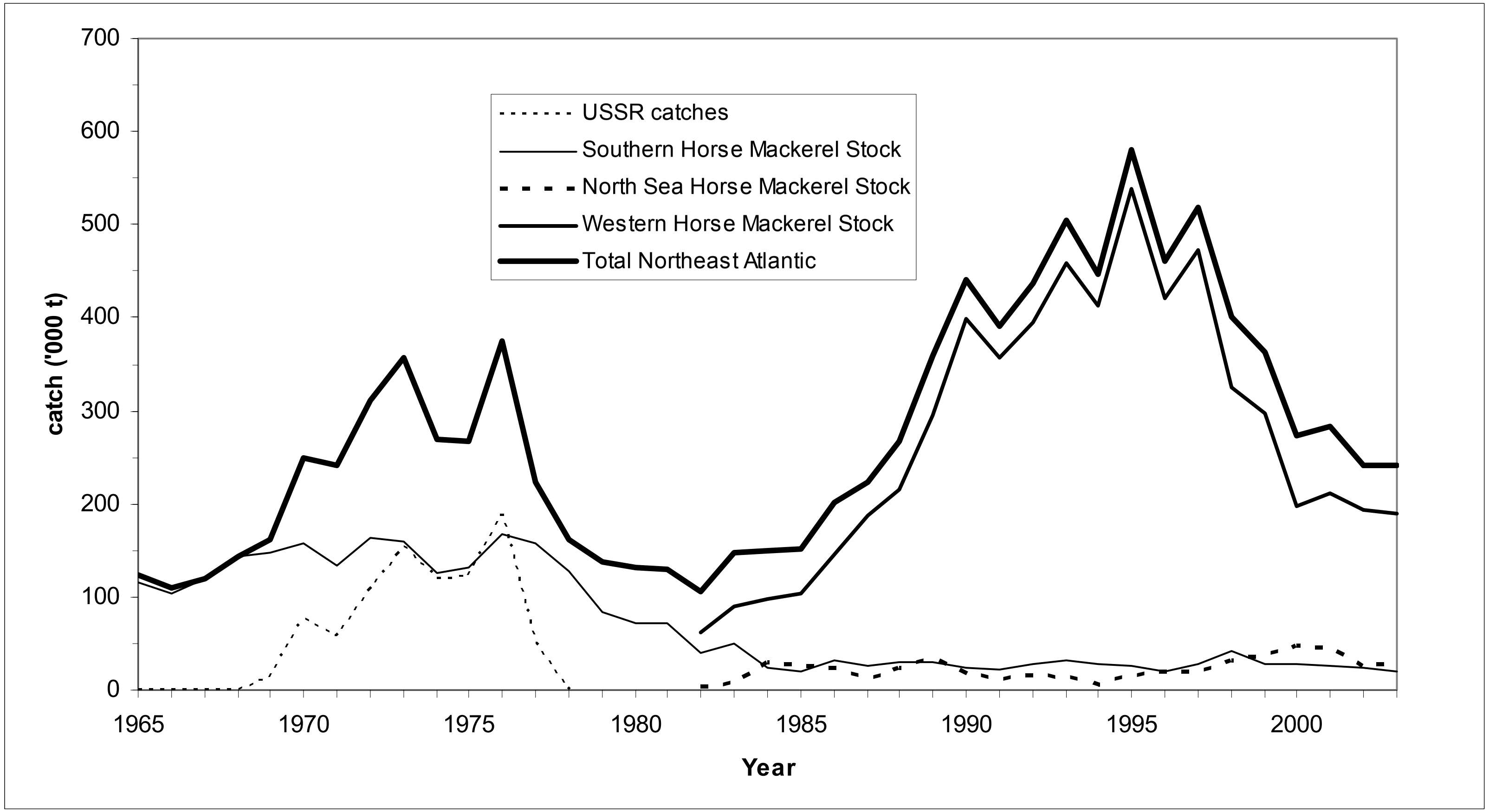


Figure 3.3.1 Total catches of horse mackerel in the northeast Atlantic during the period 1965 - 2003. The catches taken by the USSR and catches taken from the southern, western and North Sea horse mackerel stocks are shown in relation to the total catches in the northeast Atlantic. Caches from Div. VIIIc are transferred from southern stock to western stock from 1982 onwards.

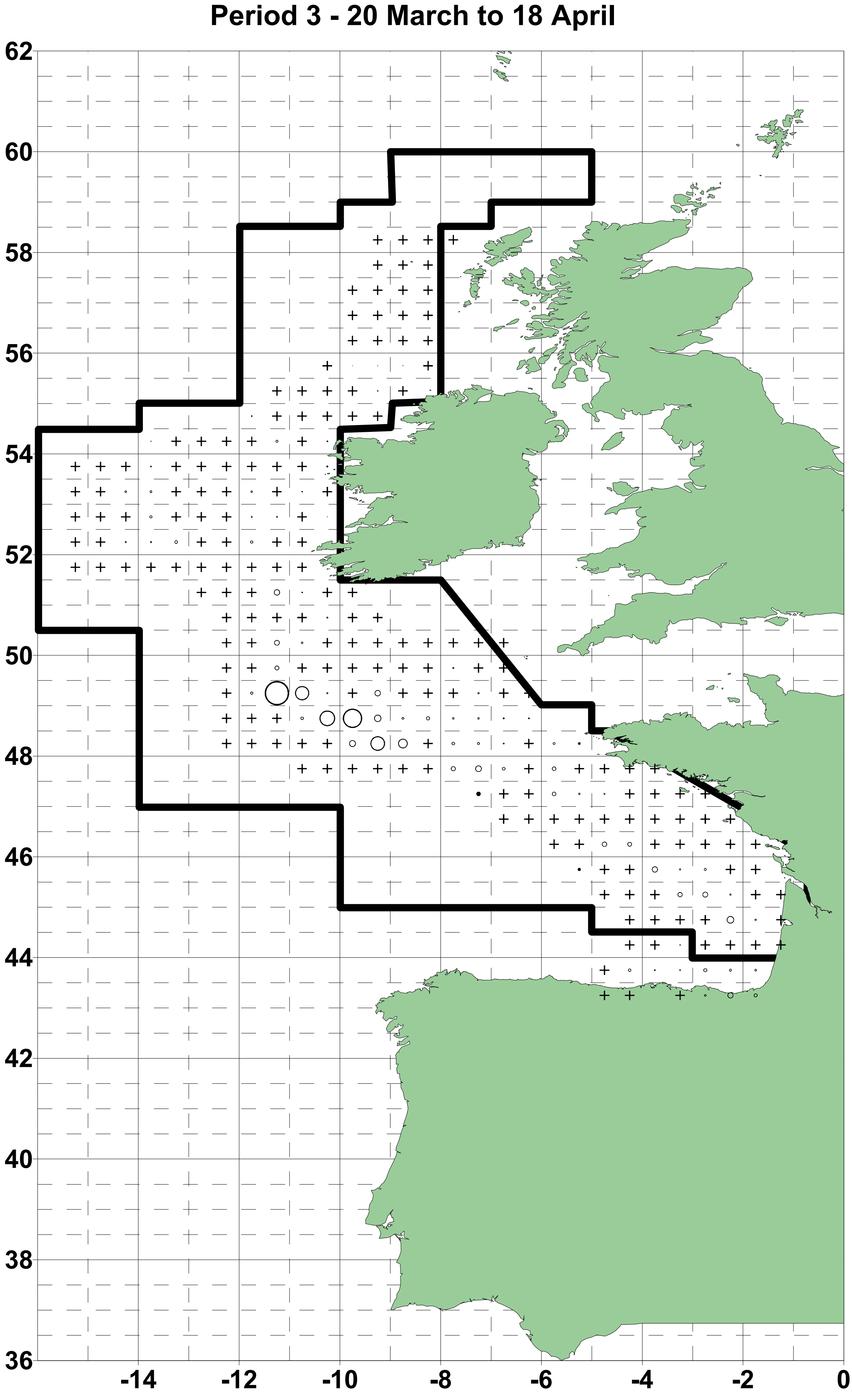


Figure 3.7.1.1.a. Horse mackerel daily egg production values from Period 3. Open circles represent observed data, and filled circles represent interpolated data. All circles are square root scaled to a max of 1000 eggs.m^{-2}.d^{-1}.

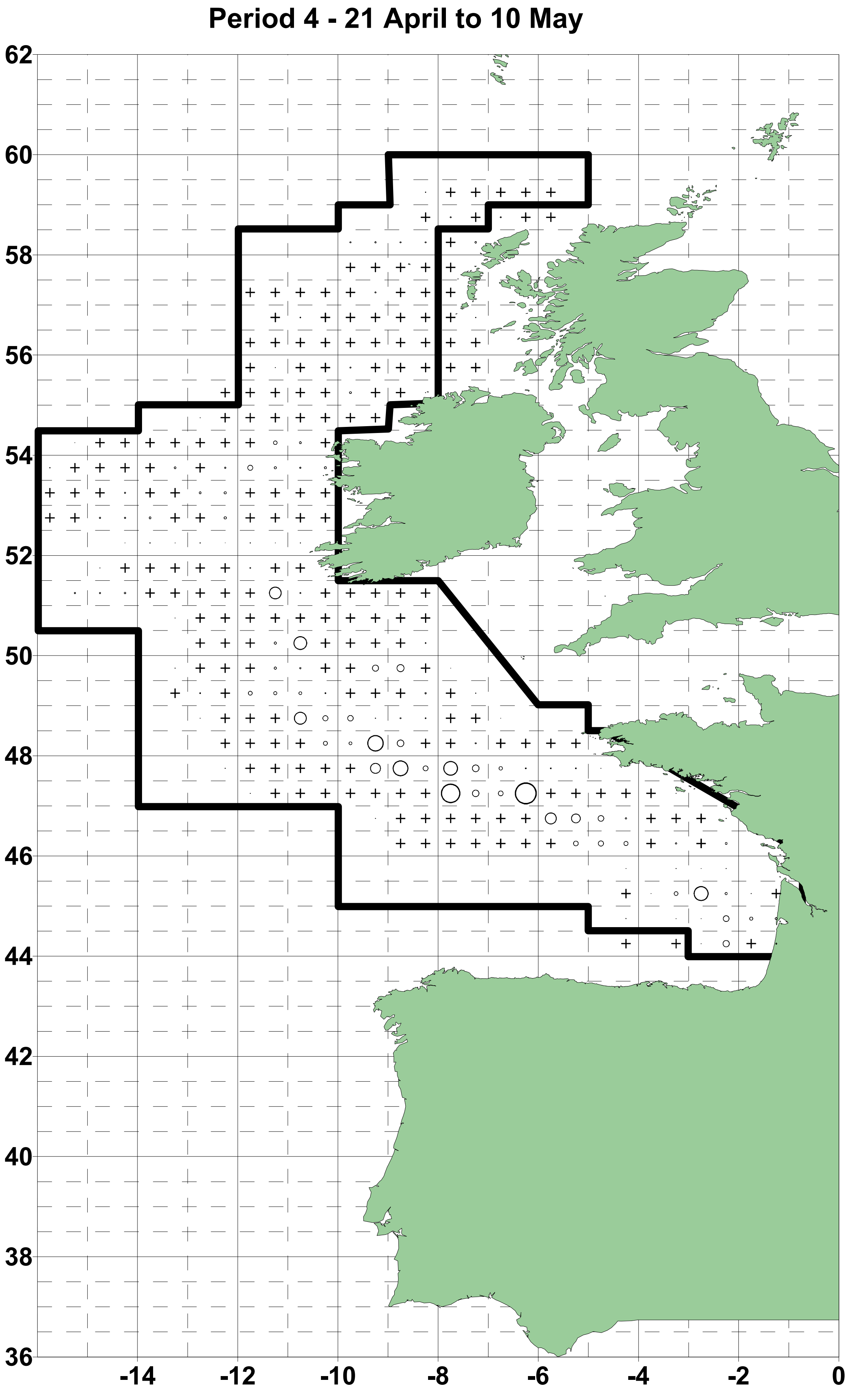


Figure 3.7.1.1.b. Horse mackerel daily egg production values from Period 4. Open circles represent observed data, and filled circles represent interpolated data. All circles are square root scaled to a max of 1000 eggs.m^{-2}.d^{-1}.

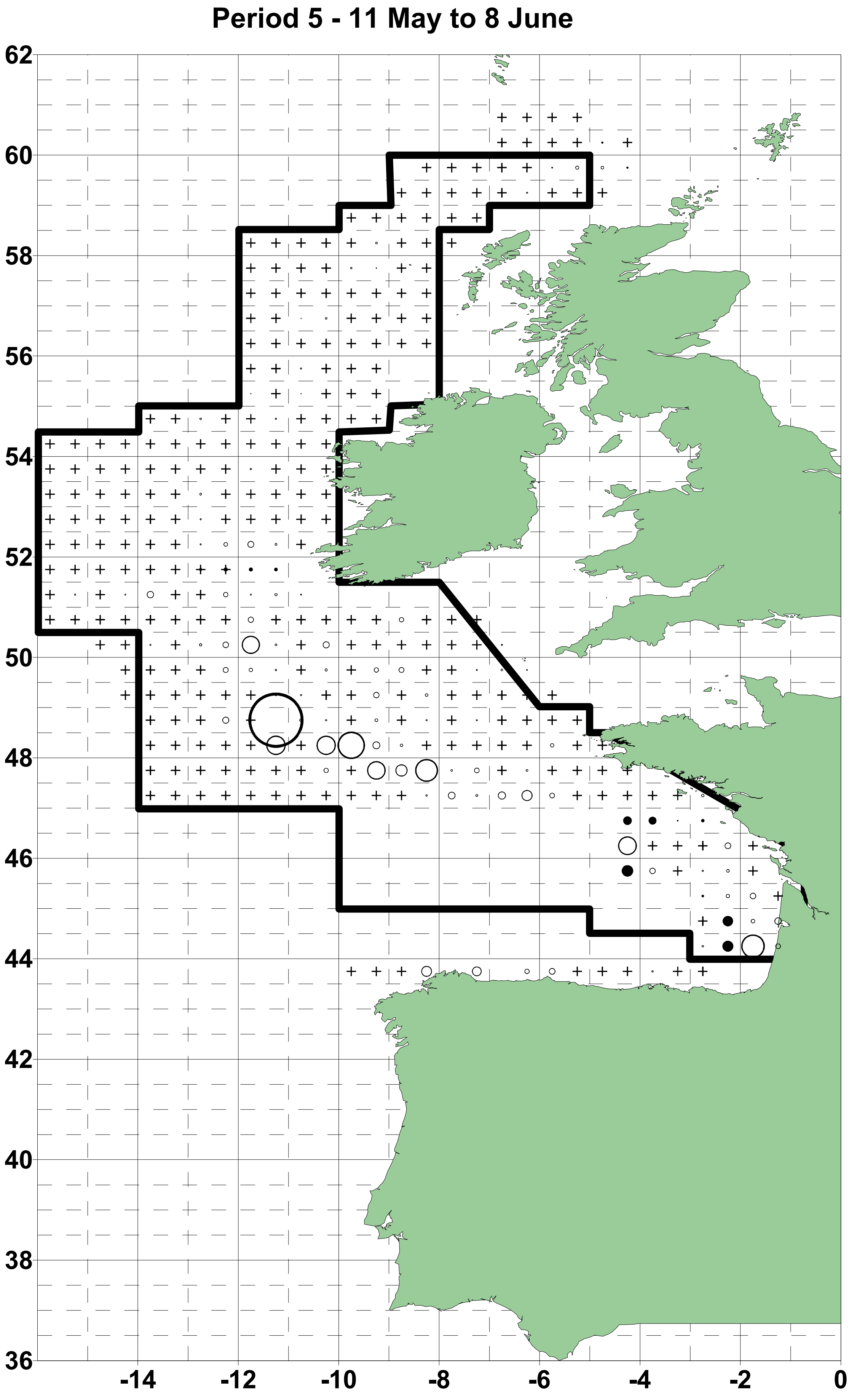


Figure 3.7.1.1.c. Horse mackerel daily egg production values from Period 5. Open circles represent observed data, and filled circles represent interpolated data. All circles are square root scaled to a max of 1000 eggs.m^{-2}.d^{-1}.

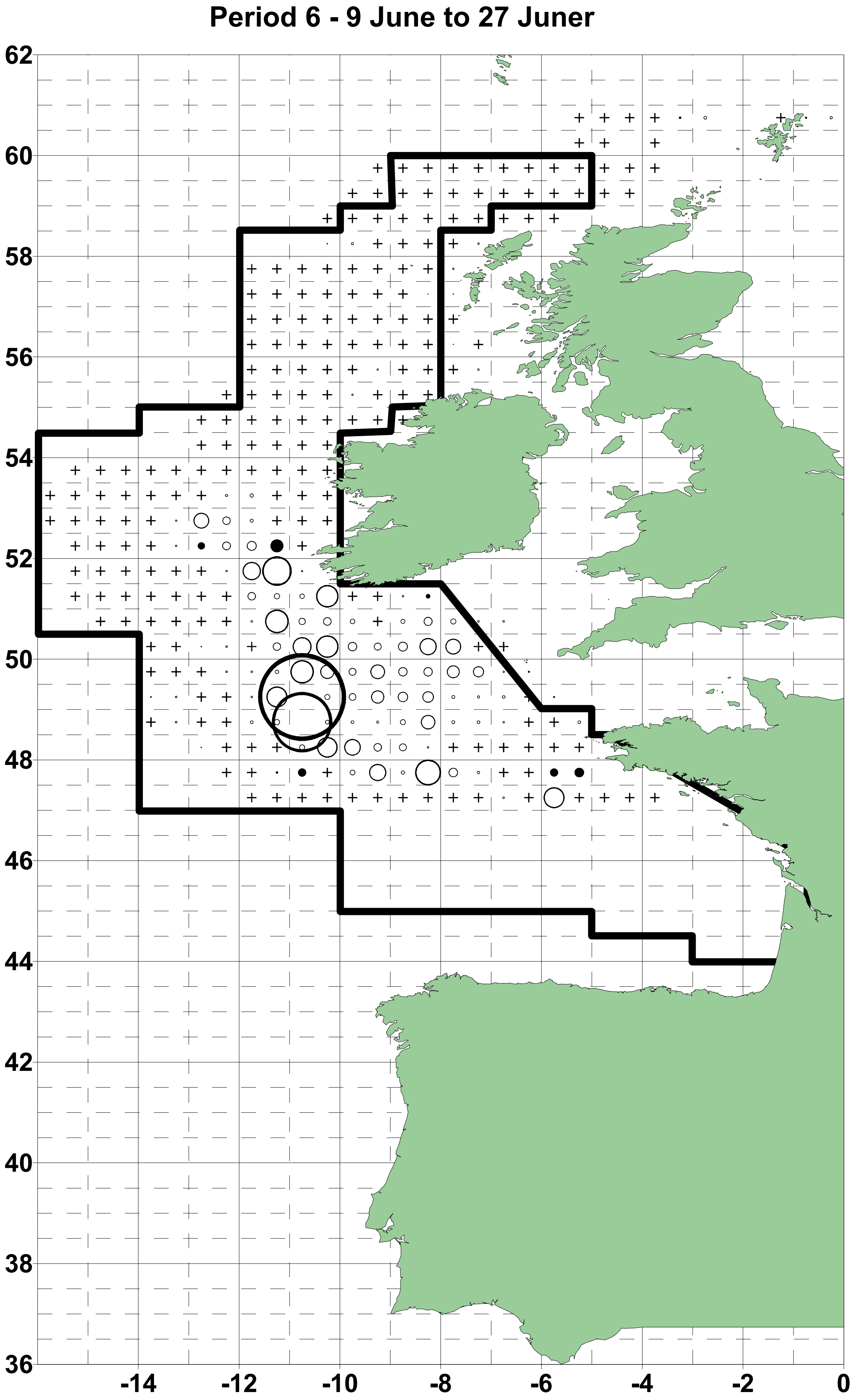


Figure 3.7.1.1.d. Horse mackerel daily egg production values from Period 6. Open circles represent observed data, and filled circles represent interpolated data. All circles are square root scaled to a max of 1000 eggs.m^{-2}.d^{-1}.

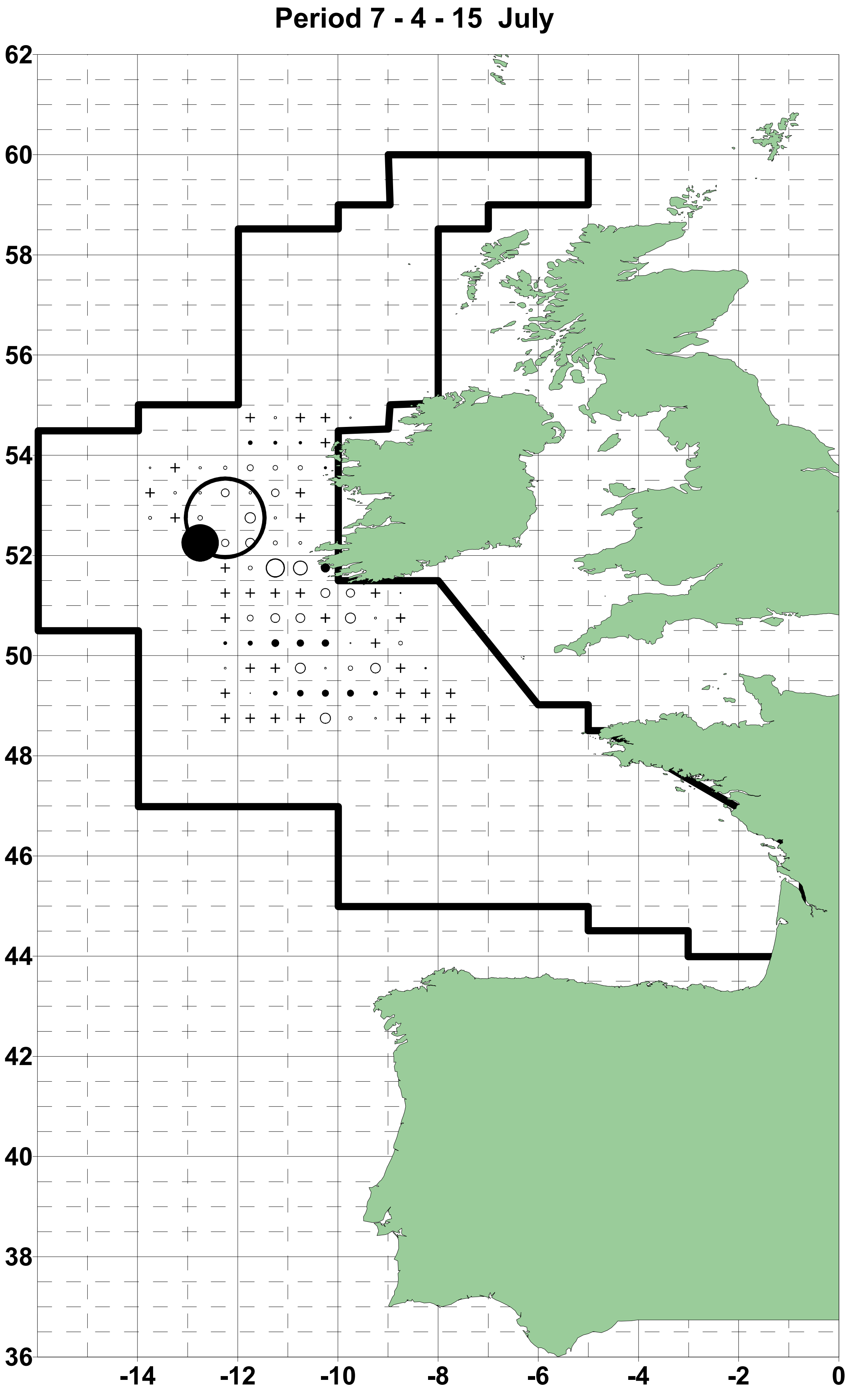


Figure 3.7.1.1.e. Horse mackerel daily egg production values from Period 7. Open circles represent observed data, and filled circles represent interpolated data. All circles are square root scaled to a max of 1000 eggs.m^{-2}.d^{-1}.

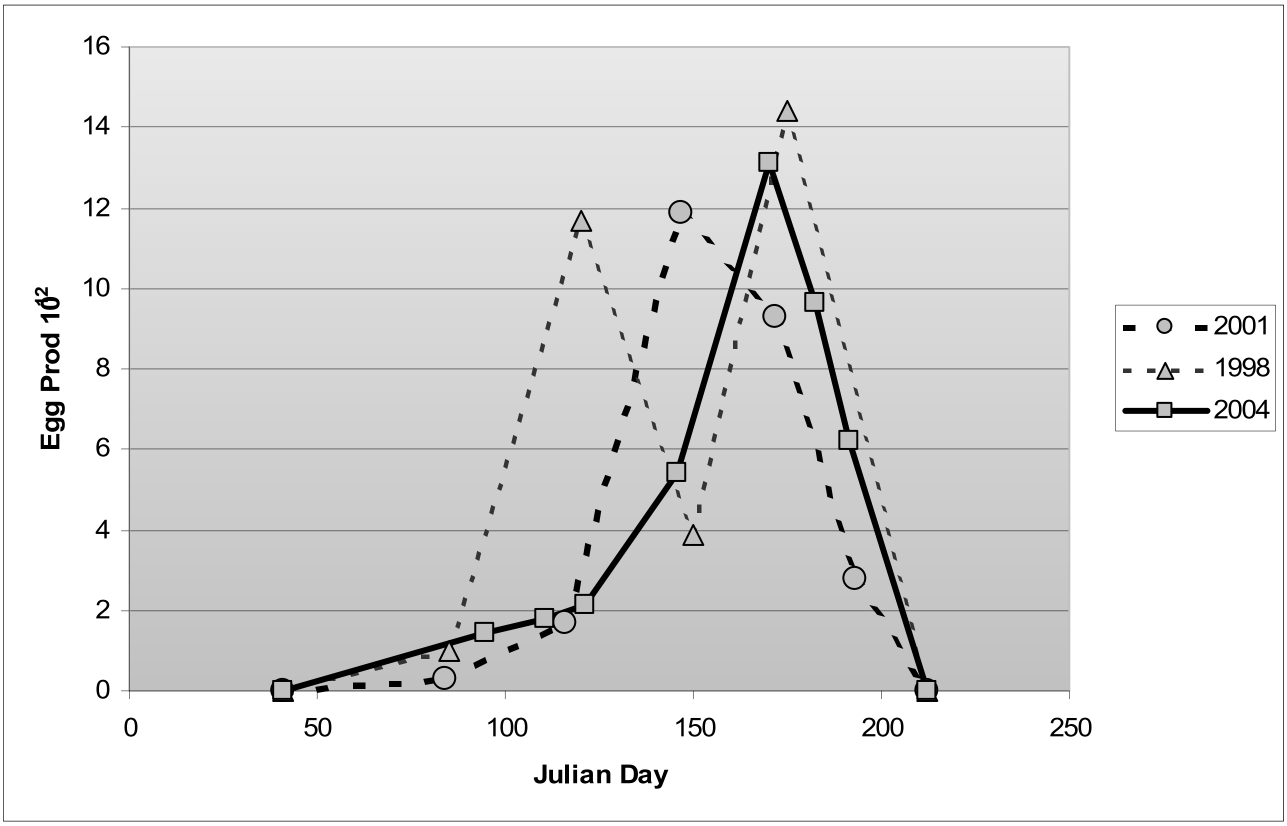


Figure 3.7.1.2. Horse mackerel egg production curve for the 2004 egg survey in the western area. The results for the 2001 and 1998 surveys are shown for comparison.

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

4.1 ACFM advice Applicable to 2003

ACFM advice in 2003 is the same as in 2002. The ACFM stated in 2002 that no assessment is possible because of insufficient data. Also fishery independent information is lacking.

Advice on management: ICES recommends that catches in 2004 be no 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.

The ACFM (in 2003) recommended a precautionary TAC not above the long term average of 18.000 tonnes in 2003.

EU has since 1987 set a TAC for EU waters in Division IIa and Sub-area IV, which is a wider area than the North Sea stock is distributed in. This TAC has been fixed at 60,000 t for 1993-1999. In 2000 the TAC was reduced to 51 000 a value which was kept for 2001 in 2002 it was 58 000 t and in 2003 it was 50 000.

4.2 The Fishery in 2003 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 1982–2003. The total catch taken from this stock in 2002 is 23380 (about half the catch of 46,425 tonnes in year 2001, which was the largest catch on record). In 2003 the catch was 32078 tonnes. 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 was 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 has cast doubt on this, so the SSB information is currently not used in assessment.

4.3.2 Bottom trawl surveys

As last year, the WG investigated the IBTS data on horse mackerel. IBTS data for North Sea Horse Mackerel are given only as catch rates by length group. Last year length distributions were converted into an index of biomass, by use of a length-weight relationship. The index of biomass was defined as

$BiomassIndex(y) = \sum_{Length} CPUE(y, Length) * \exp(a) * Length^{b}$, with b = 2.96, b = 0.0000116 as in last years report.

Only Indices for quarters 3 are used. Because the stock migrates outside the area covered by the IBTS in the first quarter, the index of first quarter is not representative for the stock, and consequently, it has not been used. Only catches from area IVb and IVc were used to calculate the index, as the fish in area IVa are not belonging to the North Sea stock. Last year, the signal from the biomass index, was in conflict with the signal from the catch data. Therefore, a new index was tested this year. This new index was based on the assumption that only small specimens of horse mackerel are subject to maximum catchability by the bottom trawl used in the IBTS. The "Number Index" was defined as the CPUE of specimens less than or equal to 23 cm. These lengths are believed to consist of mainly 1,2 and 3 group fish.

$$NumberIndex(y) = \sum_{Length \leq 23\ cm} CPUE(y, Length)$$

The two relative indices for 1992-2003 are shown in Figure 4.3.2.1. The indices are made relative by division by the sum, in order to make them compatible. As can be seen, there are considerable differences between the two indices. The new number index is less variable over years compared to the biomass index.

4.4 Biological Data

4.4.1 Catch in Numbers at Age

Catch in numbers at age by quarter and annual values were calculated according to German and Dutch samples collected in Division IVa & c from the third and fourth quarter, and in VIId from the first, second and fourth quarter. Annual catch numbers at age are given in Table 4.4.1.1.a and by area for 2003 in Table 4.4.1.2. Table 4.4.1.3 shows catch number by quarter and by area in 2003. 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).

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. In year 2001, and 2003, however, preliminary assessment were made based on available data. 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 The coverage for 1995-6 is not known. In 2003 the coverage was 67 % as shown in the text table below.

	1995	1996	1997	1998	1999	2000	2001	2002	2003
% of landings covered	62	55	57	66	77	71	50	60	67
Samples from	RV	RV+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 4.4.1.3 shows weight and length by quarter and by area in 2003. The annual average values are shown in Table 4.4.1.1.b & c.

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. The value M = 0.15 for all ages (as used for other mackerel stocks) was used in the assessment (Section 4.5.1) .

4.5 Data exploration.

Estimates of total age composition are available since 1995 based on Dutch samples (Table 4.4.1.1.a). Estimates of age composition prior to 1995 are considered unreliable, that is, not representative for the entire fishery, and should not be used for analytical assessment. During the period the catches were relatively low with an average of 18,000 t. The catch, however, has gone up considerably in recent years. In 2000 the catch level increased to the highest on record and remained at the high level in 2001, but decreased in 2002 but increased again in 2003. The egg surveys in later years for mackerel in the North Sea do not cover the spawning area of horse mackerel. Since allocation of catches to the stock is based on the temporal and spatial distribution of the fishery it is important that catches are reported by ICES rectangle and quarters.

The catch-at-age appears to have changed during the period from 1995 to 2003 (see Figure 4.4.1.3, which illustrates the catch at age numbers in Table 4.4.1.1.a), with a large reduction in mean age, mean length and mean weight. This coincide with the disappearance of the large 1982-year class, but may also be caused by biased samples. In years 1995 and 1996 a certain number of commercial catches were converted into age distributions by research vessel samples, which may not be representative for the commercial fishery. In recent years, however, a fishery for human consumption fishery has developed. This fishery targets at small size horse mackerel for the Japanese market (Eltink, pers. Com.). More younger age groups appear in the catch in recent, as demonstrated by Figure 4.4.1.3, which illustrates the catch at age numbers in Table 4.4.1.1.a.

The overall impression from Figure 4.4.1.3.is rather confusing, as year class 1998 appearing as a large one in the age distributions for years 2000 and 2001 disappear in years 2002 and 2003. In general, it is not possible to trace the cohorts in this balloon diagram, which may be caused by age reading problems or biased data. As the number of samples is small, they may not be representative for the entire stock. Any assessment based on these data should be treated with caution.

4.5.1 Exploratory analysis of data by Ad hoc method.

The Ad hoc method was tested for the first time last year. Parameters are fitted by the Chi-squared method. It deviates from other methods in that the number of parameters is smaller, which is made possible by the introduction of a number of assumptions. It was modified this year in two respects relative to the analysis in 2003. The selection model was modified, and an alternative tuning, the "Number Index" was used as an alternative to the Biomass Index used (unsuccessfully) last year.

1. The selection ogive is given by one logistic curve. This is a simplification relative to the method of last year. This modification were made to accommodate the comments made by ACFM.
2. The parameters in the selection ogive are assumed to remain constant within pre-selected sequences of years.

In the actual application of the model, selection was assumed to remain constant during the two periods (1995-1998) and (1999-2003). This should reflect the observation that more young fish appear in the catches in recent years (see Table 4.4.1.1 and Figure 4.4.1.3)

The gear selection ogive in year "y" of age group "a" is

$$\mathrm{SEL(y,a)} = \frac{1}{1+\exp(\mathrm{Sel1}(y)+\mathrm{Sel2\ (y)}*\mathrm{Lgt}\ (a))}$$

where Sel2(y) = ln(3)* $L_{50\%}$(y)/($L_{75\%}$(y) - $L_{50\%}$(y)) and Sel2(y) = ln(3)/($L_{75\%}$(y) - $L_{50\%}$(y))

$L_{50\%}$(y) = Body Length at which 50% of the fish entering the gear are retained (ignoring the right hand side selection)

$L_{75\%}$(y) = Body Length at which 75 % of the fish entering the gear are retained

Thus the selection part of the separable VPA is replaced by only 2 parameters: $L_{50\%}$ and $L_{75\%}$ for each sequence of years with constant selection.

The stock numbers in the first year were fitted to the catch numbers by N=n_1*C*Z/F/(1-exp(-Z)), where the parameter "n_1" allows for the level of all Ns in the first year to vary.

The object function to be minimized is the "modified χ^2 –criterion":

$$\chi^2 = \sum_y\sum_a \frac{(C_{Observed}(y,a)-C_{\mathrm{Predicted}}(y,a))^2}{C_{\mathrm{Predicted}}(y,a)} + W_B\sum_y \frac{(N_{\mathrm{Rel}}(y,1-3)-NumberIndex(y))^2}{N_{\mathrm{Rel}}(y,1-3)}$$

where $C_{\mathrm{Predicted}}(y,a)=N(y,a)\dfrac{F(y,a)}{Z(y,a)}(1-\exp(-Z(y,a)))$, , $F(y,a)=Sel(y,a)*F_{Max}(y)$ and W_B is the weight allocated to the IBTS-data, relative to the weight of the catch data. $F_{Max}(y)$ is the fishing mortality of age groups under full exploitation. The "NumberIndex" is the relative CPUE of fish smaller than 23 cm from the IBTS in third quarter, as explained in Section 4.3.2. The "relative numbers" are

$$N_{\mathrm{Rel}}(y,1-3)=\sum_{a=1}^{3} N(y,a)/\sum_{i=1995}^{2003}\sum_{a=1}^{3} N(a,i)$$

The method was implemented during the meeting by the "R"-language.

Input to the Ac Hoc assessment are the horse mackerel data of the IBTS data base for third quarter (1995-2003), combined with the catch at age and weight at age data (Tables 4.5.2.1 and 2). The number-index (number of specimens <= 23 cm) is shown in Table 4.5.2.3.

4.5.2 Results of the Ad Hoc assessment method

Several exploratory runs were made. One important subjective input option is the weight given to the IBTS relative to the catch at age data, when evaluating the object function. The SSD (sum of squares of deviations) for the catches has (Number of years)*(Number of age groups) terms, whereas the SSD from the Index has only (Number of years) terms, so giving the weight 1 to catch data, and 10 to index data, roughly corresponds to giving 25% less weight to the index. Giving weight 100 to the Index roughly corresponds giving seven times as much weight to the index as to the catch data. Output are presented for two alternative runs, namely with weight 10 and 100 for the survey index.

Table 4.5.2.4.a and b shows the estimated fishing mortalities. Recall that selection is modeled by an ascending logistic curve, so the selection is forced to be smooth. There are some differences for the estimates depending on the weight given to the survey index, but they are probably not statistically significant. The estimated Fs for 2003 are low compared to the fishing mortality traditionally estimated for horse mackerel.

The estimated stock numbers and biomasses (Tables 4.5.2.5.a and b) are probably also not significantly different. The stock numbers estimated in the case of low weight to the survey, are shown graphically in Figure 4.5.2.2. Figures 4.5.2.1.a and b shows that the catch residuals are very similar for the two choices of weight to the survey data. Figure 4.5.2.7.a and b shows (not surprisingly) that high weight on survey gives a better correlation with the estimated stock numbers. With weight 100, the correlation is very high.

Before presenting the summary of the assessment, the working group stresses that the results of this exercise are to be considered “data-exploration” rather than an assessment, due to the uncertainties of data, the short time series and the experimental nature of the model. The results are inconclusive, which may be due to errors in data allocation and stock identification.

Nevertheless, the results (with low weight to the survey index) can be summarised as shown in Figure 4.5.2.8. (The trends would be the same for high weight to the survey index). The stock appears to have remained relatively stable, and with the highest level in the last year. Fishing mortality is estimated between 0.1 and 0.2 with lowest level in the last year. Thus, this uncertain exploratory analysis shows a stable lightly exploited stock.

The current results are very much driven by the introduction of the “number-index”. Last years analysis did not reveal a consistent picture, as is the case this year, the reason being that a different index was used last year. The number index, i.e. CPUE of fish shorter than 23 cm, are assumed to represent the age groups 1-3. This assumption was not thoroughly tested, and if the index is to be used in 2005, the assumption should be tested. Also the assumption concerning the stock distributions are crucial for the interpretation of results. The assumption is that no mixing with the western stock takes place.

4.6 Reference Points for Management Purposes

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

4.7 Harvest Control Rules

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

4.8 Management Measures and Considerations

No forecast for the North Sea stock has been made for 2004.

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) Increase in catches during the last decade. Catches has remained high in last decade. The major part of the increased catches are taken in subdivision VIId in quarters 1 and 4.
3) Recent catches are above the advised TACs of 18000. The overage annual catch in the period 1995-2003 was 30000 tons.
4) TAC does not constrain catches.
5) The horse mackerel fishery creates by-catches of mackerel.

Table 4.4.1.1.a. Catch in numbers (millions), 1995-2002, for the North Sea horse mackerel stock

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	1.76	4.58	12.56	2.3	12.42	70.23	12.81	60.42	13.81
2	3.12	13.78	27.24	22.13	31.45	77.98	36.36	16.82	56.15
3	7.19	11.04	14.07	36.69	23.13	28.41	174.34	19.27	23.44
4	10.32	11.87	14.93	38.82	17.59	21.42	87.81	11.90	33.21
5	12.08	9.64	14.58	20.79	23.12	31.27	18.51	5.61	26.93
6	13.16	12.49	12.38	12.1	26.19	19.64	11.49	5.83	10.59
7	11.43	7.96	10.12	13.99	20.64	19.47	18.25	5.54	6.33
8	12.64	6.6	8.64	10.79	21.75	9	14.7	10.48	9.56
9	7.25	1.48	2.45	8.26	12.91	11.5	10.22	6.33	10.90
10	5.87	5.31	0.75	4.01	8.21	8.96	9.98	6.75	1.51
11	0.01	0.29	0.34	2.72	2.14	6.98	9.58	5.12	3.43
12	8.84	1.28	0.25	0.71	0.43	3.07	5.35	3.02	3.29
13	0.2	8.92	0	1.81	1.4	1.61	3.73	2.17	2.25
14	4.37	8.01	1.38	0.31	3.78	0	1.95	1.29	3.40
15+	0	0	0	5.11	4.03	12.22	5.81	2.71	4.70

Table 4.4.1.1.b. Weight at age (kg), 1995-2003, for the North Sea horse mackerel stock

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0.076	0.107	0.063	0.063	0.063	0.075	0.055	0.066	0.073
2	0.126	0.123	0.102	0.102	0.102	0.101	0.072	0.095	0.105
3	0.125	0.143	0.126	0.126	0.126	0.136	0.071	0.129	0.123
4	0.133	0.156	0.142	0.142	0.142	0.152	0.082	0.154	0.137
5	0.146	0.177	0.16	0.16	0.16	0.166	0.12	0.172	0.166
6	0.164	0.187	0.175	0.175	0.175	0.194	0.183	0.195	0.181
7	0.161	0.203	0.199	0.199	0.199	0.198	0.197	0.216	0.195
8	0.178	0.195	0.231	0.231	0.231	0.213	0.201	0.227	0.212
9	0.165	0.218	0.25	0.25	0.25	0.247	0.235	0.228	0.238
10	0.173	0.241	0.259	0.259	0.259	0.28	0.246	0.251	0.259
11	0.317	0.307	0.3	0.3	0.3	0.279	0.26	0.302	0.245
12	0.233	0.211	0.329	0.329	0.329	0.342	0.286	0.292	0.295
13	0.241	0.258	0.367	0.367	0.367	0.318	0.287	0.318	0.356
14	0.348	0.277	0.299	0.299	0.299	0.325	0.295	0.319	0.319
15+	0.348	0.277	0.36	0.36	0.36	0.332	0.336	0.390	0.380

Table 4.4.1.1.c. Length at age (cm) 1995-2003, for the North Sea horse mackerel stock

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	19.2	19.2	19.2	19.2	19.2	19	18.7	17.1	20.2
2	22	22	22	22	22	21.5	20.4	21.4	22.4
3	23.5	23.5	23.5	23.5	23.5	23.9	20.6	22.9	23.8
4	24.8	24.8	24.8	24.8	24.8	24.9	21.3	24.9	24.6
5	25.5	25.5	25.5	25.5	25.5	26	25	26.2	26.2
6	26.4	26.4	26.4	26.4	26.4	27.8	27.4	26.6	27.3
7	27.2	27.2	27.2	27.2	27.2	28.3	28	27.4	28.2
8	29.2	29.2	29.2	29.2	29.2	28.6	28.4	28.2	29.0
9	29.5	29.5	29.5	29.5	29.5	30	29.7	29.2	29.9
10	29.5	29.5	29.5	29.5	29.5	31.3	30.2	30.8	30.8
11	30.6	30.6	30.6	30.6	30.6	31.4	30.7	32.5	30.8
12	32.1	32.1	32.1	32.1	32.1	33.7	32	33.8	31.9
13	33.3	33.3	33.3	33.3	33.3	33.5	31.7	33.8	32.9
14	31.1	31.1	31.1	31.1	31.1	33.4	32.1	32.4	32.7
15+	32.5	32.5	32.5	32.5	32.5	33.4	33.4	34.4	34.6

Table 4.4.1.2 Catch number, annual mean length and annual mean weight North Sea horse mackerel stock by area in 2003.

Catch number (Total 2003)

Ages	IIIa	IVa	IVb	IVc	VIId	Sum
0	0.0	0.0	0.0	0.0	0.0	0.0
1	44.8	491.6	693.0	7089.4	5491.6	13810.4
2	1.9	39.7	5483.3	17938.2	32690.8	56154.0
3	0.0	155.3	730.0	6497.7	16059.3	23442.3
4	1.9	249.2	1711.9	6353.0	24891.6	33207.7
5	0.0	93.2	2007.2	5745.9	19083.2	26929.5
6	0.3	35.9	700.1	2453.7	7404.3	10594.2
7	0.3	29.0	384.2	985.1	4935.2	6333.7
8	0.0	18.0	847.9	1167.9	7522.8	9556.6
9	2.0	57.4	971.7	1144.0	8727.9	10903.0
10	1.4	23.5	107.2	930.8	444.9	1507.8
11	5.1	58.4	403.4	805.2	2156.9	3429.1
12	4.2	46.5	321.0	928.8	1986.4	3286.8
13	1.9	22.3	127.8	473.4	1628.4	2253.8
14	4.2	46.1	369.1	632.1	2347.2	3398.7
15+	85.2	932.6	422.7	939.8	2319.0	4699.3

Mean Weight-at-age (kg) 2003

Ages	IIIa	IVa	IVb	IVc	VIId	Mean
1	0.049	0.049	0.080	0.072	0.076	0.073
2	0.075	0.106	0.112	0.108	0.102	0.105
3		0.152	0.120	0.120	0.124	0.123
4	0.168	0.163	0.129	0.143	0.135	0.137
5		0.173	0.154	0.172	0.165	0.166
6	0.199	0.184	0.159	0.203	0.177	0.181
7	0.205	0.189	0.166	0.240	0.188	0.195
8		0.187	0.207	0.211	0.213	0.212
9	0.208	0.195	0.213	0.241	0.240	0.238
10	0.224	0.213	0.219	0.279	0.228	0.259
11	0.344	0.336	0.228	0.296	0.226	0.245
12	0.288	0.287	0.282	0.295	0.298	0.295
13	0.488	0.474	0.299	0.397	0.347	0.356
14	0.350	0.349	0.287	0.373	0.309	0.319
15+	0.454	0.454	0.343	0.418	0.339	0.380

Mean Length-at-age (cm) 2003

Ages	IIIa	IVa	IVb	IVc	VIId	Mean
1	18.5	18.5	20.4	19.9	20.6	20.2
2	21.5	22.9	22.4	22.3	22.5	22.4
3		25.3	23.4	23.3	24.0	23.8
4	27.5	26.1	24.8	24.7	24.6	24.6
5		26.7	26.1	26.1	26.3	26.2
6	29.5	27.5	27.4	27.5	27.3	27.3
7	30.5	27.9	28.3	28.7	28.1	28.2
8		27.6	28.9	28.8	29.0	29.0
9	30.2	28.6	29.7	29.9	29.9	29.9
10	30.9	29.9	30.5	30.9	30.7	30.8
11	33.7	33.4	30.6	31.1	30.6	30.8
12	34.4	34.3	31.8	31.7	31.9	31.9
13	37.5	37.1	32.1	33.8	32.6	32.9
14	34.2	34.2	32.0	34.1	32.4	32.7
15	37.2	37.2	33.6	35.3	33.3	34.6

Age	Q1 IIIa	Q1 IVa	Q1 IVb	Q1 IVc	Q1 VIId	Q1 Sum	Q2 IIIa	Q2 IVa	Q2 IVb	Q2 IVc	Q2 VIId	Q2 Sum	Q3 IIIa	Q3 IVa	Q3 IVb	Q3 IVc	Q3 VIId	Q3 Sum	Q4 IIIa	Q4 IVa	Q4 IVb	Q4 IVc	Q4 VI
	QUARTER 1						QUARTER 2						QUARTER 3						QUARTER 4				
Catch numbers at age by area and quarter																							
Age	IIIa	IVa	IVb	IVc	VIId	Sum	IIIa	IVa	IVb	IVc	VIId	Sum	IIIa	IVa	IVb	IVc	VIId	Sum	IIIa	IVa	IVb	IVc	VI
1	44.8	489.8	0.0	428.2	0.0	962.9	0.0	1.8	135.7	146.5	426.6	710.6	0.0	0.0	376.8	694.9	30.2	1101.8	0.0	0.0	180.5	5819.8	50
2	1.9	21.2	0.0	594.7	0.0	617.9	0.0	18.5	188.4	203.5	592.4	1002.7	0.0	0.0	3579.8	6601.3	795.4	10976.5	0.0	0.0	1715.2	10538.6	31
3	0.0	0.0	421.2	140.7	2434.6	2996.5	0.0	155.3	30.2	32.6	94.8	312.8	0.0	0.0	188.4	347.4	121.4	657.2	0.0	0.0	90.3	5977.1	13
4	1.9	21.2	1425.7	177.8	8240.4	9867.1	0.0	228.0	7.5	8.1	23.7	267.3	0.0	0.0	188.4	347.4	127.8	663.6	0.0	0.0	90.3	5819.8	16
5	0.0	0.0	1407.2	286.6	8133.3	9827.1	0.0	93.2	42.6	46.1	134.1	315.9	0.0	0.0	376.8	694.9	34.0	1105.7	0.0	0.0	180.5	4718.4	10
6	0.3	3.2	657.4	205.6	3799.8	4666.3	0.0	32.8	42.6	46.1	134.1	255.5	0.0	0.0	0.0	0.0	28.6	28.6	0.0	0.0	0.0	2202.0	34
7	0.3	3.2	384.2	41.5	2220.4	2649.5	0.0	25.8	0.0	0.0	0.0	25.8	0.0	0.0	0.0	0.0	9.1	9.1	0.0	0.0	0.0	943.6	27
8	0.0	0.0	777.7	305.5	4495.1	5578.3	0.0	18.0	70.2	75.8	220.7	384.7	0.0	0.0	0.0	0.0	12.6	12.6	0.0	0.0	0.0	786.5	27
9	2.0	21.8	796.3	639.9	4602.2	6062.1	0.0	35.6	175.5	189.5	551.7	952.3	0.0	0.0	0.0	0.0	15.9	15.9	0.0	0.0	0.0	314.6	35
10	1.4	15.6	37.1	225.5	214.2	493.8	0.0	7.9	70.2	75.8	220.7	374.6	0.0	0.0	0.0	0.0	0.4	0.4	0.0	0.0	0.0	629.5	9.6
11	5.1	55.2	333.3	257.5	1926.2	2577.3	0.0	3.2	70.2	75.8	220.7	369.9	0.0	0.0	0.0	0.0	0.4	0.4	0.0	0.0	0.0	471.9	9.6
12	4.2	45.8	180.6	462.6	1043.9	1737.1	0.0	0.7	140.3	151.6	441.3	734.0	0.0	0.0	0.0	0.0	1.8	1.8	0.0	0.0	0.0	314.6	49
13	1.9	21.2	92.7	120.8	535.5	772.2	0.0	1.1	35.1	37.9	110.4	184.5	0.0	0.0	0.0	0.0	2.9	2.9	0.0	0.0	0.0	314.6	97
14	4.2	45.8	263.9	360.9	1525.0	2199.7	0.0	0.3	105.3	113.7	331.1	550.4	0.0	0.0	0.0	0.0	1.5	1.5	0.0	0.0	0.0	157.5	48
15	85.2	931.3	282.4	473.6	1632.1	3404.6	0.0	1.3	140.3	151.6	441.3	734.6	0.0	0.0	0.0	0.0	0.7	0.7	0.0	0.0	0.0	314.6	24
Mean Weight at age by area (kg) and quarter						Mean						mean						mean					
1	0.049	0.049		0.064		0.056		0.088	0.064	0.064	0.064	0.064			0.084	0.084	0.070	0.084			0.084	0.071	0.0
2	0.075	0.075		0.071		0.071		0.141	0.071	0.071	0.071	0.072			0.113	0.113	0.103	0.112			0.113	0.108	0.1
3			0.111	0.097	0.111	0.110		0.152	0.090	0.090	0.090	0.121			0.136	0.136	0.131	0.135			0.136	0.120	0.1
4	0.168	0.168	0.130	0.130	0.130	0.130		0.163	0.130	0.130	0.130	0.158			0.125	0.125	0.141	0.128			0.125	0.144	0.1
5			0.149	0.164	0.149	0.150		0.173	0.181	0.181	0.181	0.178			0.162	0.162	0.212	0.164			0.162	0.174	0.1
6	0.199	0.199	0.157	0.182	0.157	0.158		0.183	0.195	0.195	0.195	0.193					0.199	0.199				0.205	0.1
7	0.205	0.205	0.166	0.166	0.166	0.166		0.187				0.187					0.219	0.219				0.243	0.2
8	0.000	0.000	0.210	0.187	0.210	0.208		0.187	0.178	0.178	0.178	0.178					0.251	0.251				0.223	0.2
9	0.208	0.208	0.216	0.202	0.216	0.215		0.187	0.200	0.200	0.200	0.199					0.267	0.267				0.343	0.2
10	0.224	0.224	0.254	0.202	0.254	0.229		0.192	0.201	0.201	0.201	0.201					0.280	0.280				0.316	0.2
11	0.344	0.344	0.222	0.254	0.222	0.228		0.203	0.259	0.259	0.259	0.259					0.280	0.280				0.325	0.2
12	0.288	0.288	0.283	0.282	0.283	0.283		0.208	0.282	0.282	0.282	0.282					0.296	0.296				0.320	0.3
13	0.488	0.488	0.287	0.326	0.287	0.299		0.197	0.329	0.329	0.329	0.328					0.382	0.382				0.433	0.3
14	0.350	0.350	0.268	0.331	0.268	0.280		0.225	0.336	0.336	0.336	0.336					0.421	0.421				0.498	0.4
15	0.454	0.454	0.318	0.389	0.318	0.369		0.219	0.394	0.394	0.394	0.394					0.382	0.382				0.473	0.3

Table 4.4.1.3 Catch, weight and Length at age of North Sea horse mackerel stock by quarter and by area in 2003 (Continued)

Table 4.4.1.3. Catch, weight and Length at age of North Sea horse mackerel stock by quarter and by area in 2003

QUARTER 1							QUARTER 2						QUARTER 3						QUARTER 4					
Age	IIIa	IVa	IVb	IVc	VIId	Sum	IIIa	IVa	IVb	IVc	VIId	Sum	IIIa	IVa	IVb	IVc	VIId	Sum	IIIa	IVa	IVb	IVc	VIId	Sum
Mean Length at age by area (cm) and quarter						mean						mean						mean						
1	18.50	18.50	0.00	20.22	0.00	19.26		19.83	20.22	20.22	20.22	20.22			20.50	20.50	20.14	20.49			20.50	19.85	20.63	20.22
2	21.50	21.50	0.00	20.86	0.00	20.88		24.49	20.86	20.86	20.86	20.93			22.45	22.45	22.57	22.46			22.45	22.23	22.49	22.43
3			23.46	22.64	23.46	23.42		25.26	22.25	22.25	22.25	23.74			23.50	23.50	24.41	23.67			23.50	23.29	24.06	23.82
4	27.50	27.50	25.07	25.13	25.07	25.08		26.02	25.50	25.50	25.50	25.94			23.50	23.50	24.77	23.74			23.50	24.74	24.31	24.41
5			26.18	26.25	26.18	26.19		26.69	26.32	26.32	26.32	26.43			26.00	26.00	27.95	26.06			26.00	26.10	26.29	26.23
6	29.50	29.50	27.32	28.21	27.32	27.36		27.35	28.68	28.68	28.68	28.51					27.45	27.45				27.36	27.16	27.24
7	30.50	30.50	28.32	28.32	28.32	28.32		27.62	0.00	0.00	0.00	27.62					28.37	28.37				28.67	27.99	28.16
8	0.00	0.00	28.86	28.96	28.86	28.86		27.65	29.00	29.00	29.00	28.94					29.79	29.79				28.70	29.28	29.15
9	30.21	30.21	29.77	29.19	29.77	29.71		27.60	29.10	29.10	29.10	29.04					30.16	30.16				32.00	30.15	30.30
10	30.90	30.90	31.50	30.03	31.50	30.81		27.95	30.00	30.00	30.00	29.96					30.50	30.50				31.25	30.50	31.24
11	33.70	33.70	30.60	30.51	30.60	30.66		28.65	30.50	30.50	30.50	30.48					30.50	30.50				31.50	30.50	31.48
12	34.36	34.36	31.78	31.75	31.78	31.85		29.00	31.75	31.75	31.75	31.75					30.97	30.97				31.50	32.38	32.04
13	37.50	37.50	31.90	32.45	31.90	32.15		28.33	32.50	32.50	32.50	32.48					33.00	33.00				34.50	33.00	33.36
14	34.22	34.22	31.31	33.63	31.31	31.76		30.00	33.83	33.83	33.83	33.83					35.00	35.00				35.50	35.00	35.12
15	37.23	37.23	32.81	35.09	32.81	34.45		29.63	35.25	35.25	35.25	35.24					33.50	33.50				35.50	33.50	34.62

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Age	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0.00	0.00	0.00	2.30	12.40	70.20	12.80	60.40	13.80
2	1.76	4.60	12.60	22.10	31.50	78.00	36.40	16.80	56.20
3	3.12	13.80	27.20	36.70	23.10	28.40	174.30	19.30	23.40
4	7.19	11.00	14.10	38.80	17.60	21.40	87.80	11.90	33.20
5	10.32	11.90	14.90	20.80	23.10	31.30	18.50	5.60	26.90
6	12.08	9.60	14.60	12.10	26.20	19.60	11.50	5.80	10.60
7	13.16	12.50	12.40	14.00	20.60	19.50	18.30	5.50	6.33
8	11.43	8.00	10.10	10.80	21.80	9.00	14.70	10.50	9.56
9	12.64	6.60	8.60	8.30	12.90	11.50	10.20	6.30	10.90
10	7.25	1.50	2.40	4.00	8.20	9.00	10.00	6.70	1.51
11	5.87	5.30	0.80	2.70	2.10	7.00	9.60	5.10	3.40
12	0.01	0.30	0.30	0.70	0.40	3.10	5.30	3.00	3.30
13	8.84	1.30	0.20	1.80	1.40	1.60	3.70	2.20	2.20
14	0.20	8.90	0.00	0.30	3.80	0.00	2.00	1.30	3.40
15	4.37	8.00	1.40	5.10	4.00	12.20	5.80	2.70	4.70

Table 4.5.2.1. Input to Ad Hoc method. Catch at age (millions).

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0.064	0.064	0.063	0.063	0.063	0.075	0.055	0.066	0.073
2	0.076	0.107	0.102	0.102	0.102	0.101	0.072	0.095	0.105
3	0.126	0.123	0.126	0.126	0.126	0.136	0.071	0.129	0.123
4	0.125	0.143	0.142	0.142	0.142	0.152	0.082	0.154	0.137
5	0.133	0.156	0.160	0.160	0.160	0.166	0.120	0.172	0.166
6	0.146	0.177	0.175	0.175	0.175	0.194	0.183	0.195	0.181
7	0.164	0.187	0.199	0.199	0.199	0.198	0.197	0.216	0.195
8	0.161	0.203	0.231	0.231	0.231	0.213	0.201	0.227	0.212
9	0.178	0.195	0.250	0.250	0.250	0.247	0.235	0.228	0.238
10	0.165	0.218	0.259	0.259	0.259	0.280	0.246	0.251	0.259
11	0.173	0.241	0.300	0.300	0.300	0.279	0.260	0.302	0.245
12	0.317	0.307	0.329	0.329	0.329	0.342	0.286	0.292	0.295
13	0.233	0.211	0.367	0.367	0.367	0.318	0.287	0.318	0.356
14	0.241	0.258	0.299	0.299	0.299	0.325	0.295	0.319	0.319
15	0.348	0.277	0.360	0.360	0.360	0.332	0.336	0.390	0.380

Table 4.5.2.2. Input to Ad Hoc method. Weight at age.

Year	Index
1995	233
1996	403
1997	379
1998	390
1999	546
2000	375
2001	430
2002	396
2003	521

Table 4.5.2.3. Input to Ad Hoc method. IBTS index. Fish of length <= 23 cm.

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0.004	0.008	0.006	0.008	0.009	0.072	0.093	0.039	0.043
2	0.009	0.018	0.014	0.020	0.022	0.105	0.135	0.057	0.062
3	0.019	0.039	0.031	0.044	0.049	0.123	0.158	0.067	0.073
4	0.037	0.074	0.059	0.083	0.093	0.131	0.168	0.071	0.078
5	0.058	0.118	0.093	0.132	0.148	0.133	0.172	0.073	0.079
6	0.076	0.154	0.122	0.172	0.193	0.134	0.173	0.073	0.080
7	0.086	0.175	0.139	0.196	0.220	0.135	0.173	0.073	0.080
8	0.092	0.186	0.147	0.208	0.233	0.135	0.173	0.073	0.080
9	0.094	0.190	0.151	0.213	0.238	0.135	0.173	0.073	0.080
10	0.095	0.192	0.152	0.215	0.241	0.135	0.173	0.073	0.080
11	0.095	0.193	0.153	0.216	0.242	0.135	0.173	0.073	0.080
12	0.095	0.193	0.153	0.216	0.242	0.135	0.173	0.073	0.080
13	0.095	0.193	0.153	0.216	0.242	0.135	0.173	0.073	0.080
14	0.095	0.193	0.153	0.216	0.242	0.135	0.173	0.073	0.080
15	0.095	0.193	0.153	0.216	0.242	0.135	0.173	0.073	0.080

Table 4.5.2.4.a. . Output Ad Hoc method. Fishing Mortality. Low weight to Index (Weight=10)

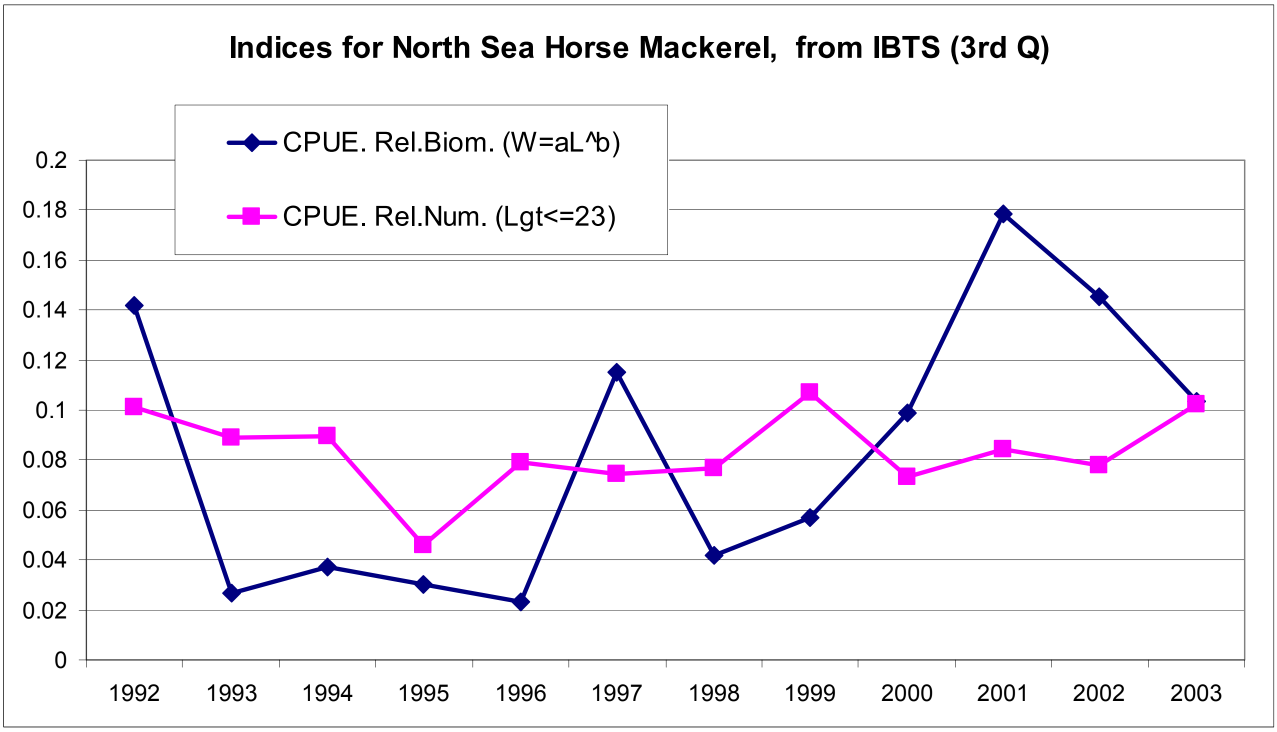


Figure 4.3.2.1. Two indices for Horse Mackerel, based on length distributions from third quarter and catches in areas IVb and c. The biomass index (number by length groups converted into biomass) was used in last year's assessment, whereas the number-index (numbers below 23 cm) was used this year.

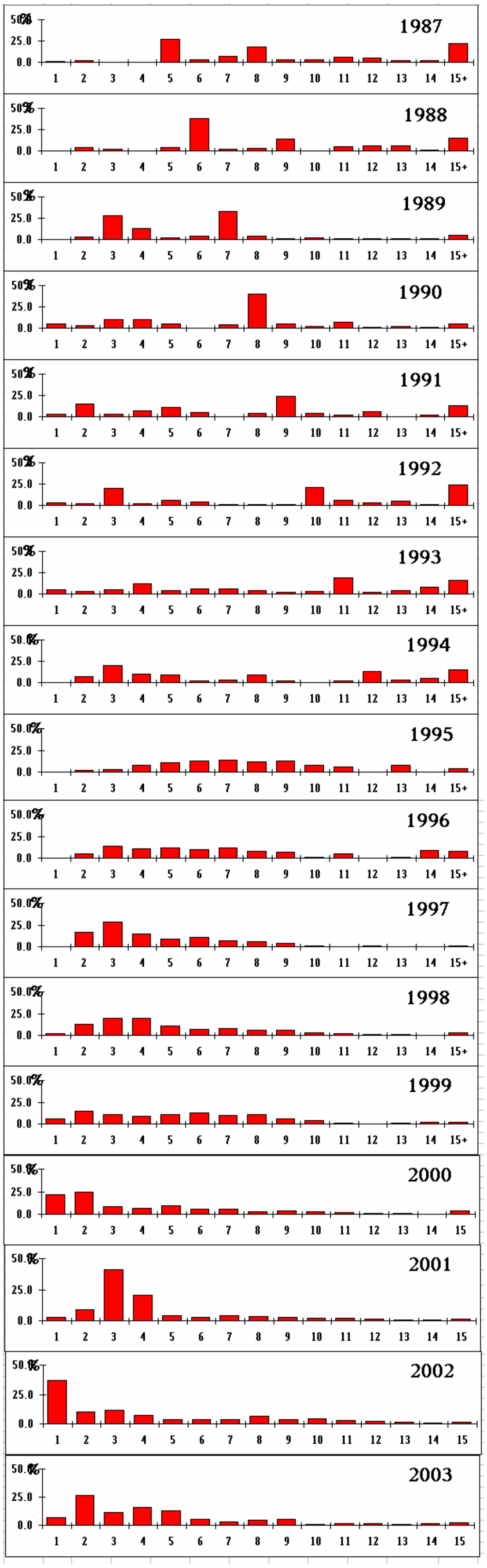
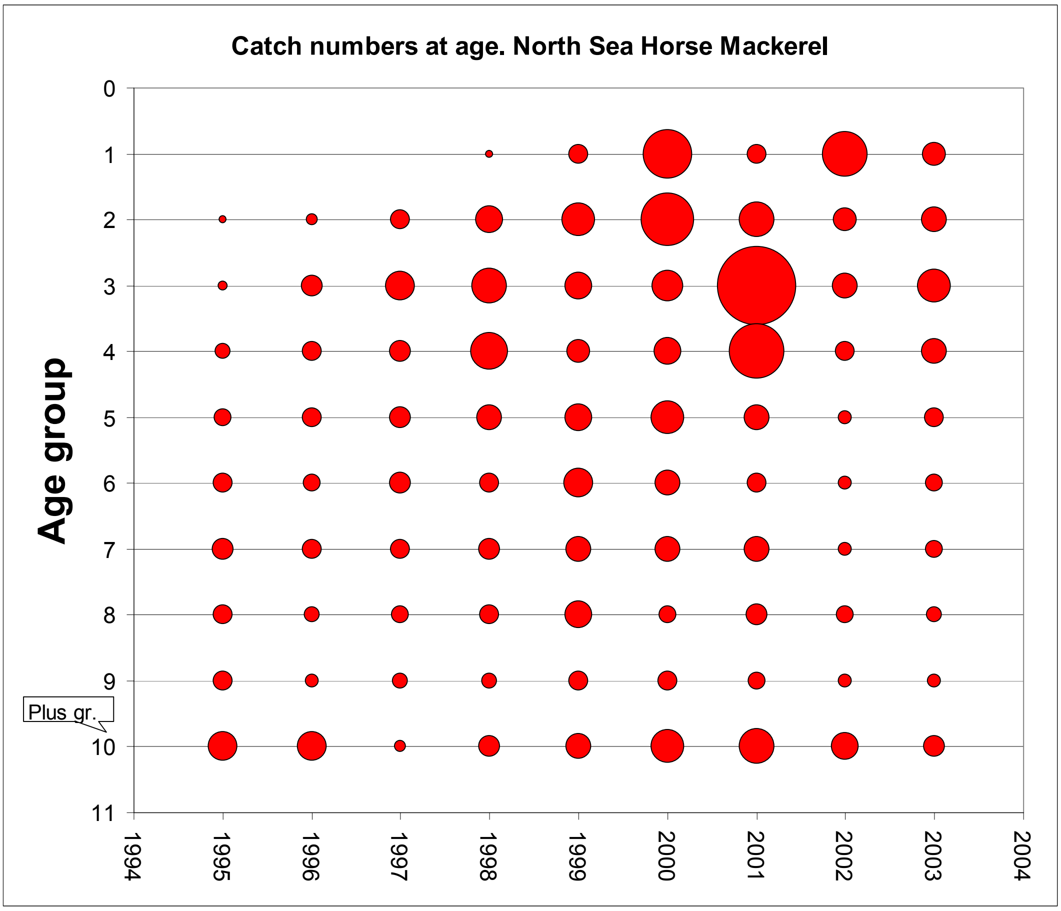


Figure 4.4.1.1. Age composition of the North Sea horse mackerel stock from commercial fishery and from research vessel samples, 1987-2003.



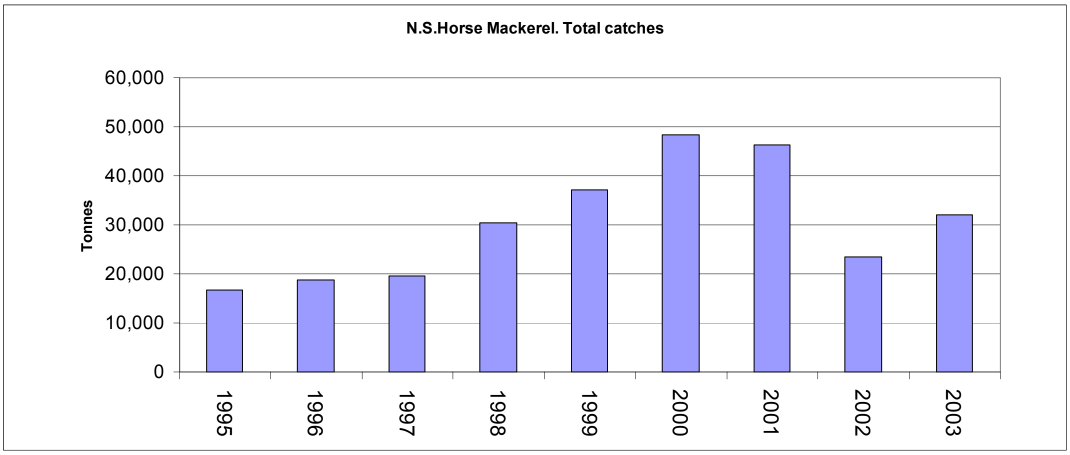


Figure 4.4.1.3. North Sea horse mackerel. Catch number at age and total catch in weight, 1995-2003 Derived from Table 4.4.1.1.a.).

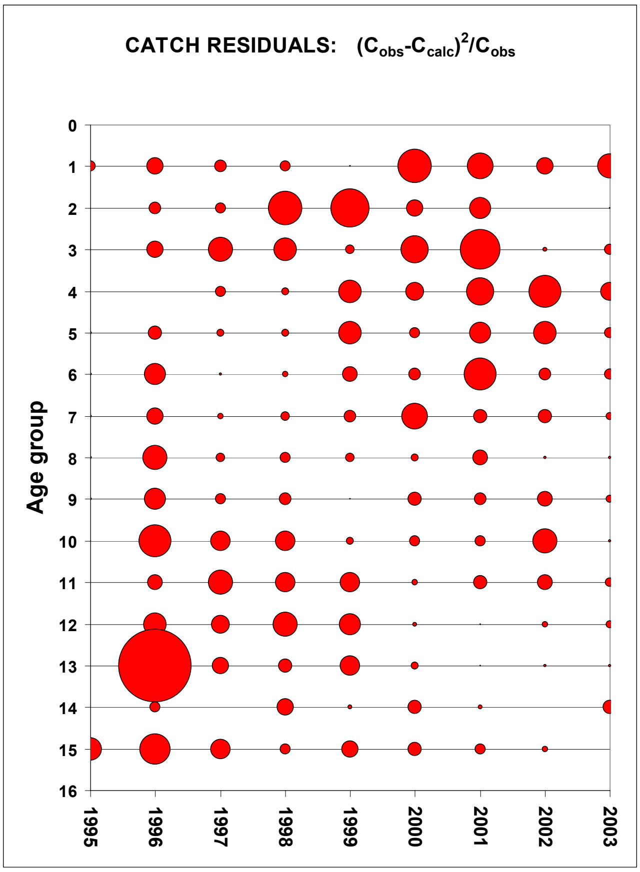


Figure 4.5.2.1.a. Output Ad Hoc method. Catch Residuals. Low weight to Index (Weight=10)

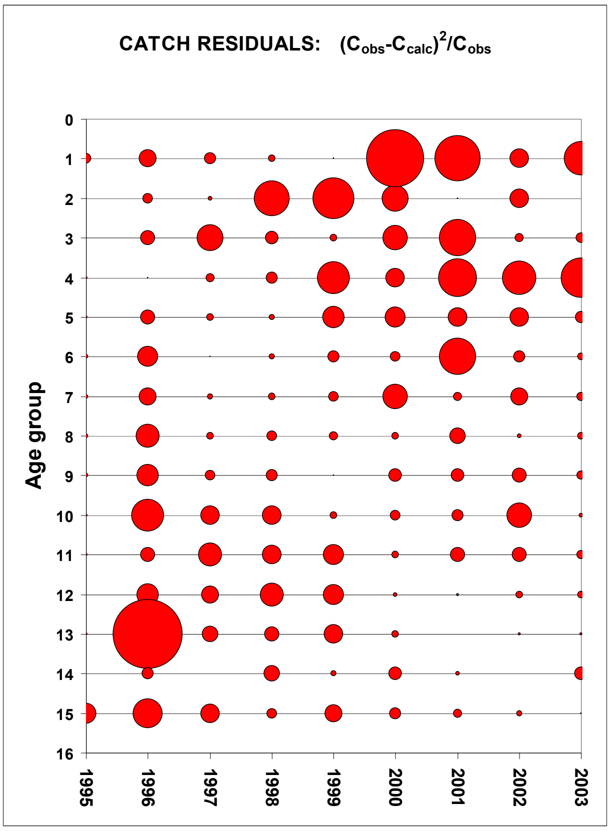
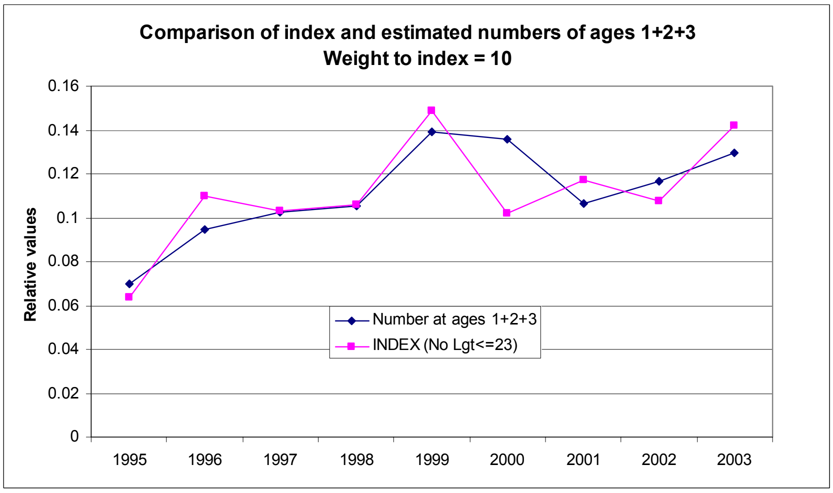


Figure 4.5.2.1.b. Output Ad Hoc method. Catch Residuals. High weight to Index (Weight=100)



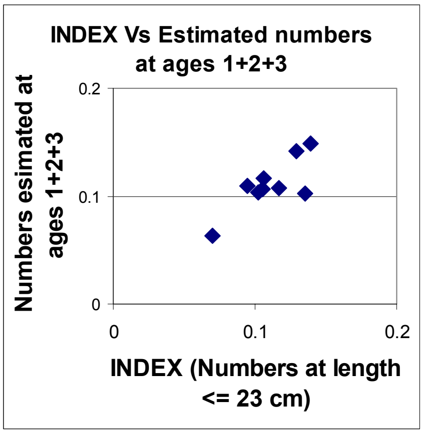
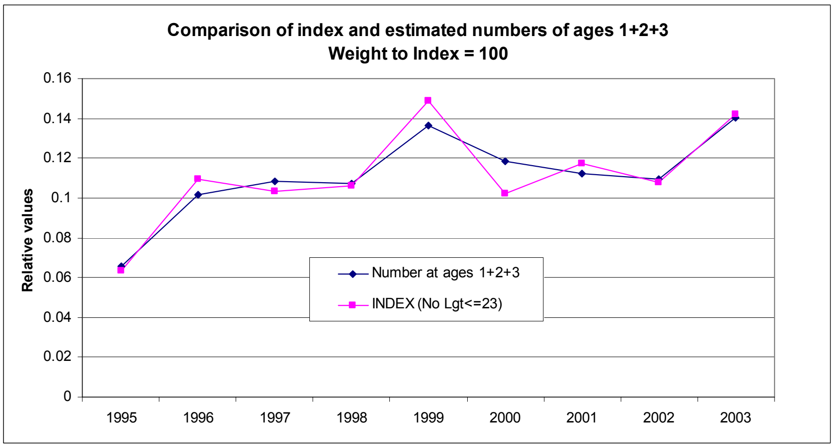


Figure 4.5.2.7.a. Output Ad Hoc method. Relative Index vs relative estimates. Low weight to Index (Weight=10)



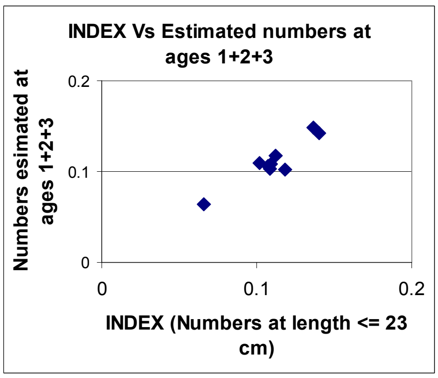


Figure 4.5.2.7.b. Output Ad Hoc method. Relative Index vs relative estimates. High weight to Index (Weight=100)

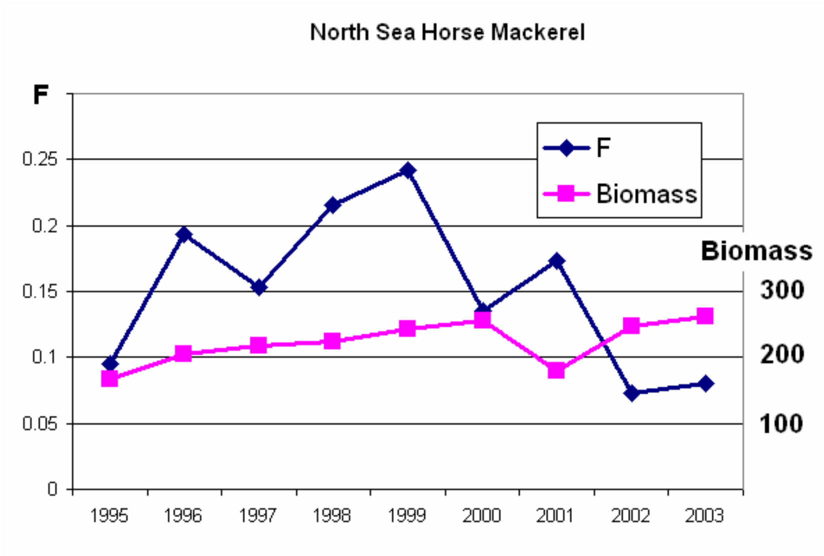


Figure 4.5.2.8. Stock biomass (000' tons) and F (for fully exploited age groups) estimated by the Ad hoc method for North Sea Horse Mackerel (low weight to survey index). The results of this exercise are to be considered "data-exploration" rather than an assessment, due to the uncertainties of data, the short time series and the experimental nature of the model. The results are inconclusive, which may be due to errors in data allocation and stock identification.

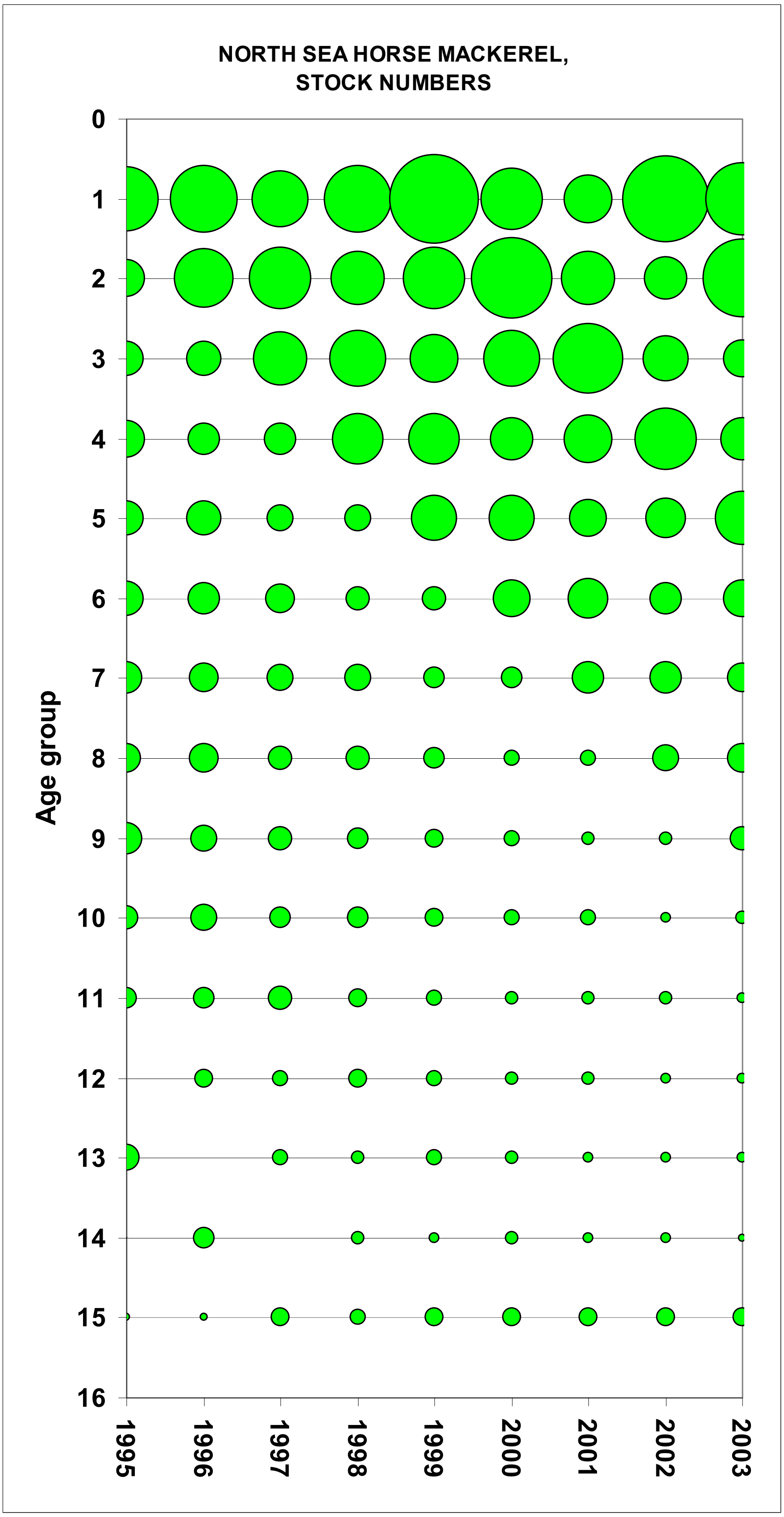


Figure 4.5.2.2. . Output Ad Hoc method. Stock Numbers. Low weight to Index (Weight=10). Derived from Table 4.5.2.5

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

For 2003 ICES adviced to limit the catches to less than 113,000 tons which corresponds to F=0.15. ICES also advised to restrict the directed horse mackerel fisheries and industrial fisheries in which juvenile horse mackerel are abundant was repeated.

For 2004 ICES advised to limit the catches to less than 130,000 tons. In the absence of outstanding year classes, sustainable yield is unlikely to be higher than about 130,000 t, dependent on the exploitation pattern. Exploitation at F0.1 will produce yields of this order on basis of average recruitment excluding the exceptional large 1982-year class. It is therefore clear that catches will have to be reduced unless another outstanding year class is produced.

The advices for 2004 and previous years do not include the fishery in Division VIIIc. This division is now included in the distribution area of the western stock.

EU has set TAC for horse mackerel since 1987 for EU waters only in Division Vb, Sub areas VI and VII, Divisions VIIIa,b,d,e. These areas do not correspond to the total distribution area of western horse mackerel, but include parts of the distribution area of the North Sea stock (Divison VIId). This TAC set by EU has been reduced every year since 1998 from 320,000 tons to 137.000 tons in 2003 and 2004. In addition EU has set a TAC for EU waters in Division IIa and Subarea IV of 50,267 tons for 2004. These areas are parts of the distribution areas of both the western and the North Sea stocks. EU has also set a TAC of 55,000 tons for Division VIIIc and Subarea IX for 2004. These areas are parts of the distribution areas of both the western and the southern stocks.

The TAC for the western stock should apply to those areas in which western horse mackerel are fished 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 2003 were about 190,200 tons, including about 20,000 tons from Division VIIIc. Division VIIIc was not included in the advice for 2003 and that means that the advised TAC was overfished by about 50% by excluding the catches in Division VIIIc.

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 2003 was 190,200 tons (Table 3.3.1) which is 4,000 tons less than in 2002.

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. The catches dropped from the record high catch of about 13,500 tons in 1992 to 24 tons in 2003.

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 and IIIa in the two last quarters of 2003 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 1987-2003. 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 2003 the total catch was about 23,300 tons which is some 10,000 tons more than in 2002.

The main part of the catches in this area is taken in a directed Irish trawl fishery for horse mackerel.

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 102,000 tons in 2003. This is about 15,000 tons more than the catch in 2002 which was the lowest catch since 1989 (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 now allocated to the western stock. The catches of horse mackerel in these areas usually fluctuate between 20,000 and 55,000 tons (except for the record high catch in 2001 of about 75,000 tons). In 2002 and 2003 the catches were about 54,600 tons and 41,700 tons respectively.

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 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 covers 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).

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 modeled 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 2004 indicates a similar availability/catch level of horse mackerel in NEZ as in 2003 (Iversen et al WD 2004).

5.4 Effort and catch per unit of effort.

Since Division VIIc is part of the western distribution area the bottom trawl fleet operating in Subdivision VIIIc West is exploiting the western stock. The effort in this fleet has decreased substantially since 2001 (table 5.4.1). The rich 1982 year class is nicely shown in the CPUE age matrix.

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 2003 the Netherlands (Divisions IVa,c, VIa, VIIb,d,e,h,j, VIIIa,d), Norway (Division IVa), Ireland (Divisions VIa and VIIb),Germany (Divisions VIIb,c,d,e,h,j) and Spain (Divisions VIIj, VIIIb,c) provided catch in numbers at age. Denmark also provided some age readings which were applied for the Dansih catches in Division VIIe,h even if the origin of these Danish samples were unclear. The catch sampled for age readings in 2003 covered 76% of the total catch. This is an improvement compared to 2002 but still the number of age readings for parts of the fishing area are considered too small to be satisfactory.

Catches from other countries were converted to numbers at age using adequate data provided by the countries quoted above. 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). Both Germany and the Netherlands provided samples and age readings from Divisions VIId,e,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. The Dutch samples were dominated by one year old fish, while German samples were dominated by two year old fish (Zimmermann et al WD 2004). The choice of schemes for filling-in unsampled catches could therefore have an enormous influence on the perception of the catch of juveniles and the strength of recruiting yearclasses. The causes for the differences in age distribution will be evaluated further by means of an otolith exchange exercise later this year. Catches from these areas were converted to numbers at age using the German and Dutch information weighed by sample number (which results in a higher number of 2-year old fish in the catch).

The total annual and quarterly catches in numbers for western horse mackerel in 2003 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 (see Figure 5.5.1.1). The 1982 year class has been included in the plus group since 1996. Last year the WG observed that catches of 1 year old horse mackerel (2001 year class) was far larger than in previous years. Also in 2003 large catches were taken of this year class. In the juvenile area 34% of the catch in number was of this year class. The total catch in the juvenile area was almost 136,000 tons, which is about 72% of the catch of the western stock. Even if the fisheries were intensified in the juvenile areas in 2002 and 2003 the high catches of the 2001 year class in both these years might indicate that this is a strong year class. These catches were mainly taken in Divisions VIIe and VIIh.

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 same countries providing data for catch in numbers by age also provide data for mean weight and length in catches by quarter and area. These data were applied to the catches from other countries using the specific software for calculating international catch at age, mean weight and mean length at age in the catches (Patterson, WD 1999). The mean weight and mean length at age in the catches by year and quarters of 2003 are shown in Tables 5.5.2.1 and 5.5.2.2.

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 5.6.1.3b). Both the The total catches of horse mackerel by country for Sub-area VIII are given in Table 5.2.5.

Tmean weight by age groups in the stock and in the catches were lower than usual in 2001, but returned to normal in 2002 and 2003.

5.5.3 Maturity ogive

There are no new data on maturity for the western horse mackerel since 1988. In 1999 the working group applied a maturity ogive based on the estimated maturity ogive from Division VIIIc (ICES, 2000/ACFM:5). The difference between the maturity ogive as used for the years 1987-1997 and the new maturity ogive applied since 1998 is shown in Table 5.6.1.2b.

5.5.4 Natural mortality

The natural mortalities applied in previous assessments of western horse mackerel are summarised and discussed in ICES (1998/Assess:6) and the Working Group admitted uncertainties in M in the range of 0.05 to 0.15. The Working Group applied M=0.15.

5.6 State of the Stock

5.6.1 Data exploration and preliminary modelling

The SAD assessment method combines a Separable VPA with an "ADAPT" model structure, and has been used by the working group since the 2000 meeting. At 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 this year's meeting, exploratory work on the SAD model to set it within a more rigorous statistical framework and to avoid the use of artificial data, 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 last year's SAD assessment.

A Separable VPA /ADAPT (SAD) assessment of the Western Horse mackerel

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 (Section 5.3.1) 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.

Several modifications have been made to the SAD model, applied until 2003, that have dealt with some of the concerns about the approach raised in the ACFM Technical Minutes of the 2003 Working Group report (ICES CM 2004/ACFM:08). These related to the use of artificial data for the years for which egg production estimates are not available over the period 1992-2001, as well as the lack of estimates of precision for model parameters. The use of artificial data was predicated on the basis of the otherwise lack of information with which to estimate the magnitude of the catchability parameter associated with the egg estimates. It was nevertheless felt that including artificial data and treating them as real data within the model was not a justifiable approach. Changes to the SAD model applied in 2003 (SAD03) compared to that developed for 2004 (SAD04) are described in the following table.

Table describing the differences in the SAD model applied in 2003 (SAD03) compared to that developed for 2004 (SAD04)

	SAD03	SAD04
Objective function	Least Squares with ad-hoc weighting of individual components. The objective function consists of two components, corresponding to egg data and catches in the separable period for ages 1-10.	Maximum likelihood, with variances of the individual components estimates within the model. The likelihood consists of three components, corresponding to egg data, catches in the separable period for ages 1-10, and catches in the plus-group
Programming tool	EXCEL spreadsheet	AD Model Builder (Otter Research Ltd)
Estimates of precision	None, but marginal profiles provided for key parameters	Available, based on the delta method
Use of artificial egg production estimates	Yes	No
Plus-group	Estimated directly from plus-group catches	Modelled as a dynamic pool, which allows plus-group catches to be included in the objective function
Separable period F-at-age	Given selectivity at age 10, and F at age 7 in the final year (parameters), a separable VPA (Pope and Shepherd, 1982) is used to calculate F-at-age based on log-catch ratios, but log-catches are then used in objective function	Given selectivity at age 7 set to 1, year and age effects are estimated (assuming log-catches normally distributed in likelihood)
F at age 10 for years other than 1992: average of F at ages 7-9, multiplied by scaling parameter	Includes 1982 year class	Excludes the 1982 year class
1983 egg estimate	Incorrect value used	Correct value used
Data	1982-2002, where data from the Western Area (as given in Table 3.3.1 but omitting Division VIIIc)	1982-2003, but also includes the egg production estimate for 2004. Data from the Western Area as before, but extended to include ICES Division VIIIc

Figure 5.6.1.1 presents an illustration of the model structure and the "free" parameters estimated by maximum likelihood (i.e. those estimated directly), and Table 5.6.1.1 summarises its main features. 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:

$$
\begin{aligned}
-\ln L = {} & \tfrac{1}{2} \sum_{y \in Y_{egg}} \left\{ \frac{\left(\ln Egg_y - \ln(q_{egg} S\hat{S}B_y)\right)^2}{\sigma_{egg}^2} + \ln\left[2\pi\sigma_{egg}^2\right] \right\} \\
& + \tfrac{1}{2} \sum_{y=2000}^{2003} \sum_{a=1}^{10} \left\{ \frac{\left(\ln C_{y,a} - \ln \hat{C}_{y,a}\right)^2}{\sigma_{sep}^2} + \ln\left[2\pi\sigma_{sep}^2\right] \right\} \\
& + \tfrac{1}{2} \sum_{y=1983}^{2003} \left\{ \frac{\left(\ln C_{y,11+} - \ln \hat{C}_{y,11+}\right)^2}{\sigma_{11+}^2} + \ln\left[2\pi\sigma_{11+}^2\right] \right\}
\end{aligned}
$$

where:

Egg_y	egg production estimate in year y;
$S\hat{S}B_y$	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
$\sigma^2_{egg/sep/11+}$	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 5.6.1.2 and 5.6.1.3. 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 5.6.1.4 presents the Egg production estimates taken from ICES (2002:G06) and Section 3.7.

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 evident when SAD03 was applied, and caused purely by variable catches in the plus-group (because under SAD03, the plus-group population numbers were estimated directly from these catches). Although the changes in SAD04 avoid the necessity for artificial data to estimate q_{egg} (the egg production catchability), q_{egg} values and fishing mortality estimates are low, and the SSB level is higher than estimated when using SAD03.

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 5.6.1.2. 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 5.6.1.2(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.

Figure 5.6.1.3 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 10-27% for the selectivity parameters, 19-24% for the SSB estimates, and 10-42% for the age 0 estimates. Point estimates and 95% confidence bounds for other key parameter estimates are given in Figure 5.6.1.4.

Fishing mortalities at age and observed catch at age are shown in Figure 5.6.1.5. They highlight the dominance of the 1982 year-class and the apparent shift in selectivity towards younger ages in recent years.

Discussion

Although SAD04 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 SSB estimates almost three times higher than estimated in previous years. A provisional analysis of log-catch ratios did not provide coherent signals about fishing mortality. Nevertheless, 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 almost trebling of SSB from SAD04 compared to SAD03 is partly caused by the very different selectivity pattern estimated for these two models (Figure 5.6.1.6(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 Figure 5.6.1.6(b), which plots the SSB trajectories for the two models on a relative scale, and the SSB estimates for SAD04 have relatively narrow 95% confidence bounds (CVs not exceeding 24%). Furthermore, SAD04 appears to be insensitive to the assumption about the length of the separable period (4 or 5 years), unlike SAD03, which showed considerable sensitivity to this assumption (ICES CM 2004/ACFM:08). It should be stressed that when comparisons are made between SAD03 and SAD04, the differences between them, described in the table above, should be carefully noted.

Aspects that warrant further investigation/exploration are:

- the availability of additional information that would allow further evaluation of the scale the model;
- the inclusion of CVs corresponding to the egg production estimates so that these estimates are weighted relative to one another;
- the feasibility of applying more flexible statistical catch-at-age models that could accommodate strong year classes such as the one in 1982

Conclusion

The SAD model implemented this year (SAD04) has several positive features compared to its predecessor: it provides a more rigorous statistical basis for estimation, avoids the use of artificial data, and the assumption of a dynamic pool to model the plus-group allows additional information to be included in the likelihood and provides more realistic population dynamics for the western horse mackerel stock. Based on qualitative information from the fishery, there are concerns about the low levels of fishing mortality (and consequently high SSB values) currently estimated, so that the SAD04 assessment is being presented as exploratory only. Nevertheless, SAD04 is able to provide relative trends in the development of SSB and recruitment over time.

SAD04 indicates strong 2001 and 2002 year-classes relative to the preceeding 6 year-classes (Figure 5.6.1.3), but the age 0 estimates for these two year-classes have relatively large 95% confidence bounds (CVs of 36 and 42% respectively).

References

Pope, J. G., and Shepherd, J. G. 1982. A simple method for the consistent interpretation of catch-at-age data. J. Cons. Int. Explor. Mer, 40: 176-184.

5.6.2 Stock assessment

The assessment is exploratory, and therefore not put forward as a final assessment.

5.6.3 Reliability of the assessment

The assessment is exploratory, and therefore not put forward as a final assessment.

5.7 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 (see section 5.12) was presented in last year's report (ICES 2004/ACFM:08). As this analysis was presented in relative terms in last year's ACFM report, it is still considered valid.

5.8 Short and medium term risk analysis

For reasons stated above, these analyses have not been carried out for this stock.

5.9 Long-Term Yield

In the absence of exceptional year classes, long-term sustainable yield is unlikely to be higher than about 130 000 t, dependent on the exploitation pattern. Exploitation at $F_{0.1}$ will produce yields of this order on basis of average recruitment (as determined by historical assessments) excluding the extremely large year classes. Given that the catch is currently above this, it is clear that catch will have to be reduced unless another exceptional year class like the 1982 year class is produced.

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} cannot be defined.

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

The age distribution is no longer dominated by a single strong year class and younger year classes have become relatively more abundant in the catch. Scaling problems in the assessment will have to be solved before HCRs can be developed.

5.12 Management considerations

The SSB of Western Horse Mackerel has been dominated by an outstanding 1982 year class and 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 some indications that the 2001 year class might be strong, but the current evidence for this is sparse. As there are no recruitment indices available, the strength of this year class can only be determined when it fully enters the fishery, which may take several years. 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.

Because of these uncertainties two catch forecasts were presented at last year's WG meeting assuming the 2001 year class either to be average weak or as strong as indicated by the model used at that time. Also, an evaluation was presented on the fishery on juvenile and adult western horse mackerel based on biological criteria by means of long-term equilibrium predictions of catch and stock and by studying the effect of area/period closures. The Working Group then recommended that a management strategy should be developed that takes into account fisheries both for juveniles and adults (similar to that for North Sea Herring, in which both adult and juvenile mortality are independently restricted). The WG considers this recommendation still to be valid.

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.

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[1]
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

[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

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

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

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

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

[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	13.866	21.891	6.529	9.419	7.730	6.327	3.911	3.995	12.424	3.947	10.330	7.708	0.506	0.350	0.109	2.585
1998	22.701	7.359	20.450	26.250	54.150	28.340	19.390	11.049	4.552	2.623	0.897	2.132	2.238	0.491	0.259	2.493
1999	30.744	50.190	17.429	3.930	19.331	18.302	10.964	13.575	11.888	8.618	4.186	0.924	1.198	0.068	0.054	0.103
2000	82.066	15.513	4.885	10.151	22.200	32.770	50.779	19.532	6.091	6.497	1.262	0.402	0.844	0.849	3.983	1.049
2001	100.998	33.875	23.985	12.557	6.815	4.238	1.308	30.670	18.740	3.667	6.075	3.411	0.470	0.571	0.187	0.439
2002	1.244	2.699	3.393	3.359	7.747	3.511	4.556	10.136	13.114	7.981	4.078	2.271	0.625	1.033	1.710	0.148
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

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

Table 5.5.1.1 Western horse mackerel catch in numbers (1000) at age by quarter and area in 2003

1Q																			
Ages	**IIa**	**IIIa**	**IIIc**	**IVa**	**Vb**	**VIa**	**VIIb**	**VIIc**	**VIIe**	**VIIf**	**VIIg**	**VIIh**	**VIIj**	**VIIIa**	**VIIIb**	**VIIIc east**	**VIIIc west**	**VIIId**	**Sum**
0																			
1					6	1401			2803	675	52			29116	1469	3991	2		39517
2					0	163			131733	225	17	58373		9705	27285	2315	7		229825
3					1	457			51530	481	37	22834		17068	303	103	7	4795	97615
4					2	1950	1021	1		613	47			19745	382	132	58	8669	32620
5					2	2064	1841	46		272	21		1284	7363	163	193	218	5669	19135
6					2	1778	1353	55		117	9		2604	3347	70	150	550	2185	12218
7					2	1965	2242	144		76	6		2440	2008	49	121	455	1642	11150
8					3	3148	3774	53		67	5		3872	2343	46	205	809	685	15010
9					5	4753	4308	288		60	5	4916	9532	1004	41	396	1060	272	26639
10					2	2041	1864	134		17	1	1475	6018	335	14	219	482		12602
11					2	858	1360	94		13	1	1967	2260		9	96	174		6832
12					1	516	1525	31		3	0	492	1262		2	40	88		3960
13					0	233	1252	17		3	0	492	729		2	26	28		2781
14					1	618	469	33		3	0	492	0		2	14	82		1715
15+					14	4533	1354	51		16	1	2458	1430		10	60	663		10590
2Q																			
Ages	**IIa**	**IIIa**	**IIIc**	**IVa**	**Vb**	**VIa**	**VIIb**	**VIIc**	**VIIe**	**VIIf**	**VIIg**	**VIIh**	**VIIj**	**VIIIa**	**VIIIb**	**VIIIc east**	**VIIIc west**	**VIIId**	**Sum**
0																			
1						4			2448	15		1783		11619	404	13865	0	3370	33508
2						37				3		379		3940	39686	7373	27	793	52237
3						312				2		246		3479	464	618	46	198	5365
4						457	10			3		322	194	4745	996	874	391	198	8191
5						187	20			2		266	1167	4096	380	1456	644	99	8316
6						66	38			2		194	1556	2914	183	1627	1114	99	7791
7						52	38			1		101	1556	1374	324	1306	778	99	5628
8						36	57			1		93	1945	1244	429	2253	1077	99	7233
9						71	90			1		131	1848	2157	398	4640	2388		11723
10						16	61			0		27	1653	451	243	2728	1390		6570
11						6	56			0		27	973	451	79	1176	562		3331
12						1	32			0		14	584	225	25	524	143		1548
13						2	22						194		17	313	22		571
14						1	11						97		11	224	193		536
15+						3	18						389		48	869	1291		2617
3Q																			
Ages	**IIa**	**IIIa**	**IIIc**	**IVa**	**Vb**	**VIa**	**VIIb**	**VIIc**	**VIIe**	**VIIf**	**VIIg**	**VIIh**	**VIIj**	**VIIIa**	**VIIIb**	**VIIIc east**	**VIIIc west**	**VIIId**	**Sum**
0																566	1		566
1						85	10		2264	2		4		3267	11401	5542	422	66	23063
2						870	71		804	1		2	192	1160	28052	22019	7110	23	60303
3	2	10		5		7309	301		73	0		0	1535	105	363	1900	2879	2	14485
4	2	10		5		10729	380		219	0		0	4221	316	578	937	1506	6	18911
5	2	10		5		4384	161		146	0		0	5756	211	389	566	426	4	12062
6	5	30		15		1541	106		73	0		0	2494	105	207	1202	534	2	6315
7	5	30		15		1213	129		73	0		0	2302	105	199	1520	352	2	5946
8	5	30		15		849	199						2302		32	1995	364		5791
9	3	20		10		1676	164						2686		57	3585	1326		9527
10	5	30		15		373	47						768		23	1161	437		2859
11	5	30		15		152	13						576		19	482	556		1848
12	3	20		10		34	10						192		26	557	361		1213
13	5	30		15		52	3						576		4	65	40		790
14	10	60		30		15	5								4	93	148		364
15+	33	189		96		61	12						384		28	1123	600		2525
4Q																			
Ages	**IIa**	**IIIa**	**IIIc**	**IVa**	**Vb**	**VIa**	**VIIb**	**VIIc**	**VIIe**	**VIIf**	**VIIg**	**VIIh**	**VIIj**	**VIIIa**	**VIIIb**	**VIIIc east**	**VIIIc west**	**VIIId**	**Sum**
0																1276			1276
1									51990	0		146193		3632	167	4700	947	5	207634
2		2	0	27		1967	42		50941	0		156503		9229	1287	12612	10715	9	243335
3		5	0	67		1773	543		16634	0		23963		1737	69	967	2442	2	48201
4		61	5	763		13657	3522		19195	0		52185	0	2332	61	467	145	2	92394
5		87	7	1086		13891	4495		17394	0		11010	0	1116	23	289	29	1	49431
6		83	6	1033		6765	2693		11583	0		7376	0	734	20	623	202	1	31120
7		13	1	163		3745	2865		2323	0		12478	0	315	17	678	274	1	22872
8		79	6	979		4293	3137		2212	0		9009	0	307	38	1158	224	1	21442
9		254	20	3165		7922	3158		5157	0		21318	0	650	59	1804	1358	3	44869
10		342	26	4257		4709	1426		5641	0		10829		170	21	580	467	2	28472
11		442	34	5495		2198	167		5671	0		2777		229	18	237	806	1	18075
12		988	76	12292		583	143		4932					124	20	298	482	1	19940
13		173	13	2148		153	204		1409					26	10	51	26	0	4213
14		158	12	1964		332	71		1414					27	4	41	193	0	4217
15+		1287	99	16017		2226	312		1426					30	8	312	610	0	22327
2003																			
Ages	**IIa**	**IIIa**	**IIIc**	**IVa**	**Vb**	**VIa**	**VIIb**	**VIIc**	**VIIe**	**VIIf**	**VIIg**	**VIIh**	**VIIj**	**VIIIa**	**VIIIb**	**VIIIc east**	**VIIIc west**	**VIIId**	**Sum**
0																1842	1		1843
1					6	1490	10		59505	692	52	147980	0	47634	13442	28098	1371	3441	303721
2		2	0	27	0	3037	113		183478	229	17	215256	192	24035	96309	44320	17859	825	585700
3	2	15	0	72	1	9850	844		68236	484	37	47042	1535	22390	1199	3588	5374	4997	165666
4	2	71	5	768	2	26793	4933	1	19414	616	47	52507	4415	27138	2018	2410	2099	8876	152117
5	2	97	7	1092	2	20527	6517	46	17541	274	21	11276	8207	12786	955	2503	1318	5774	88944
6	5	113	6	1048	2	10150	4190	55	11656	118	9	7570	6655	7100	480	3601	2400	2288	57445
7	5	43	1	178	2	6974	5274	144	2396	77	6	12579	6299	3802	589	3626	1859	1744	45596
8	5	108	6	994	3	8326	7167	53	2212	67	5	9102	8119	3894	545	5611	2473	785	49476
9	3	274	20	3176	5	14422	7720	288	5157	61	5	26365	14066	3811	554	10424	6132	275	92758
10	5	372	26	4272	2	7139	3398	134	5641	18	1	12332	8439	956	302	4689	2776	2	50503
11	5	471	34	5510	2	3214	1596	94	5671	13	1	4771	3808	680	125	1992	2098	1	30086
12	3	1008	76	12302	1	1135	1709	31	4932	3	0	505	2037	349	74	1419	1074	1	26661
13	5	202	13	2163	0	439	1480	17	1409	3	0	492	1499	26	33	456	115	0	8355
14	10	217	12	1995	1	966	556	33	1414	3	0	492	97	27	20	371	616	0	6832
15+	33	1476	99	16113	14	6822	1696	51	1426	16	1	2458	2203	30	93	2364	3164	0	38060

Table 5.5.2.1 Western horse mackerel mean weight (Kg) at age in catch by quarter and area in 2003

Ages	IIa	IIIa	IIIc	IVa	Vb	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIId	Total
1Q																			
0																			
1					0.049	0.049			0.044	0.038	0.038			0.038	0.024	0.038	0.034		0.038
2					0.067	0.063			0.036	0.073	0.073	0.036		0.073	0.031	0.045	0.091		0.037
3					0.142	0.142			0.039	0.095	0.095	0.039		0.095	0.093	0.080	0.103	0.096	0.053
4					0.164	0.160	0.187	0.121		0.108	0.108			0.107	0.105	0.131	0.171	0.109	0.114
5					0.162	0.162	0.200	0.152		0.114	0.114		0.130	0.113	0.115	0.141	0.205	0.119	0.131
6					0.188	0.176	0.191	0.170		0.113	0.113		0.148	0.112	0.113	0.163	0.218	0.116	0.144
7					0.195	0.182	0.197	0.183		0.121	0.121		0.149	0.120	0.122	0.168	0.227	0.123	0.159
8					0.190	0.190	0.197	0.188		0.114	0.114		0.166	0.114	0.117	0.170	0.225	0.113	0.171
9					0.206	0.203	0.200	0.204		0.124	0.124	0.190	0.178	0.126	0.126	0.174	0.224	0.095	0.187
10					0.232	0.241	0.225	0.221		0.127	0.127	0.176	0.189	0.122	0.131	0.181	0.229		0.201
11					0.321	0.300	0.211	0.219		0.174	0.174	0.174	0.213		0.170	0.190	0.306		0.214
12					0.282	0.277	0.216	0.258		0.192	0.192	0.192	0.216		0.190	0.217	0.246		0.222
13					0.419	0.368	0.231	0.277		0.196	0.196	0.196	0.309		0.197	0.249	0.203		0.257
14					0.341	0.333	0.215	0.270		0.190	0.190	0.190			0.191	0.232	0.317		0.256
15+					0.400	0.390	0.225	0.257		0.244	0.244	0.244	0.253		0.243	0.215	0.270		0.307
2Q																			
Ages	**IIa**	**IIIa**	**IIIc**	**IVa**	**Vb**	**VIa**	**VIIb**	**VIIc**	**VIIe**	**VIIf**	**VIIg**	**VIIh**	**VIIj**	**VIIIa**	**VIIIb**	**VIIIc east**	**VIIIc west**	**VIIId**	**Total**
0																			
1						0.088			0.044	0.042		0.042		0.044	0.036	0.037	0.052	0.035	0.040
2						0.141				0.065		0.065		0.069	0.039	0.047	0.108	0.045	0.043
3						0.152				0.095		0.095		0.097	0.075	0.069	0.109	0.087	0.094
4						0.163	0.166			0.108		0.108	0.142	0.109	0.087	0.149	0.157	0.105	0.116
5						0.173	0.179			0.122		0.122	0.143	0.126	0.114	0.157	0.168	0.101	0.137
6						0.183	0.184			0.136		0.136	0.169	0.138	0.117	0.173	0.192	0.124	0.159
7						0.187	0.191			0.128		0.128	0.178	0.127	0.129	0.177	0.201	0.132	0.164
8						0.187	0.193			0.133		0.133	0.176	0.136	0.134	0.183	0.213	0.117	0.173
9						0.187	0.199			0.165		0.165	0.185	0.165	0.145	0.180	0.193		0.180
10						0.192	0.218			0.178		0.178	0.177	0.178	0.157	0.187	0.235		0.193
11						0.203	0.217			0.222		0.222	0.195	0.222	0.196	0.196	0.275		0.213
12						0.208	0.240			0.211		0.211	0.218	0.211	0.250	0.215	0.238		0.219
13						0.197	0.251						0.202	0.000	0.276	0.235	0.203		0.224
14						0.225	0.223						0.185	0.000	0.264	0.242	0.317		0.258
15+						0.219	0.260						0.213	0.000	0.311	0.218	0.294		0.257
3Q																			
Ages	**IIa**	**IIIa**	**IIIc**	**IVa**	**Vb**	**VIa**	**VIIb**	**VIIc**	**VIIe**	**VIIf**	**VIIg**	**VIIh**	**VIIj**	**VIIIa**	**VIIIb**	**VIIIc east**	**VIIIc west**	**VIIId**	**Total**
0																0.055	0.053		0.055
1						0.088	0.115		0.057	0.057		0.057		0.057	0.052	0.063	0.088	0.057	0.056
2						0.141	0.135		0.077	0.077		0.077	0.114	0.077	0.059	0.076	0.095	0.077	0.072
3	0.134	0.134		0.134		0.152	0.144		0.095	0.095		0.095	0.115	0.095	0.086	0.108	0.105	0.095	0.130
4	0.137	0.137		0.137		0.163	0.159		0.118	0.118		0.118	0.127	0.118	0.118	0.139	0.125	0.118	0.148
5	0.163	0.163		0.163		0.173	0.173		0.137	0.137		0.137	0.144	0.137	0.138	0.157	0.136	0.137	0.155
6	0.166	0.166		0.166		0.183	0.177		0.133	0.133		0.133	0.152	0.133	0.137	0.174	0.169	0.133	0.164
7	0.178	0.178		0.178		0.187	0.179		0.133	0.133		0.133	0.161	0.133	0.135	0.188	0.206	0.133	0.175
8	0.216	0.216		0.216		0.187	0.189						0.180		0.200	0.171	0.207		0.180
9	0.211	0.211		0.211		0.187	0.188						0.183		0.202	0.194	0.227		0.194
10	0.228	0.228		0.228		0.192	0.196						0.202		0.222	0.208	0.234		0.209
11	0.261	0.261		0.261		0.203	0.219						0.191		0.230	0.245	0.267		0.231
12	0.285	0.285		0.285		0.208	0.232						0.184		0.235	0.247	0.280		0.247
13	0.351	0.351		0.351		0.197	0.222						0.224		0.226	0.297	0.360		0.243
14	0.336	0.336		0.336		0.225	0.220						0.000		0.189	0.215	0.247		0.262
15+	0.338	0.338		0.338		0.219	0.239						0.220		0.394	0.369	0.322		0.327
4Q																			
Ages	**IIa**	**IIIa**	**IIIc**	**IVa**	**Vb**	**VIa**	**VIIb**	**VIIc**	**VIIe**	**VIIf**	**VIIg**	**VIIh**	**VIIj**	**VIIIa**	**VIIIb**	**VIIIc east**	**VIIIc west**	**VIIId**	**Total**
0																0.036			0.036
1									0.066	0.064		0.070		0.058	0.056	0.059	0.090	0.067	0.069
2		0.190	0.190	0.190		0.088	0.118		0.087	0.086		0.086	0.114	0.081	0.069	0.076	0.087	0.089	0.086
3		0.245	0.245	0.245		0.115	0.164		0.116	0.111		0.108	0.115	0.108	0.103	0.103	0.090	0.114	0.111
4		0.225	0.225	0.225		0.148	0.154		0.136	0.127		0.117	0.127	0.123	0.133	0.140	0.136	0.127	0.128
5		0.262	0.262	0.262		0.166	0.170		0.161	0.143		0.118	0.144	0.140	0.145	0.158	0.169	0.140	0.156
6		0.287	0.287	0.287		0.187	0.182		0.207	0.160		0.141	0.152	0.155	0.168	0.170	0.207	0.171	0.186
7		0.298	0.298	0.298		0.191	0.184		0.198	0.180		0.154	0.161	0.168	0.182	0.187	0.231	0.175	0.171
8		0.322	0.322	0.322		0.203	0.189		0.285	0.198		0.138	0.180	0.186	0.196	0.166	0.239	0.210	0.186
9		0.353	0.353	0.353		0.215	0.188		0.271	0.204		0.136	0.183	0.198	0.206	0.193	0.244	0.204	0.192
10		0.391	0.391	0.391		0.231	0.183		0.350	0.280		0.150	0.202	0.257	0.227	0.199	0.255	0.270	0.247
11		0.402	0.402	0.402		0.256	0.258		0.345	0.247		0.174	0.191	0.241	0.236	0.239	0.274	0.261	0.320
12		0.438	0.438	0.438		0.290	0.220		0.390	0.390			0.184	0.296	0.251	0.243	0.269	0.303	0.412
13		0.453	0.453	0.453		0.312	0.250		0.349	0.349			0.224	0.349	0.259	0.291	0.330	0.329	0.399
14		0.451	0.451	0.451		0.321	0.220		0.370	0.299			0.000	0.299	0.205	0.216	0.245	0.372	0.397
15+		0.489	0.489	0.489		0.370	0.240		0.443	0.367			0.220	0.367	0.314	0.312	0.295	0.375	0.463
2003																			
Ages	**IIa**	**IIIa**	**IIIc**	**IVa**	**Vb**	**VIa**	**VIIb**	**VIIc**	**VIIe**	**VIIf**	**VIIg**	**VIIh**	**VIIj**	**VIIIa**	**VIIIb**	**VIIIc east**	**VIIIc west**	**VIIId**	**Total**
0																0.042	0.053	0.000	0.042
1					0.049	0.051	0.115		0.063	0.038	0.038	0.070		0.042	0.048	0.046	0.089	0.036	0.061
2		0.190	0.190	0.190	0.067	0.103	0.129		0.050	0.073	0.073	0.072	0.114	0.076	0.043	0.070	0.090	0.046	0.061
3	0.134	0.173	0.245	0.237	0.142	0.145	0.156		0.058	0.095	0.095	0.074	0.115	0.096	0.085	0.099	0.098	0.096	0.078
4	0.137	0.213	0.225	0.224	0.164	0.155	0.161	0.121	0.136	0.108	0.108	0.117	0.128	0.109	0.101	0.142	0.133	0.109	0.127
5	0.163	0.252	0.262	0.262	0.162	0.167	0.179	0.152	0.161	0.114	0.114	0.118	0.142	0.120	0.124	0.156	0.164	0.118	0.148
6	0.166	0.255	0.287	0.285	0.188	0.184	0.185	0.170	0.207	0.113	0.113	0.140	0.155	0.127	0.127	0.172	0.194	0.116	0.171
7	0.178	0.215	0.298	0.288	0.195	0.188	0.189	0.183	0.196	0.121	0.121	0.154	0.161	0.127	0.132	0.183	0.212	0.123	0.168
8	0.216	0.293	0.322	0.320	0.190	0.197	0.193	0.188	0.285	0.114	0.114	0.138	0.172	0.127	0.141	0.175	0.218	0.114	0.179
9	0.211	0.343	0.353	0.353	0.206	0.207	0.195	0.204	0.271	0.125	0.124	0.146	0.180	0.161	0.156	0.187	0.217	0.096	0.189
10	0.228	0.378	0.391	0.391	0.232	0.232	0.207	0.221	0.350	0.127	0.127	0.153	0.188	0.172	0.165	0.193	0.237	0.270	0.226
11	0.261	0.393	0.402	0.402	0.321	0.265	0.216	0.219	0.345	0.175	0.174	0.174	0.205	0.228	0.205	0.213	0.275	0.261	0.279
12	0.285	0.435	0.438	0.438	0.282	0.282	0.216	0.258	0.390	0.193	0.192	0.193	0.214	0.241	0.243	0.234	0.267	0.303	0.365
13	0.351	0.438	0.453	0.452	0.419	0.328	0.234	0.277	0.349	0.196	0.196	0.196	0.263	0.349	0.260	0.251	0.285	0.329	0.325
14	0.336	0.419	0.451	0.449	0.341	0.327	0.216	0.270	0.370	0.190	0.190	0.190	0.185	0.299	0.231	0.232	0.278	0.372	0.343
15+	0.338	0.470	0.489	0.488	0.400	0.382	0.229	0.257	0.443	0.244	0.244	0.244	0.240	0.367	0.329	0.302	0.294	0.375	0.396

Table 5.5.2.2 Western horse mackerel mean length (cm) at age in catch by quarter and area in 2003

1Q Ages	IIa	IIIa	IIIc	IVa	Vb	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIId	Total
0																			
1					18.5	18.5			18.0	17.8	17.8			17.8	14.7	16.4	15.7		17.6
2					20.4	19.8			16.8	21.6	21.6	16.8		21.6	16.1	17.3	22.2		16.9
3					26.0	26.0			17.3	23.5	23.5	17.3		23.4	23.3	21.0	23.2	23.6	18.8
4					27.3	27.1	28.2	25.5		24.5	24.5			24.4	24.2	25.2	27.7	24.7	24.8
5					27.2	27.2	28.9	27.4		25.1	25.1		26.1	25.1	25.2	25.9	29.6	25.2	25.9
6					28.8	27.9	28.6	28.5		25.0	25.0		27.4	24.9	25.0	27.2	30.2	25.3	26.6
7					29.5	28.3	28.8	29.2		25.7	25.7		27.2	25.7	25.7	27.5	30.6	25.7	27.4
8					28.7	28.7	28.7	29.4		24.9	24.9		28.3	24.8	25.1	27.6	30.5	25.5	27.9
9					29.8	29.3	29.1	30.3		26.1	26.1	29.6	29.0	26.2	26.1	27.9	30.5	24.5	29.1
10					30.9	30.9	30.4	31.1		25.8	25.8	29.2	29.4	25.5	26.1	28.3	30.7		29.7
11					33.3	33.0	29.9	30.8		29.3	29.3	29.3	30.7		28.9	28.8	33.8		30.5
12					33.5	32.8	29.8	32.5		29.5	29.5	29.5	30.8		29.4	30.2	31.5		30.5
13					36.2	35.2	30.5	33.6		29.5	29.5	29.5	34.5		29.5	31.7	29.5		31.8
14					34.3	34.4	29.8	32.9		30.5	30.5	30.5			30.5	30.9	34.5		32.0
15+					35.9	35.7	30.1	32.4		31.9	31.9	31.9	32.8		31.8	30.0	32.5		33.4

2Q Ages	IIa	IIIa	IIIc	IVa	Vb	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIId	Total
0																			
1						19.8			18.0	17.7		17.7	0.0	17.8	16.5	16.0	18.3	17.1	17.0
2						24.5				20.3		20.3	0.0	20.7	17.3	17.7	23.7	18.8	17.7
3						25.3				23.0		23.0	0.0	23.0	21.5	20.1	23.7	23.0	22.7
4						26.0	27.7			24.2		24.2	26.5	24.2	22.3	26.4	26.9	24.0	24.5
5						26.7	28.4			24.9		24.9	26.4	25.0	24.7	26.9	27.5	24.5	25.8
6						27.3	28.6			25.4		25.4	27.8	25.4	24.8	27.9	28.8	25.5	26.9
7						27.6	28.9			25.5		25.5	28.3	25.1	25.8	28.0	29.3	27.5	27.4
8						27.6	28.8			25.8		25.8	28.5	25.8	26.1	28.4	29.9	25.5	28.0
9						27.6	29.3			27.3		27.3	28.6	27.3	26.7	28.2	28.9		28.2
10						28.0	30.4			28.5		28.5	28.5	28.5	27.3	28.5	30.6		28.9
11						28.6	30.3			29.5		29.5	29.4	29.5	29.2	29.0	32.4		29.8
12						29.0	31.2			28.5		28.5	29.8	28.5	31.7	30.0	31.1		29.9
13						28.3	31.8						30.0		33.2	31.0	29.5		30.7
14						30.0	30.6						29.5		32.8	31.3	34.5		32.2
15+						29.6	31.7						29.8		34.0	30.1	33.4		31.8

3Q Ages	IIa	IIIa	IIIc	IVa	Vb	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIId	Total
0																18.6	18.4		18.6
1						19.8	22.8		19.1	19.1		19.1	0.0	19.1	18.7	19.5	22.0	19.1	19.0
2						24.5	24.3		21.3	21.3		21.3	22.5	21.3	19.8	20.9	22.6	21.3	20.7
3	24.5	24.5		24.5		25.3	25.0		22.5	22.5		22.5	23.1	22.5	22.1	23.5	23.3	22.5	24.3
4	25.5	25.5		25.5		26.0	26.1		24.2	24.2		24.2	24.3	24.2	24.2	25.8	24.9	24.2	25.4
5	26.5	26.5		26.5		26.7	27.0		26.0	26.0		26.0	25.7	26.0	26.0	26.9	25.6	26.0	26.2
6	27.2	27.2		27.2		27.3	27.3		25.5	25.5		25.5	26.1	25.5	25.8	27.9	27.5	25.5	26.9
7	27.8	27.8		27.8		27.6	27.4		26.5	26.5		26.5	26.8	26.5	26.6	28.7	29.6	26.5	27.6
8	29.5	29.5		29.5		27.6	28.0						27.8		29.9	27.7	29.5		27.9
9	30.5	30.5		30.5		27.6	28.0						27.6		30.0	28.9	30.6		28.6
10	30.5	30.5		30.5		28.0	28.4						28.8		30.7	29.6	30.9		29.3
11	32.8	32.8		32.8		28.6	29.8						28.5		31.1	31.2	32.4		30.5
12	33.0	33.0		33.0		29.0	30.5						28.5		31.3	31.4	33.0		31.4
13	35.2	35.2		35.2		28.3	30.0						29.8		31.1	33.7	36.0		30.7
14	34.7	34.7		34.7		30.0	30.7								29.3	30.1	31.5		31.9
15+	35.1	35.1		35.1		29.6	31.0						30.0		37.4	36.2	34.3		34.5

4Q Ages	IIa	IIIa	IIIc	IVa	Vb	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIId	Total
0																15.7			15.7
1									19.8	20.0		20.8		19.3	19.2	19.1	22.2	20.0	20.5
2		27.0	27.0	27.0		21.5	23.0		21.7	21.8		22.2	22.5	21.5	20.8	20.8	21.9	22.0	22.0
3		28.8	28.8	28.8		23.5	26.4		23.5	23.7		23.9	23.1	23.6	23.4	23.1	22.1	23.7	23.7
4		28.0	28.0	28.0		25.7	25.7		24.6	24.7		24.5	24.3	24.6	25.1	25.8	25.4	24.6	24.8
5		29.7	29.7	29.7		26.7	26.8		26.1	25.7		25.0	25.7	25.5	26.0	27.0	27.5	25.8	26.2
6		30.4	30.4	30.4		27.8	27.6		27.7	26.8		26.2	26.1	26.4	27.6	27.7	29.6	27.2	27.4
7		30.8	30.8	30.8		28.1	27.7		27.8	27.6		27.1	26.8	27.0	28.4	28.6	30.8	27.8	27.5
8		31.6	31.6	31.6		28.6	28.1		30.6	28.1		26.6	27.8	27.6	29.3	27.4	31.1	29.0	28.0
9		32.5	32.5	32.5		29.1	28.0		30.5	28.5		26.0	27.6	28.3	29.8	28.9	31.4	28.9	28.0
10		33.5	33.5	33.5		29.9	27.7		32.5	30.9		26.5	28.8	30.4	30.5	29.2	31.9	31.1	29.6
11		34.1	34.1	34.1		30.9	32.1		31.8	29.9		28.5	28.5	29.8	31.0	31.0	32.7	30.9	32.0
12		35.1	35.1	35.1		32.4	30.0		33.1	33.1		0.0	28.5	30.7	31.5	31.3	32.5	31.9	34.3
13		35.6	35.6	35.6		33.2	31.7		32.5	32.5			29.8	32.5	32.3	33.5	35.0	33.5	34.2
14		36.0	36.0	36.0		33.5	30.0		32.5	31.3				31.3	29.2	30.1	31.5	32.5	34.2
15+		36.2	36.2	36.2		34.9	31.1		34.9	33.7			30.0	33.7	34.3	34.0	33.6	35.0	35.8

2003 Ages	IIa	IIIa	IIIc	IVa	Vb	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIIc east	VIIIc west	VIIId	Total
0																16.6	18.4		16.6
1					18.5	18.6	22.8	0.0	19.7	17.8	17.8	20.7	0.0	18.0	18.2	17.3	22.1	17.2	19.6
2		27.0	27.0	27.0	20.4	22.3	23.9	0.0	18.2	21.6	21.6	20.8	22.5	21.4	17.7	20.1	22.1	18.9	19.5
3	24.5	26.0	28.8	28.5	26.0	25.0	25.9	0.0	18.8	23.5	23.5	20.7	23.1	23.4	22.3	22.7	22.8	23.6	20.8
4	25.5	27.6	28.0	28.0	27.3	25.9	26.3	25.5	24.6	24.5	24.5	24.5	24.4	24.4	23.3	26.0	25.4	24.7	24.9
5	26.5	29.4	29.7	29.7	27.2	26.8	27.4	27.4	26.1	25.1	25.1	25.0	25.9	25.2	25.3	26.8	27.2	25.2	26.1
6	27.2	29.5	30.4	30.4	28.8	27.8	27.9	28.5	27.6	25.0	25.0	26.2	27.0	25.3	25.4	27.8	28.9	25.3	27.1
7	27.8	28.7	30.8	30.5	29.5	28.0	28.2	29.2	27.8	25.7	25.7	27.1	27.3	25.6	26.1	28.4	29.9	25.8	27.5
8	29.5	31.0	31.6	31.6	28.7	28.5	28.4	29.4	30.6	25.0	24.9	26.6	28.2	25.3	26.4	27.9	30.2	25.5	27.9
9	30.5	32.4	32.5	32.5	29.8	29.0	28.6	30.3	30.5	26.1	26.1	26.7	28.7	27.2	27.3	28.6	30.1	24.5	28.4
10	30.5	33.3	33.5	33.5	30.9	30.1	29.2	31.1	32.5	25.8	25.8	26.8	29.2	27.8	27.8	28.9	30.9	31.1	29.5
11	32.8	34.0	34.1	34.1	33.3	31.4	30.1	30.8	31.8	29.3	29.3	28.8	30.0	29.6	29.7	29.8	32.6	30.9	31.3
12	33.0	35.1	35.1	35.1	33.5	32.5	29.8	32.5	33.1	29.5	29.5	29.5	30.3	29.3	31.4	30.8	32.4	31.9	33.4
13	35.2	35.5	35.6	35.6	36.2	33.7	30.7	33.6	32.5	29.5	29.5	29.5	32.1	32.5	32.5	31.7	32.9	33.5	32.8
14	34.7	35.6	36.0	36.0	34.3	34.0	29.9	32.9	32.5	30.5	30.5	30.5	29.5	31.3	31.2	30.9	32.8	32.5	33.4
15+	35.1	36.1	36.2	36.2	35.9	35.4	30.3	32.4	34.9	31.9	31.9	31.9	31.7	33.7	34.8	33.5	33.4	35.0	34.8

Table 5.6.1.1 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 5.6.1.2: 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
0	0	0	0	0	0	0	876	0	0	20632	14887	46	3686	2702	10729	4860	744	14822	637	58685	13707	1843
1	3713	7903	0	1633	0	99	27369	0	20406	33560	229703	109152	60759	165382	19774	110145	91505	97561	78856	69430	461055	303721
2	21072	2269	241360	4901	0	493	6112	0	45036	89715	36331	94500	911713	470498	658727	465350	184443	83714	131112	246525	120106	585700
3	134743	32900	4439	602992	1548	0	2099	20766	138929	23034	80552	16738	115729	424563	860992	735919	488662	176919	52716	151707	164977	165666
4	11515	53508	36294	4463	676208	2950	4402	18282	61442	207751	56275	62714	53132	215468	186306	410638	360116	265820	71779	98454	126329	152117
5	13197	15345	149798	41822	8727	891660	18968	5308	33298	143072	256085	94711	44692	59035	85508	244328	219650	254516	150869	101344	64449	88944
6	11741	44539	22350	100376	65147	2061	941725	14500	10549	73730	127048	317337	38769	90832	51365	119062	157396	212225	170393	116952	69828	57445
7	8848	52673	38244	12644	109747	41564	12115	1276731	20607	25369	49020	144610	221970	35654	55229	127658	122583	187250	177995	234832	94429	45596
8	1651	17923	34020	16172	25712	90814	39913	12046	1384850	25584	19053	70717	106512	245230	53379	134488	81499	147328	133290	203823	130285	49476
9	414	3291	14756	6200	21179	11740	67869	59357	37011	1219646	23449	32693	40799	119117	57131	109962	68264	77691	61578	103968	85325	92758
10	1651	5505	4101	9224	15271	9549	9739	83125	70512	23987	1103480	4822	42302	99495	56962	109165	50555	35635	18010	36076	45798	50503
11+	81385	129139	58370	40976	56824	62776	76096	78951	226294	137131	152305	1309609	998180	1362342	729283	601196	389594	252044	168770	132706	150103	109994

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
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
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
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
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
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
6	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
8	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
10	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

Table 5.6.1.3: Western Horse Mackerel: Input to SAD

a. Mean weight at age in the catch (kg)

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.012	0.015	0.010	0.009	0.025	0.023	0.029	0.016	0.017	0.021	0.022	0.025	0.018	0.019	0.042
1	0.054	0.039	0.034	0.029	0.029	0.068	0.031	0.050	0.032	0.034	0.023	0.034	0.037	0.038	0.036	0.039	0.042	0.033	0.054	0.043	0.039	0.061
2	0.090	0.113	0.073	0.045	0.045	0.067	0.075	0.075	0.031	0.054	0.085	0.067	0.053	0.053	0.077	0.074	0.086	0.078	0.081	0.065	0.070	0.061
3	0.142	0.124	0.089	0.087	0.110	0.110	0.114	0.149	0.090	0.113	0.115	0.126	0.108	0.076	0.091	0.093	0.102	0.110	0.097	0.103	0.096	0.078
4	0.178	0.168	0.130	0.150	0.107	0.155	0.132	0.142	0.124	0.126	0.138	0.132	0.126	0.093	0.129	0.110	0.114	0.123	0.128	0.116	0.125	0.127
5	0.227	0.229	0.176	0.156	0.171	0.143	0.147	0.142	0.126	0.149	0.144	0.147	0.158	0.130	0.146	0.143	0.141	0.142	0.140	0.133	0.143	0.148
6	0.273	0.247	0.216	0.199	0.196	0.174	0.157	0.220	0.129	0.143	0.159	0.155	0.165	0.134	0.160	0.179	0.164	0.164	0.155	0.144	0.151	0.171
7	0.276	0.282	0.245	0.243	0.223	0.198	0.240	0.166	0.202	0.153	0.166	0.169	0.170	0.175	0.172	0.190	0.176	0.189	0.161	0.154	0.166	0.168
8	0.292	0.281	0.278	0.256	0.251	0.249	0.304	0.258	0.183	0.189	0.178	0.187	0.198	0.178	0.179	0.200	0.186	0.207	0.192	0.172	0.185	0.179
9	0.305	0.254	0.262	0.294	0.296	0.264	0.335	0.327	0.227	0.185	0.227	0.204	0.204	0.202	0.197	0.211	0.195	0.216	0.210	0.197	0.212	0.189
10	0.369	0.260	0.259	0.257	0.280	0.321	0.386	0.330	0.320	0.217	0.222	0.201	0.279	0.206	0.211	0.232	0.217	0.227	0.236	0.228	0.257	0.226
11+	0.352	0.319	0.306	0.319	0.356	0.342	0.413	0.432	0.358	0.320	0.351	0.249	0.247	0.248	0.273	0.267	0.244	0.312	0.280	0.272	0.317	0.348

b. 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
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
2	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.070	0.050	0.050
3	0.080	0.080	0.077	0.081	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.066	0.095	0.080	0.090	0.110	0.087	0.074	0.109	0.110
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	0.120	0.108	0.082	0.120	0.142
5	0.232	0.227	0.155	0.140	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	0.130	0.148	0.100	0.135	0.139
6	0.269	0.257	0.201	0.193	0.169	0.150	0.141	0.131	0.135	0.143	0.151	0.166	0.185	0.152	0.148	0.162	0.142	0.160	0.170	0.121	0.146	0.161
7	0.280	0.276	0.223	0.236	0.195	0.171	0.143	0.159	0.124	0.144	0.150	0.173	0.169	0.166	0.172	0.169	0.151	0.170	0.173	0.131	0.153	0.169
8	0.292	0.270	0.253	0.242	0.242	0.218	0.217	0.127	0.154	0.150	0.158	0.172	0.191	0.178	0.183	0.184	0.162	0.180	0.193	0.142	0.177	0.169
9	0.305	0.243	0.246	0.289	0.292	0.254	0.274	0.210	0.174	0.182	0.160	0.170	0.191	0.187	0.185	0.188	0.174	0.190	0.202	0.161	0.206	0.176
10	0.369	0.390	0.338	0.247	0.262	0.281	0.305	0.252	0.282	0.189	0.182	0.206	0.190	0.197	0.202	0.208	0.191	0.210	0.257	0.187	0.216	0.176
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	0.260	0.268	0.275	0.206

Table 5.6.1.4 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
1977	5.33E+14
1980	6.35E+14
1983	3.81E+14
1986	5.08E+14
1989	1.63E+15
1992	1.58E+15
1995	1.23E+15
1998	1.00E+15
2001	6.84E+14
2004	6.78E+14

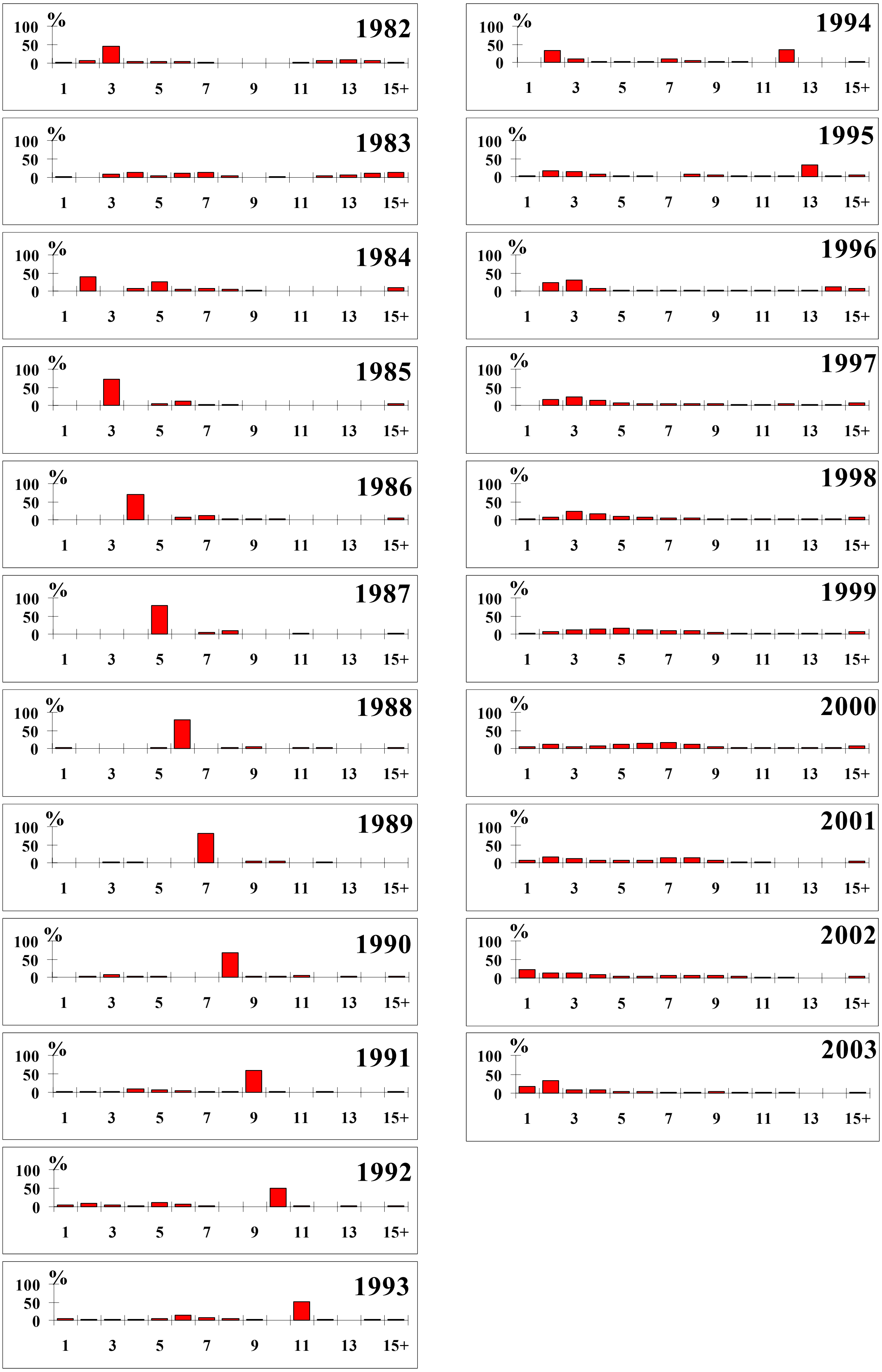
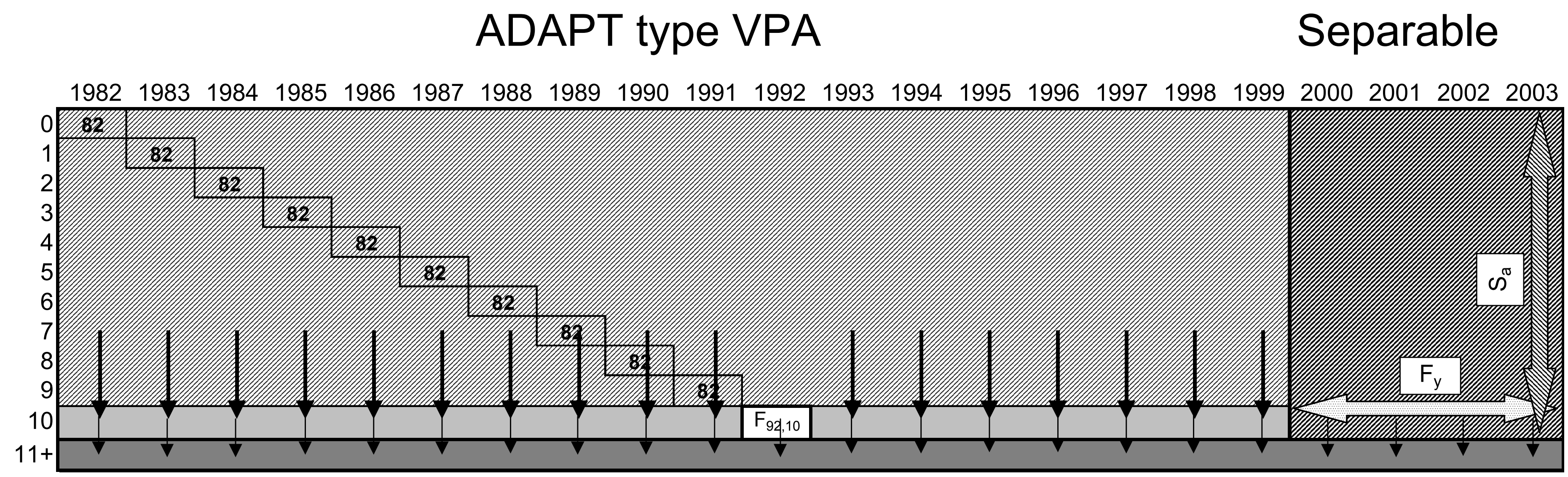


Figure 5.5.1.1 The age composition of the WESTERN HORSE MACKEREL in the international catches during 1982-2003.



Model estimated parameters

1	F_y	Year effects in separable period fishing mortalities
2	S_a	Age effects in separable period fishing mortalities (with value at age 7 set to 1)
3	$F_{92,10}$	Fishing mortality on the 1982 year class at age 10 in 1992
4	F_{scal}	The scaling parameter which adjusts fishing mortality at age 10 relative to the avererage of ages 7 - 9
5	q_{egg}	Catchability of the estimated SSB relative to the western horse mackerel egg production time series

Figure 5.6.1.1 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.

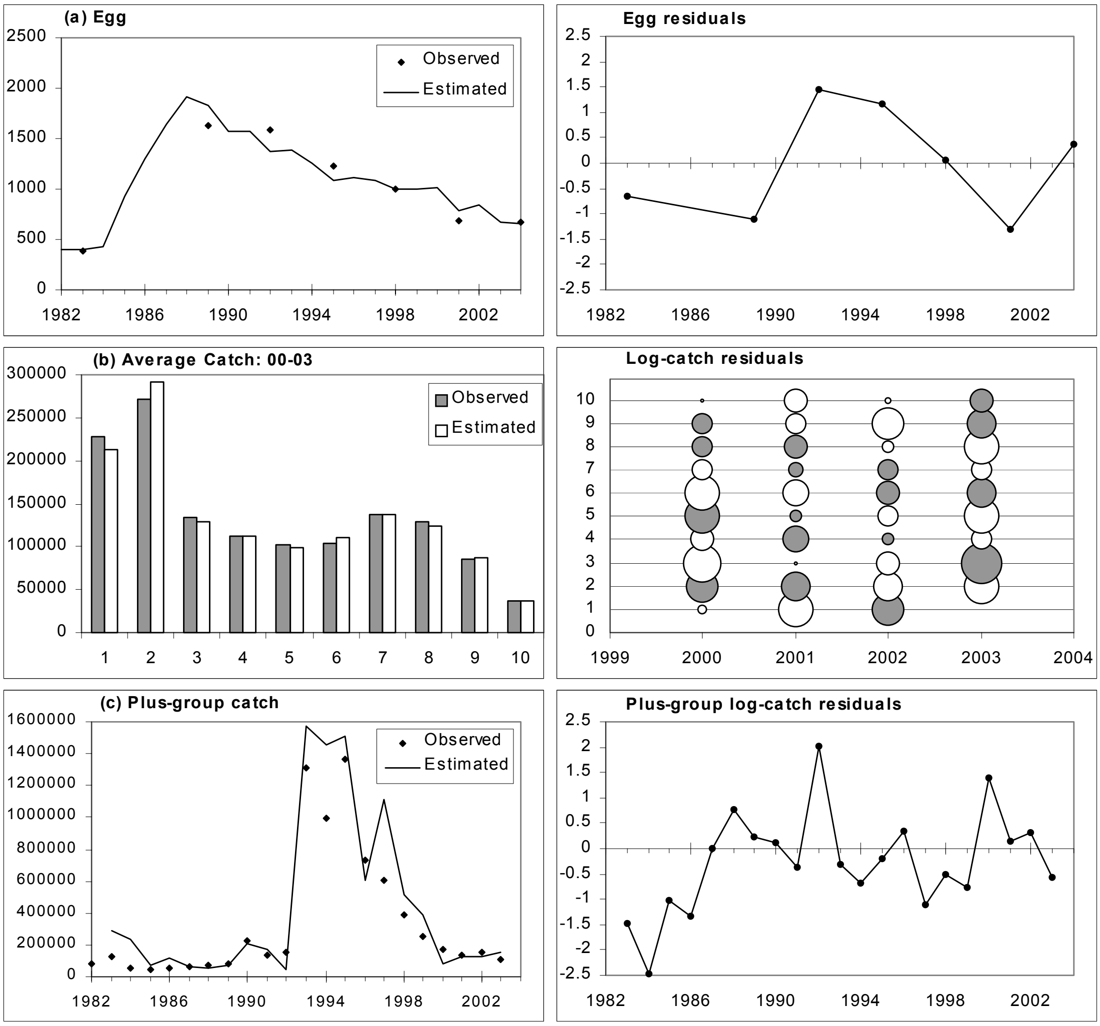


Figure 5.6.1.2 Model fits to data for the three components of the likelihood corresponding to (a) the egg estimates, (b) the catches in the separable period, and (c) to the catches in the plus-group. The left-hand column shows the actual fit to the data (average catches are shown in (b) for ease of presentation), 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).

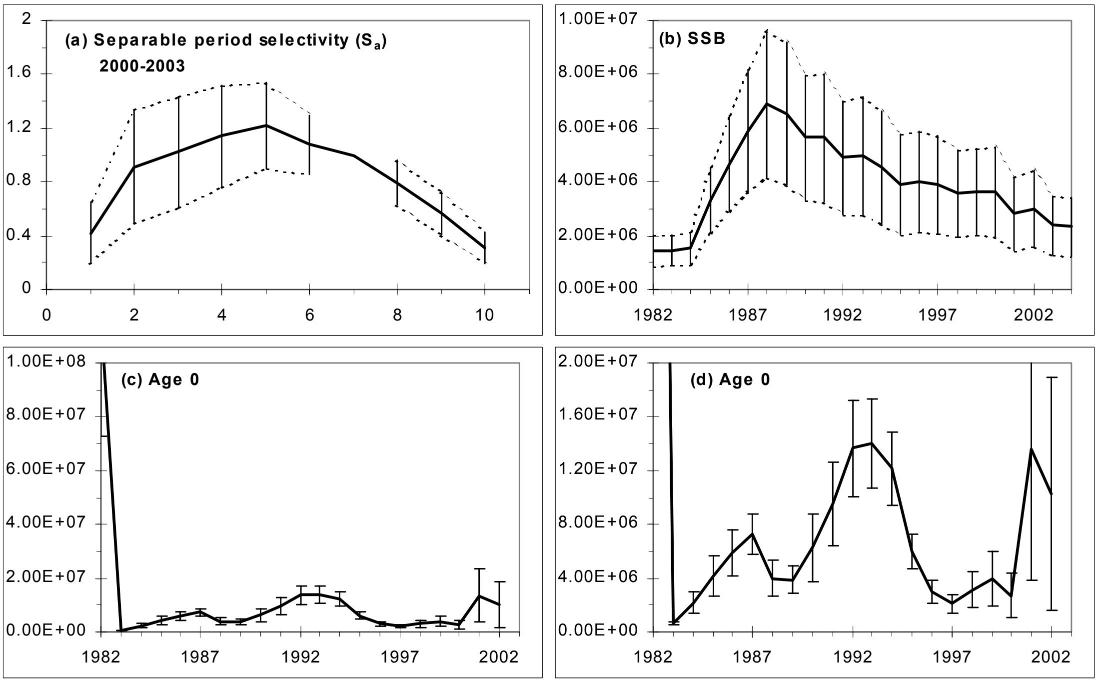


Figure 5.6.1.3 Plots of (a) the selectivity pattern, (b) the SSB trajectory, (c) numbers at age 0, and (d) the same as (c) but scaled to capture more detail. The error bars are 2 standard deviations (indicating roughly 95% confidence bounds).

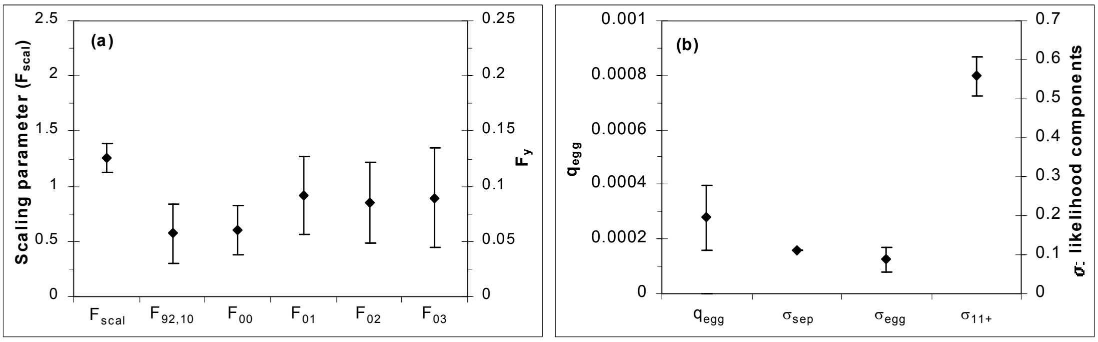
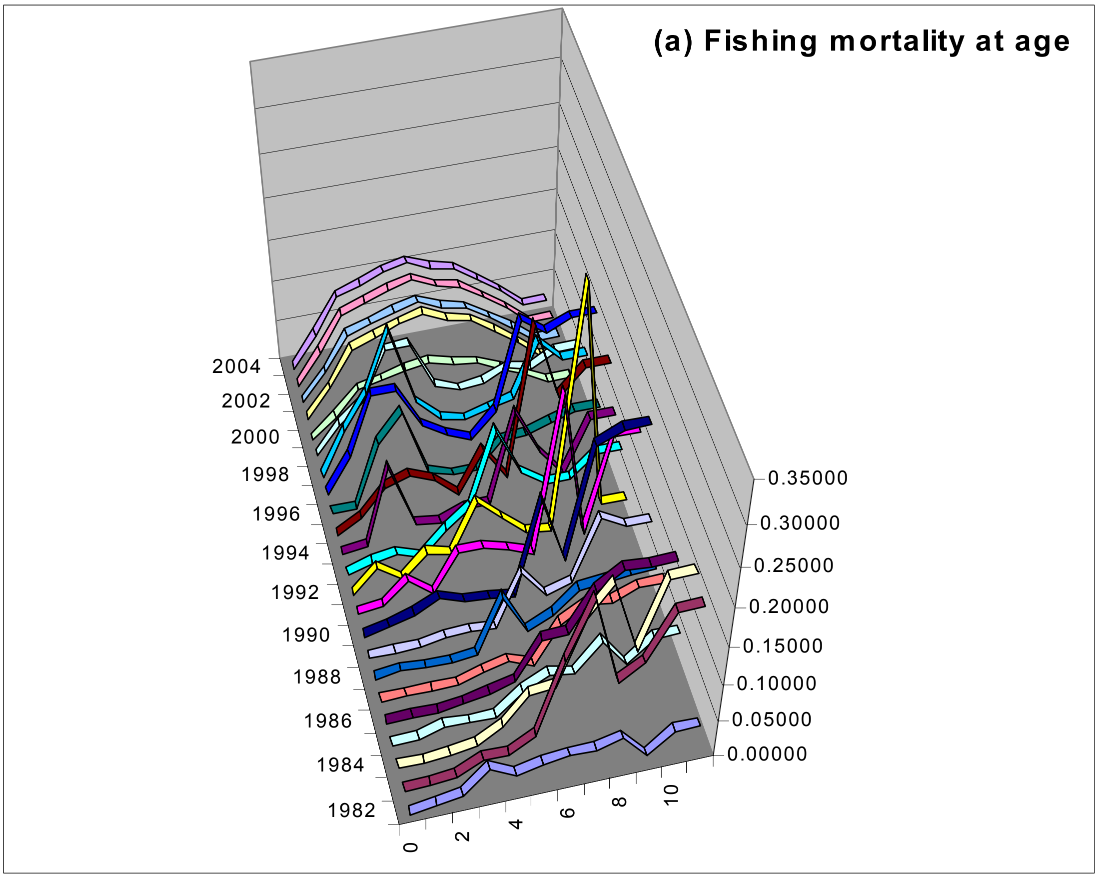


Figure 5.6.1.4 Estimates for some key parameters, with (a) corresponding to fishing mortality parameters (the scaling parameter F_{scal}, fishing mortality at age 10 in 1992, $F_{92,10}$, and the fishing mortality year effects for the separable period, F_y), and (b) the catchability parameter q_{egg}, 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).



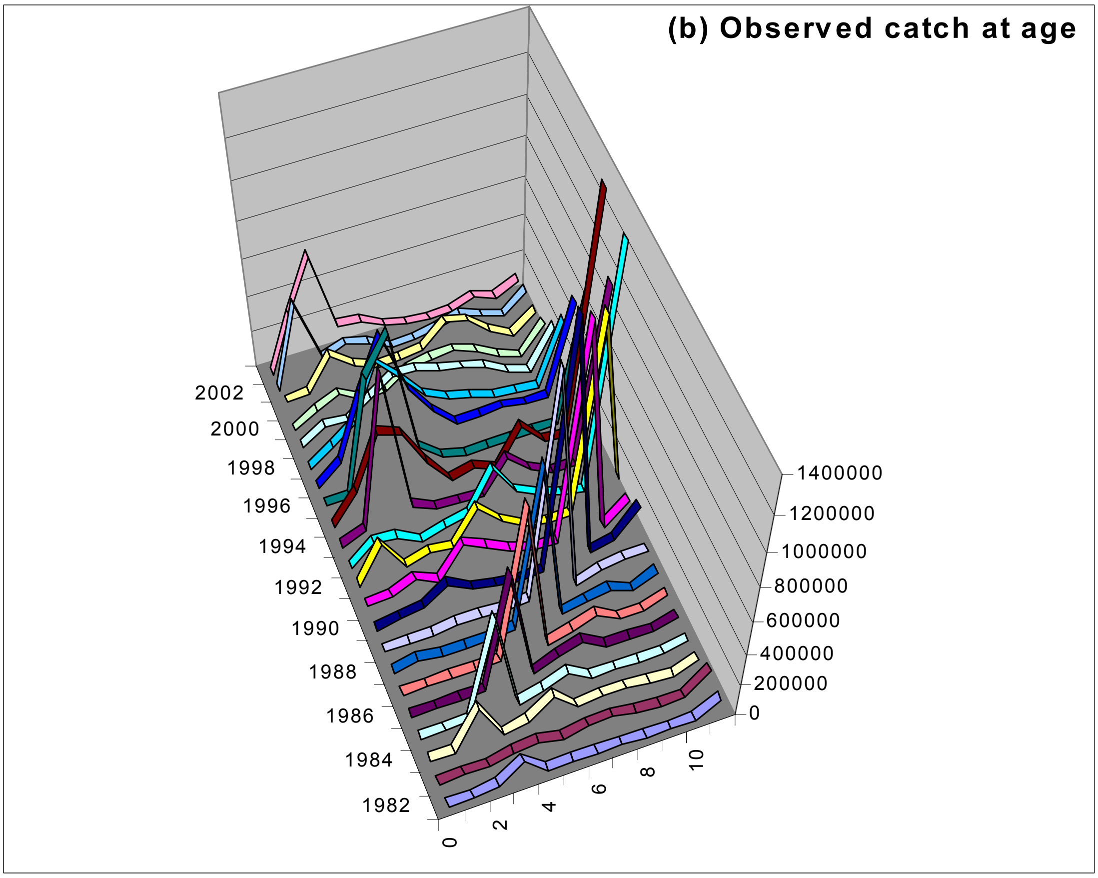


Figure 5.6.1.5 Three-dimensional plots of (a) estimated fishing mortality at age, and (b) observed catch at age.

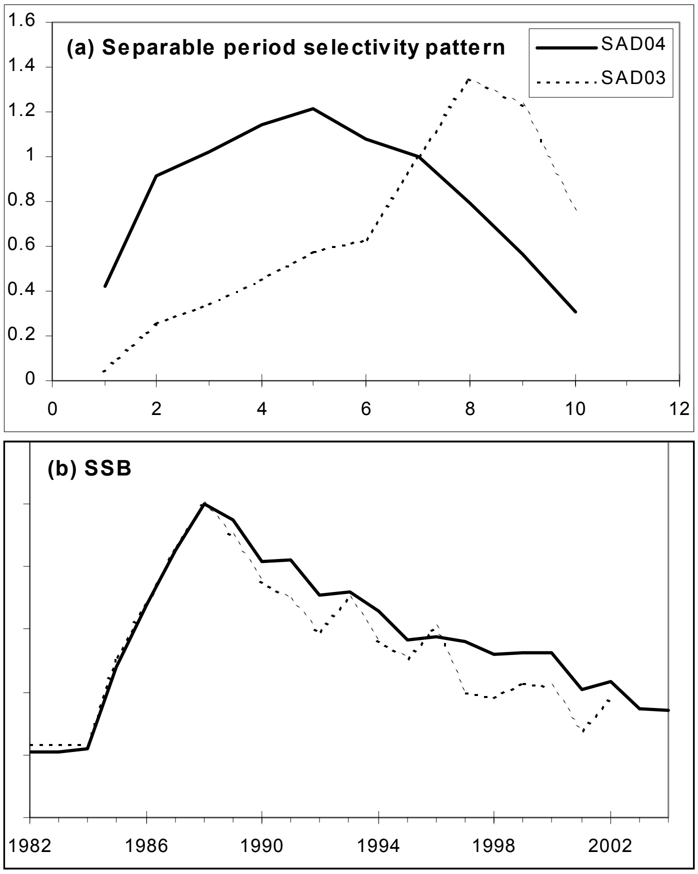


Figure 5.6.1.6 Plots of (a) the separable period selectivity pattern and (b) the SSB trajectory, comparing results for the SAD04 and SAD03 models.

6 Southern Horse Mackerel (Division IXa)

6.1 ICES advice applicable to 2003 and 2004

In 2003 ICES considered that the state of the stock was unknown and that the previously proposed reference points may not be valid as the stock identity appeared to be uncertain.

ICES further adviced that catches in 2004 should not exceed the recent average of 47, 000 t (2000-2002). The TAC for this stock should only apply to *Trachurus trachurus*.

The ICES advice was based on the information from the previously defined southern stock which included the population in Division VIIIc.

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 therefore allocated to the Southern Horse mackerel Stock. In previous years the catches from Subdivisions VIIIc west and VIIIc east, were also considered to belong to the southern horse mackerel stock. These catches have been now removed 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 1991-2003, and it is expected to go back in time until 1939 (Portuguese catches are available since 1927) during the next year (2005).

The Spanish catches in Subdivision IXa South (Gulf of Cadiz) are available for 2002 and 2003. 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 Gufl of Cadiz probably represent less than 5% of the total catch, and therefore their exclusion should not affect the reliability of the assessment. The Portuguese catches are the majority ranging from 51% of the total catch of the stock in 1998 to 86% in 1992 (table 6.2.1). The catch time series during the assessment period shows a decreasing trend since the peak reached in 1998. The catches in 2003 represented the lowest level reached in the assessment period mainly due to the markedly decreased of 21% observed in Portuguese catches comparing with the catch reported in 2002. In the assessment period the level of catches for this stock is about 26,500 (± 5,600) tonnes. The catches from bottom trawlers are the majority in the Portuguese area whereas in the Spanish one predominate the Purse seiner's catch (figures 6.2.2 and 6.2.3).

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 good coverage of the fishery (about 96% of the total catch). The number of fish aged seems also to be sufficient throught 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 previous catch in numbers estimates 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 is now defined as part of the Western stock. In the new catch in numbers at age from Subdivision IXa north, age length keys which included only otoliths from Division IXa were used. In the time series of the catch in numbers at age, the 1996 yearclass appears to be a strong one at ages 0, 1 and 2 (table 6.3.1.1). In general, catches are dominated by juveniles and young adults (ages 0 to 4).

6.3.2 Mean length and mean weight-at-age

Table 6.3.2.1 and table 6.3.2.2 show the mean weight at age in the catch, and the mean length at age in catch respectively. They were calculated by applying the mean weighted by the catch over the mean weights at age or mean lengths at age obtained by Subdivision.

Mean weight at age in the stock: Taking in consideration that: the spawning season is very long covering 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):

$Y = 1/(1 + \exp(-1 * ((-3.21055) + (2.3921) * X)))$

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 Ocotober surveys and the Spanish September/October survey. The two October surveys covered Sub-divisions VIIIc East, VIIIc West, IXa North (Spain) from 20-500 m depth and Sub-divisions IXa Central North, Central South and South, in Portugal, from 20-750 m depth. The Spanish survey was disagregated by subdivision in order to use the data from the subdivision IXa north which corresponds to the southern horse mackerel stock. The same sampling methodology was used in both surveys but there were differences in the gear design, as described in ICES (1991/G: 13). The Portuguese October and July survey indices and the Spanish September/October survey indices are estimated by strata for the range of distribution of horse mackerel in the area, which has been consistently sampled over the years. This corresponds to the 20-500 m strata boundaries. It was demonstrated that horse mackerel off the Portuguese shelf are stratified by length according to the depth and spawning time (ICES 1993/Assess: 19).

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, 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. The gaps in the two Portuguese survey series correspond to times when surveys were carried out with a different vessel and gear (for which there is no conversion factor) or were not carried at all. In 2002 the haul duration in the bottom-trawl surveys was reduced from 1 hour (as used from 1990 to 2002) to 30 minutes. The catchability of horse mackerel in the Portuguese areas is significantly different in a non-linear way between hauls of 1 hour and 30 minutes (Murta et al, in prep.). Therefore, it is considered that a new tuning series has started in 2002, that should be analysed separately from the previous one

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 whereas in the Portuguese surveys the oldest adults are not well represented.

The total number per haul is dominated by the catch on the incoming yearclass in three time series of surveys (figure 6.4.1.2). These CPUE series are used in data exploration (see section 6.7.1)

6.4.2 Egg surveys

With mounting evidence of horse mackerel being an indeterminate spawner, previous estimates of SSB obtained with the AEPM are thought to be unreliable, and therefore excluded from the assessment. As an alternative, SSB estimates are currently being calculated with the DEPM from samples collected both in AEPM cruises for horse mackerel and DEPM cruises for sardine. Two SSB estimates for the southern stock are expected to be available in the 2005 WGMHSA. 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 a significant higher catches (figures 6.2.2 and 6.2.3). However, it is clear that the current catch level is not abnormally low when compared with the catches of the first half of the 20th century. Instead, the catches from 1962-1978, appear exceptionally high when looking to the whole time series. Many 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 three bottom-trawl surveys series, available to use as tuning data in the assessment, reveal marked year-effects (Figure 6.7.1.1) possibly related to changes in catchability or abundance. These features have most probably a natural cause (not a methodological one) given the accordance in the patterns showed by the Portuguese and Spanish surveys, that are carried out independently, with different vessels and fishing gears.

Nevertheless, the evolution of the year-classes in the population can be clearly followed in the Portuguese July and October surveys (Figures 6.7.1.2 and 6.7.1.3) with the year-effects appearing only in a few ages that look, in certain year-classes, more abundant than expected. Linear regressions applied to the logarithm of the surveys catches showed a clear negative slope with, in most cases, an R-square higher than 0.6. The estimates of these regression slopes can be taken as proxies for the overall mortality of year-classes.

The Spanish October survey presents a pattern different from the Portuguese ones, with the abundance of most year-classes increasing with age (Figure 6.7.1.4). In some year-classes (e.g. 1992) the abundance appears to decrease with age initially, but starts to increase after age 6. This is related to the fact that no intermediate age individuals are caught in this survey, whereas old individuals are rare in the Portuguese surveys carried out to the south of the Spanish waters. Migrations in the stock area, along the life of each year-class, is the most likely explanation for the observed pattern, being partially supported by ongoing studies (Murta and Abaunza, in prep.). Therefore, the Spanish October survey in area IXa does not look suitable for the tuning of an assessment model.

The "Extended Survivors Analysis" (XSA) (Darby and Flatman, 1994; Shepherd, 1999) has been the method used for the assessment of the southern horse mackerel stock since 1992. Given the recent changes in stock delimitation, which had effects also on the available data for the assessment, a reappraisal of the method and of its different working options has to be done for the new stock definition and data set. Given that no survey data is available in 2002 and 2003, all assessment procedures just covered the period from 1991 to 2001.

Firstly, a separable VPA was run in order to obtain an estimate of the selection curve that would allow to define the age at which catchability becomes independent of age (therefore fixed for all ages older than that one). This procedure showed that age 9 could be chosen as the first at which catchability is fixed. Then, a preliminary run with XSA was made considering the catchability dependent on stock size for ages 0 to 8, so that the diagnostics of the regression of catchability on year-class strength would help to define the best age range at which catchability is dependent of year-class strength. According to the results from this procedure, that period was set between ages 0 and 3. Finally, the preliminary XSA run showed large log-catchability residuals in the last true age (11 years). Given that the surveys used to tune the assessment catch usually few old individuals, which may be the cause for some noise in the older ages, it was decided to apply the assessment method to ages 0 to 11+ instead of the range 0-12+ used in earlier years, being 10 years now the last true age. In all XSA runs no "shrinkage" (Darby and Flatman, 1994) of any kind was used.

6.7.2 Stock assessment

A final run with XSA was made according to the options taken during the data exploration. The report and diagnostics of this run are in Table 6.7.2.1. This table shows that the assessment model failed to converge after 30 iterations. However, after letting the model run several hundreds iterations convergence still was not achieved. It was then decided to run the same model again and stop at 30 iterations even without convergence, because practical experience has shown that unreliable results can be obtained if the model is allowed to iterate for too long.

Table 6.7.2.1 also shows that the choice of the age at which catchability becomes independent of year-class strength was well chosen, given the low values of R-square of the regressions of catchability on year-class strength above that age, both for the July and October Portuguese surveys.

However, the catchability residuals present very high residuals (in absolute value), especially for the October survey (Table 6.7.2.1, Figures 6.7.2.1 and 6.7.2.2). In the residuals for both surveys it is clear an year-effect that makes that the high residuals in each year are of the same signal (either positive or negative). This feature is most likely related to the year-effects in the survey data described in Section 6.6.1, and reveal that a major assumption of this assessment method is being violated - that of constant catchability in time for each age.

The fact that the constant catchability assumption may not be valid is probably also responsible for the pattern observed in the results of a retrospective analysis (Figure 6.7.2.3). Given that the surveys have such well marked year-effects, the removal of data from a single year may affect significantly the outcome of the assessment. Nevertheless, the retrospective pattern (Figure 6.7.2.3) shows that fishing mortality has been overestimated in previous years, which possibly results in a conservative advice based on the assessment, regarding the exploitation level of the resource.

The numbers-at-age matrix estimated from the assessment is represented in Figure 6.7.2.4. The strenght of the 1982 year-class is well marked in that figure, as are the 1984 and 1996 year-classes. The stock summary is shown in Table 6.7.2.2 and Figure 6.7.2.5. From these table and figure it is clear a stability in recent years both in the catches as in the spawning stock biomass and in the recruitment. According to this assessment the fishing mortality has a decreasing trend from 1998 to 2001.

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. Accordingly, the different sources of data do not show contradictory trends as used to happen before. However, the methods applied in the past for the assessment of this stock do not adapt very well to the characteristics of the new data set.

Given the lack of an appropriate fit of XSA to the available tuning data, the results obtained with this method can not be seen as a realistic description of the stock size and structure. The overall trends in fishing mortality, recruitment and SSB may be indicative of trends, given the good quality of the catch data. However, realistic estimates of their absolute values are not likely to be obtained with the assessment method that was used.

6.8 Short-term catch predictions

Given the low reliability of the estimates of population size, recruitment and fishing mortality in the assessment's final year, no short-term predictions were carried out.

6.9 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. Taking into account all these factors, together with the apparently stable state of the stock and exploitation pattern, it is advised that fishing effort must not increase.

Although no reliable forecasts are available for this stock, the assessment is considered to be indicative of trends. This gives the impression that there is a stability in the stock dynamics and exploitation:

- Recruitment does not show a decreasing trend, but instead a fluctuation with occasional recruitments of exceptional strength, as is typical of this species.
- Population size also does not show decreasing trends, both in the assessment performed, as in the survey data.
- Fishing effort has not increased (number of boats has decreased).

6.10 Roadblocks to the improvement of the stock assessment

The southern horse mackerel stock delimitation has been recently revised according to the conclusions of the HOMSIR project (QLK5-CT1999-01438). This revision resulted in data aggregation from Portugal and Spain different from what had been done in previous years. A result of the new stock definition is that the Spanish CPUE series from the Avilés and Coruña fleets, along with the bottom-trawl survey strata from Div. VIIIc, are now part of the western horse mackerel stock. Therefore, not only the available data to assess the southern stock has been reduced, but those data that are now part of the western stock used to have a heavy weight on the assessment results of the southern stock.

The Spanish survey strata that are now in the southern stock are characterised by the catch of juveniles and very old individuals, the intermediate ages being very scarce. When analysed as an independent series from those in the Portuguese area, this survey does not show a decrease in abundance in year-classes with time, making it unsuitable to be used as an abundance index. This feature is likely due to migrations along the stock area and throughout the life span of the fish. This problem would not exist if there was a complete coverage of the stock distribution area using a single vessel and fishing gear, or different vessels, in the same time of the year, with a known conversion factor.

Therefore, other sources of abundance indices would help to improve the assessment of this stock in the future. These sources could be:

- Bottom-trawl surveys covering coherently the whole stock distribution area.
- Acoustic surveys, currently carried out only for the sardine assessment.
- Catch-per-unit-effort from well-defined trawl fleet segments.
- Daily egg production method.

Also, further fish samples and fishery data from Moroccan waters would allow a complete clarification of the possible connection between the southern horse mackerel stock and the Moroccan population.

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)*

(*) In parenthesis: the Spanish catches from Subdivision IXa south are also included. These catches are only available for 2002 and 2003 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.

YEAR	AGES 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

Table 6.3.2.1. Southern horse mackerel. Mean weight 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

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

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	368.432	31.464	20.498	16.412	13.542	5.729	1.915	1.358	1.443	1.917	0.998	0.741	0.378	0.094	0.021	0.040
1992	225.533	686.049	159.245	38.330	24.187	13.014	8.211	6.160	4.542	3.851	6.967	2.164	1.373	0.388	0.221	0.071
1993	1505.320	268.642	338.764	167.844	34.349	5.495	3.554	3.417	0.785	1.290	0.856	2.238	0.576	0.376	0.087	0.082
1994	4.147	7.780	59.971	47.331	14.426	3.231	0.715	1.673	0.737	0.495	0.320	0.127	0.036	0.000	0.000	0.014
1995	12.355	33.941	88.959	125.383	41.345	10.775	1.788	0.752	0.324	0.229	0.167	0.416	0.448	0.636	0.226	0.175
1996*																
1997	1913.822	72.043	95.547	23.722	41.938	34.189	11.128	7.077	5.014	3.937	2.089	0.934	0.168	0.179	0.121	0.127
1998	39.938	50.809	90.788	71.327	2.723	2.814	1.861	1.070	0.536	0.291	0.145	0.022	0.003	0.000	0.000	0.000
1999*																
2000	1.455	13.907	18.474	24.501	14.034	7.591	4.445	1.187	0.439	0.129	0.027	0.008	0.003	0.001	0.000	0.000
2001	903.468	43.371	5.646	25.553	98.921	9.137	10.272	13.991	7.494	3.341	1.844	0.325	0.181	0.178	0.012	0.000
2002 [1]																
2003*																

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

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
2002 [2]																
2003*																

***** The surveys were carried out with a different gear (1994), and with a different vessel and gear (1996 and 1999)

[1] In 2002 started a new series in which the duration of the trawling per haul has changed from one hour to thirty minutes

[2] In 2002 there was no survey.

Table 6.7.2.1. XSA diagnostics

```
 Extended Survivors Analysis

 Horse mackerel south

 CPUE data from file hom9atunorig.dat

 Catch data for  11 years. 1991 to 2001. Ages  0 to  11.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 Oct Pt Survey      ,   1991, 2001,   0,    10,   .800,   .900
 Jul Pt. survey     ,   1991, 2001,   0,    10,   .540,   .630


 Time series weights :

      Tapered time weighting applied
      Power =    3 over  20 years


 Catchability analysis :

      Catchability dependent on stock size for ages <    4

         Regression type = P
         Minimum of   5 points used for regression
         Survivor estimates not shrunk to the population mean


      Catchability independent of age for ages >=    9


 Terminal population estimation :

      Final estimates not shrunk towards mean F

      Minimum standard error for population
      estimates derived from each fleet =    .300

      Prior weighting not applied


 Tuning had not converged after   30 iterations


 Total absolute residual between iterations
 29 and  30 =     .02314

 Final year F values
 Age         ,      0,      1,      2,      3,      4,      5,      6,      7,      8,      9
 Iteration 29,  .2412,  .2054,  .1110,  .1733,  .1886,  .4543,  .2866,  .2582,  .1850,  .1557
 Iteration 30,  .2402,  .2046,  .1104,  .1723,  .1872,  .4525,  .2838,  .2551,  .1827,  .1533


 Age         ,     10
 Iteration 29,  .3165
 Iteration 30,  .3104




 Regression weights
       ,  .751,  .820,  .877,  .921,  .954,  .976,  .990,  .997, 1.000, 1.000
```

Table 6.7.2.1. XSA diagnostics (cont.)

Fishing mortalities

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0,	.022,	.011,	.028,	.011,	.037,	.008,	.047,	.087,	.020,	.240
1,	.172,	.174,	.151,	.178,	.026,	.408,	.151,	.094,	.167,	.205
2,	.440,	.399,	.265,	.105,	.049,	.339,	.994,	.098,	.125,	.110
3,	.298,	.506,	.436,	.277,	.134,	.131,	.419,	.477,	.184,	.172
4,	.165,	.395,	.269,	.208,	.306,	.110,	.122,	.358,	.512,	.187
5,	.182,	.252,	.140,	.142,	.116,	.147,	.090,	.151,	.233,	.453
6,	.129,	.361,	.121,	.091,	.141,	.098,	.149,	.176,	.260,	.284
7,	.310,	.376,	.132,	.107,	.174,	.117,	.407,	.163,	.212,	.255
8,	.116,	.408,	.254,	.138,	.192,	.170,	.600,	.120,	.244,	.183
9,	.330,	.116,	.364,	.292,	1.155,	.225,	.527,	.503,	.260,	.153
10,	.086,	.445,	.203,	.512,	.704,	.704,	.837,	.484,	.669,	.310

XSA population numbers (Thousands)

	AGE									
YEAR ,	0,	1,	2,	3,	4,	5,	6,	7,	8,	9,
1992 ,	5.85E+05,	6.99E+05,	4.84E+05,	1.81E+05,	8.88E+04,	6.51E+04,	4.99E+04,	3.10E+04,	5.53E+04,	1.88E+04,
1993 ,	4.91E+05,	4.93E+05,	5.06E+05,	2.68E+05,	1.16E+05,	6.48E+04,	4.67E+04,	3.77E+04,	1.96E+04,	4.24E+04,
1994 ,	4.61E+05,	4.18E+05,	3.56E+05,	2.92E+05,	1.39E+05,	6.71E+04,	4.33E+04,	2.80E+04,	2.23E+04,	1.12E+04,
1995 ,	6.08E+05,	3.86E+05,	3.09E+05,	2.35E+05,	1.63E+05,	9.16E+04,	5.02E+04,	3.31E+04,	2.11E+04,	1.49E+04,
1996 ,	1.18E+06,	5.17E+05,	2.78E+05,	2.40E+05,	1.53E+05,	1.14E+05,	6.84E+04,	3.94E+04,	2.56E+04,	1.58E+04,
1997 ,	4.90E+05,	9.81E+05,	4.34E+05,	2.28E+05,	1.80E+05,	9.73E+04,	8.72E+04,	5.11E+04,	2.85E+04,	1.82E+04,
1998 ,	4.47E+05,	4.18E+05,	5.61E+05,	2.66E+05,	1.72E+05,	1.39E+05,	7.23E+04,	6.81E+04,	3.91E+04,	2.07E+04,
1999 ,	5.07E+05,	3.67E+05,	3.10E+05,	1.79E+05,	1.50E+05,	1.31E+05,	1.09E+05,	5.36E+04,	3.90E+04,	1.85E+04,
2000 ,	5.28E+05,	4.00E+05,	2.88E+05,	2.42E+05,	9.56E+04,	9.05E+04,	9.69E+04,	7.89E+04,	3.92E+04,	2.97E+04,
2001 ,	5.43E+05,	4.45E+05,	2.91E+05,	2.19E+05,	1.73E+05,	4.93E+04,	6.17E+04,	6.43E+04,	5.50E+04,	2.64E+04,

Estimated population abundance at 1st Jan 2002

, 0.00E+00, 3.69E+05, 3.14E+05, 2.26E+05, 1.59E+05, 1.24E+05, 2.71E+04, 4.05E+04, 4.35E+04, 3.99E+04,

Taper weighted geometric mean of the VPA populations:

, 5.75E+05, 4.94E+05, 3.54E+05, 2.21E+05, 1.36E+05, 8.63E+04, 6.49E+04, 4.83E+04, 3.23E+04, 2.38E+04,

Standard error of the weighted Log(VPA populations) :

, .2922, .3077, .2861, .2457, .2771, .3374, .3313, .3660, .3614, .7359,

	AGE
YEAR ,	10,
1992 ,	1.81E+05,
1993 ,	1.16E+04,
1994 ,	3.25E+04,
1995 ,	6.70E+03,
1996 ,	9.56E+03,
1997 ,	4.29E+03,
1998 ,	1.25E+04,
1999 ,	1.05E+04,
2000 ,	9.62E+03,
2001 ,	1.97E+04,

Estimated population abundance at 1st Jan 2002

, 1.99E+04,

Taper weighted geometric mean of the VPA populations:

, 1.57E+04,

Standard error of the weighted Log(VPA populations) :

, 1.0602,

1

Log catchability residuals.

Table 6.7.2.1. XSA diagnostics (cont.)

Fleet : Oct Pt Survey

Age	1991
0	-.42
1	-.29
2	.28
3	.51
4	-.13
5	-.19
6	-.28
7	-1.12
8	.22
9	-1.55
10	-1.20

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	-.08	.11	.13	-.14	99.99	.11	.17	99.99	-.02	.01
1	.01	.24	-.04	.23	99.99	-.59	.19	99.99	.08	.12
2	-.06	.03	.05	.24	99.99	-.05	-.22	99.99	.03	-.19
3	.20	.08	-.23	.13	99.99	-.14	-.07	99.99	-.18	-.08
4	.45	.73	-.43	.41	99.99	.24	-2.44	99.99	.12	1.21
5	.69	-.10	-.77	.13	99.99	1.23	-1.68	99.99	-.13	.85
6	.99	.41	-1.31	-.58	99.99	.71	-.85	99.99	-.18	1.13
7	1.40	.67	.04	-.94	99.99	.87	-1.06	99.99	-1.26	1.44
8	.59	.13	-.19	-1.08	99.99	1.40	-.78	99.99	-1.29	1.16
9	1.85	-.24	.33	-.77	99.99	1.82	-.67	99.99	-2.06	1.21
10	-.03	.93	-1.29	-.09	99.99	3.03	-.63	99.99	-2.05	1.04

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	4	5	6	7	8	9	10
Mean Log q	-8.3866	-8.9280	-9.4613	-9.5311	-9.7745	-9.9334	-9.9334
S.E(Log q)	1.0897	.9190	.8660	1.1354	.9942	1.4261	1.5936

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	.01	-38.752	13.16	.02	9	.19	-8.55
1	.13	-10.363	12.61	.27	9	.30	-8.93
2	.18	-16.930	12.04	.69	9	.18	-8.44
3	.17	-8.418	11.63	.32	9	.23	-8.16

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
4	.03	-8.419	11.68	.01	9	.33	-8.39
5	-.07	-6.740	11.45	.03	9	.34	-8.93
6	.15	-7.470	10.77	.24	9	.29	-9.46
7	.00	-6.418	10.79	.00	9	.44	-9.53
8	.19	-7.079	10.27	.32	9	.35	-9.77
9	.10	-3.628	10.14	.02	9	.86	-9.93
10	.27	-2.612	9.81	.13	9	1.18	-9.93

Table 6.7.2.1. XSA diagnostics (cont.)

Fleet : Jul Pt. survey

Age	1991
0	-.41
1	-.30
2	.24
3	.41
4	-.65
5	-.43
6	-.39
7	-.71
8	.66
9	-.46
10	.06

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	-.07	.10	99.99	-.11	99.99	.11	.20	99.99	.03	.00
1	-.01	.17	99.99	.22	99.99	-.44	.32	99.99	.14	-.16
2	-.24	.14	99.99	.01	99.99	.07	-.16	99.99	-.08	.06
3	.15	.08	99.99	.06	99.99	-.13	-.04	99.99	-.22	-.13
4	.05	.86	99.99	1.03	99.99	-.21	-.23	99.99	-.14	-.69
5	-.15	1.93	99.99	.22	99.99	-.73	-1.06	99.99	-.33	.70
6	-.26	2.92	99.99	-.66	99.99	-.84	-.97	99.99	-.02	.46
7	.49	2.90	99.99	-.52	99.99	-1.29	-1.11	99.99	-.04	.62
8	.00	2.25	99.99	-.47	99.99	-1.70	-.64	99.99	.25	.20
9	1.68	1.09	99.99	-.44	99.99	-1.49	-.35	99.99	.14	.21
10	.11	-.17	99.99	-.06	99.99	-.06	-.04	99.99	.16	.12

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	4	5	6	7	8	9	10
Mean Log q	-9.2219	-9.0461	-8.9512	-9.2435	-9.6086	-9.9274	-9.9274
S.E(Log q)	.6330	.9463	1.2364	1.3339	1.1406	.9723	.1136

Table 6.7.2.1. XSA diagnostics (cont.)

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0,	.00,	-18.532,	13.21,	.00,	8,	.19,	-9.70,
1,	.11,	-13.492,	12.68,	.35,	8,	.30,	-8.72,
2,	.19,	-18.163,	12.13,	.78,	8,	.17,	-9.17,
3,	.15,	-12.101,	11.83,	.47,	8,	.21,	-9.23,

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
4,	.22,	-4.430,	11.24,	.22,	8,	.31,	-9.22,
5,	-.19,	-6.684,	11.72,	.18,	8,	.33,	-9.05,
6,	-.04,	-9.081,	11.13,	.02,	8,	.33,	-8.95,
7,	-.02,	-7.841,	10.90,	.01,	8,	.40,	-9.24,
8,	.05,	-6.267,	10.39,	.02,	8,	.42,	-9.61,
9,	.41,	-2.867,	10.13,	.43,	8,	.66,	-9.93,
10,	.95,	-1.362,	9.90,	.99,	8,	.11,	-9.91,

Terminal year survivor and F summaries :

Age 0 Catchability dependent on age and year class strength

Year class = 2001

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
Oct Pt Survey ,	369995.,	.300,	.000,	.00,	1,	.500,	.000
Jul Pt. survey ,	368881.,	.300,	.000,	.00,	1,	.500,	.000
P shrinkage mean ,	493768.,	.31,,,,				.000,	.184

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
369437.,	.21,	.00,	2,	.007,	.240

Age 1 Catchability dependent on age and year class strength

Year class = 2000

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
Oct Pt Survey ,	327190.,	.219,	.067,	.31,	2,	.534,	.196
Jul Pt. survey ,	298659.,	.234,	.097,	.41,	2,	.466,	.213
P shrinkage mean ,	354038.,	.29,,,,				.000,	.183

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
313557.,	.16,	.05,	4,	.340,	.205

Age 2 Catchability dependent on age and year class strength

Year class = 1999

Table 6.7.2.1. XSA diagnostics (cont.)

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
Oct Pt Survey	,	206313.,	.225,	.133,	.59,	2,	.494,	.119
Jul Pt. survey	,	246451.,	.222,	.041,	.18,	2,	.506,	.101
P shrinkage mean	,	221230.,	.25,,,,				.000,	.112

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
225733.,	.16,	.08,	4,	.481,	.110

Age 3 Catchability dependent on age and year class strength

Year class = 1998

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
Oct Pt Survey	,	163356.,	.175,	.072,	.42,	3,	.500,	.167
Jul Pt. survey	,	155535.,	.175,	.099,	.57,	3,	.500,	.175
P shrinkage mean	,	136230.,	.28,,,,				.000,	.198

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
159398.,	.12,	.06,	6,	.453,	.172

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 1997

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
Oct Pt Survey	,	130025.,	.178,	.155,	.87,	4,	.487,	.179
Jul Pt. survey	,	119379.,	.175,	.171,	.98,	4,	.513,	.193

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
124450.,	.12,	.11,	8,	.869,	.187

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 1996

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
Oct Pt Survey	,	27778.,	.328,	.312,	.95,	4,	.458,	.442
Jul Pt. survey	,	26564.,	.313,	.224,	.72,	4,	.542,	.458

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
27113.,	.23,	.18,	8,	.776,	.453

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1995

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
Oct Pt Survey	,	41596.,	.190,	.186,	.98,	5,	.515,	.274
Jul Pt. survey	,	39278.,	.187,	.076,	.41,	5,	.485,	.288

Table 6.7.2.1. XSA diagnostics (cont.)

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
40456.,	.13,	.10,	10,	.724,	.284

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1994

Fleet, ,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
Oct Pt Survey	,	43815.,	.182,	.241,	1.33,	6,	.571,	.250
Jul Pt. survey	,	43010.,	.214,	.107,	.50,	5,	.429,	.254

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
43468.,	.14,	.14,	11,	.984,	.255

Age 8 Catchability constant w.r.t. time and dependent on age

Year class = 1993

Fleet, ,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
Oct Pt Survey	,	41513.,	.192,	.233,	1.21,	7,	.547,	.174
Jul Pt. survey	,	38099.,	.214,	.121,	.57,	6,	.453,	.188

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
39930.,	.14,	.13,	13,	.932,	.183

Age 9 Catchability constant w.r.t. time and dependent on age

Year class = 1992

Fleet, ,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
Oct Pt Survey	,	20154.,	.185,	.215,	1.16,	8,	.555,	.149
Jul Pt. survey	,	19478.,	.221,	.121,	.55,	7,	.445,	.154

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
19850.,	.14,	.12,	15,	.881,	.153

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 9

Year class = 1991

Fleet, ,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
Oct Pt Survey	,	10627.,	.213,	.228,	1.07,	9,	.282,	.355
Jul Pt. survey	,	13679.,	.227,	.108,	.48,	8,	.718,	.286

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
12739.,	.17,	.11,	17,	.625,	.310

Table 6.7.2.2. Southern horse mackerel stock. Summary of the results from the XSA model.

Summary (with SOP correction)

Terminal Fs derived using XSA (Without F shrinkage)

	RECRUITS, Age 0	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	SOPCOFAC,	FBAR 1-10,
1991,	826687,	205696,	158741,	21772,	.1372,	.8924,	.1490,
1992,	585209,	204455,	155398,	26492,	.1705,	.9574,	.2228,
1993,	491284,	128529,	91354,	31945,	.3497,	1.0141,	.3432,
1994,	460876,	147197,	103698,	25959,	.2503,	1.0009,	.2335,
1995,	607715,	149308,	104104,	25147,	.2416,	1.0007,	.2051,
1996,	1182765,	166716,	109735,	22943,	.2091,	1.0004,	.2998,
1997,	490219,	151504,	105451,	27642,	.2621,	.9365,	.2449,
1998,	447428,	151528,	109675,	41564,	.3790,	.9992,	.4296,
1999,	506627,	149521,	113021,	27733,	.2454,	1.0001,	.2624,
2000,	527784,	144495,	107166,	27160,	.2534,	1.0378,	.2866,
2001,	543259,	138887,	103809,	24910,	.2400,	.9997,	.2312,
Arith. Mean ,	606350,	157985,	114741,	27570,	.2489		.2644,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

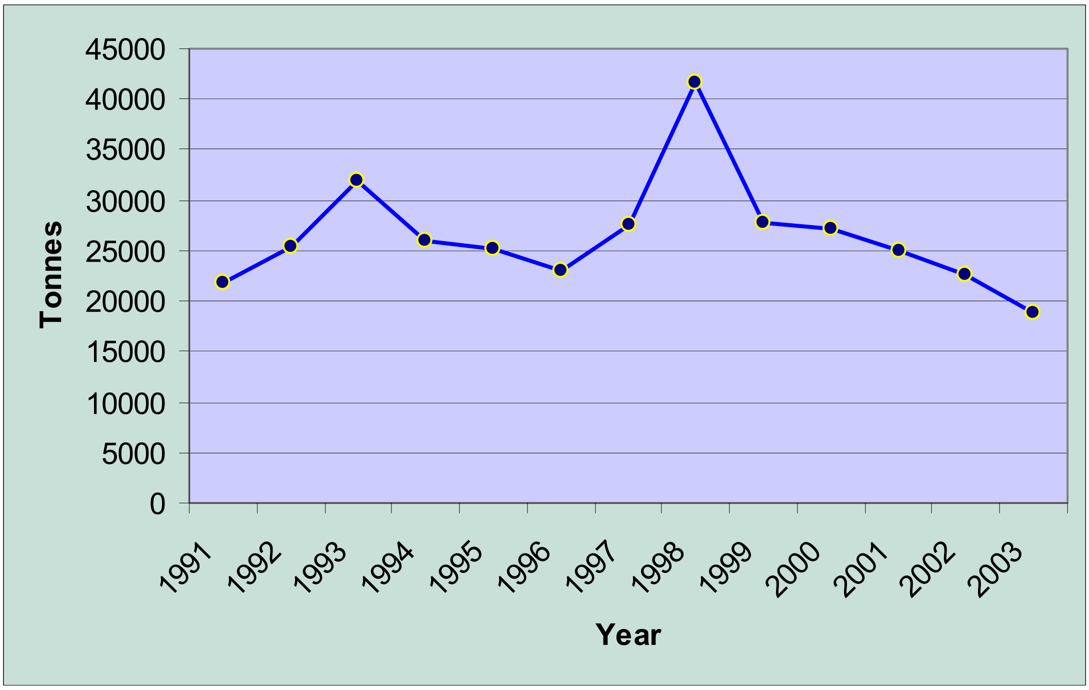


Figure 6.2.1. Time series of the total southern horse mackerel catches for the period 1991-2003 (not including catches from the Gulf of Cádiz).

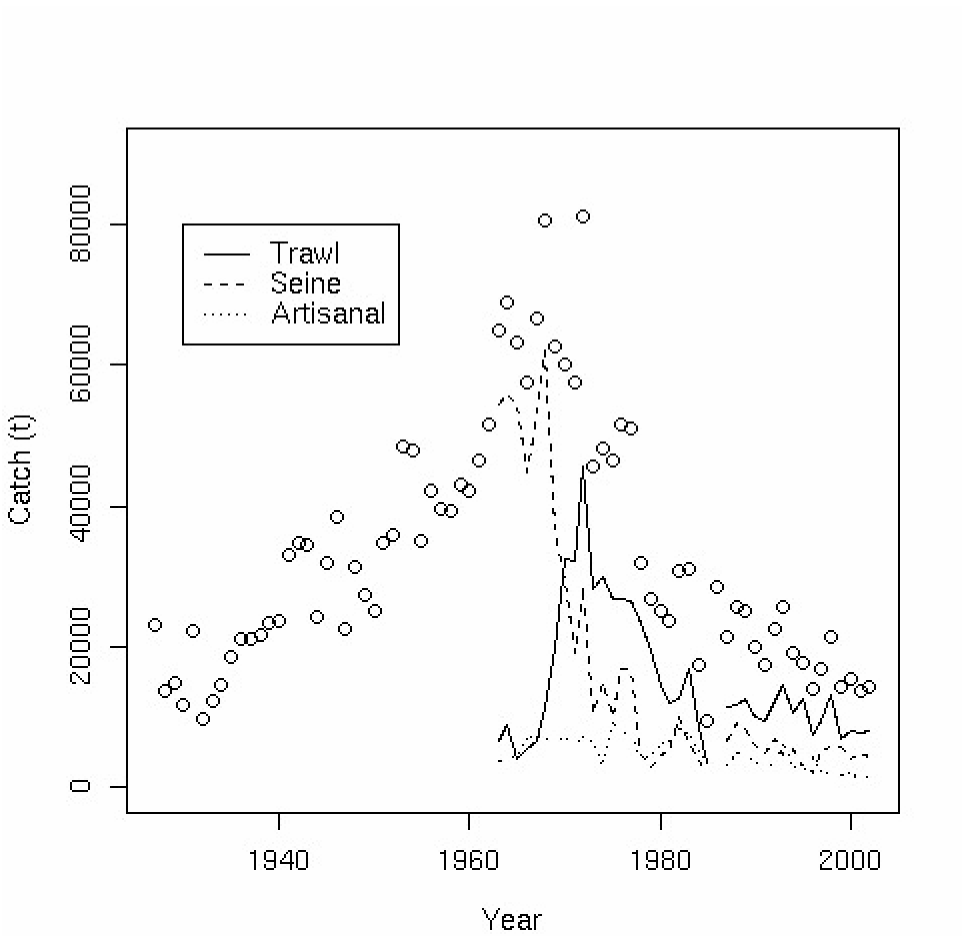


Figure 6.2.2. Time series of the Portuguese catches of horse mackerel in Division IXa: total and by fishing gear.

Figure 6.2.3. 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.

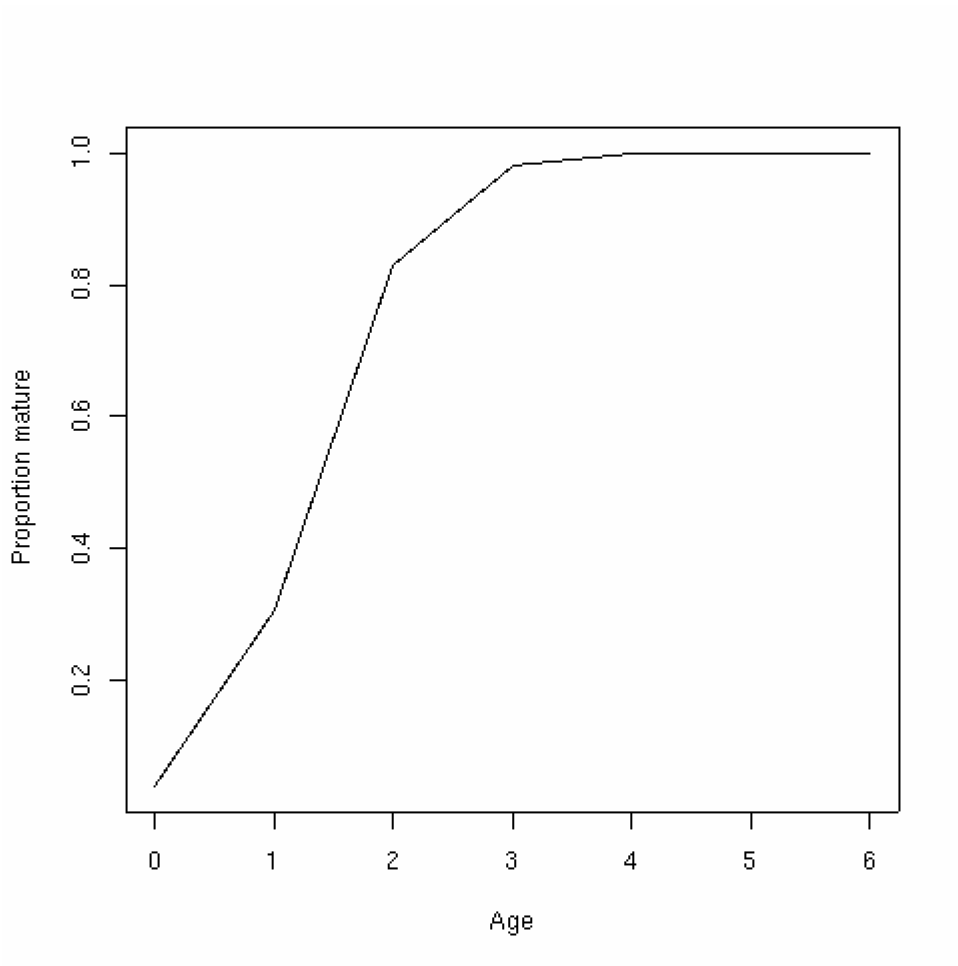


Figure 6.3.3.1. Maturity ogive adopted for southern horse mackerel stock during the assessment period.

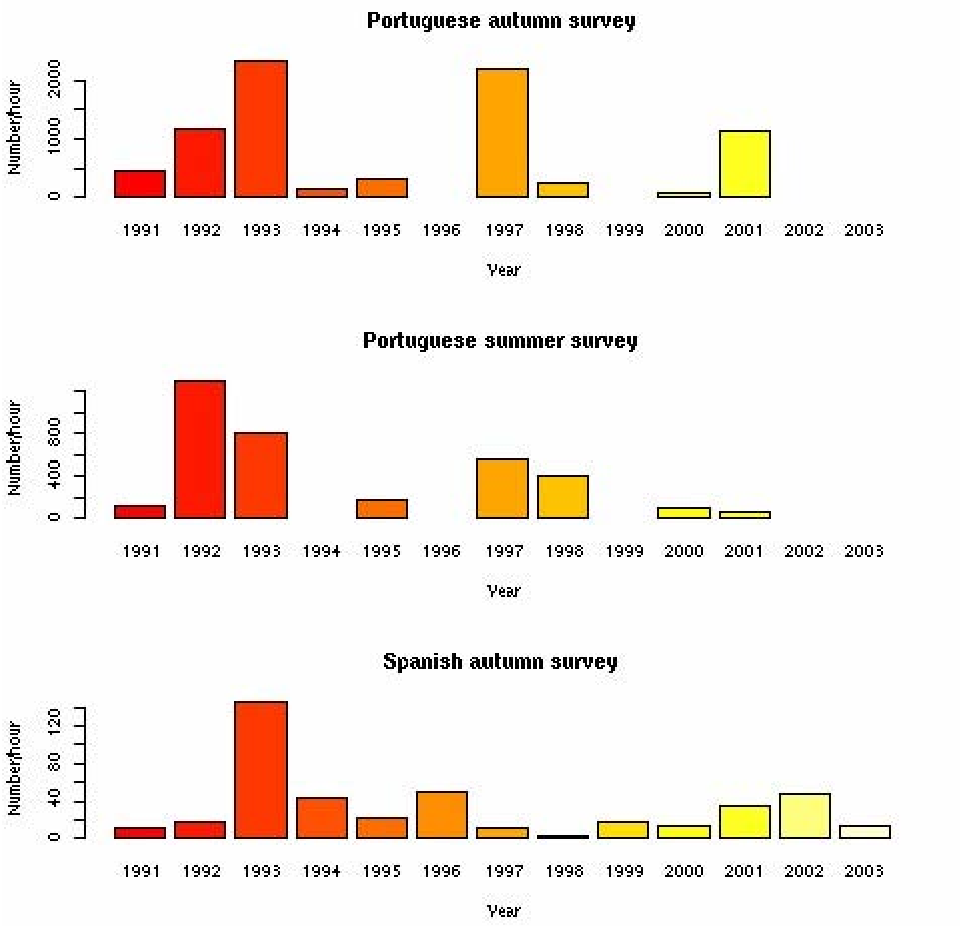


Figure 6.4.1.1. Time series of the total number/haul from the different bottom trawl surveys in Division IXa.

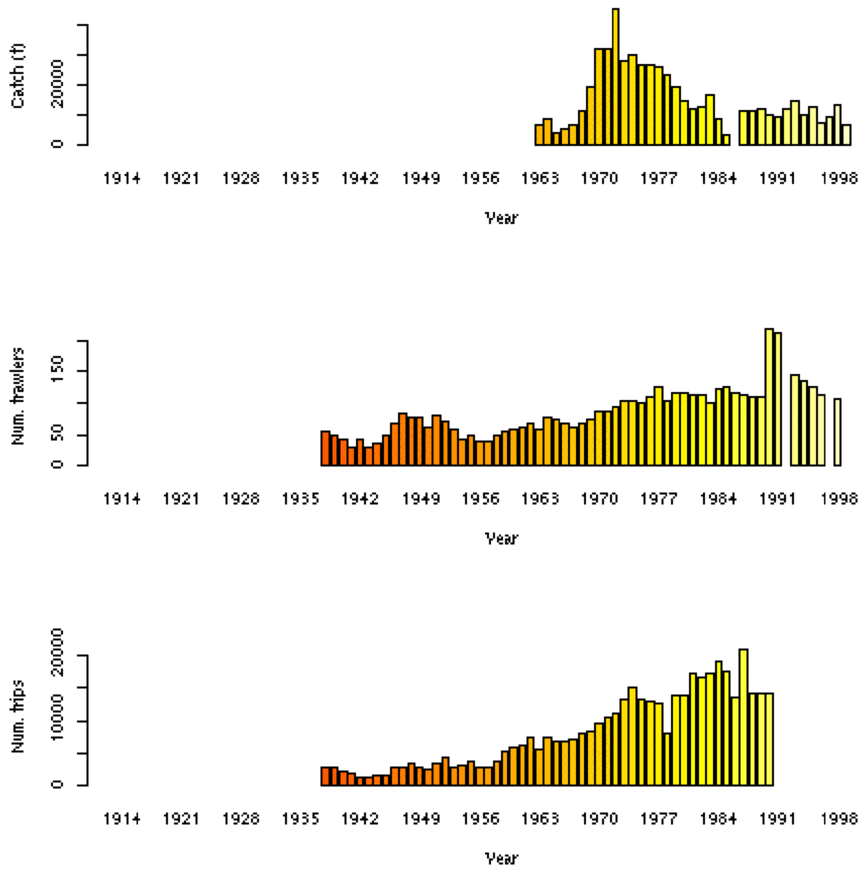


Figure 6.5.1. Time series of catch and effort from Portuguese bottom trawlers operating in Division IXa (Southern stock).

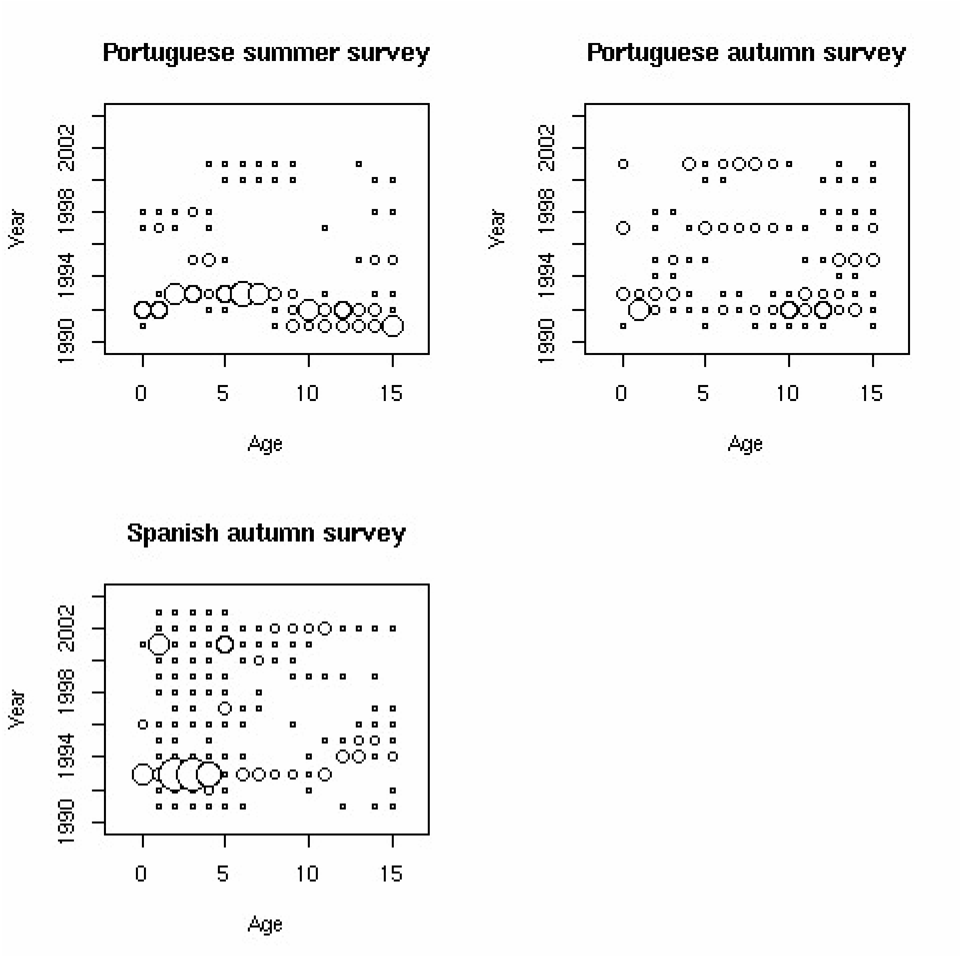


Figure 6.7.1.1. Proportion of catches by year in each age, from surveys operating in Divison IXa. It is showed the percentage of each

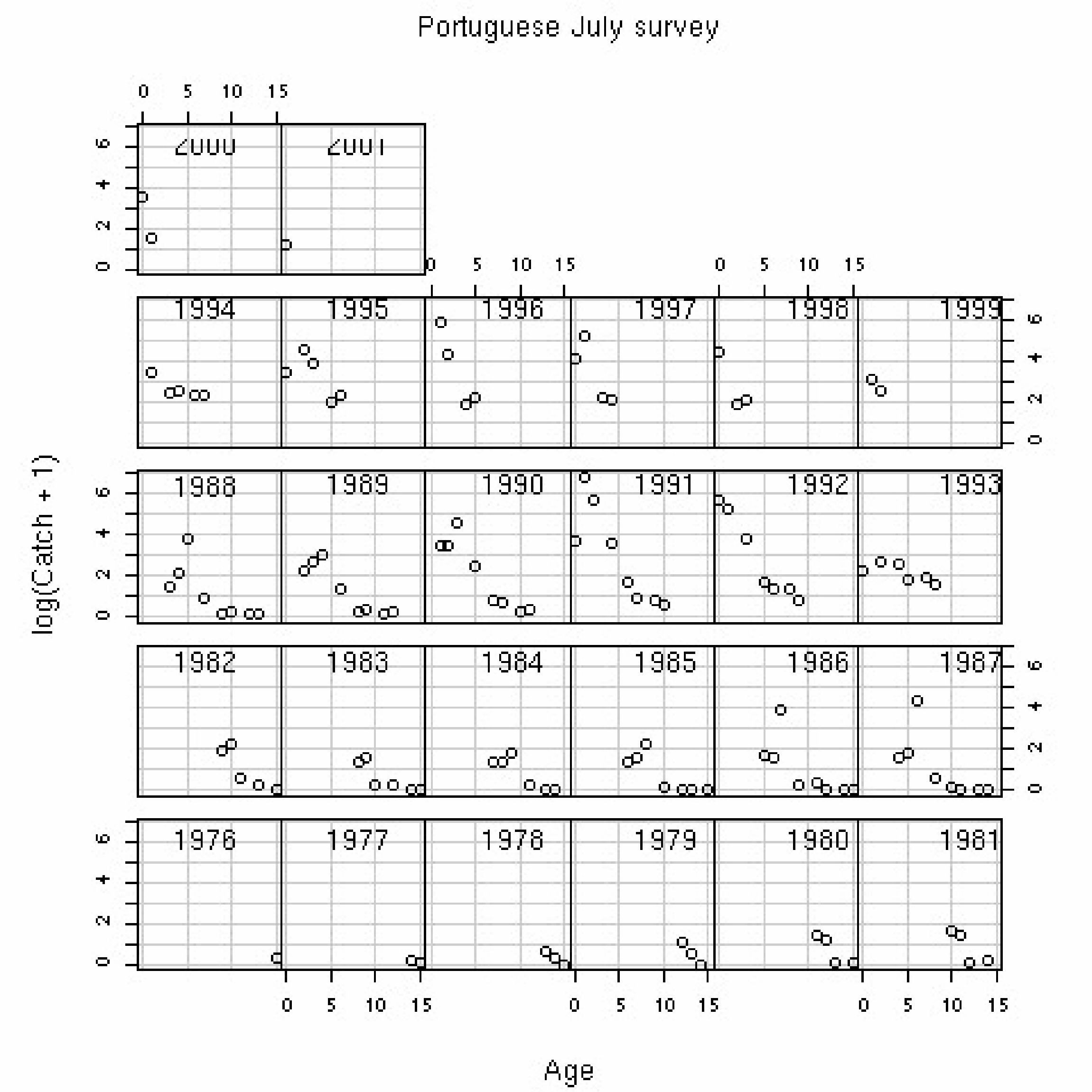


Figure 6.7.1.2. Logarithm of the catch in numbers of each yearclass in the July Portuguese bottom trawl survey.

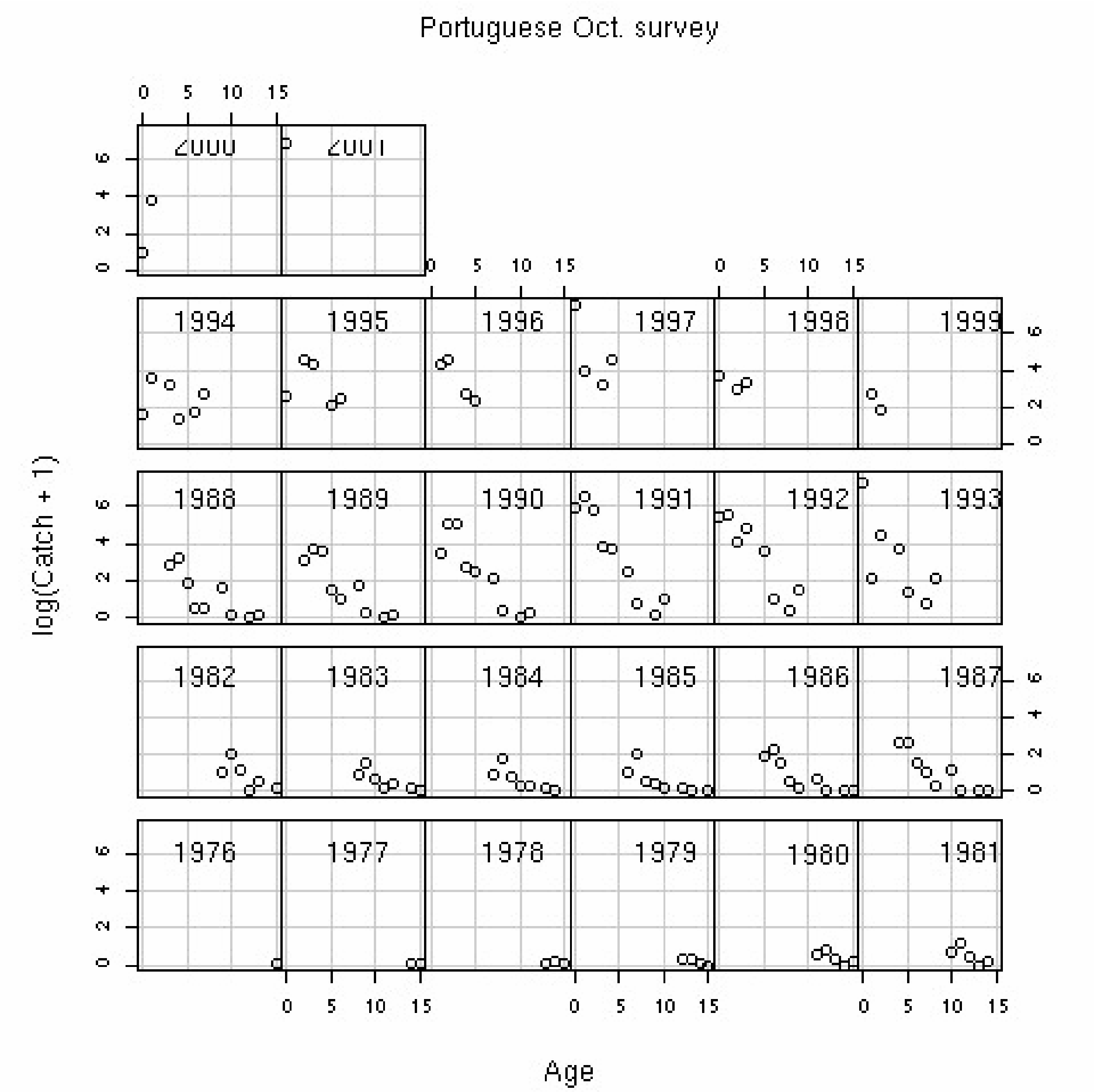


Figure 6.7.1.3. Logarithm of the catch in numbers of each yearclass in the October Portuguese bottom trawl survey.

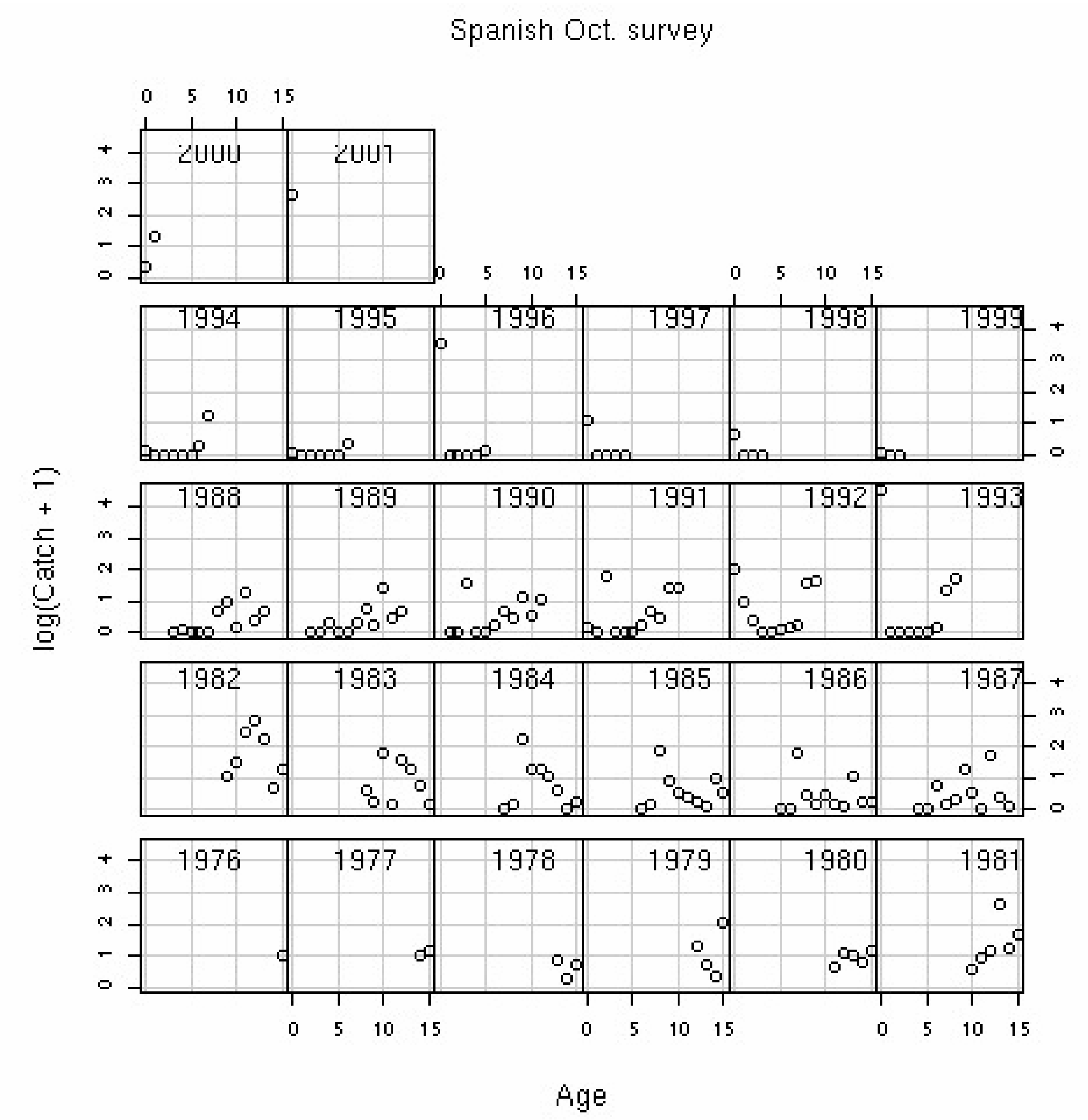


Figure 6.7.1.4. Logarithm of the catch in numbers of each yearclass in the September/ October Spanish bottom trawl survey.

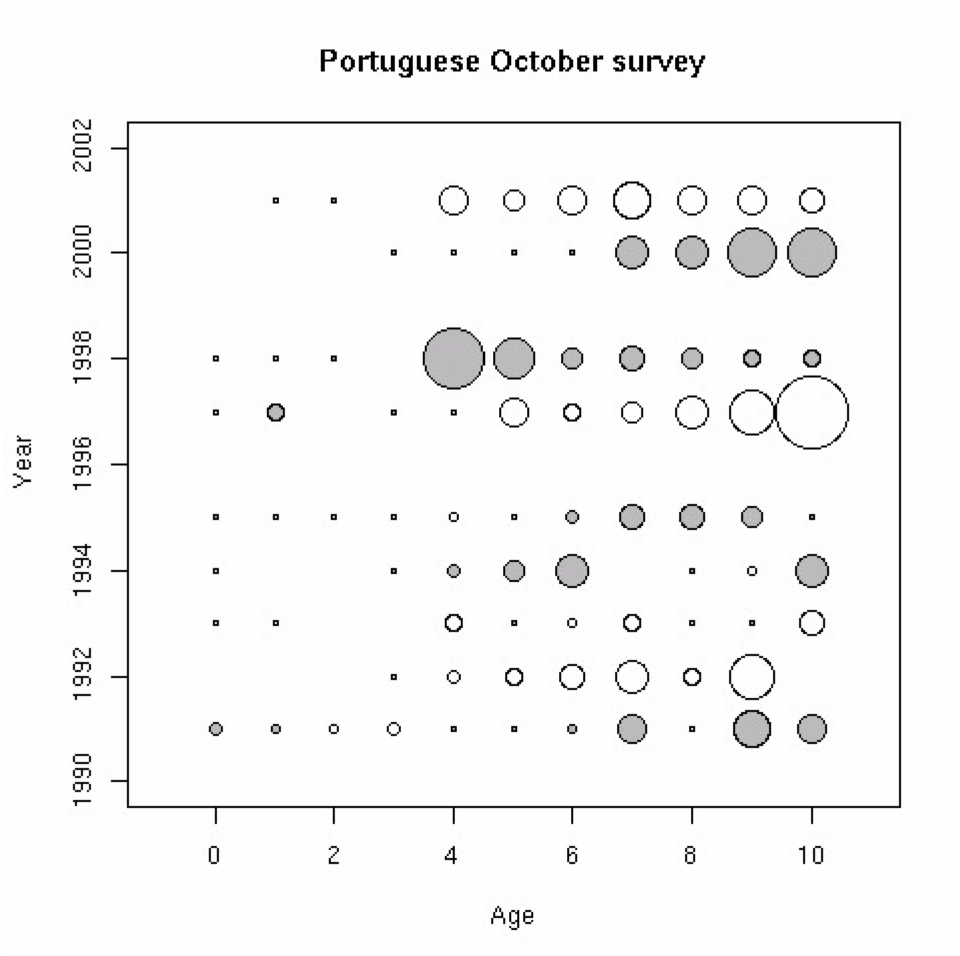


Figure 6.7.2.1. Catchability residuals from Portuguese October bottom trawl survey. In grey: negative residuals; in white: positive residuals.

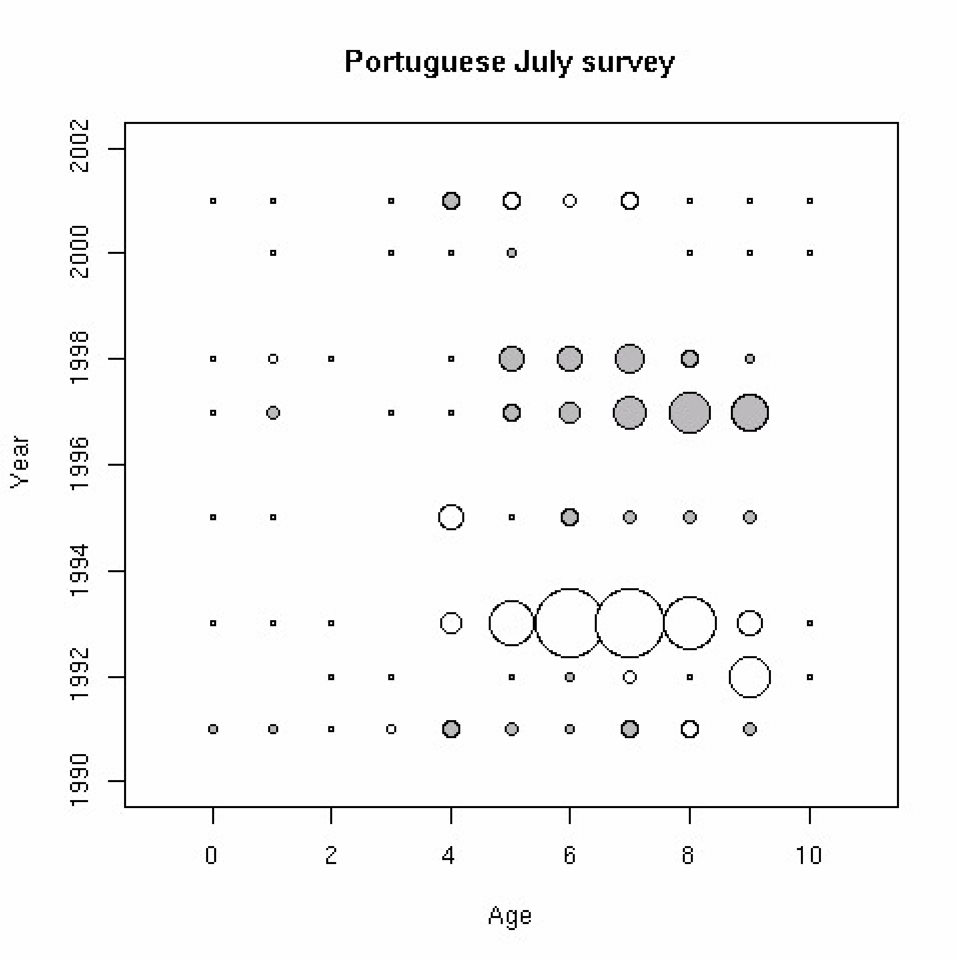


Figure 6.7.2.2. Catchability residuals from Portuguese July bottom trawl survey. In grey: negative residuals; in white: positive residuals.

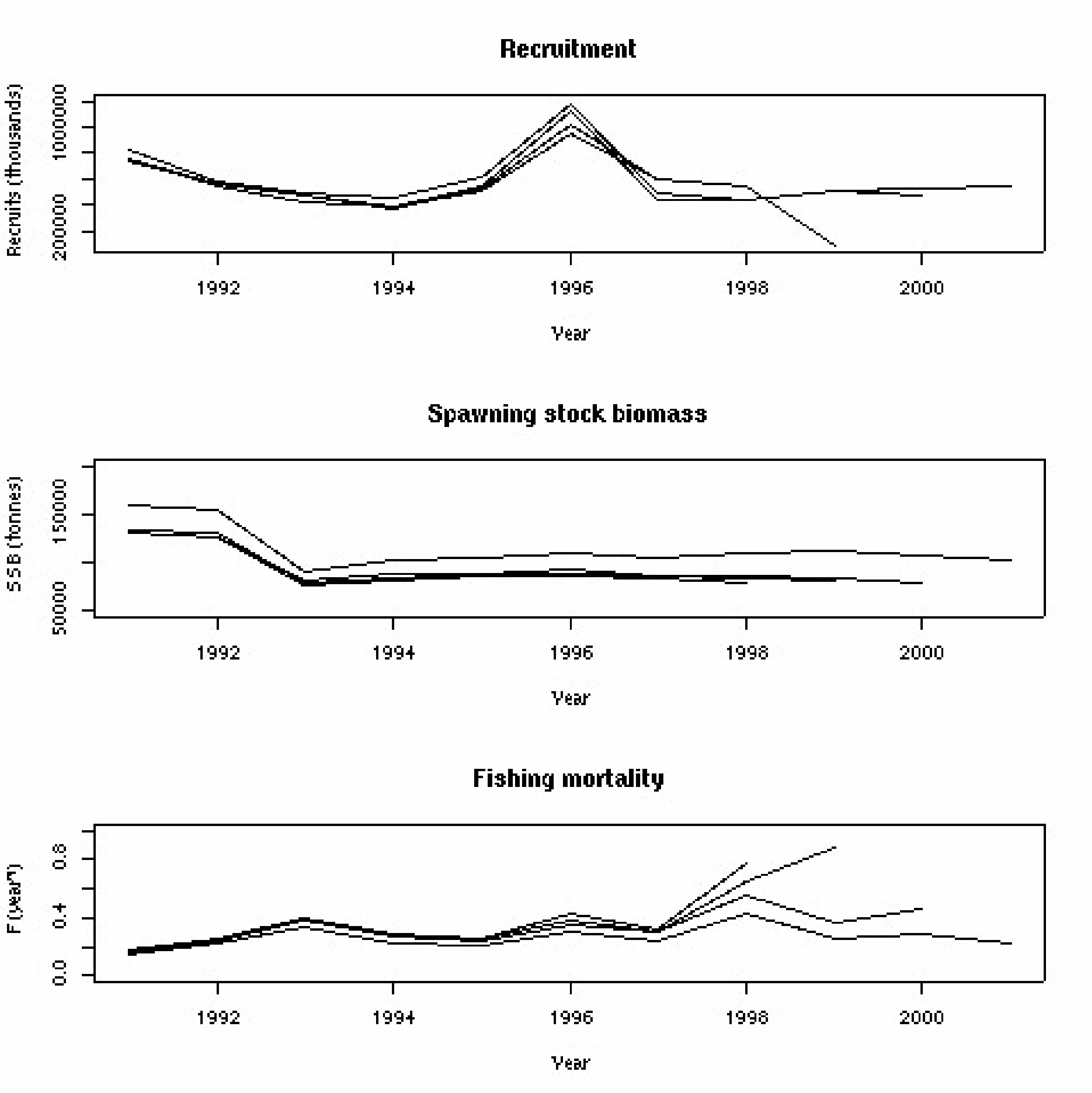


Figure 6.7.2.3. Retrospective analysis (1998-2001) with the XSA model.

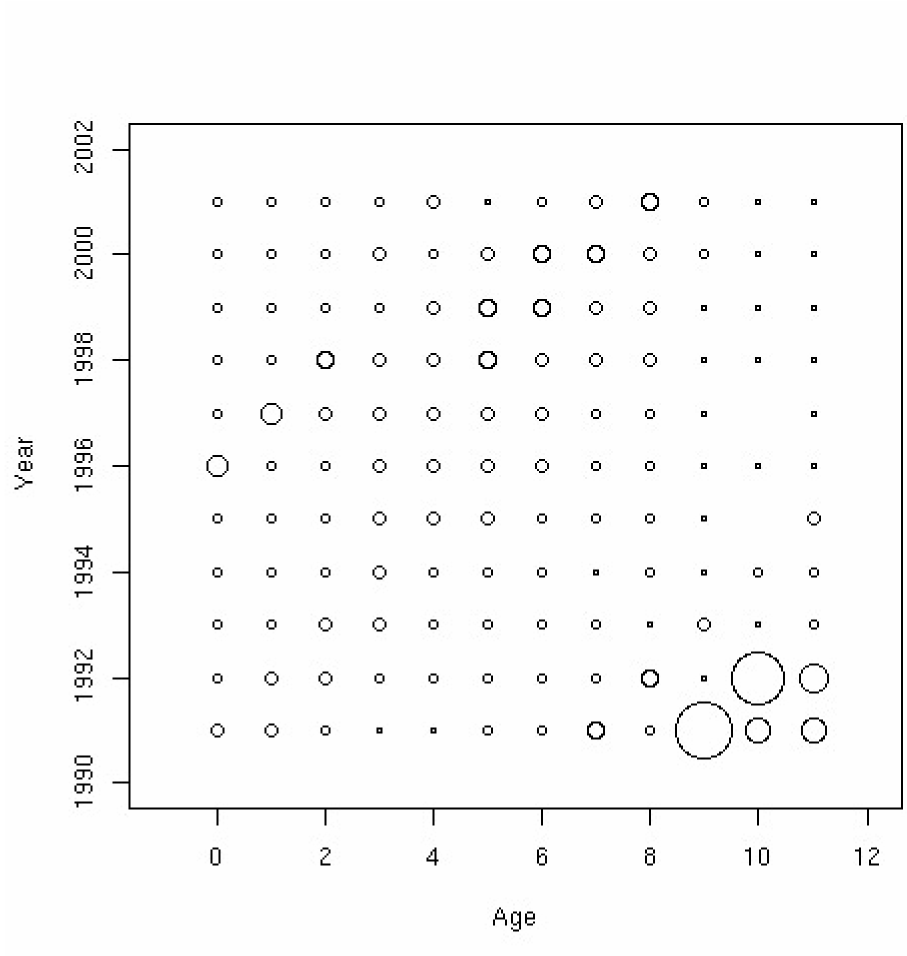


Figure 6.7.2.4. Proportion of numbers by year in each age estimated with the XSA model.

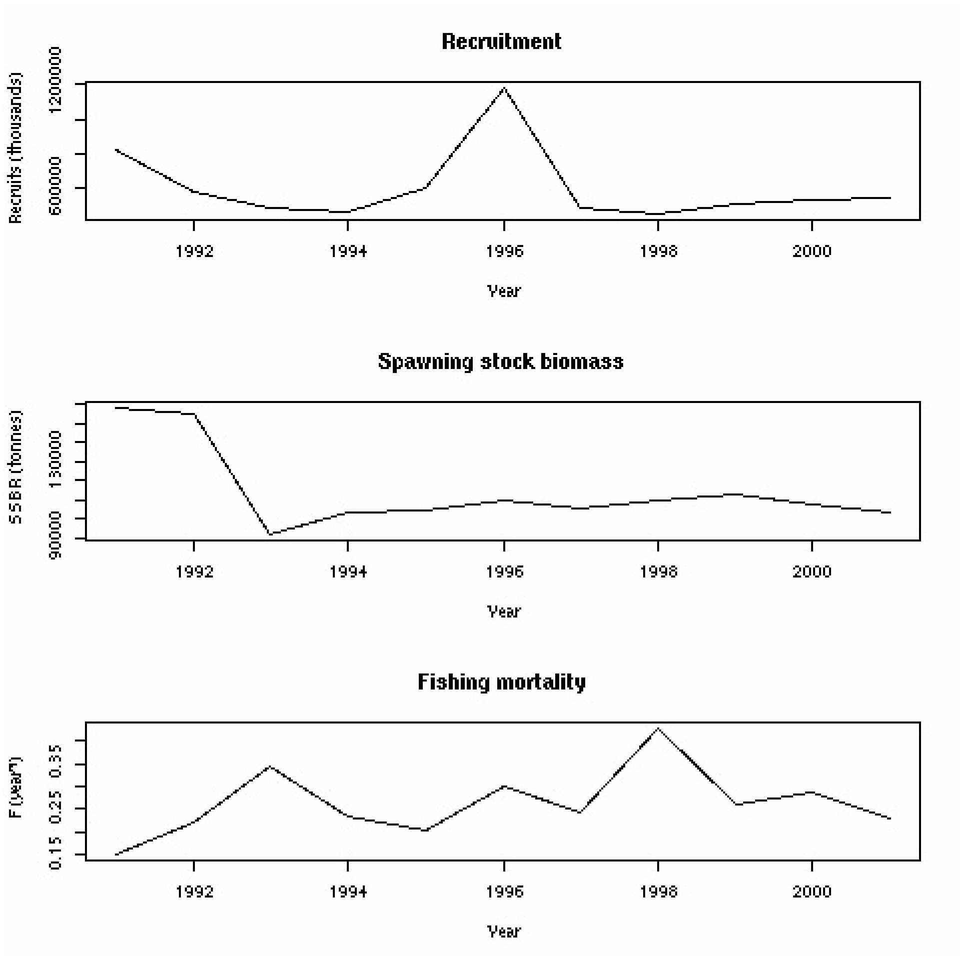


Figure 6.7.2.5. Summary figures (recruitment, spawning stock biomass and fishing mortality) from the results obtained with the XSA model.

7 Sardine general

7.1 The fisheries for sardine in the ICES area

Sardine distribution in the North-East Atlantic covers a wide range, from southern Mauritania up to Northern Sea. 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 in the stock area are discussed in section 8 below. The rest of this section is dedicated to information about sardine outside the stock area, both from fisheries and from surveys.

7.1.1 Catches in areas outside the assessment area

Commercial catch data for 2003 was provided by Portugal, Spain, France, Germany and England (Table 7.1.1.1). The total reported catch was 125,407 t, with 53% of the catches by Portugal, 26% by Spain and 17% by France. The remaining catches are reported by England&Wales and Germany mainly in Division VII. Catches in the stock area amount to 79% of the total catches, even when catches in both Spain and Portugal are regulated, while catches from the rest of the countries are not.

A series of French catch data in Division VIIIa,b from 1983 to 2003 was available to the WG this year (Table 7.1.1.2). Average catches for the period were 9,809 tonnes, and there is an increasing trend along the period, with values ranging from 4,367 t in 1983 to 15,494 t in 2003. Length distributions outside the stock are available for ICES Divisions VII and VIIIa,b (Table 7.1.1.3). Catch, weight and length at age data was reported by Germany for the 4th quarter catches in VIId and VIIe divisions (Table 7.1.1.4). Numbers and mean length and weight at age in the 2004 French catches in Divisions VIIIa,b is presented in Table 7.1.1.5.

7.2 Surveys for sardine in areas outside the assessment area

Acoustic surveys primarily for anchovy have been routinely carried out in areas VIIIa and VIIIb by IFREMER since the year 2000. Sardine abundances, length structure and distribution from these surveys have been reported to the Working Group this year. There are no estimates of abundance available for 2003 survey (although spatial distributions are presented in Figure 7.2.1.1d) as there was a very low sardine abundance in the area and a particular distribution of fish that year, according to the later period of survey and very hot spring and summer conditions. Thus estimates of abundance in that year be biased due to a low sampling level.

The distribution of sardine extends along the whole survey area (from 43º30' to 48º N) in most surveys, however in 2001 sardine was mainly found in the northern offshore waters (Figure 7.2.1). In 2004, most of the sardine was distributed in surface offshore waters (45%) in the Rochebonne and Gironde-Landes areas (Table 7.2.2). The total biomass of sardine ranged from 214,200 tonnes in 2001 to 323,021 tonnes in 2004 (mean=281,159 tonnes) and corresponded mainly to 1 and 2-year old fish (Table 7.2.1). The age structure usually observed in surveys is similar to that observed in 2003 catch data (see Table 7.1.1.5). In 2004, 1-year olds dominated the survey estimates, suggesting a high recruitment to the population in 2003. Length distributions for the surveys are shown in Figure 7.2.2.

7.3 Stock identification distribution and migration in relation to oceanographic effects.

Stock identification, distribution and migration is of special relevance for sardine assessment in ICES areas, due to the multiple evidences of possible migration across areas within the stock, as well as migrations between the stock areas and areas outside the stock. A number of projects and study groups that deal with this kind of issues are actually active, namely SGSBSA (dealing mainly with distribution and spatial variability of biological characteristics of sardine and anchovy in their stock area), SGRESP (dealing with ecological parameters affecting stock composition and adult migration) and the EU project SARDYN (Sardine Dynamics and Stock structure in the North-East Atlantic).

Results from SGSBSA on spatial analysis of biological properties of the sardine stock conclude that sardine has a strong spatial structure, with large spatial variation in mean weight, age composition and fecundity. Although relationships with oceanographic effects where not directly addressed, the spatial variability on this biological properties was believed to be due to differences in the oceanograhic conditions. SGRESP further developed this for some of the small pelagic stocks assessed by ICES, and generated hypothesis on distribution in relation to oceanographic conditions from current knowledge of the different stocks. For the special case of sardine, main important questions related to the stock distribution and migration were included as main objectives in SARDYN, with the aim of understanding the underlying process affecting stock dynamics and structure and afterwards incorporating them into assessment models which can cope with variable spatial structure and different signals in the different surveys carried out in different parts of the stock.

Ongoing research from this SG/projects has been regularly reported to the WG. Intermediate results from the SARDYN project are to be presented in next ICES ASC, and they include the following papers:

Y. Stratoudakis, S. Coombs, N. Halliday, D. Conway, T. Smyth, G. Costas, C. Franco, A. Lago de Lanzós, M. Bernal, A. Silva, M.B. Santos, P. Alvarez & M. Santos. Sardine (*Sardina pilchardus*) spawning season in the North East Atlantic and relationships with sea surface temperature

B. Peleteiro, A. Marçalo, M. Olmedo, P. Pousão-Ferreira, J. Sanchez, S. Garrido, M.B. Santos, C. Porteiro & Y. Stratoudakis. Sardine tagging off the Iberian peninsula: laboratory experiments and operations at sea

A. Bode, P. Carrera, J. Lorenzo, C. Porteiro, M.B. Santos &J.M. Cabanas. Natural abundance of stable nitrogen isotopes reflect changes in pelagic food webs and mobility of size classes of the north Iberian sardine (Sardina pilchardus)

A. Silva, M. B. Santos, A. Morais, P. Carrera, P. Alvarez, A. Jorge, E. Peleteiro, B. Caneco, C. Porteiro & A. Uriarte. Geographic variability in sardine maturity and growth within the Atlanto-Iberian stock area

M.B. Santos, G.J. Pierce, A. López, J.A. Martínez, M.T. Fernández, E. Ieno, E. Mente, C. Porteiro, P. Carrera & M. Meixide. Variability in the diet of common dolphins (*Delphinus delphis*) in Galician waters 1991-2003 and relationship with prey abundance

V. Marques, P. Carrera, A. Morais, J. Miquel, C. Porteiro & Y. Stratoudakis. Consistency of the acoustic spring surveys off the Iberian Peninsula

An update of the main results of these papers and main advances in the SARDYN project is expected by next WG meeting.

The WG encourages research both on the stock structure and its relation to environmental/oceanographic characteristics and migration within stock areas and between the stock and adjacent waters. Also the WG appreciates the increasing amount of information from areas outside the stock presented in the group, and encourages comparative studies between characteristics of the stock and the surrounding areas.

Table 7.1.1.1: Sardine-general: commercial catch data from the ICES area, available to the Working Group. Unit Tonnes

Divisions	Germany	England	France	Spain	Portugal	Total
IVc		711				711
VIId*	4	752	6024			6780
VIIe	1	3396				3397
VIIf		2				2
VIIh	11					11
VIIIa		68	15494			15562
VIIIb				1113		1113
VIIIc				16436		16436
IXaN				6383		6383
IXaCN					33 293	33293
IXaCS					24 635	24635
IXaS-Alg					8 600	8600
IXaS-Cad				8484		8484
Total	16	4929	21518	32416	66528	125407

* about 5% of these catches from France were carried out along the divisions IVb and IVc.

Table 7.1.1.2: Sardine-general: French landings in ICES Divisions VIIIa+VIIIb from 1983 to 2003.

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

Table 7.1.1.3a: Sardine-general: Catch length distributions of sardine from outside of the stock area in the 1st quarter. Unit:thousand of fish.

	Quarter 1				
Length	VIIIb	VIIIab	VIId	VIIe	Total
10.0					
10.5					
11.0					
11.5		6			6
12.0		23			23
12.5		45			45
13.0		87			87
13.5		96			96
14.0		88			88
14.5		86			86
15.0		74			74
15.5		58			58
16.0		145			145
16.5		205			205
17.0		703			703
17.5		1 544			1 544
18.0	3	1 715			1 715
18.5	3	1 068			1 068
19.0	14	872			872
19.5	16	594			594
20.0	22	435			435
20.5	13	447			447
21.0	26	440			440
21.5	9	641			641
22.0	9	835			835
22.5	13	1 093			1 093
23.0	5	1 453			1 453
23.5	4	1 025			1 025
24.0		649			649
24.5		362			362
25.0		236			236
25.5		95			95
26.0		39			39
26.5		10			10
27.0					
27.5					
28.0					
TOTAL numbers	138	15 169			15 169
Official Catch (t)	10	1 157			1 157

Table 7.1.1.3b: Sardine-general: Catch length distributions of sardine from outside of the stock area in the 2nd quarter. Unit:thousand of fish.

	Quarter 2				
Length	VIIIb	VIIIab	VIId	VIIe	Total
10.0		10			10
10.5		20			20
11.0		98			98
11.5		224			224
12.0		306			306
12.5		346			346
13.0		328			328
13.5		343			343
14.0	12	655			655
14.5	78	1 074			1 074
15.0	218	1 158			1 158
15.5	338	1 251			1 251
16.0	735	1 554			1 554
16.5	931	2 684			2 684
17.0	938	2 313			2 313
17.5	774	2 781			2 781
18.0	384	2 247			2 247
18.5	486	2 705			2 705
19.0	668	3 601			3 601
19.5	907	3 906			3 906
20.0	1267	3 384			3 384
20.5	799	2 246			2 246
21.0	527	1 906			1 906
21.5	473	1 004			1 004
22.0	298	1 091			1 091
22.5	184	1 330			1 330
23.0	124	1 498			1 498
23.5	99	1 397			1 397
24.0	36	1 135			1 135
24.5	22	927			927
25.0		569			569
25.5		174			174
26.0		268			268
26.5		16			16
27.0		8			8
27.5					
28.0		17			17
TOTAL numbers	10 298	44 572			44 572
Official Catch (t)	582	2 959			2 959

Table 7.1.1.3c: Sardine-general: Catch length distributions of sardine from outside of the stock area in the 3rd quarter. Unit:thousand of fish.

	Quarter 3				
Length	VIIIb	VIIIab	VIId	VIIe	Total
10.0					
10.5					
11.0		71			71
11.5		141			141
12.0		566			566
12.5		990			990
13.0		849			849
13.5		660			660
14.0		424			424
14.5		306			306
15.0		406			406
15.5		1 010			1 010
16.0		2 791			2 791
16.5		3 682			3 682
17.0		5 540			5 540
17.5		4 468			4 468
18.0		3 288			3 288
18.5		4 243			4 243
19.0		7 377			7 377
19.5	2	9 427			9 427
20.0	10	15 530			15 530
20.5	13	18 758			18 758
21.0	13	14 310			14 310
21.5	13	9 257			9 257
22.0	8	4 991			4 991
22.5	4	2 504			2 504
23.0	3	1 489			1 489
23.5	2	777			777
24.0		738			738
24.5		197			197
25.0		138			138
25.5					
26.0					
26.5					
27.0					
27.5					
28.0					
TOTAL numbers	69	114 928			114 928
Official Catch (t)	6	8 574			8 574

Table 7.1.1.3d: Sardine-general: Catch length distributions of sardine from outside of the stock area in the 4th quarter. Unit:thousand of fish.

	Quarter 4				
Length	VIIIb	VIIIab	VIId	VIIe	Total
10.0					
10.5					
11.0		6			6
11.5		12			13
12.0		48			48
12.5		83			83
13.0		71			71
13.5		54			54
14.0		36			36
14.5		24			24
15.0		6			6
15.5		12			12
16.0		10			10
16.5		21			21
17.0		153			153
17.5		140			140
18.0		309			309
18.5	23	683			683
19.0	41	1 082			1 082
19.5	203	2 264			2 264
20.0	906	3 035			3 035
20.5	1 175	4 581			4 581
21.0	1 200	3 904			3 904
21.5	1 208	3 053			3 053
22.0	771	3 030	1	1	3 033
22.5	410	2 733			2 733
23.0	277	1 611	5	1	1 618
23.5	145	1 326			1 326
24.0	37	793	6	1	800
24.5	20	884			884
25.0		5	6	1	11
25.5		2			2
26.0		1	4		6
26.5					
27.0			1		1
27.5					
28.0					
TOTAL numbers	6 414	29 975	23	4	30 004
Official Catch (t)	516	2 805	1		2 806

Table 7.1.1.4: Sardine-general: Catch, weight and length at age in German catches from Divisions VIId and VIIe in 2003.

		Division VIId		
		Quarter 4		
Year-class	Age	umbers at a	Mean lengtl	Mean weight
2003	0			
2002	1	0	22.5	0.118
2001	2	3	24.0	0.132
2000	3	9	24.2	0.138
1999	4	7	24.8	0.147
1998	5	3	25.0	0.150
1997	6	0		0.181
1996	7	1	25.5	0.148
Total/Mean		23	24.4	0.142
WG catch (t)		4		

		Division VIIe		
		Quarter 4		
Year-class	Age	umbers at a	Mean lengtl	Mean weigh
2003	0			
2002	1	0	21.8	0.097
2001	2	2	22.7	0.110
2000	3	2	24.0	0.128
1999	4	1	24.3	0.132
1998	5	0	24.5	0.137
1997	6	0		
1996	7	0	23.5	0.122
Total/Mean		5	23.4	0.121
WG catch (t)		1		

Table 7.1.1.5: Sardine-general: Numbers, mean length and mean weight at age in the 2003 French catches, in areas VIIIa,b.

Year Class	Age	Numbers at age ('000)	Mean Length (cm)	Mean Weight (Kg)
2003	0	4382	13.3	0.019
2002	1	84906	18.3	0.055
2001	2	57535	20.7	0.081
2000	3	24102	21.6	0.094
1999	4	14541	22.3	0.104
1998	5	8515	23.0	0.114
1997	6	5461	23.4	0.121
1996	7	2998	24.1	0.133
1995	8	1534	24.1	0.133
1994	9	670	23.7	0.126
Total/Mean -->		204644	20.1	0.076

Table 7.2.1: Sardine-general: Age composition of sardine (in %) estimated in French acoustic surveys 2000-2004.

	Age group									
Year	1	2	3	4	5	6	7	8	9 +	Biomass (tonnes)
2000	28.7	30.7	16.0	10.5	7.7	3.1	1.8	0.5	0.9	286391
2001	37.3	36.0	6.9	6.4	3.2	4.8	1.9	1.1	2.4	214200
2002	44.8	34.6	11.0	6.1	1.8	1.1	0.5	0.1		301023
2003										
2004	69.5	15.0	6.8	3.0	2.8	1.8	0.6	0.3	0.2	323021

Table 7.2.2: Sardine-general: Area distribution of sardine from the 2004 French acoustic survey. Units: tonnes.

	anchovy	**sardine**	**sprat**
Rochebonne	3 112	69 055	4 759
Gironde-Landes	28 343	60 579	8 981
Adour	13 864	7 689	0
Offshore	135	32 582	0
surface (coastal)	563	10 135	2 525
surface (offshore)	0	142 981	0
Total	**46 018**	**323 021**	**16 266**

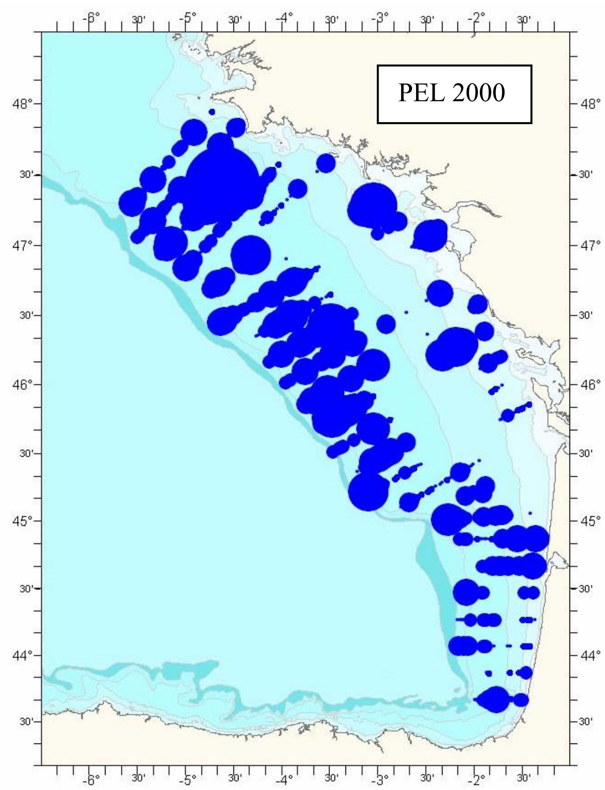


Figure 7.2.1a : Sardine-general : Distribution of sardine in the Gulf of Biscay provided by the French acoustic survey in spring (May-June 2000). Symbols are proportional to the estimated biomass.

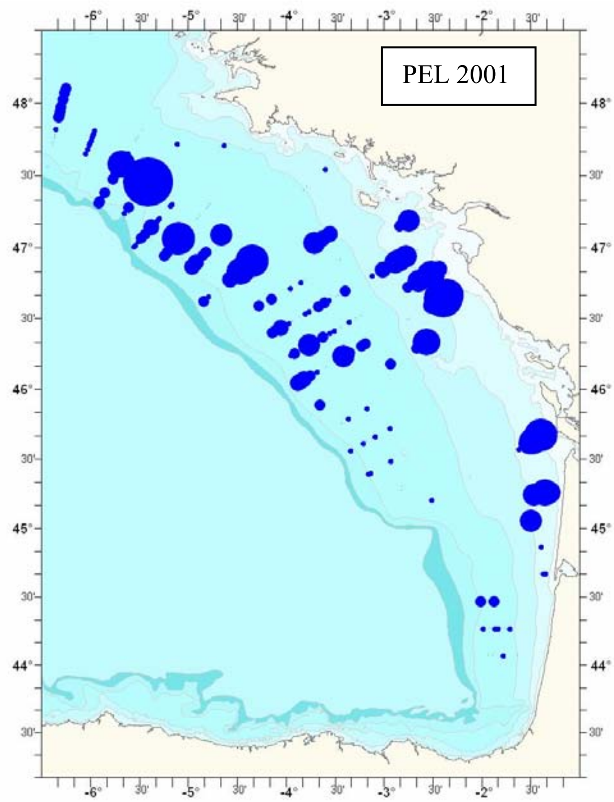


Figure 7.2.1b : Sardine-general : Distribution of sardine in the Gulf of Biscay provided by the French acoustic survey in spring (May-June 2001). Symbols are proportional to estimated biomass.

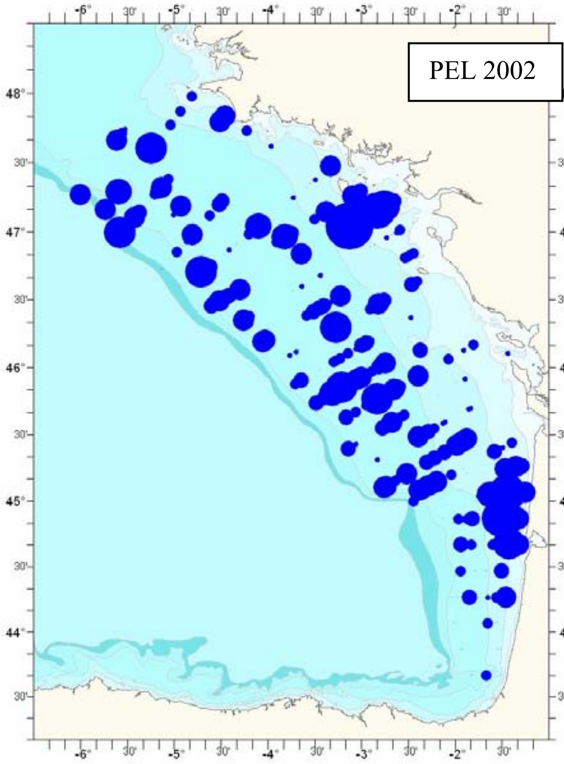


Figure 7.2.1c : Sardine-general : Distribution of sardine in the Gulf of Biscay provided by the French acoustic survey in spring (May-June 2002). Symbols are proportional to the estimated biomass.

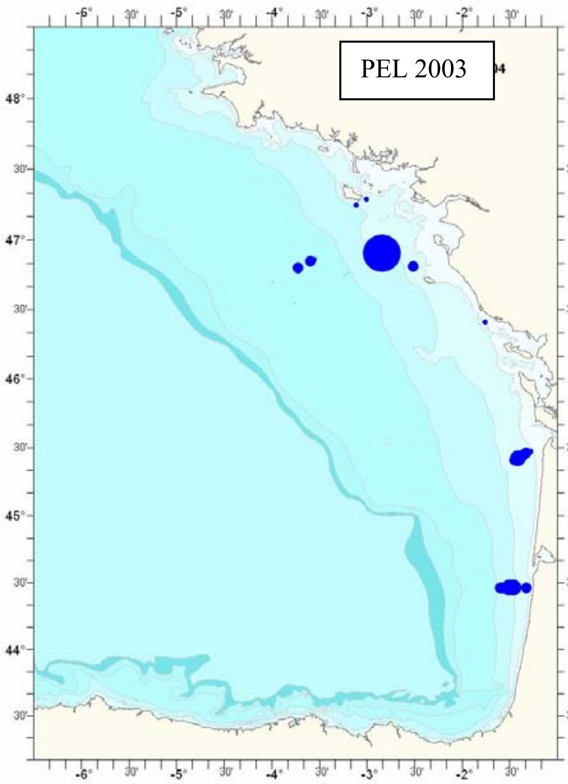


Figure 7.2.1d : Sardine-general : Distribution of sardine in the Gulf of Biscay provided by the French acoustic survey in spring (May-June 2003). Symbols are proportional to the estimated biomass. Abundance is particularly low because of the weather conditions of that survey.

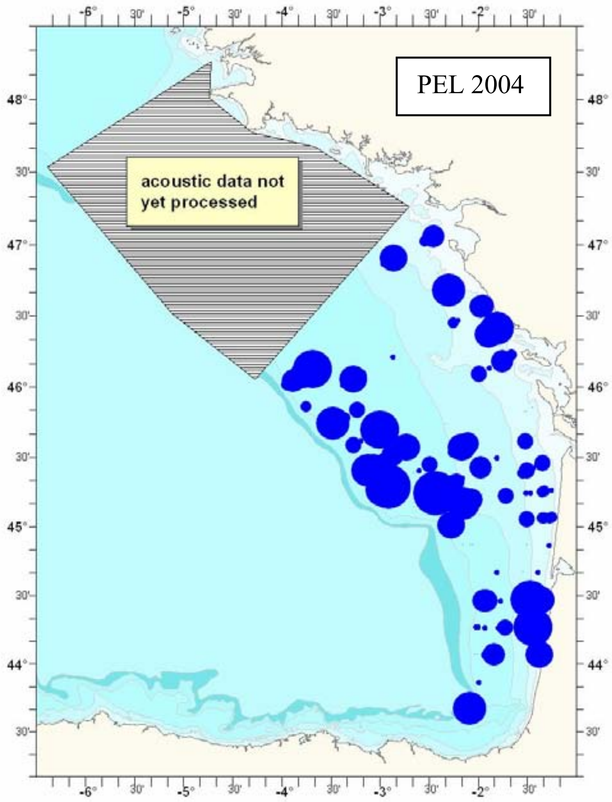


Figure 7.2.1e : Sardine-general : Distribution of sardine in the Gulf of Biscay provided by the French acoustic survey in spring (May-June 2004). Symbols are proportional to the estimated biomass.

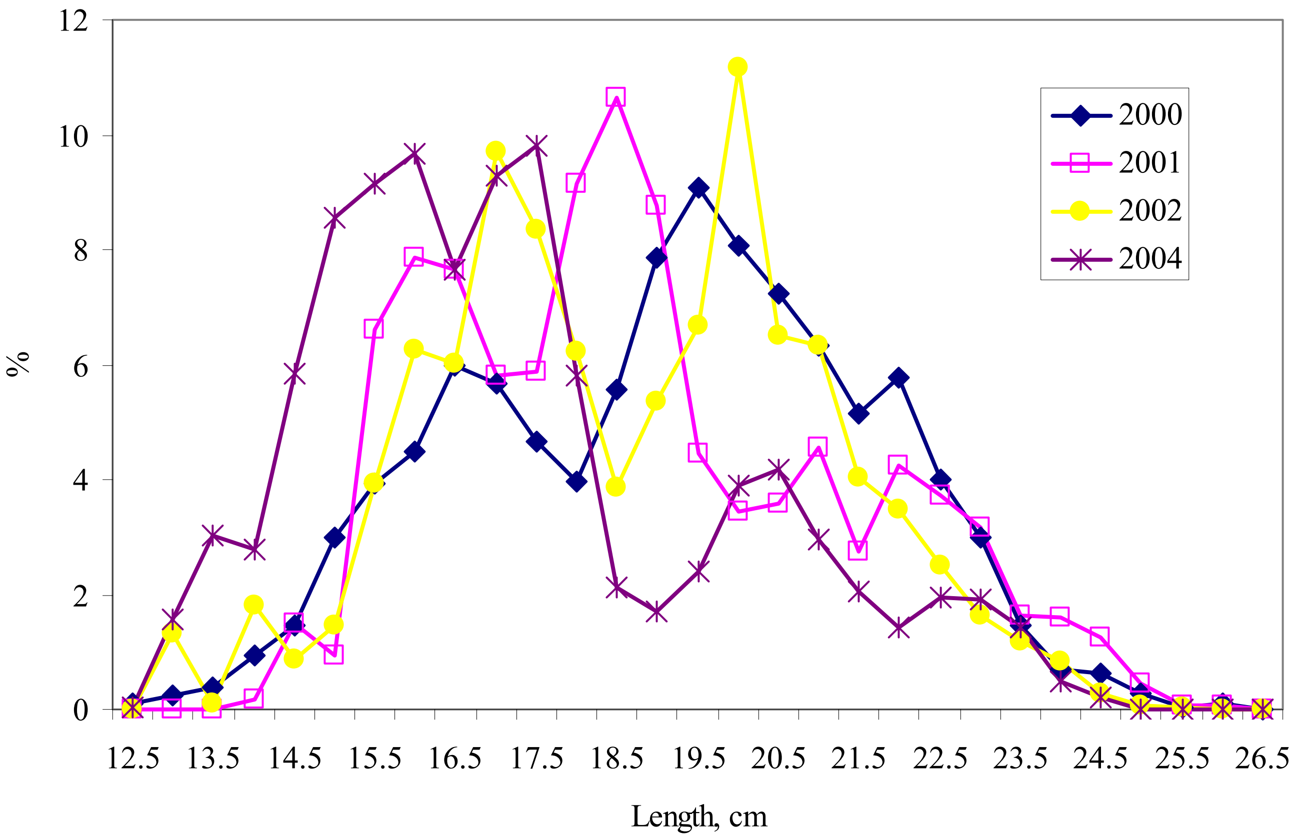


Figure 7.2.2: Sardine-general: Length distributions of sardine in the French acoustic surveys 2000-2004.

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 2001-2002 of 0.26 corresponding to a catch of less than 128 000 t. Fishing mortality in 2004 should not increase since the short term forecast indicates that the SSB is expected to decrease in 2005 unless a 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 yearclass. Historically the current level of F has been sustainable. In spite of the overall good situation of the stock, different situations are found in different areas and 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 yearclasses, and the 2002 recruitment is estimated to be around the lowest of the series.

8.2 The fishery in 2003

Management measures implemented in each country since 1997 continued to be enforced in 2002.

In Spain, due to the effects of the prestige oil spill, a fishing closure took place in January to middle March. In the subdivision VIIIc East-east (Basque country) the fishing closure started in mid January, allowing to fish a small amount of sardine in this month. Also according to Spanish regulations, a maximum daily catch of 7,000 Kg of sardines higher 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 with a limitation of 5 fishing days per week.

In Portugal, a closure of the purse-seine fishery took place in the northern part (north of the 39º42" north) of the Portuguese coast from the 1st of February to 31 of March and the yearly quota for the Producers Organization was limited to 75.0 thousand tons.

As estimated by the Working Group, sardine landings in 2003 are stable, comparatively to 2002. Total landings in divisions VIIIc and IXa were 97,831 t (31,303 t from Spain, of which 8,484 t from the Gulf of Cadiz, and 66,528 t from Portugal) (Tables 8.2.1 and 8.2.2, Figure 8.2.1). The bulk of the landings (99%) were made by purse-seiners. In Portugal, a re-definition of the fleet components used to report landings was carried out by the General Fisheries Directorate in 2003. Small vessels licensed for purse seining among other gears, previously included in the purse seine fleet, were moved to the artisanal fleet. As a consequence, 11% of the sardine landings in 2003 are reported from the artisanal fleet, 1% to the bottom trawl fleet and 88% to the purse-seine fleet.

Table 8.2.1 summarises the quarterly landings and their relative distribution by ICES Subdivision. Most of the catches (66%) were landed in the second semester (mainly in the third quarter) and were lowest on the first quarter due to the periods of fishery closure that took place in both countries. 60% of the landings took place off the west Portuguese coast (IXaCN and IXaCS), similarly to the most recent years while 23% come from the northern areas of the stock (VIIIc and IXaN) and 17% from southern areas (IXa-S). Compared with 2002, landings increased 12% in the northern areas and decreased 25% in southern areas, remaining stable off the west Portuguese coast. It is worth noting that landings have decreased continously for the last six years off the south Portuguese coast, being currently 60% of their value in 1997.

8.3 Fishery independent information

8.3.1 DEPM – based SSB estimates

No new DEPM survey was carried during 2003 (this is a triennal survey). Next surveys in both Spain and Portugal are expected for 2005 and will be planned in the next meeting of the SGSBSA (San Sebastián, November 2003).

8.3.2 Acoustic surveys

The methodology used in 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). Spring surveys are undertaken within the framework of the EU DG XIV project “Data Directive”.

8.3.2.1 Portuguese Acoustic Surveys 2003/2004

Each year two surveys are routinely performed off the Portuguese continental shelf and Gulf of Cadiz, during March (late spawning season) and November (early spawning and recruitment season) with the main objective to estimate sardine and anchovy abundance in ICES Division IXa. During 2003/2004 acoustic surveys were carried out in November 2003 and in June 2004 with R/V “Capricórnio”. The change of ship was due to repairing of “Noruega”, the vessel generally used for these surveys. The two vessels have comparable acoustic equipment, however “Capricórnio” does not perform pelagic trawling efficiently.

The November 2003 survey was marked by bad weather conditions and ship engine faults, leading to a shorter survey time (15 days) and smaller area coverage (the southwest Portuguese coast and the Gulf of Cadiz were not covered) than in previous surveys (Figure 8.3.2.1). Samples from the purse-seine landings were used to overcome deficient sampling of schools observed in mid-water, however difficulties in locating the samples decreased the confidence on the identification of species and on the estimation of population structure. The overall sampling coverage was poor (a total of 14 samples, half from the fishery, 1 from pelagic trawling and the remaining from bottom trawling). Estimates of sardine abundance were splitted according to the degree of confidence in sardine identification; high confidence estimates, from sardine identification corroborated by fishing stations, and low confidence estimates, from sardine identification based on the experience of acousticians. Sardine abundance and biomass values were derived from the sum of the two estimates (containing about half high confidence estimates). However these estimates may be biased and are considered mainly as indicative of the population level and age structure and not comparable to other values of the survey series used in the assessment of the stock.

The acoustic survey originally planned to take place in March was delayed until June due to ship engine problems (Figure 8.3.2.2). The 3 months delay relative to the usual period raises doubts about the comparability of the estimates; not only the abundance reflects additional 3 months of mortality but June corresponds to the beginning of the recruitment season and therefore the estimates reflect a different population structure. The Gulf of Cadiz (included in the index from this survey series) was not covered due to lack of survey time. There was no attempt to perform pelagic trawling and sampling of mid-water schools was carried out by commercial purse-seiners that accompanied the research vessel. However, fish avoidance of the purse-seine during daytime was considerable leading to poorly representative samples that increased the uncertainty and possibly biased the estimates of abundance and population structure.

Due to all these limitations it was decided not to integrate the results from these surveys in the time series used on the assessment of the stock. A brief description of the results is provided below.must be considered just as an indication of the recruitment strength and stock status.

The total sardine biomass in the Portuguese waters in November 2003 was 222 thousand tonnes, corresponding to 6779 billions individuals (Table 8.3.2.1 and Figure 8.3.2.1). Around 50% of the total number of sardines (43% of the biomass) were observed in the northern area and 9% in the southern waters (16% of the biomass). The proportion in the southwest area (42% in number and 40% in biomass) is possibly underestimated due to incomplete coverage of the area, although this is usually a weak sardine abundance area.

The total sardine biomass in the Portuguese waters in June 2004 was 339 thousand tonnes corresponding to 11572 billion fish, being comparable to that estimated in February 2003 (Table 8.3.2.2 and Figure 8.3.2.2, see also Fig 8.3.2.3 and 8.3.2.4 for a comparison with the historical series including DEPM and Spanish surveys). Most of the sardine was distributed off the northern waters (77% in numbers and 70% in biomass) down to the 100 m depth contour and corresponded to 0-group individuals (55%), providing some indication of a strong 2004 recruitment . Large numbers of juveniles were also observed in front of Lisbon, a typical recruitment area while both the total and the juvenile abundance in the southern waters remains low. Although these data are not comparable with estimates from previous Spring surveys, they are supported by anedoctal information from the fishery; purse-seine fishers warned to the presence of large quantities of small sardine juveniles off the northern coast in mid-April which bridged the nets, creating serious difficults to the fishing activity. Observations made by acoustic technicians on board purse seiners in that area during one week in May confirmed the situation and also highlighted that the distribution of these juveniles changed considerably in a short period (1-2 weeks).

The sardine population is dominated by 0-group and 1 year olds off the western Portuguese waters in both surveys while 1+ individuals are dominant off the southern coast (Figure 8.3.2.5). The survey information on the population structure in 2003 is not fully in agreement with the catch-at-age structure (section 8.4.1), mainly in what concerns the relative importance of the strong 2000 yearclass in the northern waters. These differences are possibly due to important bias on abundance estimates in the survey. On the other hand, the strength of this yearclass in the northern area is still clear in the June 2004 survey. Survey data for the southern waters indicate a low importance of the 2000 yearclass and a high importance of the 2001 yearclass in the area, supporting information from recent years.

8.3.2.2 Spanish April 2004 Acoustic Survey

The Spanish Spring Acoustic Surveys time series comprises data from 1986 onwards, with three gaps in 1989, 1994 and 1995. Historically, sardine abundance in number shows a high inter-annual variability up from 1986 to 1993. 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, with the highest value of the series in 2004. However, the population structure is quite different between these two periods. The 80´s period was dominated by older fish, with age groups 5 and 6+ with about half of the estimated numbers. Opposite, since the second half of the 90’s these age groups only represent less than 15% of the population.

The Spanish acoustic survey (PELACUS 0404) took place in April 2004. It was carried out on the R/V “Thalassa”, covering Spanish waters in Division VIIIc and IXa North as well as the northern part of Portugal. Simultaneously to the acoustic, CUFES sampling and extensive studies on plankton and primary production were undertaken along the surveyed area. Data from the 2004 survey were used in the WGMHSA 2004 for the 2003 assessment, but no working document with main results from the acoustic survey was presented to the WG.

The sampling covered a total of 54 acoustic tracks and 55 fishing stations in Spain (Figure 8.3.2.6). As in previous years, fishing was made both by pelagic trawls from the R/V and by a chartered purse-seiner. This purse-seiner is particularly useful in the Rias Bajas (Subdivision IXa North), where pelagic trawls are not possible to be made due the bathymetry and topography of that area.

Table 8.3.2.3 shows the sardine acoustic estimates by areas and ages. The abundance estimated in 2004 in the North Spanish area is 3170 billions, which represent the highest value of the series and an increase of 16% in respect to the 2003 value (2650 billions). Regarding biomass, the 2004 survey estimated a level of 226 thousand tonnes, which account for an increase of 18% in respect to the 2003 biomass estimate. It has to be highlighted that the 54% of the abundance in number and the 54% of the biomass of the surveyed area correspond to area VIIIc West. Opposite, the area VIIIc East west represent less than 1% from the total, both in numbers and in biomass.

Age 4 group is the most abundant, corresponding to the 2000 strong year class (Fig 8.3.2.7). This is particularly true for area VIIIc West, where age 4 group represent the 50% both in abundance and biomass. However age group 3 is the most abundance group in area VIIIc East, mainly in its eastern part. This could suggest a different population structure from the west to the eastern part of the stock.

8.4 Biological data

Biological data were provided by Spain and Portugal. In Spain samples for age length keys were pooled on a half year basis for each Sub-Division while the length/weight relationship was calculated for each quarter. Age length keys and length/weight relationship from the Cádiz area were also 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

Table 8.4.1.1 shows the quarterly length distributions of landings from each Sub-Division. Annual length distributions are bimodal, except in the south Portuguese coast (IxaS-Algarve) where a single mode at 20 cm is observed. 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 2003 in VIIIcW (north Galicia) and particularly 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 southwest Portugal (IXaCS), catches continue to be dominated by the strong 2000 yearclass (3-group in 2003), in the southern area the age structure supports previous indications of a strong 2001 recruitment and in the VIIIc East Sub.Division there is no evidence of particularly strong cohorts.

0-group catches are mainly distributed in sub-divisions IxaCN (north Portuguese waters) and IxaS-Cadiz (Gulf of Cadiz) which have been important recruitment areas in recent years. Older fish (age groups 5 and 6+) concentrate in the Bay of Biscay/Cantabrian area (VIIIcE) and southwest/south Portugal (IxaCS and IxaS-Alg).

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. However, November corresponds to an earlier phase of the spawning cycle in Portugal than March in the Spanish waters indicating that maturity and stock weights at age are not derived from equivalent phases of the spawning cycle in the two areas. The WG considers that this discrepancy might affect the maturity and weights at age estimates of the sardine stock and recommends that results from on-going studies of the seasonal cycles of fattening and maturation be available in the short term.

In 2003, maturity and weight estimates for the northern Spanish waters were based on data collected during the Spanish spring acoustic survey as usual. The Portuguese November 2002 survey covered only a small part of the southern Iberian waters therefore, maturity and weight at age estimates for 2003 were based on data from catch samples collected in the 4th quarter of 2002 off the Portuguese coast (ages shifted 1 year). The population numbers at age provided in the Portuguese and Spanish spring surveys 2003, 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 2003 maturity ogive for sardine (table below) is comparable to the ogive in the last assessment:

Age	0	1	2	3	5	5	6+
% mature fish	0	50.0	96.4	98.8	99.7	99.9	100

The 2003 stock weights at age (table below) are generally within the range of weights observed in the data series, although slightly higher on younger ages that in the last assessment. The fact that they were estimated from catch samples where the smaller sized individuals are poorly represented than in survey samples may partly explain this difference.

Age	0	1	2	3	5	5	6+
Weight, kg	0	0.027	0.054	0.064	0.075	0.082	100

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

Concerns about the effort measurements have been expressed in previous WG, and it has prevented this data to be used in the assessment. No new information on fishing effort review has been presented, and thus the situation remains the same.

8.6 Recruitment forecasting and Environmental effects

A WD was presented to the WG on the impact of the North Atlantic Oscillation (NAO) on fish recruitment variability in the Portuguese waters (WD Borges et al). This WD describes recent published information on the association between NAO and northerly winds off the Portuguese coast during winter. Upwelling events induced by winter northerly winds are considered to have a negative impact on fish recruitment due to increased mortality of eggs and larvae transported offshore. The WD further explores the incorporation of an index of NAO in winter as an additional parameter in the Ricker stock recruitment relationship using sardine data as an example.

The WG acknowledges the relevance of studies on the relationship between recruitment variability and environmental conditions and encourages their development. The information presented in WD Borges et al. is a contribute to the comprehension of sardine recruitment variability, however more data and careful statistical analyses are needed until consistent results can be produced. Results about offshore transport induced mortality are not fully supported by the SURVIVAL project and Ricker stock-recruitment curves are not generally regarded as appropriate for sardine populations. The WG considers that current knowledge on recruitment environment relationships is still at an early stage, and encourages further research along these lines in order to understand environmental effects on stock dynamics.

8.7 Data exploration

This year sardine assessment is required by ACFM as an updated assessment, and thus no model exploration, apart from usual validation of the stock assessment model (see section 8.8.1 and 8.8.2 below), were carried out. Nevertheless, an exploration of the input data for this year assessment was carried out. Area-based data exploration of the landings and acoustic data are presented in sections 8.2 and 8.3.2 respectively, while this section deals specifically with the exploration of the data as it is introduced in the assessment model. Time series of catches include the period 1978 – 2003, while acoustic survey data time series start in 1984 and has different gaps in the different countries/surveys.

Figures 8.7.1 shows the catch in numbers by age classes in the stock area. Catch in numbers in the stock show a general decline throughout the time series, although peaks of catches for ages 1, 2 and (less clearly) for age 3 can be seen in figure 8.7.1, upper panel. A continuosly decreasing trend in catches of ages 3 and above since 1996 can be observed in the figure, with the only exception of a increase in catches of age 3 for 2003. Years of good recruitment are reflected in the catches at ages 0 and above, although for recent years (2000 and 2001) there are only apparent after age 1. Good year classes can be followed in the catches up to ages 3-4 and less apparent in following age-classes (figure 8.7.1 bottom panel). Figure 8.7.2 shows the evolution of catches in tonnes in the fishery, with a general decreasing trend since 1985.

Stock weight-at-age at spawning season and mean year weight at age from the catches are shown in Figure 8.7.3. Stock weights-at-age are estimated from weight-at-age on the surveys when available, and from catches in the spawning season otherwise. Both stock weight-at-age and catches mean weight-at-age show a general increasing trend, specially since latter 90's (figure 8.7.3). Stock weight-at-age and catches mean weight-at-age show large differences, specially in age classes from 0 to 3. Due to yearly cycles in sardine condition, yearly mean weight-at-age from catches and spawning sotck weight-at-age from the surveys are expected different. Also, catches weight-at-age are believed to overestimate weight on the earlier age classes and underestimate weight on the later year classes. When no survey data is avaliable, catch data from a given quarter is used to estimate stock weight-at-age (see section 8.4.3) and the implication of this in variations in the time series is to be further analised (see for example relative changes between stock weight-at-age and catches weight-at-age in the period 1997-2002, when survey data was available, figure 8.7.3).

Stock weight-at-age in the Spanish March survey reflects weights in the peak of spawning, while weight in the Portuguese November survey reflects weights at the beginning of the spawning season (see section 8.4.3). The possible implication of this in stock assessment is to be further investigated.

Figure 8.7.4 shows the estimated proportion mature by age class in the stock. Proportion mature in Age 1 shows a large variation, values ranging from aproximately 0.2 to 0.8, while proportion mature on the other age classes show less variation and a slightly general positive trend since middle 90's. Variation of proportion mature in age 1 does not seems to be correlated with years after large recruitment, but instead may be due to changes on the sampling methodology and data availability over the time series, as well as spatial and temporal variability in adult maturity. Ongoing work on maturity ogive and update on the maturity time series is expected to be provided to next WG.

Figure 8.7.5 shows the evolution of estimated survey abundance by age classes in the Spanish and Portuguese March survey and the Portuguese November survey. Dotted vertical line in the plot represent the assumed periods of different selectivity of the survey (figure 8.7.5a). Since 1996, the Spanish March survey show a general increasing trend, while the Portuguese surveys are influenced by consecutive strong recruitments since 2000. Sygnals from the 2000 and 2001 year class can be seen in the age 0 year class of the Portuguese November survey, and can be followed in the March surveys, specially in the Spanish one in which the sygnal of the 2000 year class can be observed up to age 4 of 2004 (figure 8.7.5b). High abundances of year classes older than the 2000 one are also detected in the Spanish March survey, without clear indications of good recruitments in the Spanish surveys for those year classes. This may indicate either an immigration of fish in age classes above 2-3 to the Spanish area or a possible problem on the age length key, which may cause an expansion of the 2000 year classes to younger and older year classes. Possible problems in the age length key are to be investigated in a Workshop of otolith reading intercallibration to be perform in 2005, while migration patterns and intensity is being investigated on the SARDYN project.

Only two DEPM-based estimates of biomass are actually included in the assessment model (269000 tonnes in 1999 and 442600 tonnes in 2002), although another year (1997) may be recovered after the final revision of the SGSBSA. Also, a new DEPM survey will be carried out in 2005, with preliminary estimates of egg production and final SSB estimates expected to be provided to the WG in 2005 and 2006 respectively. DEPM based SSB levels are comparable with the different acoustic surveys (section 8.3.2, figure 8.3.2.4), although the small number of DEPM-based estimates does not allow a formal comparison. Comparison between spatial distribution of acoustic and DEPM based SSB estimates has been attempted in the SGSBSA and will be further developed in the next SG meeting.

8.8 State of Stock

8.8.1 Stock assessment

Stock assessment of sardine is carried out using the AMCI software (Skagen, 2004; ICES 2004). The final assessment selected for this year is essentially an update of last years assessment regarding both the input data and model assumptions:

		2003 assessment	2004 assessment
INPUT DATA	Catch at age	1978-2002, Divisions VIIIc+IXa	1978-2003, Divisions VIIIc+IXa
	Acoustic surveys	Spanish March, VIIIc+IXaN, 1986-2003 Portuguese March, Port. Waters + Cadiz, 1996-2003 Portuguese November survey, Port. Waters, 1984-2001	Spanish March, VIIIc+IXaN, 1986-2004 Portuguese March, Port. Waters + Cadiz, 1996-2003 * 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 age	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
# - Changes in calculation, see section 8.4.3

Table 8.8.1.1 shows the input data used for the assessment (see section 8.7 for input data exploration), 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. 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 2003 (5035 million individuals) is predicted low by the model and previous indication of a low 2002 recruitment is also supported. In the past ten years, there was a single strong yearclass (2000) in the sardine stock although the 2001 recruitment (8985 million individuals) was also above the historical geometric mean (6858 million fish). Fishing mortality shows a decreasing trend since 1998 and remains at a low level in the last year ($F_{(2-5)}$=0.20). The SSB is estimated to be 668 thousand tonnes in 2003, showing a more than doubled increase since the historically lowest value in 2000 which is due to the influence of the 2000 and also of the 2001 yearclass. Also it has to be noted that the estimates from the Spanish spring survey 2004 are the highest of the time series. As this is the only survey used for tuning in this current assessment this may also lead to a more optimist perception of the stock.

Figure 8.8.1.2 shows the catch residuals and Figure 8.8.1.3 the survey residuals. Some downwards trend in residual magnitude and mostly negative catch residuals in recent years are apparent in Figure 8.8.1.2. However, residuals do not show any alarming trend when the overall historical series is considered. In 2003, there is a slightly large positive residual in the 0-group, suggesting that information from the surveys is pointing to a lower abundance of this age group than catch information. This effect is to be expected since there is a single data point to tune the catches of this age group.

Survey residuals show a small, opposite, trend in sign in recent years in the Spanish March survey (mostly positive) and in the Portuguese November survey (mostly negative; 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.

Survey catchability estimated in the current assessment are comparable to those from last years assessment (Figure 8.8.1.4). Catchabilites in both the Spanish March survey and the Portuguese November survey show a large change in the two selected periods (84-93, 94-03). Overall catchability decreased in the Spanish survey, mainly due to a decrease in the catchability of older age groups (5 and 6+) while it increased in the Portuguese November survey due to considerably larger catchability of recruits but also of older individuals (4 and 5 year olds).The Portuguese March survey shows a catchability pattern similar to the November Portuguese survey in the same period.

Selection pattern across years and ages is comparable to that estimated in last years assessment (Figure 8.8.1.5). A shift in the selection pattern along the time series is estimated by the model, with an increase in selectivity in older age groups (with the exception of 6+) and a decrease in younger age groups in recent years. The selection patterns show a general increase with age and constant values from age 2 (in the earlier years of the series) or from age 3 (in recent years) onwards. The disapearance of the 6+ group from catches in recent years is explained by a decrease in selectivity at age 6+.

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 8.8.1.6 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 deviationt. 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 15%, one percent higher than last year due to a larger variability associated with the 2003 recruitment.

Figure 8.8.1.1 shows the relation between F-values and SSB for the time series in all bootstrap years. Mean trajectory for this plot was computed by grouping F-values in 30 classes and computing average F and average SSB in each of this classes. 90% confidence intervals and estimated standard deviations are also shown in the plot.

8.8.2 Reliability of the assessment

The major difficulties in the assessment of the sardine stock in recent years were extensively described in last years report and some are still applicable, namely:

- apparent changes in selection and catchability, believed to reflect ecological differences within the areas and not changes in the fishery or methodological changes in surveys.

- uncertainties regarding the absolute stock abundance and the relation between the biomass levels in recent years when compared to the 1980's
- spatial differences in the abundance and possibly in exploitation levels of the population

A considerable progress was made recently in the assessment of this stock regarding the selected assessment model (AMCI) due to the larger flexibility of this model to accommodate the assumptions of selection and catchability changes implicit in the data. DEPM-based SSB estimates for recent years are currently considered reliable estimates of the absolute stock biomass and are consistent with the other data sources. The acoustic surveys provide consistent information on the yearclass abundance within the survey areas and that information is in agreement with that from catch data.The conflicting trend in the Portuguese and Spanish survey residuals is still a matter of concern although this conflict is considered to be a consequence of different age distributions, possibly due to migrations within the stock area and adjacent areas. Merging the two spring surveys which are carried out jointly will possibly improve the assessment but there must be clear indications on the methodology to achieve it. Another option will be to use an area-based model but that requires information on the migration patterns and intensity between the areas. The WG encourages further research on these areas to improve the assessment of the stock. Attempts to compare abundance estimates from the Portuguese and Spanish March survey are on course and information on sardine migration is expected from the SARDYN project in the near future.

A new source of uncertainty, the lack of data from the Portuguese acoustic surveys in November 2003 and March 2004, affects the assessment this year and particularly the estimation of the 2003 recruitment. Also as aforementioned, the only tuning fleet used for assessment was the 2004 Spanish survey, which is the highest estimate of the whole time series. This may lead to a more optimist perception of the stock.

The sardine stock level estimated for the earlier period (1980s) is based on sparse survey data and no absolute SSB estimates, therefore the relation between that level and the recent estimates is uncertain. The stock level in recent years is believed to be close to the actual state of the stock as the different sources of information entering the assessment are consistent and there are reliable estimates of the absolute stock biomass. The biomass level in 2002 from the DEPM (443 thousand tonnes) could be considered at similar level as the SSB estimated by the assessment (503 thousand tonnes). Neverheless, the perspective that the sardine stock is at its highest level of biomass and lowest level of exploitation of the whole history may be misleading. Catches in the earlier period were double of the recent catch levels, and egg distribution in the late 80's covered a wider area than in actual years. Differences in catches may be partly explained by fishery regulations in recent years but may also be related to lower abundance in particular areas (such as the northern Spanish waters and off the south Portuguese coast) in comparison with the historical series.

8.9 Catch predictions

8.9.1 Divisions VIIIc and IXa

A deterministic short-term prediction was carried out using results from the final assessment. Recruitment was calculated as the geometric mean of the recruitments for the whole time series (1978-2003), $R_{GM(78\text{-}03)} = 6858$ millions individuals. There is some indication of a large 2004 yearclass off the north Portuguese coast (see section 8.3.2.1), however, the strength and spread of this year-class has to be confirmed with new information.

Weights at age in the stock and in the catch were calculated as the arithmetic mean value of the three last years (2001-2003). The maturity ogive and the exploitation pattern corresponded to the 2003 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(2002-03) unscaled.

Input values and results are shown in Tables 8.9.1.1 and 8.9.1.2. The predicted landings with Fsq (0.20) for 2004 are 112 thousand tonnes. Predictions from last WG 2003 were made with a catch constraint of 100 thousand tonnes, which generated a Fbar = 0.20. The current 2004 short term predictions increase the expected landings 12% for 2004 by maintaining the same level of fishing mortality. If fishing mortality remains at the Fsq level (0.20), the predicted yield in 2005 (106 thousand tonnes) remains close to the catch level in recent years. A 10% increase of the fishing mortality will yield 115 thousand tonnes in 2005 which is similar to the catches predicted for 2004.

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

This year sardine assessment is required by ACFM as an updated assessment and no medium term projections are required

8.12 Long term yield

No long term yield is presented as this years assessment is required by ACFM as an updated assessment

8.13 Uncertainty in the assessment

The main sources of uncertainty of the current sardine assessment have been extensively described in the reports from the last two assessments (ICES 2003, 2004). The assessment model currently used (AMCI) reduced the structural uncertainty that plagued the assessment in recent years by dealing with the assumptions of selection and catchability changes. However, uncertainty regarding the definition of the stock unit and the scarce knowledge on sardine migrations still remains. This uncertainty highlights the need of assessment methods that are able to take into account the spatial distribution in sardine population and its dynamics. Nevertheless, area based assessment requires solid information of migration patterns. The ongoing "Sardyn" project is expected to provide information about these topics.

Data exploration and assessment results have pointed out conflicts between the Portuguese and Spanish surveys which cover different areas of the stock. Although this problem was partly solved by assuming a change in the catchability pattern, the WG is aware that it may become sharper if the stock structure becomes very different in the two areas. One way that could be explored to minimize this problem is merging the spring acoustic survey, however clear indications of the method to achieve this are required.

The lack of Portuguese survey data in 2003/2004 affected the estimation of biological parameters of the stock and decreased the precision of the 2003 recruitment and spawning stock biomass (see section 8.8).

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. The WG considers that if the current assessment is accepted by ACFM, it may be relevant to consider reference points for this stock. So far, no preparatory work to establish reference points has been done, but this may be considered for next year.

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 due to the strong 2000 yearclass. The assessment indicates a SSB of 668 thousand tonnes which corresponds to the highest value of this series, however the relation of the actual stock level with that in the 1980's in uncertain. It should also be noted that estimates of the population are less precise for 2003 than for previous years and may provide an optimistic perspective of the stock (see section 8.8.1). The DEPM-based SSB estimate of this stock in 2002 (442 thousand tonnes) is comparable to the model estimate indicating a 65% increase from 1999. Fishing mortality shows a decreasing trend since 1998. Management measures undertaken by Spain and Portugal to reduce the fishing effort and the overall catches may have contributed to this decrease.

The 2000 year-class has been confirmed as a good year-class and it is both dominating the catches and survey estimates in the northwestern area of the stock. The assessment suggests that the 2001 yearclass is also above average, however there is some evidence of low 2002 and 2003 recruitments. Furthermore, the abundance of sardine in some areas of the stock continues to be low when compared to the mid 1980's. Short term catch predictions indicate that catches in 2005 will be at the current level if fishing mortality is maintained, however, the SSB will slightly decrease from 2004 onwards, unless a new strong yearclass enters the stock. These predictions highlight the dependence of the stock on the recruitment strength and alert to the possibility of a reversal in the current optimistic situation in the short term. Nevertheless, it should also be taken into account that pelagic stocks have cycles of productivity and this knowledge needs to be incorporated in the management of the stock.

Table 8.2.1 Sardine in VIIIc and IXa. Quaterly distribution of sardine landings (t) in 2003 by ICES Sub-Division. Above absolute values; below, relative numbers.

Sub-Div	**1st**	**2nd**	**3rd**	**4th**	**Total**
VIIIc-E	23	1844	1593	4475	**7935**
VIIIc-W	202	1194	4734	2371	**8500**
IXa-N	25	2398	2362	1598	**6383**
IXa-CN	611	7717	14965	10001	**33293**
IXa-CS	5914	5070	7086	6565	**24635**
IXa-S (A)	1708	2504	2025	2364	**8600**
IXa-S (C)	2601	1133	2912	1838	**8484**
Total	**11083**	**21858**	**35678**	**29212**	**97831**

Sub-Div	**1st**	**2nd**	**3rd**	**4th**	**Total**
VIIIc-E	0.02	1.88	1.63	4.57	**8.11**
VIIIc-W	0.21	1.22	4.84	2.42	**8.69**
IXa-N	0.03	2.45	2.41	1.63	**6.52**
IXa-CN	0.62	7.89	15.30	10.22	**34.03**
IXa-CS	6.05	5.18	7.24	6.71	**25.18**
IXa-S (A)	1.75	2.56	2.07	2.42	**8.79**
IXa-S (C)	2.66	1.16	2.98	1.88	**8.67**
Total	**11.33**	**22.34**	**36.47**	**29.86**	

Table 8.2.2: Sardine in VIIIc and IXa. Iberian Sardine Landings (tonnes) by sub-area and total for the period 1940-2003.

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

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

Table 8.3.2.1: Sardine in VIIIc and IXa. Sardine Assessment from the 2003 Portuguese November acoustic survey. Number in thousand fish and Biomass in tonnes.

AREA		0	1	2	3	4	5	6	7+	Total
Oc. Norte	**Biomass**	50567	27571	9238	6619	422	0	149	237	**94803**
	%	53.34	29.08	9.74	6.98	0.45	0.00	0.16	0.25	
	Mean Weight	21.5	40.5	54.7	56.2	65.8		83.0	104.8	
	No fish	2355687	681225	168789	117706	6415	0	1795	2262	**3333879**
	%	70.66	20.43	5.06	3.53	0.19	0.00	0.05	0.07	
	Mean Length	14.1	17.1	18.8	18.9	19.8		21.3	22.8	
Oc. Sul	**Biomass**	15896	34235	6047	15626	4433	3199	4955	5502	**89893**
	%	17.68	38.08	6.73	17.38	4.93	3.56	5.51	6.12	
	Mean Weight	11.7	42.6	47.3	54.2	67.3	73.3	74.0	83.9	
	No fish	1357329	803941	128034	288285	65902	43662	67011	65600	**2819764**
	%	48.14	28.51	4.54	10.22	2.34	1.55	2.38	2.33	
	Mean Length	12.0	17.8	18.3	19.1	20.3	20.8	20.9	21.7	
Algarve	**Biomass**	1406	1447	16374	13350	2386	2142	279		**37384**
	%	3.76	3.87	43.80	35.71	6.38	5.73	0.75		
	Mean Weight	33.1	42.2	59.0	65.2	66.0	76.9	80.3		
	No fish	42542	34256	277211	204674	36174	27837	3477		**626171**
	%	6.79	5.47	44.27	32.69	5.78	4.45	0.56		
	Mean Length	16.5	17.8	19.7	20.4	20.4	21.4	21.8		
Total	**Biomass**	67869	63253	31659	35595	7241	5341	5383	5739	**222080**
Portugal	**%**	30.56	28.48	14.26	16.03	3.26	2.40	2.42	2.58	
	Mean Weight	19.4	41.6	55.5	58.7	66.7	74.7	74.5	84.7	
	No fish	3755558	1519422	574034	610665	108491	71499	72283	67862	**6779814**
	%	55.39	22.41	8.47	9.01	1.60	1.05	1.07	1.00	
	Mean Length	13.4	17.5	19.1	19.5	20.3	21.1	21.0	21.7	

Table 8.3.2.2: Sardine in VIIIc and IXa. Sardine Assessment from the 2004 Portuguese June acoustic survey. Number in thousand fish and Biomass in tonnes.

AREA		0	1	2	3	4	5	6	7+	Total
Oc. Norte	**Biomass**	29357	65113	24185	30004	85523	4625		1326	**240133**
	%	12.23	27.12	10.07	12.49	35.61	1.93		0.55	
	Mean Weight	5.9	14.4	51.8	58.6	64.4	76.5		77.8	
	No fish	4948289	1620654	466759	512235	1328864	60469		17039	**8954309**
	%	55.26	18.10	5.21	5.72	14.84	0.68		0.19	
	Mean Length	9.3	11.2	18.6	19.4	20.0	21.1		21.3	
Oc. Sul	**Biomass**		30881	1761	12844	7398	3472	2693	668	**59717**
	%		51.71	2.95	21.51	12.39	5.81	4.51	1.12	
	Mean Weight		20.7	65.6	67.0	81.8	79.6	78.5	92.9	
	No fish		1489977	26861	191635	90472	43640	34309	7190	**1884084**
	%		79.08	1.43	10.17	4.80	2.32	1.82	0.38	
	Mean Length		14.5	19.3	19.3	20.3	20.2	20.1	21.0	
Algarve	**Biomass**		11978	9028	13303	3326	306	807	302	**39050**
	%		30.67	23.12	34.07	8.52	0.78	2.07		
	Mean Weight		48.1	51.9	56.2	60.6	74.7	71.4	80.8	
	No fish		249055	173890	236567	54894	4100	11302	3742	**733550**
	%		33.95	23.71	32.25	7.48	0.56	1.54		
	Mean Length		17.6	18.1	18.6	19.1	20.6	20.2	21.1	
Total	**Biomass**	29357	107972	34974	56151	96247	8403	3500	2296	**338900**
Portugal	**%**	8.66	31.86	10.32	16.57	28.40	2.48	1.03	0.68	
	Mean Weight	5.9	19.9	52.5	60.0	65.6	77.7	76.9	82.6	
	No fish	4948289	3359686	667510	940437	1474230	108209	45611	27971	**11571943**
	%	42.76	29.03	5.77	8.13	12.74	0.94	0.39	0.24	
	Mean Length	9.3	13.2	18.5	19.2	20.0	20.7	20.1	21.2	

Table 8.3.2.3: Sardine in VIIIc and IXa. Sardine Assessment from 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)	985	4855	17611	11370	6945	5584	2181	819	246	246	50843
% Biomass	1.9	9.5	34.6	22.4	13.7	11.0	4.3	1.6	0.5	0.5	100
Abundance (N in '000)	22207	86179	258237	151323	86089	66789	24939	9238	2568	2568	710139
% Abundance	3.1	12.1	36.4	21.3	12.1	9.4	3.5	1.3	0.4	0.4	100.0
Medium Weight (gr)	44.4	56.3	68.2	75.1	80.7	83.6	87.5	88.6	95.9	95.9	70.6
Medium Length (cm)	18.1	19.7	21.1	21.9	22.5	22.8	23.1	23.2	23.9	23.9	20.0

AREA VIIIcE west

AGE	1	2	3	4	5	6	7	8	9	10	TOTAL
Biomass (Tonnes)	4	162	494	224	91	54	14	4	0	0	1048
% Biomass	0.4	15.5	47.1	21.4	8.7	5.1	1.4	0.4	0	0	100
Abundance (N in '000)	77	2666	7335	3144	1209	710	182	49	2	2	15375
% Abundance	0.5	17.3	47.7	20.4	7.9	4.6	1.2	0.3	0.0	0.0	100.0
Medium Weight (gr)	52.5	60.9	67.3	71.3	75.3	76.0	79.6	79.2	88.4	88.4	67.2
Medium Length (cm)	19.3	20.3	21.0	21.5	21.9	22.0	22.4	22.3	23.3	23.3	19.7

AREA VIIIcW

AGE	1	2	3	4	5	6	7	8	9	10	TOTAL
Biomass (Tonnes)	0	3814	28227	66513	16358	10257	4955	409	0	0	130534
% Biomass	0	2.9	21.6	51.0	12.5	7.9	3.8	0.3	0	0	100
Abundance (N in '000)	0	58446	393832	891075	198377	118685	52414	4362	0	0	1717192
% Abundance	0	3.4	22.9	51.9	11.6	6.9	3.1	0.3	0	0	100
Medium Weight (gr)	0	65.3	71.7	74.6	82.5	86.4	94.5	93.8	0	0	51.7
Medium Length (cm)	0	20.8	21.5	21.8	22.6	23.0	23.8	23.8	0	0	14.3

AREA IXaN

AGE	1	2	3	4	5	6	7	8	9	10	TOTAL
Biomass (Tonnes)	1041	7512	8265	21787	2995	1134	824	388	0	0	43946
% Biomass	2.4	17.1	18.8	49.6	6.8	2.6	1.9	0.9	0	0	100
Abundance (N in '000)	25827	147247	139954	343476	41681	13672	10949	5344	0	0	728150
% Abundance	3.5	20.2	19.2	47.2	5.7	1.9	1.5	0.7	0	0	100
Medium Weight (gr)	40.3	51.0	59.1	63.4	71.8	83.0	75.3	72.6	0	0	47.0
Medium Length (cm)	17.4	19.0	20.1	20.6	21.6	22.7	21.9	21.6	0	0	15.0

TOTAL SPAIN

AGE	1	2	3	4	5	6	7	8	9	10	TOTAL
Biomass (Tonnes)	2030	16344	54597	99893	26390	17030	7975	1620	246	246	226371
% Biomass	0.9	7.2	24.1	44.1	11.7	7.5	3.5	0.7	0.1	0.1	100
Abundance (N in '000)	48112	294539	799358	1389017	327355	199856	88484	18993	2570	2570	3170856
% Abundance	1.5	9.3	25.2	43.8	10.3	6.3	2.8	0.6	0.1	0.1	100.0
Medium Weight (gr)	42.2	55.5	68.3	71.9	80.6	85.2	90.1	85.3	95.9	95.9	77.1
Medium Length (cm)	17.7	19.6	21.1	21.5	22.5	22.9	23.4	22.9	23.9	23.9	21.9

Table 8.4.1.1a: Sardine in VIIIc and IXa: Sardine length composition (thousands) by ICES Sub-Division in the first quarter 2003.

				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								
11.5								
12				58				58
12.5				291				291
13				1 340				1 340
13.5				1 310	6			1 315
14				3 203	56			3 259
14.5				2 516	50		107	2 673
15				1 732	141	5	823	2 700
15.5				921	633	16	2 385	3 955
16				1 742	1 248	41	4 116	7 147
16.5		5		1 267	2 548	200	8 903	12 923
17		15	1	2 035	4 246	712	13 047	20 056
17.5		41	5	1 056	6 960	1754	8 510	18 326
18		70	25	850	11 831	3154	6 892	22 821
18.5		77	36	720	14 960	4650	3 675	24 118
19		128	74	493	18 843	6030	3 009	28 576
19.5		227	80	351	16 144	4979	1 797	23 577
20	28	455	72	196	15 483	4935	1 039	22 208
20.5	7	620	48	239	9 405	2637	595	13 551
21	43	583	31	77	5 526	1115	318	7 693
21.5	64	263	12	28	3 004	386		3 757
22	85	184	3	17	868	125	32	1 315
22.5	14	46	2	38	301	34	143	578
23	21	48	1	3	68	11		152
23.5	7	19						27
24		11						11
24.5		2						2
25								
25.5								
26								
26.5								
27								
27.5								
28								
28.5								
29								
Total	271	2 793	390	20 481	112 321	30 783	55 391	222 430
Mean L	21.9	20.7	19.9	15.9	19.3	19.4	17.6	18.6
sd	0.84	1.14	0.98	1.94	1.27	1.03	1.17	1.74
Catch	**23**	**202**	**25**	**611**	**5914**	**1708**	**2 601**	**11 083**

Table 8.4.1.1b: Sardine in VIIIc and IXa: Sardine length composition (thousands) by ICES Sub-Division in the second quarter 2003.

				Second Quarter				
Length	**VIIIc E**	**VIIIc W**	**IXa N**	**IXa CN**	**IXa CS**	**IXa S**	**IXa S (Ca)**	**Total**
7								
7.5								
8								
8.5								
9								
9.5								
10								
10.5								
11	43			114				158
11.5	43			262				305
12	86			464				550
12.5				568				568
13	57			1 047				1 103
13.5	311			604	44			959
14	616			1 391	44			2 051
14.5	890			1 980	206			3 076
15	1 358			4 726	594			6 679
15.5	965			6 430	1 248	10	153	8 807
16	1 238			12 923	2 253	84	298	16 797
16.5	1 355	31		15 132	2 792	59	848	20 216
17	1 795	84	117	25 328	4 224	409	2 866	34 823
17.5	1 638	230	430	22 070	5 697	1922	4 278	36 267
18	1 242	391	2 252	21 768	10 042	6768	3 348	45 811
18.5	1 019	433	3 244	19 204	14 433	8527	2 609	49 469
19	1 133	718	6 703	19 578	16 109	9541	1 938	55 721
19.5	1 315	1 277	7 230	10 948	14 159	6166	1 159	42 253
20	2 255	2 557	6 560	6 195	9 230	4732	1 464	32 993
20.5	2 428	3 486	4 355	2 020	4 995	2430	624	20 338
21	2 598	3 275	2 843	919	2 361	1616	706	14 318
21.5	2 505	1 476	1 072	357	952	415	69	6 846
22	1 943	1 033	292	102	369	277		4 016
22.5	1 403	256	187	51	126	45		2 069
23	728	270	50	1	65	47		1 161
23.5	281	108	35		5			428
24	95	60	43					198
24.5	43	12						55
25	10							10
25.5	3							3
26								
26.5								
27								
27.5								
28								
28.5								
29								
Total	29 396	15 697	35 412	174 184	89 949	43 050	20 360	408 048
Mean L	19.2	20.7	19.9	17.8	19.	19.3	18.5	18.7
sd	2.67	1.14	0.98	1.52	1.30	0.97	1.20	1.70
Catch	**1 844**	**1194**	**2 398**	**7717**	**5070**	**2504**	**1 133**	**21 858**

Table 8.4.1.1c: Sardine in VIIIc and IXa: Sardine length composition (thousands) by ICES Sub-Division in the third quarter 2003.

				Third Quarter				
Length	**VIIIc E**	**VIIIc W**	**IXa N**	**IXa CN**	**IXa CS**	**IXa S**	**IXa S (Ca)**	**Total**
7								
7.5								
8								
8.5								
9								
9.5								
10	40							40
10.5	282							282
11	289			154				443
11.5	148			219		1	841	1 208
12	132		4	414	3	4	9 887	10 445
12.5	250		4	1 905	39	9	12 086	14 294
13	411		23	7 568	95	6	5 801	13 903
13.5	299		47	13 667	331	12	4 983	19 339
14	285	13	80	10 222	651	17	5 769	17 038
14.5	104	161	60	7 659	910	25	3 944	12 862
15	189	134	47	5 358	999	50	3 319	10 096
15.5	89	236	48	2 426	833	48	4 413	8 093
16	43	446	35	3 604	1 129	146	3 115	8 518
16.5	23	242	34	6 639	2 119	207	3 768	13 032
17	7	510	25	14 299	3 893	289	4 923	23 945
17.5	8	169	24	19 019	4 869	397	7 476	31 962
18	8	84	423	25 685	8 123	1276	7 358	42 957
18.5	9	4	1 349	30 097	12 996	1920	4 231	50 605
19	7	174	3 578	37 014	18 916	3386	1 577	64 652
19.5	40	1 074	5 104	35 502	19 022	3966	1 170	65 879
20	152	3 669	6 117	25 201	15 561	5815		56 515
20.5	485	9 732	5 212	14 918	9 756	3682		43 785
21	1 526	10 544	3 744	7 312	4 207	2969		30 303
21.5	2 717	10 598	1 396	1 782	1 584	1941		20 018
22	3 086	5 406	957	798	606	708		11 560
22.5	2 117	2 974	287	128	90	171		5 767
23	1 726	1 053	35	3	18	3		2 837
23.5	1 083	841	37	27				1 989
24	461	343						804
24.5	88	176						264
25	32	38						70
25.5	1							1
26				19				19
26.5								
27	8							8
27.5								
28								
28.5								
29								
Total	16 142	48 621	28 670	271 640	106 750	27 051	84 661	583 535
Mean L	20.9	21.3	20.3	18.2	19.2	20.1	15.2	18.5
sd	3.57	1.33	1.12	2.23	1.41	1.22	2.34	2.62
Catch	**1 593**	**4734**	**2 362**	**14965**	**7086**	**2025**	**2 912**	**35 678**

Table 8.4.1.1d: Sardine in VIIIc and IXa: Sardine length composition (thousands) by ICES Sub-Division in the fourth quarter 2003.

				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	219							219
10	656							656
10.5	2 186	2						2 188
11	2 186	13		568				2 767
11.5	2 186	75		1 230			41	3 532
12	1 093	221		1 662			82	3 059
12.5	656	928		2 463	68		693	4 808
13	656	1 515		4 438	68		1 103	7 780
13.5	227	1 726	98	4 986	102	9	1 214	8 363
14	245	1 945	160	6 405	102	5	2 187	11 050
14.5	44	1 104	207	5 517	68	71	2 391	9 402
15	44	485	716	6 587	113	113	3 912	11 968
15.5	81	197	700	4 473	365	222	3 842	9 879
16	150	113	609	4 794	658	332	2 820	9 476
16.5	176	62	359	6 044	1 342	309	1 285	9 577
17	123	57	240	13 478	3 101	405	1 890	19 293
17.5	35		125	19 892	5 347	752	2 292	28 443
18	48		107	33 843	10 730	1525	3 580	49 831
18.5	211		61	28 720	15 352	2852	3 865	51 061
19	614	40	201	26 812	18 781	5309	3 961	55 718
19.5	1 834	256	425	15 087	18 175	7410	2 379	45 566
20	6 062	621	2 056	9 217	12 630	8787	1 788	41 160
20.5	7 666	2 703	3 148	3 699	7 987	4655	841	30 698
21	8 139	3 652	4 569	2 601	4 429	2913	396	26 699
21.5	8 531	5 579	2 760	854	2 196	782	119	20 821
22	6 644	4 631	1 938	394	1 030	116		14 753
22.5	4 448	2 307	601	193	176	48	33	7 806
23	2 796	1 069	240	67	31			4 203
23.5	1 600	477	131	11				2 220
24	561	175	19	1				755
24.5	223	79						302
25	47	15						62
25.5	9	10						19
26		3						3
26.5		27						27
27								
27.5								
28								
28.5								
29								
Total	60 395	30 088	19 469	204 035	102 851	36 613	40 710	494 162
Mean L	19.8	19.6	20.4	17.8	19.3	19.8	17.1	18.7
sd	3.91	3.66	2.19	2.06	1.21	1.12	2.16	2.54
Catch	**4 475**	**2371**	**1 598**	**10001**	**6565**	**2364**	**1 838**	**29 212**

Table 8.4.1.2: Sardine in VIIIc and IXa: Catch in numbers (thousands) at age by quarter and by SubDivision in 2003

							First Quarter	
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	0	0	0	0	0	0	0	0
1	0	84.45	20.27	12757.77	6152.18	282.71	12619.88	31917
2	35.07	481.06	65.84	3808.54	27099.61	14908.85	32969.24	79368
3	93.39	1681.5	236.51	3528.71	49220.5	8006.35	8256.75	71024
4	76.23	396.79	39.83	253.13	14315.6	2183.38	793.5	18058
5	40.05	74.25	18.26	60.15	8714.53	3446.39	490.82	12844
6	18.33	53.16	7.97	65.78	4554.13	926.34	118	5744
7	6.43	21.78	1.35	7.15	1500.54	746.1	142.75	2426
8	0.68	0	0	0	519.96	209.72	0	730
9	0.52	0	0	0	243.6	11.44	0	256
10	0	0	0	0	0	61.94	0	62
Total	271	2793	390	20481	112321	30783	55391	222430
Catch (Tons)	23	202	25	611	5914	1708	2601	11083

							Second Quarter	
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	0	0	0	2455	294	0	0	2749
1	12298	475	1840	64524	14723	2767	1800	98428
2	5622	2704	5978	41277	31276	19420	11373	117650
3	5289	9450	21474	61505	31447	6214	5383	140761
4	3361	2230	3616	3102	5195	4735	893	23133
5	1756	417	1658	1096	3677	4960	757	14321
6	706	299	724	207	2032	2874	153	6995
7	298	122	122	18	834	1137	0	2532
8	29	0	0	0	263	614	0	906
9	38	0	0	0	188	239	0	465
10	0	0	0	0	20	79	0	99
Total	29396	15697	35412	174184	89949	43040	20360	408038
Catch (Tons)	1844	1194	2398	7717	5070	2504	1133	21858

							Third Quarter	
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	2595	1963	379	53358	6308	789	50374	115766
1	74	1484	3098	48933	22929	988	11247	88753
2	1682	10457	8201	48757	40152	6747	19904	135901
3	2309	25084	11887	103163	22766	3799	2431	171439
4	3104	5332	3470	14318	7755	4002	608	38590
5	2753	2714	974	2445	4048	3630	98	16662
6	2016	955	495	453	1650	3175	0	8744
7	1151	400	166	76	591	2380	0	4764
8	354	170	0	137	418	1154	0	2233
9	105	62	0	0	0	385	0	551
10	0	0	0	0	133	0	0	133
Total	16142	48621	28670	271640	106750	27051	84661	583535
Catch (Tons)	1593	4734	2362	14965	7086	2025	2912	35678

							Fourth Quarter	
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	10951	8451	2711	38565	2978	1609	14632	79897
1	1510	342	1290	68032	20337	1286	6799	99597
2	13536	4238	3401	35665	30891	11562	14073	113367
3	11411	11219	6699	57166	33318	12335	2917	135066
4	9136	2903	3136	3257	8276	6405	1142	34254
5	6692	1824	1149	1232	3658	2204	690	17448
6	4347	632	786	30	2262	876	318	9253
7	1999	329	296	71	601	297	140	3733
8	650	120	0	16	416	39	0	1241
9	162	31	0	0	0	0	0	193
10	0	0	0	0	114	0	0	114
Total	60395	30088	19469	204035	102851	36613	40710	494161
Catch (Tons)	4475	2371	1598	10001	6565	2364	1838	29212

							Whole Year	
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	13545	10414	3090	94379	9580	2397	65006	198412
1	13882	2385	6248	194247	64141	5325	32466	318695
2	20875	17880	17646	129507	129419	52638	78320	446285
3	19103	47435	40296	225363	136751	30355	18987	518289
4	15678	10862	10262	20930	35542	17325	3436	114035
5	11241	5029	3800	4834	20097	14240	2035	61276
6	7087	1939	2013	756	10498	7852	590	30735
7	3455	873	586	172	3527	4560	282	13455
8	1034	290	0	153	1617	2017	0	5110
9	305	92	0	0	432	636	0	1464
10	0	0	0	0	267	141	0	408
Total	106205	97199	83942	670340	411871	137486	201122	1708164
Catch (Tons)	7935	8500	6383	33293	24635	8600	8484	97831

Table 8.4.1.3: Sardine in VIIIc and IXa. Relative distribution of sardine catches. Upper pannel, relative contribution of each group within each Sub-Division. Lower pannel, relative contribution of each Sub-Division within each Age Group.

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	Xa-S (Ca)	Total
0	13%	11%	4%	14%	2%	2%	32%	12%
1	13%	2%	7%	29%	16%	4%	16%	19%
2	20%	18%	21%	19%	31%	38%	39%	26%
3	18%	49%	48%	34%	33%	22%	9%	30%
4	15%	11%	12%	3%	9%	13%	2%	7%
5	11%	5%	5%	1%	5%	10%	1%	4%
6+	11%	3%	3%	0%	4%	11%	0%	3%
	100%	100%	100%	100%	100%	100%	100%	100%

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	Xa-S (Ca)	Total
0	7%	5%	2%	48%	5%	1%	33%	100%
1	4%	1%	2%	61%	20%	2%	10%	100%
2	5%	4%	4%	29%	29%	12%	18%	100%
3	4%	9%	8%	43%	26%	6%	4%	100%
4	14%	10%	9%	18%	31%	15%	3%	100%
5	18%	8%	6%	8%	33%	23%	3%	100%
6+	23%	6%	5%	2%	32%	30%	2%	100%

Table 8.4.2.1: Sardine VIIIc and IXa: Sardine Mean length at age by quarter and by Subdivision in 2003.

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
							First Quarter	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	17.7	18.4	14.6	16.8	17.7	16.6	15.8
2	20.8	20.3	19.3	17.1	18.4	18.8	17.6	18.1
3	21.7	20.7	19.9	18.5	19.4	19.7	18.9	19.3
4	22.1	21.4	20.6	20.2	20.2	19.9	20.2	20.2
5	22.3	21.9	21.0	21.0	20.7	20.3	20.5	20.6
6	22.4	22.4	21.2	22.0	21.3	20.6	21.3	21.2
7	22.7	23.0	22.8	22.0	21.0	20.8	22.8	21.1
8	23.3	0.0	0.0	0.0	21.2	20.6	0.0	21.0
9	23.1	0.0	0.0	0.0	21.8	22.8	0.0	21.8
10	0.0	0.0	0.0	0.0	0.0	21.3	0.0	21.3

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
							Second Quarter	
0	0.0	0.0	0.0	12.7	14.5	0.0	0.0	12.9
1	16.5	17.7	18.4	16.6	17.1	17.9	17.2	16.8
2	20.1	20.3	19.3	18.0	18.8	18.8	18.0	18.6
3	21.3	20.7	19.9	19.0	19.5	19.4	19.2	19.5
4	21.9	21.4	20.6	19.9	20.2	19.8	20.4	20.5
5	22.2	21.9	21.0	20.7	20.7	20.1	20.6	20.8
6	22.3	22.4	21.2	20.9	21.1	20.4	21.1	21.0
7	23.1	23.0	22.8	21.6	21.4	21.0	0.0	21.6
8	23.5	0.0	0.0	0.0	20.9	21.0	0.0	21.0
9	23.4	0.0	0.0	0.0	20.4	20.9	0.0	20.9
10	0.0	0.0	0.0	0.0	21.8	22.6	0.0	22.5

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
							Third Quarter	
0	13.1	16.5	14.9	14.4	15.6	16.5	13.5	14.1
1	20.4	20.3	19.7	17.6	18.1	18.1	16.8	17.8
2	21.5	21.2	20.0	18.9	19.5	19.3	18.1	19.2
3	21.8	21.4	20.4	19.7	20.0	19.9	18.3	20.0
4	22.3	21.8	20.8	20.4	20.4	20.3	18.5	20.8
5	22.6	22.5	21.2	21.3	20.9	20.5	19.8	21.4
6	22.9	22.9	21.6	21.9	21.1	20.9	0.0	21.7
7	23.5	23.3	21.7	21.3	21.3	21.3	0.0	22.0
8	23.1	23.3	0.0	20.8	21.4	21.7	0.0	21.9
9	23.7	24.3	0.0	0.0	0.0	21.6	0.0	22.3
10	0.0	0.0	0.0	0.0	21.4	0.0	0.0	21.4

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
							Fourth Quarter	
0	11.9	14.0	15.6	14.2	16.4	16.7	14.7	14.2
1	19.9	20.4	19.4	17.7	18.3	18.2	16.7	17.9
2	20.8	21.5	20.9	18.7	19.1	19.5	18.7	19.3
3	21.2	21.7	21.2	19.4	19.8	19.9	19.4	20.0
4	21.9	22.1	21.5	20.5	20.6	20.4	19.7	21.1
5	22.3	22.6	21.7	20.8	20.9	20.8	20.5	21.6
6	22.5	23.0	21.9	22.5	21.1	21.0	20.7	21.9
7	23.4	23.5	22.0	22.5	21.5	21.5	21.2	22.7
8	23.0	23.1	0.0	22.3	21.3	22.3	0.0	22.4
9	23.6	24.3	0.0	0.0	0.0	0.0	0.0	23.7
10	0.0	0.0	0.0	0.0	21.3	0.0	0.0	21.3

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
							Whole Year	
0	12.1	14.4	15.5	14.3	15.8	16.6	13.8	14.1
1	16.9	19.7	19.2	17.1	17.8	18.0	16.7	17.3
2	20.7	21.1	20.0	18.5	19.0	19.0	18.0	18.9
3	21.3	21.3	20.3	19.4	19.6	19.8	19.0	19.8
4	22.0	21.8	21.0	20.4	20.4	20.2	19.8	20.7
5	22.3	22.5	21.3	21.0	20.8	20.3	20.5	21.2
6	22.6	22.9	21.6	21.6	21.2	20.7	20.9	21.5
7	23.4	23.3	22.1	21.8	21.2	21.1	22.0	22.0
8	23.1	23.2	0.0	20.9	21.2	21.4	0.0	21.8
9	23.6	24.3	0.0	0.0	21.2	21.4	0.0	22.0
10	0.0	0.0	0.0	0.0	21.4	22.0	0.0	21.6

Table 8.4.2.2: Sardine VIIIc and Ixa: Sardine Mean weight at age by quarter and by SubDivision in 2003

First Quarter

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.000	0.047	0.052	0.023	0.035	0.042	0.040	0.032
2	0.072	0.068	0.060	0.036	0.046	0.051	0.046	0.047
3	0.081	0.072	0.064	0.046	0.053	0.058	0.057	0.054
4	0.085	0.079	0.071	0.059	0.059	0.059	0.067	0.060
5	0.088	0.083	0.075	0.066	0.064	0.063	0.070	0.064
6	0.088	0.088	0.076	0.076	0.068	0.066	0.077	0.068
7	0.091	0.095	0.093	0.076	0.066	0.068	0.092	0.068
8	0.097	0.000	0.000	0.000	0.067	0.066	0.000	0.067
9	0.095	0.000	0.000	0.000	0.072	0.088	0.000	0.073
10	0.000	0.000	0.000	0.000	0.000	0.072	0.000	0.072

Second Quarter

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
0	0.000	0.000	0.000	0.016	0.023	0.000	0.000	0.016
1	0.041	0.049	0.054	0.035	0.040	0.049	0.045	0.038
2	0.070	0.072	0.063	0.045	0.054	0.054	0.052	0.052
3	0.082	0.076	0.068	0.053	0.060	0.059	0.062	0.060
4	0.087	0.083	0.075	0.061	0.069	0.062	0.073	0.071
5	0.092	0.088	0.079	0.069	0.074	0.064	0.074	0.073
6	0.093	0.094	0.080	0.071	0.079	0.066	0.080	0.076
7	0.102	0.100	0.099	0.078	0.082	0.071	0.000	0.081
8	0.106	0.000	0.000	0.000	0.076	0.071	0.000	0.074
9	0.105	0.000	0.000	0.000	0.070	0.070	0.000	0.073
10	0.000	0.000	0.000	0.000	0.086	0.085	0.000	0.085

Third Quarter

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
0	0.020	0.042	0.030	0.025	0.034	0.046	0.022	0.025
1	0.084	0.082	0.075	0.048	0.054	0.058	0.044	0.051
2	0.100	0.096	0.079	0.059	0.068	0.068	0.057	0.067
3	0.105	0.098	0.084	0.068	0.074	0.073	0.059	0.075
4	0.112	0.104	0.090	0.077	0.079	0.077	0.061	0.085
5	0.117	0.116	0.095	0.088	0.085	0.078	0.075	0.095
6	0.123	0.124	0.101	0.096	0.088	0.082	0.000	0.099
7	0.134	0.130	0.104	0.087	0.091	0.086	0.000	0.103
8	0.127	0.132	0.000	0.081	0.092	0.090	0.000	0.099
9	0.137	0.150	0.000	0.000	0.000	0.090	0.000	0.105
10	0.000	0.000	0.000	0.000	0.092	0.000	0.000	0.092

Fourth Quarter

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
0	0.013	0.021	0.031	0.022	0.038	0.040	0.026	0.022
1	0.073	0.080	0.068	0.046	0.052	0.051	0.040	0.048
2	0.085	0.096	0.087	0.056	0.061	0.062	0.059	0.064
3	0.091	0.099	0.091	0.064	0.068	0.066	0.067	0.072
4	0.102	0.105	0.096	0.077	0.078	0.070	0.070	0.086
5	0.108	0.115	0.100	0.081	0.082	0.074	0.081	0.095
6	0.112	0.121	0.102	0.107	0.084	0.076	0.083	0.101
7	0.129	0.132	0.104	0.107	0.089	0.081	0.090	0.115
8	0.121	0.123	0.000	0.102	0.087	0.089	0.000	0.109
9	0.133	0.146	0.000	0.000	0.000	0.000	0.000	0.136
10	0.000	0.000	0.000	0.000	0.086	0.000	0.000	0.086

Whole Year

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
0	0.014	0.025	0.031	0.024	0.035	0.042	0.023	0.024
1	0.045	0.074	0.067	0.042	0.048	0.051	0.042	0.044
2	0.082	0.091	0.075	0.053	0.059	0.057	0.052	0.059
3	0.090	0.093	0.076	0.062	0.062	0.063	0.060	0.067
4	0.101	0.099	0.086	0.075	0.069	0.068	0.068	0.079
5	0.108	0.113	0.089	0.082	0.073	0.069	0.075	0.084
6	0.113	0.118	0.094	0.088	0.077	0.074	0.081	0.089
7	0.128	0.126	0.103	0.094	0.078	0.079	0.091	0.096
8	0.123	0.128	0.000	0.083	0.080	0.082	0.000	0.092
9	0.131	0.149	0.000	0.000	0.072	0.082	0.000	0.094
10	0.000	0.000	0.000	0.000	0.089	0.079	0.000	0.086

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
0	449115	246016	489836	219973	106882	198412
1	366176	475225	354822	1172301	587354	318695
2	501585	361509	313972	256133	753897	446285
3	352485	339691	255523	195897	181381	518289
4	233672	177170	194156	126389	112166	114035
5	178735	105518	97693	75145	55650	61276
6	105884	72541	64373	49547	40219	51172

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
0							
1	509838	214525	91656	975603	270396	42375	48112
2	103126	160375	285808	262883	760203	773772	294539
3	80396	134618	435440	186538	448599	1041239	799358
4	33762	124313	242249	142929	651658	459583	1389017
5	20590	28357	188879	98945	318591	209138	327355
6	25410	64013	68124	66062	163290	136528	312474

Table 8.8.1.1c : 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
0						
1	1636191	5711743	6581454	18684340	12770161	5842158
2	4014982	2552623	2169927	774490	6237872	3810357
3	2190882	1460677	1221678	515440	715509	2526697
4	1433972	844435	756681	337330	479319	549396
5	1185007	595713	531945	275530	246956	361164
6	979993	469137	613224	183680	278741	201548

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	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6+
1978	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1979	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1980	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1981	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1982	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1983	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1984	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1985	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1986	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1987	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1988	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1989	0.013	0.035	0.052	0.059	0.066	0.071	0.100
1990	0.024	0.032	0.047	0.057	0.061	0.067	0.100
1991	0.020	0.031	0.058	0.063	0.073	0.074	0.100
1992	0.018	0.045	0.055	0.066	0.070	0.079	0.100
1993	0.017	0.037	0.051	0.058	0.066	0.071	0.100
1994	0.020	0.036	0.058	0.062	0.070	0.076	0.100
1995	0.025	0.047	0.059	0.066	0.071	0.082	0.100
1996	0.019	0.038	0.051	0.058	0.061	0.071	0.100
1997	0.022	0.033	0.052	0.062	0.069	0.073	0.100
1998	0.024	0.040	0.055	0.061	0.064	0.067	0.100
1999	0.025	0.042	0.056	0.065	0.070	0.073	0.100
2000	0.025	0.037	0.056	0.066	0.071	0.074	0.100
2001	0.023	0.042	0.059	0.067	0.075	0.079	0.100
2002	0.028	0.045	0.057	0.069	0.075	0.079	0.100
2003	0.024	0.044	0.059	0.067	0.079	0.084	0.100

Table 8.8.1.1f: Sardine VIIIc and IXa: Input to the AMCI assessment model: Mean weight in the Stock (kg)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6+
1978	0	0.015	0.038	0.05	0.064	0.067	0.1
1979	0	0.015	0.038	0.05	0.064	0.067	0.1
1980	0	0.015	0.038	0.05	0.064	0.067	0.1
1981	0	0.015	0.038	0.05	0.064	0.067	0.1
1982	0	0.015	0.038	0.05	0.064	0.067	0.1
1983	0	0.015	0.038	0.05	0.064	0.067	0.1
1984	0	0.015	0.038	0.05	0.064	0.067	0.1
1985	0	0.015	0.038	0.05	0.064	0.067	0.1
1986	0	0.015	0.038	0.05	0.064	0.067	0.1
1987	0	0.015	0.038	0.05	0.064	0.067	0.1
1988	0	0.015	0.038	0.05	0.064	0.067	0.1
1989	0	0.015	0.038	0.05	0.064	0.067	0.1
1990	0	0.015	0.038	0.05	0.064	0.067	0.1
1991	0	0.019	0.042	0.05	0.064	0.071	0.1
1992	0	0.027	0.036	0.05	0.062	0.069	0.1
1993	0	0.022	0.045	0.057	0.064	0.073	0.1
1994	0	0.031	0.04	0.049	0.06	0.067	0.1
1995	0	0.029	0.05	0.062	0.072	0.079	0.1
1996	0	0.036	0.047	0.061	0.069	0.075	0.1
1997	0	0.025	0.05	0.058	0.068	0.074	0.1
1998	0	0.023	0.041	0.053	0.061	0.067	0.1
1999	0	0.02	0.039	0.054	0.062	0.068	0.1
2000	0	0.017	0.043	0.059	0.064	0.067	0.1
2001	0	0.017	0.042	0.058	0.075	0.08	0.1
2002	0	0.02	0.044	0.06	0.071	0.078	0.1
2003	0	0.027	0.054	0.064	0.075	0.082	0.1

Table 8.8.1.1g: Sardine VIIIc and IXa: Input to the AMCI assessment model: Maturity ogive

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6+
1978	0	0.65	0.95	1.00	1.00	1.00	1.00
1979	0	0.65	0.95	1.00	1.00	1.00	1.00
1980	0	0.65	0.95	1.00	1.00	1.00	1.00
1981	0	0.65	0.95	1.00	1.00	1.00	1.00
1982	0	0.65	0.95	1.00	1.00	1.00	1.00
1983	0	0.65	0.95	1.00	1.00	1.00	1.00
1984	0	0.65	0.95	1.00	1.00	1.00	1.00
1985	0	0.65	0.95	1.00	1.00	1.00	1.00
1986	0	0.65	0.95	1.00	1.00	1.00	1.00
1987	0	0.65	0.95	1.00	1.00	1.00	1.00
1988	0	0.65	0.95	1.00	1.00	1.00	1.00
1989	0	0.23	0.83	0.91	0.92	0.94	0.98
1990	0	0.60	0.81	0.88	0.89	0.94	0.99
1991	0	0.74	0.91	0.96	0.97	1.00	1.00
1992	0	0.79	0.91	0.95	0.98	1.00	1.00
1993	0	0.47	0.93	0.94	0.97	0.99	1.00
1994	0	0.80	0.89	0.96	0.96	0.97	1.00
1995	0	0.73	0.98	0.97	0.99	1.00	1.00
1996	0	0.83	0.89	0.92	0.96	1.00	1.00
1997	0	0.73	0.92	0.95	0.97	0.99	1.00
1998	0	0.72	0.92	0.96	0.99	1.00	1.00
1999	0	0.62	0.91	0.99	1.00	1.00	1.00
2000	0	0.26	0.91	0.95	0.95	1.00	1.00
2001	0	0.39	0.90	0.96	0.99	1.00	1.00
2002	0	0.50	0.94	0.96	0.99	0.99	1.00
2003	0	0.50	0.96	0.99	1.00	1.00	1.00

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)	Catch
1978	11087520	276586	0.41	173761
1979	12623630	337132	0.42	162454
1980	14021863	411265	0.31	204861
1981	9298813	510092	0.37	242574
1982	6701152	534726	0.35	214148
1983	19112087	493055	0.31	176636
1984	7093281	545527	0.28	215114
1985	6002778	635725	0.27	219928
1986	5100070	571684	0.35	192838
1987	9091356	472344	0.34	176283
1988	5455745	414408	0.35	157273
1989	5532172	349393	0.38	146539
1990	5090210	315203	0.46	142966
1991	12128073	320688	0.34	132785
1992	10439439	435056	0.30	131196
1993	4550642	492864	0.36	144949
1994	4432302	505885	0.25	138725
1995	3798731	556956	0.26	126755
1996	4700456	480671	0.27	115179
1997	3702630	417053	0.35	117250
1998	3886240	342542	0.41	112033
1999	3798675	289359	0.37	95793
2000	12870806	251913	0.36	87272
2001	8985084	302281	0.27	102903
2002	5356580	503120	0.21	101741
2003	5035072	668095	0.20	99113

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	0.07	0.05	0.07	0.05	0.05	0.04	0.04	0.05	0.07
1	0.28	0.28	0.21	0.25	0.22	0.18	0.18	0.16	0.20	0.18
2	0.43	0.42	0.34	0.41	0.39	0.33	0.28	0.28	0.35	0.33
3	0.41	0.41	0.29	0.36	0.34	0.31	0.28	0.28	0.33	0.34
4	0.39	0.42	0.30	0.34	0.34	0.30	0.26	0.26	0.36	0.33
5	0.39	0.43	0.29	0.36	0.34	0.30	0.28	0.27	0.35	0.35
6	0.38	0.41	0.28	0.36	0.39	0.36	0.32	0.28	0.33	0.31

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	0.07	0.07	0.07	0.07	0.06	0.05	0.03	0.03	0.03	0.04
1	0.19	0.19	0.21	0.15	0.14	0.14	0.07	0.07	0.06	0.10
2	0.33	0.34	0.37	0.26	0.23	0.25	0.15	0.15	0.15	0.21
3	0.36	0.39	0.45	0.36	0.32	0.39	0.27	0.29	0.32	0.39
4	0.37	0.39	0.51	0.37	0.34	0.40	0.30	0.32	0.35	0.47
5	0.35	0.42	0.52	0.38	0.33	0.39	0.27	0.27	0.26	0.33
6	0.34	0.35	0.42	0.30	0.27	0.30	0.19	0.20	0.18	0.20

Age	1998	1999	2000	2001	2002	2003
0	0.06	0.05	0.05	0.03	0.02	0.02
1	0.12	0.12	0.12	0.10	0.09	0.08
2	0.24	0.22	0.21	0.16	0.13	0.12
3	0.43	0.37	0.35	0.26	0.20	0.19
4	0.51	0.46	0.43	0.32	0.25	0.24
5	0.45	0.42	0.43	0.32	0.26	0.24
6	0.20	0.17	0.16	0.12	0.10	0.09

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	11087520	12623631	14021864	9298814	6701152	19112088	7093282	6002779	5100071	9091357
1	7140867	8761394	10014893	11308347	7346180	5391141	15459506	5799368	4911911	4129522
2	3396393	3862752	4763179	5808131	6311803	4253713	3246005	9242953	3542080	2890691
3	1160187	1586702	1817566	2443269	2762594	3066741	2205943	1771444	5044959	1790515
4	542700	555555	756546	974194	1221942	1411743	1618885	1192681	957817	2607677
5	161276	264140	262760	403746	496788	627689	755227	894616	659232	481842
6	62654	109078	176332	236606	321339	411348	540949	692754	867574	783603

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	5455746	5532173	5090211	12128073	10439440	4550642	4432303	3798732	4700456	3702631
1	7203940	4292078	4378740	4019658	9603878	8365988	3662946	3648119	3140438	3865962
2	2468149	4284602	2548410	2544031	2475014	6031524	5242648	2450750	2440699	2119300
3	1495639	1270342	2202222	1268970	1409200	1411790	3367193	3247329	1513902	1507644
4	918282	746529	618629	1004989	638482	737971	689841	1845071	1741752	793320
5	1354427	457954	364445	268381	499242	326367	354971	367772	966859	886734
6	657850	1021640	735695	504594	400286	479196	413137	439841	461112	812213

Age	1998	1999	2000	2001	2002	2003
0	3886241	3798676	12870806	8985084	5356580	5035073
1	3014959	3107206	3050561	10398956	7367320	4429736
2	2521333	1927699	1975337	1937299	6741273	4861920
3	1240495	1431231	1112819	1150173	1184742	4249756
4	737437	582507	708582	562823	638452	693995
5	357288	317618	264980	330706	292708	356376
6	938227	714016	581953	479528	476390	472496

Table 8.9.1.1. Sardine VIIIc and IXa. Input data for the deterministic short term prediction.

MFDP version 1a
Run: ST_sar01
Time and date: 15:58 15/09/04
Fbar age range: 2-5

2004								
Age	Stock Size	Natural mortality	Maturity ogive	Prop. of F bef. spaw	Prop. of M bef. spaw	Weight in stock	Exploit. pattern	Weight in catch
0	6858066	0.33	0.00	0.25	0.25	0.000	0.024	0.025
1	4170318	0.33	0.50	0.25	0.25	0.021	0.083	0.044
2	2938889	0.33	0.96	0.25	0.25	0.047	0.127	0.058
3	3090083	0.33	0.99	0.25	0.25	0.061	0.198	0.068
4	2521248	0.33	1.00	0.25	0.25	0.074	0.245	0.076
5	393510	0.33	1.00	0.25	0.25	0.080	0.249	0.081
6	510475	0.33	1.00	0.25	0.25	0.100	0.097	0.100

2005								
Age	Stock Size	Natural mortality	Maturity ogive	Prop. of F bef. spaw	Prop. of M bef. spaw	Weight in stock	Exploit. pattern	Weight in catch
0	6858066	0.33	0.00	0.25	0.25	0.000	0.024	0.025
1	.	0.33	0.50	0.25	0.25	0.021	0.083	0.044
2	.	0.33	0.96	0.25	0.25	0.047	0.127	0.058
3	.	0.33	0.99	0.25	0.25	0.061	0.198	0.068
4	.	0.33	1.00	0.25	0.25	0.074	0.245	0.076
5	.	0.33	1.00	0.25	0.25	0.080	0.249	0.081
6	.	0.33	1.00	0.25	0.25	0.100	0.097	0.100

2006								
Age	Stock Size	Natural mortality	Maturity ogive	Prop. of F bef. spaw	Prop. of M bef. spaw	Weight in stock	Exploit. pattern	Weight in catch
0	6858066	0.33	0.00	0.25	0.25	0.000	0.024	0.025
1	.	0.33	0.50	0.25	0.25	0.021	0.083	0.044
2	.	0.33	0.96	0.25	0.25	0.047	0.127	0.058
3	.	0.33	0.99	0.25	0.25	0.061	0.198	0.068
4	.	0.33	1.00	0.25	0.25	0.074	0.245	0.076
5	.	0.33	1.00	0.25	0.25	0.080	0.249	0.081
6	.	0.33	1.00	0.25	0.25	0.100	0.097	0.100

Input units are thousands and kg - output in tonnes

Table 8.9.1.2. Sardine VIIIc and IXa. Short term prediction with management option table.

MFDP version 1a
Run: ST_sar01
Sardine (VIIIc+IXa), 2004 WG
Time and date: 15:58 15/09/04
Fbar age range: 2-5

Basis for 2004: Fsq = F(2002-03) unscaled; Recruitment 2004 to 2006: GM 1978-2003 = 6858 millions

2004					2005					2006	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
681840	553798	1	0.205	111553	647315	542795	0.0	0.000	0	732051	618603
					.	540302	0.1	0.021	11400	721574	606619
					.	537821	0.2	0.041	22602	711293	594909
					.	535353	0.3	0.062	33611	701204	583467
					.	532897	0.4	0.082	44429	691302	572287
					.	530454	0.5	0.103	55062	681584	561360
					.	528024	0.6	0.123	65512	672046	550682
					.	525606	0.7	0.144	75784	662684	540246
					.	523200	0.8	0.164	85880	653494	530046
					.	520807	0.9	0.185	95805	644473	520075
					.	518426	1.0	0.205	105562	635618	510329
					.	516057	1.1	0.226	115154	626924	500802
					.	513700	1.2	0.246	124585	618388	491488
					.	511355	1.3	0.267	133858	610008	482382
					.	509023	1.4	0.287	142975	601779	473479
					.	506702	1.5	0.307	151941	593700	464773
					.	504393	1.6	0.328	160757	585766	456261
					.	502096	1.7	0.348	169428	577974	447936
					.	499810	1.8	0.369	177955	570323	439796
					.	497536	1.9	0.389	186342	562808	431834
					.	495274	2.0	0.410	194592	555427	424047

Input units are thousands and kg - output in tonnes

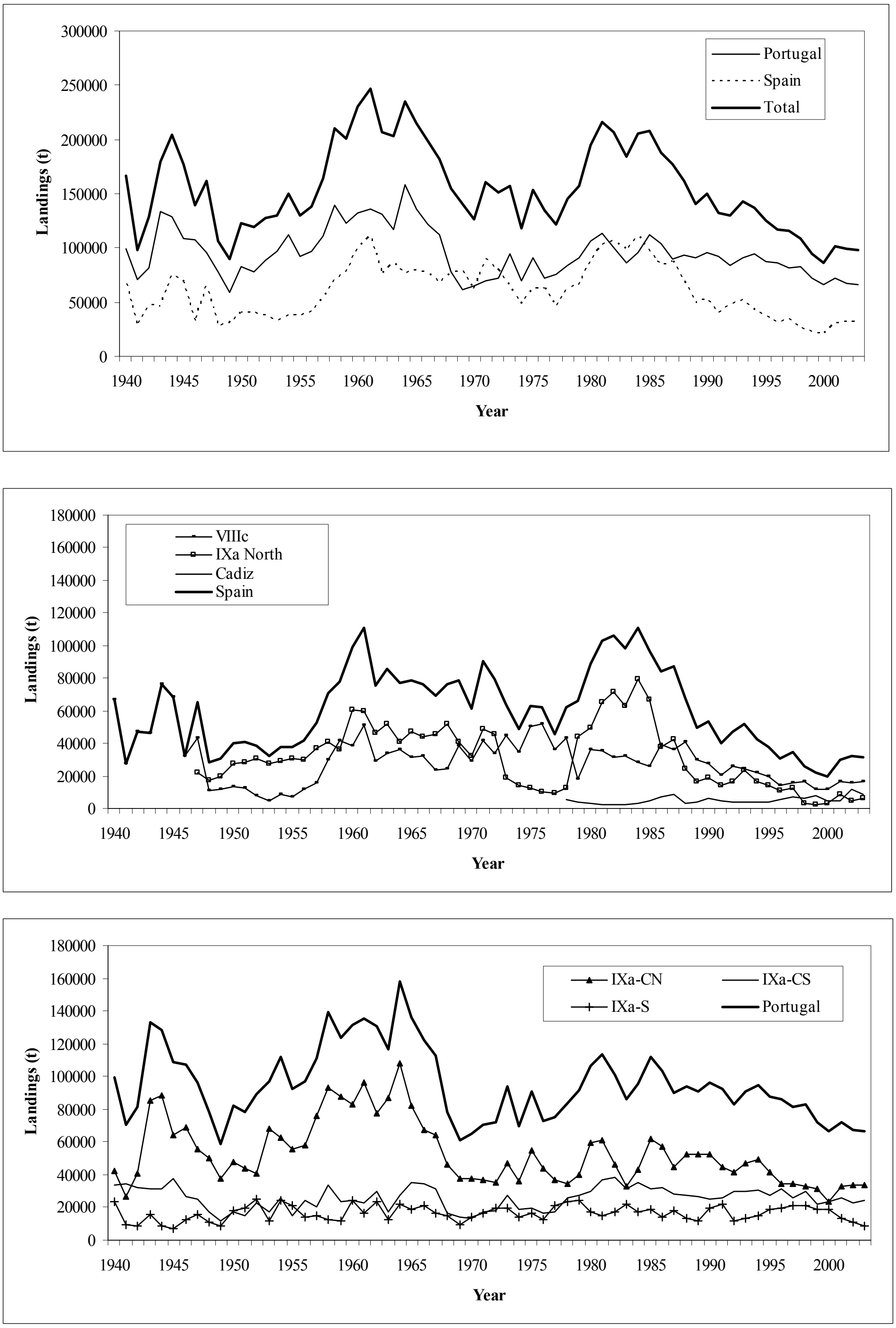


Figure 8.2.1: Sardine in VIIIc and IXa: Annual landings of sardine, by country (upper pannel) and by ICES Sub-Division and country

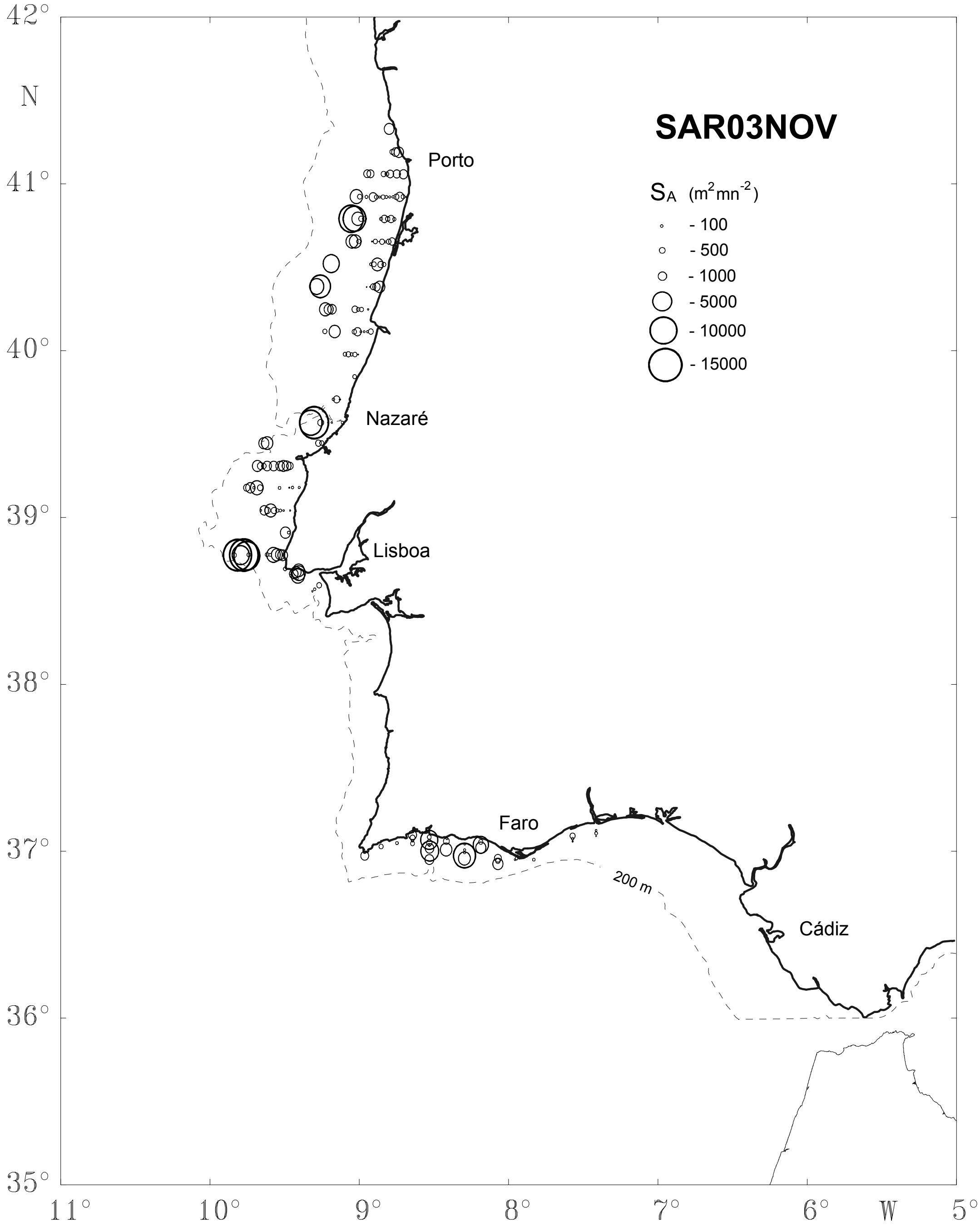


Figure 8.3.2.1 – Sardine in VIIIc and IXa: Portuguese November acoustic survey in 2003: sardine acoustic energy per nautical mile. Circle diameter is proportional to the square root of the acoustic energy (SA m2/nm2).

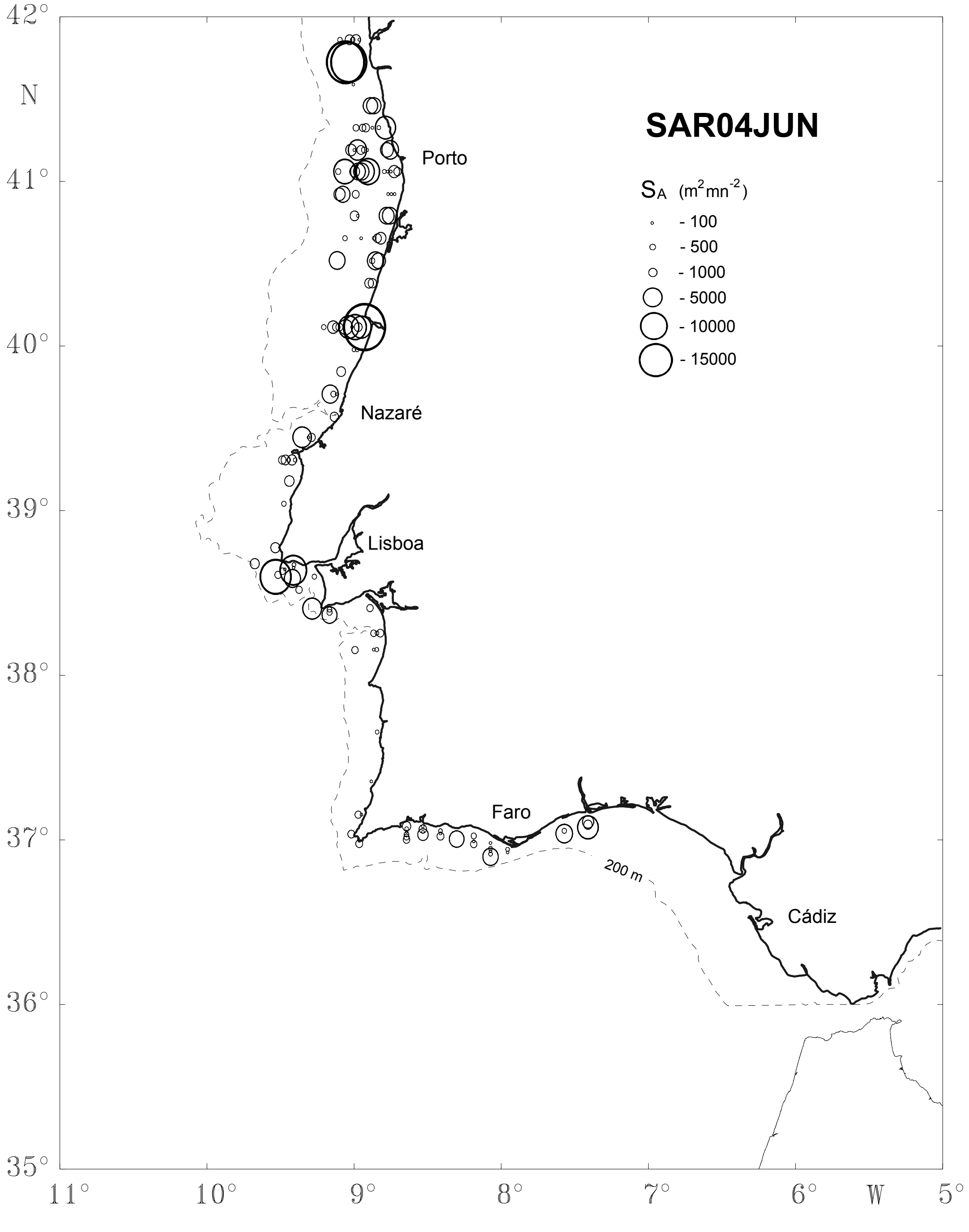
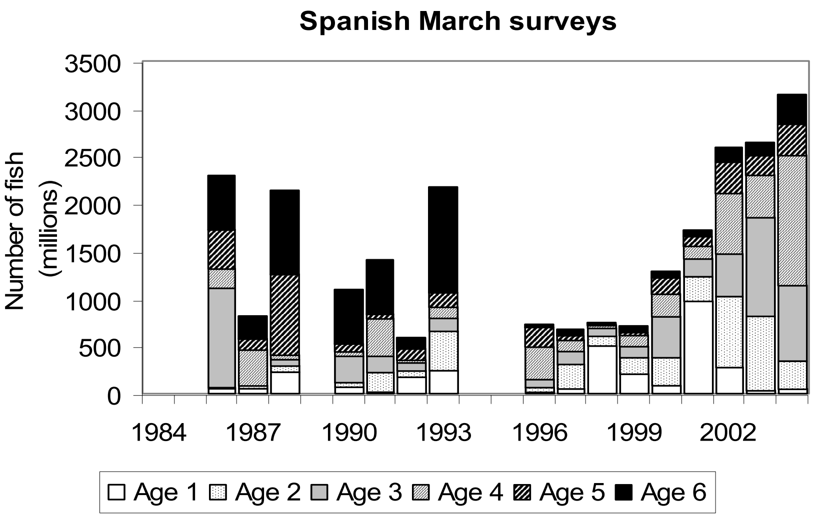
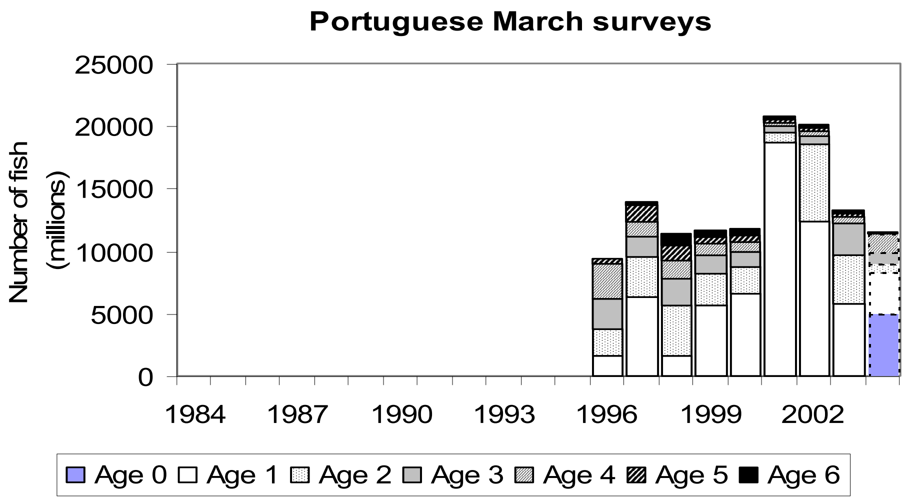


Figure 8.3.2.2 – Sardine in VIIIc and IXa: Portuguese June acoustic survey in 2004: sardine acoustic energy per nautical mile and abundance by area, in number and biomass. Circle diameter is proportional to the square root of the acoustic energy (SA m2/nm2).





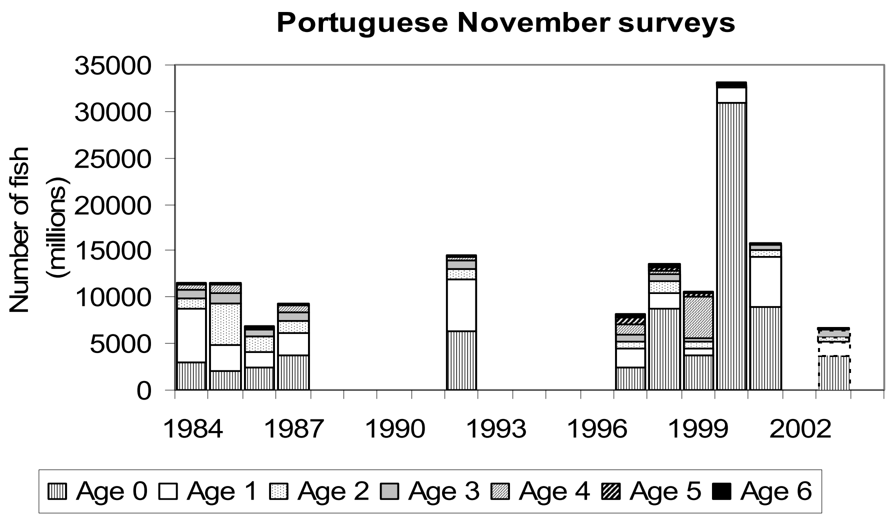


Figure 8.3.2.3 – Sardine in VIIIc and IXa: Total abundance and age structure (numbers) of sardine estimated in the acoustic surveys. The Spanish March survey series covers area VIIIc and IXa-N (Galicia), the Portuguese March surveys covers the Portuguese area and the Gulf of Cadiz (Subdivisions IXa-CN, 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.

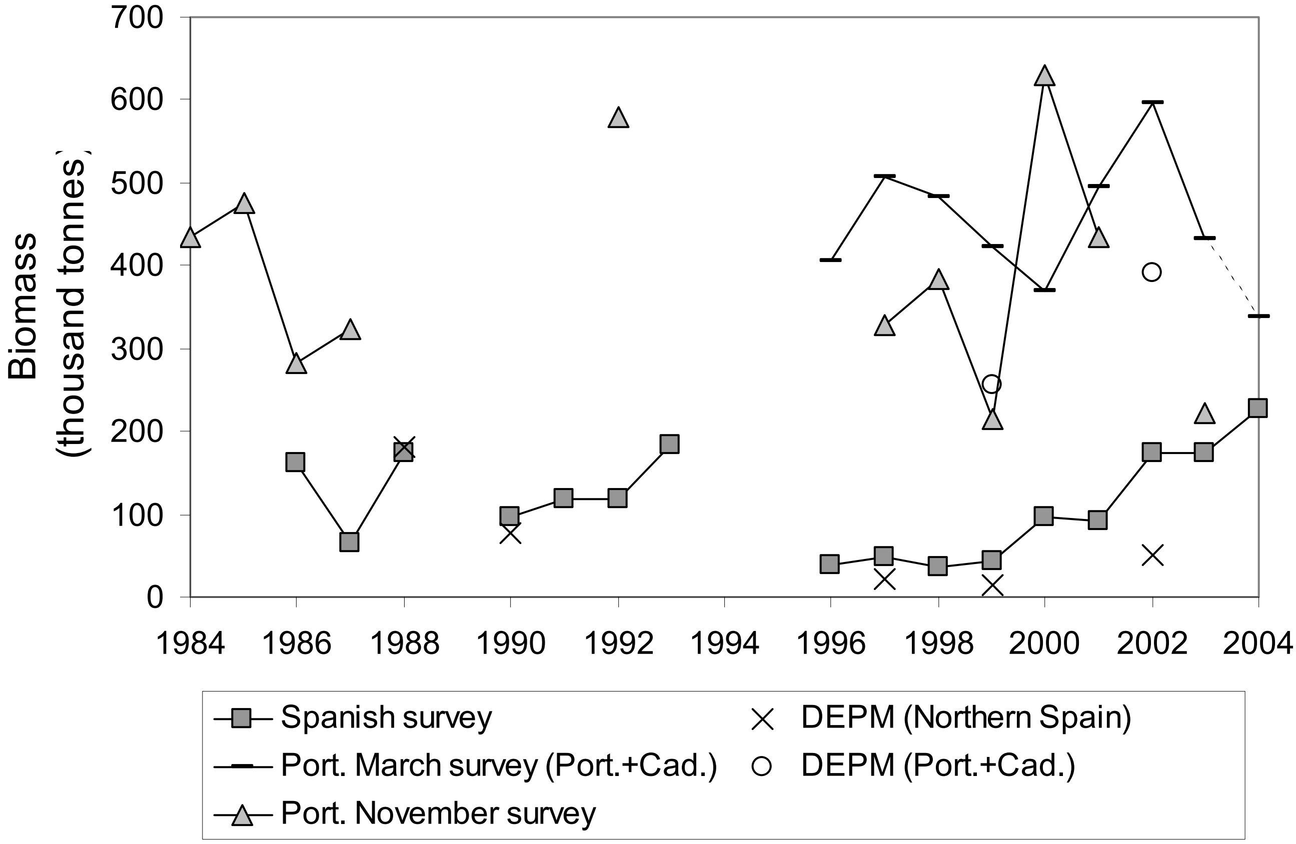


Figure 8.3.2.4 - Sardine in VIIIc and IXa: Total sardine biomass (thousand tonnes) estimated in the different series of acoustic surveys and SSB estimates from the DEPM series covering the northern area and the west and southern area of the stock.

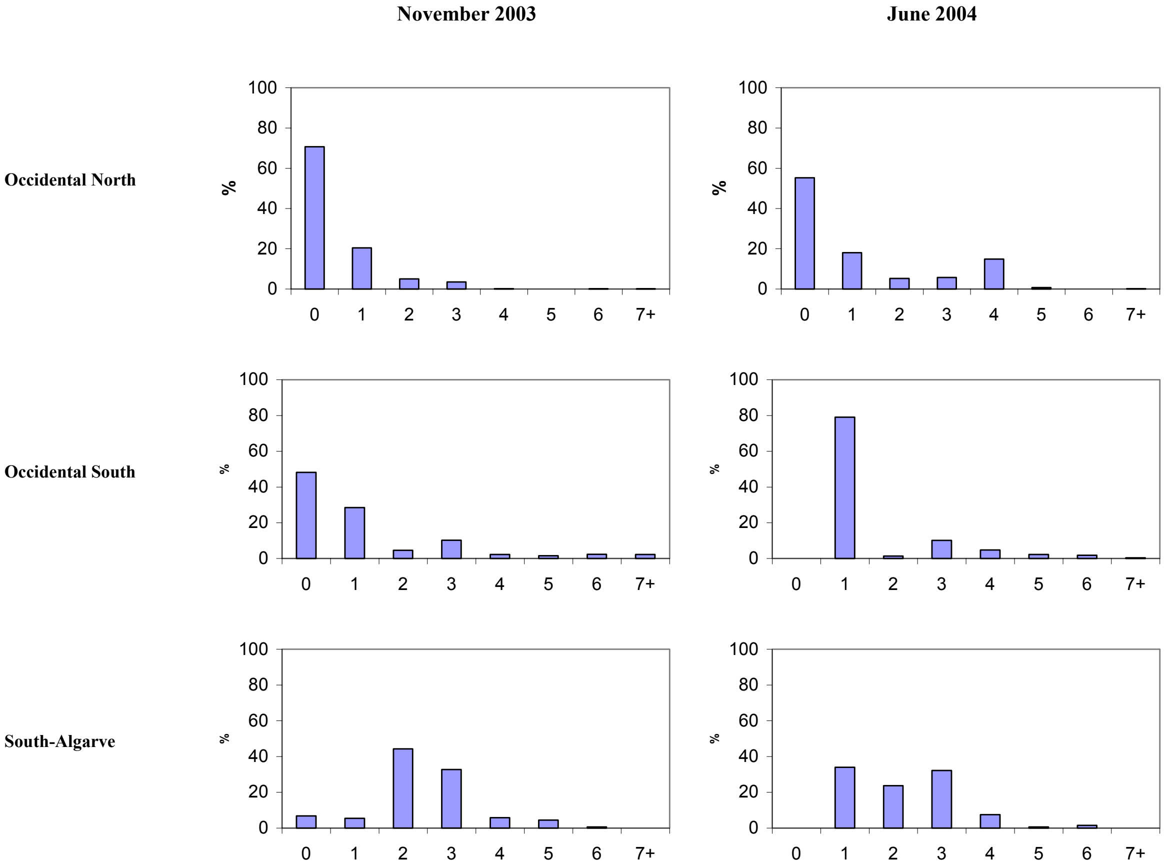
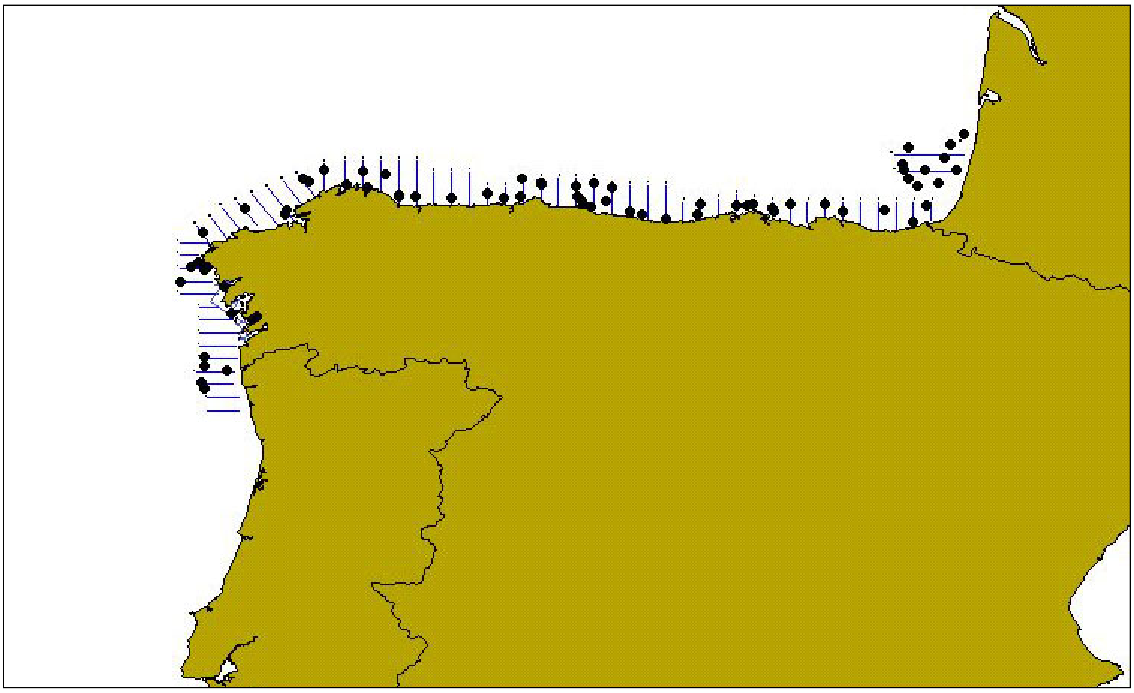


Figure 8.3.2.5: Sardine in VIIIc and IXa: Sardine relative abundance at age (%) by area, estimated in Portuguese acoustic surveys of November 2003 and June 2004.



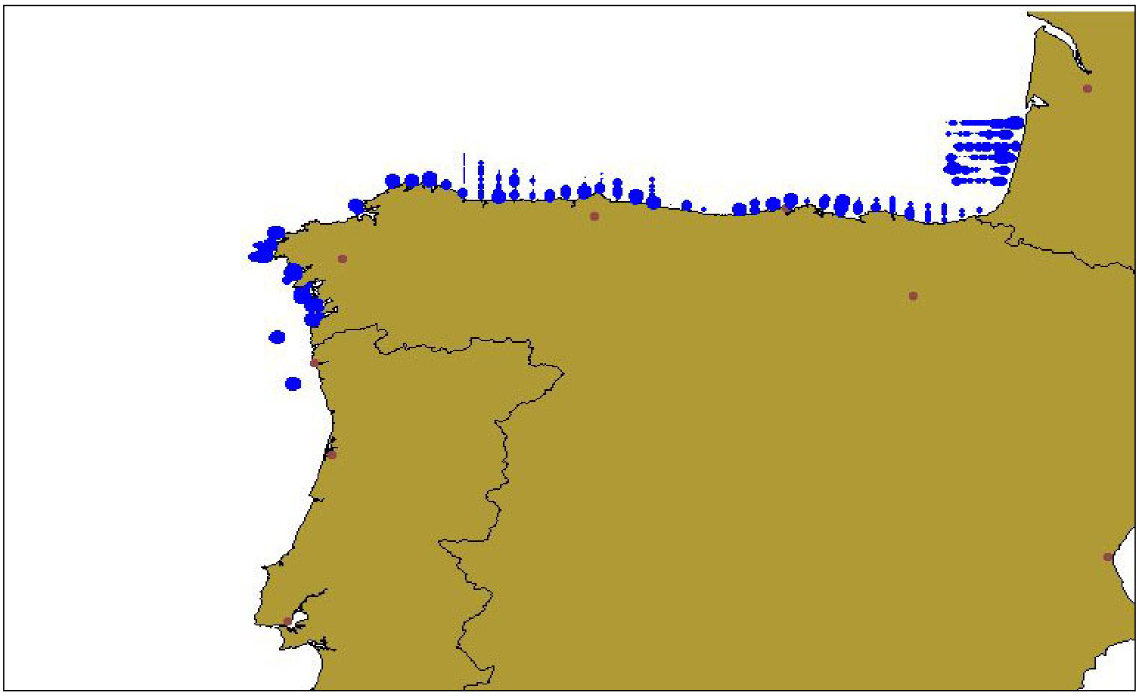


Figure 8.3.2.6. Sardine in VIIIc and IXa: Cruise tracks, fishing stations and sardine distribution as observed in the Spanish acoustic survey in 2004.

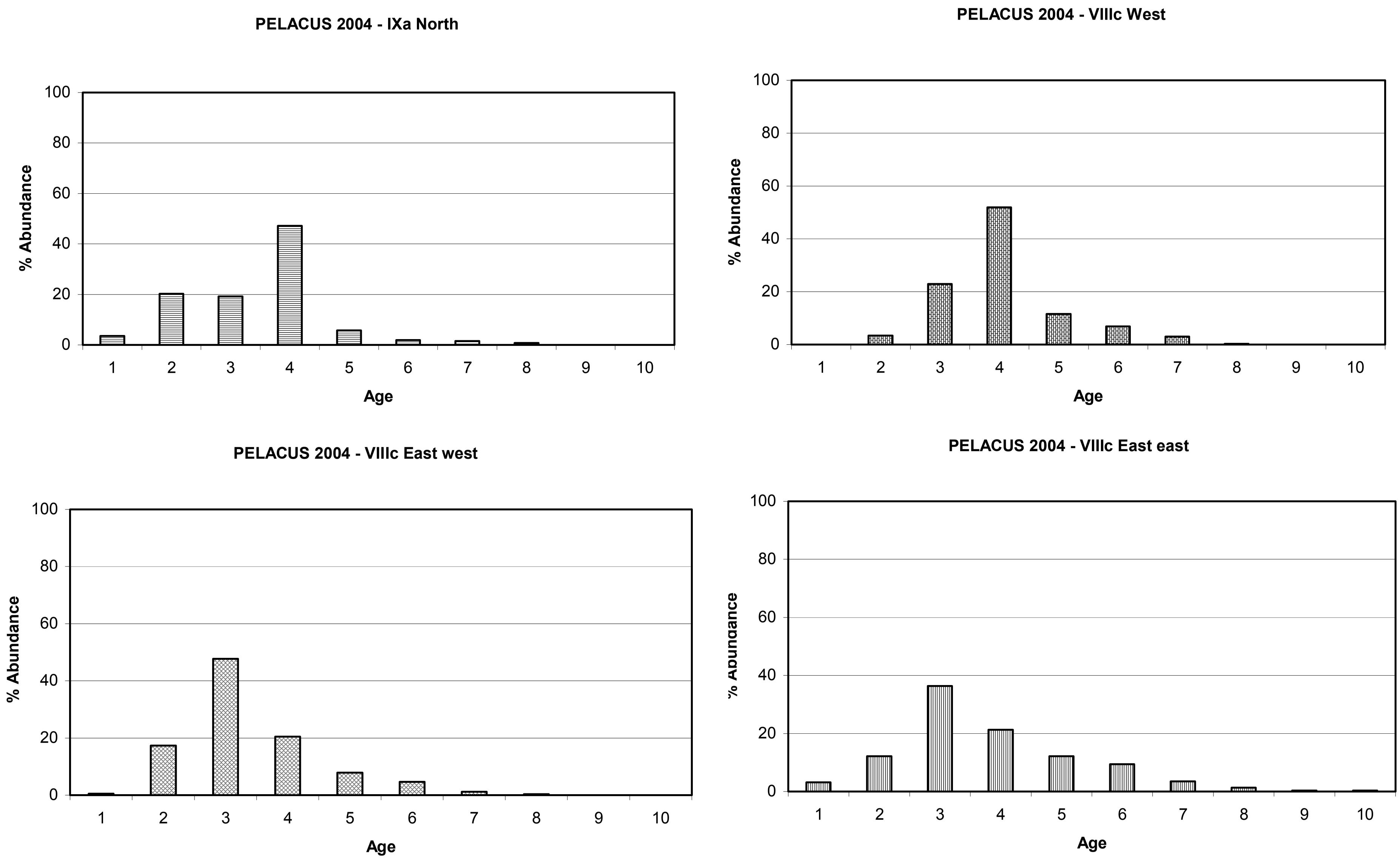


Figure 8.3.2.7. Sardine in VIIIc and IXa: Sardine relative abundance at age (percentage by area) as estimated in the Spanish acoustic survey.

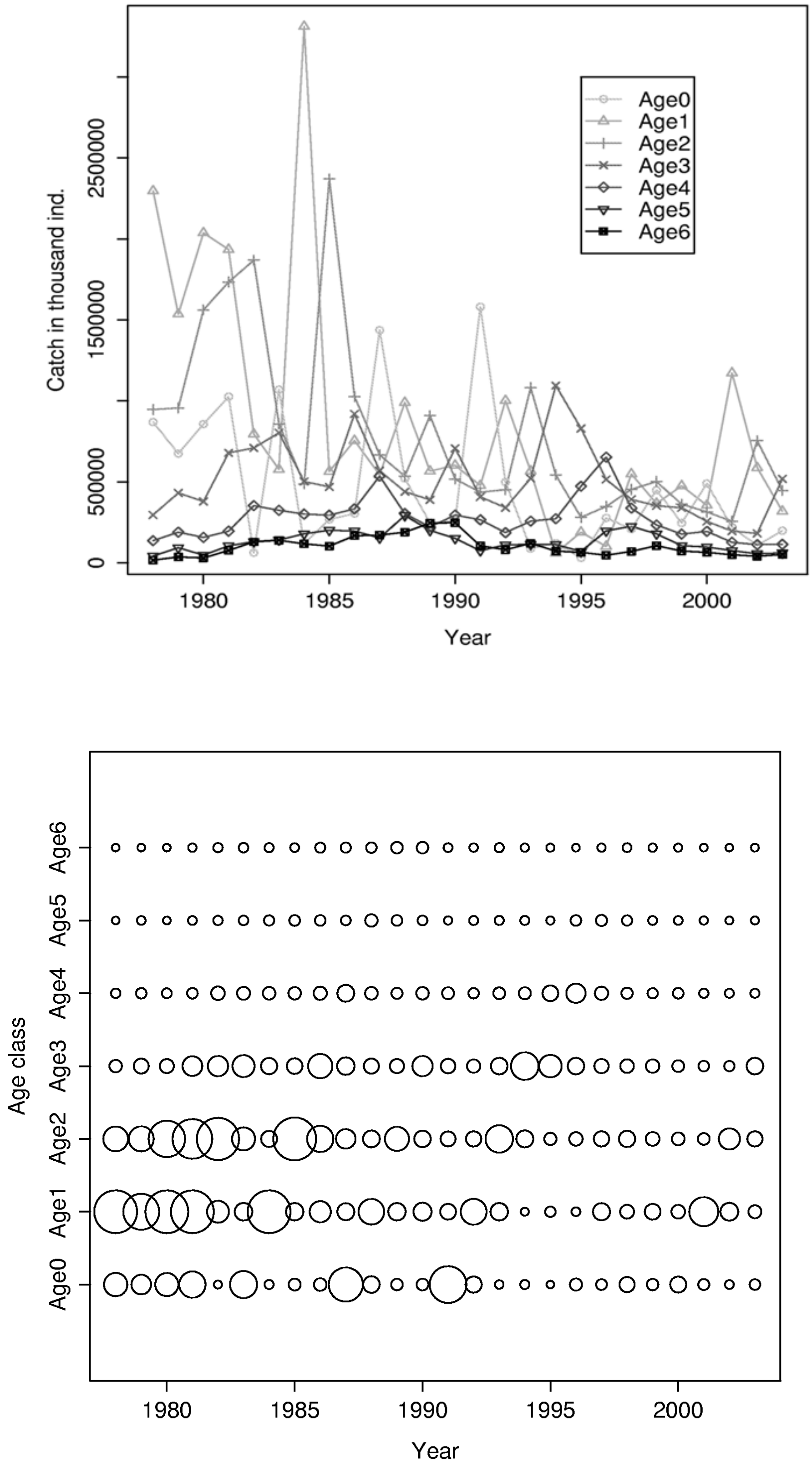


Figure 8.7.1: Sardine VIIIc and IXa: Assessment input data (I) Catch at age for the whole stock. Top panel; Abundance represented by lines. Bottom panel; bubble size proportional to catch numbers for each age and year.

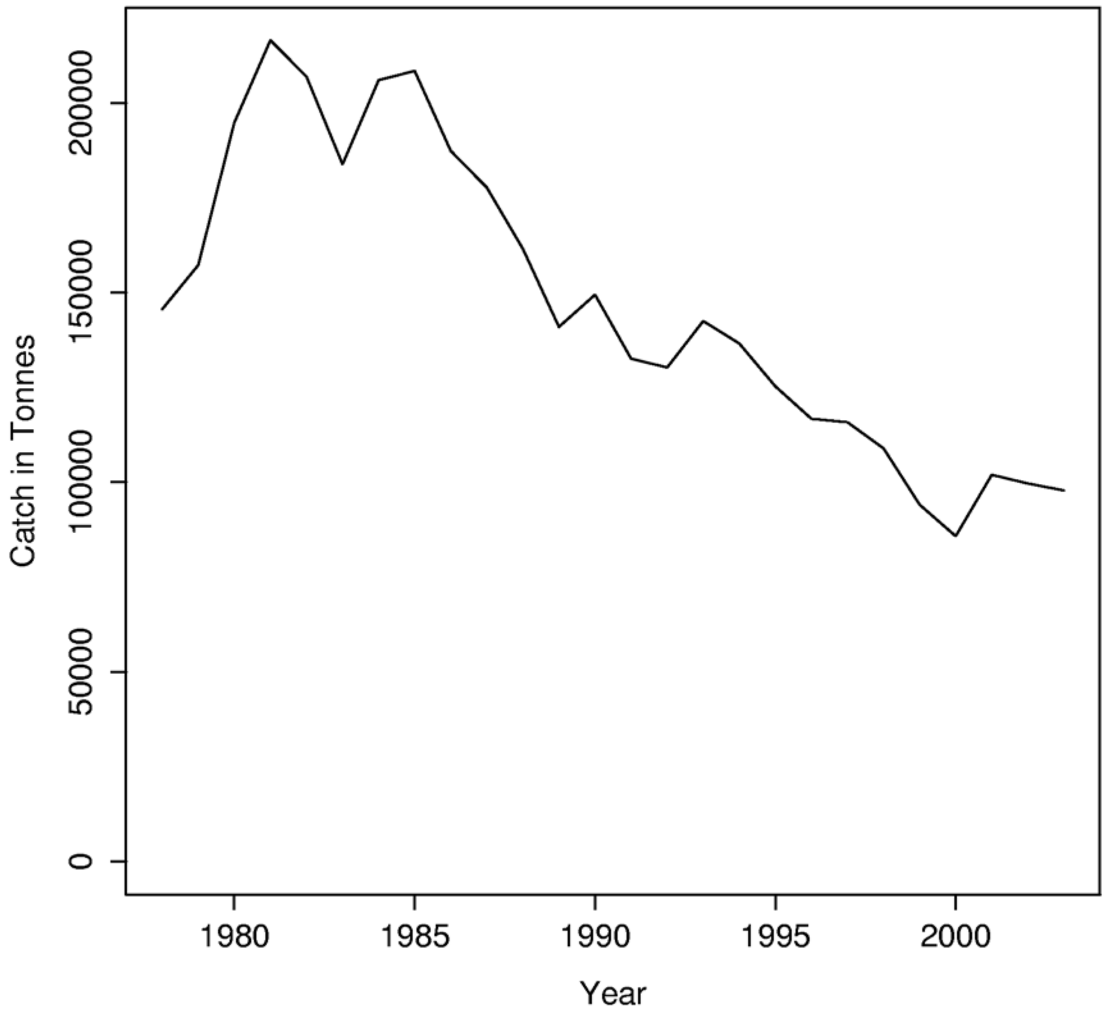


Figure 8.7.2: Sardine VIIIc and IXa: Assessment input data (II): Evolution of catches in weight.

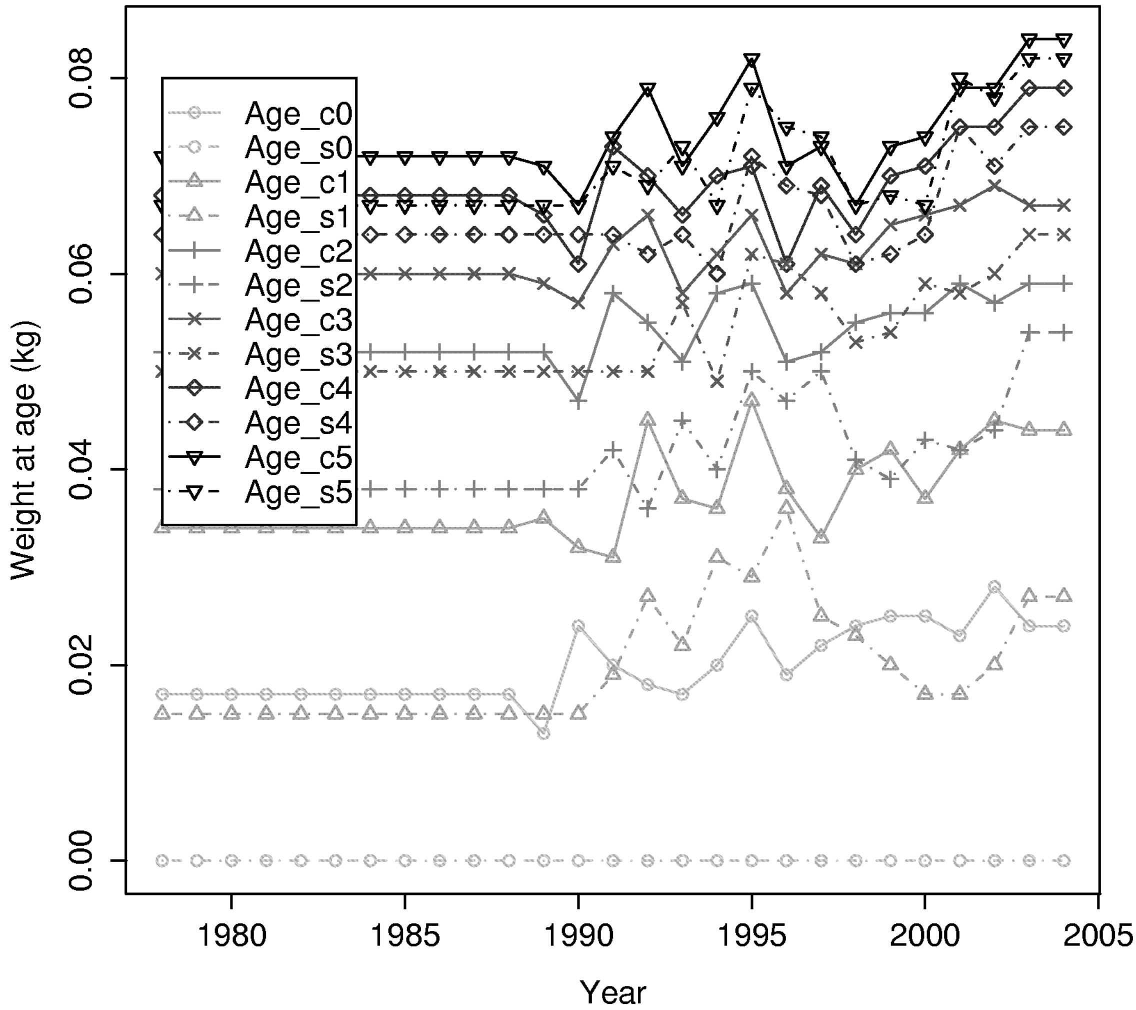


Figure 8.7.3: Sardine VIIIc and IXa: Assessment input data (III): Sardine weight-at-age, both from the survey (dotted lines) and the catch data (mean weights for all year, solid lines).

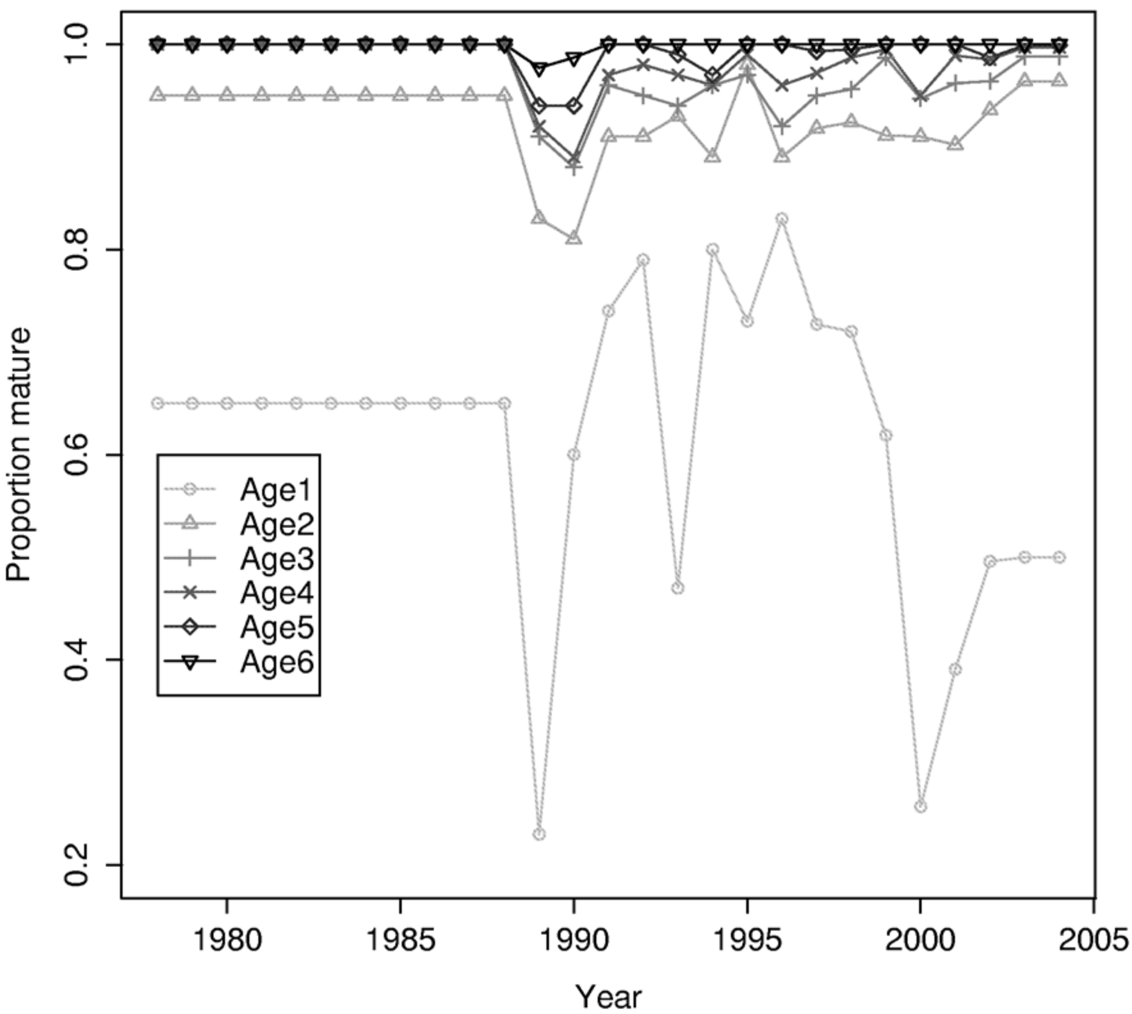


Figure 8.7.4: Sardine VIIIc and IXa: Assessment input data (IV): Proportion mature by age class. Proportion mature for Age 0 is assumed 0.

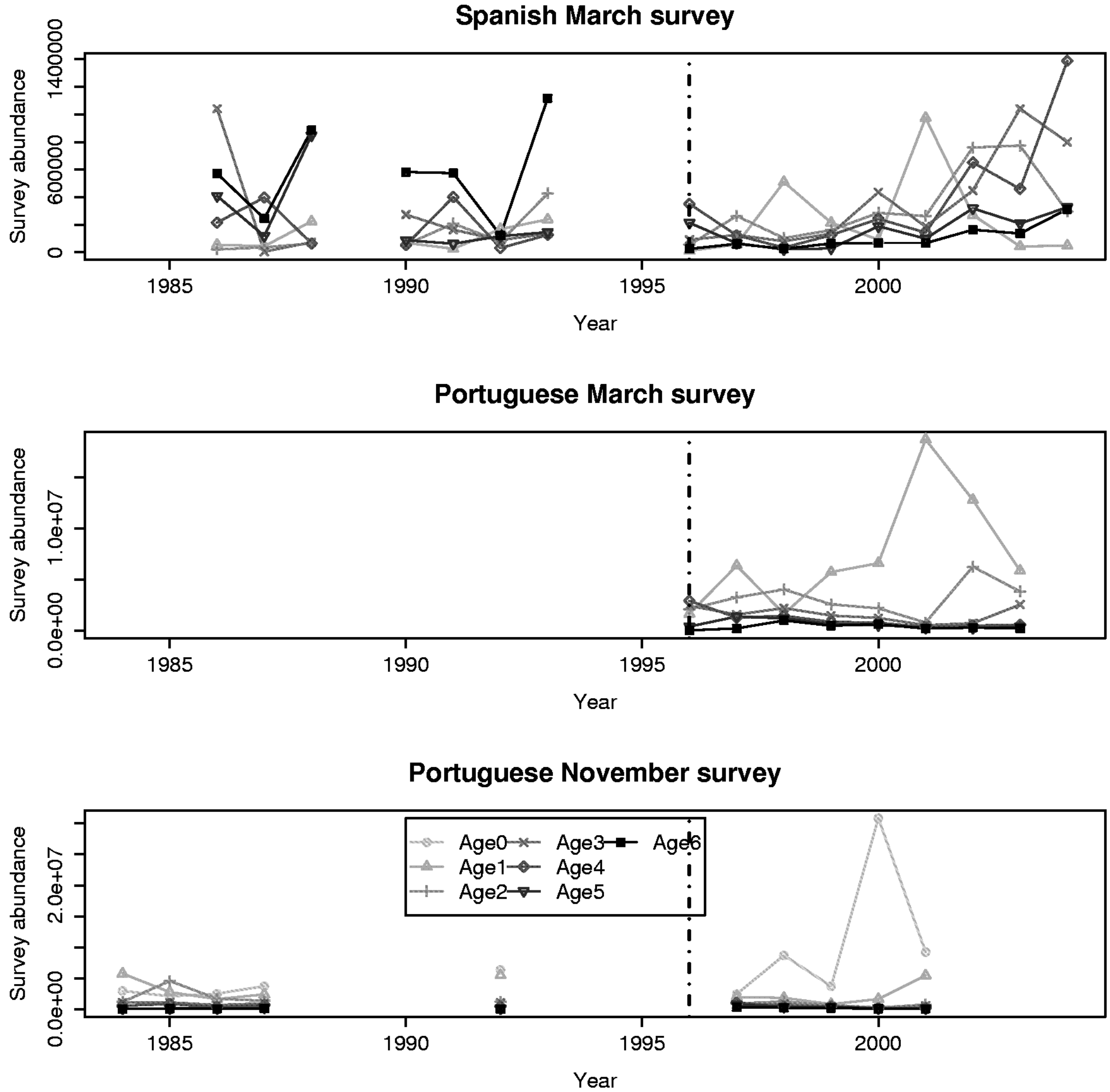


Figure 8.7.5a: Sardine VIIIc and IXa: Assessment input data (V): Survey abundances in the Spanish March acoustic survey (top), Portuguese March acoustic survey (middle) and Portuguese November survey (bottom). Vertical dotted line represent the assumed year for change in the survey catchability.

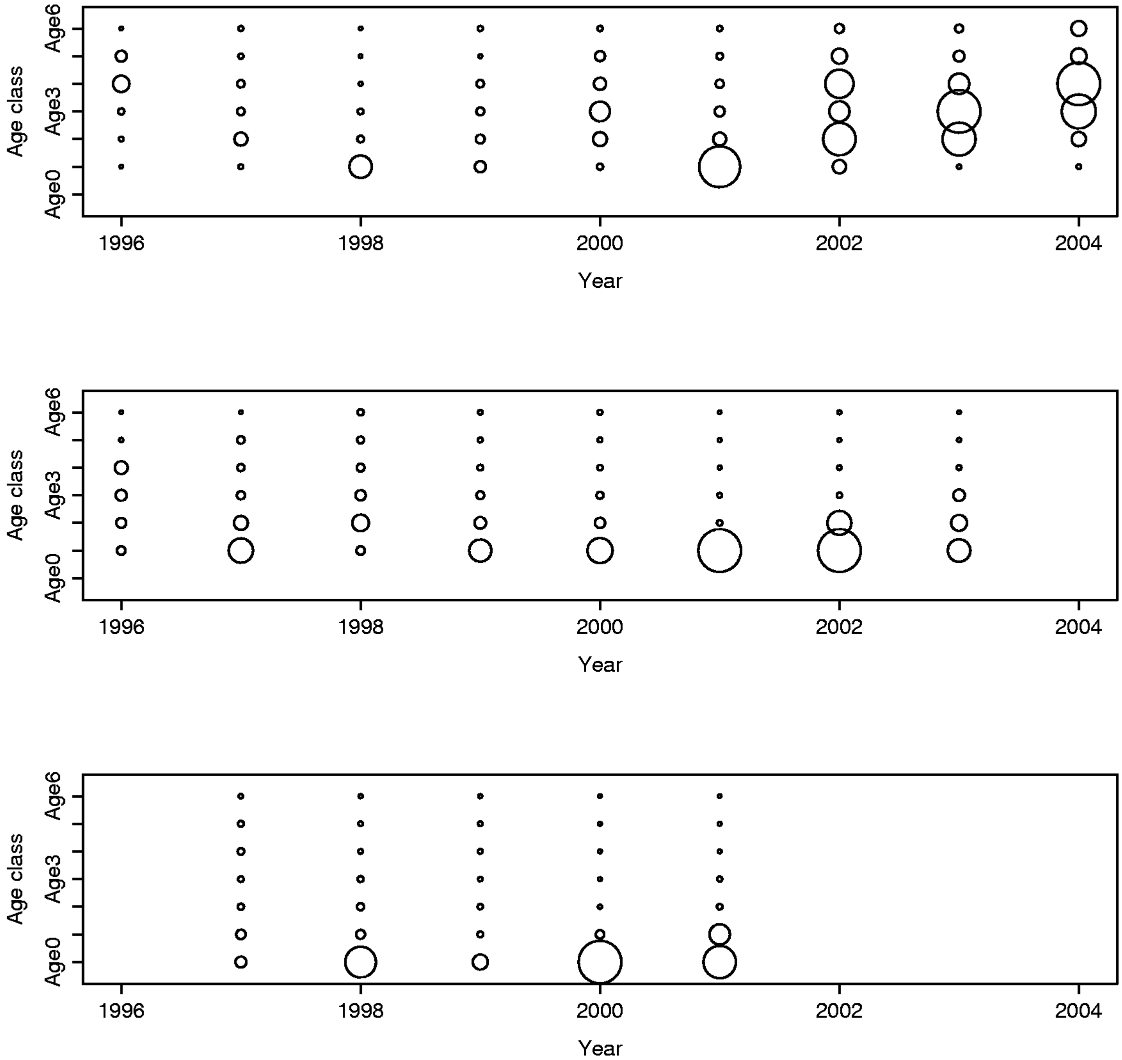


Figure 8.7.5b: Sardine VIIIc and IXa: Assessment input data (V): Survey abundances in the Spanish March acoustic survey (top), Portuguese March acoustic survey (middle) and Portuguese November survey (bottom). Bubble size proportional to estimated abundance.

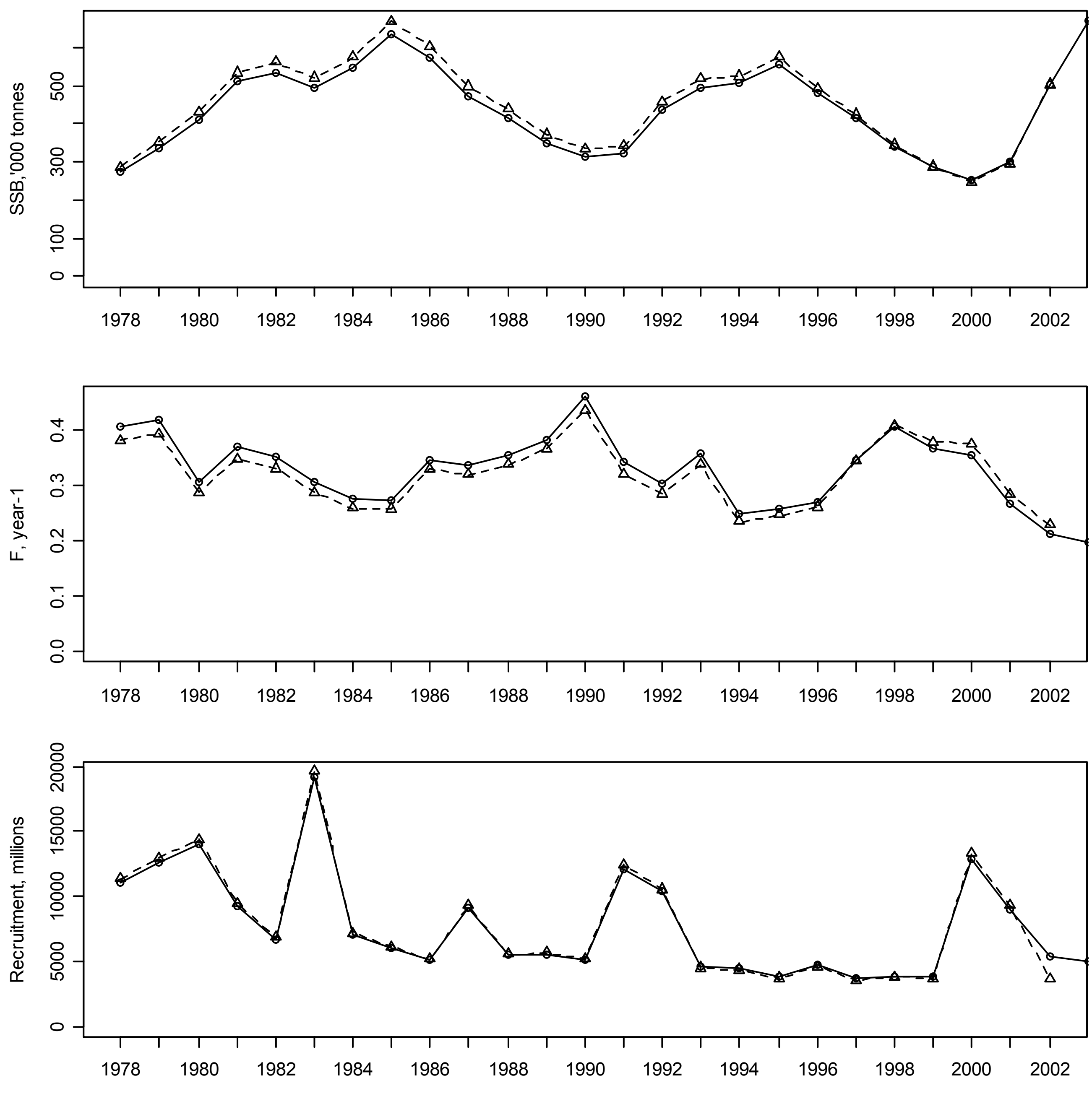


Figure 8.8.1.1. Sardine VIIIc and IXa: Comparison of assessments WG2003 (dotted lines and triangles) and WG2004 (black line and circles). SSB (top), F (middle) and recruitment (bottom) trajectories from the sardine AMCI assessment.

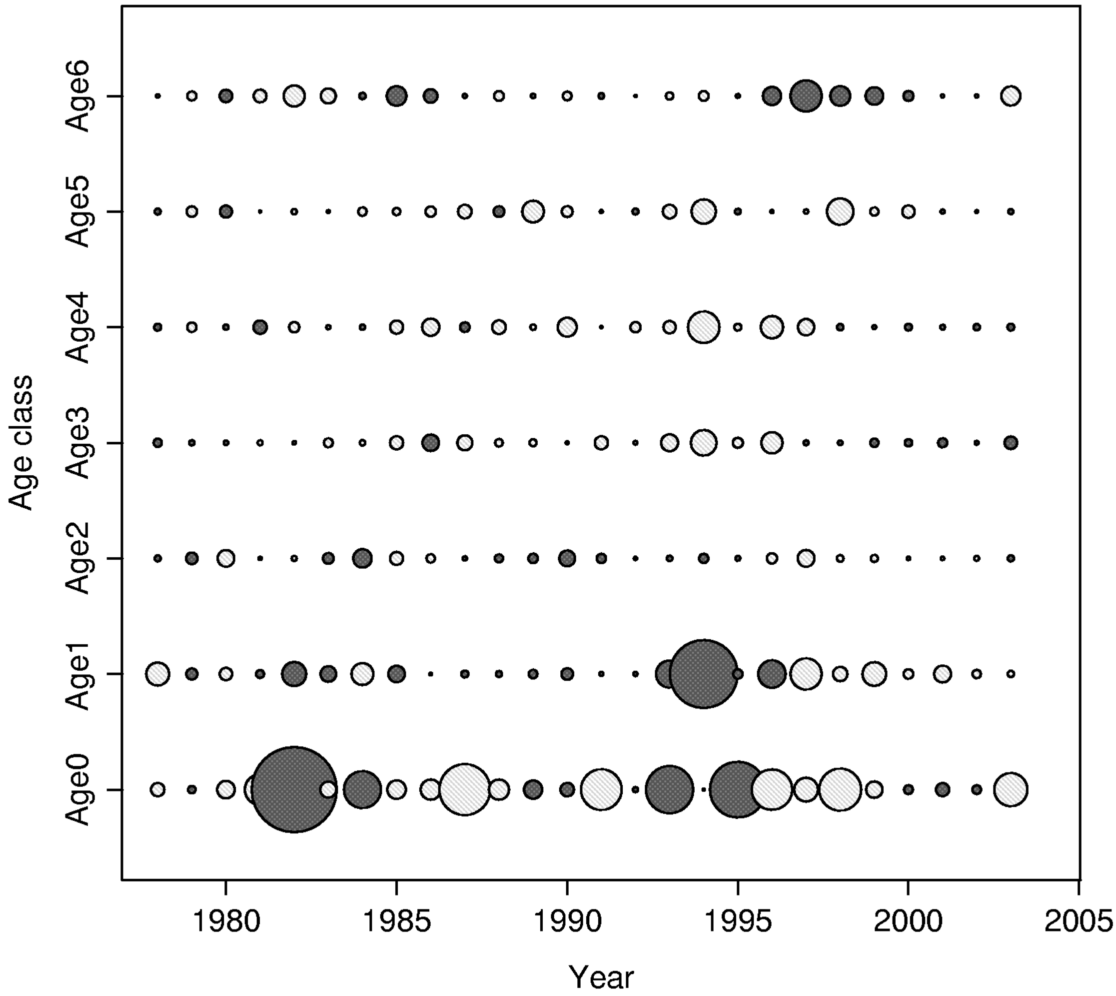


Figure 8.8.1.2: Sardine VIIIc and IXa: Catch residuals in the assessment model. Bubble size proportional to residual absolute level; grey bubbles represent negative residual, white filled bubbles represent positive residuals.

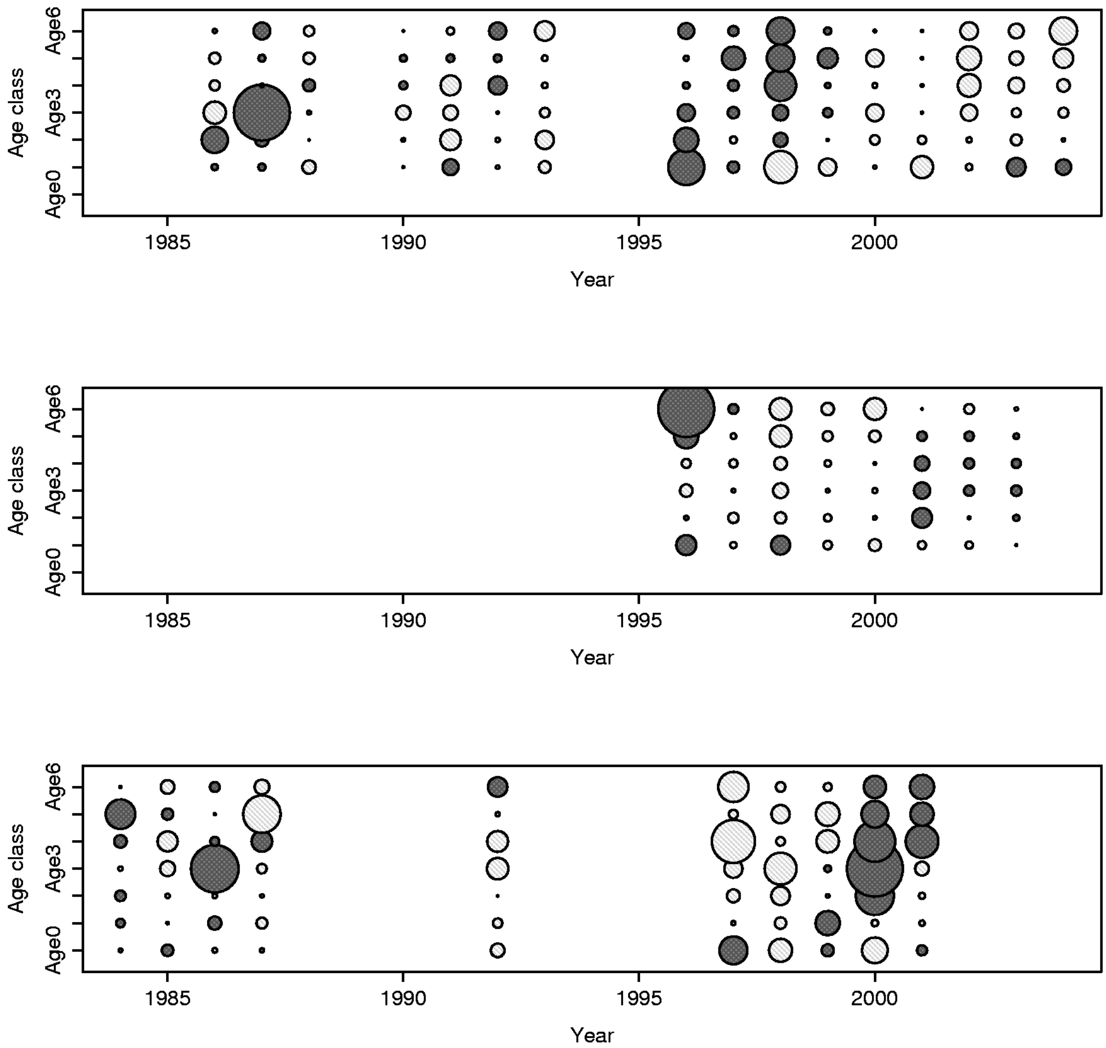


Figure 8.8.1.3. Sardine VIIIc and IXa: Survey residuals for the three different acoustic surveys used in the analysis. Top panel: Spanish March acoustic survey, middle panel: Portuguese March acoustic survey, bottom panel: Portuguese November survey. Bubble size proportional to residual absolute level; grey bubbles represent negative residual, white filled bubbles represent positive residuals.

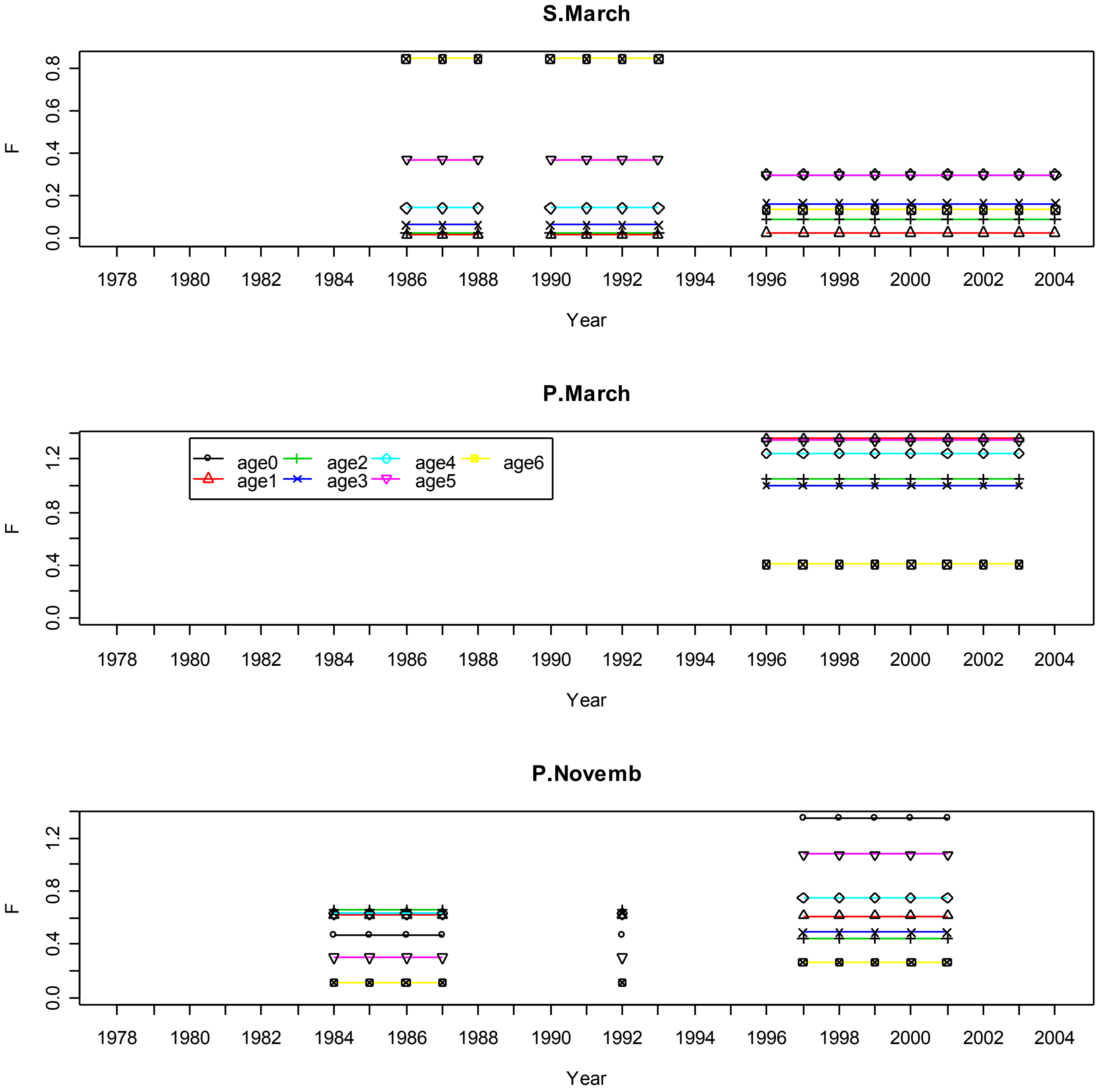


Figure 8.8.1.4: Sardine VIIIc and IXa: Catchability levels for each age and survey in the two assumed split periods (1984-1992 and 1993-2003).

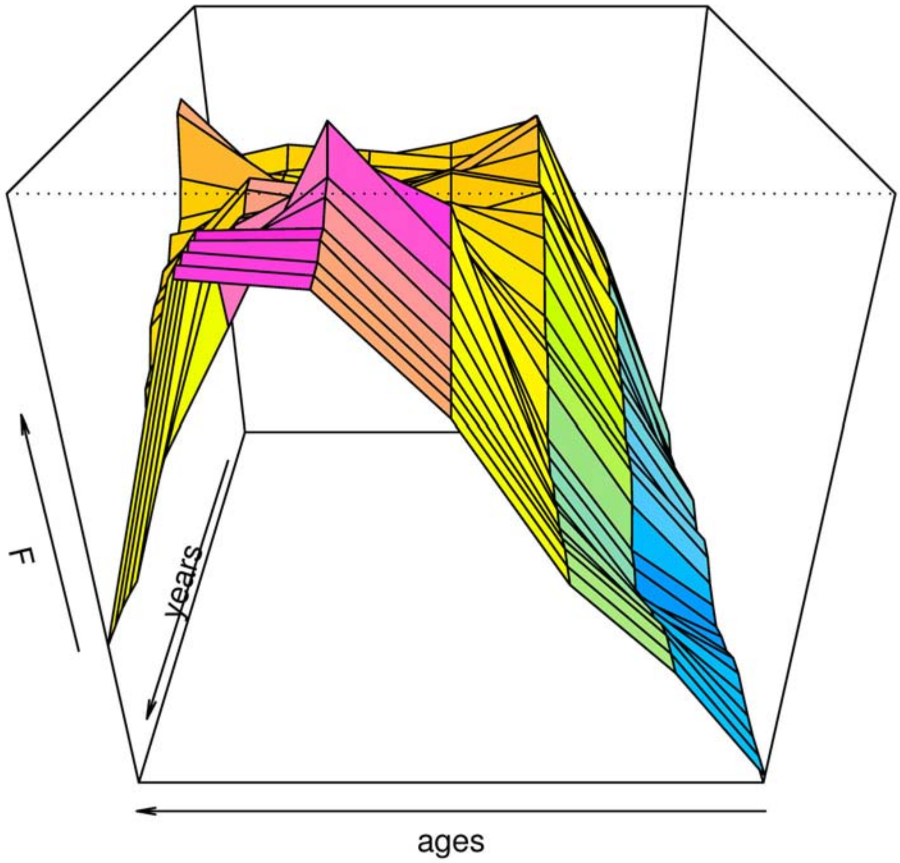


Figure 8.8.1.5: Sardine VIIIc and IXa: Selection pattern across all ages and through the time series. X-axis represents ages, y-axis years, increasing towards the back, and z-axis is the F-level. Darker greys correspond to higher F values.

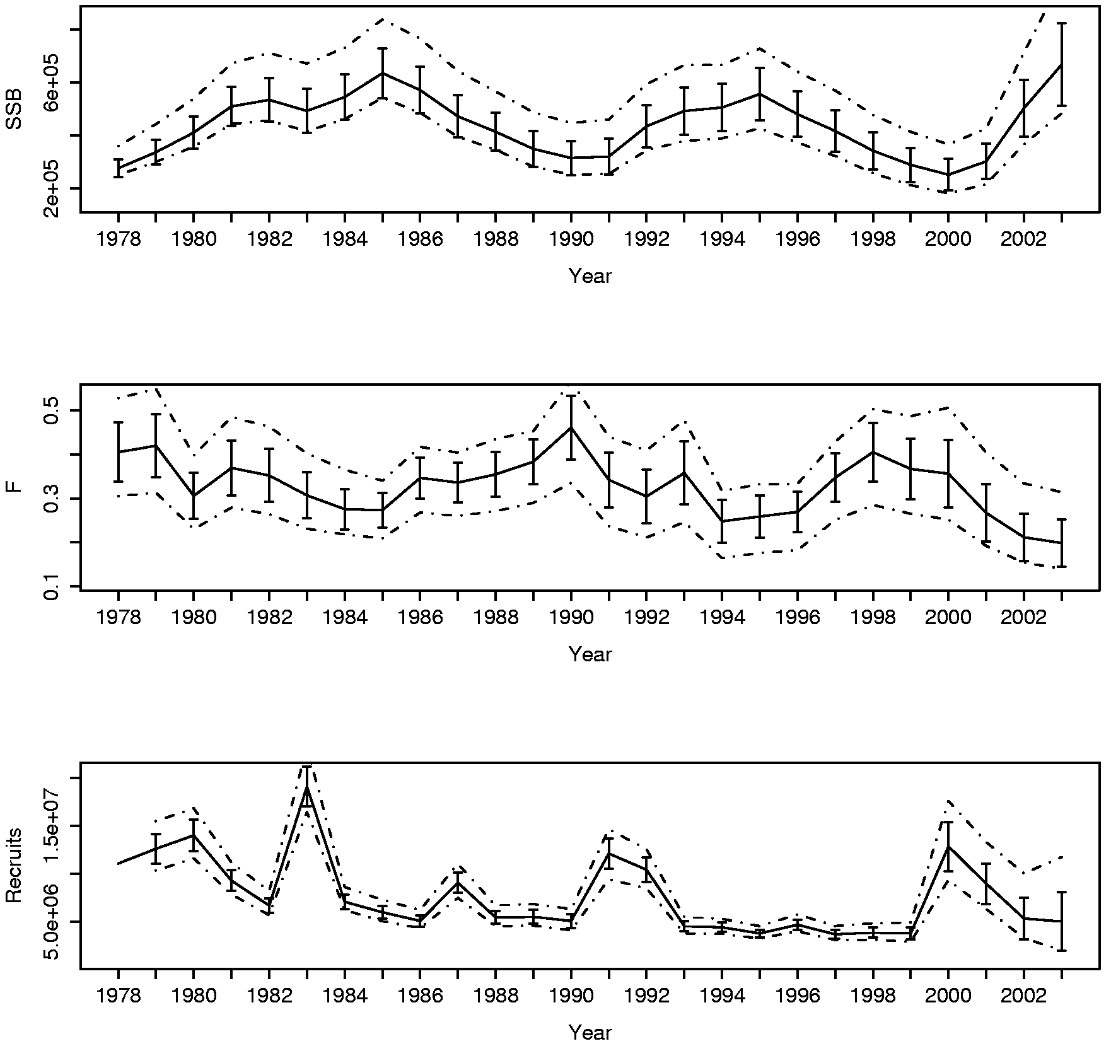


Figure 8.8.1.6. Sardine VIIIc and Ixa: Bootstrap trajectories of SSB, recruitment and F for the assessment model. Dotted lines represent the 90% limits and vertical lines represent the mean plus and minus the standard deviation of the bootstrap runs for any given year.

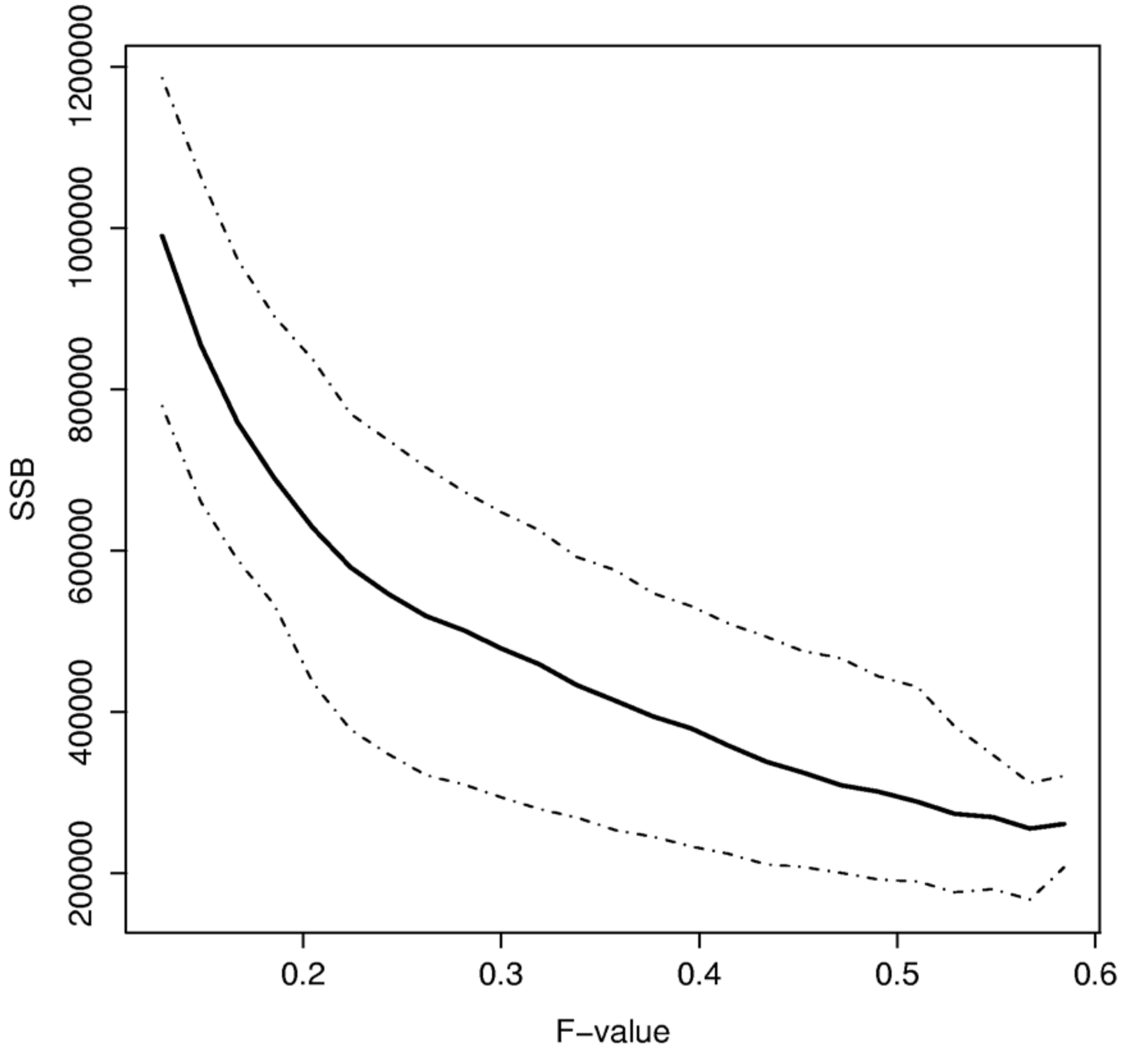


Figure 8.8.1.7: Sardine VIIIc and IXa relation between SSB and F from the bootstrap runs of the assessment model. Bold line represent the average trajectory, dotted lines represent the 90% confidence intervals.

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 to define the principal areas of fishing according to quarters. **Table 9.2.1** shows the distribution of catches of anchovy by quarters for the period 1991-2003.

In Sub-area VIII. during the first quarter in 2003 , the very scarce landings were caught around the Gironde estuary from 44°N up to 47°N by the French fleet. The Spanish purse seine fisheries were closed during the first quarter of 2003 due to the catastrophe of the *Prestige* oil spill. 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 2003, 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.

Anchovy fishery in Division IXa in 2003 was again located in the Gulf of Cadiz area (Spanish part of the Sub-division IXa South) throughout the year as observed in recent years. Highest landings this year from this Division occurred during the first and second quarters, which were mainly caught by the Spanish fleets fishing in the Gulf of Cadiz. Spanish catches from the Sub-division IXa North were negligible. Portuguese anchovy landings from Division

IXa in 2003 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.

Table 9.2.1: Catch (t) distribution of ANCHOVY fisheries by quarters in the period 1991-2003.

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

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

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

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

TOTAL	DIVISION IXa				SUB-AREA VIII					
Year	**IXa South**	**IXa CS**	**IXa CN**	**IXa North**	**VIIIc West**	**VIIIc Central**	**VIIIc East**	**VIIIb**	**VIIIa**	**VIIId**
1991	5717	3	187	15	445	1003	6177	7197	4458	-
1992	2996	1	136	33	211	1053	19122	6422	10874	-
1993	1960	1	22	1	26	101	13542	12609	13809	-
1994	3035	8	227	117	68	103	13641	13373	7172	130
1995	571	331	6725	5329	421	194	14951		14233	
1996	1831	13	2707	44	272	623	10895	11442	10946	-
1997	4614	8	610	62	307	210	5698	10027	5528	-
1998	9543	153	894	371		4294		10436	16888	0
1999	5942	96	957	413		8249		8529	10016	0
2000	2360	61	71	10		16113		8235	12647	0
2001	8655	19	397	27		15410		9908	14831	0
2002	8262	90	433	21		3713		10288	3508	0
2003	4968	67	211	23		2061		2222	6312	0

- Not available

10 Anchovy - Sub-Area VIII

10.1 ACFM Advice and STECF recommendations applicable to 2004

ICES advice from ACFM in November 2003 stated *"ICES recommends that a preliminary TAC for 2004 be set to 11 000 t. A catch of this size will, in the case of poor recruitment, maintain the fishing mortality at the current level. This TAC should be re-evaluated in the middle of the year 2004, based on the development of the fishery and on the results from the acoustic and egg surveys in May-June 2004.*

Alternatively, the TAC could be calculated based on average recruitment. Such a TAC would be about twice the preliminary TAC proposed above. But in that case the allocation for the first half year should only be half of the preliminary TAC to assure that the total amount is not fished before the mid-year adjustment. This adjustment would include the possibility that the final TAC is below the preliminary TAC".

STECF (in 2003) agreed "with the ICES assessment. STECF also considers that there are large inter-annual fluctuations in the spawning stock because recruitment is highly variable combined with anchovy's short life span. The preliminary TAC should be set at a level where this TAC, should it become the total catch in the quota year, it would provide a low risk of a stock collapse even if the incoming year class is low. The year classes 2001 and 2002 were weak. A prediction based in the weak year class in 2004 suggest that fishing in 2004 should be restricted below 10,000 t and a preliminary TAC should be set at this level.". STECF also agreed that the development of harvest control rules should be investigated.

The European Commission finally decided to set an annual TAC at the level of 33,000t, as traditionally had been done, but in addition the EC quoted (in it official announcement) a requirement for its revision. Such in year revision has not finally taken place, but it seems that progress towards the definition of an in year management system for the stock of anchovy in the Bay of Biscay are being promoted by EC.

10.2 The fishery in 2003

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**). Because of "Prestige" wreck, the Spanish and French fishery has been perturbed at the beginning of the year and the decrease of first semester in catches might be mainly related to the Prestige oil spill.

Spanish purse seine fleet: The Spanish fleet is composed of purse seines (208 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 Sub-area 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 **(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. Pelagic trawlers are very 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 threshold of 50 tons per year has been decided to separate target trawlers to occasional one. The number of vessels that fish anchovy with a pelagic trawl is very variable as a good proportion of them are polyvalent. Some vessels for example fish anchovy with a pelagic trawl during the night and practise bottom trawl during the day. Consequently, the number of pelagic trawl catching anchovy could be very different from one year to another. **(Duhamel E. *et al*, WD 2004)**

French purse seiners are also opportunistic and 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. There are also some

French purse seiners located in the Basque country (fishing mainly in the spring season in VIIIb) and in the southern part of Brittany, that catch anchovy during autumn in the north of the Bay of Biscay.

10.2.1 Catches for 2003 and first half of 2004

In 2003 a total of 10,595 tonnes were caught in Subarea VIII **(Table 10.2.1.**1 and **Figure 10.2.1.1**). This is a 39.48% decrease compared to the level of 2002 catches, and a 73.5 % decrease compared to 2001. The Spanish and French fishery decreased their landings in 52 % and 30.9 % respectively. As usual, the main Spanish fishery took place in the second quarter (94.9%) and the French catches in the second half of the year (83.9%) **(Table 10.2.1.3**).

The seasonal fisheries by countries are well described in the MHSAWG report (ICES 2004), and, in general (1992-2003), most of Spanish landings (85 %) are usually caught in divisions VIIIc and VIIIb in spring, while the French landings are caught in divisions VIIIb in first half-year (about 35 %) and 65% in summer and autumn in division VIIIa (**Table 10.2.1.2**).

In 2004 international catches of the first half of the year amounted to about 8616 t, which represents the double of 2003 catches for the same period. (**Table 10.2.1.1**). For the last two years the French and Spanish fisheries have shown a neat drop on the overall level of catches of the seasonal fisheries (**Figure 10.2.1.2**). First it was the failure in the 2002 spring Spanish purse seine fishery (**Figure 10.2.1.3 a**), followed by a reduction of the French autumn catches (**Figure 10.2.1.3 b**) and finally another failure occurred in 2003 in the first half of the year for both the French and Spanish fishery. In 2004 the Spanish fishery has increased their catches although they were still low compared to other years. The French fishery was still low during the first half of the year, this is due to the fact that the fishery started really in June due to the small average size of the anchovies encountered in the first quarter (which had a very low market price). This indicates that there is an important part of age2 in the population in 2004. The past 2 years of low catches seems to be related to the failures of last year recruitments (year classes 2001 and 2002). Low catches of the French and Spanish fleets in the first half of 2003 may be also related to the Prestige oil spill.

10.2.2 Discards

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

10.3 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 2003. In 2003 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 2003 Spanish catches showed a predominance of age 2 in the catches of the second quarter, while in French catches age 1 was predominant all over the year.

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 two 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.

A few catches of immature, 0 age group, appear during the second half of the year. This 0 group appeared to be bigger than previous years showing a high growth rate in spring and summer 2003. The estimates of the catches at age on annual basis since 1987 is presented along with the inputs to the assessment in **Table 10.7.2.1**

During the first half of 2004 (**Table 10.3.1.2**) 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.

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. In the year when the strongest failure of recruitment occurred (2001), live bait catches were minima if any and according to fishermen it was almost impossible to find any juveniles in the Bay of Biscay in summer 2001 (ICES 2003).

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 2002.

For the first quarter, IN 2003 the only fishery was the French one (Figure 10.3.2.1). The Spanish fishery did not operate because of the prestige oil spill although usually their catches are low in this quarter.

For the second quarter, the Spanish fishery is the main one and showed a unimodal distribution with a modal length of 17.6 cm (mostly age 2) as in 2002. On average, the anchovies landed by the French fleet are smaller than those caught by the Spanish one in the second quarter **(Figure 10.3.2.2**).

For the third quarter, the main fishery is the French one. The French anchovy catches had a unimodal length distribution peaking around 15.5 cm. The Spanish had one modal which was about half centimetre less than the French one. **(Figure 10.3.2.3**).

For the fourth quarter, the size distribution of the French and Spanish landings was similar. **(Figure 10.3.2.4**.).

The series of mean weight at age in the fishery by half year, from 1987 to 2001, is shown in **Table 10.3.2.2**. The French mean weights at age in the catches are based on biological sampling 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 10.7.2.1**.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 10.7.2.1.** These values are the ones estimated for the spawners during the DEPM surveys of 1990-2003. 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 between 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.

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**). In sept 2003, as the Daily Fecundity was not yet available for the 2003 survey, the working group used an estimate of biomass based on a regression of previous SSB estimates and the Total Daily Egg production (P_{tot}) (**ICES CM2004/ACFM08**) which resulted in a figure of about 33,000 tonnes for 2003. Nowadays, after the estimation of the Daily Fecundity parameters, the Biomass from the 2003 DEPM application is reported at about 24,000 (**Santos et al. WD2004**). This reduction of about 20% is due to higher estimates of spawning frequency and batch fecundity than in previous years. The text table below summarise the results of Spawning Biomass estimates from that survey:

Parameter	Estimate	S.e.	CV
DEP	2.15E+12	6.00E+11	0.279
R'	0.541	5.84E-03	0.011
S	0.2705	9.20E-03	0.034
F	17,777.60	1.27E+03	0.072
Wf	28.9395	2.00	0.069
Daily Fec.	89.9079	3.99	0.044
Biomass	23,962	6.76E+03	0.282

DEPM SSB estimates in 2003

In 2004 a new DEPM survey took place between 2 and 22 of May on board the Spanish R/V Vizconde de Eza (Santos and Uriarte WD2004). The map of egg abundance and the positive spawning area for 2003 is shown in **Figure 10.4.1.1**. One of the smallest spawning areas of the whole series of DEPM surveys was recorded in 2004. So far all the total daily egg production and most of the adult parameters are available, with the sole exception of the spawning frequency. In order to produce a preliminary estimate of Biomass from the DEPM an inference about what the spawning frequency might be was made.

Given the fact that in this year the lowest SST of the past series of application was encountered (13.7ºC), and that significant amount of beta atresia is being found (similar to the one recorded in previous “cold” years applications as in 1995), the WG accepted to take the average spawning frequency of the 6 years showing temperatures below 16ºC during the survey implementation (as proposed by **Santos and Uriarte WD2004**) (see **Figure 10.4.1.2**). This results in a spawning frequency value of 23.55% (CV=15%) which is a slightly lower value than the historical mean of 25.33%. This assumption of a relatively low spawning frequency is also in agreement with a lower than usual production of eggs per body gram of females (F/W). The preliminary biomass in this way obtained is summarised in the text table below:

Parameter	Estimate	Error est.	CV
DEP	8.4E+11	9.7E+10	0.1150
R'	0.5388	0.0045	0.0084
S	0.2351	0.0353	0.1500
F	9589.8	1145.4	0.1194
Wf	25.42	1.9867	0.0782
BIOMASA	18,113	3536.02	0.1952
Wt	20.17	1.91	0.0947
POBLACION	908.3	209.3	0.2305
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	775.0	195.4	0.2522
Nage 2	107.3	27.1	0.2525
Nage 3	26.0	7.5	0.2896

DEPM SSB estimates in 2003

The population at age estimates were obtained from individual age readings by samples or application of regional age length keys to the sample’s length distribution (**Santos & Uriarte WD2004**).

Estimates of spawning biomass by just making use of the total egg production (as made in previous years) led to similar preliminary range of SSB values: If no correction were made to the direct regression estimates based on the spawning area and on the total egg production the biomass fall in the range between 14 and 18 thousand tones. If the low temperature was taken into account to correct the above estimates then Biomasses between 19.5 and 23 thousand tonnes were achieved (see annex A1 of Santos and Uriarte WD2004). The estimate provided above is considered better since it incorporates most of the adult parameters except for Spawning frequency (S) which is assumed at the level explained above. If the historical mean S would have been assumed instead, SSB values for 2004 would be slightly smaller (16,800 t.).

The whole series of DEPM biomass estimates since 1987 are presented in **Figure 10.4.1.3**. A total of 16 years of SSB estimates and 12 years of population at ages estimates are now available for the assessment of this anchovy.

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 southwestern 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 last survey took place in May 2004 (PELGAS04) April 27th to May 25th on board R/V Thalassa. A total of 4500 nautical miles were survey, of which, c. 2500 nautical miles can be considered for the evaluation. Unfortunately, at the time of WG, only the southern and middle part of the area was processed (**Figure 10.4.2.1**). Nevertheless, the available data is sufficient to calculate a biomass as no anchovy was observed in the northern area. A total of 52 pelagic hauls (**Figure 10.4.2.2**) were carried out during this survey for identification of echo-traces and biological observations.

The situation in 2004 was more similar to a normal situation, i.e. small anchovy concentrated in front of the Gironde and bigger one in the southern part and offshore. We must point out the fact that pelagic fish (except along the shelf break where horse mackerel, mackerel and sardine where observed on a narrow belt) was rather absent in the northern area, even along the southern coast of Brittany where fishermen catch traditionally sardine at that season. The description may be done as following:

1) Anchovy was very concentrated in 2 separate areas: in front of the Gironde and in the southern part of the platform.
2) Anchovy was generally seen on the echogram as small schools scattered between 10 and 50 m above the bottom, and generally mixed with small horse mackerel (bottom depth between 100 and 130 m), with sardine and mackerel in the middle of distribution area (depth > 50m) and with sardine and sprat along the coast (20m<depth<50m).
3) No anchovy was observed in the north of the Bay of Biscay and surface schools when appeared were mainly identified as sardine according to efficient surface hauls.
4) Hydrological conditions in 2004 were close to normal situation with surface temperatures about 0.5° above the normal T° observed during the last 20 years.

After echogram scrutiny and allocation to species using the standard method - separation into strata with similar echotraces and haul results (Massé,J, WD2001), biomass were estimated for anchovy, sardine and sprat in 4 coherent areas (**Figure 10.4.2.3.**) and for the surface echoes separately. Anchovy biomass estimates are gathered in table below.

Area	Biomass (t)
zone:"Rochebonne"	3112
zone:"Gironde - Landes"	28 343
zone:"Offshore"	135
zone:"Adour"	13 864
Surface echoes	563
TOTAL	46 018

Therefore, the overall total biomass of anchovy estimate by acoustics is 46 018 t.

Based on length frequency distributions by area and using a global age/length key, the number of individuals (10^6) by age and area during PELGAS04 is given in **Table 10.4.2.1**. From these data, it appears that the 2003 year is well represented (92% in biomass and 95% in numbers. The biomass estimate is higher than last year but remain at a low level compare to 2000 for example. Therefore, the predominance of age 1 cannot prove that the recruitment is very high but at least that it is not missing this year compare to 2001 and 2002 year classes.

in numbers	total	G1	G2	G3	G4
Coastal area	2 303	2 247	42	15	0
Adour + offshore	374	218	103	48	5
TOTAL	2 678	2 465	145	63	5
%	100.00	92.05	5.40	2.35	0.20
in biomass	total	G1	G2	G3	G4
COTE	32 019	30 553	1 046	415	5
LARGE	14 000	6 571	4 680	2 403	346
TOTAL	46 018	37 124	5 726	2 818	351
%	100.00	95.42	3.27	1.30	0.02

The mean length and mean weight at age are gathered below :

L (cm)	total	G1	G2	G3	G4
Coastal area	12.04	11.98	14.45	15.07	18.68
Adour + offshore	15.87	14.93	16.98	17.45	18.96
TOTAL	12.58	12.24	16.24	16.90	18.95
W (g)	total	G1	G2	G3	G4
Coastal area	12.06	11.86	21.70	24.86	49.62
Adour + offshore	29.38	24.11	36.50	39.84	52.08
TOTAL	14.48	12.94	32.20	36.37	52.04

10.4.3 Comparison between direct measurements of stocks by DEPM and acoustics

Direct assessment surveys have been carried out for several years both by AZTI and Ifremer, using 2 different methods : DEPM and acoustics. A review of respective results have been done in order to have a better idea of how these index are comparable and how they may be used into models. One of the question was do these index have to be used as absolute or relative. For the time being ICA uses DEPM as an absolute index and acoustic as a relative one.

DEPM and acoustics biomass assessments, when both were available, are compared in **Figure 10.4.3.1.a**. Assessment are sometime in good agreement (1989, 1990, 1992, 2001, 2003) and sometimes not. It is necessary to keep in minds that the surveys are not carried out always at the same period and that a lack of one month can sometimes happen. The area coverage of each survey may also be variable. Acoustic surveys were carried out only in the southern area before 2000, then later on all the platform from the Spanish coast to the west point of Brittany. The DEPM surveys cover an intermediate area (usually up to 47ºN, trying to cover the whole spawning area for anchovy), covering as well some more offshore waters than acoustics. Nevertheless the biomass estimates arising from both assessments should be positive and significant, however this is not the case (R^2 = 36%) (**Figure 10.4.3.1.b**).

In order to analysis better this discrepancy, numbers at age estimated by the DEPM (daily egg production method) and the acoustic surveys in the series 1987-2003 (ICES WG report, 2004) were also compared. The acoustic survey was either in close agreement with the DEPM survey or had a greater estimate for both age-1 and age-2 age groups. Nevertheless, the main discrepancy seems to occur for age-2. For instance, the large cohort age-1 in 2001 (**Fig. 10.4.3.2.a**.) was estimated by acoustics with a higher value than DEPM and the difference in estimates was further increased at age-2 in 2002 (**Fig. 10.4.3.2.b.**). The percentages at age arising from surveys are rather congruent (**Fig. 10.4.3.2.c. and d.**), what means that much of the disagreements in the absolute number arise from discrepancies in the absolute level of the biomass estimates. For instances the major discrepancies in the numbers at age 2 (in years 1991 and 2002) are due to big differences in total biomass estimates. This type of errors in the absolute numbers might lead to major differences in the perception of cohort strength through an assessment like ICA.

Further investigations will be carried out in the future to better understand this catchability problems and to see how the catchability difference between the two indices, mainly in age composition, may induce bias in assessments when ICA is used. In the mean while the WG group considered not to be in a position as to reject the use of the DEPM as absolute, although the relative differences between the indices shown above suggest that the CV of both direct estimates could be high.

10.4.4 Surveys on Juvenile anchovy.

In 2003 two acoustic surveys on juvenile anchovy took place in the Bay of Biscay: A first one, called JUVENA, aimed at providing an abundance index of juvenile anchovies in autumn 2003 and it was carried out by AZTI from 17th September to 15th October 2003 (Boyra et al. WD2004). A second shorter survey, called JUVAGA, aimed at studying the ecology of juveniles anchovies was carried out by Ifremer from 9th to 15th October 2003.

The project JUVENA (Acoustic surveying of anchovy juveniles) aims at estimating the spatial distribution and relative abundance of anchovy juveniles and their biological condition during the autumn season (about four months after the spawning) in order to assess the strength of the recruitment entering the fishery in the next year.

In 2003, JUVENA survey made use of two echo sounders (Simrad EY60 of 38 kHz and 120 kHz respectively) and the area south of 46ºN was covered with a rented purse seine the “Divino Jesús de Praga”. Anchovy was mostly located at the southern part of the surveyed area (South of lat 45ºN. See **Figure 10.4.4.1**). There, almost pure schools of anchovy (all of them juveniles) were spread in a narrow strip (about 3 miles wide) parallel to the shelf edge, about five miles off shore from it. The distribution ended at –5º W longitude along the Cantabrian sea. In the northern coastal area sardine was predominant and few anchovy detections were made close to shore at the plume of the Garonne river. An acoustic index of biomass from this survey is not yet provided since the processing is still ongoing.

JUVAGA occurred one week later than JUVENA and aimed to collect samples and data to study the larval surviving through a juvenile otolith analysis. Even if the survey was very short and did not cover the whole area with an acceptable sampling strategy for a biomass estimate, a comparison of respective observations is possible. On the one hand JUVAGA did not find anymore schools of juvenile anchovy in the Cantabrian area (north of Spain) (**Figure 10.4.4.1**). This is well explained by the fact that between the two surveys and just the 2 days before JUVAGA, a strong storm occurred. Such a phenomenon is well known to destroy the aggregation patterns and it may take a few days (3-4 days) before juveniles recover a normal distribution and behaviour and therefore, detectability. On the other hand, and contrary to JUVENA observations, JUVAGA found a predominance of Juvenile anchovy close to the Gironde River plume, with a less relevant presence of sardine. Both surveys were synchronously in the area and the different observations could be due to the different catchability of fishing gears employed: purse seine (JUVENA) and pelagic trawling (JUVAGA). The above inconsistencies among the surveys require further analysis which will be relevant for the development of comparable acoustic surveys between years.

JUVENA survey is intended to last for at least 4 years in order to judge the potential of these acoustic surveys to provide an index of anchovy recruitment just in advance the fishery start to exploit it (in January next year). The biological condition of the juveniles and other complementary information obtained from the live bait tuna fishing boats should serve to contextualize the results of the acoustic survey in a broad ecological scale, for the improvement of the scientific advice.

A new JUVENA survey is being carried out in autumn 2004.

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 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 number of French purse seiners is quite constant. The low number in 2003 may be explained by the atypical situation (due to the exceptionally hot spring) of fish distribution that year which decreases a lot the catchability of anchovy for purse seiners (**Massé J.** *et al*, **WD 2003**).

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

The anchovy spawning population heavily depends upon the strength of the recruitment. This means that the dynamics of the population directly follow those of the recruitment with a very small buffer. The forecast of the fishery and the population depends therefore on the provision of a prediction estimate of the next year anchovies at age 1. Given the absence of quantitative recruitment surveys prior to the fishery, the only information presently available is the one concerning the influence of the environment on the recruitment of anchovy.

Two environmental indices have been studied and suggested during the last 10 years and were available for this WG (Borja et al. (1996; 1998) and Allain et al. 2001) and a review of the role of these environmental indices in setting the anchovy recruitment in the Bay of Biscay was made by Uriarte et al. (2002) and by Petitgas et al. (WD2003). The first one proposed by AZTI is based on the northern and eastern winds blowing in spring and early summer in the Bay of Biscay, the second one proposed by IFREMER is based on upwelling and stratification breakdown of the water column in summer.

a) The AZTI upwelling index showed the positive influence of the northern and eastern winds of medium and low intensity blowing in spring and early summer in the Bay of Biscay for the onset of good levels of recruitment at age 1 for the anchovy population in the next year. This index was built up with a long series of Recruitment based on CPUE data for the period 1967-1996 and the most recent assessments of recruitment up to that from 1999 confirmed that relationship. However the latest recruitment estimates, and particularly the recruitment from 2000 (age 1 in 2000), rendered not statistically significant the role of this index (at alpha 5%) (Uriarte *et al.* 2002). The estimates of this Upwelling index since 1986 are reported in **Table 10.6.1.** updated with the 2004 value.

The value obtained in 2004 of Borja's Upwelling index is once more low and therefore the index suggests another low recruitment. However this index has been low since 1998, while recruitment since then has been two times low and two times high and two undetermined (including 2004). According to this year assessment (up to 2003 recruits at age) this index display again a significant (but poor) positive relationship with recruitment ($R2=25\%$, $N=18$ and $P(random)=0.036$). However **as concluded in previous years this index is not use for any predictive purposes.**

b) The IFREMER anchovy recruitment index (Allain et al., 2001) is a two-covariate model. One covariate, an upwelling index (UPW), is positively related to recruitment and the other covariate, a water column stratification breakdown index (SDB), is negatively related to recruitment. The 2 covariates are estimated from outputs of a 3D hydrodynamic model forced by wind, tide and river discharges. Since 1999, the 2-covariate model of Allain et al. (2001) has been a safer predictor than the 1-covariate model of Borja et al. (1998). The 2-covariate model has been able to predict at the autumn 2001 (Petitgas et al., 2001) the recruitment failure observed in the surveys in 2002 (age-1 in 2002). Since 2000, the 2-covariate model of Allain et al. (2001) is implemented in operational mode at IFREMER to provide each year the WG with a recruitment index for next year.

For predicting anchovy abundance at age-1 in 2005, upwelling and stratification breakdown indices for the period March-July 2004 (**Table 10.6.1**.) were estimated from the hydrodynamic model outputs, and the regression model was used in extrapolation mode (Petitgas et al. WD2004). From March 1 to July 31 2004, the UPW index value (80.81 m day-1) was medium to high in the series since 1986 (Table 2). The SDB index was coded 0, meaning no stratification breakdown. A small SW gale occurred 7-8 July with wind close to 12 m s-1 which lasted 1.75 day but which was not enough to generate a severe drop in the evolution of thermal stratification. Thermal stratification seasonal increase was stopped at Julian day 190. Difference in stratification values before and after the gale was 0.5, a positive value to be compared with the negative ones in **Table 10.6.1.** Thus there was no important drop, i.e. breakdown in stratification. Therefore the SDB index was coded 0.

The UPW and SDB indices provide a simple description of the potential survival of anchovy larvae on the Biscay French shelf south of 46°30. ICES (2004b) identified the importance of the adult stock behaviour in changing the interaction between recruitment and environment. The adult stock as well as the eggs were observed south of 46°30N in the spring 2004 acoustic survey, with spatial distributions comparable to the situations of the 90s. Adult spawning behaviour in space and time being in 2004 is therefore expected to be in the range of that which occurred in the period 1987-2002. The prediction for 2005 of the 2-covariate recruitment index is therefore believed to be trustful.

The 2 covariate model was developed on the ICES age-1 series 1987-1998 (ICES 1999) based on testing the best regression model with many environmental parameters estimated from the hydrodynamic model (Allain et al., 2001). The model coefficients were updated by fitting the model on the series 1987-2002. Fitted and predicted values are represented on **Figure 10.6.1.** The value for age-1 in 2002 was used prior to its revision by the group in the present assessment but this was not considered to be a problem because it is known that it corresponds to a bad recruitment which was observed in the surveys without contest.

As the index was calculated before the assessment was done during the present WG, it was considered that age-1 in 2002 will not be updated severely because it is known that it corresponds to a bad recruitment which was observed in the surveys without contest. Therefore the 2-covariate recruitment model coefficients were:

The model fit was: R = 2777.605 + 49.18539*UPW - 3132.561*SBD

Coefficients are:

	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	2777.605	1042.9665	2.6632	0.0195
upw2	49.1854	16.8432	2.9202	0.0119
sbd2 -	3132.5612	903.9794	-3.4653	0.0042

Residual standard error: 1525 on 13 degrees of freedom

Mulitple R-Squared: 0.67

Even if this model has not proved all along the series to be enough robust to do forecast, it seems to fit well the very high (high upw and sbd=0) and the very low (sbd=1) recruitment values and is less well fitted for the medium level recruitment values. Therefore, it seems at least to be better to predict low recruitment than medium or good one and can be considered for the time being as a good alarm index when a low recruitment is suspected.

For 2005, the model predicts a medium recruitment with an average value around 6000 millions of age-1 fish.

10.7 State of the stock

10.7.1 Data exploration and Models of assessment

Last year two assessments were presented for the bay of Biscay anchovy: on the one hand the standard ICA assessment and on the other hand the biomass-based model fitted by least squares that was first attempted in 2002 (ICES2003). However, since the biomass model was still under development the ICA assessment was kept as the standard one and further work on the biomass-based model was encouraged. Following this line, this year the biomass-based model has been presented as a Bayesian state-space model (Ibaibarriaga et al, WD2004). This approach allows further exploration of the biomass-based model and is included in this section.

10.7.1.1 ICA

The assessment of the anchovy stock performed up to now using ICA has been based on fitting a separable selection model for fishing mortality, assuming a constant natural mortality, 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 2004 are again available from both methods. 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 assumption of constant fishing pattern may not be fully appropriate since two major fleets (Spanish purse seines and French pelagic trawlers –see Section 10.2) 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. For the period 1987-2003 as reported by ICES (2004), the French and Spanish landings were regressed on the spawning stock biomass (SSB). The French catches were directly proportional to the SSB (**Figure 10.7.1.1.1**), on the other hand, Spanish landings had a weaker relationship, suggesting little relation with stock size. This may indicate that the Spanish fleet (mainly purse seines) could be more influenced by the changes in behaviour of schools from year to year (accessibility) than by biomass abundance itself. These considerations about the two fleets suggest that data from the two fisheries should be better considered as separate when running ICA. Such a procedure is not currently possible with the software available, but it should be considered in the future.

A careful selection of the appropriate weighting factors for the ages in the catches in the estimation process for the assessment was undertaken 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.

This year the WG has started with an assessment with the same settings as the one produced in the last year, just including the new data available: the catches at age in 2003, the revision of the spawning biomass and population at age estimates of the DEPM in 2003 and the new estimates from both the DEPM and acoustic surveys in 2004 (Sections 10.4.1 and 10.4.2). The separable model is this time restricted to the period 1989-2003 (due to the limitation of the maximum number of years ICA allows for the separable constraint). The results can be compared with those from the last year in **Figure 10.7.1.1.2**. Both are very close to each other; there is some reduction in the recruitment of 2002 and some differences in the earlier years where the assessment is only based in VPA. The current update assessment confirms the failure of recruitment in 2001 and 2002 as pointed out the last year, as well as the general moderate recent levels of fishing mortality.

Tuning the assessment using the DEPM and acoustic indices both as aggregated indices of biomass and as aged structured indices was already discussed in previous years (ICES CM1999 2001 and 2003, 2004), although further research of the effect of the correlation inherent to that use of the input data was encouraged. No further analysis have been reported to the WG and therefore the WG continued with past practice. 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. Beyond this, the assessment uses the DEPM indices as absolute estimators of the population abundance with age structure comprising age clases 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 plus group.

In order to test the sensitivity of the assessment to the use of the DEPM and acoustic biomass estimates as relative or absolute and to the DEPM age group plus in age 2+ or 3+ different exploratory runs have been performed. **Figure 10.7.1.1.3** shows that using both survey indices as relatives leads to noticeable decrease in the levels of recruitments and biomass in comparison to any other assessments with catchability fixed to 1 either for DEPM or both indices. The final effect of fitting catchabilities is to increase fishing mortality estimates. This arises through a general reduction of the fitting residuals to almost all input data, but particularly to the age structured indices and to the catches at age (**Table 10.7.1.1.1**). This accommodation to the data is achieved through the estimation of the catchability coefficients, which are very different for each age classes of the DEPM estimates, indicating that this survey shows higher catchability for older ages than for younger ones. This result is contrary to the perception of the performance of the survey (see Section 10.4.3 and Petitgas et al.WD2004). In addition this implies using the survey age structured indices as independent indices with catchabilities estimated independently from the total aggregated biomass index itself. All these new catchability parameters allows to better accommodate to all indices and catches at age and finally result in a virtual population estimate, scaled to the level of catches. 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 presumed for the surveys in order to scale the assessment. With this purpose DEPM has been used as an absolute index following previous assessments in this working group. All other assessment shown in the table are rather similar regardless DEPM alone or both indices are taken as absolute estimators. There is no reason for not accepting the levels of biomass provided by acoustics as absolute, except for the traditionally way of dealing this acoustic indices as relative. The overall similar levels of biomass of these two indices suggest that probably they both could be taken as absolute indices. In general it seems that acoustic indicates on average slightly higher levels of biomass than DEPM (by about 25% on average) as indicated by the catchability coefficients of acoustics (in first column of **Table 10.7.1.1.1**). If both indices were taken as absolute the compromise concerning the current perception of the SSB in 2004 will be only slightly higher as shown in the table (from about 28,000 to 30,500 t in SSB2004). The WG decided to continue with the past practice of the group of taking the DEPM as absolute since it suffices to scale the whole level of biomass of the assessment in a way rather consistent with the acoustic estimates as well. The WG is moving towards more appropriate assessment of the anchovy and therefore this year can be seen as an interim one in progress towards other type of models.

Collapsing the DEPM age structured in a 2+ age group instead of 3+ lead to a slightly better fitting to the DEPM at age composition and to the catches at age. This is due to a less number of ages to fit for the DEPM and to the omission of the age abundance information what conditioned the fishing mortality at age 3. The effect is the reduction in the selectivity of the fishery to the age 3 due to a small increase in recruitments and survivors (it changes from 0.84 to 0.46) improving thus the fitting to age 3 (**Table 10.7.1.1.2**). The estimation of a low fishing selectivity at age 3 compared to age 2 to is not congruent with a fishery which mainly targets big anchovies (the bigger they are the higher the prices). For that reason it is not believed that the small reduction of residuals justifies the change in the perception of the fishing pattern and therefore the WG decided to stay at the previous approach of inputing the DEPM with 3+.

The WG is attempting several improvements in the assessment of anchovy through the biomass model applied in previous years (see below). ICA assessment may be over parameterised and therefore this year can be seen as an interim one in progress towards other type of better models and software. From that point of view and along with exploratory analysis shown above, the WG did not find sufficient elements as to change from the previous setting of the ICA model (either to include acoustic as relative or to clump the 3+ into an 2+ group for DEPM), but confirm that the previous setting were still overall adequate.

10.7.1.2 Bayesian biomass-based model

In the last two WGMHSA (ICES CM 2003) a biomass delay-difference model (Schnute, 1987), based on the model applied to squid by Roel & Butterworth (2000), has been attempted for modelling the Bay of Biscay anchovy population dynamics as an alternative to the standard ICA assessment.

The model seeks to estimate recruitment at age 1 at the beginning of each year (in mass) accounting for the signals of inter-annual biomass variations obtained from the direct surveys (DEPM and acoustics) and the level of total catches (in tonnes) produced each year. Two different seasons are considered. The first period goes from the 1st January to the 15th May and allows to obtain intermediate population biomass estimates at the time the surveys are usually conducted, so that fitting can be made. The second period just leads the surviving biomass to the beginning of the next year, when the new recruitment at age 1 enters into the population. Denoting by $B_{y,s,a}$ the population biomass (in tonnes) at the beginning of the period s of year y of the age class a, the biomass dynamic model can be formulated as follows:

For the first period the total biomass is equal to the new recruitment (in mass) and the biomass surviving from the previous year

$$B_{y,1,1+} = B_{y,1,1} + B_{y,1,1+} = B_{y,1,1} + B_{y-1,2,1+}e^{-gf_2} - C_{y-1,2,1+}e^{-g(f_2-h_2)}$$

and for the second period, the total biomass equals to that surviving since the beginning of the year

$$B_{y,2,1+} = B_{y,1,1+}e^{-gf_1} - C_{y,1,1+}e^{-g(f_1-h_1)}$$

where, g is a biomass decreasing rate accounting for growth G and natural mortality M rates (g = M – G = 1.2 - 0.52 = 0.68), f_1 and f_2 are fractions of the year corresponding to each period ($f_1 = 0.375$ and $f_2 = 0.625$) and h_1 and h_2 are fractions within each period corresponding to the elapsed time from the beginning of period to the date when catches were taken on average.

Total biomass and biomass at-age-1 estimates from the direct surveys (DEPM and Acoustics) are assumed to follow log normal observation error distributions.

Table 10.7.1.2.1 presents the input data used for fitting the biomass dynamic

In the two last years the model was fitted by a non-linear minimisation of the following objective function (in an Excel workbook):

$$\sum_y \left(\ln(B_{depm,y,2,1}) - \ln(q_{depm}B_{y,2,1})\right)^2 + \sum_y \left(\ln(B_{depm,y,2,1+}) - \ln(q_{depm}B_{y,2,1+})\right)^2 +$$
$$+ \sum_y \left(\ln(B_{ac,y,2,1}) - \ln(q_{ac}B_{y,2,1})\right)^2 + \sum_y \left(\ln(B_{ac,y,2,1+}) - \ln(q_{ac}B_{y,2,1+})\right)^2$$

where the recruitment at the beginning of the year $B_{y,1,1}$ is constrained to be greater than 3,000 tonnes just to avoid any negative values.

This year this model has been implemented as a Bayesian state-space model, in which the sampling from the posterior distribution of the parameters is done using Markov chain Monte Carlo (MCMC) algorithms (Gilks et al. 1996). The specification of the prior distribution of the parameters ($\log(q_{depm})$, $\log(q_{ac})$, ψ, B_0 and R_y for all years y) and the description of the MCMC algorithm are given in the working document (Ibaibarriaga et al. WD2004)

Similarly to ICA, in order to test the sensitivity of the assessment to the use of the indices as relative (catchability unknown parameter) or absolute (catchability fixed to 1), the biomass dynamic model has been fitted using both DEPM and acoustics as relative indices, DEPM as absolute and acoustic as relative, DEPM as relative and acoustic as absolute and both as absolute. **Figure 10.7.1.2.1** compares the posterior median recruitments (in mass) biomass for these cases. When both indices are considered as relative recruitments tend to increase, whereas catchabilities decrease. As pointed out in Ibaibarriaga et al this is due to a mis-identification problem in the model. In order to solve this and with consistency with the ICA assessment, DEPM has been considered as absolute and only the catchability of the acoustic survey is estimated. Posterior medians of the recruitment with the correspondent confidence intervals are shown in **Figures 10.7.1.2.2 and 10.7.1.2.3.** Results from the Bayesian approach is compared with the least squares estimates from the same model in **Figure 10.7.1.2.2** and with the ICA results in **Figure 10.7.1.2.3**. Posterior distribution of the current level of spawning biomass for 2004 is shown in **Figure 10.7.1.2.4**.

10.7.2 Stock assessment

As the biomass-based model and the new approach as a Bayesian state-space model are still under development, this year only the standard ICA assessment is presented as the final one (see above for details fo the Biomass model for anchovy).

ICA

Inputs for the assessment with ICA (patterson and Melvin 1996) are summarised in **Table 10.7.2.1.** The assessment uses as tuning data the DEPM (1987- 2004, 17 surveys) and the Acoustic (1989-2004, 11 surveys available) estimates both as indices of biomass and as population in numbers at age. The Acoustic estimates are treated as relative and DEPM as absolute; and both are down-weighted to 0.5 (because of the double use made of the indices as aggregated and disaggregated by age indices). For 1996, 1999 and 2000 the DEPM SSB biomasses included in the assessment are the ones obtained from models relating the Egg production and final estimates of Biomass for these surveys. For 2004 the DEPM estimate is based on assumed Spawning Frequency (see Section 10.4.1). Catch-at-age data on an annual basis are presented in the **Table 10.7.2.1.** The assessment performed used similar settings to the ones chosen for the 2003 assessment. The assessment assumes a constant natural mortality of 1.2, around the average value estimated earlier (Anon., 1995/Assess: 2, Prouzet et al. 1999).

The separable model of fishing mortality is applied over a period of 15 years (1989-2003), where the first two years (1987, 88) will be subject to a VPA based estimate. 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 down-weighting results in an improvement in the fitting of the separable model to ages 1 and 2 (ICES CM2002).

The assessment was achieved by a non-linear minimisation of the following objective function:

$$\sum_{a=0}^{a=4}\sum_{y=1989}^{y=2003}\lambda_{a,y}\left(Ln(C_{a,y})-Ln(F_y\cdot S_a.\overline{N}_{a,y})\right)^2$$

$$+\lambda_{DEPM}\sum_{y=1989}^{y=2004}\left[Ln(SSB_{DEPM})-Ln\left(\sum_{a=1}^{5}N_{a,y}\cdot O_a\cdot W_{a,y}\cdot\exp(-P_F F_Y\cdot S_a-P_M.M)\right)\right]^2$$

$$+\sum_{y=1989}^{2004}\sum_{a=1}^{3+}\lambda_{DEPM,a}\left[Ln(SP_{DEPM,a,y})-Ln(N_{a,y}\cdot\exp(-P_F\cdot F_y\cdot S_a-P_M\cdot M))\right]^2$$

$$+\lambda_{acoustics}\sum_{y=1989}^{2004}\left[Ln(SSB_{acoustic})-Ln\left(Q_{acoustic}\sum_{a=1}^{5}N_{a,y}\cdot W_{a,y}\cdot\exp(-P_F F_Y\cdot S_a-P_M.M)\right)\right]^2+$$

$$+\sum_{y=1989}^{2004}\sum_{a=1}^{2+}\lambda_{acoustics,a}\left[Ln(SP_{acoustic})-Ln(Q_{a,y}\cdot N_{a,y}\cdot\exp(-P_F\cdot F_Y\cdot S_a-P_M\cdot M))\right]^2$$

with constraints on:

$S_2=1$, $S_5=S_4=0.79$

and for reaching the interim year 2003 $F_{2004}=F_{2003}$ and weight at age in the stock in 2004 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

F_Y : Annual fishing mortality for the separable model

S_a : selection at age for the separable model

P_F and P_M : respectively proportion of F and M occurring until mid spawning time

$C_{a,Y}$: catches at age *a* the year *Y*

Q_a and $Q_{a,Y}$: catchability coefficients for the acoustic survey

SSB_{DEPM} and SSB_{acoust} : Spawning Biomass estimates from DEPM and Acoustic methods

SP_{DEPM} and SP_{acoust} : Spawning populations at age from DEPM and acoustic methods

$\lambda_{a,Y}$: 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)

λ_{DEPM} and $\lambda_{acoustics}$ are the weighting factor for the indices and/or ages (all equal a priori to 0.5) (see last portion of Table 11.7.2.2)

Results of the assessment are presented in **Table 10.7.2.2 and Figure 10.7.2.1.**

This assessment shows a slight increase of biomass in 2004 compared to 2003, which was one of the two lowest biomasses of the series since 1987. This is due to the low recruitment levels occurred in 2001 and 2002. Current assessment confirms the drop of the fishing mortality levels since 1998 as noted in past years.

10.7.3 Reliability of the assessment and uncertainty of the estimation

The assessment with ICA is heavily influenced by the surveys (DEPM and acoustics). The model fits well the aggregated indices of biomass, with no skewness or kurtosis and no clear trends in the log-residuals (**Table 10.7.2.2 and Figure 10.7.2.1**). The absolute residuals from the separable model are high both across years and ages, particularly for ages 0 and 3 onwards, which are the ones down-weighted in the assessment. The best fit is achieved for ages 1 and 2, which are the most important age groups in the catches and the population. The assessment shows a well-defined minimum at the converged level of fishing mortality for the most recent year in the analysis (2003).

As mentioned in the exploratory analysis Section (10.7.1) and in the comparison of surveys (10.4.3) the current assessment relies heavily in the assumption of absolute biomass estimates on at least one of the two surveys (in this case the DEPM) and difficulties arises for the years when both direct surveying methods (DEPM and acoustics) produce rather different estimates. In those cases the ICA assessment arrives to some sort of compromise helped by the analysis of catches at age (**Figure 10.7.3.1**). As such for year 2000 the current ICA estimate (89,255t) points closer to the acoustic estimate (98,484t) than to the DEPM estimate (45,000 t). Nevertheless both surveys were coincident to show a strong reduction of the spawning population in 2003, which matched a strong failure of catches in the fisheries of both countries (see Section 10.2). The differences in the 2004 estimates of biomass by both surveys (DEPM at 18,100 t and acoustic at 46,000t) is solved by ICA pointing to middle point at about 27,500 t, which is a bit closer to the DEPM than to the acoustic partly due to the assumption of absolute biomass estimator of DEPM. As seen in Table 10.7.1.1 the adoption of acoustic as absolute estimator would have led to SSB estimate by ICA of 30,500.

The biomass dynamic model gave similar and consistent results with ICA for most of the years (**Figure 10.7.3.1**) including 2004. Major differences in both recruitment and spawning biomass were found in 1993 and 2000. It should be noticed that for 1993 there is no survey (neither DEPM nor Acoustics) available for tuning the biomass model while ICA makes use of the catch-at-age data. In 2000 the surveys provide only aggregated indices that pointed out to different levels of biomass. The biomass model estimate is close to the mean value of both indices estimates whereas the use by ICA of the age structure favours the acoustics estimate. The ICA estimates are centred within the posterior distribution of the biomass estimates of the Bayesian method. Beyond this, the consistency between both types of assessments reflects on one hand, that the catches at age data do not contain very contrasting information. And on the other hand, that with the current ICA settings the spawning biomass is basically driven by the survey's information. The surveys themselves contain sufficient information of recruitment and spawning biomass. The ICA biomass estimate for the final is basically driven by the surveys while they are used as absolute. Catch at age analysis for this short live species cannot converge to the true population levels and makes the results of the assessment absolutely dependent of the survey indices. Both assessments point out that recruitments at age 0 in 2001 and 2002 are close to the lowest values of the series and that recruitment was probably better in 2003.

The two different direct estimates of spawning biomass (DEPM and Acoustics) are within the posterior distribution of biomass in 2004 arising from the Bayesian Biomass model (**Figure 10.7.1.2.4**). Therefore that posterior distribution may well reflects the uncertainties in the perception of the population arising from the current assessment, i.e. that current biomass may be somewhere between 15 and 50 thousands tonnes and probably above the 2003 level.

On the other hand uncertainties arising in the definition of year class strength between assessments made at consecutive years have not appeared this year but they appeared in previous years (see **Table 10.7.3.1**). This may cause concern if those readjustments were caused by simply the addition of new year classes in the information by ages coming from catches or surveys (Petitgas and Massé WD2004). The major changes recorded for the last years concerns the raising up of 1998 and 1999 cohorts and the reduction of the 2000 one. However those changes were not only to the new catches at age but mostly to corrections of preliminary estimates arising from the surveys: In 2001 the acoustic preliminary estimate for 2000 in Sept that year (about 50,000 t) was doubled what lead to increase of 1998 and 1999 year classes. In 2003 the 2002 DEPM SSB estimate was reduced from 50,900 to 30,700 tonnes, which explained reduction of the 2000 year class. And for instance in this year, the DEPM biomass estimate for 2003 is corrected and reduced by 20% (Santos et al. WD20004). This lead to the problem of the reliability of the preliminary estimates used to feed the integrated assessment in the interim year, upon which all the assessments rely. There is a clear requirement of assuring the quality of the preliminary estimates in order to improve the advice for the management of the fishery.

The simplicity and potential showed by the biomass dynamic model makes it appealing for the characteristics of this population. In addition the Bayesian framework presented here allows to infer the uncertainties of estimates by their posterior distribution, include additional information through the prior distribution and to derive naturally projections of the population for following years. However, this approach is still being tested and further development of the model itself is ongoing, particularly for avoiding the inherent correlation of the indices of DEPM and acoustics direct surveys being used both as total and as age-1 biomass indices (Ibaibarriaga et al. WD2004).

The WG group considered that the biomass Model can be as good as ICA (with less risk of over-parameterisation) and therefore considers that proper standardisation and testing of the Bayesian models already proposed should be made for the next year so that it can stand alone as an alternative method for the assessment of anchovy.

The estimates from ICA and the Bayesian biomass-based model agrees on a biomass of around 28 000 tonnes, and therefore the overall SSB level is certainly at lower levels than those estimated for previous years as 2000 or 2001. Furthermore the ICA estimate is within the 95% credibility interval (20 300-38 900) from the biomass based model.

10.8 Catch predictions

The anchovy population and the fishery are largely dependent on the incoming recruitment, which takes place in the interim year of the assessment (as age 0). However no recruitment index is nowadays available for anchovy. And hence the strength of the recruitment occurring during 2004 is unknown.

And for these reasons The WG is unable to provide a forecast for the next two years.

For the purposes of obliging the terms of reference and in consistency with previous years procedures the WG provides a deterministic projection based on a precautionary scenario of recruitment. However, the WG wants to clearly state that by the time being this recruitment scenario is as plausible as any other, and that therefore that scenario is by no way a proper catch forecast. It is just a deterministic projection of the population in a precautionary scenario.

Given the uncertainty associated to the recruitment level, a stochastic approach seems to be more adequate. The Working group considered that even for a single selected scenario a probabilistic projection would give a better understanding of the scenario than the deterministic projection. So, in addition, and for illustration purposes a subsection is also included, in which the levels of biomass for the following years under different fixed catch options are estimated from the posterior distributions of the biomass and recruitment levels arising from the Bayesian biomass-based model. The Bayesian biomass model provides a natural framework to provide population projection including both uncertainty of the current estimates and the variability in the recruitment.

Standard deterministic age structured catch prediction

As the level of recruitment (age 0) during this year, 2004, is unknown, a precautionary scenario for the recruitment occurring in this a two next years was adodpted. This approach assumes the recruitment is the geometric mean of those equal or below the median in the historical series. (Geometric mean of 1987, 88, 90, 93, 94, 98, 2001, 2002 and 2003, what equals to 7,108,542 millions).

Two Catch projections were made:

Based on a catch constraint of 16,200 t for 2004, consistent with the development of the fishery. This results from the assumption of French catches for the second half of 2004 to be at a similar level as past year. And Spanish catches for this period being consistent with the historical half year percentages of the Spanish fishery.

Projection under F status quo assumption. The status quo fishing mortality was set equal to the average of the last 7 years (1997-2003), the period of rather constant fishing mortality.

The projections were made making use of the population at age 1 in 2004 estimated directly from the ICA assessment output despite of being dependent on the preliminary biomass estimates from the surveys. Weights at age in the catch correspond to the average values recorded since 1989 (15 years). Weights at age in the stock correspond to the average from 1990 (the first year of accurate assessment of this parameter, 15 years in total). **Table 10.8.1** summarizes the inputs for the deterministic projection of the anchovy population for next year common for both procedures: catch constrain and F status quo.

The results under the catch constraint scenario are given in **Tables 10.8.2a**.

Table 10.8.2b summarizes the outputs for the deterministic projection under F status quo for 2004. This projection gives for 2004 an interim catch of about 9891tonnes, what is considered too low.

Projections from the Bayesian biomass-based model

The Bayesian approach provides a natural way of projecting forward the posterior distribution of the spawning biomass at the beginning of the second period in 2004, B($f_{1,2004}$,1+), resulting from the biomass-based model in Section 10.7.1.2. (See **Figure 10.7.1.2.4**)

Recruitment for following years is assumed to be a mixture of the posterior distributions of the recruitments from the biomass-based model in Section 10.7.1.2, i.e.

$$R_y \sim \sum_{j=1987}^{2004} w_j \, \pi(R_j | \, rest) \quad \text{where} \quad \sum_{j=1987}^{2004} w_j = 1 \ .$$

Three different scenarios for recruitment were considered:

Low recruitment, in which the weights, w_j, are chosen so that the years in which median posterior recruitment is below the median of the posterior median recruitments are equally weighted, whereas for the ones above null weights are given.

Medium recruitment, in which all the years are equally weighted.

High recruitment, in which the weights, w_j, are chosen so that the years in which median posterior recruitment is above the median of the posterior median recruitments are equally weighted, whereas for the ones below null weights are given.

Distributions of incoming recruitment under the different scenarios are shown in **Figure 10.8.1.** Combining the posterior distribution of the current biomass level and the distribution of the incoming recruitments allows obtaining the distributions of unexploited biomass in 2005 and 2006, ie, assuming no catches in the remaining of 2004 and in years 2005 and 2006 (**Figure 10.8.2**).

According to the biomass-based model in Section 10.7.1.2 catches are just removed from the biomass in each on the periods. The fractions of year corresponding to the elapsed time from the beginning of the year to the date when catches are taken on average (h_1 and h_2) are taken as the mean of previous years. Based on information about this year catch levels and knowledge from the historical catch series catch for the second period (from mid-may to the end of the year) in 2004 is taken as 13 000 tonnes (what implies an estimated annual catch of about 16,200 t).

Different levels of catches in the first half year of 2005 and 2006 and in the second half year of 2005 covering a range from 0 to 20 000 tonnes by halves of the year are considered in **Tables 10.8.3**, **10.8.4** and **10.8.5** The implications of any cross selection of allowable catches in this half-yearly basis are presented in terms of the 95% intervals of spawning biomass and probabilities of falling below Blim and Bpa. Annual catches results from the addition of the catches in the two half-year periods.

A similar study but in terms of total annual catch is presented in **Tables 10.8.6**, **10.8.7** and **10.8.8** Annual catches range from 0 to 40 000 tonnes. Proportion of catches in each of the periods is assumed to be at the historical level of percentages.

10.9 Reference points for management purposes

Reference points, B_{pa} and B_{lim}, were originally defined for this stock by ACFM (ICES CM 1998/ Assess 6:) at 18,000t for Blim (the minimum biomass estimate of the series) and at 36,000t for Bpre (which was not equal to Bpa) (see previous year report for further explanations (ICES 2004).

Last year ACFM (October 2003) redefined these biological limits:

ICES considers that:	ICES proposes that:
$\mathbf{B}_{lim}$ is 21 000 t, the lowest observed biomass in 2003 assessment.	$\mathbf{B}_{pa}$=33 000 t.
There is no biological basis for defining .	be established between 1.0-1.2.

Technical basis:

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

The uncertainties in the current ICA assessment makes that SSB estimates may be subject to inter annual variability, and therefore can give varying perceptions of Bloss and thus Blim (see Table 10.7.3.1). In spite that current SSB estimates for 1989 and 2003 might be at about 19,500 t just below Blim, the uncertainties in the assessment leads the wg not to advice any change in the Blim definition.

Given the short living of this species, the WG considered the Bpa as poor guidance for management of the population. If harvest control rules are implemented the current Bpa would be redundant.

10.10 Harvest Control Rules

A regime consisting of an initial annual TAC, which is revised in the middle of the year, after the survey estimate of biomass becomes available, was tested by means of a simulation framework during last WG (in 2003). This attempt was not taken into consideration by ACFM in 2003 even if they considered it was a progress in the management considerations of anchovy for the future.

The simulation framework consisted of an operating model of the stock dynamics and a model of the management process containing the harvest rules. This year the WG has not been able of further progressing in that line of research and therefore it just refer to past year WG report (ICES2004) Section 11.10 for considerations. However noticed that the reference points for management corresponding to such analysis were those valid in that previous years (Blim=18,000, Bpa:36,000), and not to those adopted last year by ACFM (see Section 10.9).

The options of management explored last year are examples of obvious interest to managers and were presented for the purpose of promoting a discussion with interest parties and managers. The WG considered that current or other management procedures should be considered by managers for the WG to further evaluate or to test; and according to those analysis managers could take decisions. It is not the role of the WG to propose a concrete Harvest Control Rule given the direct implications it may have on the fisheries involved and that very different HCR may have similar levels of risk but very different implications to the fisheries involved. The development of harvest control rules for anchovy would therefore require the interaction between managers, stake holders and scientists.

10.11 Management Measures and Considerations

This resource has been managed since 1979 to 2003 through the establishment of fixed annual TACs.

Management goals and ICES

From a biological point of view, managing this type of short living population in the context of the PA should aim at assuring minimum levels of Spawning biomass above Blim in the context of a moderate exploitation such as F between F40% and F66% of SPR (spawning per recruit). This can be achieved by setting goals related to:

- Maximize recruitment to spawning.
- Assure a minimum amount of survivors at the end of the year to enter new year as a buffer for the cases of low recruitment entering the population.

Since 1999 ICES suggests setting management objectives compatibles with the reference points given in **Section 10.9** aiming at minimizing the risk of falling below Blim.

Reviewing potential Management procedures solely based on TACs

The problem of the current management by annual TACs is that no reliable forecasting procedure of the recruitment entering to the population is available and thus TACs have been set so far regardless of what the actual level of recruitment will be. In this way the TAC procedure is not operative to prevent any stock overfishing.

The only way to overcome this situation is either by setting predictor tools of recruitment in advance to the setting of the initial (or annual) TACs and/or providing other alternative management tools that would meet the goals of the management in accordance with the PA policy of the EU (operative environmental or ecological indices).

The ICES, in the absence of recruitment indices, has proposed a two stage TAC management procedure. And to set the initial TAC ICES says: "An annual TAC based on the calendar year cannot be advised because of the inability to make a reliable prediction of the catch possibilities for the calendar year. Therefore, ICES advises revisiting a preliminary TAC in-season. To be precautionary, the preliminary TAC should be set conservatively. The criteria for revision of the TAC could be based on spawner escapement considerations, i.e. restricting the fishery so that the spawning biomass remains above Bpa (33 000t)".

These last year's STCEF advice has supported the precautionary approach of ICES with some minor modifications (such as being below a minimum biomass level for setting the two step TAC procedure). There is a general overall agreement on the need to elaborate harvest control rules for this fishery.

The exploration of harvest control rules made in the past year report (ICES 2004) (Section 10.10) pointed out several issues upon which managers would have to decide in the process of selection of HCR. Particularly, the average level of risk of falling below Blim, average level of catches and variability of allowed catches (or TACs) either between years or within years concerning the initial and updated TACs. Maximum or minimum TACs can also be decided. And they can also make a choice of desired ratios between initial and final TACs for each year, which have immediate impact on the seasonal national fisheries.

Given the benefits shown in the exploration of harvest control rules when Recruitment indices are available (in last year report), the WG recommends to establish direct surveys on juveniles (0 group) or pre-recruits (1 year old) in order to improve advise for the management of this fishery. They strongly recommend to Ifremer and AZTI to collaborate in order to increase their effort by coordinating their respective surveys or doing a common one.

Alternative management proposals

French surveys carried out in the Bay of Biscay since 2000 comprised acoustics, CUFES, hydrology, primary and secondary production, genetics and even top predator components such as mammals and birds during the last 2 years. Based on this, it is apparent that the evolution of the anchovy population is strongly dependant on environmental factors as well as the fishery itself. A study of anchovy population dynamics in the Bay of Biscay (Vaz & Petitgas, 2002) presented last year showed the large effect of the first year mortality on the population dynamics and confirmed the importance of recruitment for this anchovy stock. It showed that a permanent increase of the first year mortality would have resulted in population extinction and, that a reduction would have resulted in short term population demographic explosion. This study also revealed the particular importance of the area of the Gironde estuary where a substantial part of the total spawning population can be found. The spatial distribution of length was very consistent across years: the habitat of small fish (age-1 predominantly) was coastal and related to river plumes of Gironde and Adour. Fixed strata were defined and served to build a spatially explicit age-specific matrix population model. The model was used to evidence the contribution of the life history traits on the dynamics of the stock and as well as that of spawning habitats. The study also showed that changes in the fertility rates of the first reproducing age class (age class 1) or in the mortality rates in the first age class (age class 0) of the population could result in large variations in the global population growth rate. Therefore, the growth of the modelled population strongly depended on both first year mortality and fertility rates in the Gironde area.

Based on this, new management considerations for future harvest strategies are being considered in ongoing studies. These strategies go beyond just a single TAC regulation. This might include:

- Limiting fishing during the first semester in particular areas known to be important for the stock dynamics (e;g; Gironde area, or the area which was already accepted in 2000), where the fishery could be closed at least for certain periods and/or a minimum landing length to avoid catches of 0 group and young 1 group
- Imposing minimum sizes to fish in the landings by recommending a maximum grade to protect age 0 and 1 before spawning. A maximum grade around 50 (the exact level should be determined) would be preferred to a minimum size, which will probably induce discard after sorting.

The exploration carried out in the working group in 2003 of the impact harvest control rules, incorporating a protection of the recruits suggest that such measures will result in better utilisation of the stock. Nevertheless, studies were still in progress in 2004 but it was not possible to give better suggestions during 2004 WG. To run models taking into consideration ecological parameters as stated by Vaz et al (2002), it is first necessary to have a good knowledge of the fishery in terms of seasonal, geographical distribution and number of vessels. The main progress in 2004 has been to have a better analysis of the French fleet (numbers of vessels and localisation of catches by month) which will be continued in the coming months. The same information will also be required for the Spanish fishing fleet operating mainly in spring.

No further information was available for this WG concerning alternative management proposals, but WG members strongly encouraged to enforce their studies in this way so that alternative management proposals for future harvest control for anchovy, beyond just a single TAC regulation, would be proposed, which will be very promising.

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(1st half)	1,616	7,000	n/a	8,616
AVERAGE (1990-03)	14,400	15,232	291	29,840

***Provisional estimate Up to 1 st Sept 2004**

Table 10.2.1.2. Monthly catches of the Bay of Biscay anchovy by country (Sub-area VIII) (without live bait catches)

COUNTRY: FRANCE Units: t. 1000

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 (prelim)	210	106	3	11	142	1,144							1,616
Average 87-03	1,154	1,010	582	361	561	929	808	1,804	2,569	1,770	1,092	42	12,680
in percentage	9.1%	8.0%	4.6%	2.8%	4.4%	7.3%	6.4%	14.2%	20.3%	14.0%	8.6%	0.3%	100%
Average 92-03	1,467	1,246	771	140	235	1,201	1,072	2,212	3,005	2,261	1,480	17	15,107
in percentage	9.7%	8.3%	5.1%	0.9%	1.6%	8.0%	7.1%	14.6%	19.9%	15.0%	9.8%	0.1%	100%

COUNTRY: 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 (prelim)	0	0	0	2,357	3,092	1,403							6,853
Average 87-03	61	49	363	2,458	6,638	2,371	642	360	499	268	253	128	14,092
in percentage	0.4%	0.3%	2.6%	17.4%	47.1%	16.8%	4.6%	2.6%	3.5%	1.9%	1.8%	0.9%	100%
			3.4%			81.4%			10.7%			4.6%	
Average 92-03	72	65	297	2,838	7,225	2,598	764	182	468	283	180	65	15,035
in percentage	0.5%	0.4%	2.0%	18.9%	48.1%	17.3%	5.1%	1.2%	3.1%	1.9%	1.2%	0.4%	100%

COUNTRY: Total FRANCE + SPAIN

	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
Average 92-03	1,539	1,311	1,068	2,978	7,459	3,799	1,836	2,394	3,473	2,545	1,660	83	30,142
in percentage	5.1%	4.4%	3.5%	9.9%	24.7%	12.6%	6.1%	7.9%	11.5%	8.4%	5.5%	0.3%	100%

Table 10.2.1.3: ANCHOVY catches in the Bay of Biscay by country and divisions in 2003 (without live bait catches)

COUNTRIES	DIVISIONS	QUARTERS				CATCH (t)	
		1	2	3	4	ANNUAL	%
SPAIN	VIIIa	0	0	0	0	0	0.0%
	VIIIb	0	841	100	0	941	31.4%
	VIIIc	0	2,007	46	7	2,061	68.6%
	TOTAL	0	2,848	147	7	3,002	100%
	%	0.0%	94.9%	4.9%	0.2%	100.0%	
FRANCE	VIIIa	4	4	3,988	2,317	6,312	83.1%
	VIIIb	37	1,182	58	4	1,281	16.9%
	VIIIc	0	0	0	0	0	0.0%
	TOTAL	41	1,185	4,046	2,321	7,593	100%
	%	0.5%	15.6%	53.3%	30.6%	100.0%	
INTERNATIONAL	VIIIa	4	4	3,988	2,317	6,312	59.6%
	VIIIb	37	2,022	159	4	2,222	21.0%
	VIIIc	0	2,007	46	7	2,061	19.5%
	TOTAL	41	4,033	4,193	2,328	10,595	100.0%
	%	0.4%	38.1%	39.6%	22.0%	100.0%	

The separation of Spanish catches during the second half of the year between VIIIa and VIIIb are only approx. estimations

Table 10.3.1.1: ANCHOVY catch at age in thousands for 2003 by country, division and quarter (without the catches from the live bait tuna fishing boats).

units: thousands

SPAIN	QUARTERS	1	2	3	4	Annual total
	AGE	VIIIbc	VIIIbc	VIIIabc	VIIIabc	VIIIabc
	0	0	0	0	49	49
	1	0	11,761	4,724	171	16,656
	2	0	32,566	1,011	57	33,634
	3	0	28,809	269	3	29,081
	4	0	434	0	0	434
	TOTAL(n)	0	73,569	6,003	282	79,854
	W MED.	0.00	38.77	24.77	25.84	37.67
	CATCH. (t)	0.0	2848.1	146.6	7.2	3,001.9
	SOP	0.0	2852.5	148.7	7.3	3,008.5
	VAR. %	0.00%	100.16%	101.40%	101.15%	100.22%

FRANCE	QUARTERS	1	2	3	4	Annual total
	AGE	VIIIab	VIIIab	VIIIab	VIIIab	VIIIab
	0	0	0	5,894	1,587	7,481
	1	1,908	36,659	88,456	39,731	166,754
	2	348	11,633	53,032	33,042	98,055
	3	121	5,203	5,888	5,299	16,511
	4	12	441	564	588	1,605
	TOTAL(n)	2,389	53,936	153,834	80,247	290,406
	W MED.	17.01	21.97	26.30	28.94	26.15
	CATCH. (t)	40.6	1185.3	4046.0	2321.2	7,593.1
	SOP	40.6	1185.0	4046.0	2322.1	7,593.8
	VAR. %	100.05%	99.98%	100.00%	100.04%	100.01%

TOTAL Sub-area VIII	QUARTERS	1	2	3	4	Annual total
	AGE	VIIIabc	VIIIabc	VIIIabc	VIIIabc	VIIIabc
	0	0	0	5,894	1,636	7,530
	1	1,908	48,420	93,180	39,903	183,410
	2	348	44,198	54,042	33,100	131,688
	3	121	34,012	6,157	5,303	45,592
	4	12	875	564	588	2,039
	TOTAL(n)	2,389	127,505	159,837	80,529	370,260
	W MED.	17.01	31.67	26.24	28.93	28.63
	CATCH. (t)	40.6	4033.4	4192.6	2328.4	10,595.0
	SOP	40.6	4037.5	4194.7	2329.4	10,602.2
	VAR. %	100.05%	100.10%	100.05%	100.04%	100.07%

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 t**
Units: Thousands

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 Cat	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 Cat	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
Periods	1st half	2nd half	1st half
Age 0	0	7,530	0
1	50,327	133,083	237,564
2	44,546	87,142	70,641
3	34,133	11,459	10,537
4	887	1,152	97
5	0	0	0
Total #	129,893	240,366	318,839
Internat Cat	4,074	6,521	8,616
Var. SOP	100%	100%	
Annual Catch		10,595	

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 Spai	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
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
Age 0	0	52,238	0	91,400	0	4,075	0	29,057	0	439	0	748	0	239	0	49	
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	182,158
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	61,443
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	7,139
4	2,213	42	0	0	155	0	108	0	0	0	4,948	0	0	0	434	0	
5	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	250,740
Catch Spai	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	6,858
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%	
Annual Catch		19,135		10,317		8,630		13,610		19,230		23,052		6,519		3,002	

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 Franc	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
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
Age 0	0	56,936	0	41,832	0	0	0	25,300	0	4,859	0	1	0	29	0	7,481	
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	55,406
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	9,197
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	3,398
4	0	0	0	0	0	0	0	0	0	0	0	0	76	0	453	1,152	97
5	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	68,099
Catch Franc	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	1,616
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%	
Annual Catch		15,238		11,830		22,987		13,649		17,765		17,097		10,988		7,593	

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. WD1997)

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	465.13	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
0	n/a	n/a
1	n/a	n/a
2	n/a	n/a
3	n/a	n/a
Total	n/a	n/a
Catch (t)	n/a	n/a
mean W (g)	n/a	n/a

Table 10.3.2.1. Length distribution ('000) of anchovy in Dividion VIIIa,b,c by country and quarters in 2003

	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			8					
9.5			48					
10	19		28		38			
10.5	21		516		51		2	
11	60		1,073		137		33	
11.5	81		2,562	2	186		45	
12	156		3,820	21	401		178	
12.5	268		4,446	21	761		138	
13	478		4,340	266	1,565	80	530	4
13.5	361		4,271	458	3,982	150	933	7
14	224		3,607	1,263	8,926	301	2,500	12
14.5	179		4,459	1,537	20,667	1,621	4,794	67
15	172		6,466	2,242	27,726	1,871	7,414	77
15.5	158		6,325	3,105	28,733	1,074	11,929	52
16	115		4,818	3,657	29,165	375	17,637	21
16.5	46		3,256	6,458	14,504	150	14,609	21
17	26		1,810	12,217	7,796	118	9,105	9
17.5	12	1	1,160	13,028	3,660	33	4,881	3
18	6		384	12,939	2,394	47	2,367	2
18.5	5		296	8,361	2,054	109	1,278	4
19	4		243	5,484	992	66	1,238	2
19.5			76	1,769	94	6	497	
20				274		0	140	
20.5				466		3		
21								
21.5								
22								
22.5								
23								
23.5								
24								
24.5								
25								
25.5								
26								
Number('000)	2,391	1	54,013	73,569	153,834	6,003	80,247	282
Catch (t)	41	0	1,186	2,848	4,046	147	2,321	7
Mean Length(cm)	#NAME?	#NAME?	#NAME?	#NAME?	#NAME?	#NAME?	#NAME?	#NAME?
Mean weight(g)	16.99		21.95	38.71	26.30	24.43	28.92	25.54

Table 10.3.2.2.: Mean weight at age in the international catches of anchovy in SubArea VIII on half year basis
Units: grams

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 :	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 :	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	
Sources:	WG data	
Periods	1st half	2nd half
Age 0	0.0	15.4
1	21.0	25.4
2	36.2	29.5
3	40.3	36.4
4	36.9	37.9
5	0.0	0.0
Total	31.4	27.1
SOP	4,078	6,524
mean weight :	40.3	36.4

TABLE 10.4.1.1 Daily Egg Production Method.: Egg surveys on the Bay of Biscay anchovy.
Taken from ICES (2004 mhsawgReport) and updated for years 2003 and 2004 according to Santos et al. (WD2004) and Santos and Uriarte (WD2004).

YEAR		1987	1988	1989(*)	1990	1990	1991	1992	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Period of year		2 - 7 June	21 - 28 May	10 - 21 May	4 - 15 May	29 May- 15 June	16May- 07Jun	16May- 13Jun	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
Julian Mid Day		155	145	136	130	158	148	151	146	138	144	135	149	149	131	147	134		
Positive area (km^2)		23,850	45,384	17,546	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
Surveyed area (km^2)		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
Po (Egg/ 0.05m^2)(+ Area)		4.60	5.52	2.08	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
Total Daily Egg Production		2.20	5.01	0.73	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
(* 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
SSB (t)		**29,365**	**63,500**	**11,861**	**97,239**	**77,254**	**19,276**	**90,720**	**60,062**	**54,700**	**39,545**	**51,176**	**101,976**	**69,074**	**44,973**	**124,132**	**30,697**	**23,962**	**18,113**
	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	0.20
TOTAL anchovy numbers		1,129	2,675	470	5,843		966	5,797	2,954	2,644		3,738	6,282			6,048	1,039	1,296	908
(millions)	C.V.						0.14	0.25	0.19	0.11		0.16	0.13			0.23	0.1451	0.29	0.23
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**	**775.0**
	C.V.						0.16	0.26	0.23	0.13		0.17	0.15			0.27	0.30	0.30	0.25
(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**	**107.3**
	C.V.						0.17	0.22	0.19	0.23		0.10	0.14			0.22	0.13	0.34	0.25
	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**	**26**
	C.V.						0.42	0.51	0.30	0.30		0.27	0.36			0.37	0.14	0.38	0.29

(*) Likely subestimate according to authors (Motos &Santiago,1989). It inputs the assessment raised up by 1sd (DEPM SSB89=16,720 t)
(**) Estimates based on a log lineal model of biomass as function of positive spawning area and Po (Egg production per unit area)
(***) Estimates based on a log lineal model of biomass as function of positive spawning area and Po (Egg production per unit area) and Julian day of the mid day of the survey

Table 10.4.2.1: 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
DATE	20/4-25/4	30/4-13/5	23/4-2/5	12/4-25/4	6/4-29/4	13/4-30/4	15/5-27/5	6/5-22/5	20/5-7/6	18/04 - 14/05	27/04 - 6/06	6/05 - 6/06	27/5 - 25/6	27/4 - 25/5
Surveyed area	3,267	3,743	5,112	3,418 (3)	3388 (3)	2440(3)	2300(3)	1726(3)	9,400 5600 (3)	6,781	21,300	10,667	12,917	9,996
Biomass (t)	50,000	38,500	15,500	60-110,000 (4)	64,000	89,000	35,000	63,000	57,000	98,484	137,200 (5)	97,051	29,428	46,018
Number (10(-6))**	2,600	2,000	805	4,300-7,500 (4)	3,173	9,342	*na*	3351	*na*		7892 (6)	3569	1451	2678
Number of 1-group(10(-6))**	1,800 (1)	600	400	4,100-7,500 (4)	1,873	9,072	*na*	2481	*na*		6163 (6)	831	983	2465
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
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

(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 10.5.1: 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

(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 10.6.1. Series of Upwelling indexes from Borja et al. (1996,98 Updated for this WG) and two-covariate model Allain et al. (1999) & Petitgas et al (WD2004)

	Pers.Comm.		
	Borja's et al. (1996,00)	Petitgas et al. (WD2003)	
Year	Upwelling	UPW	SBD
1986	617.5	20.49	0
1987	508.4	47.25	1
1988	473.2	35.88	1
1989	970.9	45.45	0
1990	905.9	50.00	1
1991	1,076.3	110.74	0
1992	1,128.8	47.16	0
1993	570.9	53.03	0
1994	905.0	29.20	0
1995	1,204.0	74.99	0
1996	973.0	50.17	0
1997	1,230.5	100.04	0
1998	461.0	58.49	0
1999	402.0	32.68	0
2000	391.0	65.32	0
2001	418.0	57.93	1
2002	642.0	65.32	0
2003	424.0	57.93	0
2004	435.0	60.81	0

Table 10.7.1.1.1: Comparison of alternative tunings to the Assessment of the anchovy in Subarea VIII Concerning DEPM and Acoustic surveys

Type of Asses	assessment DEPMabsolute with 3+			assessment DEPMabsolute with 2+			Bosth Surveys Absolutes DEPM3+			Bosth Surveys Absolute DEPM2+			Bosth Surveys Relatives DEPM3+			Bosth Surveys Relatives DEPM2+		
Tunning Indexes																		
Assessment	Age 0	F (1-3)	SSB	Age 0	F (1-3)	SSB	Age 0	F (1-3)	SSB	Age 0	F (1-3)	SSB	Age 0	F (1-3)	SSB	Age 0	F (1-3)	SSB
Year	assessment D	assessmen	assessme	assessment D	Similar Ru	Similar R	Bosth Survey	Bosth Sur	Bosth Su	Bosth Surve	Bosth Su	Bosth Surv	Bosth Surve	Bosth Sur	Bosth Su	Bosth Surv	Bosth Sur	Bosth Surveys Relatives DEPM2+
1987	7,658,050	1.092	26,726	7,697,010	1.053	35196	8,122,640	1.064	27204	8,028,110	1.032	37863	5,847,730	1.293	19691	5,815,090	1.192	23456
1988	3,626,620	0.693	33,239	3,671,460	0.569	36981	3,749,980	0.660	35440	3,782,870	0.534	39530	2,767,330	1.146	22417	2,926,010	0.877	23786
1989	19,175,940	0.556	19,108	21,044,320	0.431	20580	20,039,650	0.547	20320	21,850,380	0.404	21906	15,176,780	1.069	11896	15,967,370	0.916	12834
1990	7,211,840	1.041	50,936	7,196,400	0.730	57247	7,673,560	1.040	53685	7,571,850	0.682	60169	5,638,490	1.764	37133	5,600,490	1.443	39777
1991	26,457,420	0.921	30,097	29,112,220	0.543	34725	27,553,450	0.881	32762	30,320,850	0.492	37400	20,679,450	1.751	19032	22,007,250	1.279	21108
1992	23,825,680	0.931	69,721	25,034,340	0.600	80807	24,147,120	0.916	73791	25,412,870	0.551	85642	18,777,510	1.718	48957	19,249,130	1.346	53910
1993	12,494,020	0.723	81,122	12,748,100	0.473	91841	12,753,620	0.724	83793	12,962,860	0.444	95459	9,526,190	1.335	55849	9,898,100	1.043	60277
1994	10,424,030	0.787	52,684	11,567,990	0.569	58487	10,417,440	0.802	54166	11,756,870	0.546	60487	8,914,330	1.463	33395	9,344,290	1.203	36329
1995	14,149,240	0.872	43,185	14,307,750	0.613	50166	14,835,860	0.895	43505	14,931,120	0.587	51637	10,538,340	1.480	30893	10,777,400	1.243	33238
1996	17,377,650	1.232	39,890	18,119,570	0.781	44787	18,329,830	1.221	42031	18,906,080	0.722	47373	11,707,650	2.158	26083	12,413,190	1.747	27791
1997	28,022,710	0.536	44,305	29,517,120	0.382	48402	29,297,650	0.522	47312	30,672,230	0.352	51340	19,031,860	1.217	25955	20,110,110	0.987	28208
1998	13,864,680	0.372	92,761	14,558,970	0.278	99136	14,319,760	0.362	98184	15,201,420	0.259	104180	10,029,070	0.865	55082	10,266,780	0.705	59414
1999	23,190,010	0.374	75,011	24,185,120	0.282	80614	25,189,220	0.367	79038	25,840,050	0.263	85167	15,659,880	0.771	43802	16,590,440	0.646	46682
2000	21,600,840	0.488	89,255	23,414,020	0.371	95293	23,488,140	0.469	97120	24,851,560	0.340	102598	15,491,170	1.004	52521	16,883,160	0.854	56388
2001	4,585,860	0.479	86,981	4,415,220	0.358	95215	4,909,640	0.451	96238	4,661,010	0.325	102976	3,407,630	1.011	52217	3,377,880	0.822	57968
2002	3,931,060	0.456	48,221	3,815,770	0.340	52121	4,299,900	0.426	54048	4,021,950	0.309	57035	2,853,940	0.955	26268	3,019,120	0.750	29299
2003	7,576,410	0.679	19,457	7,728,830	0.542	20911	8,215,970	0.641	22037	8,131,440	0.494	23082	5,289,350	1.363	10071	5,621,400	1.175	11238
2004			27,573			28291			30586			30544			16444			17630
Mean Values	11,948,072	0.719	45,929	12,381,797	0.524	51,088	12,564,586	0.705	48,986	12,901,595	0.490	54,376	8,885,668	1.316	28,950	9,247,349	1.072	31,575
	SSQ	df	Variance				SSQ	df	Variance	SSQ	df	Variance	SSQ	df	Variance	SSQ	df	Variance
Tot. WSSQ	4.660	121	0.039	3.769	107	0.035	5.017	124	0.040	3.923	110	0.036	3.459	117	0.030	3.233	104	0.031
Separ CAGE	1.630	38	0.043	1.580	38	0.042	1.886	38	0.050	1.630	38	0.043	1.518	38	0.040	1.353	38	0.036
DEPM SSB	0.565	17	0.033	0.548	17	0.032	0.603	17	0.035	0.622	17	0.037	0.460	16	0.029	0.470	16	0.029
Acoustic SSB	0.452	10	0.045	0.445	10	0.045	0.461	11	0.042	0.427	11	0.039	0.512	10	0.051	0.491	10	0.049
DEPM Pop.	1.675	42	0.040	0.904	28	0.032	1.577	42	0.038	0.868	28	0.031	0.664	39	0.017	0.646	26	0.025
Acoust. Pop.	0.339	14	0.024	0.320	14	0.023	0.490	16	0.031	0.375	16	0.023	0.283	14	0.020	0.273	14	0.020
Catchability																		
DEPM SSB	1.000			1.000			1.000			1.000			1.651			1.5130		
Acoustic SSB	1.247			1.143			1.000			1.000			2.078			1.9000		
DEPM Pop.Age 1	1.000			1.000			1.000			1.000			1.651			1.547		
DEPM Pop.Age 2	1.000			1.000			1.000			1.000			3.461			2.921		
DEPM Pop.Age 3	1.000						1.000						4.798					
Acoust. Pop. Age1	1.182			1.149			1.000			1.000			1.689			1.599		
Acoust. Pop. Age2	1.586			1.340			1.000			1.000			3.446			2.934		
	Selectivity	Mean F/age		Selectivity	Mean F/age		Selectivity	Mean F/age		Selectivity	Mean F/age		Selectivity	Mean F/age		Selectivity	Mean F/age	
Selectivity _ 0	0.003	0.0022		0.004	0.0018		0.003	0.0022		0.004	0.0018		0.002	0.0030		0.003	0.0033	
Selectivity _ 1	0.409	0.2942		0.466	0.2443		0.412	0.2904		0.477	0.2340		0.318	0.4183		0.409	0.4384	
Selectivity _ 2	1	0.7194		1	0.5245		1	0.7053		1	0.4904		1	1.3156		1	1.0722	
Selectivity _ 3	0.841	0.6046		0.458	0.2404		0.922	0.6503		0.436	0.2140		1.121	1.4745		0.841	0.9012	

Table 10.7.1.1.2 Adjustements of the catches at age by ICA with DEPM absolute and Acoustic Relative for a) DEPM 3+ and for b) DEPM2+

Catch in Numbers

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	180.1	17	86.6	38.4	63.5	59.9	49.8	109.2	133.2	4.1	54.4	5.3	0.7	0.3	7.5
1	179.7	1365.3	440.2	1441.7	1405.1	850.3	711.4	1139.2	911.3	1042	463.4	956.9	968	232.6	183.4
2	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	294.3	131.7
3	20.1	13.2	29.2	17	5.3	63	76.6	31.6	5.8	9	18.3	103	24.8	40.9	45.6
4	1	1	1	1	1	1	4.1	2.3	1	1	1.1	1	4.9	1	2
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

a) DEPM 3+

Predicted Catch in numbers

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	25.2	17.8	57.7	52.5	21.4	19.4	29.2	50.6	35.6	12.2	20.5	25	5.2	4.2	12.2
1	159.2	1534	521.8	1931.5	1408.3	794.7	721.5	1289.6	791.1	917.6	456.6	973.4	891.9	180.9	220.7
2	143	112	453.9	183	567.6	606.1	327.9	319	208.1	279.5	496.6	303.6	470.6	423.2	122.3
3	16.1	28	7	36.1	12	61.4	60.9	34.3	9.5	19.9	44.6	98	41	62.6	82.4
4	0.8	3.9	2.3	0.7	3.1	1.6	7.9	8.3	1.4	1.1	3.8	10.5	16	6.6	14.7

Residuals (Observed-Expected)

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Total
0	1.965	-0.043	0.407	-0.312	1.089	1.126	0.534	0.768	1.32	-1.097	0.974	-1.55	-1.939	-2.765	-0.481	-0.004
1	0.121	-0.116	-0.17	-0.292	-0.002	0.068	-0.014	-0.124	0.141	0.127	0.015	-0.017	0.082	0.251	-0.185	-0.115
2	-0.061	0.191	-0.34	0.205	-0.065	-0.1	-0.075	-0.108	-0.155	-0.103	0.052	0.093	0.004	-0.363	0.074	-0.751
3	0.224	-0.753	1.427	-0.753	-0.816	0.026	0.229	-0.081	-0.499	-0.793	-0.891	0.051	-0.503	-0.425	-0.592	-4.149
4	0.186	-1.358	-0.846	0.32	-1.123	-0.49	-0.651	-1.28	-0.331	-0.099	-1.249	-2.348	-1.174	-1.885	-1.977	-14.305
Totals	2.435	-2.079	0.478	-0.832	-0.917	0.63	0.023	-0.825	0.476	-1.965	-1.099	-3.771	-3.53	-5.187	-3.161	

B) DEPM2+

Predicted Catch in numbers

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	29.1	16.8	50.7	48.1	19.3	21.1	28.1	45.3	36.1	13	21.9	27.8	5.1	4.2	13.4
1	166.1	1593.4	425.8	1876.1	1315.2	785.8	758.7	1143.3	787.7	964.4	481.6	1025.8	961.8	173.1	225.9
2	133.9	99.6	404.1	169.3	554.7	597.9	299.1	307.5	202.9	265.1	471.7	290.2	439.6	411.9	112.4
3	17.5	16.8	4.3	30.6	8.9	49.6	42.9	23.2	8.5	13	26.2	58.9	24.5	37.1	56.3
4	0.9	9.1	3.7	1.5	7.7	3.5	16.3	15.2	3.5	2.4	5.3	13.3	21.2	8.8	20.6

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Total
0	1.823	0.011	0.536	-0.226	1.19	1.044	0.572	0.88	1.305	-1.159	0.911	-1.658	-1.911	-2.745	-0.578	-0.005
1	0.079	-0.154	0.033	-0.263	0.066	0.079	-0.064	-0.004	0.146	0.077	-0.039	-0.07	0.006	0.295	-0.209	-0.022
2	0.004	0.308	-0.223	0.282	-0.043	-0.087	0.017	-0.071	-0.13	-0.05	0.103	0.138	0.072	-0.336	0.158	0.142
3	0.141	-0.244	1.926	-0.589	-0.522	0.238	0.58	0.308	-0.39	-0.371	-0.36	0.56	0.014	0.098	-0.211	1.178
4	0.068	-2.211	-1.3	-0.378	-2.043	-1.249	-1.381	-1.891	-1.248	-0.872	-1.594	-2.587	-1.455	-2.173	-2.314	-22.628
Totals	2.115	-2.29	0.972	-1.174	-1.352	0.025	-0.276	-0.778	-0.317	-2.375	-0.979	-3.617	-3.274	-4.861	-3.154	

Table 10.7.1.2.1: Input data for the Biomass Dynamic Model for the Bay of Biscay anchovy

g	0.680
f1	0.375
f2	0.625

			CATCH at AGE DATA			DEPM		ACOUSTICS	
Year	**h1**	**h2**	**C(y,1,1)**	**C(y,1,2+)**	**C(y,2,1+)**	**B(y,2,1)**	**B(y,2,1+)**	**B(y,2,1)**	**B(y,2,1+)**
1987	0.307	0.194	2,711	5,607	6,543	14,235	29,365		
1988	0.325	0.177	2,602	1,262	10,954	53,087	63,500		
1989	0.282	0.233	1,723	2,152	4,442	7,282	16,720		
1990	0.307	0.206	9,314	1,259	23,574	90,650	97,239		
1991	0.235	0.198	3,903	6,288	8,196	11,271	19,276	28,322	64,000
1992	0.254	0.218	11,933	4,433	21,026	85,571	90,720	84,439	89,000
1993	0.237	0.238	6,414	7,763	25,431				
1994	0.233	0.205	3,795	9,807	20,150	34,674	60,062		35,000
1995	0.292	0.175	5,718	8,832	14,815	42,906	54,700		
1996	0.276	0.198	4,570	4,675	23,833		39,545		
1997	0.208	0.262	4,323	2,912	13,256	38,536	51,176	38,498	63,000
1998	0.199	0.257	5,898	2,089	23,588	80,357	101,976		57,000
1999	0.230	0.263	2,067	8,828	15,511		69,074		
2000	0.257	0.200	6,298	5,712	24,882		44,973		98,484
2001	0.298	0.220	5,481	5,986	28,671	73,198	124,132	90,928	137,200
2002	0.183	0.239	1,962	5,776	9,754	6,352	30,697	17,723	97,051
2003	0.300	0.279	625	1,754	8,101	16,575	23,962	15,732	29,430
2004	0.266		1,494	1,164		13,822	18,113	37,124	46,018

Table 10.7.2.1 INPUTs for the Bay of Biscay anchovy assessment

Output Generated by ICA Version 1.4 run (DEPM as Absolute)

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
0	0.3	7.5
1	232.6	183.4
2	294.3	131.7
3	40.9	45.6
4	1.0	2.0
5	1.0	1.0

x 10 ^ 6

Table 10.7.2.1 (Cont'd)

Predicted Catch in Number

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	25.2	17.8	57.7	52.5	21.4	19.4	29.2	50.6	35.6	12.2	20.5	25.0	5.2	4.2	2.2
1	159.2	1534.0	521.8	1931.5	1408.3	794.7	721.5	1289.6	791.1	917.6	456.6	973.4	891.9	180.9	20.7
2	143.0	112.0	453.9	183.0	567.6	606.1	327.9	319.0	208.1	279.5	496.6	303.6	470.6	423.2	22.3
3	16.1	28.0	7.0	36.1	12.0	61.4	60.9	34.3	9.5	19.9	44.6	98.0	41.0	62.6	82.4
4	0.8	3.9	2.3	0.7	3.1	1.6	7.9	8.3	1.4	1.1	3.8	10.5	16.0	6.6	14.7

x 10 ^ 6

Weights at age in the catches (Kg)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	.011700	.005100	.012700	.007400	.014400	.012600	.012300	.014700	.015100	.011900	.011600	.010200	.015700	.019300	.014300
1	.021300	.021900	.020300	.021800	.020300	.020600	.017800	.020300	.023700	.019900	.017200	.022900	.022300	.024400	.025200
2	.032100	.030300	.029000	.028100	.025400	.030600	.027400	.026900	.032200	.031100	.027600	.026000	.030800	.029900	.031600
3	.037700	.035000	.031000	.043300	.028200	.037700	.030500	.030700	.036400	.040100	.031900	.030700	.034800	.033600	.036800
4	.041000	.037600	.027100	.040500	.040500	.040500	.040500	.040500	.037300	.046000	.040500	.031900	.055900	.040500	.040700
5	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000

Weights at age in the catches (Kg)

AGE	2002	2003
0	.009500	.015400
1	.027100	.024200
2	.032100	.031800
3	.042300	.039300
4	.045600	.037400
5	.042000	.042000

Table 10.7.2.1 (Cont'd)

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

Weights at age in the stock (Kg)

AGE	2002	2003
0	.012000	.012000
1	.022300	.015900
2	.033200	.029000
3	.035900	.034400
4	.040500	.040500
5	.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

Table 10.7.2.1 (Cont'd)

Natural Mortality (per year)

AGE	2002	2003
0	1.2000	1.2000
1	1.2000	1.2000
2	1.2000	1.2000
3	1.2000	1.2000
4	1.2000	1.2000
5	1.2000	1.2000

Proportion of fish spawning

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Proportion of fish spawning

AGE	2002	2003
0	0.0000	0.0000
1	1.0000	1.0000
2	1.0000	1.0000
3	1.0000	1.0000
4	1.0000	1.0000
5	1.0000	1.0000

Table 10.7.2.1 (Cont'd)

INDICES OF SPAWNING BIOMASS

DEPM

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	29.36	63.50	16.72	97.24	19.28	90.72	*******	60.06	54.70	39.55	51.18	101.98	69.07	44.97	124.13

x 10 ^ 3

DEPM

	2002	2003	2004
1	30.70	23.96	18.11

x 10 ^ 3

Acoustic

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	*******	*******	15.50	*******	64.00	89.00	*******	35.00	*******	*******	63.00	57.00	*******	98.48	137.20

x 10 ^ 3

Acoustic

	2002	2003	2004
1	97.05	29.43	46.02

x 10 ^ 3

Table 10.7.2.1 (Cont'd)

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
1	283.6	1042.0	775.0
2	621.3	179.6	107.3
3	133.8	74.0	26.0

x 10 ^ 3

ACOUSTIC SURVEYS (ages 1 to 2+)

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	400.0	*******	1873.0	9072.0	*******	*******	*******	*******	2481.0	*******	*******	*******	6163.0	831.0	983.2
2	405.0	*******	1300.0	270.0	*******	*******	*******	*******	870.0	*******	*******	*******	1728.0	2738.0	467.8

x 10 ^ 3

Table 10.7.2.1 (Cont'd)

ACOUSTIC SURVEYS (ages 1 to 2+)

AGE	2004
1	2645.0
2	145.0

x 10 ^ 3

Table 10.7.2.2 OUTPUTs for the Bay of Biscay anchovy

Fishing Mortality (per year)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.0086	0.0733	0.0023	0.0042	0.0037	0.0038	0.0029	0.0032	0.0035	0.0050	0.0022	0.0015	0.0015	0.0020	0.0020
1	0.3870	0.4547	0.3032	0.5673	0.5021	0.5074	0.3940	0.4293	0.4752	0.6718	0.2925	0.2027	0.2038	0.2660	0.2614
2	1.3676	0.6517	0.7415	1.3877	1.2282	1.2410	0.9638	1.0499	1.1623	1.6431	0.7154	0.4957	0.4984	0.6507	0.6392
3	1.5200	0.9732	0.6233	1.1664	1.0323	1.0431	0.8101	0.8825	0.9769	1.3811	0.6013	0.4167	0.4190	0.5469	0.5373
4	1.0856	0.7694	0.5858	1.0962	0.9703	0.9804	0.7614	0.8294	0.9182	1.2980	0.5651	0.3916	0.3938	0.5140	0.5050
5	1.0856	0.7694	0.5858	1.0962	0.9703	0.9804	0.7614	0.8294	0.9182	1.2980	0.5651	0.3916	0.3938	0.5140	0.5050

Fishing Mortality (per year)

AGE	2002	2003
0	0.0019	0.0028
1	0.2484	0.3703
2	0.6076	0.9057
3	0.5107	0.7612
4	0.4800	0.7155
5	0.4800	0.7155

Table 10.7.2.2 (cont'd)

Population Abundance (1 January)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	7658.	3627.	19176.	7212.	26457.	23826.	12494.	10424.	14149.	17378.	28023.	13865.	23190.	21601.	4586.
1	1747.	2287.	1015.	5763.	2163.	7939.	7149.	3752.	3130.	4247.	5208.	8422.	4170.	6974.	6493.
2	348.	357.	437.	226.	984.	394.	1440.	1452.	736.	586.	653.	1171.	2071.	1024.	1610.
3	63.	27.	56.	63.	17.	87.	34.	165.	153.	69.	34.	96.	215.	379.	161.
4	35.	4.	3.	9.	6.	2.	9.	5.	21.	17.	5.	6.	19.	43.	66.
5	21.	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
0	3931.	7576.	13943.
1	1379.	1182.	2276.
2	1506.	324.	246.
3	256.	247.	39.
4	28.	46.	35.
5	4.	3.	7.

x 10 ^ 6

Table 10.7.2.2 (cont'd)

Weighting factors for the catches in number

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
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	.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	.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	.0000
3	0.1000	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	.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	.0100

Predicted SSB Index Values

DEPM

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	26727.	33240.	19108.	50937.	30097.	69721.	999990.	52684.	43185.	39890.	44306.	92762.	75012.	89255.	6981.

DEPM

	2002	2003	2004
1	48222.	19457.	27473.

Table 10.7.2.2 (cont'd)

Acoustic

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	*******	*******	23.83	*******	37.53	86.95	*******	65.70	*******	*******	55.25	115.68	*******	111.30	08.47

x 10 ^ 3

Acoustic

	2002	2003	2004
1	60.13	24.26	34.26

x 10 ^ 3

Predicted Age-Structured Index Values

DEPM SUVEYS (Ages 1 to 3+) Predicted

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	821.9	1042.1	497.1	2489.1	963.6	3528.1	*******	1730.5	1412.3	*******	2563.2	4325.7	*******	*******	3243.3
2	102.8	148.2	173.8	66.1	310.6	123.7	*******	498.7	239.5	*******	263.0	523.2	*******	*******	672.0
3	36.2	12.3	26.5	24.2	8.9	31.4	*******	64.3	62.9	*******	18.4	49.7	*******	*******	101.7

x 10 ^ 3

Table 10.7.2.2 (cont'd)

DEPM SUVEYS (Ages 1 to 3+) Predicted

AGE	2002	2003	2004
1	692.8	560.6	1079.4
2	638.1	119.1	90.4
3	128.2	117.2	32.5

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	775.9	*******	1560.4	5718.7	*******	*******	*******	*******	3992.6	*******	*******	*******	5023.1	1070.5	885.8
2	453.5	*******	793.0	383.5	*******	*******	*******	*******	635.2	*******	*******	*******	1719.7	1692.6	545.6

x 10 ^ 3

ACOUSTIC SURVEYS (ages 1 to 2+) Predicted

AGE	2004
1	1705.7
2	285.3

x 10 ^ 3

Table 10.7.2.2 (cont'd)

Fitted Selection Pattern

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.0063	0.1124	0.0031	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	0.2830	0.6977	0.4089	0.4089	0.4089	0.4089	0.4089	0.4089	0.4089	0.4089	0.4089	0.4089	0.4089	0.4089	0.4089
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	1.1114	1.4933	0.8405	0.8405	0.8405	0.8405	0.8405	0.8405	0.8405	0.8405	0.8405	0.8405	0.8405	0.8405	0.8405
4	0.7938	1.1805	0.7900	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	0.7938	1.1805	0.7900	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
0	0.0031	0.0031
1	0.4089	0.4089
2	1.0000	1.0000
3	0.8405	0.8405
4	0.7900	0.7900
5	0.7900	0.7900

Table 10.7.2.2 (cont'd)

STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 1- 3	SoP (%)
1987	7658050	153653	26726	15308	0.5728	1.0915	99
1988	3626620	110687	33239	15581	0.4687	0.6932	100
1989	19175940	285409	19108	10614	0.5555	0.5560	100
1990	7211840	174768	50936	34272	0.6728	1.0405	99
1991	26457420	461678	30097	19634	0.6524	0.9209	101
1992	23825680	423598	69721	37885	0.5434	0.9305	100
1993	12494020	307601	81122	40293	0.4967	0.7226	99
1994	10424030	263629	52684	34631	0.6573	0.7872	99
1995	14149240	258297	43185	30115	0.6973	0.8715	99
1996	17377650	296597	39890	34373	0.8617	1.2320	100
1997	28022710	417272	44305	22337	0.5042	0.5364	99
1998	13864680	328336	92761	31617	0.3408	0.3717	102
1999	23190010	413252	75011	27259	0.3634	0.3737	97
2000	21600840	420650	89255	36994	0.4145	0.4879	100
2001	4585860	213848	86981	40564	0.4664	0.4793	100
2002	3931060	138424	48221	17507	0.3631	0.4556	99
2003	7576410	129603	19457	10595	0.5445	0.6791	99

No of years for separable analysis : 15
Age range in the analysis : 0 . . . 5
Year range in the analysis : 1987 . . . 2003
Number of indices of SSB : 2
Number of age-structured indices : 2

Parameters to estimate : 40
Number of observations : 161

Conventional single selection vector model to be fitted.

Table 10.7.2.2 (cont'd)

```
 PARAMETER ESTIMATES

 ³Parm.³      ³ Maximum ³    ³         ³          ³          ³          ³ Mean of ³
 ³ No. ³      ³ Likelh. ³ CV ³  Lower  ³ Upper    ³  -s.e.   ³    +s.e. ³ Param.  ³
 ³     ³      ³ Estimate³ (%)³ 95% CL  ³ 95% CL   ³          ³          ³ Distrib.³
 Separable model : F by year
    1   1989     0.7415  21    0.4861    1.1311    0.5978    0.9198    0.7589
    2   1990     1.3877  19    0.9451    2.0375    1.1407    1.6881    1.4146
    3   1991     1.2282  18    0.8487    1.7773    1.0171    1.4830    1.2502
    4   1992     1.2410  21    0.8173    1.8844    1.0029    1.5358    1.2695
    5   1993     0.9638  21    0.6359    1.4607    0.7795    1.1915    0.9857
    6   1994     1.0499  20    0.7082    1.5563    0.8589    1.2834    1.0713
    7   1995     1.1623  21    0.7617    1.7735    0.9368    1.4419    1.1896
    8   1996     1.6431  17    1.1581    2.3311    1.3745    1.9641    1.6694
    9   1997     0.7154  21    0.4668    1.0963    0.5754    0.8895    0.7325
   10   1998     0.4957  24    0.3074    0.7993    0.3885    0.6325    0.5107
   11   1999     0.4984  25    0.3051    0.8143    0.3880    0.6403    0.5143
   12   2000     0.6507  22    0.4180    1.0129    0.5192    0.8155    0.6675
   13   2001     0.6392  21    0.4219    0.9685    0.5171    0.7902    0.6538
   14   2002     0.6076  21    0.4013    0.9199    0.4917    0.7508    0.6214
   15   2003     0.9057  19    0.6163    1.3309    0.7441    1.1022    0.9233

 Separable Model: Selection (S) by age
   16      0     0.0031  73    0.0007    0.0128    0.0015    0.0063    0.0040
   17      1     0.4089  10    0.3336    0.5011    0.3685    0.4536    0.4111
           2     1.0000     Fixed : Reference Age
   18      3     0.8405  25    0.5060    1.3962    0.6488    1.0889    0.8692
           4     0.7900     Fixed : Last true age

 Separable model: Populations in year 2003
   19      0    7576413  25    4623765  12414566   5888996   9747338   7820749
   20      1    1181820  18     827568   1687714    985368   1417438   1201512
   21      2     323875  17     231538    453035    272905    384363    328658
   22      3     247035  20     165855    367949    201594    302719    252192
   23      4      46244  26      27780     76982     35656     59977     47834
```

Table 10.7.2.2 (cont'd)

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Separable model: Populations at age
   24   1989       3038 278         12    714513       187     49266    147196
   25   1990       9054  49       3452     23745      5536     14808     10219
   26   1991       5883  37       2801     12357      4029      8591      6320
   27   1992       1820  37        879      3769      1255      2638      1950
   28   1993       9210  38       4360     19456      6289     13489      9906
   29   1994       4598  39       2104     10048      3086      6852      4979
   30   1995      20611  35      10348     41050     14502     29293     21924
   31   1996      17353  38       8183     36802     11825     25466     18678
   32   1997       5245  49       2006     13714      3212      8565      5915
   33   1998       5634  37       2693     11786      3866      8211      6048
   34   1999      19106  28      11021     33120     14430     25297     19873
   35   2000      42553  28      24181     74883     31893     56775     44359
   36   2001      66058  31      35289    123657     47974     90960     69526
   37   2002      28326  32      14970     53595     20459     39217     29865

 SSB Index catchabilities
   DEPM
 Absolute estimator. No fitted catchability.
   Acoustic
 Linear model fitted. Slopes at age :
   38   2  Q  1.247      13 1.098     1.844     1.247     1.624     1.436



 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  1.182      17 .9989     1.985     1.182     1.678     1.430
   40   2  Q  1.586      17 1.335     2.698     1.586     2.271     1.928
```

Table 10.7.2.2 (cont'd)

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	1.965	-0.043	0.407	-0.312	1.089	1.126	0.534	0.768	1.320	-1.097	0.974	-1.550	-1.939	-2.765	-.481
1	0.121	-0.116	-0.170	-0.292	-0.002	0.068	-0.014	-0.124	0.141	0.127	0.015	-0.017	0.082	0.251	-.185
2	-0.061	0.191	-0.340	0.205	-0.065	-0.100	-0.075	-0.108	-0.155	-0.103	0.052	0.093	0.004	-0.363	.074
3	0.224	-0.753	1.427	-0.753	-0.816	0.026	0.229	-0.081	-0.499	-0.793	-0.891	0.051	-0.503	-0.425	-.592
4	0.186	-1.358	-0.846	0.320	-1.123	-0.490	-0.651	-1.280	-0.331	-0.099	-1.249	-2.348	-1.174	-1.885	-.977

SPAWNING BIOMASS INDEX RESIDUALS

DEPM

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.0941	0.6473	-0.1333	0.6466	-0.4456	0.2633	*******	0.1311	0.2364	-0.0087	0.1442	0.0947	-0.0825	-0.6854	0.3557

DEPM

	2002	2003	2004
1	-0.4516	0.2082	-0.4166

Table 10.7.2.2 (cont'd)

Acoustic

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	*******	*******	-0.4300	*******	0.5337	0.0234	*******	-0.6297	*******	*******	0.1313	-0.7078	*******	-0.1224	0.2350

Acoustic

	2002	2003	2004
1	0.4787	0.1929	0.2950

AGE-STRUCTURED INDEX RESIDUALS

DEPM SUVEYS (Ages 1 to 3+)

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	-0.225	0.813	-0.360	0.813	-0.363	0.457	*******	0.160	0.469	*******	0.235	0.234	*******	*******	0.296
2	1.169	0.554	0.513	1.057	-0.068	0.526	*******	0.561	0.317	*******	0.606	0.373	*******	*******	0.843
3	1.367	1.709	-0.041	0.502	-0.615	-0.633	*******	-0.266	-0.081	*******	-0.340	0.125	*******	*******	0.194

Table 10.7.2.2 (cont'd)

DEPM SUVEYS (Ages 1 to 3+)

Age	2002	2003	2004
1	-0.893	0.620	-0.331
2	-0.027	0.411	0.171
3	0.043	-0.460	-0.222

ACOUSTIC SURVEYS (ages 1 to 2+)

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	-0.6625	*******	0.1826	0.4614	*******	*******	*******	*******	-0.4758	*******	*******	*******	0.2045	-0.2532	0.1043
2	-0.1131	*******	0.4943	-0.3510	*******	*******	*******	*******	0.3146	*******	*******	*******	0.0048	0.4810	-.1538

ACOUSTIC SURVEYS (ages 1 to 2+)

Age	2004
1	0.4387
2	-0.6768

Table 10.7.2.2 (cont'd)

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

 Separable model fitted from 1989  to 2003
 Variance                              0.0429
Skewness test stat.                   -3.6853
Kurtosis test statistic               -0.7685
Partial chi-square                     0.1507
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                              0.0664
Skewness test stat.                    0.1147
Kurtosis test statistic               -0.5353
Partial chi-square                     0.1049
Significance in fit                    0.0000
Number of observations                     17
Degrees of freedom                         17
Weight in the analysis                 0.5000
```

Table 10.7.2.2 (cont'd)

```
 DISTRIBUTION STATISTICS FOR   Acoustic


 Linear catchability relationship assumed
 Last age is a plus-group

 Variance                             0.0904
Skewness test stat.                  -0.6939
Kurtosis test statistic              -0.6911
Partial chi-square                    0.0823
Significance in fit                   0.0000
Number of observations                    11
Degrees of freedom                        10
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               0.0852    0.1230    0.1507
Skewness test stat.     0.6016    2.1341    2.5214
Kurtosis test statisti -0.7766   -0.6277    1.0314
Partial chi-square      0.0854    0.1443    0.2133
Significance in fit     0.0000    0.0000    0.0000
Number of observations      14        14        14
Degrees of freedom          14        14        14
Weight in the analysis  0.3333    0.3333    0.3333
```

Table 10.7.2.2 (cont'd)

DISTRIBUTION STATISTICS FOR ACOUSTIC SURVEYS (ages 1 to 2+)

Linear catchability relationship assumed

Age	1	2
Variance	0.0654	0.0639
Skewness test stat.	-0.5236	-0.2388
Kurtosis test statisti	-0.6990	-0.5991
Partial chi-square	0.0318	0.0339
Significance in fit	0.0000	0.0000
Number of observations	8	8
Degrees of freedom	7	7
Weight in the analysis	0.3750	0.3750

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	76.3551	161	40	121	0.6310
Catches at age	54.8012	75	37	38	1.4421
SSB Indices					
DEPM	2.2584	17	0	17	0.1328
Acoustic	1.8086	11	1	10	0.1809
Aged Indices					
DEPM SUVEYS (Ages 1 to 3+)	15.0737	42	0	42	0.3589
ACOUSTIC SURVEYS (ages 1 to 2+)	2.4132	16	2	14	0.1724

Table 10.7.2.2 (cont'd)

Weighted Statistics

Variance	SSQ	Data	Parameters	d.f.	Variance
Total for model	4.6605	161	40	121	0.0385
Catches at age	1.6296	75	37	38	0.0429
SSB Indices					
DEPM	0.5646	17	0	17	0.0332
Acoustic	0.4521	11	1	10	0.0452
Aged Indices					
DEPM SUVEYS (Ages 1 to 3+)	1.6749	42	0	42	0.0399
ACOUSTIC SURVEYS (ages 1 to 2+)	0.3394	16	2	14	0.0242

Table 10.7.3.1: Stock: Anchovy Sub- area VIII.. Historical quality of the assessment.
Assessment Quality Control Diagram 1

	Average F(1-3,u)																
Date of assessment	Year																
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1989																	
1990																	
1991																	
1992																	
1993																	
1994																	
1995																	
1996	1.014	0.99	0.993	1.992	1.343	0.926	0.901	0.825									
1997	0.554	0.678	0.61	1.449	0.892	0.585	0.643	0.738	0.855								
1998	0.541	0.617	0.629	1.299	0.891	0.574	0.679	0.862	1.172	0.414							
1999	0.501	0.581	0.615	1.258	0.863	0.565	0.679	0.861	1.238	0.486	0.251						
2000	0.589	0.527	1.048	0.8787	0.892	0.7	0.775	0.863	1.195	0.517	0.385	0.577					
2001	0.596	0.533	1.053	0.901	0.902	0.702	0.772	0.859	1.21	0.517	0.353	0.37	0.574				
2002	0.594	0.533	1.052	0.901	0.902	0.705	0.774	0.86	1.212	0.517	0.353	0.357	0.447	0.333			
2003	0.624	0.542	1.070	0.925	0.930	0.719	0.791	0.880	1.239	0.533	0.364	0.371	0.487	0.468	0.428		
2004	0.693	0.556	1.041	0.921	0.931	0.723	0.787	0.872	1.232	0.536	0.372	0.374	0.488	0.479	0.456	0.679	

Remarks: Assessment of 1996 – 2004 performed using ICA

Table 10.7.3.1: Continued
Assessment Quality Control Diagram 2

	Recruitment (age 0) Unit: millions															
Date of assessment	Year class															
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1989																
1990																
1991																
1992																
1993																
1994																
1995																
1996	3310	21395	7272	27393	27677	15551	14273	14963								
1997	3641	21990	7506	28271	28003	14455	12335	14650	17065							
1998	4294	19052	7206	27767	25764	13877	10454	14051	210443	30950						
1999	4387	19082	7319	28402	25305	13334	10275	13397	20231	34647	2977					
2000	3473	19652	7587	27632	24103	12789	10405	14514	18197	25830	7841	12582				
2001	3461	19288	7456	27443	24011	12717	10405	14254	18262	28812	13387	18419	38397			
2002	3466	19308	7467	27378	23985	12681	10411	14232	18220	28780	14268	25530	32708	4356		
2003	3458	19259	7405	27324	23971	12637	10407	14226	18063	28652	13940	23583	22807	4729	6482	
2004	3627	19176	7212	26457	23826	12494	10424	14149	17378	28023	13865	23190	21601	4586	3931	7576

Remarks: Assessment of 1996 – 2004 performed using ICA

Table 10.7.3.1: Continued
Assessment Quality Control Diagram 3

	Spawning stock biomass ('000 t)															
Date of assessment	Year															
	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1989																
1990																
1991																
1992																
1993																
1994																
1995																
1996	16,356	60,886	29,395	69,621	93,342	68,487	55,670									
1997	17,782	63,438	29,569	71,261	95,497	65,521	46,671	47,188								
1998	19,112	55,649	28,391	69,737	88,690	60,978	45,126	40,617	54,783							
1999	23,389	55,844	28,794	71,236	87,618	58,755	43,727	37,098	49,641	118,593						
2000	21,582	51,966	31,476	72,975	81,638	53,953	43,316	41,558	46,158	87,436	51,230	46,750				
2001	21,265	51,031	30,641	72,241	81,905	53,638	43,310	39,816	46,136	96,063	74,552	70,323	95,352			
2002	21,306	51,291	30,791	72,368	82,507	53,563	43,363	40,128	46,182	96,087	77,885	97,971	126,033	58,129		
2003	21,053	51,008	30,536	71,816	82,227	53,370	43,218	39,974	45,721	95,382	76,532	90,865	91,218	51,292	29,200	
2004	19,108	50,936	30,097	69,721	81,122	52,684	43,185	39,890	44,305	92,761	75,011	89,255	86,981	48,221	19,457	27,473

Remarks: Assessment of 1996 – 2004 performed using ICA

Table 10.8.1: Inputs for projections of the population and catches for the Bay of Biscay anchovy

Scenario for projections:

Run: Low recruitment (Geometric mean of those =<median R)= 7,108,542

Mean weight at age at the stock (1990-2004) and at catches (1989-2003)

Fbar age range: 1-3 Average F for the period 1997-2003

MFDP version 1a

Run: ProjectionAnchovy2004

Time and date: 09:40 16/09/2004

Fbar age range: 1-3

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	7,108,542	1.2	0	0.4	0.375	0.0123	0.0020	0.0131
1	2,275,700	1.2	1	0.4	0.375	0.0165	0.2636	0.0219
2	245,800	1.2	1	0.4	0.375	0.0295	0.6447	0.0294
3	39,437	1.2	1	0.4	0.375	0.0346	0.5419	0.0352
4	34,754	1.2	1	0.4	0.375	0.0405	0.5093	0.0404
5	7,273	1.2	1	0.4	0.375	0.0420	0.5093	0.0420

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	7,108,542	1.2	0	0.4	0.375	0.0123	0.0020	0.0131
1	.	1.2	1	0.4	0.375	0.0165	0.2636	0.0219
2	.	1.2	1	0.4	0.375	0.0295	0.6447	0.0294
3	.	1.2	1	0.4	0.375	0.0346	0.5419	0.0352
4	.	1.2	1	0.4	0.375	0.0405	0.5093	0.0404
5	.	1.2	1	0.4	0.375	0.0420	0.5093	0.0420

N_age 0 7,108,542 in 2006

1996 Remainder parameters equal to those in 2005

Table 10.8.2a: Catch option prediction for the anchovy fishery in Subarea VIII in 2003. Under Catch constrain for 2004 of 16200 t

MFDP version 1a **Very Low recruitment escenario**
Run: ProjectionAnchovy2004
Anchovy in subarea VIII WG2004- Bay of Biscay anchovy Definitive run
Time and date: 09:40 16/09/2004
Fbar age range: 1-3
Fbar age range: 1-3
PRECAUTIONARY APPROACH R=7,108.5 thousands

2004				
Biomass	SSB	FMult	FBar	Landings
135131	**24024**	1.8195	0.8795	16200

2005	2005	2005	2005	2005	2006	2006
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
136161	31220	0	0	0	146371	37730
.	30765	0.1	0.0483	1211	145573	36623
.	30318	0.2	0.0967	2383	144807	35571
.	29879	0.3	0.145	3518	144071	34570
.	29447	0.4	0.1933	4616	143362	33617
.	29023	0.5	0.2417	5680	142681	32709
.	28606	0.6	0.29	6711	142026	31843
.	28197	0.7	0.3384	7711	141395	31017
.	27794	0.8	0.3867	8680	140787	30228
.	27399	0.9	0.435	9620	140202	29475
.	27010	1	0.4834	10532	139638	28755
.	26628	1.1	0.5317	11417	139095	28067
.	26252	1.2	0.58	12277	138571	27408
.	25883	1.3	0.6284	13112	138066	26777
.	25520	1.4	0.6767	13923	137579	26173
.	25163	1.5	0.7251	14712	137109	25593
.	24812	1.6	0.7734	15478	136655	25037
.	24467	1.7	0.8217	16224	136217	24503
.	24128	1.8	0.8701	16949	135794	23989
.	23794	1.9	0.9184	17655	135386	23496
.	23466	2	0.9667	18342	134991	23022

Input units are thousands and kg - output in tonnes

Table 10.8.2b: Catch option prediction for the anchovy fishery in Subarea VIII in 2003. UnderF status quo constraint (1997-2003) (7 years)

MFDP version 1a **Very Low recruitment escenario**
Run: ProjectionAnchovyFstatusquo
Anchovy in subarea VIII WG2004- Bay of Biscay anchovy Definitive run
Time and date: 10:22 16/09/2004
Fbar age range: 1-3
PRECAUTIONARY APPROACH R=7,108.542 millions

2004				
Biomass	SSB	FMult	FBar	Landings
135131	**26742**	1	0.4834	9891

2005	2005	2005	2005	2005	2006	2006
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
140001	33669	0	0	0	147725	38594
.	33154	0.1	0.0483	1346	146847	37418
.	32649	0.2	0.0967	2646	146005	36303
.	32153	0.3	0.145	3902	145197	35243
.	31666	0.4	0.1933	5116	144422	34237
.	31188	0.5	0.2417	6291	143678	33279
.	30718	0.6	0.29	7427	142963	32368
.	30257	0.7	0.3384	8526	142277	31500
.	29805	0.8	0.3867	9591	141617	30674
.	29360	0.9	0.435	10622	140983	29885
.	28924	1	0.4834	11621	140373	29133
.	28495	1.1	0.5317	12590	139786	28415
.	28074	1.2	0.58	13528	139221	27728
.	27661	1.3	0.6284	14439	138678	27072
.	27254	1.4	0.6767	15322	138155	26444
.	26855	1.5	0.7251	16180	137651	25843
.	26463	1.6	0.7734	17012	137165	25267
.	26078	1.7	0.8217	17821	136697	24715
.	25700	1.8	0.8701	18606	136246	24185
.	25328	1.9	0.9184	19370	135811	23676
.	24963	2	0.9667	20112	135391	23188

Input units are thousands and kg - output in tonnes

Table 10.8.3. For a low recruitment scenario 95% credibility intervals, median of spawning biomass for 2005 and 2006 together with the probability of falling below Blim and Bpa under different half-year catch options.

Catch 1st semester	Catch 2nd semester	2005					2006				
		2.50%	median	97.50%	P(B<Blim)	P(B<Bpa)	2.50%	median	97.50%	P(B<Blim)	P(B<Bpa)
0	0	13041	27358	57165	0.260	0.635	18134	37553	69837	0.067	0.383
0	5000	13178	27239	57322	0.263	0.635	15436	34962	67089	0.127	0.451
0	10000	12840	27370	56927	0.274	0.637	12513	32148	64424	0.204	0.518
0	15000	12951	27529	57929	0.261	0.632	9474	28865	61118	0.288	0.585
0	20000	13004	27597	57828	0.256	0.624	6610	26416	58185	0.364	0.634
5000	0	10404	24563	55003	0.371	0.674	13089	32834	63957	0.185	0.504
5000	5000	10393	24404	55096	0.376	0.670	10078	30036	61830	0.264	0.561
5000	10000	10583	24506	54512	0.373	0.671	7325	26985	58559	0.348	0.623
5000	15000	10027	24283	54441	0.379	0.671	4061	23972	55434	0.428	0.670
5000	20000	10420	24471	54846	0.369	0.673	1096	20881	53220	0.501	0.724
10000	0	7576	21844	52083	0.471	0.701	7713	27463	59825	0.335	0.611
10000	5000	7561	21902	52516	0.470	0.699	4703	24234	56101	0.423	0.668
10000	10000	7640	21919	52376	0.470	0.696	1787	21717	53969	0.484	0.710
10000	15000	7552	21998	51993	0.466	0.703	-1439	18510	50622	0.552	0.764
10000	20000	7594	21757	51684	0.472	0.699	-4249	15699	47235	0.610	0.805
15000	0	4904	19316	49584	0.550	0.726	2311	22426	54465	0.466	0.701
15000	5000	4916	19036	49364	0.559	0.740	-473	19109	50473	0.539	0.755
15000	10000	4790	19301	50237	0.549	0.723	-3531	16751	48634	0.589	0.798
15000	15000	5073	19322	49373	0.549	0.725	-6037	13175	44572	0.653	0.846
15000	20000	4876	19090	48825	0.560	0.740	-9361	10296	42197	0.707	0.875
20000	0	2186	16488	46359	0.612	0.768	-2928	16590	48247	0.592	0.793
20000	5000	2183	16247	46770	0.624	0.773	-5877	14010	46014	0.642	0.829
20000	10000	2113	16422	46339	0.613	0.766	-8934	10868	42458	0.693	0.865
20000	15000	2241	16598	46833	0.613	0.764	-11677	8035	39988	0.739	0.896
20000	20000	2351	16697	46834	0.610	0.766	-14870	5154	37124	0.781	0.919

Table 10.8.4. For a medium recruitment scenario 95% credibility intervals, median of spawning biomass for 2005 and 2006 together with the probability of falling below Blim and Bpa under different half-year catch options.

Catch 1st semester	Catch 2nd semester	2005					2006				
		2.50%	median	97.50%	P(B<Blim)	P(B<Bpa)	2.50%	median	97.50%	P(B<Blim)	P(B<Bpa)
0	0	14402	49738	94694	0.137	0.322	23053	68356	119040	0.016	0.096
0	5000	14438	49662	94947	0.132	0.325	19968	65295	116735	0.031	0.127
0	10000	14535	49453	95011	0.134	0.321	16408	61817	113287	0.053	0.157
0	15000	14362	49598	94225	0.137	0.333	13944	58916	111037	0.074	0.178
0	20000	14611	50002	95256	0.134	0.320	10765	56545	108135	0.097	0.208
5000	0	11598	47166	91727	0.180	0.341	18285	63421	114777	0.041	0.139
5000	5000	11733	46904	92251	0.191	0.348	14188	60616	110970	0.070	0.174
5000	10000	11848	46240	92112	0.184	0.347	11391	57061	108600	0.096	0.204
5000	15000	11728	46702	92773	0.191	0.349	8907	53557	106004	0.115	0.239
5000	20000	11909	47134	91970	0.185	0.344	5415	51778	102748	0.141	0.267
10000	0	9143	44658	90024	0.226	0.349	12186	58033	109653	0.084	0.197
10000	5000	8866	44803	90407	0.233	0.357	9391	55698	106427	0.113	0.224
10000	10000	8983	44465	89303	0.230	0.355	6713	51901	103108	0.140	0.267
10000	15000	9327	44847	90135	0.236	0.354	3562	49220	100553	0.168	0.295
10000	20000	9040	44170	89024	0.233	0.361	115	46043	97679	0.191	0.334
15000	0	6273	41270	87597	0.281	0.387	6588	53363	104125	0.138	0.258
15000	5000	6307	41325	87311	0.278	0.387	4354	49837	100716	0.149	0.278
15000	10000	6364	41007	86334	0.275	0.389	1453	46405	96979	0.186	0.330
15000	15000	6046	41346	86535	0.277	0.391	-2028	43382	93582	0.222	0.372
15000	20000	6178	41743	86595	0.278	0.386	-4655	40950	92778	0.248	0.402
20000	0	3771	38712	83875	0.313	0.419	1523	46612	98777	0.185	0.327
20000	5000	3710	38898	84362	0.310	0.416	-1241	43185	95283	0.216	0.367
20000	10000	3705	38398	83608	0.319	0.423	-4138	41282	91997	0.246	0.396
20000	15000	3694	38895	84468	0.312	0.415	-7177	39145	89878	0.281	0.423
20000	20000	3585	38837	84742	0.314	0.417	-10075	35740	87017	0.316	0.467

Table 10.8.5. For a high recruitment scenario 95% credibility intervals, median of spawning biomass for 2005 and 2006 together with the probability of falling below Blim and Bpa under different half-year catch options.

Catch 1st semester	Catch 2nd semester	2005					2006				
		2.50%	median	97.50%	P(B<Blim)	P(B<Bpa)	2.50%	median	97.50%	P(B<Blim)	P(B<Bpa)
0	0	38860	70140	101278	0.001	0.007	62910	99461	134092	0.000	0.000
0	5000	38392	70247	100094	0.000	0.009	60425	96412	130846	0.000	0.000
0	10000	38807	70010	100841	0.001	0.007	56315	93636	127791	0.000	0.000
0	15000	38641	69809	100735	0.000	0.009	53367	90466	125194	0.000	0.000
0	20000	38397	70169	100326	0.000	0.006	51305	87767	121952	0.000	0.001
5000	0	35985	67080	97157	0.001	0.014	57109	93716	128310	0.000	0.000
5000	5000	36294	67121	97548	0.001	0.013	54660	90810	125674	0.000	0.000
5000	10000	35979	67656	97750	0.001	0.013	51363	88107	122423	0.000	0.001
5000	15000	36266	67425	98041	0.001	0.013	47947	84780	119057	0.000	0.001
5000	20000	36096	67193	97967	0.001	0.014	45595	82446	117124	0.000	0.002
10000	0	33473	64513	95033	0.002	0.022	51479	88358	122764	0.000	0.001
10000	5000	33381	65072	95187	0.002	0.023	49278	86146	120314	0.000	0.001
10000	10000	33633	65003	94977	0.002	0.022	45917	83083	117649	0.000	0.002
10000	15000	33971	64839	95075	0.002	0.021	42402	79551	114306	0.001	0.006
10000	20000	33715	65460	95412	0.002	0.022	40132	77354	111857	0.001	0.007
15000	0	30822	62018	92826	0.003	0.038	46617	83391	117742	0.000	0.002
15000	5000	29975	62019	91967	0.004	0.041	44572	81280	114628	0.000	0.003
15000	10000	30958	61853	92021	0.004	0.039	41216	77176	111494	0.001	0.006
15000	15000	30733	62047	92250	0.004	0.038	38151	74661	108453	0.001	0.011
15000	20000	30702	61787	92444	0.004	0.041	35164	71866	106115	0.002	0.018
20000	0	27923	59377	89637	0.005	0.060	42160	78544	112842	0.001	0.005
20000	5000	28074	59572	89335	0.006	0.063	38195	75446	109141	0.001	0.011
20000	10000	28294	59578	89327	0.006	0.057	35429	72308	106100	0.002	0.017
20000	15000	28047	59103	89656	0.007	0.065	32570	69295	103636	0.003	0.027
20000	20000	27886	59797	90287	0.007	0.061	30203	66756	100523	0.004	0.040

Table 10.8.6. For a low recruitment scenario 95% credibility intervals, median of spawning biomass for 2005 and 2006 together with the probability of falling below Blim and Bpa under different total annual catch options.

Annual catch	2005					2006				
	2.50%	median	97.50%	P(B<Blim)	P(B<Bpa)	2.50%	median	97.50%	P(B<Blim)	P(B<Bpa)
0	13119	27145	57360	0.27	0.64	18176	38028	69487	0.06	0.38
2500	12336	26502	57066	0.29	0.65	16132	35527	67284	0.11	0.44
5000	11159	25444	55766	0.33	0.66	13587	33356	65786	0.17	0.49
7500	10251	24559	54468	0.37	0.67	11477	31297	63174	0.22	0.54
10000	9705	23843	54220	0.39	0.68	9242	29212	60272	0.28	0.58
12500	8551	23031	53199	0.43	0.69	7118	27176	58353	0.35	0.62
15000	7994	22116	51866	0.46	0.70	4857	24613	56756	0.42	0.66
17500	6833	21353	51321	0.49	0.71	2502	22465	54314	0.47	0.70
20000	5869	20194	50960	0.53	0.72	480	19997	51704	0.52	0.74
22500	5199	19280	49938	0.55	0.73	-1895	17662	49266	0.57	0.78
25000	4321	18495	48771	0.57	0.74	-4214	15570	47056	0.61	0.81
27500	3342	17724	47830	0.59	0.75	-6406	13617	46215	0.64	0.83
30000	2705	16907	47372	0.61	0.77	-8372	11327	43319	0.68	0.86
32500	1789	15982	46523	0.62	0.77	-10879	9287	41439	0.73	0.89
35000	848	15097	45590	0.64	0.78	-13084	7039	38574	0.76	0.91
37500	-11	14134	44238	0.65	0.80	-15245	4288	35714	0.80	0.93
40000	-872	13124	42988	0.66	0.82	-17477	2294	33654	0.83	0.95

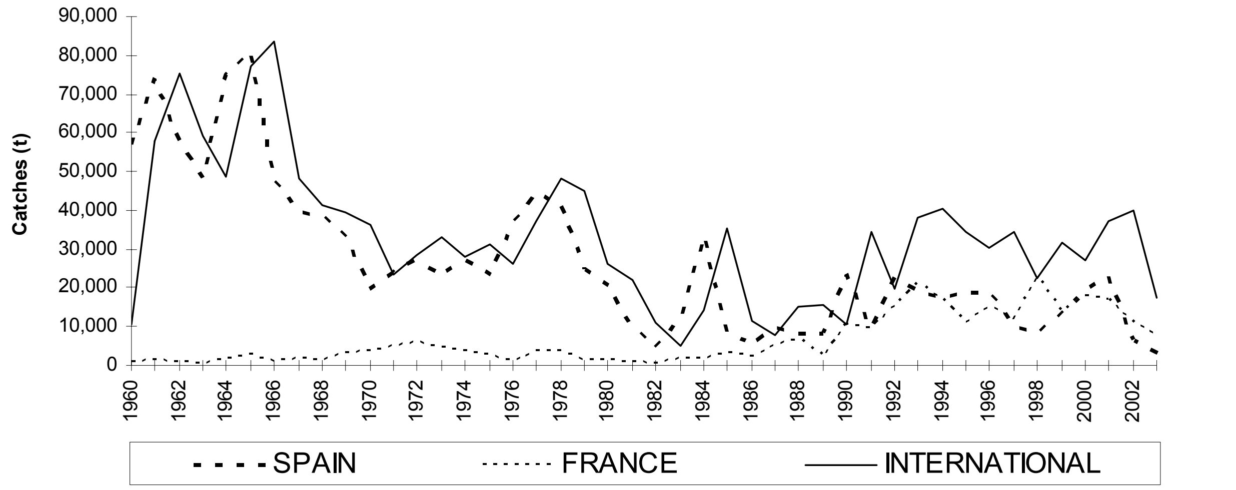
Table 10.8.7. For a medium recruitment scenario 95% credibility intervals, median of spawning biomass for 2005 and 2006 together with the probability of falling below Blim and Bpa under different total annual catch options.

Annual catch	2005					2006				
	2.50%	median	97.50%	P(B<Blim)	P(B<Bpa)	2.50%	median	97.50%	P(B<Blim)	P(B<Bpa)
0	14453	49680	94902	0.13	0.32	23124	69002	118974	0.01	0.10
2500	13854	49214	94100	0.15	0.33	20430	66513	118714	0.03	0.11
5000	12740	47813	93788	0.16	0.33	18211	64140	115690	0.04	0.14
7500	11963	47078	92373	0.19	0.34	16153	61870	113770	0.06	0.15
10000	10785	46475	91360	0.20	0.35	13872	59389	110977	0.07	0.18
12500	10219	45191	90700	0.21	0.35	11902	56698	108641	0.10	0.21
15000	9443	44652	89130	0.23	0.36	9041	54964	106675	0.11	0.22
17500	8505	43648	88729	0.24	0.36	7310	52421	104307	0.13	0.25
20000	7327	41990	87551	0.26	0.37	4719	50504	102973	0.16	0.28
22500	6533	41930	87126	0.28	0.39	3172	48147	100216	0.17	0.30
25000	5637	40854	85923	0.29	0.39	530	45438	97755	0.20	0.34
27500	5070	40695	85032	0.30	0.40	-1803	43809	95367	0.22	0.36
30000	3764	39533	84644	0.31	0.41	-4153	41589	92314	0.25	0.40
32500	2946	38002	83742	0.32	0.43	-6552	39705	90620	0.27	0.42
35000	2142	37749	83211	0.33	0.44	-8457	36828	88646	0.30	0.45
37500	1101	36819	82135	0.33	0.44	-10948	35130	86239	0.32	0.47
40000	253	35523	81446	0.34	0.46	-13302	32746	84078	0.35	0.50

Table 10.8.8. For a high recruitment scenario 95% credibility intervals, median of spawning biomass for 2005 and 2006 together with the probability of falling falling below Blim and Bpa under different total annual catch options.

Annual catch	2005					2006				
	2.50%	median	97.50%	P(B<Blim)	P(B<Bpa)	2.50%	median	97.50%	P(B<Blim)	P(B<Bpa)
0	38935	69899	100379	0.00	0.01	62723	99363	132929	0.00	0.00
2500	37542	68829	99569	0.00	0.01	60644	97600	130878	0.00	0.00
5000	36861	67987	98368	0.00	0.01	58954	95195	128719	0.00	0.00
7500	36375	67169	97915	0.00	0.01	55684	92487	127121	0.00	0.00
10000	35123	66788	96833	0.00	0.02	53072	90479	124251	0.00	0.00
12500	34412	65798	96308	0.00	0.02	51819	88216	121947	0.00	0.00
15000	33576	64867	95017	0.00	0.02	49526	86366	120072	0.00	0.00
17500	32606	63960	93940	0.00	0.03	47049	83955	118094	0.00	0.00
20000	31492	63167	93621	0.00	0.03	44156	81168	115850	0.00	0.00
22500	30722	62201	92535	0.00	0.04	42364	79238	113396	0.00	0.01
25000	30143	61366	91811	0.00	0.04	40519	77194	111238	0.00	0.01
27500	29318	60316	90599	0.00	0.05	37969	74541	108421	0.00	0.01
30000	27739	59637	90079	0.01	0.06	35475	72838	106602	0.00	0.02
32500	27749	58399	89082	0.01	0.06	34136	70166	104355	0.00	0.02
35000	26234	58170	88459	0.01	0.08	30932	68061	102649	0.00	0.03
37500	25833	57232	87643	0.01	0.08	29513	66381	99775	0.01	0.04
40000	24301	56270	86448	0.01	0.10	27386	64124	98256	0.01	0.06

Figure 10.2.1.1: Bay of Biscay anchovy: Historical evolution of the fishery since 1940



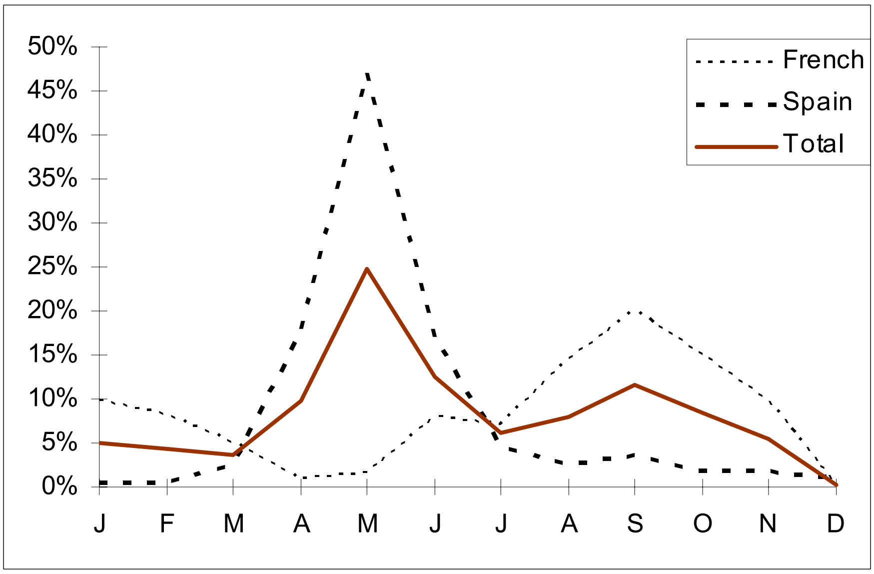


Figure 10.2.1.2: Mean monthly catches (1992-2003) for the French and Spanish fisheries on anchovy in Sub-area VIII

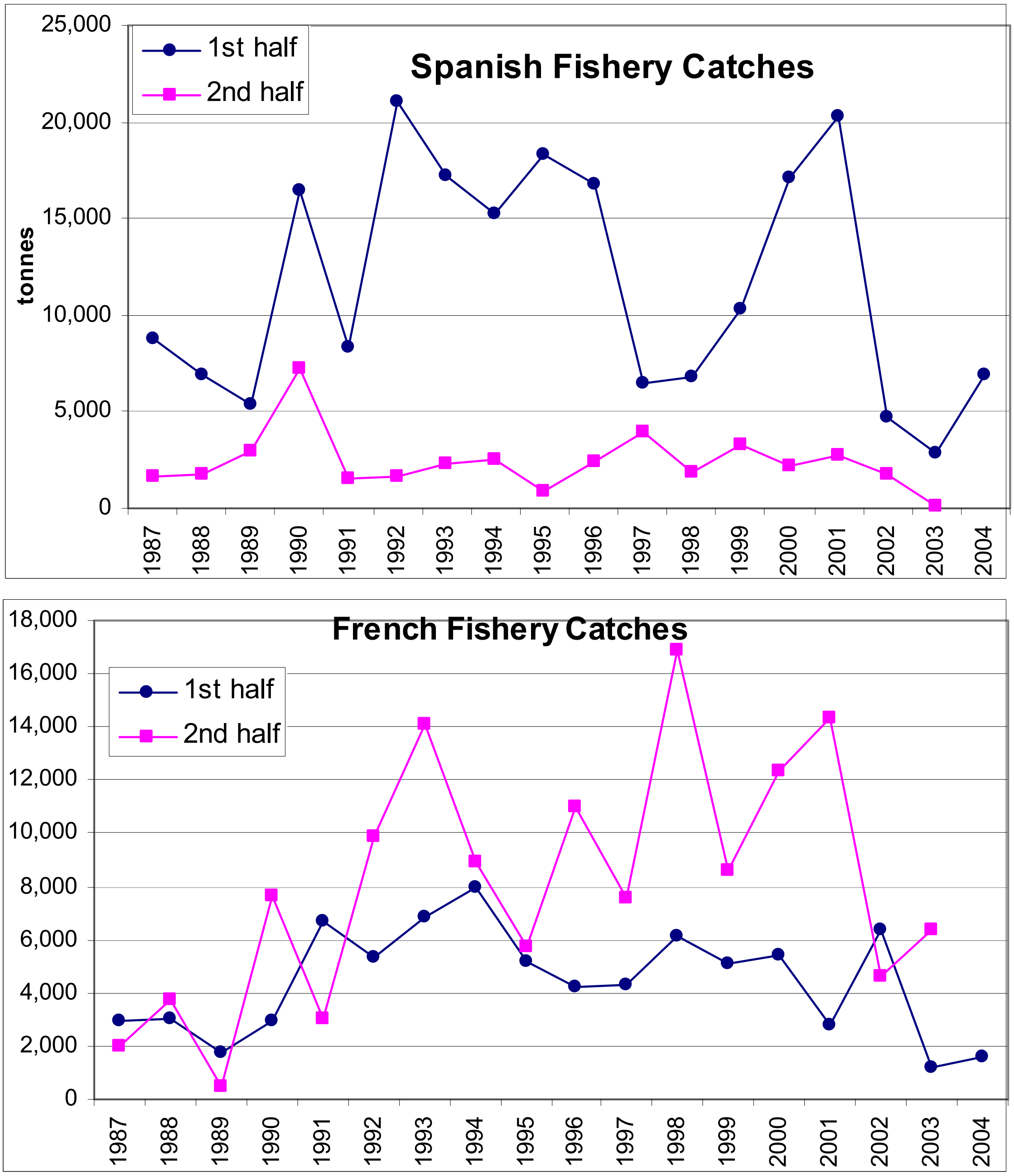


Figure 10.2.1.3: Seasonal catches of anchovy by countries since 1987:
a)Upper graphic Spanish fishery catches for the first and second half of the year
b)Bottom graphic: French fishery catches for the first and second half of the year

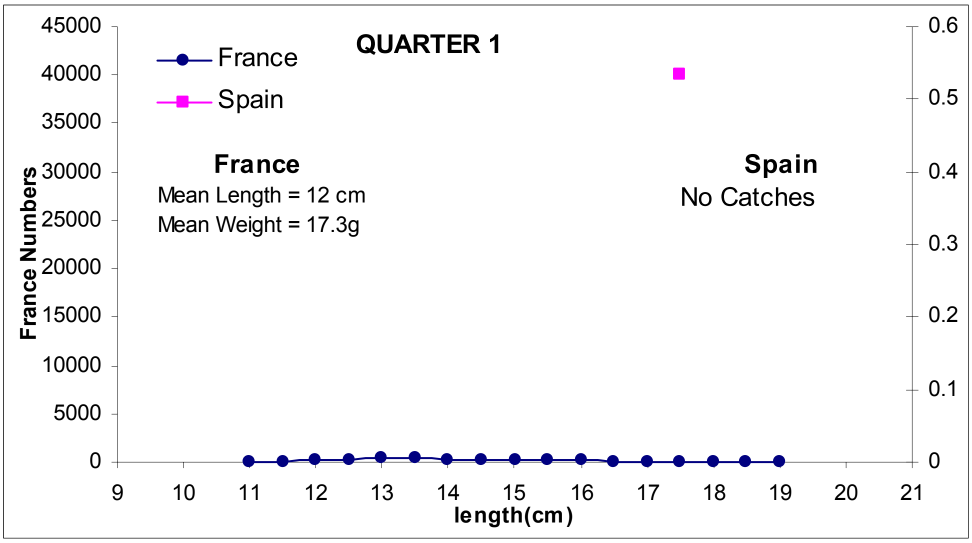


Figure 10.3.2.1: Length distribution of anchovy catches by country in 2003 Quarter 1

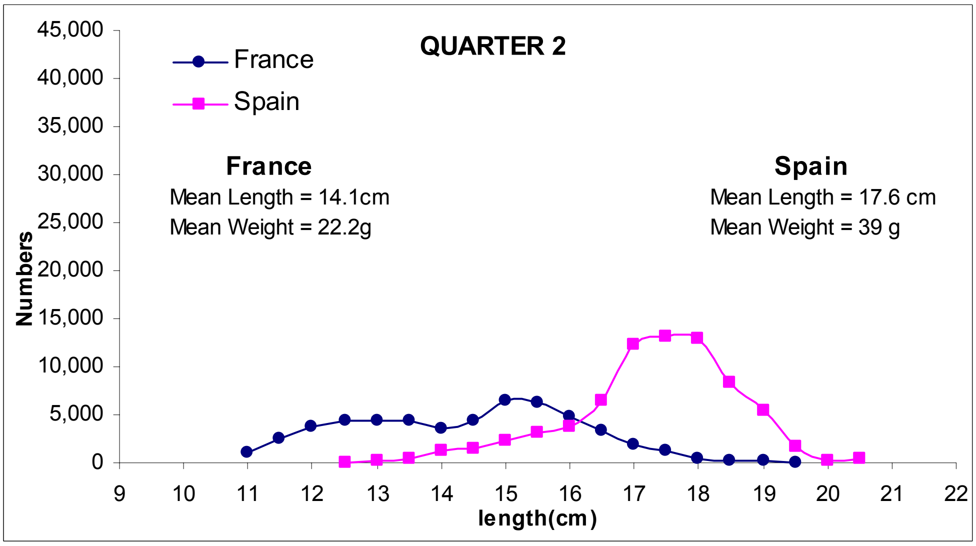


Figure 10.3.2.2: Length distribution of anchovy catches by country in 2003 Quarter 2

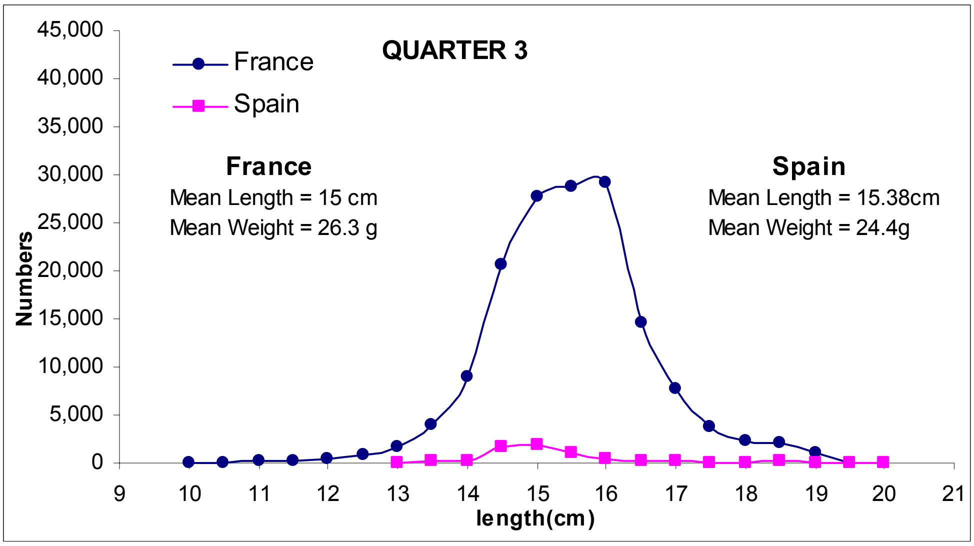


Figure 10.3.2.3: Length distribution of anchovy catches by country in 2003 Quarter 3

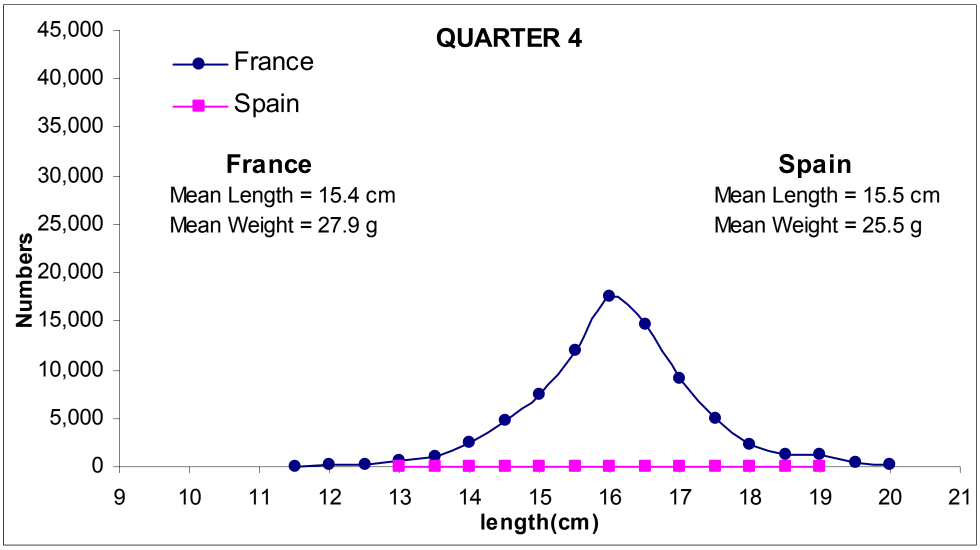


Figure 10.3.2.4: Length distribution of anchovy catches by country in 2003 Quarter 4

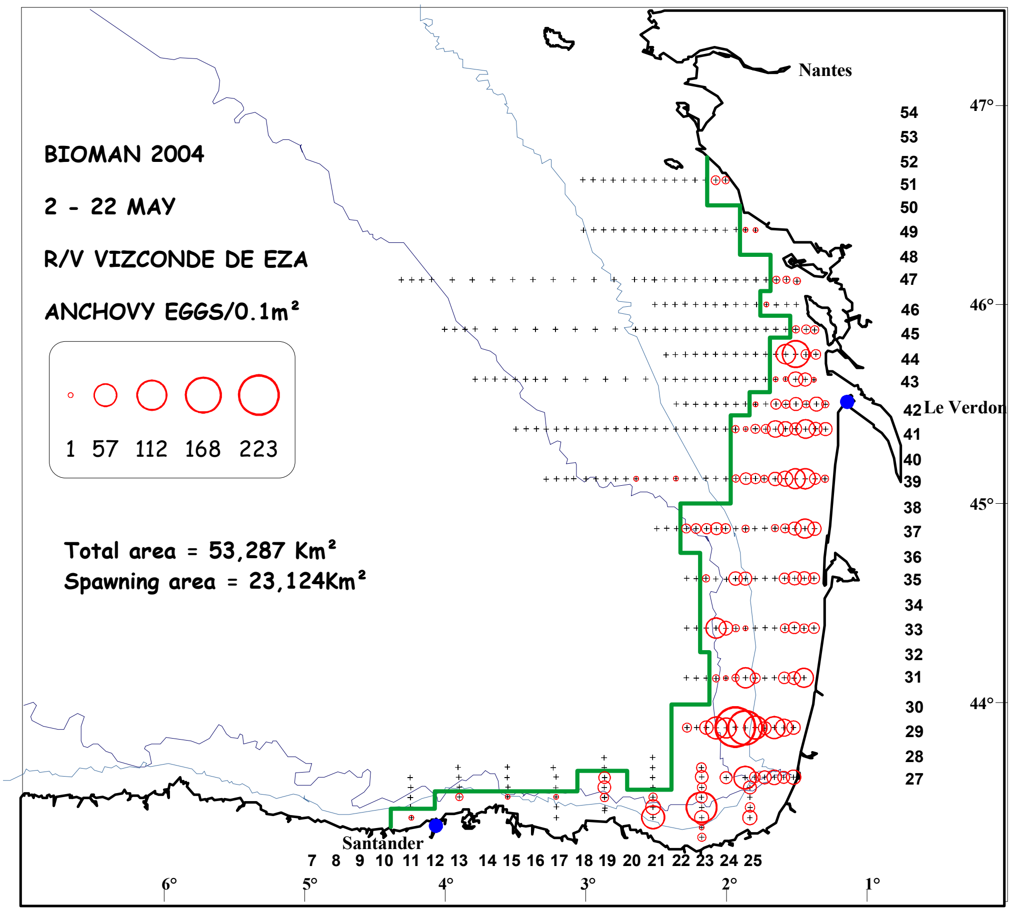


Figure 10.4.1.1: Anchovy egg/0.1m^2 distribution found during BIOMAN 2004. Solid line encloses the positive spawning area.

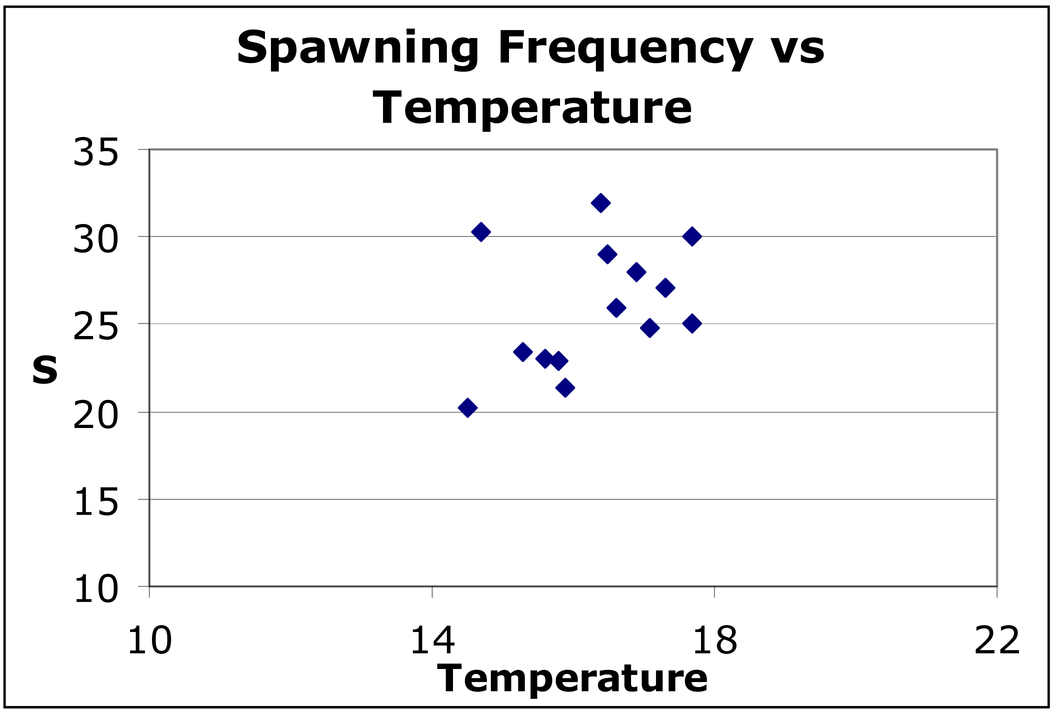


Figure 10.4.1.2: Spawning frequency estimates and sea surface temperature of the DEPM surveys for anchovy in the bay of Biscay since 1987 (a single value of June 1989 is omitted because of low amount of samples). Average sea surface temperature in the application of 2004 is 13.7ªC

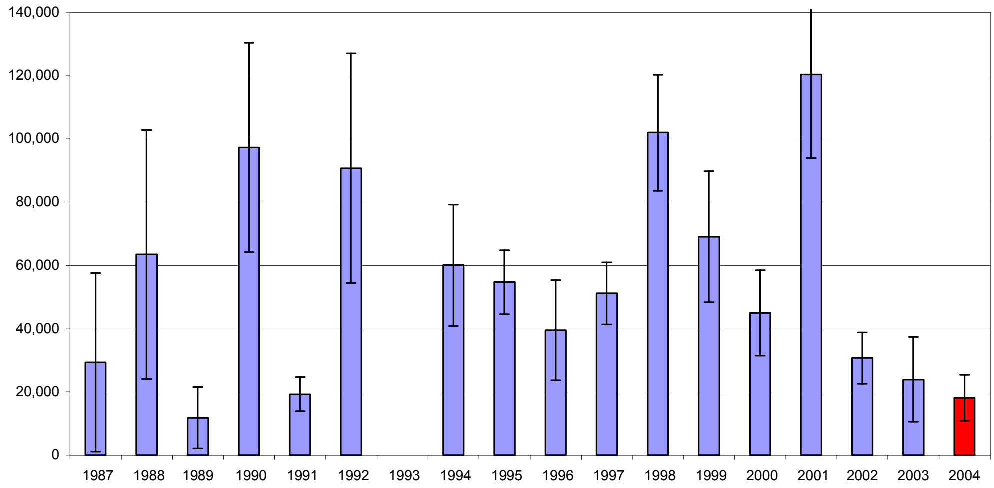


Figure 10.4.1.3: Series of biomass estimates obtained for the bay of Biscay anchovy by the Daily Egg Production Method since 1987, bounded by ± 2 s.e of the estimate.

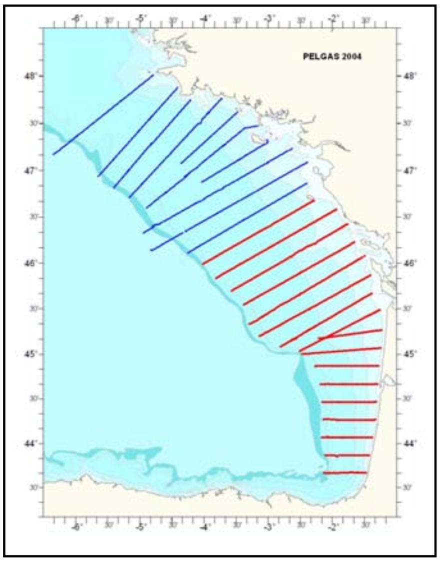


Figure 10.4.2.1: Area prospected during PELGAS04, only the red transects were processed and available for the time of the WG.

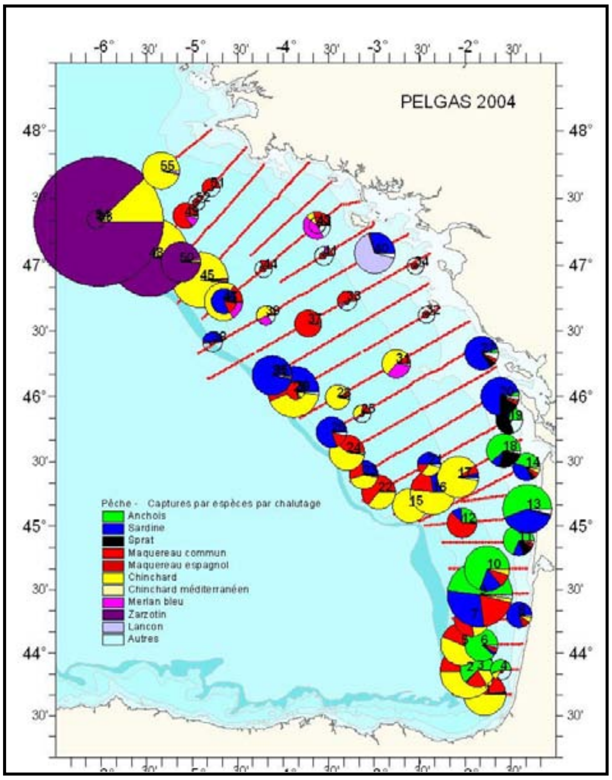


Figure 10.4.2.2: Species distribution according to identification hauls during PELGAS04 (green - anchovy ; blue - sardine ; red - mackerel ; yellow - horse mackerel ; black – sprat ; violet – *Capros aper*)

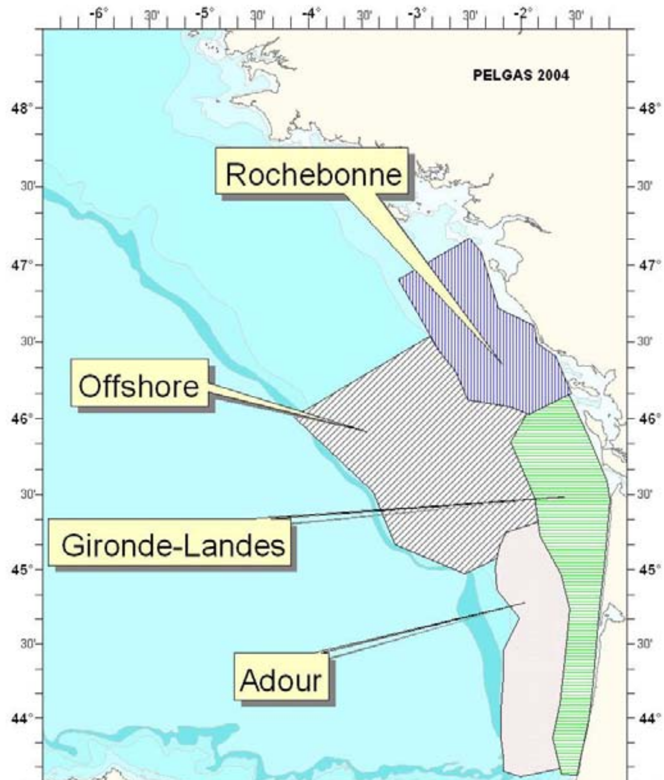
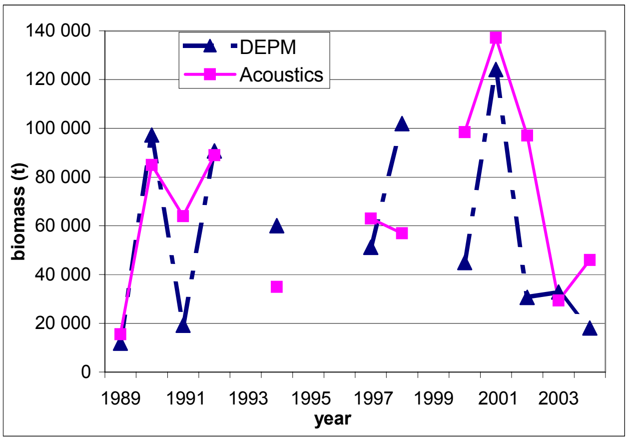
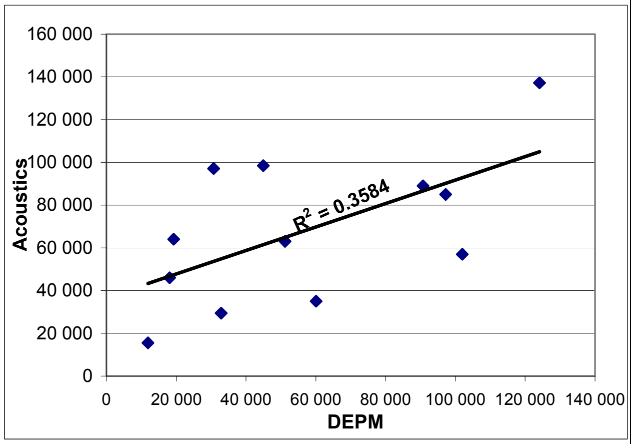


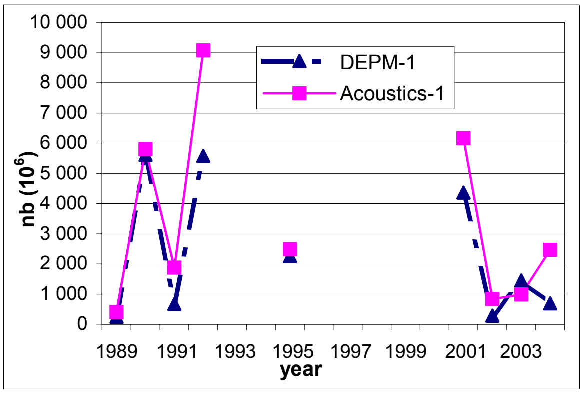
Figure 10.4.2.3: Areas taken into consideration for sardine, anchovy and sprat estimates by acoustics from PELGAS04



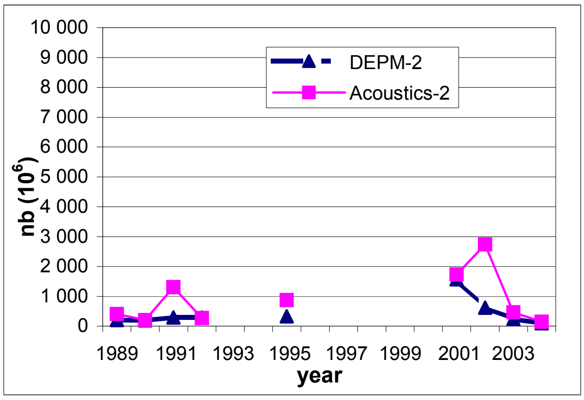
10.4.3.1.a. Biomass (in tons) comparisons between DEPM and acoustics



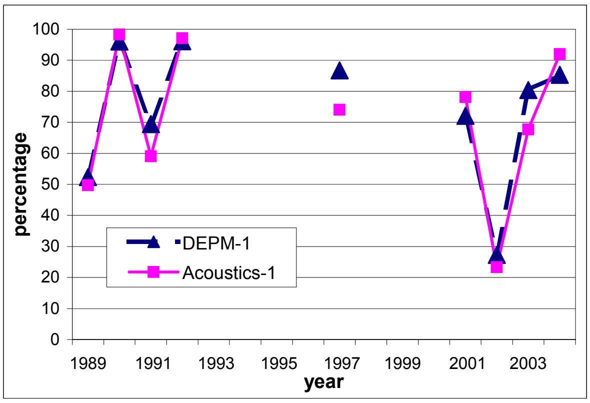
10.4.3.1.b. Correlation between DEPM and acoustics



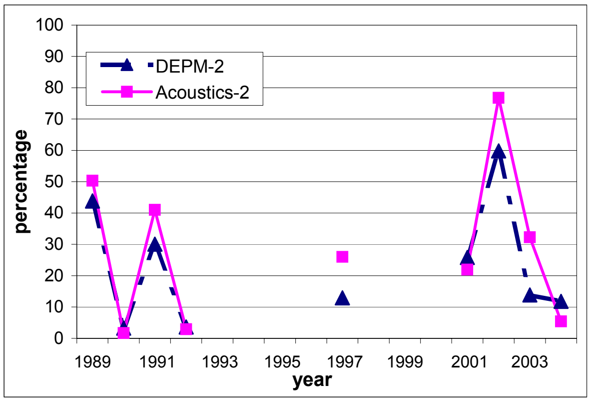
10.4.3.2.a: Assessments of age group 1 by DEPM and acoustics



10.4.3.2.b: Assessments of age group 2 by DEPM and acoustics



10.4.3.2.c: Assessments of age group 1 by DEPM and acoustics (in %)



10.4.3.2.d: Assessments of age group 2 by DEPM and acoustics (in %)

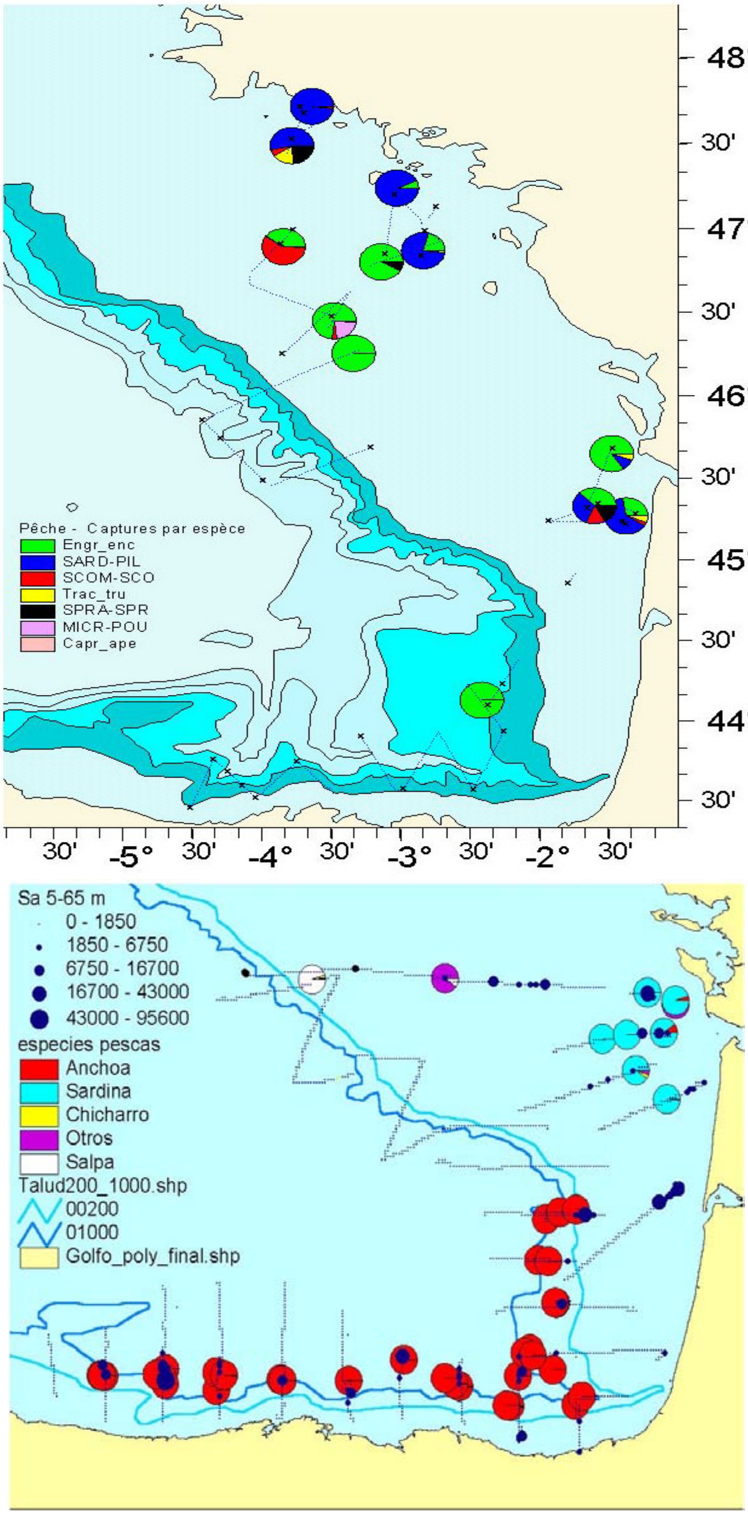


Figure 10.4.4.1: Acoustic surveys on juvenile anchovy: Top panel JUVAGA (IFREMER) – radials and pelagic trawl fishing huals. Bottom panel JUVENA03 (AZTI) – radials and purse seine fishing hauls. In JUVENA juvenile anchovy predominated all the North of Spain and southern French area and sardine predominated the areas close to the Garonne river plume. In JUVEGA, the juveniles in the north of Spain were not seen and in the Garonne area anchovy juveniles dominated.

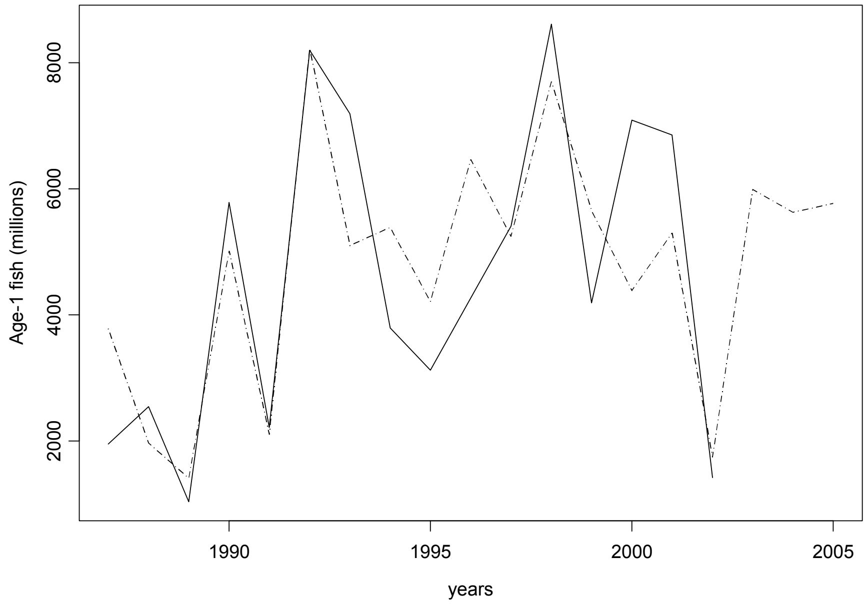


Figure 10.6.1: Age-1 as estimated by ICES in the period 1987-2002 with recruitment model fitted and predicted values (2003-2005) by two-covariate model.

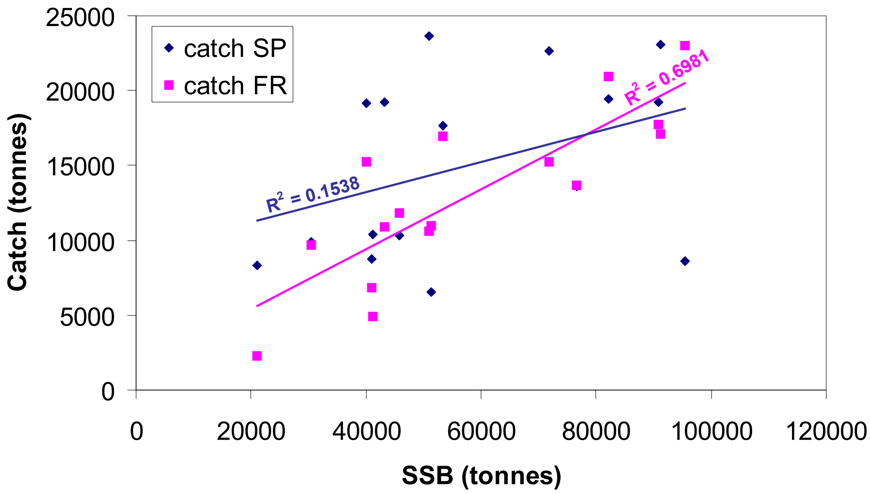


Figure 10.7.1.1.1: Spanish and French catches up to 2002 in relation to the spawning biomass estimates of the last year assessment.

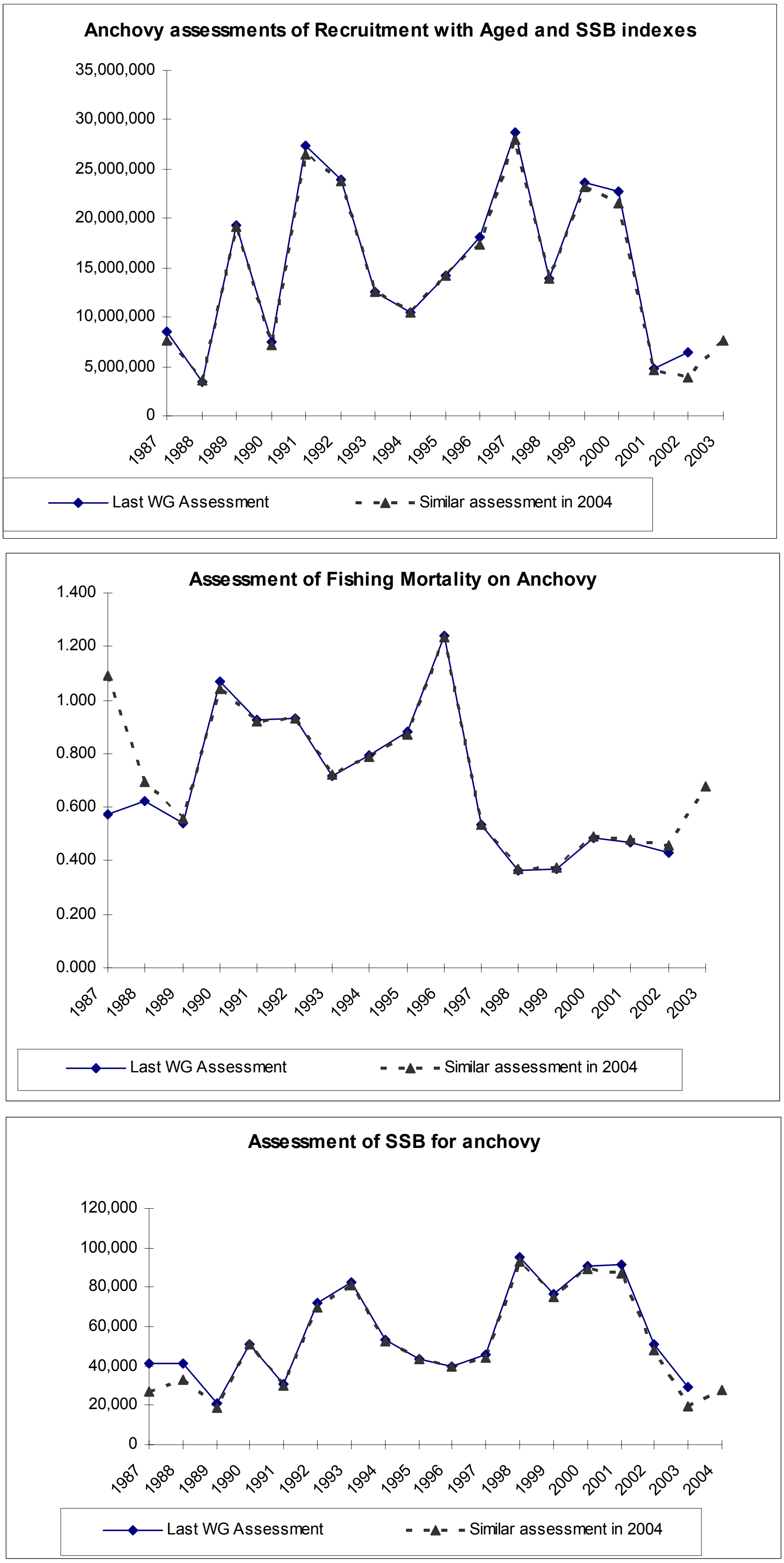
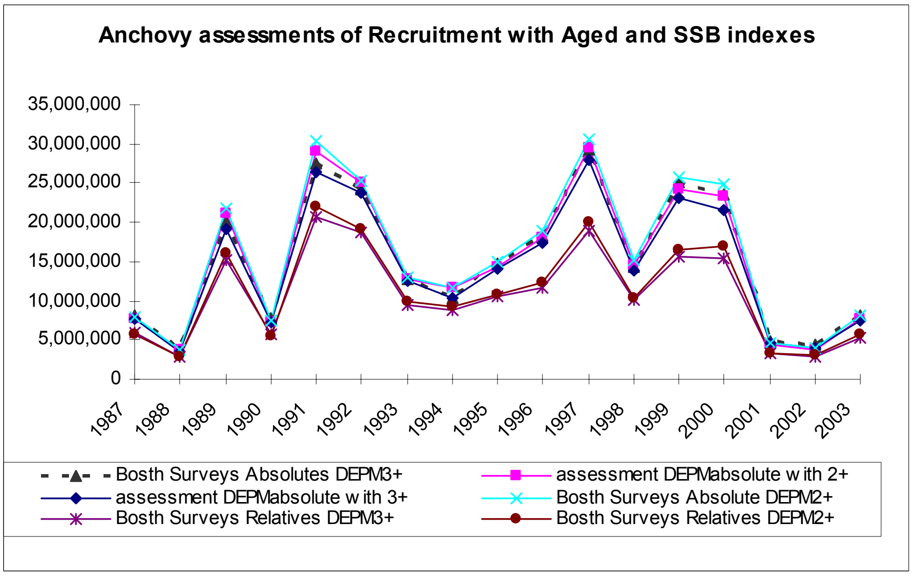
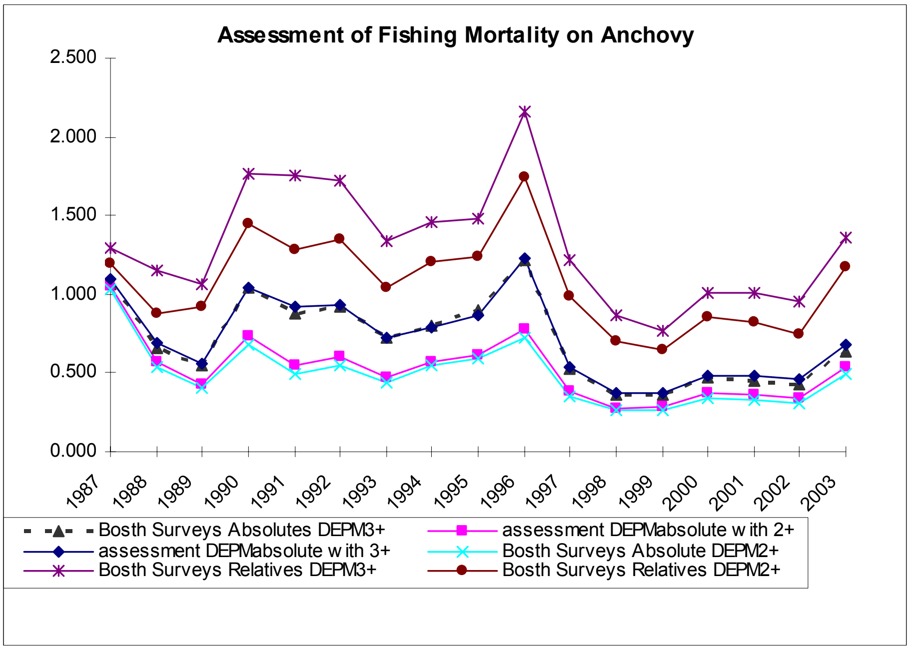


Figure 10.7.1.1.2 Comparison of last year ICES assessment with the new assessment in 2004 Concerning Anchovy in Subarea VIIII with the revision of DEPM estimate in 2003 (DEPM) and new 2004 DEPM+Acoustic estimates





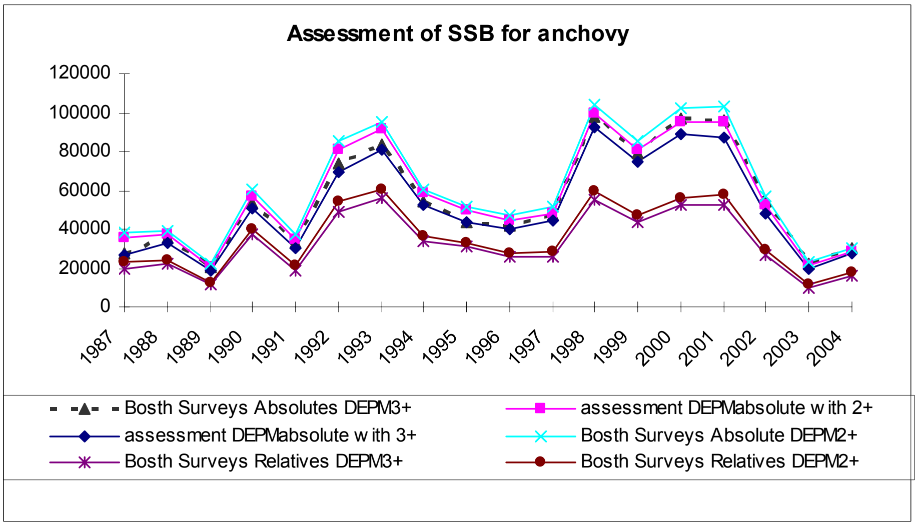


Figure 10.7.1.1.3: Comparison of different assessments for Anchovy in 2004 Concerning differente catchabilities of Surveys and the age plus group in DEPM population estimates

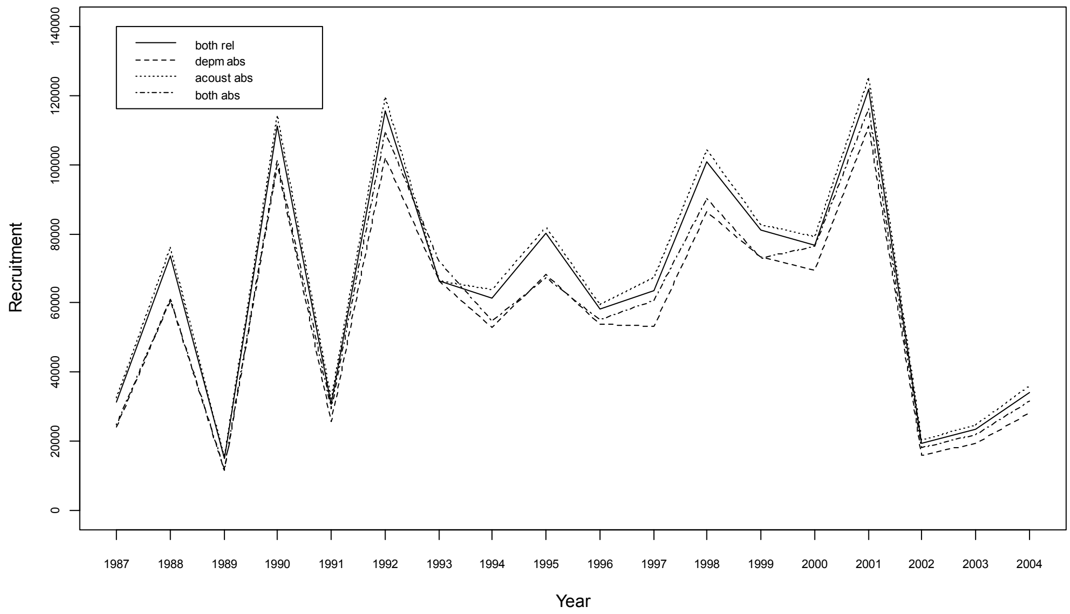


Figure 10.7.1.2.1: Posterior median recruitments for different combinations of DEPM and acoustic indices taken as absolute and/or relative.

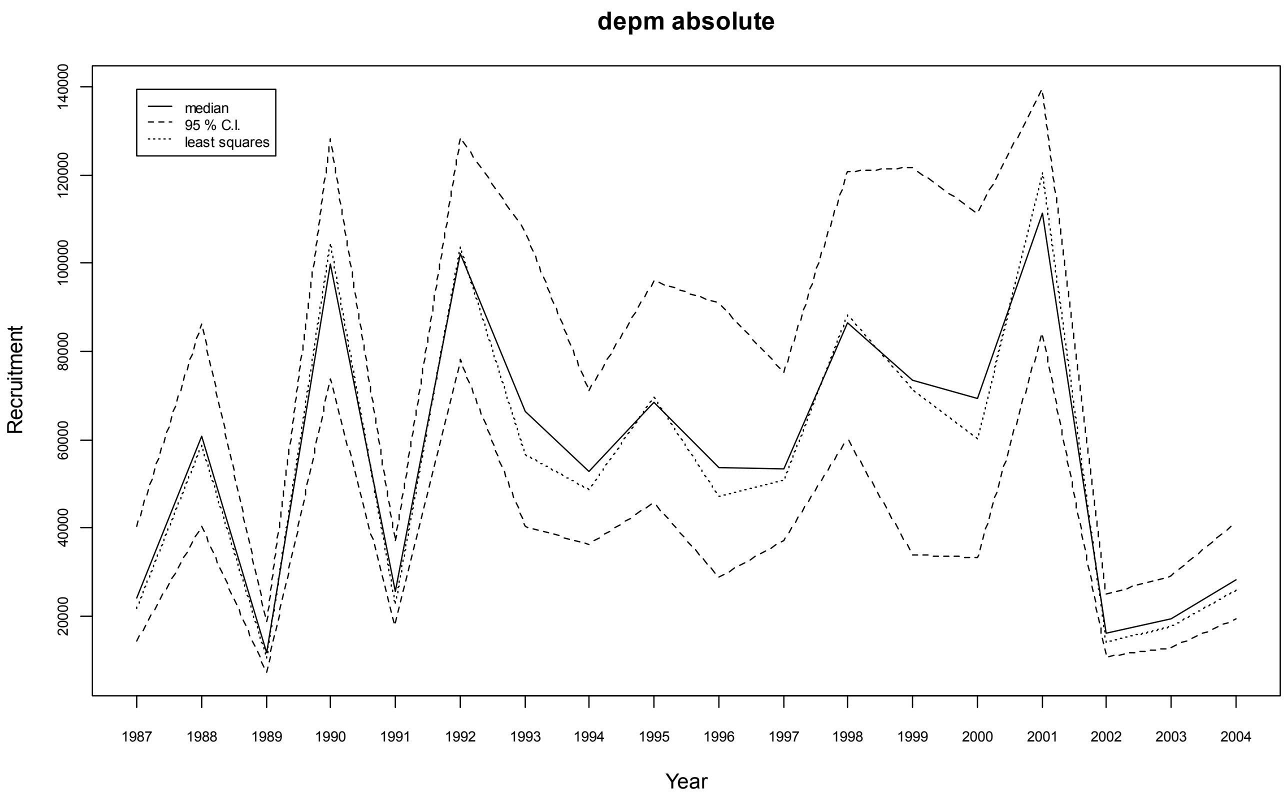


Figure 10.7.1.2.2: Recruitment least squares estimates compared to posterior medians of recruitment from the Bayesian biomass-based model and corresponding 95% credibility intervals.

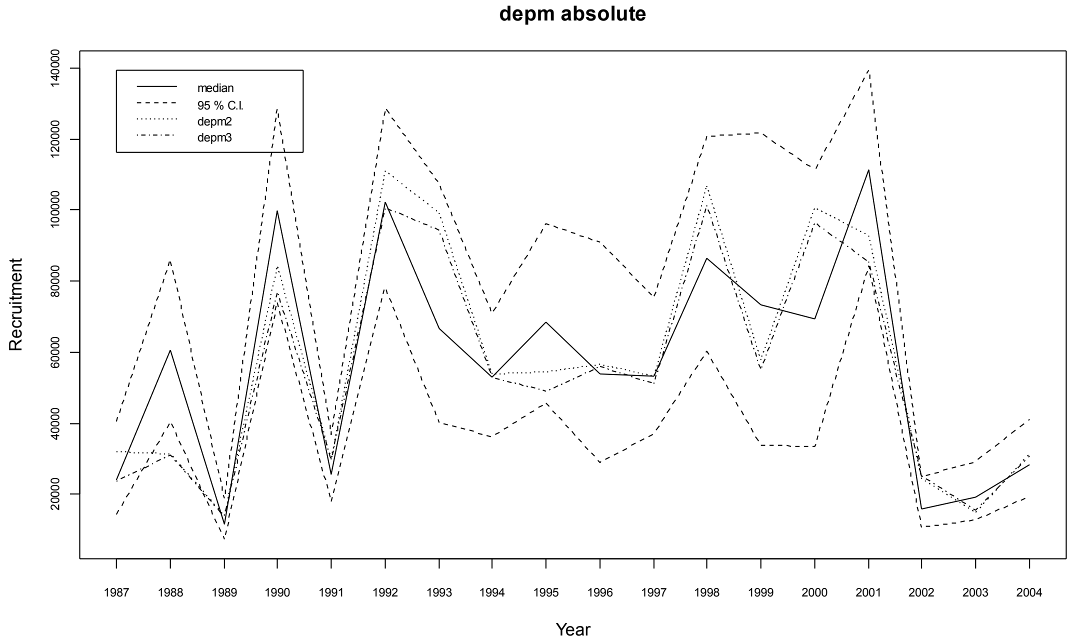


Figure 10.7.1.2.3: Recruitment estimates from ICA taking DEPM as absolute and acoustic as relative with DEPM age groups both as 2+ and 3+ compared to posterior medians of recruitment from the Bayesian biomass-based model and the corresponding 95% credibility intervals.

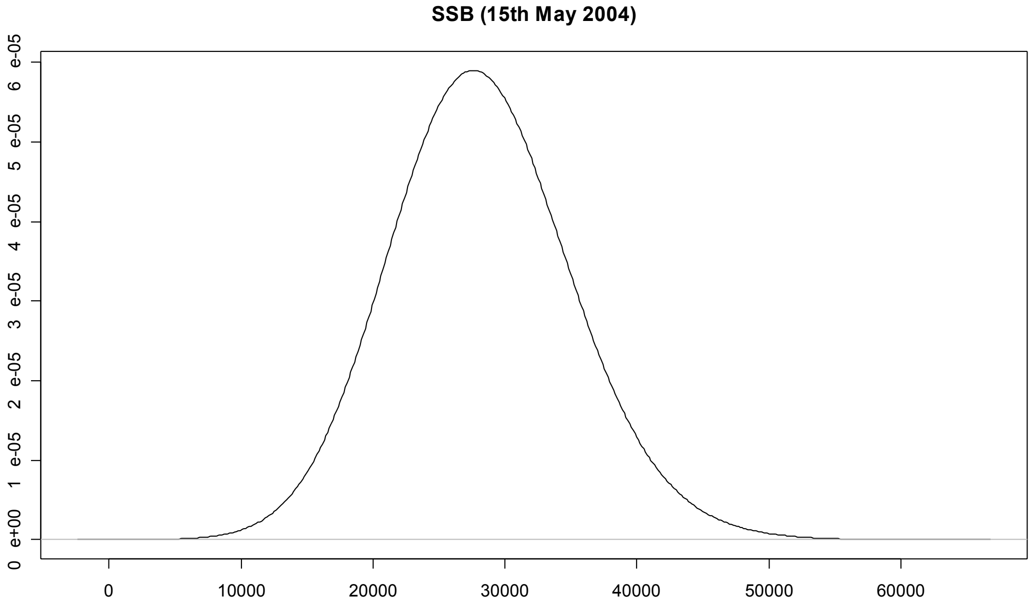
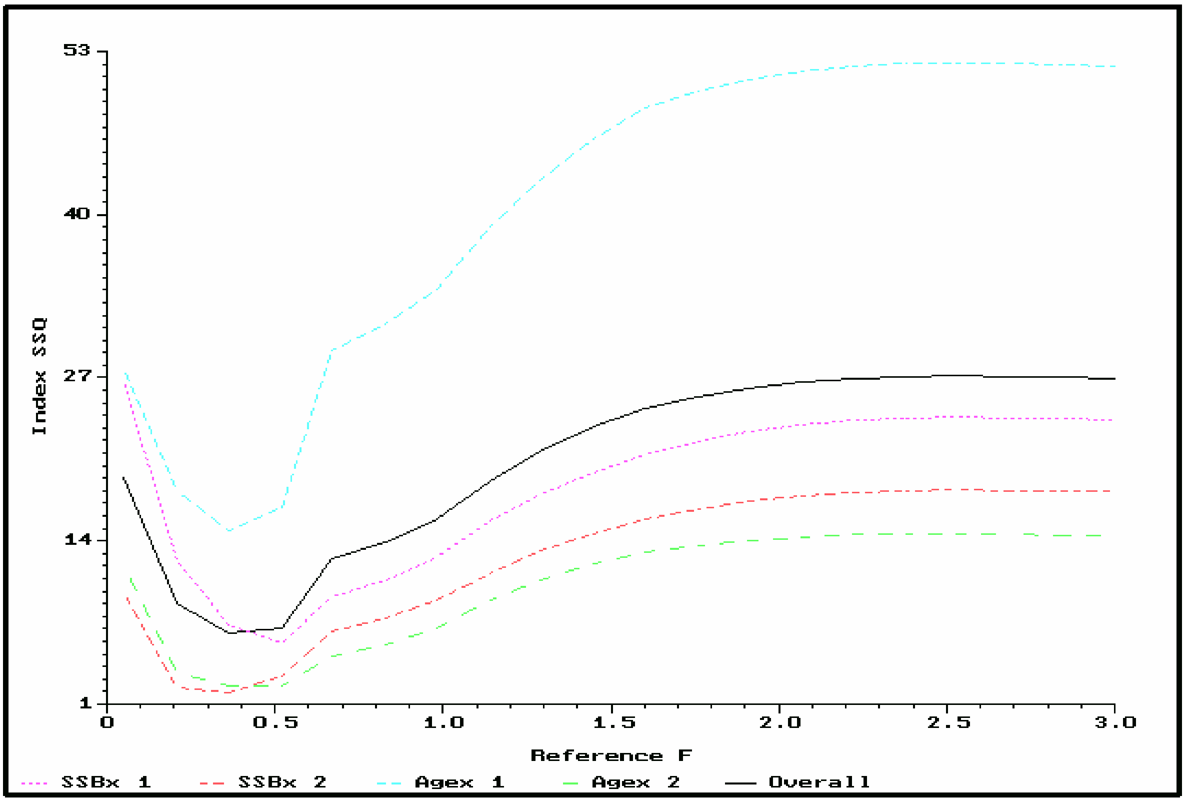


Figure 10.7.1.2.4: Posterior distribution of the spawning biomass in mid-may in 2004 from the Bayesian biomass model.



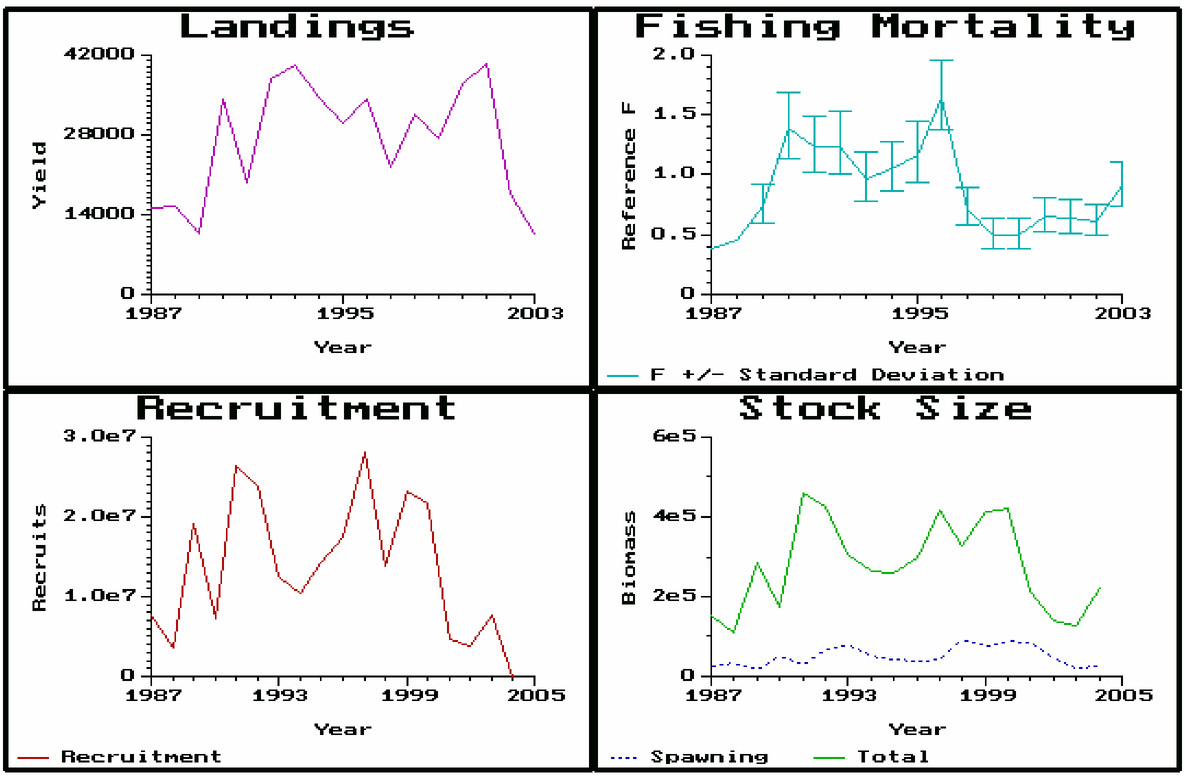


Figure 10.7.2.1. Fitting graphics of the assessment of the Bay of Biscay anchovy

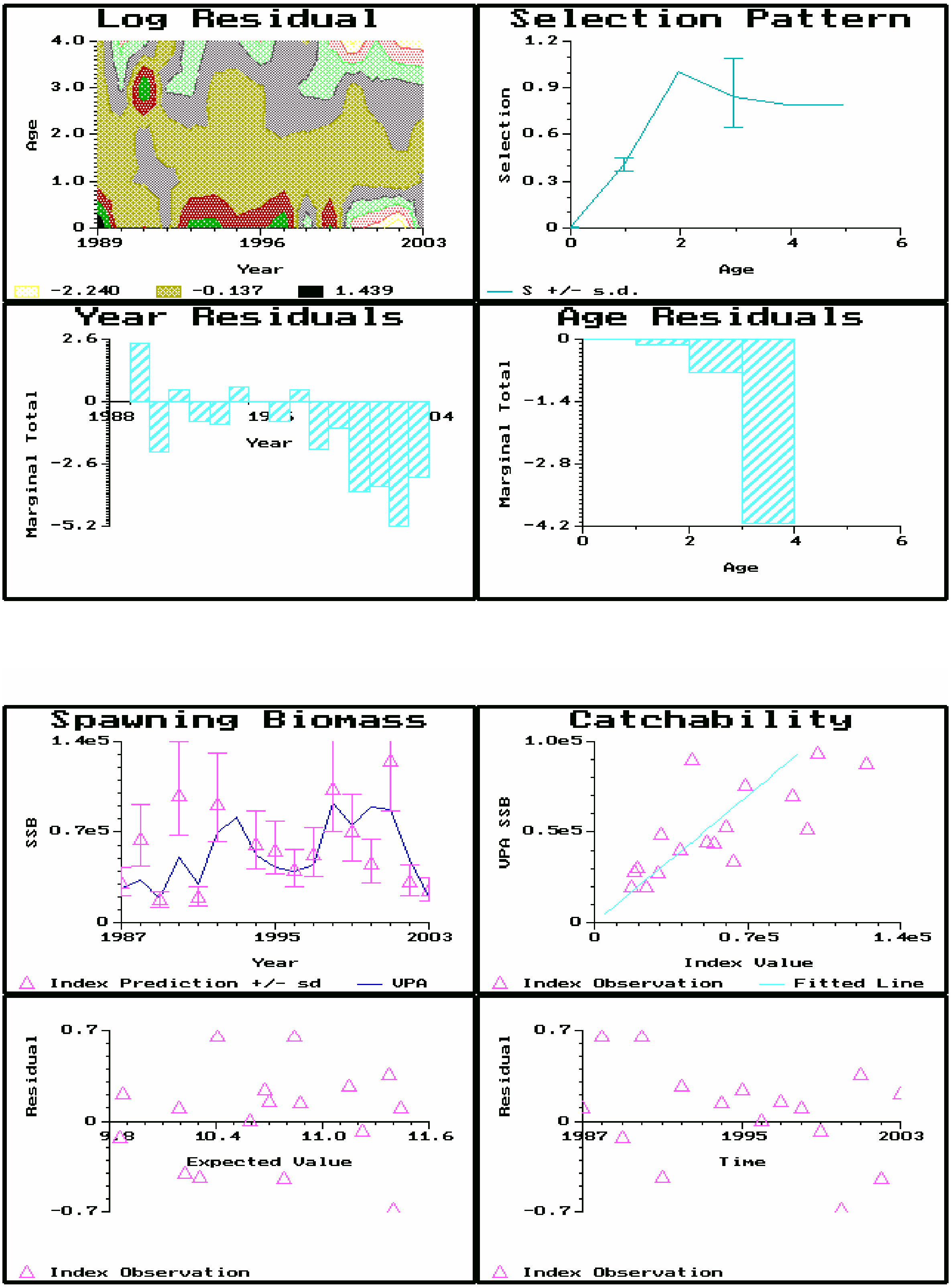


Figure 10.7.2.1 (Cont'd)

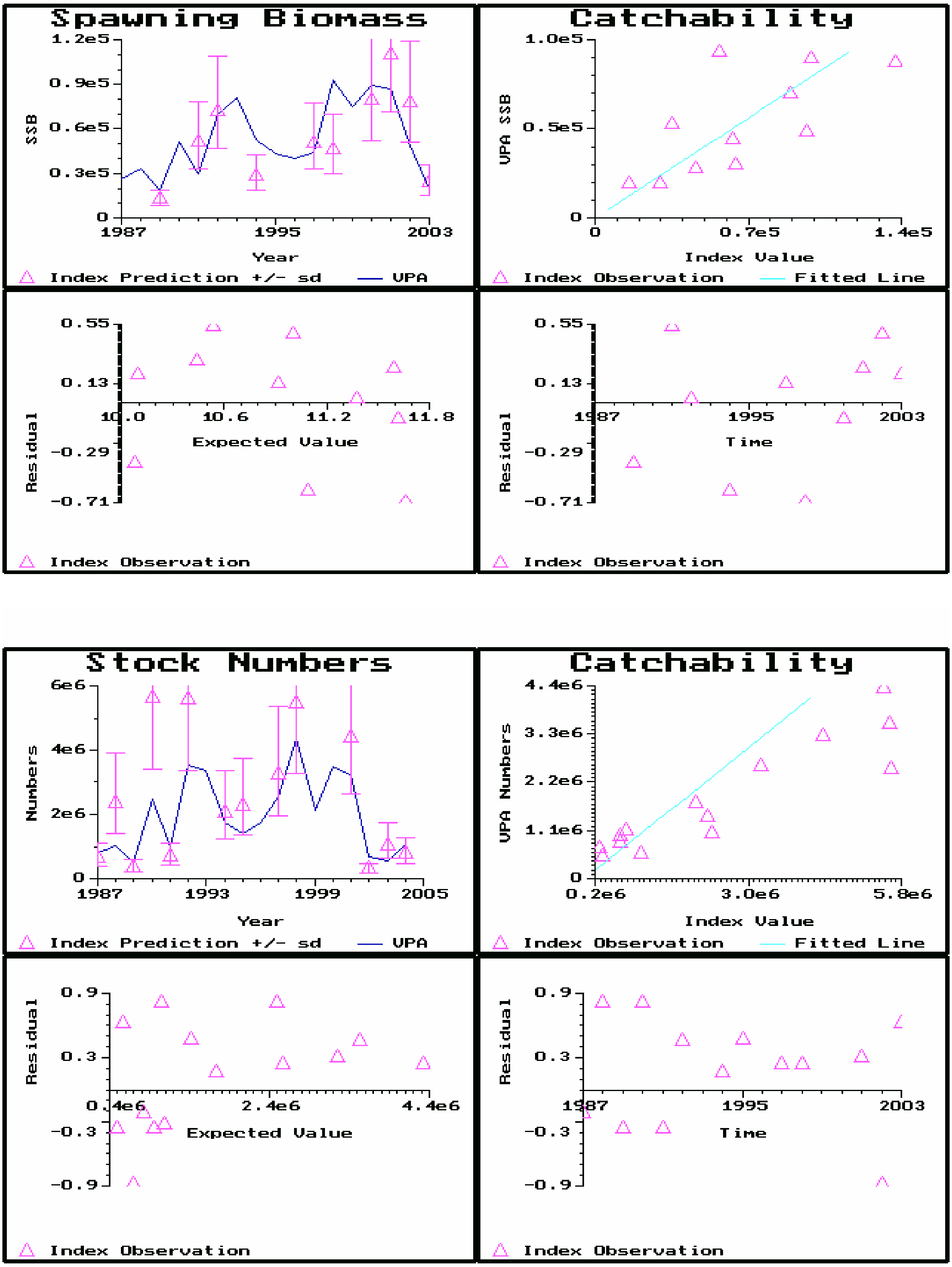
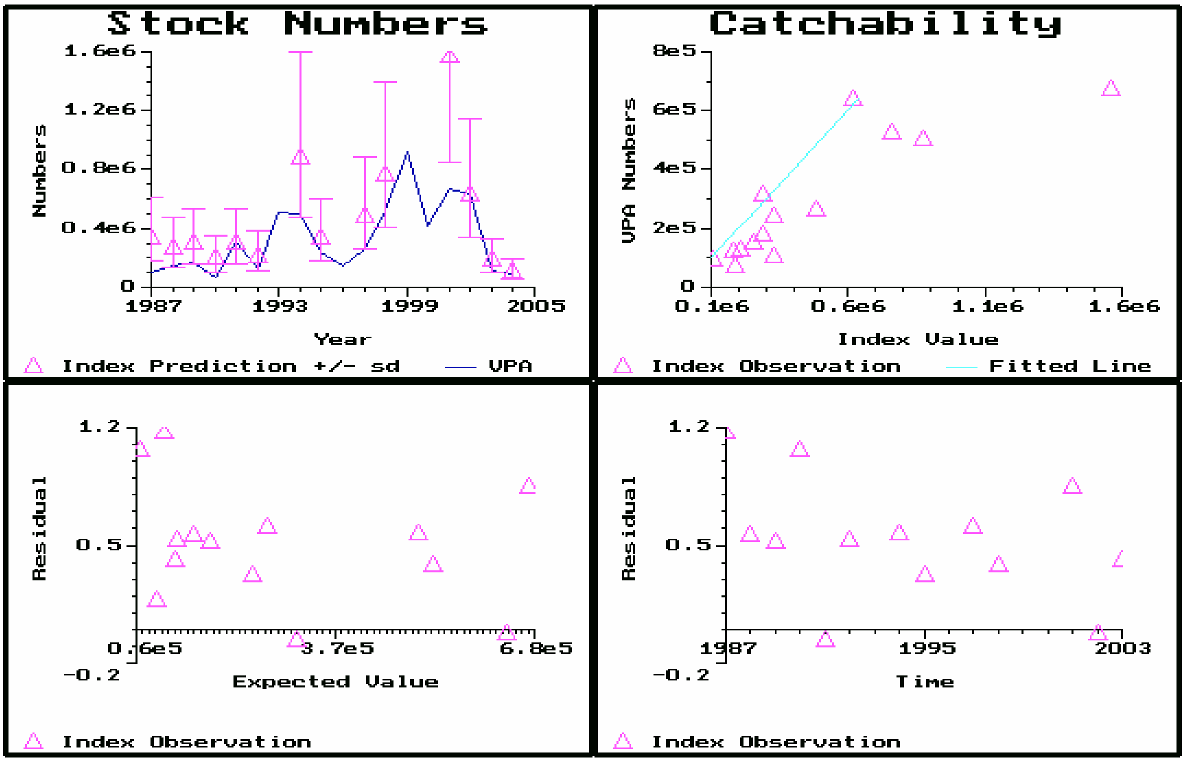


Figure 10.7.2.1 (Cont'd)



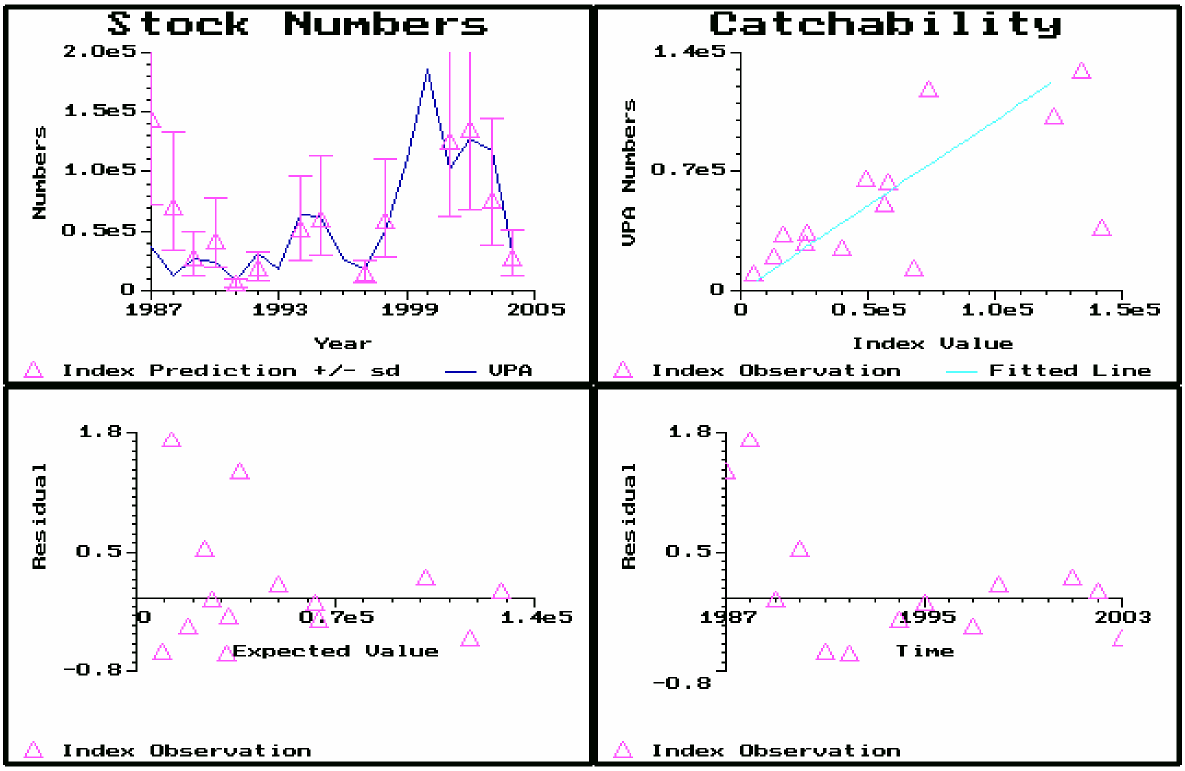
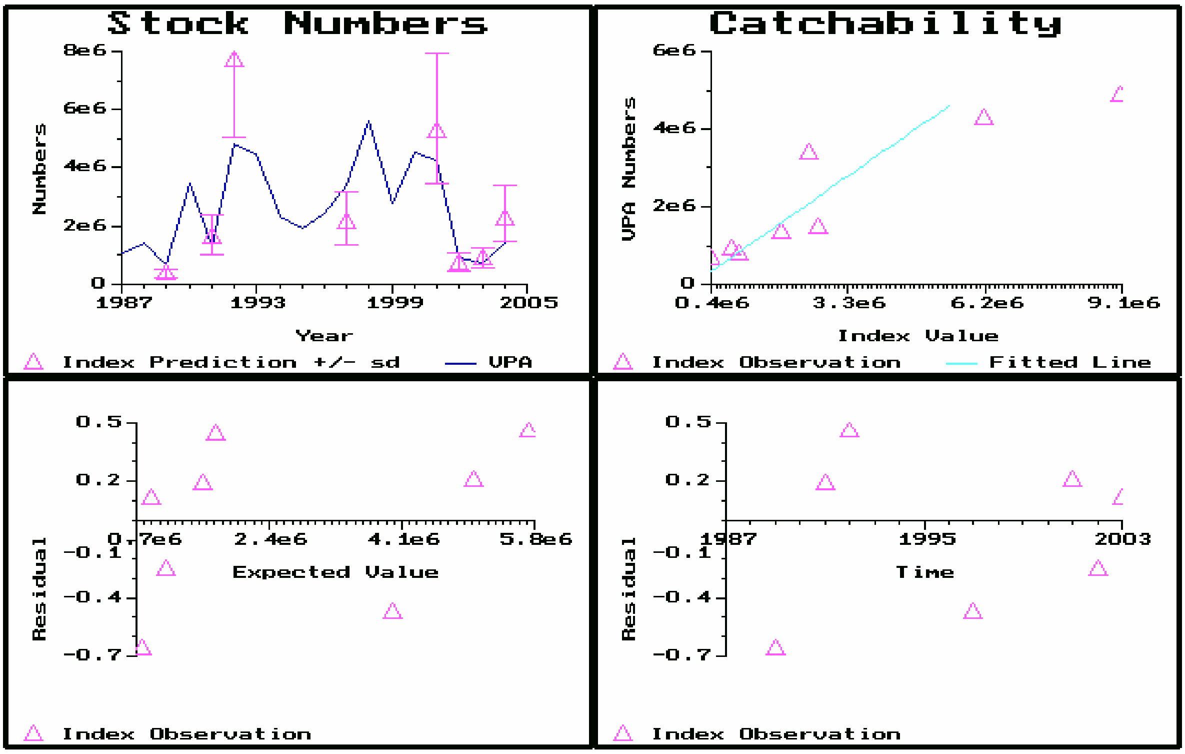


Figure 10.7.2.1 (Cont'd)



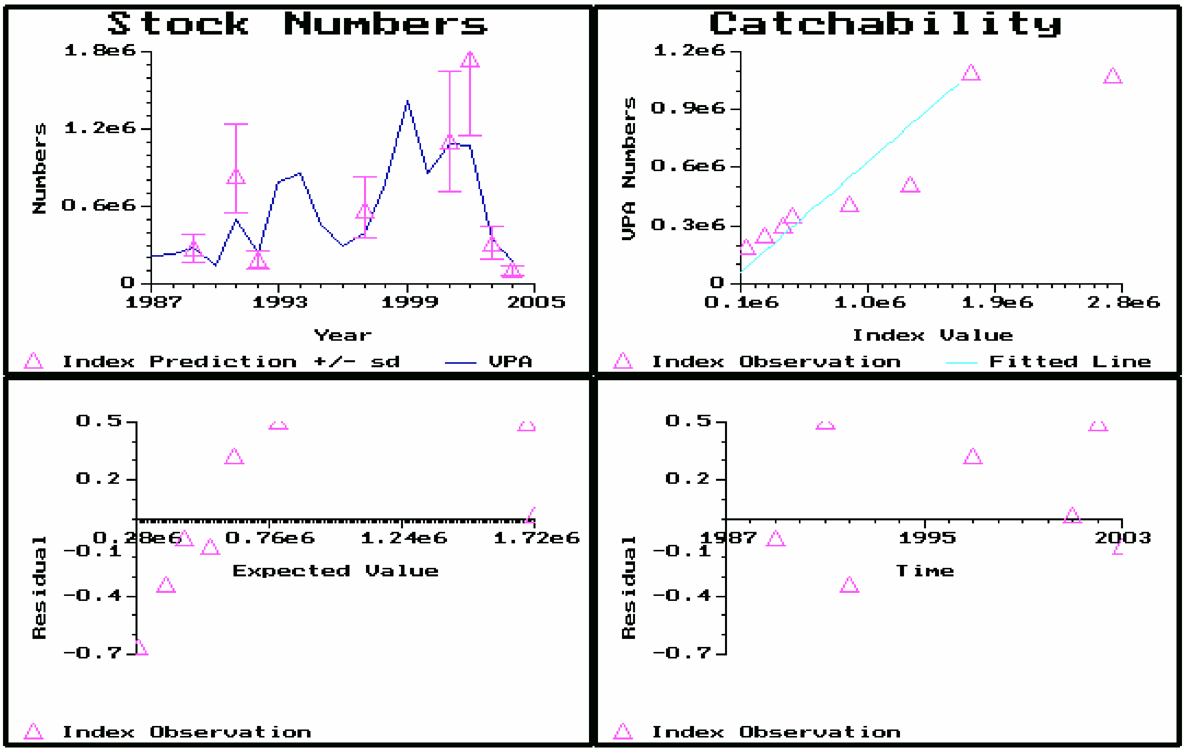


Figure 10.7.2.1 (Cont'd)

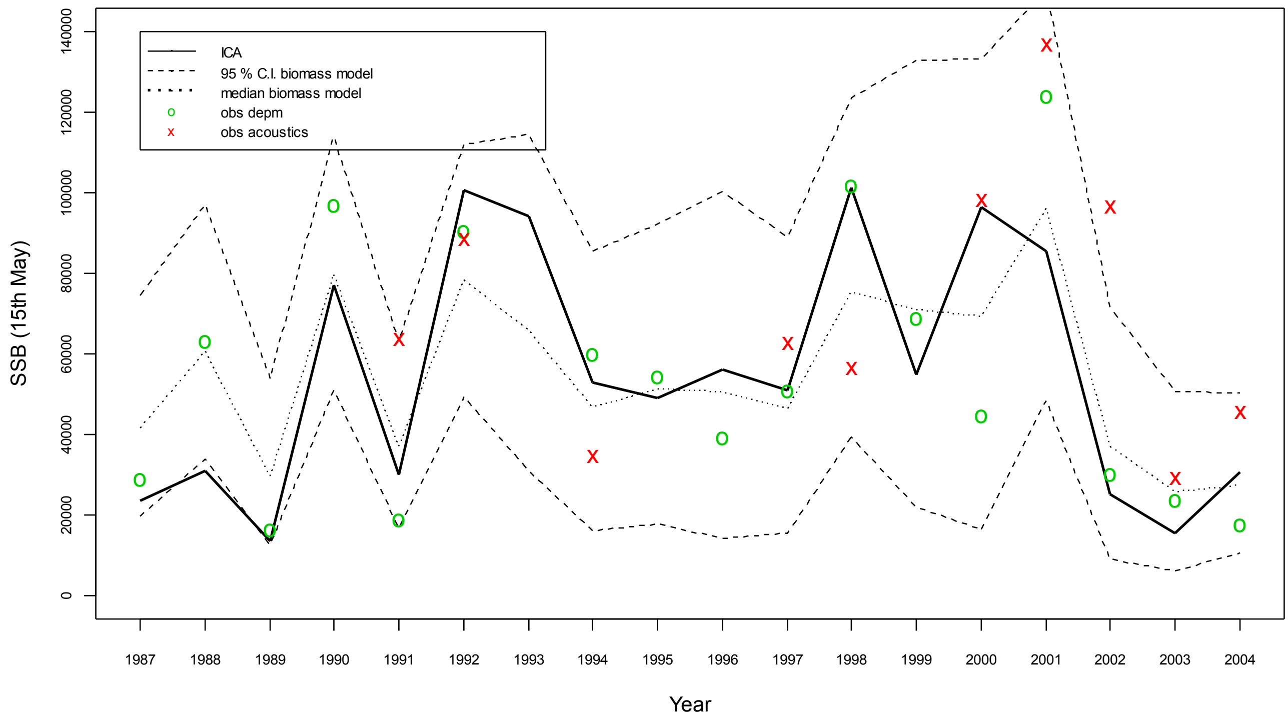


Figure 10.7.3.1: ICA biomass estimates (solid line) compared to the DEPM (circles) and acoustic (crosses) biomass estimates. Dotted lines represent the posterior biomass median and corresponding 95% intervals from the biomass-based model.

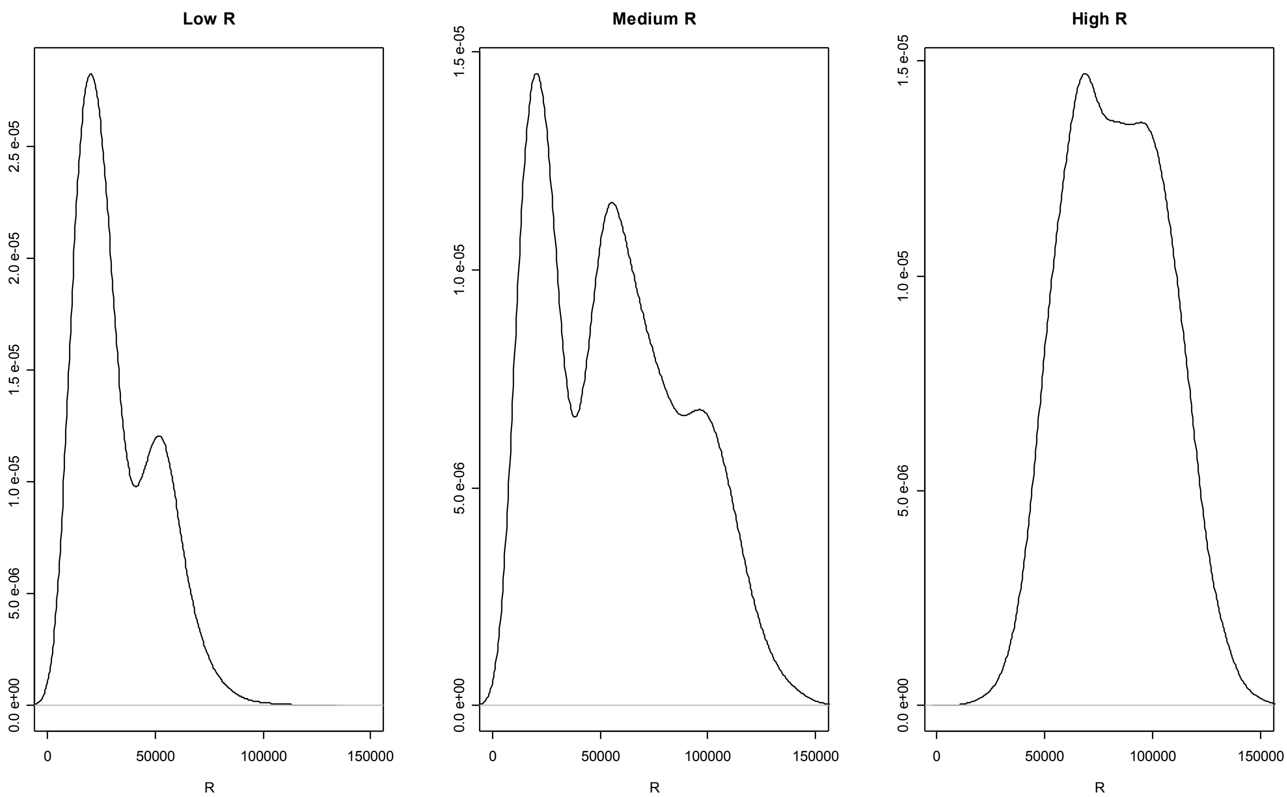


Figure 10.8.1: From the left to the right recruitment distributions under low, medium and high recruitment scenarios.

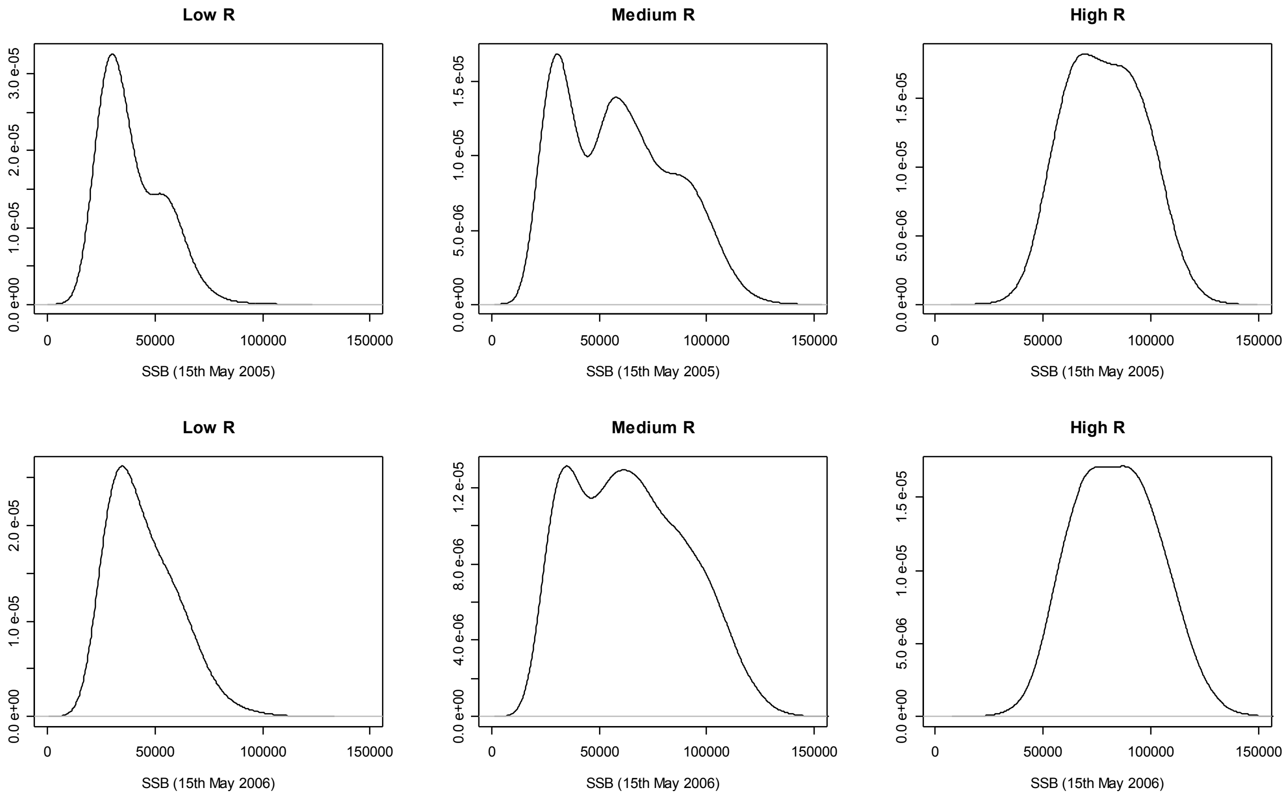


Figure 10.8.2: From the left to the right distribution of unexploited biomass for 2005 (top row) and 2006 (bottom row) under low, medium and high recruitment scenarios.

11 Anchovy in Division IXa

11.1 ACFM Advice Applicable to 2003 and 2004

The ACFM advice on management from ICES recommendations stated that catches in 2001 and 2002 were restricted to 4,900 t (ICES C.M. 2002/ACFM:06). This recommended catch level was decreased to 4,700 t for 2003, which corresponded to the level of mean catches from the period 1988-2001, excluding 1995, 1998, and 2001 (ICES C.M. 2003/ACFM:07). This last level was also recommended for 2004 and it should be kept until the response of the stock to the fishery is known (ICES C.M. 2004/ACFM:08). ACFM is aware that the state of this resource can change quickly, and therefore it considers appropriate the development and implementation of a management plan including an in-year monitoring of both the stock and the fishery with corresponding regulations.

The agreed TAC for anchovy since 2002 (for Sub-areas IX and X and CECAF 34.1.1) is of 8,000 t. Anchovy catches in Division IXa in 2002 were 8,806 t, but experienced a remarkable decrease in 2003 to 5,269 t.

11.2 The Fishery in 2003

11.2.1 Landings in Division IXa

Anchovy total landings in 2003 were 5,269 t, which approximately represented a 40% decrease in relation to the landing levels observed in 2001 (9,098 t) and 2002 (8,806 t), (**Table 11.2.1.1**, **Figure 11.2.1.1**). This decreasing trend in catches was observed in all Sub-divisions.

As usual, the anchovy fishery in 2003 was mainly harvested by purse seine fleets (96% of total catches). Portuguese and Spanish purse-seine landings accounted for 60% and 99% 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 experienced in 2003 a relative increase in landings in comparison with the preceding years (184 t, 38% of Portuguese anchovy total landings). However, landings from this fishery as well as from the trawl ones (both Spanish and Portuguese) were still small compared to the whole anchovy fishery in the Division.

11.2.2 Landings by Sub-division

The anchovy fishery was mainly located in 2003 in the Sub-division IXa South (4,968 t, *i.e.*, 94% 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 (4,768 t against 200 t landed in the Algarve). Excepting catches from IXa Central-North (211 t, only 4% of total catch), the relative importance of the remaining Sub-divisions was negligible.

The Spanish fishery in 2003 followed the same distribution pattern described for recent years, with almost the whole anchovy being fished in the Gulf of Cadiz waters (only 23 t in Sub-division IXa North, *i.e.*, southern Galician waters). This usual distribution pattern of the Spanish fishery only shifted in 1995, when favourable environmental conditions in the northwestern coastal waters of the Iberian Peninsula favoured an increased level of anchovy abundance in Sub-divisions IXa North and Central-North.

The Portuguese anchovy fishery in 2003 also showed the same pattern that the one observed last year, with catches mainly distributed between Sub-divisions IXa Central-North (211 t, 44% of total Portuguese catches) and IXa South (Algarve, 200 t, 42%), and scanty catches in IXa Central-South (67 t, 1%). Historically, each of these 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 2003 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 first 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
Portuguese Surveys	Q1				Mar		Mar	Mar	Feb	
	Q2									
	Q3									Jun
	Q4			Nov		Nov	Nov		Nov	
Spanish Surveys	Q1							Feb		
	Q2	Jun								Jun
	Q3									
	Q4									

Acoustic estimates from surveys with 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 in 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 that in dark grey the whole Sub-division IXa South. A more detailed description of results from 2003 and 2004 surveys is given below.

Portuguese Surveys

Results from the Portuguese acoustic surveys in November 2003 and June 2004 have been provided to this WG (Marques *et al*., WD 2004). Both surveys were carried out with the R/V 'Capricornio' instead of the R/V 'Noruega', the vessel routinely used in recent years. Problems with the weather and/or the vessel engine entailed that the sampled area in both surveys only included the waters of the Portuguese continental shelf (Sub-divisions IXa Central-North, Central-South and South), between 20 and 200 m depth, the Spanish waters off the Gulf of Cadiz not being sampled. The low frequency of anchovy occurrence in trawls and the low acoustic energy recorded for the species in the surveyed area led to the decision of not to perform any anchovy abundance estimation from both surveys.

Anchovy acoustic estimates from Portuguese surveys up to date are given in **Table 11.3.1.1**.

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, including the 2003 survey, 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).

The first time that Spain acoustically surveyed the Gulf of Cadiz anchovy (Sub-division IXa South) was in June 1993 (ECOCÁDIZ 0693), although restricted to the Spanish waters only. The total biomass estimated at that time in this survey was 6,569 t (ICES C.M. 1995/Assess: 02).

The following survey (SIGNOISE) was carried out in February 2002 in order to have an acoustic inter-calibration between the R/V 'Cornide de Saavedra' and the new built Spanish R/V 'Vizconde de Eza' (Carrera, 2003). The surveyed area was again restricted to the Gulf of Cadiz Spanish waters. Because of the problems found with the calibration of the 'Vizconde de Eza's acoustic equipment the assessment was only possible from 'Cornide de Saavedra's data. As for anchovy, the species showed an unexpected occurrence, particularly in the central part of the surveyed area, where almost pure anchovy occurred in a thick bottom layer. The species assessment gave for the whole area a total biomass of 212,935 t, corresponding to 18202 million fish. This estimate strongly contrasted with the one provided by the Portuguese survey in the same area just one month after (see **Table 11.3.1.1**). For this reason the Working Group recommended last year that 'Vizconde de Eza's results were also provided this year in order to corroborate the magnitude of the above huge estimates. Unfortunately, this has not been possible since SIGNOISE survey data are still under revision. The Working Group recommends that once these data be revised they be provided, if possible, to next year's WG meeting.

Results on anchovy distribution and abundance from a new acoustic survey in June 2004 with the R/V 'Cornide de Saavedra' (BOCADEVA 0604) have been provided to this WG (Ramos *et al*., WD 2004). This survey aims to be the first one of a new Spanish acoustic survey series in the area. The surveyed area included the whole of the Sub-division IXa South, between 30 and 200 m depth (**Figure 11.3.1.1**). The survey was aimed at the acoustic estimation of the anchovy SSB in the study area hence the survey season. Survey results showed that anchovy was mainly distributed in the Spanish waters off the Gulf, with higher densities occurring between 40 and 80 m depth. In Portuguese waters the species was restricted to the easternmost area only (**Figure 11.3.1.2**). The total estimated biomass for anchovy was 13,168 thousand tonnes (894.4 million fish), Spanish waters accounting for the 86.4% of this total biomass (11,376 tonnes), (**Table 11.3.1.2**).

The population size composition in this survey showed a clear distribution pattern, with the largest (-oldest) anchovies being more abundant in the westernmost limit of their distribution. So, anchovy sizes in the Portuguese waters ranged between 12 and 18 cm (mode at 14 cm, mean length at 14,19 cm). In the Spanish waters the size range oscillated between 9 and 17.5 cm (mode at 13 cm, mean length at 12, 73 cm), with anchovies smaller than 12 cm accounting for 28% of the estimated abundance in this region (**Figure 11.3.1.3**). As for ages are concerned, about 61% of the total of 2-year old anchovies estimated for the whole surveyed area was concentrated in Portuguese waters (**Table 11.3.1.3**).

The comparison of the BOCADEVA 0604 survey estimates with those from the Portuguese acoustic survey series indicates a remarkable decline in the anchovy population in 2004, the resulting estimates from the present survey being the lowest ones in the recent years (**Tables 11.3.1.1** and **11.3.1.2**, **Figure 11.3.1.4**). However, this strong decreasing trend should be considered with caution and the estimates as preliminary ones since a possible underestimation there might be resulted from an inappropriate acoustic sampling coverage of the shallowest depths. Anchovy S_A values showed an increasing inshore gradient, with the highest back-scattering values being recorded close to the shallowest limit of the sampled area (30-m depth). Probably, the prolongation of the acoustic sampling to 20-m depth (as planned in the Portuguese surveys) could have resulted in somewhat higher estimates that those herein presented. However, even so, a relatively large coastal area comprised between the Guadalquivir and Guadiana rivers would still be uncovered (both with the Portuguese and Spanish surveys), entailing that the true magnitude of the anchovy population levels in the area be unknown.

The above problem has been previously analysed in other coastal areas sharing similar physiographical and bio-ecological features than the Gulf of Cadiz (*e.g*., Guillard and Lebourges, 1998; Guennégan *et al*., 2004). Such studies have shown that the use of a vessel with a lesser draught coupled to the ordinary survey should be taken into consideration for a proper acoustic sampling of these coastal waters.

The Working Group regards this exploratory survey as a positive development and encourages not only its continuation as a routine annual survey series, but also the consideration of the above approach in the survey design for the next surveys as far as possible.

11.3.2 Egg Surveys

Spanish Surveys

The BOCADEVA 0604 survey was also planned as an anchovy DEPM pilot survey. DEPM related objectives in this survey included:

- Delimitation of the extension of the anchovy spawning grounds in the surveyed area through CUFES sampling coupled to the acoustic one.
- Collection of adult samples for an exploratory analysis of anchovy adult-DEPM parameters. Both *ad hoc* pelagic trawls and those ones for the echo-traces identification were used in order to provide samples. However, given the exploratory nature of the survey, the sampling intensity for covering these issues was lower than that usually adopted in standard DEPM surveys.
- Evaluation of the CUFES as a quantitative sampler of the anchovy eggs abundance in the study area through a CUFES/CalVET calibration exercise. Although the sampling grid of CalVET stations showed a lower spatial coverage than that needed for a standard DEPM survey, is expected that the CalVET samples from this exercise may also yield a rough estimate of the daily egg production (P_0).

Results on egg data from this survey are under preparation and they are expected to be presented in this year’s SGSBSA (San Sebastián, November 2004). Processing of adult samples is still in progress.

A standard anchovy DEPM survey is foreseen to be carried out in June 2005 as the first one within a DEPM survey series initially planned on a triennial basis. This survey will cover the same study area than the present pilot survey.

Given the absence of anchovy DEPM-based studies in the area, the Working Group recognises the progress that is being made in this research field. The Working Group also considers the 2005 survey as a very positive development and encourages to go forward in this direction.

11.4 Biological Data

11.4.1 Catch Numbers at Age

Catch-at-age data from the whole Division IXa are only available from the Spanish Gulf of Cadiz fishery (Sub-division IXa South). Data from the Spanish fishery in Sub-division IXa North were not available since commercial landings were negligible.

The whole otolith collection from Gulf of Cadiz anchovy (since 1988) is still being revised following the standards adopted in the Workshop on anchovy otoliths from Subarea VIII and Division IXa in 2002 (Uriarte *et al*., 2002; ICES C.M. 2003/ACFM: 07). The new ALK’s resulting from this revision are expected to be presented in the next year’s WG. Therefore, results herein described will correspond to those obtained from the application of ALK’s based on pre-workshop age reading criteria.

The age composition of the Gulf of Cadiz anchovy landings from 1988 to 2003 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. 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 showed a decreased but relatively stable annual contribution during the 1998-2001 period (22-37%), although in the last two years a considerable lesser importance of this age group in the fishery has been evidenced (9% in 2002 and 15% in 2003).

Total catch in the Gulf of Cadiz in 2003 was 466 million fish, which represents a remarkable overall decrease of 42% compared to the previous year (800 million). Such marked decrease was mainly caused by the 46% decrease observed in the 1-age group landings in relation to those recorded in 2002. The 2-age group was also affected by this reduction (25% decrease) whereas age 0 fish was maintained at about the same level that in the previous year. Landings of the 0 age-group anchovies are restricted to the second half of the year, 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

Spain provides annual length compositions of anchovy landings in Division IXa from 1988 to 2003 for Sub-division IXa South and from 1995 to 1999 for Sub-division IXa North. Portugal has not provided length distributions of landings in Division IXa.

Quarterly Gulf of Cadiz anchovy length distributions in 2003 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 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 2003 (**Table 11.4.2.1**, **Figure 11.4.2.1**).

Mean length and weight in the annual catch (11.2 cm and 9.8 g) were at the same level that those estimated in 2001 and 2002 and these annual estimates are the highest ones 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 Sub-division IXa North in 1998 and 1999 rendered estimates of mean sizes at ages 1, 2 and 3 of 15.5 cm, 17.6 cm and 17.9 cm respectively (ICES C.M. 2000/ACFM:05 and ICES C.M. 2001/ACFM:06). 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 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 Sub-area VIII, natural mortality is probably high (M=1.2 is used for the data exploration, see **Section 11.6**).

11.5 Effort and Catch per Unit Effort

Data on nominal fishing effort (number of fishing trips) and CPUE indices of anchovy in Division IXa only correspond to the Spanish purse-seine fleets both in the Gulf of Cadiz (since 1988) and in Sub-division IXa North (since 1995), (**Tables 11.5.1** and **11.5.2**; **Figures 11.5.1** and **11.5.2**). However, no CPUE data for Spanish fleets in IXa North are available in last years (including 2002) because of their low catches.

The description of the recent dynamics of the Spanish fleets in the Gulf of Cadiz was summarised in the last year's WG report. The fleets' behaviour in 2000 and 2001 was mainly driven by the drastic reduction of the fishing effort exerted by the Barbate single-purpose purse-seine fleet in those years. Most of the vessels of this fleet (the main responsible for anchovy exploitation in both the Moroccan and Gulf of Cadiz fishing grounds in previous years) accepted a tie-up scheme in those years because the EU-Morocco Fishery Agreement was not renewed. However, since 2002 these vessels are fishing again in the Gulf of Cadiz entailing a remarkable increase in the overall nominal fishing effort.

Standardisation of the Barbate's single-purpose fleet CPUE

The Barbate single-purpose fleet's CPUE has been used in previous years as a tuning biomass index in the exploratory assessments. Standardised half-year CPUE series of this fleet were provided to this group WG last year (Ramos *et al*., 2003). This year the CPUE standardisation includes the new data for 2003 and it was based on the fitting of quarterly log-transformed CPUE's from fleet types composing the Barbate's single-purpose fleet (high tonnage fleet: 1988-2003; medium-light tonnage fleet: 1997-2003) to a GLM (without interaction) with the form (Robson, 1966; Gavaris, 1980):

$$LnCPUE_{(ft_i,\, quarter_i)} = \mathrm{int}ercept + quarter + fleettype$$

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. The resulting standardised CPUE series is shown in **Table 11.5.3**.

11.6 Recruitment Forecasting

Recruitment forecasts of anchovy in Division IXa are not available. By analogy with the anchovy stock in Sub-area VIII, recruitment may be driven by environmental factors and may be highly variable as a result.

As described in Section 11.3, anchovy population estimates in the Sub-division IXa South by direct methods are available from the Portuguese acoustic survey series since 1998. Although Portugal provides such estimates as aggregated ones, an estimation of the recruits either from their November (as age-0 recruits in the year) or March surveys (as age-1 fish in the next year) may be derived after the application of Spanish age-length keys. However, such keys are based on commercial samples from purse-seine catches and therefore they may result in a biased picture of the population structure because of a different catchability. 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), the series of point estimates is at present scattered and scarce.

An anchovy pre-recruitment index series for the period 1997-2001 was also presented to the last year WG. Description of the estimation method of this index was given in Ramos *et al*., (2003). This index, although highly provisional awaiting a more sound estimation process, summarises the incorporation of pre-recruits into the Guadalquivir River estuary, one of the main anchovy nursery areas in the Division. The Working Group considered last year this index as a good alternative to those ones based on the fishery (age-structured CPUE series) and encouraged the continuation of their provision in next years. Unfortunately, basic data needed for the estimation of this index in 2002 and 2003 are not still available.

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; ICES C.M. 2002/ACFM: 06).

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 two years for data exploration of anchovy catch-at-age data in IXa South from 1995 onwards. Data in this model are analysed by half-year-periods, those from the Algarvian anchovy being previously compiled by applying Gulf of Cadiz ALKs (**Table 11.7.1**; **Figure 11.7.1**). Weights at age in the catches are estimated as usual, whereas weights at age in the stock correspond to yearly estimates calculated as the weighted mean weights-at-age in the catches for the second and third quarters.

The separable model has been fitted in previous years to half-year catch-at-age data and to two aggregated-biomass indices: an annual 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.

Model outputs from the last year WG has been revised and re-calculated after detecting some errors in the computation of some values. Such errors were due to the incorrect implementation of equations used in the estimation of the average population in numbers by age class. This affected then to the computation not only of these values but also to the average population biomass estimates and to the CPUE values predicted by the model. In **Table 11.7. 2** are shown the main outputs from the uncorrected and corrected estimates for the exploratory run accepted the last year WG. Once the errors were corrected, the model has been fitted this year to catch-at-age data from the period 1995 to 2003. The CPUE-based tuning index also covered the same period, and the acoustic estimates of biomass included those ones from the years 1998 to 2003.

Since the suitability of using a purse-seine CPUE as a biomass tuning index has been questioned by the WG members, three different runs have been performed this year:

- an initial run with the last year's settings and new input data. CPUE and Acoustic biomass tuning indices (both as relative ones).
- an alternative run with the CPUE index as the only tuning (relative) index.
- an alternative run with Acoustic estimates of biomass as the only tuning (relative) index.

The absence of acoustic estimates in the second half-year in both 2002 and 2003 (**Figure 11.7.2**) resulted 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.

The same above runs were then performed with this new restriction on the F value in the second half-year in 2003 (**RUN 0**, **RUN 1** and **RUN 2** respectively). **Figure 11.7.3** shows the trends exhibited by the main model outputs from each of these new runs evidencing similar trajectories regardless the tuning indices used. For this reason, outputs from **RUN 0** are summarised in **Table 11.7.3** and **Figure 11.7.4** 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, 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 11.7.4**).

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 11.7.4**). 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 11.7.3**) 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 11.7.4** 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 11.7.4**). In addition, 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.

As in previous years, the suitability of the seasonal model itself and the biomass tuning indices used in the assessment were discussed by the WG members since the model, as currently implemented, assesses the population biomass mainly according to catch levels. However, it was clearly 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 stressed 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 going 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.

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 considered preliminary and only 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 11.7.4**). By analogy with the anchovy stock in Sub-area VIII, this stock may fluctuate widely due to variations in recruitment largely driven by environmental factors.

11.8 Reference Points for Management Purposes

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

11.9 Harvest Control Rules

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

11.10 Management Considerations

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 depth: 80 m.
- 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.

It must be pointed out that the Spanish purse-seine fleet in the Gulf of Cadiz does not observe the normal voluntary closure of three months (December to February) since 1997.

Given the current uncertainty in the stock status, the WG 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

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

Table 11.2.1.2. Anchovy catches (tonnes) by gear and country in Division IXa in 1988-2003.

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

* Portuguese catches not differentiated by gear

Table 11.2.2.1. Quarterly anchovy catches (tonnes) in Division IXa by country and Subdivision in 2003.

COUNTRY	SUBDIVISIONS	QUARTER 1 C(t)	%	QUARTER 2 C(t)	%	QUARTER 3 C(t)	%	QUARTER 4 C(t)	%	ANUAL C (t)	%
SPAIN	IXa North	0.1	0.6	2	10.4	9	38.8	11	50.2	23	0.5
	IXa South	1025	21.5	2533	53.1	798	16.7	413	8.7	4768	99.5
	TOTAL	1025	21.4	2535	52.9	806	16.8	424	8.9	4791	100.0
PORTUGAL	IXa Central North	0.4	0.2	37	17.3	52	24.8	122	57.7	211	44.2
	IXa Central South	46	68.0	2	2.9	0.02	0.0	19	29.1	67	14.0
	IXa South	3	1.4	6	3.2	187	93.6	3	1.7	200	41.8
	TOTAL	49	10.2	45	9.4	239	50.1	145	30.3	478	100.0
TOTAL	IXa North	0.1	0.6	2	10.4	9	38.8	11	50.2	23	0.4
	IXa Central North	0.4	0.2	37	17.3	52	24.8	122	57.7	211	4.0
	IXa Central South	46	68.0	2	2.9	0.02	0.0	19	29.1	67	1.3
	IXa South	1027	20.7	2539	51.1	984	19.8	416	8.4	4968	94.3
	TOTAL	1074	20.4	2580	49.0	1046	19.8	569	10.8	5269	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

* 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 11.3.1.3. Anchovy in Subdivision IXa South: estimated abundance (thousands of individuals) and biomass (tonnes) by age groups in the June 2004 Spanish acoustic survey.

Age class	ALGARVE	CÁDIZ	TOTAL
	Number	**Number**	**Number**
0	0	0	0
I	82348	798175	880523
II	8423	5423	13846
III	0	0	0
TOTAL	**90771**	**803598**	**894369**

Age class	**ALGARVE**	**CÁDIZ**	**TOTAL**
	Weight	**Weight**	**Weight**
0	0	0	0
I	1546	11224	12771
II	246	151	398
III	0	0	0
TOTAL	**1793**	**11376**	**13168**

Table 11.4.1.1. Spanish catch in numbers ('000) at age of Gulf of Cadiz anchovy (Sub-division IXa-South, 1988-2003) 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
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

Table 11.4.2.1. Length distribution ('000) of Anchovy in Division IXa by country and Sub-divisions in 2003.

	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	-	-	36	-	-	36
4.5	-	-	26	-	-	0	-	-	27	-	-	63	-	-	116
5	-	-	52	-	-	39	-	-	0	-	-	127	-	-	218
5.5	-	-	140	-	-	90	-	-	46	-	-	377	-	-	653
6	-	-	551	-	-	194	-	-	77	-	-	940	-	-	1763
6.5	-	-	1645	-	-	590	-	-	270	-	-	627	-	-	3132
7	-	-	2872	-	-	979	-	-	320	-	-	628	-	-	4800
7.5	-	-	2983	-	-	1407	-	-	430	-	-	568	-	-	5389
8	-	-	3856	-	-	4244	-	-	838	-	-	1137	-	-	10074
8.5	-	-	5391	-	-	8390	-	-	1949	-	-	1642	-	-	17371
9	-	-	7225	-	-	9949	-	-	4314	-	-	2037	-	-	23525
9.5	-	-	7212	-	-	15448	-	-	6218	-	-	4568	-	-	33446
10	-	-	8717	-	-	19676	-	-	5939	-	-	8832	-	-	43164
10.5	-	-	8309	-	-	23069	-	-	7354	-	-	10073	-	-	48805
11	-	-	7192	-	-	25793	-	-	9206	-	-	8606	-	-	50797
11.5	-	-	6465	-	-	23809	-	-	9755	-	-	4725	-	-	44753
12	-	-	7099	-	-	25405	-	-	7931	-	-	2582	-	-	43017
12.5	-	-	5466	-	-	23100	-	-	7646	-	-	2331	-	-	38544
13	-	-	5623	-	-	20665	-	-	5656	-	-	1728	-	-	33673
13.5	-	-	5917	-	-	11485	-	-	3876	-	-	478	-	-	21756
14	-	-	6649	-	-	9911	-	-	1713	-	-	529	-	-	18802
14.5	-	-	4218	-	-	3738	-	-	831	-	-	82	-	-	8870
15	-	-	5282	-	-	1713	-	-	295	-	-	125	-	-	7415
15.5	-	-	1992	-	-	1036	-	-	388	-	-	2	-	-	3418
16	-	-	932	-	-	541	-	-	136	-	-	0	-	-	1609
16.5	-	-	302	-	-	256	-	-	164	-	-	0	-	-	721
17	-	-	58	-	-	242	-	-	193	-	-	0	-	-	493
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	-	-	106176	-	-	231772	-	-	75574	-	-	52841	-	-	466363
Catch (T)	0.1	49	1025	2	45	2533	9	239	798	11	145	413	23	478	4768
L avg (cm)	-	-	11.2	-	-	11.3	-	-	11.3	-	-	10.4	-	-	11.2
W avg (g)	-	-	9.7	-	-	10.3	-	-	10.0	-	-	7.1	-	-	9.8

Table 11.4.2.2: Annual Length distribution ('000) of Anchovy in Division IXa from 1988 to 2003.

	1988	1989	1990	1991	1992	1993	1994	1995		1996		1997		1998		1999		2000	2001	2002	2003
Length	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN	SPAIN
(cm)	IXa South	IXa South	IXa South	IXa South	IXa South	IXa South	IXa South	IXa North	IXa South	IXa North	IXa South	IXa North	IXa South	IXa North	IXa South	IXa North	IXa South	IXa South	IXa South	IXa South	IXa South
3.5											1349								266	77	
4			4281	172	2	49					12677						1831	114	200	275	36
4.5			18371	3937	29	707					67819		1333		4656		17055	856	1649	1463	116
5	65		32251	54991	90	1832					160894		11492		25825		41100	5006	5489	3871	218
5.5	86		46584	80537	369	3247					129791		38722		57086		36181	9391	9301	8742	653
6			45810	43303	983	5031					52812		53185		82442		19366	12961	11832	13779	1763
6.5		1185	44454	28102	2685	6463	6092				33640		50275		76694		20421	11446	15051	17768	3132
7	226	3906	37065	17847	4094	6169	13330				32469		62492		68074		17749	11754	15911	14238	4800
7.5	347	5609	34614	20448	7178	7507	20415		402		19088		42120		43197		19089	20386	10684	14800	5389
8	1871	15959	32562	20037	15632	8325	26136		402		8949		45120		32964		20835	19704	16989	14137	10074
8.5	7892	36001	43081	17916	22442	7748	24497		454		11776		36200		47796		15724	18590	19426	18211	17371
9	13492	31905	53016	19745	16924	7820	22586		2799		12007		20009	156	78561		14937	19435	22924	29985	23525
9.5	26090	36222	88097	34408	23280	8612	16520		9153		6844		13611	367	106350		17487	27397	29620	66330	33446
10	42791	69717	115050	40656	37450	7320	26383		10743		4887		8951	754	132106		23530	34049	35897	67732	43164
10.5	60760	82715	108001	59678	38310	9199	30570		13282		7156		12231	1486	150718		31482	26203	43145	60360	48805
11	73499	82718	86757	67113	39426	8500	31536		8408		17343		22647	2047	158806		33604	21814	50672	66572	50797
11.5	61624	64599	72875	63013	36883	10154	37310		7340		21738		27353	1477	133585		40004	18846	59031	65752	44753
12	66239	50823	50592	65983	39500	24246	29363	74	5279		17855		39131	1267	99586		55614	18734	66873	79576	43017
12.5	42651	42791	34023	54033	33181	33555	33560	711	4502		11544		45267	1178	76285		66384	14738	68648	61848	38544
13	26053	20237	19022	45191	19867	27543	17543	3049	2299	8	6450	374	46852	2737	44979		52625	11841	59942	54683	33673
13.5	9415	11846	12683	21333	7003	13059	9602	3381	1957	12	4468	997	38183	2403	25038	92	38719	9197	50964	54884	21756
14	4954	8397	5779	13684	3785	5710	6493	14998	1205	258	3880	2004	19127	3038	11847	246	22962	6860	39385	32016	18802
14.5	561	3048	1671	4097	2293	2793	5495	25944	194	335	1990	422	11268	2813	5712	497	13247	3713	23375	26055	8870
15	6102	2147	817	2391	521	1082	4217	46371	219	375	790	48	6370	1976	2080	1075	6811	2812	16035	14275	7415
15.5	2985	1757	402	1194	1045	525	1054	42244	8	226	703	40	3764	890	579	1160	2422	983	9402	6655	3418
16	2995	4975	370	1943	271	75	977	44171		227	159	33	2224	560	138	1658	889	294	8305	3936	1609
16.5	2621	7842	489	2406	225	17	443	14369		151		10	296	330		2430	246	4	5034	946	721
17	252	4584	275	1767	75		216	8378		104		10		438		2221		97	3065	784	493
17.5	109	1325	133	595	12			778		94		13		311		1717			2731	234	
18		621	95	75				236		24						1045			38		
18.5			10							21						397					
19										1						317			38		
19.5																138					
20																					
20.5																					
21																					
21.5																					
22																					
Total N	453679	590930	989230	786595	353555	207287	364339	204705	68647	1835	649078	3951	658223	24231	1465102	12993	630315	327225	701921	799984	466363
Catch (T)	4263	5330	5726	5697	2995	1960	3035	5329	571	44	1780	63	4600	371	8977	413	5587	2182	8216	7870	4768
L avg (cm)	11.3	11.0	9.3	9.6	10.7	10.9	10.5	15.6	10.9	15.6	6.6	14.2	9.4	13.4	9.7	16.8	10.1	9.8	11.4	11.1	11.2
W avg (g)	9.4	9.0	5.8	7.2	8.4	9.4	8.3	26.0	8.3	23.7	2.6	16.1	7.0	15.3	6.3	31.8	8.1	6.8	11.3	9.7	9.8

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, 1988-2003) 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

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

Table 11.4.2.4. Mean weight (in kg) at age in the Spanish catches of Gulf of Cadiz anchovy (Sub-division IXa-South, 1988-2003) 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
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

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

Table 11.5.1. Anchovy in Division IXa. Effort data (no. of fishing trips) for Spanish fleets in Sub-divisions IXa-South (Gulf of Cadiz) and IXa-North (Southern Galicia).(SP: single purpose; MP: multi purpose).

	SUB-DIVISION IXa SOUTH									SUB-DIVISION IXa NORTH	
	PURSE SEINE									PURSE SEINE	
Year	BARBATE (SP)	BARBATE (MP)	SANLÚCAR (SP)	SANLÚCAR (MP)	P.UMBRÍA (SP)	P.UMBRÍA (MP)	I. CRISTINA (SP)	I. CRISTINA (MP)	MEDIT. (SP)	VIGO	RIVEIRA
	No. fishing trips									No. fishing trips	
1988	3958	17	-	210	n.a.	n.a.	n.a.	n.a.	-	n.a.	n.a.
1989	4415	39	-	234	n.a.	n.a.	n.a.	n.a.	-	n.a.	n.a.
1990	4622	92	-	660	n.a.	n.a.	n.a.	n.a.	-	n.a.	n.a.
1991	3981	40	-	919	n.a.	n.a.	n.a.	n.a.	-	n.a.	n.a.
1992	3450	116	-	583	n.a.	n.a.	n.a.	n.a.	-	n.a.	n.a.
1993	2152	5	-	225	n.a.	n.a.	n.a.	n.a.	-	n.a.	n.a.
1994	1625	69	-	899	n.a.	n.a.	196	28	-	n.a.	n.a.
1995	528	17	-	377	n.a.	n.a.	22	17	-	1537	252
1996	1595	89	-	1659	n.a.	n.a.	76	55	-	32	3
1997	2207	115	-	1738	n.a.	n.a.	75	13	-	31	23
1998	2153	-	2234	-	n.a.	n.a.	177	30	-	134	269
1999	1762	9	2167	-	660	595	330	257	-	51	85
2000	785	2	2196	-	1776	169	572	-	-	n.a.	n.a.
2001	1281	89	1331	-	2367	22	1254	4	271	n.a.	n.a.
2002	3504	30	1091	-	2130	1	519	-	109	n.a.	n.a.
2003	3023	10	1230	-	1352	-	733	-	-	n.a.	n.a.

Table 11.5.2. Anchovy in Division IXa. CPUE data (Kg/fishing trip) for Spanish fleets in Sub-divisions IXa-South (Gulf of Cadiz) and IXa-North (Southern Galicia). (SP: single purpose; MP: multi purpose).(*): CPUE corresponding to an only one fishing trip.

	SUB-DIVISION IXa SOUTH									SUB-DIVISION IXa NORTH	
	PURSE SEINE									PURSE SEINE	
Year	BARBATE (SP)	BARBATE (MP)	SANLÚCAR (SP)	SANLÚCAR (MP)	P.UMBRÍA (SP)	P.UMBRÍA (MP)	I. CRISTINA (SP)	I. CRISTINA (MP)	MEDIT. (SP)	VIGO	RIVEIRA
	Kg/fishing trip									Kg/fishing trip	
1988	1047	461	-	420	n.a.	n.a.	n.a.	n.a.	-	n.a.	n.a.
1989	1139	534	-	943	n.a.	n.a.	n.a.	n.a.	-	n.a.	n.a.
1990	1128	287	-	643	n.a.	n.a.	n.a.	n.a.	-	n.a.	n.a.
1991	1312	339	-	456	n.a.	n.a.	n.a.	n.a.	-	n.a.	n.a.
1992	819	173	-	300	n.a.	n.a.	n.a.	n.a.	-	n.a.	n.a.
1993	641	268	-	225	n.a.	n.a.	n.a.	n.a.	-	n.a.	n.a.
1994	1326	262	-	398	n.a.	n.a.	204	174	-	n.a.	n.a.
1995	377	134	-	166	n.a.	n.a.	52	25	-	2509	2286
1996	497	315	-	246	n.a.	n.a.	137	157	-	847	4
1997	1580	306	-	288	n.a.	n.a.	105	126	-	1068	639
1998	3144	-	221	-	n.a.	n.a.	242	197	-	1489	512
1999	2162	219	241	-	142	143	134	150	-	1088	1585
2000	1365	77	208	-	169	142	391	-	-	n.a.	n.a.
2001	2327	1507	249	-	948	337	1539	805	2025	n.a.	n.a.
2002	1690	651	207	-	586	2082 (*)	601	-	1070	n.a.	n.a.
2003	1223	257	310	-	297	-	369	-	-	n.a.	n.a.

Table 11.5.3. Standardised anchovy CPUE series (tonnes/fishing day) of the Barbate single-purpose fleet.

Year	CPUE (tonnes/effective fishing day)						
	Q1	Q2	Q3	Q4	HY1	HY2	Annual
1988	1.072	1.382	0.862	0.771	**1.274**	**0.829**	**1.047**
1989	1.650	1.160	0.919	0.460	**1.297**	**0.859**	**1.139**
1990	1.613	1.119	0.841	0.707	**1.374**	**0.797**	**1.128**
1991	1.441	1.612	0.843	0.568	**1.581**	**0.743**	**1.312**
1992	1.351	0.828	0.451	0.240	**0.993**	**0.451**	**0.819**
1993	0.805	0.572	0.308	0.287	**0.642**	**0.305**	**0.588**
1994	2.113	1.341	0.584	0.276	**1.441**	**0.543**	**1.326**
1995	0.320	0.627	0	0	**0.377**	**0**	**0.377**
1996	0	0.628	0.235	0.199	**0.628**	**0.223**	**0.509**
1997	0.811	1.038	1.428	0.792	**0.917**	**1.249**	**1.051**
1998	3.205	2.435	1.072	2.582	**2.734**	**1.571**	**1.926**
1999	0.855	2.408	1.391	1.047	**1.490**	**1.303**	**1.421**
2000	1.531	1.558	0.410	0.882	**1.555**	**0.501**	**0.757**
2001	2.395	1.627	1.559	1.485	**1.788**	**1.539**	**1.638**
2002	2.759	2.757	1.674	1.420	**2.758**	**1.603**	**2.093**
2003	1.487	1.991	0.765	1.086	**1.813**	**0.862**	**1.440**

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: 1995-2003
Fleets: All

Half-year Catch in number (in millions) at age (1995-2003)

	1995		1996		1997		1998		1999		2000		2001		2002		2003	
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
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
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
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

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	
0	7	1	3	3	3	3	6	3	6	0.6
1	11	6	11	7	13	10	13	10	11	0.6
2	23	20	21	20	20	24	32	26	27	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	-

Annual anchovy CPUE (kg/fishing trip) of the Barbate single-purpose purse-seine fleet

	1995	1996	1997	1998	1999	2000	2001	2002	2003
Standardised	377	509	1051	1926	1421	757	1638	2093	1440

Exploratory runs with the seasonal separable model

	CPUE	Portuguese Ac. Surv.
RUN0	Standardised	whole series
RUN1	Standardised	-
RUN2	-	whole series

Table 11.7.2. Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz) .

Outputs from the seasonal separable assessment model in the last year WG and those obtained with the same settings but after correction of errors detected in the model design.

Fishing Mortality per half-year period

WG2003	1995		1996		1997		1998		1999		2000		2001		2002	
AGE	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
0	0.0000	0.1486	0.0000	0.0958	0.0000	0.2043	0.0000	0.1906	0.0000	0.2608	0.0000	0.0712	0.0000	0.1340	0.0000	0.0833
1	0.7740	1.2140	0.3666	0.7827	0.7610	1.6689	0.9489	1.5572	1.5638	2.1313	0.6711	0.5821	0.7248	1.0949	0.3819	0.6806
2	0.9166	1.8209	0.4341	1.1741	0.9012	2.5034	1.1237	2.3359	1.8517	3.1969	0.7947	0.8732	0.8583	1.6423	0.4522	1.0209

WG2003 corrected	1995		1996		1997		1998		1999		2000		2001		2002	
AGE	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
0	0.0000	0.1443	0.0000	0.0900	0.0000	0.2088	0.0000	0.1792	0.0000	0.2608	0.0000	0.0696	0.0000	0.1298	0.0000	0.0721
1	0.7820	1.2075	0.3641	0.7532	0.7719	1.7472	0.9437	1.4996	1.6356	2.1816	0.6765	0.5822	0.7205	1.0856	0.3619	0.6030
2	0.9138	1.8112	0.4255	1.1298	0.9019	2.6208	1.1026	2.2494	1.9112	3.2724	0.7905	0.8732	0.8419	1.6284	0.4229	0.9044

Fitted Selection Pattern (constant for 1995-2002)

	WG2003		WG2003 corrected	
AGE	1st half	2nd half	1st half	2nd half
0	0.0000	0.1224	0.0000	0.1195
1	1.0000	1.0000	1.0000	1.0000
2	1.1841	1.5000	1.1685	1.5000

Population abundance (millions)

WG2003	1995		1996		1997		1998		1999		2000		2001		2002	
AGE	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
0	0	805	0	1560	0	3673	0	2284	0	1046	0	2047	0	2486	0	1303
1	80	20	381	145	778	199	1643	349	1036	119	442	124	1046	278	1193	447
2	1	0	3	1	36	8	21	4	40	3	8	2	38	9	51	18

WG2003 corrected	1995		1996		1997		1998		1999		2000		2001		2002	
AGE	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
0	0	741	0	1676	0	3616	0	2573	0	1060	0	2070	0	2519	0	1581
1	80	20	352	134	841	213	1610	344	1180	126	448	125	1059	283	1214	464
2	1	0	3	1	35	8	20	4	42	3	8	2	38	9	52	19

Predicted Biomass Index values

WG2003	1995	1996	1997	1998	1999	2000	2001	2002
CPUE Index (kg/fishing day)	340	325	1554	1738	1818	687	2329	1657

WG2003 corrected	1995	1996	1997	1998	1999	2000	2001	2002
CPUE Index (kg/fishing day)	632	347	1441	1286	867	1036	2550	1532

WG2003	Nov. 98	Mar. 99	Nov. 99	Mar. 00	Nov. 00	Mar. 01	Nov. 01	Mar. 02	Nov. 02
Acoustic Index (tonnes)	15470	25177	-	-	17281	35723	39564	36817	-

WG2003 corrected	Nov. 98	Mar. 99	Nov. 99	Mar. 00	Nov. 00	Mar. 01	Nov. 01	Mar. 02	Nov. 02
Acoustic Index (tonnes)	16504	26600	-	-	16675	34554	38384	36017	-

Catchability indices

	WG2003	WG2003 correct.
CPUE (Q1)	0.1152	0.1606
Acoust.Surv. (Q2)	3.6907	3.5195

Average population Biomass (tonnes)

	1995	1996	1997	1998	1999	2000	2001	2002
WG2003	2952	2818	13493	15084	15781	5963	20215	14387
WG2003 corrected	3938	2158	8973	8006	5397	6453	15880	9538

Table 11.7.3. Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz) . Outputs from the seasonal separable assessment model. RUN0 with F in the se

Fishing Mortality per half-year period

	1995		1996		1997		1998		1999		2000		2001		2002		2003	
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
0	0.0000	0.1663	0.0000	0.0809	0.0000	0.1825	0.0000	0.1582	0.0000	0.2351	0.0000	0.0667	0.0000	0.1459	0.0000	0.2000	0.0000	0.2612
1	0.8458	1.6041	0.3622	0.7801	0.6981	1.7605	0.9134	1.5261	1.4776	2.2679	0.6721	0.6436	0.7160	1.4072	0.6479	1.9286	1.2795	2.5190
2	1.1946	2.4062	0.5115	1.1701	0.9859	2.6407	1.2900	2.2892	2.0868	3.4018	0.9492	0.9655	1.0112	2.1108	0.9151	2.8929	1.8071	3.7785

Population abundance (millions)

	1995		1996		1997		1998		1999		2000		2001		2002		2003	
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
0	0	723	0	1655	0	3612	0	2307	0	1037	0	1949	0	1638	0	1146	0	678
1	95	22	336	128	838	229	1652	364	1081	135	450	126	1001	268	777	223	515	79
2	1	0	2	1	32	7	22	3	43	3	8	2	36	7	36	8	18	2

Predicted Biomass Index values

	1995	1996	1997	1998	1999	2000	2001	2002	2003
CPUE Index (kg/fishing day	771	422	1824	1539	1039	1240	2273	990	780

	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)	19425	32625	-	-	20039	41356	32006	26612	-	19207	-

Fitted Selection Pattern

	1995		1996		1997		1998		1999		2000		2001		2002		2003	
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
0	0.0000	0.1037	0.0000	0.1037	0.0000	0.1037	0.0000	0.1037	0.0000	0.1037	0.0000	0.1037	0.0000	0.1037	0.0000	0.1037	0.0000	0.1037
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
2	1.4123	1.5000	1.4123	1.5000	1.4123	1.5000	1.4123	1.5000	1.4123	1.5000	1.4123	1.5000	1.4123	1.5000	1.4123	1.5000	1.4123	1.5000

Catchability indices

	Q
CPUE	0.2014
Acoustic Survey	4.4711

Table 11.7.3.(cont'd) Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz) .
Outputs for the seasonal separable assessment model.
RUN0 with F in the second-half in 2003 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
3826	2096	9055	7642	5157	6156	11288	4916	3872

Residuals about the model fit

Separable model residuals

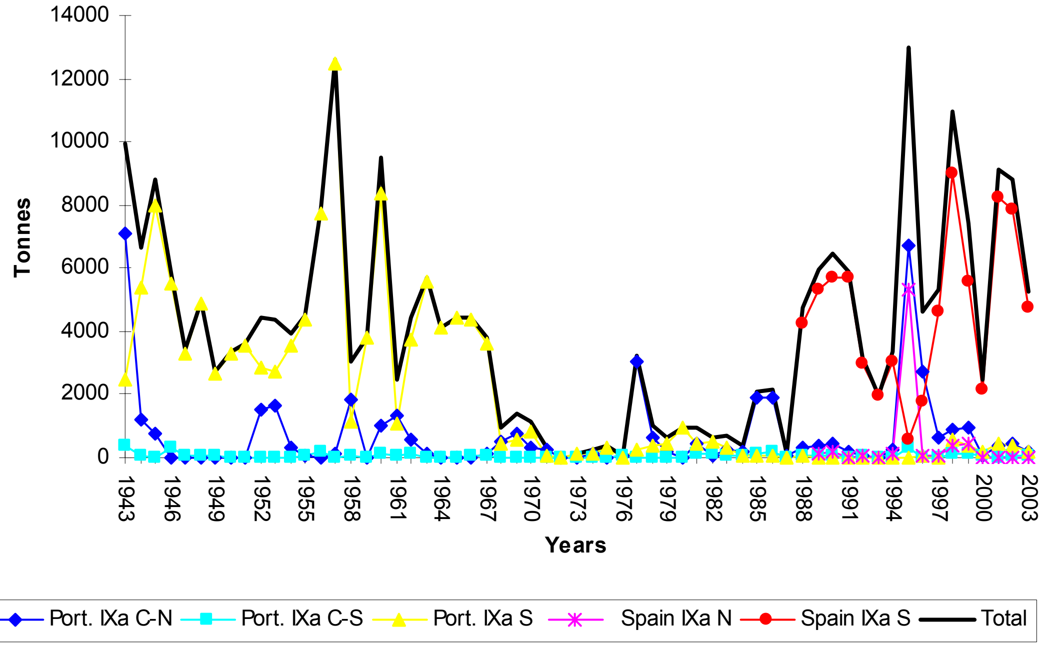
	1995		1996		1997		1998		1999		2000		2001		2002		2003	
AGE	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
0		-0.890		1.629		-0.309		0.599		-0.270		0.310		-0.039		-0.705		-0.216
1	-0.470	-0.663	0.609	-1.004	-0.539	-0.551	-0.072	0.397	-0.465	0.079	-0.057	0.237	-0.116	0.304	0.646	0.220	0.117	0.189
2	-1.076		0.162	0.998	0.710	0.875	-0.040	-0.483	0.028	0.073	-0.057	-0.366	0.075	0.003	-0.693	0.445	0.079	-0.781

Biomass index residuals

	1995	1996	1997	1998	1999	2000	2001	2002	2003
CPUE Index (kg/fishing day)	-0.714	0.187	-0.551	0.224	0.313	-0.493	-0.328	0.749	0.614

	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)	0.458	-0.276	-	-	0.526	-0.507	-0.224	-0.221	-	0.246	-

Figure 11.2.1.1. Historical series of Portuguese and Spanish anchovy landings in Division IXa (1943-2003).



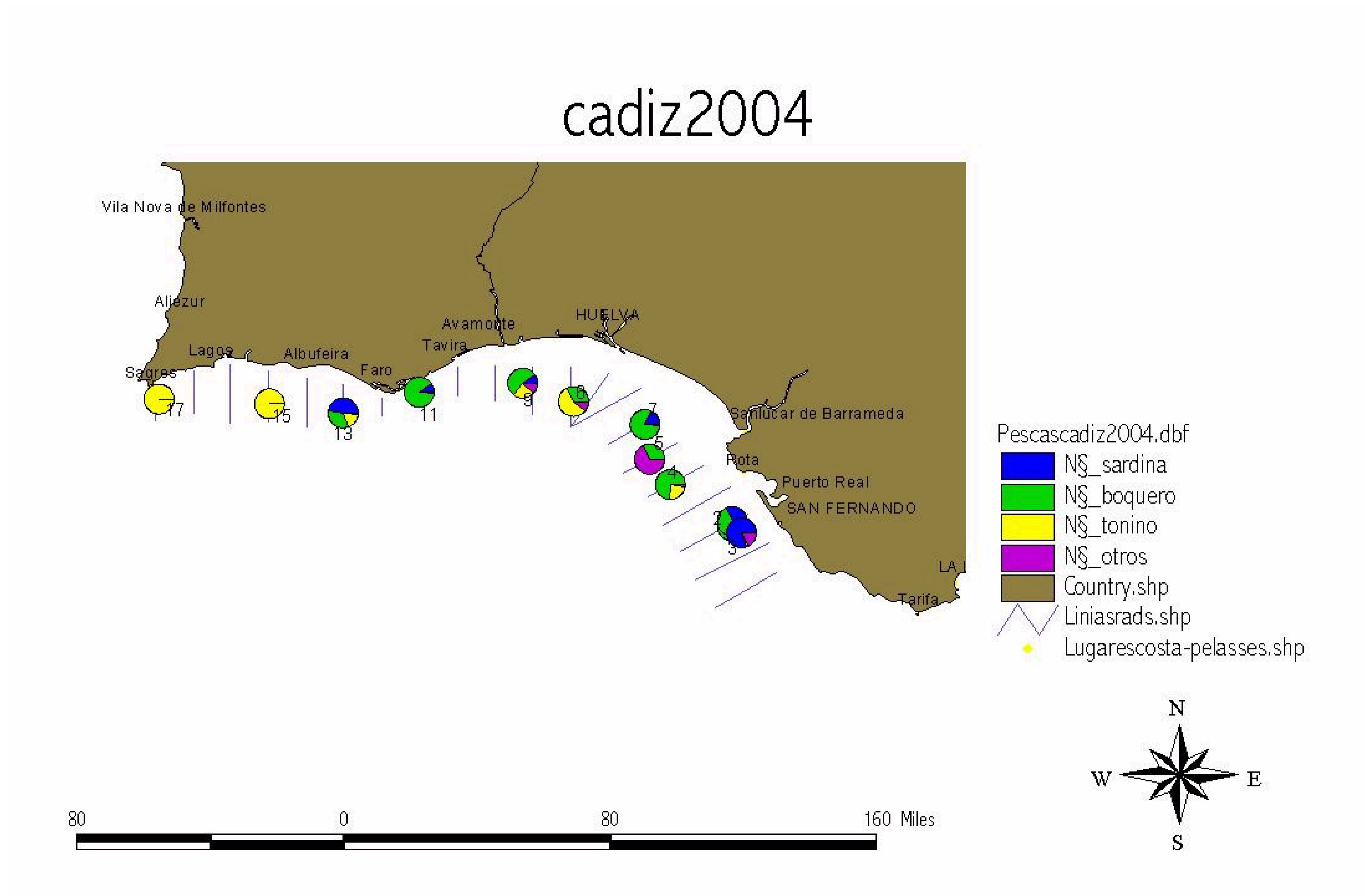


Figure 11.3.1.1. Survey tracks and location of fishing stations and their species composition (% in number) in June 2004 Spanish acoustic survey.

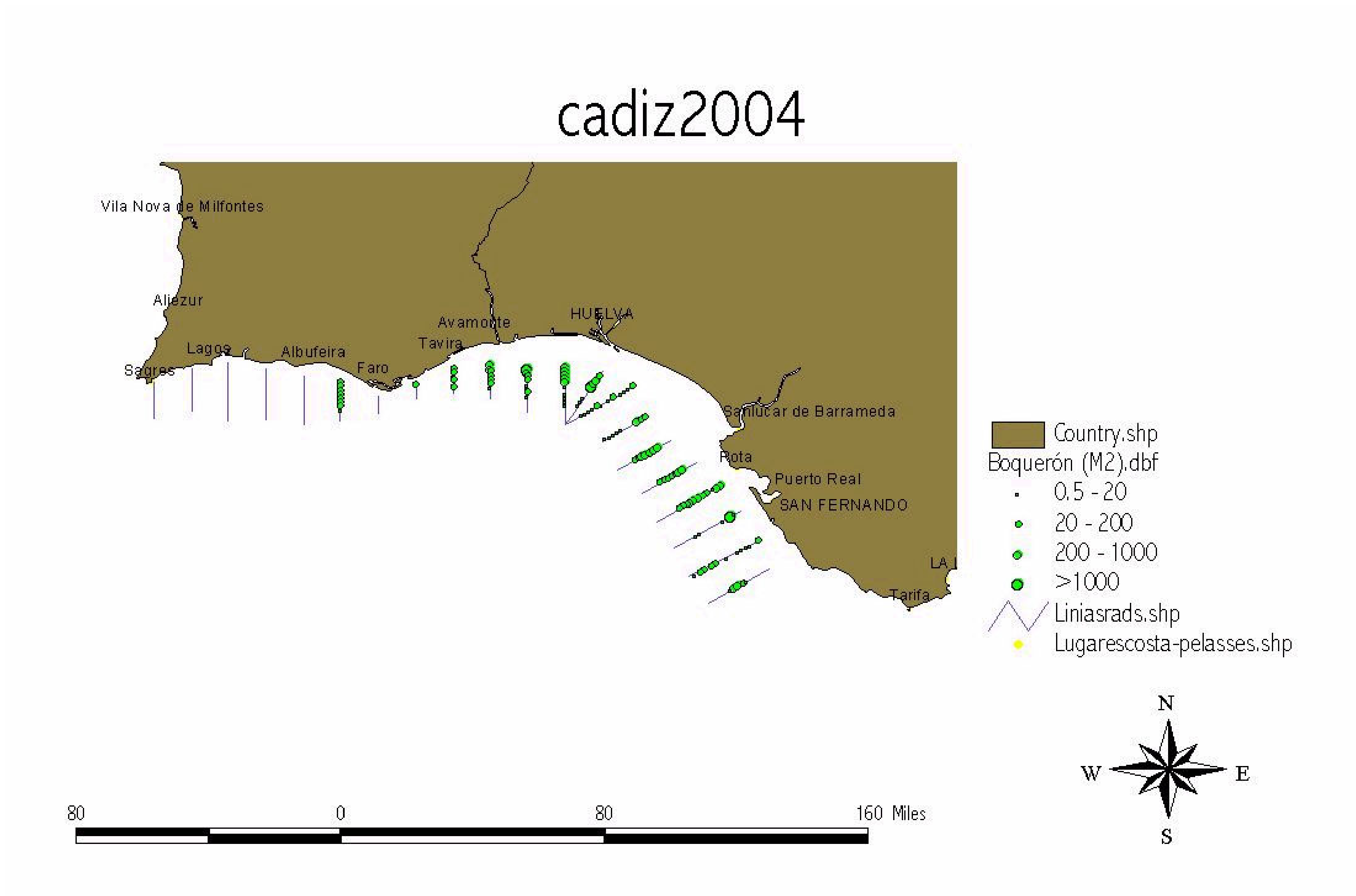


Figure 11.3.1.2. Anchovy in Subdivision IXa South: acoustic energy distribution per nautical mile during the June 2004 Spanish survey.

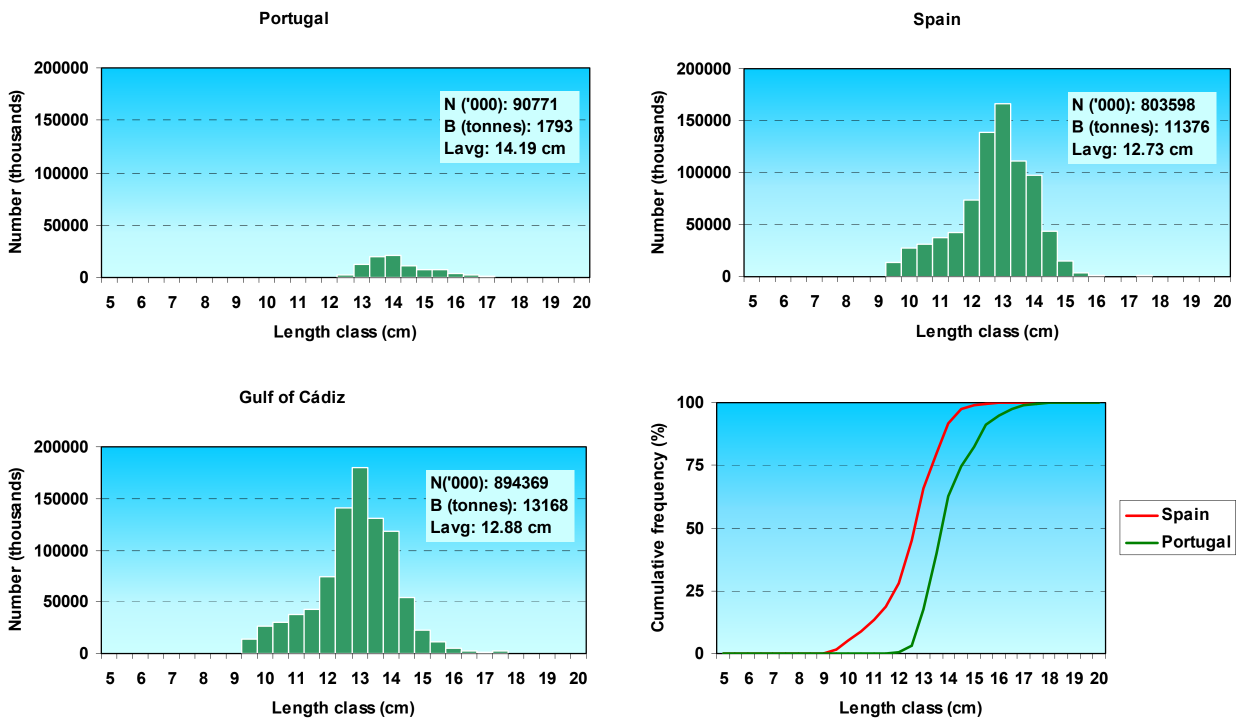


Figure 11.3.1.3. Anchovy in Subdivision IXa South: estimated abundance by length class by region and total area during the June 2004 Spanish acoustic survey. Bottom right: cumulative frequency (%) by length class and region.

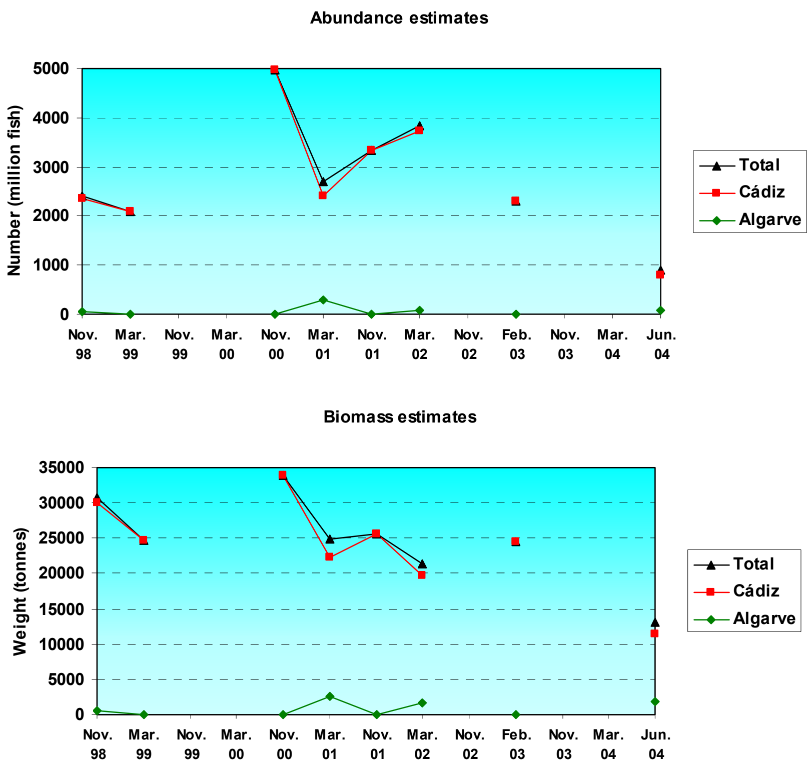


Figure 11.3.1.4. Anchovy in Subdivision IXa South: Portuguese-Spanish historical series of acoustic estimates. Data for June 2004 correspond to the Spanish acoustic survey. Estimates from the February 2002 Spanish survey are not included.

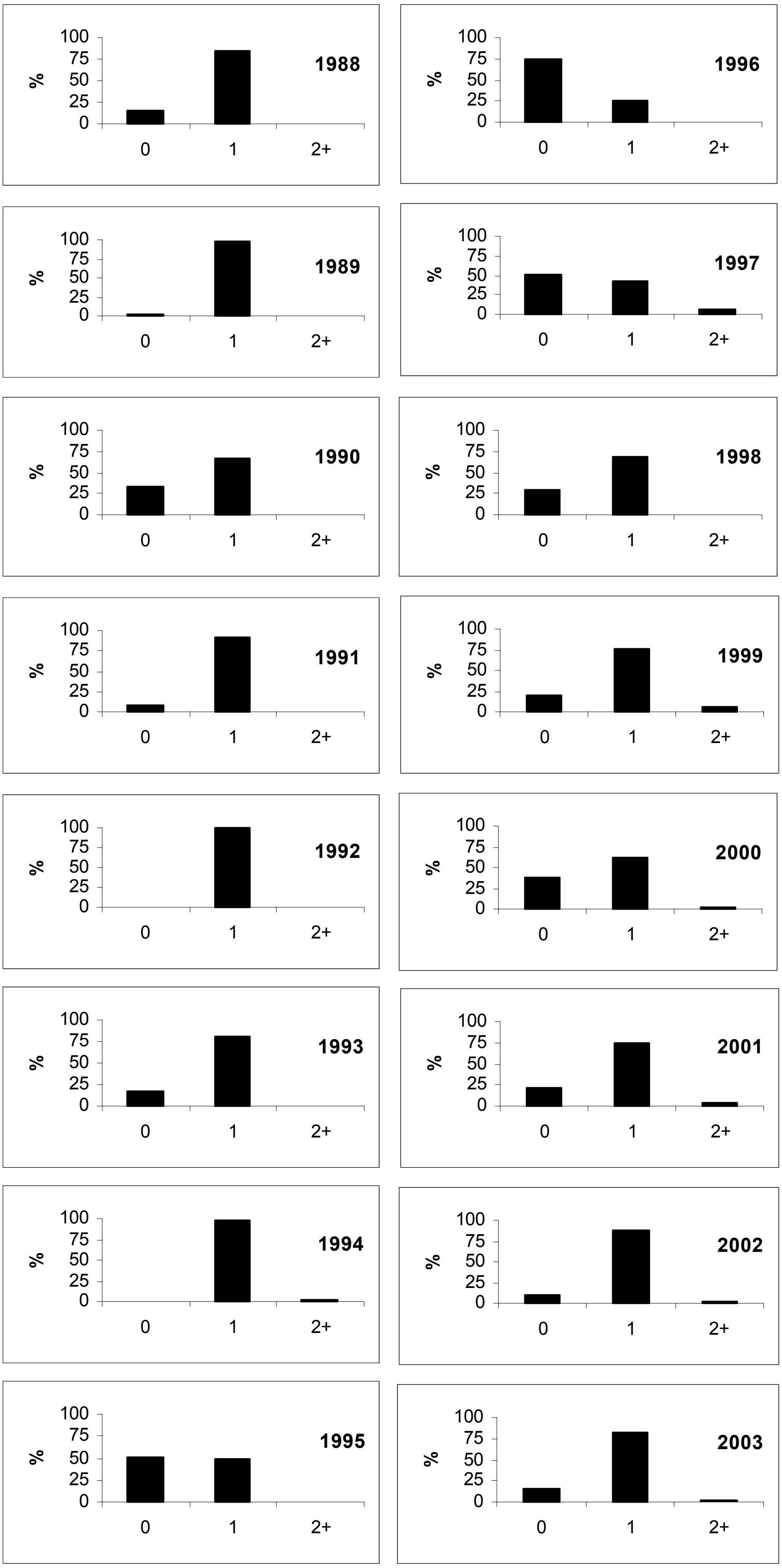


Figure 11.4.1.1. Age composition of Spanish catches of Gulf of Cadiz anchovy (Sub-division IXa-South; 1988-2003). Data for 1994 and second half in 1995 estimated from an iterated ALK by applying the Kimura and Chikuni's (1987) algorithm.

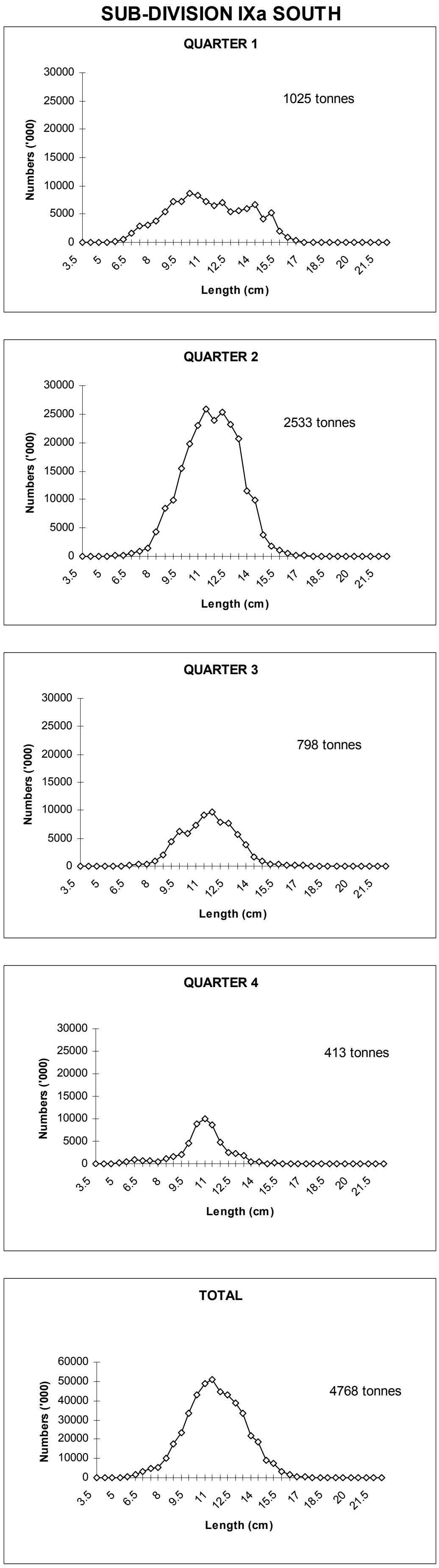


Figure 11.4.2.1. Length distribution ('000) of anchovy landings in Sub-division IXa South (Gulf of Cadiz) by quarter in 2003. Without data for Sub-division IXa North (Western Galicia).

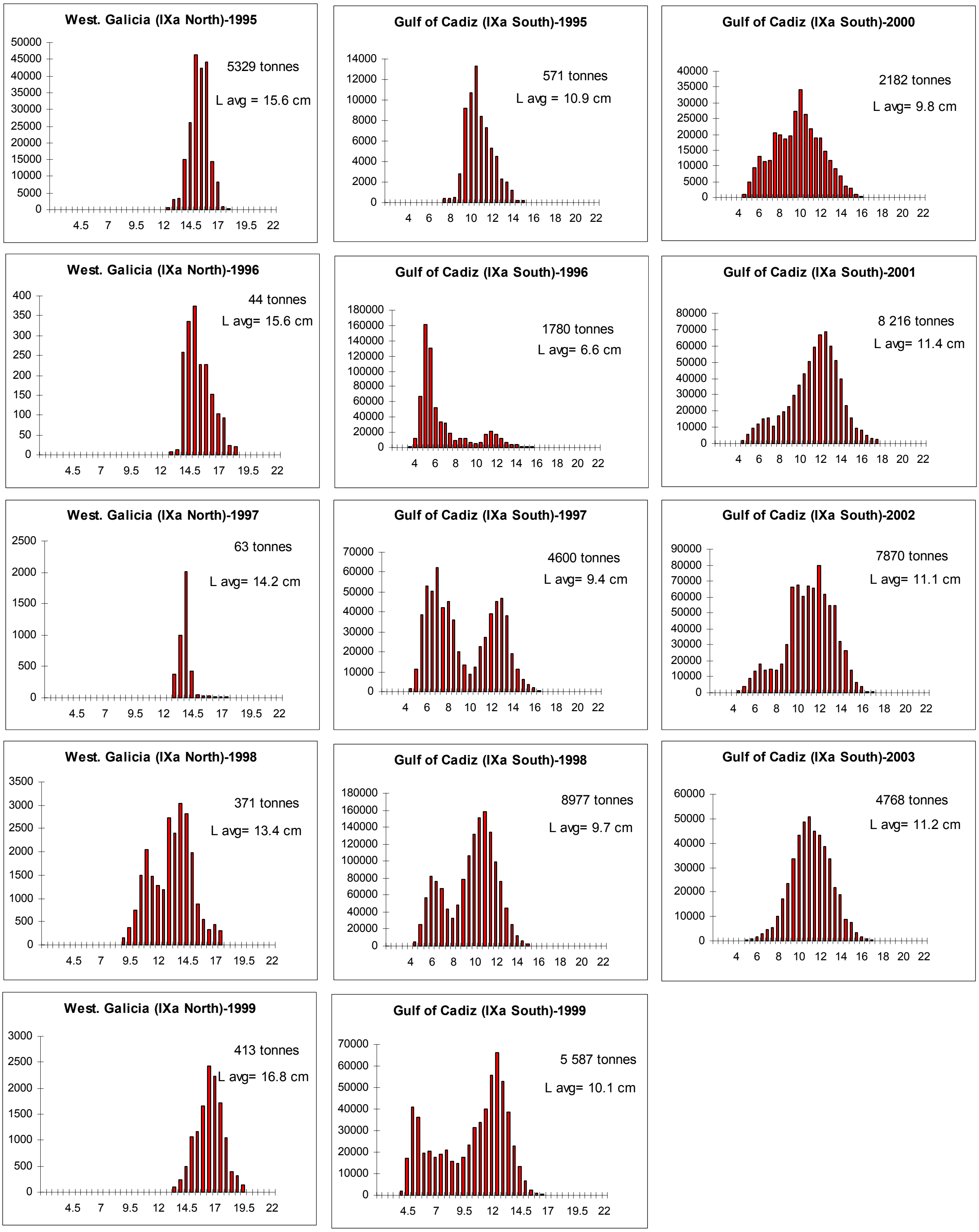


Figure 11.4.2.2. Length distribution ('000) of anchovy in Sub-divisions IXa South and IXa North (1995-2003).

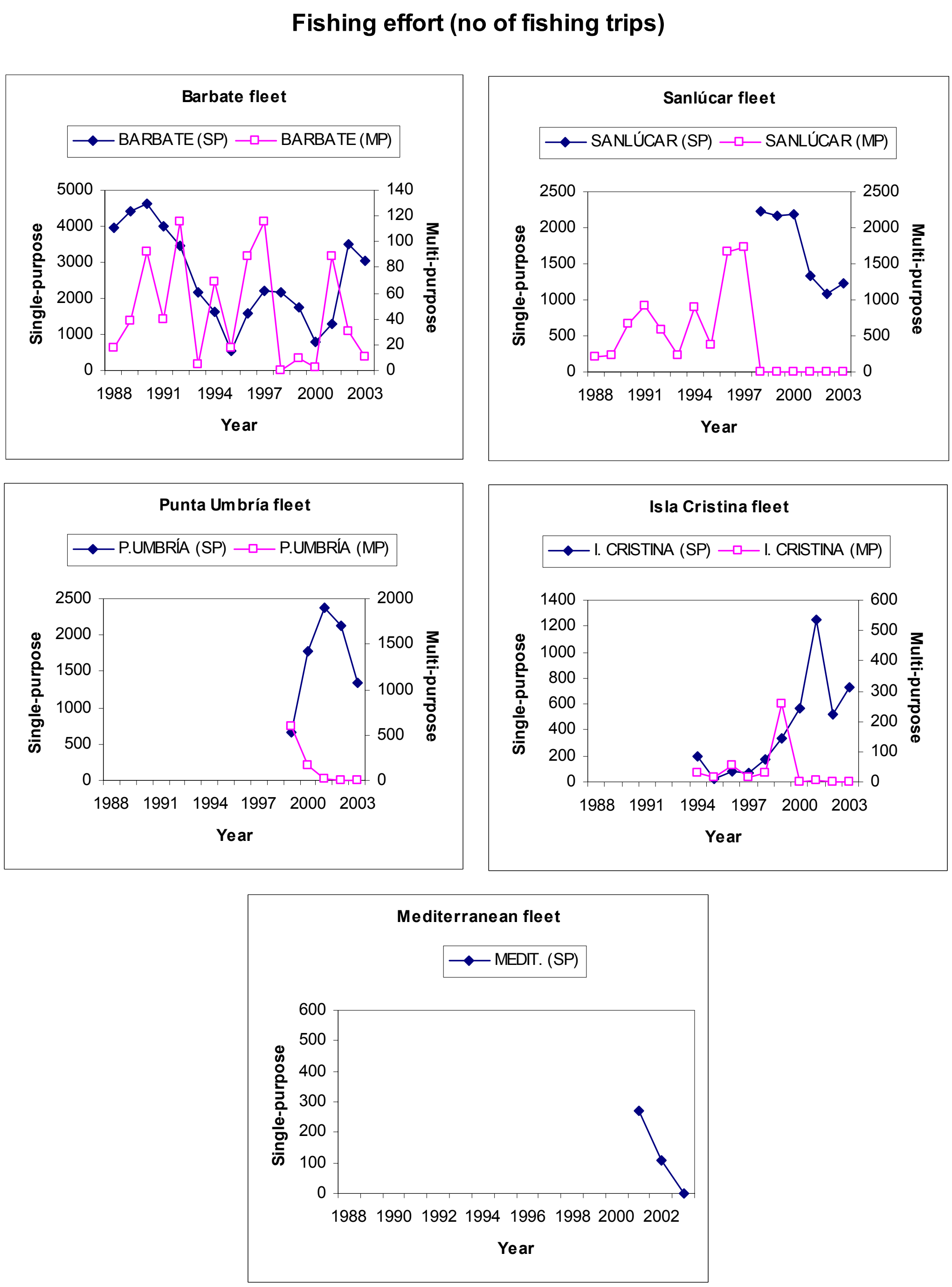


Figure 11.5.1. **Anchovy in Division IXa. Spanish Effort series (not standardised) in commercial fisheries in Gulf of Cadiz (Sub-division IXa South). SP: Single-purpose purse-seine fleets; MP: Multi-purpose purse-seine fleets.**

CPUE (Kg/fishing trip)

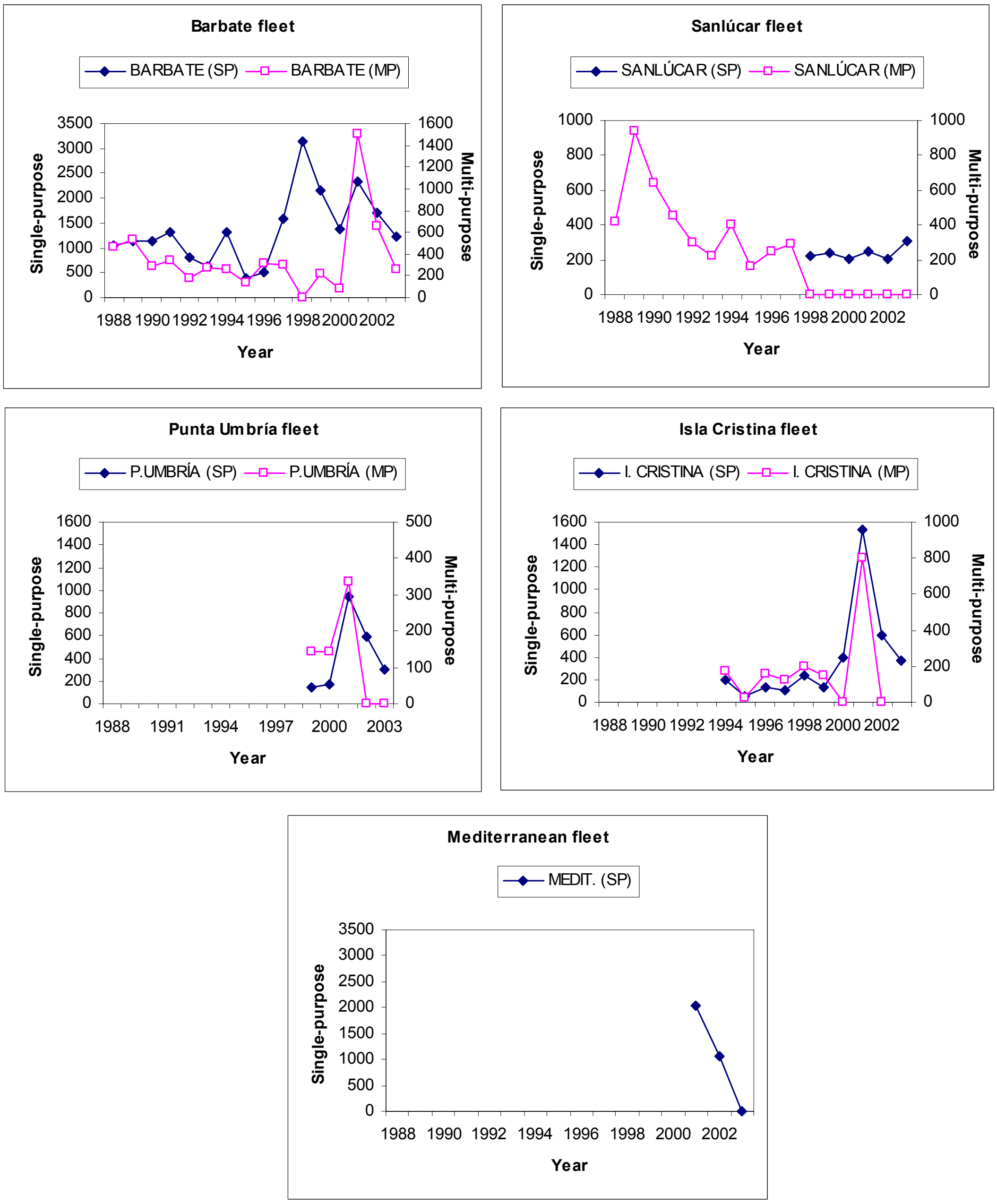
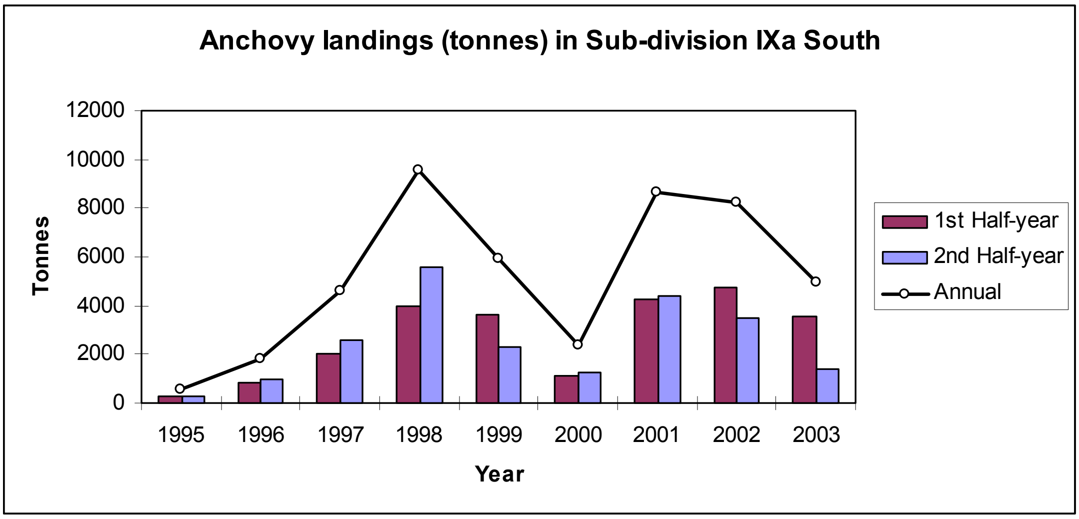


Figure 11.5.2. Anchovy in Division IXa. Spanish CPUE series (not standardised) in commercial fisheries in Gulf of Cadiz (Sub-division IXa South). SP: Single-purpose purse-seine fleets; MP: Multi-purpose purse-seine fleets.



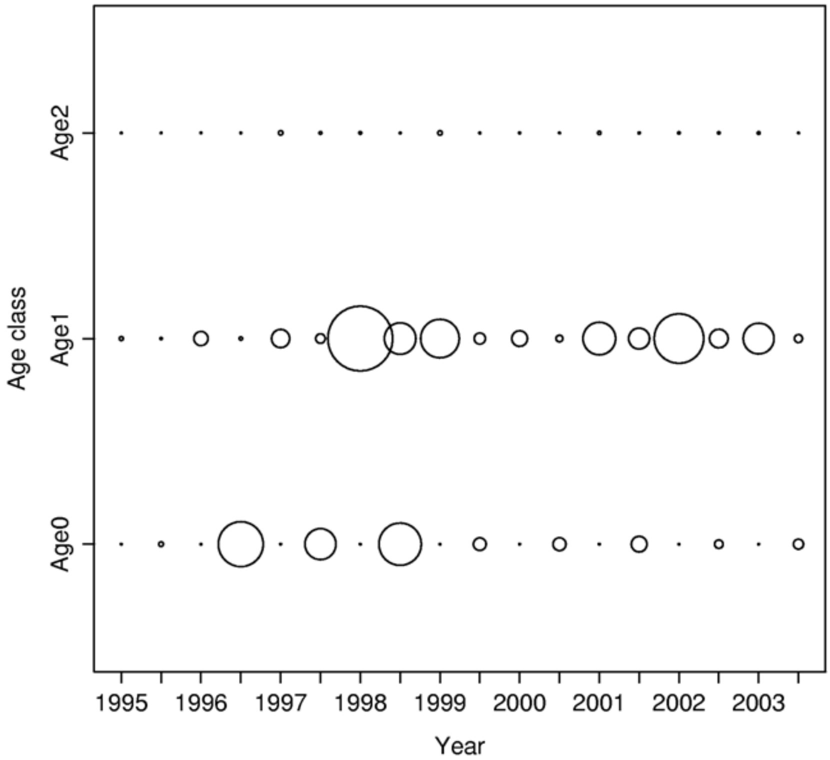


Figure 11.7.1. Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz). Trends in landings (upper panel, on an annual and half-year basis) and half-year catch-at-age numbers.

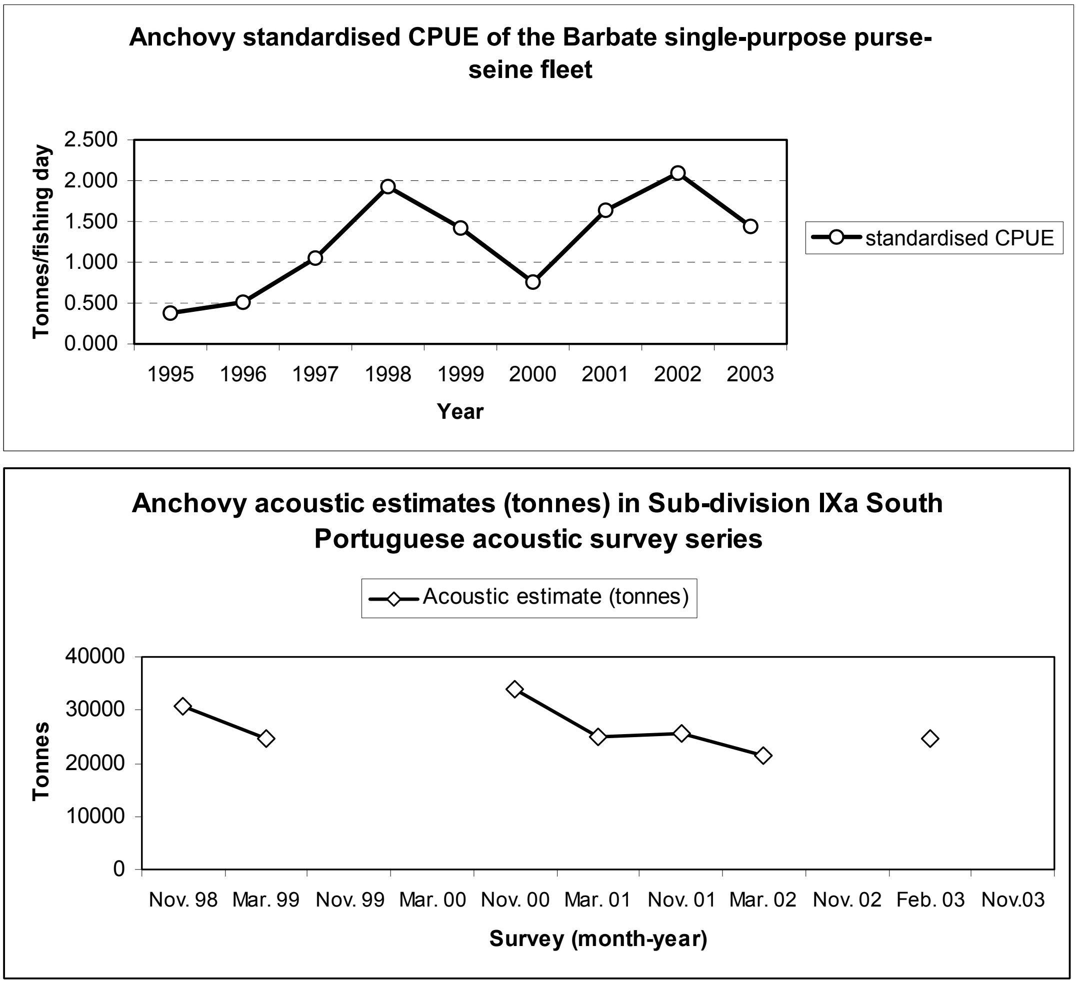
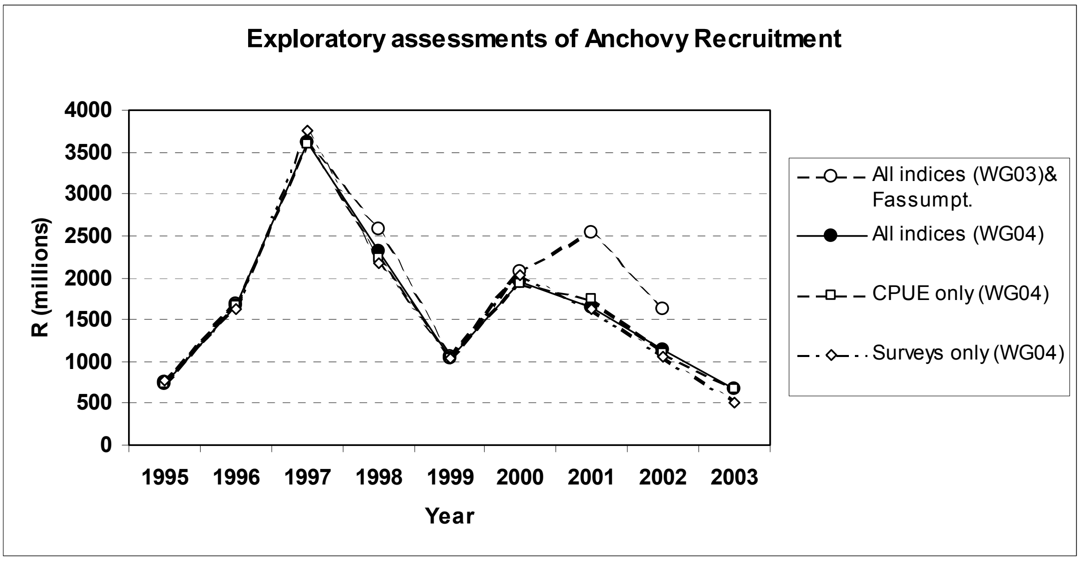
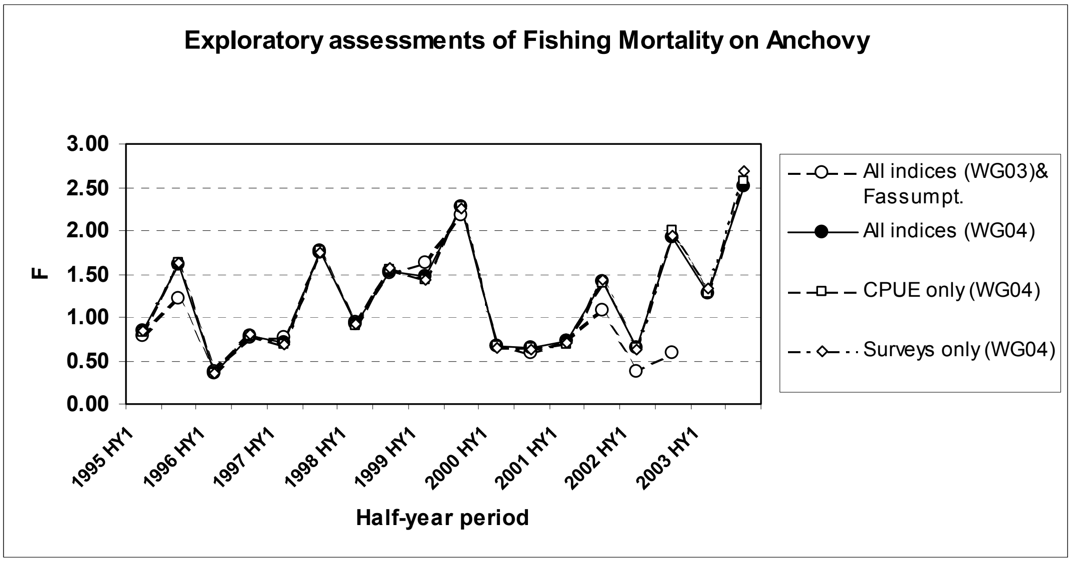


Figure 11.7.2. Anchovy in Sub-division IXa South(Algarve+Gulf of Cadiz). Trends in tuning indices (aggregated biomass) used in data exploration: standardised CPUE (upper panel) and Portuguese Acoustic Surveys estimates (lower panel).





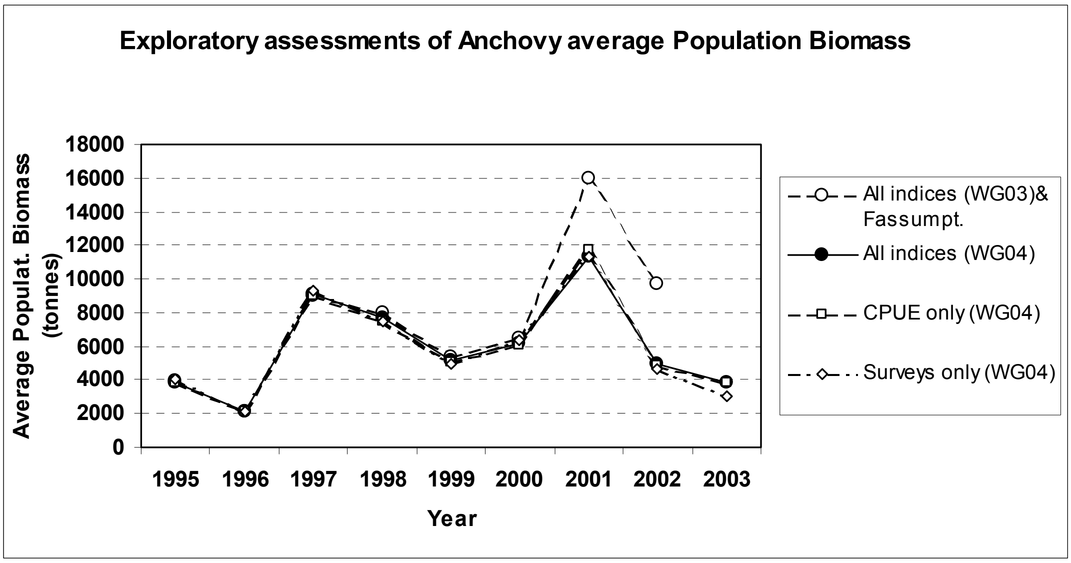
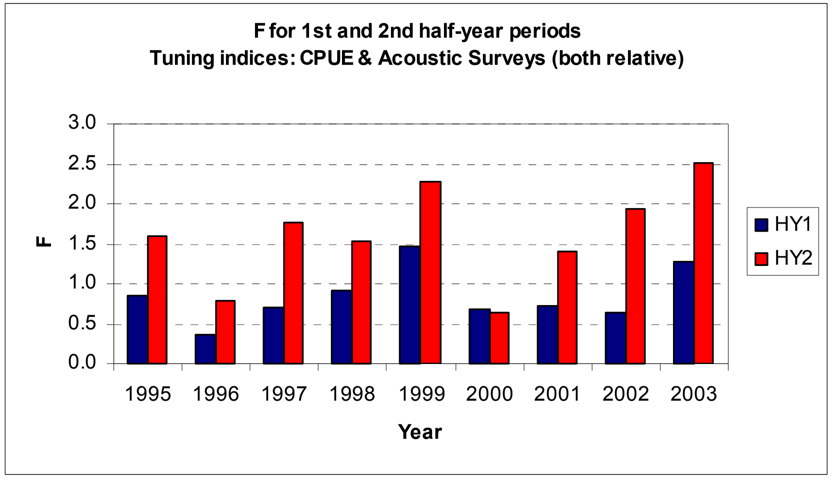
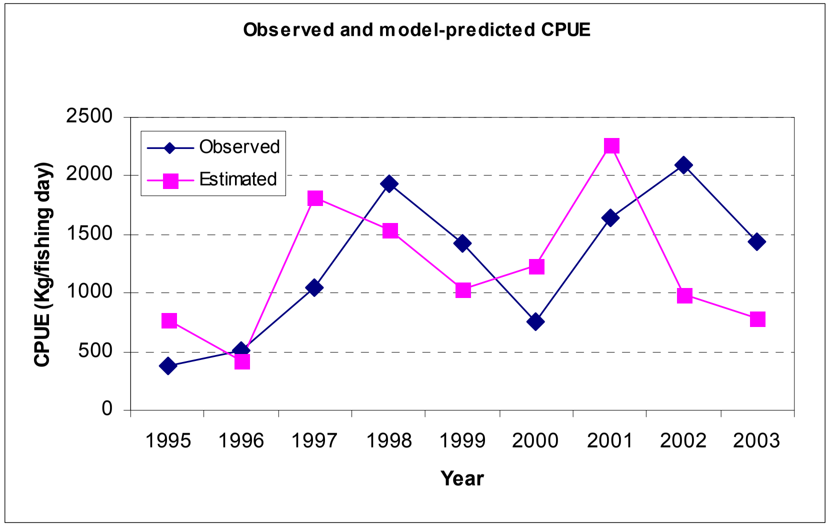
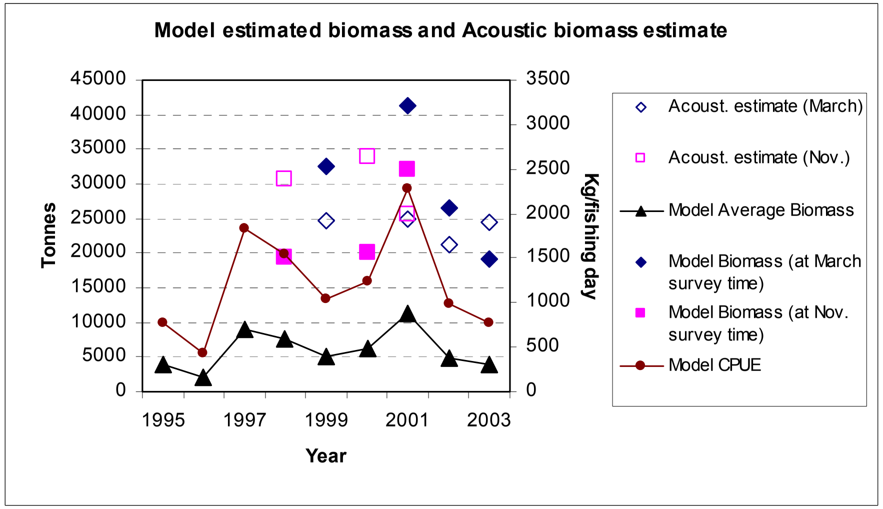


Figure 11.7.3. Anchovy in Sub-division IXa South(Algarve+Gulf of Cadiz). Comparison of last year's exploratory assessment with the new input data in 2004 setting in both cases the F in the second-half in the last assessment year as the average ratio between F half-year values of preceding years.







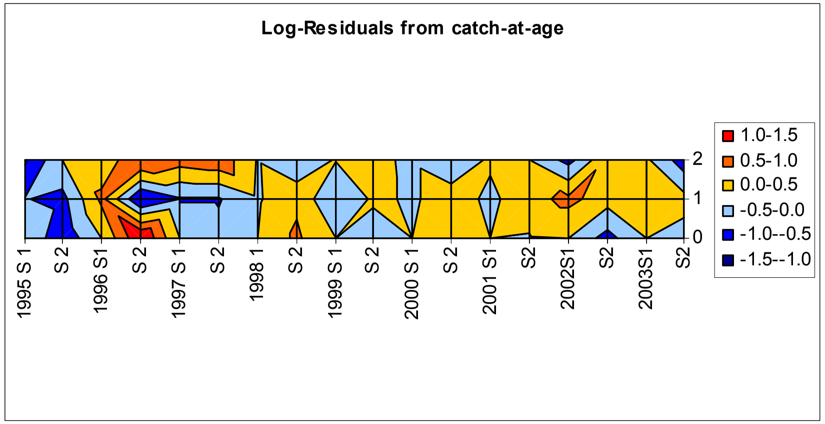


Figure 11.7.4. Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz). Results from data exploration RUN0 with the *ad-hoc* seasonal separable model: estimated fishing mortalities (F) by the separable model (upper left), observed and model predicted CPUE for the Barbate single-purpose purse-seine fleet (upper right), model estimated biomass and acoustic biomass estimates (bottom left), and Log-residuals from catch-at-age data (bottom right).

12 Recommendations

The Working Group recommends again that archives folder should be given access only to members of the MHSA WG, as it contains sensitive data.

The Working Group 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 WG recommends that each of its members raise the problem of the lack of an adequate database for the collation and handling of commercial catch and catch-at-age information (see section 1.3.6) with their ICES delegates and their ACFM members prior to the 2004 ICES ASC in Vigo.

The Working Group recommends that all the available estimates of SSB for mackerel and of annual egg production for horse mackerel, together with the respective variance estimates, should be compiled and made available for use in stock assessment.

The Working Group recommends that the work of SGSBSA be continued as an ICES Working Group.

The WG recommends improved coordination of acoustic/CUFES surveys for anchovy and Sardine

Mackerel

The Working Group highlights the possibility that discarding of small mackerel may be a problem in all areas, particularly if a strong year classes enters the fishery, as is believed to be the case for both the 2001 and 2002 year classes. Certainly the only discard information available, for IVa, shows a high discard of juvenile fish.

The Working Group, once again, strongly recommends that all countries with relatively high mackerel catches should sample for age at an adequate level.

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.

The Working Group recommends that the acoustic surveys for mackerel should be continued.

Horse mackerel

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.

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 Working Group recommends that at least once a year, a bottom-trawl survey carried out always with the same vessel and gear should cover the whole distribution area of the southern horse mackerel stock (ICES Div. IXa from 20m to 500m depth).

The WG recommends that WGMEGS carry out further research directed at using the horse mackerel egg production estimate as an absolute estimate of SSB.

Sardine

For sardine the working group recommends

- revision of maturity and weights at age of the sardine stock based on results from ongoing studies on the seasonal cycles of maturation and fattening
- continue the intercalibration of methodology and results of the Portuguese and Spanish acoustic surveys
- develop of studies to compare both the spatial distribution and biomass levels provided by acoustic and DEPM surveys
- continue the compilation of fisheries and survey data in Divisions VIIIa and VIIIb and provided data on catch structure in Division VII

The Working Group recommends that results from the February 2002 Spanish two vessels' inter-calibration experiment in February 2002 be provided if available to the next Working Group meeting because of the contrasted acoustic estimates obtained in this survey by the R/V 'Cornide de Saavedra' as compared to the ones from the Portuguese survey (conducted one month after).

Anchovy

The Working Group appreciates the progress in the direct surveying of anchovy in Division IXa by Acoustics, mainly with the new Spanish late spring survey in the Sub-division IXa South, and recommends its continuation within a routine annual 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). Further, the Working Group recommends that the acoustic surveying of the Division by Spain and Portugal achieves proper standardisation.

The Working Group recommends that previous and new age determinations of the Gulf of Cadiz anchovy according to the recommendations proposed in the 2002 Workshop on Anchovy otoliths and endorsed by this Working Group be provided to the next year meeting if possible.

The Working Group recommends to 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 Working group stressed the necessity of including an absolute scaling factor of the biomass population in the assessment of anchovy in Sub-division IXa South. In this context, the Working Group considers the DEPM-based exploratory studies carried out in the June 2004 Spainsh survey and the next realisation of a standard anchovy DEPM survey in 2005 as a very positive development and recommends the continuation of this survey in next years. The Working Group also recommends that results from these studies be provided to the next year Working Group if possible.

The Working Group recommends to recover all the information available on the anchovy fishery and biology (including information on age structure by Sub-division if available) off Portuguese waters.

The WG recommends that the biomass-based model achieves proper standardisation and testing.

The WG recommends exploring assessment models in which differences between the Spanish and the French fleets are taken into account.

The WG recommends continuing direct surveys on juveniles (0 group) or pre-recruits (1 year old) in order to improve the advice for the management of this fishery. It recommends to Ifremer and AZTI to collaborate in order to increase their effort by coordinating their respective surveys on pre-recruits or by doing a common one.

The WG recommends SGSBSA to become a WG.

The WG to continue the exchange of otoliths for anchovy between France and Spain.

13 References 1998-2004

Abaunza, P., Gordo, L., Karlou-Riga, C., Murta, A., Eltink, A.T.G.W., García Santamaría, M.T., Zimmermann, C., Hammer, C., Lucio, P., Iversen, S.A., Molloy, J., Gallo, E. 2003a. Growth and reproduction of horse mackerel, *Trachurus trachurus* (Carangidae). *Reviews in Fish Biology and Fisheries*, 13(1): 27-61.

Abaunza, P., Campbell, N., Cimmaruta, R., Comesaña, S., Dahle, G., Gallo, E., García Santamaría, M.T., Gordo, L., Iversen, S., MacKenzie, K., Magoulas, A., Mattiucci, S., Molloy, J., Murta, A., Nascetti, G., Pinto, A.L., Quinta, R., Ramos, P., Ruggi, A., Sanjuan, A., Santamaría, M.T., Santos, A.T. Stransky, C., Zimmermann, C. 2003b. Final Report of the EU funded project HOMSIR: "A multidisciplinary approach using genetic markers and biological tags in horse mackerel (*Trachurus trachurus*) stock structure analysis". Code: QLK5-Ct1999-01438.

Abaunza, P., Murta, A., Mattiucci, S., Cimmaruta, R., Nascetti, G., Magoulas, A., Sanjuan, A., Comesaña, S., MacKenzie, K., Molloy, J., Santos, A.T., Iversen, S., Dahle, G., Gordo, L., Stransky, C., Zimmermman, C., Santamaria, M.T., Ramos, P., Quinta, R., Pinto, A.L., Ruggi, A., Campbell, N. 2004. Stock discrimination of horse mackerel (*Trachurus trachurus*) in the Northeast Atlantic and Mediterranean Sea: integrating the results from different stock identification approaches. *ICES CM 2004/EE:19*. Vigo (September 2004).

Allain G., Petitgas P. & Lazure P. 2001. The influence of mesoscale ocean processes on anchovy (Engraulis encrasicolus) recruitment in the Bay of Biscay estimated with a three-dimensional hydrodynamic model. Fisheries Oceanography 10: 151-163.

Allain G., Petitgas P. and Lazure P. 2004. Use of a biophysical larval drift growth and survival model to explore the interaction between a stock and its environment: anchovy recruitment in Biscay. ICES CM 2004/J:14.

Anon. 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.

Anon. 1992. Report of the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 1992/Assess:17, 207 pp.

Anon. 1993. Report of the Working Group on the assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 1993/Assess:19.

Anon. 1995. Report of the Working Group on the assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 1995/Assess:2.

Anon. 1996. Report of the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 1996/Assess:7.

Anon. 1998. Report of the Working Group on the assessment of mackerel, horse mackerel, sardine and anchovy. ICES CM 1998/ACFM:6, 383 pp.

Anon. 1998. Report of the precautionary approach to fishery management. ICES CM 1998/ACFM:10.

Anon. 1998. Working Group on the Assessment of Mackerel Horse Mackerel, Sardine and Anchovy. ICES CM 1998/Assess:6.

Anon. 1999. Report of the Working Group on the assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 1999/ACFM:6.

Anon. 1999. Report of the study group on multiannual assessment procedures. ICES CM 1999/ACFM:11.

Anon. 1999. Report of the Horse Mackerel Otolith Workshop. ICES CM 1999/G:16.

Anon. 2000. Report of the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2000/ACFM:5.

Anon. 2000. Report of the Herring Assessment Working Group for the area south of 62ºN. ICES CM 2000/ACFM:10.

Anon. 2000. Report of the Working Group on Mackerel and Horse Mackerel Egg Surveys. ICES CM 2000/G:01.

Anon. 2001. Report of the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2001/ACFM:06.

Anon. 2002. Report of the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2002/ACFM:06.

Anon. 2002. Report of the Working Group on Methods of Fish Stock Assessment. ICES CM 2002/D:01.

Anon. 2002. Report of the Working Group on Mackerel and Horse Mackerel Egg Surveys. ICES CM 2002/G:06, Ref. D.

Anon, 2003. Report of the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2003/ACFM:07.

Anon. 2003. Report of the Study Group on Precautionary Reference Points For Advice on Fishery Management. ICES CM 2003/ACFM:15, Ref. HAWG, WGBFAS AFWG, NWWG, WGNPBW, WGNSSK, WGHMM, WGNSDS, WGSSDS, WGMHSA.

Anon. 2003. Report of the Working Group on Methods on Fish Stock Assessments. ICES CM 2003/D:03, Ref. ACFM, G.

Anon. 2003. Report of the Working Group on Mackerel and Horse Mackerel Egg Survey. ICES CM 2003/G:07, Ref. D.

Anon. 2003. Report of the Study Group on the Estimation of Spawning Stock Biomass of Sardine and Anchovy. ICES CM 2003/G:12.

ACFM cooperative report 2003

Anon. 2004. Report of the Study Group on Manegement of Integrated Data. ICES CM 2004/ACE :05

Anon, 2004. Report of the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2004/ACFM:08.

Anon. 2004. Report of the Study Group on Assessment Methods Applicable to Assessment of Norwegian Spring-Spawning Herring and Blue whiting Stocks. ICES CM 2004/ACFM:14.

Anon. 2004. Report of the Working Group on Noth Atlantic Salmon. ICES CM 2004/ACFM:20, 286 pp.

Anon. 2004. Report of the Working Group on Methods of Fish Stock Assessment. ICES CM 2004/D:03.

Anon. 2004. Study Group on Regional Scale Ecology of Small Pelagics. ICES CM 2004/G:06, Ref. ACFM, ACE.

Anon. 2004. Report of The Planning Group on Aerial And Acoustic Surveys For Mackerel. ICES CM 2004/G:07 Ref. ACFM, B.

Anon. 2004. Report of the Study Group on the Bycatch of Salmon in Pelagic Trawl Fisheries. ICES CM 2004/I:01, Ref. G, ACFM.

Arruda, L.M. 1984. Sexual maturation and growth of *Trachurus trachurus* (L.) along the Portuguese coast. *Inv. Pesq*., 48: 419-430.

Astudillo, A., Lucio, P., Prouzet, P and Uriarte, A. 1990. Summary of the results concerning the otolith reading exercise an anchovy held in San Sebastian (Spain) in January 1990. Working Document to the Working Group on the Assessment of the Stocks of sardine, horse mackerel and anchovy. ICES CM 1990/Assess:24.

Borges, M. F., Santos, A. M. P., Crato, N., Mendes, H. and Mota, B. 2003. Sardine regime shifts off Portugal: a time series analysis of catches and wind conditions. Scientia Marina, 67 (Suppl. 1): 235-244.

Borja, A., Uriarte, A., Egaña, J., Motos, L. and Valencia, V. 1998. Relationship between anchovy (Engraulis encrasicholus L.) recruitment and environment in the Bay of Biscay. Fish. Oceanogr. vol.7: ¾, pp. 375-380.

Borja, A., Uriarte, A. and Egaña, J. 2000. Environmental factors affecting recruitment of the mackerel, Scomber scombrus L. 1758, along the North-eastern Atlantic coasts of Europe. Working Document for the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2001/ACFM:06.

Borja, A., A. Uriarte, L. Motos and V. Valencia, 1996. Relationship between anchovy (Engraulis encrasicolus L.) recruitment and the environment in the Bay of Biscay. Sci., Mar., 60 (Supl. 2): 179-192.

Carrera P. 1999. Acoustic survey JUVESU 0899: preliminary results. Working Document for the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2000/ACFM:5.

Carrera, P. 2001. Acoustic Abundance Estimates From The Multidisciplinary Survey Pelacus 0401. Working Document for the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES, C. M. 2002/ACFM:06. Working Document for the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2004/ACFM:08.

Carrera, P. 2003. Preliminary results of the inter-ship acoustic calibration in the gulf of Cadiz signoise report.

Carrera P., Villamor B. and Abaunza P. 1999. Report of the acoustic survey PELACUS 0399: results on sardine, mackerel, horse mackerel and anchovy. Working Document for the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2000/ACFM:5.

Chнcharo, M. A., Esteves, E., Santos, A. M. P., dos Santos, A., Peliz, A. and Rй, P. 2003. Are sardine larvae caught off northern Portugal in winter starving? An approach examining utritional conditions. Marine Ecology Progress Series, 257: 303-309.

Darby, C. D. and Flatman, S. 1994. Virtual population analysis: version 3.1. User guide. Information technology series N 1. 85pp.

Dickey-Collas, M. and Eltink, A. T. G. W. 2003. The precision of numbers at age and mean weight estimation of mackerel and horse mackerel from Dutch market sampling from 1998 to 2002. Working Document to for the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2004/ACFM:08.

Fraga, F., Mouriño, C., Manriquez, M. 1982. Las masas de agua en la costa de Galicia: junio-octubre. (Water boddies off the Galician coast, June-October). *Resultados Expediciones Científicas*, 10: 51-77.

Fryer, R. and Stratoudakis, Y. 2000. Adult survey design and implications for sardine (Sardina pilchardus) DEPM estimation off Portugal. 2000. Working Document to the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2001/ACFM:06.

Furnestin, J. 1945. Contribution à l'étude biologique de la sardine atlantique, Rev. Trav. Off. Pêches Marit., Tome XIII, Fasc. 1-4: 221-341Fiúza, A.F.G., Macedo, M.E. and Guerreiro, M.R. 1982. Climatological space and time variation of the Portugal coastal upwelling. Oceanologica Acta, (51): 31-40.

García Santamaría, M. T. 1998. Anchovy (Engraulis encrasicolus) Otolith Exchange (1997-1998). European Fish Ageing Network (EFAN). Report 4-98, 33 pp (mimeo).

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.

Gavaris, S. 1989. An adaptive framework for the estimation of population size. Canadian Atlantic Fisheries Scientific Advisory Committee Research Document, 88/29.

Gilks, W.R., Richardson, S. and Spiegelhalter, D.J. (editors). 1996. Markov Chain Monte Carlo in practice. Chapman and Hall.

Gomes, M.C., Serrão, E., Borges, M. F. 2001. Spatial patterns of groundfish assessblages on the continental shelf of Portugal. ICES, J. Mar. Sci., 58: 633-647.

Guennégan, Y., J. Guillard, J-L. Bigot, P. Brehmer, M. Colon, Y. Cheret, B. Liorzou, 2004. Importance de la zone côtière dans les évaluations des stocks de petits poissons pélagiques: Analyse d'une série de campagnes acoustiques et d'une expérimentation en zone côtière. Working Document to the Working Group on Small Pelagics. Scientific Advisory Committee-GFCM. Sub-Committee of Stock Assessment. Málaga, Spain, 6-7 May, 2004. 17 pp.

Guillard, J., A. Lebourges, 1998. Preliminary results of fish populations' distribution in a Senegalese coastal area with depths less than 15 m, using acoustic methods. *Aquat. Living Resour*., 11: 13-20.

Hampel, F. R., Ronchetti, E. M., Rousseeuw, P. J. and Stahel, W. A.. 1986. Robust Statistics. The approach based on Influence Function. John Wiley & Sons, NY.

Hamre, J. 1978. The effect of recent changes in the North sea mackerel fishery on stock and yield. Rapp. P.-v. Reun. Cons. Int. Explor. Mer., 172:197-210.

Huber, P. J. 1981. Robust statistics. John Wiley & Sons, NY.

Kimura, D. K., Chikuni, S. 1987. Mixtures of empirical distributions: an iterative application of the age-length key. Biometrics, 43: 23-35.

Kizner Z. I. and Vasilyev, D. 1997. Instantaneous Separable VPA (ISVPA). ICES journal of Marine Science, 54, N 3: 399-411.

Lavín, A. and Cabanas, J. M. 1999. Spanish Standard Sections. ICES C:8/1999 (Annex J), p:52-57.

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.

Marques, V., 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 for 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 Cádiz (SW Spain). Fish. Res., 41:73-86.

Mohn, R. 1999. The retrospective problem in sequential population analysis: An investigation using cod fishery and simulated data. ICES Journal of Marine Science, 56:473-488.

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.

Murta, A. G. 2000. Morphological variation of horse mackerel (*Trachurus trachurus*) in the Iberian and North African Atlantic: implications for stock identification; *ICES Journal of Marine Science*; 57: 1240 – 1248.

Murta, A. and Abaunza, P. 2000. Has horse mackerel been more abundant than it is now in Iberian waters? Working Document for the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2001/ACFM:06.

Patterson, K. R. 1997. Evaluation of uncertainty in stock assessment, biological reference points and outcome of a harvest control law where model structure is uncertain using a Bayesian method: Norwegian Spring-Spawning Herring. ICES CM 1997/DD:8

Patterson, K. R. 1998. A programme for calculating total international catch at age and weight at age. Working Document to the Working Group ICES CM 1999/ACFM:6.

Patterson, K. R., Cook, R. M., Darby, C. D., Gavaris, S., Mesnil, B., Punt, A. E., Restrepo, V. R., Skagen, D. W., Stefánsson, G., Smith, M. 2000. Validating three methods for making probability statements in fisheries forecasts. ICES CM 2000/V:06.

Patterson, K. R. and Melvin, G. D. 1996. Integrated catch at age analysis version 1.2. Scottish Fisheries Research Report, 56. Aberdeen: FRS.

Patterson, K.R., Skagen, D., Pastoors, M. and Lassen, H. 1997. Harvest control rules for North Sea herring. Working Document to ACFM, 1997.

Peliz, A., Dubert, J. Haidvogel, D. B. and Le Cann, B. 2003. Generation and unstable evolution of a density-driven Eastern Poleward Current: the Iberia poleward current. Journal of Geophysical Research, 108 (C8): 3268.

Peliz, A., Rosa, T., Santos, A. M. P. and Pissarra, J. 2002. Fronts, jets and counter flows in the Western Iberia upwelling system. Journal of Marine Systems, 35(1-2): 61-77.

Peliz, A., Santos, A. M. P., Oliveira, P. B. and Dubert, J. 2004. Extreme cross-shelf transport induced by eddy interactions southwest of Iberia in winter 2001. Geophysical research letters, vol. 31: 1-4.

Pestana, G. 1996. Anchovy in Portuguese waters (IXa): landings and length distribution in surveys. Working Document to the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 1996/Assess:7.

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.

Reid, D. G. 2003. Investigation of correlates to observed mackerel fecundity changes 1995 to 1998. Working Document for the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2004/ACFM:08.

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.,

Santos, A. M. P., Peliz, A., Dubert, J., Oliveira, P. B., Angйlico, M. M. and Rй, P. 2004. Impact of a winter upwelling event on the distribution and transport of sardine (Sardina pilchardus) eggs and larvae off western Iberia: a retention mechanism. Continental Shelf Research, 24: 149-165.

Saila, S. B., Recksiek, C. W., Prager, M. H. 1988. BASIC Fishery Science Program (DAFS, 18). Elsevier, New York, 230 pp.

Schnute, J. 1987. A general fishery model for a size-structured fish population. Can. J. Fish. Aquat. Sci. 44:924-940.

Shepherd, J. G. 1999. Extended Survivors Analysis: an improved method for the analysis of catch at age data and abundance indexes. ICES J. Mar. Sci., 56: 7584-591.

Simmonds, J. 2003. The use of Egg Surveys as relative or abvsolute measures of abundance within ICA assessment of NEA mackerel. Working Document for the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2004/ACFM:08.

Skagen, D.W. 1997. Medium term simulation of management regimes for North Sea herring. 1997. Working Document to the ICES Herring assessment Working Group for the area south of 62^0N. ICES CM 1997/??

Skagen, D. W. 2003. Mortality of NEA mackerel estimated from tag recaptures. Working Document for the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2004/ACFM:08.

Skagen, D. W. 2003. Additional medium term calculations for NEA mackerel. Working Document for the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2004/ACFM:08.

Skagen, D. W. 2004. AMCI – version 2.3. Model description, instructions for installation and running file formats (in press).

Slotte, A. 2003. Historic changes in the condition of NEA mackerel – Possible effects on fecundity. Working Document for the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2004/ACFM:08.

Soares, E., Morais, A., Silva, A., Carrera, P., Jorge, A., Rico, A., Peleteiro, Q., Evano, H. 2004. Report Of The Workshop On Sardine Otolith Age Reading (Lisbon, 28 January – 1 February, 2002). IPIMAR *Relatóris Cientificos e Técnicos – Série Digital, № 14.*

Uriarte, A. 2002. 2001 anchovy otolith exchange programme from subarea VIII and Division IXa (July to September 2001). Annex to the final report to the European Commission of PELASSES project (Contract 99/010) issued in 2002.

Uriarte, A., Blanco, M., Cendrero, O., Grellier, P., Millán, M., Morais, A., and Rico, I. 2002. Workshop on anchovy otoliths from Subarea VIII and Division IXa. Working Document for the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2003/ACFM:07.

Uriarte, A., Roel B. A., Borja A., Allain, G. and O'Brien, C. M. 2002. Role of Environmental indices in determining the recruitment of the Bay of Biscay anchovy. ICES CM 2002/O:25.

Uriarte, A. and Rueda, L. 2001. Biomasses of Precaution for the Bay of Biscay anchovy population under the fishing pressure of the nineties. Working document to the 2001 ICES Working Group on the assessment of mackerel, horse mackerel, sardine and anchovy. ICES CM 2001/ACFM:06.

Vasilyev, D. A. 2001. Cohort models and analysis of commercial bioresources at information supply deficit. VNIRO Publishing: Moscow.

Vasilyev D. 2003. Is it possible to diminish the impact of unaccounted time trends in age structured surveys' catchability on the results of stock assessment by means of separable cohort models? ICES CM 2003/X:03. 13 pp.

Vasilyev, D. 2004. Description of the ISVPA (version 2004.3).

Vasilyev D.2004. Winsorization: does it help in cohort models? ICES ASC 2004. ICES CM 2004/K:45

Vaz, S. and Petitgas, P. 2002. Study of the Bay of Biscay anchovy population dynamics using spatialised age-specific matrix models. ICES CM 2002/O:07.

Vaz, S. et al. 2003.

Villamor, B. and Uriarte, A. 1996. Results of the Anchovy (Engraulis encrasicolus L.) exchange programme in 1996. Working Document to the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 1996/Assess:7.

Zimmermann, C., Kelly, C., Abaunza, P., Carrera, P., Eltink, A., Iversen, S., Murta, A., Reid, D., Silva, A., Uriarte, A., Villamor, B. 2000. White list on the functionality and properties of an input application for the submission and processing of commercial catch and sampling data within the ICES environment. Working Document for the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2001/ACFM:06

14 Abstracts of Working Documents

WD 01/04
Borges M. F., Mendes H. V., and Santos A. M.
The Multi-scale impact of North Atlantic Oscillation on sardine (*Sardina pilchardus*) fish recruitment variability in the upwelling system off Portugal. – ICES Marine Science Symposia, submitted.

Document available from: M. F. Borges, Instituto Nacional de Investigação Agrária e das Pescas (INIAP-IPIMAR), Av. Brasília, 1449-006 Lisbon, Portugal.
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Long-term periodicity in the northern wind component over the North Atlantic during the winter is associated to the North Atlantic Oscillation (NAO) phase, impacting the local seasonal upwelling intensity along the west coast of Portugal and therefore the fish productivity. Spectral analysis of the wind northern component frequency occurring during winter revealed three strong cycles of 55-60, 10-12 and 6-7, similar to the NAO decadal periodicity. These environmental indices were introduced as an extra parameter in the Ricker stock recruitment relationship during periodical cycles of high and low productivity. Using Sardine stocks as an example we present here evidence that during NAO positive phase the fish recruitment is forced to be low even maintaining spawning stock biomasses at high levels.

WD 02/04
Boyra A., Uriarte A., Alvarez P. and Cotano U.
Preliminary results of an Acoustic survey on juvenile anchovy in September 2003.

Document available from: Angel Boyra, AZTI, Instituto Tecnológico Pesquero y Alimentario, San Sebastián, País Vasco, España.
E-mail: aborja@azti.es
The project JUVENA (Acoustic surveying of anchovy juveniles) aims at estimating the spatial distribution and relative abundance of anchovy juveniles and their biological condition during the autumn season in order to assess the strength of the recruitment entering the fishery in the next year. This project is funded by the Department of Agriculture and Fisheries of the Basque Government, and it's intended to last for at least three consecutive years, seeking for improving the scientific advise for management of this population.
This report presents the preliminary results of the survey on anchovy juveniles, carried out during September and October 2003 as part of project JUVENA (AZTI). In addition, it shows the first qualitative impressions retained after the survey, along with an overview of the type of data processing that is being conducted and some considerations about the suitability of the project itself and the applicability of the working methods used in the project for the assessment of anchovy juveniles in the Bay of Biscay. The quantitative results will be ready after the acoustic data processing at the end of 2004.

WD 03/04
Duhamel E., Biseau A. and Massé J.
The French anchovy fishery.

Document available from: Erwan Duhamel, IFREMER, lab. Fisheries Research, 8 rue François Toullec 56100 Lorient, France.
E-mail: erwan.duhamel@ifremer.fr
The French fishery of anchovy is divided in two groups defined by gears (purse seine and pelagic trawl) with average length of these vessels about 20m. All trawlers use different trawls all along the year, they may even change during a day, to catch sometimes bass, tuna, hake, or scampi. Purse seiners operate often in coastal areas while trawlers may operate until 50 nautical miles offshore. The pair trawlers may operate from Basque country to western Channel while purse seiners usually stay around their home harbour. Purse seine are mainly fishing sardine and the main anchovy catches are provided by pair trawlers.

Some catches may even provide from bottom trawlers sometimes. Therefore, the pelagic fleet is the main fishing effort but to real define a target fishing fleet, it is necessary to analyse catches boat by boat along a year to separate regular to occasional vessels.

WD 04/04
Eltink G.
Removal of years from the NEA Mackerel assessment files, which have reduced age groups

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
The reviewers of last years WGMHSA report noted that it is unclear how ICA deals with the reduced age range in the catch at age data in the most earlier years and they suggested that the WG should explore truncating the time series to 1980 as was done for the AMCI and ISVPA assessments. In this paper suggested to use the fishery assessment data for NEA mackerel from 1977 onwards having a 12+group for all years.

WD 05/04
Fernandes P. G.
The 2003 North Sea Mackerel Acoustic Survey.

Document available from: Paul G. Fernandes, FRS Marine Laboratory, PO Box 101, 375 Victoria Road, Aberdeen, Scotland AB11 9DB, UK
E-mail: **fernandespg@marlab.ac.uk**
The 2003 North Sea mackerel acoustic survey was carried out by Scotland and Norway in October and November 2003. Three surveys were carried out: one complete coverage each by Norway and Scotland, and a joint survey with an interlaced design. All three surveys covered the main area of mackerel concentration along the 200 m contour in the north-eastern North Sea.

The objective of the survey was to provide an abundance estimate for mackerel in this area, to map the distribution of this species and to provide information for the purposes of research into the acoustic identification of mackerel. The survey was carried out as a part of the ICES co-ordinated mackerel acoustic survey of the North Sea.

This paper details the results of the Scottish survey and gives the results of the joint survey. The mean estimate of biomass based on all three surveys is 596,000 t. This estimate is likely to be an underestimate due to the target strength function used and to the conservative nature of the identification algorithms currently employed. Successful fishing enabled a breakdown by age to be given: the year class strengths in the survey are similar to those observed in the fishery. Although the survey may currently be subject to some bias, it is possible that it may be used as an index once a longer time series is established.

WD 06/04
Ibaibarriaga L., Fernandez C., Uriarte A. and Roel B.
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
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This working document presents the biomass-based model for the bay of Biscay anchovy as a Bayesian state-space model. Sampling from the posterior distribution of the parameters is conducted using Markov chain Monte Carlo algorithms. Results obtained when applying this methodology to 1987-2003 data are compared with the ones obtained in last years working group with the same model fitted by least squares and with the Integrated Catch at Age model. Additionally, ongoing work aiming at overcoming some of the problems encountered with the biomass-based model formulation is summarized.

WD 07/04
Iversen S. A., Skogen M. and Svendsen E.
A prediction of the Norwegian catch level of horse mackerel in 2004.

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 2004 indicates a similar availability/catch level of horse mackerel as in 2003.

WD 08/04
Kienzle M. and Simmonds J.
Simulating the dynamic of a fishery to discriminate between different stock assessment options Application to the NEA mackerel.

Document available from: Macro Kienzle, FRS Marine Laboratory, PO Box 101, Victoria Road, Aberdeen, AB11, Scotland, UK.
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The assessment of the North East Atlantic mackerel stock is performed using the Integrated Catch at Age analysis. This assessment relies on commercial catch statistics and an egg survey which is used to estimate the Spawning Stock Biomass. The egg survey measures the realised annual egg production which is corrected for estimated fecundity and atresia then raised to population level to estimate the spawning stock biomass. In recent years the fecundity of the females has diminished by 20%, increasing therefore the estimated size of the SSB index. There are also concerns about the egg mortality giving rise to underestimation of the total egg production. Recently the absolute accuracy of catch statistics have been questioned (formally in the case of Ireland) and informally in other countries such as Scotland. Estimates of under-reporting of true catch for these countries may have been of the order of 30% of the true catch. All these factors lead to uncertainty in the validity of absolute measures for NE Atlantic mackerel. The outcome of the ICA analysis is sensitive to choice between fitting the survey index as an absolute or a relative measure of the size of the SSB.

The purpose of this simulation is to determine the influence of bias in the SSB index and, in a more limited way, the catch statistics of mackerel on the perception of the status of the stock given by ICA. In particular this analysis is designed to determine whether the SSB index should be used as an absolute or a relative indication of SSB and fishing mortality.

WD 09/04
Marques V., Morais A., Silva A.
Sardine acoustic surveys carried out in November 2003 and June 2004 off the Portuguese Continental Waters on board RV "Capricórnio"

Document available from: Vitor Marques, Instituto Nacional de Investigação Agrária e das Pescas (INIAP-IPIMAR) Av. Brasília, 1449-006, Lisboa, Portugal,
E-mail: vmarques@ipimar.pt
During 2003/2004 acoustic surveys were carried out in November 2003 and in June 2004 with R/V "Capricórnio" instead of R/V "Noruega", the vessel generally used for these surveys. The two vessels have comparable acoustic equipment, however "Capricórnio" does not perform pelagic trawling efficiently. The November 2003 survey was marked by bad weather conditions and ship engine faults, leading to a shorter survey time (15 days) and smaller area coverage than in previous surveys. The acoustic survey originally planned to take place in March was delayed until June due to ship engine problems and the Gulf of Cadiz was not covered.

Due to all the above limitations results from these surveys area not comparable with those from previous surveys and should not be used in the assessment of the sardine stock. A brief description of the results from these surveys is presented. The total sardine biomass in the Portuguese waters in November 2003 was 222 thousand tonnes. Around 50% of the total number of sardines (43% of the biomass) were observed in the northern area and 9% in the southern waters (16% of the biomass). The proportion in the southwest area (42% in number and 40% in biomass) is possibly underestimated due to incomplete coverage of the area, although this is usually a weak sardine abundance area. The total sardine biomass in the Portuguese waters in June 2004 was 339 thousand tonnes, being similar to that estimated in February 2003. Most of the sardine was distributed off the northern waters (77% in numbers and 70% in biomass) down to the 100 m depth contour and corresponded to 0-group individuals (55%), providing some indication of a strong 2004 recruitment . The sardine population is dominated by 0-group and 1 year olds off the western Portuguese waters in both surveys while 1+ individuals are dominant off the southern coast. The strength of the 2000 yearclass in the northern area is still clear in the June 2004 survey. Survey data for the southern waters indicate a low importance of the 2000 yearclass and a high importance of the 2001 yearclass in the area, supporting information from recent years.

WD 10/04
Massé J., Beillois P. and Duhamel E.
Direct assessment of anchovy by the PELGAS04 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 PELGAS04 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 2003): 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 4500 nautical miles were prospected during the survey and about 2500 nautical miles are usable for evaluation. A total of 52 pelagic hauls were carried out for identification of echo-traces.

WD 11/04
Murta A., Abaunza P. and Lopes M.
Data revision for the newly defined southern horse mackerel stock.

Document available from: Alberto Murta, Instituto de Investigação das Pescas e do Mar, Avenida de Brasília, 1449-006, Lisboa, Portugal.
E-mail: amurta@ipimar.pt
The results from the EU funded project HOMSIR (QLK5-Ct1999-01438) established new boundaries for the Southern and Western horse mackerel stocks. Therefore, a new input data set of the newly defined southern horse mackerel stock had to be prepared for assessment purposes. This working document is dealing with the preparation of catch figures, catch in number at age matrix, mean weigth at age and in the stock matrix, the definition of the maturity ogive, the commercial fleets series available and the fishery independent information. In addition, a bibliographic revision about the environmental conditions that could affect the life cycle of horse mackerel in Portuguese waters is also included.

WD 12/04
Petitgas P.
Major results of SGRESP in 2004 of potential interest to WGMHSA.
Document available from: Pierre Petitgas, IFREMER, BP 21105, F- 44311, Nantes, France.
E-mail: **Pierre.Petitgas@ifremer.fr**
The ICES Study Group on Regional Scale Ecology of Small Pelagics was established for 3 years (2004–2006) at ICES ASC meeting in September 2003 with the purpose of:

- integrating various survey data together as well as with meteo, satellite, fishery and/or ecosystem model outputs and,
- feeding in the assessment WG with synthetic understanding of how the spatial dynamics of the biological cycle and the stock dynamics are related to the ecosystem thus increasing ICES ability to use ecological information in assessment, prediction and management of small pelagics.

The Study Group was recognised as essential for ICES to make progress in the understanding of environmental forcing on life history, spatial and population dynamics of pelagic fish to provide alternative basis to management on stocks recognised to fluctuate under environmental forcing. Widened participation for this group was sought including scientists from population surveying, assessment working groups, GLOBEC/SPACC and academic science.

This working document are extractions from SGRESP 2004 report (ICES CM 2004/G:06) where information thought to be relevant to WGMHSA with the intention provide WGMHSA with synthetic ecological information useful to the assessment and advisory process.

WD 13/04
Petitgas P. and Lazure P.
A recruitment index for anchovy in Biscay for 2005.

Document available from: Pierre Petitgas, IFREMER, BP 21105, F- 44311, Nantes, France.
E-mail: Pierre.Petitgas@ifremer.fr
The IFREMER ancvhovy 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 (1999) for the period 1987-1998. Coefficients of the model were updated by fitting the model using the recruit series given in ICES (2004) for the period 1987-2002. For predicting anchovy abundance at age-1 in 2005, upwelling and stratification breakdown indices for the period march-July 2004 were estimated from the hydrodynamic model outputs, and the regression model was used in extrapolation mode. The prediction for 2005 is that of an average level recruitment.

WD 14/04
Petitgas P. and Massé J.
On the quality of the assessment of bay of Biscay anchovy in recent years and its implications.

Document available from: Pierre Petitgas, IFREMER, BP 21105, F- 44311, Nantes, France.
E-mail: **Pierre.Petitgas@ifremer.fr**
The current assessment method used by the WGMHSA for anchovy in ICES area VIII is Integrated Catch Analysis in which numbers at age from the eggs and acoustic surveys are integrated with that from the Spanish and French fishery landings.

The assessment in the current year serves to project the population one year forward with different recruitment scenarios, although no probability is given for each scenario to happen. The WG advises on a annual TAC, which from the WG's perspective may vary from year to year. When the advised annual TAC is low, a mid-year revision of the TAC is advised.

The analysis of the series of population assessments performed by the WG in the period 1987-2003 shows that since 1999 the WG has been updating dramatically earlier assessments. These revisions would have changed completely the advised TAC in particular years. Therefore, the reliability of the WG's assessment and TAC advise can be questionned. The object of this note is to provide the WG with insights of the reasons why the assessment shows problems since 1999.

WD 15/04
Ramos F., Miquel J., Oñate D., Millán M. and Bellido J. M.
Preliminary results on acoustic assessment and distribution of the main pelagic fish species in the ICES Subdivision IXa South during the BOCADEVA 0604 Spanish survey (June 2004).

Document available from: Fernando Ramos, Instituto Español de Oceanografía. P.O. Box 2609, 11006 Cádiz, Spain.
E-mail: fernando.ramos@cd.ieo.es
This document presents the main results from a Spanish acoustic survey conducted in June 2004 in the Portuguese and Spanish shelf waters off the Gulf of Cadiz with the R/V "*Cornide de Saavedra*". The period of this survey were chosen aiming to obtain an acoustic estimate of the anchovy (*Engraulis encrasicolus*) SSB in the study area. The working document provides preliminary abundance and biomass estimates of anchovy (by length and age classes), sardine (*Sardina pilchardus*) and Chub mackerel (*Scomber japonicus*), the only species that were susceptible of being acoustically assessed from their occurrence and abundance levels in the study area. Distribution of these species is also presented from the mapping of their back-scattering energies. Anchovy and sardine were mainly distributed in the Spanish waters of the Gulf, whereas highest Chub mackerel densities were observed in the Algarve waters. The total biomass estimated for anchovy was 13.2 thousand tonnes (894.4 x 10^6 individuals). Sardine total estimated biomass was 26.6 thousand tonnes (937.1 x 10^6 individuals). Comparison of these estimates with those ones from the March and November Portuguese surveys series in previous years indicate that both anchovy and sardine population levels in June 2004 are the lowest ones recorded in last years. However, this strong declining trend should be considered with caution because of the different seasons when surveys were conducted and the impossibility of acoustic sampling of the shallowest waters off the Gulf. Chub mackerel total estimated biomass was 33.3 thousand tonnes (370.7 x 10^6 individuals).

WD 16/04
Santos M. and Uriarte A.
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
The assessment and scientific advice on the Bay of Biscay anchovy, entirely depends upon the availability of population direct estimates. An application of the Daily Egg Production Method to estimate the Biomass and population at age of anchovy in the Bay of Biscay has been carried out in 2004 by AZTI within the frame of the Spanish Fishery Monitoring National Programme contracted with the European Commission. The survey covered southeast of the Bay of Biscay in May 2004 to estimate the adult anchovy Biomass. In parallel and acoustic survey was carried out by the Institute Français de Recherche pour l'Exploration de la Mer (IFREMER, Nantes) to assess the anchovy population biomass, which was coordinated and simultaneous in time with the former survey to supply some of the adult samples required for the estimation of adult fecundity parameters for the DEPM implementation.

Within this international context the current survey contributes to its main objective, which is to provide biomass, and population estimates of the anchovy in the Bay of Biscay on a yearly basis for its submission to the ICES working group on the assessment of this species.

This document describes the preliminary estimates of the level of the anchovy stock in the Bay of Biscay in 2004 obtained using the DEPM in terms of biomass as in numbers at age for 2004. However the estimate of the spawning frequency is not yet available and for the Biomass estimations we present several options of spawning frequency according to the past series of this parameter and the temperatures during those surveys. This estimate will be ratified after the adult histological process which is now in process.

WD 18/04
Santos, M., Uriarte, A. and Ibaibarriaga, L.
Estimates of the Spawning Stock Biomass of the Bay of Biscay anchovy (*Engraulis encrasicolus*, L.) in 2003.

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The assessment and scientific advice on the Bay of Biscay anchovy, entirely depends upon the availability of population direct estimates. An application of the Daily Egg Production Method to estimate the Biomass and population of anchovy in the Bay of Biscay has been carried out in 2003 by AZTI within the frame of the Spanish Fishery Monitoring National Programme contracted with the European Commission. The survey covered southeast of the Bay of Biscay in May 2003 for estimating egg abundance and Daily egg production. In parallel an acoustic survey was carried out by the IFREMER to assess the anchovy population biomass, which was coordinated and simultaneous in time with the former survey to supply the adult samples required for the estimation of adult fecundity parameters for the DEPM implementation.

Within this international context the current survey contributes to its main objective, which is to provide biomass, and population estimates of the anchovy in the Bay of Biscay on a yearly basis for its submission to the ICES working group on the assessment of this species.

A preliminary estimate was already sent to the 2003 WGMHSA based on the relationship between daily egg production. That preliminary estimate pointed out a biomass of about 32,000 tones with a (adopted) CV of around 28%. However such estimate were based on the estimate of P0 and on the assumption that adult anchovy had the same daily fecundity per day (eggs per gram) as the average of previous years.

This document describes the estimation of the level of the anchovy stock in the Bay of Biscay in 2003 obtained by the DEPM (including estimation of adult parameters) in terms of biomass and numbers at age..

WD 19/04
Shamray E., Zabavnikov V., Tenningen E. and Skaret G.
Aerial surveys on mackerel in summer 2004.

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A Russian comprehensive aerial survey to map feeding mackerel was carried out in the Norwegian Sea during 11 July to 1 August 2004. Within the framework of aerial surveys, experimental and calibration works were conducted with a Russian research vessel “Persey-4”, two Norwegian vessels (“Libas” and “Endre Dyrøy”) surveying mackerel and with Russian commercial vessels fishing mackerel.

The new experimental work during this year was started. The new Norwegian LIDAR system was installed in the Russian aircraft and used in joint Russian-Norwegian investigations.

Most of the investigations followed the PGAAM 2004 recommendations and a Russian-Norwegian Program for the joint investigations in the Norwegian Sea.

This Working Document presents a short review of the aerial survey in the summer 2004.

WD 20/04
Skagen D. W.
Multi-annual TACs for NEA Mackerel.

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Setting TACs valid for more than one year for NEA mackerel has been discussed for some time. Some arguments in favour of multiannual TACs for NEA mackerel are indicates a relatively stable stock and fishery. Comparing with the rather problematic assessments, it seems likely that the stock is more stable than the assessment.

Furthermore, at least parts of the fleet and the industry may favour stable, predictable quotas rather than maximizing their yield every year. This necessarily implies that the fleets may not make full use of their capacity. However, contrary to many other fleets, notably in the demersal sector, many fleets targeting mackerel seem to be comfortable with that situation, and are more concerned that the price will go down if the catches increase. It may also matter that the price is better for large mackerel.

In this paper, some aspects of a possible procedure for setting TACs on a multiannual basis are discussed, and exemplified by a tri-annual regime for NEA mackerel.

WD 21/04

Zimmermann, C., Eltink, A., Iversen, S, Ulleweit, J., Verver, S., Dickey-Collas, M.

Variability of catch-at-age data derived from western horse mackerel sampling in the juvenile area, and its implication for the perception of recruiting year classes.

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Sampling of western horse mackerel in the juvenile area (i.e. the Western Channel area) was conducted this year by The Netherlands and Germany only. A comparison of the catch at age information revealed significant differences, especially for catch in Divs VIIe and VIIh in the fourth quarter. While the vast majority of Dutch catch appeared to be of the 2002 year class, most of the German catch was attributed to the 2001 year class. An in-depth analysis of the data demonstrated that sampled vessels were fishing at the same time in the same area and operated in the same manner. Mean weights and lengths at age were similar from both sampling programs. The two possible explanations for the differences are either a very high patchiness of horse mackerel schools in the area, or problems in the age reading. To investigate the latter further, an exchange of otoliths will be initiated in the next few months.

The effect of using the German or the Dutch samples exclusively for raising unsampled catches was explored. It was demonstrated that the perception of recruiting yearclasses could be inverted depending on the choice of samples. It is recommended to use a weighted mean (weighted by sample number) to raise unsampled catch, which reduces the amount of 2002 yc fish in the international catch. This is the standard procedure used by the stock coordinator so far.

Technical Minutes of the Review Group of the
Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy (WGMHSA)

Copenhagen, October 6-7, 2004

The Review Group met in Copenhagen, on October 6-7, 2004, and was attended by Hoskuldur Bjornsson, Ken Patterson (observer, in part), 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 thee dynamics of many of the stocks and that having more than over 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 overparameterization. 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 overparameterized. 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 overparemeterization 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 projections in a long term context. For pelagic species, it is particularly important to look at forecasts in relation to environmental conditions.

Technical note:

There is an inconsistency in the SSB values appearing in the ACFM summaries (which are based on Jan. 1) and the SSB calculations in the short term projections which are corrected to correspond to the spawning time. This is an inconsistency which should be resolved in future reporting. To be consistent the output provided to ACFM should be consistent.

Northeast Atlantic Mackerel

Northeast Atlantic Mackerel is assessed as one stock, and the results are split thereafter into management areas.

General observations on data:

- Catches 2003: 35000 t above the TACs. Plus discarded catch: 617000 t is WG estimate of catches. Official catches 580Kt. Discards 9482 t. Unofficial catches: 27660 t.
- TAC 582509 t (see page 30).
- Catch at age: relative stability (excepts perhaps to 12 plus. 2001 yc relatively strong but 2000 yc particularly weak.
- Catch curves have some information

- Absolute index: likely provide the right order of magnitude but raising egg production estimates to the spawning stock has its own set of assumptions. .
- Tagging data: Z from tagging data: of the order of 0.35 in 2001. But estimate is not precise (0.15-0.58).
- Lack of tuning data is what bothers most. With only five observations, little contrast in SSB.
- In absence of indices of recruitment, it is unclear how well recruitment is measured.
- Model fit: Declining in trend in egg survey estimates and the assessment results do not follow it.

Sampling: It was noted that the freezer trawler fleet is less well sampled. The sampling fulfills the standard sampling criteria but sampling rate is relatively low under that requirement. Also, there are logistic problems with sampling the freezer trawlers.

Need to check the consistency of Tables 2.2.1.2-4 with 2.2.1.1.

It was noted that there are many assumptions re tagging estimates: tagging loss, etc. What M was used in those calculations, etc. **The WG should have a closer look at the methods used to estimate Z from the tagging.**

The statement that the "selection increased at older ages" need to be clarified. The WG may mean that Z is higher at older ages (9+) because selection is higher at these ages… .

Methods used for estimation:
- ICA, ICA in spreadsheet, ISVPA (instantaneous separable VPA) – under development since many years, AMCI (separable, flexibility in selection model which can vary over time),
- Recruitment: no information in any model on tuning those. Recruitment arises from separability assumption and observed catches.
- Response surface flatter when index used as relative as opposed to absolute. But there is also a trade-off between variance vs bias that could be introduced when SSB index treated as absolute.

A number of issues related to treating the SSB index as absolute were discussed. In particular:
- **Trend in model SSB do not match the survey.**
- Residual pattern
- Strong retrospective
- It was noted that the general practice is to treat survey indices as relative in stock assessments. A similar debate occurred for acoustic surveys in recent years.

All models behave similarly when data are treated in a similar manner within them (i.e. absolute vs relative).

The factors that could have affected the SSB estimates from the egg production surveys in earlier years were discussed. Estimates of fecundity were discussed in that context. It was noted that fecundity had been relatively constant, with the exception of 1998 where it was much lower. The sampling may have an impact on out perception of the maturity/fecundity and sampling for maturity or proportion mature has its own pitfalls. Getting maturity at age for the younger age groups correct is quite difficult. From this discussion, there was no evidence presented that would lead to discounting earlier survey estimates in the assessment.

The Review Group concluded that in view of observation 1) that the SSB estimates from the egg production were showing a downward trend, 2) that the most recent observation was the lowest in the time series, and 3) that there was a the lack of fit as depicted with the residuals and of the strong retrospective pattern, the assessment should be based on fits to the model that treat the survey estimates as relative, not absolute.

The biases potentially arising from misreporting the catches (in particular in early to mid-1990s) were also discussed. It was noted that misreporting during that period would not influence the 1995-98 SSB estimates. Another way to account for missing catches would be to model M or to get correction for the catches themselves. However, attempting to do so would most certainly result in over-parameterization.

The Review Group noted that simulations were used to test the performance of a 3-year fixed-harvesting regime under various harvest control rules. It was noted that, in general, fixed target mortality rates are more stable regimes than those based on fixed-TAC regimes. It was also concluded that multi-annual regimes could potentially perform as well, or even better, than annual regimes. In performing such simulations in the context of testing harvest control rules, it was noted that implementation errors (e.g. overshooting the TAC, misreporting) and assessment biases (e.g. arising from the retrospective error) should be taken into account. Such biases should be sufficiently “strong” to represent what could be occurring in the real world. It was also noted that the simulations were done in the context of the stock being above B_{pa}, and that future work should capture our understanding of the recent situation where the stock is estimated to be below B_{pa}. As an example, an HRC could be used for further discussion with the managers.

In summary:

- The key issue in the assessment is the use of the mackerel egg survey tuning series as an absolute or relative index of abundance.

- The fit to the absolute biomass has a residual patterns indicating that the estimation effectively ignores historic surveys.

- When using the survey points as absolute, the SSB is pulled towards the last egg survey by the model. This is a documented (previous working groups) problem with the ICA model resulting from the low F's and convergence giving the most recent egg survey the greatest leverage in the residual SSQ.

- It was noted that the WG has commented on the sensitivity of the model to the final year estimates before. In some of the previous assessments, the surveys were actually treated as relative.

- Treating the surveys as relative makes the model less sensitive to bias.

- The most recent survey estimate is the lowest in the series and its inclusion in the series make a downward trend apparent. Such a trend is not matched in the SSB arising from the model tuned with the absolute SSB estimates.

Horse mackerel

It was noted that the stock definition had changed further to the results of the research on parasites, morphology, genetics, etc. … As a result of this, VIIIc which used to be part of the southern stock is now part of the Western Horse Mackerel. The result of this study is that these are closer to the western area as opposed to the southern stock. Previous concept of a North Sea stock was reinforced by this study.

It was noted that the Division in the channel is still problematic in some respects, mainly because the juveniles are distributed in the shallow waters of the channel. So, there is a mixed fishery on juveniles of north sea and western stocks that may cross the boundary line in their migrations/movements.

While there is evidence that the 2001 year class may be as strong as the 1982, it is unclear if this is related to availability.

The trends arising from the assessments are indicative of a population declining as a result of the single 1982 year class being fished down in absence of strong recruitment since.

In the 2004 SAD version (dynamic+grp), it was noted that the error on the numbers at age 0 is quite large. The issues related with the change in selection pattern were noted. While the results presented on Page 237 look promising, indications are that the model is overparameterized (floating SSB level arising from the model, varying selection profiles in successive applications of the formulation, etc.). We must understand the reason for the change in selection patterns as, if fishing pattern has changed towards juveniles, this may affect the ability of the stock to recover. It appears that there is insufficient information without an age structured index to distinguish between change in selection and increase in recruitment). The WG is encouraged to explore formulations that would reduce the number of parameters in the model formulation, perhaps looking at simpler models or at an estimation framework (e.g. Bayesian) that may help getting more stability/consistency in the results of annual assessments. There is a growing concern in ACFM that despite significant research efforts, we are still unable to assess this stock through an analytical model.

The Review Group agrees with the WG on using the results of this analysis as being only indicative of stock trends.

With respect to the change in the stock definition, the Review Group requested information on the level of the catches in VIIIc. From the catch tables provided, catches in VIIIc were estimated to be of the order of 20Kt. So, if the basis for advice remain as that used last year, the 130kt advises last year in the context of the former stock definition should be adjusted accordingly (i.e. raised by 20kt).

Sardine VIIIc-IXa

It was noted that the next daily egg production survey is 2006 and that, accordingly, the next benchmark assessment will be done then. This report thus presents an update assessment with:

- New Spanish acoustic survey 2004
- New Catch at age for 2003
- New Maturity ogive for 2003

AMCI was run again.

The tuning indices are as follow:

- Spanish March 1986-2004
- Portuguese March 1996-2003
- Portuguese November 1984-2001
- 2 DEPM surveys 1999-2002 (northern Spain and Port+Cad.)

Rerunning the model led to very minor changes (2-3% or less for SSB, R and F).

It was noted that there is a trend in the Spanish March survey for each age residuals.

DEPM Northern Spain residuals are not provided in the report because there are only two points. It would be useful to see residuals and qs from all surveys used in the tuning of the model.

On the Portuguese surveys, it was noted that none of them show the increase observed in the assessment (point of warning).

Mixing too many fleets together in the assessment could lead to problems. Use each one separately or take one out at a time in the runs to gain insight on the influence of each survey. When it comes to doing the benchmark, this could be done. The concern is that there is little consistency in the indices and that this should be investigated further before putting these into an estimation procedure.

It was noted that the SARDYN Program focuses on stock definition and that the results of that program will be available in 2006. This should be looked at in the next benchmark.

SSB estimate is high but more uncertain than previous years due to missing survey data.

Bootstrapping in situations where indices have different trends raises some technical issues on how to do the bootstrapping. This should be given some considerations in the future. Similarly, there are issues on how to bootstrap year or age effects when they are present.

For ACFM to consider: Managers will have to decide how they want to harvest the incoming large year class. However, species with large natural mortality like sardine (0.33) are important for the ecosystem.

Should do Yield-per-recruit and related reference points. Some issues could be related to the use of proper stock weights, etc.

Horse Mackerel – North Sea

No specific comment.

Anchovy SA VIII

The new data for the tuning were presented: one DEPM, one acoustic and catch at age for 2003. The assessment is using ICA as formulated last year.

It was noted that the acoustic survey for 2004 was a first attempt at juvenile/recruitment survey and that it is unusable for the tuning. Also, there is no index of recruitment available. It was noted that the ICA assessment is using the DEPM as absolute but that this is a "necessity" to avoid overparameterization. At best, the assessment is indicative of relative trends.

The differences between last year's assessment and this year's are minor. However, need to explain why differences in 1987 for fishing mortality and SSB.

The Bayesian approach has some potential. Some pitfalls should be avoided. Some exploration of priors (non-informative priors should be preferred to start the process). The impact of priors on final estimates of SSB and F should be investigated.

Both assessments indicate that the SSB is low. Evidence from all information is that the 2001-2002 year classes are very poor.

Anchovy – IXa

With respect to the quantification of effort for the various fleet, it would be useful to have some combined effort index, possibly weighted by vessel capacity, so that we can have an appreciation for the overall trends in effort.

Horse mackerel – Southern

The new assessment is based on the revised stock definition. The data were reworked accordingly.

While the biological sampling is considered to be very good, trawl survey indices are only available from 1 survey since 2001. The Spanish (acoustic) survey does not sample well the fish between ages 1-5. These normally comprise a significant proportion of the catch. This survey runs until 2003. The July Portuguese survey runs only to 2001. So there is no index of abundance in the tuning past 2001.

XSA doesn't converge. XSA is, at best, indicative of trends only.

It was noted that landings have been decreasing in last couple of years.